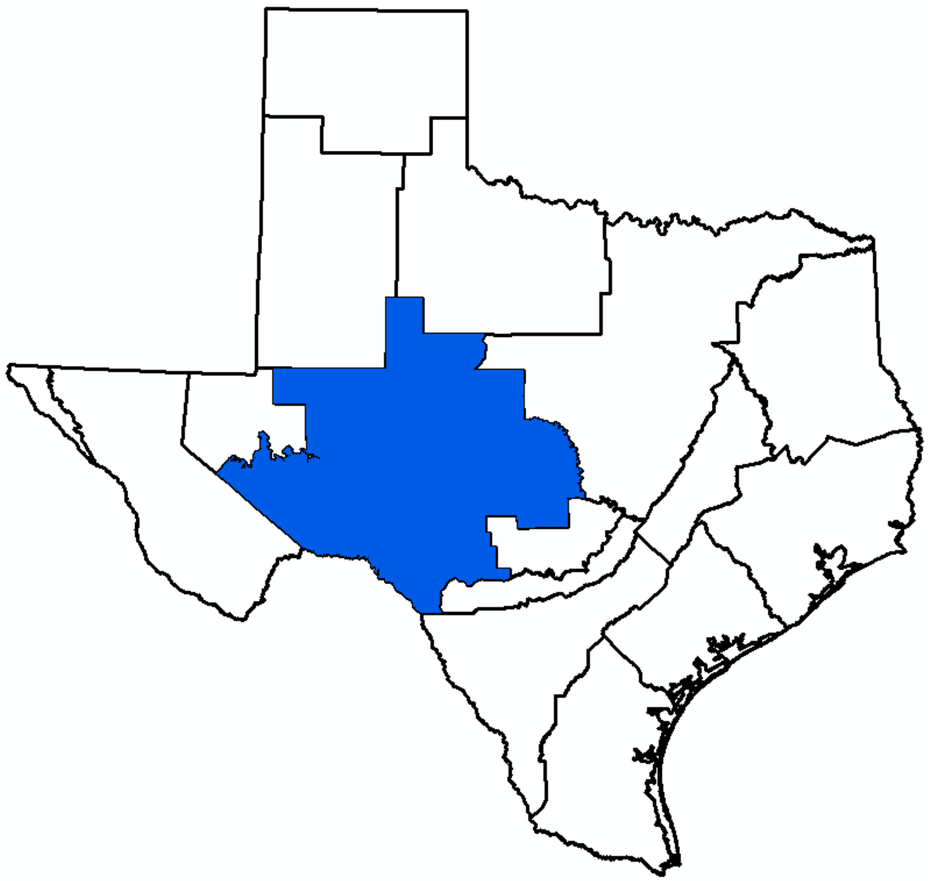
<u>Middle Pecos GCD Exhibit 30</u>

GMA 7 Explanatory Report, Edward-Trinity (Plateau), Pecos Valley and Trinity Aquifers (August 28, 2021)

GMA 7 Explanatory Report – Final

Edward-Trinity (Plateau), Pecos Valley and Trinity Aquifers



Prepared for:

Groundwater Management Area 7

Prepared by:

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August 28, 2021

GMA 7 Explanatory Report – Final
Edward-Trinity (Plateau), Pecos Valley and Trinity Aquifers

Geoscientist and Engineering Seal

This report documents the work and supervision of work of the following licensed Texas Professional Geoscientist and licensed Texas Professional Engineers:

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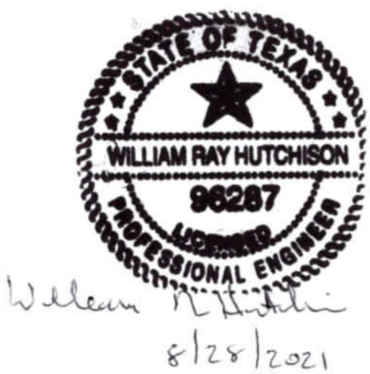
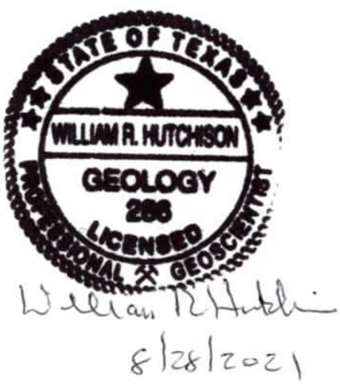
Dr. Hutchison completed the analyses and model simulations described in this report, and was the principal author of the final report.





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1.0 Groundwater Management Area 7

Groundwater Management Area 7 is one of sixteen groundwater management areas in Texas and covers that portion of west Texas that is underlain by the Edwards-Trinity (Plateau) Aquifer (Figure 1).

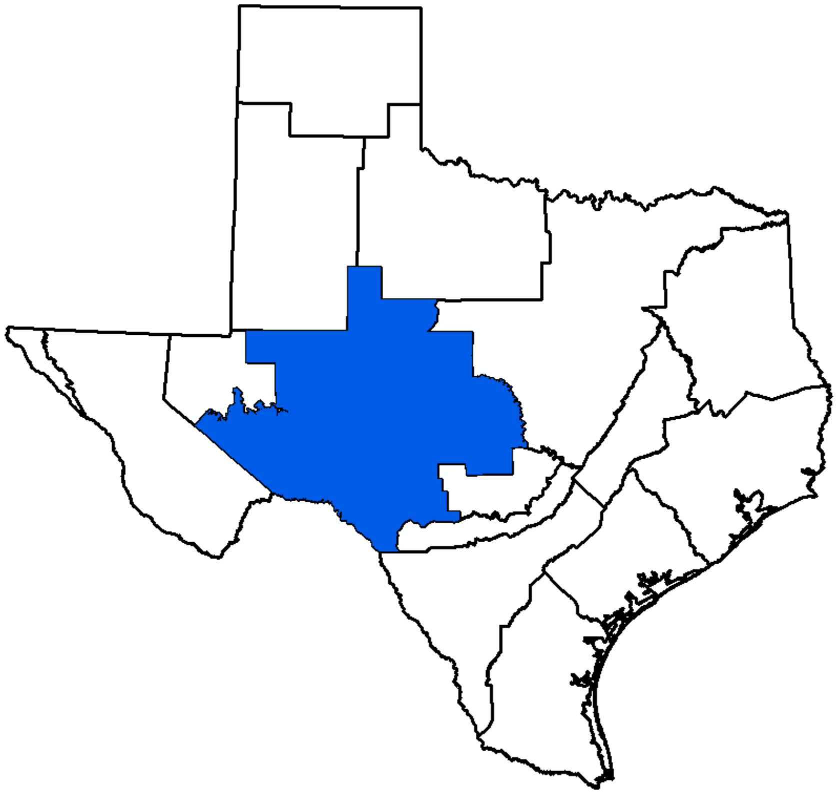

Figure 1. Groundwater Management Area 7

Groundwater Management Area 7 covers all or part of the following counties: Coke, Coleman, Concho, Crockett, Ector, Edwards, Gillespie, Glasscock, Irion, Kimble, Kinney, Llano, Mason, McCulloch, Menard, Midland, Mitchell, Nolan, Pecos, Reagan, Real, Runnels, San Saba, Schleicher, Scurry, Sterling, Sutton, Taylor, Terrell, Tom Green, Upton, and Uvalde (Figure 2).

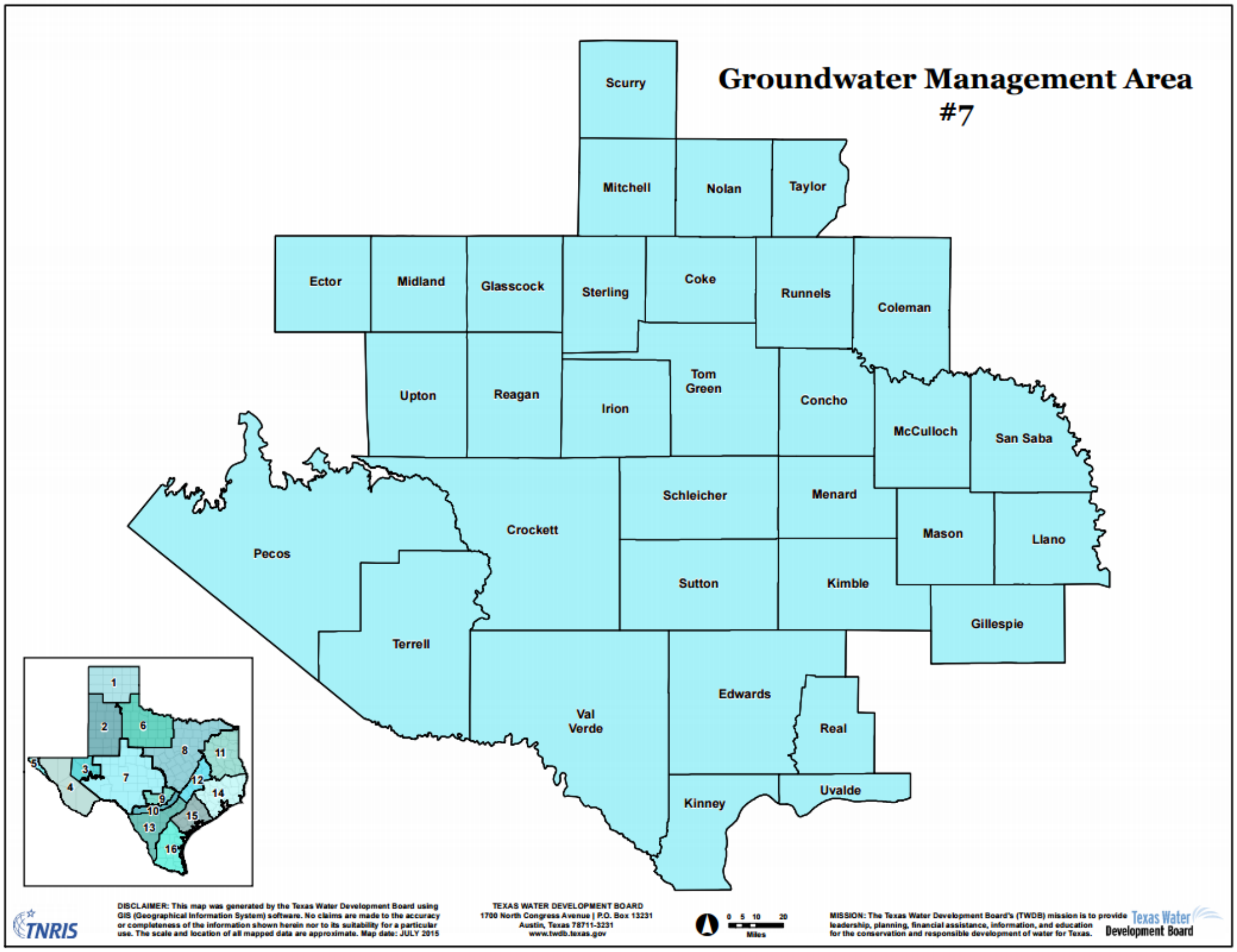

Figure 2. GMA 7 Counties (from TWDB)

There are 20 groundwater conservation districts in Groundwater Management Area 7: Coke County Underground Water Conservation District, Crockett County Groundwater Conservation District, Glasscock Groundwater Conservation District, Hickory Underground Water Conservation District No. 1, Hill County Underground Water Conservation District, Irion County Water Conservation District, Kimble County Groundwater Conservation District, Kinney County Groundwater Conservation District, Lipan-Kickapoo Water Conservation District, Lone Wolf Groundwater Conservation District, Menard County Underground Water District, Middle Pecos Groundwater Conservation District, Plateau Underground Water Conservation and Supply District, Real-Edwards Conservation and Reclamation District, Santa Rita Underground Water Conservation District, Sterling County Underground Water Conservation District, Sutton County Underground Water Conservation District, Terrell County Groundwater Conservation District, Uvalde County Underground Water Conservation District, and Wes-Tex Groundwater Conservation District (Figure 3).

The Edwards Aquifer Authority is also partially inside of the boundaries of GMA 7, but are exempt from participation in the joint planning process.

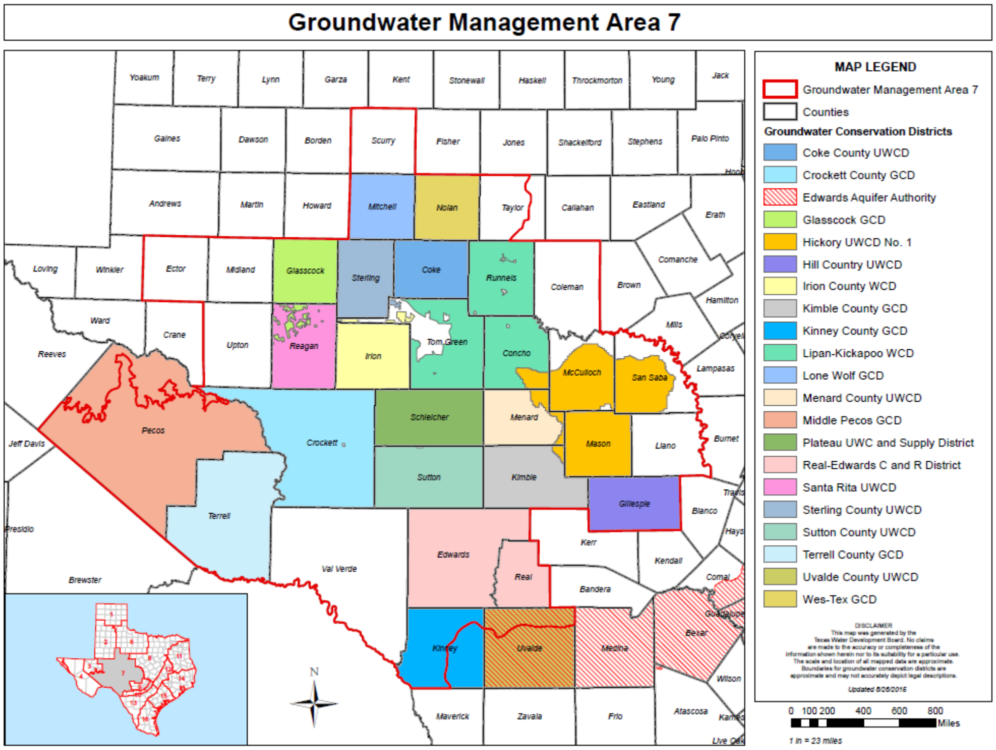

Figure 3. Groundwater Conservation Districts in GMA 7 (from TWDB)

The explanatory report covers the Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers. As described in George and others (2011):

> ***The Edwards-Trinity (Plateau) Aquifer*** *is a major aquifer extending across much of the southwestern part of the state. The water-bearing units are composed predominantly of limestone and dolomite of the Edwards Group and sands of the Trinity Group. Although maximum saturated thickness of the aquifer is greater than 800 feet, freshwater saturated thickness averages 433 feet. Water quality ranges from fresh to slightly saline, with total dissolved solids ranging from 100 to 3,000 milligrams per liter, and water is characterized as hard within the Edwards Group. Water typically increases in salinity to the west within the Trinity Group. Elevated levels of fluoride in excess of primary drinking water standards occur within Glasscock and Irion counties. Springs occur along the northern, eastern, and southern margins of the aquifer primarily near the bases of the Edwards and Trinity groups where exposed at the surface. San Felipe Springs is the largest exposed spring along the southern margin. Of groundwater pumped from this aquifer, more than two-thirds is used for irrigation, with the remainder used for municipal and livestock supplies. Water levels have remained relatively stable because recharge has generally kept pace with the relatively low amounts of pumping over the extent of the aquifer. The regional water planning groups, in their 2006 Regional Water Plans, recommended water management strategies that use the Edwards Trinity*

(Plateau) Aquifer, including the construction of a well field in Kerr County and public supply wells in Real County.

***The Pecos Valley Aquifer** is a major aquifer in West Texas. Water-bearing sediments include alluvial and windblown deposits in the Pecos River Valley. These sediments fill several structural basins, the largest of which are the Pecos Trough in the west and Monument Draw Trough in the east. Thickness of the alluvial fill reaches 1,500 feet, and freshwater saturated thickness averages about 250 feet. The water quality is highly variable, the water being typically hard, and generally better in the Monument Draw Trough than in the Pecos Trough. Total dissolved solids in groundwater from Monument Draw Trough are usually less than 1,000 milligrams per liter. The aquifer is characterized by high levels of chloride and sulfate in excess of secondary drinking water standards, resulting from previous oil field activities. In addition, naturally occurring arsenic and radionuclides occur in excess of primary drinking water standards. More than 80 percent of groundwater pumped from the aquifer is used for irrigation, and the rest is withdrawn for municipal supplies, industrial use, and power generation. Localized water level declines in south-central Reeves and northwest Pecos counties have moderated since the late 1970s as irrigation pumping has decreased; however, water levels continue to decline in central Ward County because of increased municipal and industrial pumping. The Region F Regional Water Planning Group recommended several water management strategies in their 2006 Regional Water Plan that would use the Pecos Valley Aquifer, including drilling new wells, developing two well fields in Winkler and Loving counties, and reallocating supplies.*

***The Trinity Aquifer**, a major aquifer, extends across much of the central and northeastern part of the state. It is composed of several smaller aquifers contained within the Trinity Group. Although referred to differently in different parts of the state, they include the Antlers, Glen Rose, Paluxy, Twin Mountains, Travis Peak, Hensell, and Hosston aquifers. These aquifers consist of limestones, sands, clays, gravels, and conglomerates. Their combined freshwater saturated thickness averages about 600 feet in North Texas and about 1,900 feet in Central Texas. In general, groundwater is fresh but very hard in the outcrop of the aquifer. Total dissolved solids increase from less than 1,000 milligrams per liter in the east and southeast to between 1,000 and 5,000 milligrams per liter, or slightly to moderately saline, as the depth to the aquifer increases. Sulfate and chloride concentrations also tend to increase with depth. The Trinity Aquifer discharges to a large number of springs, with most discharging less than 10 cubic feet per second. The aquifer is one of the most extensive and highly used groundwater resources in Texas. Although its primary use is for municipalities, it is also used for irrigation, livestock, and other domestic purposes. Some of the state's largest water level declines, ranging from 350 to more than 1,000 feet, have occurred in counties along the IH-35 corridor from McLennan County to Grayson County. These declines are primarily attributed to municipal pumping, but they have slowed over the past decade as a result of increasing reliance on surface water. The regional water planning groups, in their 2006 Regional Water Plans, recommended numerous* *water management strategies for the Trinity Aquifer, including developing new wells and well fields, pumping more water from existing wells, overdrafting, reallocating supplies, and using surface water and groundwater conjunctively.*

2.0 Desired Future Condition

2.1 2010 Desired Future Conditions

During development of the DFC in 2010, GMA 7 evaluated the results of 11 alternative predictive scenarios using the alternative one-layer model of the Edwards-Trinity (Plateau) and Pecos Valley aquifers. The model is documented in Hutchison and others (2011), and the simulation results are documented in Hutchison (2010). GMA 7 based their 2010 DFC on Scenario 10 of Hutchison (2010). Drawdowns calculated in Hutchison (2010) were for predictive simulations through the year 2060.

On July 29, 2010, the groundwater conservation districts in Groundwater Management Area 7 adopted desired future conditions for the Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers after evaluating ten simulations with the groundwater availability model. The desired future conditions through the year 2060 were expressed as follows:

1. An average drawdown of 7 feet for the Edwards-Trinity (Plateau) aquifer, except for Kinney County GCD, based on Scenario 10 of the TWDB GAM Run 09-35 which is incorporated in its entirety into this resolution; and
2. In Kinney County, that drawdown which is consistent with maintaining, at Las Moras Springs, an annual average flow of 23.9 cfs, and a median flow of 24.4 cfs, based on Scenario 3 of the Texas Water Development Boards' flow model presented on July 27, 2010; and
3. The Edwards-Trinity aquifer for joint planning purposes within the boundaries of the Lipan-Kickapoo WCD, the Lone Wolf GCD, and the Hickory Underground Water Conservation District No. 1; and
4. The Trinity (Hill Country) portion of the aquifer is not relevant for joint planning purposes within the boundaries of the Uvalde UWCD in GMA 7.

The table of county drawdowns that was included in the resolution is presented below:

Preliminary Results (7/29/2010)
Edwards-Trinity (Plateau) and Pecos Valley Aquifer Groundwater Model
(One Layer Model, GMA 7 Area Only)
Simulation for period 2006 to 2060
Drawdown in feet from 2010 Conditions

County	Continuation of 2005		Scenario 10	
	Pumping (AF/yr)	Drawdown in 2060 (ft)	Pumping (AF/yr)	Drawdown in 2060 (ft)
Coke	202	0	1,000	0
Concho	302	0	490	0
Crockett	4,636	4	5,475	9
Ector	4,788	1	5,534	7
Edwards	3,002	0	5,659	2
Gillespie	3,211	3	5,000	5
Glasscock	40,556	19	65,177	34
Irion	2,075	4	2,300	10
Kimble	847	1	1,400	1
Kinney	59,161	0	65,000	0
McCulloch	91	0	150	0
Mason	12	0	20	0
Menard	1,005	0	2,580	1
Midland	11,970	6	23,243	10
Nolan	351	0	700	0
Pecos	178,157	5	240,000	11
Reagan	40,576	17	68,243	37
Real	3,500	1	7,533	4
Schelicher	4,209	3	8,060	8
Sterling	2,062	3	2,500	6
Sutton	3,794	2	6,450	6
Taylor	300	0	490	0
Terrell	998	1	1,443	2
TomGreen	1,699	1	2,800	2
Upton	13,951	7	22,375	13
Uvalde	1,801	1	2,000	2
ValVerde	19,075	1	25,000	1
GMA 7	**402,331**	**4**	**570,622**	**7**

2.2 2016 Desired Future Conditions

The desired future conditions that were proposed in 2016 and finally adopted in 2017 (and revised in 2018) were expressed through the year 2070 in accordance with the requirements of the Texas Water Development Board.

The desired future condition for the Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers in GMA 7 was based on Scenario 2 as described in GMA 7 Technical Memorandum 15-06 (updated in Technical Memorandum 18-01). During review of the materials for administrative completeness for GMA 3, the Texas Water Development Board could not reproduce the average drawdowns that were used as the desired future conditions with the model files that were submitted. After several meetings and emails, the differences were attributed to the use of different "grid files".

The groundwater model simulations that were completed in 2010 during the initial round of desired future conditions used a version of the grid file that was developed in 2009. Since then, a 2011 version, a 2014 version, and a 2015 version of the grid file had been developed.

Due to an oversight, the groundwater model simulation that was the basis for the adopted desired future conditions used the outdated grid file from 2009 to calculate average drawdowns in each of the counties that comprise GMA 3 and GMA 7 instead of the most recent grid file developed by TWDB in 2015.

Because the GMA 3 files had used the same model files and post-processors as GMA 7, it was concluded that the same issues were present in GMA 7, and submittal of the materials to the Texas Water Development Board was delayed until GMA 7 met on March 22, 2018 to adopt updated desired future conditions based on the analyses presented in GMA 7 Technical Memorandum 18-01 that recalculated the average drawdowns from the GAM simulation using the 2015 grid file.

It is important to emphasize that the model run has not been changed, only the basis for calculating average drawdown. It is also important to note that the drawdown in individual cells has not changed, only the overall average in five counties.

The resolution that documents the adoption of the desired future condition on March 22, 2018 for the Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers. The desired future conditions were adopted as follows:

Average drawdown in the following GMA 7 counties not to exceed drawdowns from 2010 to 2070, as set forth in Table 5 of GMA 7 Technical Memo 18-01 (based on the Alternative GAM):

County	Corrected Desired Future Conditions: Average Drawdowns from 2010 to 2070 (ft)
Coke	0
Crockett	10
Ector	4
Edwards	2
Gillespie	5
Glasscock	42
Irion	10
Kimble	1
Menard	1
Midland	12
Pecos	14
Reagan	42
Real	4
Schelicher	8
Sterling	7
Sutton	6
Taylor	0
Terrell	2
Upton	20
Uvalde	2

The desired future conditions adopted on March 23, 2017 for Kinney and Val Verde counties were reaffirmed in the March 22, 2018 resolution as follows:

a) Total net drawdown in Kinney County in 2070, as compared with 2010 aquifer levels, shall be consistent with maintenance of an annual average flow of 23.9 cfs and an annual median flow of 23.9 cfs at Las Moras Springs (Reference: Groundwater Flow Model of the Kinney County Area by W.R. Hutchison, Ph.D., P.E., P.G., Jerry Shi, Ph.D. and Marius Jigmond, TWDB, dated August 26, 2011).
b) Total net drawdown in Val Verde County in 2070, as compared with 2010 aquifer levels, shall be consistent with maintenance of an average annual flow of 73-75 mgd at San Felipe Springs

Finally, the March 22, 2018 resolution reaffirmed the previous finding of March 23, 2017 that the Edwards-Trinity (Plateau) aquifer is not relevant for purposes of joint planning within the boundaries of the Hickory UWCD No. 1, the Lipan-Kickapoo WCD, Lone Wolf GCD, and Wes-Tex GCD, this finding is reaffirmed in this resolution.

The desired future conditions were developed after considering the simulations from three different models. For most of the area, the alternative one-layer model of the Edwards-Trinity (Plateau) and Pecos Valley aquifers was used. For Kinney County, existing model runs using the alternative model for Kinney County was used. Finally, for Val Verde County, model runs from a model developed for Val Verde County and the City of Del Rio were used. These models are described in the next three sections of this report.

2.2.1 Use of Alternative GAM of the Edwards-Trinity (Plateau) and Pecos Valley Aquifers

GMA 7 Technical Memorandum 15-06 described two new simulations that built upon Scenario 10 of Hutchison (2010). Scenario 1 used the same pumping amounts but extended the simulation to the year 2070. The results were reviewed with GMA 7 at the April 23, 2015 GMA 7 meeting. After discussion and review of the results, adjustments to pumping were made in Irion County, and the model was run again and designated as Scenario 2. These results were discussed at the January 14, 2016 and March 17, 2016 meetings of GMA 7.

The desired future conditions that were adopted were based on Scenario 2 of GMA 7 Technical Memorandum 15-06 and based on the calculation of average drawdown in GMA 7 Technical Memorandum 18-01 that are based on the 2015 grid file.

2.2.2 Use of Alternative Model for Kinney County

In 2010, the adopted desired future condition for Kinney County was based on simulations with an alternative GAM developed by TWDB (Hutchison and others, 2011). The desired future condition was based on average spring flow in Las Moras Springs. GMA 7 (and the Kinney County GCD) has voted to keep the same DFC based on the 2010 analyses despite issues that have been identified with the model.

The simulations were documented in Draft GAM Task 10-027 (revised), referenced as Hutchison (2011). The adopted desired future condition is based on Scenario 3.

In 2014, the Kinney County GCD began an intensive effort to monitor groundwater elevations and spring flow in Kinney County. This effort began with instrumenting 13 wells with transducers in 2014, and now includes 33 wells with KCGCD transducers, one stream monitoring point with a KCGCD transducer, a well instrumented by TWDB, and Las Moras Spring (monitored by the USGS).

The wet year of 2015 resulted in a pause in model development because the recovery of groundwater elevations was significant and resulted in additional analyses to better understand the differential response among the various wells.

The DFC for Kinney County was based on maintaining an average spring flow that is independent of the model used to calculate the MAG (modeled available groundwater). Although TWDB will ultimately calculate the MAG using the tool it deems most suitable, it is reasonable to expect that the alternative GAM previously used in 2010 and 2011 will be selected, the issues with the model could result in a significantly different MAG if a different method is chosen. It is possible that the resulting MAG would be lower if a different method is used. It is also reasonable to assume that that TWDB will move forward with preparing a MAG report before the new model is completed. Once the model is completed, it will be forwarded to TWDB for consideration in updating the MAG.

2.2.3 Use of Val Verde County Model

The DFC for Val Verde County was based on maintaining an average spring flow that was based on simulations with a groundwater model that was developed for Val Verde County and the City of Del Rio as part of a hydrogeologic study completed by EcoKai Environmental, Inc. (EcoKai, 2014). The overall objective of the study was to determine the correlation and potential impacts of groundwater pumping on local spring flows, lake elevations, and groundwater levels. An understanding of these correlations is necessary to evaluate the potential effects that additional groundwater pumping for export would have on the overall groundwater system.

The groundwater model developed as part of this study was based on the alternative model for Kinney County referenced above (Hutchison and Shi, 2011). Specifically, the half-mile grid spacing, the geologic framework, and many of the boundary conditions of the Kinney County model were used as the foundation of this new model. The Kinney County model was developed using annual stress period. The new model was developed using monthly stress periods from 1968 to 2013.

Model calibration was completed using 3,605 groundwater elevations from 498 wells in Val Verde County from 1968 to 2013, and using spring flows from three springs (Cantu, McKee and San Felipe). Calibration of the model was considered sufficient to advance the objectives of the study with regard to providing technical information that could be used in developing groundwater management guidelines (e.g. identification and delineation of the boundaries of groundwater management areas, conservation triggers, exportation cessation triggers, and generally characterizing groundwater conditions based on groundwater elevations and spring flows).

Specific applications of the calibrated model included: 1) a simulation to estimate the effect of Lake Amistad on groundwater elevations in the area, 2) a series of runs that were designed to provide information useful for management zone delineation, and 3) a series of simulations to evaluate the effects of large-scale pumping in three different areas to develop a better understanding of the nature and character of potential impacts of groundwater pumping on spring flow, river baseflow, aquifer drawdown, and other changes to the groundwater flow system.

The simulations that considered pumping increases considered 6 different pumping scenarios and 3 well-field location scenarios. The adopted desired future condition was based on the pumping scenarios designated 50K (50,000 AF/yr of pumping). The listed range in average spring flow in the desired future condition reflects the range of average spring flow associated with different locations of pumping. The summary table and graph are that were used by GMA 7 at the April 21, 2016 meeting to propose the desired future condition are located on page 61of the EcoKai report (Table 23 and Figure 39).

2.3 Third Round Desired Future Condition

After review and discussion, the groundwater conservation districts in Groundwater Management Area 7 found that the desired future conditions first proposed in 2016 and finally approved in 2018 would remain unchanged in the August 19, 2021 resolution. For completeness, they are repeated below.

> Average drawdown in the following GMA 7 counties not to exceed drawdowns from 2010 to 2070, as set forth in Table 5 of GMA 7 Technical Memo 18-01 (based on the Alternative GAM):

County	Corrected Desired Future Conditions: Average Drawdowns from 2010 to 2070 (ft)
Coke	0
Crockett	10
Ector	4
Edwards	2
Gillespie	5
Glasscock	42
Irion	10
Kimble	1
Menard	1
Midland	12
Pecos	14
Reagan	42
Real	4
Schelicher	8
Sterling	7
Sutton	6
Taylor	0
Terrell	2
Upton	20
Uvalde	2

The desired future conditions previously adopted on March 23, 2017 for Kinney and Val Verde counties, reaffirmed in the March 22, 2018 resolution, and then adopted again during this round of joint planning in the resolution dated August 29, 2021 as follows:

a) Total net drawdown in Kinney County in 2070, as compared with 2010 aquifer levels, shall be consistent with maintenance of an annual average flow of 23.9 cfs and an annual median flow of 23.9 cfs at Las Moras Springs (Reference: Groundwater Flow Model of the Kinney County Area by W.R. Hutchison, Ph.D., P.E., P.G., Jerry Shi, Ph.D. and Marius Jigmond, TWDB, dated August 26, 2011).
b) Total net drawdown in Val Verde County in 2070, as compared with 2010 aquifer levels, shall be consistent with maintenance of an average annual flow of 73-75 mgd at San Felipe Springs

The resolution that documents the adoption of the desired future condition for the Capitan Reef Complex Aquifer is presented in Appendix A and was adopted on August 19, 2021 by a 14-0 vote at a properly noticed meeting of Groundwater Management Area 7.

3.0 Policy Justification

As developed more fully in this report, the proposed desired future condition was adopted after considering the nine statutory factors:

1. Aquifer uses and conditions within Groundwater Management Area 7
2. Water supply needs and water management strategies included in the 2012 State Water Plan
3. Hydrologic conditions within Groundwater Management Area 7 including total estimated recoverable storage, average annual recharge, inflows, and discharge
4. Other environmental impacts, including spring flow and other interactions between groundwater and surface water
5. The impact on subsidence
6. Socioeconomic impacts reasonably expected to occur
7. The impact on the interests and rights in private property, including ownership and the rights of landowners and their lessees and assigns in Groundwater Management Area 7 in groundwater as recognized under Texas Water Code Section 36.002
8. The feasibility of achieving the desired future condition
9. Other information

In addition, the proposed desired future condition provides a balance between the highest practicable level of groundwater production and the conservation, preservation, protection, recharging, and prevention of waste of groundwater in Groundwater Management Area 7.

There is no set formula or equation for calculating groundwater availability. This is because an estimate of groundwater availability requires the blending of policy and science. Given that the tools for scientific analysis (groundwater models) contain limitations and uncertainty, policy provides the guidance and defines the bounds that science can use to calculate groundwater availability.

As developed more fully below, many of these factors could only be considered on a qualitative level since the available tools to evaluate these impacts have limitations and uncertainty.

During the initial development of desired future conditions in 2010, there was no specific statutory guidance related to factor consideration or balancing. However, GMA 7 took a proactive approach in defining qualitative goals that were evaluated with the groundwater availability model at the time. The effort was rooted as a policy consideration but tested and verified as a technical consideration. Details are discussed in the next section. This approach was extended to the process of updating the desired future conditions that were adopted in 2018, and are incorporated into the decision to “readopt” the DFCs in the third round of joint planning.

4.0 Technical Justification

The process of using the groundwater model in developing desired future conditions revolves around the concept of incorporating many of the elements of the nine statutory factors listed in the previous section. For the Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers, the initial 10 simulations completed in 2010 were evaluated as well as two new simulations. In Kinney County, the DFCs were based on an evaluation of 7 scenarios. In Val Verde County, the DFCs were based on an evaluation of 18 scenarios.

Some critics of the process asserted that the districts were "reverse-engineering" the desired future conditions by specifying pumping (e.g., the modeled available groundwater) and then adopting the resulting drawdown as the desired future condition. However, it must be remembered that among the input parameters for a predictive groundwater model run is pumping, and among the outputs of a predictive groundwater model run is drawdown. Thus, an iterative approach of running several predictive scenarios with models and then evaluating the results is a necessary (and time-consuming) step in the process of developing desired future conditions.

One part of the reverse-engineering critique of the process has been that "science" should be used in the development of desired future conditions. The critique plays on the unfortunate name of the groundwater models in Texas (Groundwater Availability Models) which could suggest that the models yield an availability number. This is simply a mischaracterization of how the models work (i.e. what is a model input and what is a model output).

The critique also relies on a fairly narrow definition of the term *science* and fails to recognize that the adoption of a desired future condition is primarily a policy decision. The call to use science in the development of desired future conditions seems to equate the term *science* with the terms *facts* and *truth*. Although the Latin origin of the word means knowledge, the term *science* also refers to the application of the scientific method. The scientific method is discussed in many textbooks and can be viewed as a means to quantify cause-and-effect relationships and to make useful predictions.

In the case of groundwater management, the scientific method can be used to understand the relationship between groundwater pumping and drawdown, or groundwater pumping and spring flow. A groundwater model is a tool that can be used to run "experiments" to better understand the cause-and-effect relationships within a groundwater system as they relate to groundwater management.

Much of the consideration of the nine statutory factors involves understanding the effects or the impacts of a desired future condition (e.g. groundwater-surface water interaction and property rights). The use of the models in this manner in evaluating the impacts of alternative futures is an effective means of developing information for the groundwater conservation districts as they develop desired future conditions.

GMA 7 articulated a qualitative vision for desired future conditions in 2010: minimize drawdown in the eastern portion of GMA 7 (where baseflow to rivers is important) and provide for irrigation demands in the western portion of GMA 7 (where there would be significant drawdown). The key issue of the model simulations was to assess the compatibility of these qualitative goals. Given that groundwater models require pumping as inputs and calculate drawdowns as one of the outputs, this led to a series of simulations that evaluated increases in pumping on drawdown in various portions of GMA 7. Initially, six scenarios were run: a base case using 2005 pumping, and 5 scenarios where pumping was increased. The base case, or continuation of 2005 pumping was designated as Scenario 0. Scenario 1 was developed by polling each district to identify their expected pumping. Scenario 2 pumping was 110 percent of Scenario 1 pumping. Scenario 3 pumping was 120 percent of Scenario 1 pumping. Scenario 3 pumping was 120 percent of Scenario 1 pumping. Scenario 4 pumping was 130 percent of Scenario 1 pumping. Scenario 5 pumping was 140 percent of Scenario 1 pumping. These results were reviewed with GMA 7 at their meeting of July 28, 2010.

At the July 28, 2010 meeting, GMA 7 representatives then identified modifications to the pumping inputs and the model was re-run at the meeting, and the results were reviewed. These runs were labeled Scenarios 6 to 10. GMA 7 adopted DFCs based on Scenario 10. Based on the review, the GCD representatives found that Scenario 10 met the predefined qualitative vision of minimizing drawdown in the east while providing for irrigation demands in the west.

The evaluation of the eastern portion is exemplified by an analysis of San Saba River flow in Menard County. Figure 4 presents the flow of the San Saba River at Menard.

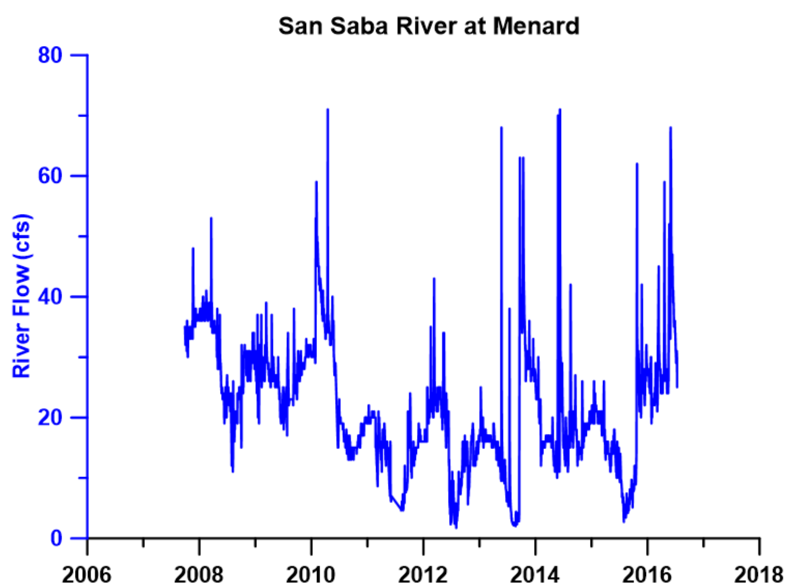

Figure 4. San Saba River at Menard

Please note that from about 2007 to 2010, minimum or base flow is about 30 cfs. From 2011 to 2014, minimum or base flow is about 10 cfs (during drought conditions), and after 2015, minimum or base flow return to about 30 cfs.

Figure 5 is a repeat of the river hydrograph and adds the hydrograph of a well completed in the Edwards-Trinity (Plateau) Aquifer several miles to the south of the stream gage.

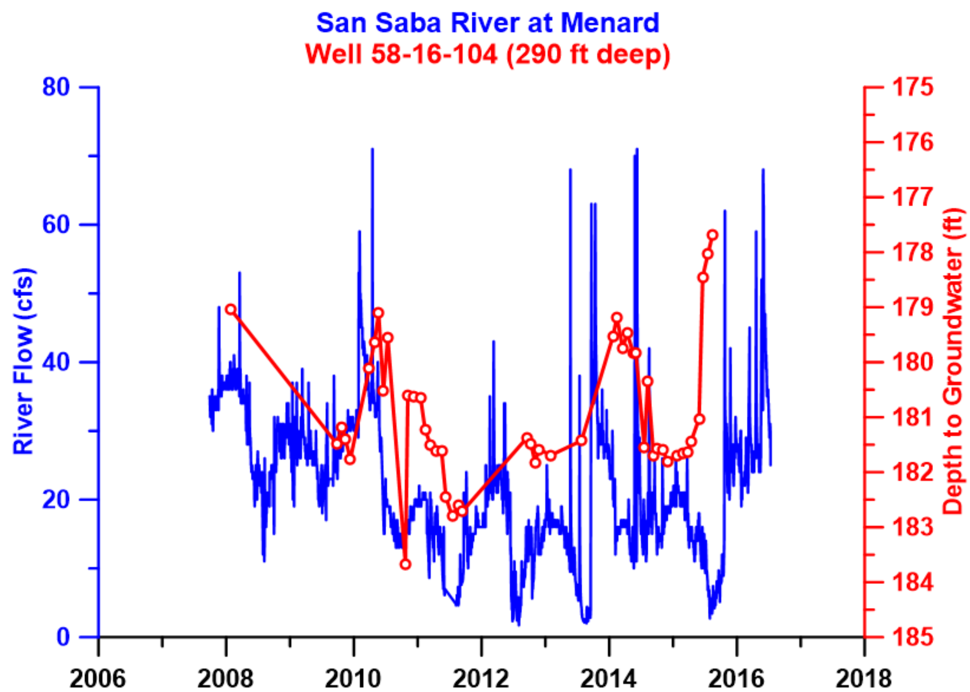

Figure 5. San Saba River at Menard and Well 58-16-104

Please note that the changes in the groundwater elevation in the well mimic the changes in river flow. The groundwater elevation from 1962 to 2016 in this well ranges from about 1,983 to 2,045 ft MSL. The stream gage elevation is 1,863 ft MSL, so it appears that this is a gaining reach of the river.

In general, the depth to water in the well is about 179 feet when river flow is high (i.e. during wet years), and the depth to water is about 182 feet when the river flow is low (i.e. during dry years). Thus, it was assumed that if, in wet periods, groundwater pumping resulted in a groundwater level decline of 3 feet, the river flow would be reduced. Thus, the pumping inputs into the GAM simulations were evaluated in the context of average drawdown that would be less than 3 feet to maintain base flow. In fact, the drawdown in Menard County under the desired future condition simulation was one foot suggested that impacts to baseflow would be minimal.

5.0 Factor Consideration

Senate Bill 660, adopted by the legislature in 2011, changed the process by which groundwater conservation districts within a groundwater management area develop and adopt desired future conditions. The new process includes nine steps as presented below:

- The groundwater conservation districts within a groundwater management area consider nine factors outlined in the statute.
- The groundwater conservation districts adopt a "proposed" desired future condition
- The "proposed" desired future condition is sent to each groundwater conservation district for a 90-day comment period, which includes a public hearing by each district
- After the comment period, each district compiles a summary report that summarizes the relevant comments and includes suggested revisions. This summary report is then submitted to the groundwater management area.
- The groundwater management area then meets to vote on a desired future condition.
- The groundwater management area prepares an "explanatory report".
- The desired future condition resolution and the explanatory report are then submitted to the Texas Water Development Board and the groundwater conservation districts within the groundwater management area.
- Districts then adopt desired future conditions that apply to that district.

The nine factors that must be considered before adopting a proposed desired future condition are:

1. Aquifer uses or conditions within the management area, including conditions that differ substantially from one geographic area to another.
2. The water supply needs and water management strategies included in the state water plan.
3. Hydrological conditions, including for each aquifer in the management area the total estimated recoverable storage as provided by the executive administrator (of the Texas Water Development Board), and the average annual recharge, inflows and discharge.
4. Other environmental impacts, including impacts on spring flow and other interactions between groundwater and surface water.
5. The impact on subsidence.
6. Socioeconomic impacts reasonably expected to occur.
7. The impact on the interests and rights in private property, including ownership and the rights of management area landowners and their lessees and assigns in groundwater as recognized under Section 36.002 (of the Texas Water Code).
8. The feasibility of achieving the desired future condition.
9. Any other information relevant to the specific desired future condition.

In addition to these nine factors, statute requires that the desired future condition provide a balance between the highest practicable level of groundwater production and the conservation, preservation, protection, recharging, and prevention of waste of groundwater and control of subsidence in the management area.

5.1 Groundwater Demands and Uses

Groundwater demands and uses from 2000 to 2012 in the Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers are presented in Appendix B. Data were obtained from the Texas Water Development Board historic pumping database:

http://www.twdb.state.tx.us/waterplanning/waterusesurvey/historical-pumpage.asp

The Modeled Available Groundwater values for the Edwards-Trinity Aquifer are summarized below in Table 1. In the Pecos Valley Aquifer, the modeled available groundwater in Crockett County is 31 AF/yr, is 113 AF/yr in Ector County, is 1,448 in Pecos County, and is 2 AF/yr in Upton County. In the Trinity Aquifer, the modeled available groundwater in Gillespie County is 2,482 AF/yr, and is 52 AF/yr in Real County.

Hydrographs that compare the historic pumping and the modeled available groundwater values are presented in Appendix C.

Table 1. Modeled Available Groundwater for the Edwards-Trinity (Aquifer)

Total = 473,169 AF/yr

County	Modeled Available Groundwater (2010 to 2070) (Acre-feet/yr)	County	Modeled Available Groundwater (2010 to 2070) (Acre-feet/yr)
Coke	997	Pecos	117,039
Crockett	5,447	Reagan	68,205
Ector	5,542	Real	7,523
Edwards	5,676	Schleicher	8,034
Gillespie	4,979	Sterling	2,495
Glasscock	65,186	Sutton	6,410
Irion	3,289	Taylor	489
Kimble	1,282	Terrell	1,420
Kinney	70,341	Upton	22,369
Menard	2,217	Uvalde	1,993
Midland	23,233	Val Verde	50,000

These data were discussed at the GMA 7 meeting of January 21, 2021 in Sonora, Texas.

5.2 Groundwater Supply Needs and Strategies

The 2021 Region F Initially Prepared Plan (IPP)summarizes a variety of metrics on a county or sub-county level: modeled available groundwater, future demand, permit authorizations, highest recent historic production. The IPP also summarizes current supplies by Water Supply Group that does not correspond well to the tabular summarizes of modeled available groundwater provided by the TWDB. In general, there appears to be no serious disconnect between the available groundwater (as defined by the modeled available groundwater) and the future demands. Thus, there was no need to reconsider the desired future condition with respect to this factor.

5.3 Hydrologic Conditions, including Total Estimated Recoverable Storage

The groundwater budget as presented by Hutchison and others (2011) for the Edwards-Trinity (Plateau) Aquifer, Pecos Valley, and Trinity aquifers is presented in Table 2.

Jones and others (2013) documented the total estimated recoverable storage for the aquifers in GMA 7. Table 3 presents storage for the Edwards-Trinity (Plateau) Aquifer. Table 4 presents storage for the Pecos Aquifer. Table 5 presents storage for the Trinity.

5.4 Other Environmental Impacts, including Impacts on Spring Flow and Surface Water

Table 2 (referenced above) includes the entire groundwater budget for the Edwards-Trinity (Plateau) Aquifer, Pecos Valley, and Trinity aquifers.

The primary consideration for the desired future conditions in Val Verde and Kinney counties was the preservation of spring flow. The primary consideration in the northeastern portion of GMA 7 was the maintenance of groundwater levels to maintain baseflow to the tributaries of the Colorado River.

5.5 Subsidence

Subsidence is not an issue in the Edwards-Trinity (Plateau) Aquifer, Pecos Valley, and Trinity aquifers in GMA 7.

Table 2. Groundwater Budget of Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers from One-Layer Model

	Water Budget 1930-1939 (acre-feet per year)	Water Budget 1940-1949 (acre-feet per year)	Water Budget 1950-1959 (acre-feet per year)	Water Budget 1960-1969 (acre-feet per year)	Water Budget 1970-1979 (acre-feet per year)	Water Budget 1980-1989 (acre-feet per year)	Water Budget 1990-1999 (acre-feet per year)	Water Budget 2000-2005 (acre-feet per year)
Inflow								
Rivers	993,229	1,009,160	1,054,950	1,107,275	1,092,402	1,048,220	1,033,690	1,033,726
Inter-aquifer Flow	1,095,795	1,100,269	1,112,419	1,123,952	1,135,663	1,131,445	1,137,506	1,136,281
Recharge	1,641,803	1,688,928	1,545,021	1,621,125	1,680,625	1,671,631	1,669,556	1,703,227
Total Inflow	3,730,827	3,798,357	3,712,390	3,852,352	3,908,690	3,851,296	3,840,752	3,873,234
Outflow								
Pumpage	-194,233	-570,080	-947,024	-1,210,949	-935,718	-651,331	-706,359	-677,860
Springs	-1,216,432	-1,210,615	-1,129,334	-1,082,433	-1,092,612	-1,101,266	-1,120,187	-1,093,636
Rivers	-1,893,959	-1,841,710	-1,767,816	-1,722,471	-1,715,415	-1,741,168	-1,756,911	-1,755,300
Inter-aquifer Flow	-560,262	-557,538	-546,381	-532,124	-526,554	-531,894	-533,580	-535,091
Total Outflow	-3,864,885	-4,179,943	-4,390,555	-4,547,978	-4,270,298	-4,025,658	-4,117,038	-4,061,887
In-Out	-134,058	-381,585	-678,165	-695,626	-361,608	-174,362	-276,286	-188,653
Storage Change	-133,865	-372,190	-678,034	-695,534	-358,631	-166,175	-250,497	-188,648
Model Error	-194	-9,395	-131	-92	-2,977	-8,187	-25,789	-5
Model Error (Percent)	-0.01	-0.25	0.00	0.00	-0.08	-0.21	-0.67	0.00

Table 3. Total Estimated Recoverable Storage - Edwards-Trinity (Plateau) Aquifer

County	Total Storage (acre-feet)	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
Coke	120,000	30,000	90,000
Concho	79,000	19,750	59,250
Crockett	1,500,000	375,000	1,125,000
Ector	220,000	55,000	165,000
Edwards	5,000,000	1,250,000	3,750,000
Gillespie	430,000	107,500	322,500
Glasscock	270,000	67,500	202,500
Irion	420,000	105,000	315,000
Kimble	1,100,000	275,000	825,000
Kinney[20]	4,400,000	1,100,000	3,300,000
Mason	51,000	12,750	38,250
McCulloch	93,000	23,250	69,750
Menard	250,000	62,500	187,500
Midland	240,000	60,000	180,000
Nolan	170,000	42,500	127,500
Pecos	3,100,000	775,000	2,325,000
Reagan	560,000	140,000	420,000
Real	1,600,000	400,000	1,200,000
Schleicher	890,000	222,500	667,500
Sterling	150,000	37,500	112,500
Sutton	1,800,000	450,000	1,350,000
Taylor	78,000	19,500	58,500
Terrell	4,500,000	1,125,000	3,375,000
Tom Green	250,000	62,500	187,500
Upton	550,000	137,500	412,500
Uvalde	1,000,000	250,000	750,000
Val Verde	10,000,000	2,500,000	7,500,000
Total	38,821,000	9,705,250	29,115,750

[20] Total storage values for Kinney County are based on the alternative model by Hutchison and others (2011), the other total storage values were based on the groundwater availability model by Anaya and Jones (2009).

Table 4. Total Estimated Recoverable Storage - Pecos Valley Aquifer

County	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Crockett	160,000	40,000	120,000
Ector	5,900,000	1,475,000	4,425,000
Pecos	910,000	227,500	682,500
Upton	4,400,000	1,100,000	3,300,000
Total	11,370,000	2,842,500	8,527,500

Table 5. Total Estimated Recoverable Storage - Trinity Aquifer

County	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Gillespie	270,000	67,500	202,500
Real	23,000	5,750	17,250
Uvalde	230,000	57,500	172,500
Total	523,000	130,750	392,250

5.6 Socioeconomic Impacts

The Texas Water Development Board prepared reports on the socioeconomic impacts of not meeting water needs for each of the Regional Planning Groups during development of the 2021 Regional Water Plans. Because the development of this desired future condition used the State Water Plan demands and water management strategies as an important foundation, it is reasonable to conclude that the socioeconomic impacts associated with this proposed desired future condition can be evaluated in the context of not meeting the listed water management strategies. Groundwater Management Area 7 is covered by Regional Planning Group F. The socioeconomic impact report for Regions F is included in Appendix D.

5.7 Impact on Private Property Rights

The impact on the interests and rights in private property, including ownership and the rights of landowners and their lessees and assigns in Groundwater Management Area 7 in groundwater is recognized under Texas Water Code Section 36.002.

The desired future conditions adopted by GMA 7 are consistent with protecting property rights of landowners who are currently pumping groundwater and landowners who have chosen to conserve groundwater by not pumping. All current and projected uses (as defined in the 2021 Region F plan) can be met based on the simulations. In addition, the pumping associated with achieving the desired future condition (the modeled available groundwater) will cause impacts to exiting well owners and to surface water. However, as required by Chapter 36 of the Water Code, GMA 7 considered these impacts and balanced them with the increasing demand of water in the GMA 7 area, and concluded that, on balance and with appropriate monitoring and project specific review during the permitting process, the desired future condition is consistent with protection of private property rights.

5.8 Feasibility of Achieving the Desired Future Condition

Groundwater levels are routinely monitored by the districts and by the TWDB in GMA 7. Evaluating the monitoring data is a routine task for the districts, and the comparison of these data with the model results that were used to develop the DFCs is covered in each district's management plan. These comparisons will be useful to guide the update of the DFCs that are required every five years.

5.9 Other Information (Devils River)

5.9.1 Letters from The Nature Conservancy, Devils River Conservancy, and Texas Parks and Wildlife

GMA 7 received two letters regarding the development of an explicit desired future condition in the Devils River area of Val Verde County. The joint letter from The Nature Conservancy of

Texas and the Devils River Conservancy (dated December 21, 2020) is presented in Appendix E. The letter from Texas Parks and Wildlife (dated December 17, 2020) is presented in Appendix F.

Both letters recognize that there is no groundwater conservation district in Val Verde County, so there is no administrative mechanism to manage groundwater nor regulate pumping. Both letters also correctly state that the current desired future condition in Val Verde County is based on maintaining flows from San Felipe Springs, and that a certain distribution in pumping was assumed in the groundwater model simulations that were used to develop the desired future conditions. If future pumping were to be developed in a different pattern than that assumed in the model simulation upon which the desired future condition was based, there may be impacts to other areas of the county, and this may result in impacts to a sensitive environment like the Devils River area. Because there is no groundwater conservation district, the only "decision-maker" in the planning, development, and pumping of groundwater in Val Verde County is the landowner.

Both letters acknowledge that groundwater models need to be refined before the next round of joint planning to allow explicit consideration of Devils River (and Pecos River) flow, spring flow in the Devils River area. Fortunately, the Texas Water Development Board is currently in the process of refining and updating the Groundwater Availability Model for the Edwards-Trinity (Plateau), and, according to the current schedule, the updated model should be available for use in the next round of joint planning.

5.9.2 Letter from Devils River Association

GMA 7 received a letter from the Devils River Association, a group composed entirely of Devils River watershed ranchers and landowners. The letter is dated January 14, 2020, and is presented in Appendix G. The letter was written to provide their views in response to the letters provided by The Nature Conservancy, Texas Parks and Wildlife, and the Devils River Conservancy discussed above (Appendices E and F).

The Association believes that the joint planning process requires that a DFC be supported by clearly defined data and appropriate modeling and should be proposed by and enforced by a groundwater conservation district for whom the DFC is adopted. The letter also opines that the current lack of aquifer defining quantitative data and reliable, calibrated and validated modeling assessments precludes the adoption of an accurate and reliable DFC and would make the creation of a GCD an expensive exercise in "sheer folly where permit approvals or denials can be legitimately challenged based upon the quality of evidence presented or lack therof.

The letter concludes by stating that neither facts, science, nor applicable legal authorities" can support to create a Devils River Watershed specific DFC or the creation of a Val Verde County groundwater conservation district based on the "facts, science nor applicable legal authorities".

5.9.3 GMA 7's Consideration of These Letters

The December 17, 2020 letter from Texas Parks and Wildlife and the December 21, 2020 joint letter from The Nature Conservancy and Devils River Conservancy were received early in the planning process and were included as Appendices E and F in a draft explanatory report (dated

January 14, 2021). Moreover, the issues raised in these two letters were discussed in the draft explanatory report in Section 5.9 (Other Information). The letters and the discussion in the draft explanatory report were discussed at the GMA 7 meeting of January 21, 2021.

The groundwater conservation districts in Groundwater Management Area 7 plan to work closely with the TWDB in the update of the groundwater availability model. Once TWDB delivers the model in final form, the utility of the model will be assessed relative to the development of desired future condition in sub areas of Val Verde County on a technical level. Once there the technical assessment is completed, recommendations regarding the model's utility and limitations will be presented at a Groundwater Management Area 7 meeting. During the fourth round of joint planning, the groundwater conservation districts in Groundwater Management Area 7 commit to revisiting this topic.

6.0 Discussion of Other Desired Future Conditions Considered

As discussed earlier in this explanatory report, desired future conditions were adopted after considering the nine statutory factors and after reviewing and discussing numerous model simulations. The simulations provided a foundation for the discussions and decisions. The Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifer simulation model was used in 12 simulations. The Kinney County simulation model was used in 7 simulations. The Val Verde County simulation model was used in 18 simulations.

7.0 Discussion of Other Recommendations

Public comments were invited, and each district held a public hearing on the proposed desired future conditions for aquifers within their boundaries as follows:

District	Date of Public Meeting	Comments Received During Public Comment Period
Coke County UWCD	7/13/2021	0
Crockett County GCD	6/7/2021	0
Glasscock County GCD	6/15/2021	0
Hill Country GCD	6/8/2021	0
Irion County WCD	5/10/2021	0
Kimble County GCD	3/22/2021	0
Kinney County GCD	6/10/2021	0
Menard County UWD	4/14/2021	0
Middle Pecos GCD	6/15/2021	3 written, 3 oral
Plateau UWC & SD	4/29/2021	0
Real-Edwards C & RD	4/28/2021	0
Santa Rita UWCD	5/18/2021	0
Sterling County UWCD	5/10/2021	0
Sutton County UWCD	4/13/2021	0
Terrell County GCD	6/15/2021	0
Uvalde County WCD	7/12/2021	0

7.1 Devils River Letters

In addition to the comments received during the public comment period, the GMA 7 coordinator received three letters regarding Val Verde County/Devils River issues. These letters are not strictly part of the public comment period because they were received prior to GMA 7 voting to propose desired future conditions as detailed below:

- December 17, 2020 letter from Texas Parks and Wildlife
- December 21, 2020 joint letter from The Nature Conservancy and Devils River Conservancy
- January 14, 2021 letter from Devils River Association

The December 17, 2020 letter from Texas Parks and Wildlife and the December 21, 2020 joint letter from The Nature Conservancy and Devils River Conservancy were received early in the process and were included as Appendices E and F in a draft explanatory report (dated January 14, 2021). Moreover, the issues raised in these two letters were discussed in the draft explanatory report in Section 5.9 (Other Information). The letters and the discussion in the draft explanatory report were discussed at the GMA 7 meeting of January 21, 2021.

The January 14, 2021 letter from the Devils River Association was used to update the discussion that appeared in the January 14, 2021 draft of the explanatory report, and is included as Appendix G.

7.2 Texas Water Trade

Texas Water Trade submitted a letter (dated June 10, 2021) to Middle Pecos Groundwater Conservation District. Texas Water Trade is involved in an effort to restore perennial flow at Comanche Springs in the Fort Stockton area. The comment letter requests that Middle Pecos Groundwater Conservation District "discuss" how the desired future condition in the GMA 7 portion of Pecos County may or may not impact Comanche Springs.

As documented in Hutchison (2017), a total of 22,636 groundwater simulations were completed with the Western Pecos Groundwater Model (WPC Model) developed by R.W. Harden & Associates and others (2011). These simulations calculated the capture of flow to Comanche Springs by wells in each cell of the model. Each simulation pumped groundwater from a single cell for 10 years and calculated the impact to the flow at Comanche Springs. If pumping in a cell resulted in a significant impact to the flow at Comanche Springs, the cell was considered part of the revised Management Zone 1.

Based on 55 sensitivity simulations using the WPC model (Hutchison, 2017) that used 2010 pumping as a base case evaluated the correlation between reduced pumping and average annual spring flow in Comanche Springs in 2070:

- A 25 percent reduction in pumping would result in an average annual spring flow of 13 cfs.
- A 50 percent reduction in pumping would result in an average annual spring flow of 27 cfs
- A 75 percent reduction in pumping would result in an average annual spring flow of 38 cfs

Model limitations for these simulations were discussed in Hutchison (2017) and included:

- The underlying assumption in model development that all boundary conditions, except pumping, are constant from 1945 to 2010, which limits the ability to quantify the effects of wet years and dry years (i.e. only average conditions can be simulated).
- The use of annual stress periods means that the WPC Model cannot be used to simulate the seasonal variation in pumping and the effect of groundwater recovery after the irrigation season on spring flow.

In response to other comments, the WPC Model was modified to address specific impacts of seasonal pumping, but only after evaluating the modifications to the model with available data on well drawdown in specific wells in the Belding Farms area. Such an extension to seasonal flow in Comanche Springs is not possible with the WPC Model due to lack of calibration data. Thus, the only current ability to estimate spring flow is using annual averages.

Work is currently underway to develop a more detailed and robust model of Pecos County that address these limitations and other limitations with existing models. The objective of this updated model is to develop an analytical tool that will advance the groundwater planning, management, and regulatory responsibilities of the Middle Pecos Groundwater Conservation District. It is expected that this model will be available for the next round of joint planning (i.e. proposed DFC deadline of May 1, 2026).

Based on this analysis, the desired future condition is consistent with historic pumping amounts, which is inconsistent with a perennial spring flow. In recent years, some spring flow is observed during the winter months (low pumping months), but spring flow ceases when pumping begins in the spring.

7.3 Belding Farms June 4, 2021 Letter

This correspondence is two letters (both dated June 4, 2021). The first notes that the second letter is an updated version of a February 2, 2021 letter.

Belding Farms provided specific comments related to four of the nine statutory factors. These comments, and the responses, are summarized by factor.

Factor 7 – impact on the interests and rights in private property: The stated concern is that Belding Farms' private property rights beneath its land are jeopardized by the DFC silence or lack of specificity on the impacts to landowners in the Middle Pecos GCD of groundwater exports to locations outside the MPGCD.

Belding Farms is in Management Zone 1 of the Middle Pecos Groundwater Conservation District, in the GMA 7 portion of Pecos County. The boundaries of Management Zone 1 were specifically established based as the area of Pecos County that provided groundwater to Comanche Springs, also located in the GMA 7 portion of Pecos County. Groundwater pumping impacts in Management Zone 1 have been evaluated in Hutchison (2017).

As to the specific concern regarding proposed groundwater export, the most significant proposed project authorized by the Middle Pecos Groundwater Conservation District is the Fort Stockton Holdings Operating Permit that was approved in 2017. As part of that approval, Fort Stockton Holdings relinquished an equivalent amount of historic water rights. Thus, there the approval of the operating permit by Middle Pecos Groundwater Conservation District resulted in no net increase in permitted pumping. The groundwater simulations that were the basis for the DFCs in GMA 7 included the use of permitted pumping amounts to ensure that private property rights (in the form of groundwater permits) were protected.

Factor 6 – socioeconomic impacts reasonably expected to occur: the stated concern is that projected groundwater impacts will "jeopardize the availability of groundwater to Belding Farms". Specifically, there is a concern that "planning for continued groundwater depletion rates will very likely cause seasonal or more permanent impacts relative to groundwater availability to specific landowners in the District." The comments noted that seasonal impacts are the significant concern, particularly for agricultural uses, and should be quantified.

The concerns regarding "groundwater depletion" and "seasonal impacts" are misplaced. Desired future conditions are planning goals and are largely policy decisions made after considering nine statutory factors and applying a balancing test. The legislature has created groundwater conservation districts to manage groundwater and has required the districts to meet within designated groundwater management areas to conduct joint planning.

If the overall policy objective was to eliminate "groundwater depletion", then clearly a DFC with some drawdown over a 50- or 60-year period would have to be scrutinized and evaluated to see if the drawdown level did, in fact, constitute a depletion in groundwater storage. However, the joint planning process requires districts to consider other factors and apply a balancing test. It should be noted that concerns about groundwater depletion and the previously stated concern regarding private property rights are part of the balancing test that is required. If groundwater depletion is prohibited, there is a high chance that property rights could be impacted. Conversely, if property rights are exercised, some degree of groundwater storage depletion is possible. The dynamics of this type of balancing is inherent in the joint planning process.

Seasonal impacts are more properly an issue for groundwater management at the district level as opposed to a planning issue for the Groundwater Management Area. However, in the interest of responding to this comment (and follow-up comments made at the public hearing as detailed below), an analysis of the impacts of changes in the timing of 28,400 AF/yr of pumping (i.e. from an agricultural pattern to alternative municipal patters) was completed. The analysis is documented in Technical Memorandum 21-01, which is attached as Appendix H.

The analysis documented in Technical Memorandum 21-01 found that under current installed capacity and annual production limits of each well in the Fort Stockton Holdings (FSH) Operating Permit, the results of simulating pumping on a municipal schedule demonstrate that impacts to the Belding Wells are nearly identical to simulated impacts to the Belding Wells when FSH Operating Permit wells are operated on an irrigation schedule. The current permit conditions require adherence to the current pump capacity and annual production limits of each well. Simulations that assumed relaxation of these limits (i.e. all FSH Operating Permit pumping over a three- or four-month period) did result in higher impacts to Belding Farms wells, but did not impact long-term drawdown, which is a groundwater planning issue.

Factor 2 – the water supply needs, and water management strategies included in the state water plan: the stated concern is that Belding Farms opposes the creation of unmet water needs, particularly those due to the export of groundwater outside the production area. The comment also notes the negative impacts of the area of origin remain a high priority for legislators as noted in interim committee reports.

This factor requires that the districts consider what the regional planning groups have completed in meeting unmet demands (or deficits) by identifying strategies. It is unclear how an unmet water need is created by exporting groundwater. In the regional planning process, an unmet demand (or deficit) exists when a future demand exceeds existing supply. Strategies are identified to make up the deficit within the constraint of availability. In the case of groundwater, the groundwater availability is defined through the joint planning process as the modeled available groundwater. Thus, a strategy that relies on a groundwater exportation strategy is constrained by groundwater availability in the area where the groundwater originates. It appears that this comment is more appropriate for the regional planning process rather than the joint planning process.

Factor 4 – other environmental impacts, including the impacts on spring flow and other interaction between groundwater and surface water: the stated concern is that the absence of restoration and preservation of spring flows as a DFC condition undermines the Middle Pecos GCD's mission to maintain a sustainable, adequate, reliable, cost effective and high-quality source of groundwater to promote the vitality, economy and environment of the District.

The comment appears to suggest that Factor 4 be given high (if not the highest) weight of all the factors. However, it should be noted that earlier in this comment letter, there is a comment regarding property rights protection (Factor 7) which means that, at a minimum, existing permits be recognized and protected. This section of the letter argues that spring flows should be restored and preserved (Factor 4). The incongruity of these two arguments highlights the difficulty that groundwater districts face in the joint planning process.

7.4 Oral Comments at Public Hearings (June 15, 2021 - MPGCD)

Mike Thornhill (on behalf of Fort Stockton Holdings): Noted that past critiques have worked themselves out and the current DFCs are working since most of the pumping in Pecos County is covered by H&E use permits and that H&E use pumping is accounted for in GAM simulations used to develop the DFCs. Mr. Thornhill believes that issues related to Management Zone 1 are not a GMA 7 issue but a MPGCD issue. However, he noted that the Management Zone 1 drought triggers have been evaluated in the context of the DFCs and that they are consistent and are protective of the aquifer. Mr. Thornhill noted that new data and new models are expected for the next round of joint planning, and there is time to incorporate this information into DFCs during the next round.

Ed McCarthy (on behalf of Fort Stockton Holdings): Reinforced what Mr. Thornhill said regarding the potential to update and refine the DFCs during the next round with updated data and model results. Mr. McCarthy also asked that the potential for additional development in the other aquifers in the district (other than the Edwards-Trinity (Plateau) Aquifer) be considered.

Ryan Reed (on behalf of Belding Farms/Cockrell Investments): Noted that Belding Farms had previously submitted a letter with comments. Also emphasized that when the last round of DFCs were adopted, the contract to export water for municipal use was not in place. Consequently, Mr. Reed requested that a quantitative assessment of how pumping about 28,000 AF/yr of water on a municipal schedule would affect the DFCs.

The comments by Mr. Thornhill regarding the Management Zone 1 issues are not a GMA 7 issue but a MPGCD issue and the triggers being consistent with the DFCs are covered in Technical Memorandum 21-01 (Appendix H).

Because Mr. McCarthy began his comments regarding the opportunities associated with updating the DFCs in the next round with updated model data and results, his comment regarding the consideration additional development in other aquifers was taken to be a recommendation for the next round of joint planning and not a recommendation for the current round and the proposed DFCs.

Mr. Reed's comment/request has been addressed in the response to the June 4, 2021 Belding Farms letter above and in Technical Memorandum 21-01 (Appendix H).

7.5 Belding Farms June 17, 2021 Letter

This letter was a follow-up to the June 4, 2021 letter and the oral comments made by Reed Ryan at the MPGCD public hearing on June 15, 2021. Three issues are discussed:

Aquifer transmissivity and hydraulic interconnection: The comment requests that MPGCD "should give greater consideration to the transmissivity and hydrologic interconnection of the respective aquifers". The letter stated that "before the DFCs are modified in a manner that allows for greater drawdown of the aquifers, the comment encourages "MPGCD to complete the additional modeling and gain a better understanding of upwelling and transmissivity".

The DFCs for all aquifers in GMA 7 that were proposed on March 18, 2021 by the groundwater conservation districts in GMA 7 were the same as the DFCs in 2016. Because this letter was a follow-up to the previous comments, it is possible that this comment is in response to Mr. McCarthy's comment at the June 15, 2021 public hearing. As noted above, because there is no proposed change to any DFC in this round of joint planning, it was taken as a recommendation for the next round of joint planning and not a recommendation for the current round and the proposed DFCs.

Purpose of DFCs and relationship to permitting decisions of MPGCD: The comment encourages MPGCD "treat adoption of the DFCs as much more than a planning exercise" because "the DFCs are inextricably linked to regulatory activities of the GCDs and more importantly the sustainability, reliability, and protection of everyone's property rights with respect to groundwater".

An example of how MPGCD has already linked DFCs and its regulatory responsibilities is contained in Section 5.10 of the most recent Management Plan, adopted by MPGCD on July 16, 2020. Specifically, the special conditions associated with the Fort Stockton Holdings Operating Permit in Management Zone 1 that includes several thresholds that can trigger pumping reductions. The thresholds were established based on avoiding groundwater elevations dropping below historic minima. This will be accomplished by routine monitoring of groundwater elevations in 11 wells and requiring non-historic use pumping reductions if certain thresholds are exceeded (i.e. groundwater elevations drop below the threshold value set for each well). When developing the thresholds, a comparison was made to evaluate the consistency with the adopted desired future condition. Figure 6 shows the results of the comparison.

Please note that the blue data points represent the groundwater elevation where pumping cutbacks begin for each well. The red dots represent the groundwater elevation where a shut-down in non-historic groundwater pumping would be required, thus providing an opportunity for groundwater elevation recovery. The black line represents one-to-one line between the DFC depth to water at each well and the threshold depth to water in each well. The data points generally fall just above or just below the black line demonstrating that the thresholds are consistent with the DFC.

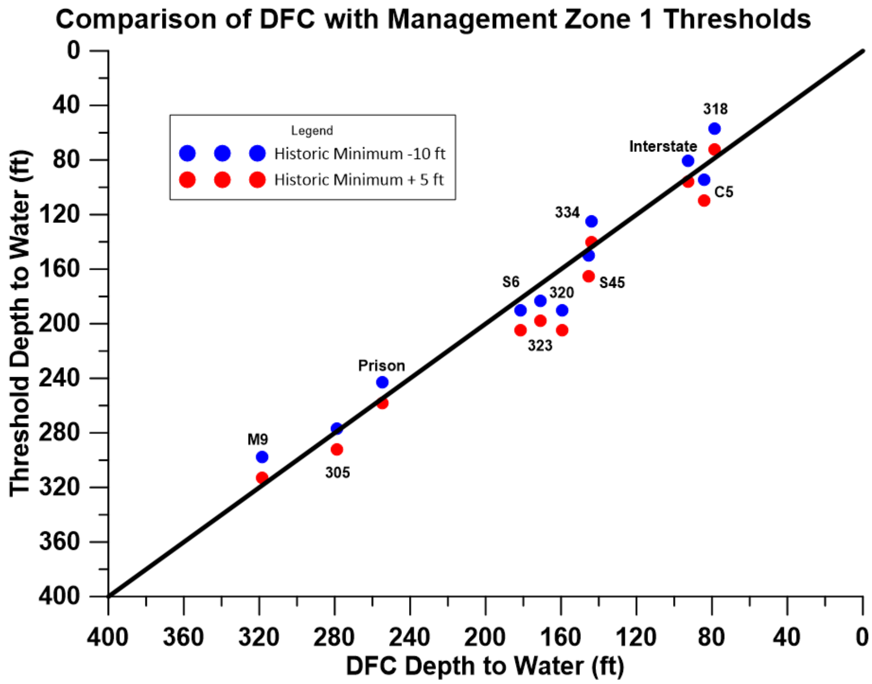

Figure 6. Comparison of DFC with Management Zone 1 Thresholds

Term Permits: The comment encourages "MPGCD to understand the effect of recently enacted section 36.1145 of the Texas Water Code on 'term' permits". Specifically, the letter recommended that "MPGCD give consideration to the noted legislation and how term permits play into the DFCs.

This comment is not strictly relevant to the joint planning process. It was specifically addressed to MPGCD regarding constraints on permit renewals and pumping curtailments, which are issues related to groundwater management and regulation and not joint planning.

8.0 References

George, P.G., Mace, R.E., and Petrossian, R., 2011. Aquifers of Texas. Texas Water Development Board Report 380, July 2011, 182p.

EcoKai Environmental, Inc. and Hutchison, William R., 2014. Hydrogeological Study for Val Verde County and City of Del Rio, Texas. Final Report, November 2014. 168p.

Hutchison, W.R., 2010. Draft GAM Run 09-035 (Version 2). Texas Water Development Board, Groundwater Resources Division, 10p.

Hutchison, W.R., 2017. Simulations with USGS Groundwater Model of Pecos County Region. GMA 7 Technical Memorandum 17-01, Draft 2. February 13, 2017, 17p.

Hutchison, W.R., Jones, I.C., and Anaya, R., 2011. Update of the Groundwater Availability Model of the Edwards-Trinity (Plateau) and Pecos Valley Aquifers of Texas. Texas Water Development Board Report, January 21, 2011, 61p.

Hutchison, W.R., Shi, J., and Jigmond, M., 2011. Groundwater Flow Model of the Kinney County Area. TWDB Report, August 26, 2011. 219p.

Jones, I.C., Bradley, R., Boghici, R., Kohlrenken, W., Shi, J., 2013. GAM Task 13-030: Total Estimated Recoverable Storage for Aquifers in Groundwater Management Area 7. Texas Water Development Board, Groundwater Resources Division, October 2, 2013, 53 p.

Appendix A

Desired Future Conditions Resolution

STATE OF TEXAS §
§ **RESOLUTION # 08-19-2021-3**
GROUNDWATER §
MANAGEMENT AREA 7 §

Resolution Adopting Desired Future Conditions for the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers in Groundwater Management Area 7

WHEREAS, Groundwater Conservation Districts (GCDs) located within or partially within Groundwater Management Area 7 (GMA 7) are required under Chapter §36.108, Texas Water Code to conduct joint planning and designate the Desired Future Conditions of aquifers within GMA 7 and;

WHEREAS, the Board Presidents or their Designated Representatives of GCDs in GMA 7 have met in various meetings and conducted joint planning in accordance with Chapter §36.108, Texas Water Code since October 2019 and;

WHEREAS, the GMA 7 Districts have received and considered Groundwater Availability Model runs and other technical advice regarding local aquifers, hydrology, geology, recharge characteristics, local groundwater demands and usage, population projections, other factors set forth in §36.108(d) of the Texas Water Code, from all aquifers within the respective GCDs, ground and surface water inter-relationships, that affect groundwater conditions through the year 2070; and

WHEREAS, the member GCDs of GMA 7, having given proper and timely notice, held an open meeting on March 18, 2021 at the Sutton County Civic Center, 1700 N Crockett, Sonora, Texas, and voted to adopt proposed Desired Future Conditions for the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers within the boundaries of GMA 7, noting these proposed DFCs are unchanged from the previously adopted DFCs; and

WHEREAS, the member GCDs in which the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers is relevant for joint planning purposes held open meetings within each said district between March 22, 2021 and July 22, 2021 to take public comment on the proposed DFCs for that district; and

WHEREAS, on this day of August 19, 2021, at an open meeting duly noticed and held in accordance with law, at the Sutton County Civic Center, 1700 N Crockett, Sonora, Texas, the GCDs within GMA 7 voted, upon motion made and seconded, 14 districts in favor, 0 districts opposed, to adopt the following DFCs for the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers in the following counties and districts through the year 2070:

a) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **0 feet in Coke County** in 2070 as compared with 2010 aquifer levels.
b) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **10 feet in Crockett County** in 2070 as compared with 2010 aquifer levels.
c) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **4 feet in Ector County** in 2070 as compared with 2010 aquifer levels.
d) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **2 feet in Edwards County** in 2070 as compared with 2010 aquifer levels.

e) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **5 feet in Gillespie County** in 2070 as compared with 2010 aquifer levels.
f) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **42 feet in Glasscock County** in 2070 as compared with 2010 aquifer levels.
g) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **10 feet in Irion County** in 2070 as compared with 2010 aquifer levels.
h) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **1 foot in Kimble County** in 2070 as compared with 2010 aquifer levels.
i) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **1 foot in Menard County** in 2070 as compared with 2010 aquifer levels.
j) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **12 feet in Midland County** in 2070 as compared with 2010 aquifer levels.
k) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **14 feet in Pecos County** in 2070 as compared with 2010 aquifer levels.
l) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **42 feet in Reagan County** in 2070 as compared with 2010 aquifer levels.
m) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **4 feet in Real County** in 2070 as compared with 2010 aquifer levels.
n) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **8 feet in Schleicher County** in 2070 as compared with 2010 aquifer levels.
o) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **7 feet in Sterling County** in 2070 as compared with 2010 aquifer levels.
p) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **6 feet in Sutton County** in 2070 as compared with 2010 aquifer levels.
q) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **0 feet in Taylor County** in 2070 as compared with 2010 aquifer levels.
r) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **2 feet in Terrell County** in 2070 as compared with 2010 aquifer levels.
s) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **20 feet in Upton County** in 2070 as compared with 2010 aquifer levels.
t) Total net drawdown of the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers not to exceed **2 feet in Uvalde County** in 2070 as compared with 2010 aquifer levels.
   *(Reference items *a)* through *t)*: GMA 7 Technical Memorandum 18-01)
u) Total net drawdown in **Kinney County** in 2070, as compared with 2010 aquifer levels, shall be consistent with maintenance of an annual average flow of 23.9 cfs and an annual median flow of **23.9 cfs at Las Moras Springs.**
   **(Reference: Groundwater Flow Model of the Kinney County Area by W.R. Hutchison and others, 2011).*
v) Total net drawdown in **Val Verde County** in 2070, as compared with 2010 aquifer levels, shall be consistent with maintenance of an average annual flow of **73-75 mgd at San Felipe Springs.**
   **(Reference: EcoKai, 2014)*
w) The Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers are not relevant for joint planning purposes in all other areas of GMA 7.

NOW THEREFORE BE IT RESOLVED, that Groundwater Management Area 7 does hereby document, record, and confirm the above-described Desired Future Conditions for the **Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers** which were adopted by vote of the following Designated Representatives of Groundwater Conservation Districts present and voting on August 19, 2021:

AYES:

DESIGNATED REPRESENTATIVE – Coke County Underground Water Conservation District

DESIGNATED REPRESENTATIVE – Crockett County Groundwater Conservation District

DESIGNATED REPRESENTATIVE – Glasscock Groundwater Conservation District

DESIGNATED REPRESENTATIVE – Hickory Underground Water Conservation District No. 1

DESIGNATED REPRESENTATIVE – Hill Country Underground Water Conservation District

DESIGNATED REPRESENTATIVE - Irion County Water Conservation District

DESIGNATED REPRESENTATIVE – Kimble County Groundwater Conservation District

DESIGNATED REPRESENTATIVE - Kinney County Groundwater Conservation District

DESIGNATED REPRESENTATIVE - Lipan-Kickapoo Water Conservation District

DESIGNATED REPRESENTATIVE - Lone Wolf Groundwater Conservation District

DESIGNATED REPRESENTATIVE – Menard County Underground Water District

DESIGNATED REPRESENTATIVE – Middle Pecos Groundwater Conservation District

DESIGNATED REPRESENTATIVE - Plateau Underground Water Conservation and Supply District

DESIGNATED REPRESENTATIVE - Real-Edwards Conservation and Reclamation District

DESIGNATED REPRESENTATIVE - Santa Rita Underground Water Conservation District

DESIGNATED REPRESENTATIVE - Sterling County Underground Water Conservation District

DESIGNATED REPRESENTATIVE – Sutton County Underground Water Conservation District

DESIGNATED REPRESENTATIVE - Terrell County Groundwater Conservation District

DESIGNATED REPRESENTATIVE - Uvalde County Underground Water Conservation District

DESIGNATED REPRESENTATIVE - Wes-Tex Groundwater Conservation District

NAYES:

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DESIGNATED REPRESENTATIVE – Coke County Underground Water Conservation District

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DESIGNATED REPRESENTATIVE – Crockett County Groundwater Conservation District

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DESIGNATED REPRESENTATIVE – Glasscock Groundwater Conservation District

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DESIGNATED REPRESENTATIVE – Hickory Underground Water Conservation District No. 1

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DESIGNATED REPRESENTATIVE – Hill Country Underground Water Conservation District

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DESIGNATED REPRESENTATIVE - Irion County Water Conservation District

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DESIGNATED REPRESENTATIVE – Kimble County Groundwater Conservation District

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DESIGNATED REPRESENTATIVE - Kinney County Groundwater Conservation District

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DESIGNATED REPRESENTATIVE - Lipan-Kickapoo Water Conservation District

____

DESIGNATED REPRESENTATIVE - Lone Wolf Groundwater Conservation District

____

DESIGNATED REPRESENTATIVE – Menard County Underground Water District

____

DESIGNATED REPRESENTATIVE – Middle Pecos Groundwater Conservation District

____

DESIGNATED REPRESENTATIVE - Plateau Underground Water Conservation and Supply District

____

DESIGNATED REPRESENTATIVE - Real-Edwards Conservation and Reclamation District

____

DESIGNATED REPRESENTATIVE - Santa Rita Underground Water Conservation District

____

DESIGNATED REPRESENTATIVE - Sterling County Underground Water Conservation District

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DESIGNATED REPRESENTATIVE – Sutton County Underground Water Conservation District

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DESIGNATED REPRESENTATIVE - Terrell County Groundwater Conservation District

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DESIGNATED REPRESENTATIVE - Uvalde County Underground Water Conservation District

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DESIGNATED REPRESENTATIVE - Wes-Tex Groundwater Conservation District

Groundwater Management Area # 7
Joint Planning Meeting

Notice is hereby given that on Thursday, **August 19, 2021 at 10:00 a.m.** that one or more members of the Board of Directors and/or the designated representative of said boards of Groundwater Conservation Districts within the Texas Water Development Board-designated **Groundwater Management Area # 7** of the State of Texas will meet at the **Sutton County Civic Center, 1700 North Crockett Street, Sonora, TX 76950,** for the purposes of conducting joint planning in compliance with the requirements of Section 36.108 of the Texas Water Code.

Agenda

1. Call to Order and Invocation
2. Introduction of Member Districts and other persons in attendance
3. Public Comment
4. Consider and Possible Action on Minutes of the March 18, 2021 meeting
5. Update from the Texas Water Development Board
6. Review of public comments received during 90-day period
7. Presentation by Dr. Bill Hutchison on draft responses to public comments on proposed DFCs
8. Consider and Possible Action on Adoption of Resolution to declare the Blaine, Igneous, Lipan, Marble Falls, Seymour, and Cross Timbers aquifers not relevant for joint planning purposes within GMA 7 and consequently not requiring adoption of a proposed Desired Future Condition or development of Managed Available Groundwater numbers by the Texas Water Development Board.
9. Consider and Possible Action on Adoption of Resolutions for proposed DFCs for the following aquifers within boundaries of GMA 7:
    a. Capitan Reef Complex Aquifer
    b. Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers.
    c. Llano Uplift region (Ellenburger-San Saba, Hickory, Marble Falls aquifers)
    d. Ogallala and Dockum aquifers
    e. Rustler Aquifer
10. Next steps in Joint Planning Process
11. Other Matters to come before the membership
12. Set date and preliminary agenda for next meeting
13. Adjourn

Groundwater Conservation Districts located partially or wholly within
Groundwater Management Area # 7 are:

Coke County UWCD; Crockett County GCD; Glasscock GCD; Hickory UWCD No. 1; Hill Country UWCD; Irion County WCD; Kimble County GCD; Kinney County GCD; Lipan-Kickapoo WCD; Lone Wolf GCD; Menard County UWD; Middle Pecos GCD; Plateau UWC&SD; Real-Edwards C&RD; Santa Rita UWCD; Sterling County UWCD; Sutton County UWCD; Terrell County GCD; Uvalde County UWCD; Wes-Tex GCD

Requests for additional information and comments may be submitted to:

Meredith Allen
GMA # 7 Coordinator
Sutton County Underground Water Conservation District
301 S. Crockett Ave, Sonora, Texas 76950
Telephone: 325-226-9093 / Fax: 325-387-5737
e-mail: manager@suttoncountyuwcd.org

Appendix B

Historic Pumping from the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers

Appendix B - Historic Pumping from the Edwards-Trinity (Plateau), Pecos Valley and Trinity Aquifers

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2000	COKE	EDWARDS-TRINITY-PLATEAU AQUIFER	30	0	0	0	50	10	90
2001	COKE	EDWARDS-TRINITY-PLATEAU AQUIFER	30	0	0	0	50	12	92
2002	COKE	EDWARDS-TRINITY-PLATEAU AQUIFER	30	0	0	0	61	10	101
2003	COKE	EDWARDS-TRINITY-PLATEAU AQUIFER	30	0	0	0	26	6	62
2004	COKE	EDWARDS-TRINITY-PLATEAU AQUIFER	29	0	0	0	47	7	83
2005	COKE	EDWARDS-TRINITY-PLATEAU AQUIFER	32	0	0	0	47	61	140
2006	COKE	EDWARDS-TRINITY-PLATEAU AQUIFER	26	0	0	0	59	68	153
2007	COKE	EDWARDS-TRINITY-PLATEAU AQUIFER	21	0	0	0	38	62	121
2008	COKE	EDWARDS-TRINITY-PLATEAU AQUIFER	24	0	0	0	43	92	159
2009	COKE	EDWARDS-TRINITY-PLATEAU AQUIFER	25	0	0	0	25	88	138
2010	COKE	EDWARDS-TRINITY-PLATEAU AQUIFER	26	0	0	0	54	80	160
2011	COKE	EDWARDS-TRINITY-PLATEAU AQUIFER	51	0	0	0	56	82	189
2012	COKE	EDWARDS-TRINITY-PLATEAU AQUIFER	58	0	0	0	33	73	164
2000	CONCHO	EDWARDS-TRINITY-PLATEAU AQUIFER	1	0	0	0	0	144	145
2001	CONCHO	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	141	141
2002	CONCHO	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	144	144
2003	CONCHO	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	116	116
2004	CONCHO	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	303	303
2005	CONCHO	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	195	195
2006	CONCHO	EDWARDS-TRINITY-PLATEAU AQUIFER	17	0	0	0	0	241	258
2007	CONCHO	EDWARDS-TRINITY-PLATEAU AQUIFER	14	0	0	0	0	292	306
2008	CONCHO	EDWARDS-TRINITY-PLATEAU AQUIFER	15	0	0	0	0	204	219
2009	CONCHO	EDWARDS-TRINITY-PLATEAU AQUIFER	16	0	0	0	0	204	220
2010	CONCHO	EDWARDS-TRINITY-PLATEAU AQUIFER	16	0	0	0	0	187	203
2011	CONCHO	EDWARDS-TRINITY-PLATEAU AQUIFER	17	0	0	0	0	184	201
2012	CONCHO	EDWARDS-TRINITY-PLATEAU AQUIFER	13	0	0	0	0	163	176
2000	CROCKETT	EDWARDS-TRINITY-PLATEAU AQUIFER	1,561	0	31	0	123	608	2,323
2001	CROCKETT	EDWARDS-TRINITY-PLATEAU AQUIFER	1,240	0	22	0	165	572	1,999
2002	CROCKETT	EDWARDS-TRINITY-PLATEAU AQUIFER	1,317	0	42	0	150	515	2,024

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2003	CROCKETT	EDWARDS-TRINITY-PLATEAU AQUIFER	1,215	0	50	0	289	435	1,989
2004	CROCKETT	EDWARDS-TRINITY-PLATEAU AQUIFER	1,209	0	50	0	242	487	1,988
2005	CROCKETT	EDWARDS-TRINITY-PLATEAU AQUIFER	1,312	0	49	0	328	607	2,296
2006	CROCKETT	EDWARDS-TRINITY-PLATEAU AQUIFER	1,366	0	40	0	373	641	2,420
2007	CROCKETT	EDWARDS-TRINITY-PLATEAU AQUIFER	1,309	0	25	0	293	631	2,258
2008	CROCKETT	EDWARDS-TRINITY-PLATEAU AQUIFER	1,331	0	30	0	279	612	2,252
2009	CROCKETT	EDWARDS-TRINITY-PLATEAU AQUIFER	1,409	0	20	0	0	605	2,034
2010	CROCKETT	EDWARDS-TRINITY-PLATEAU AQUIFER	1,426	0	20	0	115	557	2,118
2011	CROCKETT	EDWARDS-TRINITY-PLATEAU AQUIFER	1,760	0	60	0	221	549	2,590
2012	CROCKETT	EDWARDS-TRINITY-PLATEAU AQUIFER	1,509	0	120	0	162	493	2,284
2000	ECTOR	EDWARDS-TRINITY-PLATEAU AQUIFER	1,809	2,479	99	0	304	151	4,842
2001	ECTOR	EDWARDS-TRINITY-PLATEAU AQUIFER	2,008	1,826	98	0	418	92	4,442
2002	ECTOR	EDWARDS-TRINITY-PLATEAU AQUIFER	2,079	2,278	98	0	392	78	4,925
2003	ECTOR	EDWARDS-TRINITY-PLATEAU AQUIFER	1,684	2,228	99	0	116	55	4,182
2004	ECTOR	EDWARDS-TRINITY-PLATEAU AQUIFER	1,662	3,510	98	0	717	62	6,049
2005	ECTOR	EDWARDS-TRINITY-PLATEAU AQUIFER	1,787	767	98	0	918	224	3,794
2006	ECTOR	EDWARDS-TRINITY-PLATEAU AQUIFER	2,781	1,965	98	0	17	210	5,071
2007	ECTOR	EDWARDS-TRINITY-PLATEAU AQUIFER	1,738	906	13	0	170	224	3,051
2008	ECTOR	EDWARDS-TRINITY-PLATEAU AQUIFER	1,959	938	13	0	0	202	3,112
2009	ECTOR	EDWARDS-TRINITY-PLATEAU AQUIFER	2,948	586	13	0	0	224	3,771
2010	ECTOR	EDWARDS-TRINITY-PLATEAU AQUIFER	4,420	584	12	0	748	211	5,975
2011	ECTOR	EDWARDS-TRINITY-PLATEAU AQUIFER	4,862	590	12	0	351	213	6,028
2012	ECTOR	EDWARDS-TRINITY-PLATEAU AQUIFER	4,455	587	12	0	100	185	5,339
2000	EDWARDS	EDWARDS-TRINITY-PLATEAU AQUIFER	371	0	0	0	160	448	979
2001	EDWARDS	EDWARDS-TRINITY-PLATEAU AQUIFER	383	0	0	0	130	143	656
2002	EDWARDS	EDWARDS-TRINITY-PLATEAU AQUIFER	343	0	0	0	202	126	671
2003	EDWARDS	EDWARDS-TRINITY-PLATEAU AQUIFER	294	0	0	0	137	122	553
2004	EDWARDS	EDWARDS-TRINITY-PLATEAU AQUIFER	312	0	0	0	315	121	748
2005	EDWARDS	EDWARDS-TRINITY-PLATEAU AQUIFER	355	0	0	0	347	416	1,118

Appendix B - Historic Pumping from the Edwards-Trinity (Plateau), Pecos Valley and Trinity Aquifers

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2006	EDWARDS	EDWARDS-TRINITY-PLATEAU AQUIFER	345	0	0	0	359	352	1,056
2007	EDWARDS	EDWARDS-TRINITY-PLATEAU AQUIFER	286	0	0	0	104	280	670
2008	EDWARDS	EDWARDS-TRINITY-PLATEAU AQUIFER	349	0	0	0	57	465	871
2009	EDWARDS	EDWARDS-TRINITY-PLATEAU AQUIFER	327	0	0	0	0	463	790
2010	EDWARDS	EDWARDS-TRINITY-PLATEAU AQUIFER	261	0	0	0	33	432	726
2011	EDWARDS	EDWARDS-TRINITY-PLATEAU AQUIFER	387	0	0	0	257	425	1,069
2012	EDWARDS	EDWARDS-TRINITY-PLATEAU AQUIFER	329	0	0	0	97	372	798
2000	GILLESPIE	EDWARDS-TRINITY-PLATEAU AQUIFER	5	0	0	0	102	275	382
2001	GILLESPIE	EDWARDS-TRINITY-PLATEAU AQUIFER	2	0	0	0	116	261	379
2002	GILLESPIE	EDWARDS-TRINITY-PLATEAU AQUIFER	3	0	0	0	116	258	377
2003	GILLESPIE	EDWARDS-TRINITY-PLATEAU AQUIFER	3	0	0	0	116	242	361
2004	GILLESPIE	EDWARDS-TRINITY-PLATEAU AQUIFER	7	0	0	0	123	245	375
2005	GILLESPIE	EDWARDS-TRINITY-PLATEAU AQUIFER	14	0	0	0	100	374	488
2006	GILLESPIE	EDWARDS-TRINITY-PLATEAU AQUIFER	319	0	0	0	109	372	800
2007	GILLESPIE	EDWARDS-TRINITY-PLATEAU AQUIFER	257	0	0	0	9	388	654
2008	GILLESPIE	EDWARDS-TRINITY-PLATEAU AQUIFER	294	0	0	0	102	426	822
2009	GILLESPIE	EDWARDS-TRINITY-PLATEAU AQUIFER	289	0	0	0	99	398	786
2010	GILLESPIE	EDWARDS-TRINITY-PLATEAU AQUIFER	281	0	0	0	66	691	1,038
2011	GILLESPIE	EDWARDS-TRINITY-PLATEAU AQUIFER	311	0	0	0	163	711	1,185
2012	GILLESPIE	EDWARDS-TRINITY-PLATEAU AQUIFER	297	0	0	0	100	335	732
2000	GLASSCOCK	EDWARDS-TRINITY-PLATEAU AQUIFER	156	0	0	0	30,528	135	30,819
2001	GLASSCOCK	EDWARDS-TRINITY-PLATEAU AQUIFER	157	0	0	0	22,176	133	22,466
2002	GLASSCOCK	EDWARDS-TRINITY-PLATEAU AQUIFER	148	0	0	0	22,729	122	22,999
2003	GLASSCOCK	EDWARDS-TRINITY-PLATEAU AQUIFER	146	0	0	0	38,824	95	39,065
2004	GLASSCOCK	EDWARDS-TRINITY-PLATEAU AQUIFER	124	0	0	0	38,147	86	38,357
2005	GLASSCOCK	EDWARDS-TRINITY-PLATEAU AQUIFER	145	0	0	0	38,083	109	38,337
2006	GLASSCOCK	EDWARDS-TRINITY-PLATEAU AQUIFER	134	0	0	0	40,105	119	40,358
2007	GLASSCOCK	EDWARDS-TRINITY-PLATEAU AQUIFER	108	1	0	0	32,560	163	32,832
2008	GLASSCOCK	EDWARDS-TRINITY-PLATEAU AQUIFER	122	0	0	0	36,919	84	37,125

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2009	GLASSCOCK	EDWARDS-TRINITY-PLATEAU AQUIFER	124	3	0	0	39,479	89	39,695
2010	GLASSCOCK	EDWARDS-TRINITY-PLATEAU AQUIFER	126	3	0	0	49,218	107	49,454
2011	GLASSCOCK	EDWARDS-TRINITY-PLATEAU AQUIFER	143	3	0	0	45,848	118	46,112
2012	GLASSCOCK	EDWARDS-TRINITY-PLATEAU AQUIFER	167	3	0	0	38,915	84	39,169
2000	IRION	EDWARDS-TRINITY-PLATEAU AQUIFER	179	0	0	0	808	248	1,235
2001	IRION	EDWARDS-TRINITY-PLATEAU AQUIFER	170	0	0	0	640	226	1,036
2002	IRION	EDWARDS-TRINITY-PLATEAU AQUIFER	206	0	0	0	640	218	1,064
2003	IRION	EDWARDS-TRINITY-PLATEAU AQUIFER	188	0	0	0	288	150	626
2004	IRION	EDWARDS-TRINITY-PLATEAU AQUIFER	185	0	0	0	104	148	437
2005	IRION	EDWARDS-TRINITY-PLATEAU AQUIFER	190	0	0	0	180	158	528
2006	IRION	EDWARDS-TRINITY-PLATEAU AQUIFER	185	0	0	0	573	169	927
2007	IRION	EDWARDS-TRINITY-PLATEAU AQUIFER	164	0	0	0	341	168	673
2008	IRION	EDWARDS-TRINITY-PLATEAU AQUIFER	168	0	0	0	542	202	912
2009	IRION	EDWARDS-TRINITY-PLATEAU AQUIFER	175	0	0	0	225	197	597
2010	IRION	EDWARDS-TRINITY-PLATEAU AQUIFER	186	0	0	0	43	208	437
2011	IRION	EDWARDS-TRINITY-PLATEAU AQUIFER	193	0	0	0	258	218	669
2012	IRION	EDWARDS-TRINITY-PLATEAU AQUIFER	212	0	0	0	47	158	417
2000	KIMBLE	EDWARDS-TRINITY-PLATEAU AQUIFER	209	2	0	0	10	359	580
2001	KIMBLE	EDWARDS-TRINITY-PLATEAU AQUIFER	211	2	0	0	11	347	571
2002	KIMBLE	EDWARDS-TRINITY-PLATEAU AQUIFER	212	2	0	0	11	314	539
2003	KIMBLE	EDWARDS-TRINITY-PLATEAU AQUIFER	210	2	0	0	11	278	501
2004	KIMBLE	EDWARDS-TRINITY-PLATEAU AQUIFER	203	2	0	0	19	288	512
2005	KIMBLE	EDWARDS-TRINITY-PLATEAU AQUIFER	221	2	0	0	35	259	517
2006	KIMBLE	EDWARDS-TRINITY-PLATEAU AQUIFER	205	2	0	0	5	249	461
2007	KIMBLE	EDWARDS-TRINITY-PLATEAU AQUIFER	171	2	0	0	98	268	539
2008	KIMBLE	EDWARDS-TRINITY-PLATEAU AQUIFER	188	2	0	0	40	223	453
2009	KIMBLE	EDWARDS-TRINITY-PLATEAU AQUIFER	195	2	0	0	165	222	584
2010	KIMBLE	EDWARDS-TRINITY-PLATEAU AQUIFER	203	2	0	0	115	302	622
2011	KIMBLE	EDWARDS-TRINITY-PLATEAU AQUIFER	229	2	0	0	66	306	603

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2012	KIMBLE	EDWARDS-TRINITY-PLATEAU AQUIFER	221	2	0	0	84	172	479
2000	KINNEY	EDWARDS-TRINITY-PLATEAU AQUIFER	7	0	0	0	10,454	236	10,697
2001	KINNEY	EDWARDS-TRINITY-PLATEAU AQUIFER	7	0	0	0	4,435	115	4,557
2002	KINNEY	EDWARDS-TRINITY-PLATEAU AQUIFER	7	0	0	0	4,357	106	4,470
2003	KINNEY	EDWARDS-TRINITY-PLATEAU AQUIFER	7	0	0	0	7,337	78	7,422
2004	KINNEY	EDWARDS-TRINITY-PLATEAU AQUIFER	7	0	0	0	3,355	36	3,398
2005	KINNEY	EDWARDS-TRINITY-PLATEAU AQUIFER	7	0	0	0	2,959	74	3,040
2006	KINNEY	EDWARDS-TRINITY-PLATEAU AQUIFER	14	0	0	0	3,551	67	3,632
2007	KINNEY	EDWARDS-TRINITY-PLATEAU AQUIFER	12	0	0	0	1,220	61	1,293
2008	KINNEY	EDWARDS-TRINITY-PLATEAU AQUIFER	13	0	0	0	1,519	87	1,619
2009	KINNEY	EDWARDS-TRINITY-PLATEAU AQUIFER	30	0	0	0	665	100	795
2010	KINNEY	EDWARDS-TRINITY-PLATEAU AQUIFER	536	0	0	0	640	50	1,226
2011	KINNEY	EDWARDS-TRINITY-PLATEAU AQUIFER	670	0	0	0	3,425	51	4,146
2012	KINNEY	EDWARDS-TRINITY-PLATEAU AQUIFER	621	0	0	0	1,663	46	2,330
2000	MASON	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	6	6
2001	MASON	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	7	7
2002	MASON	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	6	6
2003	MASON	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	9	9
2004	MASON	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	10	10
2005	MASON	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	14	14
2006	MASON	EDWARDS-TRINITY-PLATEAU AQUIFER	1	0	0	0	0	17	18
2007	MASON	EDWARDS-TRINITY-PLATEAU AQUIFER	1	0	0	0	0	14	15
2008	MASON	EDWARDS-TRINITY-PLATEAU AQUIFER	1	0	0	0	0	14	15
2009	MASON	EDWARDS-TRINITY-PLATEAU AQUIFER	1	0	0	0	0	12	13
2010	MASON	EDWARDS-TRINITY-PLATEAU AQUIFER	2	0	0	0	0	8	10
2011	MASON	EDWARDS-TRINITY-PLATEAU AQUIFER	2	0	0	0	0	12	14
2012	MASON	EDWARDS-TRINITY-PLATEAU AQUIFER	2	0	0	0	0	11	13
2000	MCCULLOCH	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	17	17
2001	MCCULLOCH	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	12	12

Appendix B - Historic Pumping from the Edwards-Trinity (Plateau), Pecos Valley and Trinity Aquifers

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2002	MCCULLOCH	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	15	15
2003	MCCULLOCH	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	11	11
2004	MCCULLOCH	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	3	3
2005	MCCULLOCH	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	4	4
2006	MCCULLOCH	EDWARDS-TRINITY-PLATEAU AQUIFER	1	0	0	0	0	3	4
2007	MCCULLOCH	EDWARDS-TRINITY-PLATEAU AQUIFER	1	0	0	0	0	3	4
2008	MCCULLOCH	EDWARDS-TRINITY-PLATEAU AQUIFER	1	0	0	0	0	3	4
2009	MCCULLOCH	EDWARDS-TRINITY-PLATEAU AQUIFER	3	0	0	0	0	4	7
2010	MCCULLOCH	EDWARDS-TRINITY-PLATEAU AQUIFER	5	0	0	0	0	6	11
2011	MCCULLOCH	EDWARDS-TRINITY-PLATEAU AQUIFER	6	0	0	0	0	3	9
2012	MCCULLOCH	EDWARDS-TRINITY-PLATEAU AQUIFER	5	0	72	0	0	3	80
2000	MENARD	EDWARDS-TRINITY-PLATEAU AQUIFER	358	0	0	0	111	307	776
2001	MENARD	EDWARDS-TRINITY-PLATEAU AQUIFER	338	0	0	0	126	306	770
2002	MENARD	EDWARDS-TRINITY-PLATEAU AQUIFER	329	0	0	0	126	273	728
2003	MENARD	EDWARDS-TRINITY-PLATEAU AQUIFER	315	0	0	0	56	292	663
2004	MENARD	EDWARDS-TRINITY-PLATEAU AQUIFER	256	0	0	0	42	297	595
2005	MENARD	EDWARDS-TRINITY-PLATEAU AQUIFER	261	0	0	0	65	304	630
2006	MENARD	EDWARDS-TRINITY-PLATEAU AQUIFER	289	0	0	0	468	318	1,075
2007	MENARD	EDWARDS-TRINITY-PLATEAU AQUIFER	255	0	0	0	318	326	899
2008	MENARD	EDWARDS-TRINITY-PLATEAU AQUIFER	306	0	0	0	0	276	582
2009	MENARD	EDWARDS-TRINITY-PLATEAU AQUIFER	339	0	0	0	244	314	897
2010	MENARD	EDWARDS-TRINITY-PLATEAU AQUIFER	73	0	0	0	256	256	585
2011	MENARD	EDWARDS-TRINITY-PLATEAU AQUIFER	81	0	0	0	100	245	426
2012	MENARD	EDWARDS-TRINITY-PLATEAU AQUIFER	79	0	0	0	301	211	591
2000	MIDLAND	EDWARDS-TRINITY-PLATEAU AQUIFER	1,308	0	1	0	9,262	226	10,797
2001	MIDLAND	EDWARDS-TRINITY-PLATEAU AQUIFER	1,717	0	1	0	8,382	223	10,323
2002	MIDLAND	EDWARDS-TRINITY-PLATEAU AQUIFER	1,861	0	1	0	7,921	191	9,974
2003	MIDLAND	EDWARDS-TRINITY-PLATEAU AQUIFER	1,257	0	1	0	5,828	102	7,188
2004	MIDLAND	EDWARDS-TRINITY-PLATEAU AQUIFER	1,261	0	1	0	8,389	94	9,745

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2005	MIDLAND	EDWARDS-TRINITY-PLATEAU AQUIFER	1,324	0	1	0	8,982	181	10,488
2006	MIDLAND	EDWARDS-TRINITY-PLATEAU AQUIFER	1,643	0	1	0	9,851	216	11,711
2007	MIDLAND	EDWARDS-TRINITY-PLATEAU AQUIFER	1,376	0	1	0	7,403	243	9,023
2008	MIDLAND	EDWARDS-TRINITY-PLATEAU AQUIFER	1,636	0	0	0	9,584	157	11,377
2009	MIDLAND	EDWARDS-TRINITY-PLATEAU AQUIFER	2,191	0	0	0	9,997	211	12,399
2010	MIDLAND	EDWARDS-TRINITY-PLATEAU AQUIFER	2,112	0	0	0	7,128	158	9,398
2011	MIDLAND	EDWARDS-TRINITY-PLATEAU AQUIFER	3,229	0	0	0	10,087	165	13,481
2012	MIDLAND	EDWARDS-TRINITY-PLATEAU AQUIFER	3,114	0	0	0	9,715	140	12,969
2000	NOLAN	EDWARDS-TRINITY-PLATEAU AQUIFER	669	70	0	0	39	22	800
2001	NOLAN	EDWARDS-TRINITY-PLATEAU AQUIFER	2,559	76	0	0	23	10	2,668
2002	NOLAN	EDWARDS-TRINITY-PLATEAU AQUIFER	2,908	79	0	0	23	10	3,020
2003	NOLAN	EDWARDS-TRINITY-PLATEAU AQUIFER	3,390	79	0	0	25	7	3,501
2004	NOLAN	EDWARDS-TRINITY-PLATEAU AQUIFER	2,454	79	0	0	33	11	2,577
2005	NOLAN	EDWARDS-TRINITY-PLATEAU AQUIFER	2,210	105	0	0	43	143	2,501
2006	NOLAN	EDWARDS-TRINITY-PLATEAU AQUIFER	3,108	105	0	0	42	165	3,420
2007	NOLAN	EDWARDS-TRINITY-PLATEAU AQUIFER	2,905	136	0	0	47	156	3,244
2008	NOLAN	EDWARDS-TRINITY-PLATEAU AQUIFER	2,945	132	0	0	81	150	3,308
2009	NOLAN	EDWARDS-TRINITY-PLATEAU AQUIFER	2,283	86	0	0	90	143	2,602
2010	NOLAN	EDWARDS-TRINITY-PLATEAU AQUIFER	1,927	11	0	0	65	131	2,134
2011	NOLAN	EDWARDS-TRINITY-PLATEAU AQUIFER	2,307	15	0	0	98	133	2,553
2012	NOLAN	EDWARDS-TRINITY-PLATEAU AQUIFER	2,046	19	0	0	100	117	2,282
2000	PECOS	EDWARDS-TRINITY-PLATEAU AQUIFER	5,373	263	6	938	43,237	718	50,535
2001	PECOS	EDWARDS-TRINITY-PLATEAU AQUIFER	4,235	143	5	908	38,367	757	44,415
2002	PECOS	EDWARDS-TRINITY-PLATEAU AQUIFER	4,100	54	2	908	36,575	669	42,308
2003	PECOS	EDWARDS-TRINITY-PLATEAU AQUIFER	4,171	52	0	647	22,477	573	27,920
2004	PECOS	EDWARDS-TRINITY-PLATEAU AQUIFER	3,667	88	0	0	25,364	630	29,749
2005	PECOS	EDWARDS-TRINITY-PLATEAU AQUIFER	4,656	92	0	0	24,722	669	30,139
2006	PECOS	EDWARDS-TRINITY-PLATEAU AQUIFER	4,415	79	0	0	36,964	749	42,207
2007	PECOS	EDWARDS-TRINITY-PLATEAU AQUIFER	4,831	129	0	0	32,579	581	38,120

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2008	PECOS	EDWARDS-TRINITY-PLATEAU AQUIFER	5,533	75	0	0	33,983	654	40,245
2009	PECOS	EDWARDS-TRINITY-PLATEAU AQUIFER	5,203	73	0	0	54,244	603	60,123
2010	PECOS	EDWARDS-TRINITY-PLATEAU AQUIFER	5,369	149	0	0	73,249	594	79,361
2011	PECOS	EDWARDS-TRINITY-PLATEAU AQUIFER	6,925	152	0	0	74,691	586	82,354
2012	PECOS	EDWARDS-TRINITY-PLATEAU AQUIFER	4,601	159	0	0	65,828	523	71,111
2000	REAGAN	EDWARDS-TRINITY-PLATEAU AQUIFER	148	0	0	0	15,735	167	16,050
2001	REAGAN	EDWARDS-TRINITY-PLATEAU AQUIFER	848	0	0	0	11,624	132	12,604
2002	REAGAN	EDWARDS-TRINITY-PLATEAU AQUIFER	849	0	0	0	14,746	132	15,727
2003	REAGAN	EDWARDS-TRINITY-PLATEAU AQUIFER	848	0	0	0	9,911	73	10,832
2004	REAGAN	EDWARDS-TRINITY-PLATEAU AQUIFER	845	0	0	0	10,300	79	11,224
2005	REAGAN	EDWARDS-TRINITY-PLATEAU AQUIFER	750	0	0	0	12,164	150	13,064
2006	REAGAN	EDWARDS-TRINITY-PLATEAU AQUIFER	879	0	0	0	18,599	120	19,598
2007	REAGAN	EDWARDS-TRINITY-PLATEAU AQUIFER	796	0	0	0	16,863	127	17,786
2008	REAGAN	EDWARDS-TRINITY-PLATEAU AQUIFER	751	0	0	0	19,305	223	20,279
2009	REAGAN	EDWARDS-TRINITY-PLATEAU AQUIFER	762	0	0	0	16,577	224	17,563
2010	REAGAN	EDWARDS-TRINITY-PLATEAU AQUIFER	603	0	0	0	19,238	189	20,030
2011	REAGAN	EDWARDS-TRINITY-PLATEAU AQUIFER	767	0	0	0	26,164	188	27,119
2012	REAGAN	EDWARDS-TRINITY-PLATEAU AQUIFER	717	0	0	0	19,681	167	20,565
2000	REAL	EDWARDS-TRINITY-PLATEAU AQUIFER	103	0	0	0	21	131	255
2001	REAL	EDWARDS-TRINITY-PLATEAU AQUIFER	89	0	0	0	22	85	196
2002	REAL	EDWARDS-TRINITY-PLATEAU AQUIFER	95	0	0	0	22	86	203
2003	REAL	EDWARDS-TRINITY-PLATEAU AQUIFER	105	0	0	0	17	76	198
2004	REAL	EDWARDS-TRINITY-PLATEAU AQUIFER	224	0	0	0	72	74	370
2005	REAL	EDWARDS-TRINITY-PLATEAU AQUIFER	251	0	0	0	92	118	461
2006	REAL	EDWARDS-TRINITY-PLATEAU AQUIFER	263	0	0	0	284	93	640
2007	REAL	EDWARDS-TRINITY-PLATEAU AQUIFER	214	0	0	0	0	105	319
2008	REAL	EDWARDS-TRINITY-PLATEAU AQUIFER	254	0	0	0	50	93	397
2009	REAL	EDWARDS-TRINITY-PLATEAU AQUIFER	269	0	0	0	0	98	367
2010	REAL	EDWARDS-TRINITY-PLATEAU AQUIFER	471	0	0	0	88	187	746

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2011	REAL	EDWARDS-TRINITY-PLATEAU AQUIFER	511	0	0	0	188	194	893
2012	REAL	EDWARDS-TRINITY-PLATEAU AQUIFER	442	0	0	0	99	79	620
2000	RUNNELS	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	4	4
2001	RUNNELS	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	4	4
2002	RUNNELS	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	4	4
2003	RUNNELS	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	3	3
2004	RUNNELS	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	3	3
2005	RUNNELS	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	15	15
2006	RUNNELS	EDWARDS-TRINITY-PLATEAU AQUIFER	3	0	0	0	0	16	19
2007	RUNNELS	EDWARDS-TRINITY-PLATEAU AQUIFER	2	0	0	0	0	15	17
2008	RUNNELS	EDWARDS-TRINITY-PLATEAU AQUIFER	3	0	0	0	0	17	20
2009	RUNNELS	EDWARDS-TRINITY-PLATEAU AQUIFER	3	0	0	0	0	16	19
2010	RUNNELS	EDWARDS-TRINITY-PLATEAU AQUIFER	4	0	0	0	0	17	21
2011	RUNNELS	EDWARDS-TRINITY-PLATEAU AQUIFER	4	0	0	0	0	18	22
2012	RUNNELS	EDWARDS-TRINITY-PLATEAU AQUIFER	4	0	0	0	0	11	15
2000	SCHLEICHER	EDWARDS-TRINITY-PLATEAU AQUIFER	657	0	18	0	2,150	438	3,263
2001	SCHLEICHER	EDWARDS-TRINITY-PLATEAU AQUIFER	552	0	18	0	1,294	273	2,137
2002	SCHLEICHER	EDWARDS-TRINITY-PLATEAU AQUIFER	591	0	17	0	1,300	243	2,151
2003	SCHLEICHER	EDWARDS-TRINITY-PLATEAU AQUIFER	461	0	18	0	964	222	1,665
2004	SCHLEICHER	EDWARDS-TRINITY-PLATEAU AQUIFER	485	0	18	0	734	247	1,484
2005	SCHLEICHER	EDWARDS-TRINITY-PLATEAU AQUIFER	473	0	18	0	762	477	1,730
2006	SCHLEICHER	EDWARDS-TRINITY-PLATEAU AQUIFER	480	0	18	0	1,005	506	2,009
2007	SCHLEICHER	EDWARDS-TRINITY-PLATEAU AQUIFER	484	0	17	0	500	508	1,509
2008	SCHLEICHER	EDWARDS-TRINITY-PLATEAU AQUIFER	610	0	0	0	1,095	467	2,172
2009	SCHLEICHER	EDWARDS-TRINITY-PLATEAU AQUIFER	613	0	0	0	1,432	463	2,508
2010	SCHLEICHER	EDWARDS-TRINITY-PLATEAU AQUIFER	616	0	0	0	1,442	422	2,480
2011	SCHLEICHER	EDWARDS-TRINITY-PLATEAU AQUIFER	806	0	0	0	1,941	414	3,161
2012	SCHLEICHER	EDWARDS-TRINITY-PLATEAU AQUIFER	652	0	0	0	2,020	364	3,036
2000	STERLING	EDWARDS-TRINITY-PLATEAU AQUIFER	4	0	0	0	235	214	453

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2001	STERLING	EDWARDS-TRINITY-PLATEAU AQUIFER	5	0	0	0	251	270	526
2002	STERLING	EDWARDS-TRINITY-PLATEAU AQUIFER	5	0	0	0	264	236	505
2003	STERLING	EDWARDS-TRINITY-PLATEAU AQUIFER	5	0	0	0	226	145	376
2004	STERLING	EDWARDS-TRINITY-PLATEAU AQUIFER	5	0	0	0	183	164	352
2005	STERLING	EDWARDS-TRINITY-PLATEAU AQUIFER	5	0	0	0	166	208	379
2006	STERLING	EDWARDS-TRINITY-PLATEAU AQUIFER	20	0	0	0	221	217	458
2007	STERLING	EDWARDS-TRINITY-PLATEAU AQUIFER	16	0	0	0	176	236	428
2008	STERLING	EDWARDS-TRINITY-PLATEAU AQUIFER	19	0	0	0	272	196	487
2009	STERLING	EDWARDS-TRINITY-PLATEAU AQUIFER	19	0	0	0	378	208	605
2010	STERLING	EDWARDS-TRINITY-PLATEAU AQUIFER	20	0	0	0	253	183	456
2011	STERLING	EDWARDS-TRINITY-PLATEAU AQUIFER	20	0	0	0	360	176	556
2012	STERLING	EDWARDS-TRINITY-PLATEAU AQUIFER	19	0	0	0	313	157	489
2000	SUTTON	EDWARDS-TRINITY-PLATEAU AQUIFER	1,389	0	0	0	1,234	440	3,063
2001	SUTTON	EDWARDS-TRINITY-PLATEAU AQUIFER	1,338	0	0	0	1,114	208	2,660
2002	SUTTON	EDWARDS-TRINITY-PLATEAU AQUIFER	1,339	0	0	0	1,114	188	2,641
2003	SUTTON	EDWARDS-TRINITY-PLATEAU AQUIFER	1,243	0	0	0	292	150	1,685
2004	SUTTON	EDWARDS-TRINITY-PLATEAU AQUIFER	1,108	0	0	0	292	141	1,541
2005	SUTTON	EDWARDS-TRINITY-PLATEAU AQUIFER	1,142	0	0	0	1,249	396	2,787
2006	SUTTON	EDWARDS-TRINITY-PLATEAU AQUIFER	1,247	0	0	0	1,407	363	3,017
2007	SUTTON	EDWARDS-TRINITY-PLATEAU AQUIFER	1,024	0	0	0	1,542	395	2,961
2008	SUTTON	EDWARDS-TRINITY-PLATEAU AQUIFER	1,141	0	0	0	342	469	1,952
2009	SUTTON	EDWARDS-TRINITY-PLATEAU AQUIFER	891	0	0	0	567	458	1,916
2010	SUTTON	EDWARDS-TRINITY-PLATEAU AQUIFER	928	0	0	0	958	477	2,363
2011	SUTTON	EDWARDS-TRINITY-PLATEAU AQUIFER	1,285	0	0	0	1,256	495	3,036
2012	SUTTON	EDWARDS-TRINITY-PLATEAU AQUIFER	1,267	0	0	0	859	360	2,486
2000	TAYLOR	EDWARDS-TRINITY-PLATEAU AQUIFER	88	0	0	0	3	25	116
2001	TAYLOR	EDWARDS-TRINITY-PLATEAU AQUIFER	88	0	0	0	8	10	106
2002	TAYLOR	EDWARDS-TRINITY-PLATEAU AQUIFER	88	0	0	0	6	7	101
2003	TAYLOR	EDWARDS-TRINITY-PLATEAU AQUIFER	87	0	0	0	1	6	94

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2004	TAYLOR	EDWARDS-TRINITY-PLATEAU AQUIFER	85	0	0	0	1	11	97
2005	TAYLOR	EDWARDS-TRINITY-PLATEAU AQUIFER	91	0	0	0	28	32	151
2006	TAYLOR	EDWARDS-TRINITY-PLATEAU AQUIFER	123	0	0	0	26	42	191
2007	TAYLOR	EDWARDS-TRINITY-PLATEAU AQUIFER	102	0	0	0	14	36	152
2008	TAYLOR	EDWARDS-TRINITY-PLATEAU AQUIFER	113	0	0	0	0	90	203
2009	TAYLOR	EDWARDS-TRINITY-PLATEAU AQUIFER	219	0	0	0	7	82	308
2010	TAYLOR	EDWARDS-TRINITY-PLATEAU AQUIFER	328	0	0	0	21	44	393
2011	TAYLOR	EDWARDS-TRINITY-PLATEAU AQUIFER	279	0	0	0	52	47	378
2012	TAYLOR	EDWARDS-TRINITY-PLATEAU AQUIFER	293	0	0	0	19	37	349
2000	TERRELL	EDWARDS-TRINITY-PLATEAU AQUIFER	217	0	5	0	0	292	514
2001	TERRELL	EDWARDS-TRINITY-PLATEAU AQUIFER	200	0	5	0	0	280	485
2002	TERRELL	EDWARDS-TRINITY-PLATEAU AQUIFER	178	0	5	0	0	234	417
2003	TERRELL	EDWARDS-TRINITY-PLATEAU AQUIFER	175	0	5	0	0	189	369
2004	TERRELL	EDWARDS-TRINITY-PLATEAU AQUIFER	147	0	5	0	0	207	359
2005	TERRELL	EDWARDS-TRINITY-PLATEAU AQUIFER	181	0	4	0	0	233	418
2006	TERRELL	EDWARDS-TRINITY-PLATEAU AQUIFER	196	0	5	0	0	211	412
2007	TERRELL	EDWARDS-TRINITY-PLATEAU AQUIFER	192	0	4	0	255	170	621
2008	TERRELL	EDWARDS-TRINITY-PLATEAU AQUIFER	178	0	4	0	0	193	375
2009	TERRELL	EDWARDS-TRINITY-PLATEAU AQUIFER	196	0	4	0	154	206	560
2010	TERRELL	EDWARDS-TRINITY-PLATEAU AQUIFER	202	0	4	0	173	182	561
2011	TERRELL	EDWARDS-TRINITY-PLATEAU AQUIFER	218	0	9	0	398	179	804
2012	TERRELL	EDWARDS-TRINITY-PLATEAU AQUIFER	186	0	9	0	41	163	399
2000	TOM GREEN	EDWARDS-TRINITY-PLATEAU AQUIFER	123	0	0	0	131	137	391
2001	TOM GREEN	EDWARDS-TRINITY-PLATEAU AQUIFER	75	0	0	0	171	125	371
2002	TOM GREEN	EDWARDS-TRINITY-PLATEAU AQUIFER	94	0	0	0	183	143	420
2003	TOM GREEN	EDWARDS-TRINITY-PLATEAU AQUIFER	95	0	0	0	166	122	383
2004	TOM GREEN	EDWARDS-TRINITY-PLATEAU AQUIFER	92	0	0	0	538	98	728
2005	TOM GREEN	EDWARDS-TRINITY-PLATEAU AQUIFER	97	0	0	0	615	841	1,553
2006	TOM GREEN	EDWARDS-TRINITY-PLATEAU AQUIFER	129	0	0	0	731	921	1,781

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2007	TOM GREEN	EDWARDS-TRINITY-PLATEAU AQUIFER	109	0	0	0	1,520	615	2,244
2008	TOM GREEN	EDWARDS-TRINITY-PLATEAU AQUIFER	199	0	0	0	1,896	844	2,939
2009	TOM GREEN	EDWARDS-TRINITY-PLATEAU AQUIFER	448	0	0	0	1,474	764	2,686
2010	TOM GREEN	EDWARDS-TRINITY-PLATEAU AQUIFER	613	0	0	0	836	786	2,235
2011	TOM GREEN	EDWARDS-TRINITY-PLATEAU AQUIFER	825	0	0	0	174	864	1,863
2012	TOM GREEN	EDWARDS-TRINITY-PLATEAU AQUIFER	672	0	0	0	1,166	747	2,585
2000	UPTON	EDWARDS-TRINITY-PLATEAU AQUIFER	1,006	0	0	0	12,236	131	13,373
2001	UPTON	EDWARDS-TRINITY-PLATEAU AQUIFER	1,051	0	0	0	8,553	60	9,664
2002	UPTON	EDWARDS-TRINITY-PLATEAU AQUIFER	683	0	0	0	7,962	53	8,698
2003	UPTON	EDWARDS-TRINITY-PLATEAU AQUIFER	779	0	0	0	7,792	35	8,606
2004	UPTON	EDWARDS-TRINITY-PLATEAU AQUIFER	369	0	0	0	7,000	40	7,409
2005	UPTON	EDWARDS-TRINITY-PLATEAU AQUIFER	759	0	0	0	6,584	98	7,441
2006	UPTON	EDWARDS-TRINITY-PLATEAU AQUIFER	663	0	0	0	7,195	98	7,956
2007	UPTON	EDWARDS-TRINITY-PLATEAU AQUIFER	297	0	0	0	6,253	94	6,644
2008	UPTON	EDWARDS-TRINITY-PLATEAU AQUIFER	305	0	0	0	8,984	113	9,402
2009	UPTON	EDWARDS-TRINITY-PLATEAU AQUIFER	411	0	0	0	7,873	111	8,395
2010	UPTON	EDWARDS-TRINITY-PLATEAU AQUIFER	430	0	0	0	9,395	90	9,915
2011	UPTON	EDWARDS-TRINITY-PLATEAU AQUIFER	450	0	0	0	13,651	87	14,188
2012	UPTON	EDWARDS-TRINITY-PLATEAU AQUIFER	286	0	0	0	10,033	75	10,394
2000	UVALDE	EDWARDS-TRINITY-PLATEAU AQUIFER	30	0	0	0	0	381	411
2001	UVALDE	EDWARDS-TRINITY-PLATEAU AQUIFER	39	0	0	0	0	351	390
2002	UVALDE	EDWARDS-TRINITY-PLATEAU AQUIFER	41	0	0	0	0	343	384
2003	UVALDE	EDWARDS-TRINITY-PLATEAU AQUIFER	42	0	0	0	0	374	416
2004	UVALDE	EDWARDS-TRINITY-PLATEAU AQUIFER	41	0	0	0	0	40	81
2005	UVALDE	EDWARDS-TRINITY-PLATEAU AQUIFER	44	0	0	0	0	61	105
2006	UVALDE	EDWARDS-TRINITY-PLATEAU AQUIFER	25	0	0	0	0	59	84
2007	UVALDE	EDWARDS-TRINITY-PLATEAU AQUIFER	21	0	0	0	0	60	81
2008	UVALDE	EDWARDS-TRINITY-PLATEAU AQUIFER	23	0	0	0	0	53	76
2009	UVALDE	EDWARDS-TRINITY-PLATEAU AQUIFER	95	0	0	0	0	45	140

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2010	UVALDE	EDWARDS-TRINITY-PLATEAU AQUIFER	466	0	0	0	0	47	513
2011	UVALDE	EDWARDS-TRINITY-PLATEAU AQUIFER	417	0	0	0	0	49	466
2012	UVALDE	EDWARDS-TRINITY-PLATEAU AQUIFER	440	0	0	0	0	42	482
2000	VAL VERDE	EDWARDS-TRINITY-PLATEAU AQUIFER	15,766	0	0	0	245	604	16,615
2001	VAL VERDE	EDWARDS-TRINITY-PLATEAU AQUIFER	15,769	0	0	0	287	607	16,663
2002	VAL VERDE	EDWARDS-TRINITY-PLATEAU AQUIFER	15,783	0	0	0	293	541	16,617
2003	VAL VERDE	EDWARDS-TRINITY-PLATEAU AQUIFER	15,778	0	0	0	209	464	16,451
2004	VAL VERDE	EDWARDS-TRINITY-PLATEAU AQUIFER	15,746	0	0	0	97	419	16,262
2005	VAL VERDE	EDWARDS-TRINITY-PLATEAU AQUIFER	15,828	0	0	0	133	482	16,443
2006	VAL VERDE	EDWARDS-TRINITY-PLATEAU AQUIFER	11,297	0	0	0	136	464	11,897
2007	VAL VERDE	EDWARDS-TRINITY-PLATEAU AQUIFER	834	0	0	0	31	408	1,273
2008	VAL VERDE	EDWARDS-TRINITY-PLATEAU AQUIFER	903	0	0	0	16	497	1,416
2009	VAL VERDE	EDWARDS-TRINITY-PLATEAU AQUIFER	1,755	0	0	0	0	488	2,243
2010	VAL VERDE	EDWARDS-TRINITY-PLATEAU AQUIFER	11,292	0	0	0	251	458	12,001
2011	VAL VERDE	EDWARDS-TRINITY-PLATEAU AQUIFER	13,053	0	0	0	130	459	13,642
2012	VAL VERDE	EDWARDS-TRINITY-PLATEAU AQUIFER	12,677	0	0	0	61	407	13,145
2000	CROCKETT	PECOS AQUIFER	0	0	0	0	0	0	0
2001	CROCKETT	PECOS AQUIFER	0	0	0	0	0	0	0
2002	CROCKETT	PECOS AQUIFER	0	0	0	0	0	0	0
2003	CROCKETT	PECOS AQUIFER	0	0	0	0	0	0	0
2004	CROCKETT	PECOS AQUIFER	0	0	0	0	0	0	0
2005	CROCKETT	PECOS AQUIFER	0	0	0	0	0	0	0
2006	CROCKETT	PECOS AQUIFER	0	0	0	0	0	0	0
2007	CROCKETT	PECOS AQUIFER	0	0	0	0	0	0	0
2008	CROCKETT	PECOS AQUIFER	0	0	0	0	0	0	0
2009	CROCKETT	PECOS AQUIFER	0	0	0	0	0	0	0
2010	CROCKETT	PECOS AQUIFER	0	0	0	0	0	0	0
2011	CROCKETT	PECOS AQUIFER	0	0	0	0	0	0	0
2012	CROCKETT	PECOS AQUIFER	0	0	0	0	0	0	0
2000	ECTOR	PECOS AQUIFER	158	0	24	0	0	19	201

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2001	ECTOR	PECOS AQUIFER	209	0	24	0	0	6	239
2002	ECTOR	PECOS AQUIFER	213	0	13	0	0	5	231
2003	ECTOR	PECOS AQUIFER	214	0	13	0	0	4	231
2004	ECTOR	PECOS AQUIFER	207	0	13	0	0	0	220
2005	ECTOR	PECOS AQUIFER	222	0	13	0	0	0	235
2006	ECTOR	PECOS AQUIFER	0	0	13	0	0	0	13
2007	ECTOR	PECOS AQUIFER	0	0	13	0	0	0	13
2008	ECTOR	PECOS AQUIFER	0	0	13	0	0	0	13
2009	ECTOR	PECOS AQUIFER	0	0	13	0	0	0	13
2010	ECTOR	PECOS AQUIFER	0	0	13	0	0	0	13
2011	ECTOR	PECOS AQUIFER	0	0	13	0	0	0	13
2012	ECTOR	PECOS AQUIFER	0	0	13	0	0	0	13
2000	PECOS	PECOS AQUIFER	411	0	9	0	19,797	188	20,405
2001	PECOS	PECOS AQUIFER	382	0	7	0	17,567	198	18,154
2002	PECOS	PECOS AQUIFER	361	0	6	0	16,747	175	17,289
2003	PECOS	PECOS AQUIFER	328	0	6	0	10,292	149	10,775
2004	PECOS	PECOS AQUIFER	327	0	5	0	11,613	58	12,003
2005	PECOS	PECOS AQUIFER	328	0	5	0	11,320	61	11,714
2006	PECOS	PECOS AQUIFER	331	0	5	0	16,925	69	17,330
2007	PECOS	PECOS AQUIFER	351	0	5	0	14,917	53	15,326
2008	PECOS	PECOS AQUIFER	425	63	2	0	15,560	60	16,110
2009	PECOS	PECOS AQUIFER	431	63	2	0	24,837	55	25,388
2010	PECOS	PECOS AQUIFER	45	65	0	0	33,539	54	33,703
2011	PECOS	PECOS AQUIFER	241	75	0	0	34,200	54	34,570
2012	PECOS	PECOS AQUIFER	208	76	13	0	30,142	48	30,487
2000	UPTON	PECOS AQUIFER	0	0	0	0	0	1	1
2001	UPTON	PECOS AQUIFER	0	0	0	0	0	0	0
2002	UPTON	PECOS AQUIFER	0	0	0	0	0	0	0
2003	UPTON	PECOS AQUIFER	0	0	0	0	0	0	0
2004	UPTON	PECOS AQUIFER	0	0	0	0	0	0	0
2005	UPTON	PECOS AQUIFER	0	0	0	0	0	1	1
2006	UPTON	PECOS AQUIFER	0	0	0	0	0	1	1

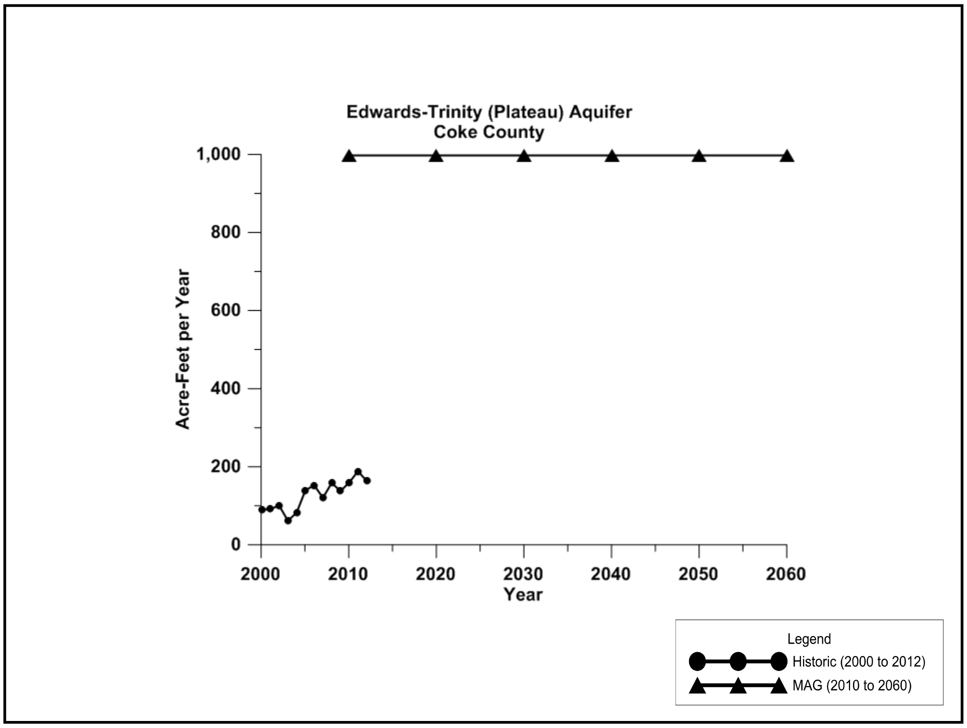
Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2007	UPTON	PECOS AQUIFER	0	0	0	0	0	1	1
2008	UPTON	PECOS AQUIFER	0	0	0	0	0	0	0
2009	UPTON	PECOS AQUIFER	0	0	0	0	0	0	0
2010	UPTON	PECOS AQUIFER	0	0	0	0	0	0	0
2011	UPTON	PECOS AQUIFER	0	0	0	0	0	0	0
2012	UPTON	PECOS AQUIFER	0	0	0	0	0	0	0
2000	GILLESPIE	TRINITY AQUIFER	542	0	0	0	982	148	1,672
2001	GILLESPIE	TRINITY AQUIFER	517	0	0	0	1,123	128	1,768
2002	GILLESPIE	TRINITY AQUIFER	553	0	0	0	1,123	127	1,803
2003	GILLESPIE	TRINITY AQUIFER	629	0	0	0	1,123	119	1,871
2004	GILLESPIE	TRINITY AQUIFER	610	0	0	0	1,189	73	1,872
2005	GILLESPIE	TRINITY AQUIFER	666	0	0	0	968	111	1,745
2006	GILLESPIE	TRINITY AQUIFER	719	0	0	0	1,059	110	1,888
2007	GILLESPIE	TRINITY AQUIFER	616	0	0	0	90	115	821
2008	GILLESPIE	TRINITY AQUIFER	681	0	0	0	985	127	1,793
2009	GILLESPIE	TRINITY AQUIFER	653	0	0	0	958	118	1,729
2010	GILLESPIE	TRINITY AQUIFER	706	0	0	0	638	245	1,589
2011	GILLESPIE	TRINITY AQUIFER	774	0	0	0	1,577	252	2,603
2012	GILLESPIE	TRINITY AQUIFER	748	0	0	0	971	119	1,838
2000	REAL	TRINITY AQUIFER	0	0	0	0	2	9	11
2001	REAL	TRINITY AQUIFER	0	0	0	0	2	7	9
2002	REAL	TRINITY AQUIFER	0	0	0	0	2	7	9
2003	REAL	TRINITY AQUIFER	0	0	0	0	1	6	7
2004	REAL	TRINITY AQUIFER	0	0	0	0	6	6	12
2005	REAL	TRINITY AQUIFER	0	0	0	0	8	10	18
2006	REAL	TRINITY AQUIFER	0	0	0	0	24	8	32
2007	REAL	TRINITY AQUIFER	0	0	0	0	0	9	9
2008	REAL	TRINITY AQUIFER	0	0	0	0	4	8	12
2009	REAL	TRINITY AQUIFER	0	0	0	0	0	8	8
2010	REAL	TRINITY AQUIFER	0	0	0	0	7	15	22
2011	REAL	TRINITY AQUIFER	31	0	0	0	15	15	61
2012	REAL	TRINITY AQUIFER	2	0	0	0	8	6	16

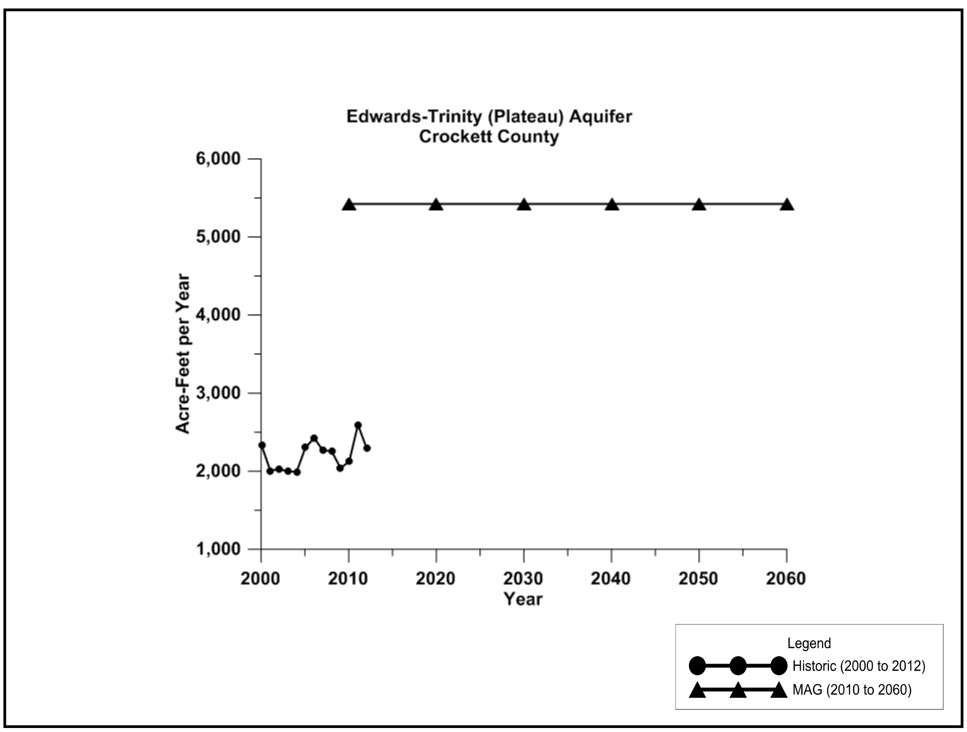
Appendix B - Historic Pumping from the Edwards-Trinity (Plateau), Pecos Valley and Trinity Aquifers

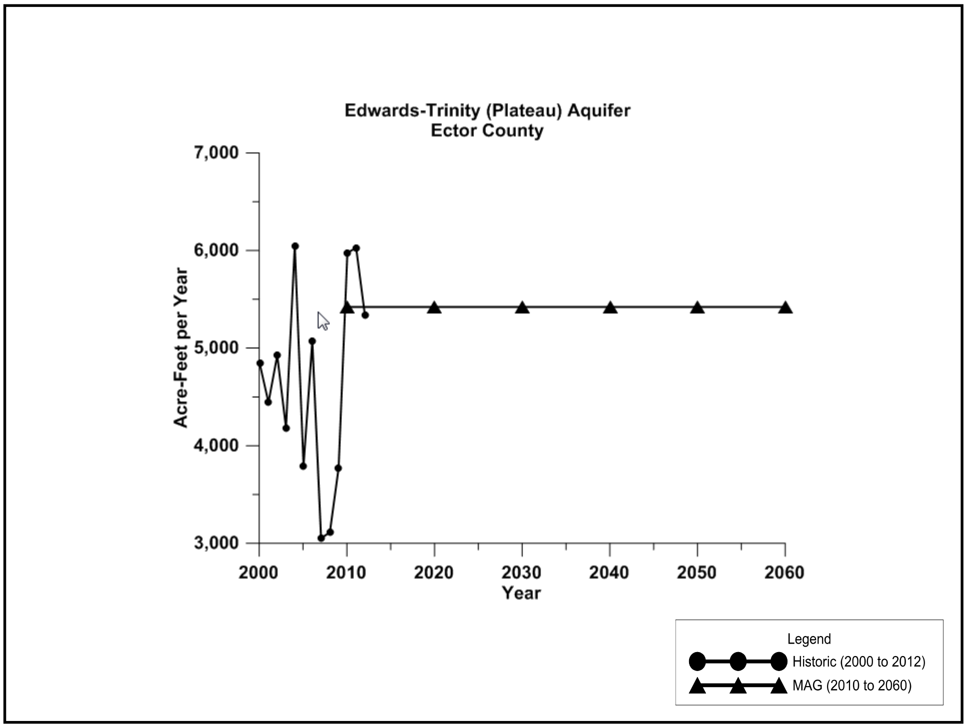
Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2000	UVALDE	TRINITY AQUIFER	0	0	0	0	0	49	49
2001	UVALDE	TRINITY AQUIFER	0	0	0	0	0	46	46
2002	UVALDE	TRINITY AQUIFER	0	0	0	0	0	45	45
2003	UVALDE	TRINITY AQUIFER	0	0	0	0	0	43	43
2004	UVALDE	TRINITY AQUIFER	0	0	0	0	0	40	40
2005	UVALDE	TRINITY AQUIFER	0	0	0	0	0	61	61
2006	UVALDE	TRINITY AQUIFER	37	0	0	0	0	59	96
2007	UVALDE	TRINITY AQUIFER	31	0	0	0	0	60	91
2008	UVALDE	TRINITY AQUIFER	117	0	0	0	0	53	170
2009	UVALDE	TRINITY AQUIFER	118	0	0	0	0	45	163
2010	UVALDE	TRINITY AQUIFER	199	0	0	0	0	47	246
2011	UVALDE	TRINITY AQUIFER	208	0	0	0	0	49	257
2012	UVALDE	TRINITY AQUIFER	153	0	0	0	0	42	195

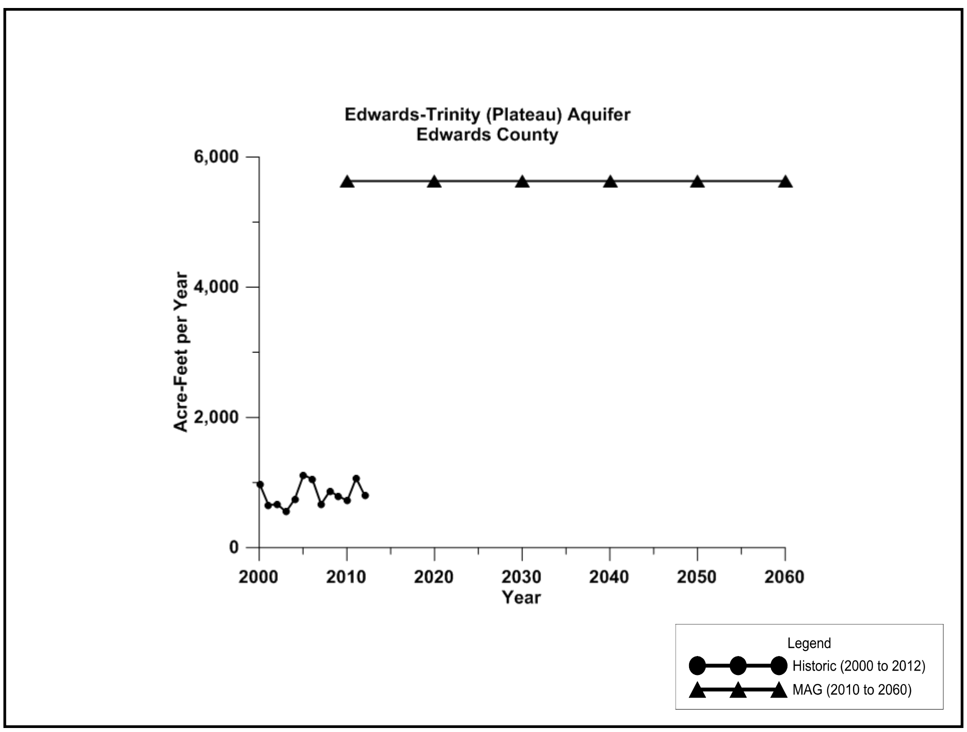
Appendix C

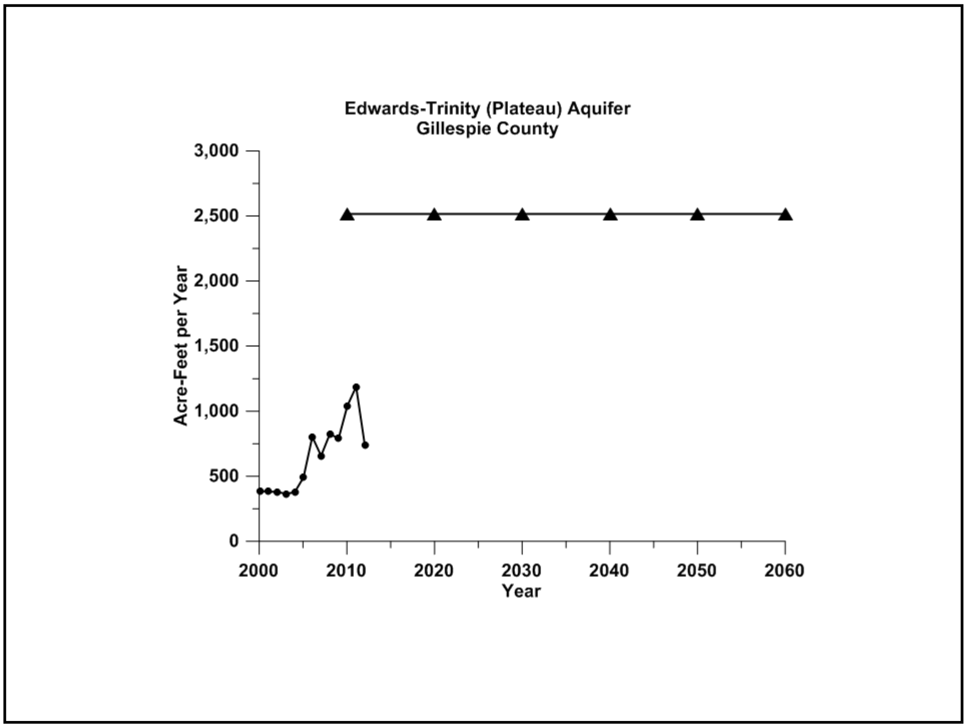
Hydrographs Comparing Historic Pumping and Modeled Available Groundwater from the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers

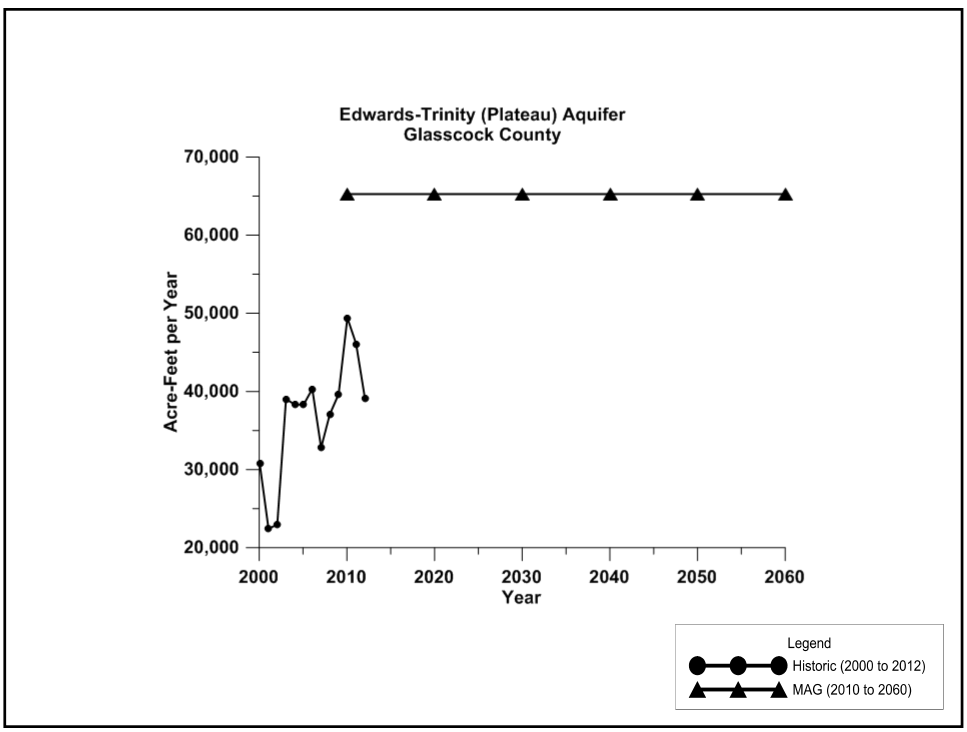

Edwards-Trinity (Plateau) Aquifer
Coke County
1,000
800
600
400
200
0
Acre-Feet per Year
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

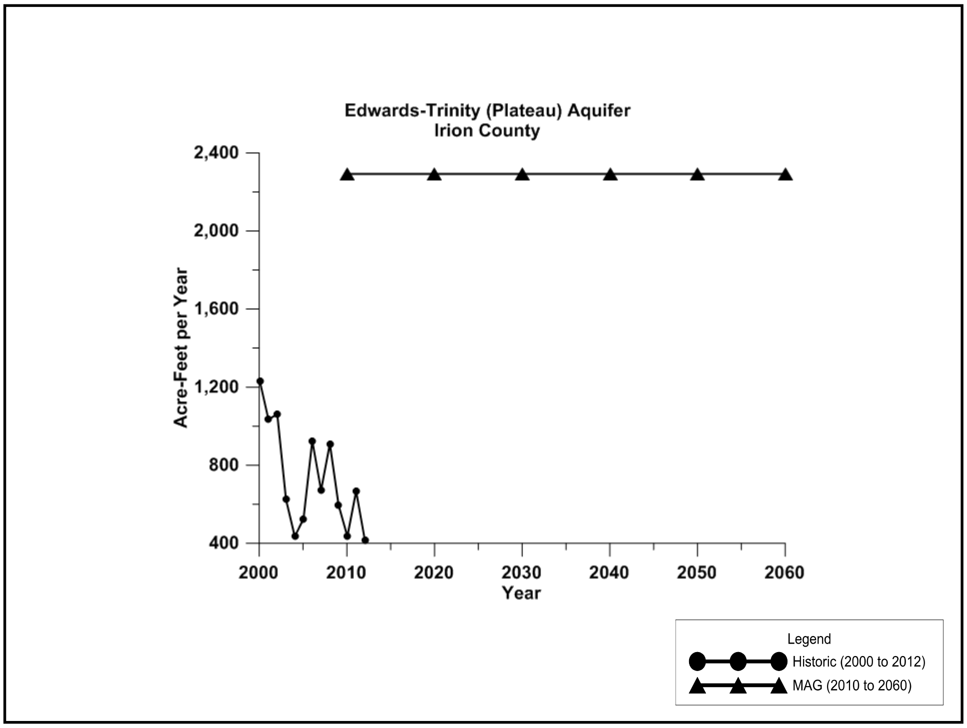

Edwards-Trinity (Plateau) Aquifer
Crockett County
6,000
5,000
4,000
3,000
2,000
1,000
Acre-Feet per Year
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)


Edwards-Trinity (Plateau) Aquifer
Ector County
7,000
6,000
5,000
4,000
3,000
Acre-Feet per Year
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

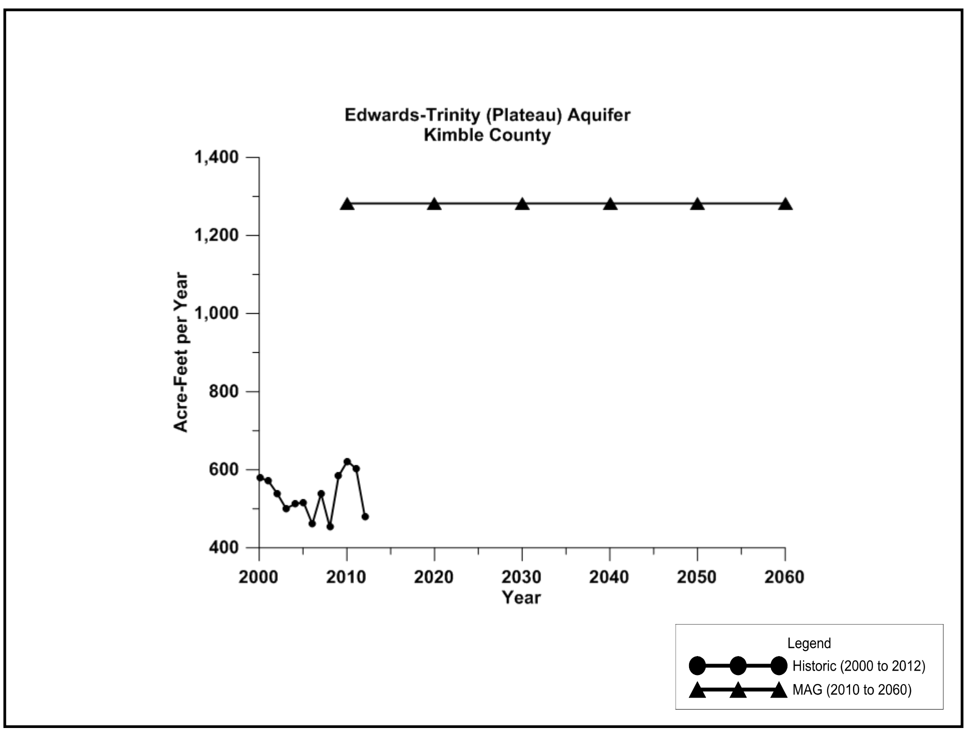

Edwards-Trinity (Plateau) Aquifer
Edwards County
6,000
4,000
2,000
0
Acre-Feet per Year
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)


Edwards-Trinity (Plateau) Aquifer
Gillespie County
3,000
2,500
2,000
1,500
1,000
500
0
Acre-Feet per Year
2000
2010
2020
2030
2040
2050
2060
Year

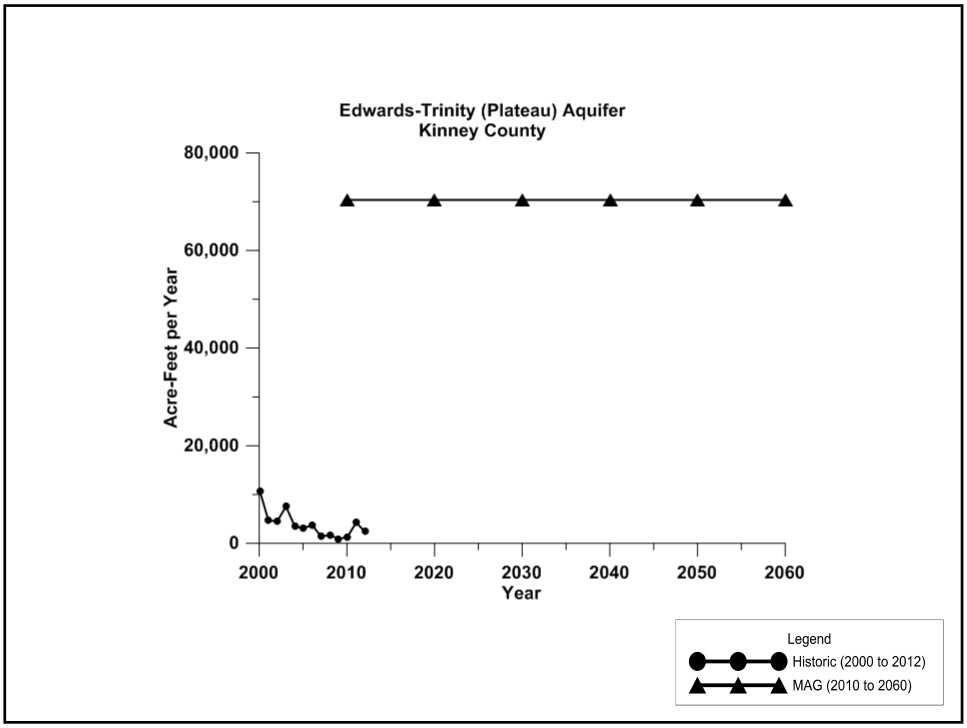

Edwards-Trinity (Plateau) Aquifer
Glasscock County
70,000
60,000
50,000
40,000
30,000
20,000
Acre-Feet per Year
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

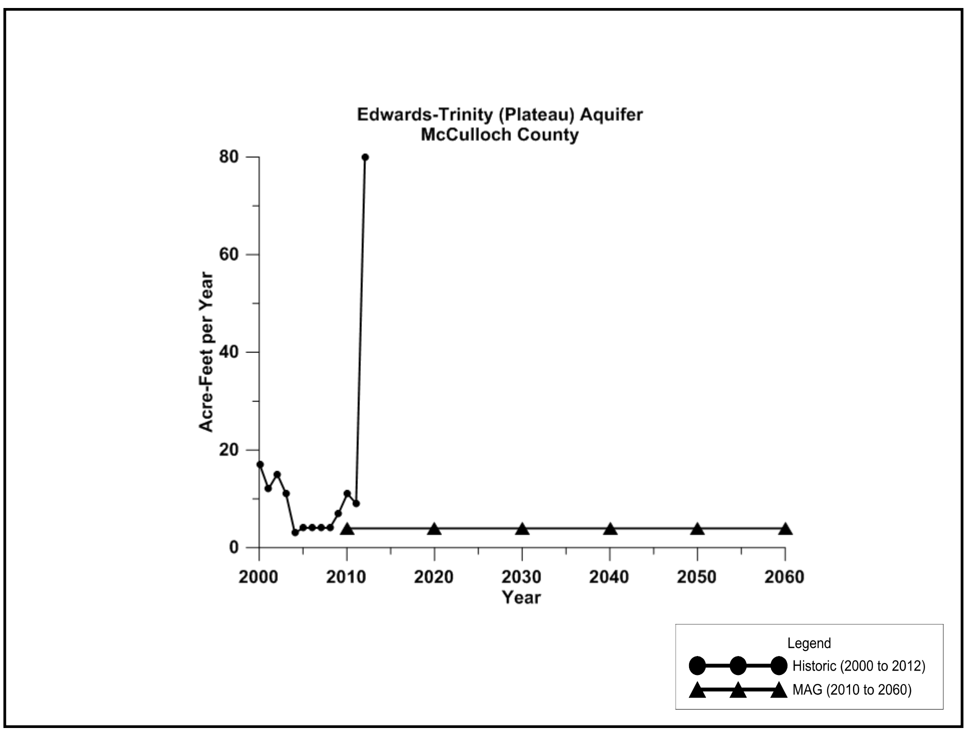


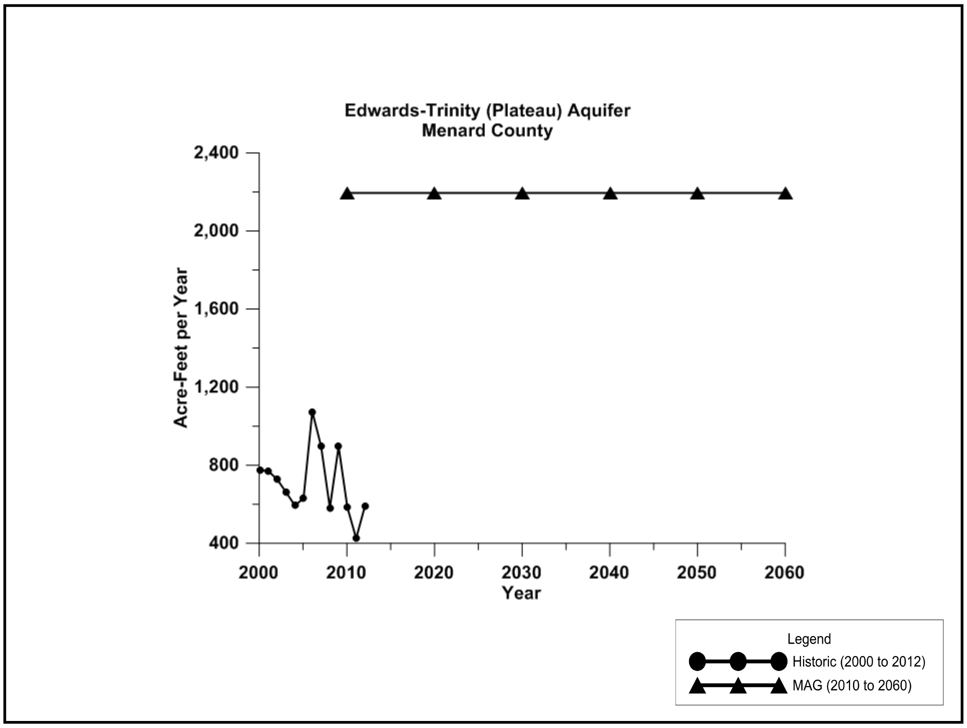
Edwards-Trinity (Plateau) Aquifer
Irion County
Acre-Feet per Year
2,400
2,000
1,600
1,200
800
400
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

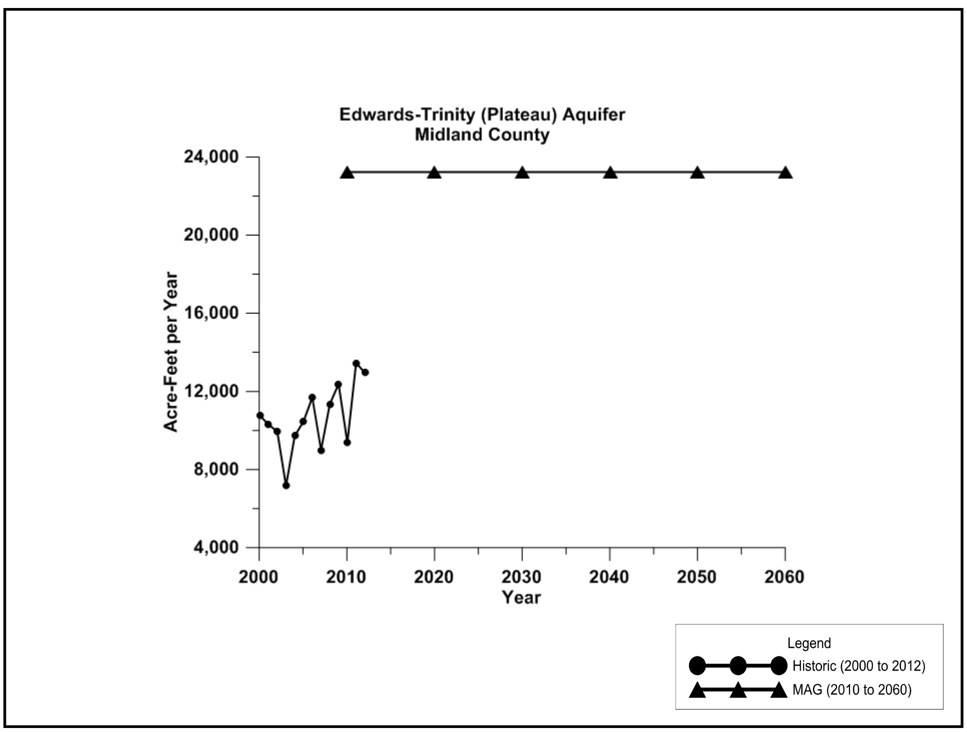


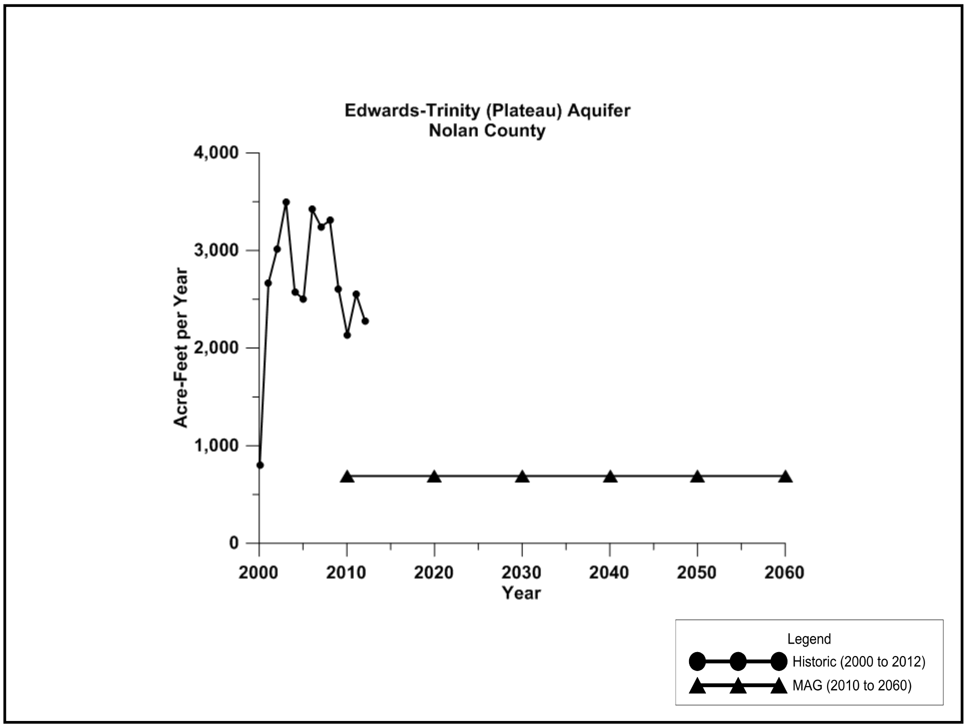
Edwards-Trinity (Plateau) Aquifer
Kimble County
Acre-Feet per Year
1,400
1,200
1,000
800
600
400
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)


Edwards-Trinity (Plateau) Aquifer
Kinney County
Acre-Feet per Year
80,000
60,000
40,000
20,000
0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

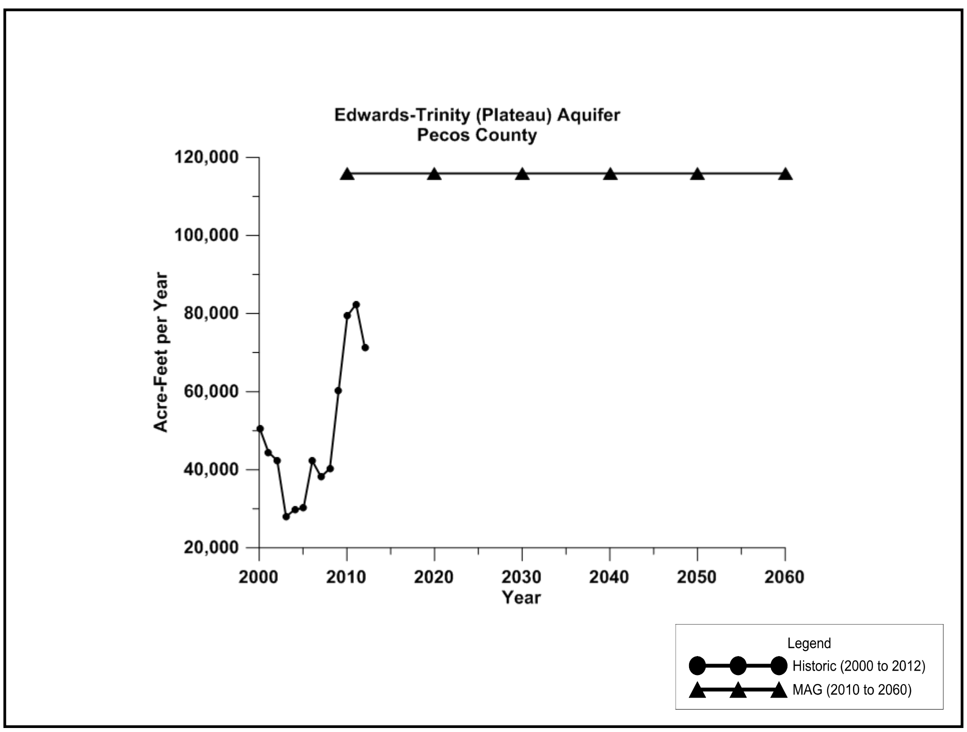

Edwards-Trinity (Plateau) Aquifer
McCulloch County
Acre-Feet per Year
80
60
40
20
0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)


Edwards-Trinity (Plateau) Aquifer
Menard County
Acre-Feet per Year
2,400
2,000
1,600
1,200
800
400
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

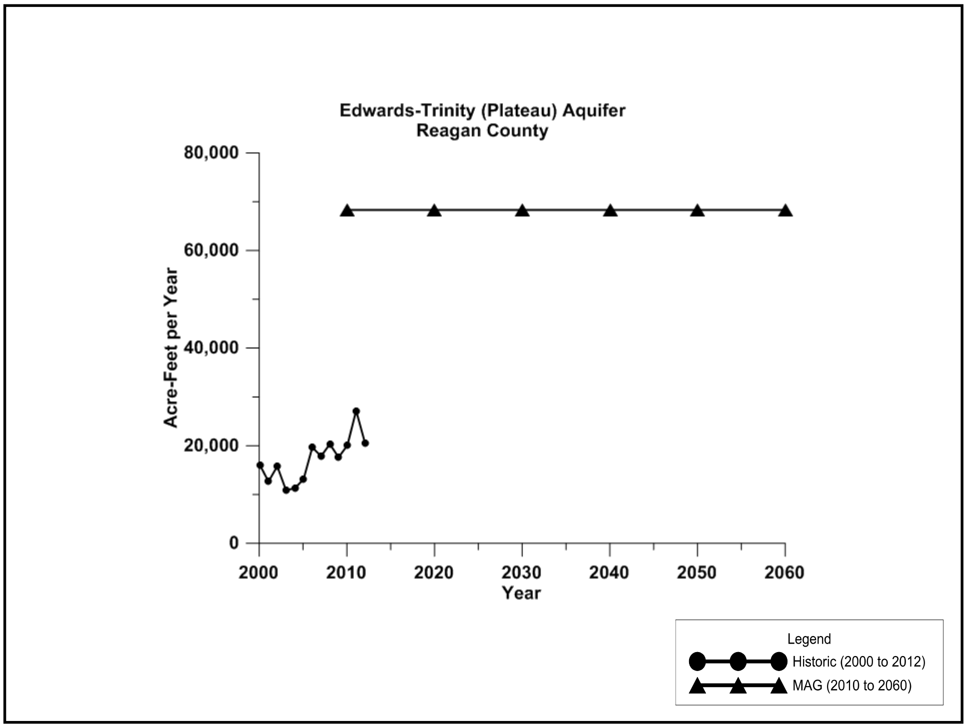

Edwards-Trinity (Plateau) Aquifer
Midland County
Acre-Feet per Year
24,000
20,000
16,000
12,000
8,000
4,000
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)



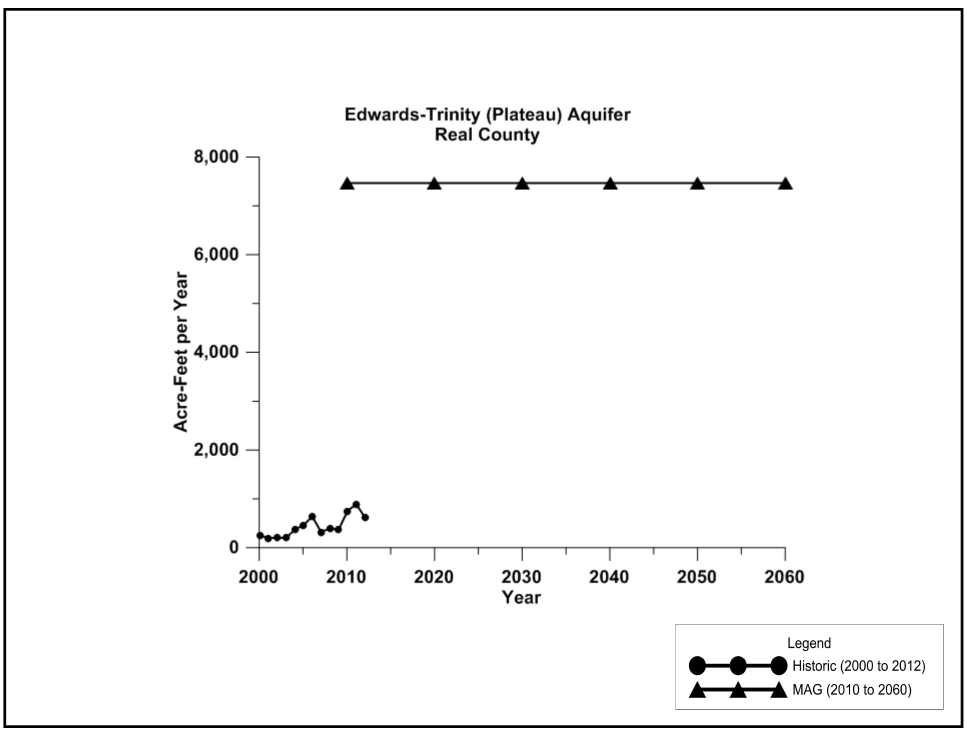
Edwards-Trinity (Plateau) Aquifer
Nolan County
Acre-Feet per Year
4,000
3,000
2,000
1,000
0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)



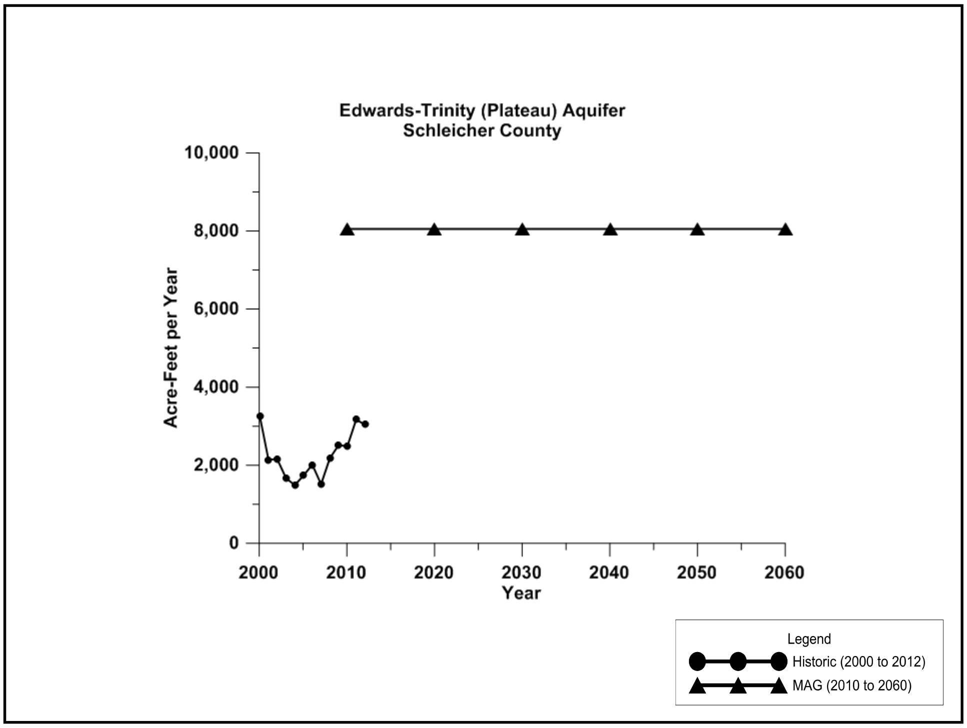
Edwards-Trinity (Plateau) Aquifer
Pecos County
Acre-Feet per Year
120,000
100,000
80,000
60,000
40,000
20,000
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

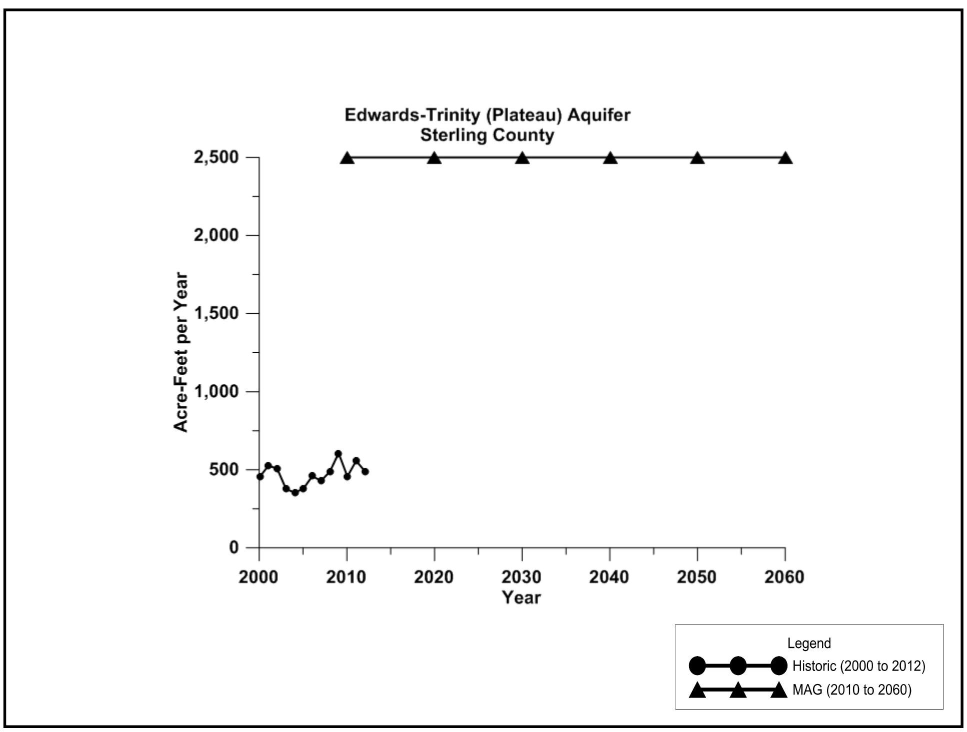


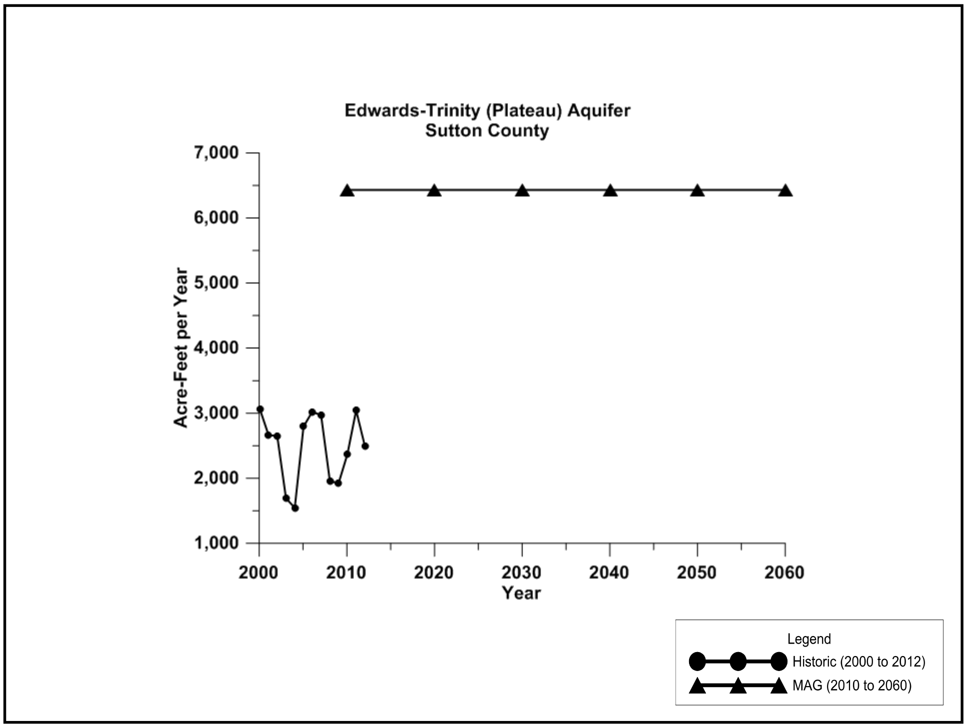
Edwards-Trinity (Plateau) Aquifer
Reagan County
80,000
60,000
40,000
20,000
0
Acre-Feet per Year
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

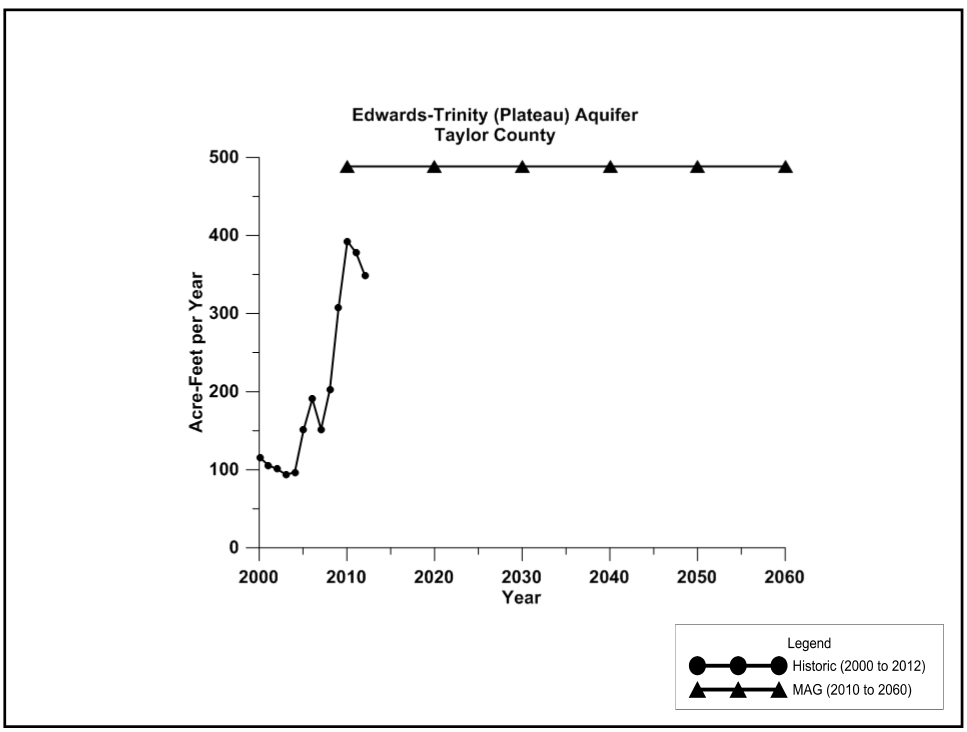


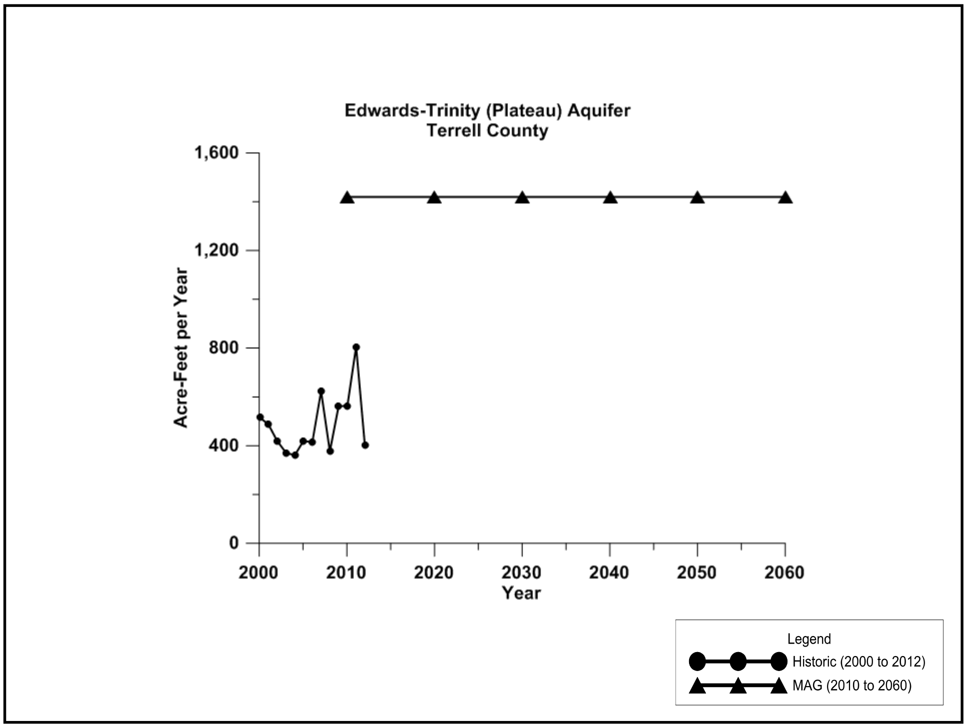
Edwards-Trinity (Plateau) Aquifer
Real County
8,000
6,000
4,000
2,000
0
Acre-Feet per Year
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

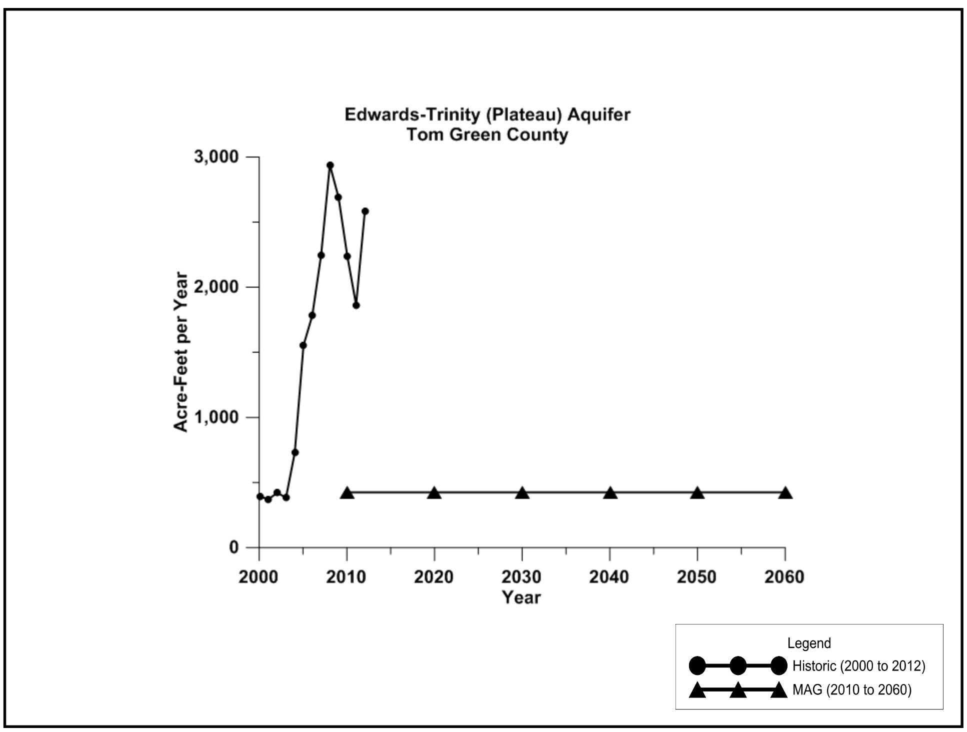

Edwards-Trinity (Plateau) Aquifer
Schleicher County
10,000
8,000
6,000
4,000
2,000
0
Acre-Feet per Year
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

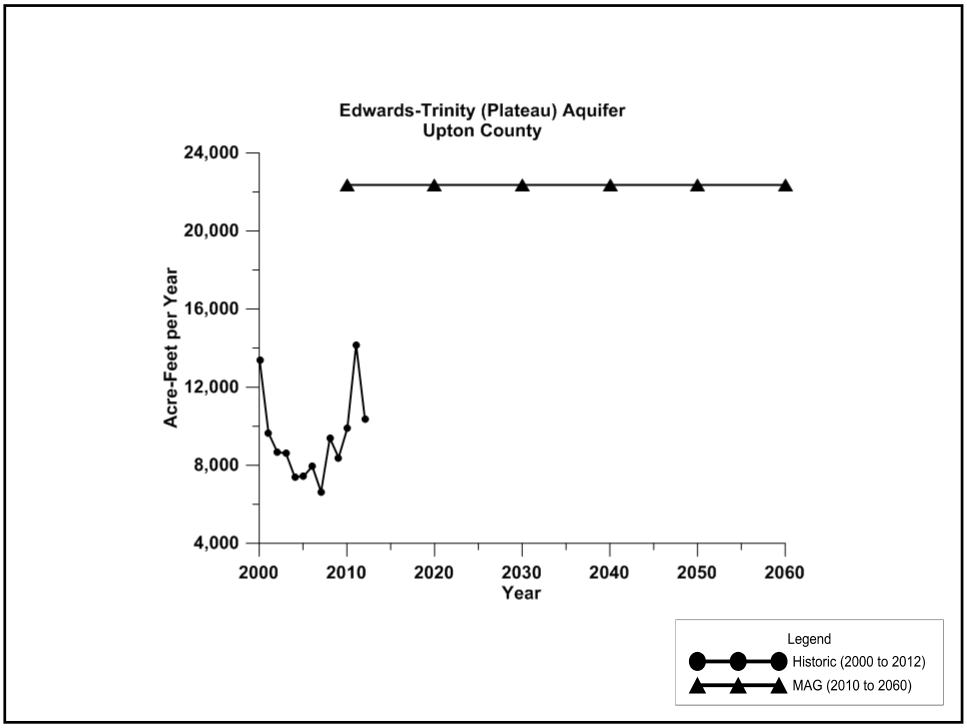

Edwards-Trinity (Plateau) Aquifer
Sterling County
2,500
2,000
1,500
1,000
500
0
Acre-Feet per Year
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

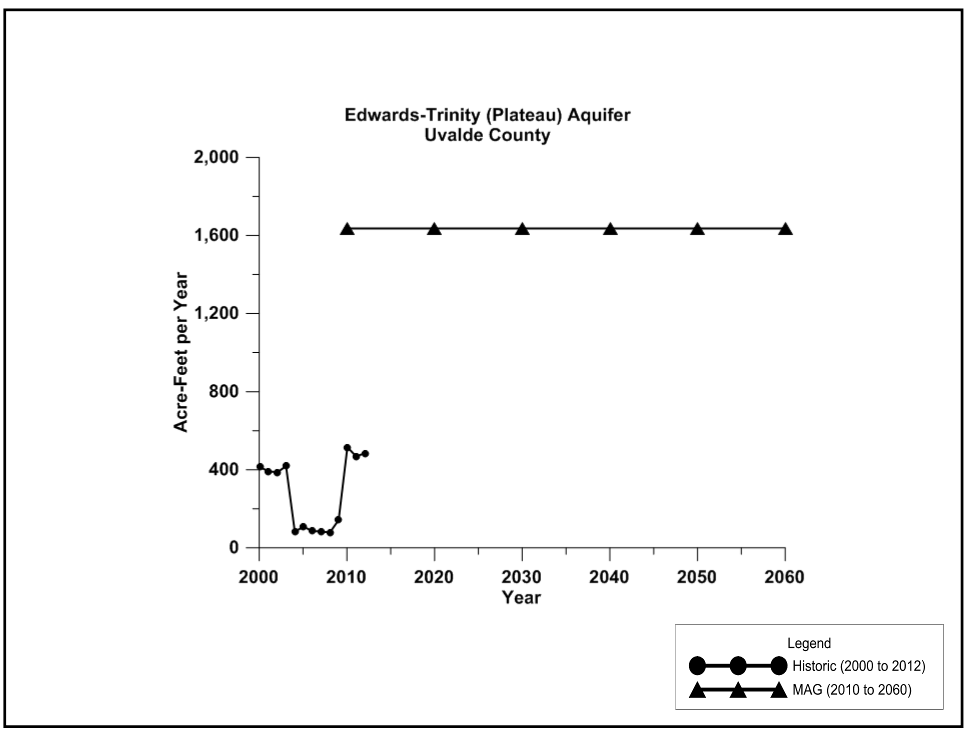

Edwards-Trinity (Plateau) Aquifer
Sutton County
Acre-Feet per Year
7,000
6,000
5,000
4,000
3,000
2,000
1,000
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

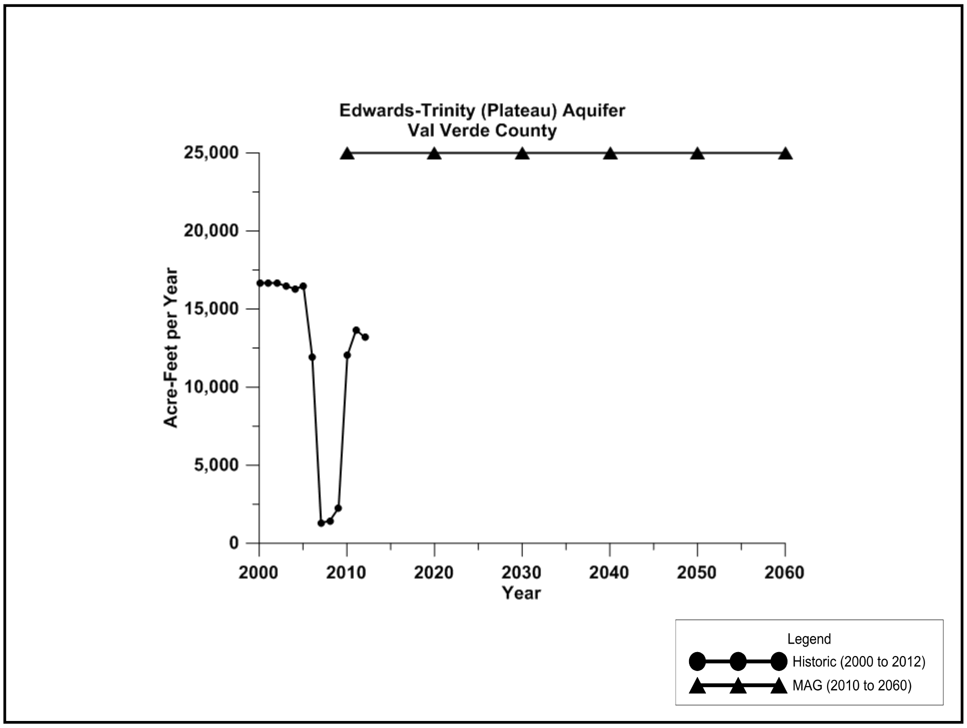

Edwards-Trinity (Plateau) Aquifer
Taylor County
Acre-Feet per Year
500
400
300
200
100
0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

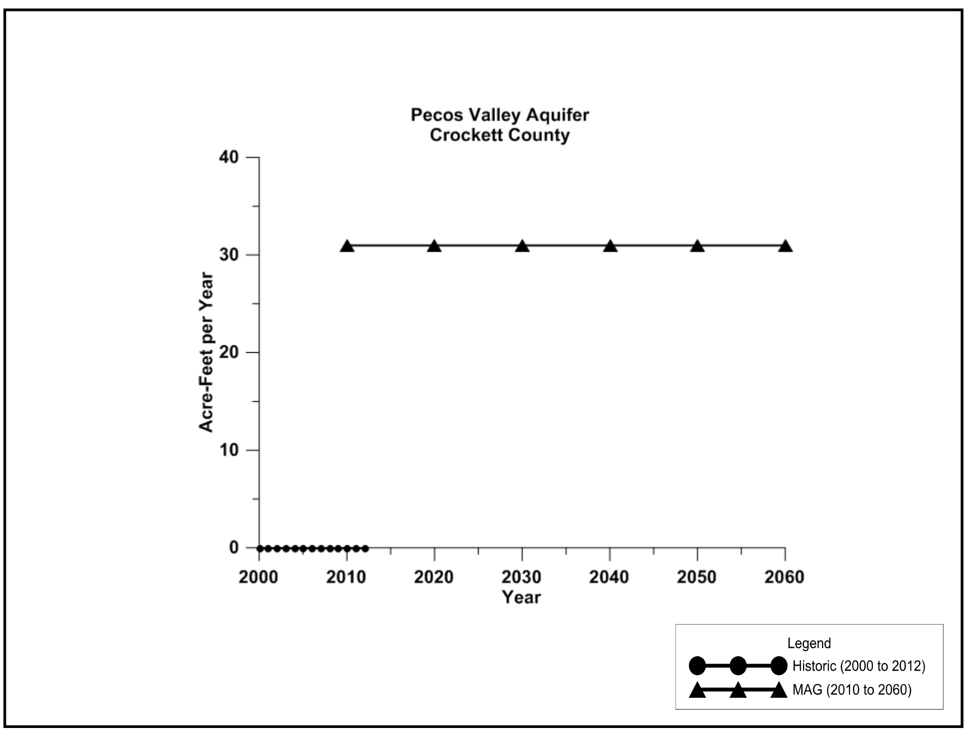

Edwards-Trinity (Plateau) Aquifer
Terrell County
Acre-Feet per Year
1,600
1,200
800
400
0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

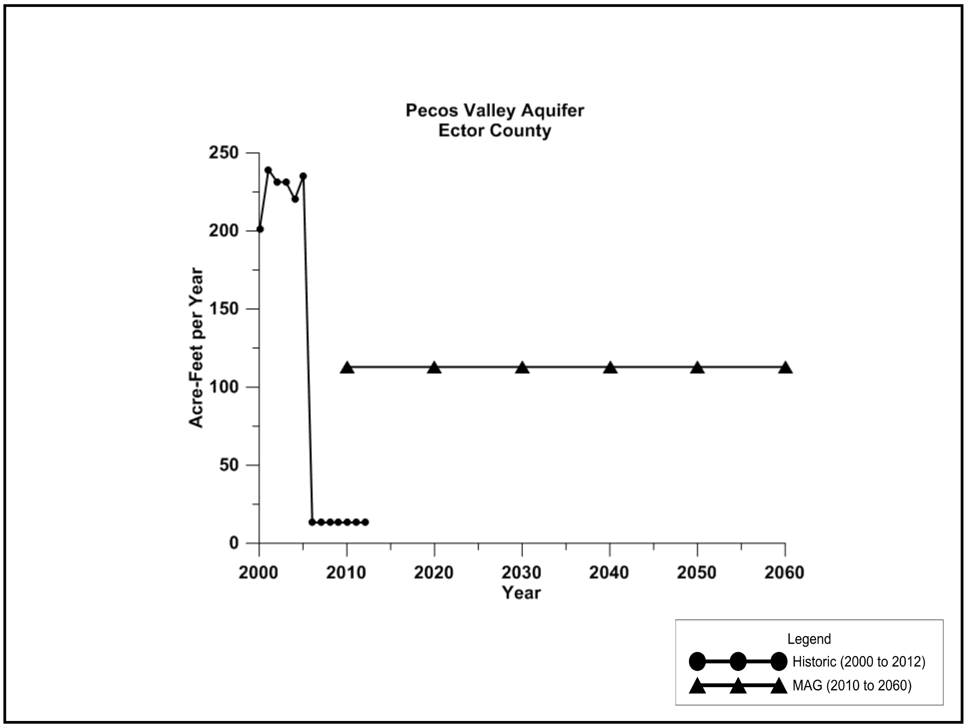

Edwards-Trinity (Plateau) Aquifer
Tom Green County
Acre-Feet per Year
3,000
2,000
1,000
0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

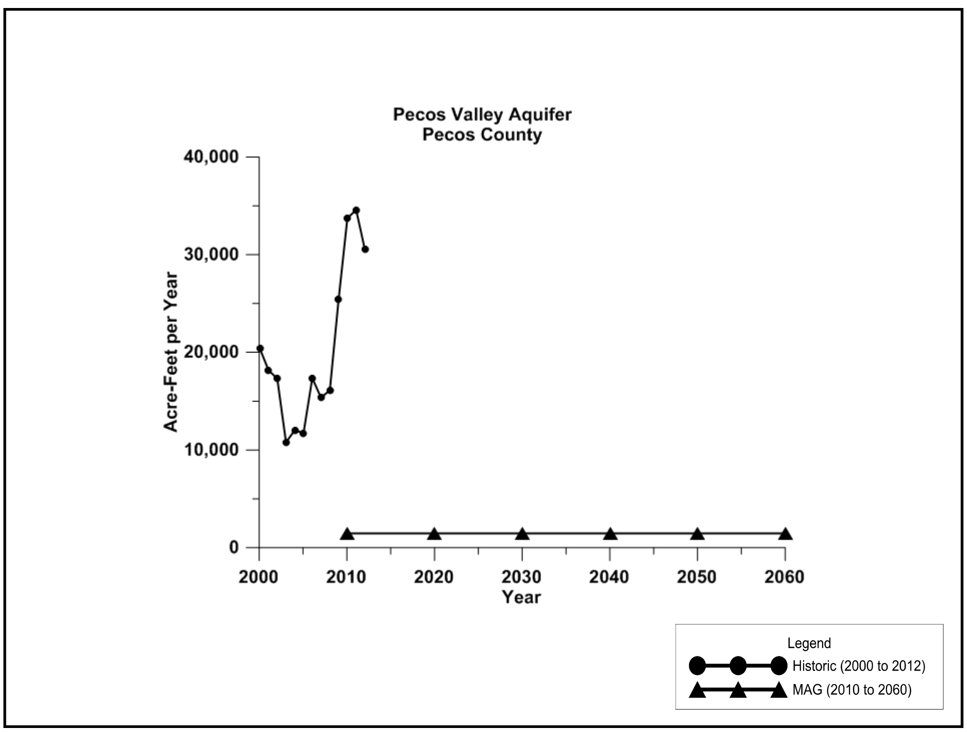

Edwards-Trinity (Plateau) Aquifer
Upton County
Acre-Feet per Year
24,000
20,000
16,000
12,000
8,000
4,000
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

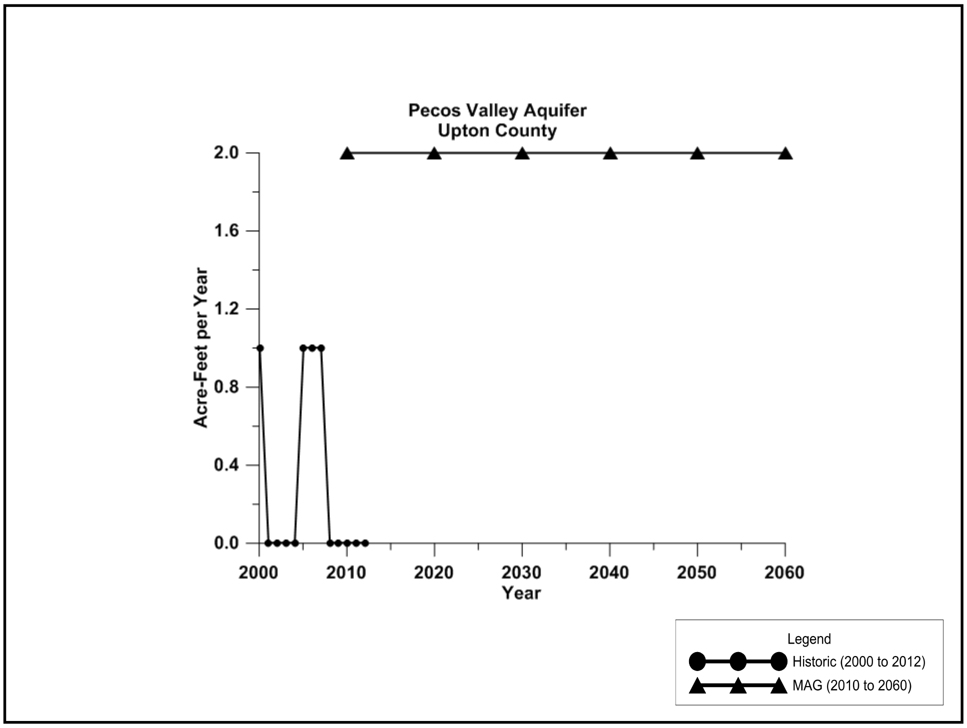

Edwards-Trinity (Plateau) Aquifer
Uvalde County
Acre-Feet per Year
2,000
1,600
1,200
800
400
0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

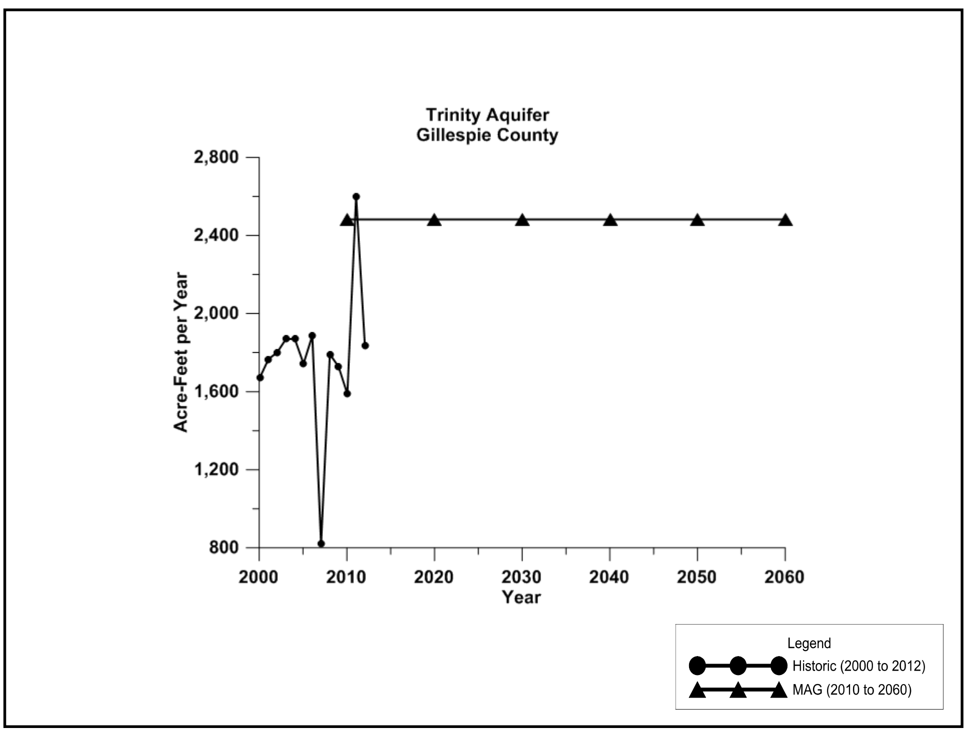

Edwards-Trinity (Plateau) Aquifer
Val Verde County
Acre-Feet per Year
25,000
20,000
15,000
10,000
5,000
0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

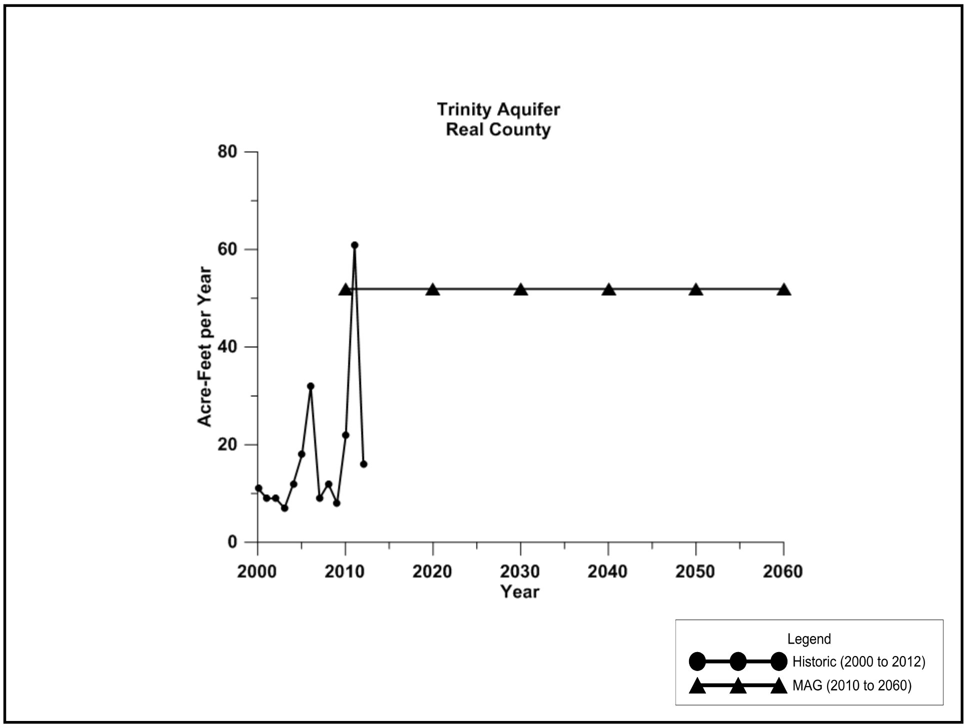

Pecos Valley Aquifer
Crockett County
Acre-Feet per Year
40
30
20
10
0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)


Pecos Valley Aquifer
Ector County
Acre-Feet per Year
250
200
150
100
50
0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)


Pecos Valley Aquifer
Pecos County
Acre-Feet per Year
40,000
30,000
20,000
10,000
0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)


Pecos Valley Aquifer
Upton County
Acre-Feet per Year
2.0
1.6
1.2
0.8
0.4
0.0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)


Trinity Aquifer
Gillespie County
Acre-Feet per Year
2,800
2,400
2,000
1,600
1,200
800
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)


Trinity Aquifer
Real County
Acre-Feet per Year
80
60
40
20
0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

Appendix D

Region F Socioeconomic Impact Reports from TWDB

Socioeconomic Impacts of Projected Water Shortages for the Region F Regional Water Planning Area

Prepared in Support of the 2021 Region F Regional Water Plan

Texas Water Development Board

Dr. John R. Ellis
Water Use, Projections, & Planning Division
Texas Water Development Board

November 2021

Table of Contents

Executive Summary

Evaluating the social and economic impacts of not meeting identified water needs is a required analysis in the regional water planning process. The Texas Water Development Board (TWDB) estimates these impacts for regional water planning groups (RWPGs) and summarizes the impacts in the state water plan. The analysis presented is for the Region F Regional Water Planning Group (Region F).

Based on projected water demands and existing water supplies, Region F identified water needs (potential shortages) that could occur within its region under a repeat of the drought of record for six water use categories (irrigation, livestock, manufacturing, mining, municipal and steam-electric power). The TWDB then estimated the annual socioeconomic impacts of those needs—if they are not met—for each water use category and as an aggregate for the region.

This analysis was performed using an economic impact modeling software package, IMPLAN (Impact for Planning Analysis), as well as other economic analysis techniques, and represents a snapshot of socioeconomic impacts that may occur during a single year repeat of the drought of record with the further caveat that no mitigation strategies are implemented. Decade specific impact estimates assume that growth occurs, and future shocks are imposed on an economy at 10-year intervals. The estimates presented are not cumulative (i.e., summing up expected impacts from today up to the decade noted), but are simply snapshots of the estimated annual socioeconomic impacts should a drought of record occur in each particular decade based on anticipated water supplies and demands for that same decade.

For regional economic impacts, income losses and job losses are estimated within each planning decade (2020 through 2070). The income losses represent an approximation of gross domestic product (GDP) that would be foregone if water needs are not met.

The analysis also provides estimates of financial transfer impacts, which include tax losses (state, local, and utility tax collections); water trucking costs; and utility revenue losses. In addition, social impacts are estimated, encompassing lost consumer surplus (a welfare economics measure of consumer wellbeing); as well as population and school enrollment losses.

IMPLAN data reported that Region F generated more than $50 billion in gross domestic product (GDP) (2018 dollars) and supported more than 424,000 jobs in 2016. The Region F estimated total population was approximately 686,000 in 2016.

It is estimated that not meeting the identified water needs in Region F would result in an annually combined lost income impact of approximately $19.6 billion in 2020 and $6.4 billion in 2070 (Table ES-1). It is also estimated that the region would lose approximately 98,000 jobs in 2020 and 39,000 in 2070.

All impact estimates are in year 2018 dollars and were calculated using a variety of data sources and tools including the use of a region-specific IMPLAN model, data from TWDB annual water use estimates, the U.S. Census Bureau, Texas Agricultural Statistics Service, and the Texas Municipal League.

Table ES-1 Region F socioeconomic impact summary

Regional Economic Impacts	2020	2030	2040	2050	2060	2070
Income losses ($ millions)*	$19,624	$19,720	$17,058	$13,443	$7,750	$6,356
Job losses	98,208	100,186	88,685	71,444	43,995	38,833
Financial Transfer Impacts	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Tax losses on production and imports ($ millions)*	$2,644	$2,647	$2,266	$1,749	$937	$725
Water trucking costs ($ millions)*	$29	$29	$29	$30	$31	$32
Utility revenue losses ($ millions)*	$56	$82	$111	$139	$172	$207
Utility tax revenue losses ($ millions)*	$1	$1	$2	$3	$3	$4
Social Impacts	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Consumer surplus losses ($ millions)*	$87	$93	$149	$183	$227	$286
Population losses	18,031	18,394	16,283	13,117	8,078	7,130
School enrollment losses	3,449	3,518	3,115	2,509	1,545	1,364

* Year 2018 dollars, rounded. Entries denoted by a dash (-) indicate no estimated economic impact. Entries denoted by a zero ($0) indicate estimated income losses less than $500,000.

1 Introduction

Water shortages during a repeat of the drought of record would likely curtail or eliminate certain economic activity in businesses and industries that rely heavily on water. Insufficient water supplies could not only have an immediate and real impact on the regional economy in the short term, but they could also adversely and chronically affect economic development in Texas. From a social perspective, water supply reliability is critical as well. Shortages could disrupt activity in homes, schools and government, and could adversely affect public health and safety. For these reasons, it is important to evaluate and understand how water supply shortages during drought could impact communities throughout the state.

As part of the regional water planning process, RWPGs must evaluate the social and economic impacts of not meeting water needs (31 Texas Administrative Code §357.33 (c)). Due to the complexity of the analysis and limited resources of the planning groups, the TWDB has historically performed this analysis for the RWPGs upon their request. Staff of the TWDB's Water Use, Projections, & Planning Division designed and conducted this analysis in support of Region F, and those efforts for this region as well as the other 15 regions allow consistency and a degree of comparability in the approach.

This document summarizes the results of the analysis and discusses the methodology used to generate the results. Section 1 provides a snapshot of the region's economy and summarizes the identified water needs in each water use category, which were calculated based on the RWPG's water supply and demand established during the regional water planning process. Section 2 defines each of ten impact assessment measures used in this analysis. Section 3 describes the methodology for the impact assessment and the approaches and assumptions specific to each water use category (i.e., irrigation, livestock, manufacturing, mining, municipal, and steam-electric power). Section 4 presents the impact estimates for each water use category with results summarized for the region as a whole. Appendix A presents a further breakdown of the socioeconomic impacts by county.

1.1 Regional Economic Summary

The Region F Regional Water Planning Area generated more than $50 billion in GDP (2018 dollars) and supported roughly 424,000 jobs in 2016, according to the IMPLAN dataset utilized in this socioeconomic analysis. This activity accounted for 3 percent of the state's total GDP of 1.73 trillion dollars for the year based on IMPLAN. Table 1-1 lists all economic sectors ranked by the total value-added to the economy in Region F. The mining sector (including oil and gas extraction) generated close to 40 percent of the region's total value-added and was also a significant source of tax revenue. The top employers in the region were in the mining, public administration, and retail trade sectors. Region F's estimated total population was roughly 686,000 in 2016, approximately 2.5 percent of the state's total.

This represents a snapshot of the regional economy as a whole, and it is important to note that not all economic sectors were included in the TWDB socioeconomic impact analysis. Data considerations prompted use of only the more water-intensive sectors within the economy because damage estimates could only be calculated for those economic sectors which had both reliable income and water use estimates.

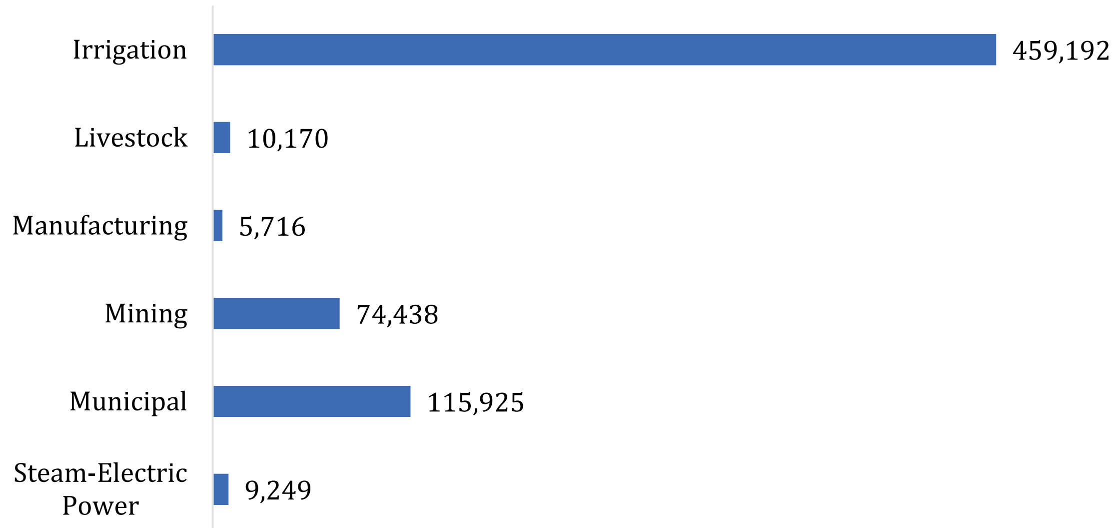
Table 1-1 Region F regional economy by economic sector*

Economic sector	Value-added ($ millions)	Tax ($ millions)	Jobs
Mining, Quarrying, and Oil and Gas Extraction	$19,711.6	$2,458.8	67,722
Public Administration	$4,274.8	$(23.0)	53,420
Real Estate and Rental and Leasing	$3,831.9	$556.6	14,285
Wholesale Trade	$3,199.8	$496.7	16,901
Manufacturing	$3,091.3	$95.4	18,614
Construction	$2,650.8	$33.3	30,015
Retail Trade	$2,203.5	$542.9	39,778
Health Care and Social Assistance	$1,743.9	$25.6	30,056
Finance and Insurance	$1,513.5	$66.2	16,366
Utilities	$1,350.0	$174.2	2,089
Accommodation and Food Services	$1,346.2	$196.9	32,131
Professional, Scientific, and Technical Services	$1,256.2	$37.8	18,165
Other Services (except Public Administration)	$1,229.4	$124.4	21,836
Transportation and Warehousing	$1,011.8	$97.2	15,793
Administrative and Support and Waste Management and Remediation Services	$719.3	$26.4	14,728
Information	$695.5	$208.0	3,546
Agriculture, Forestry, Fishing and Hunting	$412.7	$15.9	16,847
Management of Companies and Enterprises	$394.9	$9.5	3,372
Arts, Entertainment, and Recreation	$187.6	$33.8	5,317
Educational Services	$92.6	$5.4	3,175
Grand Total	**$50,917.2**	**$5,182.1**	**424,156**

*Source: 2016 IMPLAN for 536 sectors aggregated by 2-digit NAICS (North American Industry Classification System)

While the mining sector led the region in economic output, the majority (68 percent) of water use in 2016 occurred in irrigated agriculture. Notably, more than 44 percent of the state's mining water use occurred within Region F. Figure 1-1 illustrates Region F's breakdown of the 2016 water use estimates by TWDB water use category.

Figure 1-1 Region F 2016 water use estimates by water use category (in acre-feet)



Source: TWDB Annual Water Use Estimates (all values in acre-feet)

1.2 Identified Regional Water Needs (Potential Shortages)

As part of the regional water planning process, the TWDB adopted water demand projections for water user groups (WUG) in Region F with input from the planning group. WUG-level demand projections were established for utilities that provide more than 100 acre-feet of annual water supply, combined rural areas (designated as county-other), and county-wide water demand projections for five non-municipal categories (irrigation, livestock, manufacturing, mining and steam-electric power). The RWPG then compared demands to the existing water supplies of each WUG to determine potential shortages, or needs, by decade.

Table 1-2 summarizes the region's identified water needs in the event of a repeat of the drought of record. Demand management, such as conservation, or the development of new infrastructure to increase supplies, are water management strategies that may be recommended by the planning group to address those needs. This analysis assumes that no strategies are implemented, and that the identified needs correspond to future water shortages. Note that projected water needs generally increase over time, primarily due to anticipated population growth, economic growth, or declining supplies. To provide a general sense of proportion, total projected needs as an overall percentage of total demand by water use category are also presented in aggregate in Table 1-2. Projected needs for individual water user groups within the aggregate can vary greatly and may reach 100% for a given WUG and water use category. A detailed summary of water needs by WUG and county appears in Chapter 4 of the 2021 Region F Regional Water Plan.

Table 1-2 Regional water needs summary by water use category

Water Use Category		2020	2030	2040	2050	2060	2070
Irrigation	water needs (acre-feet per year)	13,528	17,957	18,618	19,676	22,157	24,740
	% of the category's total water demand	3%	4%	4%	4%	5%	5%
Livestock	water needs (acre-feet per year)	9	17	25	39	50	60
	% of the category's total water demand	0%	0%	0%	0%	0%	1%
Manufacturing	water needs (acre-feet per year)	1,137	1,226	1,269	1,461	1,664	1,851
	% of the category's total water demand	10%	10%	10%	12%	13%	15%
Mining	water needs (acre-feet per year)	23,009	22,916	19,702	15,080	7,993	5,880
	% of the category's total water demand	21%	21%	22%	23%	17%	17%
Municipal*	water needs (acre-feet per year)	16,030	24,159	33,381	42,081	52,530	63,829
	% of the category's total water demand	12%	16%	21%	25%	29%	34%
Steam-electric power	water needs (acre-feet per year)	12,746	12,793	12,850	12,945	13,042	13,129
	% of the category's total water demand	70%	71%	71%	72%	72%	73%
Total water needs (acre-feet per year)		**66,459**	**79,068**	**85,845**	**91,282**	**97,436**	**109,489**

* Municipal category consists of residential and non-residential (commercial and institutional) subcategories.

2 Impact Assessment Measures

A required component of the regional and state water plans is to estimate the potential economic and social impacts of potential water shortages during a repeat of the drought of record. Consistent with previous water plans, ten impact measures were estimated and are described in Table 2-1.

Table 2-1 Socioeconomic impact analysis measures

Regional economic impacts	Description
Income losses - value-added	The value of output less the value of intermediate consumption; it is a measure of the contribution to gross domestic product (GDP) made by an individual producer, industry, sector, or group of sectors within a year. Value-added measures used in this report have been adjusted to include the direct, indirect, and induced monetary impacts on the region.
Income losses - electrical power purchase costs	Proxy for income loss in the form of additional costs of power as a result of impacts of water shortages.
Job losses	Number of part-time and full-time jobs lost due to the shortage. These values have been adjusted to include the direct, indirect, and induced employment impacts on the region.
Financial transfer impacts	**Description**
Tax losses on production and imports	Sales and excise taxes not collected due to the shortage, in addition to customs duties, property taxes, motor vehicle licenses, severance taxes, other taxes, and special assessments less subsidies. These values have been adjusted to include the direct, indirect and induced tax impacts on the region.
Water trucking costs	Estimated cost of shipping potable water.
Utility revenue losses	Foregone utility income due to not selling as much water.
Utility tax revenue losses	Foregone miscellaneous gross receipts tax collections.
Social impacts	**Description**
Consumer surplus losses	A welfare measure of the lost value to consumers accompanying restricted water use.
Population losses	Population losses accompanying job losses.
School enrollment losses	School enrollment losses (K-12) accompanying job losses.

2.1 Regional Economic Impacts

The two key measures used to assess regional economic impacts are income losses and job losses. The income losses presented consist of the sum of value-added losses and the additional purchase costs of electrical power.

Income Losses - Value-added Losses

Value-added is the value of total output less the value of the intermediate inputs also used in the production of the final product. Value-added is similar to GDP, a familiar measure of the productivity of an economy. The loss of value-added due to water shortages is estimated by input-output analysis using the IMPLAN software package, and includes the direct, indirect, and induced monetary impacts on the region. The indirect and induced effects are measures of reduced income as well as reduced employee spending for those input sectors which provide resources to the water shortage impacted production sectors.

Income Losses - Electric Power Purchase Costs

The electrical power grid and market within the state is a complex interconnected system. The industry response to water shortages, and the resulting impact on the region, are not easily modeled using traditional input/output impact analysis and the IMPLAN model. Adverse impacts on the region will occur and are represented in this analysis by estimated additional costs associated with power purchases from other generating plants within the region or state. Consequently, the analysis employs additional power purchase costs as a proxy for the value-added impacts for the steam-electric power water use category, and these are included as a portion of the overall income impact for completeness.

For the purpose of this analysis, it is assumed that power companies with insufficient water will be forced to purchase power on the electrical market at a projected higher rate of 5.60 cents per kilowatt hour. This rate is based upon the average day-ahead market purchase price of electricity in Texas that occurred during the recent drought period in 2011. This price is assumed to be comparable to those prices which would prevail in the event of another drought of record.

Job Losses

The number of jobs lost due to the economic impact is estimated using IMPLAN output associated with each TWDB water use category. Because of the difficulty in predicting outcomes and a lack of relevant data, job loss estimates are not calculated for the steam-electric power category.

2.2 Financial Transfer Impacts

Several impact measures evaluated in this analysis are presented to provide additional detail concerning potential impacts on a portion of the economy or government. These financial transfer impact measures include lost tax collections (on production and imports), trucking costs for imported water, declines in utility revenues, and declines in utility tax revenue collected by the state. These measures are not solely adverse, with some having both positive and negative impacts. For example, cities and residents would suffer if forced to pay large costs for trucking in potable water. Trucking firms, conversely, would benefit from the transaction. Additional detail for each of these measures follows.

Tax Losses on Production and Imports

Reduced production of goods and services accompanying water shortages adversely impacts the collection of taxes by state and local government. The regional IMPLAN model is used to estimate reduced tax collections associated with the reduced output in the economy. Impact estimates for this measure include the direct, indirect, and induced impacts for the affected sectors.

Water Trucking Costs

In instances where water shortages for a municipal water user group are estimated by RWPGs to exceed 80 percent of water demands, it is assumed that water would need to be trucked in to support basic consumption and sanitation needs. For water shortages of 80 percent or greater, a fixed, maximum of $35,000[1] per acre-foot of water applied as an economic cost. This water trucking cost was utilized for both the residential and non-residential portions of municipal water needs.

Utility Revenue Losses

Lost utility income is calculated as the price of water service multiplied by the quantity of water not sold during a drought shortage. Such estimates are obtained from utility-specific pricing data provided by the Texas Municipal League, where available, for both water and wastewater. These water rates are applied to the potential water shortage to estimate forgone utility revenue as water providers sold less water during the drought due to restricted supplies.

Utility Tax Losses

Foregone utility tax losses include estimates of forgone miscellaneous gross receipts taxes. Reduced water sales reduce the amount of utility tax that would be collected by the State of Texas for water and wastewater service sales.

2.3 Social Impacts

Consumer Surplus Losses for Municipal Water Users

Consumer surplus loss is a measure of impact to the wellbeing of municipal water users when their water use is restricted. Consumer surplus is the difference between how much a consumer is willing and able to pay for a commodity (i.e., water) and how much they actually have to pay. The

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[1] Based on staff survey of water hauling firms and historical data concerning transport costs for potable water in the recent drought in California for this estimate. There are many factors and variables that would determine actual water trucking costs including distance to, cost of water, and length of that drought.

difference is a benefit to the consumer's wellbeing since they do not have to pay as much for the commodity as they would be willing to pay. Consumer surplus may also be viewed as an estimate of how much consumers would be willing to pay to keep the original quantity of water which they used prior to the drought. Lost consumer surplus estimates within this analysis only apply to the residential portion of municipal demand, with estimates being made for reduced outdoor and indoor residential use. Lost consumer surplus estimates varied widely by location and degree of water shortage.

Population and School Enrollment Losses

Population loss due to water shortages, as well as the associated decline in school enrollment, are based upon the job loss estimates discussed in Section 2.1. A simplified ratio of job and net population losses are calculated for the state as a whole based on a recent study of how job layoffs impact the labor market population.[2] For every 100 jobs lost, 18 people were assumed to move out of the area. School enrollment losses are estimated as a proportion of the population lost based upon public school enrollment data from the Texas Education Agency concerning the age K-12 population within the state (approximately 19%).

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[2] Foote, Andrew, Grosz, Michel, Stevens, Ann. "Locate Your Nearest Exit: Mass Layoffs and Local Labor Market Response." University of California, Davis. April 2015, http://paa2015.princeton.edu/papers/150194. The study utilized Bureau of Labor Statistics data regarding layoffs between 1996 and 2013, as well as Internal Revenue Service data regarding migration, to model the change in the population as the result of a job layoff event. The study found that layoffs impact both out-migration and in-migration into a region, and that a majority of those who did move following a layoff moved to another labor market rather than an adjacent county.

3 Socioeconomic Impact Assessment Methodology

This portion of the report provides a summary of the methodology used to estimate the potential economic impacts of future water shortages. The general approach employed in the analysis was to obtain estimates for income and job losses on the smallest geographic level that the available data would support, tie those values to their accompanying historic water use estimate, and thereby determine a maximum impact per acre-foot of shortage for each of the socioeconomic measures. The calculations of economic impacts are based on the overall composition of the economy divided into many underlying economic sectors. Sectors in this analysis refer to one or more of the 536 specific production sectors of the economy designated within IMPLAN, the economic impact modeling software used for this assessment. Economic impacts within this report are estimated for approximately 330 of these sectors, with the focus on the more water-intensive production sectors. The economic impacts for a single water use category consist of an aggregation of impacts to multiple, related IMPLAN economic sectors.

3.1 Analysis Context

The context of this socioeconomic impact analysis involves situations where there are physical shortages of groundwater or surface water due to a recurrence of drought of record conditions. Anticipated shortages for specific water users may be nonexistent in earlier decades of the planning horizon, yet population growth or greater industrial, agricultural or other sector demands in later decades may result in greater overall demand, exceeding the existing supplies. Estimated socioeconomic impacts measure what would happen if water user groups experience water shortages for a period of one year. Actual socioeconomic impacts would likely become larger as drought of record conditions persist for periods greater than a single year.

3.2 IMPLAN Model and Data

Input-Output analysis using the IMPLAN software package was the primary means of estimating the value-added, jobs, and tax related impact measures. This analysis employed regional level models to determine key economic impacts. IMPLAN is an economic impact model, originally developed by the U.S. Forestry Service in the 1970's to model economic activity at varying geographic levels. The model is currently maintained by the Minnesota IMPLAN Group (MIG Inc.) which collects and sells county and state specific data and software. The year 2016 version of IMPLAN, employing data for all 254 Texas counties, was used to provide estimates of value-added, jobs, and taxes on production for the economic sectors associated with the water user groups examined in the study. IMPLAN uses 536 sector-specific Industry Codes, and those that rely on water as a primary input were assigned to their appropriate planning water user categories (irrigation, livestock, manufacturing, mining, and municipal). Estimates of value-added for a water use category were obtained by summing value-added estimates across the relevant IMPLAN sectors associated with that water use category. These calculations were also performed for job losses as well as tax losses on production and imports.

The adjusted value-added estimates used as an income measure in this analysis, as well as the job and tax estimates from IMPLAN, include three components:

- ***Direct effects*** representing the initial change in the industry analyzed;
- ***Indirect effects*** that are changes in inter-industry transactions as supplying industries respond to reduced demands from the directly affected industries; and,
- ***Induced effects*** that reflect changes in local spending that result from reduced household income among employees in the directly and indirectly affected industry sectors.

Input-output models such as IMPLAN only capture backward linkages and do not include forward linkages in the economy.

3.3 Elasticity of Economic Impacts

The economic impact of a water need is based on the size of the water need relative to the total water demand for each water user group. Smaller water shortages, for example, less than 5 percent, are generally anticipated to result in no initial negative economic impact because water users are assumed to have a certain amount of flexibility in dealing with small shortages. As a water shortage intensifies, however, such flexibility lessens and results in actual and increasing economic losses, eventually reaching a representative maximum impact estimate per unit volume of water. To account for these characteristics, an elasticity adjustment function is used to estimate impacts for the income, tax and job loss measures. Figure 3-1 illustrates this general relationship for the adjustment functions. Negative impacts are assumed to begin accruing when the shortage reaches the lower bound 'b1' (5 percent in Figure 3-1), with impacts then increasing linearly up to the 100 percent impact level (per unit volume) once the upper bound reaches the 'b2' level shortage (40 percent in Figure 3-1).

To illustrate this, if the total annual value-added for manufacturing in the region was $2 million and the reported annual volume of water used in that industry is 10,000 acre-feet, the estimated economic measure of the water shortage would be $200 per acre-foot. The economic impact of the shortage would then be estimated using this value-added amount as the maximum impact estimate ($200 per acre-foot) applied to the anticipated shortage volume and then adjusted by the elasticity function. Using the sample elasticity function shown in Figure 3-1, an approximately 22 percent shortage in the livestock category would indicate an economic impact estimate of 50% of the original $200 per acre-foot impact value (i.e., $100 per acre-foot).

Such adjustments are not required in estimating consumer surplus, utility revenue losses, or utility tax losses. Estimates of lost consumer surplus rely on utility-specific demand curves with the lost consumer surplus estimate calculated based on the relative percentage of the utility's water shortage. Estimated changes in population and school enrollment are indirectly related to the elasticity of job losses.

Assumed values for the lower and upper bounds 'b1' and 'b2' vary by water use category and are presented in Table 3-1.

Figure 3-1 Example economic impact elasticity function (as applied to a single water user's shortage)

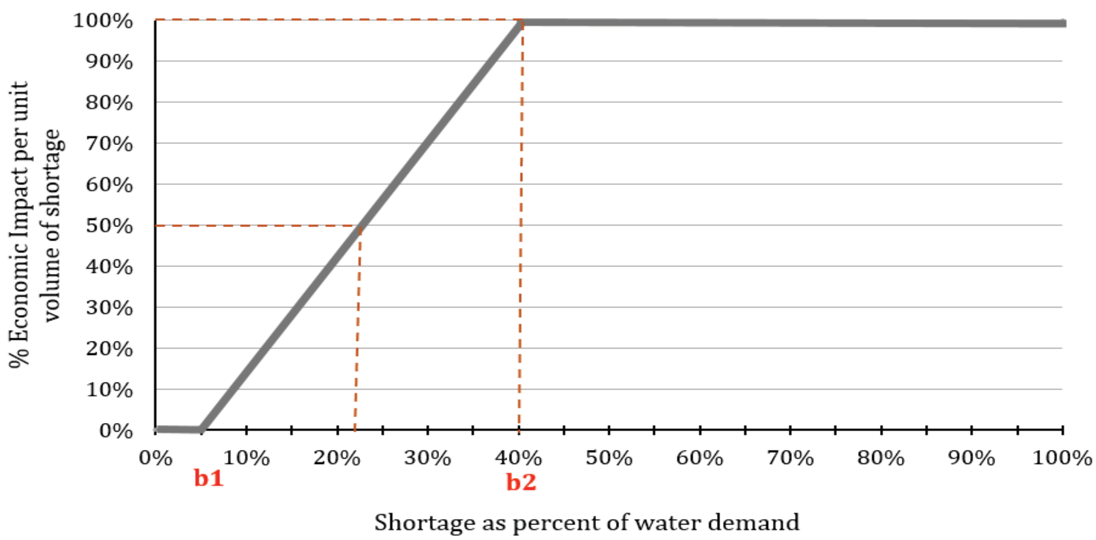

Table 3-1 Economic impact elasticity function lower and upper bounds

Water use category	Lower bound (b1)	Upper bound (b2)
Irrigation	5%	40%
Livestock	5%	10%
Manufacturing	5%	40%
Mining	5%	40%
Municipal (non-residential water intensive subcategory)	5%	40%
Steam-electric power	N/A	N/A

3.4 Analysis Assumptions and Limitations

The modeling of complex systems requires making many assumptions and acknowledging the model's uncertainty and limitations. This is particularly true when attempting to estimate a wide range of socioeconomic impacts over a large geographic area and into future decades. Some of the key assumptions and limitations of this methodology include:

1. The foundation for estimating the socioeconomic impacts of water shortages resulting from a drought are the water needs (potential shortages) that were identified by RWPGs as part of the

regional water planning process. These needs have some uncertainty associated with them but serve as a reasonable basis for evaluating the potential impacts of a drought of record event.

2. All estimated socioeconomic impacts are snapshots for years in which water needs were identified (i.e., 2020, 2030, 2040, 2050, 2060, and 2070). The estimates are independent and distinct "what if" scenarios for each particular year, and water shortages are assumed to be temporary events resulting from a single year recurrence of drought of record conditions. The evaluation assumed that no recommended water management strategies are implemented. In other words, growth occurs and future shocks are imposed on an economy at 10-year intervals, and the resulting impacts are estimated. Note that the estimates presented are not cumulative (i.e., summing up expected impacts from today up to the decade noted), but are simply snapshots of the estimated annual socioeconomic impacts should a drought of record occur in each particular decade based on anticipated water supplies and demands for that same decade.

3. Input-output models such as IMPLAN rely on a static profile of the structure of the economy as it appears today. This presumes that the relative contributions of all sectors of the economy would remain the same, regardless of changes in technology, availability of limited resources, and other structural changes to the economy that may occur in the future. Changes in water use efficiency will undoubtedly take place in the future as supplies become more stressed. Use of the static IMPLAN structure was a significant assumption and simplification considering the 50-year time period examined in this analysis. To presume an alternative future economic makeup, however, would entail positing many other major assumptions that would very likely generate as much or more error.

4. This is not a form of cost-benefit analysis. That approach to evaluating the economic feasibility of a specific policy or project employs discounting future benefits and costs to their present value dollars using some assumed discount rate. The methodology employed in this effort to estimate the economic impacts of future water shortages did not use any discounting methods to weigh future costs differently through time.

5. All monetary values originally based upon year 2016 IMPLAN and other sources are reported in constant year 2018 dollars to be consistent with the water management strategy requirements in the State Water Plan.

6. IMPLAN based loss estimates (income-value-added, jobs, and taxes on production and imports) are calculated only for those IMPLAN sectors for which the TWDB's Water Use Survey (WUS) data was available and deemed reliable. Every effort is made in the annual WUS effort to capture all relevant firms who are significant water users. Lack of response to the WUS, or omission of relevant firms, impacts the loss estimates.

7. Impacts are annual estimates. The socioeconomic analysis does not reflect the full extent of impacts that might occur as a result of persistent water shortages occurring over an extended duration. The drought of record in most regions of Texas lasted several years.

8. Value-added estimates are the primary estimate of the economic impacts within this report. One may be tempted to add consumer surplus impacts to obtain an estimate of total adverse economic impacts to the region, but the consumer surplus measure represents the change to the wellbeing of households (and other water users), not an actual change in the flow of dollars through the economy. The two measures (value-added and consumer surplus) are both valid impacts but ideally should not be summed.

9. The value-added, jobs, and taxes on production and import impacts include the direct, indirect and induced effects to capture backward linkages in the economy described in Section 2.1. Population and school enrollment losses also indirectly include such effects as they are based on the associated losses in employment. The remaining measures (consumer surplus, utility revenue, utility taxes, additional electrical power purchase costs, and potable water trucking costs), however, do not include any induced or indirect effects.

10. The majority of impacts estimated in this analysis may be more conservative (i.e., smaller) than those that might actually occur under drought of record conditions due to not including impacts in the forward linkages in the economy. Input-output models such as IMPLAN only capture backward linkages on suppliers (including households that supply labor to directly affected industries). While this is a common limitation in this type of economic modeling effort, it is important to note that forward linkages on the industries that use the outputs of the directly affected industries can also be very important. A good example is impacts on livestock operators. Livestock producers tend to suffer substantially during droughts, not because there is not enough water for their stock, but because reductions in available pasture and higher prices for purchased hay have significant economic effects on their operations. Food processors could be in a similar situation if they cannot get the grains or other inputs that they need. These effects are not captured in IMPLAN, resulting in conservative impact estimates.

11. The model does not reflect dynamic economic responses to water shortages as they might occur, nor does the model reflect economic impacts associated with a recovery from a drought of record including:
    a. The likely significant economic rebound to some industries immediately following a drought, such as landscaping;
    b. The cost and time to rebuild liquidated livestock herds (a major capital investment in that industry);
    c. Direct impacts on recreational sectors (i.e., stranded docks and reduced tourism); or,
    d. Impacts of negative publicity on Texas' ability to attract population and business in the event that it was not able to provide adequate water supplies for the existing economy.

12. Estimates for job losses and the associated population and school enrollment changes may exceed what would actually occur. In practice, firms may be hesitant to lay off employees, even in difficult economic times. Estimates of population and school enrollment changes are based on regional evaluations and therefore do not necessarily reflect what might occur on a statewide basis.

13. **The results must be interpreted carefully. It is the general and relative magnitudes of impacts as well as the changes of these impacts over time that should be the focus rather than the absolute numbers.** Analyses of this type are much better at predicting relative percent differences brought about by a shock to a complex system (i.e., a water shortage) than the precise size of an impact. To illustrate, assuming that the estimated economic impacts of a drought of record on the manufacturing and mining water user categories are $2 and $1 million, respectively, one should be more confident that the economic impacts on manufacturing are twice as large as those on mining and that these impacts will likely be in the millions of dollars. But one should have less confidence that the actual total economic impact experienced would be $3 million.

14. The methodology does not capture "spillover" effects between regions – or the secondary impacts that occur outside of the region where the water shortage is projected to occur.

15. The methodology that the TWDB has developed for estimating the economic impacts of unmet water needs, and the assumptions and models used in the analysis, are specifically designed to estimate potential economic effects at the regional and county levels. Although it may be tempting to add the regional impacts together in an effort to produce a statewide result, the TWDB cautions against that approach for a number of reasons. The IMPLAN modeling (and corresponding economic multipliers) are all derived from regional models – a statewide model of Texas would produce somewhat different multipliers. As noted in point 14 within this section, the regional modeling used by TWDB does not capture spillover losses that could result in other regions from unmet needs in the region analyzed, or potential spillover gains if decreased production in one region leads to increases in production elsewhere. The assumed drought of record may also not occur in every region of Texas at the same time, or to the same degree.

4 Analysis Results

This section presents estimates of potential economic impacts that could reasonably be expected in the event of water shortages associated with a drought of record and if no recommended water management strategies were implemented. Projected economic impacts for the six water use categories (irrigation, livestock, manufacturing, mining, municipal, and steam-electric power) are reported by decade.

4.1 Impacts for Irrigation Water Shortages

Nine of the 32 counties in the region are projected to experience water shortages in the irrigated agriculture water use category for one or more decades within the planning horizon. Estimated impacts to this water use category appear in Table 4-1. Note that tax collection impacts were not estimated for this water use category. IMPLAN data indicates a negative tax impact (i.e., increased tax collections) for the associated production sectors, primarily due to past subsidies from the federal government. However, it was not considered realistic to report increasing tax revenues during a drought of record.

Table 4-1 Impacts of water shortages on irrigation in Region F

Impact measure	2020	2030	2040	2050	2060	2070
Income losses ($ millions)*	$4	$6	$6	$7	$8	$8
Job losses	98	137	148	170	187	200

* Year 2018 dollars, rounded. Entries denoted by a dash (-) indicate no estimated economic impact. Entries denoted by a zero ($0) indicate estimated income losses less than $500,000.

4.2 Impacts for Livestock Water Shortages

One of the 32 counties in the region are projected to experience water shortages in the livestock water use category for one or more decades within the planning horizon. Estimated impacts to this water use category appear in Table 4-2.

Table 4-2 Impacts of water shortages on livestock in Region F

Impact measure	2020	2030	2040	2050	2060	2070
Income losses ($ millions)*	$-	$0	$1	$1	$1	$1
Jobs losses	-	11	26	41	52	63
Tax losses on production and imports ($ millions)*	$-	$0	$0	$0	$0	$0

* Year 2018 dollars, rounded. Entries denoted by a dash (-) indicate no estimated economic impact. Entries denoted by a zero ($0) indicate estimated income losses less than $500,000.

4.3 Impacts of Manufacturing Water Shortages

Manufacturing water shortages in the region are projected to occur in seven of the 32 counties in the region for at least one decade of the planning horizon. Estimated impacts to this water use category appear in Table 4-3.

Table 4-3 Impacts of water shortages on manufacturing in Region F

Impacts measure	2020	2030	2040	2050	2060	2070
Income losses ($ millions)*	$457	$535	$576	$684	$821	$982
Job losses	1,241	1,771	2,121	2,927	3,933	5,043
Tax losses on production and Imports ($ millions)*	$28	$33	$35	$42	$50	$60

* Year 2018 dollars, rounded. Entries denoted by a dash (-) indicate no estimated economic impact. Entries denoted by a zero ($0) indicate estimated income losses less than $500,000.

4.4 Impacts of Mining Water Shortages

Mining water shortages in the region are projected to occur in seven of the 32 counties in the region for one or more decades within the planning horizon. Estimated impacts to this water use type appear in Table 4-4.

Table 4-4 Impacts of water shortages on mining in Region F

Impacts measure	2020	2030	2040	2050	2060	2070
Income losses ($ millions)*	$18,617	$18,533	$15,686	$11,894	$5,970	$4,291
Job losses	94,650	94,226	79,758	60,489	30,375	21,842
Tax losses on production and Imports ($ millions)*	$2,604	$2,592	$2,194	$1,663	$834	$599

* Year 2018 dollars, rounded. Entries denoted by a dash (-) indicate no estimated economic impact. Entries denoted by a zero ($0) indicate estimated income losses less than $500,000.

4.5 Impacts for Municipal Water Shortages

Nineteen of the 32 counties in the region are projected to experience water shortages in the municipal water use category for one or more decades within the planning horizon.

Impact estimates were made for two sub-categories within municipal water use: residential and non-residential. Non-residential municipal water use includes commercial and institutional users, which are further divided into non-water-intensive and water-intensive subsectors including car wash, laundry, hospitality, health care, recreation, and education. Lost consumer surplus estimates were made only for needs in the residential portion of municipal water use. Available IMPLAN and TWDB Water Use Survey data for the non-residential, water-intensive portion of municipal demand allowed these sectors to be included in income, jobs, and tax loss impact estimate.

Trucking cost estimates, calculated for shortages exceeding 80 percent, assumed a fixed, maximum cost of $35,000 per acre-foot to transport water for municipal use. The estimated impacts to this water use category appear in Table 4-5.

Table 4-5 Impacts of water shortages on municipal water users in Region F

Impacts measure	2020	2030	2040	2050	2060	2070
Income losses[1] ($ millions)*	$121	$220	$362	$426	$515	$637
Job losses[1]	2,219	4,041	6,632	7,817	9,448	11,685
Tax losses on production and imports[1] ($ millions)*	$12	$23	$37	$44	$53	$65
Trucking costs ($ millions)*	$29	$29	$29	$30	$31	$32
Utility revenue losses ($ millions)*	$56	$82	$111	$139	$172	$207
Utility tax revenue losses ($ millions)*	$1	$1	$2	$3	$3	$4

[1] Estimates apply to the water-intensive portion of non-residential municipal water use.
* Year 2018 dollars, rounded. Entries denoted by a dash (-) indicate no estimated economic impact. Entries denoted by a zero ($0) indicate estimated income losses less than $500,000.

4.6 Impacts of Steam-Electric Water Shortages

Steam-electric water shortages in the region are projected to occur in four of the 32 counties in the region for one or more decades within the planning horizon. Estimated impacts to this water use category appear in Table 4-6.

Note that estimated economic impacts to steam-electric water users:

- Are reflected as an income loss proxy in the form of estimated additional purchasing costs for power from the electrical grid to replace power that could not be generated due to a shortage;
- Do not include estimates of impacts on jobs. Because of the unique conditions of power generators during drought conditions and lack of relevant data, it was assumed that the industry would retain, perhaps relocating or repurposing, their existing staff in order to manage their ongoing operations through a severe drought.
- Do not presume a decline in tax collections. Associated tax collections, in fact, would likely increase under drought conditions since, historically, the demand for electricity increases during times of drought, thereby increasing taxes collected on the additional sales of power.

Table 4-6 Impacts of water shortages on steam-electric power in Region F

Impacts measure	2020	2030	2040	2050	2060	2070
Income Losses ($ millions)*	$424	$426	$428	$431	$434	$437

* Year 2018 dollars, rounded. Entries denoted by a dash (-) indicate no estimated economic impact. Entries denoted by a zero ($0) indicate estimated income losses less than $500,000.

4.7 Regional Social Impacts

Projected changes in population, based upon several factors (household size, population, and job loss estimates), as well as the accompanying change in school enrollment, were also estimated and are summarized in Table 4-7.

Table 4-7 Region-wide social impacts of water shortages in Region F

Impacts measure	2020	2030	2040	2050	2060	2070
Consumer surplus losses ($ millions)*	$87	$93	$149	$183	$227	$286
Population losses	18,031	18,394	16,283	13,117	8,078	7,130
School enrollment losses	3,449	3,518	3,115	2,509	1,545	1,364

* Year 2018 dollars, rounded. Entries denoted by a dash (-) indicate no estimated economic impact. Entries denoted by a zero ($0) indicate estimated income losses less than $500,000.

Appendix A - County Level Summary of Estimated Economic Impacts for Region F

County level summary of estimated economic impacts of not meeting identified water needs by water use category and decade (in 2018 dollars, rounded). Values are presented only for counties with projected economic impacts for at least one decade.
(* Entries denoted by a dash (-) indicate no estimated economic impact)

		Income losses (Million $)*						Job losses					
County	Water Use Category	2020	2030	2040	2050	2060	2070	2020	2030	2040	2050	2060	2070
ANDREWS	IRRIGATION	$0.07	$1.55	$1.98	$2.84	$3.51	$3.86	2	40	51	73	91	100
ANDREWS	LIVESTOCK	-	$0.24	$0.57	$0.88	$1.13	$1.36	-	11	26	41	52	63
ANDREWS	MANUFACTURING	$0.74	$18.63	$54.78	$155.00	$279.33	$417.54	5	117	343	970	1,748	2,613
ANDREWS	MINING	$2,415.23	$2,211.91	$1,774.79	$1,228.20	$754.04	$299.20	12,260	11,228	9,009	6,234	3,828	1,519
ANDREWS	MUNICIPAL	$0.00	$0.49	$1.84	$6.40	$13.72	$24.41	0	9	34	117	251	448
ANDREWS Total		**$2,416.05**	**$2,232.81**	**$1,833.97**	**$1,393.32**	**$1,051.73**	**$746.38**	**12,266**	**11,404**	**9,463**	**7,436**	**5,970**	**4,741**
BORDEN	IRRIGATION	-	-	$0.00	$0.01	$0.01	$0.02	-	-	0	0	0	0
BORDEN Total		**-**	**-**	**$0.00**	**$0.01**	**$0.01**	**$0.02**	**-**	**-**	**0**	**0**	**0**	**0**
BROWN	IRRIGATION	$1.14	$1.15	$1.14	$1.15	$1.14	$1.14	27	28	28	28	28	28
BROWN	MINING	$21.21	$21.98	$21.89	$22.23	$21.61	$21.54	142	147	146	149	144	144
BROWN	MUNICIPAL	$0.12	$0.12	$0.11	$0.11	$0.11	$0.11	2	2	2	2	2	2
BROWN Total		**$22.46**	**$23.24**	**$23.14**	**$23.48**	**$22.86**	**$22.79**	**171**	**177**	**176**	**178**	**174**	**174**
COKE	MUNICIPAL	$2.68	$2.64	$2.62	$2.61	$2.61	$2.61	49	48	48	48	48	48
COKE Total		**$2.68**	**$2.64**	**$2.62**	**$2.61**	**$2.61**	**$2.61**	**49**	**48**	**48**	**48**	**48**	**48**
COLEMAN	IRRIGATION	$0.17	$0.17	$0.17	$0.17	$0.17	$0.17	5	5	5	5	5	5
COLEMAN	MANUFACTURING	$1.22	$1.22	$1.22	$1.22	$1.22	$1.22	10	10	10	10	10	10
COLEMAN	MUNICIPAL	$7.62	$7.53	$7.34	$7.29	$7.28	$7.28	140	138	135	134	133	133
COLEMAN Total		**$9.01**	**$8.91**	**$8.72**	**$8.67**	**$8.66**	**$8.66**	**155**	**153**	**149**	**148**	**148**	**148**
CONCHO	MUNICIPAL	$0.07	$0.07	$0.07	$0.08	$0.08	$0.08	1	1	1	1	1	1
CONCHO Total		**$0.07**	**$0.07**	**$0.07**	**$0.08**	**$0.08**	**$0.08**	**1**	**1**	**1**	**1**	**1**	**1**
ECTOR	MUNICIPAL	$1.42	$1.55	$2.77	$5.68	$22.92	$57.07	26	28	51	104	420	1,046
ECTOR	STEAM ELECTRIC POWER	$2.16	$3.83	$5.72	$8.75	$11.35	$13.61	-	-	-	-	-	-

		Income losses (Million $)*						Job losses					
County	Water Use Category	2020	2030	2040	2050	2060	2070	2020	2030	2040	2050	2060	2070
ECTOR Total		**$3.58**	**$5.38**	**$8.50**	**$14.44**	**$34.27**	**$70.68**	**26**	**28**	**51**	**104**	**420**	**1,046**
HOWARD	MANUFACTURING	-	-	-	-	$4.53	$18.06	-	-	-	-	15	59
HOWARD	MUNICIPAL	$0.98	-	-	$1.07	$8.98	$22.90	18	-	-	20	165	420
HOWARD	STEAM ELECTRIC POWER	$0.10	-	-	$0.13	$0.77	$1.40	-	-	-	-	-	-
HOWARD Total		**$1.08**	**-**	**-**	**$1.21**	**$14.27**	**$42.36**	**18**	**-**	**-**	**20**	**179**	**479**
IRION	IRRIGATION	$0.09	$0.09	$0.09	$0.09	$0.09	$0.09	3	3	3	3	3	3
IRION	MINING	$1,381.50	$1,374.78	$94.20	-	-	-	7,023	6,988	479	-	-	-
IRION Total		**$1,381.59**	**$1,374.87**	**$94.29**	**$0.09**	**$0.09**	**$0.09**	**7,025**	**6,991**	**482**	**3**	**3**	**3**
KIMBLE	IRRIGATION	$0.26	$0.26	$0.26	$0.26	$0.26	$0.26	8	8	8	8	8	8
KIMBLE	MANUFACTURING	$104.49	$121.99	$121.99	$121.99	$121.99	$121.99	312	364	364	364	364	364
KIMBLE	MUNICIPAL	$4.77	$4.72	$4.64	$4.61	$4.60	$4.60	87	87	85	85	84	84
KIMBLE Total		**$109.52**	**$126.97**	**$126.89**	**$126.86**	**$126.85**	**$126.85**	**407**	**459**	**457**	**457**	**457**	**457**
LOVING	MINING	$3,202.78	$3,202.78	$2,463.99	$1,202.04	$427.69	$571.91	16,281	16,281	12,525	6,110	2,174	2,907
LOVING Total		**$3,202.78**	**$3,202.78**	**$2,463.99**	**$1,202.04**	**$427.69**	**$571.91**	**16,281**	**16,281**	**12,525**	**6,110**	**2,174**	**2,907**
MARTIN	IRRIGATION	-	-	-	-	-	$0.18	-	-	-	-	-	4
MARTIN	MUNICIPAL	$0.04	$0.08	$0.19	$0.57	$1.11	$1.75	1	1	3	10	20	32
MARTIN Total		**$0.04**	**$0.08**	**$0.19**	**$0.57**	**$1.11**	**$1.93**	**1**	**1**	**3**	**10**	**20**	**36**
MASON	MUNICIPAL	$7.47	$7.37	$7.28	$7.23	$7.22	$7.22	137	135	133	132	132	132
MASON Total		**$7.47**	**$7.37**	**$7.28**	**$7.23**	**$7.22**	**$7.22**	**137**	**135**	**133**	**132**	**132**	**132**
MCCULLOCH	MUNICIPAL	$13.32	$13.60	$13.43	$13.50	$13.52	$13.54	244	249	246	248	248	248
MCCULLOCH Total		**$13.32**	**$13.60**	**$13.43**	**$13.50**	**$13.52**	**$13.54**	**244**	**249**	**246**	**248**	**248**	**248**
MENARD	MUNICIPAL	$1.68	$1.62	$1.57	$1.56	$1.56	$1.56	31	30	29	29	29	29
MENARD Total		**$1.68**	**$1.62**	**$1.57**	**$1.56**	**$1.56**	**$1.56**	**31**	**30**	**29**	**29**	**29**	**29**
MIDLAND	MUNICIPAL	$0.03	$111.77	$233.17	$267.70	$302.87	$341.40	0	2,049	4,275	4,908	5,553	6,259
MIDLAND Total		**$0.03**	**$111.77**	**$233.17**	**$267.70**	**$302.87**	**$341.40**	**0**	**2,049**	**4,275**	**4,908**	**5,553**	**6,259**
MITCHELL	IRRIGATION	$0.10	$0.15	$0.13	$0.11	$0.10	$0.08	2	3	2	2	2	1
MITCHELL	MUNICIPAL	-	$0.49	$0.62	$0.76	$0.94	$1.16	-	9	11	14	17	21
MITCHELL	STEAM ELECTRIC POWER	$343.68	$343.68	$343.68	$343.68	$343.68	$343.68	-	-	-	-	-	-
MITCHELL Total		**$343.78**	**$344.32**	**$344.43**	**$344.55**	**$344.71**	**$344.92**	**2**	**12**	**14**	**16**	**19**	**23**

County	Water Use Category	Income losses (Million $)* 2020	2030	2040	2050	2060	2070	Job losses 2020	2030	2040	2050	2060	2070
PECOS	MANUFACTURING	$156.91	$148.60	$148.60	$148.60	$148.60	$148.60	352	334	334	334	334	334
PECOS	MINING	$2,869.87	$2,869.87	$2,869.87	$2,869.87	-	-	14,588	14,588	14,588	14,588	-	-
PECOS Total		**$3,026.79**	**$3,018.47**	**$3,018.47**	**$3,018.47**	**$148.60**	**$148.60**	**14,940**	**14,922**	**14,922**	**14,922**	**334**	**334**
REEVES	MINING	$8,527.63	$8,527.63	$8,117.65	$6,313.72	$4,591.80	$3,279.86	43,348	43,348	41,264	32,094	23,341	16,672
REEVES	MUNICIPAL	$0.45	$0.50	$0.55	$0.58	$0.60	$0.62	8	9	10	11	11	11
REEVES Total		**$8,528.08**	**$8,528.13**	**$8,118.19**	**$6,314.30**	**$4,592.40**	**$3,280.48**	**43,356**	**43,357**	**41,274**	**32,105**	**23,352**	**16,684**
RUNNELS	MUNICIPAL	$4.00	$3.77	$3.59	$3.56	$3.59	$3.77	73	69	66	65	66	69
RUNNELS Total		**$4.00**	**$3.77**	**$3.59**	**$3.56**	**$3.59**	**$3.77**	**73**	**69**	**66**	**65**	**66**	**69**
SCURRY	IRRIGATION	$2.67	$2.68	$2.68	$2.68	$2.68	$2.68	51	51	51	51	51	51
SCURRY	MANUFACTURING	$187.78	$225.33	$225.33	$225.33	$225.33	$225.33	415	498	498	498	498	498
SCURRY	MINING	$198.43	$323.89	$343.57	$258.29	$174.65	$118.07	1,009	1,646	1,746	1,313	888	600
SCURRY	MUNICIPAL	$1.81	$1.60	$1.73	$2.36	$5.62	$11.66	33	29	32	43	103	214
SCURRY Total		**$390.68**	**$553.50**	**$573.31**	**$488.66**	**$408.28**	**$357.74**	**1,508**	**2,225**	**2,327**	**1,905**	**1,540**	**1,363**
TOM GREEN	MANUFACTURING	$6.18	$18.84	$24.06	$31.54	$40.49	$48.95	147	449	573	751	964	1,166
TOM GREEN	MUNICIPAL	$74.57	$62.49	$80.20	$100.73	$116.86	$134.43	1,367	1,146	1,470	1,847	2,142	2,465
TOM GREEN Total		**$80.75**	**$81.33**	**$104.26**	**$132.27**	**$157.35**	**$183.38**	**1,514**	**1,594**	**2,043**	**2,598**	**3,107**	**3,630**
WARD	MUNICIPAL	-	-	-	-	$1.19	$1.22	-	-	-	-	22	22
WARD	STEAM ELECTRIC POWER	$78.28	$78.28	$78.28	$78.28	$78.28	$78.28	-	-	-	-	-	-
WARD Total		**$78.28**	**$78.28**	**$78.28**	**$78.28**	**$79.47**	**$79.50**	**-**	**-**	**-**	**-**	**22**	**22**
REGION F Total		**$19,623.72**	**$19,719.90**	**$17,058.36**	**$13,443.46**	**$7,749.80**	**$6,356.45**	**98,208**	**100,186**	**88,685**	**71,444**	**43,995**	**38,833**

Appendix E

Letter from The Nature Conservancy of Texas and the Devils River Conservancy

December 21, 2020

Ms. Meredith E. Allen
Groundwater Management Area 7 Coordinator
General Manager
Sutton County Underground Water Conservation District
301 South Crockett Avenue Sonora, Texas 76950

Re: The Devils River and Val Verde County Desired Future Conditions

Dear Ms. Allen,

We appreciate the opportunity to submit comments to Groundwater Management Area 7 (GMA7) regarding the groundwater resources of Val Verde County and the important values the Edwards-Trinity Plateau Aquifer (ETP) provides to its citizens and stakeholders. Together we are (or represent) the stewards of significant land holdings in the Devils River watershed. Below we recommend important considerations for future development of Desired Future Conditions (DFCs) aimed to protect the ETP in Val Verde County.

We commend GMA7 for consideration of springflow in DFCs for both Val Verde County (based on San Felipe Springs) and Kinney County (Las Moras Springs) and for making it a general goal for DFCs in portions of the GMA where groundwater-surface water interactions are of critical importance to water resources. We also commend GMA7 for inclusion of a DFC for Val Verde County, even though there is currently no Groundwater Conservation District (GCD) in the county.

Recent recognition of the importance and complexity of water resources in Val Verde County, the Devils River in particular, warrant consideration in the joint planning process. In addition, recent groundwater development proposals for Val Verde County highlight the urgency of considering the impacts of additional water development on all the ground and surface water resources of the county. While there is not currently a GCD to implement DFCs in Val Verde County, the joint planning results inform the groundwater component of regional water planning and will advise the scope of any future created GCD or other water management entity in Val Verde County.

Value of the Devils River

The Devils River is a valuable resource and provides critical freshwater flows to downstream areas of the Rio Grande Basin, including the lower Rio Grande Valley. In a year of normal rainfall, the Devils River contributes 20% of the inflow to Amistad Reservoir which provides water supply to millions of downstream users, as well as additional recreational opportunities on the lake.

The river's undeveloped, rural watershed is the most intact ecosystem in the state and protects the region's water quality as well as provides unparalleled wilderness recreation opportunities and historical and cultural tourism attractions. Indeed, the Devils, and groundwater resources upon which it depends, has been the subject of a legislatively-requested study in 2018 and discussions of legislative interim committees in 2018 and 2020. The recognition of the importance of the Devils River has led to significant advances in understanding the river and its relationship to the aquifer, which we briefly outline below.

Recent Hydrogeological and Ecological Research in the Devils River

Much information has been developed over the last ten years on the Devils River. This work is the result of multi-partner collaborations and has brought more than $2 million in federal and private funding to research in the Devils River watershed. Key contributions have been made by stakeholders and research institutions such as Texas Parks and Wildlife Department, U.S. Fish and Wildlife Service, The Nature Conservancy, The Devils River Conservancy, University of Texas, Texas A&M University as well as philanthropic foundations and private donors.

In response to a legislative request, TWDB completed a comprehensive report synthesizing available information on the groundwater resources of Val Verde County (TWDB 2018). This report recognizes that the Devils River and its springs may be useful benchmarks for groundwater management in Val Verde County. Other researchers have also advanced the understanding of groundwater flow paths and groundwater surface water interactions in Val Verde County (Green et al. 2014, Wolaver et al. 2018, and Caldwell et al. 2020). This work supported the development of numerical groundwater models to simulate the groundwater system (Ecokai and Hutchison 2014, Green et al. 2016, Toll et al. 2017) that have been used to evaluate future water management scenarios, including additional pumping in the lower portions of the watershed (Ecokai and Hutchison 2014, Toll et al. 2017) and the headwater regions (Fratesi et al. 2019).

There has also been ongoing research and monitoring to understand the flow needs of the Devils River ecosystem and how it would repond to groundwater alteration. Instream habitat modeling studies (URG BBEST 2012, Hardy 2014) have estimated how available habitat changes with reductions in river flow, and these studies are currently being expanded to other areas of the river and updated with additional information on temperature. TPWD has also established a biological monitoring program that has informed research efforts and established a baseline for monitoring changes to ecosystem health that may result from water management, climate change or other impacts. Recent work has also increased the understanding of the flow needs of the two aquatic species in Val Verde County listed under the Endangered Species Act, the Devils River minnow (threatened) and Texas hornshell (endangered) (Randklev et al. 2018).

Devils River Flow Targets

In aggregate, these studies have resulted in scientifically-defensible information to determine levels of river flows necessary to maintain the values provided by the Devils River and could form the basis for future DFCs to protect the flow of the Devils. Some examples of potential flow targets have been based on percentages of historical flows (Smith 2007) or groundwater levels (Green 2016), similar to the approach used in the Edwards Aquifer to maintain flows at Comal and San Marcos Springs. An important advance in development of flow targets occurred during the process set forth by Senate Bill 3 (SB3) in 2007 to define environmental flow standards for Texas rivers and bays to maintain a sound ecological environment. In the Upper Rio Grande Basin, science-based recommendations were made for two locations on the Devils River which resulted in the eventual adoption of flow standards by the Texas Commission on Environmental Quality for the Devils River at Pafford's Crossing (TCEQ 2014)(Figure 1). The base flow portions of the flow standards represent seasonal flows necessary to maintain habitats and recreational opportunities, while the subsistence flow portion represents minimum flows needed to sustain the river, and rare species found there, during drought (URGB BBEST 2012).

International Boundary and Water Commission
Gage 08-4494.00, Devils River at Pafford Crossing near Comstock

Season	Hydrologic Condition	Subsistence	Base	Seasonal Pulse (1 per season)	Annual Pulse (1 per year)
Winter	Subsistence	84 cfs	175 cfs	N/A	Trigger: 3,673 cfs Volume: 34,752 af Duration: 13 days
Winter	Dry	N/A	175 cfs		
Winter	Average	N/A	200 cfs		
Winter	Wet	N/A	243 cfs		
Spring	Subsistence	91 cfs	160 cfs	Trigger: 558 cfs Volume: 17,374 af Duration: 7 days	
Spring	Dry	N/A	160 cfs		
Spring	Average	N/A	207 cfs		
Spring	Wet	N/A	253 cfs		
Fall	Subsistence	87 cfs	166 cfs	Trigger: 1,872 cfs Volume: 27,781 af Duration: 9 days	
Fall	Dry	N/A	166 cfs		
Fall	Average	N/A	206 cfs		
Fall	Wet	N/A	238 cfs		

cfs = cubic feet per second
af = acre-feet
N/A = not applicable

Figure 1. Adopted environmental flow standards for the Devils River at Pafford's Crossing.

Consideration of the Devils River in Groundwater Management and Planning

The Devils River should be specifically considered when creating and implementing DFCs for Val Verde County, and maintenance of historic surface flows should be a primary basis for groundwater management in the county should a GCD or other regulatory entity be formed. GMA 7 has set a MAG of 50,000 acre-feet for the ETP in Val Verde County, which was primarily developed with a DFC based on maintaining flows from San Felipe Springs. This degree of pumping in some areas of the county could result in unintended impacts to the groundwater resources and surface water flows of the Devils River. Recent work by SWRI (Fratesi et al. 2019) suggests that as little as 3,000 - 5,000 acre-feet of pumping beyond what is pumped now could create significant reductions in river flows during periods of drought, which in turn could have significant ecological impacts. Maintaining the previously described flow standards for the Devils River at or near the historical frequency should be considered as minimum thresholds when developing DFCs and MAGs for Val Verde County to maintain surface flows for a sound ecological environment and the downstream municipal and agricultural users historically dependent on those flows.

Consequently, groundwater models should be further refined before the next round of DFCs to allow explicit consideration of changes to Devils River (and Pecos River) flow and springflow resulting from pumping throughout the county. This would enable consideration of other approaches to more effectively manage the totality of water resources of Val Verde Co (e.g., management zones), depending on interest from stakeholders.

In closing, we commend GMA7 for consideration of the importance of Val Verde County, even though there is no GCD. The water resources of Val Verde County are uniquely important to the people of Texas. We appreciate GMA7's consideration of the Devils River and the future creation DFCs to better manage the groundwater which feeds it.

Thank you. Should you have any questions or wish to discuss this matter in more detail, please do not hesitate to contact Ryan Smith at ryan_smith@tnc.org.

Sincerely,

Ryan Smith
The Nature Conservancy of Texas

Julie Lewey
Executive Director
Devils River Conservancy

Cc: Sarah Robertson, Texas Parks and Wildlife Department

Attachment:

Fratesi, S.B., R.T. Green, and N. Martin. 2019. Evaluation of the Devils River Watershed Surface-Water/Groundwater Model for Determination of Pumping Impacts near Finnegan and Dolan Springs Image Courtesy of The Nature Conservancy. Prepared for The Nature Conservancy of Texas. Available on request and attached to these comments.

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Appendix F

Letter from Texas Parks & Wildlife

TEXAS PARKS & WILDLIFE

Life's better outside.®

December 17, 2020

Ms. Meredith E. Allen
GMA Coordinator
General Manager
Sutton County Underground Water Conservation District
301 South Crockett Avenue
Sonora, Texas 76950

Dear Ms. Allen,

As the state agency charged with the primary responsibility for protecting the state's fish and wildlife resources (Texas Parks and Wildlife Code § 12.001), and as the steward of the Devils River State Natural Area, Texas Parks and Wildlife Department appreciates this opportunity to provide comments regarding the determination of desired future conditions (DFCs) for Groundwater Management Area 7 (GMA 7).

We commend GMA7 for consideration of springflow in DFCs for both Val Verde County (based on San Felipe Springs) and Kinney County (based on Las Moras Springs) and for making it a general goal for DFCs in portions of the GMA where groundwater-surface water interactions are of critical importance to water resources. We also commend GMA7 for inclusion of a DFC for Val Verde County, even though there is currently no Groundwater Conservation District (GCD) in the county.

Recent recognition of the importance and complexity of water resources in Val Verde County, the Devils River in particular, warrant consideration in the joint planning process. In addition, recent groundwater development proposals for Val Verde County highlight the urgency of considering the impacts of additional water development on all the ground and surface water resources of the county. While there is not currently a GCD to implement DFCs in Val Verde County, the results of the joint planning process inform the groundwater component of regional water planning and will advise the scope of any future created GCD or other water management entity in Val Verde County.

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Recent Hydrogeological and Ecological Research in the Devils River
Much information has been developed over the last ten years on the Devils River. This work is the result of multi-partner collaborations and has brought more than $2 million in federal and private funding to research in the Devils River watershed. Key contributions have been made by stakeholders and research institutions such as Texas Parks and Wildlife Department, U.S. Fish and Wildlife Service, The Nature Conservancy, The Devils River Conservancy, University of Texas, Texas A&M University as well as philanthropic foundations and private donors.

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There has also been ongoing research and monitoring to understand the flow needs of the Devils River ecosystem and how it would respond to groundwater alteration. Instream habitat modeling studies (URG BBEST 2012, Hardy 2014) have estimated how available habitat changes with reductions in river flow, and these studies are currently being expanded to other areas of the river and updated with additional information on temperature. TPWD has also established a biological monitoring program that has informed research efforts and established a baseline for monitoring changes to ecosystem health that may result from water management, climate change or other impacts. Recent work has also increased the understanding of the flow needs of the two aquatic species in Val Verde County listed under the Endangered Species Act, the Devils River minnow and Texas hornshell (Randklev et al. 2018).

Devils River Flow Targets

In aggregate, these studies have resulted in scientifically-defensible information to define levels of river flows necessary to maintain the values provided by the Devils River and could form the basis for future DFCs to protect the flow of the Devils. Some examples of potential flow targets have been based on percentages of historical flows (Smith 2007) or groundwater levels (Green 2016), similar to the approach used in the Edwards Aquifer to maintain flows at Comal and San Marcos Springs. An important advance in development of flow targets occurred during the process set forth by Senate Bill 3 (SB3) in 2007 to define environmental flow standards for Texas rivers and bays to maintain a sound ecological environment. In the Upper Rio Grande Basin, science-based recommendations were made for two locations on the Devils River which resulted in the eventual adoption of flow standards by the Texas Commission on Environmental Quality for the Devils River at Pafford's Crossing (TCEQ 2014) (Figure 1). The base flow portions of the flow standards represent seasonal flows necessary to maintain habitats and recreational opportunities, while the subsistence flow portion represents minimum flows needed to sustain the river, and rare species found there, during drought (URGB BBEST 2012).

International Boundary and Water Commission
Gage 08-4494.00, Devils River at Pafford Crossing near Comstock

Season	Hydrologic Condition	Subsistence	Base	Seasonal Pulse (1 per season)	Annual Pulse (1 per year)
Winter	Subsistence	84 cfs	175 cfs	N/A	Trigger: 3,673 cfs Volume: 34,752 af Duration: 13 days
Winter	Dry	N/A	175 cfs		
Winter	Average	N/A	200 cfs		
Winter	Wet	N/A	243 cfs		
Spring	Subsistence	91 cfs	160 cfs	Trigger: 558 cfs Volume: 17,374 af Duration: 7 days	
Spring	Dry	N/A	160 cfs		
Spring	Average	N/A	207 cfs		
Spring	Wet	N/A	253 cfs		
Fall	Subsistence	87 cfs	166 cfs	Trigger: 1,872 cfs Volume: 27,781 af Duration: 9 days	
Fall	Dry	N/A	166 cfs		
Fall	Average	N/A	206 cfs		
Fall	Wet	N/A	238 cfs		

cfs = cubic feet per second
af = acre-feet
N/A = not applicable

Figure 1. Adopted environmental flow standards for the Devils River at Pafford's Crossing.

<u>Consideration of the Devils River in Groundwater Management and Planning</u>

The Devils River should be explicitly considered when creating and implementing DFCs for Val Verde County, and should be a primary basis for groundwater management in the county should a GCD or other regulatory entity be formed. GMA 7 has set the Modeled Available Groundwater (MAG) of 50,000 acre-feet for the ETP in Val Verde County, which was primarily developed with a DFC based on maintaining flows from San Felipe Springs. This degree of pumping in some areas of the county could result in unintended impacts to the groundwater resources and surface water flows of the Devils River. Recent work by SWRI (Fratesi et al. 2019) suggests that as little as 3,000 - 5,000 acre-feet of pumping beyond what is pumped now could create significant reductions in river flows during periods of drought, which in turn could have significant ecological impacts. Maintaining the previously described flow standards for the Devils River at or near the historical frequency should be considered as minimum thresholds when developing DFCs and MAGs for Val Verde County to maintain surface flows and a sound ecological environment.

Groundwater models should be further refined before the next round of DFCs to allow explicit consideration of changes to Devils River (and Pecos River) flow and springflow resulting from pumping throughout the county. This would also enable consideration of other approaches for representing the various water resources of Val Verde County (e.g., management zones), depending on interest from stakeholders.

In closing, we commend GMA7 for consideration of the importance of Val Verde County, even though there is no GCD. The water resources of Val Verde County are unique and important to the people of Texas. We appreciate GMA7's consideration of the Devils River and the future creation DFCs to better manage the groundwater which feeds it.

Thank you. Should you have any questions or wish to discuss this matter in more detail, please do not hesitate to contact Sarah Robertson at Sarah.Robertson@tpwd.texas.gov.

Sincerely,

Cindy Loeffler

Cindy Loeffler, Chief
Water Resources Branch

Cc: Ryan Smith, Texas Nature Conservancy
Julie Lewey, Devils River Conservancy

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Appendix G

Letter from Devils River Association

Devils River Association
1566 Private Road 1500
Del Rio, Texas 78840

January 14, 2021

Ms. Meredith E. Allen
GMA7 Coordinator
General Manager
Sutton County Underground Water Conservation District
301 South Crockett Avenue
Sonora, Texas 76950

Re: Proposed Consideration of a Desired Future Condition for the Devils River Watershed in Val Verde County

Dear Ms. Allen,

As Coordinator for GMA7, you likely know that the Devils River Association (DRA) has been composed entirely of Devils River Watershed ranchers and landowners since its creation. As the River's historic multi-generational stewards, DRA's membership has played a strategic role in the conservation and protection of the Devils River and its resources from prior to the Texas drought of record through to the present. It has come to DRA's attention that GMA7 has received correspondence from The Nature Conservancy and the Devils River Conservancy urging consideration for the adoption of a Devils River specific DFC (Desired Future Condition) for Val Verde County. While the DRA shares many of the preservation goals of these Conservancies, the Association believes it imperative that you and your fellow directors also consider the independent views of the DRA membership on such matters. Accordingly, at your direction and convenience, please distribute a copy of this letter to each of your member representatives.

It should be first noted that the importance and complexity of Val Verde County's water resources is not an only recently recognized phenomenon. Due to their long acknowledged value and importance, the county's groundwater resources have been extensively studied over the past 50 years, albeit without meaningful consensus among hydrogeological professionals as to critical aquifer properties and spring flow parameters. Indeed, the Texas Water Development Board (TWBD), in its 2018 Overview of Val Verde County groundwater conditions, advises that the primary obstacle preventing both such consensus and an accurate and reliable assessment of potential pumping impacts, critical to the formation of a DFC, has been the absence of adequate historic spring flow and pumping correlation data, not a lack of modeling efforts or impact studies. Texas' Region J Planning Group has also recognized this lack of correlative data in its 2021 Regional Water Plan, and rejected a proposed Water Plan recommendation that a groundwater conservation district be created for Val Verde County. It also should also be noted that there is no known urgency associated with the adoption of a watershed specific DFC, as there are no existing or proposed water development projects within Val Verde County which threaten our county's groundwater or surface water resources. Indeed, all foreseeable water needs of all significant regional water development candidates, like the cities of San Antonio, San Angelo, Midland and Abilene, have been met with executed long term supply contracts from other groundwater formations.

The Association believes that the joint planning process prescribed by Texas Water Code §36.108 requires that a DFC be supported by clearly defined data and appropriate modeling methodologies and is to be proposed by and enforced by the groundwater conservation district (GCD) for whom the DFC is adopted. The Water Code does not authorize that a DFC be created in order to be used in an effort to "define the scope of '' or otherwise serve as a prelude to an undefined and undetermined GCD that may or may not be created in the future. For the reasons further set forth below, the Association believes that a Devils River specific DFC, and any GCD creation based upon such DFC, is ill advised at this time as such proposed DFC adoption would lack the support of both critical historic data and appropriate, accurate and reliable modeling, and the creation of a GCD, without such critical data and appropriate modeling, would be premature, exceedingly costly and pose a significant "takings" liability risk.

Texas Water Code §36.1132(a) mandates that a GCD accurately and reliably ascertain "the point that total volume of exempt and permitted groundwater production will achieve an applicable desired future condition." Such an undertaking, according to the Texas Water Development Board's 2018 Overview, requires that the GCD perform a

> quantitative evaluation of the effects of potential future pumping on recharge, stream flow and groundwater-surface water interaction (requiring) an appropriately scaled, calibrated, and validated numerical model of coupled groundwater and surface water processes. (p.66)

The problem, as further explained by the TWDB in late 2018, is that "such a model is not currently available and key inputs needed to develop one are not well constrained." (Id)

The lack of adequate data and reliable, accurate modeling also precludes the development of a DFC specific to the Devils River. As frequently noted in the TWDB's 2018 Overview:

> Aquifer properties are poorly defined in most of Val Verde County because there are few data on aquifer responses to pumping stresses. These data are needed to estimate critical parameters such as aquifer hydraulic conductivity and storage. Preferably, aquifer tests could be designed and conducted on wells constructed for this purpose and located where data are most needed. (p. 76)
>
> Water level measurements are the fundamental record required to assess groundwater resources. The current network of observation wells does not provide adequate spatial or temporal detail over the extent of Val Verde County. (p. 75)
>
> Models need to incorporate higher temporal and spatial resolution than the regional Edwards-Trinity (Plateau) Aquifer GAM to assess compliance with desired future conditions, but data to support more detailed models are generally lacking. (p. 66)
>
> Several lines of evidence suggest that a large part of the Val Verde water budget actually originates outside the model domain; if so, these models are not properly calibrated and estimates of aquifer properties and the groundwater volumes available for use are likely in error. (p. 66)

No matter how well intentioned a Val Verde County GCD creation might be, because of the county's general lack of wealth, its geologic complexity and absence of correlative data, the proper functioning and development of a meaningful and enforceable management plan and permitting program, requiring 1) the acquisition and implementation of test wells and testing protocols, 2) the performance of the "quantitative evaluation" of groundwater surface water interactions described by the TWBD, and 3) the development and employment of an "appropriately scaled, calibrated, and validated numerical model of coupled groundwater and surface water processes" required for both predictive accuracy and reliability, the tax base of any Val Verde County GCD would be sorely strained if not wholly overwhelmed. Such limited tax base would be further negatively impacted by "takings" litigation, as encountered by a number of GCDs whose regulatory process and licensing efforts have been challenged for regulatory overreach and property right confiscation. The *Edwards Aquifer Authority v. Bragg* case, for example, resulted in a final takings liability award of $4.5 million against the Aquifer Authority. Unfortunately, in these litigious times, groundwater conservation districts can be easy targets for takings claims whenever such districts attempt to balance the interests of property owners wishing to maximize their business opportunities with the public goal of resource conservation. Creating a GCD without the tools and evidentiary support needed to fight off such legal challenges can only compound the prospect of fiscal failure and, in the interim, result in a false sense of resource protection.

The current lack of aquifer defining quantitative data and reliable, calibrated and validated modeling assessments both precludes the adoption of an accurate and reliable DFC and would make the creation of a GCD an expensive exercise in sheer folly where permit approvals or denials can be legitimately challenged based upon the quality of evidence presented or lack thereof. It should be noted that the lack of adequate available data and/or expert modeling analysis to support a district's regulatory decisions will not qualify as a defense of such determinations, but could readily support claims that such actions are arbitrary or capricious, thereby resulting in monetary liability.

The creation of a groundwater conservation/management district in Val Verde County has been the topic of considerable debate since the establishment of Texas Water Code Chapter 36's enabling legislation. Such creation has been repeatedly presented and rejected at the Texas Legislature over the last several legislative sessions as well as by the Region J Water Planning Group in its 2021 Water Plan. How such a district would protect either private property rights or potentially at risk water resources has beguiled stakeholders ever since such questions first arose. The lack of consensus among geohydrology professionals as to Val Verde County's aquifer recharge, conductivity and storage properties, compounded by an inadequate level of recorded water data details that can be accurately and reliably correlated to aquifer pumping in or near the Devils River Watershed, has been and continues to be a serious obstacle to the development of a DFC specific to the Devils Watershed, much less any appropriate groundwater management effort. It is beyond the purpose of a DFC to define the scope of or otherwise serve as a prelude to the creation of a DFC. Additionally, the costs and legal consequence uncertainties posed by a GCD creation confound any proposition that one be created near term. Under the totality of circumstances presented, neither the facts, nor the science nor applicable legal authorities support the adoption of a Devils River Watershed specific Desired Future Condition or the creation of a Val Verde County groundwater conservation district at this time.

Sincerely,

Skip Newsom

Skip Newsom
Water Resource Committee Chair
On Behalf of the Board of Directors
Devils River Association

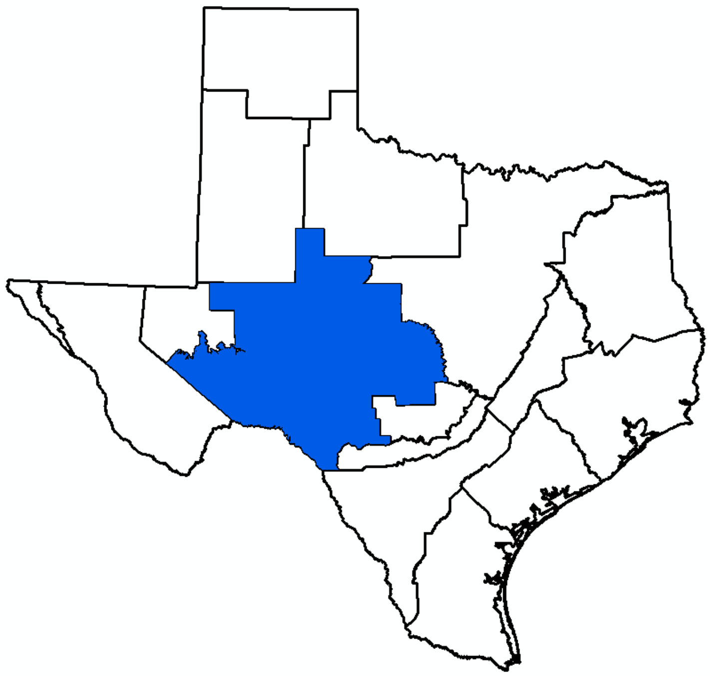
cc: Ryan Smith, The Nature Conservancy
Julie Lewey, Devils River Conservancy

Appendix H

Technical Memorandum 21-01
Analysis of Seasonal Pumping in Management Zone 1 of MPGCD

GMA 7 Technical Memorandum 21-01 - Final

Quantitative Assessment of Impacts: Conversion of Historic Groundwater Pumping from Irrigation Use to Municipal Use in Management Zone 1 of the Middle Pecos Groundwater Conservation District



Prepared for:
Groundwater Management Area 7

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August 28, 2021

GMA 7 Technical Memorandum 21-01 - Final

Quantitative Assessment of Impacts: Conversion of Historic Groundwater Pumping from Irrigation Use to Municipal Use in Management Zone 1 of the Middle Pecos Groundwater Conservation District

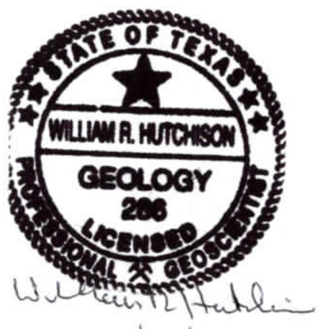
Geoscientist and Engineering Seal

This report documents the work and supervision of work of the following licensed Texas Professional Geoscientist and licensed Texas Professional Engineers:

William R. Hutchison, Ph.D., P.E. (96287), P.G. (286)

Dr. Hutchison completed the analyses and model simulations described in this report, and was the principal author of the final report.

8/28/2021



8/28/2021

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A – Belding Farms Drawdown Hydrographs

1.0 Introduction

1.1 Background

The groundwater conservation districts in Groundwater Management Area 7 proposed desired future conditions for the Edwards-Trinity (Plateau) Aquifer (and other aquifers) at their meeting of March 18, 2021. After the meeting, the Groundwater Management Area 7 coordinator sent each groundwater conservation district the proposed desired future conditions, which began a 90-day public comment period. During the public comment period, each groundwater conservation district held a public hearing and received written comments.

Belding Farms provided written comments to Middle Pecos Groundwater Conservation District in a letter dated June 4, 2021, which was an updated version of a letter sent on February 2, 2021. Mr. Ryan Reed, representing Belding Farms/Cockrell Investments, provided oral comments at the Middle Pecos Groundwater Conservation District public hearing on June 15, 2021. Finally, Belding Farms provided additional written comments in a letter to Middle Pecos Groundwater Conservation District dated June 17, 2021.

The June 4, 2021 letter stated that, since the adoption of the 2016 desired future conditions, "a permit has been granted which would allow the export of water from the MPGCD for municipal use". Further, the letter stated that "groundwater production for municipal purposes can have different pumping patterns as compared with agricultural uses". The stated concern in the letter is that the "differences can have significant effects on localized groundwater availability and reliability, and to the anticipated aquifer recovery rate". Finally, the comment concluded that "we anticipate these impacts to be most pronounced during high water use demands typical of the summer months".

The June 4, 2021 letter also characterized the modeling that has been completed as "flawed, lacks specificity in identifying the changes in pumping cycles on a monthly basis, and is not representative of the impacts seen during actual pumping".

At the public hearing, Mr. Reed requested that a quantitative assessment be completed to evaluate how pumping of about 28,000 AF/yr of water on a municipal schedule would affect the proposed desired future conditions.

1.2 Scope of Analyses

The issue raised by Mr. Reed refers to the Fort Stockton Holdings operating permit that was approved by the Middle Pecos Groundwater Conservation District in 2017. This operating permit authorizes pumping 28,400 AF/yr for agricultural, municipal, or industrial use and the groundwater can be exported outside of Pecos County. As part of approval process for the operating permit, Fort Stockton Holdings reduced their Historic and Existing Use permit by the same amount (28,400 AF/yr). Thus, the total permitted pumping for Fort Stockton Holdings (and other wells within Management Zone 1) remained the same. Thus, the stated concern revolves around the potential impact of changing the timing of the pumping from an irrigation season to a "municipal" schedule. Potentially, this could mean pumping anytime during the year rather than only during the irrigation season. In Pecos County, the irrigation season can extend from February or March to September or October depending on several factors (crop type, rainfall, etc.).

The timing of "municipal" pumping in the operating permit is not as clear, because the permit only provides limitations on annual production. It is possible that the pumping would represent a baseline supply and pumping could be constant each month (January to December). It is also possible that the pumping would be highest in the typical peak municipal demand period (June to September), and the pumping would represent a peaking supply. In general, pumping for municipal use during the summer would have similar effects as pumping for irrigation since the timing of the pumping would be similar, but concentrating the pumping over a few months at the end of the irrigation season would have greater impacts than if the pumping was spread out over the entire irrigation season. At the current time, there is no specific "municipal" schedule associated with the Fort Stockton Holdings operating permit.

Many of the comments are misplaced regarding the scope and purpose of joint planning and the development of desired future conditions. Some of the specificity that is requested is generally outside the scope of joint planning given the size of the area involved and the time frame of the planning period. It must be emphasized that the joint planning process is a "planning process" that has different goals and objectives than "management" activities or groundwater pumping "regulation".

Specifically, in the June 4, 2021 letter at the bottom of page 4, there is a statement that requests an analysis that links the desired future conditions (that are defined as an average drawdown over the GMA 7 portion of Pecos County, an area of over 3,000 square miles over a 60-year period), to the "establishment of a summer threshold". The special permit conditions in the Fort Stockton Holdings operating permit that established a series of winter and summer thresholds in 11 individual monitoring wells. Pumping reductions are specifically tied to the winter thresholds. No such pumping reduction requirements are in the special permit conditions for not meeting summer thresholds. The lack of pumping reductions associated with the summer threshold in the operating permit has been an issue of concern for Belding Farms since 2017 when the permit was approved.

Although the joint planning process and the establishment of desired future conditions is a planning activity by GMA 7, and many of the issues raised in the comments are more properly considered management or regulatory activities by Middle Pecos GCD, this technical memorandum addresses the modeling-related comments.

1.3 Organization of Technical Memorandum

The technical memorandum is organized as follows:

- Section 2 presents a summary of findings and conclusions
- Section 3 documents the pumping capacities and permit limits of the 25 wells in the Fort Stockton Holdings operating permit.

- Section 4 documents an analysis of groundwater levels in 24 Belding Farms wells. The stated concern since 2017 of Belding Farms is the ability of the Belding Farms wells to maintain production during the irrigation season. The data for these wells was previously provided to Middle Pecos Groundwater Conservation District in 2018. Middle Pecos Groundwater Conservation District previously completed a review of these data (Hutchison, 2018).
- Section 5 presents a summary of the two groundwater models used in these analyses.
- Section 6 summarizes results of four simulations that were completed using the Groundwater Availability Model used in the joint planning process in GMA 7. The results are applicable when addressing comments related to the impacts of seasonal pumping on the desired future conditions.
- Section 7 summarizes four initial simulations that were completed using the Western Pecos County groundwater model, which is more appropriate to use when addressing comments that are related to specific issues in Management Zone 1 and in individual wells. Results of these simulations are reported as drawdowns in individual Belding Farms wells.
- Section 8 summarizes four baseline simulations (two with no pumping from the FSH operating permit wells and two with pumping on an irrigation schedule) and eight simulations that consider the shift of 28,400 AF/yr of agricultural pumping to alternative municipal pumping schedules and evaluates the impacts on Belding Farms wells.

2.0 Summary of Findings and Conclusions

FSH Operating Permit Wells: Based on operating permit limits, there is significant variability in the installed capacity of the 25 FSH wells. Each well has its own installed capacity and annual production limits. Assuming 24-hour per day production at the listed capacities, 12 wells can pump their annual limit in less than four months, but nine wells require over six months to reach their annual limit.

Belding Farms Wells Groundwater Data: Minimum groundwater elevations (maximum depth to water) in the Belding Farms wells typically occur at the end of the irrigation season. An analysis of data provided by Belding Farms in 2018 shows that the most frequent month with minimum groundwater elevations is August.

GAM Simulations: The Groundwater Availability Model for the Edwards-Trinity (Plateau) Aquifer (GAM) is the model used in the joint planning process that leads to the development of desired future conditions. Simulations using the GAM quantitatively demonstrated that there is no substantial difference in predicted average drawdown in the GMA 7 portion of Pecos County and in Management Zone 1 over a 60-year period when using annual stress periods, monthly stress periods with constant pumping, and monthly stress periods using different patterns of seasonal pumping.

Initial WPC Model Simulations: Simulations with alternative patterns of seasonal pumping using the Western Pecos County Groundwater Model (WPC Model) quantified the changes in monthly groundwater elevations at 22 well sites associated with Belding Farms wells. The simulated interannual fluctuations in simulated groundwater elevation from these simulations are consistent with groundwater drawdown data provided by Belding Farms in 2018. Thus, it was concluded that the WPC could be used to simulate alternative schedules of municipal pumping from the FSH Operating Permit wells and evaluate the impacts on Belding Farms wells.

Alternative Municipal Pumping Simulations with WPC Model: Simulations with alternative patterns of seasonal pumping and alternative operations of FSH operating permit wells quantified the changes in monthly groundwater elevations at 22 well sites associated with Belding Farms wells. The significant findings and conclusions are:

- If the FSH operating permit wells were not pumped at all, the interannual variation in groundwater elevations in the Belding Farms well would be between 9 and 16 feet, depending on the length of the irrigation season.
- The interannual variation in groundwater elevations in the Belding Farms wells under scenarios where all wells in Management Zone 1 are operating on an irrigation schedule is between about 20 and 29 feet, depending on the length of the irrigation season.
- As noted above, the current installed pump capacity and per well limits associated with each FSH operating permit well means that 12 wells can pump

the full annual permit limit in less than 4 months, but nine wells must be pumped for over six months to achieve the full permit limit. Under the installed pump capacity and current annual production limits in the operating permit, the interannual variation in the groundwater elevations of the Belding Farms wells is between about 22 and 27 feet, depending on the length of the irrigation season.

- If the constraint of installed pump capacity and the current annual production limits (on a per well basis) for the FSH operating permit were relaxed and the full amount of permitted annual pumping could be extracted in four months, the interannual variation in the groundwater elevations in the Belding Farms wells is about 31 feet.

- If the constraint of installed pump capacity and the current annual production limits (on a per well basis) for the FSH operating permit were relaxed and the full amount of permitted annual pumping could be extracted in three months, the interannual variation in the groundwater elevations in the Belding Farms wells is about 33 feet.

Summary Conclusion: Under current installed capacity and annual production limits of each well in the FSH Operating Permit, the results of simulating pumping on a municipal schedule demonstrate that impacts to the Belding Wells are nearly identical to simulated impacts to the Belding Wells when FSH Operating Permit wells are operated on an irrigation schedule. The current permit conditions require adherence to the current pump capacity and annual production limits of each well. Simulations that assumed relaxation of these limits (i.e. all FSH Operating Permit pumping over a three- or four-month period) did result in higher impacts to Belding Farms wells, but did not impact long-term drawdown, which is a groundwater planning issue.

Groundwater Management and Regulation Issues: The significance of the additional impacts associated with concentrated pumping of FSH Operating Permit wells over a three- or four-month period are unknown. However, understanding the significance are more properly groundwater management and groundwater regulation issues, not groundwater planning process issues. Additional data and a more robust analytical exercise with a more appropriate model would be needed to assess the significance of these simulated impacts. Currently, there has been no request submitted to modify the installed pump capacity and/or the annual limits of individual wells, so there is no urgent need to evaluate the significance further. However, this analysis does provide some background if such a request is made in the future. Any such request would be made to the Middle Pecos Groundwater Conservation District (not Groundwater Management Area 7). Such a request would be analyzed by and would be approved by the Middle Pecos Groundwater Conservation District as part of its groundwater management and groundwater regulation activities.

3.0 Fort Stockton Holdings Wells in Operating Permit

Table 1 summarizes data taken from the Fort Stockton Holdings operating permit application for the 25 wells in the permit. Data include the well name, well coordinates, elevation, aquifer, permit limit (in AF/yr) and the peak production rate of the well (in gallons per minute). Table 1 also includes columns that show the results of the following calculations:

- Peak rate of production in AF/month and in AF/day. These values were calculated assuming operation at peak rate 24 hours per day.
- The number of months to reach annual permit limits when pumping at the peak rate (assumed a 30-day month) and the number of days to each annual permit limits when pumping at the peak rate.

Table 1. Summary of FSH Wells in Operating Permit

From Appendix B-1 of Permit Application							Calculated Values Based on Peak Rate of Production and Annual Permit Limits			
Well	Longitude	Latitude	Elevation (feet AMSL)	Aquifer	Operating Permit (AF/yr)	Peak Rate of Production (gpm)	Peak Rate of Production (AF/30 day month)	Peak Rate of Production (AF/day)	Months at Peak Rate to Reach Annual Permit Limit	Days at Max Rate to Reach Annual Limit
C-1	-103.0287	30.89099	3,005	Edwards	849	2,000	265.15	8.84	3.20	96.06
C-2	-103.0314	30.89109	3,006	Edwards	1,273	3,000	397.73	13.26	3.20	96.02
C-3	-103.0346	30.89126	3,008	Edwards	1,273	3,000	397.73	13.26	3.20	96.02
C-4	-103.0258	30.88655	3,006	Edwards	849	2,000	265.15	8.84	3.20	96.06
M-1	-103.0261	30.757445	3,293	Edwards	2,129	2,200	291.67	9.72	7.30	218.98
M-2	-103.0262	30.764695	3,279	Edwards	1,419	1,500	198.86	6.63	7.14	214.07
M-3	-103.0262	30.768281	3,277	Edwards	2,149	2,200	291.67	9.72	7.37	221.04
M-4	-103.0261	30.779308	3,262	Edwards	1,758	1,800	238.64	7.95	7.37	221.01
M-5	-103.0077	30.792598	3,238	Edwards	1,328	2,200	291.67	9.72	4.55	136.59
M-6	-103.006	30.792928	3,231	Edwards	1,727	2,000	265.15	8.84	6.51	195.40
M-7	-103.0064	30.794657	3,213	Edwards	1,727	2,000	265.15	8.84	6.51	195.40
M-8	-102.9936	30.800244	3,195	Edwards	928	1,000	132.58	4.42	7.00	209.99
M-9	-103.0262	30.772017	3,282	Edwards	332	800	106.06	3.54	3.13	93.91
NC-2	-102.9637	30.899027	2,981	unknown	212	500	66.29	2.21	3.20	95.95
S-1	-103.0435	30.815876	3,152	Edwards	458	1,400	185.61	6.19	2.47	74.03
S-2	-103.0438	30.823565	3,144	Edwards	1,352	1,800	238.64	7.95	5.67	169.97
S-4	-103.0135	30.827628	3,141	Edwards-Trinity	1,839	2,100	278.41	9.28	6.61	198.16
S-6	-103.0435	30.830453	3,121	Edwards	424	1,000	132.58	4.42	3.20	95.95
S-11	-103.0259	30.83056	3,128	Edwards-Trinity	1,381	2,500	331.44	11.05	4.17	125.00
S-13	-103.0172	30.830579	3,131	Edwards	920	1,800	238.64	7.95	3.86	115.66
S-18	-103.0103	30.859055	3,066	Edwards	406	1,000	132.58	4.42	3.06	91.87
S-19	-103.0218	30.859023	3,074	Edwards-Trinity	406	1,200	159.09	5.30	2.55	76.56
S-20	-103.0218	30.860309	3,064	Edwards	406	1,400	185.61	6.19	2.19	65.62
S-26	-103.0372	30.85887	3,077	Edwards	1,318	2,000	265.15	8.84	4.97	149.12
S-32	-103.0351	30.858848	3,088	Edwards	1,537	1,650	218.75	7.29	7.03	210.79
Totals					**28,400**	**44,050**	**5,840**			

Please note that the installed capacity of the wells and the annual permit limits suggest that it takes several months operating at full capacity to pump the annual limit of the operating permit. Twelve of the wells can reach the full limit in less than 4 months. However, nine wells require over six months of pumping to reach the operating permit limit.

4.0 Annual Minimum Depth to Water in 24 Belding Farms Wells

The data provided to Middle Pecos Groundwater Conservation District by Belding Farms for 24 of their wells in 2018 were analyzed to find the annual minimum depth to water reading for each year and for each well. The FORTRAN program *minmo.exe* was written for this purpose. All files associated with this analysis using a Google Drive folder that can be accessed at:

https://drive.google.com/drive/folders/15UanCjnyORvf9YgG72uEJQO0i7tlMnrT?usp=sharing

The program reads the file *BeldingStaticDTW.csv* (which was extracted from the data provided by Belding Farms in 2018). The program then finds the minimum depth to water for each well in each year and fills an array with the month number.

The program then writes the results to an output file named *minmo.dat*. This file was imported into Excel and saved as *BeldingMinMoCount.xlsx* for further processing. Each row of the file *minmo.dat* is a year and each column is a well. The month with the minimum depth to water is written to *minmo.dat*. If there are no data for a well in a particular year, the default value is -999. The first tab of *BeldingMinMoCount.xlsx* is the data from *minmo.dat.* The -999 values are removed from the results. The second tab of *BeldingMinMoCount.xlsx* is a summary that presents a monthly count of the minimum values.

There are 440 well-year results in the *minmo.dat* tab, and the *Summary* tab shows that August has the most minimum depth-to-water values. Figure 1 summarizes the data in the *Summary* tab. Thus, August is the month with the most minimum depth-to-water data. September has the next most, and July is slightly less than September.

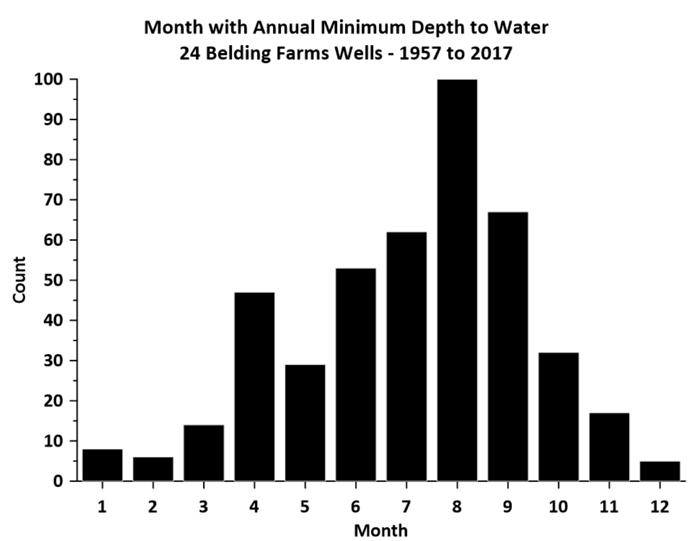

Figure 1. Month with Annual Minimum Depth to Water

There are instances in the Belding data where depth to water data were not collected in every month. Therefore, this analysis can only be considered cursory. However, the results demonstrate that the lowest groundwater levels each year tend to occur at the end of the irrigation season.

5.0 Groundwater Model Summary Descriptions

Two groundwater models were used for this effort:

- The alternative Groundwater Availability Model for the Edwards-Trinity (Plateau) Aquifer, also known as the one-layer model (Hutchison and others, 2011), has been used in the joint planning process since 2010. The model fully covers Pecos County and has one square mile grid cells (640 acres). The model calibration period was 1931 to 2005, with annual stress periods.
- The Western Pecos County Groundwater Model (WPC Model), documented in Harden and others (2011), and was reviewed by Hutchison (2017). The focus of the model development and calibration was the Leon-Belding Area (i.e. Management Zone 1). The model does not cover the full extent of Pecos County, but does fully cover Management Zone 1 as defined by the Middle Pecos Groundwater Conservation District. The model has grid cells that are 2,000 ft by 2,000 ft (about 91 acres or about 0.14 square miles). The model calibration period was 1945 to 2010, with annual stress periods.

5.1 Comparison of Pumping – Calibration Periods

The groundwater pumping from the two model were compared as follows:

- Figure 2 presents the pumping comparison in Management Zone 1,
- Figure 3 presents the pumping comparison for the Fort Stockton Holdings (FSH) wells associated with the operating permit, and
- Figure 3 presents the pumping comparison for the Belding Farm wells.

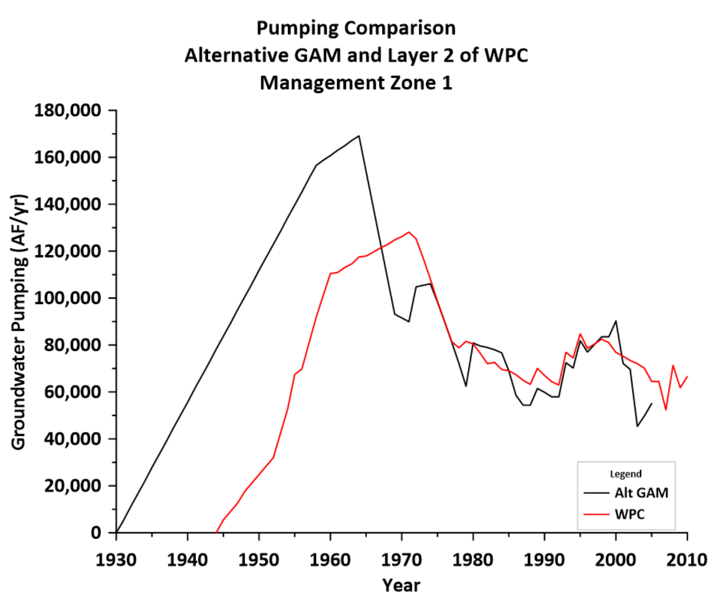

Figure 2. Pumping Comparison - Management Zone 1

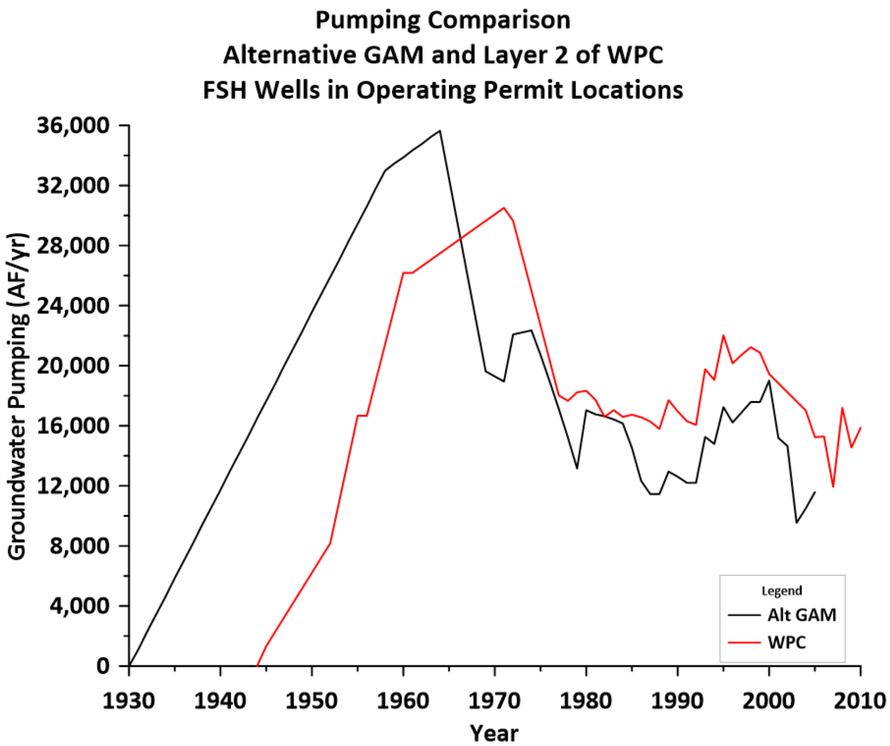

Figure 3. Pumping Comparison - FSH Operating Permit Wells

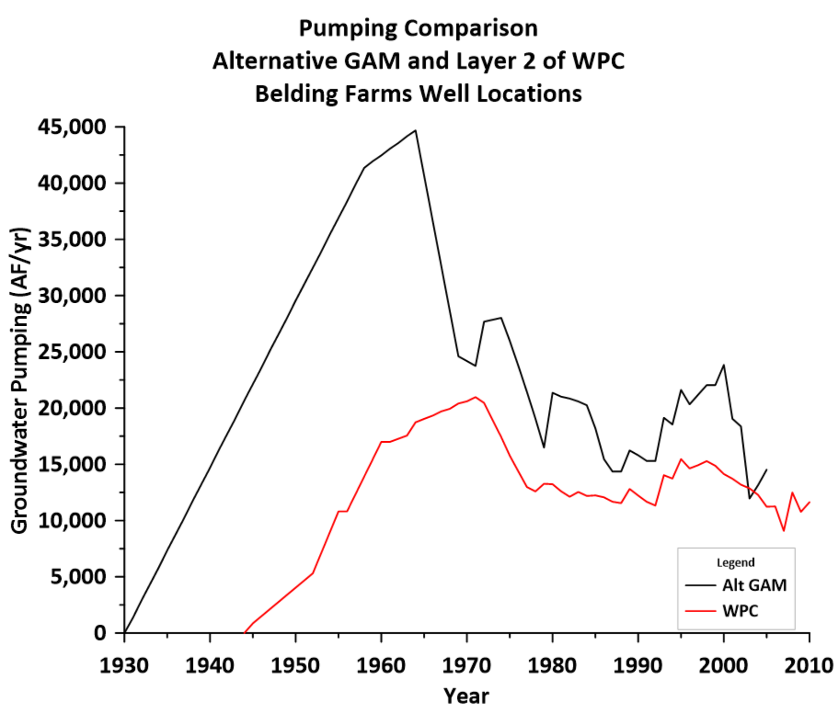

Figure 4. Pumping Comparison - Belding Farms Wells

Please note that both models have similar pumping estimates in Management Zone 1 after the mid-1970s. In general, the Alternative GAM has slightly lower estimates of pumping in the FSH Operating permit wells than the WPC Model. Also, the Alternative GAM has slightly higher estimates of pumping in the Belding Farms wells than the WPC Model.

During development of the desired future conditions starting in 2010, several simulations have been completed using the Alternative GAM. The assumed pumping for the GMA 7 portion of Pecos County is 117,309 AF/yr, and the pumping from Management Zone 1 is 74,134 AF/yr.

The WPC Model was used in a series of evaluations by Hutchison (2017) that used pumping in 2010 (the last year of the calibration period) as the baseline. In the WPC Model in the current Management Zone 1, pumping was 66,561 AF/yr in layer 2 (Edwards) and 6,474 AF/yr in layer 3 (Trinity), for a total Edwards-Trinity pumping of 73,035 AF/yr, which is reasonably close to the GAM estimate of 74,134 AF/yr. Pumping from the FSH wells associated with the operating permit in 2010 was 15,869 AF/yr for layer 2 (Edwards) and 450 AF/yr for layer 3 (Trinity), for a total Edwards-Trinity pumping of 16,319 AF/yr. This total is less than the 28,400 AF/yr associated with the operating permit. As developed further below, the pumping from the FSH wells was modified for simulations using the WPC Model as part of this analysis.

6.0 Simulations with the Alternative GAM

As detailed below, the Alternative GAM was used to complete simulations that quantitatively demonstrated that there is no substantial difference in predicted drawdown over a 60-year period when using annual stress periods, monthly stress periods with constant pumping, and monthly stress periods using different patterns of seasonal pumping.

6.1 Annual Stress Periods

The alternative GAM was used as part of the development of the desired future conditions in 2010 and 2016. The proposed desired future conditions in 2021 are the same as the final desired future conditions in 2016 (Hutchison, 2018b and Hutchison 2018c). In the GMA 7 portion of Pecos County, the desired future condition is expressed as 14 feet of drawdown from 2011 to 2070. The associated pumping in Pecos County (i.e. the modeled available groundwater) is 117,309 AF/yr. All files associated with the base run using a Google Drive folder that can be accessed at:

https://drive.google.com/drive/folders/11Qsqqdo6A6me38XPbdKKTonhMm_JPcho?usp=sharing

For purposes of this analysis, the average drawdown in Management Zone 1 was calculated from 2011 to 2070, and the pumping in Management Zone 1 was also calculated. These were accomplished with a FORTRAN post-processor *postprocann.exe* (also included in the above Google Drive link). Average drawdown in Management Zone 1 from 2011 to 2070 is 45 feet, and pumping is 74,134 AF/yr.

The issue raised in the Belding Farms comments cannot be answered with an annual model. The desired future conditions for GMA 7 were set from 2011 to 2070, and it was assumed that interannual variations were not relevant given the length of the planning period and objectives of the joint planning process. However, in response to the comment and given the nature of the expected change in a significant amount of Management Zone 1 pumping from agricultural to a mix of agricultural and municipal, a preliminary conversion of the alternative GAM to a monthly model was needed to provide preliminary answers to the questions that have been raised. An updated model that is currently in development will use monthly stress periods, at least for recent years, and will be used to address these groundwater management issues more directly and more robustly in the future.

6.2 Monthly Stress Periods – Base Case (Constant Pumping Rate)

The model input files were modified to run the simulation using monthly stress periods. For this base run, average annual rates of pumping and constant rates of recharge were maintained to demonstrate that the average drawdowns do not change using monthly stress periods or annual stress periods. All other input files were modified to handle the monthly stress periods. All files associated with this base run of the monthly stress period alternative GAM can be accessed at:

https://drive.google.com/drive/folders/16jQtUdSRbKl2AIrmfBb_XzbELXRxpCPx?usp=sharing

Average drawdown and pumping were extracted from model results using a FORTRAN post-processor *postprocann.exe* (also included in the above Google Drive link).

For the GMA 7 portion of Pecos County, average drawdown was calculated as 14 feet (13.62 feet for the monthly base model versus 13.67 feet for the annual model). Pumping for all of Pecos County was calculated as 240,206 AF/yr for the monthly base model (as compared with 240,208 AF/yr for the annual model). These differences are attributable to rounding error and are not significant for the purposes of this analysis.

Average drawdown in Management Zone 1 from 2011 to 2070 is using the monthly base model was calculated as 45 feet (45.40 feet for the monthly base model versus 45.33 feet for the annual model) and pumping from the monthly base model is 74,131 AF/yr (as compared to 74,134 for the annual model). As with the GMA 7 portion of Pecos County, these differences are attributable to rounding error and are not significant for the purposes of this analysis.

Based on these results, the change to monthly stress periods results in essentially the same drawdown for the GMA 7 portion of Pecos County and Management Zone 1 as the annual stress period simulation. The base monthly simulation did not change any assumptions relative to the simulated rate of pumping and recharge, just specified them at a constant monthly rate that changes each year rather than at annual rate that changes each year. The objective for this simulation was to test the model code relative to rounding error and other components of the simulated groundwater system.

6.3 Monthly Stress Periods with Seasonal Pumping

Three alternative seasonal pumping simulations were completed:

- Pumping from January to June, no pumping from July to December (6 months on, 6 months off, establish a baseline based on equal pumping and equal recovery time for end of year comparison).
- No pumping from January to March, pumping from April to September, no pumping from October to December (6 months on, 6 months off, agricultural pumping pattern)
- No pumping from January to February, pumping from March to October, no pumping from November to December (8 months on, 4 months off, agricultural pumping pattern)

All files for these simulations, including a pre-processor that was written to develop input pumping files (*ScenWel.exe*) and a post-processor that was written to extract pumping and drawdown results (*MonthlyScenPostProc.exe*) can be accessed at:

https://drive.google.com/drive/folders/1pfQ1wO6HeouqtH3DfiqO1t_VZ4p19BDJ?usp=sharing

6.3.1 January to June Pumping Scenario

As discussed above, the monthly simulation where pumping was held constant throughout the year was completed to quantitatively demonstrate that the average drawdowns do not change using monthly stress periods or annual stress periods. Similarly, this simulation was completed to quantitatively demonstrate that doubling the monthly rate of pumping for six months followed by six months of no pumping would results in essentially the same drawdowns as a constant monthly pumping or as a simulation that used annual stress periods. This pattern is clearly not realistic in terms of an irrigation season but was an important intermediate analytical step to interpret the results of the other two seasonal pumping scenarios.

6.3.2 April to September Pumping Scenario

This scenario has the same rates of pumping as the January to June pumping scenario (double the average annual rate of pumping) but assumes a six-month irrigation season. When evaluating end-of-year groundwater elevations or end-of-year drawdowns (i.e. end of December), this scenario does not have a full six-month recovery period as in the January to June scenario. Thus, this scenario provides a means to quantitatively evaluate differences in end-of-year drawdown without the benefit of a full six months of recovery.

6.3.3 March to October Pumping Scenario

This pumping scenario assumes pumping for eight months and four months of recovery. The pumping rate is 1.5 times the annual average rate (i.e. evenly distributed over the eight months). This is a more realistic scenario as the irrigation season is generally considered to be about eight months with some variation due to crop type and weather. This scenario provides a means to quantitatively evaluate differences in end-of-year drawdown over a short period of recovery (two months).

6.3.4 Summary of Seasonal Pumping Results

Table 2 presents a summary of results from the simulation using the GAM with annual stress periods (i.e. the basis for the desired future condition in 2016 and proposed desired future condition for 2021), and the results of the four simulations using the GAM with monthly stress periods as developed above.

Table 2. Summary of GAM Simulations - Drawdown and Pumping

	Scenario				
		Monthly Stress Periods			
	Annual Stress Periods	Constant Monthly Pumping	Pumping from Janaury to June	Pumping from April to September	Pumping from March to October
GMA 7 Portion of Pecos County					
Drawdown from 2011 to 2070 (ft)	13.67	13.62	13.27	13.65	13.74
Annual Range of Drawdown in 2011 (ft)	N/A	0.34	1.27	1.63	1.23
Annual Range of Drawdown in 2070 (ft)	N/A	0.18	1.34	1.54	1.11
Pumping (AF/yr)	117,309	117,308	116,347	117,633	118,114
Management Zone 1 in Pecos County					
Drawdown from 2011 to 2070 (ft)	45.33	45.40	44.65	45.56	45.85
Annual Range of Drawdown in 2011 (ft)	N/A	0.74	1.09	1.35	1.17
Annual Range of Drawdown in 2070 (ft)	N/A	0.64	1.05	1.29	1.10
Pumping (AF/yr)	74,134	74,131	73,525	74,337	74,640

Please note that there is some rounding error associated with converting the average annual rate of pumping to a seasonal rate of pumping for indivudal months due to the different number of days in each month. However, there is only minimal difference in the calculated drawdowns in the GMA 7 portion of Pecos County and in Management Zone 1 in Pecos County.

The results also include the difference in the maximum and minimum drawdowns in 2011 and 2070 for the GMA 7 portion of Pecos County and Management Zone 1 in Pecos County. For the constant pumping scenario, the interannual variation is the same as the average annual decline in groundwater elevation. For example, in the GMA 7 portion of Pecos County, the average drawdown from 2011 to 2070 is 13.67 feet. Over a 60-year period, this converts to an average annual rate of 0.23 ft/yr. As shown in Table 2, the 2011 rate of decline is 0.34, and the 2070 rate is 0.18. These results provide a baseline to compare the annual change associated with the seasonal pumping results.

Note that, for all scenarios, the interannual variation in average drawdown is less than 2 feet. However, at the end of the planning period (2070) drawdowns in all scenarios are essentially the same. Thus, the scenario with eight months of pumping (March to October) and only two months of recovery results in essentially the same drawdown as the other scenarios where recovery times are longer (i.e. three months or six months).

Please recall that the desired future conditions are expressed without the decimal places (i.e. rounded to the nearest foot). These results demonstrate that the differences in drawdown associated among the different seasonal pumping scenarios are within that rounding standard. It must be emphasized that although these analyses are quantiatiative, some of the assumptions are not particulely realistic (i.e. constant recharge throughout the year). Also, all pumping was assumed to be seasonal as defined by the scenario. Clearly, not all pumping would follow this pattern. The scenarios were designed to evaluate the assumption of seasonal pumping in contrast to the average annual pumping assumption in the annual GAM simulation that are the basis for the desired future conditions. By assuming all pumping as seasonal in the monthly simulations, it provides the best opportunity to evaluate the interannual variation in average drawdown over large areas. The results suggest that, for GMA 7, the assumptions of average annual pumping rates and annual stress periods are appropriate for planning purposes and development of desired future conditions.

With respect to the consitency of the desired future conditions with the FSH Operating Permit conditions, Figure 5 (appears as Figure 2 in the MPGCD Management Plan) compares the desired future condition drawdown at each of the 11 monitoring wells with two of the thresholds for each well (Historic Minimum Winter Depth to Water -10 feet and Historic Winter Minimum Depth to Water +5 feet). Please note that the blue data points represent the groundwater elevation where pumping cutbacks begin for each well. The red dots represent the groundwater elevation where a shut-down in non-historic groundwater pumping would be required, thus providing an opportunity for groundwater elevation recovery. The black line represents one-to-one line between the DFC depth to water at each well and the threshold depth to water in each well. The data points generally fall just above or just below the black line demonstrating that the thresholds are consistent with the DFC.

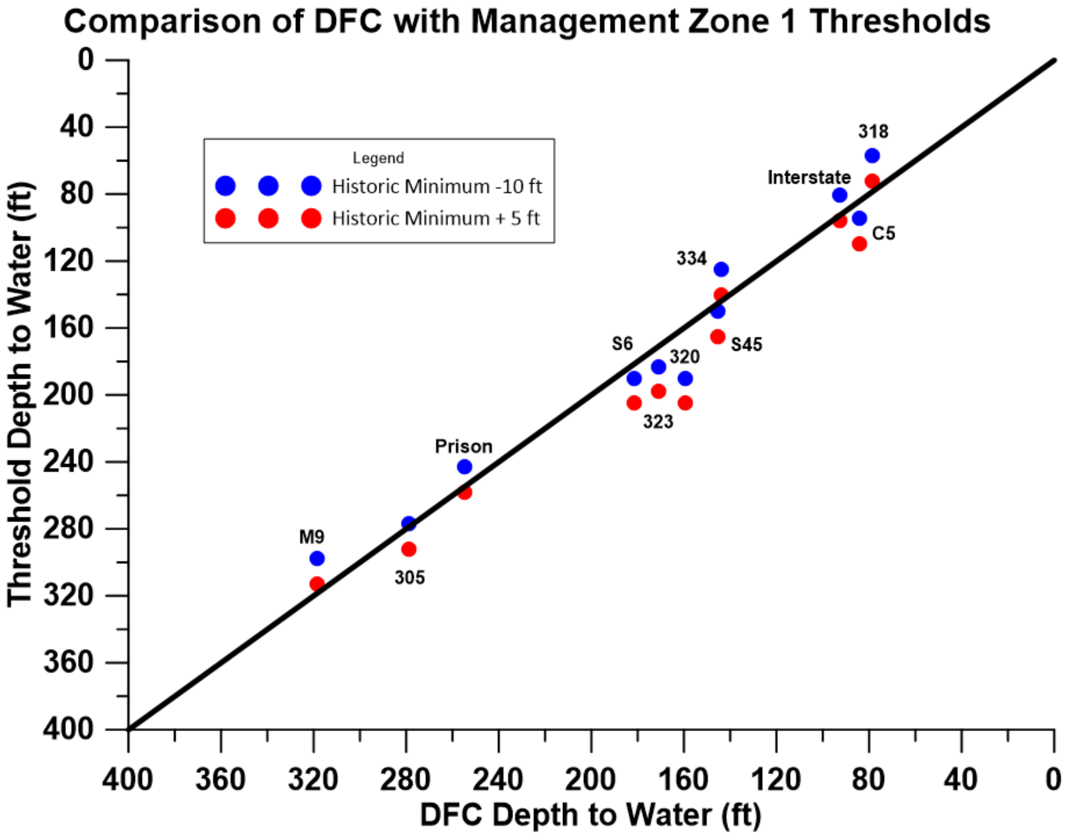

Figure 5. Comparison of DFC with Management Zone 1 Thresholds

7.0 Simulations with the Western Pecos County (WPC) Model

The simulations with the GAM presented above quantiatively demonstrated that the use of the GAM with monthly stress periods and alternative patterns of seasonal pumping provide consistent results with the simulations with annual stress periods that were used to develop desired future conditions. Consequently, it can be concluded that the use of the annual stress periods in the Alternative GAM to calculate average drawdowns in Pecos County for planning purposes is appropriate despite its inability to simulate seasonal pumping. Furthermore, the winter thresholds in the FSH Operating Permit are consistent with the desired future conditons.

The comments received from Belding Farms and the ongoing discussions between MPGCD and Belding Farms suggest that the real issue is not long term average drawdowns (i.e. desired future conditions), but the potential impacts of converting 28,400 AF/yr of agricultural pumping to municipal use. More directly, the issue is the potential impact on Belding Farms wells. The GAM is not the best analytical tool for such an analysis due to its coarse discretization (i.e. one square mile grid cells) and calibration focus over the entire GMA 3/GMA 7 area. The Western Pecos Model (WPC Model) was developed and calibrated specifically for the Leon-Belding area (i.e. Management Zone 1), and is used for additional simulations documented in this section.

As part of the review of the WPC Model (Hutchison, 2017), 55 simulations were completed that evaluated the sensitivity of pumping to average drawdown in the old Management Zone 1 and spring flow at Comanche Springs. The base case for the the effort used pumping from the last stress period of the calibration period (2010):

- Pumping in 2010, as assumed by the WPC Model in the current Management Zone 1, was 66,561 AF/yr in layer 2 (Edwards) and 6,474 AF/yr in layer 3 (Trinity), for a total Edwards-Trinity pumping of 73,035 AF/yr. This total is reasinably close to the GAM estimate of 74,134 AF/yr.
- Pumping from the FSH wells associated with the operating permit in 2010 was 15,869 AF/yr for layer 2 (Edwards) and 450 AF/yr for layer 3 (Trinity), for a total Edwards-Trinity pumping of 16,319 AF/yr. This total is less than the 28,400 AF/yr associated with the operating permit.

Initial simulations were completed that were similar to the GAM simulations described above. These were completed in order to evaluate the drawdown variation at specific Belding Farms well locations drawdown under the following scenarios:

- Annual stress periods using the model files from the base case of Hutchison (2017)
- Monthly stress period simulation using constant rate pumping based on base case of Hutchison (2017), or the same pumping rate as the base case
- Monthly stress period simulation with 6 months of pumping and 6 months of recovery (April to Septmber pumping), or double the pumping rate as the base case
- Monthly stress period simulation with 8 months of pumping and 4 months of recovery (March to October pumping), or 1.5 times the pumping rate as the base case

7.1 Annual Stress Periods

This simulation was the same as the base case documented in Hutchison (2017). All model files are available at:

https://drive.google.com/drive/folders/11g5bMhruMTm9uABmb31C3zp3Vaz-wtIX?usp=sharing

As noted above, pumping was held constant in all years (2011 to 2070) using pumping from the calibrated model in 2010. In the current Management Zone 1, pumping was 66,561 AF/yr in layer 2 (Edwards) and 6,474 AF/yr in layer 3 (Trinity), for a total Edwards-Trinity pumping of 73,035 AF/yr. This total is reasinably close to the GAM estimate of 74,134 AF/yr.

Pumping from the FSH wells associated with the operating permit in 2010 was 15,869 AF/yr for layer 2 (Edwards) and 450 AF/yr for layer 3 (Trinity), for a total Edwards-Trinity pumping of 16,319 AF/yr. This total is less than the 28,400 AF/yr associated with the operating permit.

Ouput from the model was used in a post-processor named *gethds.exe* that writes groundwater elevation and drawdown for each of the Belding Farm wells and a summary file with the drawdown for each well at the end of the simulation (2070). The post processor, source code and all output files are also available from the above link.

7.2 Monthly Stress Periods, Constant Pumping

The model input files of the WPC Model were modified to run the simulation using monthly stress periods. However, for this base run, average annual rates of pumping and constant rates of recharge were maintained to demonstrate so that that the average drawdowns do not change using monthly stress periods or annual stress periods. All other input files were modified to handle the monthly stress periods. The output control file was modified to only write cell by cell output at the end of each year rather than the end of each month due to model file size constraints. All files associated with this base run of the monthly stress period alternative GAM can be accessed at:

https://drive.google.com/drive/folders/1fQ22hD-CUkt-g7YL-xaJ4JhDlfrr5Any?usp=sharing

A post-processor named *gethds.exe* extracted results from the model output files to obtain groundwater elevation and drawdown results for each of the Belding Farm wells and a summary file with the drawdown for each well at the end of the simulation (2070). In addition, the post processor calculates the difference between the maximum drawdown each year and the minimum drawdown each year for each well site. This “interannual variation” or “amplitude” is useful to understand the seasonal variation in groundwater elevations based on the assumptions of the particular analysis. The post processor, source code and all output files are also available from the above link.

7.3 Monthly Stress Periods, April to September Pumping

This simulation assumed that all pumping occurs from April to September. Thus, the rate of constant monthly pumping for each cell from April to September was doubled, and pumping from October to March was set to zero. Pumping for this simulation was developed with the pre-processor *ScenWel.exe*. All other input files for this simulation were the same as the constant monthly pumping scenario. The output control file was modified to only write cell by cell output at the end of each year rather than the end of each month due to model file constraints. All files associated with this base run of the monthly stress period alternative GAM can be accessed at:

https://drive.google.com/drive/folders/18IUjEl270vYY6S43-2Iv1MZBx9iIN9jd?usp=sharing

A post-processor named *gethds.exe* extracted results from the model output files to obtain groundwater elevation and drawdown results for each of the Belding Farm wells and a summary file with the drawdown for each well at the end of the simulation (2070). In addition, the post processor calculates the difference between the maximum drawdown each year and the minimum drawdown each year for each well site. This "interannual variation" or "amplitude" is useful to understand the seasonal variation in groundwater elevations based on the assumptions of the particular analysis. The post processor, source code and all output files are also available from the above link.

7.4 Monthly Stress Periods, March to October Pumping

This simulation assumed that all pumping occurs from March to October. Thus, the rate of constant monthly pumping for each cell from March to October was multiplied by 1.5 and pumping from November to February was set to zero. Pumping for this simulation was developed with the pre-processor *ScenWel.exe*. All other input files for this simulation were the same as the constant monthly pumping scenario. The output control file was modified to only write cell by cell output at the end of each year rather than the end of each month due to model file constraints. All files associated with this base run of the monthly stress period alternative GAM can be accessed at:

https://drive.google.com/drive/folders/1KDzIMEb7O29iPsDIMEJ9lw8m-3lF3VzY?usp=sharing

A post-processor named *gethds.exe* extracted results from the model output files to obtain groundwater elevation and drawdown results for each of the Belding Farm wells and a summary file with the drawdown for each well at the end of the simulation (2070). In addition, the post processor calculates the difference between the maximum drawdown each year and the minimum drawdown each year for each well site. This "interannual variation" or "amplitude" is useful to understand the seasonal variation in groundwater elevations based on the assumptions of the particular analysis. The post processor, source code and all output files are also available from the above link.

7.5 Simulation Results

7.5.1 Hydrographs of Well B-7 Drawdown

Results from these simulations were focused on drawdown in individual Belding Farms wells. Results for each well were saved in individual files which are available at the links provided above. An example is Well B-7.

Figure 6 presents the drawdown results from the annual stress period simulation and the monthly stress period simulation using constant pumping. The black data points represent the annual stress period simulation results and the red line represents the results from the constant monthly pumping simulation. There is no discernable difference between these sets of results in the hydrograph.

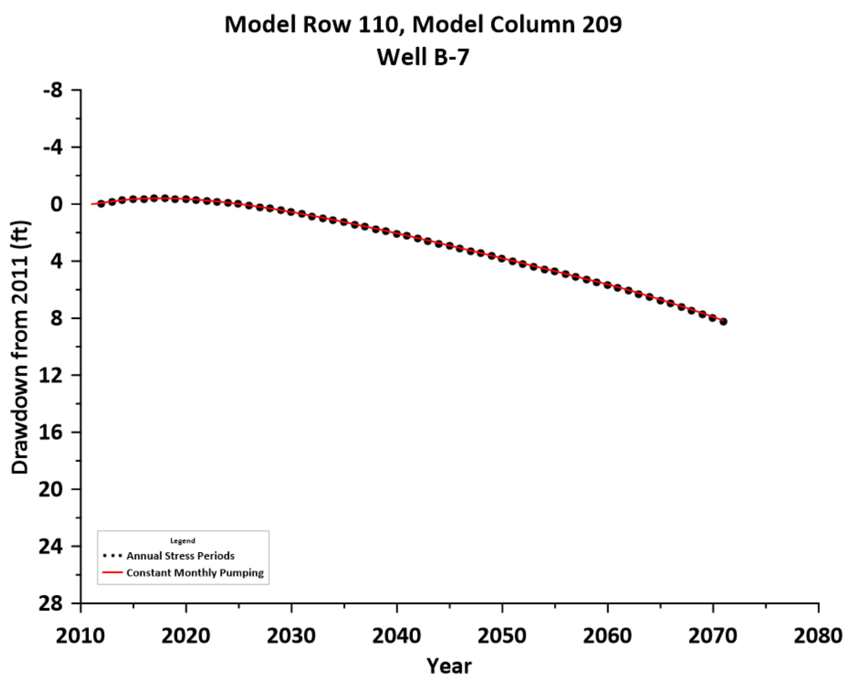

Figure 6. Well B-7 Drawdown Hydrograph - Annual Stress Period and Constant Monthly Pumping Simulations

Figure 7 presents the drawdown results from the annual stress period simulation and the monthly stress period simulation assuming pumping only from April to September. The red line represents the monthly stress period-constant pumping simulation results and the blue line represents the monthly stress period-April to September pumping simulation results. Please note that the simulation results show the seaasonal increase and decrease in groundwater elevation due to the seasonal cycle of pumping and recovery. The interannual variation or amplitude of the seasonal fluctuation exceeds 25 feet in this well. Also, please note that the model represents static groundwater levels, not pumping groundwater levels. Typcially, pumping water levels are lower than static groundwater levels as demonstrated in the Belding Farms data that was reviewed by Hutchison (2018).

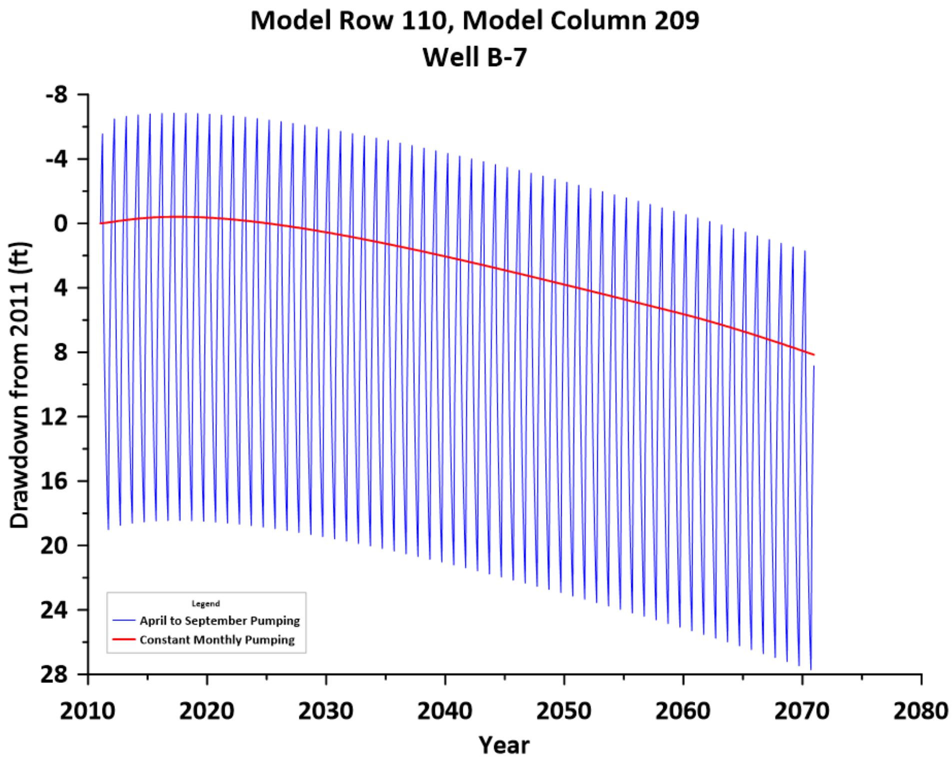

Figure 7. Well B-7 Drawdown Hydrograph - Annual Stress Period and April to September Pumping Simulations

Figure 8 presents the drawdown results from the annual stress period simulation and the monthly stress period simulation assuming pumping only from March to October. The red line represents the monthly stress period-constant pumping simulation results and the green line represents the monthly results of the March to October pumping simulation.

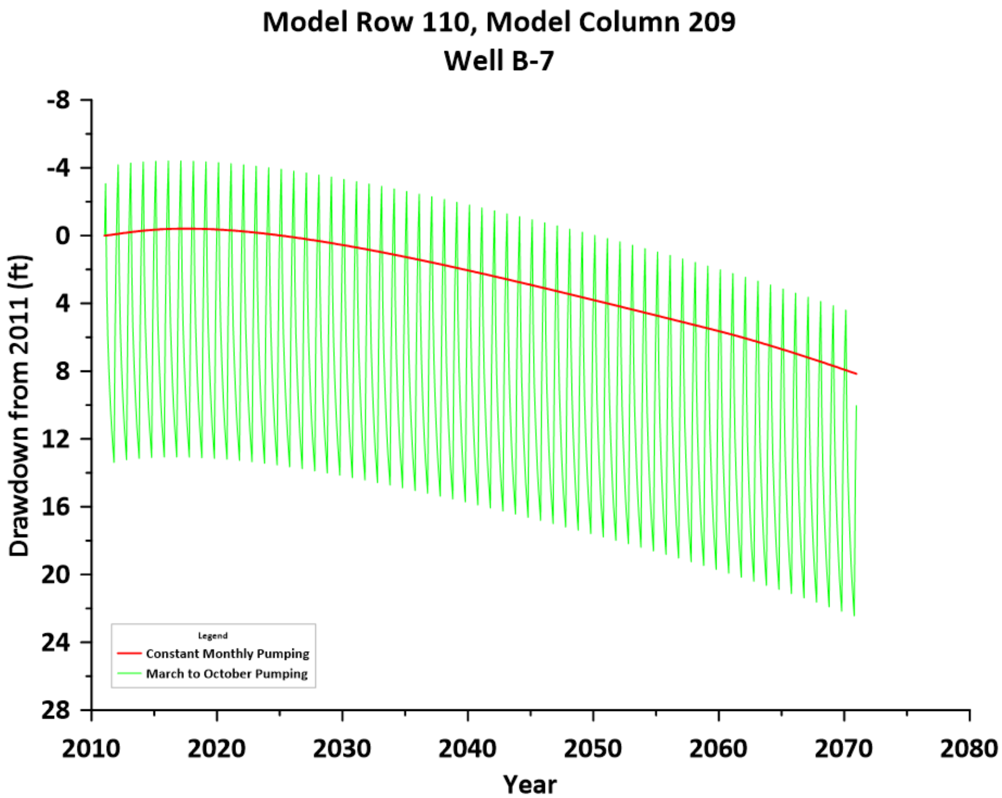

Figure 8. Well B-7 Drawdown Hydrograph - Annual Stress Period and March to April Pumping Simulations

Please note that the March to October results show a seasonal increase and decrease in groundwater elevation due to the cycle of pumping and recovery, but not to the extent as the April to September fluctuations. The interannual variation or amplitude of the seasonal fluctuation exceeds 15 feet in this well as compared to greater than 25 feet fluctuation in the April to September results previously shown in Figure 7. This is due to the higher rates of pumping in the April to September simulation (twice the average annual rate for six months) as compared to the March to October simulations (1.5 times the average annual rate for eight months).

Also, please note that the model represents static groundwater levels, not pumping groundwater levels. Typcially, pumping water levels are lower than static groundwater levels as demonstrated in the Belding Farms data that was reviewed by Hutchison (2018).

The example hydrographs are useful to visualize the differences in results between the simulations, but a more quantitative analysis of the results is provided below using all the Belding Farm well sites.

7.5.2 Summary of 2011 to 2070 Drawdown

Table 3 summarizes drawdown from 2011 to 2070 at 23 locations of Belding Farms wells. Please note that some of the three of the model cells contain two Belding Farms wells, and one cell contains three Belding Farms wells. Model row and column are provided for reference.
The fourth column is labeled "Annual Stress Period", and represents the drawdown from 2011 to 2070 for the base run of Hutchison (2017). The results of the monthly stress period simulations are presented in the next three columns. The final three columns are the difference between the annual stress period simulation drawdown and the individual monthly stress period simulations drawdown results. The final row represent the averages for each column, which are convenient to provide a basis for discussion.

Table 3. Summary of WPC Model Simulation Drawdowns in Belding Farms Wells

Well Number(s)	Model Row	Model Column	Drawdown - 2011 to 2070 (ft)				Monthly Stress Period Simulation Drawdown Difference from Annual Simulation (ft)		
			Annual Stress Period	Monthly Stress Periods					
				Constant	Apr-Sept	Mar-Oct	Constant	Apr-Sept	Mar-Oct
B1-B25	116	213	8.41	8.35	9.18	10.19	-0.06	0.77	1.78
B2	114	211	8.34	8.28	9.06	10.14	-0.06	0.72	1.80
B3	113	211	8.29	8.23	8.96	10.06	-0.06	0.67	1.77
B4	115	209	8.42	8.36	9.32	10.35	-0.06	0.90	1.93
B5	113	210	8.31	8.25	9.03	10.13	-0.06	0.72	1.82
B6	111	214	8.05	7.99	8.74	9.83	-0.06	0.69	1.78
B7	110	209	8.22	8.16	8.84	10.03	-0.06	0.62	1.81
B8-B17	110	210	8.17	8.11	8.76	9.95	-0.06	0.59	1.78
B9-B14	116	210	8.46	8.40	9.35	10.36	-0.06	0.89	1.90
B10	114	214	8.26	8.20	8.98	10.01	-0.06	0.72	1.75
B11	115	214	8.32	8.26	9.07	10.09	-0.06	0.75	1.77
B12	114	213	8.29	8.23	8.98	10.04	-0.06	0.69	1.75
B13	115	211	8.40	8.33	9.17	10.21	-0.07	0.77	1.81
B18	107	214	7.71	7.65	8.57	9.65	-0.06	0.86	1.94
B19	106	215	7.54	7.47	8.59	9.58	-0.07	1.05	2.04
B20	118	212	8.53	8.46	9.44	10.40	-0.07	0.91	1.87
B21	117	213	8.47	8.41	9.28	10.27	-0.06	0.81	1.80
B22	111	213	8.10	8.03	8.73	9.85	-0.07	0.63	1.75
B23	115	212	8.37	8.31	9.11	10.16	-0.06	0.74	1.79
B24	113	214	8.20	8.14	8.89	9.94	-0.06	0.69	1.74
B26	112	212	8.20	8.14	8.82	9.95	-0.06	0.62	1.75
B27	116	209	8.47	8.41	9.43	10.43	-0.06	0.96	1.96
B28-B29-B30	105	207	8.11	8.04	8.72	9.95	-0.07	0.61	1.84
Average			**8.25**	**8.18**	**9.00**	**10.07**	**-0.06**	**0.76**	**1.82**

Please note average drawdown for these 23 sites for the annual simulation and constant monthly simulation are within 0.1 feet (8.25 ft vs. 8.18 ft). However, the April to September simulation has a drawdown that is almost a foot less than the annual stress period simulation. The March to October drawdown is almost 2 feet lower than the annual stress period simulation. These differences are due to the timing of the "end of the year" drawdown calculation and the length of recovery from the seasonal pumping.

The April to September pumping recovers from October to March, but the drawdown in this table is calculated at the end of December, only four months into the six month recovery period. The

March to October pumping recovers from November to February. This means that the "end of the year" drawdown is calculated only two months into a four month recovery period.

The FSH operating permit thresholds do not consider "end of year" as winter groundwater elevations, but the winter maximum (whenever it occurs). The winter maximum groundwater elevations and the end of the year groundwater elevations were evaluated in Hutchison (2018) for this reason. Consequently, the differences between the drawdowns in Table 3 are not considered significant.

Also please recall from the example hydrograph of Well B-7 that the groundwater levels will rise above the annual average groundwater level in non-pumping periods and then fall below the annual average groundwater level during pumping periods. This fluctuation is well documented in the monitoring data in wells monitored by MPGCD. This fluctuation is analyzed below.

7.5.3 Interannual Variation in Groundwater Levels

Table 4 summarizes the interannual variation in 2011 and 2070 for the three monthly stress period simulations. For each well, the interannual variation is calculated as the maximum drawdown in a specific year minus the minimum drawdown in that same year. The results for 2011 are presented in the fourth, fifth, and sixth columns. The results for 2070 are presented in the seventh, eighth, and ninth columns. The final row represent the averages for each column, which are convenient to provide a basis for discussion.

Table 4. Summary of Interannual Variation in Groundwater Levels in Belding Farms Wells

Well Number(s)	Model Row	Model Column	Annual Maximum Drawdown minus Annual Minimum Drawdown (ft)					
			2011			2070		
			Constant	Apr-Sept	Mar-Oct	Constant	Apr-Sept	Mar-Oct
B1-B25	116	213	0.07	22.08	14.88	0.23	23.35	16.22
B2	114	211	0.08	22.66	15.22	0.23	23.96	16.63
B3	113	211	0.08	23.06	15.47	0.23	24.39	16.93
B4	115	209	0.08	21.20	14.17	0.23	22.42	15.50
B5	113	210	0.08	22.90	15.35	0.23	24.22	16.79
B6	111	214	0.08	22.40	15.02	0.23	23.70	16.45
B7	110	209	0.09	24.58	16.46	0.23	26.02	18.05
B8-B17	110	210	0.08	24.04	16.08	0.23	25.45	17.65
B9-B14	116	210	0.07	21.21	14.21	0.23	22.43	15.52
B10	114	214	0.07	22.60	15.23	0.23	23.90	16.62
B11	115	214	0.07	22.14	14.91	0.23	23.41	16.27
B12	114	213	0.07	22.58	15.19	0.23	23.88	16.59
B13	115	211	0.07	22.19	14.91	0.23	23.46	16.28
B18	107	214	0.09	20.19	13.41	0.23	21.39	14.76
B19	106	215	0.09	18.25	12.08	0.23	19.32	13.29
B20	118	212	0.07	20.30	13.62	0.23	21.49	14.87
B21	117	213	0.07	22.28	15.05	0.23	23.56	16.39
B22	111	213	0.08	22.86	15.32	0.23	24.19	16.79
B23	115	212	0.07	22.39	15.06	0.23	23.68	16.44
B24	113	214	0.08	23.06	15.54	0.23	24.38	16.96
B26	112	212	0.08	23.18	15.54	0.23	24.52	17.02
B27	116	209	0.08	20.59	13.76	0.23	21.78	15.03
B28-B29-B30	105	207	0.10	25.83	17.30	0.24	27.38	19.01
Average			**0.08**	**22.29**	**14.95**	**0.23**	**23.58**	**16.35**

Please note that the interannual variation in the constant monthly pumping columns for 2011 and 2070 are 0.08 ft and 0.23 ft, respectively. The annual drawdown average from Table 3 above is 8.25 feet, which is about 0.12 ft/yr. Thus, the 2011 value is below the annual average rate of decline and the 2070 value is above the annual average rate of decline. Thus, the constant pumping scenario results represent the long-term rate of decline since there is no seasonal variation associated with this simulation.

The April to September simulation fluctuation is greater than the March to October fluctuation:

- In 2011, April to September is about 22 ft and March to October is about 15 ft
- in 2070, April to September is about 24 ft and March to October is about 16 ft

This is because the pumping rate in the April to September simulation is double the average annual rate and the pumping rate in the March to October is 1.5 times the average annual rate. Pumping is more concentrated in the six month period (April to September) than it is in the eight month period (March to October). Thus, the higher seasonal variation would be expected in the scenario with the shorter pumping period.

These interannual simulation results are analogous to the results in Hutchison (2018) in evaluating the Belding Farms well drawdown data. Hutchison (2018) evaluated drawdown two ways based on the way Belding Farms records their data: 1) the difference between the static groundwater elevation and pumping groundwater elevation in the same month (informally called monthly drawdown) and 2) the difference between the winter maximum groundwater elevation and the pumping groundwater elevation for each month that year (informally called annual drawdown).

The results in Table 4 represent the difference between the winter maximum static groundwater elevation and the summer minimum static groundwater elevation in each year. The groundwater model only considers static groundwater levels, not pumping groundwater levels. It is expected, therefore, that these results would be less than the “annual” drawdowns in each well in Appendix D of Hutchison (2017). For convenient reference Appendix D of Hutchison (2018) is presented in this Technical Memorandum as Appendix A.

Please note that “annual drawdown” in hydrographs of Appendix A generally ranges between 20 and 50 feet, which, given the different definitions used in this analysis (static groundwater levels versus pumping groundwater levels) suggests that the WPC groundwater model is providing reasonable seasonal fluctuation results, despite the approximate way these simulations simulate monthly conditions (i.e. not a calibrated monthly model).

8.0 WPC Model Simulations with Alternative FSH Operating Permit Pumping Schedules

The simulations in the previous section demonstrated that the WPC Model can be used to analyze seasonal groundwater variations in the Bedling Farms wells resulting from seasonal pumping changes despite the limitations associated with converting a model that was developed and calibrated using annual stress periods. This conclusion is based on comparing the annual variation results with actual data from Belding Farms wells presented in Appendix A.

The simulations summarized in this section include:

- Four simulations that establish baselines (two with no pumping in the FSH Operating Permit wells and two with pumping in the FSH Operating Permit wells on an irrigation schedule), and
- Eight simulations that implent alternative "municipal" pumping schedules for the FSH Operating Permit wells while keeping all other wells in the model domain on an irrigation schedule (alternatively April to September or March to October).

The objective of these scenarios was to provide a basis for comparison to assess the potential for impacts to the Belding Farms wells as a result of changing the pattern of pumping by comparing the results to the results of the baseline scenarios.

All files associated with these simulations can be accessed at this link:

https://drive.google.com/drive/folders/1pmbxVpXcAUqqD_oxWzk56x76rxs9v3g9?usp=sharing

Based on the results of the WPC simulations presented above, it is evident that there is no need to simulate 60 years to obtain meaningful results relative to the objectives of this effort. Interannual variation changed only slightly between the first year and 65th year of the simulations. Thus, these simulation were run for a 10-year period using monthly stress periods.

8.1 Scenario Summary

A total of 12 scenarios were developed. Scenarios 1 to 4 were used to establish baseline conditions, and Scenarios 5 to 12 evaluated alternatives "municipal" pumping schedules for the FSH Operating Permit wells while keeping all other wells in the model domain on an irrigation schedule:

- Scenarios 1 and 2 assumed that the FSH Operating Permit wells are not pumped, and all other wells in the model domain are pumped on an irrigation schedule. Scenario 1 assumed that the irrigation season runs from April to September. Scenario 2 assumed that the irrigation season runs from March to October.
- Scenarios 3 and 4 assumed that all wells within the model domain (including the FSH Operating Permit wells) are pumped on an irrigation schedule. Scenario 3 assumed that

the irrigation season runs from April to September. Scenario 4 assumed that the irrigation season runs from March to October. Additonal details of assumptions in the specification of the pumping rate of the FSH Operating Permit wells are provided below.

- Scenarios 5 and 6 assumed that the FSH Operating Permit wells are pumped at a constant rate from January to December, simulating a municipal base supply. Scenario 5 assumed that all other pumping in the model domain occurs from April to September. Scenario 6 assumed that all other pumping in the model domain occurs from March to October. Additonal details of assumptions in the specification of the pumping rate of the FSH Operating Permit wells are provided below.
- Scenarios 7 and 8 assumed that the FSH Operating Permit wells are pumped based on a schedule that was constrained by the installed pump capacity and the annual permit limit for each well. Consequently, some wells were operated for less than four months, and some were operated for more than six months, but all pumping from these wells occurred from February to September. Details are provided below. All other pumping in the model domain occurred in April to September (Scenario 7) and March to October (Scenario 8).
- Scenarios 9 and 10 assumed that the FSH Operating Permit wells are pumped based on a schedule that was constrained by the installed pump capacity and the annual permit limit for each well. Consequently, some wells were operated for less than four months, and some were operated for more than six months, but all pumping from these wells occurred from March to October. Details are provided below. All other pumping in the model domain occurred from April to September (Scenario 9) and March to October (Scenario 10).
- Scenario 11 assumed that there was a relaxation of the permit limits associated with per well installed capacity limits to the point that all FSH Operating Permit pumping could occur in four months (June to September). All other pumping in the model domain occurred from April to September.
- Scenario 12 assumed that there was a relaxation of the permit limits associated with per well installed capacity limits to the point that all FSH Operating Permit pumping could occur in three months (July to September). All other pumping in the model domain occurred from April to September.

Groundwater pumping input for use in the simulations were developed using a pre-processor written for this effort (*ScenWelMuni.exe*). The source code, input files and output files for this pre-processor are included in the link provided above. As noted in the scenario summary above, the treatment of FSH Operating Permit wells and all other wells in the model domain were developed differently. Documentation of the development is provided below.

8.2 Development of non-FSH Operating Permit Well Pumping Input

Annual pumping for all non-FSH Operating Permit wells in the model domain was assumed equal to the 2010 pumping from the calibrated WPC Model as discussed in the previous section of this Technical Memorandum. A total of 1,364 non-FSH Operating Permit wells in the model domain were simulated in these scenarios.

As described in the previous section, pumping rates were doubled for all scenarios that assumed all non-FSH Operating Permit wells were pumped from April to September (Scenarios 1, 3, 5, 7, 9, 11 and 12), and pumping rates were multipled by 1.5 for all scenarios that assumed that all non FSH Operating Permit wells were pumped from March to October (Scenarios 2, 4, 6, 8, and 10).

8.3 Development of FSH Operating Permit Well Pumping Input

8.3.1 Scenarios with No FSH Operating Permit Well Pumping (1 and 2)

Scenarios 1 and 2 were developed to provide a baseline, and pumping for the FSH Operating Permit wells was set to zero for these scenarios.

8.3.2 Scenarios based on Average Annual Rates (3 to 6 and 11 to 12)

The pumping rates associated with the WPC Model in 2010 (Hutchison, 2017) that were used in the previous set of simulations described above were removed for these simulations. For the FSH Operating Permit wells, pumping rates for Scenarios 3 to 6 and Scenarios 11 and 12 were based on the annual operating permit limits for the 25 individual wells previosuly presented in Table 1. This annual total in AF/yr was converted to an average annual rate expressed in cubic feet per day (the units used in MODFLOW input files). This represents an average annual rate of pumping. Use of this average annual rate for these scenarios was as follows:

- For Scenario 3: the average annual rate was doubled to simulate pumping over 6 months (April to September).
- For Scenario 4, the average annual rate was multiplied by 1.5 to simulate pumping over 8 months (March to October).
- Scenarios 5 and 6: the average annual rate was used because the to simulate a constant rate of pumping from January to December.
- Scenario 11: the average annual rate was multiplied by 3 to simulate pumping over 4 months (June to September).
- Scenario 12: the average annual rate was multiplied by 4 to simulated pumping over 3 months (July to September).

These assumed rates are not entirely consistent with the permit conditions related to both installed capacity and annual permit production limits. Strict adherence to both of the conditions was simulated in Scenarios 7 to 10 as developed below.

8.3.3 Scenarios Constrained by Intalled Pump Capacity and Annual Limits (7 to 10)

Based on the insalled pump capacity and the production limits associated with each well (previously presented in Table 1), two sets of municipal pumping scnenarios were developed: one set with pumping from February to September (Scenarios 7 and 8), and one set with pumping from March to October (Scenarios 9 and 10). The development of these scenarios was completed using

Excel spreasheets that can be accessed in the link provided above (*FSHOperatingPermitWells-FebtoSep.xlsx* and *FSHOperatingPemitWells-MartoOct.xlsx*).

The last column in Table 1 (previously presented) is the number of days of pumping to reach the maximum limit based on the installed pump capacity, assuming continuous operation. This is Column K in the spreadsheet labeled The tab named *"Timing"* in the spreadsheets. Table 5 summarizes the number of days of pumping in each well for Scenarios 7 and 8 for each month to reach the annual production limit based on installed pump capacity. For this simulation, all pumps are turned on with the intention of reaching the annual limit on September 30. The companion table for Scenarios 9 and 10 assumes that the maximum limit would be reached on October 31.

For example, based on the installed capacity of Well C-1, continuous pumping would result in reaching the annual permit limit in about 96 days. In order to evaluate the maximum impact on end of September groundwater elevations, it was assumed that the well would operate for a little over 4 days in June, and then operate continuously in July, August, and September. The total in the right hand column can then be compared to verify that the number of days of pumping matches the calcuated days in the second column of the table.

Another example is M-1. Based on the installed capacity of this well, continuous pumping would result in reaching the annual permit limit in about 219 days. In order to evaluate the maximum impact on end of September groundwater elevations, it was assumed that the well would operate for just under 5 days in February, and then operate continuously from March to September.

Table 5. Scenario 7 - Number of Days of Pumping in Each FSH Well

Well Number	Days at Max Rate to Reach Annual Limit	Days Each month at Maximum Pumping								
		Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Total
C-1	96.06					4.06	31.00	31.00	30.00	96.06
C-2	96.02					4.02	31.00	31.00	30.00	96.02
C-3	96.02					4.02	31.00	31.00	30.00	96.02
C-4	96.06					4.06	31.00	31.00	30.00	96.06
M-1	218.98	4.98	31.00	30.00	31.00	30.00	31.00	31.00	30.00	218.98
M-2	214.07	0.07	31.00	30.00	31.00	30.00	31.00	31.00	30.00	214.07
M-3	221.04	7.04	31.00	30.00	31.00	30.00	31.00	31.00	30.00	221.04
M-4	221.01	7.01	31.00	30.00	31.00	30.00	31.00	31.00	30.00	221.01
M-5	136.59				14.59	30.00	31.00	31.00	30.00	136.59
M-6	195.40		12.40	30.00	31.00	30.00	31.00	31.00	30.00	195.40
M-7	195.40		12.40	30.00	31.00	30.00	31.00	31.00	30.00	195.40
M-8	209.99		26.99	30.00	31.00	30.00	31.00	31.00	30.00	209.99
M-9	93.91					1.91	31.00	31.00	30.00	93.91
NC-2	95.95					3.95	31.00	31.00	30.00	95.95
S-1	74.03						13.03	31.00	30.00	74.03
S-2	169.97			16.97	31.00	30.00	31.00	31.00	30.00	169.97
S-4	198.16		15.16	30.00	31.00	30.00	31.00	31.00	30.00	198.16
S-6	95.95					3.95	31.00	31.00	30.00	95.95
S-11	125.00				3.00	30.00	31.00	31.00	30.00	125.00
S-13	115.66					23.66	31.00	31.00	30.00	115.66
S-18	91.87						30.87	31.00	30.00	91.87
S-19	76.56						15.56	31.00	30.00	76.56
S-20	65.62						4.62	31.00	30.00	65.62
S-26	149.12				27.12	30.00	31.00	31.00	30.00	149.12
S-32	210.79		27.79	30.00	31.00	30.00	31.00	31.00	30.00	210.79

Using the number of days shown in Table 5 and the installed capacity pumping rate, the actual pumping for each month for Scenarios 7 and 8 is presented in Table 6 in acre-feet per month. This is found in the "*AF mo*" tab in the spreadsheets. Please note that for this scenario, the highest monthly total is in August, because August has 31 days and September has 30 days, even though pumping in both months is at the maximum rates for each well. Maximum pumping occurs in July, August and September. Less than maximum pumping occurs from February to June as noted in Table 6. A similar "*AF mo*" tab is in the spreasheet associated with Scenarios 9 and 10.

Table 6. Scenario 7 - Pumping (AF/month)

Well Number	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Total
C-1	0	0	0	0	36	274	274	265	849
C-2	0	0	0	0	53	411	411	398	1,273
C-3	0	0	0	0	53	411	411	398	1,273
C-4	0	0	0	0	36	274	274	265	849
M-1	48	301	292	301	292	301	301	292	2,129
M-2	0	205	199	205	199	205	205	199	1,419
M-3	68	301	292	301	292	301	301	292	2,149
M-4	56	247	239	247	239	247	247	239	1,758
M-5	0	0	0	142	292	301	301	292	1,328
M-6	0	110	265	274	265	274	274	265	1,727
M-7	0	110	265	274	265	274	274	265	1,727
M-8	0	119	133	137	133	137	137	133	928
M-9	0	0	0	0	7	110	110	106	332
NC-2	0	0	0	0	9	68	68	66	212
S-1	0	0	0	0	0	81	192	186	458
S-2	0	0	135	247	239	247	247	239	1,352
S-4	0	141	278	288	278	288	288	278	1,839
S-6	0	0	0	0	17	137	137	133	424
S-11	0	0	0	33	331	342	342	331	1,381
S-13	0	0	0	0	188	247	247	239	920
S-18	0	0	0	0	0	136	137	133	406
S-19	0	0	0	0	0	83	164	159	406
S-20	0	0	0	0	0	29	192	186	406
S-26	0	0	0	240	265	274	274	265	1,318
S-32	0	203	219	226	219	226	226	219	1,537
Total	**173**	**1,737**	**2,316**	**2,915**	**3,707**	**5,678**	**6,035**	**5,840**	**28,400**

The final step in developing the pumping input files is to convert the input pumping to cubic feet per day. The spreadsheet tab labeled "*cfd*" contains the calculations for these conversions.

Table 7 summarizes the input pumping assumptions associated with each scenario.

Table 7. Summary of Scenario Pumping Input

Scenario Number	Scenario Type	Non-FSH Operating Permit Wells		FSH Operating Permit Wells	
		Time Period of Pumping	Average Annual Pumping Rate Multiplier	Time Period of Pumping	Average Annual Pumping Rate Multiplier
1	No FSH Pumping	Apr to Sep	2.0	None	0.0
2		Mar to Oct	1.5	None	0.0
3	FSH as Irrigation Wells	Apr to Sep	2.0	Apr to Sep	2.0
4		Mar to Oct	1.5	Mar to Oct	1.5
5	FSH as Baseline Municipal Source	Apr to Sep	2.0	Jan to Dec	1.0
6		Mar to Oct	1.5	Jan to Dec	1.0
7	FSH as Peak Municipal Pumping	Apr to Sep	2.0	Feb to Sep	*See Note Below*
8		Mar to Oct	1.5	Feb to Sep	*See Note Below*
9		Apr to Sep	2.0	Mar to Oct	*See Note Below*
10		Mar to Oct	1.5	Mar to Oct	*See Note Below*
11		Apr to Sep	2.0	Jun to Sep	3.0
12		Apr to Sep	2.0	Jul to Sep	4.0

Note: Pumping not based on rate multipier, but based on Spreadsheet Calculations as documented in text

8.4 Simulation Results

Results from these simulations were focused on drawdown in individual Belding Farms wells. Results for each well were saved in individual files which are accessible at the links provided above. Results for drawdown, interannual variation in groundwater elevation, and pumping are also accessible at the links provided above.

8.4.1 Output Pumping Results

Total pumping in Management Zone 1 and pumping from the FSH Operating Permit wells was extracted from the cell by cell model output to verify the proper input pumping values as outlined above.

FSH Operating permit pumping was zero in Scenarios 1 and 2, and about 28,400 AF/yr in Scenarios 3 to 12. Small variations attributed to round error were present, but deemed insignifcant for purposes of this analysis.

Total pumping in Management Zone 1 included all FSH Operating Permit wells. The total pumping was about 60,000 AF/yr in Scenarios 1 and 2 (FSH Operating Permit wells were off), and about 88,000 AF/yr in Scenarios 3 to 12. Along with the small variations attributable to rounding error, there was also some decline in Management Zone 1 pumping that appears to be due to reduction in pumping due to dry cells. The reduction was about 600 AF for the 10-year simulation in all scenarios, and was not considered significant.

Files associated with the extraction of pumping were written by the post-proccessor *getpumpmuni.exe*. The source code, executables and output files are accessible in the link provided earlier.

8.4.2 Hydrographs of Well B-7 Drawdown

Results for each well are accessible in the link provided above, and the results are all similar. Hydrographs of Well B-7 for three of the scenarios are provided below to illustrate the interpretation of the results.

Figure 9 presents a comparison of the drawdown in Well B-7 for Scenarios 3 and 7. Please recall that Scenario 3 represents all wells pumping on an irrigation schedule that runs from April to September, and Scenario 7 represents the scenario where non-Operating Permit wells pump on an April to September irrigation schedule and FSH Operating Permit wells pumping on a schedule that is constrained by the pumping capacity and annual limits on each well as noted in Table 6 previously presented.

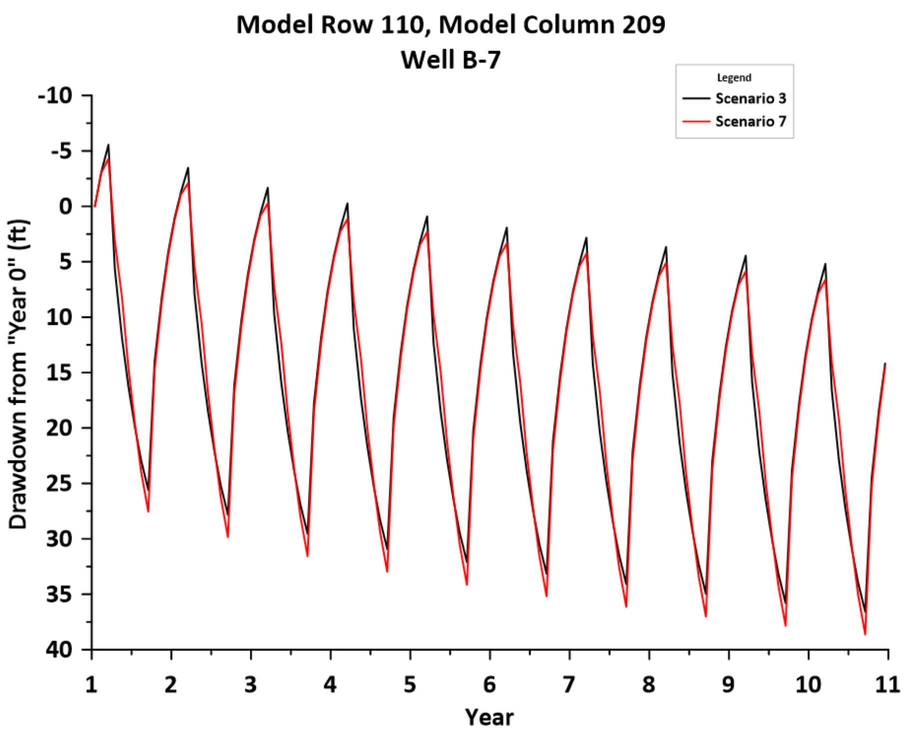

Figure 9. Well B-7 Drawdown Hydrograph - Scenarios 3 and 7

The general trend of reduced drawdown over time is evident, as well as an interannual cycle of drawdown and recovery. The drawdown trend is more pronounced in these simulations as compared to the earlier simulations because the overall pumping in higher. Please recall that the FSH Operating Permit wells in 2010 (the final year for the calibration period of the WPC Model) was about 16,300 AF/yr. Because the pumping for these simulations assumed pumping of 28,400 AF/yr, and there was no reduction in the pumping in the rest of Management Zone 1 to achieve a total of about 77,000 AF/yr, total pumping for Management Zone 1 was assumed to be about 88,000 AF/yr for these simulations, with the exception of Scenarios 1 and 2 that assumed no pumping from the FSH Operating Permit wells.

Please note that the interannual variationin groundwater elevation due to seasonal pumping is evident. The winter recovery in Scenario 3 is slightly higher than in Scenario 7 due to the nine wells that pumping in February and March in Scenario 7 that are off in Scenario 3. The maximum drawdown at the end of September is slightly higher in Scenario 7 than it is in Scenario 3 due to the higher rate of pumping in Scenario 7 associated with the nine wells that start operating in later June and are at full pumping during July, August and Septmber in Scenario 7. Scenario 3 has constant pumping in all months from April to September. However, the differences in the winter recovery levels between the two scenarios and the differences in the end-of-September groundwater levels are not signficant.

Based on this comparison, there is no significant difference between the groundwater levels in this well between the two scenarios where FSH Operating Permit wells are alternatively operated on an irrigation schedule and on an aggressive municipal schedule that maximizes production in July, August, and September consistent with the current permit conditions related to installed pump capacity and annual production limits for each well.

While Scenario 7 was constrained by current well capacities as listed in the permit, Scenario 12 represents a hypothetical assumption that the all FSH Operating Permit wells could produce their full annual permit limit in 3 months. This hypothetical assumption is inconsistent with the permit conditions, but the results are instructive to gain a better understanding of the potential impacts of concentrating pumping over a relatively short period of time. Comparison hydrographs of Scenario 3 and Scenario 12 is presented in Figure 10.

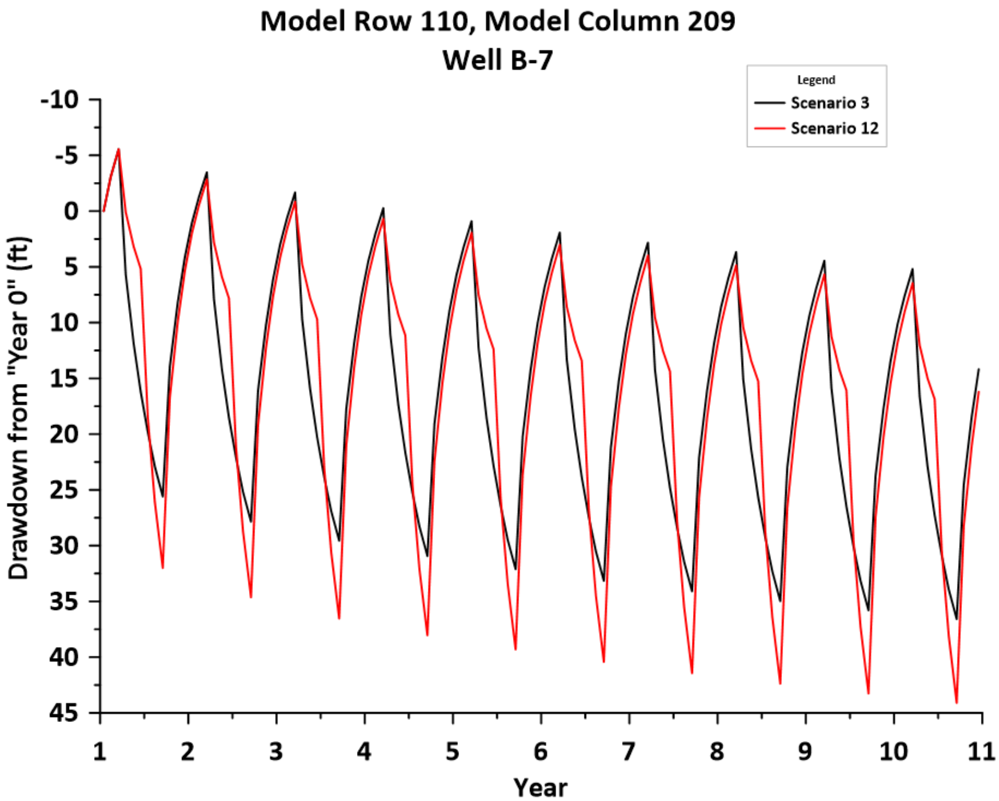

Figure 10. Well B-7 Drawdown Hydrograph - Scenarios 3 and 12

Please note the distinctive increase in Scenario 12 drawdown each July when the FSH Operating Permit wells start the three-month pumping cycle. Also, please note that the Scenario 12 end-of-September maximum drawdown is nearly 10 feet greater than the Scenario 3 end-of-September maximum drawdown. This is slightly greater than the difference between Scenario 3 and Scenario 12 end-of-September maximum drawdown.

8.4.3 Summary Results of Drawdown and Interannual Variation

The results were extracted from the model head save file using a post-processor *gethdsmuni.exe.* The source code, executable, and output files associated with this post-processor are accessible at the link provided above.

Table 8 summarizes the average simulated drawdown, simulated average interannual variation in Year 1, and the simulated average interannual vairation in Year 10 for the Belding Farms wells for each scenario.

Table 8. Summary of Simulated Average Drawdown and Interannual Variation for Belding Farms Wells

Scenario Number	Scenario Type	Average of Belding Famrs Wells		
		Drawdown (ft)	Interannual Variation (ft)	
			Year 1	Year 10
1	No FSH Pumping	-15.63	13.60	15.78
2		-14.99	8.49	10.76
3	FSH as Irrigation Wells	14.18	28.44	28.51
4		15.32	20.37	19.86
5	FSH as Baseline Municipal Source	13.93	18.31	17.78
6		14.62	13.63	12.51
7	FSH as Peak Municipal Pumping	14.36	27.39	27.35
8		15.04	22.21	21.90
9		15.83	26.66	26.28
10		16.52	22.65	21.72
11		15.27	31.14	31.07
12		16.11	33.31	33.17

Please note that in Scenarios 1 and 2 (no FSH Operating Permit well pumping), there is a overall recovery in groundwater elevations during the simulation period and interannual variation is relatively small. This is due to an overall reduction in pumping because FSH Operating Permit wells are off. Total pumping in Management Zone 1 in the scenario is about 60,000 AF/yr as compared to all other scenarios where the total pumping in Management Zone 1 is about 88,000 AF/yr.

The results of Scenario 3 and 4 represent a baseline because all pumping in the model domain is on an irrigation schedule (April to September in Scenario 3 and March to October in Scenario 4). Please note that the interannual variation is lower in the Scenario 4 than in Scenario 3 because the pumping in Scenario 4 is spread out over 8 months rather than 6 months in Scenario 3.

The simulated average interannual variation in Scenarios 5 and 6 is less than the irrigation pumping season baselines (Scenarios 3 and 4) because FSH Operating Permit well pumping is spread out over a 12 month period, thus reducing the drawdown and recovery associated with seasonal pumping for a significant portion of the total pumping in the model domain (about 28,000 AF/yr out of a total of about 88,000 AF/yr).

The simulated average interannual variation in Scenarios 7 and 9 are similar because the FSH Operating Permit well pumping is over the same time period (February to September), while all other pumping in Scenario 7 is between April and September (6 months) and other pumping in Scenario 9 is between March and October (8 months). Similarly, the simulated interannual variation in Scenarios 8 and 10 are simillar because the FSH Operating well pumping is over the same time period (March to October).

The simulated average interannual variation in Scenarios 11 and 12 is highest of all the scenarios because the FSH Operating Permit wells pumping in concentrated over a four month period

(Scenario 11) and a three month period (Scenario 12). As discussed above, this scenario is not consistent with the terms of the permit, but was completed to gain a better understanding of the potential impacts of concentrating pumping over a relatively short period of time.

8.5 Discussion of Results

Under current installed capacity and annual production limits of each well in the FSH Operating Permit, the results of simulating pumping on a municipal schedule demonstrate that impacts to the Belding Wells are nearly identical to simulated impacts to the Belding Wells when FSH Operating Permit wells are operated on an irrigation schedule. The current permit conditions require adherence to the current pump capacity and annual production limits of each well. Simulations that assumed relaxation of these limits (i.e. all FSH Operating Permit pumping over a three- or four-month period) did result in higher impacts to Belding Farms wells, but did not impact long-term drawdown, which is a groundwater planning issue.

The significance of the additional impacts associated with concentrated pumping of FSH Operating Permit wells over a three- or four-month period are unknown. However, understanding the significance is more properly groundwater management and groundwater regulation issues, not groundwater planning process issues. Additional data and a more robust analytical exercise with a more appropriate model would be needed to assess the significance of these simulated impacts. Currently, there are no plans to modify the installed pump capacity and/or the annual limits of individual wells, so there is no urgent need to evaluate the significance further. However, this analysis does provide some background if such a request is made in the future. Any such request would be made to the Middle Pecos Groundwater Conservation District (not Groundwater Management Area 7). Such a request would be analyzed by and would be approved by the Middle Pecos Groundwater Conservation District as part of its groundwater management and groundwater regulation activities.

9.0 References

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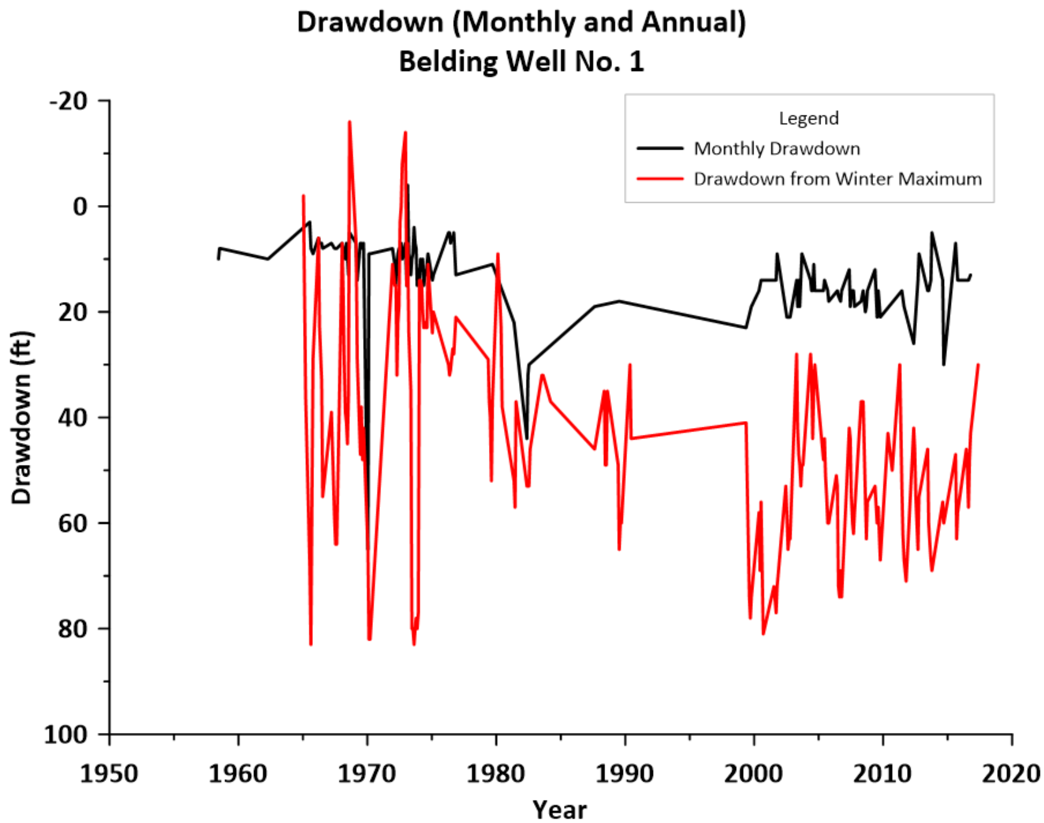
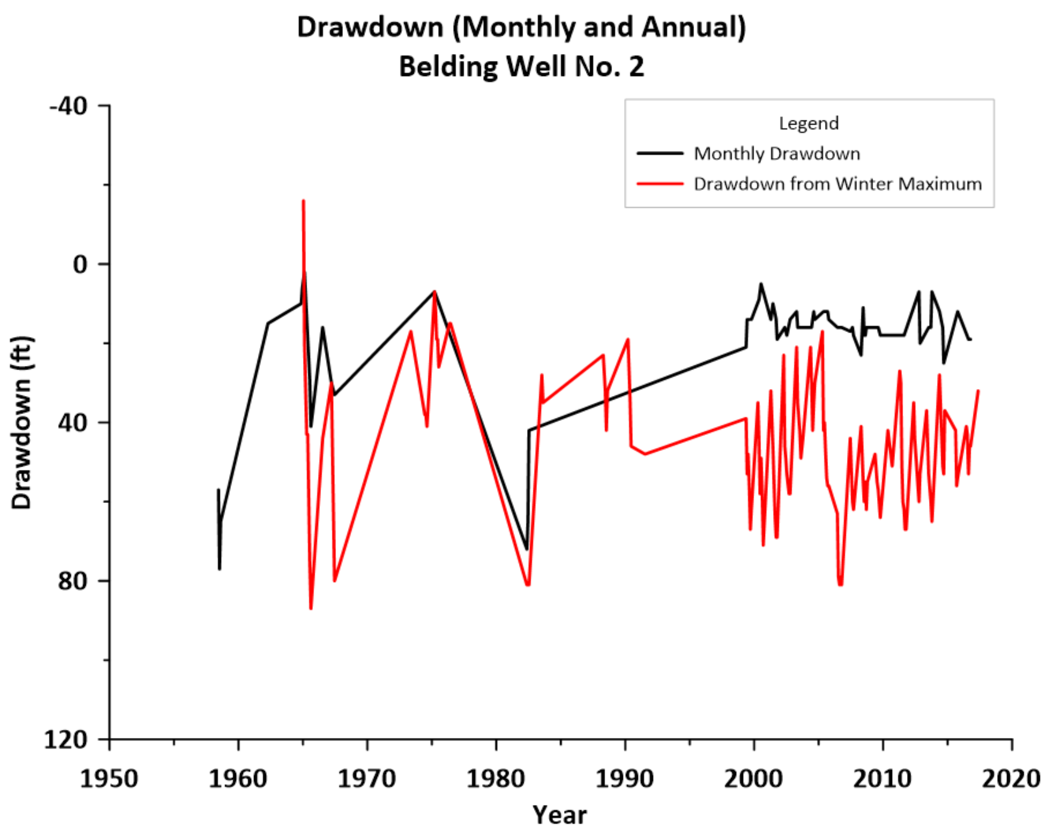
Appendix A

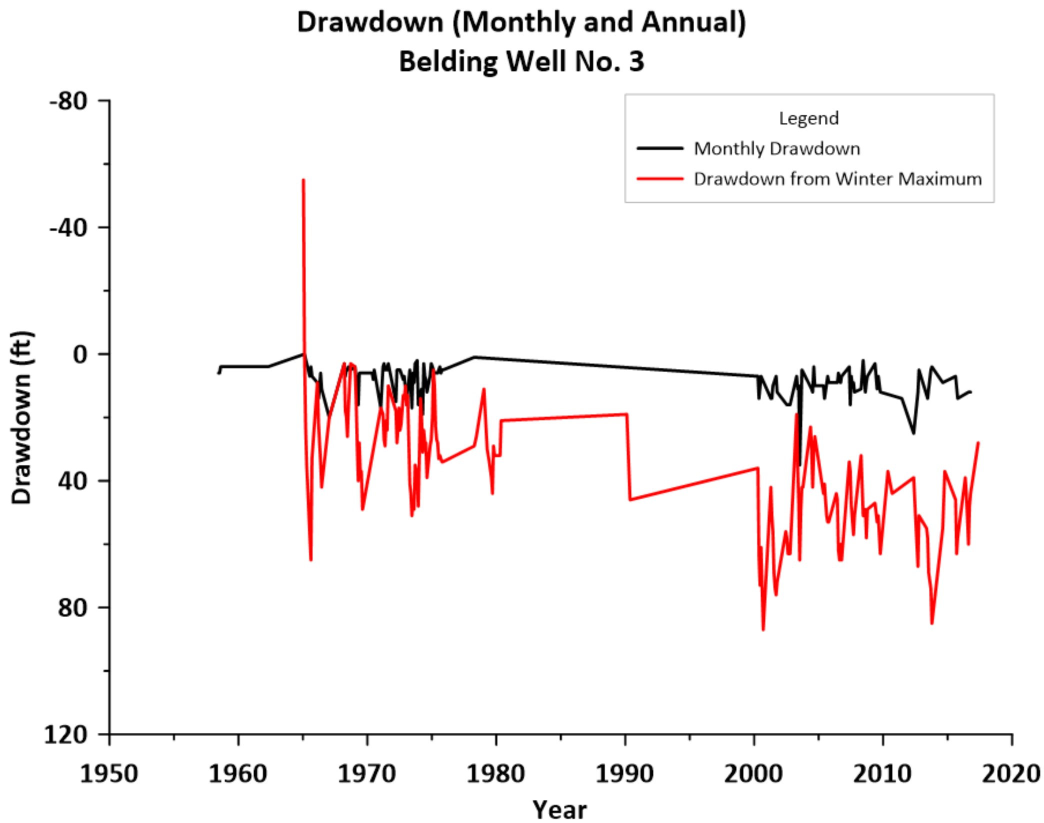
Belding Farms Drawdown Hydrographs

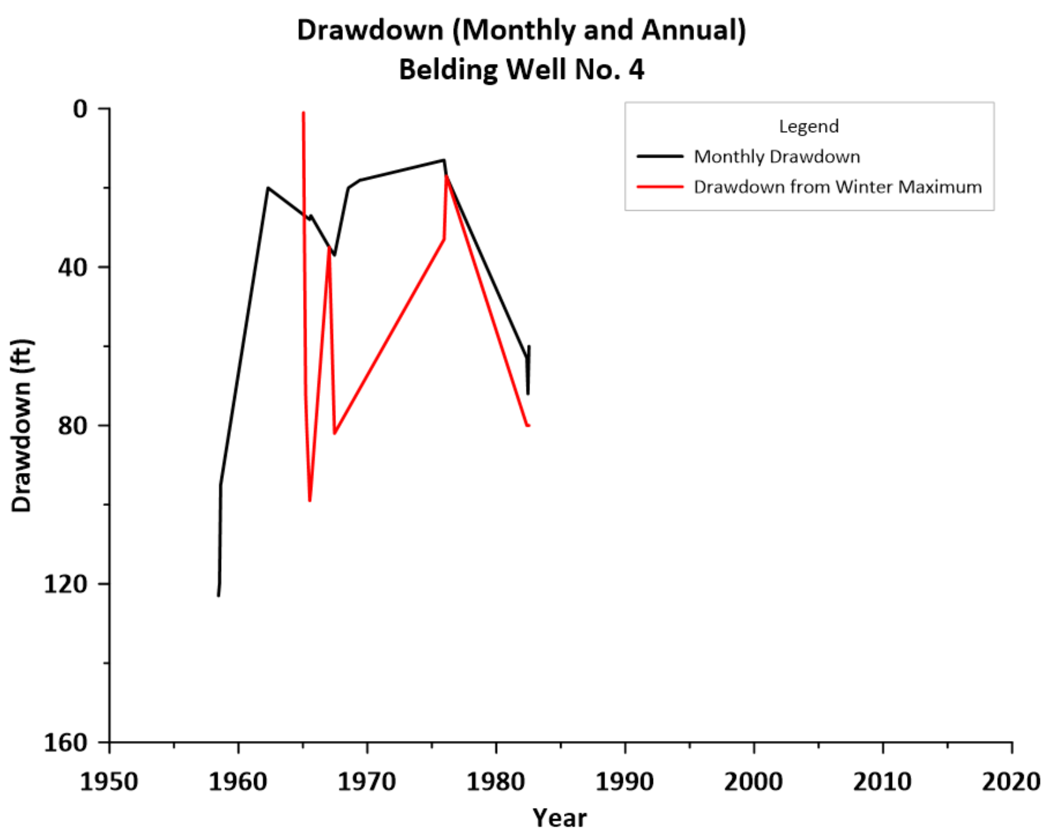


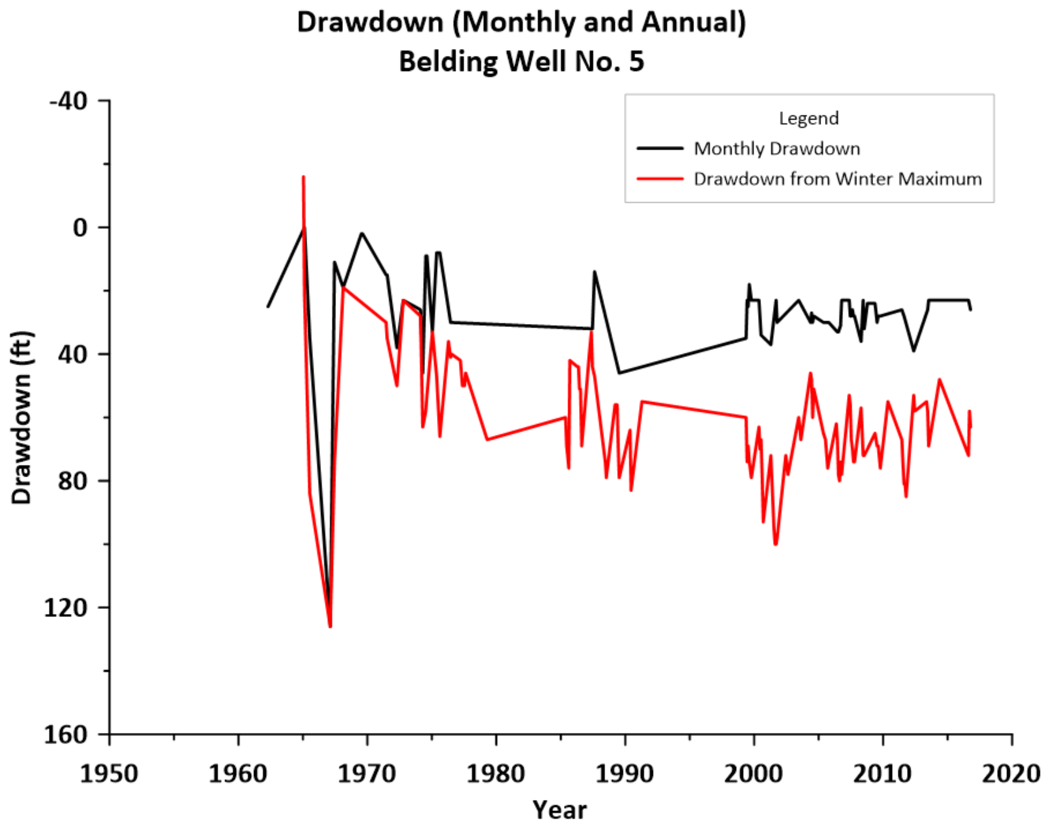
Drawdown (Monthly and Annual)
Belding Well No. 1
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
-20
0
20
40
60
80
100
1950
1960
1970
1980
1990
2000
2010
2020
Year

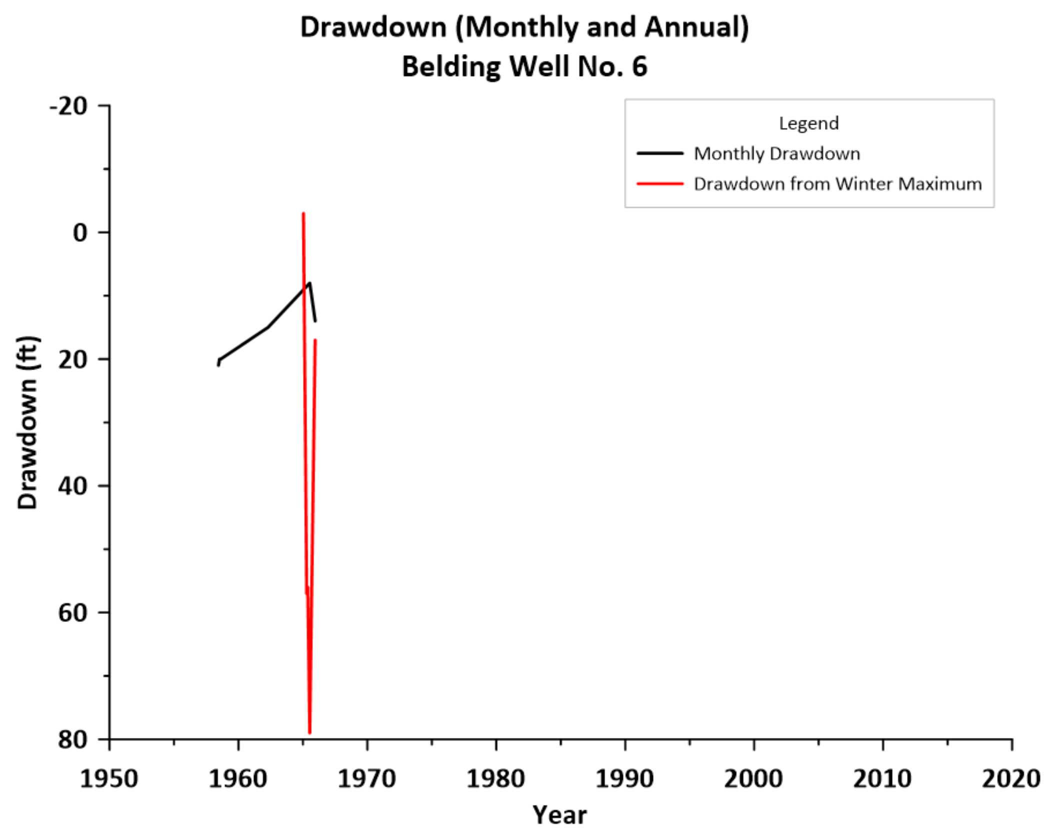


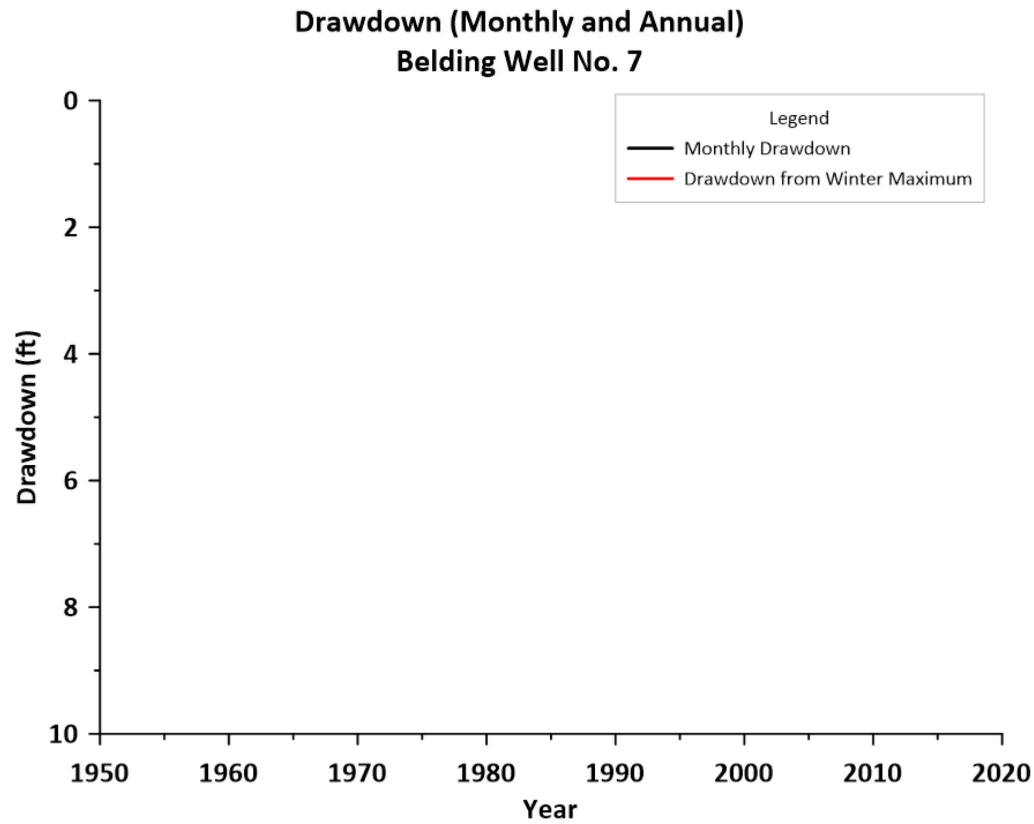
Drawdown (Monthly and Annual)
Belding Well No. 2
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
-40
0
40
80
120
1950
1960
1970
1980
1990
2000
2010
2020
Year


Drawdown (Monthly and Annual)
Belding Well No. 3
Legend
Monthly Drawdown
Drawdown from Winter Maximum
-80
-40
0
40
80
120
Drawdown (ft)
1950
1960
1970
1980
1990
2000
2010
2020
Year

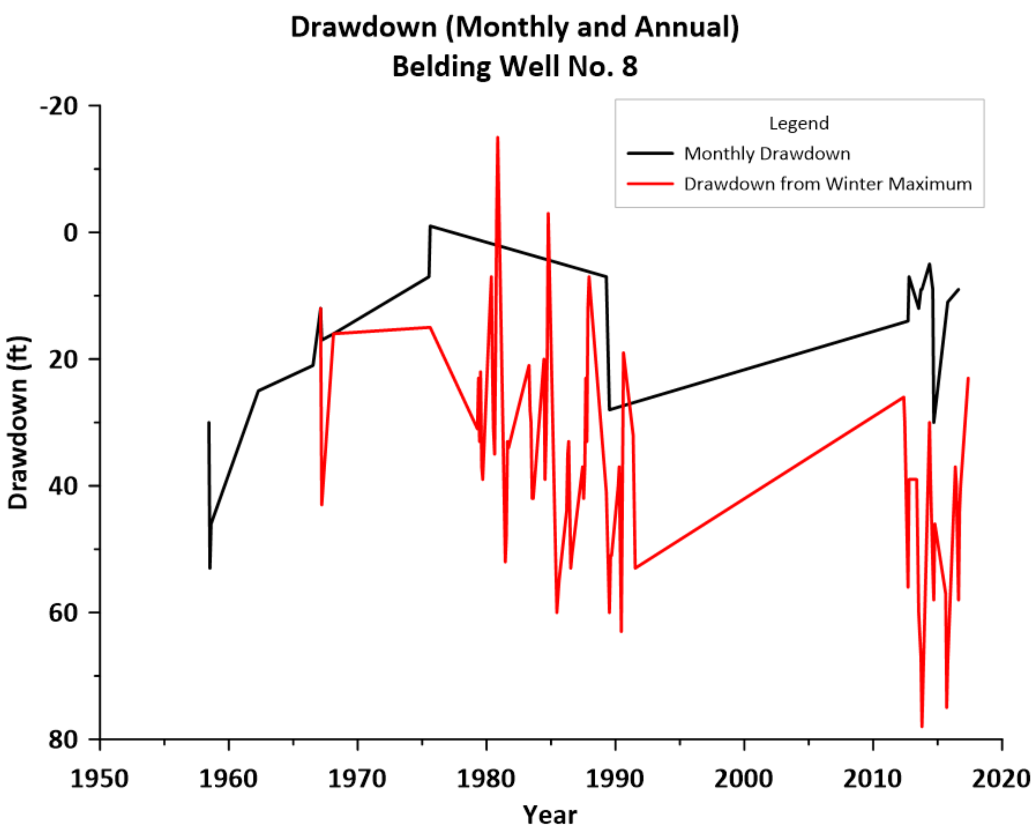

Drawdown (Monthly and Annual)
Belding Well No. 4
Legend
Monthly Drawdown
Drawdown from Winter Maximum
0
40
80
120
160
Drawdown (ft)
1950
1960
1970
1980
1990
2000
2010
2020
Year


Drawdown (Monthly and Annual)
Belding Well No. 5
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
Year
-40
0
40
80
120
160
1950
1960
1970
1980
1990
2000
2010
2020


Drawdown (Monthly and Annual)
Belding Well No. 6
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
Year
-20
0
20
40
60
80
1950
1960
1970
1980
1990
2000
2010
2020



Drawdown (Monthly and Annual)
Belding Well No. 7
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
0
2
4
6
8
10
1950
1960
1970
1980
1990
2000
2010
2020
Year



Drawdown (Monthly and Annual)
Belding Well No. 8
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
-20
0
20
40
60
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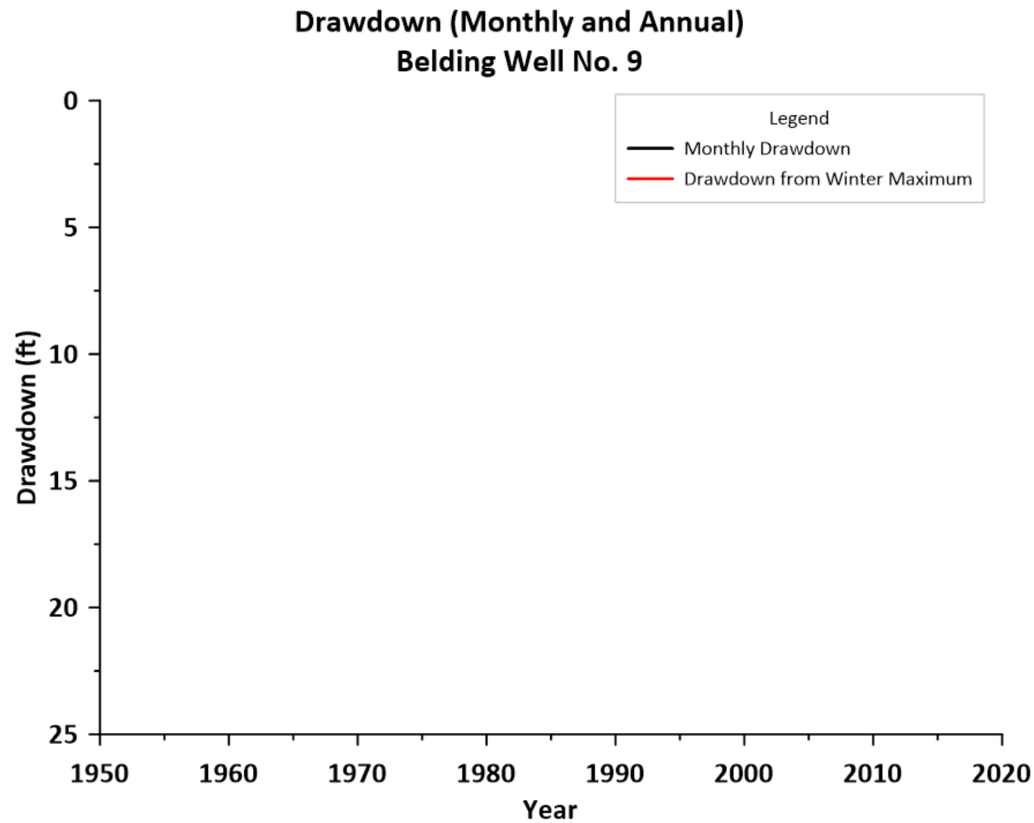
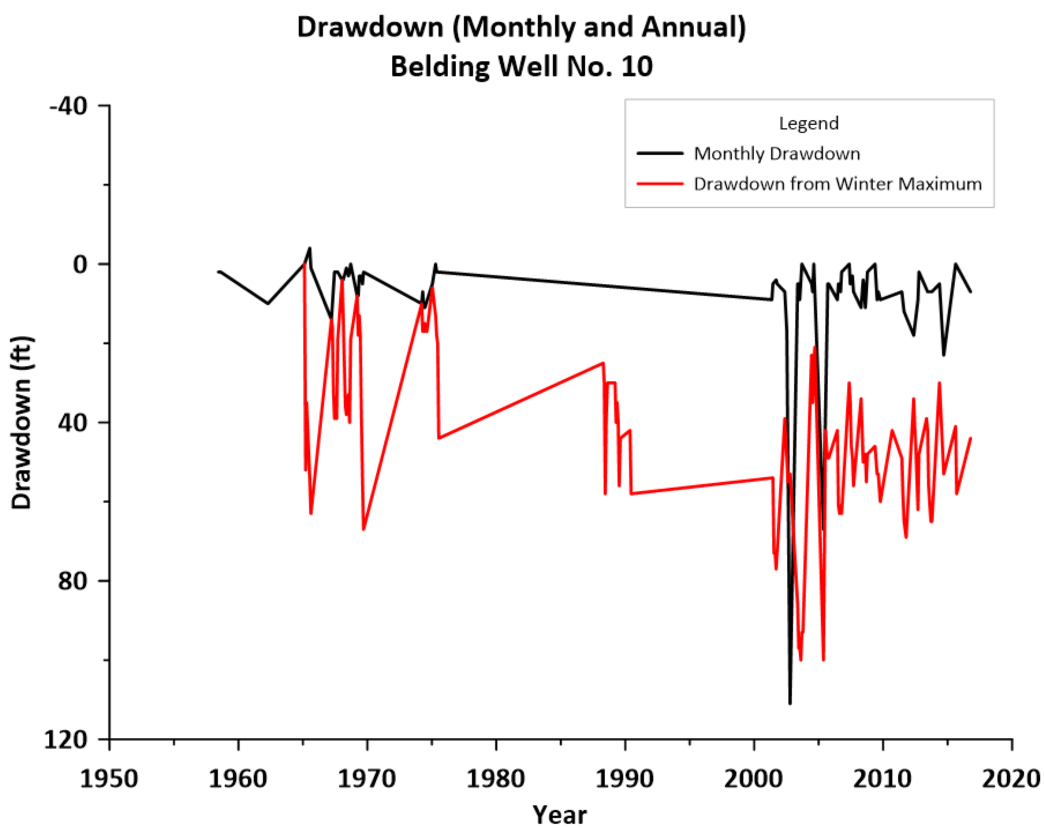
1990
2000
2010
2020
Year


Drawdown (Monthly and Annual)
Belding Well No. 9
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
0
5
10
15
20
25
1950
1960
1970
1980
1990
2000
2010
2020
Year


Drawdown (Monthly and Annual)
Belding Well No. 10
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
-40
0
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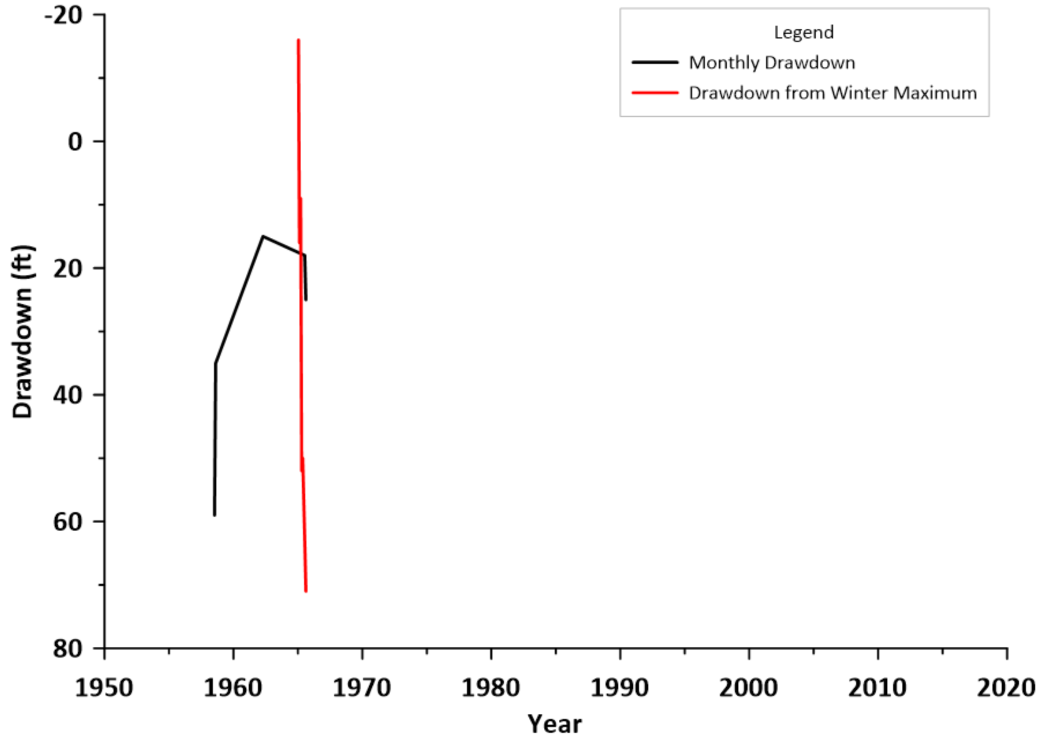
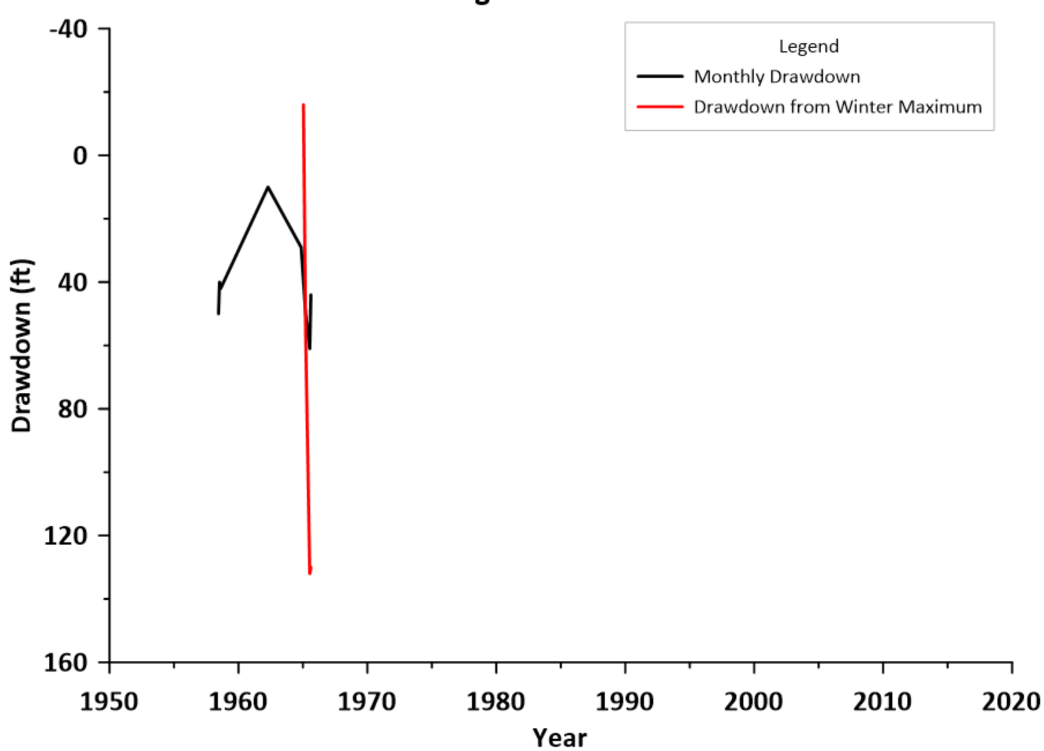
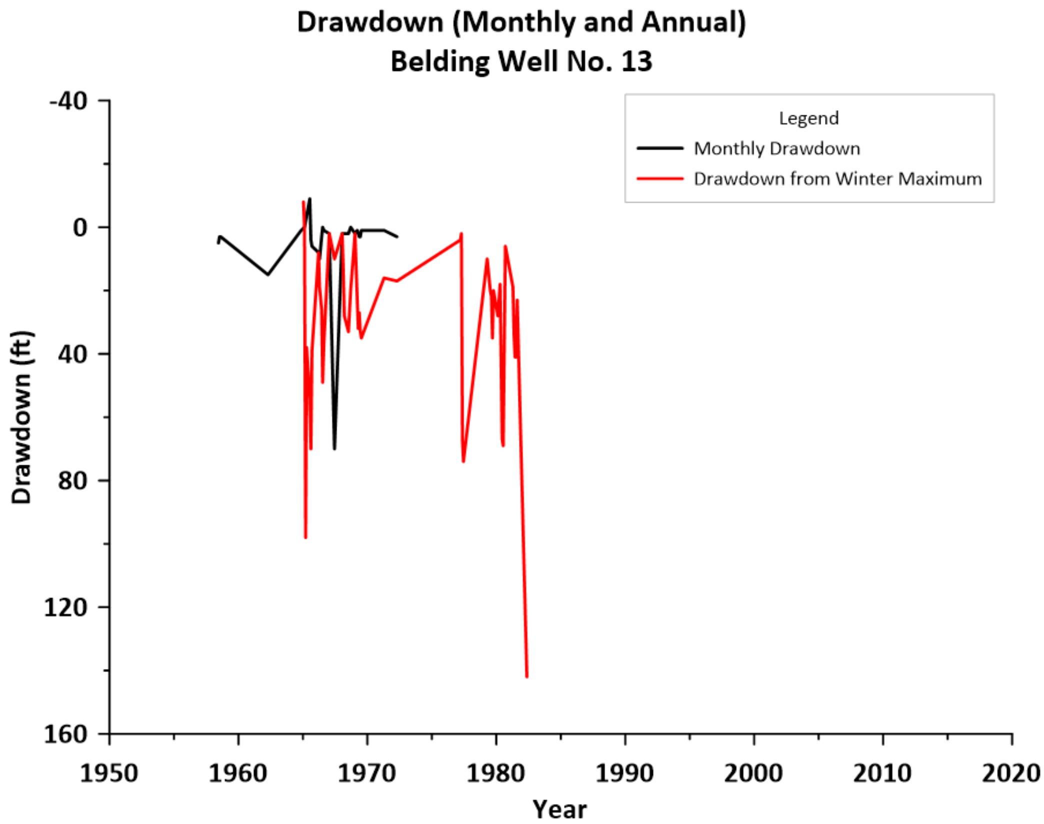
80
120
1950
1960
1970
1980
1990
2000
2010
2020
Year

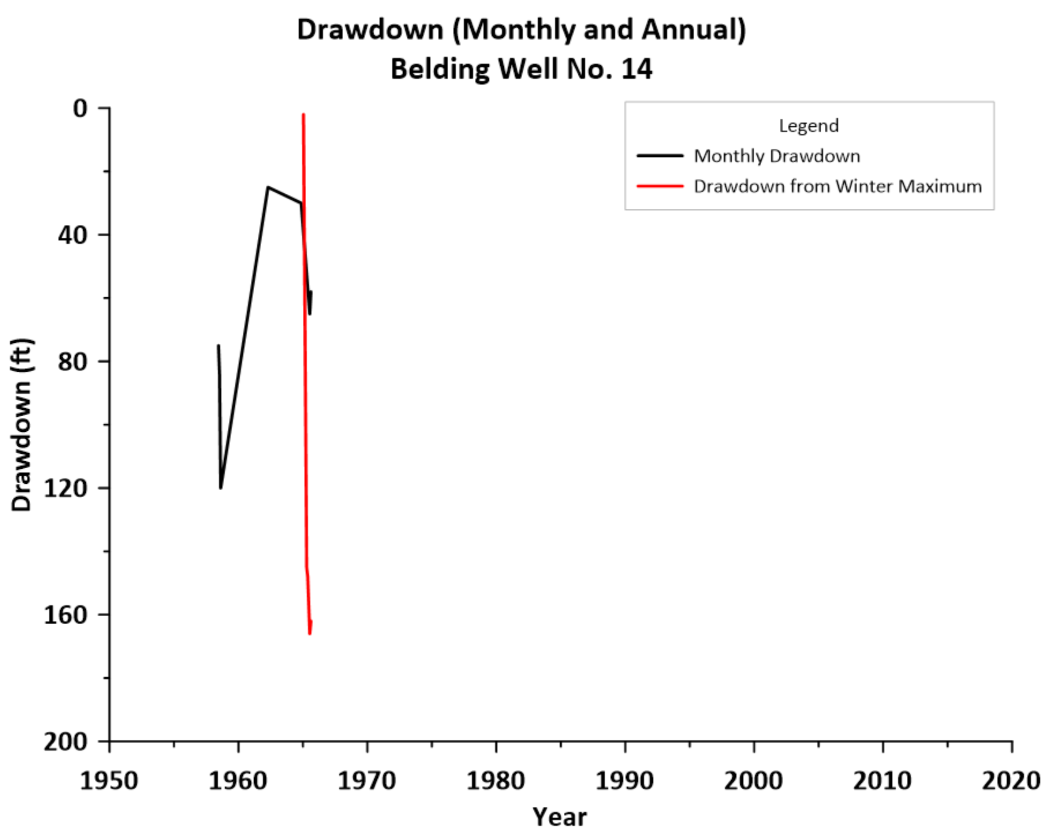
Drawdown (Monthly and Annual)
Belding Well No. 11



Drawdown (Monthly and Annual)
Belding Well No. 12




Drawdown (Monthly and Annual)
Belding Well No. 13
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
Year
-40
0
40
80
120
160
1950
1960
1970
1980
1990
2000
2010
2020


Drawdown (Monthly and Annual)
Belding Well No. 14
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
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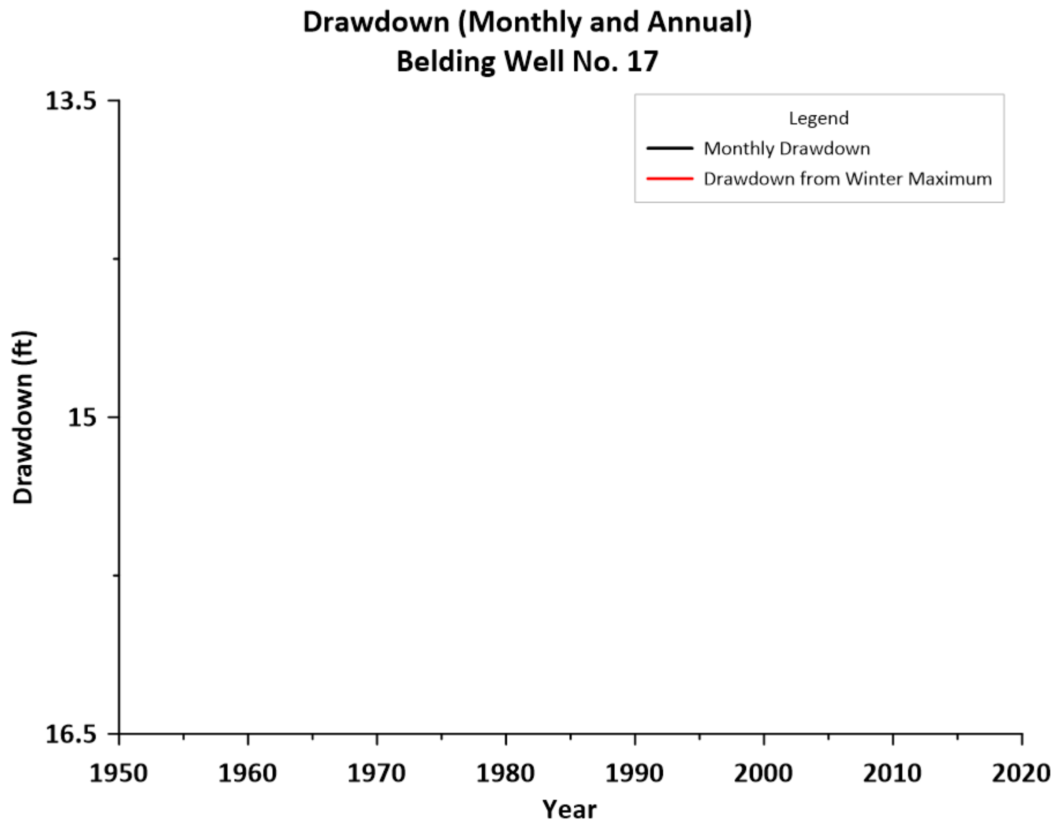
2000
2010
2020



Drawdown (Monthly and Annual)
Belding Well No. 17
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
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16.5
1950
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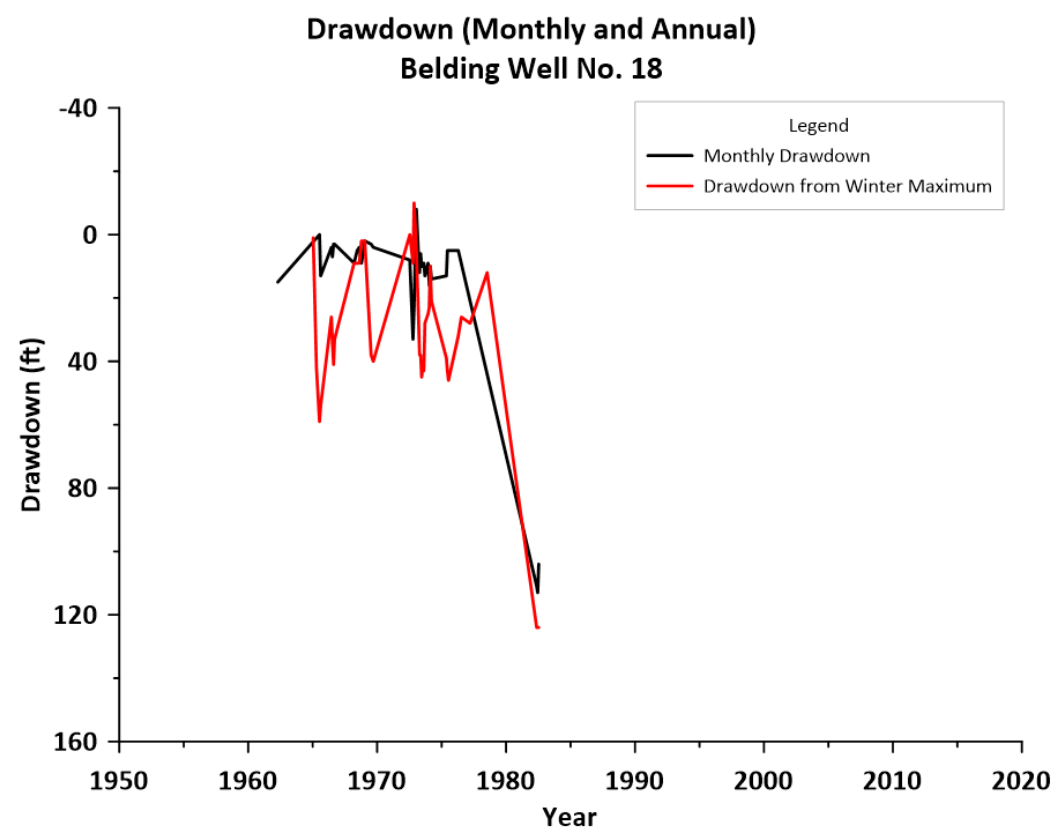
1990
2000
2010
2020
Year



Drawdown (Monthly and Annual)
Belding Well No. 18
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
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40
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120
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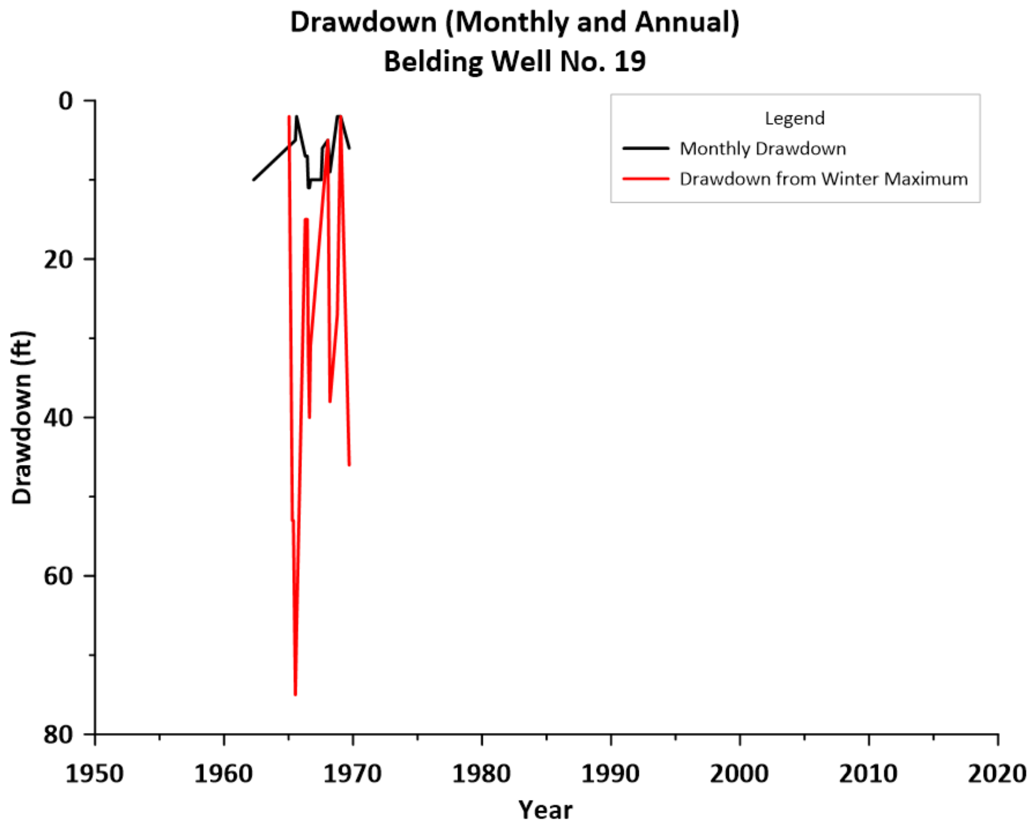
1990
2000
2010
2020
Year



Drawdown (Monthly and Annual)
Belding Well No. 19
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
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40
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80
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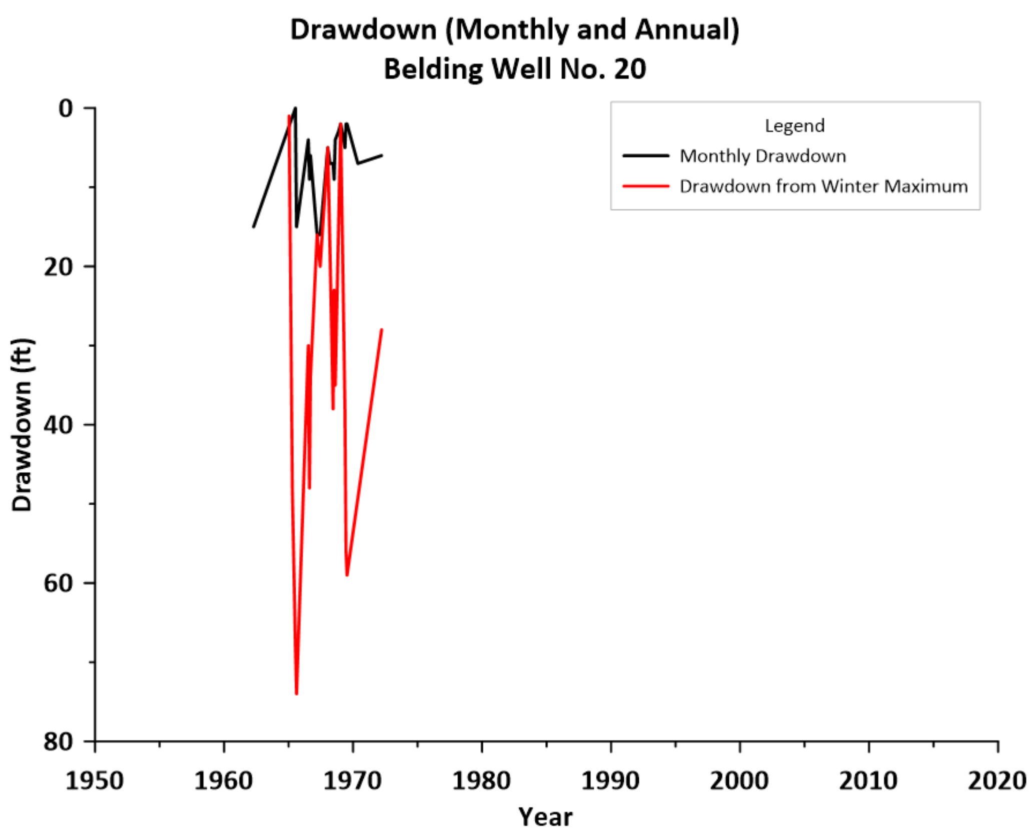
1990
2000
2010
2020
Year



Drawdown (Monthly and Annual)
Belding Well No. 20
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
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20
40
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80
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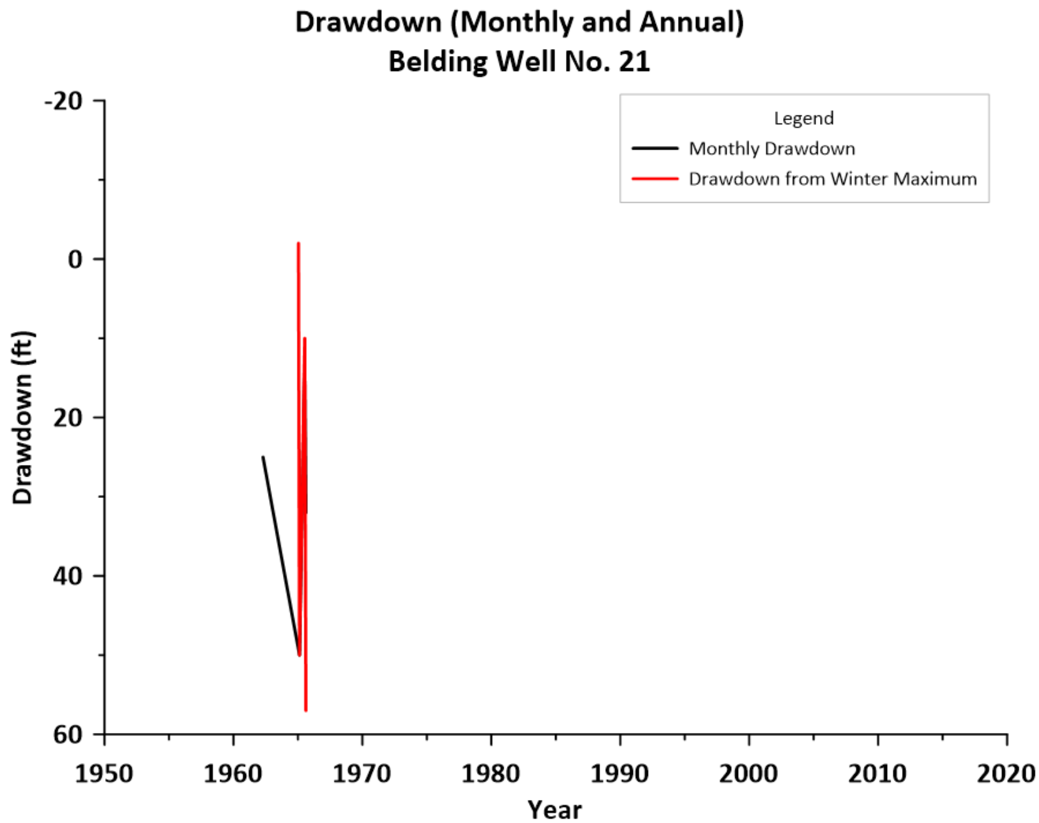
1990
2000
2010
2020
Year



Drawdown (Monthly and Annual)
Belding Well No. 21
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
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0
20
40
60
1950
1960
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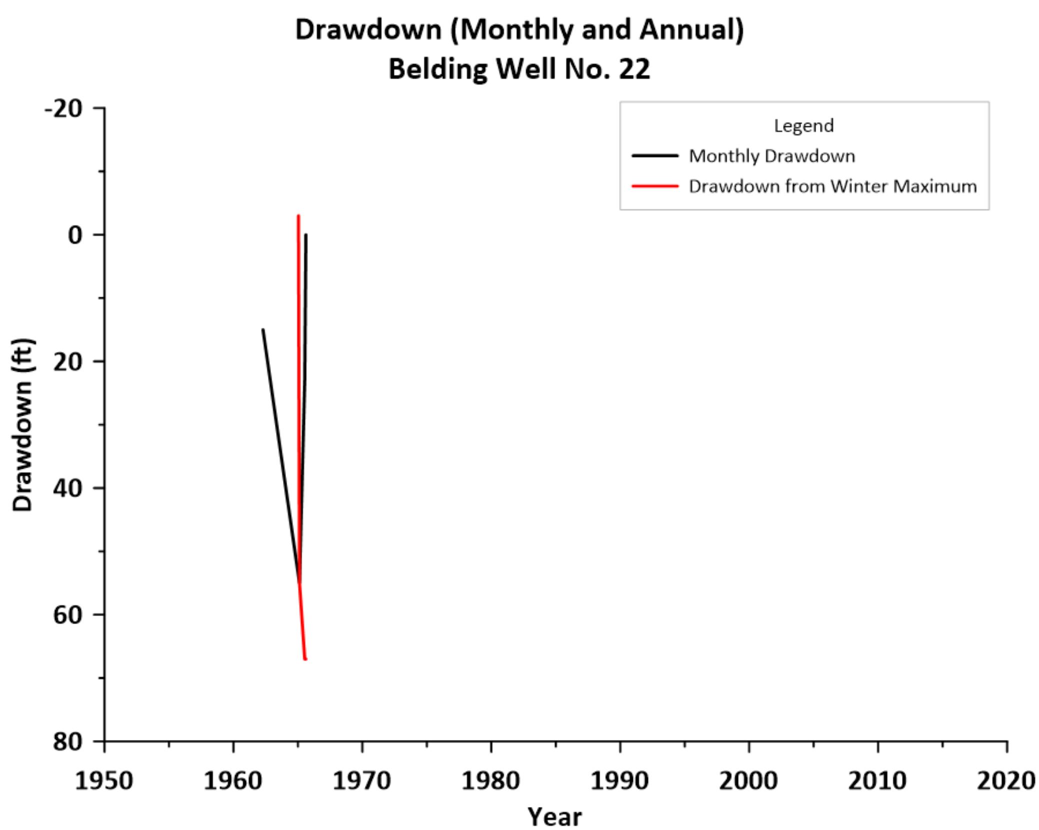
1990
2000
2010
2020
Year



Drawdown (Monthly and Annual)
Belding Well No. 22
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
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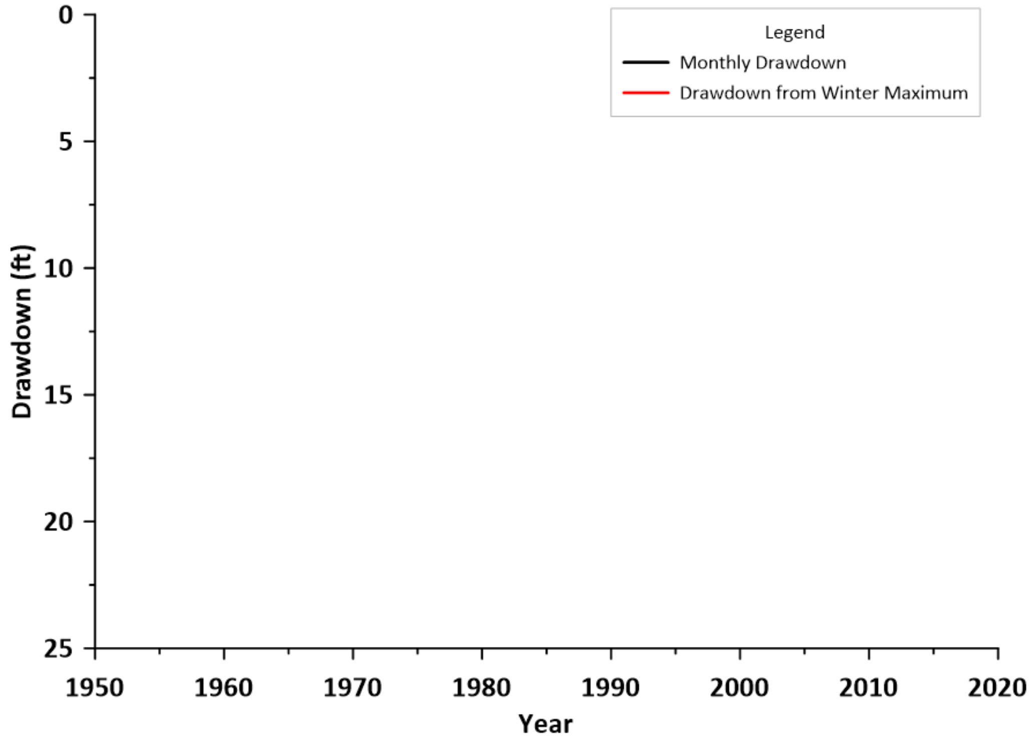
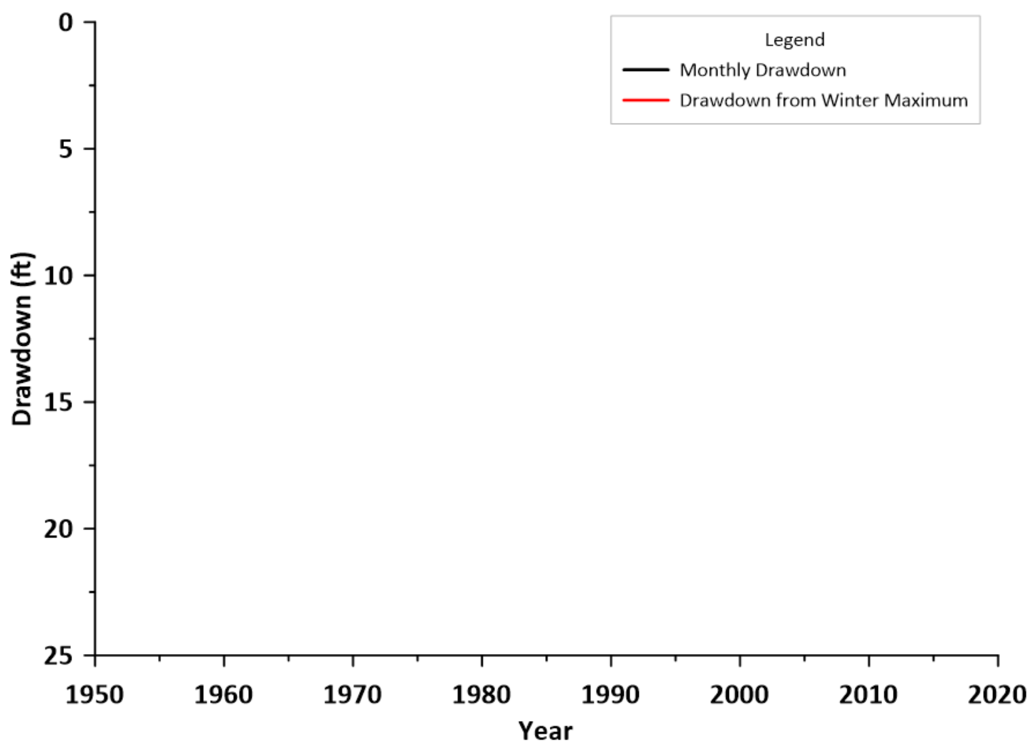
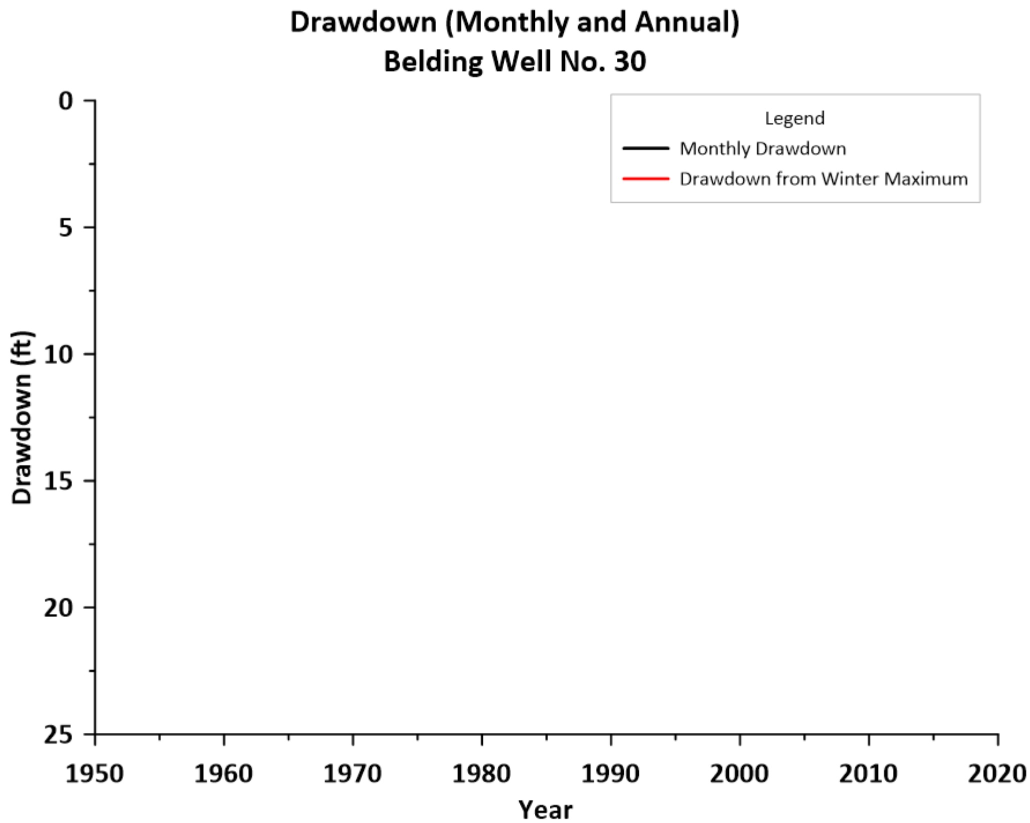
60
80
1950
1960
1970
1980
1990
2000
2010
2020
Year

Drawdown (Monthly and Annual)
Belding Well No. 28



Drawdown (Monthly and Annual)
Belding Well No. 29



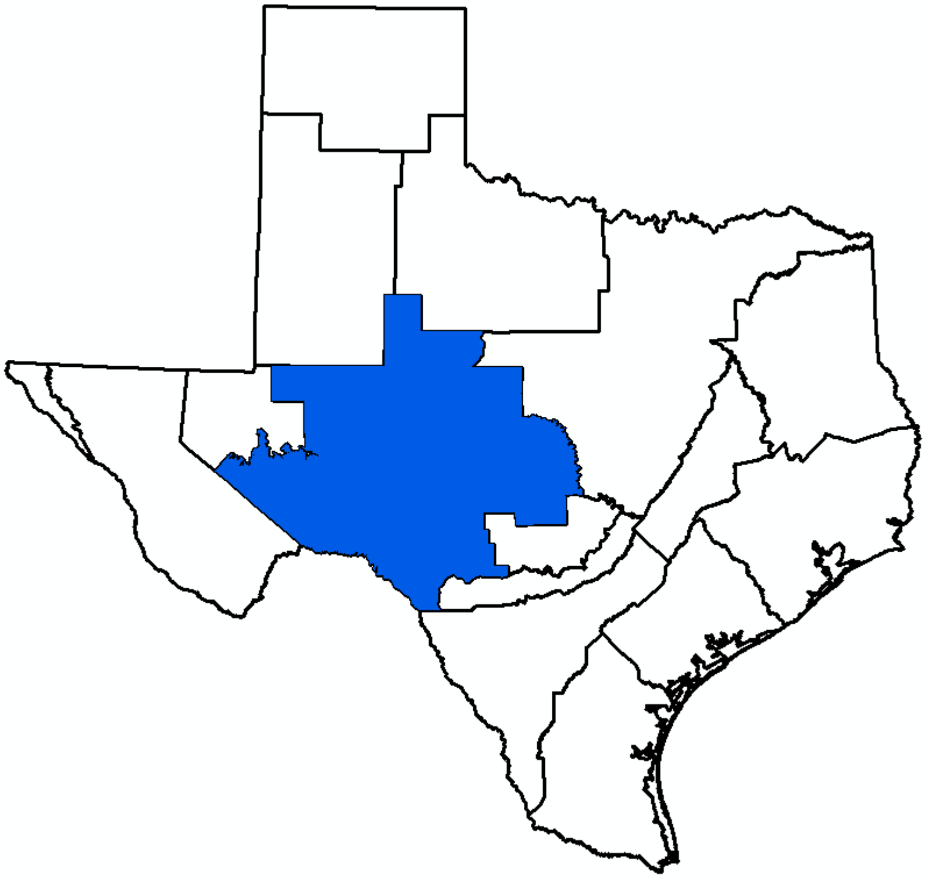

Drawdown (Monthly and Annual)
Belding Well No. 30
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
0
5
10
15
20
25
1950
1960
1970
1980
1990
2000
2010
2020
Year

Middle Pecos GCD Exhibit 31

GMA 7 Explanatory Report, Edward-Trinity (Plateau), Pecos Valley and Trinity Aquifers
(March 26, 2018)

GMA 7 Explanatory Report - Final

Edward-Trinity (Plateau), Pecos Valley and Trinity Aquifers



Prepared for:

Groundwater Management Area 7

Prepared by:

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March 26, 2018

GMA 7 Explanatory Report (Final)
Edwards-Trinity (Plateau), Pecos Valley and Trinity Aquifers

Geoscientist and Engineering Seal

This report documents the work and supervision of work of the following licensed Texas Professional Geoscientist and licensed Texas Professional Engineers:

William R. Hutchison, Ph.D., P.E. (96287), P.G. (286)

Dr. Hutchison completed the analyses and model simulations described in this report, and was the principal author of the final report.

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3/26/2018

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1.0 Groundwater Management Area 7

Groundwater Management Area 7 is one of sixteen groundwater management areas in Texas, and covers that portion of west Texas that is underlain by the Edwards-Trinity (Plateau) Aquifer (Figure 1).

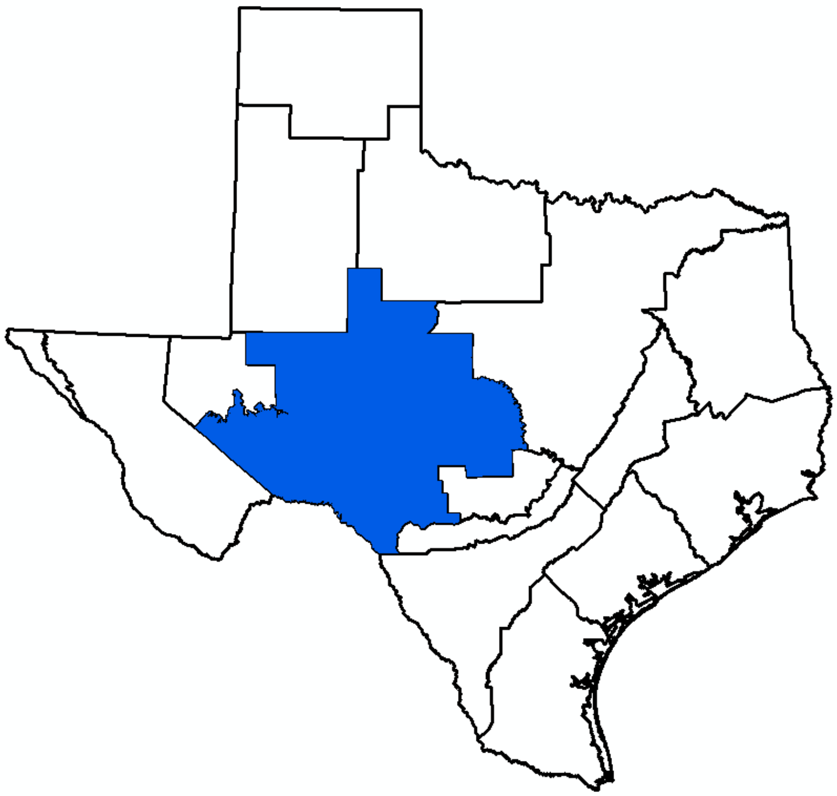


Figure 1. Groundwater Management Area 7

Groundwater Management Area 7 covers all or part of the following counties: Coke, Coleman, Concho, Crockett, Ector, Edwards, Gillespie, Glasscock, Irion, Kimble, Kinney, Llano, Mason, McCulloch, Menard, Midland, Mitchell, Nolan, Pecos, Reagan, Real, Runnels, San Saba, Schleicher, Scurry, Sterling, Sutton, Taylor, Terrell, Tom Green, Upton, and Uvalde (Figure 2).

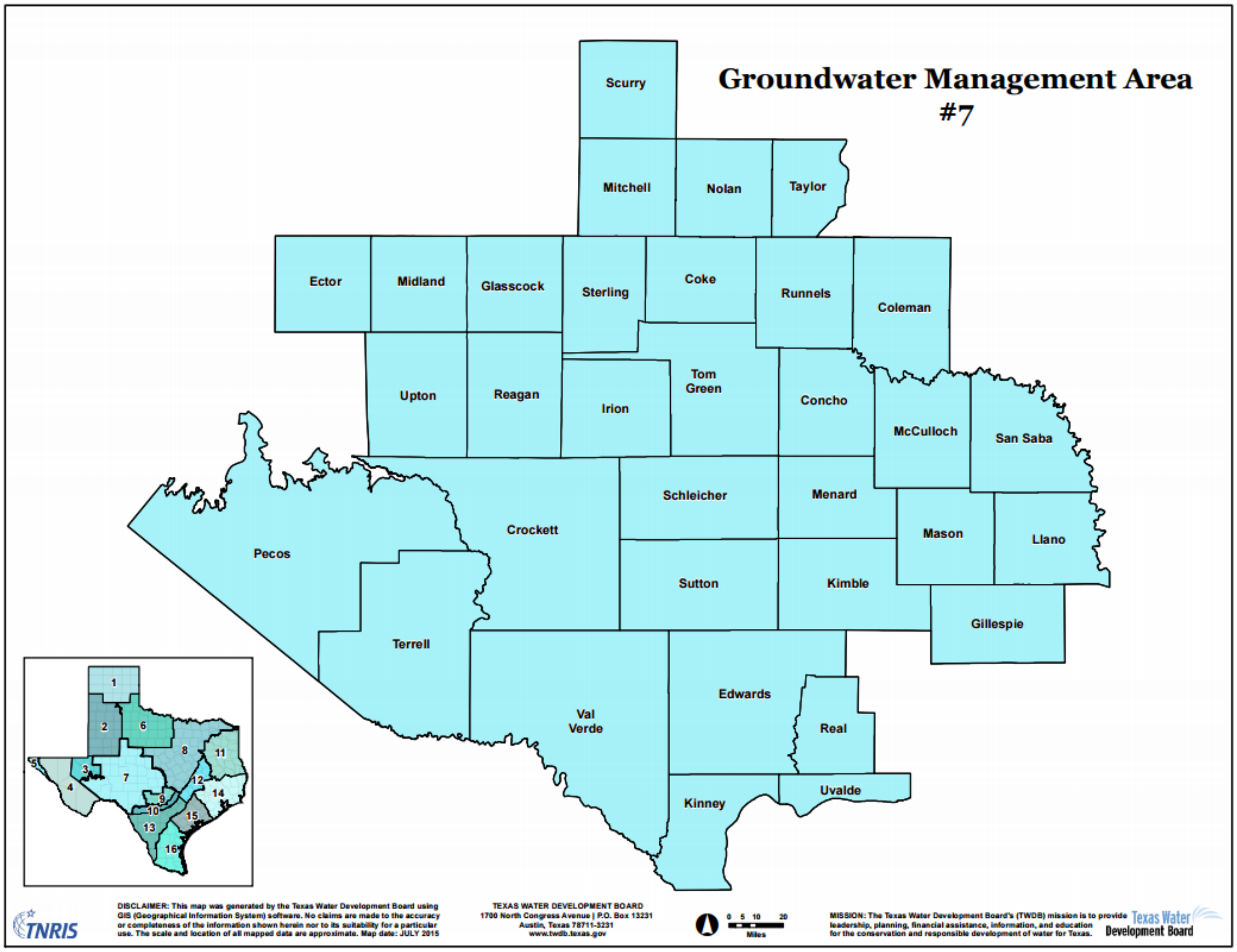


Figure 2. GMA 7 Counties (from TWDB)

There are 20 groundwater conservation districts in Groundwater Management Area 7: Coke County Underground Water Conservation District, Crockett County Groundwater Conservation District, Glasscock Groundwater Conservation District, Hickory Underground Water Conservation District No. 1, Hill County Underground Water Conservation District, Irion County Water Conservation District, Kimble County Groundwater Conservation District, Kinney County Groundwater Conservation District, Lipan-Kickapoo Water Conservation District, Lone Wolf Groundwater Conservation District, Menard County Underground Water District, Middle Pecos Groundwater Conservation District, Plateau Underground Water Conservation and Supply District, Real-Edwards Conservation and Reclamation District, Santa Rita Underground Water Conservation District, Sterling County Underground Water Conservation District, Sutton County Underground Water Conservation District, Terrell County Groundwater Conservation District, Uvalde County Underground Water Conservation District, and Wes-Tex Groundwater Conservation District (Figure 3).

The Edwards Aquifer Authority is also partially inside of the boundaries of GMA 7, but are exempt from participation in the joint planning process.

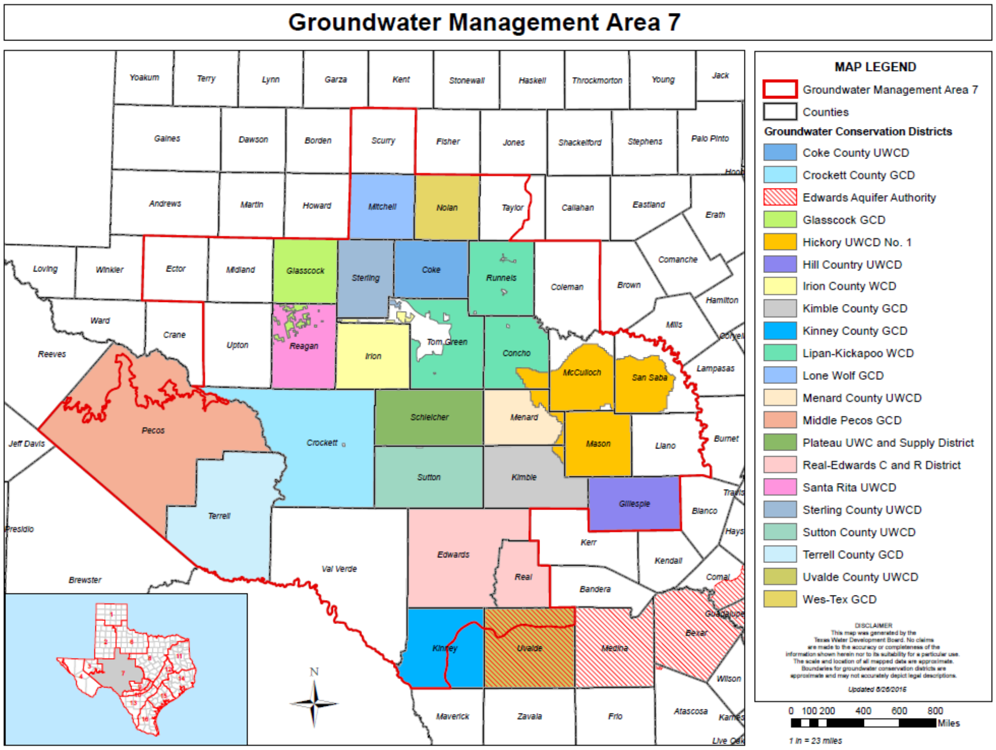


Figure 3. Groundwater Conservation Districts in GMA 7 (from TWDB)

The explanatory report covers the Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers. As described in George and others (2011):

> ***The Edwards-Trinity (Plateau) Aquifer*** *is a major aquifer extending across much of the southwestern part of the state. The water-bearing units are composed predominantly of limestone and dolomite of the Edwards Group and sands of the Trinity Group. Although maximum saturated thickness of the aquifer is greater than 800 feet, freshwater saturated thickness averages 433 feet. Water quality ranges from fresh to slightly saline, with total dissolved solids ranging from 100 to 3,000 milligrams per liter, and water is characterized as hard within the Edwards Group. Water typically increases in salinity to the west within the Trinity Group. Elevated levels of fluoride in excess of primary drinking water standards occur within Glasscock and Irion counties. Springs occur along the northern, eastern, and southern margins of the aquifer primarily near the bases of the Edwards and Trinity groups where exposed at the surface. San Felipe Springs is the largest exposed spring along the southern margin. Of groundwater pumped from this aquifer, more than two-thirds is used for irrigation, with the remainder used for municipal and livestock supplies. Water levels have remained relatively stable because recharge has generally kept pace with the relatively low amounts of pumping over the extent of the aquifer. The regional water planning groups, in their 2006 Regional Water Plans, recommended water management strategies that use the Edwards Trinity*

(Plateau) Aquifer, including the construction of a well field in Kerr County and public supply wells in Real County.

***The Pecos Valley Aquifer** is a major aquifer in West Texas. Water-bearing sediments include alluvial and windblown deposits in the Pecos River Valley. These sediments fill several structural basins, the largest of which are the Pecos Trough in the west and Monument Draw Trough in the east. Thickness of the alluvial fill reaches 1,500 feet, and freshwater saturated thickness averages about 250 feet. The water quality is highly variable, the water being typically hard, and generally better in the Monument Draw Trough than in the Pecos Trough. Total dissolved solids in groundwater from Monument Draw Trough are usually less than 1,000 milligrams per liter. The aquifer is characterized by high levels of chloride and sulfate in excess of secondary drinking water standards, resulting from previous oil field activities. In addition, naturally occurring arsenic and radionuclides occur in excess of primary drinking water standards. More than 80 percent of groundwater pumped from the aquifer is used for irrigation, and the rest is withdrawn for municipal supplies, industrial use, and power generation. Localized water level declines in south-central Reeves and northwest Pecos counties have moderated since the late 1970s as irrigation pumping has decreased; however, water levels continue to decline in central Ward County because of increased municipal and industrial pumping. The Region F Regional Water Planning Group recommended several water management strategies in their 2006 Regional Water Plan that would use the Pecos Valley Aquifer, including drilling new wells, developing two well fields in Winkler and Loving counties, and reallocating supplies.*

***The Trinity Aquifer**, a major aquifer, extends across much of the central and northeastern part of the state. It is composed of several smaller aquifers contained within the Trinity Group. Although referred to differently in different parts of the state, they include the Antlers, Glen Rose, Paluxy, Twin Mountains, Travis Peak, Hensell, and Hosston aquifers. These aquifers consist of limestones, sands, clays, gravels, and conglomerates. Their combined freshwater saturated thickness averages about 600 feet in North Texas and about 1,900 feet in Central Texas. In general, groundwater is fresh but very hard in the outcrop of the aquifer. Total dissolved solids increase from less than 1,000 milligrams per liter in the east and southeast to between 1,000 and 5,000 milligrams per liter, or slightly to moderately saline, as the depth to the aquifer increases. Sulfate and chloride concentrations also tend to increase with depth. The Trinity Aquifer discharges to a large number of springs, with most discharging less than 10 cubic feet per second. The aquifer is one of the most extensive and highly used groundwater resources in Texas. Although its primary use is for municipalities, it is also used for irrigation, livestock, and other domestic purposes. Some of the state's largest water level declines, ranging from 350 to more than 1,000 feet, have occurred in counties along the IH-35 corridor from McLennan County to Grayson County. These declines are primarily attributed to municipal pumping, but they have slowed over the past decade as a result of increasing reliance on surface water. The regional water planning groups, in their 2006 Regional Water Plans, recommended numerous* *water management strategies for the Trinity Aquifer, including developing new wells and well fields, pumping more water from existing wells, overdrafting, reallocating supplies, and using surface water and groundwater conjunctively.*

2.0 Desired Future Condition

2.1 Desired Future Conditions

The desired future condition for the Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers in GMA 7 is based on Scenario 2 as described in GMA 7 Technical Memorandum 15-06. During review of the materials for administrative completeness for GMA 3, the Texas Water Development Board could not reproduce the average drawdowns that were used as the desired future conditions with the model files that were submitted. After several meetings and emails, the differences were attributed to the use of different "grid files".

The groundwater model simulations that were completed in 2010 during the initial round of desired future conditions used a version of the grid file that was developed in 2009. Since then, a 2011 version, a 2014 version, and a 2015 version were developed.

Due to an oversight, the groundwater model simulation that was the basis for the adopted desired future conditions used the outdated grid file from 2009 to calculate average drawdowns in each of the counties that comprise GMA 3 (and GMA 7) instead of the most recent grid file developed by TWDB in 2015.

Because the GMA 3 files had used the same model files and post-processors as GMA 7, it was concluded that the same issues were present in GMA 7, and submittal of the materials to the Texas Water Development Board was delayed until GMA 7 met on March 22, 2018 to adopt updated desired future conditions based on the analyses presented in GMA 7 Technical Memorandum 18-01 that recalculated the average drawdowns from the GAM simulation using the 2015 grid file.

It is important to emphasize that the model run has not been changed, only the basis for calculating average drawdown. It is also important to note that the drawdown in individual cells has not changed, only the overall average in five counties.

The resolution that documents the adoption of the desired future condition on March 22, 2018 for the Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers is presented in Appendix A. The desired future conditions are as follows:

Average drawdown in the following GMA 7 counties not to exceed drawdowns from 2010 to 2070, as set forth in Table 5 of GMA 7 Technical Memo 18-01 (based on the Alternative GAM):

County	Corrected Desired Future Conditions: Average Drawdowns from 2010 to 2070 (ft)
Coke	0
Crockett	10
Ector	4
Edwards	2
Gillespie	5
Glasscock	42
Irion	10
Kimble	1
Menard	1
Midland	12
Pecos	14
Reagan	42
Real	4
Schelicher	8
Sterling	7
Sutton	6
Taylor	0
Terrell	2
Upton	20
Uvalde	2

The desired future conditions adopted on March 23, 2017 for Kinney and Val Verde counties were reaffirmed in the March 22, 2018 resolution as follows:

a) Total net drawdown in Kinney County in 2070, as compared with 2010 aquifer levels, shall be consistent with maintenance of an annual average flow of 23.9 cfs and an annual median flow of 23.9 cfs at Las Moras Springs (Reference: Groundwater Flow Model of the Kinney County Area by W.R. Hutchison, Ph.D., P.E., P.G., Jerry Shi, Ph.D. and Marius Jigmond, TWDB, dated August 26, 2011).
b) Total net drawdown in Val Verde County in 2070, as compared with 2010 aquifer levels, shall be consistent with maintenance of an average annual flow of 73-75 mgd at San Felipe Springs

Finally, the March 22, 2018 resolution reaffirmed the previous finding of March 23, 2017 that the Edwards-Trinity (Plateau) aquifer is not relevant for purposes of joint planning within the boundaries of the Hickory UWCD No. 1, the Lipan-Kickapoo WCD, Lone Wolf GCD, and Wes-Tex GCD, this finding is reaffirmed in this resolution.

The desired future conditions were developed after considering the simulations from three different models. For most of the area, the alternative one-layer model of the Edwards-Trinity (Plateau) and Pecos Valley aquifers was used. For Kinney County, existing model runs using the alternative model for Kinney County was used. Finally, for Val Verde County, model runs from a model developed for Val Verde County and the City of Del Rio were used. These models are described in the next three sections of this report.

2.2 Alternative GAM of the Edwards-Trinity (Plateau) and Pecos Valley Aquifers

In 2010, GMA 7 evaluated the results of 11 alternative predictive scenarios using the alternative one-layer model of the Edwards-Trinity (Plateau) and Pecos Valley aquifers. The model is documented in Hutchison and others (2011), and the simulation results are documented in Hutchison (2010). GMA 7 based their 2010 DFC on Scenario 10 of Hutchison (2010).

Drawdowns calculated in Hutchison (2010) were for predictive simulations through the year 2060. The updated desired future conditions that was adopted in 2017 is expressed through the year 2070 in accordance with the requirements of the Texas Water Development Board.

GMA 7 Technical Memorandum 15-06 described two new simulations that built upon Scenario 10 of Hutchison (2010). Scenario 1 used the same pumping amounts, but extended the simulation to the year 2070. The results were reviewed with GMA 7 at the April 23, 2015 GMA 7 meeting. After discussion and review of the results, adjustments to pumping were made in Irion County, and the model was run again and designated as Scenario 2. These results were discussed at the January 14, 2016 and March 17, 2016 meetings of GMA 7.

The desired future conditions that were adopted were based on Scenario 2 of GMA 7 Technical Memorandum 15-06, and based on the calculation of average drawdown in GMA 7 Technical Memorandum 18-01 that are based on the 2015 grid file.

2.3 Alternative Model for Kinney County

In 2010, the adopted desired future condition for Kinney County was based on simulations with an alternative GAM developed by TWDB (Hutchison and others, 2011). The desired future condition was based on average spring flow in Las Moras Springs. GMA 7 (and the Kinney County GCD) has voted to keep the same DFC based on the 2010 analyses despite issues that have been identified with the model.

The simulations were documented in Draft GAM Task 10-027 (revised), referenced as Hutchison (2011). The adopted desired future condition is based on Scenario 3.

In 2014, the Kinney County GCD began an intensive effort to monitor groundwater elevations and spring flow in Kinney County. This effort began with instrumenting 13 wells with transducers in 2014, and now includes 33 wells with KCGCD transducers, one stream monitoring point with a KCGCD transducer, a well instrumented by TWDB, and Las Moras Spring (monitored by the USGS).

The wet year of 2015 resulted in a pause in model development because the recovery of groundwater elevations was significant, and resulted in additional analyses to better understand the differential response among the various wells.

The DFC for Kinney County was based on maintaining an average spring flow that is independent of the model used to calculate the MAG (modeled available groundwater). Although TWDB will ultimately calculate the MAG using the tool it deems most suitable, it is reasonable to expect that the alternative GAM previously used in 2010 and 2011 will be selected, the issues with the model could result in a significantly different MAG if a different method is chosen. It is possible that the resulting MAG would be lower if a different method is used. It is also reasonable to assume that that TWDB will move forward with preparing a MAG report before the new model is completed. Once the model is completed, it will be forwarded to TWDB for consideration in updating the MAG.

2.4 Val Verde County Model

The DFC for Val Verde County was based on maintaining an average spring flow that was based on simulations with a groundwater model that was developed for Val Verde County and the City of Del Rio as part of a hydrogeologic study completed by EcoKai Environmental, Inc. (EcoKai, 2014). The overall objective of the study was to determine the correlation and potential impacts of groundwater pumping on local spring flows, lake elevations, and groundwater levels. An understanding of these correlations is necessary to evaluate the potential effects that additional groundwater pumping for export would have on the overall groundwater system.

The groundwater model developed as part of this study was based on the alternative model for Kinney County referenced above (Hutchison and Shi, 2011). Specifically, the half-mile grid spacing, the geologic framework, and many of the boundary conditions of the Kinney County model were used as the foundation of this new model. The Kinney County model was developed using annual stress period. The new model was developed using monthly stress periods from 1968 to 2013.

Model calibration was completed using 3,605 groundwater elevations from 498 wells in Val Verde County from 1968 to 2013, and using spring flows from three springs (Cantu, McKee and San Felipe). Calibration of the model was considered sufficient to advance the objectives of the study with regard to providing technical information that could be used in developing groundwater management guidelines (e.g. identification and delineation of the boundaries of groundwater management areas, conservation triggers, exportation cessation triggers, and generally characterizing groundwater conditions based on groundwater elevations and spring flows).

Specific applications of the calibrated model included: 1) a simulation to estimate the effect of Lake Amistad on groundwater elevations in the area, 2) a series of runs that were designed to provide information useful for management zone delineation, and 3) a series of simulations to evaluate the effects of large-scale pumping in three different areas to develop a better understanding of the nature and character of potential impacts of groundwater pumping on spring flow, river baseflow, aquifer drawdown, and other changes to the groundwater flow system.

The simulations that considered pumping increases considered 6 different pumping scenarios and 3 well-field location scenarios. The adopted desired future condition was based on the pumping scenarios designated 50K (50,000 AF/yr of pumping). The listed range in average spring flow in the desired future condition reflects the range of average spring flow associated with different locations of pumping. The summary table and graph are that were used by GMA 7 at the April 21, 2016 meeting to propose the desired future condition are located on page 61of the EcoKai report (Table 23 and Figure 39).

3.0 Policy Justification

As developed more fully in this report, the proposed desired future condition was adopted after considering the nine statutory factors:

1. Aquifer uses and conditions within Groundwater Management Area 7
2. Water supply needs and water management strategies included in the 2012 State Water Plan
3. Hydrologic conditions within Groundwater Management Area 7 including total estimated recoverable storage, average annual recharge, inflows, and discharge
4. Other environmental impacts, including spring flow and other interactions between groundwater and surface water
5. The impact on subsidence
6. Socioeconomic impacts reasonably expected to occur
7. The impact on the interests and rights in private property, including ownership and the rights of landowners and their lessees and assigns in Groundwater Management Area 7 in groundwater as recognized under Texas Water Code Section 36.002
8. The feasibility of achieving the desired future condition
9. Other information

In addition, the proposed desired future condition provides a balance between the highest practicable level of groundwater production and the conservation, preservation, protection, recharging, and prevention of waste of groundwater in Groundwater Management Area 7.

There is no set formula or equation for calculating groundwater availability. This is because an estimate of groundwater availability requires the blending of policy and science. Given that the tools for scientific analysis (groundwater models) contain limitations and uncertainty, policy provides the guidance and defines the bounds that science can use to calculate groundwater availability.

As developed more fully below, many of these factors could only be considered on a qualitative level since the available tools to evaluate these impacts have limitations and uncertainty.

During the initial development of desired future conditions in 2010, there was no specific statutory guidance related to factor consideration or balancing. However, GMA 7 took a proactive approach in defining qualitative goals that were evaluated with the groundwater availability model at the time. The effort was rooted as a policy consideration, but tested and verified as a technical consideration. Details are discussed in the next section. This approach was extended to the process of updating the desired future conditions that were adopted in 2017.

4.0 Technical Justification

The process of using the groundwater model in developing desired future conditions revolves around the concept of incorporating many of the elements of the nine statutory factors listed in the previous section. For the Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers, the initial 10 simulations completed in 2010 were evaluated as well as two new simulations. In Kinney County, the DFCs were based on an evaluation of 7 scenarios. In Val Verde County, the DFCs were based on an evaluation of 18 scenarios.

Some critics of the process asserted that the districts were "reverse-engineering" the desired future conditions by specifying pumping (e.g., the modeled available groundwater) and then adopting the resulting drawdown as the desired future condition. However, it must be remembered that among the input parameters for a predictive groundwater model run is pumping, and among the outputs of a predictive groundwater model run is drawdown. Thus, an iterative approach of running several predictive scenarios with models and then evaluating the results is a necessary (and time-consuming) step in the process of developing desired future conditions.

One part of the reverse-engineering critique of the process has been that "science" should be used in the development of desired future conditions. The critique plays on the unfortunate name of the groundwater models in Texas (Groundwater Availability Models) which could suggest that the models yield an availability number. This is simply a mischaracterization of how the models work (i.e. what is a model input and what is a model output).

The critique also relies on a fairly narrow definition of the term *science* and fails to recognize that the adoption of a desired future condition is primarily a policy decision. The call to use science in the development of desired future conditions seems to equate the term *science* with the terms *facts* and *truth*. Although the Latin origin of the word means knowledge, the term *science* also refers to the application of the scientific method. The scientific method is discussed in many textbooks and can be viewed as a means to quantify cause-and-effect relationships and to make useful predictions.

In the case of groundwater management, the scientific method can be used to understand the relationship between groundwater pumping and drawdown, or groundwater pumping and spring flow. A groundwater model is a tool that can be used to run "experiments" to better understand the cause-and-effect relationships within a groundwater system as they relate to groundwater management.

Much of the consideration of the nine statutory factors involves understanding the effects or the impacts of a desired future condition (e.g. groundwater-surface water interaction and property rights). The use of the models in this manner in evaluating the impacts of alternative futures is an effective means of developing information for the groundwater conservation districts as they develop desired future conditions.

GMA 7 articulated a qualitative vision for desired future conditions in 2010: minimize drawdown in the eastern portion of GMA 7 (where baseflow to rivers is important) and provide for irrigation demands in the western portion of GMA 7 (where there would be significant drawdown). The key issue of the model simulations was to assess the compatibility of these qualitative goals. Given that groundwater models require pumping as inputs and calculate drawdowns as one of the outputs, this led to a series of simulations that evaluated increases in pumping on drawdown in various portions of GMA 7. Initially, six scenarios were run: a base case using 2005 pumping, and 5 scenarios where pumping was increased. The base case, or continuation of 2005 pumping was designated as Scenario 0. Scenario 1 was developed by polling each district to identify their expected pumping. Scenario 2 pumping was 110 percent of Scenario 1 pumping. Scenario 3 pumping was 120 percent of Scenario 1 pumping. Scenario 3 pumping was 120 percent of Scenario 1 pumping. Scenario 4 pumping was 130 percent of Scenario 1 pumping. Scenario 5 pumping was 140 percent of Scenario 1 pumping. These results were reviewed with GMA 7 at their meeting of July 28, 2010.

At the July 28, 2010 meeting, GMA 7 representatives then identified modifications to the pumping inputs and the model was re-run at the meeting, and the results were reviewed. These runs were labeled Scenarios 6 to 10. GMA 7 adopted DFCs based on Scenario 10. Based on the review, the GCD representatives found that Scenario 10 met the predefined qualitative vision of minimizing drawdown in the east while providing for irrigation demands in the west.

The evaluation of the eastern portion is exemplified by an analysis of San Saba River flow in Menard County. Figure 4 presents the flow of the San Saba River at Menard.

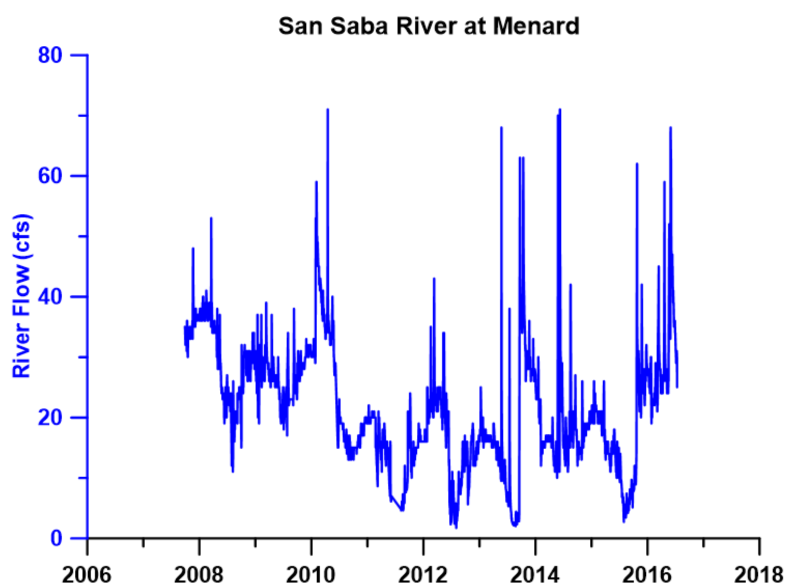


Figure 4. San Saba River at Menard

Please note that from about 2007 to 2010, minimum or base flow is about 30 cfs. From 2011 to 2014, minimum or base flow is about 10 cfs (during drought conditions), and after 2015, minimum or base flow return to about 30 cfs.

Figure 5 is a repeat of the river hydrograph and adds the hydrograph of a well completed in the Edwards-Trinity (Plateau) Aquifer several miles to the south of the stream gage.

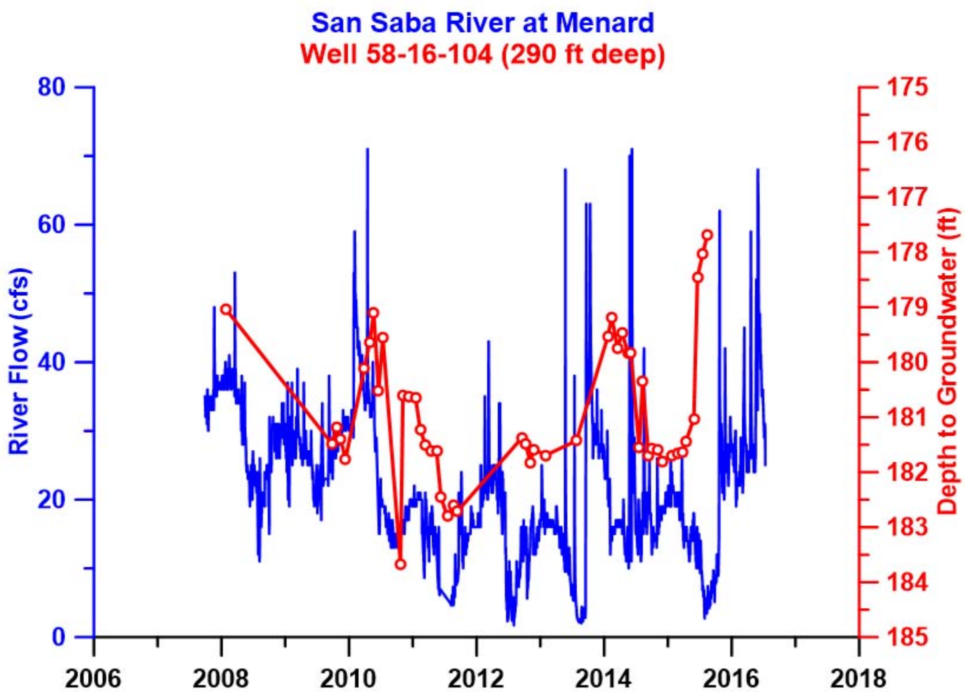


Figure 5. San Saba River at Menard and Well 58-16-104

Please note that the changes in the groundwater elevation in the well mimic the changes in river flow. The groundwater elevation from 1962 to 2016 in this well ranges from about 1,983 to 2,045 ft MSL. The stream gage elevation is 1,863 ft MSL, so it appears that this is a gaining reach of the river.

In general, the depth to water in the well is about 179 feet when river flow is high (i.e. during wet years), and the depth to water is about 182 feet when the river flow is low (i.e. during dry years). Thus, it was assumed that if, in wet periods, groundwater pumping resulted in a groundwater level decline of 3 feet, the river flow would be reduced. Thus, the pumping inputs into the GAM simulations were evaluated in the context of average drawdown that would be less than 3 feet to maintain base flow. In fact, the drawdown in Menard County under the desired future condition simulation was one foot suggested that impacts to baseflow would be minimal.

5.0 Factor Consideration

Senate Bill 660, adopted by the legislature in 2011, changed the process by which groundwater conservation districts within a groundwater management area develop and adopt desired future conditions. The new process includes nine steps as presented below:

- The groundwater conservation districts within a groundwater management area consider nine factors outlined in the statute.
- The groundwater conservation districts adopt a "proposed" desired future condition
- The "proposed" desired future condition is sent to each groundwater conservation district for a 90-day comment period, which includes a public hearing by each district
- After the comment period, each district compiles a summary report that summarizes the relevant comments and includes suggested revisions. This summary report is then submitted to the groundwater management area.
- The groundwater management area then meets to vote on a desired future condition.
- The groundwater management area prepares an "explanatory report".
- The desired future condition resolution and the explanatory report are then submitted to the Texas Water Development Board and the groundwater conservation districts within the groundwater management area.
- Districts then adopt desired future conditions that apply to that district.

The nine factors that must be considered before adopting a proposed desired future condition are:

1. Aquifer uses or conditions within the management area, including conditions that differ substantially from one geographic area to another.
2. The water supply needs and water management strategies included in the state water plan.
3. Hydrological conditions, including for each aquifer in the management area the total estimated recoverable storage as provided by the executive administrator (of the Texas Water Development Board), and the average annual recharge, inflows and discharge.
4. Other environmental impacts, including impacts on spring flow and other interactions between groundwater and surface water.
5. The impact on subsidence.
6. Socioeconomic impacts reasonably expected to occur.
7. The impact on the interests and rights in private property, including ownership and the rights of management area landowners and their lessees and assigns in groundwater as recognized under Section 36.002 (of the Texas Water Code).
8. The feasibility of achieving the desired future condition.
9. Any other information relevant to the specific desired future condition.

In addition to these nine factors, statute requires that the desired future condition provide a balance between the highest practicable level of groundwater production and the conservation, preservation, protection, recharging, and prevention of waste of groundwater and control of subsidence in the management area.

5.1 Groundwater Demands and Uses

Groundwater demands and uses from 2000 to 2012 in the Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers are presented in Appendix B. Data were obtained from the Texas Water Development Board historic pumping database:

http://www.twdb.state.tx.us/waterplanning/waterusesurvey/historical-pumpage.asp

The Modeled Available Groundwater values for the Edwards-Trinity Aquifer are summarized below in Table 1. In the Pecos Valley Aquifer, the modeled available groundwater in Crockett County is 31 AF/yr, is 113 AF/yr in Ector County, is 1,448 in Pecos County, and is 2 AF/yr in Upton County. In the Trinity Aquifer, the modeled available groundwater in Gillespie County is 2,482 AF/yr, and is 52 AF/yr in Real County.

Hydrographs that compare the historic pumping and the modeled available groundwater values are presented in Appendix C.

Table 1. Modeled Available Groundwater for the Edwards-Trinity (Aquifer)

County	Modeled Available Groundwater (2010 to 2070) (Acre-feet/yr)	County	Modeled Available Groundwater (2010 to 2070) (Acre-feet/yr)
Coke	998	Pecos	115,938
Crockett	5,426	Reagan	68,278
Ector	5,422	Real	7,477
Edwards	5,638	Schleicher	8,050
Gillespie	2,514	Sterling	2,497
Glasscock	65,213	Sutton	6,438
Irion	2,293	Taylor	489
Kimble	1,283	Terrell	1,421
Kinney	70,338	Tom Green	426
McCulloch	4	Upton	22,379
Menard	2,194	Uvalde	1,635
Midland	23,251	Val Verde	24,988
Nolan	693	Total	445,283

These data were discussed at the GMA 7 meeting of December 18, 2014 in San Angelo, Texas.

5.2 Groundwater Supply Needs and Strategies

Total future demand estimates from the Texas Water Development Board are summarized in Table 2. Recommended strategies in the 2011 Region F Water Plan for desalination, new groundwater, and well replacement are shown in Table 3.

Two alternative water supply strategies are listed for the Edwards-Trinity (Plateau) Aquifer in the 2011 Region F Water Plan. In Kimble County, a 1,000 AF/yr strategy for manufacturing is listed for the years 2010 to 2060. In Schleicher County, a 12,000 AF/yr strategy for municipal supply for the City of San Angelo is listed for the years 2040 to 2060.

5.3 Hydrologic Conditions, including Total Estimated Recoverable Storage

The groundwater budget as presented by Hutchison and others (2011) for the Edwards-Trinity (Plateau) Aquifer, Pecos Valley, and Trinity aquifers is presented in Table 4.

Jones and others (2013) documented the total estimated recoverable storage for the aquifers in GMA 7. Table 5 presents storage for the Edwards-Trinity (Plateau) Aquifer. Table 6 presents storage for the Pecos Aquifer. Table 7 presents storage for the Trinity.

5.4 Other Environmental Impacts, including Impacts on Spring Flow and Surface Water

Table 4 (referenced above) includes the entire groundwater budget for the Edwards-Trinity (Plateau) Aquifer, Pecos Valley, and Trinity aquifers.

The primary consideration for the desired future conditions in Val Verde and Kinney counties was the preservation of spring flow. The primary consideration in the northeastern portion of GMA 7 was the maintenance of groundwater levels to maintain baseflow to the tributaries of the Colorado River.

5.5 Subsidence

Subsidence is not an issue in the Edwards-Trinity (Plateau) Aquifer, Pecos Valley, and Trinity aquifers in GMA 7.

Table 2. Future Water Demands

County	Water Use (AF/yr)						Change (2020 to 2070)
	2020	2030	2040	2050	2060	2070	
Coke	2806	2823	2808	2811	2839	2848	42
Coleman	3335	3319	3274	3255	3241	3233	-102
Concho	11586	11535	11433	11335	11250	11173	-413
Crockett	5229	5563	5144	4770	4529	4541	-688
Ector	44084	48868	53855	59381	65707	72767	28,683
Edwards	1230	1211	1193	1184	1173	1166	-64
Gillespie	9142	9424	9658	9973	10338	10709	1,567
Glasscock	60554	59780	58603	57440	56409	55659	-4,895
Irion	5134	5261	4287	3317	2511	2109	-3,025
Kimble	4943	4871	4794	4722	4679	4647	-296
Kinney	8406	8397	8384	8380	8378	8378	-28
Llano	9499	9638	9563	9434	9543	9663	164
Mason	11493	11274	10907	10640	10412	10207	-1,286
McCulloch	15535	14986	13247	12230	11449	10830	-4,705
Menard	4468	4434	4298	4161	4043	3940	-528
Midland	75263	76803	79343	82052	85072	88465	13,202
Mitchell	19575	19622	19297	18942	18611	18347	-1,228
Nolan	25413	35845	35841	35883	35919	35979	10,566
Pecos	133971	134725	135119	135287	135455	135633	1,662
Reagan	24397	23330	22112	20785	19624	19007	-5,390
Real	913	890	870	855	843	835	-78
Runnels	6605	6581	6494	6441	6399	6363	-242
San Saba	9448	9323	8988	8740	8577	8442	-1,006
Schleicher	3453	3561	3371	3179	3005	2889	-564
Scurry	10891	11078	11015	10884	10785	10746	-145
Sterling	2394	2532	2349	2018	1726	1558	-836
Sutton	4134	4456	4488	4284	4081	3931	-203
Taylor	28806	29355	29801	30284	30868	31396	2,590
Terrell	1511	1604	1556	1416	1283	1178	-333
Tom Green	119070	120885	121841	122946	124361	125908	6,838
Upton	14974	14309	13442	12399	11515	11054	-3,920
Uvalde	75595	73694	71705	69993	68451	67179	-8,416
Val Verde	16777	17664	18519	19398	20262	21127	4,350
Total	770634	787641	787599	788819	793338	801907	31,273

Table 3. Recommended Groundwater Strategies in 2011 Region F Water Plan

Entity	County Used	Basin Used	Total Capital Cost	1st Decade Unit Cost	Supply (Ac-ft/yr)						2060 Unit Cost
					2010	2020	2030	2040	2050	2060	
Desalination											
City of Andrews	Andrews	Colorado	$6,717,000	$1,163	0	950	950	950	950	950	$546
CRMWD			$131,603,990	$0	0	0	0	9,500	9,500	9,500	$251
San Angelo			$75,440,000	$0	0	0	0	5,600	5,600	5,600	$473
Total			**$213,760,990**	**$1,163**	**0**	**950**	**950**	**16,050**	**16,050**	**16,050**	**$346**
New Groundwater											
Colorado City	Mitchell	Colorado	$17,855,000	$0	0	2,200	2,200	2,200	2,200	2,200	$445
City of Menard	Menard	Colorado	$1,684,000	$1,664	140	139	140	140	141	141	$610
County-Other	Menard	Colorado	$0	$0	20	21	20	20	19	19	$0
City of Midland	Midland	Colorado	$168,507,000	$0	0	0	13,600	13,600	13,600	13,600	$342
CRMWD	Multiple	Colorado	$76,268,000	$0	0	0	6,000	6,000	6,000	6,000	$251
San Angelo	Tom	Colorado	$173,307,000	$0	0	6,700	10,000	12,000	12,000	12,000	$1,670
Total			**$437,621,000**	**$1,664**	**160**	**9,060**	**31,960**	**33,960**	**33,960**	**33,960**	**$3,318**
Replacement Wells											
City of Eden	Concho	Colorado	$1,800,000	NA	0	0	0	0	0	0	NA
Richland SUD	McCulloc	Colorado	$1,701,000	NA	0	0	0	0	0	0	NA
CRMWD	Multiple	Colorado	$10,440,000	NA	0	0	0	0	0	0	NA
Total			**$13,941,000**	**NA**	**0**	**0**	**0**	**0**	**0**	**0**	**NA**

Table 4. Groundwater Budget of Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers from One-Layer Model

	Water Budget 1930-1939 (acre-feet per year)	Water Budget 1940-1949 (acre-feet per year)	Water Budget 1950-1959 (acre-feet per year)	Water Budget 1960-1969 (acre-feet per year)	Water Budget 1970-1979 (acre-feet per year)	Water Budget 1980-1989 (acre-feet per year)	Water Budget 1990-1999 (acre-feet per year)	Water Budget 2000-2005 (acre-feet per year)
Inflow								
Rivers	993,229	1,009,160	1,054,950	1,107,275	1,092,402	1,048,220	1,033,690	1,033,726
Inter-aquifer Flow	1,095,795	1,100,269	1,112,419	1,123,952	1,135,663	1,131,445	1,137,506	1,136,281
Recharge	1,641,803	1,688,928	1,545,021	1,621,125	1,680,625	1,671,631	1,669,556	1,703,227
Total Inflow	3,730,827	3,798,357	3,712,390	3,852,352	3,908,690	3,851,296	3,840,752	3,873,234
Outflow								
Pumpage	-194,233	-570,080	-947,024	-1,210,949	-935,718	-651,331	-706,359	-677,860
Springs	-1,216,432	-1,210,615	-1,129,334	-1,082,433	-1,092,612	-1,101,266	-1,120,187	-1,093,636
Rivers	-1,893,959	-1,841,710	-1,767,816	-1,722,471	-1,715,415	-1,741,168	-1,756,911	-1,755,300
Inter-aquifer Flow	-560,262	-557,538	-546,381	-532,124	-526,554	-531,894	-533,580	-535,091
Total Outflow	-3,864,885	-4,179,943	-4,390,555	-4,547,978	-4,270,298	-4,025,658	-4,117,038	-4,061,887
In-Out	-134,058	-381,585	-678,165	-695,626	-361,608	-174,362	-276,286	-188,653
Storage Change	-133,865	-372,190	-678,034	-695,534	-358,631	-166,175	-250,497	-188,648
Model Error	-194	-9,395	-131	-92	-2,977	-8,187	-25,789	-5
Model Error (Percent)	-0.01	-0.25	0.00	0.00	-0.08	-0.21	-0.67	0.00

Table 5. Total Estimated Recoverable Storage - Edwards-Trinity (Plateau) Aquifer

County	Total Storage (acre-feet)	25 percent of Total Storage (acre-feet)	75 percent of Total Storage (acre-feet)
Coke	120,000	30,000	90,000
Concho	79,000	19,750	59,250
Crockett	1,500,000	375,000	1,125,000
Ector	220,000	55,000	165,000
Edwards	5,000,000	1,250,000	3,750,000
Gillespie	430,000	107,500	322,500
Glasscock	270,000	67,500	202,500
Irion	420,000	105,000	315,000
Kimble	1,100,000	275,000	825,000
Kinney[20]	4,400,000	1,100,000	3,300,000
Mason	51,000	12,750	38,250
McCulloch	93,000	23,250	69,750
Menard	250,000	62,500	187,500
Midland	240,000	60,000	180,000
Nolan	170,000	42,500	127,500
Pecos	3,100,000	775,000	2,325,000
Reagan	560,000	140,000	420,000
Real	1,600,000	400,000	1,200,000
Schleicher	890,000	222,500	667,500
Sterling	150,000	37,500	112,500
Sutton	1,800,000	450,000	1,350,000
Taylor	78,000	19,500	58,500
Terrell	4,500,000	1,125,000	3,375,000
Tom Green	250,000	62,500	187,500
Upton	550,000	137,500	412,500
Uvalde	1,000,000	250,000	750,000
Val Verde	10,000,000	2,500,000	7,500,000
Total	38,821,000	9,705,250	29,115,750

[20] Total storage values for Kinney County are based on the alternative model by Hutchison and others (2011), the other total storage values were based on the groundwater availability model by Anaya and Jones (2009).

Table 6. Total Estimated Recoverable Storage - Pecos Valley Aquifer

County	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Crockett	160,000	40,000	120,000
Ector	5,900,000	1,475,000	4,425,000
Pecos	910,000	227,500	682,500
Upton	4,400,000	1,100,000	3,300,000
Total	11,370,000	2,842,500	8,527,500

Table 7. Total Estimated Recoverable Storage - Trinity Aquifer

County	*Total Storage (acre-feet)*	*25 percent of Total Storage (acre-feet)*	*75 percent of Total Storage (acre-feet)*
Gillespie	270,000	67,500	202,500
Real	23,000	5,750	17,250
Uvalde	230,000	57,500	172,500
Total	523,000	130,750	392,250

5.6 Socioeconomic Impacts

The Texas Water Development Board prepared reports on the socioeconomic impacts of not meeting water needs for each of the Regional Planning Groups during development of the 2011 Regional Water Plans. Because the development of this desired future condition used the State Water Plan demands and water management strategies as an important foundation, it is reasonable to conclude that the socioeconomic impacts associated with this proposed desired future condition can be evaluated in the context of not meeting the listed water management strategies. Groundwater Management Area 7 is covered by Regional Planning Group F. The socioeconomic impact report for Regions F is included in Appendix D.

5.7 Impact on Private Property Rights

The impact on the interests and rights in private property, including ownership and the rights of landowners and their lessees and assigns in Groundwater Management Area 7 in groundwater is recognized under Texas Water Code Section 36.002.

The desired future conditions adopted by GMA 7 are consistent with protecting property rights of landowners who are currently pumping groundwater and landowners who have chosen to conserve groundwater by not pumping. All current and projected uses (as defined in the 2015 Region F plan) can be met based on the simulations. In addition, the pumping associated with achieving the desired future condition (the modeled available groundwater) will cause impacts to exiting well owners and to surface water. However, as required by Chapter 36 of the Water Code, GMA 7 considered these impacts and balanced them with the increasing demand of water in the GMA 7 area, and concluded that, on balance and with appropriate monitoring and project specific review during the permitting process, the desired future condition is consistent with protection of private property rights.

5.8 Feasibility of Achieving the Desired Future Condition

Groundwater levels are routinely monitored by the districts and by the TWDB in GMA 7. Evaluating the monitoring data is a routine task for the districts, and the comparison of these data with the model results that were used to develop the DFCs is covered in each district's management plan. These comparisons will be useful to guide the update of the DFCs that are required every five years.

5.9 Other Information

GMA 7 did not consider any other information in developing these DFCs.

6.0 Discussion of Other Desired Future Conditions Considered

As discussed earlier in this explanatory report, desired future conditions were adopted after considering the nine statutory factors and after reviewing and discussing numerous model simulations. The simulations provided a foundation for the discussions and decisions. The Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifer simulation model was used in 12 simulations. The Kinney County simulation model was used in 7 simulations. The Val Verde County simulation model was used in 18 simulations.

7.0 Discussion of Other Recommendations

Public comments were invited and each district held a public hearing on the proposed desired future conditions for aquifers within their boundaries as follows:

District	Date of Public Meeting	Comments Received During Public Comment Period
Coke County UWCD	8/9/2016	none
Crockett County GCD	8/8/2016	none
Glasscock County GCD	7/22/2016	none
Hill Country GCD	7/22/2016	none
Irion County WCD	7/11/2016	none
Kimble County GCD	7/18/2016	none
Kinney County GCD	7/14/2016	none
Menard County UWD	7/12/2016	none
Middle Pecos GCD	7/19/2016	One letter, oral comments
Plateau UWC & SD	7/27/2016	none
Real-Edwards C & RD	7/13/2016	none
Santa Rita UWCD	7/19/2016	none
Sterling County UWCD	7/11/2016	none
Sutton County UWCD	7/12/2016	none
Terrell County GCD	7/27/2016	none
Uvalde County WCD	6/14/2016	none

The letter received by Middle Pecos GCD during the public comment period is included as Appendix E. Please note that this version of the letter includes large red numerals in the right-hand margin that correspond to a specific comment. Appendix F contains the responses to those comments that follows the numbering system of shown in Appendix E.

In addition to the letter (Appendix E) and the responses to the specific comments in the letter (Appendix F), an additional analysis was completed regarding the potential use of the USGS model for Pecos County (Clark and others, 2014). In response to that comment, a review of the model was completed and documented (Hutchison, 2017) and discussed at the GMA 7 meeting of February 16, 2017. In summary, the USGS model, as currently constructed, is not useful for predictive simulations, and is not an appropriate tool to evaluate and develop desired future conditions. The documentation of the model review is included as Appendix G.

8.0 References

Clark, B.R., Bumgarner, J.R., Houston, N.A., and Foster, A.L., 2014. Simulations of Groundwater Flow in the Edwards-Trinity and Related Aquifers in the Pecos County Region, Texas. USGS Scientific Investigations Report 2013-5228. Prepared in cooperation with the Middle Pecos Groundwater Conservation District, Pecos County, City of fort Stockton, Brewster County, and Pecos County Water Control and Improvement District No. 1, 67p.

George, P.G., Mace, R.E., and Petrossian, R., 2011. Aquifers of Texas. Texas Water Development Board Report 380, July 2011, 182p.

EcoKai Environmental, Inc. and Hutchison, William R., 2014. Hydrogeological Study for Val Verde County and City of Del Rio, Texas. Final Report, November 2014. 168p.

Hutchison, W.R., 2010. Draft GAM Run 09-035 (Version 2). Texas Water Development Board, Groundwater Resources Division, 10p.

Hutchison, W.R., 2017. Simulations with USGS Groundwater Model of Pecos County Region. GMA 7 Technical Memorandum 17-01, Draft 2. February 13, 2017, 17p.

Hutchison, W.R., Jones, I.C., and Anaya, R., 2011. Update of the Groundwater Availability Model of the Edwards-Trinity (Plateau) and Pecos Valley Aquifers of Texas. Texas Water Development Board Report, January 21, 2011, 61p.

Hutchison, W.R., Shi, J., and Jigmond, M., 2011. Groundwater Flow Model of the Kinney County Area. TWDB Report, August 26, 2011. 219p.

Jones, I.C., Bradley, R., Boghici, R., Kohlrenken, W., Shi, J., 2013. GAM Task 13-030: Total Estimated Recoverable Storage for Aquifers in Groundwater Management Area 7. Texas Water Development Board, Groundwater Resources Division, October 2, 2013, 53 p.

Appendix A

Desired Future Conditions Resolution

Groundwater Management Area 7
Resolution 03-22-2018-1a
Desired Future Conditions for the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers in Groundwater Management Area 7

WHEREAS, Groundwater Conservation Districts (GCDs) located within or partially within Groundwater Management Area 7 (GMA 7) are required under Chapter 36.108, Texas Water Code to conduct joint planning and designate the Desired Future Conditions of aquifers within GMA 7 and;

WHEREAS, the Board Presidents or their Designated Representatives of GCDs in GMA 7 have met in various meetings and conducted joint planning in accordance with §36.108, Texas Water Code since September 2010; and

WHEREAS, the GMA 7 committee has received and considered Groundwater Availability Model runs and other technical advice regarding local aquifers, hydrology, geology, recharge characteristics, the nine factors set forth in§36.108(d) of the Texas Water Code, local groundwater demands and usage, population projections, total water supply and quality of water supply available from all aquifers within the respective GCDs, regional water plan water management strategies, ground and surface water interactions, that affect groundwater conditions through the year 2070; and

WHEREAS, the member GCDs in which the Edwards-Trinity (Plateau), Pecos Valley and Trinity aquifers are relevant for joint planning purposes held open meetings within each said district between June 14, 2016 and July 27, 2016 to take public comment on the proposed DFCs for that district; and

WHEREAS, the member GCDs of GMA 7, having given proper and timely notice, held an open meeting on March 23, 2017 at the Texas Research and Agri-Life Center, 7887 U.S. Highway 87 North, San Angelo, Texas to vote to adopt proposed Desired Future Conditions for the Edwards-Trinity (Plateau), Pecos Valley and Trinity aquifers within the boundaries of GMA 7; and

WHEREAS on this day of March 22, 2018, at an open meeting duly noticed and held in accordance with law at the Texas Research and Agri-Life Center, 7887 U.S. Highway 87 North, San Angelo, Texas, the GCDs within GMA 7, the calculations that were presented in GMA 7 Technical Memorandum 18-01, have voted, 19 districts in favor, 0 districts opposed, to correct the DFCs in the following counties and districts through the year 2070 as follows:

> Average drawdown in the following GMA 7 counties not to exceed drawdowns from 2010 to 2070, as set forth in Table 5 of GMA 7 Technical Memo 18-01, Draft 1) attached hereto and fully incorporated herein:

County	Corrected Desired Future Conditions: Average Drawdowns from 2010 to 2070 (ft)
Coke	0
Crockett	10
Ector	4
Edwards	2
Gillespie	5
Glasscock	42
Irion	10
Kimble	1
Menard	1
Midland	12
Pecos	14
Reagan	42
Real	4
Schelicher	8
Sterling	7
Sutton	6
Taylor	0
Terrell	2
Upton	20
Uvalde	2

WHEREAS the corrected desired future conditions do not affect the desired future conditions previously adopted for Kinney or Val Verde counties, the desired future conditions adopted on March 23, 2017 for Kinney and Val Verde counties are reaffirmed as follows:

a) Total net drawdown in Kinney County in 2070, as compared with 2010 aquifer levels, shall be consistent with maintenance of an annual average flow of 23.9 cfs and an annual median flow of 23.9 cfs at Las Moras Springs (Reference: Groundwater Flow Model of the Kinney County Area by W.R. Hutchison, Ph.D., P.E., P.G., Jerry Shi, Ph.D. and Marius Jigmond, TWDB, dated August 26, 2011).
b) Total net drawdown in Val Verde County in 2070, as compared with 2010 aquifer levels, shall be consistent with maintenance of an average annual flow of 73-75 mgd at San Felipe Springs

WHEREAS the corrected desired future conditions do not affect the previous finding of March 23, 2017 that the Edwards-Trinity (Plateau) aquifer is not relevant for purposes of joint planning within the boundaries of the Hickory UWCD No. 1, the Lipan-Kickapoo WCD, Lone Wolf GCD, and Wes-Tex GCD, this finding is reaffirmed in this resolution.

NOW THEREFORE BE IT RESOLVED, that Groundwater Management Area 7 does hereby document, record, and confirm the above-described Desired Future Conditions for the Edwards-Trinity (Plateau), Pecos Valley, and Trinity aquifers which were adopted by vote of the following Designated Representatives of Groundwater Conservation Districts present and voting on March 22, 2018:

Designated Representative – Coke County UWCD

Designated Representative – Crockett County GCD

Designated Representative – Glasscock GCD

Designated Representative – Hickory UWCD #1

Designated Representative – Hill Country UWCD

Designated Representative – Irion County WCD

Designated Representative – Kimble County GCD

Designated Representative – Kinney County GCD

Designated Representative – Lipan-Kickapoo WCD

Designated Representative – Lone Wolf GCD

Designated Representative – Menard County UWD

Designated Representative – Middle Pecos GCD

Designated Representative – Plateau UWC & SD

Designated Representative – Real-Edwards Con & Rec Dist

Designated Representative – Santa Rita UWCD

Designated Representative – Sterling County UWCD

Designated Representative – Sutton County UWCD

Designated Representative – Terrell County GCD

Designated Representative – Uvalde County UWCD

Designated Representative – Wes-Tex GCD

Nays:

Designated Representative –

Designated Representative –

Designated Representative –

Designated Representative –

Designated Representative –

Designated Representative –

Appendix B

Historic Pumping from the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers

Appendix B - Historic Pumping from the Edwards-Trinity (Plateau), Pecos Valley and Trinity Aquifers

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2000	COKE	EDWARDS-TRINITY-PLATEAU AQUIFER	30	0	0	0	50	10	90
2001	COKE	EDWARDS-TRINITY-PLATEAU AQUIFER	30	0	0	0	50	12	92
2002	COKE	EDWARDS-TRINITY-PLATEAU AQUIFER	30	0	0	0	61	10	101
2003	COKE	EDWARDS-TRINITY-PLATEAU AQUIFER	30	0	0	0	26	6	62
2004	COKE	EDWARDS-TRINITY-PLATEAU AQUIFER	29	0	0	0	47	7	83
2005	COKE	EDWARDS-TRINITY-PLATEAU AQUIFER	32	0	0	0	47	61	140
2006	COKE	EDWARDS-TRINITY-PLATEAU AQUIFER	26	0	0	0	59	68	153
2007	COKE	EDWARDS-TRINITY-PLATEAU AQUIFER	21	0	0	0	38	62	121
2008	COKE	EDWARDS-TRINITY-PLATEAU AQUIFER	24	0	0	0	43	92	159
2009	COKE	EDWARDS-TRINITY-PLATEAU AQUIFER	25	0	0	0	25	88	138
2010	COKE	EDWARDS-TRINITY-PLATEAU AQUIFER	26	0	0	0	54	80	160
2011	COKE	EDWARDS-TRINITY-PLATEAU AQUIFER	51	0	0	0	56	82	189
2012	COKE	EDWARDS-TRINITY-PLATEAU AQUIFER	58	0	0	0	33	73	164
2000	CONCHO	EDWARDS-TRINITY-PLATEAU AQUIFER	1	0	0	0	0	144	145
2001	CONCHO	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	141	141
2002	CONCHO	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	144	144
2003	CONCHO	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	116	116
2004	CONCHO	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	303	303
2005	CONCHO	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	195	195
2006	CONCHO	EDWARDS-TRINITY-PLATEAU AQUIFER	17	0	0	0	0	241	258
2007	CONCHO	EDWARDS-TRINITY-PLATEAU AQUIFER	14	0	0	0	0	292	306
2008	CONCHO	EDWARDS-TRINITY-PLATEAU AQUIFER	15	0	0	0	0	204	219
2009	CONCHO	EDWARDS-TRINITY-PLATEAU AQUIFER	16	0	0	0	0	204	220
2010	CONCHO	EDWARDS-TRINITY-PLATEAU AQUIFER	16	0	0	0	0	187	203
2011	CONCHO	EDWARDS-TRINITY-PLATEAU AQUIFER	17	0	0	0	0	184	201
2012	CONCHO	EDWARDS-TRINITY-PLATEAU AQUIFER	13	0	0	0	0	163	176
2000	CROCKETT	EDWARDS-TRINITY-PLATEAU AQUIFER	1,561	0	31	0	123	608	2,323
2001	CROCKETT	EDWARDS-TRINITY-PLATEAU AQUIFER	1,240	0	22	0	165	572	1,999
2002	CROCKETT	EDWARDS-TRINITY-PLATEAU AQUIFER	1,317	0	42	0	150	515	2,024

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2003	CROCKETT	EDWARDS-TRINITY-PLATEAU AQUIFER	1,215	0	50	0	289	435	1,989
2004	CROCKETT	EDWARDS-TRINITY-PLATEAU AQUIFER	1,209	0	50	0	242	487	1,988
2005	CROCKETT	EDWARDS-TRINITY-PLATEAU AQUIFER	1,312	0	49	0	328	607	2,296
2006	CROCKETT	EDWARDS-TRINITY-PLATEAU AQUIFER	1,366	0	40	0	373	641	2,420
2007	CROCKETT	EDWARDS-TRINITY-PLATEAU AQUIFER	1,309	0	25	0	293	631	2,258
2008	CROCKETT	EDWARDS-TRINITY-PLATEAU AQUIFER	1,331	0	30	0	279	612	2,252
2009	CROCKETT	EDWARDS-TRINITY-PLATEAU AQUIFER	1,409	0	20	0	0	605	2,034
2010	CROCKETT	EDWARDS-TRINITY-PLATEAU AQUIFER	1,426	0	20	0	115	557	2,118
2011	CROCKETT	EDWARDS-TRINITY-PLATEAU AQUIFER	1,760	0	60	0	221	549	2,590
2012	CROCKETT	EDWARDS-TRINITY-PLATEAU AQUIFER	1,509	0	120	0	162	493	2,284
2000	ECTOR	EDWARDS-TRINITY-PLATEAU AQUIFER	1,809	2,479	99	0	304	151	4,842
2001	ECTOR	EDWARDS-TRINITY-PLATEAU AQUIFER	2,008	1,826	98	0	418	92	4,442
2002	ECTOR	EDWARDS-TRINITY-PLATEAU AQUIFER	2,079	2,278	98	0	392	78	4,925
2003	ECTOR	EDWARDS-TRINITY-PLATEAU AQUIFER	1,684	2,228	99	0	116	55	4,182
2004	ECTOR	EDWARDS-TRINITY-PLATEAU AQUIFER	1,662	3,510	98	0	717	62	6,049
2005	ECTOR	EDWARDS-TRINITY-PLATEAU AQUIFER	1,787	767	98	0	918	224	3,794
2006	ECTOR	EDWARDS-TRINITY-PLATEAU AQUIFER	2,781	1,965	98	0	17	210	5,071
2007	ECTOR	EDWARDS-TRINITY-PLATEAU AQUIFER	1,738	906	13	0	170	224	3,051
2008	ECTOR	EDWARDS-TRINITY-PLATEAU AQUIFER	1,959	938	13	0	0	202	3,112
2009	ECTOR	EDWARDS-TRINITY-PLATEAU AQUIFER	2,948	586	13	0	0	224	3,771
2010	ECTOR	EDWARDS-TRINITY-PLATEAU AQUIFER	4,420	584	12	0	748	211	5,975
2011	ECTOR	EDWARDS-TRINITY-PLATEAU AQUIFER	4,862	590	12	0	351	213	6,028
2012	ECTOR	EDWARDS-TRINITY-PLATEAU AQUIFER	4,455	587	12	0	100	185	5,339
2000	EDWARDS	EDWARDS-TRINITY-PLATEAU AQUIFER	371	0	0	0	160	448	979
2001	EDWARDS	EDWARDS-TRINITY-PLATEAU AQUIFER	383	0	0	0	130	143	656
2002	EDWARDS	EDWARDS-TRINITY-PLATEAU AQUIFER	343	0	0	0	202	126	671
2003	EDWARDS	EDWARDS-TRINITY-PLATEAU AQUIFER	294	0	0	0	137	122	553
2004	EDWARDS	EDWARDS-TRINITY-PLATEAU AQUIFER	312	0	0	0	315	121	748
2005	EDWARDS	EDWARDS-TRINITY-PLATEAU AQUIFER	355	0	0	0	347	416	1,118

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2006	EDWARDS	EDWARDS-TRINITY-PLATEAU AQUIFER	345	0	0	0	359	352	1,056
2007	EDWARDS	EDWARDS-TRINITY-PLATEAU AQUIFER	286	0	0	0	104	280	670
2008	EDWARDS	EDWARDS-TRINITY-PLATEAU AQUIFER	349	0	0	0	57	465	871
2009	EDWARDS	EDWARDS-TRINITY-PLATEAU AQUIFER	327	0	0	0	0	463	790
2010	EDWARDS	EDWARDS-TRINITY-PLATEAU AQUIFER	261	0	0	0	33	432	726
2011	EDWARDS	EDWARDS-TRINITY-PLATEAU AQUIFER	387	0	0	0	257	425	1,069
2012	EDWARDS	EDWARDS-TRINITY-PLATEAU AQUIFER	329	0	0	0	97	372	798
2000	GILLESPIE	EDWARDS-TRINITY-PLATEAU AQUIFER	5	0	0	0	102	275	382
2001	GILLESPIE	EDWARDS-TRINITY-PLATEAU AQUIFER	2	0	0	0	116	261	379
2002	GILLESPIE	EDWARDS-TRINITY-PLATEAU AQUIFER	3	0	0	0	116	258	377
2003	GILLESPIE	EDWARDS-TRINITY-PLATEAU AQUIFER	3	0	0	0	116	242	361
2004	GILLESPIE	EDWARDS-TRINITY-PLATEAU AQUIFER	7	0	0	0	123	245	375
2005	GILLESPIE	EDWARDS-TRINITY-PLATEAU AQUIFER	14	0	0	0	100	374	488
2006	GILLESPIE	EDWARDS-TRINITY-PLATEAU AQUIFER	319	0	0	0	109	372	800
2007	GILLESPIE	EDWARDS-TRINITY-PLATEAU AQUIFER	257	0	0	0	9	388	654
2008	GILLESPIE	EDWARDS-TRINITY-PLATEAU AQUIFER	294	0	0	0	102	426	822
2009	GILLESPIE	EDWARDS-TRINITY-PLATEAU AQUIFER	289	0	0	0	99	398	786
2010	GILLESPIE	EDWARDS-TRINITY-PLATEAU AQUIFER	281	0	0	0	66	691	1,038
2011	GILLESPIE	EDWARDS-TRINITY-PLATEAU AQUIFER	311	0	0	0	163	711	1,185
2012	GILLESPIE	EDWARDS-TRINITY-PLATEAU AQUIFER	297	0	0	0	100	335	732
2000	GLASSCOCK	EDWARDS-TRINITY-PLATEAU AQUIFER	156	0	0	0	30,528	135	30,819
2001	GLASSCOCK	EDWARDS-TRINITY-PLATEAU AQUIFER	157	0	0	0	22,176	133	22,466
2002	GLASSCOCK	EDWARDS-TRINITY-PLATEAU AQUIFER	148	0	0	0	22,729	122	22,999
2003	GLASSCOCK	EDWARDS-TRINITY-PLATEAU AQUIFER	146	0	0	0	38,824	95	39,065
2004	GLASSCOCK	EDWARDS-TRINITY-PLATEAU AQUIFER	124	0	0	0	38,147	86	38,357
2005	GLASSCOCK	EDWARDS-TRINITY-PLATEAU AQUIFER	145	0	0	0	38,083	109	38,337
2006	GLASSCOCK	EDWARDS-TRINITY-PLATEAU AQUIFER	134	0	0	0	40,105	119	40,358
2007	GLASSCOCK	EDWARDS-TRINITY-PLATEAU AQUIFER	108	1	0	0	32,560	163	32,832
2008	GLASSCOCK	EDWARDS-TRINITY-PLATEAU AQUIFER	122	0	0	0	36,919	84	37,125

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2009	GLASSCOCK	EDWARDS-TRINITY-PLATEAU AQUIFER	124	3	0	0	39,479	89	39,695
2010	GLASSCOCK	EDWARDS-TRINITY-PLATEAU AQUIFER	126	3	0	0	49,218	107	49,454
2011	GLASSCOCK	EDWARDS-TRINITY-PLATEAU AQUIFER	143	3	0	0	45,848	118	46,112
2012	GLASSCOCK	EDWARDS-TRINITY-PLATEAU AQUIFER	167	3	0	0	38,915	84	39,169
2000	IRION	EDWARDS-TRINITY-PLATEAU AQUIFER	179	0	0	0	808	248	1,235
2001	IRION	EDWARDS-TRINITY-PLATEAU AQUIFER	170	0	0	0	640	226	1,036
2002	IRION	EDWARDS-TRINITY-PLATEAU AQUIFER	206	0	0	0	640	218	1,064
2003	IRION	EDWARDS-TRINITY-PLATEAU AQUIFER	188	0	0	0	288	150	626
2004	IRION	EDWARDS-TRINITY-PLATEAU AQUIFER	185	0	0	0	104	148	437
2005	IRION	EDWARDS-TRINITY-PLATEAU AQUIFER	190	0	0	0	180	158	528
2006	IRION	EDWARDS-TRINITY-PLATEAU AQUIFER	185	0	0	0	573	169	927
2007	IRION	EDWARDS-TRINITY-PLATEAU AQUIFER	164	0	0	0	341	168	673
2008	IRION	EDWARDS-TRINITY-PLATEAU AQUIFER	168	0	0	0	542	202	912
2009	IRION	EDWARDS-TRINITY-PLATEAU AQUIFER	175	0	0	0	225	197	597
2010	IRION	EDWARDS-TRINITY-PLATEAU AQUIFER	186	0	0	0	43	208	437
2011	IRION	EDWARDS-TRINITY-PLATEAU AQUIFER	193	0	0	0	258	218	669
2012	IRION	EDWARDS-TRINITY-PLATEAU AQUIFER	212	0	0	0	47	158	417
2000	KIMBLE	EDWARDS-TRINITY-PLATEAU AQUIFER	209	2	0	0	10	359	580
2001	KIMBLE	EDWARDS-TRINITY-PLATEAU AQUIFER	211	2	0	0	11	347	571
2002	KIMBLE	EDWARDS-TRINITY-PLATEAU AQUIFER	212	2	0	0	11	314	539
2003	KIMBLE	EDWARDS-TRINITY-PLATEAU AQUIFER	210	2	0	0	11	278	501
2004	KIMBLE	EDWARDS-TRINITY-PLATEAU AQUIFER	203	2	0	0	19	288	512
2005	KIMBLE	EDWARDS-TRINITY-PLATEAU AQUIFER	221	2	0	0	35	259	517
2006	KIMBLE	EDWARDS-TRINITY-PLATEAU AQUIFER	205	2	0	0	5	249	461
2007	KIMBLE	EDWARDS-TRINITY-PLATEAU AQUIFER	171	2	0	0	98	268	539
2008	KIMBLE	EDWARDS-TRINITY-PLATEAU AQUIFER	188	2	0	0	40	223	453
2009	KIMBLE	EDWARDS-TRINITY-PLATEAU AQUIFER	195	2	0	0	165	222	584
2010	KIMBLE	EDWARDS-TRINITY-PLATEAU AQUIFER	203	2	0	0	115	302	622
2011	KIMBLE	EDWARDS-TRINITY-PLATEAU AQUIFER	229	2	0	0	66	306	603

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2012	KIMBLE	EDWARDS-TRINITY-PLATEAU AQUIFER	221	2	0	0	84	172	479
2000	KINNEY	EDWARDS-TRINITY-PLATEAU AQUIFER	7	0	0	0	10,454	236	10,697
2001	KINNEY	EDWARDS-TRINITY-PLATEAU AQUIFER	7	0	0	0	4,435	115	4,557
2002	KINNEY	EDWARDS-TRINITY-PLATEAU AQUIFER	7	0	0	0	4,357	106	4,470
2003	KINNEY	EDWARDS-TRINITY-PLATEAU AQUIFER	7	0	0	0	7,337	78	7,422
2004	KINNEY	EDWARDS-TRINITY-PLATEAU AQUIFER	7	0	0	0	3,355	36	3,398
2005	KINNEY	EDWARDS-TRINITY-PLATEAU AQUIFER	7	0	0	0	2,959	74	3,040
2006	KINNEY	EDWARDS-TRINITY-PLATEAU AQUIFER	14	0	0	0	3,551	67	3,632
2007	KINNEY	EDWARDS-TRINITY-PLATEAU AQUIFER	12	0	0	0	1,220	61	1,293
2008	KINNEY	EDWARDS-TRINITY-PLATEAU AQUIFER	13	0	0	0	1,519	87	1,619
2009	KINNEY	EDWARDS-TRINITY-PLATEAU AQUIFER	30	0	0	0	665	100	795
2010	KINNEY	EDWARDS-TRINITY-PLATEAU AQUIFER	536	0	0	0	640	50	1,226
2011	KINNEY	EDWARDS-TRINITY-PLATEAU AQUIFER	670	0	0	0	3,425	51	4,146
2012	KINNEY	EDWARDS-TRINITY-PLATEAU AQUIFER	621	0	0	0	1,663	46	2,330
2000	MASON	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	6	6
2001	MASON	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	7	7
2002	MASON	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	6	6
2003	MASON	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	9	9
2004	MASON	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	10	10
2005	MASON	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	14	14
2006	MASON	EDWARDS-TRINITY-PLATEAU AQUIFER	1	0	0	0	0	17	18
2007	MASON	EDWARDS-TRINITY-PLATEAU AQUIFER	1	0	0	0	0	14	15
2008	MASON	EDWARDS-TRINITY-PLATEAU AQUIFER	1	0	0	0	0	14	15
2009	MASON	EDWARDS-TRINITY-PLATEAU AQUIFER	1	0	0	0	0	12	13
2010	MASON	EDWARDS-TRINITY-PLATEAU AQUIFER	2	0	0	0	0	8	10
2011	MASON	EDWARDS-TRINITY-PLATEAU AQUIFER	2	0	0	0	0	12	14
2012	MASON	EDWARDS-TRINITY-PLATEAU AQUIFER	2	0	0	0	0	11	13
2000	MCCULLOCH	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	17	17
2001	MCCULLOCH	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	12	12

Appendix B - Historic Pumping from the Edwards-Trinity (Plateau), Pecos Valley and Trinity Aquifers

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2002	MCCULLOCH	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	15	15
2003	MCCULLOCH	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	11	11
2004	MCCULLOCH	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	3	3
2005	MCCULLOCH	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	4	4
2006	MCCULLOCH	EDWARDS-TRINITY-PLATEAU AQUIFER	1	0	0	0	0	3	4
2007	MCCULLOCH	EDWARDS-TRINITY-PLATEAU AQUIFER	1	0	0	0	0	3	4
2008	MCCULLOCH	EDWARDS-TRINITY-PLATEAU AQUIFER	1	0	0	0	0	3	4
2009	MCCULLOCH	EDWARDS-TRINITY-PLATEAU AQUIFER	3	0	0	0	0	4	7
2010	MCCULLOCH	EDWARDS-TRINITY-PLATEAU AQUIFER	5	0	0	0	0	6	11
2011	MCCULLOCH	EDWARDS-TRINITY-PLATEAU AQUIFER	6	0	0	0	0	3	9
2012	MCCULLOCH	EDWARDS-TRINITY-PLATEAU AQUIFER	5	0	72	0	0	3	80
2000	MENARD	EDWARDS-TRINITY-PLATEAU AQUIFER	358	0	0	0	111	307	776
2001	MENARD	EDWARDS-TRINITY-PLATEAU AQUIFER	338	0	0	0	126	306	770
2002	MENARD	EDWARDS-TRINITY-PLATEAU AQUIFER	329	0	0	0	126	273	728
2003	MENARD	EDWARDS-TRINITY-PLATEAU AQUIFER	315	0	0	0	56	292	663
2004	MENARD	EDWARDS-TRINITY-PLATEAU AQUIFER	256	0	0	0	42	297	595
2005	MENARD	EDWARDS-TRINITY-PLATEAU AQUIFER	261	0	0	0	65	304	630
2006	MENARD	EDWARDS-TRINITY-PLATEAU AQUIFER	289	0	0	0	468	318	1,075
2007	MENARD	EDWARDS-TRINITY-PLATEAU AQUIFER	255	0	0	0	318	326	899
2008	MENARD	EDWARDS-TRINITY-PLATEAU AQUIFER	306	0	0	0	0	276	582
2009	MENARD	EDWARDS-TRINITY-PLATEAU AQUIFER	339	0	0	0	244	314	897
2010	MENARD	EDWARDS-TRINITY-PLATEAU AQUIFER	73	0	0	0	256	256	585
2011	MENARD	EDWARDS-TRINITY-PLATEAU AQUIFER	81	0	0	0	100	245	426
2012	MENARD	EDWARDS-TRINITY-PLATEAU AQUIFER	79	0	0	0	301	211	591
2000	MIDLAND	EDWARDS-TRINITY-PLATEAU AQUIFER	1,308	0	1	0	9,262	226	10,797
2001	MIDLAND	EDWARDS-TRINITY-PLATEAU AQUIFER	1,717	0	1	0	8,382	223	10,323
2002	MIDLAND	EDWARDS-TRINITY-PLATEAU AQUIFER	1,861	0	1	0	7,921	191	9,974
2003	MIDLAND	EDWARDS-TRINITY-PLATEAU AQUIFER	1,257	0	1	0	5,828	102	7,188
2004	MIDLAND	EDWARDS-TRINITY-PLATEAU AQUIFER	1,261	0	1	0	8,389	94	9,745

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2005	MIDLAND	EDWARDS-TRINITY-PLATEAU AQUIFER	1,324	0	1	0	8,982	181	10,488
2006	MIDLAND	EDWARDS-TRINITY-PLATEAU AQUIFER	1,643	0	1	0	9,851	216	11,711
2007	MIDLAND	EDWARDS-TRINITY-PLATEAU AQUIFER	1,376	0	1	0	7,403	243	9,023
2008	MIDLAND	EDWARDS-TRINITY-PLATEAU AQUIFER	1,636	0	0	0	9,584	157	11,377
2009	MIDLAND	EDWARDS-TRINITY-PLATEAU AQUIFER	2,191	0	0	0	9,997	211	12,399
2010	MIDLAND	EDWARDS-TRINITY-PLATEAU AQUIFER	2,112	0	0	0	7,128	158	9,398
2011	MIDLAND	EDWARDS-TRINITY-PLATEAU AQUIFER	3,229	0	0	0	10,087	165	13,481
2012	MIDLAND	EDWARDS-TRINITY-PLATEAU AQUIFER	3,114	0	0	0	9,715	140	12,969
2000	NOLAN	EDWARDS-TRINITY-PLATEAU AQUIFER	669	70	0	0	39	22	800
2001	NOLAN	EDWARDS-TRINITY-PLATEAU AQUIFER	2,559	76	0	0	23	10	2,668
2002	NOLAN	EDWARDS-TRINITY-PLATEAU AQUIFER	2,908	79	0	0	23	10	3,020
2003	NOLAN	EDWARDS-TRINITY-PLATEAU AQUIFER	3,390	79	0	0	25	7	3,501
2004	NOLAN	EDWARDS-TRINITY-PLATEAU AQUIFER	2,454	79	0	0	33	11	2,577
2005	NOLAN	EDWARDS-TRINITY-PLATEAU AQUIFER	2,210	105	0	0	43	143	2,501
2006	NOLAN	EDWARDS-TRINITY-PLATEAU AQUIFER	3,108	105	0	0	42	165	3,420
2007	NOLAN	EDWARDS-TRINITY-PLATEAU AQUIFER	2,905	136	0	0	47	156	3,244
2008	NOLAN	EDWARDS-TRINITY-PLATEAU AQUIFER	2,945	132	0	0	81	150	3,308
2009	NOLAN	EDWARDS-TRINITY-PLATEAU AQUIFER	2,283	86	0	0	90	143	2,602
2010	NOLAN	EDWARDS-TRINITY-PLATEAU AQUIFER	1,927	11	0	0	65	131	2,134
2011	NOLAN	EDWARDS-TRINITY-PLATEAU AQUIFER	2,307	15	0	0	98	133	2,553
2012	NOLAN	EDWARDS-TRINITY-PLATEAU AQUIFER	2,046	19	0	0	100	117	2,282
2000	PECOS	EDWARDS-TRINITY-PLATEAU AQUIFER	5,373	263	6	938	43,237	718	50,535
2001	PECOS	EDWARDS-TRINITY-PLATEAU AQUIFER	4,235	143	5	908	38,367	757	44,415
2002	PECOS	EDWARDS-TRINITY-PLATEAU AQUIFER	4,100	54	2	908	36,575	669	42,308
2003	PECOS	EDWARDS-TRINITY-PLATEAU AQUIFER	4,171	52	0	647	22,477	573	27,920
2004	PECOS	EDWARDS-TRINITY-PLATEAU AQUIFER	3,667	88	0	0	25,364	630	29,749
2005	PECOS	EDWARDS-TRINITY-PLATEAU AQUIFER	4,656	92	0	0	24,722	669	30,139
2006	PECOS	EDWARDS-TRINITY-PLATEAU AQUIFER	4,415	79	0	0	36,964	749	42,207
2007	PECOS	EDWARDS-TRINITY-PLATEAU AQUIFER	4,831	129	0	0	32,579	581	38,120

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2008	PECOS	EDWARDS-TRINITY-PLATEAU AQUIFER	5,533	75	0	0	33,983	654	40,245
2009	PECOS	EDWARDS-TRINITY-PLATEAU AQUIFER	5,203	73	0	0	54,244	603	60,123
2010	PECOS	EDWARDS-TRINITY-PLATEAU AQUIFER	5,369	149	0	0	73,249	594	79,361
2011	PECOS	EDWARDS-TRINITY-PLATEAU AQUIFER	6,925	152	0	0	74,691	586	82,354
2012	PECOS	EDWARDS-TRINITY-PLATEAU AQUIFER	4,601	159	0	0	65,828	523	71,111
2000	REAGAN	EDWARDS-TRINITY-PLATEAU AQUIFER	148	0	0	0	15,735	167	16,050
2001	REAGAN	EDWARDS-TRINITY-PLATEAU AQUIFER	848	0	0	0	11,624	132	12,604
2002	REAGAN	EDWARDS-TRINITY-PLATEAU AQUIFER	849	0	0	0	14,746	132	15,727
2003	REAGAN	EDWARDS-TRINITY-PLATEAU AQUIFER	848	0	0	0	9,911	73	10,832
2004	REAGAN	EDWARDS-TRINITY-PLATEAU AQUIFER	845	0	0	0	10,300	79	11,224
2005	REAGAN	EDWARDS-TRINITY-PLATEAU AQUIFER	750	0	0	0	12,164	150	13,064
2006	REAGAN	EDWARDS-TRINITY-PLATEAU AQUIFER	879	0	0	0	18,599	120	19,598
2007	REAGAN	EDWARDS-TRINITY-PLATEAU AQUIFER	796	0	0	0	16,863	127	17,786
2008	REAGAN	EDWARDS-TRINITY-PLATEAU AQUIFER	751	0	0	0	19,305	223	20,279
2009	REAGAN	EDWARDS-TRINITY-PLATEAU AQUIFER	762	0	0	0	16,577	224	17,563
2010	REAGAN	EDWARDS-TRINITY-PLATEAU AQUIFER	603	0	0	0	19,238	189	20,030
2011	REAGAN	EDWARDS-TRINITY-PLATEAU AQUIFER	767	0	0	0	26,164	188	27,119
2012	REAGAN	EDWARDS-TRINITY-PLATEAU AQUIFER	717	0	0	0	19,681	167	20,565
2000	REAL	EDWARDS-TRINITY-PLATEAU AQUIFER	103	0	0	0	21	131	255
2001	REAL	EDWARDS-TRINITY-PLATEAU AQUIFER	89	0	0	0	22	85	196
2002	REAL	EDWARDS-TRINITY-PLATEAU AQUIFER	95	0	0	0	22	86	203
2003	REAL	EDWARDS-TRINITY-PLATEAU AQUIFER	105	0	0	0	17	76	198
2004	REAL	EDWARDS-TRINITY-PLATEAU AQUIFER	224	0	0	0	72	74	370
2005	REAL	EDWARDS-TRINITY-PLATEAU AQUIFER	251	0	0	0	92	118	461
2006	REAL	EDWARDS-TRINITY-PLATEAU AQUIFER	263	0	0	0	284	93	640
2007	REAL	EDWARDS-TRINITY-PLATEAU AQUIFER	214	0	0	0	0	105	319
2008	REAL	EDWARDS-TRINITY-PLATEAU AQUIFER	254	0	0	0	50	93	397
2009	REAL	EDWARDS-TRINITY-PLATEAU AQUIFER	269	0	0	0	0	98	367
2010	REAL	EDWARDS-TRINITY-PLATEAU AQUIFER	471	0	0	0	88	187	746

Appendix B - Historic Pumping from the Edwards-Trinity (Plateau), Pecos Valley and Trinity Aquifers

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2011	REAL	EDWARDS-TRINITY-PLATEAU AQUIFER	511	0	0	0	188	194	893
2012	REAL	EDWARDS-TRINITY-PLATEAU AQUIFER	442	0	0	0	99	79	620
2000	RUNNELS	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	4	4
2001	RUNNELS	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	4	4
2002	RUNNELS	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	4	4
2003	RUNNELS	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	3	3
2004	RUNNELS	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	3	3
2005	RUNNELS	EDWARDS-TRINITY-PLATEAU AQUIFER	0	0	0	0	0	15	15
2006	RUNNELS	EDWARDS-TRINITY-PLATEAU AQUIFER	3	0	0	0	0	16	19
2007	RUNNELS	EDWARDS-TRINITY-PLATEAU AQUIFER	2	0	0	0	0	15	17
2008	RUNNELS	EDWARDS-TRINITY-PLATEAU AQUIFER	3	0	0	0	0	17	20
2009	RUNNELS	EDWARDS-TRINITY-PLATEAU AQUIFER	3	0	0	0	0	16	19
2010	RUNNELS	EDWARDS-TRINITY-PLATEAU AQUIFER	4	0	0	0	0	17	21
2011	RUNNELS	EDWARDS-TRINITY-PLATEAU AQUIFER	4	0	0	0	0	18	22
2012	RUNNELS	EDWARDS-TRINITY-PLATEAU AQUIFER	4	0	0	0	0	11	15
2000	SCHLEICHER	EDWARDS-TRINITY-PLATEAU AQUIFER	657	0	18	0	2,150	438	3,263
2001	SCHLEICHER	EDWARDS-TRINITY-PLATEAU AQUIFER	552	0	18	0	1,294	273	2,137
2002	SCHLEICHER	EDWARDS-TRINITY-PLATEAU AQUIFER	591	0	17	0	1,300	243	2,151
2003	SCHLEICHER	EDWARDS-TRINITY-PLATEAU AQUIFER	461	0	18	0	964	222	1,665
2004	SCHLEICHER	EDWARDS-TRINITY-PLATEAU AQUIFER	485	0	18	0	734	247	1,484
2005	SCHLEICHER	EDWARDS-TRINITY-PLATEAU AQUIFER	473	0	18	0	762	477	1,730
2006	SCHLEICHER	EDWARDS-TRINITY-PLATEAU AQUIFER	480	0	18	0	1,005	506	2,009
2007	SCHLEICHER	EDWARDS-TRINITY-PLATEAU AQUIFER	484	0	17	0	500	508	1,509
2008	SCHLEICHER	EDWARDS-TRINITY-PLATEAU AQUIFER	610	0	0	0	1,095	467	2,172
2009	SCHLEICHER	EDWARDS-TRINITY-PLATEAU AQUIFER	613	0	0	0	1,432	463	2,508
2010	SCHLEICHER	EDWARDS-TRINITY-PLATEAU AQUIFER	616	0	0	0	1,442	422	2,480
2011	SCHLEICHER	EDWARDS-TRINITY-PLATEAU AQUIFER	806	0	0	0	1,941	414	3,161
2012	SCHLEICHER	EDWARDS-TRINITY-PLATEAU AQUIFER	652	0	0	0	2,020	364	3,036
2000	STERLING	EDWARDS-TRINITY-PLATEAU AQUIFER	4	0	0	0	235	214	453

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2001	STERLING	EDWARDS-TRINITY-PLATEAU AQUIFER	5	0	0	0	251	270	526
2002	STERLING	EDWARDS-TRINITY-PLATEAU AQUIFER	5	0	0	0	264	236	505
2003	STERLING	EDWARDS-TRINITY-PLATEAU AQUIFER	5	0	0	0	226	145	376
2004	STERLING	EDWARDS-TRINITY-PLATEAU AQUIFER	5	0	0	0	183	164	352
2005	STERLING	EDWARDS-TRINITY-PLATEAU AQUIFER	5	0	0	0	166	208	379
2006	STERLING	EDWARDS-TRINITY-PLATEAU AQUIFER	20	0	0	0	221	217	458
2007	STERLING	EDWARDS-TRINITY-PLATEAU AQUIFER	16	0	0	0	176	236	428
2008	STERLING	EDWARDS-TRINITY-PLATEAU AQUIFER	19	0	0	0	272	196	487
2009	STERLING	EDWARDS-TRINITY-PLATEAU AQUIFER	19	0	0	0	378	208	605
2010	STERLING	EDWARDS-TRINITY-PLATEAU AQUIFER	20	0	0	0	253	183	456
2011	STERLING	EDWARDS-TRINITY-PLATEAU AQUIFER	20	0	0	0	360	176	556
2012	STERLING	EDWARDS-TRINITY-PLATEAU AQUIFER	19	0	0	0	313	157	489
2000	SUTTON	EDWARDS-TRINITY-PLATEAU AQUIFER	1,389	0	0	0	1,234	440	3,063
2001	SUTTON	EDWARDS-TRINITY-PLATEAU AQUIFER	1,338	0	0	0	1,114	208	2,660
2002	SUTTON	EDWARDS-TRINITY-PLATEAU AQUIFER	1,339	0	0	0	1,114	188	2,641
2003	SUTTON	EDWARDS-TRINITY-PLATEAU AQUIFER	1,243	0	0	0	292	150	1,685
2004	SUTTON	EDWARDS-TRINITY-PLATEAU AQUIFER	1,108	0	0	0	292	141	1,541
2005	SUTTON	EDWARDS-TRINITY-PLATEAU AQUIFER	1,142	0	0	0	1,249	396	2,787
2006	SUTTON	EDWARDS-TRINITY-PLATEAU AQUIFER	1,247	0	0	0	1,407	363	3,017
2007	SUTTON	EDWARDS-TRINITY-PLATEAU AQUIFER	1,024	0	0	0	1,542	395	2,961
2008	SUTTON	EDWARDS-TRINITY-PLATEAU AQUIFER	1,141	0	0	0	342	469	1,952
2009	SUTTON	EDWARDS-TRINITY-PLATEAU AQUIFER	891	0	0	0	567	458	1,916
2010	SUTTON	EDWARDS-TRINITY-PLATEAU AQUIFER	928	0	0	0	958	477	2,363
2011	SUTTON	EDWARDS-TRINITY-PLATEAU AQUIFER	1,285	0	0	0	1,256	495	3,036
2012	SUTTON	EDWARDS-TRINITY-PLATEAU AQUIFER	1,267	0	0	0	859	360	2,486
2000	TAYLOR	EDWARDS-TRINITY-PLATEAU AQUIFER	88	0	0	0	3	25	116
2001	TAYLOR	EDWARDS-TRINITY-PLATEAU AQUIFER	88	0	0	0	8	10	106
2002	TAYLOR	EDWARDS-TRINITY-PLATEAU AQUIFER	88	0	0	0	6	7	101
2003	TAYLOR	EDWARDS-TRINITY-PLATEAU AQUIFER	87	0	0	0	1	6	94

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2004	TAYLOR	EDWARDS-TRINITY-PLATEAU AQUIFER	85	0	0	0	1	11	97
2005	TAYLOR	EDWARDS-TRINITY-PLATEAU AQUIFER	91	0	0	0	28	32	151
2006	TAYLOR	EDWARDS-TRINITY-PLATEAU AQUIFER	123	0	0	0	26	42	191
2007	TAYLOR	EDWARDS-TRINITY-PLATEAU AQUIFER	102	0	0	0	14	36	152
2008	TAYLOR	EDWARDS-TRINITY-PLATEAU AQUIFER	113	0	0	0	0	90	203
2009	TAYLOR	EDWARDS-TRINITY-PLATEAU AQUIFER	219	0	0	0	7	82	308
2010	TAYLOR	EDWARDS-TRINITY-PLATEAU AQUIFER	328	0	0	0	21	44	393
2011	TAYLOR	EDWARDS-TRINITY-PLATEAU AQUIFER	279	0	0	0	52	47	378
2012	TAYLOR	EDWARDS-TRINITY-PLATEAU AQUIFER	293	0	0	0	19	37	349
2000	TERRELL	EDWARDS-TRINITY-PLATEAU AQUIFER	217	0	5	0	0	292	514
2001	TERRELL	EDWARDS-TRINITY-PLATEAU AQUIFER	200	0	5	0	0	280	485
2002	TERRELL	EDWARDS-TRINITY-PLATEAU AQUIFER	178	0	5	0	0	234	417
2003	TERRELL	EDWARDS-TRINITY-PLATEAU AQUIFER	175	0	5	0	0	189	369
2004	TERRELL	EDWARDS-TRINITY-PLATEAU AQUIFER	147	0	5	0	0	207	359
2005	TERRELL	EDWARDS-TRINITY-PLATEAU AQUIFER	181	0	4	0	0	233	418
2006	TERRELL	EDWARDS-TRINITY-PLATEAU AQUIFER	196	0	5	0	0	211	412
2007	TERRELL	EDWARDS-TRINITY-PLATEAU AQUIFER	192	0	4	0	255	170	621
2008	TERRELL	EDWARDS-TRINITY-PLATEAU AQUIFER	178	0	4	0	0	193	375
2009	TERRELL	EDWARDS-TRINITY-PLATEAU AQUIFER	196	0	4	0	154	206	560
2010	TERRELL	EDWARDS-TRINITY-PLATEAU AQUIFER	202	0	4	0	173	182	561
2011	TERRELL	EDWARDS-TRINITY-PLATEAU AQUIFER	218	0	9	0	398	179	804
2012	TERRELL	EDWARDS-TRINITY-PLATEAU AQUIFER	186	0	9	0	41	163	399
2000	TOM GREEN	EDWARDS-TRINITY-PLATEAU AQUIFER	123	0	0	0	131	137	391
2001	TOM GREEN	EDWARDS-TRINITY-PLATEAU AQUIFER	75	0	0	0	171	125	371
2002	TOM GREEN	EDWARDS-TRINITY-PLATEAU AQUIFER	94	0	0	0	183	143	420
2003	TOM GREEN	EDWARDS-TRINITY-PLATEAU AQUIFER	95	0	0	0	166	122	383
2004	TOM GREEN	EDWARDS-TRINITY-PLATEAU AQUIFER	92	0	0	0	538	98	728
2005	TOM GREEN	EDWARDS-TRINITY-PLATEAU AQUIFER	97	0	0	0	615	841	1,553
2006	TOM GREEN	EDWARDS-TRINITY-PLATEAU AQUIFER	129	0	0	0	731	921	1,781

Appendix B - Historic Pumping from the Edwards-Trinity (Plateau), Pecos Valley and Trinity Aquifers

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2007	TOM GREEN	EDWARDS-TRINITY-PLATEAU AQUIFER	109	0	0	0	1,520	615	2,244
2008	TOM GREEN	EDWARDS-TRINITY-PLATEAU AQUIFER	199	0	0	0	1,896	844	2,939
2009	TOM GREEN	EDWARDS-TRINITY-PLATEAU AQUIFER	448	0	0	0	1,474	764	2,686
2010	TOM GREEN	EDWARDS-TRINITY-PLATEAU AQUIFER	613	0	0	0	836	786	2,235
2011	TOM GREEN	EDWARDS-TRINITY-PLATEAU AQUIFER	825	0	0	0	174	864	1,863
2012	TOM GREEN	EDWARDS-TRINITY-PLATEAU AQUIFER	672	0	0	0	1,166	747	2,585
2000	UPTON	EDWARDS-TRINITY-PLATEAU AQUIFER	1,006	0	0	0	12,236	131	13,373
2001	UPTON	EDWARDS-TRINITY-PLATEAU AQUIFER	1,051	0	0	0	8,553	60	9,664
2002	UPTON	EDWARDS-TRINITY-PLATEAU AQUIFER	683	0	0	0	7,962	53	8,698
2003	UPTON	EDWARDS-TRINITY-PLATEAU AQUIFER	779	0	0	0	7,792	35	8,606
2004	UPTON	EDWARDS-TRINITY-PLATEAU AQUIFER	369	0	0	0	7,000	40	7,409
2005	UPTON	EDWARDS-TRINITY-PLATEAU AQUIFER	759	0	0	0	6,584	98	7,441
2006	UPTON	EDWARDS-TRINITY-PLATEAU AQUIFER	663	0	0	0	7,195	98	7,956
2007	UPTON	EDWARDS-TRINITY-PLATEAU AQUIFER	297	0	0	0	6,253	94	6,644
2008	UPTON	EDWARDS-TRINITY-PLATEAU AQUIFER	305	0	0	0	8,984	113	9,402
2009	UPTON	EDWARDS-TRINITY-PLATEAU AQUIFER	411	0	0	0	7,873	111	8,395
2010	UPTON	EDWARDS-TRINITY-PLATEAU AQUIFER	430	0	0	0	9,395	90	9,915
2011	UPTON	EDWARDS-TRINITY-PLATEAU AQUIFER	450	0	0	0	13,651	87	14,188
2012	UPTON	EDWARDS-TRINITY-PLATEAU AQUIFER	286	0	0	0	10,033	75	10,394
2000	UVALDE	EDWARDS-TRINITY-PLATEAU AQUIFER	30	0	0	0	0	381	411
2001	UVALDE	EDWARDS-TRINITY-PLATEAU AQUIFER	39	0	0	0	0	351	390
2002	UVALDE	EDWARDS-TRINITY-PLATEAU AQUIFER	41	0	0	0	0	343	384
2003	UVALDE	EDWARDS-TRINITY-PLATEAU AQUIFER	42	0	0	0	0	374	416
2004	UVALDE	EDWARDS-TRINITY-PLATEAU AQUIFER	41	0	0	0	0	40	81
2005	UVALDE	EDWARDS-TRINITY-PLATEAU AQUIFER	44	0	0	0	0	61	105
2006	UVALDE	EDWARDS-TRINITY-PLATEAU AQUIFER	25	0	0	0	0	59	84
2007	UVALDE	EDWARDS-TRINITY-PLATEAU AQUIFER	21	0	0	0	0	60	81
2008	UVALDE	EDWARDS-TRINITY-PLATEAU AQUIFER	23	0	0	0	0	53	76
2009	UVALDE	EDWARDS-TRINITY-PLATEAU AQUIFER	95	0	0	0	0	45	140

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2010	UVALDE	EDWARDS-TRINITY-PLATEAU AQUIFER	466	0	0	0	0	47	513
2011	UVALDE	EDWARDS-TRINITY-PLATEAU AQUIFER	417	0	0	0	0	49	466
2012	UVALDE	EDWARDS-TRINITY-PLATEAU AQUIFER	440	0	0	0	0	42	482
2000	VAL VERDE	EDWARDS-TRINITY-PLATEAU AQUIFER	15,766	0	0	0	245	604	16,615
2001	VAL VERDE	EDWARDS-TRINITY-PLATEAU AQUIFER	15,769	0	0	0	287	607	16,663
2002	VAL VERDE	EDWARDS-TRINITY-PLATEAU AQUIFER	15,783	0	0	0	293	541	16,617
2003	VAL VERDE	EDWARDS-TRINITY-PLATEAU AQUIFER	15,778	0	0	0	209	464	16,451
2004	VAL VERDE	EDWARDS-TRINITY-PLATEAU AQUIFER	15,746	0	0	0	97	419	16,262
2005	VAL VERDE	EDWARDS-TRINITY-PLATEAU AQUIFER	15,828	0	0	0	133	482	16,443
2006	VAL VERDE	EDWARDS-TRINITY-PLATEAU AQUIFER	11,297	0	0	0	136	464	11,897
2007	VAL VERDE	EDWARDS-TRINITY-PLATEAU AQUIFER	834	0	0	0	31	408	1,273
2008	VAL VERDE	EDWARDS-TRINITY-PLATEAU AQUIFER	903	0	0	0	16	497	1,416
2009	VAL VERDE	EDWARDS-TRINITY-PLATEAU AQUIFER	1,755	0	0	0	0	488	2,243
2010	VAL VERDE	EDWARDS-TRINITY-PLATEAU AQUIFER	11,292	0	0	0	251	458	12,001
2011	VAL VERDE	EDWARDS-TRINITY-PLATEAU AQUIFER	13,053	0	0	0	130	459	13,642
2012	VAL VERDE	EDWARDS-TRINITY-PLATEAU AQUIFER	12,677	0	0	0	61	407	13,145
2000	CROCKETT	PECOS AQUIFER	0	0	0	0	0	0	0
2001	CROCKETT	PECOS AQUIFER	0	0	0	0	0	0	0
2002	CROCKETT	PECOS AQUIFER	0	0	0	0	0	0	0
2003	CROCKETT	PECOS AQUIFER	0	0	0	0	0	0	0
2004	CROCKETT	PECOS AQUIFER	0	0	0	0	0	0	0
2005	CROCKETT	PECOS AQUIFER	0	0	0	0	0	0	0
2006	CROCKETT	PECOS AQUIFER	0	0	0	0	0	0	0
2007	CROCKETT	PECOS AQUIFER	0	0	0	0	0	0	0
2008	CROCKETT	PECOS AQUIFER	0	0	0	0	0	0	0
2009	CROCKETT	PECOS AQUIFER	0	0	0	0	0	0	0
2010	CROCKETT	PECOS AQUIFER	0	0	0	0	0	0	0
2011	CROCKETT	PECOS AQUIFER	0	0	0	0	0	0	0
2012	CROCKETT	PECOS AQUIFER	0	0	0	0	0	0	0
2000	ECTOR	PECOS AQUIFER	158	0	24	0	0	19	201

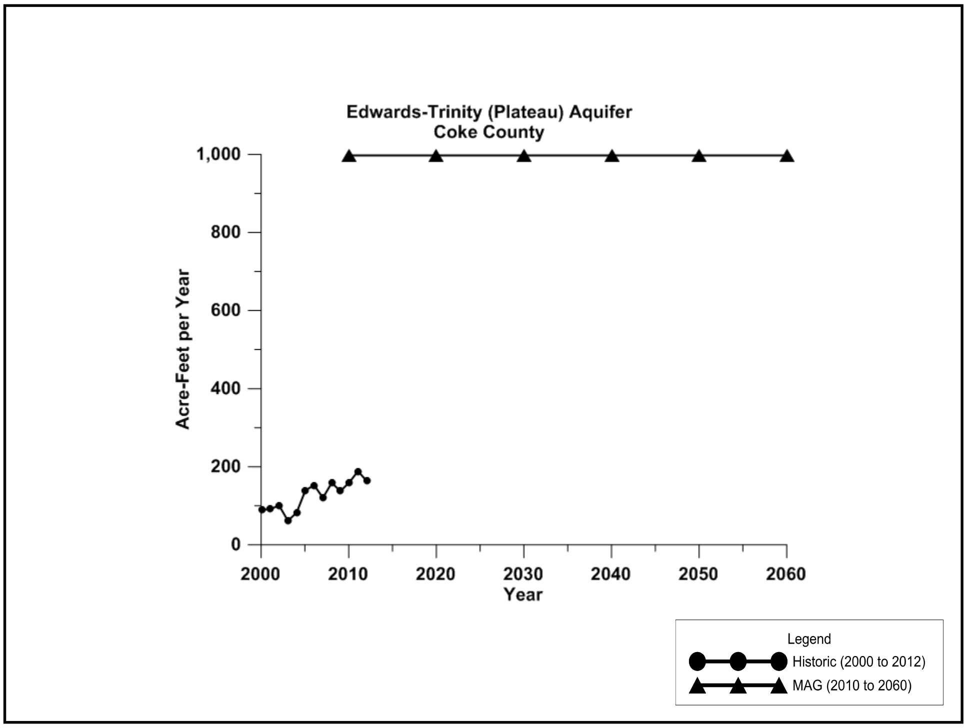
Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2001	ECTOR	PECOS AQUIFER	209	0	24	0	0	6	239
2002	ECTOR	PECOS AQUIFER	213	0	13	0	0	5	231
2003	ECTOR	PECOS AQUIFER	214	0	13	0	0	4	231
2004	ECTOR	PECOS AQUIFER	207	0	13	0	0	0	220
2005	ECTOR	PECOS AQUIFER	222	0	13	0	0	0	235
2006	ECTOR	PECOS AQUIFER	0	0	13	0	0	0	13
2007	ECTOR	PECOS AQUIFER	0	0	13	0	0	0	13
2008	ECTOR	PECOS AQUIFER	0	0	13	0	0	0	13
2009	ECTOR	PECOS AQUIFER	0	0	13	0	0	0	13
2010	ECTOR	PECOS AQUIFER	0	0	13	0	0	0	13
2011	ECTOR	PECOS AQUIFER	0	0	13	0	0	0	13
2012	ECTOR	PECOS AQUIFER	0	0	13	0	0	0	13
2000	PECOS	PECOS AQUIFER	411	0	9	0	19,797	188	20,405
2001	PECOS	PECOS AQUIFER	382	0	7	0	17,567	198	18,154
2002	PECOS	PECOS AQUIFER	361	0	6	0	16,747	175	17,289
2003	PECOS	PECOS AQUIFER	328	0	6	0	10,292	149	10,775
2004	PECOS	PECOS AQUIFER	327	0	5	0	11,613	58	12,003
2005	PECOS	PECOS AQUIFER	328	0	5	0	11,320	61	11,714
2006	PECOS	PECOS AQUIFER	331	0	5	0	16,925	69	17,330
2007	PECOS	PECOS AQUIFER	351	0	5	0	14,917	53	15,326
2008	PECOS	PECOS AQUIFER	425	63	2	0	15,560	60	16,110
2009	PECOS	PECOS AQUIFER	431	63	2	0	24,837	55	25,388
2010	PECOS	PECOS AQUIFER	45	65	0	0	33,539	54	33,703
2011	PECOS	PECOS AQUIFER	241	75	0	0	34,200	54	34,570
2012	PECOS	PECOS AQUIFER	208	76	13	0	30,142	48	30,487
2000	UPTON	PECOS AQUIFER	0	0	0	0	0	1	1
2001	UPTON	PECOS AQUIFER	0	0	0	0	0	0	0
2002	UPTON	PECOS AQUIFER	0	0	0	0	0	0	0
2003	UPTON	PECOS AQUIFER	0	0	0	0	0	0	0
2004	UPTON	PECOS AQUIFER	0	0	0	0	0	0	0
2005	UPTON	PECOS AQUIFER	0	0	0	0	0	1	1
2006	UPTON	PECOS AQUIFER	0	0	0	0	0	1	1

Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2007	UPTON	PECOS AQUIFER	0	0	0	0	0	1	1
2008	UPTON	PECOS AQUIFER	0	0	0	0	0	0	0
2009	UPTON	PECOS AQUIFER	0	0	0	0	0	0	0
2010	UPTON	PECOS AQUIFER	0	0	0	0	0	0	0
2011	UPTON	PECOS AQUIFER	0	0	0	0	0	0	0
2012	UPTON	PECOS AQUIFER	0	0	0	0	0	0	0
2000	GILLESPIE	TRINITY AQUIFER	542	0	0	0	982	148	1,672
2001	GILLESPIE	TRINITY AQUIFER	517	0	0	0	1,123	128	1,768
2002	GILLESPIE	TRINITY AQUIFER	553	0	0	0	1,123	127	1,803
2003	GILLESPIE	TRINITY AQUIFER	629	0	0	0	1,123	119	1,871
2004	GILLESPIE	TRINITY AQUIFER	610	0	0	0	1,189	73	1,872
2005	GILLESPIE	TRINITY AQUIFER	666	0	0	0	968	111	1,745
2006	GILLESPIE	TRINITY AQUIFER	719	0	0	0	1,059	110	1,888
2007	GILLESPIE	TRINITY AQUIFER	616	0	0	0	90	115	821
2008	GILLESPIE	TRINITY AQUIFER	681	0	0	0	985	127	1,793
2009	GILLESPIE	TRINITY AQUIFER	653	0	0	0	958	118	1,729
2010	GILLESPIE	TRINITY AQUIFER	706	0	0	0	638	245	1,589
2011	GILLESPIE	TRINITY AQUIFER	774	0	0	0	1,577	252	2,603
2012	GILLESPIE	TRINITY AQUIFER	748	0	0	0	971	119	1,838
2000	REAL	TRINITY AQUIFER	0	0	0	0	2	9	11
2001	REAL	TRINITY AQUIFER	0	0	0	0	2	7	9
2002	REAL	TRINITY AQUIFER	0	0	0	0	2	7	9
2003	REAL	TRINITY AQUIFER	0	0	0	0	1	6	7
2004	REAL	TRINITY AQUIFER	0	0	0	0	6	6	12
2005	REAL	TRINITY AQUIFER	0	0	0	0	8	10	18
2006	REAL	TRINITY AQUIFER	0	0	0	0	24	8	32
2007	REAL	TRINITY AQUIFER	0	0	0	0	0	9	9
2008	REAL	TRINITY AQUIFER	0	0	0	0	4	8	12
2009	REAL	TRINITY AQUIFER	0	0	0	0	0	8	8
2010	REAL	TRINITY AQUIFER	0	0	0	0	7	15	22
2011	REAL	TRINITY AQUIFER	31	0	0	0	15	15	61
2012	REAL	TRINITY AQUIFER	2	0	0	0	8	6	16

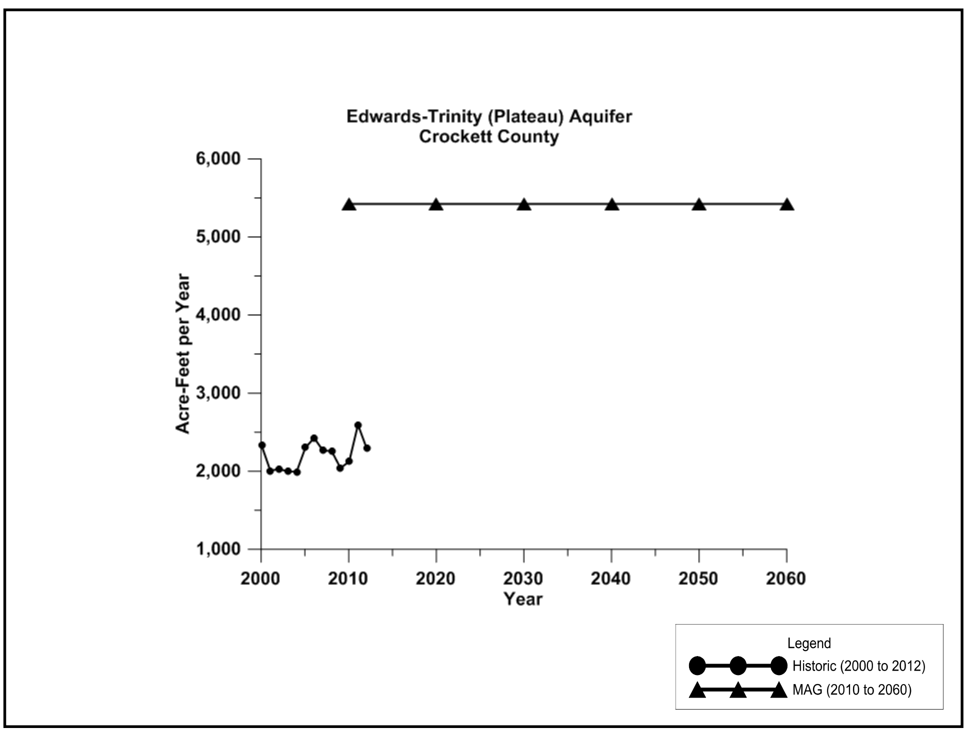
Year	County	Aquifer	Municipal	Manufacturing	Mining	Steam Electric Power	Irrigation	Livestock	Total
2000	UVALDE	TRINITY AQUIFER	0	0	0	0	0	49	49
2001	UVALDE	TRINITY AQUIFER	0	0	0	0	0	46	46
2002	UVALDE	TRINITY AQUIFER	0	0	0	0	0	45	45
2003	UVALDE	TRINITY AQUIFER	0	0	0	0	0	43	43
2004	UVALDE	TRINITY AQUIFER	0	0	0	0	0	40	40
2005	UVALDE	TRINITY AQUIFER	0	0	0	0	0	61	61
2006	UVALDE	TRINITY AQUIFER	37	0	0	0	0	59	96
2007	UVALDE	TRINITY AQUIFER	31	0	0	0	0	60	91
2008	UVALDE	TRINITY AQUIFER	117	0	0	0	0	53	170
2009	UVALDE	TRINITY AQUIFER	118	0	0	0	0	45	163
2010	UVALDE	TRINITY AQUIFER	199	0	0	0	0	47	246
2011	UVALDE	TRINITY AQUIFER	208	0	0	0	0	49	257
2012	UVALDE	TRINITY AQUIFER	153	0	0	0	0	42	195

Appendix C

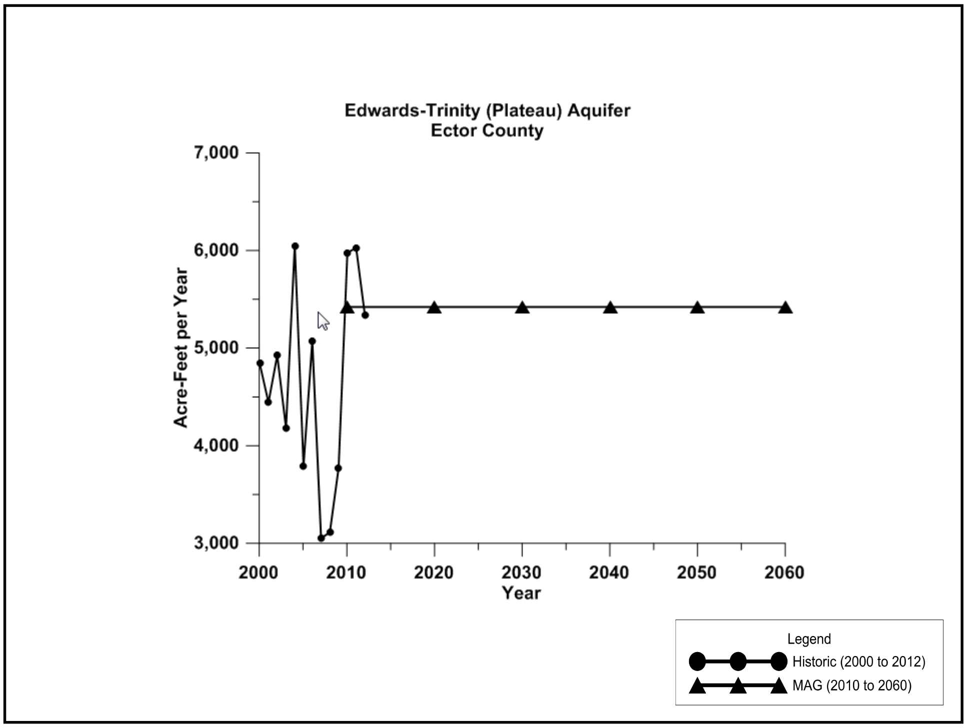
Hydrographs Comparing Historic Pumping and Modeled Available Groundwater from the Edwards-Trinity (Plateau), Pecos Valley, and Trinity Aquifers

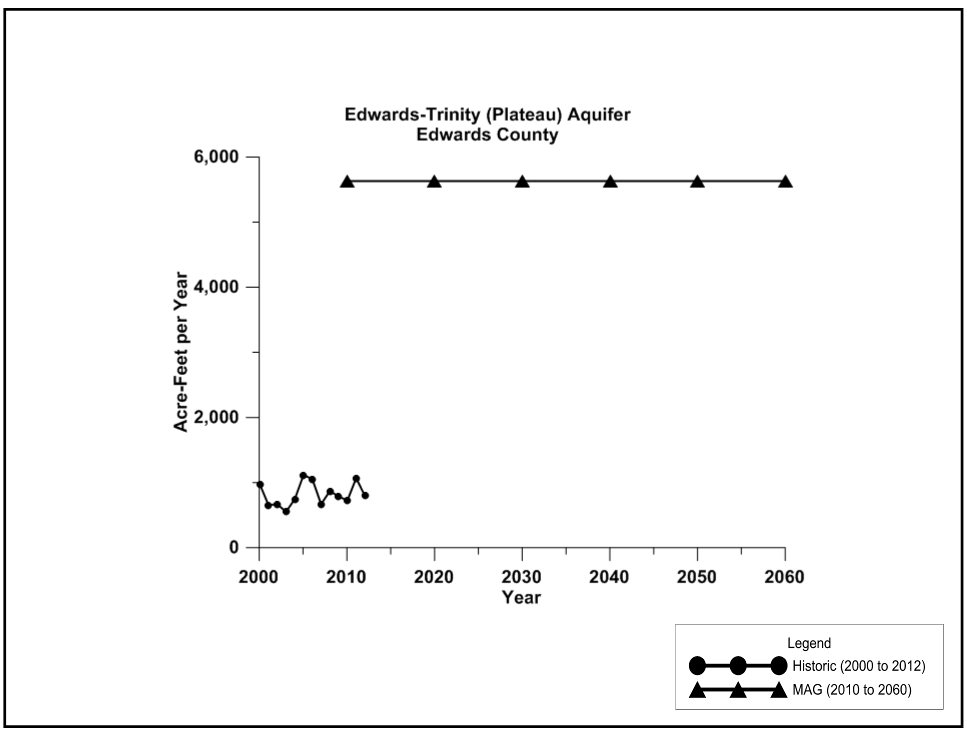


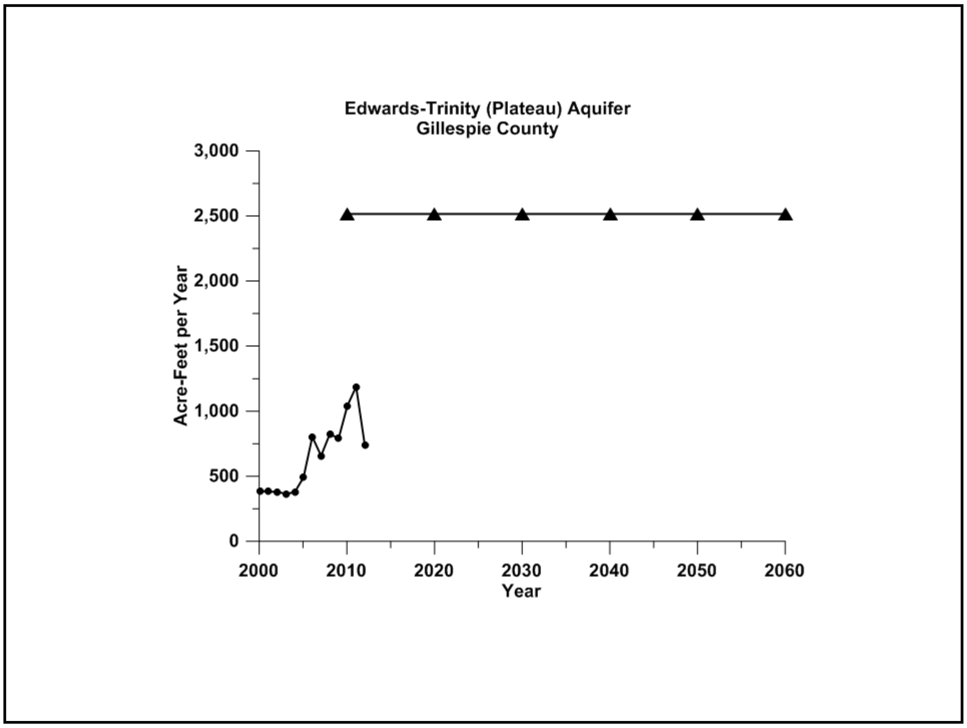
Edwards-Trinity (Plateau) Aquifer
Coke County
Acre-Feet per Year
1,000
800
600
400
200
0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

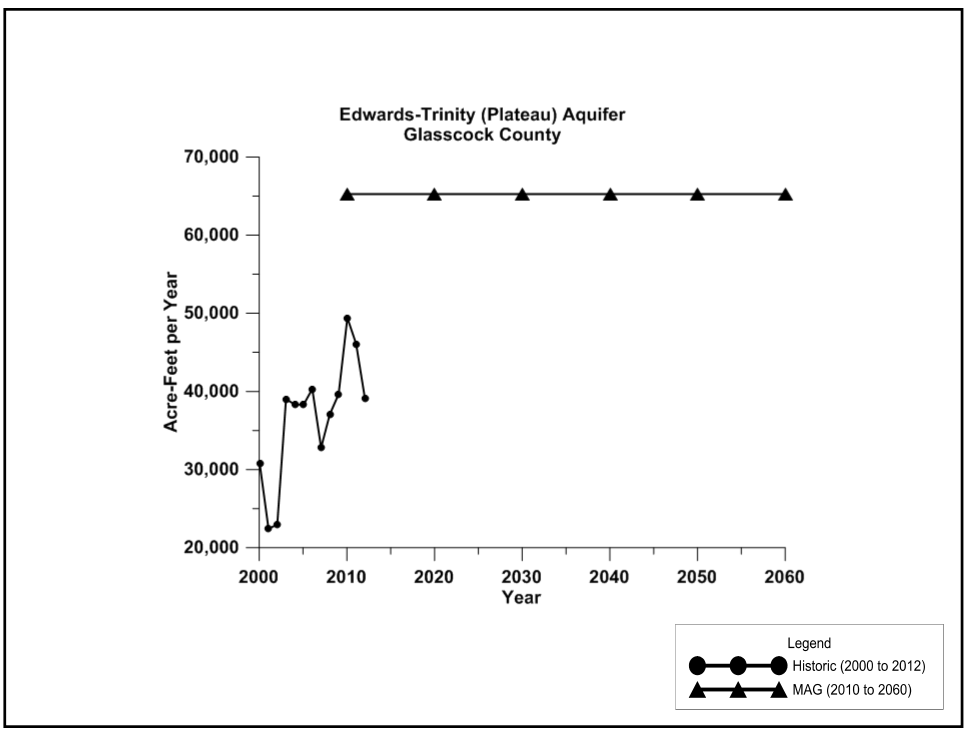


Edwards-Trinity (Plateau) Aquifer
Crockett County
Acre-Feet per Year
6,000
5,000
4,000
3,000
2,000
1,000
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)


Edwards-Trinity (Plateau) Aquifer
Ector County
Acre-Feet per Year
7,000
6,000
5,000
4,000
3,000
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)


Edwards-Trinity (Plateau) Aquifer
Edwards County
Acre-Feet per Year
6,000
4,000
2,000
0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)


Edwards-Trinity (Plateau) Aquifer
Gillespie County
Acre-Feet per Year
3,000
2,500
2,000
1,500
1,000
500
0
2000
2010
2020
2030
2040
2050
2060
Year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Glasscock County
Acre-Feet per Year
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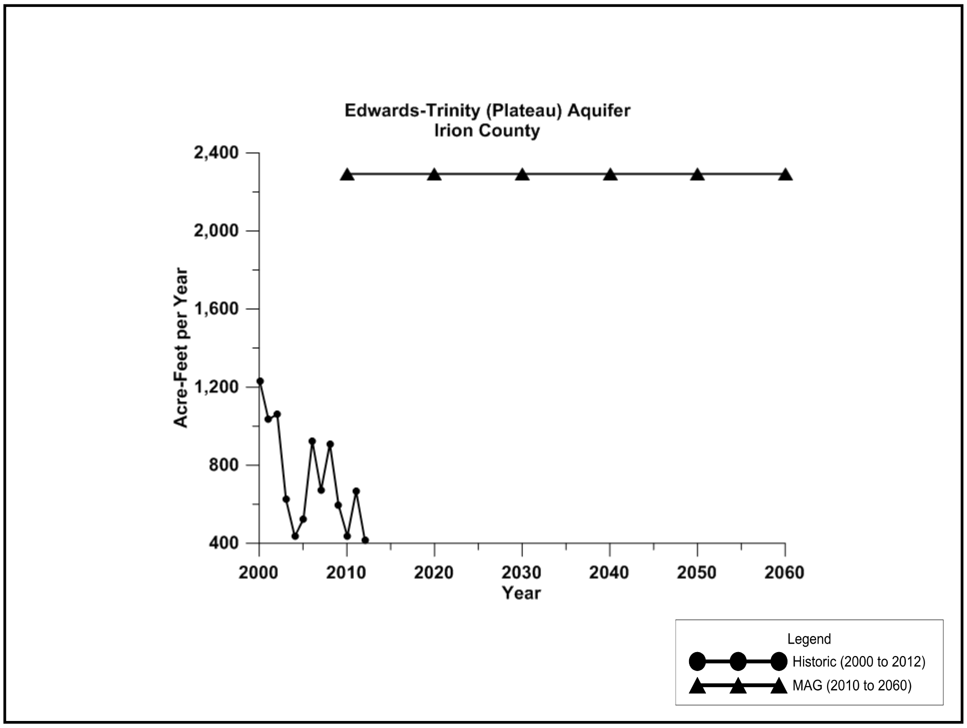
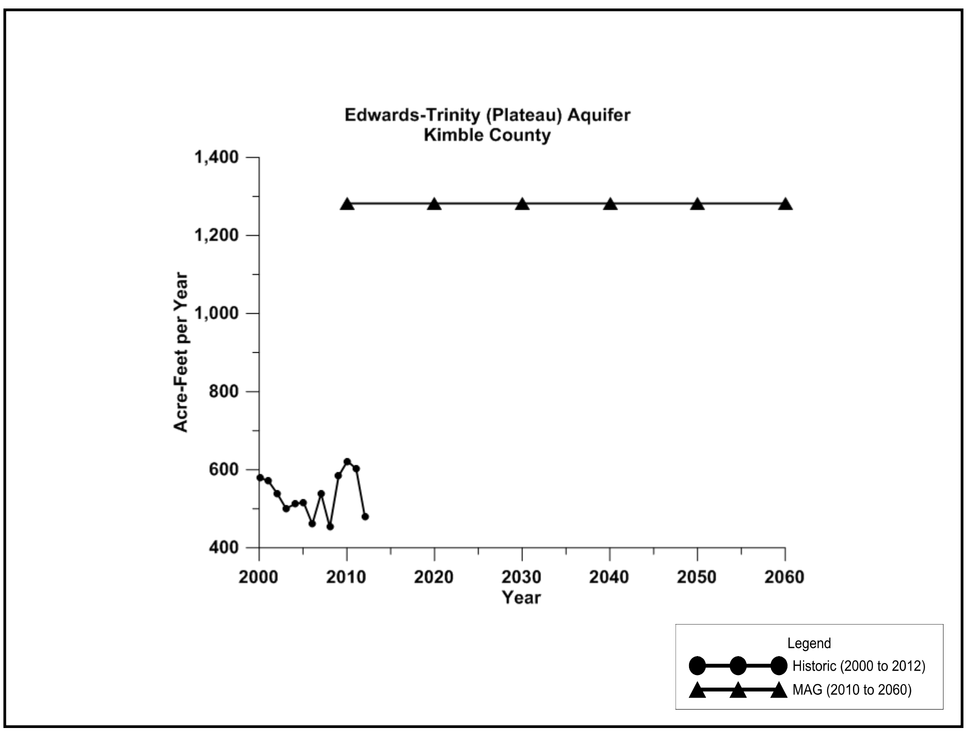
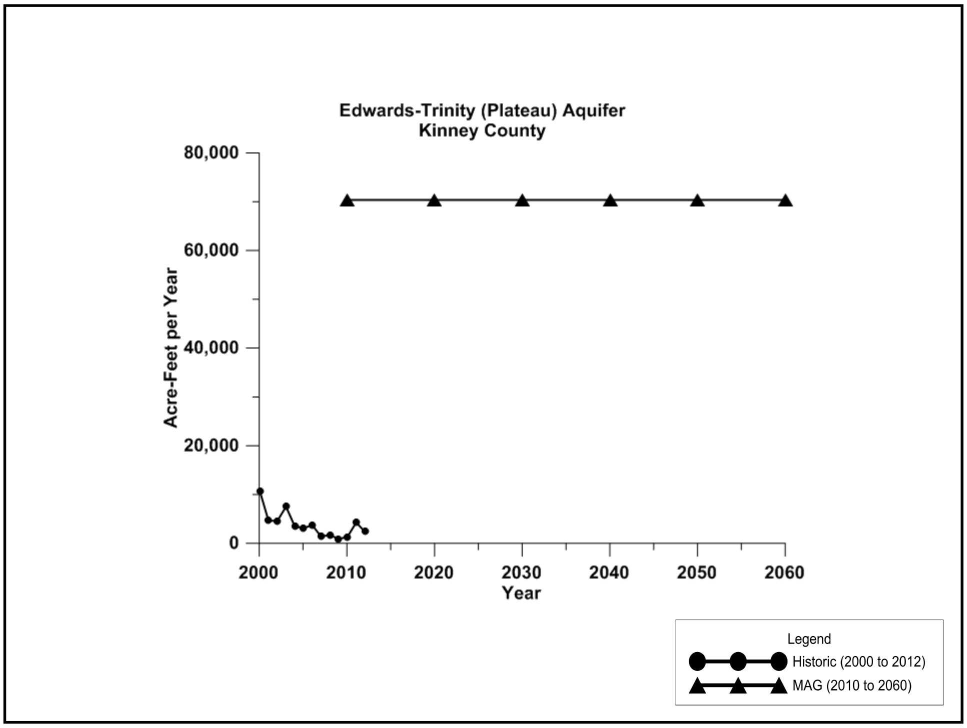
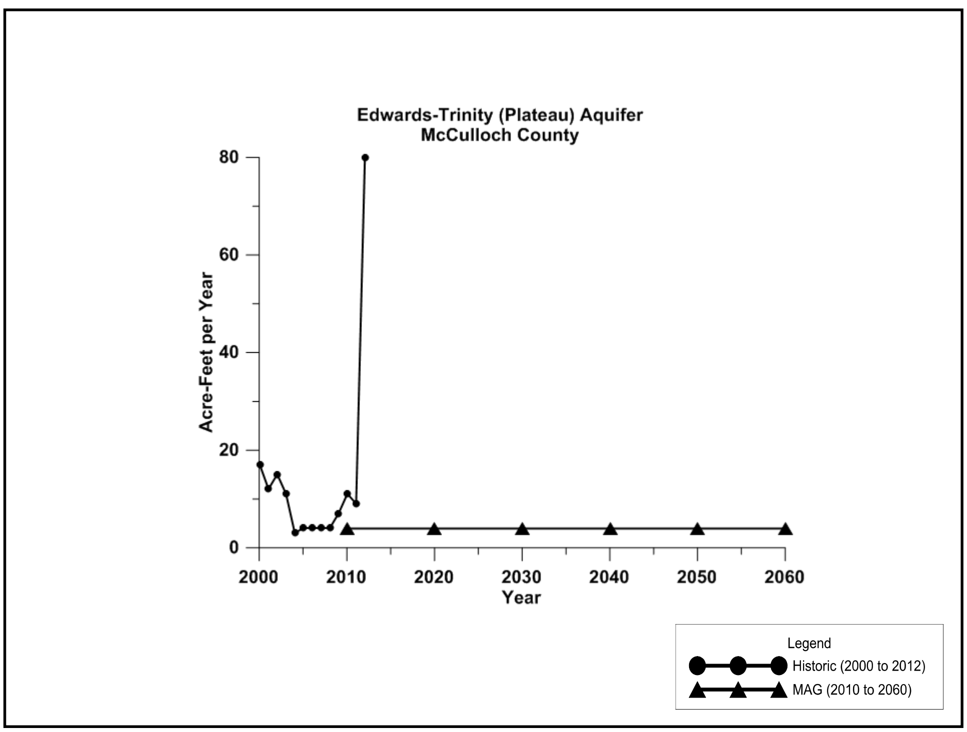
50,000
40,000
30,000
20,000
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)


Edwards-Trinity (Plateau) Aquifer
Irion County
Acre-Feet per Year
2,400
2,000
1,600
1,200
800
400
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)


Edwards-Trinity (Plateau) Aquifer
Kimble County
Acre-Feet per Year
1,400
1,200
1,000
800
600
400
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)


Edwards-Trinity (Plateau) Aquifer
Kinney County
80,000
60,000
40,000
20,000
0
Acre-Feet per Year
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)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McCulloch County
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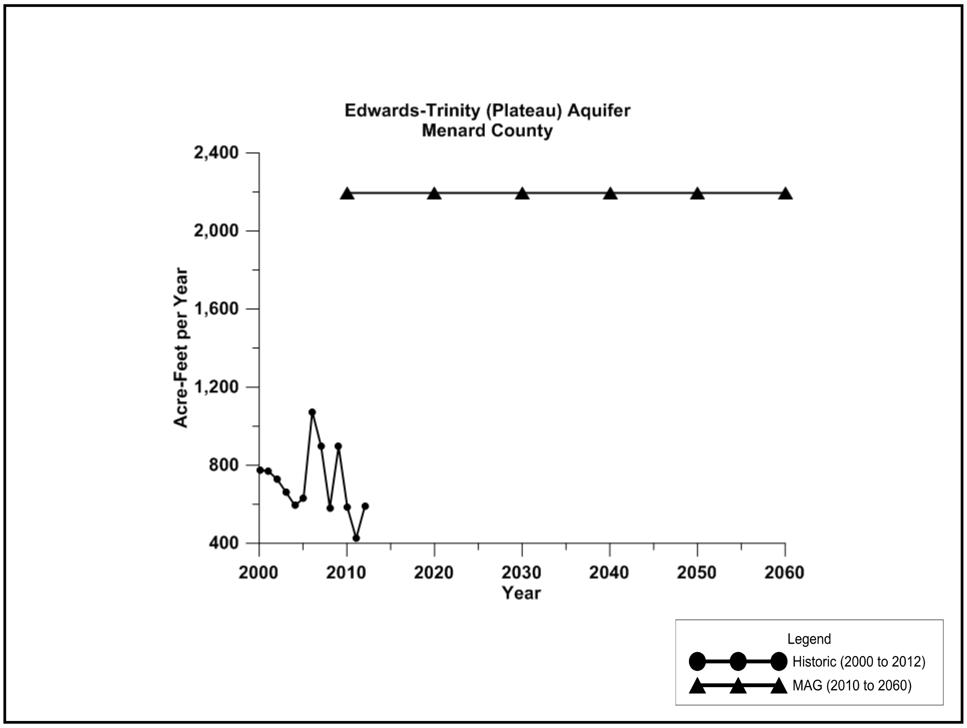
60
40
20
0
Acre-Feet per Year
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)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Menard County
Acre-Feet per Year
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2,000
1,600
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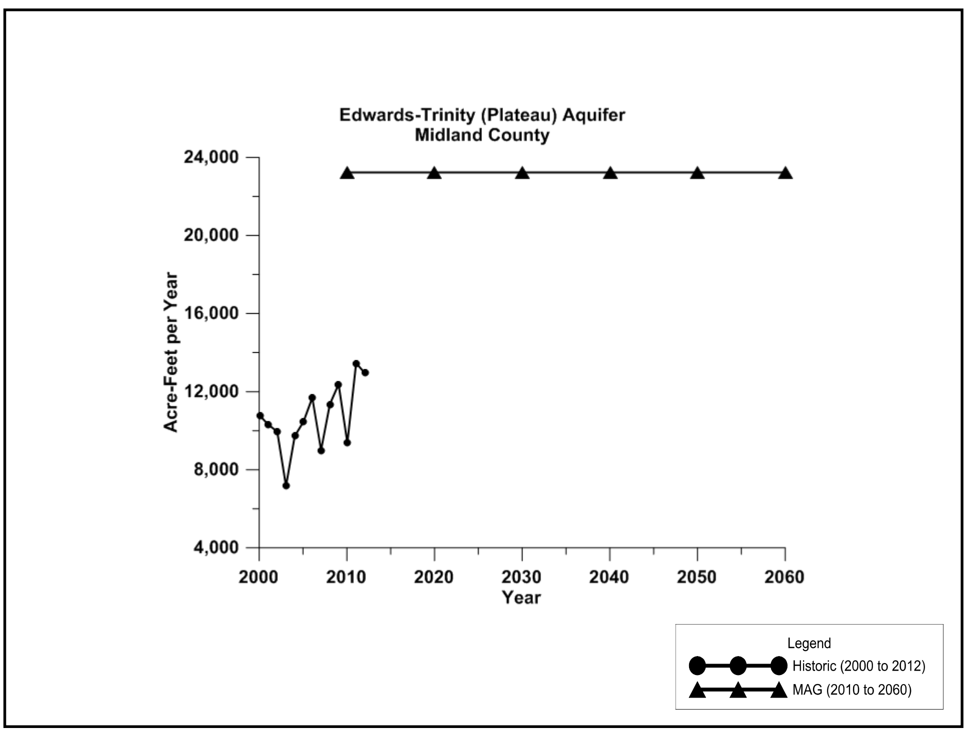
400
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)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Acre-Feet per Year
24,000
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16,000
12,000
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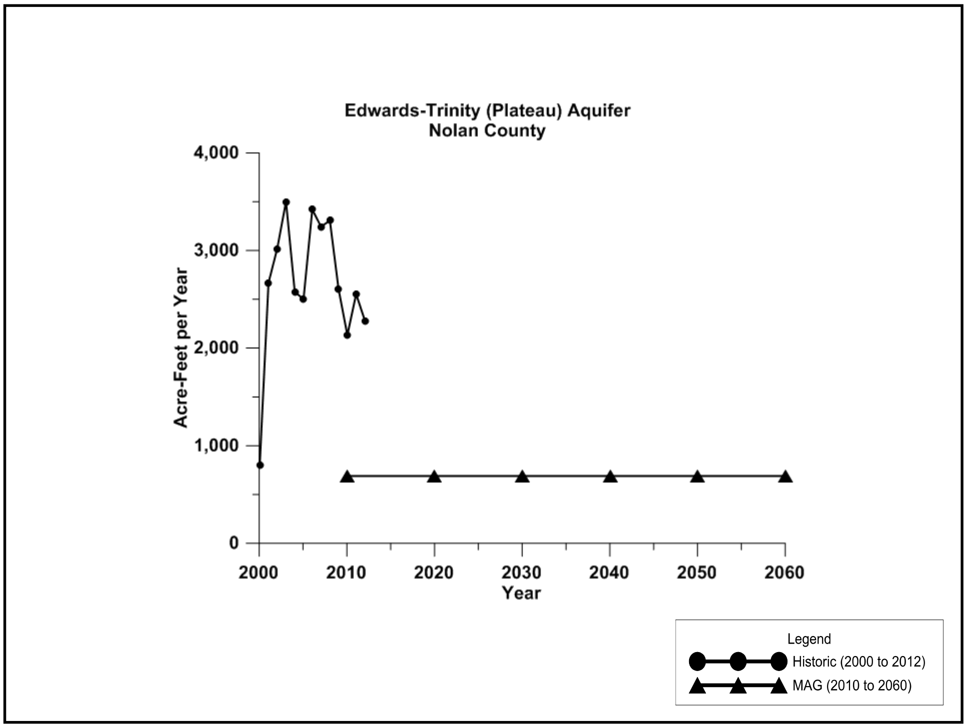
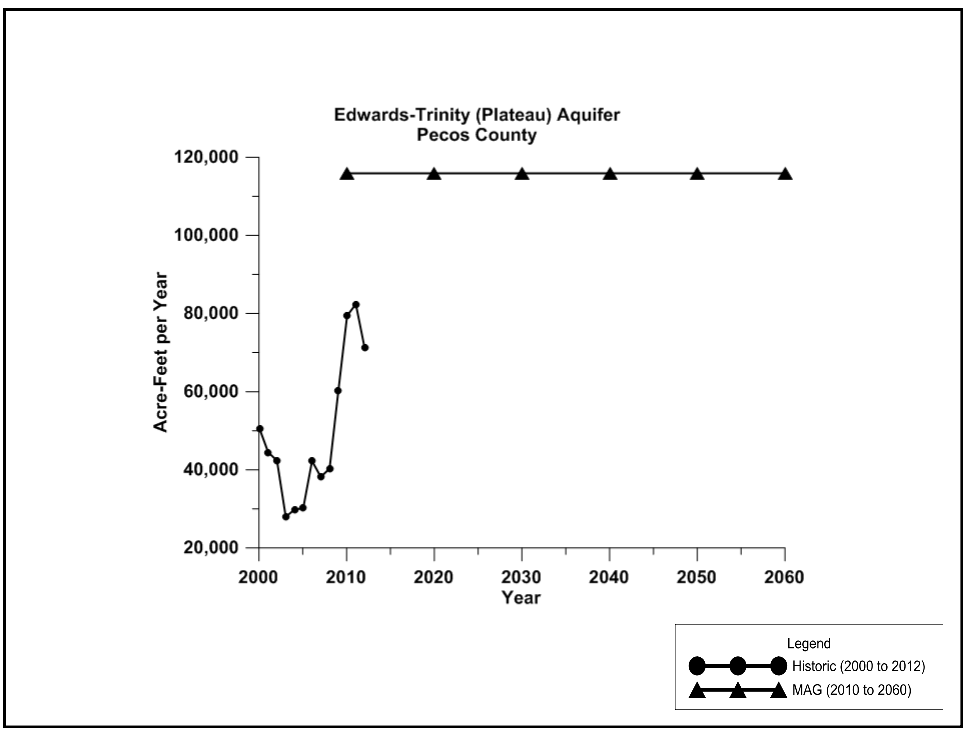
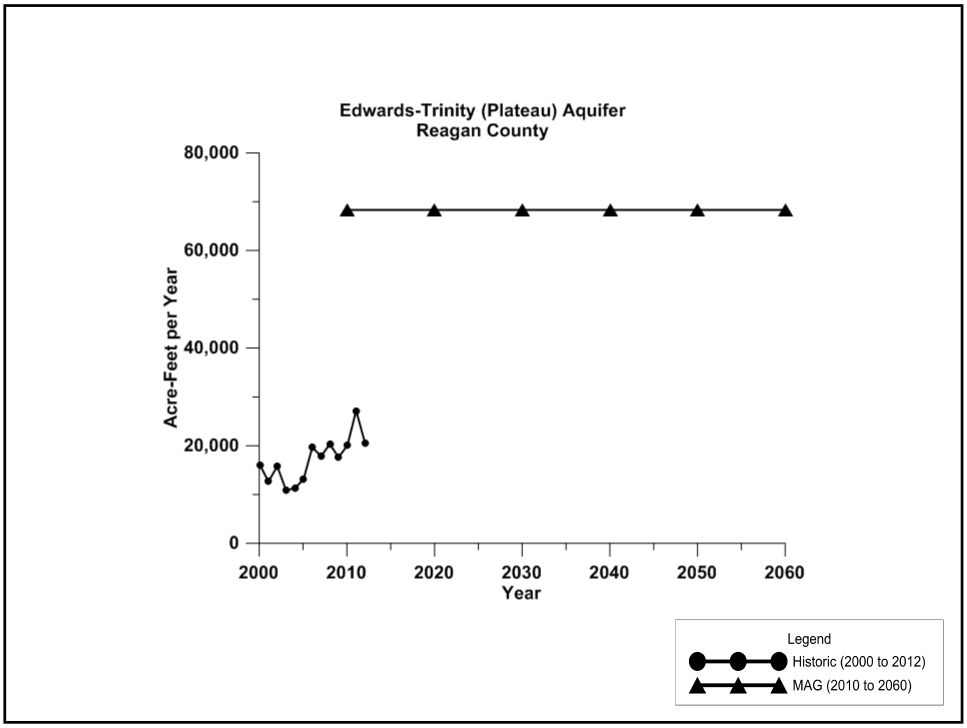
4,000
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

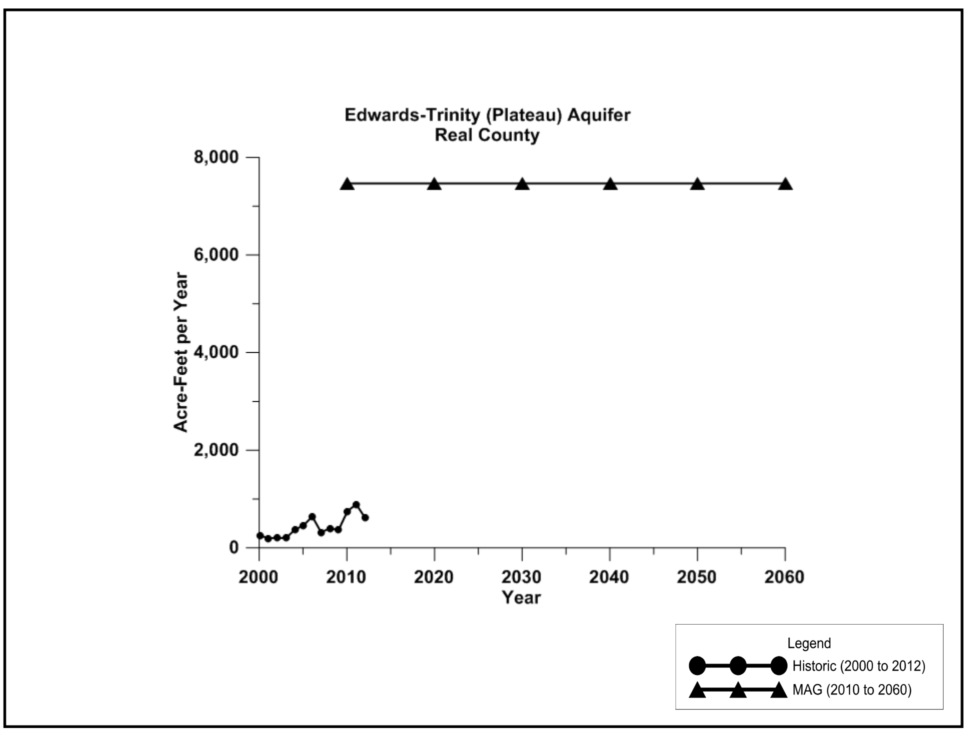


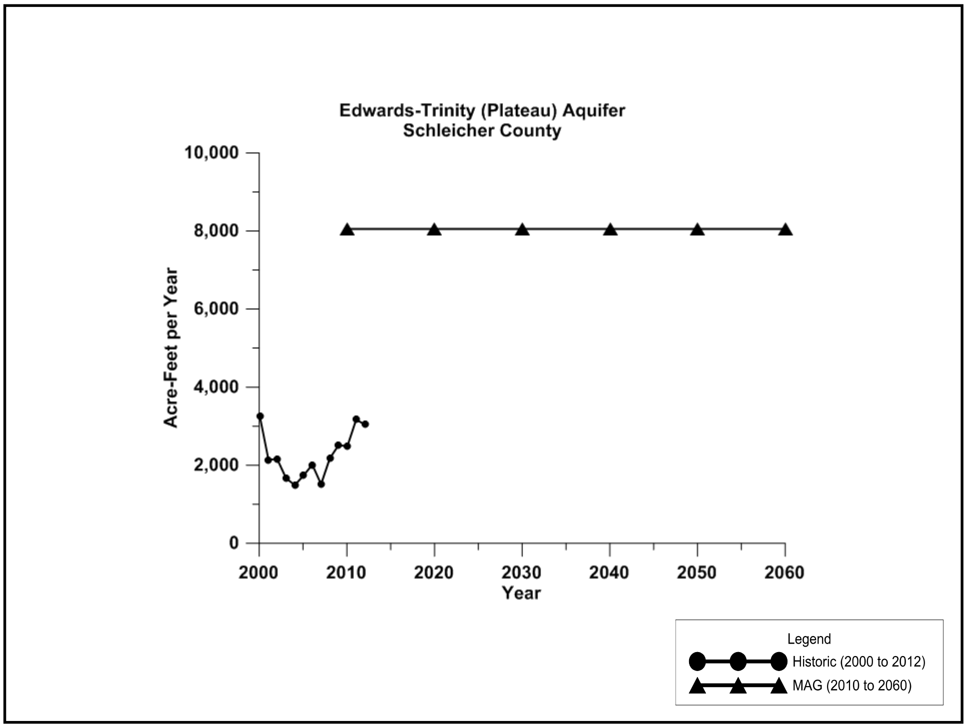
Edwards-Trinity (Plateau) Aquifer
Nolan County
Acre-Feet per Year
4,000
3,000
2,000
1,000
0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

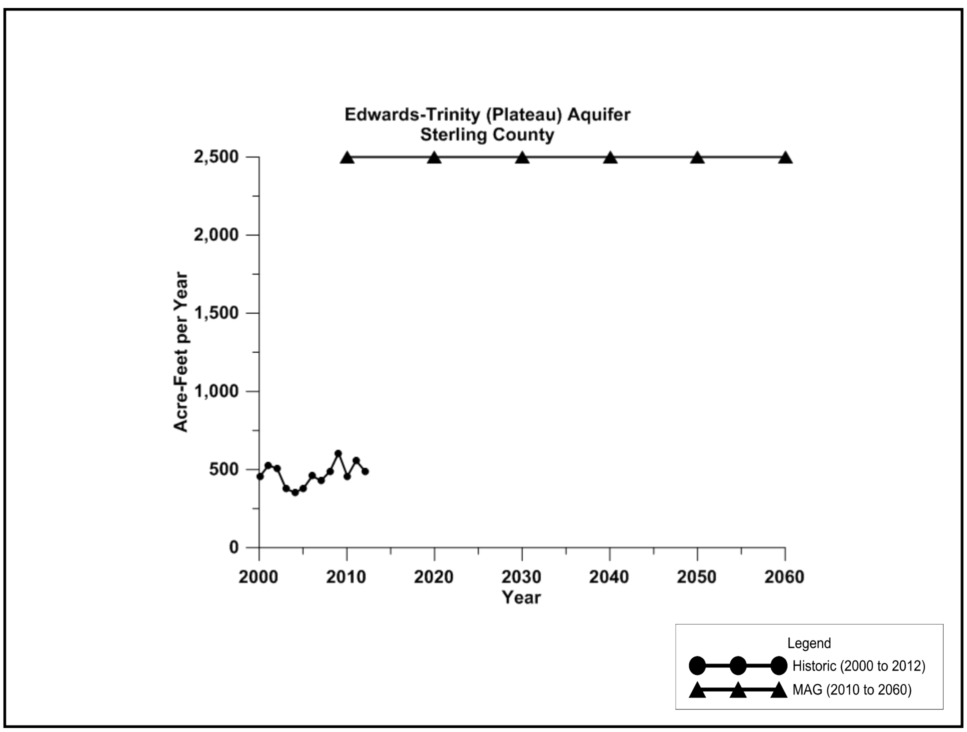


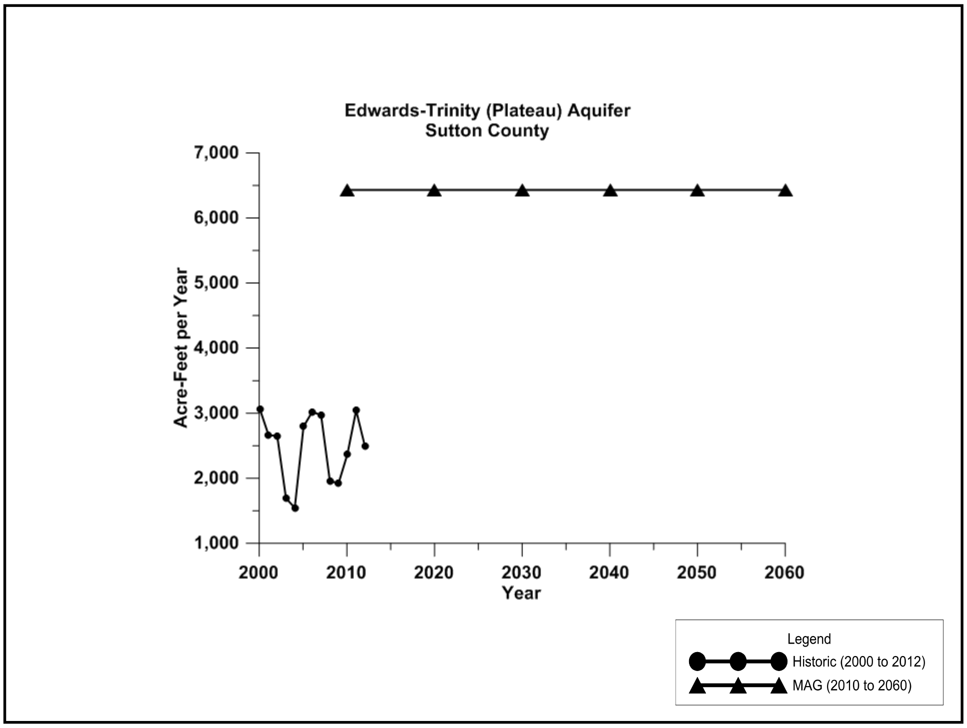
Edwards-Trinity (Plateau) Aquifer
Pecos County
Acre-Feet per Year
120,000
100,000
80,000
60,000
40,000
20,000
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

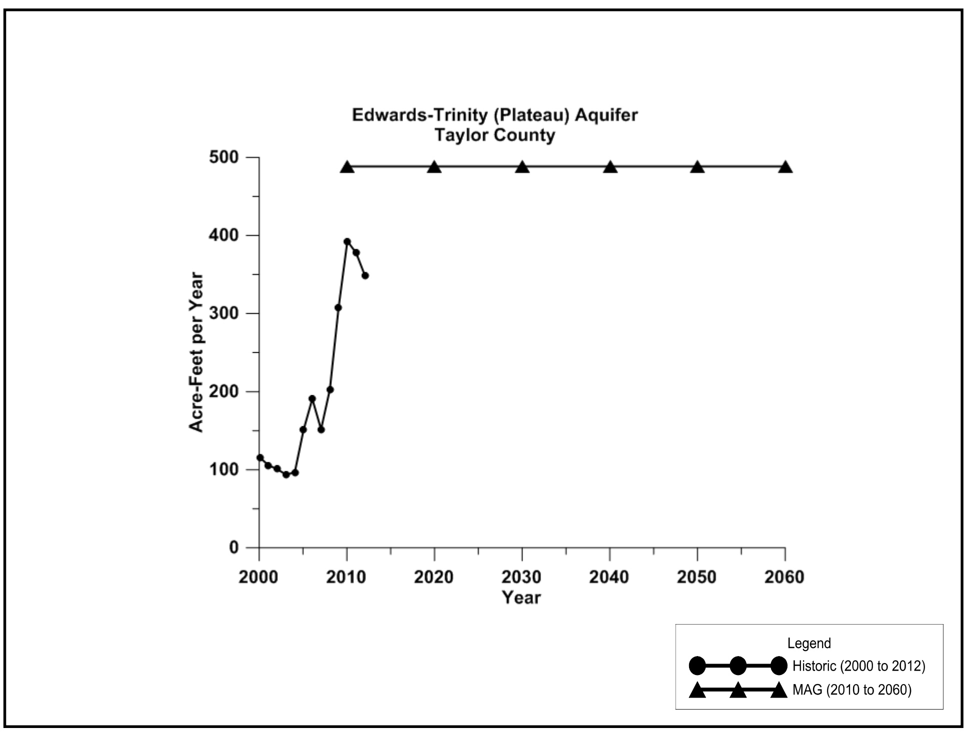

Edwards-Trinity (Plateau) Aquifer
Reagan County
80,000
60,000
40,000
20,000
0
Acre-Feet per Year
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

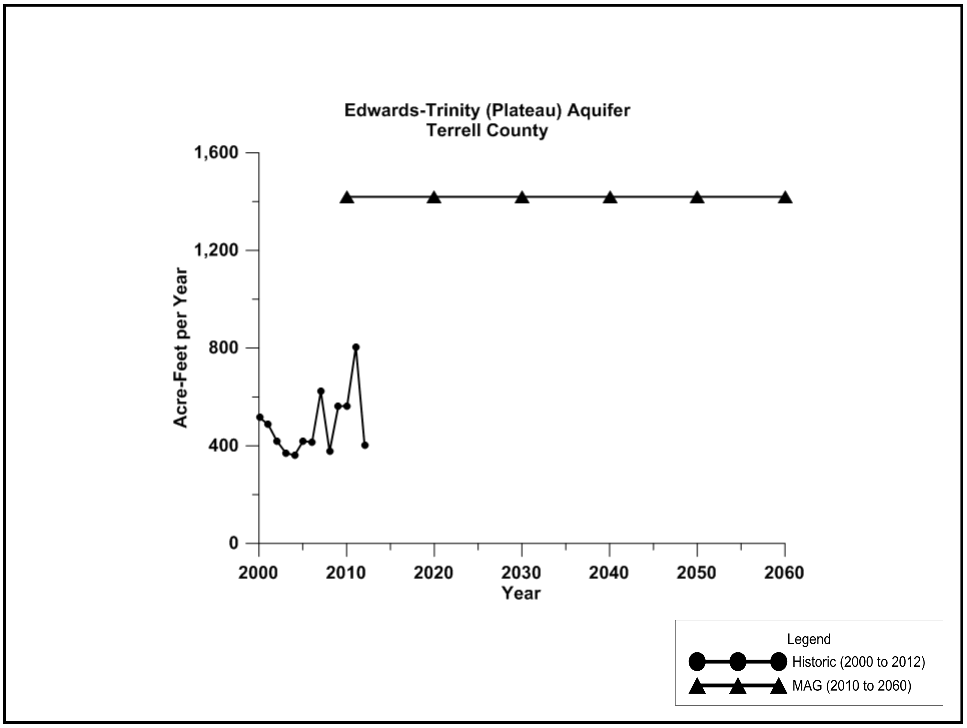

Edwards-Trinity (Plateau) Aquifer
Real County
8,000
6,000
4,000
2,000
0
Acre-Feet per Year
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

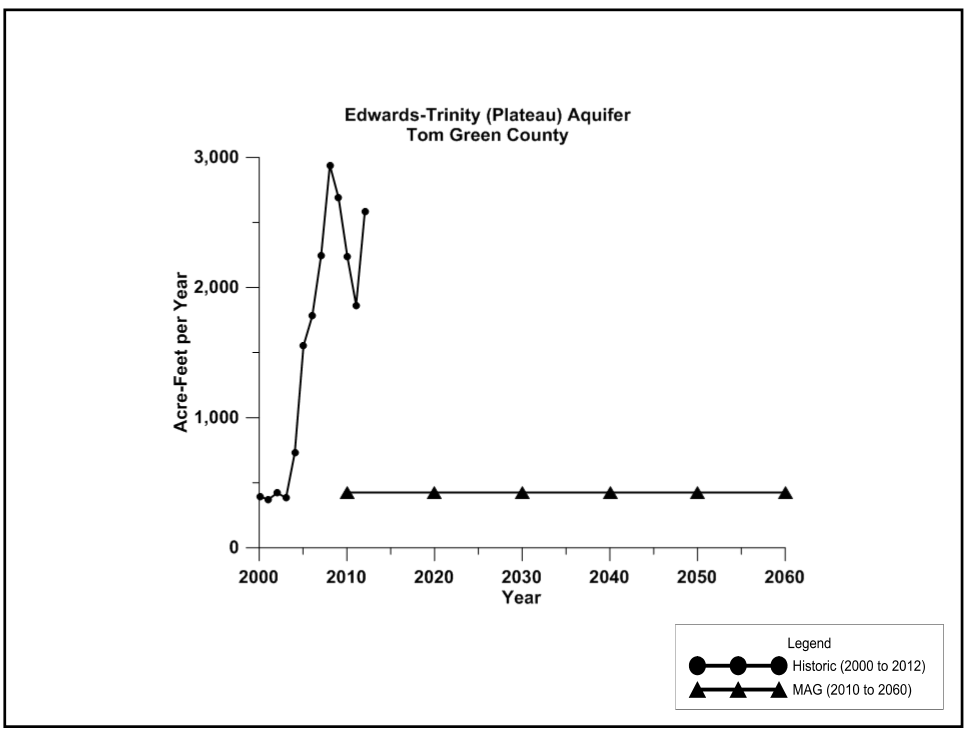

Edwards-Trinity (Plateau) Aquifer
Schleicher County
Acre-Feet per Year
10,000
8,000
6,000
4,000
2,000
0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

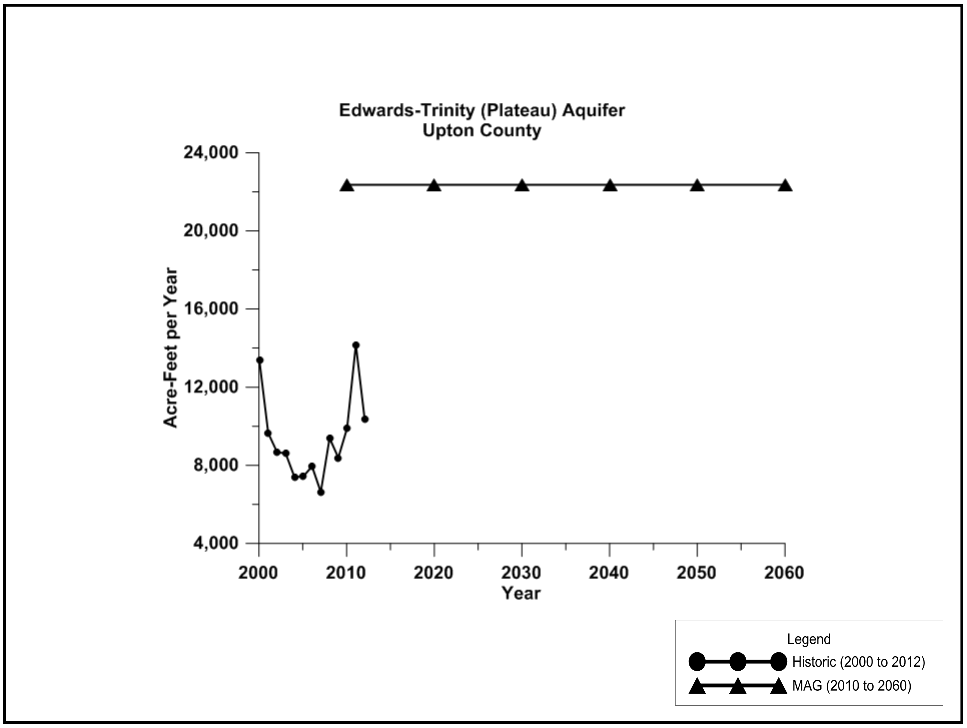

Edwards-Trinity (Plateau) Aquifer
Sterling County
Acre-Feet per Year
2,500
2,000
1,500
1,000
500
0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)


Edwards-Trinity (Plateau) Aquifer
Sutton County
Acre-Feet per Year
7,000
6,000
5,000
4,000
3,000
2,000
1,000
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

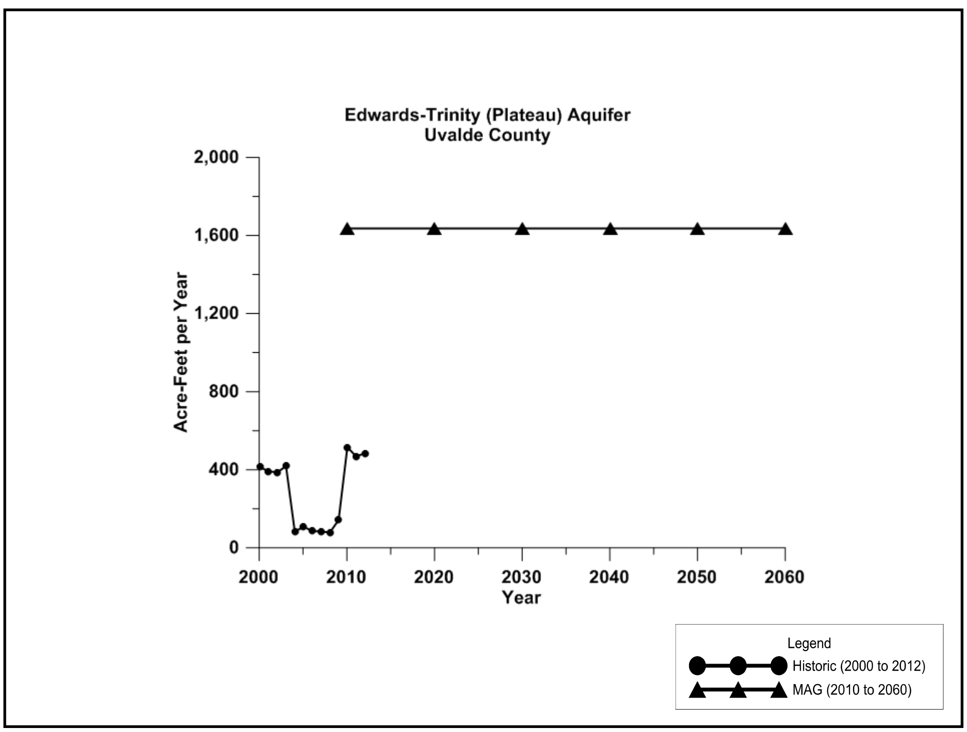

Edwards-Trinity (Plateau) Aquifer
Taylor County
Acre-Feet per Year
500
400
300
200
100
0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)


Edwards-Trinity (Plateau) Aquifer
Terrell County
Acre-Feet per Year
1,600
1,200
800
400
0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

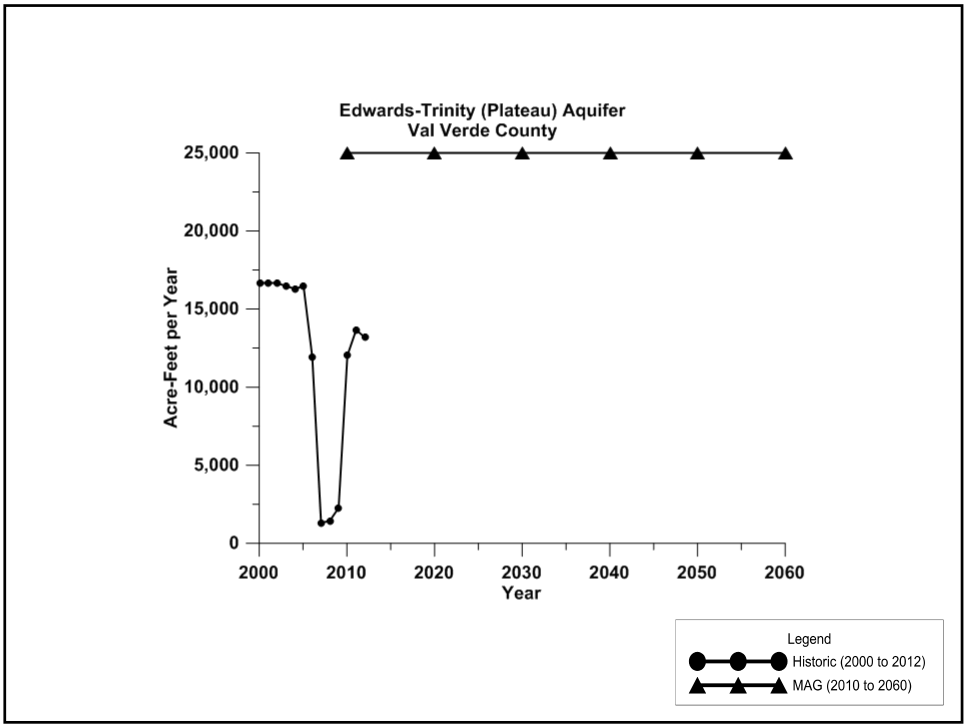

Edwards-Trinity (Plateau) Aquifer
Tom Green County
Acre-Feet per Year
3,000
2,000
1,000
0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

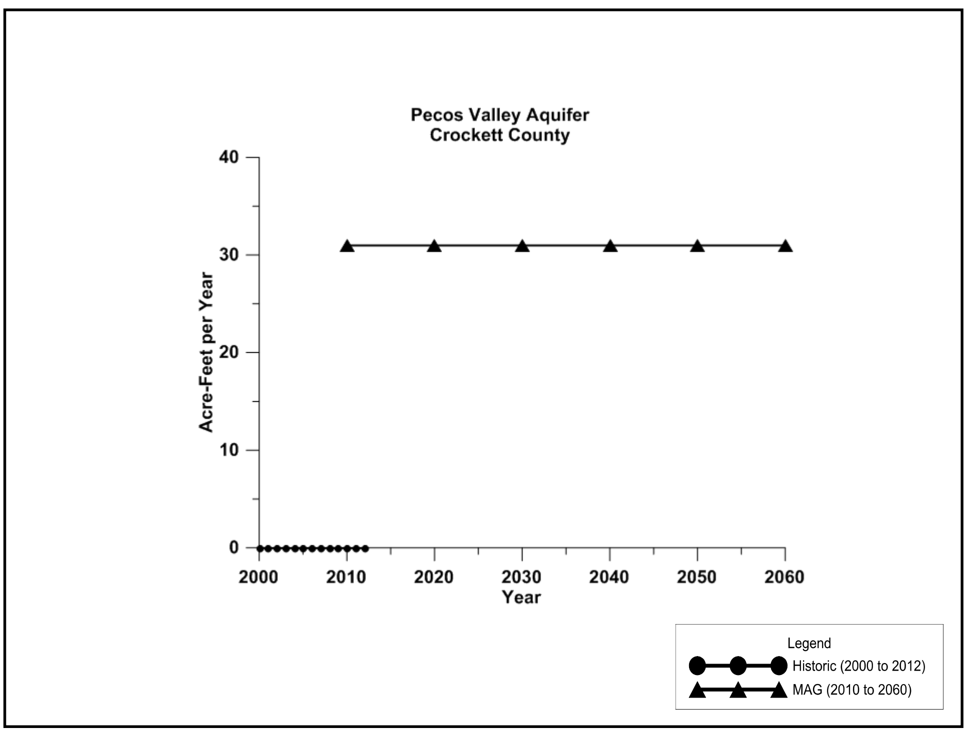


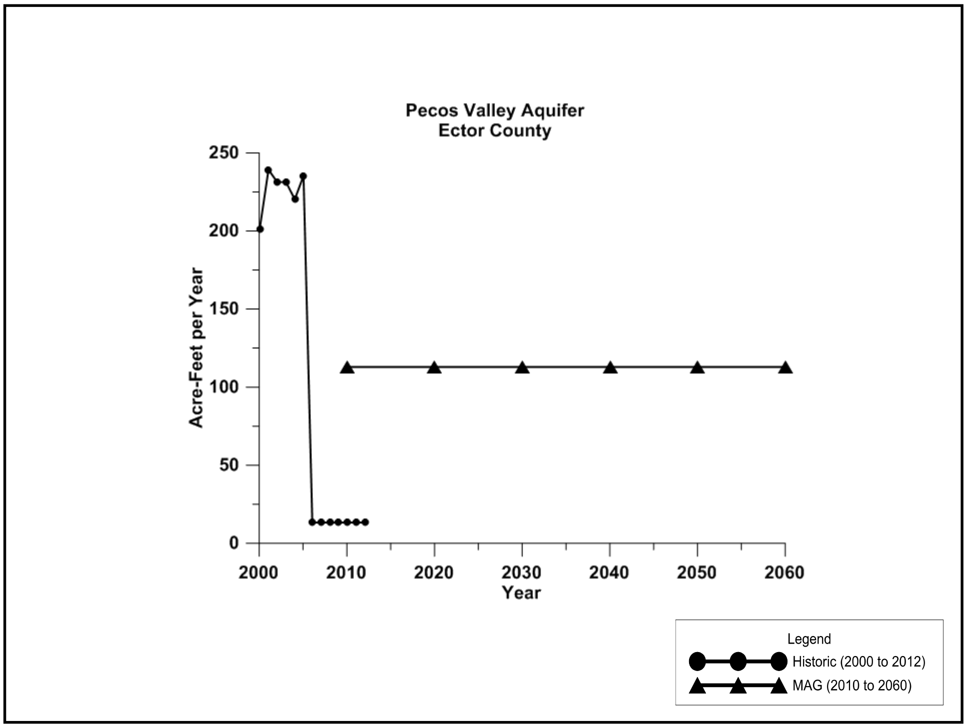
Edwards-Trinity (Plateau) Aquifer
Upton County
Acre-Feet per Year
24,000
20,000
16,000
12,000
8,000
4,000
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

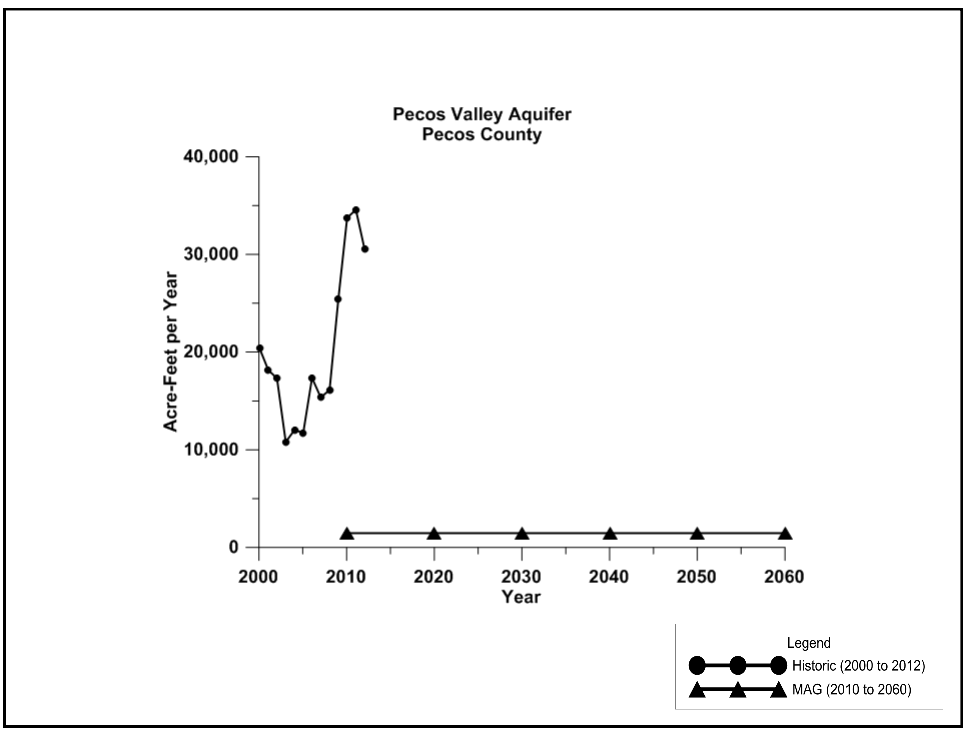


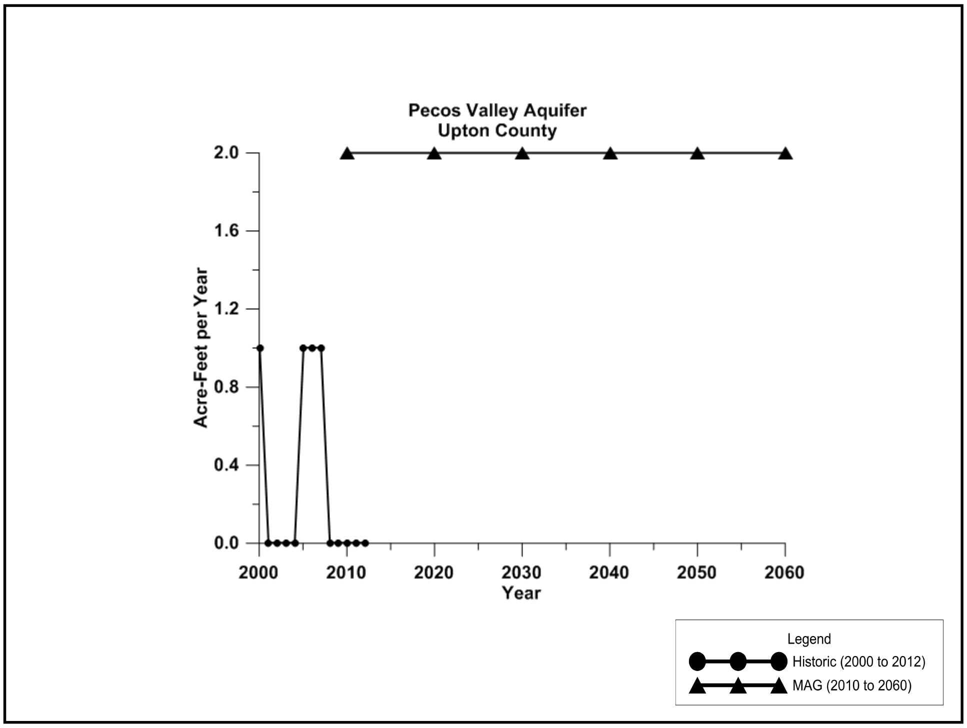
Edwards-Trinity (Plateau) Aquifer
Uvalde County
Acre-Feet per Year
2,000
1,600
1,200
800
400
0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

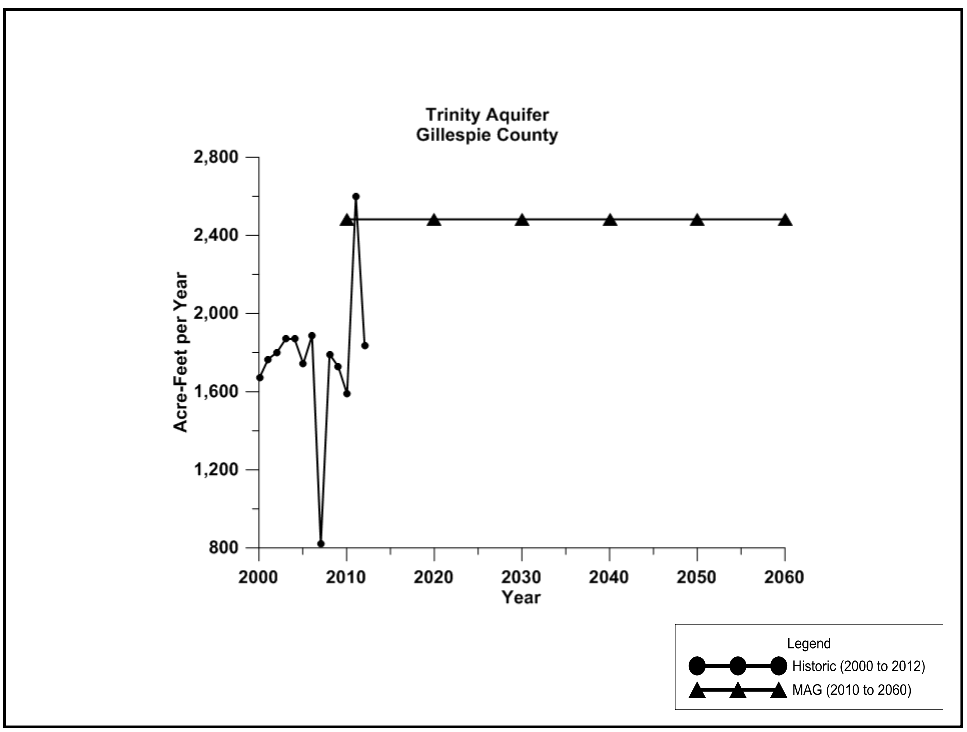

Edwards-Trinity (Plateau) Aquifer
Val Verde County
Acre-Feet per Year
25,000
20,000
15,000
10,000
5,000
0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

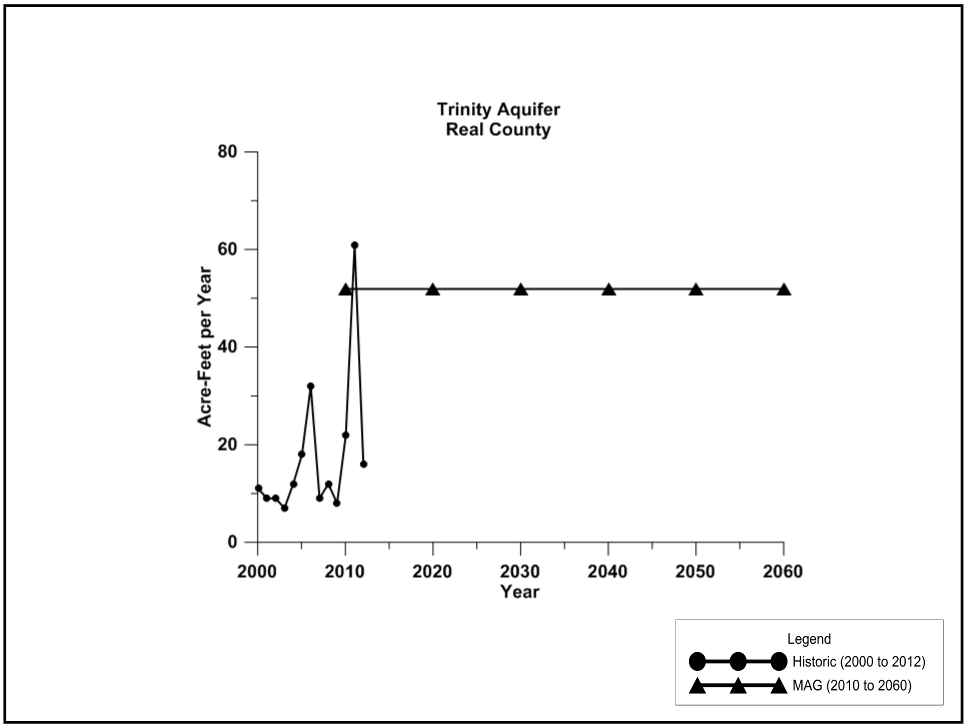

Pecos Valley Aquifer
Crockett County
Acre-Feet per Year
40
30
20
10
0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)


Pecos Valley Aquifer
Ector County
Acre-Feet per Year
250
200
150
100
50
0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)


Pecos Valley Aquifer
Pecos County
Acre-Feet per Year
40,000
30,000
20,000
10,000
0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)


Pecos Valley Aquifer
Upton County
Acre-Feet per Year
2.0
1.6
1.2
0.8
0.4
0.0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)


Trinity Aquifer
Gillespie County
Acre-Feet per Year
2,800
2,400
2,000
1,600
1,200
800
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)


Trinity Aquifer
Real County
Acre-Feet per Year
80
60
40
20
0
2000
2010
2020
2030
2040
2050
2060
Year
Legend
Historic (2000 to 2012)
MAG (2010 to 2060)

Appendix D

Region F Socioeconomic Impact Reports from TWDB

July 22, 2010

Mr. John Grant
Chairman, Region F Regional Water Planning Group
c/o Colorado River Municipal Water District
P.O. Box 869
Big Spring, Texas 79721-0869

Re: Socioeconomic Impact Analysis of Not Meeting Water Needs for the 2011 Region F Regional Water Plan

Dear Chairman Grant:

We have received your request for technical assistance to complete the socioeconomic impact analysis of not meeting water needs. In response, enclosed is a report that describes our methodology and presents the results. Section 1 provides an overview of the methodology. Section 2 presents results at the regional level, and Appendix 2 show results for individual water user groups.

If you have any questions or comments, please feel free to contact me at (512) 463-7928 or by email at stuart.norvell@twdb.state.tx.us.

Sincerely,

Stuart D. Norvell
Manager, Water Planning Research and Analysis
Water Resources Planning Division

SN/ao

Enclosure

c. Angela Kennedy, TWDB
S. Doug Shaw, TWDB

Economic Impacts of Projected Water Shortages for the Region F Regional Water Planning Area

Prepared in Support of the 2011 Region F Regional Water Plan

Stuart D. Norvell, Managing Economist
Water Resources Planning Division
Texas Water Development Board
Austin, Texas

S. Doug Shaw, Agricultural Economist
Water Resources Planning Division
Texas Water Development Board
Austin, Texas

July 2010

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Introduction

Water shortages during drought would likely curtail or eliminate economic activity in business and industries reliant on water. For example, without water farmers cannot irrigate; refineries cannot produce gasoline, and paper mills cannot make paper. Unreliable water supplies would not only have an immediate and real impact on existing businesses and industry, but they could also adversely affect economic development in Texas. From a social perspective, water supply reliability is critical as well. Shortages would disrupt activity in homes, schools and government and could adversely affect public health and safety. For all of the above reasons, it is important to analyze and understand how restricted water supplies during drought could affect communities throughout the state.

Administrative rules require that regional water planning groups evaluate the impacts of not meeting water needs as part of the regional water planning process, and rules direct TWDB staff to provide technical assistance: "*The executive administrator shall provide available technical assistance to the regional water planning groups, upon request, on water supply and demand analysis, including methods to evaluate the social and economic impacts of not meeting needs*" [(§357.7 (4)(A)]. Staff of the TWDB's Water Resources Planning Division designed and conducted this report in support of the Region F Regional Water Planning Group.

This document summarizes the results of our analysis and discusses the methodology used to generate the results. Section 1 outlines the overall methodology and discusses approaches and assumptions specific to each water use category (i.e., irrigation, livestock, mining, steam-electric, municipal and manufacturing). Section 2 presents the results for each category where shortages are reported at the regional planning area level and river basin level. Results for individual water user groups are not presented, but are available upon request.

1. Methodology

Section 1 provides a general overview of how economic and social impacts were measured. In addition, it summarizes important clarifications, assumptions and limitations of the study.

1.1 Economic Impacts of Water Shortages

1.1.1 General Approach

Economic analysis as it relates to water resources planning generally falls into two broad areas. Supply side analysis focuses on costs and alternatives of developing new water supplies or implementing programs that provide additional water from current supplies. Demand side analysis concentrates on impacts or benefits of providing water to people, businesses and the environment. Analysis in this report focuses strictly on demand side impacts. When analyzing the economic impacts of water shortages as defined in Texas water planning, three potential scenarios are possible:

1) Scenario 1 involves situations where there are physical shortages of raw surface or groundwater due to drought of record conditions. For example, City A relies on a reservoir with average conservation storage of 500 acre-feet per year and a firm yield of 100 acre feet. In 2010, the city uses about 50 acre-feet per year, but by 2030 their demands are expected to increase to 200 acre-feet. Thus, in 2030 the reservoir would not have enough water to meet the city's demands,

and people would experience a shortage of 100 acre-feet assuming drought of record conditions. Under normal or average climatic conditions, the reservoir would likely be able to provide reliable water supplies well beyond 2030.

2) Scenario 2 is a situation where despite drought of record conditions, water supply sources can meet existing use requirements; however, limitations in water infrastructure would preclude future water user groups from accessing these water supplies. For example, City B relies on a river that can provide 500 acre-feet per year during drought of record conditions and other constraints as dictated by planning assumptions. In 2010, the city is expected to use an estimated 100 acre-feet per year and by 2060 it would require no more than 400 acre-feet. But the intake and pipeline that currently transfers water from the river to the city's treatment plant has a capacity of only 200 acre-feet of water per year. Thus, the city's water supplies are adequate even under the most restrictive planning assumptions, but their conveyance system is too small. This implies that at some point – perhaps around 2030 - infrastructure limitations would constrain future population growth and any associated economic activity or impacts.

3) Scenario 3 involves water user groups that rely primarily on aquifers that are being depleted. In this scenario, projected and in some cases existing demands may be unsustainable as groundwater levels decline. Areas that rely on the Ogallala aquifer are a good example. In some communities in the region, irrigated agriculture forms a major base of the regional economy. With less irrigation water from the Ogallala, population and economic activity in the region could decline significantly assuming there are no offsetting developments.

Assessing the social and economic effects of each of the above scenarios requires various levels and methods of analysis and would generate substantially different results for a number of reasons; the most important of which has to do with the time frame of each scenario. Scenario 1 falls into the general category of static analysis. This means that models would measure impacts for a small interval of time such as a drought. Scenarios 2 and 3, on the other hand imply a dynamic analysis meaning that models are concerned with changes over a much longer time period.

Since administrative rules specify that planning analysis be evaluated under drought of record conditions (a static and random event), socioeconomic impact analysis developed by the TWDB for the state water plan is based on assumptions of Scenario 1. Estimated impacts under scenario 1 are point estimates for years in which needs are reported (2010, 2020, 2030, 2040, 2050 and 2060). They are independent and distinct "what if" scenarios for a particular year and shortages are assumed to be temporary events resulting from drought of record conditions. Estimated impacts measure what would happen if water user groups experience water shortages for a period of one year.

The TWDB recognize that dynamic models may be more appropriate for some water user groups; however, combining approaches on a statewide basis poses several problems. For one, it would require a complex array of analyses and models, and might require developing supply and demand forecasts under "normal" climatic conditions as opposed to drought of record conditions. Equally important is the notion that combining the approaches would produce inconsistent results across regions resulting in a so-called "apples to oranges" comparison.

A variety tools are available to estimate economic impacts, but by far, the most widely used today are input-output models (IO models) combined with social accounting matrices (SAMs). Referred to as IO/SAM models, these tools formed the basis for estimating economic impacts for agriculture (irrigation and livestock water uses) and industry (manufacturing, mining, steam-electric and commercial business activity for municipal water uses).

Since the planning horizon extends through 2060, economic variables in the baseline are adjusted in accordance with projected changes in demographic and economic activity. Growth rates for municipal water use sectors (i.e., commercial, residential and institutional) are based on TWDB population forecasts. Future values for manufacturing, agriculture, and mining and steam-electric activity are based on the same underlying economic forecasts used to estimate future water use for each category.

The following steps outline the overall process.

Step 1*: Generate IO/SAM Models and Develop Economic Baseline*

IO/SAM models were estimated using propriety software known as IMPLAN PRO™ (Impact for Planning Analysis). IMPLAN is a modeling system originally developed by the U.S. Forestry Service in the late 1970s. Today, the Minnesota IMPLAN Group (MIG Inc.) owns the copyright and distributes data and software. It is probably the most widely used economic impact model in existence. IMPLAN comes with databases containing the most recently available economic data from a variety of sources.[1] Using IMPLAN software and data, transaction tables conceptually similar to the one discussed previously were estimated for each county in the region and for the region as a whole. Each transaction table contains 528 economic sectors and allows one to estimate a variety of economic statistics including:

- **total sales -** total production measured by sales revenues;
- **intermediate sales -** sales to other businesses and industries within a given region;
- **final sales –** sales to end users in a region and exports out of a region**;**
- **employment -** number of full and part-time jobs (annual average) required by a given industry including self-employment;
- **regional income -** total payroll costs (wages and salaries plus benefits) paid by industries, corporate income, rental income and interest payments; and
- **business taxes -** sales, excise, fees, licenses and other taxes paid during normal operation of an industry (does not include income taxes).

TWDB analysts developed an economic baseline containing each of the above variables using year 2000 data. Since the planning horizon extends through 2060, economic variables in the baseline were allowed to change in accordance with projected changes in demographic and economic activity. Growth rates for municipal water use sectors (i.e., commercial, residential and institutional) are based on TWDB population forecasts. Projections for manufacturing, agriculture, and mining and steam-electric activity are based on the same underlying economic forecasts used to estimate future water use for each category. Monetary impacts in future years are reported in constant year 2006 dollars.

It is important to stress that employment, income and business taxes are the most useful variables when comparing the relative contribution of an economic sector to a regional economy. Total sales as reported in IO/SAM models are less desirable and can be misleading because they include sales to other industries in the region for use in the production of other goods. For example, if a mill buys grain from local farmers and uses it to produce feed, sales of both the processed feed and raw corn are counted as "output" in an IO model. Thus, total sales double-count or overstate the true economic value of goods

[1]The IMPLAN database consists of national level technology matrices based on benchmark input-output accounts generated by the U.S. Bureau of Economic Analysis and estimates of final demand, final payments, industry output and employment for various economic sectors. IMPLAN regional data (i.e. states, a counties or groups of counties within a state) are divided into two basic categories: 1) data on an industry basis including value-added, output and employment, and 2) data on a commodity basis including final demands and institutional sales. State-level data are balanced to national totals using a matrix ratio allocation system and county data are balanced to state totals.

and services produced in an economy. They are not consistent with commonly used measures of output such as Gross National Product (GNP), which counts only final sales.

Another important distinction relates to terminology. Throughout this report, the term *sector* refers to economic subdivisions used in the IMPLAN database and resultant input-output models (528 individual sectors based on Standard Industrial Classification Codes). In contrast, the phrase *water use category* refers to water user groups employed in state and regional water planning including irrigation, livestock, mining, municipal, manufacturing and steam electric. Each IMPLAN sector was assigned to a specific water use category.

Step 2: *Estimate Direct and Indirect Economic Impacts of Water Needs*

Direct impacts are reductions in output by sectors experiencing water shortages. For example, without adequate cooling and process water a refinery would have to curtail or cease operation, car washes may close, or farmers may not be able to irrigate and sales revenues fall. Indirect impacts involve changes in inter-industry transactions as supplying industries respond to decreased demands for their services, and how seemingly non-related businesses are affected by decreased incomes and spending due to direct impacts. For example, if a farmer ceases operations due to a lack of irrigation water, they would likely reduce expenditures on supplies such as fertilizer, labor and equipment, and businesses that provide these goods would suffer as well.

Direct impacts accrue to immediate businesses and industries that rely on water and without water industrial processes could suffer. However, output responses may vary depending upon the severity of shortages. A small shortage relative to total water use would likely have a minimal impact, but large shortages could be critical. For example, farmers facing small shortages might fallow marginally productive acreage to save water for more valuable crops. Livestock producers might employ emergency culling strategies, or they may consider hauling water by truck to fill stock tanks. In the case of manufacturing, a good example occurred in the summer of 1999 when Toyota Motor Manufacturing experienced water shortages at a facility near Georgetown, Kentucky.[2] As water levels in the Kentucky River fell to historic lows due to drought, plant managers sought ways to curtail water use such as reducing rinse operations to a bare minimum and recycling water by funneling it from paint shops to boilers. They even considered trucking in water at a cost of 10 times what they were paying. Fortunately, rains at the end of the summer restored river levels, and Toyota managed to implement cutbacks without affecting production, but it was a close call. If rains had not replenished the river, shortages could have severely reduced output.[3]

To account for uncertainty regarding the relative magnitude of impacts to farm and business operations, the following analysis employs the concept of elasticity. Elasticity is a number that shows how a change in one variable will affect another. In this case, it measures the relationship between a percentage reduction in water availability and a percentage reduction in output. For example, an elasticity of 1.0 indicates that a 1.0 percent reduction in water availability would result in a 1.0 percent reduction in economic output. An elasticity of 0.50 would indicate that for every 1.0 percent of unavailable water, output is reduced by 0.50 percent and so on. Output elasticities used in this study are:[4]

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[2] Royal, W. "*High And Dry - Industrial Centers Face Water Shortages*." in Industry Week, Sept, 2000.

[3] The efforts described above are not planned programmatic or long-term operational changes. They are emergency measures that individuals might pursue to alleviate what they consider a temporary condition. Thus, they are not characteristic of long-term management strategies designed to ensure more dependable water supplies such as capital investments in conservation technology or development of new water supplies.

[4] Elasticities are based on one of the few empirical studies that analyze potential relationships between economic output and water shortages in the United States. The study, conducted in California, showed that a significant number of industries would suffer reduced output during water shortages. Using a survey based approach researchers posed two scenarios to different industries. In

- if water needs are 0 to 5 percent of total water demand, no corresponding reduction in output is assumed;

- if water needs are 5 to 30 percent of total water demand, for each additional one percent of water need that is not met, there is a corresponding 0.50 percent reduction in output;

- if water needs are 30 to 50 percent of total water demand, for each additional one percent of water need that is not met, there is a corresponding 0.75 percent reduction in output; and

- if water needs are greater than 50 percent of total water demand, for each additional one percent of water need that is not met, there is a corresponding 1.0 percent (i.e., a proportional reduction).

In some cases, elasticities are adjusted depending upon conditions specific to a given water user group.

Once output responses to water shortages were estimated, direct impacts to total sales, employment, regional income and business taxes were derived using regional level economic multipliers estimating using IO/SAM models. The formula for a given IMPLAN sector is:

$D_{i,t} = Q_{i,t} *_{,} S_{i,t} * E_Q * RFD_i * DM_{i(Q, L, I, T)}$

where:

$D_{i,t}$ = direct economic impact to sector *i* in period *t*

$Q_{i,t}$ = total sales for sector *i* in period *t* in an affected county

$RFD_{i,}$ = ratio of final demand to total sales for sector *i* for a given region

$S_{i,t}$ = water shortage as percentage of total water use in period *t*

E_Q = elasticity of output and water use

$DM_{i(L, I, T)}$ = direct output multiplier coefficients for labor (L), income (I) and taxes (T) for sector *i*.

Secondary impacts were derived using the same formula used to estimate direct impacts; however, indirect multiplier coefficients are used. Methods and assumptions specific to each water use sector are discussed in Sections 1.1.2 through 1.1.4.

the first scenario, they asked how a 15 percent cutback in water supply lasting one year would affect operations. In the second scenario, they asked how a 30 percent reduction lasting one year would affect plant operations. In the case of a 15 percent shortage, reported output elasticities ranged from 0.00 to 0.76 with an average value of 0.25. For a 30 percent shortage, elasticities ranged from 0.00 to 1.39 with average of 0.47. For further information, see, California Urban Water Agencies, "*Cost of Industrial Water Shortages,*" Spectrum Economics, Inc. November, 1991.

General Assumptions and Clarification of the Methodology

As with any attempt to measure and quantify human activities at a societal level, assumptions are necessary and every model has limitations. Assumptions are needed to maintain a level of generality and simplicity such that models can be applied on several geographic levels and across different economic sectors. In terms of the general approach used here several clarifications and cautions are warranted:

1. Shortages as reported by regional planning groups are the starting point for socioeconomic analyses.

2. Estimated impacts are point estimates for years in which needs are reported (i.e., 2010, 2020, 2030, 2040, 2050 and 2060).They are independent and distinct "what if" scenarios for each particular year and water shortages are assumed to be temporary events resulting from severe drought conditions combined with infrastructure limitations. In other words, growth occurs and future shocks are imposed on an economy at 10-year intervals and resultant impacts are measured. Given, that reported figures are not cumulative in nature, it is inappropriate to sum impacts over the entire planning horizon. Doing so, would imply that the analysis predicts that drought of record conditions will occur every ten years in the future, which is not the case. Similarly, authors of this report recognize that in many communities needs are driven by population growth, and in the future total population will exceed the amount of water available due to infrastructure limitations, regardless of whether or not there is a drought. This implies that infrastructure limitations would constrain economic growth. However, since needs as defined by planning rules are based upon water supply and demand under the assumption of drought of record conditions, it improper to conduct economic analysis that focuses on growth related impacts over the planning horizon. Figures generated from such an analysis would presume a 50-year drought of record, which is unrealistic. Estimating lost economic activity related to constraints on population and commercial growth due to lack of water would require developing water supply and demand forecasts under "normal" or "most likely" future climatic conditions.

3. While useful for planning purposes, this study is not a benefit-cost analysis. Benefit cost analysis is a tool widely used to evaluate the economic feasibility of specific policies or projects as opposed to estimating economic impacts of unmet water needs. Nevertheless, one could include some impacts measured in this study as part of a benefit cost study if done so properly. Since this is not a benefit cost analysis, future impacts are not weighted differently. In other words, estimates are not discounted. If used as a measure of economic benefits, one should incorporate a measure of uncertainty into the analysis. In this type of analysis, a typical method of discounting future values is to assign probabilities of the drought of record recurring again in a given year, and weight monetary impacts accordingly. This analysis assumes a probability of one.

4. IO multipliers measure the strength of backward linkages to supporting industries (i.e., those who sell inputs to an affected sector). However, multipliers say nothing about forward linkages consisting of businesses that purchase goods from an affected sector for further processing. For example, ranchers in many areas sell most of their animals to local meat packers who process animals into a form that consumers ultimately see in grocery stores and restaurants. Multipliers do not capture forward linkages to meat packers, and since meat packers sell livestock purchased from ranchers as "final sales," multipliers for the ranching sector do fully account for all losses to a region's economy. Thus, as mentioned previously, in some cases closely linked sectors were moved from one water use category to another.

5. Cautions regarding interpretations of direct and secondary impacts are warranted. IO/SAM multipliers are based on "fixed-proportion production functions," which basically means that input use - including labor - moves in lockstep fashion with changes in levels of output. In a

scenario where output (i.e., sales) declines, losses in the immediate sector or supporting sectors could be much less than predicted by an IO/SAM model for several reasons. For one, businesses will likely expect to continue operating so they might maintain spending on inputs for future use; or they may be under contractual obligations to purchase inputs for an extended period regardless of external conditions. Also, employers may not lay-off workers given that experienced labor is sometimes scarce and skilled personnel may not be readily available when water shortages subside. Lastly people who lose jobs might find other employment in the region. As a result, direct losses for employment and secondary losses in sales and employment should be considered an upper bound. Similarly, since projected population losses are based on reduced employment in the region, they should be considered an upper bound as well.

6. IO models are static. Models and resultant multipliers are based upon the structure of the U.S. and regional economies in 2006. In contrast, water shortages are projected to occur well into the future. Thus, the analysis assumes that the general structure of the economy remains the same over the planning horizon, and the farther out into the future we go, this assumption becomes less reliable.

7. Impacts are annual estimates. If one were to assume that conditions persisted for more than one year, figures should be adjusted to reflect the extended duration. The drought of record in most regions of Texas lasted several years.

8. Monetary figures are reported in constant year 2006 dollars.

1.1.2 Impacts to Agriculture

Irrigated Crop Production

The first step in estimating impacts to irrigation required calculating gross sales for IMPLAN crop sectors. Default IMPLAN data do not distinguish irrigated production from dry-land production. Once gross sales were known other statistics such as employment and income were derived using IMPLAN direct multiplier coefficients. Gross sales for a given crop are based on two data sources:

1) county-level statistics collected and maintained by the TWDB and the USDA Farm Services Agency (FSA) including the number of irrigated acres by crop type and water application per acre, and

2) regional-level data published by the Texas Agricultural Statistics Service (TASS) including prices received for crops (marketing year averages), crop yields and crop acreages.

Crop categories used by the TWDB differ from those used in IMPLAN datasets. To maintain consistency, sales and other statistics are reported using IMPLAN crop classifications. Table 1 shows the TWDB crops included in corresponding IMPLAN sectors, and Table 2 summarizes acreage and estimated annual water use for each crop classification (five-year average from 2003-2007). Table 3 displays average (2003-2007) gross revenues per acre for IMPLAN crop categories.

Table 1: Crop Classifications Used in TWDB Water Use Survey and Corresponding IMPLAN Crop Sectors	
IMPLAN Category	**TWDB Category**
Oilseeds	Soybeans and “other oil crops”
Grains	Grain sorghum, corn, wheat and “other grain crops”
Vegetable and melons	“Vegetables” and potatoes
Tree nuts	Pecans
Fruits	Citrus, vineyard and other orchard
Cotton	Cotton
Sugarcane and sugar beets	Sugarcane and sugar beets
All “other” crops	“Forage crops”, peanuts, alfalfa, hay and pasture, rice and “all other crops”

Table 2: Summary of Irrigated Crop Acreage and Water Demand for the Region F Water Planning Area (average 2003-2007)

Sector	Acres (1000s)	Distribution of acres	Water use (1000s of AF)	Distribution of water use
Oilseeds	<1	<1%	<1	<1%
Grains	45	20%	62	17%
Vegetable and melons	5	2%	9	<1%
Tree nuts	6	3%	13	<1%
Fruits	<1	<1%	1	<1%
Cotton	104	47%	154	42%
All “other” crops	61	28%	123	34%
Total	221	100%	363	100%

Source: Water demand figures are a 5- year average (2003-2007) of the TWDB’s annual Irrigation Water Use Estimates. Statistics for irrigated crop acreage are based upon annual survey data collected by the TWDB and the Farm Service Agency. Values do not include acreage or water use for the TWDB categories classified by the Farm Services Agency as “failed acres,” “golf course” or “waste water.”

Table 3: Average Gross Sales Revenues per Acre for Irrigated Crops for the Region F Water Planning Area (2003-2007)		
IMPLAN Sector	**Gross revenues per acre**	**Crops included in estimates**
Oilseeds	$177	Irrigated figure is based on five-year (2003-2007) average weighted by acreage for “irrigated soybeans” and “irrigated ‘other’ oil crops.”
Grains	$199	Based on five-year (2003-2007) average weighted by acreage for “irrigated grain sorghum,” “irrigated corn”, “irrigated wheat” and “irrigated ‘other’ grain crops.”
Vegetable and melons	$6,053	Based on five-year (2003-2007) average weighted by acreage for “irrigated shallow and deep root vegetables”, “irrigated Irish potatoes” and “irrigated melons.”
Tree nuts	$3,451	Based on five-year (2003-2007) average weighted by acreage for “irrigated pecans.”
Fruits	$5,902	Based on five-year (2003-2007) average weighted by acreage for “irrigated citrus”, “irrigated vineyards” and “irrigated ‘other’ orchard.”
Cotton	$488	Based on five-year (2003-2007) average weighted by acreage for “irrigated cotton.”
All other crops	$335	Irrigated figure is based on five-year (2003-2007) average weighted by acreage for “irrigated ‘forage’ crops”, “irrigated peanuts”, “irrigated alfalfa”, “irrigated ‘hay’ and pasture” and “irrigated ‘all other’ crops.”
*Figures are rounded. Source: Based on data from the Texas Agricultural Statistics Service, Texas Water Development Board, and Texas A&M University.		

An important consideration when estimating impacts to irrigation was determining which crops are affected by water shortages. One approach is the so-called rationing model, which assumes that farmers respond to water supply cutbacks by fallowing the lowest value crops in the region first and the highest valued crops last until the amount of water saved equals the shortage.[5] For example, if farmer A grows vegetables (higher value) and farmer B grows wheat (lower value) and they both face a proportionate cutback in irrigation water, then farmer B will sell water to farmer A. Farmer B will fallow her irrigated acreage before farmer A fallows anything. Of course, this assumes that farmers can and do transfer enough water to allow this to happen. A different approach involves constructing farm-level profit maximization models that conform to widely-accepted economic theory that farmers make decisions based on marginal net returns. Such models have good predictive capability, but data requirements and complexity are high. Given that a detailed analysis for each region would require a substantial amount of farm-level data and analysis, the following investigation assumes that projected shortages are distributed equally across predominant crops in the region. Predominant in this case are crops that comprise at least one percent of total acreage in the region.

The following steps outline the overall process used to estimate direct impacts to irrigated agriculture:

1. *Distribute shortages across predominant crop types in the region*. Again, unmet water needs were distributed equally across crop sectors that constitute one percent or more of irrigated acreage.

2. *Estimate associated reductions in output for affected crop sectors*. Output reductions are based on elasticities discussed previously and on estimated values per acre for different crops. Values per acre stem from the same data used to estimate output for the year 2006 baseline. Using multipliers, we then generate estimates of forgone income, jobs, and tax revenues based on reductions in gross sales and final demand.

Livestock

The approach used for the livestock sector is basically the same as that used for crop production. As is the case with crops, livestock categorizations used by the TWDB differ from those used in IMPLAN datasets, and TWDB groupings were assigned to a given IMPLAN sector (Table 4). Then we:

1) *Distribute projected water needs equally among predominant livestock sectors and estimate lost output*: As is the case with irrigation, shortages are assumed to affect all livestock sectors equally; however, the category of "other" is not included given its small size. If water needs were small relative to total demands, we assume that producers would haul in water by truck to fill stock tanks. The cost per acre-foot ($24,000) is based on 2008 rates charged by various water haulers in Texas, and assumes that the average truck load is 6,500 gallons at a hauling distance of 60 miles.

3) *Estimate reduced output in forward processors for livestock sectors*. Reductions in output for livestock sectors are assumed to have a proportional impact on forward processors in the region such as meat packers. In other words, if the cows were gone, meat-packing plants or fluid milk manufacturers) would likely have little to process. This is not an unreasonable premise. Since the

[5] The rationing model was initially proposed by researchers at the University of California at Berkeley, and was then modified for use in a study conducted by the U.S. Environmental Protection Agency that evaluated how proposed water supply cutbacks recommended to protect water quality in the Bay/Delta complex in California would affect farmers in the Central Valley. See, Zilberman, D., Howitt, R. and Sunding, D. "*Economic Impacts of Water Quality Regulations in the San Francisco Bay and Delt*a." Western Consortium for Public Health. May 1993.

1950s, there has been a major trend towards specialized cattle feedlots, which in turn has decentralized cattle purchasing from livestock terminal markets to direct sales between producers and slaughterhouses. Today, the meat packing industry often operates large processing facilities near high concentrations of feedlots to increase capacity utilization.[6] As a result, packers are heavily dependent upon nearby feedlots. For example, a recent study by the USDA shows that on average meat packers obtain 64 percent of cattle from within 75 miles of their plant, 82 percent from within 150 miles and 92 percent from within 250 miles.[7]

Table 4: Description of Livestock Sectors	
IMPLAN Category	**TWDB Category**
Cattle ranching and farming	Cattle, cow calf, feedlots and dairies
Poultry and egg production	Poultry production.
Other livestock	Livestock other than cattle and poultry (i.e., horses, goats, sheep, hogs)
Milk manufacturing	Fluid milk manufacturing, cheese manufacturing, ice cream manufacturing etc.
Meat packing	Meat processing present in the region from slaughter to final processing

1.1.3 Impacts to Municipal Water User Groups

Disaggregation of Municipal Water Demands

Estimating the economic impacts for the municipal water user groups is complicated for a number of reasons. For one, municipal use comprises a range of consumers including commercial businesses, institutions such as schools and government and households. However, reported water needs are not distributed among different municipal water users. In other words, how much of a municipal need is commercial and how much is residential (domestic)?

The amount of commercial water use as a percentage of total municipal demand was estimated based on "GED" coefficients (gallons per employee per day) published in secondary sources.[8] For example, if year 2006 baseline data for a given economic sector (e.g., amusement and recreation services) shows employment at 30 jobs and the GED coefficient is 200, then average daily water use by that sector is (30 x 200 = 6,000 gallons) or 6.7 acre-feet per year. Water not attributed to commercial use is considered

[6] Ferreira, W.N. "*Analysis of the Meat Processing Industry in the United States*." Clemson University Extension Economics Report ER211, January 2003.

[7] Ward, C.E. "*Summary of Results from USDA's Meatpacking Concentration Study*." Oklahoma Cooperative Extension Service, OSU Extension Facts WF-562.

[8] Sources for GED coefficients include: Gleick, P.H., Haasz, D., Henges-Jeck, C., Srinivasan, V., Wolff, G. Cushing, K.K., and Mann, A. "*Waste Not, Want Not*: *The Potential for Urban Water Conservation in California*." Pacific Institute. November 2003. U.S. Bureau of the Census. 1982 Census of Manufacturers: Water Use in Manufacturing. USGPO, Washington D.C. See also: "*U.S. Army Engineer Institute for Water Resources, IWR Report 88-R-6.*," Fort Belvoir, VA. See also, Joseph, E. S., 1982, "*Municipal and Industrial Water Demands of the Western United States*." Journal of the Water Resources Planning and Management Division, Proceedings of the American Society of Civil Engineers, v. 108, no. WR2, p. 204-216. See also, Baumann, D. D., Boland, J. J., and Sims, J. H., 1981, "*Evaluation of Water Conservation for Municipal and Industrial Water Supply*." U.S. Army Corps of Engineers, Institute for Water Resources, Contract no. 82-C1.

domestic, which includes single and multi-family residential consumption, institutional uses and all use designated as "county-other." Based on our analysis, commercial water use is about 5 to 35 percent of municipal demand. Less populated rural counties occupy the lower end of the spectrum, while larger metropolitan counties are at the higher end.

After determining the distribution of domestic versus commercial water use, we developed methods for estimating impacts to the two groups.

Domestic Water Uses

Input output models are not well suited for measuring impacts of shortages for domestic water uses, which make up the majority of the municipal water use category. To estimate impacts associated with domestic water uses, municipal water demand and needs are subdivided into residential, and commercial and institutional use. Shortages associated with residential water uses are valued by estimating proxy demand functions for different water user groups allowing us to estimate the marginal value of water, which would vary depending upon the level of water shortages. The more severe the water shortage, the more costly it becomes. For instance, a 2 acre-foot shortage for a group of households that use 10 acre-feet per year would not be as severe as a shortage that amounted to 8 acre-feet. In the case of a 2 acre-foot shortage, households would probably have to eliminate some or all outdoor water use, which could have implicit and explicit economic costs including losses to the horticultural and landscaping industry. In the case of an 8 acre-foot shortage, people would have to forgo all outdoor water use and most indoor water consumption. Economic impacts would be much higher in the latter case because people, and would be forced to find emergency alternatives assuming alternatives were available.

To estimate the value of domestic water uses, TWDB staff developed marginal loss functions based on constant elasticity demand curves. This is a standard and well-established method used by economists to value resources such as water that have an explicit monetary cost.

A constant price elasticity of demand is estimated using a standard equation:

$$w = kc^{(-\varepsilon)}$$

where:

- w is equal to average monthly residential water use for a given water user group measured in thousands of gallons;
- k is a constant intercept;
- c is the average cost of water per 1,000 gallons; and
- ε is the price elasticity of demand.

Price elasticities (-0.30 for indoor water use and -0.50 for outdoor use) are based on a study by Bell et al.[9] that surveyed 1,400 water utilities in Texas that serve at least 1,000 people to estimate demand elasticity for several variables including price, income, weather etc. Costs of water and average use per month per household are based on data from the Texas Municipal League's annual water and wastewater rate surveys - specifically average monthly household expenditures on water and wastewater

[9] Bell, D.R. and Griffin, R.C. "*Community Water Demand in Texas as a Century is Turned*." Research contract report prepared for the Texas Water Development Board. May 2006.

in different communities across the state. After examining variance in costs and usage, three different categories of water user groups based on population (population less than 5,000, cities with populations ranging from 5,000 to 99,999 and cities with populations exceeding 100,000) were selected to serve as proxy values for municipal water groups that meet the criteria (Table 5).[10]

Table 5: Water Use and Costs Parameters Used to Estimated Water Demand Functions
(average monthly costs per acre-foot for delivered water and average monthly use per household)

Community Population	Water	Wastewater	Total monthly cost	Avg. monthly use (gallons)
Less than or equal to 5,000	$1,335	$1,228	$2,563	6,204
5,000 to 100,000	$1,047	$1,162	$2,209	7,950
Great than or equal to 100,000	$718	$457	$1,190	8,409

Source: Based on annual water and wastewater rate surveys published by the Texas Municipal League.

As an example, Table 6 shows the economic impact per acre-foot of domestic water needs for municipal water user groups with population exceeding 100,000 people. There are several important assumptions incorporated in the calculations:

1) Reported values are net of the variable costs of treatment and distribution such as expenses for chemicals and electricity since using less water involves some savings to consumers and utilities alike; and for outdoor uses we do not include any value for wastewater.

2) Outdoor and "non-essential" water uses would be eliminated before indoor water consumption was affected, which is logical because most water utilities in Texas have drought contingency plans that generally specify curtailment or elimination of outdoor water use during droughts.[11] Determining how much water is used for outdoor purposes is based on several secondary sources. The first is a major study sponsored by the American Water Works Association, which surveyed cities in states including Colorado, Oregon, Washington, California, Florida and Arizona. On average across all cities surveyed 58 percent of single family residential water use was for outdoor activities. In cities with climates comparable to large metropolitan areas of Texas, the average was 40 percent.[12] Earlier findings of the U.S. Water Resources Council showed a national

[10] Ideally, one would want to estimate demand functions for each individual utility in the state. However, this would require an enormous amount of time and resources. For planning purposes, we believe the values generated from aggregate data are more than sufficient.

[11] In Texas, state law requires retail and wholesale water providers to prepare and submit plans to the Texas Commission on Environmental Quality (TCEQ). Plans must specify demand management measures for use during drought including curtailment of "non-essential water uses." Non-essential uses include, but are not limited to, landscape irrigation and water for swimming pools or fountains. For further information see the Texas Environmental Quality Code §288.20.

[12] See, Mayer, P.W., DeOreo, W.B., Opitz, E.M., Kiefer, J.C., Davis, W., Dziegielewski, D., Nelson, J.O. "*Residential End Uses of Water*." Research sponsored by the American Water Works Association and completed by Aquacraft, Inc. and Planning and Management Consultants, Ltd. (PMCL@CDM).

average of 33 percent. Similarly, the United States Environmental Protection Agency (USEPA) estimated that landscape watering accounts for 32 percent of total residential and commercial water use on annual basis.[13] A study conducted for the California Urban Water Agencies (CUWA) calculated average annual values ranging from 25 to 35 percent.[14] Unfortunately, there does not appear to be any comprehensive research that has estimated non-agricultural outdoor water use in Texas. As an approximation, an average annual value of 30 percent based on the above references was selected to serve as a rough estimate in this study.

3) As shortages approach 100 percent values become immense and theoretically infinite at 100 percent because at that point death would result, and willingness to pay for water is immeasurable. Thus, as shortages approach 80 percent of monthly consumption, we assume that households and non-water intensive commercial businesses (those that use water only for drinking and sanitation would have water delivered by tanker truck or commercial water delivery companies. Based on reports from water companies throughout the state, we estimate that the cost of trucking in water is around $21,000 to $27,000 per acre-feet assuming a hauling distance of between 20 to 60 miles. This is not an unreasonable assumption. The practice was widespread during the 1950s drought and recently during droughts in this decade. For example, in 2000 at the heels of three consecutive drought years Electra - a small town in North Texas - was down to its last 45 days worth of reservoir water when rain replenished the lake, and the city was able to refurbish old wells to provide supplemental groundwater. At the time, residents were forced to limit water use to 1,000 gallons per person per month - less than half of what most people use - and many were having water delivered to their homes by private contractors.[15] In 2003 citizens of Ballinger, Texas, were also faced with a dwindling water supply due to prolonged drought. After three years of drought, Lake Ballinger, which supplies water to more than 4,300 residents in Ballinger and to 600 residents in nearby Rowena, was almost dry. Each day, people lined up to get water from a well in nearby City Park. Trucks hauling trailers outfitted with large plastic and metal tanks hauled water to and from City Park to Ballinger.[16]

[13] U.S. Environmental Protection Agency. *"Cleaner Water through Conservation*." USEPA Report no. 841-B-95-002. April, 1995.

[14] Planning and Management Consultants, Ltd. "*Evaluating Urban Water Conservation Programs: A Procedures Manual*." Prepared for the California Urban Water Agencies. February 1992.

[15] Zewe, C. "*Tap Threatens to Run Dry in Texas Town*." July 11, 2000. CNN Cable News Network.

[16] Associated Press, "*Ballinger Scrambles to Finish Pipeline before Lake Dries Up*." May 19, 2003.

Table 6: Economic Losses Associated with Domestic Water Shortages in Communities with Populations Exceeding 100,000 people				
Water shortages as a percentage of total monthly household demands	**No. of gallons remaining per household per day**	**No of gallons remaining per person per day**	**Economic loss (per acre-foot)**	**Economic loss (per gallon)**
1%	278	93	$748	$0.00005
5%	266	89	$812	$0.0002
10%	252	84	$900	$0.0005
15%	238	79	$999	$0.0008
20%	224	75	$1,110	$0.0012
25%	210	70	$1,235	$0.0015
30%[a]	196	65	$1,699	$0.0020
35%	182	61	$3,825	$0.0085
40%	168	56	$4,181	$0.0096
45%	154	51	$4,603	$0.011
50%	140	47	$5,109	$0.012
55%	126	42	$5,727	$0.014
60%	112	37	$6,500	$0.017
65%	98	33	$7,493	$0.02
70%	84	28	$8,818	$0.02
75%	70	23	$10,672	$0.03
80%	56	19	$13,454	$0.04
85%	42	14	$18,091 ($24,000)[b]	$0.05 ($0.07)[b]
90%	28	9	$27,363 ($24,000)	$0.08 ($0.07)
95%	14	5	$55,182 ($24,000)	$0.17 ($0.07)
99%	3	0.9	$277,728 ($24,000)	$0.85 ($0.07)
99.9%	1	0.5	$2,781,377 ($24,000)	$8.53 ($0.07)
100%	0	0	Infinite ($24,000)	Infinite ($0.07)

[a] The first 30 percent of needs are assumed to be restrictions of outdoor water use; when needs reach 30 percent of total demands all outdoor water uses would be restricted. Needs greater than 30 percent include indoor use

[b] As shortages approach 100 percent the value approaches infinity assuming there are not alternatives available; however, we assume that communities would begin to have water delivered by tanker truck at an estimated cost of $24,000 per acre-foot when shortages breached 85 percent.

Commercial Businesses

Effects of water shortages on commercial sectors were estimated in a fashion similar to other business sectors meaning that water shortages would affect the ability of these businesses to operate. This is particularly true for "water intensive" commercial sectors that are need large amounts of water (in addition to potable and sanitary water) to provide their services. These include:

- car-washes,
- laundry and cleaning facilities,
- sports and recreation clubs and facilities including race tracks,
- amusement and recreation services,
- hospitals and medical facilities,
- hotels and lodging places, and
- eating and drinking establishments.

A key assumption is that commercial operations would not be affected until water shortages were at least 50 percent of total municipal demand. In other words, we assume that residential water consumers would reduce water use including all non-essential uses before businesses were affected.

An example will illustrate the breakdown of municipal water needs and the overall approach to estimating impacts of municipal needs. Assume City A experiences an unexpected shortage of 50 acre-feet per year when their demands are 200 acre-feet per year. Thus, shortages are only 25 percent of total municipal use and residents of City A could eliminate needs by restricting landscape irrigation. City B, on the other hand, has a deficit of 150 acre-feet in 2020 and a projected demand of 200 acre-feet. Thus, total shortages are 75 percent of total demand. Emergency outdoor and some indoor conservation measures could eliminate 50 acre-feet of projected needs, yet 50 acre-feet would still remain. To eliminate" the remaining 50 acre-feet water intensive commercial businesses would have to curtail operations or shut down completely.

Three other areas were considered when analyzing municipal water shortages: 1) lost revenues to water utilities, 2) losses to the horticultural and landscaping industries stemming for reduction in water available for landscape irrigation, and 3) lost revenues and related economic impacts associated with reduced water related recreation.

Water Utility Revenues

Estimating lost water utility revenues was straightforward. We relied on annual data from the "*Water and Wastewater Rate Survey*" published annually by the Texas Municipal League to calculate an average value per acre-foot for water and sewer. For water revenues, average retail water and sewer rates multiplied by total water needs served as a proxy. For lost wastewater, total unmet needs were adjusted for return flow factor of 0.60 and multiplied by average sewer rates for the region. Needs reported as "county-other" were excluded under the presumption that these consist primarily of self-supplied water uses. In addition, 15 percent of water demand and needs are considered non-billed or "unaccountable" water that comprises things such as leakages and water for municipal government functions (e.g., fire departments). Lost tax receipts are based on current rates for the "miscellaneous gross receipts tax, "which the state collects from utilities located in most incorporated cities or towns in Texas. We do not include lost water utility revenues when aggregating impacts of municipal water shortages to regional and state levels to prevent double counting.

Horticultural and Landscaping Industry

The horticultural and landscaping industry, also referred to as the "green Industry," consists of businesses that produce, distribute and provide services associated with ornamental plants, landscape and garden supplies and equipment. Horticultural industries often face big losses during drought. For example, the recent drought in the Southeast affecting the Carolinas and Georgia horticultural and landscaping businesses had a harsh year. Plant sales were down, plant mortality increased, and watering costs increased. Many businesses were forced to close locations, lay off employees, and even file for bankruptcy. University of Georgia economists put statewide losses for the industry at around $3.2 billion during the 3-year drought that ended in 2008.[17] Municipal restrictions on outdoor watering play a significant role. During drought, water restrictions coupled with persistent heat has a psychological effect on homeowners that reduces demands for landscaping products and services. Simply put, people were afraid to spend any money on new plants and landscaping.

In Texas, there do not appear to be readily available studies that analyze the economic effects of water shortages on the industry. However, authors of this report believe negative impacts do and would result in restricting landscape irrigation to municipal water consumers. The difficulty in measuring them is two-fold. First, as noted above, data and research for these types of impacts that focus on Texas are limited; and second, economic data provided by IMPLAN do not disaggregate different sectors of the green industry to a level that would allow for meaningful and defensible analysis.[18]

Recreational Impacts

Recreational businesses often suffer when water levels and flows in rivers, springs and reservoirs fall significantly during drought. During droughts, many boat docks and lake beaches are forced to close, leading to big losses for lakeside business owners and local communities. Communities adjacent to popular river and stream destinations such as Comal Springs and the Guadalupe River also see their business plummet when springs and rivers dry up. Although there are many examples of businesses that have suffered due to drought, dollar figures for drought-related losses to the recreation and tourism industry are not readily available, and very difficult to measure without extensive local surveys. Thus, while they are important, economic impacts are not measured in this study.

Table 7 summarizes impacts of municipal water shortages at differing levels of magnitude, and shows the ranges of economic costs or losses per acre-foot of shortage for each level.

[17] Williams, D. *"Georgia landscapers eye rebound from Southeast drought."* Atlanta Business Chronicle, Friday, June 19, 2009

[18] Economic impact analyses prepared by the TWDB for 2006 regional water plans did include estimates for the horticultural industry. However, year 2000 and prior IMPLAN data were disaggregated to a finer level. In the current dataset (2006), the sector previously listed as "Landscaping and Horticultural Services" (IMPLAN Sector 27) is aggregated into "Services to Buildings and Dwellings" (IMPLAN Sector 458).

Table 7: Impacts of Municipal Water Shortages at Different Magnitudes of Shortages		
Water shortages as percent of total municipal demands	Impacts	Economic costs per acre-foot*
0-30%	✓ Lost water utility revenues ✓ Restricted landscape irrigation and non-essential water uses	\$730 - \$2,040
30-50%	✓ Lost water utility revenues ✓ Elimination of landscape irrigation and non-essential water uses ✓ Rationing of indoor use	\$2,040 - \$10,970
>50%	✓ Lost water utility revenues ✓ Elimination of landscape irrigation and non-essential water uses ✓ Rationing of indoor use ✓ Restriction or elimination of commercial water use ✓ Importing water by tanker truck	\$10,970 - varies
*Figures are rounded		

1.1.4 Industrial Water User Groups

Manufacturing

Impacts to manufacturing were estimated by distributing water shortages among industrial sectors at the county level. For example, if a planning group estimates that during a drought of record water supplies in County A would only meet 50 percent of total annual demands for manufactures in the county, we reduced output for each sector by 50 percent. Since projected manufacturing demands are based on TWDB Water Uses Survey data for each county, we only include IMPLAN sectors represented in the TWBD survey database. Some sectors in IMPLAN databases are not part of the TWDB database given that they use relatively small amounts of water - primarily for on-site sanitation and potable purposes. To maintain consistency between IMPLAN and TWDB databases, Standard Industrial Classification (SIC) codes both databases were cross referenced in county with shortages. Non-matches were excluded when calculating direct impacts.

Mining

The process of mining is very similar to that of manufacturing. We assume that within a given county, shortages would apply equally to relevant mining sectors, and IMPLAN sectors are cross referenced with TWDB data to ensure consistency.

In Texas, oil and gas extraction and sand and gravel (aggregates) operations are the primary mining industries that rely on large volumes of water. For sand and gravel, estimated output reductions are straightforward; however, oil and gas is more complicated for a number of reasons. IMPLAN does not necessarily report the physical extraction of minerals by geographic local, but rather the sales revenues reported by a particular corporation.

For example, at the state level revenues for IMPLAN sector 19 (oil and gas extraction) and sector 27 (drilling oil and gas wells) totals $257 billion. Of this, nearly $85 billion is attributed to Harris County. However, only a very small fraction (less than one percent) of actual production takes place in the county. To measure actual potential losses in well head capacity due to water shortages, we relied on county level production data from the Texas Railroad Commission (TRC) and average well-head market prices for crude and gas to estimate lost revenues in a given county. After which, we used to IMPLAN ratios to estimate resultant losses in income and employment.

Other considerations with respect to mining include:

> 1) Petroleum and gas extraction industry only uses water in significant amounts for secondary recovery. Known in the industry as enhanced or water flood extraction, secondary recovery involves pumping water down injection wells to increase underground pressure thereby pushing oil or gas into other wells. IMPLAN output numbers do not distinguish between secondary and non-secondary recovery. To account for the discrepancy, county-level TRC data that show the proportion of barrels produced using secondary methods were used to adjust IMPLAN data to reflect only the portion of sales attributed to secondary recovery.
>
> 2) A substantial portion of output from mining operations goes directly to businesses that are classified as manufacturing in our schema. Thus, multipliers measuring backward linkages for a given manufacturer might include impacts to a supplying mining operation. Care was taken not to double count in such situations if both a mining operation and a manufacturer were reported as having water shortages.

Steam-electric

At minimum without adequate cooling water, power plants cannot safely operate. As water availability falls below projected demands, water levels in lakes and rivers that provide cooling water would also decline. Low water levels could affect raw water intakes and outfalls at electrical generating units in several ways. For one, power plants are regulated by thermal emission guidelines that specify the maximum amount of heat that can go back into a river or lake via discharged cooling water. Low water levels could result in permit compliance issues due to reduced dilution and dispersion of heat and subsequent impacts on aquatic biota near outfalls.[19] However, the primary concern would be a loss of head (i.e., pressure) over intake structures that would decrease flows through intake tunnels. This would affect safety related pumps, increase operating costs and/or result in sustained shut-downs. Assuming plants did shutdown, they would not be able to generate electricity.

[19] Section 316 (b) of the Clean Water Act requires that thermal wastewater discharges do not harm fish and other wildlife.

Among all water use categories steam-electric is unique and cautions are needed when applying methods used in this study. Measured changes to an economy using input-output models stem directly from changes in sales revenues. In the case of water shortages, one assumes that businesses will suffer lost output if process water is in short supply. For power generation facilities this is true as well. However, the electric services sector in IMPLAN represents a corporate entity that may own and operate several electrical generating units in a given region. If one unit became inoperable due to water shortages, plants in other areas or generation facilities that do not rely heavily on water such as gas powered turbines might be able to compensate for lost generating capacity. Utilities could also offset lost production via purchases on the spot market.[20] Thus, depending upon the severity of the shortages and conditions at a given electrical generating unit, energy supplies for local and regional communities could be maintained. But in general, without enough cooling water, utilities would have to throttle back plant operations, forcing them to buy or generate more costly power to meet customer demands.

Measuring impacts end users of electricity is not part of this study as it would require extensive local and regional level analysis of energy production and demand. To maintain consistency with other water user groups, impacts of steam-electric water shortages are measured in terms of lost revenues (and hence income) and jobs associated with shutting down electrical generating units.

1.2 Social Impacts of Water Shortages

As the name implies, the effects of water shortages can be social or economic. Distinctions between the two are both semantic and analytical in nature – more so analytic in the sense that social impacts are harder to quantify. Nevertheless, social effects associated with drought and water shortages are closely tied to economic impacts. For example, they might include:

- demographic effects such as changes in population,
- disruptions in institutional settings including activity in schools and government,
- conflicts between water users such as farmers and urban consumers,
- health-related low-flow problems (e.g., cross-connection contamination, diminished sewage flows, increased pollutant concentrations),
- mental and physical stress (e.g., anxiety, depression, domestic violence),
- public safety issues from forest and range fires and reduced fire fighting capability,
- increased disease caused by wildlife concentrations,
- loss of aesthetic and property values, and
- reduced recreational opportunities.[21]

[20] Today, most utilities participate in large interstate "power pools" and can buy or sell electricity "on the grid" from other utilities or power marketers. Thus, assuming power was available to buy, and assuming that no contractual or physical limitations were in place such as transmission constraints; utilities could offset lost power that resulted from waters shortages with purchases via the power grid.

[21] Based on information from the website of the National Drought Mitigation Center at the University of Nebraska Lincoln. Available online at: http://www.drought.unl.edu/risk/impacts.htm. See also, Vanclay, F. "*Social Impact Assessment*." in Petts, J. (ed) International Handbook of Environmental Impact Assessment. 1999.

Social impacts measured in this study focus strictly on demographic effects including changes in population and school enrollment. Methods are based on demographic projection models developed by the Texas State Data Center and used by the TWDB for state and regional water planning. Basically, the social impact model uses results from the economic component of the study and assesses how changes in labor demand would affect migration patterns in a region. Declines in labor demand as measured using adjusted IMPLAN data are assumed to affect net economic migration in a given regional water planning area. Employment losses are adjusted to reflect the notion that some people would not relocate but would seek employment in the region and/or public assistance and wait for conditions to improve. Changes in school enrollment are simply the proportion of lost population between the ages of 5 and 17.

2. Results

Section 2 presents the results of the analysis at the regional level. Included are baseline economic data for each water use category, and estimated economics impacts of water shortages for water user groups with reported deficits. According to the 2011 *Region F Regional Water Plan*, during severe drought irrigation, livestock municipal, manufacturing, mining and steam-electric water user groups would experience water shortages in the absence of new water management strategies.

2.1 Overview of Regional Economy

On an annual basis, the Region F economy generates $20.8 billion worth of gross state product for Texas ($19.1 billion in income and $1.7 billion in business taxes) and supports nearly 227,000 jobs (Table 8). Generating about $9.8 billion in gross state product, agriculture, manufacturing, and mining are the region's primary base economic sectors.[22] Municipal sectors also generate substantial amounts of income and are major employers in the region; however, many businesses that make up the municipal category such as restaurants and retail stores are non-basic industries meaning they exist to provide services to people who work would in base industries. In other words, without base industries, many jobs categorized as municipal would not exist.

[22] Base industries are those that supply markets outside of the region. These industries are crucial to the local economy and are called the economic base of a region. Appendix A shows how IMPLAN's 529 sectors were allocated to water use category, and shows economic data for each sector.

Table 8: The Region F Economy by Water User Group ($millions)*						
Water Use Category	**Total sales**	**Intermediate sales**	**Final sales**	**Jobs**	**Income**	**Business taxes**
Irrigation	$131.11	$21.48	$109.67	2,267	$68.24	$1.79
Livestock	$801.61	$432.80	$368.82	11,083	$78.45	$11.11
Manufacturing	$8,793.15	$1,386.66	$7,406.49	36,089	$2,613.94	$51.57
Mining	$11,507.80	$5,279.12	$6,228.68	27,668	$6,415.53	$563.76
Steam-electric	$376.64	$105.96	$270.68	932	$261.54	$44.63
Municipal	$15,709.07	$3,801.30	$11,907.77	148,786	$9,682.07	$981.89
Regional total	$37,319.38	$11,027.32	$26,292.11	226,825	$19,119.77	$1,654.75

[a] Appendix 1 displays data for individual IMPLAN sectors that make up each water use category. Based on data from the Texas Water Development Board, and year 2006 data from the Minnesota IMPLAN Group, Inc.

2.2 Impacts of Agricultural Water Shortages

According to the 2011 *Region F Regional Water Plan*, during severe drought most counties in the region would experiences shortages of irrigation water ranging anywhere from about 5 to 90 percent of total annual irrigation demands. Shortages of these magnitudes would reduce gross state product (income plus state and local business taxes) by about $30 to 35 million depending upon the decade Table 9).

Table 9: Economic Impacts of Water Shortages for Irrigation Water User Groups ($millions)			
Decade	**Lost income from reduced crop production ***	**Lost state and local tax revenues from reduced crop production**	**Lost jobs from reduced crop production**
2010	$34.97	$1.70	454
2020	$34.45	$1.68	448
2030	$33.89	$1.65	442
2040	$33.02	$1.61	432
2050	$32.48	$1.58	426
2060	$31.97	$1.56	419

*Changes to income and business taxes are collectively equivalent to a decrease in gross state product, which is analogous to gross domestic product measured at the state rather than national level. Appendix 2 shows results by water user group.

2.3 Impacts of Municipal Water Shortages

Water shortages are projected to occur in a significant number of communities throughout the region, and deficits range anywhere from 1 to 100 percent of total annual water demands. At the regional level, the estimated economic value of domestic water shortages totals $164 million in 2010 and $446 million in 2060 (Table 10). Due to curtailment of commercial business activity, municipal shortages would also reduce gross state product (income plus taxes) by $40 million in 2010 and $433 million in 2060.

Table 10: Economic Impacts of Water Shortages for Municipal Water User Groups ($millions)

Decade	Monetary value of domestic water shortages	Lost income from reduced commercial business activity*	Lost state and local taxes from reduced commercial business activity	Lost jobs from reduced commercial business activity	Lost water utility revenues
2010	$164.31	$35.84	1,165	$3.58	$22.60
2020	$244.46	$36.34	1,180	$3.64	$38.89
2030	$275.39	$119.12	3,208	$9.52	$48.62
2040	$363.08	$366.53	9,367	$27.34	$62.99
2050	$432.97	$386.74	9,940	$29.00	$67.58
2060	$446.11	$403.41	10,360	$30.22	$72.94

*Changes to Income and business taxes are collectively equivalent to a decrease in gross state product, which is analogous to gross domestic product measured at the state rather than national level. Appendix 2 shows results by water user group.

2.4 Impacts of Manufacturing Water Shortages

Manufacturing water shortages are projected to occur in the counties of Coleman, Ector, Howard, Kimble, Runnels, and Tom Green. Projected shortages would reduce gross state product (income plus taxes) by an estimated $891 million in 2020 and $1,356 million in 2060 (Table 11).

Table 11: Economic Impacts of Water Shortages for Manufacturing Water User Groups ($millions)			
Decade	**Lost income due to reduced manufacturing output***	**Lost state and local business tax revenues due to reduced manufacturing output**	**Lost jobs due to reduced manufacturing output**
2010	$829.61	$62.12	15,723
2020	$936.77	$69.97	17,705
2030	$994.28	$75.07	19,076
2040	$1,092.03	$82.10	20,836
2050	$1,166.59	$87.70	22,261
2060	$1,261.31	$94.74	24,041

*Changes to Income and business taxes are collectively equivalent to a decrease in gross state product, which is analogous to gross domestic product measured at the state rather than national level. Appendix 2 shows results by water user group.

2.5 Impacts of Mining Water Shortages

Mining water shortages are projected to occur in Coleman, Coke, and Howard counties, and would primarily affect oil extraction. Combined shortages for each county would result in estimated losses of gross state product totaling $13.5 million dollars in 2010 and $11.0 million 2060 (Table 12).

Table 12: Economic Impacts of Water Shortages for Mining Water User Groups ($millions)			
Decade	**Lost income due to reduced mining output***	**Lost state and local business tax revenues due to reduced mining output**	**Lost jobs due to reduced mining output**
2010	$12.50	$0.94	78
2020	$16.04	$1.21	101
2030	$2.26	$0.14	13
2040	$4.75	$0.33	29
2050	$6.70	$0.49	41
2060	$9.83	$0.73	61

*Changes to Income and business taxes are collectively equivalent to a decrease in gross state product, which is analogous to gross domestic product measured at the state rather than national level. Appendix 2 shows results by water user group.

2.6 Impacts of Steam-electric Water Shortages

Water shortages for electrical generating units are projected in Coke, Ector, Mitchell, Tom Green and Ward counties resulting in estimated losses of gross state product totaling $607 million dollars in 2010, and $2,017 billion in 2060 (Table 13).

Table 13: Economic Impacts of Water Shortages for Steam-electric Water User Groups ($millions)			
Decade	Lost income due to reduced electrical generation*	Lost state and local business tax revenues due to reduced electrical generation	Lost jobs due to reduced electrical generation
2010	$530.83	$76.19	1,805
2020	$691.34	$99.23	2,350
2030	$1,045.50	$150.07	3,554
2040	$1,232.24	$176.87	4,189
2050	$1,468.65	$210.80	4,993
2060	$1,763.75	$253.16	5,996

*Changes to Income and business taxes are collectively equivalent to a decrease in gross state product, which is analogous to gross domestic product measured at the state rather than national level. Appendix 2 shows results by water user group.

2.7 Social Impacts of Water Shortages

As discussed previously, social impacts focus on changes in population and school enrollment in the region. In 2010, estimated population losses total 25,050 with corresponding reductions in school enrollment of 7,065 students (Table 15). In 2060, population would decline by 49,236 and school enrollment would fall by 9,106.

Table 15: Social Impacts of Water Shortages (2010-2060)		
Year	Population Losses	Declines in School Enrollment
2010	25,050	7,065
2020	26,239	7,444
2030	31,670	8,389
2040	41,980	7,759
2050	45,362	8,378
2060	49,236	9,106

2.8 Distribution of Impacts by Major River Basin

Administrative rules require that impacts are presented by both planning region and major river basin. To meet rule requirements, impacts were allocated among basins based on the distribution of water shortages in relevant basins. For example, if 50 percent of water shortages in River Basin A and 50 percent occur in River Basin B, then impacts were split equally among the two basins. Table 16 displays the results.

Table 16: Distribution of Impacts by Major River Basin (2010-2060)

River Basin	2010	2020	2030	2040	2050	2060
Brazos	1%	1%	1%	1%	1%	1%
Colorado	80%	82%	82%	83%	83%	83%
Rio Grande	19%	17%	17%	16%	16%	16%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Appendix 1: Economic Data for Individual IMPLAN Sectors

Economic Data for Agricultural Water User Groups ($millions)

Water Use Category	IMPLAN Sector	IMPLAN Code	Total Sales	Intermediate Sales	Final Sales	Jobs	Income	Business Taxes
Irrigation	Cotton Farming	8	$53.73	$0.73	$53.04	919	$19.78	$0.48
Irrigation	Vegetable and Melon Farming	3	$27.14	$0.97	$26.17	233	$19.84	$0.24
Irrigation	Tree Nut Farming	4	$19.17	$1.01	$18.16	376	$13.34	$0.46
Irrigation	All "Other" Crop Farming	10	$18.30	$16.92	$1.38	206	$8.98	$0.35
Irrigation	Grain Farming	2	$8.96	$1.29	$7.67	446	$4.14	$0.16
Irrigation	Fruit Farming	5	$3.75	$0.57	$3.18	85	$2.13	$0.08
Irrigation	Oilseed Farming	1	$0.07	$0.00	$0.07	2	$0.03	$0.00
Livestock	Cattle ranching and farming	11	$401.54	$278.43	$123.11	7,838	$31.72	$8.44
Livestock	Animal- except poultry- slaughtering	67	$315.06	$84.24	$230.82	832	$31.15	$1.73
Livestock	Animal production- except cattle and poultry	13	$54.48	$46.20	$8.29	2,237	$5.30	$0.84
Livestock	Poultry and egg production	12	$30.53	$23.93	$6.60	176	$10.28	$0.10
	Total Agriculture		$932.73	$454.27	$478.50	13,350	$146.68	$12.90

Based on year 2006 data from the Minnesota IMPLAN Group, Inc.

Economic Data for Mining and Steam-electric Water User Groups ($millions)

Water Use Category	IMPLAN Sector	IMPLAN Code	Total Sales	Intermediate Sales	Final Sales	Jobs	Income	Business Taxes
Mining	Oil and gas extraction	19	$5,205.54	$4,834.32	$371.22	8,214	$3,001.63	$308.29
Mining	Drilling oil and gas wells	27	$3,371.52	$16.83	$3,354.69	5,299	$997.63	$131.53
Mining	Support activities for oil and gas operations	28	$2,408.86	$334.58	$2,074.28	11,698	$2,184.47	$98.47
Mining	Stone mining and quarrying	24	$348.51	$35.86	$312.65	2,055	$178.44	$13.95
Mining	Natural gas distribution	31	$134.21	$53.79	$80.42	261	$31.27	$10.24
Mining	Sand- gravel- clay- and refractory mining	25	$22.60	$2.39	$20.21	85	$13.55	$0.67
Mining	Other nonmetallic mineral mining	26	$13.05	$1.30	$11.74	30	$7.39	$0.49
Mining	Support activities for other mining	29	$3.52	$0.05	$3.47	26	$1.16	$0.14
Total Mining	NA		$11,507.80	$5,279.12	$6,228.68	27,668	$6,415.53	$563.76
Steam-electric	Power generation and supply		$376.64	$105.96	$270.68	932	$261.54	$44.63

Based on year 2006 data from the Minnesota IMPLAN Group, Inc.

Economic Data for Manufacturing Water User Groups ($millions)									
Water Use Category	**IMPLAN Sector**	**IMPLAN Code**	**Total Sales**	**Intermediate Sales**	**Final Sales**	**Jobs**	**Income**	**Business Taxes**
Manufacturing	Petroleum refineries	142	$1,416.82	$526.63	$890.19	156	$154.70	$5.98
Manufacturing	New residential one-unit structures- all	33	$851.38	$0.00	$851.38	5,727	$282.36	$4.44
Manufacturing	Oil and gas field machinery and equipment	261	$523.73	$19.50	$504.22	1,465	$124.96	$2.54
Manufacturing	Other aluminum rolling and drawing	213	$482.71	$13.42	$469.30	642	$68.79	$2.74
Manufacturing	Commercial and institutional buildings	38	$479.41	$0.00	$479.41	4,993	$242.23	$2.98
Manufacturing	Air and gas compressor manufacturing	289	$392.54	$4.04	$388.51	911	$128.34	$2.41
Manufacturing	Vitreous china plumbing fixture manufacturing	182	$370.11	$19.16	$350.94	1,581	$194.11	$3.58
Manufacturing	Prefabricated metal buildings and components	232	$244.97	$12.30	$232.68	1,032	$50.43	$1.18
Manufacturing	Other new construction	41	$209.12	$0.00	$209.12	2,290	$112.29	$0.88
Manufacturing	Other miscellaneous chemical products	171	$149.55	$78.24	$71.31	333	$26.61	$0.65
Manufacturing	Synthetic rubber manufacturing	153	$148.58	$3.64	$144.94	199	$34.04	$0.82
Manufacturing	Asphalt paving mixture and blocks	143	$140.29	$125.83	$14.46	211	$27.81	$0.15
Manufacturing	Machine shops	243	$134.79	$32.53	$102.26	860	$70.03	$1.12
Manufacturing	Fabricated structural metal manufacturing	233	$121.00	$6.27	$114.74	482	$41.45	$0.67
Manufacturing	New residential additions and alterations-all	35	$120.95	$0.00	$120.95	682	$44.73	$0.63
Manufacturing	Cement manufacturing	191	$120.37	$0.32	$120.05	202	$53.57	$1.09
Manufacturing	Plastics pipe- fittings- and profile shapes	173	$116.14	$71.44	$44.70	310	$35.38	$0.80
Manufacturing	Plate work manufacturing	234	$110.15	$6.93	$103.21	446	$43.92	$0.57
Manufacturing	Iron- steel pipe and tubes	205	$107.02	$7.47	$99.55	209	$37.69	$0.96
Manufacturing	Motor vehicle parts manufacturing	350	$104.97	$8.44	$96.53	279	$26.82	$0.49
Manufacturing	Highway- street- bridge- and tunnel construct	39	$103.00	$0.00	$103.00	967	$51.86	$0.66
Manufacturing	Soft drink and ice manufacturing	85	$93.76	$5.24	$88.52	161	$7.92	$0.35
Manufacturing	New multifamily housing structures	34	$92.77	$0.00	$92.77	832	$43.47	$0.25
Manufacturing	Cut and sew apparel manufacturing	107	$76.34	$2.07	$74.27	541	$26.77	$0.43
Manufacturing	Water- sewer- and pipeline construction	40	$74.90	$0.00	$74.90	630	$33.22	$0.48
Manufacturing	Paperboard container manufacturing	126	$74.18	$0.79	$73.39	241	$18.19	$0.71
Manufacturing	Household vacuum cleaner manufacturing	328	$73.63	$2.78	$70.84	263	$24.46	$0.55
Manufacturing	All other manufacturing	various	$1,859.96	$439.61	$1,420.35	9,444	$607.80	$13.47
	Total manufacturing		**$8,793.15**	**$1,386.66**	**$7,406.49**	**36,089**	**$2,613.94**	**$51.57**
Based on year 2006 data from the Minnesota IMPLAN Group, Inc.								

Economic Data for Municipal Water User Groups ($millions)								
Water Use Category	**IMPLAN Sector**	**IMPLAN Code**	**Total Sales**	**Intermediate Sales**	**Final Sales**	**Jobs**	**Income**	**Business Taxes**
Municipal	Wholesale trade	390	$2,098.95	$1,004.90	$1,094.05	12,934	$1,105.37	$310.12
Municipal	Owner-occupied dwellings	509	$1,892.34	$0.00	$1,892.34	0	$1,465.93	$223.76
Municipal	State & Local Education	503	$1,254.80	$0.00	$1,254.79	31,837	$1,254.80	$0.00
Municipal	Telecommunications	422	$965.38	$331.59	$633.79	3,360	$362.46	$60.38
Municipal	Food services and drinking places	481	$928.45	$118.56	$809.89	19,811	$373.53	$43.64
Municipal	Monetary authorities and depository credit in	430	$736.91	$242.70	$494.21	4,003	$517.47	$9.43
Municipal	State & Local Non-Education	504	$729.16	$0.00	$729.16	13,857	$729.16	$0.00
Municipal	Offices of physicians- dentists- and other he	465	$692.35	$0.00	$692.35	6,505	$486.53	$4.26
Municipal	Pipeline transportation	396	$617.24	$269.94	$347.30	801	$204.11	$43.20
Municipal	Truck transportation	394	$524.82	$284.17	$240.64	4,007	$240.77	$5.45
Municipal	Hospitals	467	$508.85	$0.00	$508.85	4,933	$252.98	$3.23
Municipal	Motor vehicle and parts dealers	401	$498.77	$54.24	$444.54	4,626	$257.34	$72.89
Municipal	Machinery and equipment rental and leasing	434	$433.59	$235.80	$197.78	1,401	$175.66	$6.14
Municipal	Real estate	431	$414.65	$164.14	$250.51	2,447	$240.10	$50.89
Municipal	Commercial machinery repair and maintenance	485	$413.71	$217.81	$195.90	2,466	$216.38	$15.81
Municipal	Architectural and engineering services	439	$402.20	$253.54	$148.67	3,640	$201.97	$1.68
Municipal	General merchandise stores	410	$375.62	$39.59	$336.03	7,016	$167.88	$53.50
Municipal	Other State and local government enterprises	499	$356.82	$116.19	$240.62	1,797	$121.61	$0.04
Municipal	Federal Military	505	$312.73	$0.00	$312.73	4,027	$312.73	$0.00
Municipal	Food and beverage stores	405	$283.68	$37.93	$245.75	5,296	$142.16	$31.15
Municipal	Federal Non-Military	506	$261.85	$0.00	$261.84	1,655	$261.84	$0.00
Municipal	Nursing and residential care facilities	468	$260.81	$0.00	$260.81	5,608	$161.88	$3.82
Municipal	Legal services	437	$258.66	$164.16	$94.50	2,162	$161.43	$5.06
Municipal	Management of companies and enterprises	451	$243.64	$229.12	$14.52	1,331	$136.89	$2.19
Municipal	Gasoline stations	407	$243.12	$36.92	$206.19	3,266	$131.09	$35.27
Municipal	All other municipal	various	$5,964.80	$2,337.40	$3,627.40	95,011	$2,952.30	$228.33
Municipal	Total municipal		$15,709.07	$3,801.30	$11,907.77	148,786	$9,682.07	$981.89
Based on year 2006 data from the Minnesota IMPLAN Group, Inc.								

Appendix 2: Impacts by Water User Group

Irrigation cont. ($millions)						
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Andrews County						
Reduced income from curtailed crop production	$2.6873	$2.6810	$2.6522	$2.3621	$2.3197	$2.2847
Reduced business taxes from curtailed crop production	$0.1093	$0.1090	$0.1079	$0.0961	$0.0943	$0.0929
Reduced jobs from curtailed crop production	33	33	33	29	29	28
Borden County						
Reduced income from curtailed crop production	$0.49	$0.49	$0.49	$0.49	$0.49	$0.49
Reduced business taxes from curtailed crop production	$0.02	$0.02	$0.02	$0.02	$0.02	$0.02
Reduced jobs from curtailed crop production	6	6	6	6	6	6
Brown County						
Reduced income from curtailed crop production	$1.31	$1.31	$1.31	$1.30	$1.30	$1.30
Reduced business taxes from curtailed crop production	$0.06	$0.06	$0.06	$0.06	$0.06	$0.06
Reduced jobs from curtailed crop production	31	31	31	31	31	31
Coke County						
Reduced income from curtailed crop production	$0.03	$0.03	$0.03	$0.03	$0.03	$0.03
Reduced business taxes from curtailed crop production	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Reduced jobs from curtailed crop production	1	1	1	1	1	1
Coleman County						
Reduced income from curtailed crop production	$0.23	$0.23	$0.23	$0.23	$0.23	$0.23
Reduced business taxes from curtailed crop production	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01
Reduced jobs from curtailed crop production	6	6	6	6	6	6
Glasscock County						
Reduced income from curtailed crop production	$12.24	$12.06	$11.88	$11.69	$11.51	$11.33
Reduced business taxes from curtailed crop production	$0.60	$0.59	$0.58	$0.57	$0.56	$0.55
Reduced jobs from curtailed crop production	142	140	138	136	134	132

Irrigation cont. ($millions)	2010	2020	2030	2040	2050	2060
Irion County						
Reduced income from curtailed crop production	$0.13	$0.12	$0.12	$0.11	$0.11	$0.10
Reduced business taxes from curtailed crop production	$0.003	$0.003	$0.003	$0.003	$0.003	$0.003
Reduced jobs from curtailed crop production	2	2	2	1	1	1
Martin County						
Reduced income from curtailed crop production	$0.26	$0.19	$0.11	$0.00	$0.00	$0.00
Reduced business taxes from curtailed crop production	$0.01	$0.01	$0.00	$0.00	$0.00	$0.00
Reduced jobs from curtailed crop production	5	5	5	5	4	4
Menard County						
Reduced income from curtailed crop production	$0.46	$0.46	$0.45	$0.45	$0.44	$0.44
Reduced business taxes from curtailed crop production	$0.03	$0.03	$0.03	$0.02	$0.02	$0.02
Reduced jobs from curtailed crop production	10	10	10	10	10	10
Midland County						
Reduced income from curtailed crop production	$1.72	$1.73	$1.73	$1.72	$1.71	$1.69
Reduced business taxes from curtailed crop production	$0.09	$0.09	$0.09	$0.09	$0.08	$0.08
Reduced jobs from curtailed crop production	22	22	22	22	22	22
Reagan County						
Reduced income from curtailed crop production	$1.36	$1.31	$1.25	$1.18	$1.11	$1.04
Reduced business taxes from curtailed crop production	$0.07	$0.07	$0.06	$0.06	$0.06	$0.05
Reduced jobs from curtailed crop production	15	14	14	13	12	11
Runnels County						
Reduced income from curtailed crop production	$3.17	$3.09	$3.02	$2.94	$2.87	$2.79
Reduced business taxes from curtailed crop production	$0.16	$0.15	$0.15	$0.15	$0.14	$0.14
Reduced jobs from curtailed crop production	45	44	43	42	41	40
Tom Green County						
Reduced income from curtailed crop production	$0.20	$0.20	$0.20	$0.20	$0.19	$0.19
Reduced business taxes from curtailed crop production	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01
Reduced jobs from curtailed crop production	3	3	3	3	3	3
Upton County						
Reduced income from curtailed crop production	$5.99	$5.96	$5.93	$5.90	$5.86	$5.83
Reduced business taxes from curtailed crop production	$0.30	$0.30	$0.30	$0.29	$0.29	$0.29
Reduced jobs from curtailed crop production	79	78	78	77	77	77

Irrigation cont. ($millions)						
	2010	2020	2030	2040	2050	2060
Ward County						
Reduced income from curtailed crop production	$0.09	$0.08	$0.10	$0.11	$0.11	$0.11
Reduced business taxes from curtailed crop production	$0.004	$0.004	$0.005	$0.01	$0.01	$0.01
Reduced jobs from curtailed crop production	2	1	2	2	2	2

Manufacturing ($millions)						
	2010	2020	2030	2040	2050	2060
Coleman County						
Reduced income from reduced manufacturing output	$0.78	$0.78	$0.78	$0.78	$0.78	$0.78
Reduced business taxes from reduced manufacturing output	$0.11	$0.11	$0.11	$0.11	$0.11	$0.11
Reduced jobs from reduced manufacturing output	55	55	55	55	55	55
Ector County						
Reduced income from reduced manufacturing output	$14.56	$19.85	$4.30	$15.75	$15.36	$16.23
Reduced business taxes from reduced manufacturing output	$0.71	$0.97	$0.21	$0.77	$0.75	$0.80
Reduced jobs from reduced manufacturing output	147	201	43	159	155	164
Howard County						
Reduced income from reduced manufacturing output	$7.04	$11.97	$0.00	$2.82	$4.93	$8.75
Reduced business taxes from reduced manufacturing output	$0.35	$0.59	$0.00	$0.14	$0.24	$0.43
Reduced jobs from reduced manufacturing output	71	121	0	29	50	89
Kimble County						
Reduced income from reduced manufacturing output	$50.42	$55.11	$59.15	$63.27	$67.02	$72.07
Reduced business taxes from reduced manufacturing output	$2.69	$2.94	$3.16	$3.38	$3.58	$3.84
Reduced jobs from reduced manufacturing output	163	179	192	205	217	234
Runnels County						
Reduced income from reduced manufacturing output	$20.83	$23.14	$25.13	$27.11	$28.76	$31.08
Reduced business taxes from reduced manufacturing output	$1.60	$1.78	$1.93	$2.09	$2.21	$2.39
Reduced jobs from reduced manufacturing output	421	467	508	548	581	628
Tom Green County						
Reduced income from reduced manufacturing output	$735.98	$825.91	$904.93	$982.30	$1,049.74	$1,132.40
Reduced business taxes from reduced manufacturing output	$56.65	$63.58	$69.66	$75.61	$80.81	$87.17
Reduced jobs from reduced manufacturing output	14,865	16,682	18,278	19,840	21,203	22,872

Mining ($millions)						
	2010	2020	2030	2040	2050	2060
Coke County						
Reduced income from reduced mining activity	$2.12	$2.93	$0.05	$0.59	$1.06	$1.77
Reduced business taxes from reduced mining activity	$0.15	$0.20	$0.00	$0.04	$0.07	$0.12
Reduced jobs from reduced mining activity	13	18	0	4	6	11
Coleman County						
Reduced income from reduced mining activity	$1.91	$2.02	$2.02	$2.02	$2.02	$2.02
Reduced business taxes from reduced mining activity	$0.11	$0.12	$0.12	$0.12	$0.12	$0.12
Reduced jobs from reduced mining activity	11	12	12	12	12	12
Howard County						
Reduced income from reduced mining activity	$8.48	$11.09	$0.19	$2.14	$3.63	$6.04
Reduced business taxes from reduced mining activity	$0.68	$0.89	$0.02	$0.17	$0.29	$0.49
Reduced jobs from reduced mining activity	54	71	1	14	23	39

Steam-electric ($millions)						
	2010	2020	2030	2040	2050	2060
Coke County						
Reduced income from reduced electrical generation	$23.08	$18.39	$21.52	$25.24	$29.86	$35.52
Reduced business taxes from reduced electrical generation	$3.31	$2.64	$3.09	$3.62	$4.29	$5.10
Reduced jobs from reduced electrical generation	78	63	73	86	102	121
Ector County						
Reduced income from reduced electrical generation	$31.29	$203.76	$565.96	$759.10	$994.54	$1,281.52
Reduced business taxes from reduced electrical generation	$4.49	$29.25	$81.23	$108.96	$142.75	$183.94
Reduced jobs from reduced electrical generation	106	693	1,924	2,580	3,381	4,356
Mitchell County						
Reduced income from reduced electrical generation	$456.24	$440.25	$424.18	$408.10	$392.11	$376.04
Reduced business taxes from reduced electrical generation	$65.49	$63.19	$60.88	$58.58	$56.28	$53.97
Reduced jobs from reduced electrical generation	1,551	1,497	1,442	1,387	1,333	1,278
Tom Green County						
Reduced income from reduced electrical generation	$20.22	$28.93	$33.85	$39.80	$47.06	$55.92
Reduced business taxes from reduced electrical generation	$2.90	$4.15	$4.86	$5.71	$6.76	$8.03
Reduced jobs from reduced electrical generation	69	98	115	135	160	190
Ward County						
Reduced income from reduced electrical generation	$0.00	$0.00	$0.00	$0.00	$5.07	$14.74
Reduced business taxes from reduced electrical generation	$0.00	$0.00	$0.00	$0.00	$0.73	$2.12
Reduced jobs from reduced electrical generation	0	0	0	0	17	50

Municipal ($millions)						
	2010	2020	2030	2040	2050	2060
Andrews						
Monetary value of domestic water shortages	$0.00	$0.00	$0.00	$0.96	$0.98	$0.99
Lost utility revenues	$0.00	$0.00	$0.00	$1.49	$1.51	$1.53
Ballinger						
Monetary value of domestic water shortages	$7.38	$10.75	$7.67	$8.54	$23.75	$24.94
Lost income from reduced commercial business activity	$3.51	$4.15	$1.67	$1.95	$7.52	$7.90
Lost jobs due to reduced commercial business activity	132	156	63	74	284	298
Lost state and local taxes from reduced commercial business activity	$0.38	$0.45	$0.18	$0.21	$0.82	$0.86
Lost utility revenues	$1.31	$1.49	$1.35	$1.51	$2.33	$2.45
Brady						
Monetary value of domestic water shortages	$8.03	$8.13	$7.99	$7.84	$7.75	$7.75
Lost income from reduced commercial business activity	$1.06	$1.09	$1.05	$1.02	$1.00	$1.00
Lost jobs due to reduced commercial business activity	41	42	40	39	38	38
Lost state and local taxes from reduced commercial business activity	$0.12	$0.13	$0.12	$0.12	$0.12	$0.12
Lost utility revenues	$1.97	$2.00	$1.96	$1.92	$1.90	$1.90
Bronte Village						
Monetary value of domestic water shortages	$0.00	$0.02	$0.03	$0.05	$0.07	$0.09
Lost utility revenues	$0.00	$0.04	$0.06	$0.07	$0.09	$0.11
Coahoma						
Monetary value of domestic water shortages	$0.10	$0.12	$0.001	$0.01	$0.02	$0.04
Lost utility revenues	$0.10	$0.12	$0.002	$0.02	$0.04	$0.06
Coleman						
Monetary value of domestic water shortages	$25.91	$25.58	$25.24	$24.90	$24.66	$24.66
Lost income from reduced commercial business activity	$12.43	$12.28	$12.11	$11.95	$11.83	$11.83
Lost jobs due to reduced commercial business activity	348	344	339	335	332	332
Lost state and local taxes from reduced commercial business activity	$0.96	$0.95	$0.94	$0.92	$0.91	$0.91
Lost utility revenues	$2.54	$2.51	$2.48	$2.45	$2.42	$2.42

Municipal ($millions)						
	2010	2020	2030	2040	2050	2060
County-other (Coke)						
Monetary value of domestic water shortages	$0.04	$0.05	$0.00	$0.01	$0.01	$0.02
County-other (Coleman)						
Monetary value of domestic water shortages	$0.46	$0.43	$0.43	$0.43	$0.43	$0.46
County-other (Kimble)						
Monetary value of domestic water shortages	$0.01	$0.01	$0.003	$0.00	$0.00	$0.00
County-other (Menard)						
Monetary value of domestic water shortages	$0.03	$0.03	$0.03	$0.02	$0.02	$0.03
County-other (Runnels)						
Monetary value of domestic water shortages	$7.92	$6.38	$5.21	$3.96	$3.00	$1.85
County-other (Scurry)						
Monetary value of domestic water shortages	$0.07	$0.08	$0.00	$0.01	$0.03	$0.04
County-other (Tom Green)						
Monetary value of domestic water shortages	$0.04	$0.00	$0.00	$0.00	$0.00	$0.00
County-other (Ward)						
Monetary value of domestic water shortages	$0.00	$3.60	$3.60	$3.60	$3.60	$3.60
Junction						
Monetary value of domestic water shortages	$18.87	$18.85	$18.67	$18.49	$18.35	$18.35
Lost income from reduced commercial business activity	$9.58	$9.57	$9.48	$9.38	$9.31	$9.31
Lost jobs due to reduced commercial business activity	373	373	369	365	363	363
Lost state and local taxes from reduced commercial business activity	$1.22	$1.22	$1.21	$1.19	$1.19	$1.19
Lost utility revenues	$1.85	$1.85	$1.83	$1.82	$1.80	$1.80
Menard						
Monetary value of domestic water shortages	$0.07	$0.07	$0.05	$0.05	$0.04	$0.04
Lost utility revenues	$0.10	$0.10	$0.09	$0.07	$0.07	$0.07

Municipal ($millions)						
	2010	2020	2030	2040	2050	2060
Midland						
Monetary value of domestic water shortages	$1.06	$3.01	$95.81	$201.95	$244.36	$251.36
Lost income from reduced commercial business activity	$0.00	$0.00	$85.32	$311.55	$324.80	$339.87
Lost jobs due to reduced commercial business activity	0	0	2,125	7,760	8,090	8,466
Lost state and local taxes from reduced commercial business activity	$0.00	$0.00	$6.16	$22.49	$23.45	$24.54
Lost utility revenues	$2.29	$4.88	$30.91	$41.59	$42.80	$44.20
Miles						
Monetary value of domestic water shortages	$5.12	$5.60	$5.97	$3.50	$3.71	$3.91
Lost income from reduced commercial business activity	$1.54	$1.69	$1.80	$1.91	$2.03	$2.14
Lost jobs due to reduced commercial business activity	41	45	48	51	54	57
Lost state and local taxes from reduced commercial business activity	$0.19	$0.21	$0.23	$0.24	$0.26	$0.27
Lost utility revenues	$0.28	$0.30	$0.32	$0.34	$0.36	$0.38
Millersview-Doole WSC						
Monetary value of domestic water shortages	$0.02	$0.03	$0.00	$0.00	$1.66	$2.91
Lost utility revenues	$0.03	$0.05	$0.00	$0.00	$0.47	$0.57
Odessa						
Monetary value of domestic water shortages	$4.36	$61.75	$5.35	$6.24	$7.22	$10.05
Lost utility revenues	$7.35	$18.65	$7.94	$9.18	$10.61	$13.16
Robert Lee						
Monetary value of domestic water shortages	$0.16	$0.22	$0.00	$0.01	$0.03	$0.07
Lost utility revenues	$0.17	$0.21	$0.00	$0.03	$0.05	$0.10
San Angelo						
Monetary value of domestic water shortages	$64.65	$79.05	$83.30	$65.88	$76.44	$77.63
Lost income from reduced commercial business activity	$0.00	$0.00	$0.00	$21.05	$22.71	$24.02
Lost jobs due to reduced commercial business activity	0	0	0	519	559	592
Lost state and local taxes from reduced commercial business activity	$0.00	$0.00	$0.00	$1.46	$1.58	$1.67
Lost utility revenues	$0.17	$0.56	$0.30	$0.39	$0.46	$0.57

Municipal ($millions)						
	2010	2020	2030	2040	2050	2060
Snyder						
Monetary value of domestic water shortages	$0.66	$0.92	$0.01	$0.11	$0.20	$0.32
Lost utility revenues	$0.31	$0.39	$0.01	$0.07	$0.12	$0.19
Stanton						
Monetary value of domestic water shortages	$7.93	$8.54	$8.68	$8.70	$8.40	$7.95
Lost income from reduced commercial business activity	$4.90	$5.29	$5.38	$5.39	$5.20	$4.92
Lost jobs due to reduced commercial business activity	127	137	139	140	135	127
Lost state and local taxes from reduced commercial business activity	$0.40	$0.43	$0.44	$0.44	$0.42	$0.40
Lost utility revenues	$0.78	$0.84	$0.85	$0.85	$0.82	$0.78
Winters						
Monetary value of domestic water shortages	$8.90	$7.24	$7.30	$7.37	$7.42	$7.63
Lost income from reduced commercial business activity	$2.82	$2.29	$2.31	$2.33	$2.35	$2.41
Lost jobs due to reduced commercial business activity	102	83	84	85	85	88
Lost state and local taxes from reduced commercial business activity	$0.30	$0.24	$0.25	$0.25	$0.25	$0.26
Lost utility revenues	$1.09	$1.11	$1.12	$1.13	$1.14	$1.17

Appendix E

Thornhill Group, Inc. Comment Letter of August 11, 2016

THORNHILL GROUP, INC.

Professional Hydrogeologists • Water Resources Specialists

August 11, 2016

Mr. Paul Weatherby, General Manager
Middle Pecos Groundwater Conservation District
405 North Spring Drive
Fort Stockton, Texas 79735

Re: Stakeholder Comments, Recommendations, and Requests for the Proposed Desired Future Conditions Determinations — The Aquifer Systems in Groundwater Management Area 7

Dear Mr. Weatherby,

Thornhill Group, Inc. (TGI) appreciates this opportunity to, on behalf of Fort Stockton Holdings, L.P. (FSH), provide comments, recommendations, and requests pertaining to the adoption of the recently proposed 2016 Desired Future Conditions (DFCs) for Groundwater Management Area 7 (GMA 7), and specifically the DFCs as applied to the Edwards-Trinity (Plateau) within GMA 7 in Pecos County. These written comments are provided during the Public Comment Period as set in the notice published by the Middle Pecos Groundwater Conservation District (MPGCD) in GMA 7. TGI's recommendations provided herein are relevant to GMA 7, MPGCD, all GCDs across Texas, the Texas Water Development Board (TWDB), and the State of Texas Legislature.

TGI and FSH believe that the DFCs adopted in 2010 for GMA 7 and the proposed 2016 DFCs and the resulting managed available groundwater (MAG) are severely flawed constitutionally, legally and scientifically. Therefore, TGI on behalf of FSH respectfully requests that an alternative DFC be considered and adopted by GMA 7 beginning in 2016 for the Capitan Reef, Dockum, Edwards-Trinity (Plateau)/Pecos Valley Alluvium, and Rustler aquifers. This letter serves to provide for the consideration of MPGCD and GMA 7 alternative DFCs and management strategies that are based on sound science and honor Texas Water Law.

Fort Stockton Holdings, L.P. – A Vested Stakeholder

FSH is a stakeholder in GMA 7, with approximately 18,000 acres of land and 47 wells permitted by MPGCD within GMA 7. FSH clearly meets the definition of "affected person" presented by Texas Water Code Section 36.1083.(1) and Section 36.1082. – "Appeal of Desired Future Conditions" regarding the potential outcome of the proposed 2016 DFCs. The consequences of GMA 7 actions regarding determining the availability and management of 1

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groundwater directly affect the private property rights and investment-backed expectations of FSH.

Purpose, Objectives and Goals

The purpose of this letter is twofold:

(i) to express to the MPGCD that the proposed DFCs fail to meet the definitions and requirements of the Texas Regulatory Code as set forth by Title 31 of The Texas Administrative Code, and Chapter 36 of the Texas Water Code as well as the mandate of the state legislature as defined in Senate Bill 660 (SB660 2011), and

(ii) to offer a DFC metric that meets the mandate of SB660.

Specifically, the Texas Water Code and Texas Administrative Code provide the following definitions:

"Desired future condition – the desired, quantified condition of groundwater resources (such as water levels, spring flows, or volumes) within a management area at one or more specified future times as defined by participating groundwater conservation district within a groundwater management area as part of the joint planning process."

(Title 31, Part 10, §356.10(6) of the Texas Administrative Code)

"'Modeled available groundwater' means the amount of water that the executive administrator determines may be produced on an average annual basis to achieve a desired future condition established under 36.108."

(Texas Water Code 36.001(25))

"Before voting on the proposed desired future conditions of the aquifers under Subsection (d-2), the districts shall consider: … (3) hydrological conditions, including for each aquifer in the management area the total estimated recoverable storage as provided by the executive administrator, and the average annual recharge, inflows, and discharge." 2

(Senate Bill 660, §36.108(d)(3))

The Current and Proposed DFC and MAG are Flawed

TGI has extensively reviewed the proposed DFCs and based on these reviews, the proposed DFCs (2016) are legally and scientifically flawed because they do not consider "a balance between the highest practicable level of groundwater production and the conservation, 3
preservation, protection, recharging, and prevention of waste of groundwater and control of subsidence in the management area" (Code §36.108 (d)(d-2)). Basing DFCs on drawdown based on prescribed or preset pumping conditions does not meet the definition of DFCs from 4
Title 31 of the Texas Administrative Code. Drawdown levels are not equivalent to measured water levels, spring flows or volumes, the three metrics identified in the regulation. Even though drawdown is a measure of a change in water levels in a well, drawdown (particularly drawdown due to reduction of artesian pressure) is not reflective of the condition of water availability in an aquifer. The use of drawdown to develop DFCs which are based on prescribed pumping from existing permit information or water planning data unnecessarily 5
results in arbitrary and discriminatory artificial water shortages.

Arbitrary and Discriminatory Considerations

Neither the TWDB nor the Texas Legislature provided substantial technical guidance to GCDs and GMAs in deriving DFCs. In fact, the TWDB seems to promote a subjective approach to DFCs with such statements as: **"What do you want your aquifer to look like in the future?"** (Mace, Petrossian, et al. 2008)**.** Likewise, in a previous paper the TWDB leadership stated when discussing a **consensus-based** groundwater management framework, "Like beauty, availability is in the eye of the beholder" (Mace, Mullican and Way 2001, 9). Following such guidance apparently leads GMAs in deriving DFCs that are illegal and scientifically flawed because they do not consider "a balance between the highest practicable level of 6
groundwater production and the conservation, preservation, protection, recharging, and prevention of waste of groundwater and control of subsidence in the management area" (Code §36.108 (d)(d-2)). Basing MAGs on DFCs derived from prescribed pumpage data from water planning projections of future water needs within political boundaries "reverse engineering" and; (i) amounts to "regulation by planning", (ii) fails to account for the real- 7
world hydrologic conditions; and, (iii) is contrary to the legislature changes to Chapter 36 since 2008.

The Water Code seems to favor and even emphasize the concept of managing aquifers on the basis of hydrogeologic and hydrologic characteristics, rather than simply on the basis of political subdivision. **"Groundwater reservoir"** means a specified subsurface water-bearing reservoir having ascertainable boundaries containing groundwater" (Texas Water Code 36.001(6)). **"Subdivision of a groundwater reservoir"** means a definable part of a groundwater reservoir in which the groundwater supply will not be appreciably affected by 8
withdrawing water from any other part of the reservoir, as indicated by known geological and

hydrological conditions and relationships and on foreseeable economic development at the time the subdivision is designated or altered." (Texas Water Code 36.001(7)). Dr. Bill Hutchison and Kenneth L. Peterson wrote in a TWDB memorandum in 2010 that arguments against using political subdivisions to determine DFCs are not persuasive "…as long as the groundwater conservation districts do not appear to be using county or other political subdivision lines to gerrymander DFCs for purposes other than accommodating discernible, 9
substantial differences in uses or other aquifer conditions within the GMA." DFCs based on political boundaries are likely contrary to the original philosophy of the Texas Legislature in the development of GMAs, and typically do not honor the hydrogeologic and hydrologic conditions of aquifers. Such thinking allows for inequity in the opportunity to exercise property rights. Again, amendments to Chapter 36 in 2011 and 2013 corrected the errors in Mr. Peterson's thinking.

DFCs should be based on the full water balance of the coterminous aquifer (or groundwater reservoir). Such a water balance accounts for the outflows (production/discharge) of the aquifer, as well as the inflows (including average annual recharge), which are only an extremely small percentage of the water balance of the aquifers within GMA 7. In addition to outflows and inflows, the water balance includes **storage,** the largest volumetric factor 10
within the water balance of the aquifers within GMA 7, that has been ignored in the development of previous DFCs and the proposed DFCs. Such a water balance must also include the **total estimated recoverable storage** as determined by the executive administrator of the TWDB.

Reverse Engineered DFCs Based on Prescribed Pumping

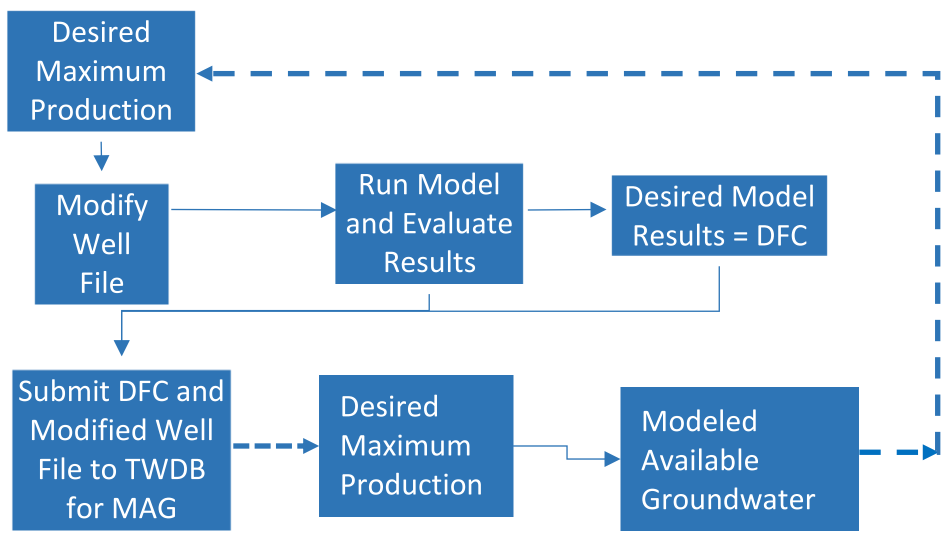
In most cases, DFCs were determined based on the amount of drawdown resulting from a prescribed amount of planned future pumping. Many of these planned future pumping estimates utilized in the initial round of DFC adoption were based on 2006/2007 regional and state water planning efforts. Groundwater "availability" was limited based on a definition of "sustainability" that was erroneously characterized as the amount of recharge to an aquifer within a certain geographic area (e.g., county). **Importantly, however, the TWDB has clearly stated that pumping is not a desired future condition, but is a means to achieve a desired future condition** (Petrossian, Ridgeway and Donnelly, 2007). The Texas Water Code and TWDB rules state that the TWDB, not GCDs and GMAs, determine the modeled available groundwater or MAG, based on DFC. Texas Water Code defines DFC and MAG as follows:

> "Desired [F]uture [C]ondition – The desired, quantified condition of groundwater resources (such as water levels, spring flows, or volumes) within **a management area** at one or more specified future times as defined by participating groundwater

conservation districts within a **groundwater management area** as part of the joint planning process."

"Modeled [A]vailable [G]roundwater" means the amount of water that the executive administrator determines may be produced on an average annual basis to achieve a desired future condition established under 36.108" (Texas Water Code 36.001 (25)).

These predicted sustainable pumping rates were utilized as the pumping files for GAMs, and the resulting aquifer drawdown was called the "DFC". Then, the prescribed pumping amounts were plugged into the GAM to calculate average drawdowns which became the DFCs. These DFCs were then sent to TWDB and the GAM was used to derive the MAG – **classic reverse engineering** as illustrated below:

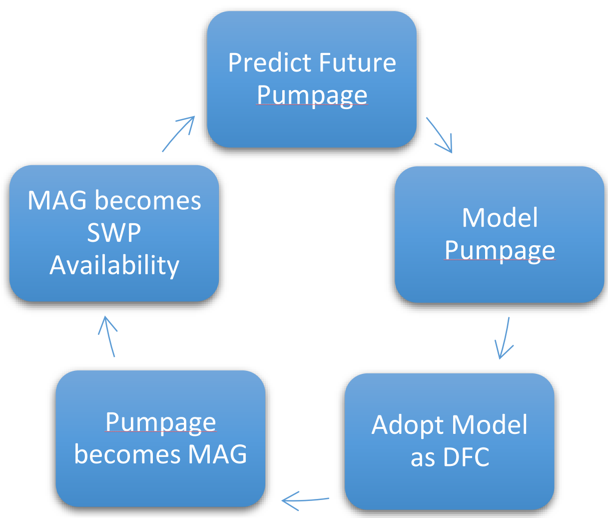


For example, based on the agenda, meeting minutes, notes and audio recordings from the GMA 7 July 29, 2010 meeting, and from GMA 7 Resolution # 07-29-10-9, it is clear that the Edwards-Trinity (Plateau) aquifer DFCs for most of GMA 7 were back-calculated (or reverse engineered) from prescribed pumping amounts (desired 11
maximum production).

Rather than first selecting an aquifer condition (remaining available storage or water levels), GMA 7 chose initial pumping scenarios for each county based initially on pumping called "a continuation of 2005", and generally slightly modified that initial pumping and calculated from those model runs the average drawdown across individual counties. Prior to the July 29, 2010 meeting, there had been five (5) pumping scenarios assessed for the Edwards-Trinity aquifer within GMA 7. During the GMA 7 meeting of July 29, 2010, the day the DFCs were adopted, the GCD general managers and representatives provided various pumping values to Dr. Bill Hutchison, who entered them into a spreadsheet based on GAM results that recalculated average drawdown with varied pumping. It is evident from discussions during

the meeting and the results from the modeling that the district general managers or
representatives did not truly consider aquifer conditions in setting various pumping amounts. 12
Based on minutes from the meeting, “Additional scenarios 6 and 7 were drafted at this time based on **pumping changes recommended by GMA members**” (emphasis added). Later that day at the Public Meeting, the minutes show that an additional three (3) scenarios were developed for consideration, including draft scenarios 9 and 10 of GAM 09-35 “…utilizing different pumping rates and the setting of individual district DFCs versus an aquifer-wide DFC” (GMA 7 Meeting Minutes). Therefore, the initial and primary consideration in the meeting appeared to be prescribing pumping amounts, rather than selecting aquifer
conditions to assess using the GAM. The TWDB has clearly stated that pumping is not a 13
desired future condition, but is a means to achieve a desired future conditions (Petrossian, Ridgeway and Donnelly, 2007).

HB 1763 (2005) mandated that the MAG be used as the groundwater availability numbers in the regional and state water plans. GCDs and GMAs have a combined propensity to reverse engineer DFCs based on water planning projections, as a result the current
DFC/MAG process is largely a 14
“regulation by planning” process that creates a “regulatory feedback loop” as illustrated here by Mr. James Bené, P.G. of R.W. Harden & Associates, Inc., diagram of the DFC/MAG:



James Bene’, R.W. Harden & Associates, Inc.

The initial DFC process has resulted in considerable regulatory, management and planning confusion. Across Texas, the DFC process has resulted in
arbitrary permit denials or restrictions, 15
false “paper”, “digital” and/or “political” water shortages, unnecessary restrictions on groundwater production, stifling of groundwater supply development, uncertainty, and considerable taking of private property rights resulting in devaluing of private property in regards to groundwater availability.

Political Subdivisions Are Not Valid Unless They Match Hydrogeologic Management Areas

Clearly, aquifers do not conform to county lines and groundwater flows across political subdivision boundaries. The original legislation providing for districts stated:

> "No petition for the creation of a District to exercise the powers and functions set forth in Subsection B of this Section 3c shall be considered by a Commissioners Court or the Board, as the case may be, unless the area to be included therein is **coterminous** with an **underground water reservoir** or **subdivision** thereof which theretofore has been defined and designated by the Board as an underground water reservoir or subdivision thereof. Such district, in conforming to a defined reservoir or subdivision, may include all or parts of a county or counties, municipal corporations or other political subdivisions, including but not limited to Water Control and Improvement Districts." (HB 162, Acts 1949, 51st R.S., ch. 306, General and Special Laws of Texas). 16

Single-county districts were allowed in the Water Code only after the mid-1980s, and were greatly proliferated between 1999 and 2001 after the passage of SB 1 (1997). It appears that the legislature attempted to mitigate the chaos caused by attempting to manage regional aquifers through single-county and small districts covering parts of a single groundwater reservoir with the passing of SB 2 (2001), and the re-establishment of GMAs. The designation of groundwater management areas is codified in the Texas Water Code §35.004, which states the following:

> "…Each groundwater management area **shall** be designated with the **objective of *providing the most suitable area for the management of the groundwater resources***. *To the extent feasible, the groundwater management area shall coincide with the boundaries of a groundwater reservoir or a subdivision of a groundwater reservoir. The Texas Water Development Board also may consider other factors, including the boundaries of political subdivision"* (emphasis added).

MPGCD has taken the erroneous political subdivision concept even further in the wrong direction by creating gerrymandered management zones within the district boundaries that already fail to meet the requirements of a groundwater management area based on a reservoir boundary. The use of "geographic areas", rather than actual underground reservoirs in establishing DFCs violates Texas Water Code §35.004 and §36.116(d) as referenced in the January 20, 2016 version of the district's rules in defining "Management Zone". The MPGCD rules relied upon to create these artificial sub-district DFCs misinterpret Texas Water Code §36.116(d) as allowing the creation of geographic boundaries for management of spacing and production by not including the full context of development of 17

geographic boundaries at the surface that correspond to the aquifer that lies in whole within the district or subdivisions of an aquifer located in part within the district. The only clearly defined subdivision allowed in the Texas Water Code for groundwater management areas relates to hydrogeologic boundaries of the groundwater reservoir or hydrological based 18
subdivisions of the groundwater reservoirs.

These concepts of aquifer based subdivisions for management of resources were further confirmed by the Texas Supreme Court in regards to regulation of groundwater in the decision of the Edwards Aquifer Authority v. Day. The court's decision stated:

> "one purpose of groundwater regulation is to afford each owner in a *common, subsurface reservoir* a *fair share*" (emphasis added).

The language used by the Texas Supreme Court of a common, subsurface reservoir falls in line with previous language quoted above in regards to defining the area of a groundwater conservation district "the area to be included therein is **coterminous** with an **underground water reservoir** or **subdivision** thereof which theretofore "has been defined and designated by the Board as an underground water reservoir or subdivision thereof (HB 162, Acts 1949, 51st R.S., ch. 306, General and Special Laws of Texas). The Texas Water Code has purposely recognized that the most suitable manner in which to manage groundwater resources is by 19
aquifer or aquifer subdivision and not gerrymandered geopolitical boundaries.

Proposed DFCs Do Not Consider Hydrogeology or Aquifer Capability

The DFCs proposed by GMA 7 are reported as decreases in average saturated thickness for unconfined aquifers and average drawdown that is determined by modeling results of the drawdown this ignores the aquifer response as demonstrated through historic water level measurements and the true physical availability of an aquifer to recharge. As stated by a former board member of the TWDB, **"Some of the desired future conditions are being driven by…a fundamental misunderstanding of how groundwater aquifers behave…"**; and **"…groundwater districts now have the power to enforce resulting managed available groundwater determination that may, in effect, ignore the capability of the aquifer to** 20
produce water" (Mr. Jack Hunt, 2009).

Average drawdown alone is a very poor metric in assessing the availability of groundwater, particularly in the oftentimes karst Edwards-Trinity (Plateau) aquifer. Similarly, estimating recharge within a county or a subarea of an aquifer or aquifer subdivision is essentially 21
meaningless with respect to assessing groundwater availability or providing a metric for groundwater management.

As the legislature directed in Senate Bill 660 (SB 660), the entire water balance of an aquifer should be considered in assessing groundwater availability. The water balance includes all 22
inflows, all outflows and storage of the aquifer or subdivision of the aquifer being considered. DFCs should be based on the full water balance of the coterminous aquifer, and **not** based on political boundaries including MPGCD's management zones. A full water balance of the coterminous aquifer accounts for the outflows (production/discharge) of the aquifer, as well as the inflows (including average annual recharge). Importantly, such a water balance must also include the total estimated recoverable storage (TERs) determined by the executive 23
administrator of the TWDB. Analyses relying on planned outflows from specific areas (e.g., management zones, or the principal areas of irrigation) used for the development of the proposed DFCs creates man-made, false groundwater shortages. This results in dysfunctional inaccurate water planning, and results in predicting premature adverse economic impacts forcing GCDs to create rules that infringe on private property rights, ultimately resulting in a regulatory taking.

Ramifications of the DFC

The current and proposed DFCs are not scientifically and legally defensible primarily because they are based on modeled average artesian drawdown over a political boundary that is back-calculated from prescribed pumping amounts. And because separate DFCs are provided for geopolitical subdivisions and not the overly large, contiguous and hydraulically continuous aquifers, the current DFCs:

- May not be achievable as defined;
- Create false groundwater shortages;
- Lead to dysfunctional and inaccurate water planning; 24
- Can result in unnecessary or premature adverse economic impacts; and,
- Likely result in GCD rules and management procedures that infringe on private property rights, as artesian drawdown is not a viable management criterion to assign "fair chance".

In developing the GAMs used to develop the DFCs very clear limitations are defined for the 25
models, and these limitations must be considered and taken seriously.

Regional Groundwater Model Limitations

The above general comments reflect assessments that can be applied to all aquifers and the proposed DFCs, below is a detailed look into the specific details related to the limitations of the groundwater models that have been misused to develop the proposed drawdown DFCs for the specific aquifers; the Capitan Reef and the Edwards-Trinity (Plateau)/Pecos Valley Alluvium. The TWDB and contracted regional groundwater model developers have clearly defined the limitations of the GAMs in the reports summarizing the Capitan Reef Complex Aquifer (Jones, 2016) and the Edwards-Trinity (Plateau)/Pecos Valley Alluvium modeling efforts (Hutchinson, et.al., 2011). Further discussion of additional limitations of the Edwards-Trinity (Plateau)/Pecos Valley Alluvium modeling efforts are presented in the April 2011 letter from Robert Mace (TWDB) to Edmond McCarthy and Michael Gerson regarding additional model efforts reported in GAM Task 10-033 (Attachment 1 is the letter from Dr. Mace).

The limitations of the regional groundwater models have been inherently ignored by GCDs in
the development of drawdown based DFCs and in particular when GCDs utilize the results of 26
the GAM models to assess site-specific permits. Below are prescribed limits of the GAM models as quoted directly from the TWDB GAM Reports:

- "*Model users should consider several limitations when using this model. To a certain extent this model is interpretive rather than being a fully predictive model because of: the limited historical stresses on the aquifer, limited amount of measured water levels, and limited hydraulic property data. In addition, because of the lack of historical stresses, it was not possible to fully calibrate the storage coefficient. The use of a constant transmissivity in the model requires that model users carefully evaluate whether it is appropriate to assume that water-level drawdown is insignificant relative to the total aquifer thickness*" (Jones, 2016).
- "***Several*** *input parameter data sets for the model are based on* ***limited*** *information. These include geologic framework, recharge, water level and streamflow data, hydraulic conductivity, specific storage, and specific yield*" (Hutchinson, et.al., 2011) (**empahsis added**). In summation nearly every input related to the solution of groundwater flow in this regional MODFLOW model are based on limited information making any analysis performed using this model a general estimation of regional groundwater flow. Applying this model in a predictive capacity means not only are any predictive assessments limited by the generalized inputs of future development, but also verty limited by the general nature of the hydrogeologic properties that have been used to create this model.
- "*There is model uncertainty associated with using annual stress periods in the model. The use of annual stress periods results in the model not simulating seasonal effects of recharge and pumping. However, attempting to simulate seasonal effects would be impractical due to the paucity of wells and frequent water level measurements needed for calibration and the fact that seasonal fluctuations may be too small to simulate with certainty at the regional scale. This updated model lumps together the two layers in the original model and thus potentially introduces uncertainty related to head differences between the Trinity and Edwards Groups*" (Hutchinson, et.al., 2011). Application of the pumping scenarios in an annual time step fashion ignores the

seasonal nature of historic pumping especially in the three irrigation districts. These areas have historically had pumping during a shortened irrigation season which lasted between five to eight months annually. During non-irrigation season months pumping is much lower and these months typically correspond to the months when weather patterns produce regional recharge primarily in the form of precipitation and the associated increase in surface water flows.

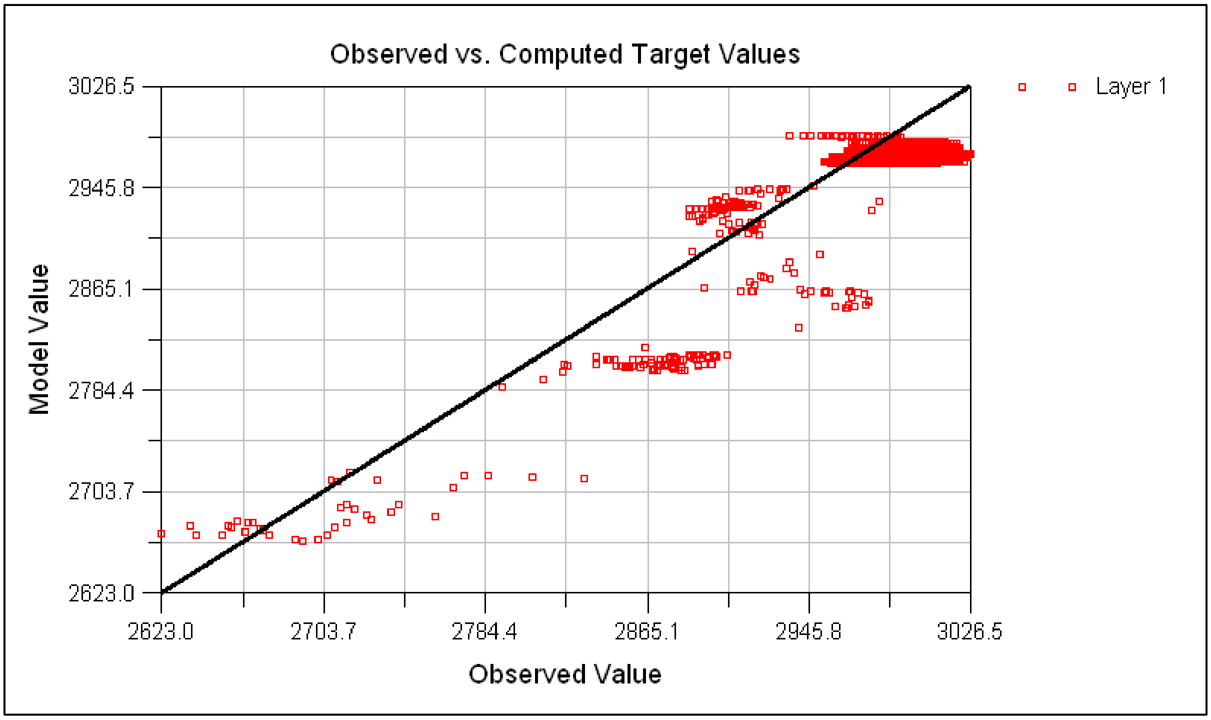
- "*There is uncertainty with simulating base flow and spring discharge at the spatial and temporal scale of this model. Actual discharge to streams occurs within small areas averaging 50 feet wide, compared to the 1 square mile of the model cells, and base flow is more variable within the annual time steps of the model. Therefore, uncertainty occurs because modeled discharge to streams is averaged over a 1-year stress period and 1 square-mile cell*" (Hutchinson, et.al., 2011). Model scale is a critical component in determining the scale at which assessment from a model can be applied. As noted in the above quoted text the scale of the model makes assessment of a critical model outlfow uncertain even with that outflow occuring at the scale of 50 feet in real world space. The uncertainty of scale is magnified at smaller scales, so any attempt to assess single well scale impacts to aquifers using this model when those wells are 33 times smaller are sure to contain a greater uncertainty.
- "*Available transmissivity and hydraulic conductivity data for the Edwards-Trinity (Plateau) and Pecos Valley aquifers is derived primarily from specific-capacity data obtained from wells scattered throughout the model area. However, these data are not located close enough to indicate more localized heterogeneity within the zones used in the model"* (Hutchinson, et.al., 2011). On a local site specific well or well field level the above model limitation represents one of the greatest inherent errors when applying MODFLOW regional models to assessment of the Edwards Aquifer. The karst nature of the Edwards Aquifer is well documented and therefore not referenced in detail in this response but specific capacity and the relationship to transmissivity are less correlative in fracture and conduit flow systems which have been observed at local levels within the modeled area. Downhole wellbore videos from the Leon-Belding Area document the presence of large subsurface solution features which cannot be represented in the model as developed, but these large transimissive features are critical to understanding the response at the well or well field level where permit decisions occur and represent a **fundamental flaw** in applying this analysis for determining DFCs that should prevent the use of this model by GMA 7 and all related GCDs.
- "*Groundwater flow between the Edwards-Trinity (Plateau) and Pecos Valley aquifers and the underlying aquifers is assumed to be negligible. This assumption is based partially on successfully calibrating the model without the need to factor in flows to or from the underlying aquifers. It was difficult for us to consider this inter-aquifer*

groundwater flow because of the paucity of water level and hydraulic property data to constrain such flow. Additionally, groundwater geochemistry studies in the Pecos Valley Aquifer, which would potentially be impacted the most by groundwater interaction with underlying aquifers, indicate only minor amounts of groundwater flow from underlying saline aquifers (Jones, 2004)" (Hutchinson, et.al., 2011). Again, TGI wants to identify that this model is being identified as having been developed with limited data at a large scale (1-mile grid), AND in this case the limited data of the model is used as justification for not including additional recharge components. The inter-aquifer flow was determined to not be a necessary component of this model because of the limited data that was used to develop this model. And since limited data was used to develop the model it was possible to achieve model calibration and adding inter-aquifer flow was not a needed component regardless of whether or not real world data shows inter-aquifer flow to be present in this area.

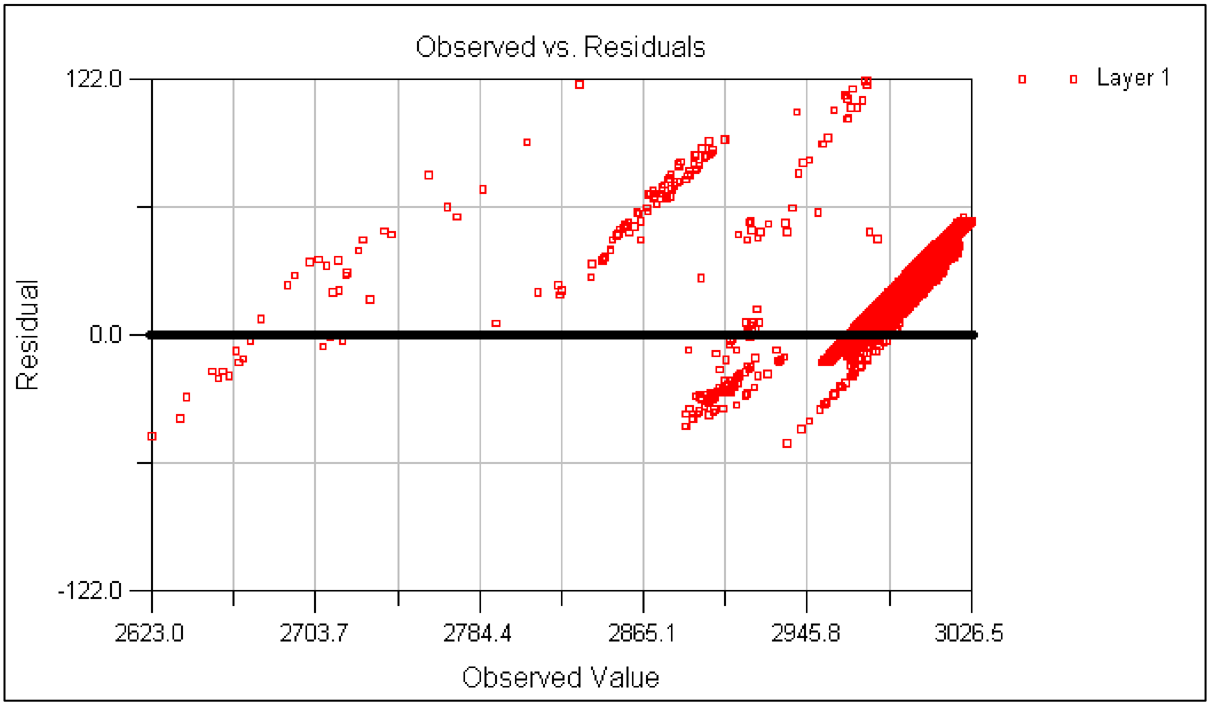
- "*The limitations described earlier and the nature of regional groundwater flow models affect the scale of application of the model. This model is most accurate in assessing larger regional-scale groundwater issues, such as predicting aquifer-wide water level changes and trends over the next 50 years that may result from different proposed water management strategies. Accuracy and applicability of the model decreases when using it to address more local-scale issues because of limitations of the information used in model construction and the model cell size that determines spatial resolution of the model. Consequently, this model is not likely to accurately predict water level declines associated with a single well or spring because (1) these water level declines depend on site-specific hydrologic properties not included in detail in regional-scale models, and (2) the cell size used in the model is too large to resolve changes in water levels that occur over relatively short distances. Addressing local-scale issues requires a more detailed model, with local estimates of hydrologic properties, or an analytical model. This model is more useful in determining the impacts of groups of wells distributed over many square miles. The model predicts changes in ambient water levels rather than actual water level changes at specific locations, such as an individual well"* (Hutchinson, et.al., 2011). The paragraph above succintly defines two key points of why this model is not appropriate for the development of DFCs for the MPGCD, the irrigation management areas, and overall why regional drawdown developed from models is not an appropriate measure to assess DFCs. The overall lack of location scale data in the development of this model and the development of model cells at large scale (1 mile by 1 mile) precelude reasonable analysis at a permit or well level. Combined with the overall lack of data used in development of the model, the generalized assumptions of the aquifer parameters that must occur for three separate confined aquifer units to be modeled as one layer, and the lack of seasonal pumping assessments make this model a poor simulation of the regional aquifer and future groundwater conditions.

Additionally, in terms of the GMA 7 Edwards-Trinity (Plateau)/Pecos Valley Alluvium GAM runs, the calibration pumping scenario inputs could not be matched to historic existing use (see Attachment 2). For example, Attachment 2 illustrates the total Historic and Existing Use (HEU) Permit amount within MPGCD Management Zone 1. This HEU permit amount totaled 90,753.0 acre-feet per year and can be compared to the total amount of pumping that was included in the GMA 7 Scenario 10 (and the extended version of Scenario 10), which is 123,341.4 acre-feet per year resulting in an over estimation of pumping by 32,588.4 acre-feet per year. In summary, the distribution of pumping in the GMA 7 Scenario 10 (and the Scenario 10 extended) Edwards-Trinity (Plateau)/Pecos Valley Alluvium GAM run includes a pumping distribution that cannot be correlated with historic or known proposed future pumping scenarios making the use of this model run for development of DFCs a poor choice. 27

Furthermore, the Leon Belding Area is an area where HEU permits are known and historical monitored water levels are available that provide an accurate water level data set to calibrate the model to and provide a base to assess future pumping scenarios against. However, this data does not appear to have been effectively used in the modeling efforts as illustrated in Attachment 3 (Hydrograph Map). As applied, the model inputs and modeled pumping scenarios used for calibration provided a poor representation of historic activity and represent another flaw in the development of this MODFLOW model. The poor quality of the calibration of the GAM model for the Leon Belding Area (using the measured and simulated values shown in Attachment 3 for the six monitor wells) can be seen by assessing the modeled calibration head levels versus measured (observed) water level records, as shown in the figure below. 28



This comparison facilitates an assessment of the regional models calibration within the local area (i.e., MPGCD Management Zone 1) to assess how well the history match is within this particular area. Based on these results the simulated versus observed water levels do not closely match based on their proximity to the one-to-one line. Additionally, the results appear biased in the positive direction when plotting the residual versus the measured (observed) values. Positive residuals indicate higher observed elevations, meaning the simulated modeled elevations are lower and not representative of aquifer conditions in the Leon Belding Area.



Requested Alternative DFC Assessment

In 2015, the Legislature took notice of the confusion, technical fallacies, understated groundwater availability and hydropolitical gridlock caused by the first cycle of setting DFCs. Additionally, new legislation (SB 332) and the Texas Supreme Court ruling in the Day Case have clarified and strengthened the understanding of **absolute groundwater ownership as a property right and the Rule of Capture.** SB 660 and the associated TWDB rules set forth some important and relevant new considerations for GCDs and GMAs in determining desired future conditions. In establishing DFCs, the following factors as identified in Texas Water Code §36.108 (d) must be considered:

"1. aquifer uses or conditions within the management area, including conditions that differ substantially from one geographic area to another;
  a. for each aquifer, subdivision of an aquifer, or geologic strata and
  b. for each geographic area overlying an aquifer

"2. the water supply needs and water management strategies included in the state water plan;

"**3. hydrological conditions, including for each aquifer in the management area the total estimated recoverable storage as provided by the executive administrator, and the average annual recharge, inflows, and discharge;**

"4. other environmental impacts on spring flow and other interactions between groundwater and surface water;
"5. the impact on subsidence;
"6. socioeconomic impacts reasonably expected to occur;
"7. the impact on the interests and rights in private property, including ownership and the rights of management area landowners and their lessees and assigns in groundwater as recognized under Section 36.002;
"8. the feasibility of achieving the desired future condition; and,
"9. **any other information relevant to the specific desired future conditions**."

DFCs proposed under Texas Water Code §36.108 (d) must also: 29

"a. be established for each aquifer, subdivision of aquifer, or geologic strata, or
"b. be established for each geographic area overlying an aquifer in whole or in part or subdivisions of an aquifer, and,
"c. provide a balance between the highest practicable level of groundwater production and the conservation, preservation, protection, recharging, and prevention of waste of groundwater and control of subsidence in the management area" (Texas Water Code 36.108(d-1) and (d-2)).

The considerations that are new and significant with respect to the current cycle of establishing DFCs and MAGs via the joint-planning process are highlighted in bold letters above. Since the implementation of SB 660, the Supreme Court of Texas has reaffirmed the absolute ownership of groundwater (*Day Case*), and that groundwater conservation districts 30
cannot cause a regulatory taking without applicable compensation (*Bragg Case*).

Recommended Alternative Management Strategy

The Texas Legislature mandated in SB 660 that GMAs and GCDs consider aquifer storage, 31
inflows and outflows – the 3 components of a water balance – when adopting DFCs. The total water balance is the only true way to measure groundwater availability, and in confined aquifers, storage is the largest component of the water balance. The record of historic water levels in much of the MPGCD area is a great tool to use for the assessment of groundwater availability in the Edwards-Trinity (Plateau)/Pecos Valley Alluvium, and can be assessed through an established water level monitoring program.

Based on Texas water law, the history of groundwater management in Texas, the hydrogeologic and hydrologic conditions in the aquifer, and the methods, processes, 32
procedures and results of the initial (2010) DFC adoption by GMA 7, TGI on behalf of FSH proposes the following alternative DFC, or Management Strategy for the portion of the

Edwards-Trinity (Plateau) aquifer in the Leon-Belding Area, which can be further applied to almost all the aquifers within and across GMA 7:

- **Delineation of groundwater reservoirs and subdivisions –** As stated previously, the Water Code seems to favor and even emphasize the concept of managing aquifers on the basis of hydrogeologic and hydrologic characteristics, rather than simply on the basis of political subdivision. **"Groundwater reservoir"** means a specified subsurface water-bearing reservoir having ascertainable boundaries containing groundwater" (Texas Water Code 36.001(6)). **"Subdivision of a groundwater reservoir"** means a definable part of a groundwater reservoir in which the groundwater supply will not be appreciably affected by withdrawing water from any other part of the reservoir, as indicated by known geological and hydrological conditions and relationships and on foreseeable economic development at the time the subdivision is designated or altered." (Texas Water Code 36.001(7)). Various reports have illustrated that the Leon-Belding Area is hydrogeologically different from surrounding areas. These difference are perhaps best represented in a map of water level declines across MPGCD's gerrymandered Management Zone 1 from a 2009 report by TGI titled the Ground-Water Supply Assessment City of Fort Stockton, Texas. Attachment 4 is a map that includes contours of water level declines across the Leon-Belding Area, Coyanosa Area, and Fort Stockton in the mid 1970's reflecting changes resulting from pumping activity that occurred between the 1950's and the early 1970's. Reported approximation of pumping from the time period indicate the Leon-Belding Area had at least 500-percent or more pumping during this time frame in comparison to the Coyanosa Area, but water level declines in the Coyanosa area were approximately 75-percent greater than in the Leon-Belding Area. The reason for the greater water level declines can only be attributed to a fundamental difference in the hydrogeologic conditions between the two areas. **This difference in water level declines suggests an aquifer subdivision could be identified to assess these two areas based on hydrogeologic differences and not include these two areas in the same gerrymandered management zone.**
- **Leon-Belding Aquifer Subdivision** - Geologic features have been identified in various well logs and geologic models that show a large trough like structure in the Leon-Belding Area. This structure dates back far enough into geologic time that much of the present day groundwater flow system in the Leon-Belding Area is a direct result of this feature. While the single layer model developed by the TWDB tried to develop model parameters to reflect this structure, the model does not truly reflect the hydrogeologic conditions and importance this feature plays in distinguishing this trough area in the model.

  The unique nature of this area should be evaluated to determine whether it meets the distinct aquifer subdivision defined in the bullet above. This would allow this area to be assigned DFCs based on water levels due to the number of water wells with historic water level data and historic pumping at rates higher than current rates which can be used to document how the aquifer has historically responded. Monitoring data shows that the aquifer is capable of recovery as it has recovered from this historic pumping and the nature of this recovery could serve as guidelines for when water levels within the aquifer indicate that pumping should be curtailed to allow recovery. A detailed study reviewing historic pumping and water levels of various wells in the area could be performed that would result in the identification of an "alert or action" water levels. A DFC or aquifer management strategy based on the historic water level data in and around the Leon-Belding irrigation area in Pecos County, Texas is recommended. Specific monitor wells that have the best available hydraulic information over a period of time with continuation of monitoring and analyses should be identified and utilized.

- **Storage Based Management Conditions–** The Texas Legislature mandated in SB 660 that GMAs and GCDs consider aquifer storage, inflows and outflows – the 3 components of a water balance – when adopting DFCs. As stated previously, the total water balance is the only true way to measure groundwater availability, and in confined aquifers, storage is the largest component of the water balance. The fact that the majority of groundwater in confined aquifers is located in storage is precisely what the legislature identified in mandating that GCDs and GMAs consider total estimated recoverable storage (TERS) and recharge, inflows and discharge when developing DFCs. Storage **must** be considered in context of the Texas Water Code and Texas Administrative Code, as well as hydrogeologically. The Texas Water Law defines total aquifer storage and total estimated recoverable storage (TERS) as follows:

  - "**total aquifer storage"** means the total calculated volume of groundwater that an aquifer is capable of producing (Texas Water Code, §36.001 (24)).
  - **Total Estimated Recoverable Storage –** the estimated amount of groundwater within an aquifer that accounts for recovery scenarios that range from 25% to 75% of the porosity adjusted aquifer volume (Texas Administrative Code §356.10 (24)).

It is important that the GCDs developing DFCs understand that large artesian water-level declines can occur locally while having essentially no impact on groundwater availability because of the large capacity of water presently in aquifer storage. Artesian drawdown is not directly tied to aquifer hydraulics (e.g., transmissivity) and is practically not affected by aquifer storage or recharge. Most importantly to the development of DFCs, very small (five percent) reductions in aquifer storage can result in large available aquifer production volumes
without causing harm to aquifers. Therefore, it is recommended for all aquifers but the 33
Edwards-Trinity (Plateau) aquifer in GMA 7 that storage-based DFCs be developed.

Additional Recommendations

TGI and FSH requests that the MPGCD work with other GCDs within GMA 7 to propose alternative DFCs for the GMA 7 aquifers that meet the requirements of SB 660 by developing DFCs based on scientific assessments of real world aquifer data considering the following criteria as objectives: Ensure that a DFC can be achieved while honoring **law** and **private property rights**, and a DFC that accurately reflects the physical availability of groundwater in the aquifer;

1. Require the assessment of whether a DFC has been impaired based on valid scientific methods that utilize actual water-level monitoring data, specifically in the outcrop areas. Equally important ensure that DFCs are NOT developed relying on the utilization of model runs that contain substantial limitations and assumptions that result in egregious errors when applied on the level of an individual permit, as the 34
errors in the assumptions of the models can be identified and demonstrated through new data collection from exploration, discovery, and aquifer monitoring as *not reflective of current real world conditions* let alone being applicable 60 years in the future;
2. Accurately establish an effective water-level monitoring program that has acceptable spatial and temporal coverage across the conterminous aquifers (water-table and artesian portions as appropriate). Existing conditions will serve as the baseline for 35
future assessments of whether storage DFCs are being achieved;
3. Recognize that aquifer water table levels and storage change ***very slowly***. Therefore, extending permit terms can be done without adverse ramifications; 36
4. As recommended in TWDB GAM reports, prohibit ***regional*** GAM runs from being utilized outside the clearly defined (by TWDB) limitations of the model such as using site specific levels derived from applying modeled drawdowns to form the basis to 37
grant and deny permits; and,
5. Do not base groundwater availability on regional groundwater models developed using production "needs assessments" for regional water planning determinations 38
that have been projected 60 years into the future.

GMA 7 Must Address Proposed DFCs per Statutory Requirements

SB660 and subsequent rules in the Texas Water Code have added requirement to GCDs and GMAs in establishing DFCs. DFC submittals must now include:

> "A copy of the adopted desired conditions and **the explanatory report** addressing the information required by Texas Water Code §36.108(d-3) and

> the criteria in Texas Water Code §36.108(d)" (31 Texas Administrative Code §356.32).

The TWDB states that the required **EXPLANATORY REPORT** "…will also be a key document if a petition is filed challenging the reasonableness of a desired future condition" (TWDB 2013). The TWDB also recommends that the explanatory report "…be organized in such a way as to facilitate use by groundwater stakeholders and district conditions" (TWDB 2013). The TWDB notes that, according to Texas Water Code § 36.108 (d-3), "…the district representatives shall produce a desired future conditions explanatory report for the management area and submit to the TWDB and each district in the management area proof that notice was posted for the joint planning meeting, a copy of the resolution, and a copy of the explanatory report. The report must:

> "1. identify each desired future condition;
> 2. provide the policy and technical justifications for each desired future condition;
> 3. include documentation that the factors under Texas Water Code §36.108 (d) were considered by the districts and a discussion of how the adopted desired future conditions impact each factor;
> 4. list other desired future condition options considered, if any, and the reasons why those options were not adopted; and,
> 5. discuss reasons why recommendations made by advisory committees and relevant public comments received by the districts were or were not incorporated into the DFCs."

Exclusion of the Proposed Alternative DFCs submitted herein as *relevant public comments* would be justification for filing an appeal of the reasonableness of any DFCs presented. 39
HB200 passed in 2015 allows affected persons to file appeals challenging the reasonableness of desired future conditions through the State Office of Administrative Hearings.

Conclusion

TGI appreciates the opportunity to provide you this assessment of the currently proposed GMA 7 DFCs, and to present you with an alternative DFC methodology for formal consideration. TGI believes the alternative DFC methodology recommended herein to GMA 7 and MPGCD should be given serious consideration, and fully evaluated before the GMA and MPGCD, finalize the adoption of the proposed 2016 DFCs that are legally and scientifically flawed.

The alternative DFC proposed herein best honors Texas Water Law, private property rights associated with the absolute ownership of groundwater, the Rule of Capture, and represents a true assessment of the aquifer's capability to produce long-term groundwater supplies based on coterminous aquifer's water balance. The development of storage based DFCs for Capitan Reef, Dockum, and Rustler aquifers as well as aquifer condition based DFCs evaluated against historic water levels specific to the Edwards-Trinity (Plateau) aquifer in the Leon-Belding Area in Pecos County.

On behalf of FSH, TGI looks forward to working with GMA 7 and its consultants in evaluating an alternative DFC as described herein, and in improving groundwater management in the region and in our State.

If you have any questions, please call.

STATE OF TEXAS
BRIAN K. BOHM
GEOLOGY
10141
LICENSED
PROFESSIONAL GEOSCIENTIST

Sincerely,
THORNHILL GROUP, INC.

Brian K. Bohm, P.G.
Managing Associate

STATE OF TEXAS
ELIZABETH FERRY
GEOLOGY
11011
LICENSED
PROFESSIONAL GEOSCIENTIST

The seal appearing on this document was authorized by Elizabeth Ferry, P.G. on August 11, 2016.

Elizabeth Ferry, P.G.
Senior Hydrogeologist

cc: Mr. Jeff Williams, Fort Stockton Holdings, L.P.
Mr. Ed McCarthy, Jackson, Sjoberg, McCarthy & Townsend, L.L.P.
Ms. Carolyn Runge, GMA 7 Administrator
Dr. Bill Hutchinson, P.E., P.G.

Attachments

Attachment 1

Texas Water Development Board

P.O. Box 13231, 1700 N. Congress Ave.
Austin, TX 78711-3231, www.twdb.state.tx.us
Phone (512) 463-7847, Fax (512) 475-2053

April 28, 2011

Edmond R. McCarthy, Jr., Esq.
Jackson, Sjoberg, McCarthy & Wilson, L.L.P.
711 West 7th Street
Austin, Texas 78701

Michael A. Gershon, Esq.
Lloyd Gosselink, Attorneys at Law
816 Congress Avenue, Suite 1900
Austin, Texas 78701

Gentlemen:

Our chairman asked me to respond to your letters concerning the use of the groundwater model for the Edwards-Trinity (Plateau) Aquifer in the Middle Pecos Groundwater Conservation District (letters from Mr. McCarthy dated March 16, 2011, and April 1, 2011, and a letter from Mr. Gershon dated March 26, 2011).

Mr. Randy Williams, on behalf of the Middle Pecos Groundwater Conservation District, requested that we provide average drawdown values for proposed management zones in Pecos County. Our response to that request was GAM Task 10-033. GAM Task 10-033 simply reports those drawdown values, based on the groundwater model simulations used to develop the desired future conditions for groundwater management areas 3 and 7. GAM Task 10-033 is not a Texas Water Development Board (TWDB) endorsement of the district's management approach or an indication that the model is the appropriate tool to guide the regulation of the aquifer in the management zones.

The development of a groundwater model is an objective-driven process. Models are developed with a specific objective in mind and are calibrated accordingly. We developed the groundwater availability models as regional tools to assist stakeholders in estimating groundwater availability, a task presently accomplished through the desired future conditions process. This does not mean that a model would not be useful for a different purpose or at a sub-regional scale.

An appropriate analysis, using appropriate data, would need to be completed to determine whether or not use of the model for a different purpose or at a different scale is appropriate. We did not do this analysis as part of GAM Task 10-033.

It is generally appropriate to use the results of a predictive run of a regional groundwater model to provide a framework or overview of results at a more local scale. A common example of this is interpreting groundwater elevation or drawdown contours derived from the results of a regional model on a county or sub-county scale. In this case, GAM Task 10-033 provides at least a framework or overview of potential future drawdowns in each of the management zones. However, it is not possible to determine whether it is appropriate to use these results for regulatory purposes without first (1) assessing the calibration of the model at the scale of the question (the management zones) and (2) assessing the assumed amount and distribution of predicted pumping within the management zones that is associated with the predicted drawdown. In response to questions in early February, Dr. Bill Hutchison of my staff discussed the need for this type of analysis with Mr. Williams. He also discussed the same issues with Mr. Mike Thornhill.

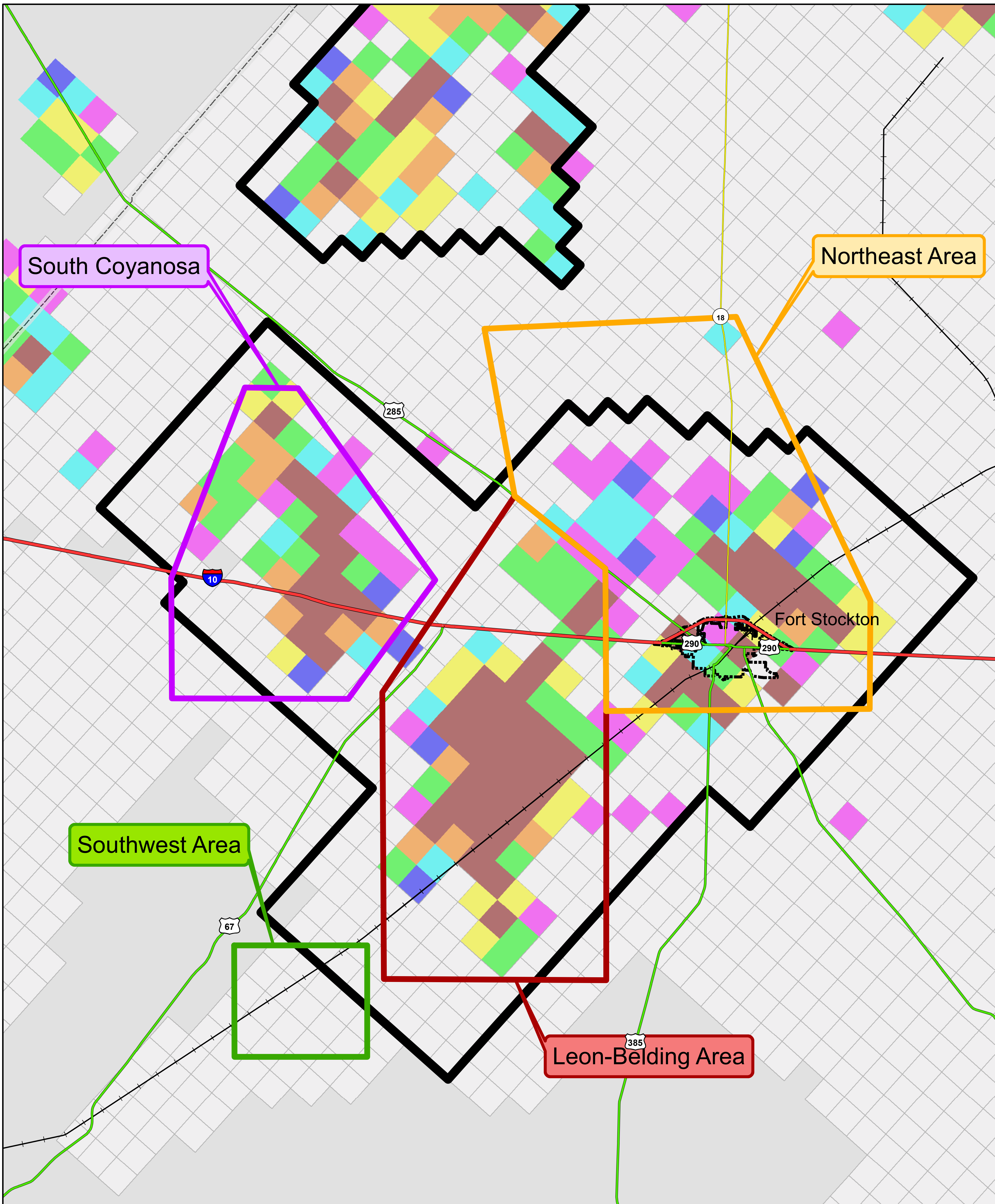
Please let me know if you have any questions or comments.

Respectfully,

Robert E. Mace, Ph.D., P.G.
Deputy Executive Administrator
Water Science and Conservation

c: Edward G. Vaughan, Chairman, TWDB
Melanie Callahan, Interim Executive Administrator, TWDB
Ken Petersen, General Counsel

Attachment 2



Area	Historic and Existing Use Permit Amount (ac-ft/yr)	GAM Run: GMA 7 Scenario 10 Pumpage Amount (ac-ft/yr)	Difference Between GAM Run and HEU Permits
Leon-Belding	69,342.8	59,045.4	(10,297.4)
Northeast	3,297.5	31,213.7	27,916.2
Southwest	210.0	3.6	(206.4)
South Coyanosa	12,554.8	29,373.7	16,818.9
MPGCD Management Zone 1 per Cell Identification Table	90,753.0	123,341.4	32,588.4

Explanation

Pumpage (ac-ft/yr)

- 0 - 25
- 26 - 50
- 51 - 100
- 101 - 250
- 251 - 500
- 501 - 750
- 751 - 1,000
- 1,001 - 9,410

- MPGCD Management Zone per Cell Identification Tables
- Interstate
- US Highway
- State Highway
- Rail Road
- City Limits
- Texas Counties

N

0 40,000
Feet

Fort Stockton Holdings, L.P.

Pumpage Distribution in Management Zone 1 for GAM Run: GMA 7 Scenario 10

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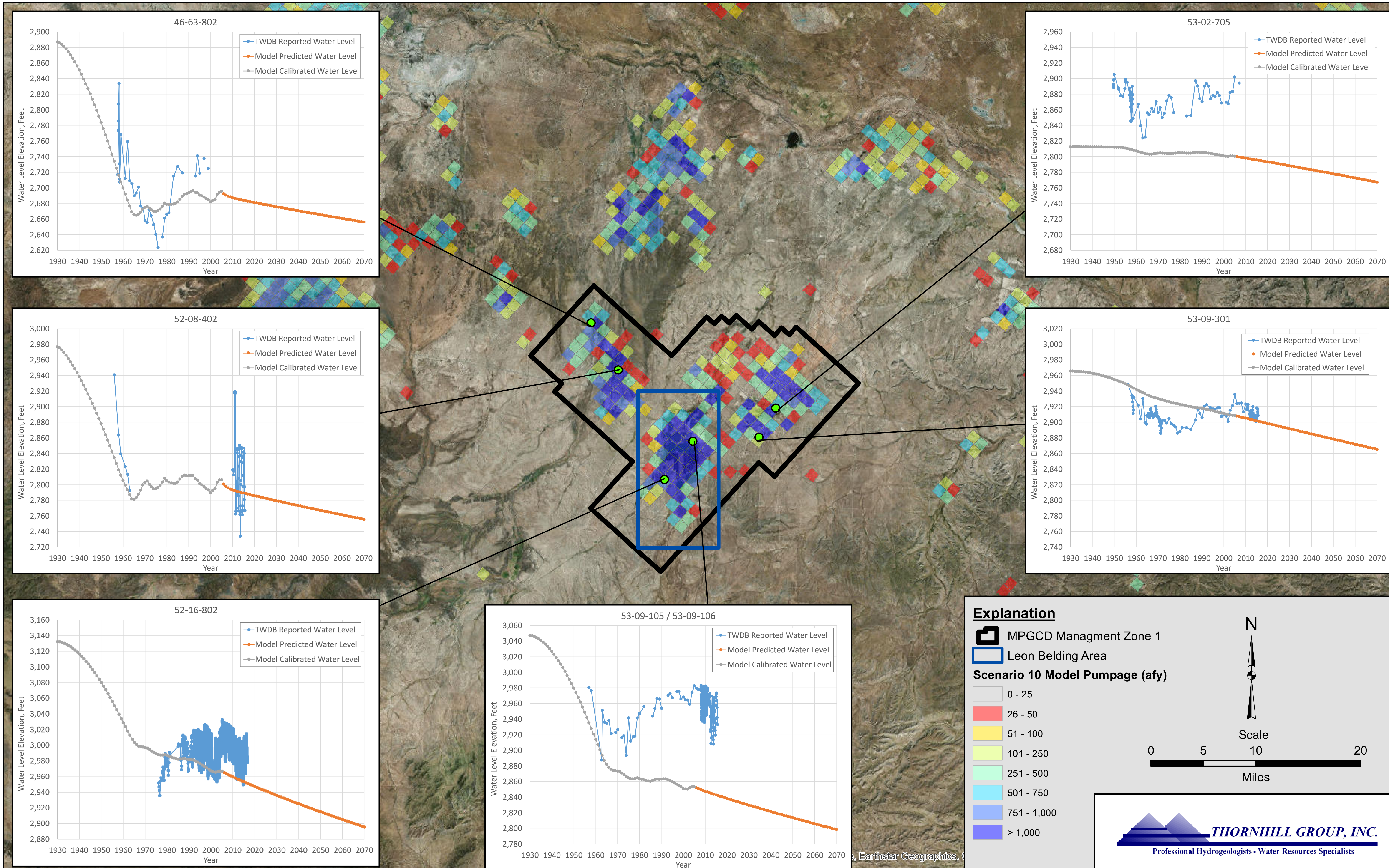
Attachment 3



46-63-802
Water Level Elevation, Feet
2,900 2,880 2,860 2,840 2,820 2,800 2,780 2,760 2,740 2,720 2,700 2,680 2,660 2,640 2,620
1930 1940 1950 1960 1970 1980 1990 2000 2010 2020 2030 2040 2050 2060 2070
Year
TWDB Reported Water Level
Model Predicted Water Level
Model Calibrated Water Level
52-08-402
Water Level Elevation, Feet
3,000 2,980 2,960 2,940 2,920 2,900 2,880 2,860 2,840 2,820 2,800 2,780 2,760 2,740 2,720
1930 1940 1950 1960 1970 1980 1990 2000 2010 2020 2030 2040 2050 2060 2070
Year
TWDB Reported Water Level
Model Predicted Water Level
Model Calibrated Water Level
52-16-802
Water Level Elevation, Feet
3,160 3,140 3,120 3,100 3,080 3,060 3,040 3,020 3,000 2,980 2,960 2,940 2,920 2,900 2,880
1930 1940 1950 1960 1970 1980 1990 2000 2010 2020 2030 2040 2050 2060 2070
Year
TWDB Reported Water Level
Model Predicted Water Level
Model Calibrated Water Level
53-09-105 / 53-09-106
Water Level Elevation, Feet
3,060 3,040 3,020 3,000 2,980 2,960 2,940 2,920 2,900 2,880 2,860 2,840 2,820 2,800 2,780
1930 1940 1950 1960 1970 1980 1990 2000 2010 2020 2030 2040 2050 2060 2070
Year
TWDB Reported Water Level
Model Predicted Water Level
Model Calibrated Water Level
53-02-705
Water Level Elevation, Feet
2,960 2,940 2,920 2,900 2,880 2,860 2,840 2,820 2,800 2,780 2,760 2,740 2,720 2,700 2,680
1930 1940 1950 1960 1970 1980 1990 2000 2010 2020 2030 2040 2050 2060 2070
Year
TWDB Reported Water Level
Model Predicted Water Level
Model Calibrated Water Level
53-09-301
Water Level Elevation, Feet
3,020 3,000 2,980 2,960 2,940 2,920 2,900 2,880 2,860 2,840 2,820 2,800 2,780 2,760 2,740
1930 1940 1950 1960 1970 1980 1990 2000 2010 2020 2030 2040 2050 2060 2070
Year
TWDB Reported Water Level
Model Predicted Water Level
Model Calibrated Water Level
Earthstar Geographics
Explanation
MPGCD Managment Zone 1
Leon Belding Area
Scenario 10 Model Pumpage (afy)
0 - 25
26 - 50
51 - 100
101 - 250
251 - 500
501 - 750
751 - 1,000
> 1,000
N
Scale
0 5 10 20
Miles
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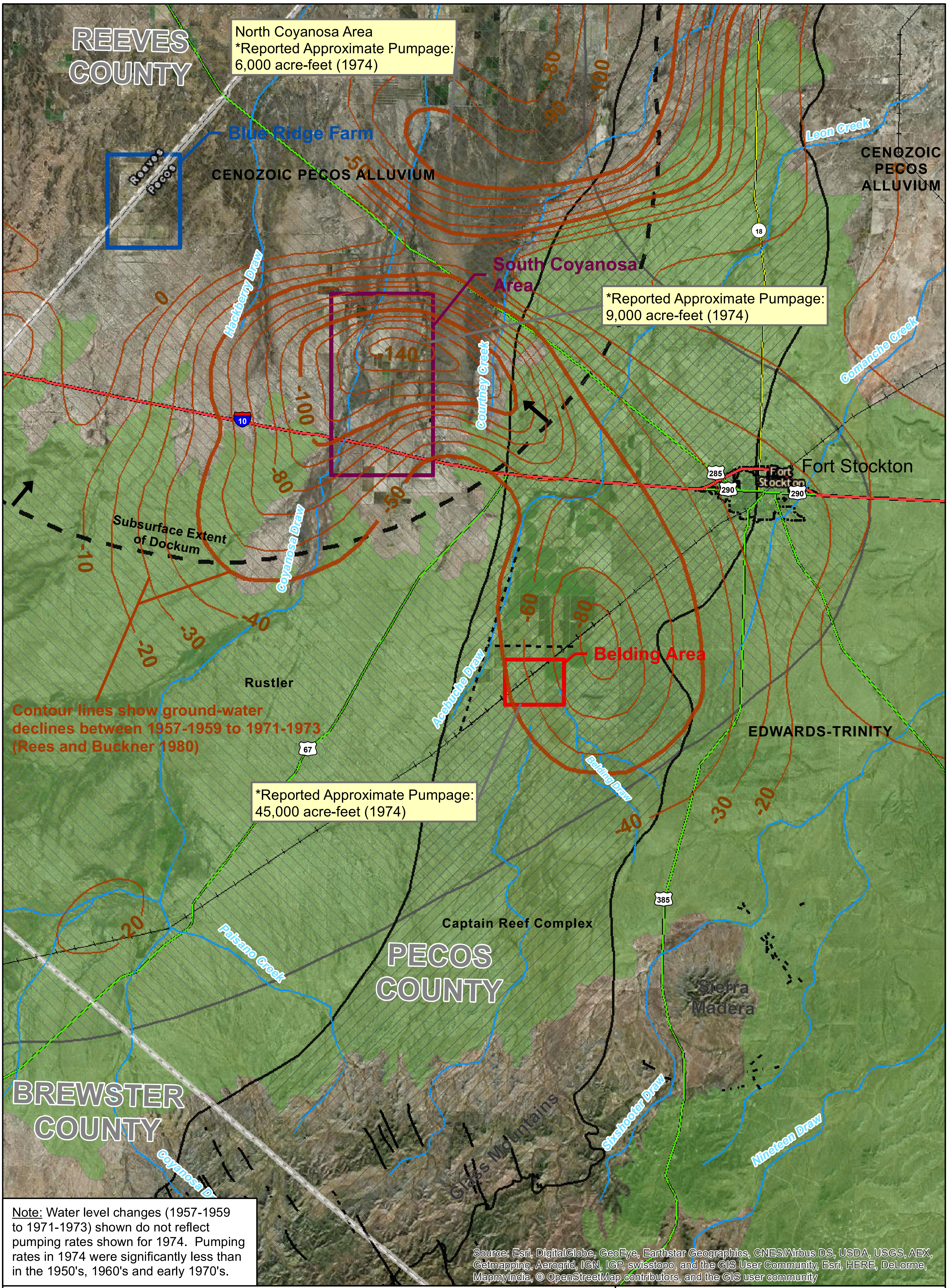
Attachment 4



Explanation

10-foot Contour Intervals *Approximate Water Level Change (1957-1959 to 1971-1973)

*Estimated 1974 Pumpage Amounts per Area

*Rees, Rhys, and A. Wayne Buckner. *Occurrence and Quality of Ground Water in the Edwards-Trinity (Plateau) Aquifer in the Trans-Pecos Region of Texas.* Report 255, Austin: Texas Department of Water Resources, 1980.

Source: Faults Obtained from B.E.G.
Aquifer Data Obtained from TWDB
Contours Digitized from TWDB R255, Fig. 8

City of Fort Stockton Wells
- Belding - Public Drinking Water
- Riley Farm
- Stockton Farm
- Blue Ridge Farm

Well Field Areas
- Belding Area
- Blue Ridge Farm
- South Coyanosa Irrigation Area

Major Aquifers
- Cenozoic Pecos Alluvium
- Edwards-Trinity, Outcrop

Minor Aquifers
- Dockum
- Rustler
- Capitan Reef Complex
- Normal Fault
- Inferred Normal Fault
- Unspecified

- Streams
- Interstate
- US Highway
- State Highway
- Rail Road
- City Limits
- Texas Counties

N

0 10,000 20,000
Feet

City of Fort Stockton

Figure 9.
Water Level Declines During Heavy Irrigation Period

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Appendix F

Responses to August 11, 2016 Comments Contained in Letter from Thornhill Group, Inc.

This appendix details responses to the comments contained in the August 11, 2016 letter to Mr. Paul Weatherby of the Middle Pecos GCD. The comments were made on the proposed desired future conditions in GMA 7, specifically in Middle Pecos GCD. A copy of the letter appears at the end of this appendix with numerical notations in the right margin. Specific responses to the comments are presented below.

Comment 1

The comment simply stated that the letter was written on behalf of Fort Stockton Holdings, a stakeholder.

Comment 2

The comment is incorrect. GMA 7 did consider all factors, including the total estimated recoverable storage prior to voting on a proposed desired future condition.

Comment 3

The comment is incorrect. GMA 7 did consider a "balance between the highest practicable level of groundwater production and the conservation, preservation, recharging, and prevention of waste of groundwater and the control of subsidence in the management area". This is evidenced by the numerous model runs that were considered in 2010 for the initial desired future condition and the proposed desired future condition (2016).

Comment 4

Drawdown is the difference between measured groundwater levels taken at two different times. All other things being equal, a positive drawdown connotes that pumping has increased over the time interval of interest, a zero drawdown connotes that pumping is essentially unchanged and an equilibrium has been reached, and a negative drawdown connotes that pumping has decreased over the time interval of interest. The Texas Water Development Board has approved as administratively complete drawdown-based desired future conditions.

Drawdown, is therefore, a measure in the change in storage. Storage calculations require knowledge of the geometry of the aquifer and groundwater levels. Change in storage calculation require knowledge of the geometry of the aquifer and the change in groundwater levels over a specific time interval. Drawdown-based desired future conditions have an advantage since a change in storage conditions can be tracked directly with measured data. Any storage-based desired future condition is saddled with the need to have knowledge of the aquifer geometry, the understanding of which changes as additional data are developed. From a regional planning perspective, it is entirely appropriate to use drawdown as a desired future condition.

Comment 5

Desired future conditions are planning goals, and not regulatory limits. This comment imputes a regulatory context to desired future conditions that are not present. To the extent that groundwater conservation districts must manage to meet desired future conditions, there is the potential for misuse and blind application of desired future conditions to permitting decisions, but this is potentially true of any desired future condition whether based on drawdown, spring flow, or storage. This comment is not relevant since it has nothing to do with the establishment of desired future conditions.

Comment 6

Citation of guidance documents from 2001 and 2008 is now irrelevant since the changes to the desired future condition process in 2011 in accordance with SB 660.

Comment 7

The process of using the groundwater model in developing desired future conditions revolves around the concept of incorporating many of the elements of the nine factors (e.g. current uses and water management strategies in the regional plan), and evaluating the impacts of changes in pumping (e.g. spring flow, surface water-groundwater interactions). For the Edwards-Trinity (Plateau) and Pecos Valley aquifers, numerous scenarios were completed, and the results discussed prior to voting on a proposed desired future condition.

This comment asserted that the districts were "reverse-engineering" the desired future conditions by specifying pumping (e.g., the modeled available groundwater) and then adopting the resulting drawdown as the desired future condition. However, it must be remembered that among the input parameters for a predictive groundwater model run is pumping, and among the outputs of a predictive groundwater model run is drawdown. Thus, an iterative approach of running several predictive scenarios with models and then evaluating the results is a necessary (and time-consuming) step in the process of developing desired future conditions.

One part of the reverse-engineering critique of the process has been that "science" should be used in the development of desired future conditions. The critique plays on the unfortunate name of the groundwater models in Texas (Groundwater Availability Models) which could suggest that the models yield an availability number. This is simply a mischaracterization of how the models work (i.e. what is a model input and what is a model output).

The critique also relies on a narrow definition of the term *science* and fails to recognize that the adoption of a desired future condition is primarily a policy decision. The call to use science in the development of desired future conditions seems to equate the term *science* with the terms *facts* and *truth*. Although the Latin origin of the word "*science*" means knowledge, the term *science* also refers to the application of the scientific method. The scientific method is discussed in many textbooks and is a process to quantify cause-and-effect relationships and to make useful predictions.

In the case of groundwater management, the scientific method can be used to understand the relationship between groundwater pumping and drawdown, or groundwater pumping and spring flow. A groundwater model is a tool that can be used to run "experiments" to better understand the cause-and-effect relationships within a groundwater system as they relate to groundwater management.

Much of the consideration of the nine statutory factors involves understanding the effects or the impacts of a desired future condition (e.g. groundwater-surface water interaction and property rights). The use of the models in this manner in evaluating the impacts of alternative futures is an effective means of developing information for the groundwater conservation districts as they develop desired future conditions.

Comment 8

Model output can define drawdown or change in storage for the entire model area, individual groundwater management areas, subdivisions of groundwater management areas, individual counties, individual groundwater conservation districts, or any combination of these. It is true that drawdowns are commonly reported by county or by district for purposes of administrative convenience and, in part, due to the dual purpose of desired future conditions which is to develop modeled available groundwater numbers for the regional planning process that is organized by political boundaries as wells as river basin boundaries.

However, the mere reporting of the drawdowns on a county level and the thrust of this comment ignore the process that has been ongoing in GMA 7 since 2010. The districts in Groundwater Management Area 7 initiated the process with a county-by-county estimate of future pumping, and this represented Scenario 1. Scenario 2 represented a 10 percent increase in pumping in each county of Groundwater Management Area 7 as compared to Scenario 1. Scenarios 3, 4, and 5 represented 20, 30, and 40 percent pumping increases in each county of Groundwater Management Area 7, respectively. The results of Scenarios 1 to 5 were summarized, distributed to the district representatives, and discussed at the July 29, 2010, meeting of Groundwater Management Area 7. The discussion focused on the districts' "vision" of groundwater conditions that qualitatively described the need to minimize drawdown in the eastern portion of Groundwater Management Area 7 to maintain spring flow and river baseflow and allow for drawdown in the western portion of Groundwater Management Area 7 where irrigated agriculture used large amounts of groundwater. The primary issue that needed to be resolved was the compatibility of these two qualitative goals. Recall that the purpose of joint planning was to regionalize groundwater management decisions among neighboring districts within a groundwater management area. Groundwater Management Area 7 included twenty groundwater conservation districts (the most in any groundwater management area), and the dynamics of discussing the impacts of various pumping scenarios was unique given the large number of stakeholders.

At the meeting, and after the general relationship between pumping and drawdown was presented and discussed, the district representatives provided updates to pumping on a county-by-county basis. Those updated pumping amounts were input into the model and runs were completed at the meeting, and the results summarized and discussed. Scenarios 6 to 10 were run during the meeting in this iterative fashion based on this input from the district representatives. After review of these model runs, the districts adopted Scenario 10 as meeting their qualitative vision of future drawdown conditions as their desired future condition.

Comment 9

As described above, in 2010, GMA 7 focused on the qualitative goal to minimize drawdown in the eastern portion of GMA 7 and provide for increased pumping in the western portion of GMA 7. The key aspects of using the model was to quantitatively evaluate the compatibility of these separate goals. The proposed desired future condition adopted in 2016 was based on the desired future condition adopted in 2010, after an updated assessment of uses and needs which are included among the nine statutory factors that have to be considered before voting on a proposed desired future condition.

The assertion in the comment that the proposed desired future condition is "based on political boundaries" is simply not true.

Comment 10

The full water balance was considered as required. However, the comment incorrectly defines the components of a water balance. The correct definition is the accounting of all inflows, all outflows, and the ***change*** in storage. The comment seems to confuse the concept of change in storage with total storage.

Total storage is a required factor to consider, and GMA 7 received and reviewed the Total Estimated Recoverable Storage estimates from the TWDB. However, the total storage is not a component of the water budget.

Comment 11

This subject has been covered in the response to Comments 8 and 9 (reverse engineering). It should be noted that the representatives of the Thornhill Group were present and actively participated at the July 29, 2010 GMA 7 meeting. Their participation included assisting the substitute representative of the Middle Pecos GCD in formulating the assumed pumping for input in the model simulations at the meeting after some initial confusion by the substitute representative of Middle Pecos GCD.

Comment 12

A description of the model runs, the underlying goals of the simulations, and the context of the discussion of the results in 2010 and again in 2016 have been covered in the response to comments 8 and 9.

Comment 13

The characterization of what the "initial and primary consideration" is not accurate. As stated above, models require pumping as input and one of the outputs is drawdown. As discussed above, the simulations were completed to evaluate the impacts of alternative pumping amounts. The primary consideration was the evaluation of GMA 7's qualitative vision of minimal drawdown in the eastern part of GMA 7 to protect spring flow and river base flow, and provide for increased pumping in the western portion of GMA 7.

Comment 14

The reference to the original legislation regarding MAGs is not relevant since:

- The term has since been changed (modeled available groundwater now versus managed available groundwater in the original legislation),
- The specifics of what a MAG is has changed in subsequent legislative sessions, and
- How the TWDB views MAGs has changed in the regional planning process.

Also, as stated above in the response to Comment 5, to the extent that GCDs must manage to meet desired future conditions, there is the potential for misuse and blind application of desired future conditions to permitting decisions, but this is potentially true of any desired future condition whether based on drawdown, spring flow, or storage. This comment is not relevant since it has nothing to do with the establishment of desired future conditions.

Comment 15

As stated above in the response to Comment 5 and Comment 14, the potential for misuse of the desired future condition is a valid concern, but this is more of a criticism of the process and not a specific comment on the proposed desired future conditions themselves.

Comment 16

This comment relies on statutory language regarding the creation of a groundwater conservation district (not the joint planning process). The incorrect assertion that the proposed desired future conditions were developed primarily along political boundaries has been discussed above in the response to Comments 8, 9, 12 and 13.

Comment 17

This comment is primarily about the management zones in Middle Pecos GCD. The proposed desired future condition has not been further subdivided into these management zones at the GMA 7 level, and it is therefore not possible to specifically respond to the issues raised.

An evaluation was of these management zones was attempted using the USGS groundwater model of Pecos County, the results of which are summarized in Technical Memorandum 17-01. Unfortunately, the model limitations prevent reliable predictive simulations or the evaluation of the management zone concept in Middle Pecos GCD.

Comment 18

As stated above in the responses to Comments 8, 9, 12, 13, and 16, this is a mischaracterization of the basis for the proposed desired future condition.

Comment 19

This is not a specific comment on the desired future condition, but rather an interpretation of statutory intent on the appropriate scale of groundwater management. Desired future conditions are planning goals, and are largely policy decisions made after considering nine statutory factors. The legislature has created the groundwater conservation districts to manage groundwater, and has required the districts to meet within designated groundwater management areas to conduct joint planning.

Comment 20

Mr. Hunt's comments were made in 2009, which was during the time that the initial desired future conditions were being developed. The first round had minimal statutory guidance as to what should be considered when establishing desired future conditions. Since then, the legislature has better defined the process by requiring groundwater conservation districts to consider nine specific factors (some that are technical and some that are more rooted in planning and policy). The proposed desired future conditions that are the subject of the comment letter were proposed after considering those statutory factors.

Mr. Hunt's discussion was focused on a single factor: the physical capability of the aquifer to produce water. This is only one of the factors that groundwater conservation districts in GMA 7 considered prior to voting on the proposed desired future conditions. In the context of the lack of specific statutory guidance at that time (2009), Mr. Hunt's was advocating that the physical capability of the aquifer to produce groundwater should be the dominant issue when establishing desired future conditions. Since then, the legislature updated the process to include nine factors, only one of which involves the physical ability of the aquifer to produce groundwater. Thus, given the current statutory language regarding the nine factors, the comment is not relevant.

Comment 21

Average drawdown is an appropriate means to quantify a planning goal. As stated in the response to Comment 4, drawdown is the difference between measured groundwater levels taken at two different times. All other things being equal, a positive drawdown connotes that pumping has increased over the time interval of interest, a zero drawdown connotes that pumping is essentially unchanged and an equilibrium has been reached, and a negative drawdown connotes that pumping has decreased over the time interval of interest. Thus, the result of the planning goal can be broadly interpreted as, over the planning period, pumping will increase, pumping will remain the same, or pumping will decrease.

This comment letter is an example of disagreements on a policy level as to how much pumping should increase. However, the joint planning process in GMA 7 began with an overall qualitative "vision" (minimal drawdown in the east and provide for increased drawdown in the west), considered a wide range of alternatives, and the potential impacts of the alternatives have been evaluated with the assistance of model simulations. The alternatives were developed, in part, based on the historic and future use of the aquifer (as required by statute).

Comment 22

This comment misstates the statutory requirements, and misstates the components of a water balance. The specific requirements in statute include total estimated recoverable storage as provided by TWDB and the average annual recharge, inflows and discharge. These are included in the third factor. In addition, the fourth factor requires consideration of the impacts on spring flow and other interactions between groundwater and surface water. These factors were considered.

As stated in the response to Comment 10, the correct definition of a water balance is the accounting of all inflows, all outflows, and the ***change*** in storage. The comment seems to confuse the concept of change in storage with total storage. Change in storage is an important factor since it can be used to characterize pumping increases, pumping stability, or pumping decreases over a specified interval of time.

As stated in the response to Comment 4 and 21, change in storage can be calculated by drawdown, which is the difference between measured groundwater levels taken at two different times. All other things being equal, a positive drawdown connotes that pumping has increased over the time interval of interest (and storage has decreased), a zero drawdown connotes that pumping is essentially unchanged and an equilibrium has been reached (and storage is unchanged), and a negative drawdown connotes that pumping has decreased over the time interval of interest (and storage has increased).

Comment 23

The total estimated recoverable storage is not part of the water budget. Also, when developing desired future conditions, the statute requires that other factors also be considered (e.g. impacts on spring flow and impacts to groundwater-surface water interactions). The consideration of these other factors will tend to result in a desired future condition that is different than a desired future condition that is only based on the physical ability of the aquifer to produce groundwater.

Comment 24

This comment is predicated on the false assertion that the proposed desired future conditions were primarily based on political boundaries and were reverse-engineered. Responses to comments 8, 9, 12, 13, 16, and 18 have covered this subject.

Comment 25

Model limitations were taken into consideration, and were an important part of the discussion at GMA 7 meetings.

Comment 26

Model limitations were taken into consideration. The potential misuse of models by individual districts in permitting decisions is not a relevant comment on the development of desired future conditions.

Comment 27

There are two issues raised in this comment: 1) historic pumping total versus Scenario 10 pumping, and 2) historic pumping distribution versus Scenario 10 pumping distribution.

As stated in the comment, the Scenario 10 pumping (i.e. simulated future pumping) is about 32,000 AF/yr more than historic pumping, and characterized this as an "overestimation". The simple matter is that Scenario 10 simulated an increase in future pumping over the historic to evaluate the potential impacts of that pumping.

The pumping distribution issue is acknowledged. The regional model used the best available information to distribute the pumping. To the extent that the distribution is inaccurate, this is a model limitation that is well known. This is one of the reasons that the models should only be used for regional assessments, and not local-scale simulations, which was done in this case.

The overall tone of the comments up to this point in the letter has been that the desired future conditions do not provide for sufficient pumping increases, will cause "paper shortages" and infringe on property rights. This comment is therefore confusing since the specific outcome of the proposed desired future condition will be a greater than 30 percent increase in pumping in Management Zone 1 of Pecos County over historic uses.

Comment 28

This comment points out a limitation in the regional model regarding the Leon Belding area. As discussed in the response to Comment 27, this limitation is well known. The model was used on a regional basis. It is agreed that this limitation is serious in the context of using the regional model for site-specific analyses (i.e. analyses associated with permitting decisions in the Leon Belding area). However, that comment is not relevant to the use of the model to evaluate regional conditions.

Comment 29

This comment is simply repeating the factors that must be considered prior to voting on a proposed desired future condition, which was done.

Comment 30

This comment mischaracterizes the "new joint planning process". The bolded items were added to the statute at the same time as the non-bolded items, all in SB 660.

The comment incorrectly suggests that the most important factors are the physical ability of the aquifer to produce water (factor 3) and the property rights (factor 7). However, there is no statutory language regarding the relative importance of one factor over another.

Comment 31

Again, the comment mischaracterizes the components of a water balance. Total storage was considered as required, and the inflows, outflows and change in storage were considered as required. However, total storage is not part of a water balance.

Comment 32

This comment offers an alternative desired future condition. The individual parts of the recommendation are discussed below:

Delineation of groundwater reservoirs and subdivisions – This comment is focused on the Leon Belding area in Pecos County, and not on the entirety of GMA 7. As discussed in the responses to previous comments, GMA 7 did qualitatively view GMA 7 in areas (east and west), and provided for minimal drawdown in the east to protect spring flow and river base flow, and provide for drawdown in the west. The model was used to evaluate the compatibility of the two separate goals. The desired future conditions are reported on a county and district basis for administrative convenience. The comment goes more to the specifics of a Pecos County, which is more appropriate for groundwater management at a district level. Based on the comment, it appears that there is disagreement on how the Leon Belding area should be defined. The comment recognizes that it is "hydrogeologically different", but disagrees with the way Middle Pecos GCD has defined Management Area 1. This is not a relevant comment for purposes of the desired future condition.

Leon Belding Aquifer Subdivision - This comment recommends that the Leon Belding area be designated as a subdivision and a separate desired future condition be established based on water levels since the regional model has limitations. Furthermore, the comment recommends detailed study to establish "alert or action" levels in water levels to curtail pumping. This recommendation is more appropriate for district-level groundwater management, and not appropriate for desired future conditions that are regional in nature. It is also confusing since the proposed desired future condition would result in over 30 percent increase in historic pumping (please see the response to Comment 27).

Storage Based Management Conditions – This comment (again) mischaracterizes the components of a water balance, which is an accounting of all inflows, outflows and ***change*** in storage (not total storage as stated in the comment). The comment also emphasizes the physical ability of the aquifer to produce groundwater, and states that the water balance is the "only true way to measure groundwater availability". The comment attempts to define the term “groundwater availability” as meaning only physical availability. However, as defined by statute, groundwater availability is largely a policy decision, and is defined and constrained by many factors. Physical availability is only one of these factors. The use of average drawdowns for desired future conditions is appropriate and can be assessed based on changes in measured groundwater levels. Measured groundwater levels would also be needed to assess storage-based desired future conditions, but with additional assumptions and calculations on aquifer geometry. Thus, the use of drawdown-based desired future conditions is superior since their evaluation require less in the way of assumptions and calculations.

Comment 33

This recommendation to establish a desired future condition of five percent reduction in storage ignores issues related the other factors, ignores the balancing requirements of the statute, and, in some cases, is not even achievable.

Comment 34

Monitoring of groundwater levels is a routine activity of the groundwater conservation districts and the Texas Water Development Board. These data provide the foundation to evaluating management decisions related to desired future conditions. The use of models in evaluating alternatives and analyzing the impacts of the alternatives in the context of the nine factors is appropriate.

Comments regarding the misuse of models in permitting decisions are not relevant to the establishment of desired future conditions.

Comment 35

As discussed in the response to Comment 34, monitoring of groundwater levels is a routine activity of the groundwater conservation districts and the Texas Water Development Board. These data provide the foundation to evaluating management decisions related to desired future conditions.

Comment 36

The comment is not relevant since permit terms have nothing to do with desired future conditions.

Comment 37

The comment is not relevant since the misuse of models in permitting decisions has nothing to do with desired future conditions.

Comment 38

One of the factors that need to be considered by statute is the "water supply needs and water management strategies included in the state water plan" (factor 2). This factor was even quoted in an earlier part of the comment letter. However, this comment seems to recommend that GMA 7 ignore this factor, and that no consideration be given to future needs in a long-term planning process. This comment is neither appropriate nor relevant since GMA 7 has endeavored to comply with the statutory requirements of the Texas Water Code and the Administrative Rules of the Texas Water Development Board in the joint planning process.

Comment 39

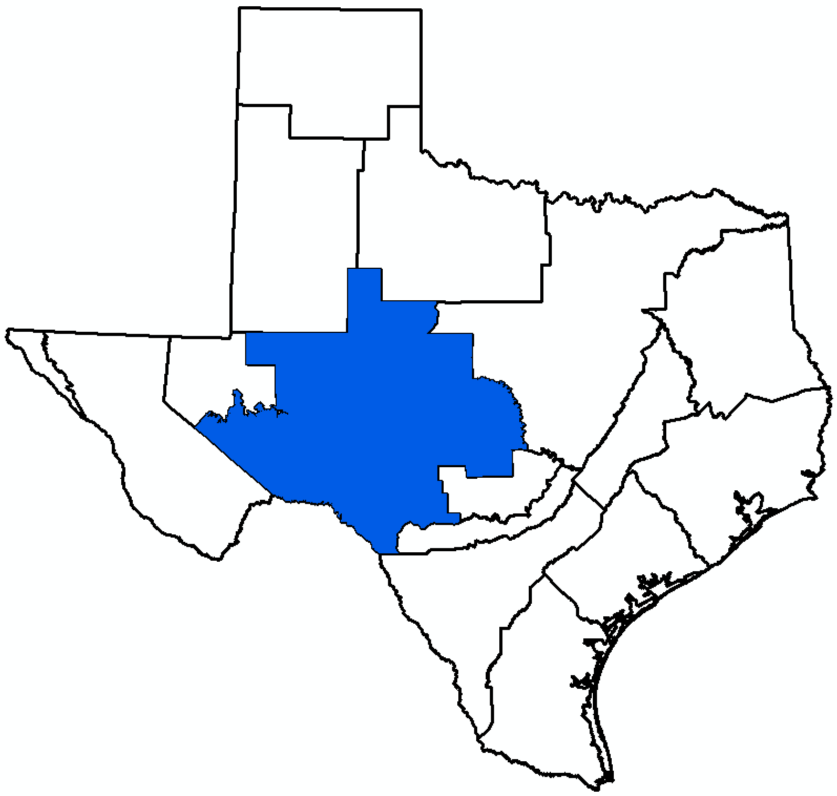
The explanatory report is not required until after the final desired future condition is adopted. This appendix is included in the explanatory report to respond to the comments provided, and to discuss the reasons the recommended desired future conditions were not incorporated into the desired future condition.

Appendix G

Simulations with USGS Groundwater Model of Pecos County Region (GMA 7 Technical Memorandum 17-01)

GMA 7 Technical Memorandum 17-01
Draft 2

Simulations with USGS Groundwater Model of Pecos County Region



Prepared for:
Groundwater Management Area 7

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February 13, 2017

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1.0 Introduction

This technical memorandum documents simulations using the USGS Groundwater Model for the Pecos County region. These simulations were completed in response to public comments of the proposed desired future condition for the Edwards-Trinity (Plateau) and Pecos Valley Aquifers.

The proposed desired future conditions were approved by GMA 7 on April 21, 2016. During the public comment period, Middle Pecos GCD received oral and written comments that included the possible use of the USGS model (Clark and others, 2014) in the development of desired future conditions. This model had not been used in the process of developing the proposed desired future condition from 2014 to 2016.

Initial review of the model suggested that it may be a better tool since it explicitly simulated flow from Comanche Springs, divided the flow system into multiple layers, had a more refined model grid, and had a more detailed and realistic specification of pumping. However, as detailed in this technical memorandum, the model, as currently constructed, is not useful for predictive simulations.

2.0 USGS Groundwater Model for the Pecos County Region

As stated in Clark and others (2014), the USGS report

> *"documents the development of a numerical model describing groundwater flow of the Edwards-Trinity and related aquifers in the Pecos County region, Tex., and summarizes potential future pumping scenarios simulated with the model. The sustainability of recent (2008) and projected water-use demands on groundwater resources in the Pecos County region study area were evaluated through the year 2040."*

2.1 Discretization

The model code used for this effort was MODFLOW-2005, a finite difference code developed by the USGS that requires the model domain to be discretized into a regular grid of cells. As described in Clark and others (2014), the Pecos County region was discretized into a 5-layer grid of cells. The grid consisted of 156 rows and 174 columns with uniform cells size of ½ mile by ½ mile. From top to bottom, the five layers represented: 1) the Pecos Valley Aquifer, or the alluvial layer, 2) the Edwards formation, 3) the Trinity formation, 4) the Dockum Aquifer, and 5) the Rustler Aquifer.

2.2 Lateral and Vertical Boundary Conditions

Of note in the construction of the model are the lateral flow boundary conditions (simulated with the general head boundary package of MODFLOW) and the use of time-variant constant heads to simulate heads in the Rustler Aquifer.

The lateral boundary conditions using the general head boundary (GHB) package were placed on the western, northwestern, north, and southeastern perimeters of the model area in layer 3 (Trinity layer) (Clark and others, 2014, pg. 10). Heads assigned to the boundary condition varied with space and time as described in Clark and others (2014, pg. 10).

The use of the time-variant constant head (CHD) package was intended "to represent water levels in the Rustler Aquifer" (Clark and others, 2014, pg. 12). The CHD input file lists 650 cells, all in layer 5, that allow interaction between the boundary and the aquifer system. Since layer 5 of the model is the Rustler Aquifer, these boundaries are, in effect, a means to specify heads in layer 5 (in cells where the CHD package is used), and allow for inflows and outflows outside the model domain (effectively with formations below layer 5).

A key feature of the implementation of the CHD package was how the heads changed with time during the calibration period. Clark and others (2014, pg. 29) noted that simulated flow at Comanche Springs did not gradually decline and then cease until addition of these boundaries in layer 5. In support of this approach, Clark and others (2014, pg. 29) cited Ewing and others (2012). Furthermore, Clark and others (2012, pg. 29) cited a geochemical analysis by Bumgarner and others (2012) that suggested “upwelling of groundwater from the Rustler Aquifer in localized areas”.

Ewing and others (2012) is a model of the Rustler Aquifer. The Rustler model is a two-layer model where layer 2 is the Rustler Aquifer and layer 1 represents all the younger overlying layers. Ewing and others used the GHB package to simulate overlying formations (in layer 1) to interact with the aquifer of interest in layer 2 (the Rustler Aquifer). A detailed description of how to use the GHB package in a predictive simulation is presented in Ewing and others (2012, pg. 11-3 and 11-4). A similar approach was used by Ewing and others (2008) for the Dockum Aquifer.

The use of GHBs for these models simply allowed interaction with overlying formations by specifying a temporally changing set of heads to simulate the interaction between the overlying formations and the aquifer of interest (either the Dockum or the Rustler). An important consideration in applying GHBs to simulate interactions with formation that overlie the area of interest is how to specify heads for predictive simulations. Hutchison (2016) described how the GHB package was applied in the Rustler Aquifer for predictive simulations for GMA 7. The issue of use of GHBs for the Dockum Aquifer in 2010 for predictive simulations resulted in modifying and recalibrating the model as described in Oliver and Hutchison (2010).

Clark and others (2014) completed predictive simulations that simply used the specified heads in the CHD package from the last stress period of the calibration period, and did not provide for any change during the 30-year predictive runs (years 2010 to 2040). Initial simulations using the USGS model in response to the public comments using the approach employed by Clark and others (2014) yielded results that were inconsistent with a conceptual understanding of the groundwater flow system and, to a certain extent, by anecdotal observations (i.e. large reductions in pumping should result in increases in spring flow). Thus, a more detailed review was completed to understand the USGS model.

2.3 Summary of CHD Specifications

CHD boundary specifications included 650 cells in layer 5. Cell-by-cell boundary heads changed for each of the 144 stress periods as described in Clark and others (2014). Because Clark and others (2014, pg. 29) stated that the CHD package was needed to simulate the reduction and cessation of spring flow during the calibration period the initial review focused on CHD boundary cells that underlie the Comanche Springs area. Comanche Springs is simulated in nine cells in layer 2 of the USGS model using the Streamflow Routing Package (SFR). Two of these SFR cells directly overlie two of the CHD cells in layer 5. Figure 1 presents the time-history of the head specification of these two CHD cells.

Please note that each of these cells included a sharp drop from 1940 to about 1960, and a more gradual decline from 1960 to 2010. Overall, total head decline for these two cells was estimated to be about 67 or 68 feet from 1940 to 2010, or just under 1 foot per year, on average. A cursory review of Ewing and others (2012, pg. 9-47) suggest that, based on measured groundwater elevations in two wells in the Rustler Aquifer in Pecos County, the continued drop specified in the CHD boundary may not be accurate. These two wells suggest a decline followed by a recovery in more recent years to elevations similar to the early 1960s.

Additional analyses were completed to gain additional perspective on the CHD specification, and the effect on spring flow.

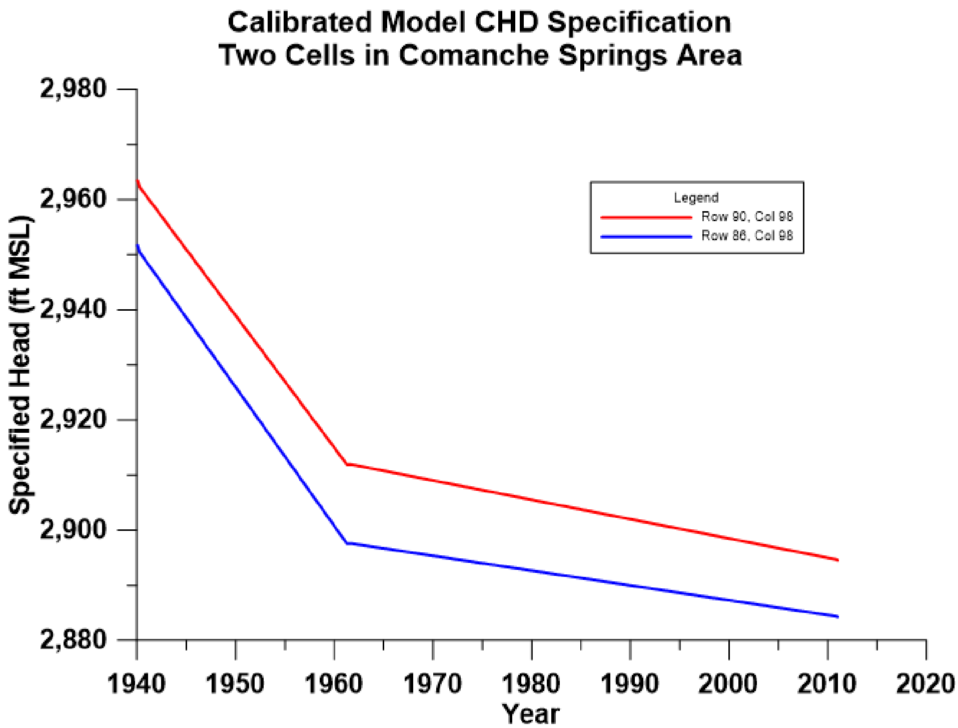

Figure 1. CHD Specification for Two Cells in Comanche Springs Area

2.4 Link Between CHD Specification and Spring Flow

Figure 2 presents model input and output data for the downstream cell associated with Comanche Springs (row 86, column 98). The model specified top elevation of layer 1 and layer 2 are shown. Also shown are the specified SFR elevation (specified for layer 2), the calibrated model head in layer 2, and the CHD boundary specification for layer 5.

Please note that when the aquifer head (black line) is above the SFR elevation (red line), groundwater flows out of the aquifer and becomes spring flow. From 1940 to about 1960, the black line is above the red line, and spring flow was noted (Clark and others, 2014, pg. 31).

Also, please note that the head in layer 2 (black line) and the CHD specification in layer 5 (blue line) are very similar after the early 1960s. This results in a situation where the specification of the CHD boundary in layer 5 will have a controlling influence on the head in layer 2. The head in layer 2 is important since it will determine whether there is spring flow or not, depending on whether the head is above or below the SFR specification for spring elevation. Another consideration is that, due to the CHD boundary, the upwelling of water from formations below layer 5 is an inflow component to the model. Clark and others (2014, pg.40) summarize the overall water budget of the calibration period, and includes a hydrograph of the "upwelling from lower units". For most years, this upwelling is the highest inflow component (up to about 400 million gallons per day). The upwelling peaks in the 1960s, and gradually declines from the 1960s to 2010, apparently due to the change in rate of decline of the CHD boundary heads specified in the input.

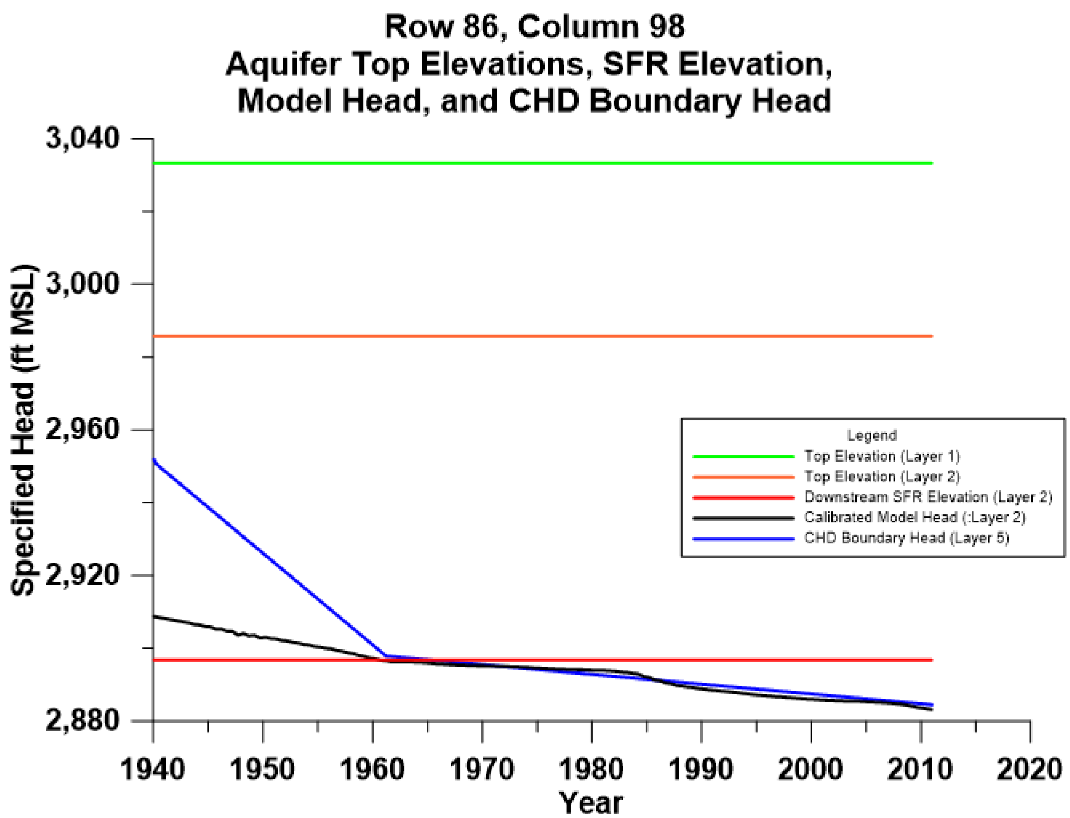

Figure 2. Model Input and Output Data for Downstream Cell of Comanche Springs

The top elevations for layer 1 and layer 2 are not directly involved in these calculations, but are presented to show an apparent inconsistency in the model input since the SFR elevation is substantially below the aquifer top elevation. Given that the model input for the LPF package is for "confined aquifers" (Clark and others, 2014, pg. 40) the top and bottom elevations are only used for calculation of aquifer transmissivity which is constant for the entire calibration period, and have no bearing on any other calculations.

3.0 Simulations with the USGS Model

The initial objective of these simulations was to test the usefulness of the USGS model in the development of desired future conditions. Spring flow is generally considered a good indicator of aquifer conditions on a regional scale, and the USGS model was reported to have been calibrated, in part, with data from Comanche Springs. As stated in some of the public comments, there was an interest in developing a desired future condition on something other than drawdown. In GMA 7, two proposed desired future conditions in the Edwards-Trinity (Plateau) Aquifer are specified with spring flow (Val Verde County and Kinney County). Thus, it seemed that if the USGS model was a suitable tool, the potential for establishing a desired future condition based on spring flow could be considered.

3.1 Initial Simulations

Initially, a set of 14 simulations were developed based on the varying pumping within each management zone in Middle Pecos GCD. Although the management zones are not included in the proposed desired future condition, the management zones were the subject of some of the comments received, and part of this effort included the review of pumping in each of the management zones and the impacts of pumping across management zones.

3.1.1 Historic Pumping, Permit Totals, and Modeled Available Groundwater

The simulations were developed from a foundation of historic pumping, permit totals and current modeled available groundwater (MAG) organized by management zone. Middle Pecos GCD has formally designated Management Zones 1, 2 and 3. For purposes of this technical memorandum, Management Zone 4 is the area of Middle Pecos GCD that is not in Management Zones 1, 2, or 3. Figure 3 presents the locations of Management Zones 1, 2, and 3.

A summary of pumping from each management zone is presented in Figures 4 to 7. Please note that each graph of pumping is from output from the USGS model, and presents the pumping from each of the top 3 layers (alluvium, Edwards, and Trinity) from 1940 to 2010. In addition, the total permitted pumping and the 2010 Modeled Available Groundwater (MAG) are shown for comparative purposes.

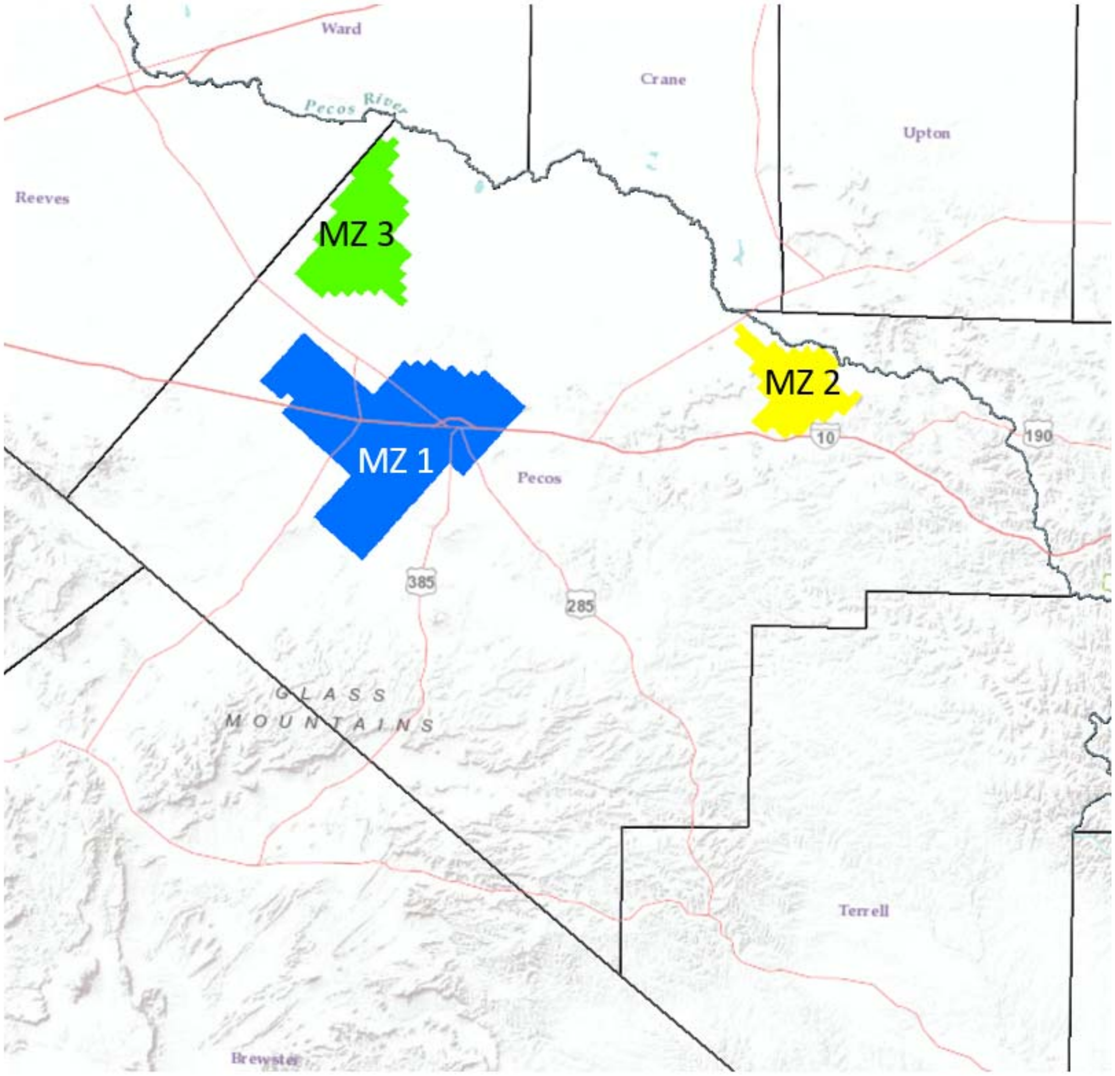

Figure 3. Locations of Management Zones 1, 2, and 3

Please note that Management Zone is labeled MZ in figure

Areas in Pecos County not in Management Zone 1, 2, or 3 are informally designated Management Zone 4 in this Technical Memorandum (please see Figure 7)

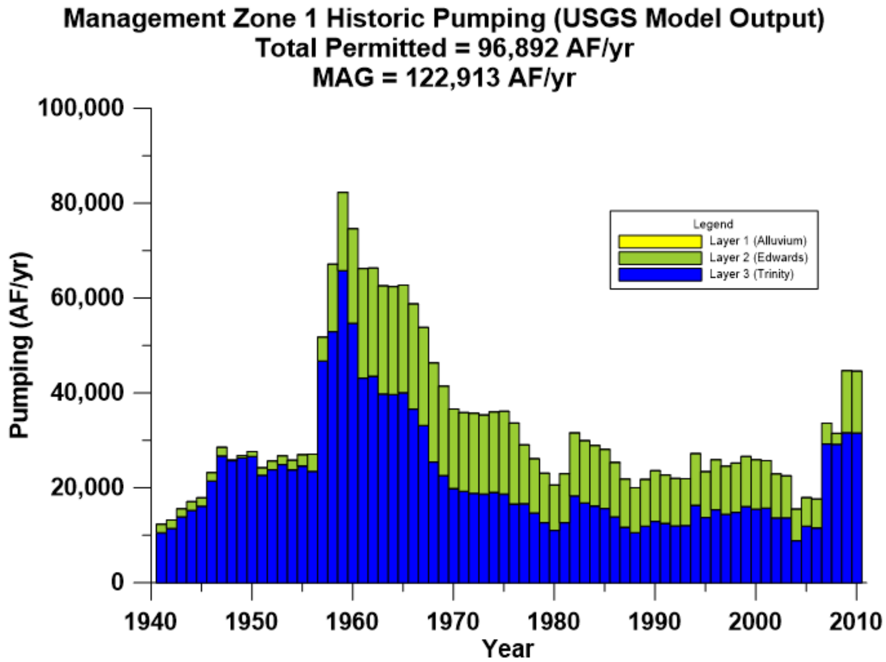

Figure 4. Management Zone 1 Historic Pumping

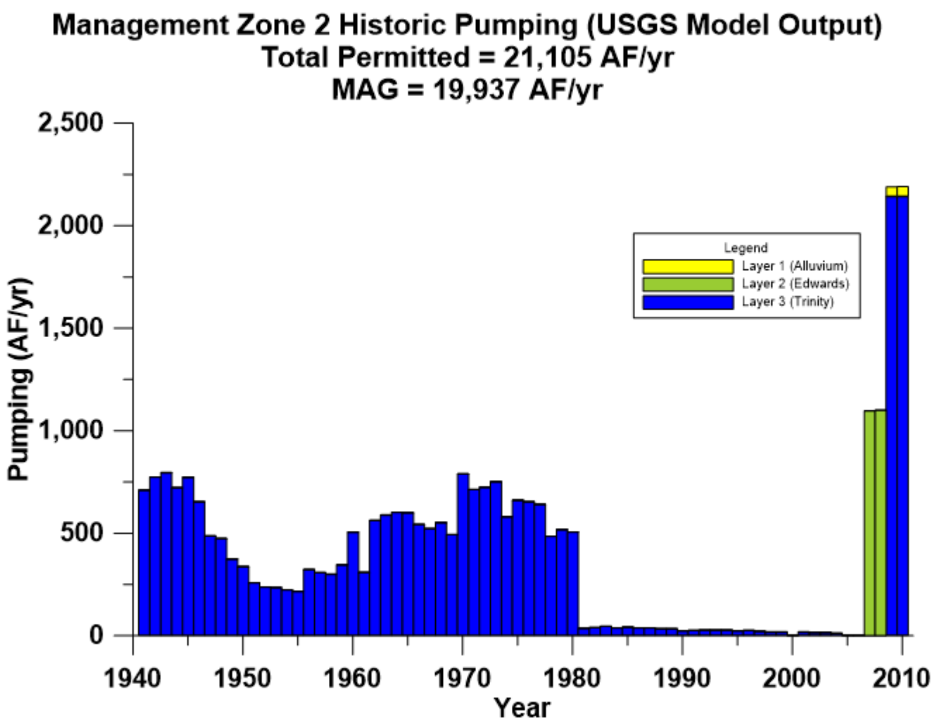

Figure 5. Management Zone 2 Historic Pumping

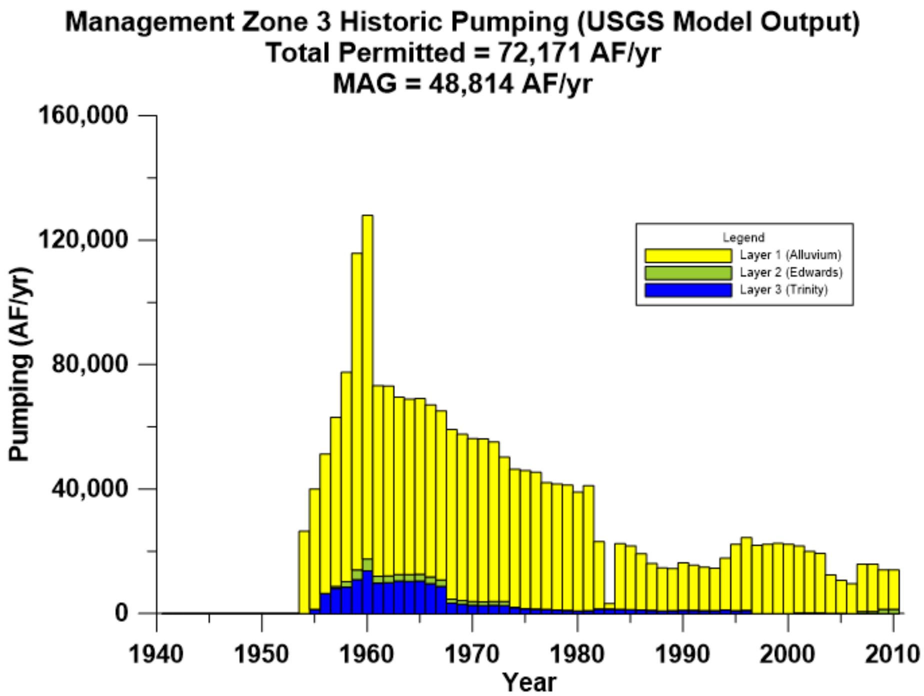

Figure 6. Management Zone 3 Historic Pumping

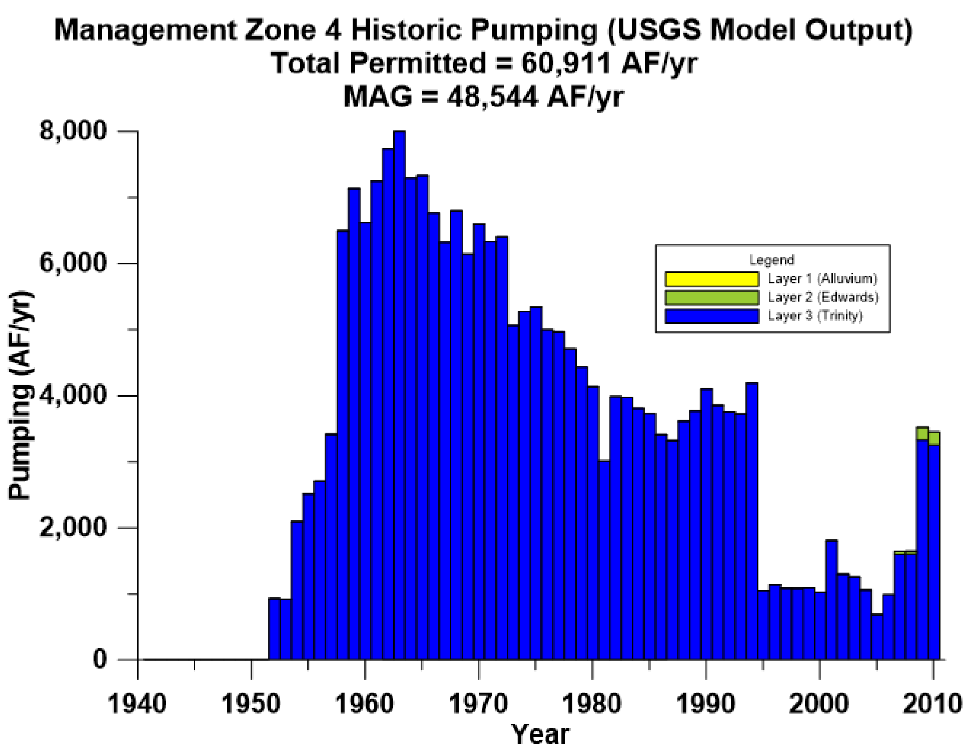

Figure 7. Management Zone 4 Historic Pumping

Based on an evaluation of the historic pumping, a base scenario was developed using stress period 41 (March to September, 1959) for Management Zones 1, 3, and 4, and stress period 139 (March to September, 2008) for Management Zone 2. This approach allowed the use of the specific well locations and completion intervals used in the calibrated USGS model for the simulations by simply assigning alternative pumping rates.

Table 1 summarizes the pumping amounts used for input for the base scenario, and the permit totals and 2010 modeled available groundwater (MAG) for comparative purposes.

Table 1. Summary of Base Scenario Input, Permit Totals, and 2010 MAG by Management Zone

Management Zone	Base Scenario Pumping Input (AF/yr)	Permit Total (AF/yr)	2010 MAG (AF/yr)
1	75,490	96,892	122,913
2	2,180	21,105	19,937
3	149,146	72,171	48,814
4	6,214	60,911	48,544

3.1.2 Development of Initial Scenarios

The initial scenarios were developed as follows:

- Scenario 1 is the baseline pumping presented in Table 1.
- Scenario 2 scaled the baseline pumping to match the permitted total in each management zone.
- Scenario 3 scaled the baseline pumping to match the 2010 MAG for each management zone.
- Scenarios 4, 5, and 6 scaled the baseline pumping to evaluate the effects of reduced pumping in Management Zone 1.
- Scenarios 7, 8, and 9 scaled the baseline pumping to evaluate the effects of increased pumping in Management Zone 2.
- Scenarios 10 and 11 scaled the baseline pumping to evaluate the effects of increased and decreased pumping in Management Zone 3.
- Scenarios 12, 13, and 14 scaled the baseline pumping to evaluate the effects of increased pumping in Management Zone 4.

Table 2 summarizes the 14 initial scenarios and the scaling factors used.

Table 2. Summary of Scaling Factors for Pumping in the 14 Scenarios

Scenario	Description	MZ1	MZ2	MZ3	MZ4
1	Baseline	1.00	1.00	1.00	1.00
2	Permit	1.28	9.68	0.48	9.80
3	MAG	1.63	9.15	0.33	7.81
4	MZ1-1	0.25	1.00	0.50	1.00
5	MZ1-2	0.50	1.00	0.50	1.00
6	MZ1-3	0.75	1.00	0.50	1.00
7	MZ2-1	1.00	2.00	0.50	1.00
8	MZ2-2	1.00	4.00	0.50	1.00
9	MZ2-3	1.00	6.00	0.50	1.00
10	MZ3-1	1.00	1.00	1.25	1.00
11	MZ3-2	1.00	1.00	0.75	1.00
12	MZ4-1	1.00	1.00	0.50	2.00
13	MZ4-2	1.00	1.00	0.50	4.00
14	MZ4-3	1.00	1.00	0.50	6.00

Scenarios were developed to run with annual stress periods from 2011 to 2070. Heads from the calibrated model in 2010 were used as initial conditions. Clark and others (2014) used GHB and CHD input from the last stress period (2010) for their predictive simulations, and this convention was followed for these initial simulations. All other inputs also followed the concepts of the USGS predictive runs (e.g. RIV, SFR, and RCH), but the time of the simulation was extended to 2070.

3.1.3 Results of Initial Simulations

The spring flow output from the initial simulations was evaluated from each of the 14 scenarios. In all cases, even the ones where pumping was reduced dramatically in Management Zone 1 (e.g. Scenario 4), there was no spring flow. This means that the heads in layer 2 did not rise above the SFR boundary elevations to cause groundwater to discharge from the spring. It would be expected that pumping reductions would result in a recovery of heads sufficient to result in at least some spring flow in Comanche Springs, so additional simulations were completed to gain an understanding of model behavior.

Specifically, the role of the GHB and CHD boundaries were evaluated since these were the only model inputs that varied with time during the calibration period.

3.2 Simulations with Alternative GHB Boundaries

The same of 14 scenarios were run in this set of simulations, but with a GHB package that had head values equal to the first stress period of the calibrated model rather than the last as was used in the initial simulations described above and in the USGS predictive simulations.

Results of these simulations also showed no spring flow in any of the scenarios, again which is not expected in scenarios where pumping in Management Zone 1 is reduced.

3.3 Simulations with Alternative CHD Boundaries

The same set of 14 scenarios were run in this set of simulations, but with a CHD package that had head values equal to the first stress period of the calibrated model rather than the last as was used in the initial simulations described above and in the USGS predictive simulations.

The estimated spring flow in 2011 and 2070 are summarized for each scenario in Table 3.

Table 3. Summary of Estimated Spring Flow for Alternative CHD Scenarios

Scenario	Description	Spring Flow in 2011 (cfs)	Spring Flow in 2070 (cfs)
1	Baseline	20.70	32.81
2	Permit	20.34	32.05
3	MAG	19.89	31.10
4	MZ1-1	21.67	34.85
5	MZ1-2	21.35	34.17
6	MZ1-3	21.02	33.49
7	MZ2-1	20.70	32.81
8	MZ2-2	20.70	32.81
9	MZ2-3	20.70	32.81
10	MZ3-1	20.70	32.81
11	MZ3-2	20.70	32.81
12	MZ4-1	20.70	32.81
13	MZ4-2	20.70	32.81
14	MZ4-3	20.70	32.81

Please note the following:

- Spring flow increases from 2011 to 2070 due to an overall recovery of groundwater levels associated with the higher CHD specification.
- Spring flows vary with pumping changes in Management Zone 1 pumping, but not to changes in pumping in Management Zones 2, 3 and 4.
- Spring flow is relatively high in pumping scenarios with high pumping, which is inconsistent with observations.

The specification of higher boundary elevations in layer 5 resulted in heads to rise above the SFR boundary elevation. This recovery occurred over a 15- to 20-year period, resulting in increasing spring flows during this transition period. After this transition period, spring flows were essentially constant.

3.4 Simulations with Alternative GHB and CHD Boundaries

The final set of simulations used alternative GHB and CHD boundaries that were evaluated individually as described above. The objective of this set of simulations was to test the sensitivity of the GHB boundary conditions when the CHD boundaries are set to the higher first stress period values.

Spring flow results are summarized in Table 4, and are similar to Table 3. Thus, the change in GHB head specification does not result in changes to spring flow.

Table 4. Summary of Estimated Spring Flow for Alternative GHB and CHD Scenarios

Scenario	Description	Spring Flow in 2011 (cfs)	Spring Flow in 2070 (cfs)
1	Baseline	20.71	32.99
2	Permit	20.35	32.23
3	MAG	19.91	31.28
4	MZ1-1	21.69	35.03
5	MZ1-2	21.36	34.35
6	MZ1-3	21.04	33.67
7	MZ2-1	20.71	32.99
8	MZ2-2	20.71	32.99
9	MZ2-3	20.71	32.99
10	MZ3-1	20.71	32.99
11	MZ3-2	20.71	32.99
12	MZ4-1	20.71	32.99
13	MZ4-2	20.71	32.99
14	MZ4-3	20.71	32.99

4.0 Discussion of Results

The results of the simulations show that spring flow is sensitive to the selection of CHD boundary heads in layer 5. The use of CHD boundary heads from 2010 in predictive simulations results in no spring flow since the heads in layer 2 have equilibrated to the CHD boundary head, and remain below the SFR elevation. Essentially, changes in pumping in layer 2 or layer 3 near Comanche Springs will cause little or no change to the spring flow. Because of the sensitivity of spring flow to the CHD boundary heads, it is not a useful tool for predictive simulations.

This limitation also extends to using the model to drawdown estimates using the model. Because the CHD boundary head specification causes layer 2 heads to equilibrate to essentially the same value, the resulting drawdown calculations would be tied more to layer 5 CHD boundary specification than to evaluating the drawdown effects of pumping.

The USGS model needs to be reconceptualized and recalibrated to be useful for predictive simulations. The choice of using CHD boundaries to essentially drive the heads in layer 5 needs to be reevaluated.

Clark and others (2014) noted that the CHD boundary was needed to achieve model-estimated spring flows that approximated actual spring flow data. This choice, however, has resulted in a model that requires specification of CHD boundaries for predictive simulations that control spring flow estimates to such an extent that the predictions are not useful to evaluate impacts of pumping on spring flow.

Based on these simulations, the USGS model is not an appropriate tool to evaluate and develop desired future conditions.

5.0 References

Clark, B.R., Bumgarner, J.R., Houston, N.A., and Foster, A.L., 2014. Simulations of Groundwater Flow in the Edwards-Trinity and Related Aquifers in the Pecos County Region, Texas. USGS Scientific Investigations Report 2013-5228. Prepared in cooperation with the Middle Pecos Groundwater Conservation District, Pecos County, City of fort Stockton, Brewster County, and Pecos County Water Control and Improvement District No. 1, 67p.

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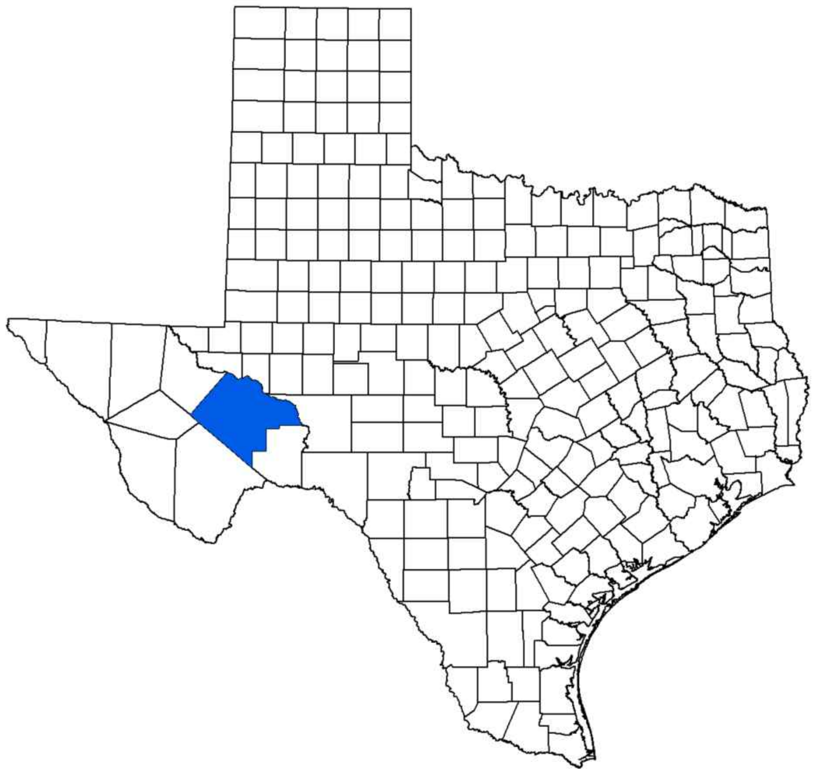
Middle Pecos GCD Exhibit 32

Review of Belding Farms Database, prepared by William R. Hutchison, Ph.D., P.E., P.G., January 24, 2025, and Water Level Data

Review of Belding Farms Database
(Final)



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Finalized on January 24, 2025 (unchanged from draft of December 7, 2018)

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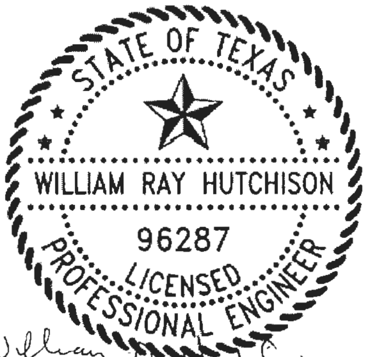
F – Annual Pumping vs. Summer Minimum Groundwater Elevations

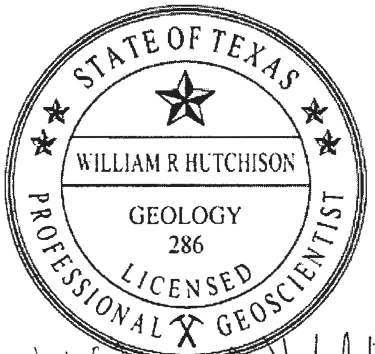
Professional Engineer and Professional Geoscientist Seals

This report was prepared by William R. Hutchison, Ph.D., P.E., P.G., who is licensed in the State of Texas as follows:

- Professional Engineer (Geological and Civil) No. 96287
- Engineering Firm Registration No. 14526
- Professional Geoscientist (Geology) No. 286



William R Hutchison
1/24/2025



William R Hutchison
1/24/2025

Note: This is a finalized version of a draft report dated December 7, 2018. The draft was circulated, reviewed and discussed with Belding Farms representatives in late 2018 through the middle of 2019. There were no specific comments on the 2018 draft report provided by Cockrell or other stakeholders during this time and the report was left in draft form.

In 2023, updated Belding data were provided, and the updated analysis was presented to MPGCD at a Board meeting on October 17, 2023 (the PowerPoint slides were the only documentation of the updated analysis).

Therefore, for completeness, this report was finalized on January 24, 2025 and is unchanged from the December 7, 2018 draft.

1.0 Introduction

This report summarizes the results of analyses of groundwater data recently obtained from Belding Farms. The context of this effort is complex and rooted in the settlement of litigation between Fort Stockton Holdings, LP and Clayton Williams Farms, Inc., and Republic Water of Texas LLC against the Middle Pecos Groundwater Conservation District that was settled in July 2017, and new litigation between Cockrell Investments Partners, L.P. (owners of Belding Farms) against the Middle Pecos Groundwater Conservation District.

Sections 1.1 to 1.4 summarizes the relevant history to provide some context prior to a discussion of the objectives of the effort (Section 1.5). Section 1.6 discusses the preliminary release of some of the analyses described in this report to the interested parties. Section 1.7 discusses a recent review of the Western Pecos County groundwater model completed by Southwest Research Institute, a technical consultant for Cockrell Investments Partners, L.P. and Belding Farms.

1.1 Draft Report on Monitoring Thresholds

On June 16, 2017, I submitted a draft report to the Middle Pecos Groundwater Conservation District in support of a settlement proposal dated April 28, 2017 between the Middle Pecos Groundwater Conservation District, Fort Stockton Holdings, LP and Clayton Williams Farms, Inc., and Republic Water of Texas LLC (Hutchison, 2017b). This draft report summarized the results of analyses to:

- Support changes in the boundaries of Management Zone 1.
- Evaluate data and simulations results for individual monitor well locations in the proposed Management Zone 1 related to regulatory thresholds that could be included as special permit conditions and data and information related to planning-level desired future conditions

1.2 Cockrell Review Comments on Draft Report

On June 28, 2017, I received a phone call from Kaveh Khorzad, a consulting hydrogeologist for Cockrell Investments Partners, L.P. and Belding Farms to discuss the results, findings and recommendations of the report (Hutchison, 2017b). During the call, Mr. Khorzad stated that Belding Farms had been collecting groundwater data for years. When I asked about the availability of the data for use in the effort to establish thresholds, Mr. Khorzad said he would let me know if it could be released.

On July 14, 2017, Mr. Khorzad submitted a letter outlining his review and concerns regarding the recommendations. The letter contained a recommendation that thresholds be established that "would protect long term aquifer levels, meet DFC requirements and protect historic use permits". He also recommended thresholds be set on monitoring data, not models without providing specifics. Despite the recommendation to set thresholds based on monitoring data, there was no mention in the letter of making the historic Belding Farms data available to assist in the effort.

Regarding the implementation of the monitoring wells to trigger pumping reductions in Fort Stockton Holdings wells, the July 14, 2017 letter contained the following recommendations:

- The number of monitoring wells be reduced from 11 to 6 (no specific list was provided)
- A single well not meeting the threshold level would trigger reductions rather than 6 of 11 wells described in my draft report of June 16, 2017 (Hutchison, 2017b).
- The thresholds be considered "any time" thresholds which would remove the distinction between winter and summer thresholds
- A 10-day running average threshold be implemented.
- Specific changes to the level of pumping reductions if the groundwater level thresholds were exceeded were provided

1.3 Approval of Fort Stockton Holding Permit

On July 17, 2017, representatives from party litigants and Cockrell met to discuss the June 16, 2017 draft report (Hutchison, 2017b) and the various comment letters that had been received. As a result of those discussions, the threshold table in the draft report was modified slightly for presentation to the Middle Pecos Groundwater Conservation District Board of Directors. This updated table is presented as Table 1.

On July 18, 2017, the Middle Pecos Groundwater Conservation District Board of Directors approved two sets of permit applications for Fort Stockton Holdings that essentially shifted 28,400 AF/yr from Historical and Existing Use to a production and transport authorization. The new beneficial use for the groundwater is for municipal, industrial, and/or agricultural purposes within and outside the District. The thresholds in Table 1 were adopted as special conditions that govern production restrictions based on aquifer-trigger levels in certain wells.

Prior to adoption of the permit and special conditions at the July 18, 2017 Board of Directors meeting, representatives from Cockrell stated that none of the recommendations in their July 14, 2017 letter had been incorporated. However, at the July 17, 2017 meeting, Cockrell's specific concern regarding the consistency of the thresholds with the adopted Desired Future Condition was discussed.

Table 1. Monitor Well Thresholds Adopted on July 18, 2017 - FSH Permit

Well		Reference Point Elevation (ft MSL)	Winter Threshold 1		Winter Threshold 2 (Historic Minimum)		Winter Threshold 3		Winter Threshold 4		Maximum Recent Drawdown (Winter to Summer)	Summer Threshold		Recent Depth to Water	
Short Name	Long Name		Depth to Water (ft)	Basis	Depth to Water (ft)	Basis	Depth to Water (ft)	Basis	Depth to Water (ft)	Basis		Depth to Water (ft)	Basis	Winter	Summer
Mpgcd320	King, Woodward, #320	3068	205	Win2+5	200	Data 1/1999	195	Win2-5	190	Win2-10	45	245	Win2+Max DD	113	148
Mpgcd323	Ft Stockton, Cemetery, #323	3031	198	Win2+5	193	Data 1/2000	188	Win2-5	183	Win2-10	15	208	Win2+Max DD	146	148
C-5	C-5, FSH Well	3009	110	Win2+5	105	WPC 1973	100	Win2-5	95	Win2-10	72	177	Win2+Max DD	60	107
M-9	M-9, FSH Well	3261	313	Win2+5	308	WPC 1973	303	Win2-5	298	Win2-10	48	356	Win2+Max DD	246	283
S-45	S-45, FSH Well	3067	165	Win2+5	160	WPC 1973	155	Win2-5	150	Win2-10	56	216	Win2+Max DD	92	115
S-6	S-6, FSH Well	3123	205	Win2+5	200	WPC 1973	195	Win2-5	190	Win2-10	62	262	Win2+Max DD	118	159
Mpgcd305	Cockrell_Belding, #305	3233	292	Win2+5	287	WPC 1973	282	Win2-5	277	Win2-10	75	362	Win2+Max DD	206	250
Mpgcd318	Goldman Ranch, Well 1	2957	72	Win2+5	67	WPC 1975	62	Win2-5	57	Win2-10	33	100	Win2+Max DD	30	49
Mpgcd334	Carpenter, #334	3051	140	Win2+5	135	WPC 1975	130	Win2-5	125	Win2-10	36	171	Win2+Max DD	104	126
Interstate	Interstate Well, FSH Well	2988	96	Win2+5	91	WPC 1975	86	Win2-5	81	Win2-10	40	131	Win2+Max DD	49	71
Prison	TDCJ, Prison Well	3199	258	Win2+5	253	WPC 1973	248	Win2-5	243	Win2-10	50	303	Win2+Max DD	184	224

Threshold	Action
Winter Threshold 1	If 6 of 11 are below threshold, 100% reduction in FSH non-historical use pumping
Winter Threshold 2	If 6 of 11 are below threshold, 50% reduction in FSH non-historical use pumping
Winter Threshold 3	If 6 of 11 are below threshold, 30% reduction in FSH non-historical use pumping
Winter Threshold 4	If 6 of 11 are below threshold, 10% redcution in FSH non-historical use pumping
Summer Threshold	If 6 of 11 are below threshold, meeting in 60 days between FSH and MPGCD to discuss data

Notes

Maximum Recent Drawdown (Winter to Summer) based on evaluation of recent data (~2010 to 2016)

Summer Thresholds derived by adding maximum recent drawdown (from historic data) to Winter 1 Threshold

Recent Depth to Water are from actual data: maximum (summer) and minimum (winter) from spring 2016 to winter 2017

Figure 1 presents a summary comparison of thresholds and the Desired Future Conditions on a well-by-well basis for the 11 monitoring wells. This analysis was completed specifically in response to Mr. Khorzad's July 14, 2017 letter, and demonstrates that the thresholds are consistent with the Desired Future Conditions.

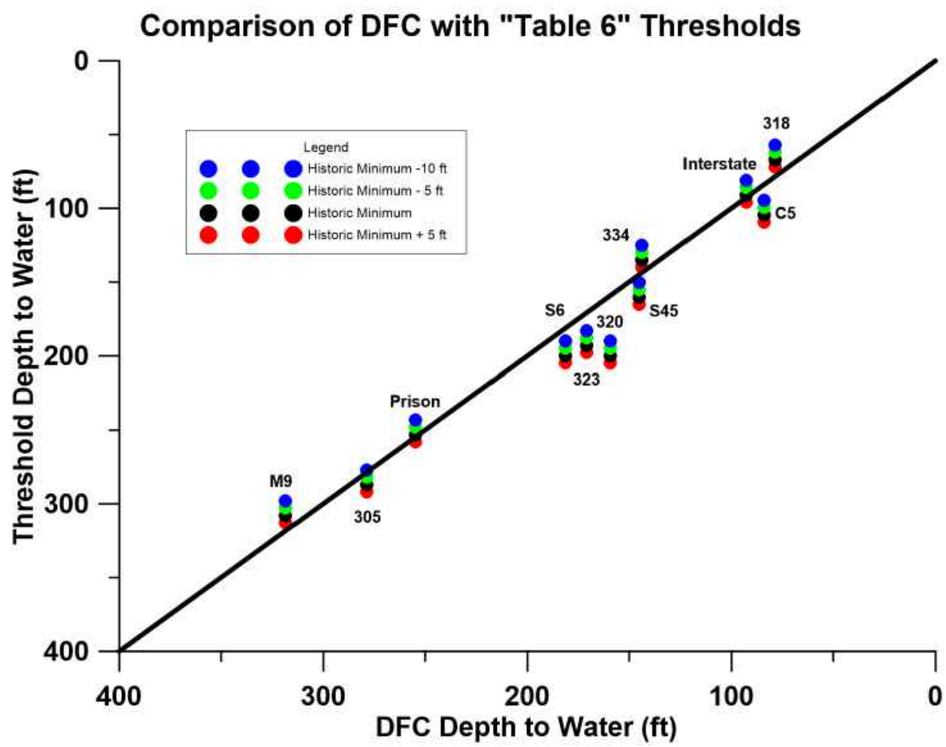


Figure 1. Comparison of Desired Future Conditions with Adopted Thresholds

1.4 Cockrell Litigation

On October 10, 2017, Cockrell Investments Partners, L.P. filed a lawsuit challenging the District's denial of Cockrell's Requests for Party Status in conjunction with the Fort Stockton Holding permit proceedings on July 18, 2017. At the October 17, 2017 Middle Pecos Groundwater Conservation District Board of Directors meeting, attorneys for Cockrell stated that they intend to engage in good faith negotiations and discussion with Fort Stockton Holdings and the Middle Pecos Groundwater Conservation District and avoid litigation.

As a result of this pending litigation, Middle Pecos Groundwater Conservation District has not completed the rules revisions that would modify the boundaries of Management Zone 1 as recommended in my June 16, 2017 draft report (Hutchison, 2017b).

As part of the ongoing negotiations and discussions to avoid litigation, on September 4, 2018, Kaveh Khorzad emailed to me a file named *Belding Farms Database.xlsx*. This Excel file had seven individual sheets:

- Wells (location and construction data regarding 54 wells, 28 of which are listed as owned by Cockrell or Belding Farms)
- Monthly Precipitation (January 1964 to April 2017)
- Monthly Production (26 wells from January 1967 to November 2017)
- Annual Production (26 wells from 1967 to 2017)
- Static Water Levels (33 wells from May 1957 to May 2017)
- Pumping Water Levels (33 wells from May 1957 to May 2017)
- Charts (5 graphs that summarize selected data)

On September 18, 2018, the Middle Pecos Groundwater Conservation District Board of Directors approved a proposal from Cockrell to fund up to $10,000 for additional work by Middle Pecos Groundwater Conservation district associated with analyzing the Belding Farms data in the context of my June 16, 2017 draft report and analysis (Hutchison, 2017b). Cockrell's proposal is outlined in a September 11, 2018 letter from Buck Benson (attorney for Cockrell) to Ty Edwards (General Manager of Middle Pecos Groundwater Conservation District).

The Middle Pecos Groundwater Conservation District also received a letter from Edmond McCarthy (attorney for Fort Stockton Holdings) on September 17, 2018 expressing some concerns regarding Mr. Benson's characterization of the June 16, 2017 draft report (Hutchison, 2017b), the scope of the additional investigation, and the reliability of the data.

1.5 Objectives

The objectives of this analysis were specific to the general concern of Cockrell: Are the adopted thresholds protective of the Belding Farms wells? Specific concerns raised in the July 14, 2017 letter are also addressed. To meet these objectives and to address some of the concerns raised in Mr. McCarthy's letter to Mr. Edwards of September 17, 2018, the following analyses were completed with the data provided in the September 4, 2018 email from Kaveh Khorzad:

- Annual pumping from Belding Farms wells separated by aquifer
- Static groundwater elevation hydrographs
- Pumping groundwater elevation hydrographs
- Comparison of end-of-year groundwater elevations with results of Western Pecos Model estimated groundwater elevations
- Comparison of end-of-year groundwater elevations with "winter maximum" groundwater elevations
- Hydrographs of drawdown for each well (comparison of month-based drawdown and drawdown from maximum winter groundwater elevation)
- Cross plots of selected Belding Farms wells with the 11 monitoring wells listed in Table 1
- Cross plots of Belding Farms annual pumping from Edwards-Trinity wells with summer minimum static and pumping groundwater elevations.

1.6 Distribution of Preliminary Results

On October 29, 2018, I emailed a file (*Processing Belding Farms Data 102918.pdf*) to Ty Edwards which contained preliminary summaries and graphs of the data analysis. This file was then forwarded to interested parties representing Cockrell and Fort Stockton Holdings. The intent of distributing the preliminary graphs was to provide an update on progress and provide representatives of Cockrell and Fort Stockton Holdings the opportunity to provide input and feedback prior to releasing a draft report.

1.7 SwRI Review of Western Pecos County Model

On November 27, 2018, Ron Green emailed a review report of the Western Pecos County (WPC) Groundwater Model (Martin and Green, 2018). The main issue identified in the review is related to recharge in the source area of the Leon-Belding area. As stated in the Executive Summary (Martin and Green, 2018):

> *"Based on currently available data and conceptual models of the area, the WPC Model appears to convey more water than is actually available to pumping wells in the vicinity of the Belding Farms Property. The source of the additional water in the model is an arbitrarily large recharge rate which is preferentially applied within the recharge source area for the Belding Farms Property."*

Martin and Green (2018, pg. 65) also noted five specific "minor discrepancies or peculiarities" with the model, including model pumping estimates that are too high in the Edwards-Trinity Aquifer and too low in the Rustler and older Formations as compared to Belding Farms data that were not available to the developers of the model. Martin and Green (2018, pg. 65) stated that these five issues would "likely have only a minor impact on overall WPC Model-related conclusions and projections".

2.0 Well Construction Data

The provided file (*Belding Farms Database.xlsx*) included a sheet named "Wells" that contained geographic and construction data on 54 wells, 28 of which are listed as owned by Cockrell or Belding Farms. Of the 28 Cockrell/Belding wells, 23 wells are reportedly completed in the Edwards-Trinity Plateau, four wells are reportedly completed in the Rustler, and one well is reportedly completed in the Capitan Reef.

These data were used to segregate the wells by ownership (only the Belding Farms wells were used for the analysis) and by reported completion of the well (only the Edwards-Trinity data were used, except for a comparison of pumping totals).

3.0 Pumping Data

The provided file (*Belding Farms Database.xlsx*) included a sheet named "Annual Production" that contained annual pumping in AF/yr for 26 Belding Farms wells from 1967 to 2017. Based on the data in the sheet named "Monthly Production", it was assumed that the data for 2017 are only for a partial year, since monthly production was only listed through May 2017.

Please note that the database does not include pumping data for Wells 6, 7, 9, 12, 14, 21, and 22. These wells are listed as Edwards-Trinity wells, and each of them have at least one pumping water level data point in the database. Based on this comparison, it is reasonable to conclude that not all pumping on Belding Farms has been metered, or at least not reported in this database.

In their recent review of the Western Pecos County groundwater model, Martin and Green (2018) compared the pumping data from the database to estimates of pumping used in the model. Since it appears that not all the Belding Farms pumping was metered (or at least not reported in the database), it is not possible to draw definitive conclusions regarding the accuracy of the amount of pumping estimated in the Western Pecos Model since the database appears incomplete. Martin and Green (2018) stated that differences in the pumping would "likely have only a minor impact on overall WPC Model-related conclusions and projections".

Using the data from the sheet named "Wells", the pumping was summed for the Edwards-Trinity wells and for the Rustler and Capitan Reef Wells. Figure 2 presents a plot of the pumping data that were made available. Please note that most of the reported Belding Farms pumping is from the Rustler and the Capitan. Based on the available data, Belding Farms pumping in the Edwards-Trinity was higher in the 1960s and 1970s than it has been in recent years.

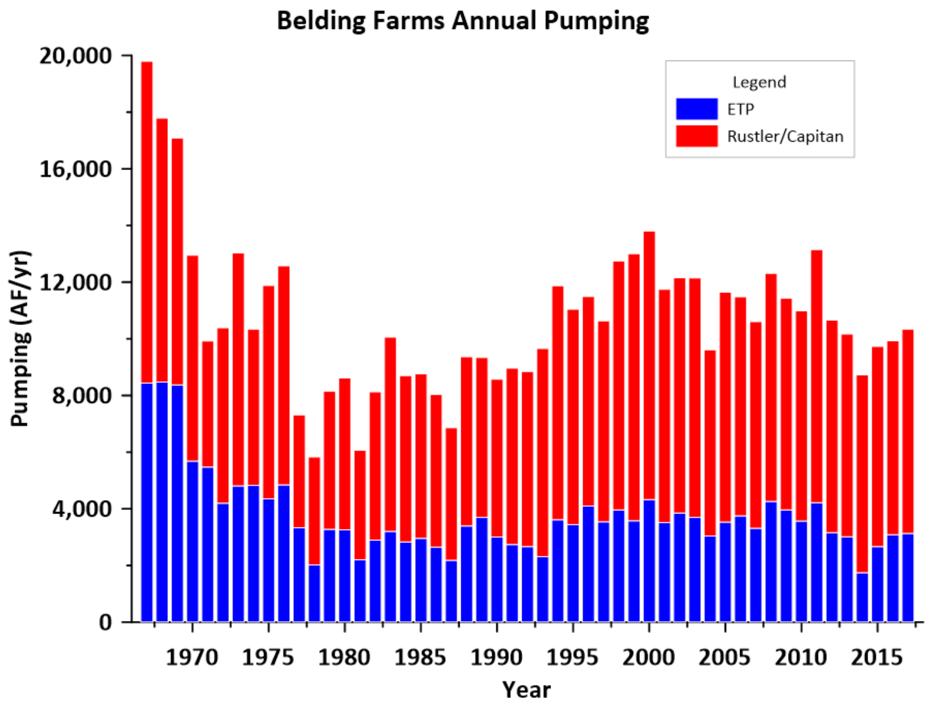


Figure 2. Belding Farms Annual Pumping

4.0 Static and Pumping Water Levels

4.1 Processing Static Water Levels

The provided file (*Belding Farms Database.xlsx*) included a sheet named "Static Water Levels" that contained depth to water data for 33 wells from May 1957 to May 2017. The data were organized by month and by well. Thus, only a single reading is recorded in the spreadsheet for a month. However, several months have no data and are left blank. The data were saved in a separate spreadsheet named *StaticDTW.xlsx* (dated 10/22/2018). The wells completed in the Rustler and Capitan Reef were deleted, and three columns were added (month, year, decimal date). Empty cells were populated with the value "-999" to facilitate reading and further processing. The file was saved as *StaticDTW.csv* (dated 10/22/2018) so it could be read by the FORTRAN program named *getactgwe.exe*, which was written for this analysis.

For the static water levels, the program *getactgwe.exe* reads *StaticDTW.csv* (month, year, date, and static depth to water). It also reads a file (*fnelev.csv*) that contains filenames for the output for each well, the reference point elevation for each well, the depth of each well, and the elevation of the bottom of the well. The program then calculates the groundwater elevation for each well for each month and the height of the water in the well (groundwater elevation – bottom elevation of the well). The program writes the data to individual files for each well (month, day, year, reference point elevation, depth to water, groundwater elevation, well depth, bottom elevation, and height of water in the well).

During initial hydrograph construction, the following data were deleted:

- Well No. 2 (August 2005)
    - Depth to water listed as 1,997 ft (typo for 197? or 199?)
- Well No. 3 (October 2010)
    - Depth to water listed as 53 ft (August 2010 was 185 ft and November 2010 was 178 ft, no obvious typo)
- Well No. 8 (March 1981)
    - Depth to water listed as 1,664 ft (Typo for 164? Or 166?)
- Well No. 18 (August 1978)
    - Depth to water listed as 251 ft (June 1978 was 146 ft and September 1978 was 140 ft, no obvious typo)

4.2 Processing Pumping Water Levels

The provided file (*Belding Farms Database.xlsx*) included a sheet named "Pumping Water Levels" that contained depth to water data for 33 wells from May 1957 to May 2017. The data were organized by month and by well. Thus, only a single reading is recorded in the spreadsheet for a month. However, several months have no data and are left blank. The data were saved in a separate spreadsheet named *PumpingDTW.xlsx* (dated 10/22/2018). The wells completed in the Rustler and Capitan Reef were deleted, and three columns were added (month, year, decimal date). Empty cells were populated with the value "-999" to facilitate reading and further processing. The file was saved as *PumpingDTW.csv* (dated 10/22/2018) so it could be read by the FORTRAN program named *getactgwe.exe*, which was written for this analysis.

For the pumping water levels, the program *getactgwe.exe* reads *PumpingDTW.csv* (month, year, date, and static depth to water). It also reads a file (*fnelev.csv*) that contains filenames for the output for each well, the reference point elevation for each well, the depth of each well, and the elevation of the bottom of the well. The program then calculates the groundwater elevation for each well for each month and the height of the water in the well (groundwater elevation – bottom elevation of the well). The program writes the data to individual files for each well (month, day, year, reference point elevation, depth to water, groundwater elevation, well depth, bottom elevation, and height of water in the well).

During initial hydrograph construction, the following data were identified as outliers:

- Well No. 3 (May 1982)
    - Pumping water level listed as 278 ft (lowest in record)
    - No data since May 1980, and no data until June 1989
    - Well bottom 241 feet below this pumping water level
    - Production in 1982 was not as high as 1983
    - Left in for purposes of hydrograph construction
- Well No. 8 (May 1982 and June 1982)
    - Pumping water level listed as 315 ft (both months, lowest in record)
    - No data since September 1981, and no data until April 1983
    - Well bottom 260 feet below this pumping water level
    - Production not as high as more recent years
    - Left in for purposes of hydrographs

- Well No. 11 (January 1965)
  - Pumping water level listed as 230 ft (highest in record)
  - Higher than all but two static water levels recorded in 1957
  - Static water level in December 1964 was 246 ft
  - No early 1965 static water levels
  - Predates production data (1967)
  - Left in for purposes of hydrographs
- Well No. 12 (January 1965)
  - Pumping water level listed as 217 ft (highest in record)
  - Higher than all static water levels
  - No static water level in January 1965
  - Static water level in December 1964 was 233 ft
  - Static water level in March 1965 was 239 ft
  - Predates production data (1967)
  - Left in for purposes of hydrographs
- Well No. 13 (May 1982)
  - Pumping water level listed as 340 ft (lowest in record)
  - Last pumping water level was August 1981 (214 ft)
  - No pumping water levels have May 1982
  - No static water level for May 1982
  - Pumping in 1983 was higher than 1982
  - Left in for purposes of hydrograph
- Well No. 14 (January 1965)
  - Pumping water level listed as 211 ft (highest in record)
  - Pumping water level in November 1964 was 250 ft
  - Pumping water level in April 1965 was 354 ft
  - No static water level in January 1965
  - Static water level in December 1964 was 248 ft
  - Static water level in February 1965 was 209 ft
  - Predates production data (1967)
  - Possible that this is supposed to be a static water level
  - Left in for purposes of hydrograph
- Well No. 18 (May 1982, June 1982, July 1982)
  - Pumping water levels listed as 265 ft (lowest in record)
  - Last pumping water levels recorded
  - Most recent prior pumping water level was 158 ft (July 1978)
  - Static water level for May 1982 was 154 ft
  - Static water level for June 1982 was 152 ft
  - Static water level for July 1982 was 161 ft
  - Deleted for purposes of hydrograph
- Well No. 22 (January 1965)
  - Pumping water level listed as 220 ft (highest on record)
  - Pumping water level for April 1962 was 295 ft
  - Pumping water level for February 1965 was 278 ft
  - Static water level for February 1965 was 223 ft
  - Predates production data (1967)
  - Left in for purposes of hydrograph

4.3 Hydrographs of Static and Pumping Groundwater Elevations

Hydrographs of 23 wells owned by Belding Farms that are reportedly completed in the Edwards-Trinity are presented in Appendix A. The solid black line represents all static groundwater elevations, and the red dots represent all pumping groundwater elevations. Please note that Wells 28 and 30 have no data.

5.0 Comparison of End-of-Year Static Groundwater Elevations and Simulated Groundwater Elevations from Western Pecos Model

As explained in my draft report of June 16, 2017 (Hutchison, 2017b), and as noted on Table 1 presented previously, many of the monitor well thresholds in Table 1 were based on the historic minimum groundwater elevation from the Western Pecos Model developed in 2011 (R.W. Harden & Associates and others, 2011). These historic minima were used because data did not exist during the high pumping periods of the 1960s and 1970s in these wells. Had the Belding Farms data been available at the time of preparing the draft report of June 16, 2017 (Hutchison, 2017b), the model may not have been needed to develop the monitor well thresholds.

The thresholds were established with the goal of avoiding groundwater levels to drop below historic minima. The avoidance of dropping below the historic minima was the basis of the settlement of the litigation between Fort Stockton Holdings and the Middle Pecos Groundwater Conservation District.

Now that the Belding Farms data are available, the objective of this part of the analysis was to compare actual data with the simulated groundwater elevations of the Western Pecos County Model. The Western Pecos County Model has limitations as described in my earlier review report (Hutchison, 2017a) and as described in the more recent review (Martin and Green, 2018). Now that the Belding Farms are available, we are in a better position to assess the model's usefulness, and if the use of model-estimated groundwater elevations in the 1970s is consistent with the objectives of avoiding the decline of groundwater elevations below the historic minimum levels.

The model domain in the Western Pecos County Model was subdivided (or discretized) into 5 layers of 56,322 cells (total of 281,610 cells) each covering an area of about 92 acres (2,000 feet by 2,000 feet). Model results include an estimate of groundwater elevation for each cell and for each year of the simulation period (1945 to 2010). These estimates can be compared with actual data with knowledge of the geographic location of the well from which the actual data was measured. Please recognize that the estimated groundwater elevation represents an average groundwater elevation over the 92-acre area of the cell. Because the geographic locations of each of the Belding Farms wells was provided, it was possible to locate the well on the model grid. This procedure is discussed in Section 5.2 of this report.

The analysis was completed by comparing the actual end-of-year groundwater elevations with the model-estimated groundwater elevations. If the actual data during the 1960s and 1970s are higher than the simulated values during the 1960s and 1970s, it would be reasonable to conclude that the assumptions inherent in the development of the thresholds were flawed, and the thresholds might not be protective of the Belding Farms wells. If, on the other hand, the actual data during the 1960s and 1970s are lower than the simulated values during the 1960s and 1970s, it would be reasonable to conclude that the assumptions inherent in the development of the thresholds are conservative, and the thresholds are reasonable in the protection of historically observed groundwater levels in the Belding Farms wells.

5.1 End-of-Year Static Groundwater Elevations

A FORTRAN program (*getactgwe.exe*) was written to write individual files (i.e. one for each well) for hydrograph construction. The "end-of-year" criterion was implemented based on a priority of data. If a December data point was available, it was used. If a December data point was not available, then the program used January of the next year, November, or February of the next year as alternates (in that order of priority). If no data existed in these four months, no data were used. The program then wrote individual files of groundwater elevations that included the name of the well, the decimal year for plotting, the reference point elevation, the end-of-year depth to water, the end-of-year groundwater elevation, the well depth, the well bottom elevation, and the water depth in the well (groundwater elevation minus the bottom elevation).

5.2 Location of Belding Farms Wells in Model Grid

In order to compare the actual end-of-year Belding Farms well data with the simulated values of the Western Pecos Model, the location of each Belding Farms well in the model grid was needed. The file *ThornhillModel_Grid.dbf.csv* (dated February 19, 2017), previously developed by Allan Standen, was used to identify the x- and y-coordinates of each model grid cell in the GAM coordinate system. This file was modified as saved as *ThornhillGrid.csv* (dated October 17, 2018).

The provided file (*Belding Farms Database.xlsx*) included a sheet named "Wells" that contained geographic and construction data on 54 wells, 28 of which are listed as owned by Cockrell or Belding Farms. This sheet was extracted and saved as *BeldingWells.xlsx* (dated October 17, 2018). The geographic coordinates were provided in latitude and longitude. Two columns were added (GAMx and GAMy) to represent the x- and y-coordinates in the GAM coordinate system. Surfer (commercial software from Golden Software) was used to convert the latitude and longitude coordinates to x- and y-coordinates in the GAM coordinate system.

The resulting file was saved as *BeldingWellsxy.csv* (dated October 17, 2018) and included the well number, the x- and y-coordinates and the aquifer of completion. Please note that in this file, the names of the Belding Wells were converted to a standard format (B-xx) where the xx represented the two-digit number of the well.

The assignment of the model row and column was completed using the FORTRAN program *getrc.exe,* which was written for this analysis. The program searches all cells in the model and returns the cell (identified by row and column) with the smallest distance between the well and the cell center. Output from this program was saved as *wellrowcol.dat* (dated October 22, 2018). Belding Farms wells were saved as *Beldingrc.csv* (dated October 22, 2018).

5.3 Simulated Groundwater Elevations

The FORTRAN program *getwpched.exe*, written for this analysis, was used to read the simulated heads from the end of 1944 to the end of 2010 (*revwpc.hds)* and write individual files for simulated heads for each Belding Farms well completed in the Edwards-Trinity. Simulated groundwater elevations for layer 2 (Edwards) and layer 3 (Trinity) were included in the output files.

As described in my report covering the review of the Western Pecos Model (Hutchison, 2017a), the model was run with a revised output control file and a revised WEL file for the first stress period. The output control file revisions included a specification that saved only the final time step of each stress period (rather than the first- and last-time step of each stress period) in order to reduce the output file sizes and streamline post-processing. The modification to the first stress period of the WEL file was limited to adding a single well with no pumping in stress period 1, which results in a cell-by-cell flow file that has the same number of water budget components in all stress periods. Neither of these changes results in any substantive change to the output as compared with the files that were provided. Thus, the simulated groundwater elevations from the Western Pecos Model used in this analysis represent the simulated groundwater elevations from the calibrated model from 1944 to 2010 without any changes to any input files that would alter the results (i.e. changes to pumping).

5.4 Comparison Hydrographs

The hydrographs comparing the actual end-of-year groundwater elevations and the simulated groundwater elevations for each of the 23 Belding Farms wells completed in the Edwards-Trinity are presented in Appendix B. Please note that the actual data are shown as red dots. Simulated data for layer 2 (Edwards) are plotted as a green line, and simulated data for layer 3 (Trinity) are plotted as a blue line.

***Well 1* –** Please note that the historic minimum of the actual data in the mid-1970s approximately corresponds to the historic minimum of the simulated data. However, the actual data is about 40 feet below the simulated data at this historic minimum.

***Well 2* –** Please note that the historic minimum of the actual data occurs in the mid-1960s and not the mid-1970s when the historic minimum occurs in the simulated data. In fact, there were actual data collected in the mid-1970s that were about 40 feet above the historic minimum. However, the historic minimum of the actual data is about 20 feet below the historic minimum of the simulated groundwater elevations, even though they did not occur at the same time period.

***Well 3* –** Similar to Well 2, the historic minimum of the actual data occurs in the mid- to late-1960s, several years before the simulated historic minimum. The historic minimum of the actual data is about 20 feet below the historic minimum of the simulated groundwater elevations, even though they did not occur at the same time period.

***Well 4* –** Please note that the historic minimum of the actual data occurs in the early-1970s and is about 60 feet lower than the historic minimum of the simulated groundwater elevations, even though they did not occur at the same time period.

***Well 5* –** Similar to Wells 2 and 3, the historic minimum of the actual data occurs in the mid- to late-1960s, several years before the simulated historic minimum. The historic minimum of the actual data is about 80 feet below the historic minimum of the simulated groundwater elevations, even though they did not occur at the same time period.

***Wells 6 and 7* –** Please note that these wells did not have enough data to be useful to this analysis.

***Well 8* –** Please note that the historic minimum of the actual data occurs in the mid-1970s at the same time as the historic minimum of the simulated data. The historic minimum of the actual data is less than 20 feet lower than the historic minimum of the simulated data.

***Well 9* –** Please note that there are no end-of-year actual data for Well 9.

***Well 10* –** Please note that although there are a few actual data points in the 1960s and 1970s, the limited data results and gaps during the specific time period of the historic minimum of the simulated data makes interpretation difficult and likely not reliable.

***Wells 11 and 12* –** Please note that these wells did not have enough data to be useful to this analysis.

***Well 13* –** Please note that the historic minimum of the actual data occurs in the mid-1970s at the same time as the historic minimum of the simulated data. The historic minimum of the actual data is about 60 feet lower than the historic minimum of the simulated data.

***Well 14* –** Please note that the historic minimum of the actual data occurs in the mid-1970s at the same time as the historic minimum of the simulated data. The historic minimum of the actual data is about 100 feet lower than the historic minimum of the simulated data.

***Well 17* –** Please note that there are no end-of-year actual data for Well 17.

***Well 18* –** Please note that the historic minimum of the actual data occurs in the early-1970s, a few years before the time period of the historic minimum of the simulated data. The historic minimum of the actual data is about 30 feet lower than the historic minimum of the simulated data.

***Wells 19, 20, 21, 22, 28, 29, and 30* –** Please note that these wells either did not have enough data to be useful to this analysis or had no end-of-year actual data.

Please note that the gap in well numbering (i.e. Wells 23 to 27) are wells identified as Rustler or Capitan Reef wells and were not included in this analysis.

5.5 Summary of Interpretations

Hydrographs of 23 wells are presented in Appendix B and discussed in the previous section. Of the 23 wells, 14 did not have enough data to make any interpretations or draw and conclusions. The nine wells were sufficient for the comparison between actual data and simulated groundwater elevations from the Western Pecos Model. This comparison showed that the historic minimum of the actual groundwater elevations is between 20 to 100 feet below the simulated historic minimum groundwater elevations.

This underprediction of drawdown suggests that the model is not well calibrated in the Belding Farms area during the high-pumping periods of the 1960s and 1970s. The underprediction of drawdown is also consistent with the review comments of Martin and Green (2018) related to the possible overestimation of recharge. It is also important to emphasize that recharge in the Western Pecos County Model is assumed constant in all years. Thus, drought periods have the same recharge as wet periods. This had previously been described as a limitation of the model in my previous review of the model (Hutchison, 2017a).

The fact that the Western Pecos Model is not well calibrated in the Belding Farms area, however, does not render it useless for the evaluation of the monitor well thresholds. As described in my June 16, 2017 draft report (Hutchison, 2017b), the historic minimum groundwater elevation for a well was used where no data for that time period existed. The use of these model estimated historic minima were limited to wells that had otherwise reasonably good matches between actual and simulated data. As seen in the hydrographs in Appendix B, the Belding Farms often have reasonable matches in more recent years. The poor matches are generally during the 1960s and 1970s, when the historic minima occur. Furthermore, the poor matches are characterized by estimated groundwater elevations that are higher than the actual data.

Relying on the historic minimum of the Western Pecos Model, therefore, is a conservative assumption when setting threshold values. If winter groundwater elevations in the 11 monitoring wells were to approach the threshold values listed in Table 1, it is reasonable to assume that groundwater elevations will also drop in the Belding Farms wells and approach the model-estimated historic minima. The historic minima defined by the model are tens-of-feet higher than the true historic minima as defined by the data. Thus, it is reasonable to conclude that if groundwater elevations dropped to the point that pumping reductions were required, groundwater levels in the Belding Farms wells would still be above their historic minima as defined by the data.

5.6 Specific Example of Interpretation of Results

Kaveh Khorzad's July 14, 2017 letter stated that annual thresholds and annual pumping reductions are not adequate, and that pumping reductions should be implemented if a threshold groundwater elevation is exceeded at any time during the year.

The data show that groundwater elevations fluctuate based on pumping. During the irrigation season, groundwater elevations decline and then recover in the fall and winter months after the irrigation season is over. During the 1960s and 1970s, groundwater elevations were lower than they have been in more recent years due to less pumping, but the characteristic seasonal pattern is consistent.

The specific approach to applying thresholds and pumping reductions on an annual basis was implemented because there are no pressing concerns to reduce pumping on a more frequent basis (i.e. endangered species in spring areas). The use of annual pumping reductions also provides certainty to non-historical use permit holders on an annual basis.

The example provided in the Mr. Khorzad's July 14, 2017 letter describes the comparison of the

Prison Well and Belding Farms No. 1. Please note that pumping reductions would begin at Winter Threshold 4 (depth to water of 243 feet, or a groundwater elevation of 2,956 ft MSL). The historic minimum-based threshold is Winter Threshold 2 (depth to water of 253 feet, or a groundwater elevation of 2,946). This historic minimum-based threshold was set based on the historic minimum of the Western Pecos Model in 1973 because there were no data available for the Prison Well during the 1960s and 1970s.

Actual data from Belding Well No. 1 showed that the lowest groundwater elevation in the winter period was 2,902 ft MSL in 1974 (depth to water of 301 feet). At the site of Well No. 1, the Western Pecos Model showed that lowest groundwater elevation occurred in 1973 and was 2939.71 ft (depth to water of 272.29 feet).

The Winter Threshold 2 at the Prison Well was set based on the model estimated value at that site (253 feet) and is comparable to the model-estimated value at the Belding No. 1 site is 272 feet. However, the actual data show that "true" historic minimum was 301 feet.

For purposes of this discussion, it is assumed that if the Prison Well threshold is exceeded, then the thresholds in at least five other wells are also exceeded. Pumping reductions would begin when groundwater elevations are 10 feet above the model-based historic minimum (i.e. 243 feet at the Prison Well, and, by extrapolation, 262 feet at the Belding No. 1 well). Thus, pumping reductions would begin when groundwater elevations at the Belding No. 1 well are 39 feet above the data-based historic minimum. Pumping cessation (100 percent pumping reduction) would occur when the Prison Well depth to water is 258 feet (five feet below the historic minimum). The comparable depth to water threshold in the Belding No. 1 well is 258 feet, 33 feet above the data-based historic minimum.

The pumping data for Well No. 1 showed that the two years with the highest pumping are 1973 and 1974 (1,346 AF and 1,503 AF, respectively). During those years, pumping water levels reached a minimum of 328 feet in 1973 and 331 feet in 1974. Mr. Khorzad's July 14, 2017 letter stated that the pump was set at 330 feet, so it is reasonable to conclude that the pump had been set at a lower depth during the 1970s. Well depth is reported as 586 in the database and the July 14, 2017 letter, so lowering the pump to depth greater than 330 feet is possible.

6.0 Winter Maximum Groundwater Elevation vs. End-of-Year Groundwater Elevation

One the important features of the monitoring program is that the "winter maximum" groundwater elevation for each well is used to compare with the threshold values and initiate any cutbacks to non-historic pumping permit amounts for that year. The winter maximum is not necessarily the same as the end-of-year measurement.

The winter maximum groundwater elevations were obtained from the FORTRAN program *getactgwe.exe*. The program searched the static groundwater elevations from October to March and returned the value that was highest. These results were saved in individual well files for comparison of the end-of-year groundwater elevations and the winter maximum groundwater elevation.

The data that were available at the time of the draft June 16, 2017 (Hutchison, 2017b) included several examples of multiple readings during the October to March period in a single well. These data were processed to return the single highest value from October to March and designate it as the "winter maximum". As described in Hutchison (2017b), most of the available data did not include enough data in the 1960s and 1970s to identify a historic minimum "winter maximum", and results from the Western Pecos Model were used to extend the dataset.

Appendix C includes hydrographs that plot end of year groundwater elevations (red line) and winter maximum groundwater elevations (blue dots). Please note that, in many years, the winter maximum groundwater elevation can be up to about 20 feet higher than the end-of-year groundwater elevations.

The concept of winter maximum groundwater elevation is an important (and often misunderstood) aspect of the monitoring program. The monitoring wells are equipped with pressure transducers that are programmed to take readings every hour. The historic data show that the maximum winter groundwater elevation often occurs in February or March. The monitoring program and the permit conditions set April 1 as the date to define the end of the "winter maximum" period. The highest groundwater elevation during that period is used to compare with the threshold values.

7.0 Drawdown

Drawdown was defined two ways using the Belding Farms database in the context of this analysis: 1) the difference between the static groundwater elevation and pumping groundwater elevation in the same month (informally called monthly drawdown), and 2) the difference between the winter maximum groundwater elevation and pumping groundwater elevation for each month during that year (informally called annual drawdown). The FORTRAN program *getactgwe.exe* was used to develop two sets of well-by-well output files, one set for each definition of drawdown.

Appendix D presents hydrographs of drawdown. The black line represents the month-to-month drawdown of static groundwater elevation minus pumping groundwater elevation. The red line represents the winter maximum groundwater elevation minus a monthly pumping groundwater elevation.

Only a handful of wells have adequate records to evaluate any trends (i.e. Wells 1, 2, 3, 5, 8, and 10). The monthly drawdown data (using the static groundwater elevation and pumping groundwater elevation in the same month) do not exhibit any significant trend of increasing drawdown with time. This suggests that well performance has not significantly degraded over the last 40 to 50 years.

The annual drawdown data (using the winter maximum static groundwater elevation and pumping groundwater elevation in a month) tend to show that annual drawdown is slightly higher in recent years as compared to earlier years. This may be the result of the higher static groundwater elevations in the recent years as groundwater elevations have recovered since the 1960s and 1970s. This observation suggests that the use of recent drawdown data for the summer thresholds previously presented in Table 1 are appropriate.

8.0 Cross Plots of the 11 Monitoring Wells and Selected Belding Farms Wells

Cross-plots of the 11 monitoring wells and selected individual Belding Farms wells were constructed. These plots are useful to evaluate the correlation in groundwater elevations in two different wells. Please note that the Belding Farms wells used for this analysis are the ones with adequate data (Wells 1, 2, 3, 5, 8, and 10).

Appendix E presents the cross plots. Please note that The Prison well is presented twice, once with all the data and once with data from November 2000 to July 2001 deleted. It appears that the float in the well was stuck for a few months. Also, please note that all the plots contain the Winter 1 and Winter 4 Threshold values for reference. Table 2 presents the monitoring well winter thresholds of the 11 monitoring wells in terms of groundwater elevation. These are the same thresholds in Table 1 expressed as groundwater elevations rather than as depth to water.

As an example of the plots, Figure 3 presents a single cross plot of the Prison Well and Belding Well No. 1.

Table 2. Monitoring Well Thresholds Expressed as Groundwater Elevations

Well		Groundwater Elevation (ft MSL)			
Short Name	Long Name	Winter Threshold 1	Winter Threshold 2 (Historic Minimum)	Winter Threshold 3	Winter Threshold 4
Mpgcd320	King, Woodward, #320	2863	2868	2873	2878
Mpgcd323	Ft Stockton, Cemetery, #323	2833	2838	2843	2848
C-5	C-5, FSH Well	2899	2904	2909	2914
M-9	M-9, FSH Well	2948	2953	2958	2963
S-45	S-45, FSH Well	2902	2907	2912	2917
S-6	S-6, FSH Well	2918	2923	2928	2933
Mpgcd305	Cockrell_Belding, #305	2941	2946	2951	2956
Mpgcd318	Goldman Ranch, Well 1	2885	2890	2895	2900
Mpgcd334	Carpenter, #334	2911	2916	2921	2926
Interstate	Interstate Well, FSH Well	2892	2897	2902	2907
Prison	TDCJ, Prison Well	2941	2946	2951	2956

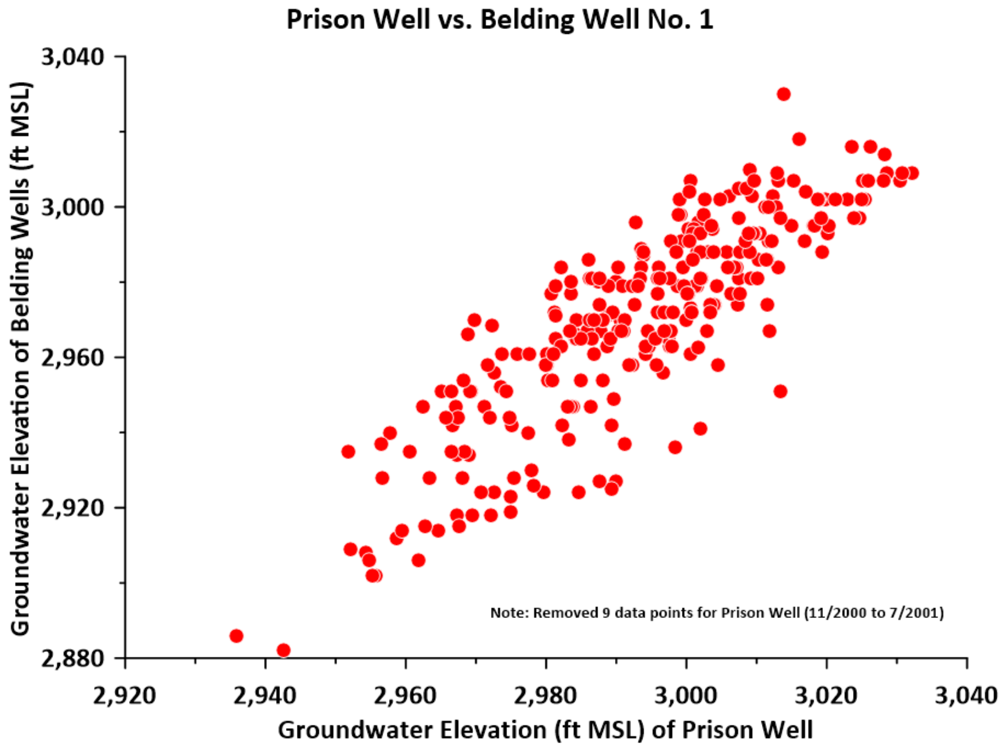


Figure 3. Prison Well vs. Belding Well No. 1

The characteristic slope of the data points shows the general correlation in groundwater elevations (i.e. when groundwater elevations are low in the monitoring well, groundwater elevations are low in the Belding Farms wells). This is consistent with the conceptualization that the aquifer is highly transmissive.

As seen in Figure 3, a given elevation in the prison well correlated with a groundwater elevation that can vary about 40 feet. This observation is characteristic of all the plots and suggests that using a single well for thresholds and triggers is not as robust as using a network of wells given the degree of variability in each well.

9.0 Annual Pumping vs. Summer Minimum Groundwater Elevations

Appendix F contains cross plots of annual pumping as reported in the Belding Farms Database vs. summer minimum groundwater elevations for each well. Please note that the plots are limited to Belding Farms wells with adequate data (Wells 1, 2, 3, 4, 5, 8, 10, 13, 18, 19, and 20). This minimum summer elevation was defined as the lowest groundwater elevation (static or pumping) observed from April to September. The selection was completed with the FORTRAN program *MinSummer.exe*, written for this analysis.

These plots are useful to evaluate concerns that the summer groundwater elevations could drop to an extent that the well would "go dry". Each page of the Appendix includes two plots of the same well. The upper graph plots pumping on the x-axis and groundwater elevation on the y-axis. Please note that the static groundwater elevations are presented as blue dots and pumping groundwater elevations are presented as red dots. The lower graph also plots pumping in the x-axis, but the y-axis is the height of the water column in the well in feet (groundwater elevation minus the well bottom elevation). Please note that the well bottom elevation is used since the database did not include any data on depth of pump setting, which would have been more useful.

The plots generally show that the correlation between annual pumping and the minimum summer groundwater elevation (static and pumping). The plots also show that historic summer minimum pumping groundwater elevations resulted in water column heights of between 75 and 290 feet.

10.0 References

Hutchison, W.R., 2017a. Review of Western Pecos County Groundwater Model. Report prepared for Middle Pecos Groundwater Conservation District, March 10, 2017, 55p.

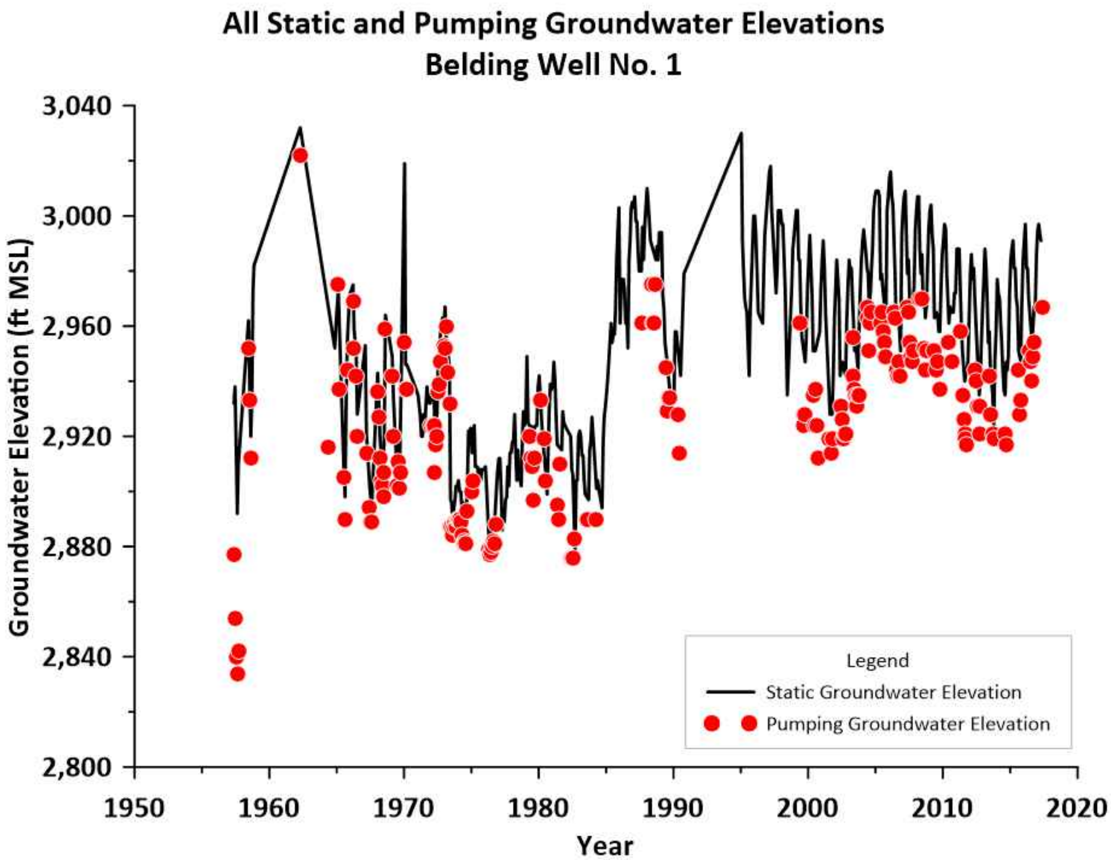
Hutchison, W.R., 2017b. Proposed Changes to Management Zone 1 and Proposed Monitor Well Data and Comparison with Model Simulations. Report prepared for Middle Pecos Groundwater Conservation District. June 16, 2017, 21p.

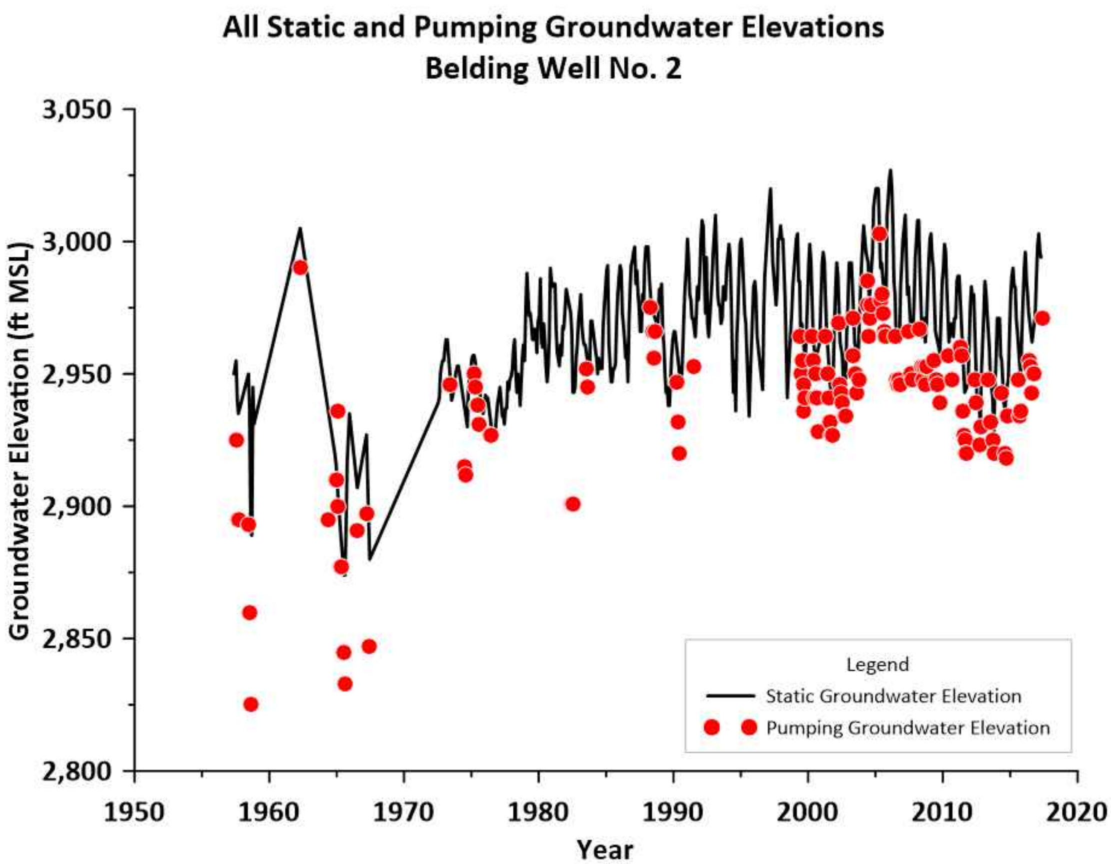
R.W. Harden & Associates, Inc., LBG-Guyton Associates, and Thornhill Group, Inc., 2011. Hydrogeologic, Geochemical and Groundwater Modeling Evaluation of the Leon-Belding Area in Pecos County. Report prepared for Fort Stockton Holdings, L.P. April 14, 2011, 95p.

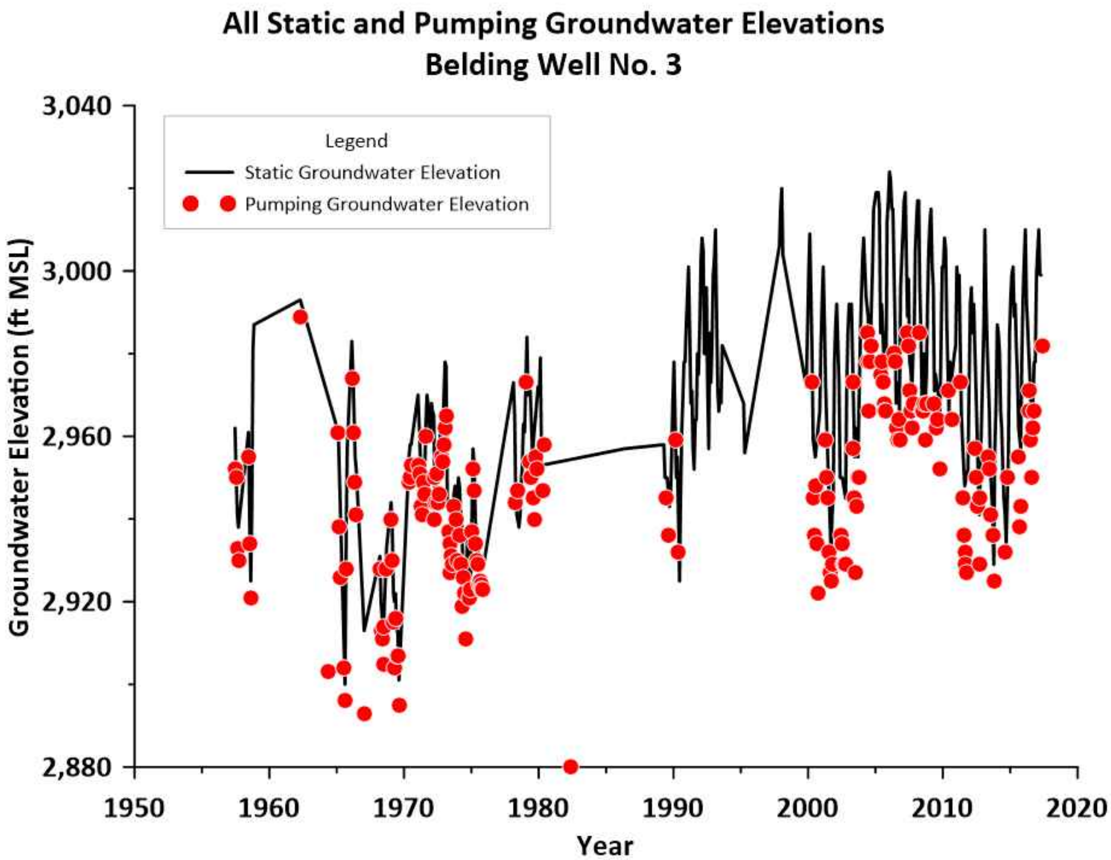
Martin, N. and Green, R., 2018. Evaluation of the Western Pecos County Groundwater Model. Report prepared for Cockrell Interests LLC. Southwest Research Institute, November 26, 2018, 97p.

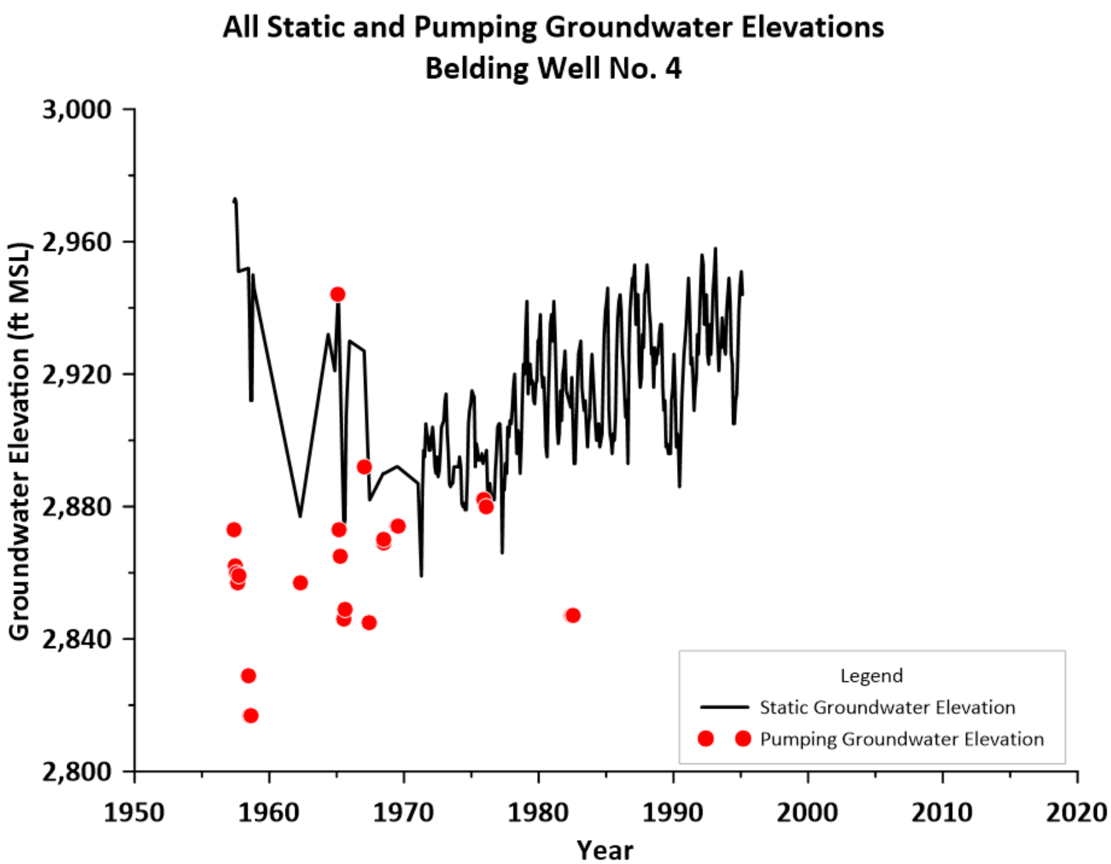
Appendix A

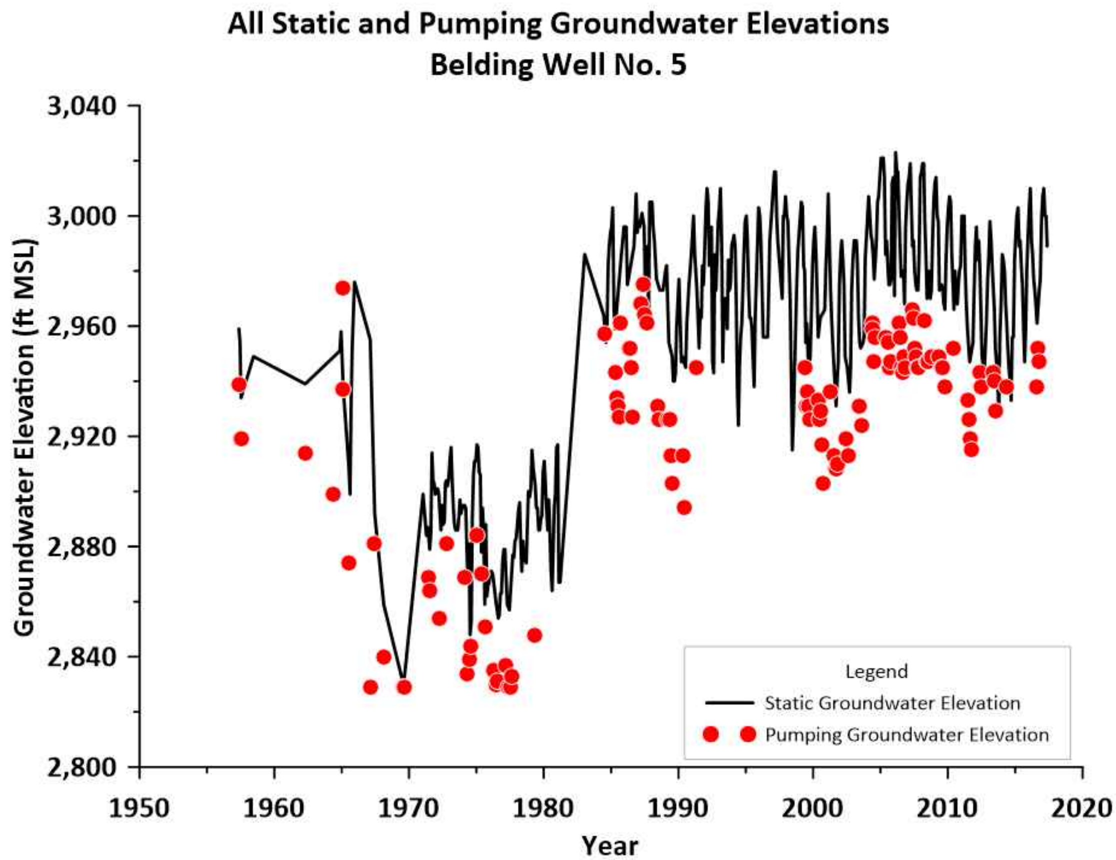
All Static and Pumping Groundwater Elevations

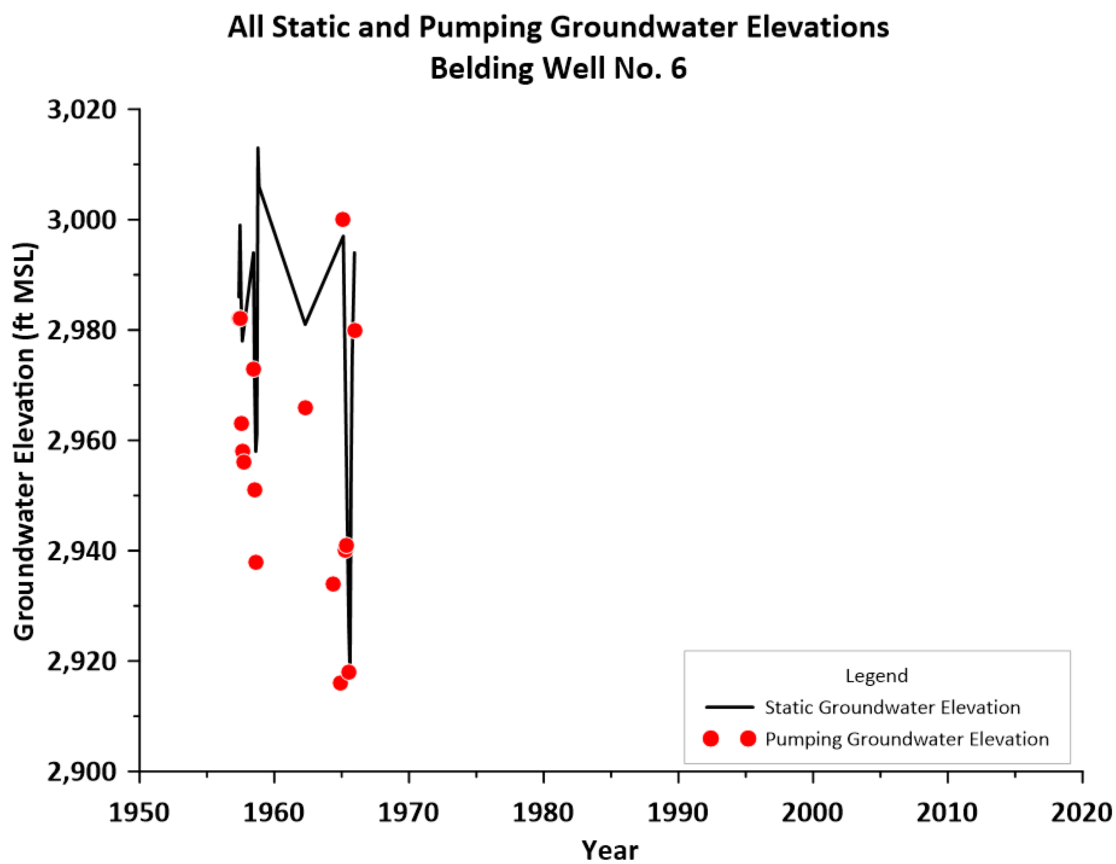

All Static and Pumping Groundwater Elevations
Belding Well No. 1
Groundwater Elevation (ft MSL)
3,040
3,000
2,960
2,920
2,880
2,840
2,800
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

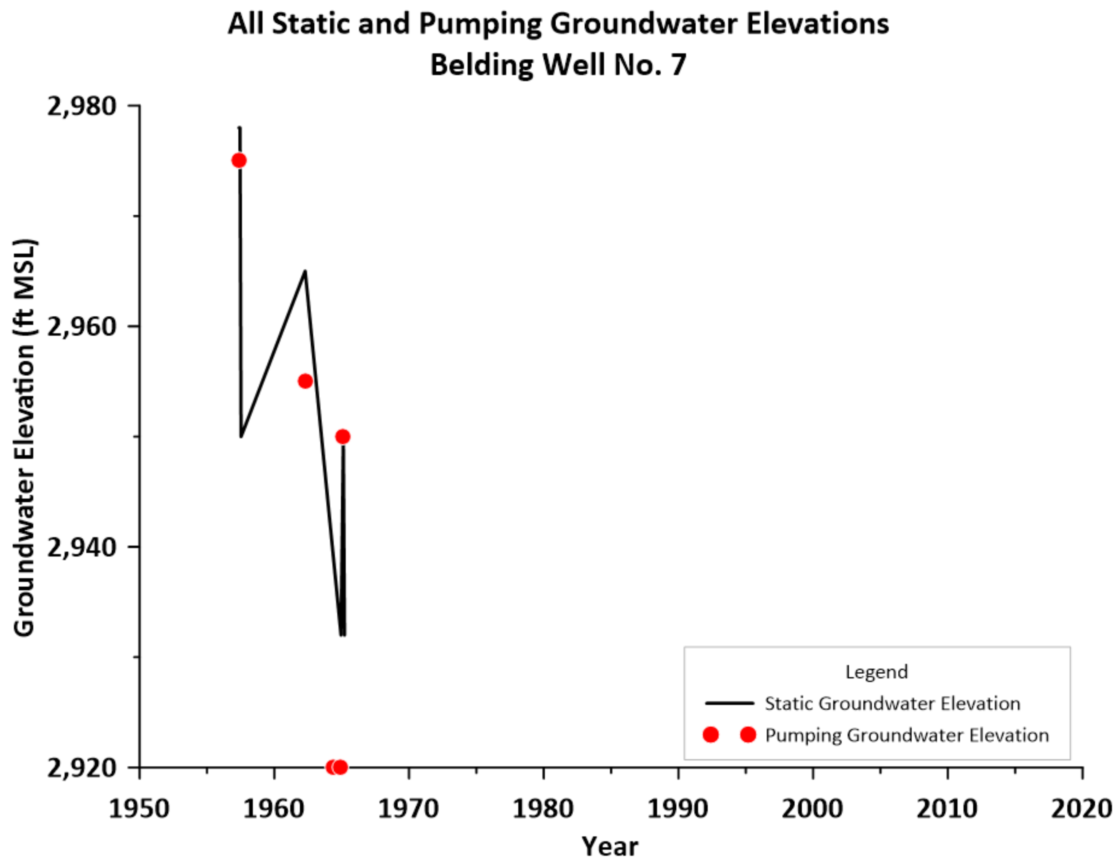

All Static and Pumping Groundwater Elevations
Belding Well No. 2
Groundwater Elevation (ft MSL)
3,050
3,000
2,950
2,900
2,850
2,800
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation


All Static and Pumping Groundwater Elevations
Belding Well No. 3
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation
Groundwater Elevation (ft MSL)
3,040
3,000
2,960
2,920
2,880
1950
1960
1970
1980
1990
2000
2010
2020
Year

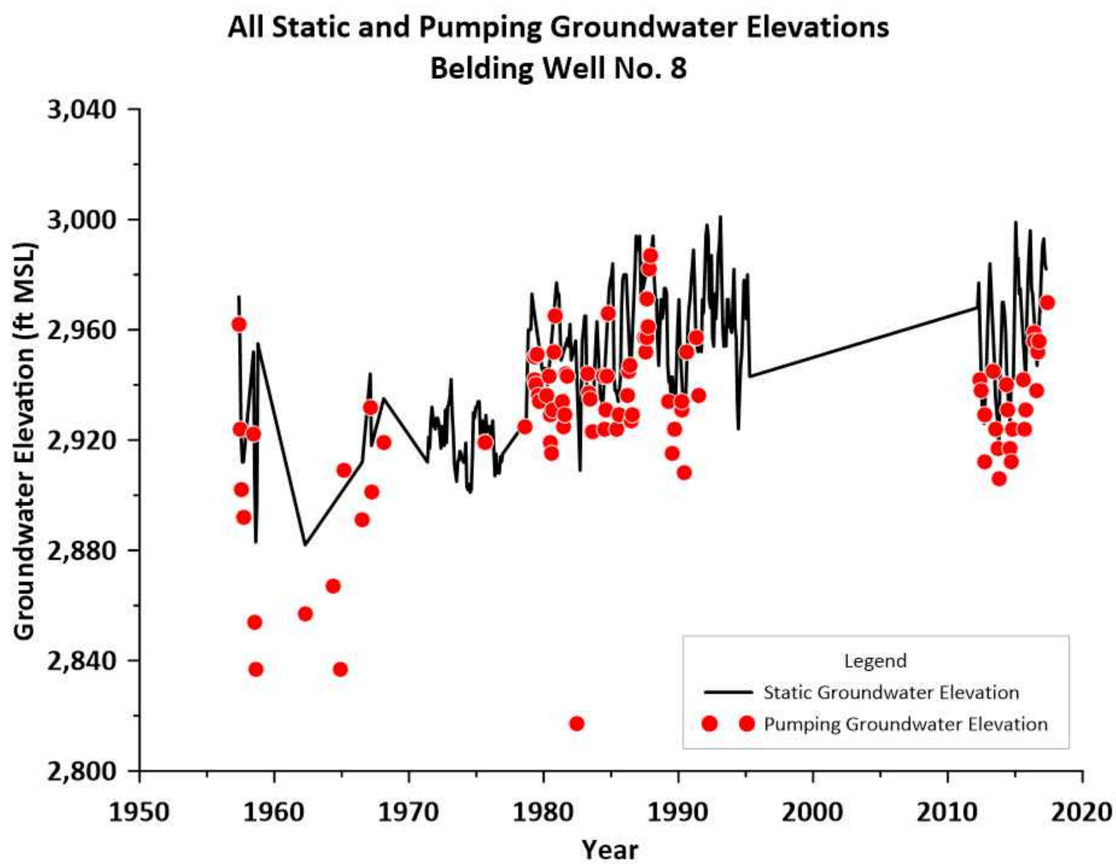

All Static and Pumping Groundwater Elevations
Belding Well No. 4
Groundwater Elevation (ft MSL)
3,000
2,960
2,920
2,880
2,840
2,800
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation


All Static and Pumping Groundwater Elevations
Belding Well No. 5
Groundwater Elevation (ft MSL)
3,040
3,000
2,960
2,920
2,880
2,840
2,800
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

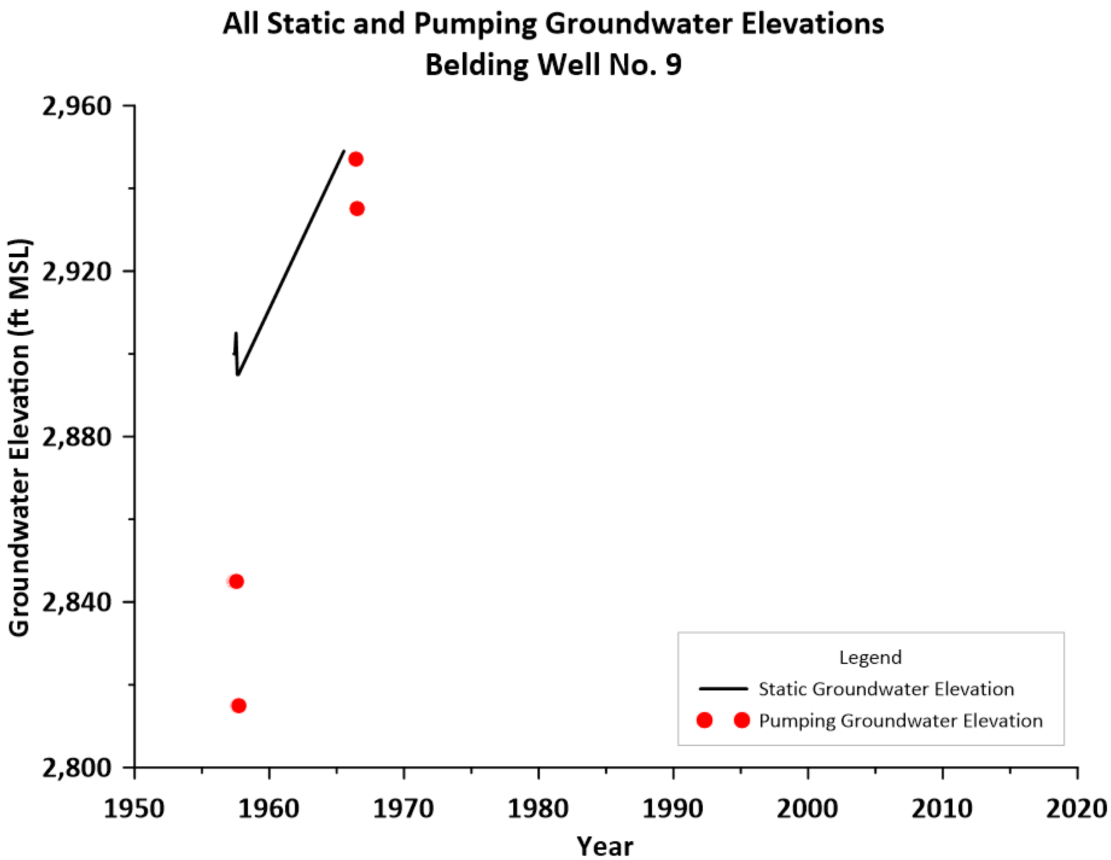

All Static and Pumping Groundwater Elevations
Belding Well No. 6
Groundwater Elevation (ft MSL)
3,020
3,000
2,980
2,960
2,940
2,920
2,900
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

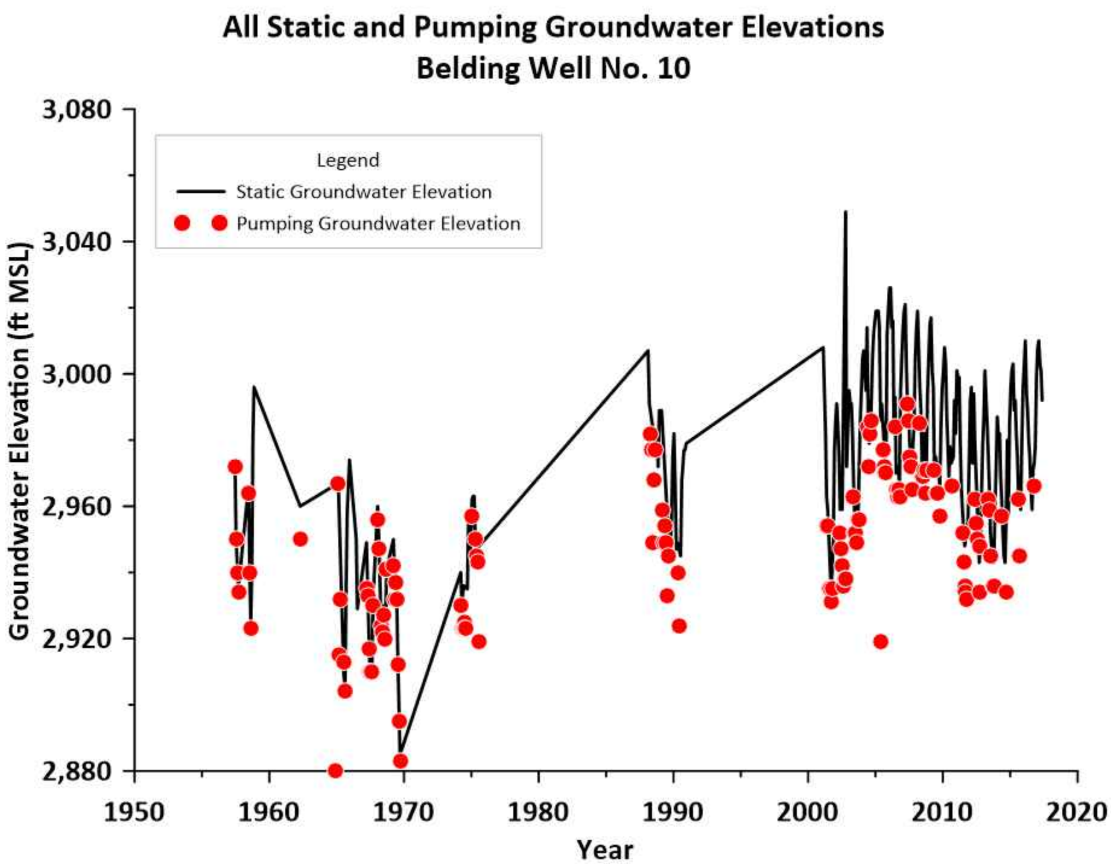


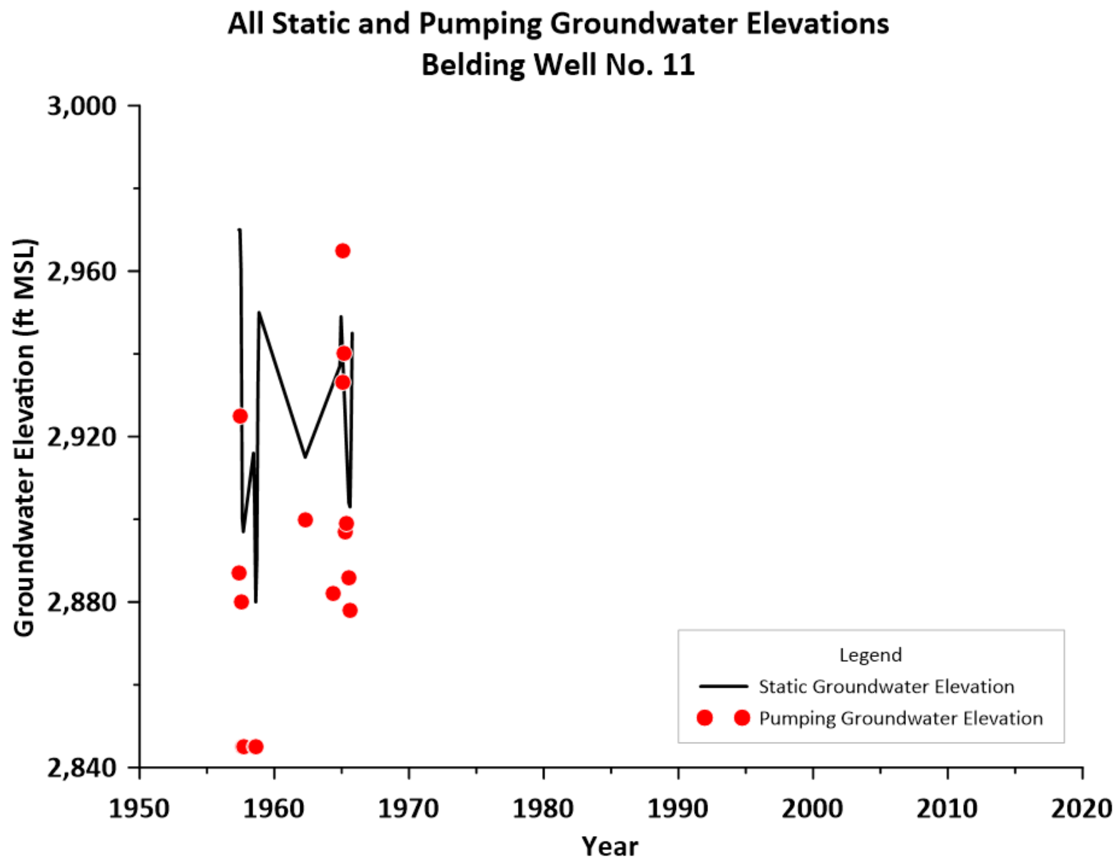
All Static and Pumping Groundwater Elevations
Belding Well No. 7
Groundwater Elevation (ft MSL)
2,980
2,960
2,940
2,920
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

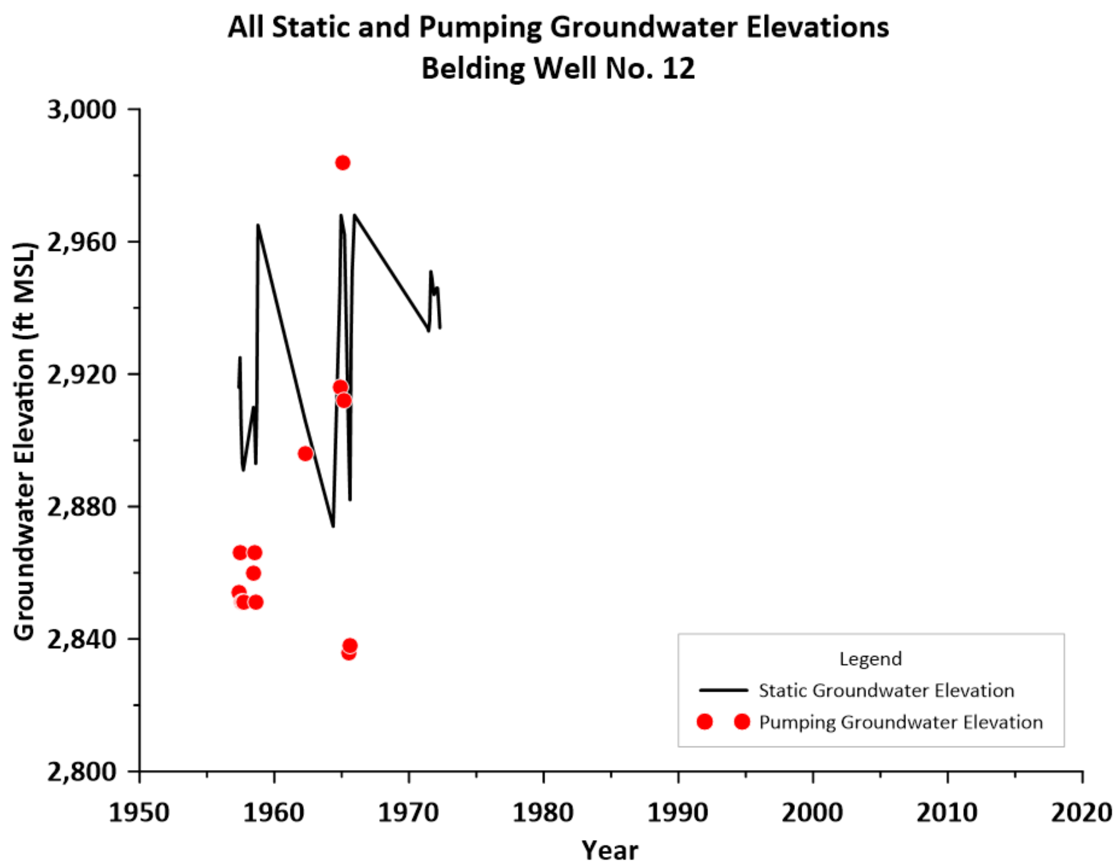


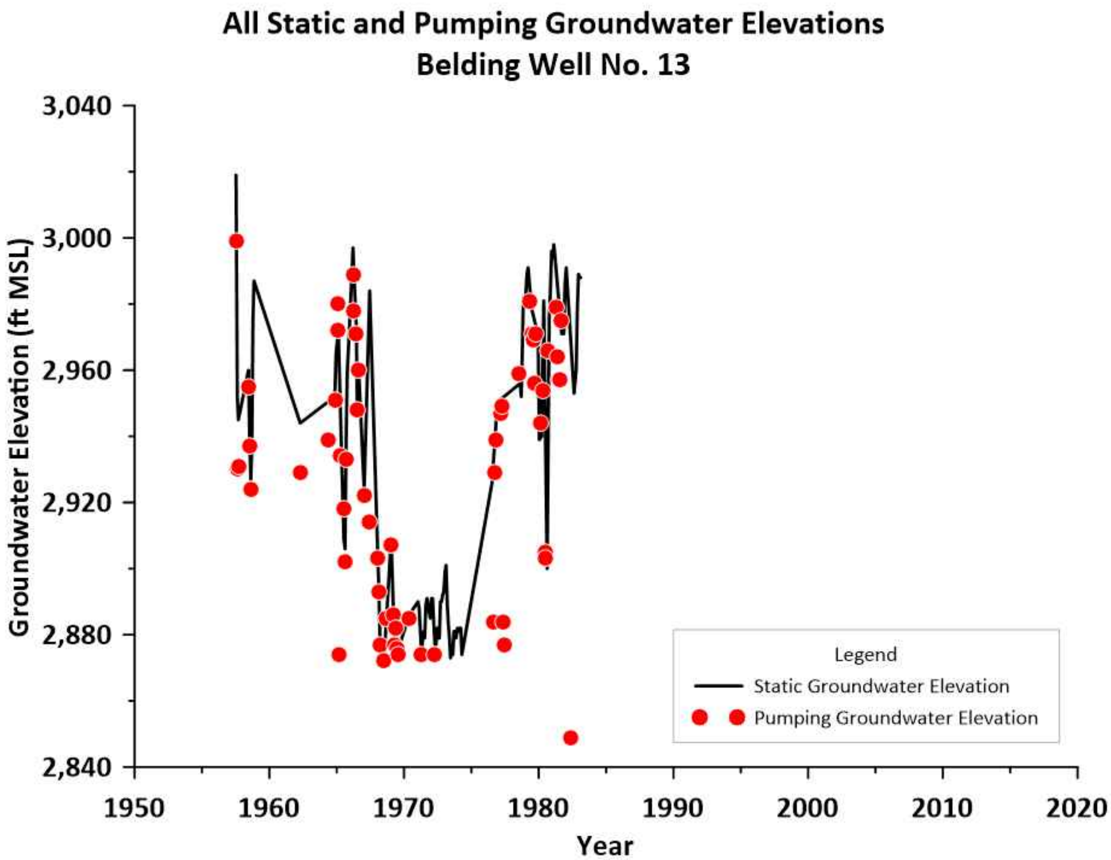
All Static and Pumping Groundwater Elevations
Belding Well No. 8
Groundwater Elevation (ft MSL)
3,040
3,000
2,960
2,920
2,880
2,840
2,800
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

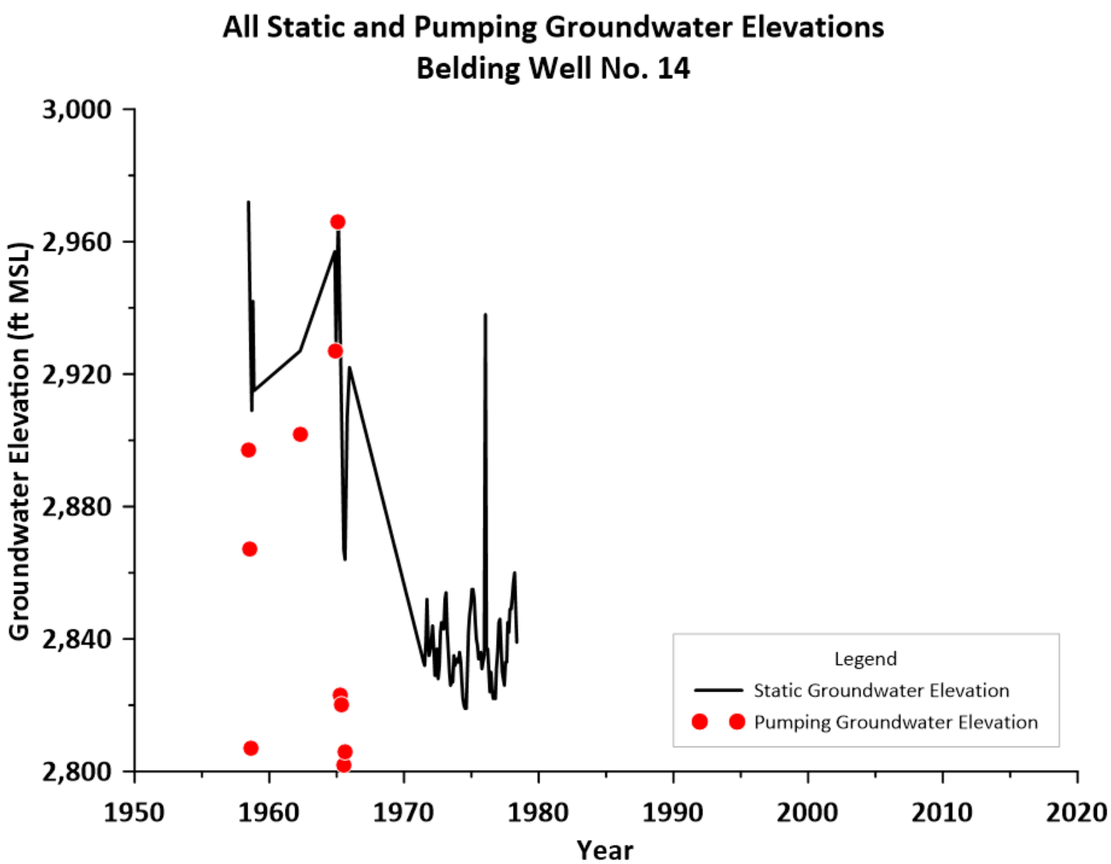

All Static and Pumping Groundwater Elevations
Belding Well No. 9
Groundwater Elevation (ft MSL)
2,960
2,920
2,880
2,840
2,800
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

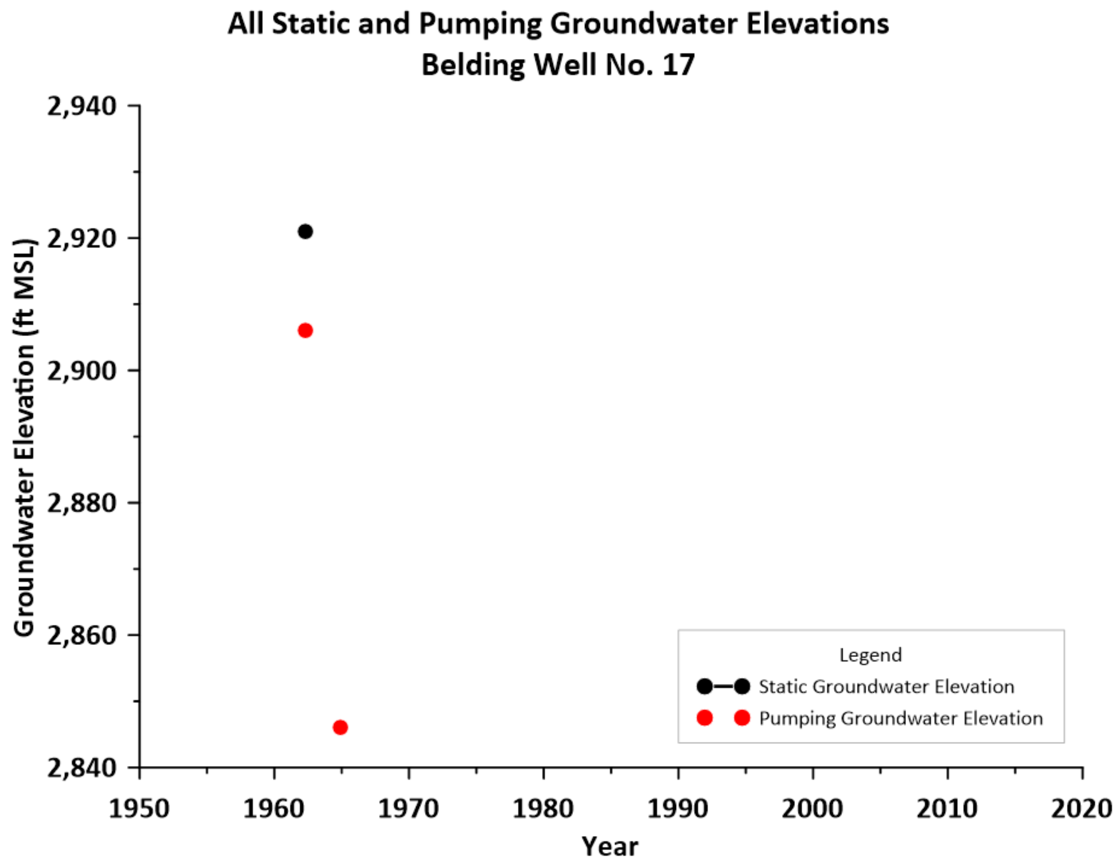

All Static and Pumping Groundwater Elevations
Belding Well No. 10
Groundwater Elevation (ft MSL)
3,080
3,040
3,000
2,960
2,920
2,880
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

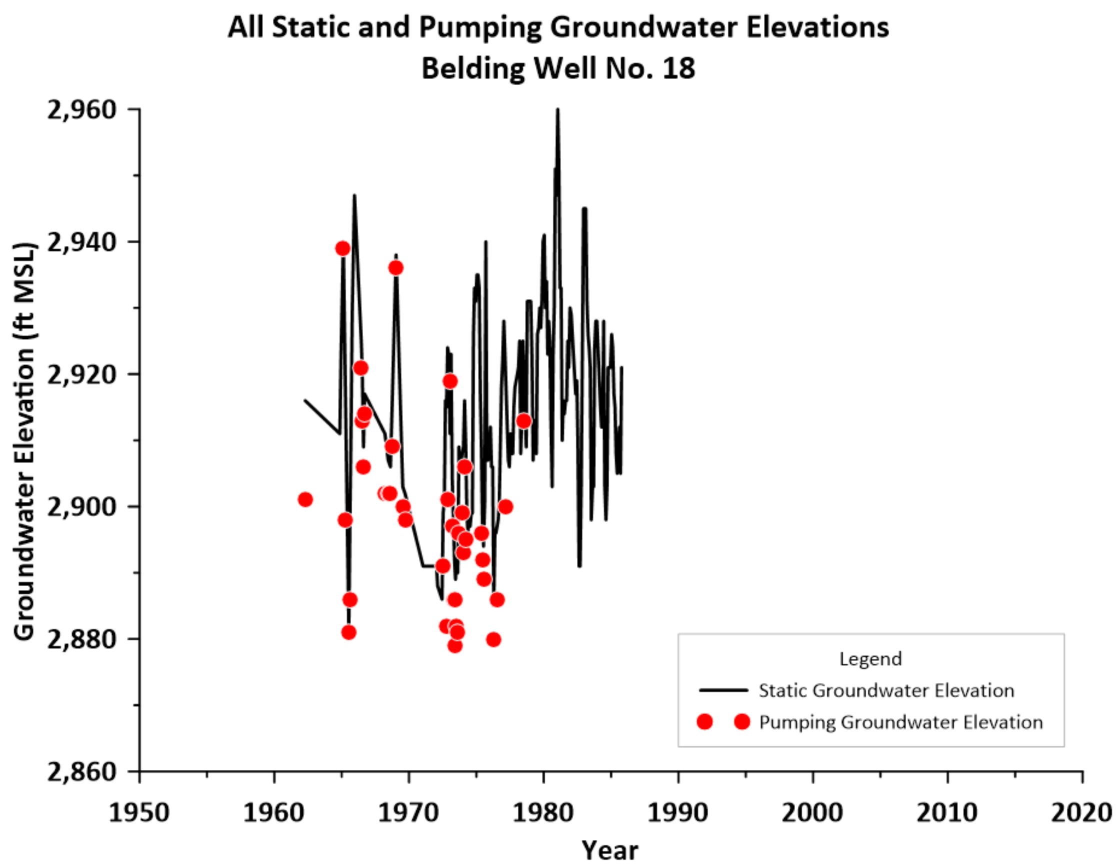

All Static and Pumping Groundwater Elevations
Belding Well No. 11
Groundwater Elevation (ft MSL)
3,000
2,960
2,920
2,880
2,840
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation


All Static and Pumping Groundwater Elevations
Belding Well No. 12
Groundwater Elevation (ft MSL)
3,000
2,960
2,920
2,880
2,840
2,800
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

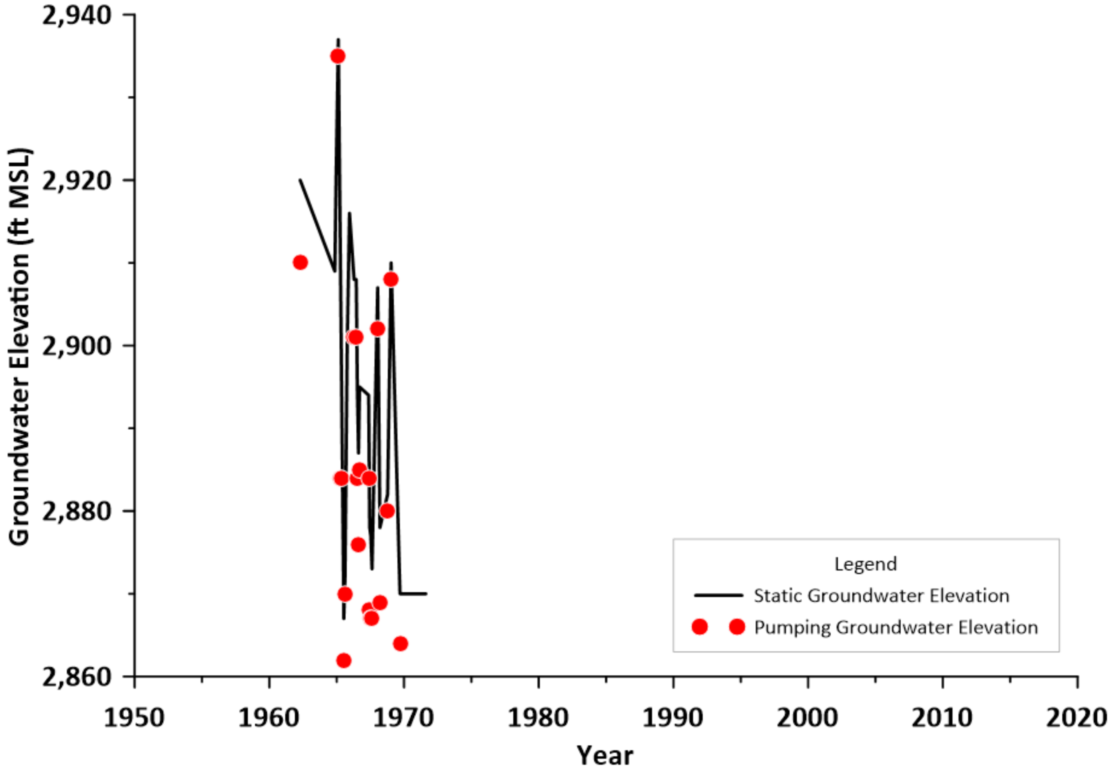

All Static and Pumping Groundwater Elevations
Belding Well No. 13
3,040
3,000
2,960
2,920
2,880
2,840
Groundwater Elevation (ft MSL)
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation


All Static and Pumping Groundwater Elevations
Belding Well No. 14
3,000
2,960
2,920
2,880
2,840
2,800
Groundwater Elevation (ft MSL)
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

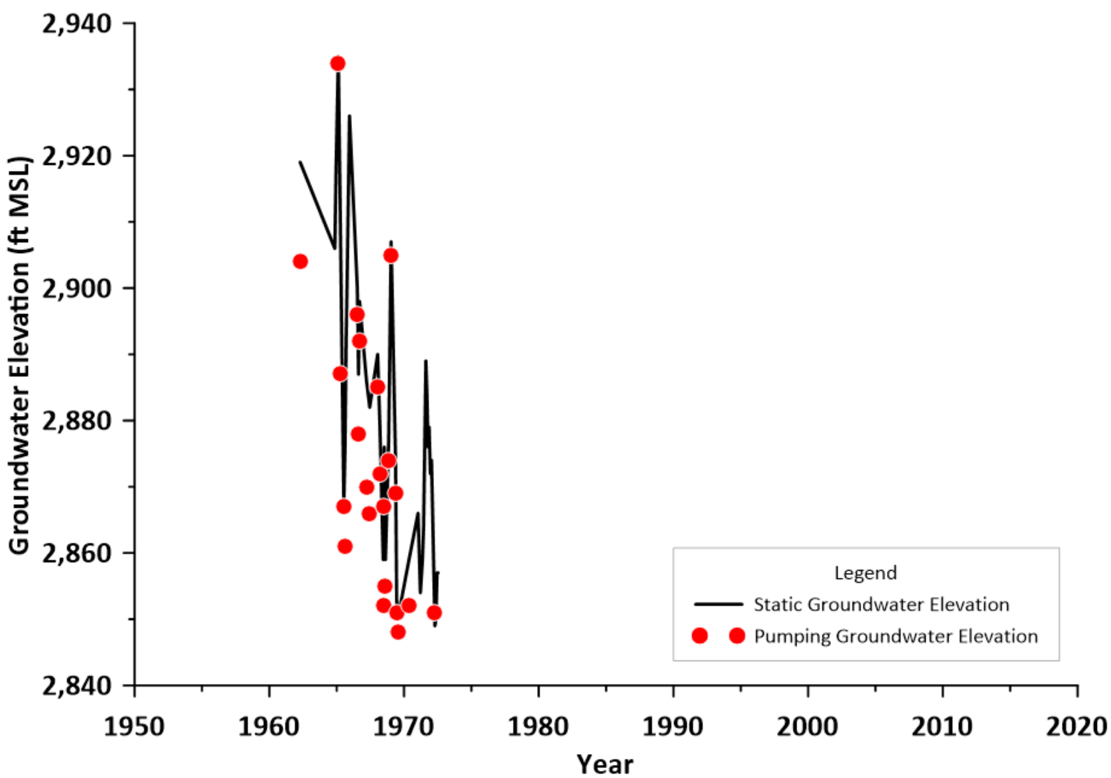

All Static and Pumping Groundwater Elevations
Belding Well No. 17
Groundwater Elevation (ft MSL)
2,940
2,920
2,900
2,880
2,860
2,840
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

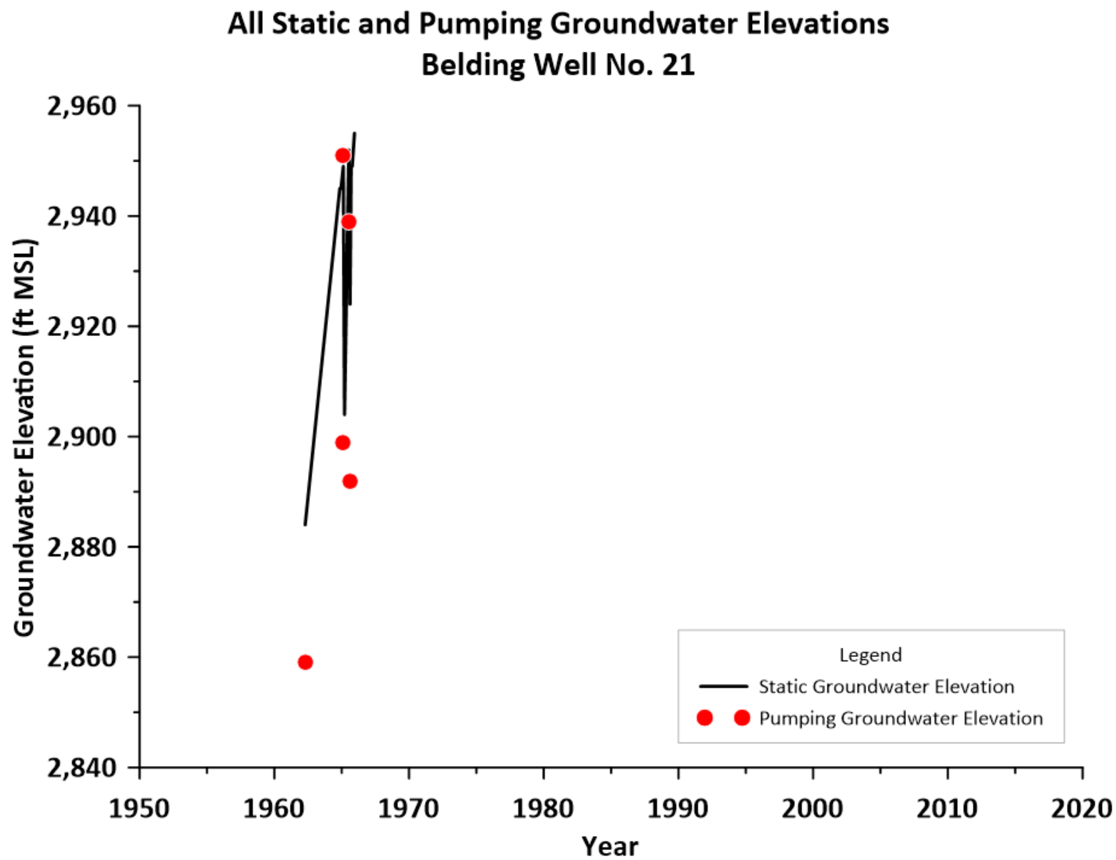

All Static and Pumping Groundwater Elevations
Belding Well No. 18
Groundwater Elevation (ft MSL)
2,960
2,940
2,920
2,900
2,880
2,860
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

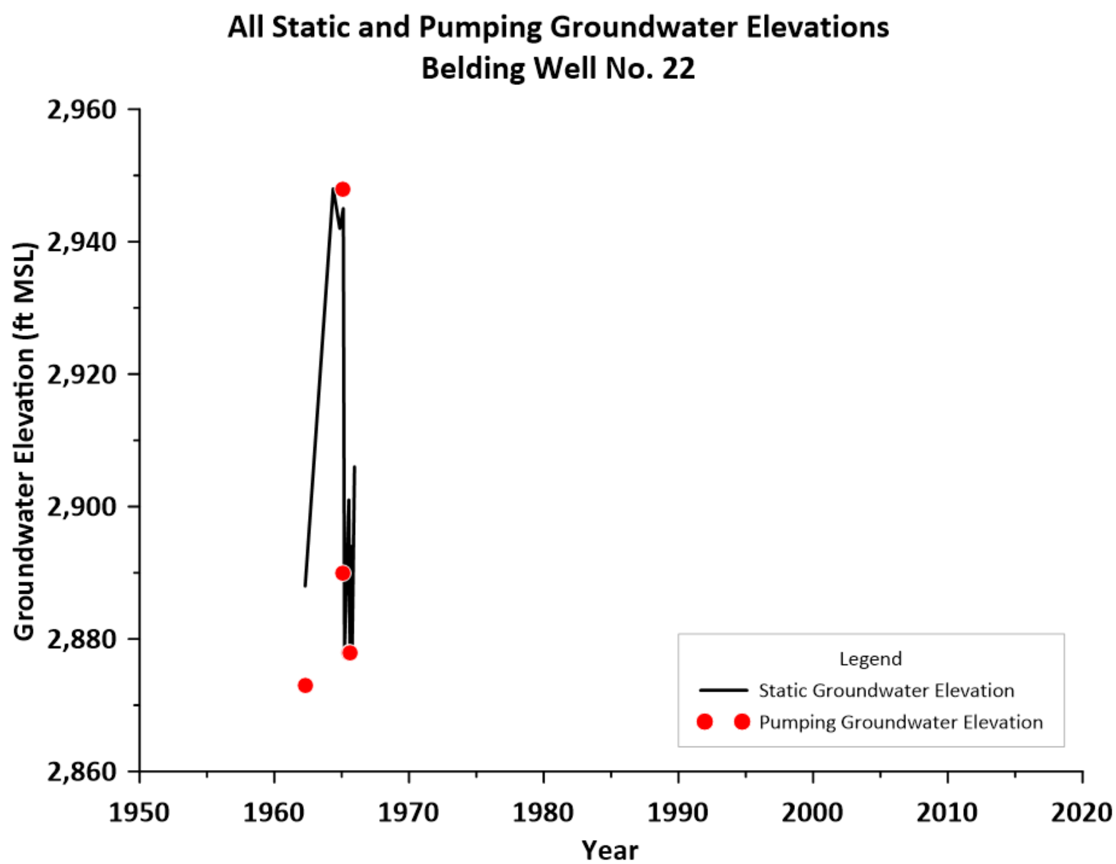
All Static and Pumping Groundwater Elevations
Belding Well No. 19

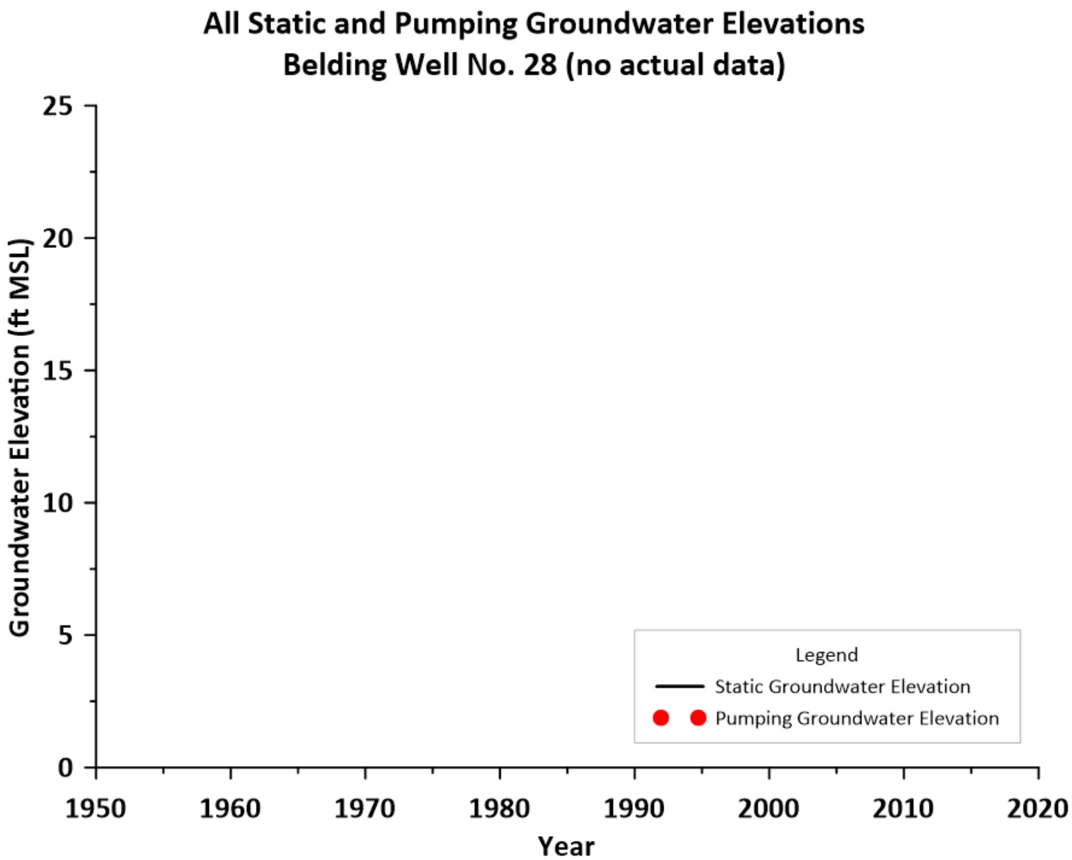


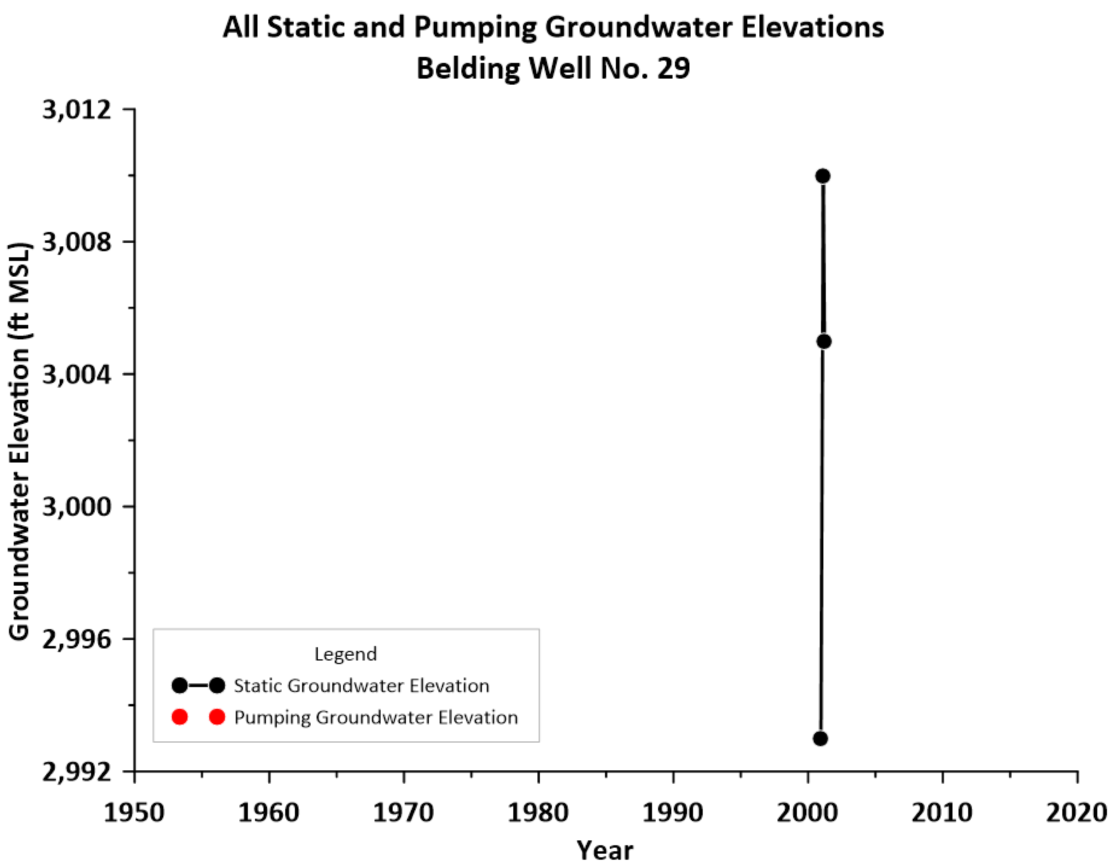
All Static and Pumping Groundwater Elevations
Belding Well No. 20

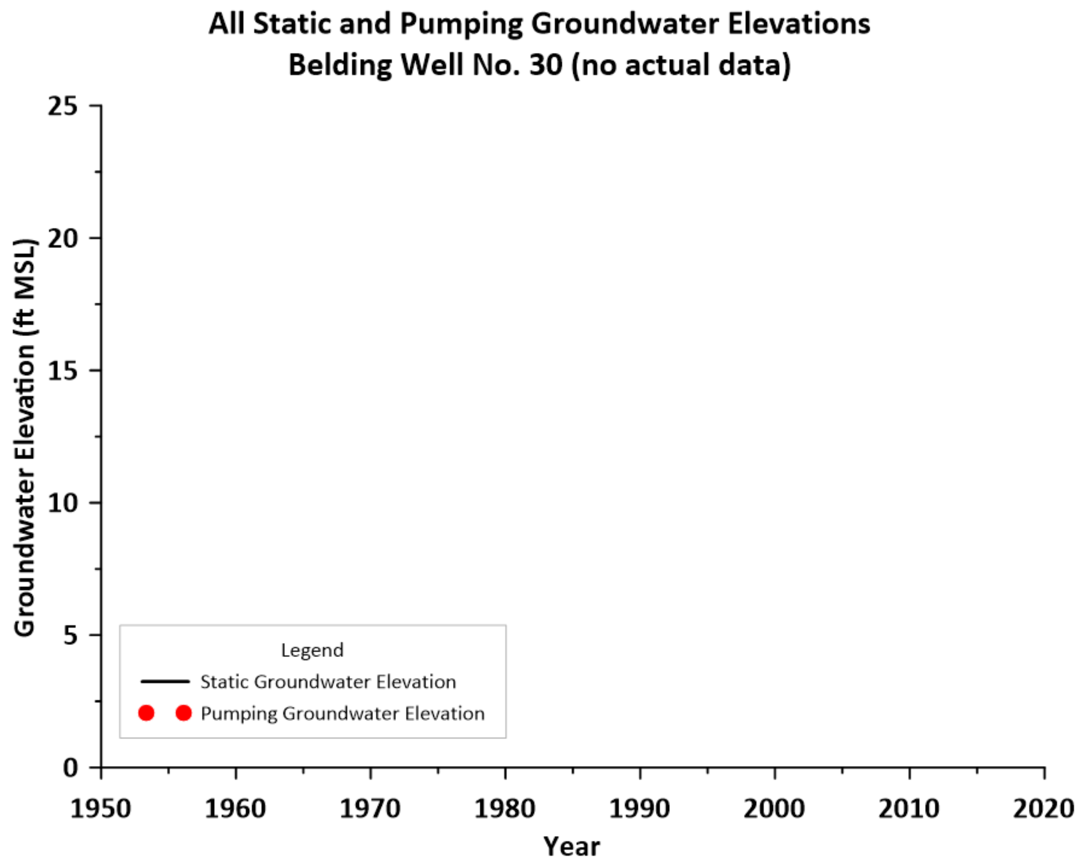



All Static and Pumping Groundwater Elevations
Belding Well No. 21
Groundwater Elevation (ft MSL)
2,960
2,940
2,920
2,900
2,880
2,860
2,840
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation


All Static and Pumping Groundwater Elevations
Belding Well No. 22
Groundwater Elevation (ft MSL)
2,960
2,940
2,920
2,900
2,880
2,860
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

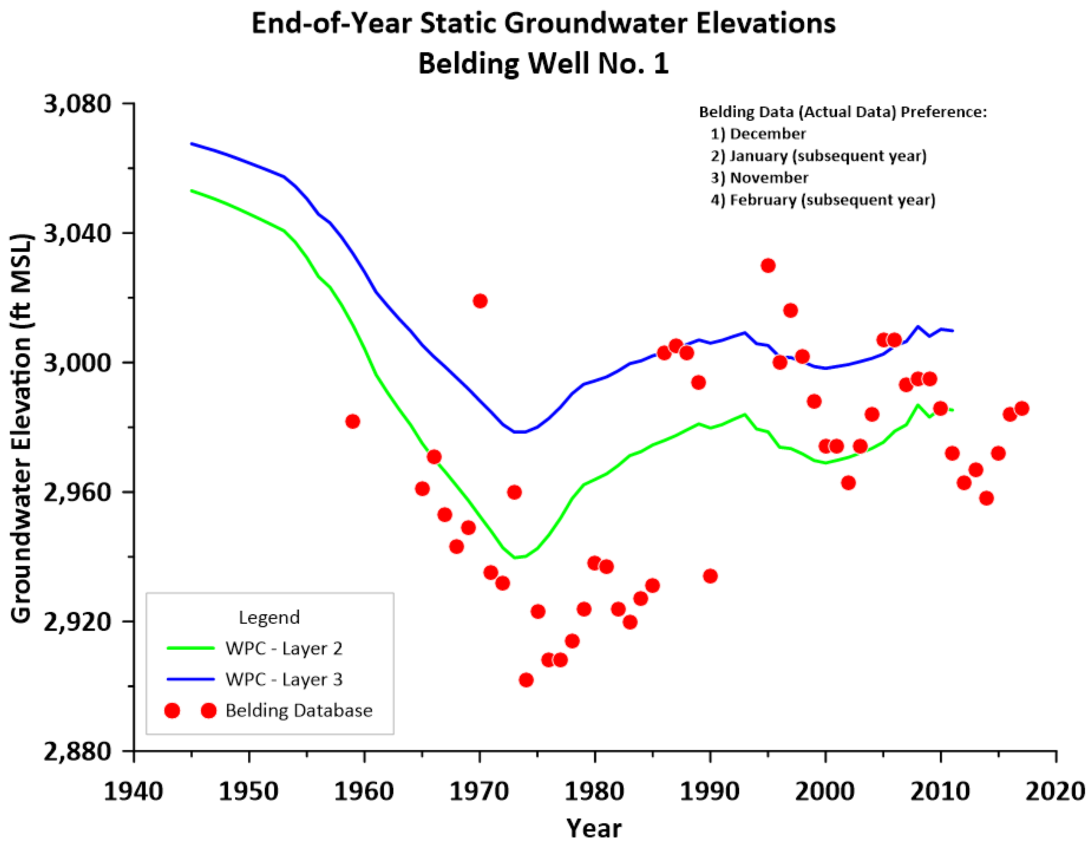

All Static and Pumping Groundwater Elevations
Belding Well No. 28 (no actual data)
Groundwater Elevation (ft MSL)
25
20
15
10
5
0
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

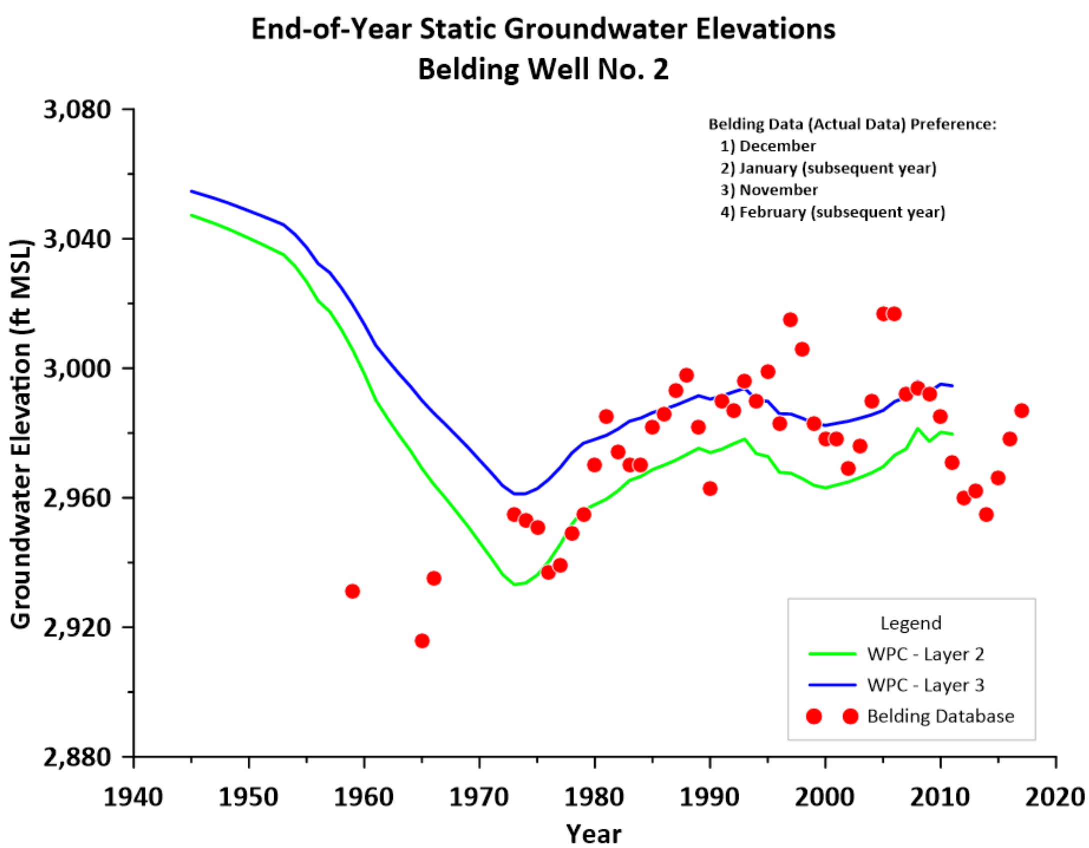

All Static and Pumping Groundwater Elevations
Belding Well No. 29
Groundwater Elevation (ft MSL)
3,012
3,008
3,004
3,000
2,996
2,992
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation


All Static and Pumping Groundwater Elevations
Belding Well No. 30 (no actual data)
Groundwater Elevation (ft MSL)
25
20
15
10
5
0
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

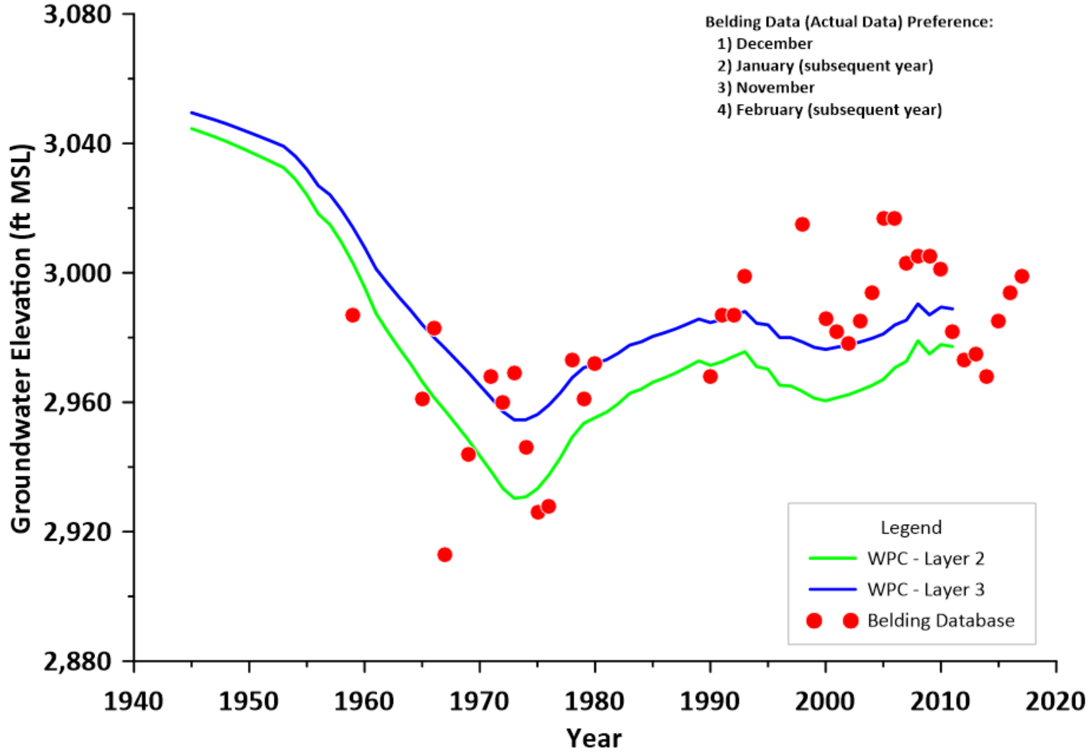
Appendix B

End-of-Year Static Groundwater Elevations and Simulated Groundwater Elevations from Western Pecos Model Hydrographs

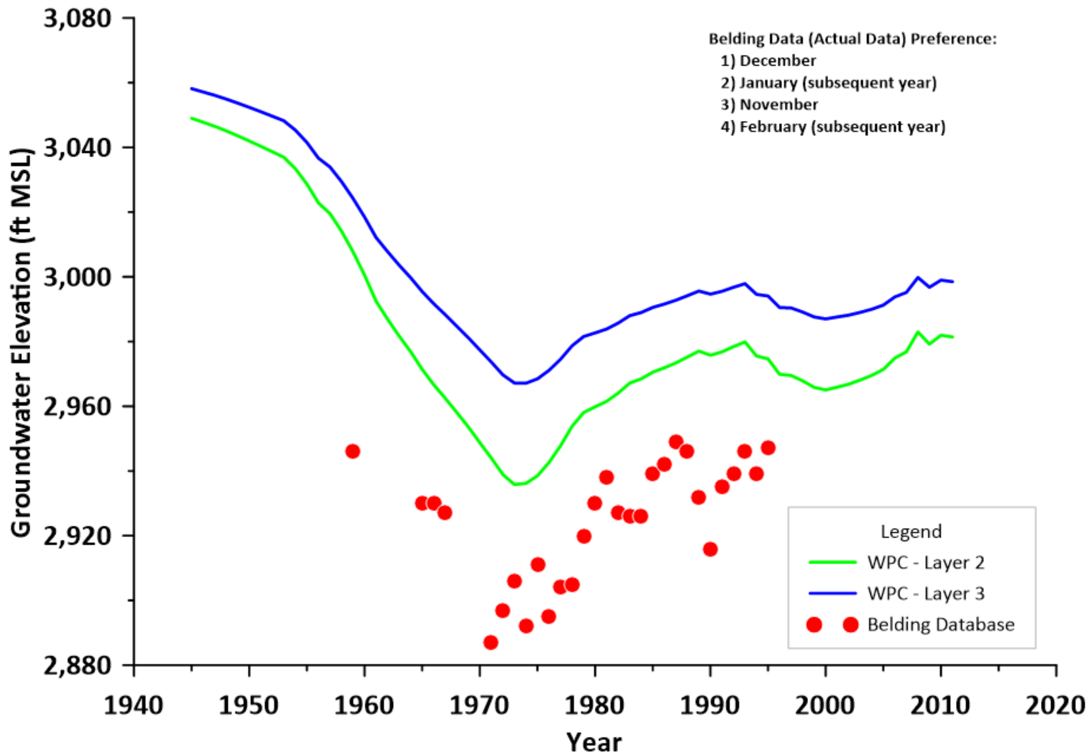

End-of-Year Static Groundwater Elevations
Belding Well No. 1
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Groundwater Elevation (ft MSL)
3,080
3,040
3,000
2,960
2,920
2,880
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database


End-of-Year Static Groundwater Elevations
Belding Well No. 2
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Groundwater Elevation (ft MSL)
3,080
3,040
3,000
2,960
2,920
2,880
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database

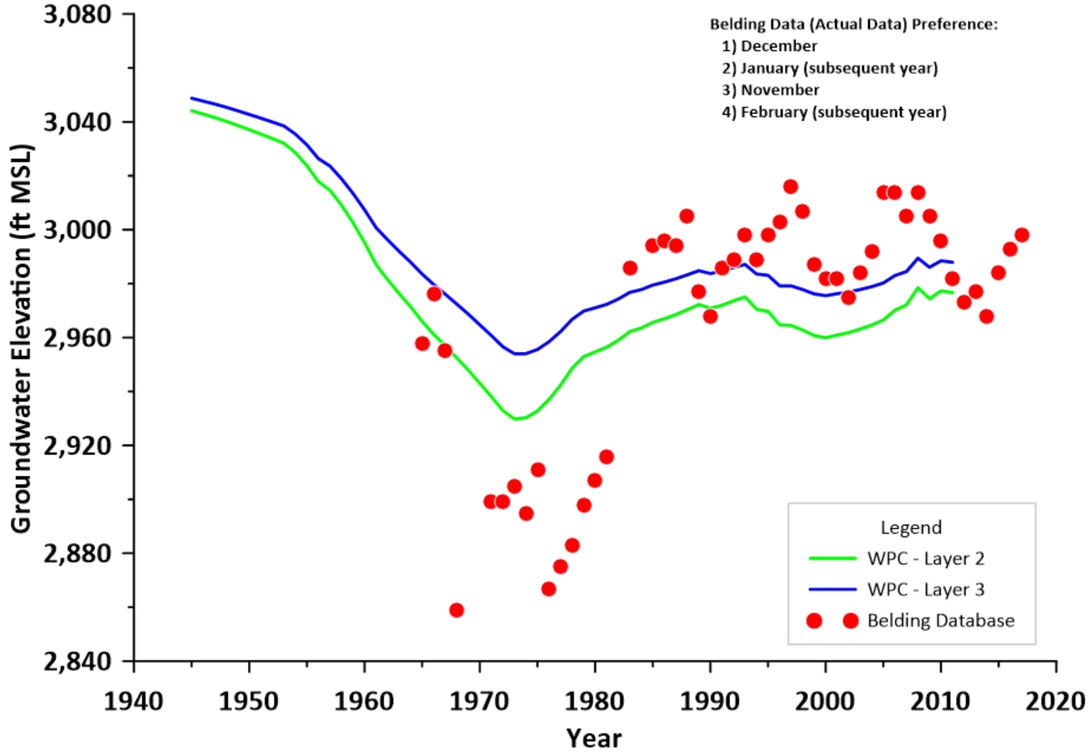
End-of-Year Static Groundwater Elevations
Belding Well No. 3



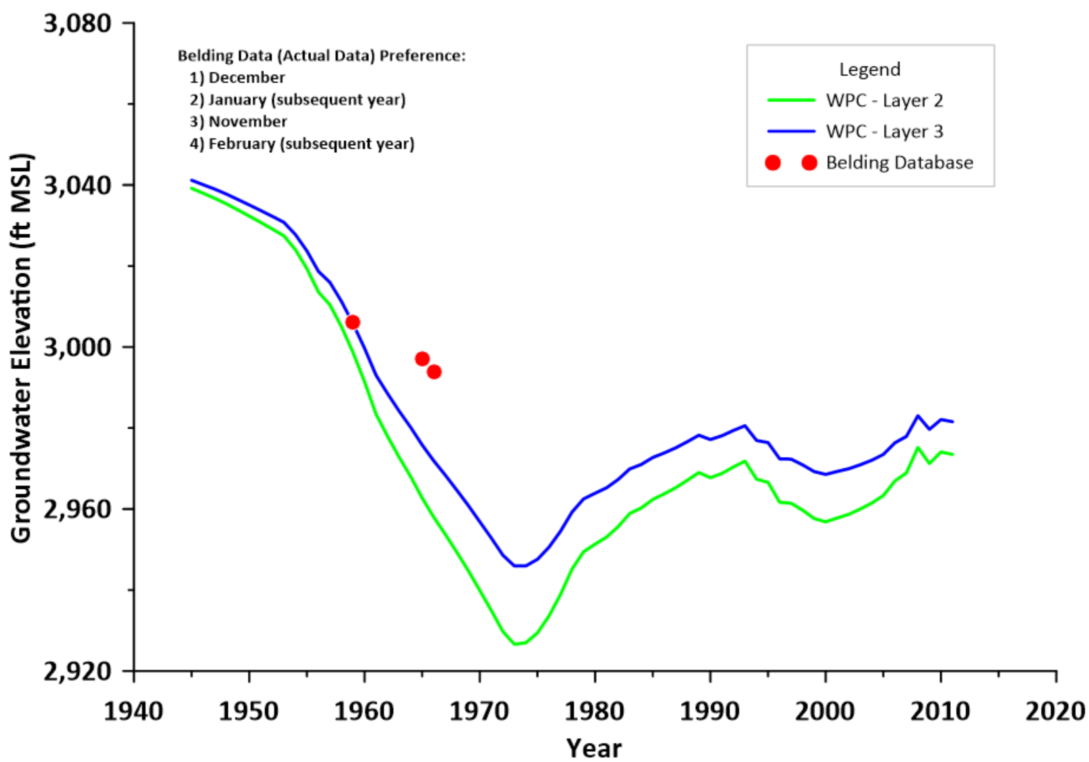
End-of-Year Static Groundwater Elevations
Belding Well No. 4

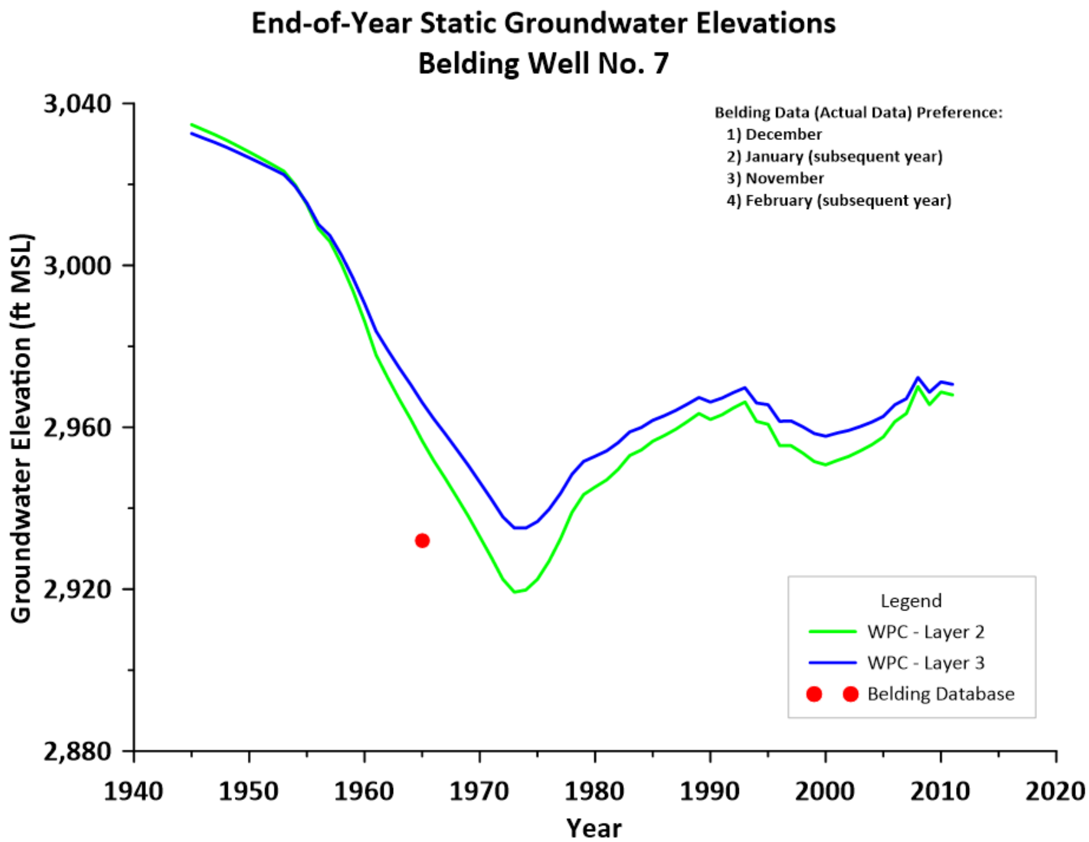


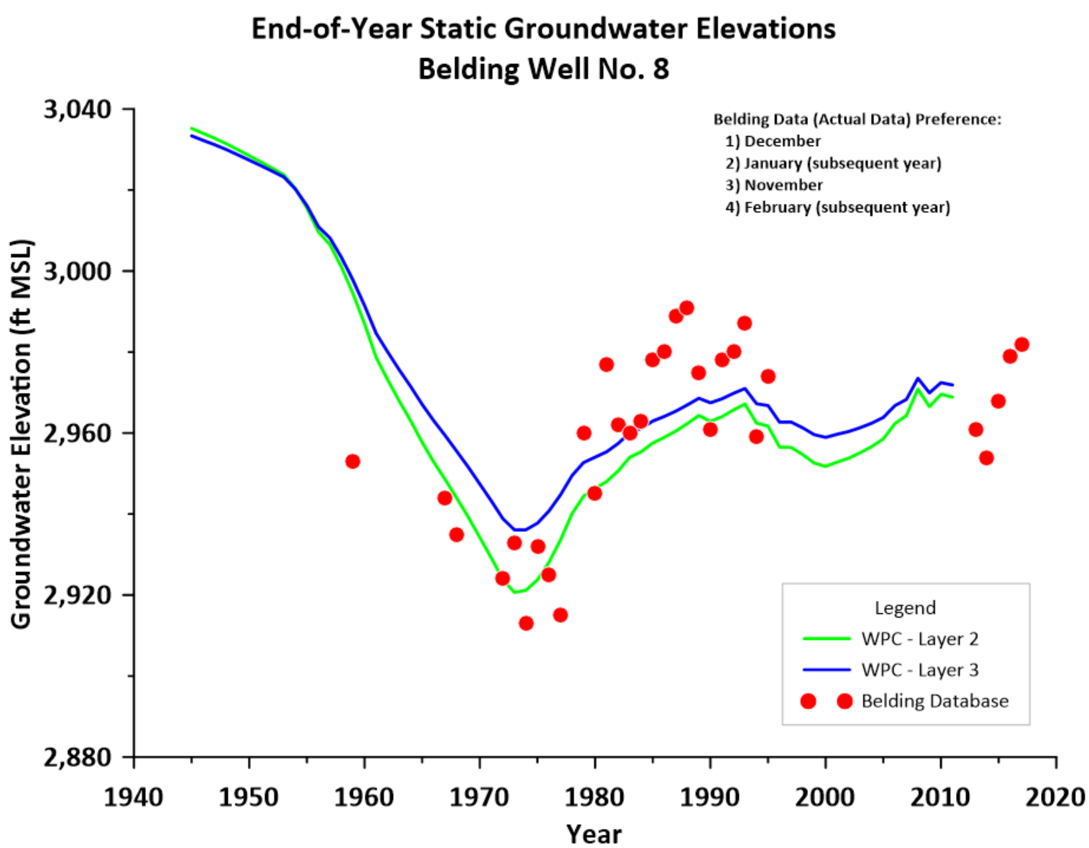
End-of-Year Static Groundwater Elevations
Belding Well No. 5

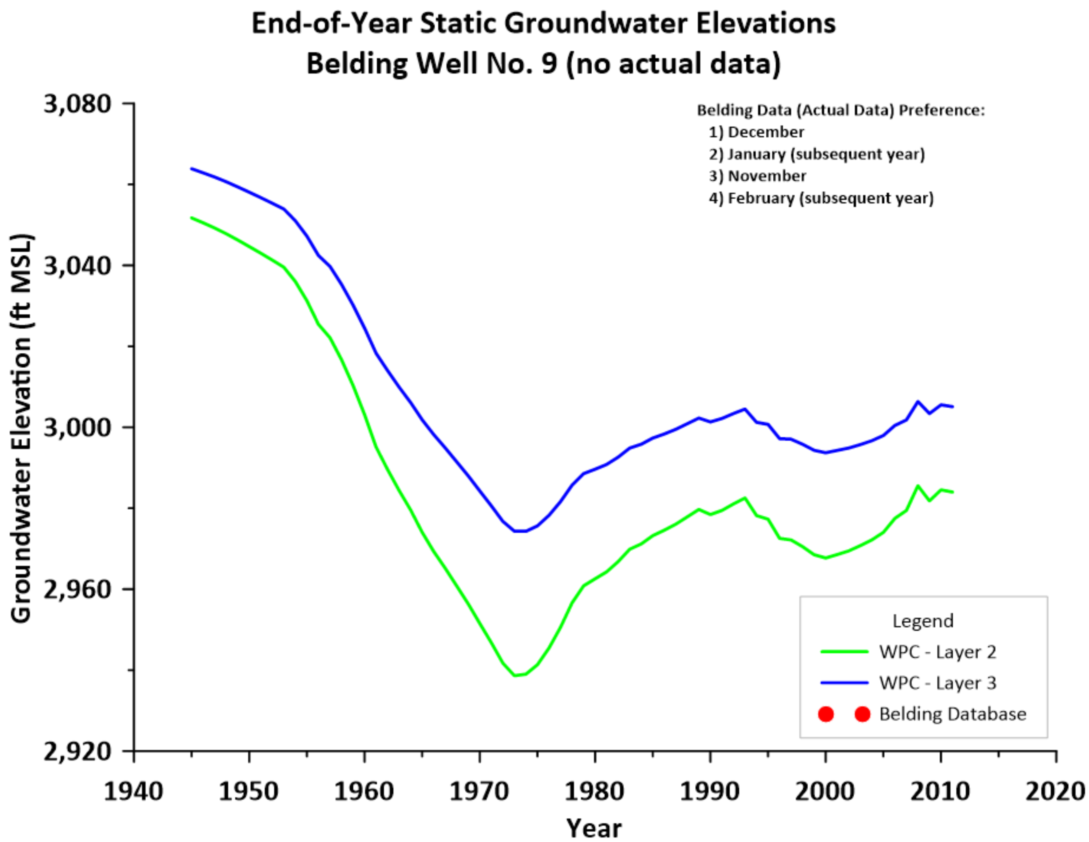


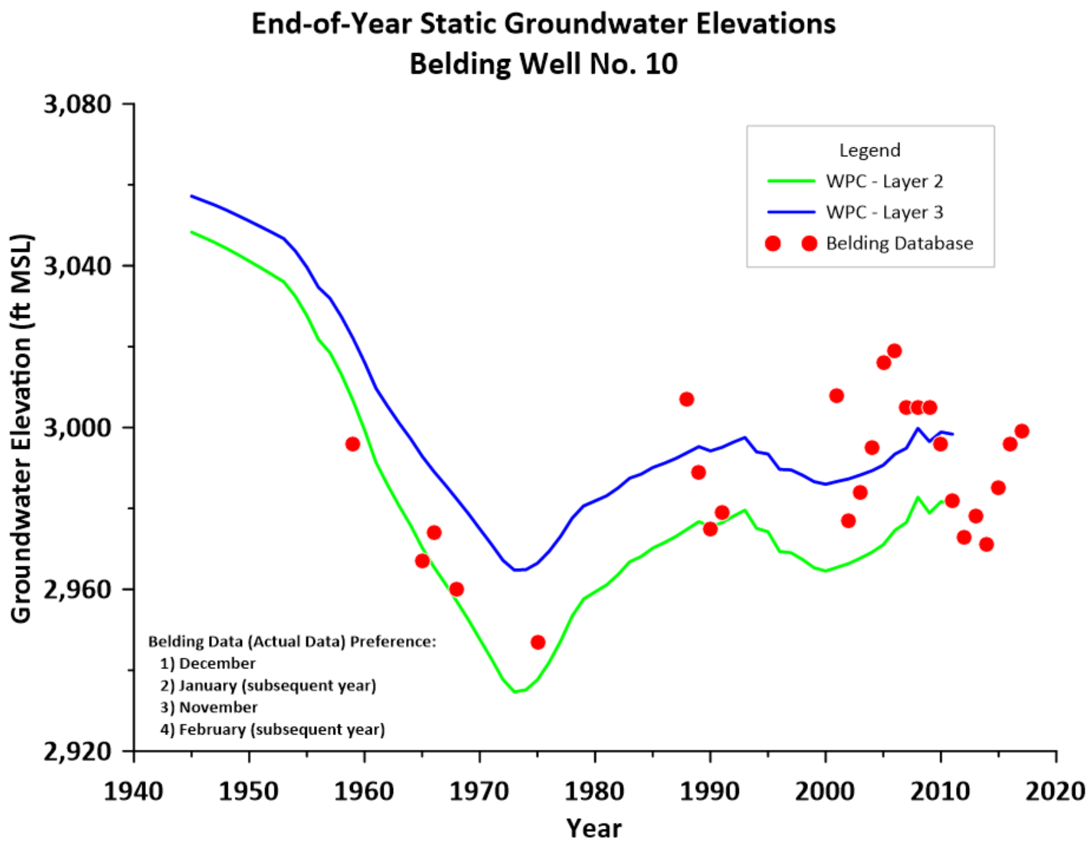
End-of-Year Static Groundwater Elevations
Belding Well No. 6



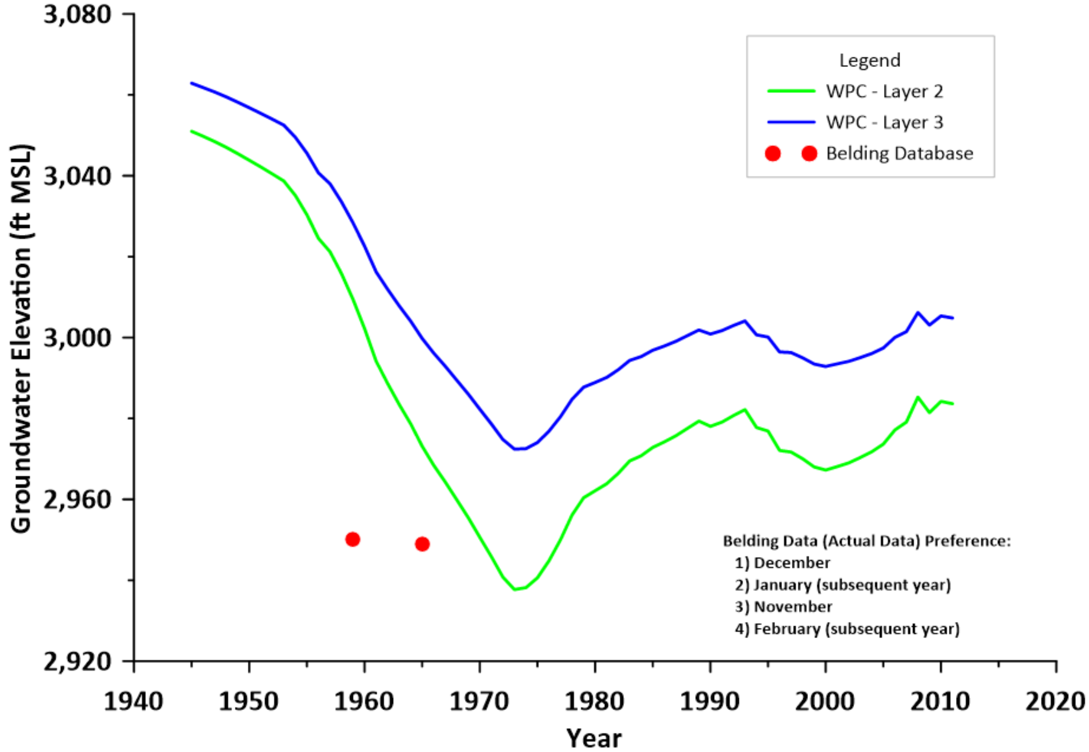

End-of-Year Static Groundwater Elevations
Belding Well No. 7
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Groundwater Elevation (ft MSL)
Year
3,040
3,000
2,960
2,920
2,880
1940
1950
1960
1970
1980
1990
2000
2010
2020


End-of-Year Static Groundwater Elevations
Belding Well No. 8
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Groundwater Elevation (ft MSL)
Year
3,040
3,000
2,960
2,920
2,880
1940
1950
1960
1970
1980
1990
2000
2010
2020

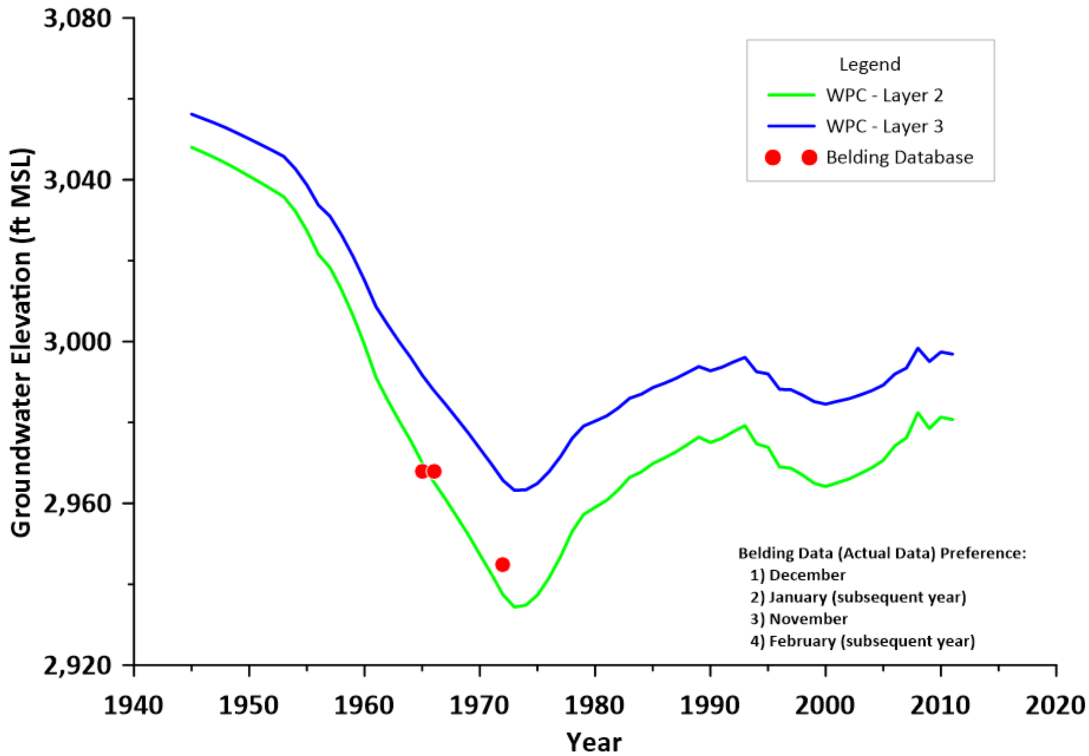

End-of-Year Static Groundwater Elevations
Belding Well No. 9 (no actual data)
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Groundwater Elevation (ft MSL)
3,080
3,040
3,000
2,960
2,920
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year

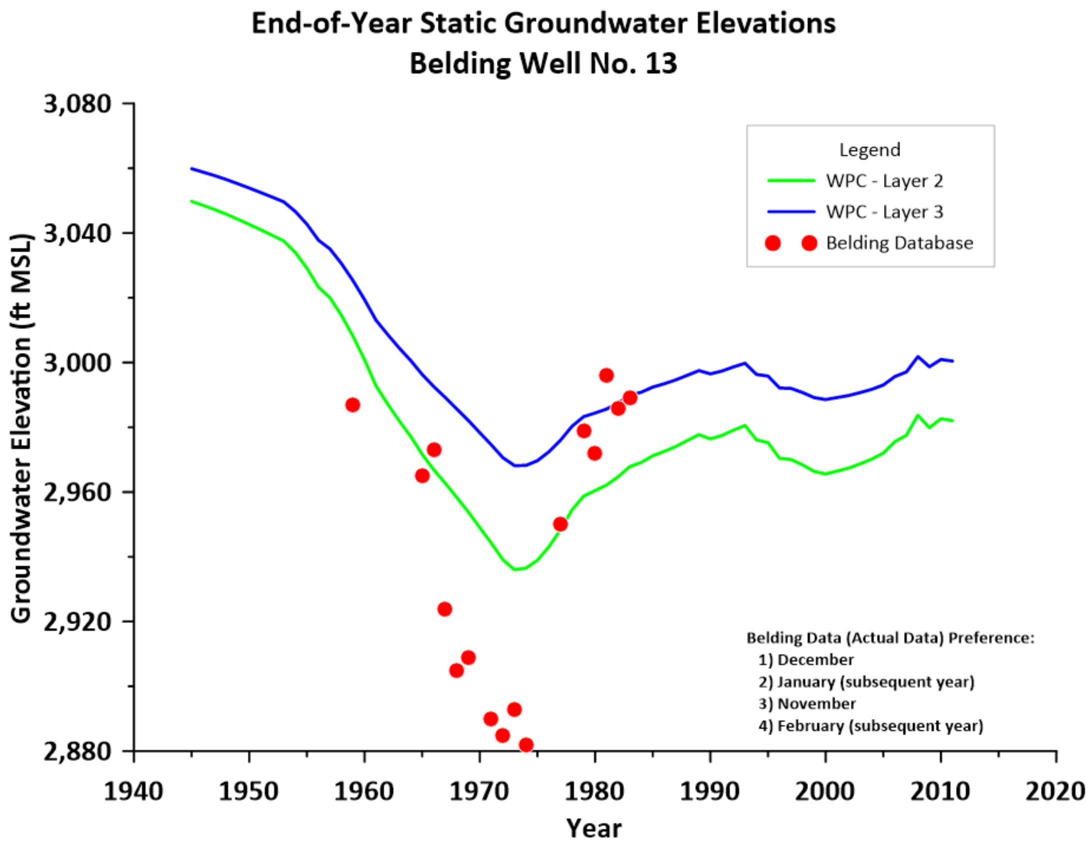

End-of-Year Static Groundwater Elevations
Belding Well No. 10
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Groundwater Elevation (ft MSL)
3,080
3,040
3,000
2,960
2,920
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year

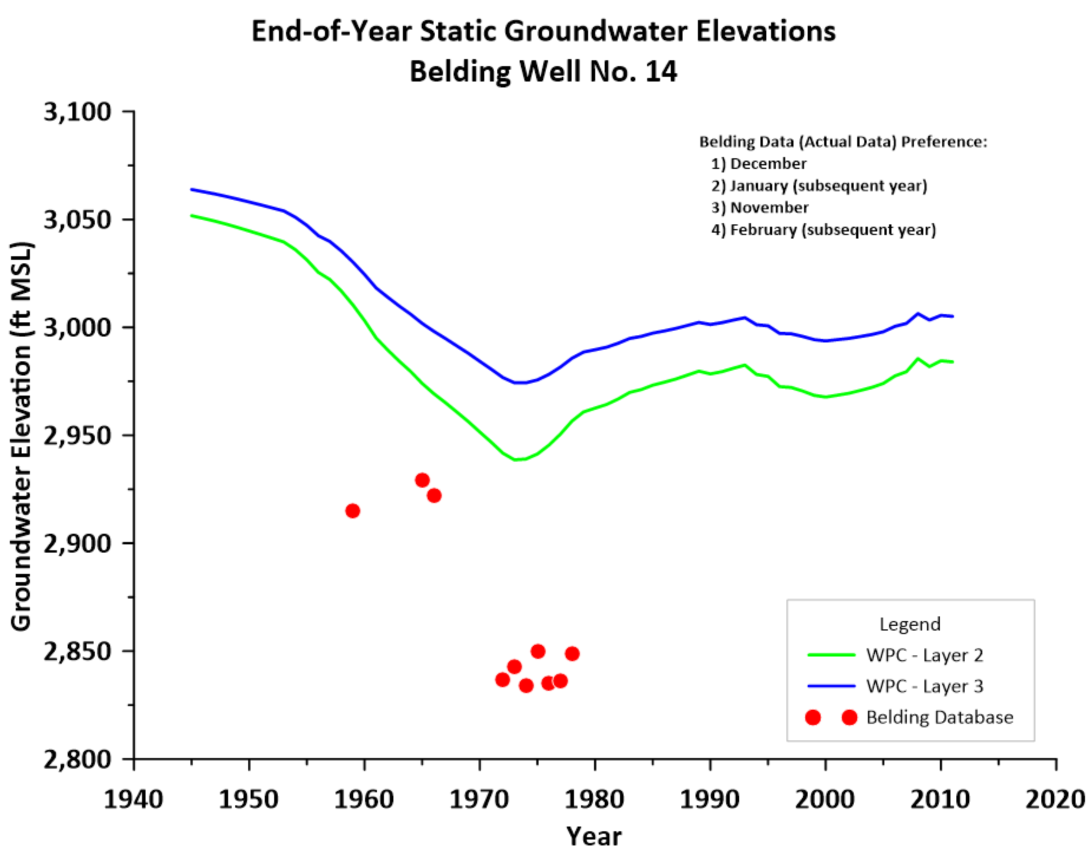
End-of-Year Static Groundwater Elevations
Belding Well No. 11

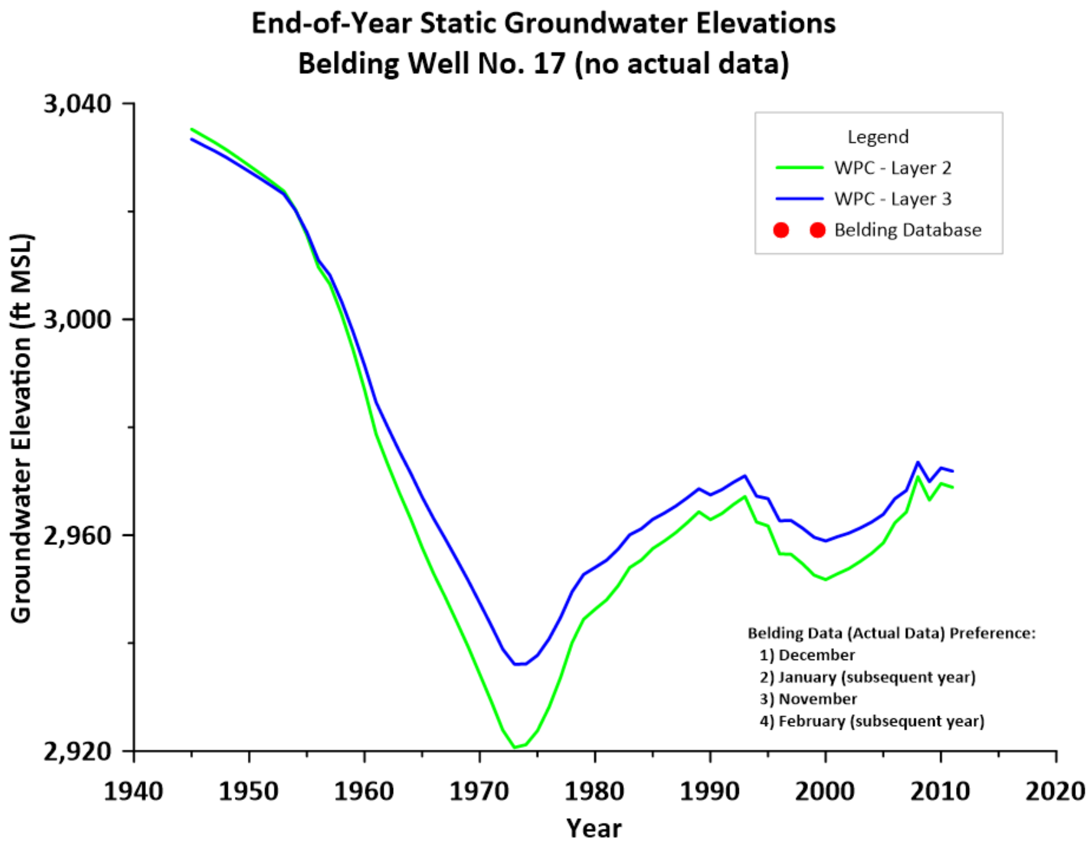


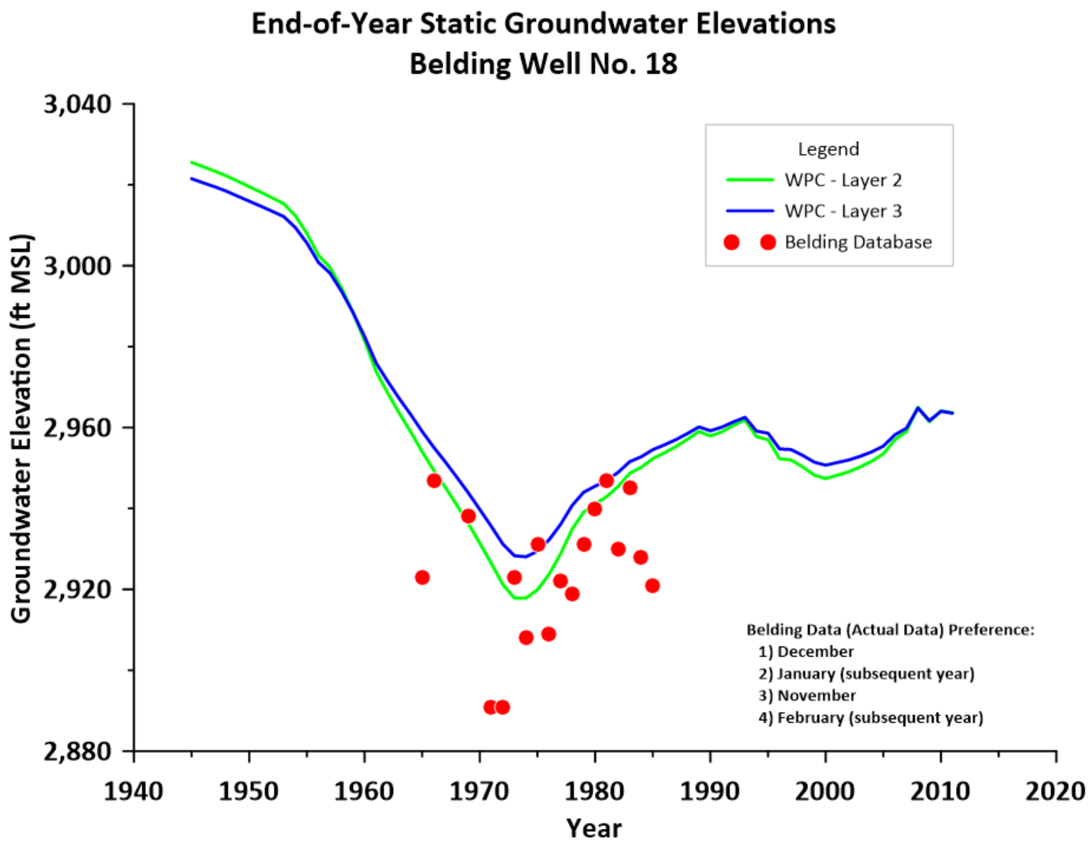
End-of-Year Static Groundwater Elevations
Belding Well No. 12

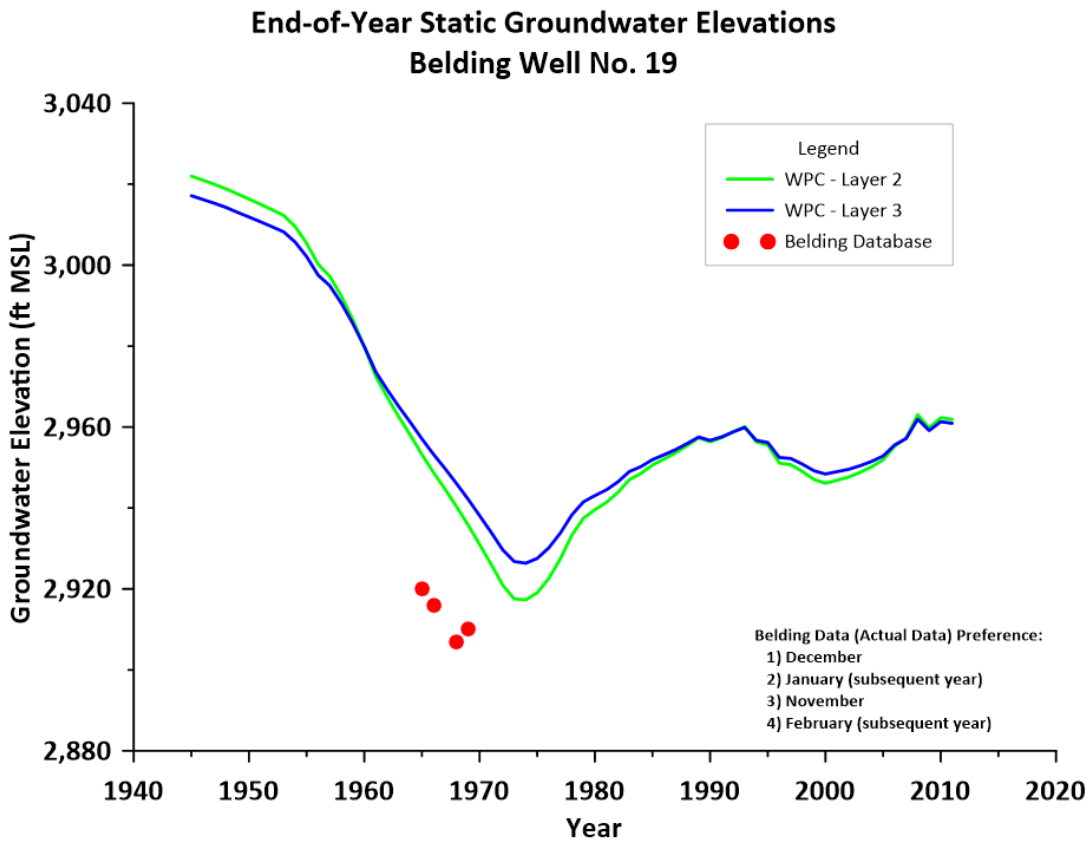


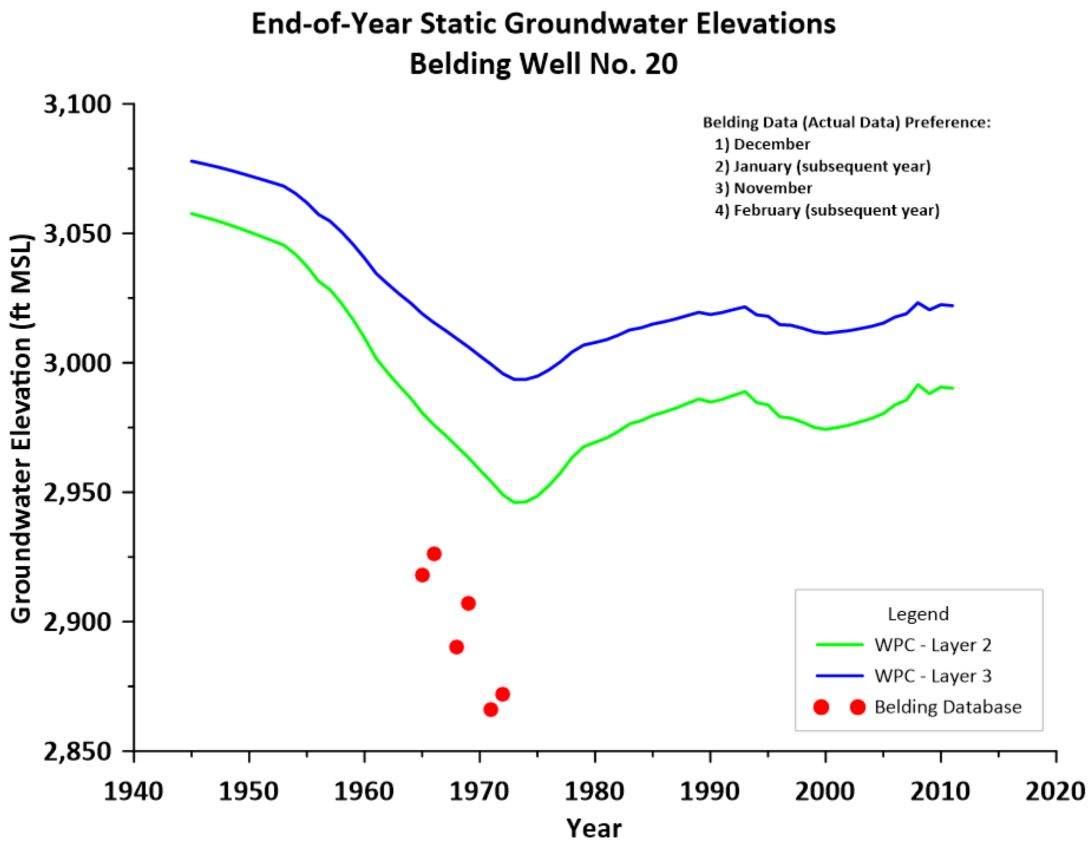

End-of-Year Static Groundwater Elevations
Belding Well No. 13
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Groundwater Elevation (ft MSL)
3,080
3,040
3,000
2,960
2,920
2,880
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year

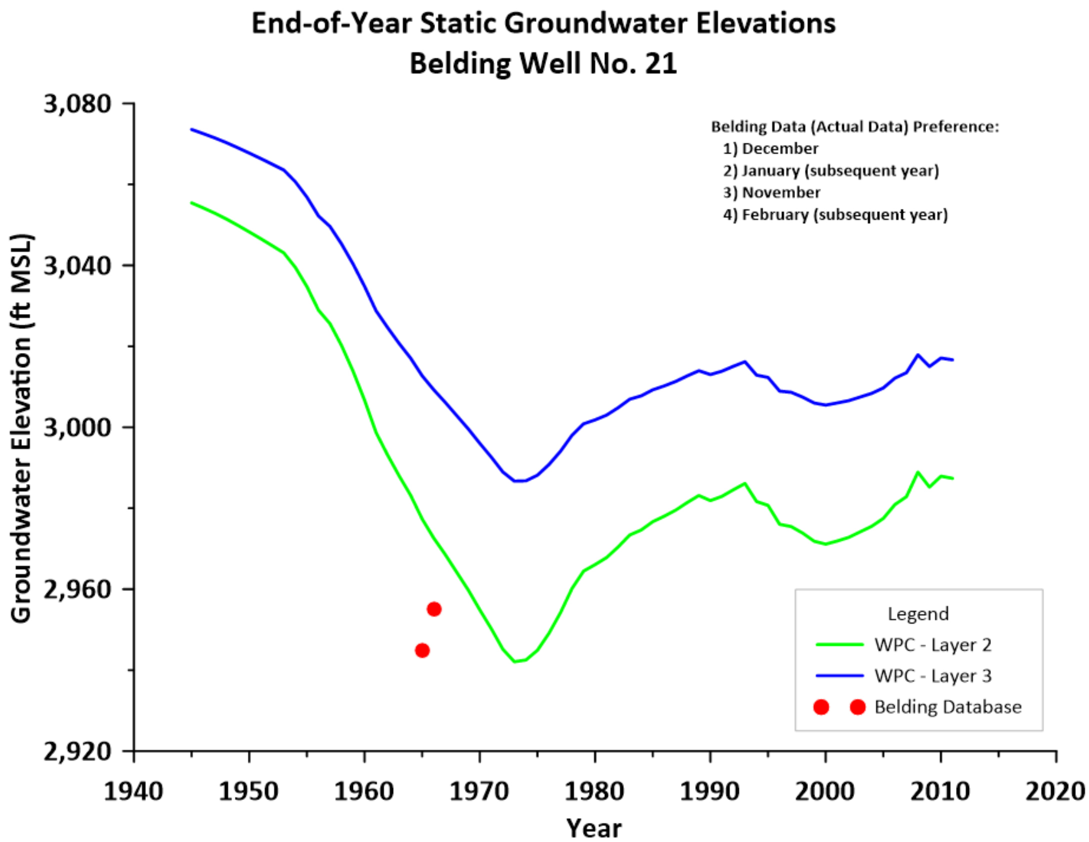

End-of-Year Static Groundwater Elevations
Belding Well No. 14
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Groundwater Elevation (ft MSL)
3,100
3,050
3,000
2,950
2,900
2,850
2,800
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year

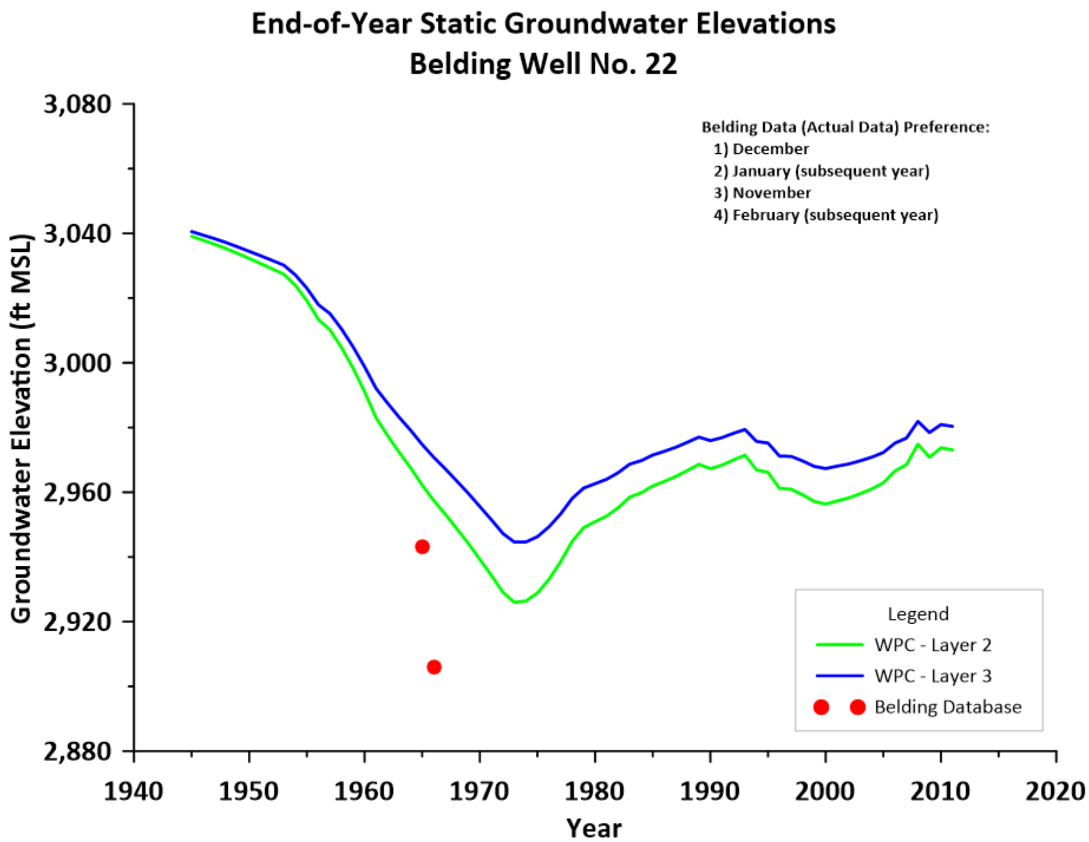

End-of-Year Static Groundwater Elevations
Belding Well No. 17 (no actual data)
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Groundwater Elevation (ft MSL)
Year
3,040
3,000
2,960
2,920
1940
1950
1960
1970
1980
1990
2000
2010
2020

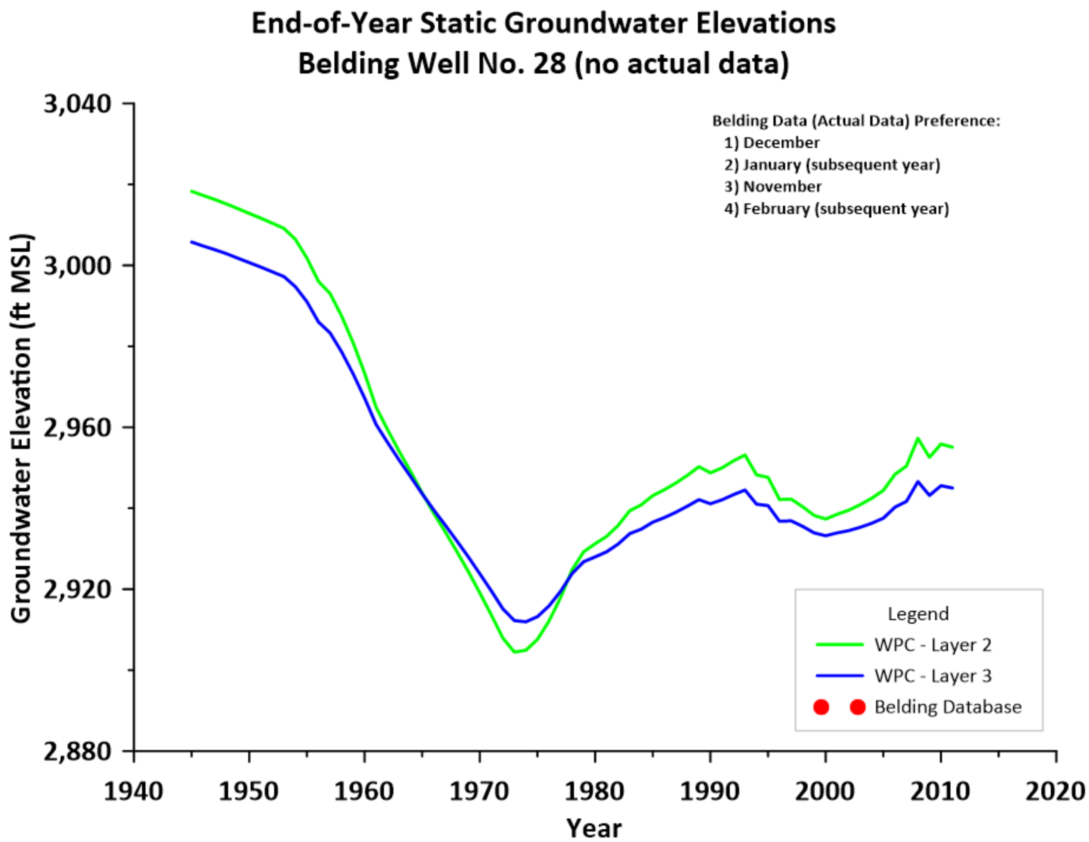

End-of-Year Static Groundwater Elevations
Belding Well No. 18
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Groundwater Elevation (ft MSL)
Year
3,040
3,000
2,960
2,920
2,880
1940
1950
1960
1970
1980
1990
2000
2010
2020

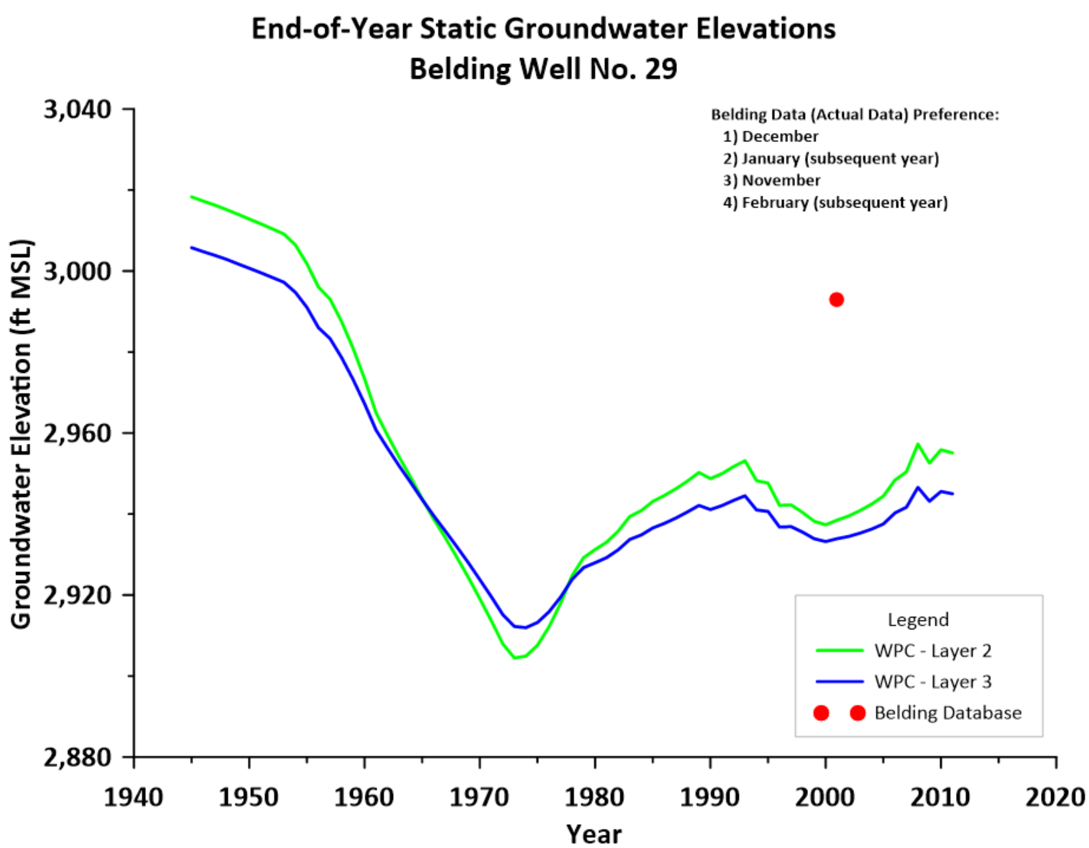

End-of-Year Static Groundwater Elevations
Belding Well No. 19
Groundwater Elevation (ft MSL)
Year
3,040
3,000
2,960
2,920
2,880
1940
1950
1960
1970
1980
1990
2000
2010
2020
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

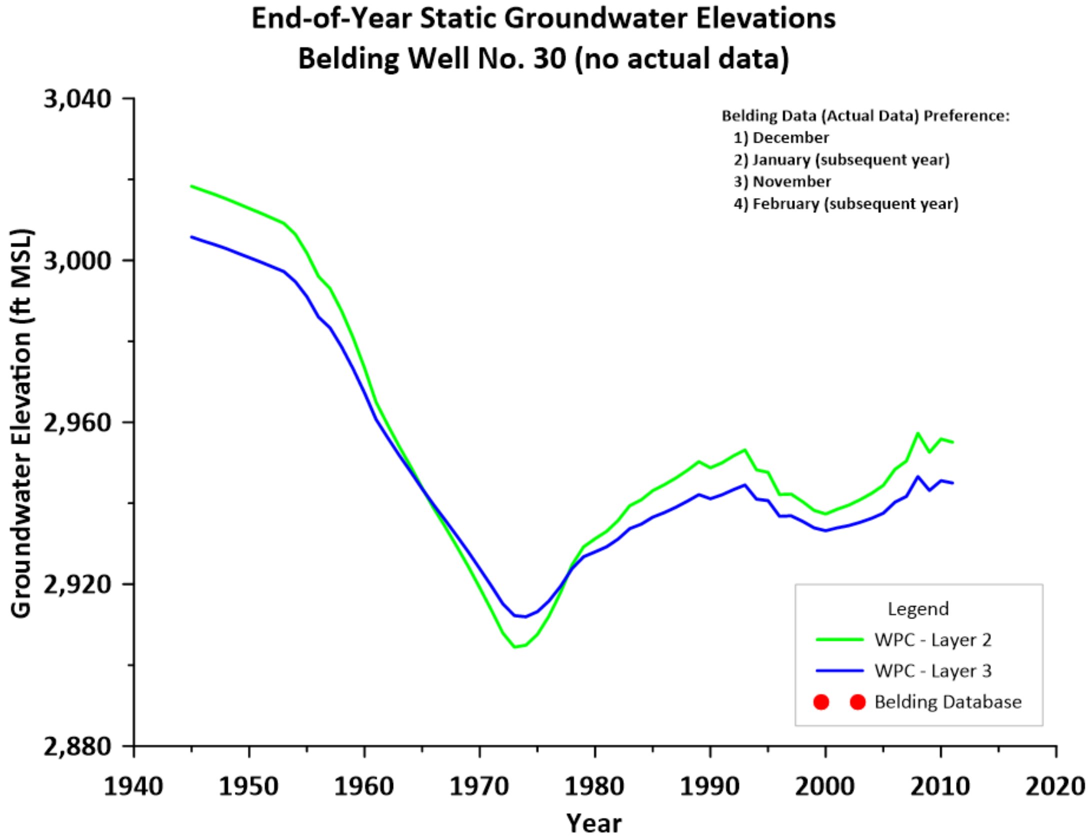

End-of-Year Static Groundwater Elevations
Belding Well No. 20
Groundwater Elevation (ft MSL)
Year
3,100
3,050
3,000
2,950
2,900
2,850
1940
1950
1960
1970
1980
1990
2000
2010
2020
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database


End-of-Year Static Groundwater Elevations
Belding Well No. 21
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Groundwater Elevation (ft MSL)
3,080
3,040
3,000
2,960
2,920
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year


End-of-Year Static Groundwater Elevations
Belding Well No. 22
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Groundwater Elevation (ft MSL)
3,080
3,040
3,000
2,960
2,920
2,880
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year


End-of-Year Static Groundwater Elevations
Belding Well No. 28 (no actual data)
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Groundwater Elevation (ft MSL)
3,040
3,000
2,960
2,920
2,880
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database

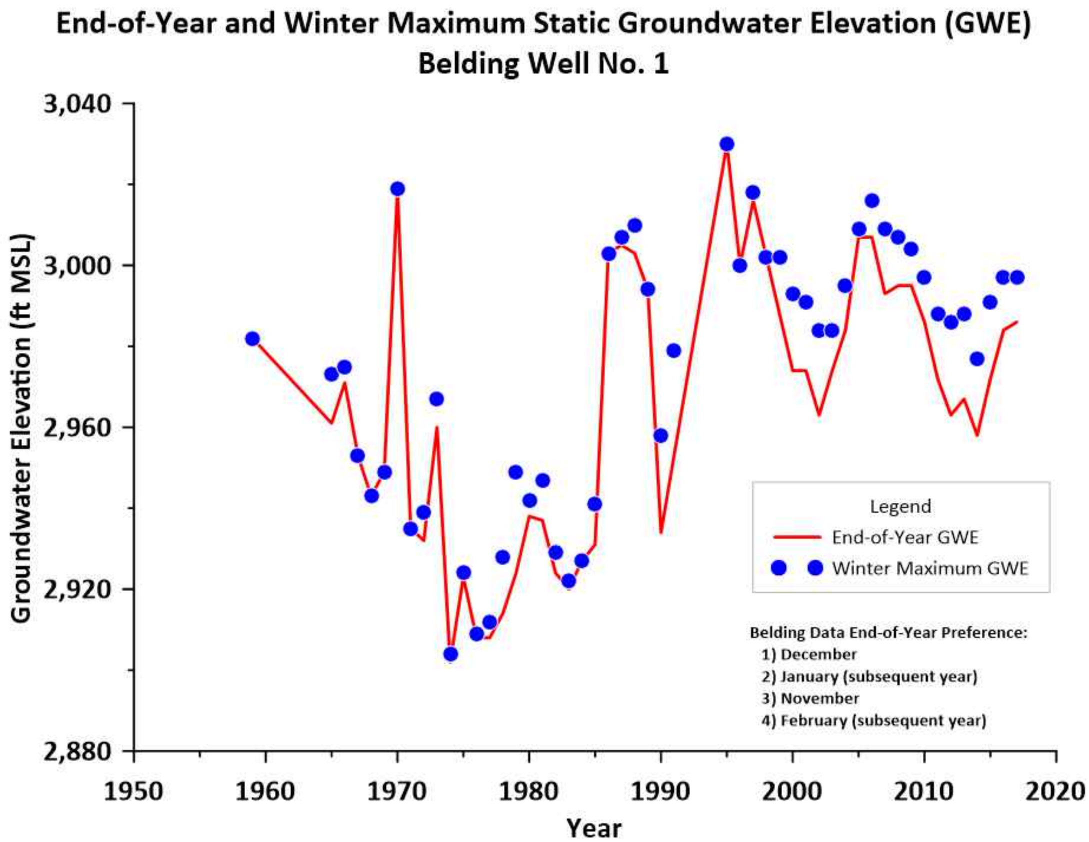

End-of-Year Static Groundwater Elevations
Belding Well No. 29
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Groundwater Elevation (ft MSL)
3,040
3,000
2,960
2,920
2,880
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database

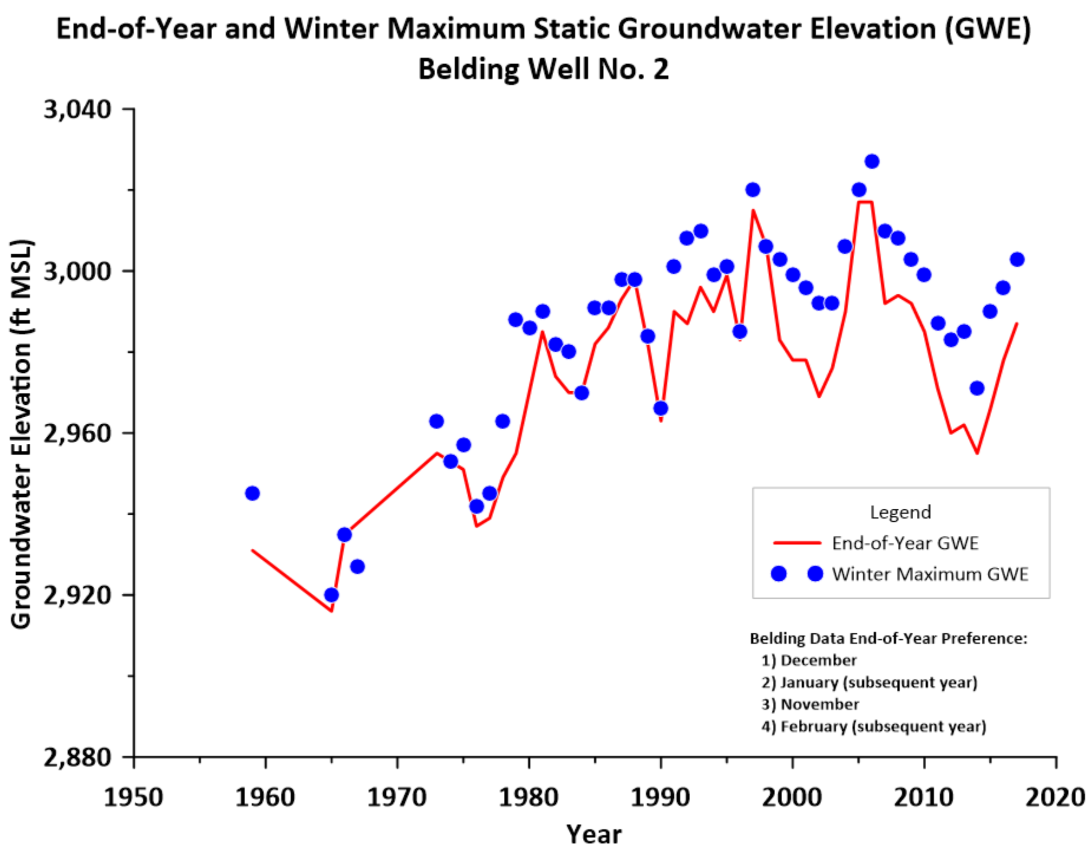


End-of-Year Static Groundwater Elevations
Belding Well No. 30 (no actual data)
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Groundwater Elevation (ft MSL)
3,040
3,000
2,960
2,920
2,880
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database

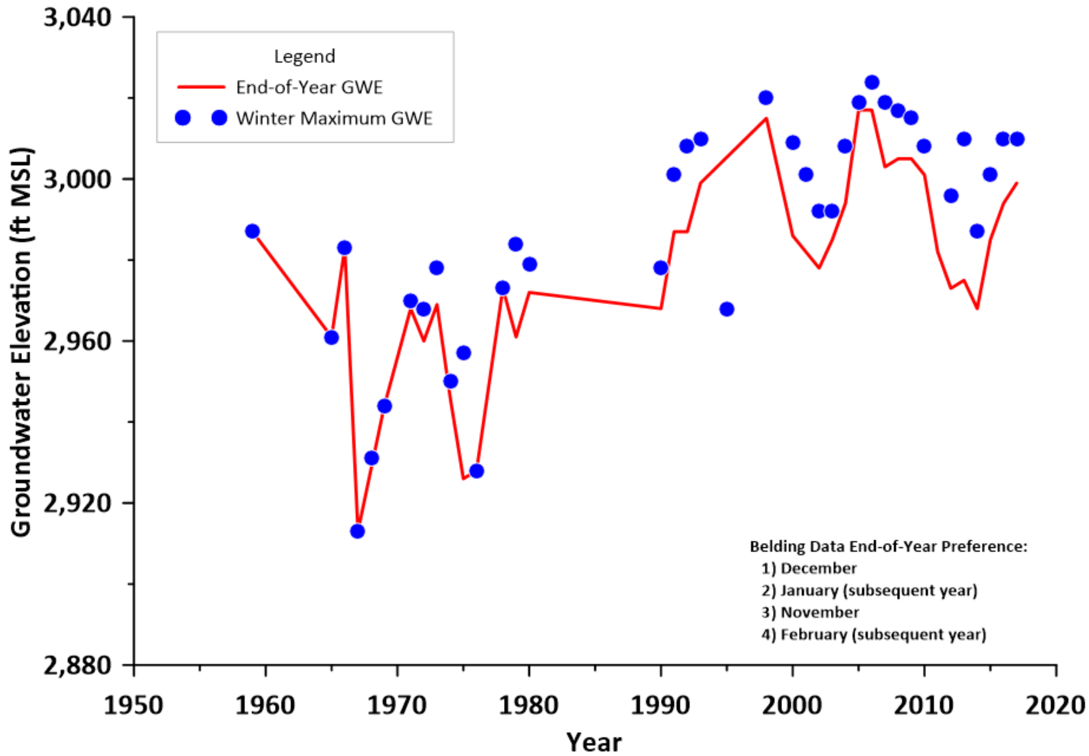
Appendix C

End-of-Year Static Groundwater Elevations and Winter Maximum Static Groundwater Elevations Hydrographs

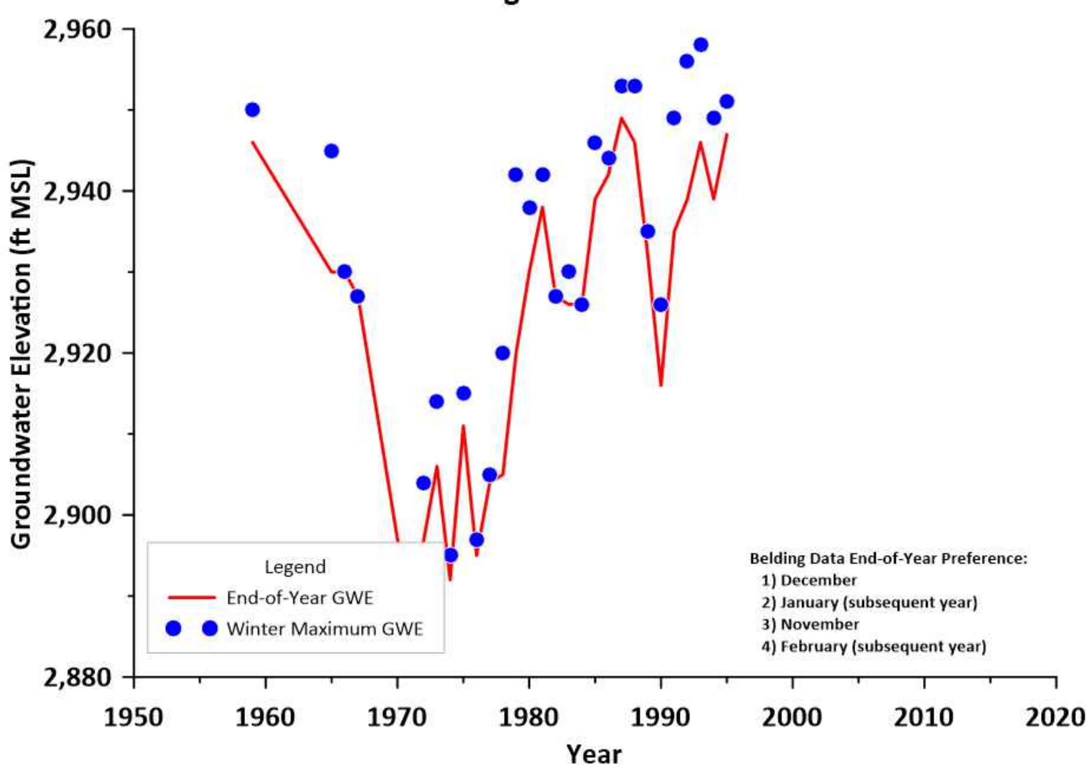

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 1
3,040
3,000
2,960
2,920
2,880
Groundwater Elevation (ft MSL)
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

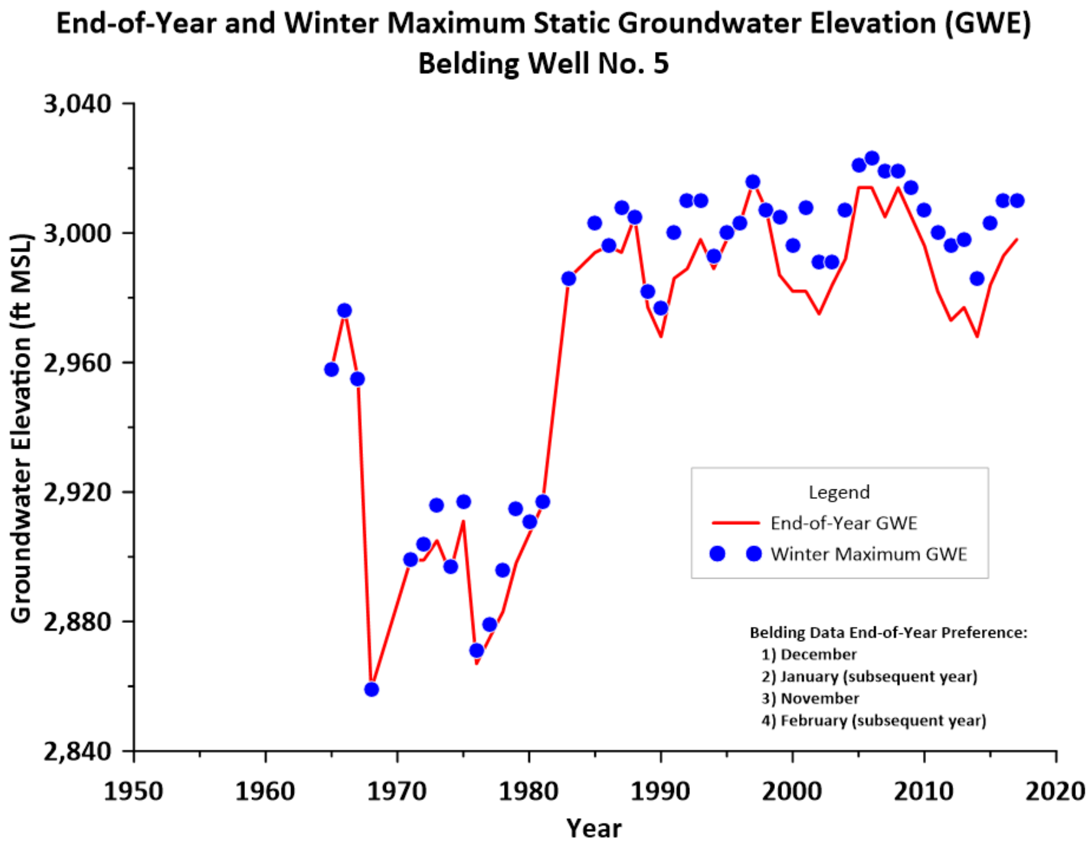

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 2
3,040
3,000
2,960
2,920
2,880
Groundwater Elevation (ft MSL)
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

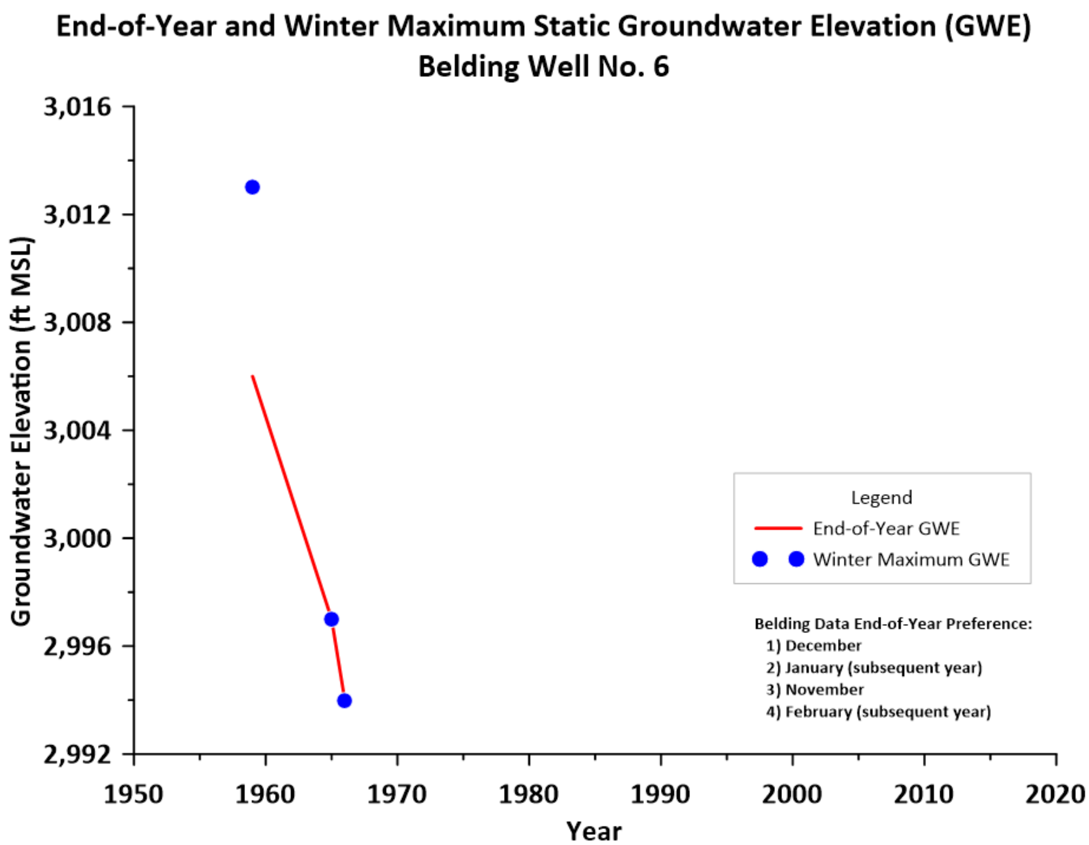
End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 3

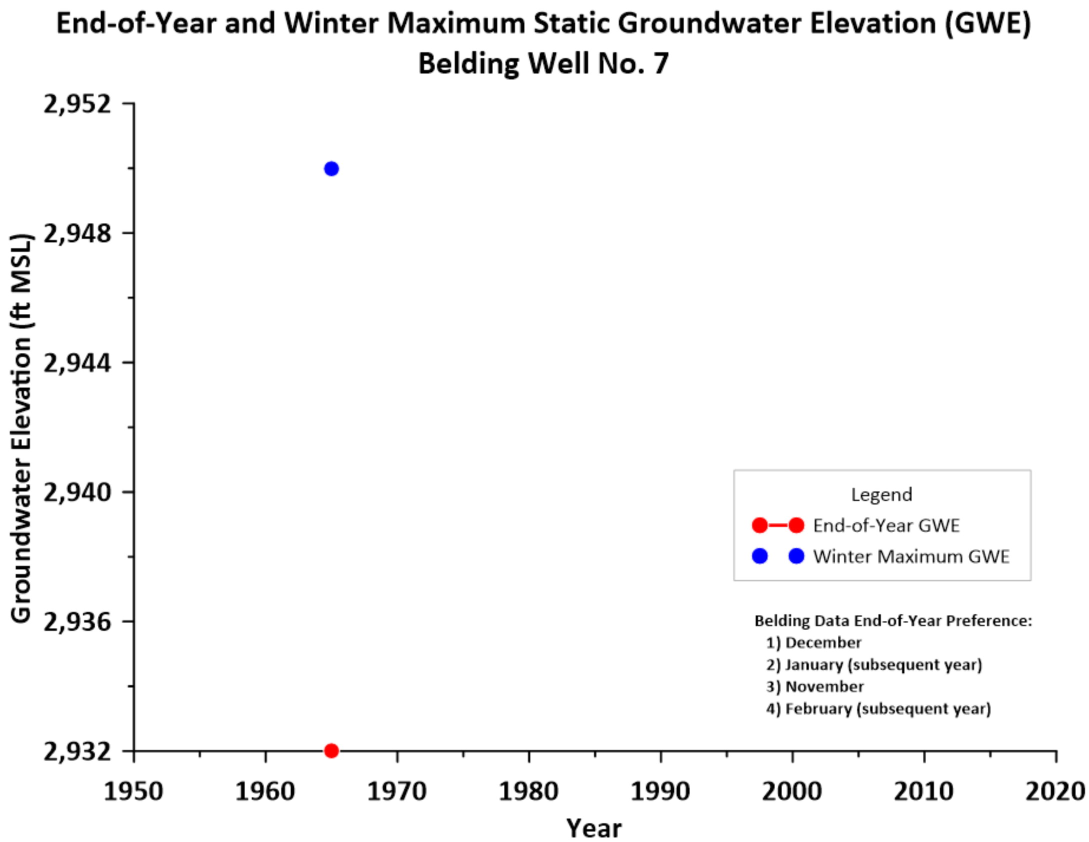


End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 4

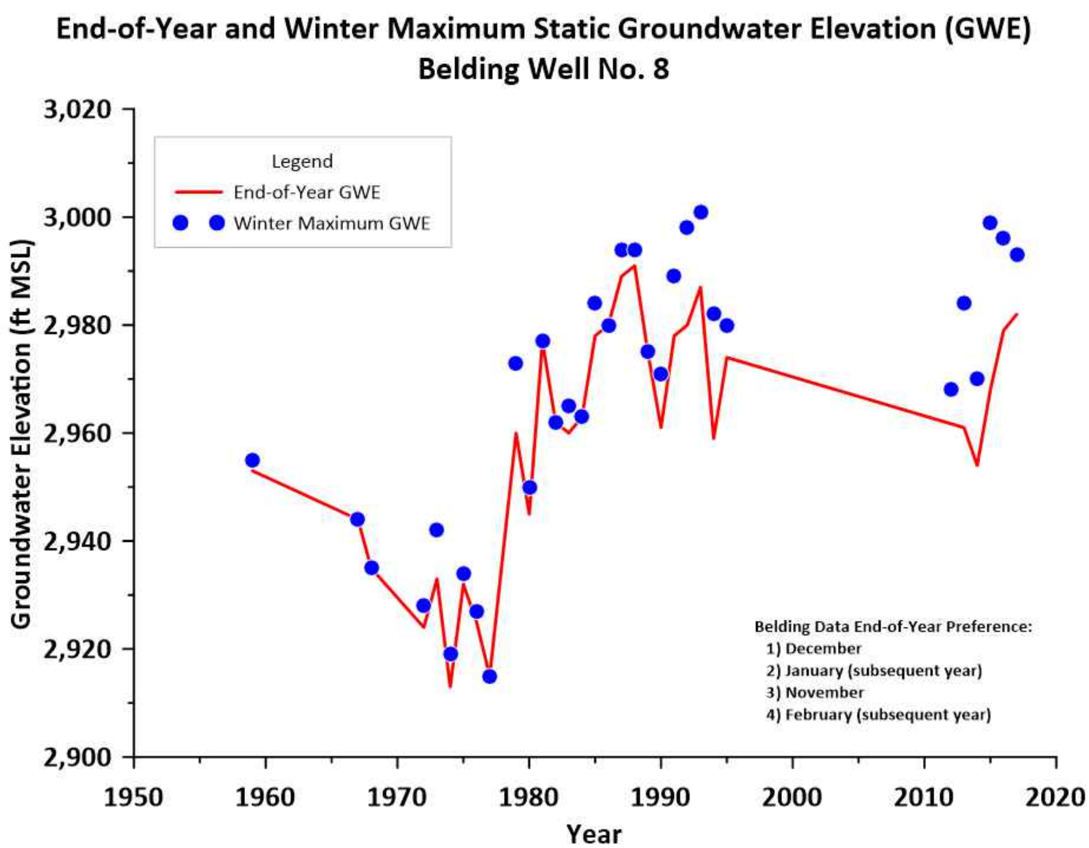



End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 5
3,040
3,000
2,960
2,920
2,880
2,840
Groundwater Elevation (ft MSL)
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

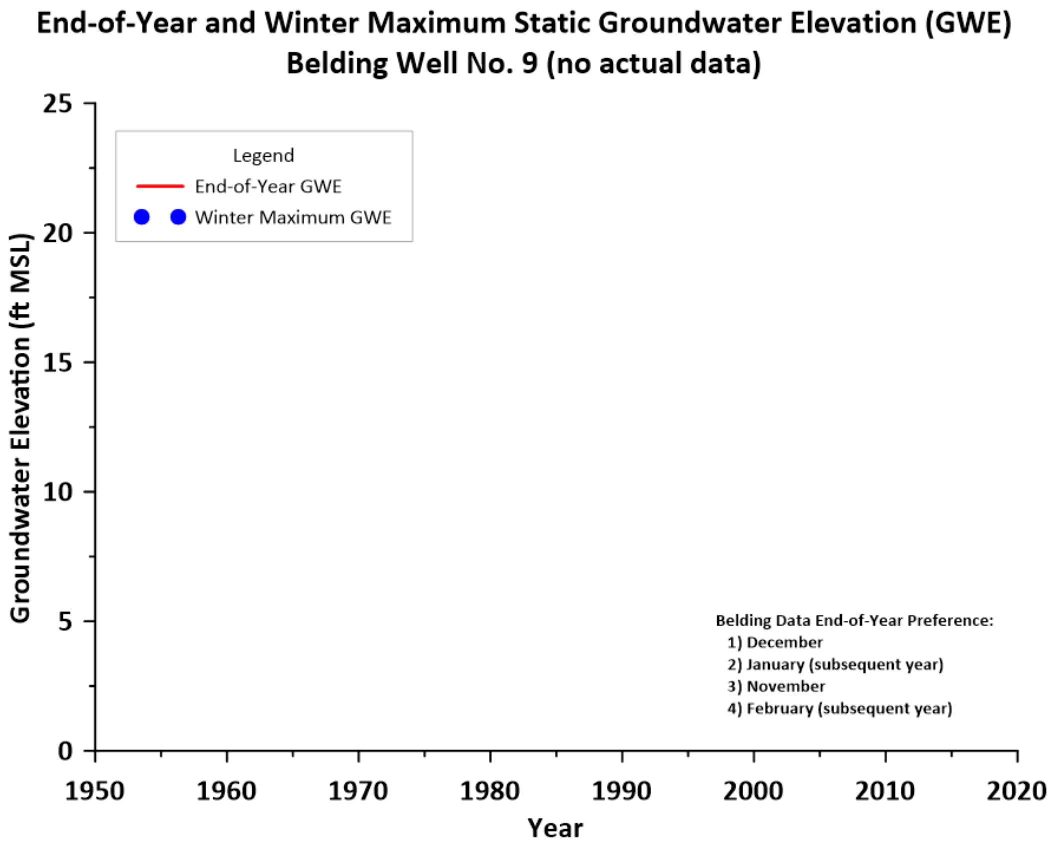

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 6
3,016
3,012
3,008
3,004
3,000
2,996
2,992
Groundwater Elevation (ft MSL)
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

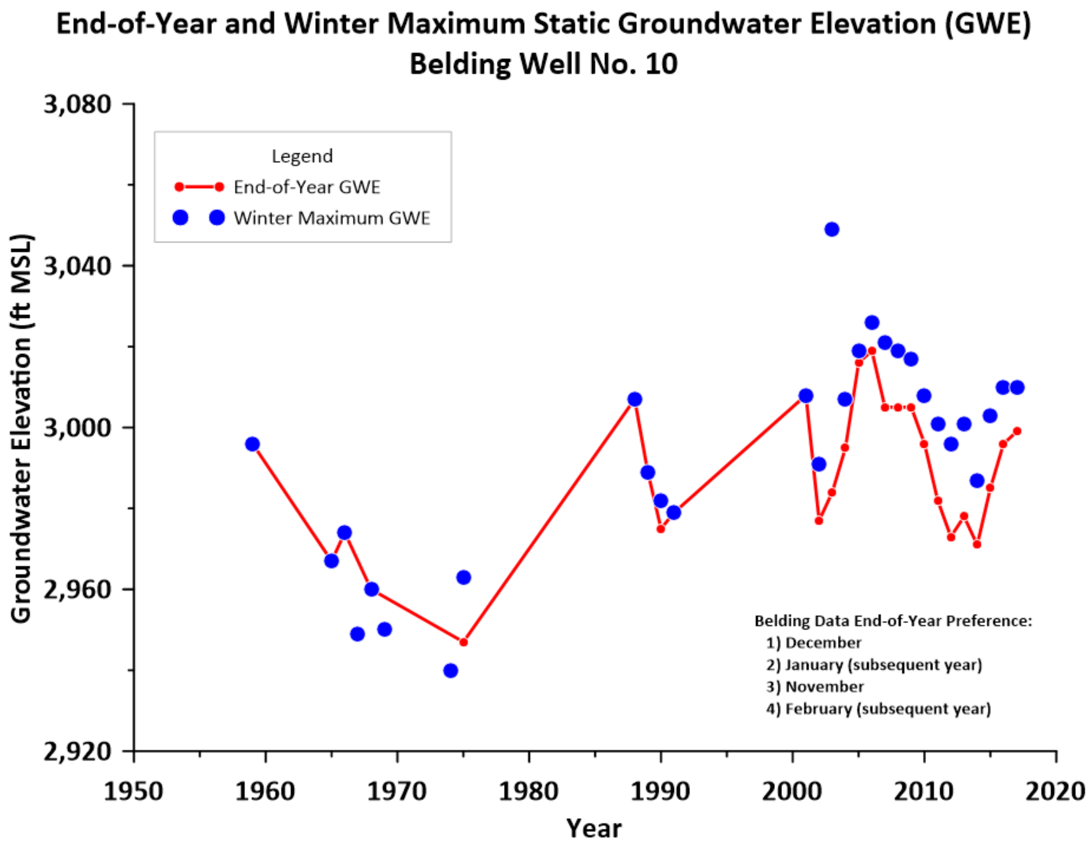


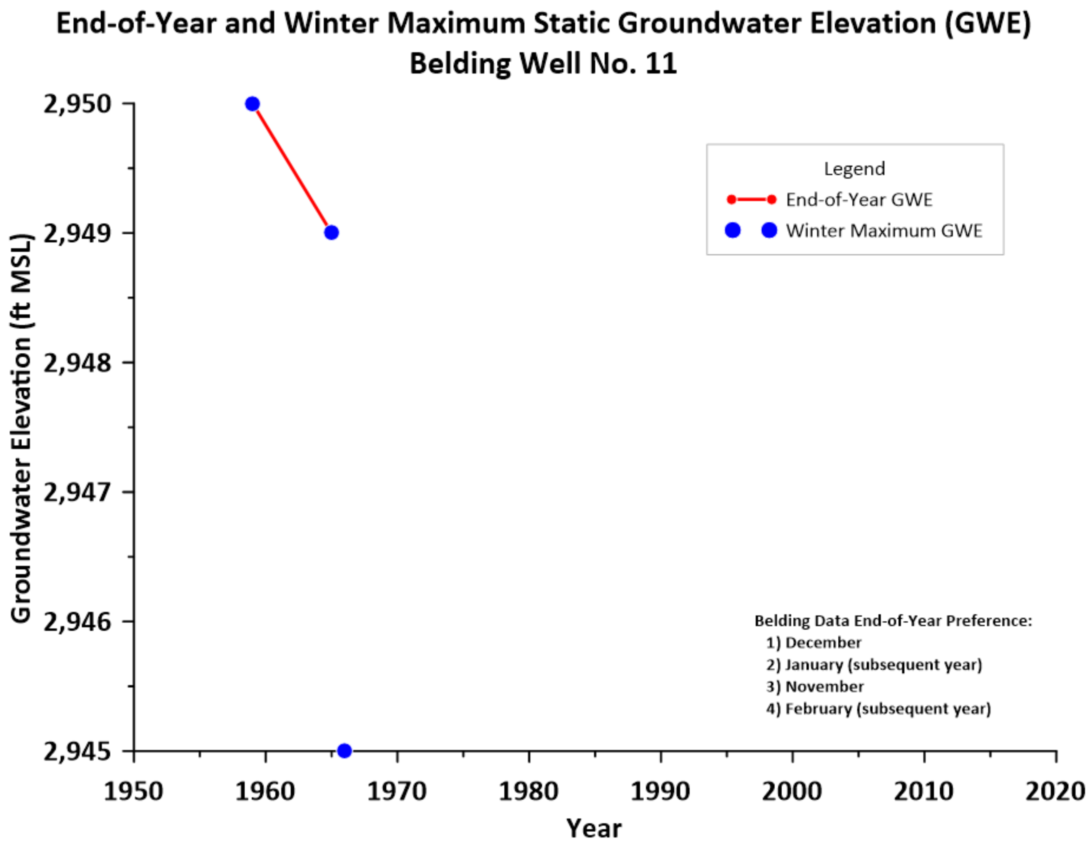
End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 7
Groundwater Elevation (ft MSL)
2,952
2,948
2,944
2,940
2,936
2,932
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

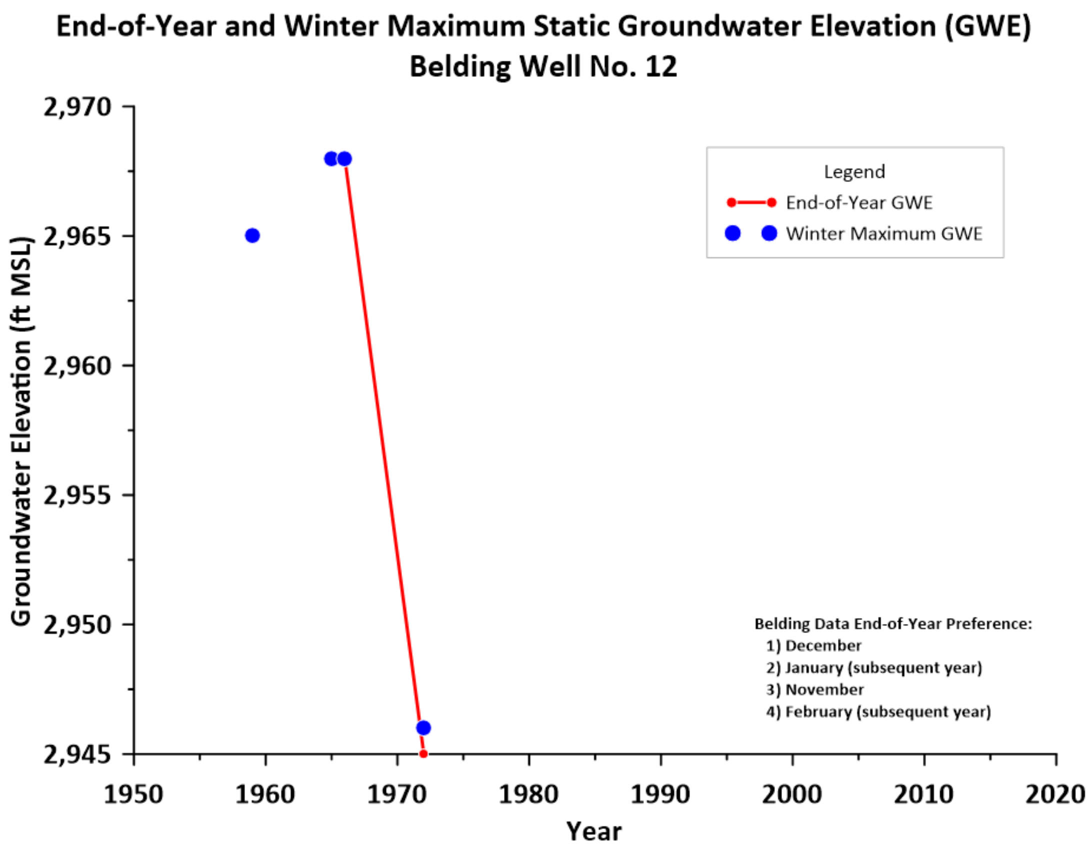


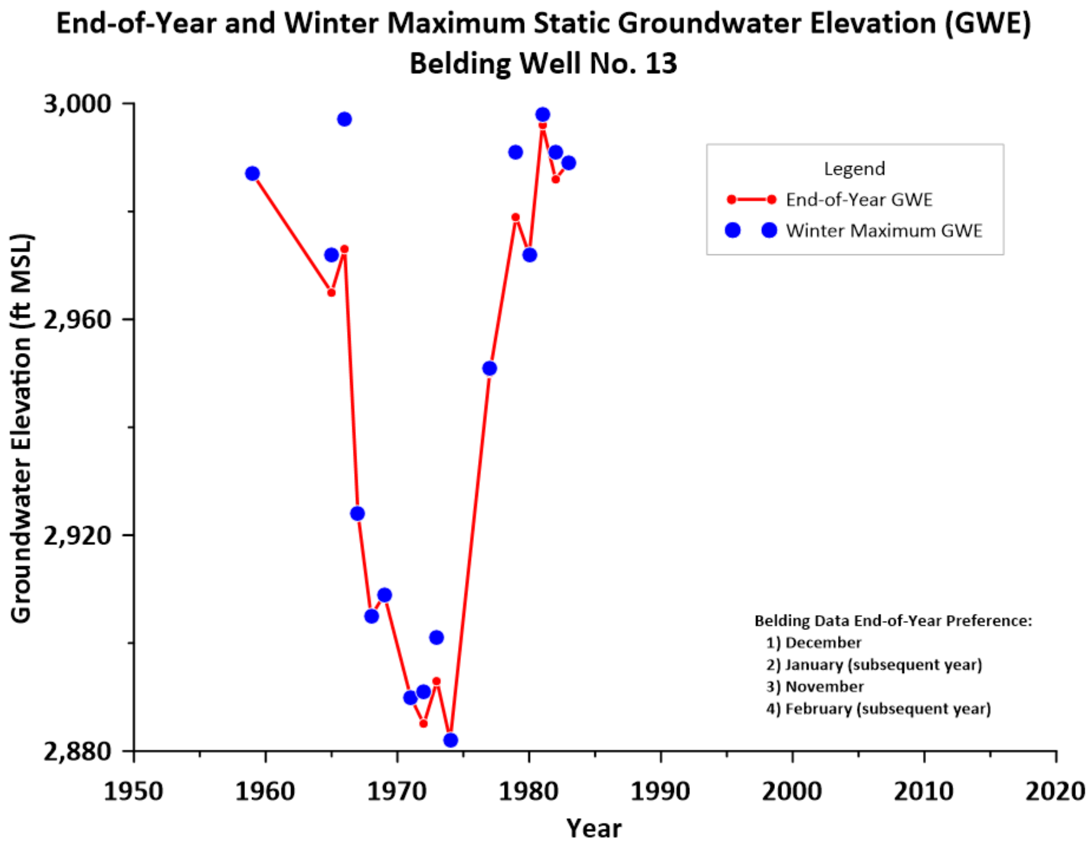
End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 8
Groundwater Elevation (ft MSL)
3,020
3,000
2,980
2,960
2,940
2,920
2,900
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

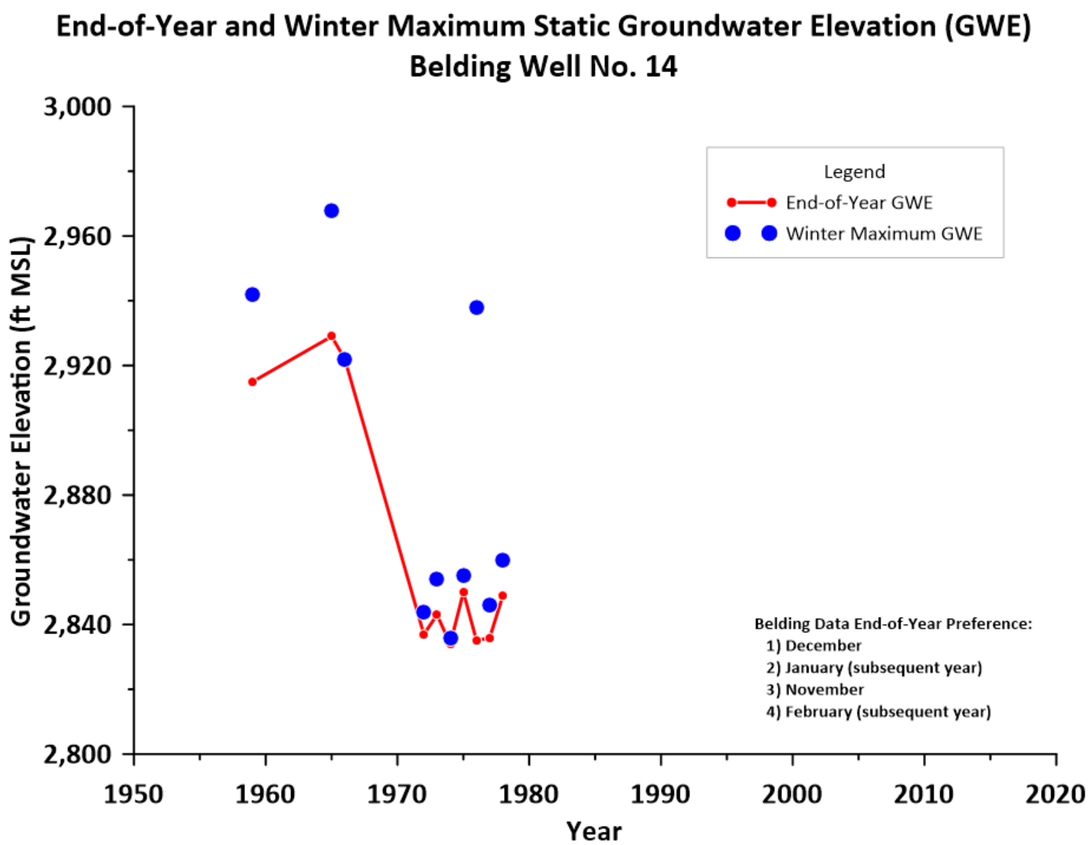

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 9 (no actual data)
Legend
End-of-Year GWE
Winter Maximum GWE
Groundwater Elevation (ft MSL)
Year
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

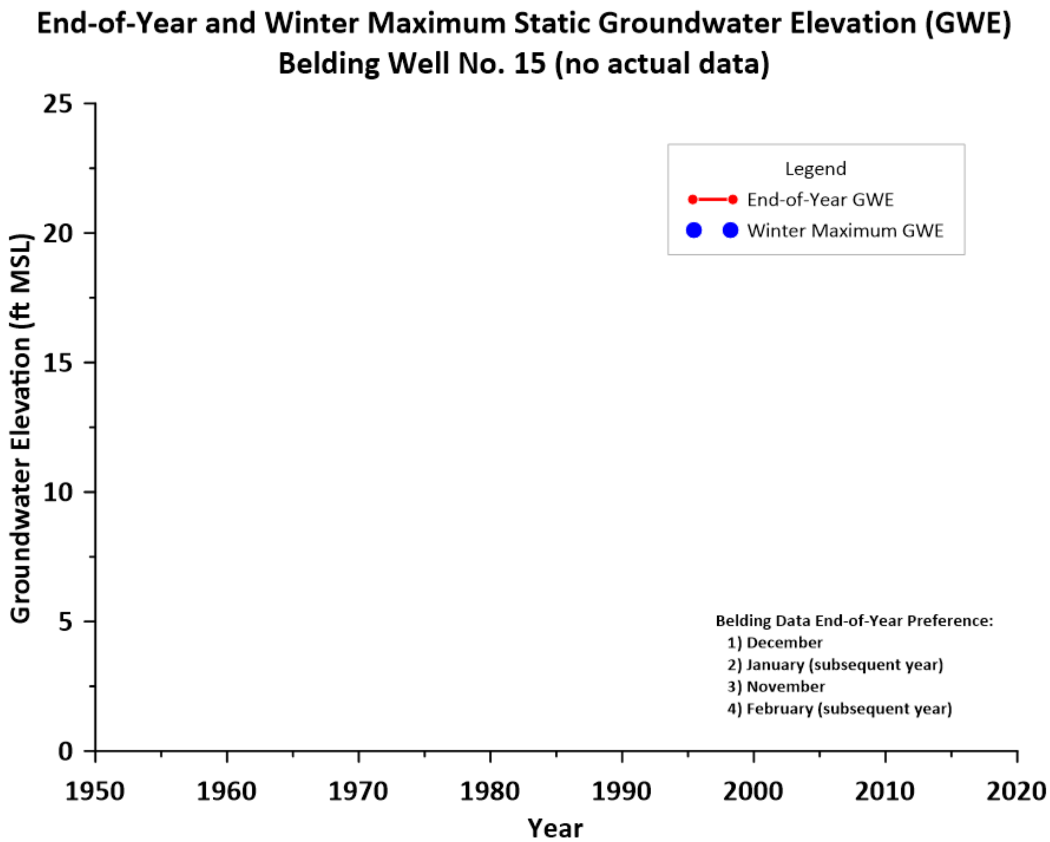

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 10
Legend
End-of-Year GWE
Winter Maximum GWE
Groundwater Elevation (ft MSL)
Year
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

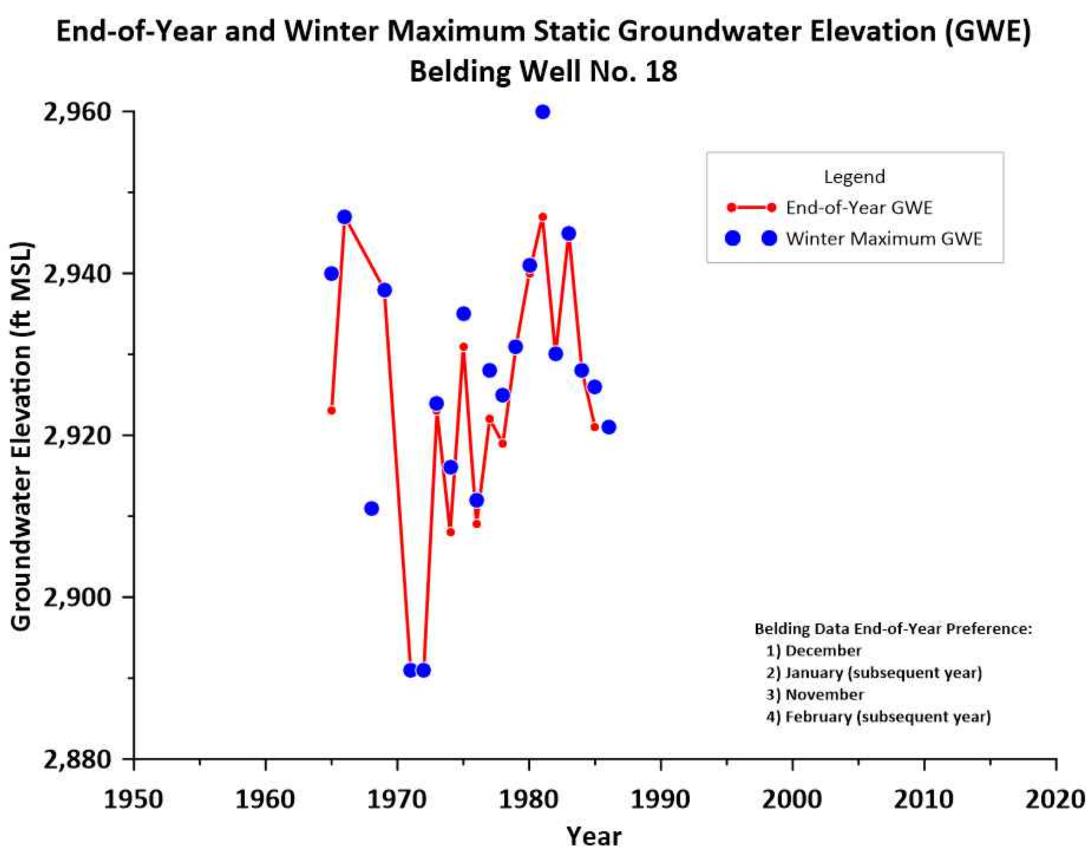

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 11
Groundwater Elevation (ft MSL)
2,950
2,949
2,948
2,947
2,946
2,945
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

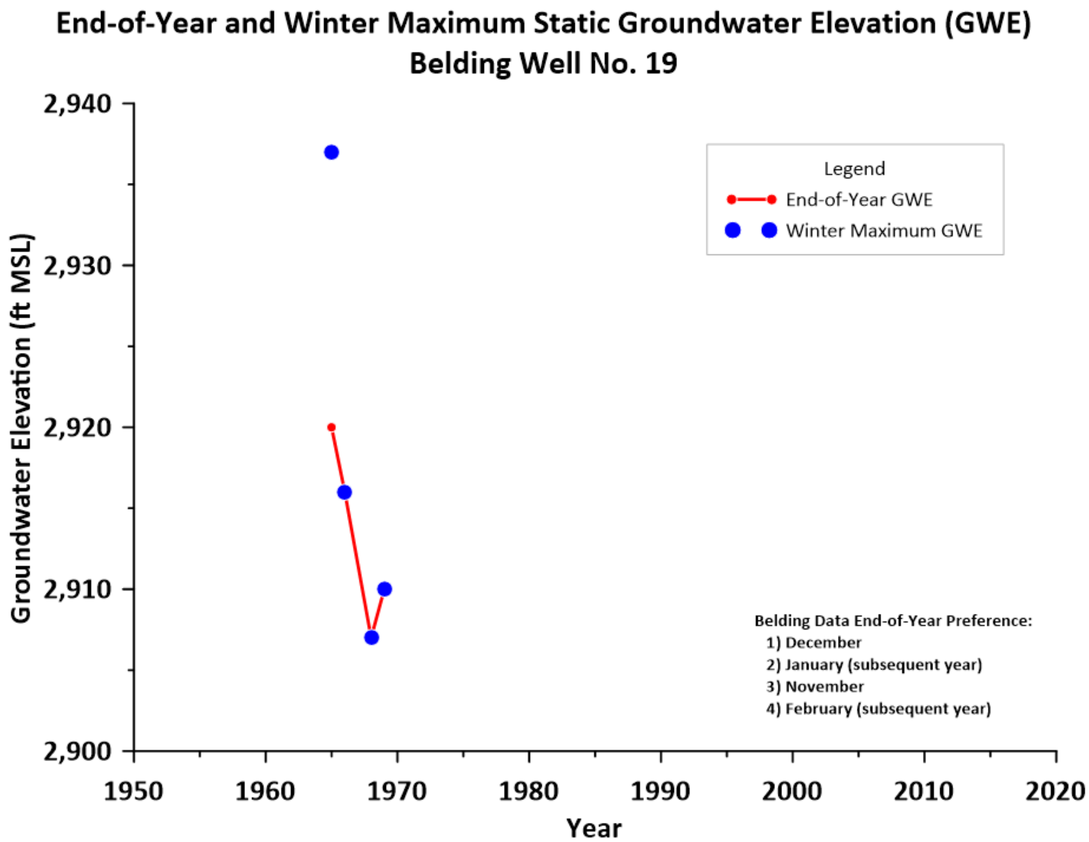

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 12
Groundwater Elevation (ft MSL)
2,970
2,965
2,960
2,955
2,950
2,945
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

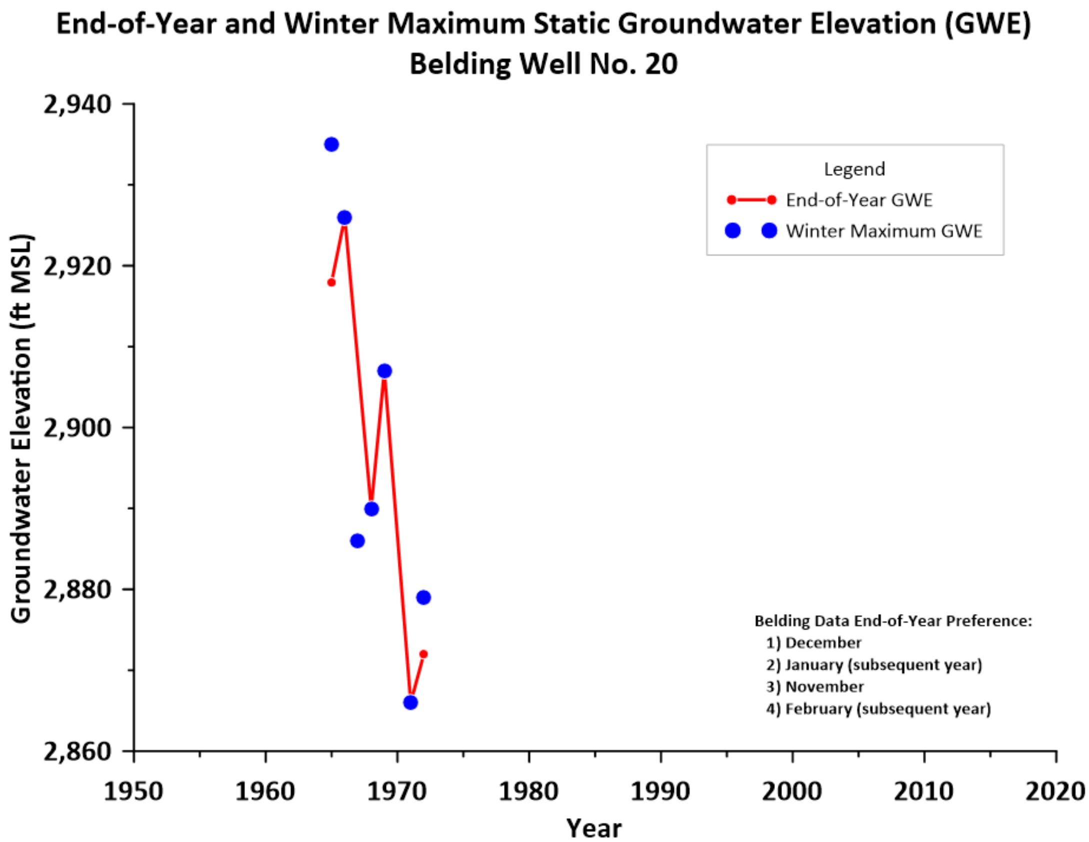

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 13
Groundwater Elevation (ft MSL)
3,000
2,960
2,920
2,880
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

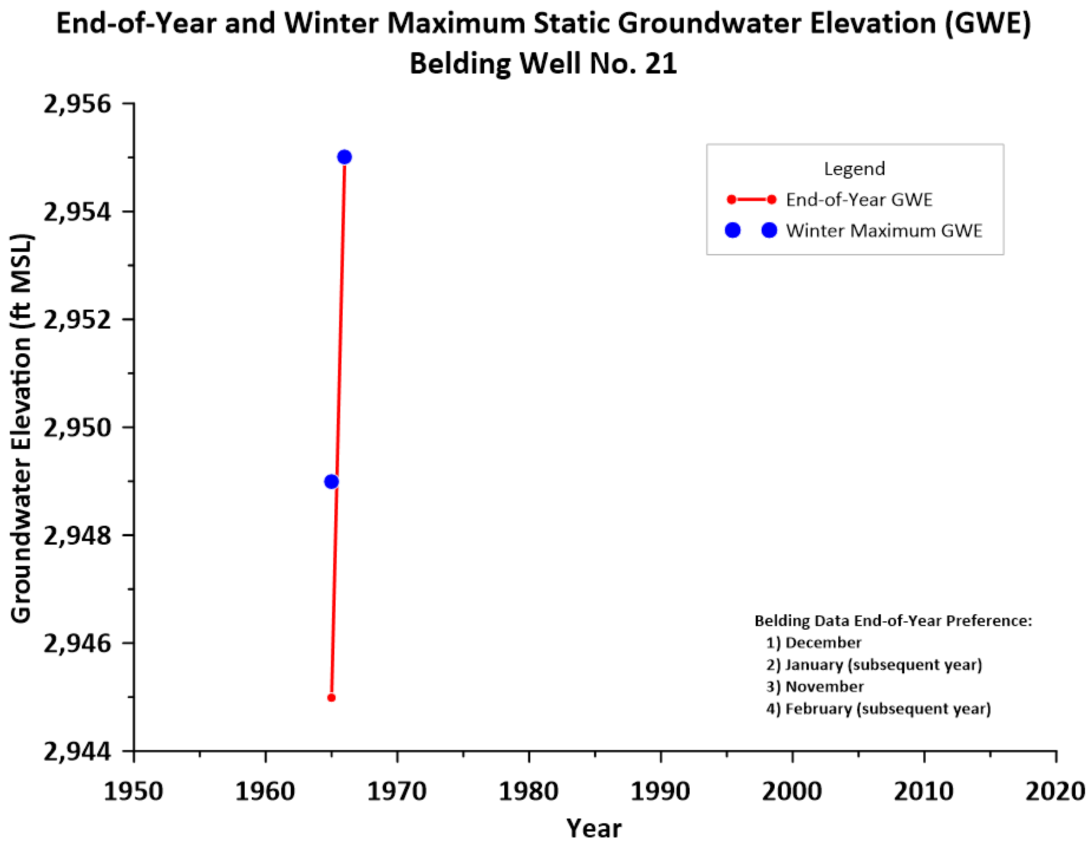

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 14
Groundwater Elevation (ft MSL)
3,000
2,960
2,920
2,880
2,840
2,800
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

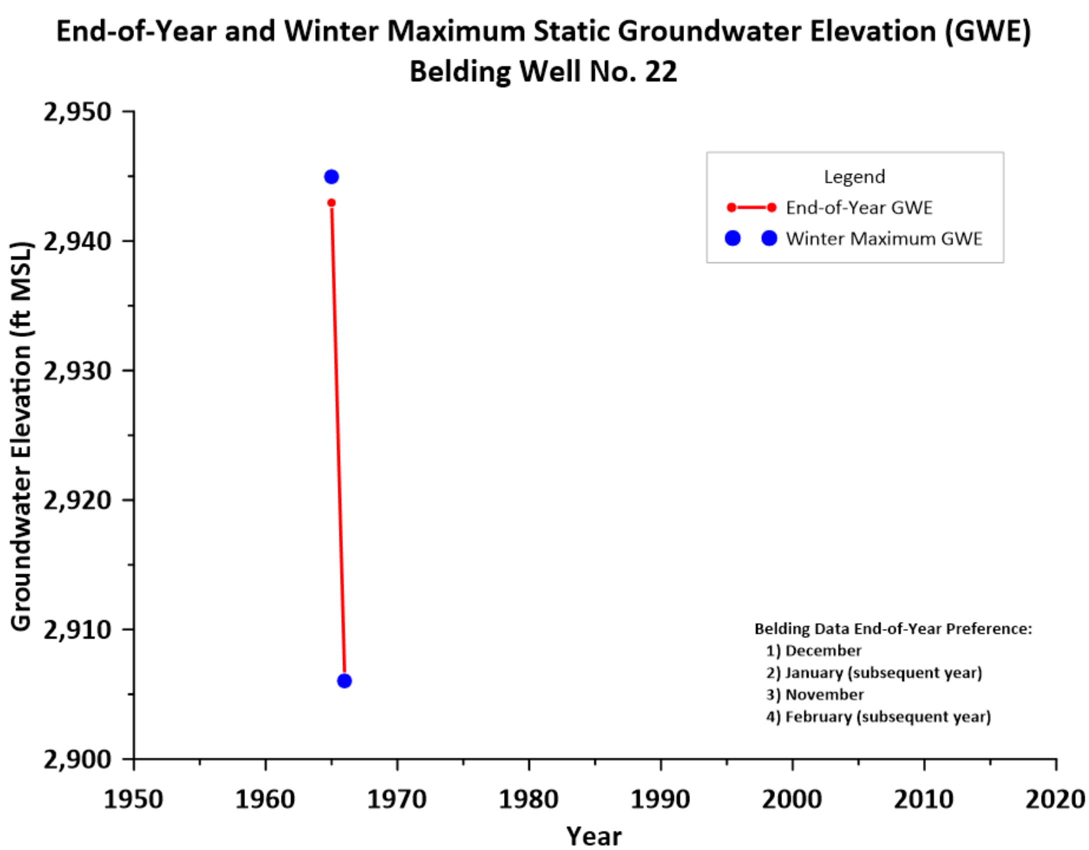

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 15 (no actual data)
Groundwater Elevation (ft MSL)
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
25
20
15
10
5
0
1950
1960
1970
1980
1990
2000
2010
2020

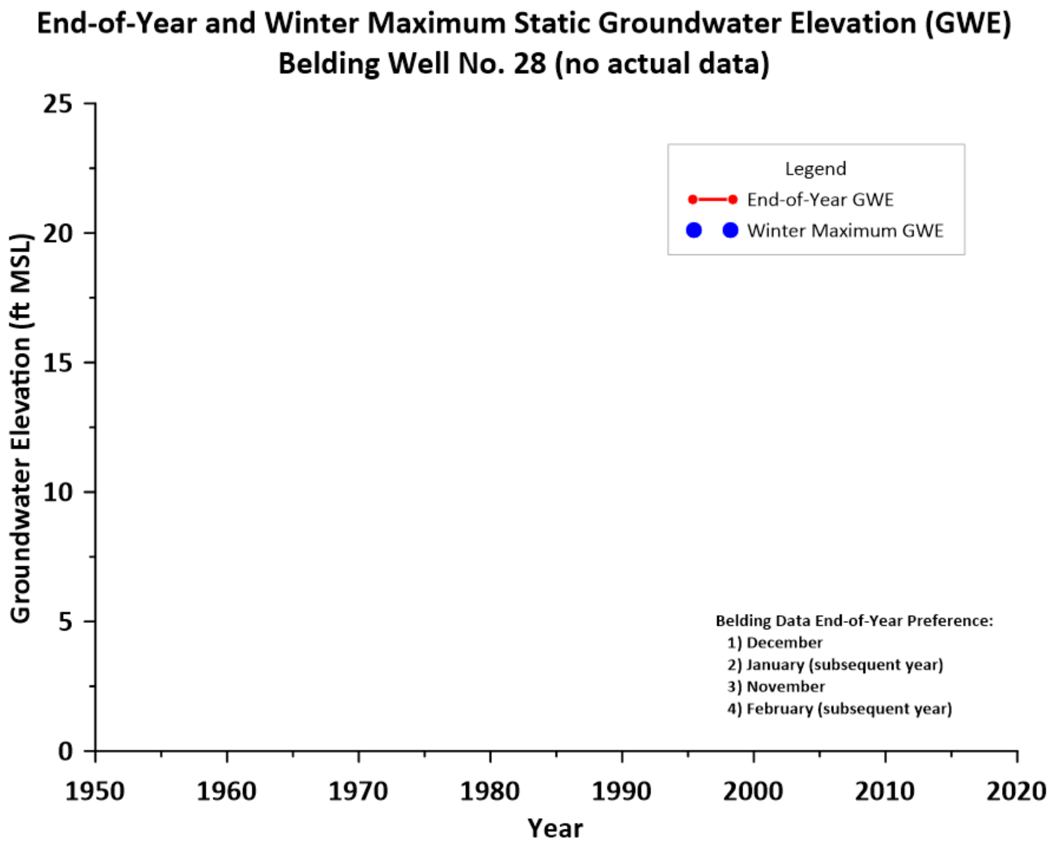

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 18
Groundwater Elevation (ft MSL)
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
2,960
2,940
2,920
2,900
2,880
1950
1960
1970
1980
1990
2000
2010
2020

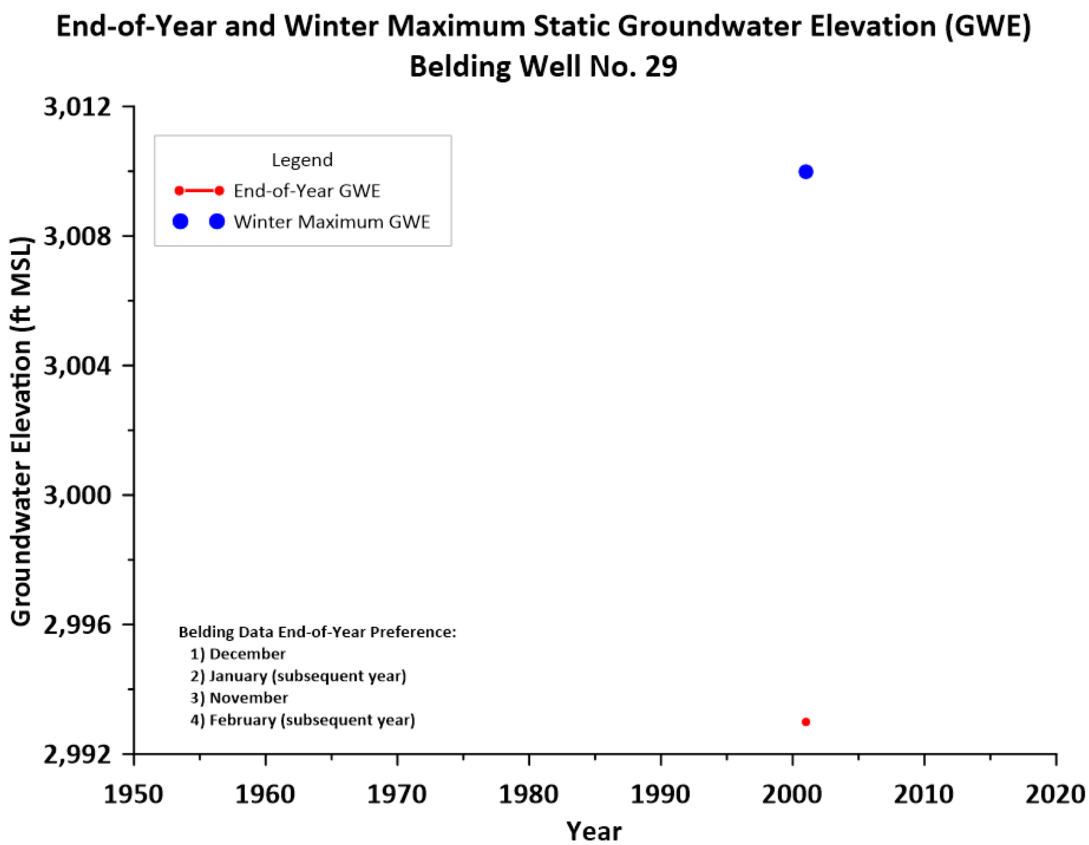

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 19
Groundwater Elevation (ft MSL)
2,940
2,930
2,920
2,910
2,900
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

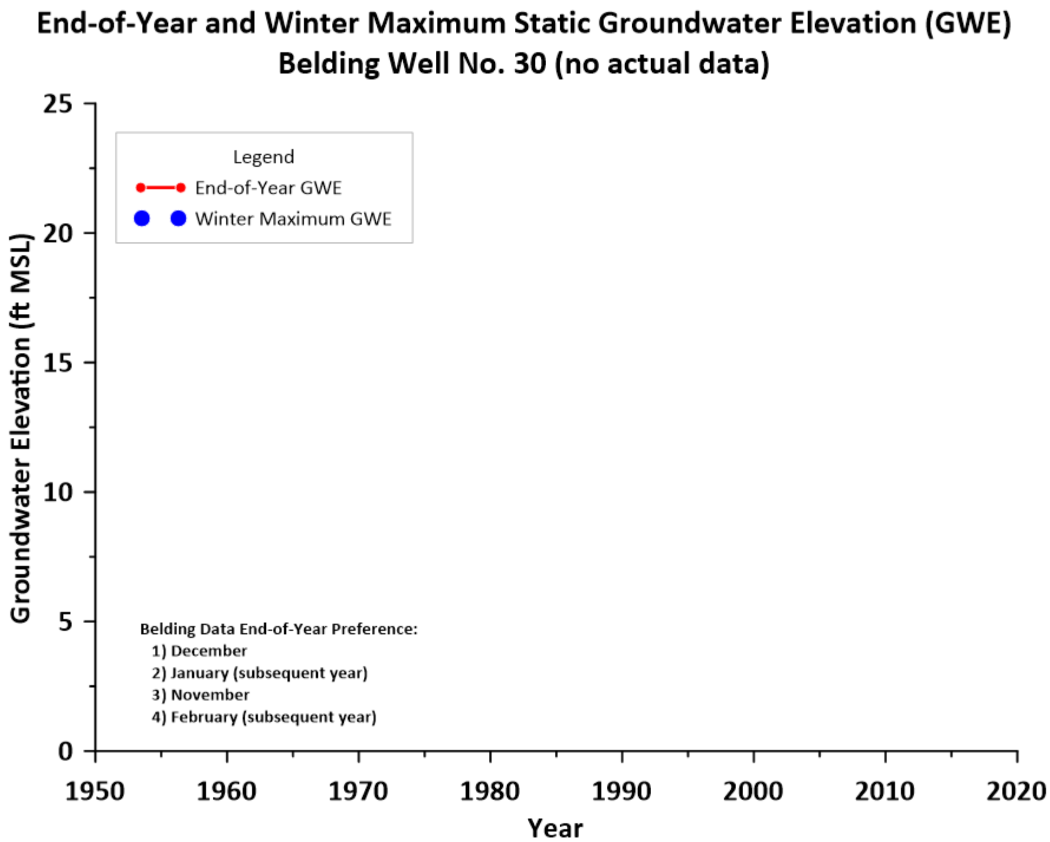

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 20
Groundwater Elevation (ft MSL)
2,940
2,920
2,900
2,880
2,860
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)


End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 21
Groundwater Elevation (ft MSL)
2,956
2,954
2,952
2,950
2,948
2,946
2,944
Year
1950
1960
1970
1980
1990
2000
2010
2020
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)


End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 22
Groundwater Elevation (ft MSL)
2,950
2,940
2,930
2,920
2,910
2,900
Year
1950
1960
1970
1980
1990
2000
2010
2020
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)


End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 28 (no actual data)
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Groundwater Elevation (ft MSL)
Year
25
20
15
10
5
0
1950
1960
1970
1980
1990
2000
2010
2020

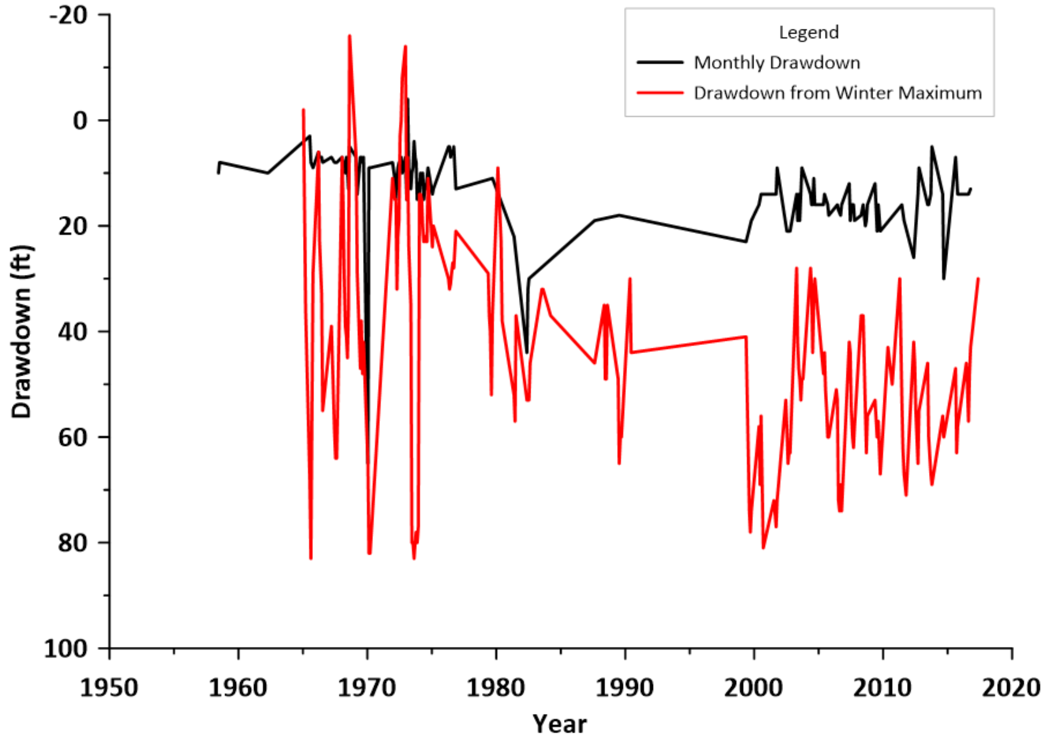

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 29
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Groundwater Elevation (ft MSL)
Year
3,012
3,008
3,004
3,000
2,996
2,992
1950
1960
1970
1980
1990
2000
2010
2020


End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 30 (no actual data)
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Groundwater Elevation (ft MSL)
Year
0
5
10
15
20
25
1950
1960
1970
1980
1990
2000
2010
2020

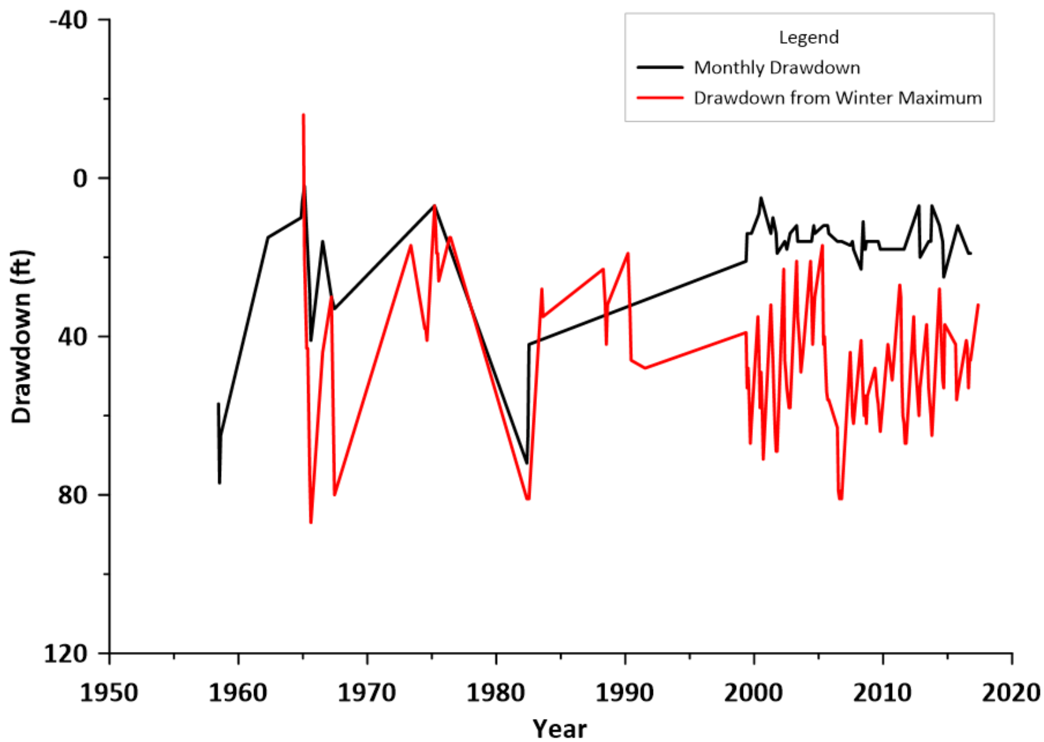
Appendix D

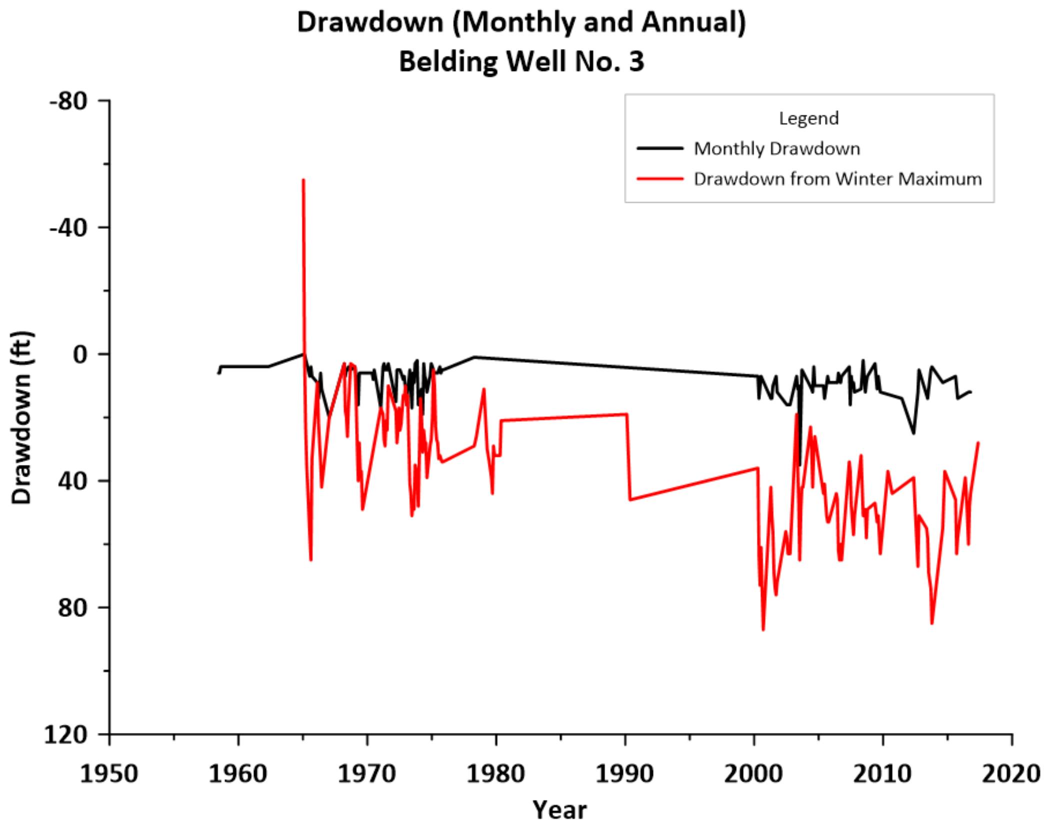
Drawdown Hydrographs

Drawdown (Monthly and Annual)
Belding Well No. 1

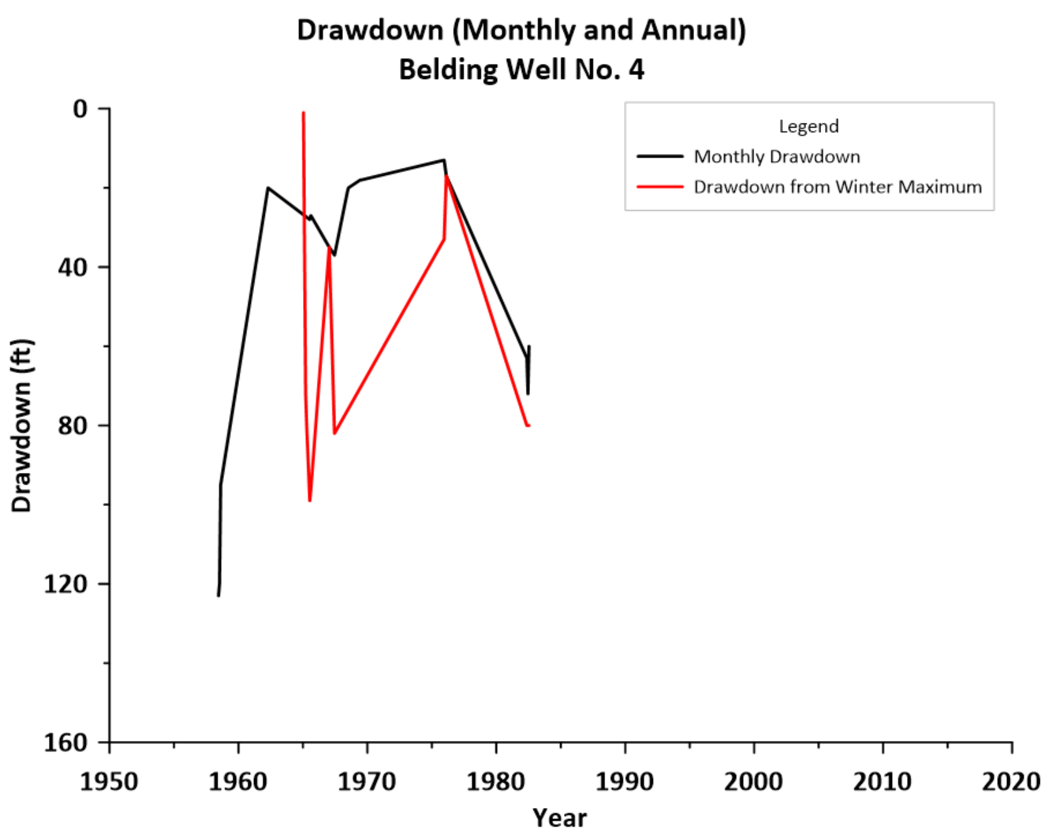


Drawdown (Monthly and Annual)
Belding Well No. 2

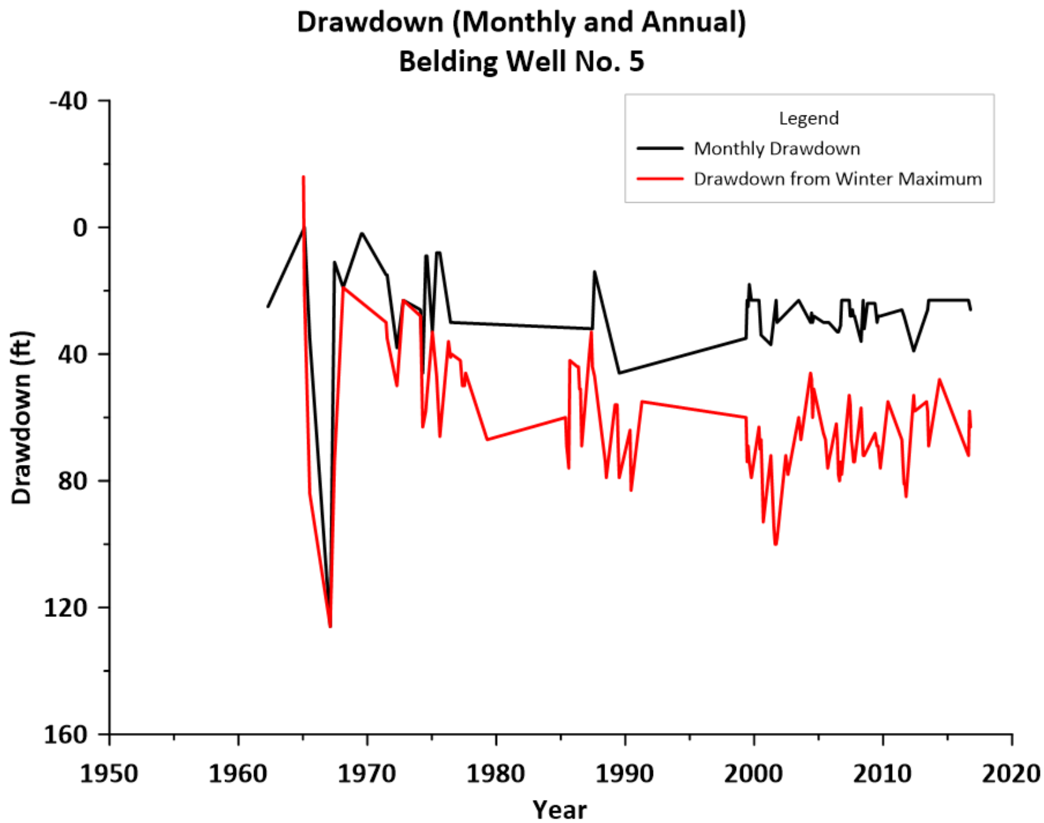


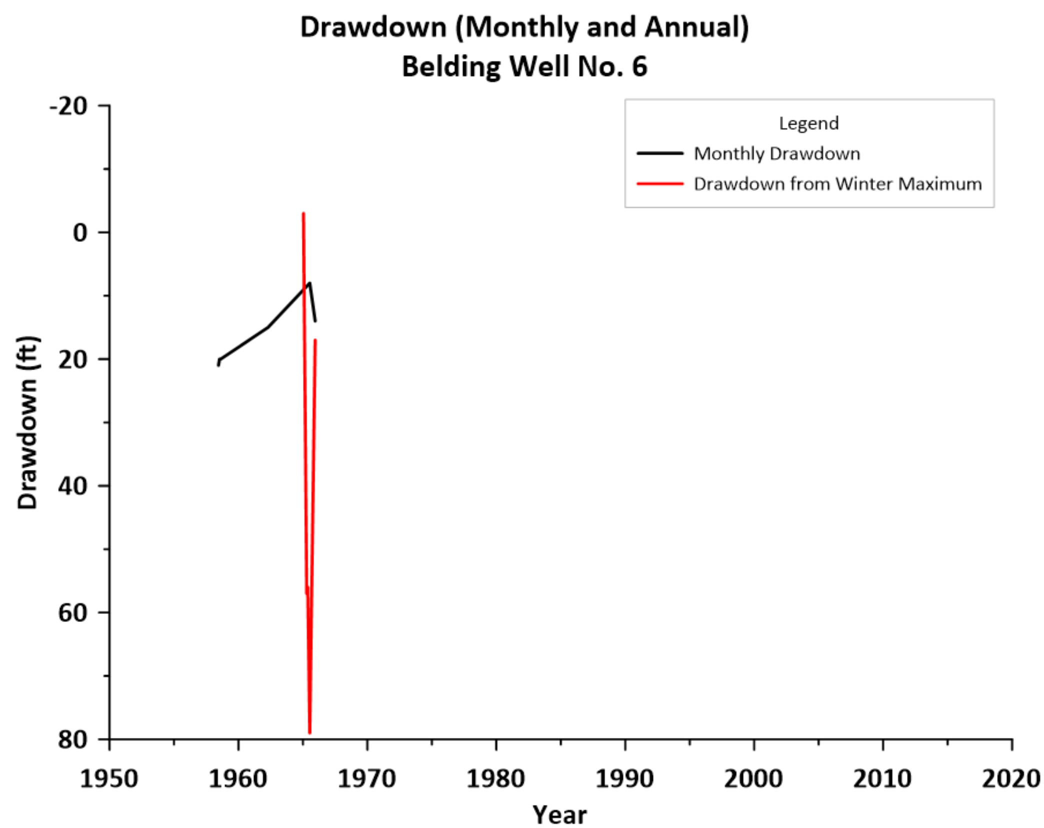


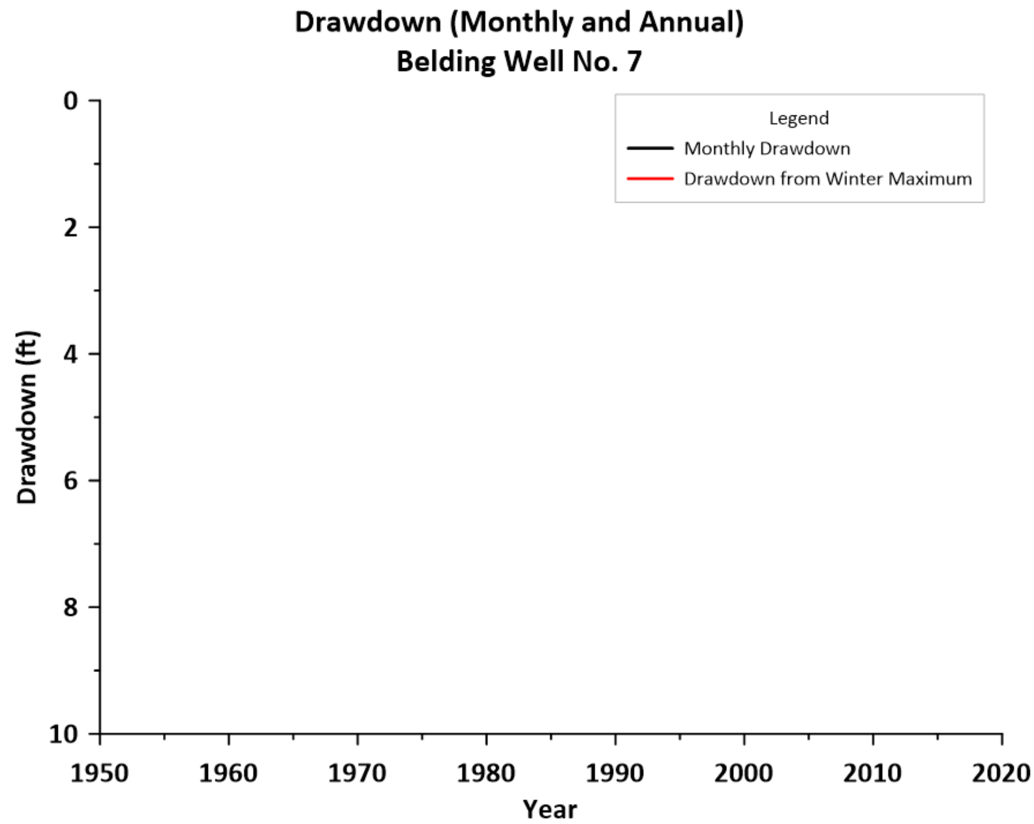
Drawdown (Monthly and Annual)
Belding Well No. 3
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
-80
-40
0
40
80
120
1950
1960
1970
1980
1990
2000
2010
2020
Year



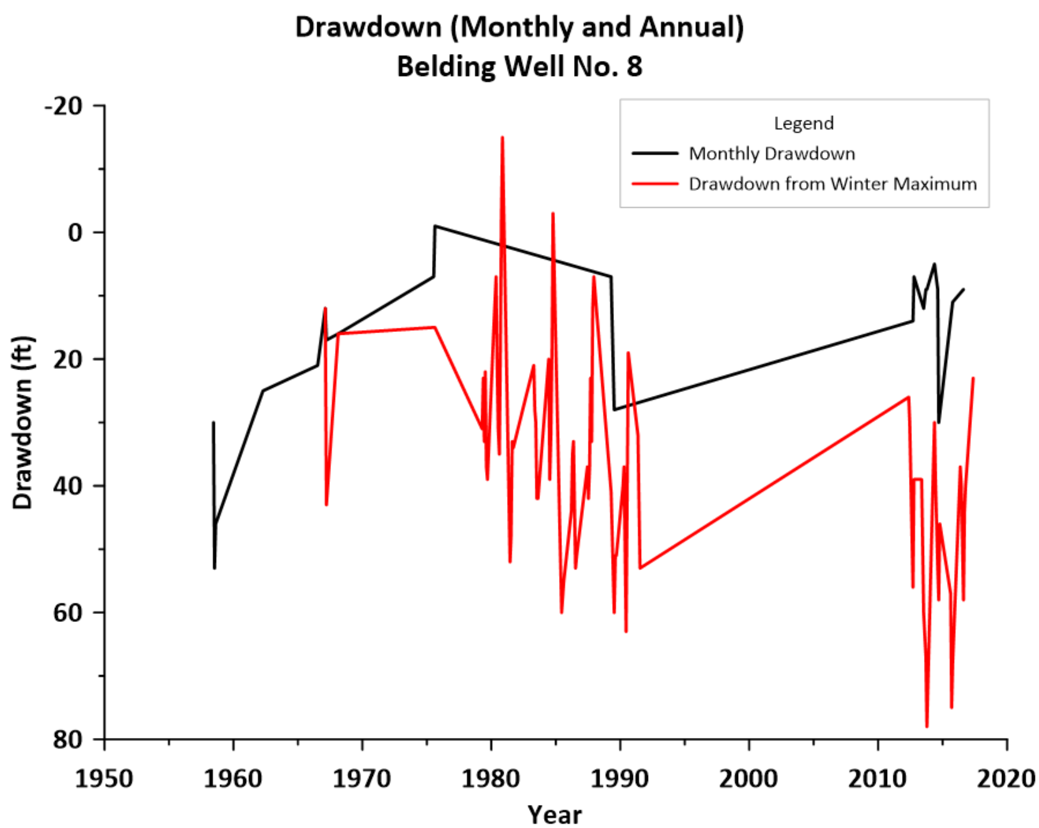
Drawdown (Monthly and Annual)
Belding Well No. 4
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
0
40
80
120
160
1950
1960
1970
1980
1990
2000
2010
2020
Year


Drawdown (Monthly and Annual)
Belding Well No. 5
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
-40
0
40
80
120
160
1950
1960
1970
1980
1990
2000
2010
2020
Year

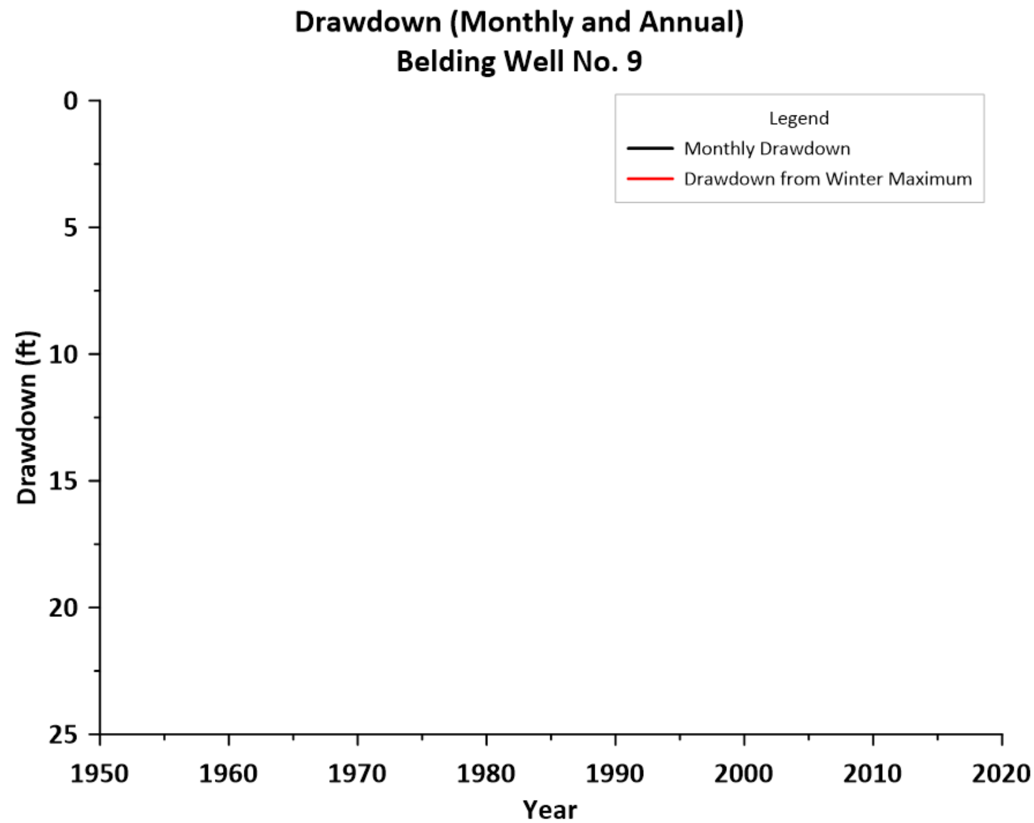

Drawdown (Monthly and Annual)
Belding Well No. 6
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
-20
0
20
40
60
80
1950
1960
1970
1980
1990
2000
2010
2020
Year

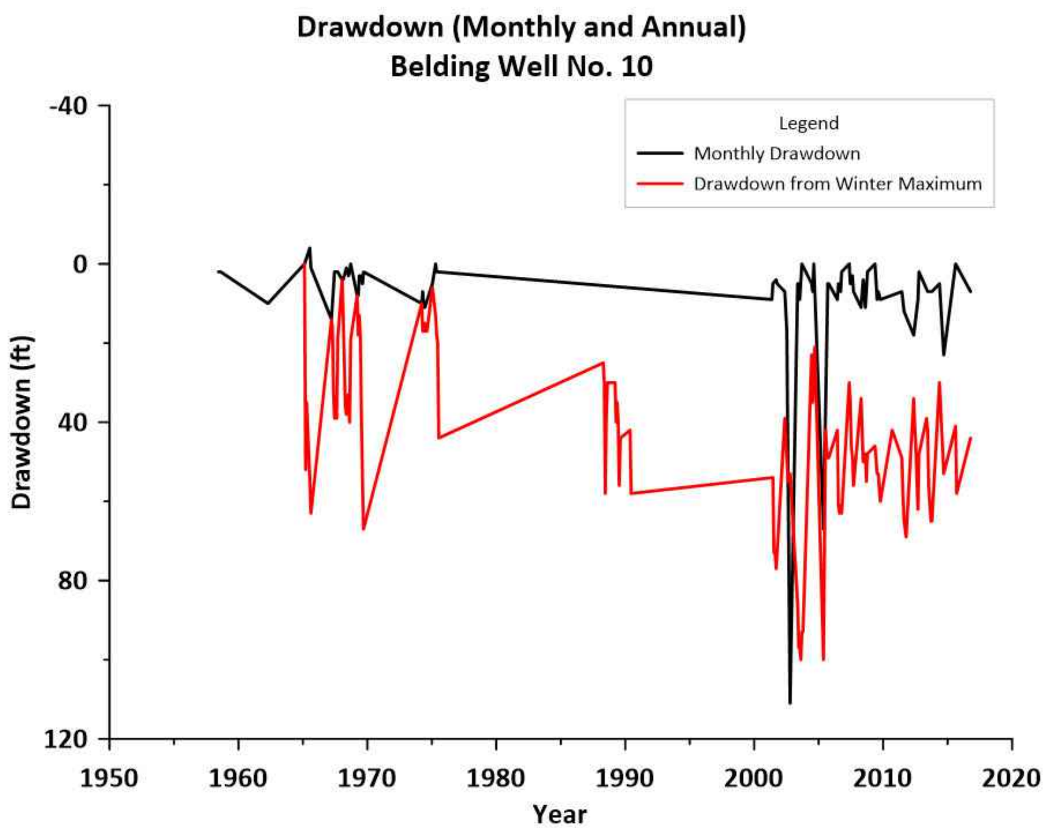


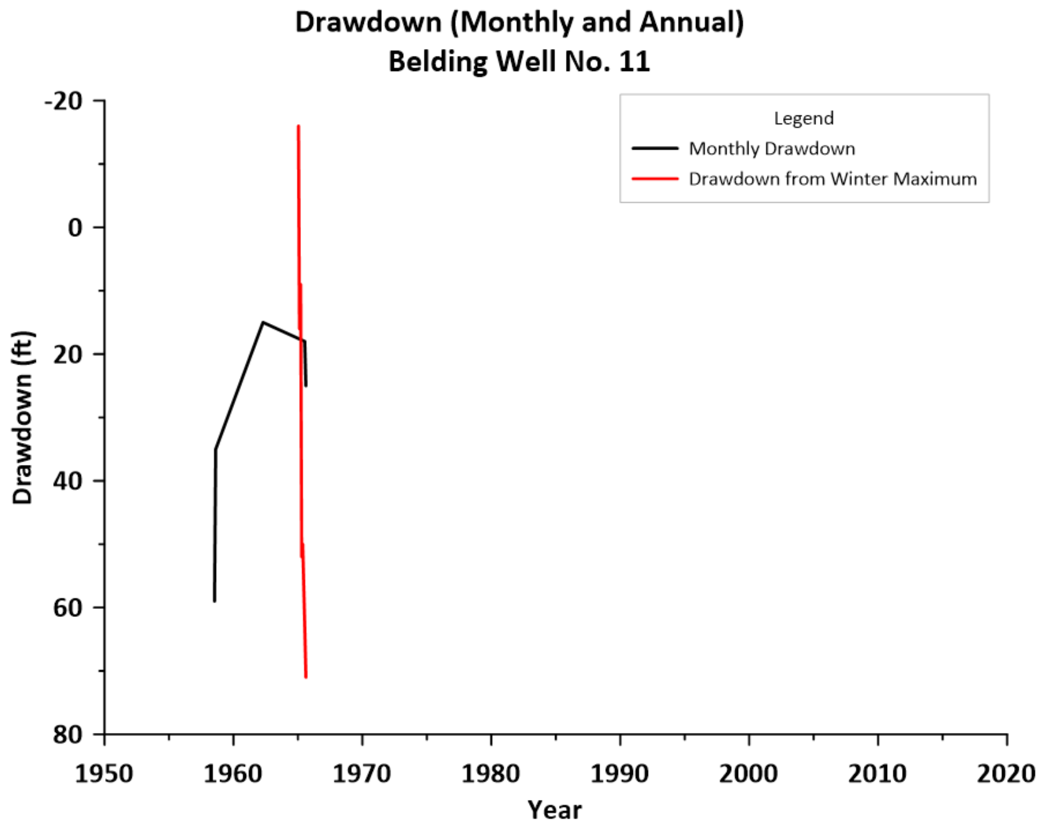
Drawdown (Monthly and Annual)
Belding Well No. 7
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
0
2
4
6
8
10
1950
1960
1970
1980
1990
2000
2010
2020
Year

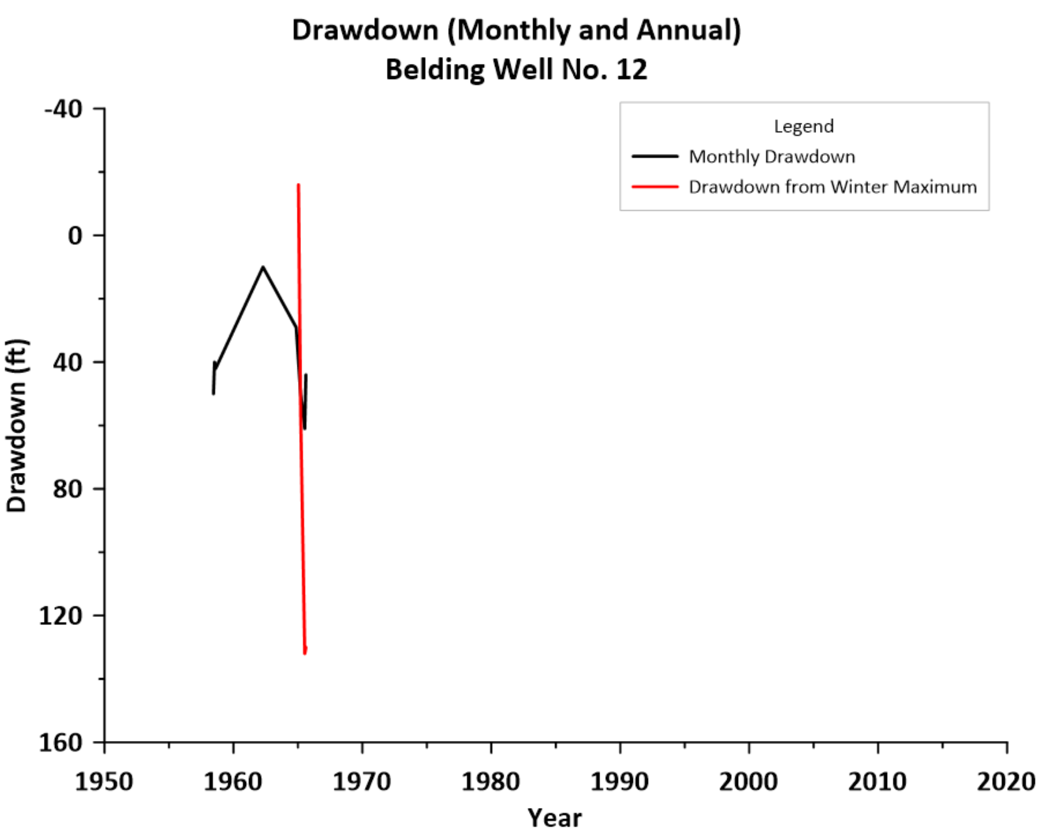


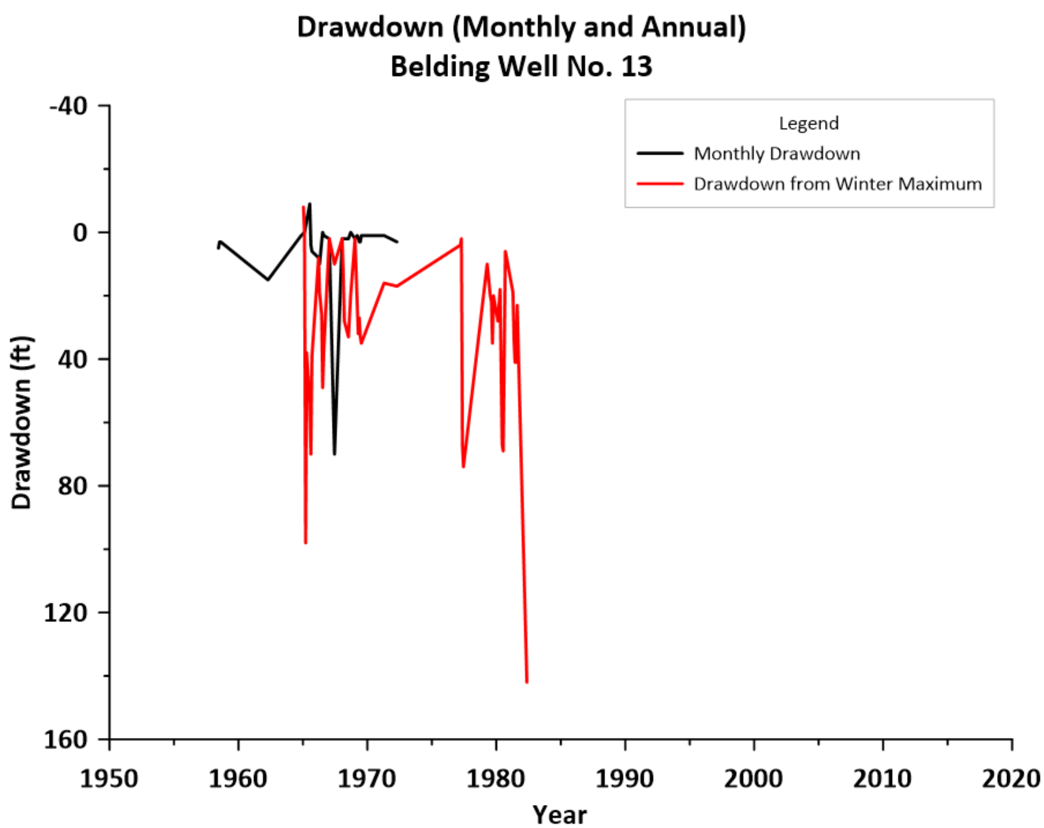
Drawdown (Monthly and Annual)
Belding Well No. 8
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
-20
0
20
40
60
80
1950
1960
1970
1980
1990
2000
2010
2020
Year

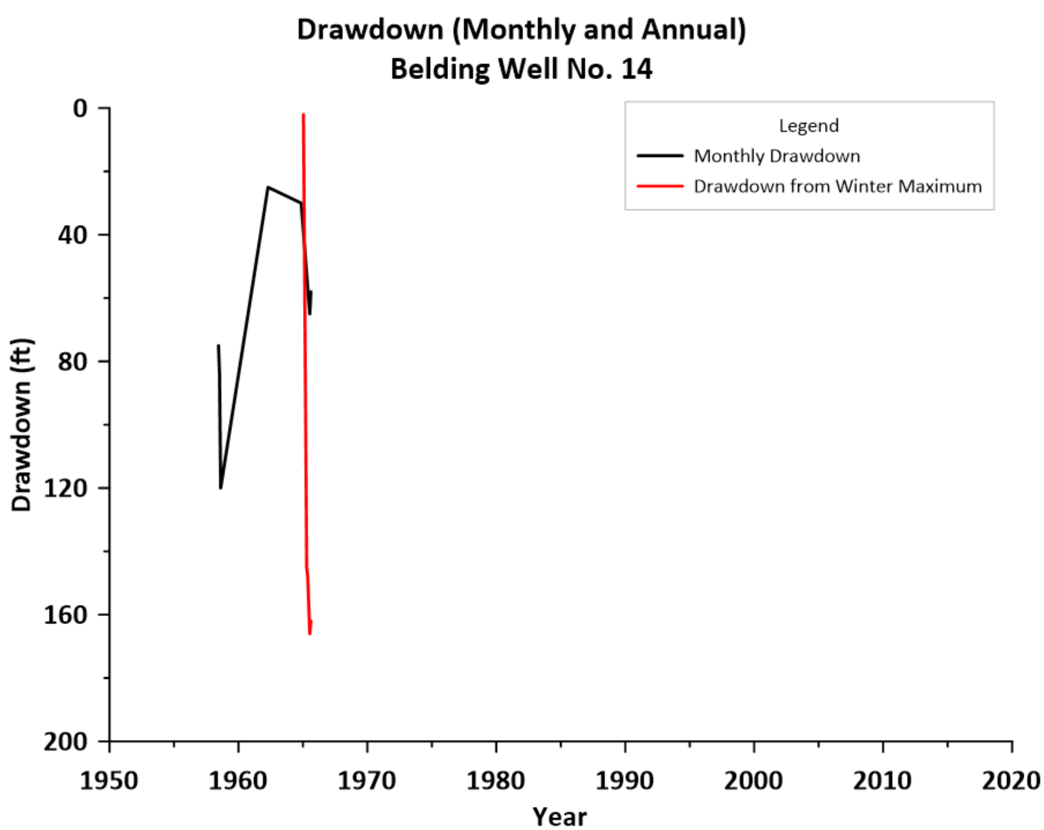

Drawdown (Monthly and Annual)
Belding Well No. 9
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
0
5
10
15
20
25
1950
1960
1970
1980
1990
2000
2010
2020
Year

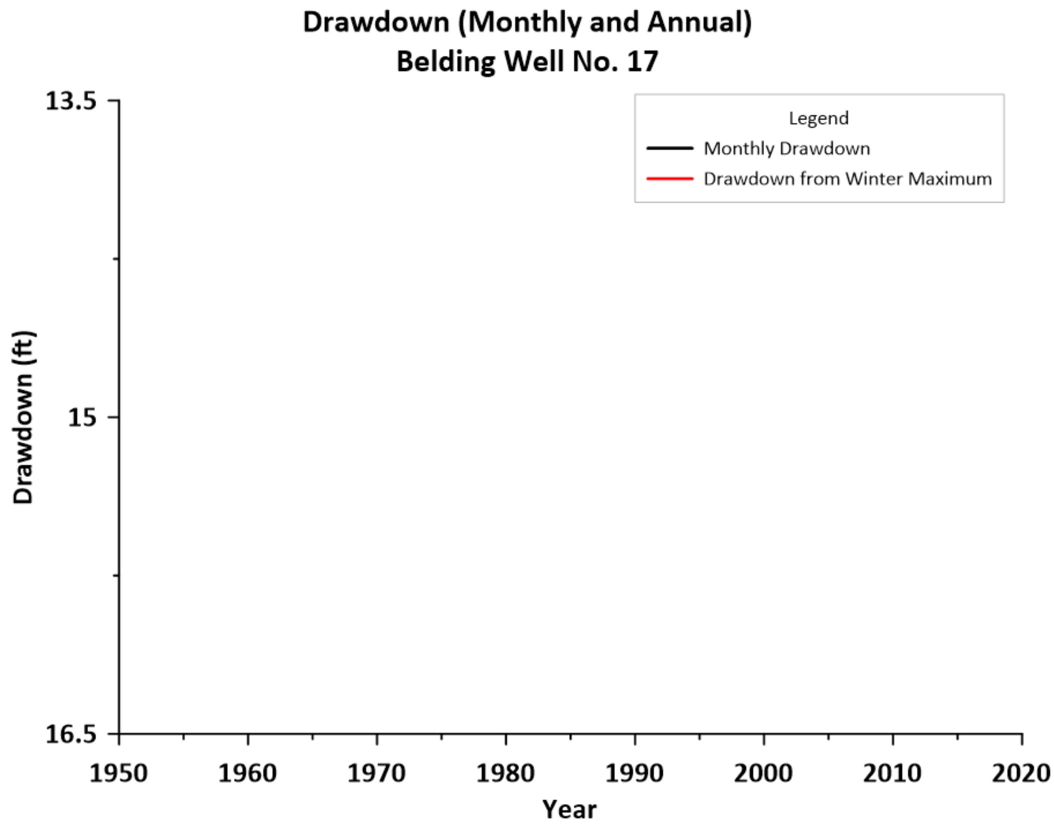

Drawdown (Monthly and Annual)
Belding Well No. 10
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
-40
0
40
80
120
1950
1960
1970
1980
1990
2000
2010
2020
Year

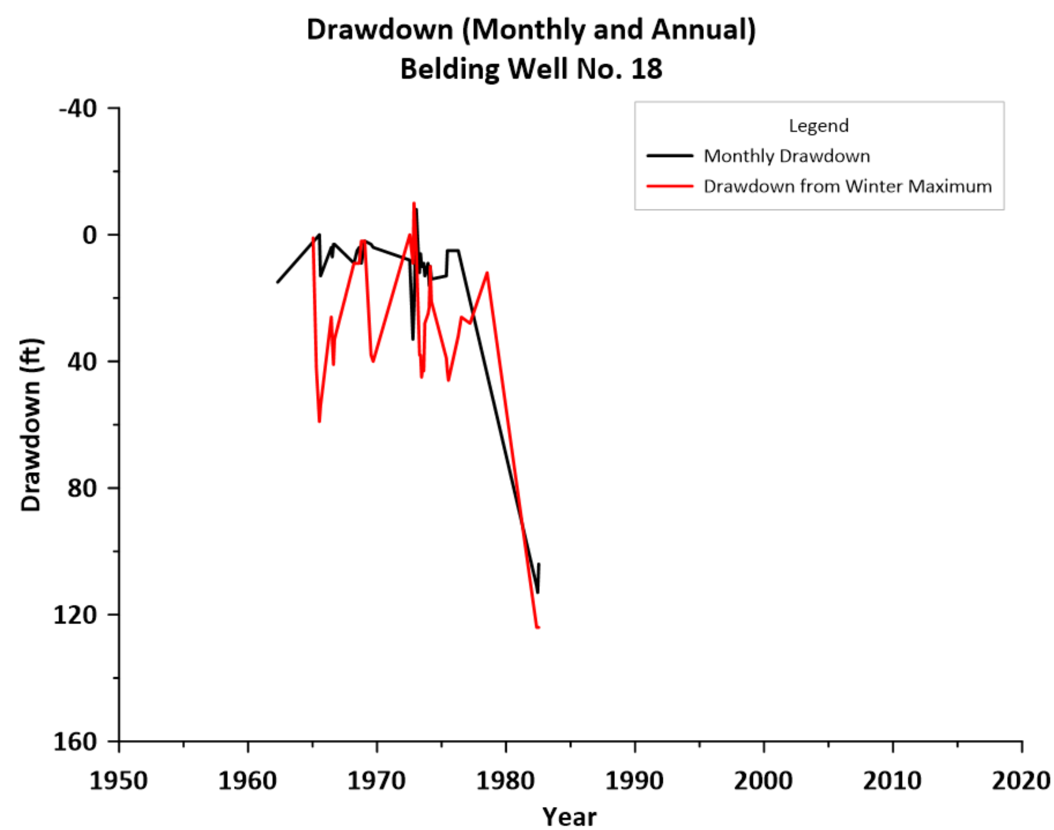

Drawdown (Monthly and Annual)
Belding Well No. 11
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
-20
0
20
40
60
80
1950
1960
1970
1980
1990
2000
2010
2020
Year

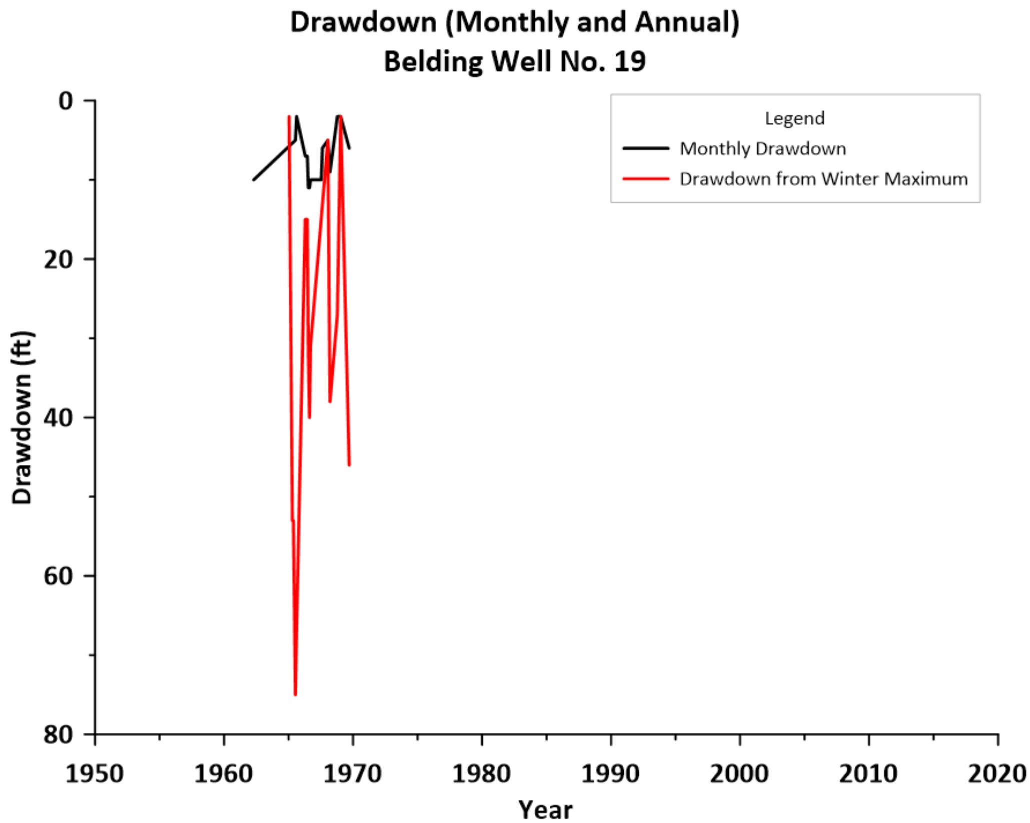

Drawdown (Monthly and Annual)
Belding Well No. 12
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
-40
0
40
80
120
160
1950
1960
1970
1980
1990
2000
2010
2020
Year

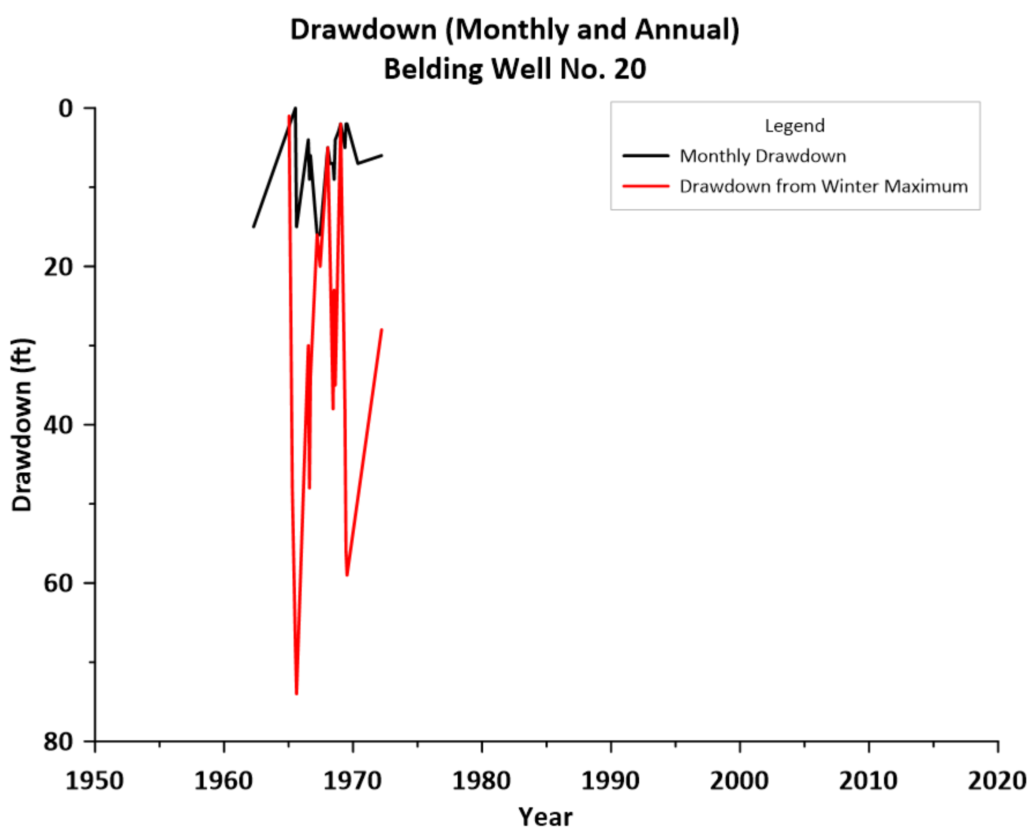

Drawdown (Monthly and Annual)
Belding Well No. 13
Legend
Monthly Drawdown
Drawdown from Winter Maximum
-40
0
40
80
120
160
Drawdown (ft)
1950
1960
1970
1980
1990
2000
2010
2020
Year

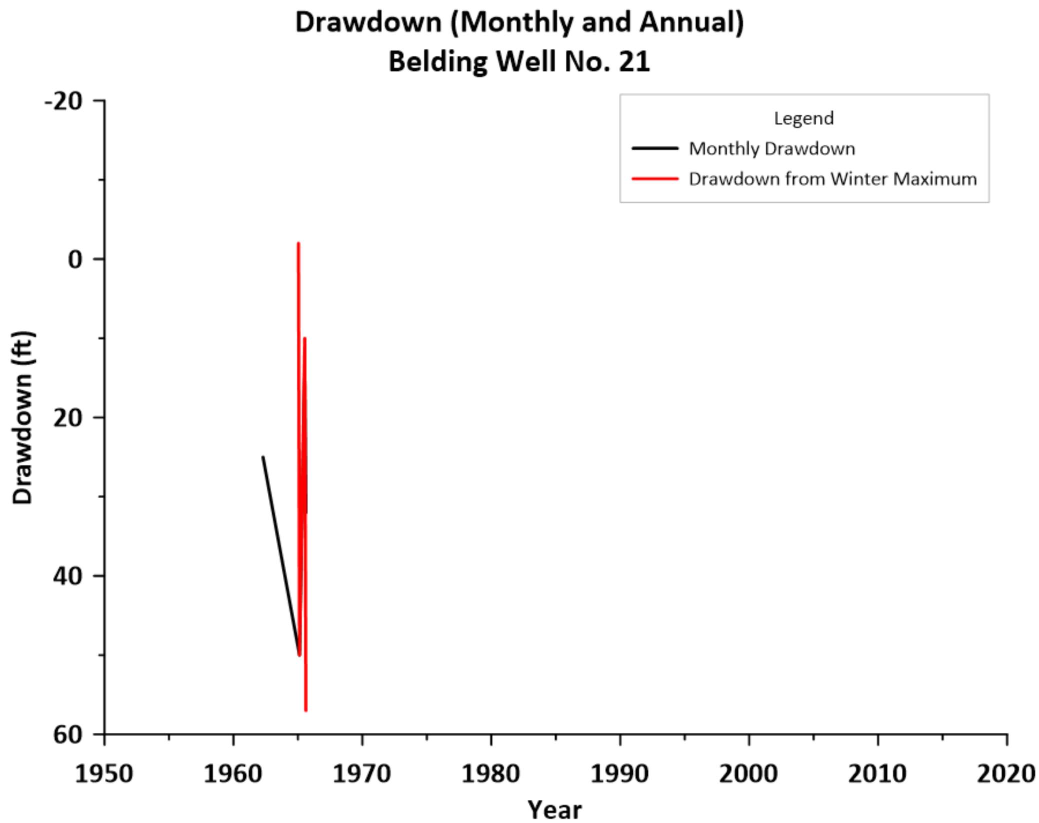

Drawdown (Monthly and Annual)
Belding Well No. 14
Legend
Monthly Drawdown
Drawdown from Winter Maximum
0
40
80
120
160
200
Drawdown (ft)
1950
1960
1970
1980
1990
2000
2010
2020
Year


Drawdown (Monthly and Annual)
Belding Well No. 17
Legend
Monthly Drawdown
Drawdown from Winter Maximum
13.5
15
16.5
Drawdown (ft)
1950
1960
1970
1980
1990
2000
2010
2020
Year

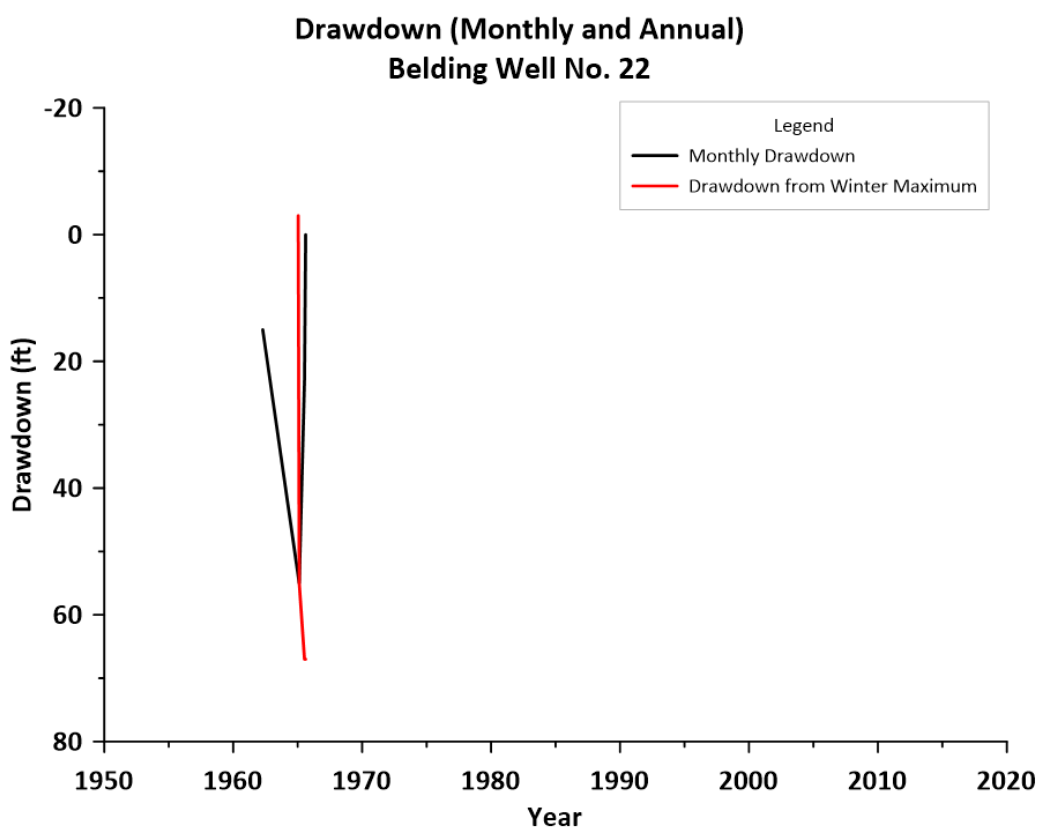

Drawdown (Monthly and Annual)
Belding Well No. 18
Legend
Monthly Drawdown
Drawdown from Winter Maximum
-40
0
40
80
120
160
Drawdown (ft)
1950
1960
1970
1980
1990
2000
2010
2020
Year


Drawdown (Monthly and Annual)
Belding Well No. 19
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
0
20
40
60
80
1950
1960
1970
1980
1990
2000
2010
2020
Year

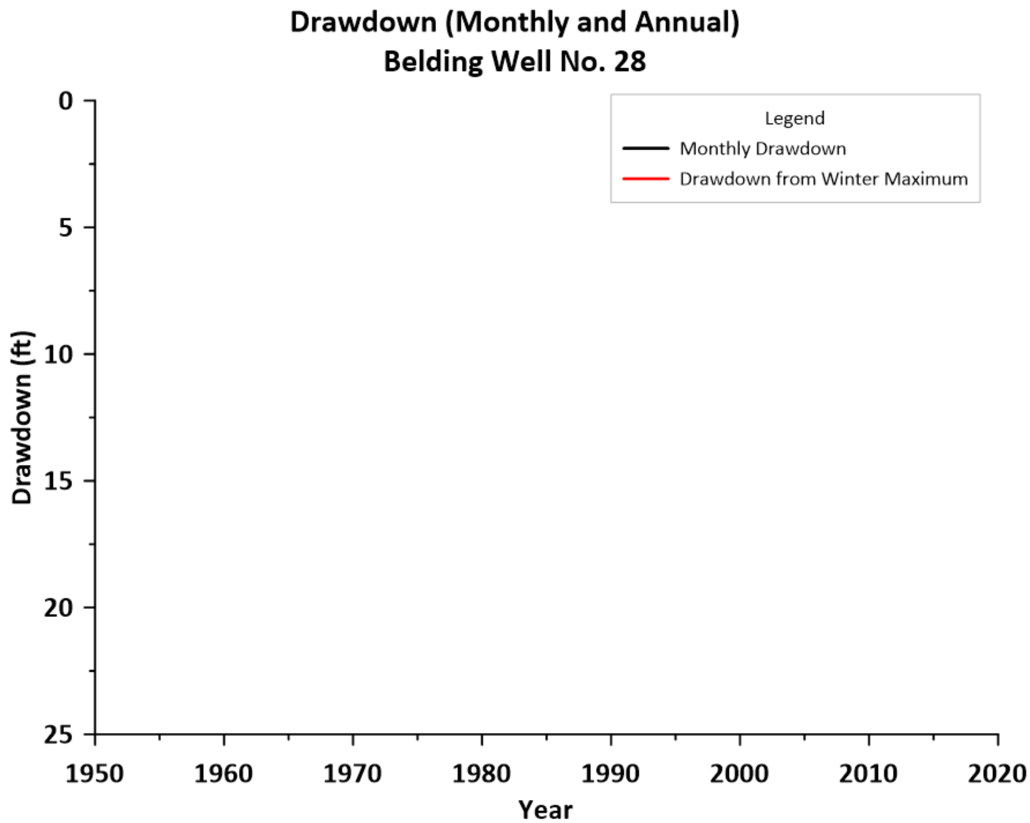

Drawdown (Monthly and Annual)
Belding Well No. 20
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
0
20
40
60
80
1950
1960
1970
1980
1990
2000
2010
2020
Year

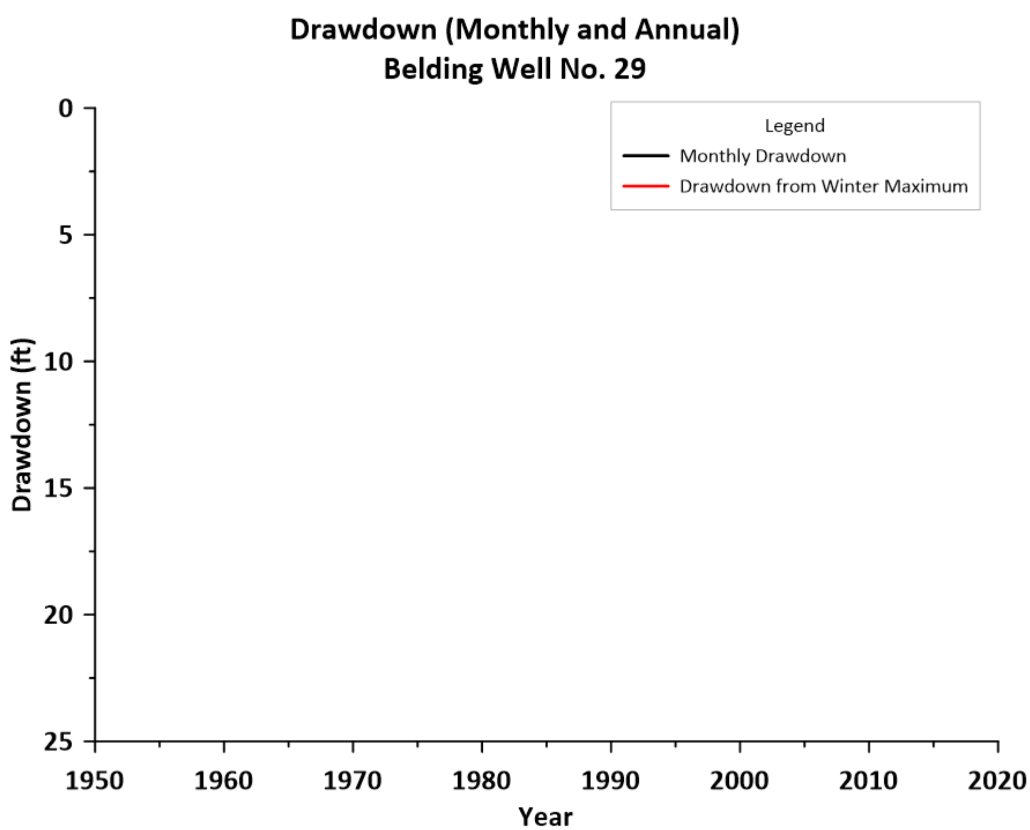


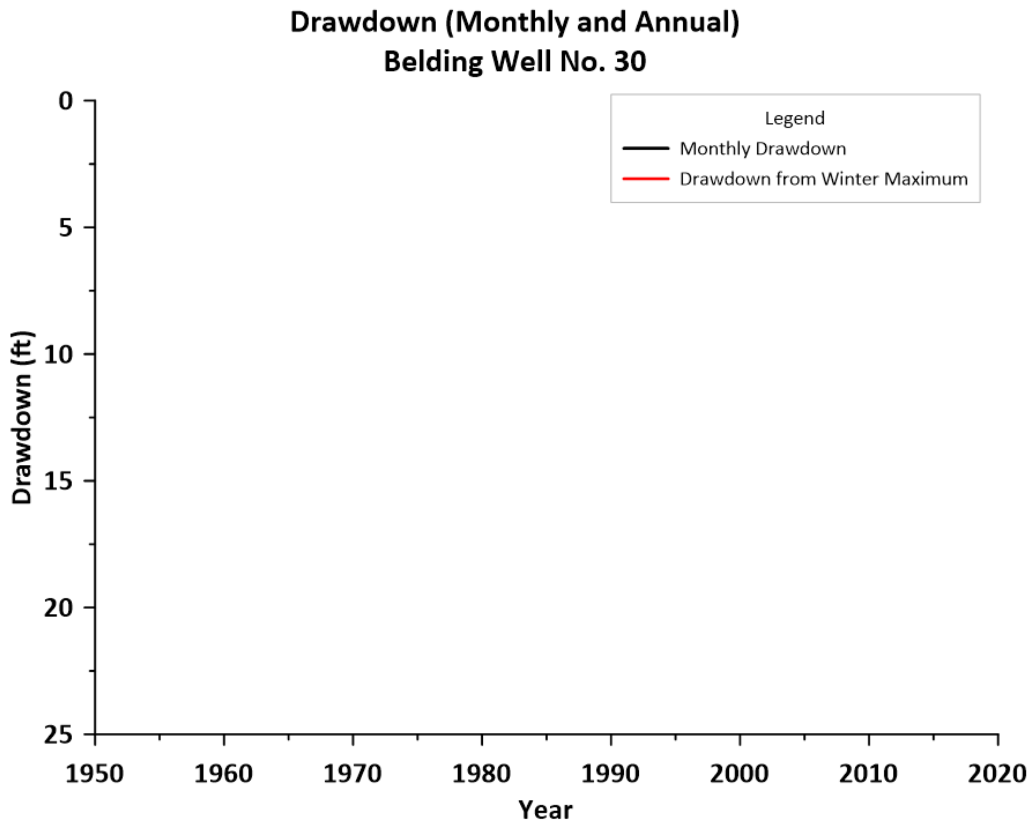
Drawdown (Monthly and Annual)
Belding Well No. 21
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
Year
-20
0
20
40
60
1950
1960
1970
1980
1990
2000
2010
2020



Drawdown (Monthly and Annual)
Belding Well No. 22
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
Year
-20
0
20
40
60
80
1950
1960
1970
1980
1990
2000
2010
2020

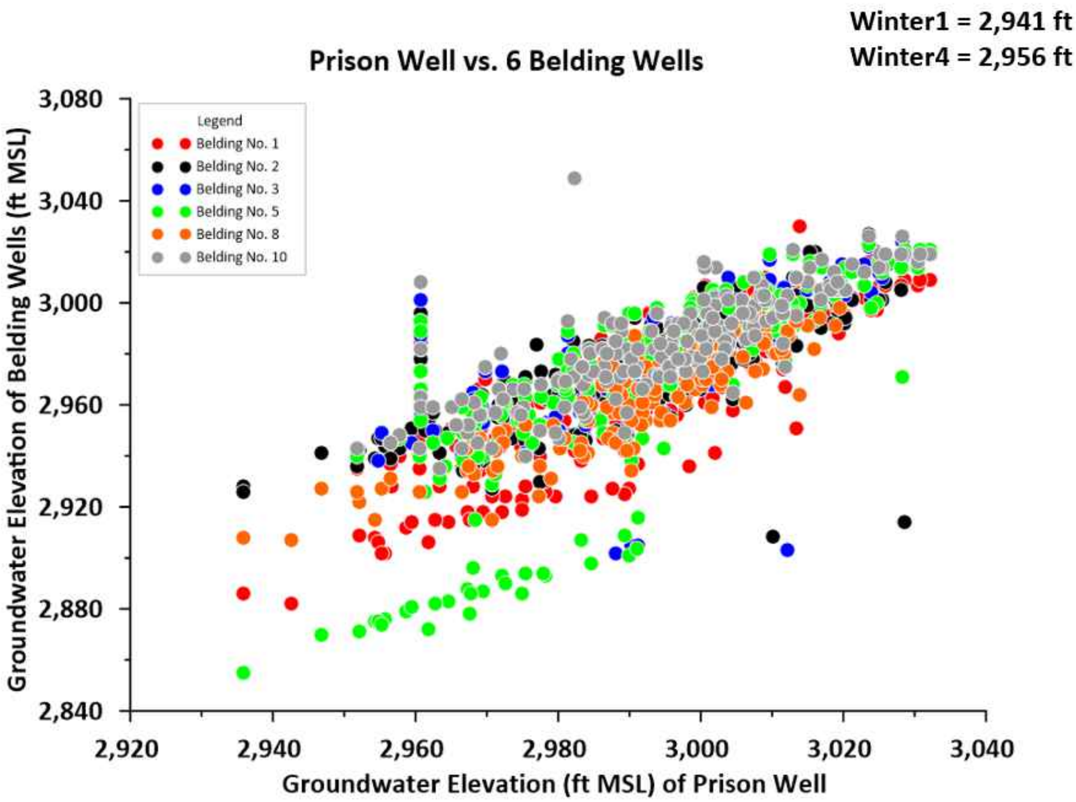

Drawdown (Monthly and Annual)
Belding Well No. 28
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
0
5
10
15
20
25
1950
1960
1970
1980
1990
2000
2010
2020
Year


Drawdown (Monthly and Annual)
Belding Well No. 29
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
0
5
10
15
20
25
1950
1960
1970
1980
1990
2000
2010
2020
Year

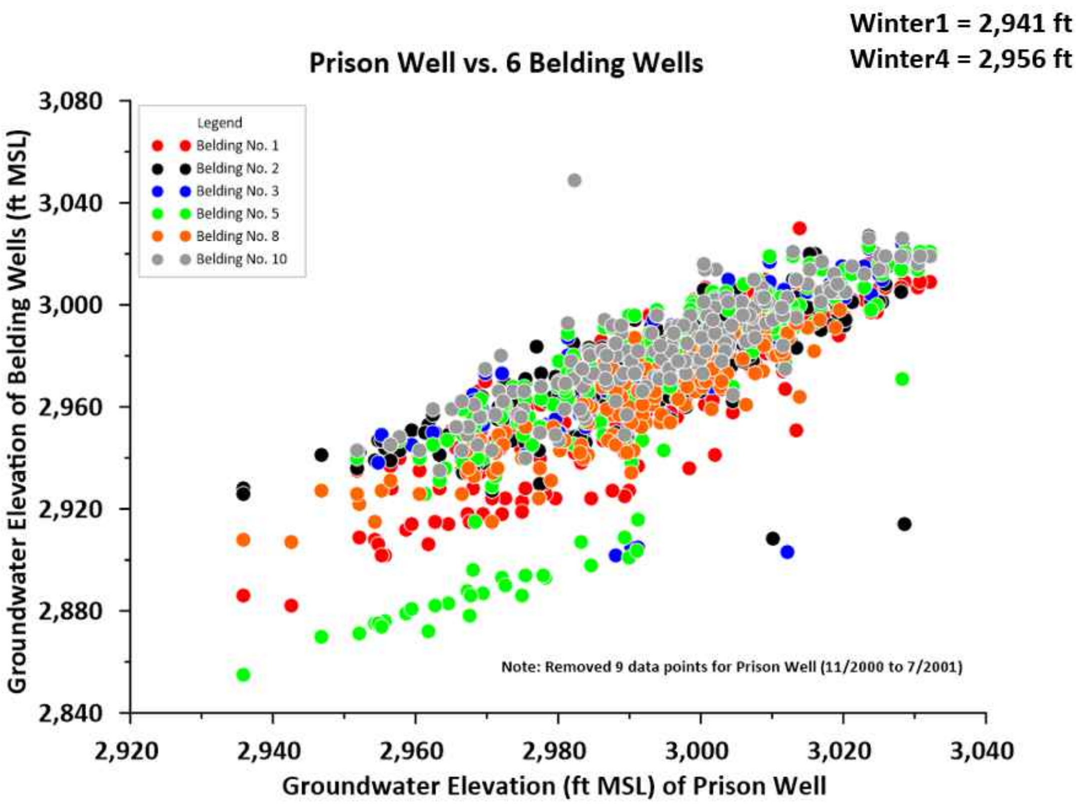

Drawdown (Monthly and Annual)
Belding Well No. 30
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
0
5
10
15
20
25
1950
1960
1970
1980
1990
2000
2010
2020
Year

Appendix E

Cross Plots of the 11 Monitoring Wells and Selected Belding Farms Wells

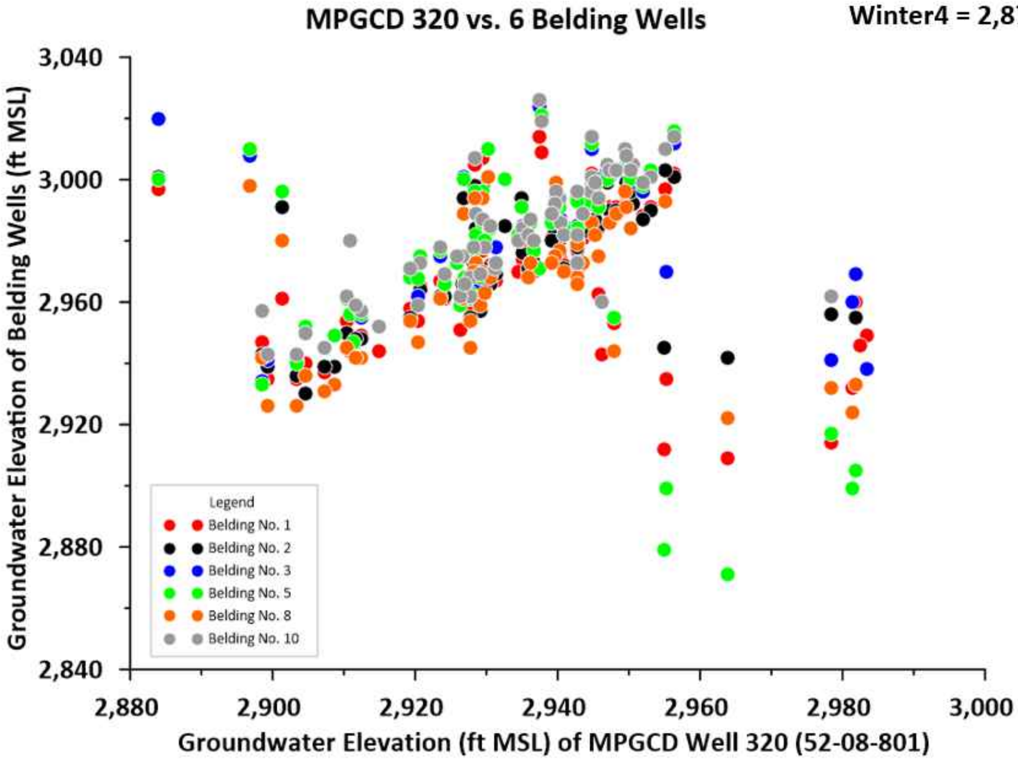


Winter1 = 2,941 ft
Winter4 = 2,956 ft
Prison Well vs. 6 Belding Wells
Legend
Belding No. 1
Belding No. 2
Belding No. 3
Belding No. 5
Belding No. 8
Belding No. 10
Groundwater Elevation of Belding Wells (ft MSL)
Groundwater Elevation (ft MSL) of Prison Well
3,080
3,040
3,000
2,960
2,920
2,880
2,840
2,920
2,940
2,960
2,980
3,000
3,020
3,040

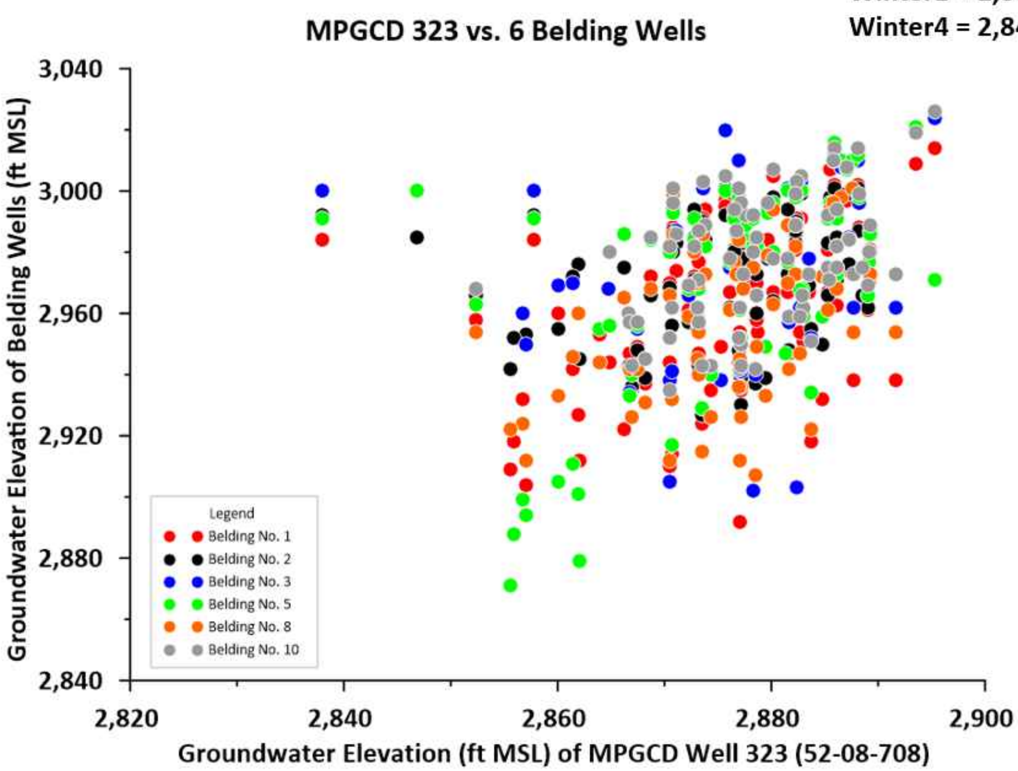


Winter1 = 2,941 ft
Winter4 = 2,956 ft
Prison Well vs. 6 Belding Wells
Legend
Belding No. 1
Belding No. 2
Belding No. 3
Belding No. 5
Belding No. 8
Belding No. 10
Note: Removed 9 data points for Prison Well (11/2000 to 7/2001)
Groundwater Elevation of Belding Wells (ft MSL)
Groundwater Elevation (ft MSL) of Prison Well
3,080
3,040
3,000
2,960
2,920
2,880
2,840
2,920
2,940
2,960
2,980
3,000
3,020
3,040

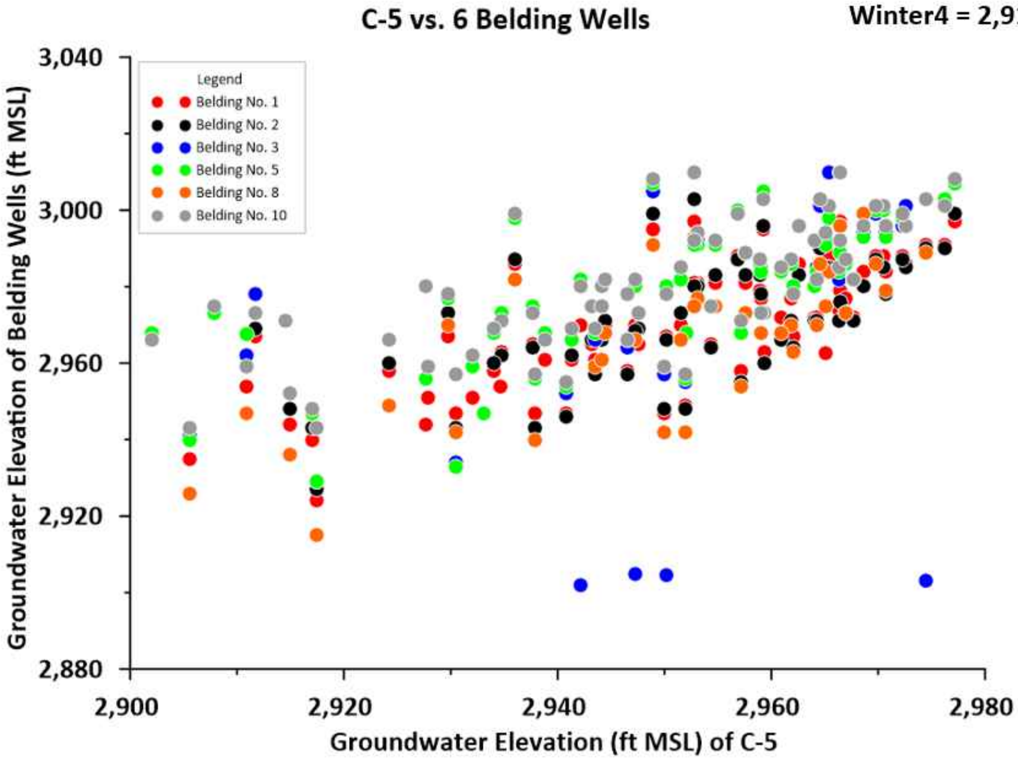
Winter1 = 2,836 ft
Winter4 = 2,878 ft



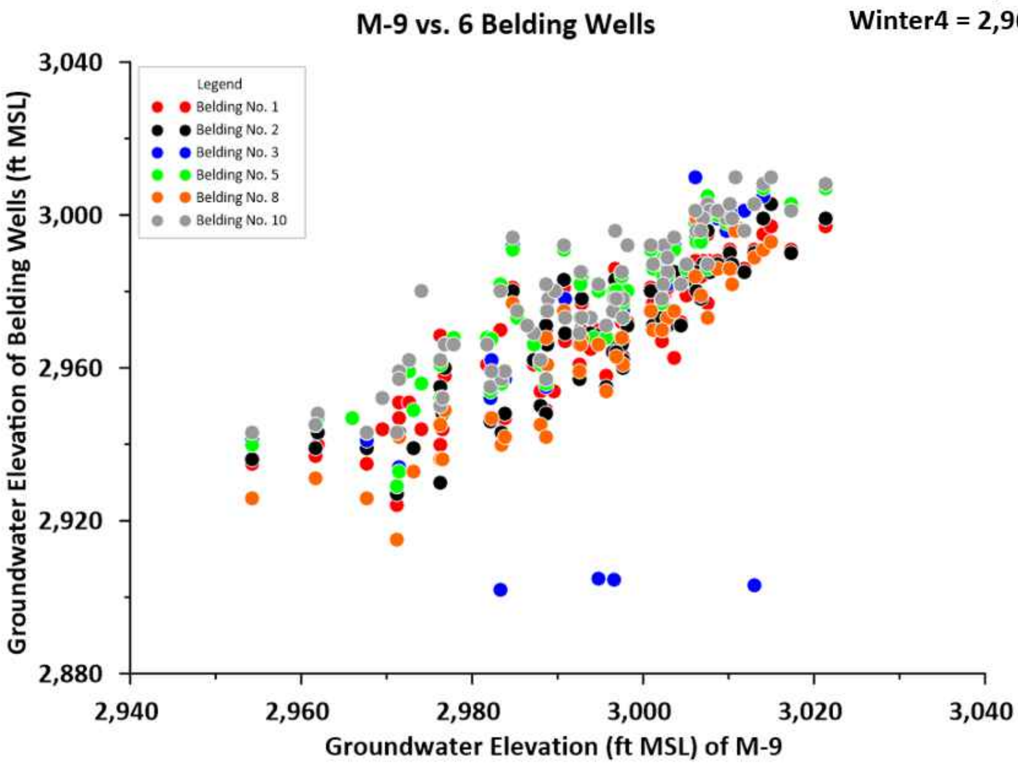
Winter1 = 2,833 ft
Winter4 = 2,848 ft

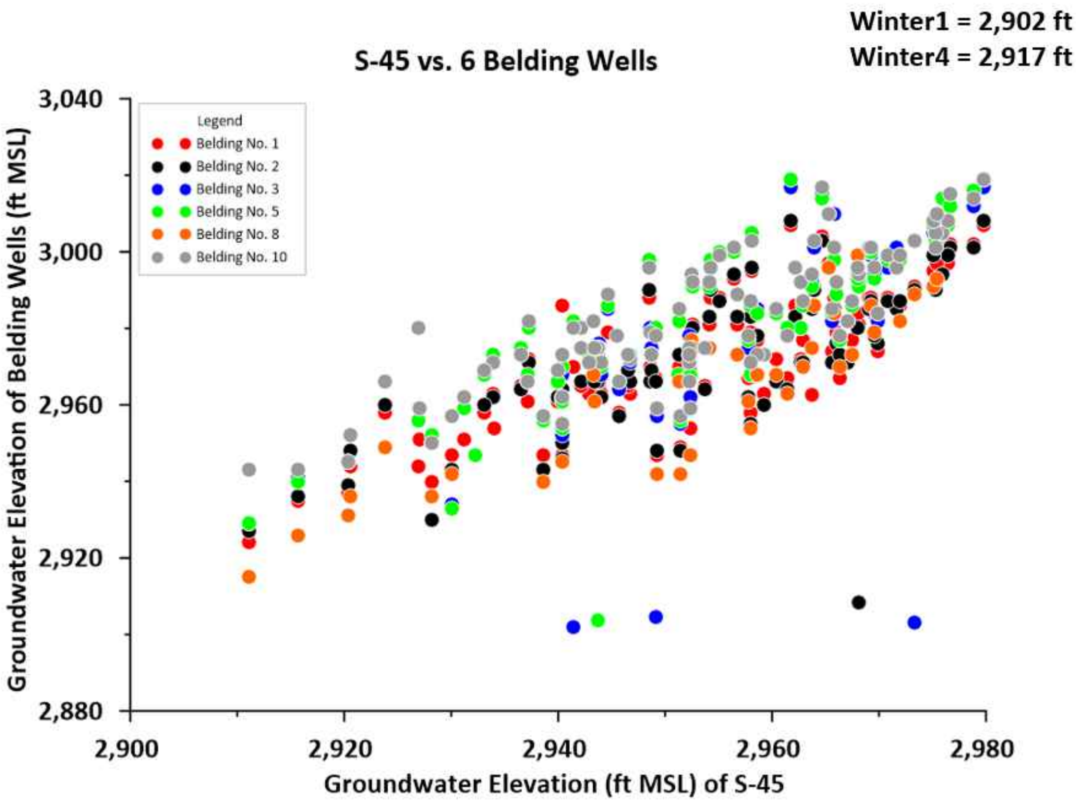


Winter1 = 2,899 ft
Winter4 = 2,914 ft

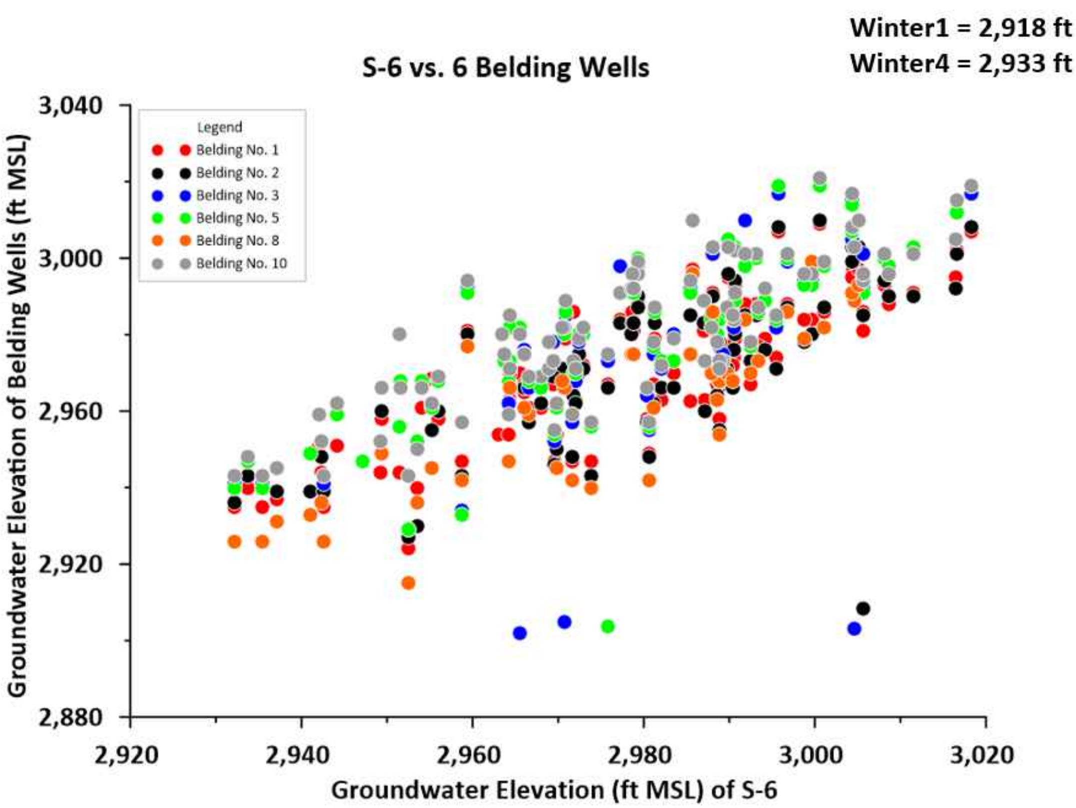


Winter1 = 2,948 ft
Winter4 = 2,963 ft



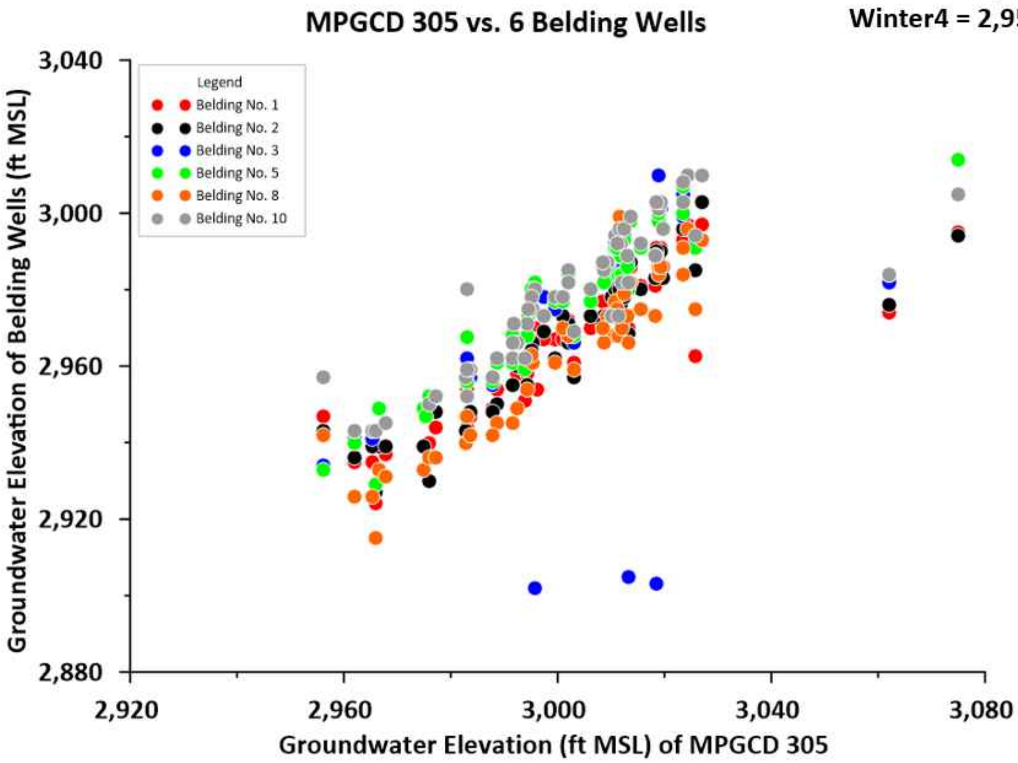


Winter1 = 2,902 ft
Winter4 = 2,917 ft
S-45 vs. 6 Belding Wells
Legend
Belding No. 1
Belding No. 2
Belding No. 3
Belding No. 5
Belding No. 8
Belding No. 10
Groundwater Elevation of Belding Wells (ft MSL)
Groundwater Elevation (ft MSL) of S-45

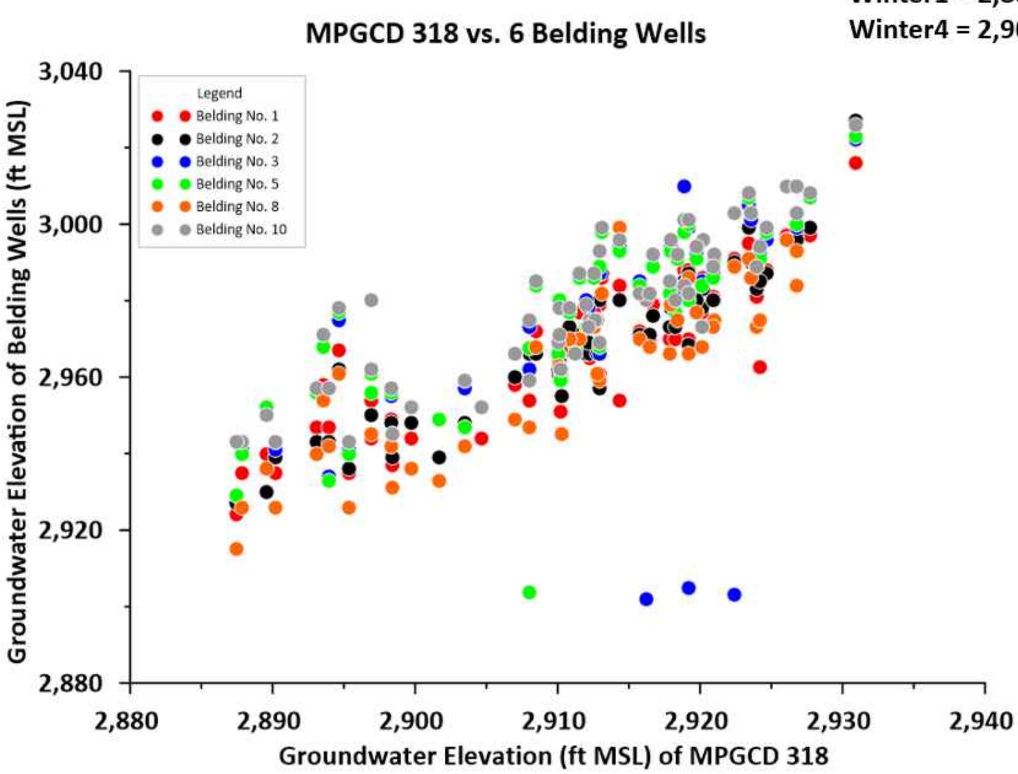


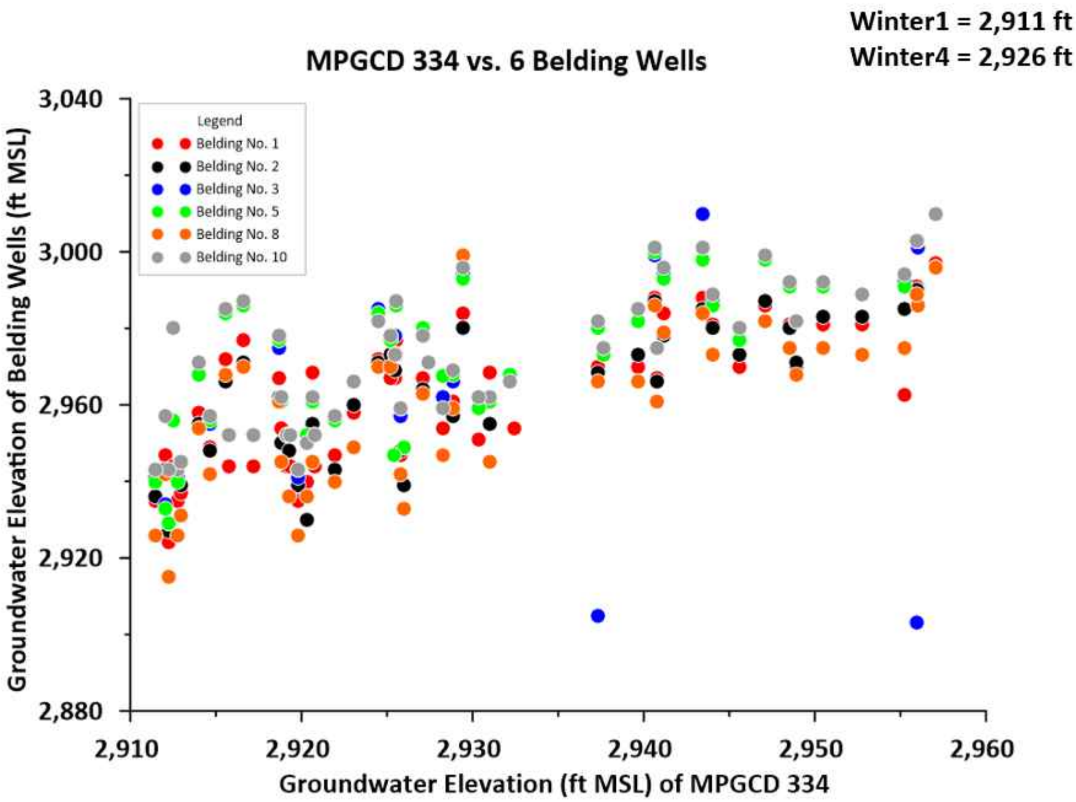
Winter1 = 2,918 ft
Winter4 = 2,933 ft
S-6 vs. 6 Belding Wells
Legend
Belding No. 1
Belding No. 2
Belding No. 3
Belding No. 5
Belding No. 8
Belding No. 10
Groundwater Elevation of Belding Wells (ft MSL)
Groundwater Elevation (ft MSL) of S-6

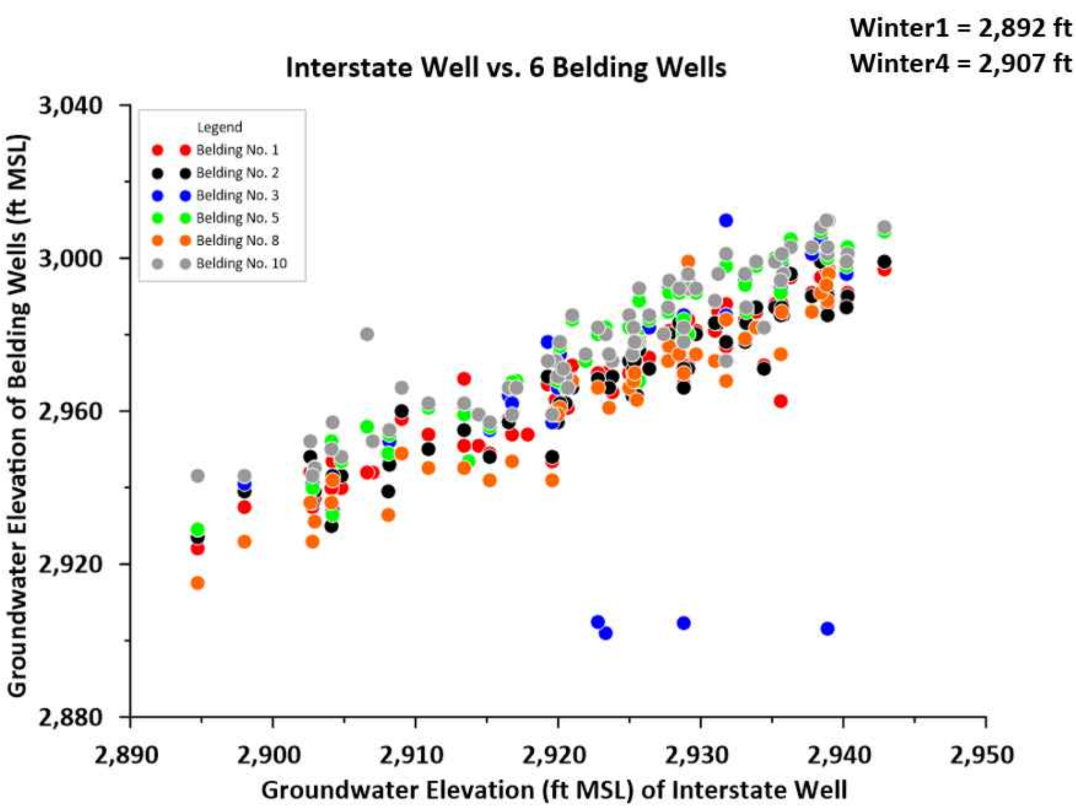
Winter1 = 2,941 ft
Winter4 = 2,956 ft



Winter1 = 2,885 ft
Winter4 = 2,900 ft



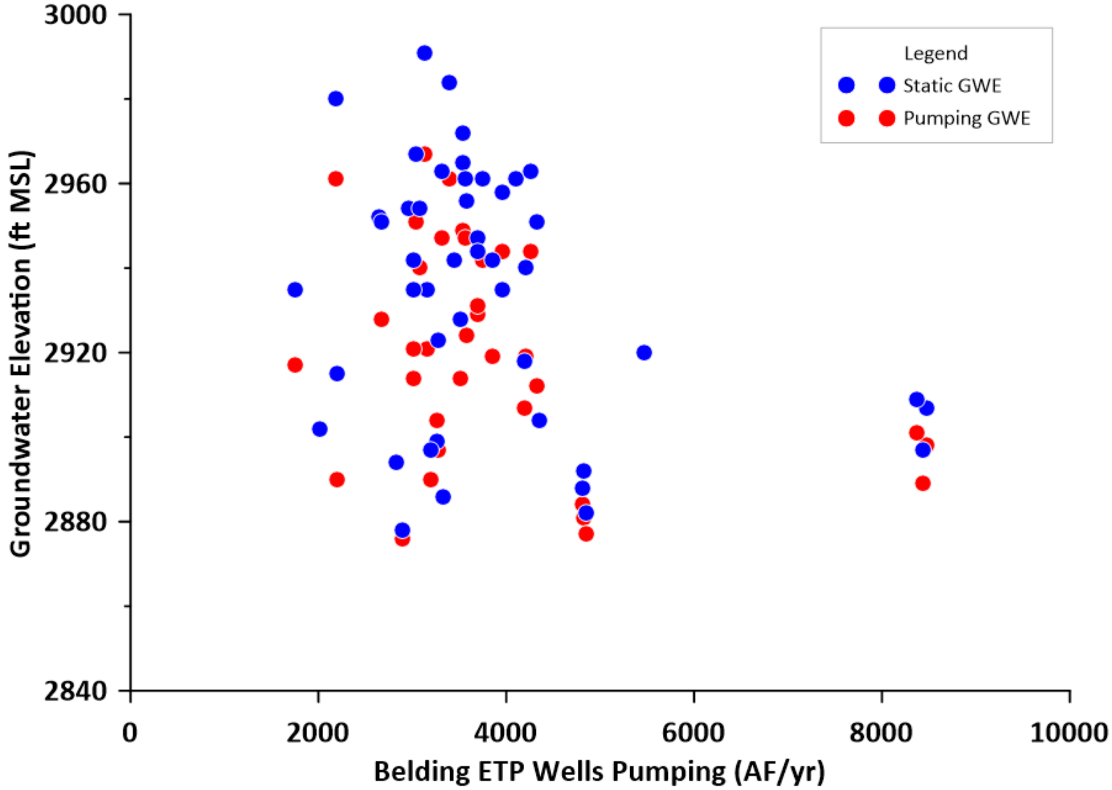

Winter1 = 2,911 ft
Winter4 = 2,926 ft
MPGCD 334 vs. 6 Belding Wells
Legend
Belding No. 1
Belding No. 2
Belding No. 3
Belding No. 5
Belding No. 8
Belding No. 10
3,040
3,000
2,960
2,920
2,880
Groundwater Elevation of Belding Wells (ft MSL)
2,910
2,920
2,930
2,940
2,950
2,960
Groundwater Elevation (ft MSL) of MPGCD 334


Winter1 = 2,892 ft
Winter4 = 2,907 ft
Interstate Well vs. 6 Belding Wells
Legend
Belding No. 1
Belding No. 2
Belding No. 3
Belding No. 5
Belding No. 8
Belding No. 10
3,040
3,000
2,960
2,920
2,880
Groundwater Elevation of Belding Wells (ft MSL)
2,890
2,900
2,910
2,920
2,930
2,940
2,950
Groundwater Elevation (ft MSL) of Interstate Well

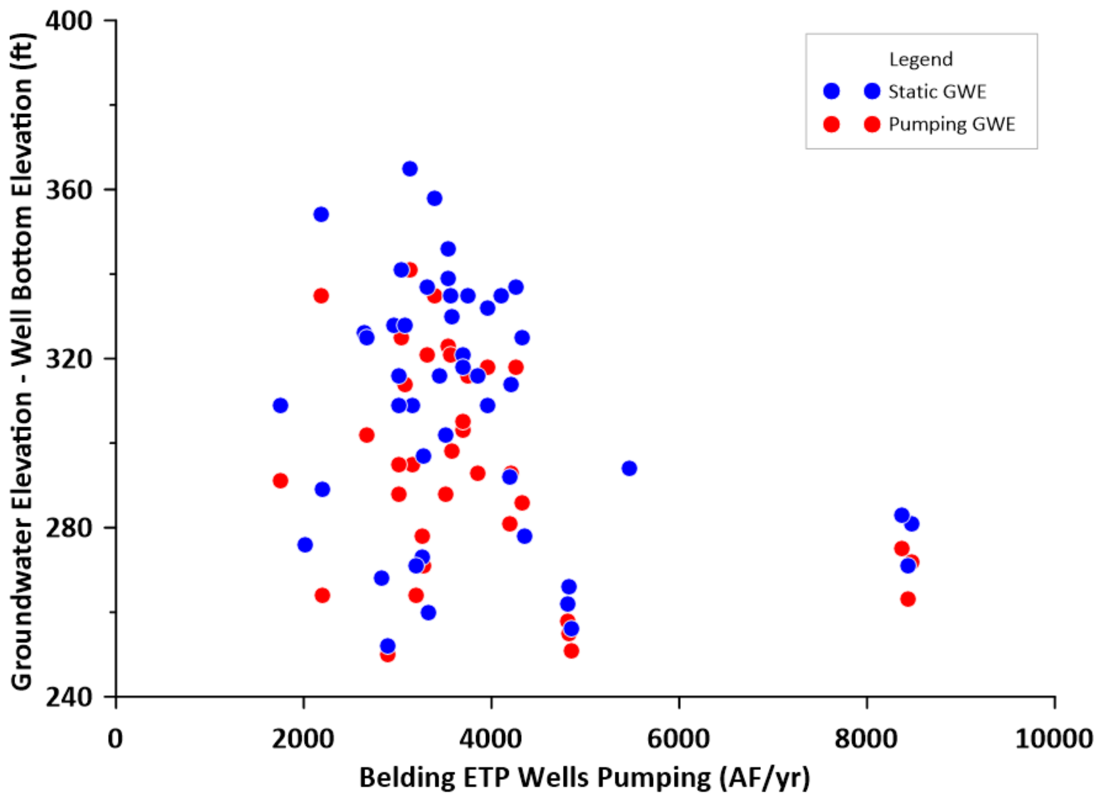
Appendix F

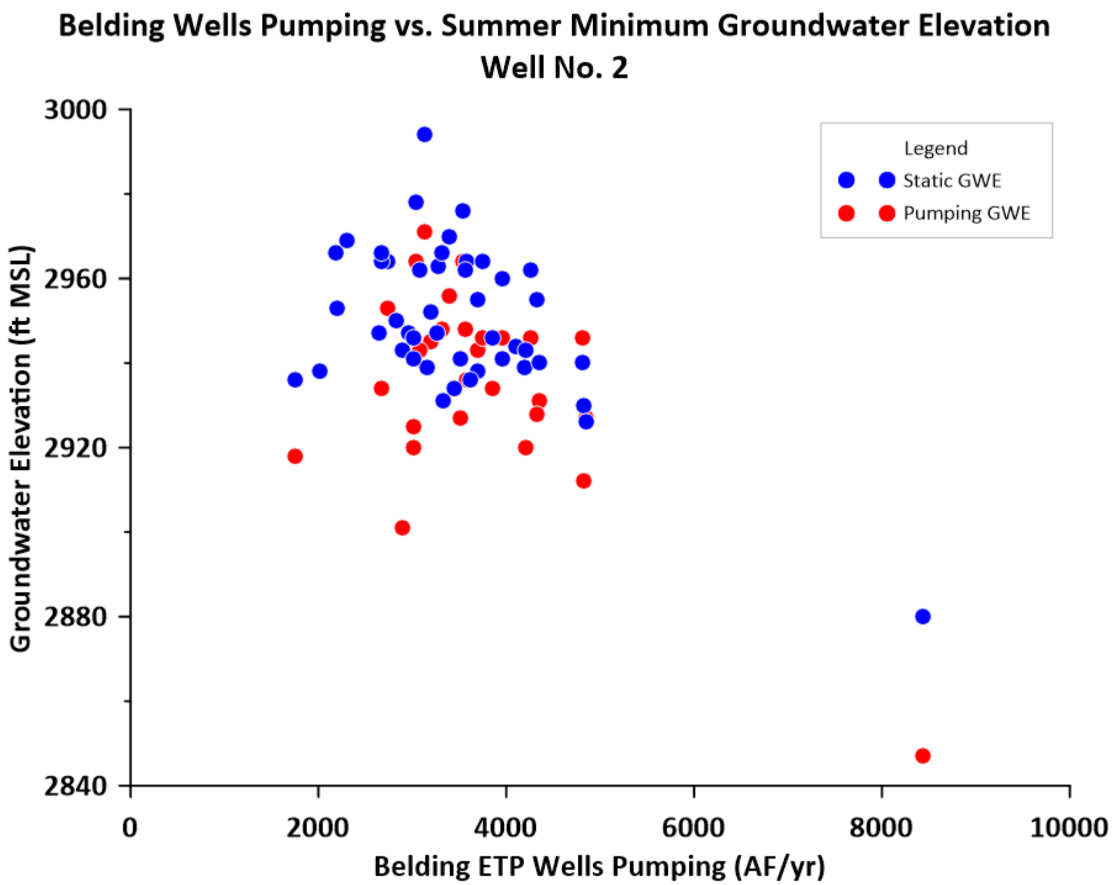
Annual Pumping vs. Summer Minimum Groundwater Elevations

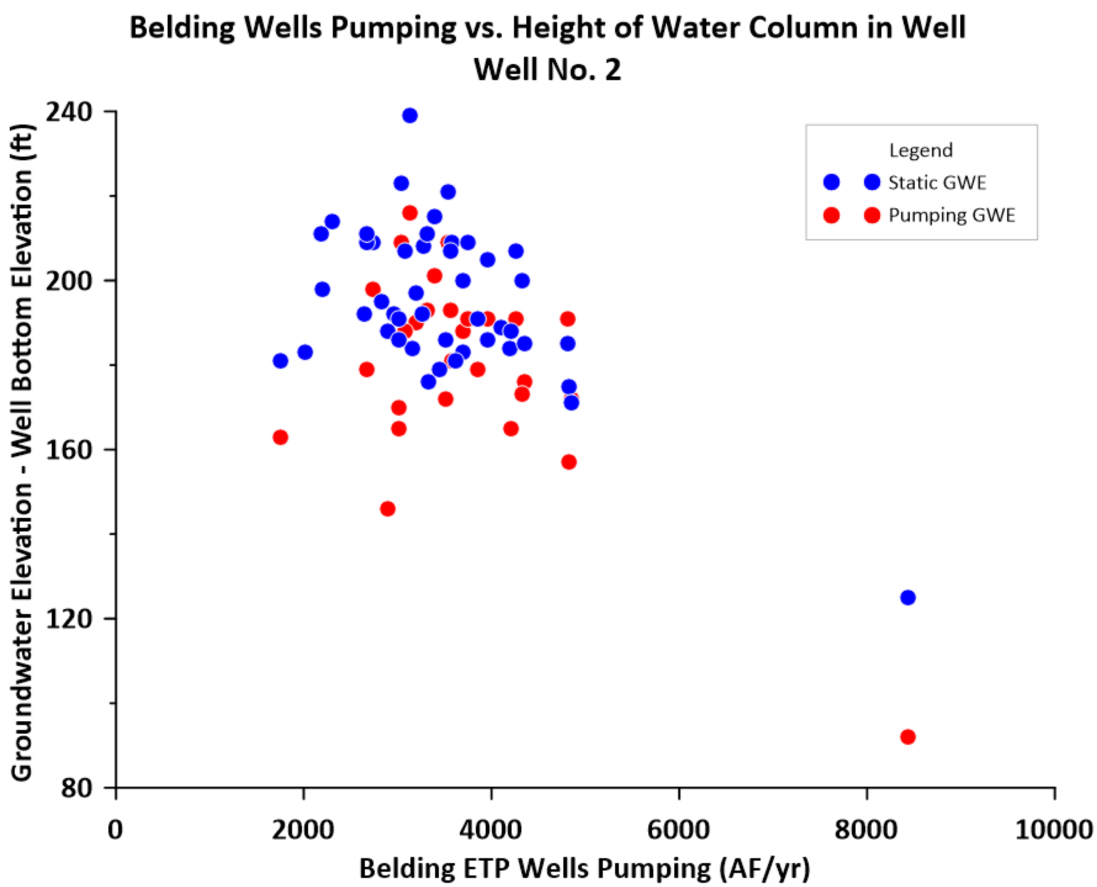
Belding Wells Pumping vs. Summer Minimum Groundwater Elevation
Well No. 1



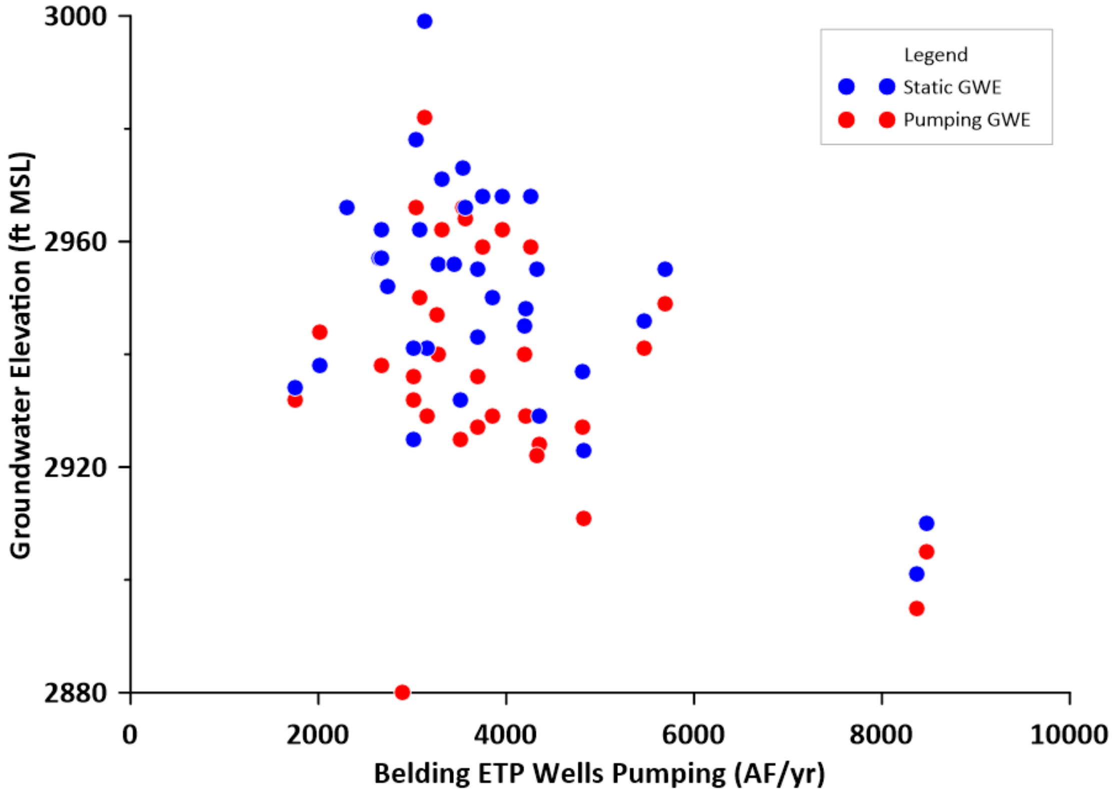
Belding Wells Pumping vs. Height of Water Column in Well
Well No. 1



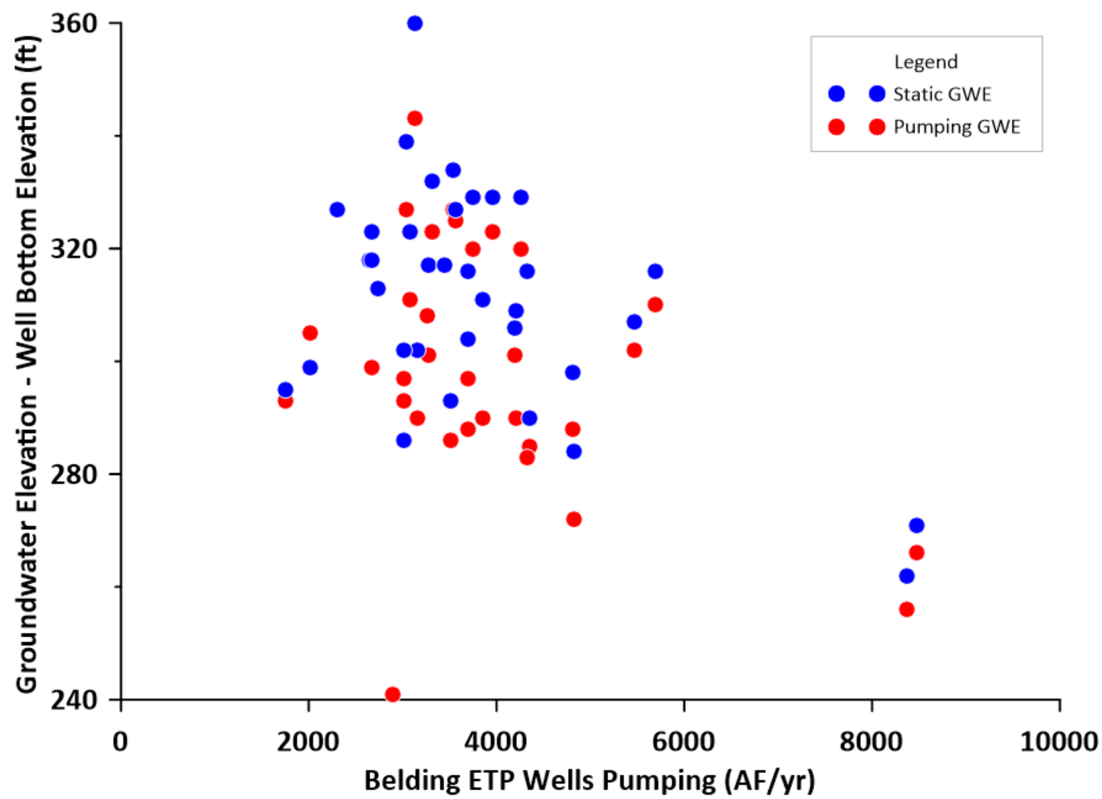

Belding Wells Pumping vs. Summer Minimum Groundwater Elevation
Well No. 2
Legend
Static GWE
Pumping GWE
Groundwater Elevation (ft MSL)
3000
2960
2920
2880
2840
0
2000
4000
6000
8000
10000
Belding ETP Wells Pumping (AF/yr)

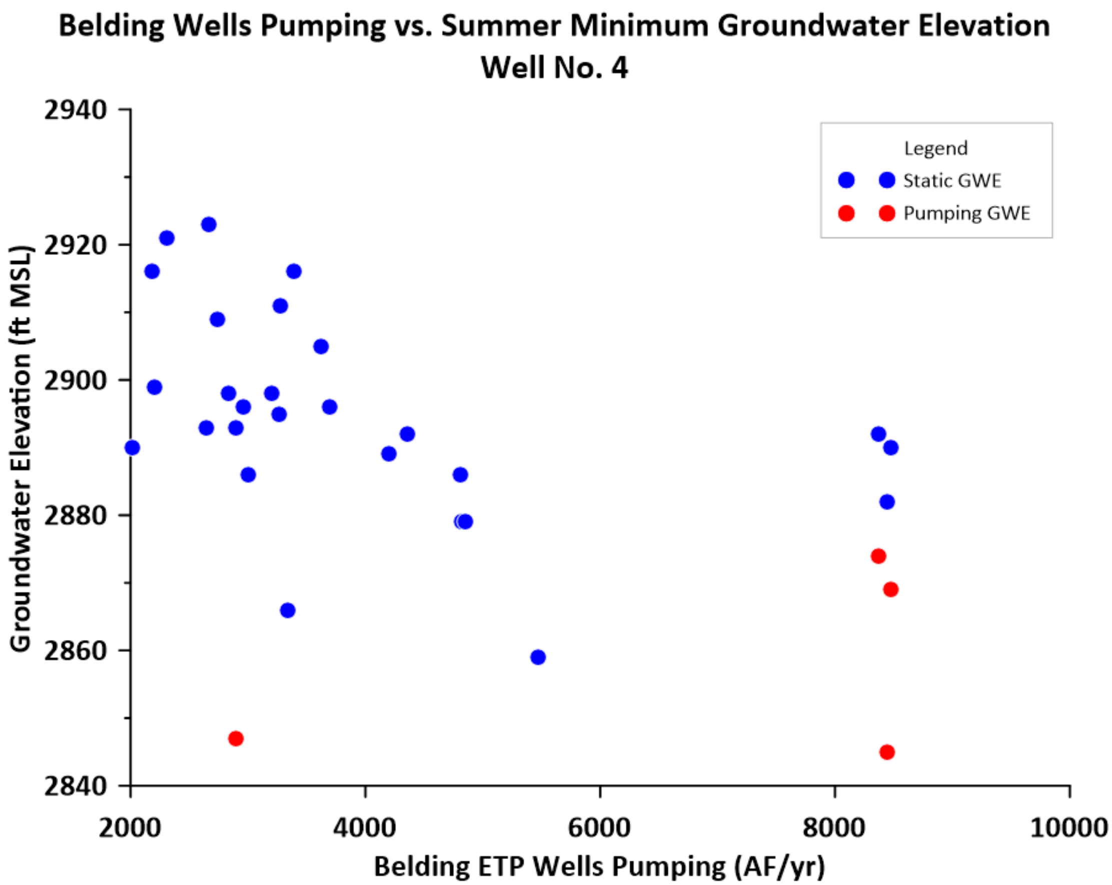

Belding Wells Pumping vs. Height of Water Column in Well
Well No. 2
Legend
Static GWE
Pumping GWE
Groundwater Elevation - Well Bottom Elevation (ft)
240
200
160
120
80
0
2000
4000
6000
8000
10000
Belding ETP Wells Pumping (AF/yr)

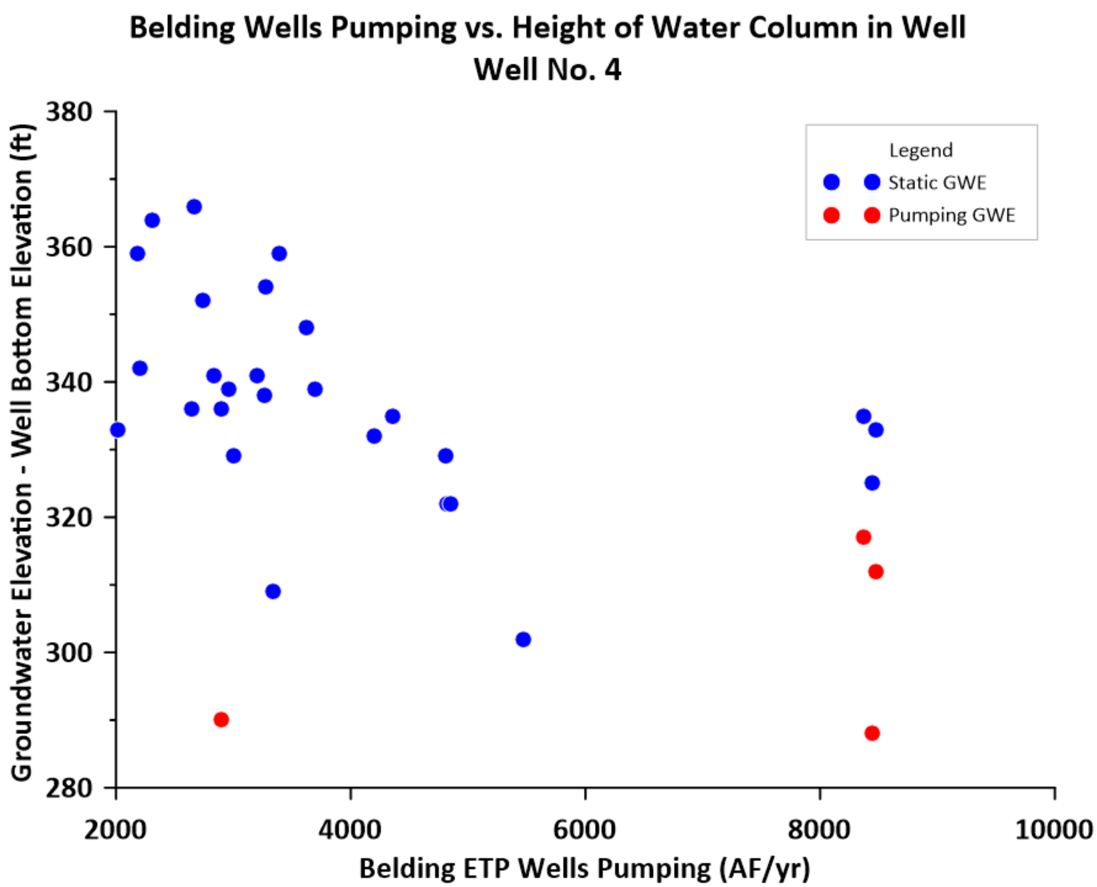
Belding Wells Pumping vs. Summer Minimum Groundwater Elevation
Well No. 3

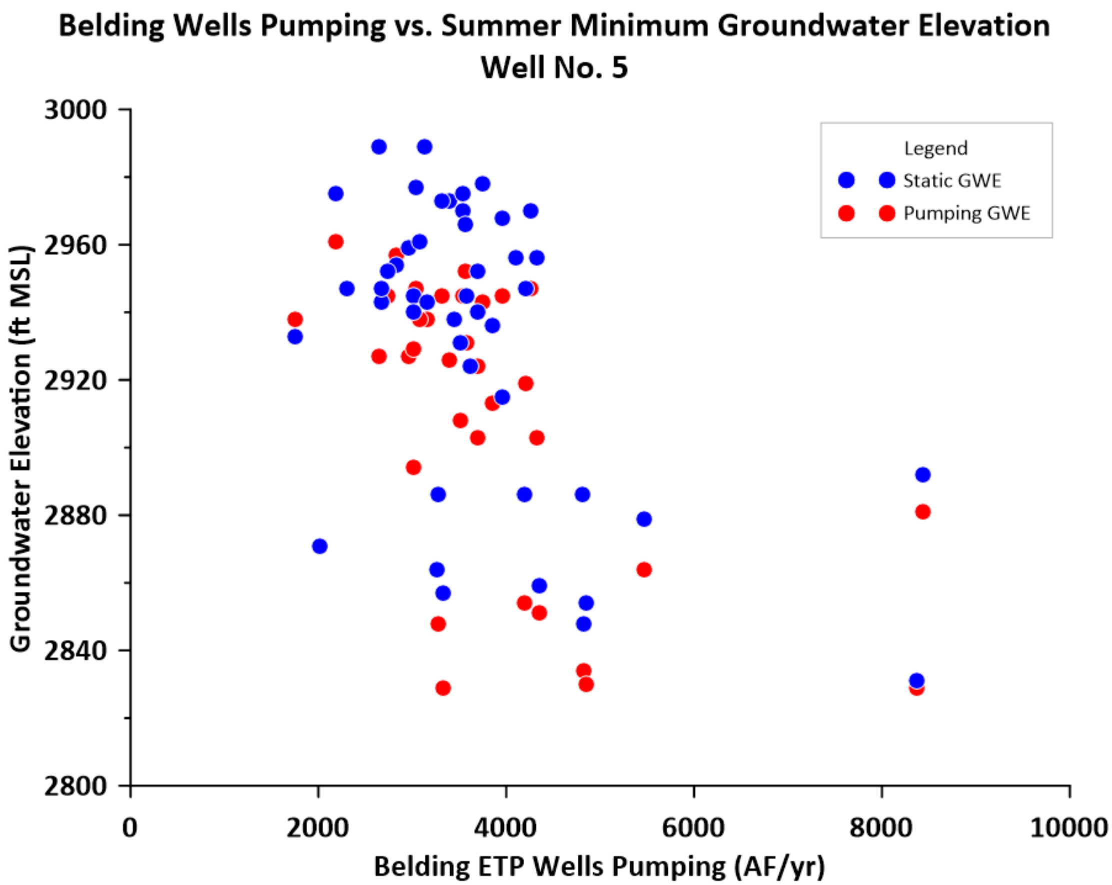


Belding Wells Pumping vs. Height of Water Column in Well
Well No. 3

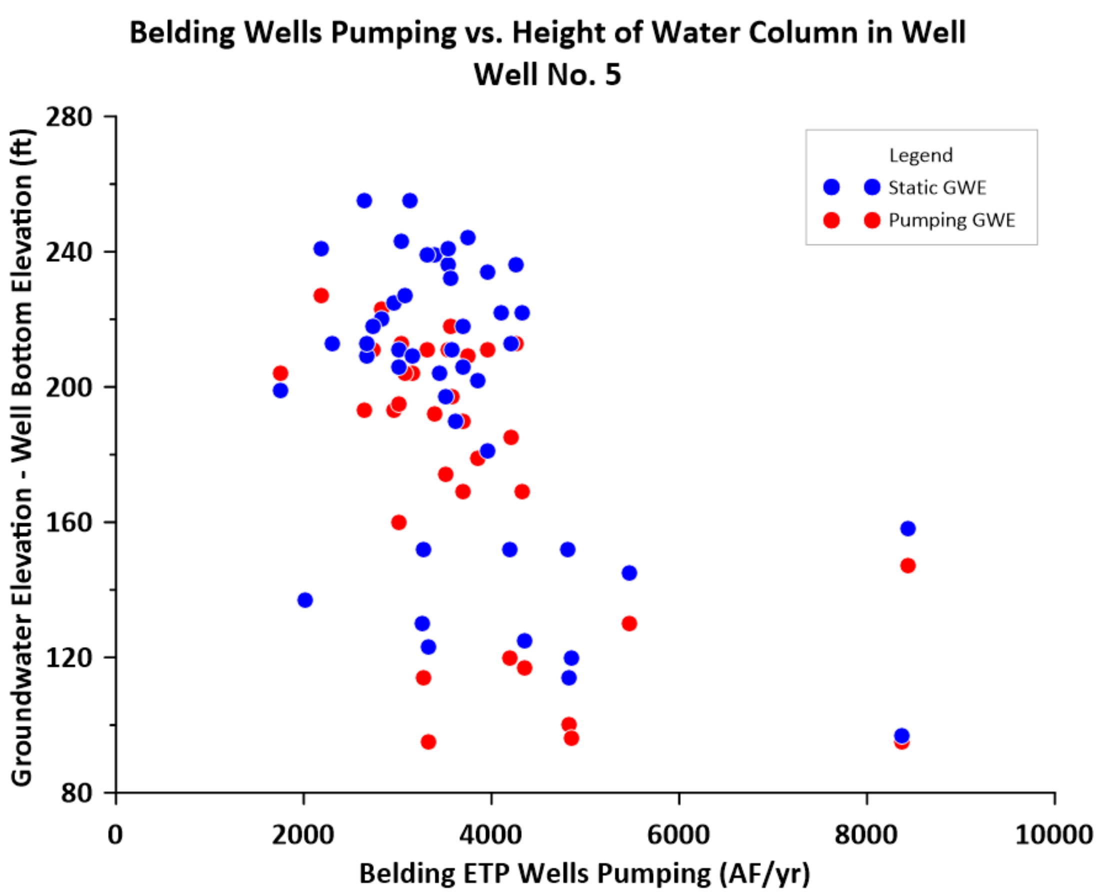



Belding Wells Pumping vs. Summer Minimum Groundwater Elevation
Well No. 4
Legend
Static GWE
Pumping GWE
Groundwater Elevation (ft MSL)
2940
2920
2900
2880
2860
2840
2000
4000
6000
8000
10000
Belding ETP Wells Pumping (AF/yr)


Belding Wells Pumping vs. Height of Water Column in Well
Well No. 4
Legend
Static GWE
Pumping GWE
Groundwater Elevation - Well Bottom Elevation (ft)
380
360
340
320
300
280
2000
4000
6000
8000
10000
Belding ETP Wells Pumping (AF/yr)

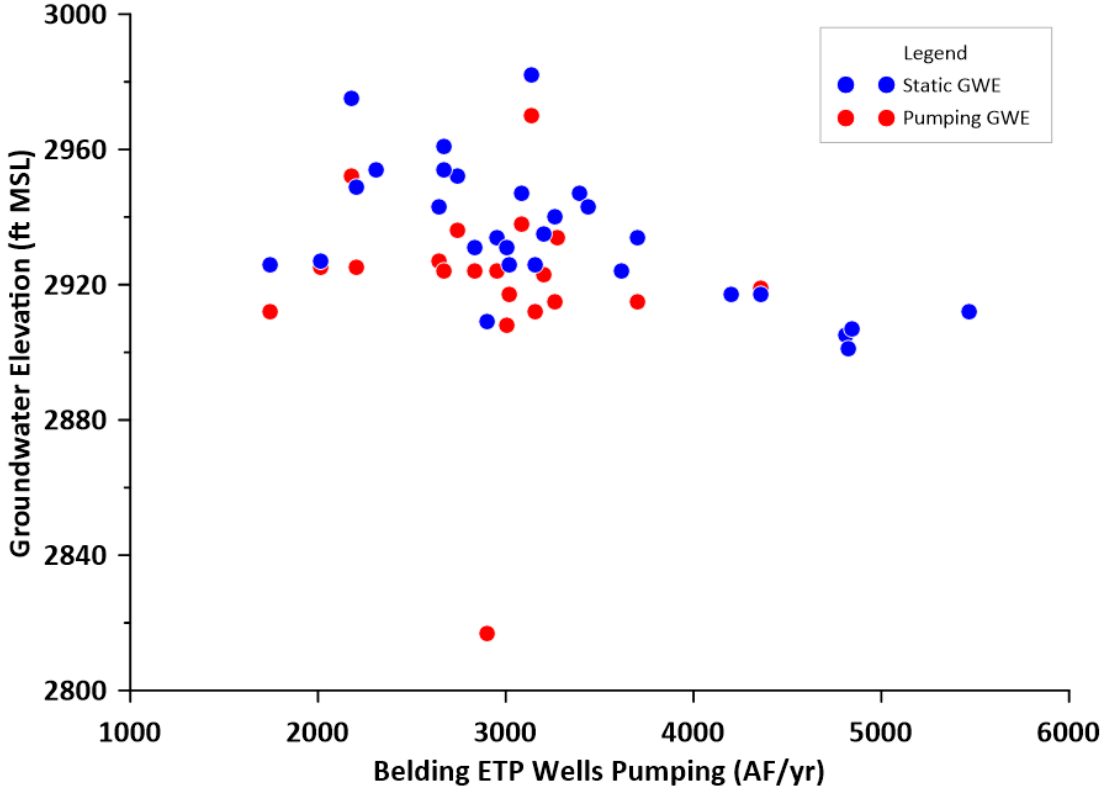


Belding Wells Pumping vs. Summer Minimum Groundwater Elevation
Well No. 5
Legend
Static GWE
Pumping GWE
Groundwater Elevation (ft MSL)
3000
2960
2920
2880
2840
2800
0
2000
4000
6000
8000
10000
Belding ETP Wells Pumping (AF/yr)

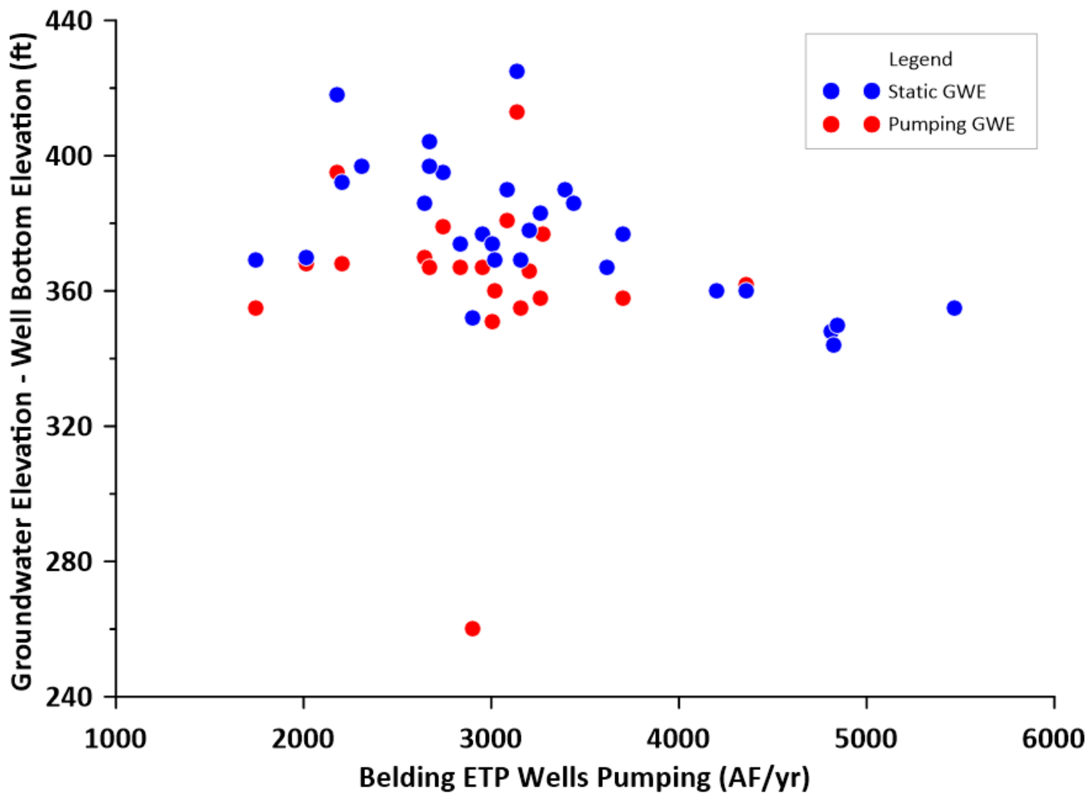


Belding Wells Pumping vs. Height of Water Column in Well
Well No. 5
Legend
Static GWE
Pumping GWE
Groundwater Elevation - Well Bottom Elevation (ft)
280
240
200
160
120
80
0
2000
4000
6000
8000
10000
Belding ETP Wells Pumping (AF/yr)

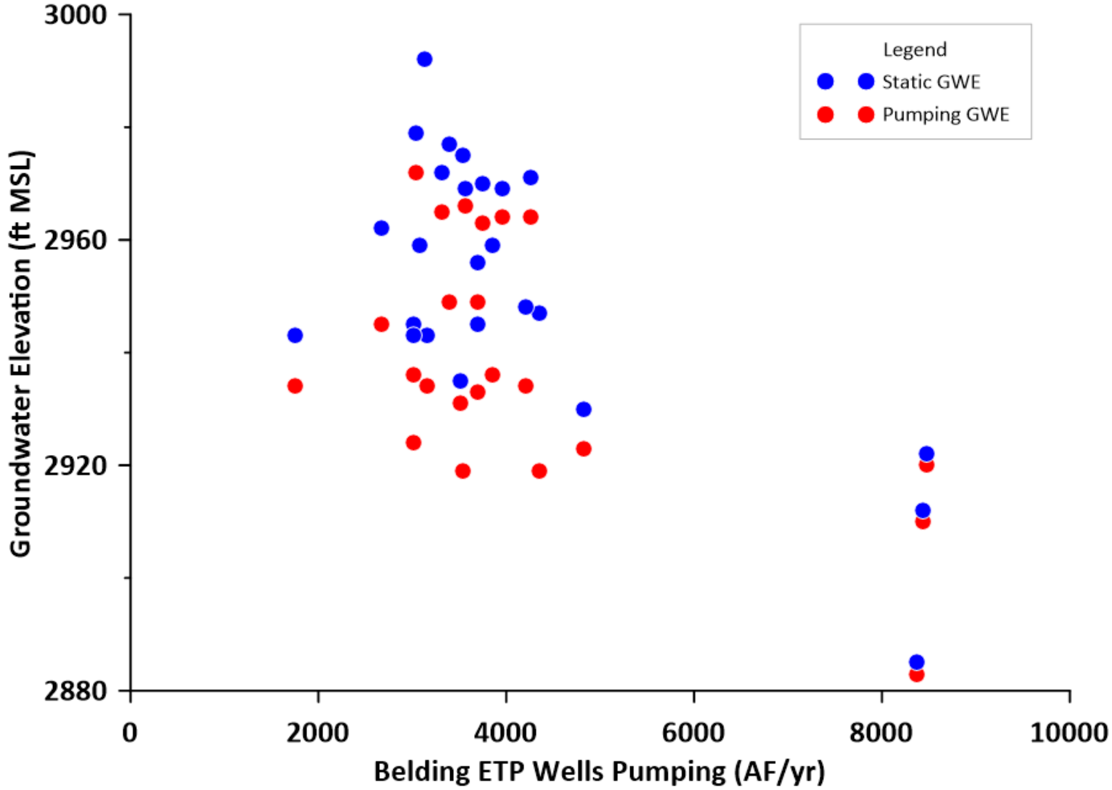
Belding Wells Pumping vs. Summer Minimum Groundwater Elevation
Well No. 8



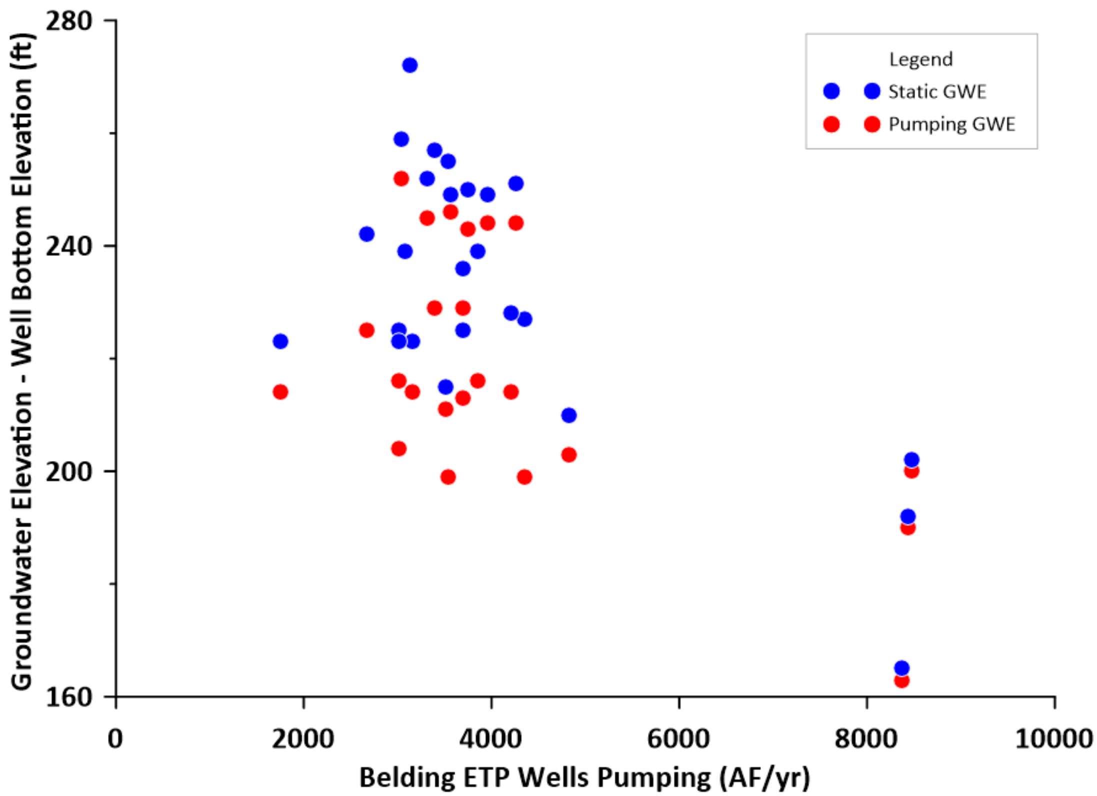
Belding Wells Pumping vs. Height of Water Column in Well
Well No. 8

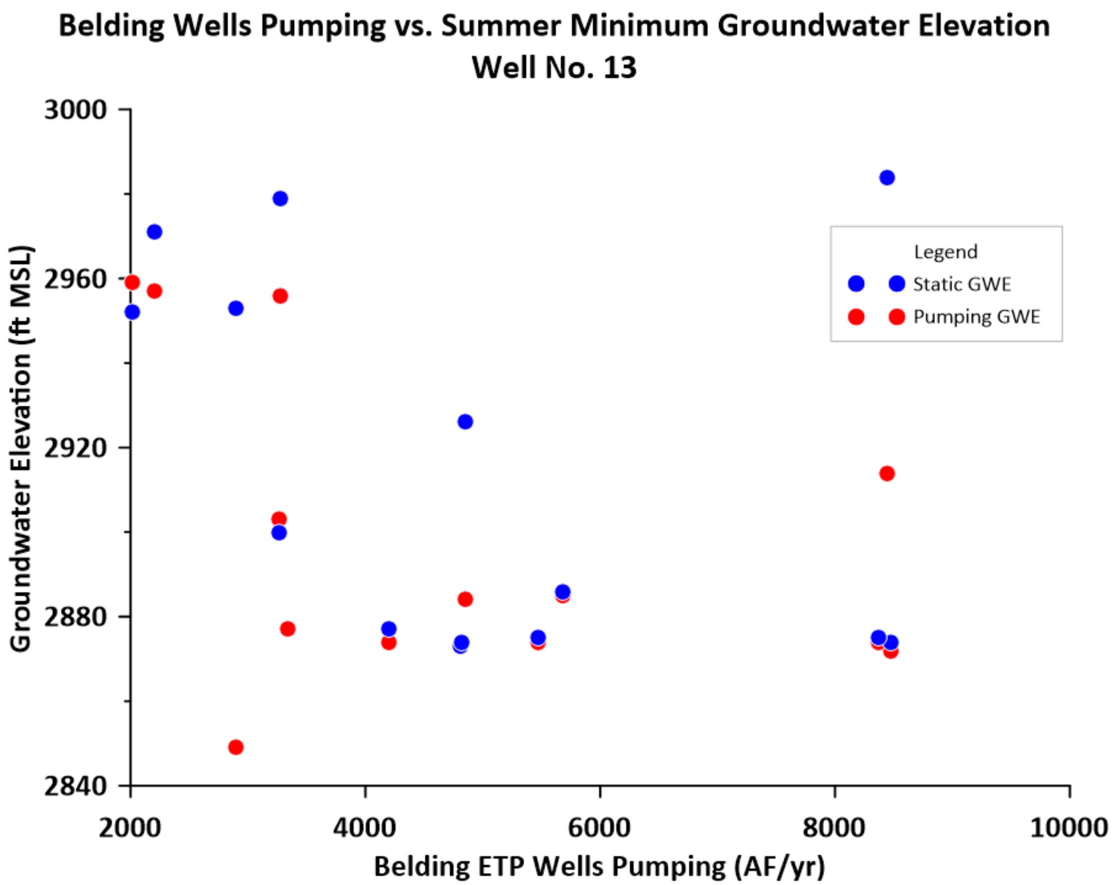


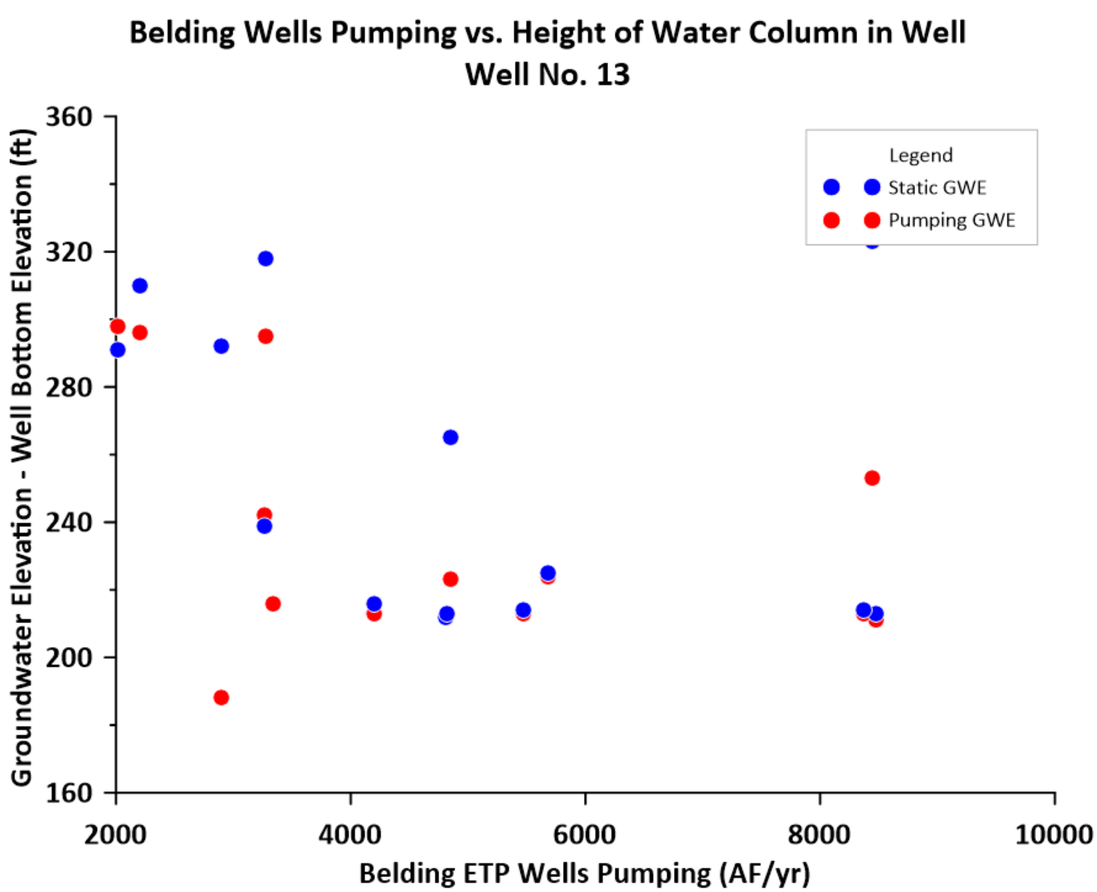
Belding Wells Pumping vs. Summer Minimum Groundwater Elevation
Well No. 10

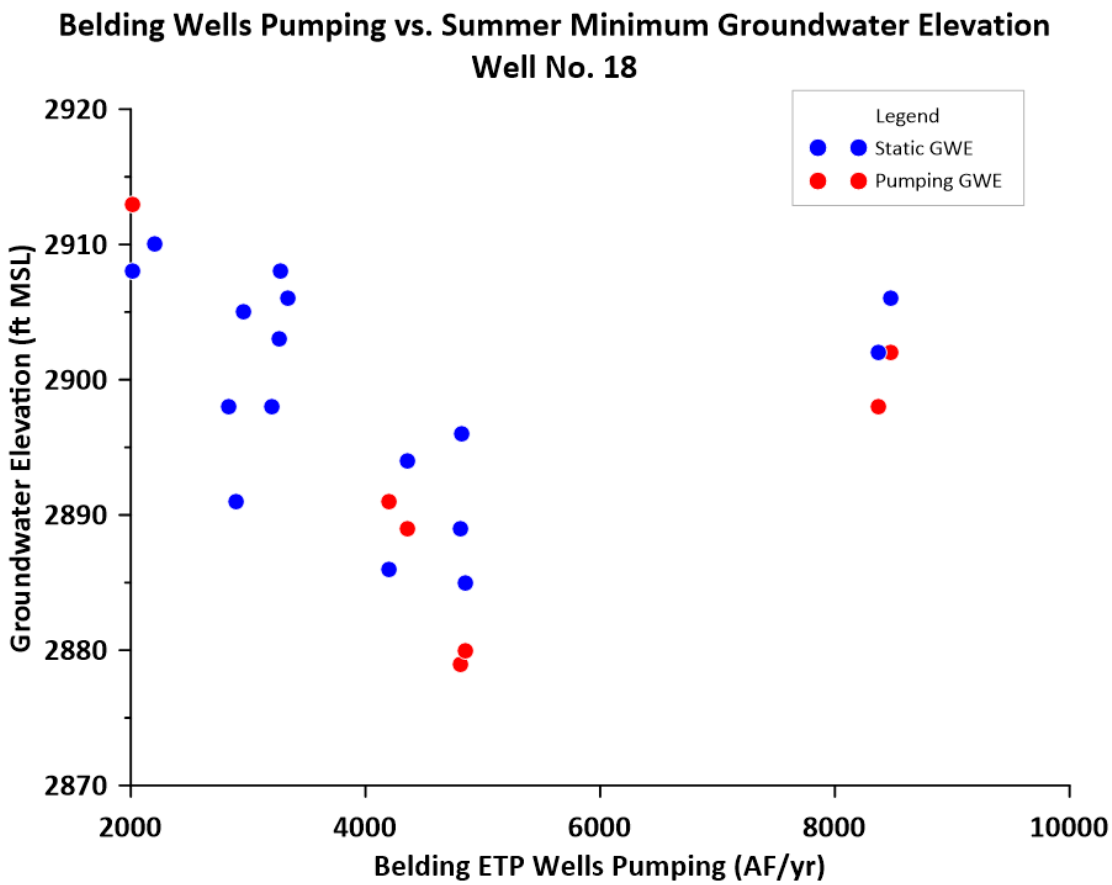


Belding Wells Pumping vs. Height of Water Column in Well
Well No. 10

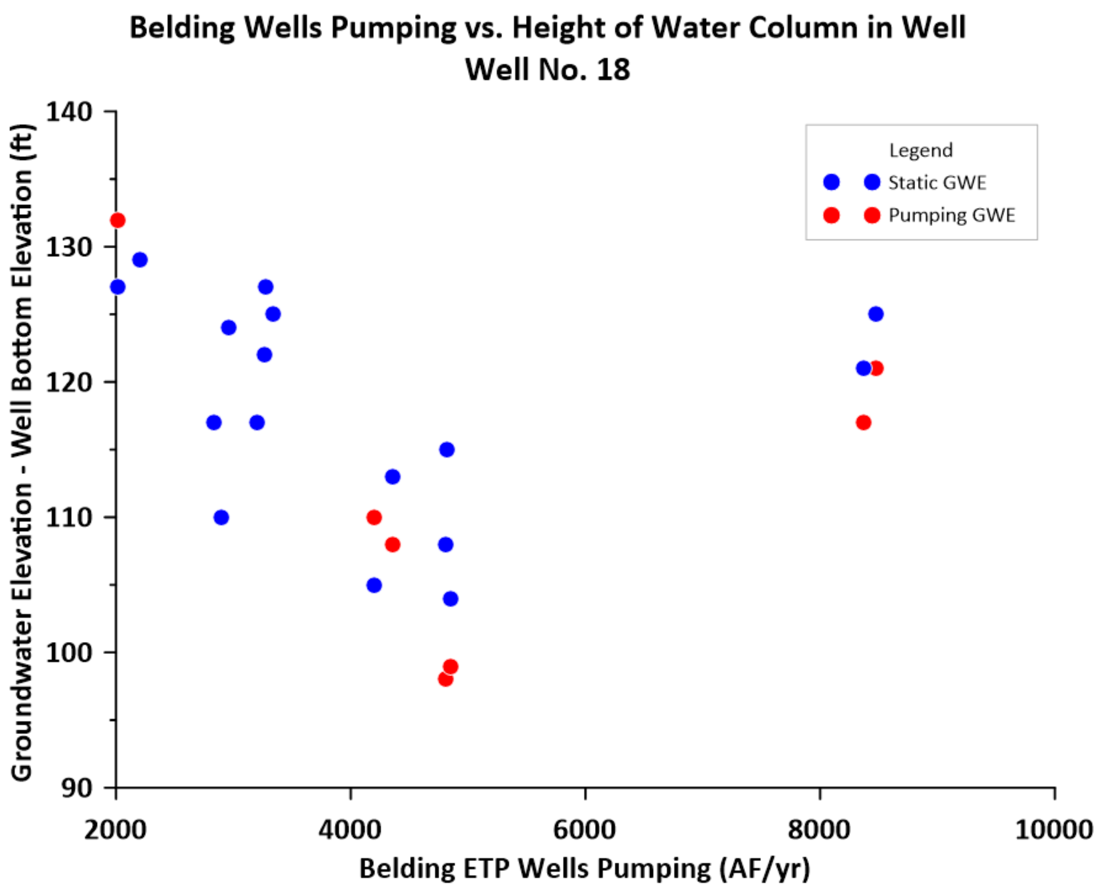



Belding Wells Pumping vs. Summer Minimum Groundwater Elevation
Well No. 13
Groundwater Elevation (ft MSL)
3000
2960
2920
2880
2840
2000
4000
6000
8000
10000
Belding ETP Wells Pumping (AF/yr)
Legend
Static GWE
Pumping GWE

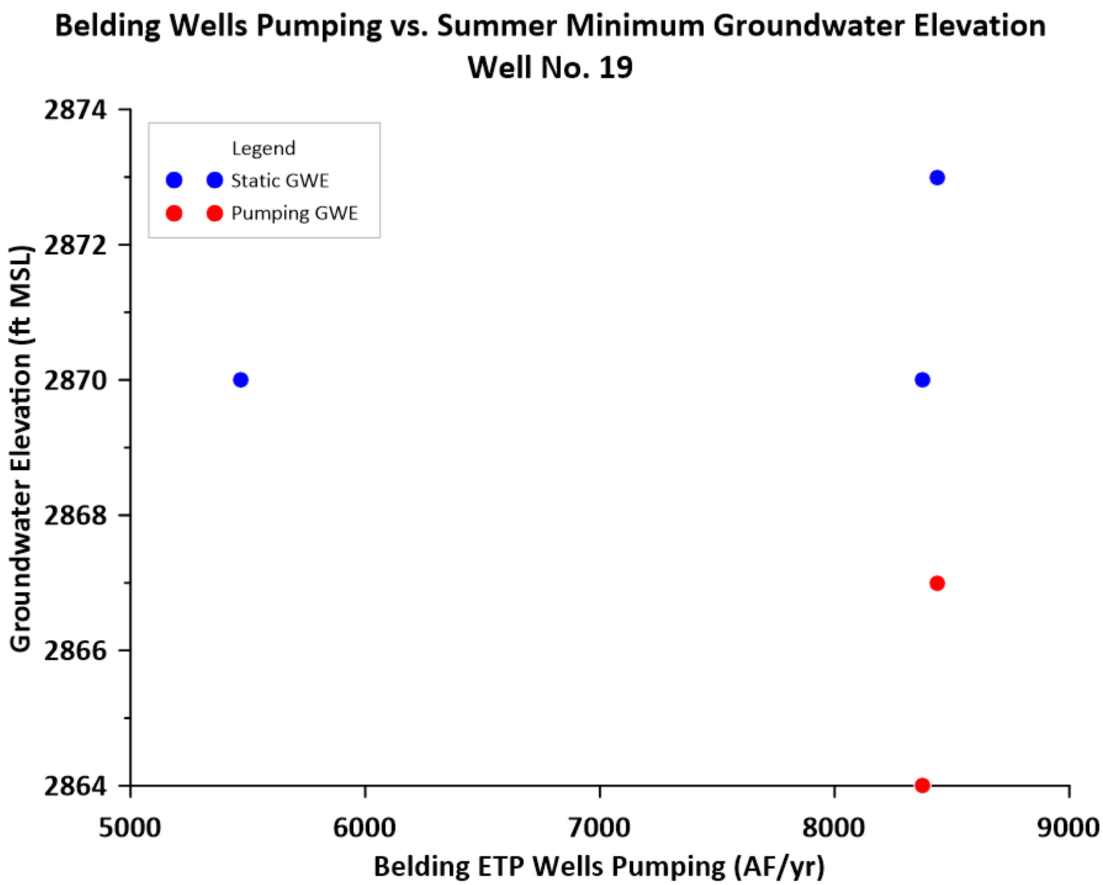

Belding Wells Pumping vs. Height of Water Column in Well
Well No. 13
Groundwater Elevation - Well Bottom Elevation (ft)
360
320
280
240
200
160
2000
4000
6000
8000
10000
Belding ETP Wells Pumping (AF/yr)
Legend
Static GWE
Pumping GWE

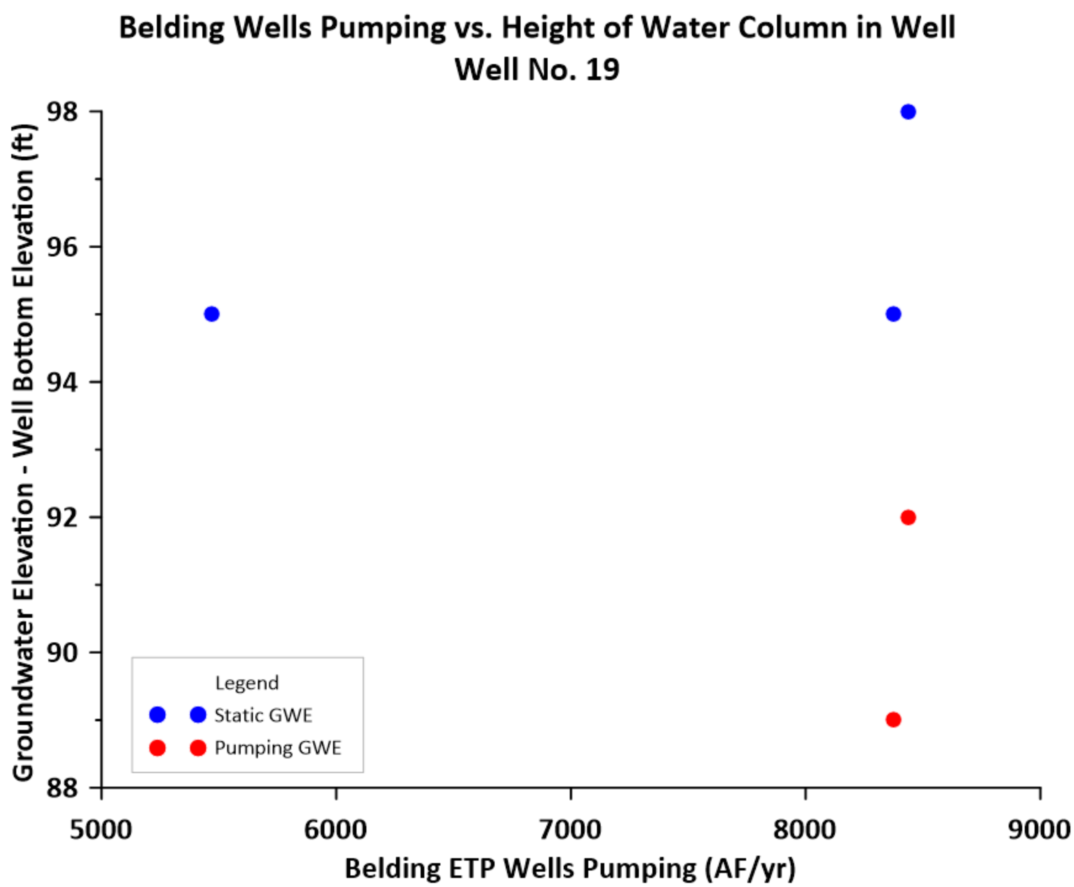


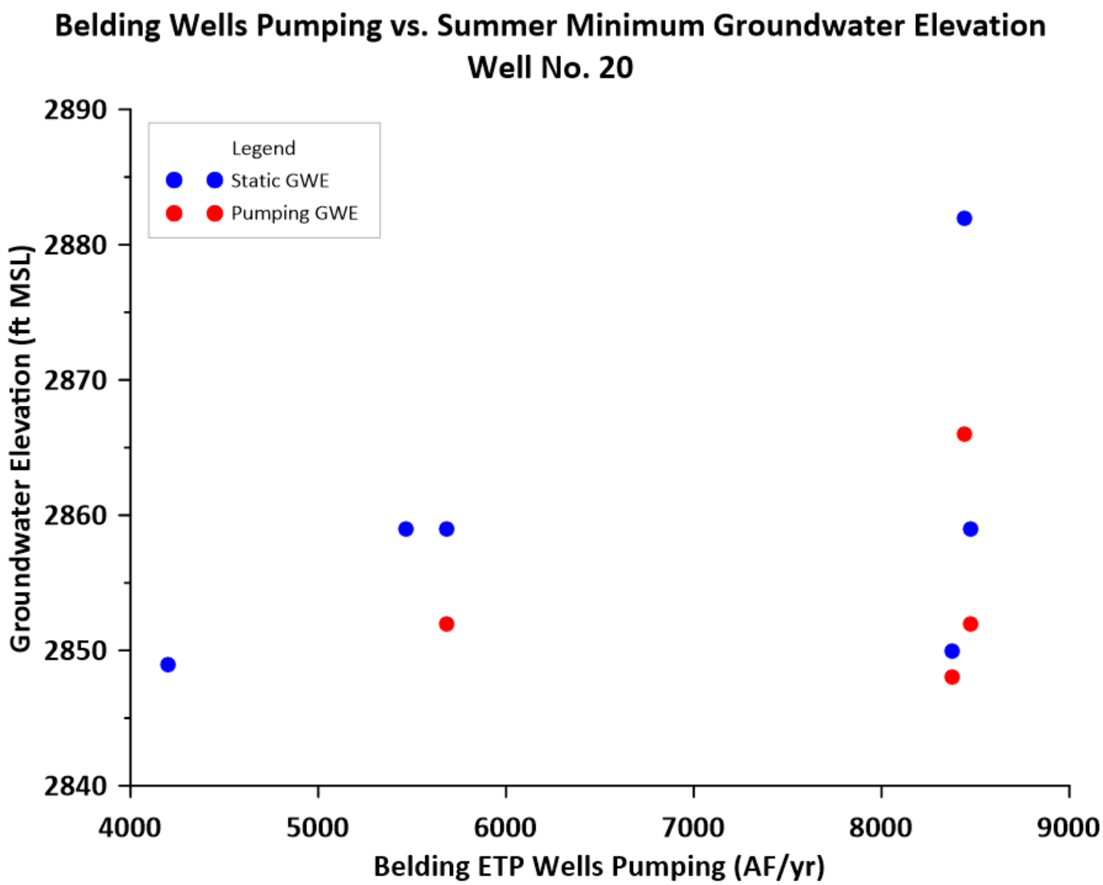
Belding Wells Pumping vs. Summer Minimum Groundwater Elevation
Well No. 18
Legend
Static GWE
Pumping GWE
Groundwater Elevation (ft MSL)
2920
2910
2900
2890
2880
2870
2000
4000
6000
8000
10000
Belding ETP Wells Pumping (AF/yr)

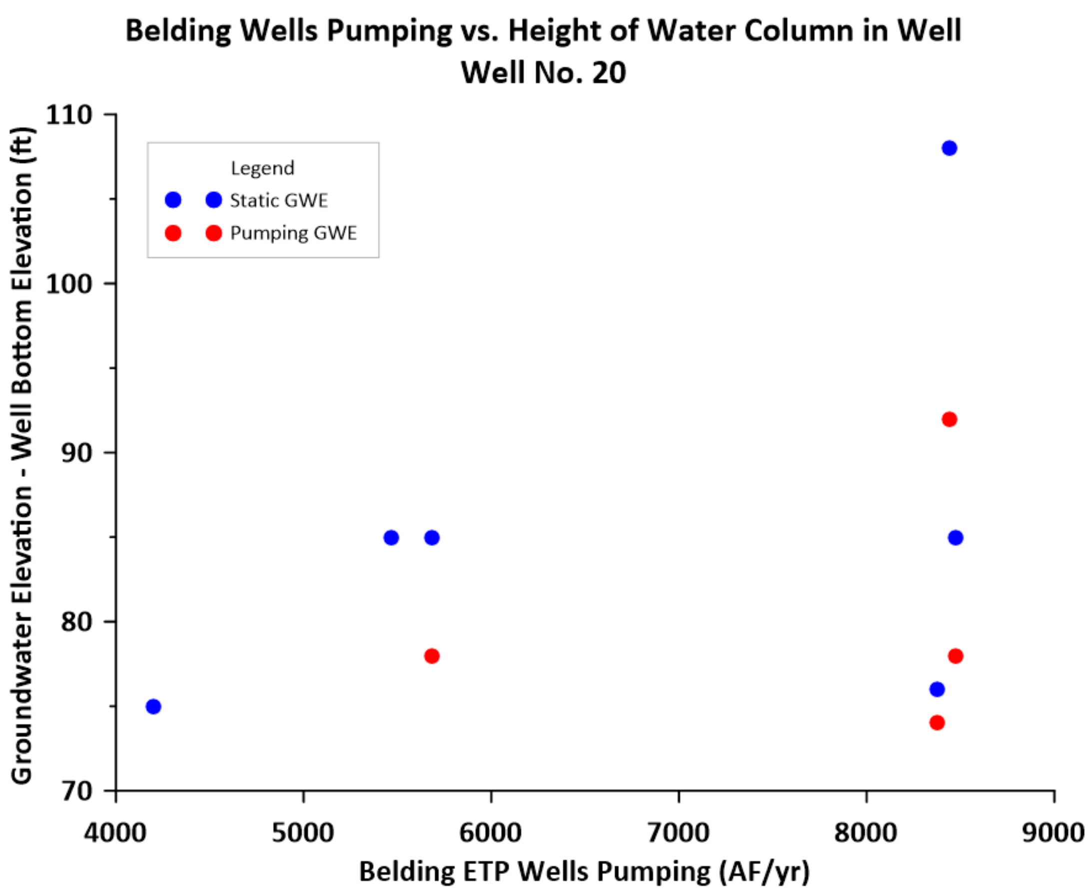


Belding Wells Pumping vs. Height of Water Column in Well
Well No. 18
Legend
Static GWE
Pumping GWE
Groundwater Elevation - Well Bottom Elevation (ft)
140
130
120
110
100
90
2000
4000
6000
8000
10000
Belding ETP Wells Pumping (AF/yr)


Belding Wells Pumping vs. Summer Minimum Groundwater Elevation
Well No. 19
Legend
Static GWE
Pumping GWE
Groundwater Elevation (ft MSL)
2874
2872
2870
2868
2866
2864
5000
6000
7000
8000
9000
Belding ETP Wells Pumping (AF/yr)


Belding Wells Pumping vs. Height of Water Column in Well
Well No. 19
Groundwater Elevation - Well Bottom Elevation (ft)
98
96
94
92
90
88
Legend
Static GWE
Pumping GWE
5000
6000
7000
8000
9000
Belding ETP Wells Pumping (AF/yr)


Belding Wells Pumping vs. Summer Minimum Groundwater Elevation
Well No. 20
Legend
Static GWE
Pumping GWE
Groundwater Elevation (ft MSL)
2890
2880
2870
2860
2850
2840
4000
5000
6000
7000
8000
9000
Belding ETP Wells Pumping (AF/yr)


Belding Wells Pumping vs. Height of Water Column in Well
Well No. 20
Legend
Static GWE
Pumping GWE
Groundwater Elevation - Well Bottom Elevation (ft)
110
100
90
80
70
4000
5000
6000
7000
8000
9000
Belding ETP Wells Pumping (AF/yr)

<u>Middle Pecos GCD Exhibit 33</u>

Cockrell Investment Partners, L.P. and Belding Farms' First Petition for Rulemaking
(December 18, 2023)

MIDDLE PECOS
Groundwater Conservation District

P. O. Box 1644, Fort Stockton, Texas 79735
Phone: 432/336-0698; Fax: 432/336-3407
Email: mpgcd@mpgcd.org

PETITION TO ADOPT OR MODIFY A DISTRICT RULE

Instructions: This Petition to Adopt or Modify a District Rule form must be completed as required by District Rule 6.5 and filed at the District office. Each rule adoption or modification requested must be submitted on a separate Petition to Adopt or Modify a District Rule form.

A person unable to comply with any procedures under District Rule 6.5, or to provide the information required by this form, may file a written explanation as to why compliance with the required procedure(s) is not possible along with a written request that the District waive the specific procedure(s). The written explanation and written request must be submitted to the District Office at the same time as this Form.

Additional information may be attached to this form.

1. **Text of Proposed Rule or Rule Modification** (underline words proposed to be added to the text of the current rules and strike through words proposed to be deleted from the text of the current rules):

RULE 10.8 RULES FOR MANAGEMENT ZONE 1

(a) All non-exempt permit holders are required to meter all non-exempt wells, unless permit is for fewer than 100 ac/ft. Meters to be installed on or before 12/31/2023, and upon completion of any new wells.

(b) All new, non-exempt wells constructed within Management Zone 1 are required to install a 1" pvc line for pressure transducers or concurrently install a monitoring well.

(c) On or before 12/31/2023, all permitholders over 1000 ac/ft are required to pay for a pressure transducer on up to 10% of their wells and allow MPGCD access to the well to install, repair, and monitor. MPGCD may decide in which wells to install transducers.

(d) MPGCD will perform water quality testing (lab result type) in all MPGCD monitoring wells in July and January. All permitholders over 1000 ac/ft are required to perform same test in 50% their wells in July and January and submit to District.

... Continued in attached "PROPOSED MPGCD RULES FOR MZ1."

2. **Written Explanation of the Intended Purpose of the Proposed Rule or Rule Modification:**

To properly ensure that the District's Management Plan for Management Zone 1 accounts for the overall health and future resilience of the aquifer for all beneficial uses, Cockrell requests that the District adopt the Proposed Rule 10.8 to establish (a) more precise and consistent monitoring of wells within Management Zone 1; and (b) year-round thresholds that monitor declining water levels and are able to trigger automatic pumping cutbacks if the water level drops below the threshold. If the above issues are addressed through meaningful rulemaking procedures, the groundwater levels will be more consistent and the aquifer will be healthier. Enforcing year-round thresholds (not just in the winter recovery period) will allow the District to use index wells to protect the health of the aquifer throughout the entire year by making sure the water levels are maintained at a certain level even during the summer months where irrigation and municipal use are at their highest. Establishing year-round thresholds is not unusual, as many other groundwater conservation districts across the state implement them. The identified thresholds are designed to protect the aquifer at historic lows.

3. **Allegation of Injury or Inequity that could Result from Failure to Adopt Proposed Rule or to Modify Current Rule:**

The current Management Plan and FSH Special Permit Conditions provide that if 6 of the 11 monitoring wells within Management Zone 1 do not recover above the Winter Thresholds, then specified reductions in pumping will be implemented for the remainder of the year. However, the Management Plan does not provide for a year-round or floor threshold with any real consequences for what occurs if the groundwater level drops too low. Of particular concern is the fact that once the water level in a specific monitoring well recovers above an applicable winter threshold, even if just for an instant, the Management Plan considers the monitoring well to have achieved recovery and cutbacks will not be considered until the following year. Once recovered above the Winter Threshold, the permit holders can proceed with pumping groundwater without threat of cutbacks. This allows for water levels to continue dropping as irrigation begins.

Another problem with the current Management Plan is that it allows for certain groundwater permitholders to “game” the monitoring well system. Specifically, during the winter recovery period, permitholders who have higher usage needs can increase pumping from wells that are farther from the specified monitoring wells in order to allow 6 or more monitoring wells to register levels that rise above the Winter Thresholds, meaning normal pumping can resume across the board without consequence of cutbacks.

Without significant rulemaking changes in cutback threshold levels are determined and maintained, the following issues likely occur: declining water levels, decreased transmissibility, decreased levels of production, increased levels of solids in the water, higher production costs, and potential need to install larger pumps, drill deeper wells, and even re-drill some wells. Lack of proper enforcement and pumping adjustments based on water levels increases risks of long-term damage to the aquifer and its ability to adequately recover after the summer irrigation season. Increased strain on the aquifer could also damage other nearby aquifers. Individual users, such as Belding Farms, may experience a loss or degradation of water at or below historic levels.

4. **Description of Petitioner(s) Real Property Interest in Groundwater in the District** (attach proof of real property interest in groundwater located within the District for each petitioner):

Cockrell is a landowner within the District. Cockrell/Belding Farms owns a 2,205 acre commercial pecan orchard consisting of approximately 68,000 trees. For its orchard, Cockrell utilizes its substantial water rights in the Edwards-Trinity Aquifer, which supports its pecan orchard.

Cockrell currently has a Historic Existing Use Permit that was issued in July 2006 for 16 wells in the amount of 15,528.846 acre feet, which is used to, among other things, supply water/irrigation requirements for its pecan orchard consisting of approximately 68,000 trees. In fact, Cockrell’s 2,205-acre orchard is a part of 6,663.18 acres owned and leased by Cockrell.

For additional details, please see COCKRELL INVESTMENT PARTNERS, L.P.’S PETITION TO ADOPT RULE submitted to the MPGCD on September 5, 2023, and attached hereto.

Petitioner(s) Information (Please include information for additional petitioners as appropriate).

Petitioner #1:

Cockrell Investment Partners, LP and Belding Farms, c/o Ryan C. Reed, Attorney

(210) 222-9494; rreed@pulmanlaw.com

First Name Last Name Phone Number Email Address

Pulman, Cappuccio & Pullen, LLP, 2161 NW Military Hwy, Suite 400, San Antonio, TX 78213

Physical Address City State Zip code

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Mailing Address City State Zip code

/s/ Ryan C. Reed 12/18/2023

Signature *Date*

Petitioner #2:

First Name Last Name Phone Number Email Address

Physical Address City State Zip code

Mailing Address City State Zip code

Signature *Date*

Petitioner #3:

First Name Last Name Phone Number Email Address

Physical Address City State Zip code

Mailing Address City State Zip code

Signature *Date*

Additional information may be attached to this form.

RULE 10.8 Rules for Management Zone 1

(a) All non-exempt permit holders are required to meter all non-exempt wells, unless permit is for fewer than 100 ac/ft. Meters to be installed on or before 12/31/2023, and upon completion of any new wells.

(b) All new, non-exempt wells constructed within Management Zone 1 are required to install a 1" pvc line for pressure transducers or concurrently install a monitoring well.

(c) On or before 12/31/2023, all permitholders over 1000 ac/ft are required to pay for a pressure transducer on up to 10% of their wells and allow MPGCD access to the well to install, repair, and monitor. MPGCD may decide in which wells to install transducers.

(d) MPGCD will perform water quality testing (lab result type) in all MPGCD monitoring wells in July and January. All permitholders over 1000 ac/ft are required to perform same test in 50% their wells in July and January and submit to District.

(e) All permit holders subject to metering requirements under these Rules are required to submit to the MPGCD, on a quarterly basis, their meter readings, subject to additional reporting requirements under Reporting Threshold levels.

(f) Thresholds, Reporting Requirements, and Cutbacks

(1) The Prison Well, MPGCD 320, S-45, and S-6 are designated as groundwater elevation trigger wells. Threshold triggers are invoked when two of the four wells register groundwater elevations below the specified groundwater trigger elevations set forth herein. When invoked, cutbacks and contingency planning set forth herein will be instituted. Groundwater elevation trigger levels for all four wells are summarized in **Table 1.**

Table 1. Groundwater elevation trigger levels (ft, msl | depth to water)

Well	Threshold 1		Threshold 2		Threshold 3	
Prison Well	2960	239	2950	249	2900	299
S-6	2935	188	2925	198	2875	248
S-45	2920	147	2910	157	2860	207
MPGCD 320	2900	168	2890	178	2840	228

(2) Threshold 1: District Action -

i. District sends written notice to all permitholders of Threshold being reached and requirements for permitholders and/or publishes on Website/via Email
ii. All permitholders monitor and report water levels monthly
iii. All permitholders report lowering of pumps and new pump depth
iv. No new transport/export permits considered by MPGCD
v. No applications for non-exempt wells considered
vi. Schedule Agenda item for next board meeting to discuss results of monitoring data including reporting data, water levels, pump depth, etc.
vii. This remains in effect for 30 days, even if levels go above Threshold 1

(3) Threshold 2: District Action -

i. District sends written notice to all permitholders of Threshold being reached and requirements for permitholders and/or publishes on Website/via Email
ii. All permitholders monitor and report water levels monthly
iii. All permitholders report lowering of pumps and new pump depth
iv. No new transport/export permits considered by MPGCD
v. No applications for non-exempt wells considered
vi. Schedule board meeting within 10 days to discuss potential exercise of District's emergency powers
vii. Production permit holders in Management Zone 1 will only be authorized to produce 50 percent of 1/365 of their respective annual permitted pumping amount on a daily basis. Production permit holders may resume pumping their full permitted amount ten (10) days after three of the four trigger wells register daily groundwater elevations above Threshold 2 triggers.

(4) Threshold 3: District Action -

i. Production permit holders in Management Zone 1 will cease to be authorized to produce under their production permit. Production permit holders may resume pumping: (i) 50 percent of 1/365 of their respective annual permitted pumping amount on a daily basis ten (10) days after three of the four trigger wells register daily groundwater elevations above Threshold 3 triggers, and (ii) their full permitted amount ten (10) days after three of the four trigger wells register daily groundwater elevations above Threshold 2 triggers.

(5) If, during any year, Threshold 2 trigger levels are exceeded and there is no adverse impact on the aquifer, following an evidentiary hearing at which it is determined that (a) no Management Zone 1 groundwater permit holder's (i) Total Dissolved Solids have increased by more than 5.0% over TDS levels observed in wells in calendar years 2017-2023; (ii) Sodium levels have increased by more than 5.0% over Sodium levels observed in wells in calendar years 2017-2023; (iii) Calcium levels have increased by more than 5.0% over Calcium levels observed in its wells in calendar years 2017-2023; and (iv) production rates have decreased by more than 5.0% over rates observed in its wells in calendar years 2017-2023, and (b) other aquifers are not recharging the Edwards-Trinity Aquifer, the Threshold trigger levels in Table 1 may be adjusted by no more than 10 feet (10' decrease for msl, 10' increase for depth to water) for the following year. Provided, however, that if FSH's Special Permit Conditions Winter Threshold 1 is invoked in any year, the Thresholds in Table 1 shall apply for the following year.

<u>**Middle Pecos GCD Exhibit 34**</u>

Summary of Cockrell's Proposed Rule 10.8(a)-(f) and Board Deliberation and General Manager's Comments during Board Deliberation (March 2024)

Summary of Cockrell's Proposed Rule 10.8(a)-(f) and Board Deliberation and General Manager's Comments during Board Deliberation

Proposed Rule	Summary of Proposed Rule (only applicable in MZ 1)	Summary of Board Deliberation and General Manager's Comments during Board Deliberation
(a)	Meters would be required for new and existing non-exempt wells producing ≥ 100 afy	<u>Not necessary</u>: There's no disagreement about the importance of being accountable for pumping. We already achieve this because all nonexempt wells have to report pumping. The following high-volume permit holders already meter: Cockrell, FSH, prison, and City's wells are all metered, and the Pecos Pecan wells will be soon. If a well isn't metered, then its production is calculated by alternative measuring methods (using crop records and electric/power usage records, which are commonly used in other districts). <u>Cost impact</u>: Proposed to be on landowners, not the District.
(b)	1" pvc line for pressure transducers required for new non-exempt wells	<u>Not necessary</u>: We don't need to use a transducer in every new non-exempt well because we've already placed transducers in our monitoring wells, which we've been intentional in selecting. <u>Cost impact</u>: Proposed to be on landowners, not the District.
(c)	Permit holders authorized to pump > 1,000 afy must pay for pressure transducers on 10% of their wells selected by MPGCD with access for MPGCD	<u>Not necessary</u>: We don't need these transducers because we've already been intentional in selecting 36-37 monitoring wells in MZ 1, with 31 transducers already installed in those wells. <u>Cost impact</u>: Proposed to be on landowners, not the District.
(d)	Water quality testing by lab required in all monitoring wells in January and July Permit holders authorized to pump > 1,000 afy must perform same test in 50% of their wells in January and July and provide results to MPGCD	<u>Not warranted</u>: First, this is not practical because most of our monitoring wells don't have pumps. Our solution has been to take samples from every pumping well we can get to, including those wells near monitoring wells. Second, we're already assessing water quality based on unique circumstances (e.g., well location, pumping patterns) and our recognition that water quality can change—picking January and July is arbitrary. <u>Cost impact</u>: Proposed to be on landowners, not the District.

Proposed Rule	Summary of Proposed Rule	Summary of Board Deliberation and General Manager’s Comments during Board Deliberation
(e)	Permit holders subject to metering under Rule 10.8 must submit quarterly readings to MPGCD Permit holders subject to metering under Rule 10.8 must comply with additional reporting requirements under Rule 10.8(f) thresholds	Not necessary: Landowners have to keep records of all pumping. Currently, we require submission of some readings monthly, and some annually. We can inspect/request records any time, so a quarterly requirement is unnecessarily burdensome to landowners. It is apparent that we have a good understanding of usage in MZ 1.
(f)	Three (3) well-level thresholds established in four (4) wells: Prison Well and Well #s S-6, S-45, and MPGCD 320 When 2 of 4 wells hit specified thresholds: · notice to MZ 1 permit holders · enhanced reporting by MZ 1 permit holders · moratorium within MZ 1 on new permit apps and export-authorizations · Board reviews data, considers exercising emergency powers · pumping cutbacks imposed within MZ 1 · if no “adverse impact” (defined by increase in any permit holders’ TDS, sodium, and calcium levels >5%; production-rate decline >5%; and no recharge to Edw-Tr from other aquifers) determined after evidentiary hearing, then well-threshold levels adjusted downward by not more than 10'. · if FSH SPC Threshold 1 triggered, then Rule 10.8(f) thresholds apply for the following year	Not presently necessary: Consistent with ongoing research and analysis, landowners ought to report when pumps are lowered and production decline—shouldn’t wait to hit thresholds. District would inspect and evaluate. Note that every morning our GM is reviewing current data. Current rules provide a process for accelerating review and restrictions if adverse effects are occurring. Our current cutback thresholds only affect FSH’s 28,400 afy permit. Note that permitting moratoria have been criticized at the Legislature. We’re a private-property rights state—how can we restrict new applications? Note that regular production permits in addition to FSH could be affected.

<u>Middle Pecos GCD Exhibit 35</u>

Review of Petition to Adopt or Modify a District Rule Submitted By Cockrell Investment Partners, LP and Belding Farms (March 11, 2024)

Final Report

Review of Petition to Adopt or Modify a District Rule Submitted by Cockrell Investment Partners, LP and Belding Farms

Prepared for:

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Middle Pecos Groundwater Conservation District
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Fort Stockton, TX 79735

Prepared by:

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March 11, 2024

Geoscientist and Engineering Seal

This report documents the work of the following licensed Texas Professional Geoscientist and licensed Texas Professional Engineers:

William R. Hutchison, Ph.D., P.E. (96287), P.G. (286)

Dr. Hutchison completed the data review and analyses described in this report and was the principal author of the final report.

STATE OF TEXAS
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PROFESSIONAL ENGINEER

William R Hutchison
3/11/2024

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3/11/2024

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B – Comment letters received on Hutchison (2017)
C – Hutchison (2018) Draft Report on review of Belding Farms data
D – Updated Analysis of Belding Farms Data and Proposed “Anytime” Thresholds (October 17, 2023 Presentation)

1.0 Introduction

On December 18, 2023, Cockrell Investment Partners, LP and Belding Farms submitted a Petition to Adopt or Modify a District Rule to the Middle Pecos Groundwater Conservation District (MPGCD). The petition was submitted in accordance with MPGCD Rule 6.5 which provides details on required information to be submitted in support of the petition and the procedures and deadlines related to consideration of the petition by MPGCD. The requested rule modifications include six separate items in a proposed new Rule 10.8 (labeled a to f) that are specific to Management Zone 1. In summary the proposed rule would:

a) Require flow meters for all non-exempt wells with permits over 100 AF/yr.
b) Require tremie pipe and pressure transducers for all new non-exempt wells.
c) Require pressure transducers on up to ten percent of existing wells for permit holders over 1,000 AF/yr
d) Require MPGCD to perform water quality sampling and analysis of all MPGCD monitoring wells and require permit holders over 1,000 AF/yr to sample and analyze 50 percent of their wells each January and July and submit results to MPGCD.
e) Require permit holders to submit meter readings to MPGCD quarterly.
f) Establish three year-round thresholds in four monitoring wells and specifies management action associated with reaching each threshold level.

At the regular meeting of the MPGCD Board of Directors on February 20, 2024, a public hearing was held to receive testimony on the petition. Cockrell Investment representatives used a PowerPoint presentation to highlight various points to support their request for modification to the MPGCD Rules. The PowerPoint presentation focused on year-round thresholds (proposed Rule 10.8(f) in the petition) and did not address the other items in the petition (proposed Rules 10.8(a) to 10.8(e) in the petition).

After the completion of the public hearing, MPGCD Board members discussed the petition. Two motions (one to deny the petition and one to grant the petition and initiate rulemaking proceedings on the subject matter) failed to receive sufficient votes, and the matter was tabled until the MPGCD Board meeting of March 18, 2024.

During the discussion of the motion to deny the petition, it was recognized that MPGCD Rule 6.5(h)(2) requires that if the petition is denied, an explanation for denial must be included in the minutes of the Board meeting or in a separate written statement to be kept in the District's records.

This report provides a review of the relevant activities since 2017 to provide context to the subsequent review of the individual components of the petition and the Cockrell Investments oral testimony at the February 20, 2024. The proposed rules are also reviewed in the context of the current rules of MPGCD.

If the MPGCD Board chooses to deny the petition, this report could serve as the "explanation for denial" document. If the MPGCD Board chooses to grant the petition and initiate rulemaking proceedings on the subject matter, this report can be used as a baseline document for the rulemaking proceedings.

2.0 Background and History

2.1 Development of Thresholds (2017)

In early 2017, initial discussions to settle the litigation brought by Fort Stockton Holdings, LP, Clayton Williams Farms, Inc., and Republic Water of Texas, LLC against MPGCD focused on establishing regulatory thresholds that defined the historic minimum groundwater elevations that could be used as special permit conditions for a proposed groundwater export project by Fort Stockton Holdings. After several meetings in the spring of 2017 that were attended by interested parties (including Cockrell Investments Partners and Belding Farms), a draft report was circulated that included monitoring threshold recommendations (Hutchison, 2017).

This draft report from 2017 is presented in Appendix A. Among the key elements of that report:

- Eleven wells were identified as suitable as monitoring points.
- The monitoring threshold recommendations were based on the "historic minimum groundwater elevations". The thresholds were developed based on a combination of historic data and model estimates, with a preference for actual historic data.
- The threshold recommendations were developed without the benefit of historic data from Belding Farms wells. These data were requested but were not provided prior to approval of the thresholds.

Interested parties were invited to provide comments on the draft report. Two letters were received and are presented as Appendix B.

2.2 Approval of Special Permit Condition Thresholds (2017)

Among the comments made by Cockrell Investments and Belding Farms on the draft report was a concern that the thresholds may not be consistent with the desired future conditions. In response to the comment, an analysis was completed that compared the proposed thresholds and the depth to water at each of the sites associated with the desired future condition.

On July 17, 2017, a meeting with interested parties (including representatives of Cockrell Investments) resulted in modified recommendations for monitoring thresholds. On July 18, 2017, the MPGCD Board approved the settlement agreement, the Fort Stockton Holdings production permit applications, and the modified recommendations for monitoring thresholds as special permit conditions.

Table 1 presents the approved thresholds expressed as depth to water. Table 2 presents the approved thresholds expressed as groundwater elevations. Figure 1 presents the comparison of the desired future conditions groundwater levels and the thresholds that was completed based on the comments from Cockrell Investments and Belding Farms discussed previously.

Table 1. FSH Special Permit Condition Monitoring Well Thresholds (Depth to Water)

FSH Special Permit Conditions - Monitor Well Thresholds Adopted on July 18, 2017
Thresholds Expressed as Depth to Water in Each Well

Well		Reference Point Elevation (ft MSL)	Winter Threshold 1		Winter Threshold 2 (Historic Minimum)		Winter Threshold 3		Winter Threshold 4		Maximum Recent Drawdown (Winter to Summer)	Summer Threshold		Recent Depth to Water	
Short Name	Long Name		Depth to Water (ft)	Basis	Depth to Water (ft)	Basis	Depth to Water (ft)	Basis	Depth to Water (ft)	Basis		Depth to Water (ft)	Basis	Winter	Summer
Mpgcd320	King, Woodward, #320	3068	205	Win2+5	200	Data 1/1999	195	Win2-5	190	Win2-10	45	245	Win2+Max DD	113	148
Mpgcd323	Ft Stockton, Cemetery, #323	3031	198	Win2+5	193	Data 1/2000	188	Win2-5	183	Win2-10	15	208	Win2+Max DD	146	148
C-5	C-5, FSH Well	3009	110	Win2+5	105	WPC 1973	100	Win2-5	95	Win2-10	72	177	Win2+Max DD	60	107
M-9	M-9, FSH Well	3261	313	Win2+5	308	WPC 1973	303	Win2-5	298	Win2-10	48	356	Win2+Max DD	246	283
S-45	S-45, FSH Well	3067	165	Win2+5	160	WPC 1973	155	Win2-5	150	Win2-10	56	216	Win2+Max DD	92	115
S-6	S-6, FSH Well	3123	205	Win2+5	200	WPC 1973	195	Win2-5	190	Win2-10	62	262	Win2+Max DD	118	159
Mpgcd305	Cockrell_Belding, #305	3233	292	Win2+5	287	WPC 1973	282	Win2-5	277	Win2-10	75	362	Win2+Max DD	206	250
Mpgcd318	Goldman Ranch, Well 1	2957	72	Win2+5	67	WPC 1975	62	Win2-5	57	Win2-10	33	100	Win2+Max DD	30	49
Mpgcd334	Carpenter, #334	3051	140	Win2+5	135	WPC 1975	130	Win2-5	125	Win2-10	36	171	Win2+Max DD	104	126
Interstate	Interstate Well, FSH Well	2988	96	Win2+5	91	WPC 1975	86	Win2-5	81	Win2-10	40	131	Win2+Max DD	49	71
Prison	TDCJ, Prison Well	3199	258	Win2+5	253	WPC 1973	248	Win2-5	243	Win2-10	50	303	Win2+Max DD	184	224

Threshold	Action
Winter Threshold 1	If 6 of 11 are below threshold, 100% reduction in FSH non-historical use pumping
Winter Threshold 2	If 6 of 11 are below threshold, 50% reduction in FSH non-historical use pumping
Winter Threshold 3	If 6 of 11 are below threshold, 30% reduction in FSH non-historical use pumping
Winter Threshold 4	If 6 of 11 are below threshold, 10% redcution in FSH non-historical use pumping
Summer Threshold	If 6 of 11 are below threshold, meeting in 60 days between FSH and MPGCD to discuss data

Notes
Maximum Recent Drawdown (Winter to Summer) based on evaluation of recent data (~2010 to 2016)
Summer Thresholds derived by adding maximum recent drawdown (from historic data) to Winter 1 Threshold
Recent Depth to Water are from actual data: maximum (summer) and minimum (winter) from spring 2016 to winter 2017

Table 2. FSH Special Permit Condition Monitoring Well Thresholds (Groundwater Elevation)

FSH Special Permit Conditions - Monitor Well Thresholds Adopted on July 18, 2017
Thresholds Expressed as Groundwater Elevation in Each Well

Well		Reference Point Elevation (ft MSL)	Winter Threshold 1		Winter Threshold 2 (Historic Minimum)		Winter Threshold 3		Winter Threshold 4		Maximum Recent Drawdown (Winter to Summer)	Summer Threshold		Recent Groundwater Elevation (ft MSL)	
Short Name	Long Name		Groundwater Elevation (ft MSL)	Basis	Groundwater Elevation (ft MSL)	Basis	Groundwater Elevation (ft MSL)	Basis	Groundwater Elevation (ft MSL)	Basis		Groundwater Elevation (ft MSL)	Basis	Winter	Summer
Mpgcd320	King, Woodward, #320	3068	2863	Win2+5	2868	Data 1/1999	2873	Win2-5	2878	Win2-10	45	2823	Win2+Max DD	2955	2920
Mpgcd323	Ft Stockton, Cemetery, #323	3031	2833	Win2+5	2838	Data 1/2000	2843	Win2-5	2848	Win2-10	15	2823	Win2+Max DD	2885	2883
C-5	C-5, FSH Well	3009	2899	Win2+5	2904	WPC 1973	2909	Win2-5	2914	Win2-10	72	2832	Win2+Max DD	2949	2902
M-9	M-9, FSH Well	3261	2948	Win2+5	2953	WPC 1973	2958	Win2-5	2963	Win2-10	48	2905	Win2+Max DD	3015	2978
S-45	S-45, FSH Well	3067	2902	Win2+5	2907	WPC 1973	2912	Win2-5	2917	Win2-10	56	2851	Win2+Max DD	2976	2953
S-6	S-6, FSH Well	3123	2918	Win2+5	2923	WPC 1973	2928	Win2-5	2933	Win2-10	62	2861	Win2+Max DD	3005	2964
Mpgcd305	Cockrell_Belding, #305	3233	2941	Win2+5	2946	WPC 1973	2951	Win2-5	2956	Win2-10	75	2871	Win2+Max DD	3027	2983
Mpgcd318	Goldman Ranch, Well 1	2957	2885	Win2+5	2890	WPC 1975	2895	Win2-5	2900	Win2-10	33	2857	Win2+Max DD	2927	2908
Mpgcd334	Carpenter, #334	3051	2911	Win2+5	2916	WPC 1975	2921	Win2-5	2926	Win2-10	36	2880	Win2+Max DD	2947	2925
Interstate	Interstate Well, FSH Well	2988	2892	Win2+5	2897	WPC 1975	2902	Win2-5	2907	Win2-10	40	2857	Win2+Max DD	2939	2917
Prison	TDCJ, Prison Well	3199	2941	Win2+5	2946	WPC 1973	2951	Win2-5	2956	Win2-10	50	2896	Win2+Max DD	3015	2975

Threshold	Action
Winter Threshold 1	If 6 of 11 are below threshold, 100% reduction in FSH non-historical use pumping
Winter Threshold 2	If 6 of 11 are below threshold, 50% reduction in FSH non-historical use pumping
Winter Threshold 3	If 6 of 11 are below threshold, 30% reduction in FSH non-historical use pumping
Winter Threshold 4	If 6 of 11 are below threshold, 10% redcution in FSH non-historical use pumping
Summer Threshold	If 6 of 11 are below threshold, meeting in 60 days between FSH and MPGCD to discuss data

Notes
Maximum Recent Drawdown (Winter to Summer) based on evaluation of recent data (~2010 to 2016)
Summer Thresholds derived by adding maximum recent drawdown (from historic data) to Winter 1 Threshold
Recent Depth to Water are from actual data: maximum (summer) and minimum (winter) from spring 2016 to winter 2017

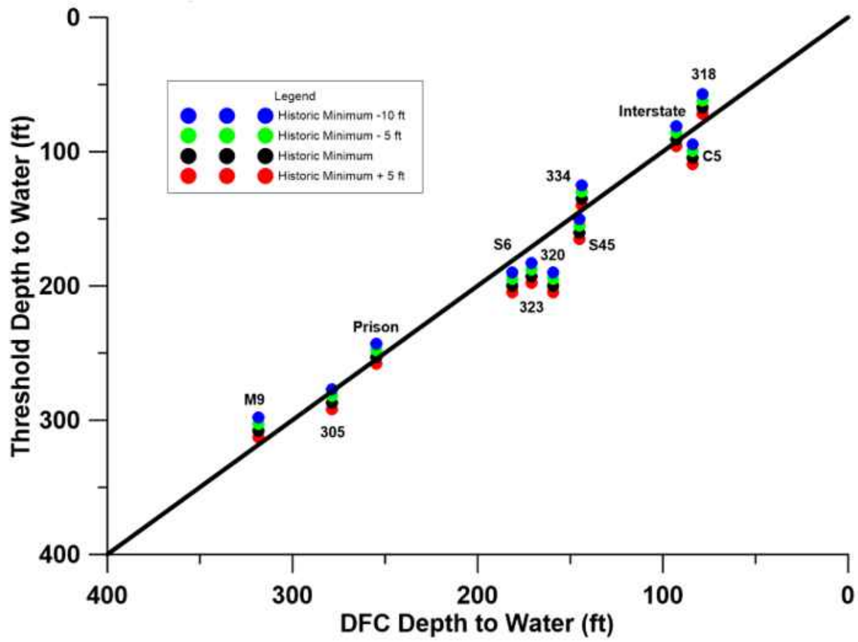

Figure 1. Comparison of Desired Future Condition (DFC) with Monitoring Well Thresholds

The general agreement between the desired future conditions and the thresholds is rooted in the fact that the desired future conditions were established with historic and existing uses as one of the key elements (i.e. future pumping was assumed equal to all permitted uses). The objective of the thresholds was to define historic minimum groundwater levels. Because the historic minimum groundwater levels are associated with the maximum historic pumping, it is not surprising that the desired future conditions and thresholds would be similar.

2.3 Review of Belding Farms Data (2018)

In September 2018, Cockrell Investments provided the Belding Farms data that were not made available at the time of threshold development. A draft report that summarized the results of review and analyses of the provided data was completed in December 2018 (Hutchison, 2018).

The draft data review report is presented as Appendix C. Key findings from the review were:

- The Belding Farms groundwater level data have been generally collected monthly since 1957.
- Groundwater levels recover in winter during the non-irrigation season.
- Drawdown (monthly and annual) is well defined within Belding Farms data.
- The Belding Farms groundwater level data are well correlated with other groundwater level data in the Leon-Belding area, which is further confirmation that the groundwater system is well connected (i.e. groundwater levels rise and fall due to regional recharge and regional pumping throughout the Leon-Belding area).

- The good correlation in groundwater levels provides a basis to use the Belding Farms groundwater level data to extend the evaluation of historic minimum groundwater levels to other parts of the Leon-Belding area with more limited historic groundwater level data.
- Application of the correlation of Belding Farms groundwater levels to the threshold levels in the 11 monitoring wells suggests that the threshold values are conservative with respect to protecting historic minimum groundwater levels. Specifically, the good correlation allows for the calculation of the groundwater level in each Belding Farms well that is expected for each threshold value. This analysis shows that the calculated groundwater level equivalent to the threshold value is higher (shallower) than the actual historic minimum groundwater level in each Belding Farms well.
- Depth of pump setting in the Belding Farms wells was not provided and would be needed to evaluate the summer thresholds further.

2.4 Updated Review of Belding Farms Data (2023)

On August 30, 2023, Belding Farms provided an updated set of data that included pump setting depths. The updated review was documented in a PowerPoint file that was presented at the October 17, 2023 MPGCD Board meeting. This PowerPoint file is presented in Appendix D.

The October 17, 2023 presentation extended the 2018 review of the updated Belding Farms data and offered conclusions related to an earlier version of the Cockrell petition to change the MPGCD Rules. Among the key findings were:

- Higher pumping in the 1960s and 1970s correlated with lower groundwater levels.
- Recent Belding Farms pumping has sometimes exceeded individual well permit limits as reported in the Belding Farms data.
- Lower groundwater levels in the 1960s and 1970s recovered when regional pumping (including pumping at Belding Farms) was reduced in more recent years.

The updated analysis also confirmed the conclusions of the 2018 review:

- Belding Farms data were not available in 2017 when thresholds were developed.
- If Belding Farms data had been available in 2017, the winter thresholds would have been set lower. Fort Stockton Holdings chose not to request (or initiate) revisions to the thresholds based on the 2018 analysis of Belding Farms data.
- The analysis of the 2018 Belding Farms data demonstrated that summer thresholds could be revisited due to better data availability. The inclusion of pump setting data in Belding Farms wells in the 2023 data provided to MPGCD provides an important element that could be used in revising the summer thresholds if current pump settings are used as one of the criteria to establish the summer threshold.

3.0 Review of December 19, 2023 Petition

This section is organized to correspond to each subsection of Cockrell's proposed Rule 10.8 as presented in the December 19, 2023 petition.

3.1 Flow Meters (Proposed Rule 10.8(a))

Proposed Rule 10.8(a) would require meters on all existing and new nonexempt wells that produce more than 100 AF/yr.

Currently, Rule 10.7 requires every owner of a nonexempt well to measure withdrawals from each well either by a District-approved meter or alternative measuring method. As required in Rule 10.7(b), alternative approaches must be approved by the MPGCD General Manager if the applicant can demonstrate that the alternative method can accurately measure the groundwater withdrawals.

Based on current Rule 10.7, proposed Rule 10.8(a) is duplicative and not necessary.

3.2 Tremie Pipes and Pressure Transducers (Proposed Rules 10.8(b) and 10.8(c))

Proposed Rule 10.8(b) would require installation of a 1-inch PVC line (tremie pipe) and pressure transducers for all new nonexempt wells. Proposed Rule 10.8(c) would require pressure transducers on up to ten percent of existing wells for permit holders over 1,000 AF/yr.

Currently, Rule 10.5(e)(1) the District is required to establish several monitoring wells in and around each Management Zone. Rules 10.5(e)(4) and 10.5(e)(5) require the District to observe the recovery of aquifer water levels in the monitoring wells after the "intensive use" season and determine the apparent point of maximum water level recovery.

Based on current Rule 10.5(e), these proposed rules appear arbitrary and could be considered too prescriptive. MPGCD has a robust monitoring network in Management Zone 1 (and in other parts of the District). This monitoring network has evolved over several years and is consistent with the data analyses that demonstrate the good correlation in groundwater levels between wells.

There is no analysis provided in the petition that suggests that the current monitoring network is deficient or supports the need for additional monitoring. As has been demonstrated over the past several years, MPGCD will continue to expand the monitoring network as needed and within budgetary constraints. This proposed rule, therefore, is not needed.

3.3 Water Quality Sampling (Proposed Rule 10.5(d))

Proposed Rule 10.5(d) would require MPGCD to perform water quality sampling and analysis of *all MPGCD monitoring wells* (emphasis added) and require permit holders over 1,000 AF/yr to sample and analyze 50 percent of their well each January and July and submit results to MPGCD.

Please note that the proposed rule does not specify what parameters the water quality analysis should include. Current Rules 11.9.2(b)(3)(I) and 11.9.2(b)(3)(J) specifies parameters that MPGCD requires for water quality analysis associated with pumping tests.

The proposed requirement to sample all monitoring wells fails to recognize that most monitoring wells have no installed pump, which makes them ideal for monitoring groundwater levels. To obtain a sample from "all MPGCD monitoring wells", there would be considerable cost and time associated with obtaining a sample. The current MPGCD practice to obtain water quality samples from production wells is far more practical and reasonable for purposes of characterizing water quality.

Overall, there is no analysis provided in the petition that suggests that the current water quality monitoring approach and use of production wells is deficient or supports the need for additional monitoring. As has been demonstrated over the past several years, MPGCD will continue to expand water quality sampling as needed and within budgetary constraints. This proposed rule, therefore, is not needed.

3.4 Quarterly Reporting of Meter Readings (Proposed Rule 10.5(e))

Proposed Rule 10.5(e) would require all permit holders to submit meter reading to MPGCD quarterly.

Current Rule 10.7 covers requirements for measuring and reporting groundwater withdrawals by permittees (either from a meter or an approved alternative method):

- Current Rule 10.7(d) requires the permit holder to read the meter monthly, and report annual withdrawals.
- Current Rule 10.7(d) also states that the General Manager can request more frequent reporting.
- Other parts of Current Rule 10.7 include provisions related to meter accuracy, provisions for violation of metering and reporting requirements, and permittee recordkeeping requirements.
- Current Rule 10.7(j) specifically states that if the Board or General Manager "deems it useful or otherwise necessary", monthly groundwater use must be reported to the District.

Based on Current Rule 10.7, proposed Rule 10.5(e) is duplicative and unnecessary.

3.5 Year-Round Thresholds (Proposed Rule 10.5(f))

Proposed Rule 10.5(f) would establish three year-round thresholds in four monitoring wells and specifies management action associated with reaching each threshold level. It should be noted that the proposed year-round thresholds contained in the December 17, 2023 petition are unchanged from earlier proposed thresholds that were reviewed and discussed at the October 17, 2023 MPGCD Board meeting (as noted above, this review is presented in Appendix D of this report). Table 3 presents the proposed year-round thresholds as presented in the December 17, 2023 petition.

Table 3. Proposed Year-Round Thresholds

Well	Threshold 1		Threshold 2		Threshold 3	
Prison Well	2960	239	2950	249	2900	299
S-6	2935	188	2925	198	2875	248
S-45	2920	147	2910	157	2860	207
MPGCD 320	2900	168	2890	178	2840	228

Based on an analysis of the thresholds and the Belding Farms data presented above, these proposed thresholds are inconsistent with the current thresholds. The current thresholds were developed to avoid groundwater levels dropping below the historic minimum groundwater levels. The proposed thresholds would avoid dropping groundwater levels below some undefined level that is significantly higher than historic minimum groundwater levels.

Based on the analysis presented in 2023 (Appendix D), the proposed thresholds would trigger actions that would be relatively frequent based on the historic record of groundwater levels at Belding Farms for months at a time. Moreover, the proposed year-round thresholds and management actions would provide no meaningful benefit to Belding Farms based on a review of their historic pumping and groundwater levels.

3.6 Review of Intended Purpose of Proposed Rules

The petition submitted on December 17, 2023 was consistent with the requirements of MPGCD Rule 6.5 and included a written explanation of the intended purpose of the proposed rule. Statements made in this section of the petition are addressed below.

Cockrell requests that Proposed Rule 10.8 is needed "to properly ensure" "the overall health and future resilience of the aquifer for all beneficial uses". The petition provides no definition for the terms "overall heath" and "future resilience" of the aquifer. The petition provides no data, information, or analysis to support the assertion that the special permit condition thresholds threaten the "overall health and future resilience of the aquifer". The current thresholds were developed without the benefit of Belding Farms data to avoid groundwater levels dropping below historic minima. The Belding Farms data analysis demonstrated that the current thresholds would, in fact, likely be triggered at groundwater levels above the historic minima.

Cockrell requests more precise and consistent monitoring of wells within Management Zone 1. The petition provides no data, information, or analysis that specifies the lack of precision in the current monitoring network. There is also no statement regarding how the current monitoring network lacks consistency and what it should be consistent with. The monitoring network associated with the current thresholds consists of 11 wells. The proposed year-round thresholds are associated with only four wells, all of which are part of the current 11 well network.

Cockrell requests that year-round thresholds monitor declining water levels and are able to trigger automatic pumping cutbacks if the water level drops below the threshold. The request for automatic reductions is inconsistent with current rules and is unnecessary when considering the historical data.

The Belding Farms data provide a quantitative understanding of annual and monthly drawdowns. The Belding Farms data also provide a quantitative understanding of the winter (or non-pumping season) recovery, even during the period of the highest pumping and lowest historic groundwater levels (1960s and 1970s).

Current Rule 10.2 provide that production permits are issued based on annual production. Current Rule 10.3(b) states that the District will "continue to study" what aquifer conditions may "indicate" a proportional adjustments to the annual permitted production for both production permits and historic and existing use permits to "avoid impairment of the Desired Future Conditions". As discussed above, the current thresholds are consistent with the Desired Future Conditions.

Current Rule 10.4 provides the process for the Board to implement "Proportional Adjustments" to production permits and historic and existing use permits. Therefore, the current threshold triggers that require reductions in annual amounts are consistent with the current rules.

Cockrell's proposal to include automatic pumping reductions in the middle of a year is inconsistent with the current rules because it does not provide an opportunity for notice and hearing similar to the provisions in the current rules. Current Rule 10.5(f) explicitly provides for a notice and hearing process to establish proportional adjustment reductions to avoid impairment of the desired future conditions.

Cockrell asserts that the proposed rules will result in "more consistent" groundwater levels and the aquifer will be "healthier". The petition does not provide a definition of "more consistent" groundwater levels and does not define what constitutes a "healthy" aquifer. The current thresholds were not developed to maintain "more consistent" groundwater levels, but to avoid groundwater levels to drop below historic minima.

Cockrell asserts that enforcing year-round thresholds will protect the health of the aquifer throughout the year by making sure the water levels are maintained at a certain level even during the summer months when irrigation and municipal demands are the highest. The petition provides no definition or standard on what "protect the health of the aquifer" means. Historically, groundwater levels decline in the summer in response to pumping and recover in the winter in response to cessation of pumping.

During the periods of highest pumping (1960s and 1970s) pumping data from Belding Farms documented higher winter pumping than in more recent years as shown in Figure 2 (and lower winter groundwater levels than in more recent years). Yet, summer pumping at Belding farms during that same period was not apparently impacted based on Belding Farms data (i.e. summer pumping was as high or higher than summer pumping in more recent years) as shown in Figure 3.

The historic summer month groundwater levels are well documented in the Belding Farms data, even during the period of maximum historic pumping (1960s and 1970s). The Belding Farms data also provide a quantitative understanding of monthly and annual drawdown, as well as recovery in the non-irrigation season. Without a definition of "aquifer health" and given the conclusions drawn from the Belding Farms data, the Cockrell assertion is unsupported.

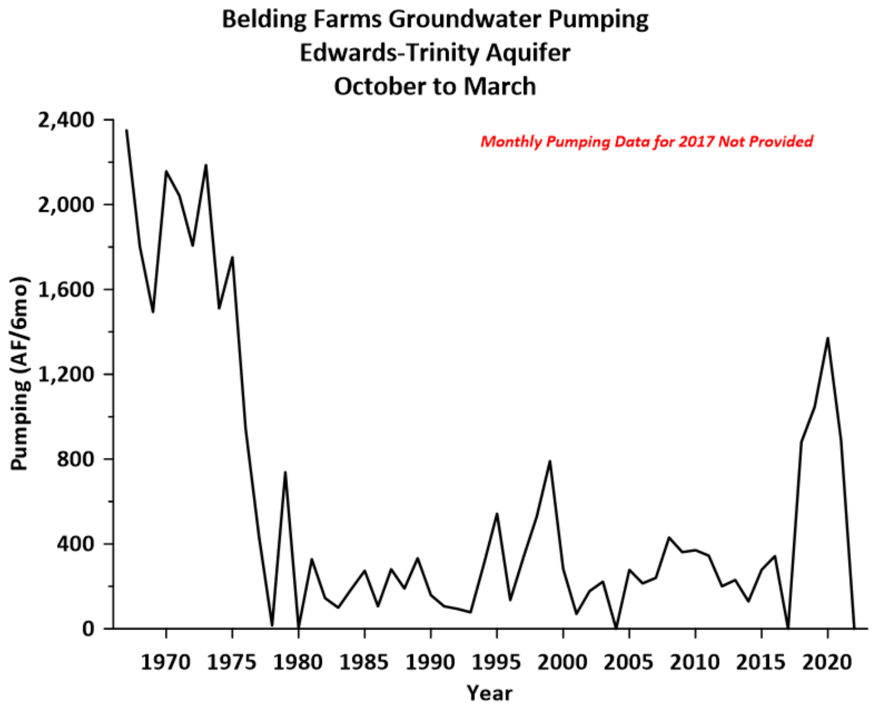

Figure 2. Belding Farms Historic Pumping: October to March

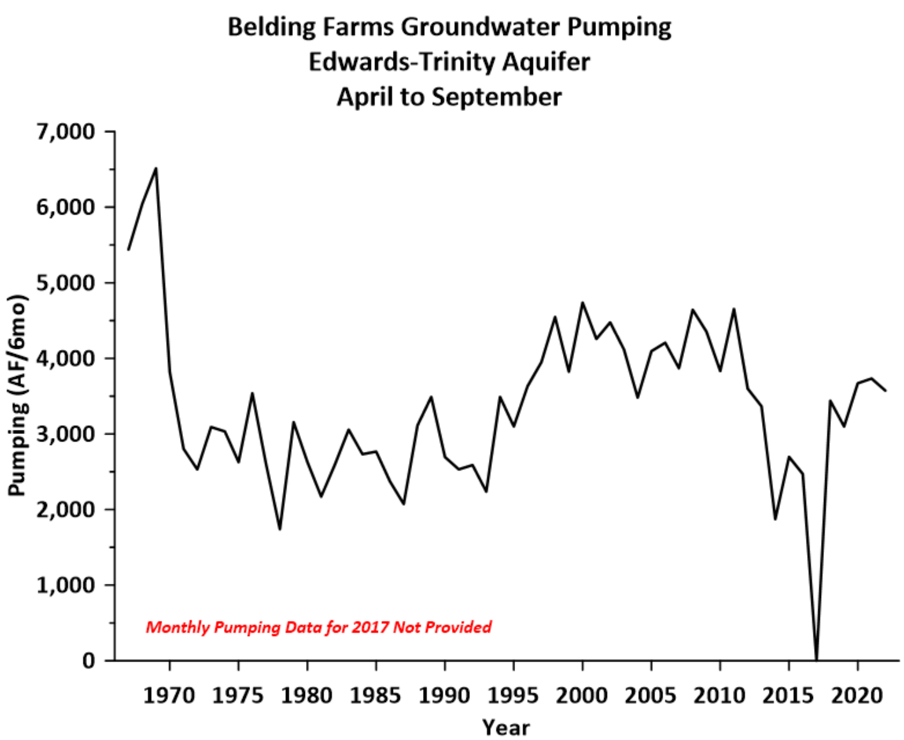

Figure 3. Belding Farms Historic Pumping: April to September

Cockrell asserts that establishing year-round thresholds is not unusual and states that many other groundwater conservation districts across the state implement them. The petition provides no specifics on how many districts implement year-round thresholds or name any of the districts. The Edwards Aquifer Authority does implement year-round thresholds, but the history, background, circumstances, management objectives, and budgetary resources of the Edwards Aquifer Authority are significantly different than MPGCD, and, therefore, is not a reasonable basis for comparison.

Cockrell states that their proposed year-round thresholds are "designed to protect the aquifer at historic lows". As detailed above and in the various appendices to this report, this statement is incorrect. The proposed year-round thresholds would result in groundwater levels that are higher than historic minima, but at an unspecified level.

3.7 Review of Alleged Injury or Inequity

The petition submitted on December 17, 2023 was consistent with the requirements of MPGCD Rule 6.5 and included a written explanation of the alleged injury or inequity that could result from failure to adopt the proposed rule. Statements made in this section of the petition are addressed below.

In this section of the petition, the term "current management plan" is used repeatedly. The current management plan does generally discuss groundwater management in Management Zone 1. However, the details of the thresholds and the management actions are special permit conditions and are not included in the management plan. Therefore, in introducing the topics covered in this portion of the petition, the term "current management plan" is not used. When necessary, the term "special permit conditions" is used instead of "current management plan" to discuss the issues raised in this portion of the petition.

Cockrell correctly summarizes the management action if six of the 11 winter thresholds are not met (pumping reductions). Cockrell then correctly notes that there are no automatic pumping reductions in the middle of a year. Cockrell then states: "This allows for water levels to continue dropping as irrigation begins". The use of the term "allows" in the context of describing the result of the special permit conditions a poor choice. Groundwater levels drop during the irrigation season and recover after the non-irrigation season. Belding Farms data are the most comprehensive data that can be used to quantify this annual cycle of drawdown and recovery since the late 1950s. The special permit conditions do not "allow" groundwater levels to "drop" during irrigation season, groundwater pumping for irrigation causes decline in groundwater levels, cessation of major pumping after the summer irrigation season causes the recovery of groundwater levels, and this cycle has been observed for several decades.

Cockrell asserts that "certain groundwater permit holders" could "game" the monitoring system. The good correlation between monitoring wells and the Belding Farms data demonstrate that the groundwater system is well connected and the ability to "game" the system is limited. The current monitoring network associated with the special permit conditions consists of 11 wells, and failure to meet a threshold in six of them would trigger a management action (pumping reduction).

In contrast, the proposed year-round monitoring network proposed by Cockrell consists of four wells, and failure to meet the threshold in two of the wells would trigger management action. Also in contrast, in their original comments to the special permit condition thresholds and monitoring network dated July 14, 2017 (presented in Appendix B), one of Cockrell's technical consultants (Kaveh Khorzad) recommended that the monitoring network consist of six wells and only a single failure to meet the threshold in a single well would trigger pumping reductions.

The good connection within the groundwater system suggests that opportunities to "game" the monitoring network would be limited. From a pure numbers perspective, the current special permit conditions rely on six triggers in 11 wells, which would likely be a better guard against such gaming as compared to either the year-round monitoring network (two triggers in four wells) or the monitoring network proposed in the July 14, 2017 letter (one trigger in six wells).

Cockrell asserts that the following issues would likely occur under the current special permit conditions: declining water levels, decreased "transmissibility", decreased levels of production, increased levels of "solids in the water", higher production costs, potential need to install larger pumps, drill deeper wells, re-drill some wells. There are no supporting data, information, or studies provided to support these assertions.

To the extent that groundwater levels would drop below levels observed in the last 10 to 20 years, this assertion is true if pumping were to increase to levels above those observed in the last 10 to 20 years. The current special permit conditions are designed to avoid groundwater levels below historic minima, which occurred in the 1960s and 1970s.

The term "transmissibility" has not been used in hydrogeology for decades. The modern term is transmissivity and is simply the hydraulic conductivity (essentially the permeability of the aquifer) times the saturated thickness. Groundwater in the area is produced from a confined aquifer. Thus, drawdowns are a pressure response to pumping and saturated thickness does not decline. Therefore, transmissivity of the aquifer will not be reduced due to a pressure decline.

In general, decreased levels of production are possible in an individual well with declining groundwater levels, due to pump characteristics. The Belding Farms data suggests that, historically, more groundwater was pumped in the 1960s and 1970s than in recent years. The petition provided no evidence that supports this assertion.

In terms of groundwater quality changes, "solids in the water" is an unknown term. Total dissolved solids is routinely used to characterize the salinity of groundwater. Data suggests that, in some areas, groundwater salinity has increased, and that it may be associated with upwelling of poor-quality groundwater from formations that underly the Edwards-Trinity (Plateau) Aquifer, most notably the Rustler Aquifer. This is the subject of ongoing research and investigations by the District.

Higher production costs are difficult to assess unless there is a baseline. It would be reasonable to expect that if future groundwater levels drop to near historic minima, the energy required to lift the water would be no more than that required in the past when groundwater levels were at their minimum (1960s and 1970s). The cost of energy in the future could be higher than the cost of energy in the 1960s and 1970s, which could push the total lift cost higher than had occurred in the past.

Evaluations related to the need to install larger pumps or lower pumps also requires a baseline. The Belding Farms data demonstrate that pumps were set deeper in the 1960s and 1970s than they are today because some summer water levels in the 1960s and 1970s are below the current pump depth. If groundwater levels decline to levels close to the historic minima, it is possible that some pumps would need to be lowered to depths similar to the 1960s and 1970s.

The assertion that wells would have to be drilled deeper is unsupported since the special permit condition thresholds were designed to avoid groundwater levels dropping below historic minima, and the Belding Farms data suggest that the special condition thresholds are set higher than true historic minima.

It is unclear how the special permit conditions would result in the need to re-drill wells.

Cockrell asserts that lack of proper enforcement and pumping adjustments based on water levels increases risks of long-term damage to the aquifer and its ability to adequately recover after the summer irrigation season. The petition does not define "proper enforcement". The petition also ignores the fact that the special condition thresholds require pumping reductions based on groundwater levels. Current groundwater levels have not triggered any thresholds since their adoption in 2017 because current pumping in the area is well below historic maximum pumping, which occurred in the 1960s and 1970s.

The special permit conditions require pumping reductions if there is a failure to meet winter thresholds. Also, the petition provides no data, information, or studies that suggest that there would be "long-term" damage to the aquifer under the current thresholds, or the nature of the "damage". Finally, the assertion that the groundwater levels would not recover after the irrigation season is inconsistent with Belding Farms data that date back to 1957. The petition provides no details on what condition would cause a lack of recovery after the irrigation season which has been consistently observed for over 60 years.

Cockrell asserts that the "increased strain on the aquifer" could damage nearby aquifers. The petition does not provide a definition of the term "increased strain". The special permit conditions are designed to avoid groundwater levels dropping below historic minima, and the Belding Farms data are useful to define groundwater conditions and pumping capability during that time in history (1960s and 1970s). If the "strain" contemplated is the lowered groundwater levels caused by increased groundwater pumping (as compared to recent years), groundwater levels under the special permit conditions would be no lower than the groundwater levels observed in the past. The petition does not specify what "nearby" aquifer could be damaged, or the nature of that damage.

Cockrell asserts that individual users, such as Belding Farms, may experience a loss or degradation of water at or below historic levels. The Belding Farms data demonstrate the groundwater conditions and historical pumping in the 1960s and 1970s. This period represents the period of maximum historic pumping and minimum historic groundwater levels. The Belding Farms data demonstrate that the assertion is without foundation.

4.0 Review of Testimony: February 20, 2024 Public Hearing

During the public hearing on the petition at the February 20, 2024 public hearing, representatives of Cockrell Investments Partners and Belding Farms provided oral testimony supported by a PowerPoint presentation. This section of the report provides a review of key themes in the oral testimony and pertinent points in the PowerPoint presentation that have not been discussed above.

4.1 Aquifer Protection

The third bullet of slide 4 asserts that the District's Rules and the special permit conditions do not reliably protect the aquifer. The fifth bullet on slide 11 asserts that Cockrell's proposed year-round thresholds "promote sustainability". Oral testimony on these points referenced two key points: the District should be managing groundwater to levels similar to those observed over the last 30 years, and the aquifer should be managed sustainably.

4.1.1 Groundwater Level Management Baseline

As described above, the thresholds in the special permit conditions were designed to avoid groundwater levels dropping below historic minimum groundwater levels and the thresholds are consistent with the desired future conditions that were adopted by the District. This means that, in the future, groundwater levels could drop to levels observed in the 1960s and 1970s. As developed above, it appears that the proposed year-round thresholds are designed to avoid groundwater levels dropping to a level that is not defined, but higher than the historic maximum.

Based on the oral testimony, it appears that Cockrell's proposed thresholds are designed to manage groundwater levels consistent with those observed over the last 30 years, which is fundamentally different than the stated objective of the special permit condition thresholds (historic minimum groundwater levels).

4.1.2 Sustainable Groundwater Management

Mace (2021, pg. 19) defined groundwater sustainability as the development and use of groundwater in a manner that can be maintained for an indefinite period of time without causing unacceptable environmental, economic, or social consequences. This definition was derived from Alley and others (1999). Mace (2021, pg. 19) further noted that groundwater sustainability has to be defined by a decisionmaker, ideally through a stakeholder process.

Current Rule 10.5(b) links the concepts of sustainable groundwater use and the desired future conditions. In essence, the District has defined sustainable groundwater management as meeting the desired future condition in this Rule. The desired future conditions for the District were initially established in 2010. Desired future conditions were also approved in 2016 and again in 2021 by the Middle Pecos Groundwater Conservation District (a decisionmaker in Mace's definition).

It 2016 and 2021, the desired future conditions were adopted after considering nine factors as defined in Section 36.108(d) of the Texas Water Code. These factors include various environmental, economic (including property rights) and social elements that are contained with the Mace (2021) definition of groundwater sustainability. Current Rule 10.5(b) links sustainable groundwater development in the District and the desired future conditions. As described above, the thresholds in the special permit conditions are consistent with the desired future conditions.

To the extent that the oral testimony inferred that the current desired future condition and the current thresholds associated with the special permit conditions are “not sustainable”, the foundation for those comments appear to be focused on what constitutes “unacceptable consequences” as articulated in the definition of Mace (2021). The comments of Cockrell representatives at the petition public hearing ignore the history of development of the desired future conditions (a deliberative process with opportunity for public input and comment). Cockrell’s representatives simply assert that the District is not managing sustainably because of the apparent disagreement with how the District defined “unacceptable consequences” that was the result of a deliberative process that required the balance of groundwater conservation and maximum practicable use as required by Texas Water Code 36.108(d-2).

Mace (2021, pg. 37) used the Middle Pecos Groundwater Conservation District management of the Leon-Belding area as an example of “desire driven” sustainable groundwater management. This category of Mace (2021) focused on local authorities that decide to manage groundwater sustainably, and he cited the joint planning process (which resulted in desired future conditions) as the process to develop this management approach. Specific to the Leon-Belding area, Mace (2021) stated that sustainable management was chosen “to protect the longevity of production from an aquifer”.

Despite assertions to the contrary offered in oral testimony and the associated PowerPoint presentation, Middle Pecos Groundwater Conservation District is managing sustainably as defined in their current rules and as cited in Mace (2021).

The joint planning process (Texas Water Code 36.108) requires that desired future conditions be updated every five years. Because the District is continuously collecting monitoring data and updating studies, there is ample opportunity to revisit the current desired future conditions and, by extension, the special permit condition thresholds. The next proposed desired future condition is due on May 1, 2026. Once proposed, there is a public comment period of at least 90 days. The next final desired future condition is due on January 5, 2027.

4.2 Regulatory Certainty

The second bullet of slide 5 stated that the year-round thresholds will create certainty. The second bullet in slide 6 claims that the winter thresholds are “measured during ill-defined period”.

The winter period is defined in the special permit conditions as October 1 to March 31. This is historically the time period when the winter maximum groundwater level is observed. Thus, on April 1, the annual production permit for Fort Stockton Holdings is known. If six of the 11 monitoring thresholds are met, the full permit limit is in effect for the year (April 1 to March 31). If six of 11 monitoring thresholds are not met, then the special permit conditions define the permit reduction from April 1 to March 31. This provides certainty for the production permit each year.

In contrast, Cockrell's proposed year-round thresholds provide less certainty for all users in Management Zone 1 because pumping could be curtailed in the middle of the year. Analyses of historical groundwater levels using the Belding Farms data suggests that the pumping reductions could last for months or years during drought periods and would lead to greater uncertainty to individual permit holders ability to pump groundwater.

4.3 Emergency Powers

The fourth bullet on slide 6 assert that "emergency powers are ambiguous and no measurable trigger".

Current Rules 7.1 and 7.2 define the District's emergency powers. These rules cover situations where there is a "substantial likelihood of imminent peril to the public health, safety, or welfare". There are also provisions under emergency powers to authorize temporary production for demonstrated emergency need. None of these "emergency powers" are applicable to pumping reductions due to failure to meet special permit condition thresholds.

More specific to the District's authority to reduce pumping, current Rule 10.4 (Proportional Adjustment) and Rule 10.5(f) define the process (including notice and hearing) to reduce pumping. Foundational to this process in the current rules is avoiding impairment of the desired future conditions. From a practical perspective, this process provides the opportunity to transparently assess monitoring data with the objective of avoiding impairment of the desired future conditions.

4.4 Exploration

The third bullet on slide 11 asserts that the year-round thresholds "allow exploration in a more reliable environment". This was supported in oral testimony by pointing out that the there is a large gap between Cockrell's proposed year-round threshold 2 and Cockrell's proposed year-round thresholds 3 (labeled the "great unknown" in slide 8, a hydrograph of the Prison Well) to provide an opportunity to "explore" the impacts of reduced groundwater levels.

Because the special permit conditions thresholds were based on historic groundwater level minima, and because the analysis of the Belding Farms data demonstrated that the special permit conditions thresholds are likely above the true historic minima, there is no "exploration" involved in the application of the special permit condition thresholds.

4.5 Drawdown and Recovery of Groundwater Levels

Slide 15 expressed concerns related to drawdown and recovery of groundwater levels: "Hutchison's analysis indicates that the aquifer should always recover and should not decline by more than 50 feet from winter to summer".

The use of the terms "should always recover" and "should not decline by more than 50 feet" are misleading. The analyses of drawdown and recovery are not qualitative opinions, but conclusions based on the analysis of Belding Farms data. Figure 4 presents a frequency plot of the difference between winter maximum groundwater levels and summer minimum groundwater levels (summer drawdown) at Belding Farms. The data are from 26 wells for the years 1959 to 2023, for a total of 572 data point comparisons.

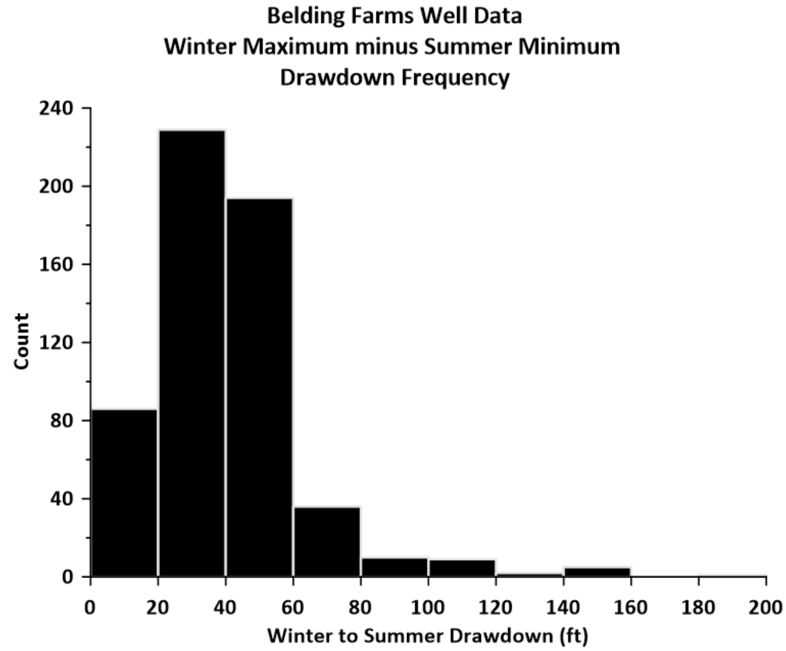

Figure 4. Belding Farms Winter to Summer Drawdown Frequency

Please note:

- The median drawdown is 39 feet.
- 76 percent of the drawdown measurements are between 20 and 60 feet.
- 46 percent of the drawdown measurements are between 30 and 50 feet.

Figure 5 presents a frequency plot of the difference between winter maximum groundwater levels and the previous summer minimum groundwater levels (winter recovery) at Belding Farms. The data are from 26 wells for the years 1959 to 2023, for a total of 564 data point comparisons.

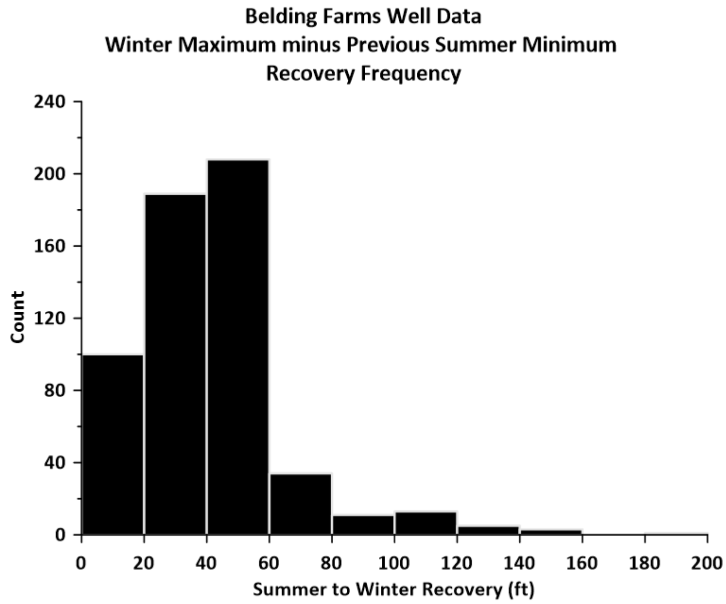

Figure 5. Belding Farms Summer to Winter Recovery Frequency

Please note:

- The median recovery is 39 feet.
- 72 percent of the recovery measurements are between 20 and 60 feet.
- 42 percent of the recovery measurements are between 30 and 50 feet.

Based on the Belding Farms data, drawdown in the summer (during the irrigation season) and recovery during winter (during the non-irrigation season) are well understood quantitatively. The petition contains no data, information, or results of studies that explain concerns that groundwater levels would not recover when pumping is reduced (associated with the non-irrigation season or associated with pumping reductions imposed if special permit condition thresholds are not met).

5.0 References

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Hutchison, W.R., 2017. Proposed Changes in Management Zone 1 and Proposed Monitor Well Data and Comparisons with Model Simulations (Draft 1). Prepared for Middle Pecos Groundwater Conservation District, June 16, 2017, 21p.

Hutchison, W.R., 2018. Review of Belding Farms Database (Draft). Prepared for Middle Pecos Groundwater Conservation District, December 7, 2018, 94p.

Mace, R.E., 2021. Five Gallons in a Ten Gallon Hat: Groundwater Sustainability in Texas. Report 2021-08, The Meadows Center for Water and the Environment, Texas State University. November 2021, 52p.

Appendix A

Hutchison (2017) Draft Report on Threshold Development

Proposed Changes to Management Zone 1 and Proposed Monitor Well Data and Comparisons with Model Simulations

(Draft 1)

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June 16, 2017

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1.0 Introduction

In support of a settlement proposal dated April 28, 2017 between Middle Pecos Groundwater Conservation District, Fort Stockton Holdings, LP and Clayton Williams Farms, Inc., and Republic Water of Texas LLC, this report summarizes the results of analyses to:

- Support changes in the boundaries of Management Zone 1.
- Evaluate data and simulations results for individual monitor well locations in the proposed Management Zone 1 related to regulatory thresholds that could be included as special permit conditions and data and information related to planning-level desired future conditions.

For purposes of this analysis, Comanche Springs is designated as the primary hydrogeologic feature of the proposed Management Zone 1. The Western Pecos Groundwater Model (WPC Model) was used to identify the area that contributed significantly to Comanche Springs. The WPC Model was completed and documented in 2011 by R.W. Harden & Associates, Inc., LBG-Guyton Associates, and Thornhill Group, Inc. in support of Fort Stockton Holdings, L.P. permit application seeking a new production permit from Middle Pecos GCD to produce groundwater for municipal and/or industrial use, referenced as R.W. Harden & Associates and others (2011).

In addition, monitor well data for wells located within the proposed Management Zone 1 were reviewed and compared with model simulations. The monitoring data and model simulation results were used to:

1. Identify appropriate wells within the proposed Management Zone 1 that can be used to compare desired future conditions and establish threshold groundwater elevations.
2. Develop updated estimates of desired future conditions based on the proposed Management Zone 1 using the regional alternative Groundwater Availability Model (GAM)
3. Provide specific well drawdown estimates of desired future conditions for proposed monitor wells within the proposed Management Zone 1.
4. Recommend thresholds for each well that can be used as special permit conditions for Fort Stockton Holdings non-historic use pumping.

2.0 WPC Model Analysis

The WPC Model domain includes the western part of Pecos County, nearly all of Reeves County, and parts of Loving, Ward, Crane, Brewster Jeff Davis, and Culberson counties. There are 22,635 model cells in Pecos County, with each cell covering an area of 2,000 ft by 2,000 ft (about 92 acres). The simulations were designed to simulate the effect of pumping on Comanche Springs flow in each of the cells in Pecos County. Thus, a total of 22,636 simulations were completed: a base case where no pumping occurred and 22,635 simulations where pumping occurred in a single model cell. If pumping in a cell resulted in a significant impact to the flow at Comanche Springs, the cell was considered part of the proposed Management Zone 1.

For each of the 22,635 pumping simulations, pumping in a single cell at a rate of 1,500 gallons per minute for 10 years was simulated. The flow from Comanche Springs was then compared with the flow from the spring for the base case (no pumping). Results were tabulated by individual cell and used to construct maps showing the impact of pumping in each cell on Comanche Springs.

Pumping of 1,500 gpm translates to a flow of about 3.43 cfs. The spring flow reduction when pumping occurred in the cell where Comanche Springs is located was 3.43 cfs after 10 years, which means that the pumping was 100 percent spring flow capture. Overall, areas that would result in 90 percent or greater capture was about 0.06 percent of the model area. In about 43 percent of the cells, the pumping had no impact on spring flow (i.e. the pumping in these areas does not result in any capture of spring flow). A summary of the percentage of captured spring flow for all 22,635 simulations is shown in Table 1.

Table 1. Summary of Spring Flow Capture Analysis

Spring Flow Capture (Percent)	Percent of Model Domain
0	43.2
< 10	35.1
10 to 20	11.5
20 to 30	7.06
30 to 40	2.15
40 to 50	0.42
50 to 60	0.28
60 to 70	0.11
70 to 80	0.08
80 to 90	0.07
90 to 100	0.06

After evaluation of the results, a threshold capture of 35 percent was used to construct the map shown as Figure 1 that delineates the proposed area of Management Zone 1, along with the present outline of Management Zone 1.

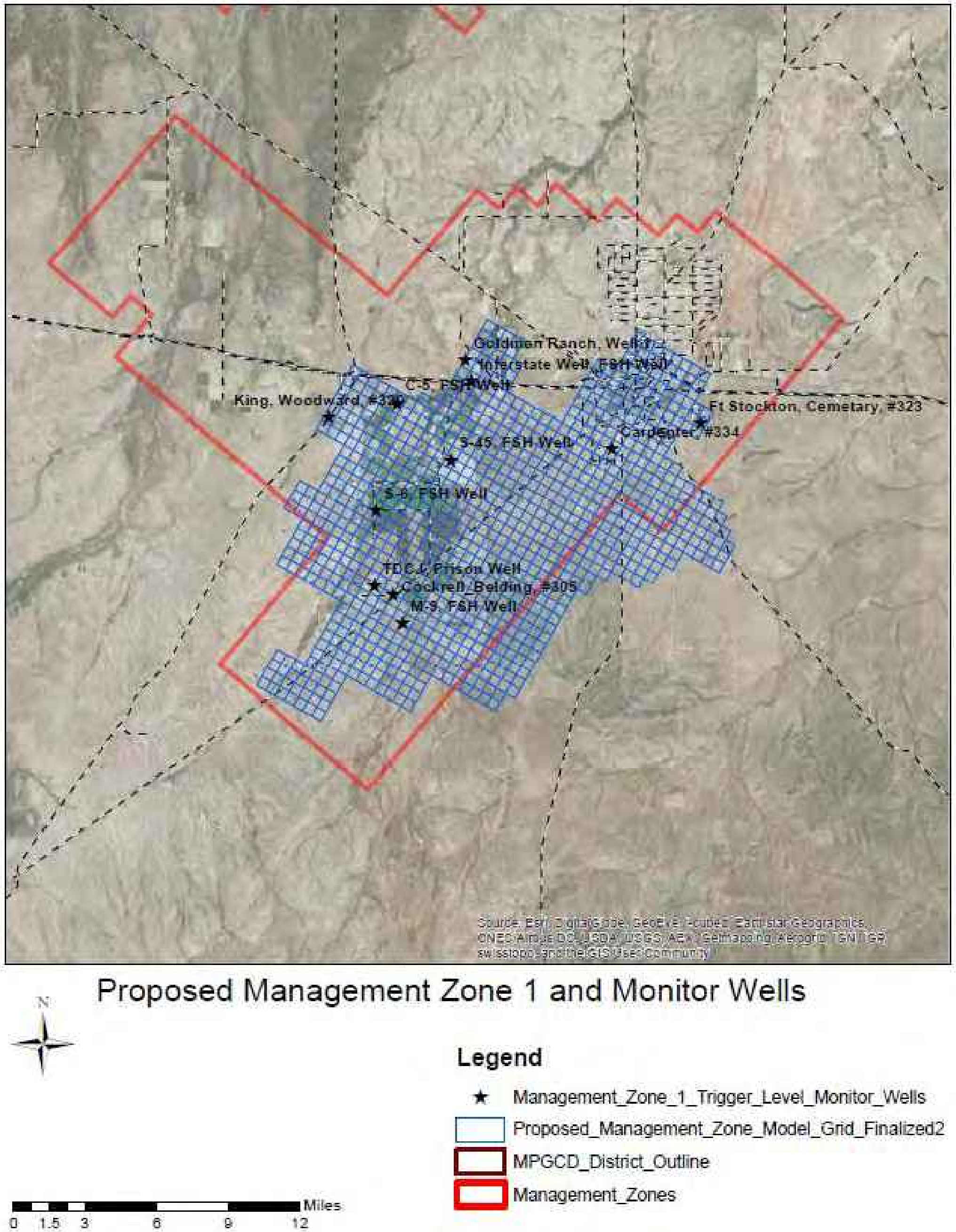


Figure 1. Proposed Management Area 1 Based on 35 Percent Spring Flow Capture

3.0 Monitor Well Selection

Potential monitor wells within the proposed Management Zone 1 were identified. A key objective of this effort was to identify the historic minimum groundwater elevation for use in establishing thresholds. The following factors were considered when reviewing the historical data and calibration period estimates from the WPC Model and the Regional Alternative GAM:

- Length of historical record
- Frequency of historic data (annual versus seasonal)
- Agreement between calibrated model estimates and historic data

Preference was given to actual data rather than model estimates. When historic data were not available and model estimates and the limited historic data showed good agreement, model estimates were considered useful to extend the historic record.

Based on this analysis, eleven wells were selected for use as monitor wells. A summary of the selected wells is presented in Table 2. As noted, two of these wells were selected based on the historic data. Also, as noted, nine of the wells were selected based on reasonable agreement between WPC model predictions and actual data. Wells that were rejected because of this evaluation included wells that had short historical records and poor agreement with model estimates which prevented extrapolating the historic data with model estimates with any reasonable degree of confidence.

Table 2. Summary of Selected Monitoring Wells

Well		Data or Model?	WPC Column	WPC Row
Short Name	Long Name			
Mpgcd320	King, Woodward, #320	Data	199	106
Mpgcd323	Ft Stockton, Cemetery, #323	Data	230	89
C-5	C-5, FSH Well	Model	204	102
M-9	M-9, FSH Well	Model	215	119
S-45	S-45, FSH Well	Model	211	104
S-6	S-6, FSH Well	Model	207	111
Mpgcd305	Cockrell Belding, #305	Model	213	118
Mpgcd318	Goldman Ranch, Well 1	Model	208	95
Mpgcd334	Carpenter, #334	Model	224	95
Interstate	Interstate Well, FSH Well	Model	209	96
Prison	TDCJ, Prison Well	Model	211	118

Hydrographs of these eleven wells are presented in Appendix A. The hydrographs include plots of historic groundwater elevation data (blue line), simulated groundwater elevation estimates at the location of the well from the WPC Model for the calibration period (red line), simulation groundwater elevation estimates at the location of the well from the Regional Alternative GAM (black line), and predicted groundwater elevation estimates from the desired future condition simulation (purple line) from Hutchison (2016).

3.1 Comparison of Model Results and Actual Data

An inspection of the hydrographs in Appendix A reveal the following observations:

- The historic data include both summer and winter readings, so the data can be used to evaluate groundwater levels during the irrigation season (summer) and the non-irrigation season (winter).
- The model estimates include estimates of end-of-year conditions only since both models simulated annual stress periods.
- Based on the above, the models are not suitable to simulate groundwater elevations during the irrigation season.
- Typically, the WPC Model simulates the groundwater elevations of these eleven wells better than the regional alternative GAM.
- The rate of decline in the WPC and the alternative GAM are similar, and, thus, regional GAM estimates of drawdown could be used for broad planning purposes.
- Use of the regional GAM results for individual predictions of groundwater elevations in a regulatory sense is not recommended.

As a final check on the comparison between models, Figure 2 summarizes the estimates of pumping in proposed Management Zone 1 from the WPC Model and from the regional alternative GAM. Note that after about 1970, the WPC model and the regional alternative GAM provide pumping estimates that are reasonably consistent.

Also, please note that the DFC simulation assumes pumping that is higher than recent years, but lower than the historic maxima estimated from the 1970s to the late 1990s. If the management approach in the proposed Management Zone 1 is to provide for the opportunity to reduce groundwater levels to their historic minima, the DFC simulation should be updated to reflect a higher level of assumed pumping.

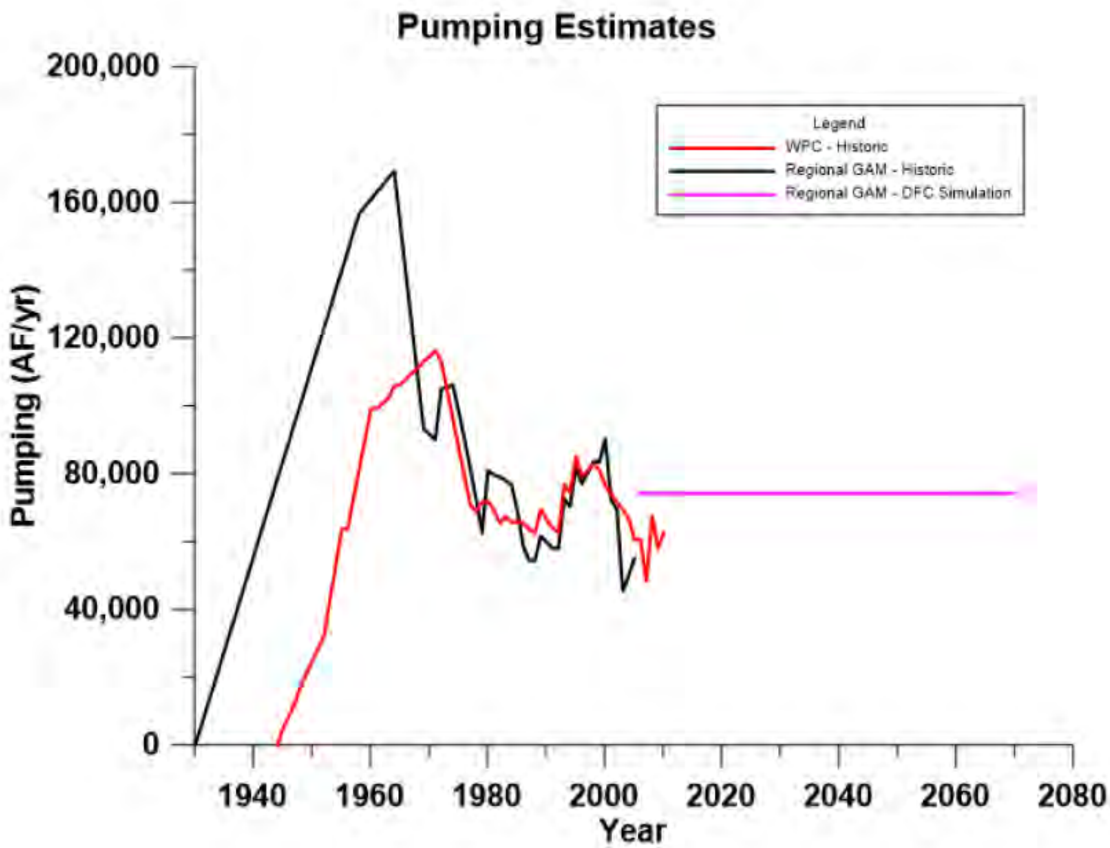


Figure 2. Pumping Comparisons for Proposed Management Zone 1: WPC Model and Regional GAM

4.0 Desired Future Conditions in Proposed Management Zone 1

Rule 10.5 of the Middle Pecos GCD covers the management zones of Pecos County. Management Zone 1 is described in Rule 10.5(a), but the description provides no basis of how the zone was delineated. Based on this analysis, the proposed Management Zone 1 is delineated based on a hydrogeologic analysis of potential pumping impacts to Comanche Springs.

Rule 10.5(b) summarizes average drawdown for each of the three management zones for every five-year period from 2015 to 2060. These estimates are derived from TWDB Task Report 10-033, and are based on simulations with the regional alternative GAM, and essentially represent the desired future condition that was adopted for Pecos County broken down by smaller management areas. The resulting estimates are still averages, but over a smaller area.

Table 3 summarizes the current average drawdowns for the current Management Zone 1 (taken from the Rules), and compares them with the updated average drawdown for the proposed Management Zone 1 using the current desired future conditions simulation.

Table 3. Summary of Drawdowns for Management Zone 1 (Current and Proposed)

Year	Drawdown (ft) from 2010 Conditions	
	Current Management Zone 1	Proposed Management Zone 1
2015	3	4
2020	7	8
2025	10	12
2030	13	16
2035	17	20
2040	20	24
2045	23	27
2050	26	31
2055	29	35
2060	32	38
2065	N/A	42
2070	N/A	45

The practical administration of average drawdown is difficult given the fact that the desired future condition is a planning goal and incorporated into the average drawdowns are many assumptions related to timing and location of pumping. More importantly, the average drawdown includes a calculation of an entire area. Within any of these areas, there are a limited number of monitoring wells. Thus, there is an inherent difficulty in comparing a few locations where actual data exist to an overall average drawdown that was based on an idealized model simulation with several assumptions that may or may not be realistic over a defined time period (timing and location of pumping, average recharge conditions).

An alternative way to compare desired future conditions and actual data is on a well-by-well basis. The output from the DFC simulations was used to plot groundwater elevation estimates as shown on each of the eleven hydrographs in Appendix A. As discussed earlier, the actual groundwater elevation estimates are not as reliable as drawdown estimates for these eleven wells. These data were processed to develop Table 4, a summary of the drawdowns in individual wells.

Table 4. Summary of Drawdown for Individual Wells in Proposed Management Zone 1

Year	Mpgcd320	Mpgcd323	C-5	M-9	S-45	S-6	Mpgcd305	Mpgcd318	Mpgcd334	Interstate	Prison
2015	4	2	4	6	5	5	6	4	4	4	6
2020	8	4	9	13	9	9	12	8	7	8	12
2025	11	6	13	19	14	14	18	13	11	12	18
2030	15	8	17	25	18	18	24	17	15	16	23
2035	19	11	21	30	22	23	30	20	18	20	29
2040	23	13	25	36	26	27	35	24	21	23	34
2045	26	16	29	41	30	31	40	28	25	27	39
2050	30	18	33	47	34	35	46	32	28	31	44
2055	33	21	37	52	38	40	51	36	32	34	49
2060	37	23	41	57	41	44	56	39	35	38	54
2065	40	26	44	62	45	48	61	43	38	42	59
2070	43	28	48	67	49	51	66	46	41	45	63

Because the drawdown estimates are based on a calculation of groundwater elevations in 2010 and the year of interest, and because the eleven proposed monitor wells have records that generally begin in 2010, it is possible to compare the actual drawdown to the desired future condition. Table 5 presents this comparison for the eleven proposed monitoring wells for the period end-of-2010 to end-of-2016.

Please note that two of the eleven wells have drawdowns that are greater than the DFC drawdown, and nine of the wells have drawdowns that are less than the DFC drawdown. Also, please note that seven of the wells have groundwater elevation recoveries (negative drawdowns) from 2010 to 2016.

The DFC simulations assumed an idealized case where recharge was average for the entire period from 2005 to 2070, and pumping did not vary from year to year. Actual data suggest that there is considerable variation in groundwater elevations from year to year based on a combination of variations in recharge conditions and variations in pumping. Thus, it would be inappropriate to conclude that there was a problem with meeting the DFC in Well C-5 despite the data showing a 19.5 ft drawdown from 2010 to 2016 and the idealized DFC simulation estimated a 5.3 ft drawdown. The overall results suggest that, as of 2016, there is an overall consistency between the actual data and the overall planning goal (DFC).

It is recommended that Rule 10.5 be updated and that Middle Pecos GCD implement a well-by-well comparison between DFCs and actual data. The concept of average drawdown is appropriate as a planning goal and is useful to compare and contrast alternative DFCs, but the practical implementation of the planning goal should be based on more tangible and reproducible data and analyses.

Table 5. Comparison of DFC Drawdown and Actual Data for Eleven Proposed Monitoring Wells (2010 to 2016)

Well	One-Layer Model			Measured Data		
	End of 2010 Groundwater Elevation (ft MSL)	End of 2016 Groundwater Elevation (ft MSL)	Partial DFC - Drawdown from 2010 to 2016 (ft)	End of 2010 Groundwater Elevation (ft MSL)	End of 2016 Groundwater Elevation (ft MSL)	Actual Drawdown from 2010 to 2016 (ft)
Mpgcd320	2901.13	2896.54	4.59	2952.00	2950.25	1.75
Mpgcd323	2814.13	2811.69	2.44	2888.17	2882.30	5.87
C-5	2855.36	2850.08	5.28	2972.30	2952.80	19.50
M-9	2969.94	2962.2	7.74	3009.70	3015.00	-5.30
S-45	2831.22	2825.51	5.71	2970.80	2975.40	-4.60
S-6	2946.34	2940.85	5.49	2993.20	3005.10	-11.90
Mpgcd305	2966.42	2958.85	7.57	3019.63	3027.10	-7.47
Mpgcd318	2833.19	2828.05	5.14	2924.70	2926.75	-2.05
Mpgcd334	2821.93	2817.39	4.54	2948.50	2947.10	1.40
Interstate	2892.69	2887.81	4.88	2940.20	2938.80	1.40
Prison	2965.61	2958.35	7.26	3007.60	3014.94	-7.34
Average	2890.72	2885.21	5.51	2966.07	2966.87	-0.79

Notes:
MPGCD 305 - no measured data at end of 2010, data shown is for end of 2011
MPGCD 318 - no measured data at end of 2010, data shown is for end of 2012

5.0 Proposed Thresholds for Individual Monitor Wells

As part of the analysis, recommendations for establishing threshold values for the individual monitor wells were developed. Conceptually, these recommendations were based on discussions with FSH representatives in Fort Stockton on April 17, 2017 and with the Middle Pecos GCD Board of Directors on April 18, 2017. Table 5 summarizes these recommendations.

Each of the eleven proposed monitoring wells is listed along with the reference point elevation for measuring groundwater levels. The “Winter Threshold 1” is the minimum historic level. For Wells MPGCD 320 and MPGCD 323, these were developed on actual data. For the other nine wells, they were based on the historic minimum elevation from the WPC Model. As noted at the bottom of Table 5, the proposed action if 6 of the 11 wells fall below the listed threshold is a 100 percent reduction in FSH non-historical use pumping.

“Winter Threshold 2” is 5 feet above “Winter Threshold 1”, and, if 6 of the 11 wells fall below the listed threshold, there would be a 30 percent reduction in FSH non-historical use pumping as a means to reduce the rate of decline.

“Winter Threshold 3” is 10 feet above “Winter Threshold 1”, and, if 6 of the 11 wells fall below the listed threshold, there would be a 10 percent reduction in FSH non-historical use pumping as a means to reduce the rate of decline.

The monitor well data were used to establish a recent maximum drawdown between winter and summer depth to water data. This maximum drawdown was added to the Winter Threshold 1 to establish a recommended Summer Threshold that would be considered an early warning trigger that groundwater levels may not recover to above the winter thresholds. If 6 of the 11 wells falls below the summer threshold, the “action” would be to have the technical representatives of MPGCD and FSH to meet within 60 days to review pumping and groundwater level data.

The final two columns of Table 5 show the minimum (winter) and maximum (summer) depth to water data in each well from spring 2016 to winter 2017. These are provided for context and to facilitate comparison of current conditions and the recommended thresholds.

Table 6. Monitor Well Threshold Recommendations

Well		Reference Point Elevation (ft MSL)	Winter Threshold 1		Winter Threshold 2		Winter Threshold 3		Maximum Recent Drawdown (Winter to Summer)	Summer Threshold		Recent Depth to Water	
Short Name	Long Name		Depth to Water (ft)	Basis	Depth to Water (ft)	Basis	Depth to Water (ft)	Basis		Depth to Water (ft)	Basis	Winter	Summer
Mpgcd320	King, Woodward, #320	3068	200	Data 1/1999	195	Win1-5	190	Win1-10	45	245	Win1+Max DD	113	148
Mpgcd323	Ft Stockton, Cemetery, #323	3031	193	Data 1/2000	188	Win1-5	183	Win1-10	15	208	Win1+Max DD	146	148
C-5	C-5, FSH Well	3009	105	WPC 1973	100	Win1-5	95	Win1-10	72	177	Win1+Max DD	60	107
M-9	M-9, FSH Well	3261	308	WPC 1973	303	Win1-5	298	Win1-10	48	356	Win1+Max DD	246	283
S-45	S-45, FSH Well	3067	160	WPC 1973	155	Win1-5	150	Win1-10	56	216	Win1+Max DD	92	115
S-6	S-6, FSH Well	3123	200	WPC 1973	195	Win1-5	190	Win1-10	62	262	Win1+Max DD	118	159
Mpgcd305	Cockrell_Belding, #305	3233	287	WPC 1973	282	Win1-5	277	Win1-10	75	362	Win1+Max DD	206	250
Mpgcd318	Goldman Ranch, Well 1	2957	67	WPC 1975	62	Win1-5	57	Win1-10	33	100	Win1+Max DD	30	49
Mpgcd334	Carpenter, #334	3051	135	WPC 1975	130	Win1-5	125	Win1-10	36	171	Win1+Max DD	104	126
Interstate	Interstate Well, FSH Well	2988	91	WPC 1975	86	Win1-5	81	Win1-10	40	131	Win1+Max DD	49	71
Prison	TDCJ, Prison Well	3199	253	WPC 1973	248	Win1-5	243	Win1-10	50	303	Win1+Max DD	184	224

Threshold	**Action**
Winter Threshold 1	If 6 of 11 are below threshold, 100% reduction in FSH non-historical use pumping
Winter Threshold 2	If 6 of 11 are below threshold, 30% reduction in FSH non-historical use pumping
Winter Threshold 3	If 6 of 11 are below threshold, 10% redcution in FSH non-historical use pumping
Summer Threshold	If 6 of 11 are below threshold, meeting in 60 days between FSH and MPGCD to discuss data

Notes

Maximum Recent Drawdown (Winter to Summer) based on evaluation of recent data (~2010 to 2016)

Summer Thresholds derived by adding maximum recent drawdown (from historic data) to Winter 1 Threshold

Recent Depth to Water are from actual data: maximum (summer) and minimum (winter) from spring 2016 to winter 2017

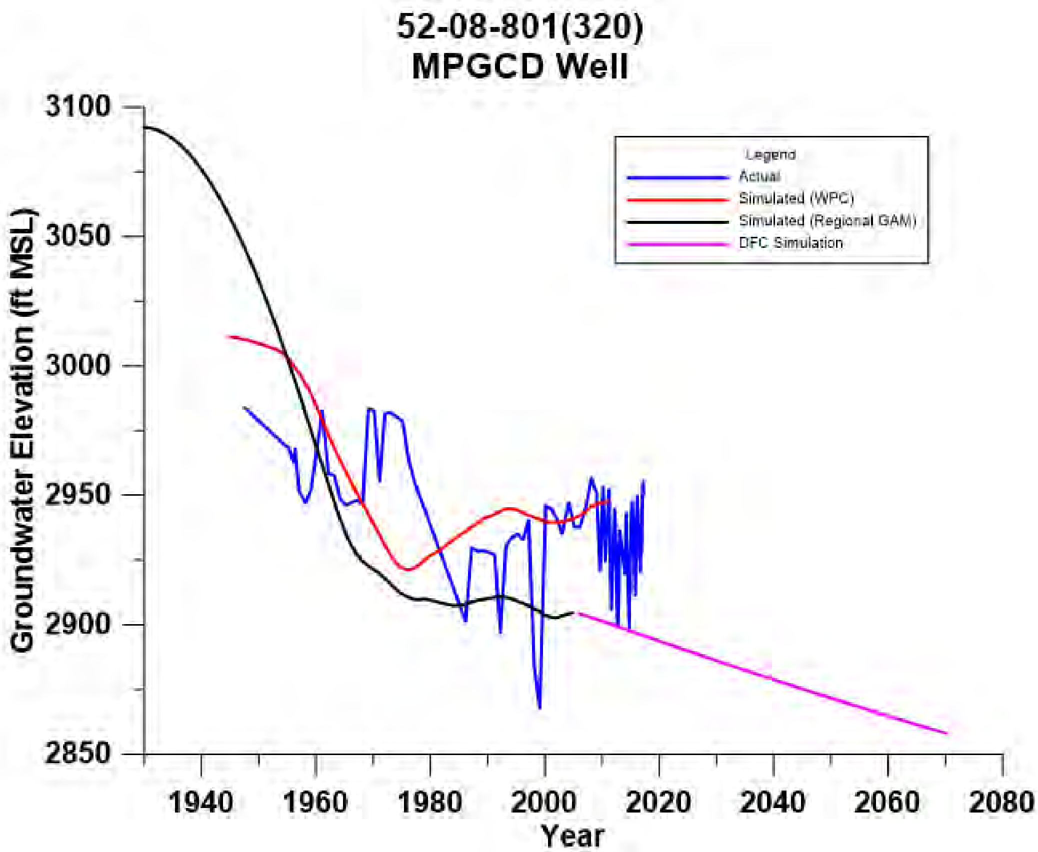
6.0 References

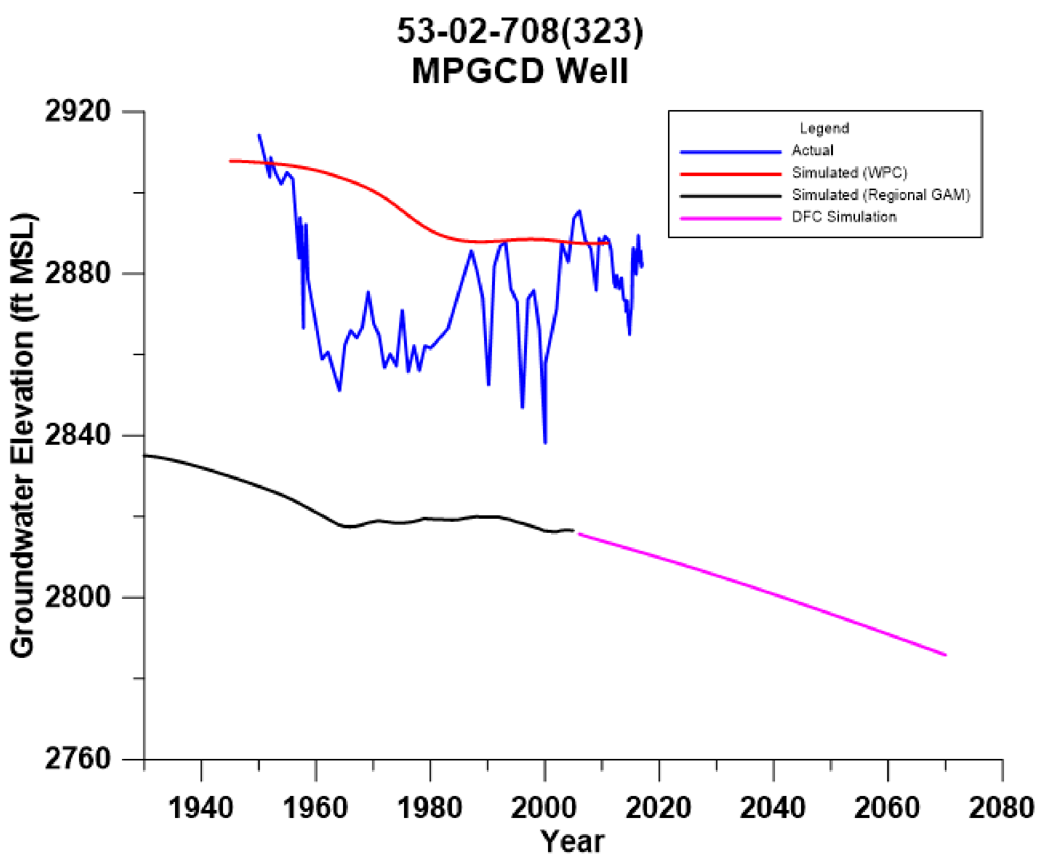
Hutchison, W.R., 2016. Edwards-Trinity (Plateau), Pecos Valley and Trinity Aquifers: Nine Factor Documentation and Predictive Simulations. GMA 7 Technical Memorandum 15-06 (Draft 2), May 24, 2016, 16p.

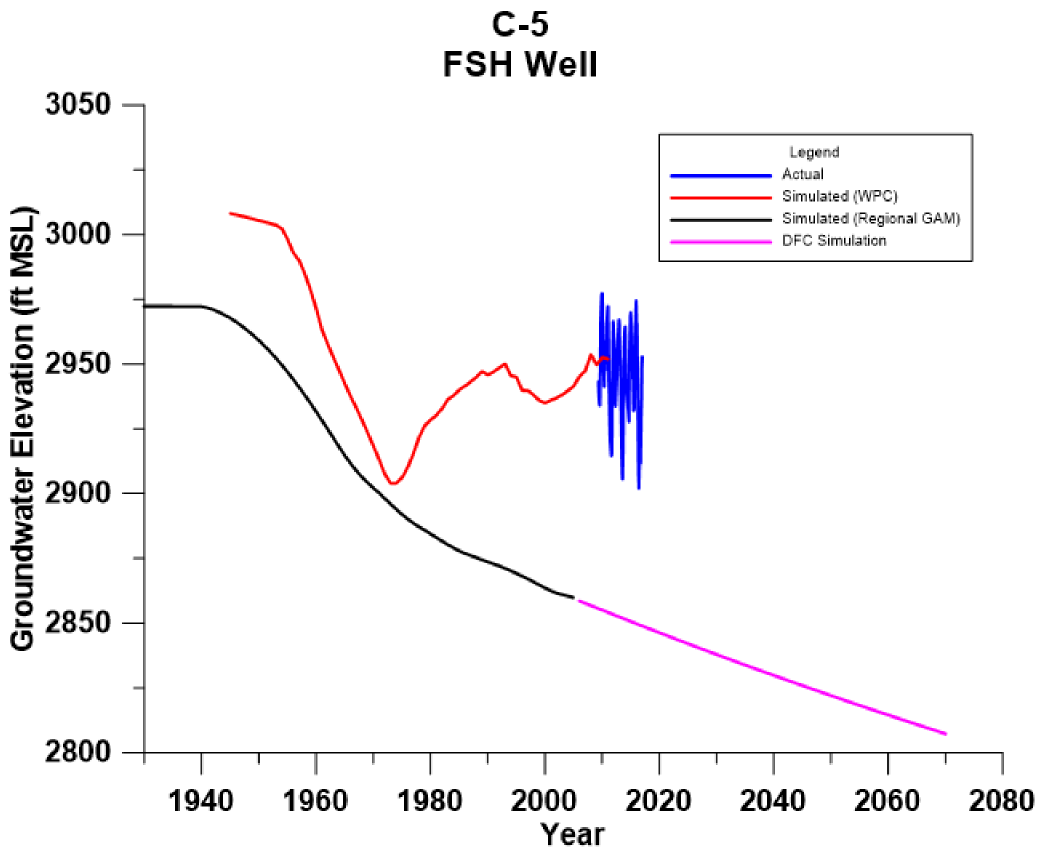
R.W. Harden & Associates, Inc., LBG-Guyton Associates, and Thornhill Group, Inc., 2011. Hydrogeologic, Geochemical and Groundwater Modeling Evaluation of the Leon-Belding Area in Pecos County. Report prepared for Fort Stockton Holdings, L.P. April 14, 2011, 95p.

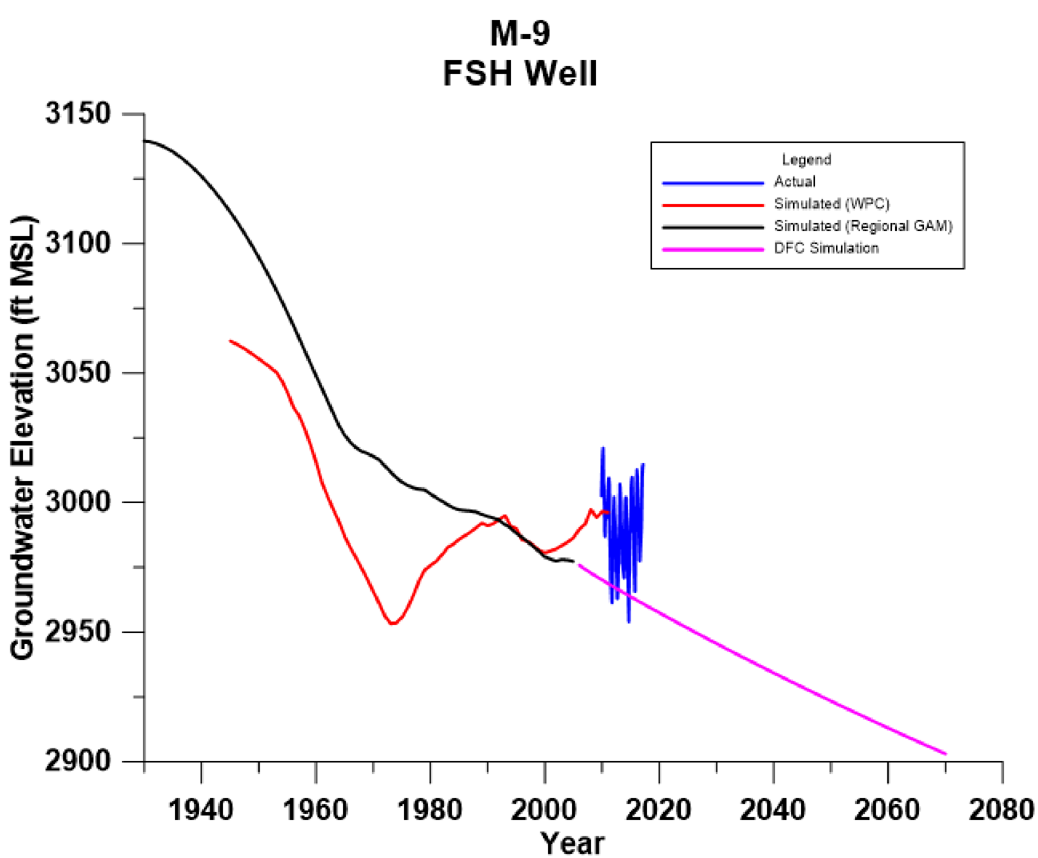
Appendix A

Hydrographs of Eleven Selected Monitoring Wells

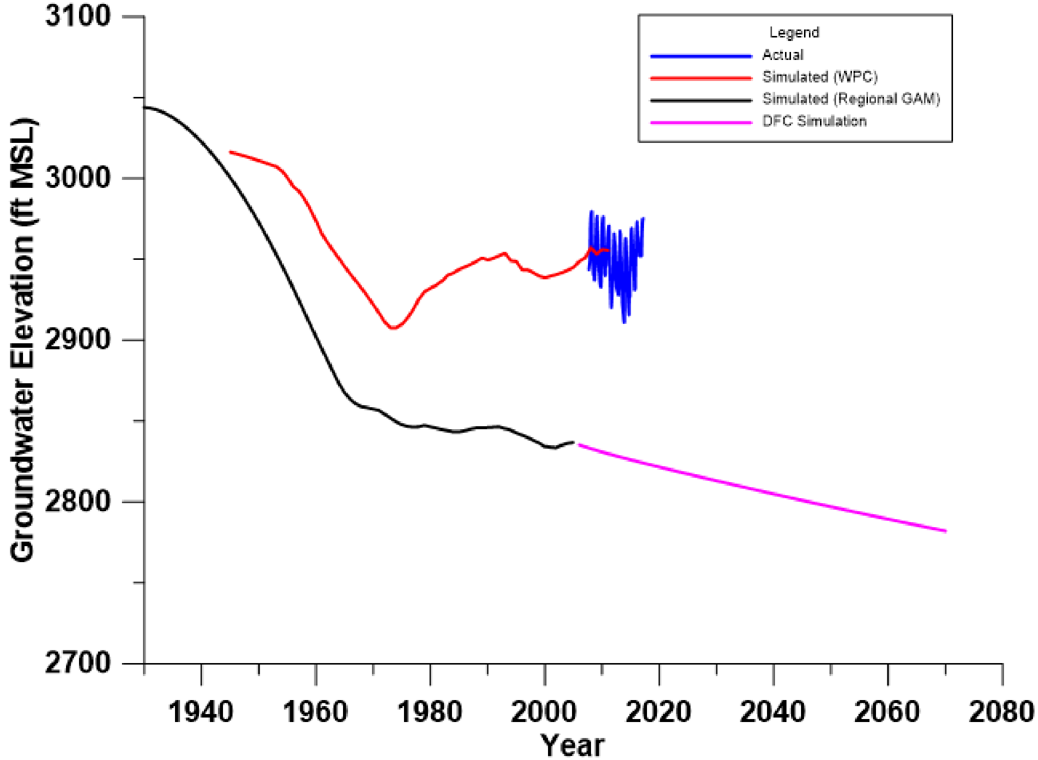

52-08-801(320)
MPGCD Well
Legend
Actual
Simulated (WPC)
Simulated (Regional GAM)
DFC Simulation
Groundwater Elevation (ft MSL)
Year
3100
3050
3000
2950
2900
2850
1940
1960
1980
2000
2020
2040
2060
2080


53-02-708(323)
MPGCD Well
Legend
Actual
Simulated (WPC)
Simulated (Regional GAM)
DFC Simulation
Groundwater Elevation (ft MSL)
Year
2920
2880
2840
2800
2760
1940
1960
1980
2000
2020
2040
2060
2080

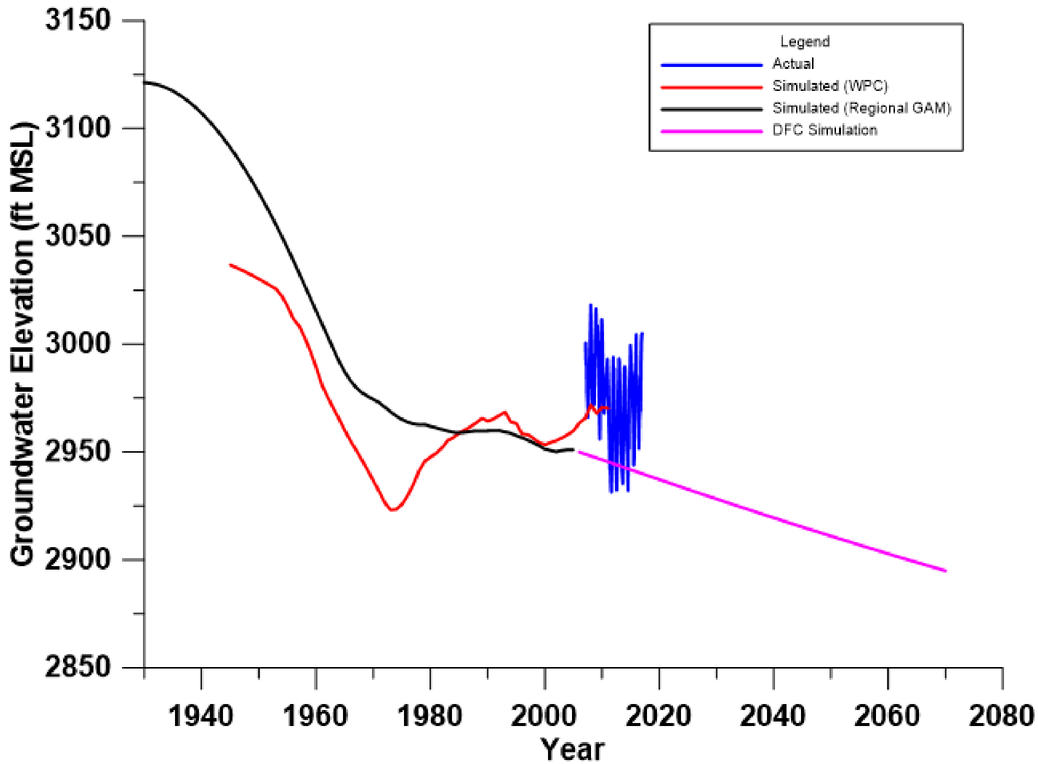

C-5
FSH Well
Groundwater Elevation (ft MSL)
Year
3050
3000
2950
2900
2850
2800
1940
1960
1980
2000
2020
2040
2060
2080
Legend
Actual
Simulated (WPC)
Simulated (Regional GAM)
DFC Simulation

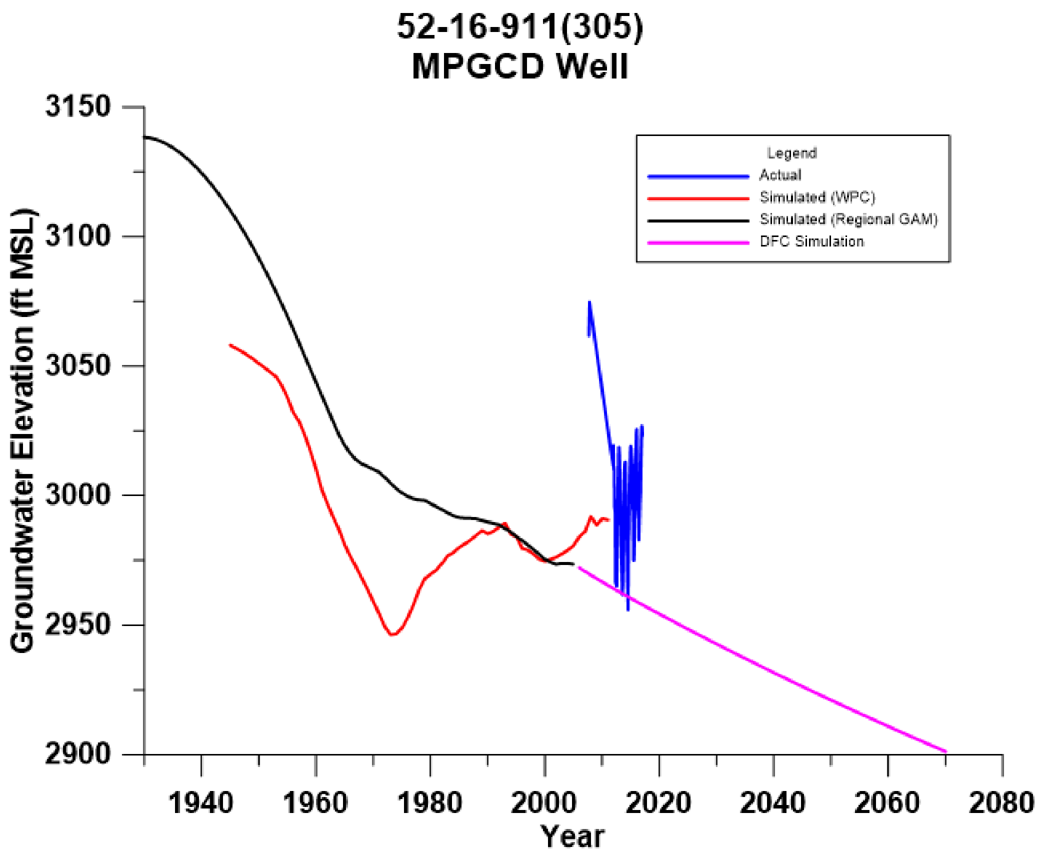

M-9
FSH Well
Groundwater Elevation (ft MSL)
Year
3150
3100
3050
3000
2950
2900
1940
1960
1980
2000
2020
2040
2060
2080
Legend
Actual
Simulated (WPC)
Simulated (Regional GAM)
DFC Simulation

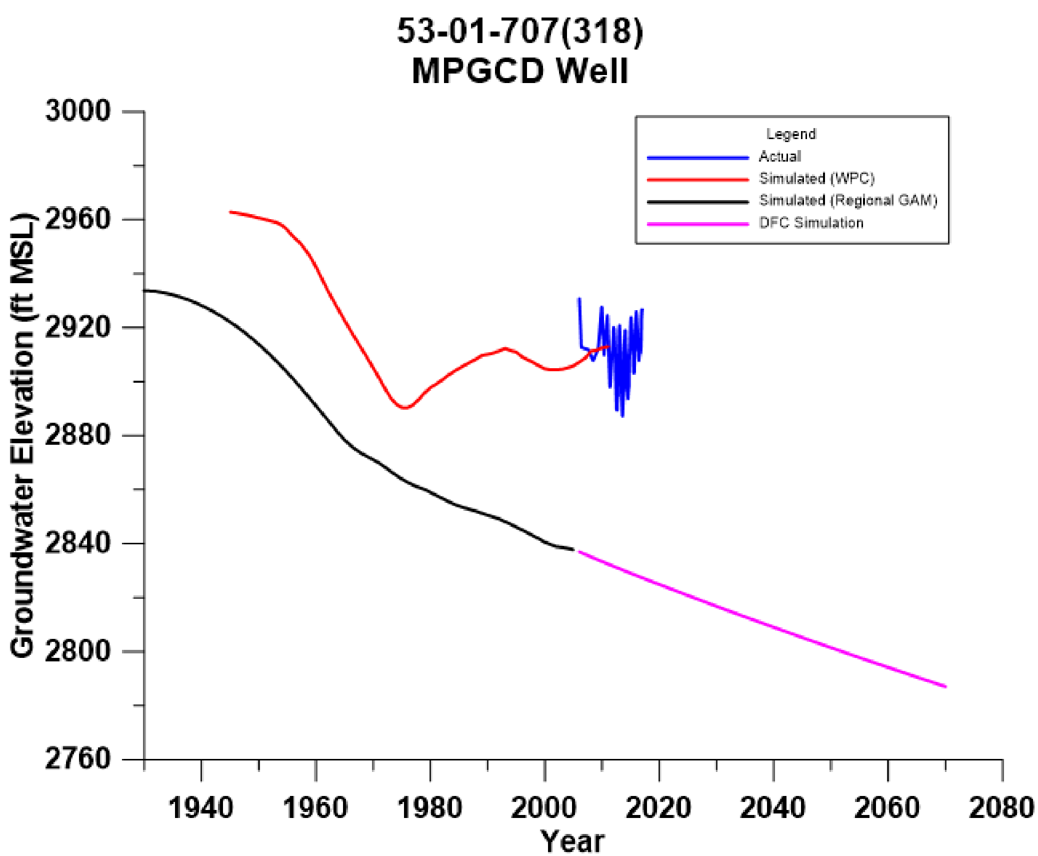
S-45
FSH Well



S-6
FSH Well




52-16-911(305)
MPGCD Well
Groundwater Elevation (ft MSL)
3150
3100
3050
3000
2950
2900
1940
1960
1980
2000
2020
2040
2060
2080
Year
Legend
Actual
Simulated (WPC)
Simulated (Regional GAM)
DFC Simulation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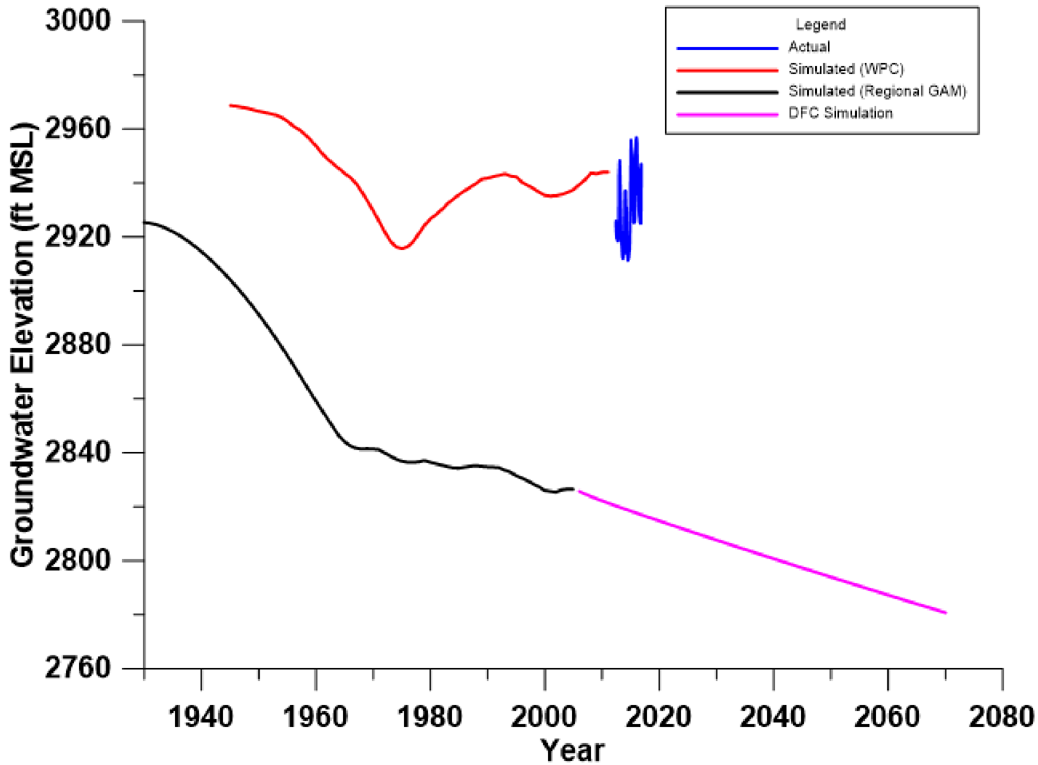
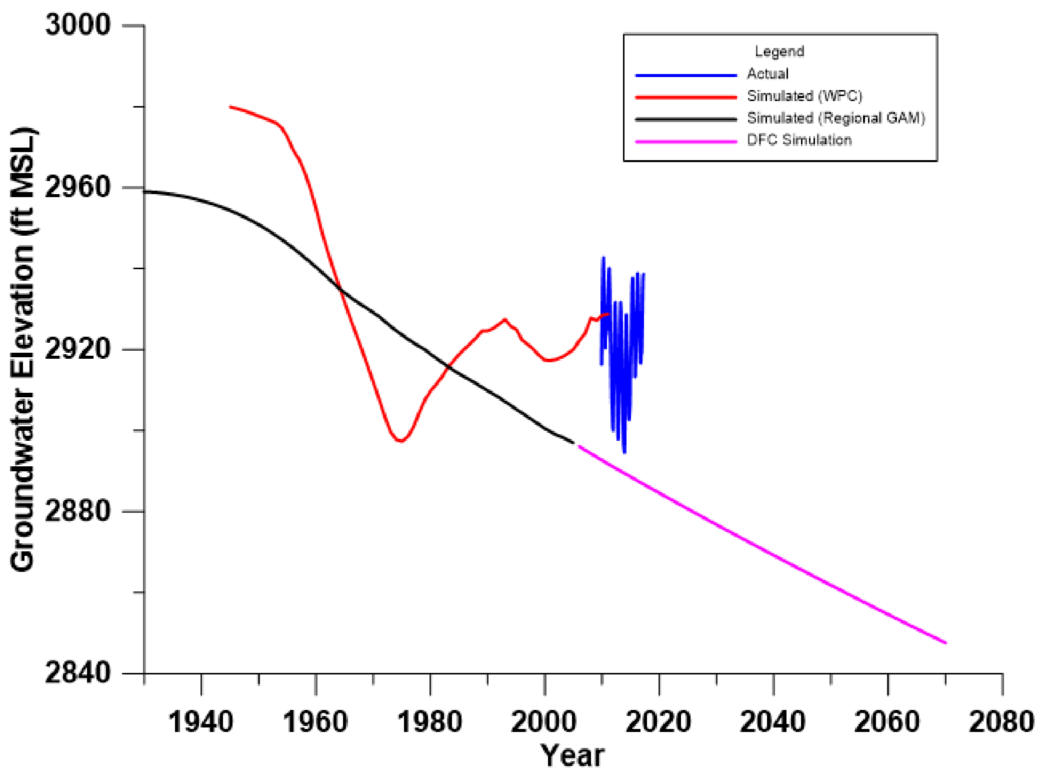
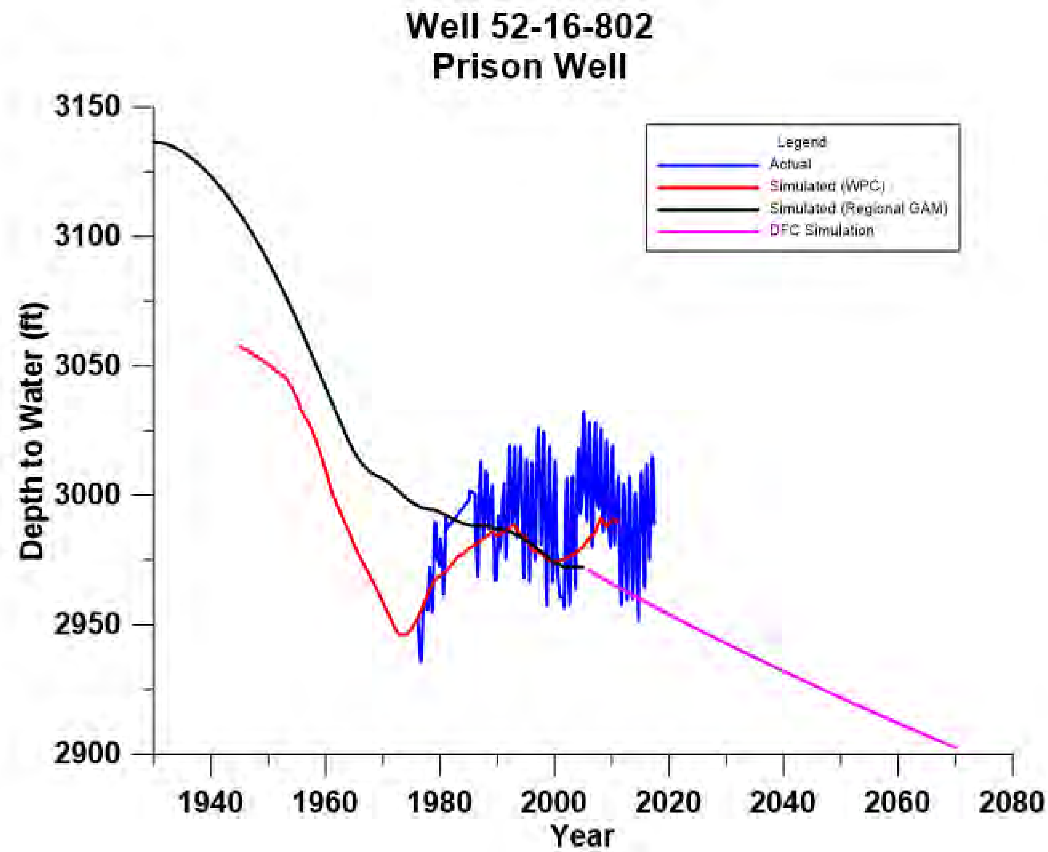
MPGCD Well
Groundwater Elevation (ft MSL)
3000
2960
2920
2880
2840
2800
2760
1940
1960
1980
2000
2020
2040
2060
2080
Year
Legend
Actual
Simulated (WPC)
Simulated (Regional GAM)
DFC Simulation

53-09-309(334)
MPGCD Well



Interstate
FSH Well





Well 52-16-802
Prison Well
Legend
Actual
Simulated (WPC)
Simulated (Regional GAM)
DFC Simulation
Depth to Water (ft)
3150
3100
3050
3000
2950
2900
1940
1960
1980
2000
2020
2040
2060
2080
Year

Appendix B

Comment Letters Received on Hutchison (2017)

LAW OFFICES OF

McCARTHY & McCARTHY, L.L.P.

1122 COLORADO, SUITE 2399
AUSTIN, TEXAS 78701
(512) 904-2310
(512) 692-2826 (FAX)

MEMORANDUM

TO: Ty Edwards, General Manager, MPGCD *via e-mail*
Mike Gershon, General Counsel, MPGCD
Alan Standen, Consulting Geologist, MPGCD
Dr. Bill Hutchison, Consulting Hydrogeologist, MPGCD

FROM: Ed McCarthy

DATE: July 13, 2017

RE: MPGCD's proposed modifications related to Management Zone 1 and the issuance of a new Production Permit to FSH for 28,400 acre-feet

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Fort Stockton Holdings ("FSH") has been discussing the draft report done by Dr. Hutchison, which we spoke about late last month at the Middle Pecos Groundwater Conservation District's ("District") office, and working with its hydrogeologic consultants since that meeting to develop the attached comments and recommendations related to both the rulemaking the District is engaged in related to the reconfigured Management Zone 1 Area, and for special conditions to the FSH permit. We have appreciated your patience as we worked through the information and preliminary recommendations presented by Dr. Hutchison. Please feel free to share this information with whomever you wish, including posting it on the District's website if you feel that would be helpful or productive.

Our hope is that you (Ty, Mike and the District's consultants), and any other interested parties the District wants to invite could meet Monday afternoon prior to the scheduled hearing on Tuesday to discuss the attached. At that meeting, FSH's consultants and the District's consultants (and any attending interested stakeholders) can discuss and vet both the attached proposal and Dr. Hutchinson's draft preliminary assessment.

Please let us know if you all would be amenable to such a meeting after lunch Monday. In the interim, if we can answer any questions, please do not hesitate to contact me at 512-904-2312, or via email. You can also contact FSH's hydrogeologic consultants and Jeff Williams directly.

As always, we appreciate your assistance and efforts with this matter.

MPGCD's Reconfigured Management Zone No. 1

FSH's Rationale for Triggers, Stages and Pumping Reductions

Introduction

Fort Stockton Holdings LP offers these comments in support of the proposed modification to the geographic boundaries of the MPGCD Management Zone No. 1, and the efforts to develop (i) rules specific to the reconfigured Management Zone No. 1, and (ii) special conditions for inclusion in FSH's new production permit authorizing production of 28,400 acre-feet per annum of groundwater from the Edwards-Trinity Aquifer. Set forth herein are FSH's comments and recommendations for these purposes.

These comments and recommendations build upon the recent preliminary draft report and recommendations of the District's consulting hydrogeologist Dr. Bill Hutchison, Ph.D., entitled "Proposed Changes to Management Zone 1 and Proposed Monitor Well Data and Comparisons with Model Simulations (Draft 1)" (hereinafter referred to as "Hutchison (2017-Draft)"), they also find support in the extensive knowledge FSH has developed over almost a century of intensive groundwater production in the Leon-Belding Area of Pecos County at Clayton Williams Farms and multiple hydrogeologic studies dating back to the 1980s.

Finally, these comments and recommendations are offered to the District for consideration of the factors below, which FSH (i) identified after having the benefit of the preliminary assessment in Dr. Hutchison's Draft Report, and (ii) assumes are unintended consequences. Specifically, adoption of a permanent "hard cap" of not allowing the levels in the Edwards-Trinity Aquifer to drop below the historic low documented in 1973, while conservative and certainly protective of the aquifer, has the following detrimental effects not addressed by or considered in the Draft Report:

A) All pumping, not just FSH pumping within the MZ1 Area must be terminated when the historic low is reached – this includes all H&E Permit production; and

B) Absent a documented scientific basis to provide a reasoned justification for adoption of such a hard cap would affect an undeniable "regulatory taking" of the property rights in the groundwater available from the aquifer below that historic low level; and

C) Effecting a permanent regulatory taking by adoption of an unsupported hard cap would result in (i) creating an undesirable instability in the management of both the Edwards-Trinity and, in particular, management within the management zone, and (ii) potentially opening the District to costly and unnecessary litigation from landowners wishing to exercise their property rights in groundwater after the artificial and unsupported hard cap is reached.

History has shown that the Edwards-Trinity Plateau aquifer in the farming region of Pecos County known as the "Leon-Belding Area" is steady and very resilient from the standpoint of groundwater inflow. The region benefits from the enormous recharge area to the south and west that includes the Davis and Glass Mountain ranges. Although increased production clearly reduces water levels in area wells, reduced production also results in distinct rises in water levels.

Most of the water-level changes are a response to changes in artesian pressure directly associated with increases and decreases in local pumping rates. They are not related to substantial variations in recharge. In short, the aquifer within the Leon-Belding Area (*i.e.*, Management Zone 1) acts very similarly to the San Antonio segment of the Edwards Aquifer with the exception that recharge to the Edwards-Trinity in Management Zone 1 from lateral inflows are more certain and steady than in the San Antonio segment of the Edwards. This is largely due to the increased time and distance required for lateral inflow to reach the MZ1 Area from the recharge area. Although the recharge to the San Antonio segment is variable, both aquifers share the characteristic of long-term resiliency.

Because of this resiliency, and a long, documented history of water levels, pumping and springflows, the Edwards Aquifer Authority (EAA) has developed a different approach to managing the San Antonio segment of the Edwards Aquifer then the approach that has been used across Texas in many other aquifers. The EAA's unique approach acknowledges the relative resiliency of the aquifer while protecting the groundwater levels and water quality, etc., during critical periods by setting "triggers" at which certain responsive protective steps, including pumping reductions, will occur.

The EAA (2016) clearly describes that among other goals, one important purpose of the management rules and regulations is to protect endangered species that rely on springflows. The Edwards-Trinity Plateau Aquifer in the Leon-Belding Area does not have either the EAA's endangered species issues, or attendant springflow issues. *See Pecos County WCID No. 1 v. Williams,* 271 S.W.2d 503 (Tex. Civ. App. – El Paso 1954, writ ref'd n.r.e.).

In recognition of a long and documented history of intensive pumping and water levels in the MZ 1 Area, the MPGCD has determined to set management goals associated with the maximum historical impact on water levels from pumping in Management Zone 1 (*i.e.,* the deepest known or estimated water levels in the MZ1 Area). Review of the most recent State Water Plan indicates that there are no specific, or planned, future demands in the area. Additionally, study of the local aquifer transmissivity, ranges and trends of historic water-level changes, and the artesian pressure and saturated thickness indicate that some areas of the Edwards-Trinity aquifer capable of producing water are quite variable due to the variability of the karst nature of the major producing units in the Pecos County.

As part of previous permitting activities of the MPGCD, a groundwater model has been developed specifically for application to MPGCD's Management Area 1. The model is referred to as the Western Pecos Groundwater Model ("WPC Model"). The WPC Model was completed and documented in 2011 by R.W. Harden & Associates, Inc. ("Harden"), LBG-Guyton Associates ("Guyton"), and Thornhill Group, Inc. ("TGI") in support of Fort Stockton Holdings, L.P. permit application seeking a new production permit from MPGCD to produce groundwater for municipal and/or industrial use (referenced as Harden and others (2011)). To assist in delineation of the appropriate area for the reconfigured Management Zone 1, model simulations were conducted using the WPC model to better understand common reservoir boundaries by hydrogeologic consultants for both MPGCD (Hutchison (2017-Draft)) and FSH (Harden, Guyton & TGI).

Management Goals for Management Zone 1

The MPGCD has indicated the desire to maintain water levels within Management Zone 1 at or above the historic winter low that occurred in 1973 when irrigation pumping was at a historic high. FSH supports this concept as a starting point, subject to the ability to modify regulatory limitations prospectively based upon scientific data to be gathered.

The historic high rate of pumping that resulted in the 1973 measured aquifer levels within the MZ1 Area was associated with the desire of irrigators to increase crop yields in response to high agriculture commodity prices at the time. Economic factors in 1973, including an unprecedented embargo on oil and natural gas resulting in supply shortages and significant price increases, and a significant drop in the price of cotton, a major cash crop in the area at the time, led to a set of circumstances making it economically unfeasible to continue producing groundwater. It also resulted in a number of farming operators going out of business. Due solely to economic reasons, and in the complete absence of any documented evidence of the presence of adverse conditions, effects or impacts on the aquifer or to any groundwater producers, pumping was curtailed by the pumpers themselves. In response to the resultant reduction in pumping, the water levels within the aquifer within the MX1 area rebounded from what has become known as the "historic low levels."

It is important to note that there were no hydrologic, hydrogeologic and/or environmental or legal factors or reasons connected to the 1973 change in pumping, nor was there any evidence the aquifer was under any threat or undue strain at the time of the historic winter low. MPGCD's stated purpose in maintaining the water levels above the historic low is that there is no evidence of any water quality deterioration or degradation at that level of production. While the MPGCD position on water quality at the historic low level is accurate, there is similarly no scientific data or documented evidence to support a hypothesis that water quality will deteriorate, or become degraded to the point of curtailing existing uses of the groundwater if the water level in the aquifer drops below the historic winter low.

Statistically speaking, it is a Type 1 rejection of the null hypothesis. Specifically, because there is no data to substantiate the hypothesis that water quality will deteriorate below the historic low water level, from a scientific standpoint, it is inappropriate to (i) assume degradation will occur if water levels drop below the historic low, or (ii) to imply any causality between lower water levels and water quality deterioration without data to support the hypothesis. A more scientifically based adaptive management approach that will help identify the highest practicable production from the MZ1 Area, while maintaining reasonable water quality, therefore, is both appropriate and recommended. More importantly, it will avoid the adverse unintended consequences described above.

A scientific approach for developing appropriate triggers and pumping reductions to implement such an adaptive management approach to protect both the aquifer and those who pump it, and the property rights of landowners within the reconfigured MZ1 Area is described below.

The proposed methodology allows full use of all permits until the winter water level is below the 1973 winter low. If water levels fall below the historic low, water quality can be closely monitored (i) to establish if there is a correlation between lower water levels and water quality below the historic winter low of 1973, and (ii) to document effects on the aquifer and those pumping from it under lower aquifer level conditions.

Scientific Approach for Establishing Pumping Reductions for the MZ1 Area

To better understand the cause and effect relationship between annual production and the traditionally expanded winter water level, reported pumping in the MZ1 Area was compared to the winter water levels for the years 2007 through 2016 for each of the monitoring wells identified in the draft assessment prepared by Dr. Hutchison (Hutchison (2017-Draft)). This assessment relies on actual water level measurements and reported (estimated) pumping, but does not incorporate model results. These correlations are referred to as rating curves for the purposes of this discussion and are included in Appendix A.

As shown in Appendix A to Dr. Hutchison's preliminary draft assessment, a rating curve was developed for each of the proposed monitoring wells identified by the draft plan. Hutchison (2017-Draft). Evaluation of the relationship between estimated pumping and winter water levels indicates that for the period of study, there is about 1 foot of drop in winter water levels for every

1000 acre-foot per year increase in production from the MZ1 Area. This relationship varies from well to well due to aquifer variability, pumping distribution and timing, estimation errors, and other factors. This relationship is helpful, however, as it provides insight into likely aquifer responses at production levels approaching the full amount of production permitted by MPGCD for production in the MZ1 Area – 86,448 acre-feet per year. This information can provide a guide to the likely increase in winter water level following annual reductions in pumping.

Table 1 attached hereto provides FSH's proposed triggers, stages and withdrawal reduction for MPGCD Management Zone 1 based upon the information in Dr. Hutchison's draft preliminary assessment, and the knowledge and experience developed by FSH. The proposed triggers, stages and withdrawal reductions are patterned after the rules that have been developed by the EAA and successfully implemented over the last 25 years.

Consistent with the logic discussed in the previous section, the withdrawal reductions are not implemented until water levels drop below the 1973 winter low. This approach allows for improved scientific data to be collected to establish water quality relationships at levels below the historic winter low, as well as continued beneficial use of the groundwater property right by the landowners and pumpers within the MZ1 Area. The proposed reductions are more stringent for non-H&E permits than for H&E permits for each stage. Remembering that the estimated increase in winter water level (in the winter following reductions) will be about 1 foot per 1000 af/yr reduction, the reductions will allow a potential continued decrease in water levels below the historic winter low because the reductions will not necessarily reduce the pumping enough to increase the water level back to the historic winter low based on the 1000: 1 ratio that is estimated from recent data.

For example, in proposed Stage 3, the total reduction in all permits is about 6,112 af/yr. This reduction in production is estimated to increase winter water levels by about 6 feet based on the 1000:1 ratio, but the water level that triggers that reduction is 10 feet below the historic winter low. This is consistent with the concept that allows for the collection of more scientific data to establish the relationship between water quality and water levels below the 1973 winter low.

In proposed Stage 5, however, the reduction percentage increases to a level that the total reduction in pumping in the MZ1 Area is about 27,506 af/yr. This level of reduction in production is estimated to increase the winter water level by about 28 feet. History indicates that this level of pumping reduction would be very effective in halting any anticipated continuation of water level decline within the MZ1 Area. However, if the lateral inflow is relatively constant, it is highly unlikely that the MZ1 Area will ever reach aquifer levels triggering the higher stages of pumping reductions, because the reductions from the previous year(s) would be partially or wholly effective in reducing water level declines.

Adaptive Management as Dictated by New Data and Best Available Science & FSH Permit Conditions

Implementing the pumping reductions outlined in the attached Table 1 allows for more water quality data to be collected at levels below the 1973 winter low, should these water levels ever occur. As discussed above, this new data will allow a more scientific approach to setting and adjusting trigger and reduction levels in the future, and allows for adaptive management based on the best available science. Should the water quality analysis reveal a statistically significant causality between water levels below the 1973 winter low and water quality, the triggers and reduction levels could be adjusted to account for the new data and best available science.

1. If any future temporary curtailment of groundwater production in the MZ1 Area is required by the District for permits issued by the District were to affect FSH's pumping, FSH agrees to accept and would not contest temporary curtailment of its production at twice the rate of curtailment imposed upon Historic & Existing use permits in the MZ1 Area.

2. This permit provision would not be effective unless and until the District adopts a rule change related to the prospective curtailment of permits within the MZ1 Area, including at the ratio of 2:1 (which ratio will apply to not only FSH's Permits, but also to (i) any future permits and/or (ii) permit amendments that are not for H&E use within the MZ1 Area).

3. FSH will not oppose or appeal the adoption of rules that adhere to the spirit of that objective.

Table 1 attached hereto provides a suggested outline of curtailments the District could adopt.

Conclusion

FSH remains committed to the long-term goal of protecting the Edwards-Trinity Aquifer and the property rights of landowners within the Management Zone 1 Area, and in that regard, is interested in maintaining both the quantitative and qualitative characteristics of the aquifer, particularly within the MZ1 Area. Also looking long term, however, FSH is equally committed to maintaining and protecting both landowners' property rights in the groundwater available from the aquifer below the 1973 historic low level, and the integrity of the MPGCD to continue to function and achieve the desired balance between the competing interests.

To this end, FSH recommends the following steps be taken by MPGCD in the current rulemaking related to the reconfigured MZ1 Area:

1) Adopt a so-called "moratorium" on groundwater production with the MZ1 Area that results in aquifer levels dropping below the documented 1973 historic low level. The 1973 aquifer level should be used as the "benchmark" during the a short-term moratorium – not to exceed 18 months;

2) During the moratorium period, the trigger levels prepared in the preliminary draft report (Hutchison 2017-Draft) will be incorporated into a District adopted rulemaking that includes an express "expiration date" of the rules tied to the end of the 18-month moratorium;

3) During the 18 months, (i) the stakeholders will adhere to Dr. Hutchison's recommended regulatory constraints on groundwater production from the Edwards-Trinity aquifer within the MZ1 Area, and (ii) the stakeholders and the MPGCD undertake studies to move in the direction of FSH's recommendations pursuant to an adaptive management policy;

4) Prior to the conclusion of the 18-month moratorium and the expiration of the proposed rules, the District will conduct a rulemaking hearing to evaluate the results of the scientific studies contemplated herein, and adopt updated rules, including triggers, etc., based upon those studies.

This approach will facilitate:

(ii) the conservative approach recommended in Dr. Hutchison's preliminary draft report to protect the aquifer and the pumping rights within the MZ1 Area,

(iii) maximize the opportunity for landowners to exercise their property rights and beneficially use the groundwater beneath their land, and

(iiii) protect the District from the liability that will result from unnecessary regulatory takings litigation.

In furtherance of these objectives and recommendations, in addition to the four monitor wells FSH has agreed to convert from production wells and dedicate to the MPGCD MZ1 Area monitoring program, FSH will commit to fund scientific studies of the Edwards-Trinity Aquifer within the MZ1 Area during the 18-month moratorium in cash and in-kind hydrogeologic sources equivalent to at least $________, to support appropriate science-based modification of the rules to accomplish the stated objectives.

Bibliography

Edwards Aquifer Authority, 2016. Edwards Aquifer Authority Rules (Effective Date: December 23, 2016).

Hutchison, W.R., 2017. Proposed Changes to Management Zone 1 and Proposed Monitor Well Data and Comparisons with Model Simulations (Draft 1).

R.W. Harden & Associates, Inc., LBG-Guyton Associates, and Thornhill Group, Inc., 2011. Hydrogeologic, Geochemical and Groundwater Modeling Evaluation of the Leon-Belding Area in Pecos County. Report prepared for Fort Stockton Holdings, L.P. April 14, 2011, 95p.

Pecos County WCID No. 1 v. Williams, 271 S.W.2d 503 (Tex. Civ. App. – El Paso 1954, writ ref'd n.r.e.)

Table 1. Triggers, Stages and Withdrawal Reduction for MPGCD Management Zone 1					
Trigger	**Stage 1**	**Stage 2**	**Stage 3**	**Stage 4**	**Stage 5**
6 of 11 wells below WT1[1,2]	WT1+25 feet	WT1	WT1 minus 10 feet	WT1 minus 20 feet	WT1 minus 30 feet
Additional Data Collection/Evaluation	MZ1 Aquifer Study[3]			MZ1 Aquifer Study[3]	
Non-H&E Reduction for Calendar Year	0%	5%	10%	15%	45%
H&E Reduction for Calendar Year	0%	0%	5%	7.5%	22.5%
Non-H&E Volumetric Reduction (af/yr)[4]	0	1,790	3,580	5,370	16,110
H&E Volumetric Reduction (af/yr)[4]	0	0	2,532	3,799	11,396
Total Volumetric Reduction (af/yr)[4]	0	1,790	6,112	9,169	27,506
Estimated Water Level Rebound (feet)[5]	0	2	6	9	28
Reduction as a Percent of Total Permits[4]	0%	2%	7%	11%	32%

1. WT1 – Winter Threshold 1 – as shown in Table 6 of Hutchison (2017-Draft) as measured between November 1 and March 31
2. A change to a stage with higher withdrawal reduction percentages, including initially into Stage I for Management Zone 1, is triggered if daily aquifer levels at 6 of 11 Monitor Wells, as applicable, drop below the Winter Threshold 1 for 10 consecutive days. A change from any stage to a stage with a lower withdrawal reduction percentage, is triggered only when if daily aquifer levels at 6 of 11 Monitor Wells rise above the Winter Threshold 1 for 10 consecutive days. To trigger a new stage, the same 6 wells must meet the trigger criteria for 10 consecutive days.
3. MZ1 Aquifer Study – enhanced collection and evaluation of water level and water quality data. The scope and duration of the study will be determined by the district.
4. Assumes 35,800 af/yr non-H&E permits and 50,648 af/yr H&E permits and a total permit volume of 86,448 af/yr
5. Estimated water level rebound in Management Zone 1 based on a 1000:1 ratio of total pumping (af/yr) increase to decrease in winter water level.

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July 14, 2017

Mr. Ty Edwards, General Manager
Middle Pecos Groundwater Conservation District
P.O. Box 1644
Fort Stockton,, Texas 79735

RE: Analysis of Proposed Changes to Management Zone 1 and Proposed Monitor Well Data and Comparisons with Model Simulations (Draft 1) (dated June 16, 2017)

Dear Mr. Edwards:

My company has been retained by Cockrell Investment Partners, L.P., which owns Belding Farms in Pecos County, Texas, to review and analyze the June 16, 2017 first draft prepared by Dr. William R. Hutchison (Dr. Hutchison) for the Middle Pecos Groundwater Conservation District (the District) titled "Proposed Changes to Management Zone 1 and Proposed Monitor Well Data and Comparisons with Model Simulations (Draft 1)" (the "Proposal"). In particular, I was asked to evaluate the impact of the Proposal on the conservation and protection of groundwater resources in the District.

Belding Farms has invested approximately 50 years of time and money developing and growing its pecan trees. During this time, Belding Farms has relied on its historical permits for the water resources that its trees need. If water is not available even for just one season, Belding Farms' pecan trees would be materially and irreparably harmed. This is a major concern because unlike row crops (corn, alfalfa, etc.), pecan trees cannot simply be replanted the next spring. The trees take decades to mature; starting over is not a viable option. As a result, Belding Farms is an important stakeholder in this process. If the District does not manage Fort Stockton Holdings' permits responsibly and in a manner that is consistent with its mission, then Belding Farms' pecan trees could be lost, putting an end to one of Pecos County and the City of Fort Stockton's important businesses and employers.

I am a graduate of The University of Texas at Austin, from which I received a Bachelor of Science (BS) and Master of Science (MS). I am a licensed Professional Geoscientist and the President and Senior Hydrologist at Wet Rock Groundwater Services, L.L.C. (Wet Rock), which I founded in 2002. Wet Rock is a full service water resources firm with a team of hydrogeologists specializing in providing solutions to water needs. Among other things, we specialize in water supply studies, public supply well plans, groundwater modeling services, and studies, reports, and plans relating to water permitting issues.

Proposed Management Zone 1

Dr. Hutchison used the Western Pecos Groundwater Model (WPC Model), an alternative model developed by R.W. Harden and Associates, Inc., LBG-Guyton and Associates, and the Thornhill Group, to determine the boundaries of the Proposed Management Zone 1. This model was developed and used

1. This letter addresses only the Proposal by the District. Belding Farms does not here address the comments and proposed settlements submitted by Fort Stockton Holdings on July 12, 2017. Belding Farms reserves all of its rights with respect to Fort Stockton Holdings and any other stakeholders who participate in this process. Belding Farms intends to participate in discussions involving Fort Stockton and the District regarding the Proposal and proposed rules.

by Fort Stockton Holdings, L.P. (FSH) in their permit application in 2011. The WPC Model was used in the development of Management Zone 1 boundaries.

Determination of the proposed boundary of Management Zone 1 was based upon whether a given cell in the groundwater model had a spring flow capture percentage of 35 percent or greater producing at a rate of 1,500 gpm with no other production occurring. Each cell in the model represents an area of 2,000 ft. by 2,000 ft. The spring flow percentage represents the flow captured by that cell that would have otherwise flowed to Comanche Springs.

The proposed boundaries of Management Zone 1 covers the FSH well field, the City of Fort Stockton and Belding Farms. Although determination of the boundary based upon a 35% springflow capture is arbitrary we agree with the methodology used and the proposed boundary of Management Zone 1.

Monitor Wells and Desired Future Conditions in Proposed Management Zone 1

Dr. Hutchison selected eleven monitor wells within Management Zone 1 to establish regulatory thresholds used as a special permit condition for regular production permits. Figure 1 provides the location of the eleven monitor wells in relation to FSH's proposed production wells. The monitor wells cover the area around the FSH proposed well field and to the south of Fort Stockton.

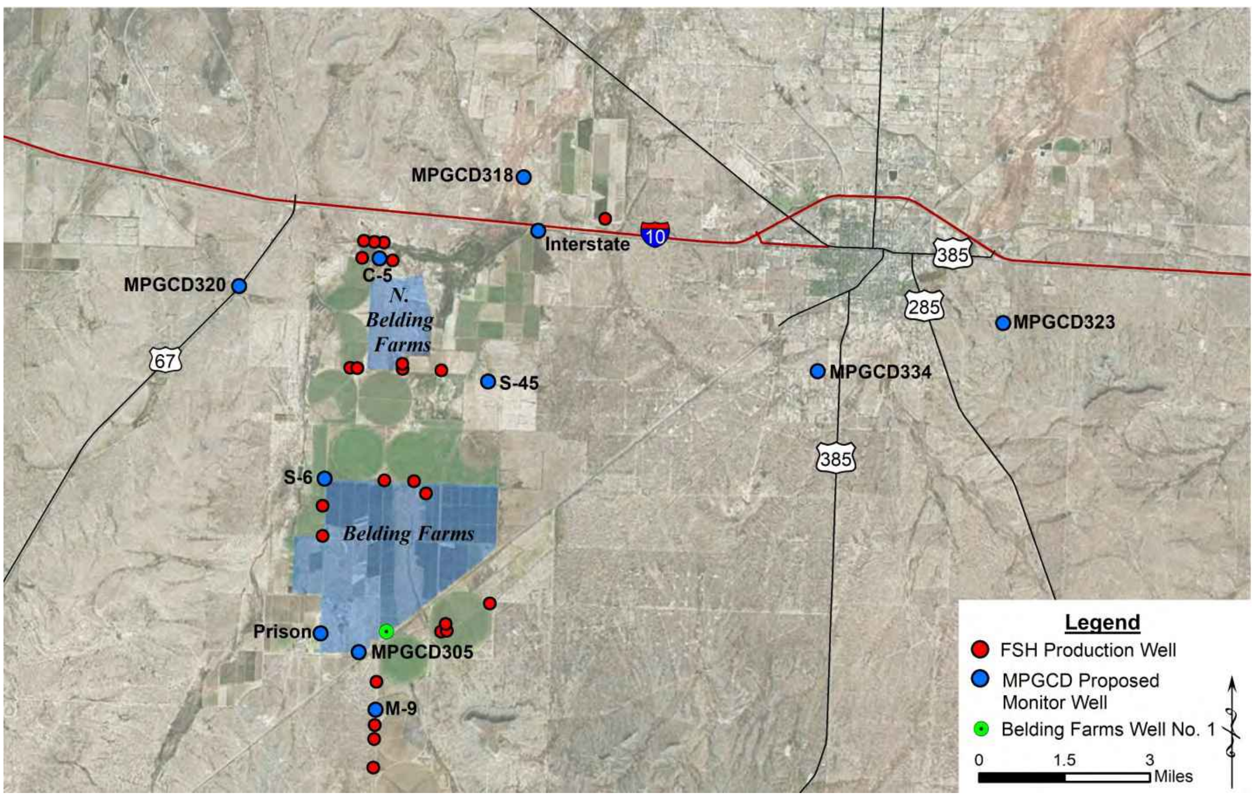

Figure 1: Location map of monitor wells identified by the District. ***Belding Farms property shown in blue.***

Dr. Hutchison then compared average drawdown using the regional alternative GAM for the current Management Zone 1 area versus the proposed Management Zone 1 area. The purpose of comparison of the average drawdown is to determine whether the Desired Future Condition for the

Edwards-Trinity Aquifer can be met. This area of Pecos County is within Groundwater Management Area (GMA) 7; which has a DFC for the Edwards-Trinity (Plateau) Aquifer of an average drawdown of 7 feet over the entire area of GMA 7.

The average drawdown within Management Zone 1 currently ranges from 3 feet in 2015 up to 32 feet in 2060. Within the proposed Management Zone 1 area the average drawdown ranges from 4 feet in 2015 to 38 feet in 2060. Dr. Hutchison then compared DFCs to modeled drawdown on each of the eleven monitor wells to determine whether planning goals regarding DFCs can be met. A recommendation of implementing a well-by-well comparison between DFCs and actual data was provided.

While I agree with the recommendation that DFCs should be compared to actual measured data on each of the monitor wells to determine whether planning goals are being met I do not agree with the use of groundwater models as a regulatory tool to determine whether DFCs are being met on a well-by-well basis. Regional groundwater models are not designed to accurately determine water level elevations on a well-by-well basis and as such should not be used for that purpose.

Monitor Wells and Proposed Thresholds for Individual Monitor Wells

Threshold values for each of the eleven monitor wells were established which include a Winter Threshold 1, Winter Threshold 2, Winter Threshold 3 and Summer Threshold. The Winter Threshold 1 level is the minimum historic level in each well; for two of the eleven wells (MPGCD 320 and MPGCD 323) the level was based upon historic data. For the remaining nine wells, the Winter Threshold 1 was based upon the historic minimum elevation from the WPC Model. Based upon the Proposal, cutbacks to production would occur if the water level in the winter time in six of the eleven monitor wells encounters their respective Winter Threshold. Table 2 provides the Winter and Summer Thresholds for each monitor well. Cutbacks would be initiated to the permit on an annual basis for the following year as follows:

- If six of the eleven monitor wells encounter the Winter Threshold 1 water level in the winter time, then a 100% reduction in FSH non-historical use pumping will be initiated the following year;

- Winter Threshold 2 is located 5 feet above Winter Threshold 1 and if six of the eleven monitor wells encounter the Winter Threshold 2 water level in the winter time, then a 30% reduction in FSH non-historical use pumping will be initiated the following year;

- Winter Threshold 3 is located 10 feet above Winter Threshold 1 and if six of the eleven monitor wells encounter the Winter Threshold 3 water level in the winter time, then a 10% reduction in FSH non-historical use pumping will be initiated the following year; and

- The Summer Threshold was determined by calculating the recent maximum drawdown experienced (2010 to 2016) in each monitor well between winter and summer water levels and added to the Winter Threshold 1 level. If six of the eleven monitor wells encounter the Summer Threshold, then technical representatives of MPGCD and FSH are to meet within 60 days to review pumping and groundwater level data.

Table 2: Recommended Monitor Well Thresholds. ***From Hutchison***

Well	Reference Point (ft MSL)	Winter Threshold 1		Winter Threshold 2	Winter Threshold 3	Recent Max. Drawdown (ft.)	Summer Threshold
		Depth to Water (ft.)	Basis	Depth to Water (ft.)	Depth to Water (ft.)		Depth to Water (ft.)
MPGCD 320	3068	200	Data 1-1999	195	190	45	245
MPGCD 323	3031	193	Data 1-2000	188	183	15	208
C-5	3009	105	WPC Model	100	95	72	177
M-9	3261	308	WPC Model	303	298	48	356
S-45	3067	160	WPC Model	155	150	56	216
S-6	3123	200	WPC Model	195	190	62	262
MPGCD 305	3233	287	WPC Model	282	277	75	362
MPGCD 318	2957	67	WPC Model	62	57	33	100
MPGCD 334	3051	135	WPC Model	130	125	36	171
Interstate	2988	91	WPC Model	86	81	40	131
Prison	3199	253	WPC Model	248	243	50	303

Figure 2 provides a graphical representation of the thresholds for the Prison Well located adjacent to the southwest corner of Belding Farms.

Figure 2: Hydrograph of Prison Well showing proposed thresholds.

I agree that a monitor well network should be established with water level triggers initiating cutbacks to pumping of non-historical use permits; however the following changes should be made in establishing the monitor well network:

1. **Establish Clear Goals for the Monitor Well Network**: Monitor well networks with trigger levels initiating cutbacks to pumping are established within Groundwater Conservation Districts throughout the state. Trigger levels are developed to meet an established goal. We would recommend the District establish goals that would protect long term aquifer levels, meet DFC requirements and protect historic use permits.

2. **Cutbacks should occur if trigger levels are encountered at any time during the year**: It is my opinion that the proposed monitor network and thresholds do not adequately protect the aquifer's long term sustainability, historic use permits and the ability for historic water users to maintain and use their water rights.

   The first concern I have with the Proposal is that triggers are initiated only when the winter water level in a well encounters its respective threshold. The District has an obligation to protect historic water rights and the ability for these rights to be used. The establishment of pumpage cutbacks only when a winter water level encounters a threshold does not protect a historic water right holder's ability to use their permitted right. The Proposal allows for the drawdown of the aquifer during the spring, summer and fall with no reduction in pumpage. In addition, if water levels in six of eleven monitor wells reach the Summer Threshold, cutbacks to pumpage still do not occur. Belding Farms uses their Historic Use Permit from the Edwards-Trinity Aquifer to irrigate the farm and a large pecan orchard. Most of the irrigation and pumpage occurs during the summer. Under Proposal, the water level in the aquifer can be lowered without any reductions in pumpage during the spring, summer and fall when Historic User Permits are most used. The ability to lower the water levels during the aquifer impacts Belding Farms' ability to use their Historic User Permit.

   For example, at the Prison Well located adjacent to Belding Farms (Figure 1), the Winter Threshold 1 water level is at 253 feet below ground surface (bgs). Belding Farms Well No. 1 is located near the Prison Well and is an irrigation well with a Historic Use Permit that has been used at Belding Farms since at least 1957. The well is completed to a total depth of 586 ft. bgs with a pump setting of 330 ft. bgs. Under the Proposal, water levels could be lowered to the pump during the summer thereby eliminating the well's ability to produce with zero pumpage cutbacks. Well No. 1 is one of six Historic Use irrigation wells completed in the Edwards-Trinity Aquifer at Belding Farms that will be impacted by the proposed production at the FSH Well Field.

3. **Simplify the Monitor Well Network and Cutbacks.** The requirement to have six of eleven wells meet a certain threshold allows for water levels in certain parts of Management Zone 1 to be greatly depleted without even initiating a reduction in pumpage. For example, production from the proposed FSH Well Field could affect five or less monitor wells greatly reducing water levels in these wells below the established thresholds with no cutbacks in pumping. This also allows a well field to be concentrated in production in certain parts while reducing pumpage in others thereby disproportionately affecting certain parts of the aquifer to avoid initiating cutbacks to production. We recommend that the monitor well network be kept intact; however the number of wells required to initiate a cutback should be reduced. We recommend that six wells be chosen: 1) the Prison Well; 2) MPGCD Well 305; 3) S-6 Well; 4) S-45; 5) C-5 Well; and 6) M-9

Well. Of these six wells, if the water level in any one well encounters a threshold, then associated cutbacks are initiated.

We understand that as part of the settlement agreement FSH agrees to provide a minimum of four of its existing wells as monitoring wells. Additional wells can be used to monitor water levels within Management Zone 1 however; the wells used to determine pumping reductions should be simplified.

4. **Cutbacks to production should be set to protect historic low water levels.** The use of the term "Winter" and "Summer" thresholds should be eliminated and reduction in pumpage should occur when the thresholds are encountered at any time during the year. We would recommend changing the term "threshold" to trigger level and called "Level 1", "Level 2", etc.

   Level 3 (Similar to Winter Threshold 1) would represent the historic low water level of the associated monitor well and if encountered at any time would initiate a 100% reduction in pumping.

   Level 2 (Similar to Winter Threshold 2) located 10 feet above Level 3 would initiate a 50% reduction in pumping if encountered at any time during the year.

   Level 1 (Similar to Winter Threshold 3) and located 15 feet above Level 3 would initiate a 20% reduction in pumping if encountered at any time during the year.

   Level 4 (Similar to Summer Threshold) would result in technical representatives of MPGCD, Belding Farms and FSH to meet within 10 days to review pumping and groundwater level data. If the resulting water level reductions are shown to be caused by the FSH Well Field then the MPGCD Board shall review the permit to determine if further modifications are needed.

   We also recommend that trigger levels be established based upon actual measured data (which is available for these wells) rather than modeled data. Models have inherent error associated with them and are not intended to be used on a well to well basis.

5. **The volume of reduction in pumping to non-historical permits should be allocated on a minimum monthly basis and not upon an annual volume.** When an associated trigger level in a monitor well is encountered and a reduction in pumping occurs, the volume of reduction should be based upon an allocated monthly or daily production volume and not on an annual basis. Having a reduction in pumping based upon an annual volume allows a non-historic permit holder to continue pumping at current rates during the summer when an end user needs the water and allows them to reduce pumping to meet cutback requirements during winter times when an end user may not need the water. This has the effect of not reducing production when a cutback is required to protect water levels.

   We recommend that a non-historical permit's production volume get allocated on a monthly basis; when pumping cutbacks are initiated, production gets reduced on a percentage basis per the monthly production volume.

6. **Define what triggers a cutback reduction and when the trigger and associated cutback are no longer valid.** When a monitor well encounters a trigger level it should be defined as to when the associated cutback is initiated. For example, typically when water level in a monitor well is below the trigger level for a set number of days then cutbacks in pumping are initiated. Also, when water levels go back above the trigger level for a period of time then the cutbacks move to the trigger level above.

   We recommend that when the 10-day average water level in a monitor well goes below a trigger level, then cutbacks to production are initiated. Conversely, pumping volumes are increased when the 10-day average water level in the monitor well goes above the trigger level.

7. **Water Quality should be incorporated as part of the Monitor Network.** Understanding the impact to water level is an important part of a monitoring network. It is also important to understand the change in water quality, if any, due to a reduction in water levels. We recommend that water quality samples be taken from Belding Farms' wells, the FSH Well Field and representative wells within Management Zone 1 prior to commencement of pumping from the FSH Well Field for non-historic use and taken quarterly thereafter. Water quality should be analyzed to determine if there are any changes or trends in water quality due to production from the FSH Well Field. Constituents to analyze for the water quality sampling can be established; we recommend at a minimum that pH, Total Dissolved Solids (TDS), sulfate and chloride be analyzed.

Historically, large volumes of water have been produced from the Edwards-Trinity Aquifer however; there are relatively little historical data on actual metered production volumes on the FSH wells year to year. Production volumes have not been consistent in the past, though once the FSH municipal permit commences, consistent volumes of water will be produced. This consistently large volume of production year to year has shown to lower water levels within the aquifer over time. For Historic User Permit holders such as Belding Farms, located within the FSH Well Field, which count on using their water rights for irrigation during the summer we ask the District to re-evaluate the proposed monitor network to protect their ability to use their water right.

In summary, I believe these simple changes will cure the most significant problems with the Proposal and further the District's important mission to conserve and protect the District's groundwater resources. Please let us know if you would like to discuss these matters in more detail.

Respectfully,

Wet Rock Groundwater Services, L.L.C.

Kaveh Khorzad, P.G.
President/ Senior Hydrogeologist

The seal appearing on this document was authorized by Kaveh Khorzad, P.G. License No. 1126 on July 14, 2017.

Wet Rock Groundwater Services, LLC
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Cc:
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Buck Benson – Pulman, Cappuccio, Pullen, Benson & Jones, LLP
Bobby Hatcher and Geoff Pike Jr. – Cockrell Investment Partners, LP
Glenn Honaker – Belding Farms

Appendix C

Hutchison (2017) Draft Report on Review of Belding Farms Data

Review of Belding Farms Database
(Draft)

Prepared for:
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December 7, 2018

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1.0 Introduction

This report summarizes the results of analyses of groundwater data recently obtained from Belding Farms. The context of this effort is complex and rooted in the settlement of litigation between Fort Stockton Holdings, LP and Clayton Williams Farms, Inc., and Republic Water of Texas LLC against the Middle Pecos Groundwater Conservation District that was settled in July 2017, and new litigation between Cockrell Investments Partners, L.P. (owners of Belding Farms) against the Middle Pecos Groundwater Conservation District.

Sections 1.1 to 1.4 summarizes the relevant history to provide some context prior to a discussion of the objectives of the effort (Section 1.5). Section 1.6 discusses the preliminary release of some of the analyses described in this report to the interested parties. Section 1.7 discusses a recent review of the Western Pecos County groundwater model completed by Southwest Research Institute, a technical consultant for Cockrell Investments Partners, L.P. and Belding Farms.

1.1 Draft Report on Monitoring Thresholds

On June 16, 2017, I submitted a draft report to the Middle Pecos Groundwater Conservation District in support of a settlement proposal dated April 28, 2017 between the Middle Pecos Groundwater Conservation District, Fort Stockton Holdings, LP and Clayton Williams Farms, Inc., and Republic Water of Texas LLC (Hutchison, 2017b). This draft report summarized the results of analyses to:

- Support changes in the boundaries of Management Zone 1.
- Evaluate data and simulations results for individual monitor well locations in the proposed Management Zone 1 related to regulatory thresholds that could be included as special permit conditions and data and information related to planning-level desired future conditions

1.2 Cockrell Review Comments on Draft Report

On June 28, 2017, I received a phone call from Kaveh Khorzad, a consulting hydrogeologist for Cockrell Investments Partners, L.P. and Belding Farms to discuss the results, findings and recommendations of the report (Hutchison, 2017b). During the call, Mr. Khorzad stated that Belding Farms had been collecting groundwater data for years. When I asked about the availability of the data for use in the effort to establish thresholds, Mr. Khorzad said he would let me know if it could be released.

On July 14, 2017, Mr. Khorzad submitted a letter outlining his review and concerns regarding the recommendations. The letter contained a recommendation that thresholds be established that "would protect long term aquifer levels, meet DFC requirements and protect historic use permits". He also recommended thresholds be set on monitoring data, not models without providing specifics. Despite the recommendation to set thresholds based on monitoring data, there was no mention in the letter of making the historic Belding Farms data available to assist in the effort.

Regarding the implementation of the monitoring wells to trigger pumping reductions in Fort Stockton Holdings wells, the July 14, 2017 letter contained the following recommendations:

- The number of monitoring wells be reduced from 11 to 6 (no specific list was provided)
- A single well not meeting the threshold level would trigger reductions rather than 6 of 11 wells described in my draft report of June 16, 2017 (Hutchison, 2017b).
- The thresholds be considered "any time" thresholds which would remove the distinction between winter and summer thresholds
- A 10-day running average threshold be implemented.
- Specific changes to the level of pumping reductions if the groundwater level thresholds were exceeded were provided

1.3 Approval of Fort Stockton Holding Permit

On July 17, 2017, representatives from party litigants and Cockrell met to discuss the June 16, 2017 draft report (Hutchison, 2017b) and the various comment letters that had been received. As a result of those discussions, the threshold table in the draft report was modified slightly for presentation to the Middle Pecos Groundwater Conservation District Board of Directors. This updated table is presented as Table 1.

On July 18, 2017, the Middle Pecos Groundwater Conservation District Board of Directors approved two sets of permit applications for Fort Stockton Holdings that essentially shifted 28,400 AF/yr from Historical and Existing Use to a production and transport authorization. The new beneficial use for the groundwater is for municipal, industrial, and/or agricultural purposes within and outside the District. The thresholds in Table 1 were adopted as special conditions that govern production restrictions based on aquifer-trigger levels in certain wells.

Prior to adoption of the permit and special conditions at the July 18, 2017 Board of Directors meeting, representatives from Cockrell stated that none of the recommendations in their July 14, 2017 letter had been incorporated. However, at the July 17, 2017 meeting, Cockrell's specific concern regarding the consistency of the thresholds with the adopted Desired Future Condition was discussed. Figure 1 presents the summary comparison of thresholds and the Desired Future Conditions on a well-by-well basis for the 11 monitoring wells. This analysis was completed specifically in response to Mr. Khorzad's July 14, 2017 letter, and demonstrates that the thresholds are consistent with the Desired Future Conditions.

1.4 Cockrell Litigation

On October 10, 2017, Cockrell Investments Partners, L.P. filed a lawsuit challenging the District's denial of Cockrell's Requests for Party Status in conjunction with the Fort Stockton Holding permit proceedings on July 18, 2017. At the October 17, 2017 Middle Pecos Groundwater Conservation District Board of Directors meeting, attorneys for Cockrell stated that they intend to engage in good faith negotiations and discussion with Fort Stockton Holdings and the Middle Pecos Groundwater Conservation District and avoid litigation.

As a result of this pending litigation, Middle Pecos Groundwater Conservation District has not completed the rules revisions that would modify the boundaries of Management Zone 1 as recommended in my June 16, 2017 draft report (Hutchison, 2017b).

Table 1. Monitor Well Thresholds Adopted on July 18, 2017 - FSH Permit

Well		Reference Point Elevation (ft MSL)	Winter Threshold 1		Winter Threshold 2 (Historic Minimum)		Winter Threshold 3		Winter Threshold 4		Maximum Recent Drawdown (Winter to Summer)	Summer Threshold		Recent Depth to Water	
Short Name	Long Name		Depth to Water (ft)	Basis	Depth to Water (ft)	Basis	Depth to Water (ft)	Basis	Depth to Water (ft)	Basis		Depth to Water (ft)	Basis	Winter	Summer
Mpgcd320	King, Woodward, #320	3068	205	Win2+5	200	Data 1/1999	195	Win2-5	190	Win2-10	45	245	Win2+Max DD	113	148
Mpgcd323	Ft Stockton, Cemetery, #323	3031	198	Win2+5	193	Data 1/2000	188	Win2-5	183	Win2-10	15	208	Win2+Max DD	146	148
C-5	C-5, FSH Well	3009	110	Win2+5	105	WPC 1973	100	Win2-5	95	Win2-10	72	177	Win2+Max DD	60	107
M-9	M-9, FSH Well	3261	313	Win2+5	308	WPC 1973	303	Win2-5	298	Win2-10	48	356	Win2+Max DD	246	283
S-45	S-45, FSH Well	3067	165	Win2+5	160	WPC 1973	155	Win2-5	150	Win2-10	56	216	Win2+Max DD	92	115
S-6	S-6, FSH Well	3123	205	Win2+5	200	WPC 1973	195	Win2-5	190	Win2-10	62	262	Win2+Max DD	118	159
Mpgcd305	Cockrell_Belding, #305	3233	292	Win2+5	287	WPC 1973	282	Win2-5	277	Win2-10	75	362	Win2+Max DD	206	250
Mpgcd318	Goldman Ranch, Well 1	2957	72	Win2+5	67	WPC 1975	62	Win2-5	57	Win2-10	33	100	Win2+Max DD	30	49
Mpgcd334	Carpenter, #334	3051	140	Win2+5	135	WPC 1975	130	Win2-5	125	Win2-10	36	171	Win2+Max DD	104	126
Interstate	Interstate Well, FSH Well	2988	96	Win2+5	91	WPC 1975	86	Win2-5	81	Win2-10	40	131	Win2+Max DD	49	71
Prison	TDCJ, Prison Well	3199	258	Win2+5	253	WPC 1973	248	Win2-5	243	Win2-10	50	303	Win2+Max DD	184	224

Threshold	**Action**
Winter Threshold 1	If 6 of 11 are below threshold, 100% reduction in FSH non-historical use pumping
Winter Threshold 2	If 6 of 11 are below threshold, 50% reduction in FSH non-historical use pumping
Winter Threshold 3	If 6 of 11 are below threshold, 30% reduction in FSH non-historical use pumping
Winter Threshold 4	If 6 of 11 are below threshold, 10% redcution in FSH non-historical use pumping
Summer Threshold	If 6 of 11 are below threshold, meeting in 60 days between FSH and MPGCD to discuss data

Notes

Maximum Recent Drawdown (Winter to Summer) based on evaluation of recent data (~2010 to 2016)

Summer Thresholds derived by adding maximum recent drawdown (from historic data) to Winter 1 Threshold

Recent Depth to Water are from actual data: maximum (summer) and minimum (winter) from spring 2016 to winter 2017

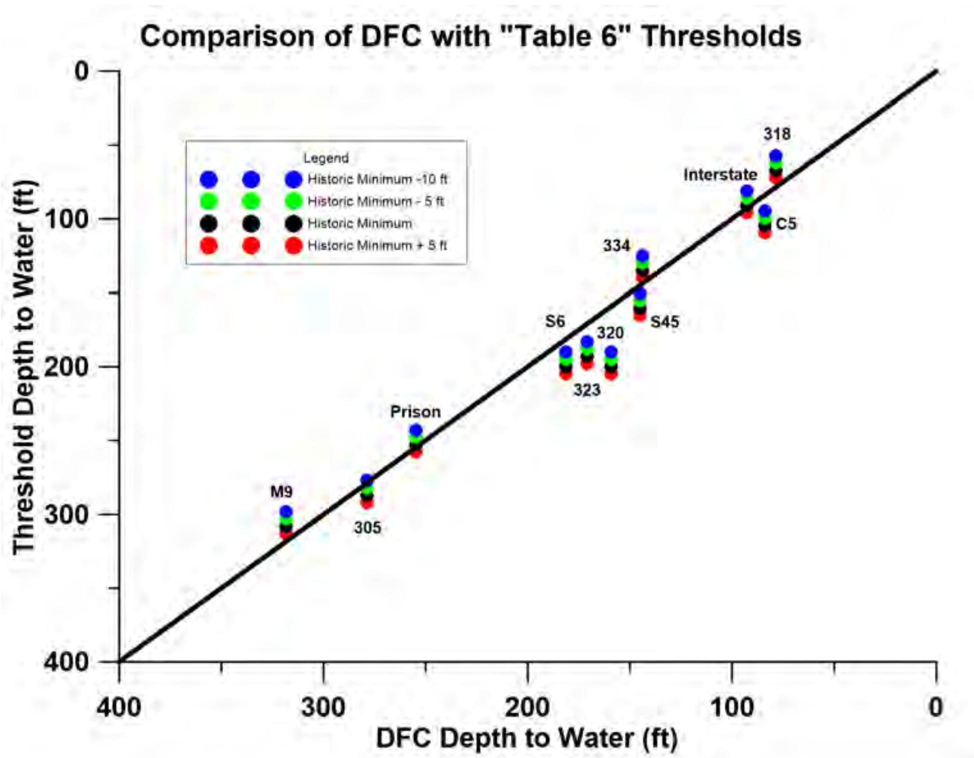


Figure 1. Comparison of Desired Future Conditions with Adopted Thresholds

As part of the ongoing negotiations and discussions to avoid litigation, on September 4, 2018, Kaveh Khorzad emailed to me a file named *Belding Farms Database.xlsx*. This Excel file had seven individual sheets:

- Wells (location and construction data regarding 54 wells, 28 of which are listed as owned by Cockrell or Belding Farms)
- Monthly Precipitation (January 1964 to April 2017)
- Monthly Production (26 wells from January 1967 to November 2017)
- Annual Production (26 wells from 1967 to 2017)
- Static Water Levels (33 wells from May 1957 to May 2017)
- Pumping Water Levels (33 wells from May 1957 to May 2017)
- Charts (5 graphs that summarize selected data)

On September 18, 2018, the Middle Pecos Groundwater Conservation District Board of Directors approved a proposal from Cockrell to fund up to $10,000 for additional work by Middle Pecos Groundwater Conservation district associated with analyzing the Belding Farms data in the context of my June 16, 2017 draft report and analysis (Hutchison, 2017b). Cockrell's proposal is outlined in a September 11, 2018 letter from Buck Benson (attorney for Cockrell) to Ty Edwards (General Manager of Middle Pecos Groundwater Conservation District).

The Middle Pecos Groundwater Conservation District also received a letter from Edmond McCarthy (attorney for Fort Stockton Holdings) on September 17, 2018 expressing some concerns regarding Mr. Benson's characterization of the June 16, 2017 draft report (Hutchison, 2017b), the scope of the additional investigation, and the reliability of the data.

1.5 Objectives

The objectives of this analysis were specific to the general concern of Cockrell: Are the adopted thresholds protective of the Belding Farms wells? Specific concerns raised in the July 14, 2017 letter are also addressed. To meet these objectives and to address some of the concerns raised in Mr. McCarthy's letter to Mr. Edwards of September 17, 2018, the following analyses were completed with the data provided in the September 4, 2018 email from Kaveh Khorzad:

- Annual pumping from Belding Farms wells separated by aquifer
- Static groundwater elevation hydrographs
- Pumping groundwater elevation hydrographs
- Comparison of end-of-year groundwater elevations with results of Western Pecos Model estimated groundwater elevations
- Comparison of end-of-year groundwater elevations with "winter maximum" groundwater elevations
- Hydrographs of drawdown for each well (comparison of month-based drawdown and drawdown from maximum winter groundwater elevation)
- Cross plots of selected Belding Farms wells with the 11 monitoring wells listed in Table 1
- Cross plots of Belding Farms annual pumping from Edwards-Trinity wells with summer minimum static and pumping groundwater elevations.

1.6 Distribution of Preliminary Results

On October 29, 2018, I emailed a file (*Processing Belding Farms Data 102918.pdf*) to Ty Edwards which contained preliminary summaries and graphs of the data analysis. This file was then forwarded to interested parties representing Cockrell and Fort Stockton Holdings. The intent of distributing the preliminary graphs was to provide an update on progress and provide representatives of Cockrell and Fort Stockton Holdings the opportunity to provide input and feedback prior to releasing a draft report.

1.7 SwRI Review of Western Pecos County Model

On November 27, 2018, Ron Green emailed a review report of the Western Pecos County (WPC) Groundwater Model (Martin and Green, 2018). The main issue identified in the review is related to recharge in the source area of the Leon-Belding area. As stated in the Executive Summary (Martin and Green, 2018):

> *"Based on currently available data and conceptual models of the area, the WPC Model appears to convey more water than is actually available to pumping wells in the vicinity of the Belding Farms Property. The source of the additional water in the model is an arbitrarily large recharge rate which is preferentially applied within the recharge source area for the Belding Farms Property."*

Martin and Green (2018, pg. 65) also noted five specific "minor discrepancies or peculiarities" with the model, including model pumping estimates that are too high in the Edwards-Trinity Aquifer and too low in the Rustler and older Formations as compared to Belding Farms data that were not available to the developers of the model. Martin and Green (2018, pg. 65) stated that these five issues would "likely have only a minor impact on overall WPC Model-related conclusions and projections".

2.0 Well Construction Data

The provided file (*Belding Farms Database.xlsx*) included a sheet named "Wells" that contained geographic and construction data on 54 wells, 28 of which are listed as owned by Cockrell or Belding Farms. Of the 28 Cockrell/Belding wells, 23 wells are reportedly completed in the Edwards-Trinity Plateau, four wells are reportedly completed in the Rustler, and one well is reportedly completed in the Capitan Reef.

These data were used to segregate the wells by ownership (only the Belding Farms wells were used for the analysis) and by reported completion of the well (only the Edwards-Trinity data were used, except for a comparison of pumping totals).

3.0 Pumping Data

The provided file (*Belding Farms Database.xlsx*) included a sheet named "Annual Production" that contained annual pumping in AF/yr for 26 Belding Farms wells from 1967 to 2017. Based on the data in the sheet named "Monthly Production", it was assumed that the data for 2017 are only for a partial year, since monthly production was only listed through May 2017.

Please note that the database does not include pumping data for Wells 6, 7, 9, 12, 14, 21, and 22. These wells are listed as Edwards-Trinity wells, and each of them have at least one pumping water level data point in the database. Based on this comparison, it is reasonable to conclude that not all pumping on Belding Farms has been metered, or at least not reported in this database.

In their recent review of the Western Pecos County groundwater model, Martin and Green (2018) compared the pumping data from the database to estimates of pumping used in the model. Since it appears that not all the Belding Farms pumping was metered (or at least not reported in the database), it is not possible to draw definitive conclusions regarding the accuracy of the amount of pumping estimated in the Western Pecos Model since the database appears incomplete. Martin and Green (2018) stated that differences in the pumping would "likely have only a minor impact on overall WPC Model-related conclusions and projections".

Using the data from the sheet named "Wells", the pumping was summed for the Edwards-Trinity wells and for the Rustler and Capitan Reef Wells. Figure 2 presents a plot of the pumping data that were made available. Please note that most of the reported Belding Farms pumping is from the Rustler and the Capitan. Based on the available data, Belding Farms pumping in the Edwards-Trinity was higher in the 1960s and 1970s than it has been in recent years.

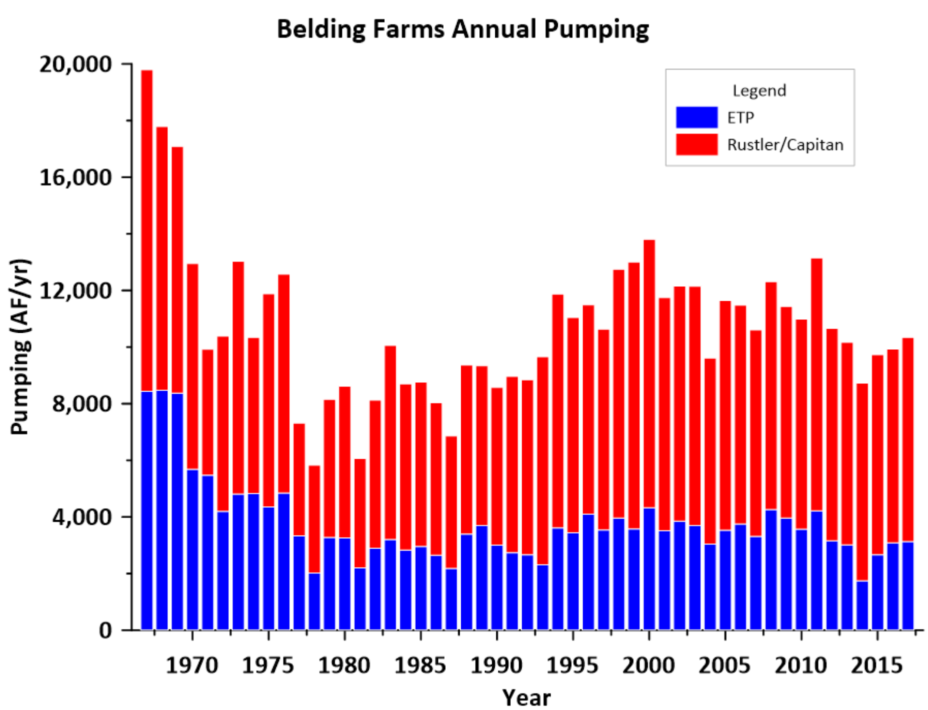


Figure 2. Belding Farms Annual Pumping

4.0 Static and Pumping Water Levels

4.1 Processing Static Water Levels

The provided file (*Belding Farms Database.xlsx*) included a sheet named "Static Water Levels" that contained depth to water data for 33 wells from May 1957 to May 2017. The data were organized by month and by well. Thus, only a single reading is recorded in the spreadsheet for a month. However, several months have no data and are left blank. The data were saved in a separate spreadsheet named *StaticDTW.xlsx* (dated 10/22/2018). The wells completed in the Rustler and Capitan Reef were deleted, and three columns were added (month, year, decimal date). Empty cells were populated with the value "-999" to facilitate reading and further processing. The file was saved as *StaticDTW.csv* (dated 10/22/2018) so it could be read by the FORTRAN program named *getactgwe.exe*, which was written for this analysis.

For the static water levels, the program *getactgwe.exe* reads *StaticDTW.csv* (month, year, date, and static depth to water). It also reads a file (*fnelev.csv*) that contains filenames for the output for each well, the reference point elevation for each well, the depth of each well, and the elevation of the bottom of the well. The program then calculates the groundwater elevation for each well for each month and the height of the water in the well (groundwater elevation – bottom elevation of the well). The program writes the data to individual files for each well (month, day, year, reference point elevation, depth to water, groundwater elevation, well depth, bottom elevation, and height of water in the well).

During initial hydrograph construction, the following data were deleted:

- Well No. 2 (August 2005)
  - Depth to water listed as 1,997 ft (typo for 197? or 199?)
- Well No. 3 (October 2010)
  - Depth to water listed as 53 ft (August 2010 was 185 ft and November 2010 was 178 ft, no obvious typo)
- Well No. 8 (March 1981)
  - Depth to water listed as 1,664 ft (Typo for 164? Or 166?)
- Well No. 18 (August 1978)
  - Depth to water listed as 251 ft (June 1978 was 146 ft and September 1978 was 140 ft, no obvious typo)

4.2 Processing Pumping Water Levels

The provided file (*Belding Farms Database.xlsx*) included a sheet named "Pumping Water Levels" that contained depth to water data for 33 wells from May 1957 to May 2017. The data were organized by month and by well. Thus, only a single reading is recorded in the spreadsheet for a month. However, several months have no data and are left blank. The data were saved in a separate spreadsheet named *PumpingDTW.xlsx* (dated 10/22/2018). The wells completed in the Rustler and Capitan Reef were deleted, and three columns were added (month, year, decimal date). Empty cells were populated with the value "-999" to facilitate reading and further processing. The file was saved as *PumpingDTW.csv* (dated 10/22/2018) so it could be read by the FORTRAN program named *getactgwe.exe*, which was written for this analysis.

For the pumping water levels, the program *getactgwe.exe* reads *PumpingDTW.csv* (month, year, date, and static depth to water). It also reads a file (*fnelev.csv*) that contains filenames for the output for each well, the reference point elevation for each well, the depth of each well, and the elevation of the bottom of the well. The program then calculates the groundwater elevation for each well for each month and the height of the water in the well (groundwater elevation – bottom elevation of the well). The program writes the data to individual files for each well (month, day, year, reference point elevation, depth to water, groundwater elevation, well depth, bottom elevation, and height of water in the well).

During initial hydrograph construction, the following data were identified as outliers:

- Well No. 3 (May 1982)
    - Pumping water level listed as 278 ft (lowest in record)
    - No data since May 1980, and no data until June 1989
    - Well bottom 241 feet below this pumping water level
    - Production in 1982 was not as high as 1983
    - Left in for purposes of hydrograph construction
- Well No. 8 (May 1982 and June 1982)
    - Pumping water level listed as 315 ft (both months, lowest in record)
    - No data since September 1981, and no data until April 1983
    - Well bottom 260 feet below this pumping water level
    - Production not as high as more recent years
    - Left in for purposes of hydrographs
- Well No. 11 (January 1965)
    - Pumping water level listed as 230 ft (highest in record)
    - Higher than all but two static water levels recorded in 1957
    - Static water level in December 1964 was 246 ft
    - No early 1965 static water levels
    - Predates production data (1967)
    - Left in for purposes of hydrographs
- Well No. 12 (January 1965)
    - Pumping water level listed as 217 ft (highest in record)
    - Higher than all static water levels
    - No static water level in January 1965
    - Static water level in December 1964 was 233 ft
    - Static water level in March 1965 was 239 ft
    - Predates production data (1967)
    - Left in for purposes of hydrographs
- Well No. 13 (May 1982)
    - Pumping water level listed as 340 ft (lowest in record)
    - Last pumping water level was August 1981 (214 ft)
    - No pumping water levels have May 1982
    - No static water level for May 1982
    - Pumping in 1983 was higher than 1982
    - Left in for purposes of hydrograph

- Well No. 14 (January 1965)
  - Pumping water level listed as 211 ft (highest in record)
  - Pumping water level in November 1964 was 250 ft
  - Pumping water level in April 1965 was 354 ft
  - No static water level in January 1965
  - Static water level in December 1964 was 248 ft
  - Static water level in February 1965 was 209 ft
  - Predates production data (1967)
  - Possible that this is supposed to be a static water level
  - Left in for purposes of hydrograph
- Well No. 18 (May 1982, June 1982, July 1982)
  - Pumping water levels listed as 265 ft (lowest in record)
  - Last pumping water levels recorded
  - Most recent prior pumping water level was 158 ft (July 1978)
  - Static water level for May 1982 was 154 ft
  - Static water level for June 1982 was 152 ft
  - Static water level for July 1982 was 161 ft
  - Deleted for purposes of hydrograph
- Well No. 22 (January 1965)
  - Pumping water level listed as 220 ft (highest on record)
  - Pumping water level for April 1962 was 295 ft
  - Pumping water level for February 1965 was 278 ft
  - Static water level for February 1965 was 223 ft
  - Predates production data (1967)
  - Left in for purposes of hydrograph

4.3 Hydrographs of Static and Pumping Groundwater Elevations

Hydrographs of 23 wells owned by Belding Farms that are reportedly completed in the Edwards-Trinity are presented in Appendix A. The solid black line represents all static groundwater elevations, and the red dots represent all pumping groundwater elevations. Please note that Wells 28 and 30 have no data.

5.0 Comparison of End-of-Year Static Groundwater Elevations and Simulated Groundwater Elevations from Western Pecos Model

As explained in my draft report of June 16, 2017 (Hutchison, 2017b), and as noted on Table 1 presented previously, many of the monitor well thresholds in Table 1 were based on the historic minimum groundwater elevation from the Western Pecos Model developed in 2011 (R.W. Harden & Associates and others, 2011). These historic minima were used because data did not exist during the high pumping periods of the 1960s and 1970s in these wells. Had the Belding Farms data been available at the time of preparing the draft report of June 16, 2017 (Hutchison, 2017b), the model may not have been needed to develop the monitor well thresholds.

The thresholds were established with the goal of avoiding groundwater levels to drop below historic minima. The avoidance of dropping below the historic minima was the basis of the settlement of the litigation between Fort Stockton Holdings and the Middle Pecos Groundwater Conservation District.

Now that the Belding Farms data are available, the objective of this part of the analysis was to compare actual data with the simulated groundwater elevations of the Western Pecos County Model. The Western Pecos County Model has limitations as described in my earlier review report (Hutchison, 2017a) and as described in the more recent review (Martin and Green, 2018). Now that the Belding Farms are available, we are in a better position to assess the model's usefulness, and if the use of model-estimated groundwater elevations in the 1970s is consistent with the objectives of avoiding the decline of groundwater elevations below the historic minimum levels.

The model domain in the Western Pecos County Model was subdivided (or discretized) into 5 layers of 56,322 cells (total of 281,610 cells) each covering an area of about 92 acres (2,000 feet by 2,000 feet). Model results include an estimate of groundwater elevation for each cell and for each year of the simulation period (1945 to 2010). These estimates can be compared with actual data with knowledge of the geographic location of the well from which the actual data was measured. Please recognize that the estimated groundwater elevation represents an average groundwater elevation over the 92-acre area of the cell. Because the geographic locations of each of the Belding Farms wells was provided, it was possible to locate the well on the model grid. This procedure is discussed in Section 5.2 of this report.

The analysis was completed by comparing the actual end-of-year groundwater elevations with the model-estimated groundwater elevations. If the actual data during the 1960s and 1970s are higher than the simulated values during the 1960s and 1970s, it would be reasonable to conclude that the assumptions inherent in the development of the thresholds were flawed, and the thresholds might not be protective of the Belding Farms wells. If, on the other hand, the actual data during the 1960s and 1970s are lower than the simulated values during the 1960s and 1970s, it would be reasonable to conclude that the assumptions inherent in the development of the thresholds are conservative, and the thresholds are reasonable in the protection of historically observed groundwater levels in the Belding Farms wells.

5.1 End-of-Year Static Groundwater Elevations

A FORTRAN program (*getactgwe.exe*) was written to write individual files (i.e. one for each well) for hydrograph construction. The "end-of-year" criterion was implemented based on a priority of data. If a December data point was available, it was used. If a December data point was not available, then the program used January of the next year, November, or February of the next year as alternates (in that order of priority). If no data existed in these four months, no data were used. The program then wrote individual files of groundwater elevations that included the name of the well, the decimal year for plotting, the reference point elevation, the end-of-year depth to water, the end-of-year groundwater elevation, the well depth, the well bottom elevation, and the water depth in the well (groundwater elevation minus the bottom elevation).

5.2 Location of Belding Farms Wells in Model Grid

In order to compare the actual end-of-year Belding Farms well data with the simulated values of the Western Pecos Model, the location of each Belding Farms well in the model grid was needed. The file *ThornhillModel_Grid.dbf.csv* (dated February 19, 2017), previously developed by Allan Standen, was used to identify the x- and y-coordinates of each model grid cell in the GAM coordinate system. This file was modified as saved as *ThornhillGrid.csv* (dated October 17, 2018).

The provided file (*Belding Farms Database.xlsx*) included a sheet named "Wells" that contained geographic and construction data on 54 wells, 28 of which are listed as owned by Cockrell or Belding Farms. This sheet was extracted and saved as *BeldingWells.xlsx* (dated October 17, 2018). The geographic coordinates were provided in latitude and longitude. Two columns were added (GAMx and GAMy) to represent the x- and y-coordinates in the GAM coordinate system. Surfer (commercial software from Golden Software) was used to convert the latitude and longitude coordinates to x- and y-coordinates in the GAM coordinate system.

The resulting file was saved as *BeldingWellsxy.csv* (dated October 17, 2018) and included the well number, the x- and y-coordinates and the aquifer of completion. Please note that in this file, the names of the Belding Wells were converted to a standard format (B-xx) where the xx represented the two-digit number of the well.

The assignment of the model row and column was completed using the FORTRAN program *getrc.exe,* which was written for this analysis. The program searches all cells in the model and returns the cell (identified by row and column) with the smallest distance between the well and the cell center. Output from this program was saved as *wellrowcol.dat* (dated October 22, 2018). Belding Farms wells were saved as *Beldingrc.csv* (dated October 22, 2018).

5.3 Simulated Groundwater Elevations

The FORTRAN program *getwpched.exe*, written for this analysis, was used to read the simulated heads from the end of 1944 to the end of 2010 (*revwpc.hds)* and write individual files for simulated heads for each Belding Farms well completed in the Edwards-Trinity. Simulated groundwater elevations for layer 2 (Edwards) and layer 3 (Trinity) were included in the output files.

As described in my report covering the review of the Western Pecos Model (Hutchison, 2017a), the model was run with a revised output control file and a revised WEL file for the first stress period. The output control file revisions included a specification that saved only the final time step of each stress period (rather than the first- and last-time step of each stress period) in order to reduce the output file sizes and streamline post-processing. The modification to the first stress period of the WEL file was limited to adding a single well with no pumping in stress period 1, which results in a cell-by-cell flow file that has the same number of water budget components in all stress periods. Neither of these changes results in any substantive change to the output as compared with the files that were provided. Thus, the simulated groundwater elevations from the Western Pecos Model used in this analysis represent the simulated groundwater elevations from the calibrated model from 1944 to 2010 without any changes to any input files that would alter the results (i.e. changes to pumping).

5.4 Comparison Hydrographs

The hydrographs comparing the actual end-of-year groundwater elevations and the simulated groundwater elevations for each of the 23 Belding Farms wells completed in the Edwards-Trinity are presented in Appendix B. Please note that the actual data are shown as red dots. Simulated data for layer 2 (Edwards) are plotted as a green line, and simulated data for layer 3 (Trinity) are plotted as a blue line.

Well 1 – Please note that the historic minimum of the actual data in the mid-1970s approximately corresponds to the historic minimum of the simulated data. However, the actual data is about 40 feet below the simulated data at this historic minimum.

Well 2 – Please note that the historic minimum of the actual data occurs in the mid-1960s and not the mid-1970s when the historic minimum occurs in the simulated data. In fact, there were actual data collected in the mid-1970s that were about 40 feet above the historic minimum. However, the historic minimum of the actual data is about 20 feet below the historic minimum of the simulated groundwater elevations, even though they did not occur at the same time period.

Well 3 – Similar to Well 2, the historic minimum of the actual data occurs in the mid- to late-1960s, several years before the simulated historic minimum. The historic minimum of the actual data is about 20 feet below the historic minimum of the simulated groundwater elevations, even though they did not occur at the same time period.

Well 4 – Please note that the historic minimum of the actual data occurs in the early-1970s and is about 60 feet lower than the historic minimum of the simulated groundwater elevations, even though they did not occur at the same time period.

Well 5 – Similar to Wells 2 and 3, the historic minimum of the actual data occurs in the mid- to late-1960s, several years before the simulated historic minimum. The historic minimum of the actual data is about 80 feet below the historic minimum of the simulated groundwater elevations, even though they did not occur at the same time period.

Wells 6 and 7 – Please note that these wells did not have enough data to be useful to this analysis.

Well 8 – Please note that the historic minimum of the actual data occurs in the mid-1970s at the same time as the historic minimum of the simulated data. The historic minimum of the actual data is less than 20 feet lower than the historic minimum of the simulated data.

Well 9 – Please note that there are no end-of-year actual data for Well 9.

Well 10 – Please note that although there are a few actual data points in the 1960s and 1970s, the limited data results and gaps during the specific time period of the historic minimum of the simulated data makes interpretation difficult and likely not reliable.

Wells 11 and 12 – Please note that these wells did not have enough data to be useful to this analysis.

Well 13 – Please note that the historic minimum of the actual data occurs in the mid-1970s at the same time as the historic minimum of the simulated data. The historic minimum of the actual data is about 60 feet lower than the historic minimum of the simulated data.

Well 14 – Please note that the historic minimum of the actual data occurs in the mid-1970s at the same time as the historic minimum of the simulated data. The historic minimum of the actual data is about 100 feet lower than the historic minimum of the simulated data.

Well 17 – Please note that there are no end-of-year actual data for Well 17.

Well 18 – Please note that the historic minimum of the actual data occurs in the early-1970s, a few years before the time period of the historic minimum of the simulated data. The historic minimum of the actual data is about 30 feet lower than the historic minimum of the simulated data.

Wells 19, 20, 21, 22, 28, 29, and 30 – Please note that these wells either did not have enough data to be useful to this analysis or had no end-of-year actual data.

Please note that the gap in well numbering (i.e. Wells 23 to 27) are wells identified as Rustler or Capitan Reef wells and were not included in this analysis.

5.5 Summary of Interpretations

Hydrographs of 23 wells are presented in Appendix B and discussed in the previous section. Of the 23 wells, 14 did not have enough data to make any interpretations or draw and conclusions. The nine wells were sufficient for the comparison between actual data and simulated groundwater elevations from the Western Pecos Model. This comparison showed that the historic minimum of the actual groundwater elevations is between 20 to 100 feet below the simulated historic minimum groundwater elevations.

This underprediction of drawdown suggests that the model is not well calibrated in the Belding Farms area during the high-pumping periods of the 1960s and 1970s. The underprediction of drawdown is also consistent with the review comments of Martin and Green (2018) related to the possible overestimation of recharge. It is also important to emphasize that recharge in the Western Pecos County Model is assumed constant in all years. Thus, drought periods have the same recharge as wet periods. This had previously been described as a limitation of the model in my previous review of the model (Hutchison, 2017a).

The fact that the Western Pecos Model is not well calibrated in the Belding Farms area, however, does not render it useless for the evaluation of the monitor well thresholds. As described in my June 16, 2017 draft report (Hutchison, 2017b), the historic minimum groundwater elevation for a well was used where no data for that time period existed. The use of these model estimated historic minima were limited to wells that had otherwise reasonably good matches between actual and simulated data. As seen in the hydrographs in Appendix B, the Belding Farms often have reasonable matches in more recent years. The poor matches are generally during the 1960s and 1970s, when the historic minima occur. Furthermore, the poor matches are characterized by estimated groundwater elevations that are higher than the actual data.

Relying on the historic minimum of the Western Pecos Model, therefore, is a conservative assumption when setting threshold values. If winter groundwater elevations in the 11 monitoring wells were to approach the threshold values listed in Table 1, it is reasonable to assume that groundwater elevations will also drop in the Belding Farms wells and approach the model-estimated historic minima. The historic minima defined by the model are tens-of-feet higher than the true historic minima as defined by the data. Thus, it is reasonable to conclude that if groundwater elevations dropped to the point that pumping reductions were required, groundwater levels in the Belding Farms wells would still be above their historic minima as defined by the data.

5.6 Specific Example of Interpretation of Results

Kaveh Khorzad's July 14, 2017 letter stated that annual thresholds and annual pumping reductions are not adequate, and that pumping reductions should be implemented if a threshold groundwater elevation is exceeded at any time during the year.

The data show that groundwater elevations fluctuate based on pumping. During the irrigation season, groundwater elevations decline and then recover in the fall and winter months after the irrigation season is over. During the 1960s and 1970s, groundwater elevations were lower than they have been in more recent years due to less pumping, but the characteristic seasonal pattern is consistent.

The specific approach to applying thresholds and pumping reductions on an annual basis was implemented because there are no pressing concerns to reduce pumping on a more frequent basis (i.e. endangered species in spring areas). The use of annual pumping reductions also provides certainty to non-historical use permit holders on an annual basis.

The example provided in the Mr. Khorzad's July 14, 2017 letter describes the comparison of the Prison Well and Belding Farms No. 1. Please note that pumping reductions would begin at Winter Threshold 4 (depth to water of 243 feet, or a groundwater elevation of 2,956 ft MSL). The historic minimum-based threshold is Winter Threshold 2 (depth to water of 253 feet, or a groundwater elevation of 2,946). This historic minimum-based threshold was set based on the historic minimum of the Western Pecos Model in 1973 because there were no data available for the Prison Well during the 1960s and 1970s.

Actual data from Belding Well No. 1 showed that the lowest groundwater elevation in the winter period was 2,902 ft MSL in 1974 (depth to water of 301 feet). At the site of Well No. 1, the Western Pecos Model showed that lowest groundwater elevation occurred in 1973 and was 2939.71 ft (depth to water of 272.29 feet).

The Winter Threshold 2 at the Prison Well was set based on the model estimated value at that site (253 feet) and is comparable to the model-estimated value at the Belding No. 1 site is 272 feet. However, the actual data show that "true" historic minimum was 301 feet.

For purposes of this discussion, it is assumed that if the Prison Well threshold is exceeded, then the thresholds in at least five other wells are also exceeded. Pumping reductions would begin when groundwater elevations are 10 feet above the model-based historic minimum (i.e. 243 feet at the Prison Well, and, by extrapolation, 262 feet at the Belding No. 1 well). Thus, pumping reductions would begin when groundwater elevations at the Belding No. 1 well are 39 feet above the data-based historic minimum. Pumping cessation (100 percent pumping reduction) would occur when the Prison Well depth to water is 258 feet (five feet below the historic minimum). The comparable depth to water threshold in the Belding No. 1 well is 258 feet, 33 feet above the data-based historic minimum.

The pumping data for Well No. 1 showed that the two years with the highest pumping are 1973 and 1974 (1,346 AF and 1,503 AF, respectively). During those years, pumping water levels reached a minimum of 328 feet in 1973 and 331 feet in 1974. Mr. Khorzad's July 14, 2017 letter stated that the pump was set at 330 feet, so it is reasonable to conclude that the pump had been set at a lower depth during the 1970s. Well depth is reported as 586 in the database and the July 14, 2017 letter, so lowering the pump to depth greater than 330 feet is possible.

6.0 Winter Maximum Groundwater Elevation vs. End-of-Year Groundwater Elevation

One the important features of the monitoring program is that the "winter maximum" groundwater elevation for each well is used to compare with the threshold values and initiate any cutbacks to non-historic pumping permit amounts for that year. The winter maximum is not necessarily the same as the end-of-year measurement.

The winter maximum groundwater elevations were obtained from the FORTRAN program *getactgwe.exe*. The program searched the static groundwater elevations from October to March and returned the value that was highest. These results were saved in individual well files for comparison of the end-of-year groundwater elevations and the winter maximum groundwater elevation.

The data that were available at the time of the draft June 16, 2017 (Hutchison, 2017b) included several examples of multiple readings during the October to March period in a single well. These data were processed to return the single highest value from October to March and designate it as the "winter maximum". As described in Hutchison (2017b), most of the available data did not include enough data in the 1960s and 1970s to identify a historic minimum "winter maximum", and results from the Western Pecos Model were used to extend the dataset.

Appendix C includes hydrographs that plot end of year groundwater elevations (red line) and winter maximum groundwater elevations (blue dots). Please note that, in many years, the winter maximum groundwater elevation can be up to about 20 feet higher than the end-of-year groundwater elevations.

The concept of winter maximum groundwater elevation is an important (and often misunderstood) aspect of the monitoring program. The monitoring wells are equipped with pressure transducers that are programmed to take readings every hour. The historic data show that the maximum winter groundwater elevation often occurs in February or March. The monitoring program and the permit conditions set April 1 as the date to define the end of the "winter maximum" period. The highest groundwater elevation during that period is used to compare with the threshold values.

7.0 Drawdown

Drawdown was defined two ways using the Belding Farms database in the context of this analysis: 1) the difference between the static groundwater elevation and pumping groundwater elevation in the same month (informally called monthly drawdown), and 2) the difference between the winter maximum groundwater elevation and pumping groundwater elevation for each month during that year (informally called annual drawdown). The FORTRAN program *getactgwe.exe* was used to develop two sets of well-by-well output files, one set for each definition of drawdown.

Appendix D presents hydrographs of drawdown. The black line represents the month-to-month drawdown of static groundwater elevation minus pumping groundwater elevation. The red line represents the winter maximum groundwater elevation minus a monthly pumping groundwater elevation.

Only a handful of wells have adequate records to evaluate any trends (i.e. Wells 1, 2, 3, 5, 8, and 10). The monthly drawdown data (using the static groundwater elevation and pumping groundwater elevation in the same month) do not exhibit any significant trend of increasing drawdown with time. This suggests that well performance has not significantly degraded over the last 40 to 50 years.

The annual drawdown data (using the winter maximum static groundwater elevation and pumping groundwater elevation in a month) tend to show that annual drawdown is slightly higher in recent years as compared to earlier years. This may be the result of the higher static groundwater elevations in the recent years as groundwater elevations have recovered since the 1960s and 1970s. This observation suggests that the use of recent drawdown data for the summer thresholds previously presented in Table 1 are appropriate.

8.0 Cross Plots of the 11 Monitoring Wells and Selected Belding Farms Wells

Cross-plots of the 11 monitoring wells and selected individual Belding Farms wells were constructed. These plots are useful to evaluate the correlation in groundwater elevations in two different wells. Please note that the Belding Farms wells used for this analysis are the ones with adequate data (Wells 1, 2, 3, 5, 8, and 10).

Appendix E presents the cross plots. Please note that The Prison well is presented twice, once with all the data and once with data from November 2000 to July 2001 deleted. It appears that the float in the well was stuck for a few months. Also, please note that all the plots contain the Winter 1 and Winter 4 Threshold values for reference. Table 2 presents the monitoring well winter thresholds of the 11 monitoring wells in terms of groundwater elevation. These are the same thresholds in Table 1 expressed as groundwater elevations rather than as depth to water.

As an example of the plots, Figure 3 presents a single cross plot of the Prison Well and Belding Well No. 1.

Table 2. Monitoring Well Thresholds Expressed as Groundwater Elevations

Well		Groundwater Elevation (ft MSL)			
Short Name	Long Name	Winter Threshold 1	Winter Threshold 2 (Historic Minimum)	Winter Threshold 3	Winter Threshold 4
Mpgcd320	King, Woodward, #320	2863	2868	2873	2878
Mpgcd323	Ft Stockton, Cemetery, #323	2833	2838	2843	2848
C-5	C-5, FSH Well	2899	2904	2909	2914
M-9	M-9, FSH Well	2948	2953	2958	2963
S-45	S-45, FSH Well	2902	2907	2912	2917
S-6	S-6, FSH Well	2918	2923	2928	2933
Mpgcd305	Cockrell_Belding, #305	2941	2946	2951	2956
Mpgcd318	Goldman Ranch, Well 1	2885	2890	2895	2900
Mpgcd334	Carpenter, #334	2911	2916	2921	2926
Interstate	Interstate Well, FSH Well	2892	2897	2902	2907
Prison	TDCJ, Prison Well	2941	2946	2951	2956

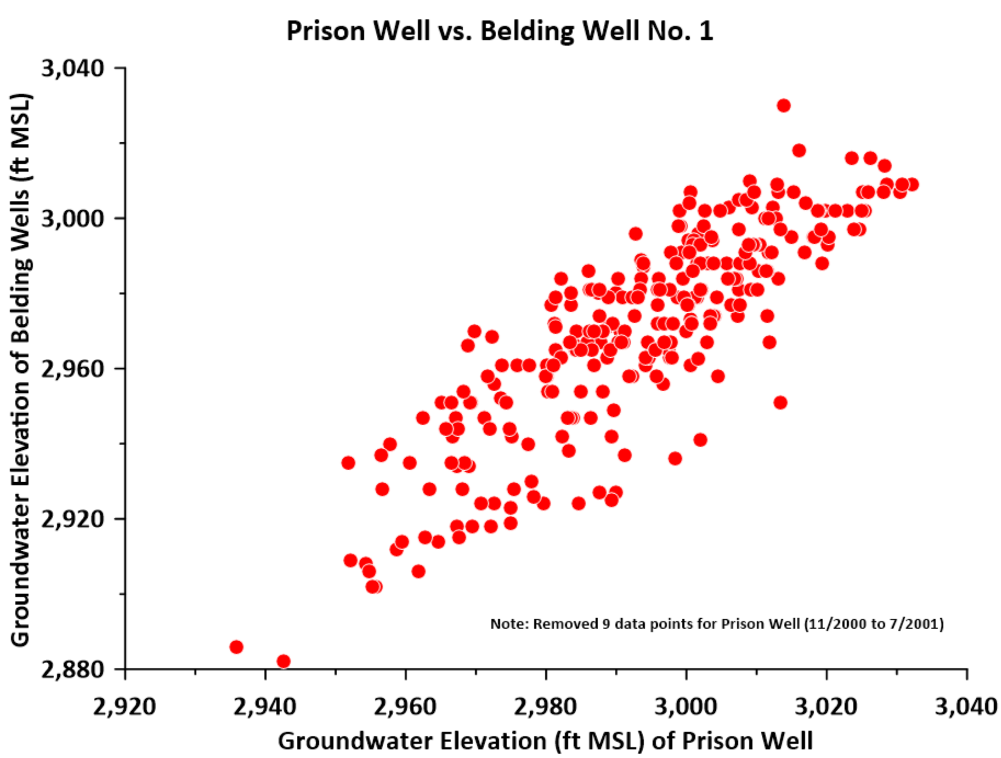


Figure 3. Prison Well vs. Belding Well No. 1

The characteristic slope of the data points shows the general correlation in groundwater elevations (i.e. when groundwater elevations are low in the monitoring well, groundwater elevations are low in the Belding Farms wells). This is consistent with the conceptualization that the aquifer is highly transmissive.

As seen in Figure 3, a given elevation in the prison well correlated with a groundwater elevation that can vary about 40 feet. This observation is characteristic of all the plots and suggests that using a single well for thresholds and triggers is not as robust as using a network of wells given the degree of variability in each well.

9.0 Annual Pumping vs. Summer Minimum Groundwater Elevations

Appendix F contains cross plots of annual pumping as reported in the Belding Farms Database vs. summer minimum groundwater elevations for each well. Please note that the plots are limited to Belding Farms wells with adequate data (Wells 1, 2, 3, 4, 5, 8, 10, 13, 18, 19, and 20). This minimum summer elevation was defined as the lowest groundwater elevation (static or pumping) observed from April to September. The selection was completed with the FORTRAN program *MinSummer.exe*, written for this analysis.

These plots are useful to evaluate concerns that the summer groundwater elevations could drop to an extent that the well would "go dry". Each page of the Appendix includes two plots of the same well. The upper graph plots pumping on the x-axis and groundwater elevation on the y-axis. Please note that the static groundwater elevations are presented as blue dots and pumping groundwater elevations are presented as red dots. The lower graph also plots pumping in the x-axis, but the y-axis is the height of the water column in the well in feet (groundwater elevation minus the well bottom elevation). Please note that the well bottom elevation is used since the database did not include any data on depth of pump setting, which would have been more useful.

The plots generally show that the correlation between annual pumping and the minimum summer groundwater elevation (static and pumping). The plots also show that historic summer minimum pumping groundwater elevations resulted in water column heights of between 75 and 290 feet.

10.0 References

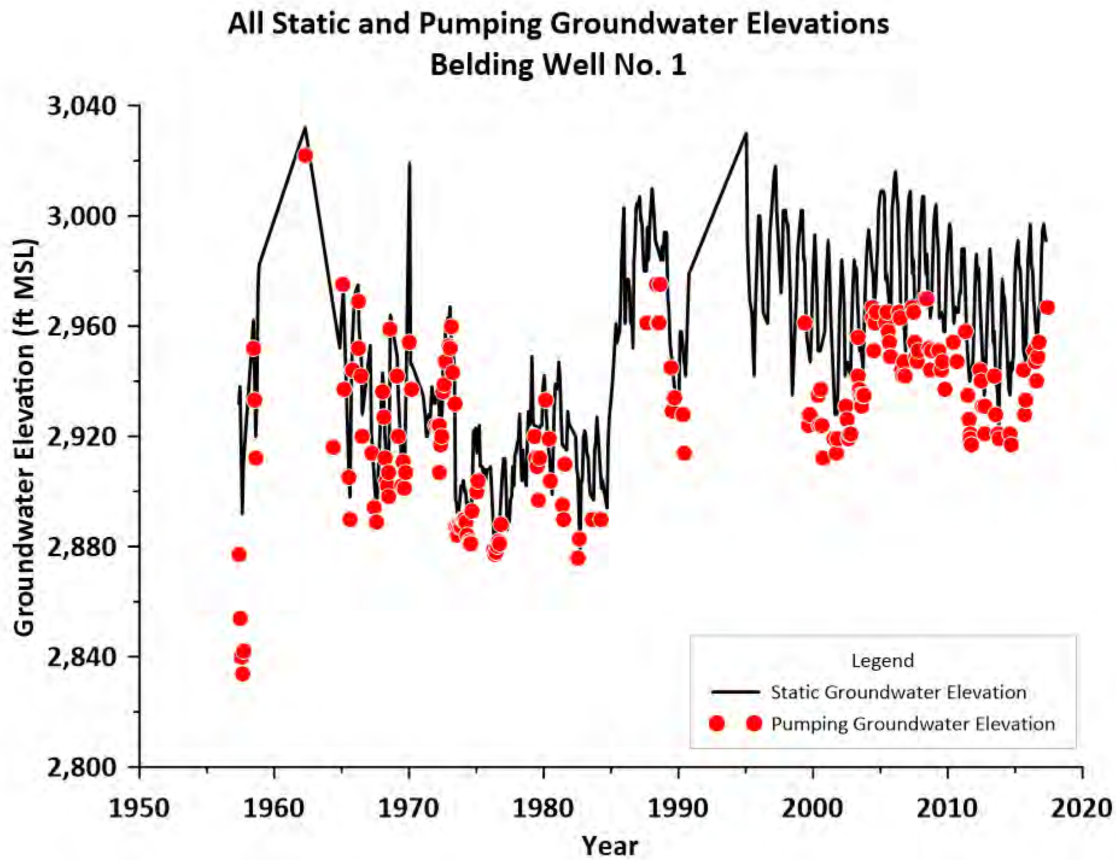
Hutchison, W.R., 2017a. Review of Western Pecos County Groundwater Model. Report prepared for Middle Pecos Groundwater Conservation District, March 10, 2017, 55p.

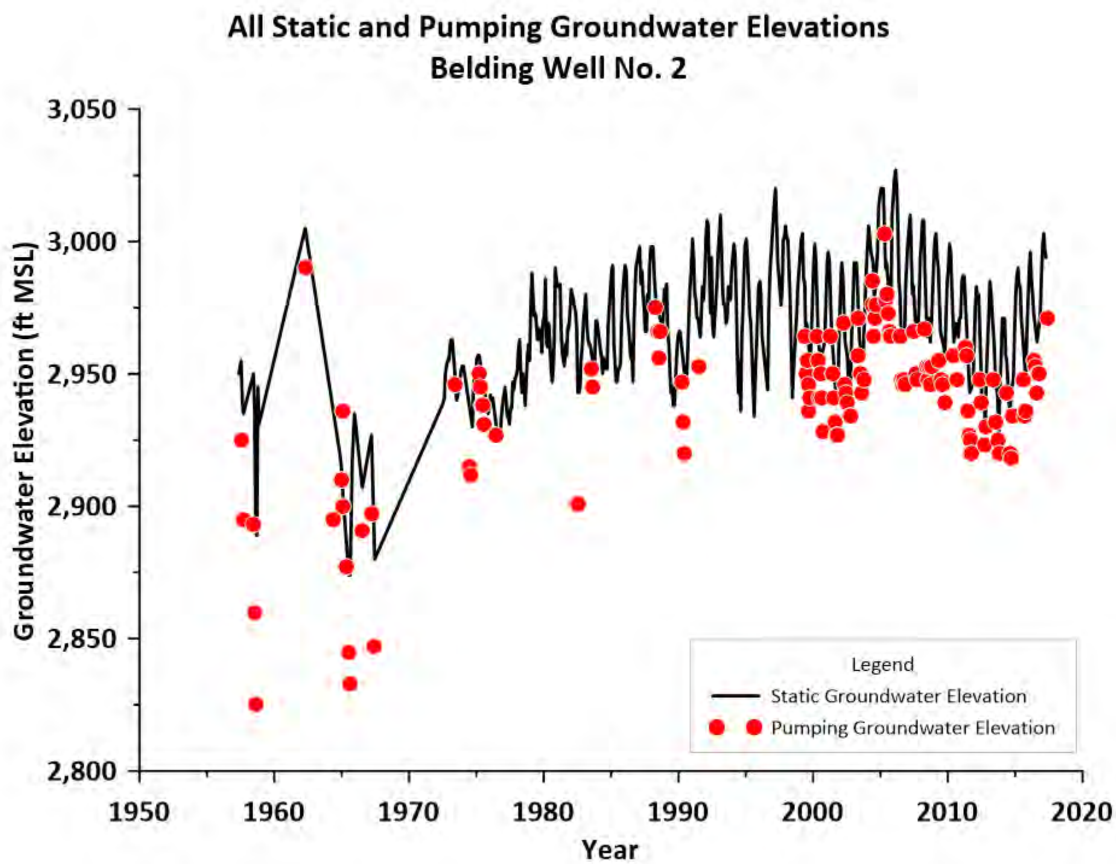
Hutchison, W.R., 2017b. Proposed Changes to Management Zone 1 and Proposed Monitor Well Data and Comparison with Model Simulations. Report prepared for Middle Pecos Groundwater Conservation District. June 16, 2017, 21p.

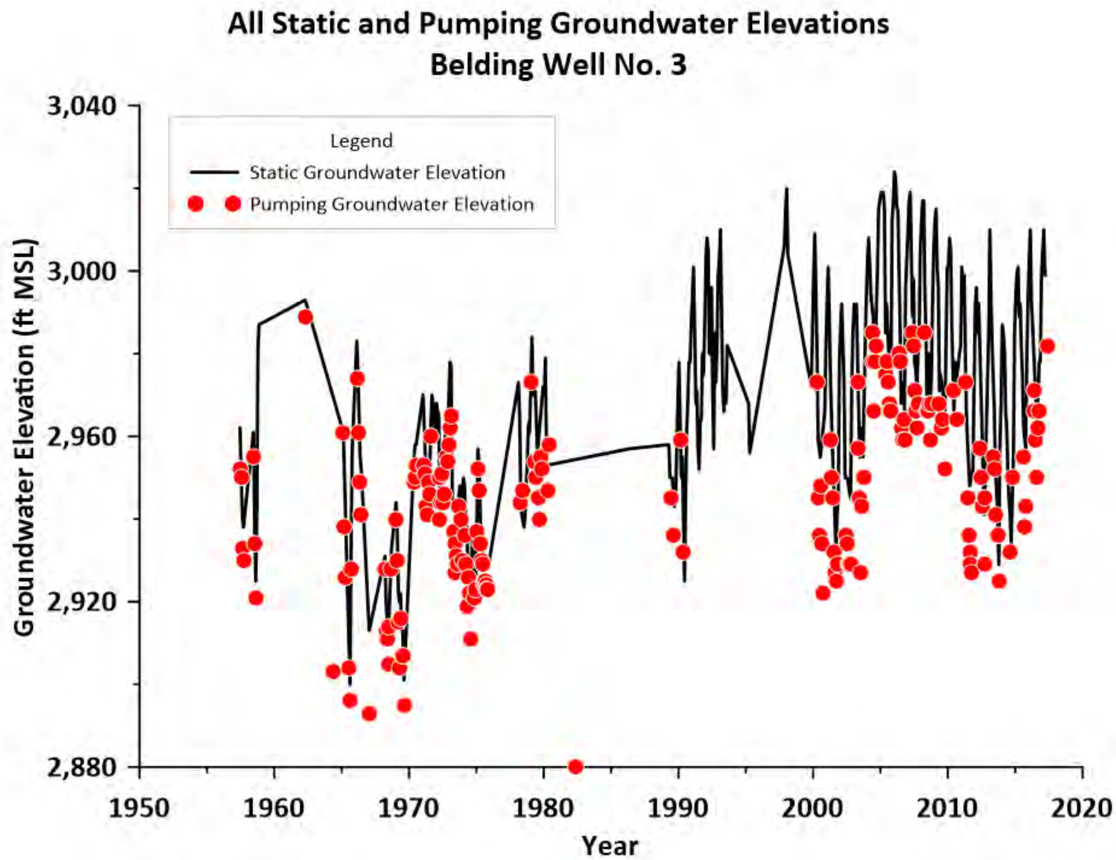
R.W. Harden & Associates, Inc., LBG-Guyton Associates, and Thornhill Group, Inc., 2011. Hydrogeologic, Geochemical and Groundwater Modeling Evaluation of the Leon-Belding Area in Pecos County. Report prepared for Fort Stockton Holdings, L.P. April 14, 2011, 95p.

Martin, N. and Green, R., 2018. Evaluation of the Western Pecos County Groundwater Model. Report prepared for Cockrell Interests LLC. Southwest Research Institute, November 26, 2018, 97p.

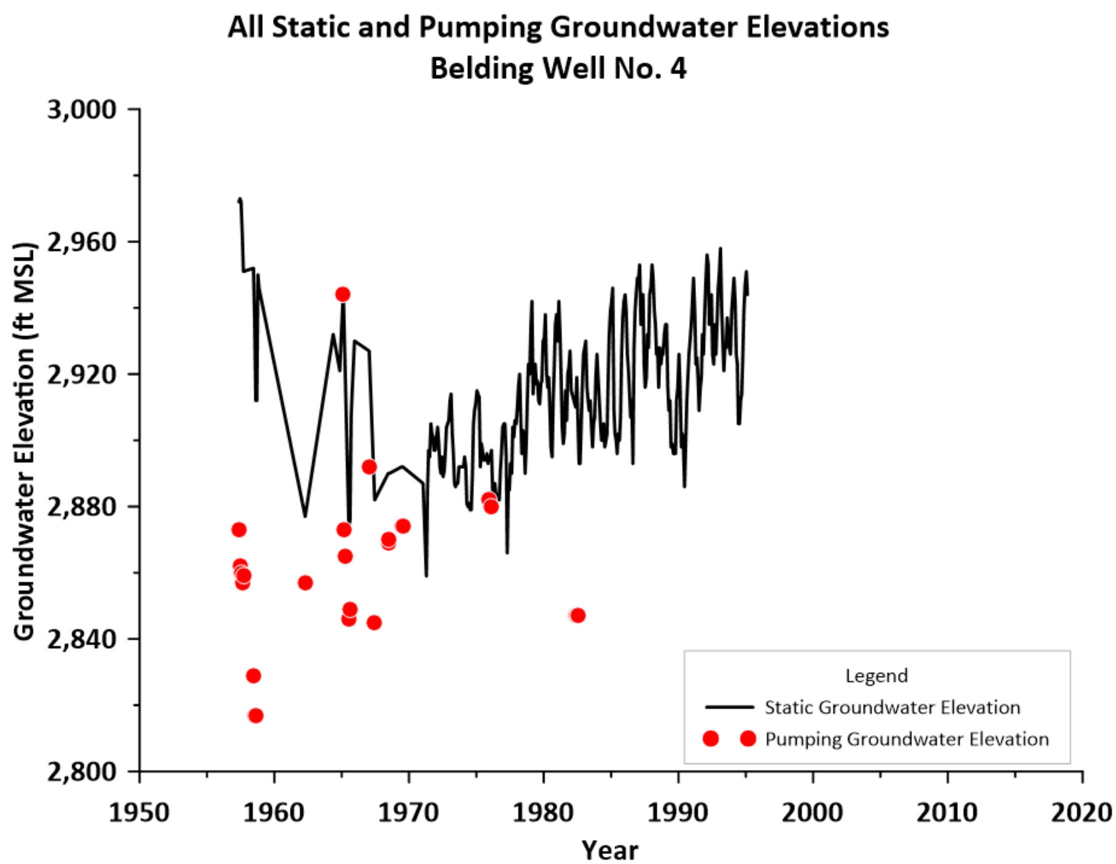
Appendix A
All Static and Pumping Groundwater Elevations


All Static and Pumping Groundwater Elevations
Belding Well No. 1
Groundwater Elevation (ft MSL)
3,040
3,000
2,960
2,920
2,880
2,840
2,800
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

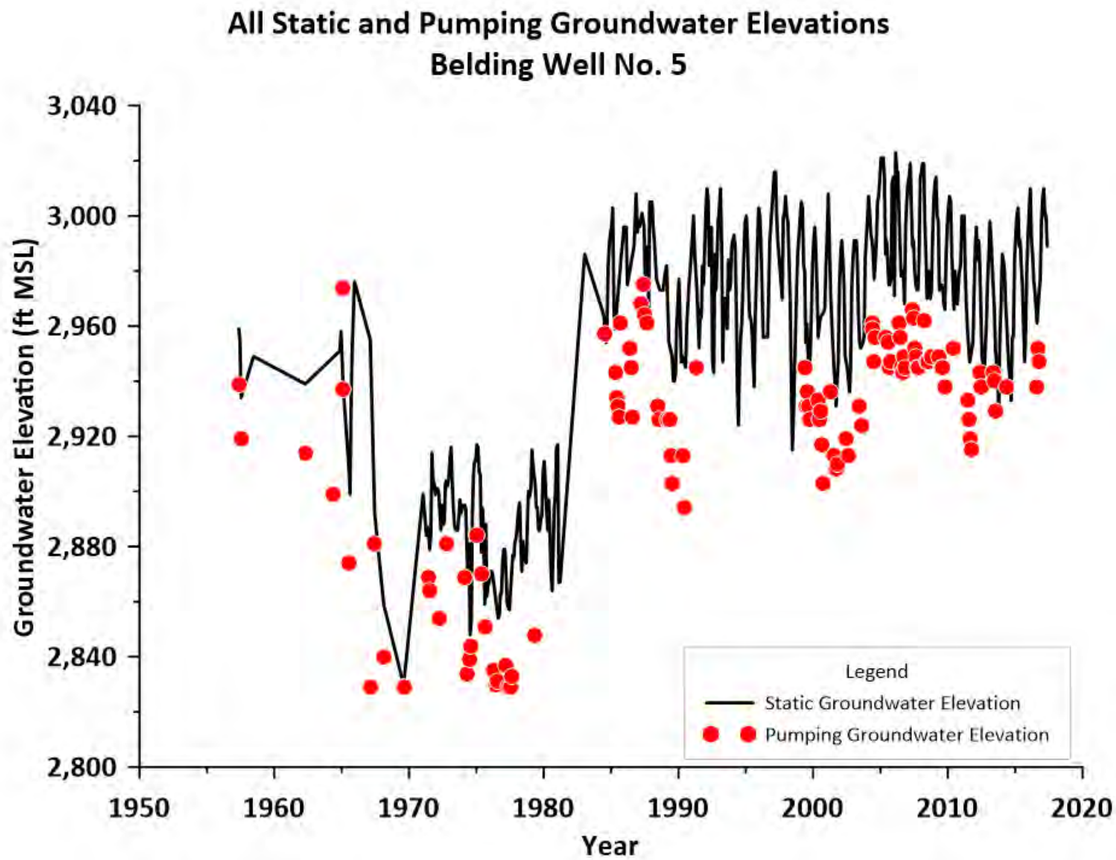

All Static and Pumping Groundwater Elevations
Belding Well No. 2
Groundwater Elevation (ft MSL)
3,050
3,000
2,950
2,900
2,850
2,800
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

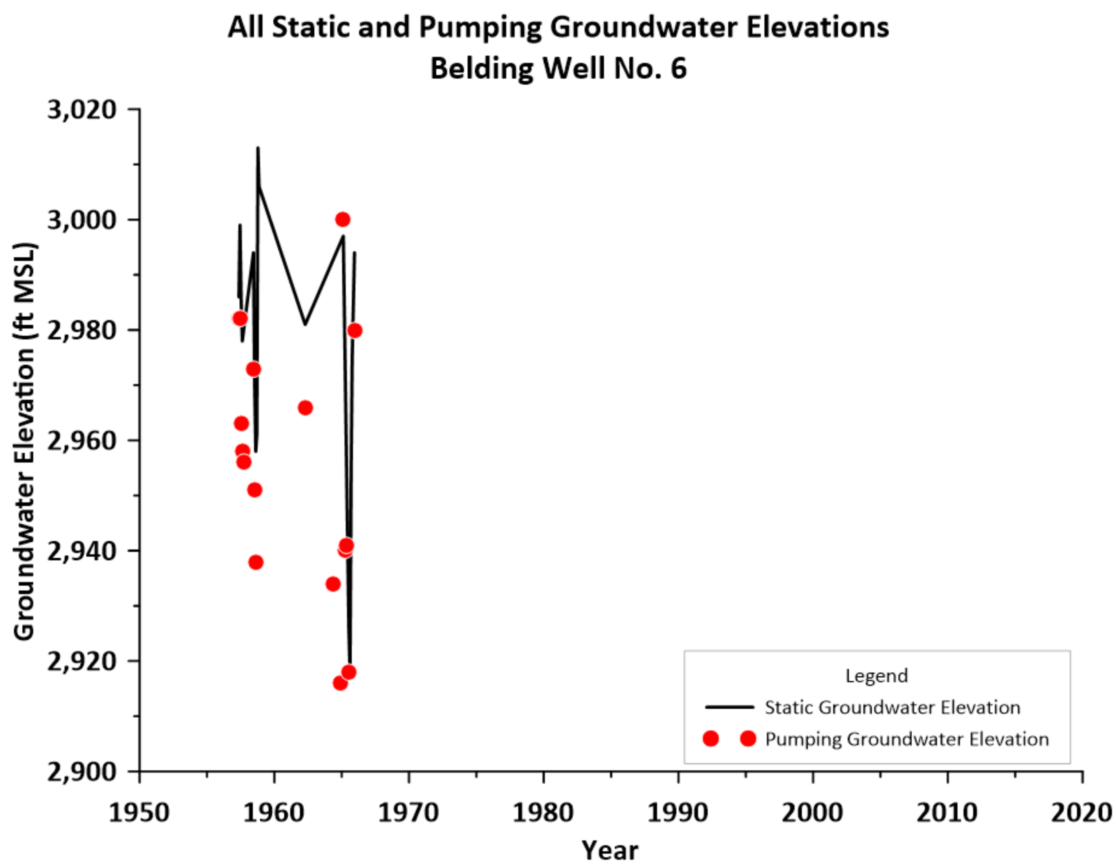


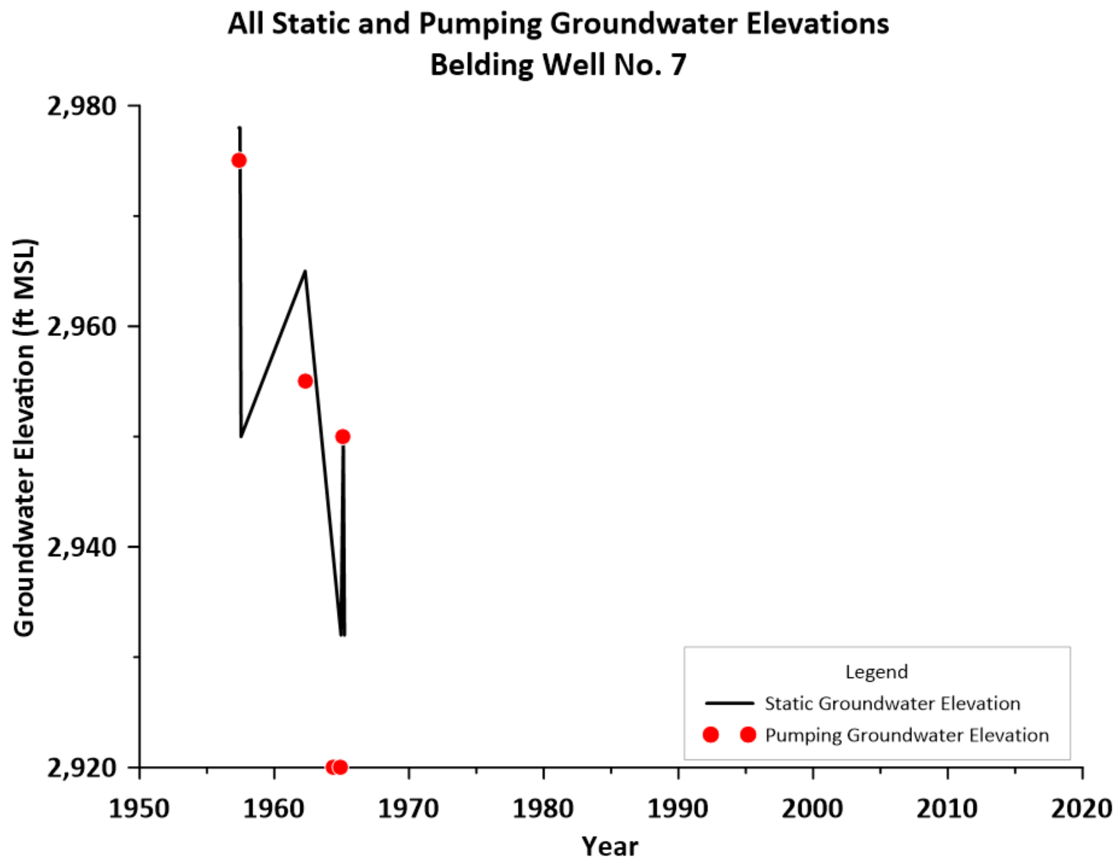
All Static and Pumping Groundwater Elevations
Belding Well No. 3
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation
Groundwater Elevation (ft MSL)
3,040
3,000
2,960
2,920
2,880
1950
1960
1970
1980
1990
2000
2010
2020
Year



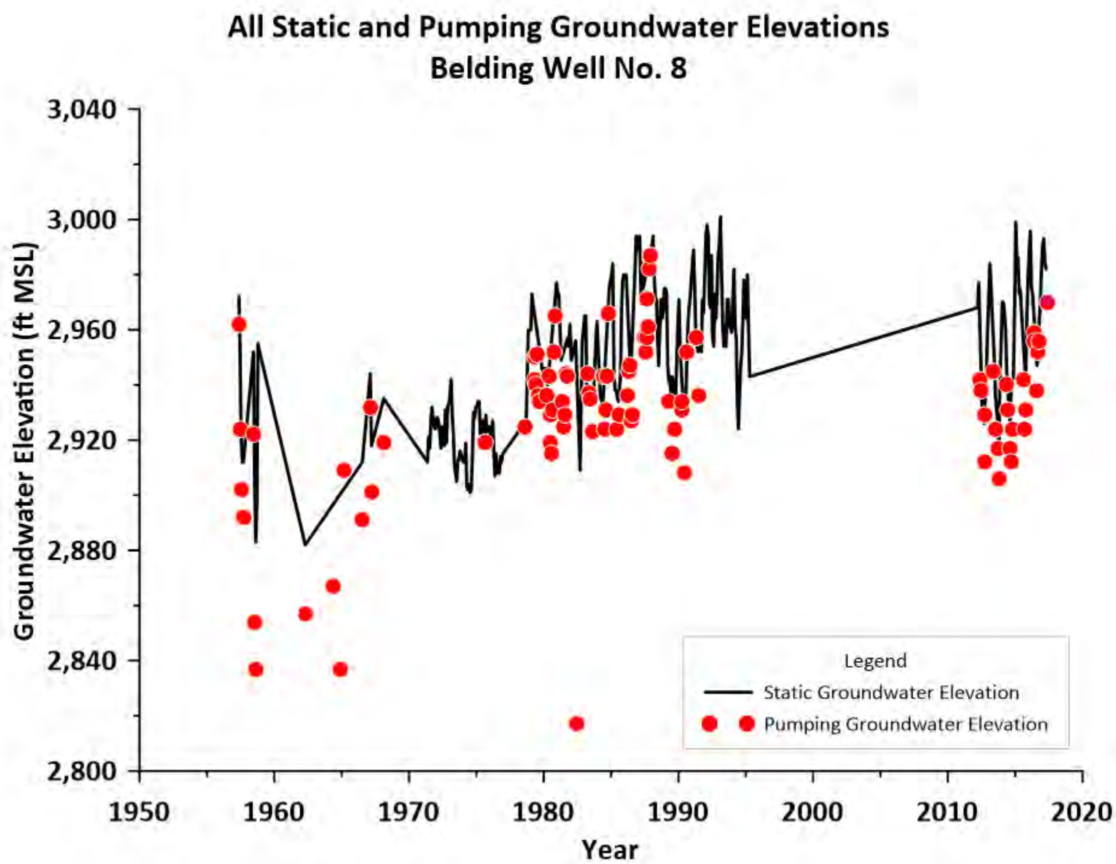
All Static and Pumping Groundwater Elevations
Belding Well No. 4
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation
Groundwater Elevation (ft MSL)
3,000
2,960
2,920
2,880
2,840
2,800
1950
1960
1970
1980
1990
2000
2010
2020
Year


All Static and Pumping Groundwater Elevations
Belding Well No. 5
3,040
3,000
2,960
2,920
2,880
2,840
2,800
Groundwater Elevation (ft MSL)
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

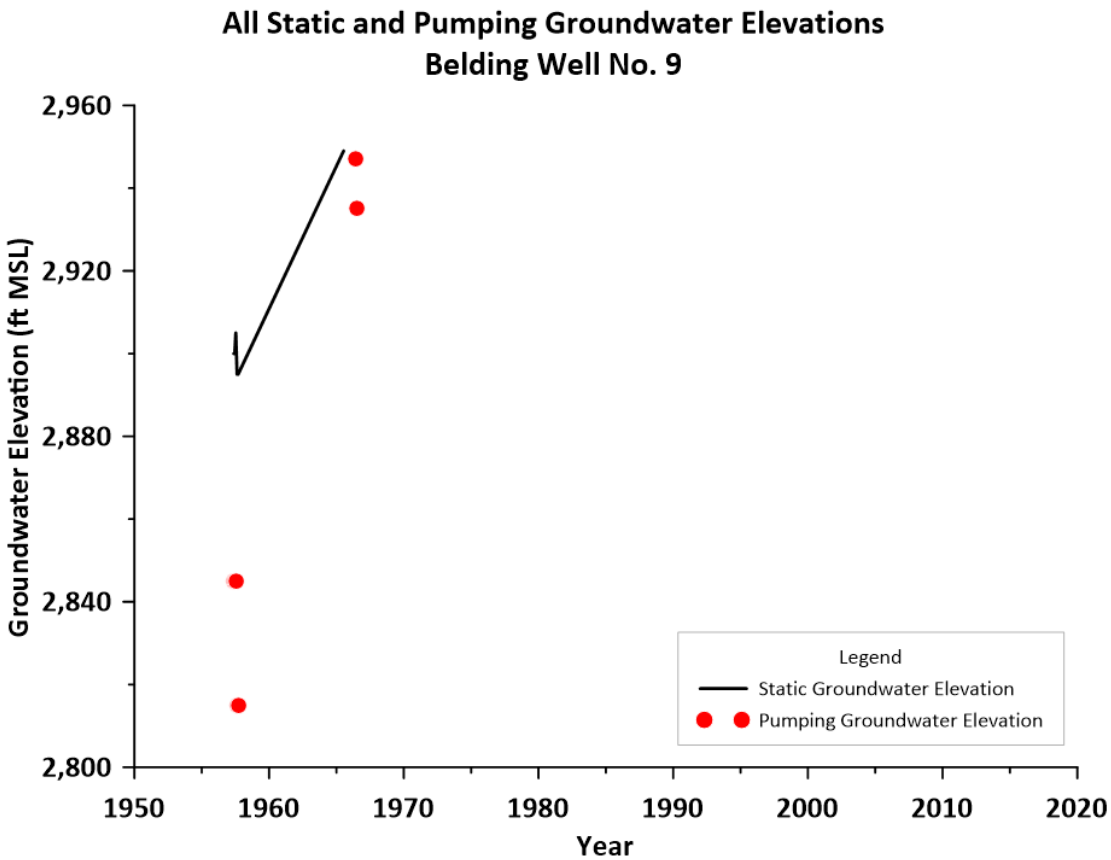

All Static and Pumping Groundwater Elevations
Belding Well No. 6
3,020
3,000
2,980
2,960
2,940
2,920
2,900
Groundwater Elevation (ft MSL)
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

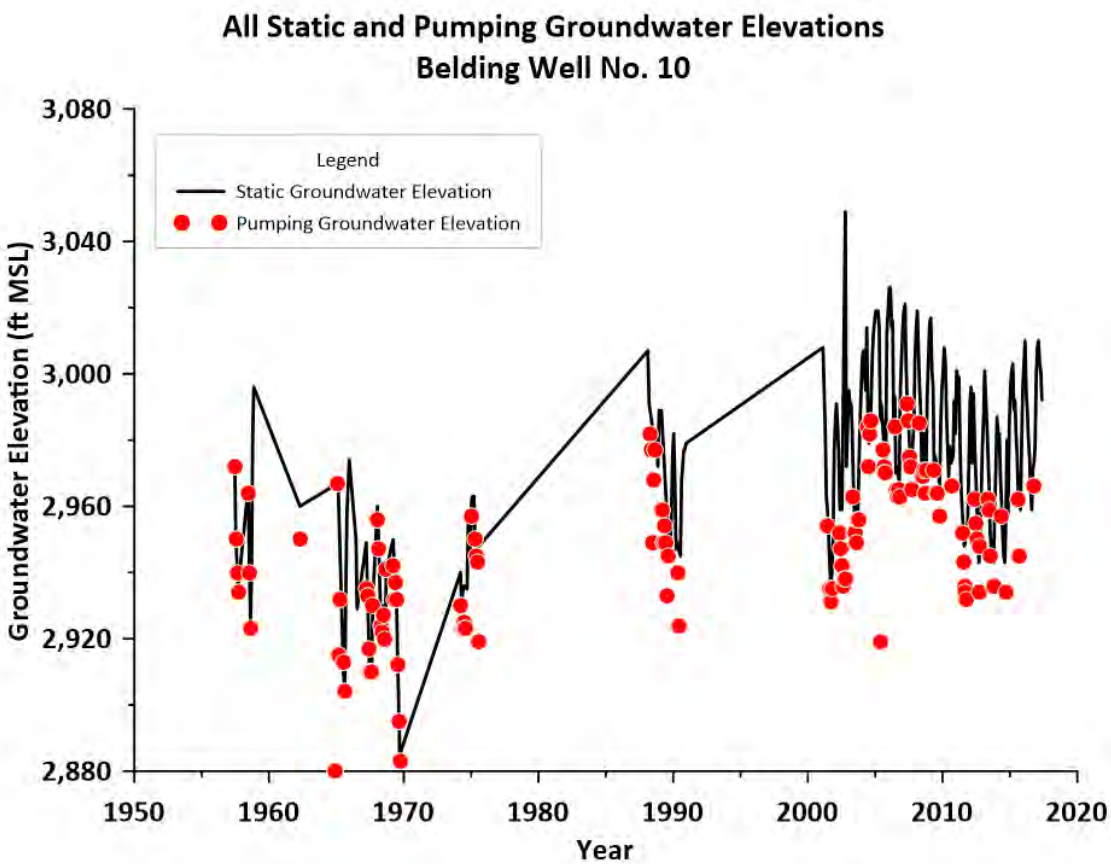


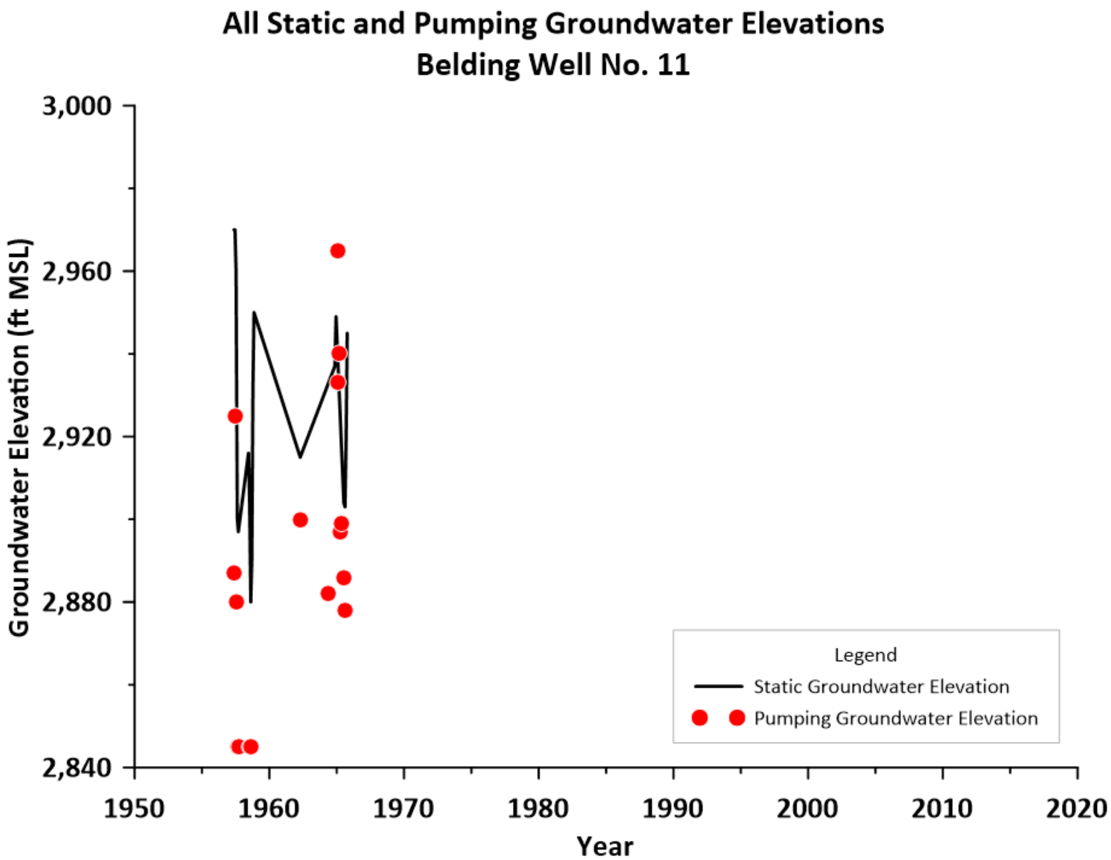
All Static and Pumping Groundwater Elevations
Belding Well No. 7
Groundwater Elevation (ft MSL)
2,980
2,960
2,940
2,920
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

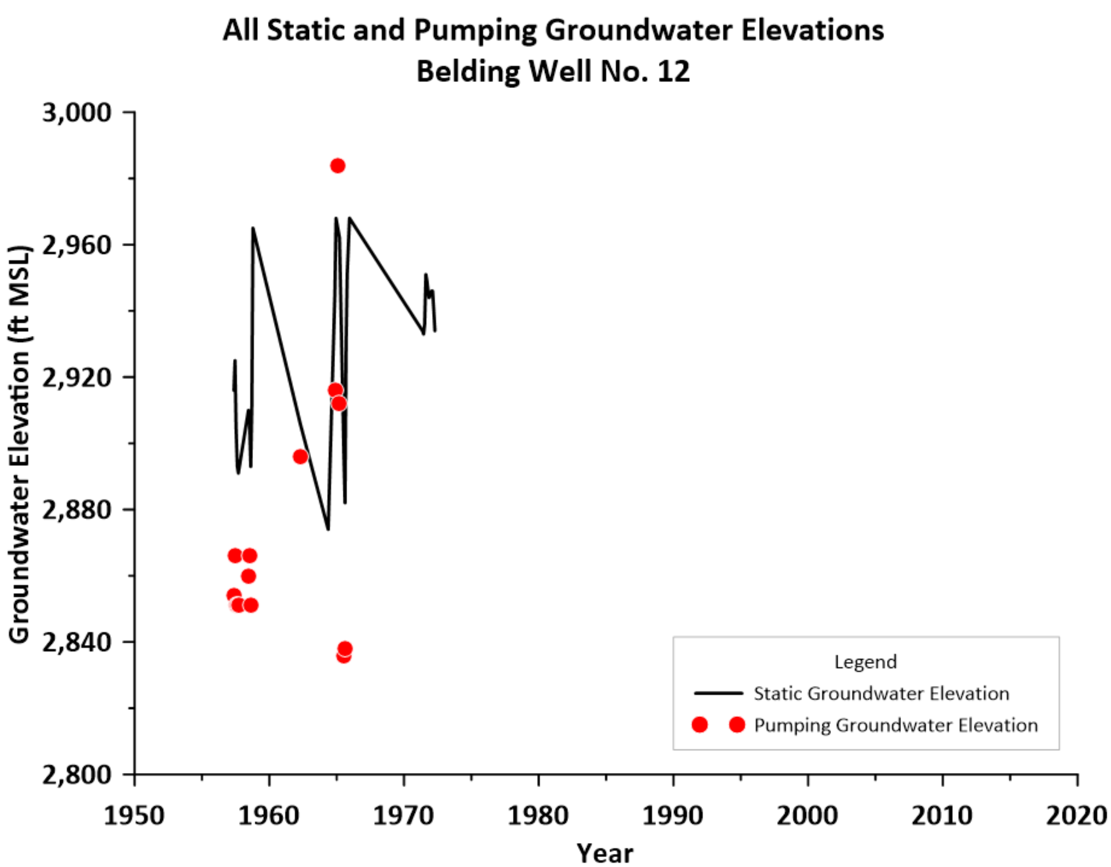


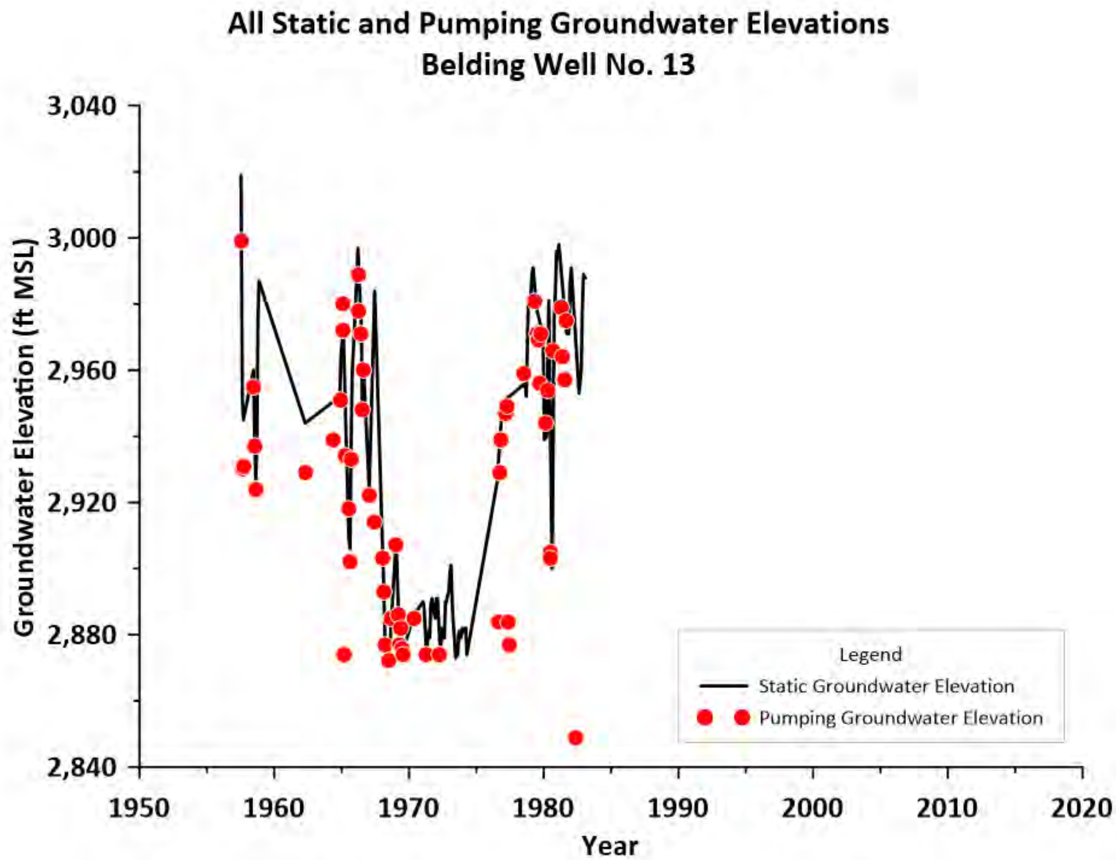
All Static and Pumping Groundwater Elevations
Belding Well No. 8
Groundwater Elevation (ft MSL)
3,040
3,000
2,960
2,920
2,880
2,840
2,800
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

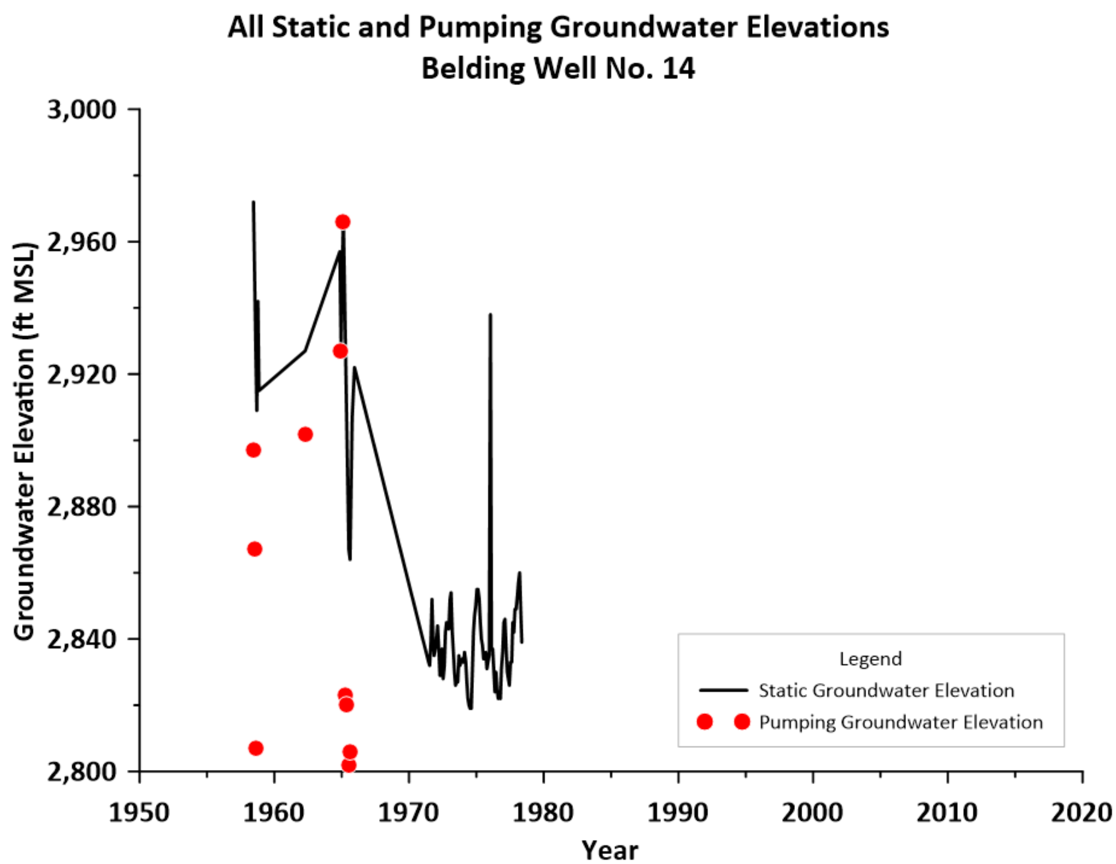

All Static and Pumping Groundwater Elevations
Belding Well No. 9
Groundwater Elevation (ft MSL)
2,960
2,920
2,880
2,840
2,800
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

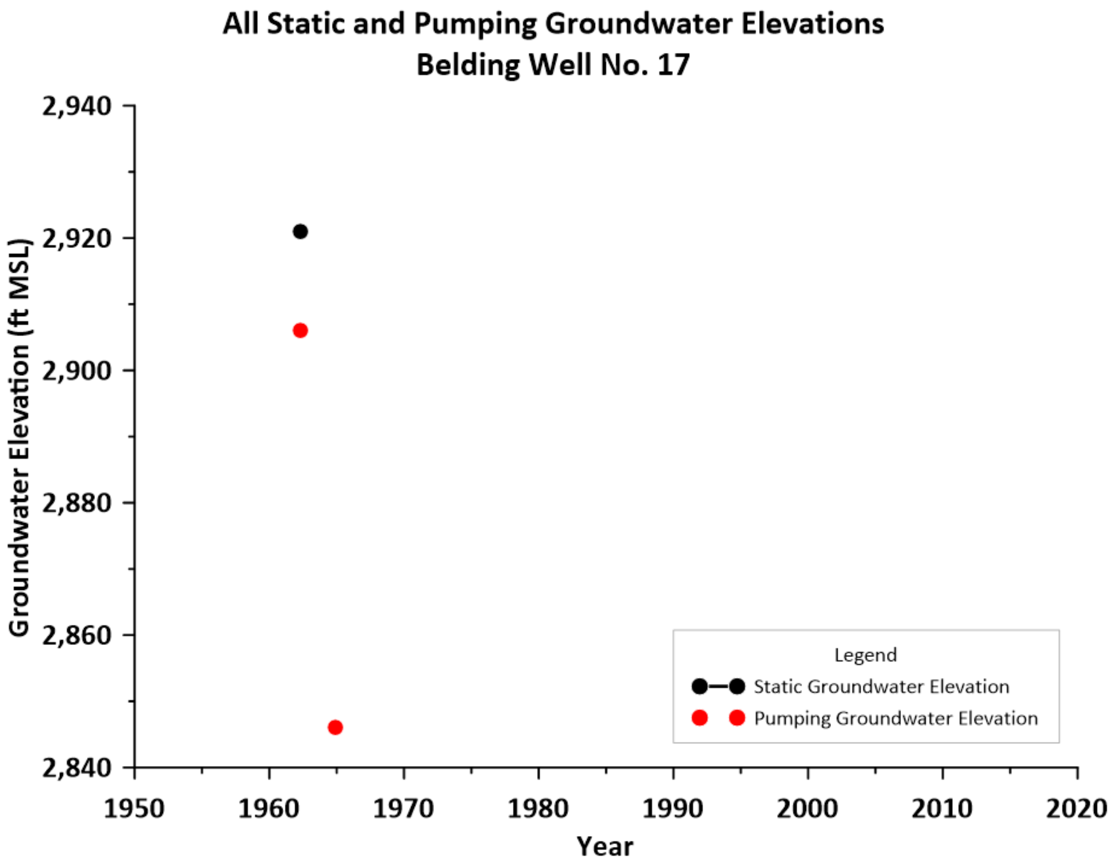

All Static and Pumping Groundwater Elevations
Belding Well No. 10
Groundwater Elevation (ft MSL)
3,080
3,040
3,000
2,960
2,920
2,880
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

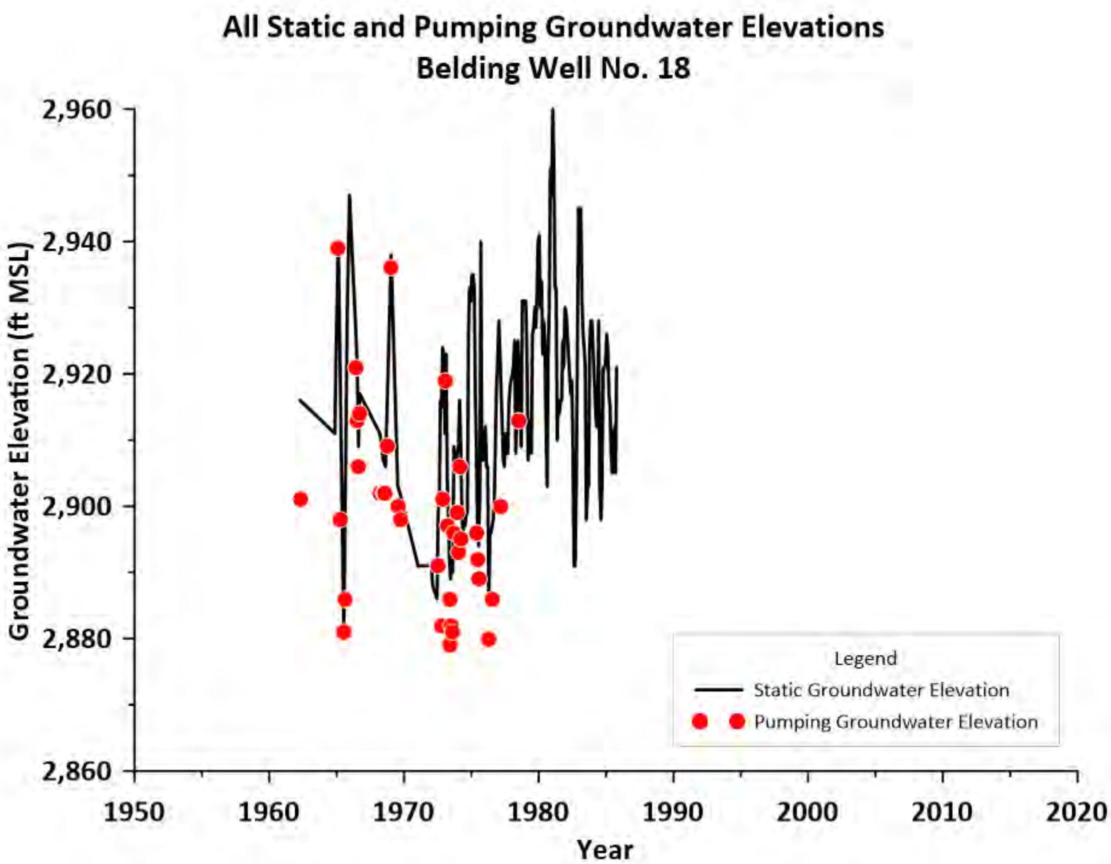

All Static and Pumping Groundwater Elevations
Belding Well No. 11
Groundwater Elevation (ft MSL)
3,000
2,960
2,920
2,880
2,840
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

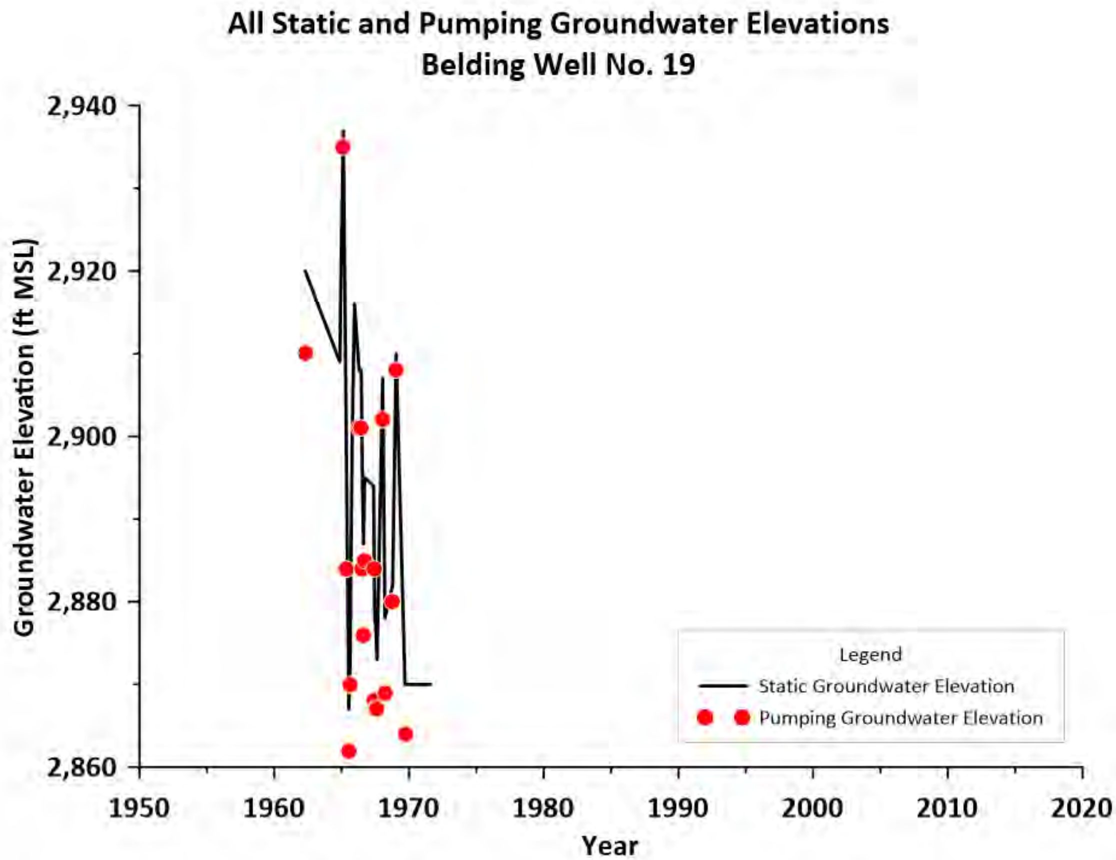

All Static and Pumping Groundwater Elevations
Belding Well No. 12
Groundwater Elevation (ft MSL)
3,000
2,960
2,920
2,880
2,840
2,800
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

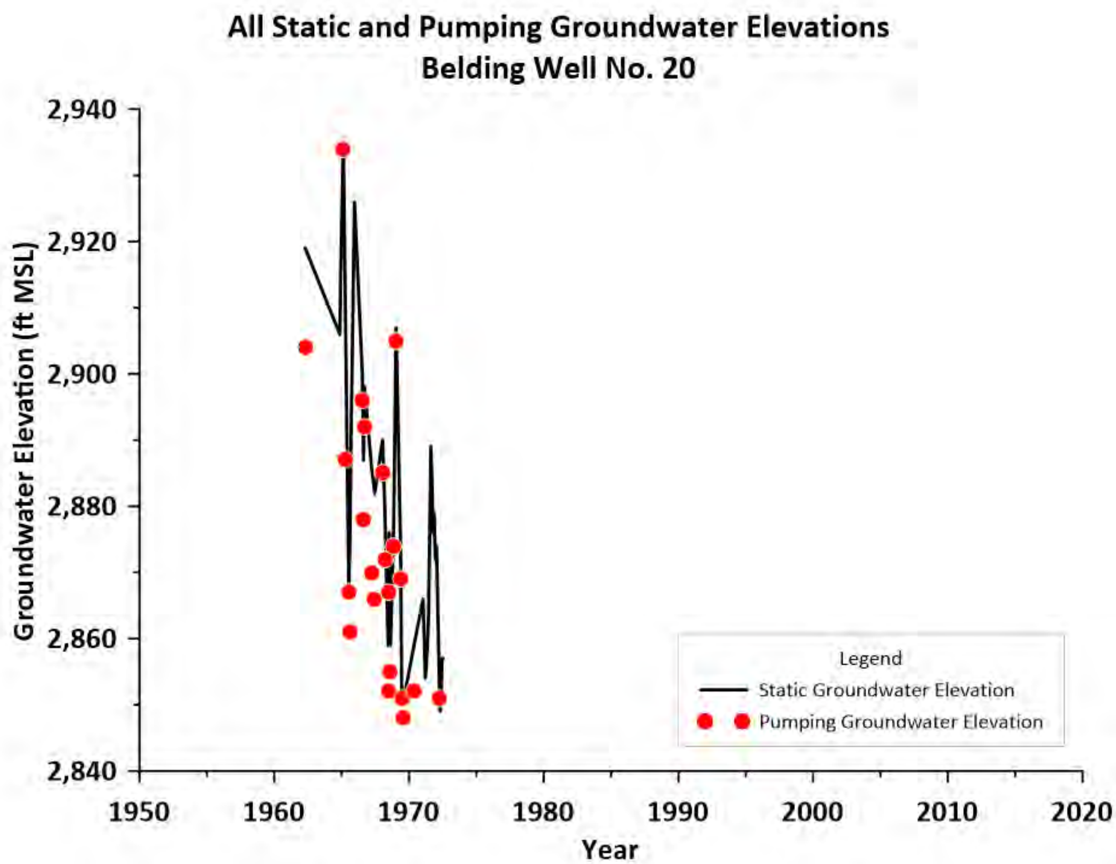

All Static and Pumping Groundwater Elevations
Belding Well No. 13
Groundwater Elevation (ft MSL)
3,040
3,000
2,960
2,920
2,880
2,840
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

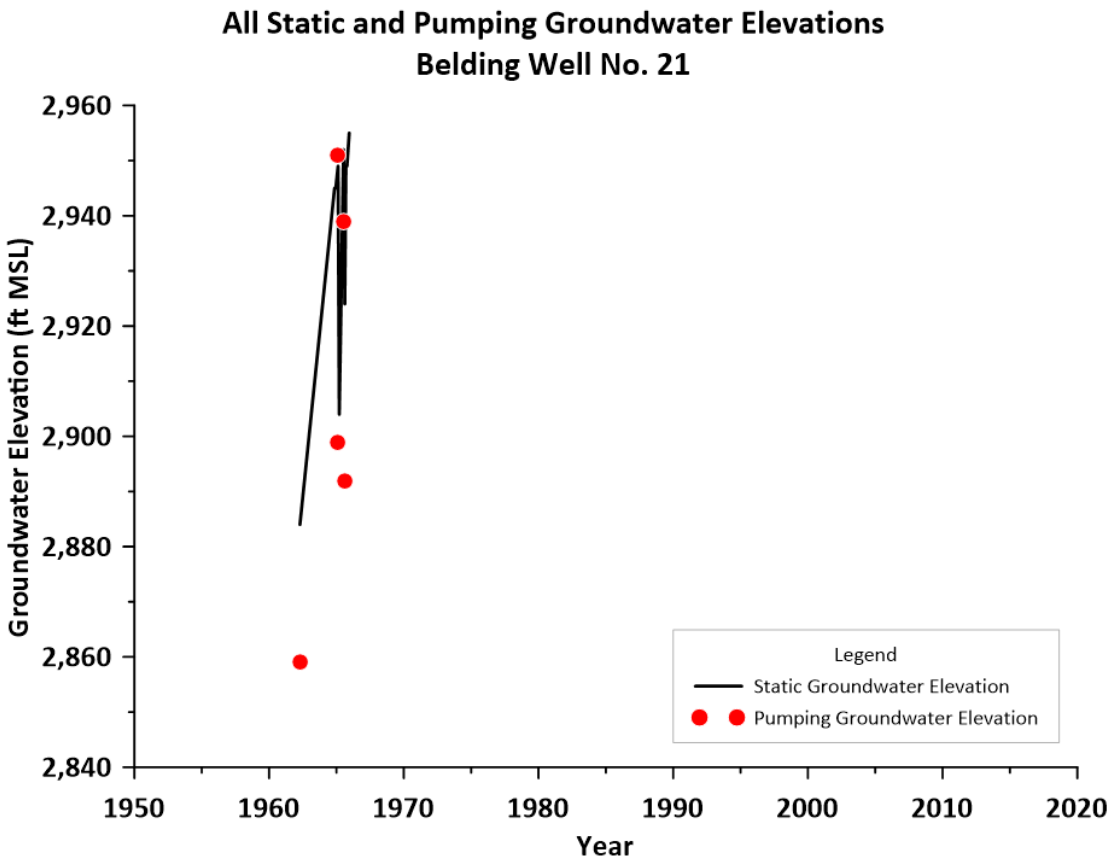

All Static and Pumping Groundwater Elevations
Belding Well No. 14
Groundwater Elevation (ft MSL)
3,000
2,960
2,920
2,880
2,840
2,800
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

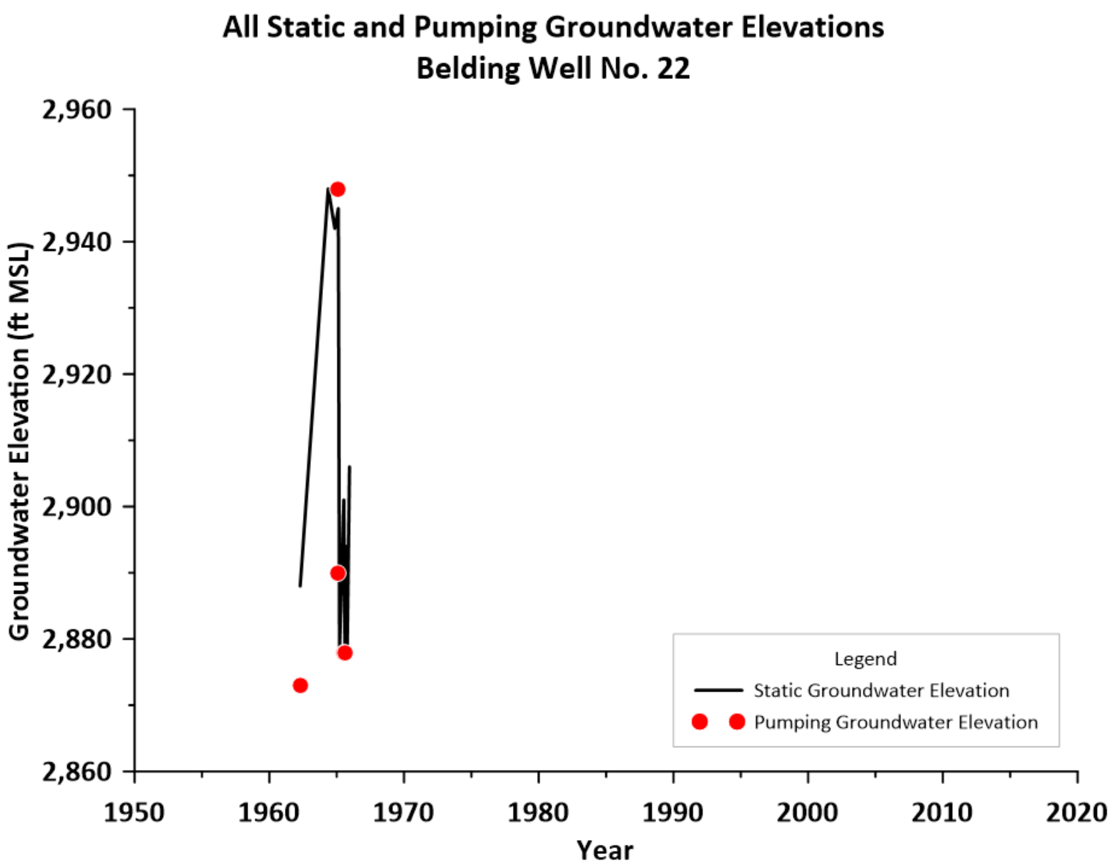

All Static and Pumping Groundwater Elevations
Belding Well No. 17
Groundwater Elevation (ft MSL)
2,940
2,920
2,900
2,880
2,860
2,840
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

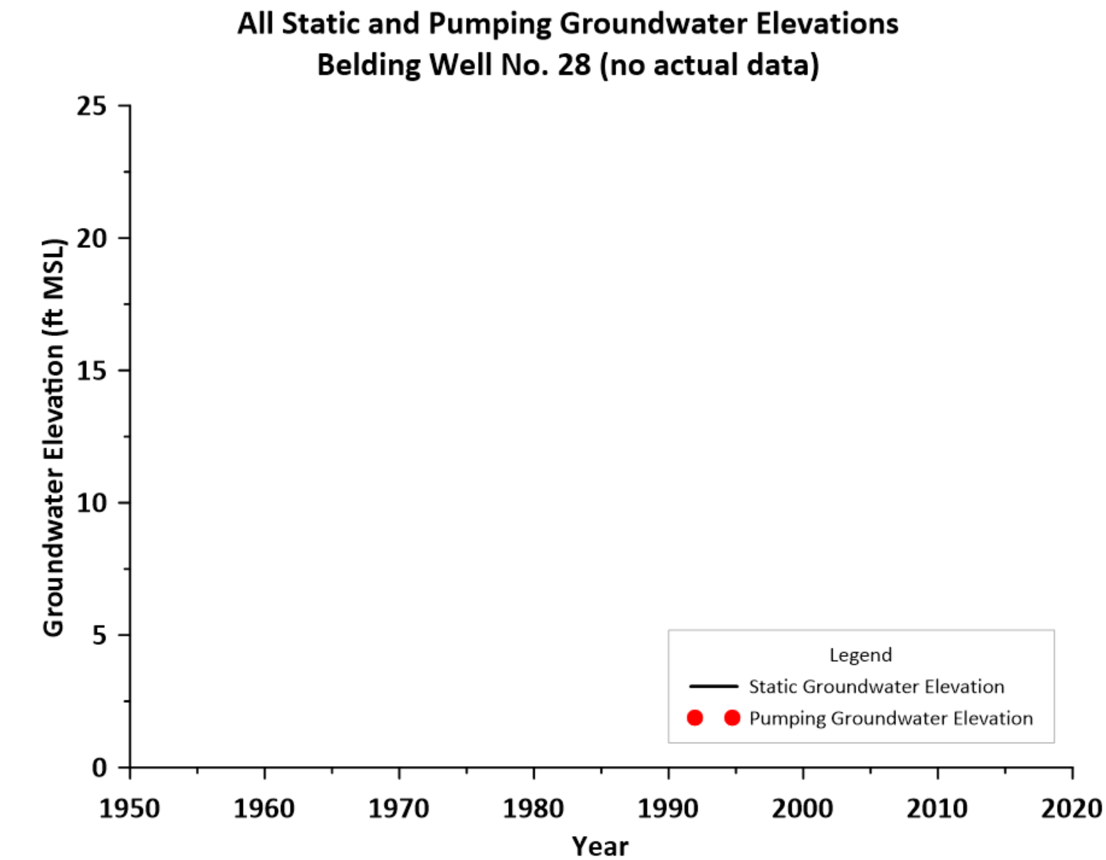

All Static and Pumping Groundwater Elevations
Belding Well No. 18
Groundwater Elevation (ft MSL)
2,960
2,940
2,920
2,900
2,880
2,860
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation


All Static and Pumping Groundwater Elevations
Belding Well No. 19
Groundwater Elevation (ft MSL)
2,940
2,920
2,900
2,880
2,860
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

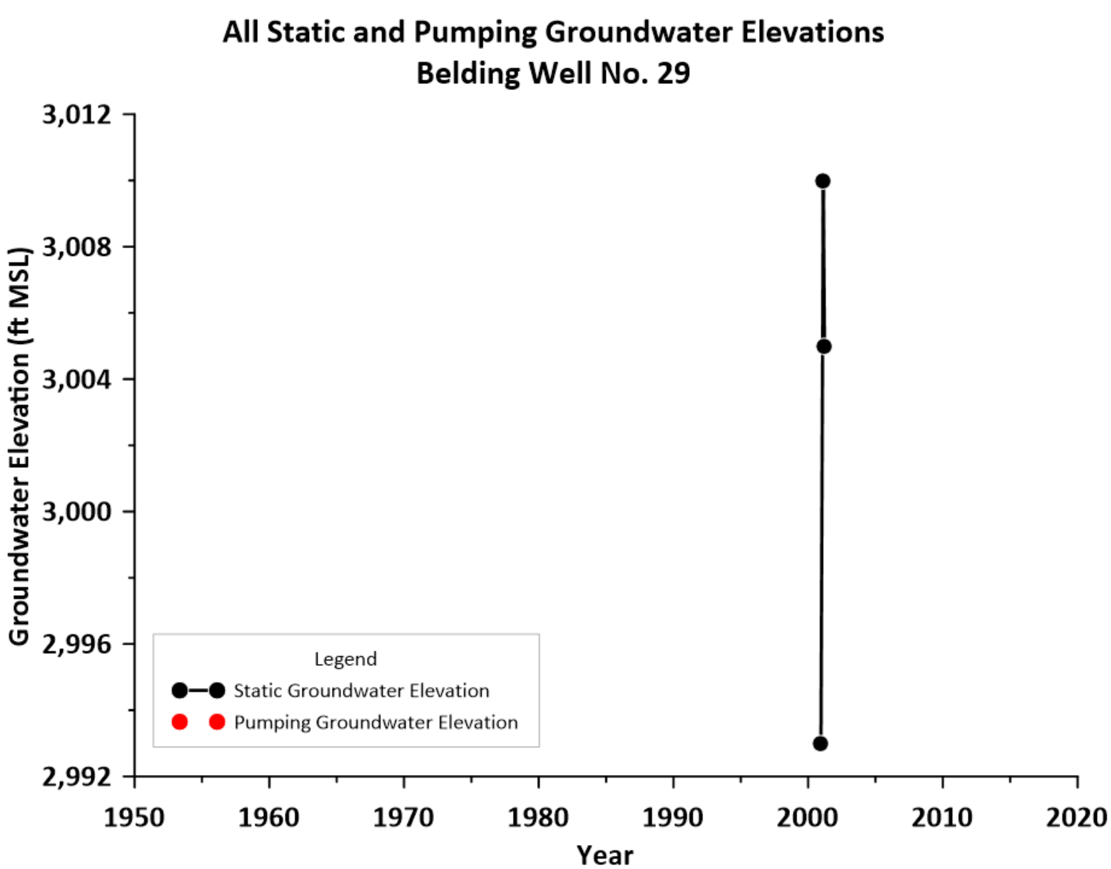

All Static and Pumping Groundwater Elevations
Belding Well No. 20
Groundwater Elevation (ft MSL)
2,940
2,920
2,900
2,880
2,860
2,840
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation


All Static and Pumping Groundwater Elevations
Belding Well No. 21
Groundwater Elevation (ft MSL)
2,960
2,940
2,920
2,900
2,880
2,860
2,840
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

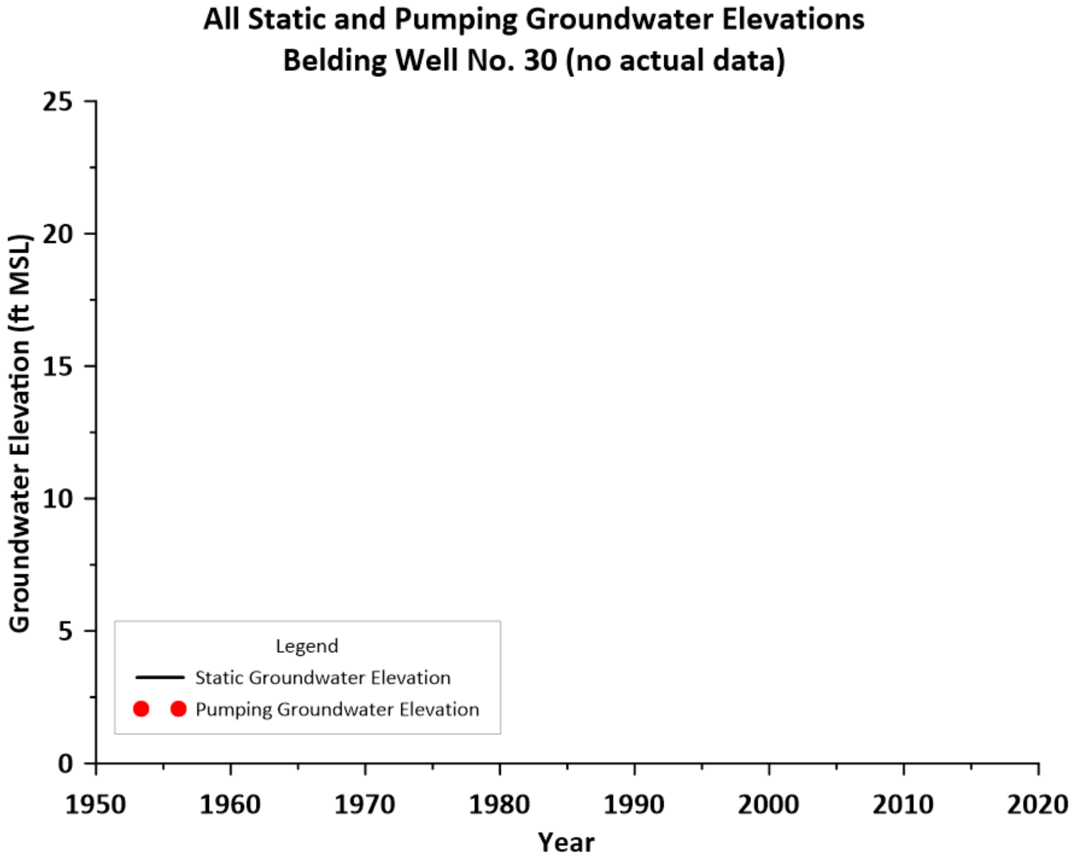

All Static and Pumping Groundwater Elevations
Belding Well No. 22
Groundwater Elevation (ft MSL)
2,960
2,940
2,920
2,900
2,880
2,860
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation



All Static and Pumping Groundwater Elevations
Belding Well No. 28 (no actual data)
Groundwater Elevation (ft MSL)
25
20
15
10
5
0
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

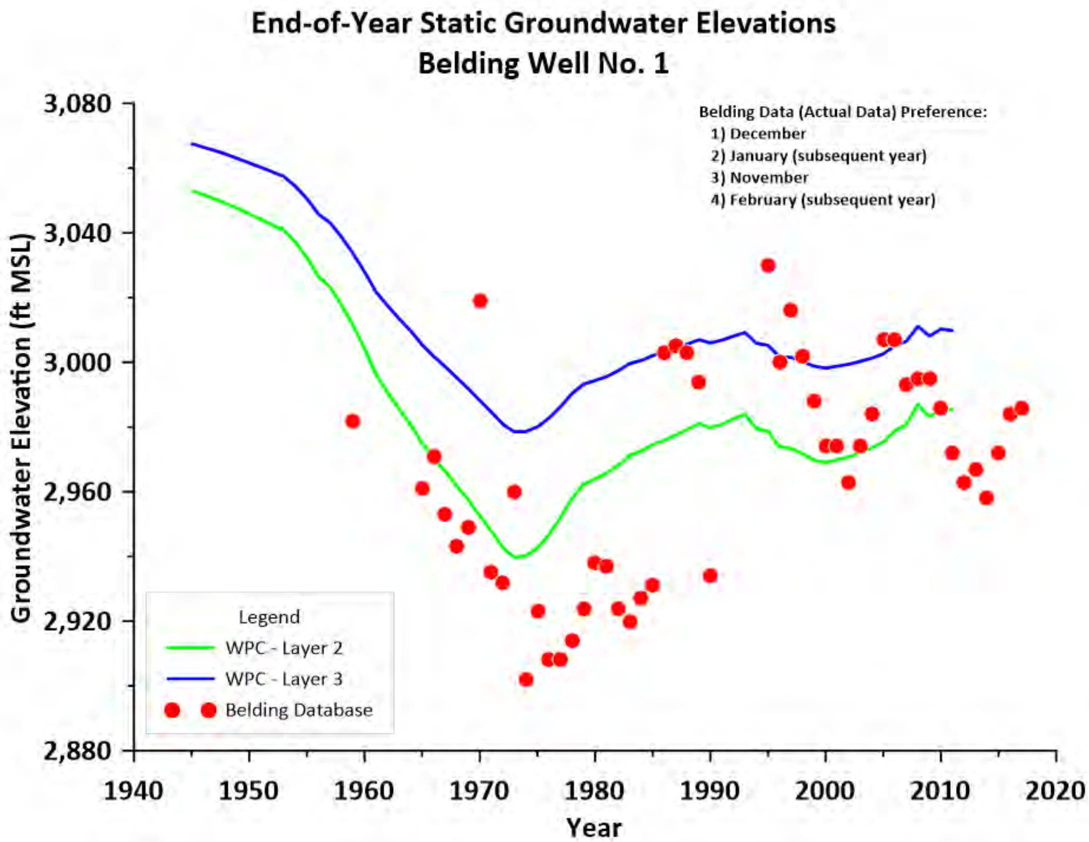


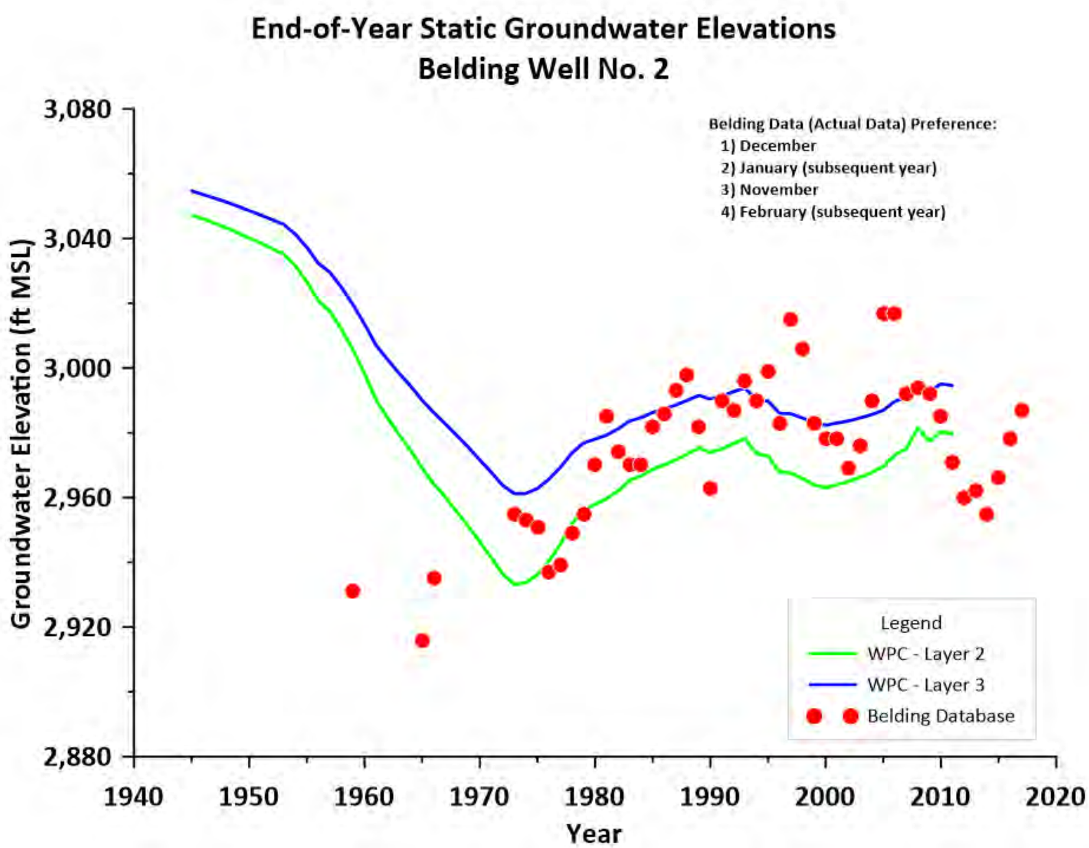
All Static and Pumping Groundwater Elevations
Belding Well No. 29
Groundwater Elevation (ft MSL)
3,012
3,008
3,004
3,000
2,996
2,992
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

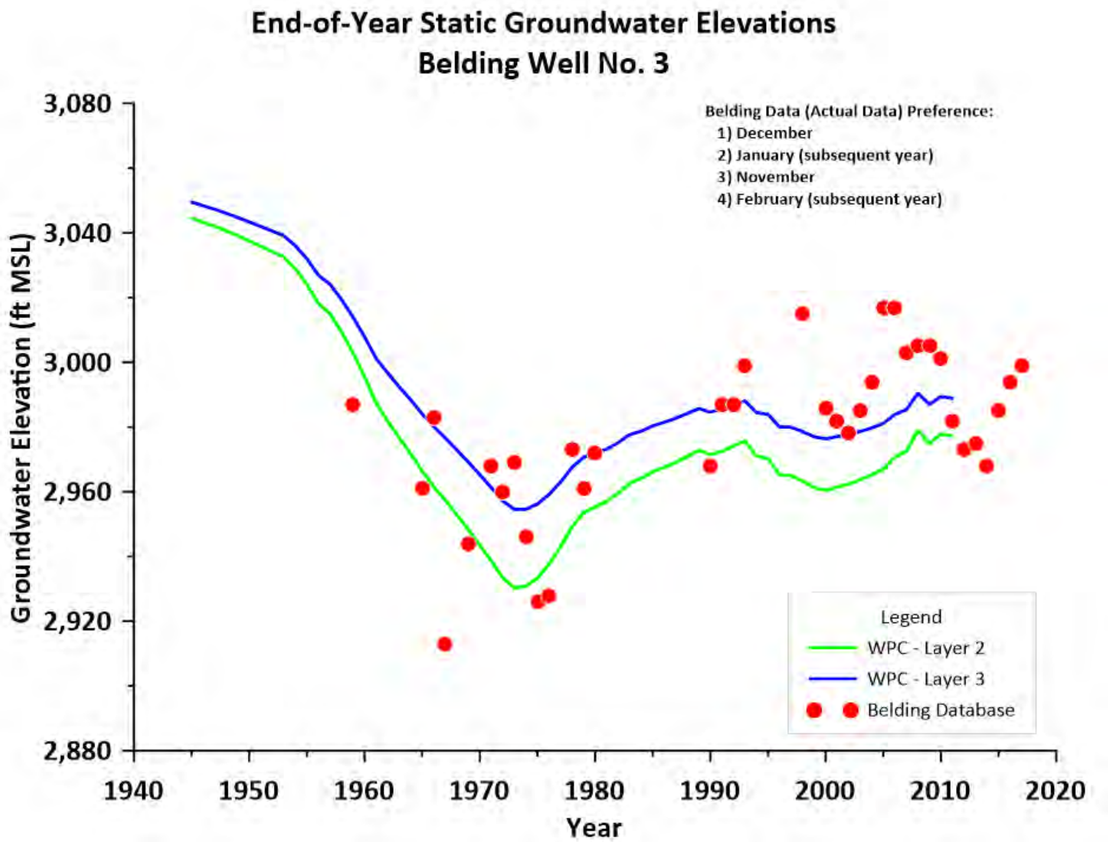

All Static and Pumping Groundwater Elevations
Belding Well No. 30 (no actual data)
Groundwater Elevation (ft MSL)
25
20
15
10
5
0
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
Static Groundwater Elevation
Pumping Groundwater Elevation

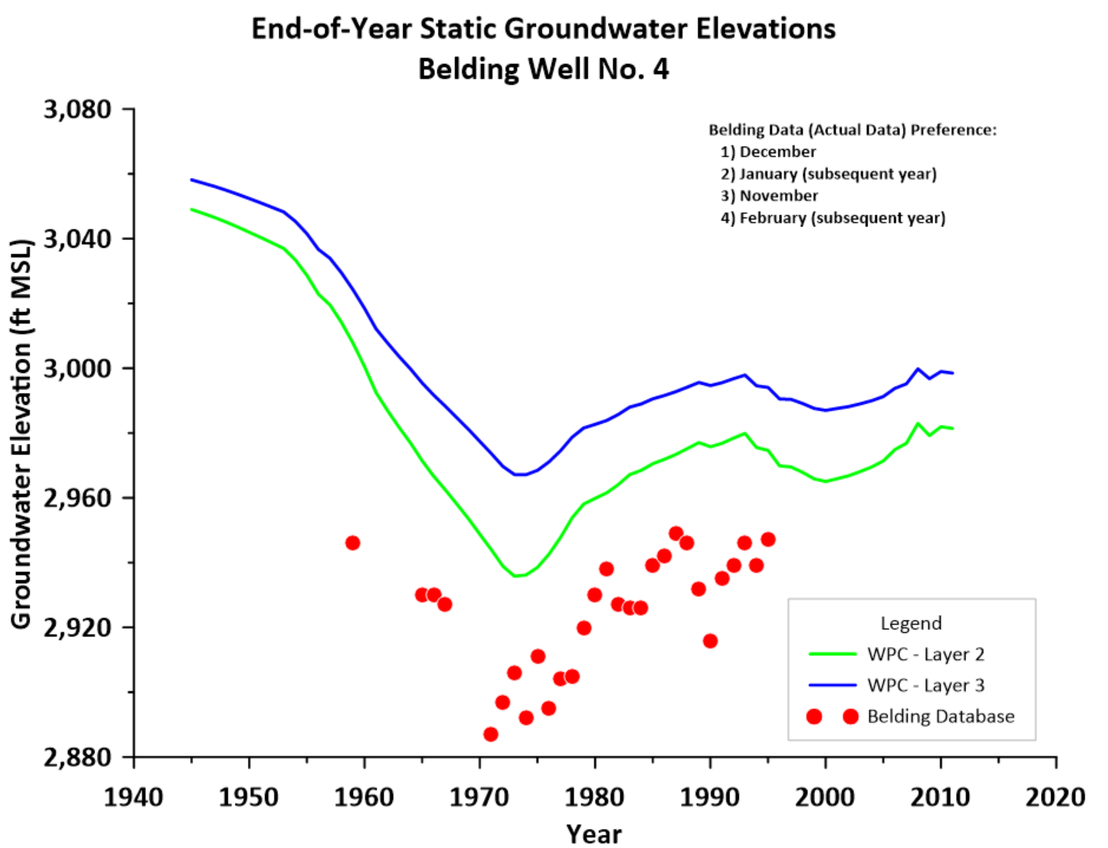
Appendix B

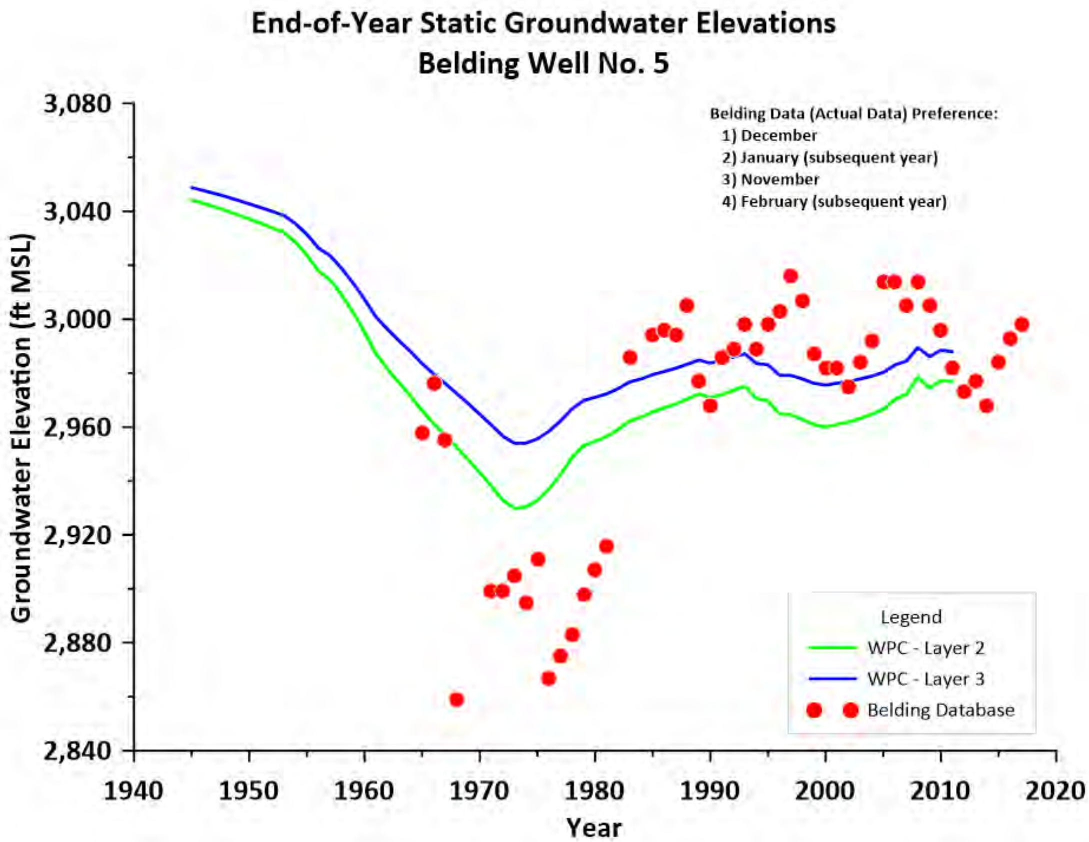
End-of-Year Static Groundwater Elevations and Simulated Groundwater Elevations from Western Pecos Model Hydrographs


End-of-Year Static Groundwater Elevations
Belding Well No. 1
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Groundwater Elevation (ft MSL)
Year
3,080
3,040
3,000
2,960
2,920
2,880
1940
1950
1960
1970
1980
1990
2000
2010
2020

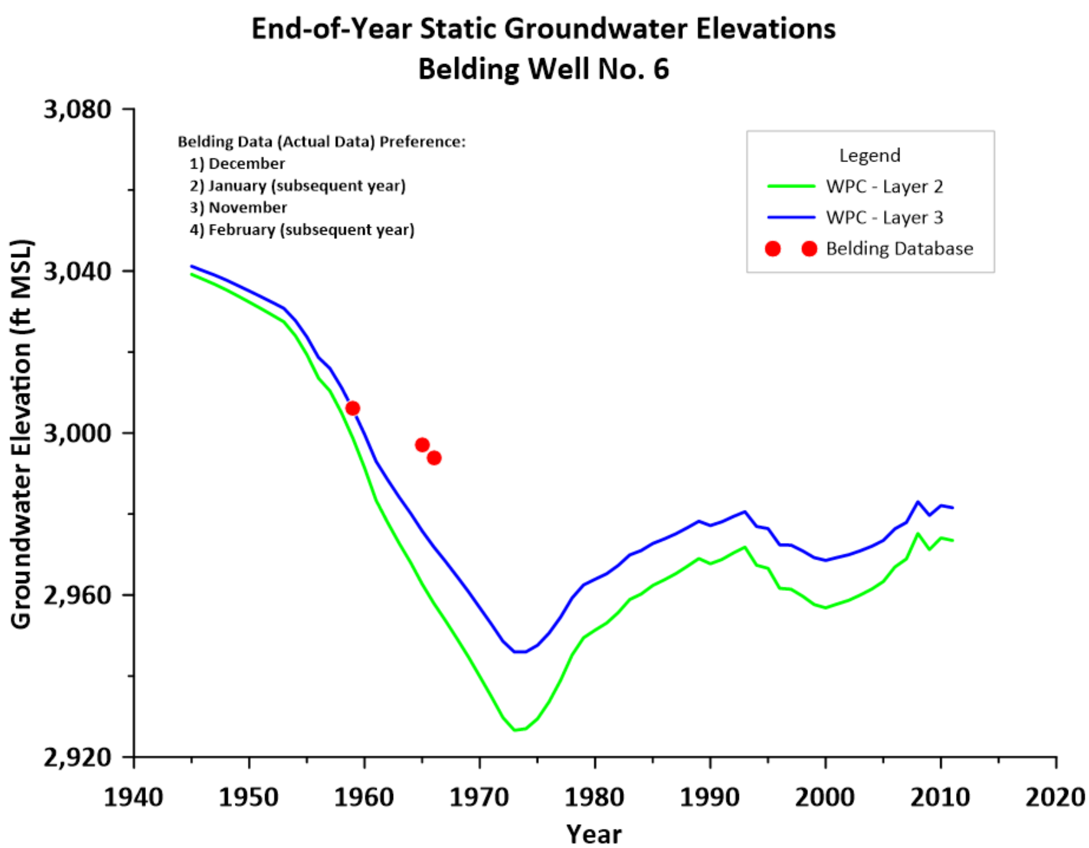

End-of-Year Static Groundwater Elevations
Belding Well No. 2
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Groundwater Elevation (ft MSL)
Year
3,080
3,040
3,000
2,960
2,920
2,880
1940
1950
1960
1970
1980
1990
2000
2010
2020


End-of-Year Static Groundwater Elevations
Belding Well No. 3
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Groundwater Elevation (ft MSL)
Year
3,080
3,040
3,000
2,960
2,920
2,880
1940
1950
1960
1970
1980
1990
2000
2010
2020

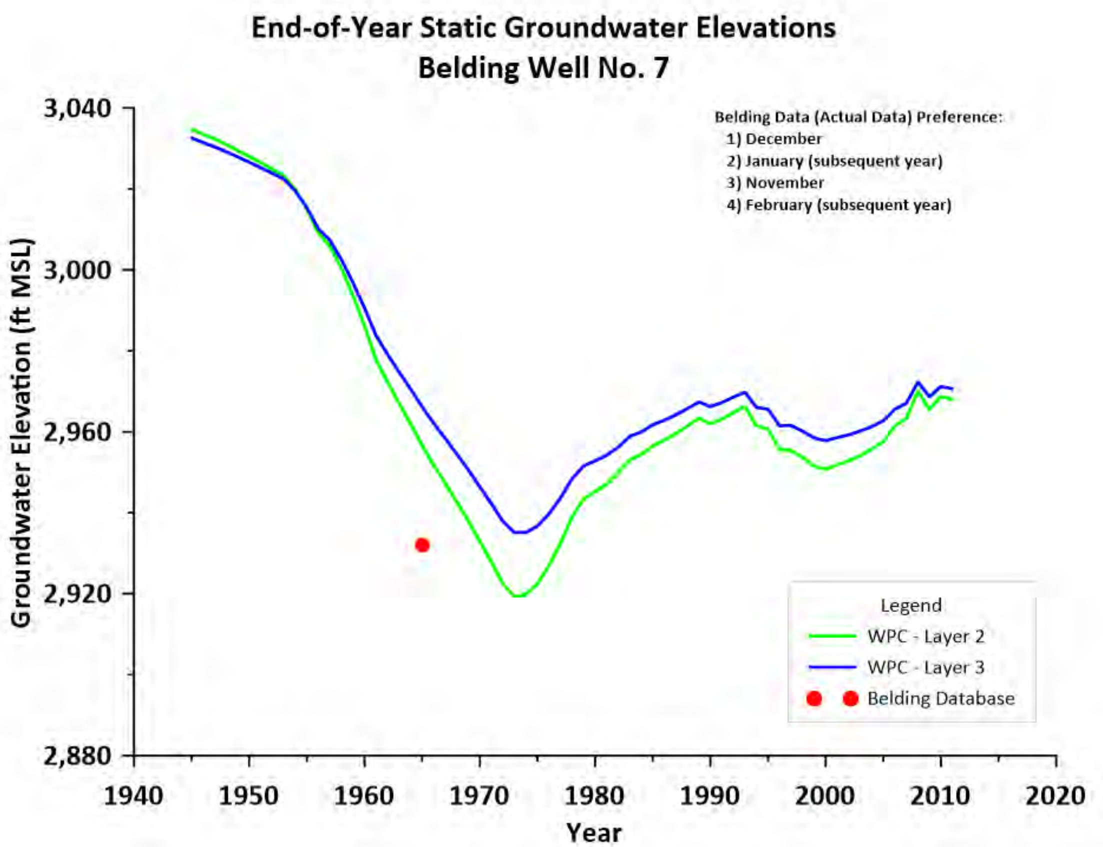

End-of-Year Static Groundwater Elevations
Belding Well No. 4
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Groundwater Elevation (ft MSL)
Year
3,080
3,040
3,000
2,960
2,920
2,880
1940
1950
1960
1970
1980
1990
2000
2010
2020

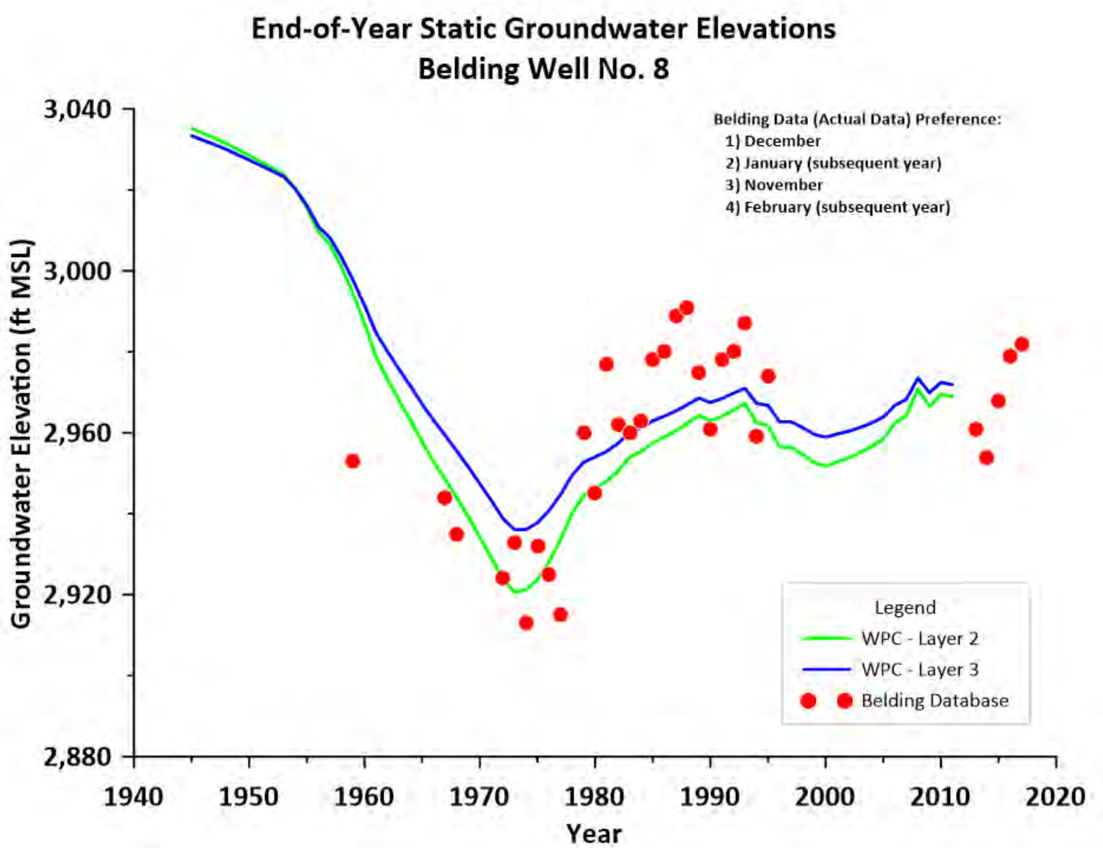


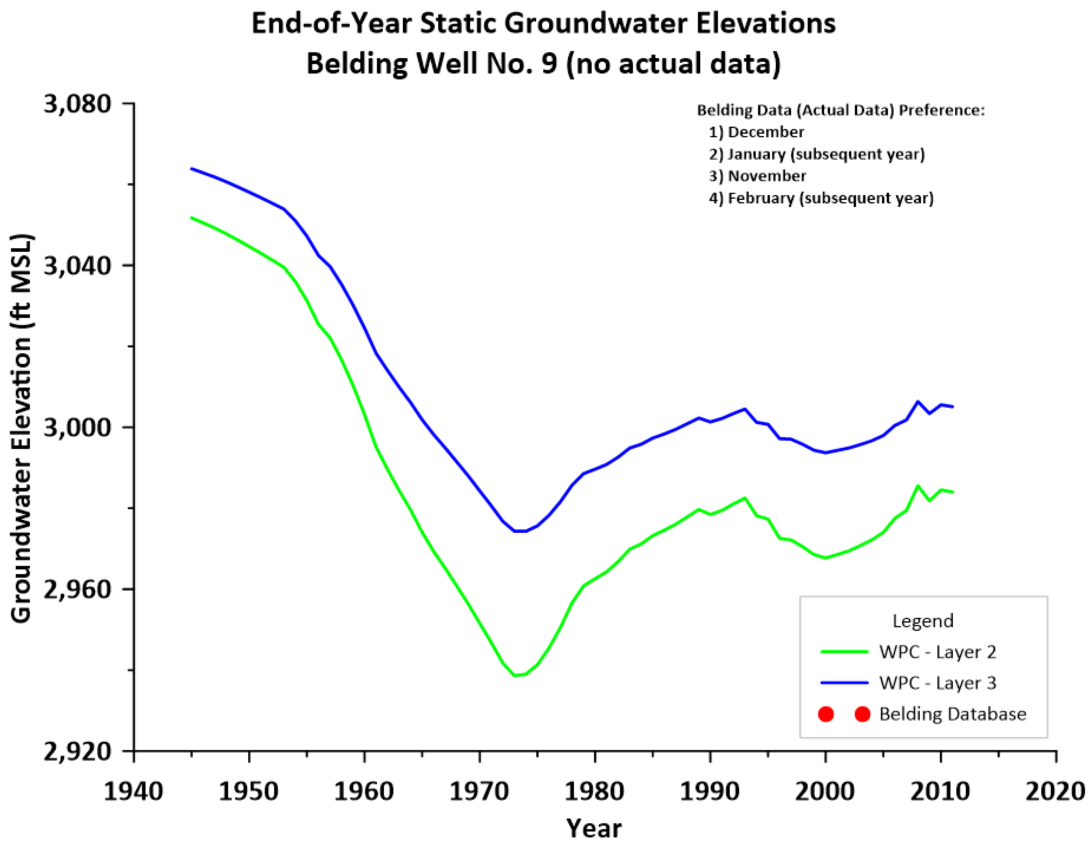
End-of-Year Static Groundwater Elevations
Belding Well No. 5
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Groundwater Elevation (ft MSL)
3,080
3,040
3,000
2,960
2,920
2,880
2,840
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year

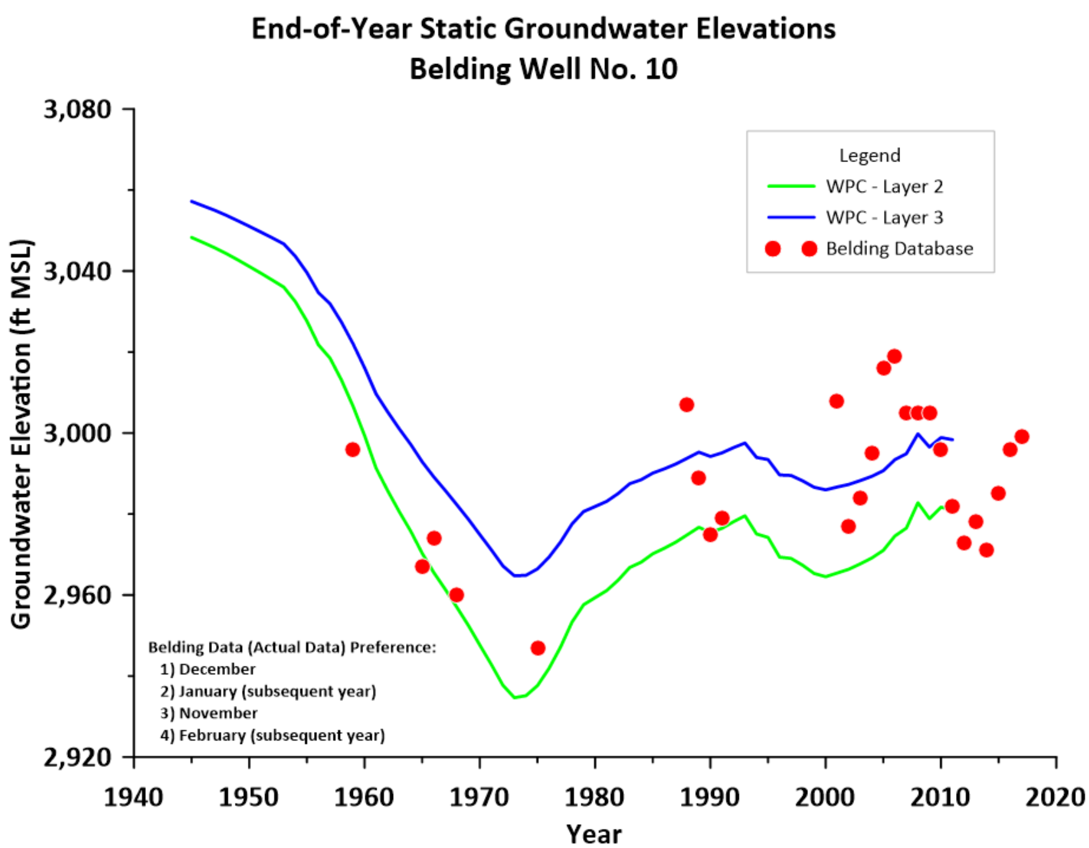


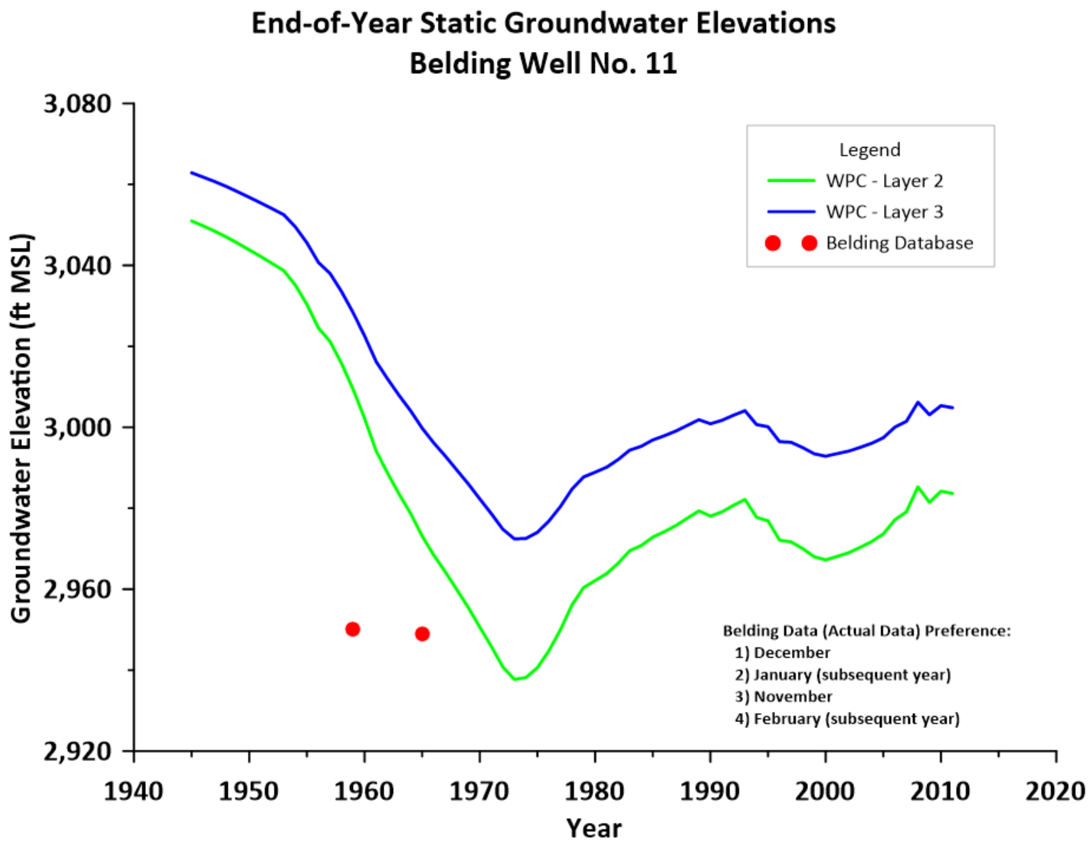
End-of-Year Static Groundwater Elevations
Belding Well No. 6
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Groundwater Elevation (ft MSL)
3,080
3,040
3,000
2,960
2,920
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year

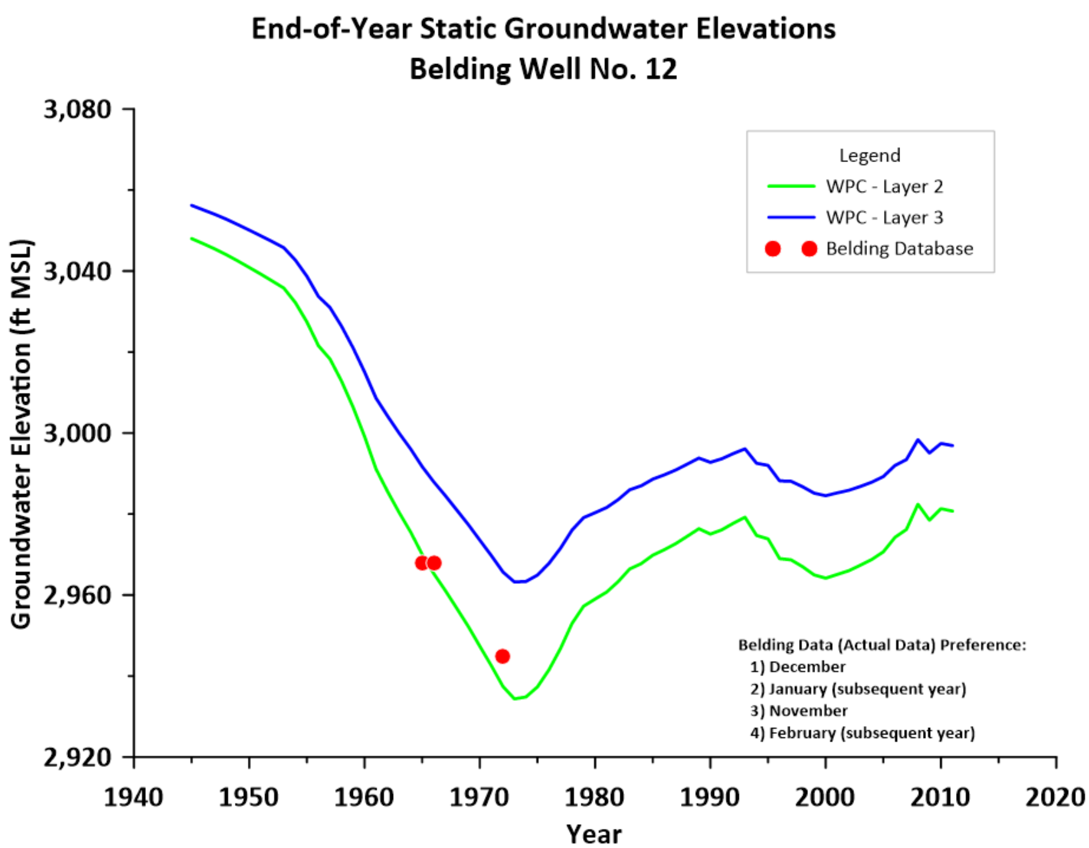

End-of-Year Static Groundwater Elevations
Belding Well No. 7
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Groundwater Elevation (ft MSL)
3,040
3,000
2,960
2,920
2,880
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database

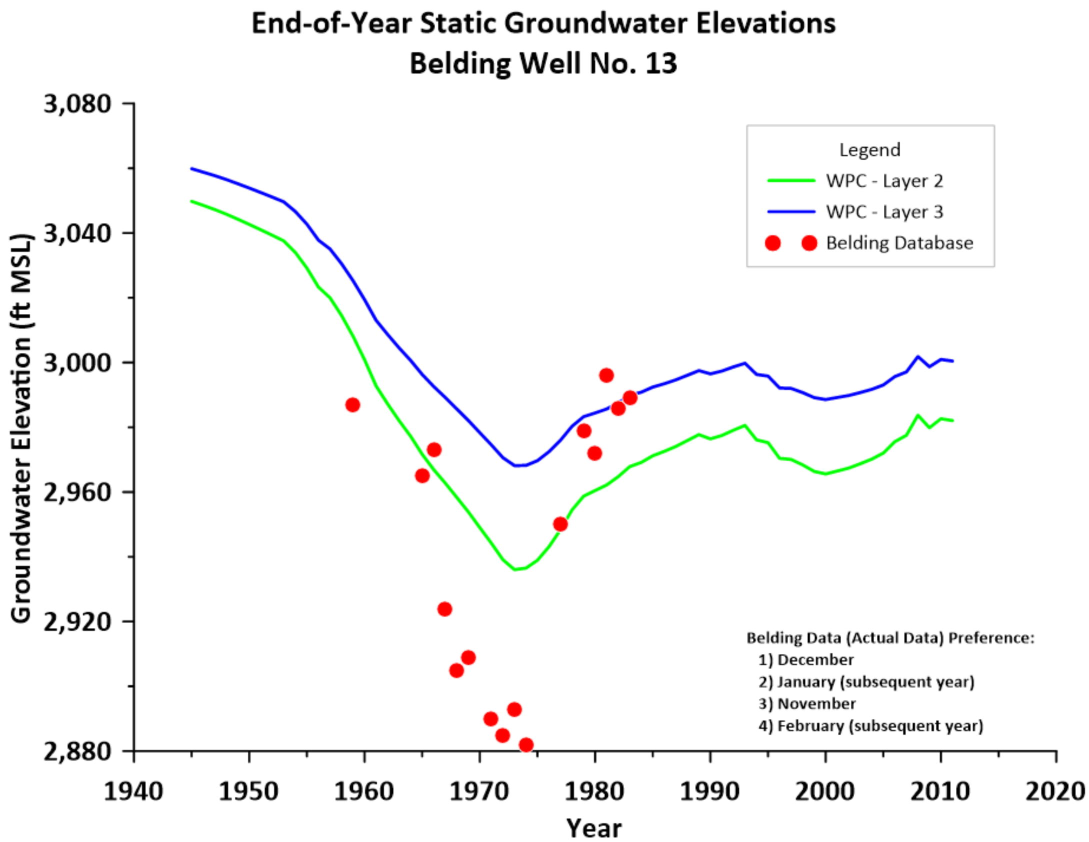

End-of-Year Static Groundwater Elevations
Belding Well No. 8
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Groundwater Elevation (ft MSL)
3,040
3,000
2,960
2,920
2,880
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database

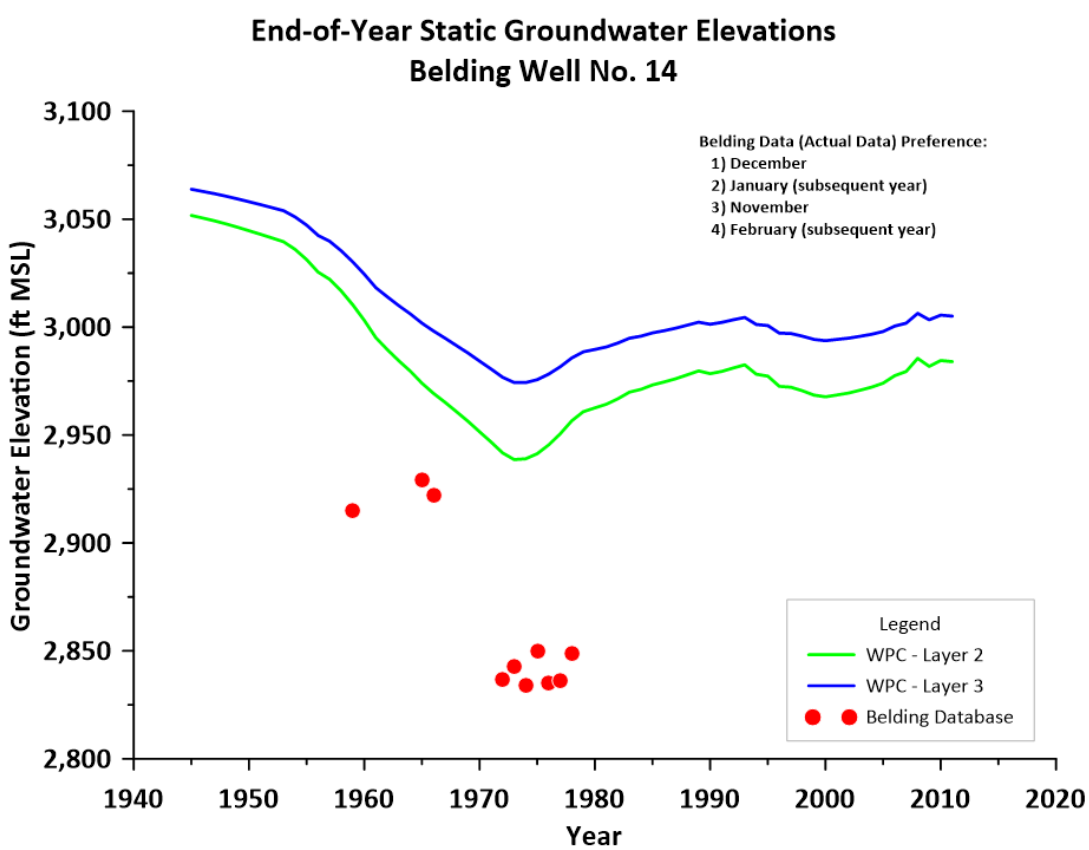

End-of-Year Static Groundwater Elevations
Belding Well No. 9 (no actual data)
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Groundwater Elevation (ft MSL)
3,080
3,040
3,000
2,960
2,920
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year

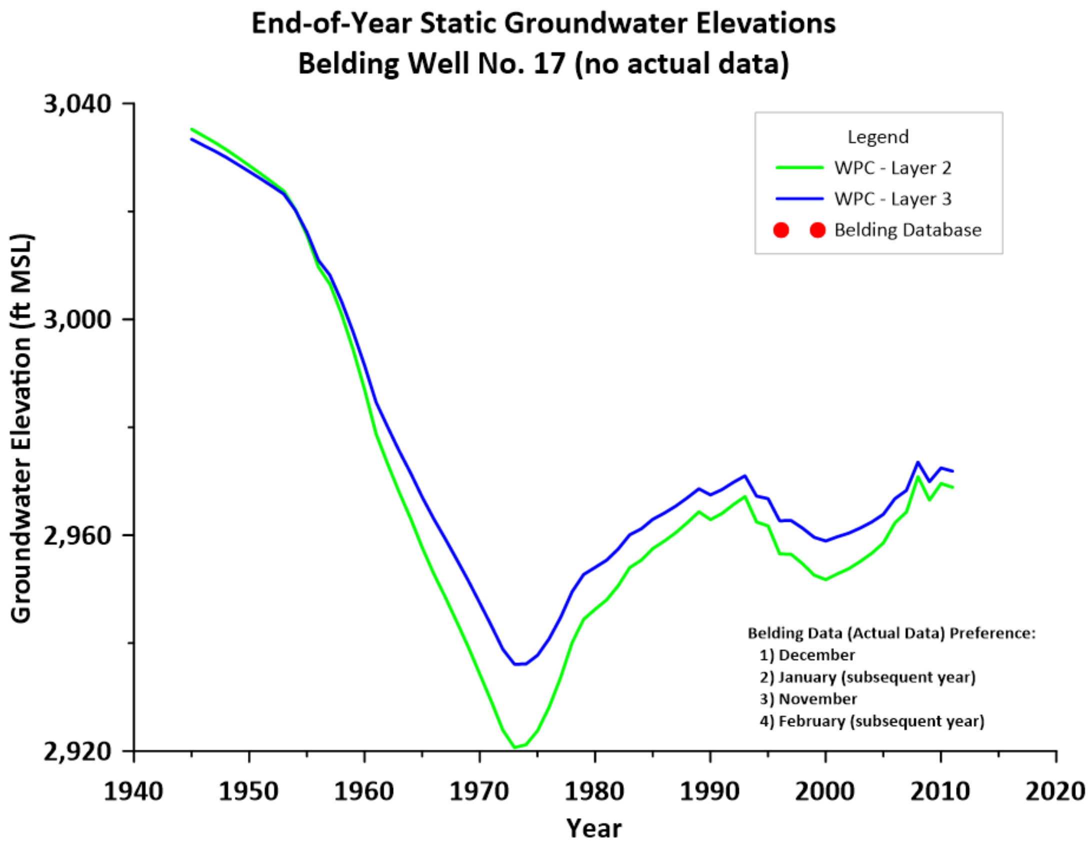

End-of-Year Static Groundwater Elevations
Belding Well No. 10
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Groundwater Elevation (ft MSL)
3,080
3,040
3,000
2,960
2,920
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year

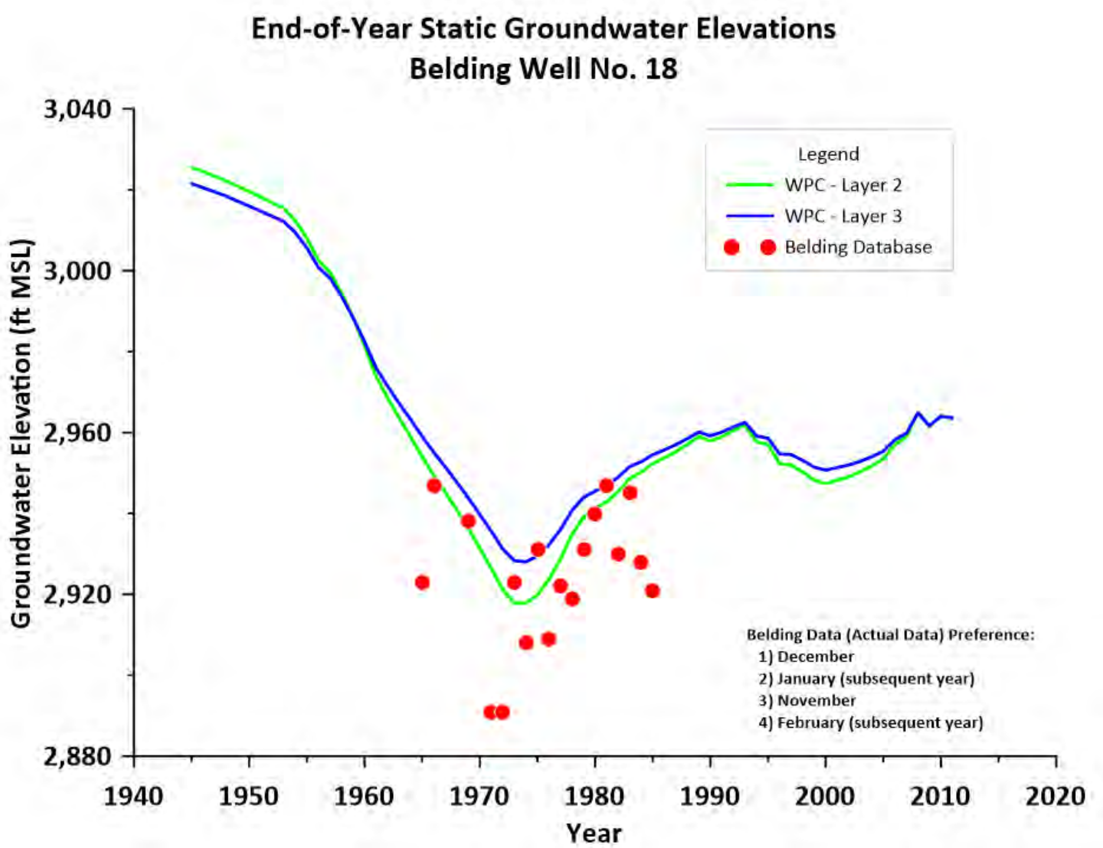

End-of-Year Static Groundwater Elevations
Belding Well No. 11
Groundwater Elevation (ft MSL)
3,080
3,040
3,000
2,960
2,920
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

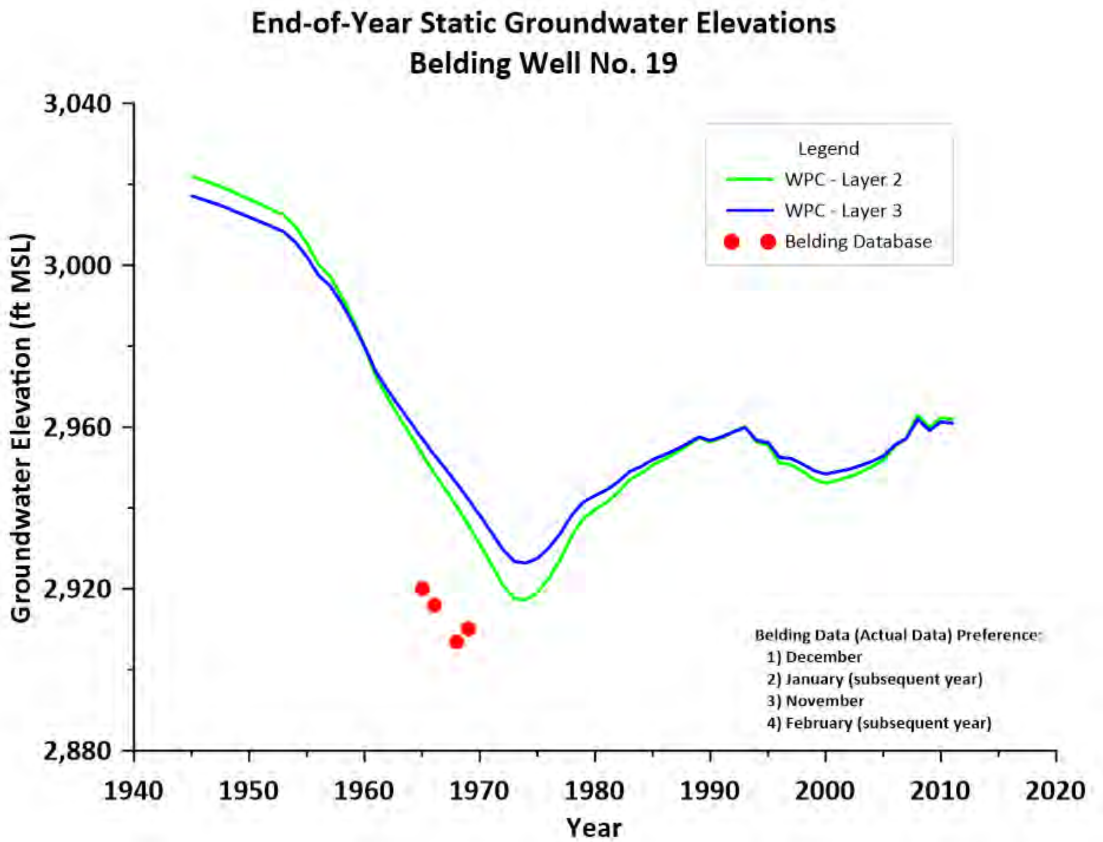

End-of-Year Static Groundwater Elevations
Belding Well No. 12
Groundwater Elevation (ft MSL)
3,080
3,040
3,000
2,960
2,920
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

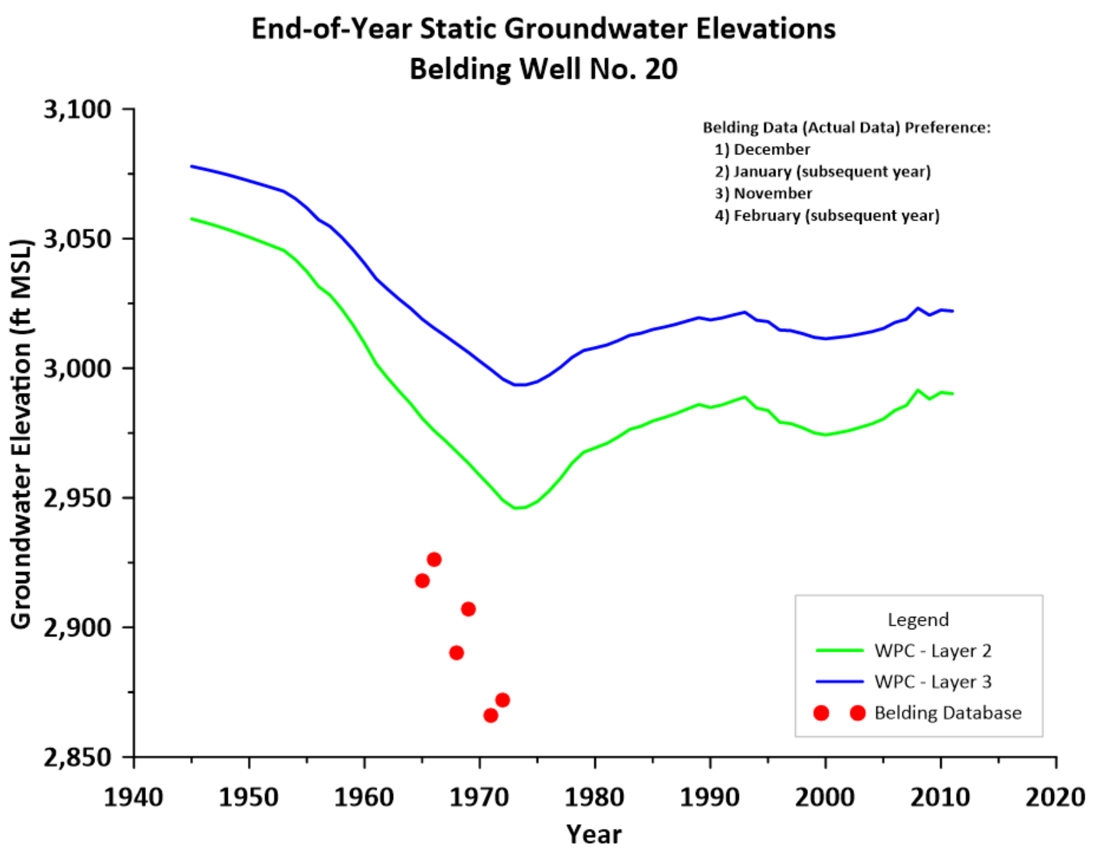

End-of-Year Static Groundwater Elevations
Belding Well No. 13
Groundwater Elevation (ft MSL)
3,080
3,040
3,000
2,960
2,920
2,880
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

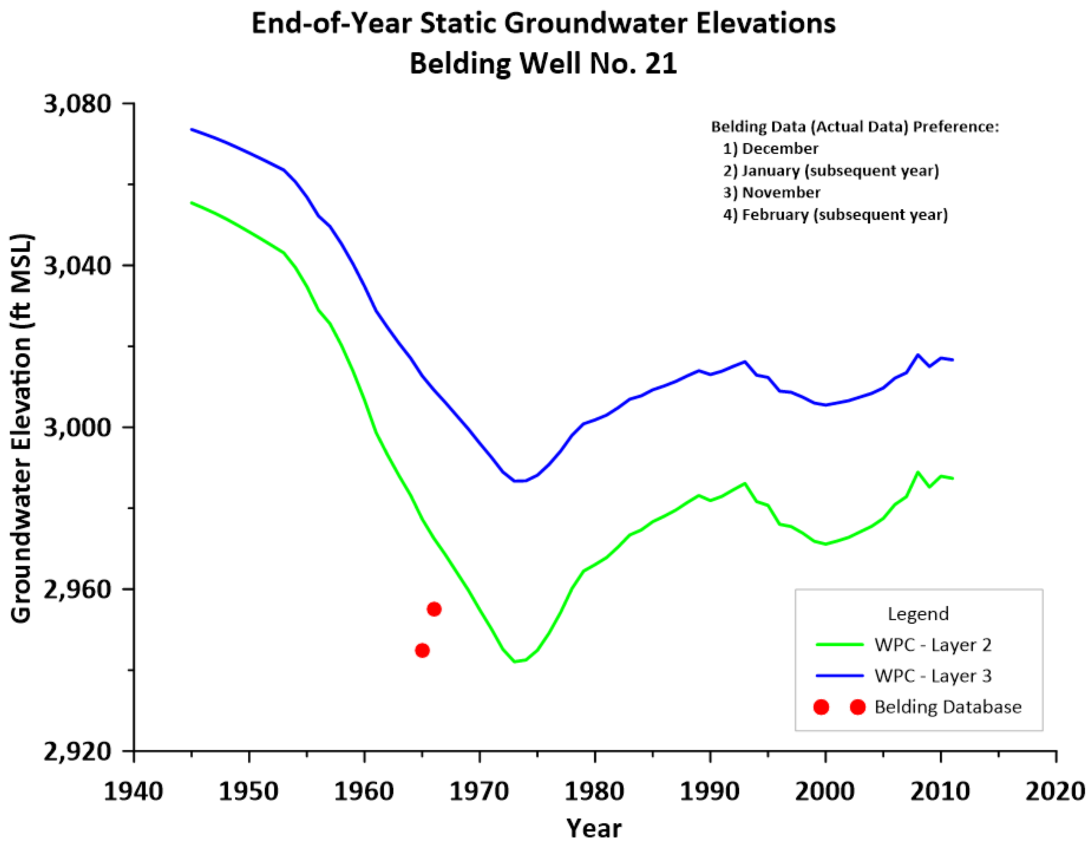

End-of-Year Static Groundwater Elevations
Belding Well No. 14
Groundwater Elevation (ft MSL)
3,100
3,050
3,000
2,950
2,900
2,850
2,800
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database


End-of-Year Static Groundwater Elevations
Belding Well No. 17 (no actual data)
Groundwater Elevation (ft MSL)
3,040
3,000
2,960
2,920
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

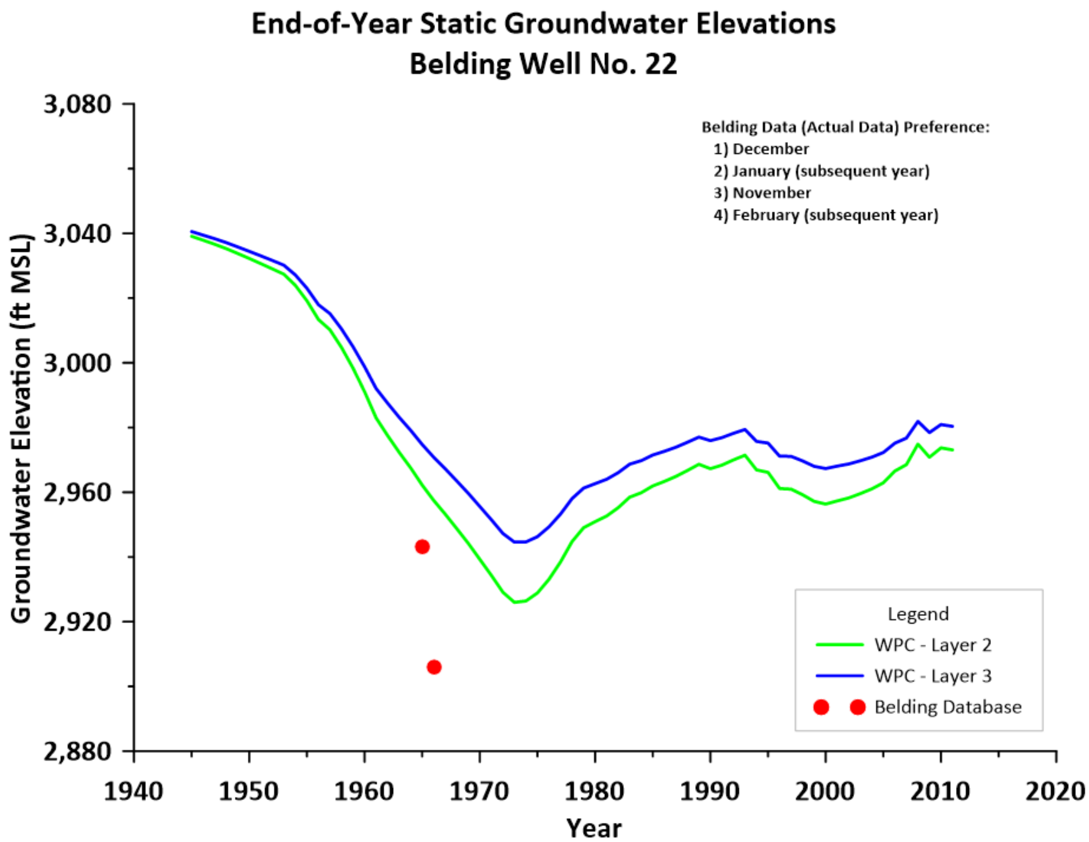

End-of-Year Static Groundwater Elevations
Belding Well No. 18
Groundwater Elevation (ft MSL)
3,040
3,000
2,960
2,920
2,880
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)


End-of-Year Static Groundwater Elevations
Belding Well No. 19
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Groundwater Elevation (ft MSL)
3,040
3,000
2,960
2,920
2,880
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year

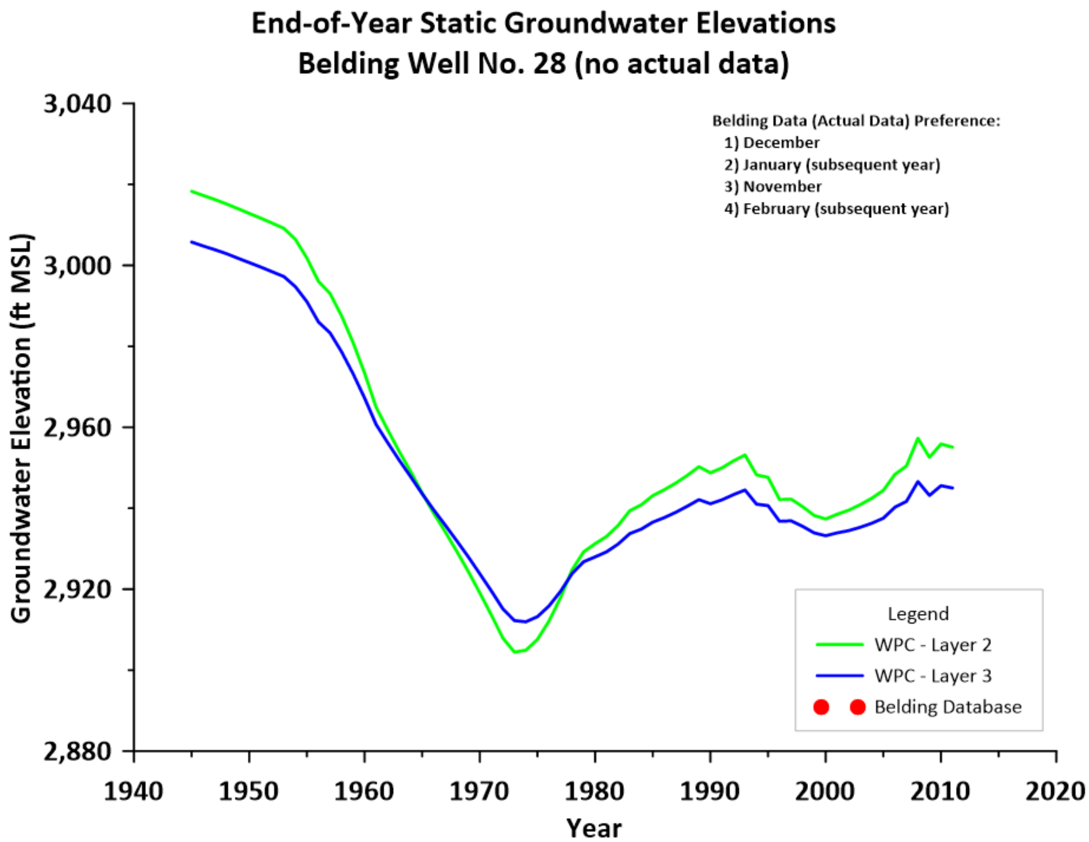

End-of-Year Static Groundwater Elevations
Belding Well No. 20
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Groundwater Elevation (ft MSL)
3,100
3,050
3,000
2,950
2,900
2,850
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year

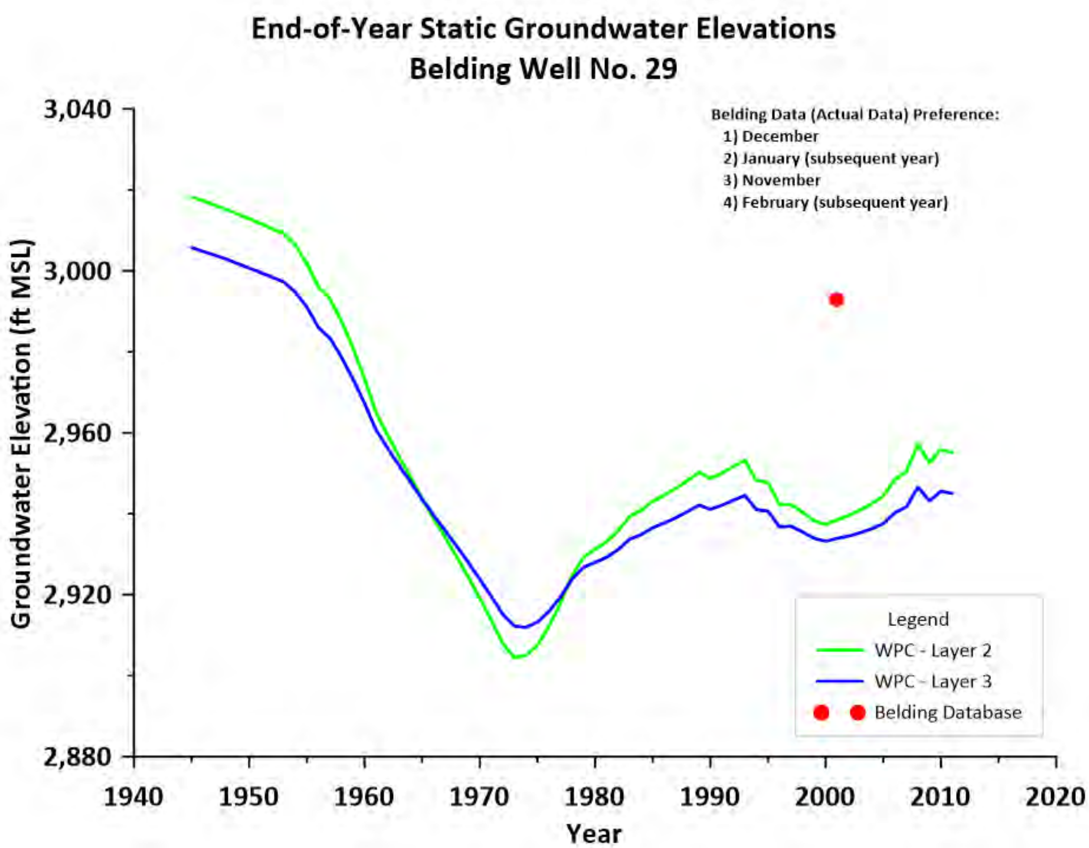


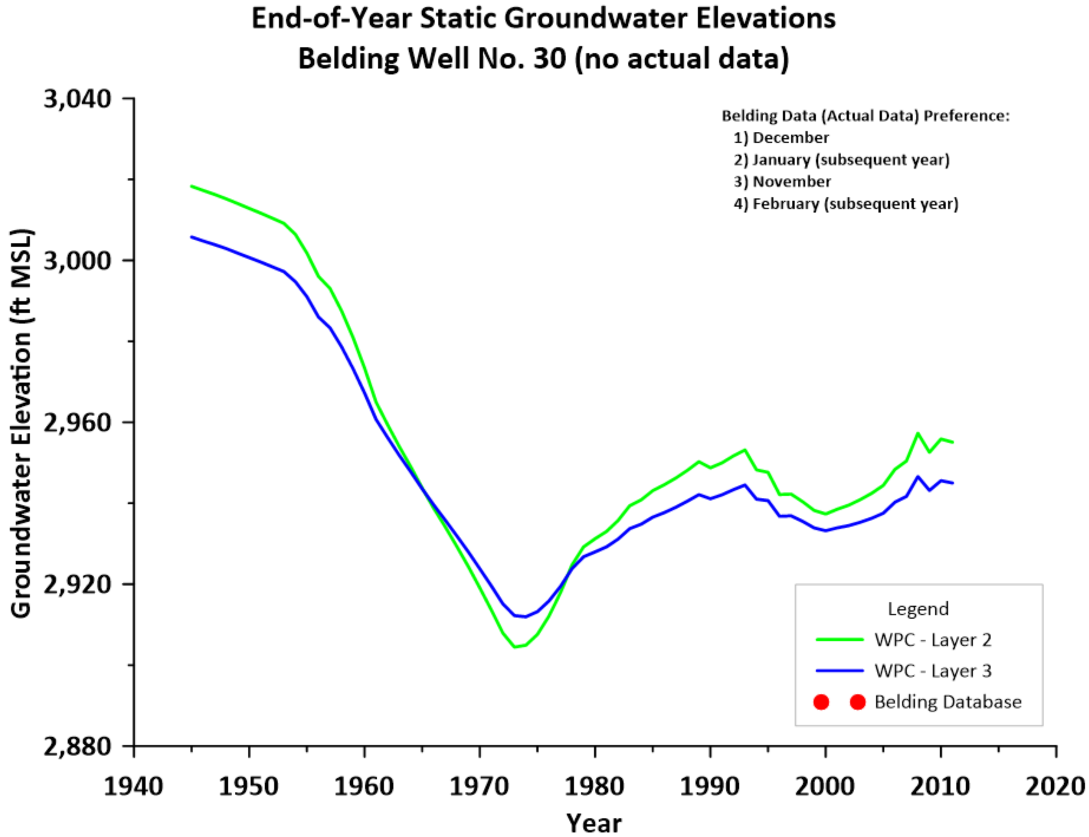
End-of-Year Static Groundwater Elevations
Belding Well No. 21
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Groundwater Elevation (ft MSL)
3,080
3,040
3,000
2,960
2,920
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year



End-of-Year Static Groundwater Elevations
Belding Well No. 22
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Groundwater Elevation (ft MSL)
3,080
3,040
3,000
2,960
2,920
2,880
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year

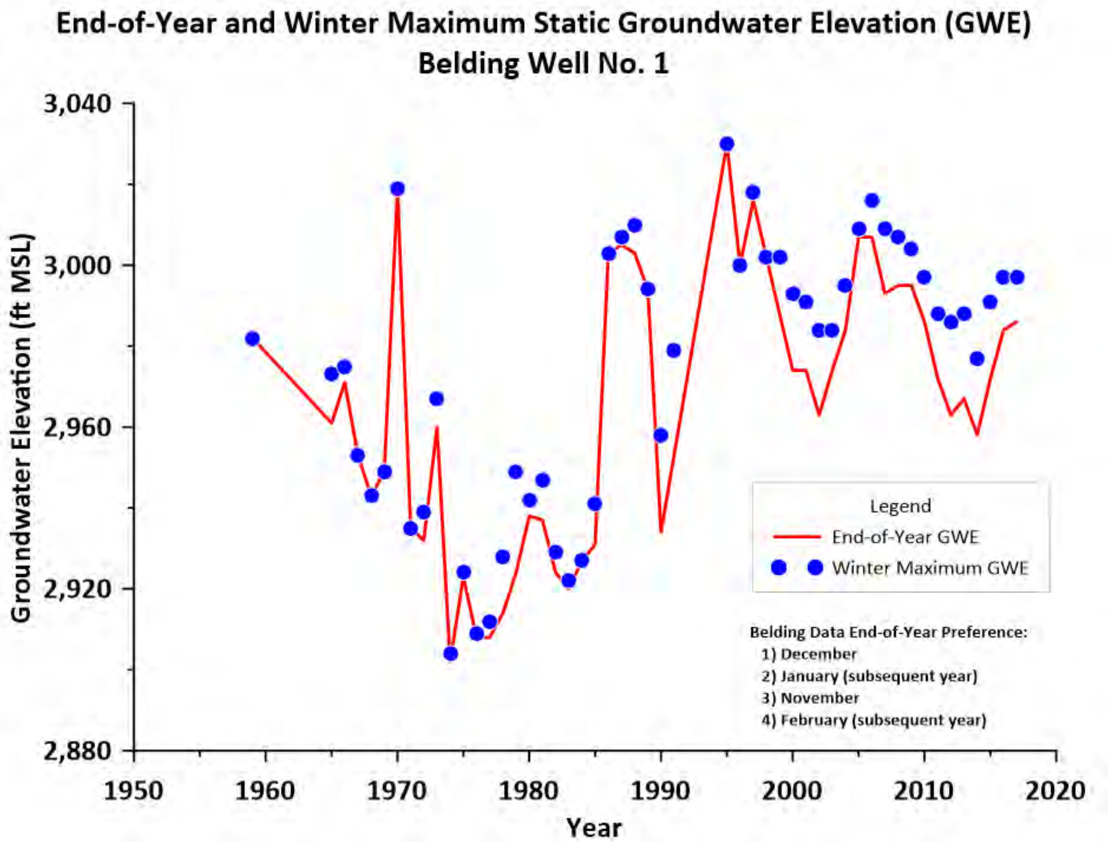

End-of-Year Static Groundwater Elevations
Belding Well No. 28 (no actual data)
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Groundwater Elevation (ft MSL)
3,040
3,000
2,960
2,920
2,880
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year


End-of-Year Static Groundwater Elevations
Belding Well No. 29
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database
Groundwater Elevation (ft MSL)
3,040
3,000
2,960
2,920
2,880
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year

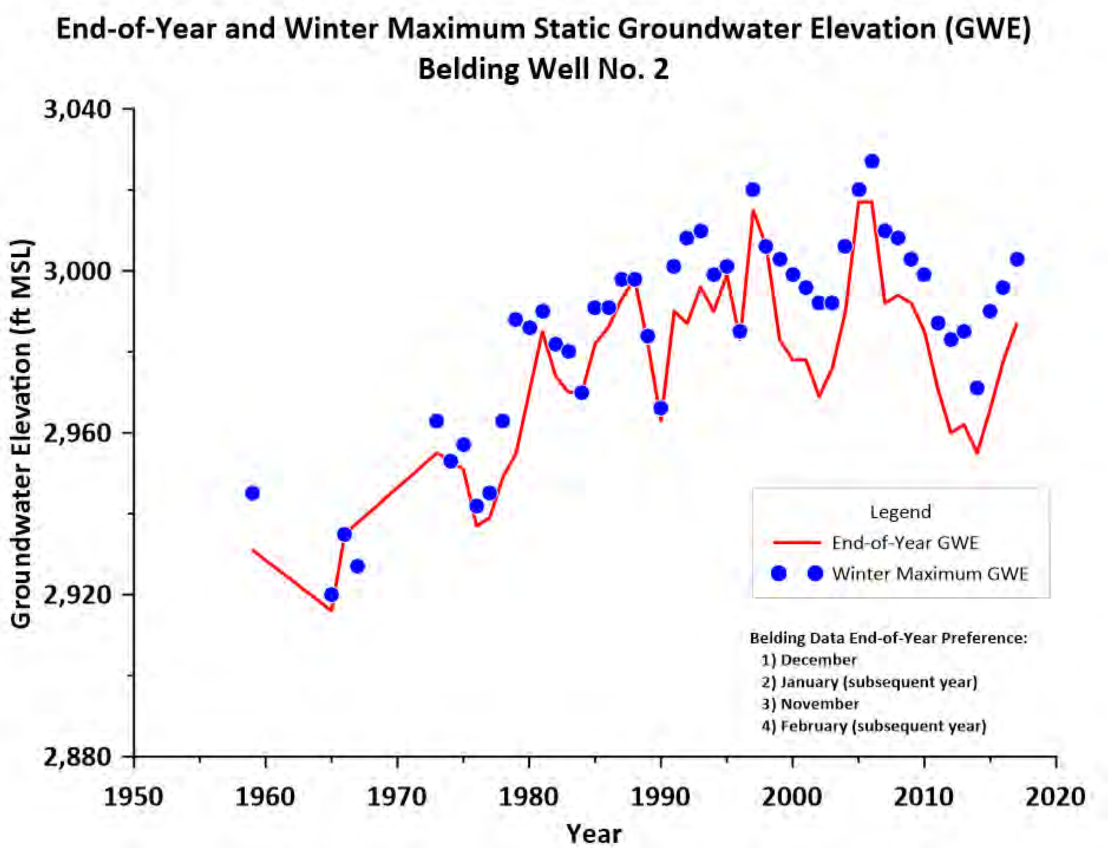

End-of-Year Static Groundwater Elevations
Belding Well No. 30 (no actual data)
Belding Data (Actual Data) Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Groundwater Elevation (ft MSL)
3,040
3,000
2,960
2,920
2,880
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
WPC - Layer 2
WPC - Layer 3
Belding Database

Appendix C

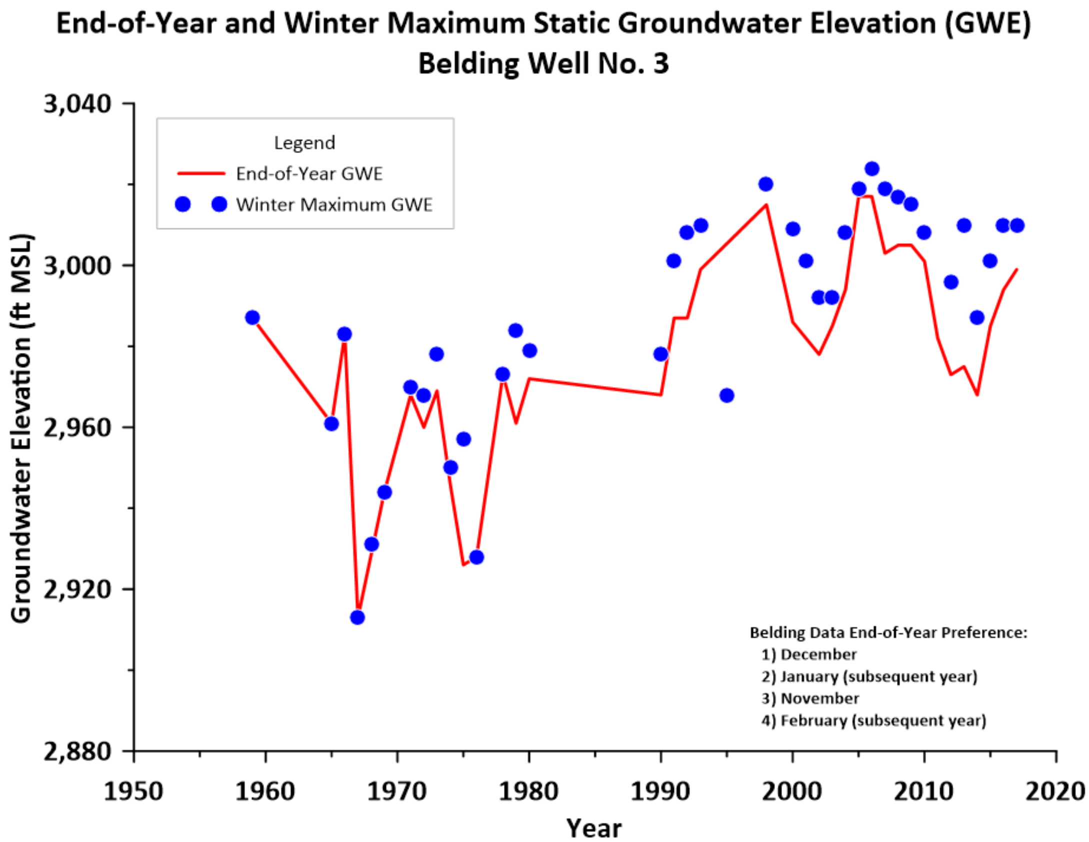
End-of-Year Static Groundwater Elevations and Winter Maximum Static Groundwater Elevations Hydrographs

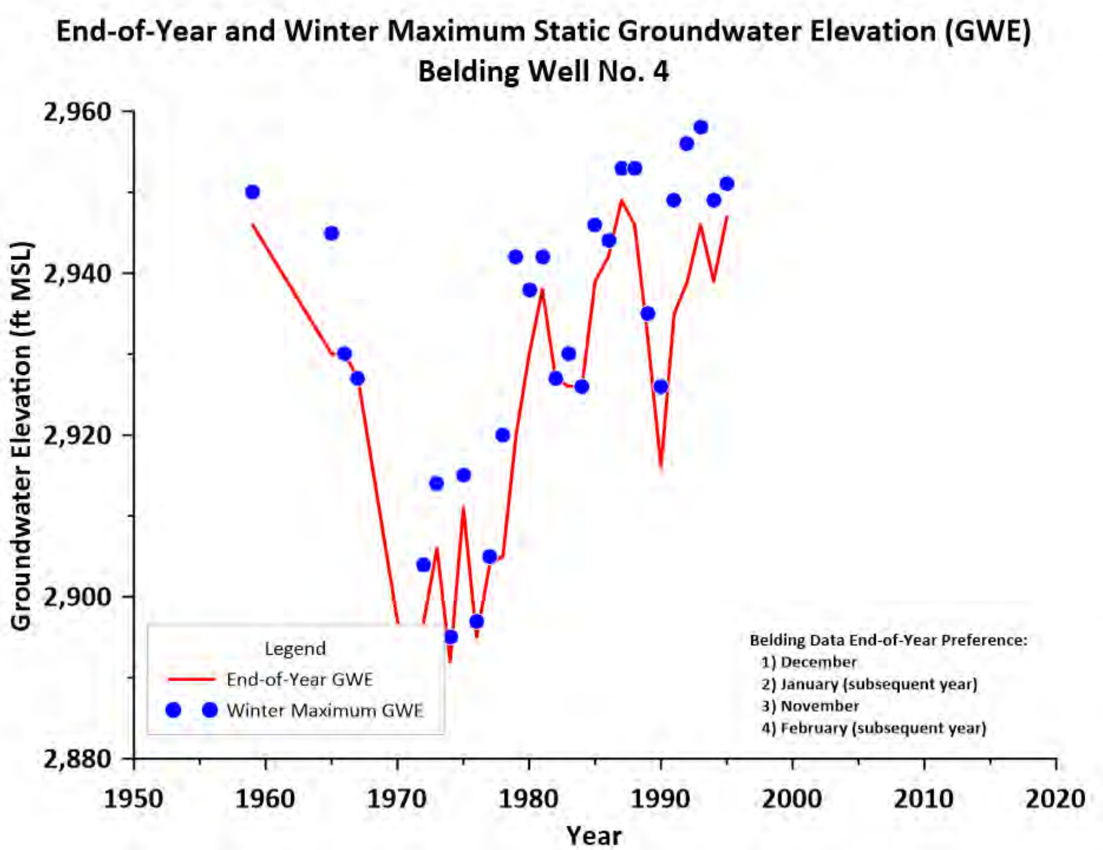


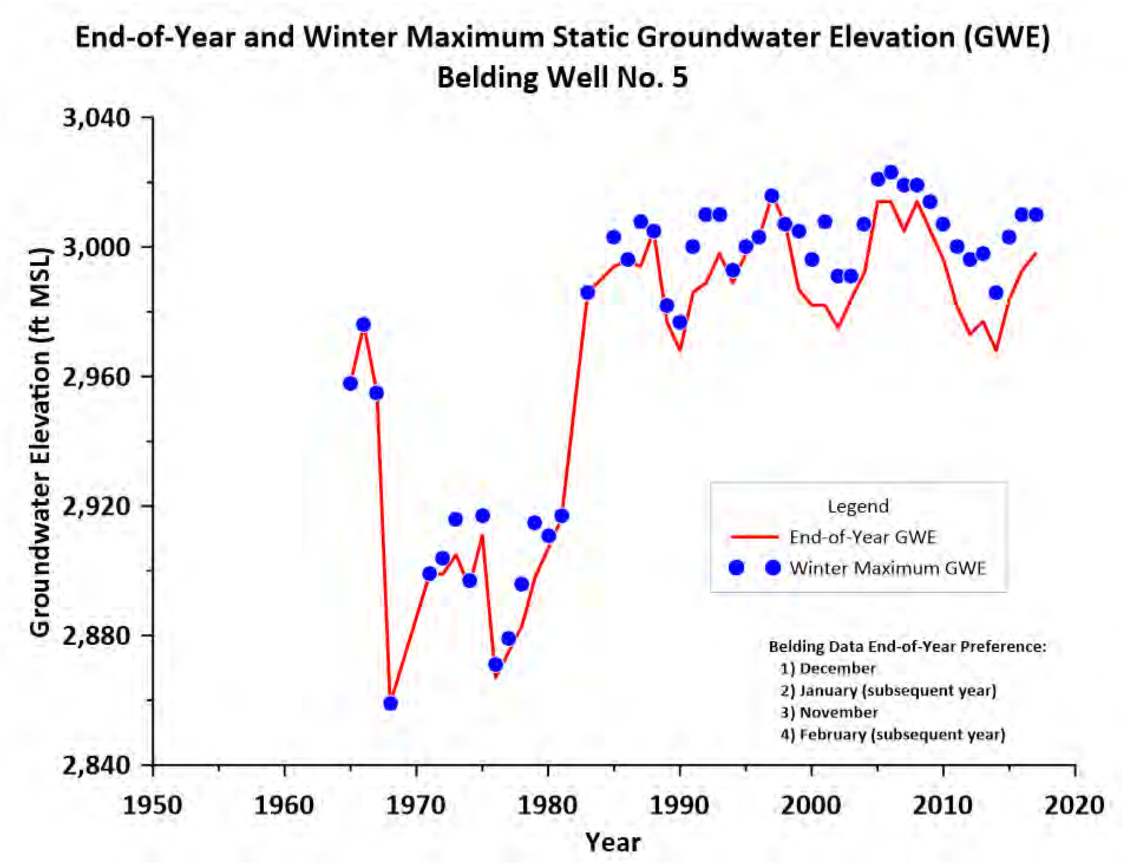
End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 1
Groundwater Elevation (ft MSL)
3,040
3,000
2,960
2,920
2,880
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)



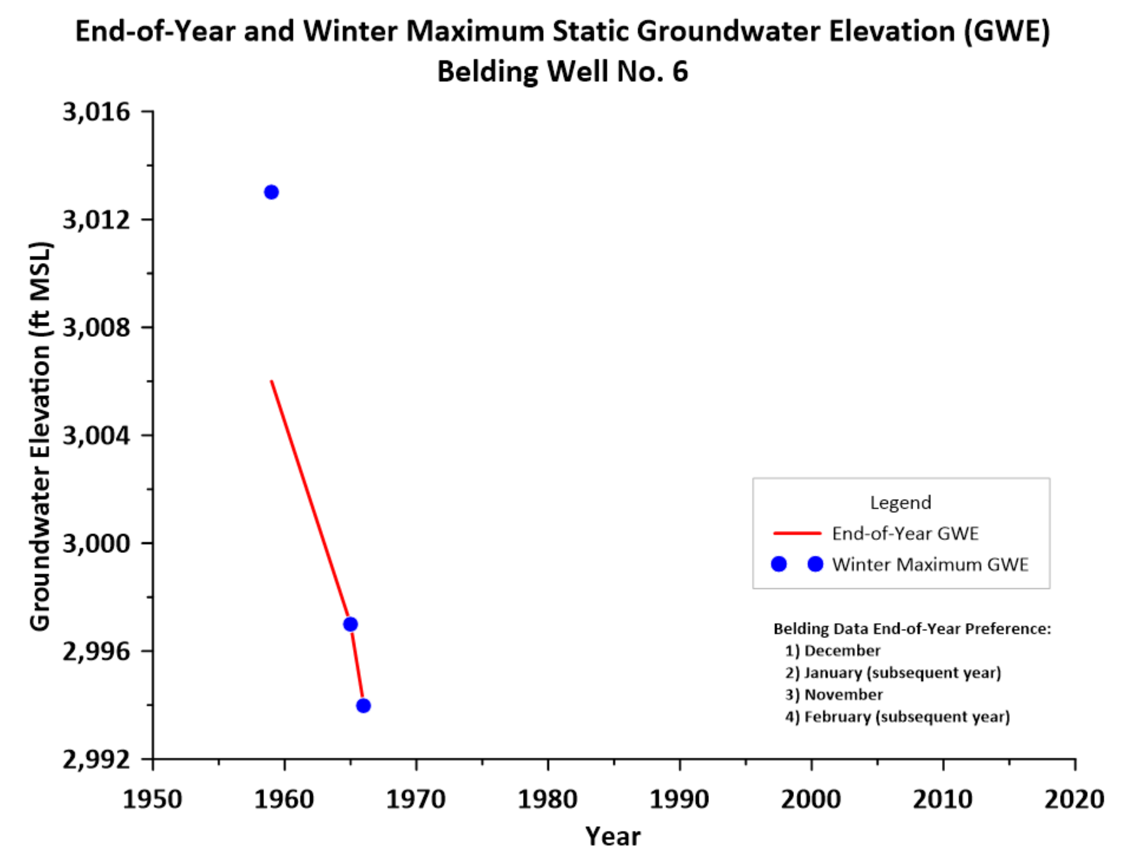
End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 2
Groundwater Elevation (ft MSL)
3,040
3,000
2,960
2,920
2,880
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)


End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 3
Legend
End-of-Year GWE
Winter Maximum GWE
Groundwater Elevation (ft MSL)
3,040
3,000
2,960
2,920
2,880
1950
1960
1970
1980
1990
2000
2010
2020
Year
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

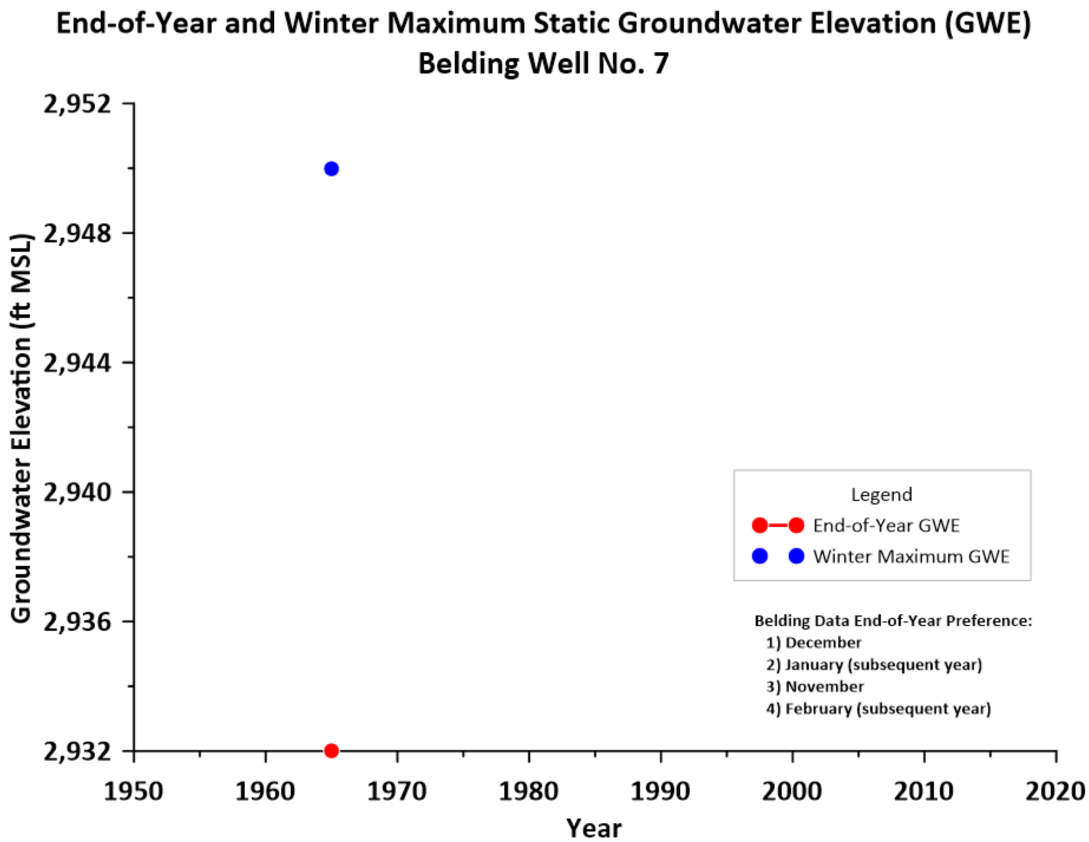

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 4
Legend
End-of-Year GWE
Winter Maximum GWE
Groundwater Elevation (ft MSL)
2,960
2,940
2,920
2,900
2,880
1950
1960
1970
1980
1990
2000
2010
2020
Year
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)



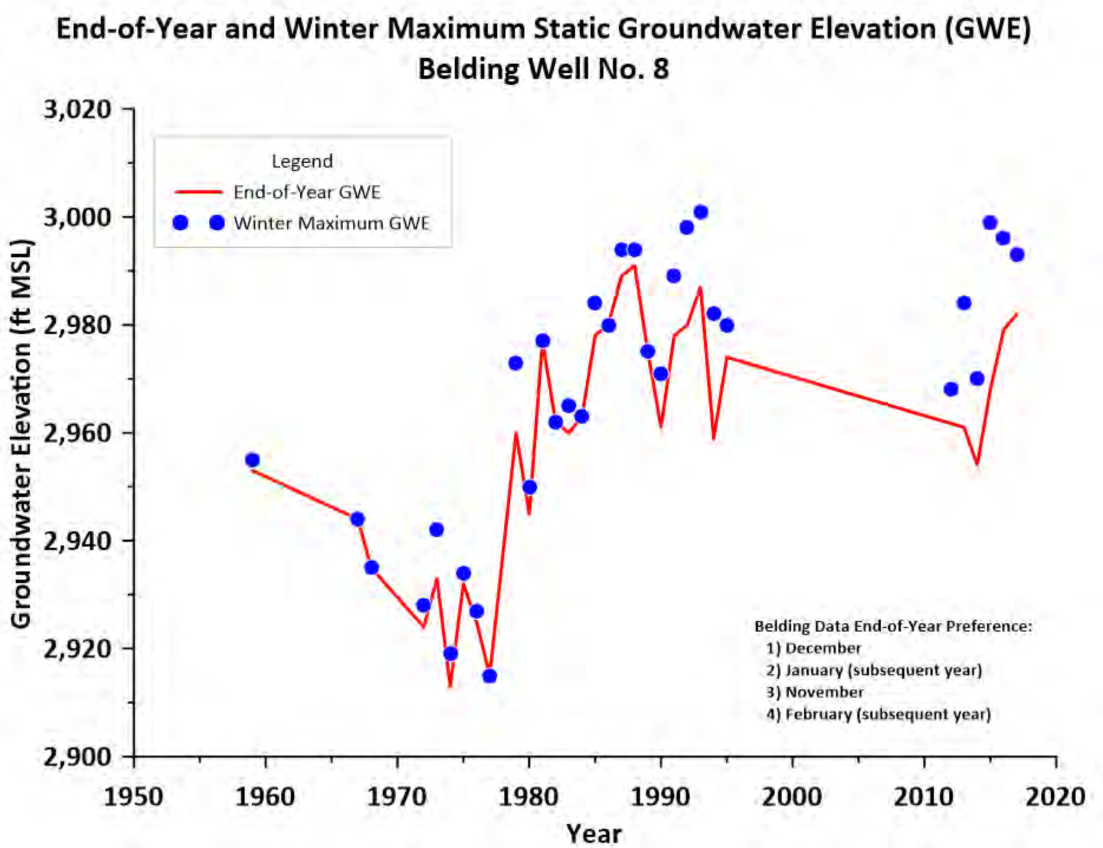
End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 5
Groundwater Elevation (ft MSL)
3,040
3,000
2,960
2,920
2,880
2,840
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)



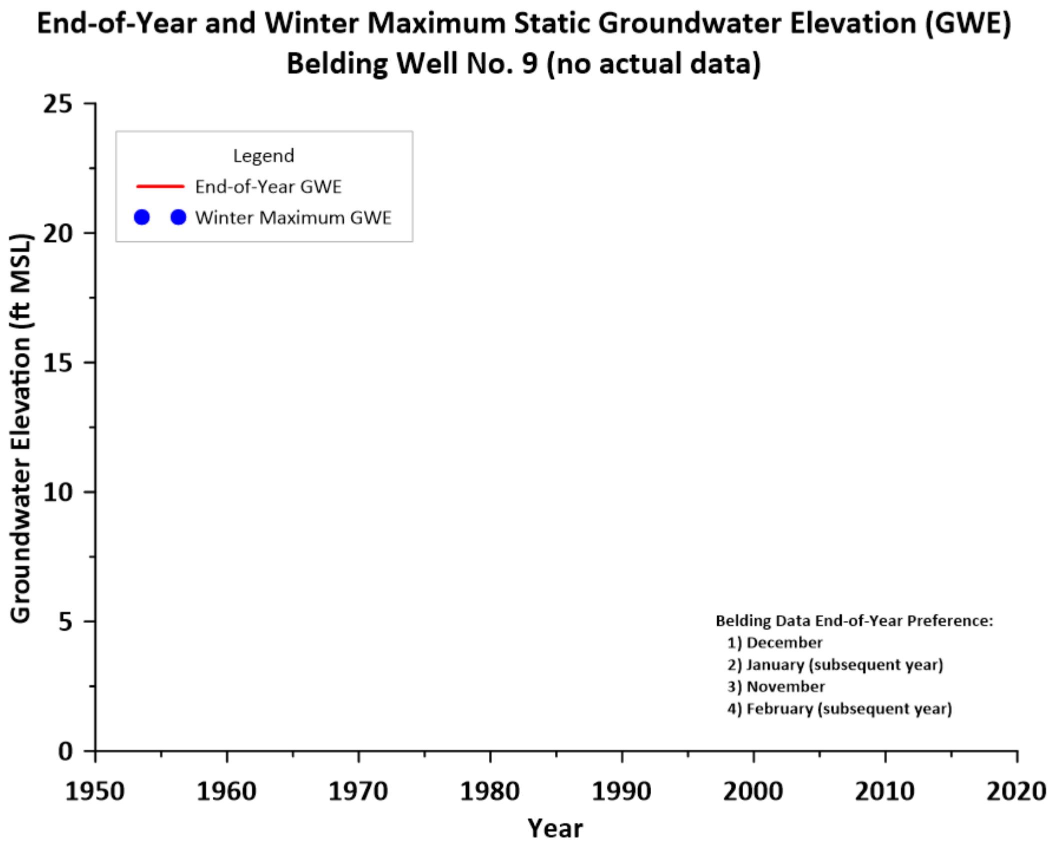
End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 6
Groundwater Elevation (ft MSL)
3,016
3,012
3,008
3,004
3,000
2,996
2,992
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

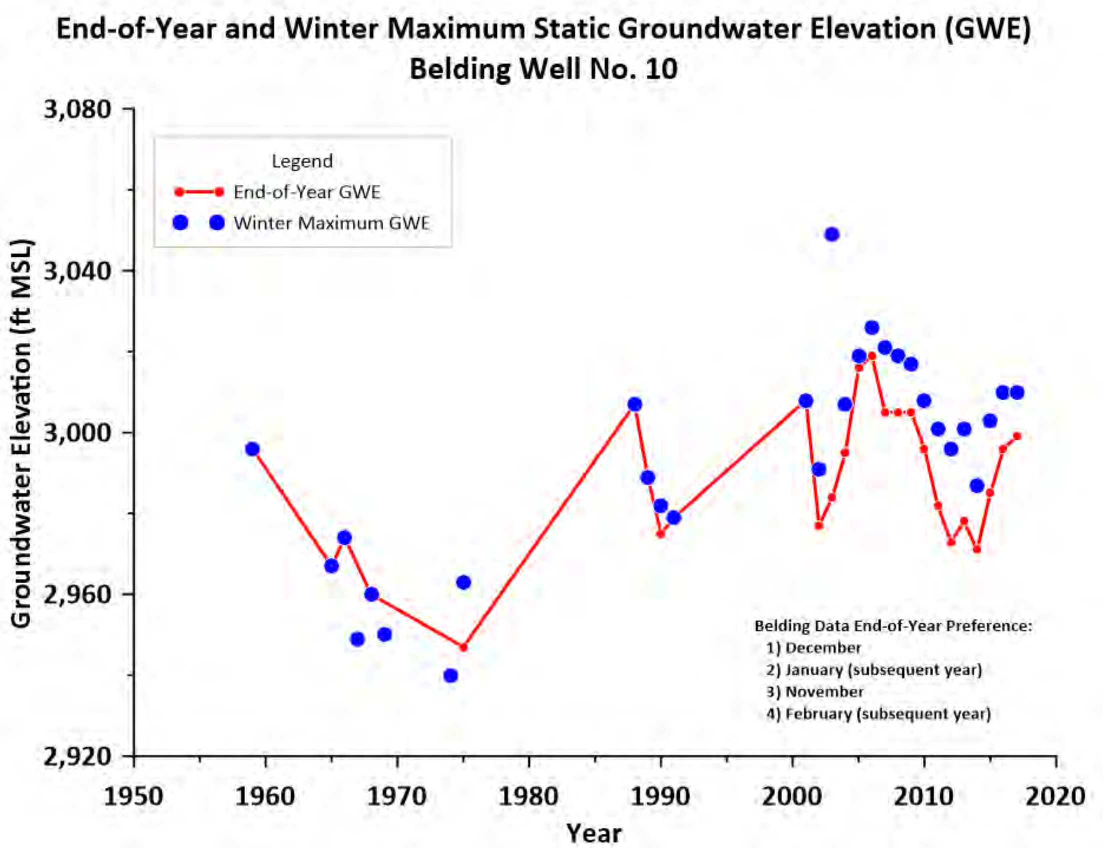


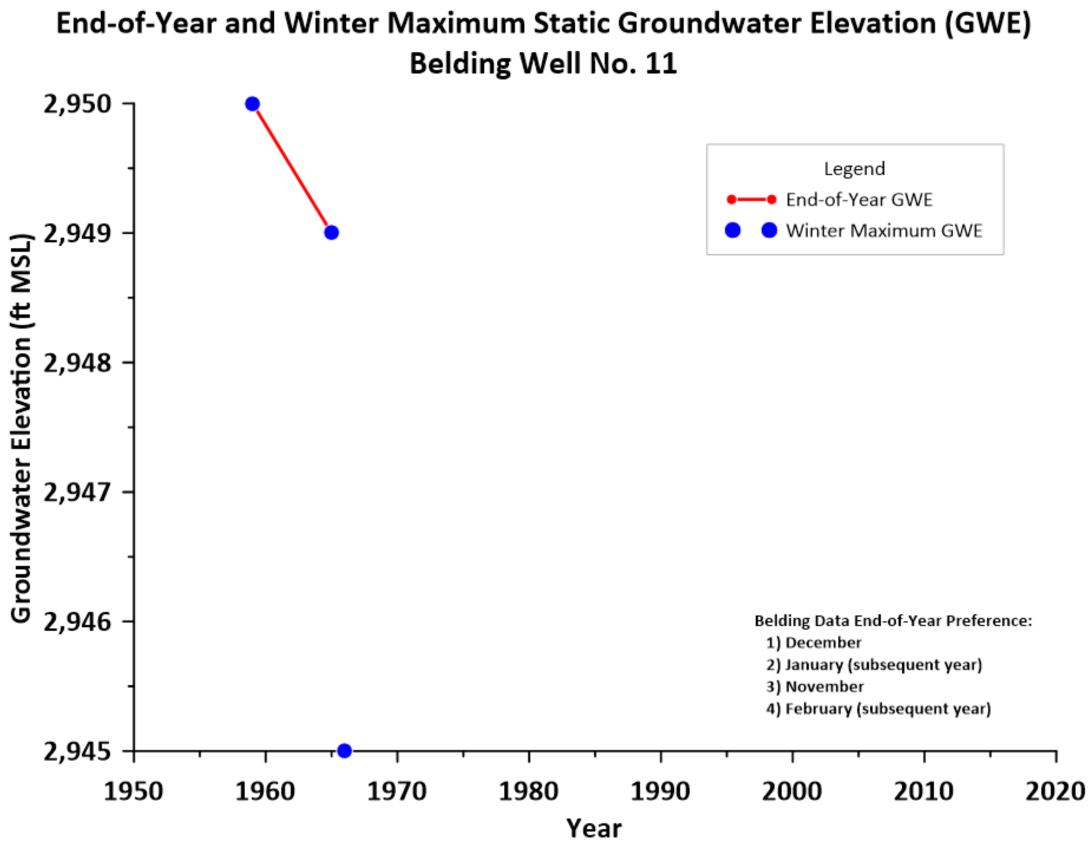
End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 7
Groundwater Elevation (ft MSL)
2,952
2,948
2,944
2,940
2,936
2,932
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

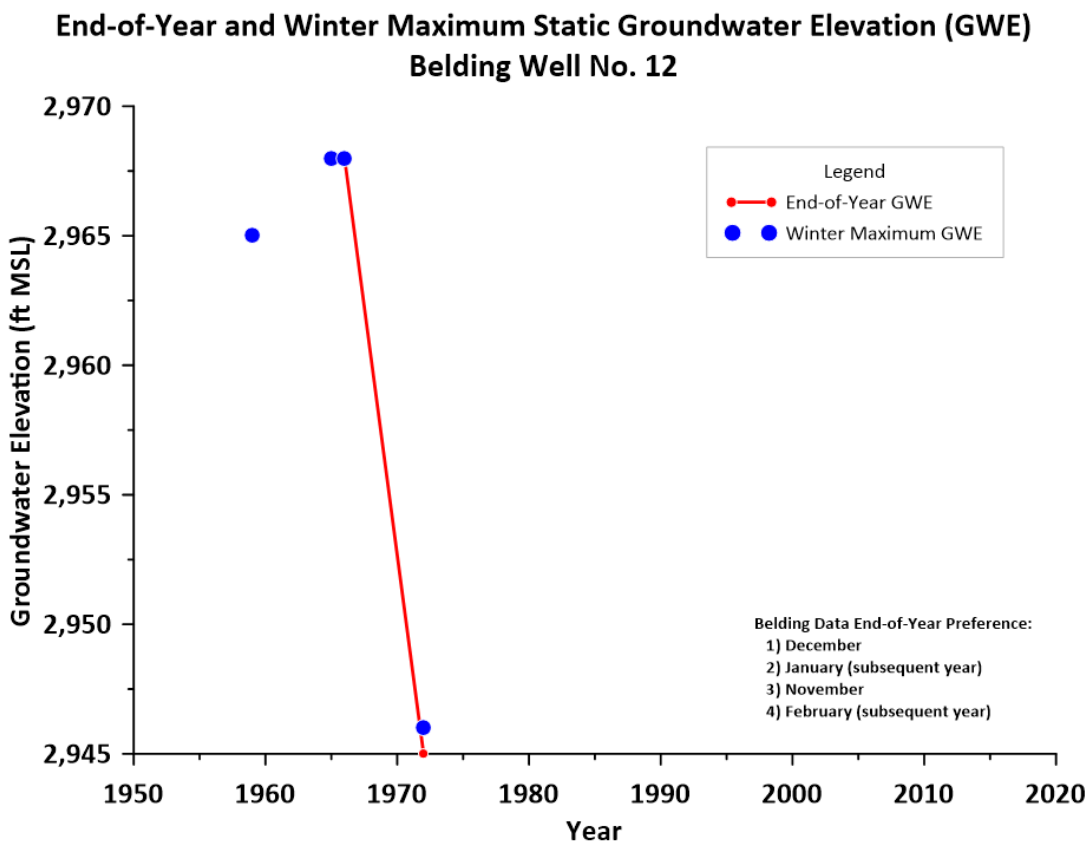


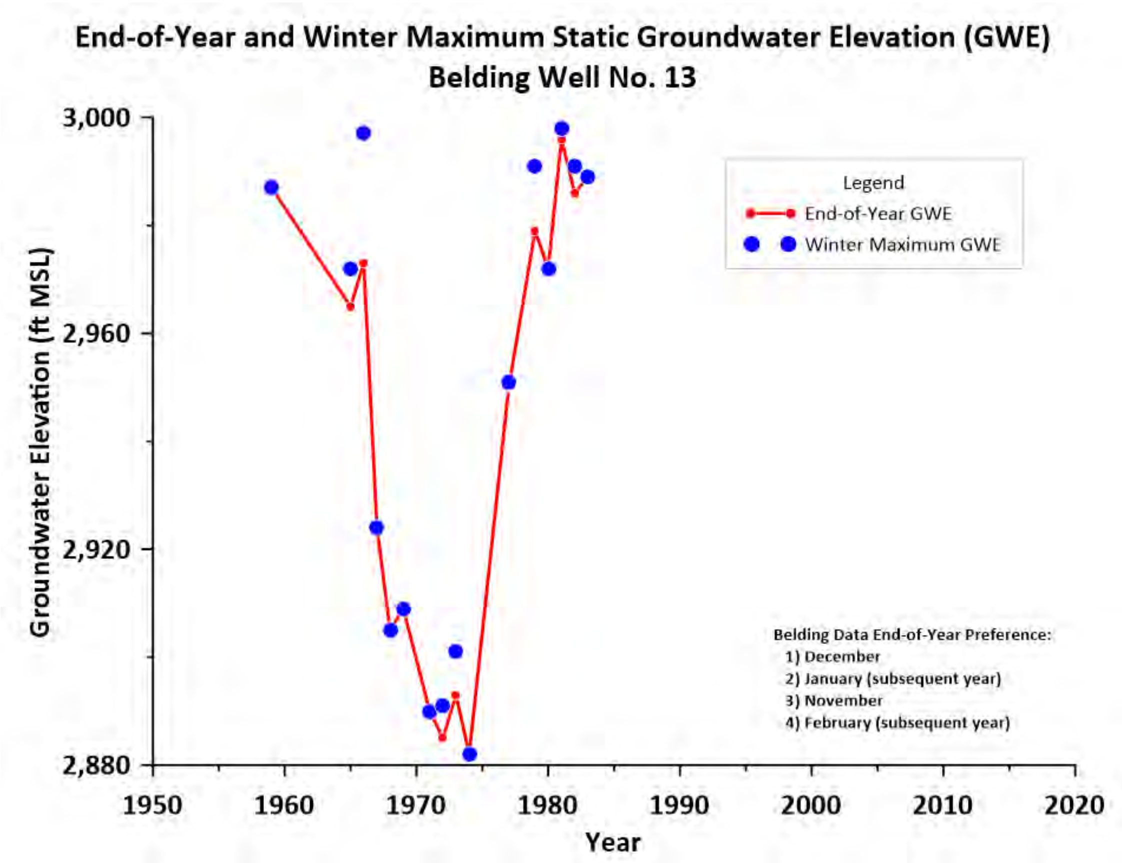
End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 8
Groundwater Elevation (ft MSL)
3,020
3,000
2,980
2,960
2,940
2,920
2,900
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

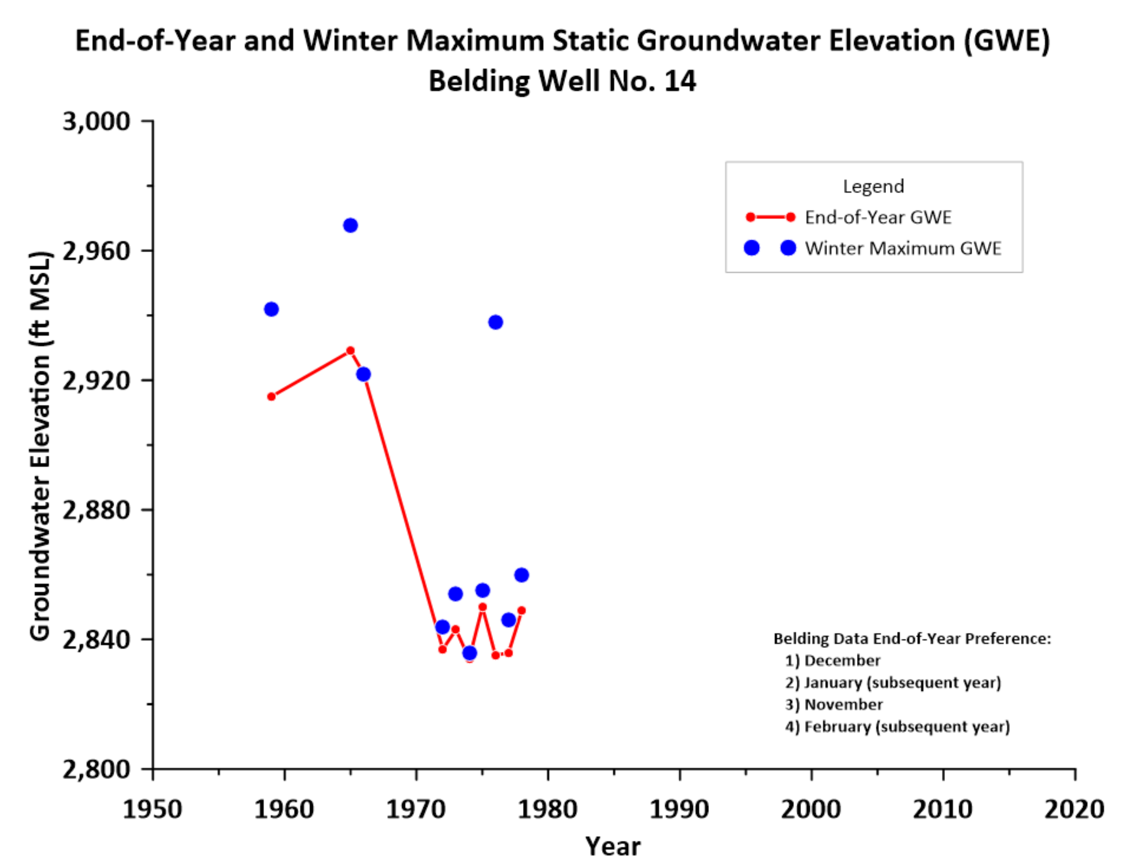

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 9 (no actual data)
Legend
End-of-Year GWE
Winter Maximum GWE
Groundwater Elevation (ft MSL)
25
20
15
10
5
0
1950
1960
1970
1980
1990
2000
2010
2020
Year
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

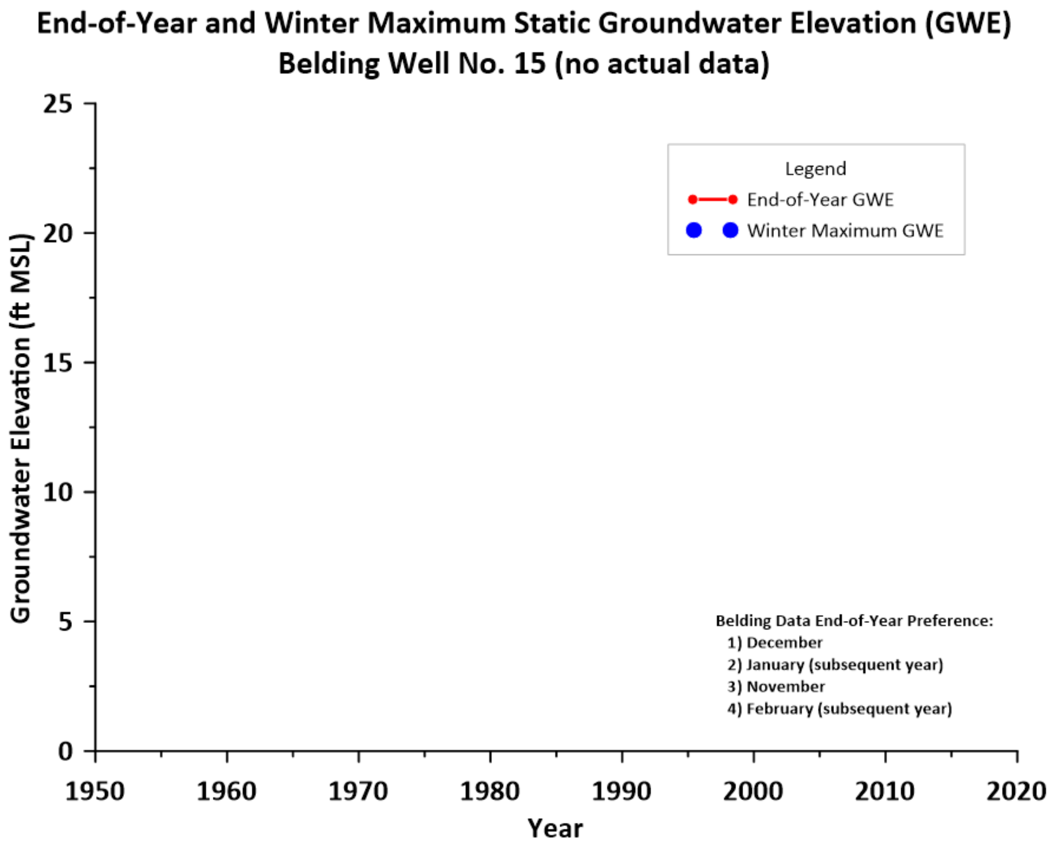

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 10
Legend
End-of-Year GWE
Winter Maximum GWE
Groundwater Elevation (ft MSL)
3,080
3,040
3,000
2,960
2,920
1950
1960
1970
1980
1990
2000
2010
2020
Year
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

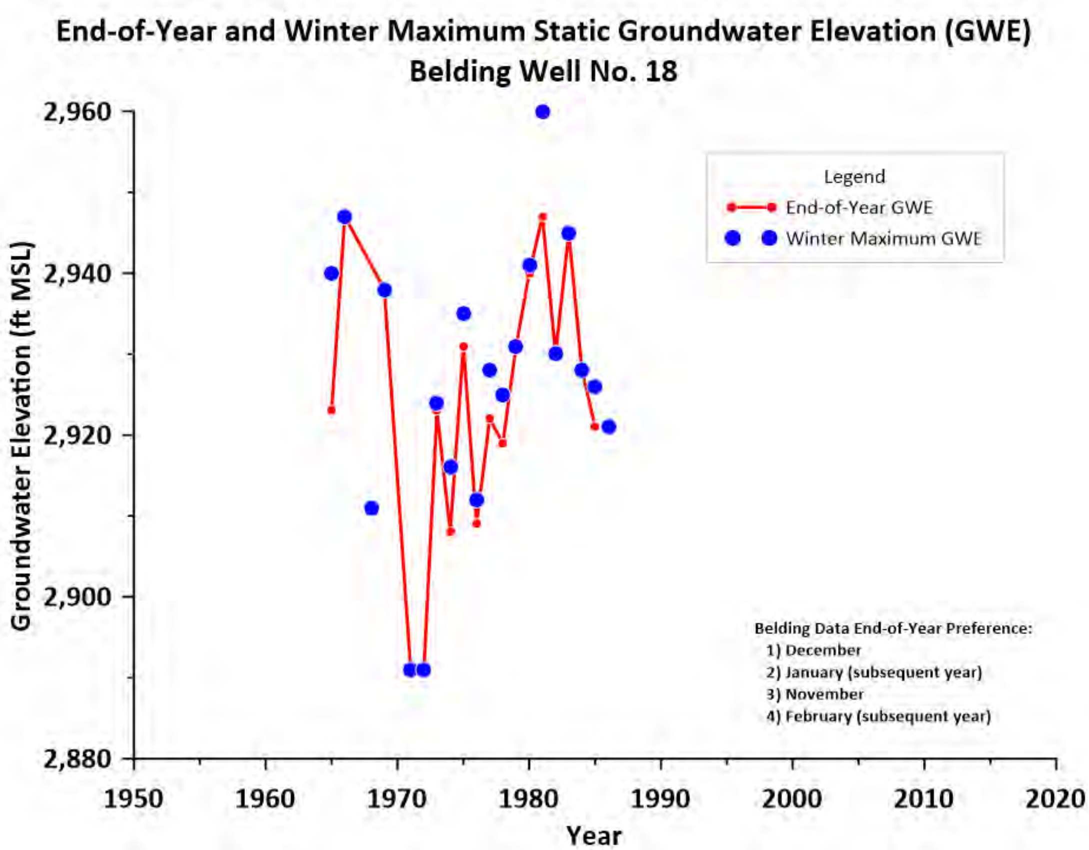

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 11
Groundwater Elevation (ft MSL)
2,950
2,949
2,948
2,947
2,946
2,945
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

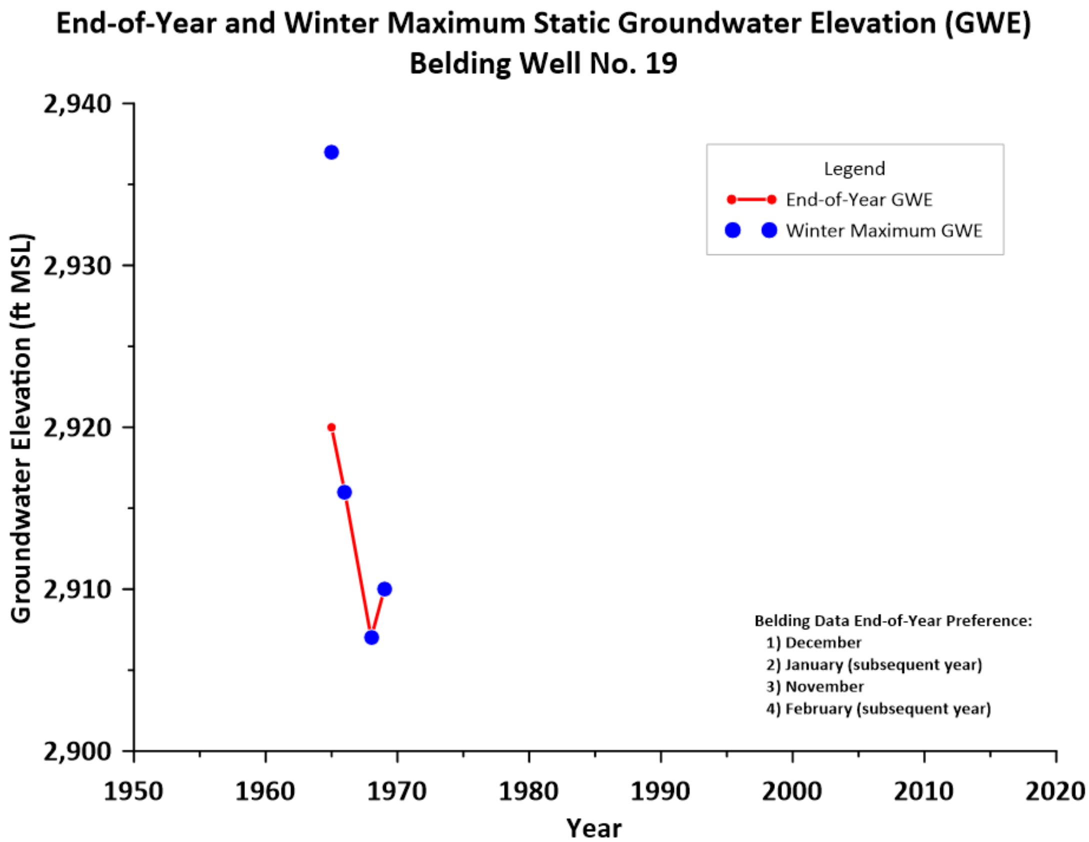

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 12
Groundwater Elevation (ft MSL)
2,970
2,965
2,960
2,955
2,950
2,945
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

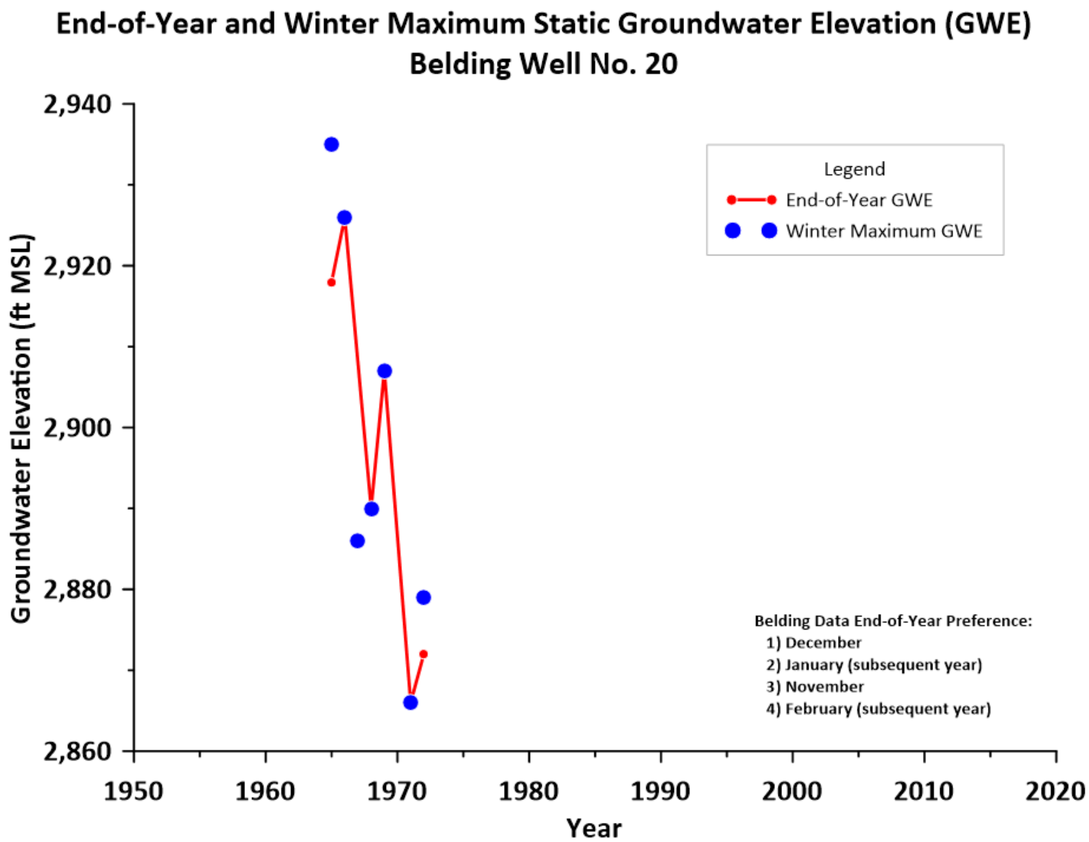

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 13
Groundwater Elevation (ft MSL)
3,000
2,960
2,920
2,880
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

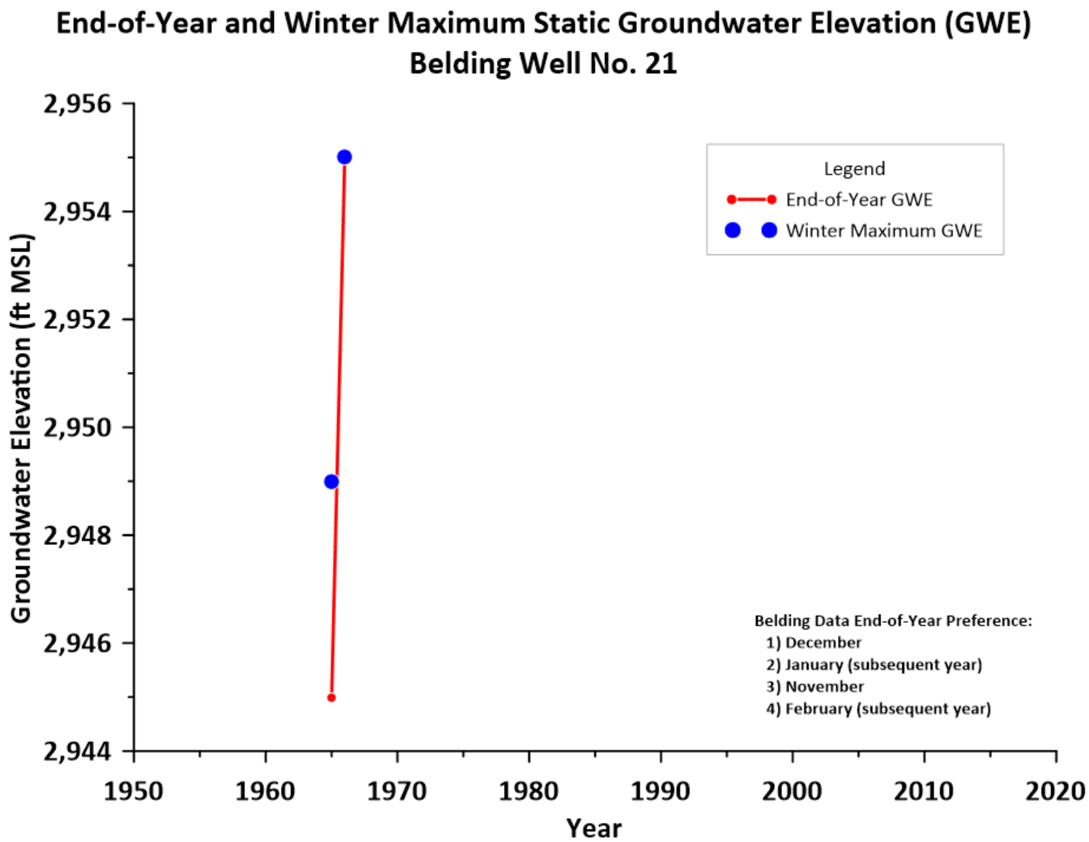

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 14
Groundwater Elevation (ft MSL)
3,000
2,960
2,920
2,880
2,840
2,800
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

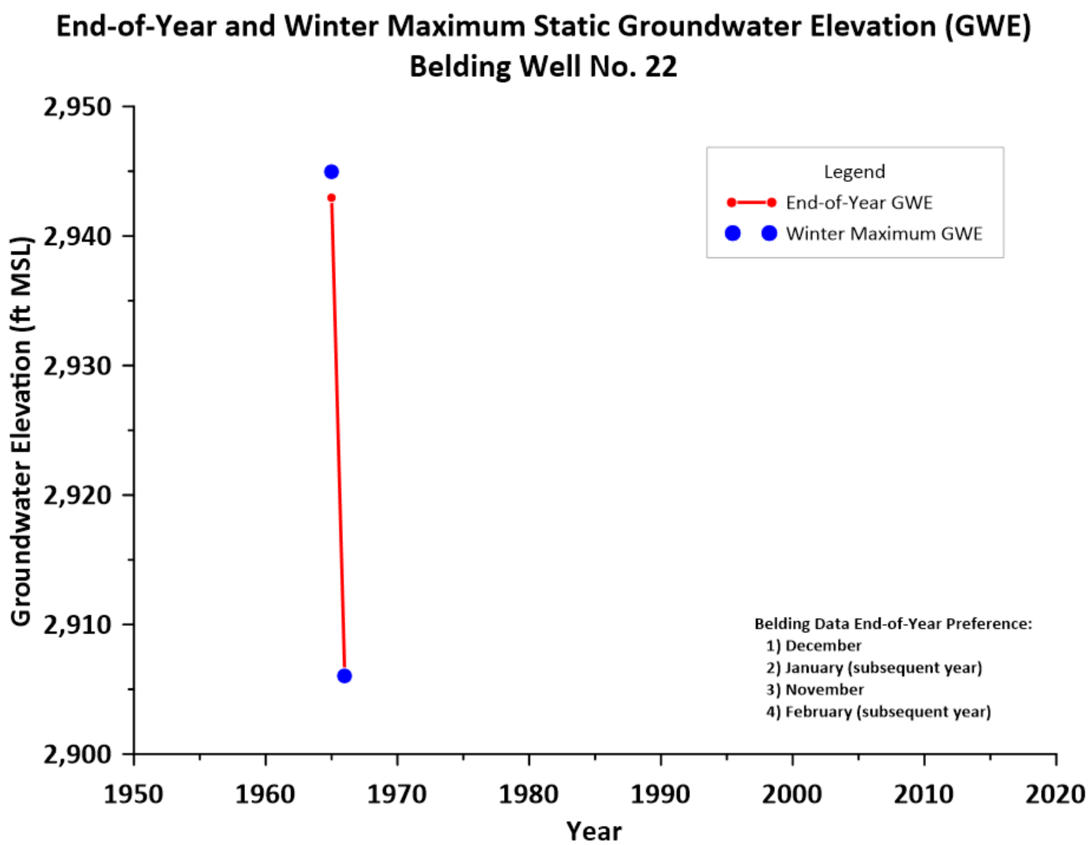

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 15 (no actual data)
Groundwater Elevation (ft MSL)
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

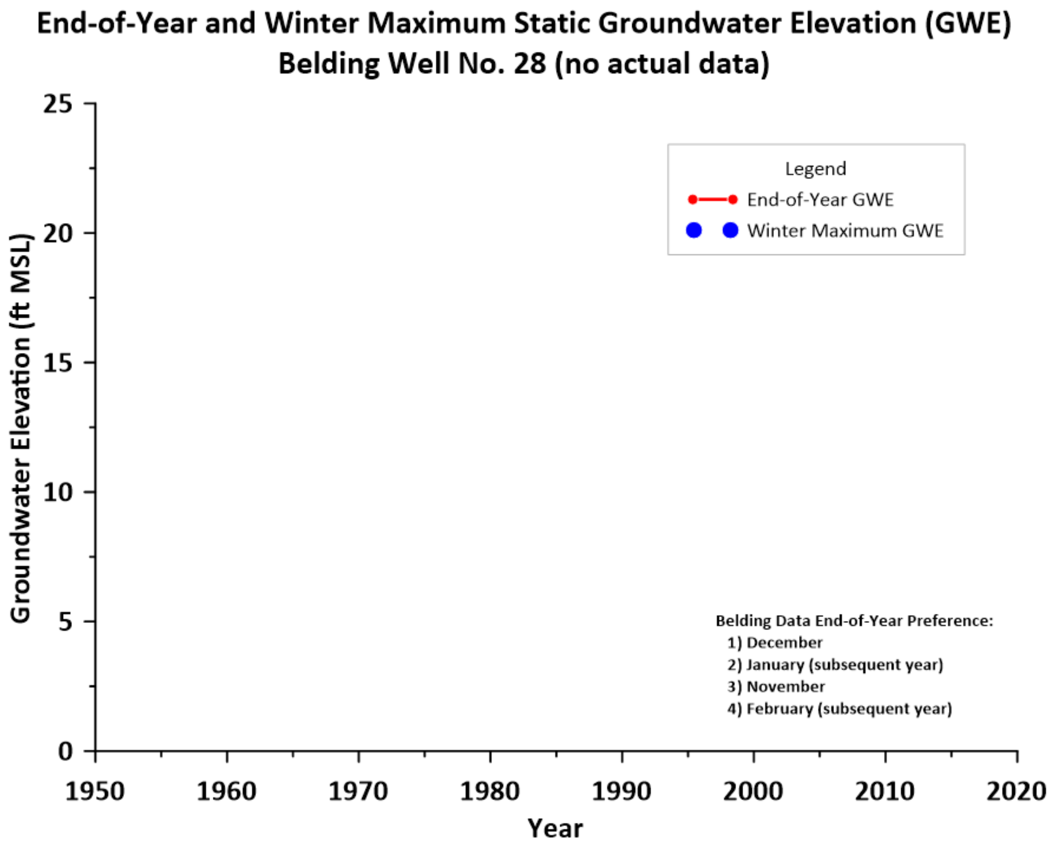

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 18
Groundwater Elevation (ft MSL)
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

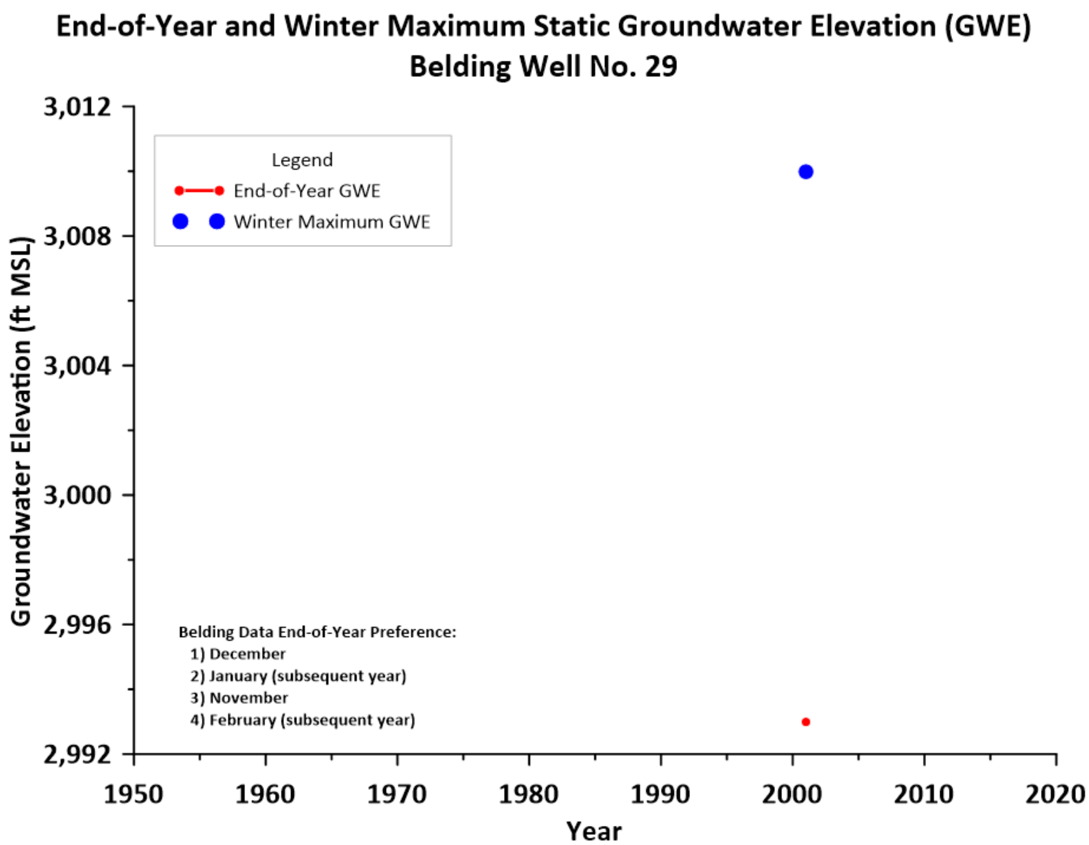

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 19
Groundwater Elevation (ft MSL)
2,940
2,930
2,920
2,910
2,900
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

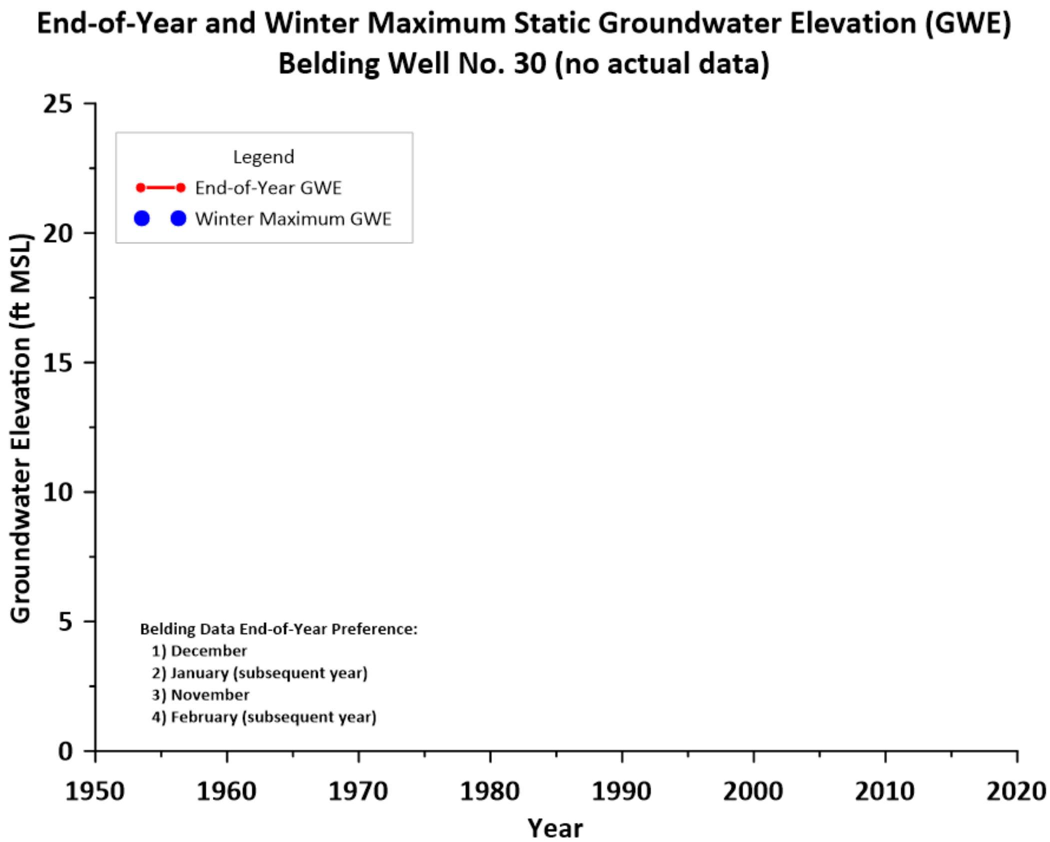

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 20
Groundwater Elevation (ft MSL)
2,940
2,920
2,900
2,880
2,860
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)


End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 21
Groundwater Elevation (ft MSL)
2,956
2,954
2,952
2,950
2,948
2,946
2,944
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)


End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 22
Groundwater Elevation (ft MSL)
2,950
2,940
2,930
2,920
2,910
2,900
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

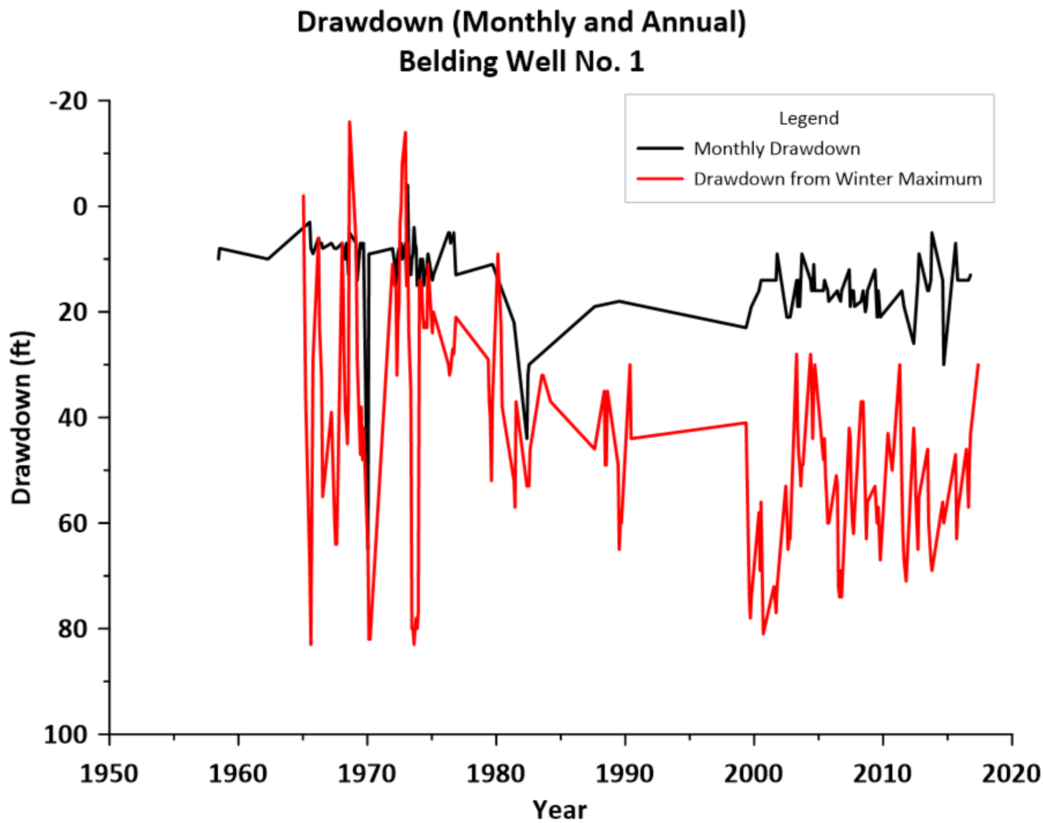

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 28 (no actual data)
Groundwater Elevation (ft MSL)
25
20
15
10
5
0
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

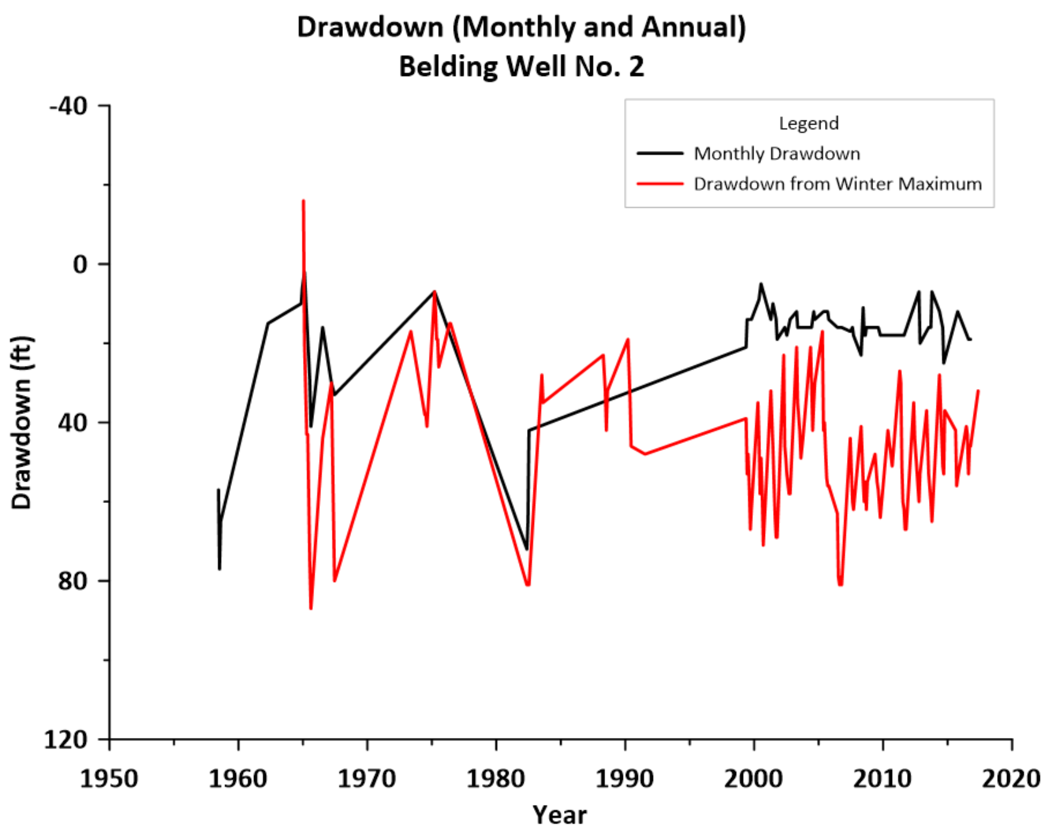

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 29
Groundwater Elevation (ft MSL)
3,012
3,008
3,004
3,000
2,996
2,992
1950
1960
1970
1980
1990
2000
2010
2020
Year
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)

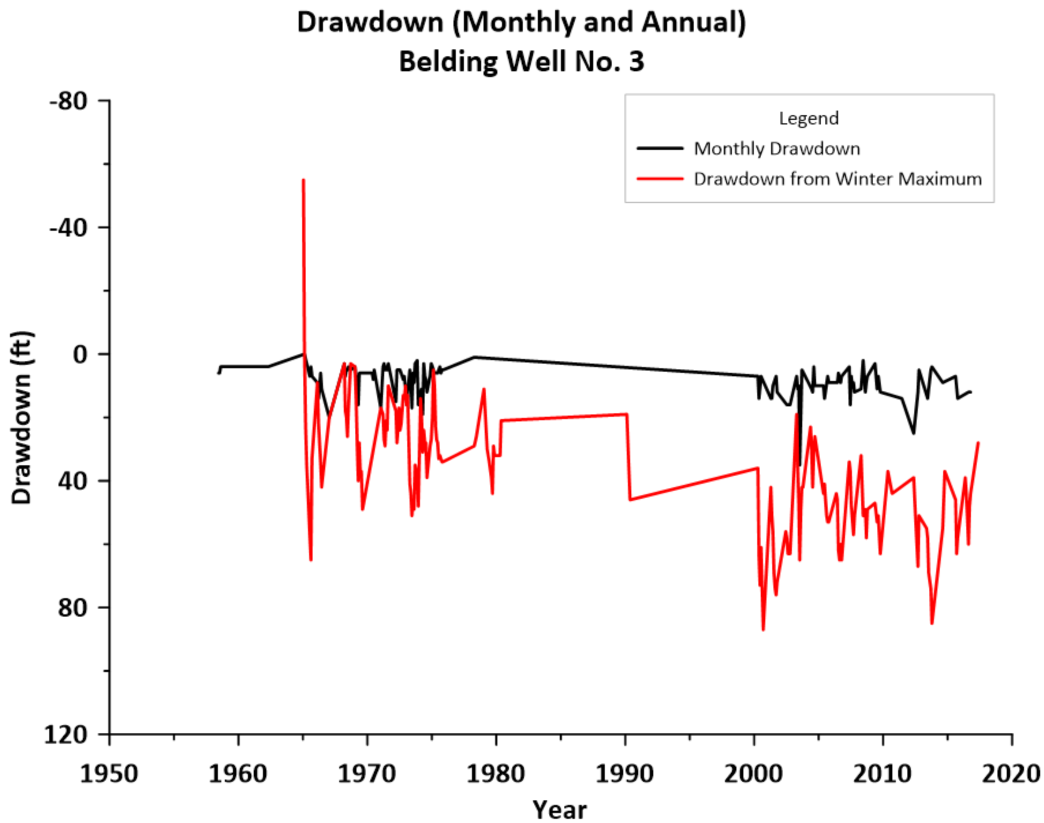

End-of-Year and Winter Maximum Static Groundwater Elevation (GWE)
Belding Well No. 30 (no actual data)
Legend
End-of-Year GWE
Winter Maximum GWE
Belding Data End-of-Year Preference:
1) December
2) January (subsequent year)
3) November
4) February (subsequent year)
Groundwater Elevation (ft MSL)
Year
0
5
10
15
20
25
1950
1960
1970
1980
1990
2000
2010
2020

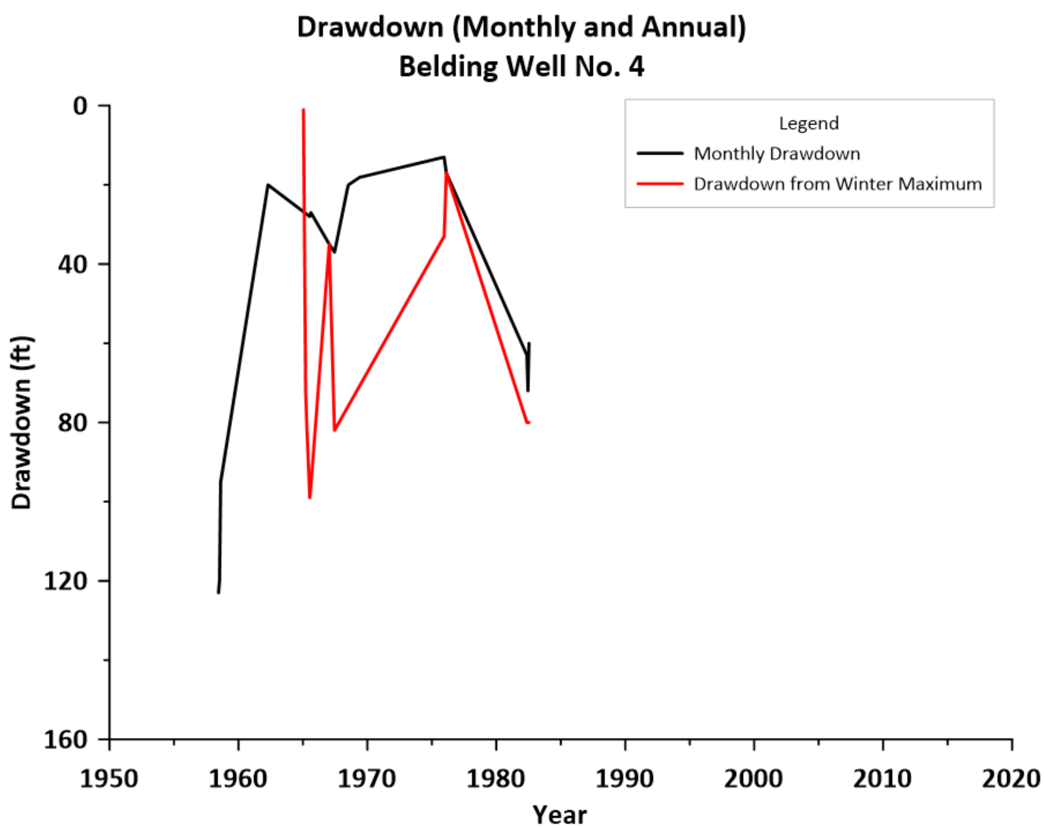
Appendix D

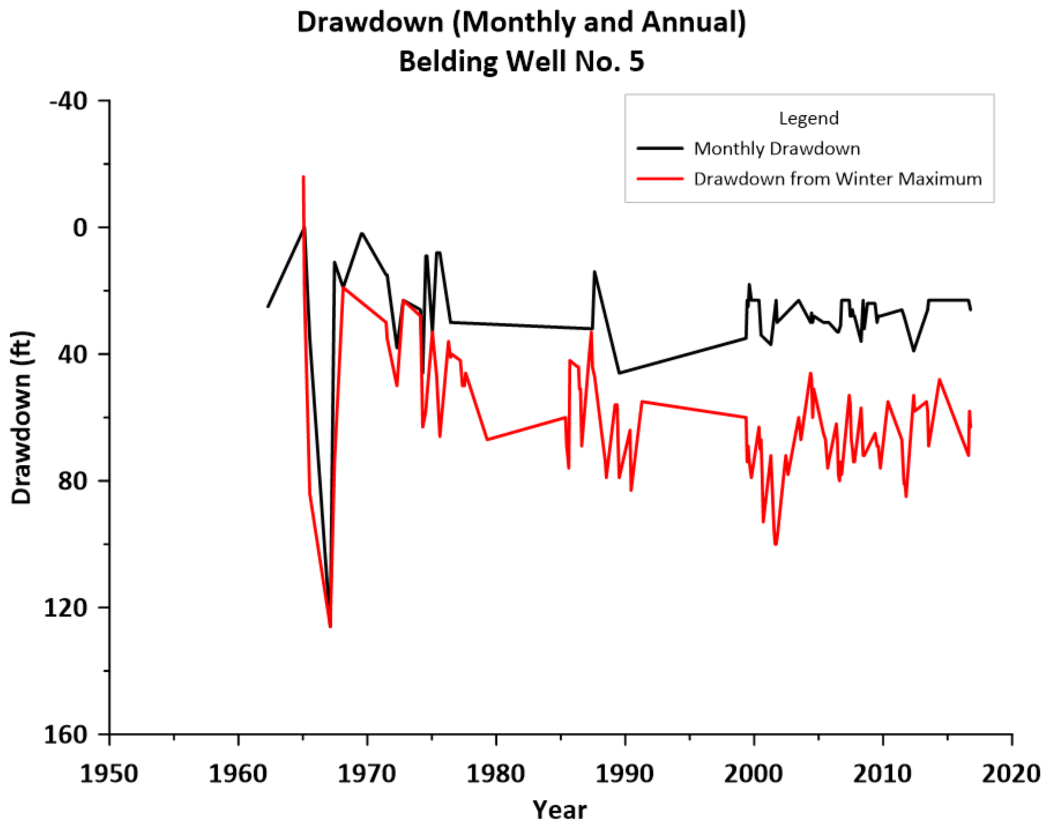
Drawdown Hydrographs

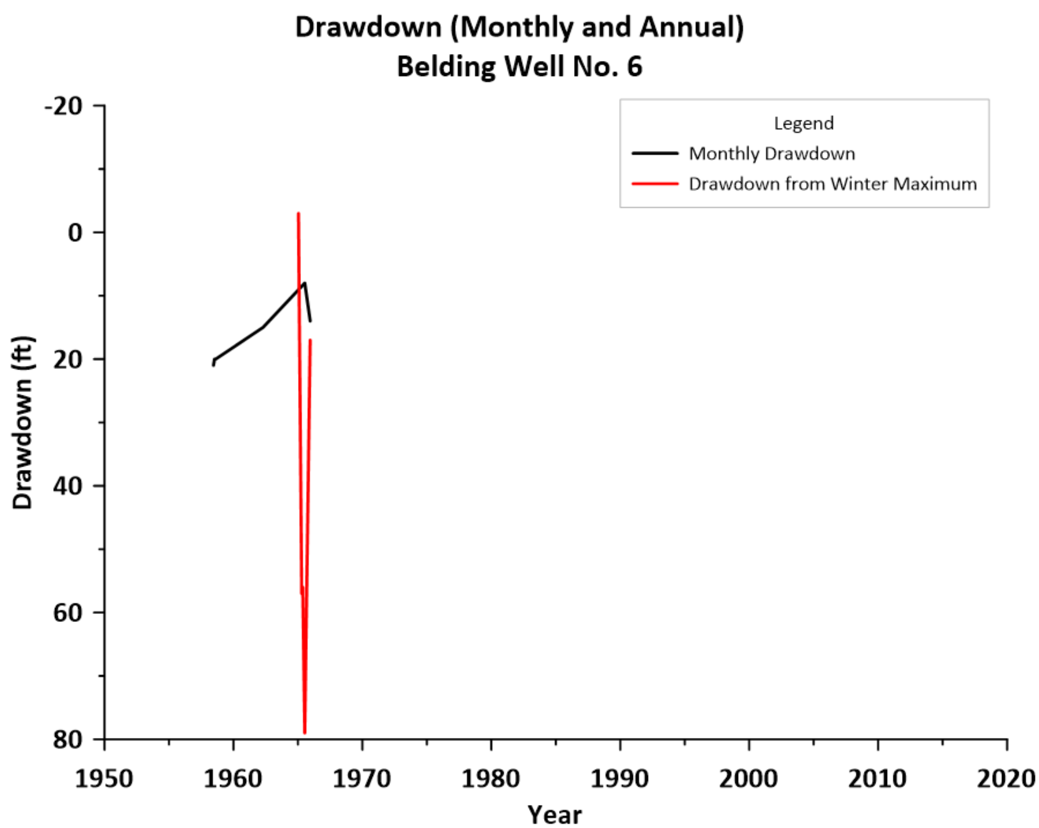

Drawdown (Monthly and Annual)
Belding Well No. 1
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
-20
0
20
40
60
80
100
1950
1960
1970
1980
1990
2000
2010
2020
Year

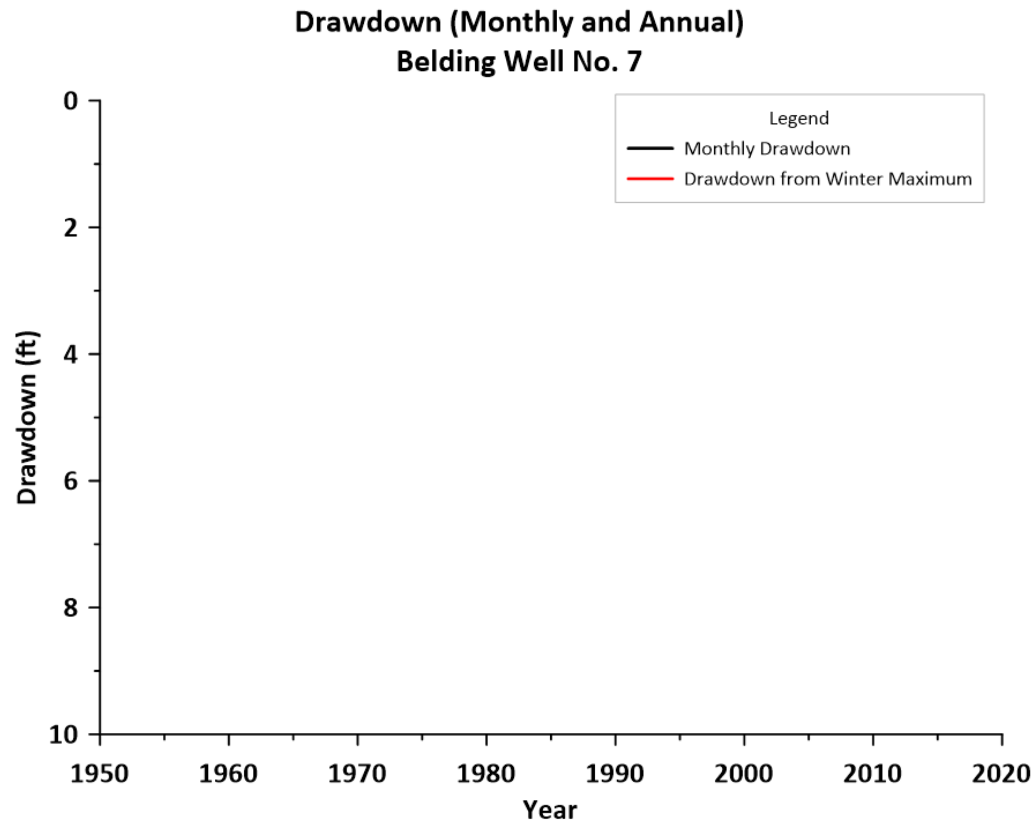

Drawdown (Monthly and Annual)
Belding Well No. 2
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
-40
0
40
80
120
1950
1960
1970
1980
1990
2000
2010
2020
Year

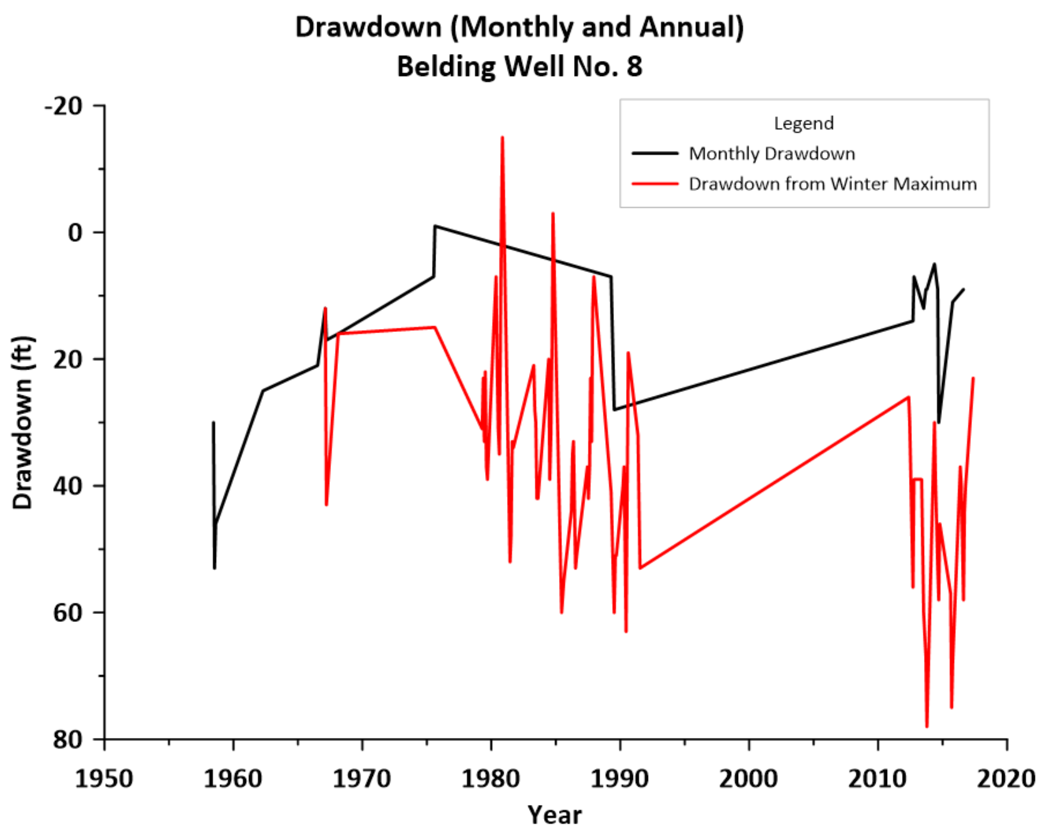

Drawdown (Monthly and Annual)
Belding Well No. 3
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
Year
-80
-40
0
40
80
120
1950
1960
1970
1980
1990
2000
2010
2020

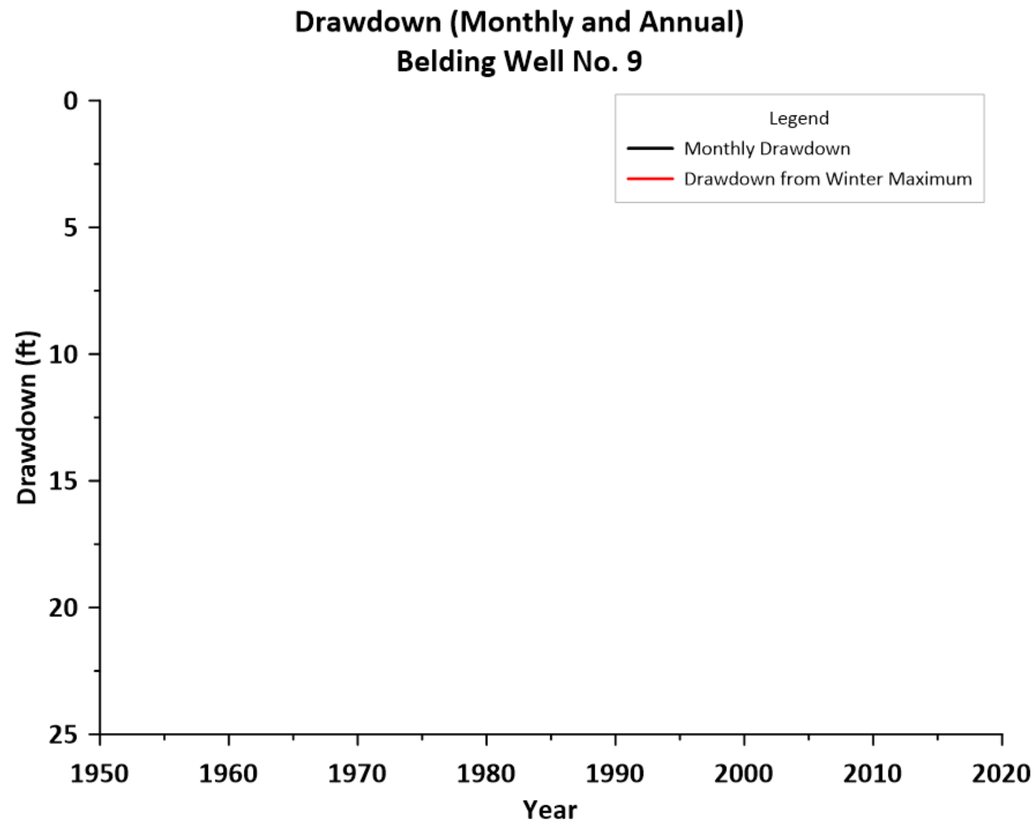

Drawdown (Monthly and Annual)
Belding Well No. 4
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
Year
0
40
80
120
160
1950
1960
1970
1980
1990
2000
2010
2020

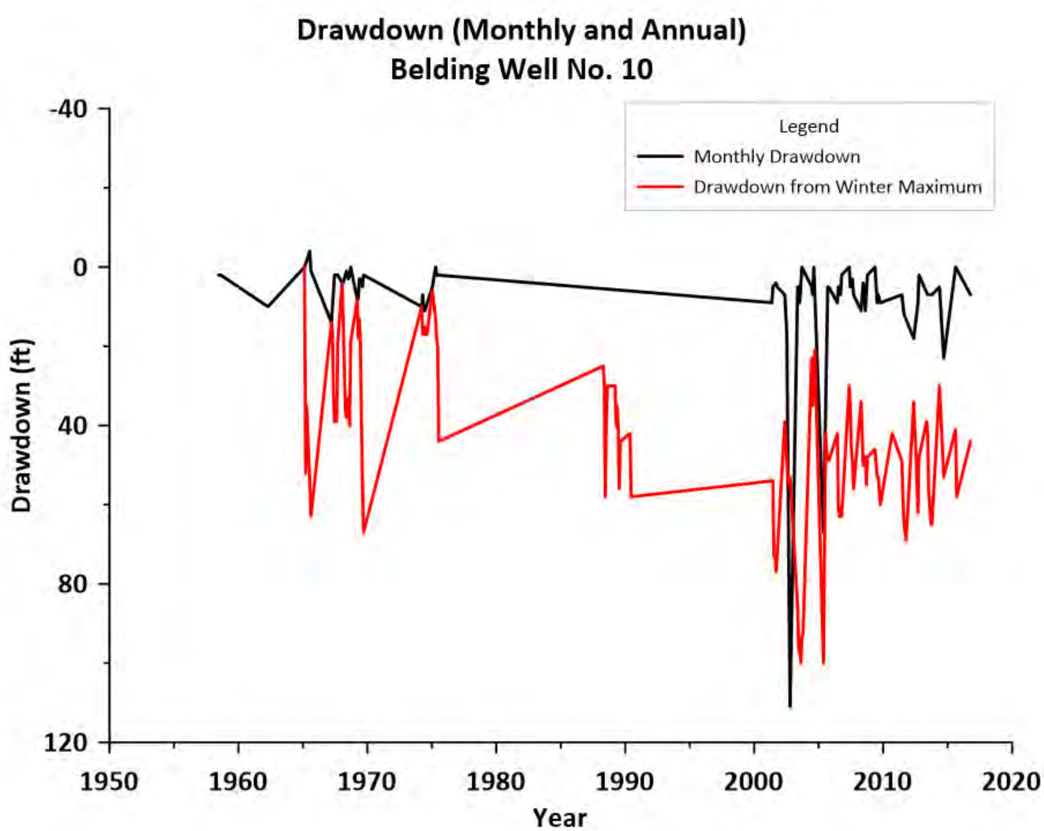

Drawdown (Monthly and Annual)
Belding Well No. 5
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
-40
0
40
80
120
160
1950
1960
1970
1980
1990
2000
2010
2020
Year

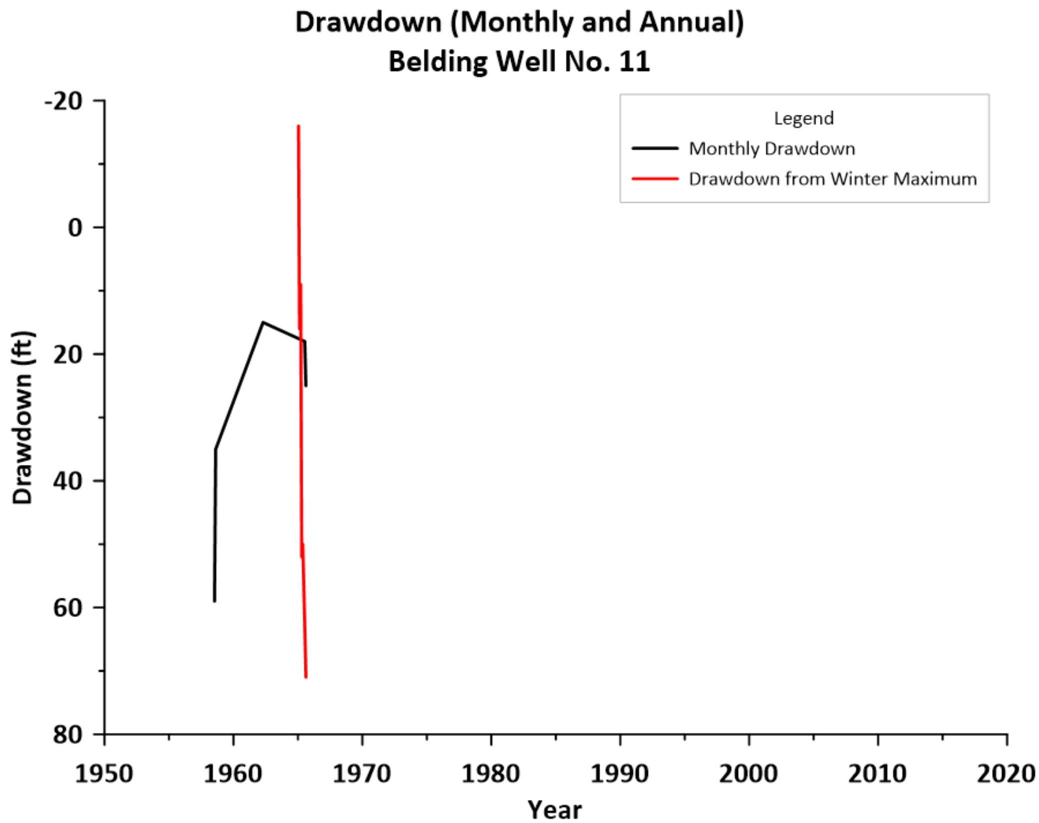

Drawdown (Monthly and Annual)
Belding Well No. 6
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
-20
0
20
40
60
80
1950
1960
1970
1980
1990
2000
2010
2020
Year

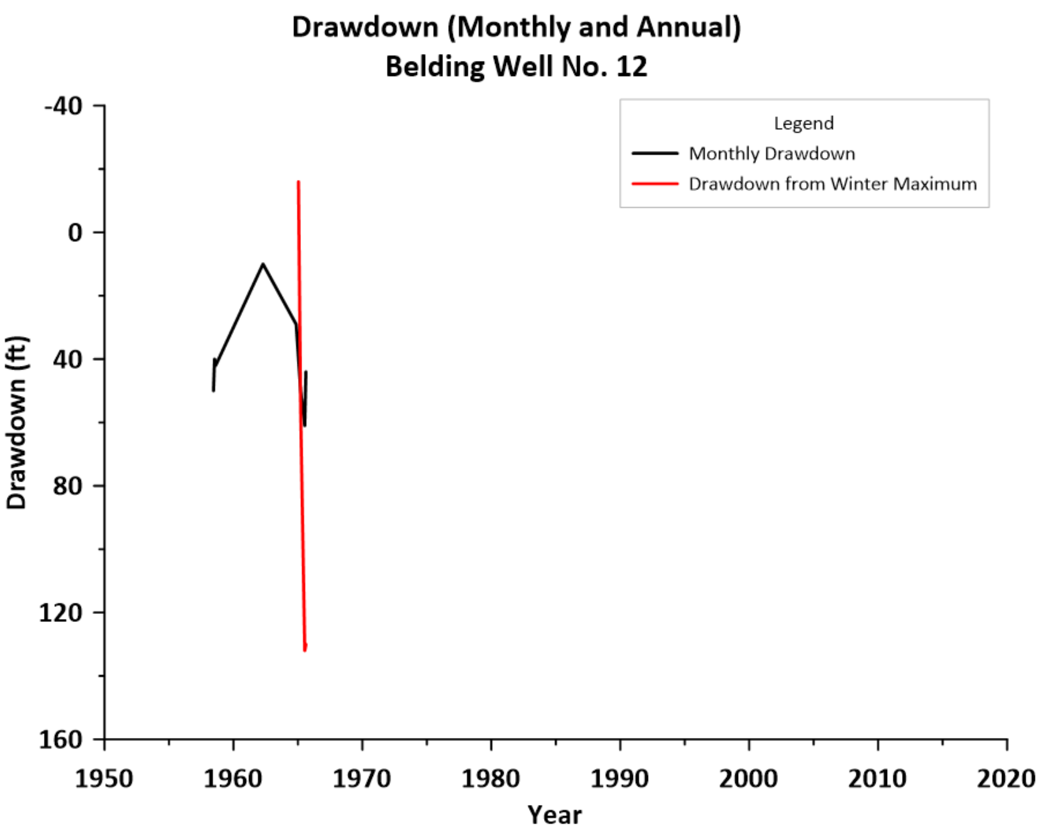

Drawdown (Monthly and Annual)
Belding Well No. 7
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
0
2
4
6
8
10
1950
1960
1970
1980
1990
2000
2010
2020
Year

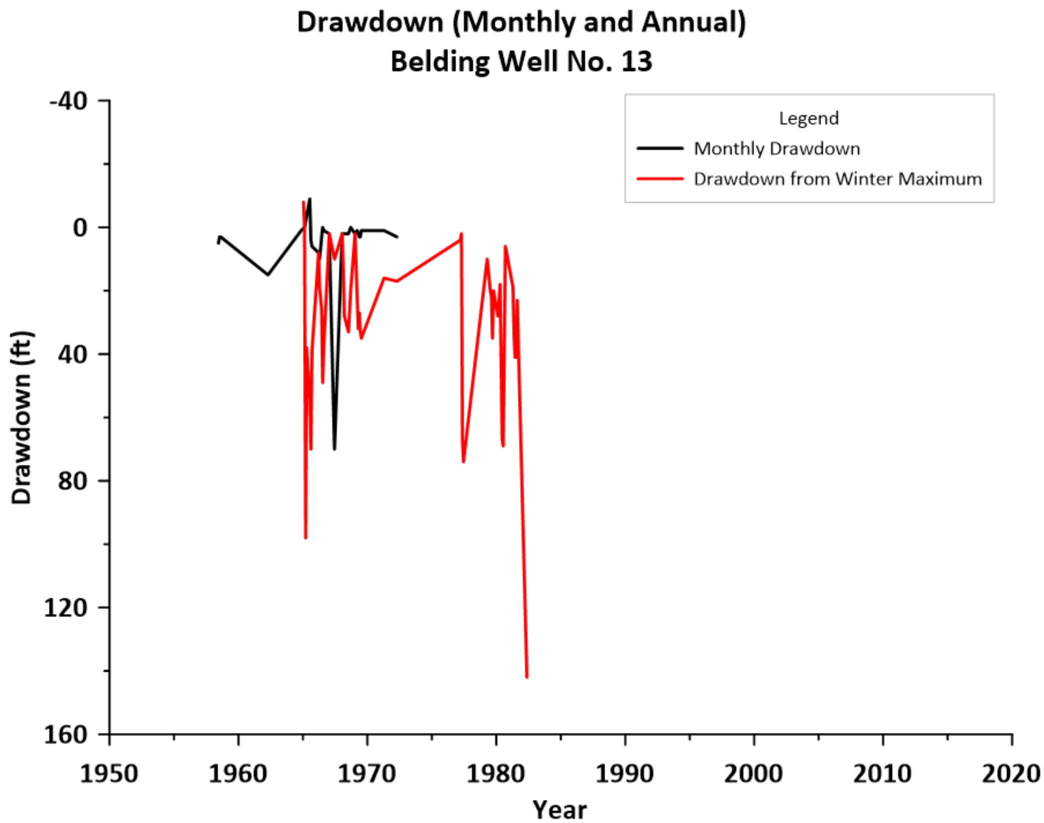

Drawdown (Monthly and Annual)
Belding Well No. 8
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
-20
0
20
40
60
80
1950
1960
1970
1980
1990
2000
2010
2020
Year


Drawdown (Monthly and Annual)
Belding Well No. 9
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
0
5
10
15
20
25
1950
1960
1970
1980
1990
2000
2010
2020
Year

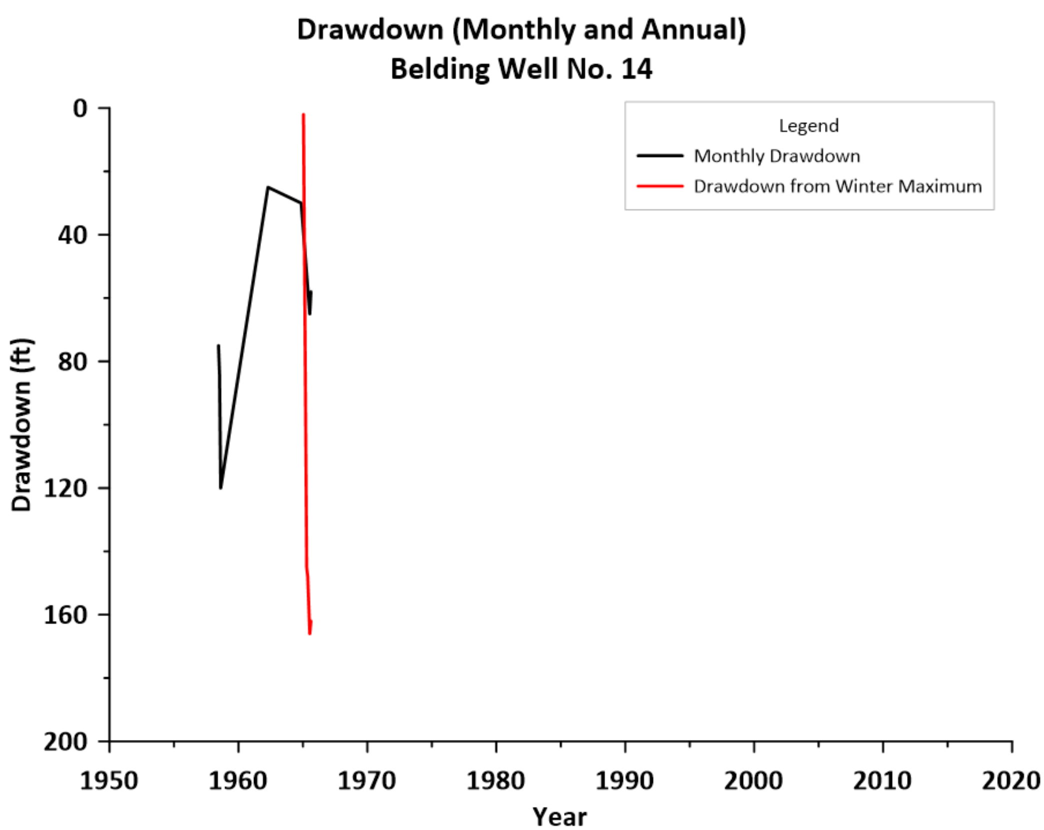

Drawdown (Monthly and Annual)
Belding Well No. 10
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
-40
0
40
80
120
1950
1960
1970
1980
1990
2000
2010
2020
Year


Drawdown (Monthly and Annual)
Belding Well No. 11
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
Year
-20
0
20
40
60
80
1950
1960
1970
1980
1990
2000
2010
2020


Drawdown (Monthly and Annual)
Belding Well No. 12
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
Year
-40
0
40
80
120
160
1950
1960
1970
1980
1990
2000
2010
2020

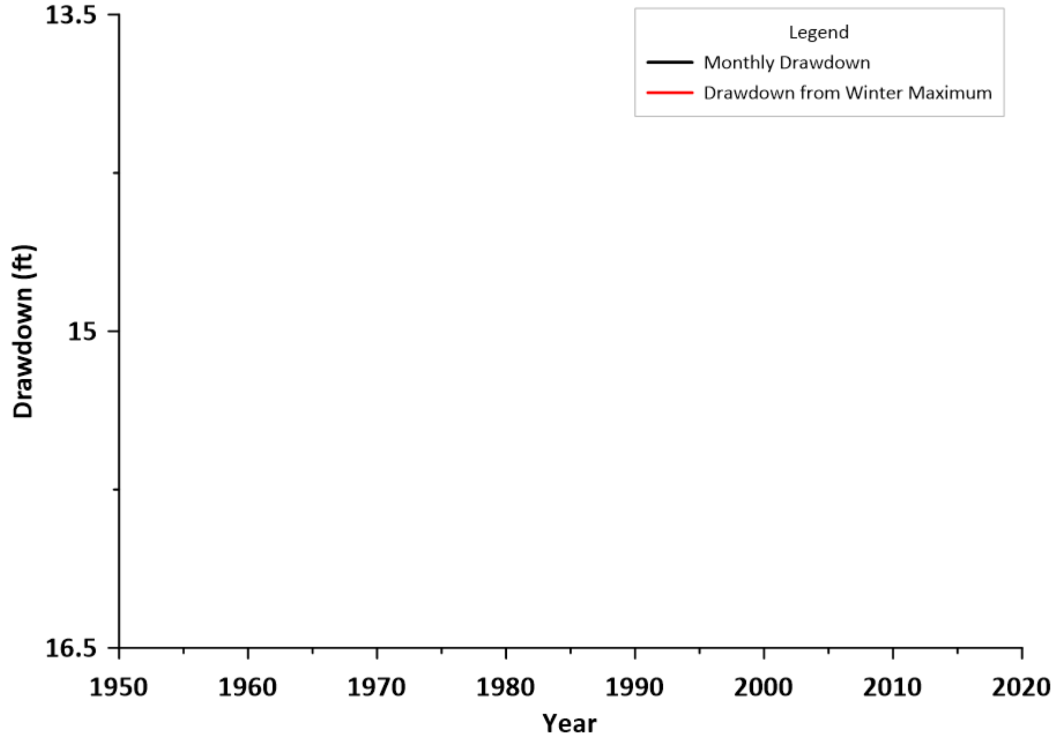


Drawdown (Monthly and Annual)
Belding Well No. 13
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
Year
-40
0
40
80
120
160
1950
1960
1970
1980
1990
2000
2010
2020

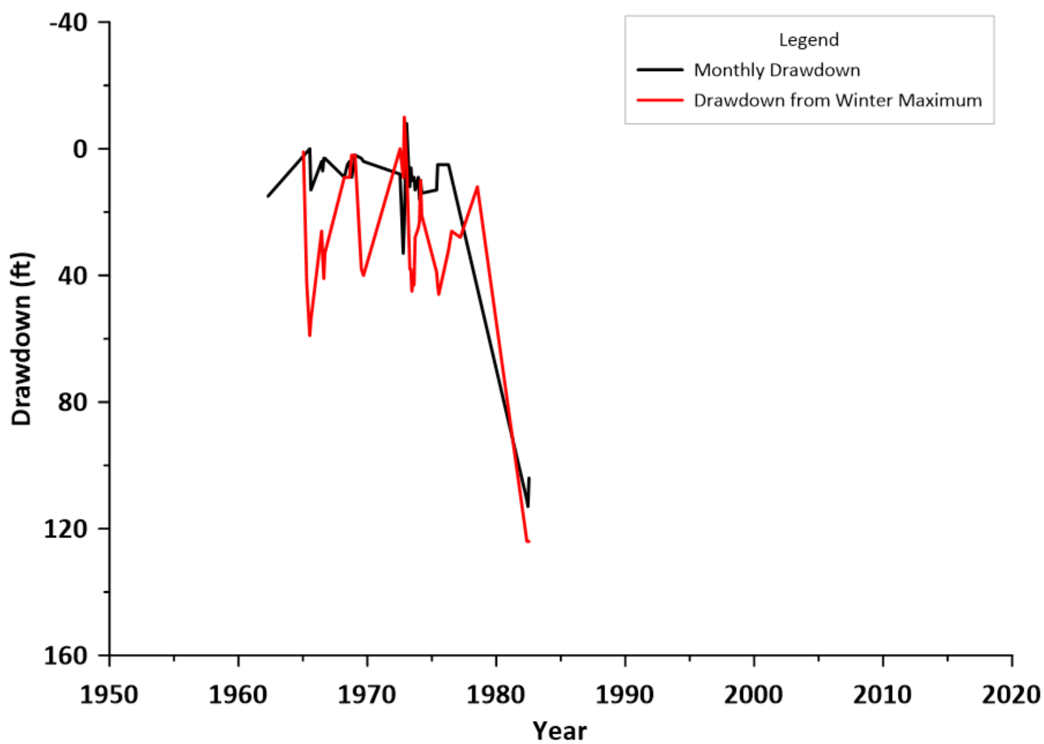


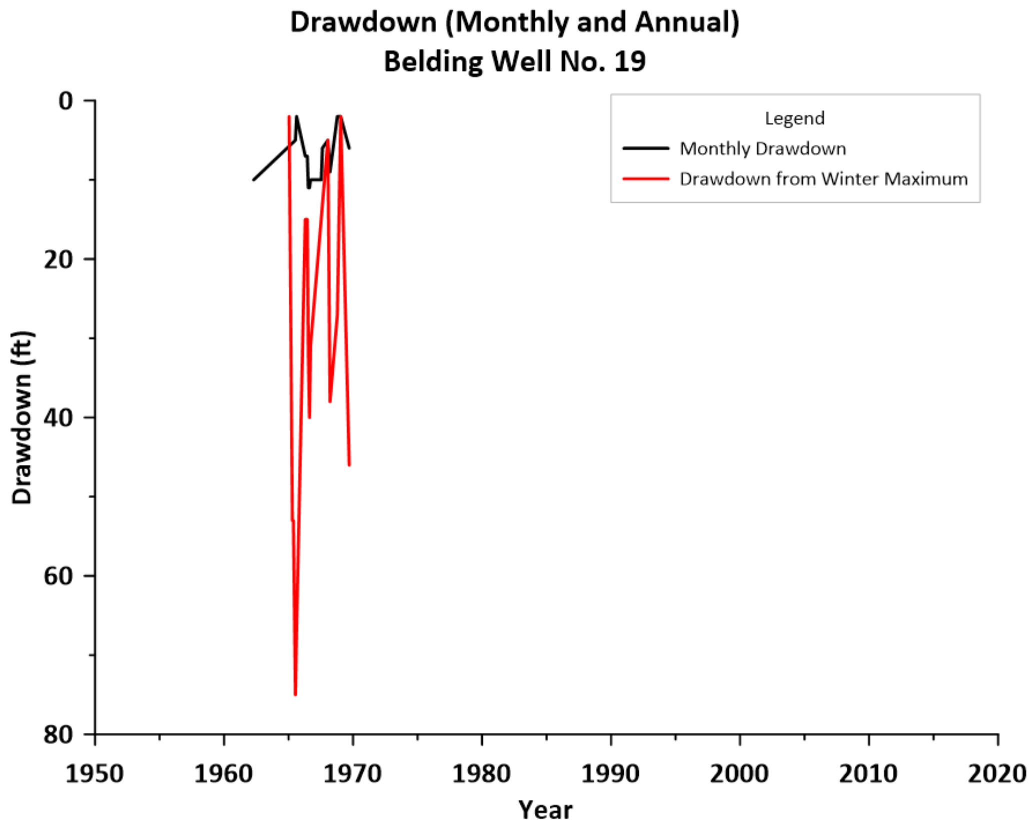
Drawdown (Monthly and Annual)
Belding Well No. 14
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
Year
0
40
80
120
160
200
1950
1960
1970
1980
1990
2000
2010
2020

Drawdown (Monthly and Annual)
Belding Well No. 17

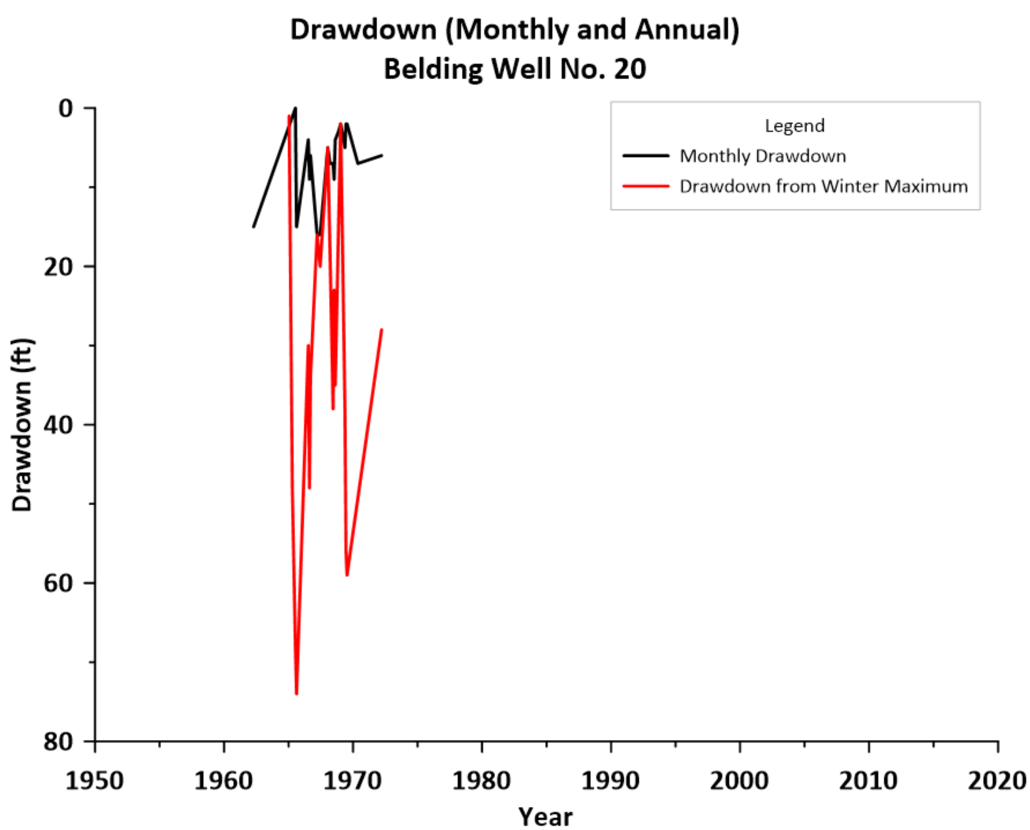


Drawdown (Monthly and Annual)
Belding Well No. 18

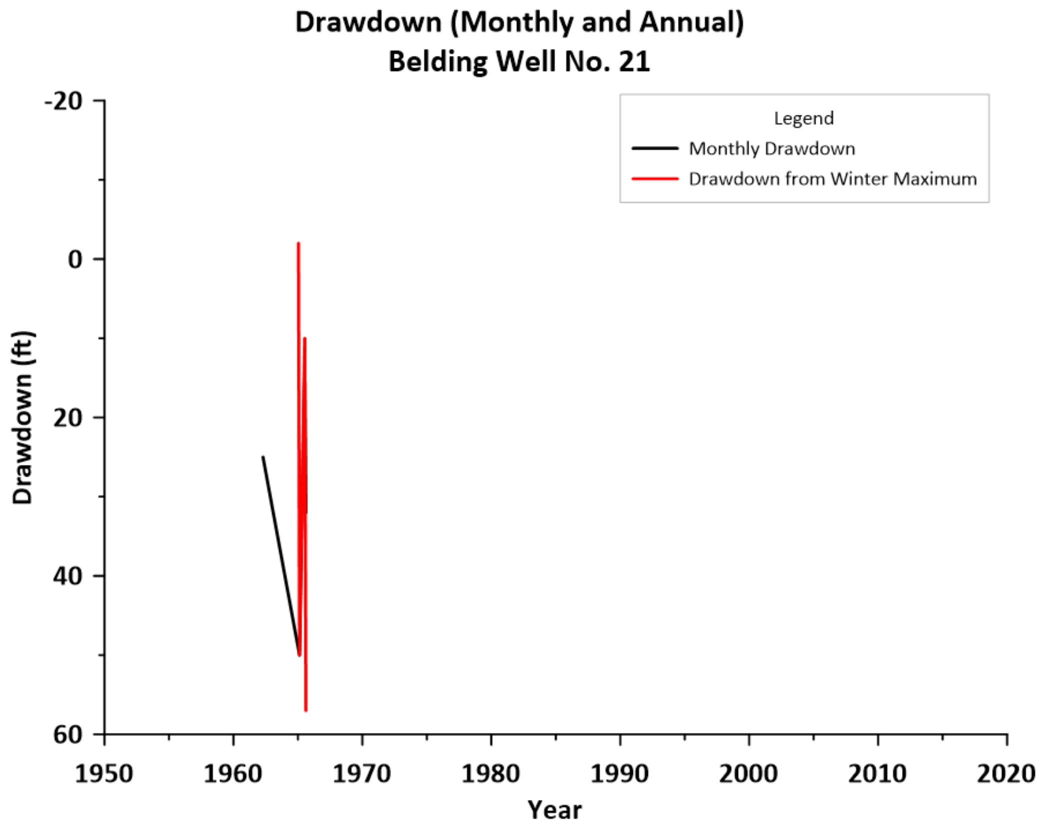


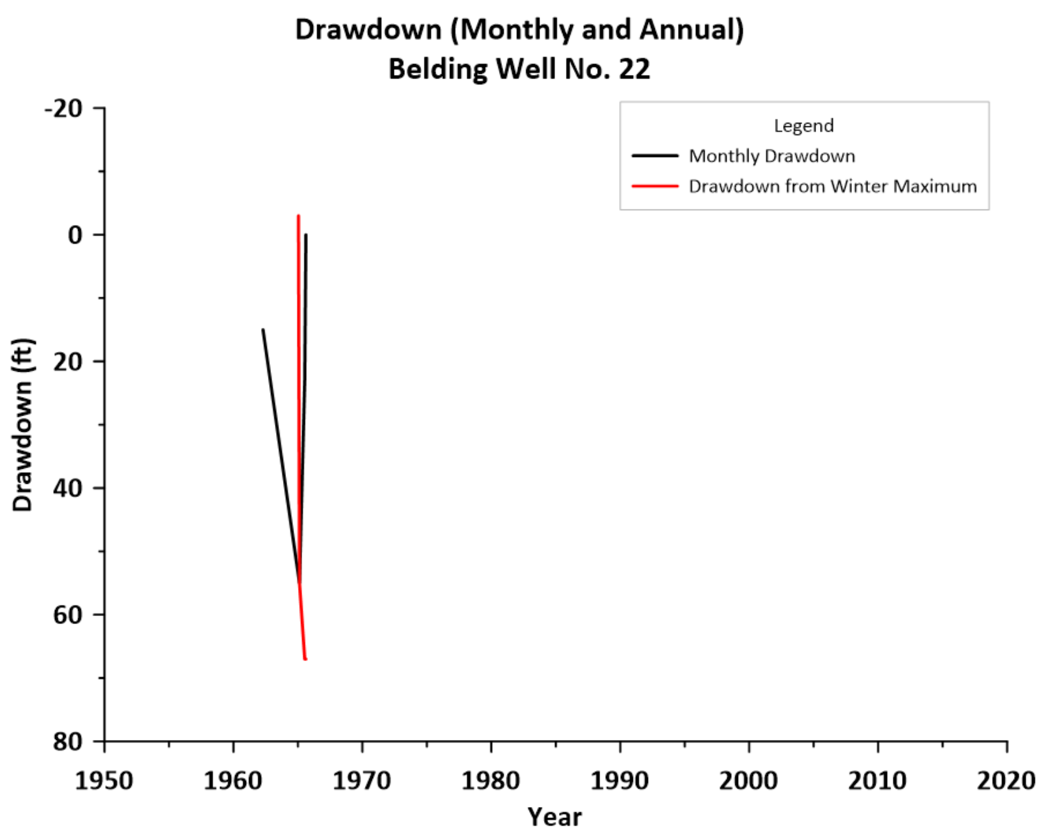


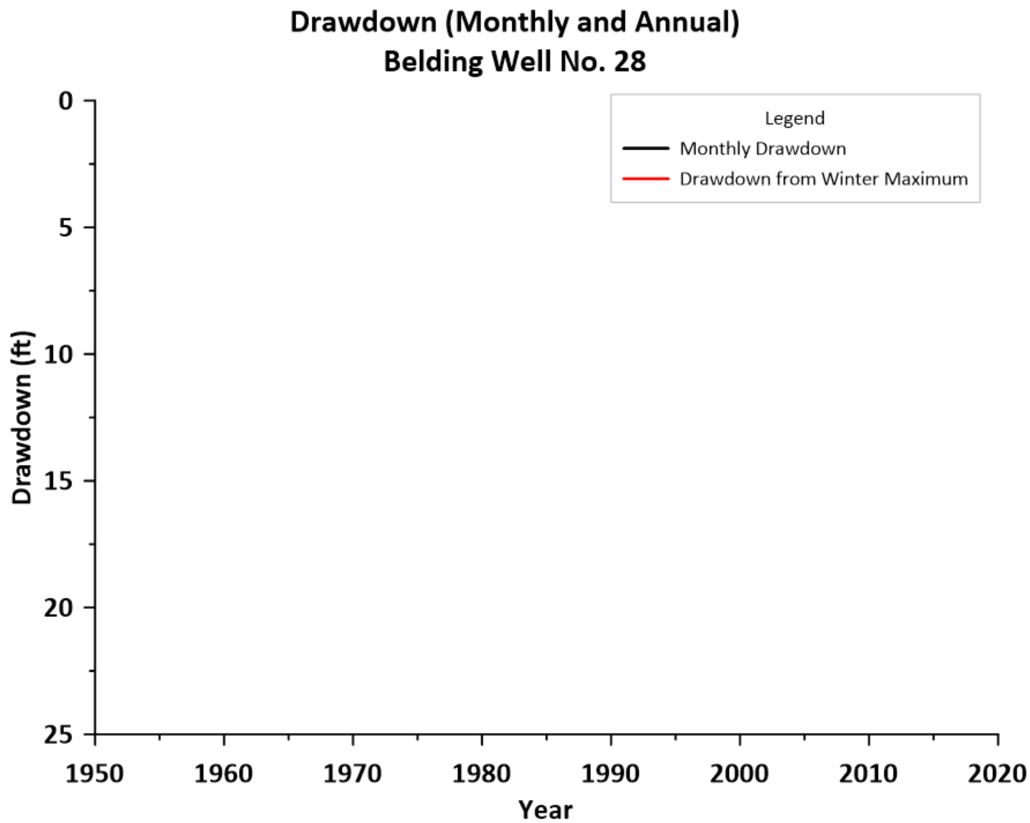
Drawdown (Monthly and Annual)
Belding Well No. 19
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
0
20
40
60
80
1950
1960
1970
1980
1990
2000
2010
2020
Year

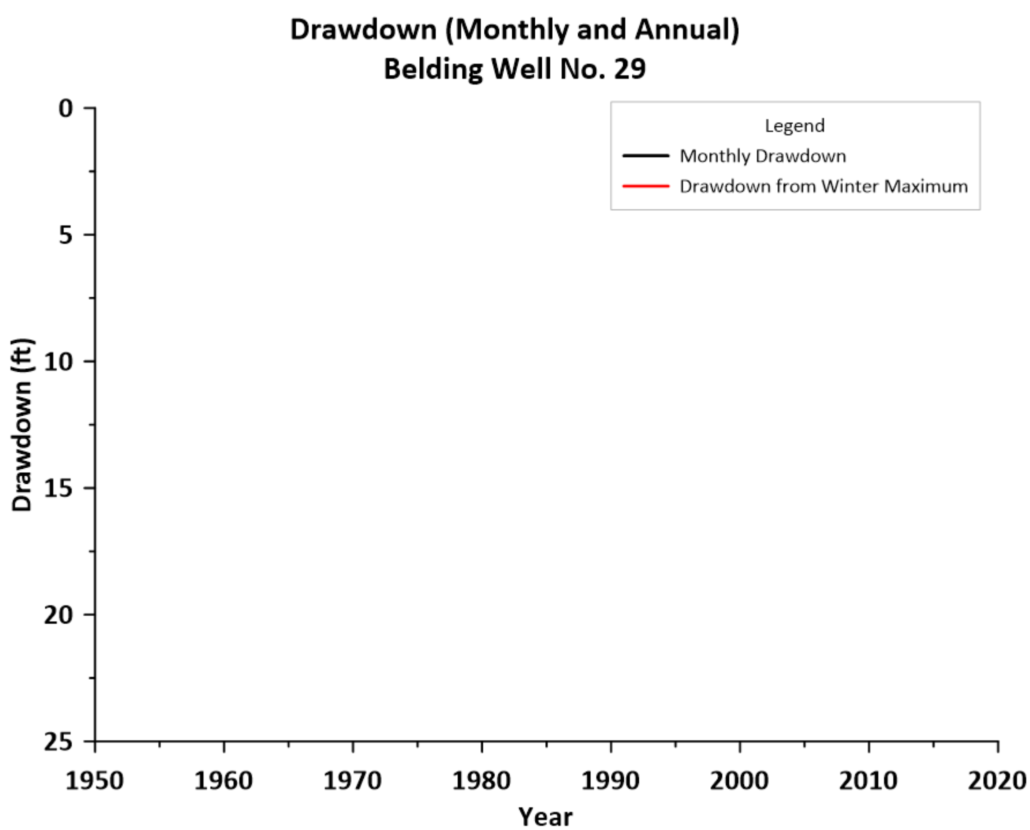


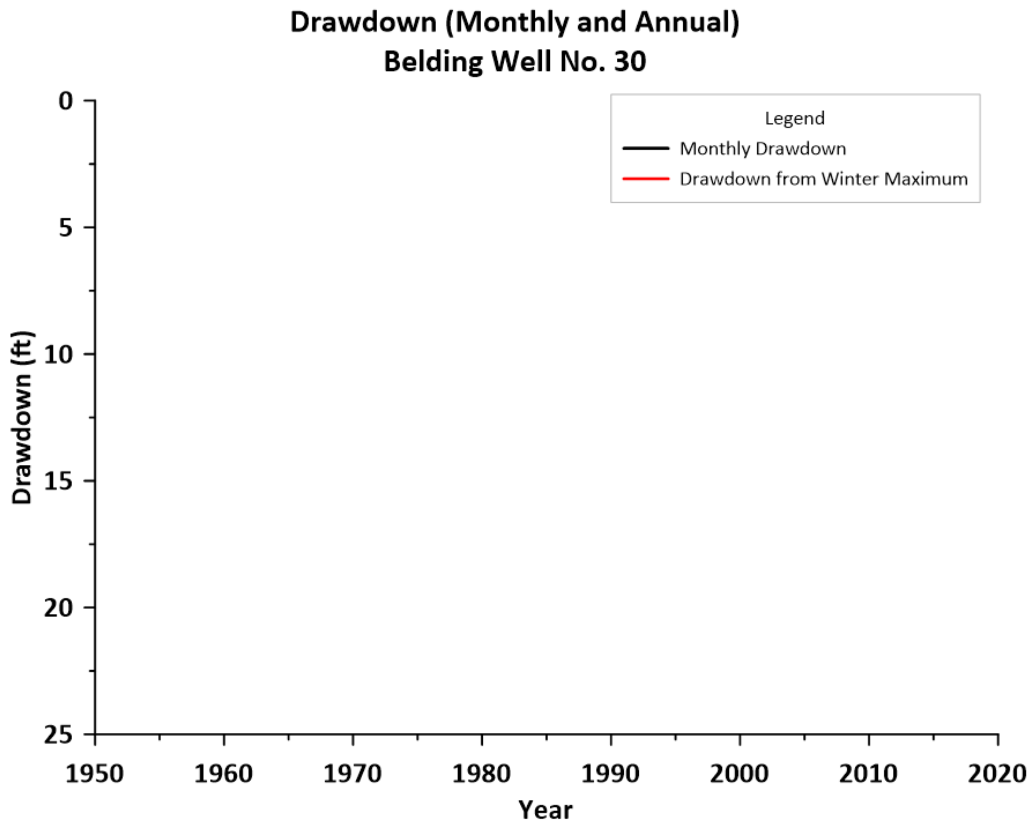
Drawdown (Monthly and Annual)
Belding Well No. 20
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
0
20
40
60
80
1950
1960
1970
1980
1990
2000
2010
2020
Year


Drawdown (Monthly and Annual)
Belding Well No. 21
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
-20
0
20
40
60
1950
1960
1970
1980
1990
2000
2010
2020
Year


Drawdown (Monthly and Annual)
Belding Well No. 22
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
-20
0
20
40
60
80
1950
1960
1970
1980
1990
2000
2010
2020
Year

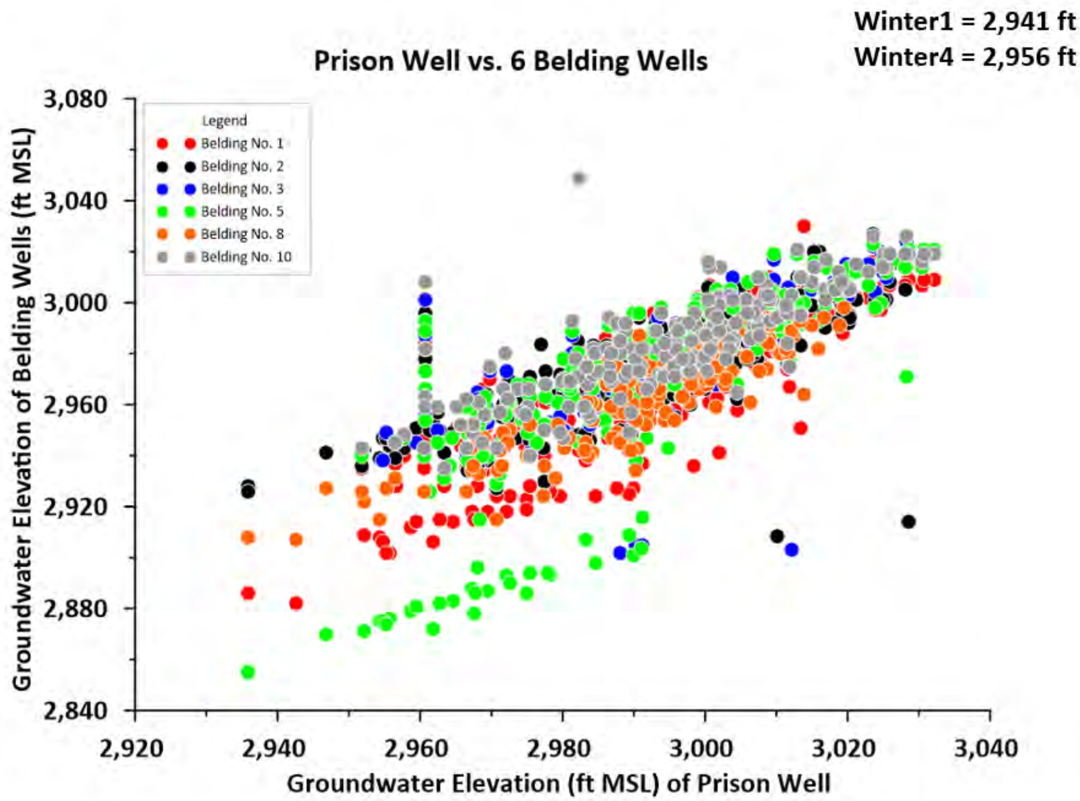

Drawdown (Monthly and Annual)
Belding Well No. 28
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
0
5
10
15
20
25
1950
1960
1970
1980
1990
2000
2010
2020
Year


Drawdown (Monthly and Annual)
Belding Well No. 29
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
0
5
10
15
20
25
1950
1960
1970
1980
1990
2000
2010
2020
Year

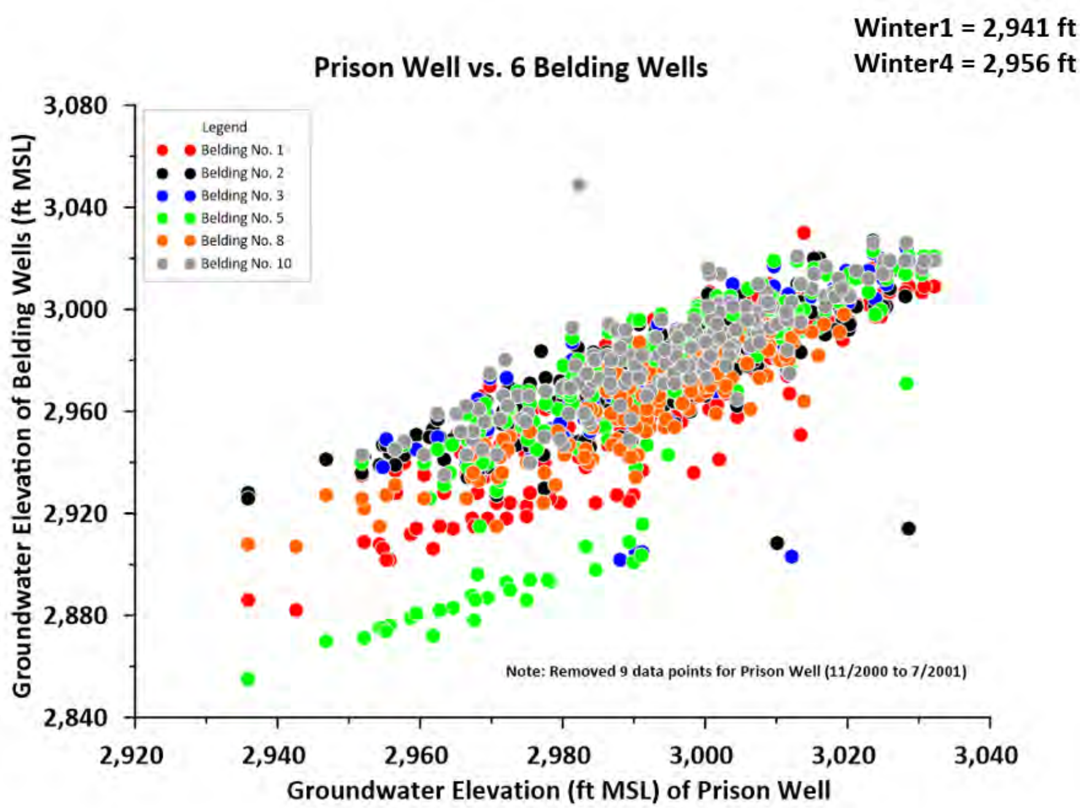

Drawdown (Monthly and Annual)
Belding Well No. 30
Legend
Monthly Drawdown
Drawdown from Winter Maximum
Drawdown (ft)
0
5
10
15
20
25
1950
1960
1970
1980
1990
2000
2010
2020
Year

Appendix E

Cross Plots of the 11 Monitoring Wells and Selected Belding Farms Wells

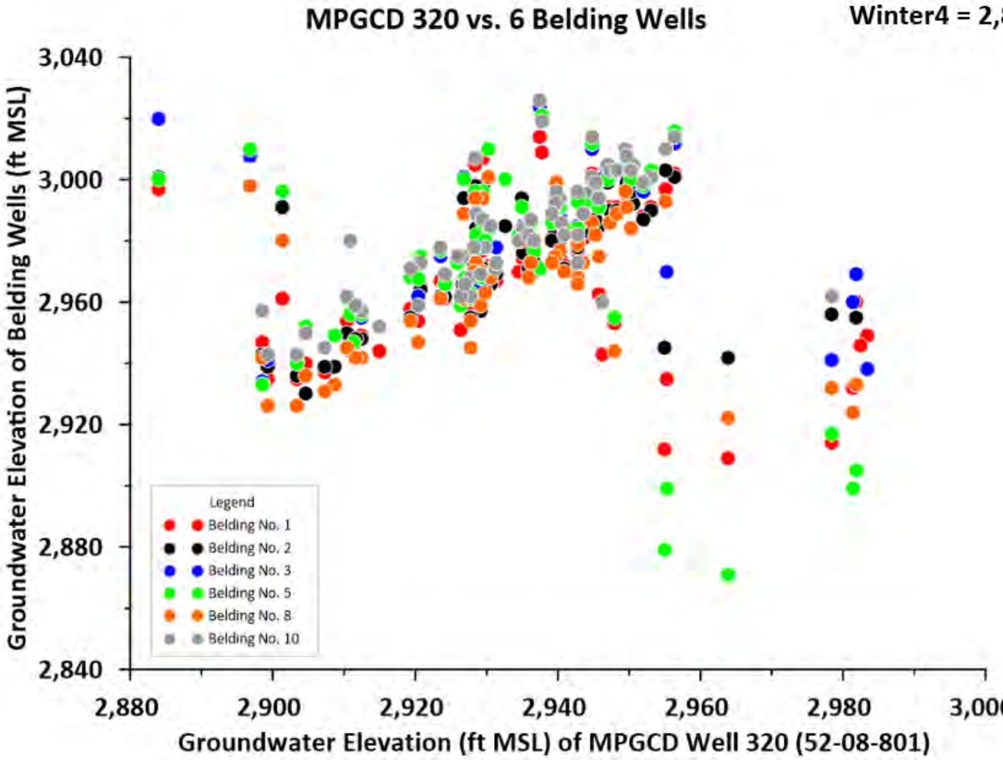


Winter1 = 2,941 ft
Winter4 = 2,956 ft
Prison Well vs. 6 Belding Wells
Legend
Belding No. 1
Belding No. 2
Belding No. 3
Belding No. 5
Belding No. 8
Belding No. 10
Groundwater Elevation of Belding Wells (ft MSL)
Groundwater Elevation (ft MSL) of Prison Well
3,080
3,040
3,000
2,960
2,920
2,880
2,840
2,920
2,940
2,960
2,980
3,000
3,020
3,040

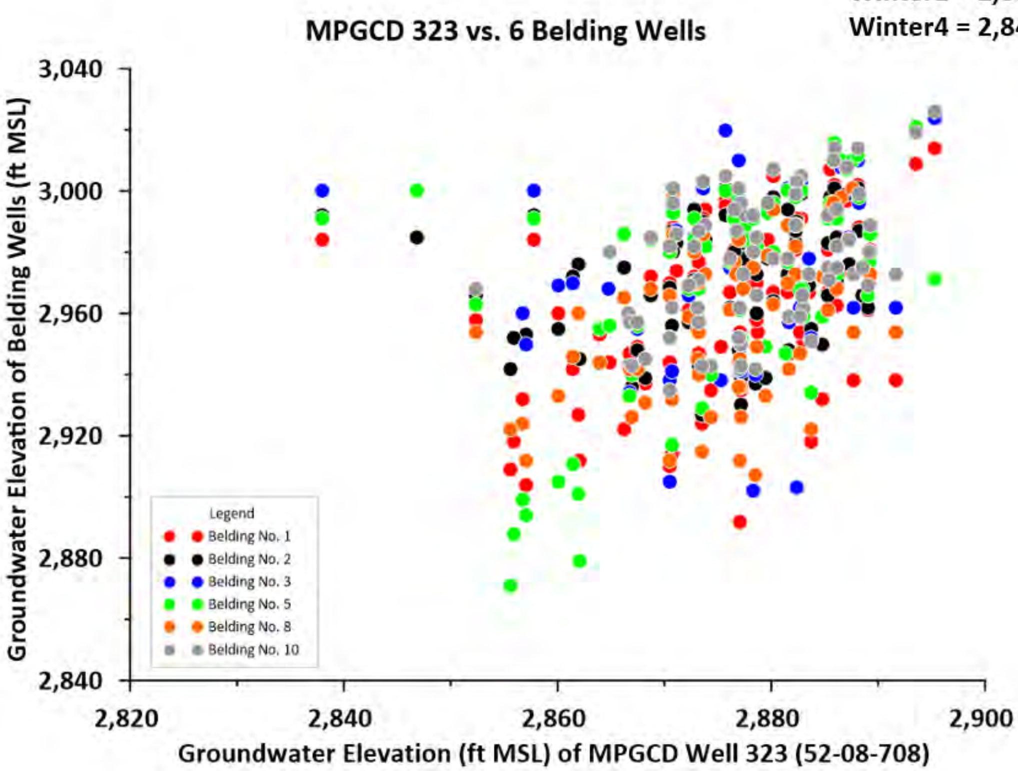


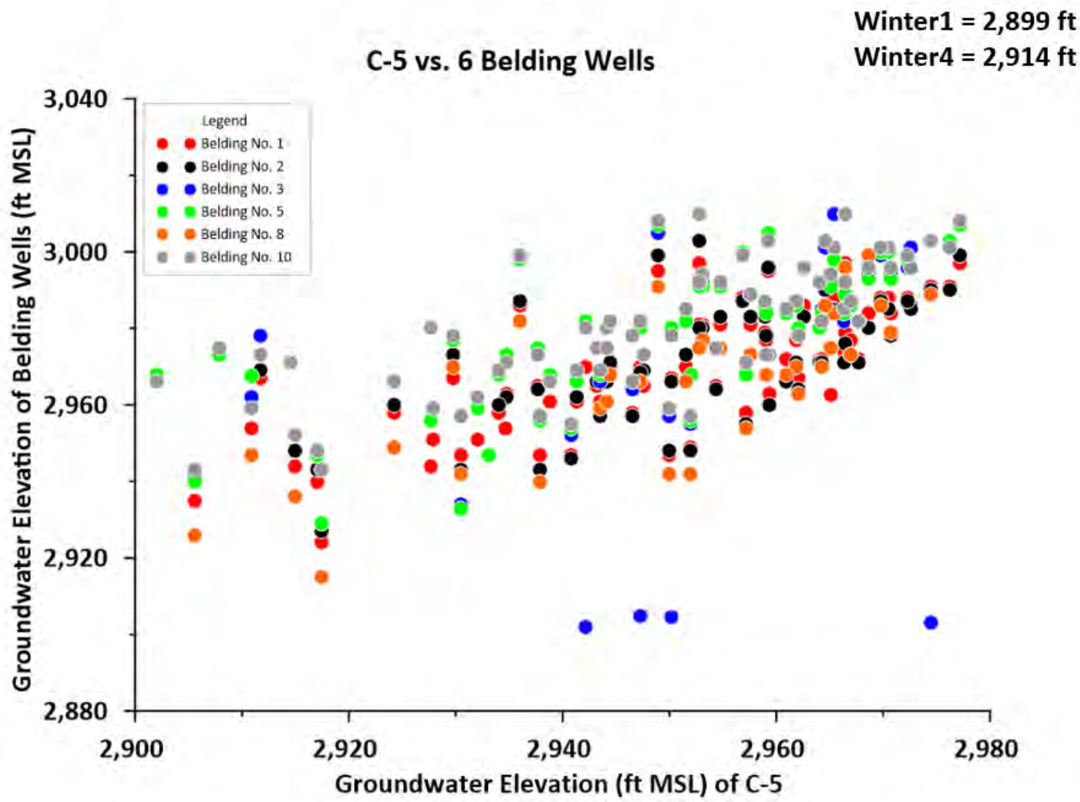
Winter1 = 2,941 ft
Winter4 = 2,956 ft
Prison Well vs. 6 Belding Wells
Legend
Belding No. 1
Belding No. 2
Belding No. 3
Belding No. 5
Belding No. 8
Belding No. 10
Groundwater Elevation of Belding Wells (ft MSL)
Groundwater Elevation (ft MSL) of Prison Well
Note: Removed 9 data points for Prison Well (11/2000 to 7/2001)
3,080
3,040
3,000
2,960
2,920
2,880
2,840
2,920
2,940
2,960
2,980
3,000
3,020
3,040

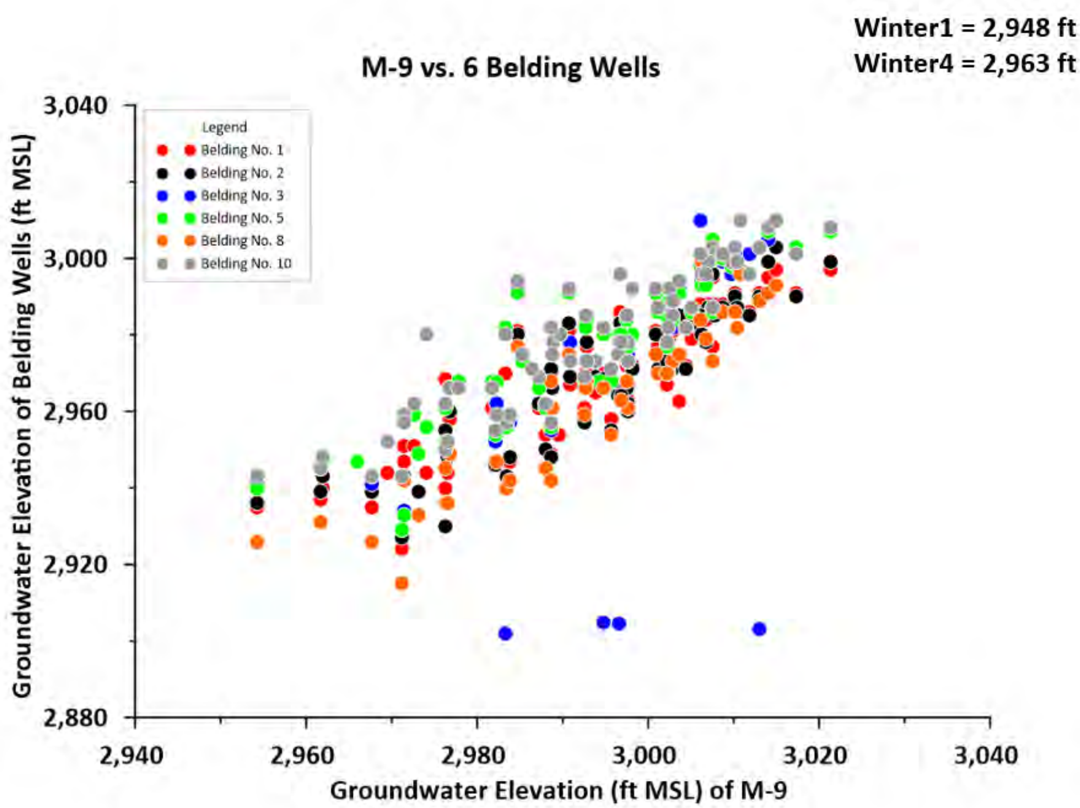
Winter1 = 2,836 ft
Winter4 = 2,878 ft

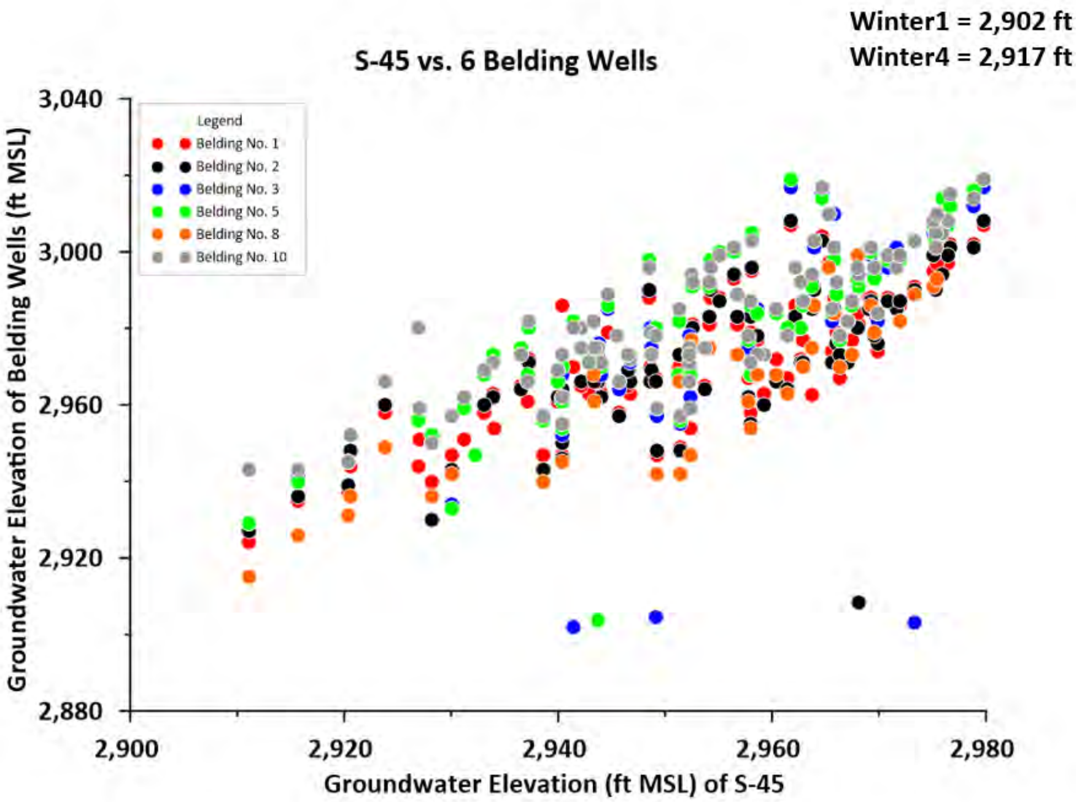


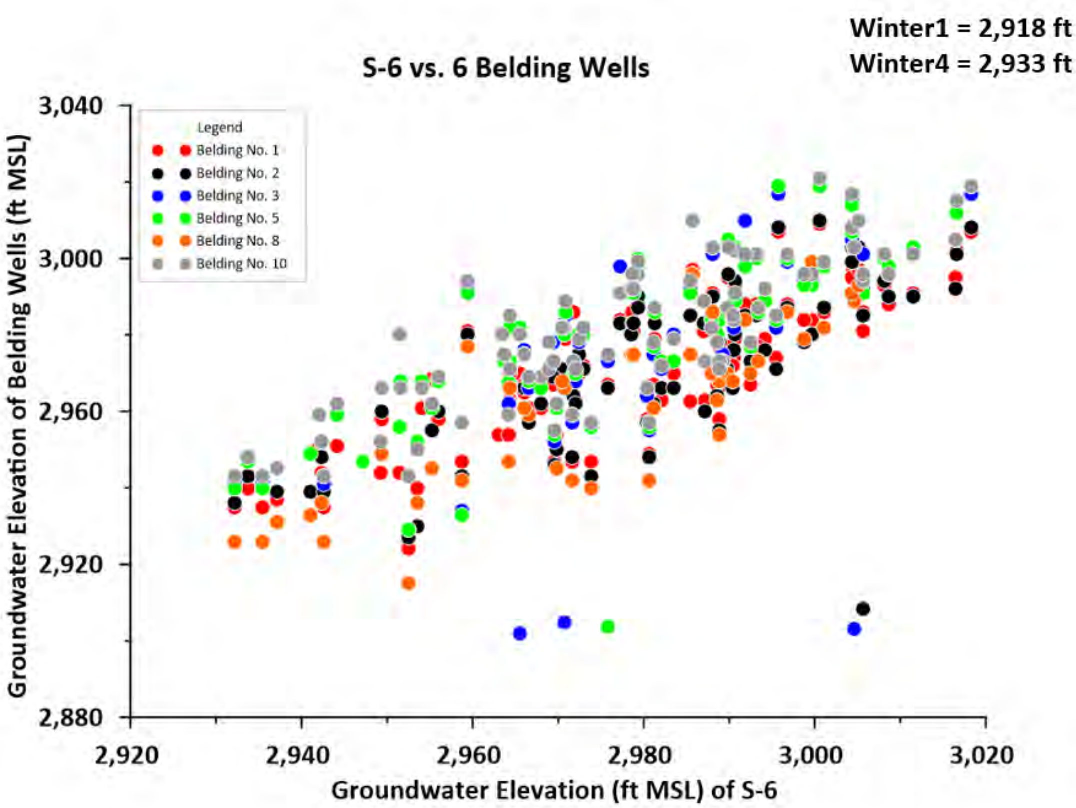
Winter1 = 2,833 ft
Winter4 = 2,848 ft



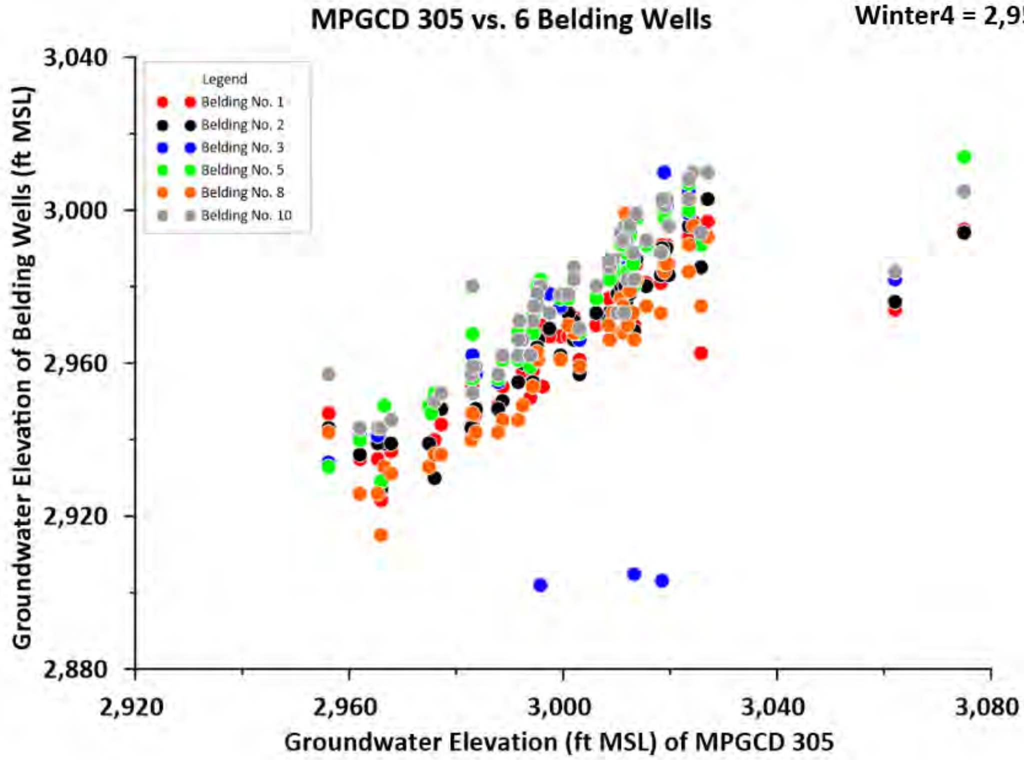

Winter1 = 2,899 ft
Winter4 = 2,914 ft
C-5 vs. 6 Belding Wells
Legend
Belding No. 1
Belding No. 2
Belding No. 3
Belding No. 5
Belding No. 8
Belding No. 10
Groundwater Elevation of Belding Wells (ft MSL)
Groundwater Elevation (ft MSL) of C-5
3,040
3,000
2,960
2,920
2,880
2,900
2,920
2,940
2,960
2,980


Winter1 = 2,948 ft
Winter4 = 2,963 ft
M-9 vs. 6 Belding Wells
Legend
Belding No. 1
Belding No. 2
Belding No. 3
Belding No. 5
Belding No. 8
Belding No. 10
Groundwater Elevation of Belding Wells (ft MSL)
Groundwater Elevation (ft MSL) of M-9
3,040
3,000
2,960
2,920
2,880
2,940
2,960
2,980
3,000
3,020
3,040

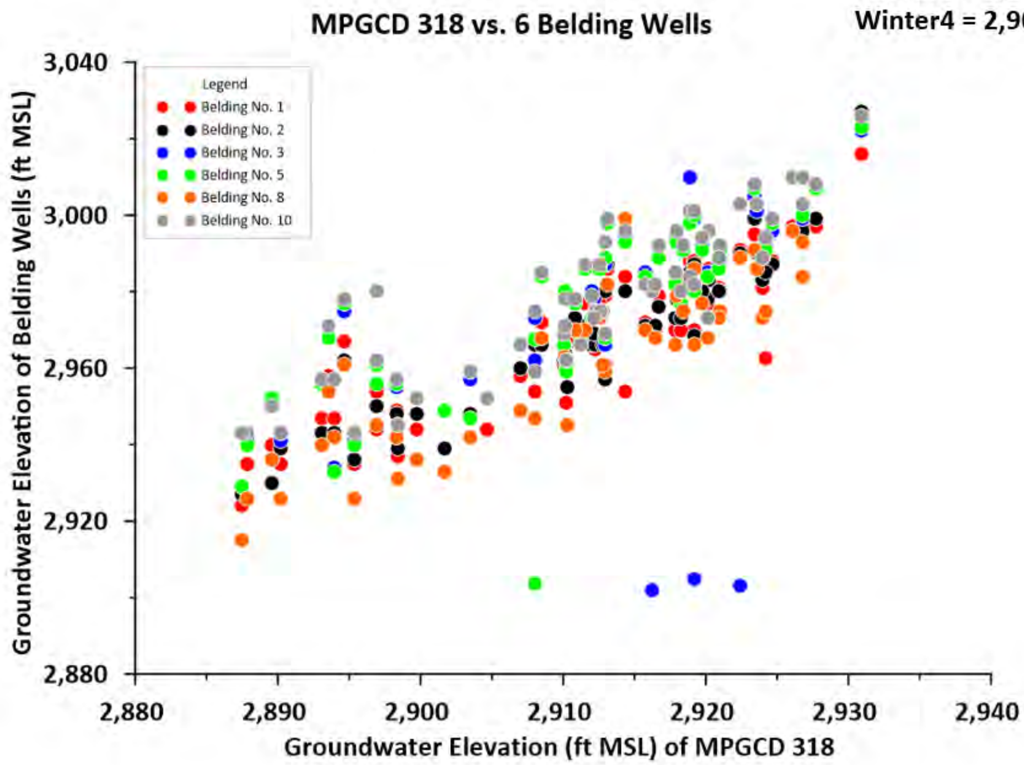

Winter1 = 2,902 ft
Winter4 = 2,917 ft
S-45 vs. 6 Belding Wells
Legend
Belding No. 1
Belding No. 2
Belding No. 3
Belding No. 5
Belding No. 8
Belding No. 10
Groundwater Elevation of Belding Wells (ft MSL)
Groundwater Elevation (ft MSL) of S-45
3,040
3,000
2,960
2,920
2,880
2,900
2,920
2,940
2,960
2,980

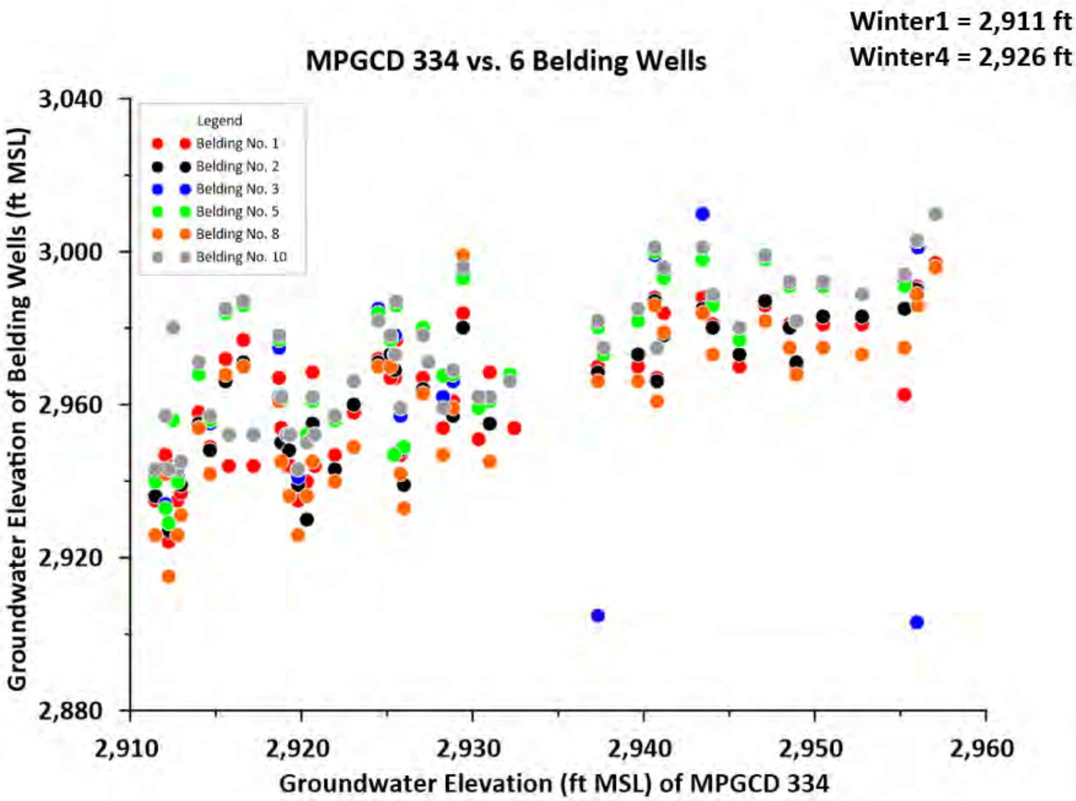

Winter1 = 2,918 ft
Winter4 = 2,933 ft
S-6 vs. 6 Belding Wells
Legend
Belding No. 1
Belding No. 2
Belding No. 3
Belding No. 5
Belding No. 8
Belding No. 10
Groundwater Elevation of Belding Wells (ft MSL)
Groundwater Elevation (ft MSL) of S-6
3,040
3,000
2,960
2,920
2,880
2,920
2,940
2,960
2,980
3,000
3,020

Winter1 = 2,941 ft
Winter4 = 2,956 ft

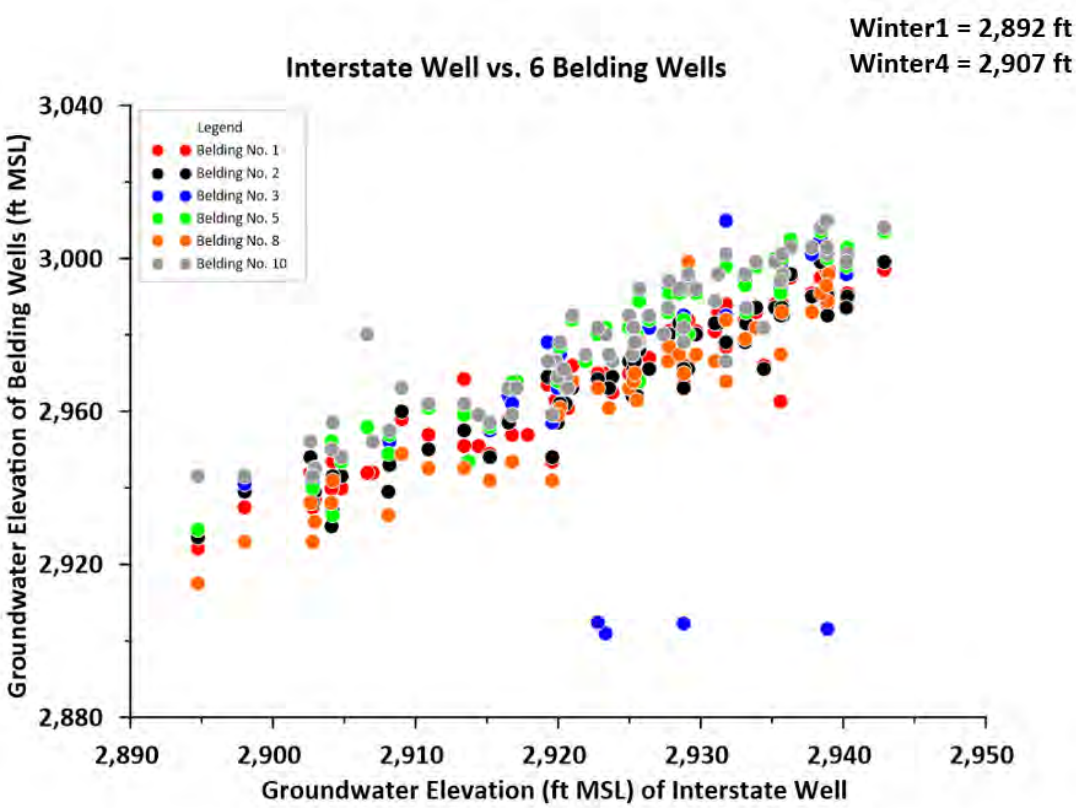


Winter1 = 2,885 ft
Winter4 = 2,900 ft





Winter1 = 2,911 ft
Winter4 = 2,926 ft
MPGCD 334 vs. 6 Belding Wells
Legend
Belding No. 1
Belding No. 2
Belding No. 3
Belding No. 5
Belding No. 8
Belding No. 10
3,040
3,000
2,960
2,920
2,880
Groundwater Elevation of Belding Wells (ft MSL)
2,910
2,920
2,930
2,940
2,950
2,960
Groundwater Elevation (ft MSL) of MPGCD 334

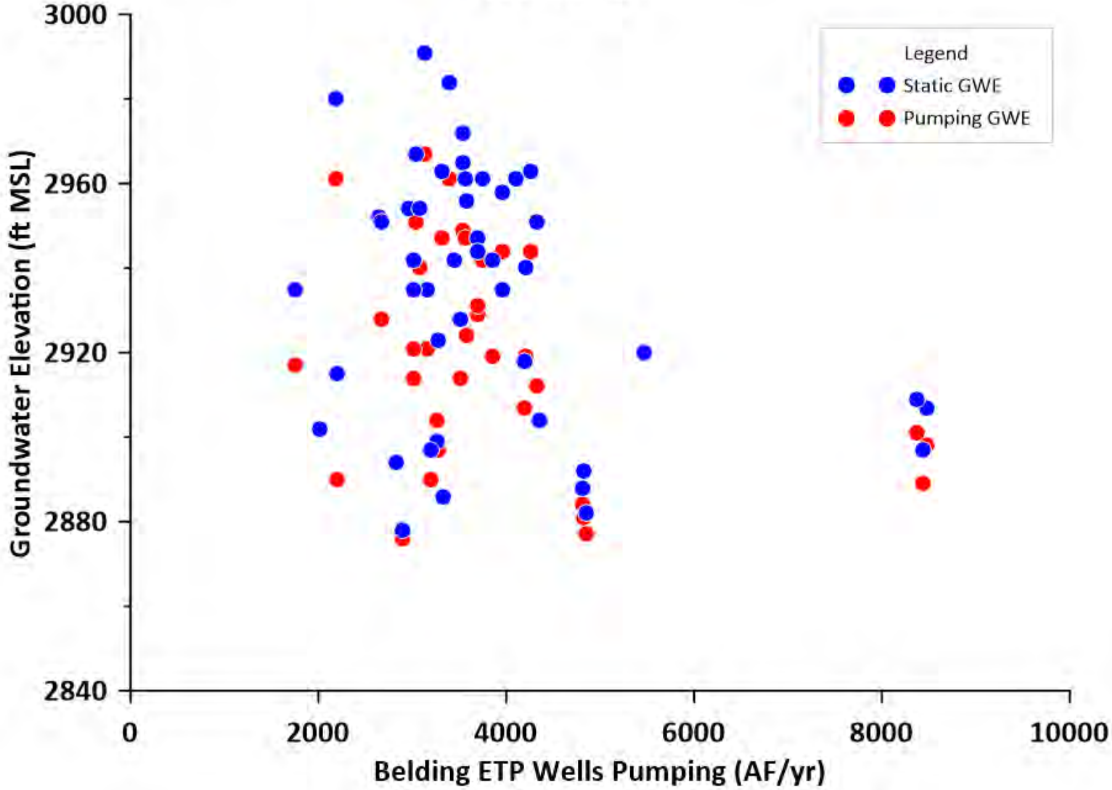


Winter1 = 2,892 ft
Winter4 = 2,907 ft
Interstate Well vs. 6 Belding Wells
Legend
Belding No. 1
Belding No. 2
Belding No. 3
Belding No. 5
Belding No. 8
Belding No. 10
3,040
3,000
2,960
2,920
2,880
Groundwater Elevation of Belding Wells (ft MSL)
2,890
2,900
2,910
2,920
2,930
2,940
2,950
Groundwater Elevation (ft MSL) of Interstate Well

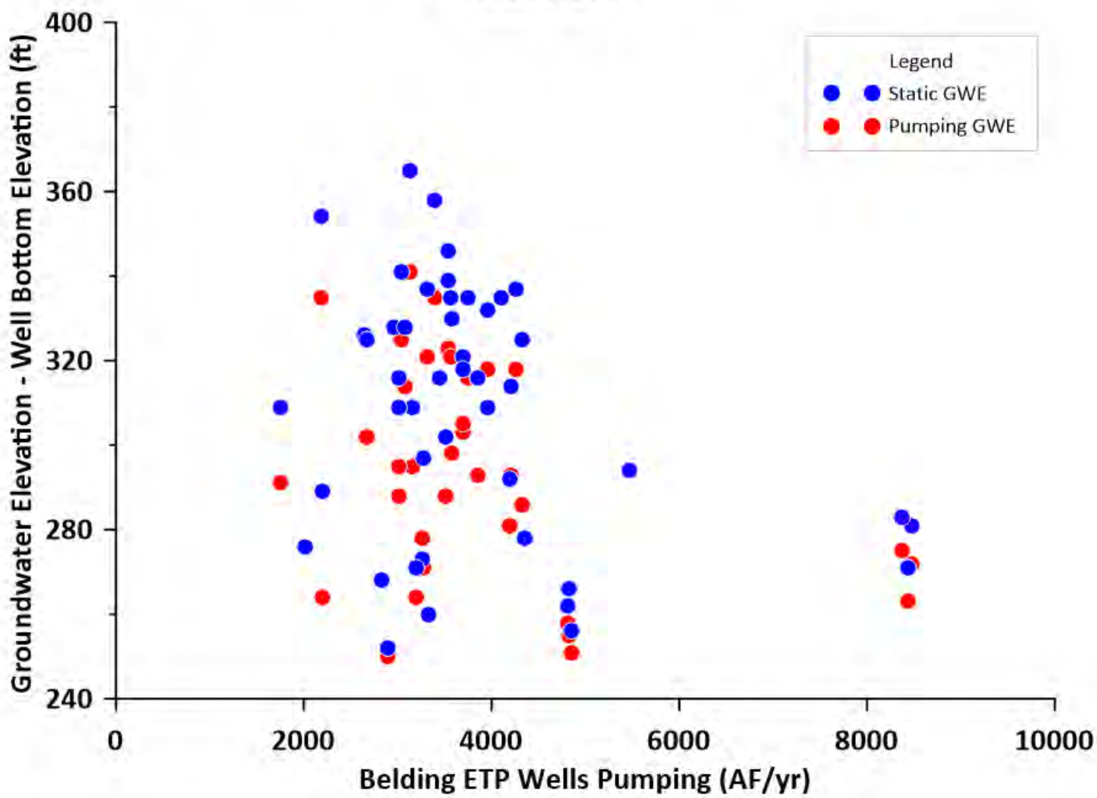
Appendix F

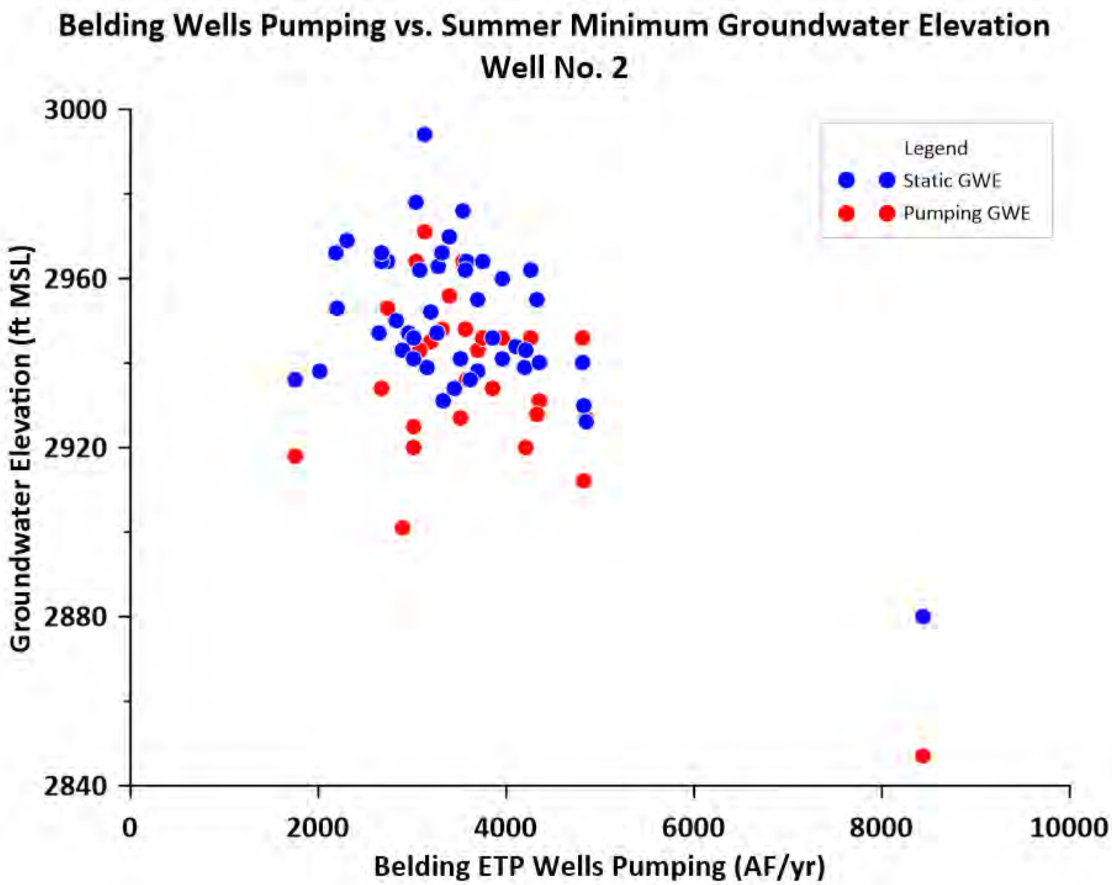
Annual Pumping vs. Summer Minimum Groundwater Elevations

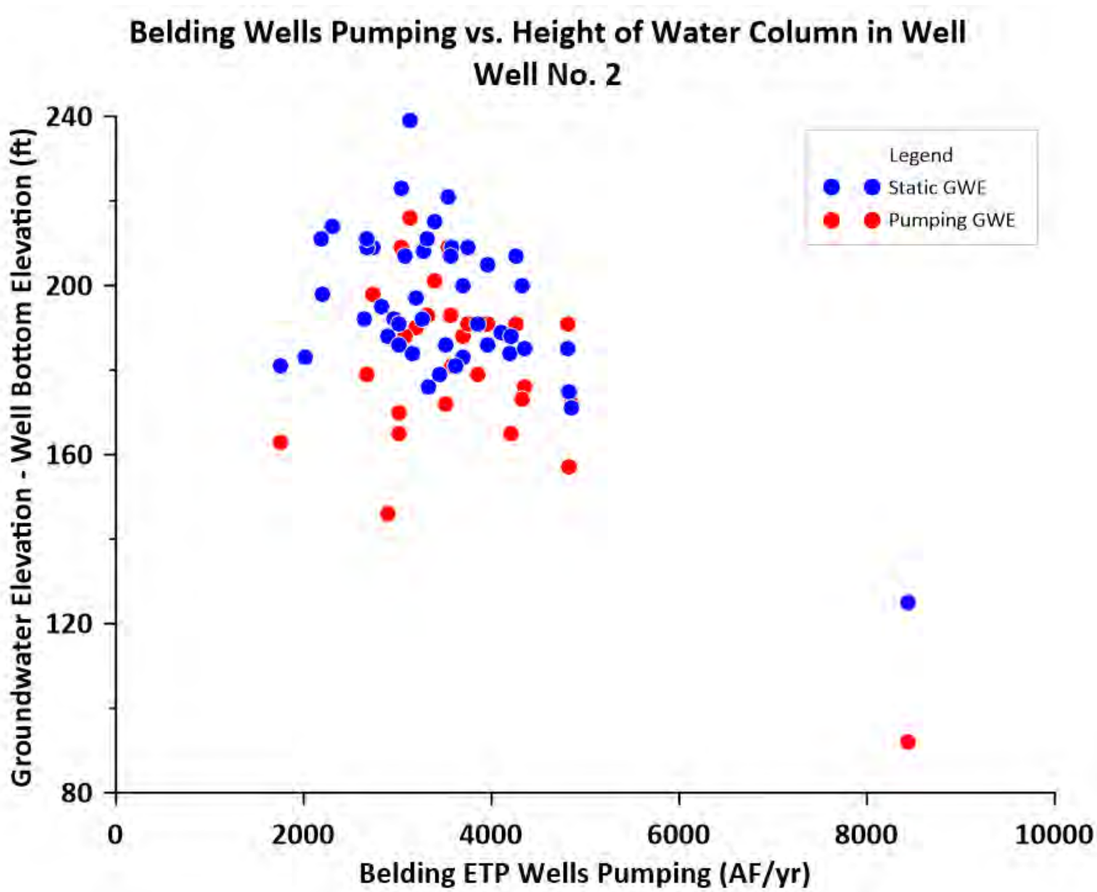
Belding Wells Pumping vs. Summer Minimum Groundwater Elevation
Well No. 1



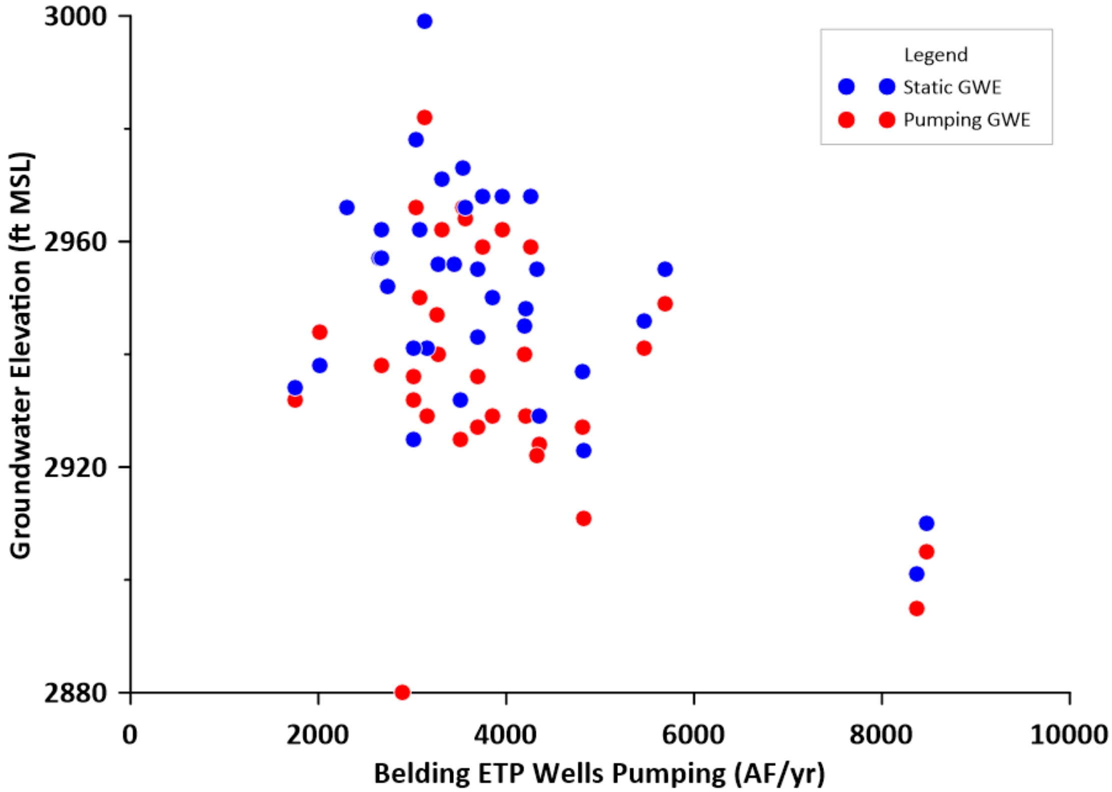
Belding Wells Pumping vs. Height of Water Column in Well
Well No. 1



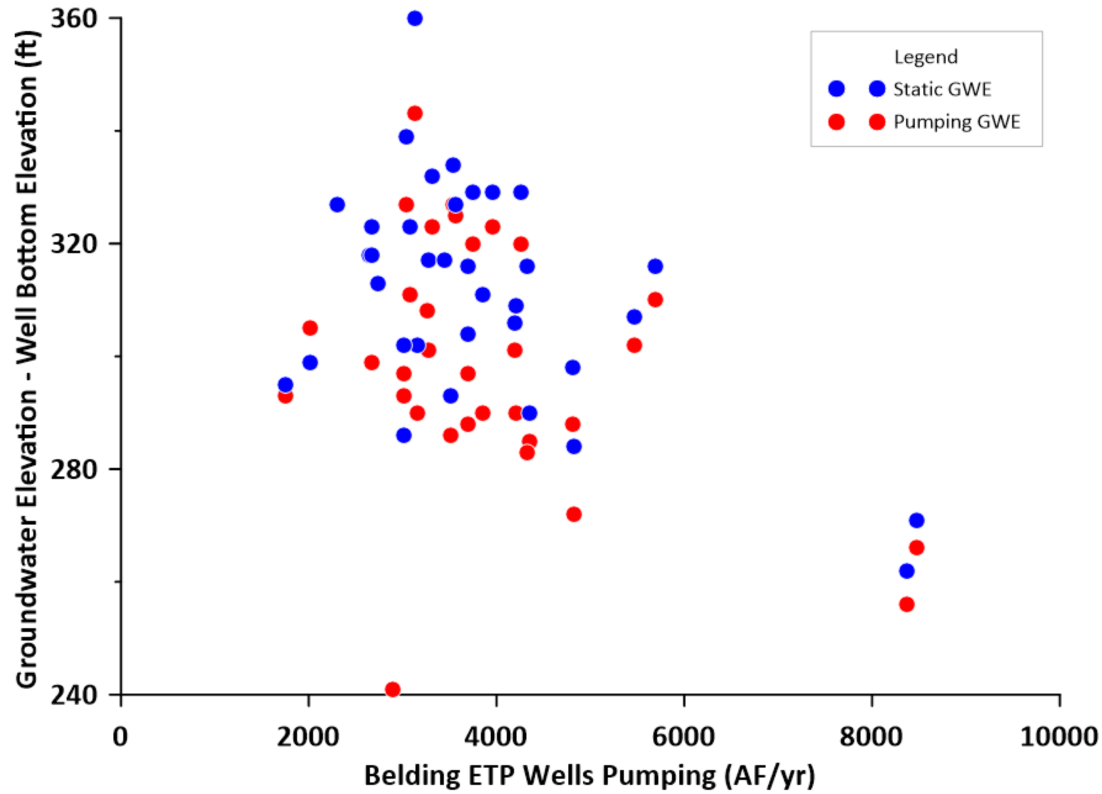

Belding Wells Pumping vs. Summer Minimum Groundwater Elevation
Well No. 2
Groundwater Elevation (ft MSL)
3000
2960
2920
2880
2840
0
2000
4000
6000
8000
10000
Belding ETP Wells Pumping (AF/yr)
Legend
Static GWE
Pumping GWE


Belding Wells Pumping vs. Height of Water Column in Well
Well No. 2
Groundwater Elevation - Well Bottom Elevation (ft)
240
200
160
120
80
0
2000
4000
6000
8000
10000
Belding ETP Wells Pumping (AF/yr)
Legend
Static GWE
Pumping GWE

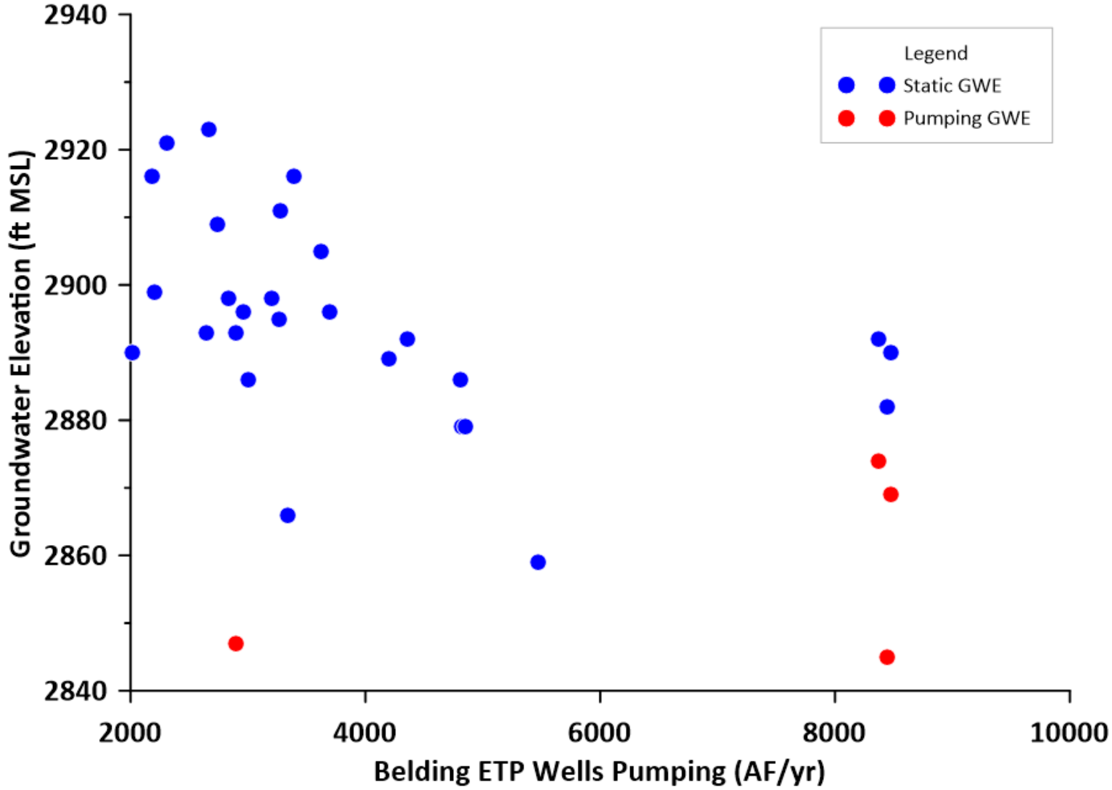
Belding Wells Pumping vs. Summer Minimum Groundwater Elevation
Well No. 3



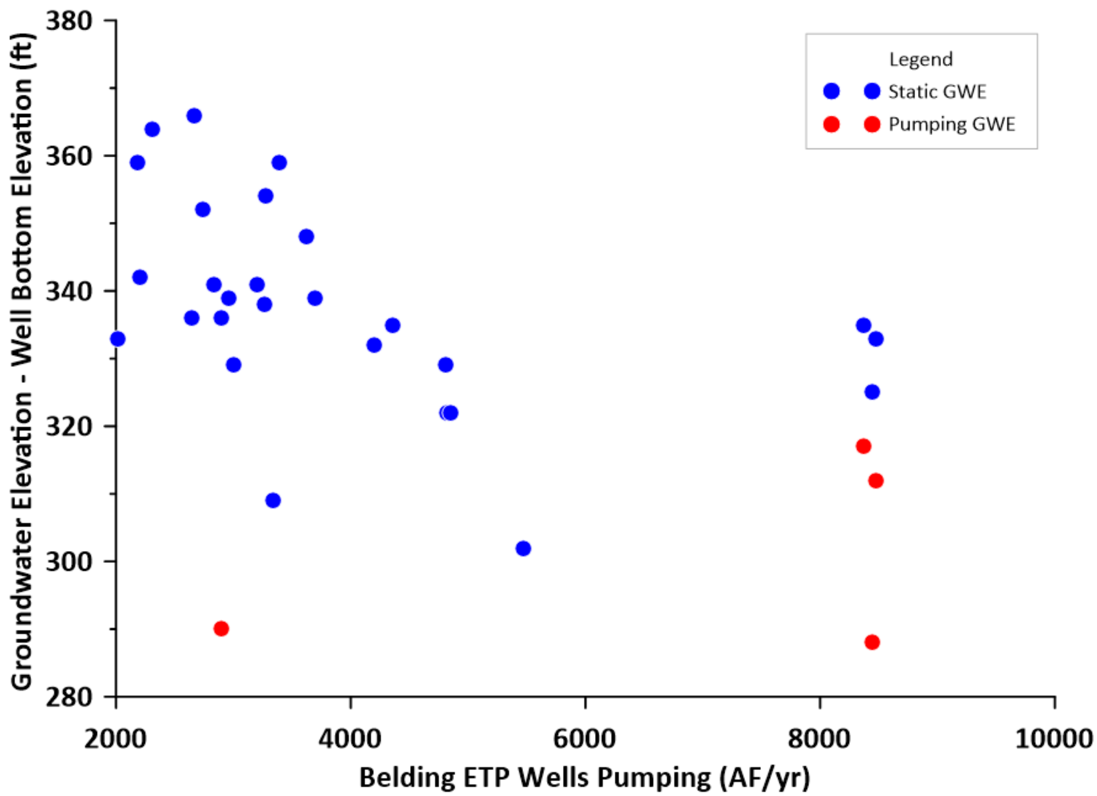
Belding Wells Pumping vs. Height of Water Column in Well
Well No. 3

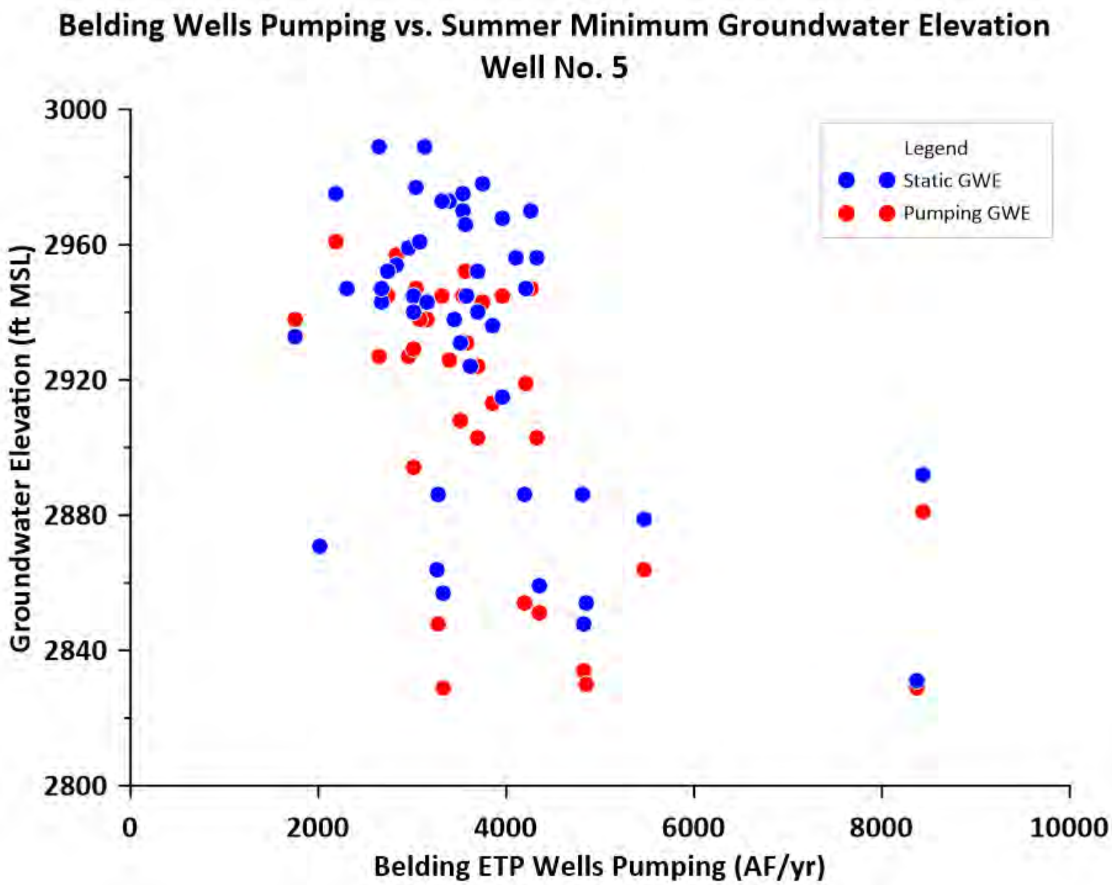


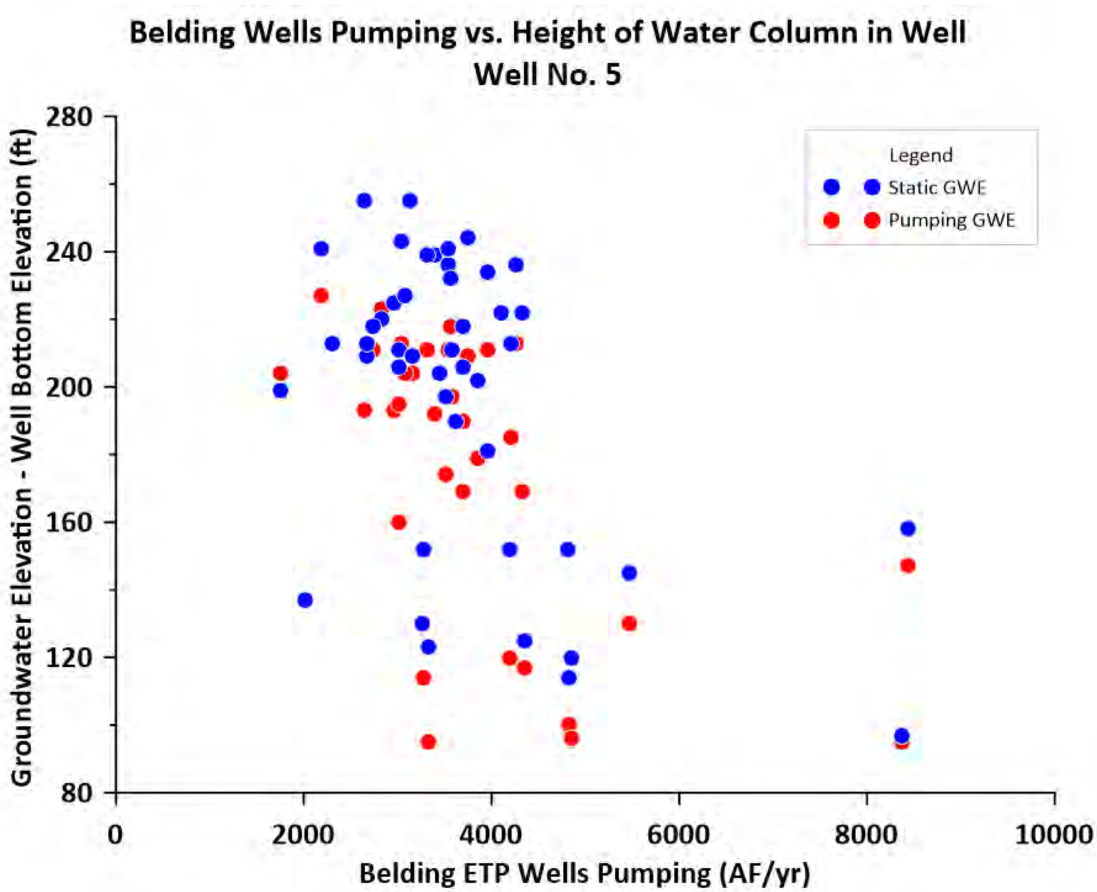
Belding Wells Pumping vs. Summer Minimum Groundwater Elevation
Well No. 4

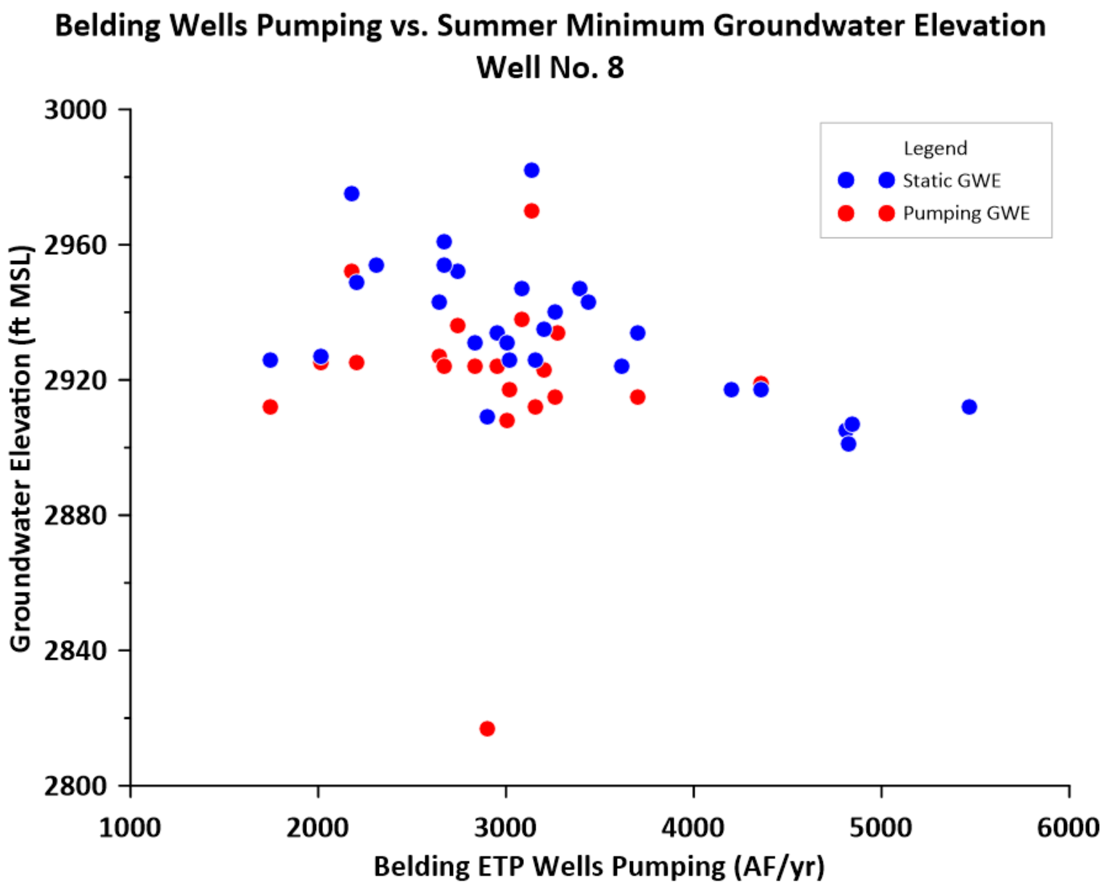


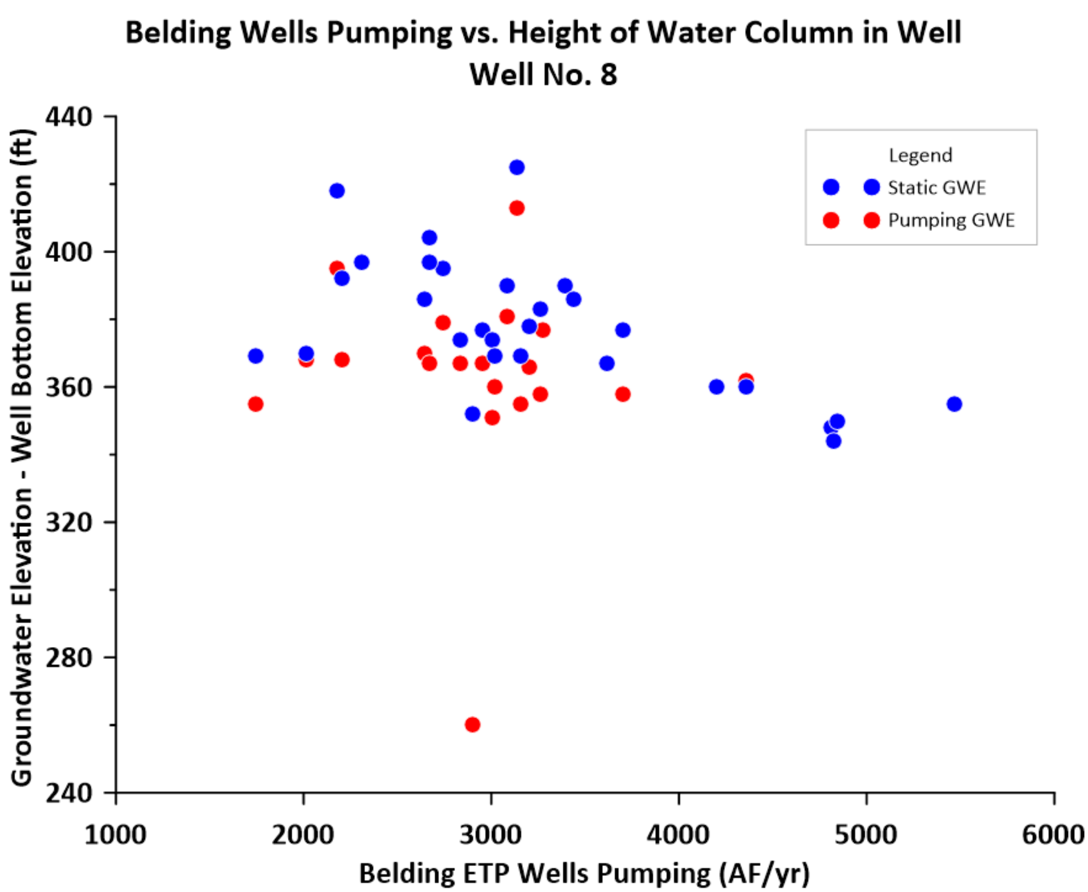
Belding Wells Pumping vs. Height of Water Column in Well
Well No. 4

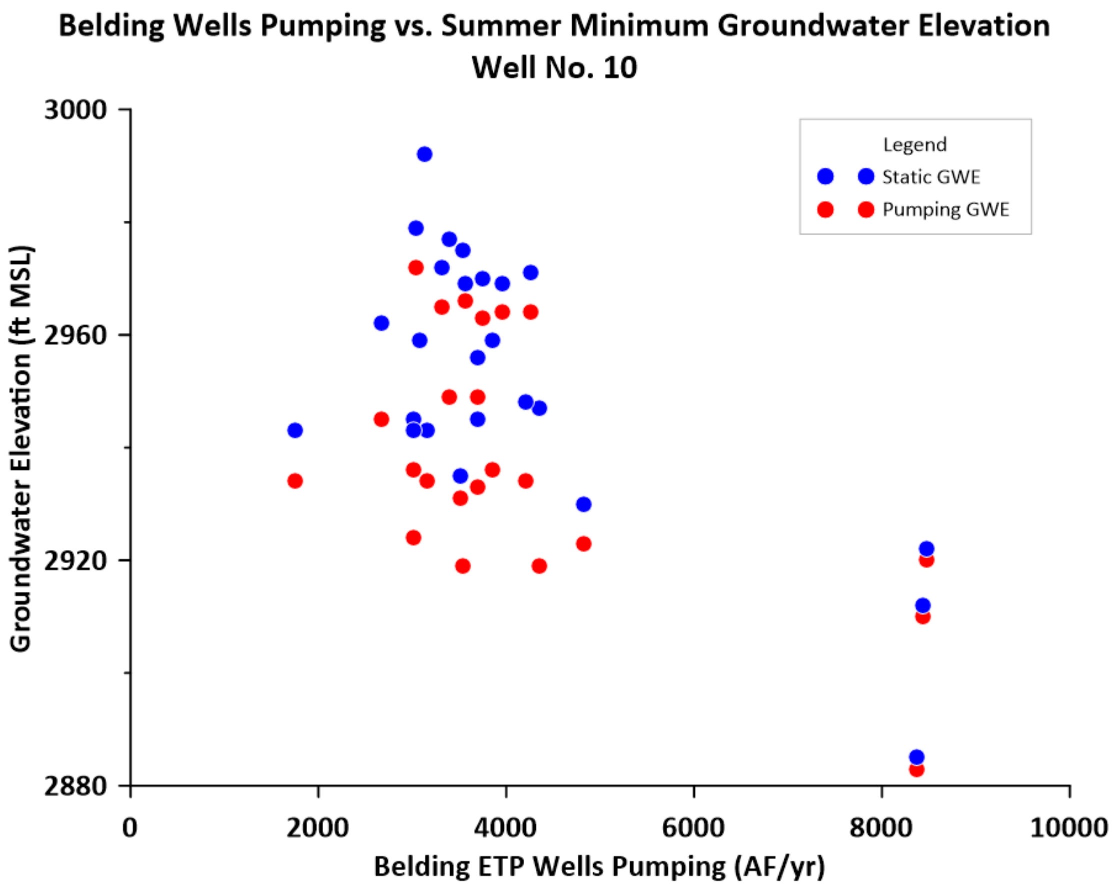


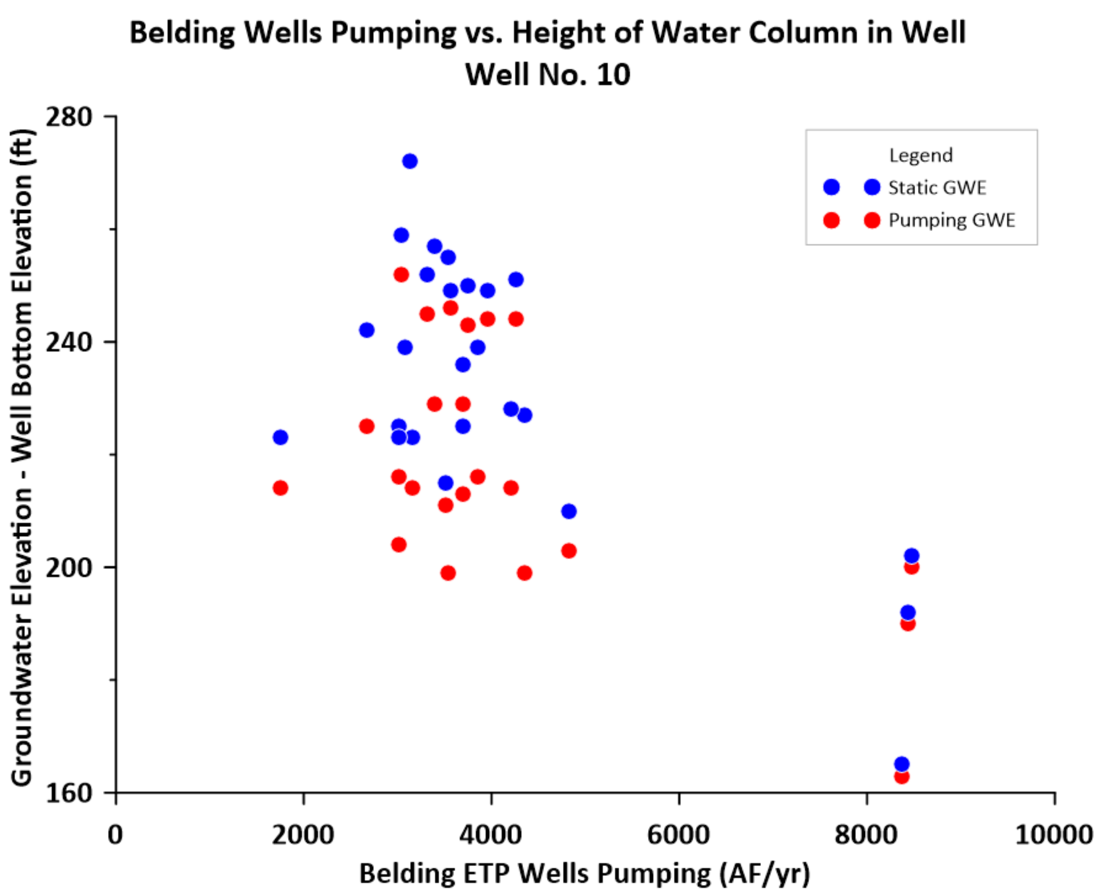

Belding Wells Pumping vs. Summer Minimum Groundwater Elevation
Well No. 5
Groundwater Elevation (ft MSL)
3000
2960
2920
2880
2840
2800
0
2000
4000
6000
8000
10000
Belding ETP Wells Pumping (AF/yr)
Legend
Static GWE
Pumping GWE

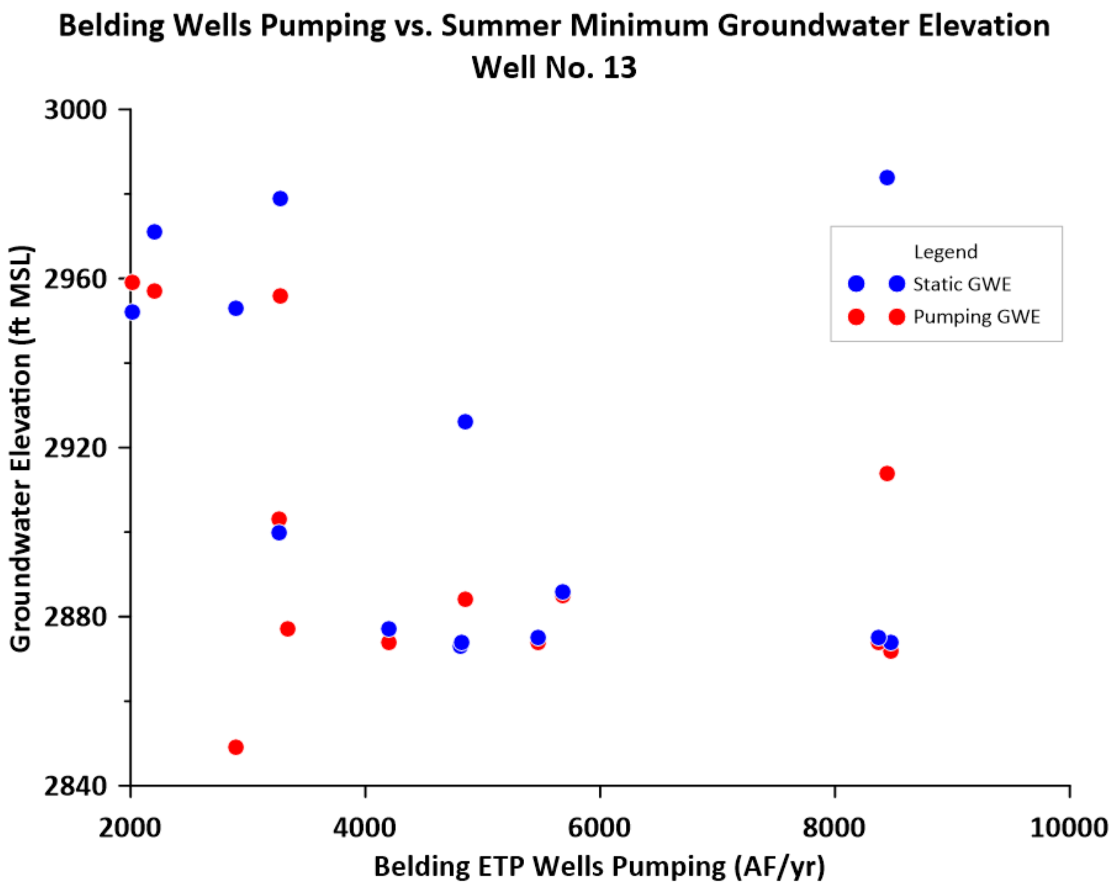

Belding Wells Pumping vs. Height of Water Column in Well
Well No. 5
Groundwater Elevation - Well Bottom Elevation (ft)
280
240
200
160
120
80
0
2000
4000
6000
8000
10000
Belding ETP Wells Pumping (AF/yr)
Legend
Static GWE
Pumping GWE

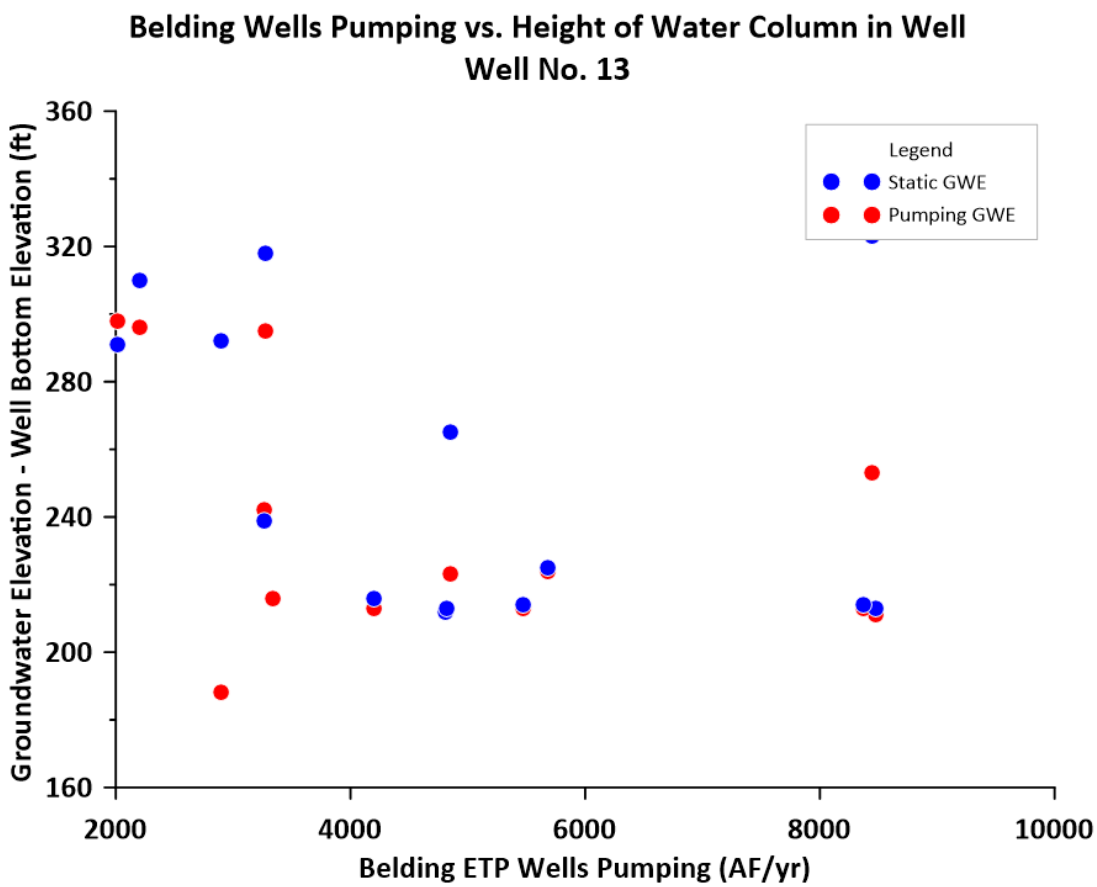

Belding Wells Pumping vs. Summer Minimum Groundwater Elevation
Well No. 8
Groundwater Elevation (ft MSL)
Belding ETP Wells Pumping (AF/yr)
Legend
Static GWE
Pumping GWE
3000
2960
2920
2880
2840
2800
1000
2000
3000
4000
5000
6000

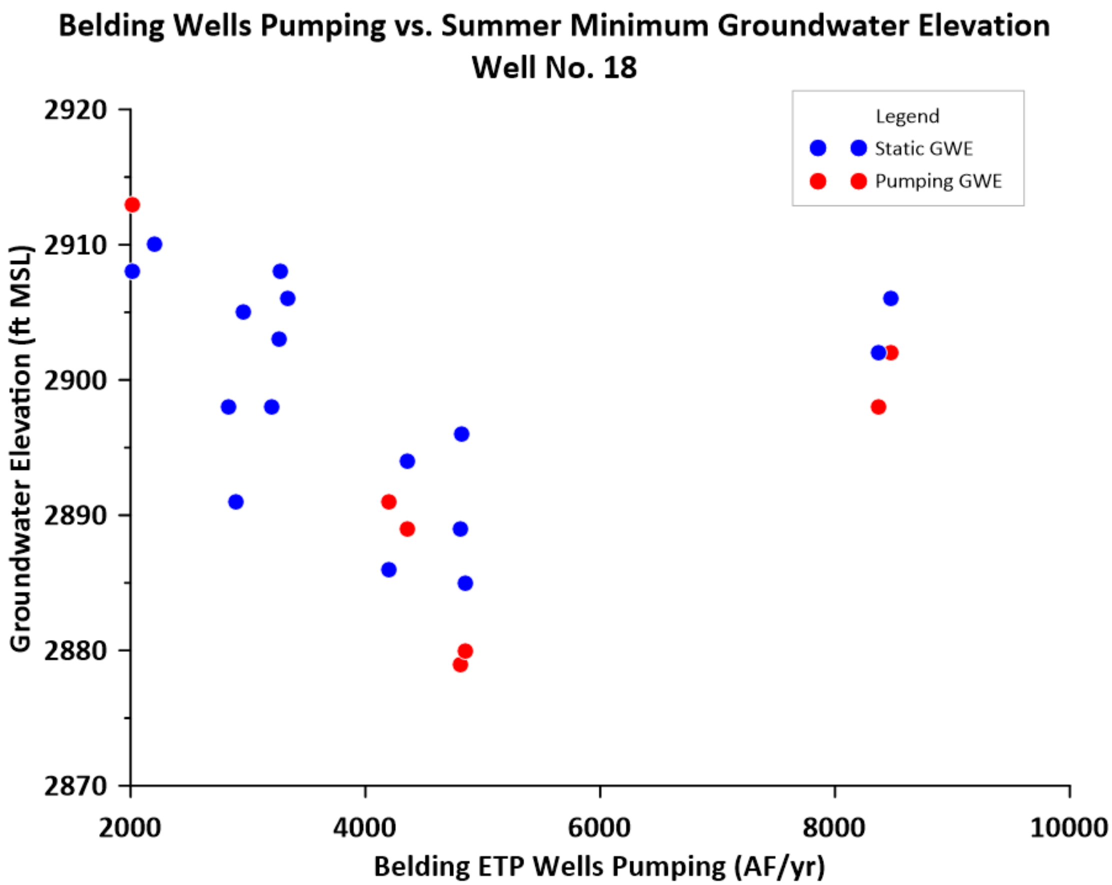

Belding Wells Pumping vs. Height of Water Column in Well
Well No. 8
Groundwater Elevation - Well Bottom Elevation (ft)
Belding ETP Wells Pumping (AF/yr)
Legend
Static GWE
Pumping GWE
440
400
360
320
280
240
1000
2000
3000
4000
5000
6000


Belding Wells Pumping vs. Summer Minimum Groundwater Elevation
Well No. 10
Groundwater Elevation (ft MSL)
Belding ETP Wells Pumping (AF/yr)
3000
2960
2920
2880
0
2000
4000
6000
8000
10000
Legend
Static GWE
Pumping GWE

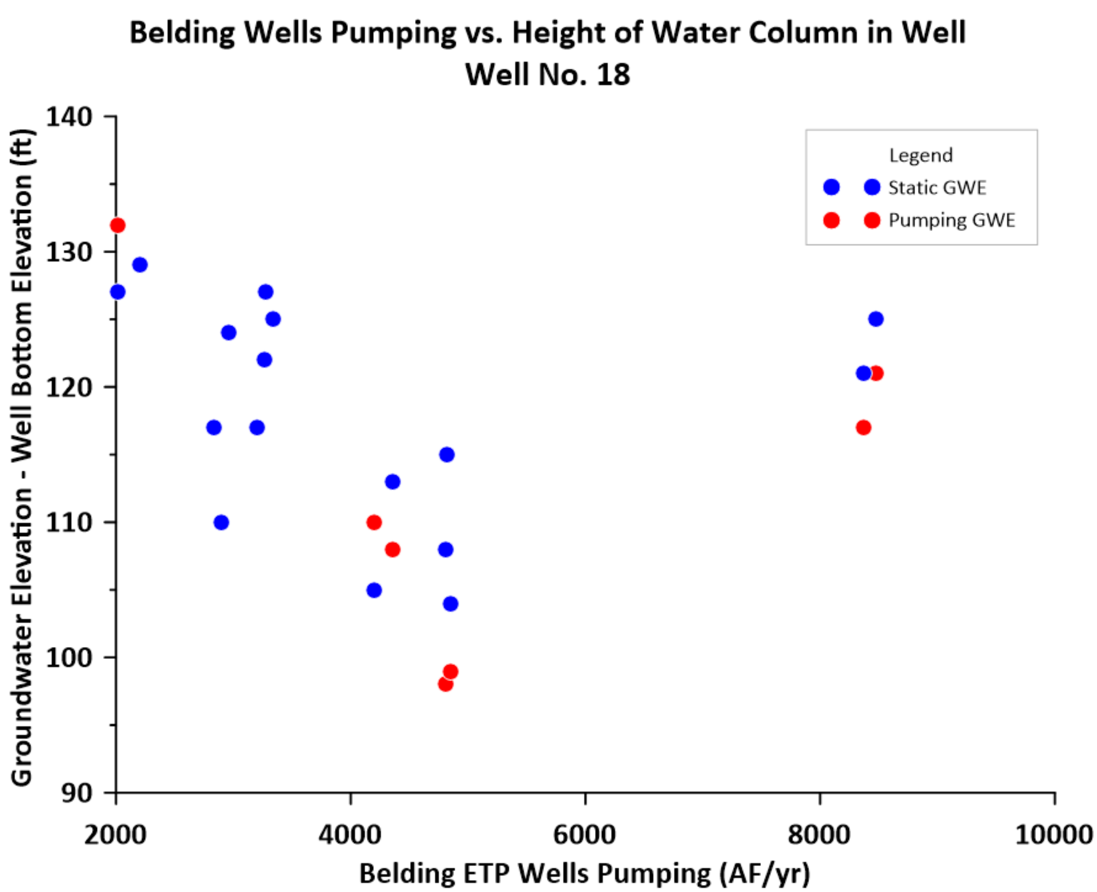

Belding Wells Pumping vs. Height of Water Column in Well
Well No. 10
Groundwater Elevation - Well Bottom Elevation (ft)
Belding ETP Wells Pumping (AF/yr)
280
240
200
160
0
2000
4000
6000
8000
10000
Legend
Static GWE
Pumping GWE


Belding Wells Pumping vs. Summer Minimum Groundwater Elevation
Well No. 13
3000
2960
2920
2880
2840
Groundwater Elevation (ft MSL)
2000
4000
6000
8000
10000
Belding ETP Wells Pumping (AF/yr)
Legend
Static GWE
Pumping GWE

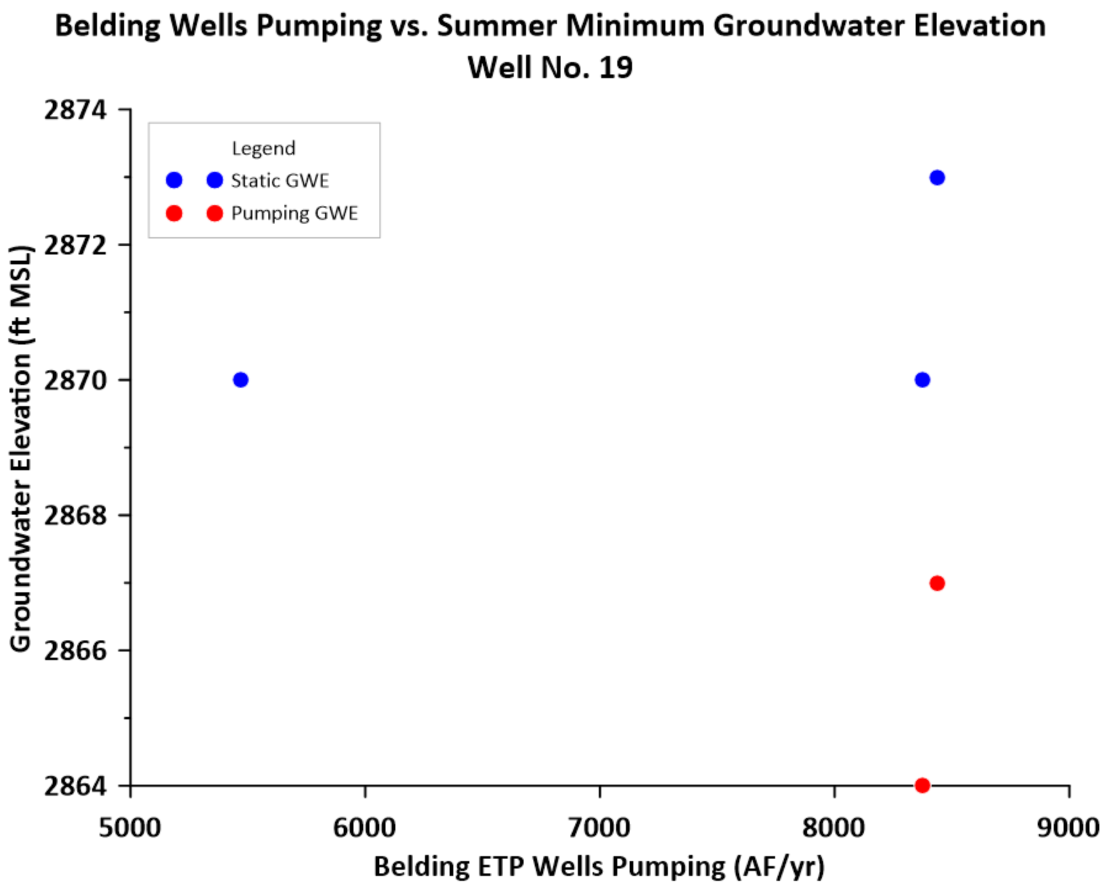

Belding Wells Pumping vs. Height of Water Column in Well
Well No. 13
360
320
280
240
200
160
Groundwater Elevation - Well Bottom Elevation (ft)
2000
4000
6000
8000
10000
Belding ETP Wells Pumping (AF/yr)
Legend
Static GWE
Pumping GWE

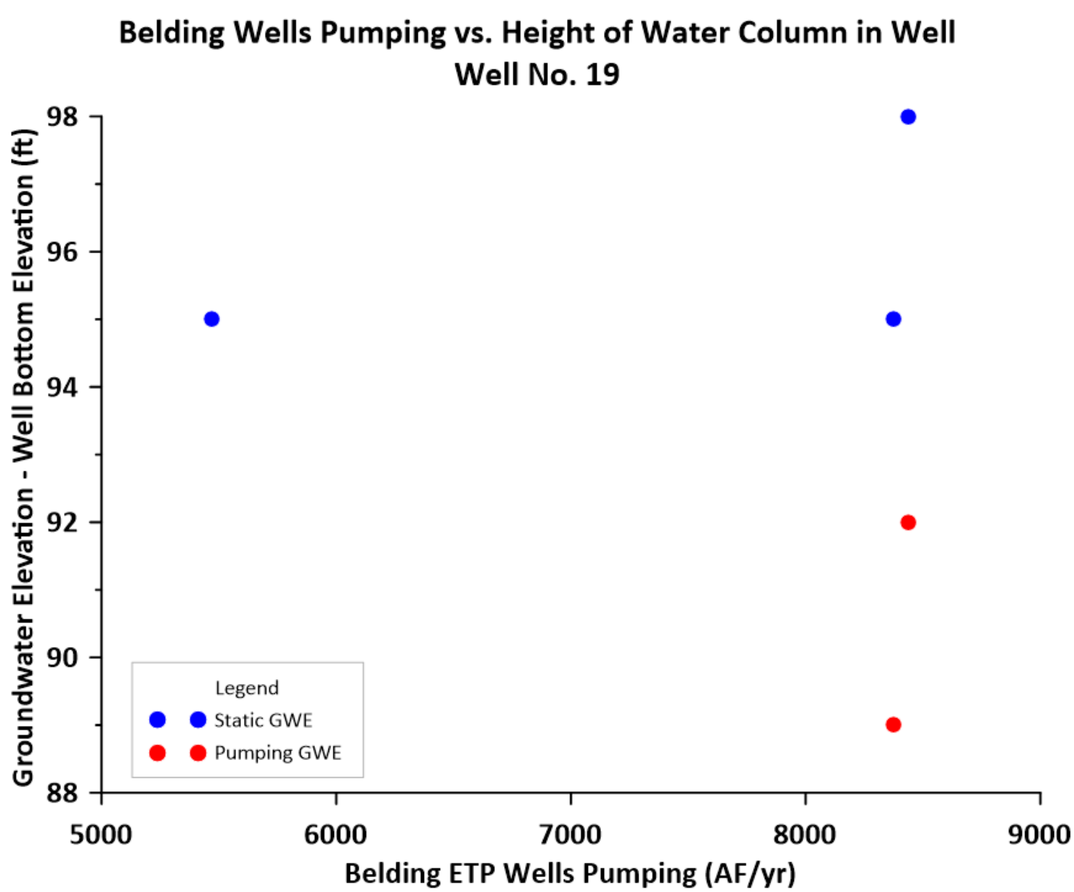


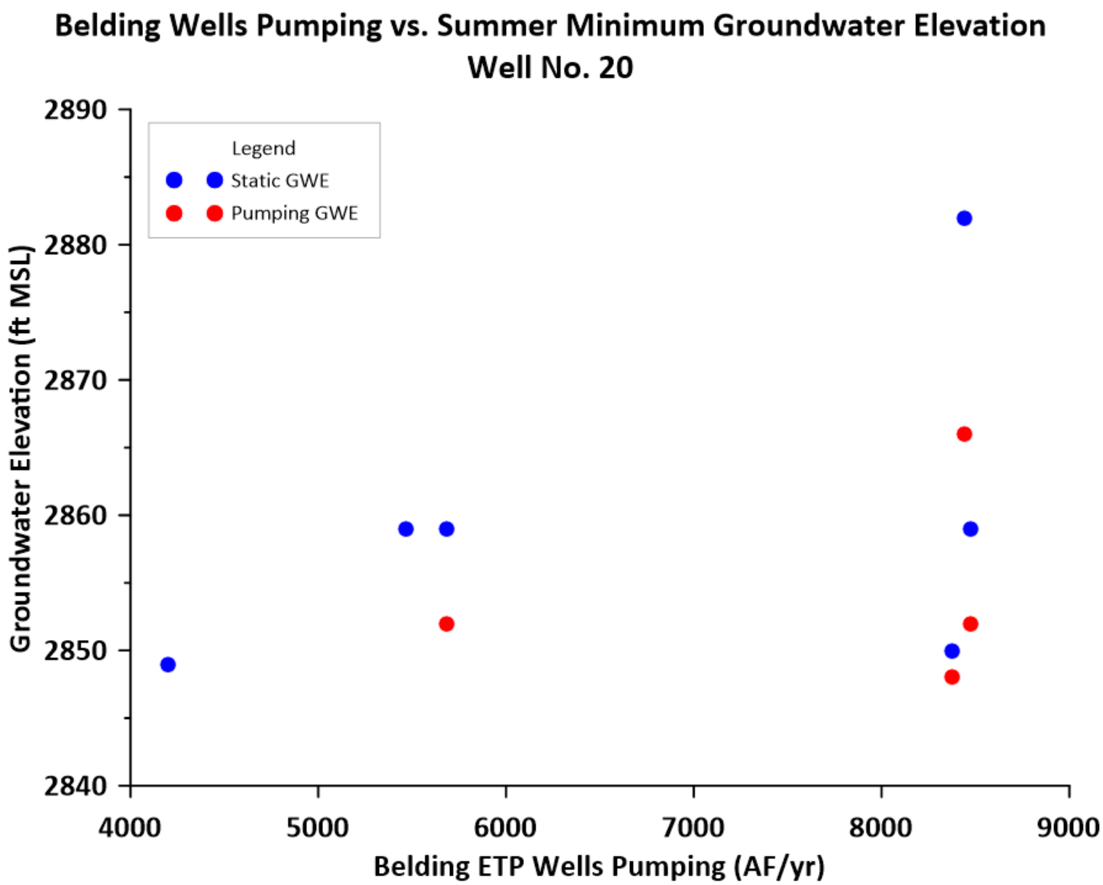
Belding Wells Pumping vs. Summer Minimum Groundwater Elevation
Well No. 18
Legend
Static GWE
Pumping GWE
Groundwater Elevation (ft MSL)
2920
2910
2900
2890
2880
2870
2000
4000
6000
8000
10000
Belding ETP Wells Pumping (AF/yr)

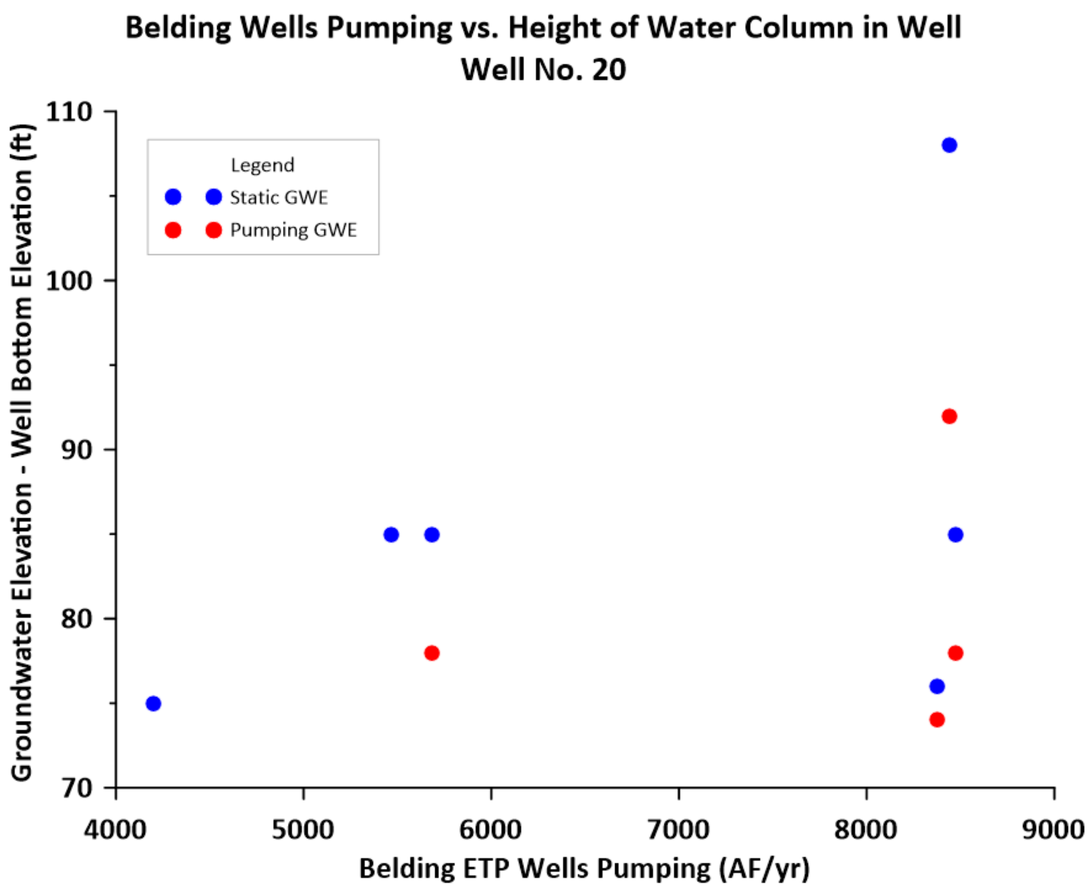


Belding Wells Pumping vs. Height of Water Column in Well
Well No. 18
Legend
Static GWE
Pumping GWE
Groundwater Elevation - Well Bottom Elevation (ft)
140
130
120
110
100
90
2000
4000
6000
8000
10000
Belding ETP Wells Pumping (AF/yr)


Belding Wells Pumping vs. Summer Minimum Groundwater Elevation
Well No. 19
Groundwater Elevation (ft MSL)
2874
2872
2870
2868
2866
2864
Legend
Static GWE
Pumping GWE
5000
6000
7000
8000
9000
Belding ETP Wells Pumping (AF/yr)


Belding Wells Pumping vs. Height of Water Column in Well
Well No. 19
Groundwater Elevation - Well Bottom Elevation (ft)
98
96
94
92
90
88
Legend
Static GWE
Pumping GWE
5000
6000
7000
8000
9000
Belding ETP Wells Pumping (AF/yr)


Belding Wells Pumping vs. Summer Minimum Groundwater Elevation
Well No. 20
Legend
Static GWE
Pumping GWE
Groundwater Elevation (ft MSL)
2890
2880
2870
2860
2850
2840
4000
5000
6000
7000
8000
9000
Belding ETP Wells Pumping (AF/yr)


Belding Wells Pumping vs. Height of Water Column in Well
Well No. 20
Legend
Static GWE
Pumping GWE
Groundwater Elevation - Well Bottom Elevation (ft)
110
100
90
80
70
4000
5000
6000
7000
8000
9000
Belding ETP Wells Pumping (AF/yr)

Appendix D

Updated Analysis of Belding Farms Data and Proposed “Anytime” Thresholds (October 17. 2023 Presentation)

Updated Analysis of Belding Farms Data and Proposed "Anytime" Thresholds

Bill Hutchison

October 17, 2023

1

Summary of Data Analysis History

- 2017
  - FSH Litigation Settled/Permit Issued
    - FSH and Belding Farms representatives participated in discussions and reviewed/commented on draft thresholds
    - Report (June 16, 2017)
      - Thresholds (4 winter, 1 summer) in 11 wells based on historic minimum groundwater elevations (based on data and model)
    - No Belding Farms data were available when thresholds were established
- 2018
  - Belding Farms data provided to MPGCD
  - Analyses
    - Report (December 7, 2018)
    - Presentation (December 18, 2018)
- 2019 to 2022
  - No meaningful discussions/analyses
- 2023
  - Cockrell provided and updated set of data (including pump settings)
  - Analyzed in context of rules petition

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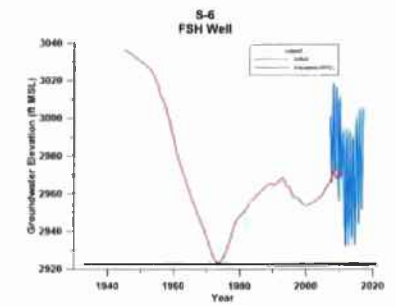

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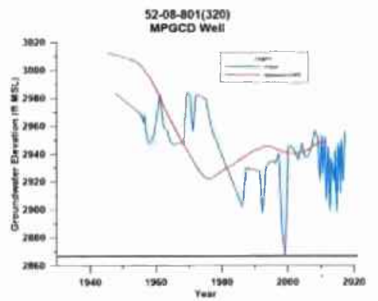

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2018 Report and Presentation

- One focus was "summer thresholds" (special condition on FSH permit) vs. "anytime thresholds" (Cockrell proposal)
- 2018 analysis evaluated Cockrell proposed "anytime thresholds" in the context of 6 Belding pumping wells
- Belding Farms data did not include pump setting in these 6 pumping wells
  - Without the pump depth data, not possible to fully evaluate

5

Conclusions from 2018 Analyses

- Groundwater elevations recover in winter (non-irrigation season)
- Drawdown (monthly and annual) is well defined with Belding Farms data
- Groundwater elevations in all MZ1 wells are "connected"
  - Also supported by MPGCD 11 monitoring well data
- Adopted thresholds are conservative and protective of Belding wells (and other MZ1 wells)

6

Conclusion Related to Cockrell's Ability to Pump

- Belding pumping data from 1960s and 1970s show that Cockrell's actual pumping was above Cockrell's current permit limits (no permit limits in 1960s and 1970s)
- Groundwater levels in 1960s and 1970s were much lower than recent groundwater levels
- Belding Farms data show that Belding Farms pumped as much as 8,000 AF/yr (from ETP Aquifer) when groundwater levels were lower than Cockrell's proposed "anytime" thresholds
- Cockrell's stated concerns about inability to pump are not supported by Belding Farms data

7

Updated (2023) Analyses

- Objective: Evaluate the proposed thresholds contained in Cockrell's petition/proposed MZ1 rules submitted in September 2023
- Update analysis of historic pumping in MZ1
  - Including Belding Farms pumping
- Focus on evaluation of Belding Farms winter maximum and summer minimum groundwater levels
  - Integrate pump setting data into analysis
- Update analysis of proposed (Cockrell) "anytime" thresholds in the context of Belding Farms pumping wells (Edwards-Trinity Plateau Aquifer)
- Review groundwater quality data evaluated in 2017 during development of settlement
  - Groundwater quality is a component of Cockrell petition/proposed MZ1 rules

8

Potential Errors in Belding Farms Data

- Static Water Levels and Pumping Water Levels
  - Depth to Water reported or blank if no data
  - Some cells had a "0", which were removed (assumed to be no data)
- Surface Elevation of Well 8
  - Listed as 2,132 ft MSL
  - Assumed to be a typo (used 3,132 ft MSL in analyses)

9

Historic Pumping in MPGCD Management Zone 1

- Western Pecos Model (R.W. Harden & Associates and others, 2011)
  - Pumping estimates in MZ1 from model output
  - Leon-Belding area estimates of pumping based on satellite analysis for three years (1954, 1974, 2005) completed by Resource Analysis and Mapping (RAM) and LBG-Guyton Associates (Appendix B of model report)
- MPGCD Permitted Pumping Data
- Belding Farms Pumping Data

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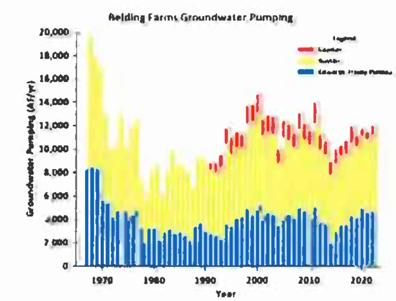

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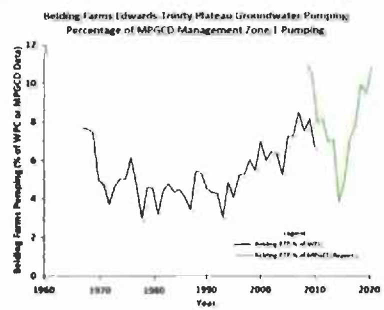

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Historic Pumping Conclusions

- MZ 1 pumping in 1960s and 1970s was more than recent years
- Based on FSH's retirement of historic and existing use permits, "export" pumping will not result in an increase in pumping above that experienced in the 1960s and 1970s
  - Foundation to special condition thresholds (protect historic minimum groundwater levels)
- Belding Farms pumping from Edwards-Trinity (Plateau) Aquifer (ETP) represents between 22 and 43 percent of total Belding Farms pumping (since 2010)
- Belding Farms ETP pumping has been 3 to 10 percent of MZ1 pumping from ETP

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Belding Farms Pumping and Groundwater Levels

- Focused on six ETP production wells
  - 1, 2, 3, 5, 8, 10
- Historic individual well pumping
  - Current permit limit
- Static depth-to-water data for each year
  - Winter maximum
  - Summer minimum
- Pump depth

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Winter Maximum Static Water Level Example

- Belding Well 1 (1974)
  - "Winter" period is November to March
  - Depth to water (from Belding Farms data)
    - November 1973 = 310 ft
    - December 1973 = 310 ft
    - January 1974 = 308 ft
    - February 1974 = 312 ft
    - March 1974 = 312 ft

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Winter Maximum Static Water Level Example

- Belding Well 1 (1974)
  - "Winter" period is November to March
  - Depth to water (from Belding Farms data)
    - November 1973 = 310 ft
    - December 1973 = 310 ft
    - January 1974 = 308 ft
    - February 1974 = 312 ft
    - March 1974 = 312 ft

Winter Maximum for 1974 = 308 ft

17

Summer Minimum Static Water Level Example

- Belding Well 1 (1982)
  - "Summer" period is April to October
  - Depth to water (from Belding Farms data)
    - April 1982 = No data
    - May 1982 = 292 ft
    - June 1982 = 304 ft
    - July 1982 = 306 ft
    - August 1982 = No data
    - September 1982 = 334 ft
    - October 1982 = 331 ft

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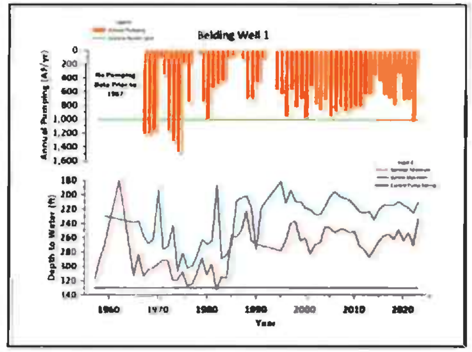
Summer Minimum Static Water Level Example

- Belding Well 1 (1982)
  - "Summer" period is April to October
  - Depth to water (from Belding Farms data)
    - April 1982 = No data
    - May 1982 = 292 ft
    - June 1982 = 304 ft
    - July 1982 = 306 ft
    - August 1982 = No data
    - September 1982 = 334 ft
    - October 1982 = 331 ft

Summer Minimum for 1982 = 334 ft

19



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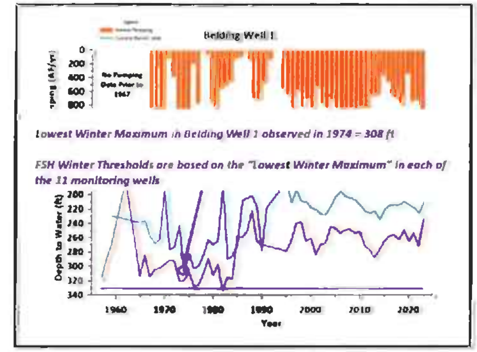

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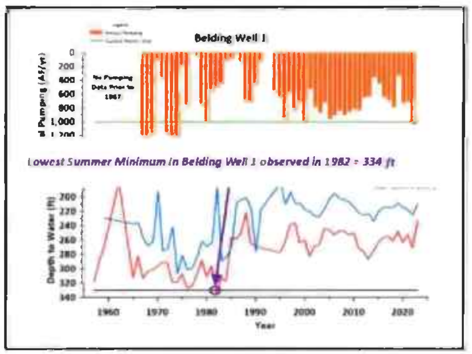

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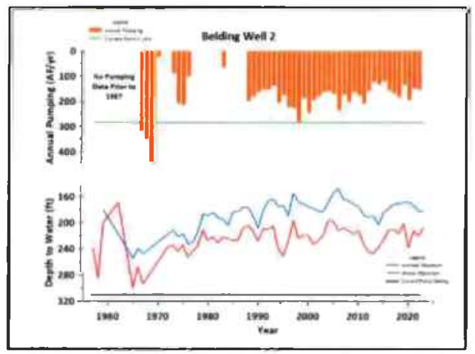

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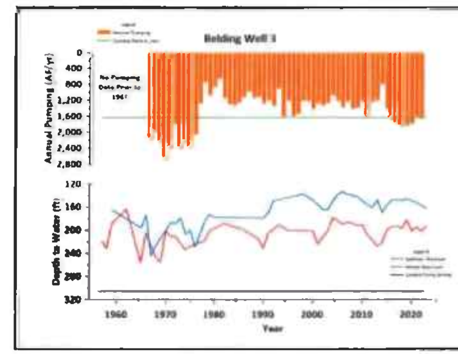

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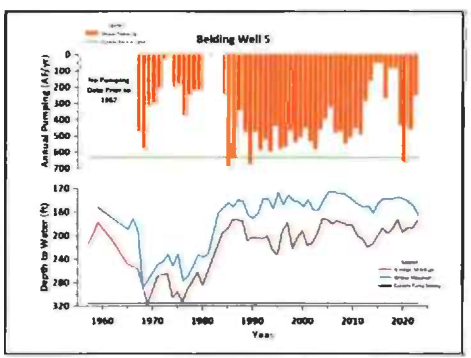

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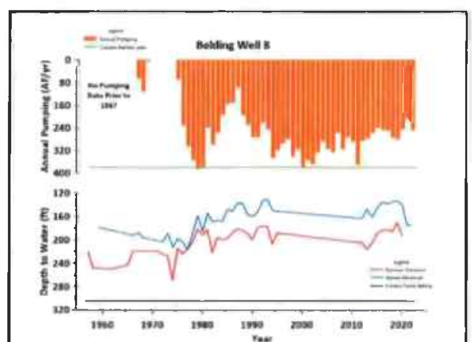

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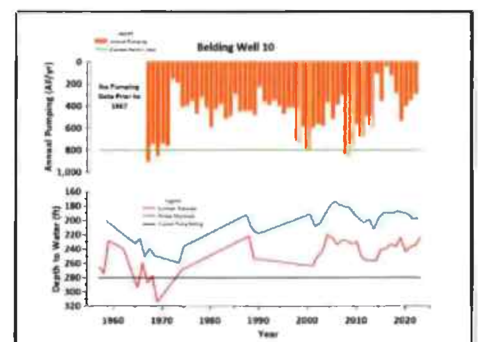

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Historic Pumping Conclusions

- Higher pumping in 1960s and 1970s correlate with lower groundwater levels
- Recent pumping has sometimes exceeded individual well permit limits as reported in Belding Farms database
- Lower groundwater levels in 1960s and 1970s recovered when pumping was reduced
  - Suggests that special condition pumping reductions for FSH wells would result in recovery of groundwater levels if implemented
- No long-term decline in winter groundwater levels in last 30+ years
  - Suggests pumping at current levels is sustainable
    - Not the same as "sustainable management" linked to year round spring flow
- At least 4 of the 6 Belding Farms production wells analyzed had lower pump settings in 1960s and 1970s when groundwater levels were lower
  - Based on comparison of summer minimum, current pump setting, and historic pumping

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Summary of Cockrell Proposed "Anytime" Thresholds

- Four monitoring wells
- Specified MPGCD action if groundwater levels drop below two of the four wells

Table 1. Groundwater elevation trigger levels (ft, msl | depth to water)

Well	Threshold 1		Threshold 2		Threshold 3	
Prison Well	2960	239	2950	249	2900	299
S-6	2935	188	2925	198	2875	248
S-45	2920	147	2910	157	2860	207
MPGCD 320	2900	168	[illegible]	178	2840	228

29

Proposed Actions/Pumping Reductions

- Threshold 1 actions include several administrative actions including a moratorium on permits, and discussion at Board meeting
  - Lasts 30 days
- Proposed production reductions (all "production permit holders" in MZ1):
  - Threshold 1: None
  - Threshold 2: 50%
  - Threshold 3: 100%

30

Administration of Proposed Reductions

- Daily reductions in permit limits under Thresholds 2 and 3
- Requires 10 days above threshold limit to resume "normal" permit limits (3 of 4 wells)
- Provisions to adjust Threshold 2 limits after "evidentiary hearing" and analysis of groundwater quality data
  - Essentially demonstrating that there was "no adverse impact to the aquifer" if Threshold 2 was triggered
  - Caveat: if FSH Winter Threshold 1 is invoked, no changes can be made

31

Analyses of Proposed "Anytime" Thresholds

- 2018 report and presentation included correlation analysis of groundwater elevations
  - Belding Farms wells
  - 11 MPGCD monitoring wells in FSH special permit conditions
- Provided data at the time did not include pump settings
- Updated the analysis
  - Calculated the range of groundwater levels in 6 Belding Farms wells based on proposed thresholds for 4 MPGCD monitoring wells
  - Compared to static water levels in 6 Belding Farms production wells (1,2,3,5,8,10)
    - Winter maximum
    - Summer minimum

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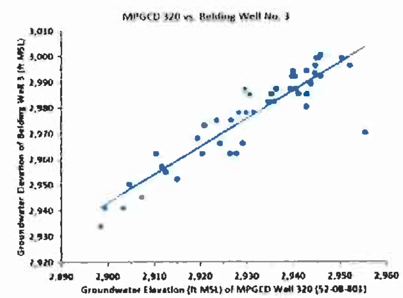

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Proposed "Anytime" Threshold Hydrographs

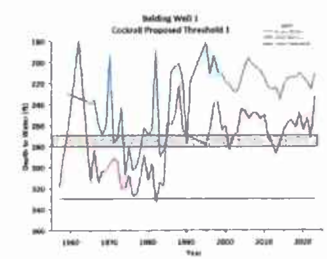
- Six Belding Farms production wells
  - 1, 2, 3, 5, 8, 10
- Three proposed "anytime" thresholds in those six wells
  - Range based on correlation with four wells with proposed thresholds
  - Winter maximum and summer minimum depth to water data
  - Pump setting
- Total of 18 hydrographs (6 wells x 3 thresholds)

34

Belding Well 1

- Well Depth = 586 ft
- Pump Setting = 330 ft
- Average Pumping
  - 1967 to 1974 = 1,023 AF/yr
  - 2010 to 2022 = 675 AF/yr

35



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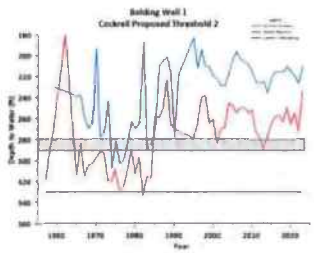

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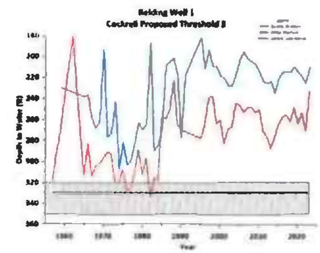

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Belding Well 2

- Well Depth = 420 ft
- Pump Setting = 310 ft
- Average Pumping
  - 1967 to 1974 = 182 AF/yr
  - 2010 to 2022 = 162 AF/yr

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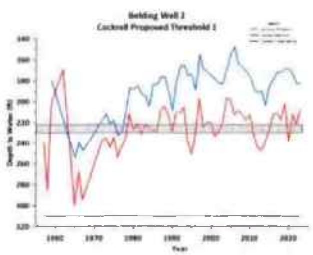

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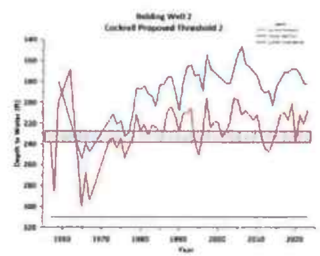

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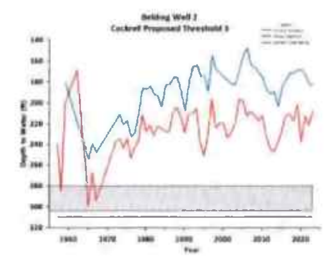

42

Belding Well 3

- Well Depth = 519 ft
- Pump Setting = 305 ft
- Average Pumping
  - 1967 to 1974 = 2,244 AF/yr
  - 2010 to 2022 = 1,524 AF/yr

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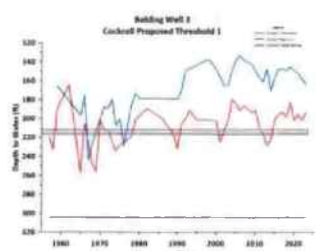

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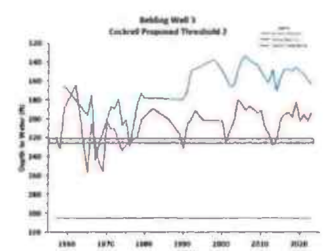

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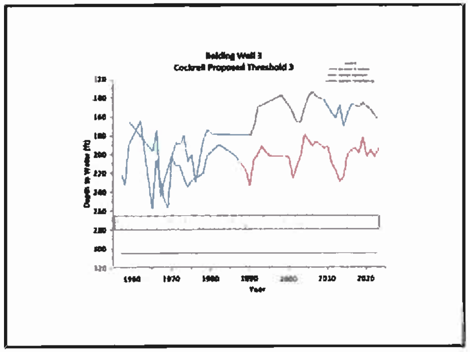

46

Belding Well 5

- Well Depth = 415 ft
- Pump Setting = 315 ft
- Average Pumping
  - 1967 to 1974 = 268 AF/yr
  - 2010 to 2022 = 293 AF/yr

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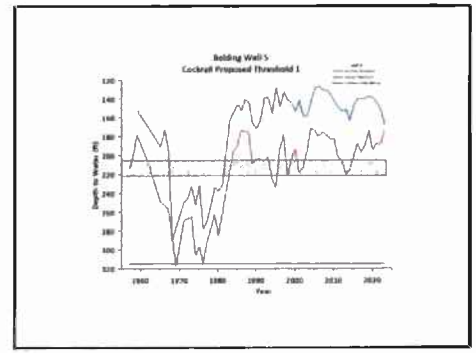

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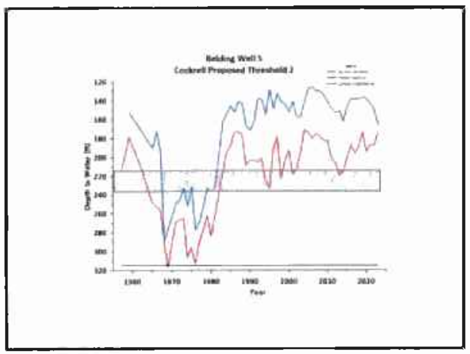

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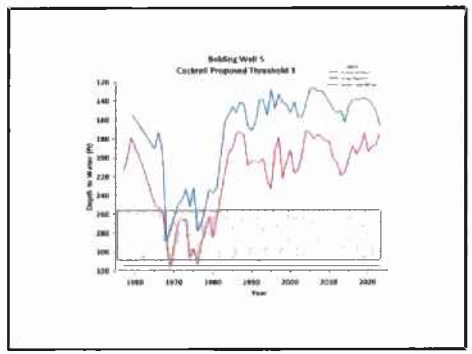

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Belding Well 8

- Well Depth = 575 ft
- Pump Setting = 305 ft
- Average Pumping
  - 1967 to 1974 = 24 AF/yr
  - 2010 to 2022 = 270 AF/yr

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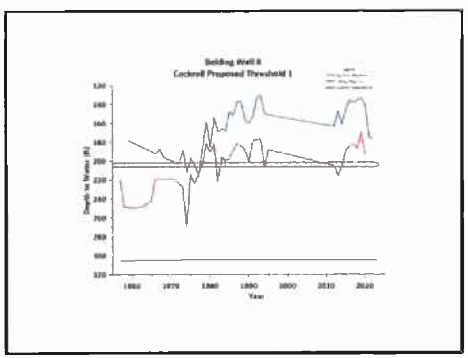

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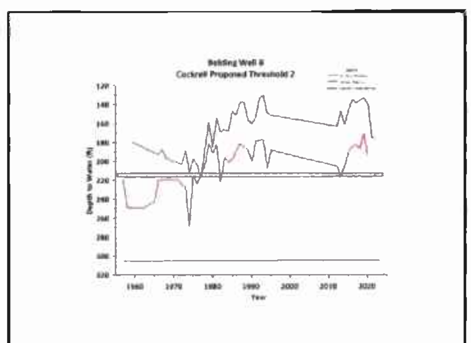

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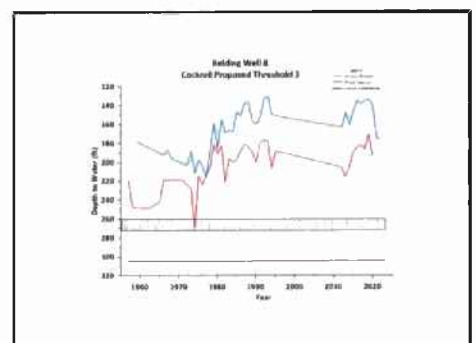
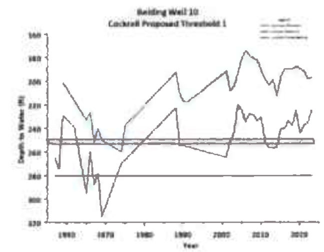


54

Belding Well 10

- Well Depth = 480 ft
- Pump Setting = 280 ft
- Average Pumping
  - 1967 to 1974 = 602 AF/yr
  - 2010 to 2022 = 377 AF/yr

55



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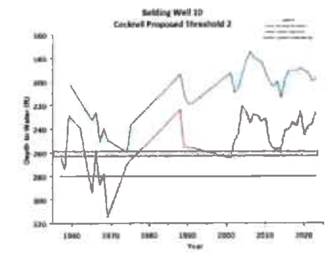

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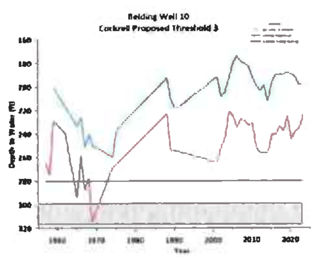

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Analysis of Current FSH Thresholds in the Context of Belding Farms Wells

- Belding Farms data were not available in 2017 when thresholds were developed
- 2018 data analysis concluded that the winter thresholds are conservative in protecting groundwater levels in MZ1 wells
  - If Belding Farms data had been available in 2017, winter thresholds would have been set lower
  - FSH chose to not request (or initiate) revisions based on the 2018 data analysis of Belding Farms data
    - Awaiting results of additional studies and monitoring results
- Discussion of 2018 Belding Farms data analysis included recognition that summer thresholds could be revised
  - Requested pump setting data to include as a criterion to revise summer thresholds

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Winter Threshold Hydrographs

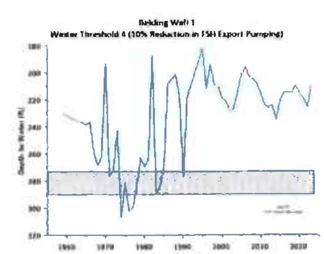
- Six Belding Farms production wells
  - 1, 2, 3, 5, 8, 10
- Four FSH winter thresholds in those six wells
  - Range based on correlation with four wells from Cockrell proposal
  - Winter maximum depth to water data
- Total of 24 hydrographs (6 wells x 4 thresholds)
  - Winter 4 = 10% FSH export pumping reduction
  - Winter 3 = 30% FSH export pumping reduction
  - Winter 2 = 50% FSH export pumping reduction
  - Winter 1 = 100% FSH export pumping reduction

60

Belding Well 1

- Well Depth = 586 ft
- Pump Setting = 330 ft
- Average Pumping
  - 1967 to 1974 = 1,023 AF/yr
  - 2010 to 2022 = 675 AF/yr

61



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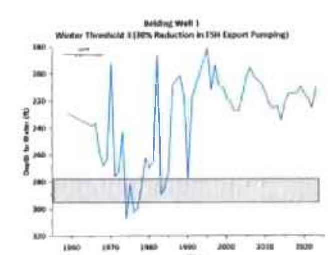

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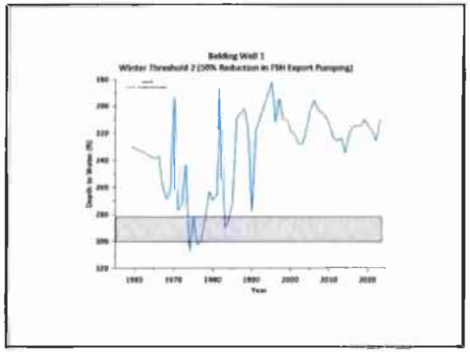

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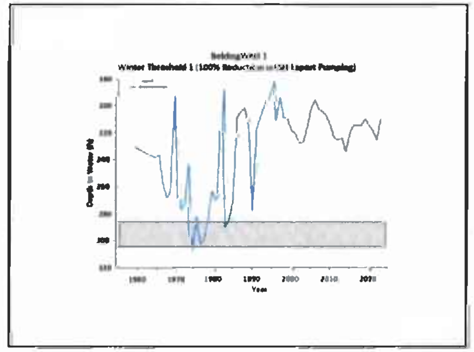

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Belding Well 2

- Well Depth = 420 ft
- Pump Setting = 310 ft
- Average Pumping
  - 1967 to 1974 = 182 AF/yr
  - 2010 to 2022 = 162 AF/yr

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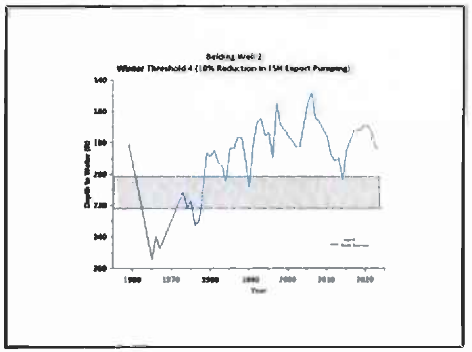

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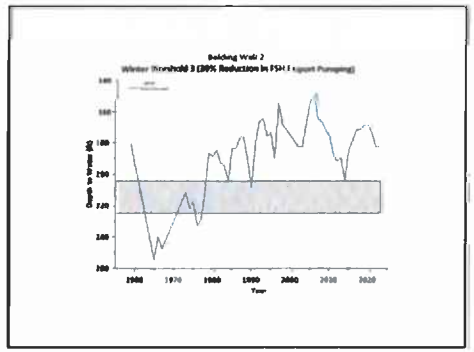

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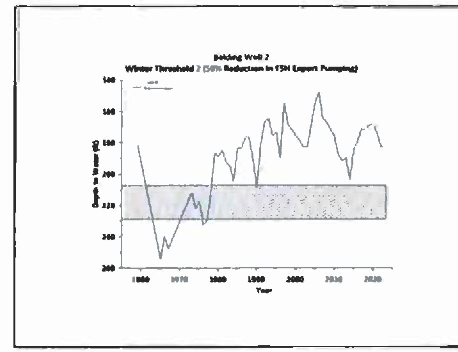

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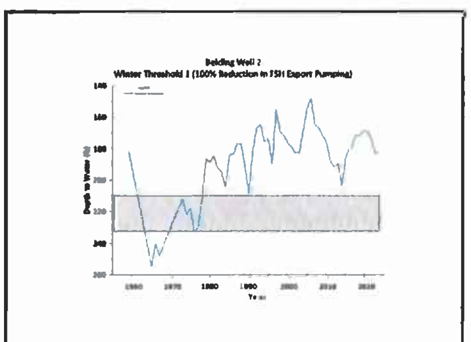

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Belding Well 3

- Well Depth = 519 ft
- Pump Setting = 305 ft
- Average Pumping
  - 1967 to 1974 = 2,244 AF/yr
  - 2010 to 2022 = 1,524 AF/yr

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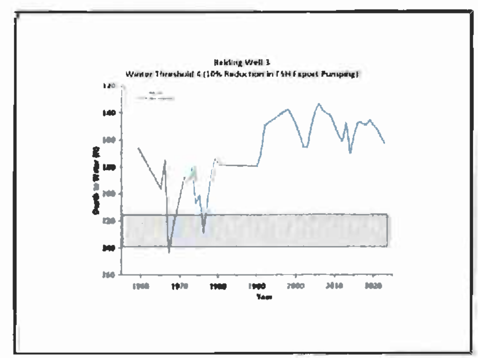

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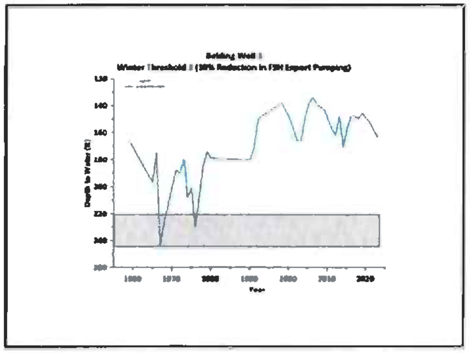

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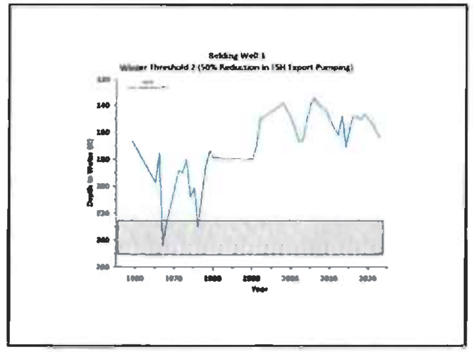

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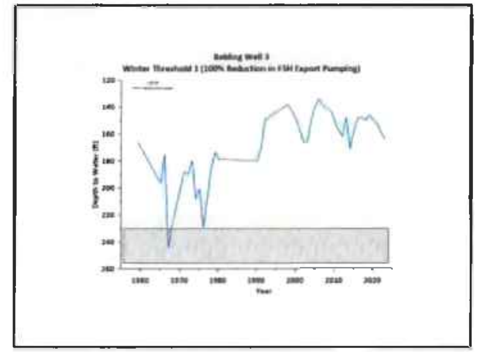
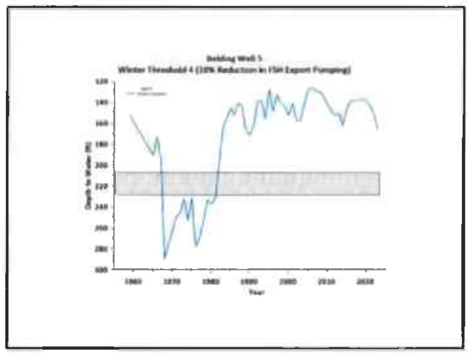


75

Belding Well 5

- Well Depth = 415 ft
- Pump Setting = 315 ft
- Average Pumping
  - 1967 to 1974 = 268 AF/yr
  - 2010 to 2022 = 293 AF/yr

76



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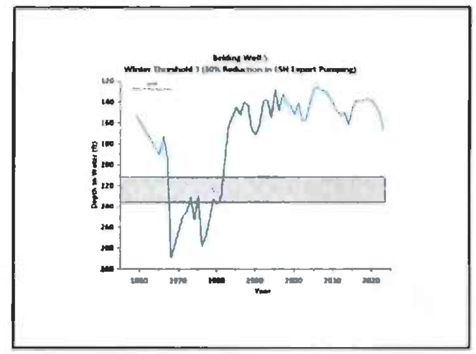

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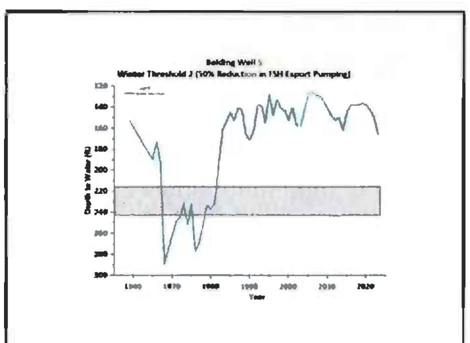

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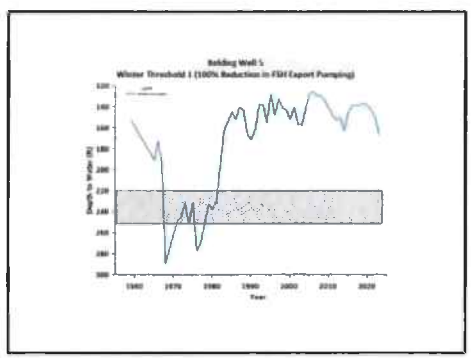
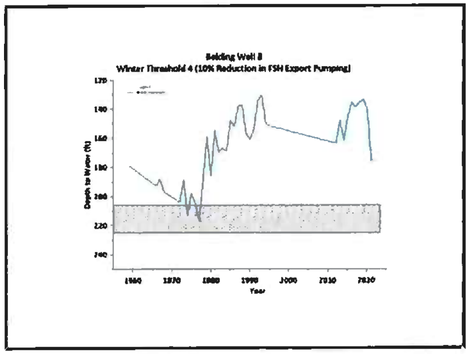


80

Belding Well 8

- Well Depth = 575 ft
- Pump Setting = 305 ft
- Average Pumping
  - 1967 to 1974 = 24 AF/yr
  - 2010 to 2022 = 270 AF/yr

81



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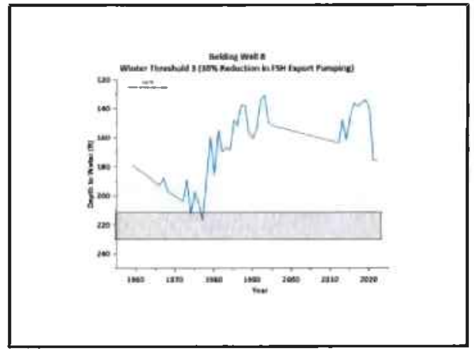

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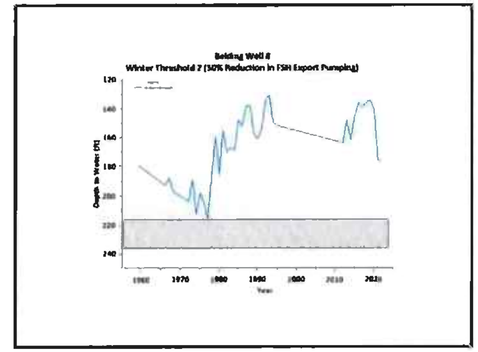

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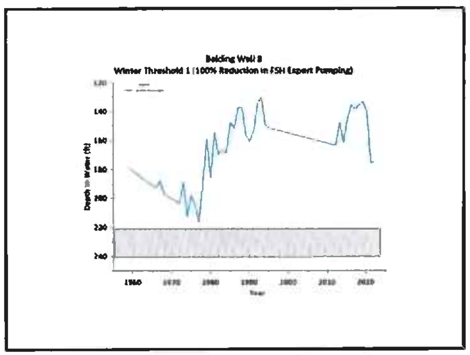
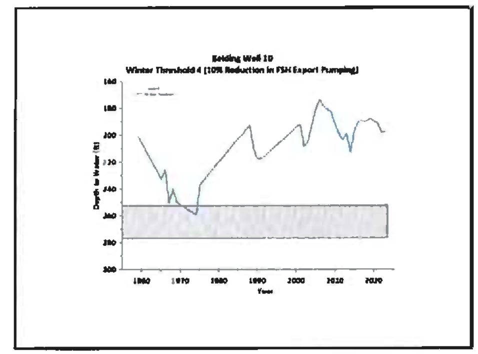


85

Belding Well 10

- Well Depth = 480 ft
- Pump Setting = 280 ft
- Average Pumping
  - 1967 to 1974 = 602 AF/yr
  - 2010 to 2022 = 377 AF/yr

86



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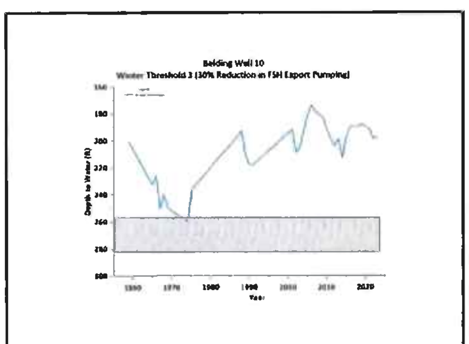

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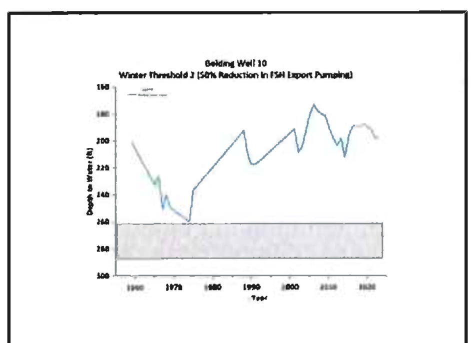

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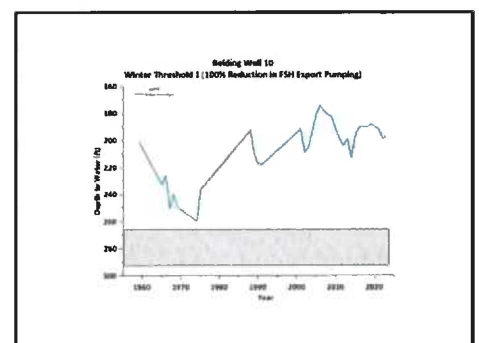


90

Winter Threshold Conclusions

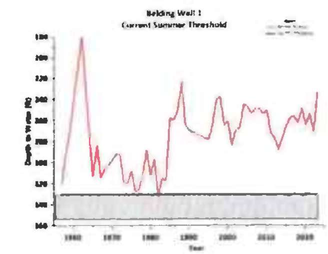
- Conservative based on Belding data not available in 2017 when thresholds were set
- 10% and 30% reductions will result in groundwater level recovery
- Completion of additional studies and monitoring data could lead to modifications of winter thresholds in future

91

Existing Summer Threshold Hydrographs

- In 2017, summer thresholds were developed with limited summer data
  - Based on recent drawdown data
- Belding Farms data are a more robust dataset to set summer thresholds
  - Discussed in 2018, but lack of pump depth limited our ability to complete analysis
- 2023 data update provides pump depth
- Plots summer threshold range from four wells in rules petition (see previous slides) to six Belding Farms wells
- Conclusion: minor adjustments (upward or shallower thresholds) are warranted
  - No change from 2018 conclusion

92



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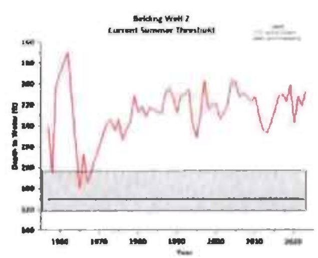

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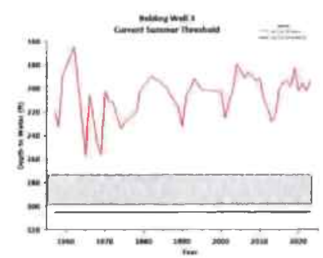

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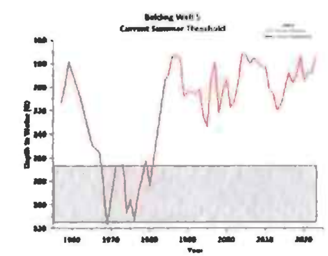

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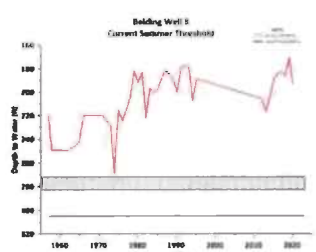

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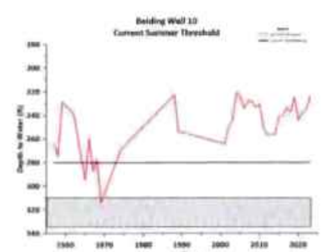

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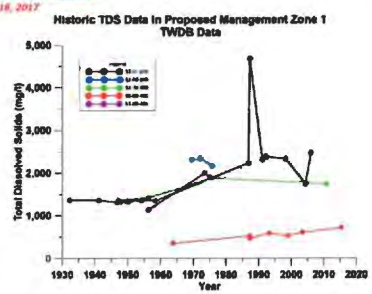
Groundwater Quality

- 2017 report that documented threshold development for FSH special permit conditions did not cover groundwater quality
  - Meetings in 2017: groundwater quality was discussed in general
  - No reported groundwater quality degradation associated with high pumping in 1960s and 1970s
    - Pumping reduction after 1970s due to change in economic conditions
- Available data evaluated in 2017
  - 5 wells
  - 34 data points
  - Date range: 1932 to 2010

99

Presented and Discussed
July 18, 2017



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Proposed MZ1 Rules – Groundwater Quality

- Important component of demonstrating "no adverse impact on the aquifer"
- Relies on baseline of 2017 to 2023
  - No data provided to support use of this baseline
  - Silent on well-by-well analysis or lump all data together to form a baseline
- Three of the "tests" to demonstrate "no adverse impact on the aquifer": less than 5% increase in:
  - Total dissolved solids (TDS)
  - Sodium
  - Calcium

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Impact Analysis Process

- Three-part test
  - Measurable
  - Attributable
  - Significant
- Is a 5% increase in TDS measurable?
  - Yes, if there is a sufficient baseline of data
- Is a 5% increase in TDS attributable to FSH pumping?
  - Can't say without good baseline
  - 5% could be "noise" in the data
- Is 5% increase in TDS significant with respect to the "aquifer"?
  - Need to consider use of water and reversibility of increase with groundwater level recovery

102

Overall Conclusions and Recommendations

- Submitted thresholds in proposed MZ 1 rules:
  - Inconsistent with foundation of settlement (avoid dropping below historic minimum groundwater levels)
  - Would result in Threshold 1 actions for months at a time
    - Permit moratorium
    - Meetings to discuss data
  - Would result in Threshold 2 actions for months at a time
    - 50% reduction in FSH export pumping
    - No benefit to Belding Farms
  - Would result in Threshold 3 actions during drought conditions (high irrigation pumping)
    - 100% reduction in FSH export pumping
    - No benefit to Belding Farms

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<u>Middle Pecos GCD Exhibit 36</u>

Explanation for Denial of Cockrell's First Petition for Rulemaking (March 2024)

MIDDLE PECOS GROUNDWATER CONSERVATION DISTRICT
P.O. Box 1644 Fort Stockton, TX 79735 Phone (432)336-0698 Fax (432)336-3407
405 North Spring Drive Fort Stockton, Texas 79735
Email: mpgcd@mpgcd.org Website: www.middlepecosgcd.org

EXPLANATION FOR DENIAL OF *PETITION TO ADOPT OR MODIFY A DISTRICT RULE* JOINTLY SUBMITTED BY COCKRELL INVESTMENT PARTNERS, LP AND ITS AFFILIATE BELDING FARMS

BACKGROUND

This statement was prepared at the direction of Director Alvaro Mandujano, Jr., who made a motion to deny the *Petition to Adopt or Modify a District Rule* that was submitted jointly by Cockrell Investment Partners, LP and its affiliate Belding Farms. Director Mandujano's motion was seconded by Director Weldon Blackwelder, and approved unanimously by all present Directors (8-0), with three Directors absent from the Board meeting. The motion was approved at the District's meeting held March 18, 2024, within 90 days of submission of the petition (submitted on December 19, 2023).

As part of his motion, Director Mandujano stated that he wanted this separate written statement to memorialize the reasons for denial of the petition and to serve as the explanation required by the applicable statute (Texas Water Code Section 36.1025(c)(1) and rule (District Rule 6.5(h)(2)), and consistent with District Board President Jerry McGuairt's suggested procedure.

EXPLANATION

Director Mandujano attended the hearing on the petition held February 20, 2024, and participated in the Board deliberation about the petition on February 20th and March 18th. The motion proposed denial of the petition after consideration of the petition, written public comments, public comments during the hearing, requested input from the District's professionals during and after the hearing, and Board discussion. Each subsection of the proposed rules (10.8(a)-(f)) is unnecessary standing alone, and together, because current rules adequately protect the aquifers and users of the aquifers in Management Zone 1. Specifically:

- our approach to metering and alternative measuring is sufficient
- a tremie pipe does not need to be installed in all new wells because we adequately measure water levels in other wells and can access many if not most wells that don't have tremie pipes
- additional transducers aren't needed because we've already identified wells to be measured with transducers and can add more if needed
- our water quality testing program is good, and the proposed testing of monitoring wells that don't have pumps doesn't make sense
- quarterly reporting does not enhance what rules already require and what rules already allow the GM to request from pumpers
- it's not necessary to impose the restrictions in the proposed subsection (f)—our General Manager is constantly reviewing data with our experts and briefing the Board, and current rules provide a process for accelerating review and restrictions if adverse effects are foreseeable

<u>Middle Pecos GCD Exhibit 37</u>

Cockrell Investment Partners, L.P.'s Second Petition for Rulemaking (August 18, 2024)

MIDDLE PECOS
Groundwater Conservation District
P. O. Box 1644, Fort Stockton, Texas 79735
Phone: 432/336-0698; Fax: 432/336-3407
Email: mpgcd@mpgcd.org

PETITION TO ADOPT OR MODIFY A DISTRICT RULE

Instructions: This Petition to Adopt or Modify a District Rule form must be completed as required by District Rule 6.5 and filed at the District office. Each rule adoption or modification requested must be submitted on a separate Petition to Adopt or Modify a District Rule form.

A person unable to comply with any procedures under District Rule 6.5, or to provide the information required by this form, may file a written explanation as to why compliance with the required procedure(s) is not possible along with a written request that the District waive the specific procedure(s). The written explanation and written request must be submitted to the District Office at the same time as this Form.

Additional information may be attached to this form.

1. **Text of Proposed Rule or Rule Modification** (underline words proposed to be added to the text of the current rules and strike through words proposed to be deleted from the text of the current rules):

Restated Rule 16.1:
The District shall charge an export fee or surcharge of twenty (20) cents per thousand gallons of water exported by a permit holder, which shall automatically increase at a rate of three (3) percentage per year to the maximum extent allowed by Texas law.

Proposed New Rule entitled "Mitigation Fund":
The District shall, upon collection of the export fee or surcharge, establish a mitigation fund, which shall be maintained and utilized for the purposes of (1) making grants, loans, or contractual payments to achieve, facilitate, and expedite reductions in groundwater pumping, (2) developing or distributing alternative water supplies, and (3) maintaining the operability of wells significantly affected by groundwater development. The District shall, upon application, provide permitees who demonstrate that they have been significantly affected by the production and export of water with the resources necessary to operate their wells and recoup the adverse economic impacts caused by the decline of groundwater levels.

2. **Written Explanation of the Intended Purpose of the Proposed Rule or Rule Modification:**

The Texas Legislature recognizes that large scale production for export of groundwater has, in fact, resulted in negative socioeconomic impacts to local users, a concern evidenced by the passage of HB 3059 during the 88th legislative sessions. To ensure that the District is protecting groundwater for all permit holders, Cockrell requests that the District adopt the Proposed Rule to create a fund that is available for permit holders adversely affected by the production and export of groundwater. The Proposed Rule, which tracks HB3059, requires the District to create a fund from resources already available to it, maximize that fund, and allow groundwater permit holders negatively affected by increased pumping of the aquifer to receive compensation for the economic costs that will arise from a decline in the aquifer levels.

3. **Allegation of Injury or Inequity that could Result from Failure to Adopt Proposed Rule or to Modify Current Rule:**

The District's Management Plan does not provide for a year-round floor or thresholds with production cutbacks or any other real consequences for damages that may occur as a result of declining aquifer levels. Without significant rulemaking changes in cutback threshold levels, the following issues are likely to occur: declining water levels, decreased transmissibility, decreased levels of production, increased levels of solids in the water, higher production costs, and potential need to lower pumps, install larger pumps, drill deeper wells, and even re-drill some wells. Lack of proper enforcement of pumping cutbacks based on water level triggers increases the risk of long-term damage to the aquifer and its ability to adequately recover after the summer irrigation season. Increased strain on the aquifer could also damage other nearby aquifers. Individual permitees, such as Belding Farms, may experience a loss or degradation of water at or below historic levels. The cost to drill deeper and retrofit wells, as well as the economic impacts of loss of crop because of a decrease in water production or water quality, should not be borne by a permit holder who has made investment decision based on historic use of groundwater. A mitigation fund will allow the District to impose a surcharge on the commercial sale and export of water and establish a fund to assist permitees affected by the increased production.

4. **Description of Petitioner(s) Real Property Interest in Groundwater in the District** (attach proof of real property interest in groundwater located within the District for each petitioner):

Cockrell is a landowner within the District. Cockrell/Belding Farms owns a 2,205 acre commercial pecan orchard consisting of approximately 77,000 trees. For its orchard, Cockrell utilizes its substantial water rights in the Edwards-Trinity Aquifer, which supports its pecan orchard.

Cockrell currently has a Historic Existing Use Permit that was issued in July 2006 for 16 wells in the amount of 15,528.846 acre feet, which is used to, among other things, supply water/irrigation requirements for its pecan orchard consisting of approximately 77,000 trees. In fact, Cockrell's 2,205-acre orchard is a part of 6,663.18 acres owned and leased by Cockrell.

Petitioner(s) Information (Please include information for additional petitioners as appropriate).

Petitioner #1:

Cockrell Investment Partners, LP and Belding Farms, c/o Ryan C. Reed, Attorney

(210) 222-9494; rreed@pulmanlaw.com

First Name Last Name Phone Number Email Address

Pulman, Cappuccio & Pullen, LLP, 2161 NW Military Hwy, Suite 400, San Antonio, TX 78213

Physical Address City State Zip code

Pulman, Cappuccio & Pullen, LLP, 2161 NW Military Hwy, Suite 400, San Antonio, TX 78213

Mailing Address

/s/ Ryan C. Reed 08/19/2024

Signature *Date*

Petitioner #2:

First Name Last Name Phone Number Email Address

Physical Address City State Zip code

Mailing Address City State Zip code

Signature *Date*

Petitioner #3:

First Name Last Name Phone Number Email Address

Physical Address City State Zip code

Mailing Address City State Zip code

Signature *Date*

Additional information may be attached to this form.

<u>Middle Pecos GCD Exhibit 38</u>

Cockrell Investment Partners, L.P.'s Third Petition for Rulemaking (August 18, 2024)

MIDDLE PECOS
Groundwater Conservation District
P. O. Box 1644, Fort Stockton, Texas 79735
Phone: 432/336-0698; Fax: 432/336-3407
Email: mpgcd@mpgcd.org

PETITION TO ADOPT OR MODIFY A DISTRICT RULE

Instructions: This Petition to Adopt or Modify a District Rule form must be completed as required by District Rule 6.5 and filed at the District office. Each rule adoption or modification requested must be submitted on a separate Petition to Adopt or Modify a District Rule form.

A person unable to comply with any procedures under District Rule 6.5, or to provide the information required by this form, may file a written explanation as to why compliance with the required procedure(s) is not possible along with a written request that the District waive the specific procedure(s). The written explanation and written request must be submitted to the District Office at the same time as this Form.

Additional information may be attached to this form.

1. **Text of Proposed Rule or Rule Modification** (underline words proposed to be added to the text of the current rules and strike through words proposed to be deleted from the text of the current rules):

Proposed New Rule entitled "Unreasonable Impacts":
Unreasonable Impacts: In order to help achieve a balance between production and conservation of groundwater resources, and to ensure that the District is able to achieve the Desired Future Condition, the District will consider the impacts to the Edwards Trinity Aquifer to be unreasonable if the average water level of all Monitoring Wells in Management Zone 1 on September 1 of any year is more than seven (7) feet less than the average water level of all Monitoring Wells in Management Zone 1 on September 1, 2018.

Action. If the foregoing measurements indicate unreasonable impacts, the District shall:
1. Sends written notice to all permitholders and publish notice on Website
2. Require permitholders to monitor and report water levels monthly
3. Require permitholders to report lowering of pumps and new pump depth
4. Suspend consideration of new transport/export permits
5. Schedule board meeting within 10 days to discuss exercise of District's emergency powers, including curtailment of production by permit holders up to 50 percent.

2. **Written Explanation of the Intended Purpose of the Proposed Rule or Rule Modification:**

To ensure that the District is protecting groundwater for all permit holders and achieving the DFC, Cockrell requests that the District adopt the Proposed Rule to establish measures that will be implemented when pumping in the District causes unreasonable impacts on permitees. Under section 36.113(d) of the Water Code, the District is required to consider whether use of water unreasonably affects existing resources and permitees when it considers permits. The Proposed Rule requires the District to define unreasonable impacts and implement protections for the benefit of all permitees when pumping of the aquifer creates unreasonable impacts. The seven (7) foot draw-down represents a proactive measurement of the actual impact of production on the aquifer, and is fifty percent (50%) of the planned draw-down over the next 25 years. Fifty percent (50%) of the planned draw-down is an objective measurement intended to identify needed action to ensure that the established DFC will be complied with and remains a viable target by 2050.

3. **Allegation of Injury or Inequity that could Result from Failure to Adopt Proposed Rule or to Modify Current Rule:**

The District does not define unreasonable impacts or address how it intends to achieve the DFC. Without significant rulemaking changes and in light of additional pumping from exports, unreasonable impacts resulting from increased production, including long-term damage to the aquifer and its ability to adequately recover after the summer irrigation season, may occur. All permitees, including Belding Farms, will experience a loss or degradation of water if the District does not protect against unreasonable impacts. The best way to prevent unreasonable impacts is to ensure that the District is on track to comply with the DFC. If the DFC is exceeded, permitees will be met with costs to drill deeper and retrofit wells, as well as the economic impacts of loss of water or degradation of water quality.

4. **Description of Petitioner(s) Real Property Interest in Groundwater in the District** (attach proof of real property interest in groundwater located within the District for each petitioner):

Cockrell is a landowner within the District. Cockrell/Belding Farms owns a 2,205 acre commercial pecan orchard consisting of approximately 77,000 trees. For its orchard, Cockrell utilizes its substantial water rights in the Edwards-Trinity Aquifer, which supports its pecan orchard.

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Petitioner(s) Information (Please include information for additional petitioners as appropriate).

Petitioner #1:

Cockrell Investment Partners, LP and Belding Farms, c/o Ryan C. Reed, Attorney

(210) 222-9494; rreed@pulmanlaw.com

First Name | Last Name | Phone Number | Email Address

Pulman, Cappuccio & Pullen, LLP, 2161 NW Military Hwy, Suite 400, San Antonio, TX 78213

Physical Address | City | State | Zip code

Pulman, Cappuccio & Pullen, LLP, 2161 NW Military Hwy, Suite 400, San Antonio, TX 78213

Mailing Address

/s/ Ryan C. Reed 08/19/2024

Signature *Date*

Petitioner #2:

First Name | Last Name | Phone Number | Email Address

Physical Address | City | State | Zip code

Mailing Address | City | State | Zip code

Signature *Date*

Petitioner #3:

First Name | Last Name | Phone Number | Email Address

Physical Address | City | State | Zip code

Mailing Address | City | State | Zip code

Signature *Date*

Additional information may be attached to this form.

<u>Middle Pecos GCD Exhibit 39</u>

Middle Pecos GCD's Comparison of Cockrell's Proposed Rules to MPGCD's Current Rules and Policy (October 2024)

Comparison of Cockrell's Proposed Rules to MPGCD's Current Rules and Policy

I. First Petition

A. Proposed "Restated" Rule 16.1 (Export Fees)

Summary of "Restated" Rule 16.1 (proposal to repeal and replace current rule)	**Summary of Current MPGCD Rule 16.1**
mandates the statutory maximum export fee of $0.20/1,000 gal.	***discretion*** to set export fee up to statutory maximum of $0.20/1,000 gal… …***or a fee negotiated with the exporter*** (flexibility to negotiate higher fee or to accept unique consideration (e.g., Waha/Enstor))
automatically increases fee by statutory maximum (3%/year)	***discretion*** to increase fee by statutory maximum (3%/year)
deletes hearing on fees and fee increases required by § 36.122(e-3) (perhaps presuming that a § 36.101 rulemaking hearing serves as the hearing on fees?)	***after a § 36.122(e-3) hearing***, fee and fee increases set by Board resolution Note: Board should call a hearing to pass a resolution adopting an export fee (and probably allowing for negotiation of fee). Note: Although Cockrell did *not* raise it, current Rule 16.1(a) could and probably should be amended at some point to delete the 10% cap imposed by enabling act, as authorized by § 36.122(e-2) (N/A currently because we do not assess production fees; enabling act states that export fee cannot exceed 10% of production fees).

Bottom line: Under existing rules, MPGCD can set $0.20/1,000 gal. export fee and a 3% increase effective in 2024 (20.6¢/1,000 gal.), while maintaining flexibility to negotiate upward/downward on fees or for consideration other than fee payment (e.g., Enstor/Waha), by adopting a resolution after a hearing on fees.

I. First Petition

B. Proposed New Rule (requiring District to award funds from a dedicated mitigation fund on specific applied-for requests)

Summary of Proposed Rule	§ 36.207 (Use of Fees) (amended by HB 3059)	Summary of Current MPGCD Rules and Policy
mandates export fees be deposited into a Mitigation Fund, and that the fund be used for ***limited, listed purposes***…	export fees may be used for ***broad purposes*** under § 36.207(***a***)	export fees are used to fund budget for ***broad purposes*** authorized by statute
requires that Mitigation Fund be supplemented and maximized by "resources already available to it [MPGCD]"	no statutory requirement though § 36.207(a) would authorize earmarking or creating a fund for mitigation	MPGCD has authority to use its tax and export-fee revenues for mitigation and related research whether or not it has a fund—each year anticipated expenses could be budgeted
contemplates using [≤3% increase] for ***broader*** purposes than listed in § 36.207(b)	§ 36.207(***b***) requires that GCDs earmark "amount that an export fee is increased under Section 36.122(e-1)" [≤3% increase] for purposes listed in statute	mandates earmarking [≤3% increase] for purposes listed in statute
mandates that MPGCD disburse funds from Mitigation Fund to qualified applicants (permit holders) who demonstrate a significant effect from export	silent – nothing express in the statute; excludes exempt users	MPGCD has authority to use its tax and export-fee revenues for mitigation; it is recommended that any landowner-specific disbursement be developed to equitably consider impacts and equitably disburse funds It's a mixed science-policy question whether effects will be unreasonable and, if so, whether to start setting aside $$ for future mitigation. Other districts and stakeholders are estimating potential effects (e.g., Gonzales County UWCD, Guadalupe County GCD, Brazos Valley GCD, Post Oak Savannah GCD)

Tex. Water Code § 36.207 (amendments by HB 3059 shown in underlined text):

"(a) A district may use funds obtained from administrative, production, or export fees collected under a special law governing the district or this chapter for any purpose consistent with the district's approved management plan, including, without limitation, making grants, loans, or contractual payments to achieve, facilitate, or expedite reductions in groundwater pumping or the development or distribution of alternative water supplies or to maintain the operability of wells significantly affected by groundwater development to allow for the highest practicable level of groundwater production while achieving the desired future conditions established under Section 36.108.

(b) A district may use funds obtained from the amount that an export fee is increased under Section 36.122(e-1) on or after January 1, 2024, only for costs related to assessing and addressing impacts associated with groundwater development, including:

(1) maintaining operability of wells significantly affected by groundwater development;
(2) developing or distributing alternative water supplies; and
(3) conducting aquifer monitoring, data collection, and aquifer science."

I. First Petition
C. Analysis of Cockrell's *"Allegation of Injury or Inequity"* (consequences) if MPGCD does not adopt proposed rule

<table>
<tr><th>Alleged Injury or Inequity (Consequence)</th><th>Comment</th></tr>
<tr><td><u>lack of year-round floor or threshold for pumping cutbacks</u>:
➢ may cause loss or degradation of water at or below historic levels</td><td><u>currently…no problem</u> with water quality or water levels
<u>proactively…MPGCD is</u>:
➢ actively monitoring aquifer and water levels from extensive well-monitoring network, real-time transducers, and near daily field measurements and sampling
➢ relying upon and continuing multi-year, multi-million dollar research efforts</td></tr>
<tr><td><u>lack of proper enforcement of pumping cutbacks</u>:
➢ increases risk of:
o long-term damage to the aquifer
o ability to adequately recover after summer irrigation season
➢ could damage nearby aquifers
➢ may cause Cockrell and other permittees to experience loss or degradation of water at or below historic levels</td><td><u>MPGCD has robust enforcement rules and contingency/emergency rules if something unlikely and unforeseeable arises</u></td></tr>
<tr><td><u>lack of Mitigation Fund deprives Cockrell and other permittees affected by export of mitigation $$</u></i></td><td><i><u>Texas law recognizes</u>:</i>
(1) property rights of landowners to pump (but not a specific volume)
(2) GCDs authority to regulate subject to possible regulatory taking
(3) Rule of Capture (don't have to compensate your neighbor for damages with limited exceptions)
(4) newly evolving legislative intent to allow but not mandate mitigation

MPGCD has discretion to budget for mitigation; it's a policy decision whether to start setting aside $$ for future mitigation (see p. 2 above).</td></tr>
</table>

II. Second Petition
A. Proposed New Rule (defining "Unreasonable Impacts")

<table>
<tr><th>Summary of Proposed Definition and Proposed Regulatory Program</th><th>Summary of Current MPGCD Rules, Regulatory Program and Research</th></tr>
<tr><td><u>creates a new definition</u>:

"<u>Unreasonable Impacts</u>: In order to help achieve a balance between production and conservation of groundwater resources, and to ensure that the District is able to achieve the Desired Future Condition, the District will consider the impacts to the Edwards Trinity Aquifer to be unreasonable <u>if the average water level of all Monitoring Wells in Management Zone 1 on September 1 of any year is more than seven (7) feet less than the average water level of all Monitoring Wells in Management Zone 1 on September 1, 2018</u>"</td><td>MPGCD's <u>existing rules address</u>:

"<u>unreasonable effects</u>" on existing groundwater and surface water resources or existing permit holders <u>during permitting</u> (see § 36.113(d), Section 11 of Rules)

<u>statutory "impacts" during DFC-setting process</u> (see § 36.118(d), Section 17 of Rules)

<u>premature to establish a bright-line threshold</u> (A) prior to completion of ongoing research project and (B) without evidence of a need based on historical and real-time data from MPGCD's extensive well-monitoring program...

...as deliberated by Board in February, March and April 2024 (see minutes, especially March 18th Board meeting)</td></tr>
</table>

II. Second Petition

B. Proposed New Rule (creating detailed regulatory program to address Unreasonable Impacts)

<table>
<tr><th>Summary of Proposed Regulatory Program</th><th>Summary of Current MPGCD Rules</th></tr>
<tr><td><u>creates a new program</u>:

if "Unreasonable Impacts" threshold is hit, then District must:

1. issue notice to all permittees and public
2. require permittees to monitor and report water levels monthly
3. require permittees to report lowering of pumps and new pump depth
4. suspend consideration of new export permit applications
5. schedule Board meeting within 10 days to discuss exercise of District's emergency powers, including curtailment of production by permittees up to 50%</td><td><u>premature to establish a bright-line threshold</u> (A) prior to completion of ongoing research project and (B) without evidence of a need based on historical and real-time data from MPGCD's extensive well-monitoring program...

...as deliberated by Board in February, March and April 2024 (see minutes, especially March 18th Board meeting)</td></tr>
<tr><td><u>rationale is</u> that 7-foot threshold = 50% of acceptable DFC drawdown over 25 years, and is an objective benchmark <u>"to ensure that the District is on track to comply with the DFC"</u></td><td>policy decision based on best-available science and DFC factors; current best-available science reflects that District is on track to comply with DFC</td></tr>
</table>

II. Second Petition
C. Analysis of Cockrell's *"Allegation of Injury or Inequity"* (consequences) if MPGCD does not adopt proposed rule

<table>
<tr><th>Alleged Injury or Inequity (Consequence)</th><th>Comment</th></tr>
<tr><td><u>Failure to define Unreasonable Impacts and establish a new cutback-based regulatory program</u>:
➢ may cause:
  o long-term damage to the aquifer
  o ability to adequately recover after summer irrigation season
➢ may cause Cockrell and other permittees to experience loss or degradation of water</td><td><u>currently…no problem</u> with water quality or water levels
<u>proactively…MPGCD is</u>:
➢ actively monitoring aquifer and water levels from extensive well-monitoring network, real-time transducers, and near daily field measurements and sampling
➢ relying upon and continuing multi-year, multi-million dollar research efforts

<u>MPGCD has robust enforcement rules and contingency/emergency rules if something unlikely and unforeseeable arises</u></td></tr>
</table>

Middle Pecos GCD Exhibit 40

Explanation for Denial of Cockrell's second and third Petitions for Rulemaking (October 2024)

MIDDLE PECOS GROUNDWATER CONSERVATION DISTRICT
P.O. Box 1644 Fort Stockton, TX 79735 Phone (432)336-0698 Fax (432)336-3407
405 North Spring Drive Fort Stockton, Texas 79735
Email: mpgcd@mpgcd.org Website: www.middlepecosgcd.org

EXPLANATION FOR DENIAL OF *PETITION TO ADOPT OR MODIFY A DISTRICT RULE* JOINTLY SUBMITTED BY COCKRELL INVESTMENT PARTNERS, LP AND ITS AFFILIATE BELDING FARMS

BACKGROUND

This statement was prepared at the direction of Director Janet Groth, who made a motion to deny the *Petition to Adopt or Modify a District Rule* that was submitted jointly by Cockrell Investment Partners, LP and its affiliate Belding Farms. Director Groth's motion was seconded by Director Alvaro Mandujano, Jr., and approved by all present Directors (8-0), with three Directors absent. The motion was approved at the District's meeting held October 15, 2024, within 90 days of submission of the petition (submitted on August 19, 2024).

As part of her motion, Director Groth stated that she wanted this separate written statement to memorialize the reasons for denial of the petition and to serve as the explanation required by the applicable statute (Texas Water Code Section 36.1025(c)(1) and rule (District Rule 6.5(h)(2)), and consistent with District Board President Jerry McGuairt's suggested procedure.

EXPLANATION

Director Groth attended the hearing on the petition held October 15, 2024, and participated in the Board deliberation about the petition on October 15th. The motion proposed denial of the petition after consideration of the petition, written public comments, public comments during the hearing, requested input from the District's professionals during and after the hearing, and Board discussion. Each subsection of the proposed rules (Restated Rule 16.1 and creation of a Mitigation Fund) is unnecessary standing alone, and together, because current rules adequately protect the aquifers and give the District adequate discretion to assess export fees after a statutorily required hearing. Specifically:

- the District's approach to assessing and increasing export fees is sufficient
- it's not necessary to mandate the amount of our export fees because our current rules already give us discretion to set export fees that the proposed rule calls for
- the proposed mandatory 3% increase in fees every year is not necessary because our rules already allow us to increase fees up to 3% should the District decide to do so
- the Water Code requires us to hold a hearing and pass a Board resolution on export fees and export fee increases and the proposed rules would delete and sidestep that requirement
- the District values the discretion we have to set export fees because it allows us to adapt to changing circumstances and meet the specific needs of the District
- the proposed rules setting up a mitigation fund would force us to pay permittees and landowners for their own economic losses, which could be economically impracticable and which would commit funding that could deprive the District of using the funds for other expressly authorized mitigation measures
- the District has discretion to use its export fee revenues for mitigation and related research, without the need for a dedicated fund, while ensuring impacts are considered fairly

MIDDLE PECOS GROUNDWATER CONSERVATION DISTRICT
P.O. Box 1644 Fort Stockton, TX 79735 Phone (432)336-0698 Fax (432)336-3407
405 North Spring Drive Fort Stockton, Texas 79735
Email: mpgcd@mpgcd.org Website: www.middlepecosgcd.org

EXPLANATION FOR DENIAL OF *PETITION TO ADOPT OR MODIFY A DISTRICT RULE* JOINTLY SUBMITTED BY COCKRELL INVESTMENT PARTNERS, LP AND ITS AFFILIATE BELDING FARMS

BACKGROUND

This statement was prepared at the direction of Director Alvaro Mandujano, Jr., who made a motion to deny the *Petition to Adopt or Modify a District Rule* that was submitted jointly by Cockrell Investment Partners, LP and its affiliate Belding Farms. Director Mandujano's motion was seconded by Director Vanessa Cardwell, and approved by all present Directors (8-0), with three Directors absent. The motion was approved at the District's meeting held October 15, 2024, within 90 days of submission of the petition (submitted on August 19, 2024).

As part of his motion, Director Mandujano stated that he wanted this separate written statement to memorialize the reasons for denial of the petition and to serve as the explanation required by the applicable statute (Texas Water Code Section 36.1025(c)(1) and rule (District Rule 6.5(h)(2)), and consistent with District Board President Jerry McGuairt's suggested procedure.

EXPLANATION

Director Mandujano attended the hearing on the petition held October 15, 2024, and participated in the Board deliberation about the petition on October 15th. The motion proposed denial of the petition after consideration of the petition, written public comments, public comments during the hearing, requested input from the District's professionals during and after the hearing, and Board discussion. Each subsection of the proposed rules titled "Unreasonable Impacts" is unnecessary standing alone, and together, because current rules adequately protect the aquifers and users of the aquifers in Management Zone 1. Specifically:

- the District's current rules already provide sufficient protection for the aquifer by addressing unreasonable *effects* on groundwater
- it is premature to define unreasonable *impacts* with a bright-line threshold before completing ongoing research and analyzing hydrogeologic data from the District's monitoring efforts
- the proposed seven-foot drawdown limit is arbitrary and not supported by scientific evidence or historical data—past documented fluctuations have not caused long-term harm
- the District has a robust system of monitoring wells in Management Zone 1, generating daily data that allows for real-time adaptive management
- the proposed rule conflicts with our existing science-based management practices, which already include well-established water level thresholds
- the current system already provides adequate oversight and enforcement measures, ensuring swift action if adverse effects on the aquifer are detected
- imposing the rule now could lead to unnecessary restrictions on water use, affecting all permit holders, without considering future conditions or new insights from ongoing studies
- this proposed definition is not based on express authority—nowhere in the Water Code or case law is "unreasonable impacts" defined, and would require the District to apply implied authority

Middle Pecos GCD Exhibit 41

Fort Stockton Holdings, LLC's Production Permit

MIDDLE PECOS
Groundwater Conservation District
Drawer 1644, Fort Stockton, Texas 79735
Phone: 432/336-0698 Fax: 432/336-3407

"AMENDED" APPLICATION FOR A PRODUCTION PERMIT AND AUTHORIZING EXPORT

General Instructions: A Production Permit is required by the District for operating or producing groundwater from any non-exempt well for which a Historic and Existing Use Permit or amendment thereto to include the well has not been issued by the District or timely applied for and awaiting District action. An application for a Production Permit shall contain all the information requested in Rule 11.9. An applicant may file a Production Permit Application for more than one well and also, if the wells are part of a well system as defined by the District's Rules.

Applicant(s) Information: Provide the information requested below. If the Applicant is more than one individual with different residences, attach a separate sheet with a description of their respective interests in the well(s), listing their names and addresses, and designating a contact person. If the Applicant is a corporation, partnership, limited partnership or other business association, state its name and address below and attach written documentation that the Authorized Representative, whose name is provided below, is authorized to represent the well owner. If the applicant is other than the owner of the property, attach documentation establishing the applicable authority to construct and operate a well(s) subject to this application.

Please Print or Type

Applicant: Fort Stockton Holdings, L.P. Phone: (432) 688-3038 Fax: (432) 688-3247

Mailing Address: 6 Desta Drive, Suite 6500 City Midland ST TX Zip 78705

Physical Address: Same E-Mail: platham@claytonwilliams.com

Contact/Authorized Representative: ~~Paul Latham, Vice President~~ ~~**(See Attachments "A" and "B")**~~ See **Appendix A**

Relationship to Owner/Applicant ~~Vice President, Clayton Williams Farms, Inc., general partner, Fort Stockton Holdings, L.P.~~ See **Appendix A**

Phone: ~~Same~~ Fax: ~~Same~~ E-mail: ~~Same~~

Mailing Address: ~~Same~~ City ~~Same~~ ST Zip ~~Same~~

Aquifer: This application is for a Production Permit from the following Aquifer: Edwards-Trinity

Proposed Groundwater Withdrawal Amount: Total amount of groundwater applied for in this application in acre-feet per year (1 acre-foot equals 325,851 gallons): ~~47,41849,000 ac-ft/year, *less* the volume of water produced under Applicant's Existing and Historic Use Permits for the same wells during the same calendar year.*~~ **28,400** acre-feet per year

List the requested amount of groundwater withdrawal for each purpose in acre-feet per year (1 acre-foot is 325,851 gallons), the duration required for each use (if perpetual, mark as such, otherwise, provide a date for the last withdrawal) and describe in detail each proposed use:

Domestic Amount: ~~N/A 0.0 ac-ft/yr~~ Duration of Use: ~~N/A0.0 ac-ft/yr~~

28,400 ac-ft/yr for **Agricultural** use, less the volume produced for other authorized uses of **municipal** and **industrial**.

Livestock Amount: ~~N/A0.0 ac-ft/yr~~ Duration of Use: ~~N/A0.0 ac-ft/yr~~

Proposed Use (Number and type of livestock): ~~N/A0.0 ac-ft/yr~~

Irrigation Amount: ~~N/A0.0 ac-ft/yr~~ Duration of Use: ~~N/A0.0 ac-ft/yr~~

Proposed Use (Type and acreage of crops, type of irrigation (spray, drip, etc.)): ~~N/A0.0 ac-ft/yr~~

Public Supply Amount: ~~N/A 47,418 ac-ft/yr, *less* the volume of water produced under Applicant's Existing and Historic Use Permits for the same wells during the same calendar year, and less the volume of water produced for Industrial use pursuant to this permit during the same calendar year.*~~ **28,400 ac-ft/yr**, less the volume produced for other authorized uses of **agricultural** and **industrial.**

Duration of Use: ~~5 years minimum/50 years contingent, as further described in the attached Permit Supplement D(1), and renewable thereafter. Applicant intends to apply for renewals.~~

See **Special Permit Condition 2** (attached)

Proposed Use (location, number of people, provide copy of contract): Supply wholesale water to municipal water purveyors within the Texas Water Development Board's State Water Plan "Region F" Planning Area (31 TAC) as described in the attached Permit Supplement.

Industrial Amount: ~~N/A 47,418 ac-ft/yr, *less* the volume of water produced under Applicant's Existing and Historic Use Permits for the same wells during the same calendar year, and less the volume of water produced for Public Supply use pursuant to this permit during the same calendar year.*~~ **28,400 ac-ft/yr**, less the volume produced for other authorized uses of **agricultural** and **municipal.**

Duration of Use: ~~5 years minimum/50 years contingent, as further described in the attached Permit Supplement D(1), and renewable thereafter. Applicant intends to apply for renewals.~~ See **Special Permit Condition 2** (attached)

Proposed Use (type of industry): e.g. manufacturing, electric generation, Oil & Gas, etc.

Other Amount: ~~49,000 acre-feet/year~~0.0 ~~ac-ft/yr~~ Duration of Use: ~~perpetual~~0.0 ~~ac-ft/yr~~

Proposed Use: ~~Multiple uses for Public Supply, Industrial, Irrigation, and Livestock purposes~~0.0 ac-ft/yr

~~*** This application is not requesting any increase in the total volume of groundwater production already approved by the District, because the production allowed under this proposed permit would be limited to the amount of groundwater production not used under applicant's Existing and Historic Use Permits in a given year for the same wells. As explained in greater detail elsewhere in the Application, the maximum annual volume of water Applicant will be entitled to produce during any calendar year, whether allocated to Public Supply or Industrial purposes, shall never exceed 47,418 ac-ft/yr. Moreover, in combination with Applicant's separate Existing and Historic Use Permits issued by the District, which authorize total production of 47,418 ac-ft/yr, Applicant has requested inclusion of a Special Condition in its Production Permit to be issued pursuant to this Application which would limit Applicant's total annual production pursuant to its new Production Permit and its Existing and Historic Use Permits to a combined maximum production volume of 47,418 ac-ft/yr. Applicant understands that water produced under this permit for Public Supply and/or Industrial purposes will be subject to the District's rules relating to new permits, and not the rules which remain applicable to its Existing and Historic Use Permits.**~~

Rate of Production for each well subject to this application (in gallons per minute): ~~**(See Attachment "C")**~~ See **Appendix B-1**
Estimated Rate of withdrawal per year: ~~**(See Attachment "C")**~~ See **Appendix B-1**
Maximum Rate of withdrawal per year: ~~**(See Attachment "C")**~~ See **Appendix B-1**

Location of Use: Please describe the location of use: Within Texas Water Development Board's State Water Plan "Region F" Planning Area (31 TAC) as described in the attached Supplement. ~~**(See Attachment "D")**~~

If the proposed location of use is outside Pecos County, attach a separate sheet that addresses the three issues set forth in District Rule 11.9.1(a)~~(7).~~ **See Attached** ~~**Supplement**~~ **Special Permit Conditions**

Land ownership: Total number of acres of land contiguous in ownership with the land where the well(s) are located: ~~18,510.61~~ ~~**acres.**~~ 14,191.08 acres

Provide well owner's identification name for each well relied upon to support this application: See **Appendix C**

Well Owner's Name:	Well Reference in Applicant's Registration
~~Fort Stockton Holdings, L.P.~~	~~See Attachment "C"~~
Same	
Same	

SEE SUPPLEMENT ATTACHED

DECLARATION: I agree that the water withdrawn from the well(s) will be put to beneficial, nonwasteful use at all times. I agree that reasonable diligence will be used to protect groundwater quality. I agree to abide by the rules of the Middle Pecos Groundwater Conservation District, the District Management Plan, and orders of the District's Board of Directors. I agree to comply with the District's well capping and plugging guidelines and report any well closure to the District. Furthermore, I agree not to exceed the production allowance of the Production Permit. **I understand and agree that my withdrawal and beneficial use of groundwater authorized by a Production Permit issued by the District may be limited if the District determines that reductions are necessary pursuant to the aquifer-based production limit, proportional adjustment, or permit limit rules of the District (District Rules 10.3, 10.4, and 10.5).**

Although Applicant understands this permit will be subject to the District's rules, and Applicant agrees to abide by such rules, nothing in this application should be construed as a waiver of Applicant's right to obtain compensation for a taking of its vested property rights in the event that the application of the District's rules to Applicant's groundwater rights results in a taking of vested property rights in any given year. Furthermore, nothing in this application should be construed as a waiver of Applicant's right to appeal or challenge the validity of any of the District's rules either administratively or in a court of competent jurisdiction.

I hereby certify that the information contained herein is true and correct to the best of my knowledge and belief.

Signature of Applicant: LPL Date: July 8, 2009

L. Paul Latham, Vice President

<u>**AFFIDAVIT**</u>

STATE OF TEXAS §
§
COUNTY OF TRAVIS §

Before me, the undersigned authority, on this day personally appeared L. Paul Latham, acting in his capacity as Vice President, Clayton Williams Farms, Inc., a Delaware corporation, as the sole General Partner of Fort Stockton Holdings, L.P., a Texas limited partnership, the Applicant in Application filed with the Middle Pecos Groundwater Conservation District on July 13, 2009, who after being by me duly sworn, upon oath deposes and says that he has read the statements and information in the foregoing letter providing amendatory and supplemental/clarifying language in connection with said July 13th Application and that the same are true and correct to the best of his knowledge.

LPL

L. Paul Latham for the Applicant

Subscribed and Sworn to before me this 24th day of September, 2009.

McRAE M. BIGGAR
Notary Public
State of Texas
Comm. Expires 10-10-2010

McRae M. Biggar
Signature of Notary

McRae M. Biggar
Printed Name of Notary

10-10-2010
Date of Expiration

Approval or denial of this application is subject to the rules of the District.

For District Use Only:

Date Application Received: 9/28/09 Mapped: ____________

Field Inspection: ____________

District Well Nos. ____________

Paul Weatherby
Signature

General Manager 9/28/09
Title Date

Application Approved:
______ YES ✓ NO

Signature: Glenn Honaker

Date: 10 June 2011

Permit Approved.
Jerry McGuairt
Jerry McGuairt 7-18-17
Board President **Date**

See attached special permit.

FORT STOCKTON HOLDINGS, L.P. PRODUCTION PERMIT
SPECIAL PERMIT CONDITIONS

1. Groundwater production is authorized in the amount of 28,400 acre-feet of Edwards-Trinity aquifer per year produced from the FSH-owned (not leased) properties for municipal, industrial, and agricultural purposes within and outside of the District.

2. The permit term shall be three years as provided for in Texas Water Code Section 36.122(i)(1), or thirty years as provided for in Texas Water Code Section 36.122(i)(2).

3. Production from this Production Permit shall be from those wells in those amounts set forth on the attached well schedule; provided, however, FSH may file applications for new or replacement wells as authorized by the District's rules.

4. FSH will not file a permit application to produce additional quantities of groundwater from the Edwards-Trinity aquifer on the properties at issue in FSH's application for a period of not less than five (5) years.

5. If the District imposes Management Zone 1 pro-rata cutbacks and those cutbacks are less restrictive than the restrictions in the special permit condition, the less restrictive cutbacks are applicable to FSH.

6. FSH agrees that it is subject to the District's rules as may be amended.

7. FSH must develop and adopt a conservation plan consistent with the District's rules, including a provision requiring FSH's subsequent customers to develop and implement water conservation plans consistent with the District's Rules, including notice of potential curtailment of production.

8. FSH agrees to meter and report separately water produced from its wells for agricultural use on the FSH property and water transported for municipal and industrial purposes off the property under its H&E Permits and the new Operating Permit.

9. FSH agrees to designate those wells identified in the attached "Monitor Well Thresholds and Cutbacks" as monitor wells and install monitoring and associated satellite telemetry equipment to allow the District to monitor aquifer conditions based upon its production. The selection of these wells and details of the monitoring equipment and related commitments must be mutually agreed upon with the District and memorialized in a monitoring well agreement between FSH and the District.

FORT STOCKTON HOLDINGS, L.P. PRODUCTION PERMIT
SPECIAL PERMIT CONDITIONS

10. FSH agrees to pay the District an export or transport fee on groundwater produced and delivered for beneficial use outside of the District at a rate either on a per acre-foot or 1,000 gallon unit basis consistent with other export fee rates the District has negotiated recently, which the Parties anticipate to be an agreed export fee rate of $0.025 per 1,000 gallons. This agreement will be similar to existing agreements for payment of export fees recently entered into with other permittees.

11. FSH will look to the development of aquifers other than the Edwards-Trinity Aquifer (specifically, the Capitan and/or Rustler Aquifers) for additional permitted water for export for municipal and industrial purposes before applying for permits to export additional Edwards-Trinity Aquifer water for municipal and industrial use.

12. This permit is contingent on FSH's and Republic Water Company of Texas, LLC's (Republic LLC's) performance under the settlement agreement executed among the District, FSH, Republic LLC, and Clayton Williams Farms, Inc.

13. **The attached schedule entitled "Monitor Well Thresholds and Cutbacks" applies to this permit until a Joint Study can be conducted and until such time as the Board determines relaxing the restrictions in this schedule are justified by the results of the Joint Study. Any cutbacks in this schedule shall go into effect April 1st of each year and remain effect through March 31st of the immediately following year.**

14. **The Study scope, project management, and responsibility for funding shall be agreed to between FSH and District within 6 months. The study shall commence shortly after an agreement is reached on the scope.**

15. If the District imposes MZ 1 pro-rata cutbacks and those cutbacks are less restrictive than the restrictions in this special permit condition, the less restrictive cutbacks are applicable to FSH.

Monitor Well Thresholds and Cutbacks

Well		Reference Point Elevation (ft MSL)	Winter Threshold 1		Winter Threshold 2 (Historic Minimum)		Winter Threshold 3		Winter Threshold 4		Maximum Recent Drawdown (Winter to Summer)	Summer Threshold		Recent Depth to Water	
Short Name	Long Name		Depth to Water (ft)	Basis	Depth to Water (ft)	Basis	Depth to Water (ft)	Basis	Depth to Water (ft)	Basis		Depth to Water (ft)	Basis	Winter	Summer
Mpgcd320	King, Woodward, #320	3068	205	Win2+5	200	Data 1/1999	195	Win2-5	190	Win2-10	45	245	Win2+Max DD	113	148
Mpgcd323	Ft Stockton, Cemetery, #323	3031	198	Win2+5	193	Data 1/2000	188	Win2-5	183	Win2-10	15	208	Win2+Max DD	146	148
C-5	C-5, FSH Well	3009	110	Win2+5	105	WPC 1973	100	Win2-5	95	Win2-10	72	177	Win2+Max DD	60	107
M-9	M-9, FSH Well	3261	313	Win2+5	308	WPC 1973	303	Win2-5	298	Win2-10	48	356	Win2+Max DD	246	283
S-45	S-45, FSH Well	3067	165	Win2+5	160	WPC 1973	155	Win2-5	150	Win2-10	56	216	Win2+Max DD	92	115
S-6	S-6, FSH Well	3123	205	Win2+5	200	WPC 1973	195	Win2-5	190	Win2-10	62	262	Win2+Max DD	118	159
Mpgcd305	Cockrell_Belding, #305	3233	292	Win2+5	287	WPC 1973	282	Win2-5	277	Win2-10	75	362	Win2+Max DD	206	250
Mpgcd318	Goldman Ranch, Well 1	2957	72	Win2+5	67	WPC 1975	62	Win2-5	57	Win2-10	33	100	Win2+Max DD	30	49
Mpgcd334	Carpenter, #334	3051	140	Win2+5	135	WPC 1975	130	Win2-5	125	Win2-10	36	171	Win2+Max DD	104	126
Interstate	Interstate Well, FSH Well	2988	96	Win2+5	91	WPC 1975	86	Win2-5	81	Win2-10	40	131	Win2+Max DD	49	71
Prison	TDCJ, Prison Well	3199	258	Win2+5	253	WPC 1973	248	Win2-5	243	Win2-10	50	303	Win2+Max DD	184	224

Threshold	Action
Winter Threshold 1	If 6 of 11 are below threshold, 100% reduction in FSH non-historical use pumping
Winter Threshold 2	If 6 of 11 are below threshold, 50% reduction in FSH non-historical use pumping
Winter Threshold 3	If 6 of 11 are below threshold, 30% reduction in FSH non-historical use pumping
Winter Threshold 4	If 6 of 11 are below threshold, 10% redcution in FSH non-historical use pumping
Summer Threshold	If 6 of 11 are below threshold, meeting in 60 days between FSH and MPGCD to discuss data

Notes

Maximum Recent Drawdown (Winter to Summer) based on evaluation of recent data (~2010 to 2016)
Summer Thresholds derived by adding maximum recent drawdown (from historic data) to Winter 1 Threshold
Recent Depth to Water are from actual data: maximum (summer) and minimum (winter) from spring 2016 to winter 2017

Appendix A

Contact/Authorized Representative

Jeff Williams
#6 Desta Drive
Suite 5725
Midland, TX 79705
Phone: (432) 682-6324
Fax: (432) 336-3842
E-Mail: gataga73@yahoo.com

Ed McCarthy
1122 Colorado Street
Suite 2399
Austin, TX 78701
Phone: (512) 904-2310
Fax: (512) 692-2826
E-Mail: ed@ermlawfirm.com

Mike Thornhill
1104 S. Mays Street
Suite 200
Round Rock, TX 78664
Phone: (512) 244-2172
E-Mail: MThornhill@tgi-water.com

Appendix B-1

MPGCD Number	Well	General Description	Longitude	Latitude	Elevation (feet AMSL)	Survey Name	Abstract Number	Range of Well Depth (feet below ground level)	Aquifer	Property Offsets	Peak Rate of Production (gpm)	Pump and Pump Capacity
2005021409	C-1	2.16 miles ESE of intersection of I-10 Service Rd. and CR 4839	-103.028650	30.890990	3005	GC&SF RR CO	4402	362**	Edwards	1,042 feet from West property line 2,740 feet from North property line	2,000	125 HP, 2,000 gpm (est)
2005021410	C-2	2 miles ESE of intersection of I-10 Service Rd. and CR 4839	-103.031400	30.891090	3006	GC&SF RR CO	4402	346**	Edwards	179 feet from West property line 2,756 feet from North property line	3,000	300 HP, 3,000 gpm (est)
2005021411	C-3	1.83 miles ESE of intersection of I-10 Service Rd. and CR 4839	-103.034550	30.891260	3008	Taylor, E.	4627	350**	Edwards	811 feet from East property line 1,208 feet fromSouth property line	3,000	300 HP, 3,000 gpm (est)
2005021412	C-4	2.42 miles ESE of intersection of I-10 Service Rd. and CR 4839	-103.025820	30.886550	3006	GC&SF RR CO	4402	406**	Edwards	1,970 feet from West property line 1,665 feet from South property line	2,000	200 HP, 2,000 gpm (est)
2005021130	M-1	2.26 miles S of southernmost intersection of CR 896 & FM 2037	-103.026135	30.757445	3293	T&P RR CO	5276	725***	Edwards	45 feet from West property line 27 feet from south property line	2,200	450 HP, 2,200 gpm (est)
2005021131	M-2	1.76 miles S of southernmost intersection of CR 896 & FM 2037	-103.026150	30.764695	3279	T&P RR CO	5276	432*	Edwards	48 feet from West property line 2,663 feet from South property line	1,500	450 HP, 1,500 gpm (est)
2005021132	M-3	1.51 miles S of southernmost intersection of CR 896 & 2037	-103.026160	30.768281	3277	T&P RR CO	5276	410***	Edwards	49 feet from West property line 1,358 feet from North property line	2,200	450 HP, 2,200 gpm (est)
2005021133	M-4	0.76 miles S of southernmost intersection of CR 896 & FM 2037	-103.026148	30.779308	3262	T&P RR CO	5274	410***	Edwards	62 feet from West property line 2,642 feet from North property line	1,800	200 HP, 1,800 gpm (est)
2005021134	M-5	0.82 miles E of nothermost intersection of CR 896 & FM 2037	-103.007656	30.792598	3238	T&P RR CO	6015	330***	Edwards	605 feet from West property line 2,316 feet from South property line	2,200	450 HP, 2,200 gpm (est)
2005021135	M-6	0.92 miles E of nothernmost intersection of CR 896 & FM 2037	-103.005992	30.792928	3231	T&P RR CO	6015	335**	Edwards	1,130 feet from West property line 2,316 feet from South property line	2,000	300 HP, 2,000 gpm (est)
2005021136	M-7	0.9 miles E of northernmost intersection of CR 896 & FM 2037	-103.006354	30.794657	3213	T&P RR CO	6015	343*	Edwards	1,029 feet from West property line 2,945 feet from South property line	2,000	450 HP, 2,000 gpm (est)
2005021137	M-8	0.95 miles E of intersection of FM 2037 & Old Alpine Hwy.	-102.993600	30.800244	3195	T&P RR CO	6015	520**	Edwards	308 feet from East property line 206 feet from North property line	1,000	250 HP, 1,000 gpm (est)
2005021138	M-9	1.26 miles E of northernmost intersection of CR 896 & FM 2037	-103.026153	30.772017	3282	T&P RR CO	5276	545*	Edwards	55 feet from West property line 0 feet from North property line	800	100 HP, 800 gpm (est)
2005021444	NC-2	0.34 miles NE of intersection of I-10 Service Rd. & Leon Farms Rd.	-102.963650	30.899027	2981	Handy, J.H.	5486	na	unknown	1,493 feet from West property line 15 feet from South property line	500	150 HP, 500 gpm (est)
2005020923	S-1	2.6 miles N of Old Alpine Hwy & Pecan Rd.	-103.043509	30.815876	3152	T&P RR CO	5601	340***	Edwards	62 feet from East property line 50 feet from South property line	1,400	250 HP, 1,400 gpm (est)

2005020924	S-2	2.5 miles NW of Intersectionof FM 2037 & Old Alpine Hwy.	-103.043829	30.823565	3144	T&P RR CO	5601	465**	Edwards	155 feet from East property line 2,470 feet from North property line
2005020926	S-4	1,480 feet N of S-2	-103.013542	30.827628	3141	T&P RR CO	5601	510*	Edwards-Trinity	60 feet from East property line feet from North property line
2005020928	S-6	2,407 feet N of S-2	-103.043513	30.830453	3121	T&P RR CO	8970	455*	Edwards	55 feet from East property line feet from South property line
2005020933	S-11	0.99 miles south of Intersection of Williams Rd. & Brangus Rd.	-103.025942	30.830560	3128	T&P RR CO	9548	425**	Edwards-Trinity	100 feet from West property line feet from South property line
2005020937	S-13	2,743 feet E of S-11	-103.017201	30.830579	3131	T&P RR CO	9548	360***	Edwards	2,354 feet from East property line feet from South property line
2005021109	S-18	0.45 miles W of Intersection of FM 2037 & Brangus Rd.	-103.010304	30.859055	3066	GC&SF RR CO	8357	312*	Edwards	2,325 feet from east property line feet from South property line
2005021110	S-19	3,593 feet W of S-18	-103.021756	30.859023	3074	GC&SF RR CO	8357	302*	Edwards-Trinity	179 feet from West property line feet from South property line
2005021111	S-20	468 feet N of S-19	-103.021846	30.860309	3064	GC&SF RR CO	8357	360*	Edwards	150 feet from West property line feet from South property line
200502116	S-26	2.05 miles W of Intersection of FM 2037 & Brangus Rd.	-103.037221	30.858870	3077	GC&SF RR CO	4563	500**	Edwards	738 feet from East property line feet from North property line
2005021120	S-32	1.93 miles W of Intersection of FM 2037 & Brangus Rd.	-103.035110	30.858848	3088	GC&SF RR CO	4563	316**	Edwards	76 feet from East property line feet from North property line

Williams Wells

Appendix C

FSH/CWF Well Schedule

Farm/ Well Name	MPGCD #	Historic & Existing Use	New Operating Permit	Historic & Existing Remaining	Year of Maximum H&E Use			
Mesa Farm								
M-1	2005021130	2,129.00	2,129.00	0.00	1993			
M-2	2005021131	1,419.00	1,419.00	0.00	1993			
M-3	2005021132	2,149.00	2,149.00	0.00	1990			
M-4	2005021133	1,758.00	1,758.00	0.00	1990			
M-5	2005021134	1,328.00	1,328.00	0.00	2004			
M-6	2005021135	1,727.00	1,727.00	0.00	2003			
M-7	2005021136	1,727.00	1,727.00	0.00	2003			
M-8	2005021137	928.00	928.00	0.00	1994			
M-9	2005021138	332.00	332.00	0.00	1994			
		13,497 H&E	13,497.00	0.00				
Stockton Farm								
#1	2005020923	458.00	458.00	0.00	1996			
#2	2005020924	1,352.00	1,352.00	0.00	2002			
#3	2005020925	27.00		27.00	1993			
#4	2005020926	1,839.00	1,839.00	0.00	2004			
#5	2005020927	1,590.00		1,590.00	2004		Leased on Ryan	
#6	2005020928	424.00	424.00	0.00	2000			
#7	2005020929	1,297.00		1,297.00	2004			
#8	2005020930	1,400.00		1,400.00	1993			
#9	2005020931	742.00		742.00	2003			
#10	2005020932	1,789.00		1,789.00	1990			
#11	2005020933	1,381.00	1,381.00	0.00	2002			
#12	2005020934	8.00		8.00	2001			
#13	2005020937	924.00	920.00	0.00	2002			
#15	2005020938	948.00		948.00	2004			
#18	2005021109	406.00	406.00	0.00	1994			
#19	2005021110	406.00	406.00	0.00	1994			
#20	2005021111	406.00	406.00	0.00	1994			
#21	2005021112	2,456.00		2,456.00	2004			
#22	2005021113	1,452.00		1,452.00	2004		Leased on McKenzie	
#23	2005021114	1,638.00		1,638.00	1990			
#25	2005021115	1,169.00		1,169.00	2004			
#26	2005021116	1,318.00	1,318.00	0.00	2004			
#27	2005021117	940.00		944.00	2004			
#28	2005021118	875.00		875.00	2004			
#29	2005021119	875.00		875.00	2004			
#32	2005021120	1,537.00	1,537.00	0.00	2004			
#33	2005021121	1,678.00		1,678.00	2004			
#34	2005021122	1196	Rustler (0)		2004		Leased on Pryor	
#40	2005021123	68.00		68.00	1996			
		30,597 H&E	10,447.00	18,954.00				
Caramba Farms								
C-1 (Brown#1)	2005021409	849.00	849.00	0.00				
C-2 (Brown#2)	2005021410	1,273.00	1,273.00	0.00				
C-3 (Brown#3)	2005021411	1,273.00	1,273.00	0.00				
C-4 (Brown#4)	2005021412	849.00	849.00	0.00				
Caramba#2	2005021444	212.00	212.00	0				
		4,456 H&E	4,456.00	0.00				
NOTE: MOVED 4 AC-FT FROM #13 TO #27 (WILL REQUEST IN AMENDMENT)								
		Total H&E (including the leased land)	New Operating Permit	Remaing H&E Permit	H&E on Leased Land			
Mesa Farm		13,497.00	13,497.00	0.00	0.00			
Stockton Farm		30,597.00	10,447.00	18,954.00	8,332.00			
Caramba		4,456.00	4,456.00	0.00	0			
Grand Totals		48,550.00			8,332.00			
	S#34 Rustler 1196 ac-ft							
	Totals	[illegible]	[illegible]	[illegible]	7,136 E/T			
				20,150 ac-ft total H&E Remaining				

FSH shows 47,418. There is an error from Carnba farms C-6 40 ac-ft and Caramba farms C-Orchard 14 ac-ft and a correction on S-6 from 434 to 424 ac-ft

Board action on Jan 18th 2006 is only 5 wells on Caramba for 4,456

Middle Pecos GCD Exhibit 42

Middle Pecos GCD's 2022 Annual Report, 2023 Annual Report, and 2024 Annual Report

Middle Pecos Groundwater Conservation District
2022- Annual Report

General Manager: Ty Edwards

Submitted by Ty Edwards, General Manager
02/21/2023

Middle Pecos Groundwater Conservation District
2022 Annual Report

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Texas Drought Monitor Map:
- **January 2022- December 2022**

Comanche Springs:
- **Comanche Springs**
- **Prison**

The Nature Conservancy:
- **Diamond Y/ Euphrasia Spring**

Pecos River:
- **Pecos River- Girvin, Texas**
- **Pecos River- Sheffield, Texas**

Fort Stockton Holdings:
- **FSH Agreed Threshold Monitoring**
- **FSH Remaining Threshold and Well Locations**
- **FSH Threshold Table**

Conservation Letters:
- **Rainwater Harvesting**
- **Annual Newspaper Article for Publics Information Regarding Groundwater Conservation**

MIDDLE PECOS GROUNDWATER CONSERVATION DISTRICT
P.O. Box 1644 Fort Stockton, TX 79735 Phone (432)336-0698 Fax (432)336-3407
405 North Springs Drive Fort Stockton, Texas 79735
Email: mpgcd@mpgcd.org Website: www.middlepecosgcd.org

2022 Annual Manager's Report

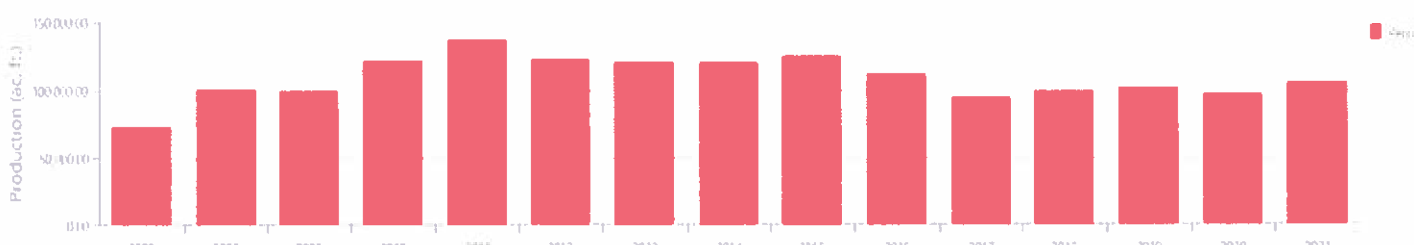
MPGCD Board of Directors

The District was very busy this year working towards a resolution for the abandoned well problem in Pecos County. The District staff and Board spent a significant amount of time and money on addressing the issues. Banner Public Affairs, LLC was hired to find a funding solution at the Federal level. Banner has arranged for numerous meetings with Congressional members and staff over the last several months, along with Federal agencies overseeing programs that could help with the problem. The District has continued the efforts at the State level including testifying at the RRC, State Capitol and onsite visits with committee and staff members. The Texas Legislative session will start on January 10, 2023, and the District has 3 draft bills ready to be filed to address the P-13 issues at the RRC.

The District has continued to tend to MPGCD business in managing the groundwater resources of Pecos County. A summary of that work is below. Annual groundwater production and number of registered water wells in the District are:

NUMBER OF WELLS
3,871 Total
2,898 Exempt
973 Non-Exempt

Production Explorer

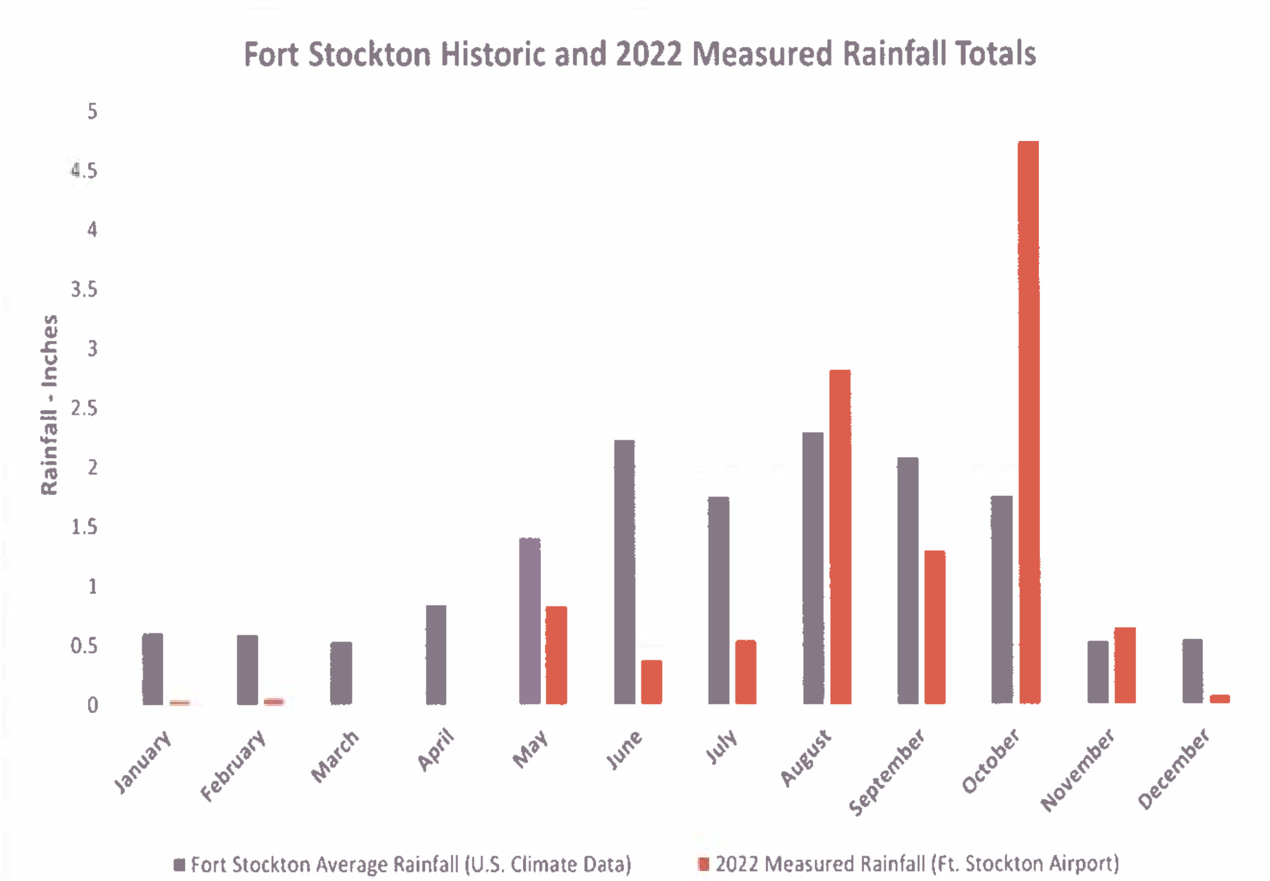


	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Pecos	72,879 56	100,641 13	99,624 66	120,924 12	136,393 17	122,620 20	120,478 82	120,735.30	124,900 19	111,572 54	94,196 04	98,822 37	101,072 95	96,639 19	104.979 27

Wells

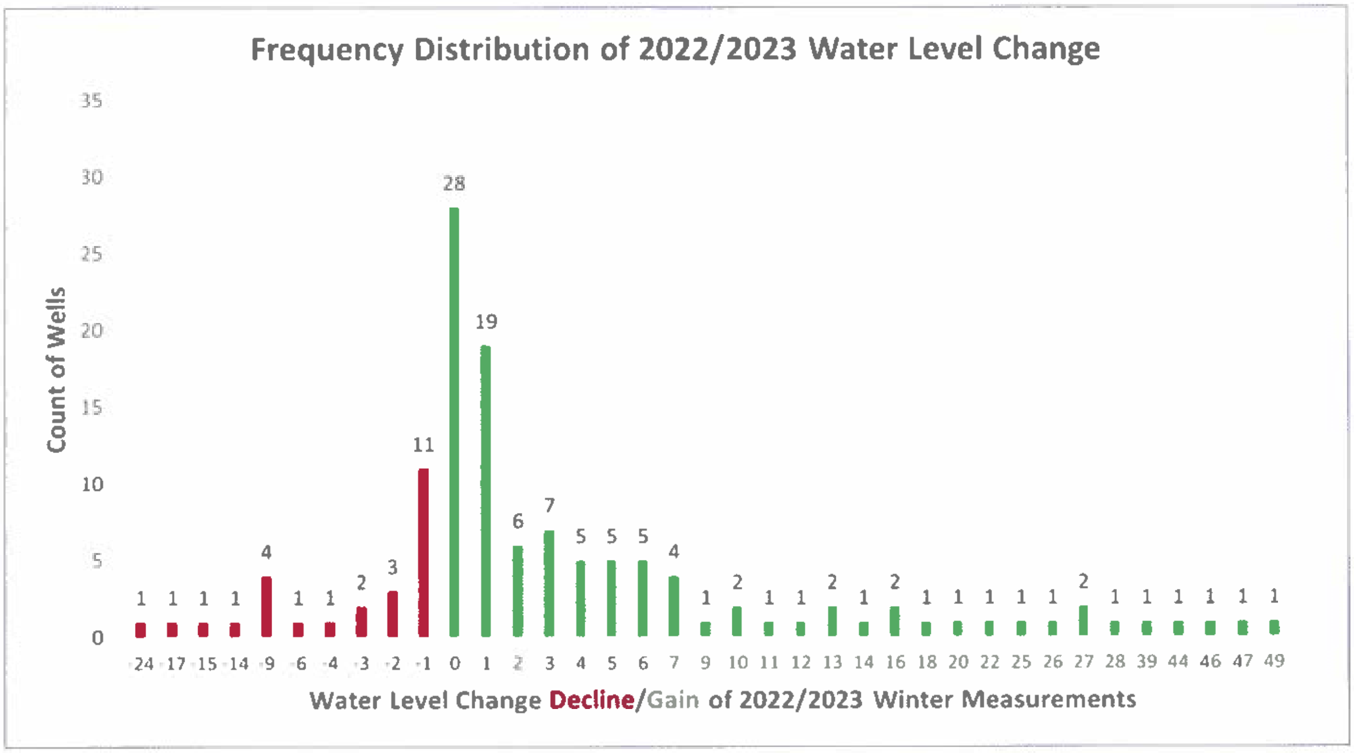
- **2022 Rainfall**

The 2022 year began with most of Pecos County in severe or extreme drought. These conditions worsened throughout the spring and into the summer months, and much of the County experienced exceptional drought. Significant rainfall events began to alleviate the drought in August and the County ended the year without a drought declaration. Much of the observed rainfall was experienced between August and November with western Pecos County being the main beneficiary. Fort Stockton 2022 rainfall was below the historic average of 15.15", with the City receiving ~75% of its average annual rainfall despite the above average late year rainfall totals.



- **Winter Water Levels**

Steady water level declines, consistent with drought were observed throughout the first half of 2022. As drought ended many of these declines were quickly erased and most monitor well water levels are higher than were observed this time last year (Figure 2). This turnaround highlights the importance of rainfall to the overall health of the aquifer systems within Pecos County, TX.

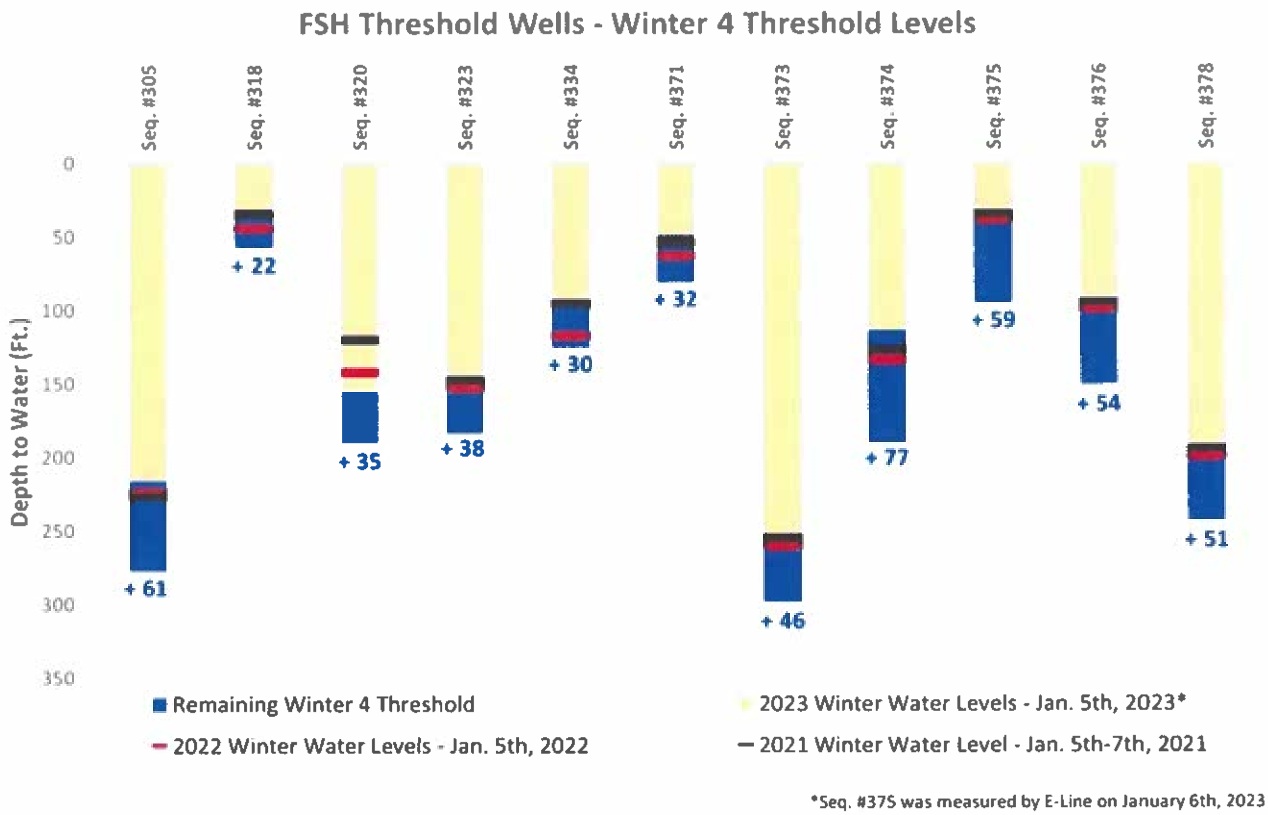


Currently 133 water wells are monitored in Pecos County with roughly 75% of monitor wells exhibiting a gain or recovery when compared to their 2022 winter measurement. Of the 26 wells experiencing drawdowns, 22 showed less than 10 feet of decline while the other four wells showed declines between 14 and 24 feet. The most significant signs of recovery were observed within Management Zone 1. When comparing 2011-12 water levels to current measurements, the general trend is flat to slightly downward, with most drawdowns being observed in Management Zone 3 and along the Reeves County border. Monitor well #230 in southern Pecos County has shown the most significant decline over the period, a reoccurring trend that has been observed over the last several years.

- In Corporation with local landowners **50** water samples have been collected across Pecos County in 2022.

- **Fort Stockton Holdings** 28,400 ac/ft export permit was renewed for a 3-year permit term effective July 18, 2020-2023, in accordance with District Rule 11.8(f) and Texas Water Code 36.1145. FSH and MPGCD approved a Joint Study to be proactive, to develop scientific data that will provide FSH, the District, and other stakeholders with more certainty about conditions in the Edwards-Trinity Aquifer. FSH agreed to pay $250,000 to contribute to the study. As of this date the District has installed transducers, which are recording pressure, temperature, and conductivity at the 11 Threshold monitor well sites.

  FSH Threshold Well Dashboard is available at https://mpgcd.halff.com/Dashboard.



- **COCKRELL #1-** Cockrell Investment Partners, L.P v. Middle Pecos Groundwater Conservation District, Cause NO. P-12176-112-CV was filed in District court over denial of Party status to the Fort Stockton Holdings (FSH) Hearings. Judge Ables ruled in favor of the District on December 17, 2020 granting the District Pleas to the Jurisdiction and awarded attorney fees. This case has been appealed to El Paso Court of Appeals, Appellate Case No. 08-21-00017-CV. Waiting on a ruling from the court.

- **COCKRELL #2-** Cockrell Investment Partners, L.P v. Middle Pecos Groundwater Conservation District, Cause NO. P-8277-83-CV (Second Law Suite Permit Renewal). Signed by the parties noting that Cockrell Investment Partners has agreed to pay the mandatory awarded fees. Cockrell Investment Partners has appealed Judge Ables decision to the El Paso Court of Appeals. Waiting on a ruling from the court.

- **Diamond Y Spring**-The Nature Conservancy has installed Telemetry in Diamond Y Springs. The Conservancy has created an extensive groundwater monitoring program to track spring flows, water quality, and the health of the pupfish and other species. Over the last few years, we have seen a decrease in flows during the summer months and a recovery in winter months. Diamond Y Spring Preserve protects one of the largest and last remaining Cienega systems in West Texas. The District updated the geologic model in 2021, around the Diamond Y Spring area and was able to map several faults. Work is ongoing.

- **Santa Rosa Spring-** continues to remain dry. The spring bed is being monitored and we are tracking changes in pressure during rain fall events.

- **Comanche Spring-** is continually monitored for flow, pressure, and conductivity during the Winter Spring Season. The Spring began flowing on December 15, 2022.

- The District was awarded a **FY 21 TWDB Agricultural Water Conservation Grant** for metering in Management Zone 1. Outreach is ongoing and hope to begin installation of meters in early 2023.

- The District Board approved the drilling of a **Monitor Well at the MPGCD Office located at 405 North Spring Drive**. The purpose of the well will be to have an educational monitoring site outside the office. An 8ft Areomotor windmill has been installed over the well with full time In-Situ monitoring equipment downhole. A full exhibit has been erected at the site.

- **San Andres Flowing Wells-** Research is continuing pertaining to the artesian wells around the Imperial area. Currently seven wells have been plugged. The District budgeted $150,000 for fiscal year 2022-2023 to start a plugging effort to address the remaining well issues. Banner Public Affairs, LLC has been hired to help with outreach at a Federal level. State outreach is ongoing with several bills filed to address the P-13 issue including Boehmer Lake.

- **Phase 1** of building a groundwater flow model have begun with completion of the model anticipated for 2024. The objective is to develop a tool that would assist the District in groundwater management. The google link for the tech memos is available at:

  https://drive.google.com/drive/folders/1HYj8JRV4omAgKPJWBta-T20hZUbtyaPS.

  Specific uses that are contemplated include:

  - DFC development without the need to use regional GAM's.
  - Provide a quantitative basis for future updates to the District's rules that set a threshold on well size/pumping amount for requiring permit applicants to prepare hydrologic reports.
  - Provide a tool that can be used to review permit applications by quantifying the potential impacts of new pumping for any formation/aquifer in the District on a regional scale.
  - Assess the relationship between groundwater pumping and spring flow at Comanche Springs on a monthly time scale.

- The **third round of joint planning** for Groundwater Management **Areas 3 and 7** is complete and the fourth round of joint planning is underway. For this round, the statutory deadline to propose desired future conditions (DFC's) is May 1, 2026, and the deadline to submit final DFC's to the Texas Water Development Board is January 5, 2027. I attended 100% of all the GMA 3 and GMA 7 meetings held in 2022.

  https://www.twdb.texas.gov/groundwater/management_areas/gma3.asp

  https://www.twdb.texas.gov/groundwater/management_areas/gma7.asp

- The **Region F Water Planning Group** is tasked with developing and adopting a regional water plan in accordance with Texas Senate Bill 1 and Texas Senate Bill 2. The 2021 Region F Plan was submitted to the Texas Water Development Board, and we held our last meeting to adopt the 2021 plan on September 17, 2020. The sixth cycle of regional planning is underway for the 2026 State

Water Plan. I am a voting member of Region F representing Groundwater Management Area 3 and have attended 100 percent of the scheduled meetings for Region F in 2022.

https://www.twdb.texas.gov/waterplanning/rwp/plans/2021/index.asp

- The Texas Legislature is underway starting **January 10, 2023**. Pecos County is in State House District 53 (Andrew Murr) and Senate District 29 (Cesar Blanco).

  House Committee on Natural Resource held hearings on issues affecting groundwater management policy and regulatory framework. The Committee heard testimony related to the following topics:

  (1) Large-Scale Transfers

  The Legislature should examine the outdated export fee structure to help provide additional funding for continued monitoring and developing science for assessing and addressing impacts from large-scale water transfers.

  (2) Desired Future Conditions

  The state should encourage progress towards achievement of DFCs by requiring representatives in a GMA – using groundwater availability models – to adopt intermediate DFCs for each five-year period in the 50-year plan.

  The Legislature should appropriate additional funding and full-time staff to the Texas Water Development Board (TWDB) to support state-of-the-art groundwater availability modeling, and to provide technical and financial support to GCDs as they develop their DFCs.

  (3) Transparency in the Permit Application Process

  The Legislature should consider legislation providing that in GCDs with rules requiring well spacing from other existing wells, a notice of a permit application should be provided to neighboring landowners who own land within the spacing distances from other existing wells and whose right to drill a well on their property would be impacted under the spacing rules if the district approves the application for which the notice is provided.

  (4) Abandoned and Deteriorated Water Wells & Orphan Oil and Gas Wells.

  The Railroad Commission (RRC) has jurisdiction over P-13 (Oil Wells transferred to Water Wells) wells and is the only regulatory agency with the expertise, personnel, and funding necessary to address the issue. The RRC should take steps to plug abandoned oil wells including P-13 wells. The RRC is properly positioned to address sulfur wells despite any jurisdictional confusion and should work to address the issue.

  (5) Promote Conservation and Achieve Waste.

  The Committee made recommendations to revise and clarify the definitions of "waste" and "beneficial use" throughout the Texas Water Code.

Senate Committee on Agriculture, Water & Rural Affairs published their Interim Report to the 88th Legislature. Based on testimony presented during the hearings, the Committee made the following recommendations:

- Groundwater Conservation Districts (GCDs) should be encouraged to maximize tools such as export fees and contracts to adequately plan for mitigation and to educate landowners on the benefits of data for the use of well meters.

- The state should invest in updated groundwater availability models at TWDB; consider grants to GCDs to employ the best available science at a local level; and replenish Agriculture Conservation grant funding to incentive drip irrigation and other conservation technologies.

- The public should be better educated on the importance of water conservation. This work can start in public schools.

Senate Committee on Natural Resources and Economic Development also published an Interim Report. The Report focuses more on economic development issues than natural resource issues. There was mention of abandoned oil and gas wells that is summarized below.

<u>Monitoring HB 3973 relating to a study on abandoned oil and gas wells and the use of the oil and gas regulation and cleanup fund.</u>

- The 82nd Legislature established the Oil and Gas Regulation and Cleanup Fund (OGRC) to manage the state's plugging program, address orphaned wells, and clean up abandoned oil field locations. Last session, HB 3973 created a joint interim committee to study matters related to abandoned oil and gas wells in the state, including the costs associated with plugging abandoned wells. However, the joint interim committee was never appointed and, therefore, failed to meet. The Committee determined that P-13 wells should continue to be monitored and the Legislature should address the current oversight of the agencies involved and make changes, as necessary.

- As General Manager of the District, I would like to thank MPGCD Directors for all the hard work and time you dedicated to 2022.

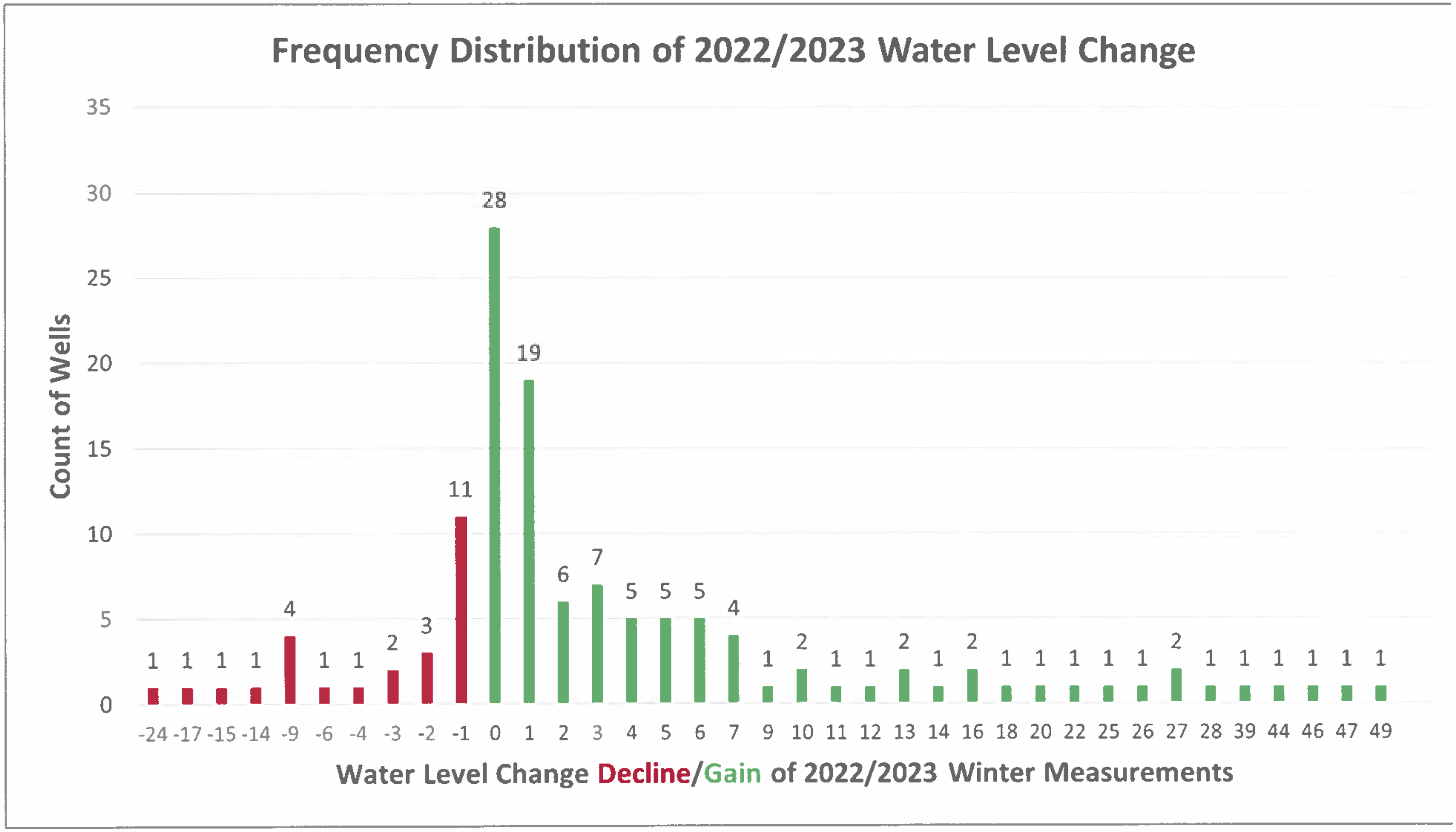
Ty Edwards, General Manager

NUMBER OF WELLS
3,871 Total
2,898 Exempt
973 Non-Exempt

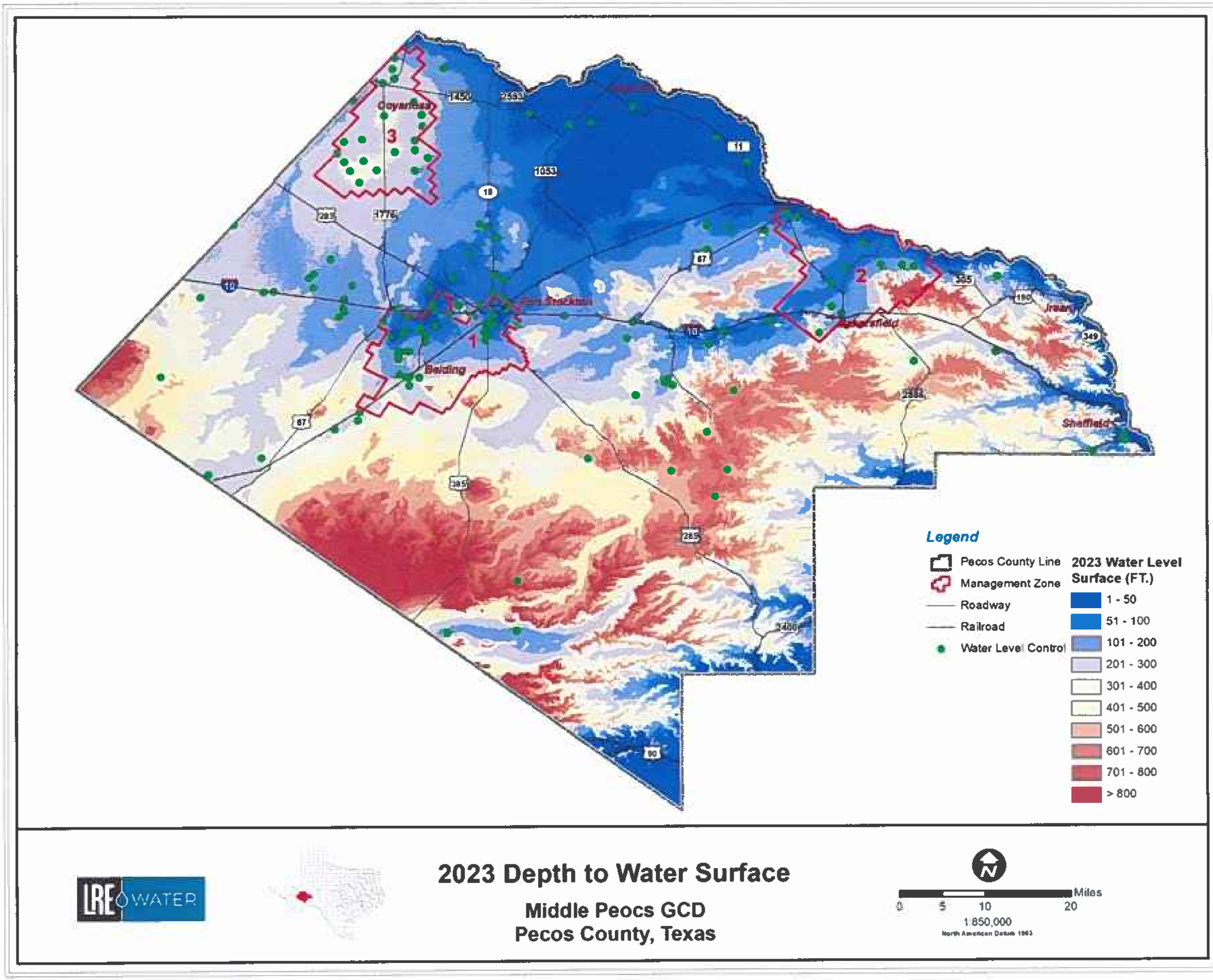
Production Explorer

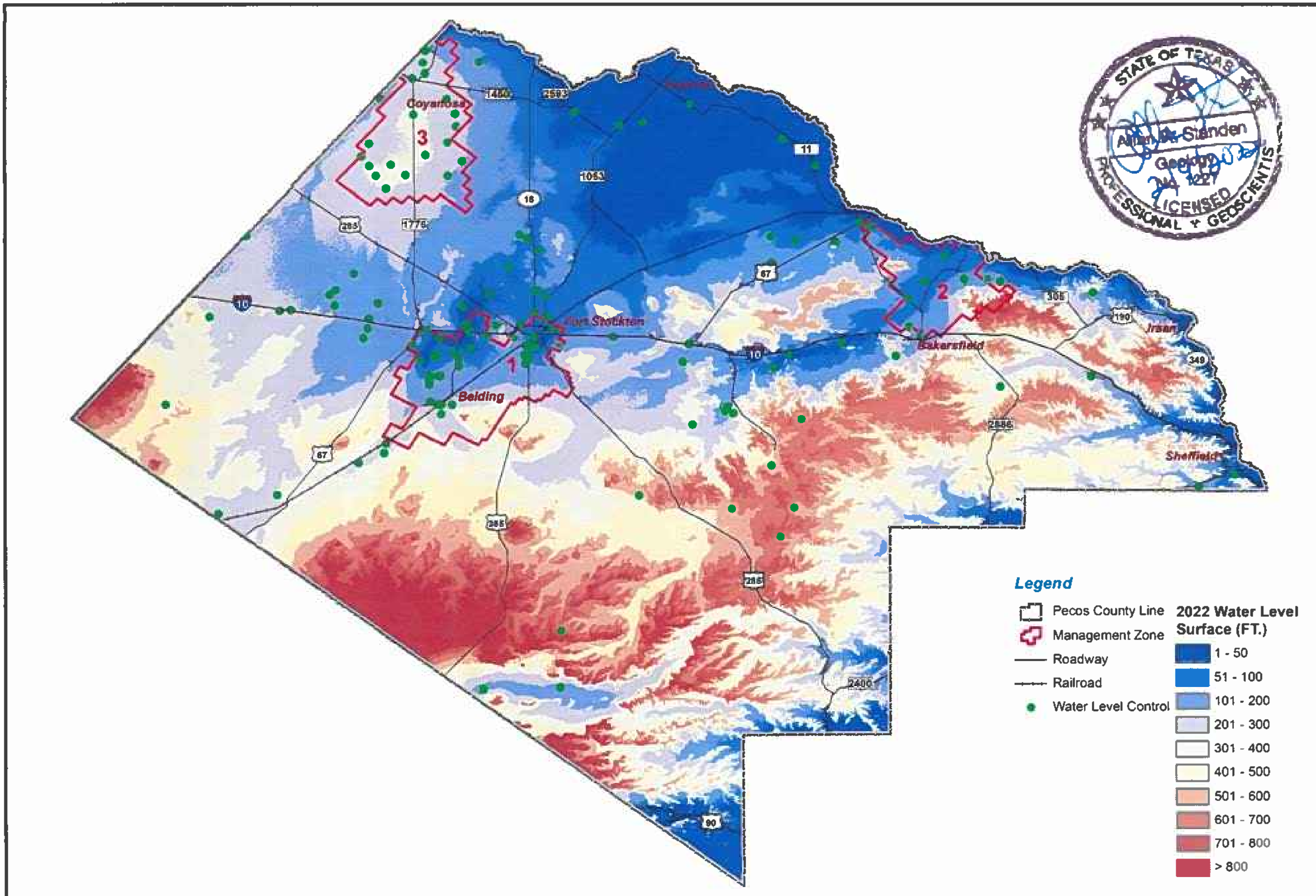
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Pecos	72,879.56	100,641.13	99,624.66	120,924.12	136,393.17	122,620.20	120,478.82	120,735.30	124,900.19	111,572.54	94,196.04	98,822.37	101,072.95	96,639.19	104,979.27

Wells


Frequency Distribution of 2022/2023 Water Level Change
Count of Wells
35
30
25
20
15
10
5
0
1 1 1 1 4 1 1 2 3 11 28 19 6 7 5 5 5 4 1 2 1 1 2 1 2 1 1 1 1 1 2 1 1 1 1 1 1
-24 -17 -15 -14 -9 -6 -4 -3 -2 -1 0 1 2 3 4 5 6 7 9 10 11 12 13 14 16 18 20 22 25 26 27 28 39 44 46 47 49
Water Level Change Decline/Gain of 2022/2023 Winter Measurements

Water Level Surface 2023



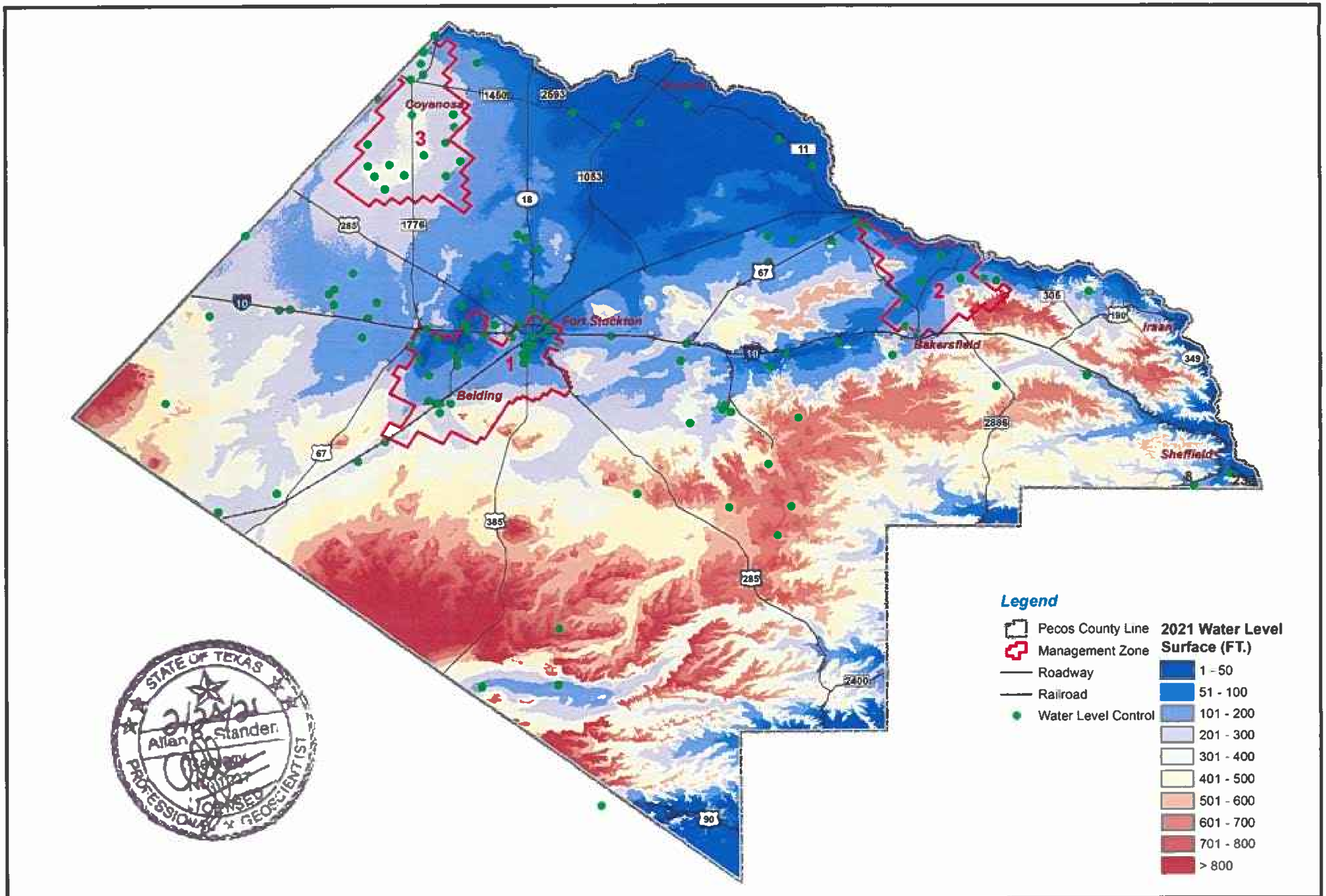


Allan R. Standen LLC
Groundwater & Natural Resource Consulting

2022 Depth to Water Surface

Pecos County, Texas

Miles
0 5 10 20
1:850,000
North American Datum 1983

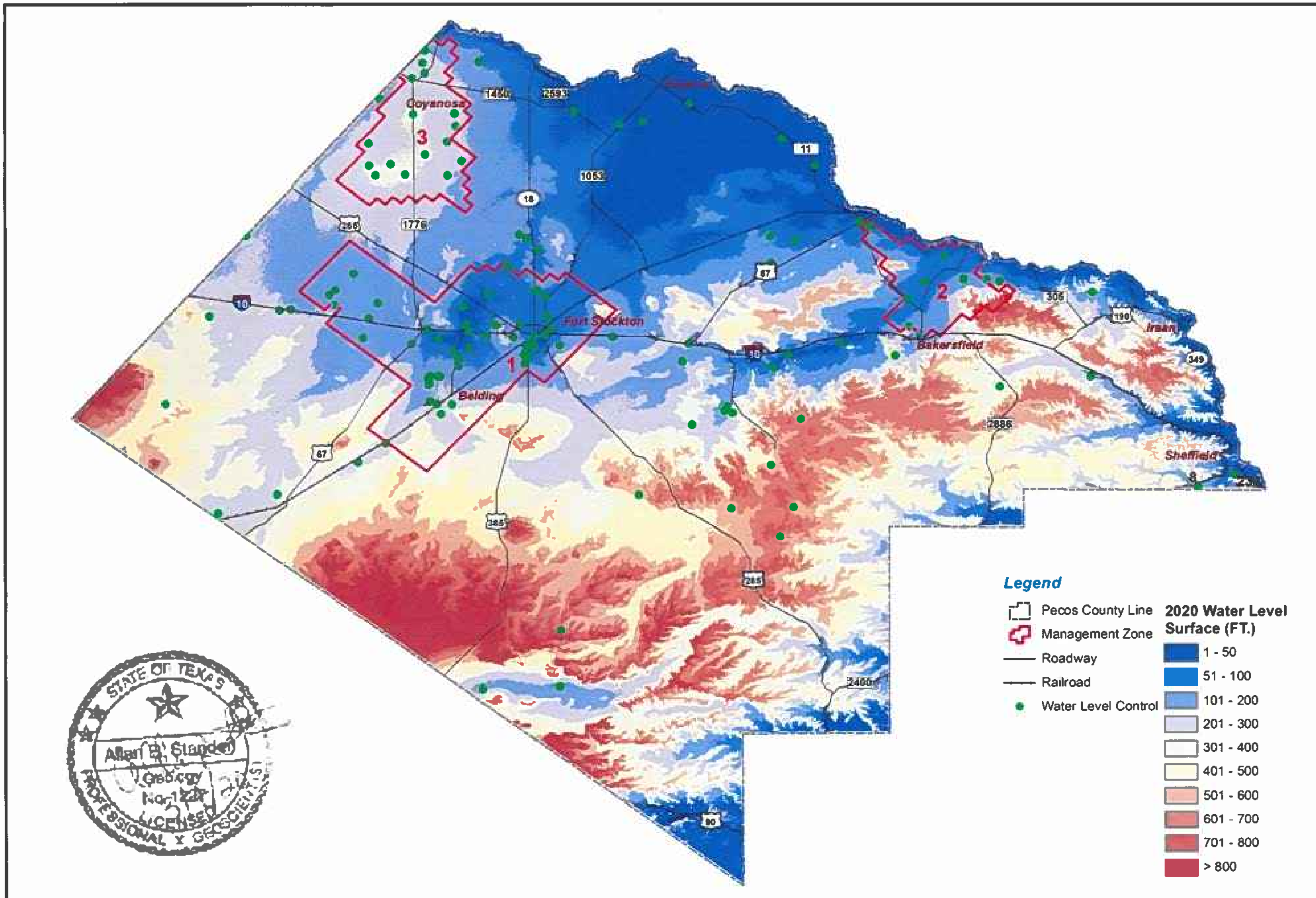


Allan R. Standen LLC
Groundwater & Natural Resource Consulting

2021 Depth to Water Level

Pecos County, Texas

Miles
0 5 10 20
1:850,000
North American Datum 1983



Allan R. Standen LLC
Groundwater & Natural Resource Consulting

2020 Depth to Water Level

Pecos County, Texas

Miles
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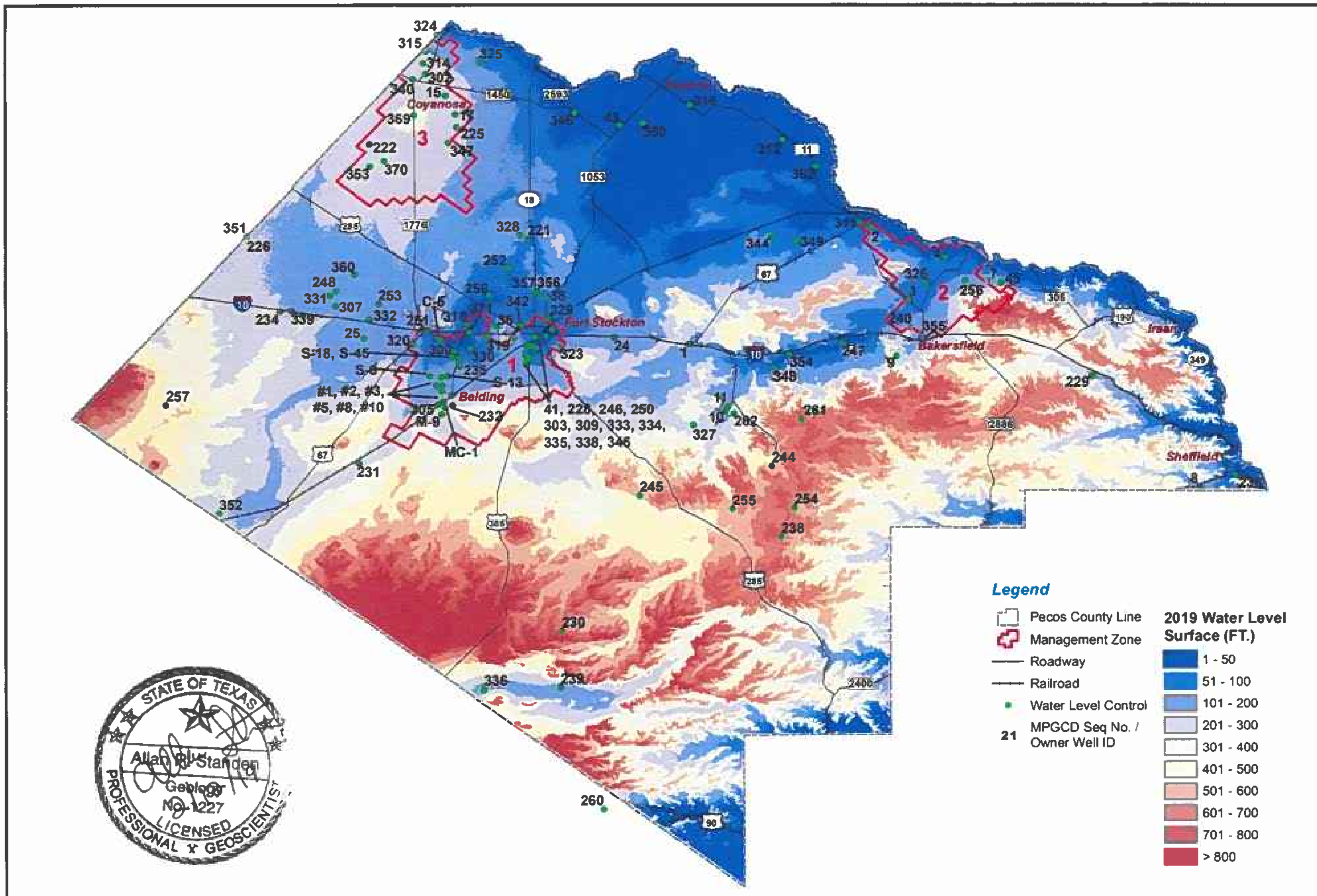
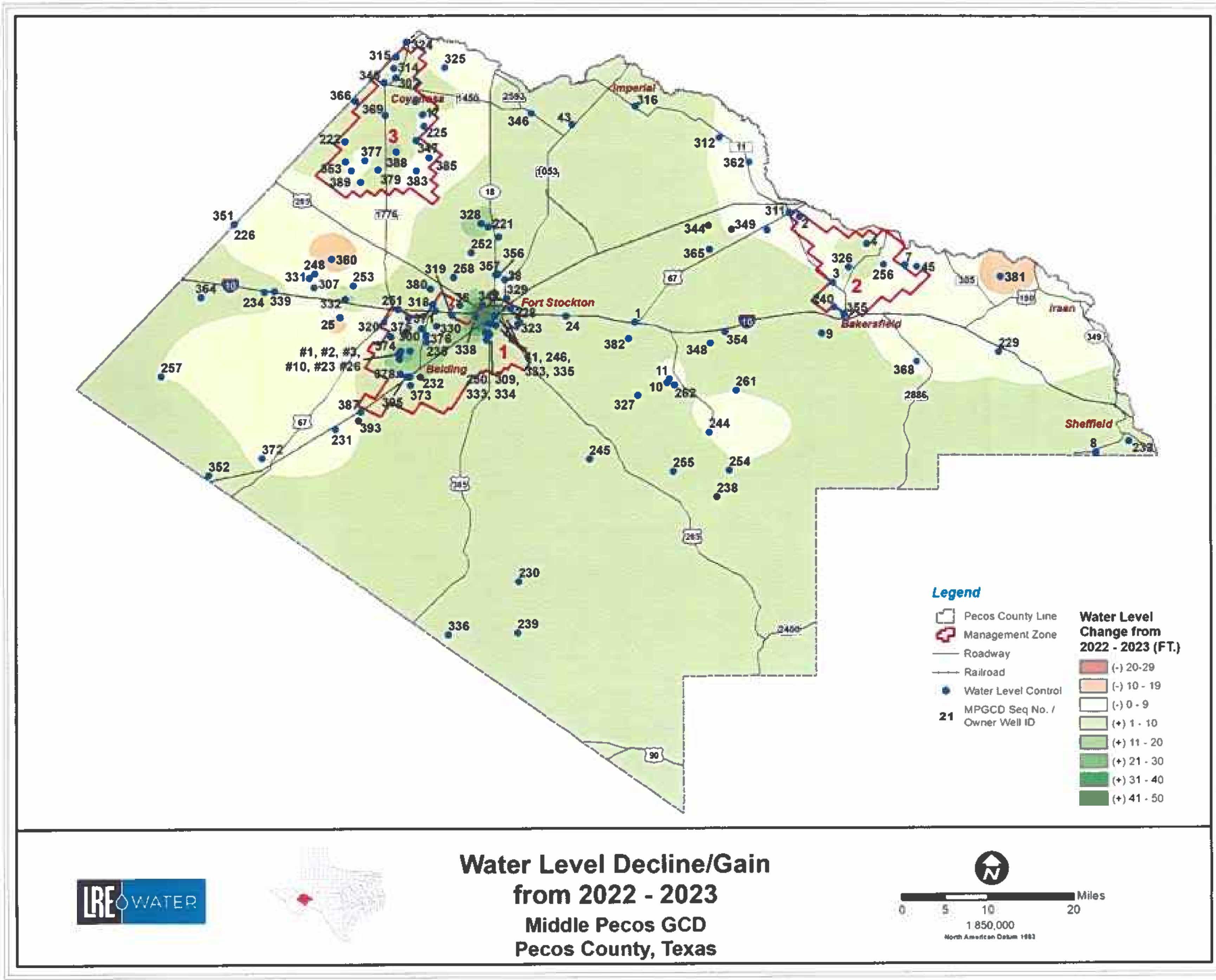
1:850,000
North American Datum 1983



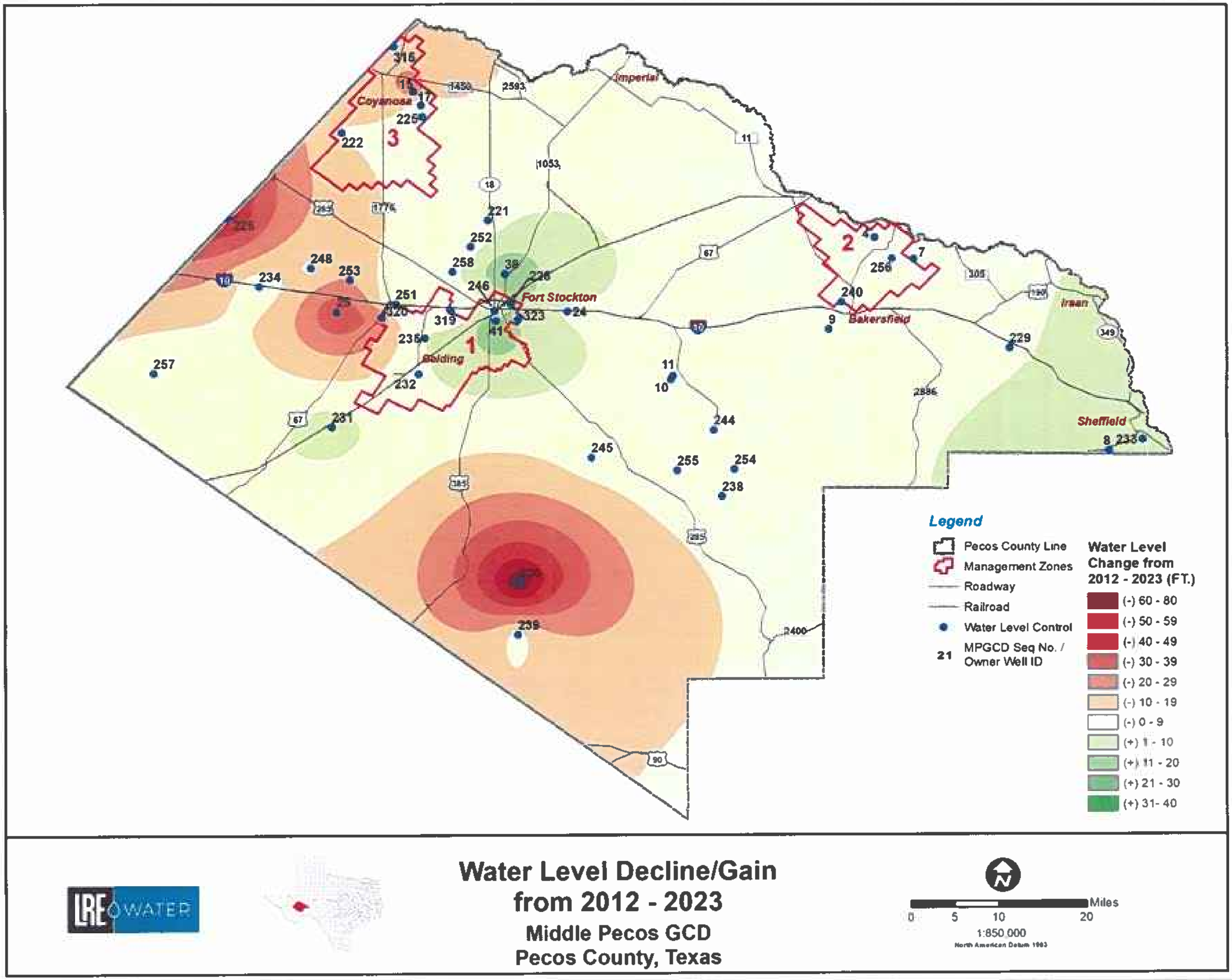
2019 Depth to Water Level

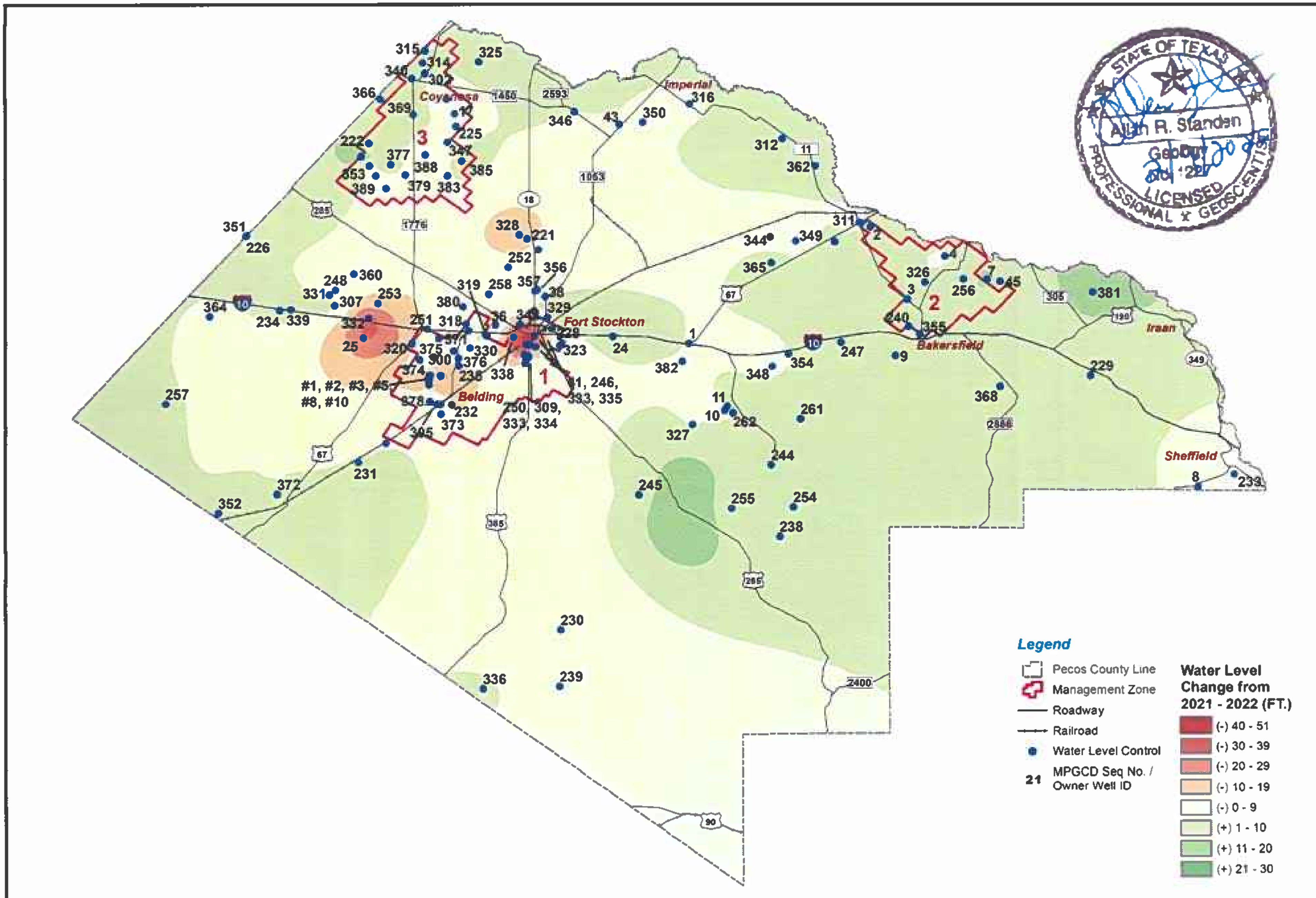
Pecos County, Texas

Water Level Change 2022 to 2023.



Water Level Change 2012 to 2023





Water Level Decline/Gain from 2021 - 2022

Pecos County, Texas

Miles
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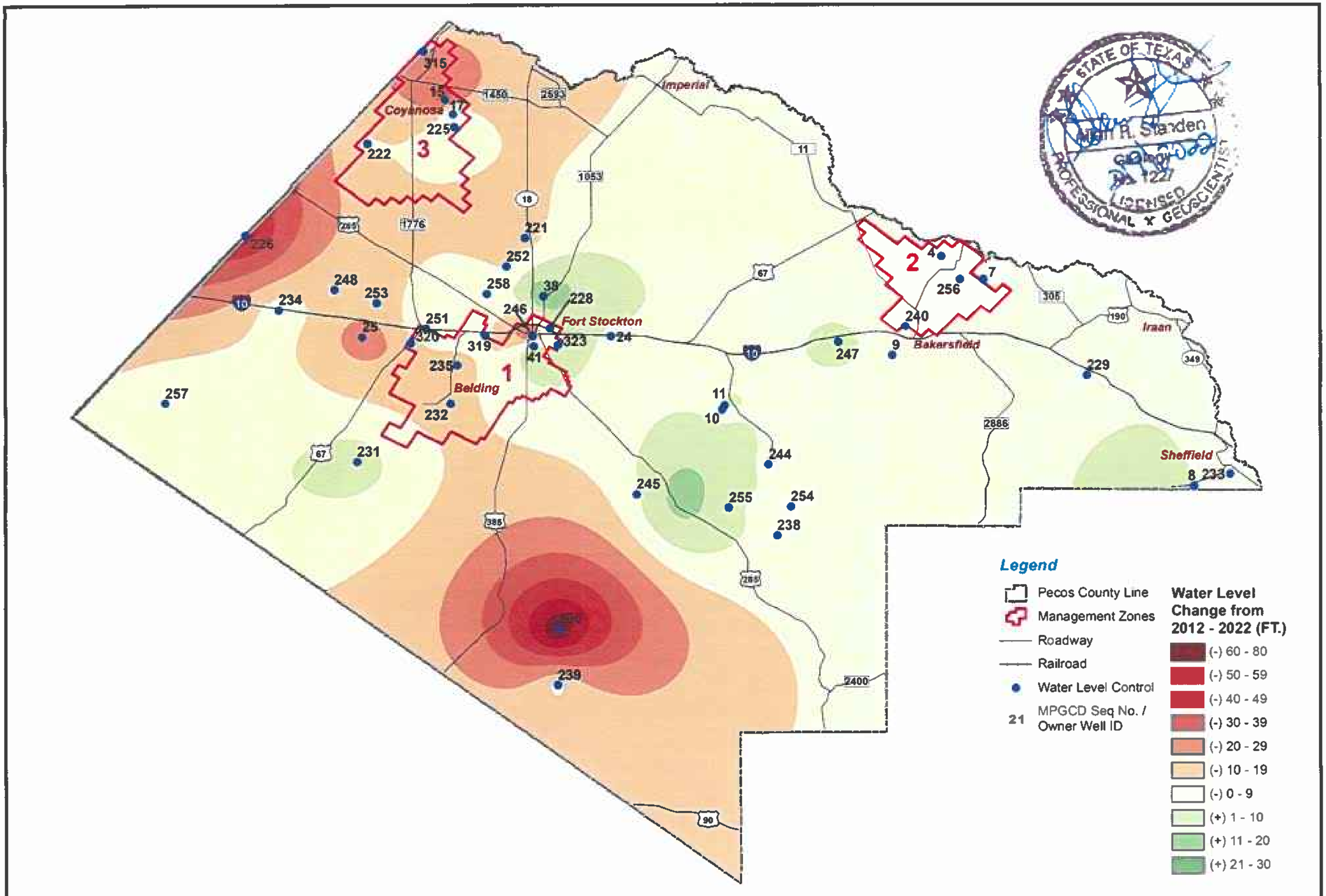
1:850,000
North American Datum 1983

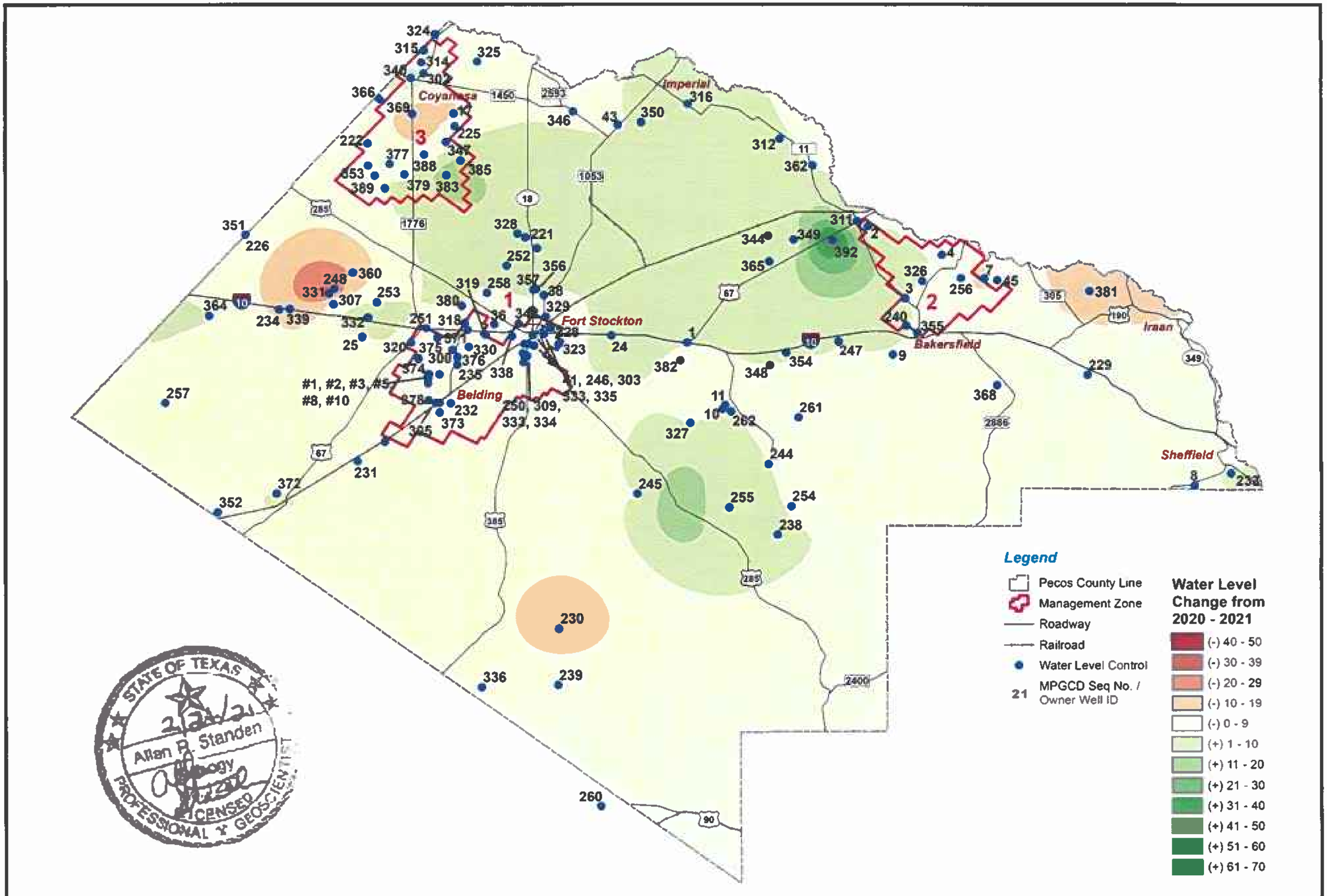


Water Level Decline/Gain from 2012 - 2022

Pecos County, Texas

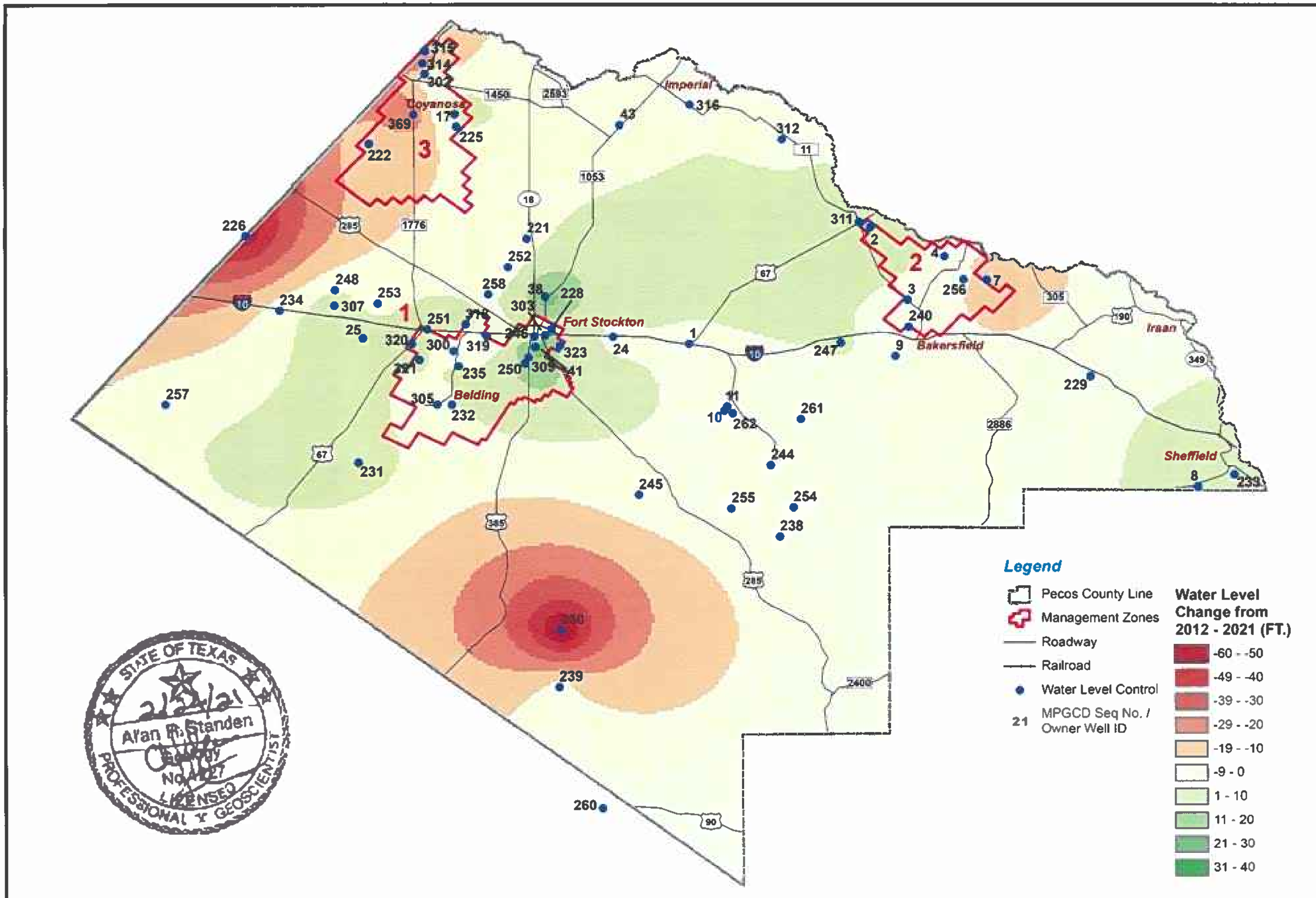
Allan R. Standen LLC
Groundwater & Natural Resource Consulting

Miles
0 5 10 20
1:850,000
North American Datum 1983



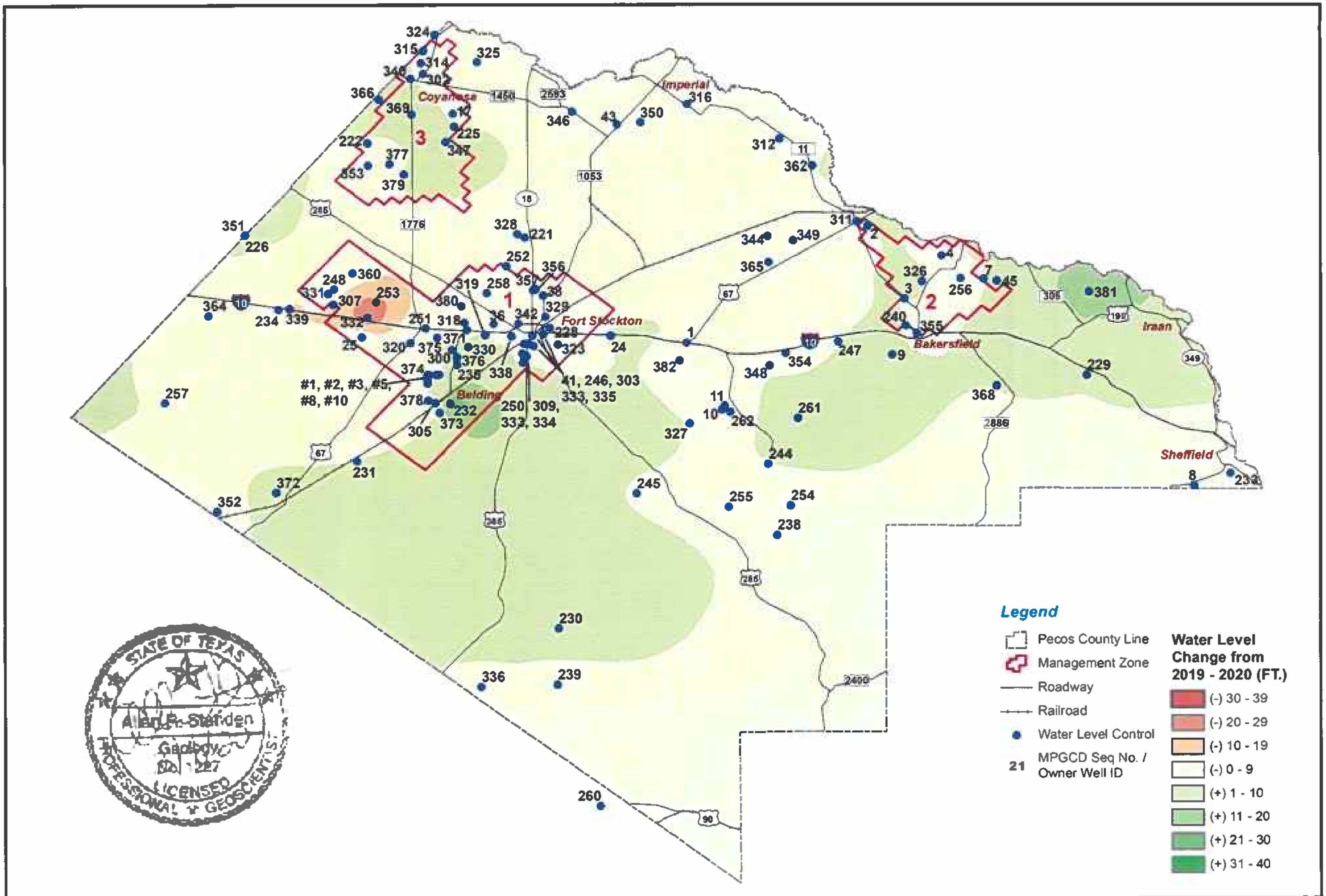
Water Level Decline/Gain from 2020 - 2021

Pecos County, Texas



Water Level Decline/Gain from 2012 - 2021

Pecos County, Texas



Allan R. Standen LLC
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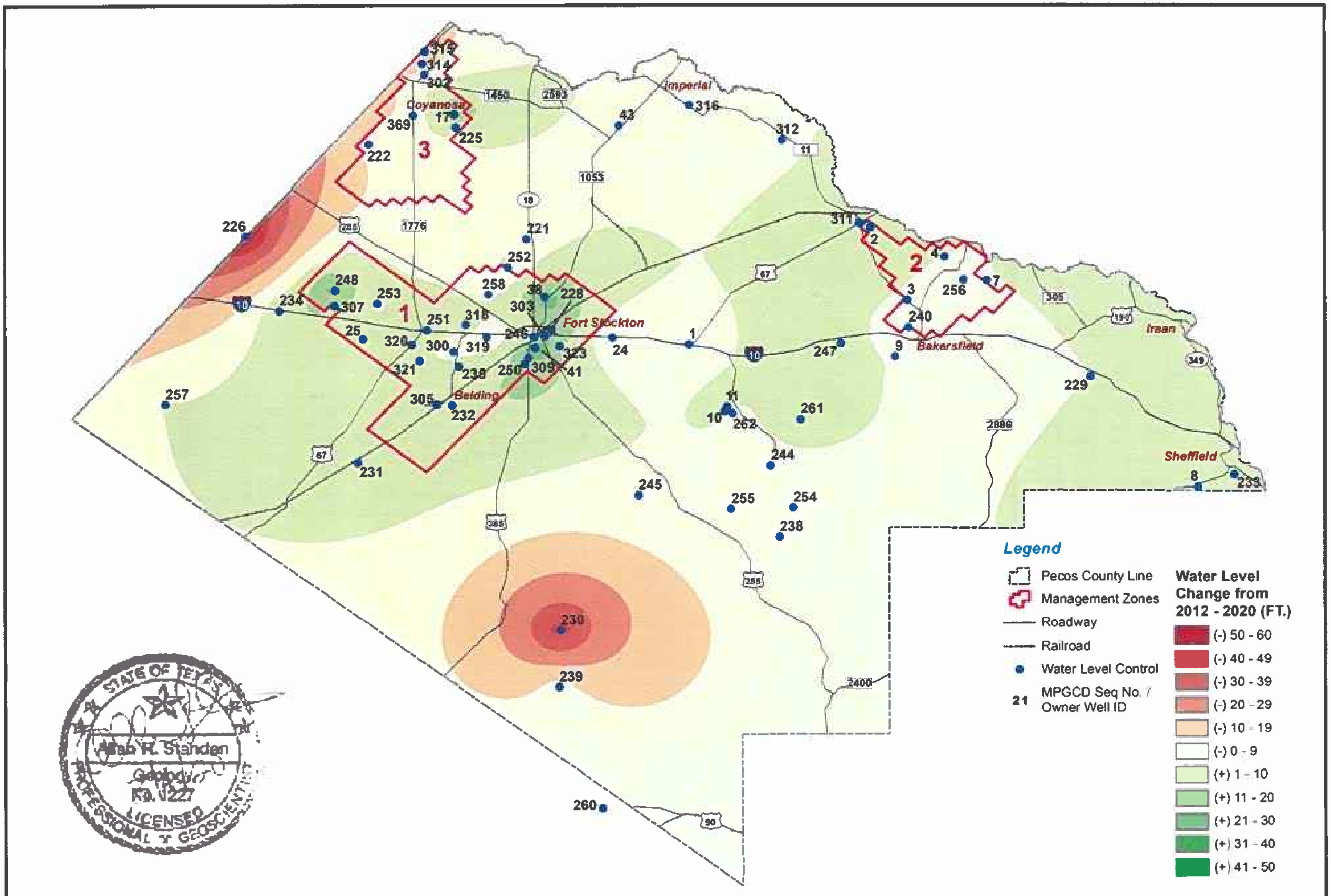
Water Level Decline/Gain from 2019 - 2020

Pecos County, Texas

Miles
0 5 10 20
1:850,000
North American Datum 1983



Water Level Decline/Gain from 2012 - 2020

Pecos County, Texas

Miles
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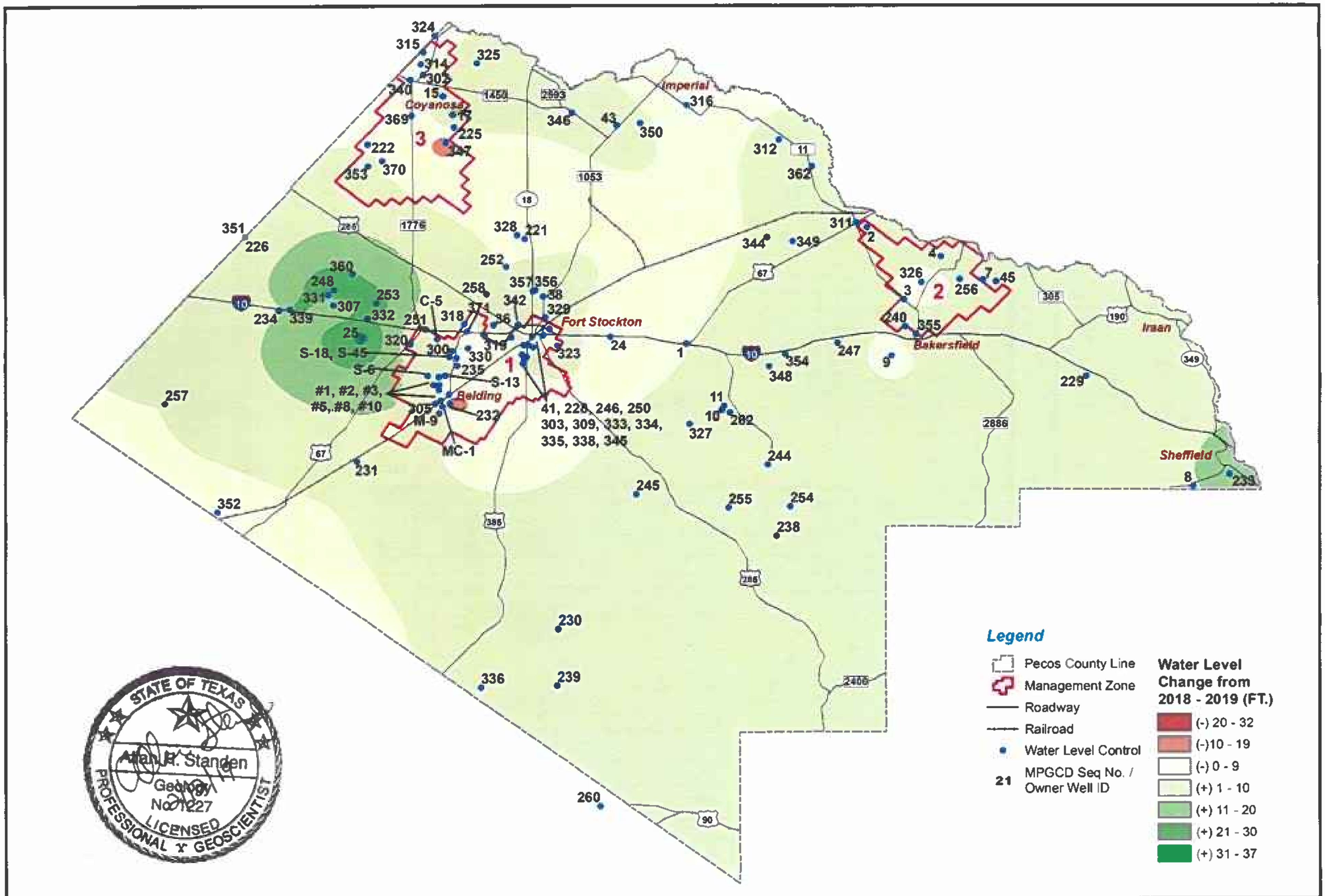
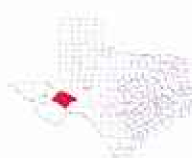
1:850,000
North American Datum 1983





Water Level Decline/Gain from 2018 - 2019

Pecos County, Texas

Miles
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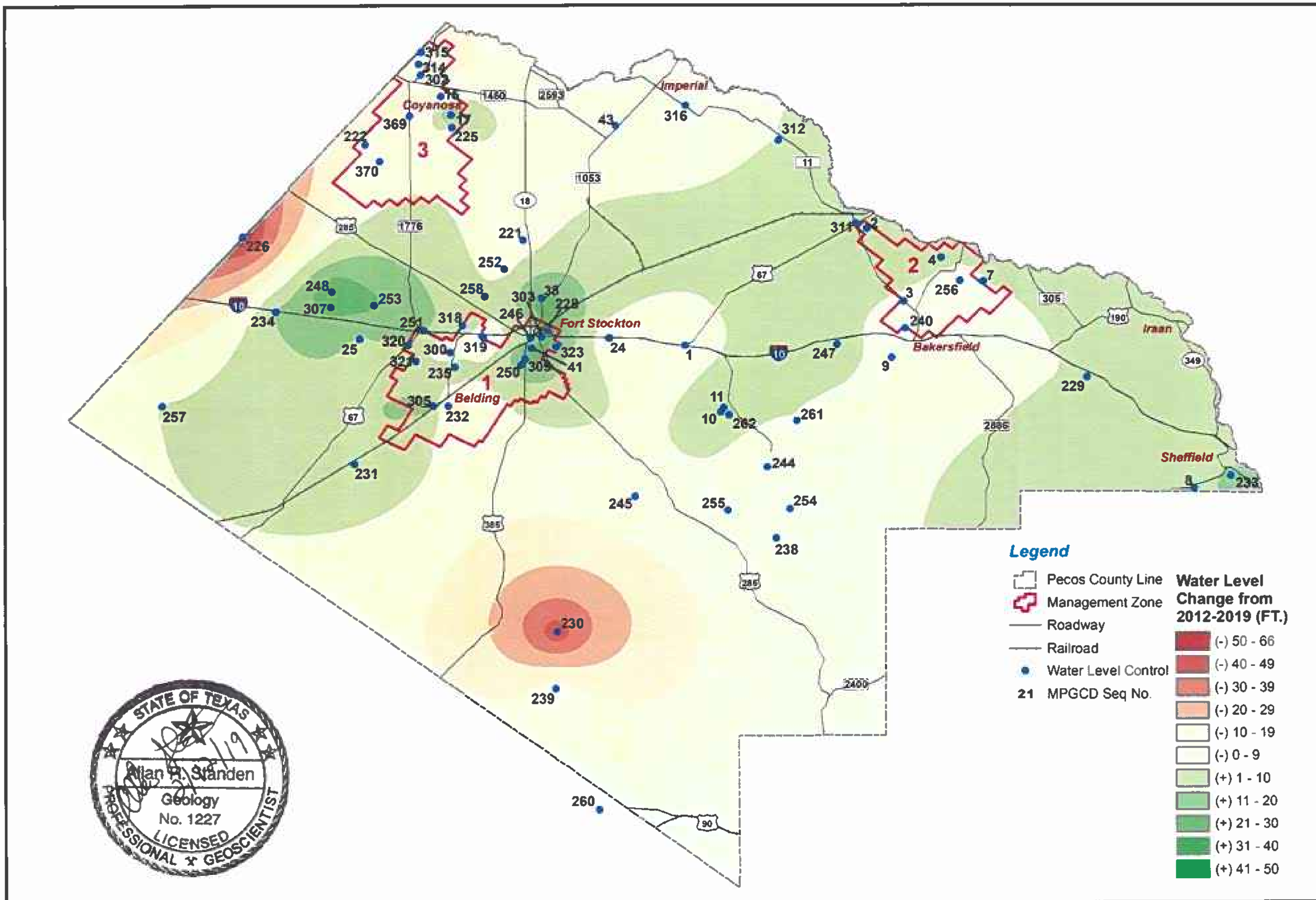
1:850,000
North American Datum 1983

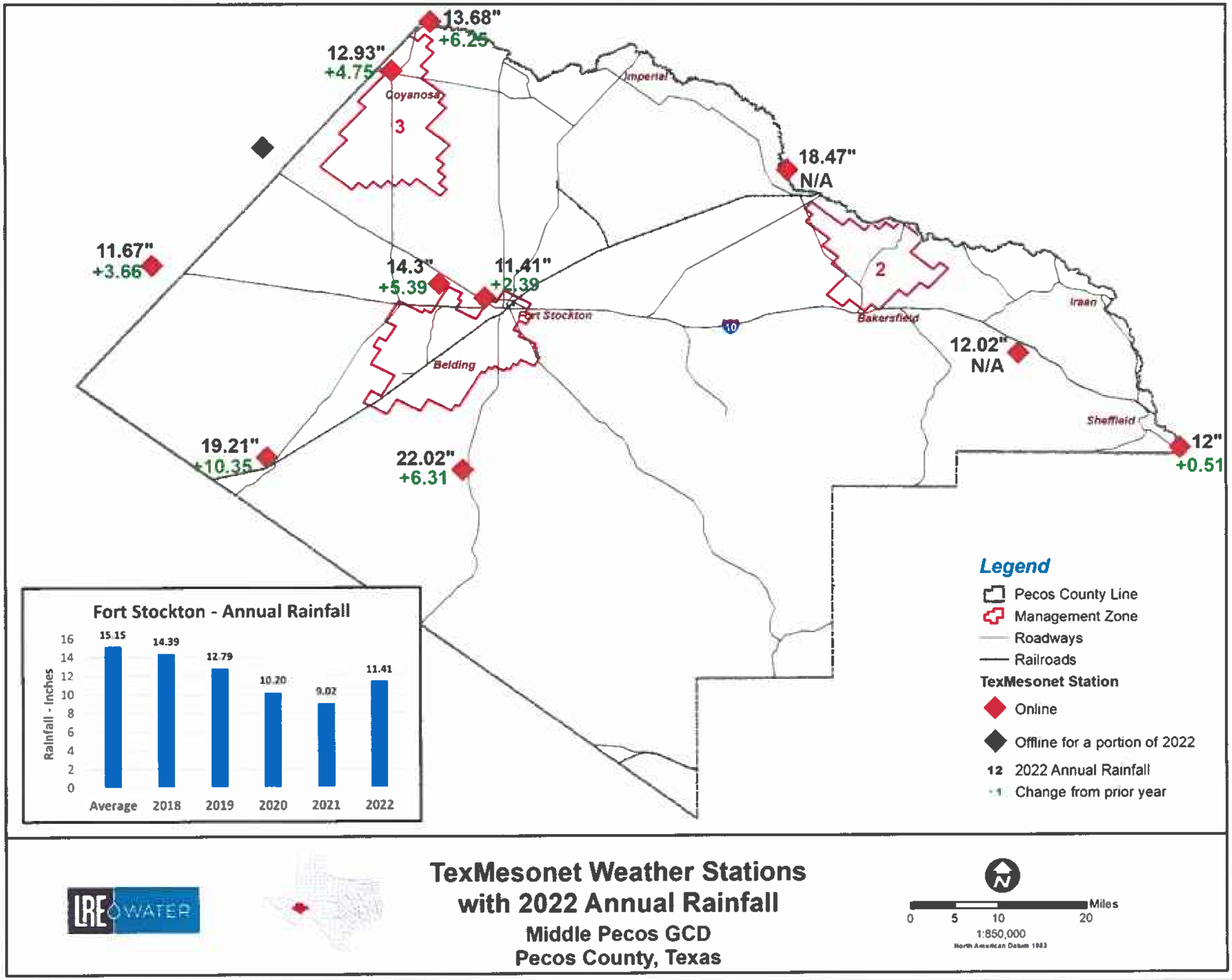


Water Level Decline/Gain from 2012 - 2019

Pecos County, Texas

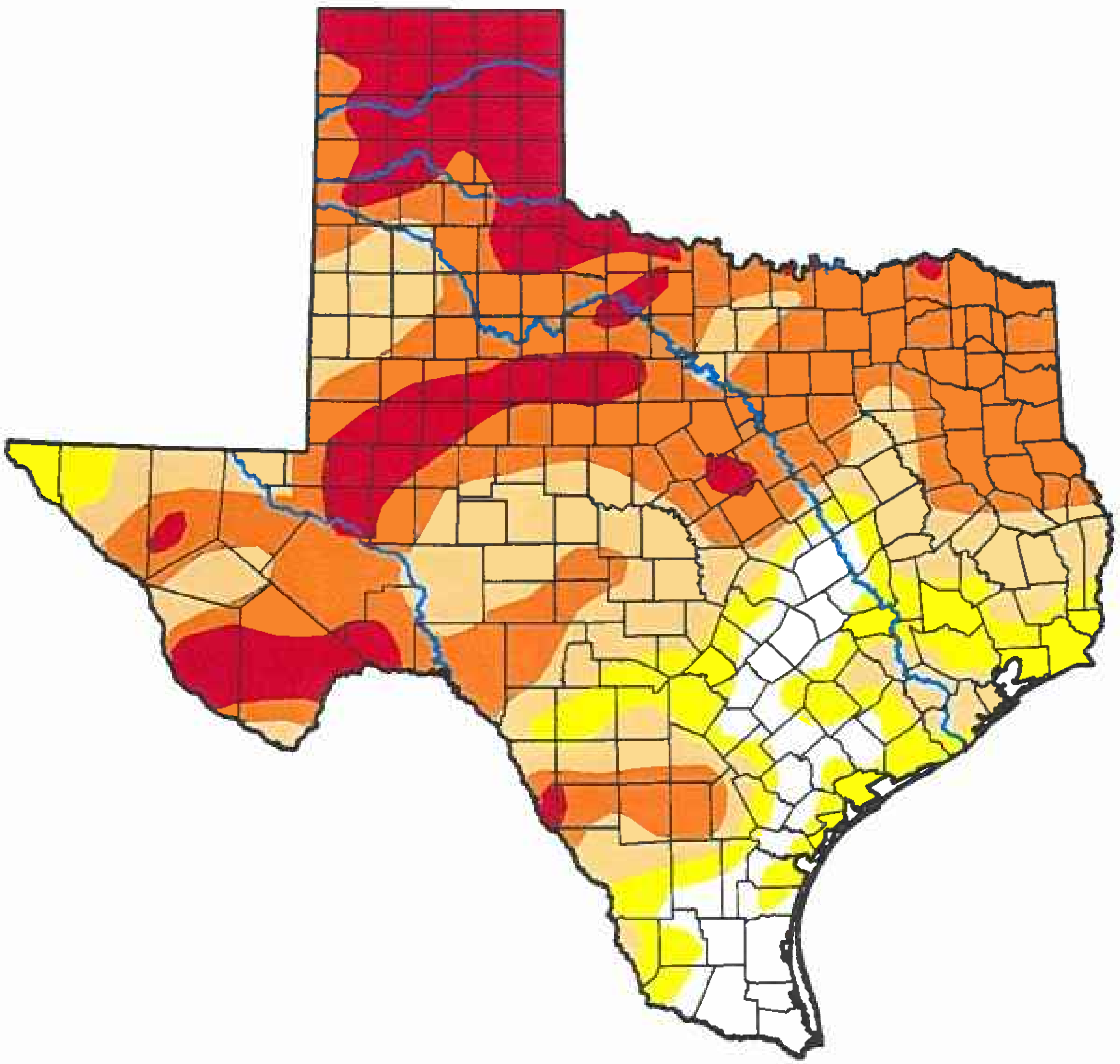
Miles
0 5 10 20
1:850,000
North American Datum 1983

Tex Mesonet Weather Station 2022 Rainfall



U.S. Drought Monitor
Texas

January 4, 2022
(Released Thursday, Jan. 6, 2022)
Valid 7 a.m. EST



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	7.58	92.42	79.83	54.25	16.69	0.00
Last Week *12-28-2021*	13.02	86.98	67.27	36.58	10.65	0.00
3 Months Ago *10-05-2021*	55.05	44.95	8.26	0.27	0.00	0.00
Start of Calendar Year *01-04-2022*	7.58	92.42	79.83	54.25	16.69	0.00
Start of Water Year *09-28-2021*	45.57	54.43	7.26	0.27	0.00	0.00
One Year Ago *01-05-2021*	17.37	82.63	58.34	37.80	19.24	8.20

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

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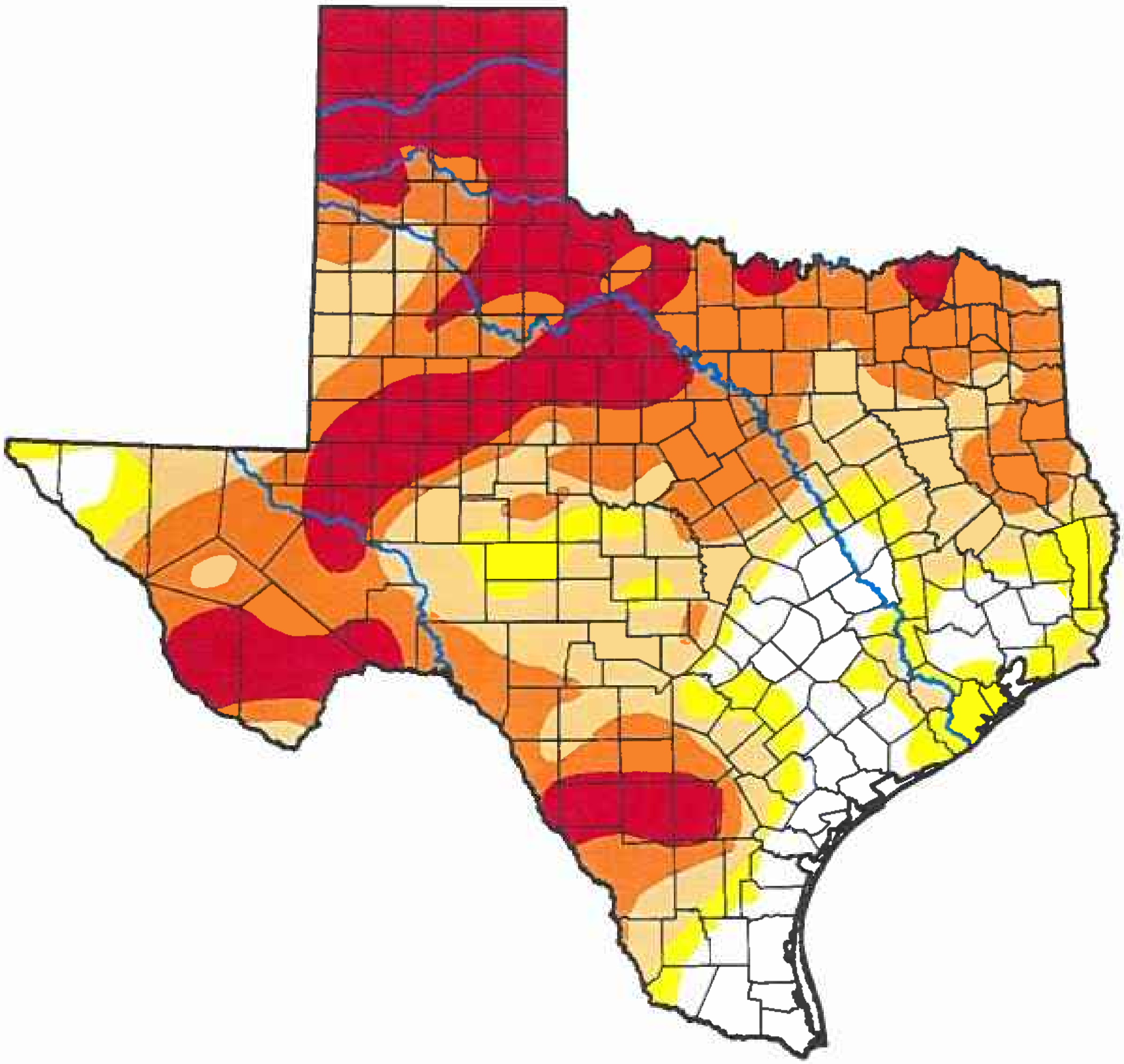
U.S. Drought Monitor
Texas

February 8, 2022
(Released Thursday, Feb. 10, 2022)
Valid 7 a.m. EST



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	11.83	88.17	78.09	55.00	23.88	0.00
Last Week *02-01-2022*	7.04	92.96	83.79	69.20	31.56	0.00
3 Months Ago *11-09-2021*	38.58	61.42	32.22	5.62	0.00	0.00
Start of Calendar Year *01-04-2022*	7.58	92.42	79.83	54.25	16.69	0.00
Start of Water Year *09-28-2021*	45.57	54.43	7.26	0.27	0.00	0.00
One Year Ago *02-09-2021*	25.73	74.27	46.98	30.24	18.16	5.56

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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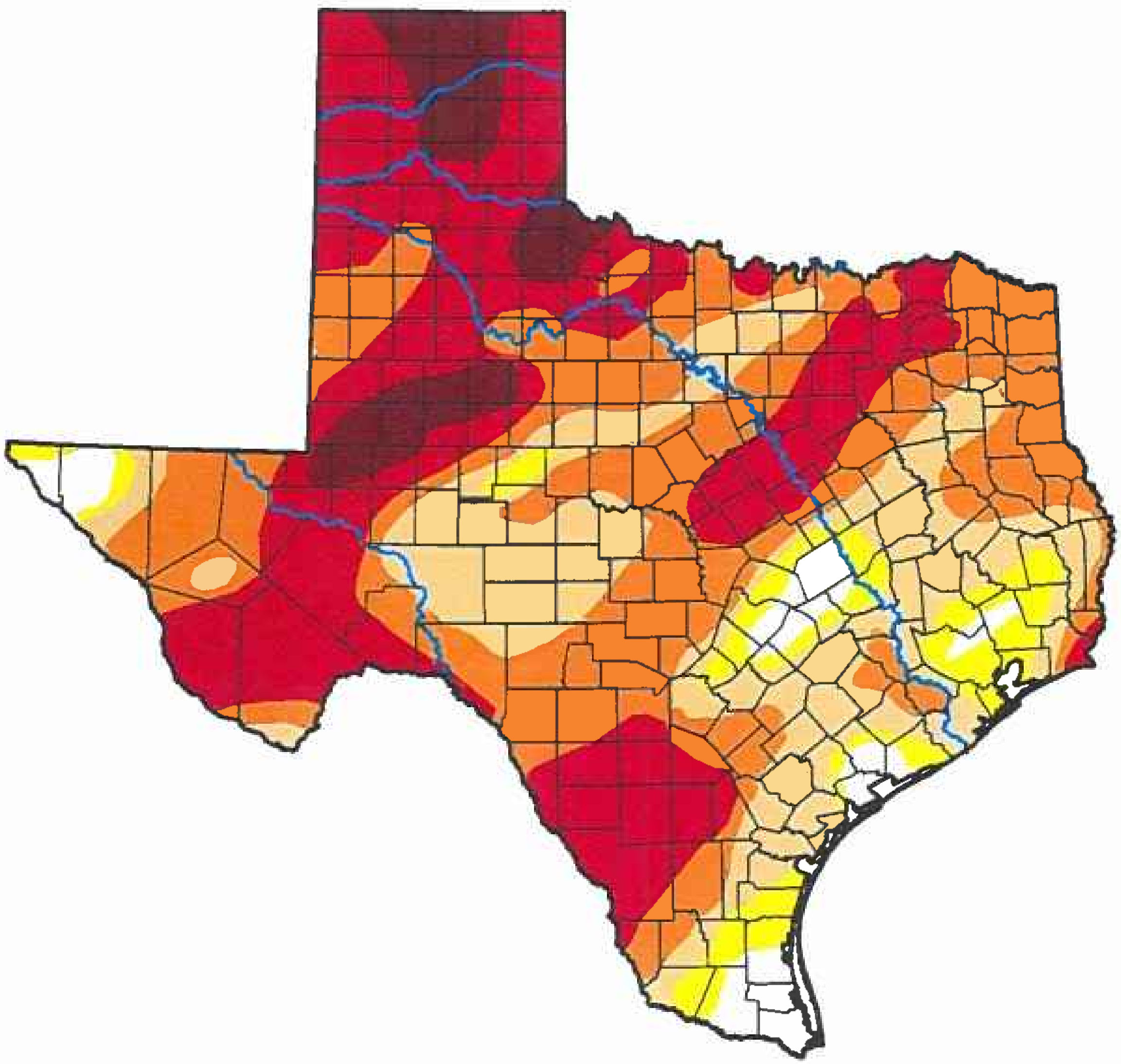
U.S. Drought Monitor
Texas



March 8, 2022
(Released Thursday, Mar. 10, 2022)
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	3.95	96.05	89.93	68.43	36.38	6.39
Last Week *03-01-2022*	6.66	93.34	80.71	56.71	24.47	0.00
3 Months Ago *12-07-2021*	18.80	81.20	55.01	20.05	0.14	0.00
Start of Calendar Year *01-04-2022*	7.58	92.42	79.83	54.25	16.69	0.00
Start of Water Year *09-28-2021*	45.57	54.43	7.26	0.27	0.00	0.00
One Year Ago *03-09-2021*	10.83	89.17	62.49	32.36	18.27	6.11

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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USDA NDMC NOAA

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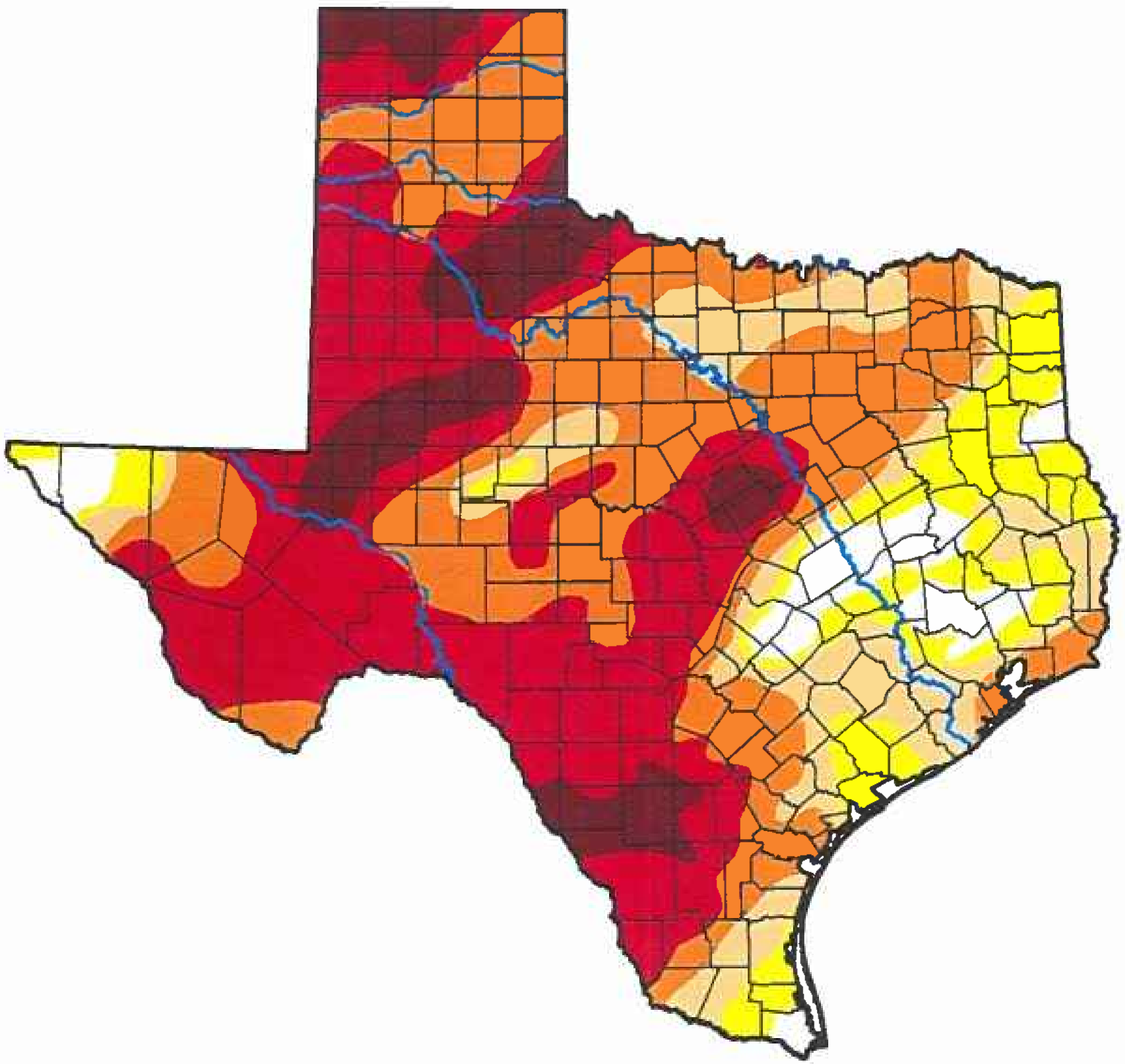
U.S. Drought Monitor
Texas



April 5, 2022
(Released Thursday, Apr. 7, 2022)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	4.95	95.05	84.73	71.45	40.56	9.78
Last Week *03-29-2022*	4.90	95.10	88.22	70.79	42.10	7.03
3 Months Ago *01-04-2022*	7.58	92.42	79.83	54.25	16.69	0.00
Start of Calendar Year *01-04-2022*	7.58	92.42	79.83	54.25	16.69	0.00
Start of Water Year *09-28-2021*	45.57	54.43	7.26	0.27	0.00	0.00
One Year Ago *04-06-2021*	8.55	91.45	74.45	38.46	23.57	8.53

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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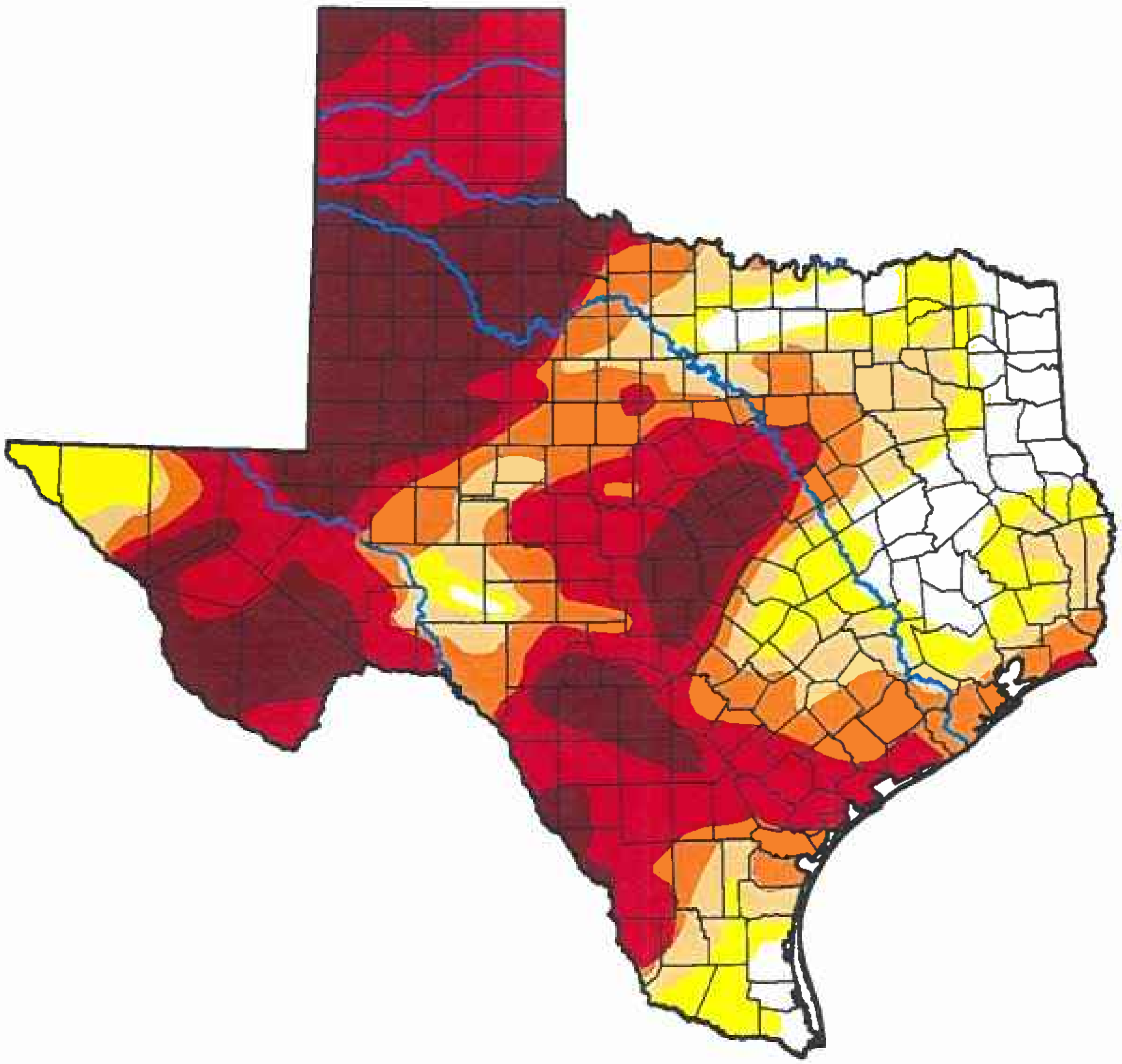
U.S. Drought Monitor
Texas



May 3, 2022
(Released Thursday, May. 5, 2022)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	8.83	91.17	80.02	67.29	50.91	23.19
Last Week 04-26-2022	6.21	93.79	82.11	70.28	50.25	19.62
3 Months Ago 02-01-2022	7.04	92.96	83.79	69.20	31.56	0.00
Start of Calendar Year 01-04-2022	7.58	92.42	79.83	54.25	16.69	0.00
Start of Water Year 09-28-2021	45.57	54.43	7.26	0.27	0.00	0.00
One Year Ago 05-04-2021	33.23	66.77	45.00	27.61	16.73	7.85

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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Author:
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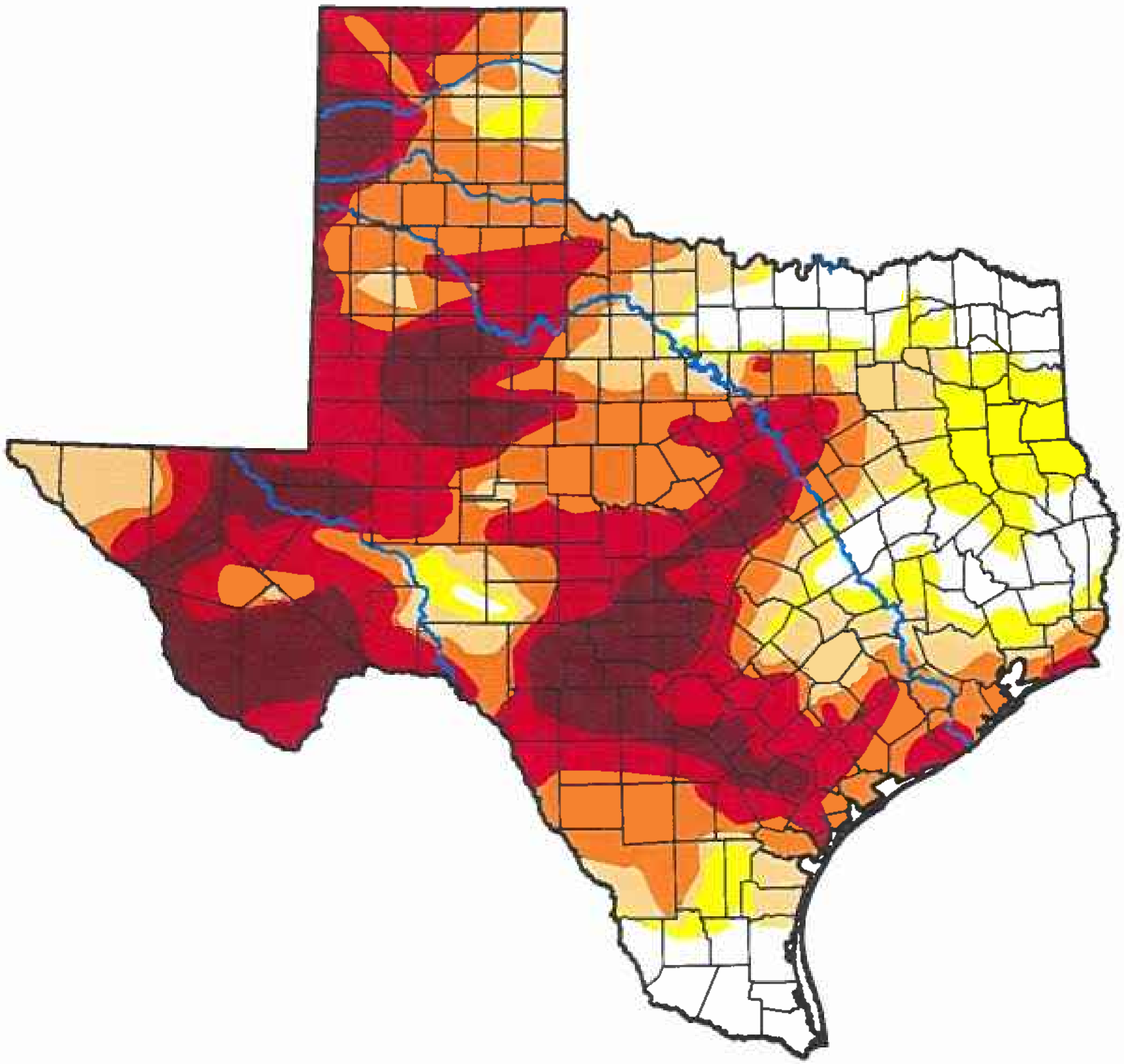
U.S. Drought Monitor
Texas



June 7, 2022
(Released Thursday, Jun. 9, 2022)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	11.75	88.25	78.81	64.99	40.11	15.60
Last Week *05-31-2022*	14.11	85.89	78.44	66.35	44.07	17.91
3 Months Ago *03-08-2022*	3.95	96.05	89.93	68.43	36.38	6.39
Start of Calendar Year *01-04-2022*	7.58	92.42	79.83	54.25	16.69	0.00
Start of Water Year *09-28-2021*	45.57	54.43	7.26	0.27	0.00	0.00
One Year Ago *06-08-2021*	77.24	22.76	12.57	7.71	4.47	1.16

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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Author:
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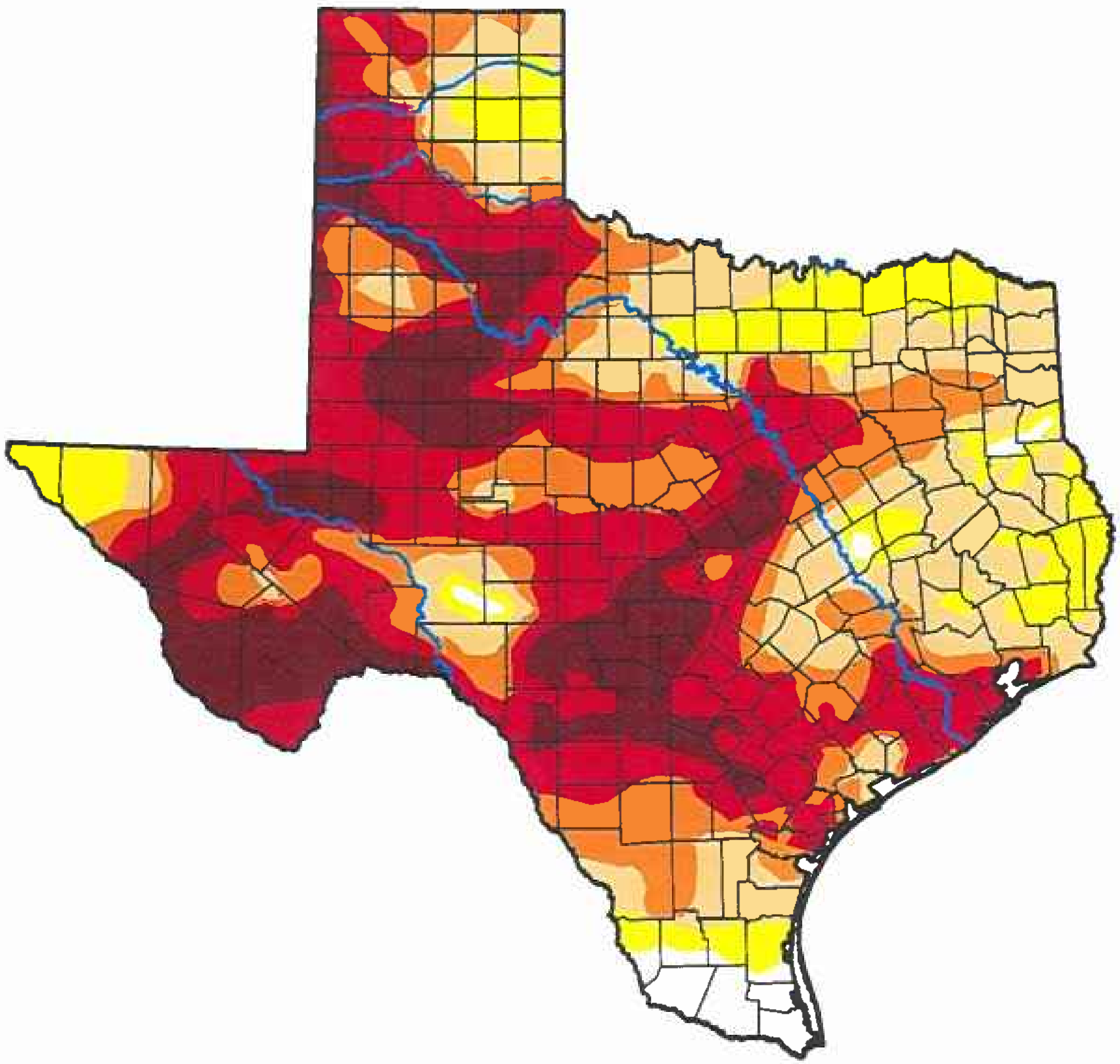
U.S. Drought Monitor

Texas



July 5, 2022

(Released Thursday, Jul. 7, 2022)

Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	2.47	97.53	86.79	66.05	45.91	16.11
Last Week *06-28-2022*	3.71	96.29	86.39	64.99	43.79	15.82
3 Months Ago *04-05-2022*	4.95	95.05	84.73	71.45	40.56	9.78
Start of Calendar Year *01-04-2022*	7.58	92.42	79.83	54.25	16.69	0.00
Start of Water Year *09-28-2021*	45.57	54.43	7.26	0.27	0.00	0.00
One Year Ago *07-06-2021*	87.07	12.93	5.98	1.17	0.00	0.00

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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Author:

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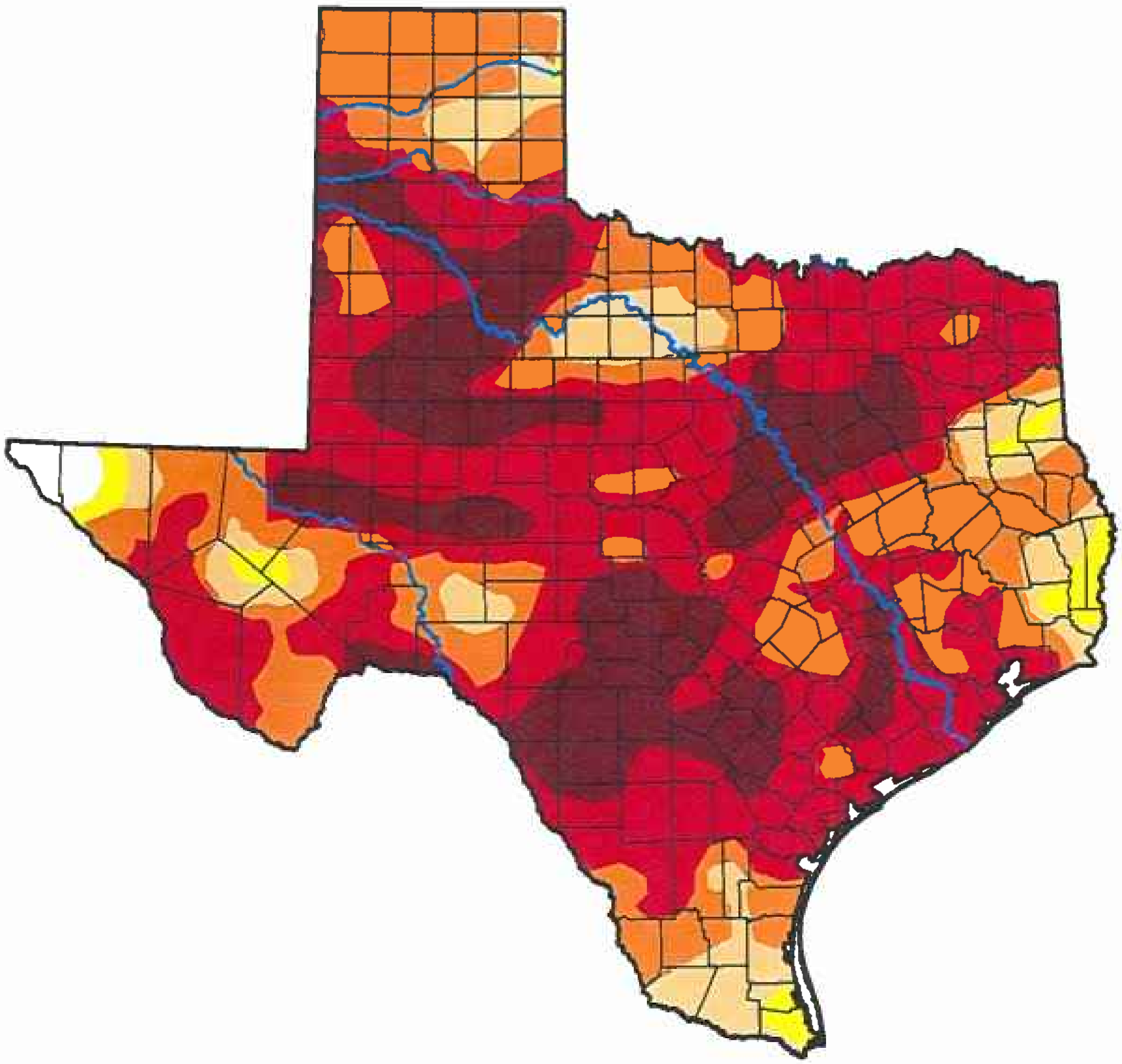
U.S. Drought Monitor
Texas

August 2, 2022
(Released Thursday, Aug. 4, 2022)
Valid 8 a.m. EDT



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.82	99.18	97.11	87.92	61.86	21.31
Last Week *07-26-2022*	0.82	99.18	97.40	85.15	60.06	18.80
3 Months Ago *05-03-2022*	8.83	91.17	80.02	67.29	50.91	23.19
Start of Calendar Year *01-04-2022*	7.58	92.42	79.83	54.25	16.69	0.00
Start of Water Year *09-28-2021*	45.57	54.43	7.26	0.27	0.00	0.00
One Year Ago *08-03-2021*	94.72	5.28	1.10	0.00	0.00	0.00

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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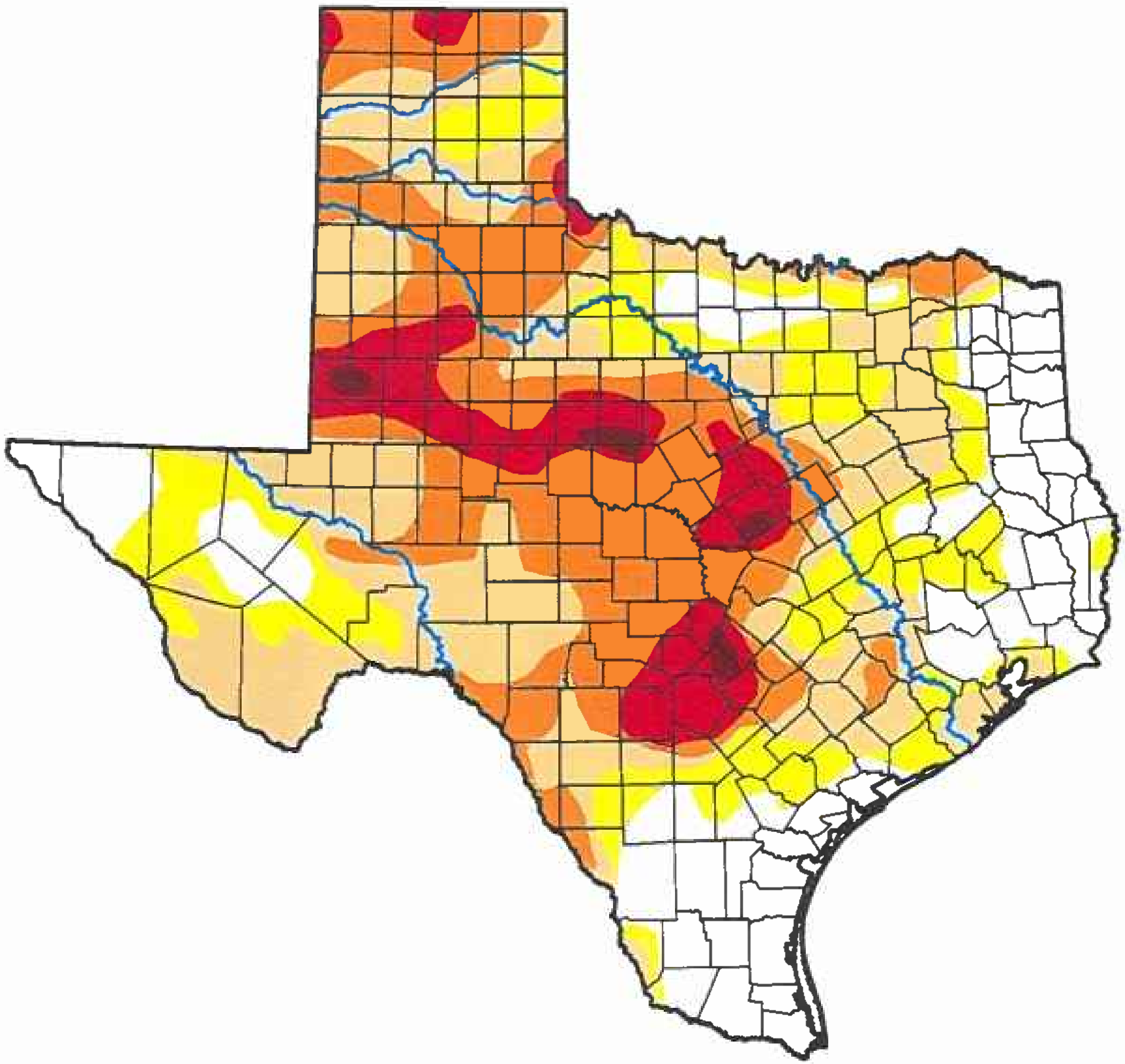
U.S. Drought Monitor
Texas

September 6, 2022
(Released Thursday, Sep. 8, 2022)
Valid 8 a.m. EDT



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	20.57	79.43	62.32	33.57	9.26	0.90
Last Week *08-30-2022*	9.53	90.47	76.03	52.48	26.38	5.28
3 Months Ago *06-07-2022*	11.75	88.25	78.81	64.99	40.11	15.60
Start of Calendar Year *01-04-2022*	7.58	92.42	79.83	54.25	16.69	0.00
Start of Water Year *09-28-2021*	45.57	54.43	7.26	0.27	0.00	0.00
One Year Ago *09-07-2021*	89.25	10.75	0.48	0.00	0.00	0.00

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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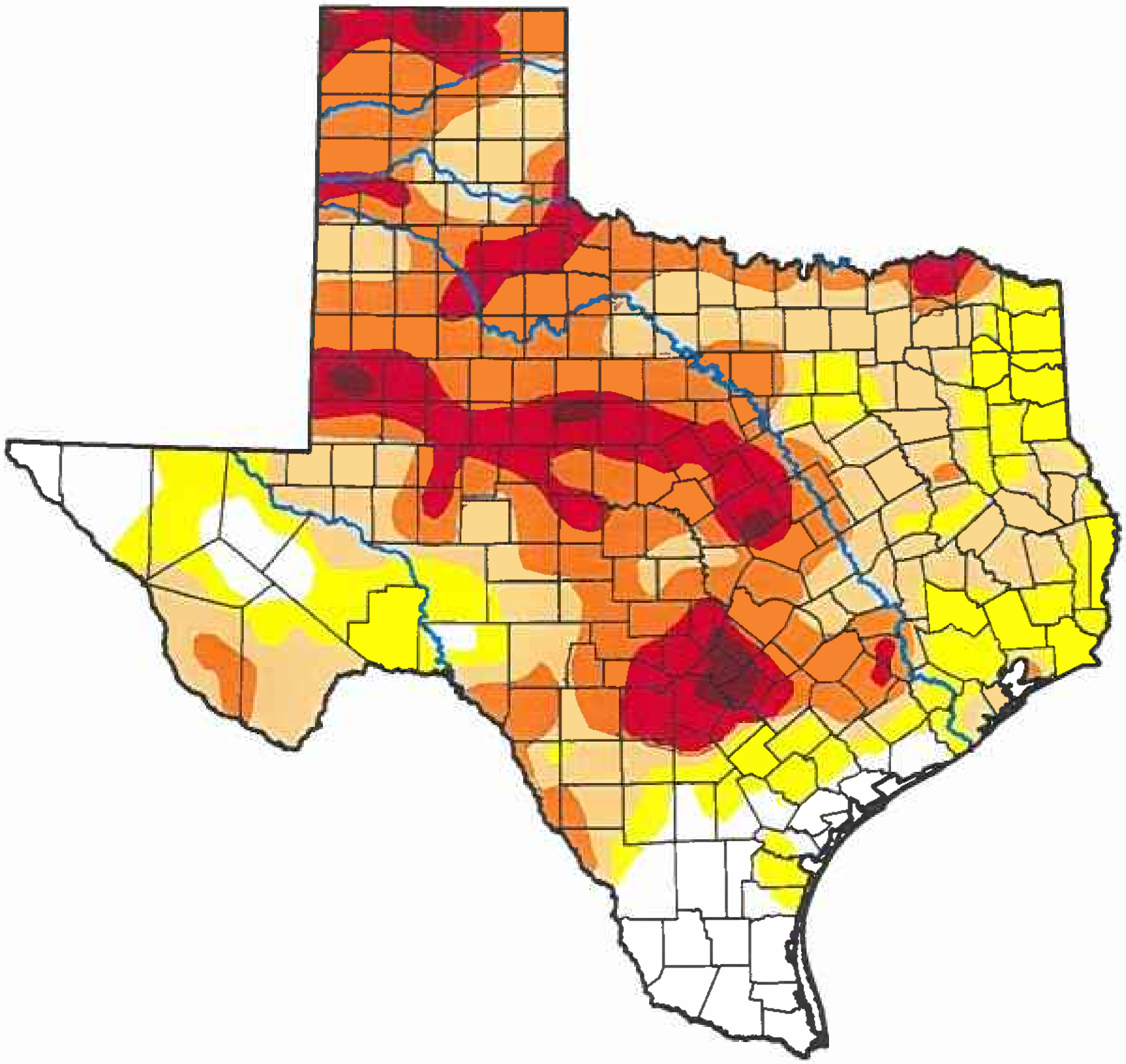
U.S. Drought Monitor
Texas

October 4, 2022
(Released Thursday, Oct. 6, 2022)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	10.94	89.06	71.07	43.13	14.01	1.63
Last Week *09-27-2022*	14.96	85.04	61.36	31.61	8.82	1.06
3 Months Ago *07-05-2022*	2.47	97.53	86.79	66.05	45.91	16.11
Start of Calendar Year *01-04-2022*	7.58	92.42	79.83	54.25	16.69	0.00
Start of Water Year *09-27-2022*	14.96	85.04	61.36	31.61	8.82	1.06
One Year Ago *10-05-2021*	55.05	44.95	8.26	0.27	0.00	0.00



Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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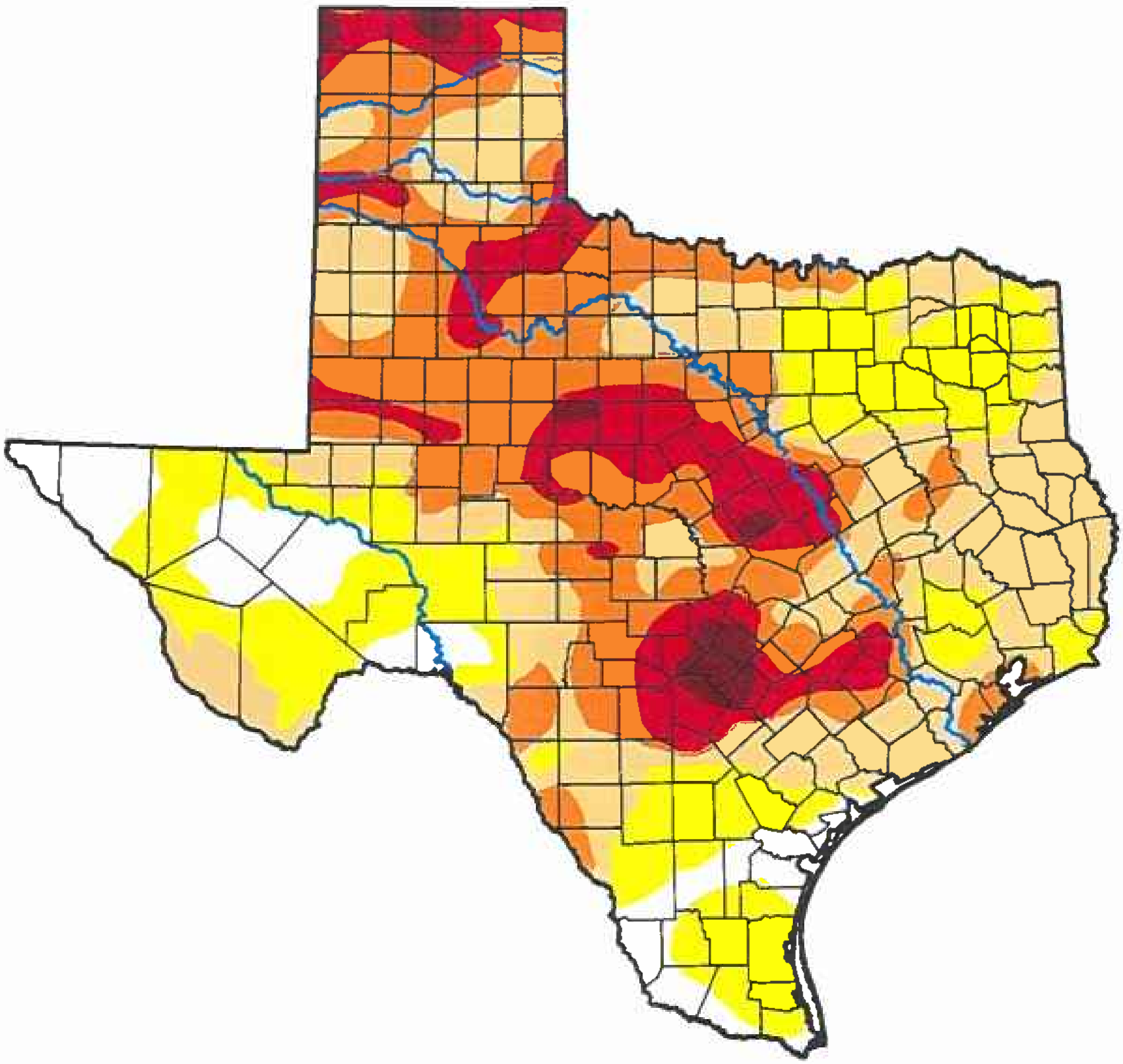
U.S. Drought Monitor
Texas



November 1, 2022
(Released Thursday, Nov. 3, 2022)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	8.10	91.90	69.56	40.13	13.43	1.73
Last Week *10-25-2022*	6.59	93.41	74.73	43.05	13.04	1.39
3 Months Ago *08-02-2022*	0.82	99.18	97.11	87.92	61.86	21.31
Start of Calendar Year *01-04-2022*	7.58	92.42	79.83	54.25	16.69	0.00
Start of Water Year *09-27-2022*	14.96	85.04	61.36	31.61	8.82	1.06
One Year Ago *11-02-2021*	38.20	61.80	32.90	6.44	0.00	0.00

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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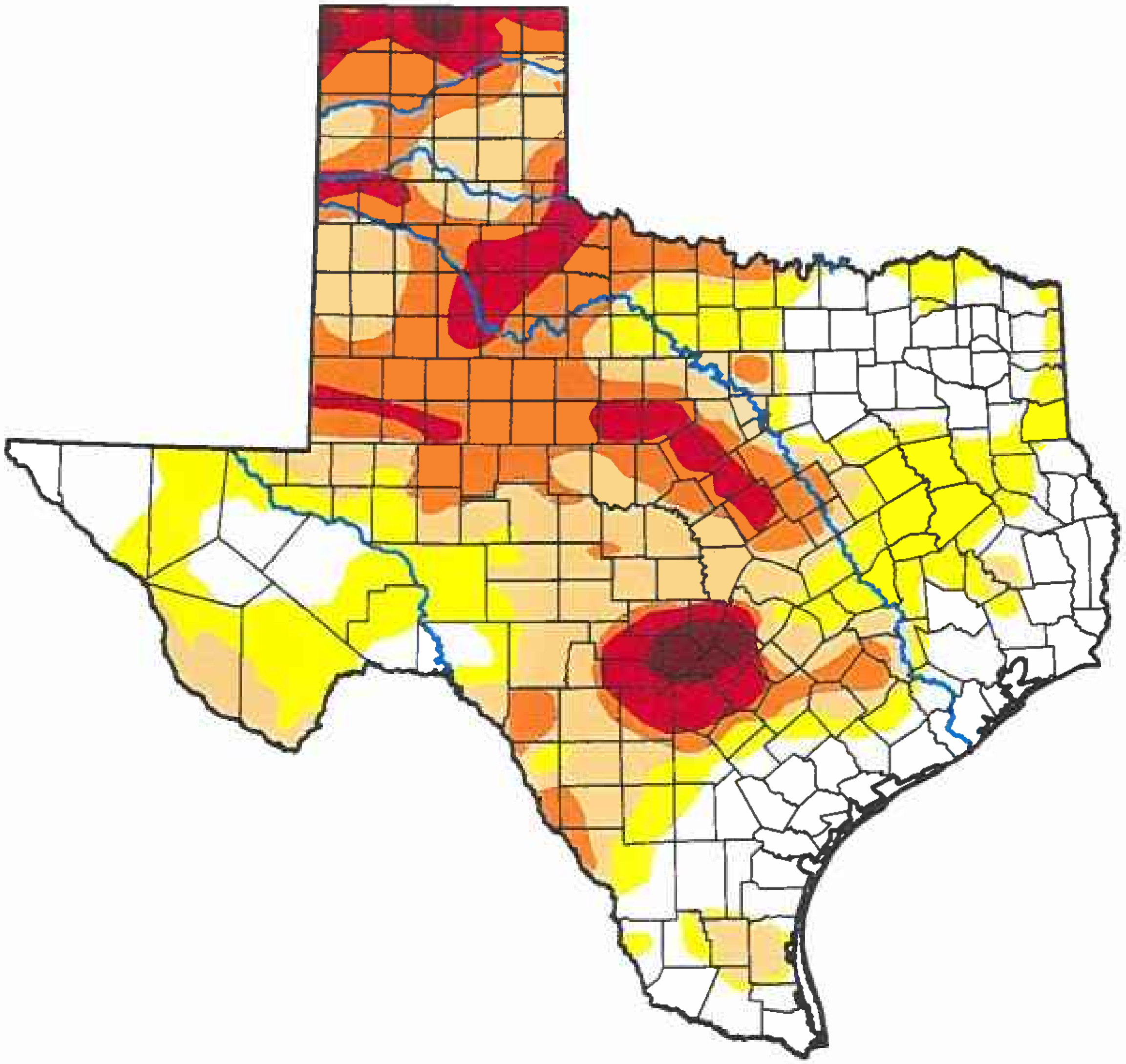
U.S. Drought Monitor
Texas

December 6, 2022
(Released Thursday, Dec. 8, 2022)
Valid 7 a.m. EST



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	25.79	74.21	52.44	29.26	9.23	1.39
Last Week *11-29-2022*	25.86	74.14	51.97	29.26	9.23	1.39
3 Months Ago *09-06-2022*	20.57	79.43	62.32	33.57	9.26	0.90
Start of Calendar Year *01-04-2022*	7.58	92.42	79.83	54.25	16.69	0.00
Start of Water Year *09-27-2022*	14.96	85.04	61.36	31.61	8.82	1.06
One Year Ago *12-07-2021*	18.80	81.20	55.01	20.05	0.14	0.00

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

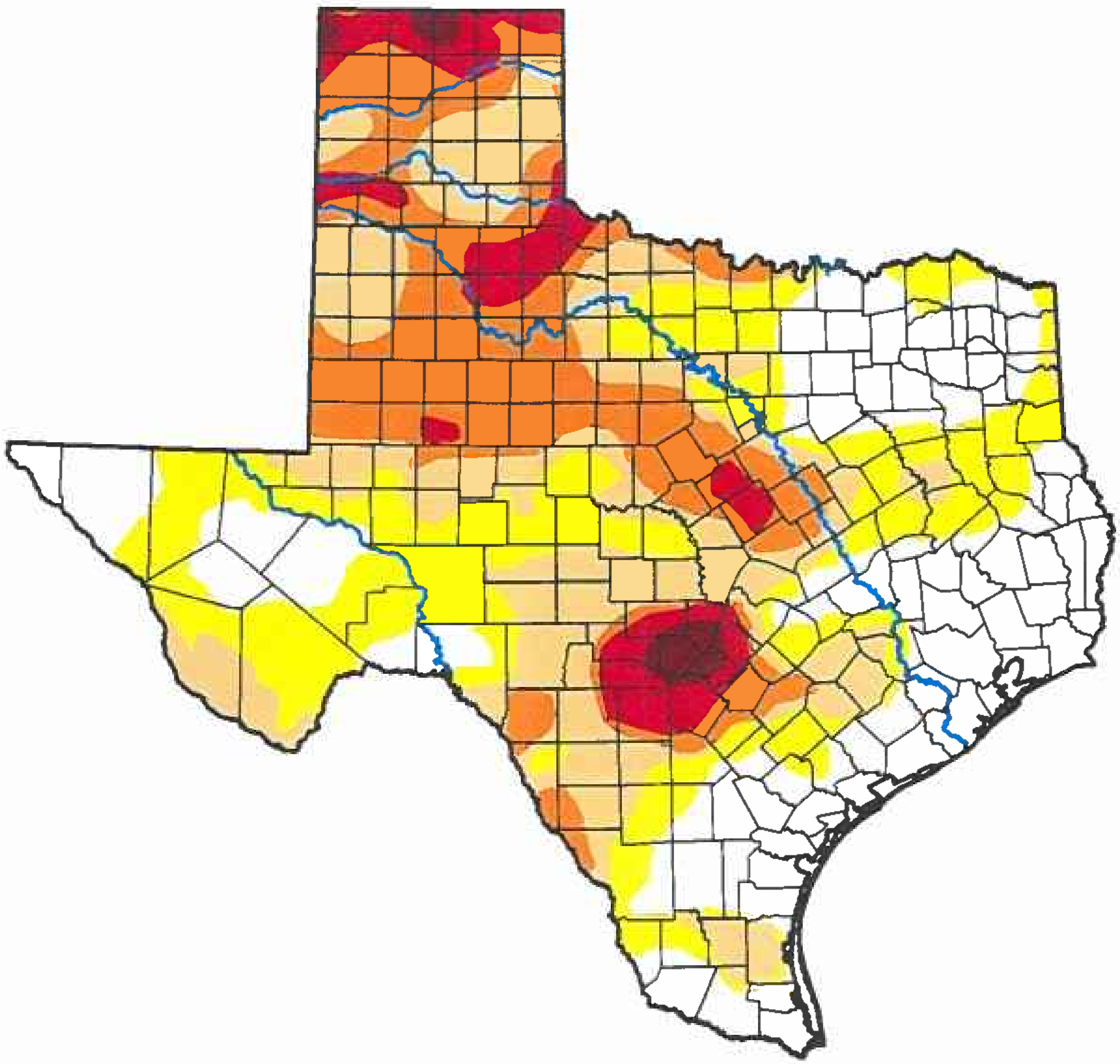
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:

David Simeral
Western Regional Climate Center

droughtmonitor.unl.edu

U.S. Drought Monitor
Texas



December 27, 2022
(Released Thursday, Dec. 29, 2022)
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	27.57	72.43	48.59	25.88	7.13	1.24
Last Week *12-20-2022*	27.57	72.43	48.59	25.88	7.13	1.24
3 Months Ago *09-27-2022*	14.96	85.04	61.36	31.61	8.82	1.06
Start of Calendar Year *01-04-2022*	7.58	92.42	79.83	54.25	16.69	0.00
Start of Water Year *09-27-2022*	14.96	85.04	61.36	31.61	8.82	1.06
One Year Ago *12-28-2021*	13.02	86.98	67.27	36.58	10.65	0.00

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:

Richard Heim
NCEI/NOAA

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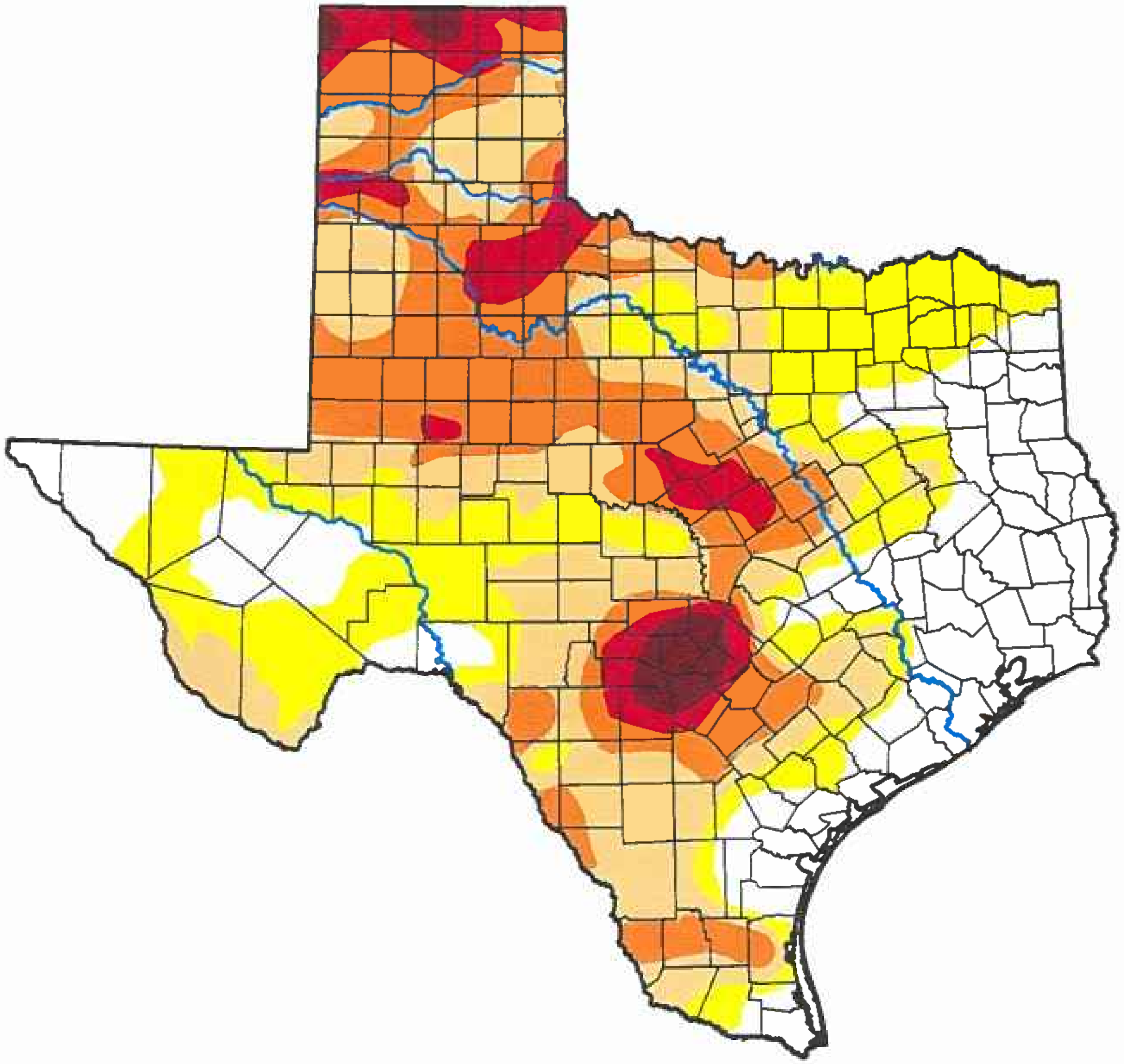
U.S. Drought Monitor
Texas

January 17, 2023
(Released Thursday, Jan. 19, 2023)
Valid 7 a.m. EST



Intensity:

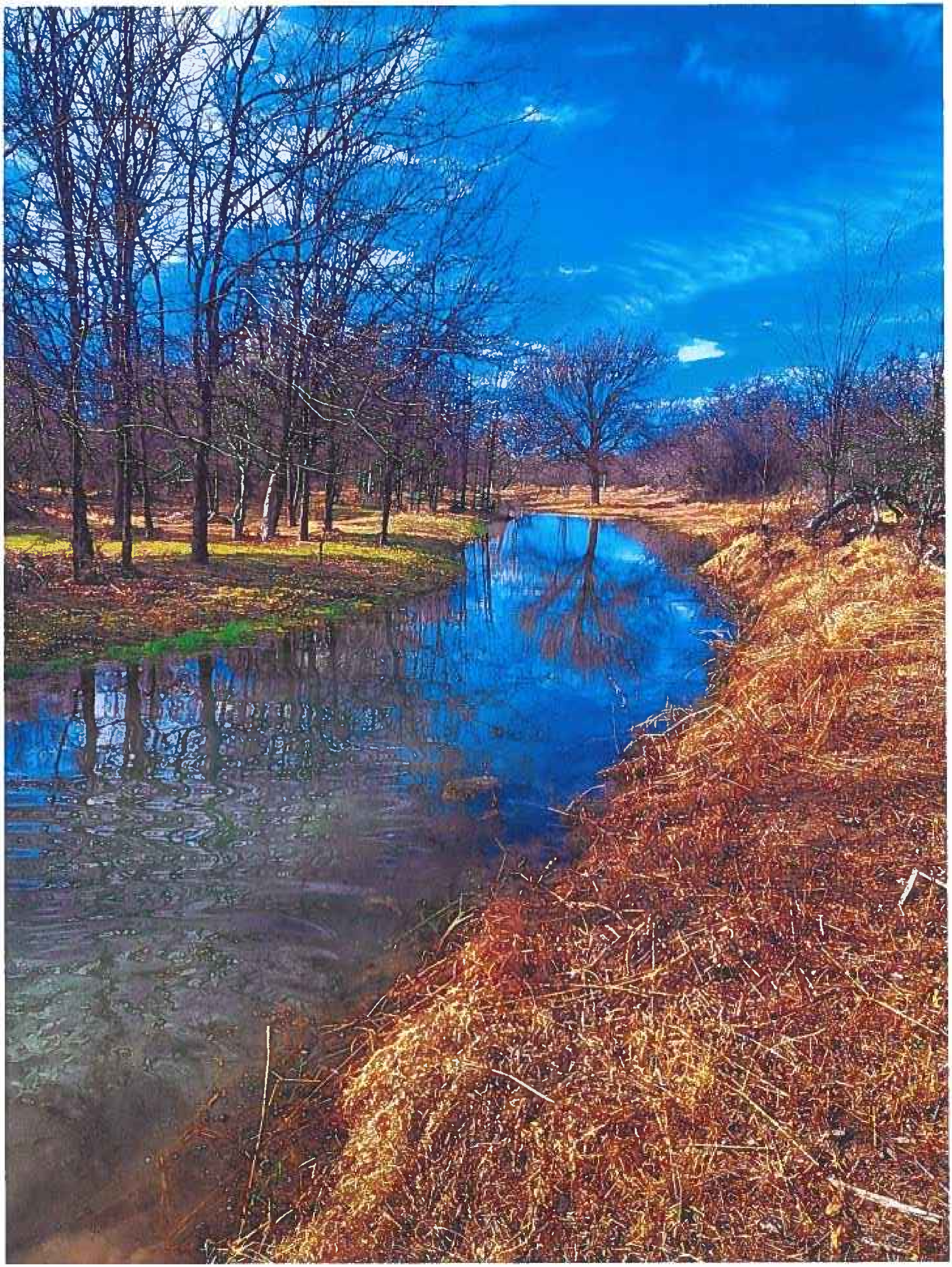
- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

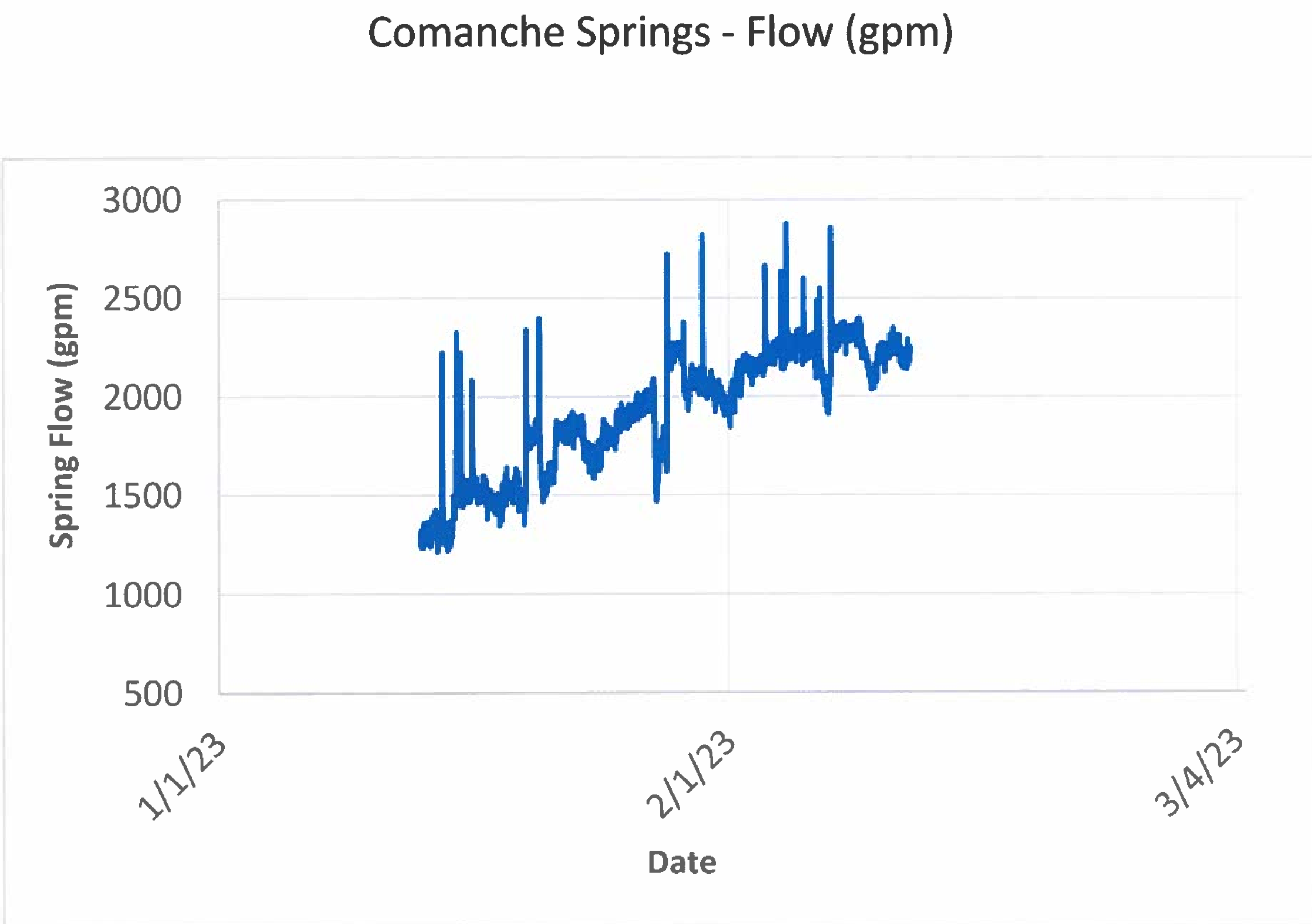
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

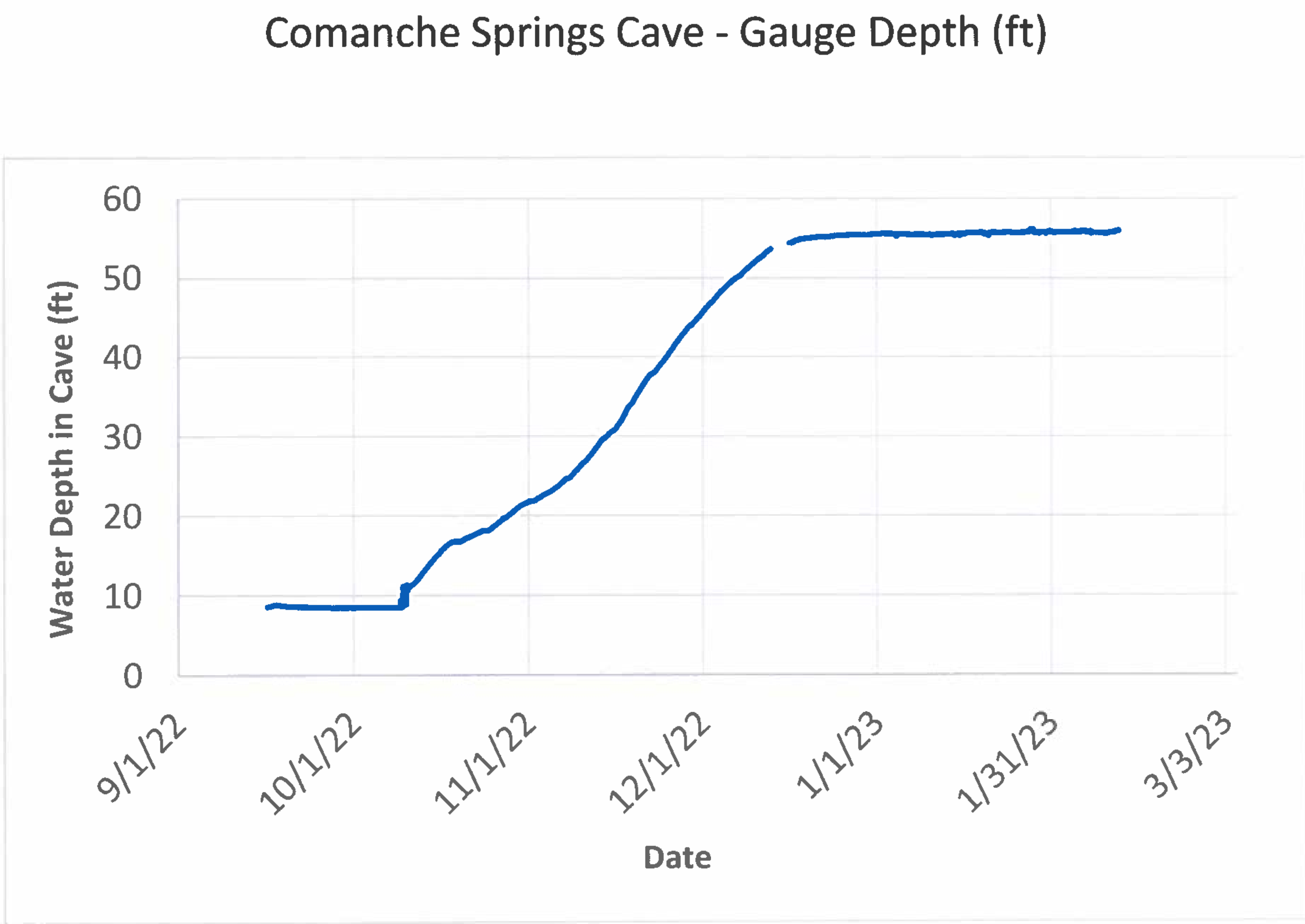
Author:

Deborah Bathke
National Drought Mitigation Center

droughtmonitor.unl.edu

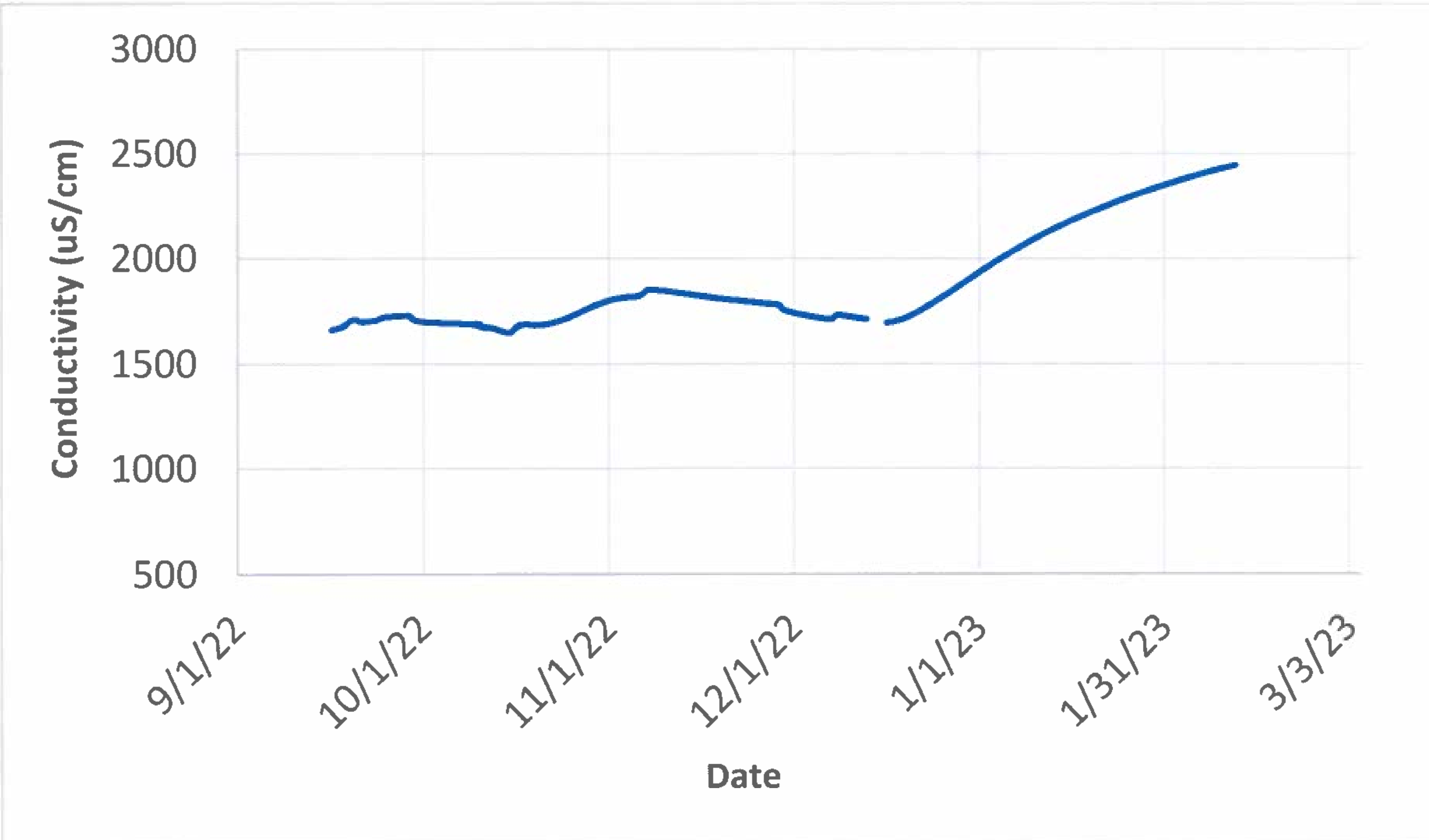



Comanche Springs - Flow (gpm)
Spring Flow (gpm)
3000
2500
2000
1500
1000
500
1/1/23
2/1/23
3/4/23
Date



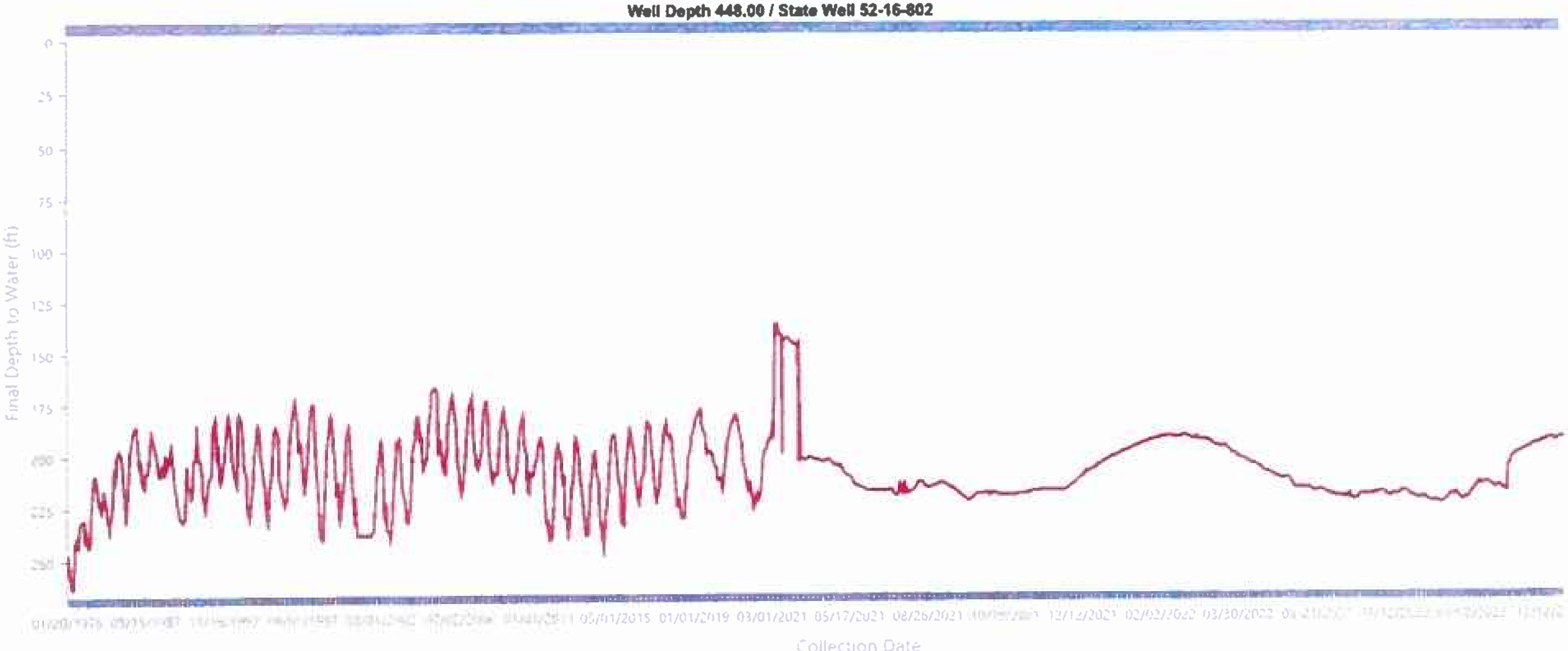
Comanche Springs Cave - Gauge Depth (ft)
60
50
40
30
20
10
0
Water Depth in Cave (ft)
9/1/22
10/1/22
11/1/22
12/1/22
1/1/23
1/31/23
3/3/23
Date

Comanche Springs Cave - Conductivity (uS/cm)



Water Level Details

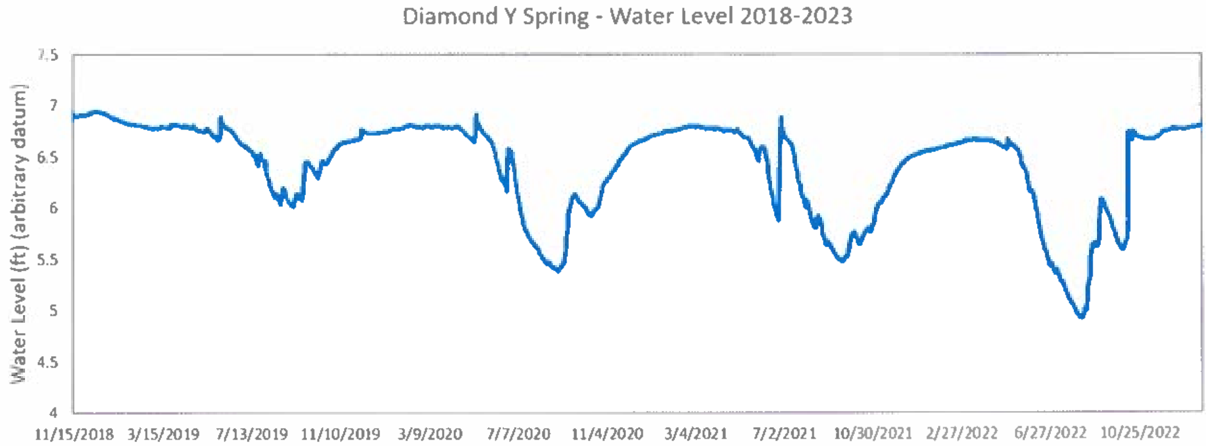
Monitor #378 Prison Well- TWDB Monitor/City of Fort Stockton Static Water Level
Well Depth 448.00 / State Well 52-16-802

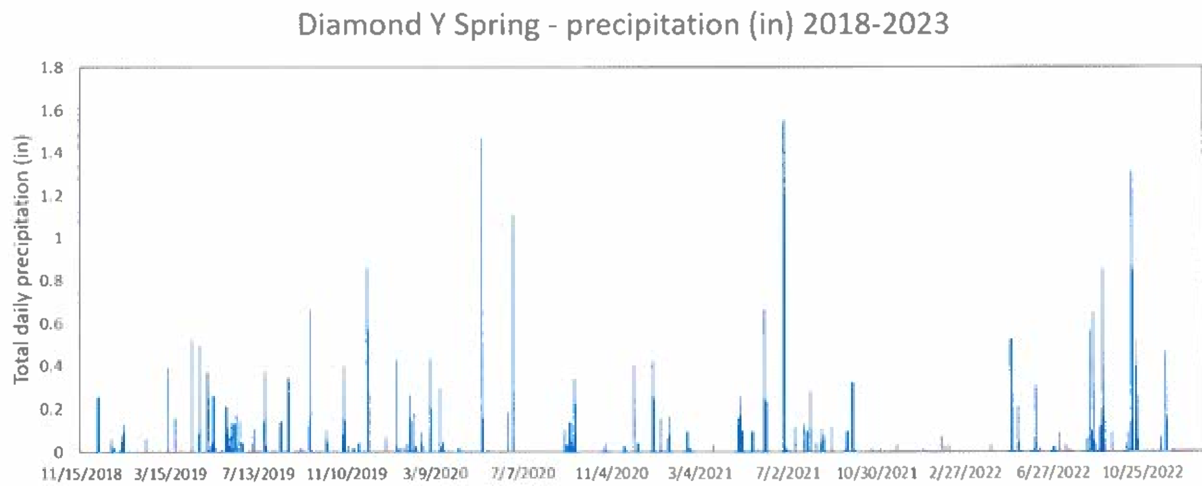


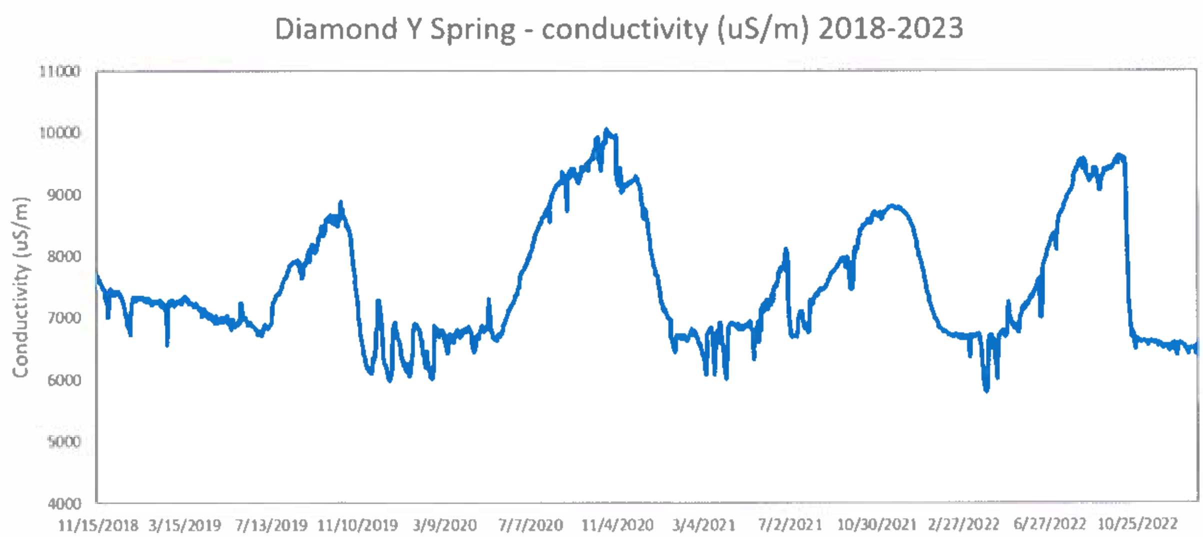
Date	Measurement Method	Measurement Source	Pumping Status	Final Depth To Water	
1/20/1976	E-Line/ Mon tored by TWDB via Te...	MPGCD	Unknown	246.88	
3/17/1976	E-Line/ Monitored by TWDB via Te...	MPGCD	Unknown	252 18	
5/9/1976	E-Line/ Monitored by TWDB via Te...	MPGCD	Unknown	256.38	
7/13/1976	E-Line/ Monitored by TWDB via Te...	MPGCD	Unknown	263.22	
9/15/1976	E-Line/ Monitored by TWDB via Te...	MPGCD	Unknown	263 1	
12/21/1976	E-Line/ Monitored by TWDB via Te...	MPGCD	Unknown	244 72	
2/16/1977	E-Line/ Monitored by TWDB via Te	MPGCD	Unknown	240 36	
10/17/1977	E-Line/ Monitored by TWDB via Te...	MPGCD	Unknown	243 33	
12/1/1977	E-Line/ Monitored by TWDB via Te...	MPGCD	Unknown	234.45	

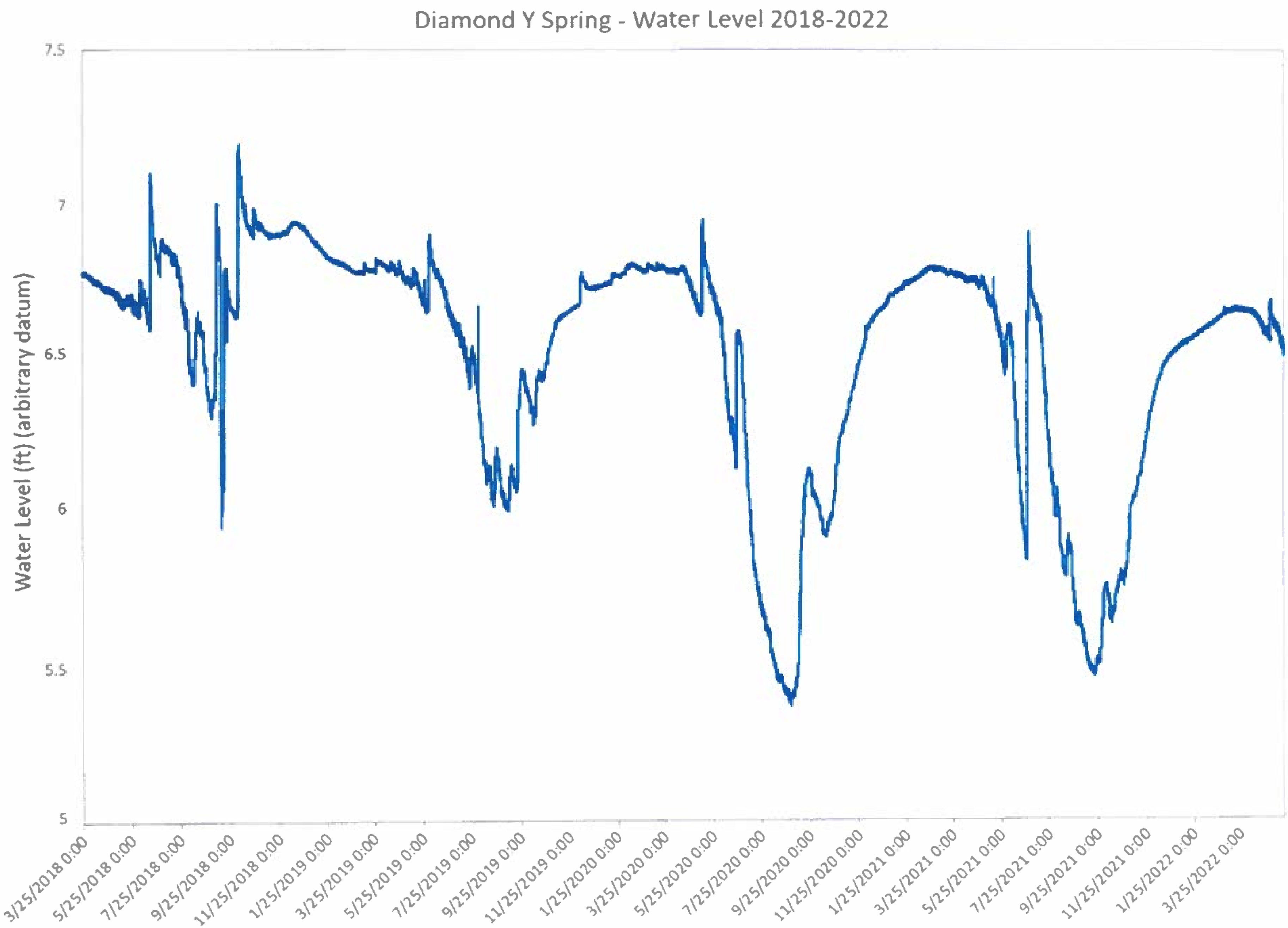
Diamond Y Spring

The Nature Conservancy/UT Bureau of Economic Geology








Diamond Y Spring - Water Level 2018-2022
Water Level (ft) (arbitrary datum)
7.5
7
6.5
6
5.5
5
3/25/2018 0:00
5/25/2018 0:00
7/25/2018 0:00
9/25/2018 0:00
11/25/2018 0:00
1/25/2019 0:00
3/25/2019 0:00
5/25/2019 0:00
7/25/2019 0:00
9/25/2019 0:00
11/25/2019 0:00
1/25/2020 0:00
3/25/2020 0:00
5/25/2020 0:00
7/25/2020 0:00
9/25/2020 0:00
11/25/2020 0:00
1/25/2021 0:00
3/25/2021 0:00
5/25/2021 0:00
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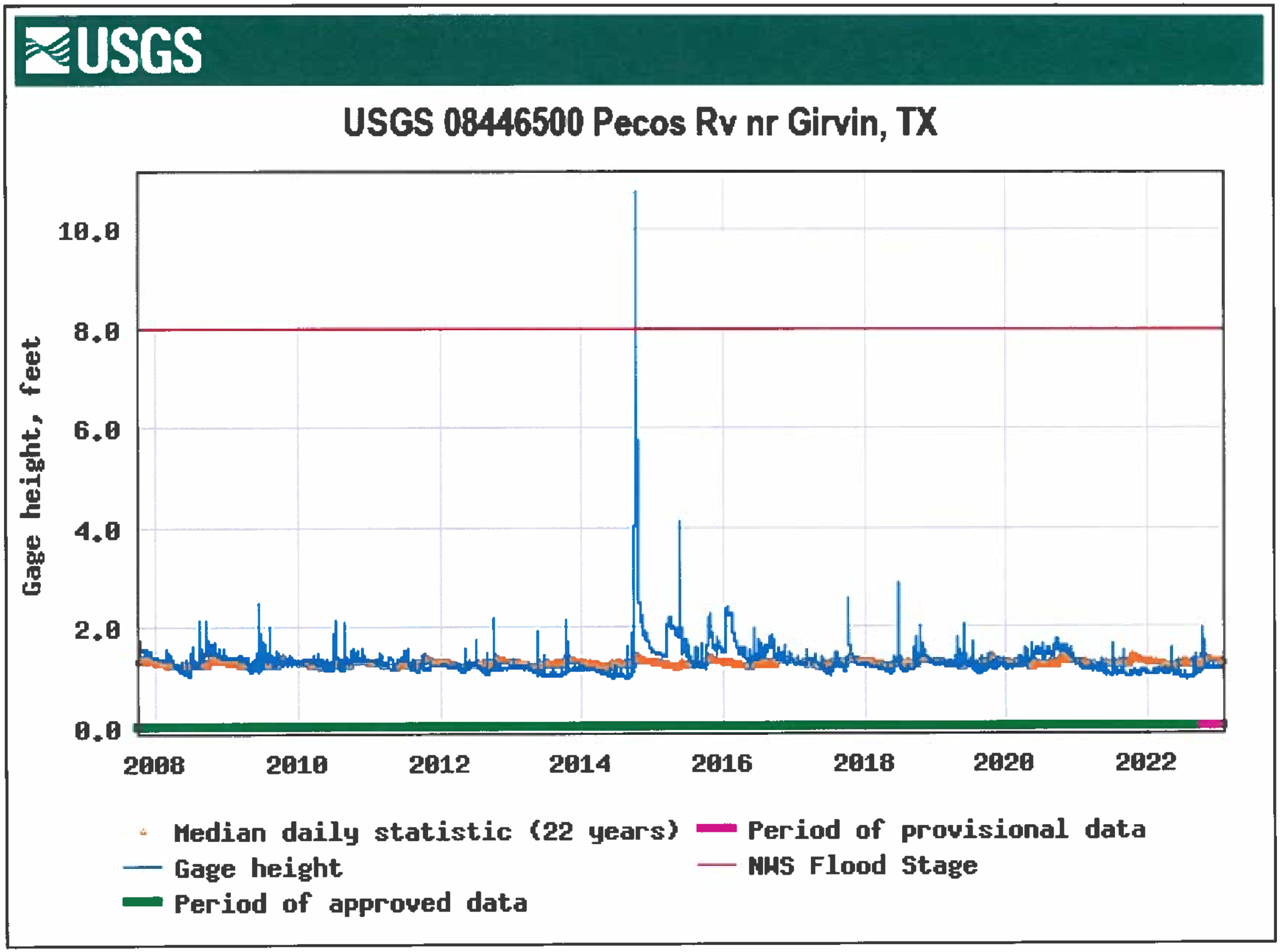
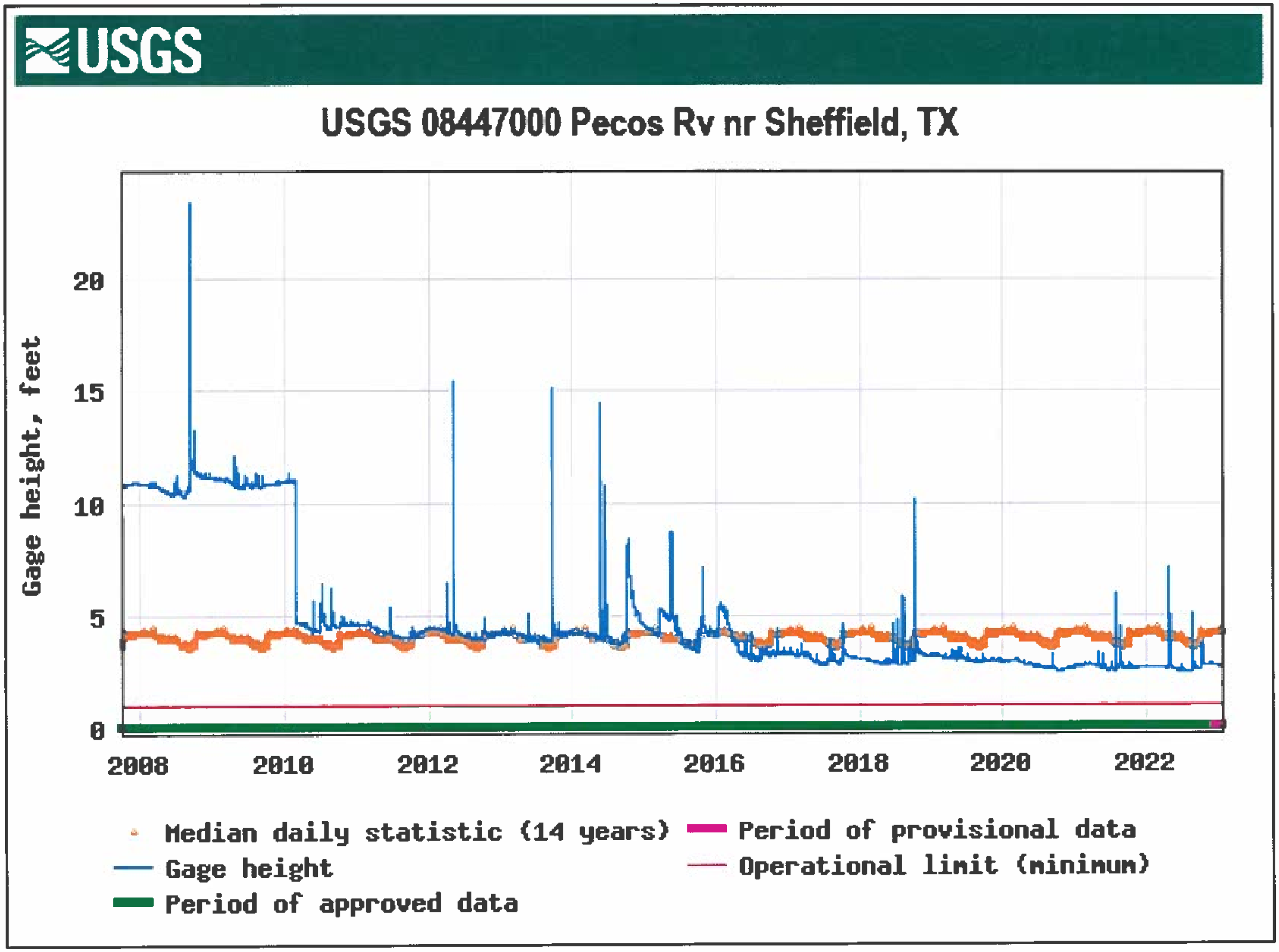
11/25/2021 0:00
1/25/2022 0:00
3/25/2022 0:00


USGS
USGS 08446500 Pecos Rv nr Girvin, TX
Gage height, feet
10.0
8.0
6.0
4.0
2.0
0.0
2008
2010
2012
2014
2016
2018
2020
2022
Median daily statistic (22 years)
Gage height
Period of approved data
Period of provisional data
NWS Flood Stage

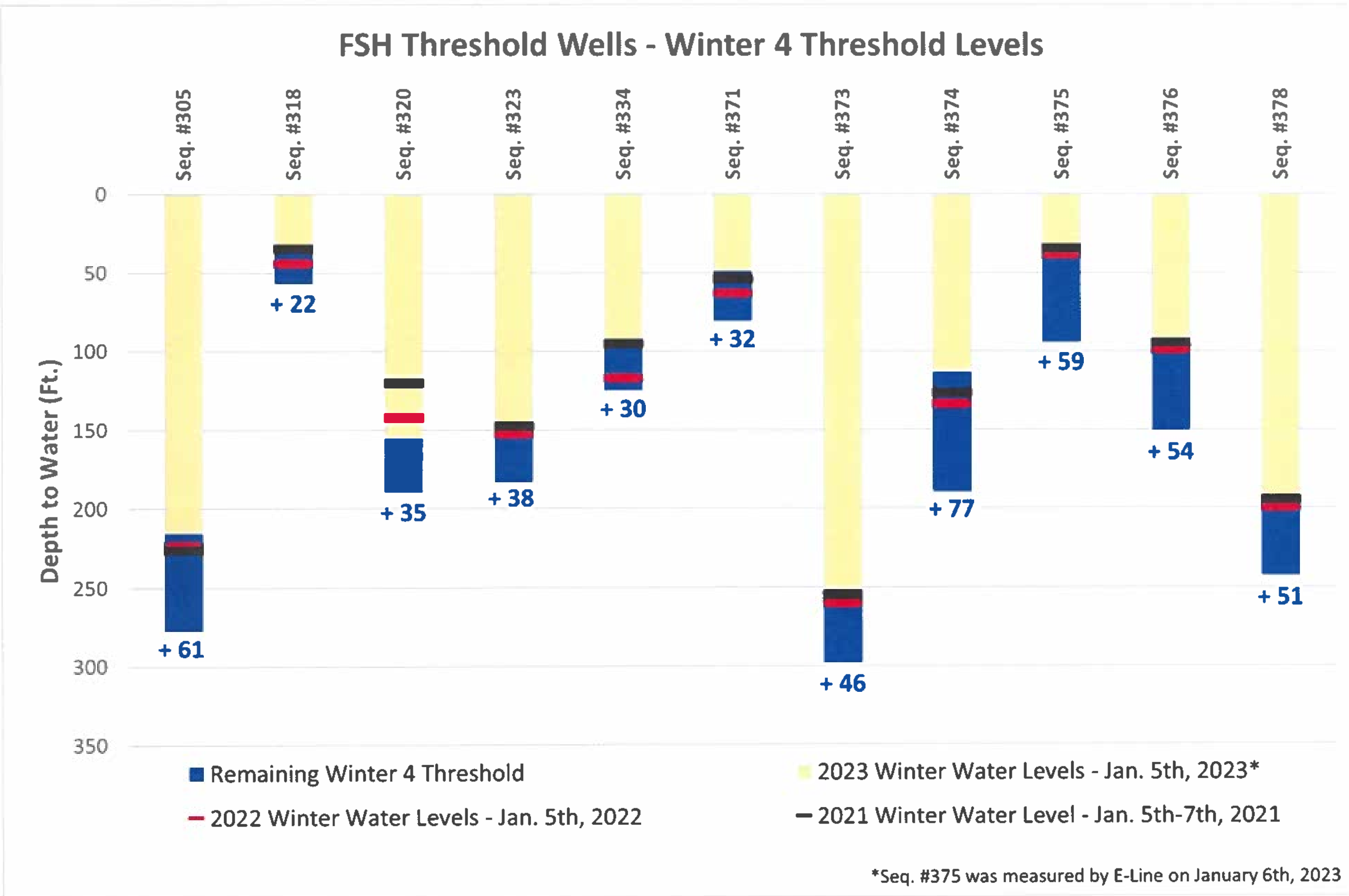

USGS
USGS 08447000 Pecos Rv nr Sheffield, TX
Gage height, feet
20
15
10
5
0
2008
2010
2012
2014
2016
2018
2020
2022
Median daily statistic (14 years)
Gage height
Period of approved data
Period of provisional data
Operational limit (minimum)

Threshold Table

Show more threshold data

Well		Reference Point Elevation (ft)	Winter Thresh... 1	Winter Threshold 2 (Historic Minimum)	Winter Threshold 3	Winter Threshold 4	Summer Threshold	Most recent Depth to Water		Winter Max Depth to Water	Sum... Min Depth to Water
Short Name	Long Name		Depth to Water	Depth to Water	Depth to Water	Depth to Water	Depth to Water	Depth to water	Measure... Date		
Mpgcd320	King, Woodward, #320	3068	205	200	195	190	245	154.73	01/24/2023	159.55	147.09
Mpgcd323	Ft Stockton, Cemetery, #323	3031	198	193	188	183	208	143.09	01/25/2023	152.25	146.48
C-5	C-5, FSH Well	3009	110	105	100	95	177	32.29	01/24/2023	60	46.95
M-9	M-9, FSH Well	3261	313	308	303	298	356	249.03	01/25/2023	276.75	261.6
S-45	S-45, FSH Well	3067	165	160	155	150	216	92.91	01/24/2023	117.65	107.58
S-6	S-6, FSH Well	3123	205	200	195	190	262	105.8	01/24/2023	154.25	112.25
Mpgcd305	Cockrell_Belding, #305	3233	292	287	282	277	362	212.79	01/25/2023	229	225.44
Mpgcd318	Goldman Ranch, Well 1	2957	72	67	62	57	100	33.54	01/25/2023	51.5	38.57
Mpgcd334	Carpenter, #334	3051	140	135	130	125	171	94.03	01/25/2023	118.89	99.16
Interstate	Interstate Well, FSH Well	2988	96	91	86	81	141	48.29	01/24/2023	69.45	53.58
Prison	TDCJ, Prison Well	3199	258	253	248	243	293	189.75	01/24/2023	218.8	202.08

HydroVu Water Levels


FSH Threshold Wells - Winter 4 Threshold Levels
Seq. #305
Seq. #318
Seq. #320
Seq. #323
Seq. #334
Seq. #371
Seq. #373
Seq. #374
Seq. #375
Seq. #376
Seq. #378
Depth to Water (Ft.)
0
50
100
150
200
250
300
350
+ 61
+ 22
+ 35
+ 38
+ 30
+ 32
+ 46
+ 77
+ 59
+ 54
+ 51
Remaining Winter 4 Threshold
2023 Winter Water Levels - Jan. 5th, 2023*
2022 Winter Water Levels - Jan. 5th, 2022
2021 Winter Water Level - Jan. 5th-7th, 2021
*Seq. #375 was measured by E-Line on January 6th, 2023

Rainwater Harvesting

For centuries, people have relied on rainwater harvesting to supply water for household, landscape, livestock, and agricultural uses. Before the advent of large centralized water supply systems, rainwater was collected from roofs and stored on site in tanks known as cisterns. With the development of large, reliable water treatment and distribution systems and more affordable well drilling equipment, rain harvesting was all but forgotten, even though it offered a source of pure, soft, low-sodium water.

A renewed interest in this time-honored approach of collecting water has emerged in Texas and elsewhere because of escalating environmental and economic costs of providing water by centralized water systems or by well drilling. The health benefits of rainwater and potential cost savings associated with rainwater collection systems have further spurred this interest.

Texas is one of only a few states in the nation that has devoted a considerable amount of attention to rainwater harvesting and has enacted many laws regulating the practice of collecting rainwater.

- Texas Tax Code 151.355 allows for a state sales tax exemption on rainwater harvesting equipment.
- Texas Property Code 202.007 prevents homeowners associations from banning rainwater harvesting installations.
- Texas House Bill 3391 requires rainwater harvesting system technology to be incorporated into the design of new state buildings and allows financial institutions to consider making loans for developments using rainwater as the sole source of water supply.

For in-depth descriptions of rules in Texas and other states, visit the National Conference of State Legislatures.

Recent Maps

Texas Rain Catcher Award Winners

Protect, Conserve and Prevent Waste of Groundwater

Our mission at *Middle Pecos Groundwater Conservation District (MPGCD)* is to develop and implement an efficient, economical and environmentally sound groundwater management program to protect, maintain and enhance the groundwater resources of the District, and to communicate and administer to the needs and concerns of the citizens of Pecos County associated with these groundwater resources.

We have an 11-member Board of Directors that is elected by the citizens of Pecos County. There are two directors representing each county precinct, one representing the City of Fort Stockton, one representing the City of Iraan, and one representing Pecos County at large. Your current Directors are: Jerry McGuairt, Janet Groth, Weldon Blackwelder, Puja Boinpally, Vanessa Cardwell, Allan Childs, Jr., Ronnie Cooper, Larry Drgac, M. R. Gonzalez, Alvaro Mandujano, Jr., and Jeff Sims.

In keeping an eye on Pecos County groundwater, the District monitors 128 water wells that are scattered throughout Pecos County. We check water quality analysis and depth of water levels monthly.

The public is invited to join us at our monthly Board Meetings that are normally held on the 3rd Tuesday of each month at our office located at 405 North Spring Drive in Fort Stockton, Texas. Our agendas are posted on our website 72 hours before our meetings and can be reviewed at: https://www.middlepecosgcd.org/.

MPGCD requires water well owners to register all water well(s) with the District. A non-potable analysis can be provided by the District at no cost. MPGCD can carry out the overall responsibility of protecting our water supply by knowing where and how many wells we have in Pecos County. Examples of protection are oil/gas activity, excessive water production, monitoring water levels/analysis, and contamination.

Our office is willing to discuss any concerns, issues, etc., pertaining to our most precious natural resource – GROUNDWATER. You may contact us at 432-336-0698 or come by 405 North Spring Drive, Fort Stockton, Texas.

Efforts to Control and Prevent Waste of Groundwater and Promote Conservation

To promote conservation and prevent waste of groundwater related to agricultural, the following are the best management practices as stated by the Texas Water Development Board Conservation Division : * Irrigation water use management - irrigation scheduling, measurement of irrigation water use, crop residue management and conservation tillage, irrigation audit; * land management systems – furrow dikes, land leveling, contour farming, conversion of supplemental irrigated farm land to dry land, brush management; * on-farm water delivery systems – lining of on-farm irrigation ditches, replacement of on-farm irrigation ditches and pipelines, low-pressure center pivot sprinkler irrigation systems, drip/micro-irrigation systems, gated and flexible pipe for field water distribution systems, surge flow for field water distribution systems, and linear move sprinkler irrigation systems; * Water district delivery systems – lining of district delivery systems, replacement of irrigation district canals and lateral canals with pipelines; * Miscellaneous systems – tailwater recovery and reuse system, nursery production systems.

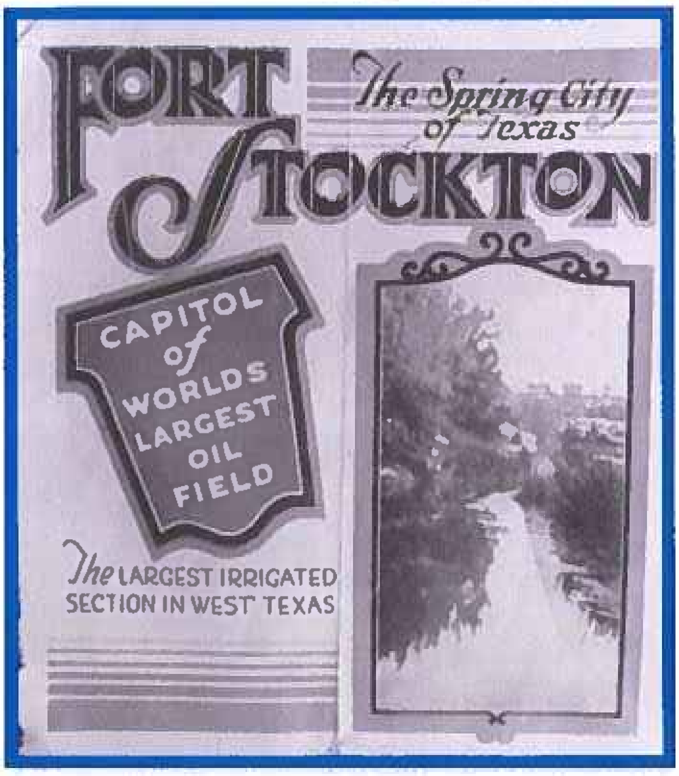
Other ways to promote conservation and prevent waste of groundwater: Sweep rather than hose driveways and other areas; use drip irrigation rather than spray irrigation; wash your car at a car wash; downsize your lawn area and/or Xeriscape; irrigate during the coolest part of the day; never water on windy days; protect plants with mulch and compost to reduce water loss; install low flow shower heads; insulate hot water pipes; reduce showering time; operate dishwasher and washing machine on full loads; install an aerator on kitchen faucet; and turn the water off while brushing teeth and on to rinse. If you see signs of contaminating substances on the surface, remember it could end up contaminating the water source below, so please report to us if you find signs of contamination that need to be checked out.

Middle Pecos Groundwater Conservation District 2022

Directors		
Jerry McGuairt	President: Director Since February 19, 2013	Precinct 1
Janet Groth	Vice President: Director Since June 15, 2010	Precinct 1
M. R. Gonzalez	Secretary/Treasurer: Director Since December 11, 2000	Precinct 2
Puja Boinpally	Director Since April 18, 2017	Precinct 2
Weldon Blackwelder	Director Since August 16, 2011	Precinct 3
Larry Drgac	Director Since August 13, 2019	Precinct 3
Alvaro Mandujano, Jr.	Director Since November 5, 2002	Precinct 4
Ronnie Cooper	Director Since September 15, 2009	Precinct 4
Vanessa Cardwell	Director Since July 21, 2009	City of Fort Stockton
Jeff Sims	Director Since November 8, 2016	City of Iraan
Allan Childs, Jr.	Director Since November 8, 2016	At Large
Current Employees		
Ty Edwards	General Manager: Since January 17, 2017	Assistant Manager: Since December 2, 2013
Gail Reeves	Office Secretary: Since June 3, 2013	
Anthony Bodnar	Field Technician: Since May 7, 2018	

Middle Pecos Groundwater Conservation District
2023- Annual Report

General Manager: Ty Edwards



Submitted by Ty Edwards, General Manager
02/20/2024

Middle Pecos Groundwater Conservation District
2023 Annual Report

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Pecos River:

- **Pecos River- Girvin, Texas**
- **Pecos River- Sheffield, Texas**

Conservation Letters:

- **Rainwater Harvesting**
- **Annual Newspaper Article for Publics Information Regarding Groundwater Conservation**

MIDDLE PECOS GROUNDWATER CONSERVATION DISTRICT
P.O. Box 1644 Fort Stockton, TX 79735 Phone (432)336-0698 Fax (432)336-3407
405 North Spring Drive Fort Stockton, Texas 79735
Email: mpgcd@mpgcd.org Website: www.middlepecosgcd.org

2023 Annual Manager's Report
MPGCD Board of Directors

The District continued working towards a resolution for the abandoned wells problem in Pecos County. Our staff and Board spent a significant amount of time and money on addressing the issues. Efforts at the State level allowed for HB 4256 to pass the Texas Legislature providing $10 Million dollars to plug some abandoned wells in Pecos County. An official complaint has been filed at the Railroad Commission of Texas to plug wells within RRC jurisdiction. The complaint process is ongoing and will continue to work for a solution in 2024. The District continues to tend to MPGCD business in managing the groundwater resources of Pecos County. A summary of that work is below.

Annual groundwater production and number of registered water wells in the District are:

- **2023 Rainfall**

The 2023 year began with nearly 60% of Pecos County out of drought while the other 40% was under abnormally dry conditions (Water Data for Texas, 2024). These conditions worsened throughout the spring and into the summer months when much of the county entered severe drought. As the summer season ended, the rains began to fall. By year-end, drought declarations were removed across much of Pecos County. Although drought was not as persistent or as exceptional in 2024, it was a year of very low rainfall totals for much of Pecos County (Figure 1, Figure 2, Appendix A). At the Fort Stockton Pecos County Airport station, the 2023 rainfall total was nearly 70% below its historic annual rainfall average with most county stations observing annual declines. Eastern Pecos County did however record a year-over-year increase (Figure 2).

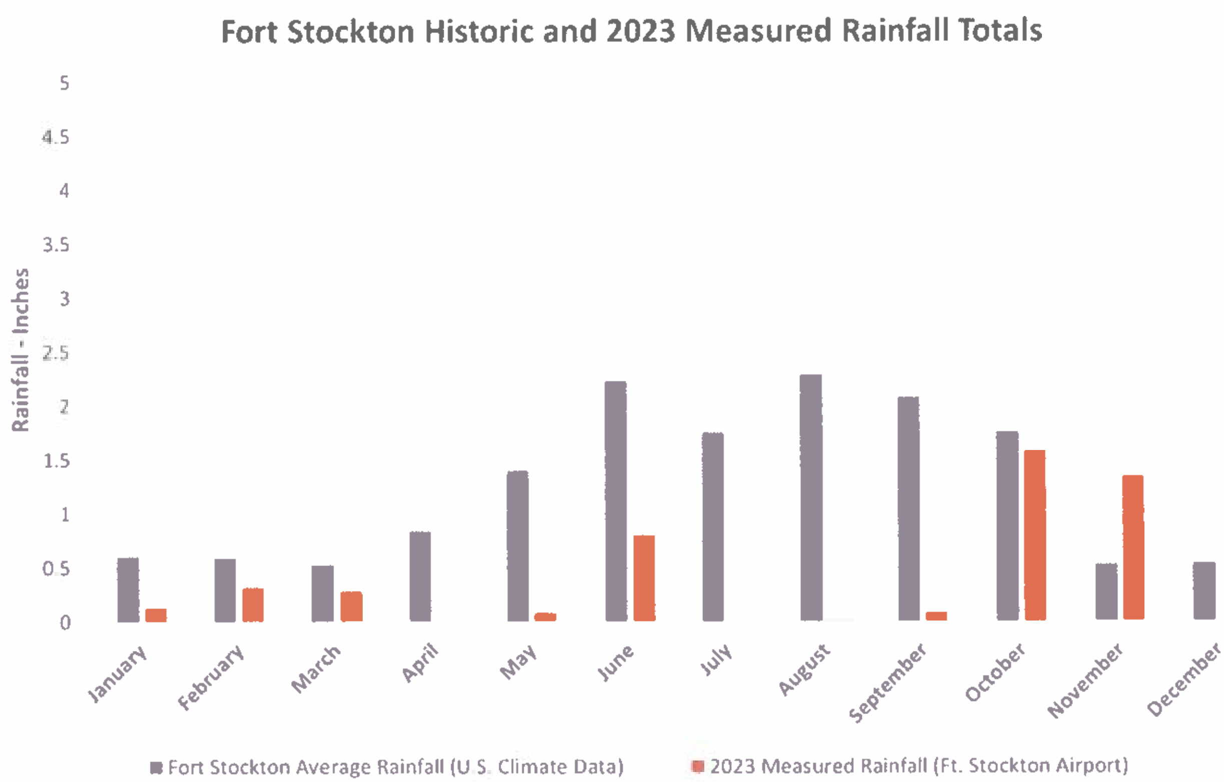


Figure 1 – Fort Stockton, Pecos County, TX Historic and 2023 Measured Rainfall Totals. Historic rainfall data according to the U.S. Climate Data and Center and measured rainfall according to TexMesonet KFST station data.

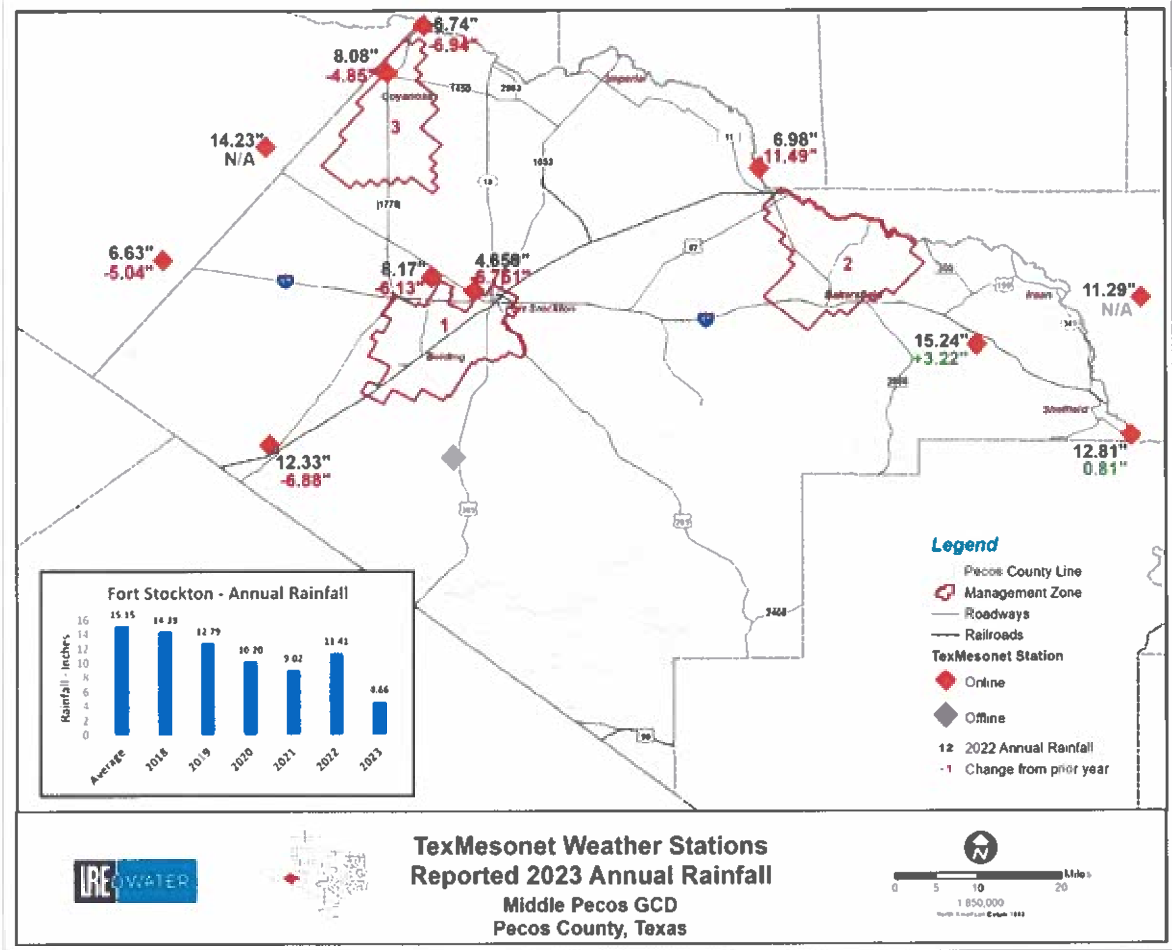


Figure 2 – TesMesonet weather stations across Pecos County, Texas with reported rainfall totals and change from prior year.

- **Winter Water Levels**

Steady water level declines and seasonal fluctuations consistent with drought were observed across the county (Figure 3). In areas with little to no pumping the water levels remained relatively constant. Whereas areas with irrigated croplands (Management Zone 1 and 3) had drawdowns that were noticeably higher. The most significant year-over-year drawdowns are observed in wells west of Fort Stockon. The highest drawdowns were observed at monitor well #360. The historic water level observations suggest that drawdowns are now occurring over a longer duration that in turn is leading to a shorter recovery period (Middle Pecos Groundwater Database, 2024). This could be due to changes in agricultural practices within this area of the county.

Currently, 139 water wells are monitored in Pecos County with 56% remaining stable or showing a gain when compared to their 2022 winter measurement (Figure 4). Of the 58 wells experiencing drawdowns, 46 demonstrated less than 10 feet of decline while only two wells had declines over 20 feet.

When comparing 2011-12 water levels to 2024 measurements, the general trend is flat to slightly downward, with most drawdowns being observed in Management Zone 3 and along the Reeves County border (Figure 5). Monitor well 230 in southern Pecos County has shown the most significant decline over the period. This is a previously discussed reoccurring trend, however, more recently has shown signs of stability.

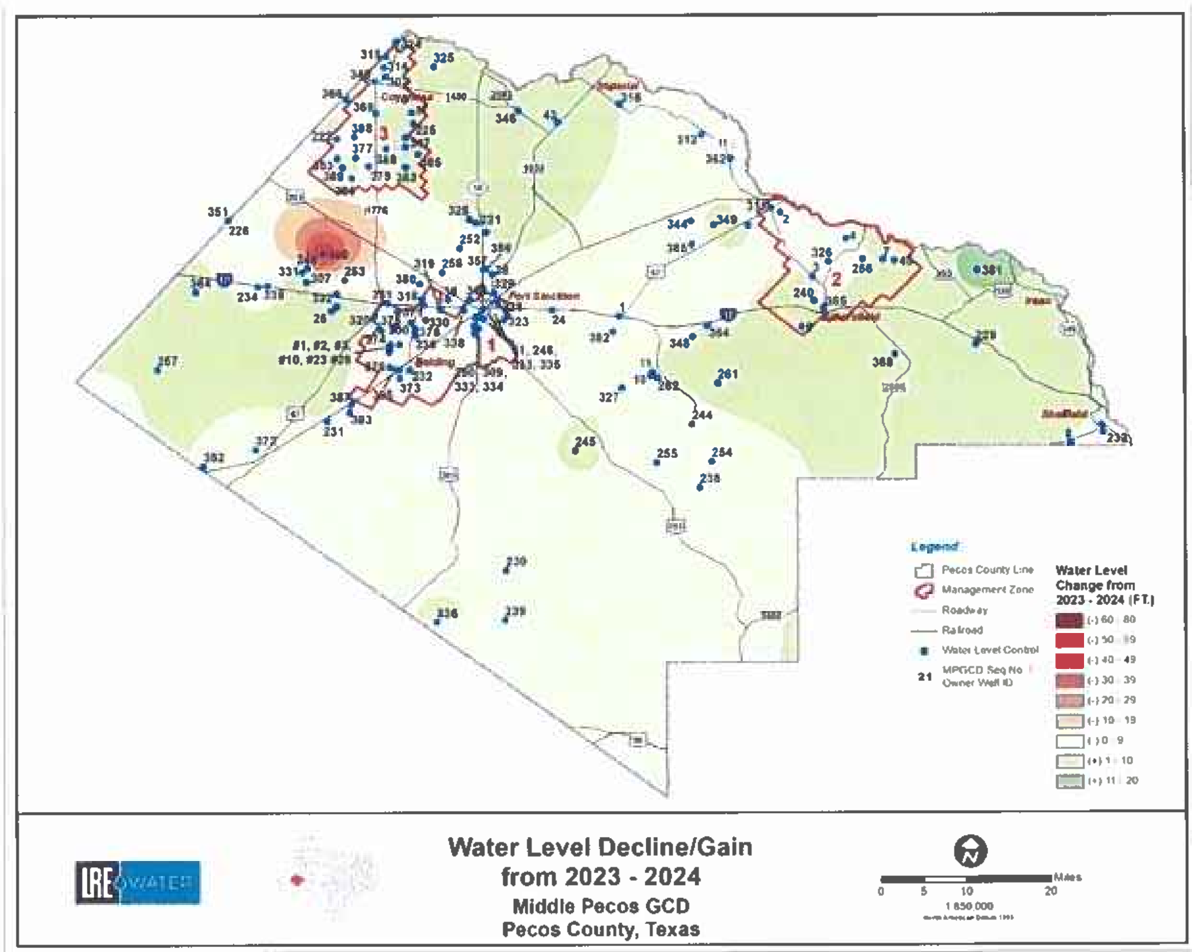


Figure 3 – Pecos County, TX Water Level Decline/Gain from 2023 – 2024. Gains are visible as shades of green while declines are illustrated as yellow to shades of red.

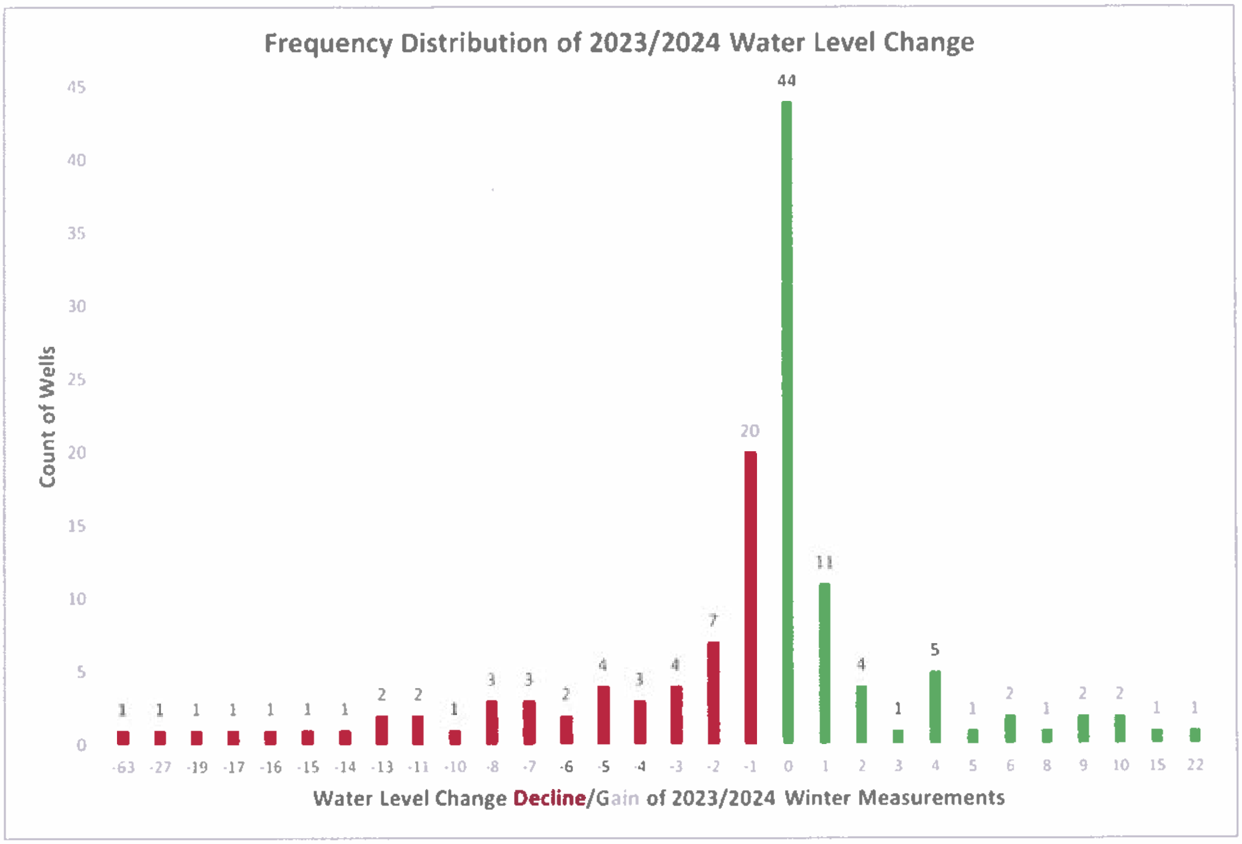


Figure 4 – Monitor well water level change from 2023 to 2024. Red illustrates a year-over-year decline while green illustrates a water level gain (recovery). This chart includes data from the monitor wells where 2023 and 2024 winter measurements were available.

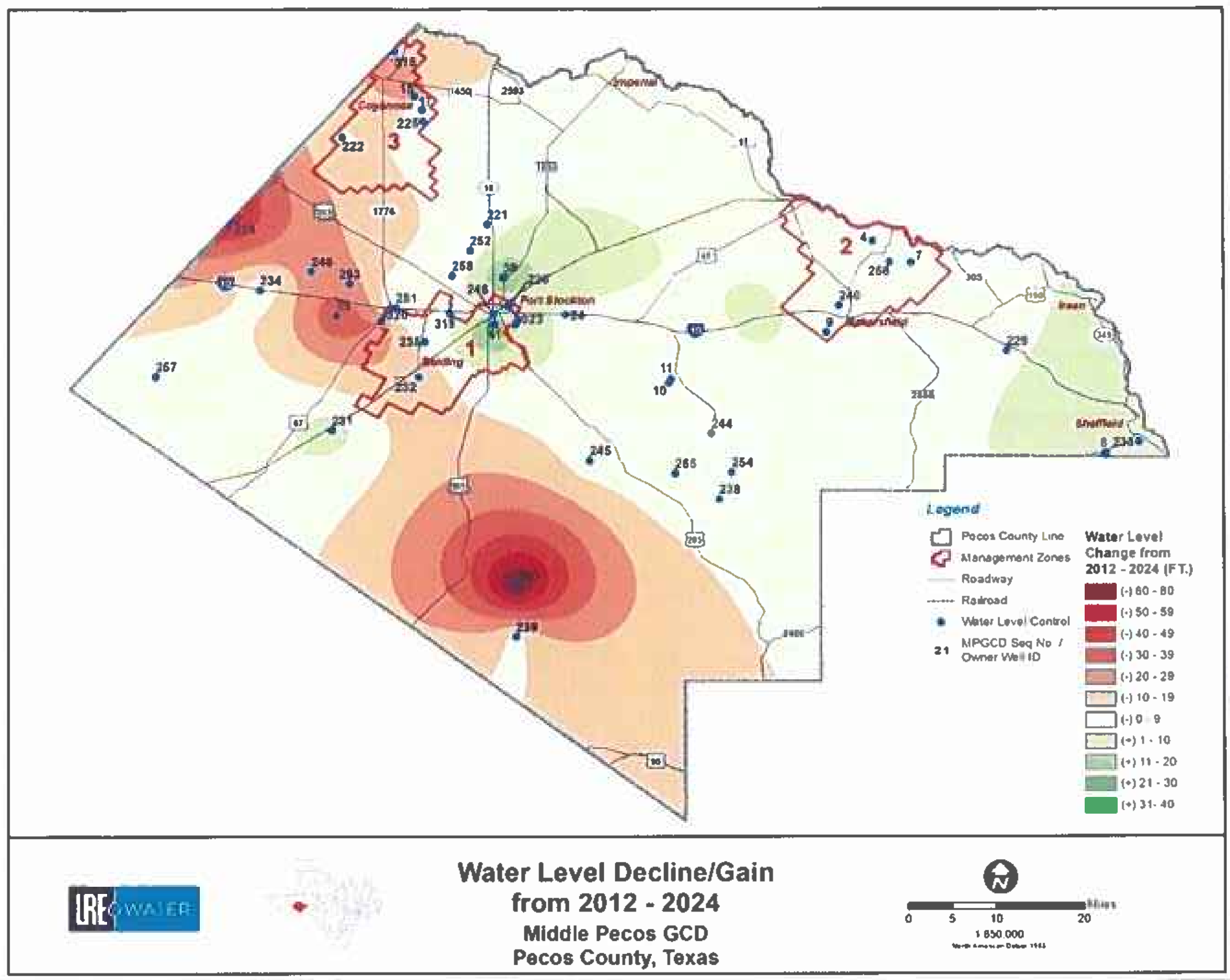


Figure 5 - Pecos County, TX Water Level Decline/Gain from 2012 - 2024. Gains are visible as shades of green while declines are illustrated as yellow to shade of red.

- In Corporation with local landowners **76** water samples have been collected across Pecos County in 2023.

- **Fort Stockton Holdings** 28,400 ac/ft export permit was renewed for a 3-year permit term effective July 18, 2023-2026, in accordance with District Rule 11.8(f) and Texas Water Code 36.1145. FSH and MPGCD approved a Joint Study to be proactive, to develop scientific data that will provide FSH, the District, and other stakeholders with more certainty about conditions in the Edwards-Trinity Aquifer. FSH agreed to pay $250,000 to contribute to the study. As of this date the District has installed transducers, which are recording pressure, temperature, and conductivity at the 11 Threshold monitor well sites.

  FSH Threshold Well Dashboard is available at https://mpgcd.halff.com/Dashboard.

Remaining 2024 Winter 4 Threshold Levels on January 5th, 2024 (Figure 6). These water levels demonstrate relative year-over-year consistency as they are mostly in line with 2022 and 2023 measurements.

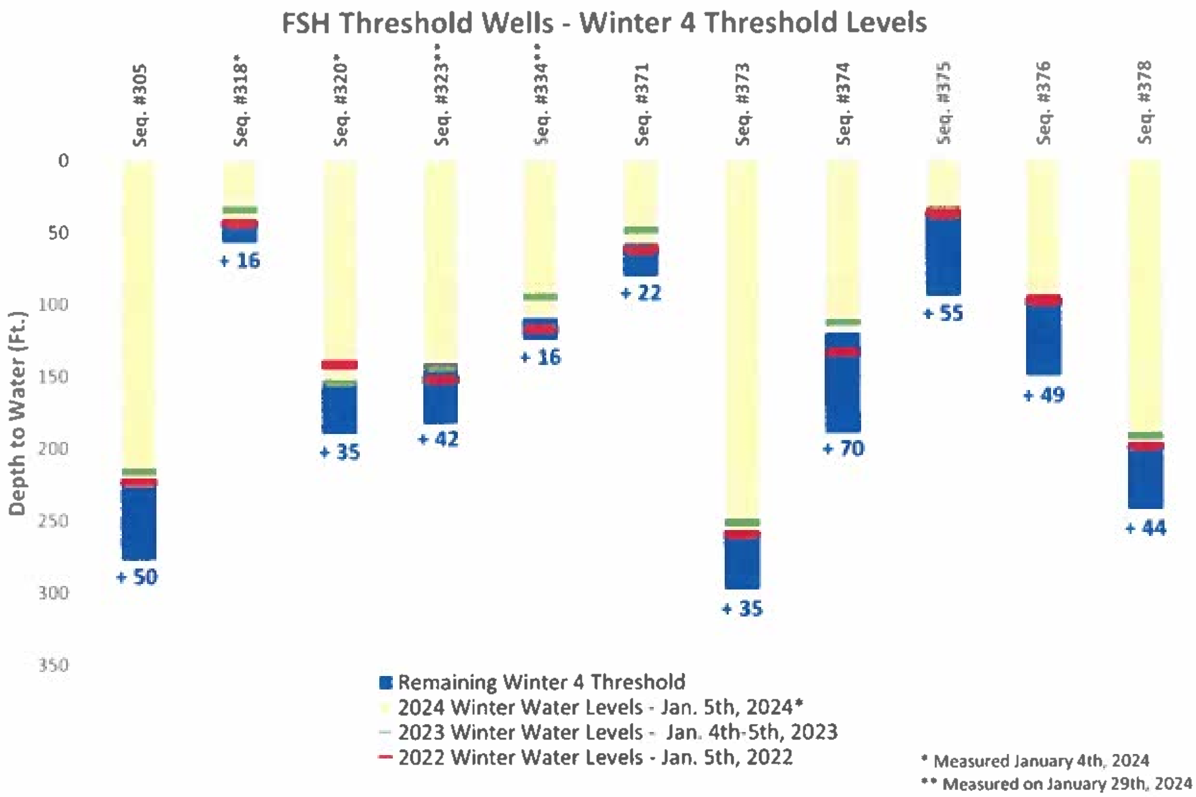


Figure 6 – Remaining Winter 4 Threshold Levels. The remaining threshold drawdown is visible in blue, while prior year measurements are visible as red and green lines.

Cockrell vs MPGCD

A. **Cockrell Investment Partners, L.P. v. MPGCD and its Board President in his official capacity, FSH and Republic Water Company of Texas, L.P.**, Case No. 23-0742 (Texas Supreme Court)(Cockrell I);

In Cockrell I, the El Paso Court of Appeals on July 13th denied Cockrell's motion for rehearing after further briefing thereby affirming the trial court's ruling in favor of the District's decision. A new deadline to appeal to the Texas Supreme Court is September 27th by petition for review. A 2nd new deadline to appeal has been approved for October 27th. On November 9th, the District and FSH filed brief responses with the Court advising that in accordance with Rule 53, each party will respond if the court is interested in responses. A Petition for Review is under review by the Court.

B. **Cockrell Investment Partners, L.P. v. MPGCD and its General Manager in his official capacity, and FSH**, Case No. 23-0593 (Texas Supreme Court)(Cockrell II);

In Cockrell II, the El Paso Court of Appeals on July 10th denied Cockrell's motion for rehearing after further briefing thereby affirming the trial court's ruling in favor of the District's decision. The Court of Appeals issued a substitute opinion and judgment with its reasoning that there is no jurisdiction in the courts for Cockrell to pursue its claim, including the reason that Cockrell prematurely filed its lawsuit by not waiting for its motion for rehearing filed at the District to expire. On August 2nd, the Court of Appeals issued a revised opinion and judgment correcting typographical errors. September 18 Cockrell requests extension to file appeal with Texas Supreme Court. On October 25th Cockrell timely filed Petition for Review. On November 9th the District and FSH filed brief responses with the Court advising Rule 53. On November 28 Petition for Review is "under review" by the Court.

C. **Cockrell Investment Partners, L.P. v. Ty Edwards, In His Capacity as General Manager, and FSH**, Case No. 08-23-00178-CV (El Paso Court of Appeals)(Cockrell III);

In Cockrell III, a hearing in front of Judge Ables occurred on May 30, 2023. The Court ruled in favor of FSH and MPGCD by granting their Pleas to the Jurisdiction. There was a disagreement with Cockrell over the finality of the trial court's judgment and fee reimbursement, which Judge Ables cleared up by signing a modified order on July 19. August 14th is the deadline for Cockrell to file its appellate brief at the Court of Appeals. Cockrell timely filed and the District and FSH's appellate briefs were timely filed September 26. On October 13th Cockrell filed a reply brief.

D. **Cockrell Investment Partners, L.P. v. Middle Pecos Groundwater Conservation District**, Cause No. P-8626-83-CV (83rd District Court)(Cockrell IV); and

In Cockrell IV, the lawsuit was filed on August 17th and served on September 13th by agreement. The District's answer and counterclaim was timely filed October 9th. FSH has advised that it will intervene and file plea to the jurisdiction.

E. **Cockrell Investment Partners, L.P. v. Middle Pecos Groundwater Conservation District**, Cause No. P-13031-112-CV (112th District Court)(Cockrell V).

In Cockrell V, the lawsuit was filed on August 23rd and served on September 13th by agreement. The District's answer and counterclaim was timely filed October 9th. FSH has advised that it will intervene and file plea to the jurisdiction.

- **Diamond Y Spring**-The Nature Conservancy has installed Telemetry in Diamond Y Springs. The Conservancy has created an extensive groundwater monitoring program to track spring flows, water quality, and the health of the pupfish and other species. Over the last few years, we have seen a decrease in flows during the summer months and a recovery in winter months. Diamond Y Spring Preserve protects one of the largest and last remaining Cienega systems in West Texas. The District updated the geologic model in 2021 and 2023, around the Diamond Y Spring area and was able to map several faults. The District has installed 6 full time monitoring wells equipped with In-Situ Transducers recording water level and water quality in real time. This equipment is installed in 5 Edwards Trinity Wells and 1 Rustler Well around the spring area.

- **Santa Rosa Spring-** continues to remain dry. The spring bed is being monitored and we are tracking changes in pressure during rain fall events.

- **Comanche Spring**- is continually monitored for flow, pressure, and conductivity during the Winter Spring Season. Noi Flow at Comanche Spring was measured in Winter of 2023.

- The District was awarded a **FY 21 TWDB Agricultural Water Conservation Grant** for metering in Management Zone 1. Outreach is ongoing and hope to begin installation of meters in early 2024.

- The District drilled a **Monitor Well at the MPGCD Office located at 405 North Spring Drive**. The purpose of the well is for educational monitoring site outside the office. An 8ft Aeromotor windmill has been installed over the well with full time In-Situ monitoring equipment downhole. A full exhibit has been erected at the site.

- **San Andres Abandoned Wells-** Progress has been made on the abandoned well problems in 2023. HB 4256 passed the Texas Legislature with overwhelming support. $10 Million Dollars has been set aside for TCEQ to start a program to plug some of the wells that qualify.

  An official complaint has been filed at the RRC to plug 12 of the abandoned wells. A preliminary hearing has been held with another scheduled for early 2024. If successful several wells at issue could be added to the State well plugging program.

- **PECOS COUTNY GROUNDWATER MODEL Phase 1** of building a groundwater flow model have begun with completion of the model anticipated for 2024. The objective is to develop a tool that would assist the District in groundwater management. The google link for the tech memos is available at:

  https://drive.google.com/drive/folders/1HYj8JRV4omAgKPJWBta-T20hZUbtyaPS.

  Specific uses that are contemplated include:

  - DFC development without the need to use regional GAM's.
  - Provide a quantitative basis for future updates to the District's rules that set a threshold on well size/pumping amount for requiring permit applicants to prepare hydrologic reports.
  - Provide a tool that can be used to review permit applications by quantifying the potential impacts of new pumping for any formation/aquifer in the District on a regional scale.
  - Assess the relationship between groundwater pumping and spring flow at Comanche Springs on a monthly time scale.

- The **third round of joint planning** for Groundwater Management **Areas 3 and 7** is complete and the fourth round of joint planning is underway. For this round, the statutory deadline to propose desired future conditions (DFC's) is May 1, 2026, and the deadline to submit final DFC's to the Texas Water Development Board is January 5, 2027. I attended 100% of all the GMA 3 and GMA 7 meetings held in 2023.

  https://www.twdb.texas.gov/groundwater/management_areas/gma3.asp

  https://www.twdb.texas.gov/groundwater/management_areas/gma7.asp

- The **Region F Water Planning Group** is tasked with developing and adopting a regional water plan in accordance with Texas Senate Bill 1 and Texas Senate Bill 2. The 2021 Region F Plan was submitted to the Texas Water Development Board, and we held our last meeting to adopt the 2021 plan on September 17, 2020. The sixth cycle of regional planning is underway for the 2026 State Water Plan. I am a voting member of Region F representing Groundwater Management Area 3 and have attended 100 percent of the scheduled meetings for Region F in 2023.

  https://www.twdb.texas.gov/waterplanning/rwp/plans/2021/index.asp

LEGISLATION PASSED DURING THE 88TH REGULAR SESSION THAT AFFECTS GROUNDWATER CONSERVATION DISTRICTS

Legislation Amending GCD Procedures

- **HB 1971** –Reduces the number of Board Members required to act on a permit application, for GCD Boards of 10 or more, to a majority of those eligible to vote; Addresses the timing and substance of a GCD Board's final decision and effectuates SOAH's proposal for decision (PFD) if a GCD's Board has not made a decision within 180 days of the SOAH Judge's issuance of a PFD; Prohibits a conflicted Board Member from joining executive session or voting unless a majority of the Members also have a conflict related to a similar interest; Limits the time for a continuance.

- **HB 2443** – Allows a person with a property interest in groundwater in a GCD to petition the GCD to adopt or modify a rule; Requires GCD to prescribe the form for a petition and the procedure for the submission, consideration, and disposition of the petition; If a GCD denies a petition, requires the GCD explain its reason for denying a petition; No private cause of action created for a decision to accept or deny a petition.

Legislation Relating to Permitting and Fees

- **HB 3059** – Allows a GCD to charge a maximum export fee up to 20 cents for each one thousand gallons of water (maximum fee to increase by 3% each year) and to use export fee funds for mitigation—to maintain wells, develop or distribute alternative water supplies, and developing aquifer science.

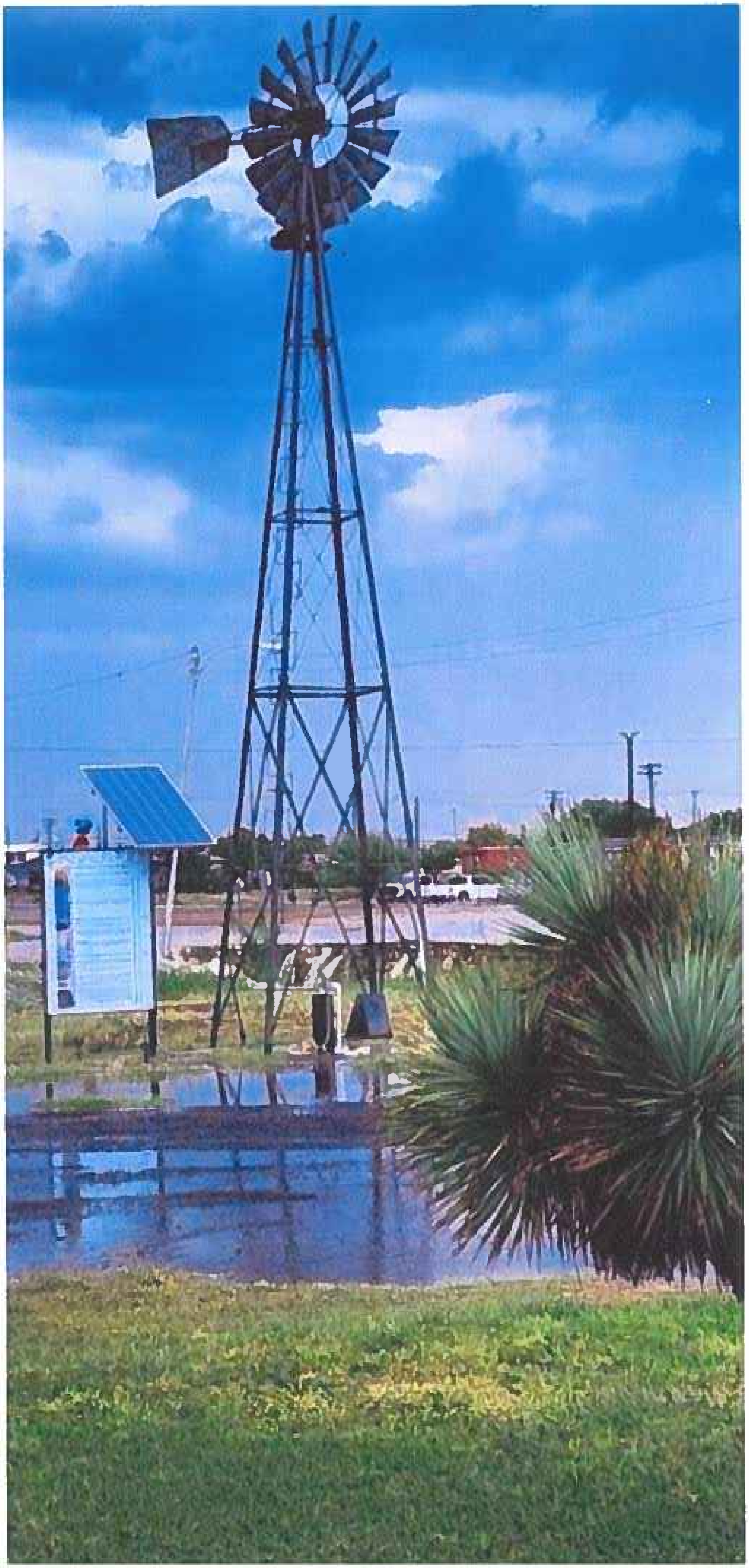
- **SB 1746** – Creates a groundwater production permit exemption for wells drilled for temporary use to supply water for a rig actively engaged in drilling a permitted groundwater production well.

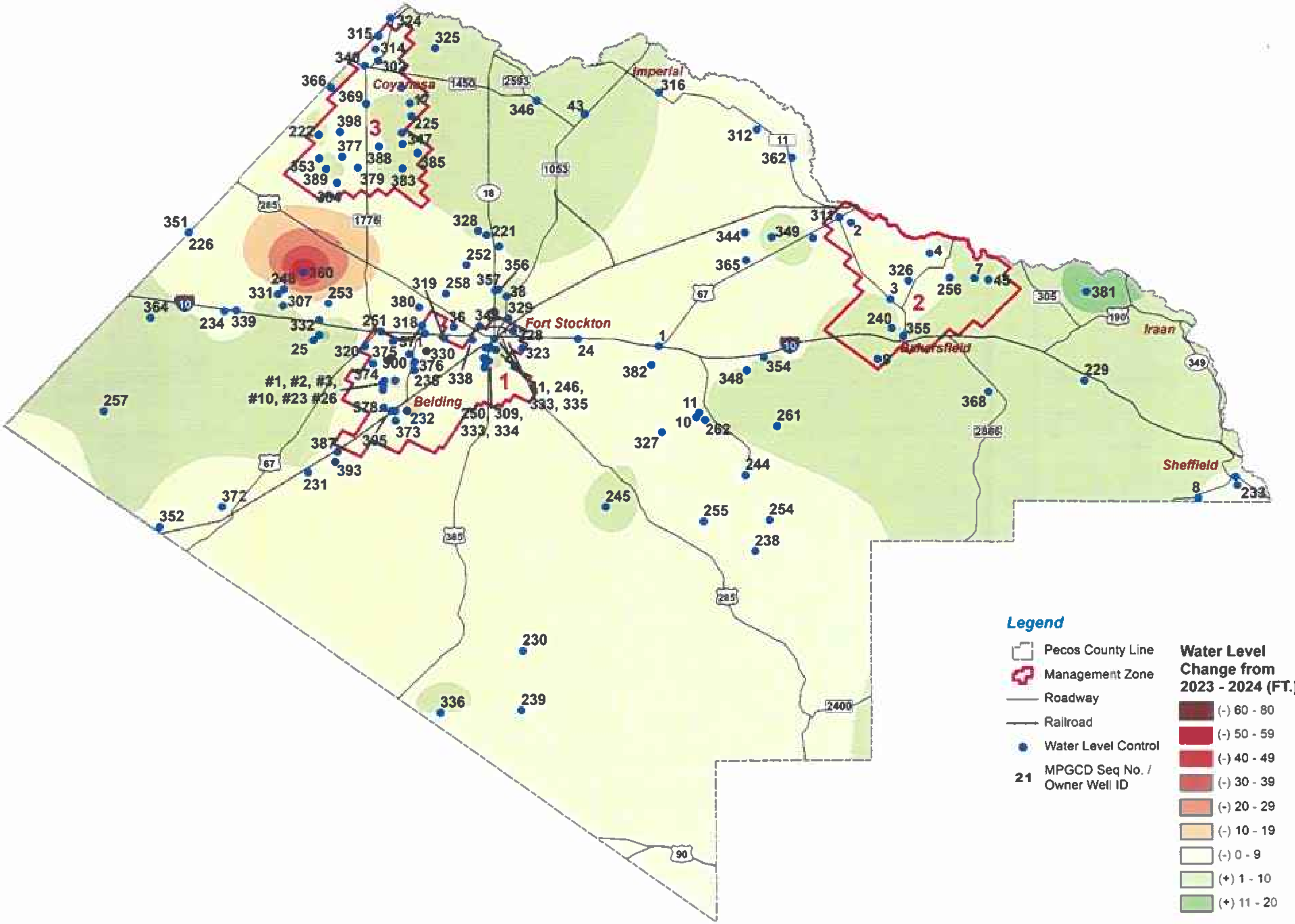
Legislation Relating to DFCs, GAMs and WAMs

- **HB 3278 –** Requires each GCD to provide on the GCD's webpage and to the GMA all materials received during the public comment period, including new or revised GAM run results; Requires public comment at the GMA as the Districts' Representatives are reviewing the information provided by each GCD and that the explanatory report address public comment before the GCDs and at the GMA.

- As General Manager of the District, I would like to thank MPGCD Directors for all the hard work and time you dedicated to 2023.

Ty Edwards, General Manager



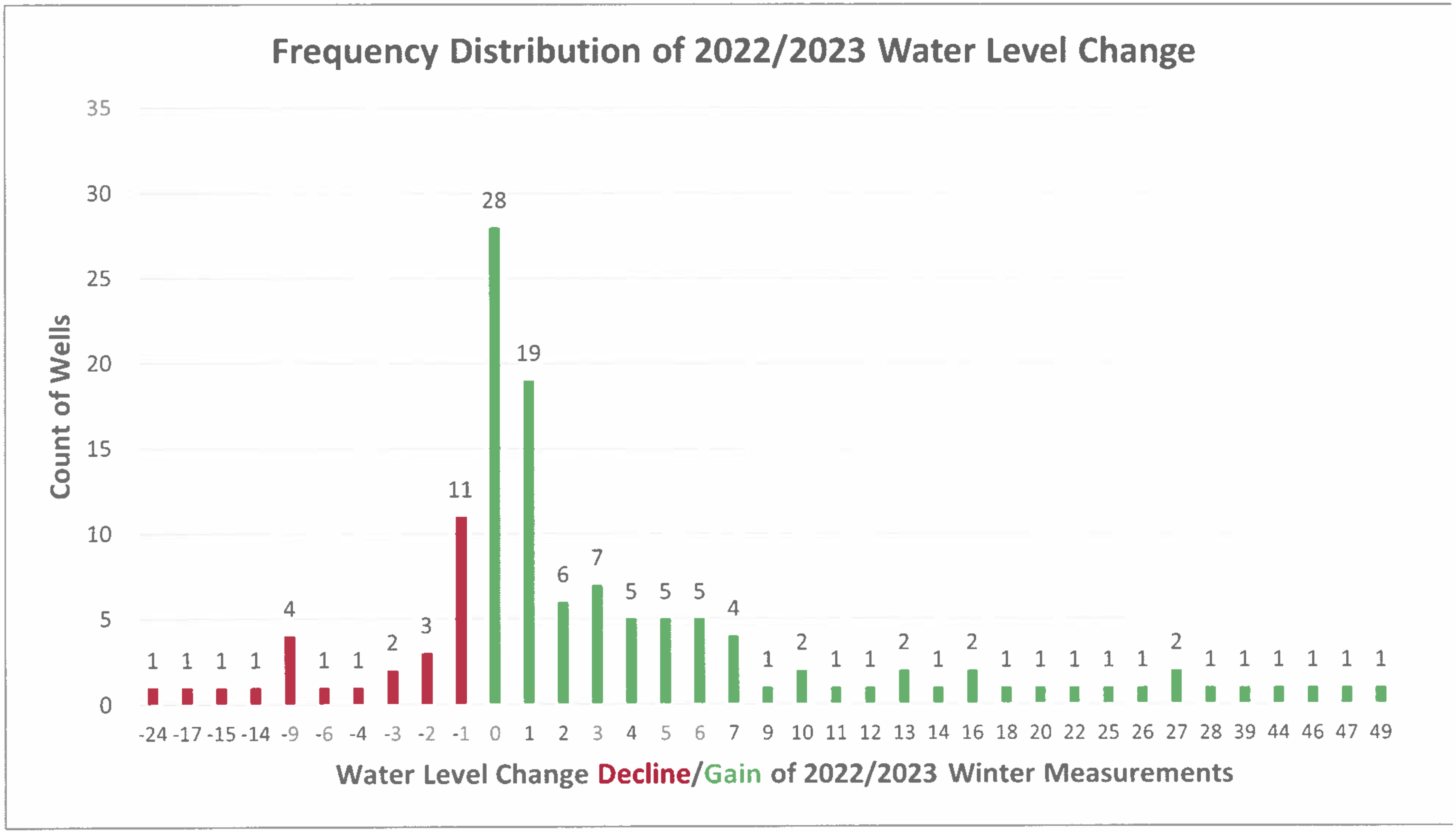


LRE WATER

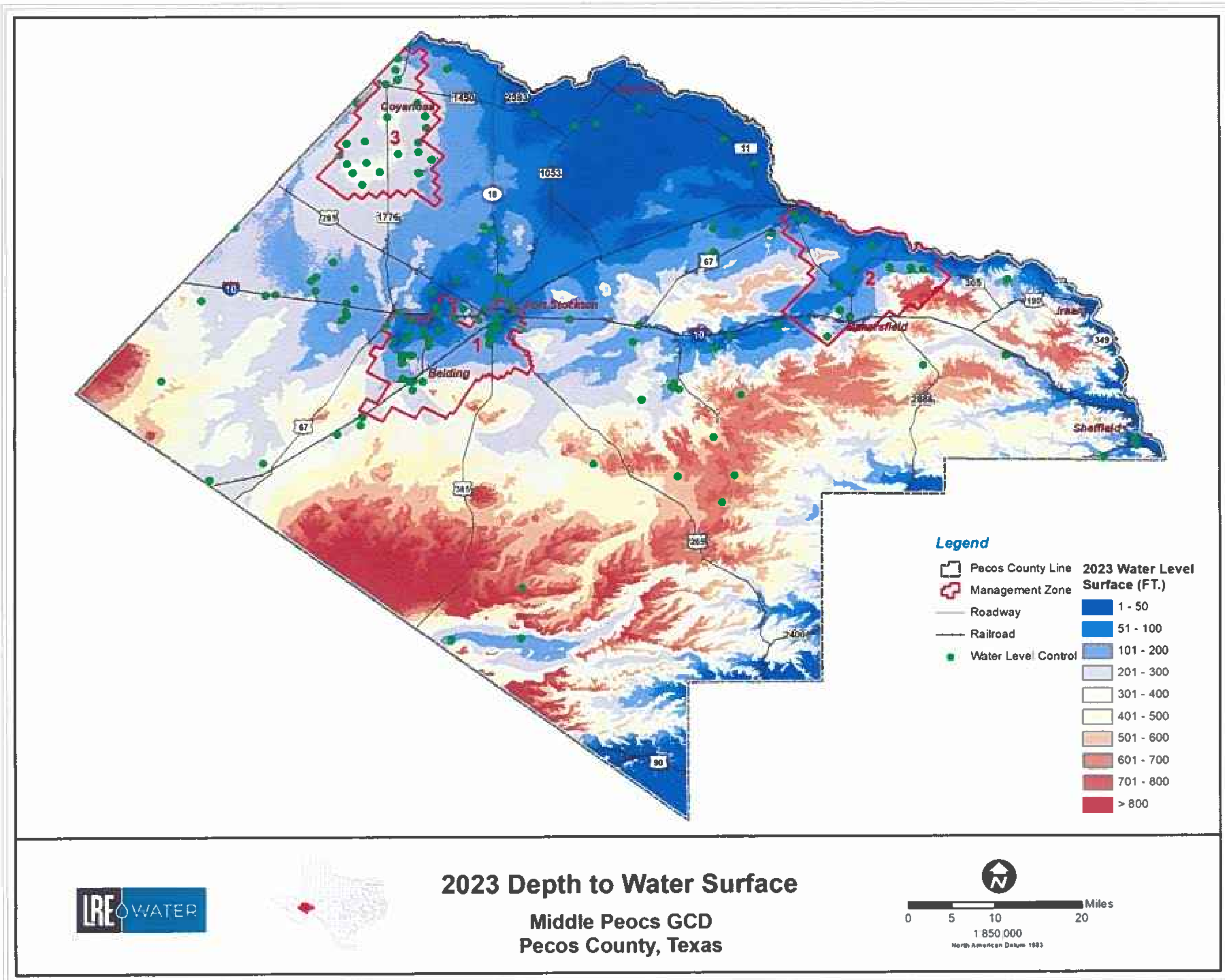
Water Level Decline/Gain from 2023 - 2024

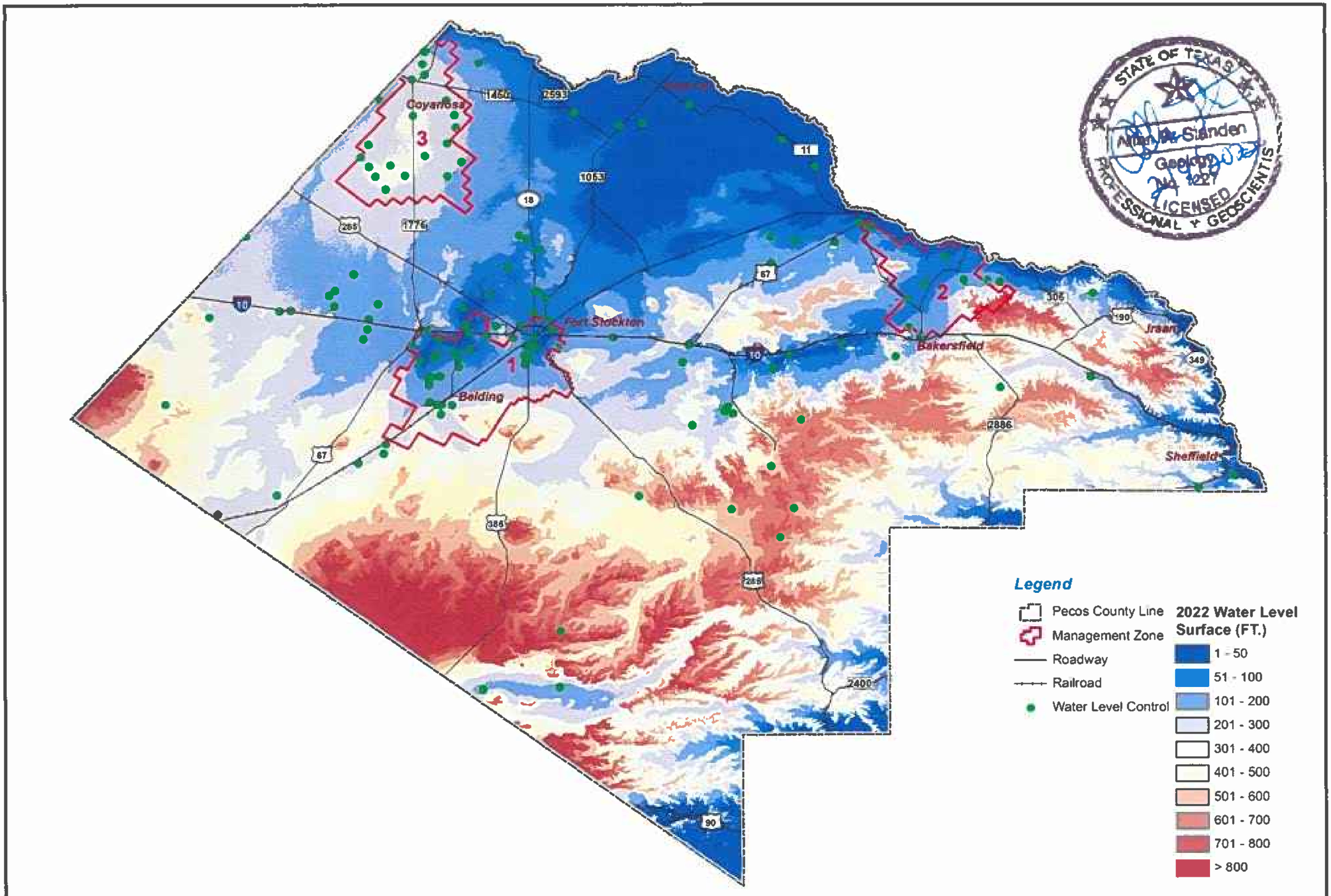
Middle Pecos GCD
Pecos County, Texas

Miles
0 5 10 20
1:850,000
North American Datum 1983


Frequency Distribution of 2022/2023 Water Level Change
Count of Wells
0
5
10
15
20
25
30
35
1 1 1 1 4 1 1 2 3 11 28 19 6 7 5 5 5 4 1 2 1 1 2 1 2 1 1 1 1 1 2 1 1 1 1 1 1
-24 -17 -15 -14 -9 -6 -4 -3 -2 -1 0 1 2 3 4 5 6 7 9 10 11 12 13 14 16 18 20 22 25 26 27 28 39 44 46 47 49
Water Level Change Decline/Gain of 2022/2023 Winter Measurements

Water Level Surface 2023

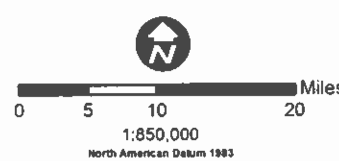


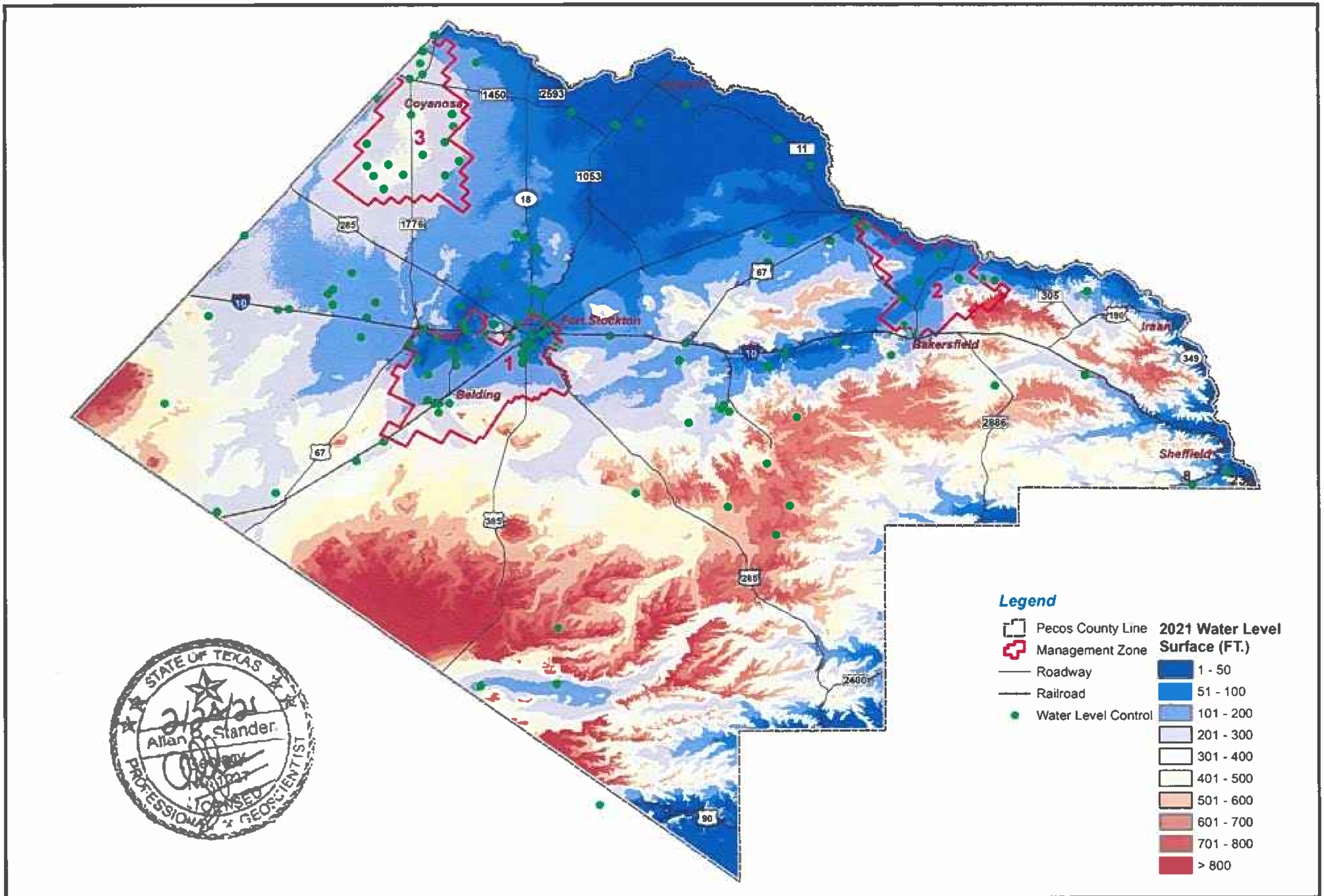


Allan R. Standen LLC
Groundwater & Natural Resource Consulting

2022 Depth to Water Surface

Pecos County, Texas



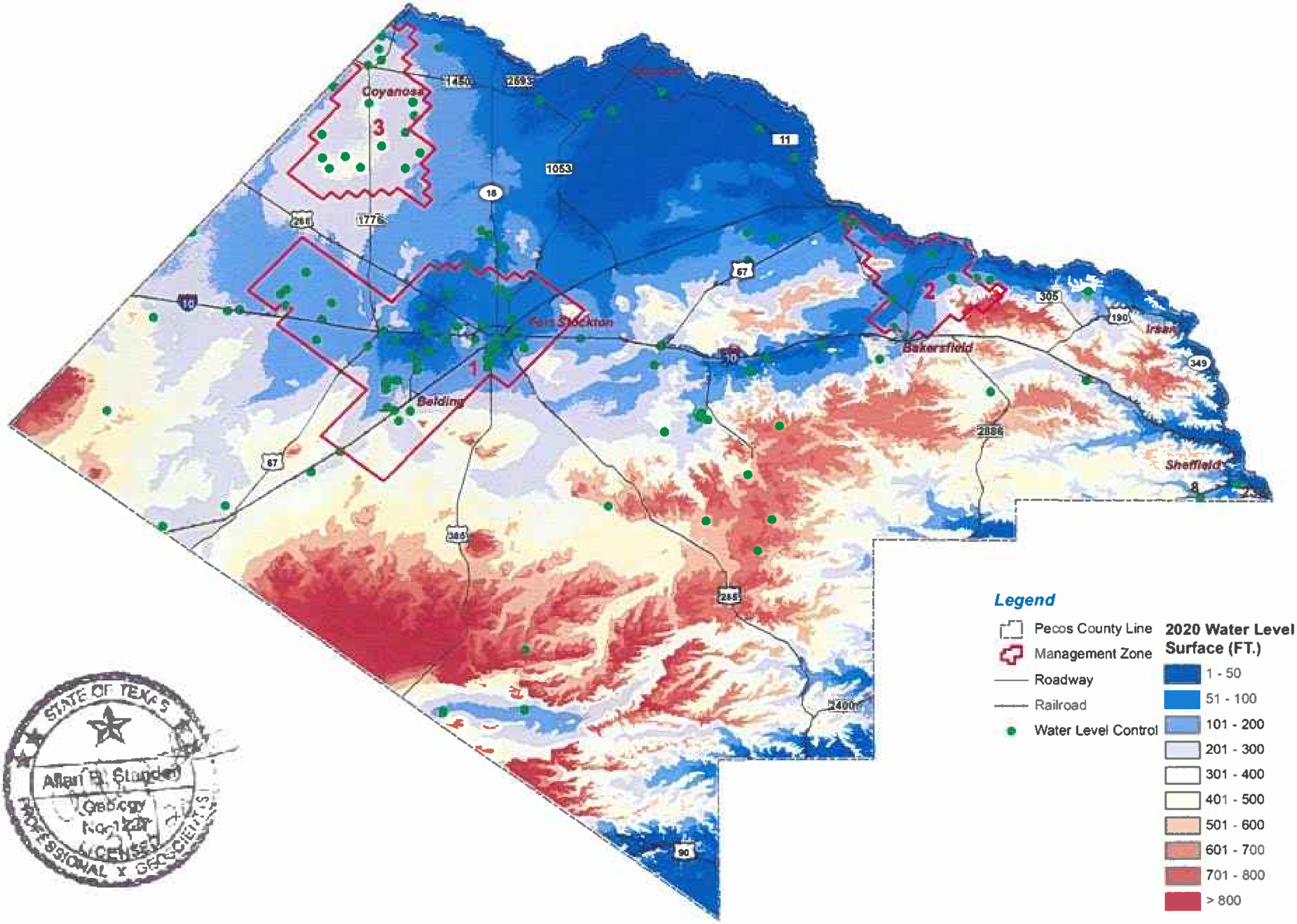


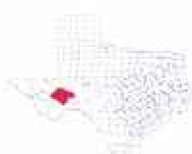
2021 Depth to Water Level

Pecos County, Texas

Allan R. Standen LLC
Groundwater & Natural Resource Consulting

Miles
0 5 10 20
1:850,000
North American Datum 1983

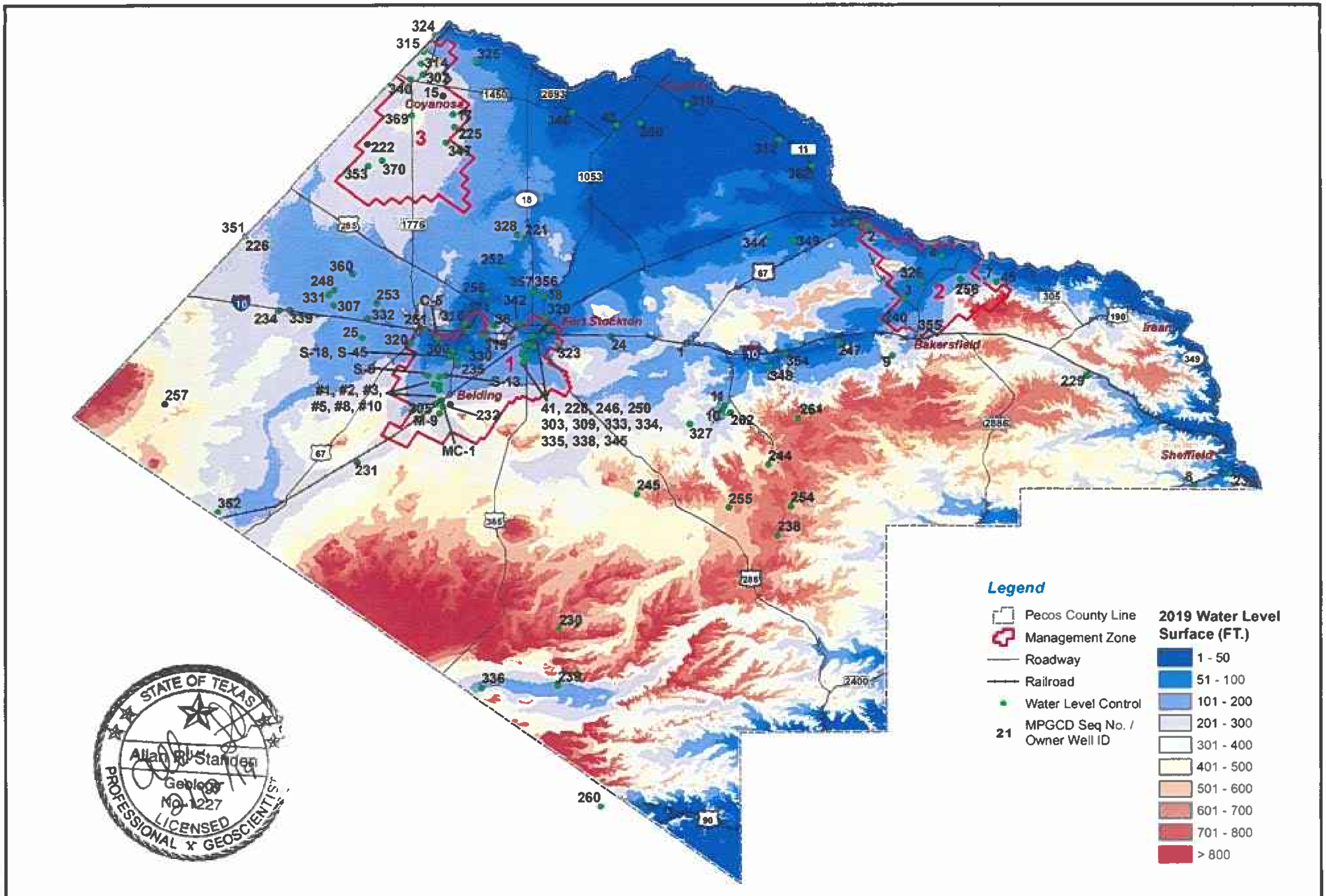




2020 Depth to Water Level

Pecos County, Texas

0 5 10 20 Miles
1:850,000
North American Datum 1983

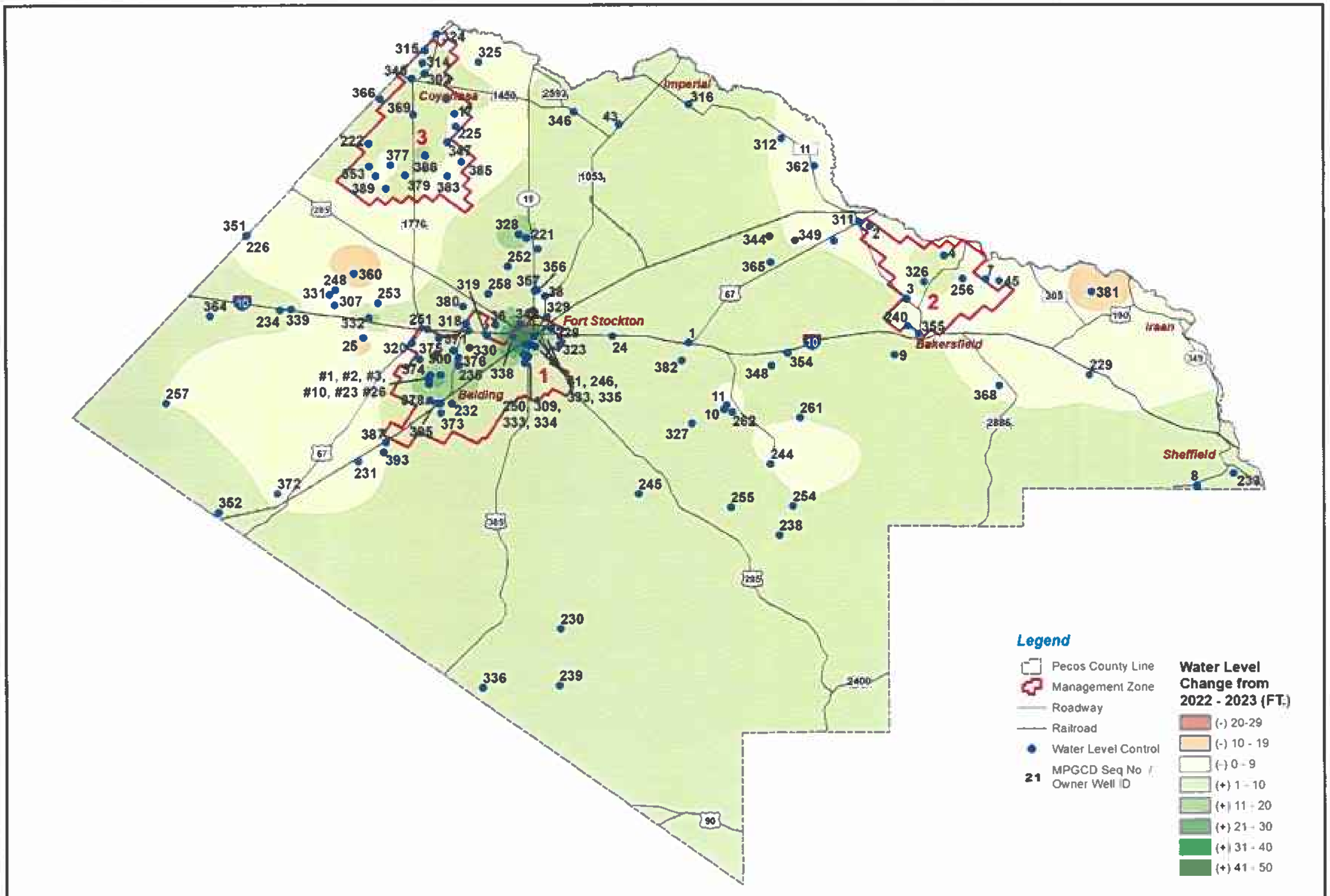


2019 Depth to Water Level

Pecos County, Texas

Miles
0 5 10 20
1:850,000
North American Datum 1983

Water Level Change 2022 to 2023.

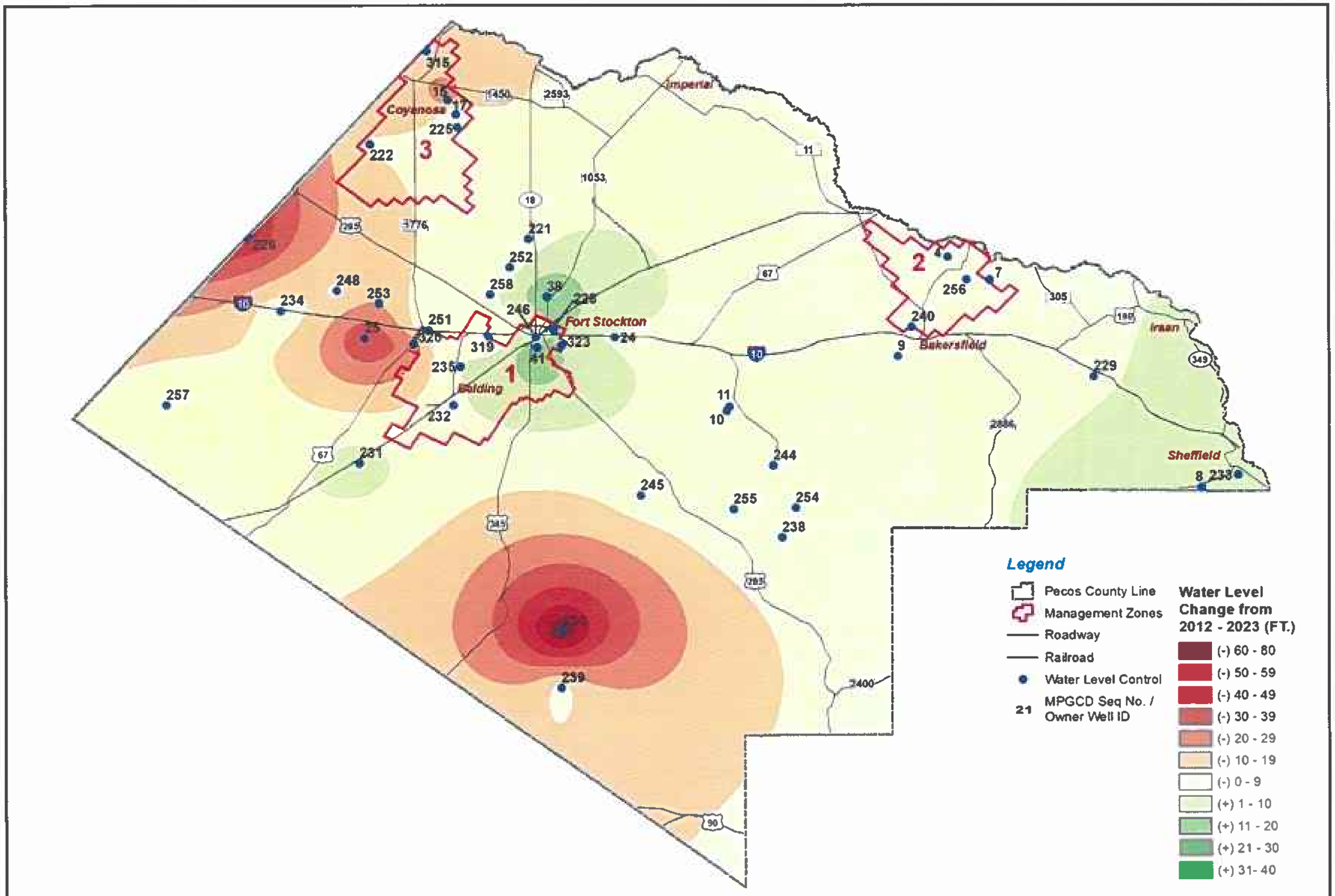


Water Level Decline/Gain from 2022 - 2023

Middle Pecos GCD

Pecos County, Texas

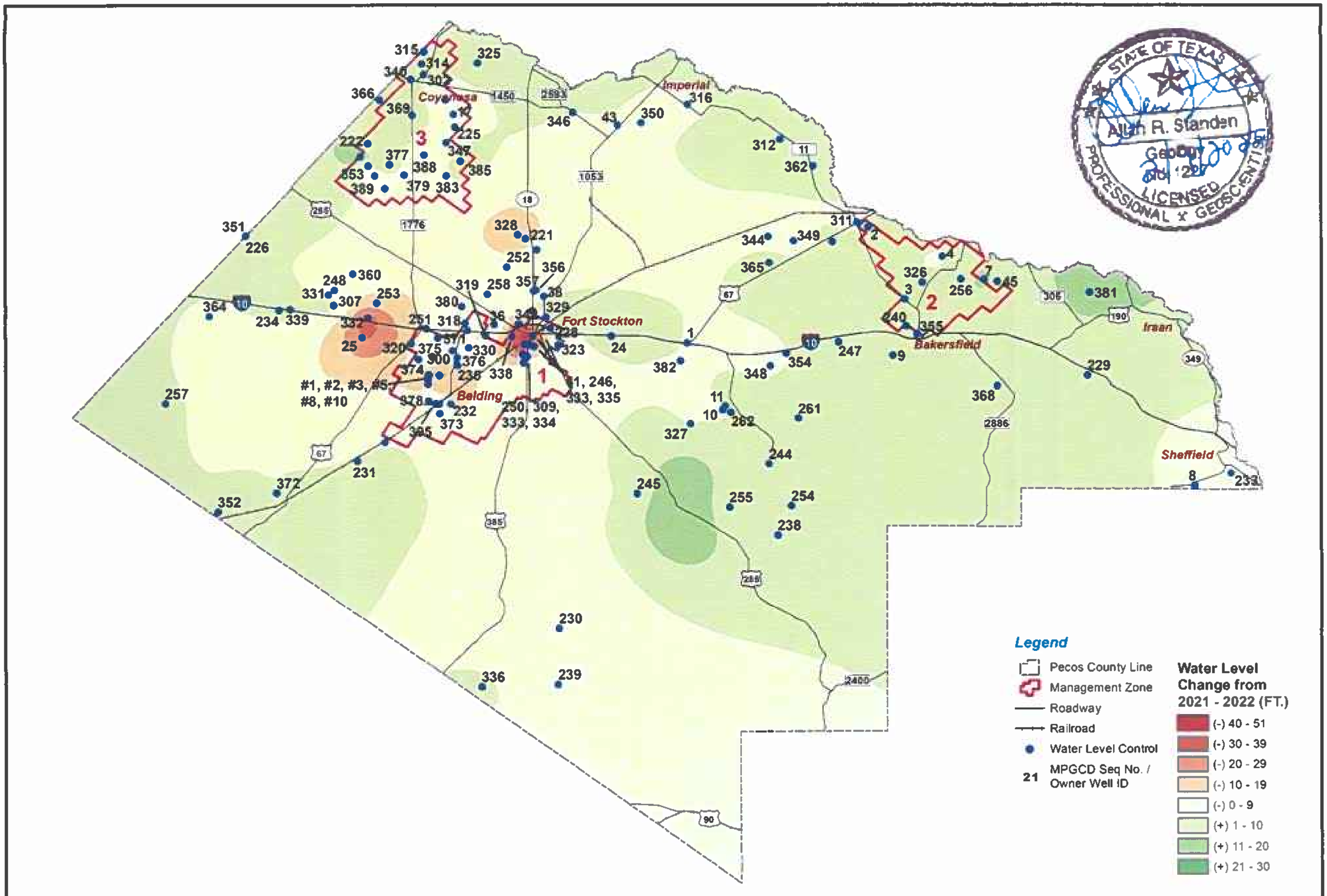
Water Level Change 2012 to 2023



Water Level Decline/Gain from 2012 - 2023

Middle Pecos GCD

Pecos County, Texas

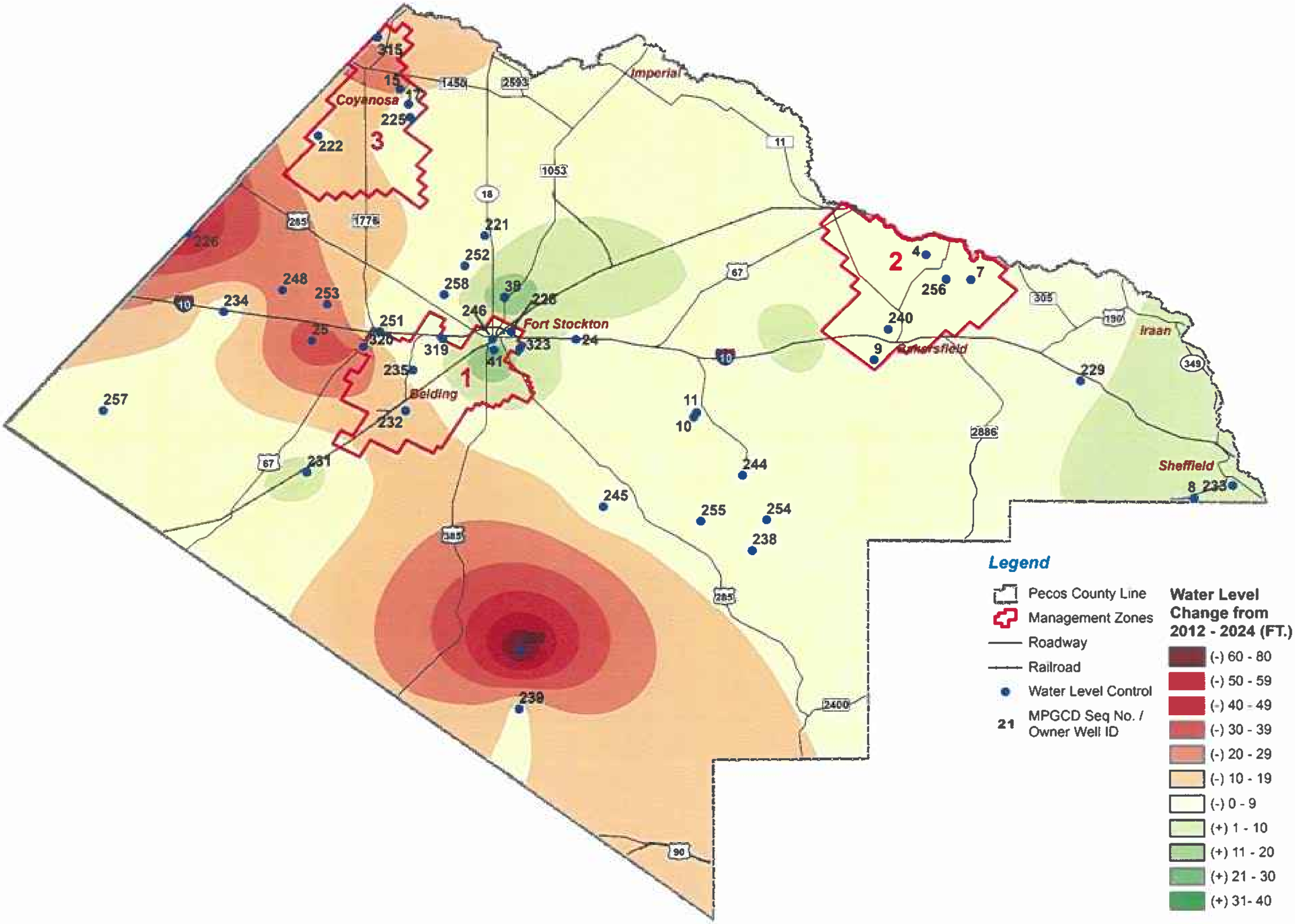


Allan R. Standen LLC
Groundwater & Natural Resource Consulting

Water Level Decline/Gain from 2021 - 2022

Pecos County, Texas

0 5 10 20 Miles
1:850,000
North American Datum 1983

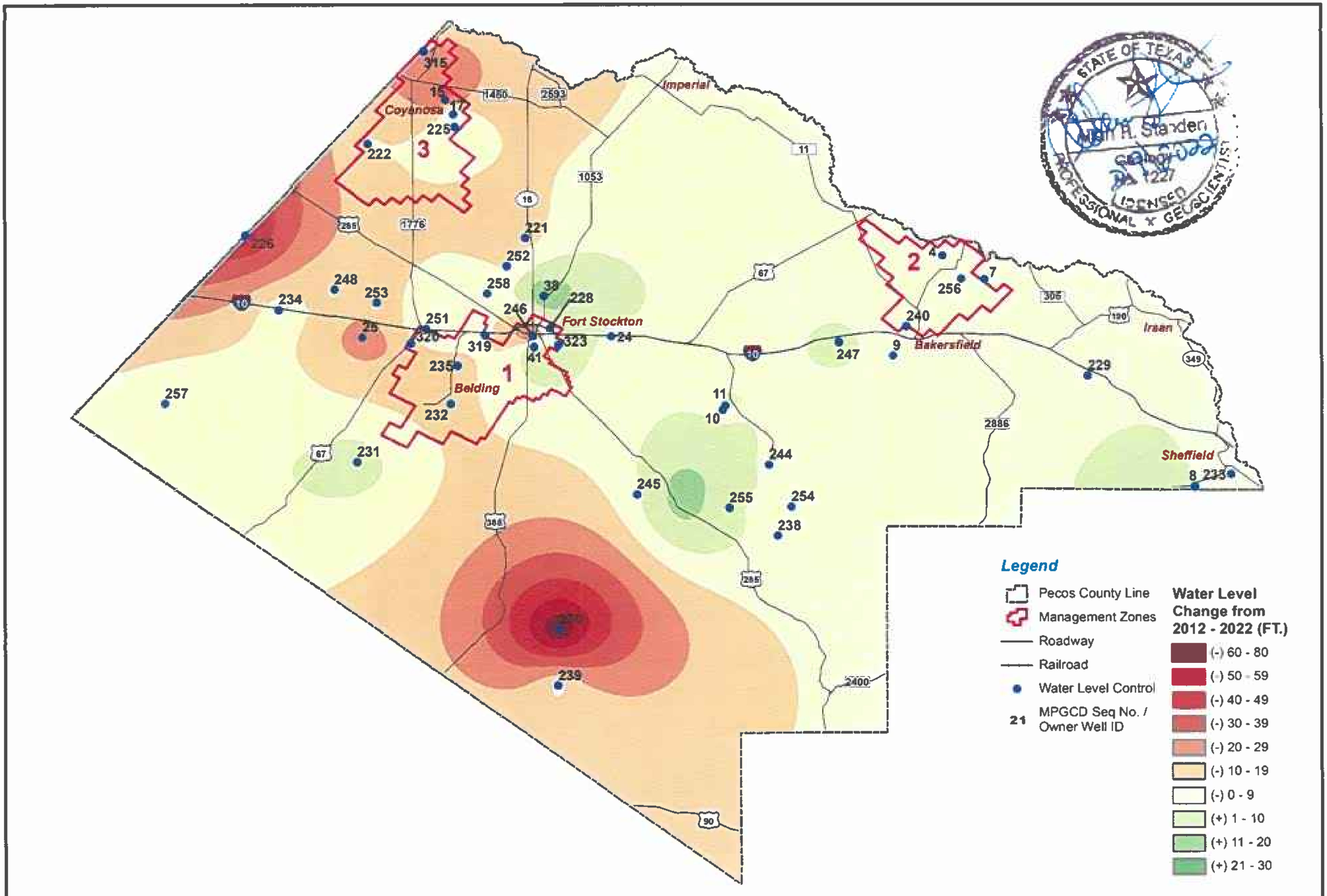


Water Level Decline/Gain from 2012 - 2024

Middle Pecos GCD

Pecos County, Texas

Miles
0 5 10 20
1:850,000
North American Datum 1983

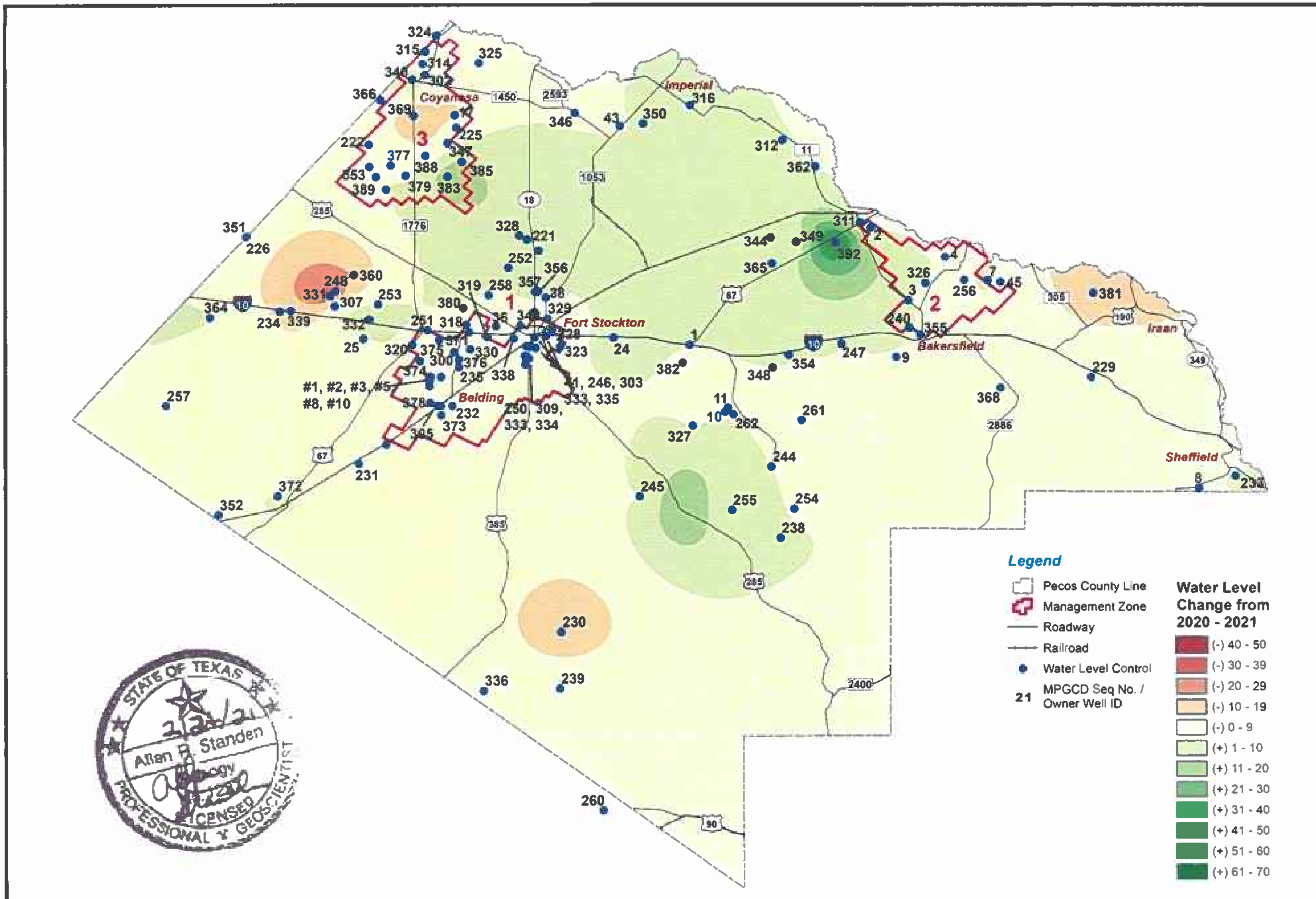


Water Level Decline/Gain from 2012 - 2022

Pecos County, Texas

Allan R. Standen LLC
Groundwater & Natural Resource Consulting

0 5 10 20 Miles
1:850,000
North American Datum 1983

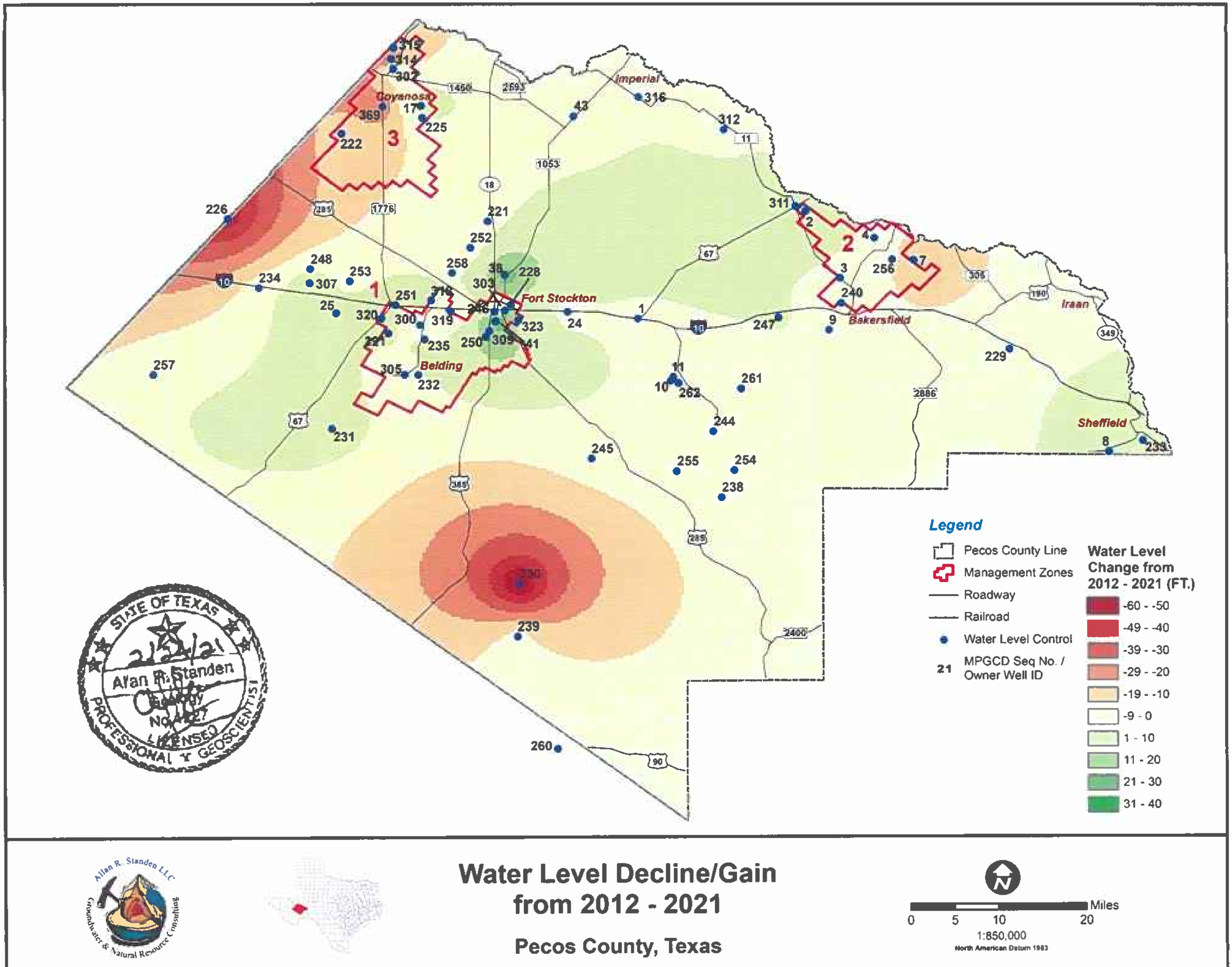


Allan R. Standen LLC
Groundwater & Natural Resource Consulting

Water Level Decline/Gain from 2020 - 2021

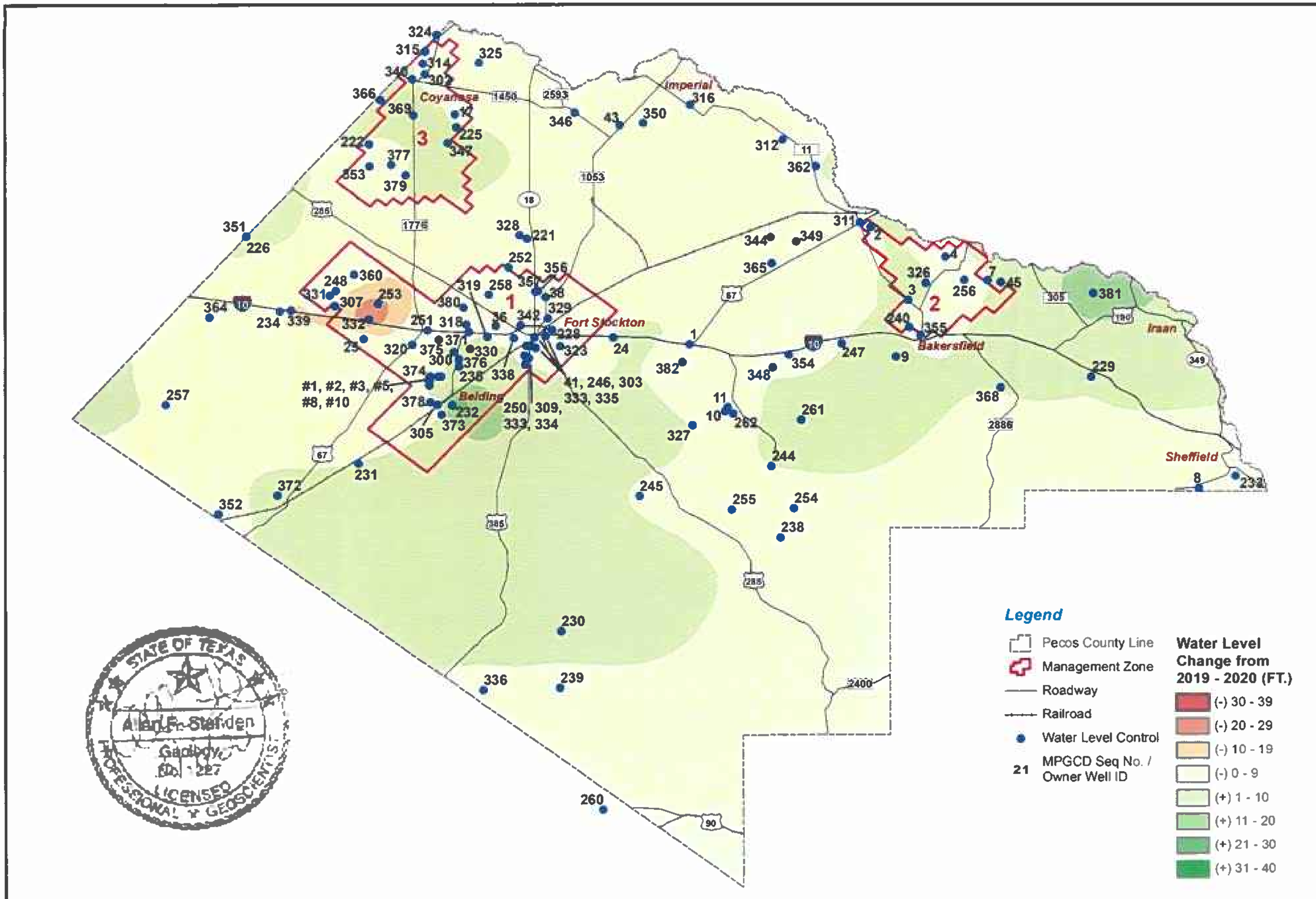
Pecos County, Texas

Miles
0 5 10 20
1:850,000
North American Datum 1983



Water Level Decline/Gain from 2012 - 2021

Pecos County, Texas

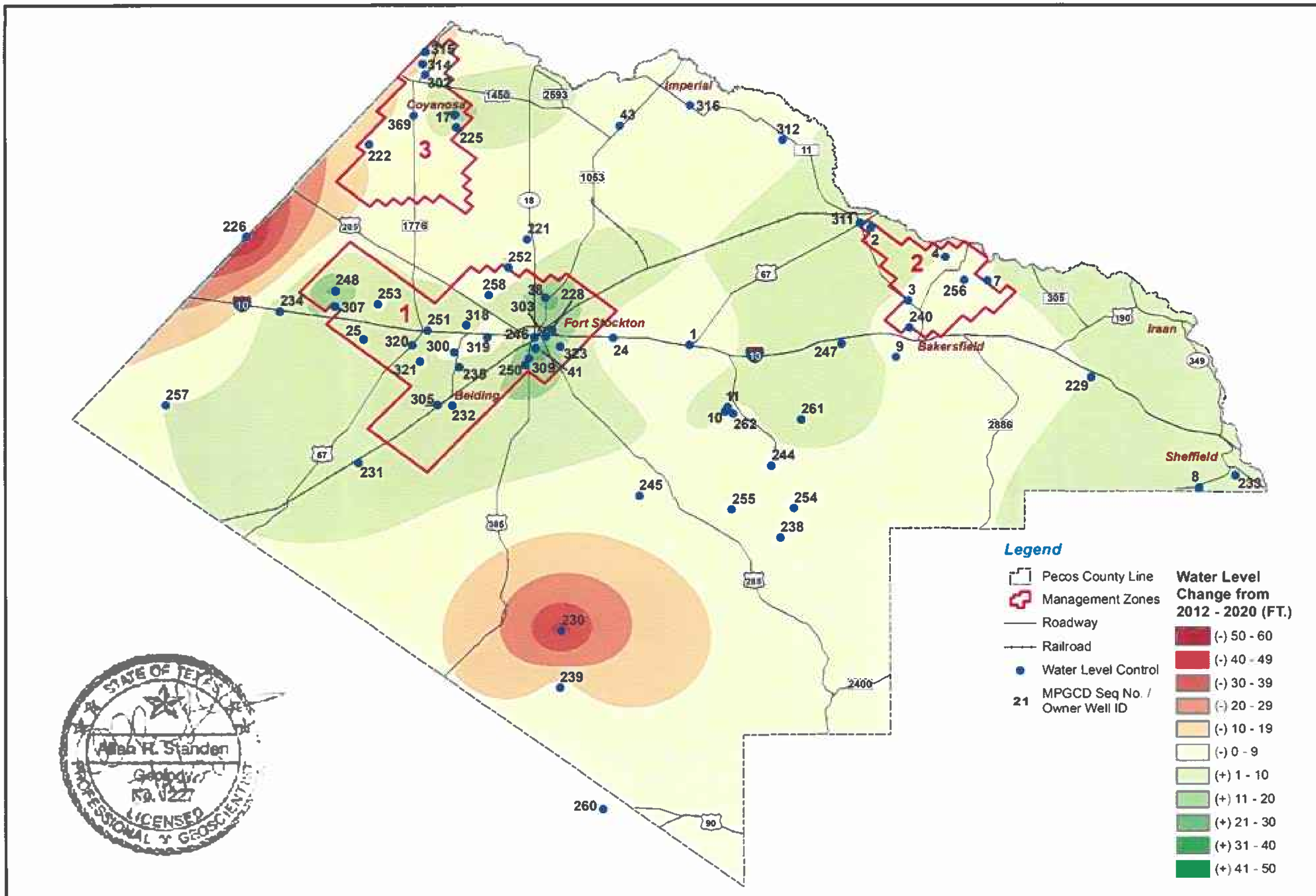


Water Level Decline/Gain from 2019 - 2020

Pecos County, Texas

Allan R. Standen LLC
Groundwater & Natural Resource Consulting

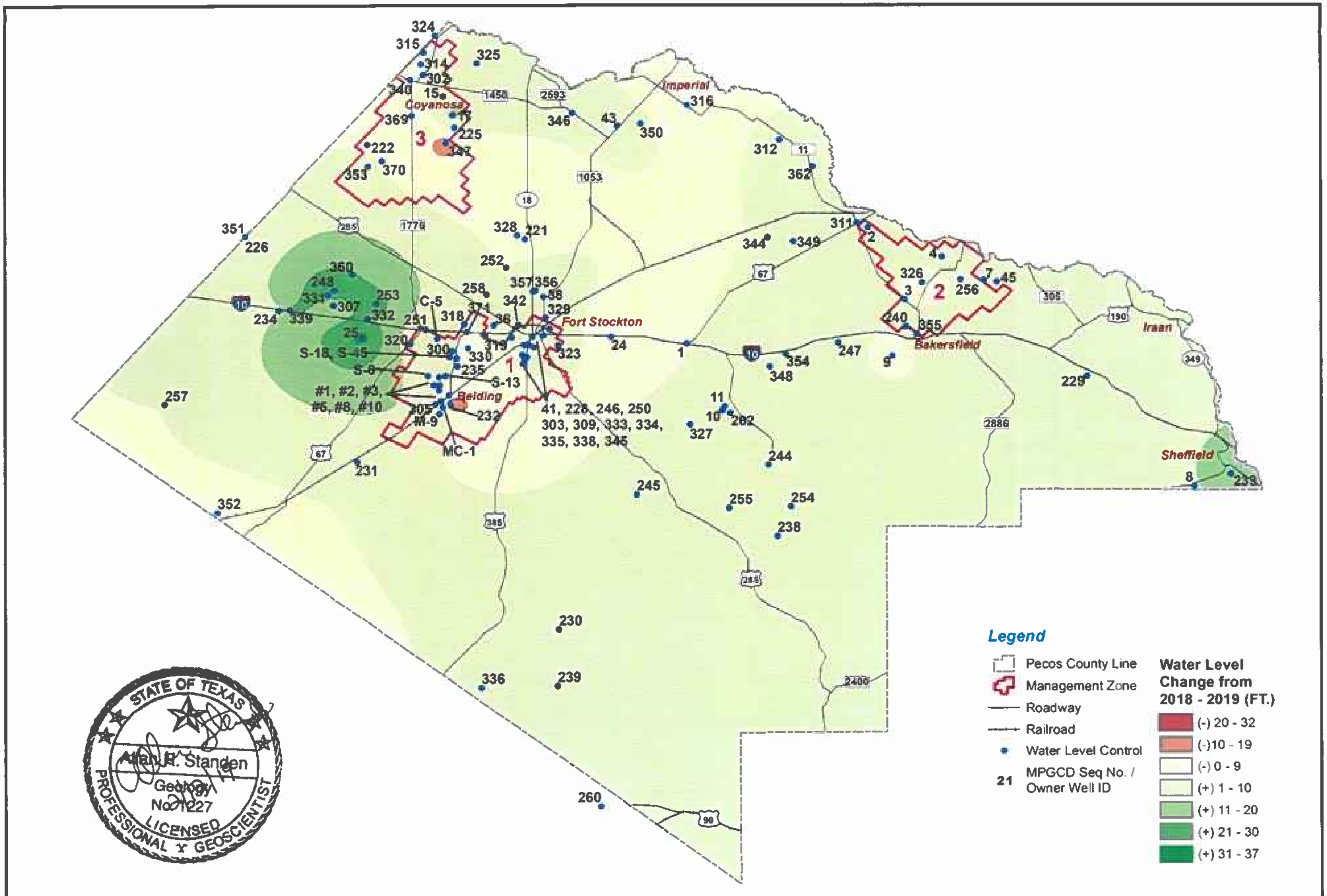
Miles
0 5 10 20
1:850,000
North American Datum 1983



Water Level Decline/Gain from 2012 - 2020

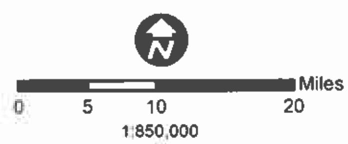
Pecos County, Texas

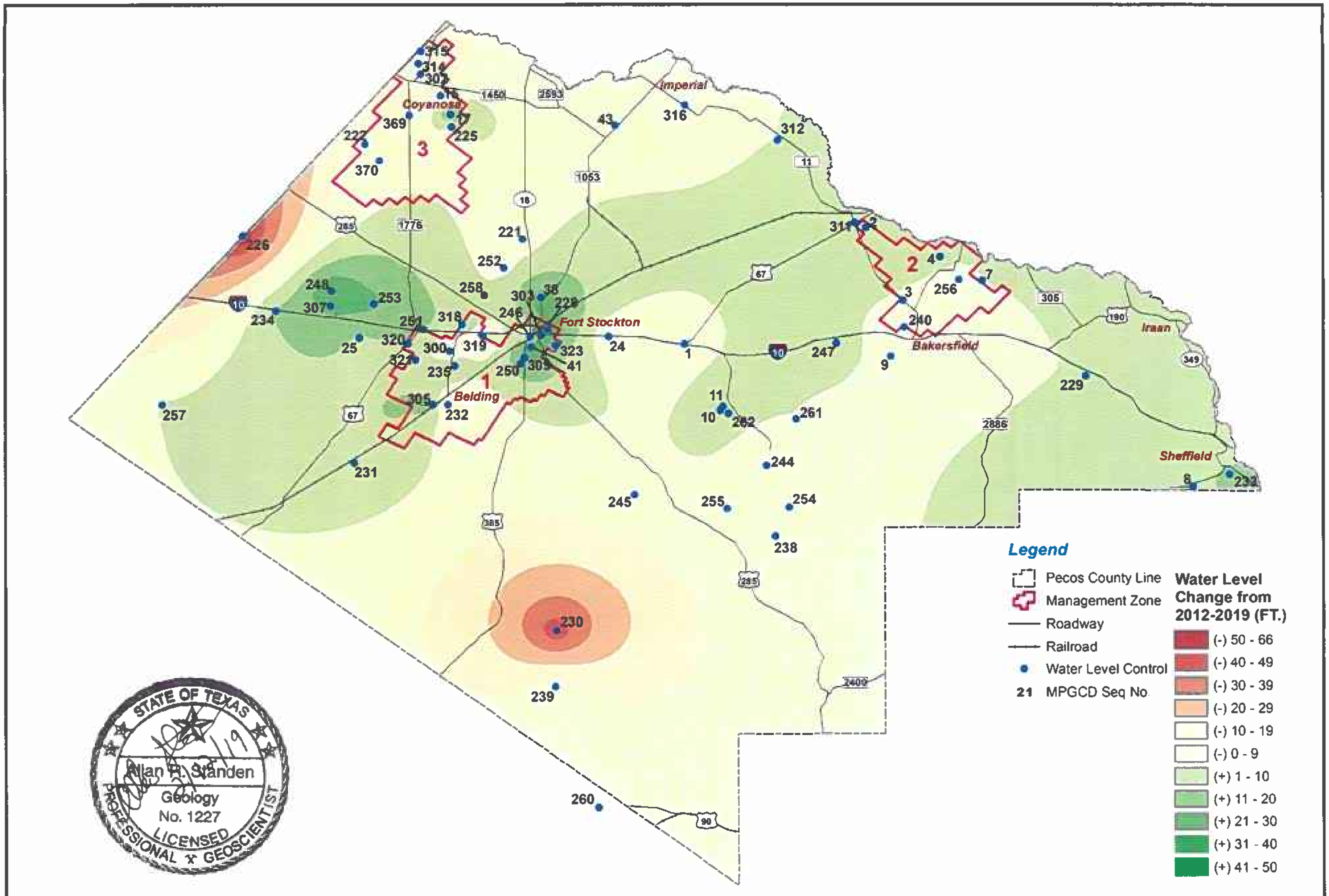
Miles
0 5 10 20
1:850,000
North American Datum 1983



Water Level Decline/Gain from 2018 - 2019

Pecos County, Texas



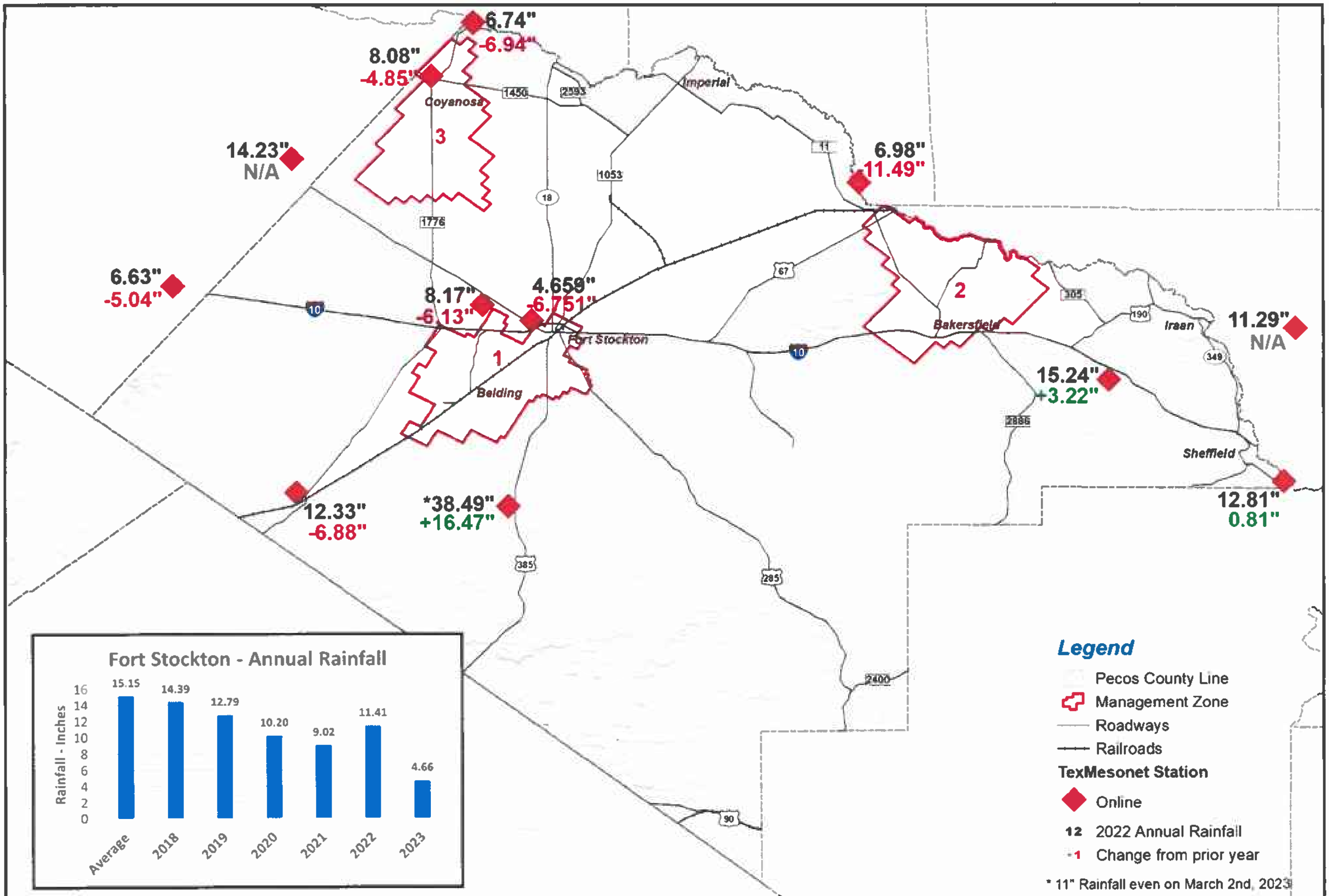


Allan R. Standen LLC
Groundwater & Natural Resource Consulting

Water Level Decline/Gain from 2012 - 2019

Pecos County, Texas

Miles
0 5 10 20
1:850,000
North American Datum 1983



LRE WATER

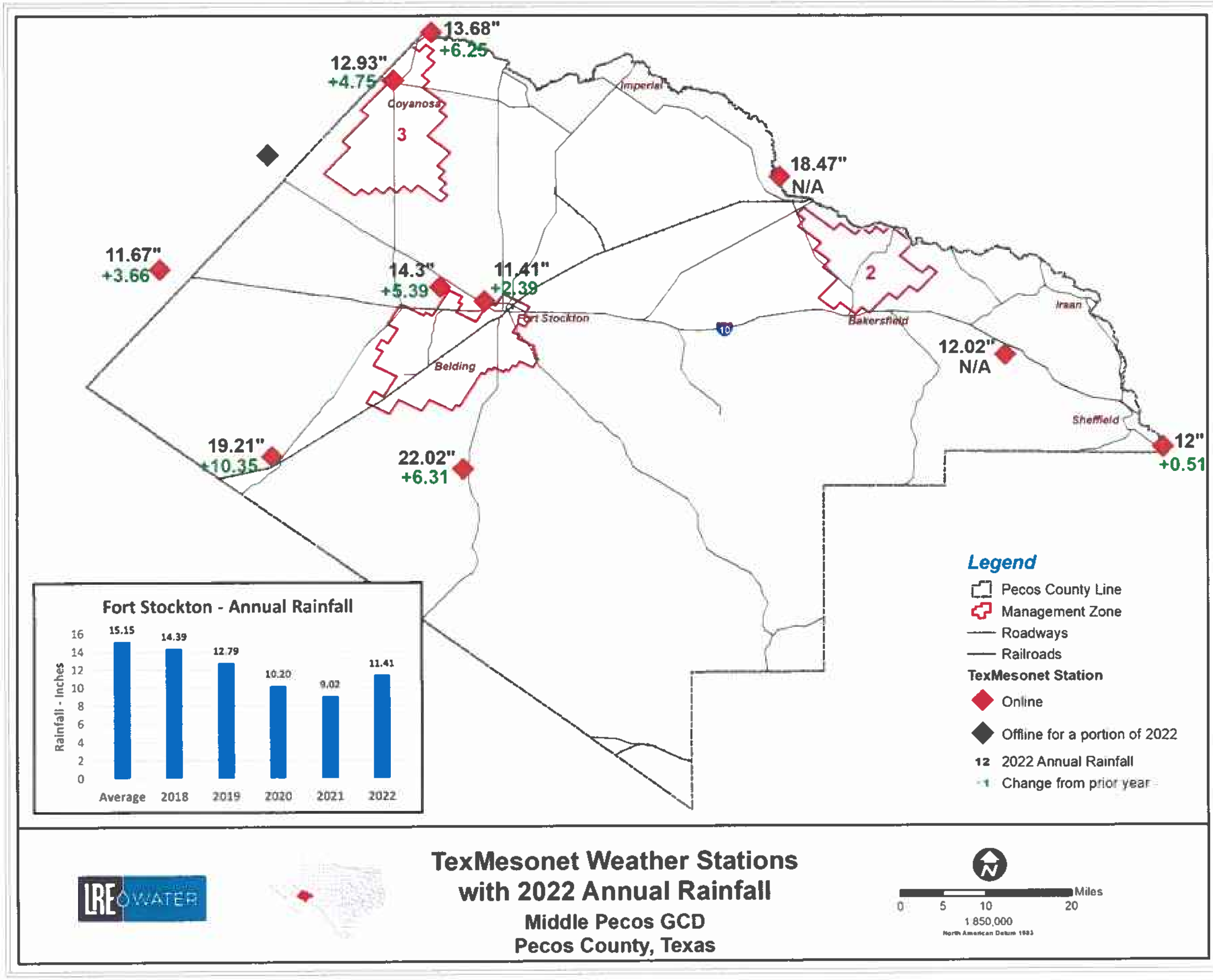
TexMesonet Weather Stations
Reported 2023 Annual Rainfall

Middle Pecos GCD

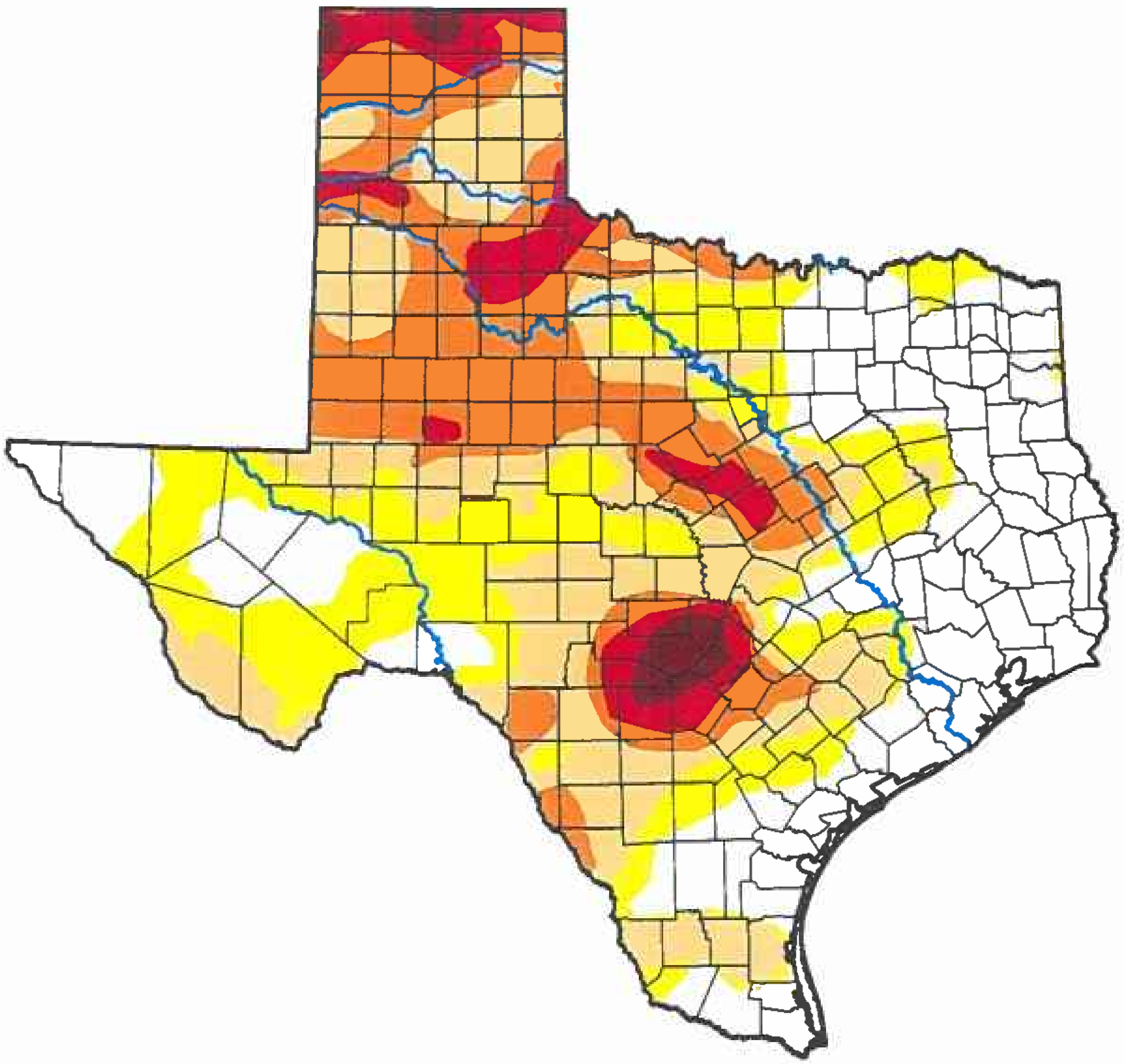
Pecos County, Texas

Miles
0 5 10 20
1:850,000
North American Datum 1983

Tex Mesonet Weather Station 2022 Rainfall



U.S. Drought Monitor
Texas



January 3, 2023
(Released Thursday, Jan. 5, 2023)
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	28.84	71.16	49.90	26.60	7.41	1.60
Last Week 12-27-2022	27.57	72.43	48.59	25.88	7.13	1.24
3 Months Ago 10-04-2022	10.94	89.06	71.07	43.13	14.01	1.63
Start of Calendar Year 01-03-2023	28.84	71.16	49.90	26.60	7.41	1.60
Start of Water Year 09-27-2022	14.96	85.04	61.36	31.61	8.82	1.06
One Year Ago 01-04-2022	7.58	92.42	79.83	54.25	16.69	0.00

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

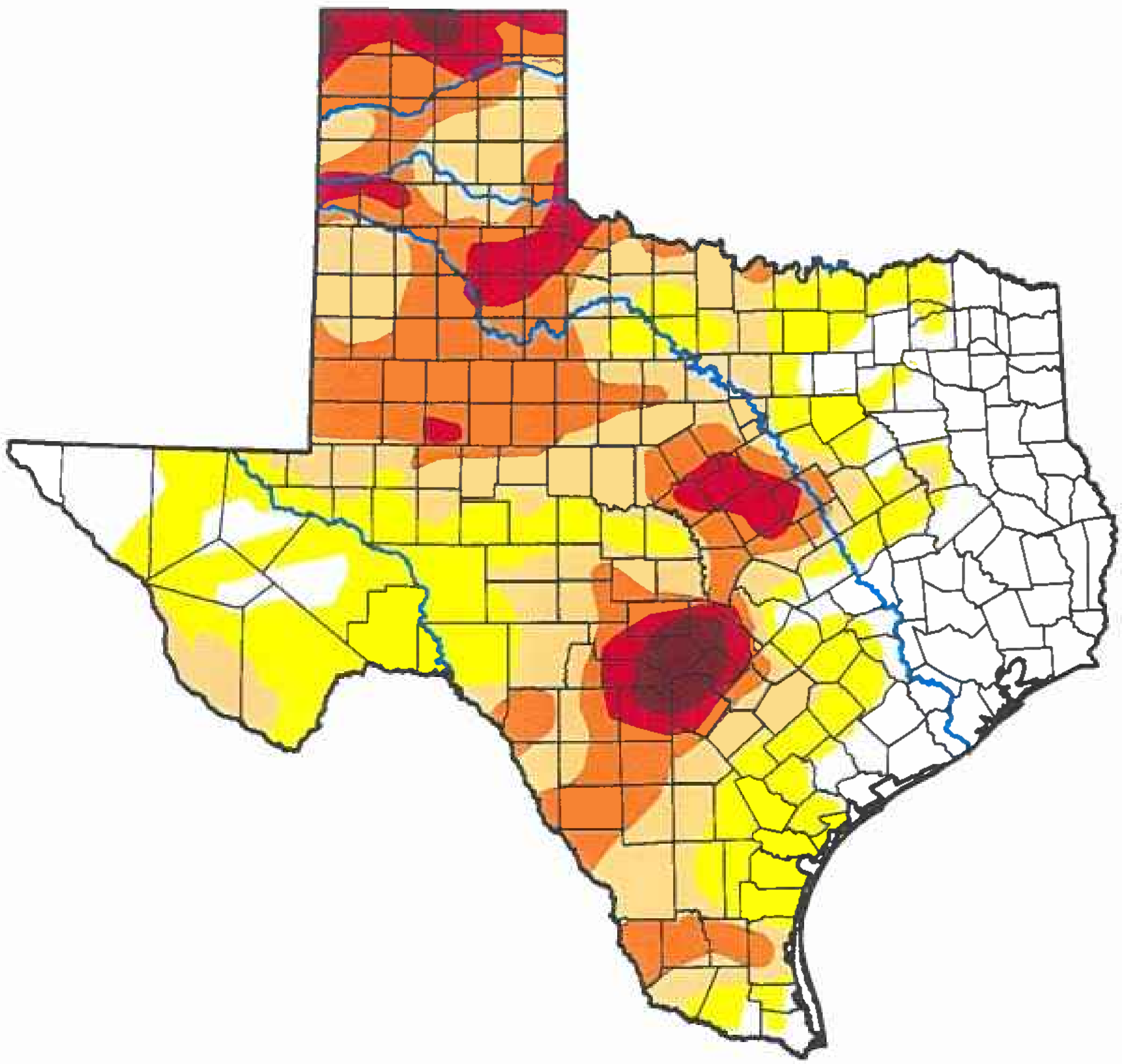
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:
Brad Pugh
CPC/NOAA

droughtmonitor.unl.edu

U.S. Drought Monitor
Texas

February 7, 2023
(Released Thursday, Feb. 9, 2023)
Valid 7 a.m. EST



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	21.63	78.37	53.15	28.67	7.89	1.82
Last Week *01-31-2023*	19.54	80.46	53.35	28.62	7.89	1.80
3 Months Ago *11-08-2022*	9.80	90.20	64.84	40.18	14.86	1.73
Start of Calendar Year *01-03-2023*	28.84	71.16	49.90	26.60	7.41	1.60
Start of Water Year *09-27-2022*	14.96	85.04	61.36	31.61	8.82	1.06
One Year Ago *02-08-2022*	11.83	88.17	78.09	55.00	23.88	0.00

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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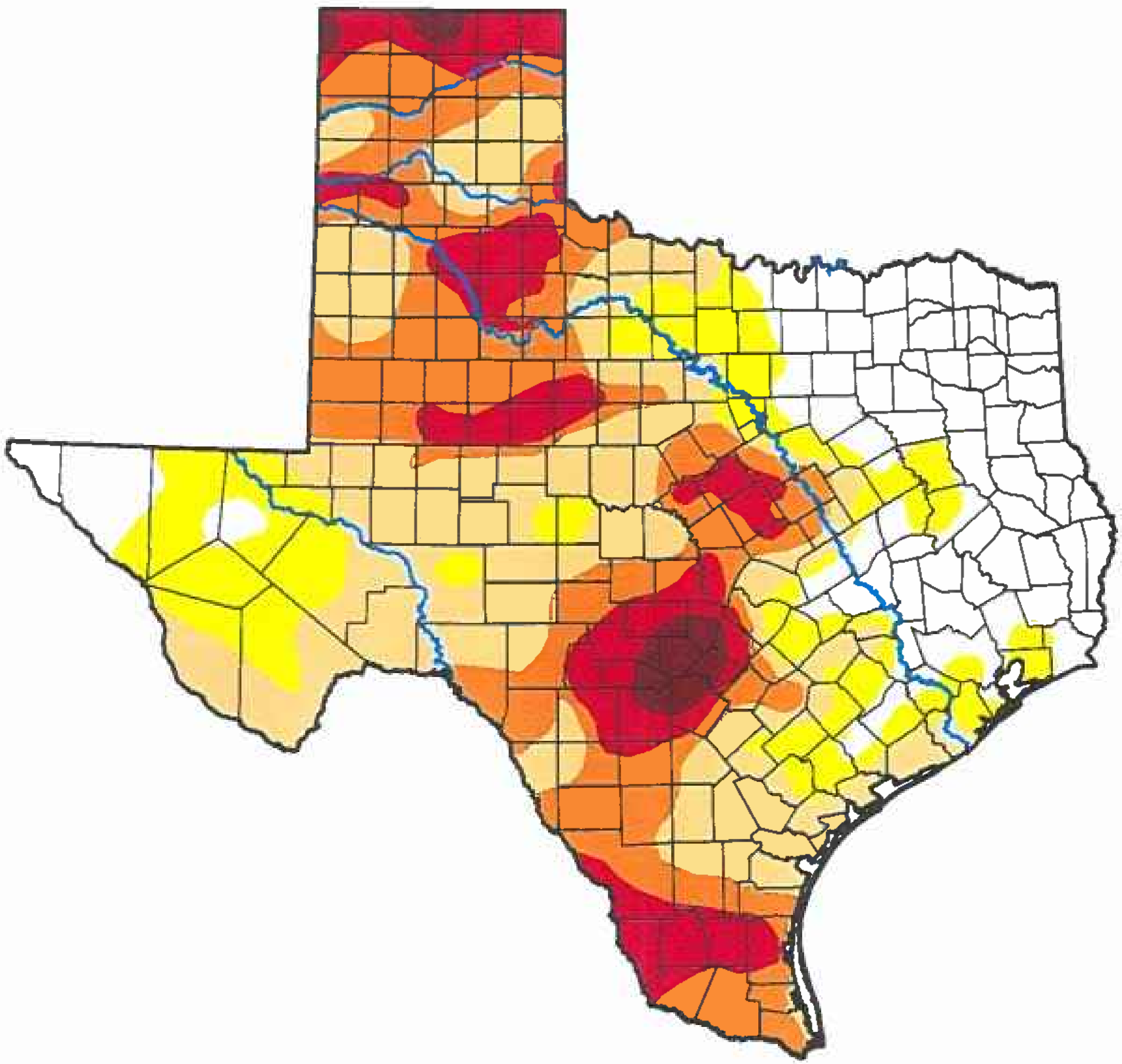
Author:

Brian Fuchs
National Drought Mitigation Center

droughtmonitor.unl.edu

U.S. Drought Monitor
Texas



March 7, 2023
(Released Thursday, Mar. 9, 2023)
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	20.52	79.48	64.01	35.54	13.41	1.84
Last Week 02-28-2023	21.85	78.15	62.21	32.63	12.27	1.84
3 Months Ago 12-06-2022	25.79	74.21	52.44	29.26	9.23	1.39
Start of Calendar Year 01-03-2023	28.84	71.16	49.90	26.60	7.41	1.60
Start of Water Year 09-27-2022	14.96	85.04	61.36	31.61	8.82	1.06
One Year Ago 03-08-2022	3.95	96.05	89.93	68.43	36.38	6.39

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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Author:
Deborah Bathke
National Drought Mitigation Center

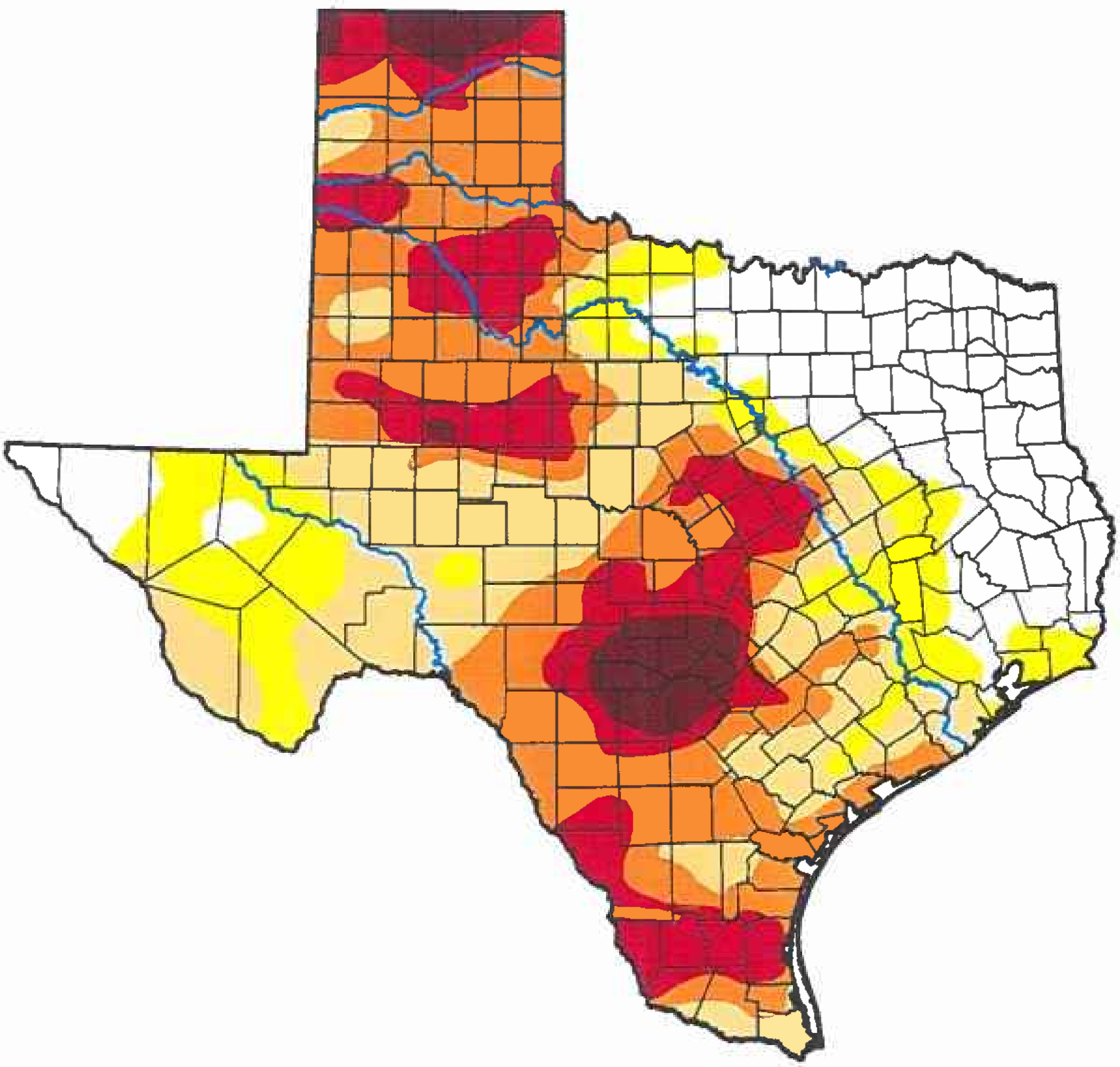
droughtmonitor.unl.edu

U.S. Drought Monitor
Texas

April 4, 2023

(Released Thursday, Apr. 6, 2023)

Valid 8 a.m. EDT



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	19.10	80.90	66.89	45.25	18.98	4.19
Last Week *03-28-2023*	19.12	80.88	67.24	46.39	17.33	3.78
3 Months Ago *01-03-2023*	28.84	71.16	49.90	26.60	7.41	1.60
Start of Calendar Year *01-03-2023*	28.84	71.16	49.90	26.60	7.41	1.60
Start of Water Year *09-27-2022*	14.96	85.04	61.36	31.61	8.82	1.06
One Year Ago *04-05-2022*	4.95	95.05	84.73	71.45	40.56	9.78

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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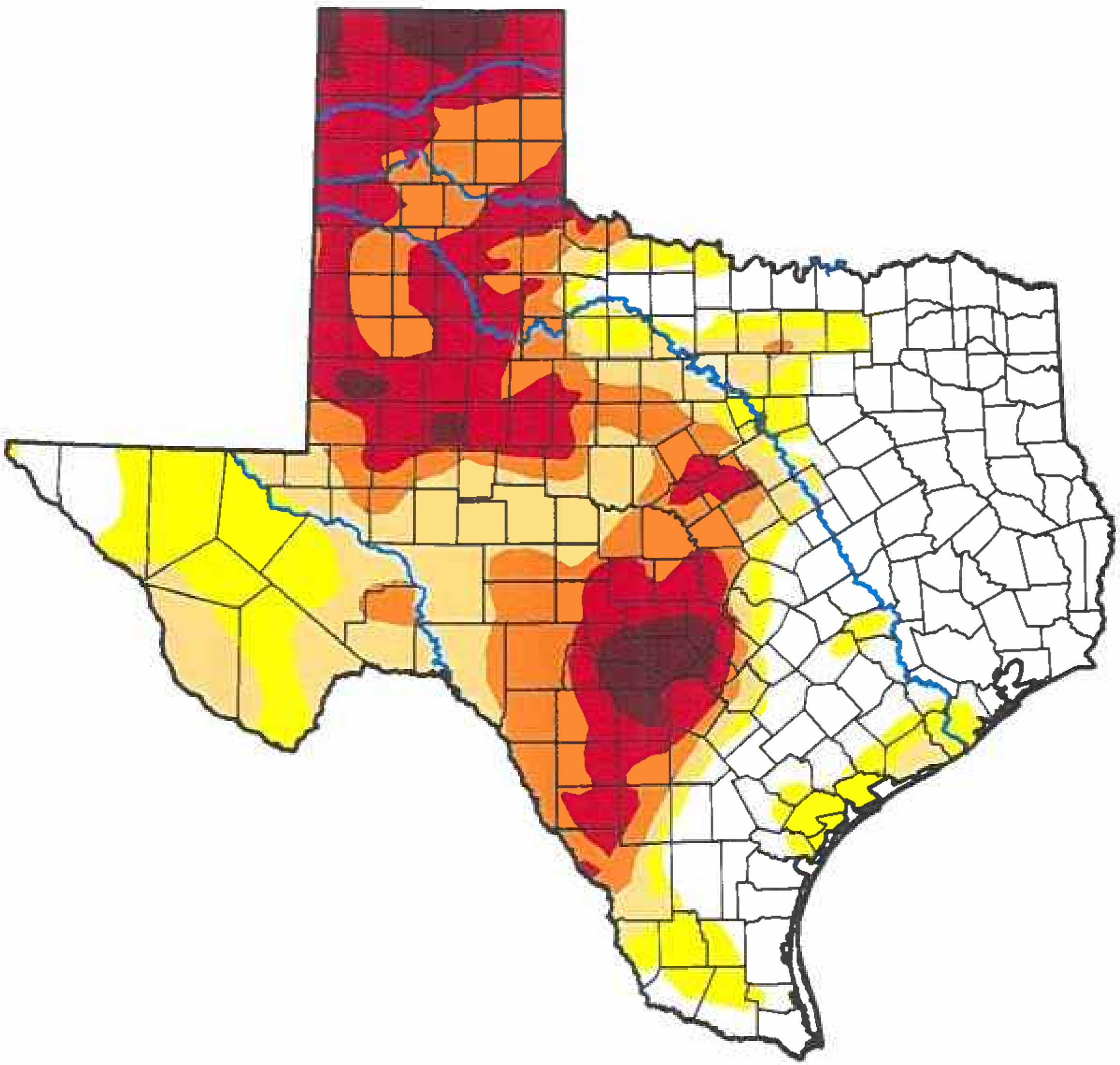
Author:

David Simeral
Western Regional Climate Center

droughtmonitor.unl.edu

U.S. Drought Monitor
Texas

May 2, 2023
(Released Thursday, May. 4, 2023)
Valid 8 a.m. EDT



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	31.81	68.19	53.66	37.73	20.66	3.37
Last Week *04-25-2023*	26.78	73.22	55.32	38.21	16.58	3.50
3 Months Ago *01-31-2023*	19.54	80.46	53.35	28.62	7.89	1.80
Start of Calendar Year *01-03-2023*	28.84	71.16	49.90	26.60	7.41	1.60
Start of Water Year *09-27-2022*	14.96	85.04	61.36	31.61	8.82	1.06
One Year Ago *05-03-2022*	8.83	91.17	80.02	67.29	50.91	23.19

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

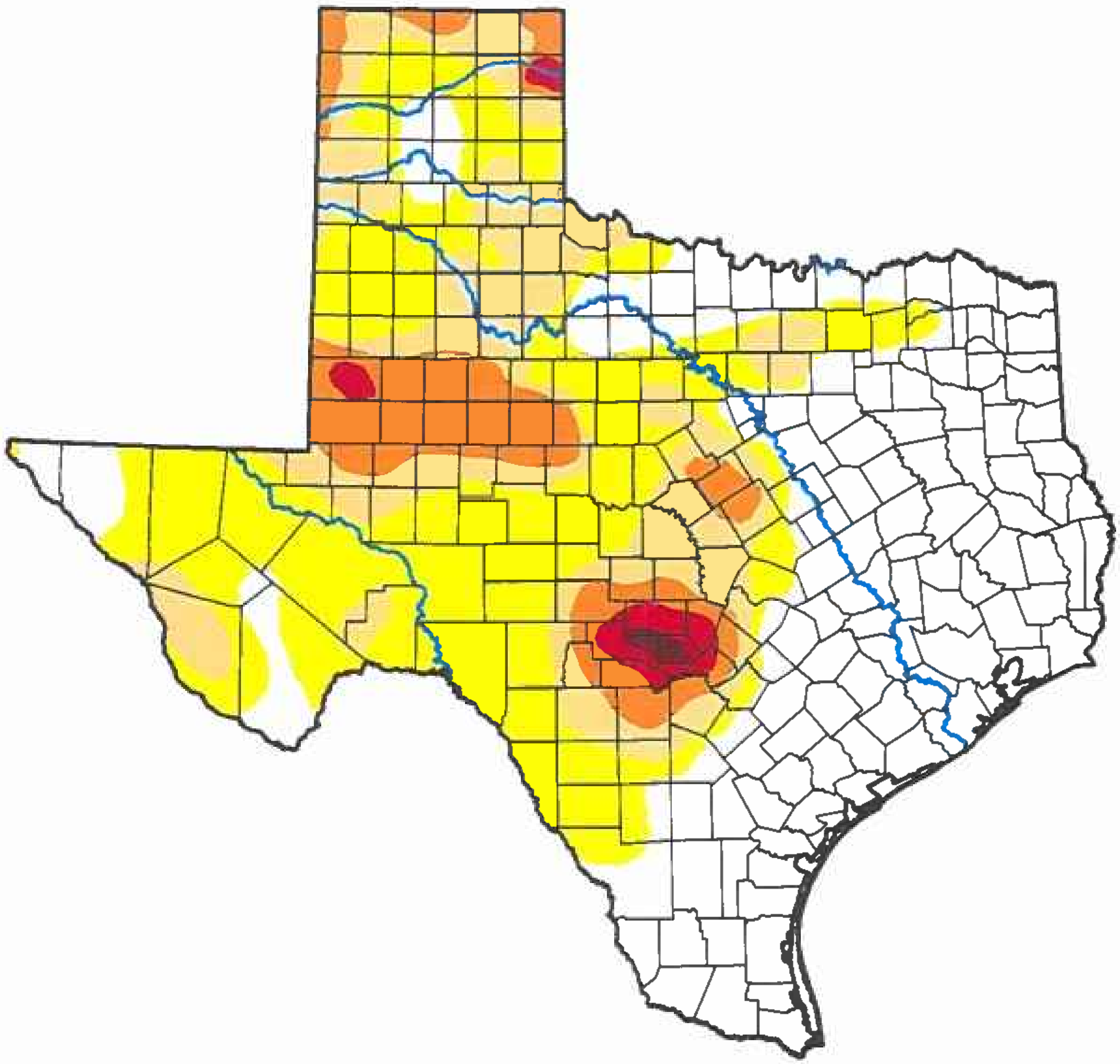
Author:

Brad Pugh
CPC/NOAA

droughtmonitor.unl.edu

U.S. Drought Monitor
Texas

June 6, 2023
(Released Thursday, Jun. 8, 2023)
Valid 8 a.m. EDT



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	41.15	58.85	27.63	10.45	1.79	0.29
Last Week *05-30-2023*	39.95	60.05	33.52	16.16	4.71	0.29
3 Months Ago *03-07-2023*	20.52	79.48	64.01	35.54	13.41	1.84
Start of Calendar Year *01-03-2023*	28.84	71.16	49.90	26.60	7.41	1.60
Start of Water Year *09-27-2022*	14.96	85.04	61.36	31.61	8.82	1.06
One Year Ago *06-07-2022*	11.75	88.25	78.81	64.99	40.11	15.60

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:
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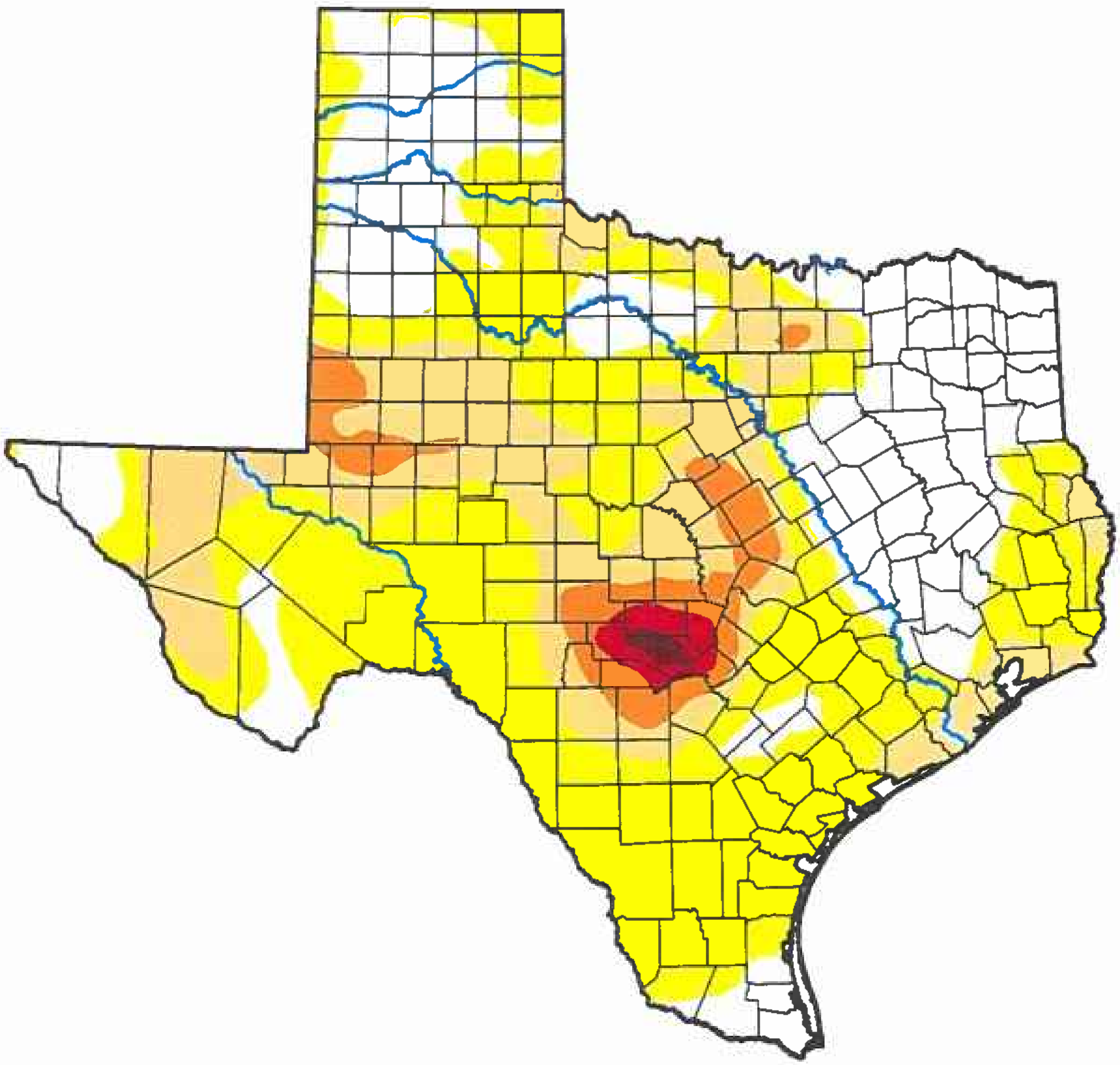
National Drought Mitigation Center

droughtmonitor.unl.edu

U.S. Drought Monitor
Texas

July 4, 2023
(Released Thursday, Jul. 6, 2023)
Valid 8 a.m. EDT



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	27.86	72.14	27.25	6.64	1.37	0.29
Last Week *06-27-2023*	30.71	69.29	24.38	6.05	1.37	0.29
3 Months Ago *04-04-2023*	19.10	80.90	66.89	45.25	18.98	4.19
Start of Calendar Year *01-03-2023*	28.84	71.16	49.90	26.60	7.41	1.60
Start of Water Year *09-27-2022*	14.96	85.04	61.36	31.61	8.82	1.06
One Year Ago *07-05-2022*	2.47	97.53	86.79	66.05	45.91	16.11

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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Author:
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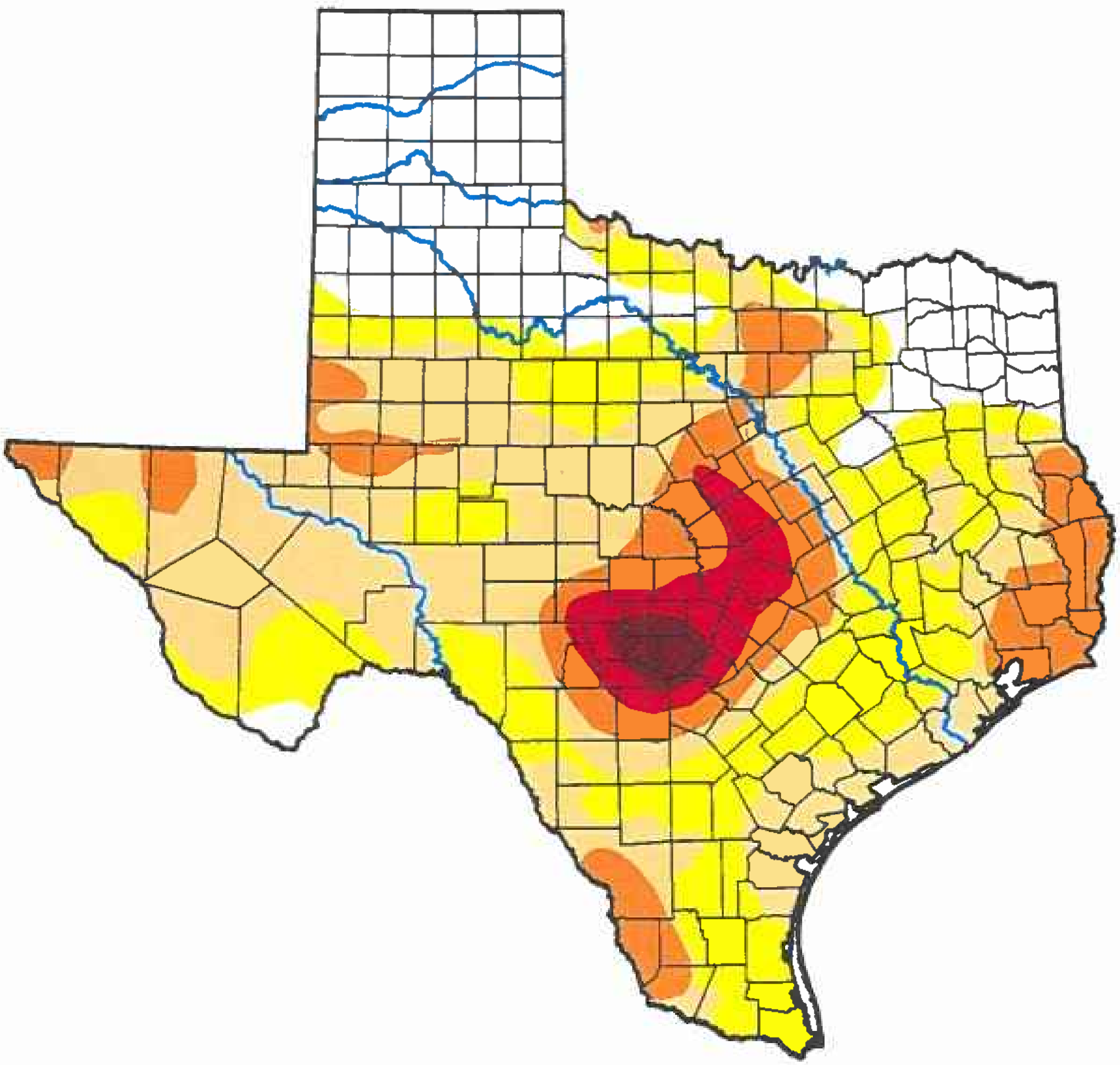
droughtmonitor.unl.edu

U.S. Drought Monitor
Texas

August 1, 2023
(Released Thursday, Aug. 3, 2023)
Valid 8 a.m. EDT



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	21.20	78.80	52.09	19.26	4.81	1.06
Last Week *07-25-2023*	21.67	78.33	48.61	18.01	4.81	1.06
3 Months Ago *05-02-2023*	31.81	68.19	53.66	37.73	20.66	3.37
Start of Calendar Year *01-03-2023*	28.84	71.16	49.90	26.60	7.41	1.60
Start of Water Year *09-27-2022*	14.96	85.04	61.36	31.61	8.82	1.06
One Year Ago *08-02-2022*	0.82	99.18	97.11	87.92	61.86	21.31

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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Author:

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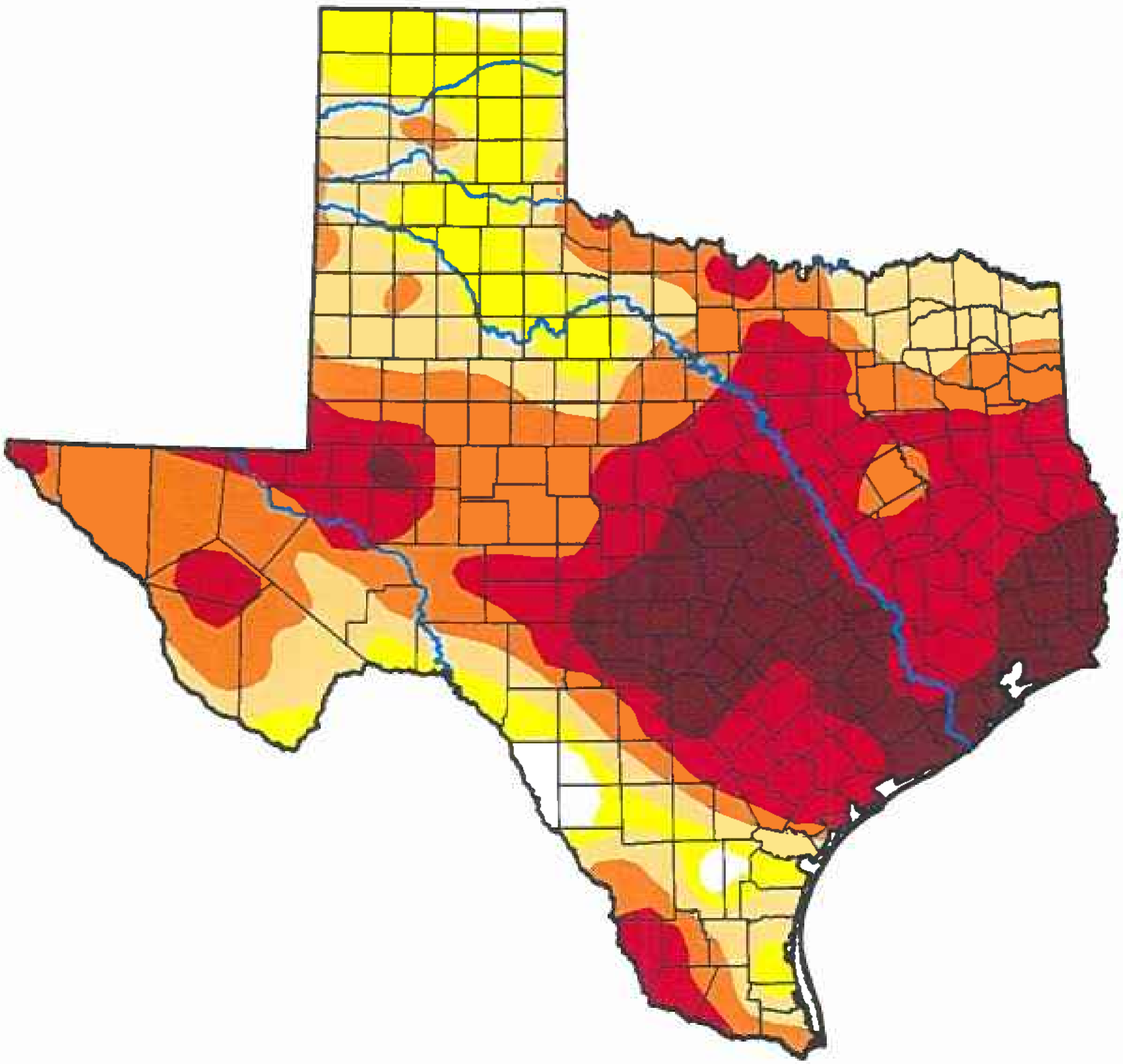
U.S. Drought Monitor
Texas



September 5, 2023
(Released Thursday, Sep. 7, 2023)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	1.61	98.39	85.68	66.45	40.53	14.76
Last Week *08-29-2023*	1.55	98.45	75.83	61.41	32.33	12.64
3 Months Ago *06-06-2023*	41.15	58.85	27.63	10.45	1.79	0.29
Start of Calendar Year *01-03-2023*	28.84	71.16	49.90	26.60	7.41	1.60
Start of Water Year *09-27-2022*	14.96	85.04	61.36	31.61	8.82	1.06
One Year Ago *09-06-2022*	20.57	79.43	62.32	33.57	9.26	0.90

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:

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CPC/NOAA/NWS/NCEP

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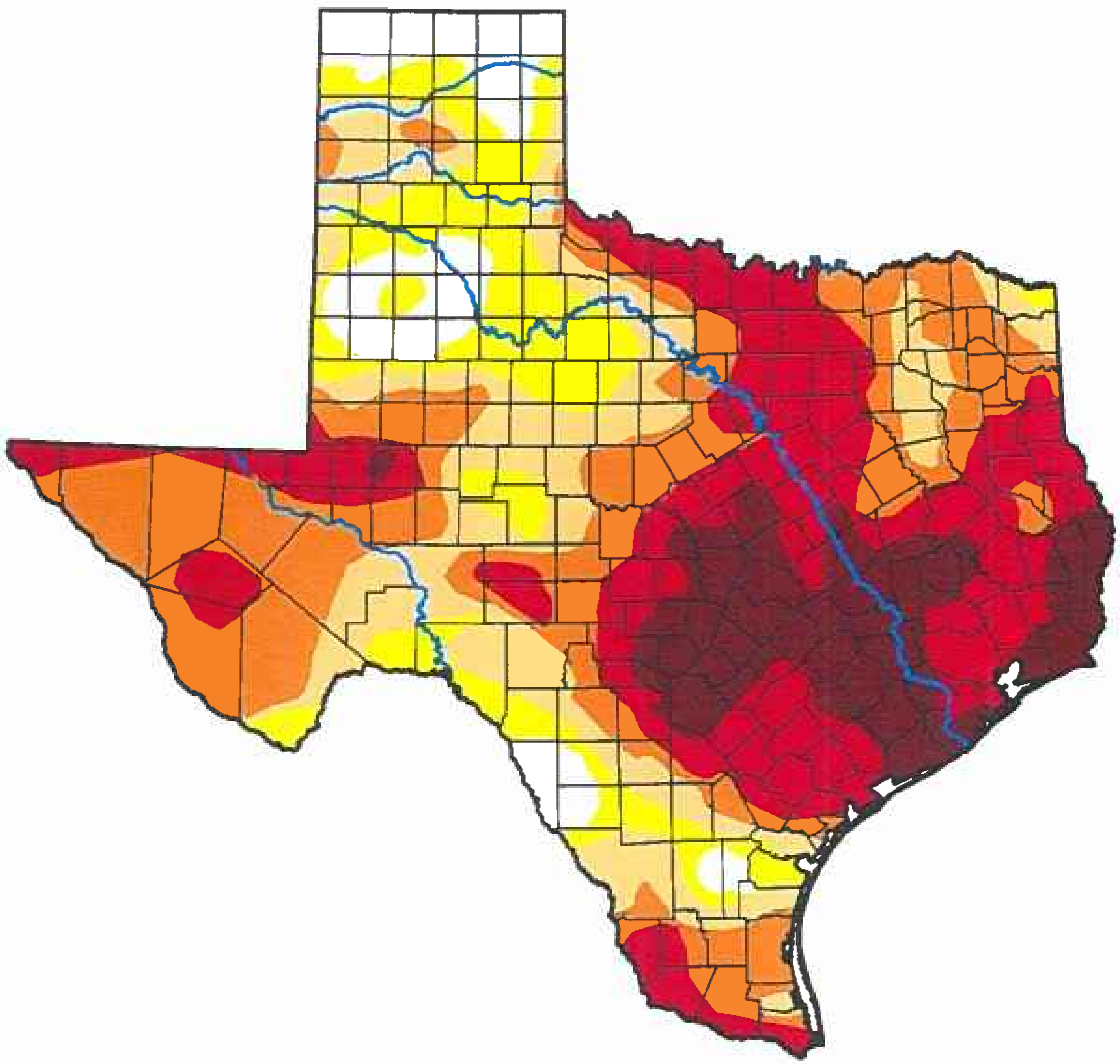
U.S. Drought Monitor
Texas

October 3, 2023
(Released Thursday, Oct. 5, 2023)
Valid 8 a.m. EDT



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	6.88	93.12	79.86	61.97	37.15	12.78
Last Week *09-26-2023*	3.03	96.97	80.64	59.66	38.06	12.68
3 Months Ago *07-04-2023*	27.86	72.14	27.25	6.64	1.37	0.29
Start of Calendar Year *01-03-2023*	28.84	71.16	49.90	26.60	7.41	1.60
Start of Water Year *09-26-2023*	3.03	96.97	80.64	59.66	38.06	12.68
One Year Ago *10-04-2022*	10.94	89.06	71.07	43.13	14.01	1.63

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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Author:
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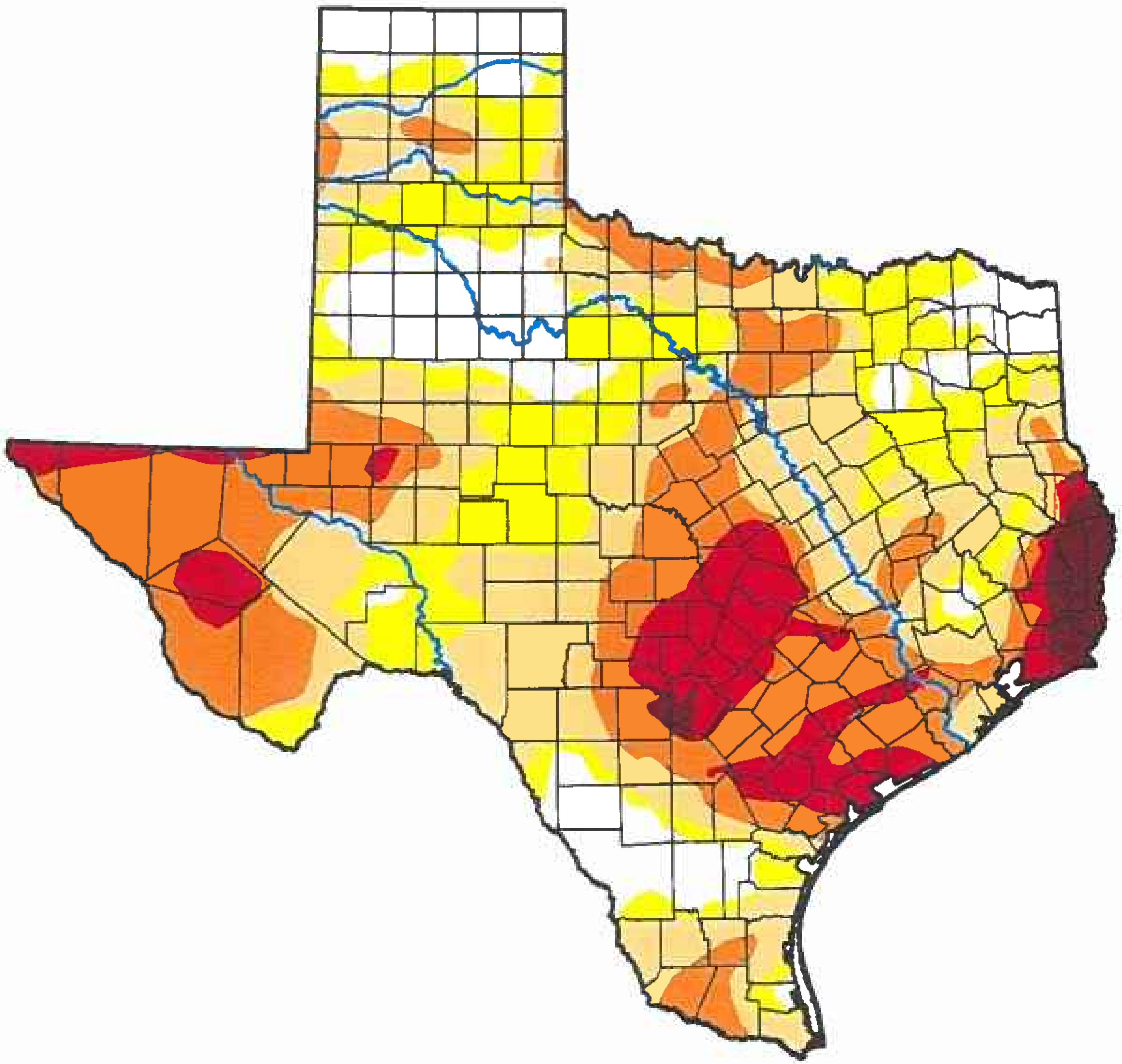
U.S. Drought Monitor
Texas

November 7, 2023
(Released Thursday, Nov. 9, 2023)
Valid 7 a.m. EST



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	13.62	86.38	65.36	35.90	10.88	1.86
Last Week *10-31-2023*	13.61	86.39	65.37	38.54	10.94	1.78
3 Months Ago *08-08-2023*	13.97	86.03	68.76	34.27	7.87	1.18
Start of Calendar Year *01-03-2023*	28.84	71.16	49.90	26.60	7.41	1.60
Start of Water Year *09-26-2023*	3.03	96.97	80.64	59.66	38.06	12.68
One Year Ago *11-08-2022*	9.80	90.20	64.84	40.18	14.86	1.73

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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Author:
Lindsay Johnson
National Drought Mitigation Center

droughtmonitor.unl.edu

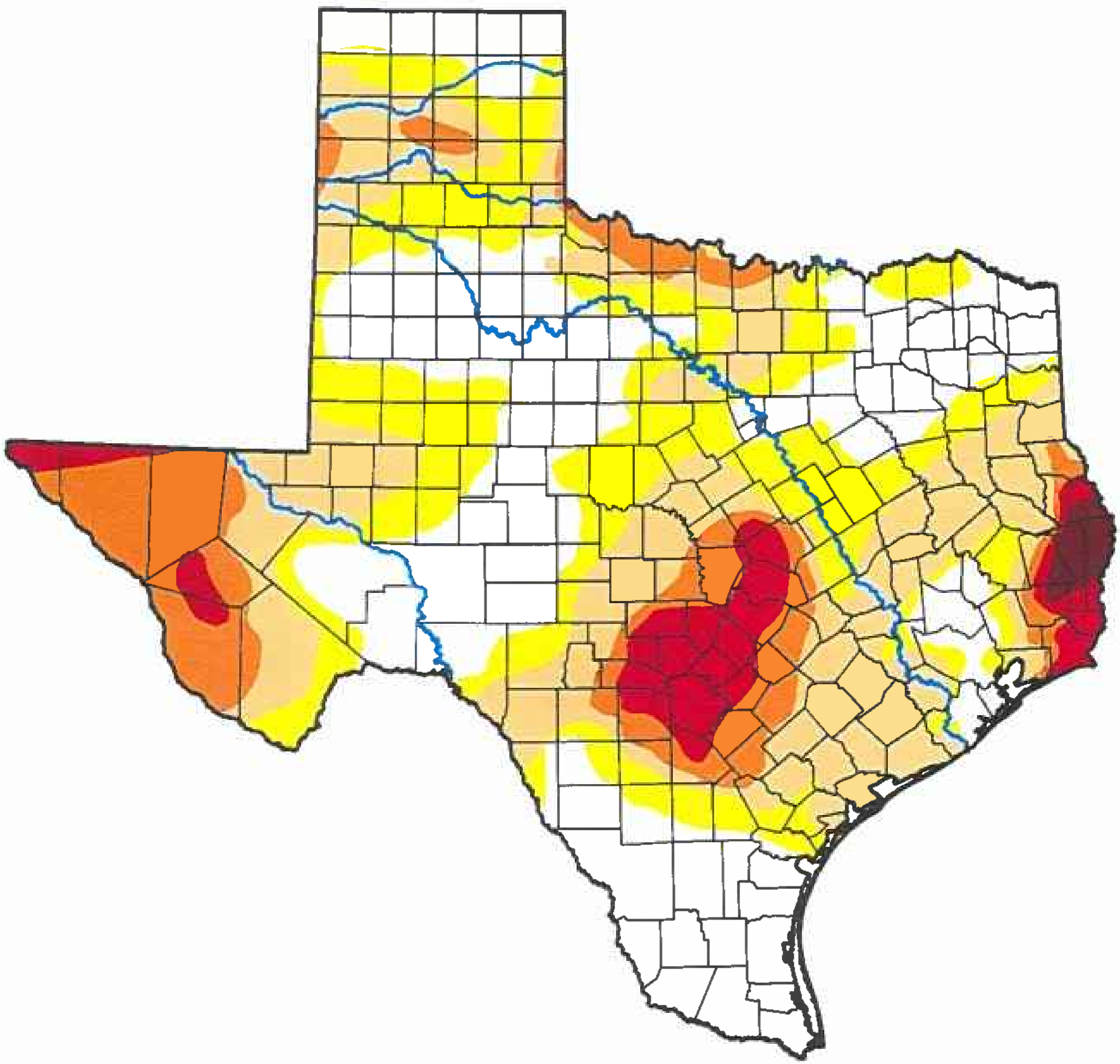
U.S. Drought Monitor

Texas

December 12, 2023

(Released Thursday, Dec. 14, 2023)

Valid 7 a.m. EST



Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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Author:

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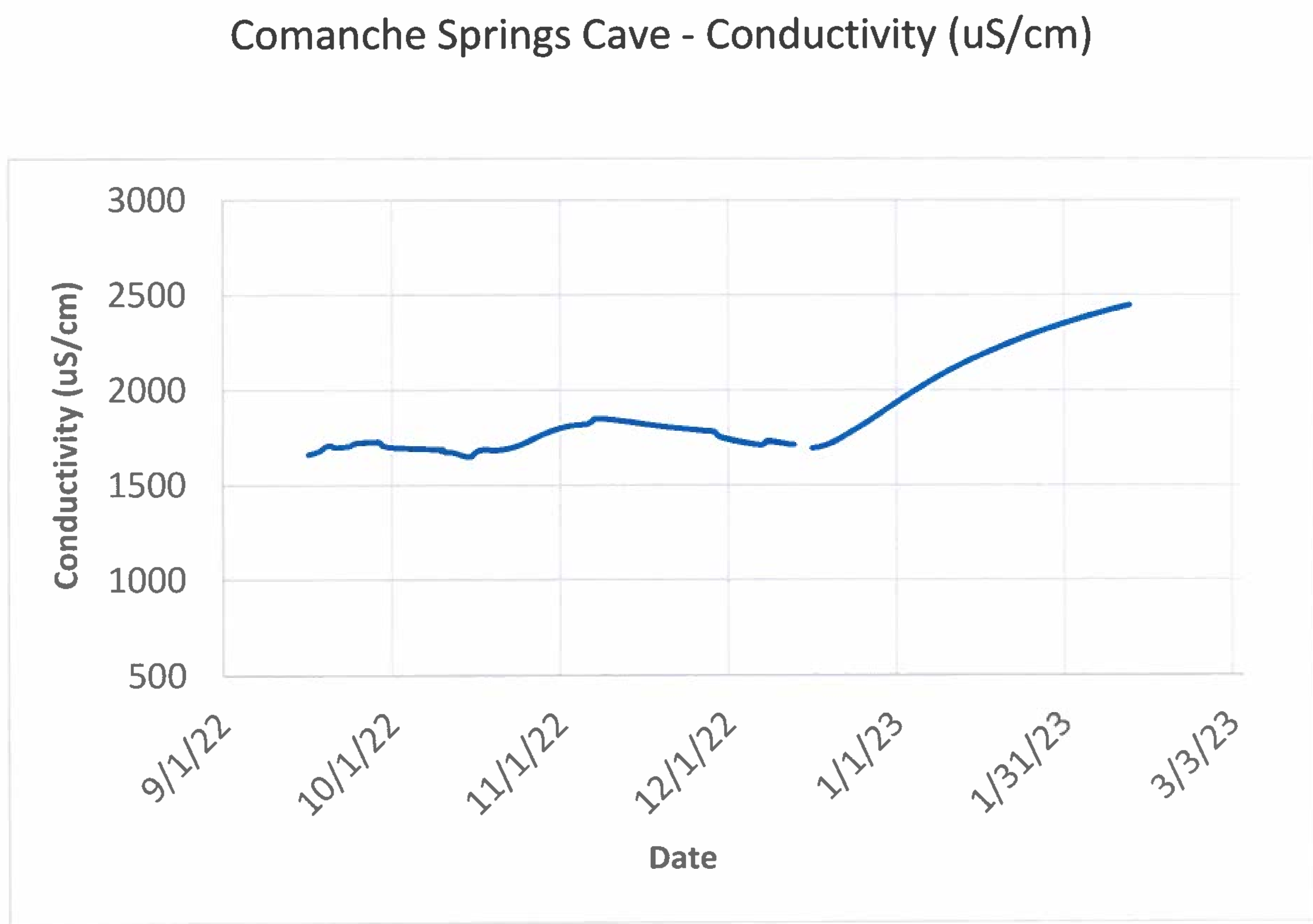
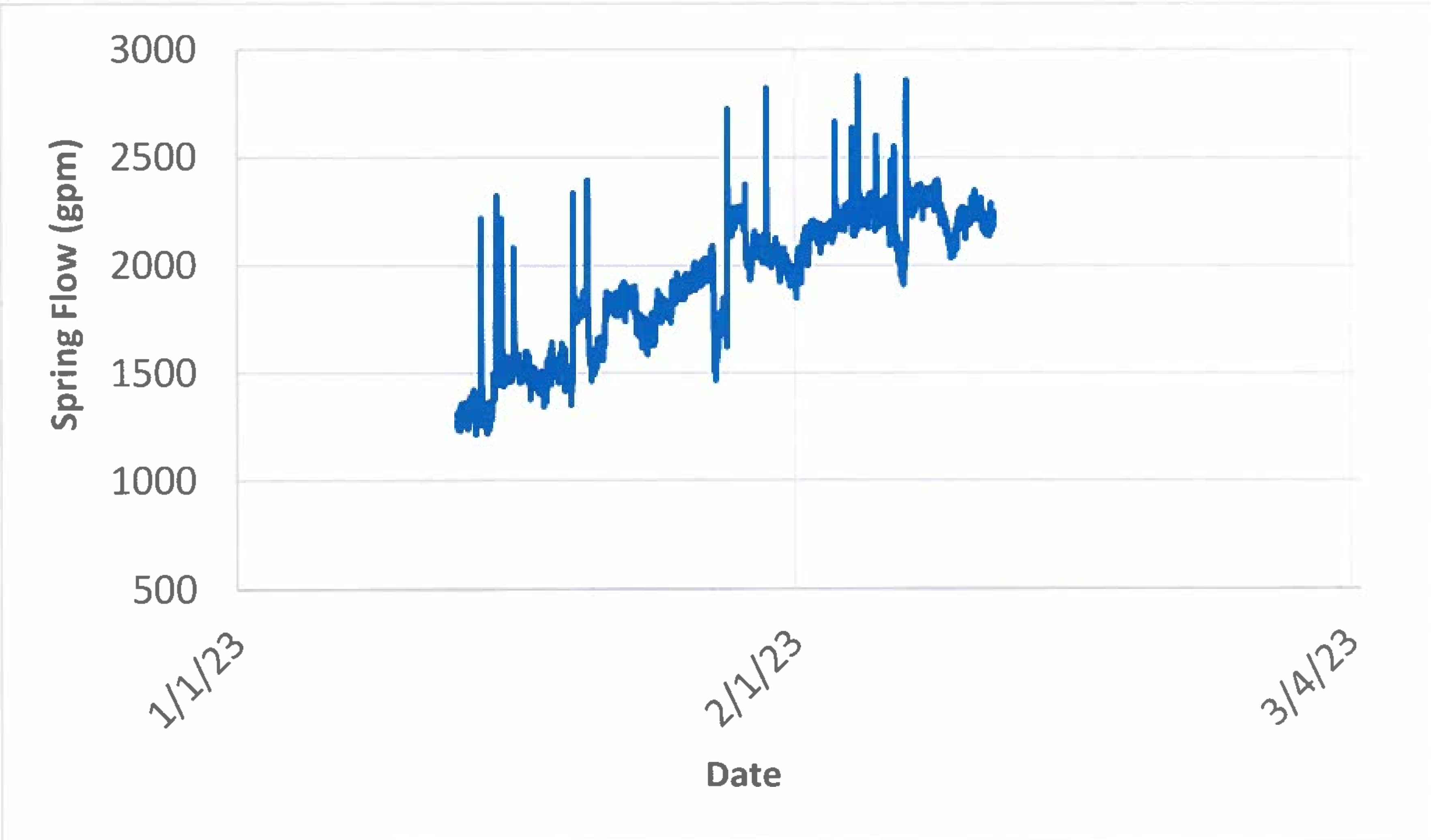
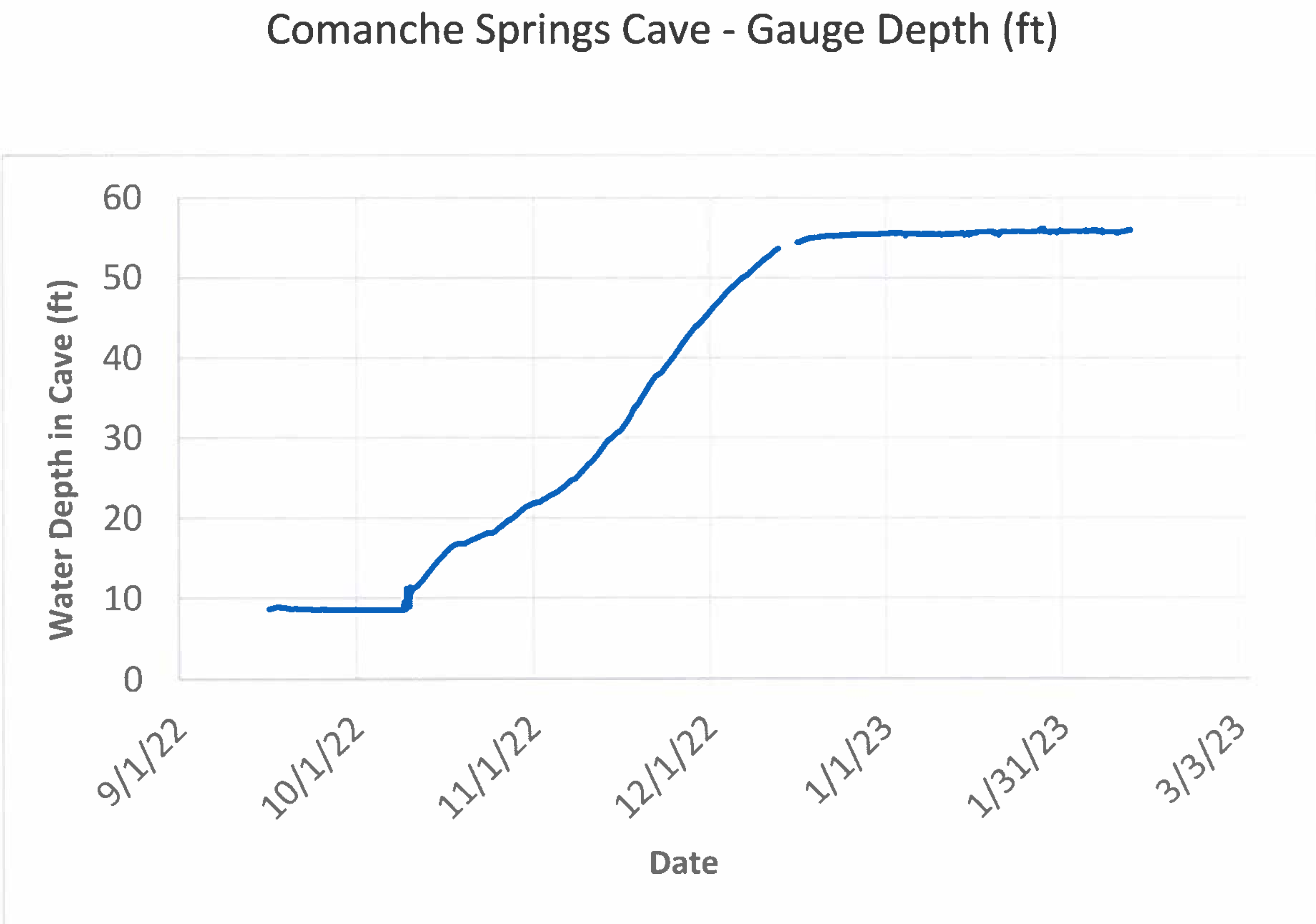


Comanche Springs Cave - Conductivity (uS/cm)
3000
2500
2000
1500
1000
500
Conductivity (uS/cm)
9/1/22
10/1/22
11/1/22
12/1/22
1/1/23
1/31/23
3/3/23
Date

Comanche Springs - Flow (gpm)

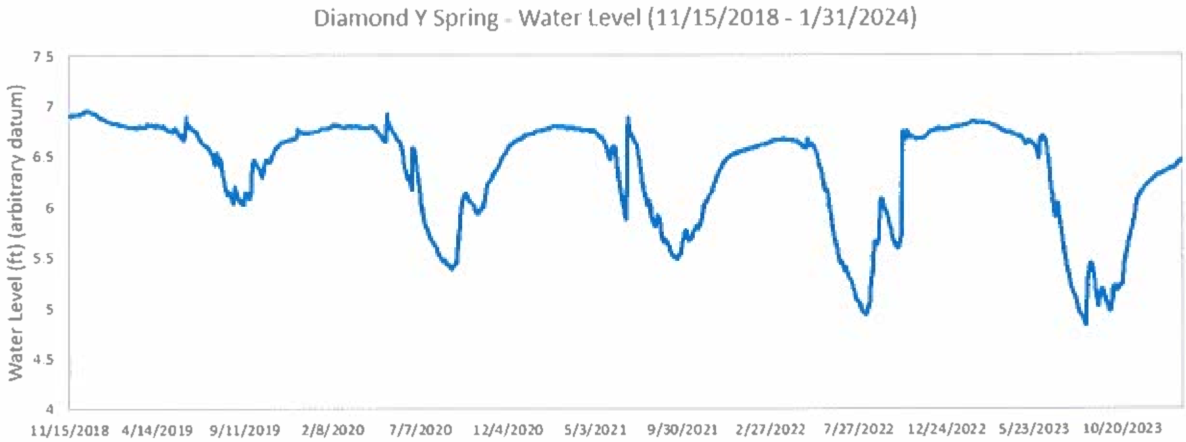


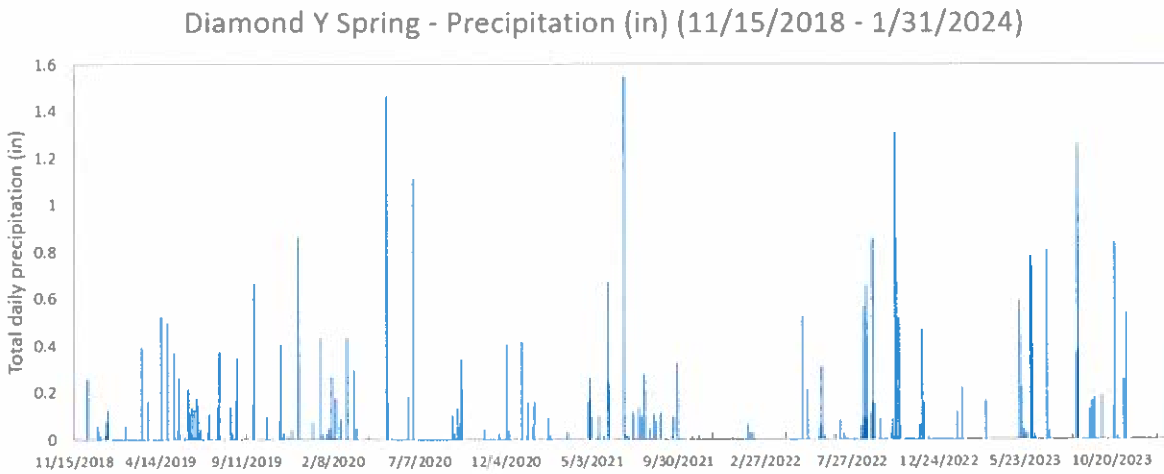


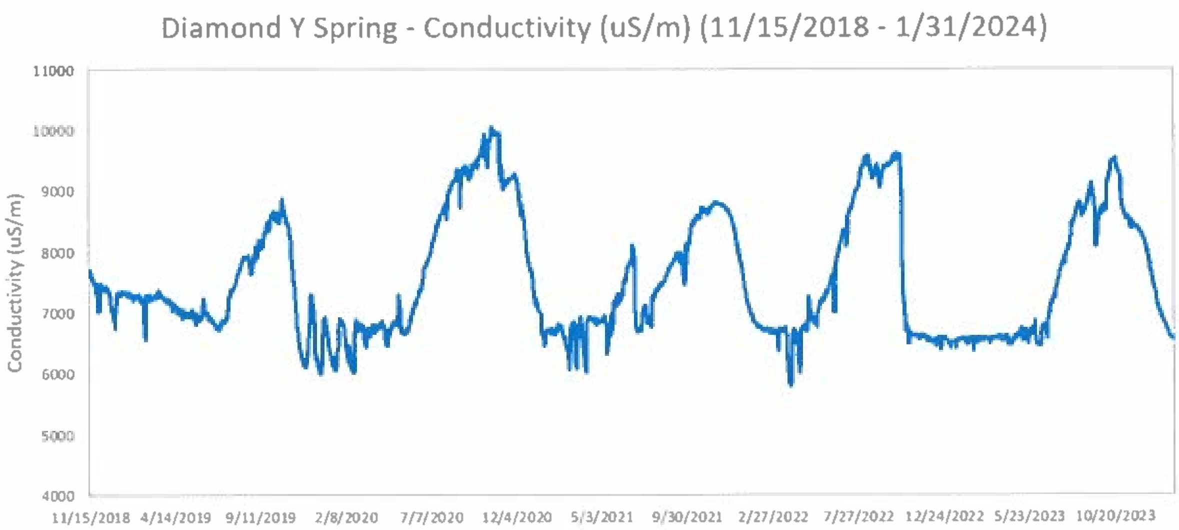
Comanche Springs Cave - Gauge Depth (ft)
Water Depth in Cave (ft)
60
50
40
30
20
10
0
9/1/22
10/1/22
11/1/22
12/1/22
1/1/23
1/31/23
3/3/23
Date

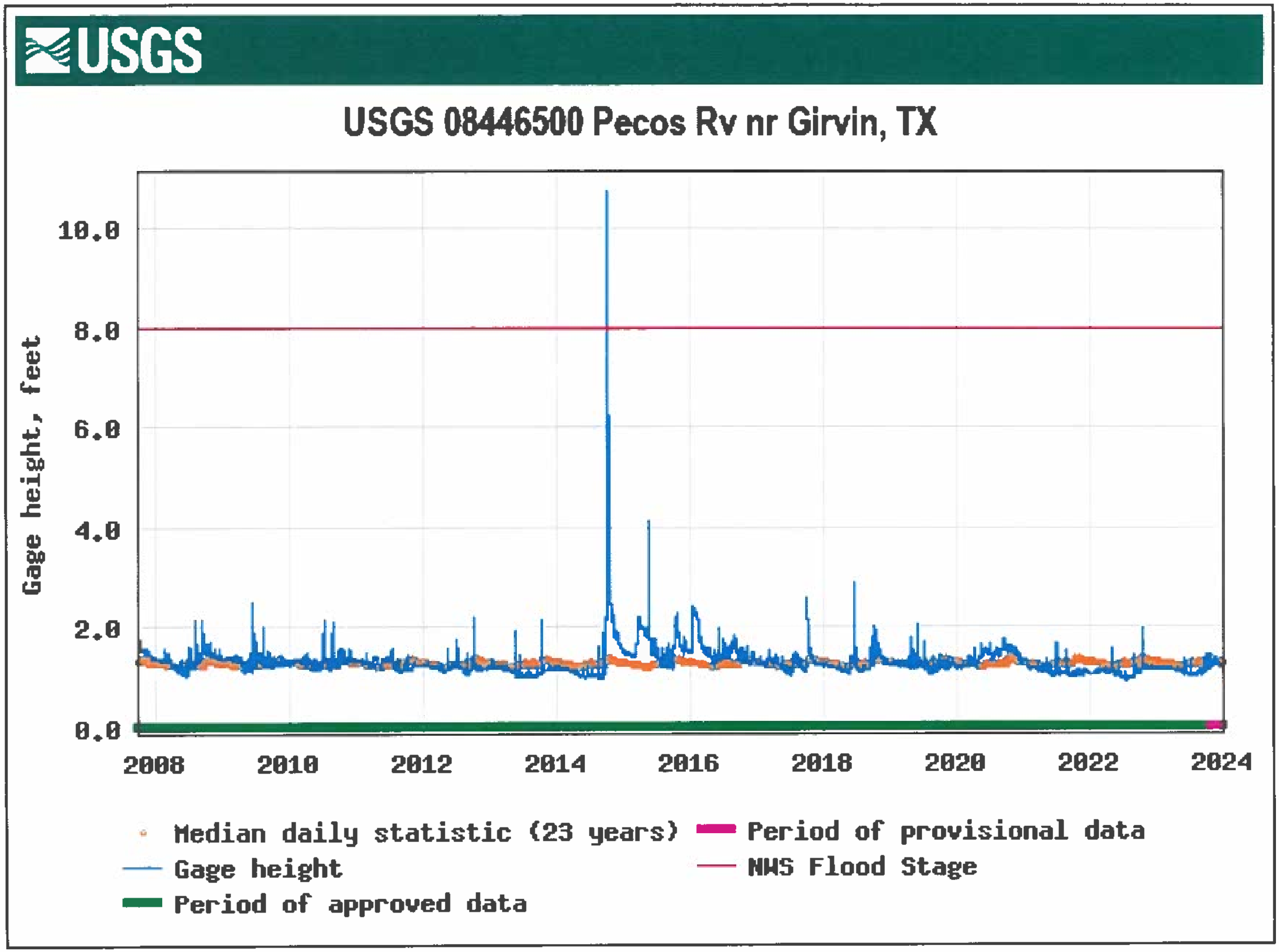
Diamond Y Spring

The Nature Conservancy/UT Bureau of Economic Geology 11/15/2018-1/31/2024

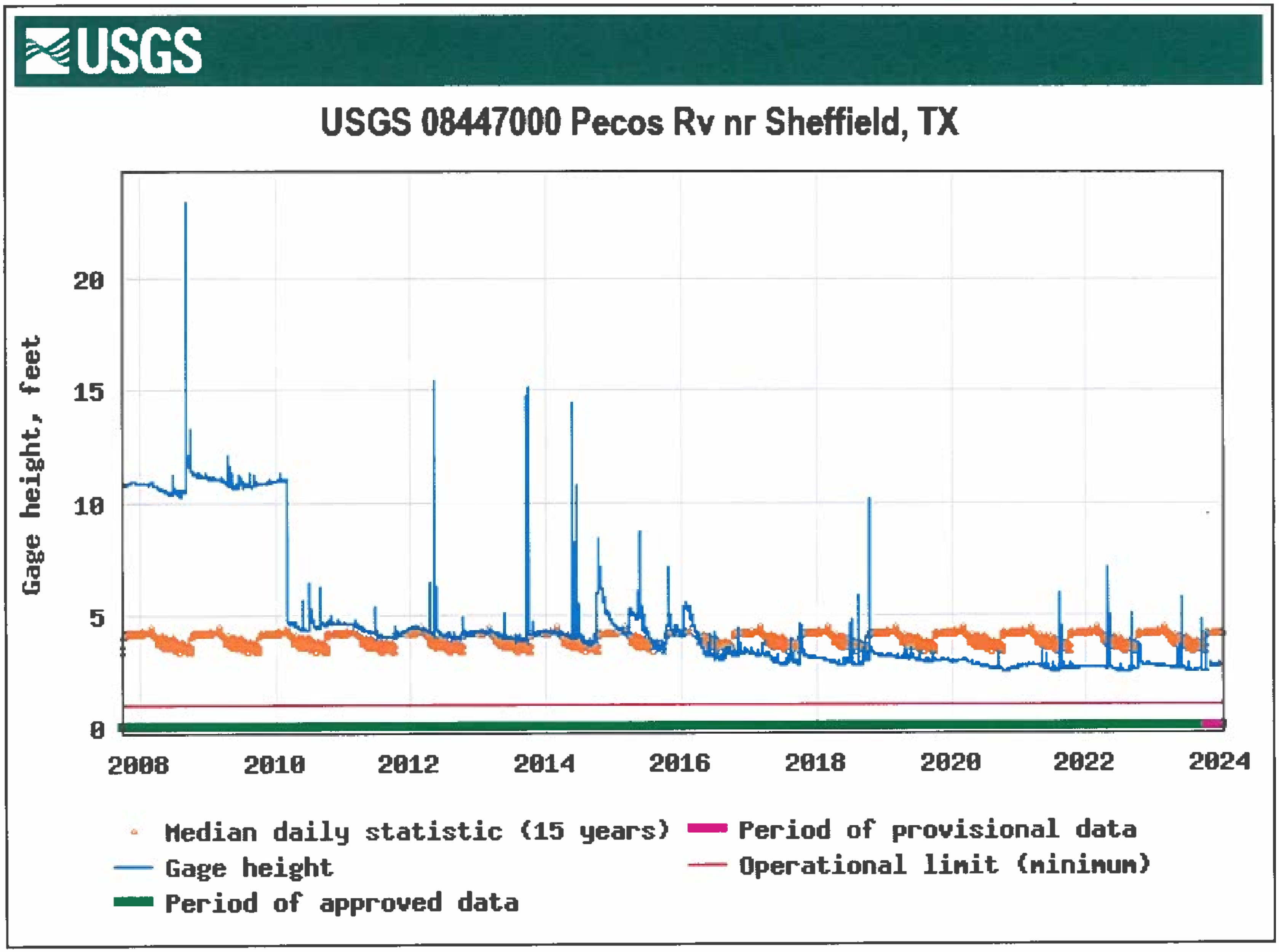








USGS
USGS 08446500 Pecos Rv nr Girvin, TX
Gage height, feet
10.0
8.0
6.0
4.0
2.0
0.0
2008
2010
2012
2014
2016
2018
2020
2022
2024
Median daily statistic (23 years)
Gage height
Period of approved data
Period of provisional data
NWS Flood Stage


USGS
USGS 08447000 Pecos Rv nr Sheffield, TX
Gage height, feet
20
15
10
5
0
2008
2010
2012
2014
2016
2018
2020
2022
2024
Median daily statistic (15 years)
Gage height
Period of approved data
Period of provisional data
Operational limit (minimum)

Rainwater Harvesting

For centuries, people have relied on rainwater harvesting to supply water for household, landscape, livestock, and agricultural uses. Before the advent of large centralized water supply systems, rainwater was collected from roofs and stored on site in tanks known as cisterns. With the development of large, reliable water treatment and distribution systems and more affordable well drilling equipment, rain harvesting was all but forgotten, even though it offered a source of pure, soft, low-sodium water.

A renewed interest in this time-honored approach of collecting water has emerged in Texas and elsewhere because of escalating environmental and economic costs of providing water by centralized water systems or by well drilling. The health benefits of rainwater and potential cost savings associated with rainwater collection systems have further spurred this interest.

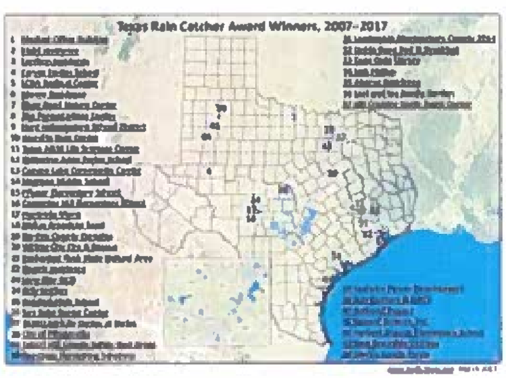
Texas is one of only a few states in the nation that has devoted a considerable amount of attention to rainwater harvesting and has enacted many laws regulating the practice of collecting rainwater.

- Texas Tax Code 151.355 allows for a state sales tax exemption on rainwater harvesting equipment.
- Texas Property Code 202.007 prevents homeowners associations from banning rainwater harvesting installations.
- Texas House Bill 3391 requires rainwater harvesting system technology to be incorporated into the design of new state buildings and allows financial institutions to consider making loans for developments using rainwater as the sole source of water supply.

For in-depth descriptions of rules in Texas and other states, visit the [National Conference of State Legislatures.]

Recent Maps

Texas Rain Catcher Award Winners



Protect, Conserve and Prevent Waste of Groundwater

Our mission at *Middle Pecos Groundwater Conservation District (MPGCD)* is to develop and implement an efficient, economical and environmentally sound groundwater management program to protect, maintain and enhance the groundwater resources of the District, and to communicate and administer to the needs and concerns of the citizens of Pecos County associated with these groundwater resources.

We have an 11-member Board of Directors that is elected by the citizens of Pecos County. There are two directors representing each county precinct, one representing the City of Fort Stockton, one representing the City of Iraan, and one representing Pecos County at large. Your current Directors are: Jerry McGuairt, Janet Groth, Weldon Blackwelder, Puja Boinpally, Vanessa Cardwell, Allan Childs, Jr., Ronnie Cooper, Larry Drgac, M. R. Gonzalez, Alvaro Mandujano, Jr., and Jeff Sims.

In keeping an eye on Pecos County groundwater, the District monitors 128 water wells that are scattered throughout Pecos County. We check water quality analysis and depth of water levels monthly.

The public is invited to join us at our monthly Board Meetings that are normally held on the 3rd Tuesday of each month at our office located at 405 North Spring Drive in Fort Stockton, Texas. Our agendas are posted on our website 72 hours before our meetings and can be reviewed at: https://www.middlepecosgcd.org/.

MPGCD requires water well owners to register all water well(s) with the District. A non-potable analysis can be provided by the District at no cost. MPGCD can carry out the overall responsibility of protecting our water supply by knowing where and how many wells we have in Pecos County. Examples of protection are oil/gas activity, excessive water production, monitoring water levels/analysis, and contamination.

Our office is willing to discuss any concerns, issues, etc., pertaining to our most precious natural resource – GROUNDWATER. You may contact us at 432-336-0698 or come by 405 North Spring Drive, Fort Stockton, Texas.

Efforts to Control and Prevent Waste of Groundwater and Promote Conservation

To promote conservation and prevent waste of groundwater related to agricultural, the following are the best management practices as stated by the Texas Water Development Board Conservation Division : * Irrigation water use management - irrigation scheduling, measurement of irrigation water use, crop residue management and conservation tillage, irrigation audit; * land management systems – furrow dikes, land leveling, contour farming, conversion of supplemental irrigated farm land to dry land, brush management; * on-farm water delivery systems – lining of on-farm irrigation ditches, replacement of on-farm irrigation ditches and pipelines, low-pressure center pivot sprinkler irrigation systems, drip/micro-irrigation systems, gated and flexible pipe for field water distribution systems, surge flow for field water distribution systems, and linear move sprinkler irrigation systems; * Water district delivery systems – lining of district delivery systems, replacement of irrigation district canals and lateral canals with pipelines; * Miscellaneous systems – tailwater recovery and reuse system, nursery production systems.

Other ways to promote conservation and prevent waste of groundwater: Sweep rather than hose driveways and other areas; use drip irrigation rather than spray irrigation; wash your car at a car wash; downsize your lawn area and/or Xeriscape; irrigate during the coolest part of the day; never water on windy days; protect plants with mulch and compost to reduce water loss; install low flow shower heads; insulate hot water pipes; reduce showering time; operate dishwasher and washing machine on full loads; install an aerator on kitchen faucet; and turn the water off while brushing teeth and on to rinse. If you see signs of contaminating substances on the surface, remember it could end up contaminating the water source below, so please report to us if you find signs of contamination that need to be checked out.

Middle Pecos Groundwater Conservation District 2023

Directors		
Jerry McGuairt	President: Director Since February 19, 2013	Precinct 1
Janet Groth	Vice President: Director Since June 15, 2010	Precinct 1
M. R. Gonzalez	Secretary/Treasurer: Director Since December 11, 2000	Precinct 2
Puja Boinpally	Director Since April 18, 2017	Precinct 2
Weldon Blackwelder	Director Since August 16, 2011	Precinct 3
Larry Drgac	Director Since August 13, 2019	Precinct 3
Alvaro Mandujano, Jr.	Director Since November 5, 2002	Precinct 4
Ronnie Cooper	Director Since September 15, 2009	Precinct 4
Vanessa Cardwell	Director Since July 21, 2009	City of Fort Stockton
Jeff Sims	Director Since November 8, 2016	City of Iraan
Allan Childs, Jr.	Director Since November 8, 2016	At Large
Current Employees		
Ty Edwards	General Manager: Since January 17, 2017	Assistant Manager: Since December 2, 2013
Gail Reeves	Office Secretary: Since June 3, 2013	
Anthony Bodnar	Field Technician: Since May 7, 2018	

Middle Pecos Groundwater Conservation District
2024- Annual Report

General Manager: Ty Edwards

Submitted by Ty Edwards, General Manager
02/18/2025

Middle Pecos Groundwater Conservation District
2024 Annual Report

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- **Karges Spring**

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- **Pecos River- Sheffield, Texas**

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- **Annual Newspaper Article for Publics Information Regarding Groundwater Conservation** (6.2)

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Middle Pecos Groundwater Conservation District 2024

Directors		
Jerry McGuairt	President: Director Since February 19, 2013	Precinct 1
Janet Groth	Vice President: Director Since June 15, 2010	Precinct 1
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Ronnie Cooper	Director Since September 15, 2009	Precinct 4
Vanessa Cardwell	Director Since July 21, 2009	City of Fort Stockton
Jeff Sims	Director Since November 8, 2016	City of Iraan
Billy Jackson	Director Since November 5, 2024	At Large
Current Employees		
Ty Edwards	General Manager: Since January 17, 2017	Assistant Manager: Since December 2, 2013
Gail Reeves	Office Secretary: Since June 3, 2013	
Anthony Bodnar	Field Technician: Since May 7, 2018	

Intentionally

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MIDDLE PECOS GROUNDWATER CONSERVATION DISTRICT
P.O. Box 1644 Fort Stockton, TX 79735 Phone (432)336-0698 Fax (432)336-3407
405 North Spring Drive Fort Stockton, Texas 79735
Email: mpgcd@mpgcd.org Website: www.middlepecosgcd.org

2024 Annual Manager's Report
MPGCD Board of Directors

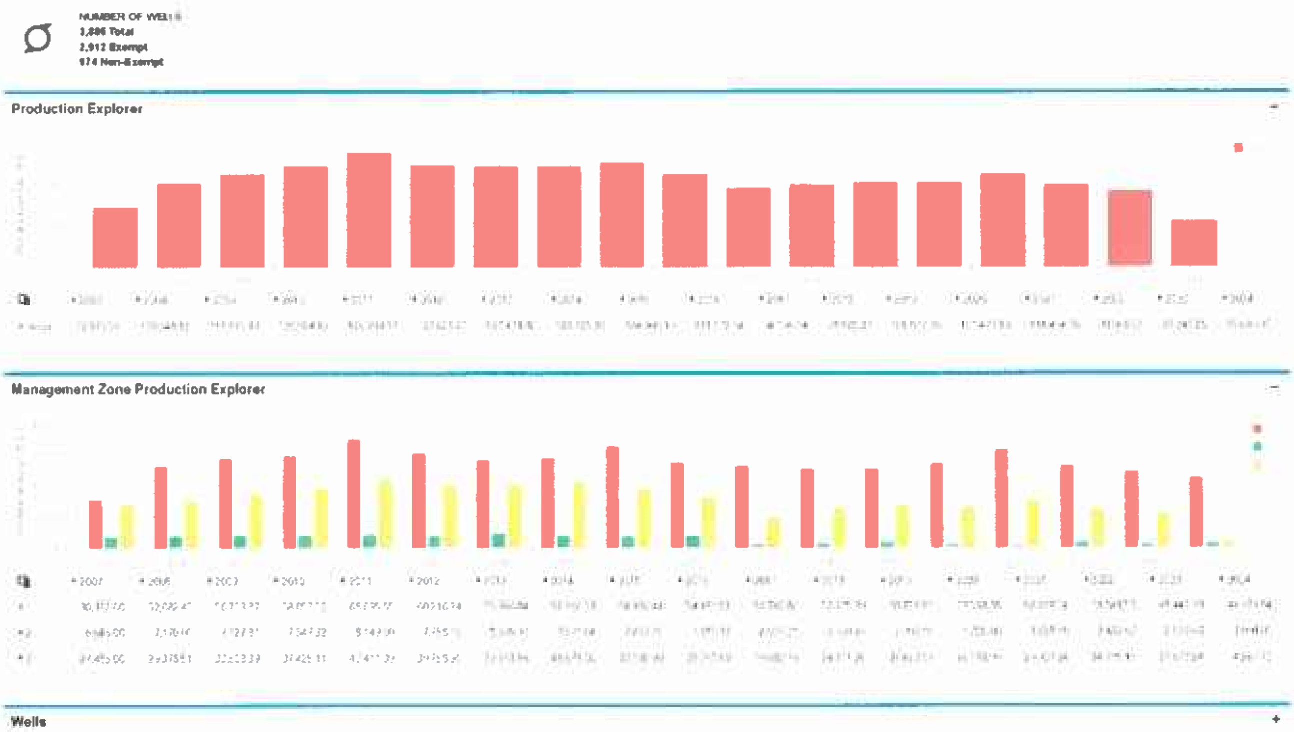
2024 has been an extremely busy and successful year for MPGCD Board Members and staff. The District continues its commitment to manage and protect the groundwater resources of Pecos County and help maintain a sustainable, adequate, reliable, cost effective and high-quality source of groundwater to promote the vitality, economy and environment of the District.

The District held three Rule Petition hearings filed by Cockrell Investment Partners and Belding Farms. We spent a significant amount of time reviewing and addressing the comments and concerns in the Rule Petitions. At the end of the day the District felt comfortable with its current permitting program in place. A petition was filed by Cockrell Investment Partners, LP. at TCEQ on December 30, 2024. Cockrell is an affected person as defined in Texas Water Code Section 36.3011 (as a local landowner and permit holder) and submitted its Petition for Inquiry pursuant to that statute and 30 Texas Administrative Code Section 293.23.

The District continued efforts at the State level have progressed after HB 4256 passed the Texas 88th Legislature providing $10 Million dollars to plug "Leaking Water Wells" in Pecos County. The District has met with TCEQ senior management and program staff concerning the new plugging program and awaits rulemaking.

A prehearing conference with the Railroad Commission was held on September 26, 2023, in accordance with Tex. Nat. Res. Code § 89.041 to Determine the Proper Plugging of Twelve Wells in Pecos County, Texas; District 08. The conference was continued to allow for more briefing and introduction of evidence regarding jurisdiction. A second prehearing conference was held on February 6, 2024, which required extensive argument, witness testimony, and examination and questioning by the Judge and accompanying Technical Examiner. The Judge ruled in favor of the RRC and denied the District's request to hold a hearing on the merits. This RRC position is not a surprise, and the procedure was required to exhaust administrative remedies before seeking a judicial opinion about RRC's jurisdiction and duty to plug wells. The District filed an original petition for judicial review, declaratory relief, and mandamus relief in the Travis County District Court on August 16, 2024, and a second cause filed on October 11, 2024. On September 13, 2024, the Railroad Commission filed Defendants Original Answer denying all allegations.

This Annual Report is an update on the District's performance in achieving the management goals contained in the District's management plan and a review of this year's work is outlined below.



Annual Production Reporting by Management Zone and Aquifer

- **2024 Rainfall**
  According to the United States Drought Monitor for Pecos County, TX, the year began with less than 40% of Pecos County experiencing drought conditions (Figure 1, Water Data for Texas, 2025). By the end of 2024, however, 100% of the County was under a drought declaration, with nearly 90% facing severe or extreme drought. Throughout the County and surrounding areas, most TexMesonet stations recorded a decline in annual rainfall (Figure 2). At the Fort Stockton Pecos County Airport station, the 2024 rainfall total was nearly 70% below its historic annual rainfall average (Figure 3).

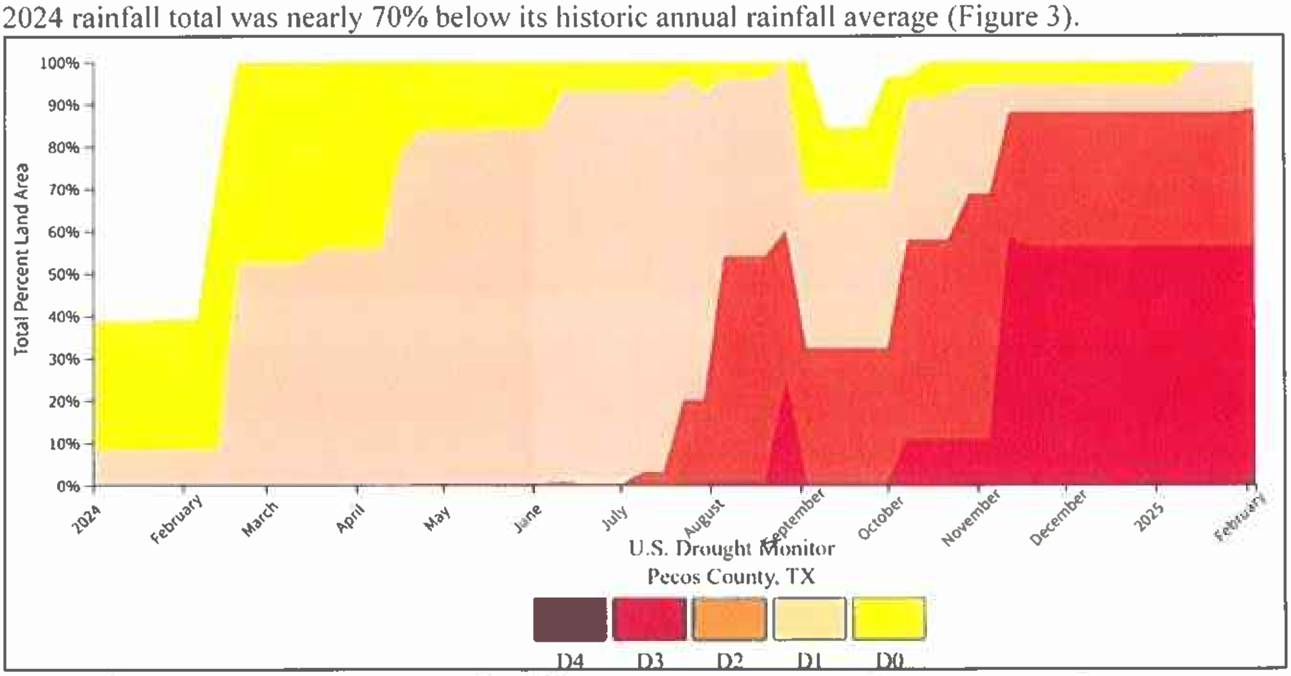


Figure 1 – United States Drought Monitor for Pecos County, Texas from 1/1/2024 to 2/1/2025. D0 = Abnormally Dry, D1 = Moderate Drought, D2 = Severe Drought, D3 = Extreme Drought, D4 = Exceptional Drought.

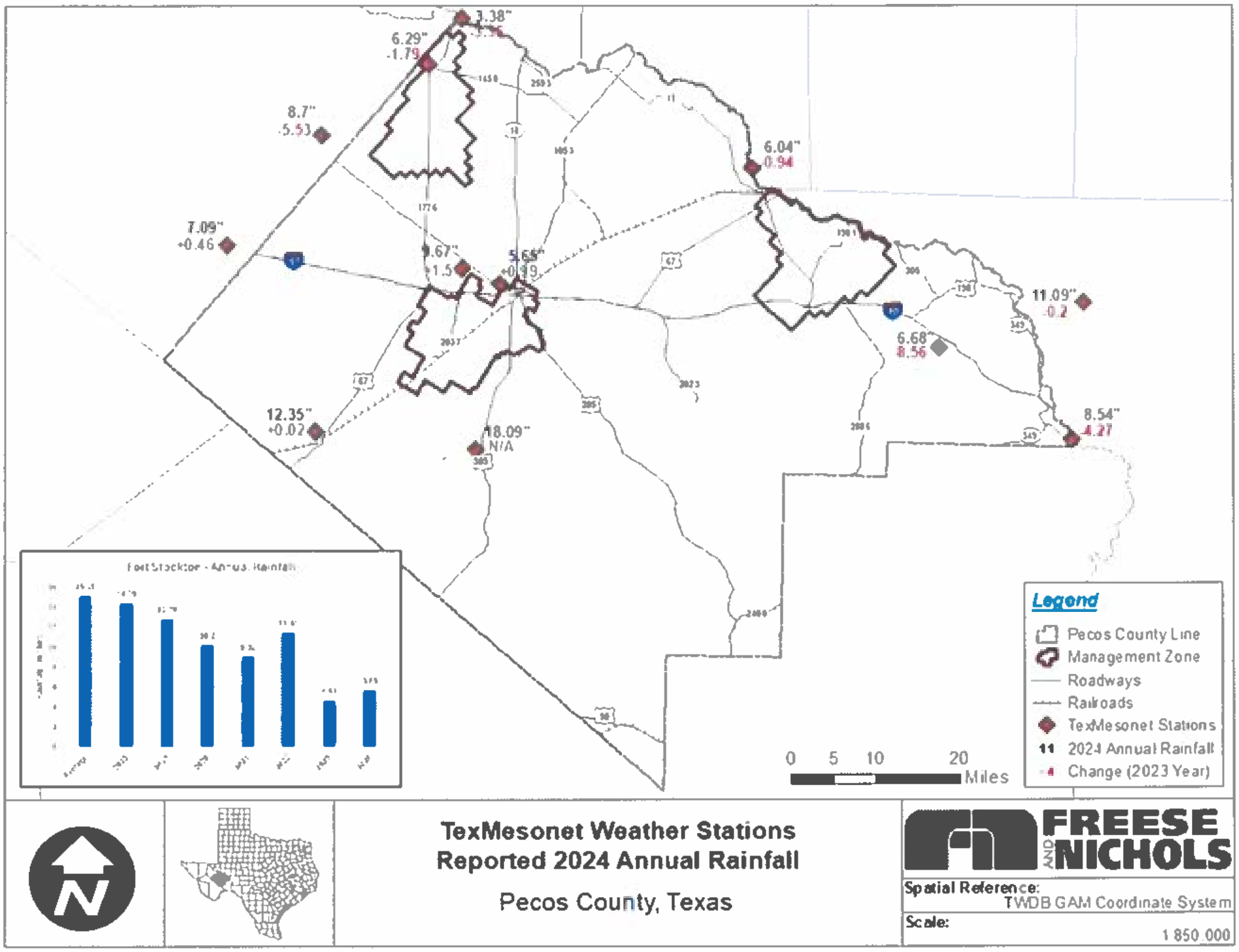


Figure 2 – TexMesonet weather stations across Pecos County, TX and surrounding areas with reported rainfall totals and change from prior year.

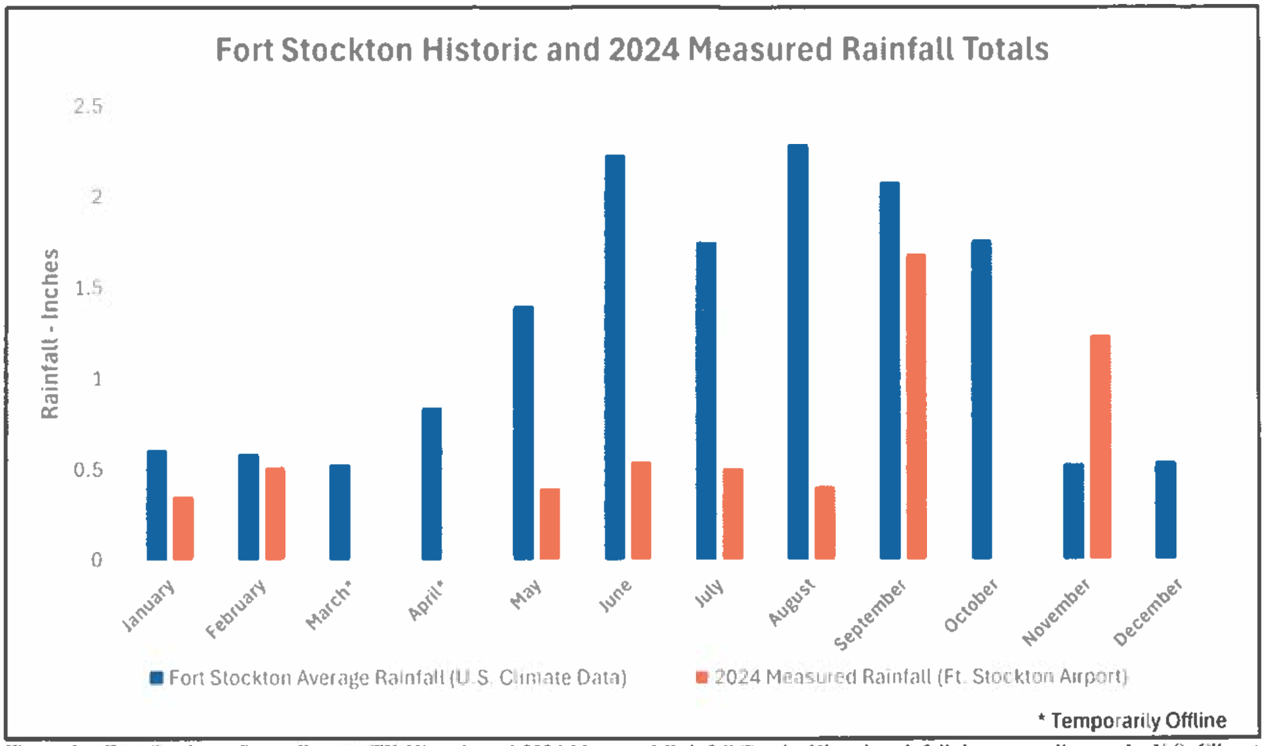


Figure 3 – Fort Stockton, Pecos County, TX Historic and 2024 Measured Rainfall Totals. Historic rainfall data according to the U.S. Climate Data and Center and measured rainfall according to TexMesonet KFST station data.

- **2024 Water Levels**

Steady water level declines and seasonal fluctuations consistent with drought were observed across the County (Figure 4). In areas with minimal pumping, water levels remained relatively constant. Whereas areas with irrigated croplands (Management Zone 1 and 3) showed relatively mild drawdowns.

Currently, 139 water wells are monitored in Pecos County, with 58% (81 of 139) remaining stable or showing a gain (recovery) when compared to their 2024 winter measurement (Figure 4). Of the 58 wells experiencing drawdowns, 52 demonstrated less than 10 feet of decline while only two wells had declines over 20 feet.

When comparing 2012 to 2025 water level measurements, the general trend is flat to slightly downward, with most drawdown observed in Management Zone 3 and along the Reeves County Line (Figure 5). Monitor well #230 ("Allison Ranch Generator Well") in southern Pecos County has shown the most significant decline over the period. This has been previously discussed in prior General Manager Reports, and more recently has shown signs of stability.

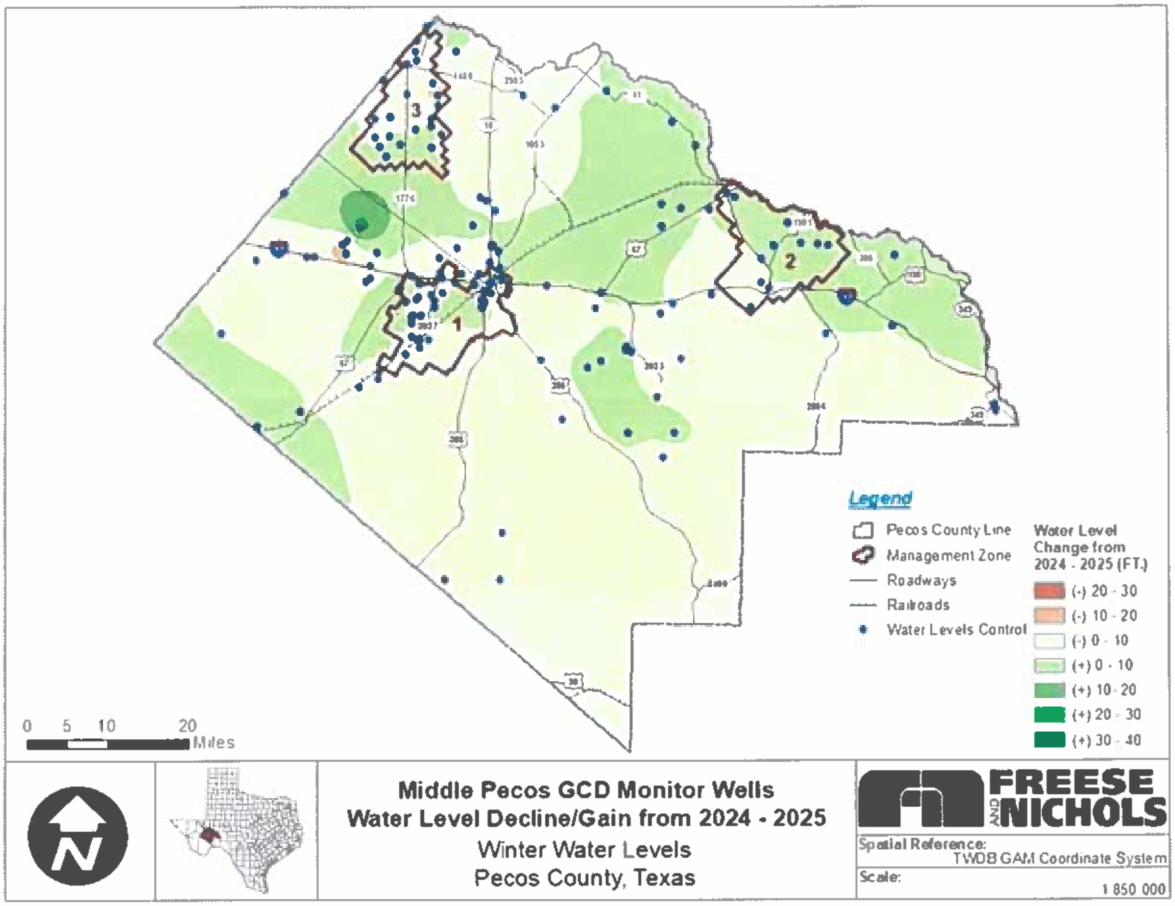


Figure 3 – Pecos County, TX Water Level Decline/Gain from 2023 – 2024. Gains are visible as shades of green while declines are illustrated as yellow to shades of red.

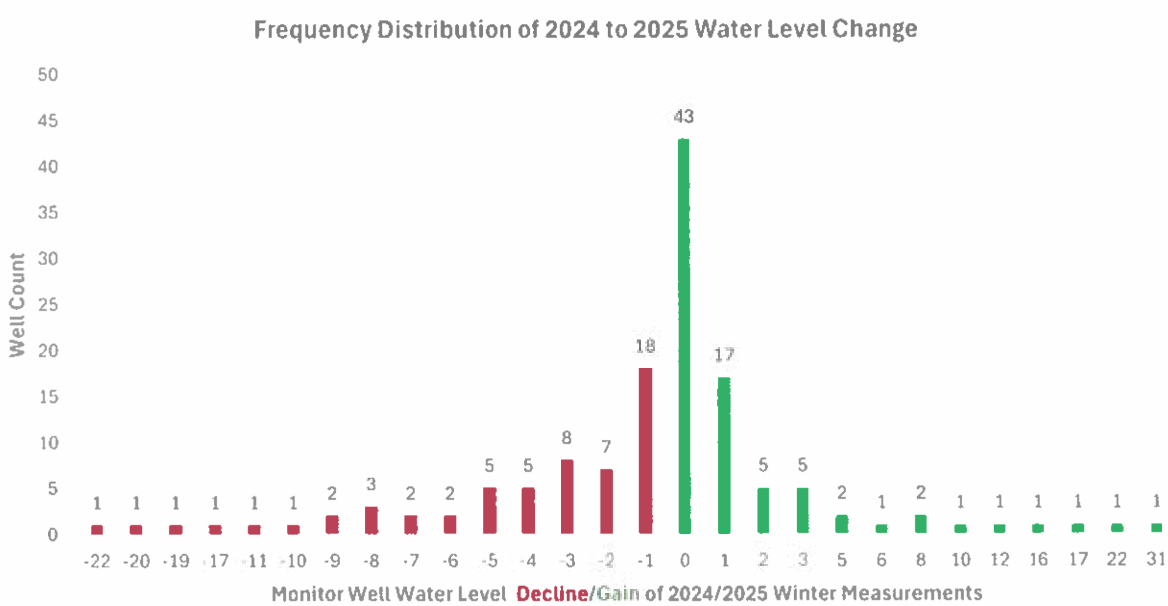


Figure 4 – Monitor well winter water level change from 2024 to 2025. Red illustrates a year-over-year decline while green illustrates a water level gain (recovery). This chart includes data from the monitor wells where 2024 and 2025 winter measurements were available.

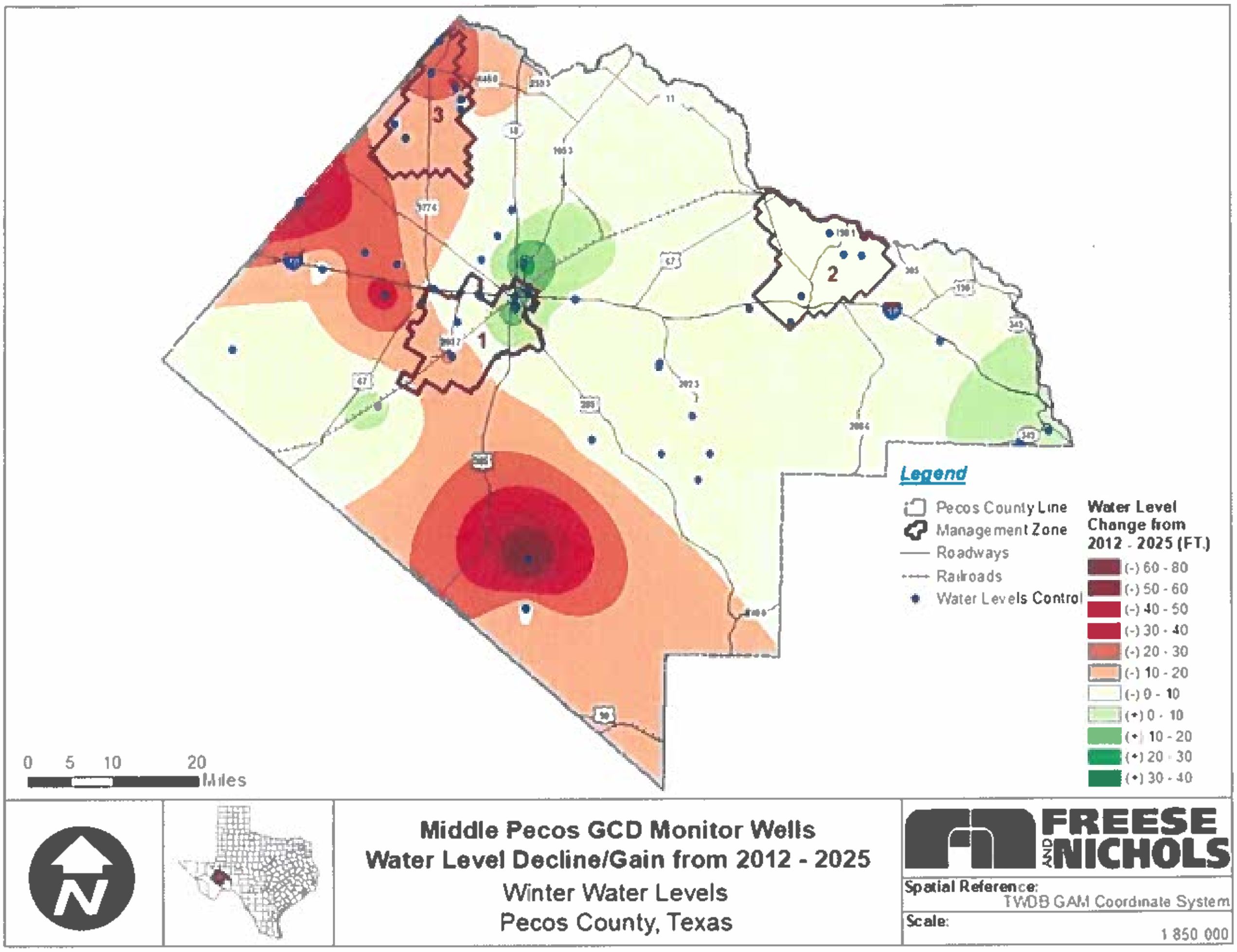


Figure 5 - Pecos County, TX Water Level Decline/Gain from 2012 - 2025. Gains are visible as shades of green while declines are illustrated as yellow to shade of red.

- In Corporation with local landowners **50** water samples have been collected across Pecos County in 2024.

- **Diamond Y Spring**-The Nature Conservancy has installed Telemetry in Diamond Y Springs. The Conservancy has created an extensive groundwater monitoring program to track spring flows, water quality, and the health of the pupfish and other species. Over the last few years, we have seen a decrease in flows during the summer months and a recovery in winter months. Diamond Y Spring Preserve protects one of the largest and last remaining Cienega systems in West Texas. The District updated the geologic model in 2021 and 2023, around the Diamond Y Spring area and was able to map several faults. The District has installed 6 full time monitoring wells equipped with In-Situ Transducers recording water level and water quality in real time. This equipment is installed in 5 Edwards Trinity Wells and 1 Rustler Well around the spring area.

- **Santa Rosa Spring-** continues to remain dry. The spring bed is being monitored and we are tracking changes in pressure during rain fall events.

- **Comanche Spring-** is continually monitored for flow, pressure, and conductivity during the Winter Spring Season. No Flow at Comanche Spring was measured in Winter of 2024.

- The District drilled a **Monitor Well at the MPGCD Office located at 405 North Spring Drive**. The purpose of the well is for an educational monitoring site outside the office. An 8ft Aeromotor windmill has been installed over the well with full time In-Situ monitoring equipment downhole. A full exhibit has been erected at the site.

- **San Andres Abandoned Wells-** Progress has been made on the abandoned well problems in 2024. HB 4256 passed the Texas Legislature with overwhelming support in 2023 and made available $10 Million Dollars to start a program to plug some of the wells that qualify. The District has met with TCEQ staff multiple times and await TCEQ rulemaking.

  An official complaint has been filed at the RRC to plug 12 of the abandoned wells. The regulatory hearings activity from last fall through this summer at the Railroad Commission, and ultimately the Commissioners' final action on our request that wells be added to RRC's plugging list and prioritized for plugging. The RRC denied all our requests, which is not a surprise. This procedure was required to exhaust administrative remedies before seeking a judicial opinion about RRC's jurisdiction and duty to plug. The next step was for the District to file an original petition for judicial review, declaratory relief, and mandamus relief in the Travis County District Court, which was accomplished on August 16, 2024. Because RRC undertook additional procedural steps, we were conservative to ensure that we exhausted administrative remedies and then filed a second original petition on October 11, 2024, Cause No. D-1-GN-24-005222 (200th District Court, Travis County).

- **PECOS COUTNY GROUNDWATER MODEL Phase 1** of building a groundwater flow model has begun with completion of the model anticipated for 2025. The objective is to develop a tool that would assist the District in groundwater management. The google link for the tech memos is available at:

  https://drive.google.com/drive/folders/1HYj8JRV4omAgKPJWBta-T20hZUbtyaPS.

  Specific uses that are contemplated include:

  - DFC development without the need to use regional GAM's.
  - Provide a quantitative basis for future updates to the District's rules that set a threshold on well size/pumping amount for requiring permit applicants to prepare hydrologic reports.
  - Provide a tool that can be used to review permit applications by quantifying the potential impacts of new pumping for any formation/aquifer in the District on a regional scale.
  - Assess the relationship between groundwater pumping and spring flow at Comanche Springs on a monthly time scale.

- The **third round of joint planning** for Groundwater Management **Areas 3 and 7** is complete and the fourth round of joint planning is underway. For this round, the statutory deadline to propose desired future conditions (DFC's) is May 1, 2026, and the deadline to submit final DFC's to the Texas Water

Development Board is January 5, 2027. I attended 100% of all the GMA 3 and GMA 7 meetings held in 2024.

https://www.twdb.texas.gov/groundwater/management_areas/gma3.asp

https://www.twdb.texas.gov/groundwater/management_areas/gma7.asp

- The **Region F Water Planning Group** is tasked with developing and adopting a regional water plan in accordance with Texas Senate Bill 1 and Texas Senate Bill 2. The 2021 Region F Plan was submitted to the Texas Water Development Board, and we held our last meeting to adopt the 2021 plan on September 17, 2020. The sixth cycle of regional planning is underway for the 2026 State Water Plan. I am a voting member of Region F representing Groundwater Management Area 3 and have attended 100 percent of the scheduled meetings for Region F in 2024.

  https://www.twdb.texas.gov/waterplanning/rwp/plans/2021/index.asp

- **Fort Stockton Holdings** 28,400 ac/ft export permit was renewed for a 3-year permit term effective July 18, 2023-2026, in accordance with District Rule 11.8(f) and Texas Water Code 36.1145. FSH and MPGCD approved a Joint Study to be proactive, to develop scientific data that will provide FSH, the District, and other stakeholders with more certainty about conditions in the Edwards-Trinity Aquifer. FSH agreed to pay $250,000 to contribute to the study. As of this date the District has installed transducers, which record pressure, temperature, and conductivity at the 11 Threshold monitor well sites.

  FSH Threshold Well Dashboard is available at https://mpgcd.halff.com/Dashboard.

  As contemplated in the joint study agreement FSH and the District began work on Rustler Monitor Well Recommendations and beginning scope of work on drilling of well and bid specs for same. The District met on site with Jeff Williams and Raymond Straub to decide on a preliminary drilling location and source water.

- **Management Zone 1 Threshold Wells**
  Management Zone 1 Threshold Wells are continuously monitored, and data is provided by telemetry in HydroVu (Figure 6). Water levels demonstrate relative year-over-year consistency as they are mostly in line with 2022 and 2023 measurements. All threshold wells will be evaluated on April 1st for Winter 1 – 4 water level threshold trigger levels.

Figure 6 – HydroVu Threshold Well Dashboard. The HydroVu dashboard provides continuous reporting of water level depth, temperature, pressure, conductivity, and total dissolved solids.

Cockrell vs MPGCD

A. **Cockrell Investment Partners, L.P. v. MPGCD and its Board President in his official capacity, FSH and Republic Water Company of Texas, L.P.**, Case No. 23-0742 (Texas Supreme Court)(Cockrell I);

In Cockrell I, the El Paso Court of Appeals on July 13th denied Cockrell's motion for rehearing after further briefing thereby affirming the trial court's ruling in favor of the District's decision. A new deadline to appeal to the Texas Supreme Court is September 27th by petition for review. A 2nd new deadline to appeal has been approved for October 27th. On November 9th, the District and FSH filed brief responses with the Court advising that in accordance with Rule 53, each party will respond if the court is interested in responses. A Petition for Review is under review by the Court.

B. **Cockrell Investment Partners, L.P. v. MPGCD and its General Manager in his official capacity, and FSH**, Case No. 23-0593 (Texas Supreme Court)(Cockrell II);

In Cockrell II, the El Paso Court of Appeals on July 10th denied Cockrell's motion for rehearing after further briefing thereby affirming the trial court's ruling in favor of the District's decision. The Court of Appeals issued a substitute opinion and judgment with its reasoning that there is no jurisdiction in the courts for Cockrell to pursue its claim, including the reason that Cockrell prematurely filed its lawsuit by not waiting for its motion for rehearing filed at the District to expire. On August 2nd, the Court of Appeals issued a revised opinion and judgment correcting typographical errors. September 18 Cockrell requests extension to file appeal with Texas Supreme Court. On October 25th Cockrell timely filed Petition for Review. On November 9th the District and FSH filed brief responses with the Court advising Rule 53. On November 28 Petition for Review is "under review" by the Court.

C. **Cockrell Investment Partners, L.P. v. Ty Edwards, In His Capacity as General Manager, and FSH**, Case No. 08-23-00178-CV (El Paso Court of Appeals)(Cockrell III);

In Cockrell III, a hearing in front of Judge Ables occurred on May 30, 2023. The Court ruled in favor of FSH and MPGCD by granting their Pleas to the Jurisdiction. There was a disagreement with Cockrell over the finality of the trial court's judgment and fee reimbursement, which Judge Ables cleared up by signing a modified order on July 19. August 14th is the deadline for Cockrell to file its appellate brief at the Court of Appeals. Cockrell timely filed and the District and FSH's appellate briefs were timely filed September 26. On October 13th Cockrell filed a reply brief.

D. **Cockrell Investment Partners, L.P. v. Middle Pecos Groundwater Conservation District**, Cause No. P-8626-83-CV (83rd District Court)(Cockrell IV); and

In Cockrell IV, the lawsuit was filed on August 17th and served on September 13th by agreement. The District's answer and counterclaim was timely filed October 9th. FSH has advised that it will intervene and file plea to the jurisdiction.

E. **Cockrell Investment Partners, L.P. v. Middle Pecos Groundwater Conservation District**, Cause No. P-13031-112-CV (112th District Court)(Cockrell V).

In Cockrell V, the lawsuit was filed on August 23rd and served on September 13th by agreement. The District's answer and counterclaim was timely filed October 9th. FSH has advised that it will intervene and file plea to the jurisdiction.

- The 89th Texas Legislature is underway. Lawmakers will convene in Austin on January 14, 2025 and have already filed nearly 2,000 bills since November 12, 2024. Of particular interest to the GCD community, Rep. Mark Dorazio has filed an attorney's fees bill (HB 1050) and Rep. Harris has filed a bill establishing a groundwater science fund at the TWDB (HB 1400).

- As General Manager of the District, I would like to thank MPGCD Directors for all the hard work and time you dedicated to 2024.

Ty Edwards, General Manager

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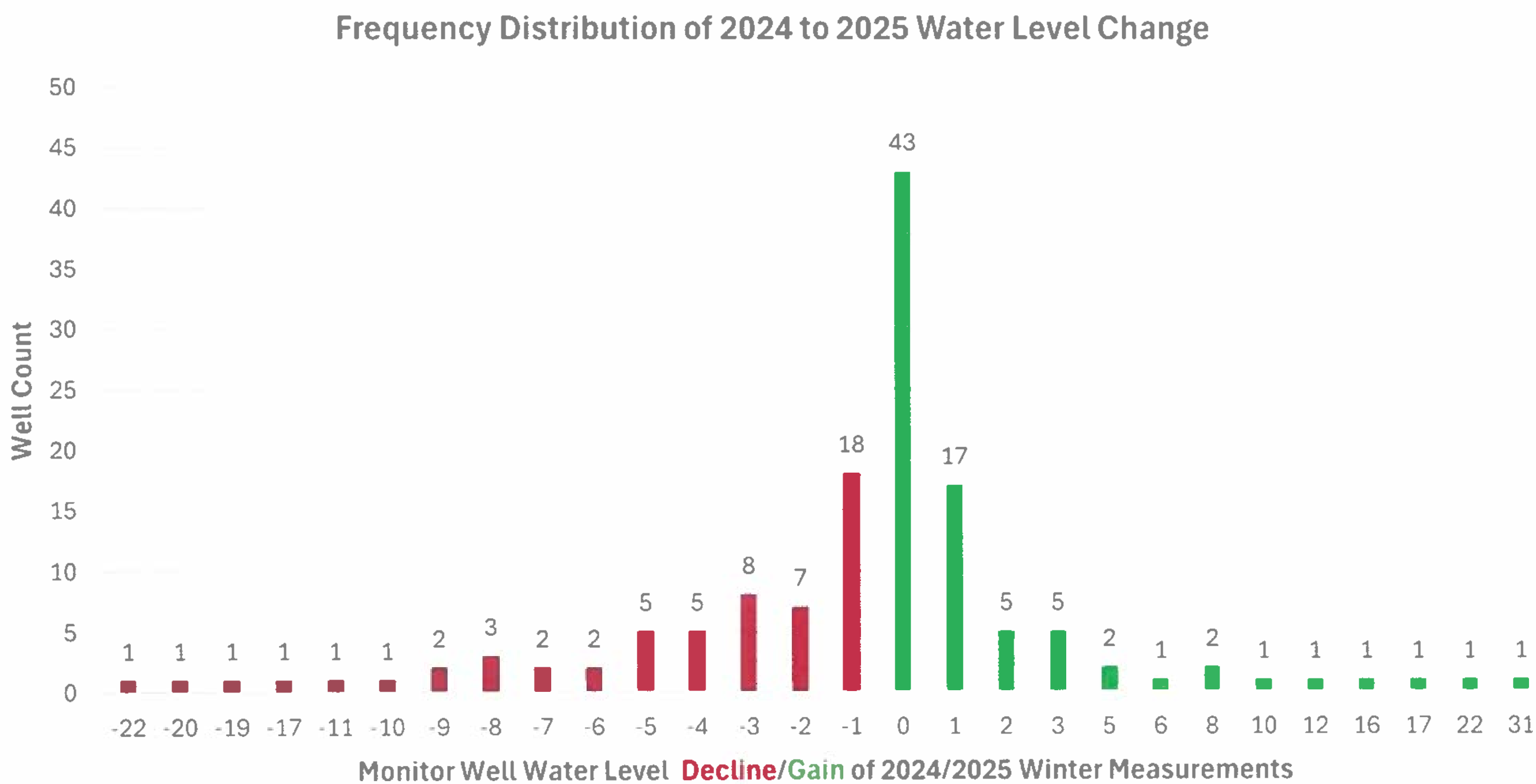
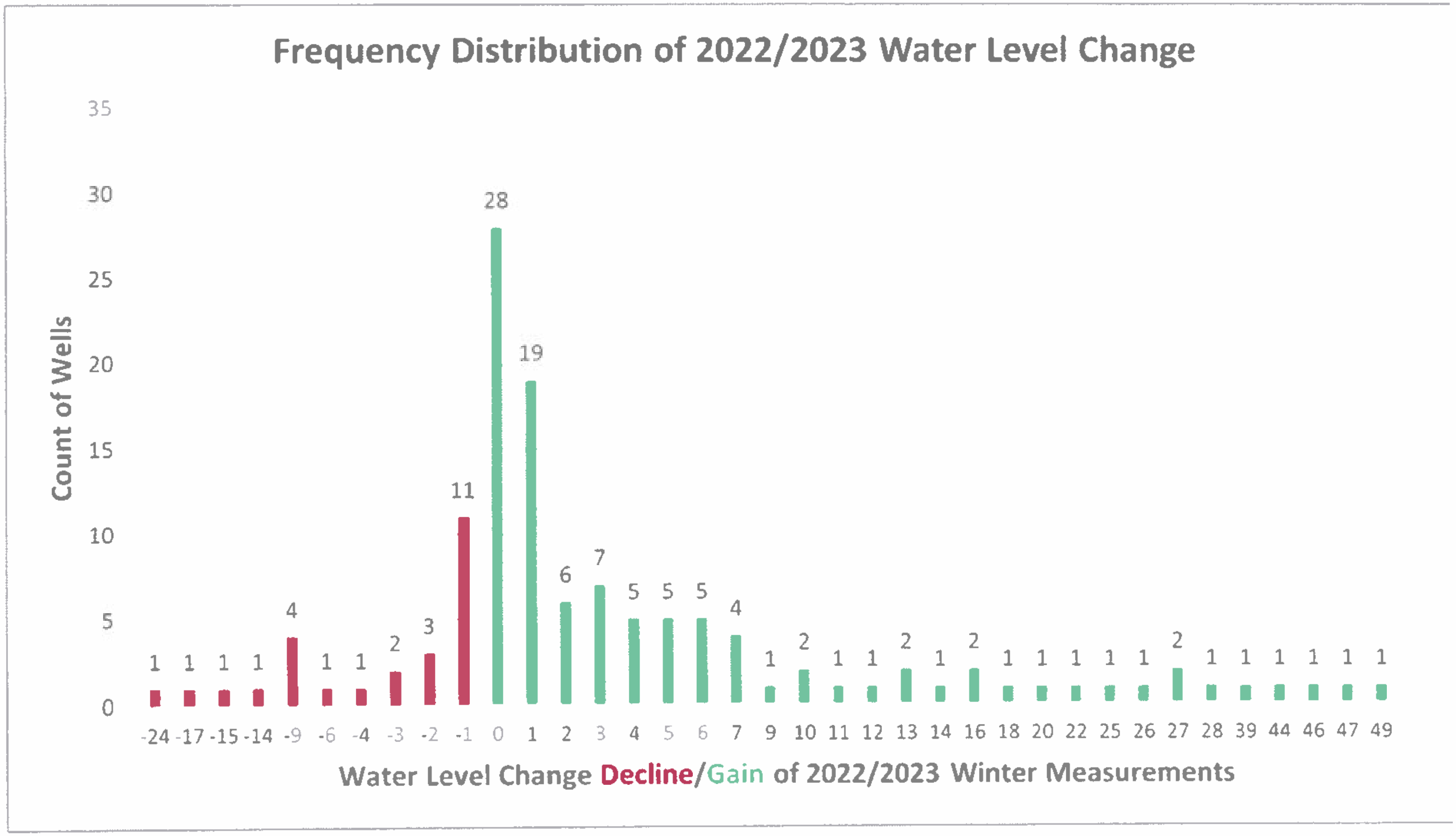


Frequency Distribution of 2024 to 2025 Water Level Change
Well Count
50
45
40
35
30
25
20
15
10
5
0
1 1 1 1 1 1 2 3 2 2 5 5 8 7 18 43 17 5 5 2 1 2 1 1 1 1 1 1
-22 -20 -19 -17 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 5 6 8 10 12 16 17 22 31
Monitor Well Water Level Decline/Gain of 2024/2025 Winter Measurements


Frequency Distribution of 2022/2023 Water Level Change
Count of Wells
35
30
25
20
15
10
5
0
1 1 1 1 4 1 1 2 3 11 28 19 6 7 5 5 5 4 1 2 1 1 2 1 2 1 1 1 1 1 2 1 1 1 1 1 1
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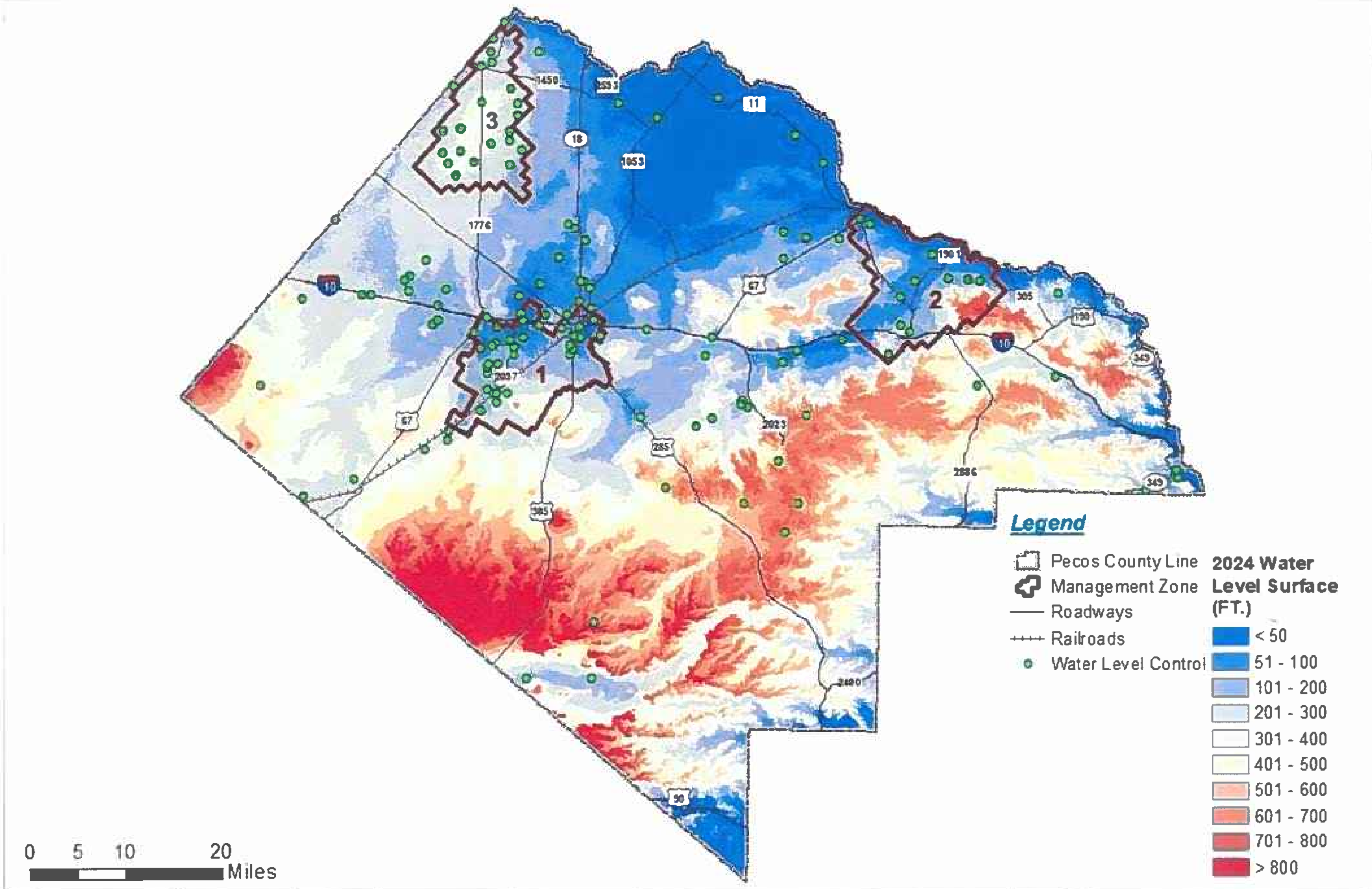
Water Level Change Decline/Gain of 2022/2023 Winter Measurements



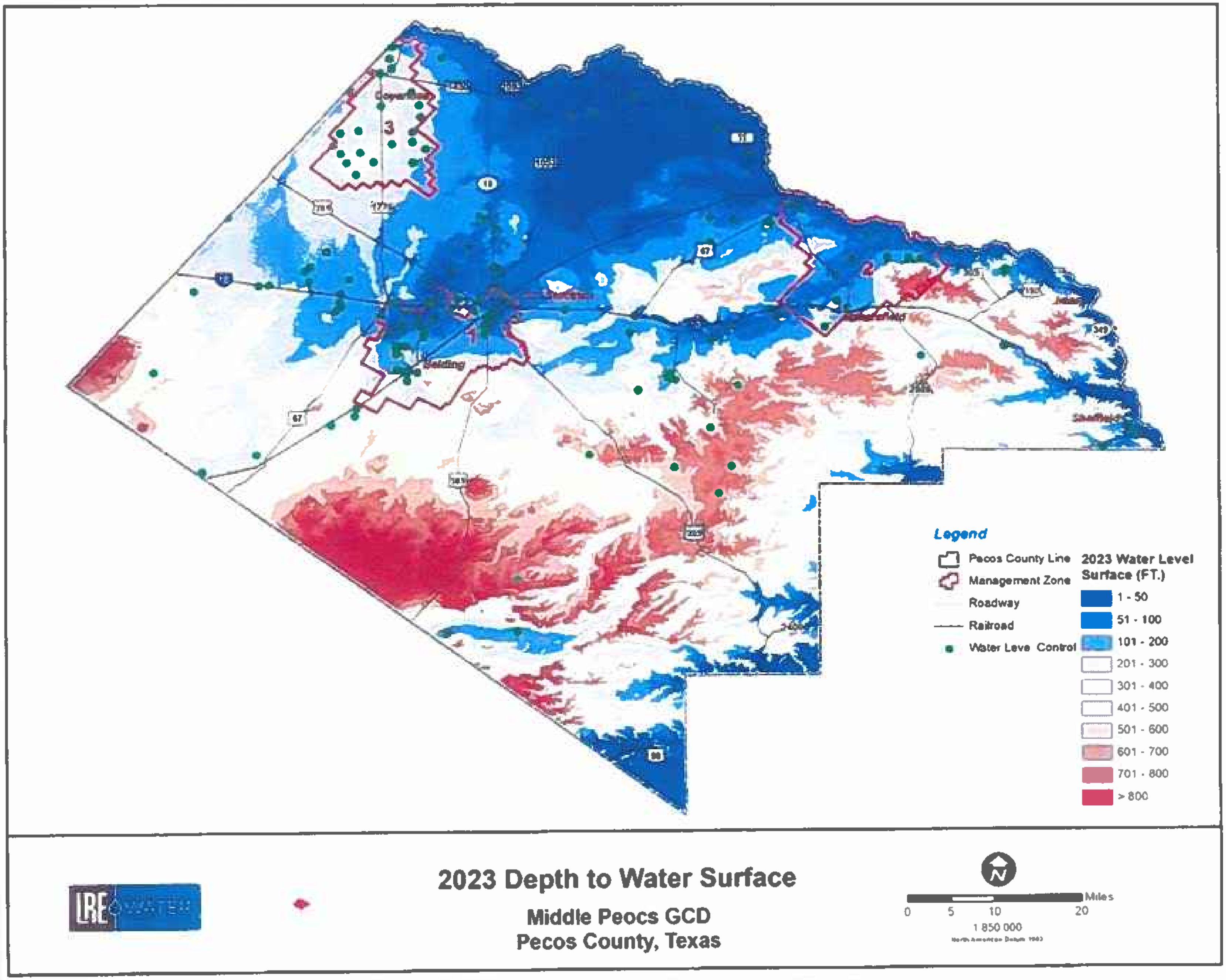
2024 Depth to Water Surface
Middle Pecos GCD
Winter Water Levels
Pecos County, Texas

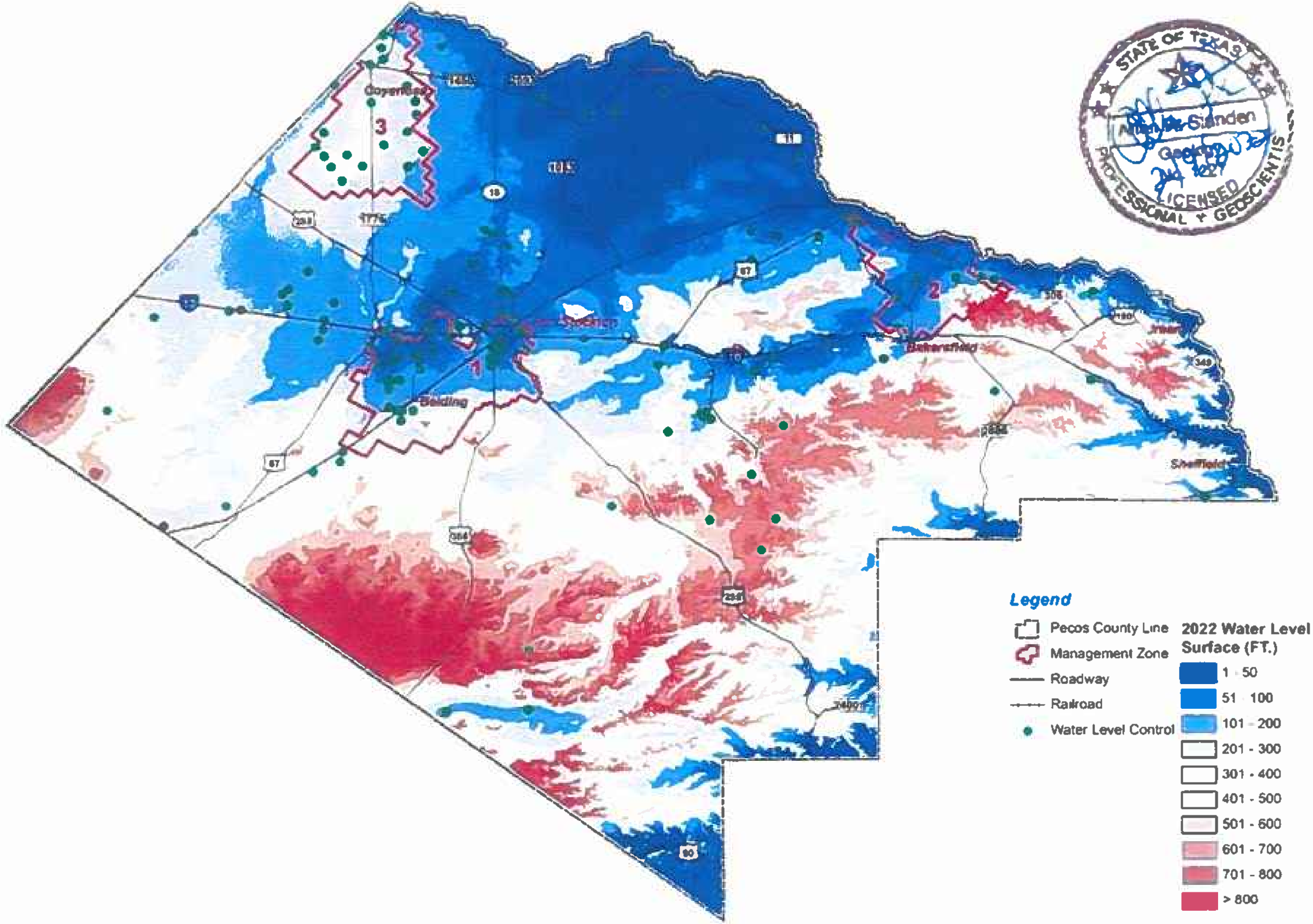
FREESE AND NICHOLS

Spatial Reference: TWDB GAM Coordinate System

Scale: 1:850,000

Water Level Surface 2023





Allan R. Standen LLC
Groundwater & Natural Resource Consulting

2022 Depth to Water Surface

Pecos County, Texas

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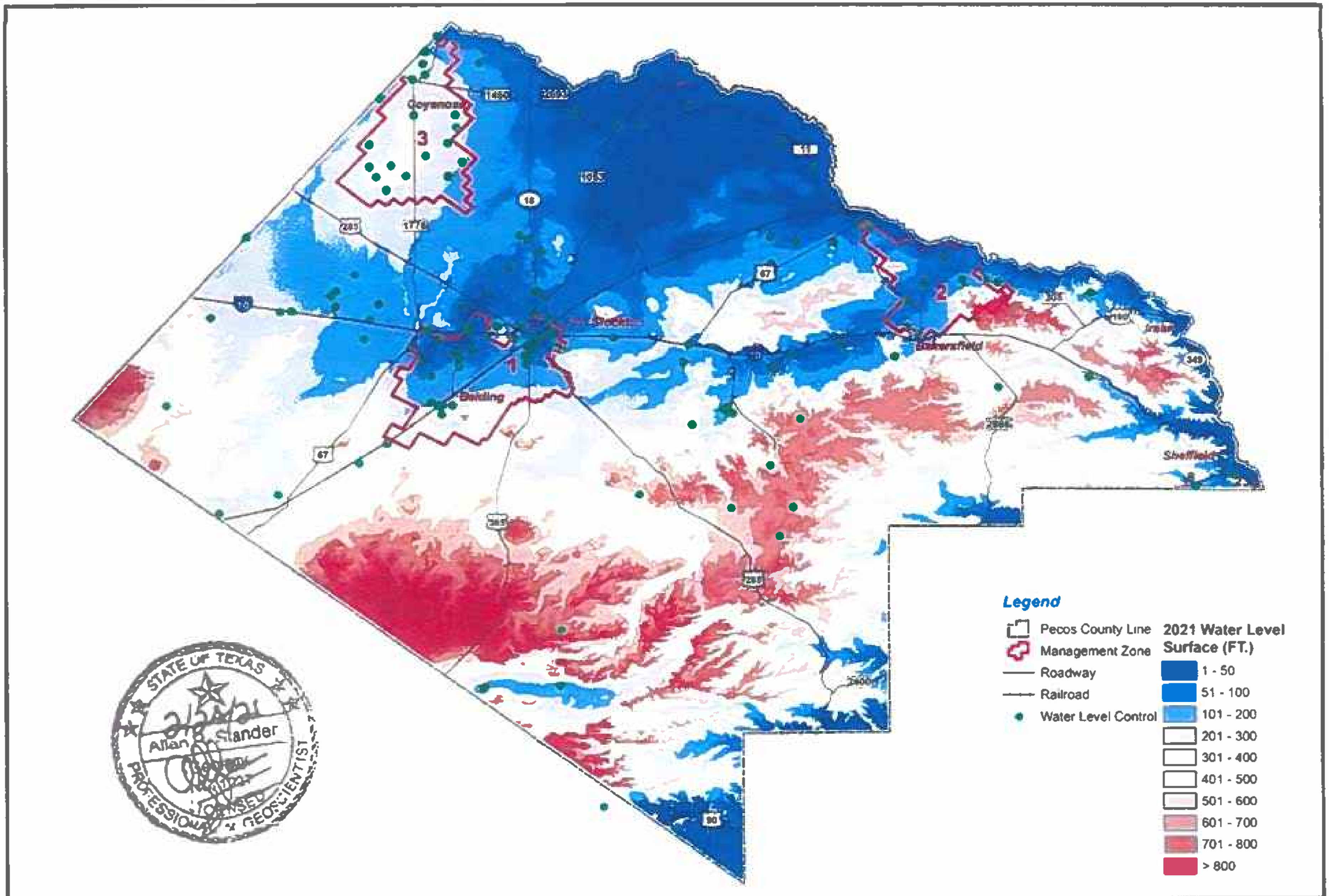
1:650,000
North American Datum 1983



Allan R. Standen LLC

2021 Depth to Water Level

Pecos County, Texas

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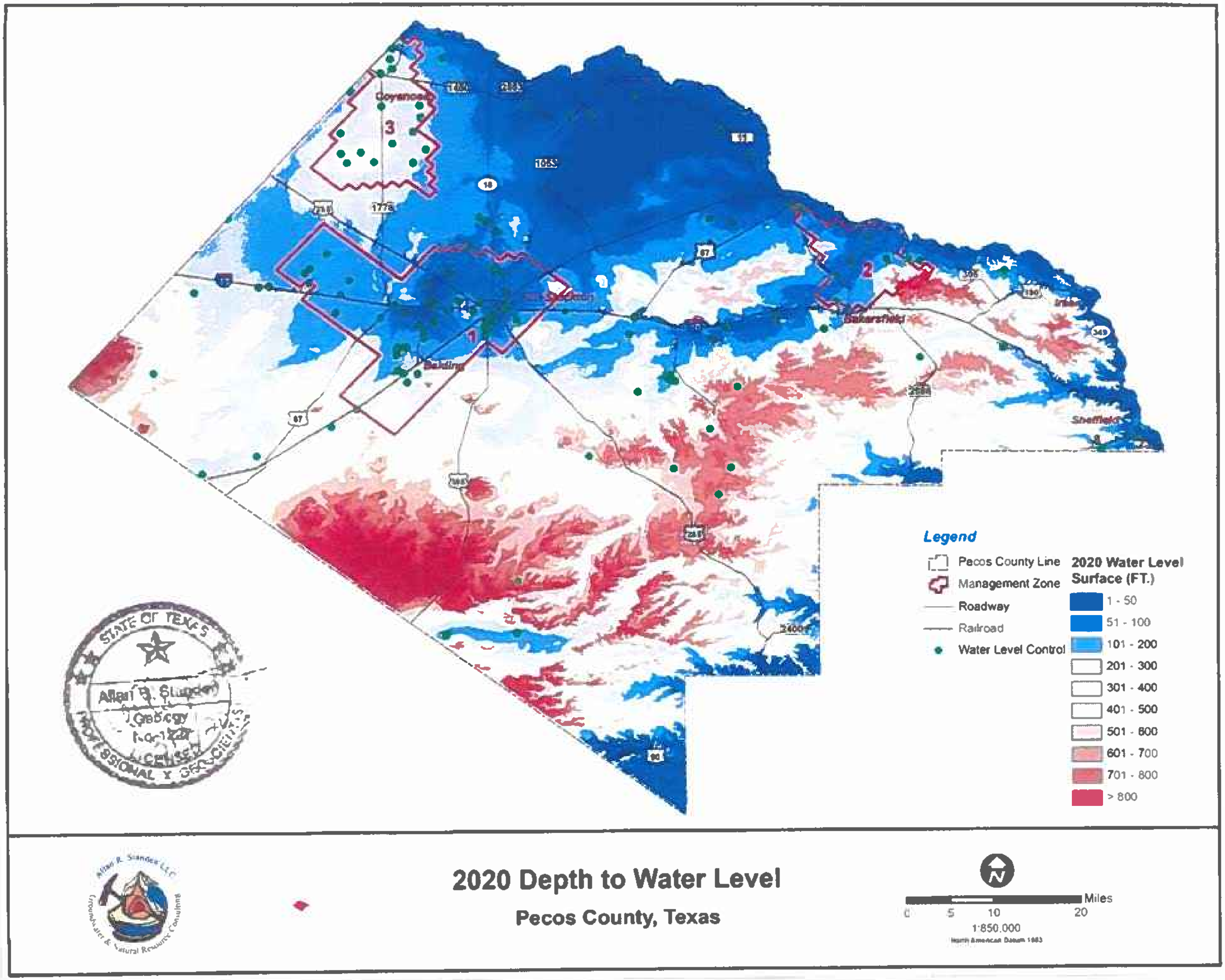
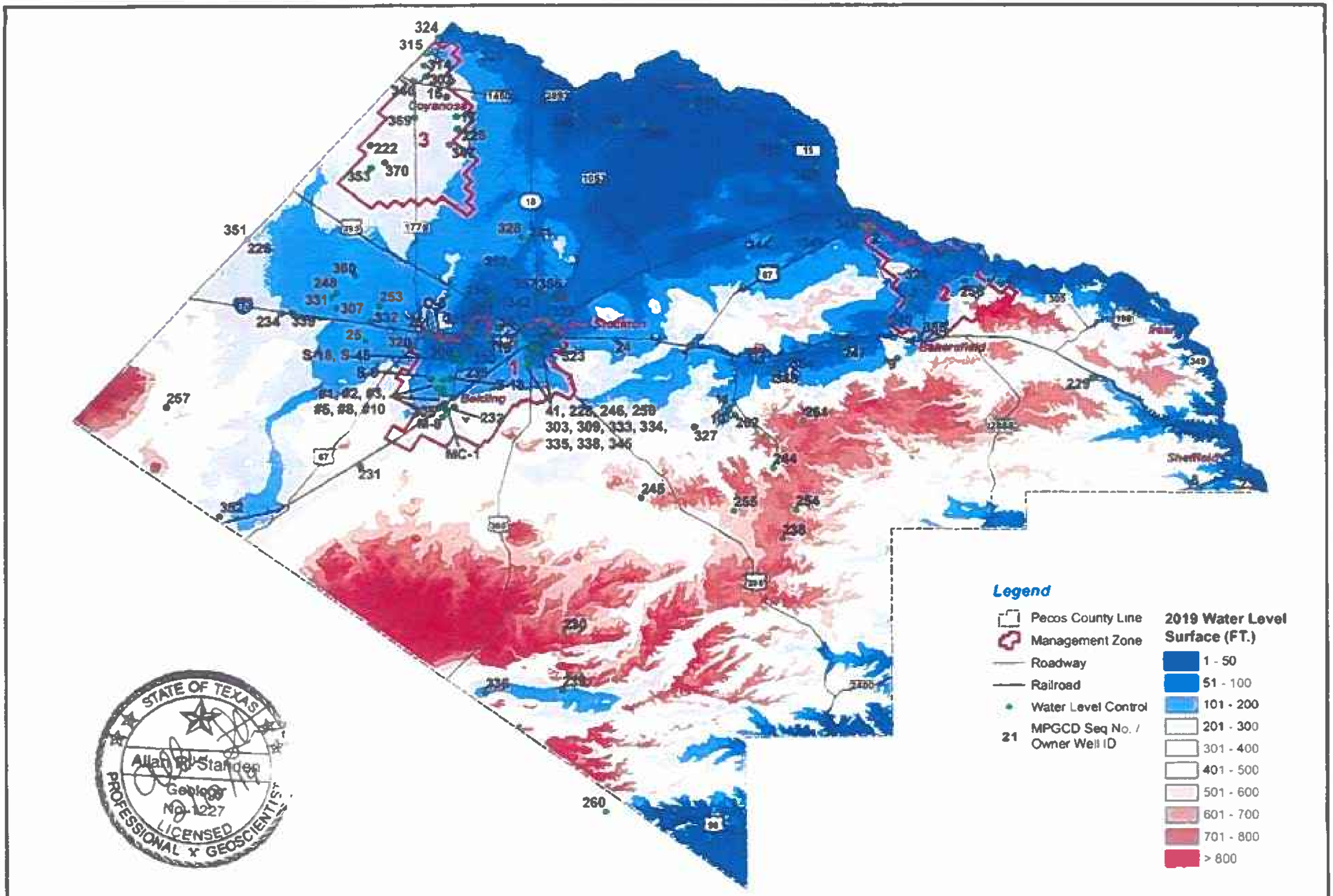
North American Datum 1983



2020 Depth to Water Level

Pecos County, Texas



Allan R. Standen LLC
Groundwater & Natural Resource Consulting

2019 Depth to Water Level

Pecos County, Texas

Miles
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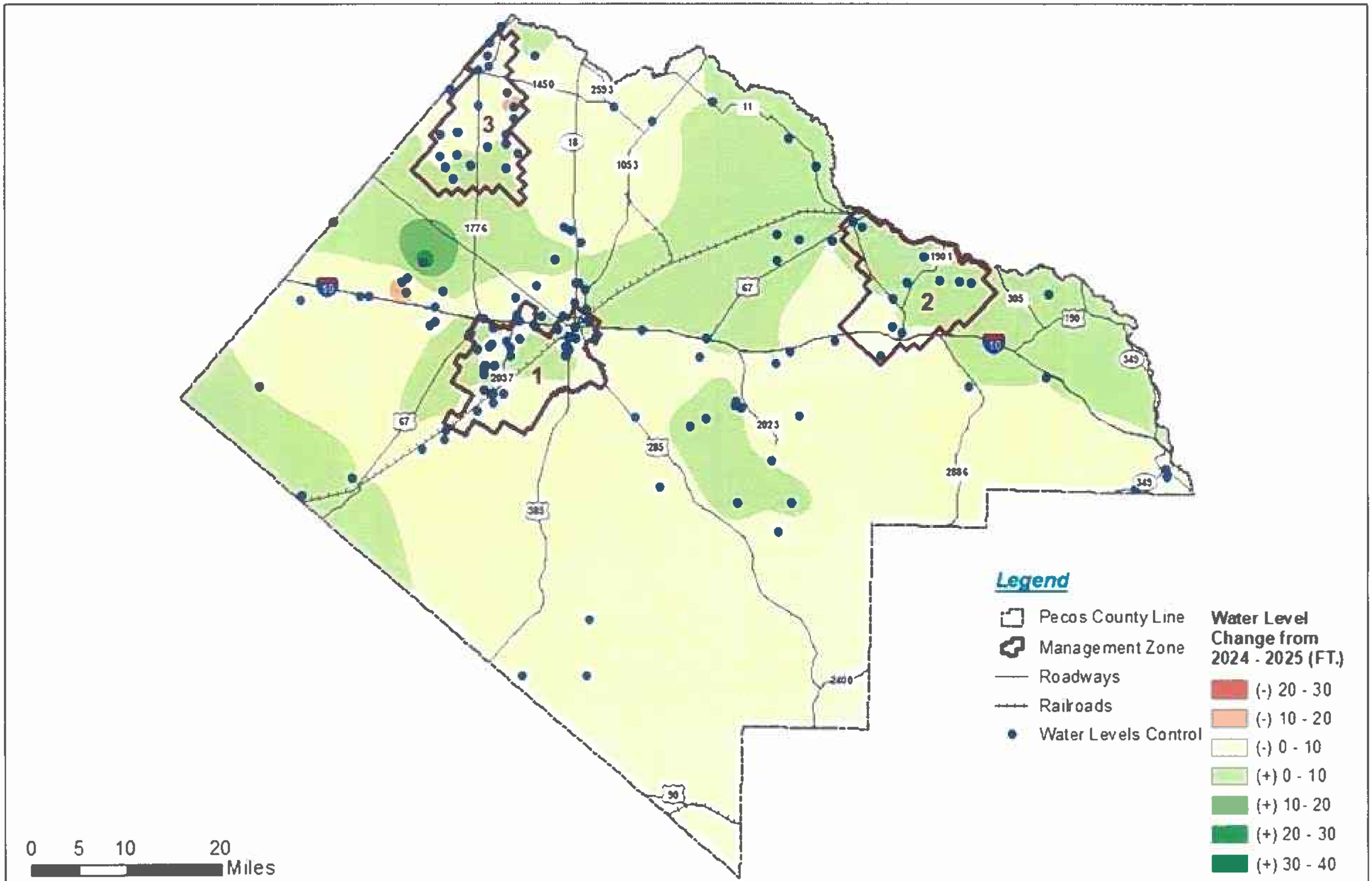
1:850,000
North American Datum 1983

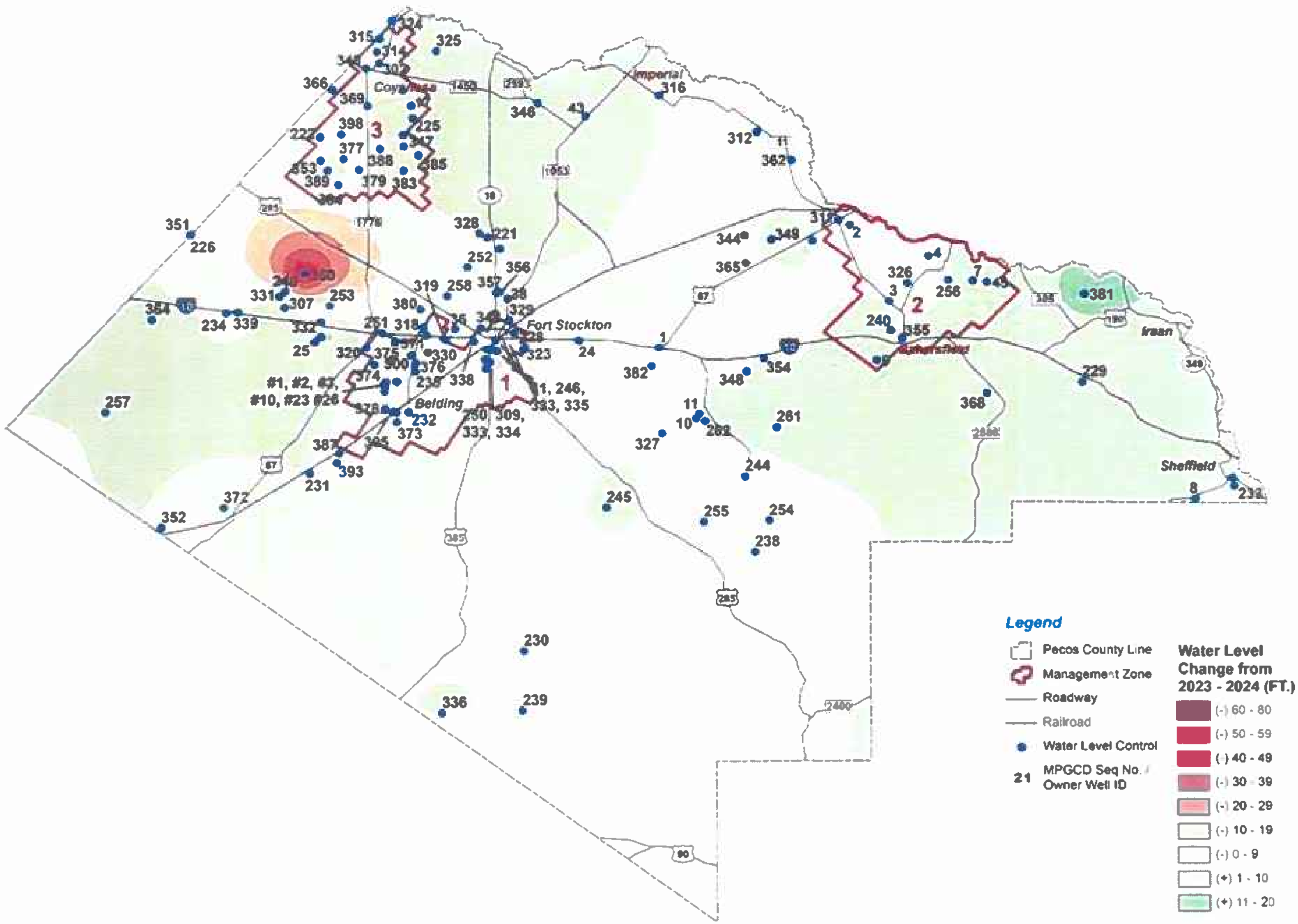


Middle Pecos GCD Monitor Wells
Water Level Decline/Gain from 2024 - 2025
Winter Water Levels
Pecos County, Texas

FREESE AND NICHOLS

Spatial Reference: TWDB GAM Coordinate System

Scale: 1 850 000



LRE WATER

Water Level Decline/Gain from 2023 - 2024

Middle Pecos GCD
Pecos County, Texas

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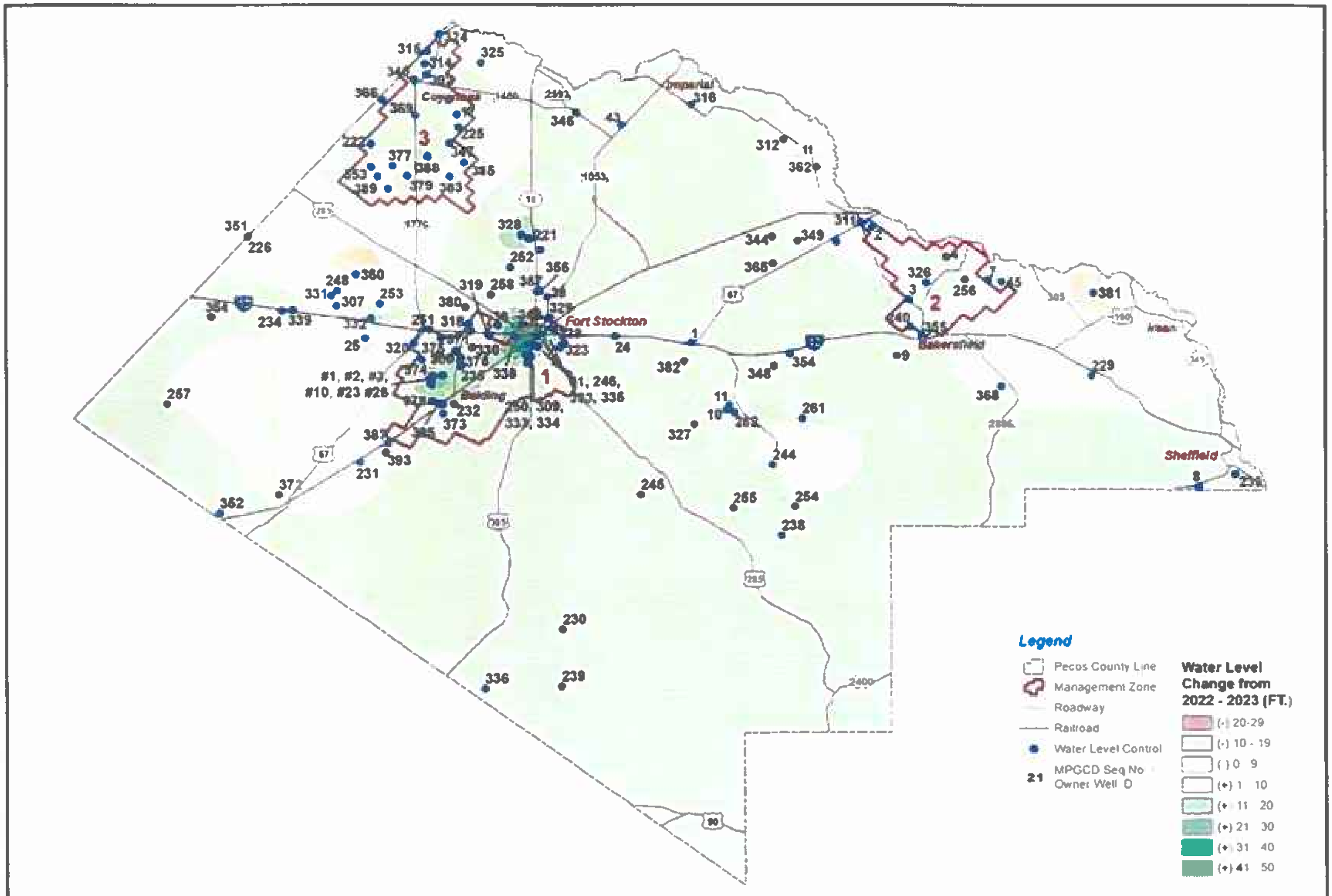
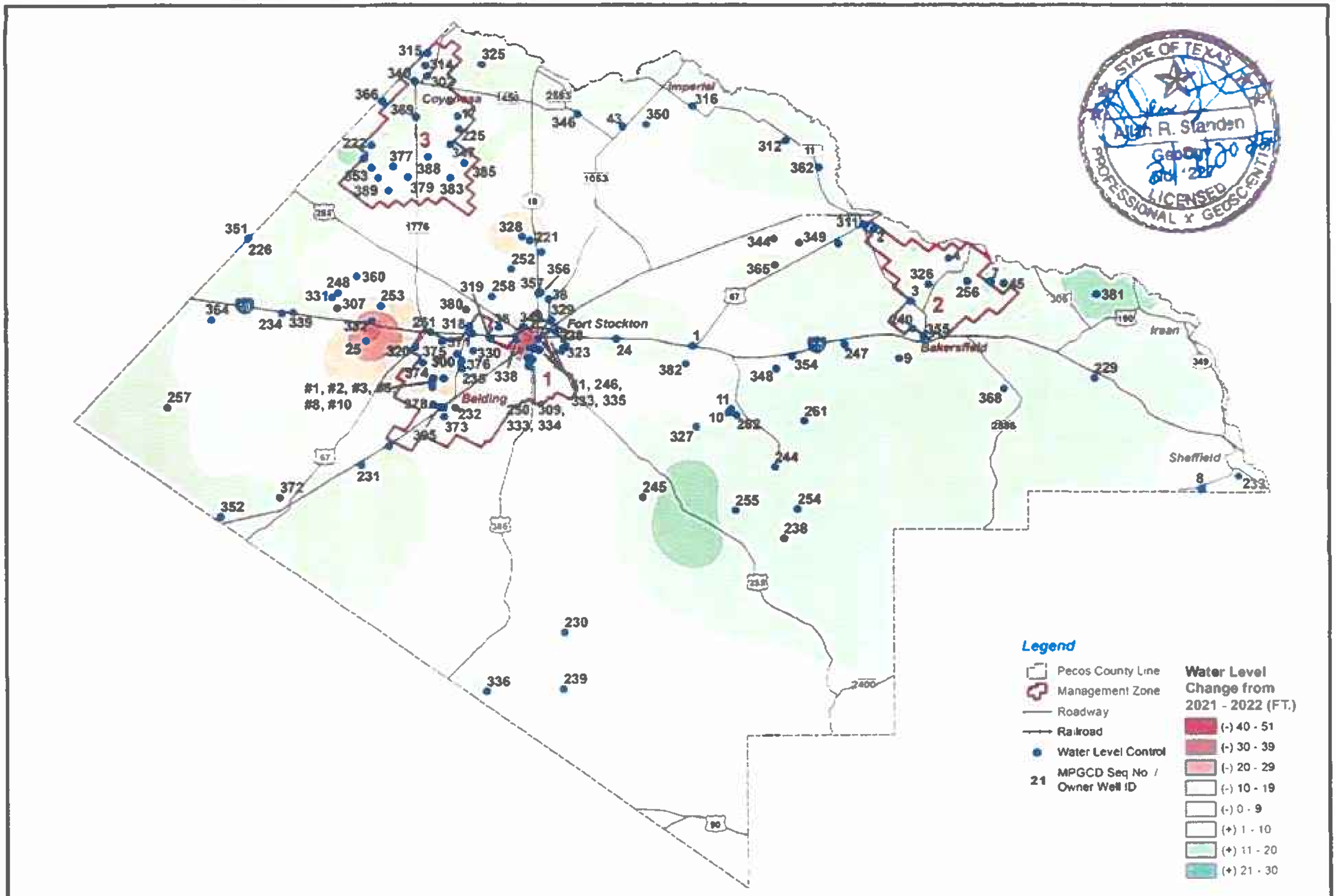
Water Level Change 2022 to 2023.



Water Level Decline/Gain from 2022 - 2023

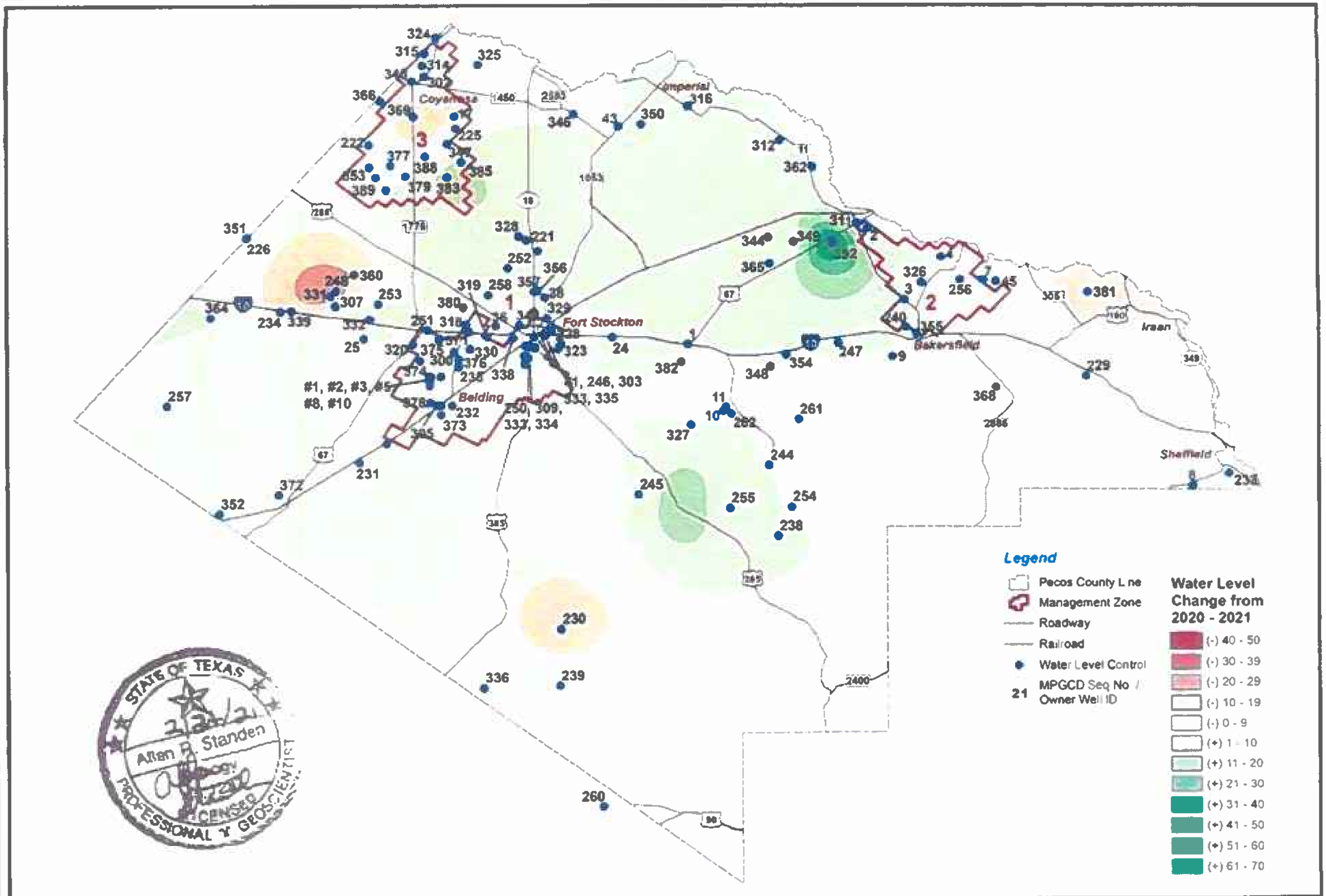
Middle Pecos GCD

Pecos County, Texas



Water Level Decline/Gain from 2021 - 2022

Pecos County, Texas



Water Level Decline/Gain from 2020 - 2021

Pecos County, Texas

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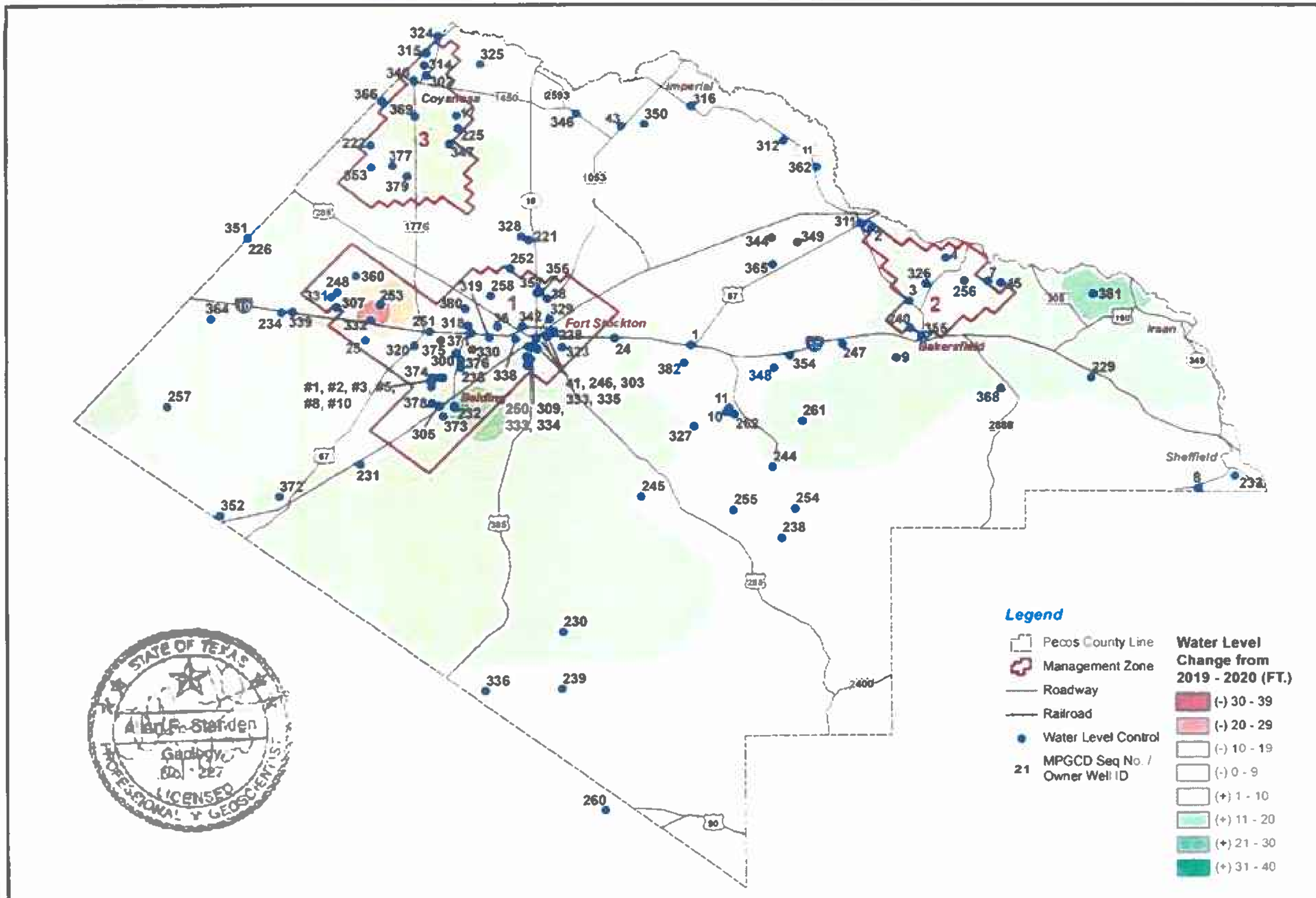
North American Datum 1983



Water Level Decline/Gain from 2019 - 2020

Pecos County, Texas

Miles
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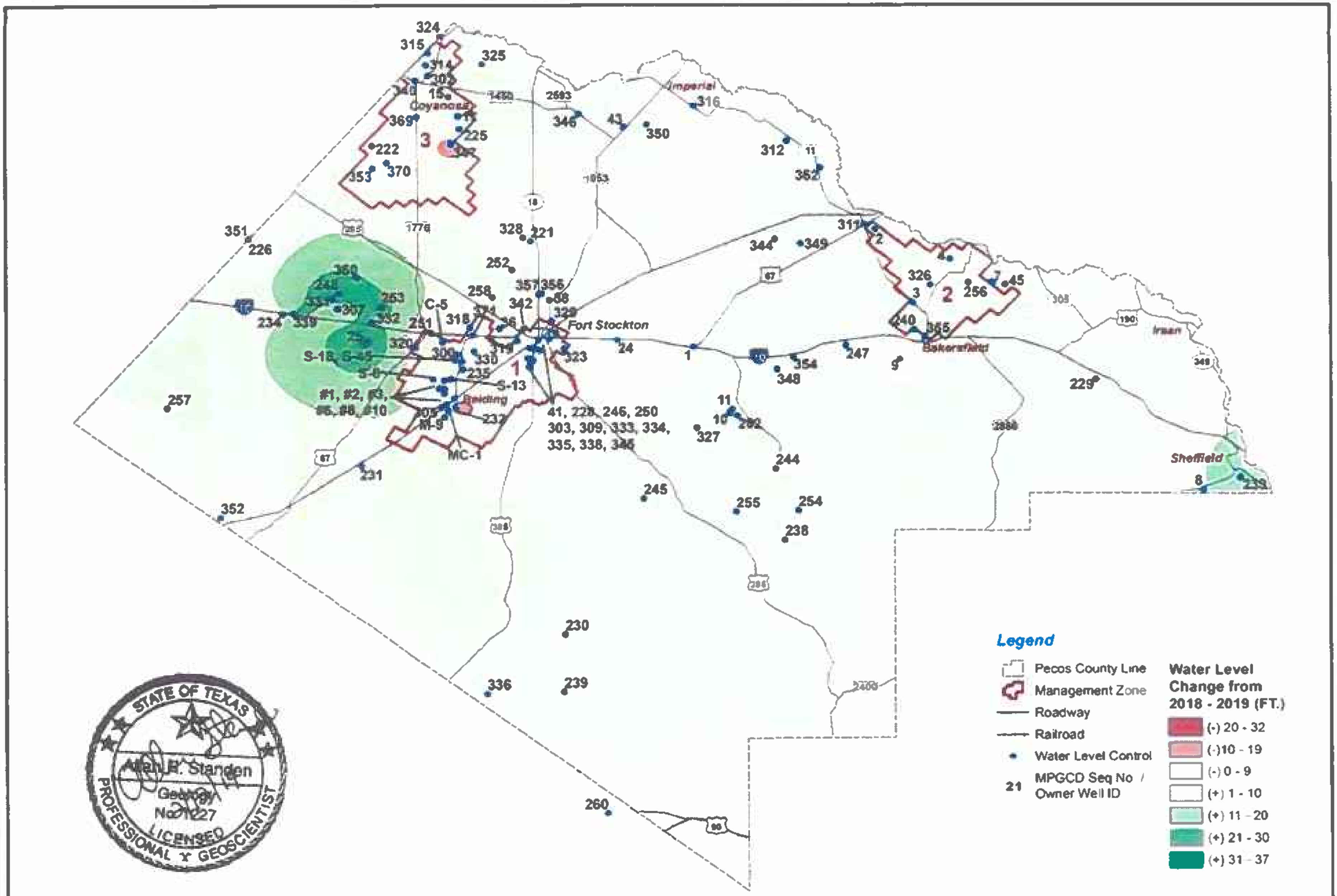
North American Datum 1983



Water Level Decline/Gain from 2018 - 2019

Pecos County, Texas

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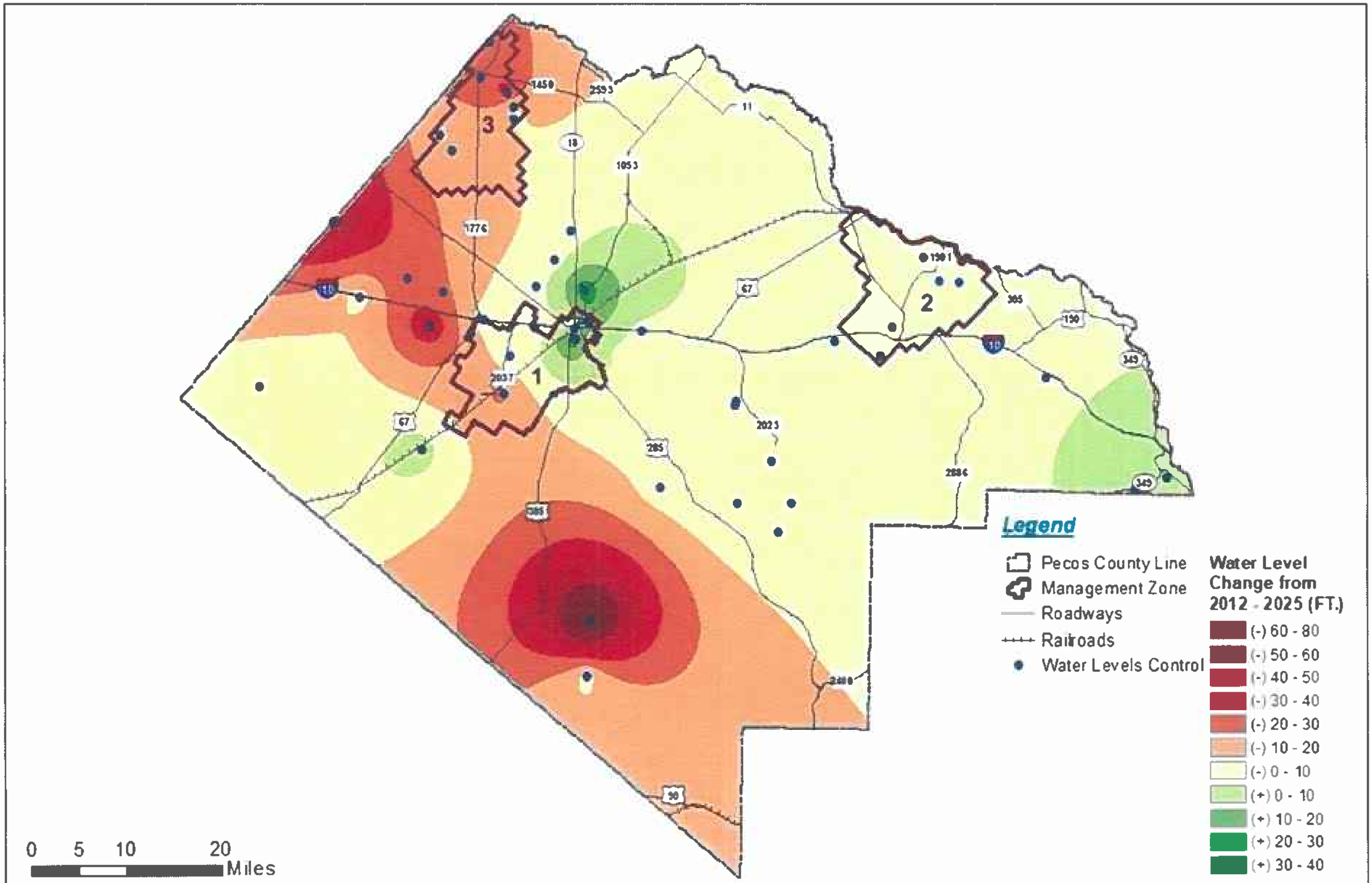
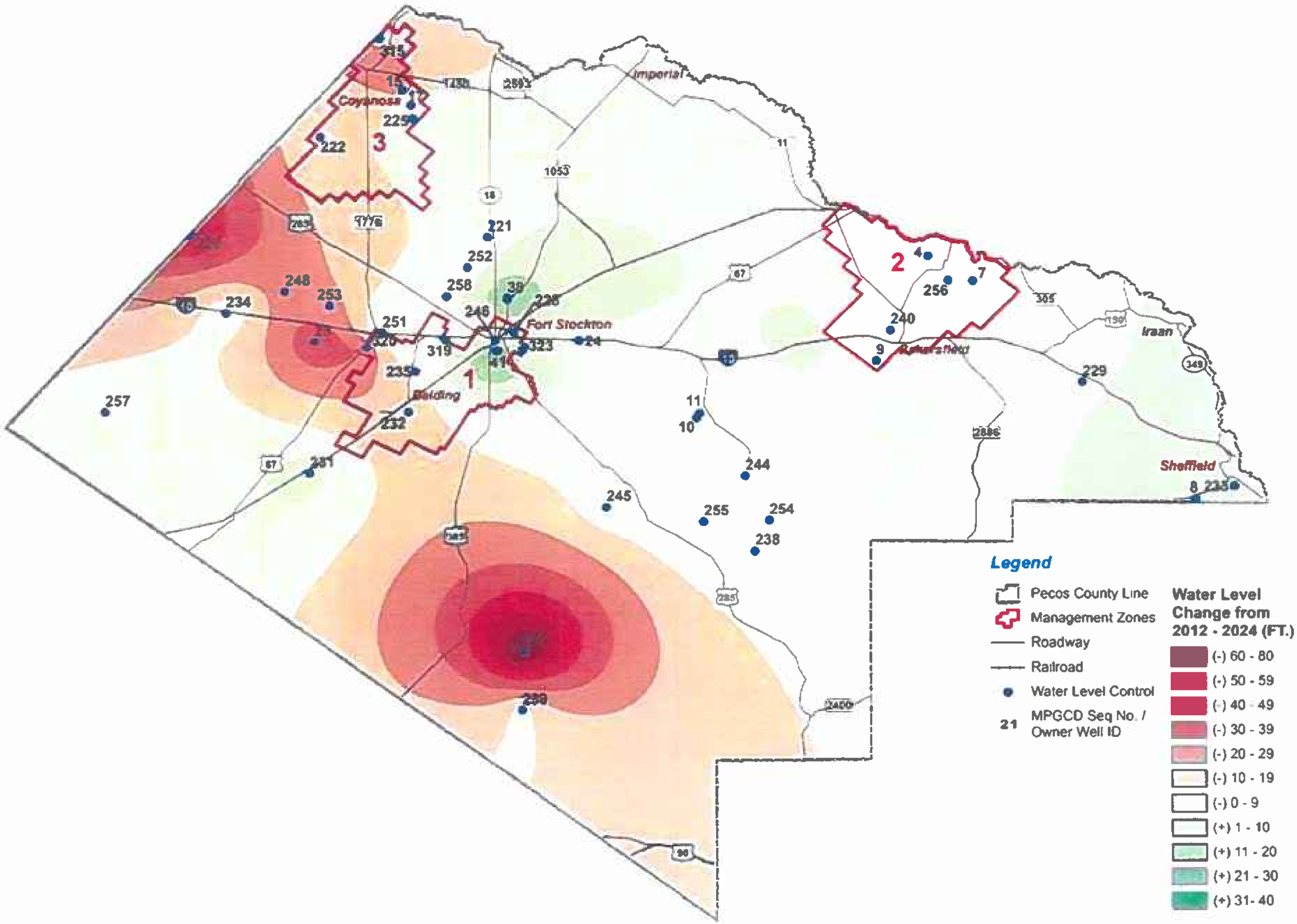


Middle Pecos GCD Monitor Wells
Water Level Decline/Gain from 2012 - 2025
Winter Water Levels
Pecos County, Texas

FREESE AND NICHOLS

Spatial Reference: TWDB GAM Coordinate System

Scale: 1 850 000

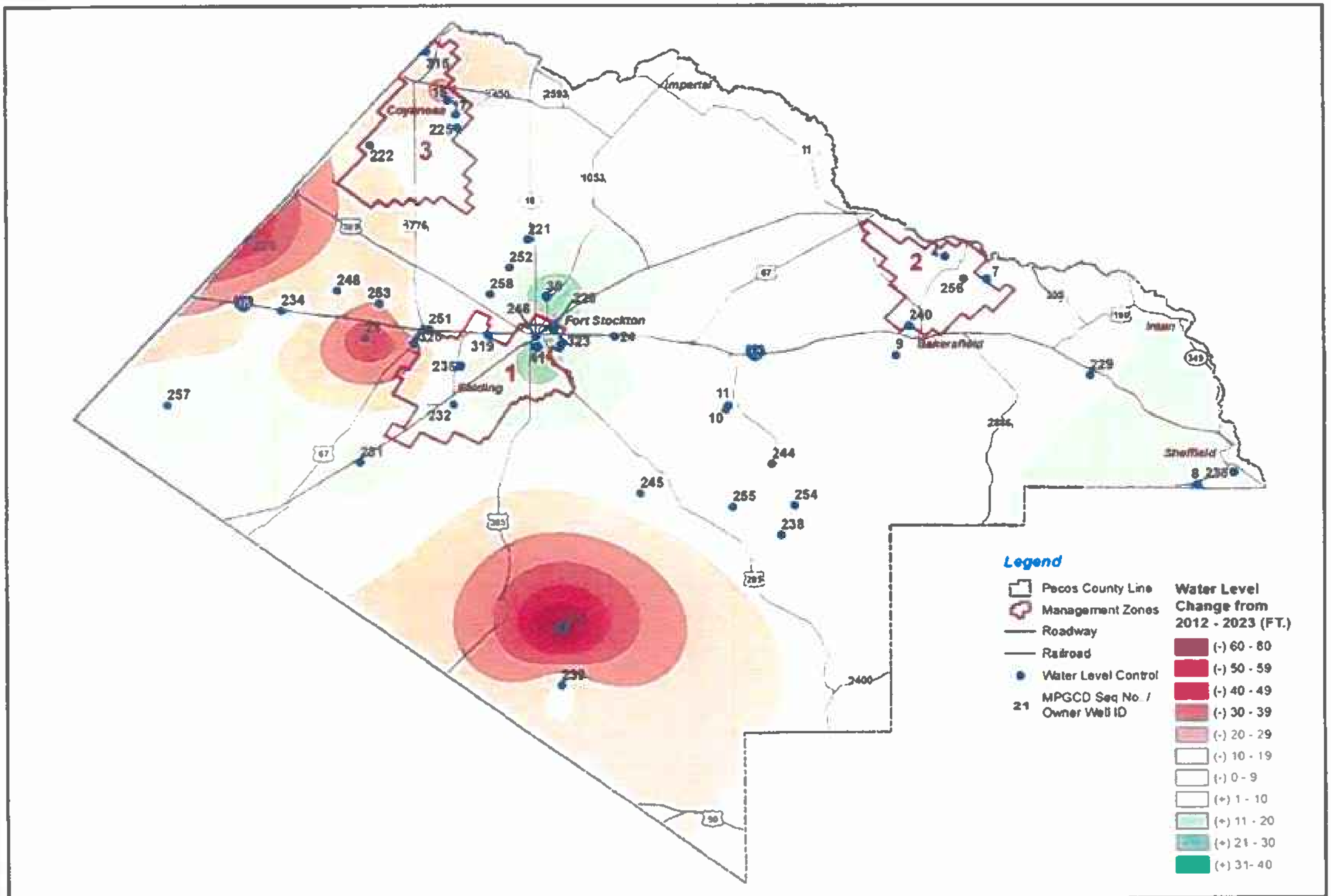


Water Level Decline/Gain from 2012 - 2024

Middle Pecos GCD

Pecos County, Texas

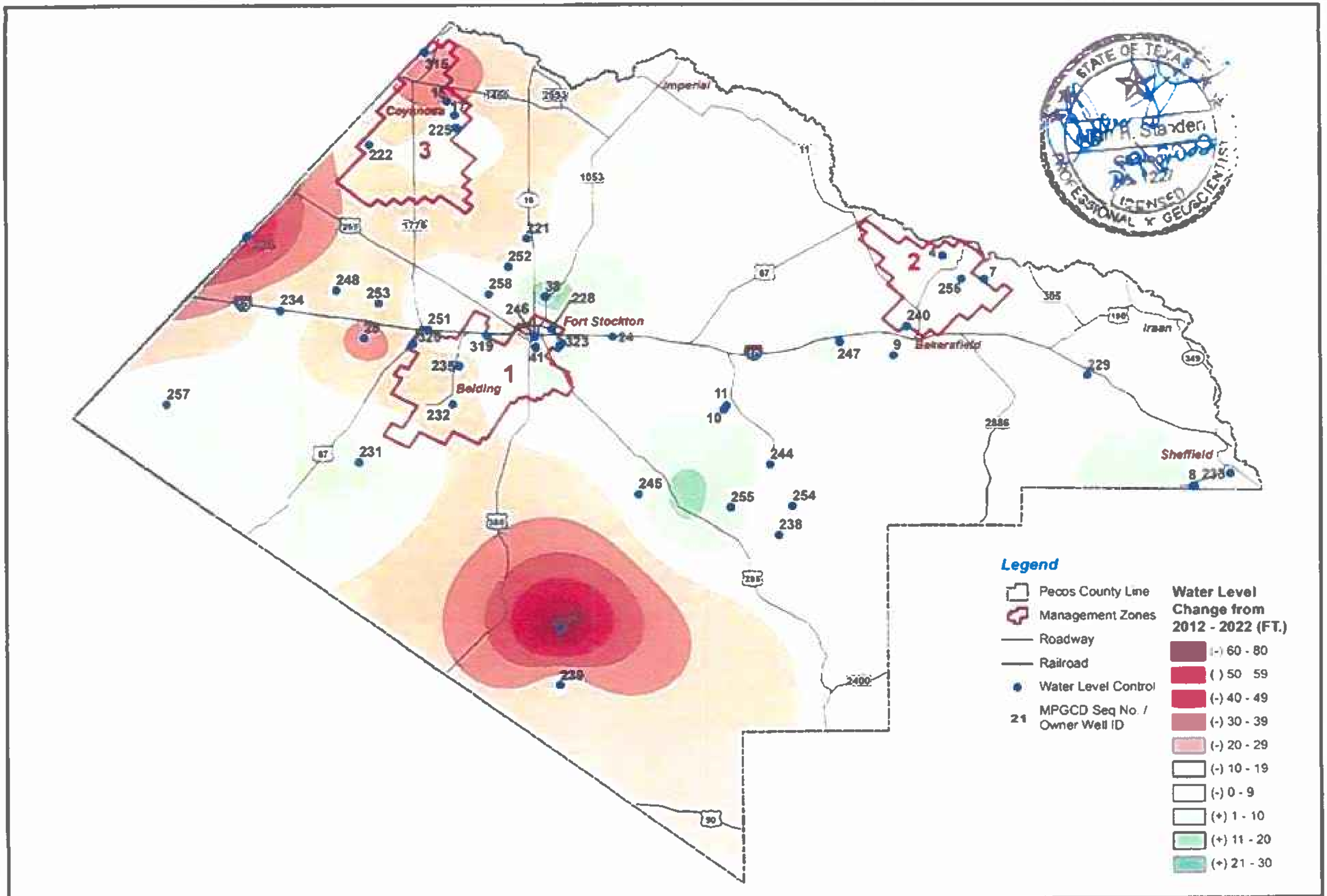
Water Level Change 2012 to 2023



Water Level Decline/Gain from 2012 - 2023

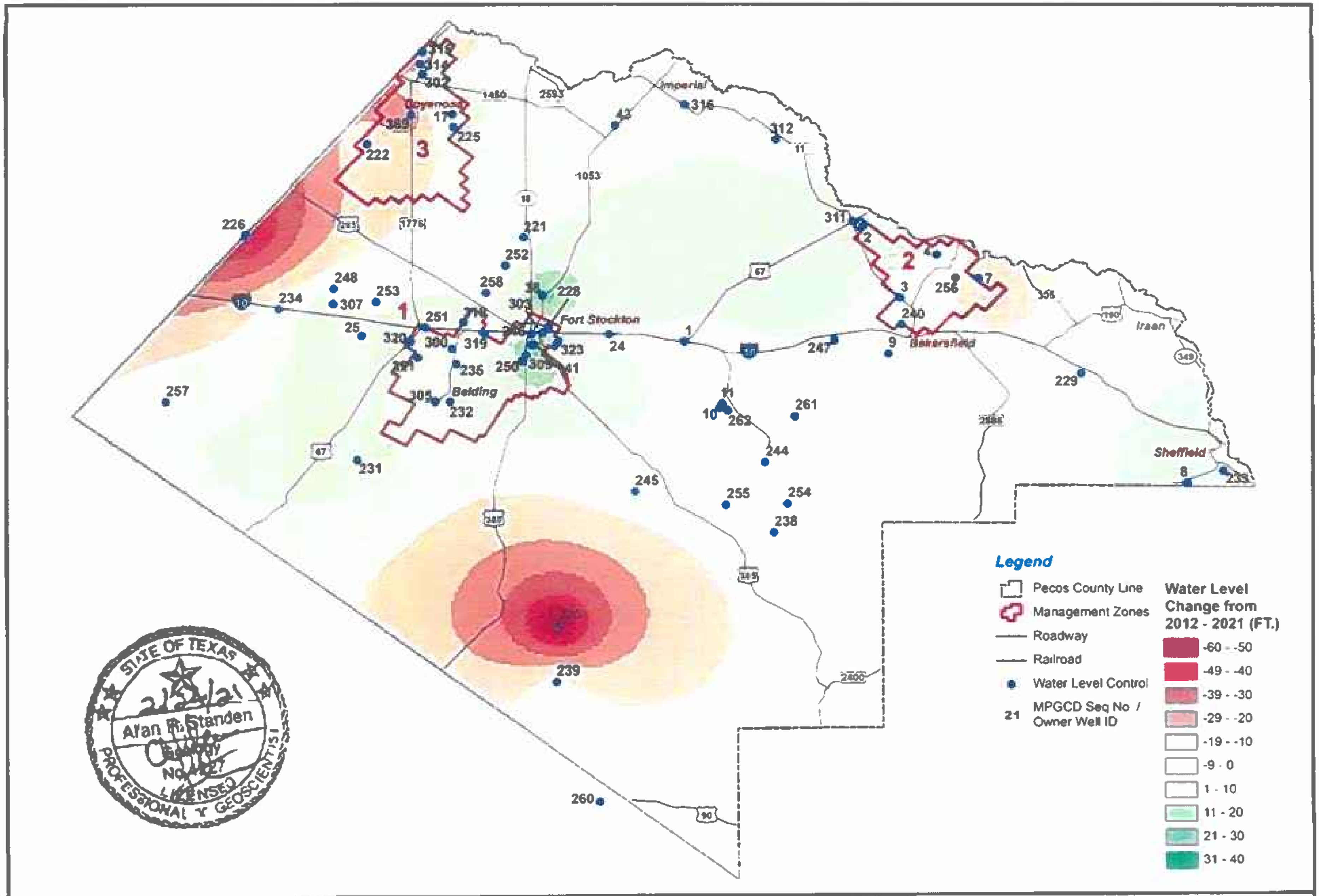
Middle Pecos GCD

Pecos County, Texas



Water Level Decline/Gain from 2012 - 2022

Pecos County, Texas



Water Level Decline/Gain from 2012 - 2021

Pecos County, Texas

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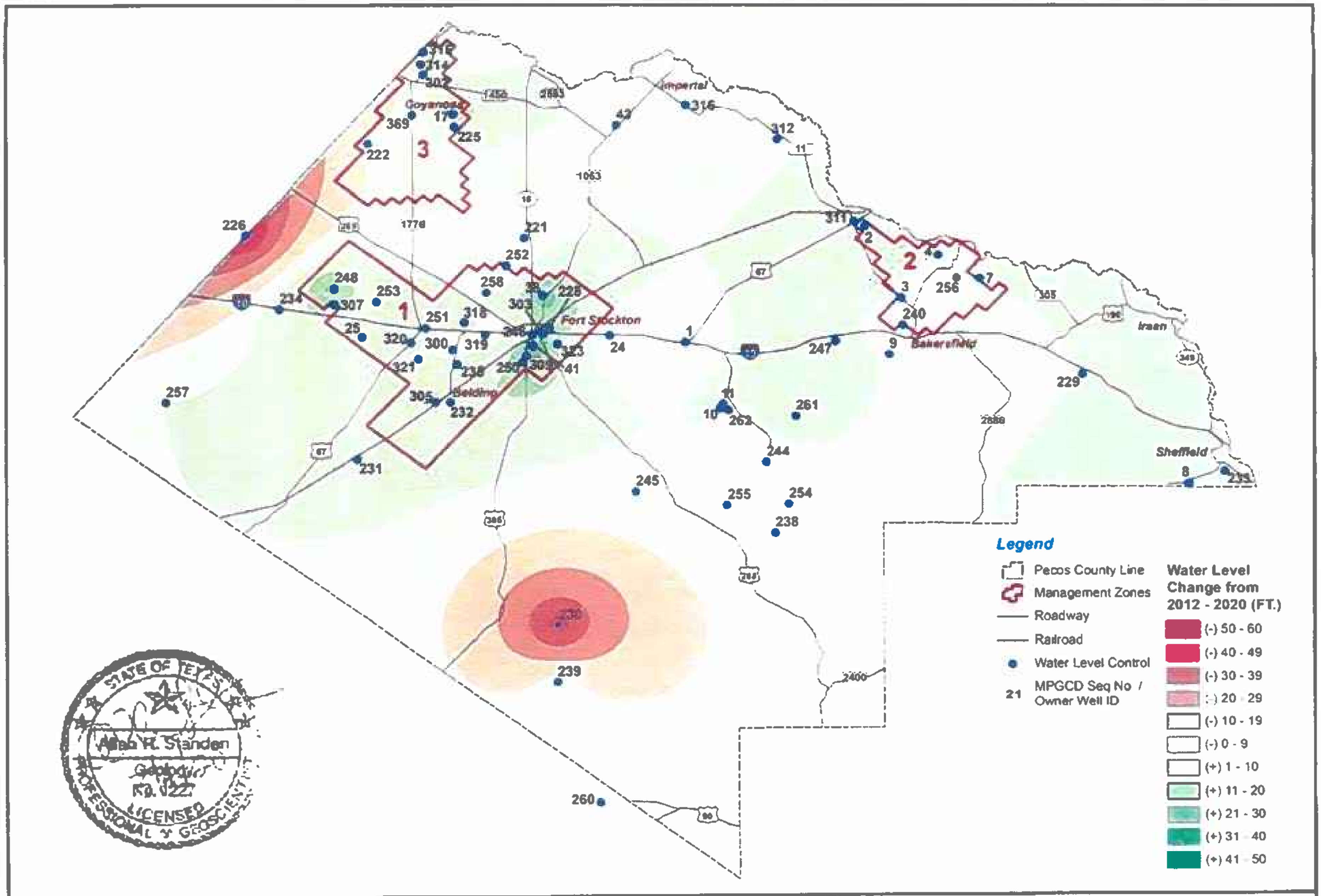
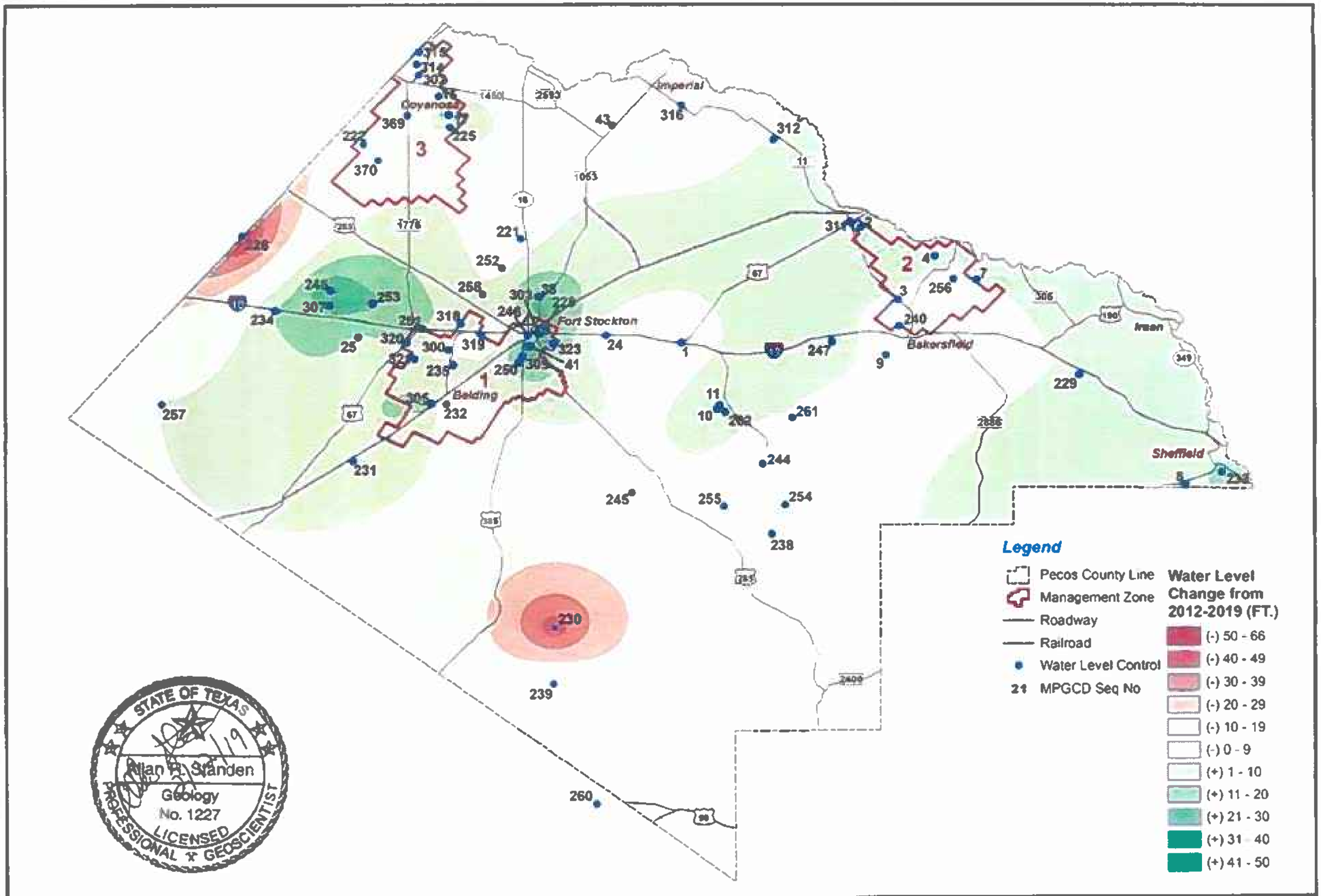


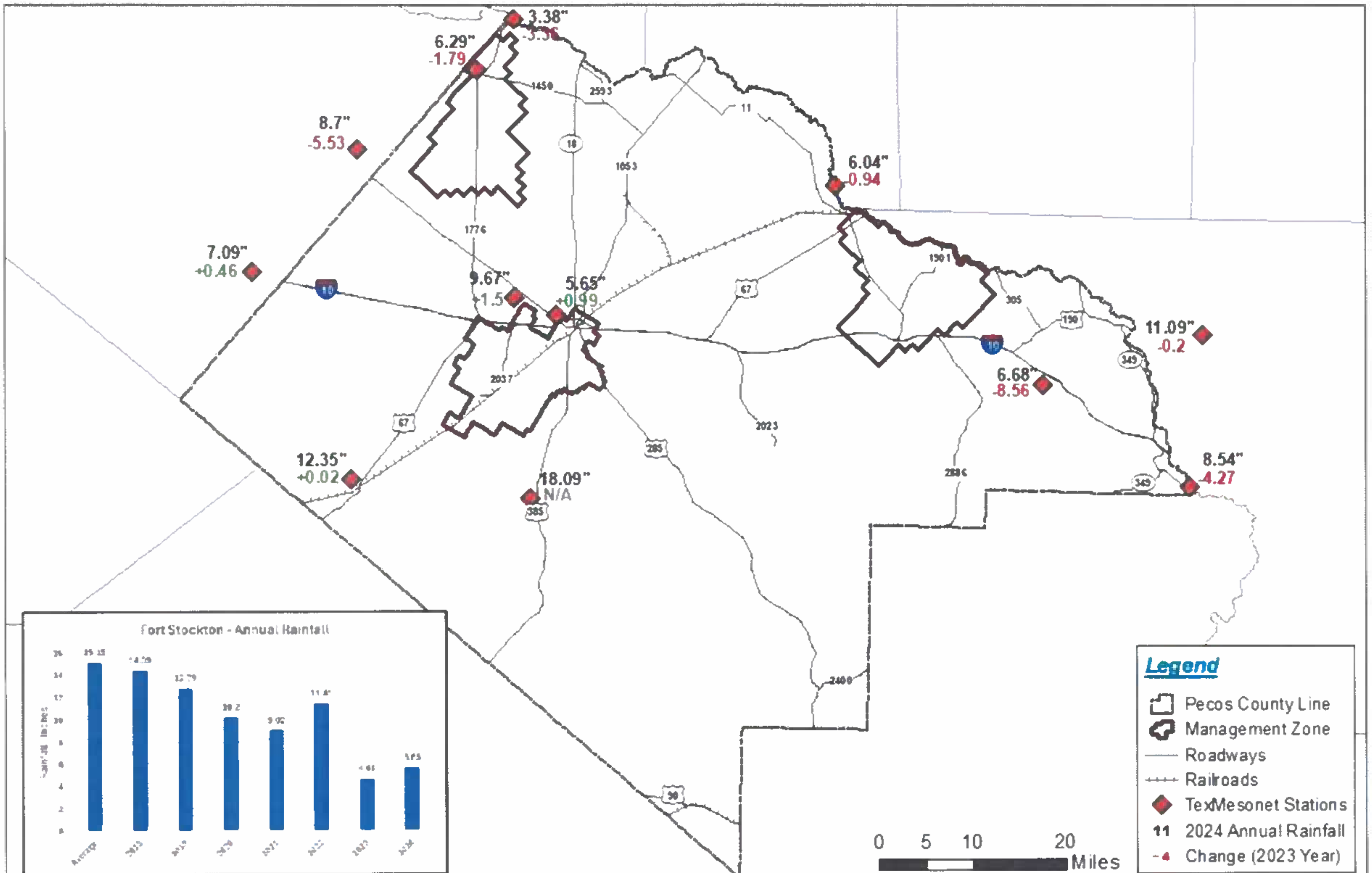
Water Level Decline/Gain from 2012 - 2020

Pecos County, Texas



Water Level Decline/Gain from 2012 - 2019

Pecos County, Texas



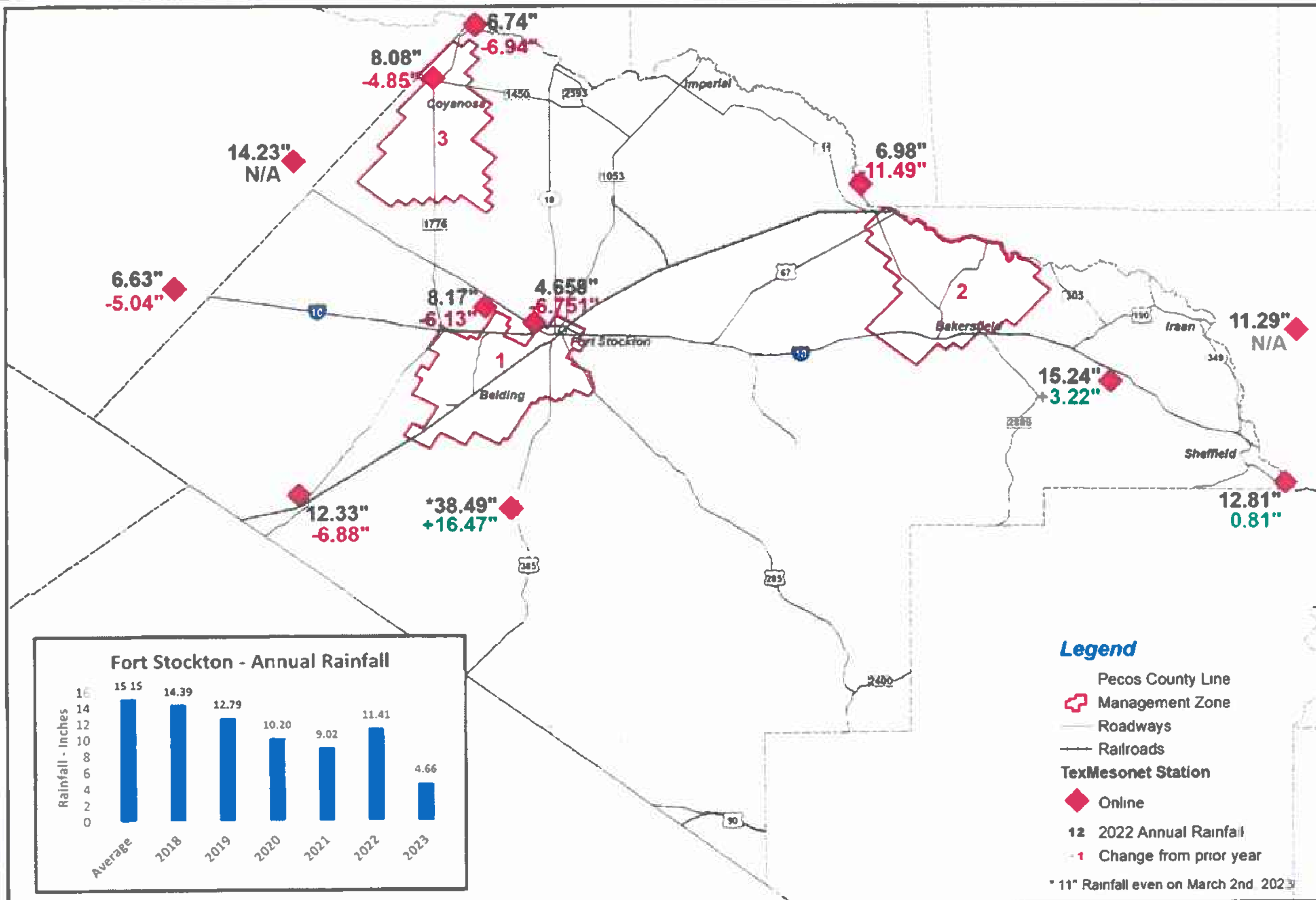
TexMesonet Weather Stations
Reported 2024 Annual Rainfall

Pecos County, Texas

FREESE AND NICHOLS

Spatial Reference: TWDB GAM Coordinate System

Scale: 1:850,000

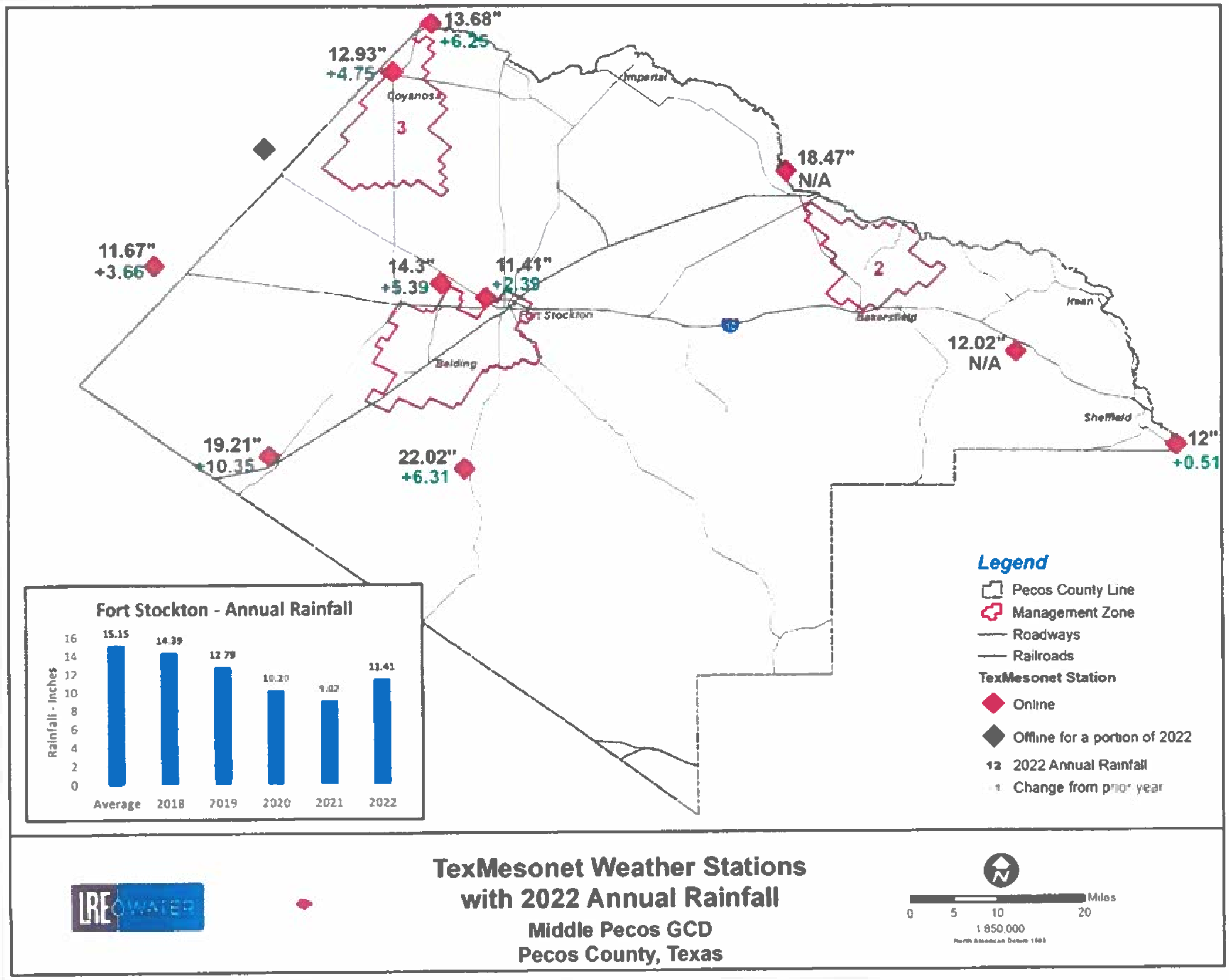


TexMesonet Weather Stations Reported 2023 Annual Rainfall

Middle Pecos GCD

Pecos County, Texas

Tex Mesonet Weather Station 2022 Rainfall



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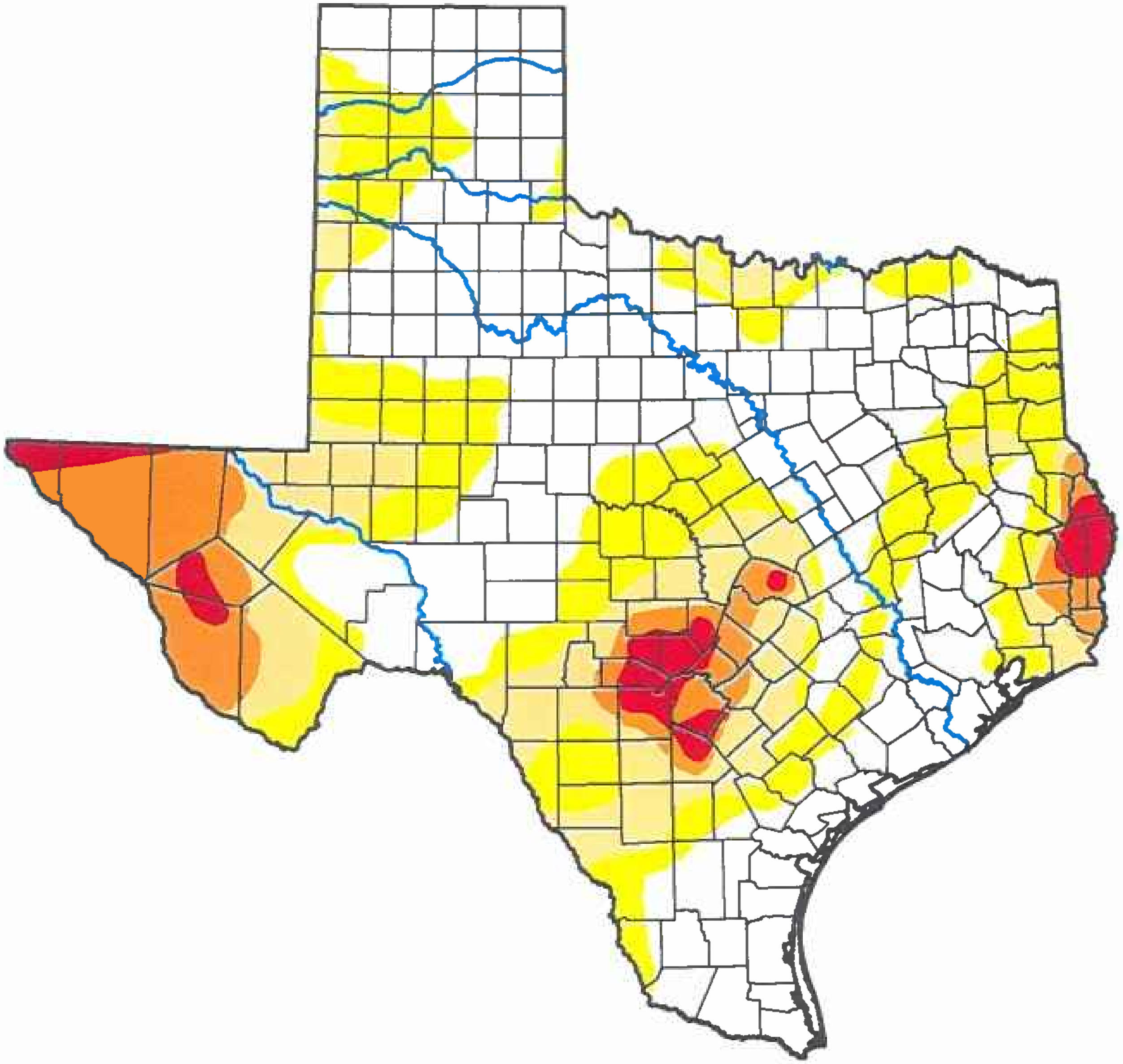
U.S. Drought Monitor
Texas

January 23, 2024
(Released Thursday, Jan. 25, 2024)
Valid 7 a.m. EST



Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

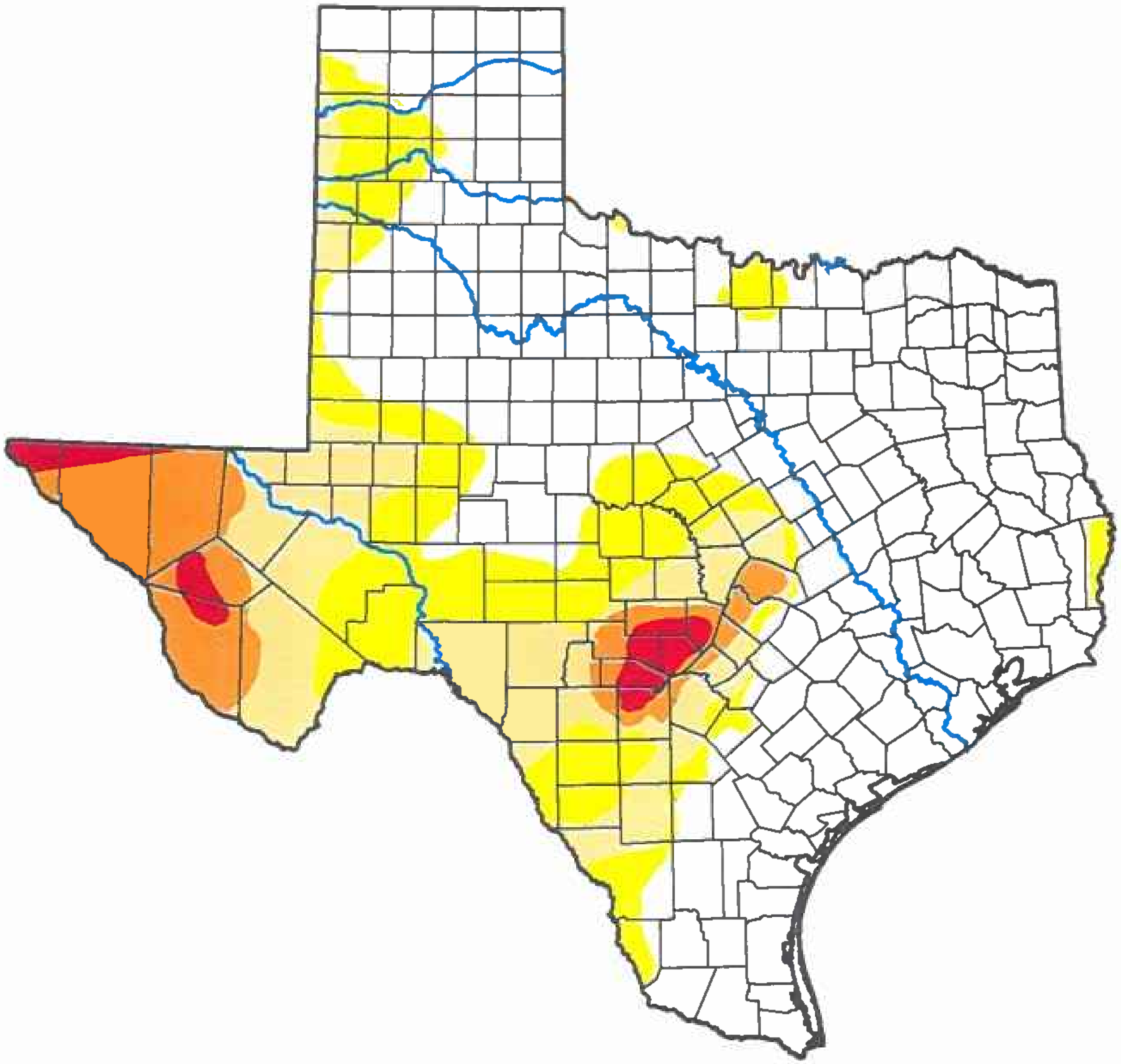
Author:

Brian Fuchs
National Drought Mitigation Center

droughtmonitor.unl.edu

U.S. Drought Monitor
Texas

February 20, 2024
(Released Thursday, Feb. 22, 2024)
Valid 7 a.m. EST



Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

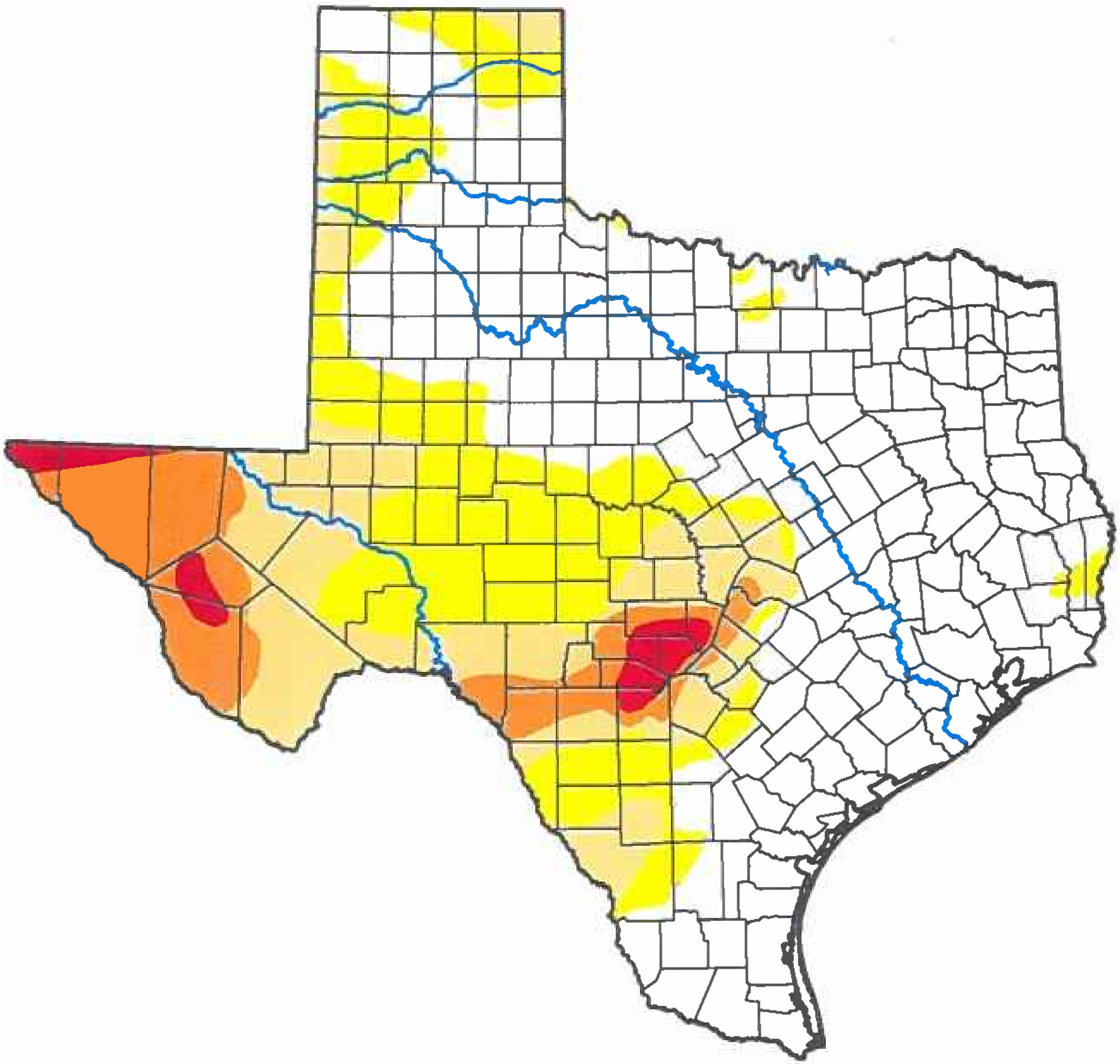
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:
Richard Heim
NCEI/NOAA

droughtmonitor.unl.edu

U.S. Drought Monitor
Texas

March 26, 2024
(Released Thursday, Mar. 28, 2024)
Valid 8 a.m. EDT



Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:

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U.S. Department of Agriculture

droughtmonitor.unl.edu

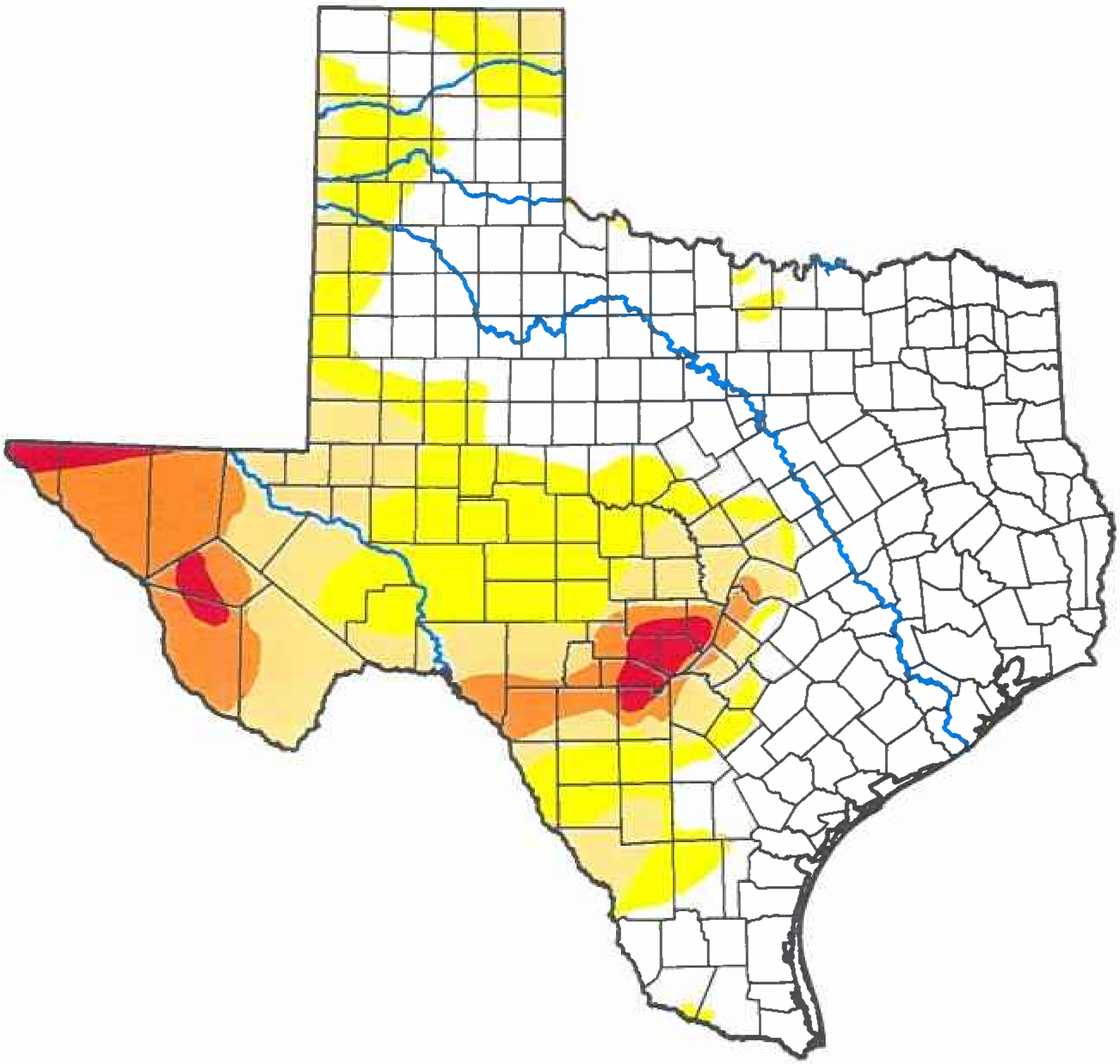
U.S. Drought Monitor

Texas

April 9, 2024

(Released Thursday, Apr. 11, 2024)

Valid 8 a.m. EDT



Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:

Brad Pugh
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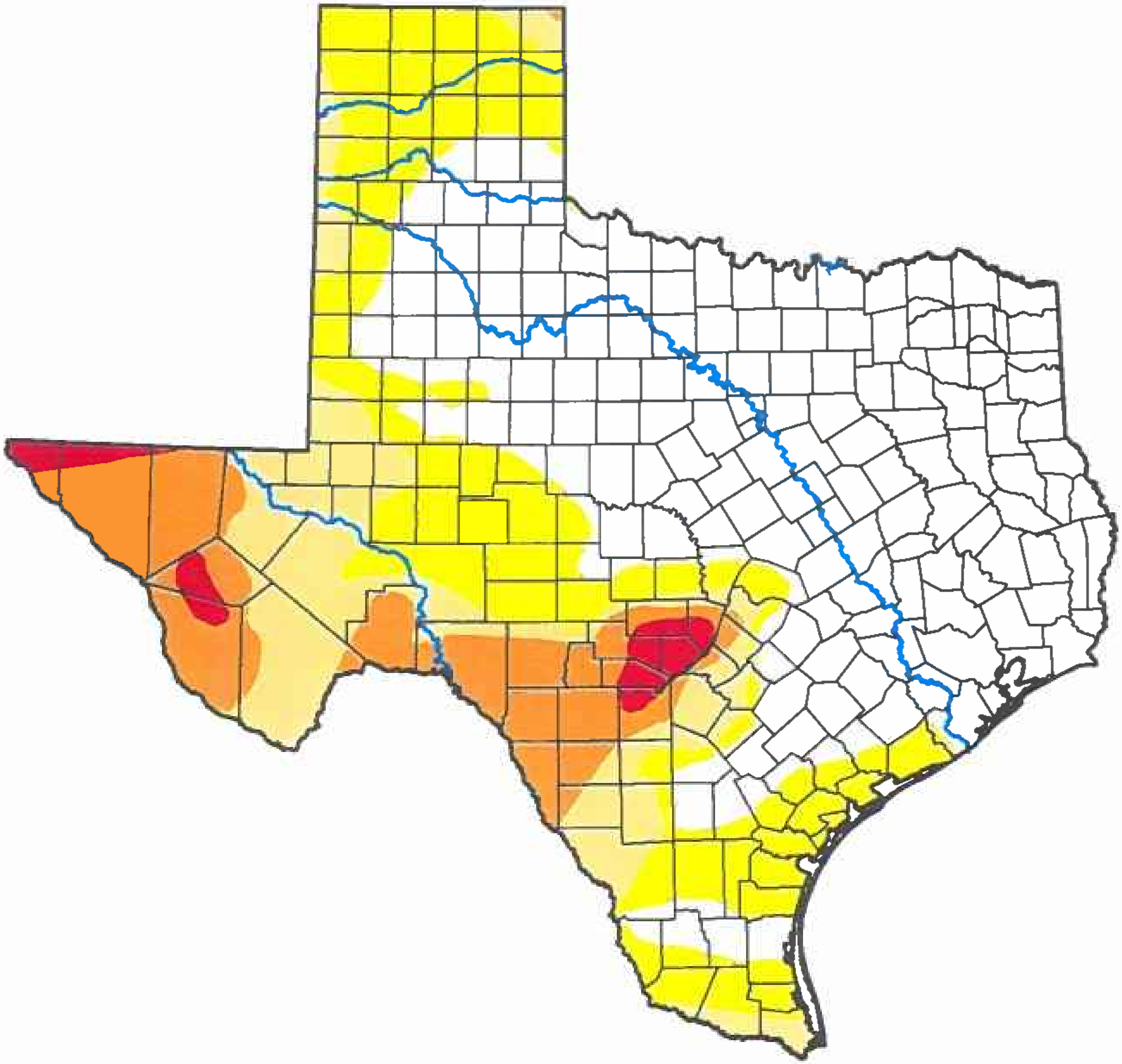
droughtmonitor.unl.edu

U.S. Drought Monitor
Texas

May 14, 2024
(Released Thursday, May. 16, 2024)
Valid 8 a.m. EDT



Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:

Lindsay Johnson
National Drought Mitigation Center

USDA NDMC NOAA

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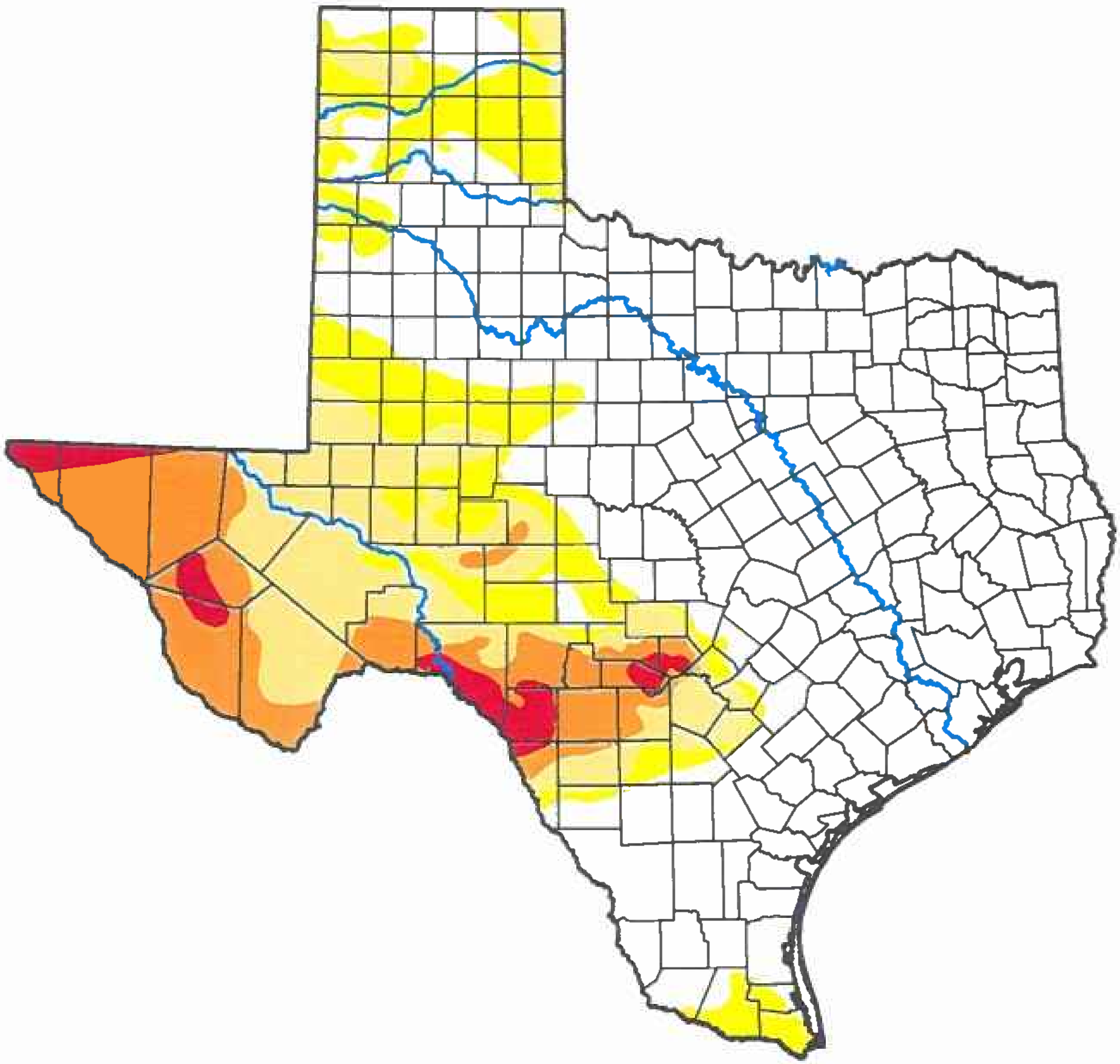
U.S. Drought Monitor
Texas

June 25, 2024
(Released Thursday, Jun. 27, 2024)
Valid 8 a.m. EDT



Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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Author:

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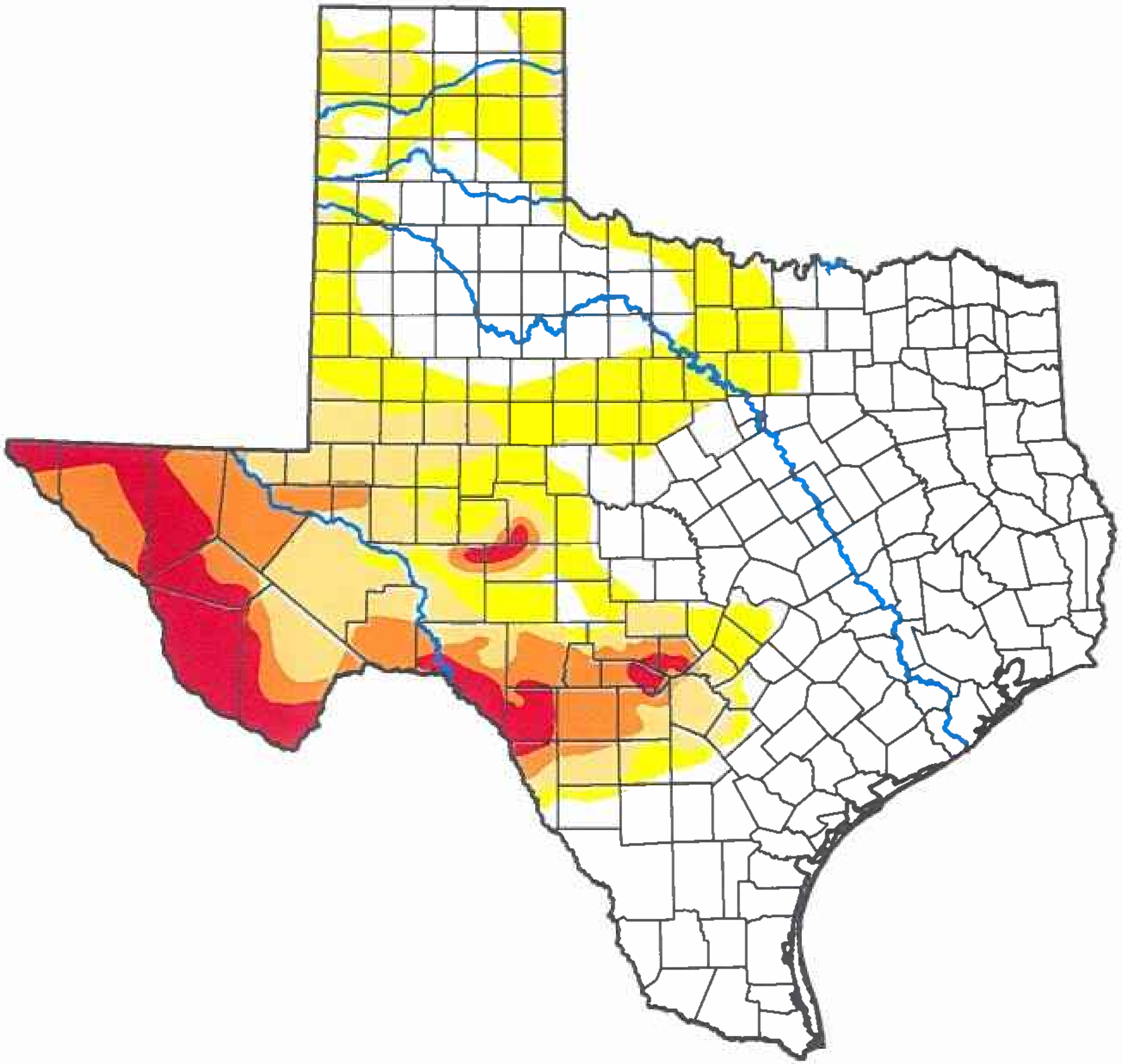
U.S. Drought Monitor
Texas

July 9, 2024
(Released Thursday, Jul. 11, 2024)
Valid 8 a.m. EDT



Intensity:

	None
	D0 Abnormally Dry
	D1 Moderate Drought
	D2 Severe Drought
	D3 Extreme Drought
	D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:

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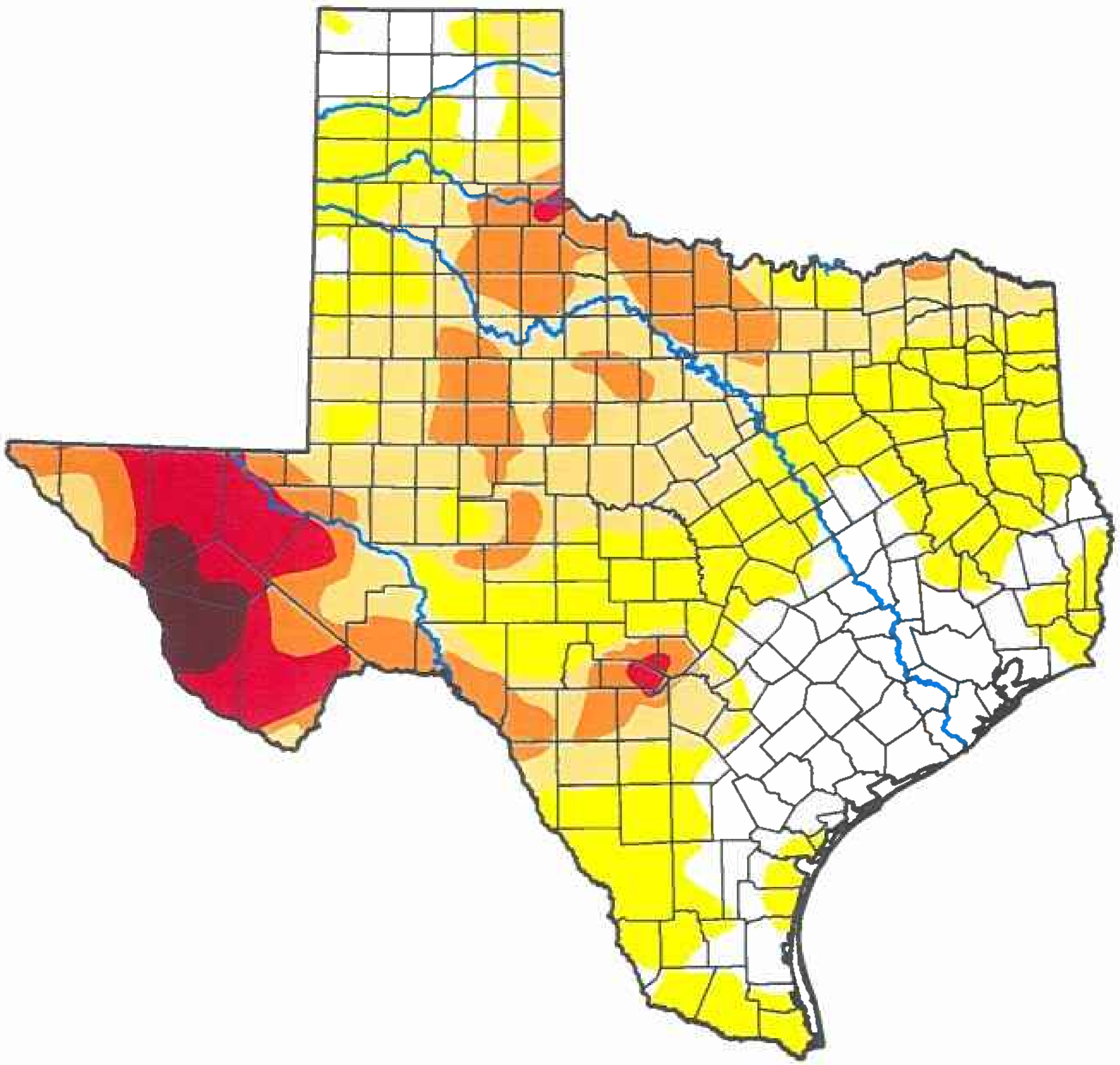
U.S. Drought Monitor
Texas

August 27, 2024
(Released Thursday, Aug. 29, 2024)
Valid 8 a.m. EDT



Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:

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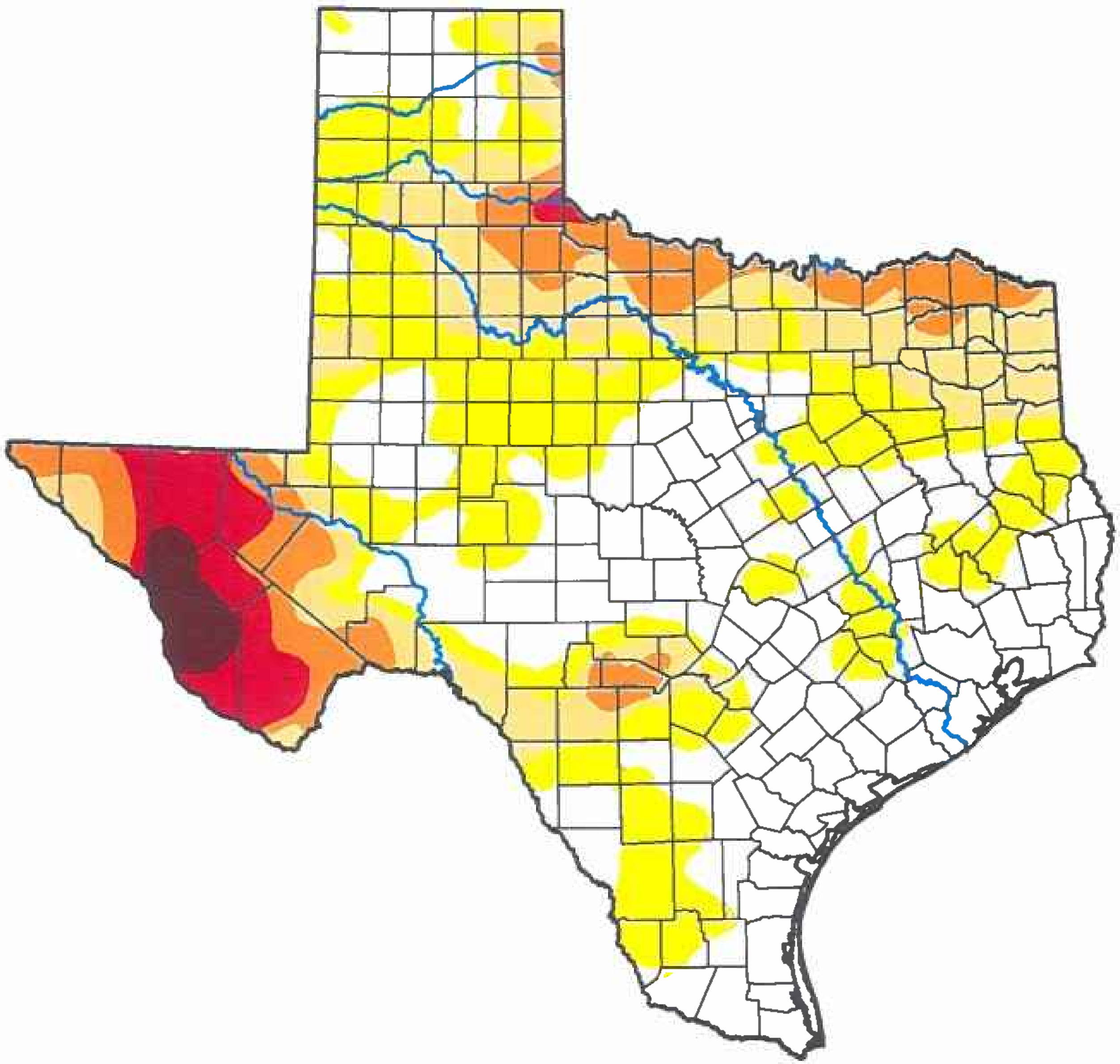
U.S. Drought Monitor

Texas

September 10, 2024

(Released Thursday, Sep. 12, 2024)

Valid 8 a.m. EDT



Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:

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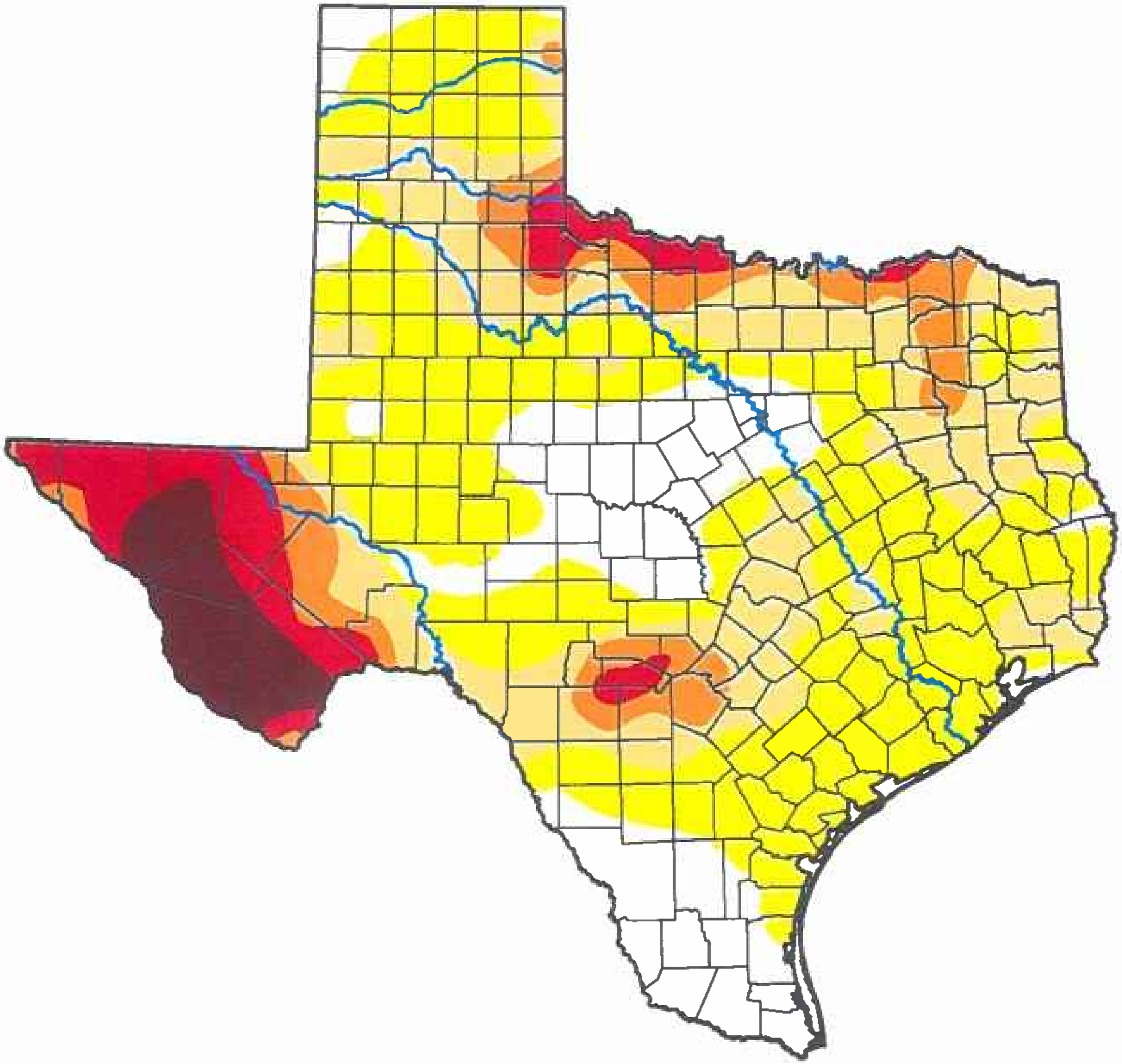
droughtmonitor.unl.edu

U.S. Drought Monitor
Texas

October 8, 2024
(Released Thursday, Oct. 10, 2024)
Valid 8 a.m. EDT



Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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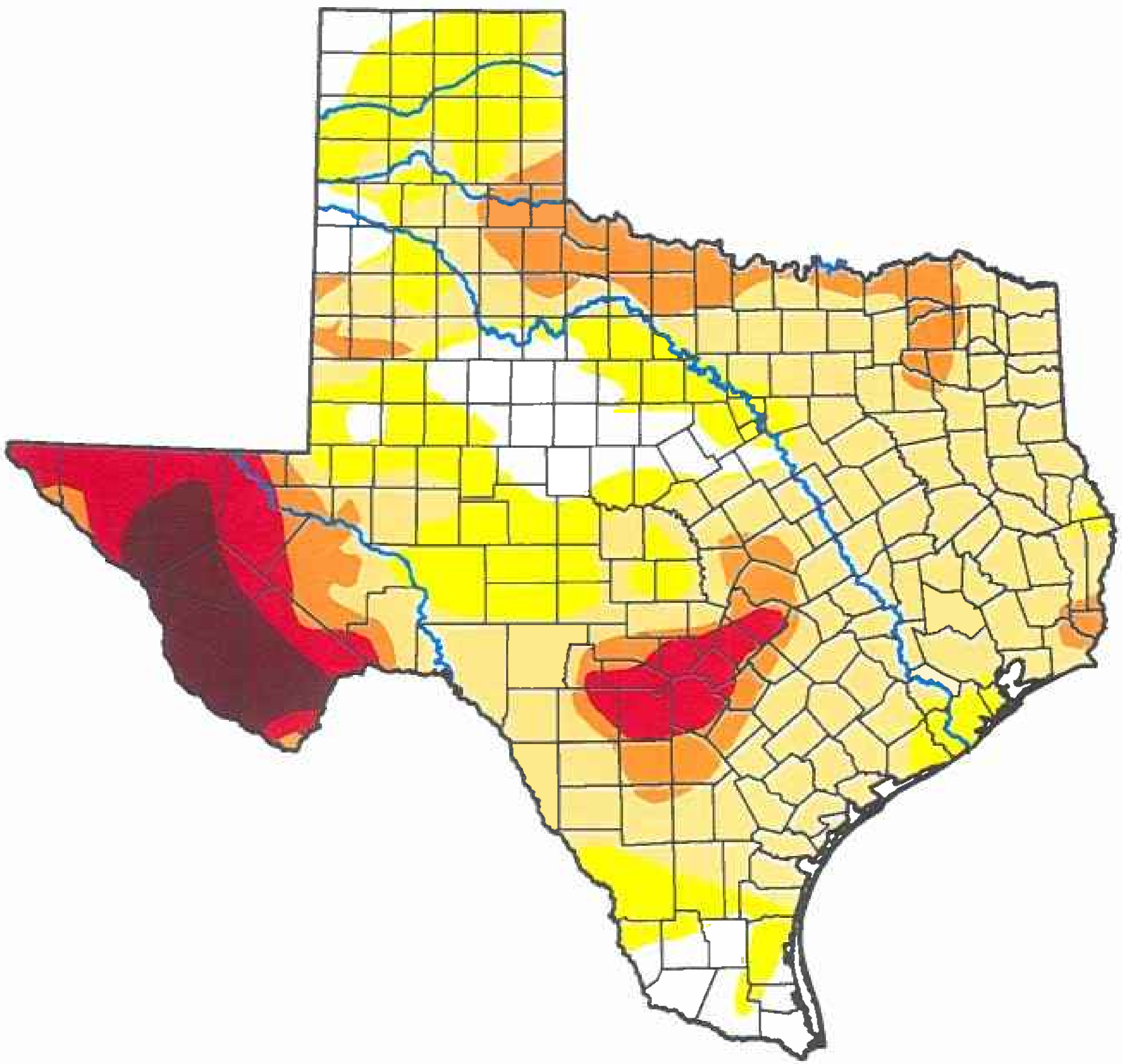
U.S. Drought Monitor

Texas

November 5, 2024

(Released Thursday, Nov. 7, 2024)

Valid 7 a.m. EST



Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:

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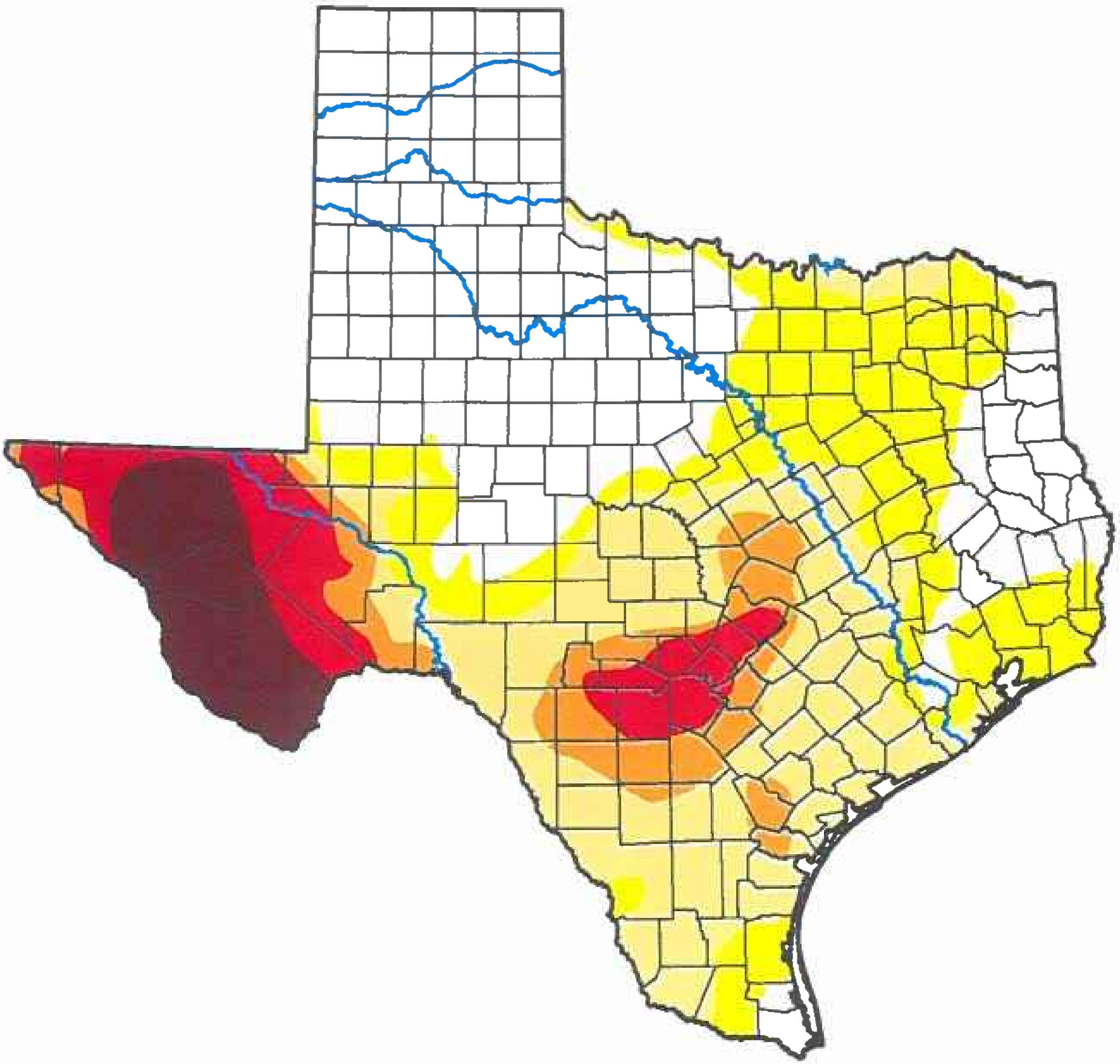
U.S. Drought Monitor
Texas

December 31, 2024
(Released Wednesday, Jan. 1, 2025)
Valid 7 a.m. EST



Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:

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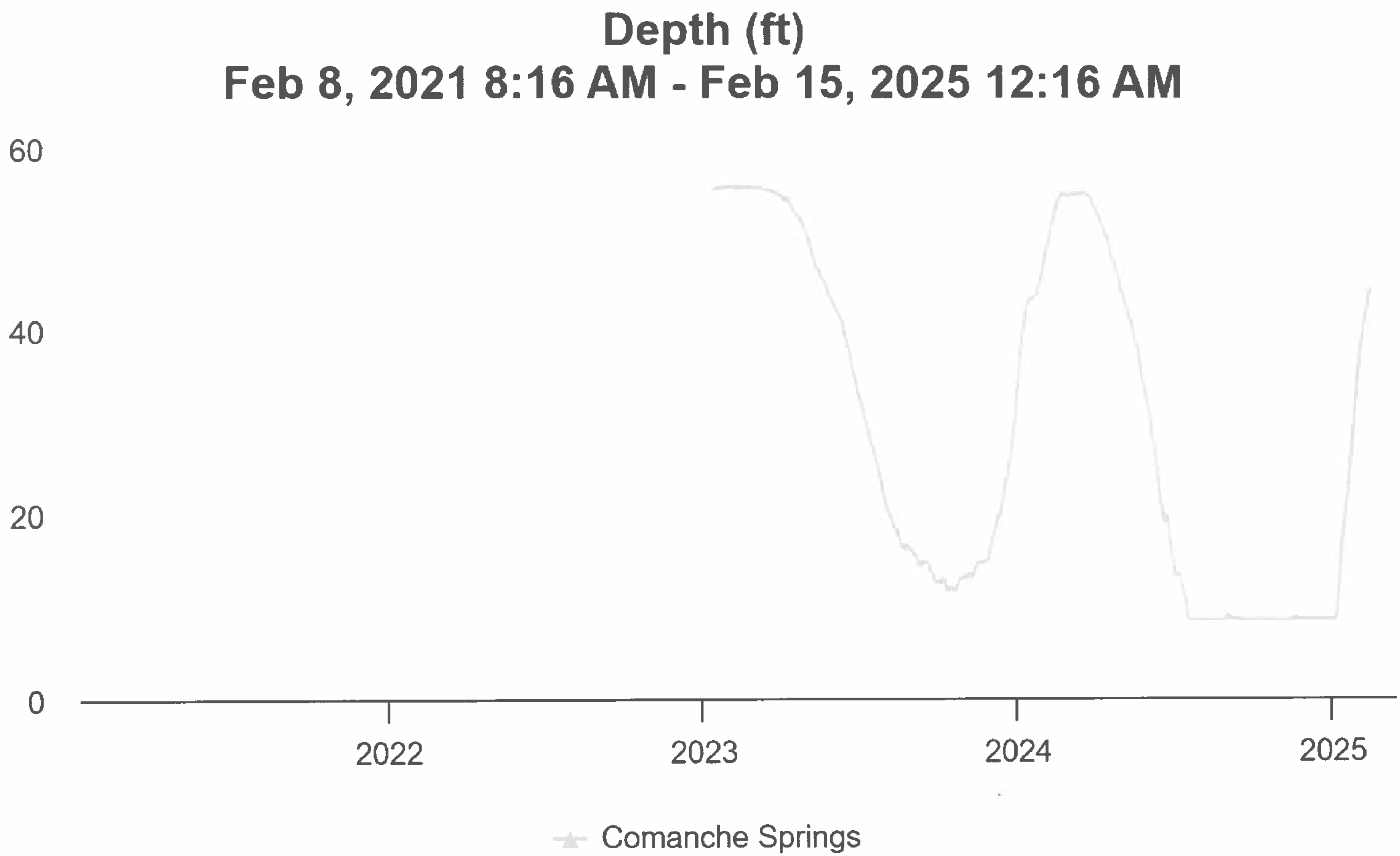
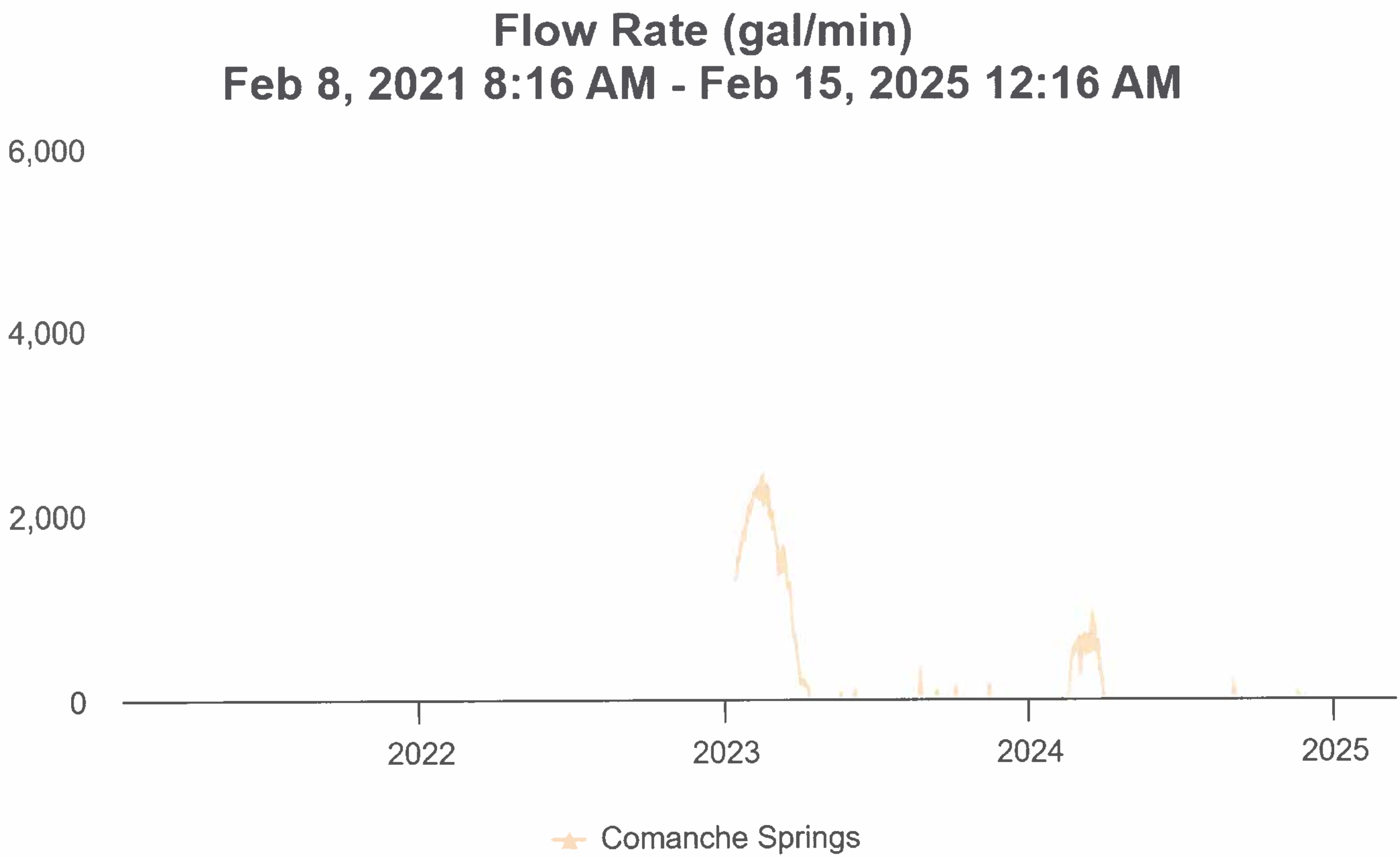
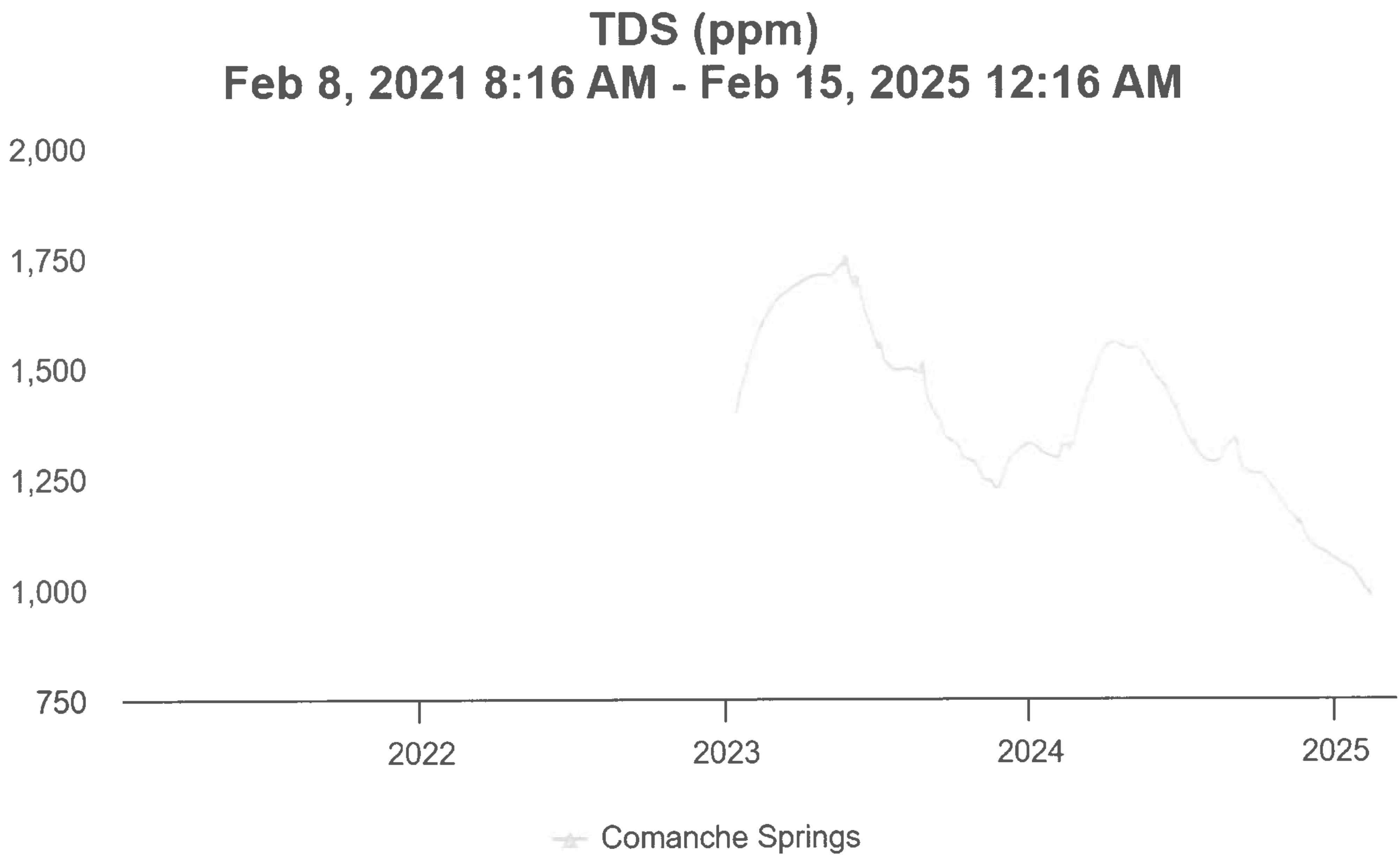


Depth (ft)
Feb 8, 2021 8:16 AM - Feb 15, 2025 12:16 AM
60
40
20
0
2022
2023
2024
2025
Comanche Springs



Flow Rate (gal/min)
Feb 8, 2021 8:16 AM - Feb 15, 2025 12:16 AM
6,000
4,000
2,000
0
2022
2023
2024
2025
Comanche Springs


TDS (ppm)
Feb 8, 2021 8:16 AM - Feb 15, 2025 12:16 AM
2,000
1,750
1,500
1,250
1,000
750
2022
2023
2024
2025
Comanche Springs

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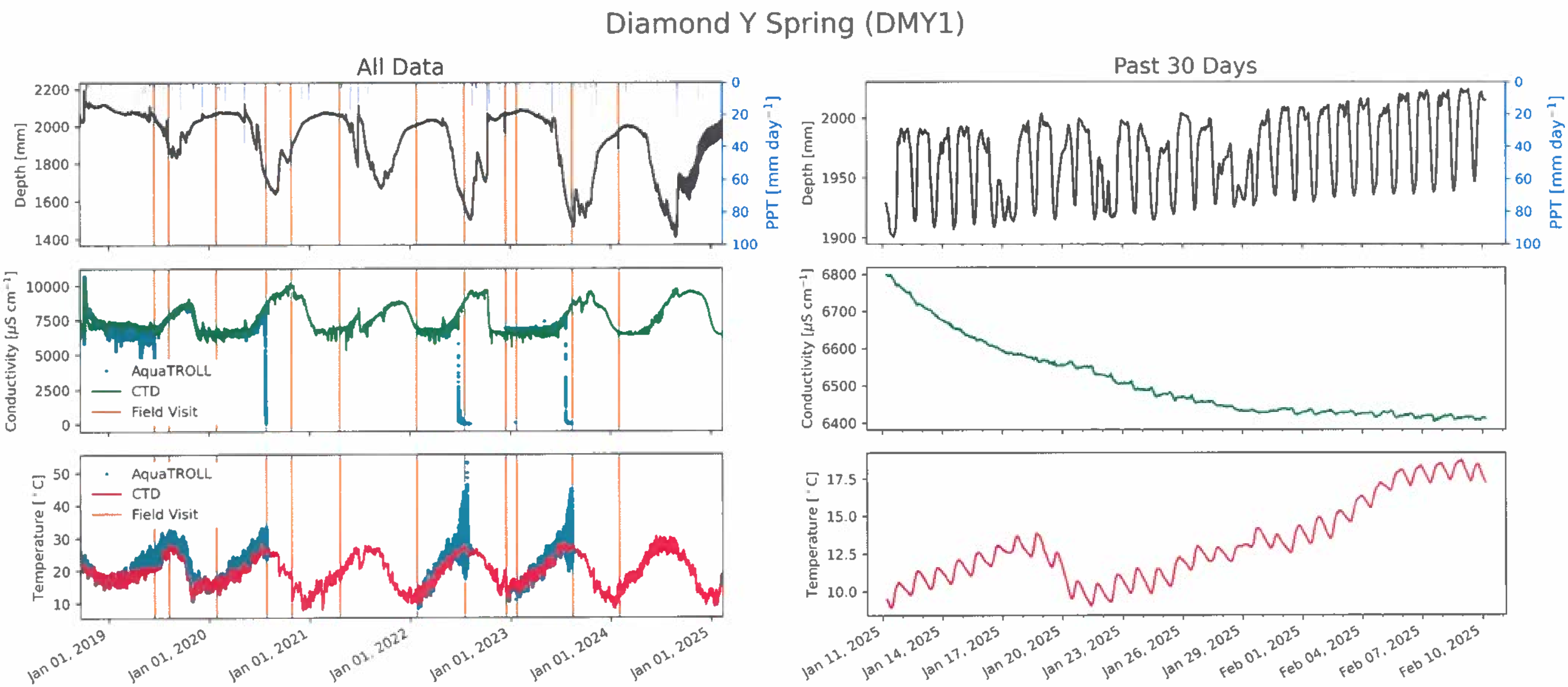
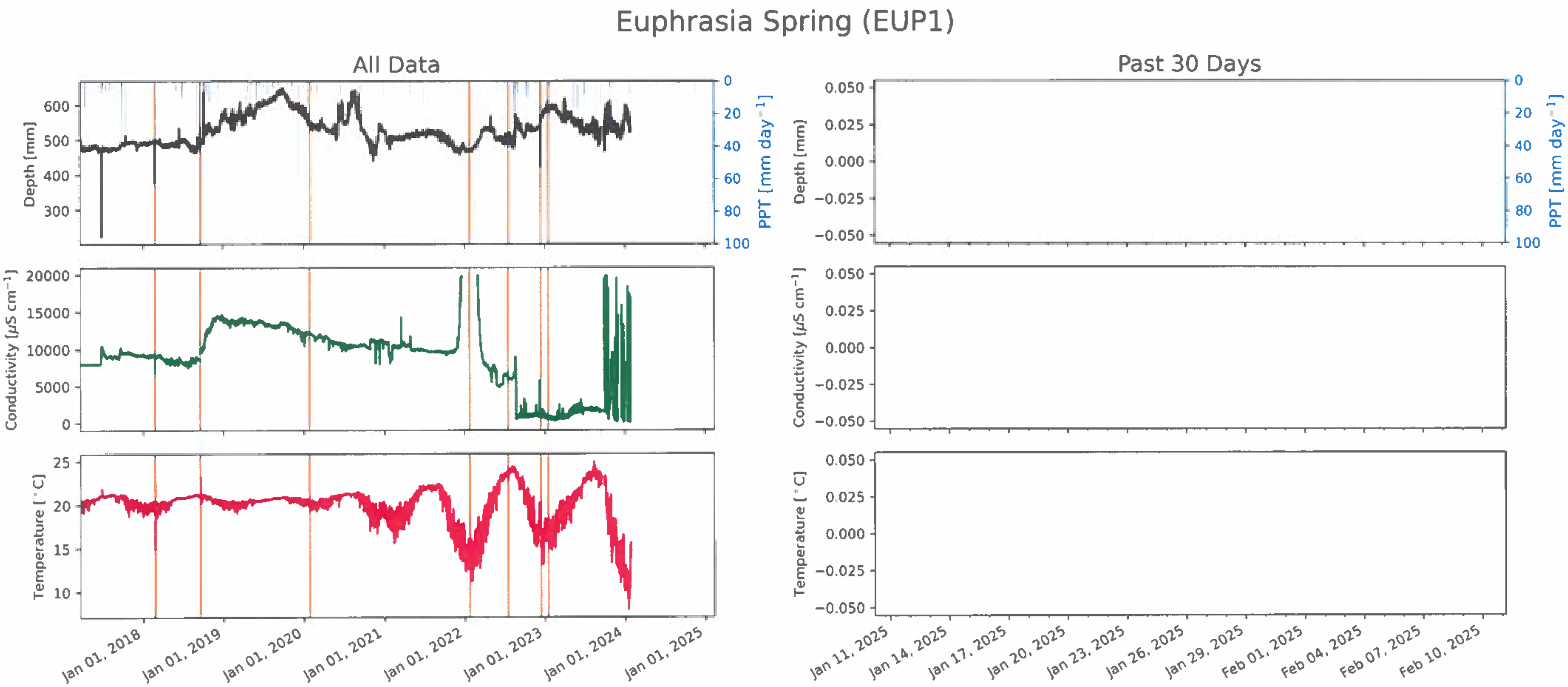
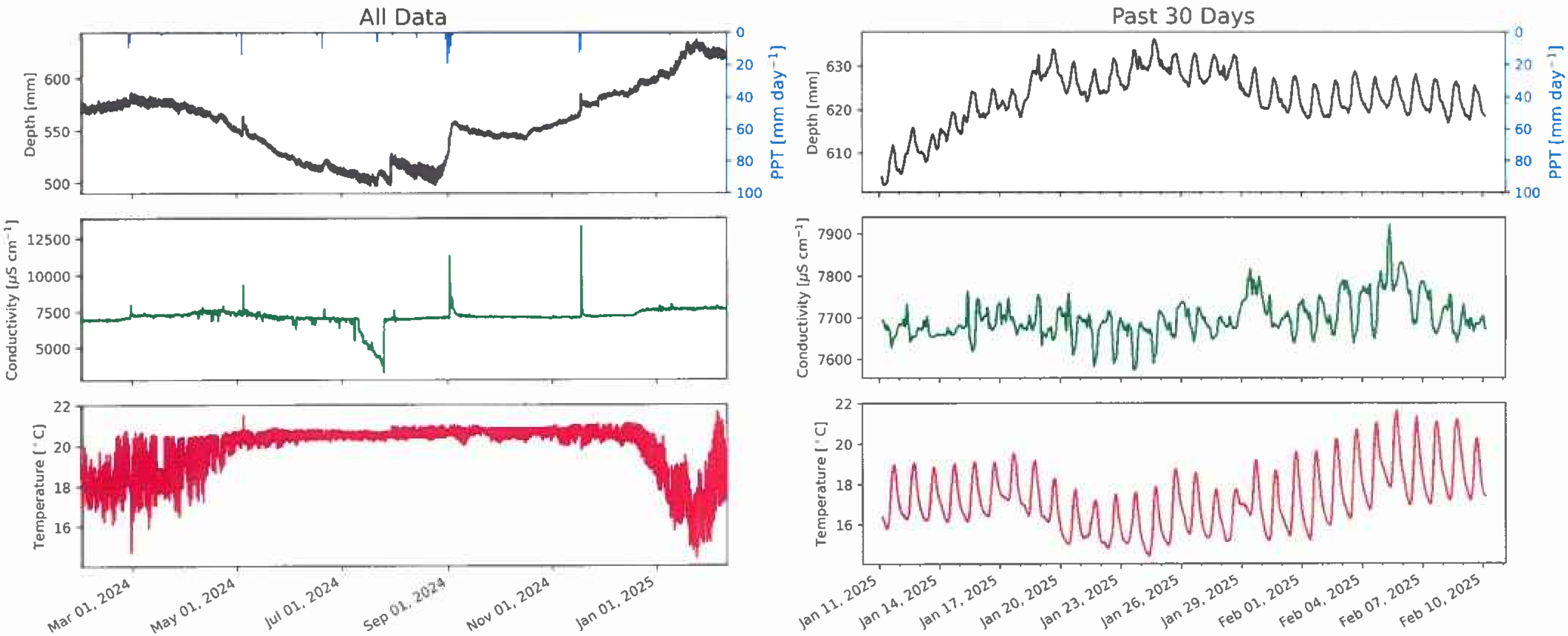


Diamond Y Spring (DMY1)
All Data
Past 30 Days
Depth [mm]
PPT [mm day⁻¹]
Conductivity [µS cm⁻¹]
Temperature [°C]
AquaTROLL
CTD
Field Visit
Jan 01, 2019
Jan 01, 2020
Jan 01, 2021
Jan 01, 2022
Jan 01, 2023
Jan 01, 2024
Jan 01, 2025
Jan 11, 2025
Jan 14, 2025
Jan 17, 2025
Jan 20, 2025
Jan 23, 2025
Jan 26, 2025
Jan 29, 2025
Feb 01, 2025
Feb 04, 2025
Feb 07, 2025
Feb 10, 2025


Euphrasia Spring (EUP1)
All Data
Past 30 Days
Depth [mm]
PPT [mm day^{-1}]
Conductivity [μS cm^{-1}]
Temperature [$^\circ$C]
Jan 01, 2018
Jan 01, 2019
Jan 01, 2020
Jan 01, 2021
Jan 01, 2022
Jan 01, 2023
Jan 01, 2024
Jan 01, 2025
Jan 11, 2025
Jan 14, 2025
Jan 17, 2025
Jan 20, 2025
Jan 23, 2025
Jan 26, 2025
Jan 29, 2025
Feb 01, 2025
Feb 04, 2025
Feb 07, 2025
Feb 10, 2025

Karges Spring (KRG1)



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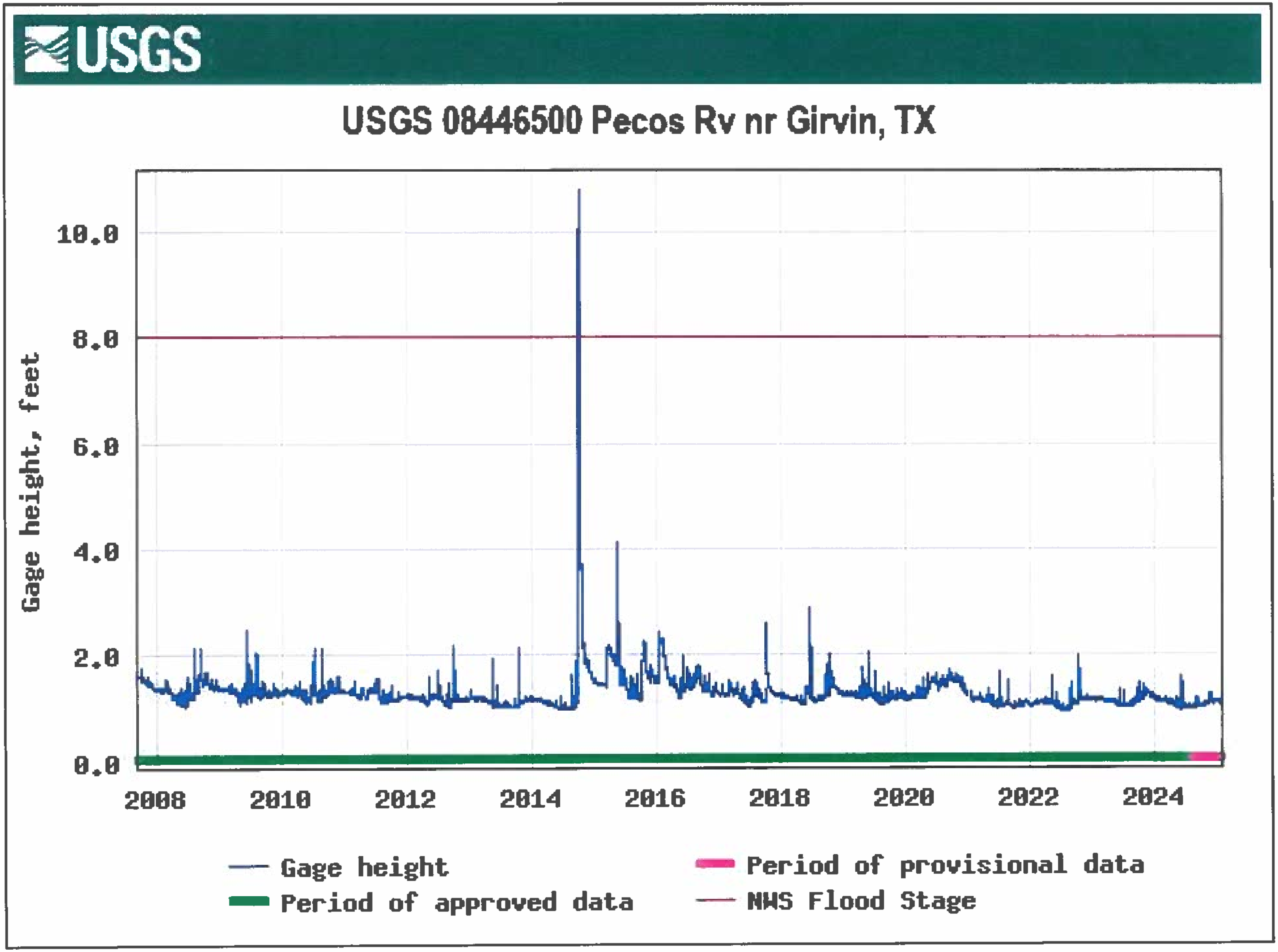
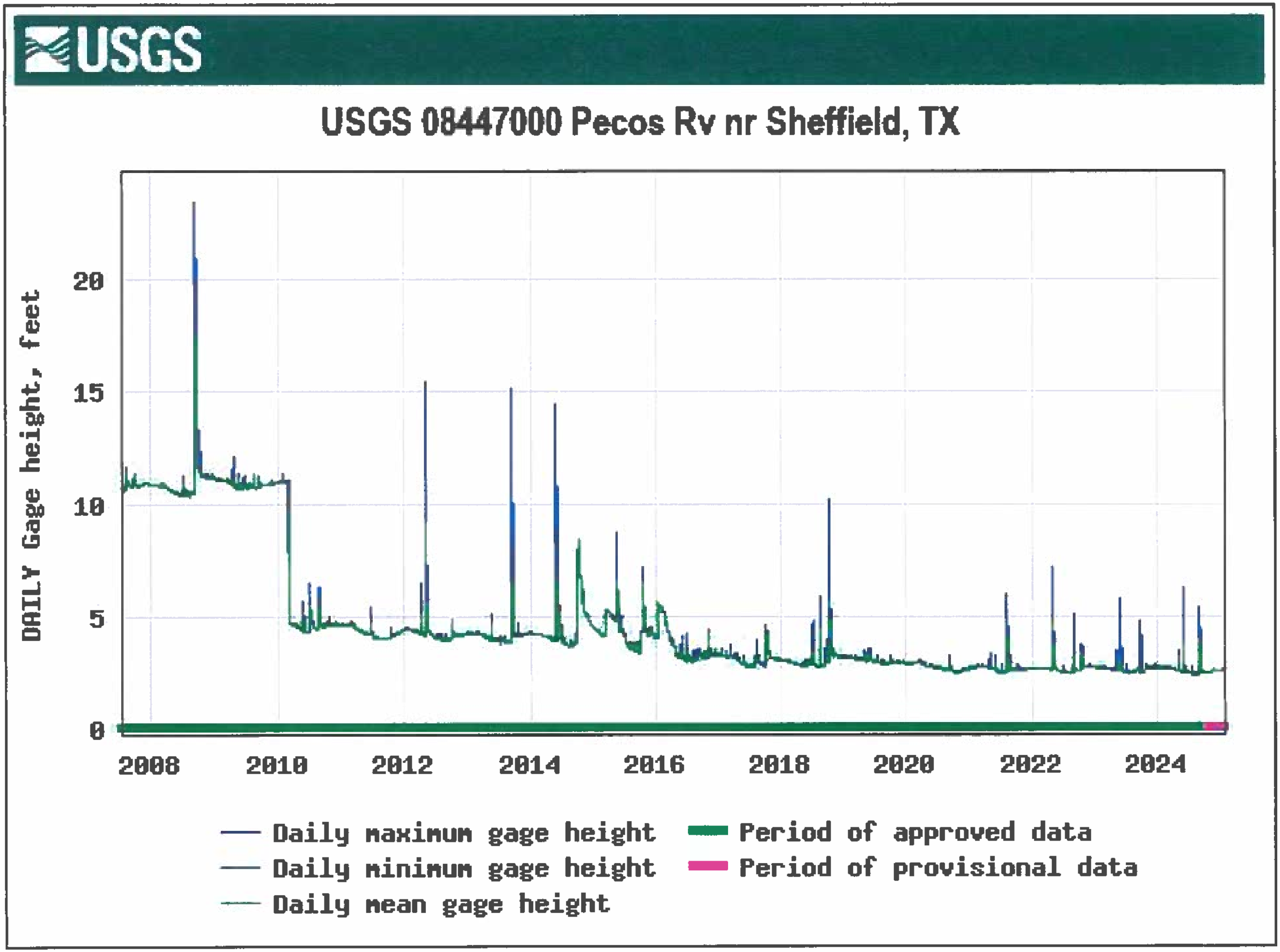


USGS
USGS 08446500 Pecos Rv nr Girvin, TX
Gage height, feet
10.0
8.0
6.0
4.0
2.0
0.0
2008
2010
2012
2014
2016
2018
2020
2022
2024
Gage height
Period of approved data
Period of provisional data
NWS Flood Stage



USGS
USGS 08447000 Pecos Rv nr Sheffield, TX
DAILY Gage height, feet
0
5
10
15
20
2008
2010
2012
2014
2016
2018
2020
2022
2024
Daily maximum gage height
Daily minimum gage height
Daily mean gage height
Period of approved data
Period of provisional data

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Rainwater Harvesting

For centuries, people have relied on rainwater harvesting to supply water for household, landscape, livestock, and agricultural uses. Before the advent of large centralized water supply systems, rainwater was collected from roofs and stored on site in tanks known as cisterns. With the development of large, reliable water treatment and distribution systems and more affordable well drilling equipment, rain harvesting was all but forgotten, even though it offered a source of pure, soft, low-sodium water.

A renewed interest in this time-honored approach of collecting water has emerged in Texas and elsewhere because of escalating environmental and economic costs of providing water by centralized water systems or by well drilling. The health benefits of rainwater and potential cost savings associated with rainwater collection systems have further spurred this interest.

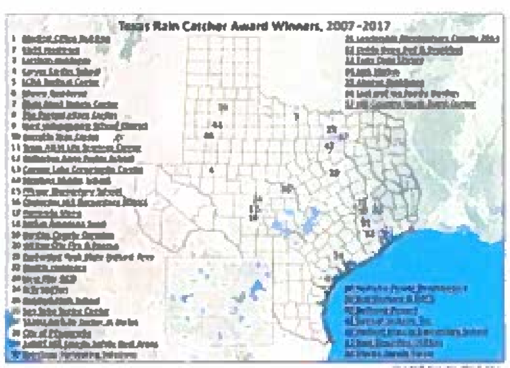
Texas is one of only a few states in the nation that has devoted a considerable amount of attention to rainwater harvesting and has enacted many laws regulating the practice of collecting rainwater.

- Texas Tax Code 151.355 allows for a state sales tax exemption on rainwater harvesting equipment.
- Texas Property Code 202.007 prevents homeowners associations from banning rainwater harvesting installations.
- Texas House Bill 3391 requires rainwater harvesting system technology to be incorporated into the design of new state buildings and allows financial institutions to consider making loans for developments using rainwater as the sole source of water supply.

For in-depth descriptions of rules in Texas and other states, visit the National Conference of State Legislatures.

Recent Maps

Texas Rain Catcher Award Winners



Protect, Conserve and Prevent Waste of Groundwater

Our mission at *Middle Pecos Groundwater Conservation District (MPGCD)* is to develop and implement an efficient, economical and environmentally sound groundwater management program to protect, maintain and enhance the groundwater resources of the District, and to communicate and administer to the needs and concerns of the citizens of Pecos County associated with these groundwater resources.

We have an 11-member Board of Directors that is elected by the citizens of Pecos County. There are two directors representing each county precinct, one representing the City of Fort Stockton, one representing the City of Iraan, and one representing Pecos County at large. Your current Directors are: Jerry McGuairt, Janet Groth, Weldon Blackwelder, Puja Boinpally, Vanessa Cardwell, Billy Jackson., Ronnie Cooper, Larry Drgac, M. R. Gonzalez, Alvaro Mandujano, Jr., and Jeff Sims.

In keeping an eye on Pecos County groundwater, the District monitors 139 water wells that are scattered throughout Pecos County. We check water quality analysis and depth of water levels monthly.

The public is invited to join us at our monthly Board Meetings that are normally held on the 3rd Tuesday of each month at our office located at 405 North Spring Drive in Fort Stockton, Texas. Our agendas are posted on our website 72 hours before our meetings and can be reviewed at: https://www.middlepecosgcd.org/.

MPGCD requires water well owners to register all water well(s) with in Pecos County. A non-potable analysis can be provided by the District at no cost. MPGCD can carry out the overall responsibility of protecting our water supply by knowing where and how many wells we have in Pecos County. Examples of protection are oil/gas activity, excessive water production, monitoring water levels/analysis, and contamination.

Our office is willing to discuss any concerns, issues, etc., pertaining to our most precious natural resource – GROUNDWATER. You may contact us at 432-336-0698 or come by 405 North Spring Drive, Fort Stockton, Texas.

Efforts to Control and Prevent Waste of Groundwater and Promote Conservation

To promote conservation and prevent waste of groundwater related to agricultural, the following are the best management practices as stated by the Texas Water Development Board Conservation Division : * Irrigation water use management - irrigation scheduling, measurement of irrigation water use, crop residue management and conservation tillage, irrigation audit; * land management systems – furrow dikes, land leveling, contour farming, conversion of supplemental irrigated farm land to dry land, brush management; * on-farm water delivery systems – lining of on-farm irrigation ditches, replacement of on-farm irrigation ditches and pipelines, low-pressure center pivot sprinkler irrigation systems, drip/micro-irrigation systems, gated and flexible pipe for field water distribution systems, surge flow for field water distribution systems, and linear move sprinkler irrigation systems; * Water district delivery systems – lining of district delivery systems, replacement of irrigation district canals and lateral canals with pipelines; * Miscellaneous systems – tailwater recovery and reuse system, nursery production systems.

Other ways to promote conservation and prevent waste of groundwater: Sweep rather than hose driveways and other areas; use drip irrigation rather than spray irrigation; wash your car at a car wash; downsize your lawn area and/or Xeriscape; irrigate during the coolest part of the day; never water on windy days; protect plants with mulch and compost to reduce water loss; install low flow shower heads; insulate hot water pipes; reduce showering time; operate dishwasher and washing machine on full loads; install an aerator on kitchen faucet; and turn the water off while brushing teeth and on to rinse. If you see signs of contaminating substances on the surface, remember it could end up contaminating the water source below, so please report to us if you find signs of contamination that need to be checked out.

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Threshold Table

Show more threshold data

Well		Winter Threshold 1	Winter Threshold 2 (Historic Minimum)	Winter Threshold 3	Winter Threshold 4	Most recent Depth to Water	
Short Name	Long Name	Depth to Water	Depth to Water	Depth to Water	Depth to Water	Depth to water	Measure... Date
Mpgcd320	King, Woodward, #320	205	200	195	190	137.68	02/05/2025
Mpgcd323	Ft Stockton, Cemetery, #323	198	193	188	183	155.98	02/05/2025
C-5	C-5, FSH Well	110	105	100	95	40.45	02/05/2025
M-9	M-9, FSH Well	313	308	303	298	259.14	02/05/2025
S-45	S-45, FSH Well	165	160	155	150	101.29	02/05/2025
S-6	S-6, FSH Well	205	200	195	190	130.88	02/05/2025
Mpgcd305	Cockrell_Belding, #305	292	287	282	277	222	02/05/2025
Mpgcd318	Goldman Ranch, Well 1	72	67	62	57	40.39	02/05/2025
Mpgcd334	Carpenter, #334	140	135	130	125	113.4	02/05/2025
Interstate	Interstate Well, FSH Well	96	91	86	81	58.09	02/05/2025
Prison	TDCJ, Prison Well	258	253	248	243	202.5	01/15/2025

HydroVu Water Levels

Table 6. Monitor Well Threshold Recommendations

Well		Reference Point Elevation (ft MSL)	Winter Threshold 1		Winter Threshold 2 (Historic Minimum)		Winter Threshold 3		Winter Threshold 4		Maximum Recent Drawdown (Winter to Summer)	Summer Threshold		Recent Depth to Water	
Short Name	Long Name		Depth to Water (ft)	Basis	Depth to Water (ft)	Basis	Depth to Water (ft)	Basis	Depth to Water (ft)	Basis		Depth to Water (ft)	Basis	Winter	Summer
Mpgcd320	King, Woodward, #320	3068	205	Win2+5	200	Data 1/1999	195	Win2-5	190	Win2-10	45	245	Win2+Max DD	113	148
Mpgcd323	Ft Stockton, Cemetery, #323	3031	198	Win2+5	193	Data 1/2000	188	Win2-5	183	Win2-10	15	208	Win2+Max DD	146	148
C-5	C-5, FSH Well	3009	110	Win2+5	105	WPC 1973	100	Win2-5	95	Win2-10	72	177	Win2+Max DD	60	107
M-9	M-9, FSH Well	3261	313	Win2+5	308	WPC 1973	303	Win2-5	298	Win2-10	48	356	Win2+Max DD	246	283
S-45	S-45, FSH Well	3067	165	Win2+5	160	WPC 1973	155	Win2-5	150	Win2-10	56	216	Win2+Max DD	92	115
S-6	S-6, FSH Well	3123	205	Win2+5	200	WPC 1973	195	Win2-5	190	Win2-10	62	262	Win2+Max DD	118	159
Mpgcd305	Cockrell_Belding, #305	3233	292	Win2+5	287	WPC 1973	282	Win2-5	277	Win2-10	75	362	Win2+Max DD	206	250
Mpgcd318	Goldman Ranch, Well 1	2957	72	Win2+5	67	WPC 1975	62	Win2-5	57	Win2-10	33	100	Win2+Max DD	30	49
Mpgcd334	Carpenter, #334	3051	140	Win2+5	135	WPC 1975	130	Win2-5	125	Win2-10	36	171	Win2+Max DD	104	126
Interstate	Interstate Well, FSH Well	2988	96	Win2+5	91	WPC 1975	86	Win2-5	81	Win2-10	40	131	Win2+Max DD	49	71
Prison	TDCJ, Prison Well	3199	258	Win2+5	253	WPC 1973	248	Win2-5	243	Win2-10	50	303	Win2+Max DD	184	224

Threshold	Action
Winter Threshold 1	If 6 of 11 are below threshold, 100% reduction in FSH non-historical use pumping
Winter Threshold 2	If 6 of 11 are below threshold, 50% reduction in FSH non-historical use pumping
Winter Threshold 3	If 6 of 11 are below threshold, 30% reduction in FSH non-historical use pumping
Winter Threshold 4	If 6 of 11 are below threshold, 10% redcution in FSH non-historical use pumping
Summer Threshold	If 6 of 11 are below threshold, meeting in 60 days between FSH and MPGCD to discuss data

Notes

Maximum Recent Drawdown (Winter to Summer) based on evaluation of recent data (~2010 to 2016)
Summer Thresholds derived by adding maximum recent drawdown (from historic data) to Winter 1 Threshold
Recent Depth to Water are from actual data maximum (summer) and minimum (winter) from spring 2016 to winter 2017

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Final Report

2024 Update: Comparison of Groundwater Elevations and Drawdowns: GAM DFC Simulation and Measured Data from TWDB

Prepared for:
Middle Pecos Groundwater Conservation District
PO Box 1644
Ft. Stockton, TX 79735
432-336-0698

Prepared by:
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February 13, 2025

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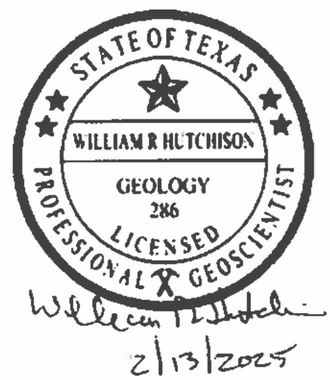
Professional Engineer and Professional Geoscientist Seals

This report was prepared by William R. Hutchison, Ph.D., P.E., P.G., who is licensed in the State of Texas as follows:

- Professional Engineer (Geological and Civil) No. 96287
- Engineering Firm Registration No. 14526
- Professional Geoscientist (Geology) No. 286



1.0 Introduction

One of the required goals (Goal 8) of the Middle Pecos Groundwater Conservation District Management Plan is a how the District addresses the desired future conditions in a quantitative manner. This report:

- Summarizes the available data from the TWDB Groundwater Database
- Describes the analyses that were completed to select monitoring wells for the comparison with the simulations that are the basis for the desired future condition
- Provides a comparison of model simulated groundwater elevations and drawdowns with actual data and provides some context to the results with an analysis of precipitation in the area.

The 2020 management plan included an appendix providing documentation of this comparison (Hutchison, 2020). An update was completed as documented in Hutchison (2023). This report contains an update through 2023 for inclusion in the 2025 management plan. The analysis ends in 2023 because complete groundwater level and precipitation data for 2024 are not yet available on the TWDB website.

2.0 TWDB Data

2.1 Groundwater Level Data

The TWDB groundwater database includes a site for water levels by county:

https://www3.twdb.texas.gov/apps/reports/GWDB/WaterLevelsByCounty

Data for Pecos County were downloaded on January 21, 2025 for use in this report. The raw data were filtered to only include records with water level data after 2005 (the base year for the desired future condition). Sorting the data by date resulted in the identification of 38 wells that could be used for this analysis.

The Fortran program *TWDBData.exe* was written to read the list of wells, read the water level data, and return end-of-year water levels. For purposes of this selection, the monthly priority of groundwater levels to assign an end-of-year groundwater level was:

1. December of the current year
2. January of the next year
3. November of the current year
4. February of the next year

This effort yielded 503 groundwater level records for the 38 wells. As noted in Hutchison (2020 and 2023), the water level data in the TWDB database can only be used to compare the DFCs in the Edwards-Trinity (Plateau) and Pecos Valley Alluvium. Data are not available to evaluate the DFCs for the Capitan Reef Complex, Dockum, and Rustler aquifers.

The Fortran program *etppvrowcol.exe* was written to locate each well on the grid of the Groundwater Availability Model used as the basis for the desired future conditions (DFC) in GAM 3 and GAM 7. The results are expressed in terms of the model row and column.

Table 1 summarizes information on the 38 wells, and Figure 1 presents their locations. Please note that the Well ID from Table 1 is used to identify each well location in Figure 1.

Table 1. Summary of Well Information

Well ID	TWDB Well Number	Number of Records (2005 to 2022)	GAMx	GAMy	Well Depth (ft)	Reference Point Elevation (ft MSL)	GAM Row	GAM Col	Distance to Nearest Cell Center (ft)
1	4562402	14	4180198	19622464	120	2,533	169	141	1,198
2	4562901	16	4215270.5	19605324	190	2,302	167	148	1,794
3	4563701	5	4221824	19602964	138	2,298	166	150	3,170
4	4648502	17	3969727	19718808	724	2,525	182	99	2,007
5	4648503	17	3971253.8	19725630	625	2,513	181	99	1,570
6	4648604	7	3975771	19716692	425	2,528	182	100	3,498
7	4648801	3	3968880.3	19702396	400	2,578	184	101	2,971
8	4655603	16	3943139.8	19674652	600	2,694	192	101	2,374
9	4656201	16	3964642.3	19690156	865	2,623	187	102	2,188
10	4656301	8	3974916.3	19685516	568	2,618	186	104	1,762
11	4656306	17	3984143.3	19690126	615	2,594	184	105	1,293
12	4656401	5	3947945.8	19675934	400	2,686	191	102	1,623
13	5206501	12	3881571	19588218	351	3,077	212	104	3,353
14	5206701	10	3871409.3	19565630	510	3,237	216	105	363
15	5207302	4	3938322.8	19599728	501	2,964	203	110	1,237
16	5207502	12	3924182.8	19585546	280	3,020	207	110	2,446
17	5207901	17	3937220.5	19567040	612	3,081	208	114	2,586
18	5208302	9	3975494.3	19595652	310	3,018	199	116	2,206
19	5208801	16	3959985.3	19562958	200	3,086	205	118	1,659
20	5216202	14	3963653.8	19554044	666	3,098	206	119	2,137
21	5216302	4	3973889.5	19552850	320	3,080	205	121	730
22	5216505	9	3962363.8	19545166	246	3,141	207	120	2,815
23	5216609	5	3973211.8	19534436	1,975	3,192	208	123	2,730
24	5216802	18	3967842.3	19530824	448	3,201	209	123	1,474
25	5221301	11	3853462.8	19511174	350	3,512	226	109	1,735
26	5301707	14	3986188.8	19573280	98	2,969	200	120	2,374
27	5301805	14	4000338.3	19572294	341	3,029	199	122	1,802
28	5301902	16	4018509.5	19565434	180	2,981	197	126	2,849
29	5302708	17	4030551.5	19560160	227	3,025	197	128	1,853
30	5303901	17	4092037	19559444	462	2,876	189	137	1,129
31	5306501	17	4196969.5	19581700	425	2,410	173	149	2,839
32	5307202	14	4234979	19591762	Unknown	2,425	166	153	1,855
33	5307203	11	4241304	19590826	Unknown	2,354	166	154	2,181
34	5307601	6	4243929	19582876	931	2,978	166	155	2,422
35	5309105	3	3982084.3	19550196	200	3,087	204	122	2,770
36	5309301	18	4015507.3	19553902	210	3,012	199	127	2,749
37	5309306	13	4018967.8	19559648	235	2,971	198	126	2,728
38	5312702	15	4108293.3	19521890	Unknown	2,916	192	144	1,307

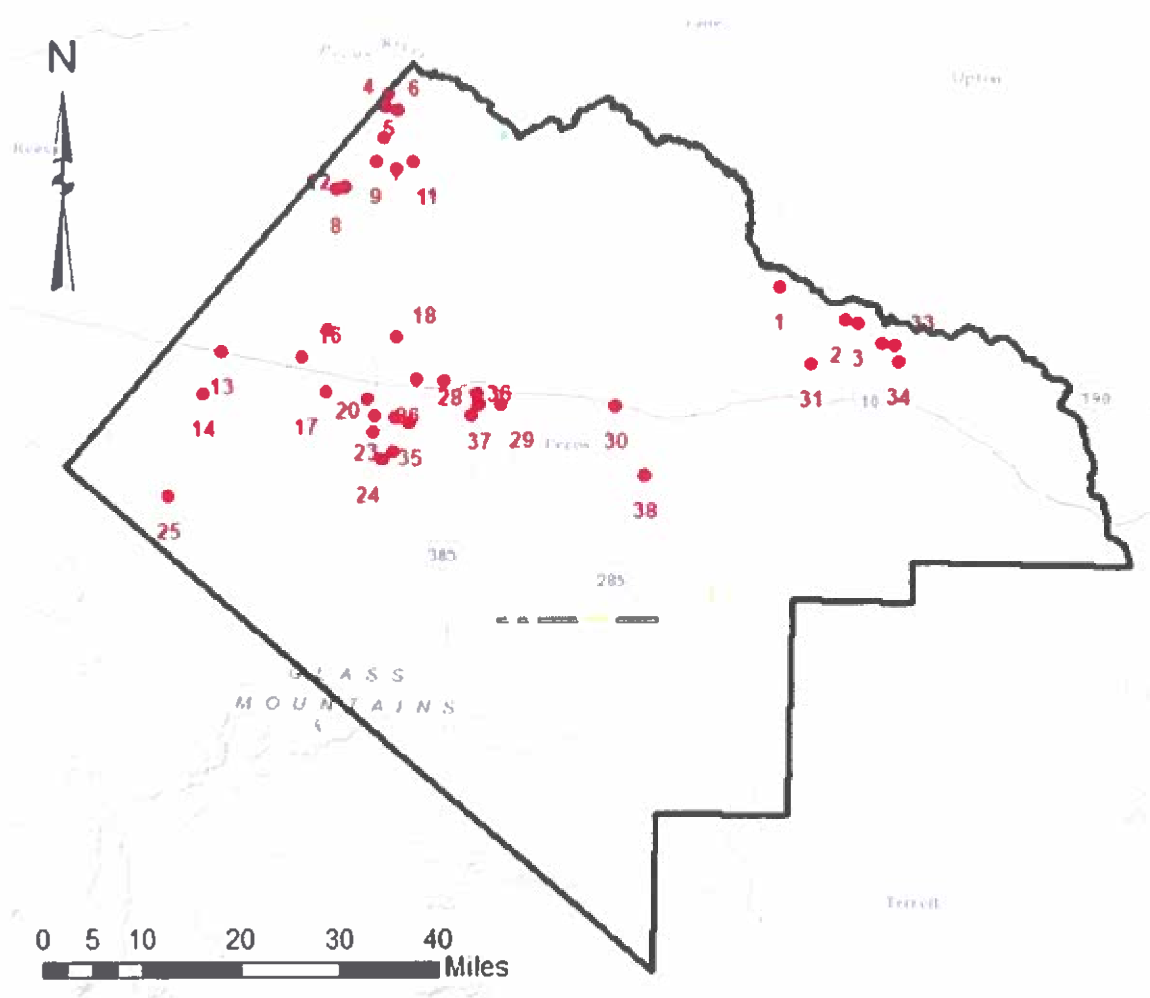


Figure 1. Well Locations

2.2 Precipitation Data

Precipitation data were downloaded from the TWDB website:

https://waterdatafortexas.org/lake-evaporation-rainfall

As seen in Figure 2, Pecos County is in parts of four quadrangles (604, 605, 704, and 705). The available data for the four quadrangles include monthly totals of precipitation from 1940 to 2023. Data for 2024 are limited to the first quarter (January, February, and March). These data were saved to the file *MPGCD Pcp.xlsx*. The monthly data were averaged across all four quadrangles, the annual totals for each year were calculated and presented in Column M. The annual rainfall was also expressed in terms of a percent average for the entire period in Column N. The average rainfall from 1940 to 2023 was 13.36 inches. Annual departures from the average are presented in Column O. The pertinent data for the years of interest (2005 to 2023) are summarized in Table 2.

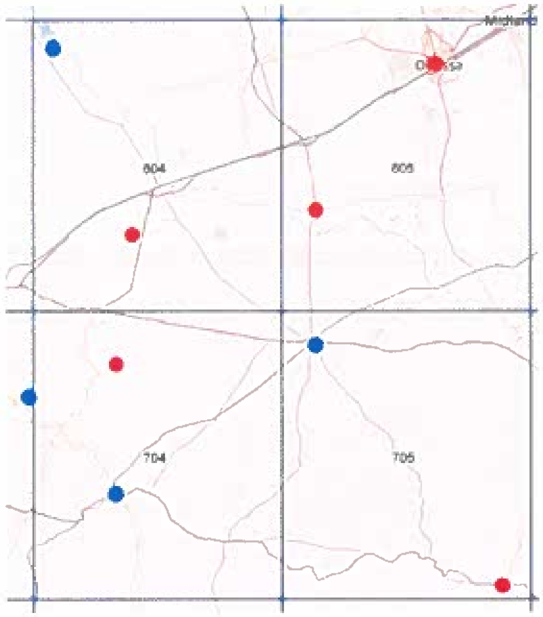


Figure 2. Location of Precipitation Quads

Table 2. Precipitation for Quadrangles 604, 605, 704, and 705: 2005 to 2023

Year	Annual Precipitation (in)	Annual Precipitation (% of Average)	Annual Difference from Average (in)
2005	15.60	116.75	2.24
2006	11.17	83.59	-2.19
2007	18.79	140.66	5.43
2008	12.02	89.99	-1.34
2009	12.00	89.82	-1.36
2010	16.60	124.27	3.24
2011	3.08	23.07	-10.28
2012	12.32	92.18	-1.05
2013	10.53	78.80	-2.83
2014	11.58	86.70	-1.78
2015	19.41	145.30	6.05
2016	13.32	99.70	-0.04
2017	13.39	100.24	0.03
2018	14.85	111.13	1.49
2019	14.30	107.04	0.94
2020	7.76	58.07	-5.60
2021	10.37	77.62	-2.99
2022	12.50	93.53	-0.87
2023	9.26	69.27	-4.11

Annual departures from the long term mean precipitation is presented in Figure 3 and highlights the current drought (2020 to 2023). Please note that the last wet year was 2015. Since then, there were three near-average years (2016, 2017, and 2018) followed by four dry years (2020, 2021, 2022, and 2023).

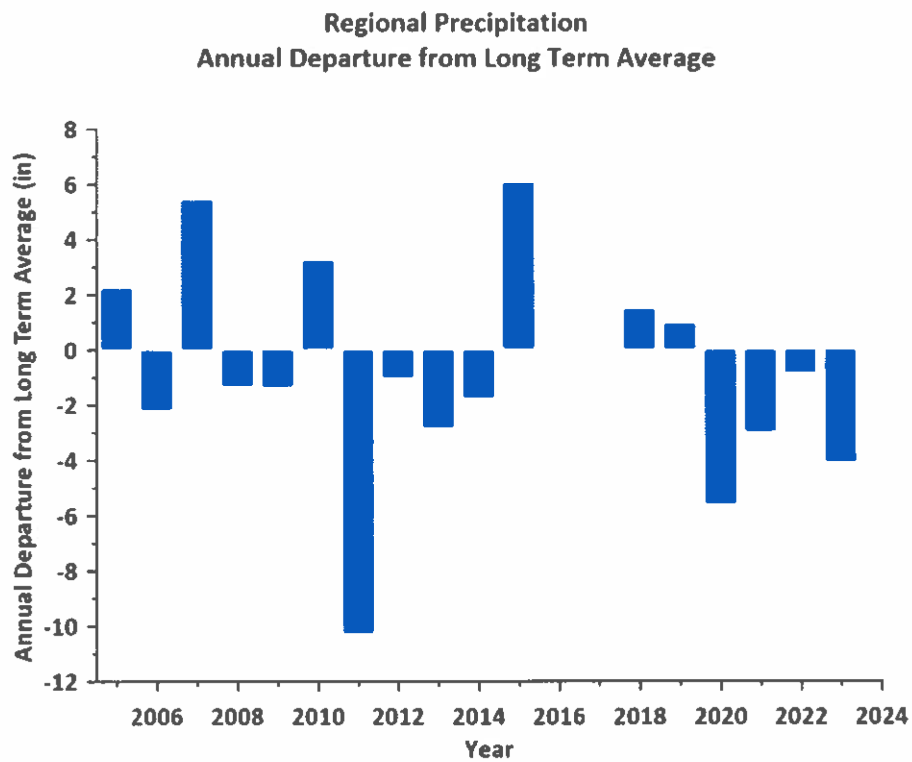


Figure 3. Regional Precipitation Annual Departures from Average

3.0 GAM Results and Comparison to Actual Data

The Fortran program *getDFCdd.exe* reads the actual drawdown data described above (503 records) and extract the groundwater elevations from those same points and years from the calibrated model (2005) and the DFC simulation (2006 to 2070). The results are saved in the Excel spreadsheet *ActualDD Sim DD 2005 to 2024.xlsx*. Also included in these results are the precipitation data for the years 2005 to 2023. Table 3 presents the annual summary included in the Excel file.

Table 3. Summary of Annual Drawdown Comparison

Year	Record Count	Average Actual Drawdown (ft)	Average Simulated Drawdown (ft)	Precipitation (in)	Precipitation (% of Average)
2005	38	0.00	0.00	15.60	116.75
2006	27	-0.05	2.18	11.17	83.59
2007	26	-1.25	3.32	18.79	140.66
2008	22	5.28	4.21	12.02	89.99
2009	31	-0.24	4.71	12.00	89.82
2010	25	2.16	4.93	16.60	124.27
2011	30	8.93	5.46	3.08	23.07
2012	29	13.39	5.99	12.32	92.18
2013	29	15.37	6.45	10.53	78.80
2014	29	12.56	6.91	11.58	86.70
2015	28	4.25	7.32	19.41	145.30
2016	27	4.13	7.80	13.32	99.70
2017	22	6.17	8.57	13.39	100.24
2018	23	4.83	9.00	14.85	111.13
2019	23	17.13	9.41	14.30	107.04
2020	23	15.39	9.82	7.76	58.07
2021	23	14.46	10.22	10.37	77.62
2022	23	12.24	10.62	12.50	93.53
2023	23	13.46	11.02	9.26	69.27
2024	2	25.23	18.42	NA	NA

Figure 4 presents a hydrograph of actual average drawdown and simulated average drawdown from 2005 to 2023. Please note that the blue numbers represent the annual precipitation for each year expressed as a percentage of long-term average, and the red numbers represent the numbers of records that were compared in each year.

Please note that the simulated drawdown is declining from 2005 to 2021 with only slight variations from a linear trend. The linear trend is expected because the simulation assumed constant and average rainfall and recharge conditions.

Based on the last few years, it is expected that the TWDB precipitation data for 2024 will be posted in April or May 2025. The groundwater level data for 2024 does not yet appear complete. This may suggest that this analysis be completed later in the calendar year in the future to get a more complete picture in the annual assessment.

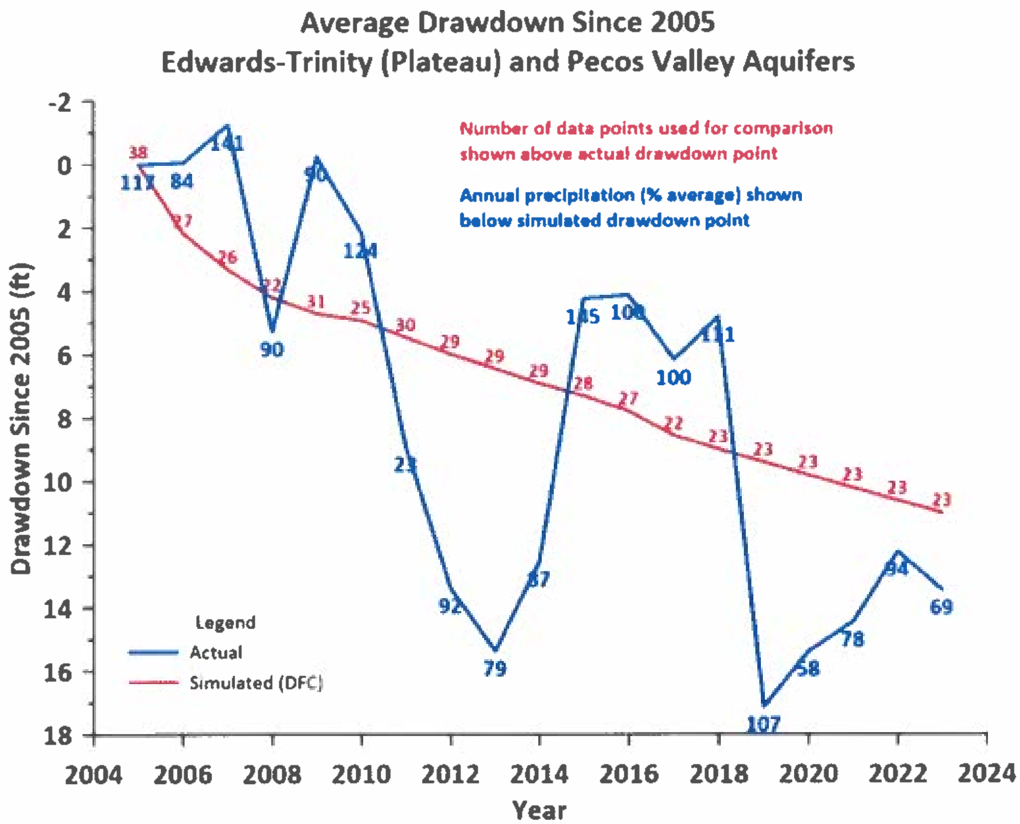


Figure 4. Average Drawdown Comparison (2005 to 2023)

The actual drawdown appears to rise and fall generally with precipitation (wet years yield low drawdowns and dry years yield higher drawdowns). This is expected since pumping generally increases during drought years as irrigation demands are higher.

A more complete analysis of this observation is presented in Figure 5, which presents a plot of annual precipitation vs. measured average drawdown, along with the best-fit line based on a second-order polynomial regression of drawdown in feet (DD) and annual precipitation in inches (PCP):

$$DD = 9.86 + (0.70*PCP) - 0.063*PCP^2)$$

The 98% confidence of the linear regression is also shown.

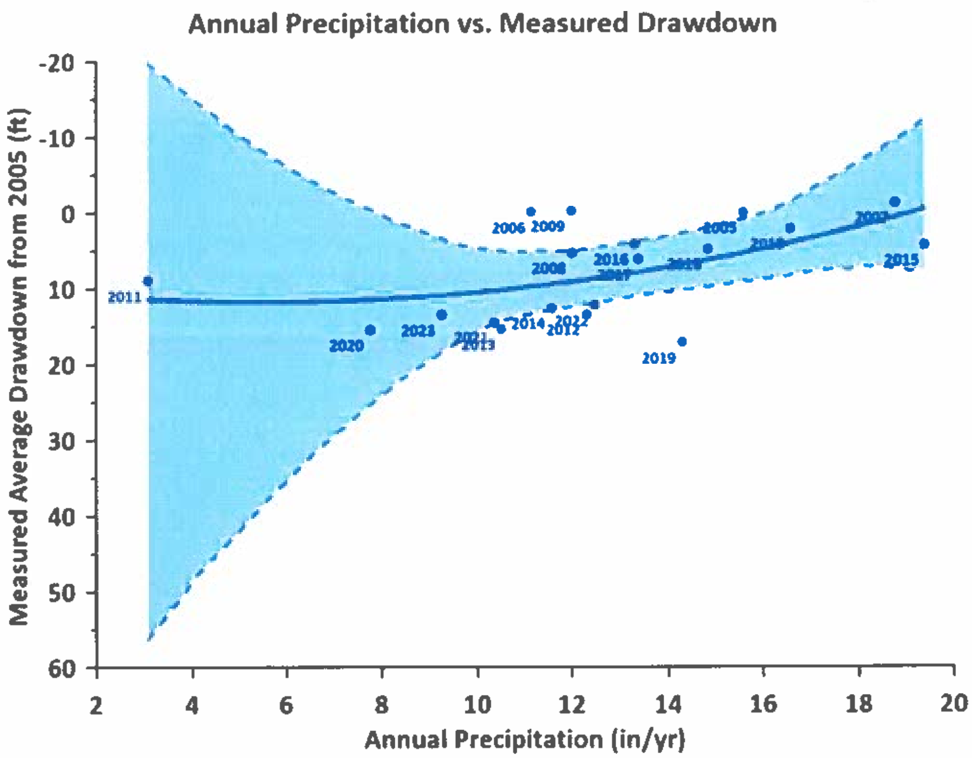


Figure 5. Annual Precipitation vs. Measured Drawdown

Please note that the year is also shown on each data point. As expected, the higher the rainfall, the lower the drawdown. However, the plot shows considerable scatter. During dry years, the confidence band is wider due to that general lack of data (2011 was an exceptionally dry year with only about 3 inches of precipitation).

The correlation is not particularly strong, which means that there are several influences and factors that are not considered in this simple analysis. A cursory review of the figure also shows that 2019 is anomalous. In 2019, the average drawdown is greater than expected given the precipitation that year. Pumping from exempt oil and gas operations was unusually high in 2019 (about 11,000 AF/yr), which could explain the high drawdown in 2019 compared to the other years if the monitoring wells that were used for this analysis were located near the pumping. Please note that since the subsequent years generally fall within the confidence band, there is little need to delve into this issue further for purposes of comparing actual and simulated drawdowns.

4.0 Discussion and Recommendations

The TWDB database was sampled to find wells with groundwater elevation measurements in Pecos County. The analysis showed that the TWDB database did not have sufficient groundwater elevation data to complete a comparison with simulated drawdowns for the Capitan Reef Complex, Dockum, and Rustler aquifers. It is recommended that monitoring of wells completed in these aquifers be identified and data collection from these wells improved, or the aquifers be classified as not relevant for purposes of joint planning. Such a classification would result in no desired future condition for that aquifer in Pecos County and would result in no modeled available groundwater calculation by the Texas Water Development Board. The Regional Planning Group (Region F) would be responsible for establishing groundwater availability if an aquifer is classified as not relevant for purposes of joint planning.

The analysis showed that the TWDB database had sufficient groundwater elevation data to complete a comparison with simulated drawdown for the Edwards-Trinity (Plateau) and Pecos Valley aquifers. The database was sampled to find wells in Pecos County with groundwater elevation measurements in 2005 to compare with simulated drawdowns from the GAM simulation that was the basis for the desired future condition.

The comparison of measured drawdowns with simulated drawdowns showed that, in general, when annual precipitation is higher than average, measured drawdown is less than simulated drawdown and when annual precipitation is less than average, measured drawdown is higher than simulated drawdown. In general, lower than average precipitation correlates with lower-than-average recharge and higher than average pumping. However, this relationship is complex and other factors are important. This analysis shows a weak correlation between annual precipitation and measured drawdown, but the analysis also shows that the measured drawdowns are consistent with the simulation that was the basis for the desired future condition.

Based on this analysis, it is recommended that the future annual updates to this analysis be delayed until later in the year to provide more groundwater level data. If the analysis were completed in the fall, more data from the end of the previous year will be available for analysis.

5.0 References

Hutchison, W.R., 2020. Comparison of Groundwater Elevations and Drawdowns: GAM DFC Simulation and Measured Data from TWDB. Report to Middle Pecos Groundwater Conservation District, Fort Stockton, Texas. June 8, 2020, 50p.

Hutchison, W.R., 2023. 2024 Update: Comparison of Groundwater Elevations and Drawdowns: GAM DFC Simulation and Measured Data from TWDB. Report to Middle Pecos Groundwater Conservation District, Fort Stockton, Texas. May 11, 2023, 11p.

<u>Middle Pecos GCD Exhibit 43</u>

Middle Pecos GCD's Management Plan (2020)

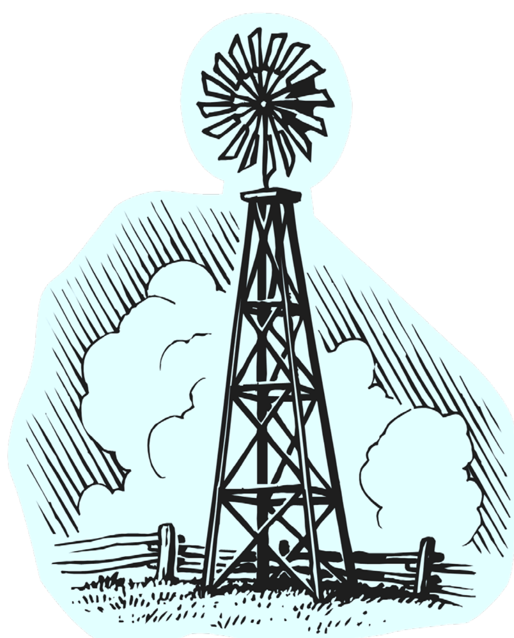
Groundwater Management Plan

Pecos County

Prepared by:

Middle Pecos
Groundwater Conservation District
Fort Stockton, Texas

Ty Edwards
General Manager



July 16, 2020 (Final Approved Plan)

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Middle Pecos Groundwater Conservation District
Groundwater Management Plan
July 16, 2020 (Final Approved Plan)

1.0 District Mission

The Middle Pecos Groundwater Conservation District (the District) is committed to manage and protect the groundwater resources of The District. The District was created to help maintain a sustainable, adequate, reliable, cost effective and high-quality source of groundwater to promote the vitality, economy, and environment of the District. The District will work with and for the citizens of the District and cooperate with other local, regional, and State agencies involved in the study and management of groundwater resources.

2.0 Purpose of Management Plan

In 1997 the 75th Texas Legislature established a statewide comprehensive regional water planning initiative with the enactment of Senate Bill 1 (SB1). Among the provisions of SB1 were amendments to Chapter 36 of the Texas Water Code requiring groundwater conservation districts to develop a groundwater management plan that shall be submitted to the Texas Water Development Board (TWDB) for approval. The groundwater management plan was specified to contain estimates on the availability of groundwater in the district, details of how the district would manage groundwater, and management goals for the district. In 2001 the 77th Texas Legislature further clarified the water planning and management provisions of SB1 with the enactment of Senate Bill 2 (SB2).

The requirements of the Chapter 36 Texas Water Code provisions for groundwater management plan development are specified in 31 Texas Administrative Code Chapter 356 of the TWDB Rules. This plan fulfills all requirements for groundwater management plans in SB1, SB2, Chapter 36 Texas Water Code, and TWDB rules.

3.0 Time Period of Management Plan

This plan shall be in effect for a period of five years from the date of approval by TWDB, unless a new or amended management plan is adopted by the District Board of Directors and approved by TWDB. The management plan will be readopted with or without changes by the District Board and submitted to TWDB for approval at least every five years.

4.0 Middle Pecos Groundwater Conservation District

The District was created in 1999. The creation of the District is recorded in Chapter 1331 of the Acts of the 76th Texas Legislature (SB 1911). This act enabled the District to function in a limited capacity until the creation of the District was fully validated in the 77th Legislature. The validation of the District is recorded in Chapter 1299 of the Acts of the 77th Texas Legislature (HB 1258). The District was confirmed by local election held in Pecos County on November 5, 2002.

The District boundaries are coterminous with the boundaries of Pecos County, Texas. The District is bounded by Reeves, Ward, Crane, Crockett, Terrell, Brewster, and Jeff Davis counties. As of the plan date, groundwater conservation districts (GCDs) that bound the District are in Reeves, Jeff Davis, Brewster, and Crockett Counties. The GCDs neighboring the District are Brewster County GCD, Jeff Davis County Underground Water Conservation District (UWCD), Terrell County GCD, and Crockett County GCD.

Most of the District is in Groundwater Management Area (GMA) 7, with the northern part of the District in GMA 3. Chapter 36 of the Texas Water Code authorizes the District to co-ordinate its management of groundwater with other GCDs in both GMA 7 and GMA 3. GMA 3 consists of Middle Pecos GCD and Reeves County GCD. The other GCDs that are located in GMA 7 are: Crockett County GCD, Santa Rita UWCD (Reagan), Irion County Water Conservation District (WCD), Glasscock GCD, Sterling County UWCD, Lone Wolf GCD (Mitchell), Terrell GCD, Wes-Tex GCD (Nolan), Coke County UWCD, Lipan-Kickapoo WCD (Tom Green, Concho, and Runnels), Hickory UWCD No. 1 (McCulloch, San Saba, and Mason), Menard County UWD, Hill Country UWCD (Gillespie), Kimble County GCD, Plateau Underground Water Conservation and Supply District (Schleicher), Sutton County UWCD, Real-Edwards Conservation and Reclamation District, Uvalde County UWCD, and Kinney County GCD.

The District Board of Directors is composed of eleven members elected to staggered four-year terms. Two directors are elected from each of the four county precincts, one director is elected at-large, one director is elected from the City of Iraan and one director is elected from the City of Fort Stockton. The Board of Directors holds regular meetings, at least quarterly. Meetings of the Board of Directors are public meetings noticed and held in accordance with public meeting requirements.

4.1 Authority of the District

The District derives its authority to manage groundwater use within the District by virtue of the powers granted and authorized in the District enabling act HB 1258 of the 77th Texas Legislature. The District, acting under authority of the enabling legislation, assumes all the rights and responsibilities of a groundwater conservation district specified in Chapter 36 of the Texas Water Code. The District has developed rules specifying the bounds of due process governing District actions.

4.2 Groundwater Resources of the District

There are six sources of groundwater recognized by TWDB in the District. Two of these sources; the Edwards-Trinity (Plateau) Aquifer and the Pecos Valley Aquifer are classified as major aquifers by TWDB. (Fig. 3) The other four sources of groundwater; the Rustler Aquifer, the Dockum Aquifer, the Igneous Aquifer and the Capitan Reef Complex Aquifer are classified as minor aquifers by TWDB. A major aquifer produces large amounts of water over larger areas and a minor aquifer produces minor amounts of water over large areas or large amounts of water over small areas.

The groundwater sources in the District may produce both fresh and moderately saline (brackish) water. The geologic origins of the groundwater sources of the District cover a broad range of geologic time. Listed in ascending order by geologic age, these sources and their ages are: Rustler Formation and Capitan Reef Complex (Permian), Dockum aquifer (Triassic), Edwards-Trinity (Plateau) aquifer (Cretaceous), and Pecos Valley (Quaternary). The geologic age of the various sources of groundwater in the District and the geologic history of Pecos County have a bearing on the structure of the groundwater sources of the District and their relationships.

4.3 Management Zones

The District has established groundwater management zones in the principal areas of irrigation (or other groundwater demand) and pertinent surrounding areas of Pecos County, as described below:

1) The Leon-Belding Irrigation Area and the vicinity of the City of Fort Stockton to include the outlets of Comanche Springs.
2) The Bakersfield Irrigation Area.
3) The Coyanosa Irrigation Area.

A map that shows the boundaries of the management zones is presented in Figure 1. The District recognizes that groundwater use in the areas of principal groundwater demand in the District has the potential to result in localized aquifer draw down sufficient to possibly impair the DFCs of the aquifer in District as a whole (within each GMA). Please note that the management zone map is an updated version as compared to the current rules. An update to the rules to implement these management zone changes is expected in the next several weeks.

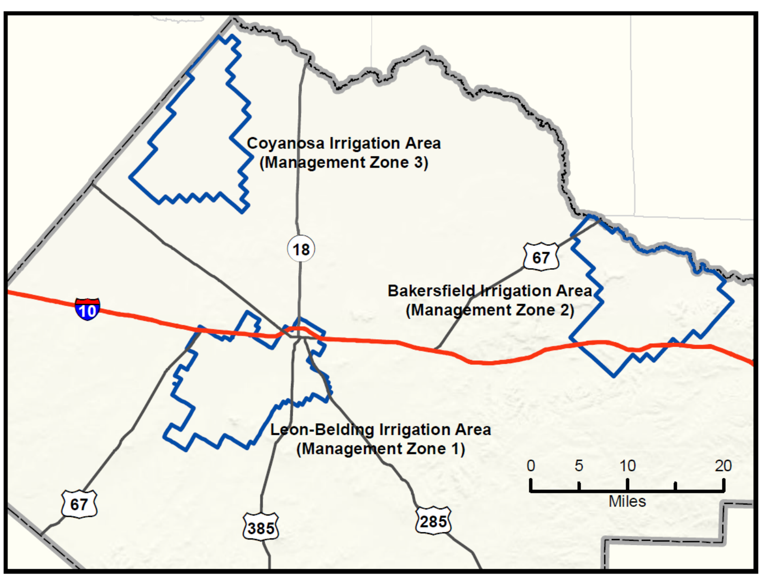

Figure 1. Groundwater Management Zones in MPGCD

5.0 Technical Information Required by Texas Administrative Code

The information in this section is provided pursuant to statutes and rules as summarized in the TWDB Groundwater Conservation District Management Plan Checklist, effective December 6, 2012. The information is organized according to the order in the checklist.

5.1 Estimate of the Modeled Available Groundwater in the District

Modeled available groundwater is defined in TWC §36.001 as "the amount of water that the executive administrator determines may be produced on an average annual basis to achieve a desired future condition established under Section 36.108." The District is within the boundaries of two Groundwater Management Areas (GMAs): GMA 3 and GMA 7.

The Texas Water Development Board website has summaries of desired future conditions and modeled available groundwater estimates for each Groundwater Management Area, including tabulations for each groundwater conservation district in GMAs 3 and 7. These summaries are available at:

http://www.twdb.texas.gov/groundwater/dfc/2016jointplanning.asp

The desired future conditions for Middle Pecos Groundwater Conservation District are presented in Table 1. The modeled available groundwater estimates for Middle Pecos Groundwater Conservation District are presented in Table 2.

Table 1. Summary of Desired Future Conditions for MPGCD

Aquifer	Groundwater Management Area	Desired Future Condition (DFC)	Date DFC Adopted
Capitan Reef Complex	3	Total net drawdown not to exceed 4 feet in Pecos County (Middle Pecos GCD) in 2070 as compared with aquifer levels in 2006	10/20/2016
Capitan Reef Complex	7	Total net drawdown of the Capitan Reef Aquifer not to exceed 56 feet in Pecos County (Middle Pecos GCD) in 2070 as compared with 2006 aquifer levels.	3/23/2017
Dockum	3	Total net drawdown not to exceed 52 feet in 2070, as compared with aquifer levels in 2012	10/20/2016
Dockum	7	Total net drawdown of the Dockum Aquifer not to exceed 52 feet in Pecos County (Middle Pecos GCD) in 2070, as compared with 2012 aquifer levels.	9/22/2016
Edwards-Trinity (Plateau) and Pecos Valley	3	Total net drawdown not to exceed 14 feet in 2070, as compared with aquifer levels in 2010	10/20/2016, revised on 12/13/2017
Edwards-Trinity (Plateau) and Pecos Valley	7	Average drawdown not to exceed 14 feet of drawdown from 2010 to 2070	3/22/2018
Rustler	3	Total net drawdown not to exceed 69 feet in 2070, as compared with aquifer levels in 2009	10/20/2016
Rustler	7	Total net drawdown of the Rustler Aquifer in Pecos County (Middle Pecos GCD) in 2070 not to exceed 94 feet as compared with 2009 aquifer levels	9/22/2016

Table 2. Summary of Modeled Available Groundwater for MPGCD

Aquifer	Groundwater Management Area	Modeled Available Groundwater (AF/yr)						TWDB Report
		2020	2030	2040	2050	2060	2070	
Capitan Reef Complex	3	4	4	4	4	4	4	GR 16-027 MAG
Capitan Reef Complex	7	26,164	26,164	26,164	26,164	26,164	26,164	GR 16-026 MAG v.2.
Dockum	3	6,142	6,142	6,142	6,142	6,142	6,142	GR 16-027 MAG
Dockum	7	2,022	2,022	2,022	2,022	2,022	2,022	GR 16-026 MAG v.2.
Edwards-Trinity (Plateau) and Pecos Valley	3	122,899	122,899	122,899	122,899	122,899	122,899	GR 16-027 MAG
Edwards-Trinity (Plateau) and Pecos Valley	7	117,309	117,309	117,309	117,309	117,309	117,309	GR 16-026 MAG v.2.
Rustler	3	3	3	3	3	3	3	GR 16-027 MAG
Rustler	7	7,040	7,040	7,040	7,040	7,040	7,040	GR 16-026 MAG v.2.

5.2 Estimate of the Amount of Groundwater Being Used within the District on an Annual Basis

Please refer to Appendix A: Estimated Historical Water Use and 2017 State Water Plan Datasets: Middle Pecos Groundwater Conservation District.

5.3 Estimate of the Annual Amount of Recharge from Precipitation

Please refer to Appendix B: GAM Run 19-021: Middle Pecos Groundwater Conservation District Management Plan, dated February 18, 2020.

5.4 Estimate of the Annual Volume of Water That Discharges to Springs and Surface Water Bodies

Please refer to Appendix B: GAM Run 19-021: Middle Pecos Groundwater Conservation District Management Plan, dated February 18, 2020.

5.5 Estimate of the Annual Volume of flow into the District, out of the District, and between Aquifers

Please refer to Appendix B: GAM Run 19-021: Middle Pecos Groundwater Conservation District Management Plan, dated February 18, 2020.

5.6 Estimate of the Projected Surface Water Supply within the District

Please refer to Appendix A: Estimated Historical Water Use and 2017 State Water Plan Datasets: Middle Pecos Groundwater Conservation District.

5.7 Estimate of the Projected Total Demand for Water within the District

Please refer to Appendix A: Estimated Historical Water Use and 2017 State Water Plan Datasets: Middle Pecos Groundwater Conservation District.

5.8 Water Supply Needs

Please refer to Appendix A: Estimated Historical Water Use and 2017 State Water Plan Datasets: Middle Pecos Groundwater Conservation District. There are no water supply needs for the District.

5.9 Water Management Strategies

Please refer to Appendix A: Estimated Historical Water Use and 2017 State Water Plan Datasets: Middle Pecos Groundwater Conservation District.

Page 7 of Appendix A includes five specific water conservation strategies (i.e. demand reduction strategies), one weather modification strategy that will yield additional 264 AF/yr of supply, and one groundwater development project that would yield an additional 250 AF/yr of supply for Pecos County WCID #1.

These specific water management strategies were considered and included in the overall preparation of this management plan.

5.10 How the District Will Manage Groundwater Supplies

The Texas Legislature established that groundwater conservation districts are the preferred method of groundwater management in Section 36.0015 of the Texas Water Code. The District will cooperate with the other Groundwater Conservation Districts in the Groundwater Management Areas which Pecos County is located.

The District will manage the supply of groundwater within the District to conserve the resource while seeking to maintain the economic viability of all resource user groups, public and private. The District seeks to manage the groundwater resources of the District as practicably as possible in a sustainable manner through the development of the Desired Future Conditions of Aquifers within the District.

The District will protect the existing and historical use of groundwater that occurred in the District prior to the effective date of the rules establishing the claims process. To obtain a historic use permit, an existing or historic user had to prove the maximum annual amount of groundwater that the user put towards a beneficial use during an existing and historic use period established in the District rules. The protection extended to historic use permit holders is achieved by imposing more restrictive permit conditions on new permit applications. In extending this protection to historic use permit holders the District established limitations that:

a) Apply to all subsequent new applications for the permitted use of groundwater and applications for the increased use of groundwater by holders of historic user permits regardless of the type or location of use
b) Bear a reasonable relationship to the District's management plan
c) Are reasonably necessary to protect existing use and maintain established Desired Future Conditions of aquifers, aquifer subdivisions or management established by the District.

In consideration of the economic and cultural activities occurring within the District, the District will identify and engage in such activities and practices, that if implemented may result in the conservation of groundwater in the District. The District will manage groundwater resources through rules developed and implemented in accordance with Chapter 36 of the Texas Water Code and the provisions of the District Enabling Act recorded in Chapter 1299 of the Acts of the 77th Texas Legislature (HB 1258).

The District will require that any well that is constructed as an exempt well under activities regulated by the Texas Railroad Commission (TRC) and later converted to another use not regulated by the TRC will be required to seek a permit for the use of groundwater in the District if the converted use of the well is otherwise not exempted from permitting under the Texas Water Code or Rules of the District.

In each Management Zone, the District seeks to avoid impairment of the adopted DFCs for the District as a whole (within the portions of the District in each of GMAs 3 and 7) by establishing benchmarks of sustainable groundwater use over time in the District Rules. The assessment of the change in average draw-down values over time will be indexed to year 2010 water levels to be consistent with the adopted DFCs of the Edwards-Trinity (Plateau) and Pecos Valley aquifers. By managing the change in aquifer water levels over time in the management zones, the District can provide for the sustainability of the aquifers and avoid impairment of the aquifer DFCs established by the GMAs.

An example of this management activity is when special permit conditions were adopted in Management Zone 1. The thresholds were established based on avoiding groundwater elevations dropping below historic minima. This will be accomplished by routine monitoring of groundwater elevations in 11 wells and requiring non-historic use pumping reductions if certain thresholds are exceeded (i.e. groundwater elevations drop below the threshold value set for each well). When developing the thresholds, a comparison was made to evaluate the consistency with the adopted desired future condition. Figure 2 shows the results of the comparison.

Please note that the blue data points represent the groundwater elevation where pumping cutbacks begin for each well. The red dots represent the groundwater elevation where a shut-down in non-historic groundwater pumping would be required, thus providing an opportunity for groundwater elevation recovery. The black line represents one-to-one line between the DFC depth to water at each well and the threshold depth to water in each well. The data points generally fall just above or just below the black line demonstrating that the thresholds are consistent with the DFC.

The District may employ technical resources at its disposal, as needed, to evaluate the resources available within the District and to determine the effectiveness of regulatory or conservation measures. In consideration of individual, localized or District-wide conditions the District may allow the production in a management zone to exceed the sustainable amount for a period considered necessary by the District. The exercise of this discretion by the District shall not be construed as limiting the authority of the District in any other matter. A public or private user may appeal to the Board for discretion in enforcement of the provisions of a reduction in the permitted use of groundwater on grounds of adverse economic hardship or unique local conditions. The exercise of said discretion by the Board shall not be construed as limiting the power of the Board.

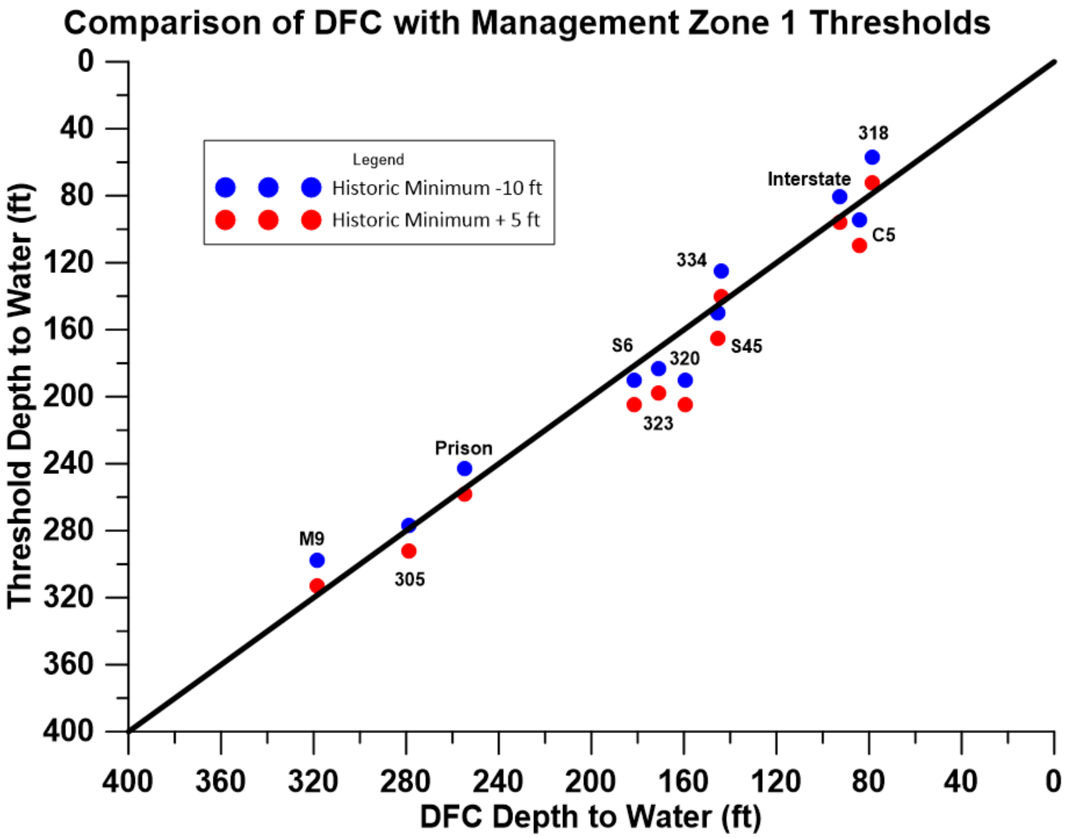

Figure 2. Comparison of DFC with Management Zone 1 Thresholds

5.11 Actions, Procedures, Performance, and Avoidance Necessary to Effectuate the Management Plan

The District will implement the goals and provisions of this Management Plan and will utilize the objectives of this Management Plan as a guideline in its decision-making to be consistent with the provisions of this plan.

The District has adopted rules, in accordance with Chapter 36 of the Texas Water Code, that implement the Management Plan. The current version of the rules is dated June 19, 2018, and is attached as Appendix C. The rules are also available at:

https://www.middlepecosgcd.org/pdf/rules/2018/MPGCD%20Rules%20adopted%20June%2019%202018.pdf?_t=1536326104

All rules will be followed and enforced. The District will amend the District rules as necessary to comply with changes to Chapter 36 of the Texas Water Code and to ensure the best management of the groundwater within the District. The development and enforcement of the rules of the District will be based on the best scientific and technical evidence available to the District. If, at any point, it appears the District will not be able to achieve the adopted Desired Future Conditions the Board of Directors will amend the rules as necessary to ensure the Desired Future Conditions will be achieved.

The District may deny a well construction permit or limit groundwater withdrawals in accordance with the guidelines stated in the rules of the District. In making a determination to deny a permit or reduce the amount of groundwater withdrawals authorized in an existing permit, the District will weigh the public benefit in managing the aquifer to be derived from the denial of a groundwater withdrawal permit or the reduction of the amount of authorized groundwater withdrawals against the individual hardship imposed by the permit denial or authorization reduction.

The relevant factors to be considered in deciding to deny a permit or limit groundwater withdrawals may include:

- The rules of the District
- The distribution of groundwater resources in the aquifers or aquifer subdivisions of the District or any management zones established by the District
- The economic hardship resulting from grant or denial of a permit or the terms prescribed by the permit

In pursuit of the District's mission of protecting the resource, the District may require reduction of groundwater withdrawals. To achieve this purpose, the District may, at the Boards discretion amend or revoke any permits after notice and hearing. The determination to seek the amendment, reduction, or revocation of a permit by the District will be based on aquifer conditions observed by the District. The District will, when necessary, enforce the terms and conditions of permits and the rules of the District by enjoining the permit holder in a court of competent jurisdiction as provided for in Texas Water Code Chapter 36.102.

The District will establish rules for the proportional reduction of the permitted use of groundwater in the District that will recognize the following priorities of use:

- Exempt users with consideration to livestock and domestic use
- Holders of historic use of groundwater permits
- Holders of non-historic groundwater use permits

The General Manager of the District will prepare and submit an annual report (Annual Report) to the District Board of Directors. The Annual Report will include an update on the District's performance in achieving the management goals contained in this plan. The general manager will present the Annual Report to the Board of Directors within one hundred twenty (120) days following the completion of the District's Fiscal Year, currently the District fiscal year ends on September 30 of each calendar year. A copy of the annual audit of District financial records will be included in the Annual Report. The District will maintain a copy of the Annual Report on file for public inspection at the District offices, upon adoption by the Board of Directors.

5.12 Evidence that the Plan was Adopted after Notice and Hearing

The notice for the public hearing was posted with the Pecos County Clerk on June 29, 2020, and the management plan was posted on the District's website on June 30, 2020. The public hearing was held at the Middle Pecos Groundwater Conservation District during the regular Board meeting on July 14. 2020. There were no comments during the public hearing. The Board approved the plan on July 14, 2020 after the close of the public hearing.

Please refer to Appendix D for copies of the notice, agenda, and Board resolution for the public hearing.

5.13 Evidence that District Coordinated with Regional Surface Water Management Entities Following Notice and Hearing

Please refer to Appendix E.

5.14 Site-Specific Information

Not Applicable

6.0 Management Goals

6.1 Providing for the Most Efficient Use of Groundwater in the District

Objective – Each year, the District will require all new exempt or permitted wells that are constructed within the boundaries of the District to be registered with the District in accordance with the District rules.

Performance Standard – Each Year the number of exempt and permitted wells registered by the District for the year will be incorporated into the Annual Report submitted to the Board of Directors of the District.

6.2 Controlling and Preventing the Waste of Groundwater in the District

Objective – Each year, the District will provide information to the public on eliminating and reducing wasteful practices in the use of groundwater either by a page on groundwater waste reduction or a link to information on groundwater waste reduction on the District's website or by providing an article on eliminating and reducing wasteful practices to a newspaper of general circulation in the District for potential publication.

Performance Standard – Submit an article annually regarding the elimination of wasteful practices to a local publication for distribution in Pecos County. A copy of the information provided on groundwater waste reduction will be included in the District's Annual Report to be given to the District Board of Directors.

6.3. Controlling and Preventing Subsidence

The subsidence tool developed by the Texas Water Development Board was used to assess the potential for subsidence in the five aquifers in the District using the default values provided. The tool can be accessed at:

http://www.twdb.texas.gov/groundwater/models/research/subsidence/subsidence.asp

The tool provides a numeric total weighted risk factor that ranges from 0 (low risk) to 10 (high risk). The results of applying the default values from the tool yield the following scores:

- Capitan Reef Complex Aquifer: 2.66
- Dockum Aquifer: 3.75
- Edwards-Trinity (Plateau) Aquifer: 2.97
- Pecos Valley Aquifer: 5.78
- Rustler Aquifer: 3.59

Based on applying the tool, this management goal is not applicable to the District due to the low risk of subsidence in Pecos County.

6.4. Addressing Conjunctive Surface Water Management Issues

Objective – Each year, the District will participate in the regional planning process by being represented at the Region F Regional Water Planning Group meetings.

Performance Standard – The attendance of a District representative to at least 50 percent of the Region F Regional Water Planning Group meetings will be noted in the Annual Report presented to the District Board of Directors.

6.5 Addressing Natural Resource Issues That Affect the Use and Availability of Groundwater and which are Impacted by the Use of Groundwater

Objective – Each year the District will monitor the discharge of Comanche and related springs or acquire the monitoring data on spring discharge developed by others.

Performance Standard – Each year, a summary of the collected or gathered spring data will be included in the Annual Report submitted to the District Board of Directors.

Objective - By attending GMA 3 and GMA 7 meetings, there is the opportunity to participate in discussions, planning and education concerning the interrelationship of groundwater with other natural resource issues. The MPGCD designated representative will attend 50% of the GMA 3 and GMA 7 meetings annually.

Performance Standard - The minutes for all attended meetings of GMA 3 and GMA 7 will be maintained in the District for a period of three (3) years from their accepted date. A report of all attended meetings will be given to the Board at the regular meeting.

6.6 Addressing Drought Conditions

Objective – Each month, the District will download available drought information, for the District, from available websites on the internet such as (last accessed on June 4, 2020):

https://droughtmonitor.unl.edu/CurrentMap/StateDroughtMonitor.aspx?TX

Performance Standard – Quarterly, the District will assess the status of drought in the District and prepare a briefing for the Board of Directors. The downloaded maps, reports, and information will be included with copies of the quarterly briefing in the District Annual Report to the Board of Directors.

6.7 Addressing Conservation, Recharge Enhancement, Rainwater Harvesting, Precipitation Enhancement, and Brush Control Where Cost Effective

6.7.1 Addressing Conservation

Objective – The District will submit an article annually, regarding water conservation for publication to at least one newspaper of general circulation in Pecos County.

Performance Standard – A copy of the article submitted by the District for publication to a newspaper of general circulation in Pecos County regarding water conservation will be included in the Annual Report to the Board of Directors.

6.7.2 Recharge Enhancement

This management goal is not applicable to the District due to lack of available surface water of acceptable quality and cost effectiveness.

6.7.3 Rainwater Harvesting

Objective – The District will post an article or a link to an article annually, regarding rainwater harvesting on the District website www.middlepecosgcd.org

Performance Standard – A copy of the article posted on the District website regarding rainwater harvesting will be included in the Annual Report to the Board of Directors.

6.7.4 Precipitation Enhancement

This management goal is not applicable to the District because of the generally low annual precipitation, and is considered not cost effective at this time.

6.7.5 Brush Control

This management goal is not applicable to the District because the objective is not cost effective due to the sparse nature of the vegetation in the District and the fact that much of the recharge to the District's aquifers are outside the boundaries of the District.

6.8 Addressing the Desired Future Conditions

Objective – The desired future conditions for the Captain Reef Complex, Dockum, Edwards-Trinity (Plateau), Pecos Valley Alluvium, and Rustler aquifers were adopted after the review of results from Groundwater Availability Model simulations. The model results include cell-by-cell estimates of groundwater elevations and drawdown for each year of the predictive period (through 2070). To assess the desired future condition in the District, these model results are compared annually to groundwater monitoring data that are available from the TWDB groundwater database.

Performance Standard – Each year, the District will download groundwater data from Pecos County from the Texas Water Development Board groundwater database. The comparison of model results will be on a well-by-well basis for data that are available. The data downloaded from the database will be compared to model results each year and presented at a regular Board meeting in the form of tables and graphs as appropriate. These comparisons will be supplemented by data and information related to drought conditions and permitted pumping data. An example of the analysis completed in 2020 is provided in Appendix F.

Appendix A

Estimated Historical Water Use and 2017 State Water Plan Datasets: Middle Pecos Groundwater Conservation District

Estimated Historical Water Use And 2017 State Water Plan Datasets:

Middle Pecos Groundwater Conservation District

by Stephen Allen
Texas Water Development Board
Groundwater Division
Groundwater Technical Assistance Section
stephen.allen@twdb.texas.gov
(512) 463-7317
April 14, 2020

GROUNDWATER MANAGEMENT PLAN DATA:

This package of water data reports (part 1 of a 2-part package of information) is being provided to groundwater conservation districts to help them meet the requirements for approval of their five-year groundwater management plan. Each report in the package addresses a specific numbered requirement in the Texas Water Development Board's groundwater management plan checklist. The checklist can be viewed and downloaded from this web address:

http://www.twdb.texas.gov/groundwater/docs/GCD/GMPChecklist0113.pdf

The five reports included in this part are:

1. Estimated Historical Water Use (checklist item 2)

   from the TWDB Historical Water Use Survey (WUS)

2. Projected Surface Water Supplies (checklist item 6)
3. Projected Water Demands (checklist item 7)
4. Projected Water Supply Needs (checklist item 8)
5. Projected Water Management Strategies (checklist item 9)

   from the 2017 Texas State Water Plan (SWP)

Part 2 of the 2-part package is the groundwater availability model (GAM) report for the District (checklist items 3 through 5). The District should have received, or will receive, this report from the Groundwater Availability Modeling Section. Questions about the GAM can be directed to Dr. Shirley Wade, shirley.wade@twdb.texas.gov, (512) 936-0883.

DISCLAIMER:

The data presented in this report represents the most up-to-date WUS and 2017 SWP data available as of 4/14/2020. Although it does not happen frequently, either of these datasets are subject to change pending the availability of more accurate WUS data or an amendment to the 2017 SWP. District personnel must review these datasets and correct any discrepancies in order to ensure approval of their groundwater management plan.

The WUS dataset can be verified at this web address:

http://www.twdb.texas.gov/waterplanning/waterusesurvey/estimates/

The 2017 SWP dataset can be verified by contacting Sabrina Anderson (sabrina.anderson@twdb.texas.gov or 512-936-0886).

For additional questions regarding this data, please contact Stephen Allen (stephen.allen@twdb.texas.gov or 512-463-7317).

Estimated Historical Water Use
TWDB Historical Water Use Survey (WUS) Data

Groundwater and surface water historical use estimates are currently unavailable for calendar year 2018. TWDB staff anticipates the calculation and posting of these estimates at a later date.

PECOS COUNTY

All values are in acre-feet

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2017	GW	5,268	88	1,003	0	137,334	531	144,224
	SW	0	0	0	0	3,146	28	3,174
2016	GW	5,217	221	247	0	147,893	599	154,177
	SW	0	0	0	0	3,910	32	3,942
2015	GW	5,294	142	189	0	151,876	595	158,096
	SW	0	0	0	0	2,972	31	3,003
2014	GW	5,173	133	89	0	159,501	643	165,539
	SW	0	0	0	0	0	34	34
2013	GW	5,635	137	52	0	139,488	601	145,913
	SW	0	0	0	0	0	32	32
2012	GW	4,174	252	5	0	110,247	619	115,297
	SW	0	0	0	0	0	33	33
2011	GW	6,421	244	2	0	125,090	694	132,451
	SW	0	0	0	0	55,000	37	55,037
2010	GW	4,771	247	182	0	122,675	703	128,578
	SW	0	0	57	0	3,358	37	3,452
2009	GW	4,902	211	263	0	90,845	714	96,935
	SW	0	0	81	0	1,345	38	1,464
2008	GW	5,229	239	342	0	56,914	774	63,498
	SW	0	0	105	0	0	41	146
2007	GW	4,565	231	5	0	54,562	688	60,051
	SW	0	0	0	0	3,348	37	3,385
2006	GW	4,649	184	5	0	61,906	886	67,630
	SW	0	0	0	0	7,150	47	7,197
2005	GW	4,406	195	5	0	41,404	792	46,802
	SW	0	0	0	0	5,199	42	5,241
2004	GW	4,361	178	5	0	42,478	746	47,768
	SW	0	0	0	0	191	39	230
2003	GW	4,818	142	6	0	37,644	743	43,353
	SW	0	0	0	0	0	39	39
2002	GW	4,334	142	7	0	61,255	867	66,605
	SW	0	0	0	0	1,250	46	1,296

Projected Surface Water Supplies
TWDB 2017 State Water Plan Data

PECOS COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	Source Name	2020	2030	2040	2050	2060	2070
F	IRRIGATION, PECOS	RIO GRANDE	RED BLUFF LAKE/RESERVOIR	1,558	1,559	1,560	1,561	1,562	1,563
F	IRRIGATION, PECOS	RIO GRANDE	RIO GRANDE RUN-OF-RIVER	4,444	4,444	4,444	4,444	4,444	4,444
F	LIVESTOCK, PECOS	RIO GRANDE	RIO GRANDE LIVESTOCK LOCAL SUPPLY	52	52	52	52	52	52
	Sum of Projected Surface Water Supplies (acre-feet)			**6,054**	**6,055**	**6,056**	**6,057**	**6,058**	**6,059**

Projected Water Demands
TWDB 2017 State Water Plan Data

Please note that the demand numbers presented here include the plumbing code savings found in the Regional and State Water Plans.

PECOS COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
F	COUNTY-OTHER, PECOS	RIO GRANDE	415	427	453	478	501	522
F	FORT STOCKTON	RIO GRANDE	4,910	5,230	5,548	5,853	6,138	6,398
F	IRAAN	RIO GRANDE	459	486	513	541	567	591
F	IRRIGATION, PECOS	RIO GRANDE	126,023	126,023	126,023	126,023	126,023	126,023
F	LIVESTOCK, PECOS	RIO GRANDE	932	932	932	932	932	932
F	MANUFACTURING, PECOS	RIO GRANDE	103	103	103	103	103	103
F	MINING, PECOS	RIO GRANDE	690	1,068	1,072	861	672	524
F	PECOS COUNTY WCID #1	RIO GRANDE	439	456	475	496	519	540
		Sum of Projected Water Demands (acre-feet)	**133,971**	**134,725**	**135,119**	**135,287**	**135,455**	**135,633**

Projected Water Supply Needs
TWDB 2017 State Water Plan Data

Negative values (in red) reflect a projected water supply need, positive values a surplus.

PECOS COUNTY

All values are in acre-feet

RWPG	WUG	WUG Basin	2020	2030	2040	2050	2060	2070
F	COUNTY-OTHER, PECOS	RIO GRANDE	0	0	0	0	0	0
F	FORT STOCKTON	RIO GRANDE	0	0	0	0	0	0
F	IRAAN	RIO GRANDE	0	0	0	0	0	0
F	IRRIGATION, PECOS	RIO GRANDE	5	6	7	8	9	10
F	LIVESTOCK, PECOS	RIO GRANDE	0	0	0	0	0	0
F	MANUFACTURING, PECOS	RIO GRANDE	0	0	0	0	0	0
F	MINING, PECOS	RIO GRANDE	0	0	0	0	0	0
F	PECOS COUNTY WCID #1	RIO GRANDE	0	0	0	0	0	0
	Sum of Projected Water Supply Needs (acre-feet)		**0**	**0**	**0**	**0**	**0**	**0**

Projected Water Management Strategies
TWDB 2017 State Water Plan Data

PECOS COUNTY

WUG, Basin (RWPG)

All values are in acre-feet

Water Management Strategy	Source Name [Origin]	2020	2030	2040	2050	2060	2070
FORT STOCKTON, RIO GRANDE (F)							
MUNICIPAL CONSERVATION - FORT STOCKTON	DEMAND REDUCTION [PECOS]	50	53	57	60	63	66
		50	**53**	**57**	**60**	**63**	**66**
IRAAN, RIO GRANDE (F)							
MUNICIPAL CONSERVATION - IRAAN	DEMAND REDUCTION [PECOS]	7	8	8	9	9	10
		7	**8**	**8**	**9**	**9**	**10**
IRRIGATION, PECOS, RIO GRANDE (F)							
IRRIGATION CONSERVATION - PECOS COUNTY	DEMAND REDUCTION [PECOS]	6,301	12,602	18,903	18,903	18,903	18,903
WEATHER MODIFICATION	WEATHER MODIFICATION [ATMOSPHERE]	264	264	264	264	264	264
		6,565	**12,866**	**19,167**	**19,167**	**19,167**	**19,167**
MINING, PECOS, RIO GRANDE (F)							
MINING CONSERVATION - PECOS COUNTY	DEMAND REDUCTION [PECOS]	48	75	75	60	47	37
		48	**75**	**75**	**60**	**47**	**37**
PECOS COUNTY WCID #1, RIO GRANDE (F)							
DEVELOP ADDITIONAL EDWARDS-TRINITY PLATEAU AQUIFER SUPPLIES - PECOS COUNTY WCID #1	EDWARDS-TRINITY-PLATEAU AQUIFER [PECOS]	250	250	250	250	250	250
MUNICIPAL CONSERVATION - PECOS WCID	DEMAND REDUCTION [PECOS]	19	20	22	23	24	25
		269	**270**	**272**	**273**	**274**	**275**
Sum of Projected Water Management Strategies (acre-feet)		**6,939**	**13,272**	**19,579**	**19,569**	**19,560**	**19,555**

Appendix B

GAM Run 19-021: Middle Pecos Groundwater Conservation District Management Plan

Texas Water
Development Board

P.O. Box 13231, 1700 N. Congress Ave.
Austin, TX 78711-3231, www.twdb.texas.gov
Phone (512) 463-7847, Fax (512) 475-2053

February 18, 2020

Mr. Ty Edwards
General Manager
Middle Pecos Groundwater Conservation District
P.O. Box 1644
Fort Stockton, TX 79735

Dear Mr. Edwards:

This letter transmits information to you in partial fulfilment of Texas Water Code, Section 36.1071, Subsections (e) and (h), which require that the Executive Administrator of the Texas Water Development Board (TWDB) provide groundwater availability modeling information to a groundwater conservation district for use in developing its groundwater management plan.

The TWDB provides this information to the Middle Pecos Groundwater Conservation District in two parts. Part 1 is the Estimated Historical Water Use/State Water Plan datasets report, which will be provided to you separately from the TWDB Groundwater Technical Assistance Department. The Part 1 water data report includes estimates of historical water use, projected surface water supplies, projected water demands, projected water supply needs, and projected water management strategies for the groundwater conservation district. Please direct questions about the water data report to Mr. Stephen Allen at (512) 463-7317 or Stephen.Allen@twdb.texas.gov. Part 2 is the required groundwater availability modeling information and is provided with this letter. This information includes:

1. the annual amount of recharge from precipitation, if any, to each aquifer within the district;
2. for each aquifer within the district, the annual volume of water that discharges from the aquifer to springs and any surface-water bodies, including lakes, streams, and rivers; and
3. the annual volume of flow into and out of the district within each aquifer and between aquifers in the district.

This model run, GAM Run 19-021, replaces GAM Run 14-010 as the approach used for analyzing model results has been since refined to more accurately delineate flows between hydraulically connected units. In addition, GAM Run 19-021 includes results from the Groundwater Availability Model for the Capitan Reef Complex Aquifer and the Groundwater Availability Model for the High Plains Aquifer System to analyze the Dockum Aquifer. For your convenience, an electronic version of the GAM Run 19-021 report is available to download at http://www.twdb.texas.gov/groundwater/docs/GAMruns/GR19-021.pdf.

The groundwater management plan for the Middle Pecos Groundwater Conservation District should be adopted by the district on or before June 17, 2020 and submitted to the Executive Administrator of the TWDB on or before July 17, 2020. The current management plan for the Middle Pecos Groundwater Conservation District expires on September 15, 2020.

If you have any further questions or concerns about the model run, please feel free to contact Grayson Dowlearn of our Groundwater staff at (512) 475-1552 or Grayson.Dowlearn@twdb.texas.gov , or Cindy Ridgeway of our Groundwater staff at (512) 936-2386 or Cindy.Ridgeway@twdb.texas.gov.

Sincerely,

Jeff Walker
Executive Administrator

Enclosures

c w/o enc.: Cindy Ridgeway, P.G., Groundwater
Stephen Allen, P.G., Groundwater
Grayson Dowlearn, Groundwater

GAM Run 19-021: Middle Pecos Groundwater Conservation District Management Plan

By Grayson Dowlearn
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Department
(512) 475-1552
February 18, 2020

Cynthia K. Ridgeway is the manager of the Groundwater Availability Modeling Department and is responsible for the oversight of work performed by Grayson Dowlearn under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G. 471 on February 18, 2020.

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GAM RUN 19-021: MIDDLE PECOS GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

By Grayson Dowlearn
Texas Water Development Board
Groundwater Division
Groundwater Availability Modeling Department
(512) 475-1552
February 18, 2020

EXECUTIVE SUMMARY:

Texas State Water Code, Section 36.1071, Subsection (h) (Texas Water Code, 2011), states that, in developing its groundwater management plan, a groundwater conservation district shall use groundwater availability modeling information provided by the Executive Administrator of the Texas Water Development Board (TWDB) in conjunction with any available site-specific information provided by the district for review and comment to the Executive Administrator.

The TWDB provides data and information to the Middle Pecos Groundwater Conservation District in two parts. Part 1 is the Estimated Historical Water Use/State Water Plan dataset report, which will be provided to you separately by the TWDB Groundwater Technical Assistance Department. Please direct questions about the water data report to Mr. Stephen Allen at 512-463-7317 or stephen.allen@twdb.texas.gov. Part 2 is the required groundwater availability modeling information and this information includes:

1. the annual amount of recharge from precipitation, if any, to the groundwater resources within the district;
2. for each aquifer within the district, the annual volume of water that discharges from the aquifer to springs and any surface-water bodies, including lakes, streams, and rivers; and
3. the annual volume of flow into and out of the district within each aquifer and between aquifers in the district.

The groundwater management plan for the Middle Pecos Groundwater Conservation District should be adopted by the district on or before June 17, 2020 and submitted to the executive administrator of the TWDB on or before July 17, 2020. The current management plan for the Middle Pecos Groundwater Conservation District expires on September 15, 2020.

We used four groundwater availability models to estimate the management plan information for the aquifers within the Middle Pecos Groundwater Conservation District. Information for the Pecos Valley and Edwards-Trinity (Plateau) aquifers is from version 1.01 of the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers (Anaya and Jones, 2009). Information for the Dockum Aquifer is from version 1.01 of the groundwater availability model for the High Plains aquifer system (Deeds and Jigmond, 2015 and Deeds and Hamlin, 2015). Information for the Rustler Aquifer is from version 1.01 of the groundwater availability model for the Rustler Aquifer (Ewing and others, 2012). Information for the Capitan Reef Complex Aquifer is from version 1.01 of the groundwater availability model for the Capitan Reef Complex Aquifer (Jones, 2016). While a small portion of the Igneous Aquifer underlies the district at the western tip of Pecos County, the model for the Igneous Aquifer does not extend into Pecos County. For more information concerning this aquifer, please contact Mr. Stephen Allen at 512-463-7317 or stephen.allen@twdb.texas.gov.

This report replaces the results of GAM Run 14-010 (Jones, 2014), as the approach used for analyzing model results has been since refined to more accurately delineate flows between hydraulically connected units and official aquifer boundaries. In addition, this analysis includes results from the groundwater availability model for the Capitan Reef Complex Aquifer and the groundwater availability model for the High Plains Aquifer System, both of which were released since the publication of GAM Run 14-010. Tables 1, 2, 3, 4, and 5 summarize the groundwater availability model data required by statute and Figures 1, 2, 3, 4, and 5 show the area of the models from which the values in the tables were extracted. If, after review of the figures, the Middle Pecos Groundwater Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the TWDB at your earliest convenience.

METHODS:

In accordance with the provisions of the Texas State Water Code, Section 36.1071, Subsection (h), the groundwater availability models mentioned above were used to estimate information for the Middle Pecos Groundwater Conservation District management plan. Water budgets were extracted for the Edwards-Trinity (Plateau) and Pecos Valley aquifers (1981-2000), Dockum Aquifer (1980-2012), Rustler Aquifer (1980-2008), and

Capitan Reef Complex Aquifer (1980-2005). We used ZONEBUDGET Version 3.01 (Harbaugh, 2009) to extract water budgets from the model results. The average annual water budget values for recharge, surface-water outflow, inflow to the district, outflow from the district, and the flow between aquifers within the district are summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Capitan Reef Complex Aquifer

- We used version 1.01 of the groundwater availability model for the Capitan Reef Complex Aquifer. See Jones (2016) for assumptions and limitations of the groundwater availability model.

- The model has five active layers representing the Edwards-Trinity (Plateau) and Pecos Valley aquifers (Layer 1); Dockum Aquifer and Dewey Lake Formation (Layer 2); Rustler Aquifer (Layer 3); Artesia Group, Salado Formation, and Castile Formation (Layer 4); and Capitan Reef Complex Aquifer, Delaware Basin, and San Andres Formation (Layer 5).

- While the model for the Capitan Reef Complex Aquifer includes the Pecos Valley, Edwards-Trinity (Plateau), Dockum, and Rustler aquifers, the focus of the model run was to extract information for the Capitan Reef Complex Aquifer. Thus, model Layer 5 was used for the management plan analysis.

- Water budget terms were averaged for the period 1980 through 2005 (stress periods 50 through 75).

- The model was run with MODFLOW-2005 (Harbaugh, 2005).

Rustler Aquifer

- We used version 1.01 of the groundwater availability model for the Rustler Aquifer. See Ewing and others (2012) for assumptions and limitations of the groundwater availability model.

- The model has two active layers representing the Dewey Lake Formation and Dockum Aquifer (Layer 1) and the Rustler Aquifer (Layer 2). While the model for the Rustler Aquifer includes the Dockum Aquifer, the focus of the model run was to extract information for the Rustler Aquifer. Therefore, model Layer 2 was used for the management plan analysis.

- Water budget terms were averaged for the period 1980 through 2008 (stress periods 63 through 91).

- The model was run with MODFLOW-2000 (Harbaugh and Others, 2000).

Dockum Aquifer

- We used version 1.01 of the groundwater availability model for the High Plains Aquifer System. See Deeds and Jigmond (2015) for assumptions and limitations of the model for the High Plains Aquifer System.

- The groundwater availability model for the High Plains Aquifer System contains four layers representing the Ogallala Aquifer and the Pecos Valley Aquifer (Layer 1); the Rita Blanca Aquifer, the Edwards-Trinity (High Plains) Aquifer, and the Edwards-Trinity (Plateau) Aquifer (Layer 2); the upper Dockum Group (Layer 3); and the lower Dockum Group (Layer 4). Layers 3 and 4, representing the Dockum Aquifer, were analyzed together. While the Pecos Valley and Edwards-Trinity (Plateau) aquifers are included in this model, they were not the focus of the model. Therefore, we used version 1.01 of the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers for analyzing these aquifers,

- Water budget terms were averaged for the period 1980 through 2012 (stress periods 52 through 84).

- The model was run with MODFLOW-NWT (Niswonger and others, 2011).

Edwards-Trinity (Plateau) and Pecos Valley Aquifers

- We used version 1.01 of the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers. See Anaya and Jones (2009) for assumptions and limitations of the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers.

- The model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers includes two active layers representing the Pecos Valley Aquifer and the Edwards Group and equivalent limestone hydrostratigraphic units (Layer 1) and the undifferentiated Trinity Group hydrostratigraphic units (Layer 2) in the district.

- A portion of the area underlying the district represents both the Pecos Valley and Edwards-Trinity (Plateau) aquifers within Layer 1 of the model. We assumed certain model cells are assigned to the Pecos Valley Aquifer and the remaining cells are assigned to the Edwards-Trinity (Plateau) Aquifer where this condition exists.

- Water budget terms were averaged for the period 1981 through 1999 (stress periods 2 through 21).

- The model was run with MODFLOW-96 (Harbaugh and McDonald, 1996).

RESULTS:

A groundwater budget summarizes the amount of water entering and leaving the aquifer according to the groundwater availability model. Selected groundwater budget components listed below were extracted from the model results for the aquifers located within the district and averaged over the historical calibration periods, as shown in Tables 1, 2, 3, 4 and 5.

1. Precipitation recharge—the areally distributed recharge sourced from precipitation falling on the outcrop areas of the aquifers (where the aquifer is exposed at land surface) within the district.

2. Surface-water outflow—the total water discharging from the aquifer (outflow) to surface-water features such as streams, reservoirs, and springs.

3. Flow into and out of district—the lateral flow within the aquifer between the district and adjacent counties.

4. Flow between aquifers—the net vertical flow between the aquifer and adjacent aquifers or confining units. This flow is controlled by the relative water levels in each aquifer and aquifer properties of each aquifer or confining unit that define the amount of leakage that occurs.

The information needed for the district's management plan is summarized in Tables 1, 2, 3, 4 and 5. It is important to note that sub-regional water budgets are not exact. This is due to the size of the model cells and the approach used to extract data from the model. To avoid double accounting, a model cell that straddles a political boundary, such as a district or county boundary, is assigned to one side of the boundary based on the location of the centroid of the model cell. For example, if a cell contains two counties, the cell is assigned to the county where the centroid of the cell is located.

TABLE 1: SUMMARIZED INFORMATION FOR THE CAPITAN REEF COMPLEX AQUIFER THAT IS NEEDED FOR THE MIDDLE PECOS GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Capitan Reef Complex Aquifer	4,860
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers.	Capitan Reef Complex Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Capitan Reef Complex Aquifer	29,953
Estimated annual volume of flow out of the district within each aquifer in the district	Capitan Reef Complex Aquifer	2,823
Estimated net annual volume of flow between each aquifer in the district	From Capitan Reef Complex Aquifer to Artesia Group/Salado Formation/Castile Formation	23,463
	From Capitan Reef Complex Aquifer to Capitan Reef Complex and other units	9,085

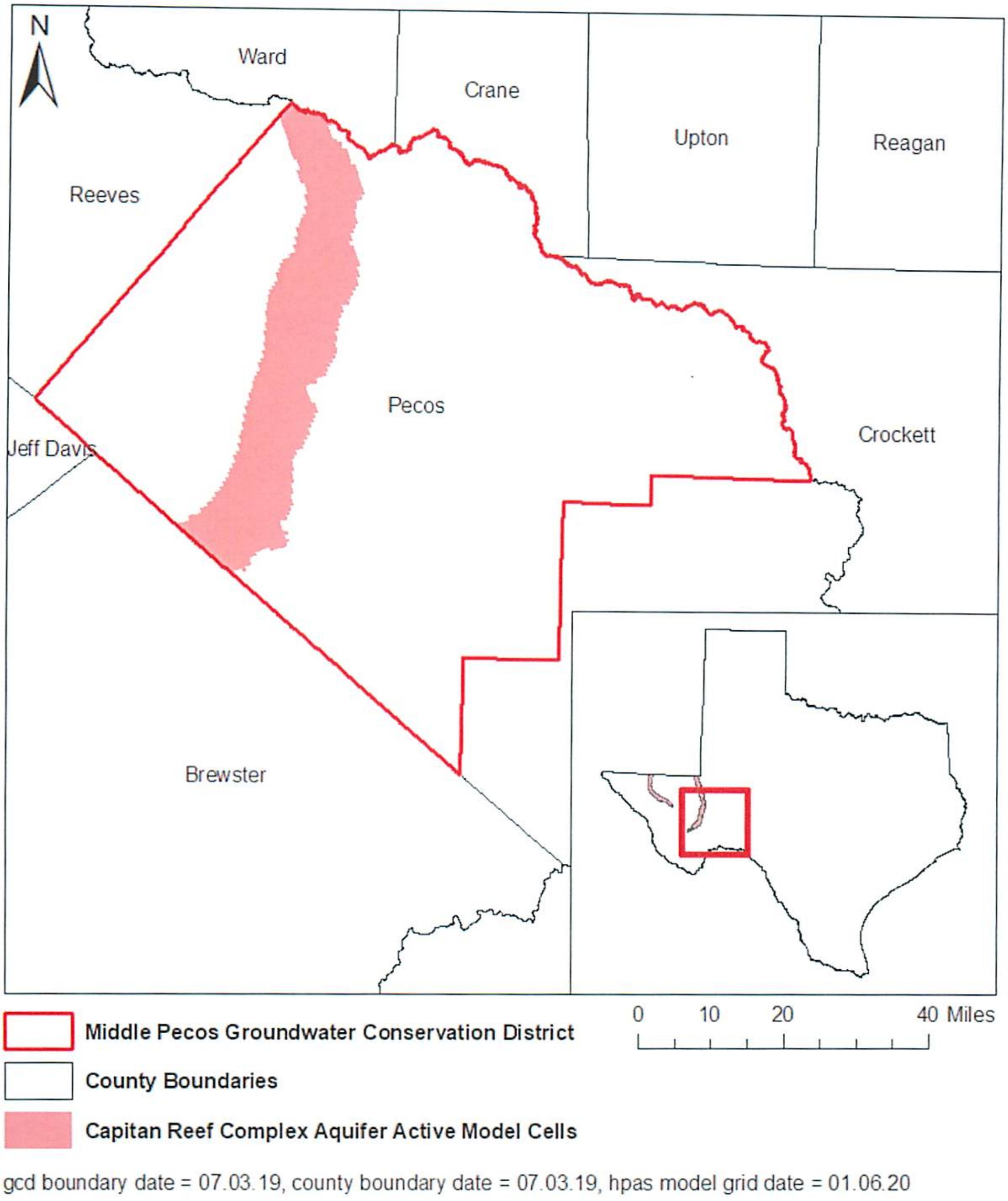

FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE CAPITAN REEF COMPLEX AQUIFER FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE CAPITAN REEF COMPLEX AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 2: SUMMARIZED INFORMATION FOR THE RUSTLER AQUIFER THAT IS NEEDED FOR THE MIDDLE PECOS GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Rustler Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers.	Rustler Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Rustler Aquifer	539
Estimated annual volume of flow out of the district within each aquifer in the district	Rustler Aquifer	418
Estimated net annual volume of flow between each aquifer in the district	From the Rustler Aquifer to the Dockum Aquifer	856
	To the Rustler Aquifer from other overlying units	342
	To the Rustler Aquifer from Rustler Formation	532

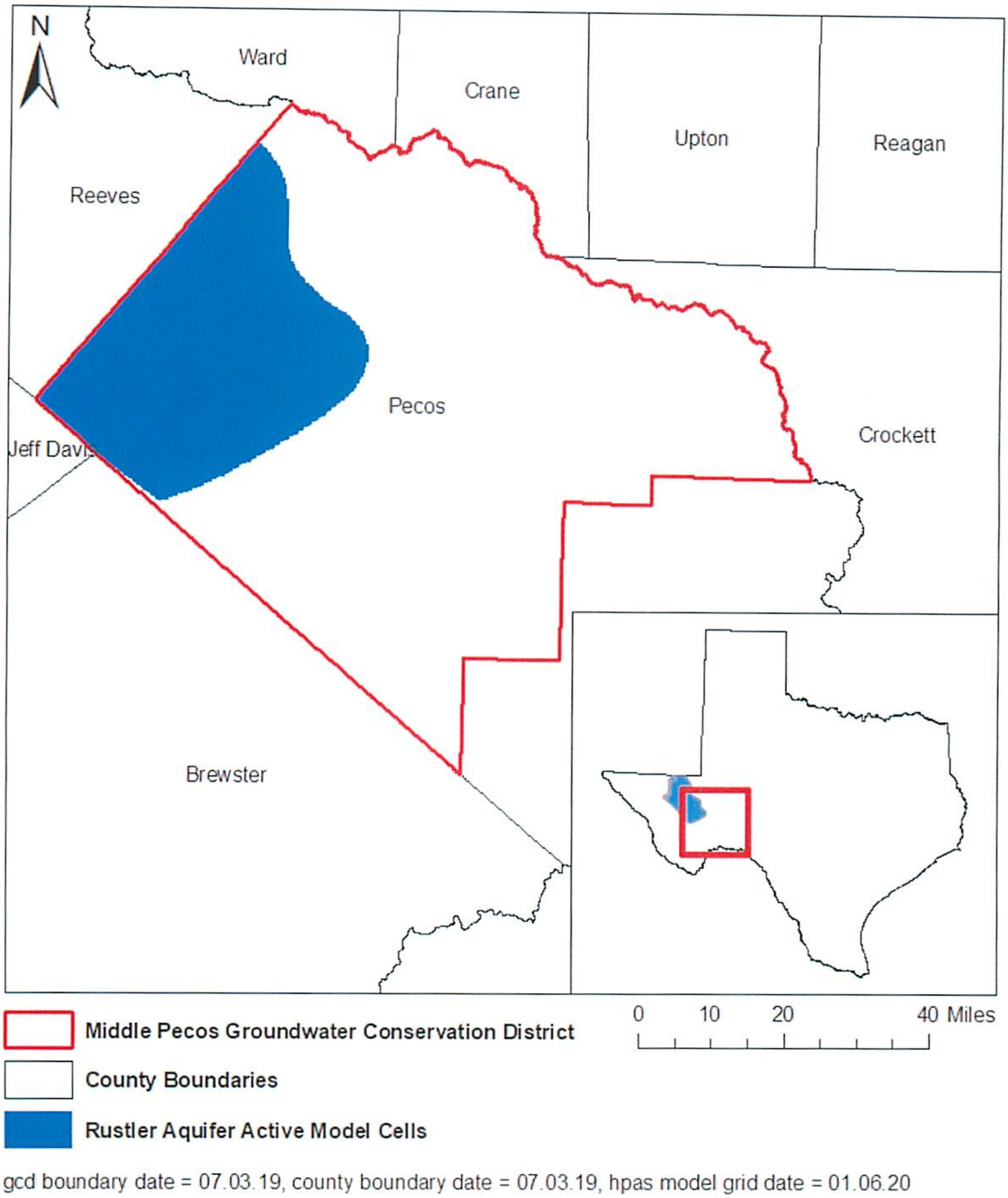

FIGURE 2: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE RUSTLER AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE RUSTLER AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 3: SUMMARIZED INFORMATION FOR THE DOCKUM AQUIFER THAT IS NEEDED FOR THE MIDDLE PECOS GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Dockum Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers.	Dockum Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Dockum Aquifer	511
Estimated annual volume of flow out of the district within each aquifer in the district	Dockum Aquifer	320
Estimated net annual volume of flow between each aquifer in the district	From the Dockum Aquifer to the Pecos Valley Aquifer	118
	To the Dockum Aquifer from the Edwards-Trinity (Plateau) Aquifer	160
	To Dockum Aquifer from Rustler Aquifer	856*
	From Dockum Aquifer to Dockum Formation	87

* Indicates value calculated from the groundwater availability model for the Rustler Aquifer, all other values are from the groundwater availability model for the High Plains Aquifer System.

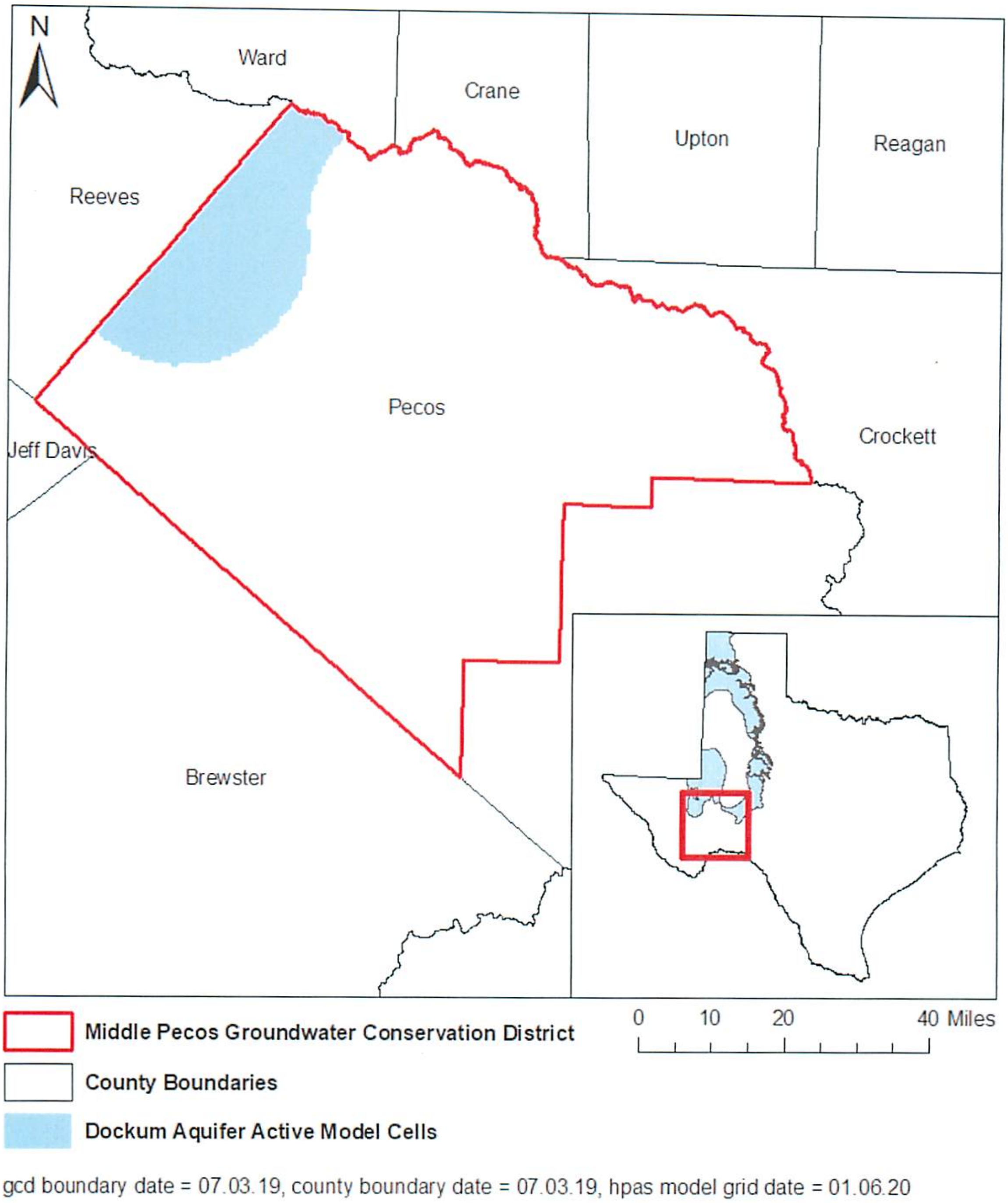

FIGURE 3: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE HIGH PLAINS AQUIFER SYSTEM FROM WHICH THE INFORMATION IN TABLE 3 WAS EXTRACTED (THE DOCKUM AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 4: SUMMARIZED INFORMATION FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER THAT IS NEEDED FOR THE MIDDLE PECOS GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Edwards-Trinity (Plateau) Aquifer	141,982
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers.	Edwards-Trinity (Plateau) Aquifer	24,024
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	32,418
Estimated annual volume of flow out of the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	77,569
Estimated net annual volume of flow between each aquifer in the district	From the Edwards-Trinity (Plateau) Aquifer to the Pecos Valley Aquifer	41,370
	From the Edwards-Trinity (Plateau) Aquifer to the Dockum Aquifer	160*

* Indicates values calculated from the groundwater availability model for the High Plains Aquifer System, all other values are calculated from the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers.

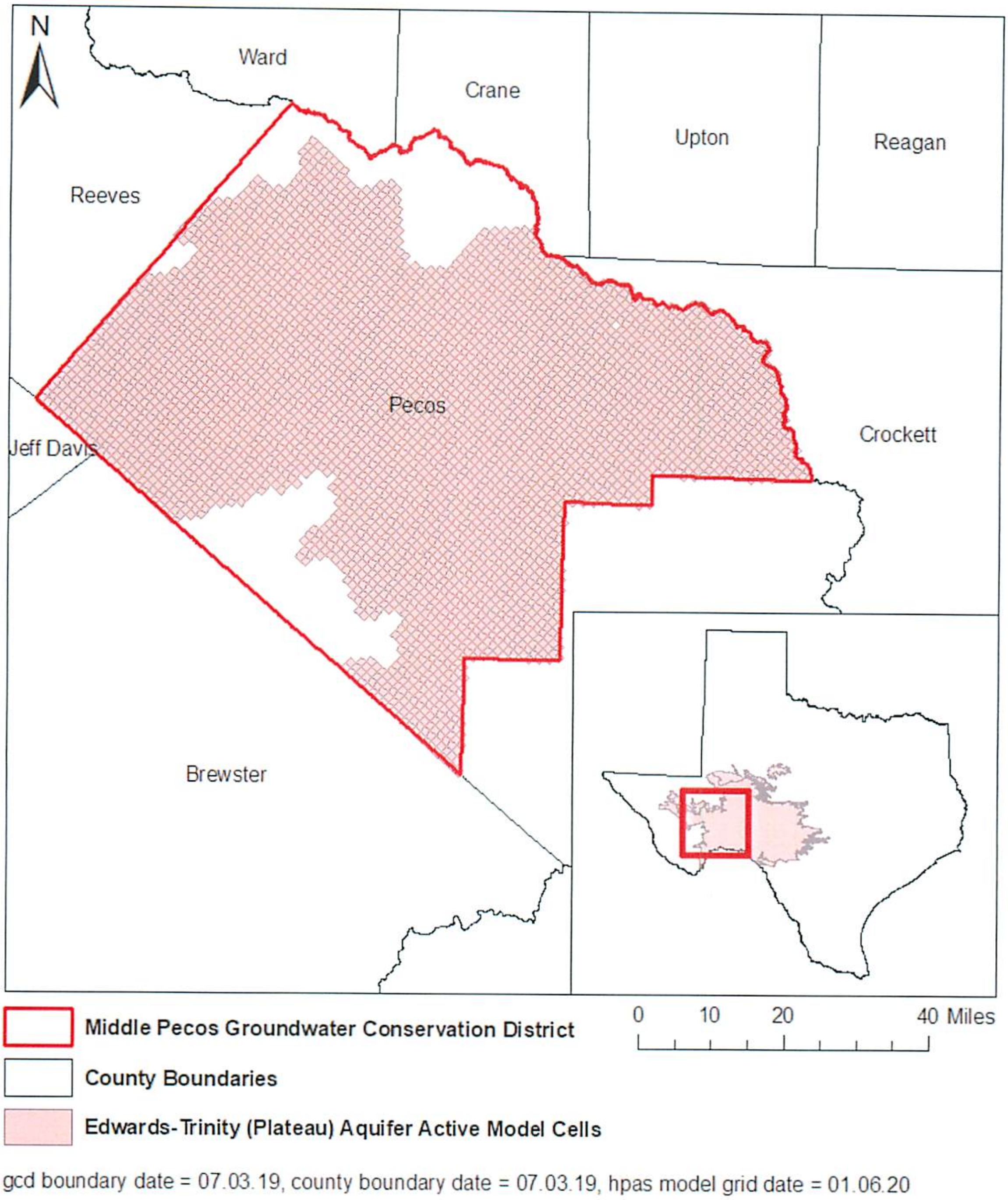

FIGURE 4: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AND PECOS VALLEY AQUIFERS FROM WHICH THE INFORMATION IN TABLE 4 WAS EXTRACTED (THE EDWARDS-TRINITY (PLATEAU) AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 5: SUMMARIZED INFORMATION FOR THE PECOS VALLEY AQUIFER THAT IS NEEDED FOR THE MIDDLE PECOS GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Pecos Valley	35,919
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers.	Pecos Valley	23,989
Estimated annual volume of flow into the district within each aquifer in the district	Pecos Valley	3,225
Estimated annual volume of flow out of the district within each aquifer in the district	Pecos Valley	15,118
Estimated net annual volume of flow between each aquifer in the district	To the Pecos Valley Aquifer from the Edwards-Trinity (Plateau) Aquifer	41,370
	To the Pecos Valley Aquifer from the Dockum Aquifer	118*

* Indicates values calculated from the groundwater availability model for the High Plains Aquifer System, all other values are calculated from the groundwater availability model for the Edwards-Trinity (Plateau) and Pecos Valley aquifers.

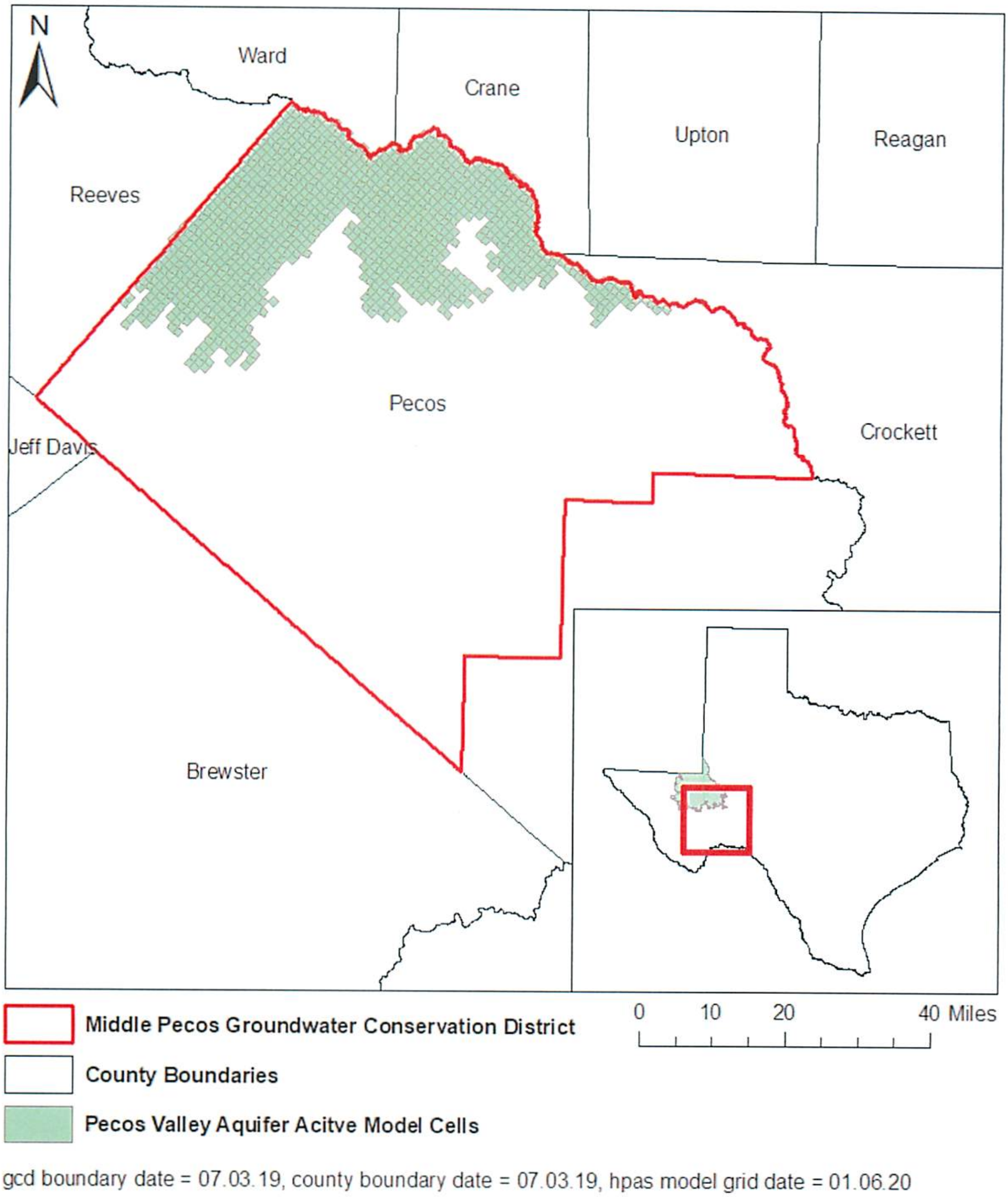

FIGURE 5: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE EDWARDS-TRINITY (PLATEAU) AND PECOS VALLEY AQUIFERS FROM WHICH THE INFORMATION IN TABLE 5 WAS EXTRACTED (THE PECOS VALLEY AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

LIMITATIONS:

The groundwater models used in completing this analysis is the best available scientific tool that can be used to meet the stated objectives. To the extent that this analysis will be used for planning purposes and/or regulatory purposes related to pumping in the past and into the future, it is important to recognize the assumptions and limitations associated with the use of the results. In reviewing the use of models in environmental regulatory decision making, the National Research Council (2007) noted:

> *"Models will always be constrained by computational limitations, assumptions, and knowledge gaps. They can best be viewed as tools to help inform decisions rather than as machines to generate truth or make decisions. Scientific advances will never make it possible to build a perfect model that accounts for every aspect of reality or to prove that a given model is correct in all respects for a particular regulatory application. These characteristics make evaluation of a regulatory model more complex than solely a comparison of measurement data with model results."*

A key aspect of using the groundwater model to evaluate historic groundwater flow conditions includes the assumptions about the location in the aquifer where historic pumping was placed. Understanding the amount and location of historic pumping is as important as evaluating the volume of groundwater flow into and out of the district, between aquifers within the district (as applicable), interactions with surface water (as applicable), recharge to the aquifer system (as applicable), and other metrics that describe the impacts of that pumping. In addition, assumptions regarding precipitation, recharge, and interaction with streams are specific to particular historic time periods.

Because the application of the groundwater models was designed to address regional scale questions, the results are most effective on a regional scale. The TWDB makes no warranties or representations related to the actual conditions of any aquifer at a particular location or at a particular time.

It is important for groundwater conservation districts to monitor groundwater pumping and overall conditions of the aquifer. Because of the limitations of the groundwater model and the assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine this analysis in the future given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future. Historic precipitation patterns also need to be placed in context as future climatic conditions, such as dry and wet year precipitation patterns, may differ and affect groundwater flow conditions.

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Appendix C

Middle Pecos Groundwater Conservation District Effective June 18, 2018

MIDDLE PECOS GROUNDWATER CONSERVATION DISTRICT

RULES

Effective June 19, 2018

PECOS COUNTY, TEXAS

TABLE OF CONTENTS

INTRODUCTION

BACKGROUND AND PURPOSE

Texas faces a difficult challenge to develop water policies that serve county, state, regional, and individual Texans' interests. The Texas Constitution authorizes the creation of groundwater conservation districts to plan for, develop, and regulate the use of groundwater. A groundwater conservation district is a local unit of government authorized by the Texas Legislature and ratified by local election of the district's constituents to manage and protect groundwater.

The MIDDLE PECOS GROUNDWATER CONSERVATION DISTRICT (the "District") was created in the 76th Legislature, 1999 by Senate Bill 1911, and ratified in the 77th Legislature, 2001 by House Bill 1258. The District was confirmed by qualified voters of Pecos County in November of 2002.

The boundaries of the District are coextensive with the boundaries of Pecos County, Texas. Aquifers and other recognized groundwater formations underlying Pecos County include the Capitan Reef, Dockum, Edwards-Trinity, Pecos Valley, Rustler, and San Andres.

The District is governed by a board of eleven directors elected as follows:

(1) One director shall be elected by the qualified voters of the entire district;

(2) Two directors shall be elected from each of the four Pecos County Commissioners' precincts by the qualified voters of each respective precinct;

(3) One director shall be elected from the City of Iraan by the qualified voters of that city; and

(4) One director shall be elected from the City of Fort Stockton by the qualified voters of that city.

The District has the rights, powers, privileges, authority, functions, and the duties provided by the general law of the State, Chapter 36 of the Texas Water Code, and the District Act.

The substantive rules of the District were initially adopted by the District's Board of Directors on August 18, 2004, at a duly posted public meeting in compliance with the Texas Open Meetings Act and following notice and hearing in accordance with Section 36.101 of the Texas Water Code. The District's rules are hereby adopted as the rules of this District in accordance with Section 59 of Article XVI of the Texas Constitution, Chapter 36 of the Texas Water Code, and the District Act.

The District's rules are and have been adopted to simplify procedures, avoid delays, and facilitate the administration of the water laws of the State of Texas. These rules are to be construed to attain those objectives. These rules may be used as guides in the exercise of discretion, where discretion is vested. However, these rules shall not be construed as a limitation or restriction upon the exercise of discretion conferred by law, nor shall they be construed to deprive the District or the District's Board of any powers, duties, or jurisdiction provided by law.

These rules will not limit or restrict the amount and accuracy of data or information that may be required for the proper administration of the law.

Nothing in these rules or Chapter 36 of the Texas Water Code shall be construed as granting the authority to deprive or divest a landowner, including a landowner's lessees, heirs, or assigns, of the groundwater ownership and rights described by Section 36.002 of the Texas Water Code, recognizing, however, that Section 36.002 does not prohibit the District from limiting or prohibiting the drilling of a well for failure or inability to comply with minimum well spacing or tract size requirements adopted by the District; affect the ability of the District to regulate groundwater production as authorized under Section 36.113, 36.116, or 36.122 or otherwise under Chapter 36, Texas Water Code, or a special law governing the District; or require that a rule adopted by the District allocate to each landowner a proportionate share of available groundwater for production from the aquifer based on the number of acres owned by the landowner.

PURPOSE OF THE DISTRICT

By statutory enactment and declaration by the Texas Supreme Court, groundwater management by groundwater conservation districts is the state's preferred method of groundwater management in order to protect property rights, balance the conservation and development of groundwater to meet the needs of this state, and use the best available science in the conservation and development of groundwater. The District's locally elected board of directors and staff accomplish this purpose by performing certain duties set forth in the general law of the State, Chapter 36 of the Texas Water Code, and the District Act, and implemented in accordance with these rules.

MISSION STATEMENT

Develop and implement an efficient, economical and environmentally sound groundwater management program to protect, maintain and enhance the groundwater resources of the District, and to communicate and administer to the needs and concerns of the citizens of Pecos County associated with these groundwater resources.

SECTION 1. DEFINITIONS, PURPOSE, AND CONCEPTS OF THE RULES

RULE 1.1 DEFINITIONS OF TERMS

In the administration of its duties the District defines terms as set forth in Chapter 36 of the Texas Water Code unless otherwise modified or defined herein as necessary to apply to unique attributes of the District. The specific terms hereinafter defined shall have the following meaning in these rules, the District's Management Plan, forms, and other documents of the District:

"Abandoned Well" means a well that has not been used for a beneficial purpose for at least one year and/or a well not registered with the District. A well is considered to be in use in the following cases:

(a) a non-deteriorated well which contains the casing, pump and pump column in good condition; or

(b) a non-deteriorated well which has been capped.

"Affected Person" means, with respect to a Groundwater Management Area:

(1) an owner of land in the Groundwater Management Area;

(2) a district in or adjacent to the Groundwater Management Area;

(3) a regional water planning group with a water management strategy in the Groundwater Management Area;

(4) a person who holds or is applying for a permit from a district in the Groundwater Management Area;

(5) a person who has groundwater rights in the Groundwater Management Area;

(6) or any other person defined as affected by a TCEQ rule.

"Animal Feeding Operation" means a lot or facility (other than an aquatic animal production facility) where animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 (forty-five) calendar days or more in any 12-month period, and the animal confinement areas do not sustain crops, vegetation, forage growth, or postharvest residues in the normal growing season over any portion of the lot or facility.

"Aquifer" means a geologic formation that will yield water to a well in sufficient quantities to make the production of water from this formation feasible for beneficial use. When the term "Aquifer" is used in these rules, it shall also mean the Aquifer's subdivisions.

"Aquifer Storage and Recovery Project" or "ASR Project" means a project involving the injection of water into a geologic formation for the purpose of subsequent recovery and beneficial use by the Project Operator.

"ASR" means aquifer storage and recovery.

"ASR Injection Well" means a Class V injection well used for the injection of water into a geologic formation as part of an ASR Project.

"ASR Recovery Well" means a well used for the recovery of water from a geologic formation as part of an ASR Project.

"Beneficial Use" means "use for a beneficial purpose," which means use for:

(a) agricultural, gardening, domestic, stock raising, municipal, mining, manufacturing, industrial, commercial, recreational, or pleasure purposes;

(b) exploring for, producing, handling, or treating oil, gas, sulphur, or other minerals; or

(c) any other purpose that is useful and beneficial to the user.

"Best available science" means conclusions that are logically and reasonably derived using statistical or quantitative data, techniques, analyses, and studies that are publicly available to reviewing scientists and can be employed to address a specific scientific question.

"Board" means the Board of Directors of the District.

"Capitan Limestone Aquifer" means the Capitan Reef Complex consists of the Capitan Reef and associated reefs and limestones which were deposited around the perimeter of the Delaware Basin during Permian time. The reef complex is composed of approximately 2,000 feet of massive, vuggy to cavernous limestone and dolomite, bedded limestone, and reef talus. In the study area, (located in the northern part of the Trans-Pecos region of West Texas, which is in the Great Plains physiographic province, and falls within the Rio Grande basin), the reef occurs in a 6 to 10 mile wide, south-southeast trending belt, extending from New Mexico through western Winkler, central Ward, and western Pecos Counties. Depth to the top of the reef ranges from 2,400 to 3,600 feet (Guyton and Associates, 1958). The Capitan Reef Complex yields small to large quantities of moderately to very saline water to wells in the study area that primarily have been used for secondary recovery of oil in Ward and Winkler Counties(Richey and others, 1985).

"Capping" means equipping a well with a securely affixed, removable device that will prevent the entrance of surface pollutants into the well in compliance with regulations of the Texas Department of Licensing and Regulations.

"Casing" means a tubular structure installed in the excavated or drilled borehole to maintain the well opening.

"Concentrated Animal Feeding Operation" ("CAFO") means any animal feeding operation with the number of animals established in TCEQ's rules, including at least 37,500 chickens (other than laying hens), or that has been designated by the TCEQ's Executive Director as a CAFO because it is a significant contributor of pollutants into or adjacent to water in the state.

"Conservation" refers to those water saving practices, techniques, and technologies that will reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of waste, or increase the recycling and reuse of water so that a water supply is made available for future or alternative uses.

"Desired Future Condition" means a quantitative description, adopted in accordance with Section 36.108, Texas Water Code, of the desired condition of the groundwater resources in a Groundwater Management Area at one or more specified future times.

"Dewatering Well" means a well used to remove groundwater from a construction site or excavation, or to relieve hydrostatic uplift on permanent structures.

"Director" means an elected or appointed member of the Board of Directors of the District.

"Discharge" means the volume of water that passes a given point within a given period of time.

"District" means the Middle Pecos Groundwater Conservation District.

"District Act" means the District's enabling legislation to be codified in Chapter 8851 of the Texas Special District Local Laws effective on April 1, 2013, and originally enacted by Act of the 76th Legislature, 1999, Regular Session, Chapter 1331 (Senate Bill 1911), as amended by Act of the 77th Legislature, 2001, Regular Session, Chapter 1299 (House Bill 1258), and Act of the 82nd Legislature, 2011, Regular Session, Chapter 199 (Senate Bill 564).

"District Management Plan" or **"Management Plan"** means the plan promulgated and adopted by the District, as may be amended and revised by the Board from time to time, pursuant to Sections 36.1071-36.1073 of the Texas Water Code.

"Dockum Group Aquifer" – The Dockum Group of Triassic age consists of upper and lower shaley units and a middle water-bearing sandstone unit often referred to as the "Santa Rosa." Small to moderate quantities of fresh to moderately saline water are produced from the sandstone in Winkler, Ward, eastern Loving, and eastern Reeves Counties, primarily where the aquifer is relatively shallow. In parts of Pecos, Reeves, Ward, and Winkler Counties, where the sandstone is hydraulically connected to the Pecos Valley Aquifer, the combination has been referred to as the Allurosa aquifer.

"District Office" means the principal office of the District at such location as may be established by the Board.

"Domestic Use" means water used by and connected to a household for personal needs or for household purposes such as drinking, bathing, heating, cooking, sanitation or cleaning, and landscape irrigation. Ancillary use may include watering of domestic animals.

"Domestic Well" means a well providing groundwater for domestic use.

"Drill" means drilling, equipping, completing wells, or modifying the size of wells or well pumps/motors (resulting in an increase in pumpage volume) whereby a drilling or service rig must be on location to perform the activity.

"Edwards-Trinity (Plateau) Aquifer" – The Edwards-Trinity (Plateau) aquifer underlies the Pecos Valley Aquifer in the study area, (located in the northern part of the Trans-Pecos region of West Texas, which is in the Great Plains physiographic province, and falls within the Rio Grande basin), in the southwest half of Reeves County and a portion of the Coyanosa area in northwest Pecos County. The aquifer is composed of water-bearing lower Cretaceous sands and limestones that are hydraulically connected to the overlying alluvium. Wells completed in the aquifer produce small to moderate quantities of fresh to moderately saline water, which is generally similar to that of the overlying alluvium. The poorest quality water is the aquifer, with dissolved solids in excess of 3,000 milligrams per liter (mg/l), occurs in the southwestern part of Reeves County where the aquifer receives recharge from the sulfate-rich Rustler aquifer. Water from the Edwards-Trinity(Plateau) aquifer is mostly used for irrigation, with a lesser amount used for industrial purposes in western Reeves County.

"Evidence of Historic or Existing Use" means evidence that is material and relevant to a determination of the amount of groundwater beneficially used without waste by a permit applicant during the relevant time period set by District rule that regulates groundwater based on historic use. Evidence in the form of oral or written testimony shall be subject to cross-examination. The Texas Rules of Evidence govern the admissibility and introduction of evidence of historic or existing use, except that evidence not admissible under the Texas Rules of Evidence may be admitted if it is of the type commonly relied upon by reasonably prudent persons in the conduct of their affairs.

"Exempt Well" means a well that is exempt pursuant to District Rule 11.3.

"Existing Well" means any well in the District that was drilled on or before the effective date of these rules.

"Export of Groundwater" means pumping, transferring, or transporting groundwater out of the District. The terms "transfer," "transport," or "export" of groundwater are used interchangeably within Chapter 36 of the Texas Water Code and these rules.

"Fees" means charges imposed by the District pursuant to these rules.

"Groundwater Management Area" means an area designated and delineated by the TWDB as suitable for the management of groundwater resources.

"Groundwater Reservoir" means a specific subsurface water-bearing reservoir having ascertainable boundaries and containing groundwater.

"Historic and Existing Use Period" means the period September 1, 1989, through the effective date of the rules adopting "Historic and Existing Use" rules, September 1, 2004; provided, however, that this period shall extend an additional consecutive 12-month period dating from September 1 - August 30 ("12-month period" or "year") for each such year during which the applicant demonstrates continued beneficial use of water in that year and demonstrates continued beneficial use in each and every year between September 1, 1989, and September 1, 2004, up to an additional, consecutive fifteen years extending to September 1, 1974.

"Hydrogeological Report" means a report that identifies the availability of groundwater in a particular area and formation, and which also addresses the issues of quantity and quality of that water and the impacts of pumping that water on the surrounding environment including impacts to nearby or adjacent wells.

"Irrigation Use" means the application of water, not associated with agricultural irrigation use, to plants or land in order to promote growth of plants, turf, or trees. Irrigation use includes but is not limited to athletic fields, parks, golf courses, and landscape irrigation not tied to domestic use.

"Irrigation Well" means a well providing groundwater for irrigation use (a nonexempt well).

"Leachate Well" means a well used to remove contamination from soil or groundwater.

"Livestock" means domesticated horses, cattle, goats, sheep, swine, poultry, ostriches, emus, rheas, deer and antelope, and other similar animals involved in farming or ranching operations on land, recorded and taxed in the County as an agricultural land use. Dogs, cats, birds, fish, reptiles, small mammals, potbellied pigs, and other animals typically kept as pets are not considered livestock. Livestock-type animals kept as pets or in a pet-like environment are not considered livestock.

"Managed Available Groundwater" refers to the term used by the TWDB in some of its models and associated reports, model runs, and other written documents, and which was defined by statutory law in existence prior to the 2011 legislative session, during which the 82nd Legislature replaced the concept of Managed Available Groundwater with Modeled Available Groundwater.

"Management Zone" means a geographic area delineated under District Rule 10.5 and in accordance with Section 36.116(d), Texas Water Code, and is sometimes referred to as a "management zone".

"Maximum Historic and Existing Use" means the quantity of water put to beneficial use during the single 12-month period (September 1 – August 30) of maximum beneficial use during the Historic and Existing Use Period.

"Modeled Available Groundwater" means the amount of water that the Executive Administrator of the TWDB determines may be produced on an average annual basis to achieve the Desired Future Conditions established for the Aquifers in the District.

"Modify" means to alter the physical or mechanical characteristics of a well, its equipment, or production capabilities. This does not include repair of equipment, well houses or enclosures, or replacement with comparable equipment.

"Monitoring Well" means a well installed exclusively to measure some property of the groundwater or an aquifer that it penetrates, that does not produce more than 5,000 gallons per year.

"New Well" means any well that is not an existing well, or any existing well, which has been modified to increase water production after the effective date of these Rules.

"Office" means the State Office of Administrative Hearings.

"Pecos Valley Aquifer" – During the Cenozoic Era, a thick sequence of alluvial deposits accumulated in two large slumpage depressions. These depressions are herein referred to as the Monument Draw Trough, which developed along the eastern margin of the Delaware Basin, and the Pecos Trough, which occupies the south-central part of the Basin. The troughs were formed by dissolution and removal of evaporates in the underlying Ochoan Series, which resulted in the collapse of the Rustler Formation and younger rocks into the voids (Maley and Huffington, 1953). Water saturated alluvial fill in these troughs is classified as the Pecos Valley Aquifer.

"Permit Amendment" means a minor or major change in a permit.

"Person" includes a corporation, individual, organization, cooperative, government or governmental subdivision or agency, business trust, estate, trust, partnership, association, or any other legal entity.

“Personal Justiciable Interest” means an interest related to a legal right, duty, privilege, power, or economic interest affected by a permit or permit amendment application. A justiciable interest is an interest beyond that shared by the general public.

“Plugging” means the permanent closure of a well in accordance with approved District standards.

“Pollution” means the alteration of the physical, thermal, chemical, or biological quality of, or the contamination or degradation of, any groundwater within the District that renders the groundwater harmful, detrimental, or injurious to humans, animal life, vegetation, or property or to public health, safety, or impairs the usefulness or the public or private use or enjoyment of the water for any lawful or reasonable purpose.

“Presiding Officer” means the Board President or, in the Board President’s absence, a Director delegated authority by the Board to preside over a hearing.

“Production Permit” is synonymous with “Operating Permit,” both terms which mean the type of a permit that authorizes the operation and production from a water well.

“Project Operator” means a person holding an authorization under this subchapter to undertake an ASR Project.

“Retail Public Utility” means any person, corporation, public utility, water supply or sewer service corporation, municipality, political subdivision or agency operating, maintaining, or controlling in this state, facilities (such as a public water supply well) for providing potable water service for compensation.

“Rustler Aquifer” – The Rustler Formation underlies the entire study area, (located in the northern part of the Trans-Pecos region of West Texas, which is in the Great Plains physiographic province, and falls within the Rio Grande basin), and consists of 200 to 500 feet of anhydrite and dolomite with a basal zone of sandstone and shale. Slightly to moderately saline water occurs in the formation in most of Reeves and western Loving, Ward, and Pecos Counties and has mostly been used for irrigation and livestock supply. Elsewhere, the formation produces very saline to brine quality water that is used primarily for secondary oil recovery. Water in the aquifer occurs under artesian conditions, except in the out crop in the Rustler Hills to the west and in collapsed zones in the two troughs.

“Rules” means the standards and regulations promulgated by the District, as they may be amended from time to time, and are often referred to generally as “rules” or the District’s rules.

“Seal” means the impermeable material, such as cement grout, bentonite, or puddling clay, placed in the annular space between the borehole wall and the casing to prevent the downhole movement of surface water or the vertical mixing of groundwater.

“SOAH” means the State Office of Administrative Hearings.

“Special Provisions” means the conditions or requirements added to a permit, which may be more or less restrictive than the Rules as a result of circumstances unique to a particular situation.

“Spring” means a point(s) of natural discharge from an aquifer.

“Static Water Level” means the water level in a well that has not been affected by withdrawal of groundwater.

“Stratum” means a layer of rock having a similar composition throughout.

“Subsidence” means the lowering in elevation of the land surface caused by withdrawal of groundwater.

“Surface Completion” means sealing off access of undesirable water, surface material, or other potential sources of contamination to the wellbore by proper casing and/or cementing procedures.

“TCEQ” means the Texas Commission on Environmental Quality, and its predecessor and any successor agencies.

“TWDB” means the Texas Water Development Board.

“User” means a person who produces, distributes, or uses water from any Aquifer within the District.

“Waste” shall have the meaning provided for in District Rule 14.1.

“Water Table” means the upper boundary of the saturated zone in an unconfined aquifer.

“Water Tight Seal” means a seal that prohibits the entrance of liquids or solutions, including water, which may enter through the wellhead and potentially, contaminate the well.

“Water Well” means any drilled or excavated facility, device, or method used to withdraw groundwater from the groundwater supply.

“Well” means any artificial excavation or borehole constructed for the purposes of exploring for or producing groundwater, or for injection, monitoring, or dewatering purposes.

“Well Registration” means the creation of a record of the well by use and a well identification number for purposes of registering the well as to its geographic location and for notification to the well owner in cases of spills or accidents, data collection, recordkeeping and for future planning purposes. (See Section 9 of the District’s rules).

“Well System” means two or more wells owned, operated, or otherwise under the control of the same person and that are held under the same permit.

“Withdraw or Withdrawal” means the act of extracting groundwater by pumping or any other method other than the discharge of natural springs.

RULE 1.2 PURPOSE OF RULES

The rules of the District are promulgated and adopted under the District's statutory authority to achieve the following purposes and objectives: to provide for conserving, preserving, protecting, and recharging of groundwater or of a groundwater reservoir or its subdivisions, in order to control subsidence, or prevent waste of groundwater. The District's orders rules, requirements, resolutions, policies, guidelines or similar measures have been implemented to fulfill these objectives.

RULE 1.3 USE AND EFFECT OF RULES

These rules are used by the District as guides in the exercise of the powers conferred by law and in the accomplishment of the purposes of the District Act and Chapter 36 of the Texas Water Code. They shall not be construed as a limitation or restriction on the exercise of any discretion, where it exists, nor shall they be construed to deprive the District or Board of the exercise of any powers, duties or jurisdiction conferred by law; nor shall they be construed to limit or restrict the amount and character of data or information that may be required to be collected for the proper administration of the District Act or Chapter 36.

RULE 1.4 AMENDING OF RULES

The Board may, following notice and hearing, amend or repeal these rules or adopt new rules from time to time, following the procedure set forth in the Rulemaking Section of these rules, and applicable law.

RULE 1.5 HEADINGS AND CAPTIONS

The section and other headings and captions contained in these rules are for reference purposes only and do not affect in any way the meaning or interpretation of these rules.

RULE 1.6 CONSTRUCTION

A reference to a title or chapter without further identification is a reference to a title or chapter of the Texas Water Code, unless the context of usage clearly implies otherwise. A reference to a section or rule without further identification is a reference to a section or rule in these rules, unless the context of usage clearly implies otherwise. Construction of words and phrases is governed by the Code Construction Act, Subchapter B, Chapter 311, Texas Government Code. The singular includes the plural, and the plural includes the singular. The words "and" and "or" are interchangeable and shall be interpreted to mean and/or.

RULE 1.7 SEVERABILITY

In case any one or more of the provisions contained in these rules shall for any reason be held to be invalid, illegal, or unenforceable in any respect, such invalidity, illegality, or unenforceability shall not affect any other rules or provisions hereof, and these rules shall be construed as if such invalid, illegal, or unenforceable rule or provision had never been contained herein.

RULE 1.8 SEVERABILITY CLAUSE

If any section, sentence, paragraph, clause, or part of these rules should be held or declared invalid for any reason by a final judgment of the courts of this state or of the United States, such decision or holding shall not affect the validity of the remaining portions of these rules, and the Board does hereby declare that it would have adopted and promulgated such remaining portions irrespective or the fact that any other sentence, section, paragraph, clause, or part thereof may be declared invalid.

RULE 1.9 COMPLIANCE

All permit holders and registrants of the District shall comply with all applicable rules and regulations of other governmental entities. Where the District's rules and regulations are more stringent than those of other governmental entities, the District's rules and regulations shall control.

RULE 1.10 VERB USAGE

The verbs may, can, might, should, or could are used when an action is optional or may not apply in every case. The verbs will, shall, or must are used when an action is required. The verb cannot is used when an action is not allowed or is not achievable. Unless otherwise expressly provided for in these rules, the past, present, and future tense shall include each other.

SECTION 2. BOARD AND DISTRICT STAFF

RULE 2.1 MEETINGS

The Board shall meet at least once each quarter and may meet more frequently as the Board may establish from time to time. At the request of the Board President, or by written request of at least three members, the Board may hold special meetings. All Board meetings will be held and conducted according to the Texas Open Meetings Act, Chapter 551, Texas Government Code. Directors shall not knowingly conspire to meet in numbers less than a quorum for the purpose of secret deliberations.

RULE 2.2 COMMITTEES

The Board President may establish committees for formulation of policy recommendations to the Board, and appoint the chair and membership of the committees. Committee members serve at the pleasure of the Board President.

RULE 2.3 ASSISTANT SECRETARY

A Director or member of the District staff may be appointed by the Board as Assistant Secretary to the Board to assist in meeting the responsibilities of the Board Secretary, if desired by the Board.

RULE 2.4 GENERAL MANAGER

The Board may employ or contract with a person to manage the District, and title this person "General Manager". The General Manager shall have full authority to manage and operate the affairs of the District, subject only to Board orders. The Board will review the compensation and/or contract of the General Manager each year at the beginning of the third quarter of every fiscal year. The General Manager, with approval of the Board, may employ all persons necessary for the proper handling of business and operation of the District, and their compensation will be set by the Board.

SECTION 3. BOARD

RULE 3.1 PURPOSE OF BOARD

The Board was created to determine policy and regulate the withdrawal of groundwater within the boundaries of the District for conserving, preserving, protecting and recharging the groundwater and aquifers within the District, and to exercise its rights, powers, and duties in a way that will effectively and expeditiously accomplish the purposes of the District Act. The Board's responsibilities include, but are not limited to, the adoption, implementation, and enforcement of the District's rules and orders.

RULE 3.2 BOARD STRUCTURE, OFFICERS

The Board may elect officers annually, but must elect officers at the first meeting following the November elections of each even-numbered year. Directors and officers serve until their successors are elected or appointed and sworn in accordance with the District Act and these rules, and qualified under applicable State law. If there is a vacancy on the Board, the remaining Directors shall appoint a Director to serve the remainder of the term. If at any time there are fewer than three qualified Directors, the Pecos County Commissioners Court shall appoint the necessary number of persons to fill all the vacancies on the Board. The appointed Director's term shall end on qualification of the Director elected at that election.

RULE 3.3 EX PARTE COMMUNICATIONS

Directors may not communicate, directly or indirectly, about any issue of fact or law in any contested hearing before the Board, with any agency, person, party or their representatives, except on notice and opportunity for all parties to participate. This rule does not apply to a Director who abstains from voting on any matter in which ex parte communications have occurred or to communications between the Board and the staff, professional, or consultants of the District.

SECTION 4. GENERAL PROCEDURAL PROVISIONS

RULE 4.1 DISTRICT ADDRESS

The District's mailing address is P.O. Box 1644, Fort Stockton, Texas, 79735, and its physical address shall be established by the Board and posted on the District's Internet site, if the District has a functioning Internet site.

RULE 4.2 COMPUTING TIME

In computing any period of time specified by these rules, by a Presiding Officer, by the Board, or by law, the period shall begin on the day after the act, event, or default in question, and shall conclude on the last day of that designated period, unless the last day is a Saturday, Sunday, or legal holiday on which the District Office is closed, in which case the period runs until the end of the next day which is neither a Saturday, Sunday, nor legal holiday on which the District Office is closed.

RULE 4.3 FILING OF DOCUMENTS AND TIME LIMIT

Applications, requests, or other papers or documents shall be filed either by hand delivery, mail, or telephonic document transfer to the District Office. The document shall be considered filed as of the date received by the District for a hand delivery; as of the date reflected by the official United States Postal Service postmark if mailed; and, for telephonic document transfers, as of the date on which the telephonic document transfer is complete, except that any transfer occurring after 5:00 p.m. will be deemed complete on the following business day. If a person files a document by facsimile, he or she must file a copy by mail within three (3) calendar days. A document may be filed by electronic mail ("email") only if the Board or Presiding Officer has expressly authorized filing by email for that particular type of document and expressly established the appropriate date and time deadline, email address, and any other appropriate filing instructions.

RULE 4.4 METHODS OF SERVICE UNDER THE RULES

Except as otherwise provided for in these rules, and notice or document required by these rules to be served or delivered may be delivered to the recipient, or the recipient's authorized representative, in person, by agent, by courier-receipted delivery, by certified or registered mail sent to recipient's last known address, by email to the recipient's email address on file with the District if written consent is granted by the recipient, or by facsimile to the recipient's current facsimile number and shall be accomplished by 5:00 o'clock p.m. (as shown by the clock in the recipient's office) of the date on which it is due. Service by mail is complete upon deposit in a post office or other official depository of the United States Postal Service. Service by facsimile is complete upon transfer, except that any transfer commencing after 5:00 o'clock p.m. (as shown by the clock in the recipient's office) shall be deemed complete the following business day. If service or delivery is by mail, and the recipient has the right to perform some act or is required to perform some act within a prescribed period of time after service, three (3) calendar days will be added to the prescribed period. Where service by other methods has proved unsuccessful, the service shall be complete by such other method as may be approved by the Board. The person or person's attorney shall certify compliance with this rule in writing over signature and on the filed document. A certificate by a person or the person's attorney of record, or the return of an officer, or the affidavit of any person showing service of a document, shall be prima facie evidence of the fact of service.

RULE 4.5 USE OF FORMS

The General Manager will furnish forms and instructions for the preparation of any application, declaration, registration or other document that is required to be filed with the District on a form prepared by the District. The use of such forms is mandatory. Supplements may be attached if there is insufficient space on the form. If supplements are used, the data and information entered therein shall be separated into sections that are numbered to correspond with the numbers of the printed form.

RULE 4.6 MINUTES AND RECORDS OF THE DISTRICT

All official documents, reports, records, and minutes of the District will be available for public inspection and copying in accordance with the Texas Public Information Act.

RULE 4.7 APPLICABILITY; PROCEDURES NOT OTHERWISE PROVIDED FOR

This Section 4 shall apply to all types of hearings conducted by the District to the extent this Section is not inconsistent with any other section of these rules that applies to the type of hearing at issue. If, in connection with any hearing, the Board determines that there are no statutes or other applicable rules resolving particular procedural questions then before the Board, the Board will direct the parties to follow procedures consistent with the purpose of these rules, the District Act, and Chapter 36 of the Texas Water Code.

RULE 4.8 CONTINUANCE

Unless provided otherwise in these Rules, any meeting, workshop, or hearing may be continued from time to time and date to date without published notice after the initial notice, in conformity with the Texas Open Meetings Act.

RULE 4.9 REQUEST FOR RECONSIDERATION

To appeal a decision of the District, including any determinations made by the General Manager, concerning any matter not covered under any other section of these rules, a request for reconsideration may be filed with the District within 20 (twenty) calendar days of the date of the decision. Such request for reconsideration must be in writing and must state clear and concise grounds for the request. The Board will make a decision on the request for reconsideration within 45 (forty-five) calendar days thereafter. The failure of the Board to grant or deny the request for reconsideration within 45 (forty-five) calendar days of the date of filing shall constitute a denial of the request.

SECTION 5. HEARINGS GENERALLY

RULE 5.1 APPLICABILITY

(a) Rulemaking hearings are governed by Section 6 of the District's rules.

(b) Hearings on the District Management Plan are governed by Section 8 of the District's rules.

(c) Permit-related hearings and hearings on applications for well-spacing exceptions are governed by Section 11 of the District's rules.

(d) Hearings to prevent waste, pollution, or degradation of the quality of groundwater under Section 14 of the District's rules may be conducted under Rule 14.4.

(e) Enforcement hearings are governed by Section 15 of the District's rules.

(f) Hearings on the Desired Future Conditions, including the appeal process of Desired Future Conditions, are governed by Section 17 of the District's rules.

(g) All other hearings not described in this rule are governed by Rule 5.2.

RULE 5.2 HEARINGS ON OTHER MATTERS

A public hearing may be held on any matter beyond rulemaking, the District Management Plan, enforcement, and permitting, within the jurisdiction of the District, if the Board deems a hearing to be in the public interest or necessary to effectively carry out the duties and responsibilities of the District. Not less than ten (10) calendar days prior to the date of a public hearing, the Board shall publish notice of the subject matter of the hearing, the time, date, and place of the hearing, in a newspaper of general circulation in the District, in addition to posting the notice in the manner provided by the Texas Open Meetings Act.

SECTION 6. RULEMAKING HEARINGS

RULE 6.1 GENERAL

A rulemaking hearing involves matters of general applicability that implement, interpret, or prescribe the law or District's policy, or that describe the procedure or practice requirements of the District. The District will update its rules to implement the Desired Future Conditions before the first anniversary of the date that the TWDB approves the District Management Plan that has been updated to reflect the adopted Desired Future Conditions.

RULE 6.2 NOTICE AND SCHEDULING OF HEARINGS

(a) For all rulemaking hearings, the notice shall include a brief explanation of the subject matter of the hearing, the time, date, and place of the hearing, location, or Internet site at which a copy of the proposed rules may be reviewed or copied, if the District has a functioning Internet site, and any other information deemed relevant by the General Manager or the Board.

(b) Not less than 20 (twenty) calendar days prior to the date of the hearing, and subject to the notice requirements of the Texas Open Meetings Act the General Manager shall:

    (1) post notice in a place readily accessible to the public at the District Office;

    (2) provide notice to the County Clerk of Pecos County;

(3) publish notice in one or more newspapers of general circulation in the District;

(4) provide notice by mail, fax, or email to any person who has requested notice under Subsection (c); and

(5) make available a copy of all proposed rules at a place accessible to the public during normal business hours, and post an electronic copy on the District's Internet site, if the District has a functioning Internet site.

(c) A person may submit to the District a written request for notice of a rulemaking hearing. A request is effective for the remainder of the calendar year in which the request is received by the District. To receive notice of a rulemaking hearing in a later year, a person must submit a new request. An affidavit of an officer or employee of the District establishing attempted service by first class mail, fax, or email to the person in accordance with the information provided by the person is proof that notice was provided by the District.

(d) Failure to provide notice under Subsection (c) does not invalidate an action taken by the District at a rulemaking hearing.

(e) Any hearing may or may not be scheduled during the District's regular business hours, Monday through Friday of each week, except District holidays. Any hearing may be continued from time to time and date to date without published notice after the initial published notice in conformity with the Texas Open Meetings Act. The District must conduct at least one hearing prior to adopting amendments to the District's rules.

RULE 6.3 RULEMAKING HEARINGS PROCEDURES

(a) General Procedures: The Presiding Officer will conduct the rulemaking hearing in the manner the Presiding Officer deems most appropriate to obtain all relevant information pertaining to the subject of the hearing as conveniently, inexpensively, and expeditiously as possible. In conducting a rulemaking hearing, the Presiding Officer may elect to utilize procedures set forth in these Rules for permit hearings to the extent that and in the manner that the Presiding Officer deems most appropriate for the particular rulemaking hearing. The Presiding Officer will prepare and keep a record of the rulemaking hearing in the form of an audio or video recording or a court reporter transcription at his or her discretion.

(b) Submission of Documents: Any interested person may submit written statements, protests, or comments, briefs, affidavits, exhibits, technical reports, or other documents relating to the subject of the hearing. Such documents must be submitted no later than the time of the hearing, as stated in the notice of hearing; provided, however, the Presiding Officer may grant additional time for the submission of documents.

(c) Oral Presentations: Any person desiring to testify on the subject of the hearing must so indicate on the registration form provided at the hearing. The Presiding Officer establishes the order of testimony and may limit the number of times a person may speak, the time period for oral presentations, and the time period for raising questions. In addition, the Presiding Officer may limit or exclude cumulative, irrelevant, or unduly repetitious presentations.

(d) Conclusion of the hearing: At the conclusion of the hearing, the Board may take action on the subject matter of the hearing, take no action, or postpone action until a future meeting or hearing of the Board. When adopting, amending, or repealing any rule, the District shall:

(1) consider all groundwater uses and needs;
(2) develop rules that are fair and impartial;
(3) consider the groundwater ownership and rights described by Section 36.002, Texas Water Code;
(4) consider the public interest in conservation, preservation, protection, recharging, and prevention of waste of groundwater, and of groundwater reservoirs or their subdivisions, and in controlling subsidence caused by withdrawal of groundwater reservoirs or their subdivision, consistent with the objectives of Section 59, Article XVI, Texas Constitution;
(5) consider the goals developed as part of the District Management Plan under Section 36.1071, Texas Water Code; and
(6) not discriminate between land that is irrigated for production and land that was irrigated for production and enrolled or participating in a federal conservation program.

(e) Hearing Registration Form: A person participating in a rulemaking hearing shall complete a hearing registration form stating the person's name, address, and whom the person represents, if applicable.

RULE 6.4 CONDUCT AND DECORUM

Every person, party, representative, witness, and other participant in a proceeding must conform to ethical standards of conduct and must exhibit courtesy and respect for all other participants. No person may engage in any activity during a proceeding that interferes with the orderly conduct of District business. If in the judgment of the Presiding Officer, a person is acting in violation of this provision, the Presiding Officer will first warn the person to refrain from engaging in such conduct. Upon further violation by the same person, the Presiding Officer may exclude that person from the proceeding for such time and under such conditions as the Presiding Officer deems necessary.

SECTION 7. EMERGENCY RULES AND ORDERS

RULE 7.1 EMERGENCY RULES

The Board may adopt an emergency rule without prior notice and/or hearing if the Board finds that a substantial likelihood of imminent peril to the public health, safety, or welfare, or a requirement of state or federal law, requires adoption of a rule on less than 20 (twenty) calendar days' notice. The Board shall prepare a written statement of the reasons for this finding. An emergency rule adopted shall be effective for not more than 90 (ninety) calendar days after its adoption by the Board. The Board may extend the 90-day period for an additional 90 (ninety) calendar days if notice of a hearing on the final rule is given not later than the 90th calendar day after the date the rules is adopted. An emergency rule adopted without notice and/or a hearing must be adopted at a meeting conducted under Chapter 551, Texas Government Code.

RULE 7.2 EMERGENCY ORDER AUTHORIZING TEMPORARY PRODUCTION FOR DEMONSTRATED EMERGENCY NEED

(a) A person can request in writing that the District issue an emergency order authorizing the production of groundwater for a beneficial use without a permit for a temporary period of time during which the person can submit a Production Permit application. This request must be in writing and include sufficient factual detail of the emergency situation; the quantity of groundwater needed (in gallons or acre feet); the proposed source of the groundwater (identify the aquifer); the specific location of the well from which the groundwater will be produced; and the period of time proposed for the requested emergency authorization. This request must be submitted to the District's office by any means that ensures receipt by the District.

(b) Upon receipt and consideration of the written request for an emergency order under this rule, the District's Board President or General Manager may issue an emergency order partially or fully granting the request. An order issued under this rule will provide a time limit during which it is effective, which may not exceed 75 (seventy-five) calendar days.

(c) Upon issuance of an order under this rule, the requestor is not required to hold a permit but must use its best efforts to prepare and submit a Production Permit application. The beneficiary of the emergency order authorization must submit a Production Permit application to the District within 20 (twenty) calendar days of issuance of the emergency order. If a Production Permit application is timely submitted under this subsection, then it is within the discretion of the District's Board President or General Manager to extend the 75-day timeframe of the emergency order while the application is pending.

(d) If neither the District's Board President nor General Manager issues an order under this rule after reviewing the request, the requestor's remedy is to submit a Production Permit application.

(e) If an emergency order is issued, the District's Board must be notified of the circumstances and relief granted at the District's next Board meeting.

RULE 7.3 EMERGENCY PERMIT AMENDMENT

If an emergency water need is demonstrated to the Board, the Board may amend a Production Permit or Historic or Existing Use Permit to authorize production from one or more additional wells owned or operated by the permit holder to provide flexibility to the entity with the emergency water need as long as the amendment is consistent with Rule 11.1(b). A hearing is not required under this rule. The Board may take action under this rule at a meeting for which notice has been provided in accordance with the Texas Open Meetings Act.

SECTION 8. DISTRICT MANAGEMENT PLAN

RULE 8.1 ADOPTION OF A MANAGEMENT PLAN

The Board shall adopt a Management Plan that specifies the acts, procedures, performance and avoidance necessary to minimize as far as practicable the drawdown of the water table or the reduction of artesian pressure, to prevent interference between wells, to prevent degradation of water quality, to prevent waste, and to avoid impairment of Desired Future Conditions. The District shall use the District's rules to implement the Management Plan.

RULE 8.2 AMENDMENT

The Board will review and readopt or amend the plan at least every fifth year after its last approval by TWDB. The District will amend its plan to address goals and objectives consistent with achieving the Desired Future Conditions within two years of the adoption of the Desired Future Conditions by the Groundwater Management Area.

RULE 8.3 EFFECTIVE DATE

The Management Plan and any amendments thereto take effect on approval by the TWDB's Executive Administrator or, if appealed, on approval by the TWDB. Approval of the Management Plan remains in effect until the District fails to timely readopt a Management Plan, the District fails to timely submit the District's readopted Management Plan to the TWDB's Executive Administrator, or the TWDB's Executive Administrator determines that the readopted Management Plan does not meet the requirements for approval, and the District has exhausted all appeals to the TWDB or appropriate court.

RULE 8.4 NOTICE

(a) The notice of a hearing on any adoption or amendment of the Management Plan shall include the time, date, and place of the hearing, location or Internet site at which a copy of the proposed plan may be reviewed or copied, if the District has a functioning Internet site, and any other information deemed relevant by the General Manager or the Board.

(b) Not less than ten (10) calendar days prior to the date of the hearing, and subject to the notice requirements of the Texas Open Meetings Act, the General Manager shall:

(1) post notice in a place readily accessible to the public at the District Office;
(2) provide notice to the county clerk of Pecos County; and
(3) make available a copy of the proposed plan at a place accessible to the public during normal business hours, and post an electronic copy on the District's Internet site, if the District has a functioning Internet site.

(c) Any hearing may or may not be scheduled during the District's regular business hours, Monday through Friday of each week, except District holidays. Any hearing may be continued from time to time and date to date without notice after the initial notice, in compliance with the Texas Open Meetings Act. The District must conduct at least one hearing prior to adopting the plan or any amendments to the plan.

RULE 8.5 HEARING PROCEDURES

(a) General Procedures: The Presiding Officer will conduct the hearing in the manner the Presiding Officer deems most appropriate to obtain all relevant information pertaining to the subject of the hearing as conveniently, inexpensively, and expeditiously as possible. The Presiding Officer will prepare and keep a record of the hearing in the form of an audio or video recording or a court reporter transcription at his or her discretion.

(b) Submission of Documents: Any interested person may submit written statements, protests, or comments, briefs, affidavits, exhibits, technical reports, or other documents relating to the subject of the hearing. Such documents must be submitted no later than the time of the hearing, as stated in the notice of hearing; provided, however, the Presiding Officer may grant additional time for the submission of documents.

(c) Oral Presentations: Any person desiring to testify on the subject of the hearing must so indicate on the registration form provided at the hearing. The Presiding Officer establishes the order of testimony and may limit the number of times a person may speak, the time period for oral presentations, and the time period for raising questions. In addition, the Presiding Officer may limit or exclude cumulative, irrelevant, or unduly repetitious presentations.

(d) Conclusion of the hearing: At the conclusion of the hearing, the Board may take action on the subject matter of the hearing, take no action, or postpone action until a future meeting or hearing of the Board. When adopting, amending, or repealing the Management Plan, the District shall:

(1) use the District's best available data and groundwater availability modeling information provided by the TWDB's Executive Administrator together with any available site-specific information that has been provided by the District to the TWDB's Executive Administrator for review and comment before being used in the plan;
(2) address the management goals set forth in Section 36.1071, Texas Water Code; and
(3) use and address objectives consistent with achieving the Desired Future Conditions as adopted during the joint planning process.

(e) Hearing Registration Form: A person participating in a hearing on the Management Plan shall complete a hearing registration form stating the person's name, address, and whom the person represents, if applicable.

SECTION 9. WATER WELL REGISTRATION

RULE 9.1 REGISTRATION

All water wells, existing and new, exempt and nonexempt, must be registered with the District and are required to comply with the District's registration requirements in these rules.

RULE 9.2 GENERAL REGISTRATION POLICIES AND PROCEDURES

9.2.1 Each person who intends to drill, equip, modify, complete, operate, change type of use, plug, abandon, or alter the size of a well within the District must complete and submit to the District the District's Notice of Intent to Drill a New Well (Notice of Intent), registration or permit application form, as applicable, even though the well may be exempt from the requirement of a permit under District Rule 11.3.

9.2.2 Pre-registration: For all proposed new exempt and nonexempt wells, the owner of the proposed new well, or the well operator or any other person acting on behalf of the owner of the proposed new well must file a Notice of Intent prior to drilling the proposed new well. If it is believed by the person filing the Notice of Intent that the proposed new well will be exempt under District Rule 11.3, then the Notice of Intent must reflect the basis for the exemption, and must be approved by the District prior to drilling the new well. Within five (5) calendar days from receipt of a Notice of Intent, the District's General Manager shall (1) determine whether the well is exempt under the District's rules, (2) complete the District Use Only section at the end of the Notice of Intent indicating whether the well is exempt, and (3) return a copy of the completed Notice of Intent by facsimile or mail to the address(es) and facsimile number(s) set forth in the Notice of Intent. If the District's determination is that the well is exempt, drilling may begin immediately upon receiving the approved Notice of Intent. The drilling of a new exempt well is subject to the rules of the District. Upon completion of the new exempt well, a registration form must be completed and filed. If the District's determination is that the well is nonexempt, a Drilling Permit application must be filed and approved by the District before drilling may begin.

9.2.3 Registration: All wells must be registered. Existing nonexempt and exempt wells shall be registered immediately. New nonexempt wells shall be registered immediately upon completion pursuant to a Drilling Permit. New exempt wells shall be registered immediately upon completion pursuant to an approved pre-registration.

9.2.4 Re-registration: If the owner or operator of a registered well plans to change the type of use of the groundwater, increase the withdrawal rate, or substantially alter the size of the well or well pump in a manner that does not require a permit, the well must be re-registered on a new registration form.

9.2.5 In the event of an emergency during the drilling of a new exempt well or with an existing well, as defined by the well driller or well service operator, as applicable, an exempt well may be reworked prior to re-registration. The registration requirement will be waived for a 48-hour period.

9.2.6 Term: A registration certificate is perpetual in nature, subject to cancellation for violation of these Rules.

9.2.7 Transfer of Registration: Upon submission to the District of written notice of transfer of ownership or control of any water right or water well covered by a registration and documents evidencing the transfer, the District's General Manager will amend the well registration to reflect the new owner(s).

SECTION 10. PRODUCTION LIMITATIONS

RULE 10.1 HISTORIC AND EXISTING USE PERMITS

The District shall designate the quantity of groundwater that may be produced on an annual basis in each Historic and Existing Use Permit issued by the District, and each permit shall be subject to the conditions of the District Act, Chapter 36 of the Texas Water Code, and these rules, provided, however, that the quantity that may be withdrawn shall not exceed the Maximum Historic and Existing Use demonstrated by the applicant, and determined by the Board, except as that designated quantity of groundwater may be reduced if the District imposes restrictions under these rules and/or permit conditions, or consistent with a Demand Management Plan developed under Rule 10.3(b).

RULE 10.2 PRODUCTION PERMITS

The District shall designate the quantity of groundwater that may be produced on an annual basis under a Production Permit pursuant to the conditions of the District Act, Chapter 36 of the Texas Water Code, and these rules, provided, however, that the quantity shall not exceed an amount demonstrated by the applicant and determined by the Board to be necessary for beneficial use throughout the permit term, except as may be reduced if the District imposes restrictions under these rules and/or permit conditions, or consistent with a Demand Management Plan developed under Rule 10.3(b).

RULE 10.3 AQUIFER-BASED PRODUCTION LIMITS

(a) The District may limit the total amount of authorized annual production and maximum annual rate of groundwater withdrawal for any aquifer within the District as the District determines to be necessary based upon the best available hydrogeologic, geographic, and other relevant scientific data, including but not limited to noted changes in the water levels, water quality, groundwater withdrawals, annual recharge, or the loss of stored water in the aquifer, to avoid impairment of any Desired Future Condition. The District may also develop, utilize, and/or adopt groundwater availability models in support of the District's management of the groundwater within its jurisdiction. The District may establish a series of index or monitoring wells to aid in this determination.

(b) The District will continue to study what aquifer conditions may indicate that proportional adjustment reductions to the amount of permitted production of groundwater are necessary to avoid impairment of the Desired Future Conditions of any of the various aquifers within the District. The District will also continue to study what quantity of proportional adjustment reductions to the amount of permitted production of groundwater are necessary to avoid impairment of the Desired Future Conditions of any of the various aquifers within the District. The Board will consider the findings of the District regarding actions necessary to avoid impairment of the Desired Future Conditions of any of the various aquifers within the District, and may adopt, after appropriate rulemaking notice and hearing, an aquifer-specific Demand Management Plan setting forth a schedule of the actions that may be necessary to avoid impairment of the Desired Future Conditions of any of the various aquifers within the District.

(c) The Board has the right to modify a permit if data from monitoring wells within the source aquifer or other evidence reflects conditions such as but not limited to an unacceptable level of decline in water quality of the aquifer, or as may be necessary to prevent waste and achieve water conservation, minimize as far as practicable the drawdown of the water table or the reduction of artesian pressure, lessen interference between wells, or control and prevent subsidence, or to avoid impairment of the Desired Future Conditions of any of the various aquifers within the District. If the Board has an interest in modifying a permit under this rule, it must provide notice and an opportunity for hearing pursuant to Section 11 of the District's rules.

(d) Upon adoption of Desired Future Conditions and setting of the Modeled Available Groundwater numbers for any aquifer or its subdivisions in the District, the District shall, to the extent possible, issue permits up to the point that the total volume of exempt and permitted groundwater production will achieve an applicable Desired Future Condition for each such aquifer or its subdivision in the District. If the total amount of production within an aquifer, or its subdivision, as applicable, is less than the total volume of exempt and permitted groundwater production that will achieve an applicable Desired Future Condition for that aquifer, production amounts authorized under Historic and Existing Use and Production Permits may remain the same or be increased, as set forth under these rules. As determined by the District, if the total amount of production within an aquifer exceeds the Modeled Available Groundwater set for an aquifer, production amounts may be decreased proportionally among all permit holders producing from that aquifer, if necessary to avoid impairment of the Desired Future Condition. Any necessary reductions will first be applied to Production Permits, and, subsequently, if production still exceeds the Modeled Available Groundwater set for an aquifer after reducing Production Permits in their entirety, to Historic and Existing Use Permits, as set forth under Rule 10.4.

RULE 10.4 PROPORTIONAL ADJUSTMENT

(a) When establishing proportional adjustment restrictions, the Board shall first set aside an amount of groundwater equal to an estimate of total exempt use.

(b) After setting aside an amount of groundwater for exempt use, to the extent of remaining groundwater availability, the Board shall allocate groundwater to Historic and Existing Use Permits according to the permitted Maximum Historic and Existing Use in each. If there is insufficient groundwater availability to allow withdrawal under all Historic and Existing Use Permits, the Board shall allocate the groundwater availability first to the Historic and Existing Permits in an amount up to the Eligible Recharge Credit, on a pro rata basis relative to all other Historic and Existing Permits. The Eligible Recharge Credit shall mean 30% of the permitted Maximum Historic and Existing Use that is designated for and previously put to irrigation use in each Historic and Existing Use Permit. The groundwater authorized for withdrawal pursuant to an Eligible Recharge Credit must be withdrawn from the same aquifer that has been recharged with groundwater allocated under the respective permit or application. The remaining groundwater availability shall then be allocated among the Historic and Existing Use Permits up to an amount authorized under each permit on an equal percentage basis until total authorized production equals groundwater availability for a particular aquifer district-wide or within a management zone, if applicable. The Eligible Recharge Credit shall be applied in such a manner that the irrigation user's Existing and Historic Use Permit shall not be proportionally reduced to the extent of the Eligible Recharge Credit. The only basis for proportionately reducing the Eligible Recharge Credit shall be in the event that 100% of the non-recharge credit portion of the Historic and Existing Use Permit allotments has been reduced. If it can be demonstrated and the Board takes official action to determine that the irrigation recharge is more or less than 30%, then the Eligible Recharge Credit may be adjusted by subsequent rulemaking. No groundwater shall be authorized for production under Production Permits if there is insufficient water availability to satisfy all Historic and Existing Use Permits and exempt use, subject to Subsection (e) of this rule. The Eligible Recharge Credit for irrigation use under a Production Permit shall not be applied where there is equal to or less than enough groundwater to satisfy all Historic and Existing Use Permits and exempt use.

(c) If there is sufficient groundwater to satisfy all Historic and Existing Use Permits and exempt use, the Board shall then allocate remaining water availability first to the existing Production Permit holders in an amount equal to their Eligible Recharge Credit, on a pro rata basis relative to all other Production Permits. The Eligible Recharge Credit shall mean 30% of the groundwater allocated under each Production Permit that is designated for and previously put to irrigation use. The groundwater authorized for withdrawal pursuant to an Eligible Recharge Credit must be withdrawn from the same aquifer that has been recharged with groundwater allocated under the respective Production Permit. The remaining groundwater availability shall then be allocated among the Production Permits up to an amount authorized under each permit on an equal percentage basis until total authorized production equals groundwater availability for a particular aquifer district-wide or within a management zone, if applicable. The recharge credit shall be applied in such a manner that the irrigation user's Production Permit shall not be proportionally reduced to the extent of the recharge credit. The only occasion for proportionately reducing the Eligible Recharge Credit shall be in the event that 100% of the non-recharge credit portion of the Production Permit allotments has been reduced, and there is only sufficient groundwater availability to supply exempt use and Historic and Existing Use. If it can be demonstrated and the Board takes official action to determine that the irrigation recharge is more or less than 30%, then the recharge credit shall be adjusted accordingly. No groundwater may be authorized for production under new Production Permits if there is insufficient groundwater availability to satisfy all existing Production Permits, subject to Subsection (e) of this rule.

(d) If there is sufficient groundwater to satisfy all Historic and Existing Use Permits, exempt use, and existing Production Permits, the Board may then allocate remaining groundwater availability to applications for new or amended Production Permits approved by the District.

(e) When establishing proportional adjustment restrictions that contemplate the reduction of authorized production or a prohibition on authorization for new or increased production, the Board may also choose to proportionately reduce any existing Production Permits on a pro rata basis, excluding the authorized Eligible Recharge Credit, in order to make groundwater available for new applications for Production Permits and may allocate to each surface acre a designated amount of groundwater. In doing so, the Board may elect to allocate more water to surface acreage recognized under existing Production Permits than to surface acreage associated with applications for new Production Permits.

RULE 10.5 MANAGEMENT ZONES

(a) As set forth in the District Management Plan and illustrated in Figures 1 through 4 below, the following management zones are established within the principal areas of irrigation and pertinent surrounding areas of Pecos County:

Management Zone 1 – Leon-Belding Irrigation Area and Vicinity of City of Fort Stockton to include outlets of Comanche Springs:

This management zone area is generally bounded by the TWDB Edwards-Trinity (Plateau) / Pecos Valley Aquifer GAM-Grid cells that contain the following sets of latitude and longitude coordinates: (30.90321N, -102.8566 W); (30.85306N, -102.8928 W); (30.69796 N, -10.15137 W). The specific GAM-grid cells composing Management Zone 1 are provided in Appendix G of the District Management Plan.

Management Zone 2 – Bakersfield Irrigation Area:

This management zone area is generally bounded by the TWDB Edwards-Trinity (Plateau) / Pecos Valley Aquifer GAM-Grid cells that contain the following sets of latitude and longitude coordinates: (except where cells are truncated by intersection with the Pecos County-line): (31.05667 N, -102.3717 W); (30.8992 N, -102.28911 W); (30.95167 N, -102.1653 W); (30.96833 N, -102.2169 W). The specific GAM-Grid cells used to compose Management Zone 2 are provided in Appendix G of the District Management Plan.

Management Zone 3 – Coyanosa Irrigation Area:

This management zone area is generally bounded by the TWDB Edwards-Trinity (Plateau) / Pecos Valley Aquifer GAM-Grid cells that contain the following sets of latitude and longitude coordinates (except where cells are truncated by intersection with the Pecos County-line): (31.1805 N, 103.0202 W); (31.3169 N, 103.0511 W); 31.2097 N, 103.0026 W); (31.1105 N, 102.9924 W); (31.1025 N, 103.1022 W); (31.1834 N, 103.1347 W). The specific GAM-Grid cells used to compose Management Zone 3 are provided in Appendix G of the District Management Plan.

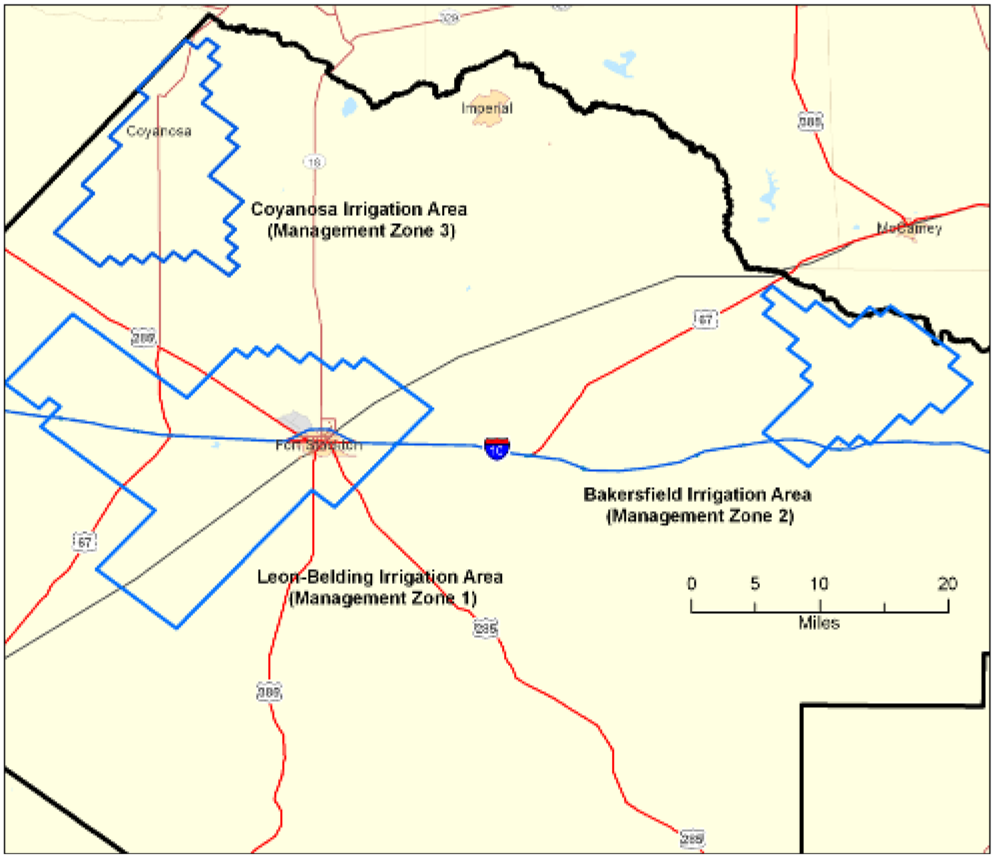

Figure 1, District Designated Management Zones

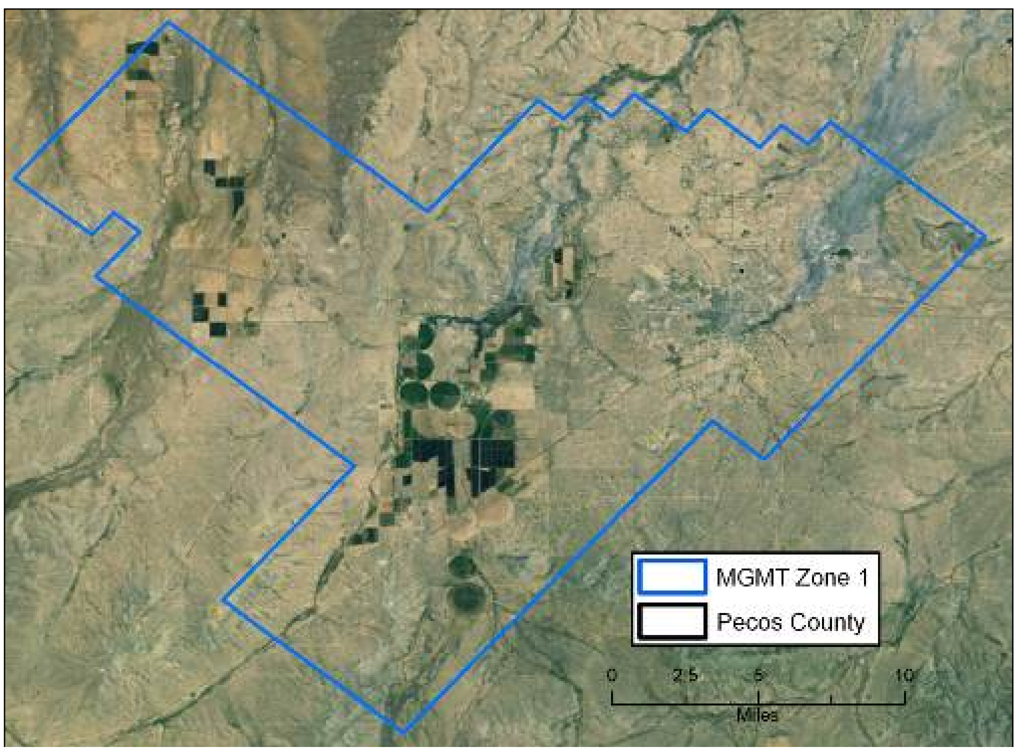

Figure 2, District Management Zone 1

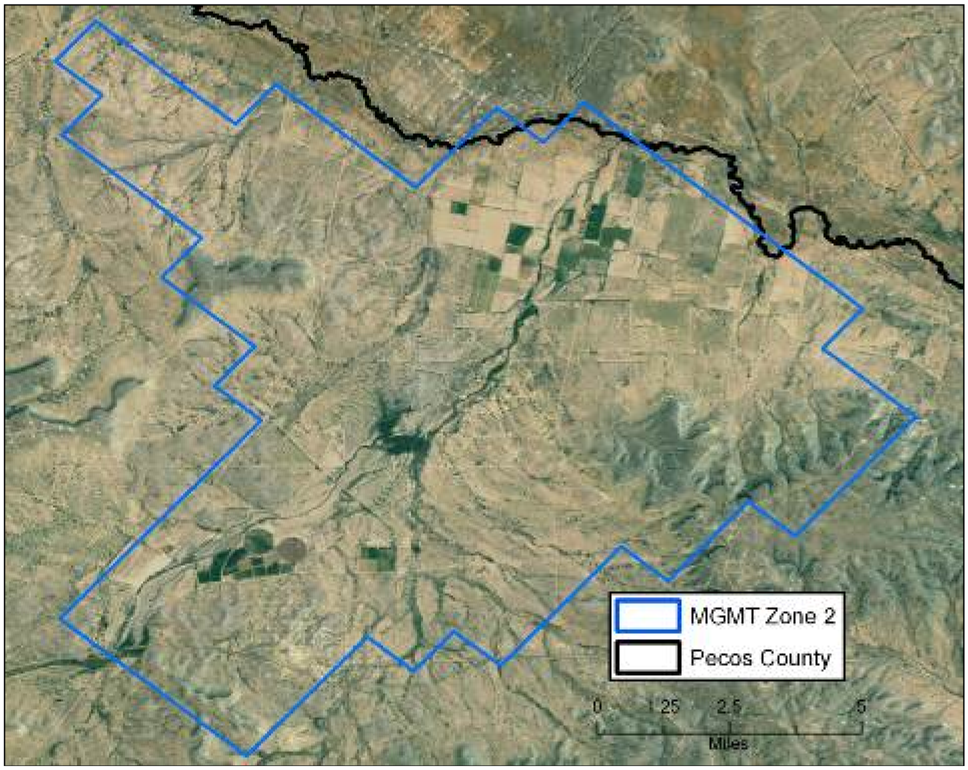

Figure 3, District Management Zone 2

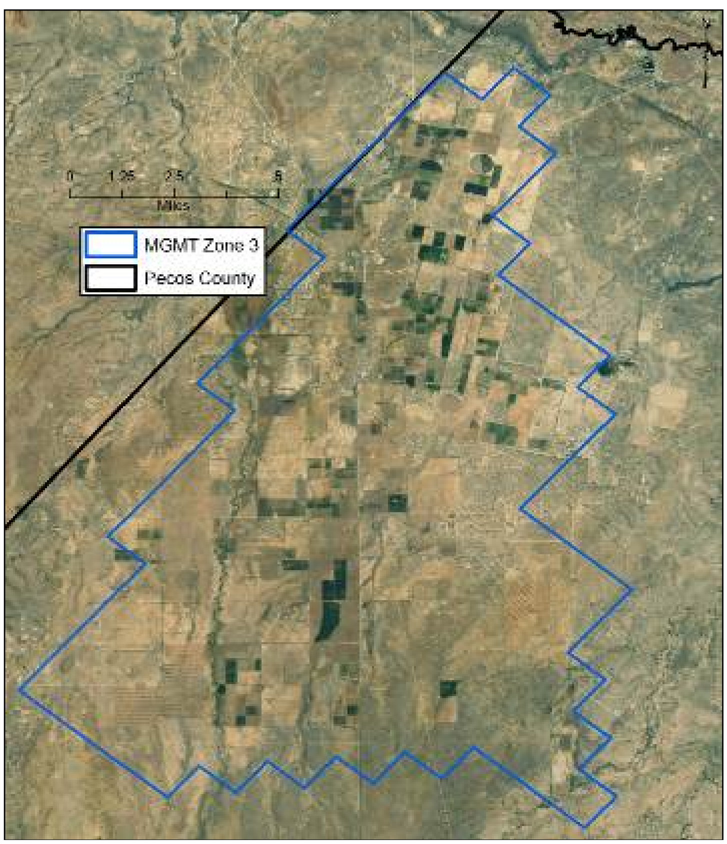

Figure 4, District Management Zone 3

(b) The District shall establish benchmarks of sustainable groundwater use over time to avoid impairment of the Desired Future Condition of each of the aquifers within each management zone, and will re-establish benchmarks from time to time as necessary to be consistent with such Desired Future Conditions. The benchmarks of sustainable groundwater use are threshold amounts of acceptable drawdown over time. The threshold amounts of acceptable drawdown are the average predicted drawdown values over time for each management zone predicted in Scenarios 10 and 11 of TWDB GAM-Run 09-35, Version 2, used to establish the DFCs for the Edwards-Trinity (Plateau) and Pecos Valley aquifers in the District. The predicted drawdown values over time for Management Zones 1 and 2, located in the GMA-7 portion of the District, are from Scenario 10. The predicted drawdown values over time for Management Zone 3, located in the GMA-3 portion of the District, are from Scenario 11. The threshold amounts of acceptable drawdown over time for each management zone are as presented in TWDB GAM Task Report 10-033, which presents more detailed information on Pecos County than otherwise available in but consistent with Scenarios 10 and 11 of TWDB GAM-Run 09-35. The threshold amounts of acceptable drawdown over time for each management zone are as follows:

Year	Management Zone-1 Average Draw-Down (in feet, rounded to nearest foot)	Management Zone-2 Average Draw-Down (in feet, rounded to nearest foot)	Management Zone-3 Average Draw-Down (in feet, rounded to nearest foot)
2015	3	1	2
2020	7	2	4
2025	10	2	5
2030	13	2	7
2035	17	2	8
2040	20	3	9
2045	23	3	11
2050	26	3	12
2055	29	3	13
2060	32	3	15

Table 1, Example Predictive Average Drawdown Values over Time in Edwards-Trinity (Plateau) and Pecos Valley Aquifers for MPGCD Management Zones from TWDB GAM Task Report 10-033.

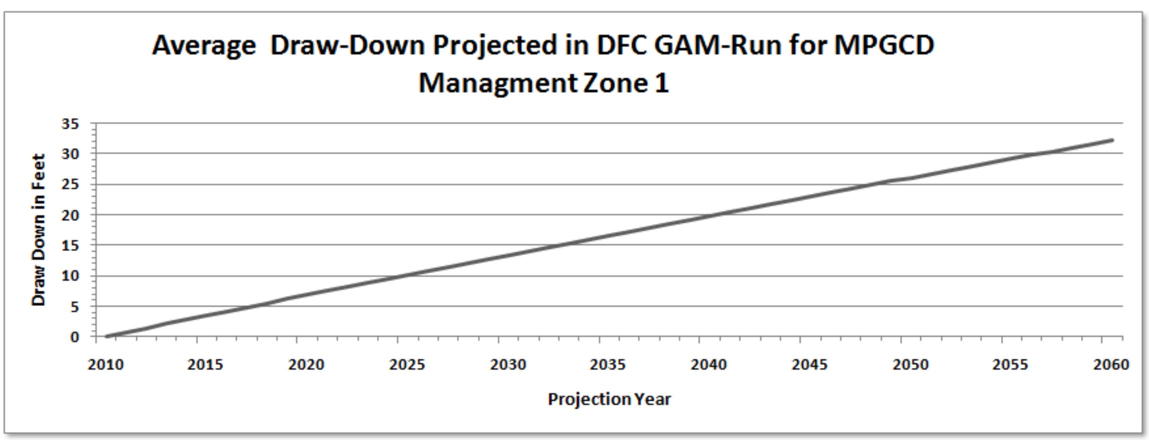

Figure 5, Chart of Predictive Average Drawdown Values over Time in Edwards-Trinity (Plateau) and Pecos Valley Aquifers for MPGCD Management Zone 1 from TWDB GAM Task Report 10-033.

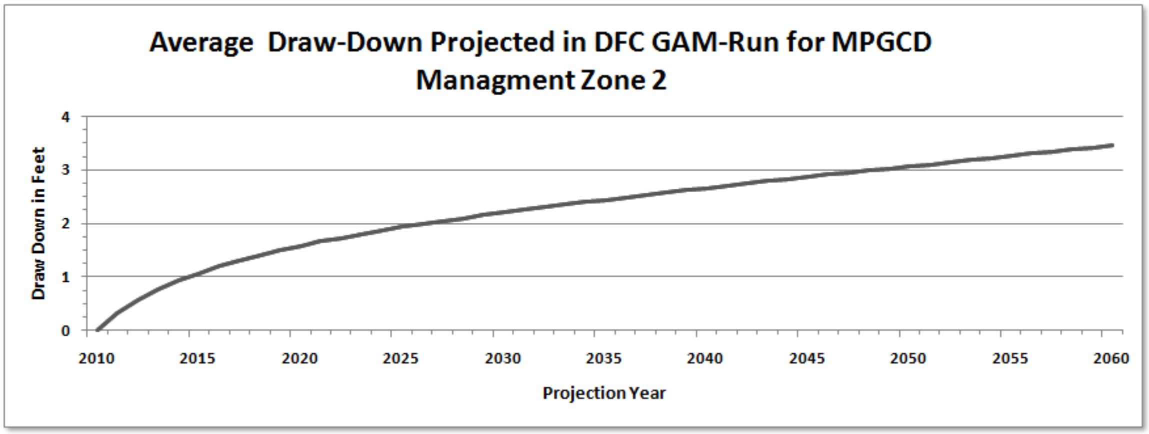

Figure 6, Chart of Predictive Average Drawdown Values over Time in Edwards-Trinity (Plateau) and Pecos Valley Aquifers for MPGCD Management Zone 2 from TWDB GAM Task Report 10-033.

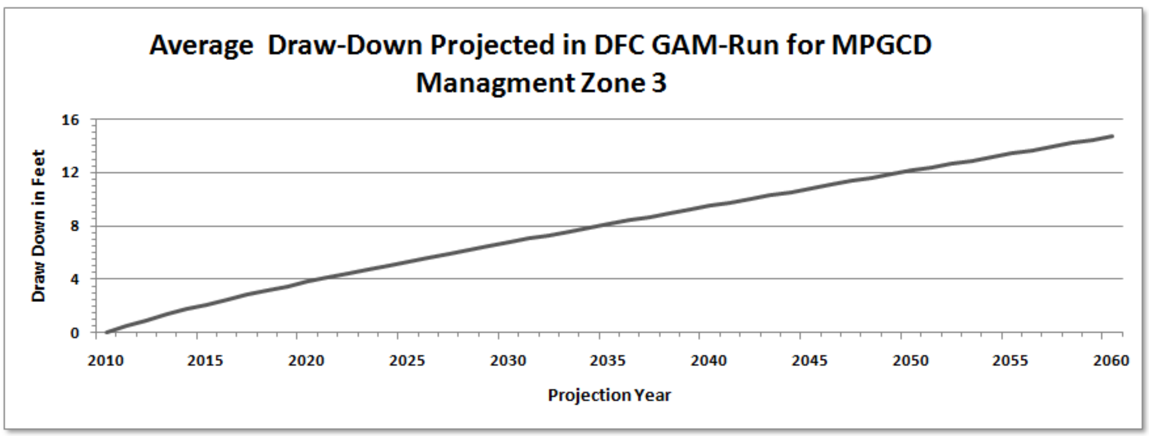

Figure 7, Chart of Predictive Average Drawdown Values over Time in Edwards-Trinity (Plateau) and Pecos Valley Aquifers for MPGCD Management Zone 3 from TWDB GAM Task Report 10-033.

(c) At least every five years, the District will assess the amount of average drawdown realized in each of the management Zones established by the District. The District will compare the amount of realized drawdown in each Management Zone to the time-appropriate threshold of acceptable drawdown in order to determine whether the amount of groundwater use occurring in the Management Zone appears likely to impair the DFC. The District may elect to assess the aquifer drawdown realized in any Management Zone and compare the realized drawdown to the time-appropriate threshold of acceptable drawdown as often as necessary to effectively manage groundwater use and insure the aquifer DFCs are not impaired. The Board may authorize the General Manager to determine whether a comparison of realized drawdown to the threshold of acceptable drawdown is needed for any Management Zone.

(d) The District recognizes that, as of the date of these Rules, the majority of groundwater used the Management Zones is for agricultural irrigation involving widespread intensive seasonal use of groundwater followed by a general cessation of use by the majority of users in the Management Zones. The District further recognizes that after the general cessation of use the aquifer recovers from the effects of the previous intensive seasonal use to reach a point of maximum water-level recovery prior to initiation of the succeeding intensive-use season. The District also recognizes that the threshold of acceptable drawdown values generally represent the year-end maximum recovered water level of the aquifer in the Management Zones for the referenced year. However, the actual date of the maximum recovery of the aquifer water levels in the Management Zone may occur anytime from the month of November of a given calendar year through the month of February of the following year.

(e) To facilitate the comparison of realized drawdown to the thresholds of acceptable drawdown over time in the Management Zones the District will use the following procedures or actions:

(1) Establish several monitor wells in and around each Management Zone for the purpose of observing and quantifying the amount of aquifer drawdown realized over time in each Management Zone;
(2) Develop maps of maximum water-level recovery conditions for year 2010 following procedures in this subsection below;
(3) On or before February 25, 2013, adopt after notice and hearing, the maps of 2010 Management Zone water levels as the 2010 benchmarks for future comparisons of water levels under these rules;
(4) Observe the recovery of aquifer water levels as represented by the monitor wells after the intensive-use season to determine the apparent point of maximum water-level recovery in the Management Zone;
(5) In observing the recovering water levels in the monitor wells of a Management Zone, the District may determine that the apparent point of maximum water-level recovery from the season of intensive use in any given year occurs on a date through the month of February of the succeeding year;
(6) Compile the water-level data, of the Management Zone for the year in which the comparison is to be made;
(7) Determine the water-level drawdown from the established year 2010 conditions for the centroid of each grid-cell of the TWDB Edwards-Trinity (Plateau) / Pecos Valley Aquifer GAM located in the Management Zone area from the water-level contour map;
(8) Calculate the average drawdown of aquifer water levels for the year in which the comparison is to be made in each Management Zone using the set of GAM grid-cell centroid drawdown values for that year;
(9) Compare the calculated average water-level drawdown value for the Management Zone to the DFC-based threshold of acceptable drawdown for the year in which the comparison is to be made, taking into consideration how the distribution of monitoring wells and the amount of pumping known or estimated to be occurring within a Management Zone may affect comparison with the results of TWDB GAM Task Report 10-033 used to establish the thresholds of acceptable drawdown; and
(10) Adopt, after notice and hearing, maps of water levels of all the aquifers, which were not addressed in subsection (3) above, as benchmarks for future comparisons of water levels under these rules.

(f) The Board may, after appropriate rulemaking notice and hearing, establish proportional adjustment reductions based upon the availability of groundwater, benchmarks of sustainable groundwater use over time, and/or degradation of water quality that could result from declining water levels if the Board determines reductions are required to conform with these rules. Upon adoption of a Desired Future Condition and setting of Modeled Available Groundwater for an aquifer within the District, the District shall ensure that the groundwater available for production within a management zone or among management zones designated for that aquifer does not impair the Desired Future Condition and is consistent with the Modeled Available Groundwater for that aquifer within the District. Restrictions within a certain management zone will be uniformly applied within that management zone.

(g) As determined by the District, if the total amount of production within a management zone causes the benchmark of sustainable use within the management zone to be impaired, production amounts authorized under Historic and Existing Use and Production Permits may be decreased within a management zone.

RULE 10.6 LIMIT SPECIFIED IN PERMIT

The maximum annual quantity of groundwater that may be withdrawn under a Historic and Existing Use Permit or Production Permit issued by the District shall be no greater than the amount specified in the permit or the amended permit unless the District makes a determination under Section 10 to increase or decrease the authorized amount of withdrawal. Permits may be issued subject to conditions and restrictions placed on the rate and amount of withdrawal pursuant to the District's rules and permit terms necessary to prevent waste and achieve water conservation, minimize as far as practicable the drawdown of the water table or the reduction of artesian pressure, lessen interference between wells, or control and prevent subsidence. The permit holder, by accepting the permit, agrees to abide by any and all groundwater withdrawal regulations established by the District that are currently in place, as well as any and all regulations established by the District in the future. Acceptance of the permit by the person to whom it is issued constitutes acknowledgment of and agreement to comply with all of the terms, provisions, conditions, limitations, and restrictions.

In addition to any special provisions or other requirements incorporated into the permit, each permit is subject to the following standard permit provisions:

(a) This permit is granted in accordance with the provisions of the rules of the District, and acceptance of this permit constitutes an acknowledgment and agreement that the permit holder will comply with the rules of the District.

(b) The permit terms may be modified or amended pursuant to the provisions of the District's rules or to comply with statutory requirements.

(c) The operation of the well for the authorized withdrawal must be conducted in a non-wasteful manner.

(d) Withdrawals from all nonexempt wells must be accurately measured either by meter or District-approved alternative measuring method, in accordance with the District's rules. The owner or operator of all permitted wells must file an annual pumpage report with the

District. If the well is metered, the meter readings must be attached to the annual pumpage report filed with the District. Wells that are drilled, completed, or equipped so that they are incapable of producing more than 25,000 gallons per day are not required to have a meter or report annual production if used for domestic purposes or for watering livestock or poultry.

(e) The General Manager or Board may, after notice and hearing consistent with permitting hearings governed by Section 11, reduce the quantity of groundwater authorized under a production permit if the applicant has not demonstrated that the water allocated has been withdrawn and put to beneficial use for the purpose and in the amount described in the permit for at least one calendar year during the first three full calendar years following issuance of the permit. The applicant has the burden of proof to demonstrate that the groundwater allocated has been withdrawn and put to beneficial use for the purpose and in the amount described in the permit. No parties other than the permit holder and General Manager may be named as parties in the hearing. The District shall provide written notice of this hearing by certified mail (return receipt requested), hand delivery, first class mail, fax, email, FedEx, UPS, or any other type of public or private courier or delivery service. If the District is unable to provide notice to the permit holder by any of these forms of notice, the District may tape the notice on the door of the permit holder's office or home, or post notice in the newspaper of general circulation in the District and within the county in which the alleged violator resides or in which the alleged violator's office is located.

(f) The well site must be accessible to District representatives for inspection, and the permit holder agrees to cooperate fully in any reasonable inspection of the well and well site by the District representatives.

(g) The application pursuant to which this permit has been issued is incorporated in the permit, and the permit is granted on the basis of, and contingent upon, the accuracy of the information supplied in that application. A finding that false information has been supplied is grounds for immediate revocation of the permit.

(h) Violation of a permit's terms, conditions, requirements, or special provisions is punishable by civil penalties as provided by the District's rules.

(i) The permit may also contain provisions relating to the means and methods of export outside the District of groundwater produced within the District.

RULE 10.7 MEASURING AND REPORTING GROUNDWATER WITHDRAWALS

(a) Nonexempt wells: Every owner or operator of a nonexempt Water Well is responsible for measuring withdrawals from each Water Well either by a District-approved meter or alternative measuring method. Meters must be selected and installed in accordance with the District General Manager's specifications and approval, at the well owner's cost. Meters are not required to be installed on nonexempt wells that are drilled, completed, or equipped so that they are incapable of producing more than 25,000 gallons per day, as long as an alternative measuring method approved by the District is used to record and report groundwater production from this type of well.

(b) Alternative measuring method: The District may authorize the use of an alternative measuring method in lieu of a meter if it can be demonstrated by the well owner that the alternative measuring method is capable of accurate measurement of groundwater withdrawal. The owner of a nonexempt well must secure the District General Manager's approval of an alternative measuring method of determining the amount of groundwater withdrawn. The District General Manager may authorize the alternative measuring method if the applicant well owner demonstrates that the alternative measuring method can accurately measure the groundwater withdrawn. Reporting shall still be required by an owner or operator of a well who is using a District-approved alternative measuring method. A report reflecting annual withdrawals, on a calendar-year basis, shall be provided by any means approved by the General Manager, or more frequently, if requested by the General Manager.

(c) Exempt wells:

(1) An entity holding a permit issued by the Railroad Commission of Texas under Chapter 134, Texas Natural Resources Code, that authorizes the drilling of a water well, shall report monthly to the District:

(A) the total amount of water withdrawn during the month;
(B) the quantity of water necessary for mining activities; and
(C) the quantity of water withdrawn for other purposes.

(2) A report reflecting the total amount of water withdrawn each month from a well exempt under District Rule 11.3(a)(2) must be submitted to the District by the owner or operator. The owner and the operator of such a well may coordinate to determine the amount of monthly withdrawals and to submit this report. However, both the owner and operator of such a well are responsible for ensuring that the withdrawals are determined and that the report is submitted to the District.

(3) The groundwater production from wells subject to reporting under this Subsection (c) must be measured by meter or alternative measuring method approved under this Rule 10.7.

(d) A meter shall be read and the meter reading monthly recorded to reflect the actual amount of pumpage throughout each calendar year. A report reflecting the annual withdrawals and annual system water loss, on a calendar-year basis, shall be provided by any means approved by the General Manager, or more frequently, if requested by the General Manager. The permit holder subject to this reporting requirement shall keep accurate records of the amount of groundwater withdrawn and the purpose of the withdrawal, and such records shall be available for inspection by the District or its representatives. Where wells are permitted in the aggregate, metering and reporting are required on a well-by-well basis.

(e) Immediate written notice shall be given to the District in the event a withdrawal exceeds or is anticipated to exceed the quantity authorized by a permit issued by the District.

(f) Meter accuracy to be tested. The District may require a well owner or operator, at the well owner's or operator's expense, to test the accuracy of the meter and submit a certificate of the test results. The District also has the authority to test a meter. If a test reveals that a meter is not registering within an accuracy of 95%-105% of actual flow, or is not properly recording the total flow of groundwater withdrawn from the well or Well System, the well owner or operator must take appropriate steps to remedy the problem, and to retest the meter within 90 (ninety) calendar days from the date the problem is discovered.

(g) Violation of Metering and Reporting Requirements: False reporting or logging of meter readings, intentionally tampering with or disabling a meter, or similar actions to avoid accurate reporting of groundwater use and pumpage shall constitute a violation of these rules and shall subject the person performing the action, as well as the well owner, and/or the primary operator who authorizes or allows that action, to such remedies as provided in the District Act and these rules.

(h) Recordkeeping Required until Installation of Meter: In the event that a well owner or operator is not measuring withdrawals by District-approved meter or alternative measuring method, the well owner or operator shall be required to keep an accurate log of dates of operation of each well, the duration of such operation, and the purpose and place of use of the water produced until such time as the well owner or operator installs a District-approved meter or secures an alternate measuring method. Such metering log shall be submitted to the District in writing and sworn to within ten (10) calendar days of the installation of the meter or approval of an alternate measuring method, whichever is earlier. Failure to provide the metering log as required by this rule or the provision of false information therein shall be a violation of these rules and grounds for permit denial or revocation.

(i) Meter Maintenance: Costs of meter maintenance shall be borne by the well owner or operator.

(j) Water Use Reporting: Pursuant to Texas Water Code Sections 36.109 and 36.111, if the Board or General Manager deems it useful or otherwise necessary for the District to secure monthly groundwater use data, the General Manager may notify any user of groundwater that monthly groundwater use must be reported to the District.

SECTION 11. GENERAL PERMITTING POLICIES AND PROCEDURES

RULE 11.1 REQUIREMENT FOR PERMIT TO DRILL, OPERATE, OR ALTER THE SIZE OF A WELL OR WELL PUMP; PERMIT AMENDMENT

(a) Permits Required: No person may drill, operate, equip, complete, or alter the size of a well or well pump without first obtaining a permit or approved pre-registration, as applicable, from the District as provided by statutory law and these rules.

(b) Permit Amendment Required: A permit amendment is required prior to any deviation from the permit terms regarding the maximum amount of groundwater to be produced from a well, the location of a proposed well, the purpose of use of the groundwater, the location of use of the groundwater, or the drilling and operation of additional wells, even if aggregate withdrawals remain the same. A Historic and Existing Use Permit may not be amended to modify the purpose of use for which the Historic and Existing Use Permit was originally granted, but may be amended to modify the place of use to a place inside or outside the district. The District may authorize a permit holder to lease or otherwise transfer ownership of a Historic and Existing Use Permit or the amount of groundwater production authorized under such a permit, as long as the purpose of use does not change and as long as the withdrawal is made from the same aquifer and within the same management zone, if applicable, and such transfers are subject to the Rule 11.9.1 and Rule 11.10.10.

(c) Absent an express reservation of rights in the transferor, the transfer of ownership of the well(s) designated by a permit is presumed to transfer ownership of the permit, and the transfer of the land and well site on which the well is located is presumed to transfer ownership of the well. The ownership of a permit may be transferred separately from the ownership of water rights and a well and land and well site on which the well is located, subject to these Rules and permit conditions, with sufficient documentation of an ownership or contractual right to hold the permit. If a transferor retains any interest in the permit, the District may issue a second permit to the transferee that contains the benefits severed and transferred. The District may thereafter amend the permit of the transferor accordingly, along with any appropriate conditions relevant to the transfer imposed by the District. The District shall limit the amount of production authorized in the transfer of a permit to a different location of use to the amount of water produced and beneficially used by the transferor under the original permit.

(d) If the production authorized for two or more wells that have been aggregated to function as part of a Well System under Rule 11.2 and one or more wells under the Well System will be transferred, the District may allocate a pro rata share of the total authorized production to each well transferred unless the conveyance documents transferring the well(s) clearly provides for a different method of allocation.

(e) Upon submission to the District of written notice of transfer of ownership or control of any water right or water well covered by a permit and documents evidencing the transfer, the District's General Manager will amend the permit to reflect the new owner(s).

RULE 11.2 AGGREGATION OF WITHDRAWAL AMONG MULTIPLE WELLS

A Drilling Permit application must be filed for each well that requires permitting. However, one application shall be filed for a Production Permit, or for renewal thereof, which consolidates two or more wells that will function as part of a Well System.

RULE 11.3 PERMIT EXCLUSIONS AND EXEMPTIONS

(a) The District's permit requirements in these rules do not apply to:

(1) drilling or operating a well used solely for domestic use or for providing water for livestock or poultry if the well is located or to be located on a tract of land larger than 10 acres and drilled, completed, or equipped so that it is incapable of producing more than 25,000 gallons of groundwater a day; provided, however, that this exemption shall also apply after the effective date of this rule to a well to be drilled, completed, or equipped on a tract of land equal to or less than 10 acres in size only if:

(A) the well is to be used solely for domestic use or for providing water for livestock or poultry on the tract;

(B) such tract was equal to or less than 10 acres in size prior to the effective date of this rule; and

(C) such tract is not further subdivided into smaller tracts of land after the effective date of this rule and prior to the drilling, completion, or equipping of the well.

i. A well qualifying for exemption under this subsection must observe a minimum distance of 50 feet from the property line and 50 feet from other wells.

ii. For purposes of an exemption under this subsection, the terms "livestock use" and "poultry use" do not include livestock or poultry operations that fall under the definition of "Animal Feeding Operation" or "Concentrated Animal Feeding Operation" set forth in District Rule 1.1.

(2) drilling a water well used solely to supply water for a rig that is actively engaged in drilling or exploration operations for an oil or gas well permitted by the Railroad Commission of Texas provided that the person holding the permit is responsible for drilling and operating the water well and the water well is located on the same lease or field associated with the drilling rig.

(3) drilling a water well authorized under a permit issued by the Railroad Commission of Texas under Chapter 134, Texas Natural Resources Code, or for production from the well to the extent the withdrawals are required for mining activities regardless of any subsequent use of the water.

(4) an injection water source well permitted by the Railroad Commission of Texas for secondary or enhanced oil or gas recovery.

(5) a well used for an ASR Project, except as provided under District Rule 18.1.

(6) monitoring wells.

(7) leachate wells.

(8) dewatering wells.

(b) A well exempted under Subsections (a)(2), (3), (4), and (5) above loses its exemption and must be permitted and comply with all the District's rules in order to be operated if:

(1) the groundwater withdrawals that were exempted under Subsection (a)(2) are no longer used solely to supply water for a rig that is actively engaged in drilling or exploration operations for an oil or gas well permitted by the Railroad Commission of Texas;

(2) the groundwater withdrawals that were exempted under Subsection (a)(3) are no longer necessary for mining activities or are greater than the amount necessary for mining activities specified in the permit issued by the Railroad Commission of Texas under Chapter 134, Texas Natural Resources Code;

(3) the groundwater withdrawals that were exempted under Subsection (a)(4) are no longer used solely to supply water for secondary or enhanced oil recovery pursuant to the terms of the permit issued by the Railroad Commission of Texas; or

(4) the groundwater withdrawals that were exempted under Subsection (a)(5) exceed the amount specified in the permit issued by TCEQ.

(c) A water well exempted under Section (a) above shall:

(1) be pre-registered and registered in accordance with rules promulgated by the District; and

(2) be equipped and maintained so as to conform to the District's rules requiring installation of casing, pipe, and fittings to prevent the escape of groundwater from a groundwater reservoir to any reservoir not containing groundwater and to prevent the pollution of harmful alteration of the character of the water in any groundwater reservoir.

(d) Registered wells observe exemptions that were in place at the time of filing the registration.

(e) A well exempt under this section will lose its exempt status if the well is subsequently used for a purpose or in a manner that is not exempt.

RULE 11.4 HISTORIC AND EXISTING USE PERMITS

The District recognizes the validity of Historic and Existing Use Permits granted under the District's rules and will continue to recognize the rules and procedures applicable to a Historic and Existing Use permit existing at the time the permit was granted. The District no longer accepts applications for Historic and Existing Use Permits because the deadline has passed, and the application procedures and the Historic and Existing Use Permit permitting process are now obsolete. Historic and Existing Use Permits are subject to the transfer, renewal, and permit amendment provisions set forth in these rules.

RULE 11.5 PERMITS REQUIRED TO DRILL A NEW WELL

(a) Every person who drills a water well after the initial effective date of these rules must file the Notice of Intent provided for in Rule 9.2. Every person who drills a nonexempt well must file a permit application on a form approved by the District.

(b) Drilling Permit Requirement: The well owner, well operator, or any other person acting on behalf of the well owner must obtain a Drilling Permit from the District prior to drilling a new water well, perforating an existing well or increasing the size of a well pump therein so that the well could reasonably be expected to produce 25,000 gallons per day or more, unless the well is an exempt well under District Rule 11.3.

RULE 11.6 PERMITS REQUIRED TO OPERATE A NEW WELL OR FOR INCREASED WITHDRAWAL AND BENEFICIAL USE FROM AN EXISTING WELL

Prior to and no later than 21 (twenty-one) calendar days after completion of a new water well, or reworking or re-equipping an existing water well, the well owner or well operator must file a completed Production Permit application on a form approved by the District. A Production Permit may only be issued if the well from which water is proposed to be withdrawn has been drilled or if the Production Permit is subject to the well being drilled in accordance with the terms of a Drilling Permit. If the Drilling Permit expires without a well being drilled, any associated Production Permit shall expire at the same time the Drilling Permit expires.

RULE 11.7 PERMIT TERM

(a) Drilling Permit Term: Unless specified otherwise by the Board or these rules, Drilling Permits are effective for a term ending 120 (one hundred twenty) calendar days after the date the permit is issued by the District, which may be extended by the General Manager with good cause shown.

(b) Historic and Existing Use Permit and Production Permit Terms: Unless specified otherwise by the Board or these rules, Historic and Existing Use Permits and Production Permits are effective until the end of the calendar year in which they are issued. If renewed, such permits shall thereafter be effective for one-year terms from the initial expiration date unless specified otherwise by the Board. The permit term will be shown on the permit. A permit applicant requesting a permit term longer than one year must substantiate its reason for the longer term and its need to put groundwater to beneficial use throughout the proposed permit term.

RULE 11.8 PERMIT RENEWAL

(a) Permit Renewal: Renewal applications shall be provided by the District prior to expiration of the permit term, and shall be filed with the District no later than January 15th of the new year for which the permit renewal is requested. Production Permits will not be renewed unless the well has been drilled at the time of the renewal application.

(b) Renewal Application Requirements: The District will timely provide a form for an application for renewal prior to expiration of the permit term. The renewal application will be a streamlined application and will not include all of the elements required for an original application.

(c) The District shall, without a hearing, renew or approve an application to renew a Production Permit before the date on which the permit expires, provided that:

(1) the application is submitted in a timely manner; and

(2) the permit holder is not requesting a change related to the renewal that would require a permit amendment under the District's rules.

(d) The District is not required to renew a permit under District Rule 11.8(c) if the applicant:

(1) is delinquent in paying a fee required by the District;

(2) is subject to a pending enforcement action for a substantive violation of a District permit, order, or rule that has not been settled by agreement with the District or a final adjudication; or

(3) has not paid a civil penalty or has otherwise failed to comply with an order resulting from a final adjudication of a violation of a District permit, order, or District rule.

(e) If the District is not required to renew a permit under District Rule 11.8(d), the permit remains in effect until the final settlement or adjudication on the matter of the substantive violation.

(f) Any permit holder seeking renewal may appeal the General Manager's ruling by filing, within ten (10) calendar days of notice of the General Manager's ruling, a written request for a hearing before the Board. The Board will hear the applicant's appeal at the next available regular Board meeting. The General Manager shall inform the Board of any renewal applications granted or denied. On the motion of any Board member, and a majority concurrence in the motion, the Board may overrule the action of the General Manager. The General Manager may authorize an applicant for a permit renewal to continue operating under the conditions of the prior permit, subject to any changes necessary under proportional adjustment regulations or these rules, for any period in which the renewal application is the subject of a hearing.

(g) If the holder of a Production Permit, in connection with the renewal of a permit or otherwise, requests a change that requires an amendment to the permit under District Rule 11.1, the permit as it existed before the permit amendment process remains in effect until the later of:

(1) the conclusion of the permit amendment or renewal process, as applicable; or

(2) a final settlement or adjudication on the matter of whether the change to the permit requires a permit amendment.

(h) If the permit amendment process results in the denial of an amendment, the permit as it existed before the permit amendment process shall be renewed under District Rule 11.8(c) without penalty, unless subsection (d) of District Rule 11.8 applies to the applicant.

(i) The District may initiate an amendment to a Production Permit, in connection with the renewal of a permit or otherwise, for the purpose of achieving a Desired Future Condition or another statutory purpose of the District. Any amendment initiated by the District shall be processed in accordance with Section 11 of the District's rules. If the District initiates an amendment to a Production Permit, the permit as it existed before the permit amendment process shall remain in effect until the conclusion of the permit amendment or renewal process, as applicable.

RULE 11.9 PERMIT APPLICATIONS

11.9.1 Requirements for All Permit Applications:

(a) Each application for a water well Drilling Permit, Production Permit, and permit amendment requires the filing of a separate application. The application must be completed on the District's form and may be supplemented. Each application for a permit shall be in writing and sworn to, and shall include the name, mailing address, phone number, and email address of the applicant and the owner of the land on which the well or Well System is or will be located.

(b) In addition to the information required of all permit applications in Rule 11.9.1(a), an application for a Drilling Permit or to amend a Drilling Permit must include the following information:

(1) if the applicant does not own the well site(s) and proposed well(s), documentation establishing the applicable authority to construct, drill, and complete each well on each proposed well site;

(2) the location of each well and the estimated rate at which water will be withdrawn;

(3) the conditions and restrictions, if any, placed on the rate and amount of withdrawal;

(4) the date the permit is to expire if each well is not drilled or if each existing well is not properly completed to meet all statutory and regulatory requirements for the intended purpose of use;

(5) a declaration that the applicant will comply with all District well plugging and capping guidelines and report closure to the Commission;

(6) a location map of all existing wells within a one half (1/2) mile radius of the proposed well or Well System or the existing well or wells to be modified;

(7) a map or other document from the Pecos County Tax Appraisal District indicating the ownership and location of the subject property;

(8) a document indicating the location of each proposed well or each existing well to be modified, the subject property, and adjacent owners' physical and mailing addresses;

(9) notice of any application to TCEQ to obtain or modify a Certificate of Convenience and Necessity to provide water and wastewater service with water obtained pursuant to the requested permit; and

(10) a statement of the nature and purpose of the proposed use and the amount of water to be used for each purpose.

(c) In addition to the information required of all permit applications in Rule 11.9.1(a), an application for a production permit or to amend a production permit must include the following information:

(1) if the applicant does not own the well site(s), proposed well(s), and groundwater, documentation establishing the applicable authority to operate each well and produce and beneficially use the groundwater from each well;

(2) the annual amount of groundwater claimed to be necessary for beneficial use during each year of the proposed permit term with information supporting the annual amount of use requested for each proposed purpose of use;

(3) a requirement that the water withdrawn under the permit be put to beneficial use at all times;

(4) the location of the use of the water from the well or Well System;

(5) the conditions and restrictions, if any, placed on the rate and amount of withdrawal;

(6) a declaration that the applicant will comply with the District's rules and all groundwater use permits and plans promulgated pursuant to the District's rules;

(7) a declaration that the applicant will comply with the District Management Plan;

(8) a drought contingency plan;

(9) a declaration that the applicant will comply with all District well plugging and capping guidelines and report closure to the Commission;

(10) the duration the permit is proposed to be in effect, if greater than one year;

(11) a written statement addressing each of the applicable criteria in Rules 10.2 and 11.10.10(a), (b), and (c) and substantiating why the applicant believes the Board should consider each of these applicable criteria in a manner favorable to the applicant; and

(12) if groundwater is proposed to be exported out of the District, the applicant shall describe the following issues and provide documents relevant to these issues:

(A) the availability of water in the District and in the proposed receiving area during the period for which the water supply is requested;

(B) the projected effect of the proposed export on aquifer conditions, depletion, subsidence, or effects on existing permit holders or other groundwater users within the District; and

(C) how the proposed export is consistent with the approved regional water plan and certified District Management Plan.

(13) a hydrogeological report shall be attached to an application that:

(A) requests a new Production Permit for 1,000 acre feet or more per year from one or more wells or an associated Well System;

(B) requests a new Production Permit or amendment to an existing Production Permit in an amount that when combined with the amount of an existing Production or Historic and Existing Use permit or permits associated with the same well or wells or Well System is at least 1, 000 acre feet per year; or

(C) requests to amend and increase by at least 250 acre feet the annual maximum permitted use of a Production Permit for a well or Well System.

This report must address the area of influence of the well(s) and any associated Well System for which a permit is being requested and a description of the aquifer that will supply water to each well, and be complete in a manner that complies with the requirements adopted in Rule 11.9.3.

(14) the hydrogeological report required in Subsection (13) shall be updated for each and every permit amendment application that requests an increase in production of at least 1,000 acre feet per year from one or more wells or an associated Well System authorized under an existing Production or Historic and Existing Use Permit or Permits that currently authorize at least 1,000 acre feet per year.

(15) the results of a pump test for each well for which a production permit or amendment to a production permit is being requested depends upon the following thresholds:

(A) If the annual amount of groundwater withdrawal from one or more wells or an associated Well System in any calendar year during the permit term is more than 20 acre feet and less than 1,000 acre feet, the pump test(s) and results must meet the requirements of Rule 11.9.2(a);

(B) If an application is subject to the hydrogeological report requirements in Subsection (13) of this rule, the pump test(s) and results must meet the requirements of Rule 11.9.2(b).

(d) The General Manager or Board may waive one or more of the informational requirements for an application to amend a production permit depending on the nature of the amendment provided that the Board has sufficient, relevant information to consider the application at the hearing.

(e) The applicant must provide the District with the information relevant to the type of application that is required in this Rule 11.9 for the District to declare that the application is administratively complete. If the District provides a written list of application deficiencies, the applicant shall have 60 (sixty) calendar days to fully respond to the General Manager's satisfaction, after which a deficient application expires. The applicant may request an extension of this 60-day period or a ruling on the administrative completeness of its application by filing a written request with the District. The District will set an applicant's request under this rule on its next regularly scheduled Board meeting agenda, with three (3) calendar days' notice compliant with the Texas Open Meetings Act. The Board will consider and take action on an applicant's request under this rule at this meeting.

11.9.2 Specific Capacity Pump Test and Pump Test Report Requirements

(a) Specific Capacity Pump Test and Pump Test Report Requirements required by Rule 11.9.1(c)(15)(A)(for one or more nonexempt wells or an associated Well System proposed to be authorized to annually withdraw less than 1,000 acre feet): The specific capacity pump test will provide the District with site-specific aquifer properties and well-yield information necessary to better evaluate a production permit application. The District is aware that a pump test to obtain aquifer specific capacity information requires site preparation, specialized monitoring equipment, monitoring during the test and pump test data analysis which can be time consuming and somewhat costly. The District will assist the production permit applicant with site preparation, provide the required water level monitoring equipment and conduct the technical analysis of the specific capacity pump test.

As part of its consideration of the relevant permitting factors in Rules 11.10.10, the MPGCD Board will consider the specific capacity pump test analysis results provided by the applicant along with input on these results from MPGCD's General Manager and professionals and, if there is a contested hearing, input on these results from any parties admitted into the contested hearing.

The dedicated pump must have the production capacity to meet the permit applicant's requested groundwater demand. The District must be notified at least 14 days in advance of any specific capacity pump test. A specific capacity pump test conducted without prior approval from the District will be deemed noncompliant with MPGCD permit requirements.

If the specific capacity pump test activity is found to be flawed or not acceptable by the District's General Manager, the District's General Manager may require the specific capacity pump test to be repeated.

The District Manager has the authority to exempt a permit applicant from this requirement provided the permit applicant provides good cause why other information submitted with the application is sufficient to describe the type of site-specific aquifer properties and well-yield information that would be obtained from the pump test and associated analysis.

(1) Specific Capacity Pump Test Site Preparation

(A) Availability of local monitor wells: The District is working to expand its understanding of the groundwater resources within the District to ensure the best available science is considered during the permitting process. If a well located within 1,000 feet of and completed within the same aquifer as the permit applicant's specific capacity pump test well is available to be monitored during the pump test, the General Manager may require that it be monitored during the test. This monitor well would provide additional, important aquifer properties. A monitor well(s) may not be actively pumping during the pump test.

(B) Installation of Water-level Transducers and the Determination of Static Water Levels

i. The District staff will assist in the installation of District's own water-level transducers into the permit applicant's well to be pump tested and additional transducers into any monitor wells identified for the specific capacity pump test.

ii. The District staff will determine the depth from the static water level of the well to the top of the pump intake (pump test water column thickness) prior to a pump test to understand at what water level depth the water level will drop below the water level transducer or below the pump intake. It is recommended that the water level transducer depth should be located at least 10 feet above the pump intake.

iii. Prior to a specific capacity pump test, static water levels of the pump test well and any associated monitor wells must be measured by transducers for at least 24 hours prior to the pump test.

iv. The District's staff will make sure that the transducers are time synchronized if there is more than one transducer. The transducers will be programmed to collect water levels every 15 minutes during the entire pump test event which includes: 24 hours before pumping commences, during pumping (8 or 12 hours), and for at least 8 hours after pumping concludes (well recovery measurements).

(2) Determination of Specific Capacity Pump Test Discharge Rate: The specific capacity pump test discharge rate should be representative of the production needed to meet the permit applicant's requested instantaneous production rate (expressed in gallons per minute) and annual quantity of production (expressed in gallons or acre-feet per year). The District's General Manager will provide guidance to the permit applicant on a recommended pump test discharge rate.

(3) Monitoring of Specific Capacity Pump Test Discharge Rate: During a specific capacity pump test, the water level within the well usually declines and, as it does, the well discharge rate will also decrease. The permit applicant needs to provide a flow meter or a method to accurately estimate (within 10% of the actual rate) the pump test discharge rate during the specific capacity pump test. The pump test discharge monitoring method must be pre-approved by the District's General Manager before the pump test begins.

There should be allowance for increasing the pump rpm to maintain a constant discharge rate during the specific capacity pump test or, with the District General Manager's approval, the average discharge rate during the pump test could be used to calculate the well's specific capacity.

(4) Specific Capacity Pump Test Time Period: The specific capacity pump test time period will vary depending on the aquifer and will be confirmed by the District's General Manager in the following ranges:

(A) At least an 8-hour specific capacity pump test for the Edwards-Trinity, Pecos Alluvium and Dockum aquifers.

(B) At least a 12-hour specific capacity pump test for the Rustler, Capitan, San Andres and Igneous aquifers.

(5) Specific Capacity Pump Test

(A) The District staff will help initiate the pump test at an agreed-upon time determined by the District General Manager and the permit applicant. The District will verify that the water-level transducers are active and collecting water level data.

(B) Using a conductivity meter provided by the District measure the discharge water conductivity at 5 to 10 minutes after the pump test has started, mid-way through the pump test and at the end of the pump test. The District's staff will collect the first and last conductivity measurements.

(C) The permit applicant is responsible for monitoring and recording the pumping well's discharge rate changes during the pump test and the mid-pump test water quality conductivity measurement.

(D) Upon completion of the required time for the pump test, the District's staff will shut down the pump test and confirm that the water-level transducers are still active and collecting water level data.

(6) Post Specific Capacity Pump Test: After the completion of the water level recovery measurements, the District's staff will:

(A) Remove transducers from all the wells, and collect pump test information from the permit applicant (variation in pump test discharge rates or the time which permit applicant adjusted pump rate to fixed discharge rate and mid-pump test water quality measurement).

(B) The District's staff will download all the water level transducer data into an Excel spreadsheet with notations on the variations of pump discharge rates with time.

(C) District's groundwater consultant (PG or PE) will take pump test data provided by the District and calculate specific capacity and determine aquifer properties for the monitor wells (if available).

(D) District's groundwater consultant will prepare a brief report to provide to the District's Board and the permit applicant.

(b) Pump Test and Pump Test Report Requirements Associated with Hydrogeological Report required by Rule 11.9.1(c)(14) and (15)(B) (for one or more nonexempt wells or an associated Well System proposed to be authorized to annually withdraw at least 1,000 acre feet): The American Society of Testing and Materials (ASTM) documents D4043 (Selection of Aquifer Test Method) and D4050 (Field Procedure, Pump Tests) provide guidance for designing and implementation of pump tests, and D4105 (Confined Aquifer Pump Test Analysis) or D4106 (Unconfined Aquifer Pump Test Analysis) provide guidance to determine aquifer properties. A permit applicant can purchase these documents at http://global.ihs.com/standards.cfm?publisher=ASTM&RID=Z06&MID=5280 and is strongly encouraged to review these documents prior to designing and conducting any pump tests.

(1) Pump Tests:

Pump tests conducted without prior approval from the District may be deemed noncompliant with the District's Production Permit requirements. The District must be notified at least 48 hours in advance of any pump test conducted as part of the hydrogeological investigation.

Texas registered geoscientists (P.G.) and/or engineers (P.E.) with five years or more of groundwater experience will be required to oversee the design and implementation of each pump test and associated monitor wells and will evaluate the pump test results to determine aquifer properties. Aquifer properties to be determined from the pump tests include specific capacity, transmissivity, hydraulic conductivity, and possibly storage coefficient or storativity values.

(2) Pump Test Monitor Wells:

Monitor wells are required for applicant well fields with multiple wells. Monitor wells selected by the applicant for the pump test must comply with the District's monitor well requirements and the monitor well selection must be pre-approved by the District's General Manager. Monitor wells may not be actively pumping during the pump test. The use of existing private wells within two miles of the pumping wells and within the same groundwater producing formation is acceptable if the well meets the District's monitor well requirements.

A monitor well selected for the pump test is required to monitor only the applicant's aquifer and exhibit a connection with the pumping wells indicated by a minimum of 0.2 feet of drawdown during the pump test. For confined aquifers, the District may also require a monitor well in an overlying aquifer to monitor potential water level fluctuations and to determine whether there is communication between the applicant's aquifer and overlying aquifers.

(3) Pump Test Requirements:

(A) If possible, the District and/or the applicant will meet with any adjacent landowners with large operating wells (>250 gpm) within a two-mile radius of the pump test pumping wells prior to the pump test. The District and/or the applicant will inform the landowners of the date of the pump test, and, if possible, determine whether the landowners' wells will be active during the scheduled pump test. If the landowners' wells are going to be active during the pump test, the District will request that the landowners do not vary the pumping rates during the pump test.

(B) The designed pump test results must be able to be used to mimic the well field's impact of the applicant's requested acre feet per year pumpage.

(C) Static water levels of each pump test pumping and monitor wells should be measured every 12 hours for a total of 36 hours for the Pecos Valley Alluvium, Edwards-Trinity Plateau, and Dockum clastic aquifers and for a total of 72 hours for the Rustler and Capitan Reef Complex karstic aquifers and the San Andres karstic formation prior to the beginning of the pump test.

(D) Flow meters will be used to monitor each pumping well's groundwater production.

(E) Measure water levels and pump test discharge rates and times during pump test at acceptable frequency according to ASTM 4050.

(F) A metered pump test of not less than a continuous 36 hours for the dominantly clastic aquifers, including the Pecos Valley Alluvium (clastic), Edwards-Trinity Plateau (carbonate karst and clastic), and Dockum (clastic).

(G) The documentation of times of field activities, weather changes, and pump test adjustments and/or problems will be recorded.

(H) A recovery phase of a period sufficient for a 95 percent recovery of beginning water levels of each pumping well and 90 percent recovery for each monitor well, not to exceed time period of pumping activity. Water level measurements during recovery should be measured at the same frequency as during the pumping phase (frequent at beginning and decreasing frequency with time).

(I) Water quality parameters (pH, temperature, and conductivity) of the pump test wells' discharged water will be measured at the beginning of the pump test and every 12 hours during the pump test.

(J) Water quality analysis will include TDS, SO4, Cl, Ca, Mg, Na, HCO3, F, Br, and NO3 from each pumping well and will be collected twice—prior to and at the end of each pump test.

The applicant may request that the District's General Manager consider a variation of the above pump test requirements. The District's General Manager has 30 days to review and approve or disapprove the variance request.

(4) Pump Test Report Requirements:

(A) A discussion about the general characteristics of the aquifer, including, but not limited to: confined or unconfined, clastic or karstic, variation in aquifer thickness, and interpreted degree of karst development. Discuss whether the production wells are partially or fully penetrating and the impact on monitor well selection.

(B) For each pump test and monitor well, tables listing water level changes with times, initial water levels at the start of pump test (for pumping and monitor wells), pump test date, start time, end time, changes during and final pumping rates, and water quality parameters measured during the pump test, as a report appendix.

(C) For each pump test and monitor well, a table listing the water level recovery measurements with times as a report appendix.

(D) Copies of field notes collected during the pump test as a report appendix.

(E) A discussion of the reasoning for the selection of the pump test analysis method used to estimate the aquifer properties for each pumping and monitor well in the pump test.

(F) A table listing final estimated aquifer properties for each pumping and monitor well in the pump test.

(G) A table of the pumping wells water quality parameters collected during the pump test.

(H) A discussion of any observed groundwater quality changes (if any) that occurred during the pump test.

If the pump test activity or analysis is found to be flawed or not acceptable by the District's General Manager, the District's General Manager may require that the pump test or analysis be repeated in an acceptable manner before the groundwater Production Permit application may be considered.

11.9.3 Hydrogeological Report Requirements for Production Permits for >1,000 Or More Acre-Feet Per Year: Planning and implementation of all hydrogeological reports required for a Production Permit application should be coordinated with the District to minimize technical issues and to expedite the review process of the application. The District may exercise discretion in the application of the guidelines on an individual and site-specific basis in order to allow a practicable application of the guidelines while ensuring a result yielding the information needed by the District to manage groundwater resources.

The hydrogeological report is intended to provide information to the District on:

(1) the geologic setting of the applicant's proposed production well field;

(2) well construction information of production and monitor wells;

(3) local aquifer characterization of aquifer properties by pump tests; and

(4) an evaluation of whether the proposed use of water unreasonably affects existing groundwater resources or existing permit holders.

(a) Geologic Setting of Applicant's Proposed Production Well Field: The report shall include a discussion of the surface and subsurface geology of the applicant's tract of land on which each proposed production well or wells are located and will include a brief description of the local geology and the selected aquifer within a two-mile radius of each of Applicant's proposed wells. The description will include:

(1) A table that illustrates the stratigraphic column of geological formations overlying and underlying the applicant's identified producing aquifer.

(2) The following figures will be required for the hydrogeological report based on available subsurface well data. The aerial extent of the following figures will include the applicant's proposed production well field and a two-mile buffer zone, reflected by concentric circles with a radius of two miles from each of the applicant's proposed wells.

(A) A figure illustrating the location of the applicant's proposed production and monitor wells, property boundary, and each existing water well located within a two-mile radius of the applicant's proposed production wells. This figure will include the name of each adjacent landowner whose property adjoins the applicant's, the locations of existing water wells, and the names of local streets and/or roads.

(B) A figure illustrating the contoured top depth of the producing aquifer. (This is not required for the Pecos Valley Alluvium or Edwards-Trinity Plateau aquifers.)

(C) A figure illustrating the most recent available water level measurements of the applicant's and adjacent landowners' existing water wells within a two-mile radius of the proposed well field.

(b) Required Well Construction Information: The hydrogeological report will include well construction information for each of the applicant's existing groundwater production and monitor well(s) to be used in the proposed well field. New, proposed production and monitor wells will need a well construction schematic, based on available information. Well construction information for each production and monitor well should include the following:

(1) the identification of the aquifer to be produced from;

(2) the total depths, diameters, and expected screen or production intervals of each of the applicant's existing and proposed production and monitor wells;

(3) each production well's proposed maximum pumping rate; and

(4) a water well driller's report and/or driller's log (if available) for existing wells.

(c) Local Aquifer Characterization: The District may require a pump test to determine local aquifer characterization of the applicant's proposed well field and to evaluate the potential impact of the requested production on existing wells and the District's DFCs. Production from all confined aquifers will require pump tests. The District may exempt the applicant from conducting pump tests on unconfined aquifers if:

(1) the proposed well field (multiple production wells) is in an unconfined aquifer and each proposed well is more than two miles from the applicant's property lines;

(2) the proposed well field involves a single production well in an unconfined aquifer and is more than one mile from the applicant's property lines; or

(3) there are no other landowners' production wells using the applicant's designated unconfined aquifer within two miles of the applicant's property lines.

If the District grants an exemption to the applicant for a pump test, local aquifer properties from available groundwater models (TWDB, USGS, or available reviewed consultant's groundwater models with the District's prior approval) will be used to estimate the potential for unreasonable effects on existing wells by the proposed pumping, including, but not limited to, identifying water level declines within a two-mile radius from each of the applicant's proposed wells.

The applicant may appeal the District's General Manager's decision to require pump tests by filing with the District a request for reconsideration identifying all the reasons why the applicant believes a pump test is unnecessary. The District's General Manager has 30 days to review the appeal and decide whether to support or repeal the pump test requirement. The applicant may appeal the General Manager's decision on the request for reconsideration by filing with the District a written appeal to the District's Board identifying all the reasons why the applicant believes a pump test is unnecessary.

*Pump test and pump test report guidance is provided in Rule 11.9.2.

(d) Potential of Unreasonable Effects from Proposed Production on Existing Wells and Groundwater Resources: The applicant is required to estimate the potential water level impacts caused by the proposed pumping to wells located within a two-mile radius of the applicant's well field applying the assumptions and otherwise meeting the requirements enumerated below in this section. This analysis must mimic the applicant's expected full production operations.

(1) The time periods for water level decline analyses are 30, 180, 365, and 730 days.

(2) The water level impact for the above time periods must be estimated for each well within a two-mile radius from each of the applicant's proposed wells; or a figure illustrating calculated water level decline contours at one quarter (1/4) mile intervals up to two miles (eight contour intervals) for each time period is acceptable.

(3) The water level impact information should also be summarized in a report table.

The applicant has two options on how to evaluate the potential of water level impacts:

Option 1: The applicant can have the District's consultant hydrogeologist assist in completing Section (d) of the applicant's hydrogeological report. If the applicant chooses this option, the applicant realizes that having the District's hydrogeologist complete the hydrogeological report does not guarantee that the District's Board will approve the application, just that the hydrogeological report will be administratively and technically complete. The hydrogeological analysis of the provided pump test results may be favorable or unfavorable for the applicant. The District's hydrogeologist will make a recommendation to the District's Board based on his or her professional opinion of the hydrogeological information provided and compiled in the report.

The applicant will provide the completed hydrogeological report (Sections (a), (b), and (c)) and the pump test results (in an Excel format) to the District's hydrogeologist. If a Production Permit application requests 10,000 acre feet per year or less, then the District's hydrogeologist will use the applicant's pump test derived aquifer properties and estimate water level declines for all the report required wells using pump test simulation software.

If a Production Permit application requests more than 10,000 acre feet per year, then an existing groundwater availability model will be run to estimate the water level declines and potential DFC impacts. The groundwater availability model used for this analysis will be selected by the District's hydrogeologist after discussions with the applicant's groundwater consultants. In the case of the San Andres formation (for which no groundwater availability models exist), a detailed analysis using pump test simulation software will be completed.

If no pump test was required from the applicant for the hydrogeological report, the local aquifer properties will be obtained from the District's hydrogeologist's selected groundwater availability model (USGS, TWDB, or consultant's groundwater model) to determine the water level impact analyses. After running the pump test simulation software (<10,000 acre feet) or groundwater models (>10,000 acre feet), the District's hydrogeologist will generate all the required well level change text, figures, and charts necessary to complete the applicant's hydrogeological report.

The District will charge the applicant the District's hydrogeologist's hourly fee for this service.

Option 2: The applicant may use their own consultant and/or groundwater model (groundwater model must be reviewed and accepted by the District's hydrogeologist prior to model runs) to complete the water level impact analyses. The applicant's consultant will provide text, figures, and tables to meet the above-stated District requirements for the water level impact analyses.

RULE 11.10 PERMIT HEARINGS

11.10.1 All hearings shall be held before a quorum of the Board, a hearings examiner delegated in writing the responsibility to preside over the hearing, or SOAH in accordance with Rule 11.10.4.

11.10.2 Notice and Scheduling of Hearing: Once the District has received an administratively complete application for a water well Drilling Permit, Production Permit, or a permit amendment, or if the Board desires to modify an existing permit, the General Manager will issue a written notice of the hearing on the application in accordance with these rules.

(a) Notices of all hearings of the District shall be prepared by the General Manager and shall, at a minimum, state the following information:

(1) the name and address of the applicant or permit holder;

(2) the name or names of the owner or owners of the land if different from the applicant or permit holder;

(3) the time, date, and location of the hearing;

(4) the address or approximate proposed location of the well or Well System, if different than the address of the applicant or permit holder;

(5) a brief explanation of the proposed permit or permit amendment, including any requested amount of groundwater, the purpose of the proposed use, and any change in use, or if the Board desires to modify an existing permit, a brief explanation of the proposed permit modification and the basis for the proposed

modification; and

(6) any other information the Board or General Manager deems appropriate to include in the notice.

(b) Not less than ten (10) calendar days prior to the date of the hearing, notice shall be:

(1) posted by the General Manager at a place readily accessible to the public in the District office;

(2) provided by the General Manager to the County Clerk of Pecos County, whereupon the County Clerk shall post the notice on a bulletin board at a place convenient to the public in the county courthouse; and

(3) provided to the applicant by regular mail.

Not less than ten (10) calendar days prior to the date of the hearing, notice may be provided by regular mail to landowners who, in the discretion of the General Manager, may be affected by the application.

(c) A person may request notice from the district of a hearing on a permit or a permit amendment application. The request shall be memorialized in writing and is effective for the remainder of the calendar year in which the request is received by the District. To receive notice of a hearing in a later year, a person must submit a new request. An affidavit of an officer or employee of the District establishing attempted service by first class mail, fax, or email to the person in accordance with the information provided by the person is proof that notice was provided by the District.

(d) Failure to provide notice under Subsection (c) does not invalidate an action taken by the District at the hearing.

(e) The Board shall conduct an evidentiary hearing on a permit or permit amendment application if a party appears to protest that application or if the General Manager proposes to deny that application in whole or in part, unless the applicant or other party in a contested hearing requests the District to contract with SOAH to conduct the evidentiary hearing. If no one appears at the initial, preliminary hearing and the General Manager proposes to grant the application, the permit or permit amendment application is considered uncontested, and the Board may act on the permit application after considering the permitting criteria in these rules. Unless one of the parties in a contested hearing requests a continuance and demonstrates good cause for the continuance, the Board may conduct the preliminary and evidentiary hearings on the same date.

(f) Any hearing may or may not be scheduled during the District's regular business hours, Monday through Friday of each week, except District holidays. All hearings shall be held at the location set forth in the notice.

(g) The General Manager shall set an initial, preliminary hearing date within 60 (sixty) calendar days after the date the administratively complete application is submitted. The initial, preliminary hearing shall be held within 35 (thirty-five) calendar days after the setting of the date. Within this same time frame, the General Manager shall post notice and set a hearing on the application before the District Board. The General Manager may schedule as many applications at one hearing as the General Manager deems necessary.

11.10.3 Authority of Presiding Officer: The Presiding Officer may conduct preliminary and evidentiary hearings or other proceedings in the manner the Presiding Officer deems most appropriate for the particular hearing. The Presiding Officer has the authority to:

(a) set hearing dates, other than the initial, preliminary hearing date for permit matters;

(b) convene the hearing at the time and place specified in the notice for public hearing;

(c) rule on motions;

(d) permit the receipt of and rule on the admissibility of evidence consistent with Subchapter D, Chapter 2001, Texas Government Code;

(e) establish the order for presentation of evidence;

(f) administer oaths to all persons presenting testimony;

(g) examine and allow cross-examination of witnesses;

(h) ensure that information and testimony are introduced as conveniently and expeditiously as possible, without prejudicing the rights of any party to the proceeding;

(i) conduct public hearings in an orderly manner in accordance with these rules;

(j) recess any hearing from time to time and place to place;

(k) issue subpoenas, require depositions, or order other discovery consistent with Subchapter D, Chapter 2001, Texas Government Code;

(l) exercise any other appropriate powers necessary or convenient to effectively carry out the responsibilities of Presiding Officer; and

(m) determine how to apportion among the parties the costs related to a contract for the services of a Presiding Officer and the preparation of the official hearing record.

11.10.4 Appearance; Presentation; Time for Presentation; Ability to Supplement; Conduct and Decorum; Written Testimony; Hearing before SOAH:

(a) Appearance: Protestants and non-protestant interested persons may present evidence, exhibits, or testimony, or make an oral presentation as allowed by the Presiding Officer. A person appearing in a representative capacity may be required to prove proper authority. Each person attending and participating in a hearing of the District must submit on a form provided by the District, prior to or at the commencement of the initial, preliminary hearing, the following information: the person's name and address, who the person represents if other than himself, whether the person wishes to testify, whether the person is protesting the application, and any other information relevant to the hearing.

(1) Protestants: To protest an application for a permit or permit amendment, a potential party must attend the permit hearing prepared to articulate his or her justiciable interest related to a legal right, duty, privilege, power, or economic interest that is within the District's regulatory authority and how that justiciable interest would be adversely affected by the permit proposed by the application. This potential party must attend the initial, preliminary hearing and be prepared to address and respond to inquiry and any cross-examination regarding their alleged justiciable interest. A justiciable interest does not include persons who have only an interest common to members of the general public. It is recommended that a person desiring to protest an application for a permit or permit amendment file with the District a notice of protest setting forth the protestant's justiciable interest related to a legal right, duty, privilege, power, or economic interest that is within the District's regulatory authority and how that justiciable interest would be adversely affected by the permit proposed by the application. It is recommended that the notice of protest be submitted so that it is received by the District at least two business days before the permit hearing. The Board may take testimony and shall deliberate and take official action at the hearing to determine whether the protestant has sufficiently demonstrated their justiciable interest and how that justiciable interest would be adversely affected by the permit proposed by the application. If the Board finds that a protestant does not adequately establish that its justiciable interest is affected by the proposed permit, then the protestant shall not be allowed to participate in the hearing.

(2) Non-protestant interested persons: A person may appear at an initial, preliminary hearing in person or by representative provided the representative is fully authorized, in writing, to speak and act for the principal. Any person appearing and offering any evidence pursuant to this subsection shall be subject to cross-examination.

(3) Request for SOAH Hearing: If an application is contested, any party to the hearing may request that the District contract with SOAH to conduct further proceedings in the hearing. A request for a SOAH hearing under this rule must be made to the Board at the initial, preliminary hearing and is untimely if submitted after the conclusion of the preliminary hearing.

(b) After the Presiding Officer calls a hearing to order, the Presiding Officer shall announce the subject matter of the hearing and the order and procedure for presentations.

(c) The Presiding Officer may prescribe reasonable time limits for the presentation of evidence and oral argument at the preliminary and evidentiary hearings.

(d) If requested with good cause shown and if allowed in the sole discretion of the Presiding Officer, any person who appears at a hearing and makes a presentation before the Board may supplement that presentation by filing additional written evidence with the Board within ten (10) calendar days after the date of conclusion of the hearing. Cumulative, repetitive, and unduly burdensome evidence filed under this subsection will not be considered by the Board. A person who files additional written material with the presiding officer under this subsection must also provide the material, not later than the 10th calendar day after the date of the hearing, to any person who provided comments on an uncontested application or any party to a contested hearing. A person who receives additional written material under this subsection may file a response to the material with the presiding officer not later than the 10th day after the date the material was received.

(e) Every person, party, representative, witness, and other participant in a proceeding must conform to ethical standards of conduct and must exhibit courtesy and respect for all other participants. No person may engage in any activity during a proceeding that interferes with the orderly conduct of District business. If in the judgment of the Presiding Officer, a person is acting in violation of this provision, the Presiding Officer will first warn the person to refrain from engaging in such conduct. Upon further violation by the same person, the Presiding Officer may exclude that person from the proceeding for such time and under such conditions as the Presiding Officer deems necessary.

(f) Written Testimony: When the Presiding Officer determines that a proceeding will be expedited and the interest of the parties will not be prejudiced substantially, the Presiding Officer may allow testimony to be received in written form, which testimony shall be subject to cross-examination. If the Presiding Officer allows written testimony, the written testimony of a witness, either in narrative or question and answer form, may be admitted into evidence upon the witness being sworn and identifying the testimony as a true and accurate record of what the testimony would be if given orally.

(g) SOAH Hearing:

(1) Deadline, Location: If timely requested by the applicant or other party to a contested hearing, the District shall contract with SOAH to conduct the hearing on the application. The Board shall determine whether the SOAH hearing will be held in Travis County or at the District Office or other regular meeting place of the Board, after considering the interests and convenience of the parties, and the expense of a SOAH contract.

(2) Costs, Deposit: The party requesting that the hearing be conducted by SOAH shall pay all costs associated with the contract for the hearing and shall make a deposit with the District in an amount that is sufficient to pay the estimated SOAH contract amount before the hearing begins. If the total cost for the contract exceeds the amount deposited by the paying party at the conclusion of the hearing, the party that requested the hearing shall pay the remaining amount due to pay the final price of the contract. If there are unused funds remaining from the deposit at the conclusion of the hearing, the unused funds shall be refunded to the paying party.

(3) Referral: Upon execution of a contract with SOAH and receipt of the deposit from the appropriate party or parties, the District's Presiding Officer shall refer the application to SOAH. The Presiding Officer's referral to SOAH shall be in writing and shall include procedures established by the Presiding Officer under

Subsection (g)(4) below; a copy of the permit application, all evidence admitted at the preliminary hearing, the District's rules and other relevant policies and precedents, the District Management Plan, and the District Act; and guidance and the District's interpretation regarding its regulations, permitting criteria, and other relevant law to be addressed in a Proposal for Decision and Findings of Fact and Conclusions of Law to be prepared by SOAH. The District or Presiding Officer may not attempt to influence the Finding of Facts or the Administrative Law Judge's application of the law in a contested case except by proper evidence and legal argument. SOAH may certify one or more questions to the District's Board seeking the District Board's guidance on District precedent or the District Board's interpretation of its regulations or other relevant law, in which case the District's Board shall reply to SOAH in writing.

(4) Procedure before SOAH: A hearing conducted by SOAH is governed by SOAH's procedural rules; Subchapters C, D, and F, Chapter 2001, Texas Government Code; and, to the extent, not inconsistent with these provisions, any procedures established by the Presiding Officer under District Rule 11.10.3.

(5) District's Receipt of SOAH's Proposal for Decision and Findings of Fact and Conclusions of Law: The District's Board shall conduct a hearing within 45 (forty-five) days of receipt of SOAH's Proposal for Decision and Findings of Fact and Conclusions of Law, and shall act on the application at this hearing or no later than 60 days after the date that the Board's final hearing on the application is concluded in a manner consistent with Section 2001.058, Texas Government Code. At least ten (10) calendar days prior to this hearing, the Presiding Officer shall provide written notice to the parties of the time and place of the Board's hearing under this subsection by mail and fax, for each party with a fax number. The Presiding Officer shall exercise his or her authority under Rule 11.10.3 in conducting this hearing.

(6) The Board may change a finding of fact or conclusion of law made by the Administrative Law Judge, or may vacate or modify an order issued by the Administrative Law Judge, only if the Board determines:

(A) that the Administrative Law Judge did not properly apply or interpret applicable law, District rules, written policies, or prior administrative decisions;

(B) that a prior administrative decision on which the Administrative Law Judge relied is incorrect or should be changed; or

(C) that a technical error in a finding of fact should be changed.

11.10.5 Recording

(a) Contested Hearings: Contested Hearings: A record of the hearing in the form of an audio or video recording or a court reporter transcription shall be kept in a contested hearing. The Presiding Officer shall have the hearing transcribed by a court reporter upon a request by a party to a contested hearing. Court reporter transcription costs may be assessed against the party requesting the transcription or among the parties to the hearing. In assessing reporting and transcription costs, the Presiding Officer must consider the following factors:

(1) the party who requested the transcript;
(2) the financial ability of the requesting party to pay the costs;
(3) the extent to which the requesting party participated in the hearing;
(4) the relative benefits to the various parties of having a transcript;
(5) the budgetary constraints of a governmental entity participating in the proceeding; and
(6) any other factor that is relevant to a just and reasonable assessment of costs.

(b) Uncontested Hearings: In an uncontested hearing, the Presiding Officer may substitute meeting minutes or the report required under Rule 11.10.9 for a method of recording the hearing.

11.10.6 Evidence; Broadening the Issues

(a) The Presiding Officer shall admit evidence if it is relevant to an issue at the hearing.

(b) The Presiding Officer may exclude evidence that is irrelevant, immaterial, or unduly repetitious.

(c) No person will be allowed to appear in any hearing whose appearance, in the opinion of the Presiding Officer, is for the sole purpose of unduly broadening the issues to be considered in the hearing.

11.10.7 Continuance: The Presiding Officer may continue hearings or other proceedings from time to time and from place to place without the necessity of publishing, serving, mailing, or otherwise issuing a new notice. If a hearing or other proceeding is continued and a time and place for the hearing or other proceeding to reconvene are not publicly announced at the hearing or other proceeding by the Presiding Officer before it is recessed, a notice of any further setting of the hearing or other proceeding which shall include the date, hour, place and subject of the meeting will be provided by regular mail at a reasonable time to the parties and any other person the Presiding Officer deems appropriate, but it is not necessary to post or publish a notice of the new setting, except as required by the Texas Open Meetings Act. This rule applies only to permit hearings.

11.10.8 Uncontested Hearings: If no persons timely protest the application and the General Manager proposes to grant the application, the application shall be considered uncontested and the General Manager may act on the application without subjecting the application to a permit hearing before the Board.

(a) The Board may take action on any uncontested application at a properly noticed public meeting held at any time after the public hearing at which the application is scheduled to be heard. The Board may issue a written order to:

(1) grant the application;

(2) grant the application with special conditions; or

(3) deny the application.

(b) An applicant may, not later than the 20th day after the date the Board issues an order granting the application, demand a contested case hearing if the order:

(1) includes special conditions that were not part of the application as finally submitted; or

(2) grants a maximum amount of groundwater production that is less than the amount requested in the application.

(c) If, during a contested case hearing, all interested persons contesting the application withdraw their protests or are found by the Board not to have a justiciable interest affected by the application, or the parties reach a negotiated or agreed settlement which, in the judgment of the Board, settles the facts or issues in controversy, the proceeding will be considered an uncontested hearing and the Board may take any action authorized under District Rule 11.10.8(a).

11.10.9 Proposal for Decision: If the hearing was conducted by a quorum of the Board and if the Presiding Officer prepared a record of the hearing as provided by Rule 11.10.5(a), the Presiding Officer shall determine whether to prepare and submit a Proposal for Decision ("PFD") to the Board under this rule. If a PFD is required, the Presiding Officer shall submit a PFD to the Board within 30 days after the date the hearing is finally concluded. The PFD must include a summary of the subject matter of the hearing, the evidence or public comments received, and the Presiding Officer's recommendations for Board action on the subject matter of the hearing. A copy of the PFD shall be provided to the applicant and each designated party. The applicant and any designated party may submit to the Board written exceptions to the PFD. The Presiding Officer may direct the General Manager or another District representative to prepare the PFD and recommendations required by this Rule. The Board shall consider the PFD at a final hearing. Additional evidence may not be presented during this final hearing, however the parties may present oral argument to summarize the evidence, present legal argument, or argue an exception to the PFD. A final hearing may be continued in accordance with Rule 11.10.7 and Section 36.409, Texas Water Code.

11.10.10 Board Action: Either on the final hearing date or no later than 60 (sixty) calendar days after the final hearing date is concluded, the Board must take action on the subject matter of the hearing.

(a) In deciding whether or not to issue or amend a Drilling Permit, Production Permit, or Historic and Existing Use Permit, and in setting the permitted volume and other terms of a permit, the Board must consider whether:

(1) the application contains accurate information and conforms to the requirements prescribed by Chapter 36, Texas Water Code;

(2) the water well(s) complies with spacing and production limitations identified in these rules;

(3) the proposed use of water does or does not unreasonably affect existing groundwater and surface water resources or existing permit holders;

(4) the proposed use of water is dedicated to a beneficial use;

(5) the proposed use of water is consistent with the District Management Plan;

(6) the applicant agrees to avoid waste and achieve water conservation;

(7) the applicant has agreed that reasonable diligence will be used to protect groundwater quality and that the applicant will follow well plugging guidelines at the time of well closure; and

(8) for those hearings conducted by SOAH under Rule 11.10.4, the Board shall consider the Proposal for Decision and Findings of Fact and Conclusions of Law issued by SOAH.

(b) In deciding whether or not to modify a permit, and in setting the modified permitted volume and other terms of a permit, the Board must consider whether the data from monitoring wells within the source aquifer or other evidence reflects:

(1) an unacceptable level of decline in water quality of the aquifer;

(2) that modification of the permit is necessary to prevent waste and achieve water conservation;

(3) that modification of the permit will minimize as far as practicable the drawdown of the water table or the reduction of artesian pressure;

(4) that modification of the permit will lessen interference between wells;

(5) that modification of the permit will control and prevent subsidence; and

(6) that modification of the permit is necessary to avoid impairment of Desired Future Conditions.

(c) The Board shall consider the relevant criteria and observe the relevant restrictions and may exercise the authority set forth in Sections 36.113, 36.1131, and 36.122 of the Texas Water Code. In issuing permits, the District shall manage total groundwater production on a long-term basis to achieve an applicable Desired Future Condition and consider:

(1) the Modeled Available Groundwater;

(2) the TWDB Executive Administrator's estimate of the current and projected amount of groundwater produced under exemptions granted by District Rule 11.3 and Section 36.117, Texas Water Code;

(3) the amount of groundwater authorized under permits previously issued by the District;

(4) a reasonable estimate of the amount of groundwater that is actually produced under permits issued by the District; and

(5) yearly precipitation and production patterns.

(d) The District may not impose any restrictions on the production of groundwater for use outside of the District other than imposed upon production for in-district use, and shall be fair, impartial, and nondiscriminatory.

11.10.11 Request for Rehearing and Appeal:

(a) An applicant in a contested or uncontested hearing on an application or a party to a contested hearing may administratively appeal a decision of the Board on a permit or permit amendment application by requesting written findings of fact and conclusions of law from the Board not later than the 20th calendar day after the date of the decision.

(b) On receipt of a timely written request, the Board shall make written findings and conclusions regarding a decision of the Board on a permit or permit amendment application. The Board shall provide certified copies of the findings and conclusions to the party who requested them, and to each designated party, not later than the 35th calendar day after the date the Board receives the request. A party to the contested case hearing may request a rehearing before the Board not later than the 20th calendar day after the date the Board issues the findings and conclusions. A party to a contested hearing must first make a request for written findings and conclusions under District Rule 11.10.11(a) before a party to the contested case may submit a request for rehearing under this rule.

(c) A request for rehearing must be filed in the District office and must state clear and concise grounds for the request. The person requesting a rehearing must provide copies of the request to all parties to the hearing.

(d) If the Board grants a request for rehearing, the Board shall, after proper notice, schedule the rehearing not later than the 45th calendar day after the date the request is granted.

(e) The failure of the Board to grant or deny a request for rehearing before the 91st calendar day after the date the request is submitted is a denial of the request.

(f) A decision by the Board on a permit or permit amendment application is final:

(1) if a request for rehearing is not filed on time, on the expiration of the period for filing a request for rehearing;

(2) if a request for rehearing is filed on time and the Board denies the request for rehearing, on the date the Board denies the request for rehearing; or

(3) if a request for rehearing is filed on time and the Board grants the request for rehearing:

(A) on the final date of the rehearing if the Board does not take further action;

(B) if the Board takes further action after rehearing, on the expiration of the period for filing a request for rehearing on the Board's modified decision if a request for rehearing is not timely filed; or

(C) if the Board takes further action after rehearing and another request for rehearing on this Board action is timely filed, then Subsections 3(A) and (C) of this rule shall govern the finality of the Board's decision.

(g) The applicant or party to a contested case hearing must exhaust all administrative remedies with the District prior to seeking judicial relief from a District decision on a permit or permit amendment application. After all administrative remedies are exhausted with the District, an applicant or a party to a contested case hearing must file suit in a court of competent jurisdiction in Pecos County to appeal the District's decision on a permit or permit amendment application within 60 (sixty) calendar days after the date the District's decision is final. An applicant or party to a contested case hearing is prohibited from filing suit to appeal a District's permitting decision if a request for rehearing was not timely filed.

SECTION 12. REWORKING AND REPLACING A WELL

RULE 12.1 REWORKING AND REPLACING A WELL

(a) An existing well may be reworked or re-equipped in a manner that will not change the existing well status.

(b) A permit must be applied for and granted by the Board if a party wishes to replace an existing well with a replacement well.

(c) A replacement well, in order to be considered such, must be drilled within a reasonable distance of the existing well as long as it meets the District's spacing requirements.

(d) In the event the application meets spacing and production requirements, the General Manager may grant such application without further notice.

SECTION 13. WELL LOCATION AND COMPLETION

RULE 13.1 RESPONSIBILITY

(a) After an application for a well Drilling Permit has been granted, the well or wells, if drilled, must be drilled within a reasonable distance of the location specified in the Drilling Permit, and not elsewhere, provided, however, that spacing restrictions be met. If the well or wells are drilled at a different location, the drilling or operation of such well may be enjoined by the Board pursuant to Chapter 36, Texas Water Code.

(b) As described in the Texas Water Well Drillers' Rules, all well drillers and persons having any exempt or nonexempt well drilled, deepened, or otherwise altered shall adhere to the provisions of the rule prescribing the location of wells and proper completion. Each and every exempt and nonexempt well shall be completed in accordance with all statutory and regulatory requirements applicable to the type of well required for the purpose of use authorized under the permit. The driller of any exempt or nonexempt well shall file with the District the well log required by Section 1901.251, Texas Occupations Code, and, if available, the geophysical log and electric log.

RULE 13.2 LOCATION OF DOMESTIC, INDUSTRIAL, INJECTION, IRRIGATION WELLS

Location of wells should be as specified in *16 Texas Administrative Code, Chapter 76.1000*.

RULE 13.3 STANDARDS OF COMPLETION FOR DOMESTIC, INDUSTRIAL, INJECTION, AND IRRIGATION WELLS

Standards of completion shall be as specified in *16 Texas Administrative Code, Chapter 76.1000*.

RULE 13.4 RE-COMPLETIONS

Standards shall be as specified in *16 Texas Administrative Code, Chapter 76.1003*.

RULE 13.5 SPACING REQUIREMENTS

(a) Spacing and Location of Existing Wells: Wells drilled prior to the Effective Date of these rules are not subject to spacing requirements of this rule except that these existing wells shall have been drilled in accordance with state law in effect, if any, on the date such drilling commenced.

(b) Spacing and Location of New Wells: All new permitted wells must comply with the spacing and location requirements set forth under the Texas Water Well Drillers and Pump Installers Administrative Rules, Title 16, Part 4, Chapter 76, Texas Administrative Code, except that wells shall not be located within 50 (fifty) feet from a property line or any existing well. Water well drillers shall indicate the method of completion performed on the Well Report (Texas Department of Licensing and Regulation Form #001 WWD, Section 10, Surface Completion). The District does not impose any additional requirements, but shall consider evidence submitted at the hearing on the permit application that demonstrates that the proposed new well(s) adversely impact and interfere with neighboring wells.

(c) Exceptions to Spacing Requirements:

(1) The Board may grant exceptions to the spacing requirements of the District if the requirements of this section are met.

(2) If an exception to the spacing requirements of the District is desired, the person seeking the exception shall submit an application to the Board and provide written notice of the application to all owners of adjacent property and owners of registered wells located on adjacent property. In the application, the applicant must explain the circumstances justifying an exception to the spacing requirements of the District. The application must include a plat or sketch, drawn to scale, one inch equaling 200 feet. The application and plat must be certified by some person actually acquainted with the facts who shall state that the facts contained in the application and plat are true and correct, and that notice was sent to each of the appropriate property and well owners.

(3) The Board shall conduct a hearing within 65 (sixty-five) calendar days after the application is administratively complete, and no sooner than 20 (twenty) calendar days after the applicant's notice was sent to each of the appropriate property and well owners. The District shall post notice and conduct the public hearing in accordance with Section 11 of the District's rules. Provided, however, if all owners of adjacent property and owners of registered wells execute a waiver in writing, stating that they do not object to the granting of the exception, the Board may proceed, upon notice to the applicant only and without hearing, and determine the outcome of the application. The applicant may waive notice or hearing or both.

(4) If the applicant presents waivers signed by all landowners and well owners whose property or permitted wells would be located within the applicable minimum distance established under these Rules from the proposed well site stating that they have no objection to the proposed location of the well site, the Board, upon the General Manager's recommendation, may waive certain spacing requirements for the proposed well location.

SECTION 14. WASTE AND BENEFICIAL USE

RULE 14.1 DEFINITION OF WASTE

"Waste" means any one or more of the following:

(a) withdrawal of groundwater from a groundwater reservoir at a rate and in an amount that causes or threatens to cause intrusion into the reservoir of water unsuitable for municipal, industrial, agricultural, gardening, domestic, or stock raising purposes;

(b) the flowing or producing of wells from a groundwater reservoir if the water produced is not used for a beneficial purpose, or is not used for such purposes with a reasonable degree of efficiency. Includes line losses in excess of those determined to be unavoidable.

(c) escape of groundwater from a groundwater reservoir to any other reservoir or geologic strata that does not contain groundwater;

(d) pollution or harmful alteration of groundwater in a groundwater reservoir by saltwater or by other deleterious matter admitted from another stratum or from the surface of the ground;

(e) willfully or negligently causing, suffering, or allowing groundwater to escape into any river, creek, natural watercourse, depression, lake, reservoir, drain, sewer, street, highway, road, or road ditch, or onto any land other than that of the owner of the well other than the natural flow of natural springs unless such discharge is authorized by permit, rule, or order issued by TCEQ under Chapter 26 of the Texas Water Code, *Water Quality Control*;

(f) groundwater pumped for irrigation that escapes as irrigation tailwater onto land other than that of the owner of the well unless permission has been granted by the occupant of the land receiving the discharge;

(g) groundwater used for heating or cooling that is allowed to drain on the land surface as tailwater and not re-circulated back to the aquifer;

(h) the loss of groundwater in the distribution system and/or storage facilities of the water supply system which should not exceed acceptable "system water losses" as defined by the American Water Works Association standard; or

(i) Pursuant to Section 11.205 of the Texas Water Code, unless the water from an artesian well is used for a purpose and in a manner in which it may be lawfully used on the owner's land, it is waste and unlawful to willfully cause or knowingly permit the water to run off the owner's land or to percolate through the stratum above which the water is found.

RULE 14.2 WASTEFUL USE OR PRODUCTION

(a) No person shall intentionally or negligently commit waste.

(b) Underground water shall not be produced within, or used within or without the District in such a manner as to constitute waste.

(c) Any person producing or using groundwater shall use every possible precaution, in accordance with the most approved methods, to stop and prevent waste of water.

RULE 14.3 POLLUTION OR DEGRADATION OF QUALITY OF GROUNDWATER

(a) No person shall cause pollution or harmfully alter the character of the underground water of the District by means of salt water or other deleterious matter admitted from another stratum or strata or from the surface of the ground, or from the operation of a well.

(b) No person shall cause pollution or harmfully alter the character of the underground water of the District by activities on the surface of the ground which cause or allow pollutants to enter the groundwater through recharge features, whether natural or manmade.

(c) No person shall cause degradation of the quality of groundwater.

RULE 14.4 ORDERS TO PREVENT WASTE, POLLUTION, OR DEGRADATION OF QUALITY OF GROUNDWATER

After providing 15 (fifteen) calendar days' notice to affected parties and an opportunity for a hearing, the Board may adopt orders to prohibit or prevent waste, pollution, or degradation of the quality of groundwater. If the factual basis for the order is disputed, the Board shall direct that an evidentiary hearing be conducted prior to consideration and decision on the entry of such an order. If the Board President or his or her designee determines that an emergency exists requiring the immediate entry of an order to prohibit waste or pollution and protect the public health, safety, and welfare, he or she may enter a temporary order without notice and hearing provided, however, the temporary order shall continue in effect for the lesser of 15 (fifteen) calendar days or until a hearing can be conducted. In such an emergency, the Board President or his or her designee is also authorized, without notice or hearing to pursue a temporary restraining order, injunctive, and other appropriate relief in a court of competent jurisdiction.

RULE 14.5 REQUIRED EQUIPMENT ON WELLS FOR THE PROTECTION OF GROUNDWATER QUALITY

14.5.1 EQUIPMENT REQUIRED. The following equipment must be installed on all wells having a chemical injection, chemigation or foreign substance unit in the water delivery system: an in-line, automatic quick-closing check valve capable of preventing pollution or harmful alteration of the groundwater. Such equipment must be installed on all new wells at the time of completion. Such equipment shall be installed on all existing wells the next time the wells are serviced.

14.5.2 CHECK VALVES. The type of check valve installed shall meet the following specifications:

(a) Check valves must be equipped with a TCEQ-approved hazardous materials backflow device, and installed in a manner approved by Texas Department of Licensing and Regulation (“TDLR”).

(b) A vacuum-relief device shall be installed between the pump discharge and the check valve in such a position and in such a manner that insects, animals, floodwater, or other pollutants cannot enter the well though the vacuum-relief device. The vacuum-relief device may be mounted on the inspection port as long as it does not interfere with the inspection of other anti-pollution devices.

SECTION 15. INVESTIGATIONS AND ENFORCEMENT

RULE 15.1 NOTICE AND ACCESS TO PROPERTY

Board Members and District agents and employees are entitled to access to all property within the District to carry out technical and other investigations necessary to the implementation of the District’s rules. Prior to entering upon property for the purpose of conducting an investigation, the person seeking access must give notice in writing or in person or by telephone to the owner, lessee, or operator, agent, or employee of the well owner or lessee, as determined by information contained in the application or other information on file with the District. Notice is not required if prior permission is granted to enter without notice. Inhibiting or prohibiting access to any Board Member or District agents or employees who are attempting to conduct an investigation under the District’s rules constitutes a violation and subjects the person who is inhibiting or prohibiting access, as well as any other person who authorizes or allows such action, to the penalties set forth in Texas Water Code Chapter 36.

RULE 15.2 CONDUCT OF INVESTIGATION

Investigations or inspections by the District that require entrance upon property must be conducted at reasonable times, and must be consistent with the establishment’s rules and regulations concerning safety, internal security, and fire protection. The District representative or representatives conducting such investigations must identify themselves and present credentials upon request of the owner, lessee, operator, or person in charge of the well or property.

RULE 15.3 RULE ENFORCEMENT; ENFORCEMENT HEARING

15.3.1 If it appears that a person has violated or is violating any provision of the District’s rules, the District may employ any of the following means, or a combination thereof, in providing notice of the violation:

(a) Informal Notice: The officers, staff or agents of the District acting on behalf of the District or the Board may inform the person of the violation via telephone by informing, or attempting to inform, the appropriate person to explain the violation and the steps necessary to cure the violation. The information received by the District through this informal notice concerning the violation and the date and time of the telephone call will be documented and will remain in the District's files. Nothing in this subsection shall limit the authority of the District to take action, including emergency actions or any other appropriate enforcement action, without prior notice provided under this subsection.

(b) Written Notice of Violation: The District may inform the person of the violation through written notice of violation. Each notice of violation issued herein shall explain the basis of the violation, identify the rule or order that has been violated or is currently being violated, and list specific required actions that must be satisfactorily completed to cure a past or present violation to address each violation raised, and may include the payment of applicable civil penalties. Notice of a violation issued herein shall be provided through a delivery method in compliance with these Rules. Nothing in this Subsection shall limit the authority of the District to take action, including emergency actions or any other appropriate enforcement action, without prior notice provided under this subsection.

(c) Compliance Meeting: The District may hold a meeting with any person whom the District believes to have violated, or to be violating, a District rule or order to discuss each such violation and the steps necessary to satisfactorily remedy each such violation. The General Manager may conduct a compliance meeting without the Board, unless otherwise determined by the Board or General Manager. The information received in any meeting conducted pursuant to this subsection concerning the violation will be documented, along with the date and time of the meeting, and will be kept on file with the District. Nothing in this subsection shall limit the authority of the District to take action, including emergency actions or any other appropriate enforcement action, without prior notice provided under this subsection.

15.3.2 Show Cause Hearing.

(a) Upon recommendation of the General Manager to the Board or upon the Board's own motion, the Board may order any person that it believes has violated or is violating any provision of the District's rules a District order to appear before the Board at a public meeting, held in accordance with the Texas Open Meetings Act, and called for such purpose and to show cause of the reasons an enforcement action, including the assessment of civil penalties and initiation of a suit in a court of competent jurisdiction in Pecos County, should not be pursued against the person made the subject of the show cause hearing. The Presiding Officer may employ the procedural rules in Section 11 of the District's rules.

(b) No show cause hearing under subsection (a) of this Rule may be conducted unless the District serves, on each person made the subject of the show cause hearing, a written notice ten (10) calendar days prior to the date of the hearing. Such notice shall include all of the following information:

(1) the time, date, and place for the hearing; and
(2) the basis of each asserted violation; and
(3) the rule or order that the District believes has been violated or is currently being violated; and
(4) a request that the person duly appear and show cause of the reasons an enforcement action should not be pursued.

(c) The District may pursue immediate enforcement action against the person cited to appear in any show cause order issued by the District where the person cited fails to appear and show cause of the reasons an enforcement action should not be pursued.

(d) Nothing in this rule shall constrain the authority of the District to take action, including emergency actions or any other enforcement action, against a person at any time, regardless of whether the District decides to hold a hearing under this Section.

15.3.3 Remedies

(a) The Board shall consider the appropriate remedies to pursue against an alleged violator during the show cause hearing, including assessment of a civil penalty, injunctive relief, or assessment of a civil penalty and injunctive relief. In assessing civil penalties, the Board may determine that each day that a violation continues shall be considered a separate violation. The civil penalty for a violation of any District rule is hereby set at the lower of $10,000.00 per violation or a lesser amount determined after consideration, during the enforcement hearing, of the criteria in subsection (b) of this rule.

(b) In determining the amount of a civil penalty, the Board of Directors shall consider the following factors:

(1) compliance history;
(2) efforts to correct the violation and whether the violator makes a good faith effort to cooperate with the District;
(3) the penalty amount necessary to ensure future compliance and deter future noncompliance;
(4) any enforcement costs related to the violation; and
(5) any other matters deemed necessary by the Board.

15.3.4 The District shall collect all past due fees and civil penalties accrued that the District is entitled to collect under the District's rules. The District shall provide written notice of the alleged violation and show cause hearing by certified mail, return receipt requested, hand delivery, first class mail, facsimile, email, FedEx, UPS, or any other type of public or private courier or delivery service. If the District is unable to provide notice to the alleged violator by any of these forms of notice, the District may tape the notice on the door of the alleged violator's office or home, or post notice in the newspaper of general circulation in the District and within the county in which the alleged violator resides or in which the alleged violator's office is located. Any person or entity in violation of these rules is subject to all past due fees and civil penalties along with all fees and penalties occurring as a result of any violations that ensue after the District provides written notice of a violation. Failure to pay required fees will result in a violation of the District's rules and such failure is subject to civil penalties.

15.3.5 The District may afford an opportunity to the alleged violator to cure a violation through coordination and negotiation with the District.

15.3.6 After conclusion of the show cause hearing, the District may commence suit. Any suit shall be filed in a court of competent jurisdiction in Pecos County. If the District prevails in a suit brought under this Section, the District may seek and the court shall grant, in the interests of justice and as provided by Subsection 36.066(h), Texas Water Code, in the same action, recovery of attorney's fees, costs for expert witnesses, and other costs incurred by the District before the court.

RULE 15.4 SEALING OF WELLS

Following notice to the well owner and operator and upon resolution by the Board, the District may seal wells that are prohibited from withdrawing groundwater within the District to ensure that such wells are not operated in violation of the District's rules. A well may be sealed when: (1) no application has been made for a permit to drill a new water well which is not excluded or exempted; or (2) no application has been made for a Production permit to withdraw groundwater from an existing well that is not excluded or exempted from the requirement that a permit be obtained in order to lawfully withdraw groundwater; or (3) the Board has denied, canceled or revoked a Drilling Permit or a Production permit.

The well may be sealed by physical means, and tagged to indicate that the well has been sealed by the District, and other appropriate action may be taken as necessary to preclude operation of the well or to identify unauthorized operation of the well.

Tampering with, altering, damaging, or removing the seal of a sealed well, or in any other way violating the integrity of the seal, or pumping of groundwater from a well that has been sealed constitutes a violation of these rules and subjects the person performing that action, as well as any well owner or primary operator who authorizes or allows that action, to such penalties as provided by the District's rules.

RULE 15.5 CAPPING AND PLUGGING OF WELLS

(a) The District may require a well to be capped to prevent waste, prevent pollution, or prevent further deterioration of a well casing. The well must remain capped until such time as the conditions that led to the capping requirement are eliminated. If well pump equipment is removed from a well and the well will be re-equipped at a later date, the well must be capped, provided however that the casing is not in a deteriorated condition that would permit co-mingling of water strata, in which case the well must be plugged. The cap must be capable of sustaining a weight of at least four hundred (400) pounds and must be constructed with a water tight seal to prevent entrance of surface pollutants into the well itself, either through the well bore or well casing.

(b) A deteriorated or abandoned well must be plugged in accordance with the Texas Department of License and Regulation, Water Well Drillers and Pump Installers Rules (16 TAC Chapter 76). It is the responsibility of the landowner to see that such a well is plugged to prevent pollution of the underground water and to prevent injury to persons and animals. Registration of the well is required prior to, or in conjunction with, well plugging.

Any person that plugs a well in the District must submit a copy of the plugging report to the District and the Texas Department of License and Regulation within 30 (thirty) calendar days of plugging completion.

(c) If the owner or lessee fails or refuses to plug or cap the well in compliance with this rule and District standards within 30 (thirty) calendar days after being requested to do so in writing by an officer, agent, or employee of the District, then, upon Board approval, any person, firm, or corporation employed by the District may go on the land and plug or cap the well safely and securely, pursuant to TWC Chapter 36.118.

Reasonable expenses incurred by the District in plugging or capping a well constitutes a lien on the land on which the well is located.

The District shall perfect the lien by filing in the deed records an affidavit, executed by any person conversant with the facts, stating the following:

(1) the existence of the well;
(2) the legal description of the property on which the well is located;
(3) the approximate location of the well on the property;
(4) the failure or refusal of the owner or lessee, after notification, to close the well within 30 (thirty) calendar days after the notification;
(5) the closing of the well by the District, or by an authorized agent, representative, or employee of the District; and
(6) the expense incurred by the District in closing the well.

SECTION 16. FEES

RULE 16.1 GROUNDWATER EXPORT FEE

(a) The District may impose an export fee or surcharge, established by Board resolution, for export of groundwater out of the District using one of the following methods:

(1) a fee negotiated between the District and the exporter; or

(2) a rate not to exceed the equivalent of the District's tax rate per hundred dollars of valuation for each thousand gallons of water exported from the District or 2.5 cents per thousand gallons of water, if the District assesses a tax rate of less than 2.5 cents per hundred dollars of valuation.

If a production fee is assessed, this export fee shall not exceed 10 percent of the amount of the fee assessed for the production of water for use within the District.

(b) Payment of the Groundwater Export Fee shall be made at a time negotiated under 16.1(a)(1) or no later than the payment deadline established by the General Manager.

RULE 16.2 RETURNED CHECK FEE

Any person who tenders to the District a check that is returned to the District for insufficient funds, account closed, signature missing, or any other reason shall immediately remit funds to the District in the amount of the check that was returned and reimburse the District for any expenses associated with the returned check that were incurred by the District.

SECTION 17. PROPOSED DESIRED FUTURE CONDITIONS; PUBLIC COMMENT, HEARING, AND BOARD ADOPTION; APPEAL OF DESIRED FUTURE CONDITIONS

RULE 17.1 PUBLIC COMMENT

Upon receipt of proposed Desired Future Conditions from the Groundwater Management Area's district representatives, a public comment period of 90 (ninety) calendar days commences, during which the District will receive written public comments and conduct at least one hearing to allow public comment on the proposed Desired Future Conditions relevant to the District. The District will make available at the Distriict Office a copy of the proposed Desired Future Conditions and any supporting materials, such as the documentation of factors considered under Subsection 36.108(d) and groundwater availability model run results.

RULE 17.2 NOTICES OF HEARING AND MEETING

(a) At least ten (10) calendar days before a hearing or meeting under this Section, the Board must post notice that includes:

  (1) the proposed Desired Future Conditions and a list of any other agenda items;
  (2) the date, time, and location of the hearing;
  (3) the name, telephone number, and address of the person to whom questions or requests for additional information may be submitted;
  (4) the names of the other districts in the District's management area; and
  (5) information on how the public may submit comments.

(b) Except as provided by Subsection (a), the hearing and meeting notice must be provided in the manner prescribed for a rulemaking hearing under Rule 6.2(b) and Subsection 36.101(d), Texas Water Code.

RULE 17.3 HEARING

The District shall hold a public hearing to accept public comments using procedures prescribed in Section 6 of these rules.

RULE 17.4 DISTRICT'S REPORT ON PUBLIC COMMENTS AND SUGGESTED REVISIONS

After the public hearing, the District shall compile for consideration at the next joint planning meeting a summary of relevant comments received, any suggested revisions to the proposed Desired Future Conditions, and the basis for any suggested revisions.

RULE 17.5 BOARD ADOPTION OF DESIRED FUTURE CONDITIONS

As soon as possible after the District receives the Desired Future Conditions resolution and explanatory report from the Groundwater Management Area's district representatives pursuant to Subsection 36.108(d-3), the Board shall adopt the Desired Future Conditions in the resolution and explanatory report that apply to the District. The Board shall issue notice of its meeting at which it will take action on the Desired Future Conditions in accordance with Rule 17.2(a) and (b).

RULE 17.6 APPEAL OF DESIRED FUTURE CONDITIONS

(a) Not later than 120 (one hundred twenty) calendar days after the date on which the District adopts a Desired Future Condition under Subsection 36.108(d-4), Texas Water Code, a person determined by the District to be an affected person may file a petition appealing the reasonableness of a Desired Future Condition. The petition must include:

(1) evidence that the petitioner is an affected person;

(2) a request that the District contract with SOAH to conduct a hearing on the petitioner's appeal of the reasonableness of the Desired Future Condition;

(3) evidence that the districts did not establish a reasonable Desired Future Condition of the groundwater resources within the relevant Groundwater Management Area.

(b) Not later than ten (10) calendar days after receiving a petition described by Subsection (a), the District's Presiding Officer shall determine whether the petition was timely filed and meets the requirements of Rule 17.6(a) and, if so, shall submit a copy of the petition to the TWDB. If the petition was untimely or did not meet the requirements of Rule 17.6(a), the District's Presiding Officer shall return the petition to the petitioner advising of the defectiveness of the petition. Not later than 60 (sixty) calendar days after receiving a petition under Rule 17.6(a), the District shall:

(1) contract with SOAH to conduct the requested hearing; and

(2) submit to SOAH a copy of any petitions related to the hearing requested under Rule 17.6(a) and received by the District.

(c) A hearing under District Rule 17.6 must be held:

(1) at the District office or Pecos County Courthouse unless the District's Board provides for a different location; and

(2) in accordance with Chapter 2001, Texas Government Code, and SOAH's rules.

Not less than ten (10) calendar days prior to the date of the hearing, notice may be provided by regular mail to landowners who, in the discretion of the General Manager, may be affected by the application.

(d) Not less than ten (10) calendar days prior to the date of the SOAH hearing under this rule, notice shall be issued by the District and meet the following requirements:

(1) state the subject matter, time, date, and location of the hearing;

(2) be posted at a place readily accessible to the public at the District's office;

(3) be provided to the County Clerk of Pecos County, whereupon the County Clerk shall post the notice on a bulletin board at a place convenient to the public in the County Courthouse; and

(4) be sent by certified mail, return receipt requested; hand delivery; first class mail; fax; email; FedEx; UPS; or any other type of public or private courier or delivery service to:

(A) the petitioner;

(B) any person who has requested notice in writing to the District;

(C) each nonparty district and regional water planning group located within the same Groundwater Management Area as a district named in the petition;

(D) TWDB's Executive Administrator; and

(E) TCEQ's Executive Director.

If the District is unable to provide notice by any of these forms of notice, the District may tape the notice on the door of the individual's or entity's office or home, or post notice in the newspaper of general circulation in the District and within the county in which the person or entity resides or in which the person's or entity's office is located.

(e) Before a hearing is conducted under this rule, SOAH shall hold a prehearing conference to determine preliminary matters, including:

(1) whether the petition should be dismissed for failure to state a claim on which relief can be granted;

(2) whether a person seeking to participate in the hearing is an affected person who is eligible to participate; and

(3) each affected person that shall be named as a party to the hearing.

(f) The petitioner shall pay the costs associated with the contract for the hearing conducted by SOAH under this rule. The petitioner shall deposit with the District an amount sufficient to pay the contract amount before the hearing begins. After the hearing, SOAH may assess costs to one or more of the parties participating in the hearing and the District shall refund any money exceeding actual hearing costs to the petitioner. SOAH shall consider the following in apportioning costs of the hearing:

(1) the party who requested the hearing;

(2) the party who prevailed in the hearing;

(3) the financial ability of the party to pay the costs;

(4) the extent to which the party participated in the hearing; and

(5) any other factor relevant to a just and reasonable assessment of costs.

(g) On receipt of the SOAH Administrative Law Judge's findings of fact and conclusions of law in a proposal for decision, which may include a dismissal of a petition, the District shall issue a final order stating the District's decision on the contested matter and the District's findings of fact and conclusions of law. The District may change a finding of fact or conclusion of law made by the Administrative Law Judge, or may vacate or modify an order issued by the Administrative Law Judge, as provided by Section 2001.058(e), Texas Government Code.

(h) If the District vacates or modifies the proposal for decision, the District shall issue a report describing in detail the District's reasons for disagreement with the Administrative Law Judge's findings of fact and conclusions of law. The report shall provide the policy, scientific, and technical justifications for the District's decision.

(i) If the District in its final order finds that a Desired Future Condition is unreasonable, not later than the 60th calendar day after the date of the final order, the District shall coordinate with the districts in the Groundwater Management Area at issue to reconvene in a joint planning meeting for the purpose of revising the Desired Future Condition found to be unreasonable in accordance with the procedures in Section 36.108, Texas Water Code.

(j) The Administrative Law Judge may consolidate hearings requested under this rule that affect two or more districts. The Administrative Law Judge shall prepare separate findings of fact and conclusions of law for each district included as a party in a multidistrict hearing.

SECTION 18. AQUIFER STORAGE AND RECOVERY (ASR)

RULE 18.1 APPLICABILITY OF DISTRICT'S RULES TO ASR PROJECTS

(a) As a general matter, TCEQ has exclusive jurisdiction over the regulation and permitting of ASR Injection Wells. However, the District has concurrent jurisdiction over an ASR Injection Well that also functions as an ASR Recovery Well. The District is entitled to notice of and may seek to participate in an ASR permitting matter pending at TCEQ and, if the District qualifies as a party, in a contested hearing on an ASR application.

(b) The provisions of District Rule 18.1 apply to an ASR Recovery Well that also functions as an ASR Injection Well.

(c) A Project Operator shall:

(1) register an ASR Injection Well and ASR Recovery Well associated with the ASR Project if a well is located in the District;

(2) submit to the District the monthly report required to be provided to TCEQ under Section 27.155, Texas Water Code, at the same time the report is submitted to TCEQ; and

(3) submit to the District the annual report required to be provided to TCEQ under Section 27.156, Texas Water Code, at the same time the report is submitted to TCEQ.

(d) If an ASR Project recovers an amount of groundwater that exceeds the volume authorized by TCEQ to be recovered under the project, the Project Operator shall report to the District the volume of groundwater recovered that exceeds the volume authorized to be recovered in addition to providing the report required by District Rule 18.1(c)(2).

(e) Except as provided by District Rule 18.1(f), the District may not require a permit for the drilling, equipping, operation, or completion of an ASR Injection Well or an ASR Recovery Well that is authorized by TCEQ.

(f) Each ASR Recovery Well that is associated with an ASR Project is subject to the permitting, spacing, and production requirements of the District if the amount of groundwater recovered from the wells will exceed the volume authorized by TCEQ to be recovered under the project. The requirements of the District apply only to the portion of the volume of groundwater recovered from the ASR Recovery Well that exceeds the volume authorized by TCEQ to be recovered.

(g) A Project Operator may not recover groundwater from an ASR Project in an amount that exceeds the volume authorized by TCEQ to be recovered under the project unless the Project Operator complies with the applicable requirements of the District as described by this rule.

(h) The District may not assess a production fee or export fee or surcharge for groundwater recovered from an ASR Recovery Well, except to the extent that the amount of groundwater recovered under the ASR Project exceeds the volume authorized by TCEQ to be recovered.

(i) The District may consider hydrogeologic conditions related to the injection and recovery of groundwater as part of an ASR Project in the planning for and monitoring of the achievement of a Desired Future Condition for the aquifer in which the wells associated with the project are located.

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Appendix D

Evidence of Notice and Hearing

MIDDLE PECOS GROUNDWATER CONSERVATION DISTRICT

NOTICE OF PUBLIC HEARING ON AMENDMENTS TO MANAGEMENT PLAN

July 14, 2020 at 10:00 a.m.
District's Office, 405 North Spring Drive
Fort Stockton, Texas 79735

The Middle Pecos Groundwater Conservation District (District) will hold a public hearing on proposed amendments to the District's management plan on July 14, 2020, at 10:00 a.m. at its office at 405 North Spring Drive, Fort Stockton, Texas 79735. All interested parties are invited to attend and are encouraged to provide input, and may do so orally or in written form. Additionally, this public hearing will be accessible via videoconference call in accordance with Governor Abbott's declaration of the COVID-19 public health threat and action to temporarily suspend certain provisions of the Texas Open Meetings Act. Members of the public may listen to and participate in the meeting via the web video link and toll-free call-in number below.

Link:	https://us02web.zoom.us/j/84263436983	Call-in #: 1-888-992-1129
Meeting ID:	842 6343 6983	
Password:	754489	

The proposed amendments to the management plan incorporate the updated Desired Future Conditions and Modeled Available Groundwater information developed from the work of the Texas Water Development Board (TWDB), groundwater conservation districts and other stakeholders within Groundwater Management Areas 3 and 7, and amends certain management objectives and performance standards. Following this hearing, the District will, in coordination with surface water management entities on a regional basis, complete the management plan to address the management goals statutorily required in Section 36.1071 of the Texas Water Code and TWDB's rules.

Copies of the proposed management plan are available for review at the District's office at 405 North Spring Drive, Fort Stockton, Texas 79735, and on the District's webpage at www.middlepecosgcd.org.

The District is committed to compliance with the Americans with Disabilities Act (ADA). If you require special assistance to participate in this hearing, please call (432) 336-0698 at least 24 hours in advance of the meeting to make arrangements. For more information about the management plan or public hearing, please contact the District's General Manager Ty Edwards at (432) 336-0698.

FILED
JUN 29 2020
LIZ CHAPMAN
CLERK COUNTY COURT, PECOS CO., TEXAS
By J. Kurtz Deputy
10:35am

MIDDLE PECOS GROUNDWATER CONSERVATION DISTRICT

P.O Box 1644 Fort Stockton, TX 79735 Phone (432)336-0698 Fax (432)336-3407
405 North Spring Drive Fort Stockton, Texas 79735
Email: mpgcd@mpgcd.org Website: www.middlepecosgcd.org

NOTICE OF REGULAR BOARD MEETING AND PUBLIC HEARING TO BE HELD BY VIDEOCONFERENCE AND TELECONFERENCE[1]

July 14, 2020
Call to Order at 10:00 a.m.

In accordance with Governor Abbott's declaration of the COVID-19 public health threat and action to temporarily suspend certain provisions of the Texas Open Meetings Act, a quorum of the District's Board of Directors will hold its regular Board meeting and hearing by videoconference and teleconference. There will not be an in-person meeting. The public may join this meeting as follows:

Access the videoconference at this link: https://us02web.zoom.us/j/84263436983
Password: 754489 / Meeting ID: 842 6343 6983

Alternatively, call in to this meeting at this toll-free number: 1-888-992-1129

Members of the public wishing to make public comment during the meeting and/or hearing must register by emailing mpgcd@mpgcd.org prior to 9:30 a.m. on July 14, 2020. A copy of the agenda packet will be available on the District's website at the time of the meeting.

During this meeting, the Board reserves the right to go into executive session for any of the purposes authorized under the Texas Open Meetings Act, Chapter 551 of the Texas Government Code, for any item on this agenda or as otherwise authorized by law.

REGULAR BOARD MEETING

I Call to order regular Board meeting and roll call.

II Comments from **public and media** (limit 5 minutes per person cumulative for all items addressed). Members of the public may address the Board for a limited time concerning any subject whether or not it is on the agenda (each person wishing to speak must submit a completed public comment form).[2]

III Consider and/or act upon **Minutes of Regular Meeting on June 16, 2020.**

PUBLIC HEARING ON AMENDMENTS TO MANAGEMENT PLAN[3]

I Call to Order at 10:00 a.m.

II Public hearing to receive public input on proposed Amendments to Management Plan.

III Adjourn.

REGULAR BOARD MEETING – CONTINUED

IV Consider and/or act upon **Treasurer's Report for the Month Ending June 30, 2020.**

V Consider and review **2020-2021 draft budget.**

VI Consider and/or act upon **2020 Amendments to Management Plan.**

VII Consider and/or act on **Cockrell Investment Partners, L.P.'s (Cockrell's) pending motion for contested case hearing and referral to State Office of Administrative Hearings (SOAH) on District's proposed rules** (filed August 10, 2017).

VIII Consider and/or act regarding **rules acted on at June 16, 2020 Board meeting and future workshop(s) and/or hearing(s) on proposed rules.**

IX Consider and/or act on **Cockrell's Request for Reconsideration regarding third-party party status concerning Fort Stockton Holdings, L.P.'s (FSH's) Application for Permit Renewal** (filed July 6, 2020).

X Consider and/or act on **Cockrell's Request for Findings and Conclusions regarding FSH's Application for Permit Renewal** (filed July 6, 2020).

XI Briefing and take action as necessary on **Cockrell Investment Partners, L.P. v. Middle Pecos Groundwater Conservation District,** Cause No. P-12176-112-CV (Pecos County District Court).

XII Consider and/or act upon **Order of General Election for November 3, 2020.**

XIII Consider and/or act regarding compliance with and/or exemption from recently adopted **Texas Commission on Environmental Quality rules regarding recycling** and associated statutory requirements.

XIV **Progress Reports: Well Registrations, Production Permits, Drilling Permits, Data Loggers, Drought Monitor Map, Water Quality Analysis and General Manager's Correspondence.**[4]

XV **Directors' Comments**[4] and consider and/or act upon **agenda for next meeting.**

XVI **Adjourn** Board meeting.

[1] The Board may break for lunch and commence or continue the Board meeting and/or hearing immediately after lunch. Requests for accommodations under the ADA/Americans with Disabilities Act must be made 48 hours prior to this meeting by contacting Ty Edwards at 432-336-0698.

[2] The Board will apply new statutory law governing public comment. If more than 5 minutes (cumulative) is requested, there must be good cause in the sole discretion of the Presiding Officer. The Board is not allowed to take action on any subject presented that is not on the agenda, nor is the Board required to provide a response; any substantive consideration and action by the Board will be conducted under a specific item on a future agenda.

[3] Additional more detailed notice of this public hearing required by state law and the District's rules was separately issued by the District.

[4] No action will be taken on these agenda items. These items are on the agenda to provide the District's General Manager and Directors an opportunity to bring to the public's and each other's attention important issues pertinent to groundwater management within the District such that any substantive deliberation and formal action on any of these issues will be conducted under a specific item on a future agenda.

RESOLUTION
OF THE BOARD OF DIRECTORS OF THE MIDDLE PECOS GROUNDWATER CONSERVATION DISTRICT HEARING HELD JULY 14, 2020

A RESOLUTION ADOPTING THE DISTRICT'S MANAGEMENT PLAN

WHEREAS, the Middle Pecos Groundwater Conservation District (the "District") is a political subdivision of the State of Texas organized and existing under and by virtue of Article XVI, Section 59, of the Texas Constitution, and a groundwater conservation district acting under Chapter 36 of the Texas Water Code and the District's enabling act, Texas Special District Local Laws Code Chapter 8851;

WHEREAS, under the direction of the Board of Directors (the "Board"), and in accordance with Section 36.1071, Texas Water Code; Chapter 356, Title 31, Texas Administrative Code; and Section 8 of the District's rules, the District has revised its Management Plan;

WHEREAS, the District held a properly noticed public hearing to receive and consider public comments on the Management Plan for the District at 405 North Spring Drive (District Office), Fort Stockton, Texas on July 14, 2020;

WHEREAS, on June 29, 2020, more than 10 days prior to its July 14th public hearing, the District made its Management Plan available for public review at the District's office and on the District's webpage;

WHEREAS, the District obtained comments from the Texas Water Development Board ("TWDB") through a preliminary review of the District's Management Plan conducted by TWDB staff, and the District has considered and addressed all such comments in the development of its Management Plan;

WHEREAS, the Board received and considered the advice of the District's legal counsel and consultant on the revisions to the District's Management Plan;

WHEREAS, the Board received public comments on the District's Management Plan, considered and reviewed those comments in preparing revisions to its Management Plan, and completed its five-year review;

WHEREAS, the District has coordinated and will continue to coordinate with the appropriate surface water management entities pursuant to Section 36.1071, Texas Water Code; and

WHEREAS, the Board of Directors finds that the Management Plan meets all of the requirements of Chapter 36, Texas Water Code, and Chapter 356, Title 31, Texas Administrative Code.

NOW THEREFORE BE IT RESOLVED THAT:

1. The above recitals are true and correct.

2. The Management Plan is hereby adopted as the groundwater management plan for the District.

3. The District's Board, General Manager, legal counsel and consultant are further authorized to take any and all action necessary to file the adopted Management Plan with TWDB and to coordinate with TWDB as may be required in furtherance of TWDB's approval pursuant to the provisions of Chapter 36 of the Texas Water Code and other applicable law.

AND IT IS SO ORDERED.

Upon motion duly made by Director Ronald Cooper, and seconded by Director M.R. Gonzalez, and upon discussion, the Board voted 10 in favor, Ø opposed, Ø abstained, and 1 absent, and the motion thereby PASSED on this 14th day of July, 2020.

MIDDLE PECOS GROUNDWATER CONSERVATION DISTRICT

By: Jerry McGuairt
Board President

ATTEST:

M R Gonzalez
Board Secretary

Appendix E

Coordination with Surface Water Entities

Bill Hutchison

From: Middle Pecos GCD <mpgcd@mpgcd.org>
Sent: Wednesday, July 15, 2020 9:46 AM
To: PCWID2@hotmail.com; Ronnie Cooper; redbluff@windstream.net; Melissa Mills
Subject: MPGCD 2020 Management Plan
Attachments: MPGCD Notice of Public Hearing on Amendments to Managment Plan 7-14-2020 (1).pdf; 07-14-2020 mgmt plan resol - executed.pdf

By way of this email The Middle Pecos Groundwater Conservation District is notifying you we have adopted our 2020 Management Plan.

A copy of the 2020 MPGCD Management Plan is available here.

PCWID #2
PCWID2@hotmail.com

PCWID#3
ronniec@valornet.com

Red Bluff Water Power Control District
GM: Robin Prutte
432-448-2818
e-mail: redbluff@windstream.net

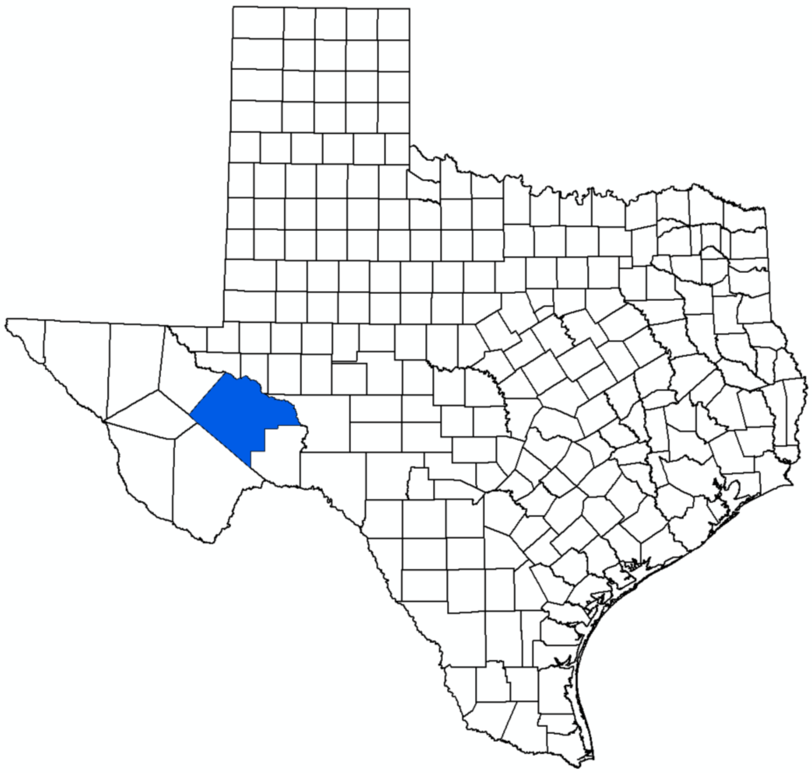
Ty Edwards
General Manager
Middle Pecos GCD
PO Box 1644
405 North Spring Drive
Ft. Stockton Texas 79735
Cell: 432-940-1357
Office: 432-336-0698
www.mpgcd.org

Appendix F

Comparison of Groundwater Elevations and Drawdowns: GAM DFC Simulation and Measured Data from TWDB

Final Report

Comparison of Groundwater Elevations and Drawdowns: GAM DFC Simulation and Measured Data from TWDB



Prepared for:
Middle Pecos Groundwater Conservation District
PO Box 1644
Ft. Stockton, TX 79735
432-336-0698

Prepared by:
William R. Hutchison, Ph.D., P.E., P.G.
Independent Groundwater Consultant
9305 Jamaica Beach
Jamaica Beach, TX 77554
512-745-0599
billhutch@texasgw.com

June 8, 2020

Professional Engineer and Professional Geoscientist Seals

This report was prepared by William R. Hutchison, Ph.D., P.E., P.G., who is licensed in the State of Texas as follows:

- Professional Engineer (Geological and Civil) No. 96287
- Engineering Firm Registration No. 14526
- Professional Geoscientist (Geology) No. 286

STATE OF TEXAS
WILLIAM RAY HUTCHISON
96287
LICENSED
PROFESSIONAL ENGINEER

William R Hutchison
6/8/20

STATE OF TEXAS
WILLIAM R. HUTCHISON
GEOLOGY
286
LICENSED
PROFESSIONAL GEOSCIENTIST

William R Hutchison
6/8/20

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Appendix

1.0 Introduction

One of the required goals (Goal 8) of the Middle Pecos Groundwater Conservation District Management Plan is a how the District addresses the desired future conditions in a quantitative manner. This report:

- Summarizes the available data from the TWDB Groundwater Database
- Describes the analyses that were completed to select monitoring wells for the comparison with the simulations that are the basis for the desired future condition
- Provides a comparison of model simulated groundwater elevations and drawdowns with actual data and provides some context to the results with an analysis of precipitation in the area.

1.1 2020 District Management Plan

The updated 2020 District Management Plan outlines a process where the District downloads groundwater data for Pecos County from the Texas Water Development Board groundwater database and compares the model results on a well-by-well basis for data that are available. As described in the management plan, wells were selected using the following criteria:

1. The well was located within the boundaries of the District
2. The TWDB database included aquifer completion information
3. End-of-the-year groundwater elevation data are available for 2005 which is the starting point of the drawdown calculation of the desired future condition for the Edwards-Trinity (Plateau) and Pecos Valley aquifers.

As developed in this report, data are insufficient to complete this comparison for the Capitan Reef Complex, Dockum, and Rustler aquifers.

1.2 TWDB Database

1.2.1 Groundwater Levels

The groundwater level database for Texas which includes groundwater levels for the major and minor aquifers was downloaded from the TWDB website on May 15, 2020. The files *WaterLevelsMajor.txt* and *WaterLevelsMinor.txt* contain all water level data for Texas. The data for Pecos County were used for this effort.

There was a total of 26,527 groundwater level entries in Pecos County from 564 wells. Of the entries in the database, 25,799 had depth to water data (i.e. 728 had no data entered for a variety of reasons). Of the 25,799 entries that had data, 25,404 from 545 wells were labeled "publishable" (i.e. 395 were labeled "questionable" for a variety of reasons).

The "publishable" data cover the period March 3, 1940 to April 30, 2020. The number of readings in each aquifer (as labeled by TWDB) are as follows:

- Capitan Reef Complex Aquifer: 38
- Dockum Aquifer: 1
- Edwards-Trinity (Plateau) Aquifer: 20,712
- Pecos Valley Aquifer: 4,436
- Rustler Aquifer: 217

The "publishable" groundwater level data were saved in the file *PecosPubWL.xlsx*.

1.2.2 Geographic Coordinates, Well Depths, and Well Use

Geographical coordinates, well depths, and well use for the 545 wells with "publishable" data were extracted from the file *WellMain.txt* from the TWDB groundwater database. These data were combined with the groundwater level data in *PecosPubWL.xlsx* and resulted in adding the well coordinates, depths, and well use to the groundwater level data. These coordinates from the TWDB are expressed in latitude and longitude. The coordinates were converted into x- and y-coordinates (GAM coordinate system) using the commercial software *Surfer*. The results were saved in the file *PecosPubWLCoord.xlsx*.

1.2.3 GAM Row and Column Locations

The x- and y-coordinates of the well locations were used to find the well in terms of the appropriate model grids of the GAMs (Capitan Reef Complex Aquifer, Edwards-Trinity (Plateau)/Pecos Valley aquifers, and Rustler Aquifer). There was only one data point for the Dockum aquifer in the TWDB database and it was taken in 1964 and is not useful for the analysis of comparing simulated drawdowns with actual monitoring data in the context of evaluating consistency with desired future conditions.

FORTRAN programs were written to find the appropriate model grid cell:

- Capitan Reef Complex Aquifer: *capitanrowcol.exe*
- Edwards-Trinity (Plateau) and Pecos Valley aquifers: *etppvrowcol.exe*
- Rustler Aquifer: *rustlerrowcol.exe*

Results were written to the following files:

- Capitan Reef Complex Aquifer: *capitanrowcolwl.dat*
- Edwards-Trinity (Plateau) and Pecos Valley aquifers: *etppvrowcolwl.dat*
- Rustler Aquifer: *rustlerrowcolwl.dat*

1.2.4 End-of-Year Groundwater Elevations

The data files for each aquifer were combined into a file named *allrowcolwl.dat*. A FORTRAN program named *AnnGWData.exe* was written to pick an end-of-year groundwater level that can be used to compare with GAM simulation results. For purposes of this selection, the priority of groundwater levels was as follows:

1. December of the current year
2. January of the next year
3. November of the current year
4. February of the next year

Data from March to October were ignored for purposes of this end-of-year selection. Output from the FORTRAN program includes a file named *annwellcount.dat* that contains the number of annual readings for each well and the earliest and most reading year of data, and a file named *anngwe.dat* that contains the measured end-of-year groundwater elevation. Please note of the 545 wells that had "published" data in the file *allrowcolwl.dat*, only 443 had end-of-year data. The ID number in the first column of *anngwe.dat* was also used to track data in addition to the state well number (as shown in the file *annwellcount.dat*).

1.2.5 Simulated Groundwater Elevations from Groundwater Availability Models

The Capitan Reef Complex Aquifer GAM calibration period was 1931 to 2005 (75 annual stress periods). The predictive scenarios were run for the period 2006 to 2070 (65 annual stress periods). The FORTRAN program *getcaphed.exe* was developed to extract simulated groundwater elevations for both the calibrated model and the simulation that was the basis for the desired future condition (Scenario 4). The simulated groundwater elevations were chosen based on the TWDB groundwater database monitoring points in *anngwe.dat* described in the previous section. Comparisons were limited to the wells identified in the TWDB database as Capitan Reef Complex Aquifer wells. Results were written to the file *caphedcompare.dat.*

The calibration period of the alternative GAM that covers the Edwards-Trinity (Plateau) and Pecos Valley aquifers was 1930 to 2005 (76 annual stress periods). The predictive scenarios were run for the period 2006 to 2070 (65 annual stress periods). The FORTRAN program *getetppvhed.exe* was developed to extract simulated groundwater elevations for both the calibrated model and the simulation that was the basis for the desired future condition (Scenario 2). The simulated groundwater elevations were chosen based on the TWDB groundwater database monitoring points in *anngwe.dat* described in the previous section. Comparisons were limited to wells identified in the TWDB database as Edwards-Trinity (Plateau) or Pecos Valley aquifer wells. Results were written to the file *etppvhedcompare.dat.*

The Rustler Aquifer GAM calibration period was 1918 to 2008 (91 annual stress periods). The predictive scenarios were run for the period 2009 to 2070 (62 annual stress periods). The FORTRAN program *getrustlerhed.exe* was developed to extract simulated groundwater elevations for both the calibrated model and the simulation that was the basis for the desired future condition (Scenario 4). The simulated groundwater elevations were chosen based on the TWDB groundwater database monitoring points in *anngwe.dat* described in the previous section. Comparisons were limited to the wells identified in the TWDB database as Rustler Aquifer wells. Results were written to the file *rustlerhedcompare.dat.*

2.0 Comparison of Measured Data with GAM Results

2.1 Capitan Reef Complex and Rustler Aquifers

The comparison of actual data to GAM results for the Capitan Reef Complex Aquifer yielded only six end-of-year groundwater elevations in five wells have been collected since 2005 (the end of the calibration period of the GAM). The comparison results are contained in the file *caphedcompare.dat*. There is general lack of data and there is a poor match between actual data and GAM results. However, the high pumping anticipated in the predictive run that was the basis for the desired future condition has not started. Thus, any variation in the actual groundwater elevations that may have occurred would be the result of natural variation in recharge and the small amount of pumping from this aquifer. This review suggests that additional monitoring be initiated, or the aquifer should be classified as not relevant for purposes of joint planning. If the aquifer were classified as not relevant for purposes of joint planning, Middle Pecos GCD would still manage groundwater and could still issue permits for production under its rules. However, no desired future condition would be established, no modeled available groundwater would be calculated by TWDB, and groundwater availability for this aquifer would be established by the regional planning group.

The comparison of actual data to GAM results for the Rustler Aquifer yielded only 11 end-of-year groundwater elevations in three wells have been collected since 2009 (the end of the calibration period of the GAM). The comparison results are contained in the file *RustlerHedCompare.xlsx.* There is a general lack of data and there is a poor match between the actual data and GAM results in the one well that has a multi-year record (Well 52-16-202). Actual data from 2010 to 2018 show a decline of about 7 feet. However, the GAM at the location of the well predicts a decline of about 93 feet. This review suggests that additional monitoring be initiated, or the aquifer should be classified as not relevant for purposes of joint planning. If the aquifer were classified as not relevant for purposes of joint planning, Middle Pecos GCD would still manage groundwater and could still issue permits for production under its rules. However, no desired future condition would be established, no modeled available groundwater would be calculated by TWDB, and groundwater availability for this aquifer would be established by the regional planning group.

2.2 Edwards-Trinity (Plateau) and Pecos Valley Aquifers

The comparison of actual data to GAM results for the Edwards-Trinity (Plateau) and Pecos Valley aquifers yielded 3,313 end-of-year groundwater elevations for both the calibration period and predictive period of the GAM runs. These data were further divided into readings through 2005 (calibration period) and after 2005 (predictive period). The file *ETPPVHeadcompare.xlsx* includes a sheet named “All” with all the data, a sheet named “Calibration” that contains 2,395 end-of-year groundwater elevations through 2005, and a sheet named “Prediction” that contains 882 end-of-year groundwater elevations from 2006 to 2019.

2.2.1 Overall Evaluation of Model Calibration

The GAM was calibrated to achieve a reasonable fit throughout the regional aquifer. This analysis involves evaluating the calibration specifically in Pecos County. Model calibration for Pecos County was evaluated graphically and with summary statistics. Figure 1 presents a cross plot of measured groundwater elevations vs. simulated groundwater elevation.

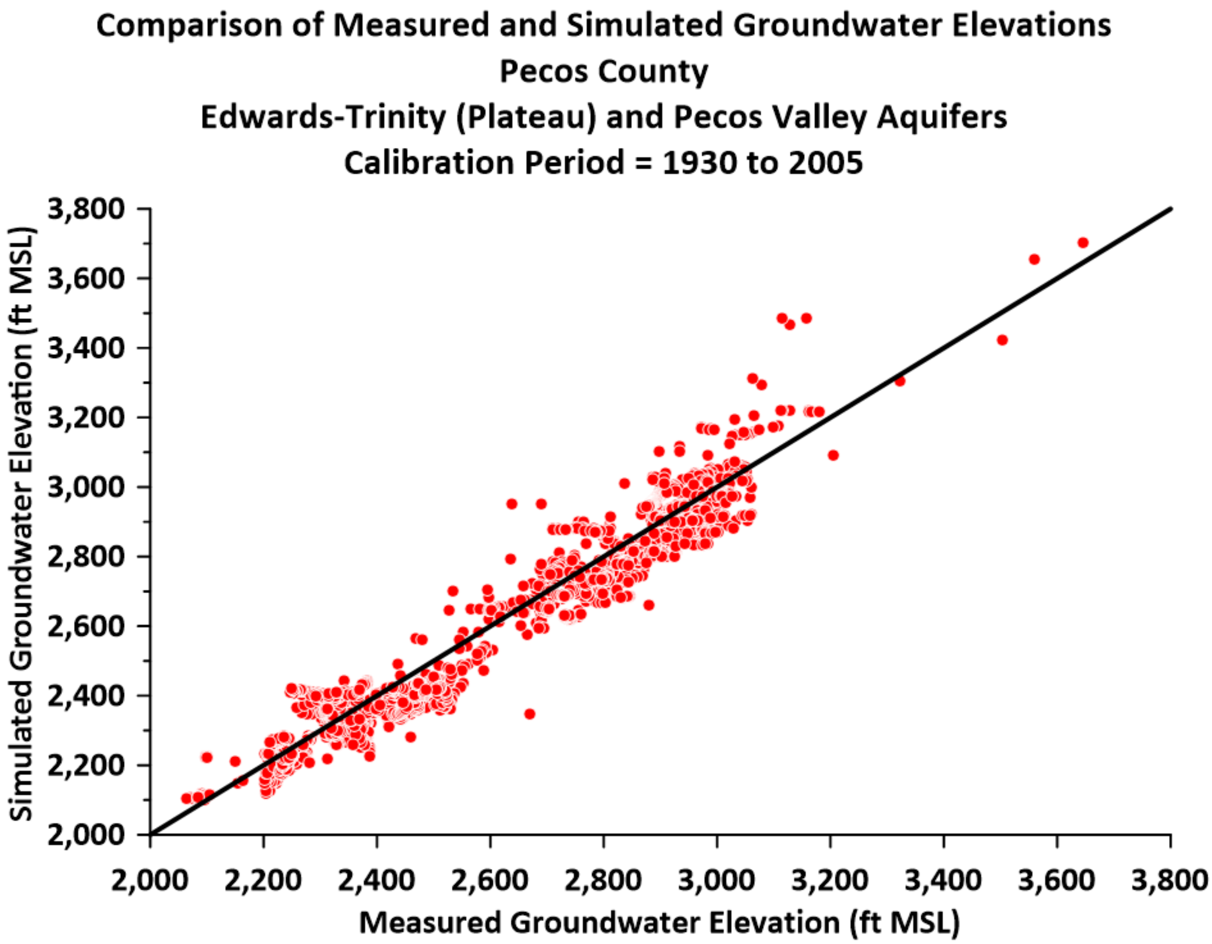


Figure 1. Comparison of Groundwater Elevations - Calibration Period

Each red data point shows the relationship between the measured groundwater elevation and the simulated groundwater elevation. An ideal match lies on the black 1 to 1 line. Points that lie below or to the right of the black line are instances where the simulated groundwater elevation is less than the measured groundwater elevation. Points that lie above or to the left of the black line are instances where the simulated groundwater elevation is higher than the measured groundwater elevation.

Table 1 summarizes the calibration statistics in Pecos County. The residual is calculated as the measured groundwater elevation minus the simulated groundwater elevation. The mean of the residual (23.20 feet), therefore, reflects that the average simulated groundwater elevation is 23.20 feet below the average measured groundwater elevation. A measure to assess the overall calibration is the scaled residual standard deviation (the residual standard deviation divided by the range in measurements). Typically, a value of less than 0.1 is considered acceptable. Please note that the calculated value for this analysis is 0.04.

Table 1. Pecos County Calibration Statistics

Statistic	Value
Residual Mean	23.20
Absolute Residual Mean	55.25
Residual Standard Deviation	64.21
Sum of Squared Residuals	11,160,002
Root Mean Square Error	68.26
Minimum Residual	-372.34
Maximum Residual	323.05
Number of Observations	2,395
Range in Observations	1,581.77
Scaled Residual Standard Deviation	0.0406
Scaled Absolute Residual Mean	0.0349
Scaled Root Mean Square Error	0.0432
Scaled Residual Mean	0.0147

Based on this analysis, the calibration is considered generally acceptable, but with some limitations due to the relatively large residual mean and root mean square error. Limitations to the calibration were considered when evaluating the comparison of the predictive simulation (i.e. the basis for the desired future condition) and actual monitoring data from 2006 to present.

2.2.2 Overall Comparison of Predictive Simulation

A cross plot of the overall comparison between measured groundwater elevations in Pecos County from 2006 to 2019 vs. simulated groundwater elevation at each point for the same period under the predictive simulation that was the basis for the desired future condition is presented in Figure 2. The associated statistics of this comparison are presented in Table 2.

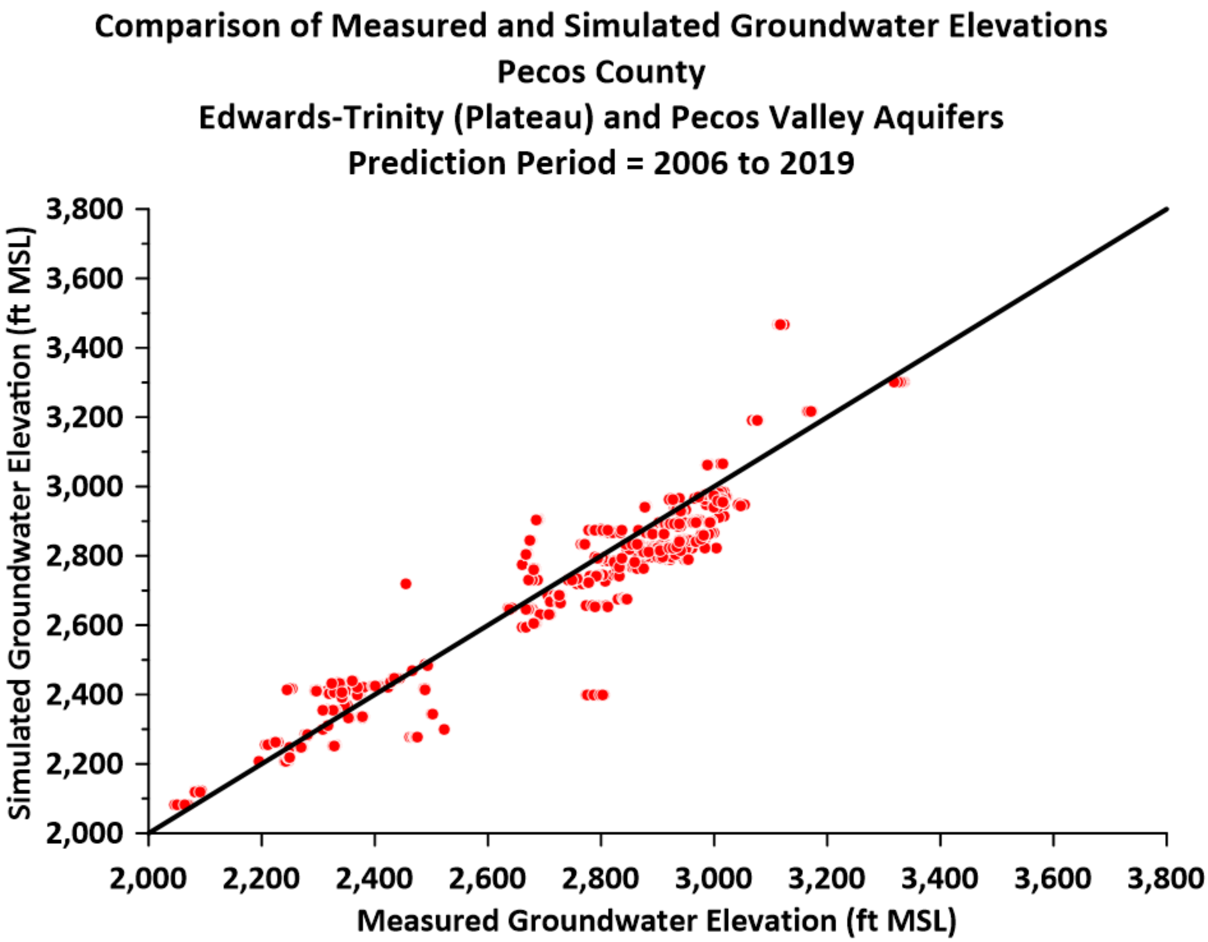


Figure 2. Comparison of Groundwater Elevations - Predictive Period

The predictive simulation assumed average rainfall and recharge conditions for each year from 2006 to 2070. Therefore, the only variation in simulated groundwater elevations is due to changes in groundwater pumping. However, the variation in measured groundwater elevations is due to a combination of changes in pumping and variations in rainfall and recharge. Thus, a more detailed comparison between measured groundwater elevations and simulated groundwater elevations is necessary as described below.

Table 2. Pecos County Predictive Simulation Comparison Statistics

Statistic	Value
Residual Mean	15.40
Absolute Residual Mean	71.00
Residual Standard Deviation	96.08
Sum of Squared Residuals	8,342,707
Root Mean Square Error	97.26
Minimum Residual	-354.28
Maximum Residual	405.97
Number of Observations	882
Range in Observations	1,289.82
Scaled Residual Standard Deviation	0.0745
Scaled Absolute Residual Mean	0.0550
Scaled Root Mean Square Error	0.0754
Scaled Residual Mean	0.0119

3.0 Drawdown Comparison

3.1 Well Selection

The desired future condition for the Edwards-Trinity (Plateau) and Pecos Valley aquifers as adopted by the groundwater conservation districts of Groundwater Management Area 7 for Pecos County is average drawdown not to exceed 14 feet from 2010 to 2070. This average drawdown was calculated based on a model run that was completed from 2006 to 2070 since the calibration period ended in 2005.

Inspection of the available measured data in 2005 yields 28 wells with a measured groundwater elevation at the end of 2005. The inspection also yields that there were 15 wells with end-of-year measurements in 2010. Thus, comparison of the predictive run using 2005 as a basis for the comparison will yield almost twice the number of the comparisons as a comparison based on 2010. As a result of the more comprehensive comparison, all drawdown calculations and comparisons will be based on 2005 measurements as a starting point.

The 28 wells with data in 2005 are summarized in Table 3 and the locations of these wells are presented in Figure 3.

Table 3. Summary of 28 Wells Used in Comparison

Well ID	State Well Number	Aquifer	GAM Row	GAM Column	2005 End-of-Year Measured Groundwater Elevation (ft MSL)
102	4562402	ETP	169	141	2,459.00
103	4562901	PV	167	148	2,249.70
105	4563701	ETP	166	150	2,244.74
113	4648604	PV	182	100	2,249.51
114	4648801	PV	184	101	2,327.96
127	4656306	ETP	184	105	2,369.81
130	4656401	PV	191	102	2,486.30
167	5206501	ETP	212	104	2,874.43
180	5207302	ETP	203	110	2,795.13
184	5207502	ETP	207	110	2,872.89
190	5207901	ETP	208	114	2,943.59
196	5208302	ETP	199	116	2,875.00
199	5208801	ETP	205	118	2,955.50
226	5216302	ETP	205	121	2,997.89
239	5216505	PV	207	120	3,015.00
252	5216802	ETP	209	123	3,027.20
263	5221301	ETP	226	109	3,179.15
320	5301707	ETP	200	120	2,942.92
326	5301902	ETP	197	126	2,924.36
360	5302708	ETP	197	128	2,889.32
370	5303901	ETP	189	137	2,730.61
385	5306501	ETP	173	149	2,311.42
399	5307202	ETP	166	153	2,268.60
400	5307203	ETP	166	154	2,211.60
421	5309105	ETP	204	122	2,979.63
425	5309301	ETP	200	127	2,923.96
430	5309306	ETP	198	126	2,927.00
448	5312702	ETP	192	144	2,757.00

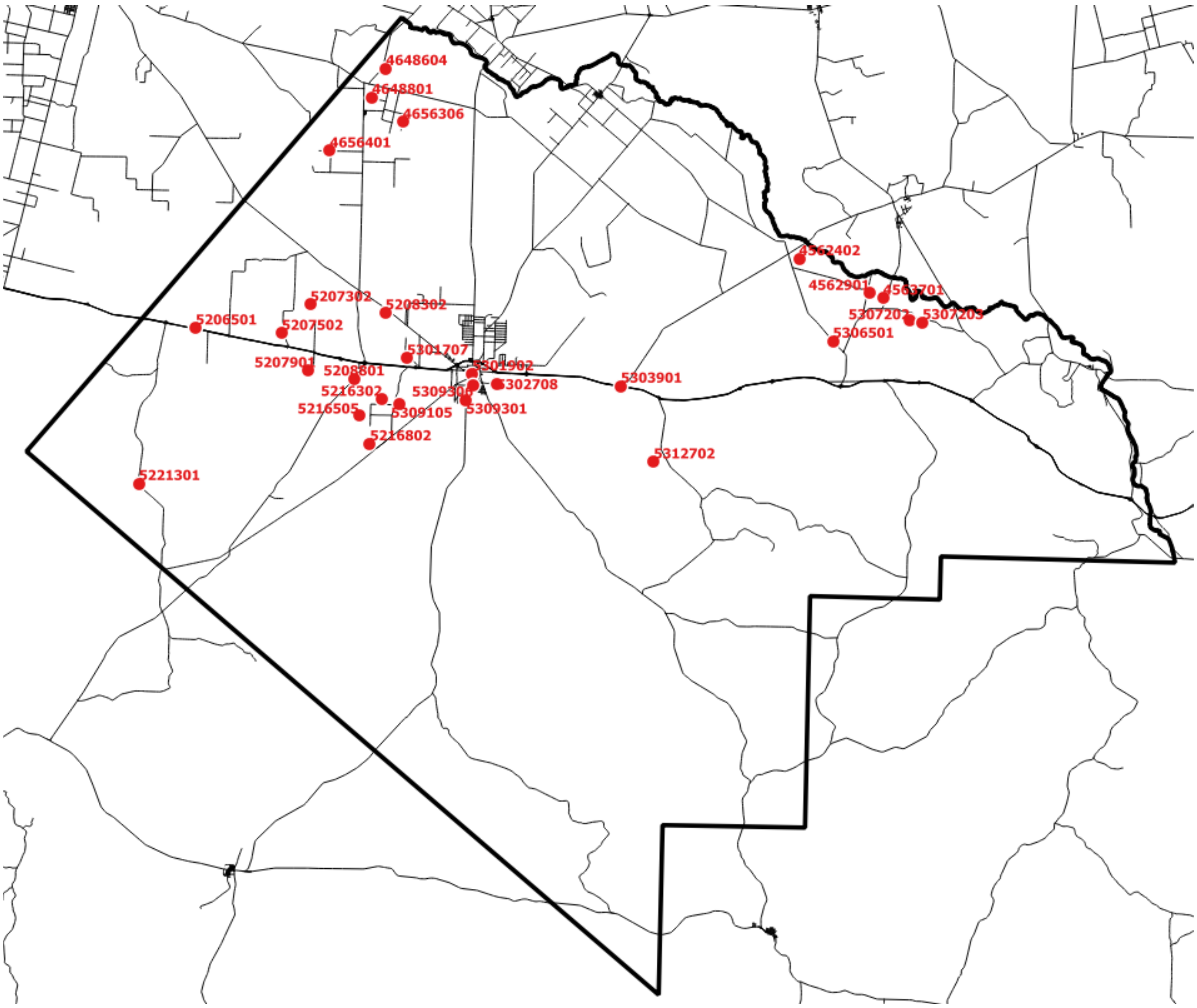


Figure 3. Location of Edwards-Trinity (Plateau) and Pecos Valley Aquifer Wells with 2005 Data

3.2 Drawdown Calculation

The FORTRAN program *getDFCdd.exe* was written to complete the drawdown calculations. The program reads the binary output files of the calibrated model (*etppv4.hds*) and the predictive run (*pred.hds*). The program then reads the list of the 28 wells used for the analysis (*2005ActGWE.csv*) that includes the id number, the state well number, the aquifer designation, the model row and column, the actual measured groundwater elevation at the end of 2005 and the simulated groundwater elevation at the end of 2005 from the calibrated model.

The file with the actual data for all wells (*etppvhedcompare.dat*) is read. Actual drawdown for the 28 wells is then calculated as the groundwater elevation in 2005 minus the actual groundwater elevation of the data point for each well. Simulated drawdown is calculated for the 28 wells.

Two output files are written, one with a summary of all drawdown comparisons (a total of 910), and two files are written for each of the 28 wells: one file with actual drawdown and one file with simulated drawdown. The individual files were used to construct hydrographs of drawdown that are presented in Appendix A.

The 910 drawdown comparisons were saved as an Excel spreadsheet (*PrePost2005Compare.xlsx*). The tab labeled "All" contains all 910 comparisons. The tab labeled "Pre2005" contains 640 comparisons before 2005 (1946 to 2004). These are useful to assess the calibration of the model in terms of drawdown. The tab labeled "Post2005" contains 242 comparisons after 2005 (2006 to 2019).

A summary tab is included as is reproduced as Table 4, which includes the number of wells for each year of the comparison, the average measured drawdown, and the average simulated drawdown from those wells with measured data. Please note that 2019 only had a single measured drawdown. The average drawdown data from 2006 to 2018 are presented in Figure 4. Each measured drawdown point in Figure 4 includes the annual precipitation in inches during that year. Average rainfall was 13.48 inches from 1940 to 2019.

Table 4. Summary of Average Drawdown 2006 to 2019

Year	Number of Wells	Average Measured Drawdown (ft from 2005)	Average Simulated Drawdown (ft from 2005)
2006	17	1.47	2.20
2007	17	0.23	3.72
2008	14	5.52	4.04
2009	21	0.55	4.76
2010	15	4.49	5.40
2011	19	10.85	5.68
2012	21	12.51	6.06
2013	21	17.87	6.55
2014	21	13.78	7.02
2015	21	3.68	7.49
2016	21	4.24	7.94
2017	16	6.18	8.90
2018	17	2.78	9.31
2019	1	13.11	17.07

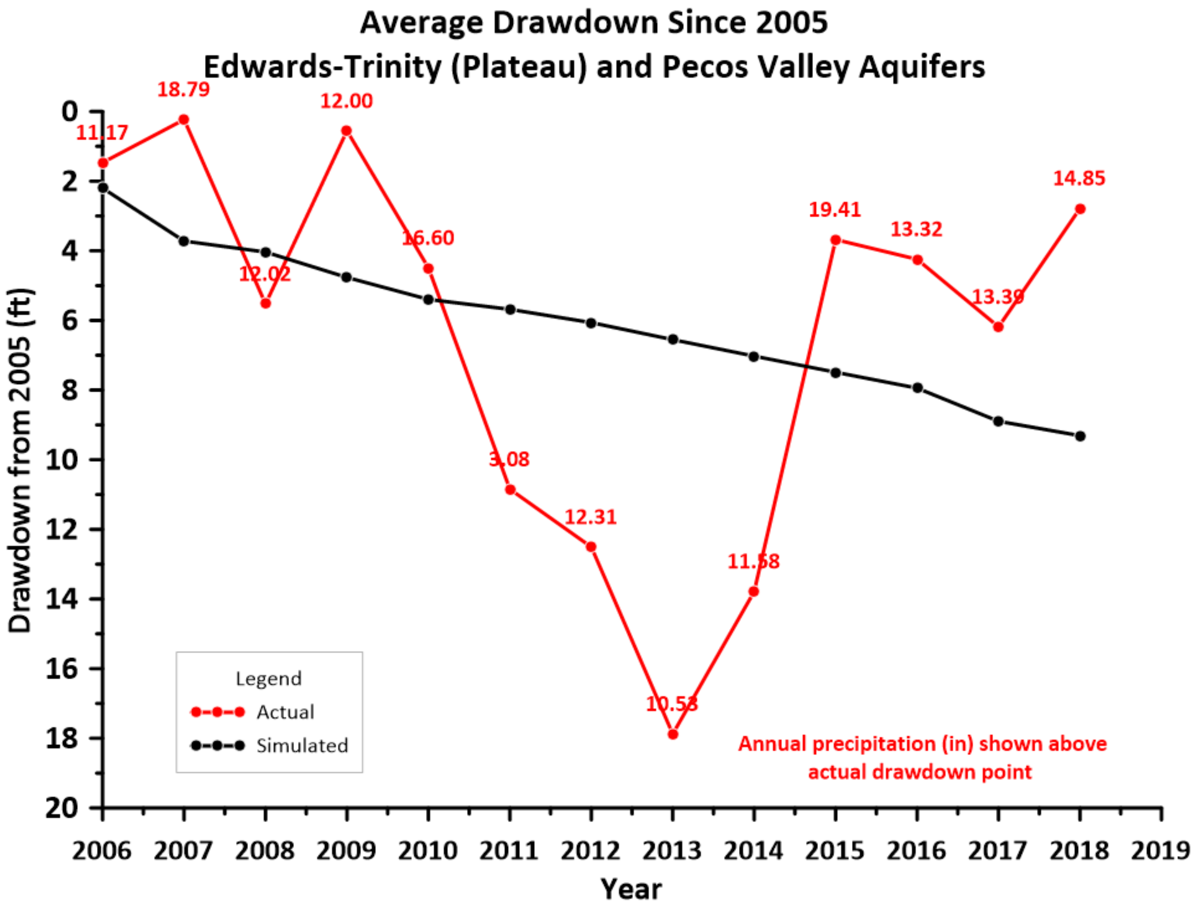


Figure 4. Average Drawdown (2005 to 2018)

Please note that the simulated drawdown is declining from 2006 to 2018 with only slight variations from a linear trend. The linear trend is expected because the simulation assumed constant and average rainfall and recharge conditions. The slight variation is expected because the specific wells used in the calculation change from year to year depending on data availability (i.e. not all wells have an end-of-year groundwater elevation measurement).

The actual drawdown, in contrast, exhibits larger variation than the simulated drawdown. To further assess the variation in the actual drawdown, an analysis of rainfall in the region was completed.

4.0 Precipitation Evaluation

Precipitation data were downloaded from the TWDB website (*https://waterdatafortexas.org/lake-evaporation-rainfall*). As seen in Figure 6, Pecos County is in parts of four quadrangles (604, 605, 704,and 705).

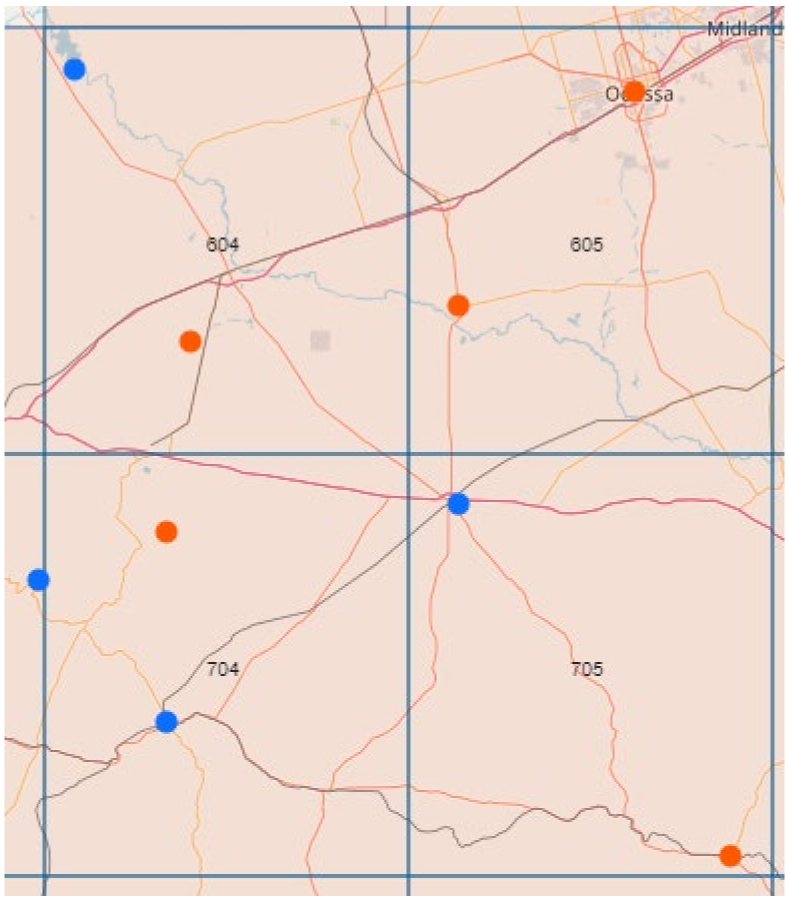


Figure 5. Location of Precipitation Quads

3.1 Annual Precipitation

The available data for the four quadrangles include monthly totals of precipitation from 1940 to 2019. These data were saved to the file *PecosPrecip.xlsx* in the tab labeled "All". The monthly data were averaged across all four quadrangles, the annual totals for each year were summed and presented in Column J. The annual rainfall was also expressed in terms of a percent average for the entire period in Column K. Average rainfall from 1940 to 2019 was 13.48 inches. Annual departures from the average are presented in Column L, and the cumulative departures from the average are presented in Column M. The pertinent data for the years of interest (2006 to 2019) are summarized in Table 6.

Table 5. Precipitation (in/yr) for Quadrangles 604, 605, 704, and 705: 2006 to 2019

Year	Annual Precipitation (in)	Annual Precipitation (% of Average)	Annual Departure from Average (in)	Cumulative Departure from Average Since 1940 (in)
2006	11.17	82.82	-2.32	3.08
2007	18.79	139.38	5.31	8.39
2008	12.02	89.17	-1.46	6.93
2009	12.00	89.00	-1.48	5.45
2010	16.60	123.13	3.12	8.57
2011	3.08	22.86	-10.40	-1.83
2012	12.32	91.34	-1.17	-3.00
2013	10.53	78.08	-2.96	-5.96
2014	11.58	85.90	-1.90	-7.86
2015	19.41	143.97	5.93	-1.93
2016	13.32	98.79	-0.16	-2.09
2017	13.39	99.33	-0.09	-2.18
2018	14.85	110.12	1.36	-0.82
2019	14.30	106.06	0.82	0.00

The annual totals for the average of the four Quadrangles for all years were plotted and are presented in Figure 6. The plot shows the significance of 2011 in the context of the entire record as the driest year.

Although 2011 was the driest year in the record (3.08 in), it must be placed in context of persistent periods of less than average precipitation as shown in Figure 7, the dry period around 2010 was about the same as the dry period in the early 2000s. However, a persistent dry period started in the 1950s and extended through the late 1970s when a series of wet years were observed. The driest period coincides with the period of lowest recorded groundwater elevations in the 1970s, which appear to be due to a combination of high groundwater pumping and persistent drought conditions.

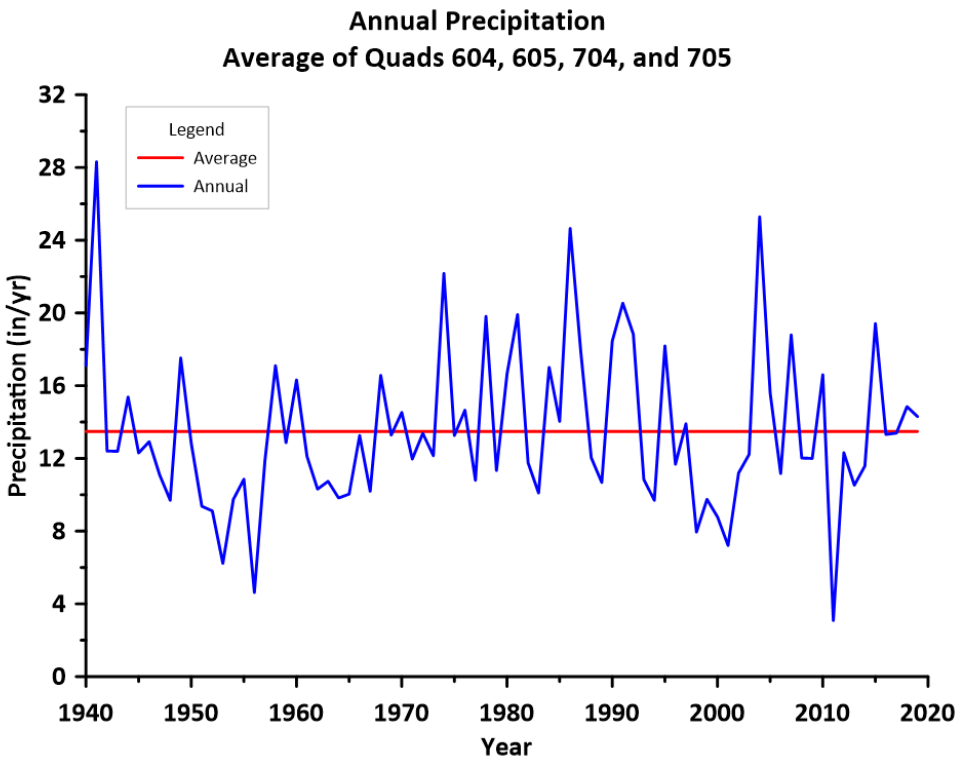


Figure 6. Annual Precipitation in Pecos County Area

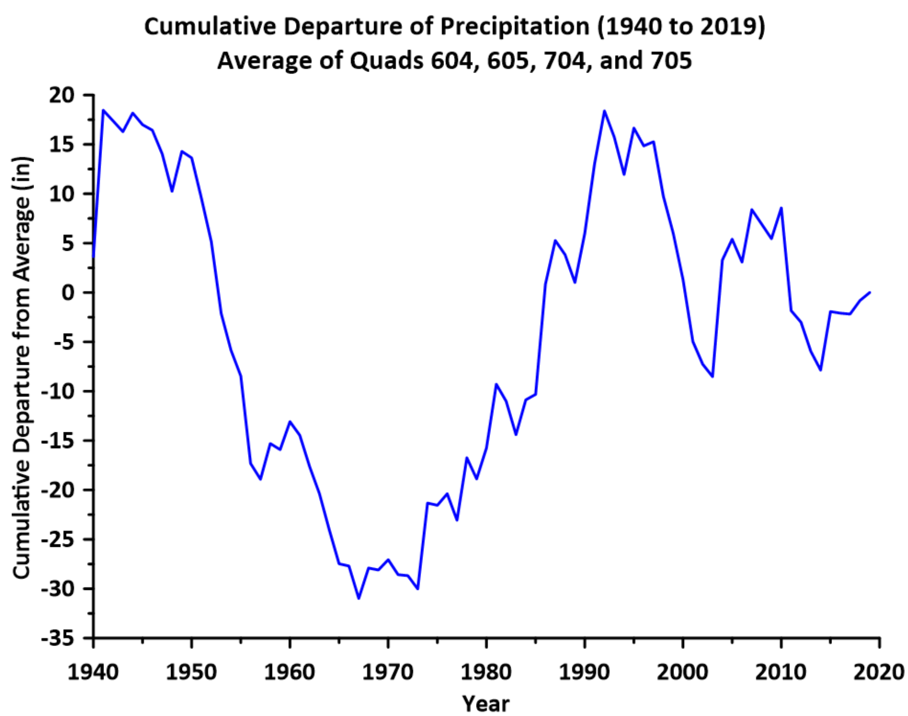


Figure 7. Cumulative Departure from Average Precipitation

Figure 8 presents a plot of annual precipitation vs. measured drawdown, along with the best-fit line based on a linear regression. Please note that the year is also shown on each data point. As expected, the higher the rainfall, the lower the drawdown. However, the plot shows considerable scatter. The 95% confidence of the linear regression is also shown.

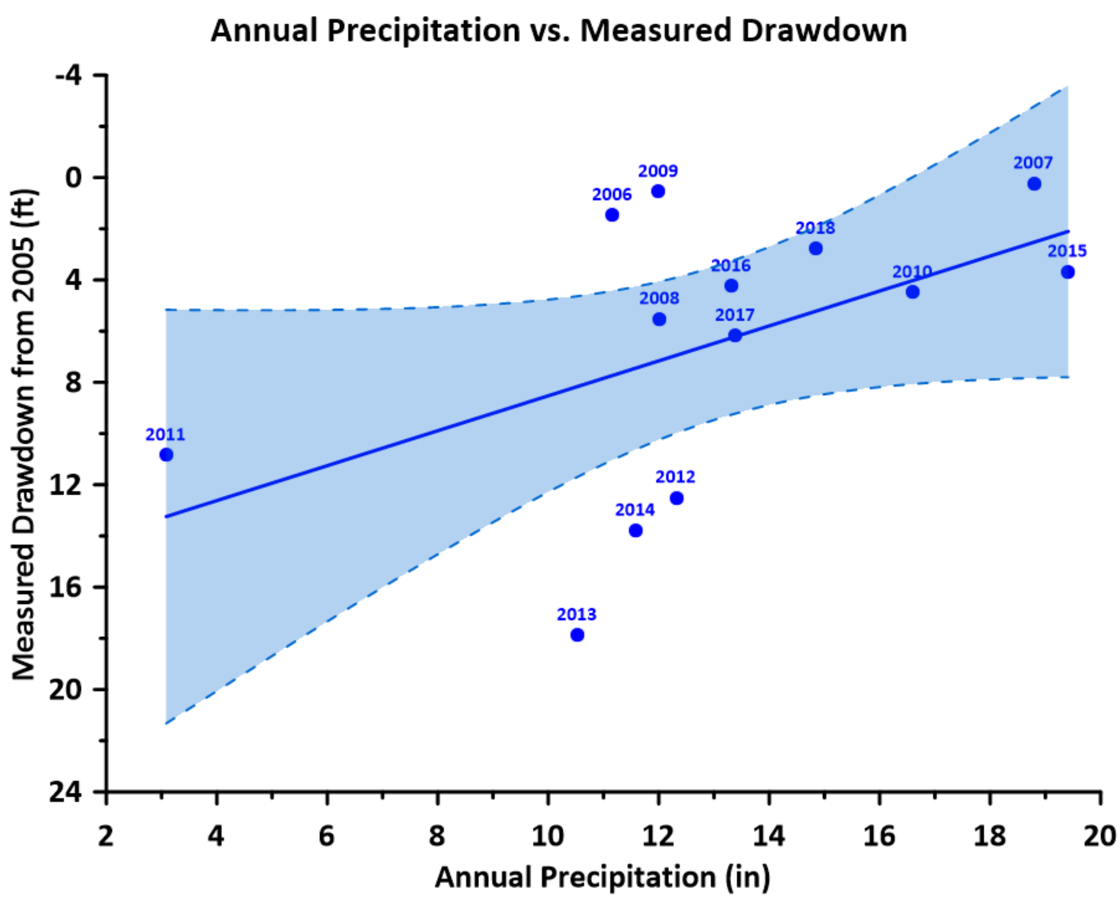


Figure 8. Annual Precipitation vs. Measured Drawdown

5.0 Discussion and Recommendations

The TWDB database was sampled to find wells with groundwater elevation measurements in Pecos County.

The analysis showed that the TWDB database did not have sufficient groundwater elevation data to complete a comparison with simulated drawdowns for the Capitan Reef Complex, Dockum, and Rustler aquifers. It is recommended that monitoring of wells completed in these aquifers be identified and data collection from these wells improved, or the aquifers be classified as not relevant for purposes of joint planning. Such a classification would result in no desired future condition for that aquifer in Pecos County and would result in no modeled available groundwater calculation by the Texas Water Development Board. The Regional Planning Group (Region F) would be responsible for establishing groundwater availability if an aquifer is classified as not relevant for purposes of joint planning.

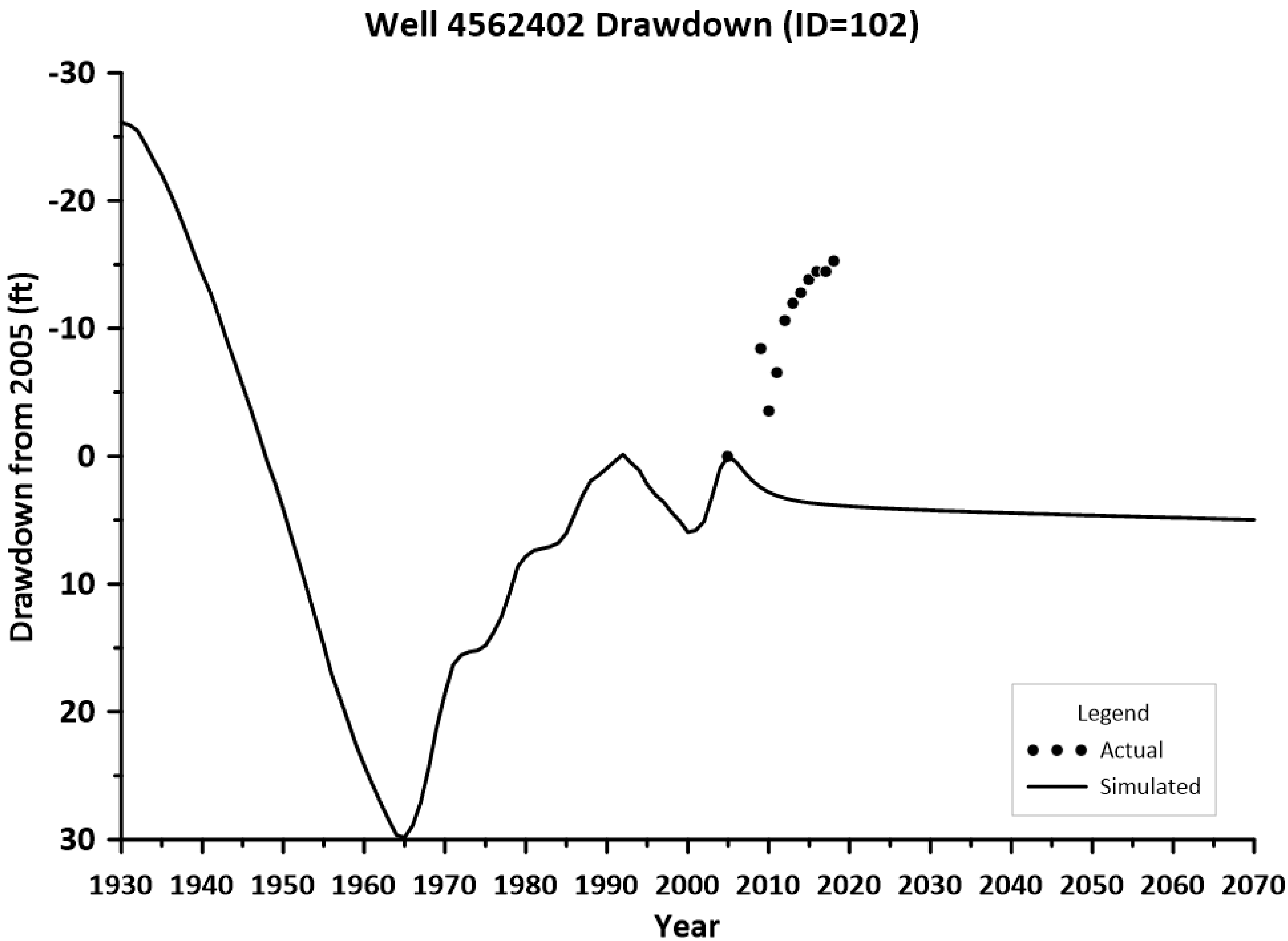
The analysis showed that the TWDB database had sufficient groundwater elevation data to complete a comparison with simulated drawdown for the Edwards-Trinity (Plateau) and Pecos Valley aquifers. The database was sampled to find wells in Pecos County with groundwater elevation measurements in 2005 to compare with simulated drawdowns from the GAM simulation that was the basis for the desired future condition.

The comparison of measured drawdowns with simulated drawdowns showed that, in general, when annual precipitation is higher than average, measured drawdown is less than simulated drawdown and when annual precipitation is less than average, measured drawdown is higher than simulated drawdown. In general, lower than average precipitation correlates with lower than average recharge and higher than average pumping. However, this relationship is complex and other factors are important. This analysis shows a weak correlation between annual precipitation and measured drawdown, but the analysis also shows that the measured drawdowns are consistent with the simulation that was the basis for the desired future condition.

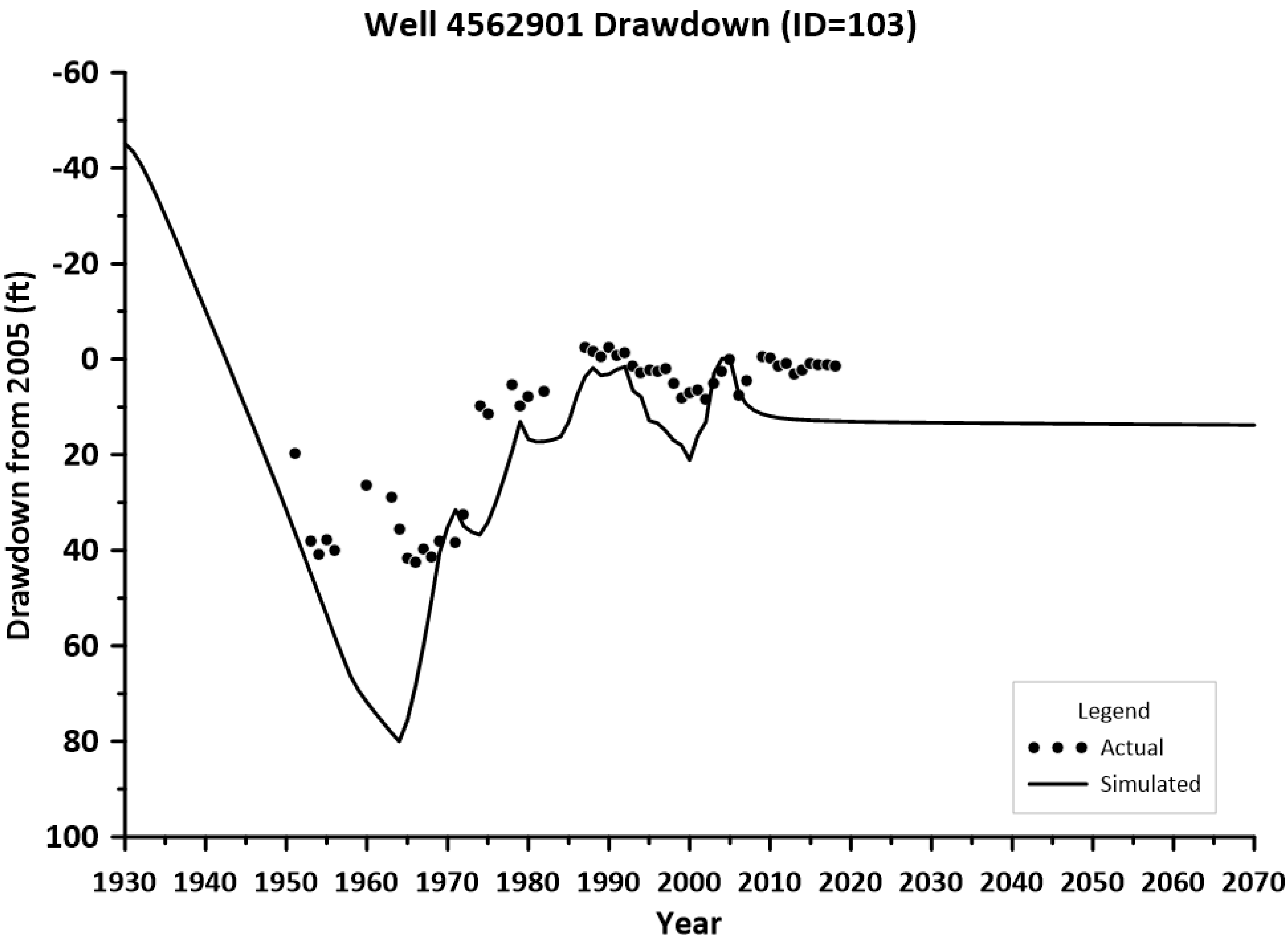
Based on this analysis, it is recommended that the approach used in this analysis should be incorporated into the Middle Pecos GCD management plan to specifically address Goal 8. The current plan also has other elements related to monitoring that are valid and important for other specific groundwater management activities within the District. The comparison of measured data with the desired future condition is a specific activity related to advancing the planning goals of Groundwater Management Areas 3 and 7 and are not necessarily the same as the management activities of other monitoring.

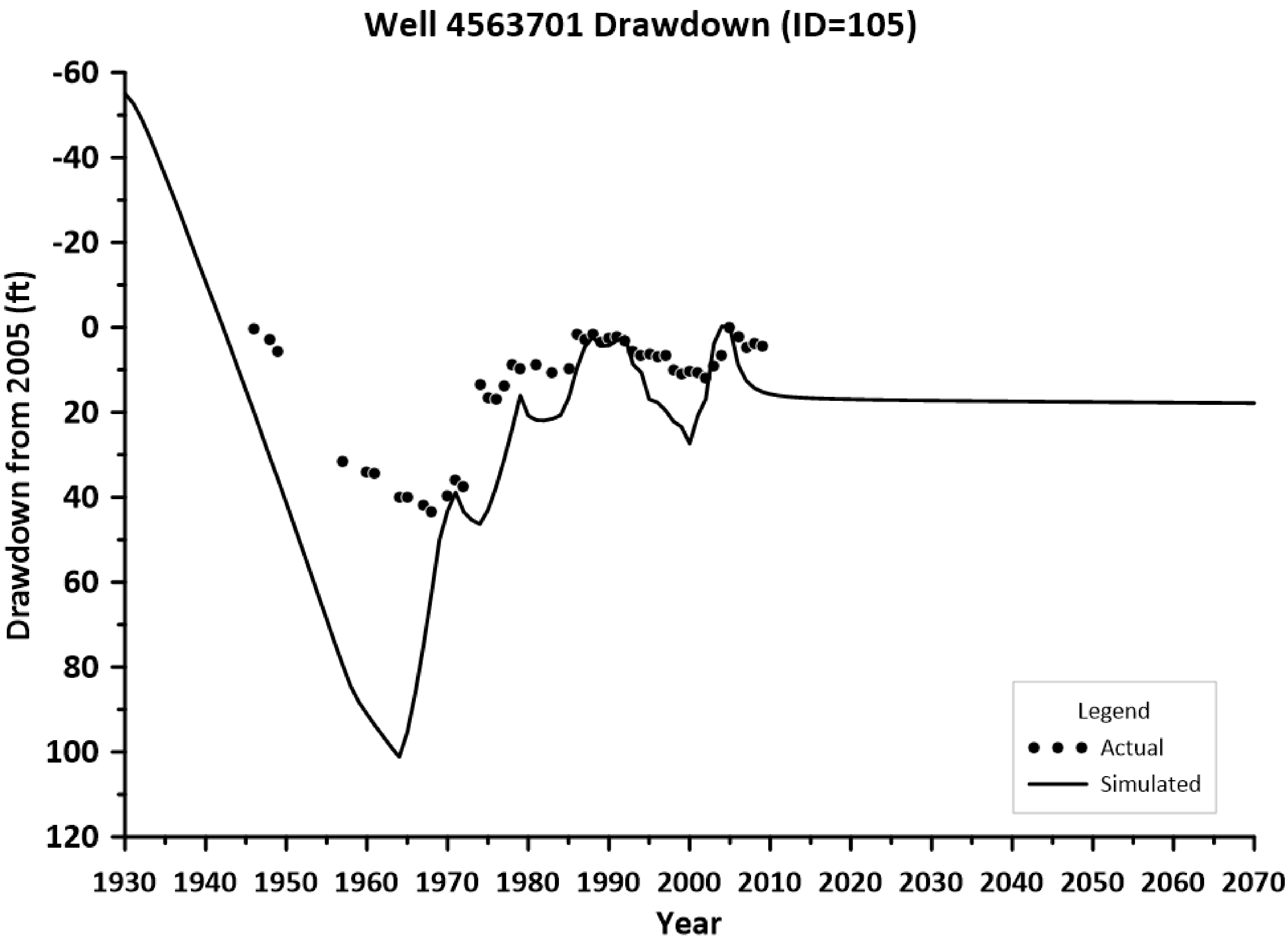
Appendix A

Hydrographs for 28 Monitoring Wells

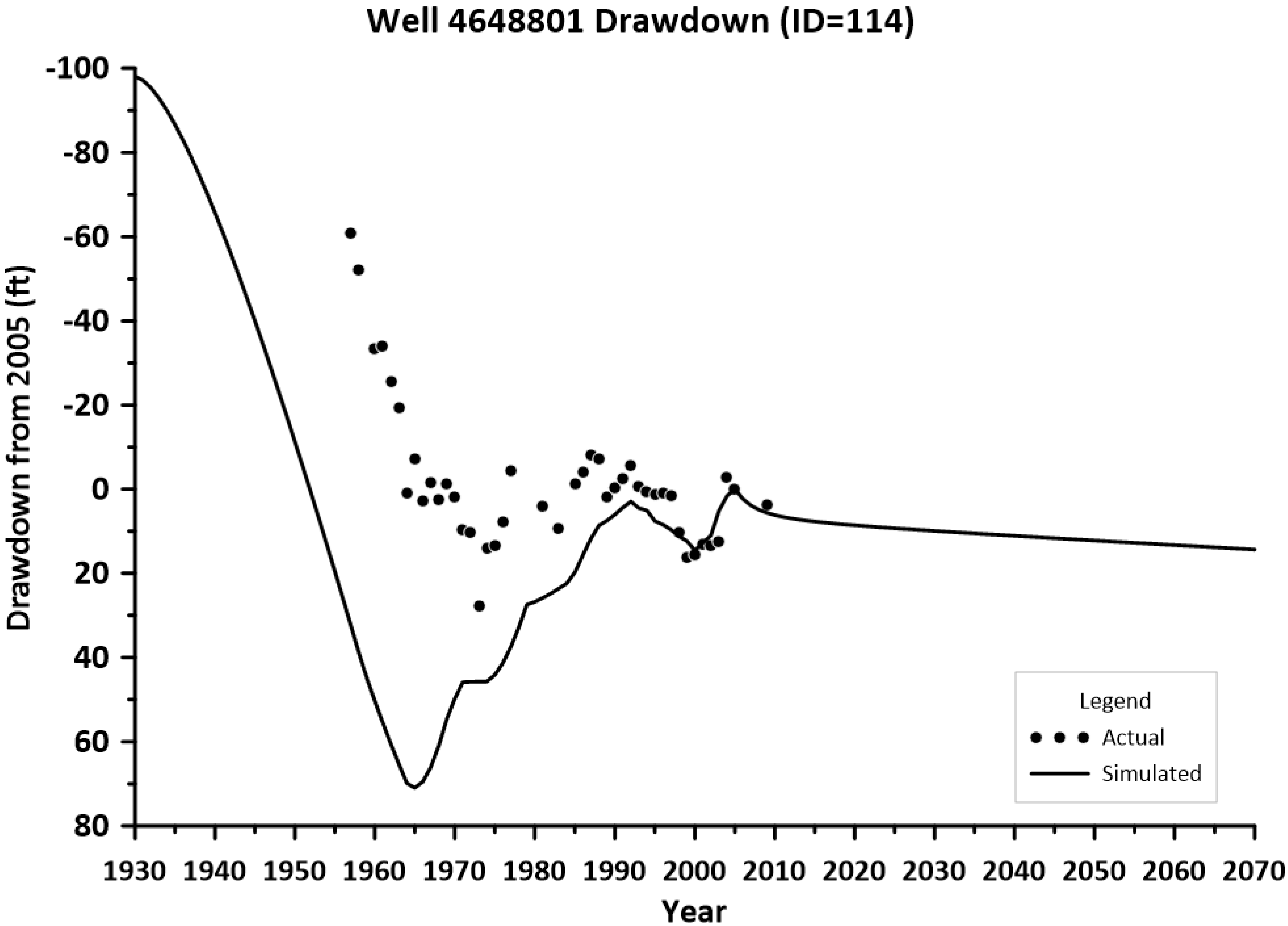


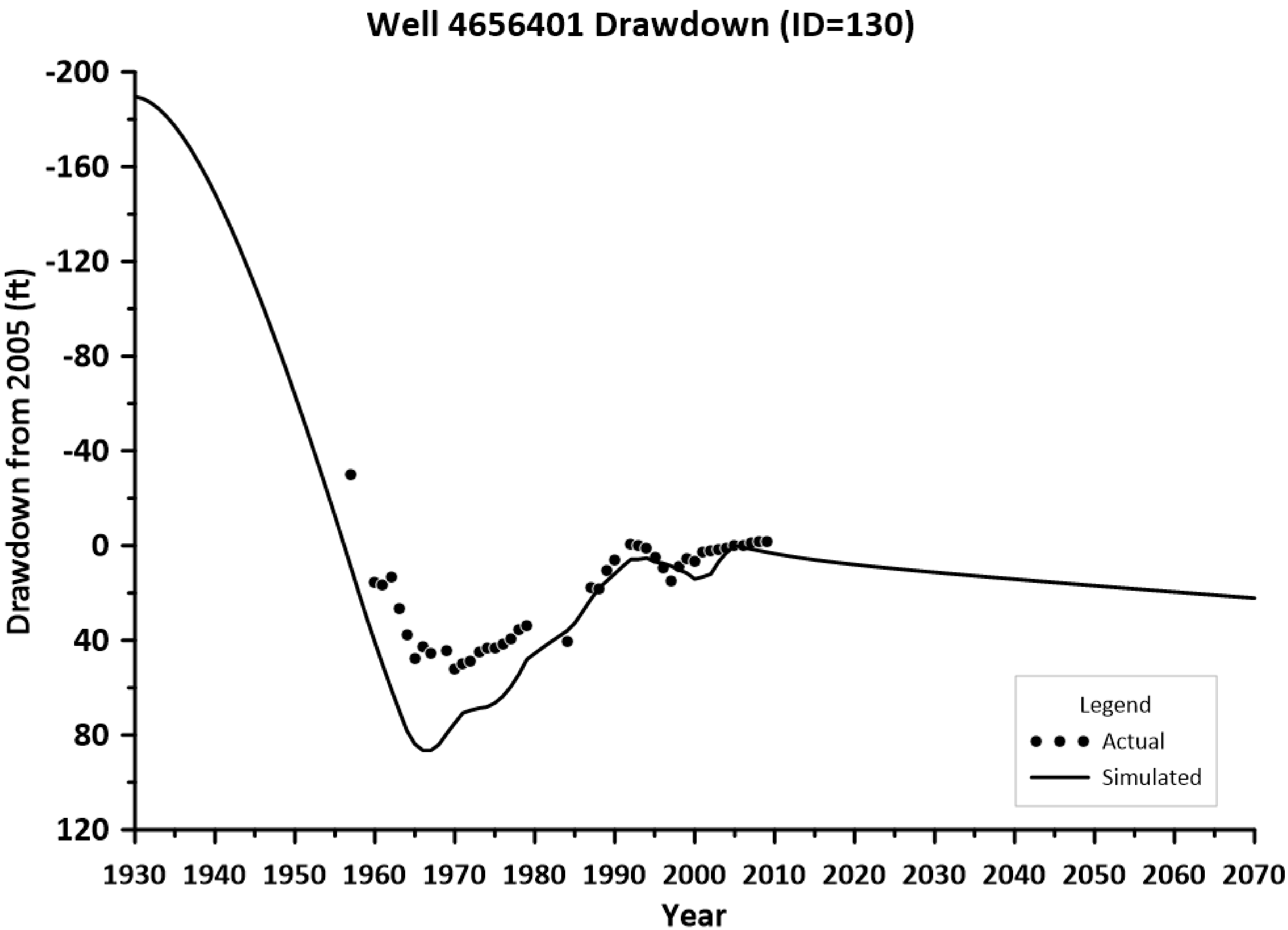
Well 4562402 Drawdown (ID=102)
Drawdown from 2005 (ft)
-30
-20
-10
0
10
20
30
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Year
Legend
Actual
Simulated


Well 4562901 Drawdown (ID=103)
-60
-40
-20
0
20
40
60
80
100
Drawdown from 2005 (ft)
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Year
Legend
Actual
Simulated

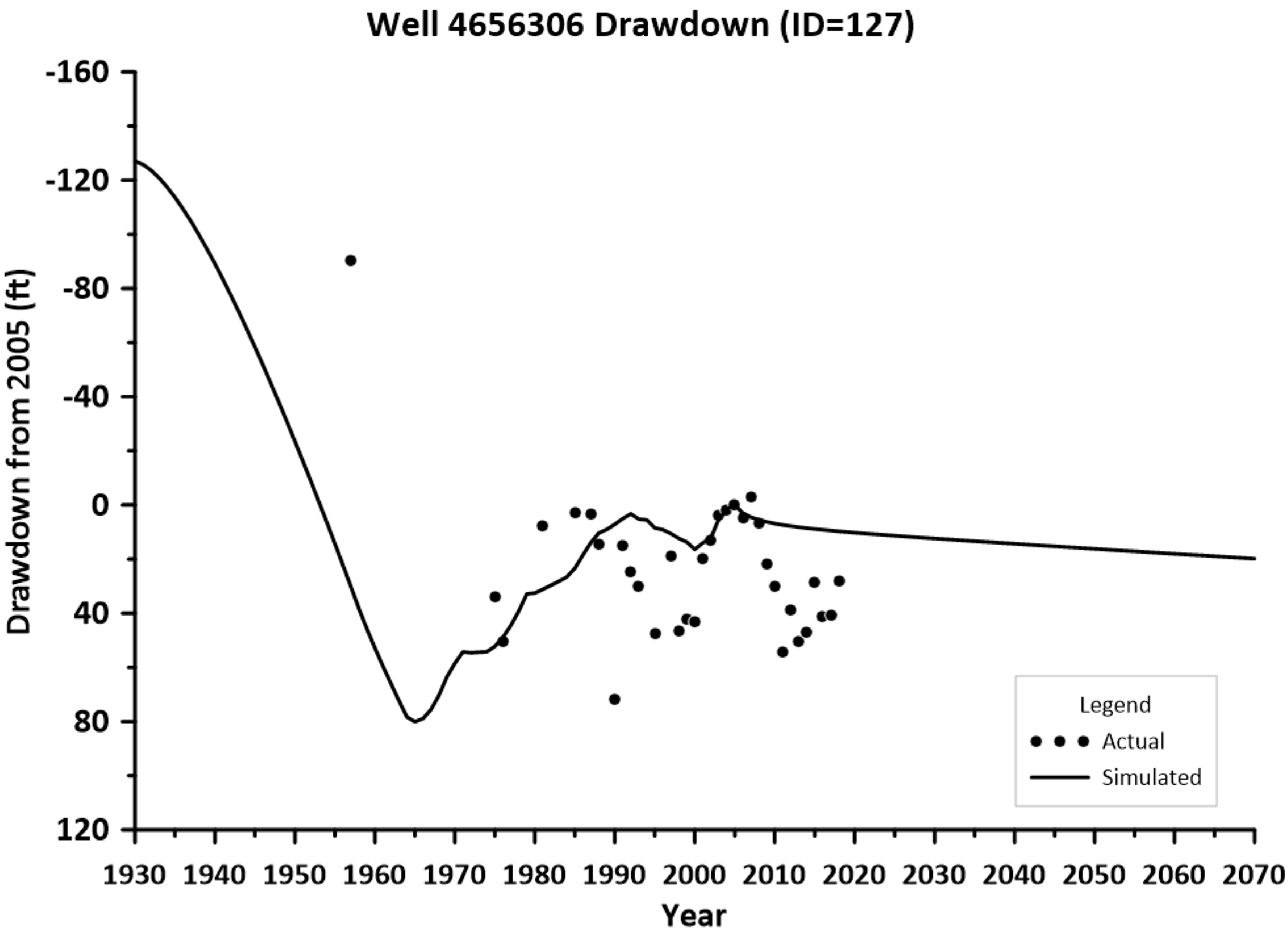


Well 4563701 Drawdown (ID=105)
-60
-40
-20
0
20
40
60
80
100
120
Drawdown from 2005 (ft)
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Year
Legend
Actual
Simulated

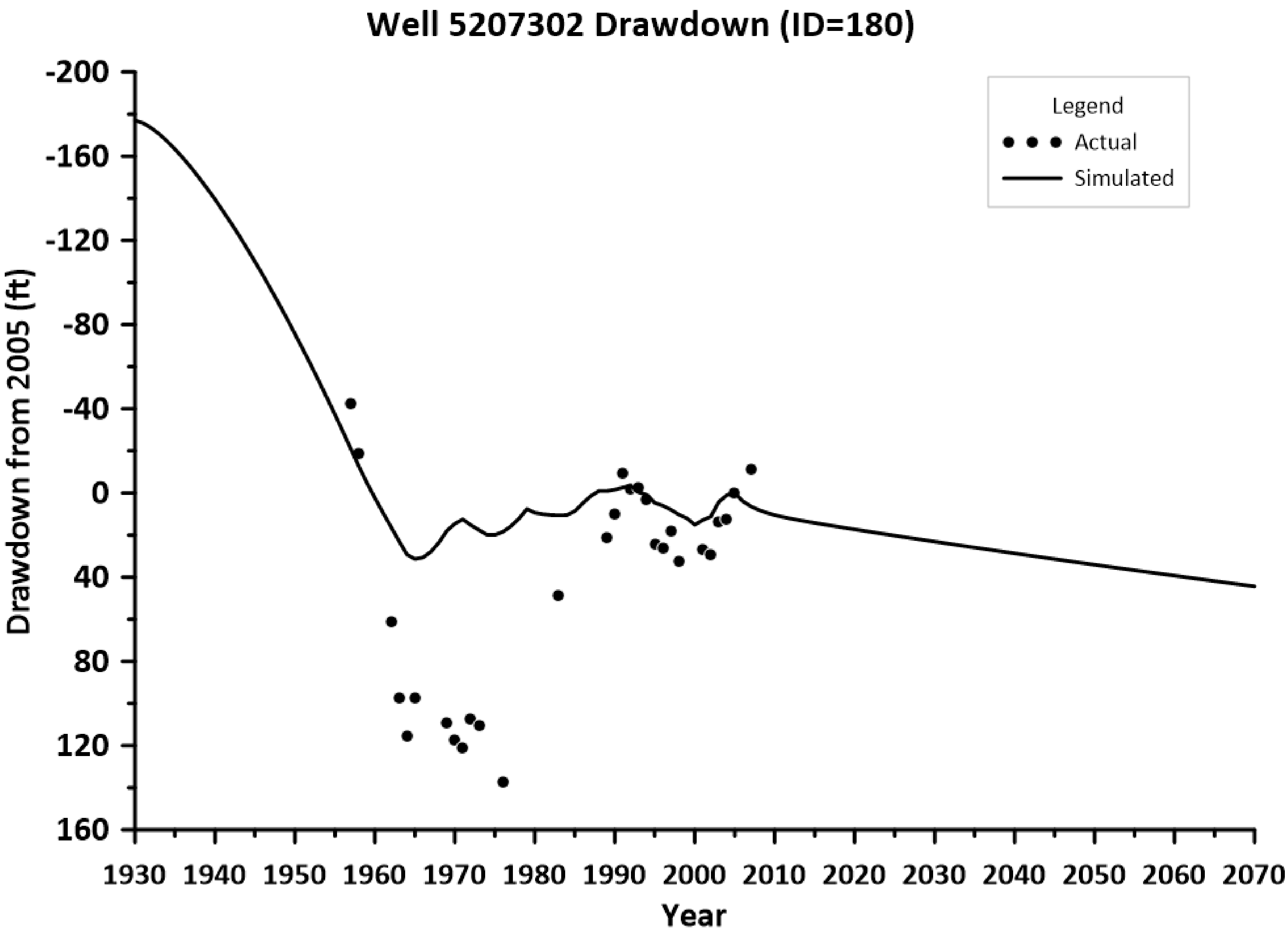

Well 4648801 Drawdown (ID=114)
Drawdown from 2005 (ft)
-100
-80
-60
-40
-20
0
20
40
60
80
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Year
Legend
Actual
Simulated



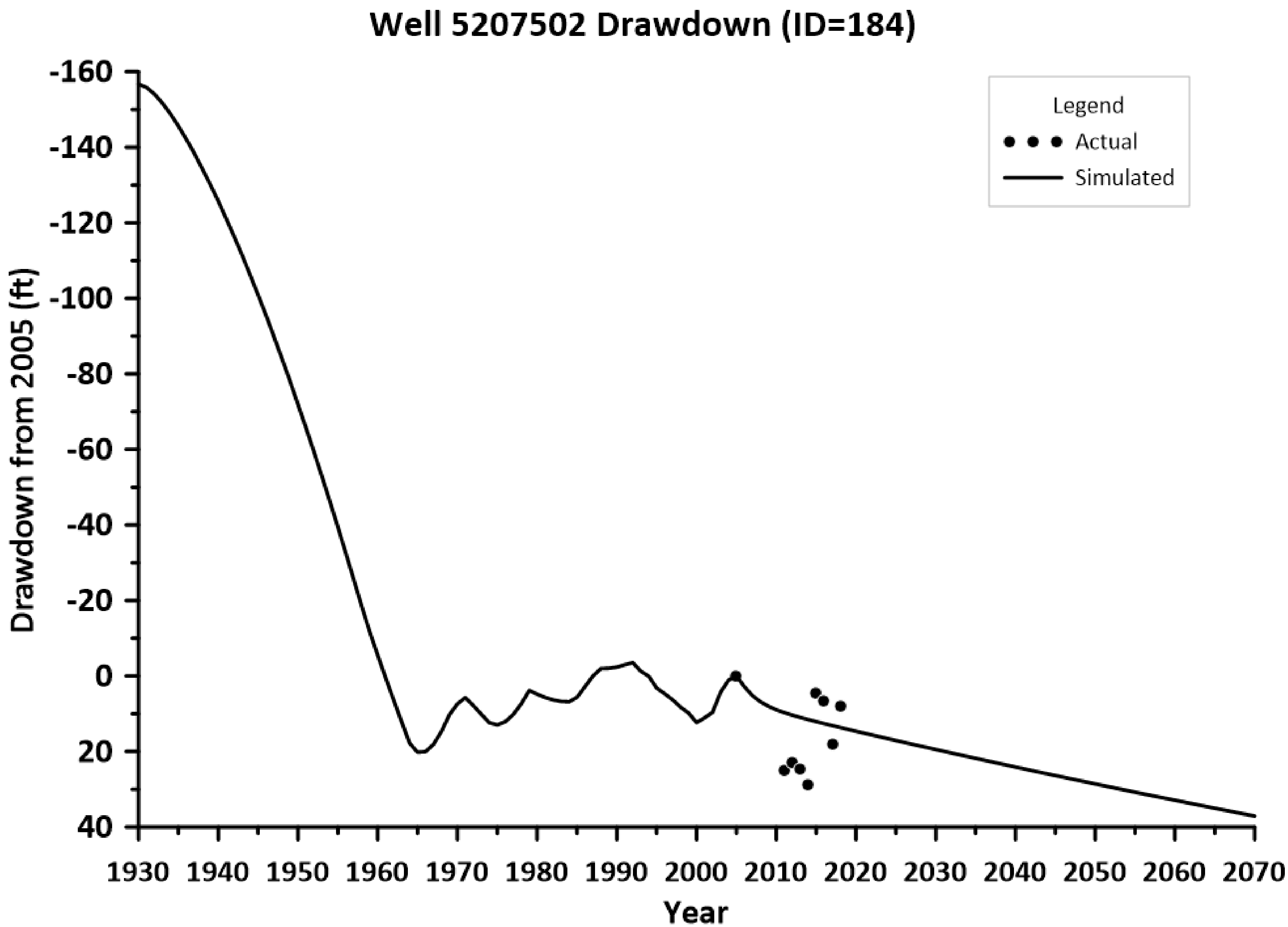
Well 4656401 Drawdown (ID=130)
Drawdown from 2005 (ft)
-200
-160
-120
-80
-40
0
40
80
120
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Year
Legend
Actual
Simulated



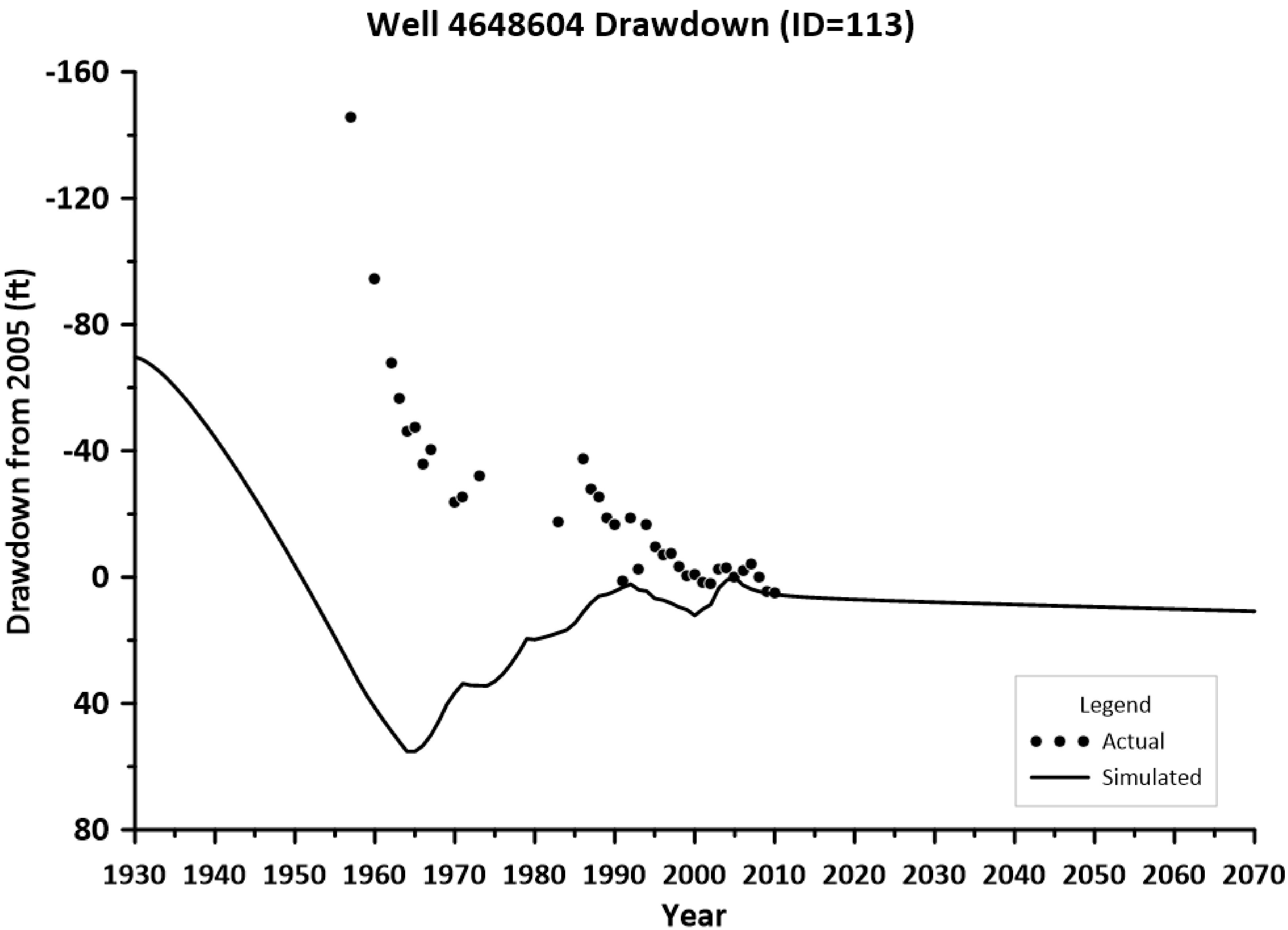
Well 4656306 Drawdown (ID=127)
-160
-120
-80
-40
0
40
80
120
Drawdown from 2005 (ft)
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Year
Legend
Actual
Simulated



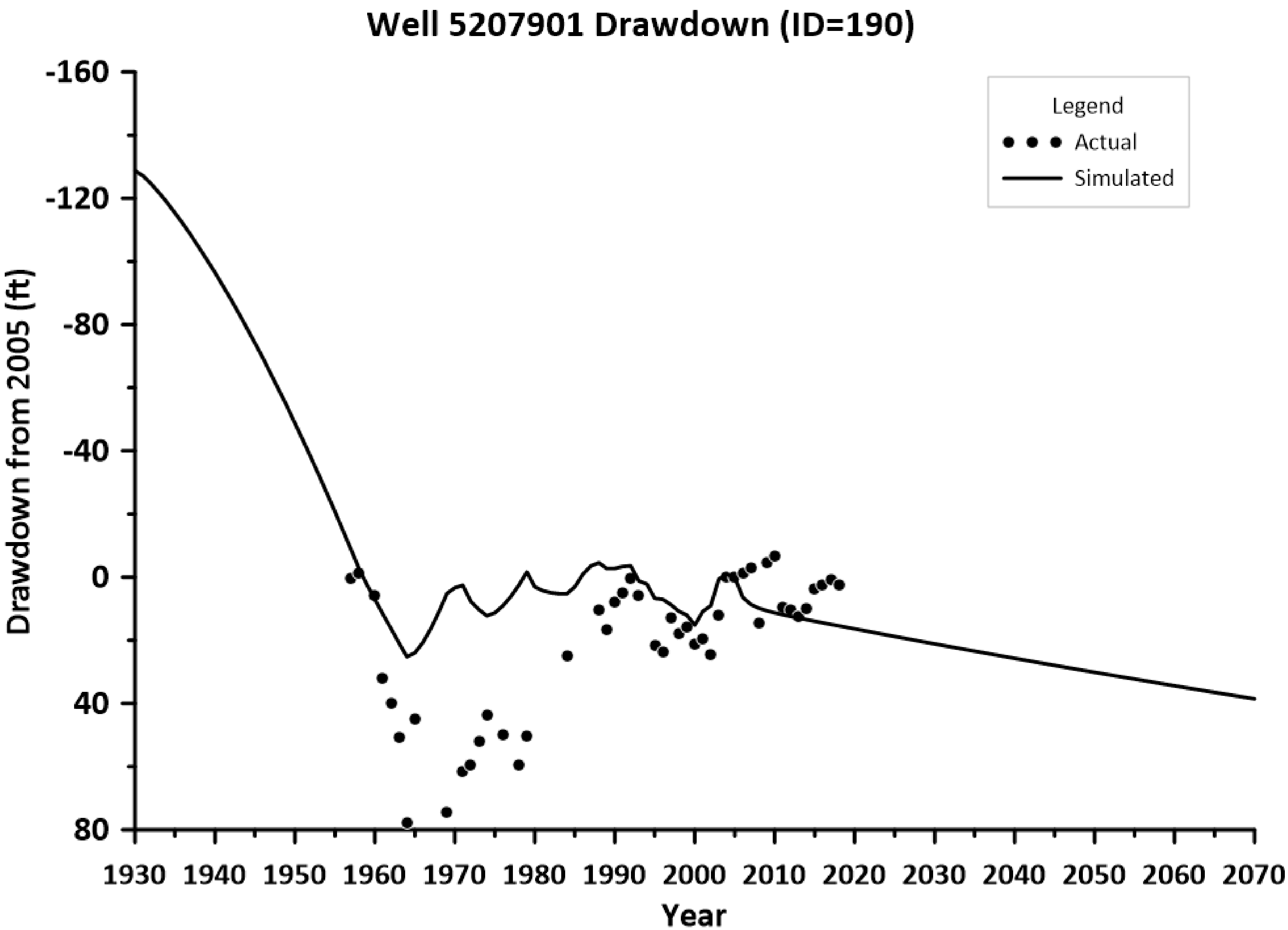
Well 5207302 Drawdown (ID=180)
Legend
Actual
Simulated
Drawdown from 2005 (ft)
-200
-160
-120
-80
-40
0
40
80
120
160
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Year

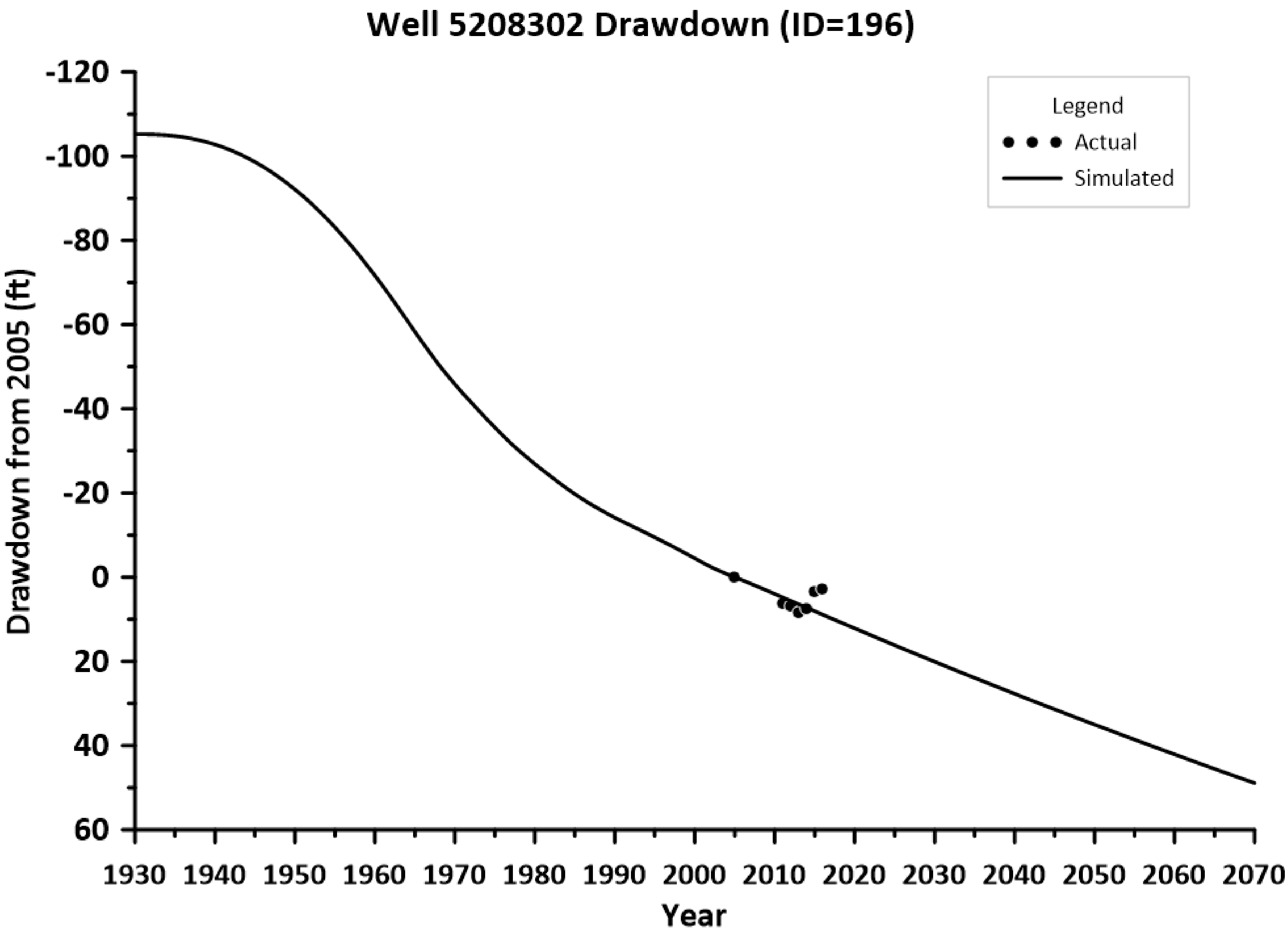


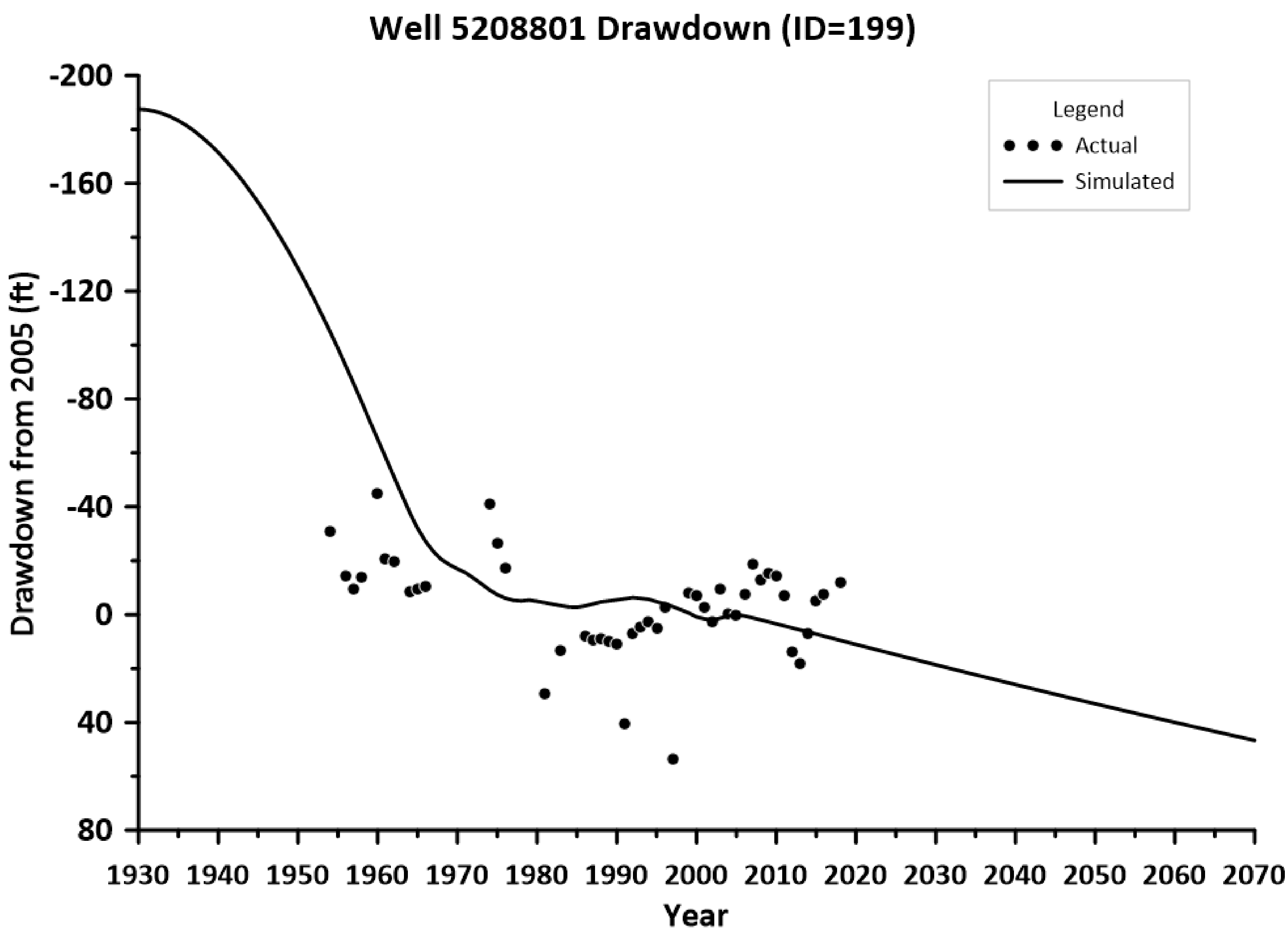
Well 5207502 Drawdown (ID=184)
Legend
Actual
Simulated
Drawdown from 2005 (ft)
-160
-140
-120
-100
-80
-60
-40
-20
0
20
40
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Year



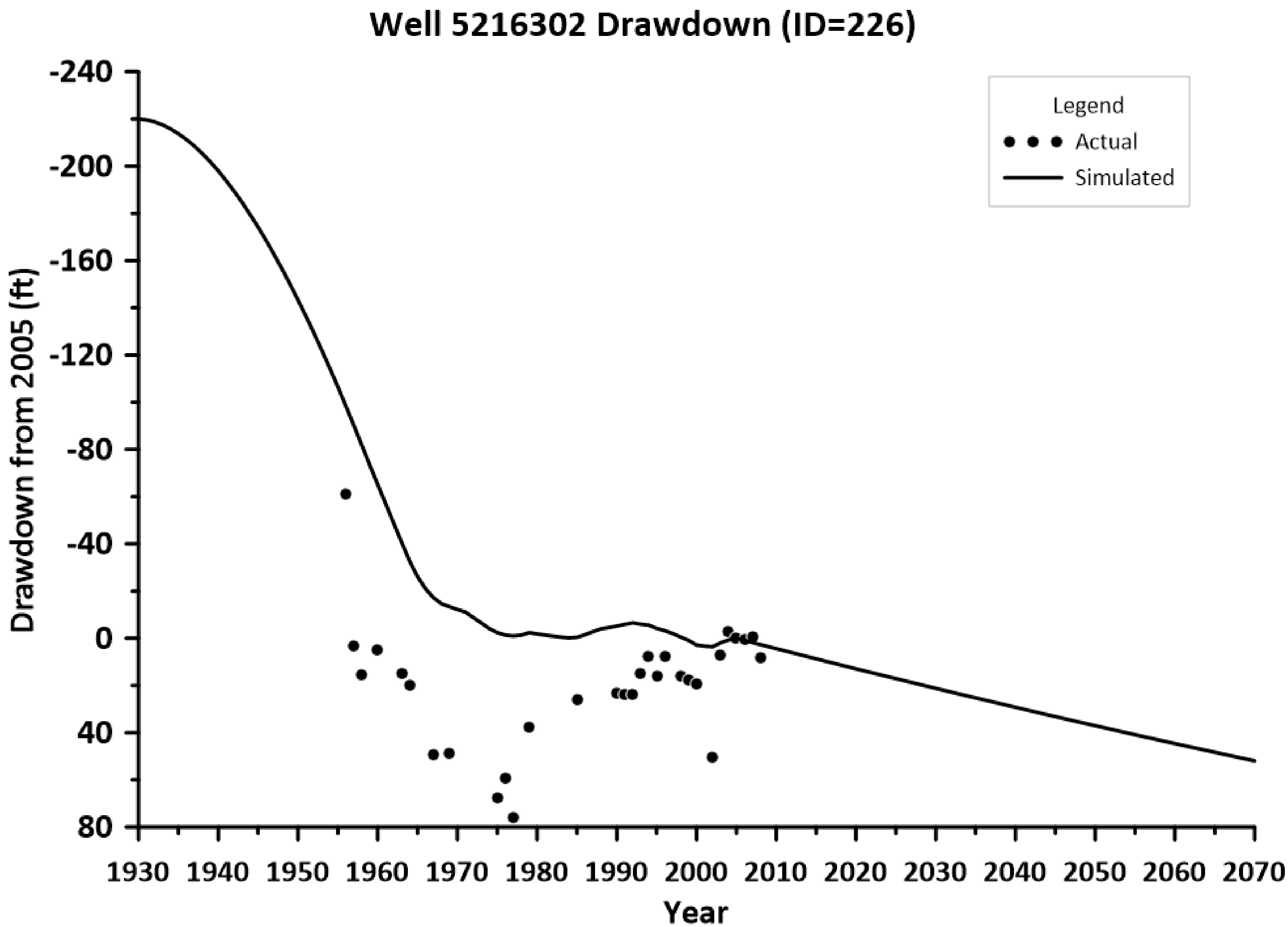
Well 4648604 Drawdown (ID=113)
-160
-120
-80
-40
0
40
80
Drawdown from 2005 (ft)
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Year
Legend
Actual
Simulated


Well 5207901 Drawdown (ID=190)
Legend
Actual
Simulated
Drawdown from 2005 (ft)
-160
-120
-80
-40
0
40
80
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Year

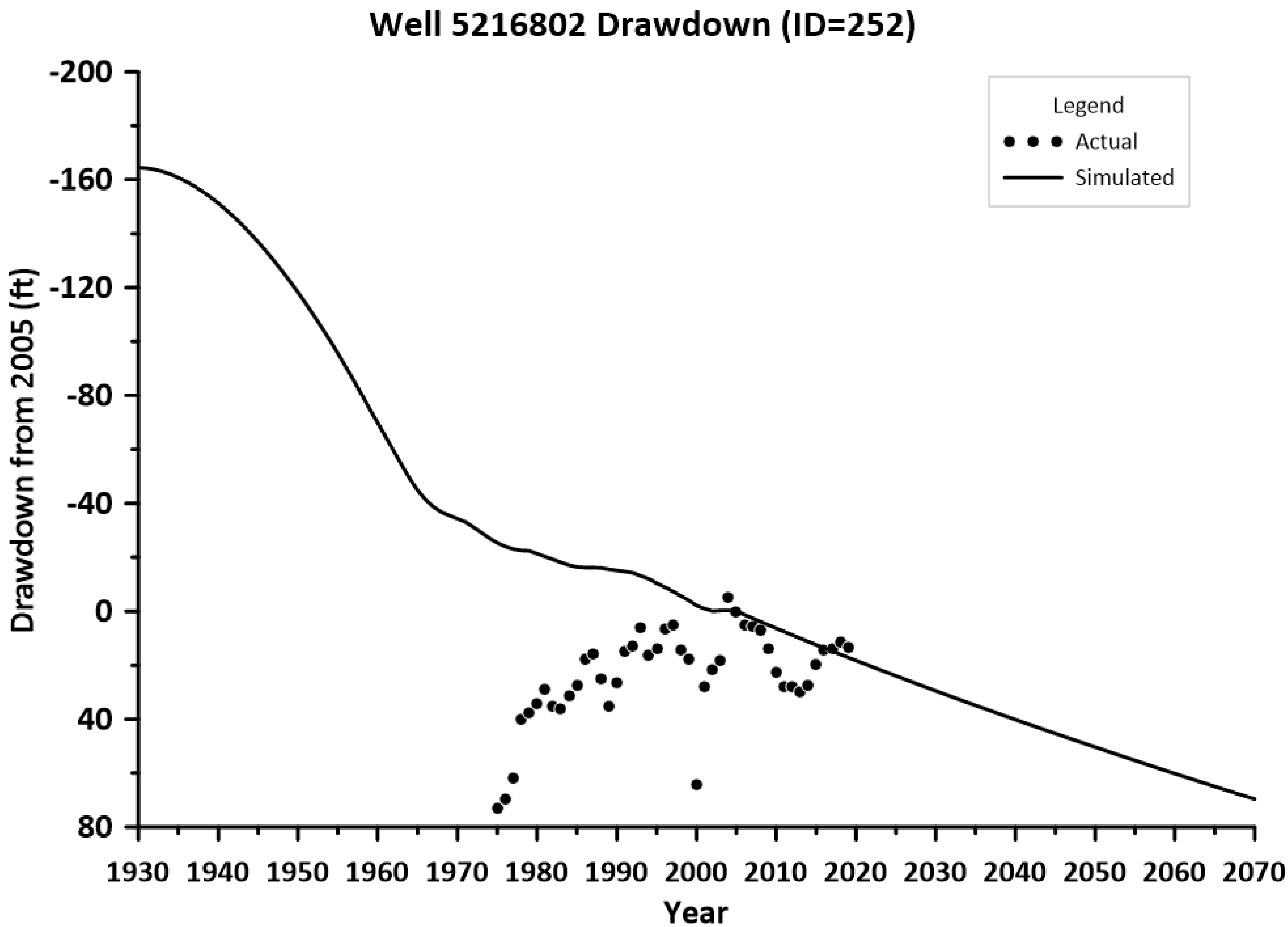

Well 5208302 Drawdown (ID=196)
Legend
Actual
Simulated
Drawdown from 2005 (ft)
-120
-100
-80
-60
-40
-20
0
20
40
60
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Year

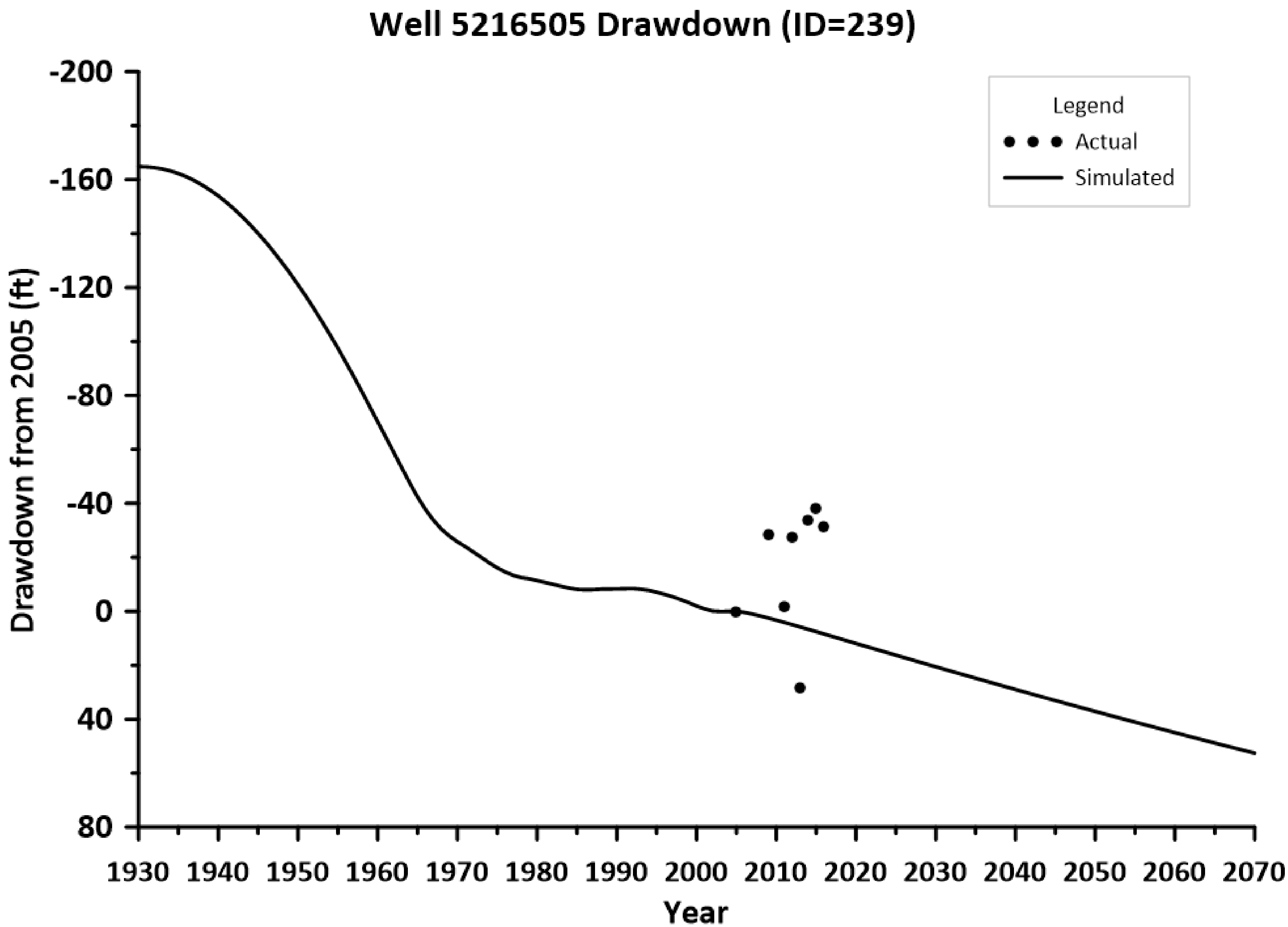


Well 5208801 Drawdown (ID=199)
Legend
Actual
Simulated
Drawdown from 2005 (ft)
-200
-160
-120
-80
-40
0
40
80
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Year

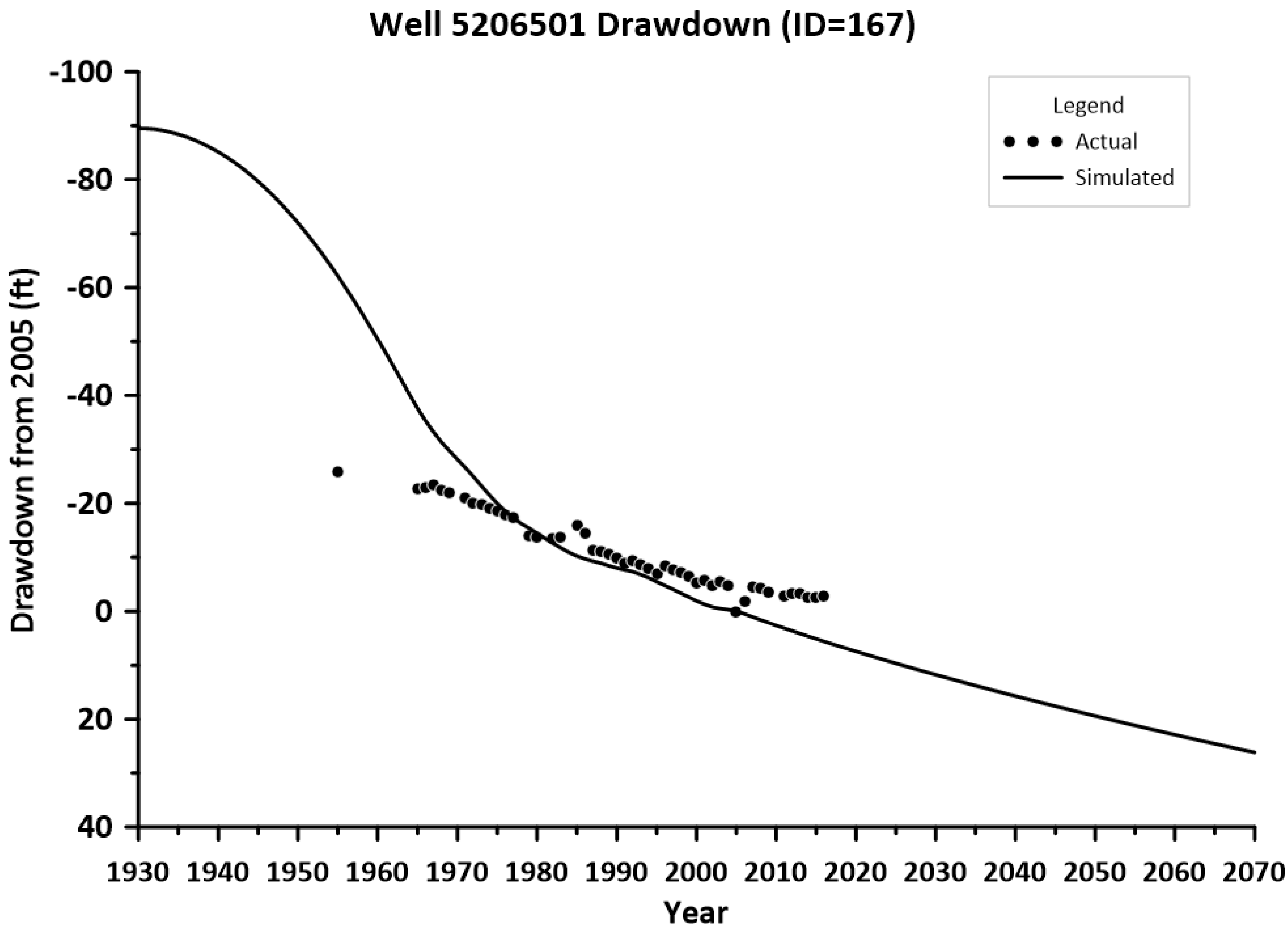


Well 5216302 Drawdown (ID=226)
Legend
Actual
Simulated
Drawdown from 2005 (ft)
-240
-200
-160
-120
-80
-40
0
40
80
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Year

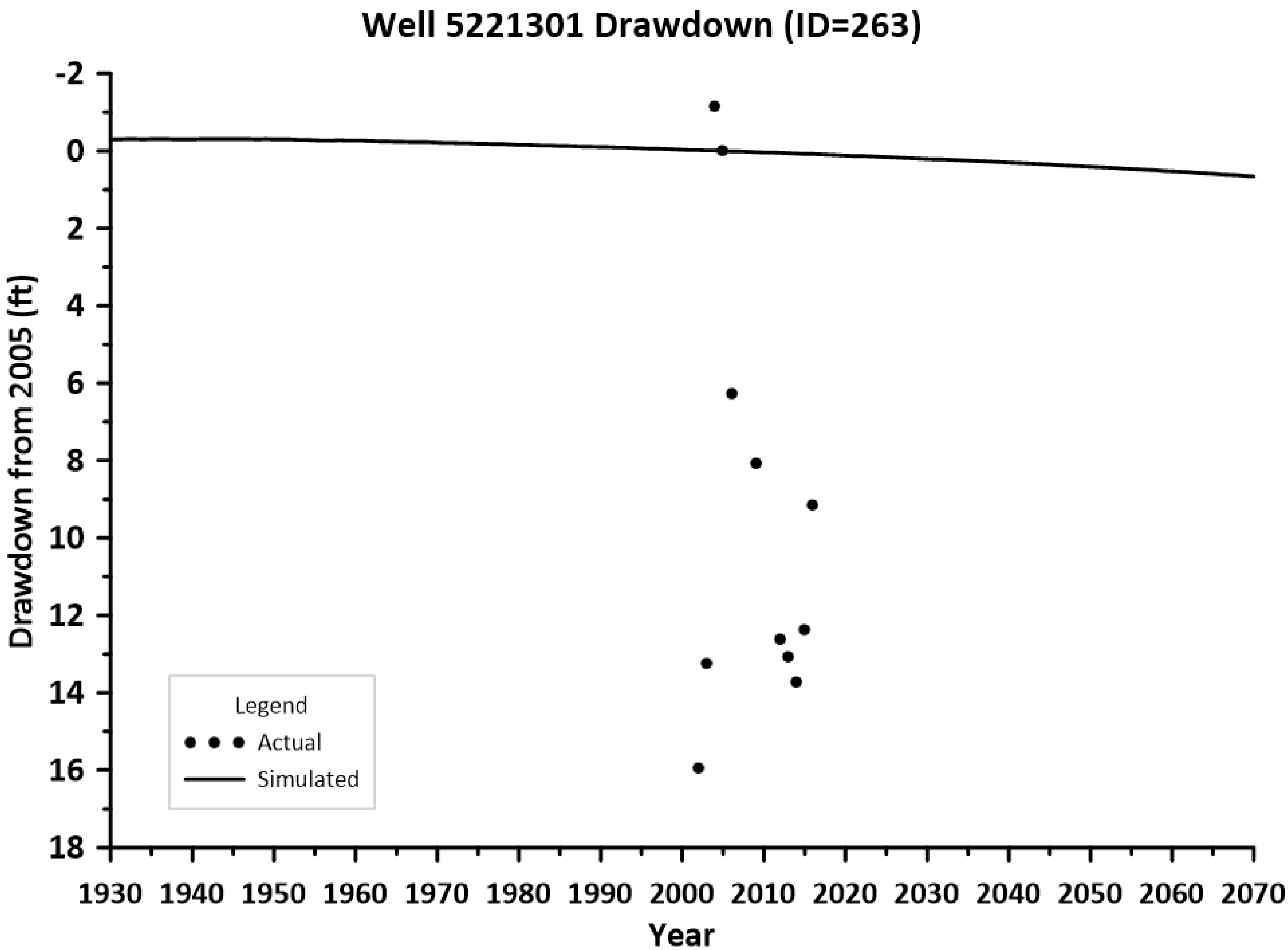

Well 5216802 Drawdown (ID=252)
Legend
Actual
Simulated
Drawdown from 2005 (ft)
-200
-160
-120
-80
-40
0
40
80
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Year



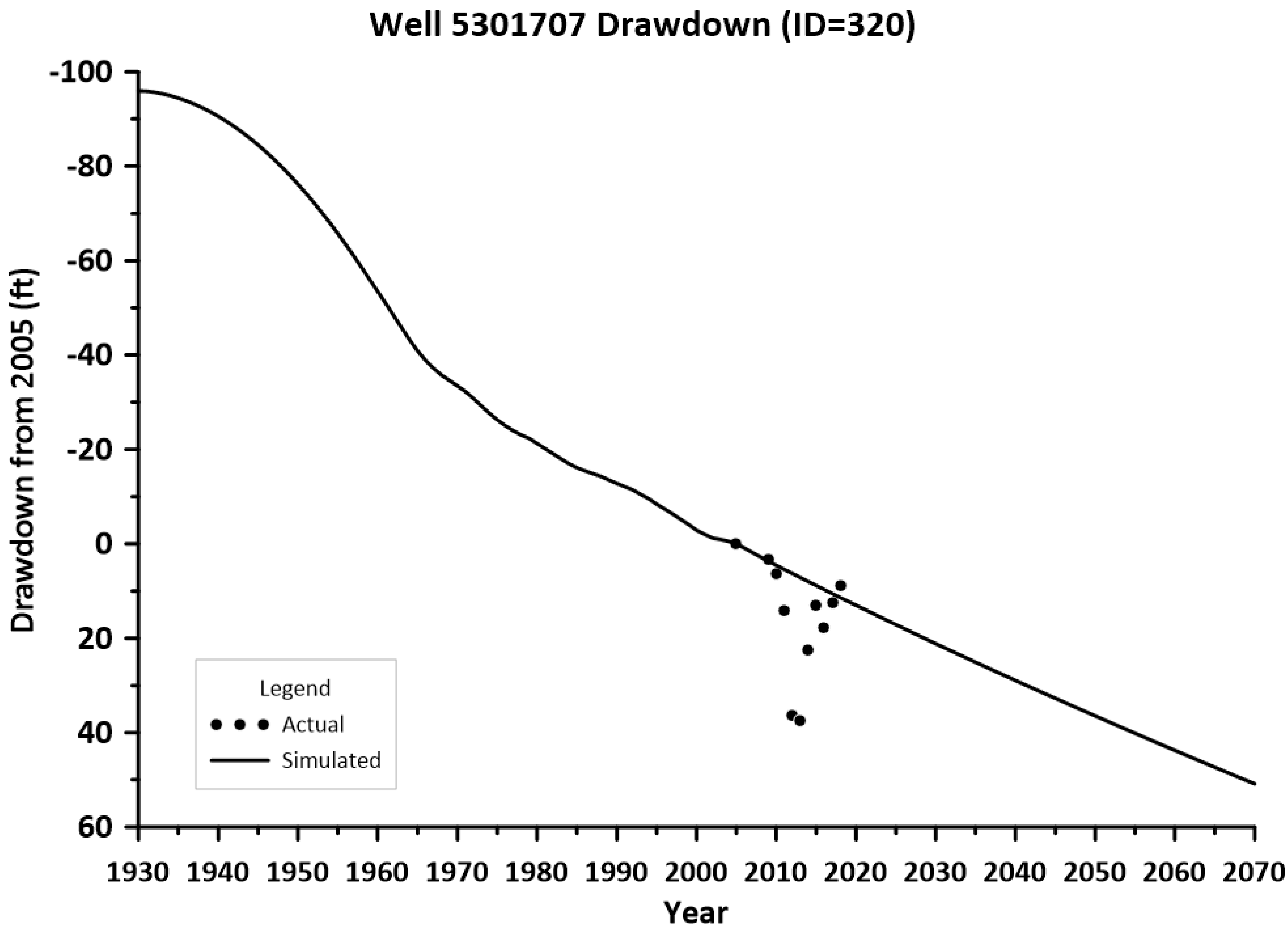
Well 5216505 Drawdown (ID=239)
Drawdown from 2005 (ft)
-200
-160
-120
-80
-40
0
40
80
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Year
Legend
Actual
Simulated



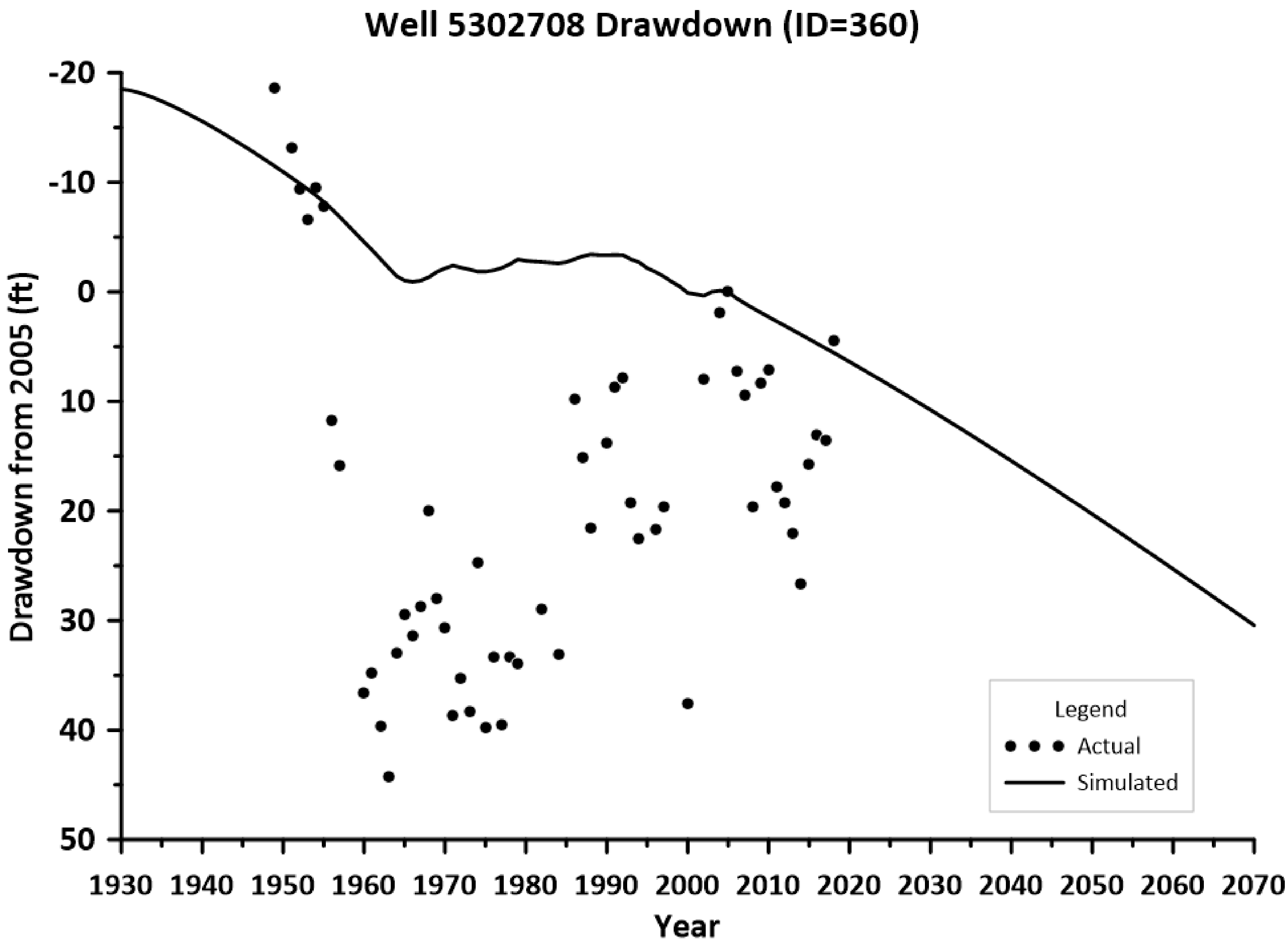
Well 5206501 Drawdown (ID=167)
Drawdown from 2005 (ft)
-100
-80
-60
-40
-20
0
20
40
Year
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Legend
Actual
Simulated



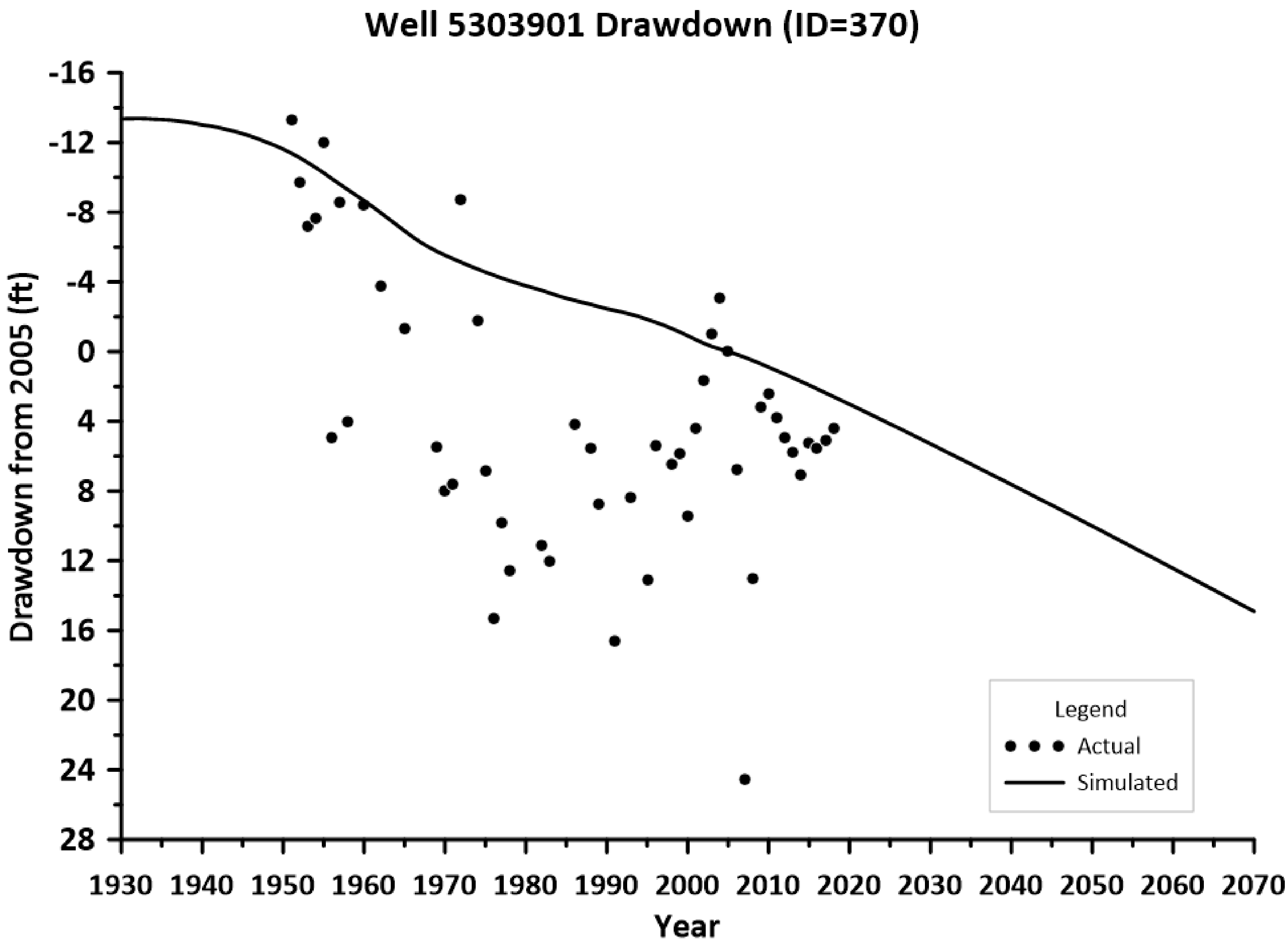
Well 5221301 Drawdown (ID=263)
Drawdown from 2005 (ft)
-2
0
2
4
6
8
10
12
14
16
18
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Year
Legend
Actual
Simulated



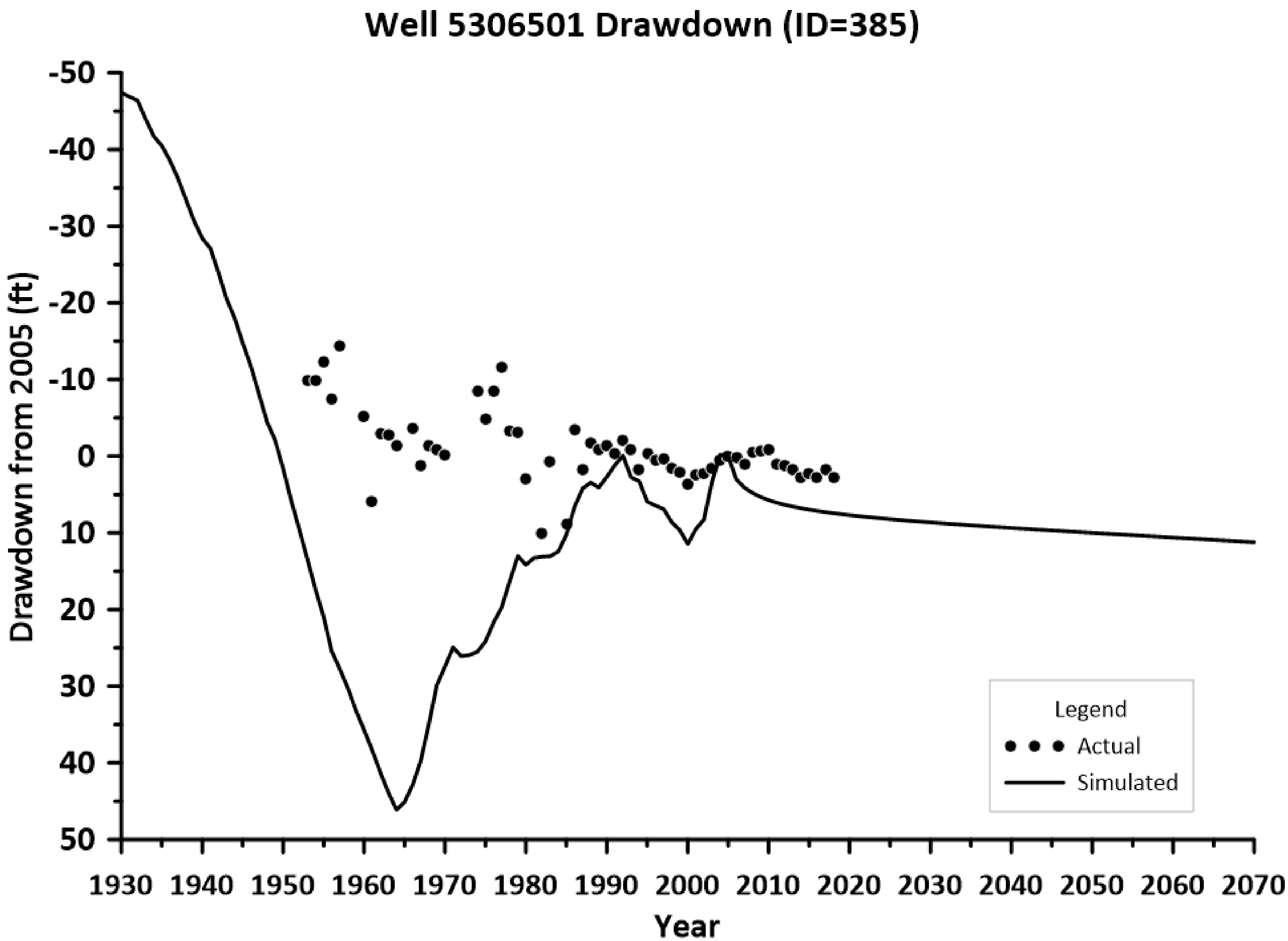
Well 5301707 Drawdown (ID=320)
Drawdown from 2005 (ft)
-100
-80
-60
-40
-20
0
20
40
60
Year
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Legend
Actual
Simulated



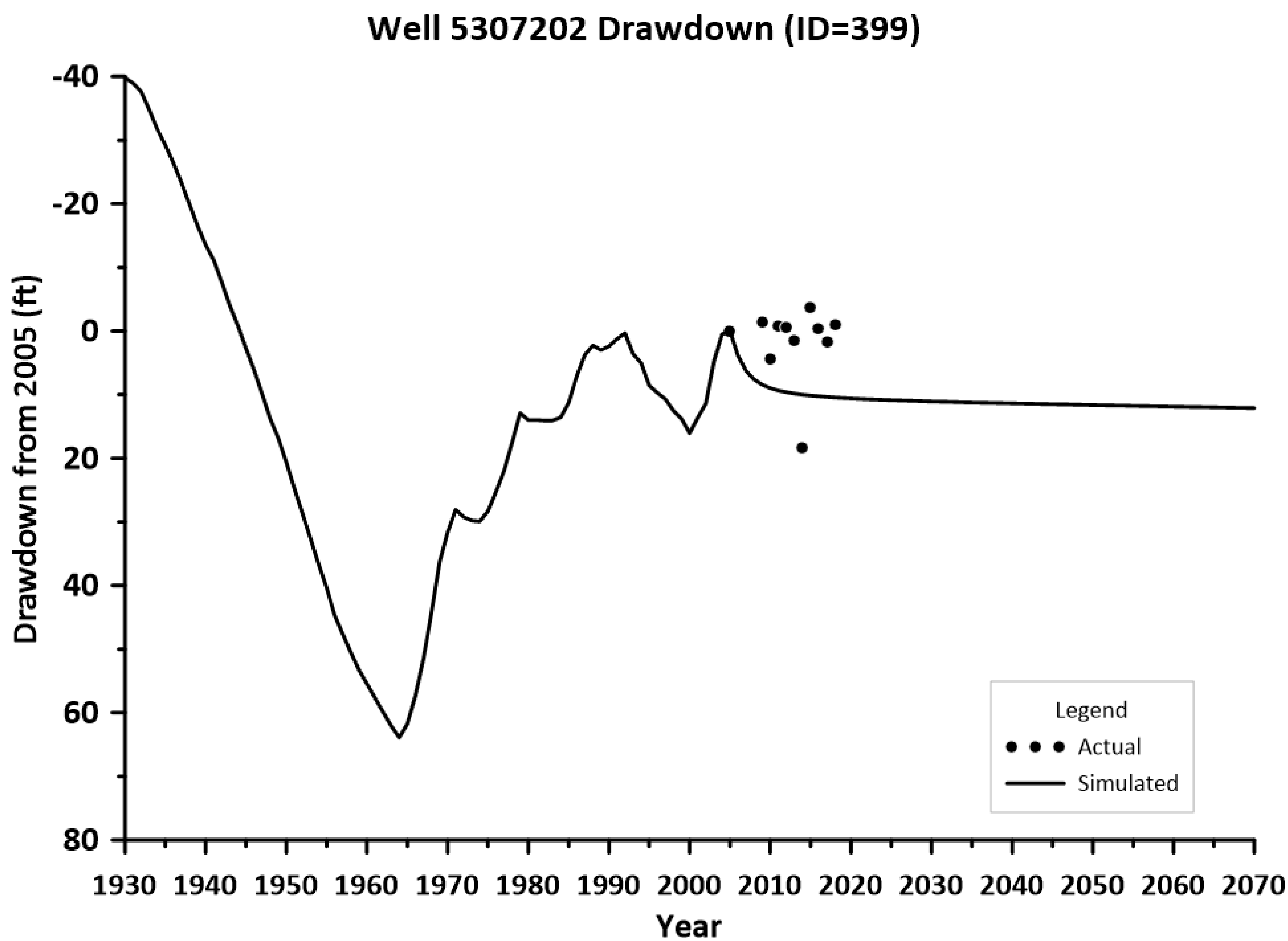
Well 5302708 Drawdown (ID=360)
Drawdown from 2005 (ft)
-20
-10
0
10
20
30
40
50
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Year
Legend
Actual
Simulated



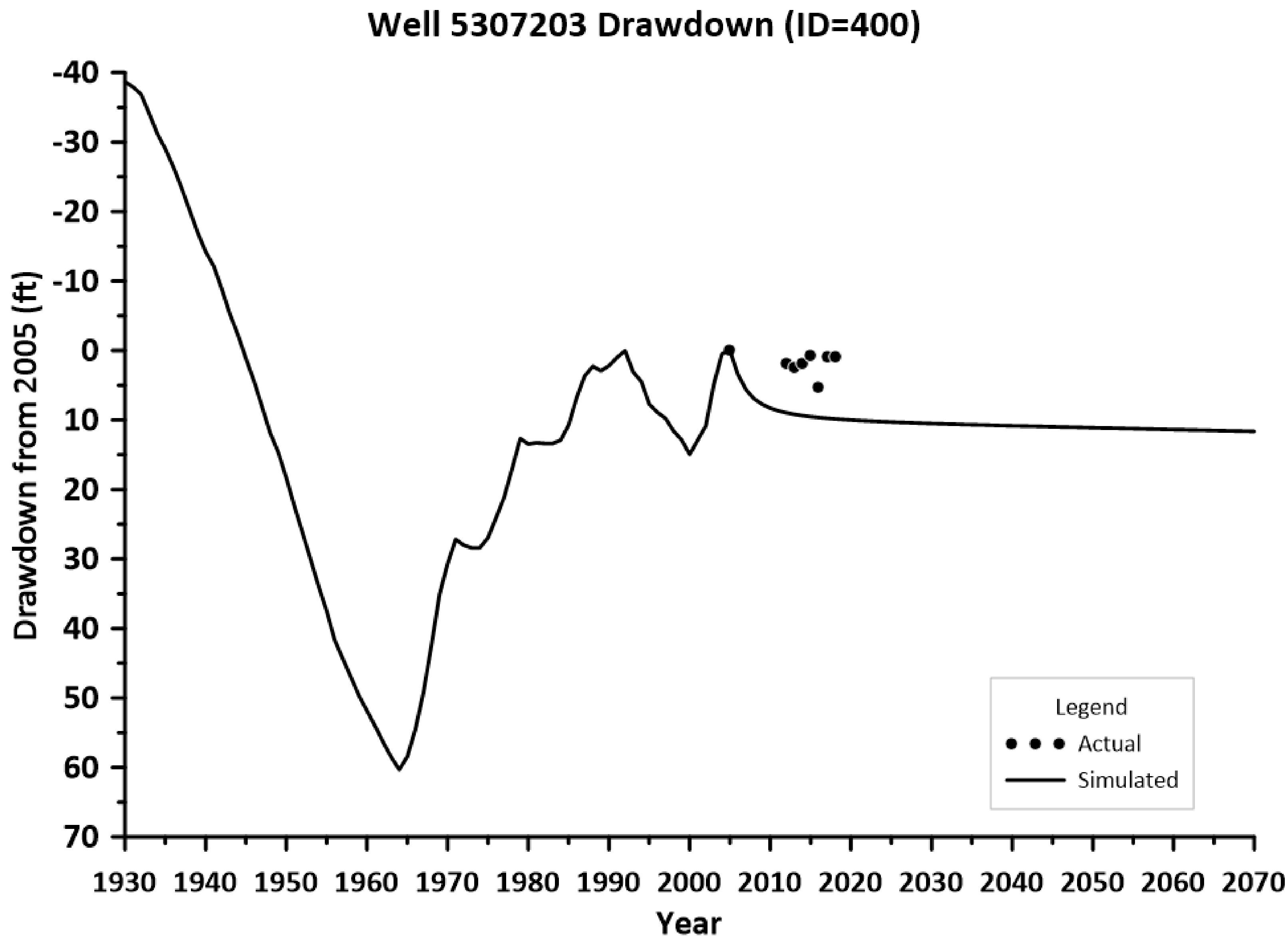
Well 5303901 Drawdown (ID=370)
Drawdown from 2005 (ft)
-16
-12
-8
-4
0
4
8
12
16
20
24
28
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Year
Legend
Actual
Simulated



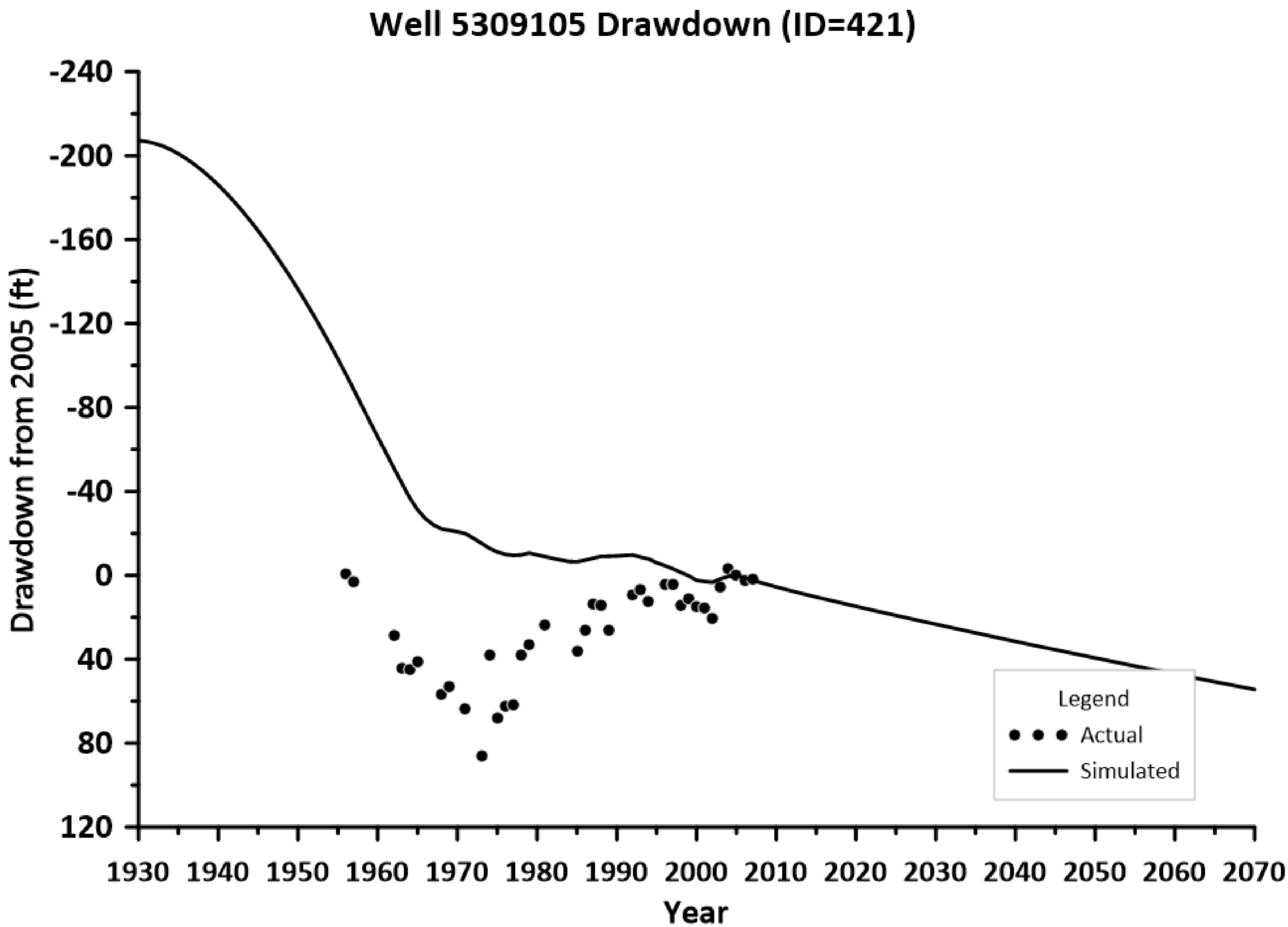
Well 5306501 Drawdown (ID=385)
Drawdown from 2005 (ft)
-50
-40
-30
-20
-10
0
10
20
30
40
50
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Year
Legend
Actual
Simulated

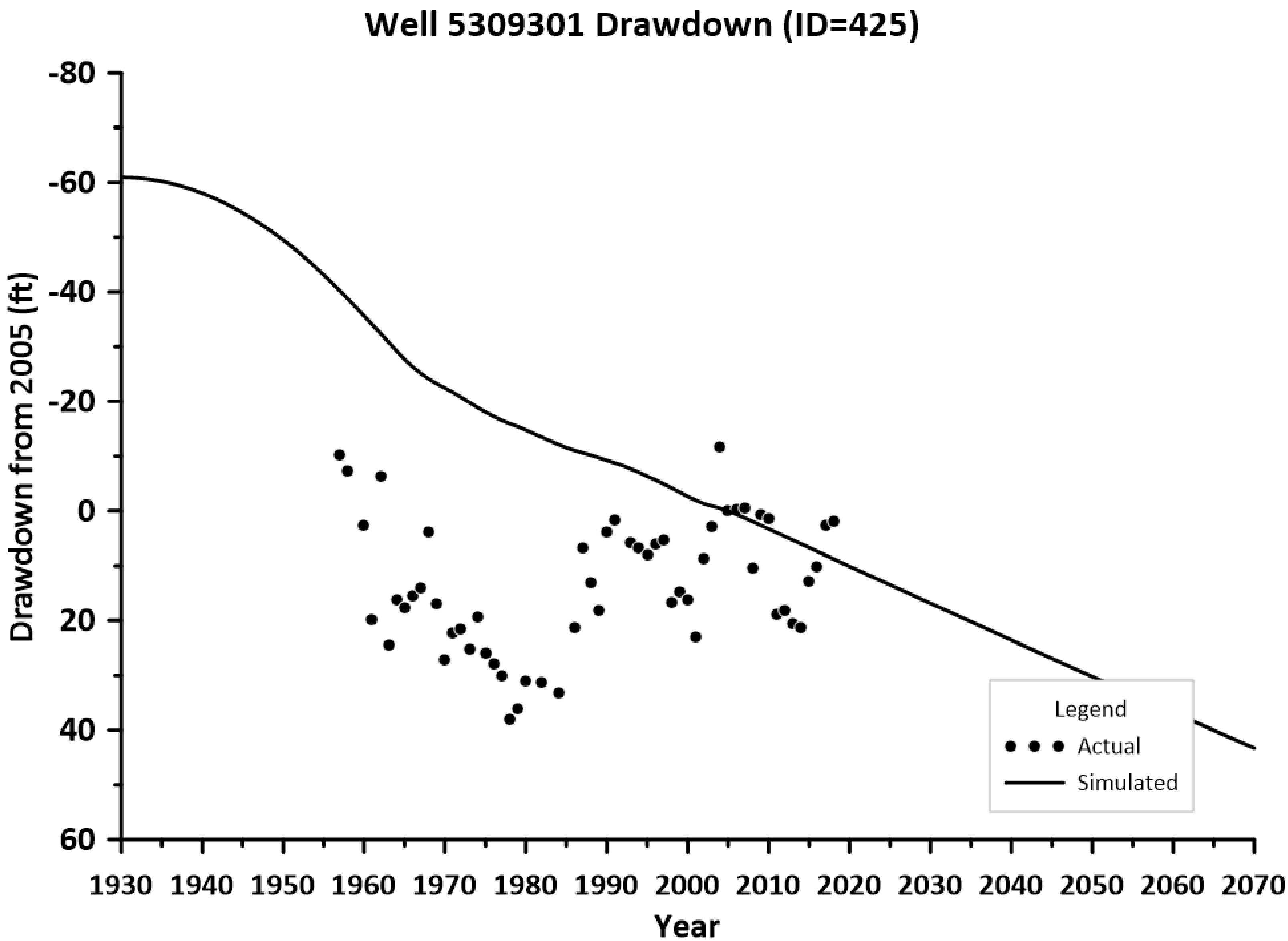


Well 5307202 Drawdown (ID=399)
Drawdown from 2005 (ft)
-40
-20
0
20
40
60
80
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Year
Legend
Actual
Simulated

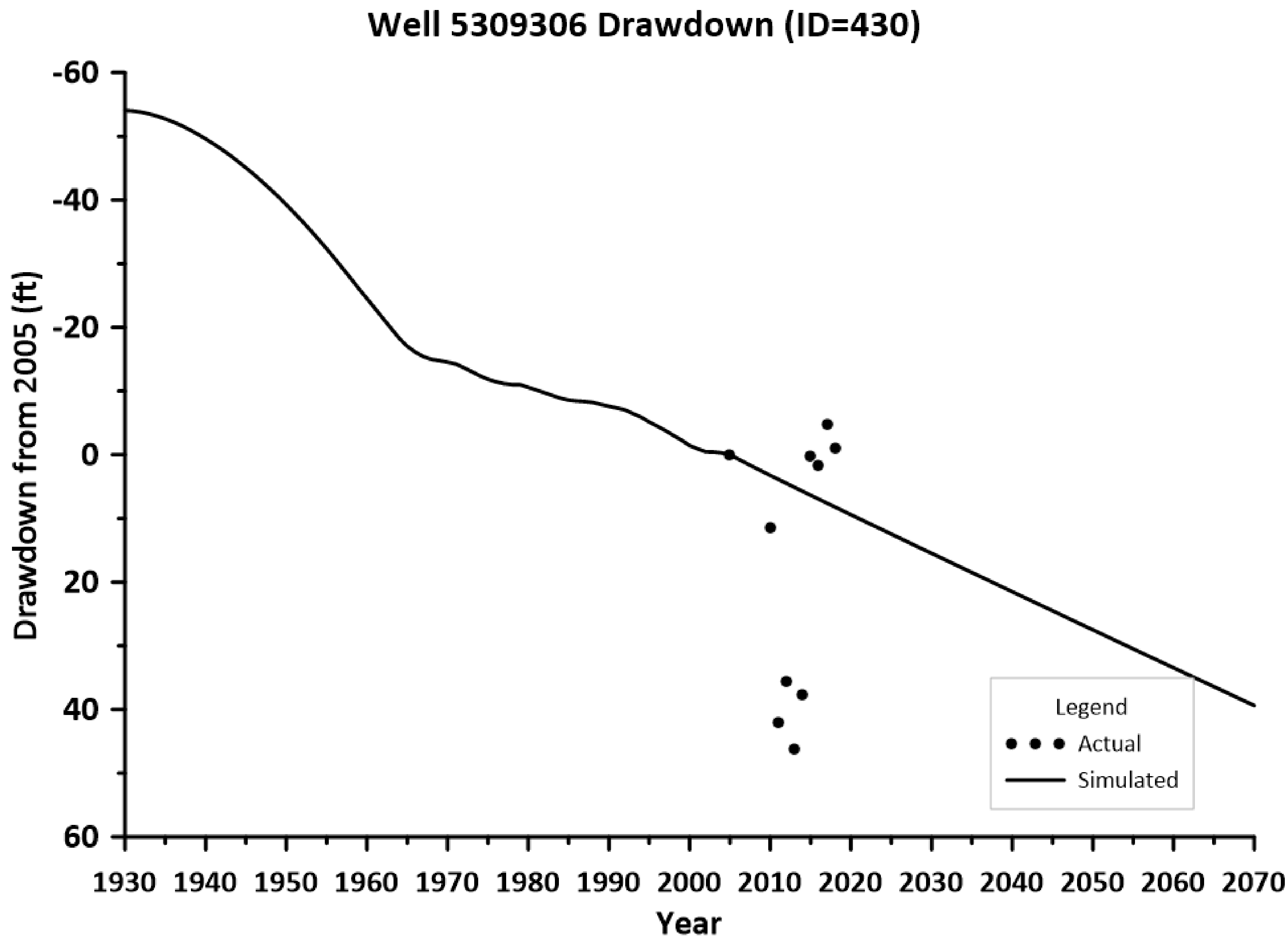


Well 5307203 Drawdown (ID=400)
-40
-30
-20
-10
0
10
20
30
40
50
60
70
Drawdown from 2005 (ft)
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Year
Legend
Actual
Simulated

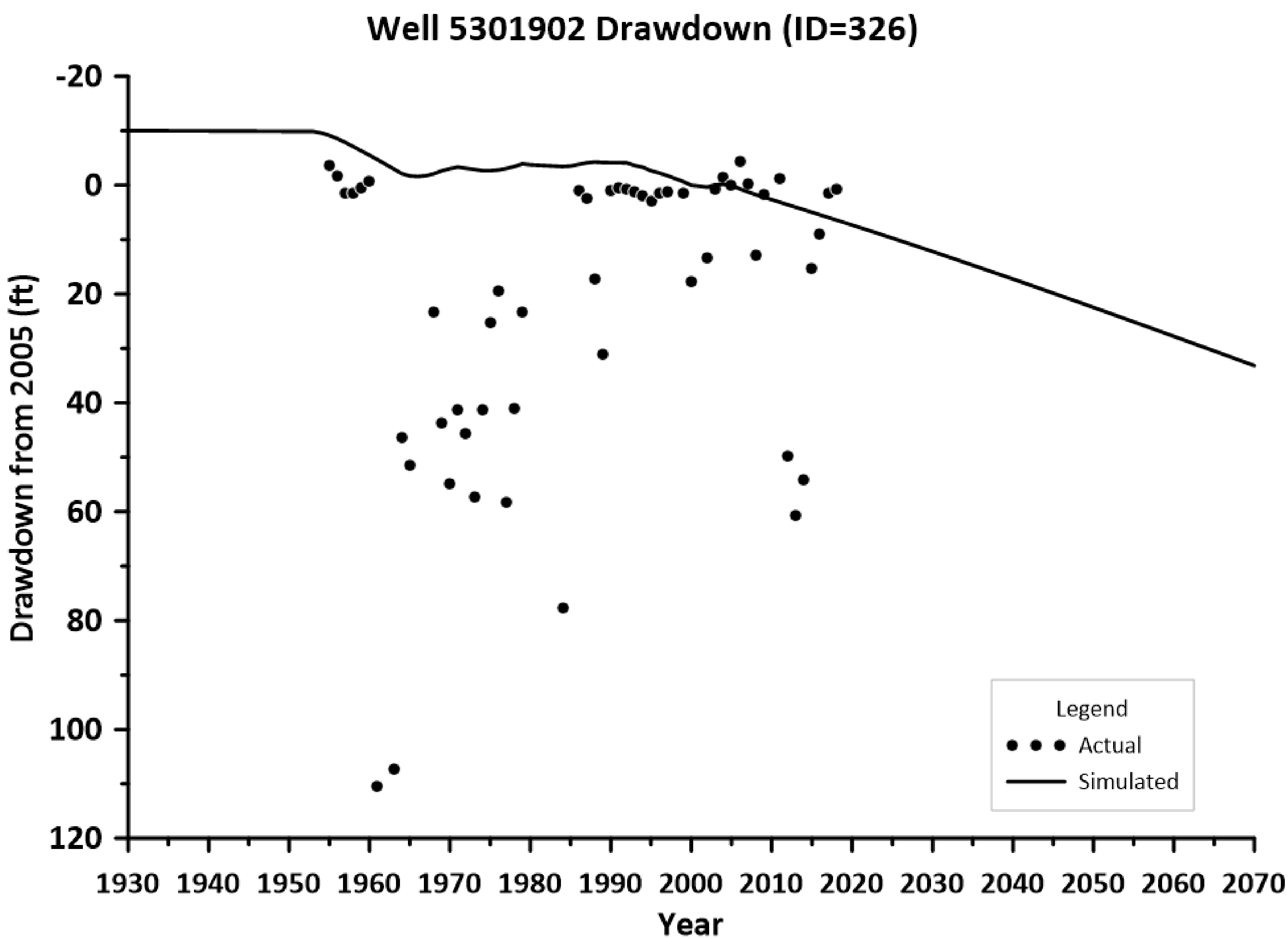

Well 5309105 Drawdown (ID=421)
Drawdown from 2005 (ft)
-240
-200
-160
-120
-80
-40
0
40
80
120
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Year
Legend
Actual
Simulated

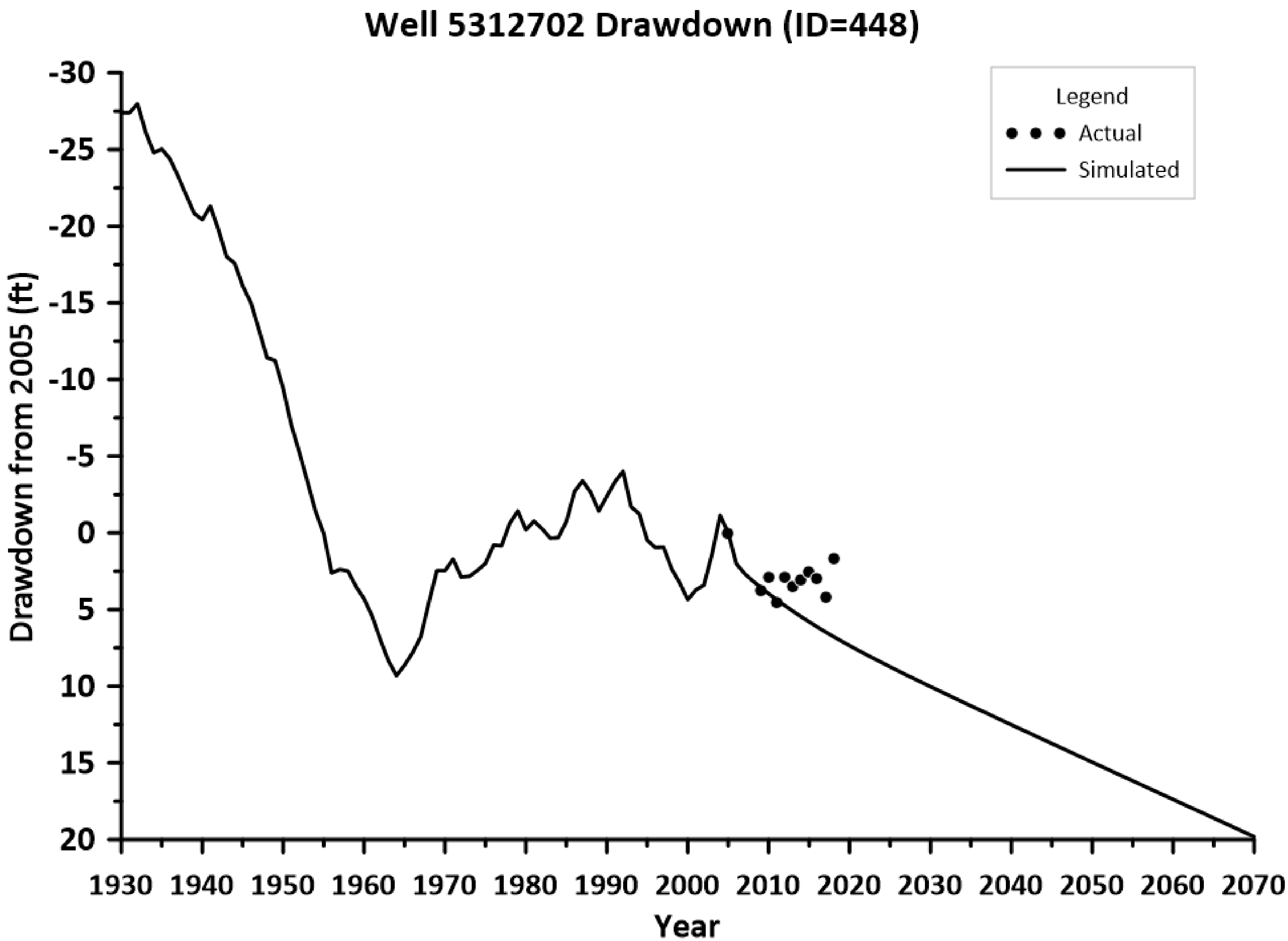


Well 5309301 Drawdown (ID=425)
Drawdown from 2005 (ft)
-80
-60
-40
-20
0
20
40
60
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Year
Legend
Actual
Simulated



Well 5309306 Drawdown (ID=430)
Drawdown from 2005 (ft)
-60
-40
-20
0
20
40
60
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Year
Legend
Actual
Simulated


Well 5301902 Drawdown (ID=326)
Drawdown from 2005 (ft)
-20
0
20
40
60
80
100
120
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Year
Legend
Actual
Simulated


Well 5312702 Drawdown (ID=448)
Legend
Actual
Simulated
Drawdown from 2005 (ft)
-30
-25
-20
-15
-10
-5
0
5
10
15
20
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
Year