BEFORE THE NEW MEXICO PUBLIC REGULATION COMMISSION

IN THE MATTER OF SOUTHWESTERN PUBLIC SERVICE COMPANY'S APPLICATION FOR: (1) REVISION OF ITS RETAIL RATES UNDER ADVICE NOTICE NO. 312; (2) AUTHORITY TO ABANDON THE PLANT X UNIT 1, PLANT X UNIT 2, AND CUNNINGHAM UNIT 1 GENERATING STATIONS AND AMEND THE ABANDONMENT DATE OF THE TOLK GENERATING STATION; AND (3) OTHER ASSOCIATED RELIEF, **SOUTHWESTERN PUBLIC SERVICE COMPANY,** **APPLICANT.**	)	**CASE NO. 22-00286-UT**

DIRECT TESTIMONY

of

RICHARD L. BELT

on behalf of

SOUTHWESTERN PUBLIC SERVICE COMPANY

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GLOSSARY OF ACRONYMS AND DEFINED TERMS

Acronym/Defined Term	**Meaning**
AGS	Advanced Groundwater Solutions, LLC
Commission	New Mexico Public Regulation Commission
gpm	Gallons per minute
GWhrs	Gigawatt-hours
HPWD	High Plains Water District
MW	Megawatt
PSCo	Public Service Company of Colorado, a Colorado corporation
SPS	Southwestern Public Service Company, a New Mexico corporation
Tolk	Tolk Generating Station
USGS	United States Geological Survey
Xcel Energy	Xcel Energy Inc.
XES	Xcel Energy Services Inc.

LIST OF ATTACHMENTS

Attachment	Description
RLB-1	2021 Groundwater Modeling Results for Tolk Station and Plant X in Lamb County, Texas by Advanced Groundwater Solutions, dated January 25, 2022 (*Filename*: RLB-1.pdf)
RLB-2	SPS Water Modeling Spreadsheet (*Filename*: RLB-2.xlxm, provided in native format)
RLB-3	Tolk Wellfield Map (*Filename*: RLB-3.pdf)

Case No. 22-00286-UT
Direct Testimony
of
Richard L. Belt

I. WITNESS IDENTIFICATION AND QUALIFICATIONS

Q. Please state your name and business address.

A. My name is Richard L. Belt. My business address is 1800 Larimer Street, Denver, Colorado 80202.

Q. On whose behalf are you testifying in this proceeding?

A. I am filing testimony on behalf of Southwestern Public Service Company, a New Mexico corporation ("SPS"). SPS is a wholly-owned electric utility subsidiary of Xcel Energy Inc. ("Xcel Energy").

Q. By whom are you employed and in what position?

A. I am employed by Xcel Energy Services Inc. ("XES"), the service company affiliate of Xcel Energy, as Director of the Chemistry and Water Resources group within the Environmental Services Department of Energy Supply, which is the generation operation and maintenance business unit of Xcel Energy. Prior to my current role, I was the Supervisor of the Water Resources Team.

Q. Please briefly outline your responsibilities as the Director of Chemistry and Water Resources group in the Environmental Services Department.

A. I am responsible for providing strategic leadership and direction for general laboratory chemistry, power plant chemistry, and water resources management in all of Xcel Energy's geographic regions. Under the water resources management role, I am responsible for ensuring that the generating units in the Energy Supply fleet, particularly those of SPS and Public Service Company of Colorado, a Colorado corporation ("PSCo"), have adequate water to operate. I also manage analysts and contractors, and I oversee the work of consultants to support this function. Finally, I support other departments such as Projects, Environmental, Regulatory, Resource Planning, and Siting and Land Rights with respect to water issues that may affect the work of those groups.

Q. Please describe your educational background.

A. I have a Bachelor of Science degree in Civil Engineering from the University of Colorado and a Masters of Watershed Science from Colorado State University. I have a number of continuing education credits in business and water resources-related coursework.

Q. Please describe your professional experience.

A. I have 27 years of experience in the water resources field, including 12 years with Xcel Energy operating the water supply portfolio to serve electric generation and ancillary needs. Prior to working for Xcel Energy, I worked for approximately 15 years as a consultant with several firms specializing in water resources engineering.

In that capacity, I conducted studies, designed water infrastructure projects, and advised clients in municipal, industrial, and agricultural sectors on a variety of water supply issues.

Q. Do you hold a professional license?

A. Yes. I am a registered professional engineer in Georgia, Colorado, and Nebraska. I am also a registered professional hydrologist recognized by the American Institute of Hydrology.

Q. Are you a member of any professional organizations?

A. Yes. I am a member of the American Institute of Hydrology.

Q. Have you testified in any prior proceeding?

A. Yes. I submitted prefiled written testimony in SPS's most recent base rate case before the New Mexico Public Regulation Commission ("Commission"), which was Case No. 20-00238. I also submitted prefiled written testimony in SPS's most recent base rate case before the Public Utility Commission of Texas, and I have submitted testimony in PSCo's Energy Resource Plan and Clean Energy Plan filing before the Colorado Public Utilities Commission.

II. ASSIGNMENT AND SUMMARY OF TESTIMONY AND RECOMMENDATIONS

Q. What is your assignment in this proceeding?

A. To inform the Commission and interested parties, my testimony discusses water-related matters of material interest to SPS's generation operations. I describe the studies that SPS and others have conducted to determine how much economically recoverable groundwater is available to operate the Tolk Generating Station ("Tolk"), a 1,082-megawatt ("MW") coal-fired power plant located near Muleshoe, Texas. I also estimate the depletion range for the economically available water to operate the Tolk generating units based on a scenario of dispatching the units at approximately 4,000 gigawatt hours per year ("GWhrs/year") beginning in 2023, as described in the direct testimony of SPS witness Ben R. Elsey.

Q. Please summarize the conclusions in your testimony.

A. Based on recent groundwater measurements, SPS's groundwater modeling, and reporting by other water users and government agencies, it is clear that the amount of economically recoverable groundwater[1] available to operate Tolk is declining

[1] "Economically recoverable groundwater" is defined as groundwater that is producible by high-capacity wells. Given the geology of the Ogallala Aquifer underlying the Tolk wellfield, this is water which is at or above 40 feet of saturated thickness in the aquifer.

year-over-year. Based on the groundwater modeling studies that I describe in my testimony, I estimate that the Tolk generating units will have adequate groundwater to run until 2028 under the expected dispatch scenario in which coal operations at Tolk operate economically in response to higher gas prices, and in which SPS manages generation output to a target of approximately 4,000 GWhrs/year beginning in 2023. This dispatch scenario is discussed in the direct testimonies of SPS witnesses Brooke A. Trammell and Ben R. Elsey. The economical benefits of this dispatch scenario for customers, paired with the scarce water availability and significant water competition in and around the Tolk wellfield, support SPS's proposed 2028 retirement date of coal operations at Tolk.[2]

Q. Are Attachments RLB-1 and RLB-3 true and correct copies of the documents you represent them to be?

A. Yes.

Q. Was Attachment RLB-2 prepared by you or under your direct supervision and control?

A. Yes.

[2] Please refer to the direct testimonies of Ms. Trammell and Mr. Elsey for more detail.

III. TOLK WATER LIMITATIONS

Q. Please summarize how SPS is currently dispatching the Tolk units.

A. SPS is currently dispatching Tolk as a generating facility and plans to continue operating Tolk as a generating facility as described above and by Mr. Elsey until 2028, at which time the facility will cease coal operations. During the period from 2028 through 2055, SPS intends to continue operating Tolk as a synchronous condenser for voltage support, and expects that replacement generation would be constructed at the Tolk location.

Q. What is the primary driver for SPS's plan to generate electricity from Tolk at approximately 4,000 GWhrs/year between 2023 and 2028, and then to cease coal operations at Tolk in 2028?

A. The primary driver is the shortage of economically-recoverable groundwater in the Tolk area. Steam generating electric facilities such as Tolk require reliable sources of water for generation and cooling. An expected dispatch scenario of 4,000 GWhrs per year between 2023 and 2028 will enable SPS's customers to continue to (1) receive low cost energy from Tolk's coal operations, particularly in periods of higher gas prices, while (2) prudently managing the declining water availability in the Tolk wellfield, and (3) preserving the value of Tolk's accredited capacity on SPS's system through the timeframe until replacement generation resources can be determined following SPS's next Integrated Resource Planning process.

Q. Please generally describe the water limitations affecting Tolk's coal operations and remaining useful life.

A. Coal operations at Tolk rely exclusively on groundwater from the Ogallala Aquifer for generation and cooling, and not only is the portion of the Ogallala Aquifer underlying the Tolk wellfield in an irreversible decline, but the amount of economically recoverable groundwater in this area is declining year-over-year.

Q. What is the Ogallala Aquifer?

A. The Ogallala Aquifer is a large, connected body of groundwater that underlies much of the central United States, including the panhandle and south plains areas of Texas.

Q. Why is the Ogallala Aquifer declining?

A. The part of the aquifer that includes the Tolk wellfield is thin relative to other areas of the aquifer, and it is being depleted by agricultural, municipal, and industrial uses. Because groundwater extraction for these uses significantly exceeds the aquifer recharge rate, the saturated thickness of the aquifer has declined by over 300 feet in some areas of the Texas panhandle and will ultimately cause the aquifer productivity to decline to a point where it will be uneconomical to recover water for certain uses or in certain areas.

Q. Does the historical data show that the economically-recoverable groundwater in the Tolk wellfield has declined over time?

A. Yes. Only groundwater levels above 40 feet of saturated thickness are economical to recover, as defined previously in this testimony. In the late 1940s, which was before the start of widespread irrigated agriculture in the region, there was approximately 170 feet of economically-recoverable saturated thickness in the Tolk wellfield.[3] By 2021, the economically-recoverable saturated thickness (i.e., the thickness above 40 feet) had been reduced to approximately 8 feet. In other words, approximately 5% of the economically-recoverable water remains in this area of the aquifer today relative to what was available in the 1940s.

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[3] At that time, the total saturated thickness, which consisted of 170 feet of economically-recoverable water and 40 feet of water that was not economical to recover, was 210 feet.

Q. Please describe how the water limitations will affect Tolk's operations.

A. The declining saturated thickness of the aquifer reduces the aggregate wellfield productivity, diminishing the ability of the aquifer to supply sufficient water to support peak generation demands at the plant. When the saturated thickness level of the aquifer declines below 40 feet, wellfield productivity rapidly declines and high well production rates can no longer be sustained, even though there is still water in the aquifer formation.

Q. Can SPS increase the peak wellfield production by drilling more wells?

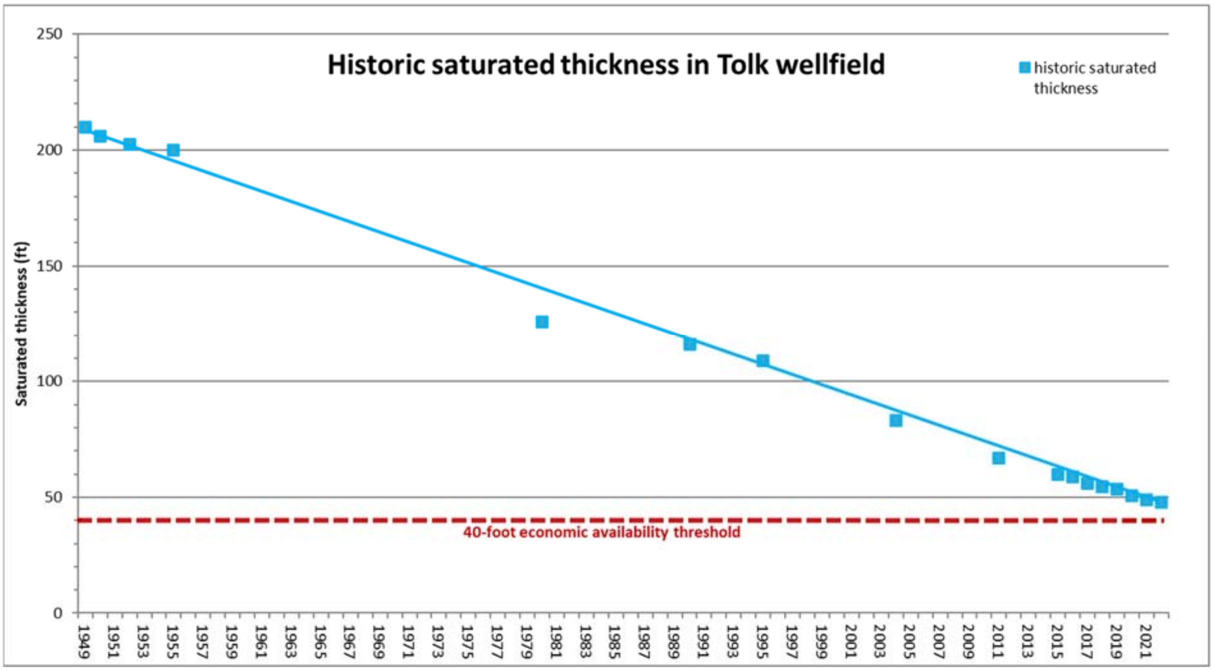
A. No. Since 2007, SPS's overall Tolk wellfield acreage has increased and the number of active wells has grown by over 77%, but peak water production capacity has declined by 24%. Since well productions rates decline every year, new wells are drilled by SPS nearly annually just to maintain wellfield production rates to support peak generation demands. The loss of high-capacity well productivity means that multiple new lower-capacity wells are required to offset lost productivity from each high-capacity well, increasing the cost and complexity of wellfield operations. For example, a 200 gallon per minute ("gpm") well may need to be replaced by four or more 50 gpm wells just to maintain equivalent wellfield production.

Consequently, SPS would need to make a significant investment in drilling a sufficient number of smaller capacity replacement wells for each existing higher capacity well to maintain the necessary volume of water required for Tolk's current generation cooling needs. At saturated thicknesses less than 40 feet, it becomes economically infeasible to provide adequate water supply to operate the Tolk units due to the number of additional wells required and the associated operation and maintenance expense associated with the wells. Therefore, this 40-foot threshold is considered the limit of the economically-recoverable water in the aquifer.

Q. Is the Ogallala Aquifer approaching the 40-foot saturated thickness threshold you describe above?

A. Yes. As discussed above, by 2022, the saturated thickness in Lamb County had declined to 48 feet, as documented in the annual saturated thickness survey prepared by the High Plains Water District ("HPWD"). SPS has spent considerable time and effort in monitoring and analyzing the Ogallala Aquifer and how it behaves over time. Figure RLB-1 shows the actual decline in the aquifer's saturated thickness underlying the Tolk wellfield, dating back to widespread development of irrigated agriculture in the area.

Figure RLB-1: Saturated Thickness History of Tolk Wellfield Through 2021



Despite the substantial growth in the number of wells to supply Tolk station, wellfield productivity will be unable to keep pace with Tolk's needs in the future due to the overall decline of the aquifer. The number of wells will continue to dramatically increase into the future, and productivity will continue to decline, until coal plant operations can no longer be maintained.

Q. Does SPS have empirical evidence demonstrating the aquifer decline?

A. Yes. There is a substantial amount of data from groundwater districts, the federal government, and SPS's groundwater consultant, all of which document the aquifer decline on scales ranging from local to an aquifer-wide basis. Specifically, SPS has data from the following sources documenting that the aquifer water levels are declining:

- three-dimensional ("3-D") modeling prepared by the HPWD in 2011 and updated in 2013;
- public data from HPWD monitoring the Ogallala Aquifer static water elevation on an annual, county-by-county basis;
- information compiled by the United States Geological Survey ("USGS");
- semi-annual wellfield productivity tests beginning in 2016; and
- groundwater modeling results prepared by Advanced Groundwater Solutions, LLC ("AGS") since 2007, including studies completed in 2016, 2017, 2018, 2019, 2020, and 2021.[4]

Q. Please explain what the 3-D modeling prepared for the HPWD in 2011 demonstrates with regard to the water volume in the Ogallala Aquifer.

A. In 2011, HPWD groundwater consultant Daniel B. Stephens & Associates created a 3-D hydrostratiagraphic model and conducted a volumetric analysis of the Ogallala Aquifer within a five-county study area that included Bailey, Castro, Deaf

[4] AGS is SPS's current groundwater consultant. In 2017, an entity called WSP USA acquired LBG-Guyton Associates, the entity that SPS had previously engaged to perform groundwater modeling at Tolk. In 2021, the team responsible for the development of the Tolk groundwater model formed their own company, Advanced Groundwater Solutions, LLC. For ease of reference, I will refer to all of these entities as AGS throughout my testimony.

Smith, Parmer, and Lamb Counties.[5] The 2011 study, which evaluated the stratigraphy and structure of the Ogallala Aquifer in the study area by using data obtained from high-graded well drillers' reports, used a total of 2,753 wells to help delineate the subsurface of the geology in the study area. The modeling results showed that the water volume in storage in the Tolk wellfield (shown as "Xcel Energy" on Table RLB-1) had decreased from 1.4 million acre-feet prior to 1950 to 0.52 million acre-feet in 2010.

Table RLB-1: Estimated Water in Storage for Individual Stakeholders

Year	Estimated Water in Storage (million acre-feet)				
	LCEC	DSEC	BCWF	**Xcel Energy**	Five-County Area
1950	9.8	59.5	2.5	**1.4**	101
1960	8.5	51.2	2.25	**1.3**	88.6
1970	7.4	41.5	2.2	**1.2**	74.3
1980	6.5	34.7	2.0	**1.1**	63.4
1990	5.9	31.0	1.9	**1.0**	56.9
2000	4.8	26.2	1.8	**0.8**	47.5
2010	3.6	22.4	1.64	**0.52**	39.2

[5] HPWD commissioned the study in cooperation with the City of Lubbock, Deaf Smith County Electric Cooperative, Lamb County Electric Cooperative, Golden Spread Electric Cooperative, Inc., and Xcel Energy.

It is important to note that the water volumes provided in the table include the total amount of water in the aquifer, including water that is stored below 40 feet of saturated thickness and therefore uneconomic to recover. Thus, the amount of economically-recoverable groundwater is less than what is shown in the table. And as the table shows, there is a clear trend of declining water volume in the aquifer for all study participants, including Xcel Energy.

Q. You testified earlier that HPWD updated the 2011 study in 2013. What did the 2013 update show?

A. The 2013 update estimated that water in storage in the five-county area had further decreased from 39.2 million acre-feet in 2010 to approximately 36.8 million acre-feet in 2013. It also showed a decrease from 1950 through 2013 of more than 60% reduction in total aquifer volume. The percentage reduction in economically-recoverable groundwater was even greater.

Q. You also testified that HPWD performs annual monitoring of the Ogallala Aquifer static water elevation on a county-by-county basis. What does that data show with respect to the area around Tolk?

A. Tolk is located in Lamb County, Texas. The HPWD data show that, on average in Lamb County, the aquifer groundwater level declined by 18.91 feet between 2007 and 2021. The data also shows that, by early 2022, the aquifer had an estimated average saturated thickness of just 48 feet for Lamb County. The HPWD data reinforces the conclusions that SPS has drawn from the results of modeling completed internally and by external consultants – the economically recoverable groundwater in the Tolk wellfield is declining rapidly.

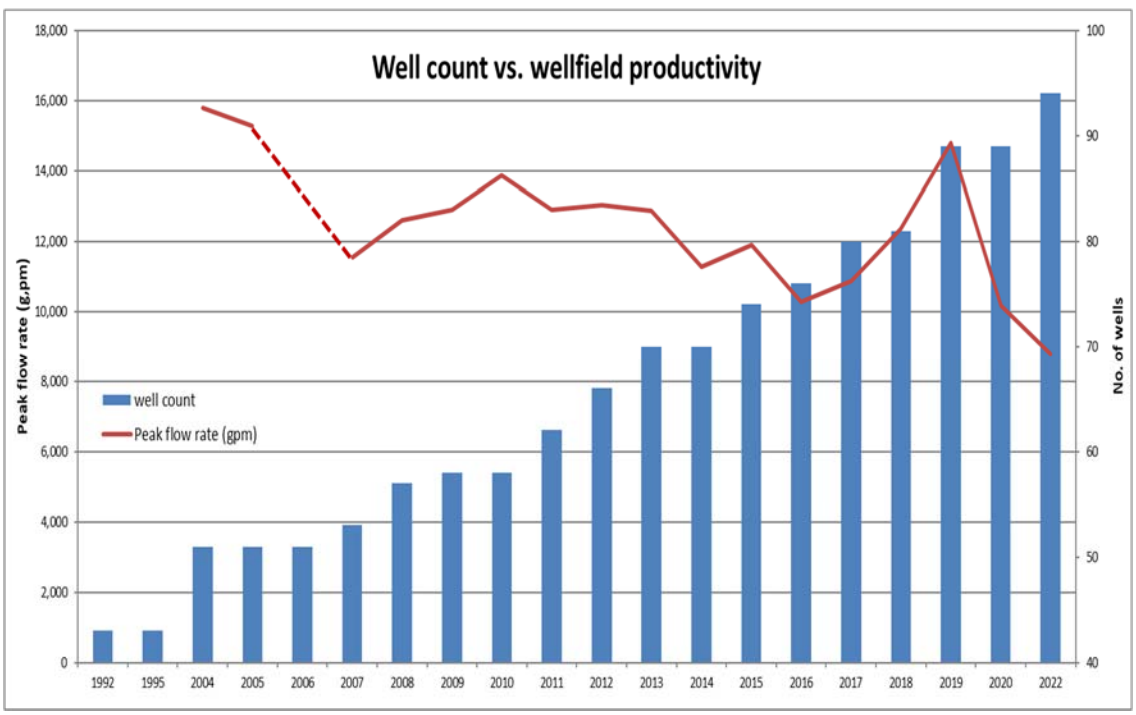
Q. What does the USGS data demonstrate about the water levels in the Ogallala Aquifer?

A. The USGS data also reflects significant groundwater declines throughout the Texas panhandle, which generally corroborates the data collected by HPWD. SPS, however, does not rely heavily on the USGS data because it does not have the same level of granularity as the HPWD data and the other modeling results.

Q. Earlier you mentioned that Tolk Station has undergone semi-annual wellfield productivity tests. Please explain what those are and their results.

A. Beginning in 2016, SPS began performing semi-annual wellfield productivity tests to monitor instantaneous total wellfield productivity and to compare the results to previous results in order to document the rate of productivity decline over time. Wellfield productivity assessments since 1992 show a decline in overall wellfield productivity along with a dramatic expansion in wellfield size, as shown in Figure RLB-2 (below). Results since 2016 show that SPS has been maintaining the minimum wellfield productivity necessary to support the plant's peak operating demand though the addition of new wells. The testing confirms that it has become increasingly critical to add wells to the wellfield to offset the annual productivity loss and maintain peak flows to support generation at the Tolk units.

Figure RLB-2: Tolk Wellfield Productivity Decline Since 1992



Q. Please elaborate on productivity loss of the Tolk wellfield.

A. At the time Tolk was built on the wellfield, the average well's productivity was approximately 700 gpm and sustained this rate for years. Today, a new well's productivity is approximately 200 gpm and begins to decline almost immediately, depending on the geology and saturated thickness in the well's immediate vicinity. This illustrates the peak production challenge discussed earlier, and it is an impact of aquifer decline that SPS has observed first-hand in the Tolk wellfield. It is not speculation. As the saturated thickness at any well declines toward 40 feet, well productivity will likely fall further to the 50- to 80-gpm range, and ultimately to zero. In fact, many of the original wells in the wellfield are no longer producing at all, while some are producing well under 100 gpm. This is evidenced in Figure RLB-2 between 2017 and 2022. Eighteen new wells were added to the wellfield over that period (including one horizontal well). Wellfield productivity improved over that time, but then declined by 20% by 2022, demonstrating the declining productivity of both new and older wells in the wellfield.

Although the overall Tolk wellfield averages 48 feet of saturated thickness over the existing 50,000 acre wellfield, it ranges from 25-30 feet in the western portion of the wellfield to approximately 65 feet in the eastern portion, an area located approximately 25 miles from Tolk Station (see Attachment RLB-3). This is a 70-80% reduction in the overall saturated thickness (i.e., including thickness below 40 feet which is not economically recoverable) from predevelopment thickness. Only 5% of the economically-recoverable saturated thickness remains.

As the saturated thickness declines, the water flow into each well decreases and the production drops accordingly. As shown by Figure RLB-2 above, although SPS has increased the well count by approximately 220% since 1992, the total wellfield production has declined by approximately 45% over the same period. Therefore, SPS must add new wells nearly every year to maintain the water flows necessary to operate the Tolk units. This effort is becoming increasingly expensive with diminishing returns, and therefore it is not sustainable long-term.

Q. Earlier you mentioned that SPS uses the services of AGS, a third-party groundwater consultant. Who is AGS?

A. AGS is a Texas-based consulting firm specializing in groundwater, with significant local experience throughout Texas and specifically with the Ogallala Aquifer. The AGS consultants with whom SPS has worked are experts in groundwater modeling, particularly in the Tolk region.

Q. Please describe generally the groundwater modeling methodology used by AGS.

A. AGS conducts groundwater modeling using MODFLOW, the industry standard groundwater modeling software. The AGS model, which uses the same basic data (e.g., base of the aquifer, values for various aquifer parameters, and monitoring well calibration observations) as the regional groundwater planning models prepared by the Texas Water Development Board, has been revised to incorporate updated regional model data as they have improved. In addition, the model calibration uses local data collected from the Tolk wellfield (water level measurements and pumping estimates) to improve the model calibration around the wellfield.

Q. Please describe the frequency of the modeling performed by AGS.

A. Initially, AGS conducted groundwater modeling every few years. Modeling increased as SPS considered a number of options for Tolk's coal operations. SPS has continued to present groundwater modeling in regulatory proceedings to support proposals for earlier retirement dates. AGS is presently conducting groundwater modeling annually in order to monitor the rapid decline of the aquifer as SPS manages its remaining water resources in the Tolk wellfield.

Q. Did any of the modeling assumptions change over time?

A. Yes. When it began modeling, AGS focused primarily on the overall water stored in the Tolk wellfield, under the assumption that neighboring activities (e.g., agricultural and municipal use of water from the aquifer) could be safely ignored given the wellfield's large size. Over time, it became clear that, in fact, surrounding agricultural and municipal uses of the aquifer were having an effect on recoverable water in storage in SPS's wellfield, so AGS revised the model to encompass a larger area around the wellfield to be able to better gauge that impact.

Q. Have the modeling tools continued to evolve and improve over time?

A. Yes. The USGS, which developed the MODFLOW model, has continued to improve the model code, which led to more accurate results from later model generations. AGS completed new groundwater studies for SPS in 2016, 2017, 2018, 2019, 2020, and 2021 using the same general model and updated inputs to account for changed conditions annually.[6] For example, one of the most significant variables in the AGS model relates to the volume of agricultural water use within

[6] The 2016 AGS groundwater model was peer-reviewed by another local hydrogeology consultant, DBS&A, who found that the analysis methodology used by AGS yielded reasonable results.

the model domain but outside of the SPS wellfield, which drives overall water usage in the area. Agricultural water use in the model domain is not metered, per HPWD rules, so approximations of agricultural water use represent the best-available estimate for use in the model. Estimated water use in recent years is comparable to the (unmeasured) 18-inch per acre per year water production limit allowed for groundwater users in the HPWD. The model is calibrated annually based on real well observations, so this assumption is verified annually.

Q. Does SPS have measures of individual well production and aquifer characteristics?

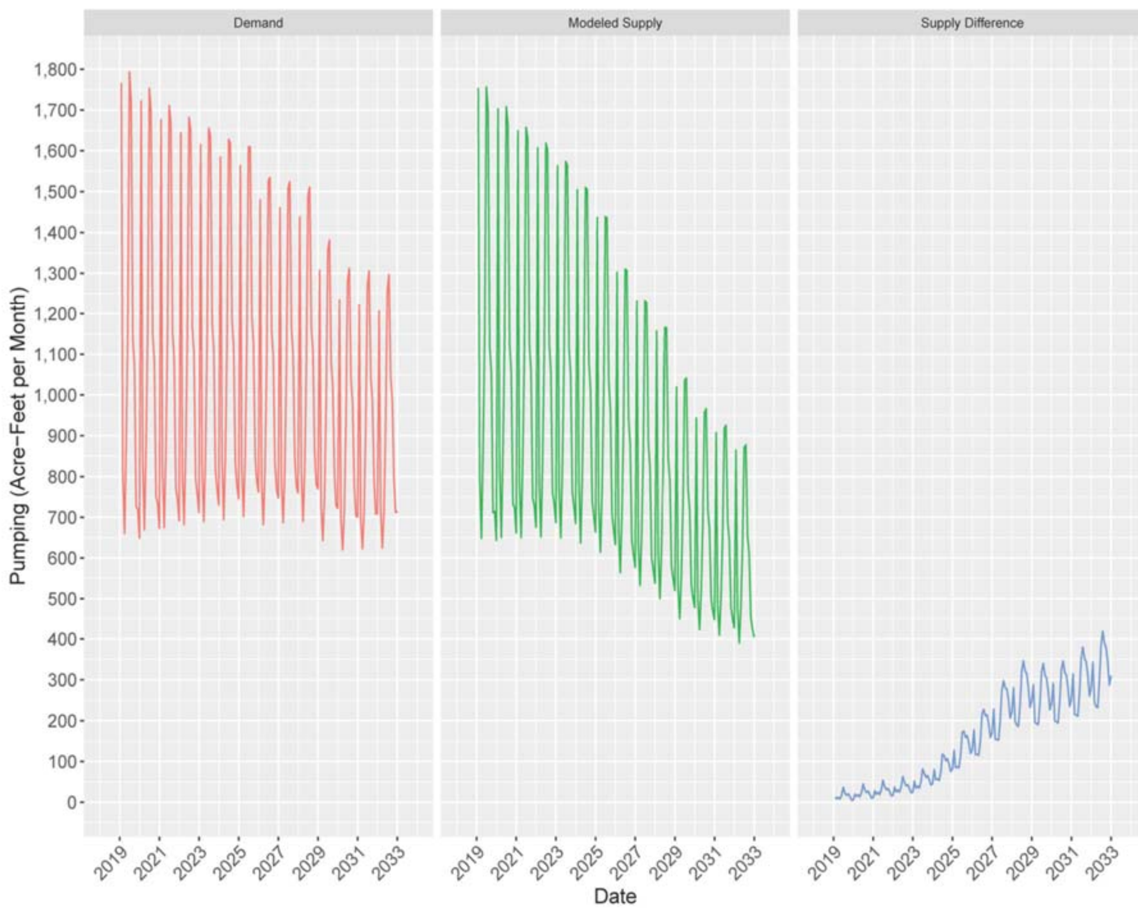
A. Yes. AGS measures well production and aquifer characteristics for a representative selection of wells on an annual basis. These measurements are used for quality control and to calibrate AGS's groundwater model.

Q. Please describe the 2021 study and its conclusions.

A. The 2021 AGS report, which is Attachment RLB-1, confirms the overall rapid decline of the Ogallala Aquifer and the Tolk wellfield. It also projects how the aquifer would respond to two Tolk operational scenarios: a "typical" demand scenario and an "seasonally-restricted" demand scenario.[7] The results from the predictive runs indicate that SPS will have challenges meeting the average annual groundwater demands under the typical scenario, with the challenges accelerating from 2024 on. The 2021 report further confirms SPS's experience that meeting summer peak demands began to be a challenge for the wellfields starting in 2019. These results have been consistent between model updates in recent years, and, in response, Tolk added 12 new wells between 2018 and 2022 to help offset the predicted production deficits. Nevertheless, aggregate well productivity has declined approximately 40% since these new wells were added.

[7] The "typical" scenario assumes economic dispatch in all months. The "seasonally-restricted" scenario (referenced as "optimized" in the 2021 AGS report) assumes economic dispatch in only the peak months.

Figure RLB-3: Figure 3-2 From 2021 AGS Report: Typical Demand R



Q. What conclusions do you draw from the 2021 groundwater study results?

A. The 2021 groundwater study results confirm that SPS should be able to operate under the optimized scenario, i.e., economic dispatch with a 4,000 GWh/year target, through 2028. A new groundwater study is currently underway which will update the aquifer conditions and operating scenario based on 2022 data. This model should be available in January 2023.

Q. Has SPS performed any other analysis showing how alternative Tolk generation scenarios would affect the period in which economically recoverable water remains available in the Tolk wellfield?

A. Yes. In addition to the AGS analysis, SPS conducted its own modeling to evaluate Tolk's long-term water supply under various operating scenarios. The model, which is Attachment RLB- 2 to my testimony, allows for variation of key input variables to produce an estimate of when the economically recoverable groundwater in the Tolk wellfield will be depleted. SPS has updated the model numerous times as new data becomes available and assumptions are improved.

Q. What are some of the key variables used in SPS's modeling of the water depletion window?

A. There are several key variables used in the model, including the following:

- generating unit capacity factors and monthly/seasonal variability;
- auxiliary water demand;
- available reservoir storage;

- wellfield capacity, outage rate, rate of productivity decline, and starting capacity of new wells;
- water demand for potential environmental controls;
- variables to account for other variation in water use by each unit; and
- estimate of starting recoverable groundwater volume (derived from MODFLOW modeling described previously).

The variables can be modified as needed to assess the impact of potential future plant operations on wellfield longevity.

Q. How are the results of SPS's water modeling used to estimate retirement dates for Tolk?

A. The "water depletion window" is the range of years in which SPS predicts the water level will become insufficient to economically provide for Tolk's coal generation cooling needs. The start of the depletion window begins when the model indicates 50,000 acre-feet of recoverable water remaining in storage and ends when the model indicates less than 20,000 acre-feet of recoverable water.

Q. Please describe how SPS's water model was used to determine depletion ranges associated with alternative operating scenarios for the Tolk units.

A. SPS modeled the aquifer depletion based on the forecasted generation for Tolk provided by SPS's Resource Planning group to determine a depletion range for the optimized generation scenario. Attachment RLB-2 shows the economic water production window for the scenarios described in Mr. Elsey's direct testimony based on modeled water demand, electric generation, and total water availability predicted by the AGS groundwater model. For example, the model predicts that the economic depletion range of the aquifer (expressed in years of service of Tolk) would be at the end of 2028. This is shown as Scenario 1 on the Summary Tab of Attachment RLB-2.

Q. Does SPS's water modeling present a reasonable estimate of the potential depletion of the aquifer relative to Tolk operations?

A. Yes. SPS's water modeling provides a reasonable estimate of aquifer depletion that affects Tolk's coal operations. SPS's water modeling results are consistent with the available water modeling, water reports, and water studies that SPS has reviewed from third parties (such as AGS, HPWD, and the USGS). Put simply, every source confirms that the Ogallala aquifer is in a state of persistent and irreversible decline.

Given the known direction of aquifer depletion, the drop in the per well production, the prohibitive cost of new water well infrastructure, and the continued agriculture, municipal, and domestic demand for water from the aquifer, much of which is beyond SPS's control, it is reasonable to conclude that the useful lives of the Tolk generating units will not reach the currently-approved retirement date of 2032. In times of higher gas prices, customers will benefit from the economic dispatch of Tolk operations and an annual generation target of 4,000 GWhs/year will optimize economic operations for customers while managing the remaining water resources and preserving the accredited capacity value of Tolk's coal generation through the timeframe until replacement generation resources can be determined following SPS's next Integrated Resource Planning process. SPS expects water depletion will make water recovery uneconomic at Tolk past 2028 and SPS must plan accordingly.

Q. Does this conclude your pre-filed direct testimony?

A. Yes.

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SOUTHWESTERN PUBLIC SERVICE COMPANY,	)	
APPLICANT.	)	

VERIFICATION

On this day, November 18, 2022, I, Richard L. Belt, swear and affirm under penalty of perjury under the law of the State of New Mexico, that my testimony contained in Direct Testimony of Richard L. Belt is true and correct.

/s/ Richard L. Belt
Richard L. Belt

2021 GROUNDWATER MODELING RESULTS FOR TOLK STATION AND PLANT X IN LAMB COUNTY, TEXAS

Prepared for:

Xcel Energy®
RESPONSIBLE BY NATURE™

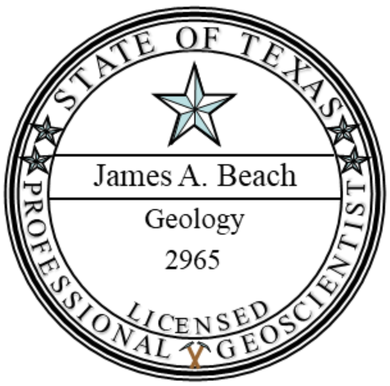
Submitted | January 25, 2022

Prepared by:

AGS
Advanced Groundwater Solutions, LLC

www.advancedgw.com

Professional Seal



The seal appearing on this document was authorized
by James A. Beach on January 25, 2022.
Advanced Groundwater Solutions, LLC
TBPG Firm Registration No. 50639

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1.0 Executive Summary

The groundwater flow model used by Xcel Energy (Xcel) to predict the future production from wells in the Xcel water rights area (XWRA) was updated and used to simulate two pumping scenarios. As with previous years (WSP 2019, WSP 2020) the two scenarios consisted of a typical case and an optimized case. The typical pumping scenario reflects current pumping trends with the goal of producing more groundwater now and the optimized scenario uses reduced pumping rates early with the goal of extending wellfield life and reducing the production deficit over time. In both scenarios, the limiting factor to the amount of groundwater that can be produced from the wellfield is the saturated thickness limit set in the model at 40 feet. Once the average saturated thickness in a gridblock drops below 40 feet, simulated production rates in wells are reduced by the model, which creates a deficit between the groundwater demand that is input into the model and the simulated production.

Results from both scenarios indicate Xcel will likely have deficits attempting to meet annual production demands in the 12-year simulation. However, the typical scenario produces more groundwater early and less volumes later in the simulation, leading to greater deficits compared to the optimized scenario, which produces less groundwater during the 12-year period, but at a steadier rate, which results in smaller deficits in the later years.

2.0 Groundwater Model Updates and Revisions

2.1 Pumping Updates and Predictive Pumping Estimates

All methods used in previous model updates (WSP USA, 2019, 2020) are continued to be used in this year's update. We defer to those reports for the full explanation on the methodology and will summarize here any updates to those methodologies, quick summary of the methodology, and major assumptions for each.

2.1.1 Historic Xcel Wells Pumping Rates

- Reuses pumping rates from previous model updates.
- Incorporates pumping estimates from 2018 for years 2019 and 2020

2.1.2 Xcel Wells Pumping Distribution

- Distribution is broken down as a percentage of contribution to total production rates based on data collected in 2015.
- Assumes that pumping distributions have remained the same or similar since 2015.

2.1.3 Predictive Pumping Estimates for Xcel Wells

- Pumping rates from 2021 (current rates) are reused for each predictive year.
- Assume that production distribution will remain the same or similar into the future.

2.1.4 Xcel Potential Future Wells (P wells)

- One new P well will be added to the model per year starting in 2022.
- Pumping will be set to the first quantile of all Xcel pumping per month per year.
- Assume the estimated location and pumping rate of each P well.
- Assume the one new well will be drilled and production ready each year.

2.1.5 Xcel Horizontal Wells (H wells)

- Started producing groundwater in 2017.
- Modeled as four separate wells to replicate the horizontal design.
- Constant total pumping rate 1,290 acre-feet per year (800 gpm).
- Assume horizontal well design will prevent production loss and can produce at a constant rate and will therefore the rate will not be changed in the creation of the well file.
    - Well pumping rate can still be lowered by the model.

2.1.6 Xcel Pumping Correction

- Predictive rates need to be corrected in order for them to produce the desired amount set in the two scenarios.
- To implement corrections - the following assumptions are applied:
    - All wells that produce under 45 gpm are removed from the scenario well file, as it is assumed they would be shut off instead of left to run.

- The model may cutback pumping below the 45 gpm during the model run, and those wells were not removed.
- All H wells production rates remain constant and do not change based on the desired annual rate.
- The remaining wells pumping rates are altered by a percentage to increase or decrease all pumping so that the total annual pumping rate matches the desired scenario rate.

The annual Xcel pumping demand simulated in the optimized and typical scenarios is shown Table 1.

Table 1. Xcel Pumping Demand for Optimized and Typical Scenarios

Year	Optimized Demand (AFY)	Typical Demand (AFY)
2021	10,900	10,900
2022	13,500	13,500
2023	13,500	13,500
2024	13,500	13,500
2025	6,500	13,500
2026	6,500	13,500
2027	6,500	13,500
2028	6,500	13,500
2029	6,500	13,500
2030	6,500	13,500
2031	6,500	13,500
2032	6,500	13,500

2.2 Groundwater Flow Model

The code used to simulate groundwater flow was MODFLOW-NWT (Niswonger et al., 2011) as modified for the HPAS GAM. The modification altered the original MODFLOW-NWT code to accept a constant saturated thickness value over a percentage. For illustrative purposes, Figure 1 shows how pumping is cutback as water levels decline. This alteration allowed for the entire model to have the same saturated thickness cutoff value, while the original MODFLOW-NWT code could have variable saturated thickness cutoffs due to different aquifer thicknesses throughout the model (Deeds et al., 2015). Another advantage of using MODFLOW-NWT code over other versions is its ability to handle dry cells, or cells that have water levels that go below the bottom of an aquifer. Because we are dealing with the Ogallala aquifer, an unconfined aquifer, dry cells would have been a major concern. However, due to the automated reduction of pumping, the model can both create a more realistic pumping scenario in which pumping would naturally drop off as water levels decline, while also creating a model that will not have any computational issues due to model cells becoming deactivated as they become dry.

For the Xcel model analysis the saturated thickness threshold remains the same as previous years at 40 feet. This value was chosen as it is the value at which large production wells may struggle to produce or maintain their production capacity. While the 40-foot threshold is a fixed value in the model where well production is decreased, that value likely varies from well to well in the aquifer due to site-specific geology, well construction, pump characteristics, and other factors. The 40-foot threshold should be viewed as conservative average estimate as to when well production loss would begin to occur.

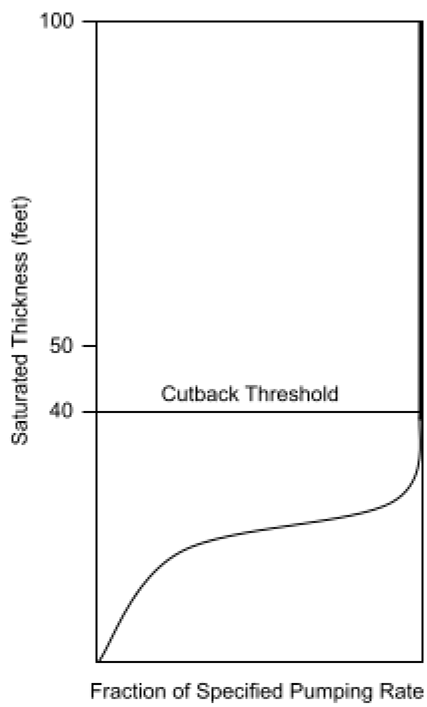

Figure 1. Illustrative example of how MODFLOW-NWT reduces pumping when water levels in a cell grid drop below the saturated thickness limit in the modified HPAS GAM. Modified from Niswonger et al., 2011.

3.0 Model Results

The results from the optimized and typical scenarios were processed and compared to one another in order to show how the changes in pumping between the two scenarios would affect the future groundwater supply within XWRA. The three main simulated groundwater results analyzed were the modeled groundwater supply, saturated thickness, and stored groundwater.

3.1 Modeled Groundwater Supply Results

Results for the modeled groundwater supply are shown as a series of three line graphs plotting the pumping in acre-feet per month from 2019 through 2032 (figure 2). The three lines represent the pumping demand (red line), modeled supply (green line), and the supply difference (blue line). The pumping demand section plots the desired pumping rate and represents the values imputed into the model. The modeled supply plot shows the pumping rate after cutbacks were applied to the model due to water level declines. The supply difference is the difference between the demand and the modeled supply and represents the monthly production rates that cannot be met due to simulated declines in groundwater levels through time.

The optimized scenario graph (figure 2) clearly shows the large change from the initial higher demand starting in 2021 until the start of the reduced demand in 2025. This is reflected in the supply difference with larger and more pronounced spikes in supply difference during the high demand phase, and lower spikes in the lower demand phase. Due to the difference in pumping it can be observed that the supply difference reaches the max difference both during 2024 and at the end of the model run in 2032. While the initial pumping reaches that amount within 4 years, the lower pumping phase takes another 8 years before it reaches the max again.

The typical scenario groundwater supply graph (figure 3) shows how the pumping rate quickly increases and remains high throughout the entire model run. The modeled supply line shows a clear decreasing trend that is very noticeable when looking at the maximum and minimum pumping for each year. With each year the values start to become lower, and as the model progresses the amount that is lost per year also increases. This can be seen easier in the supply difference line. Through time the amount of groundwater supply that cannot be achieved increases, but also becomes more exaggerated due to the seasonal variations. The maximum supply difference is around 500 acre-feet per month.

A comparison graph showing the supply difference between the optimized and typical run was produced to show how they directly compare to one another. Figure 4 shows the optimized supply difference in blue and the typical supply difference in yellow. The graph shows that the two scenarios do not split until the start of 2025 when the scenarios pumping rates split, with the typical set to 13,500 acre-feet per year and the optimized to 6,500 acre-feet per year. From 2025 on the difference between the two is noticeable and grows with time. The typical scenario has both a much larger overall supply difference, but also shows much larger seasonal variation per year. Whereas the optimized scenario shows much lower overall supply difference and much smaller variation within the seasonal variation.

Figure 5 shows the groundwater supply results for all pumping outside of XWRA. The first thing to note is that the pumping outside Xcel is much larger as it makes up for all other pumping within the model which consists of large agricultural producers. Second, the model estimates that pumping rates cannot be maintained at the desired demand. Lastly, the seasonal variation also appears to be much more exaggerated with the peak seasons showing major reduction in groundwater production, while the off seasons show the model able to meet most of the demand.

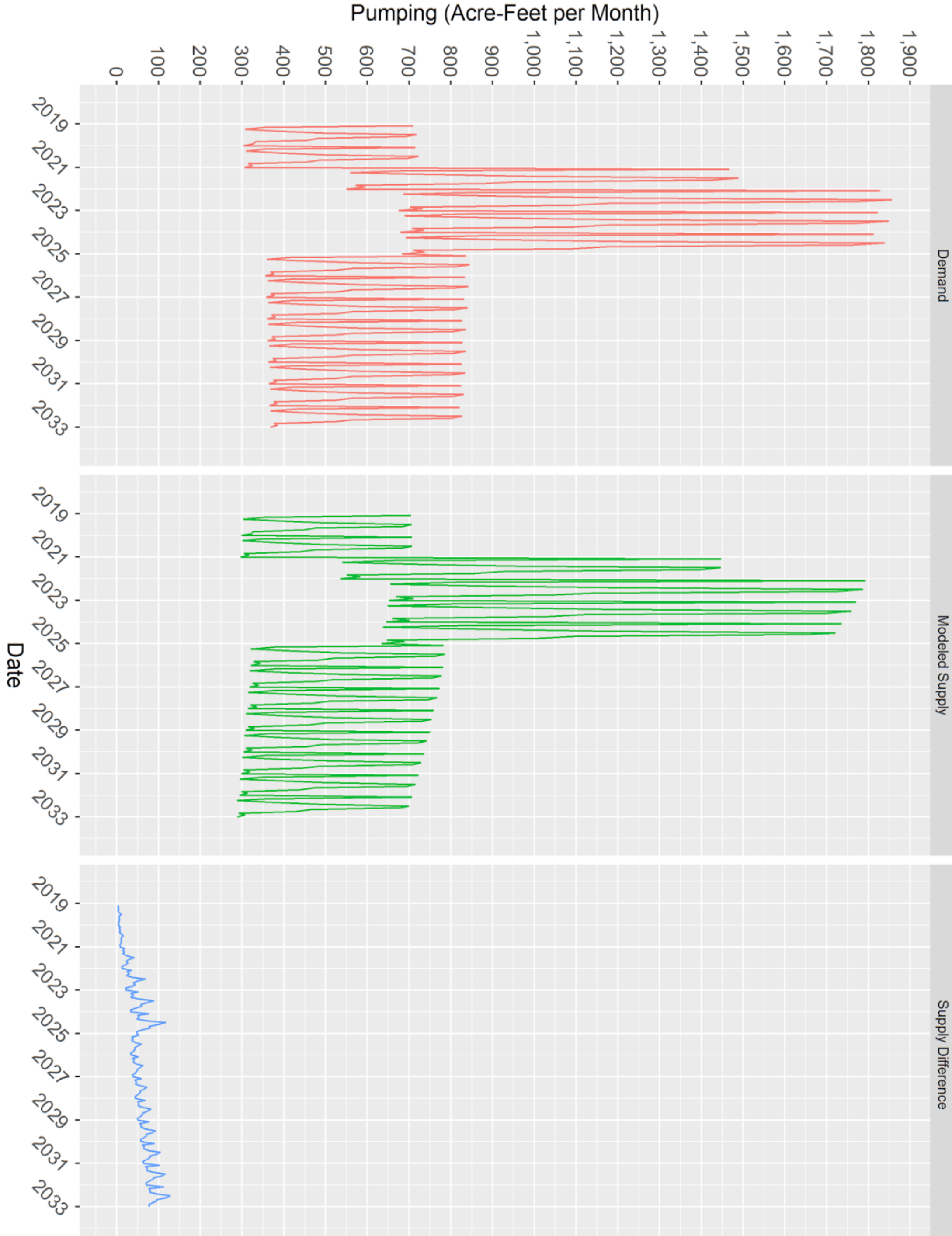

Figure 2. Optimized scenario modeled groundwater supply results showing the demand, modeled supply, and difference for Xcel wells.

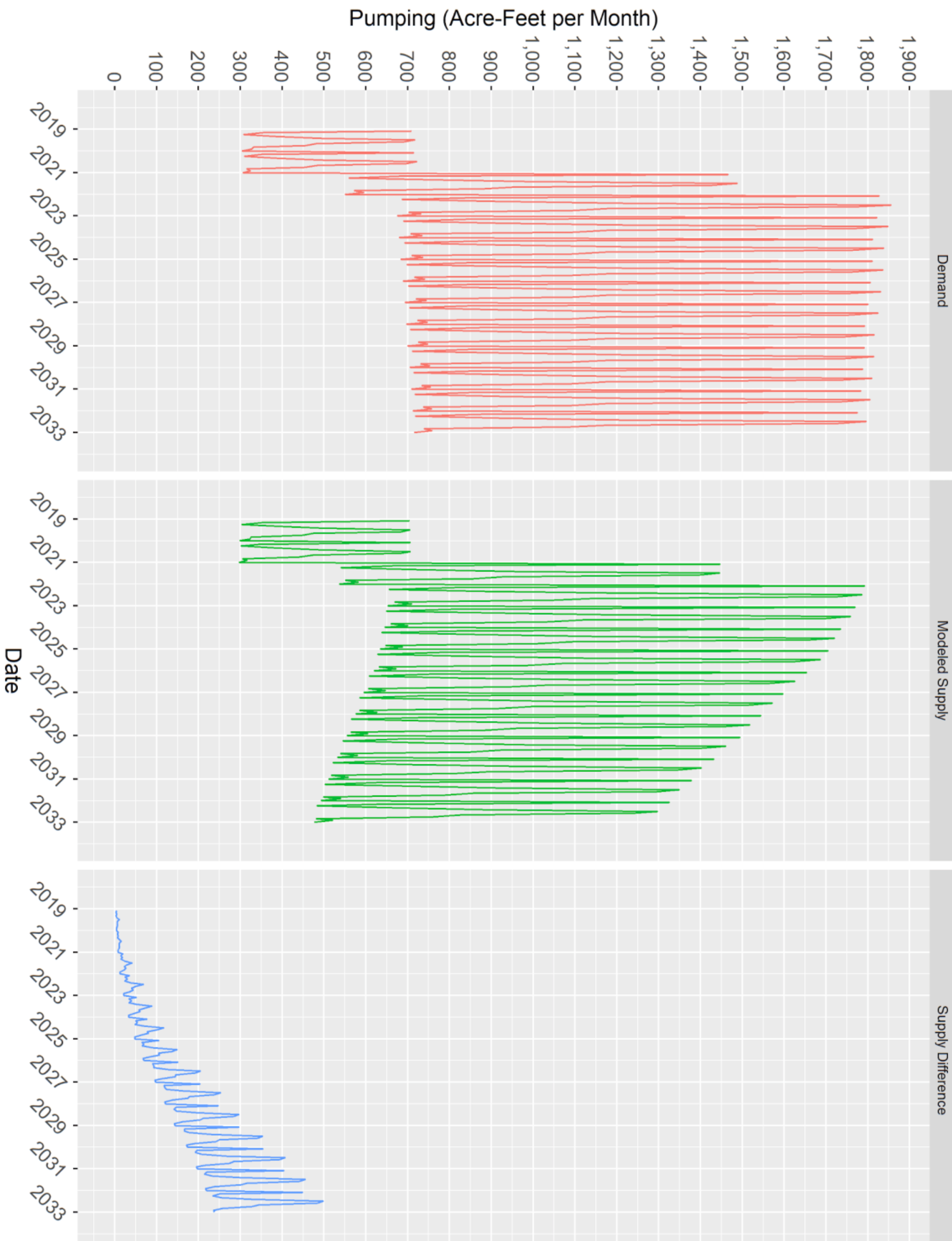

Figure 3. Optimized scenario modeled groundwater supply results showing the demand, modeled supply, and difference for Xcel wells.

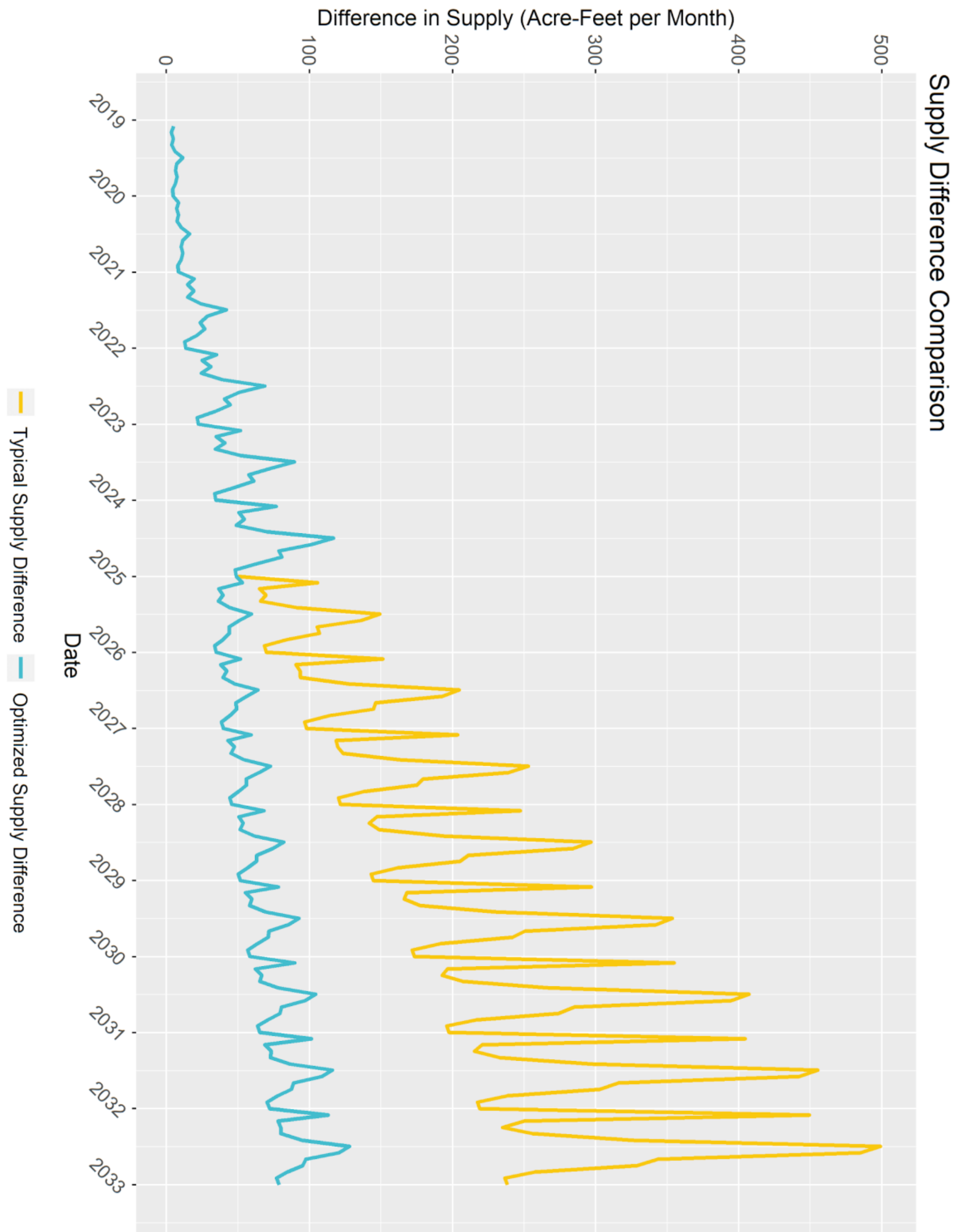

Figure 4. Groundwater supply difference comparison between the optimized and typical scenario.

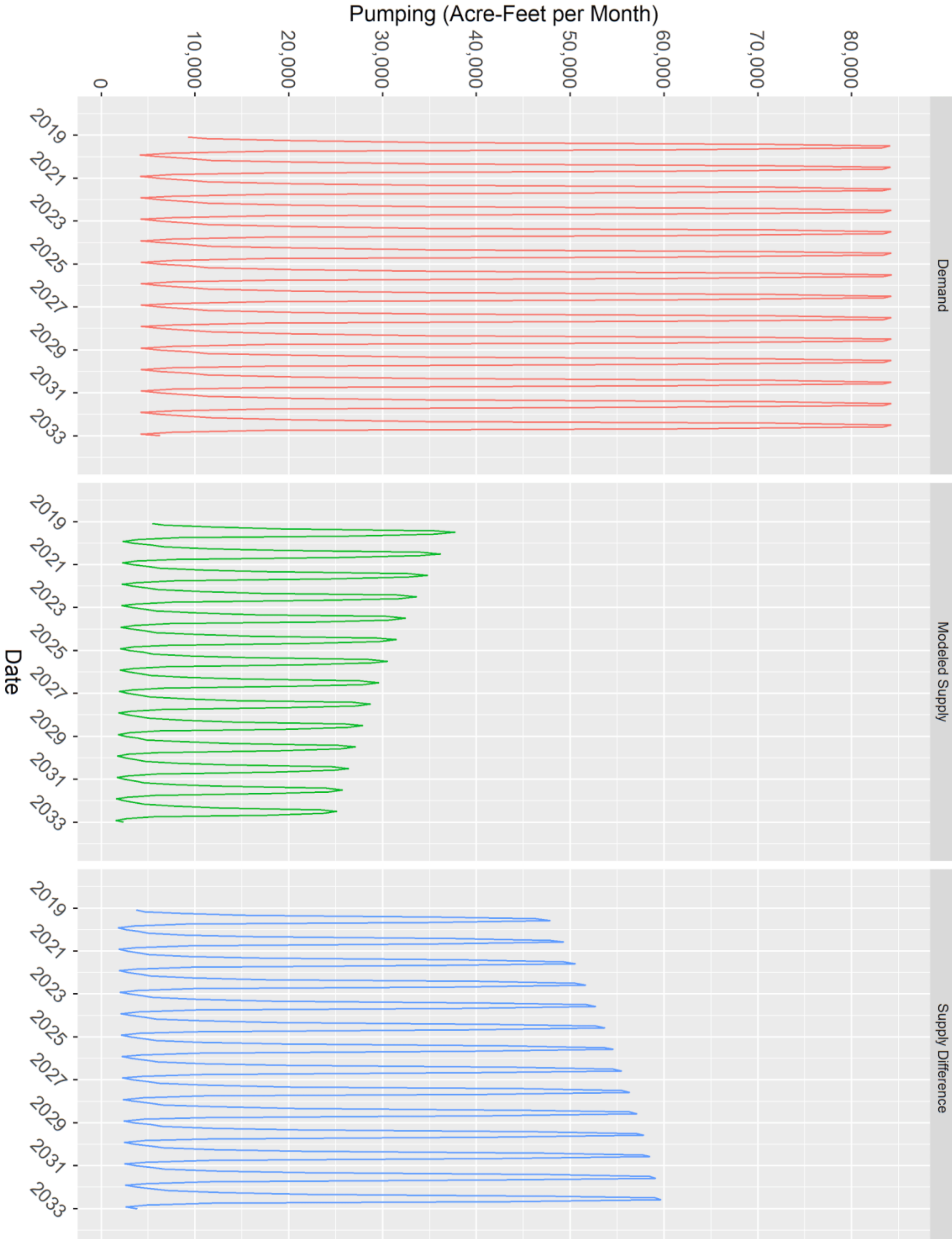

Figure 5. Modeled groundwater supply for pumping outside XWRA.

3.2 Saturated Thickness Results

Due to the importance of saturated thickness in the model simulations, it is important to understand and analyze where and how much the saturated thickness is changing within XWRA. To do that the saturated thickness for all model cells within Xcels property were plotted (gray lines) through time along with the average saturated thickness value (blue line) for both the optimized (figure 6) and typical scenarios (figure 7). For both scenarios, the variation of saturated thickness within XWRA is large with values ranging between 110 to 10 starting in 2019 and decreases to between 75 to 5 at the end of the model run. Both scenarios show very similar results in saturated thickness overall with the average saturated thickness showing a small difference of about 3 feet at the end of 2032, 33 feet for the optimized and 30 feet for the typical scenario. In both cases though, there is a clear decline in saturated thickness with time.

To visualize how saturated thickness is changing spatially within XWRA, a series of saturated thickness contours were created for each year in the model run starting in 2022. Each map shows the December values for each year along with all active wells on the map, this includes P wells that are added one per year starting in 2022. Figure 8 shows the saturated thickness contours for the optimized scenario in December 2022 and figure 9 for December 2032. At the start of the model run water levels are generally higher in the eastern properties and lower in the western sections. Within the western sections some areas are already below or at the 40 foot saturated thickness level. As the model progresses and we arrive at the last time interval in 2032, the general trend still holds that the eastern section has higher saturated thickness relative to the western section. However, the change in saturated thickness is much more prominent in the eastern section. This is likely due to the eastern wells being able to pump at much higher rates due to the higher saturated thickness leading to increased groundwater decline, whereas the western section was already starting at or close to the 40 foot saturated thickness limit. This lower pumping prevents the water levels from declining as fast as the eastern section. Figure 10 shows the saturated thickness contours for the typical scenario in December 2022 and figure 11 shows the results for December 2032. The typical scenario has very similar results to the optimized, except that the magnitude of groundwater decline is larger. In the optimized case the minimum saturated contour line in the eastern properties was 30 feet whereas in the typical case is 20 feet. In the western section the contours are nearly identical, which once again is likely due to starting at or below the saturated limit causing pumping to be similar in both scenarios.

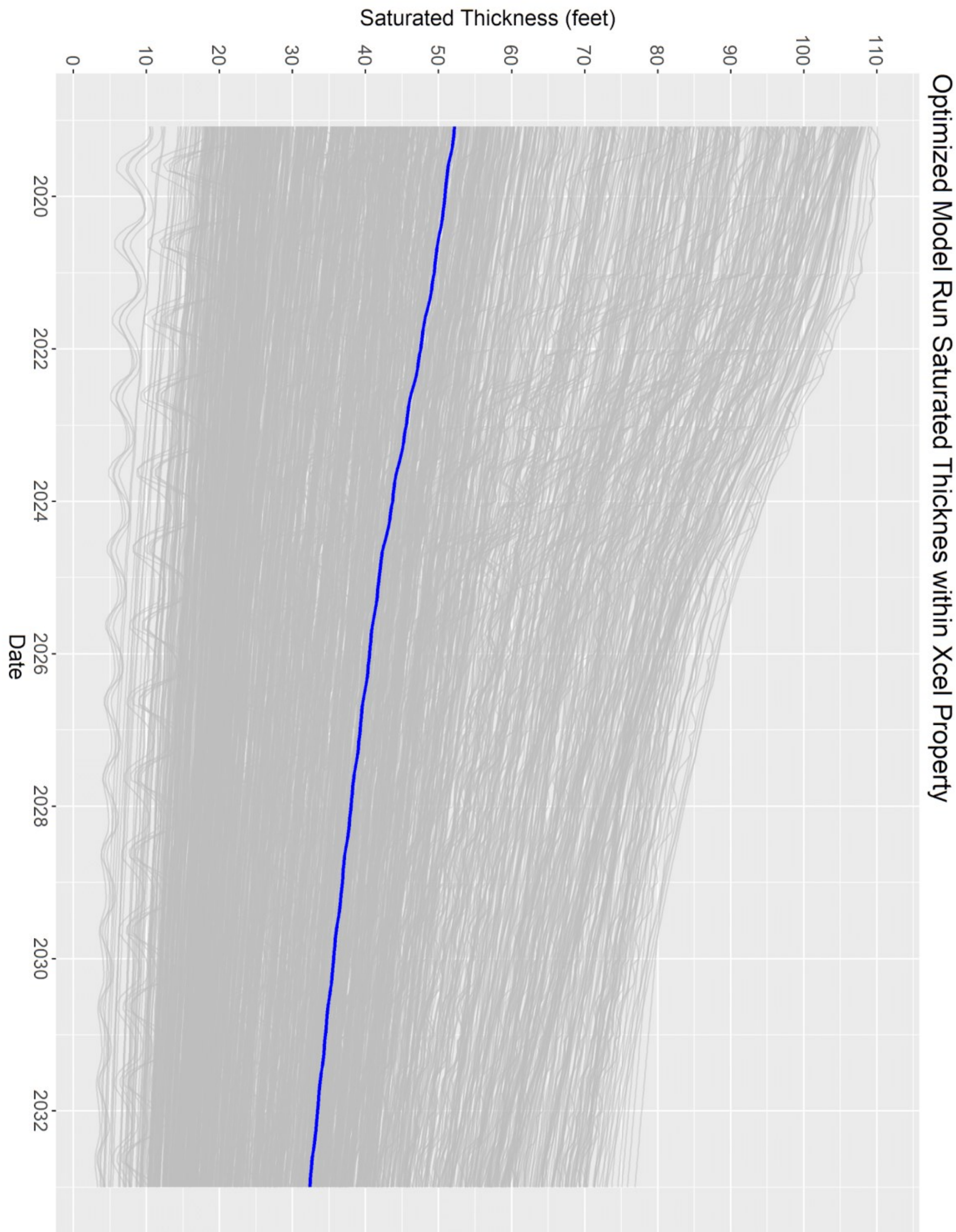

Figure 6. Optimized scenario saturated thickness values for all model cells within XWRA through time. Gray lines represent individual model cells and the blue line represents the average saturated thickness.

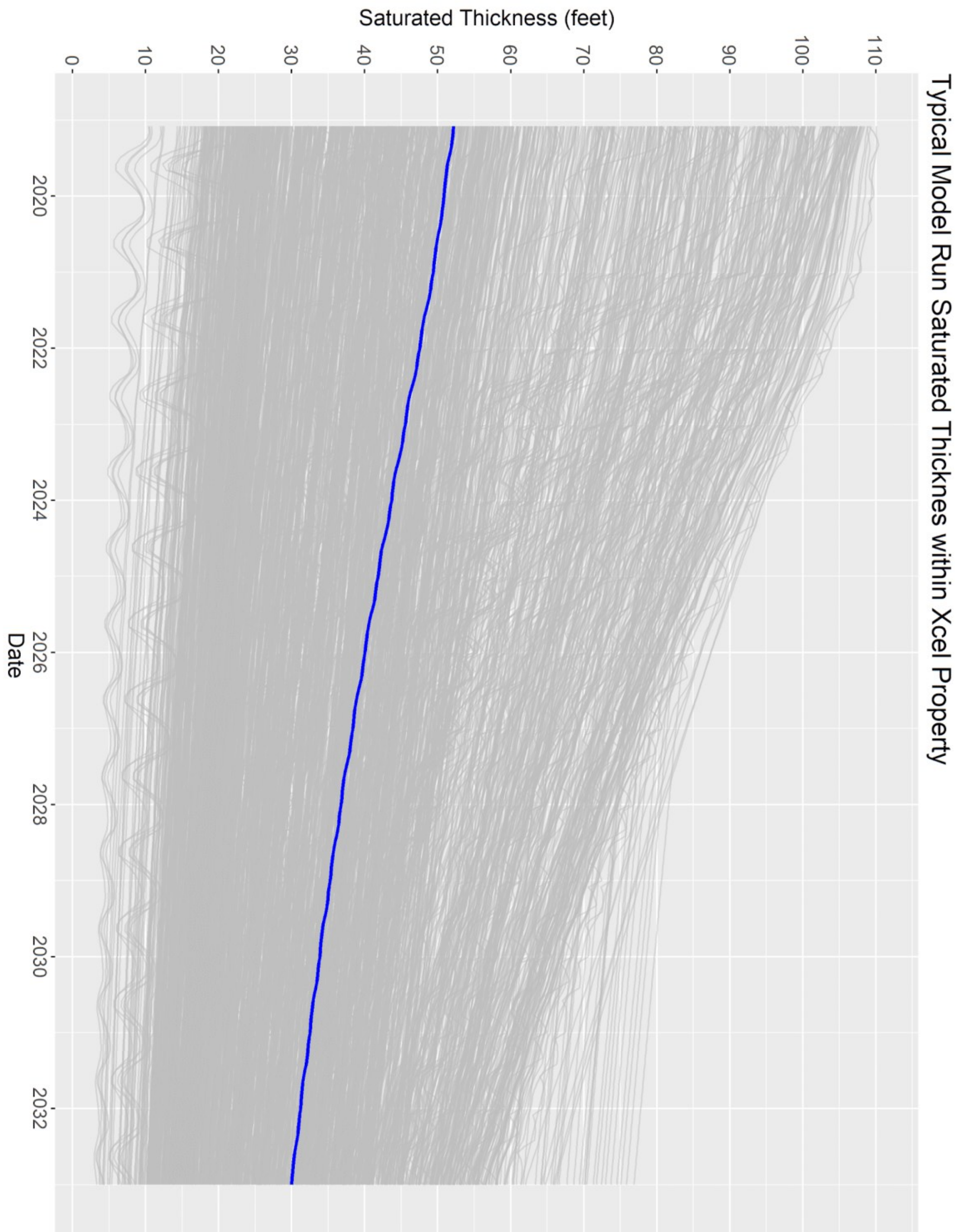

Figure 7. Typical scenario saturated thickness values for all model cells within XWRA through time. Gray lines represent individual model cells and the blue line represents the average saturated thickness.

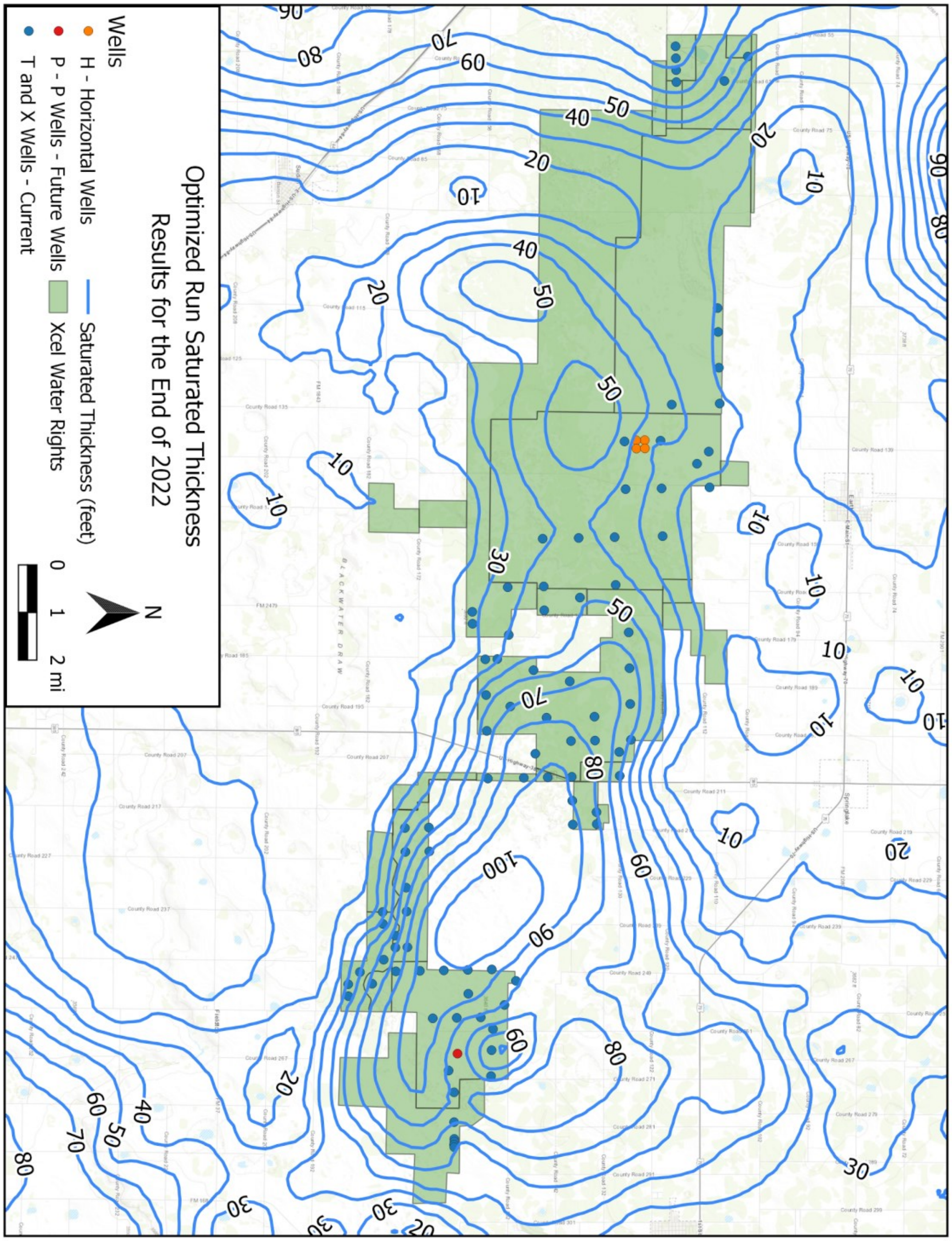

Figure 8. Modeled optimized scenario saturated thickness contours for XWRA in December 2022.

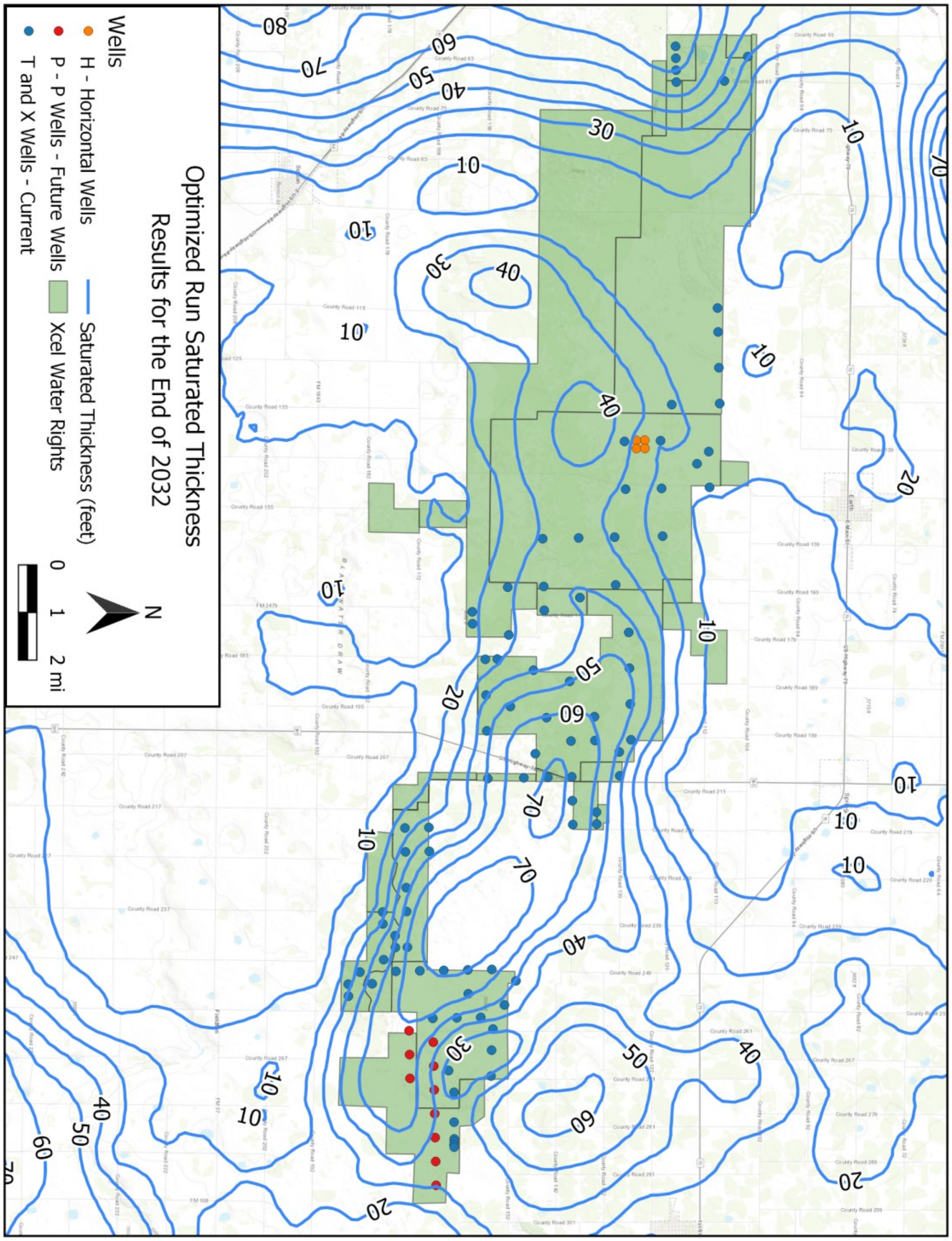

Figure 9. Modeled optimized scenario saturated thickness contours for XWRA in December 2032.

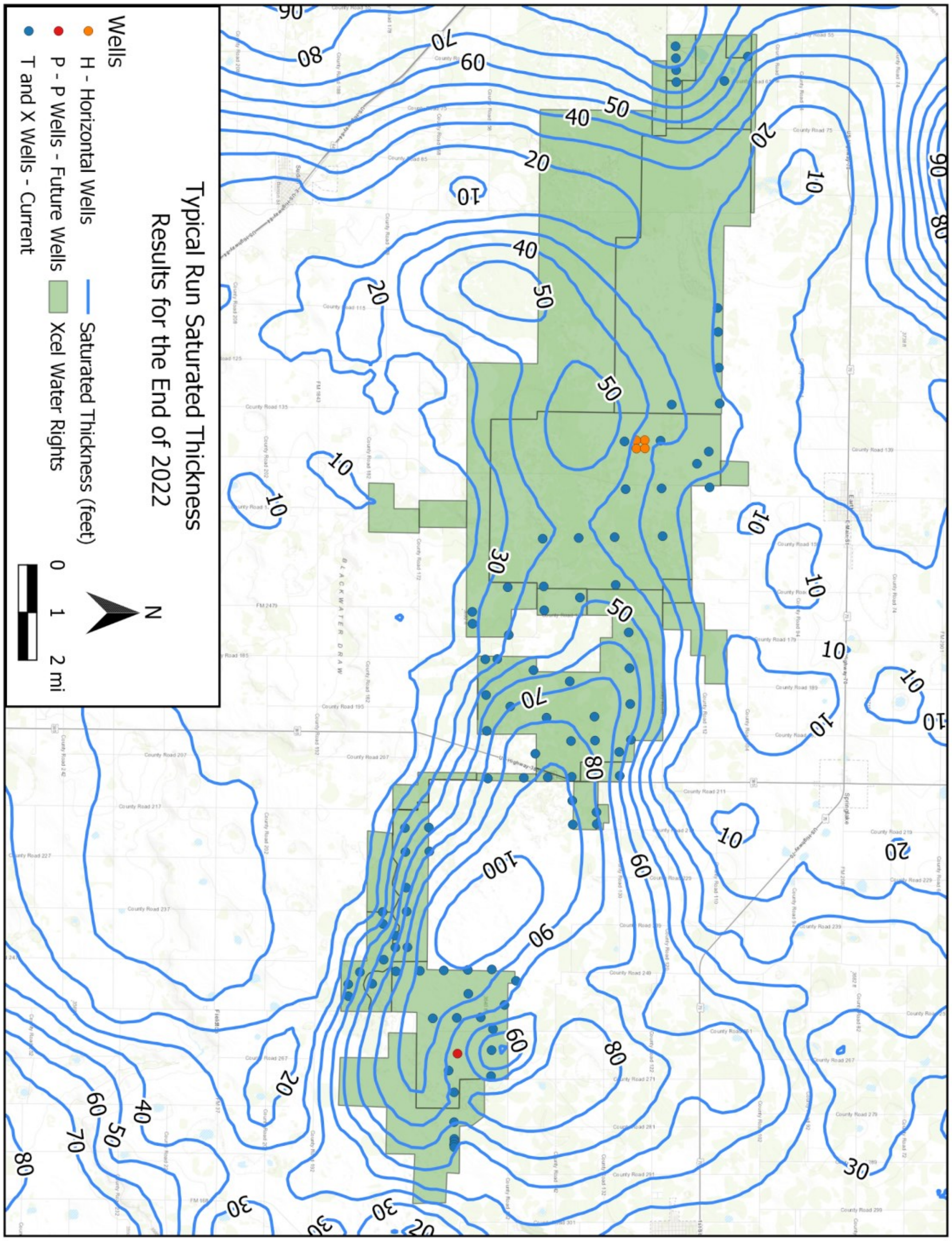

Figure 10. Modeled typical scenario saturated thickness contours for XWRA in December 2022.

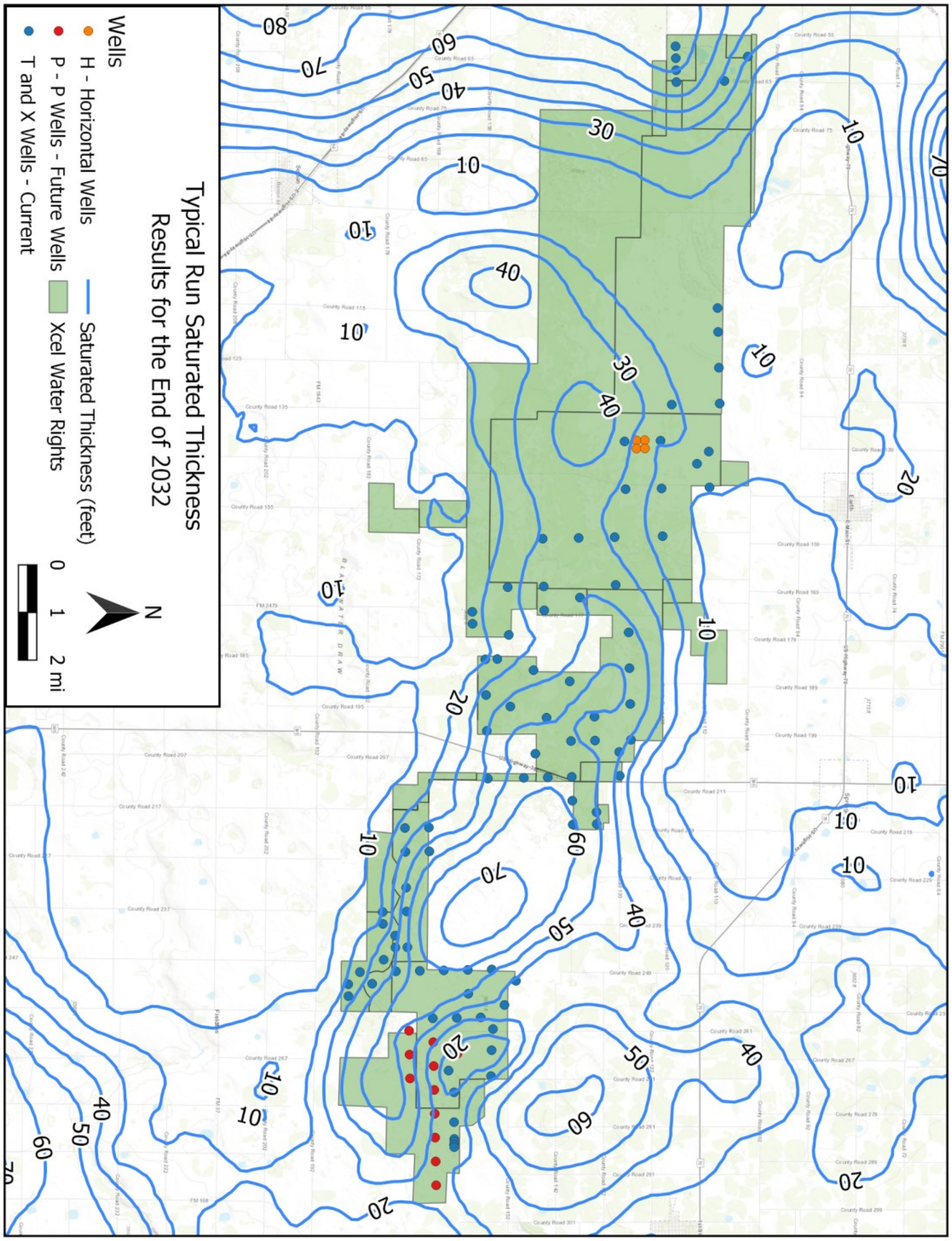

Figure 11. Modeled typical scenario saturated thickness contours for XWRA in December 2032

3.3 Stored Groundwater

To understand how much water is potentially available for extraction, the simulated volume of water in XWRA was calculated and graphed. The volume of water was split based on the 40-foot saturated thickness limit. All groundwater levels above the 40 foot limit was considered recoverable, while all groundwater levels below that limit are classified as non-recoverable. Figure 12 shows a graph of the volume of groundwater below Xcel property split by recoverable (blue) and non-recoverable (yellow). As the model progresses the simulated available groundwater declines with time, with the recoverable groundwater storage declining at a much faster rate.

Figure 13 shows the comparison of recoverable groundwater between the optimized and typical scenarios. As with the groundwater supply curves shown earlier, the two scenarios do not diverge until after the pumping change between the scenarios in 2025. At this point the typical scenario shows a sharper downward decline relative to the optimized scenario. The end of the simulation estimates a difference of about 12,000 acre-feet per month in stored available groundwater between the two scenarios.

The method for splitting between recoverable and non-recoverable is calculated using the 40 foot saturated thickness limit and assumes any groundwater under that limit cannot be recovered. This is not the case for the model, it can and does still allow extraction of water under the limit but just at a reduced rate. The values shown and calculated here should be considered conservitive estimates of stored groundwater under XWRA.

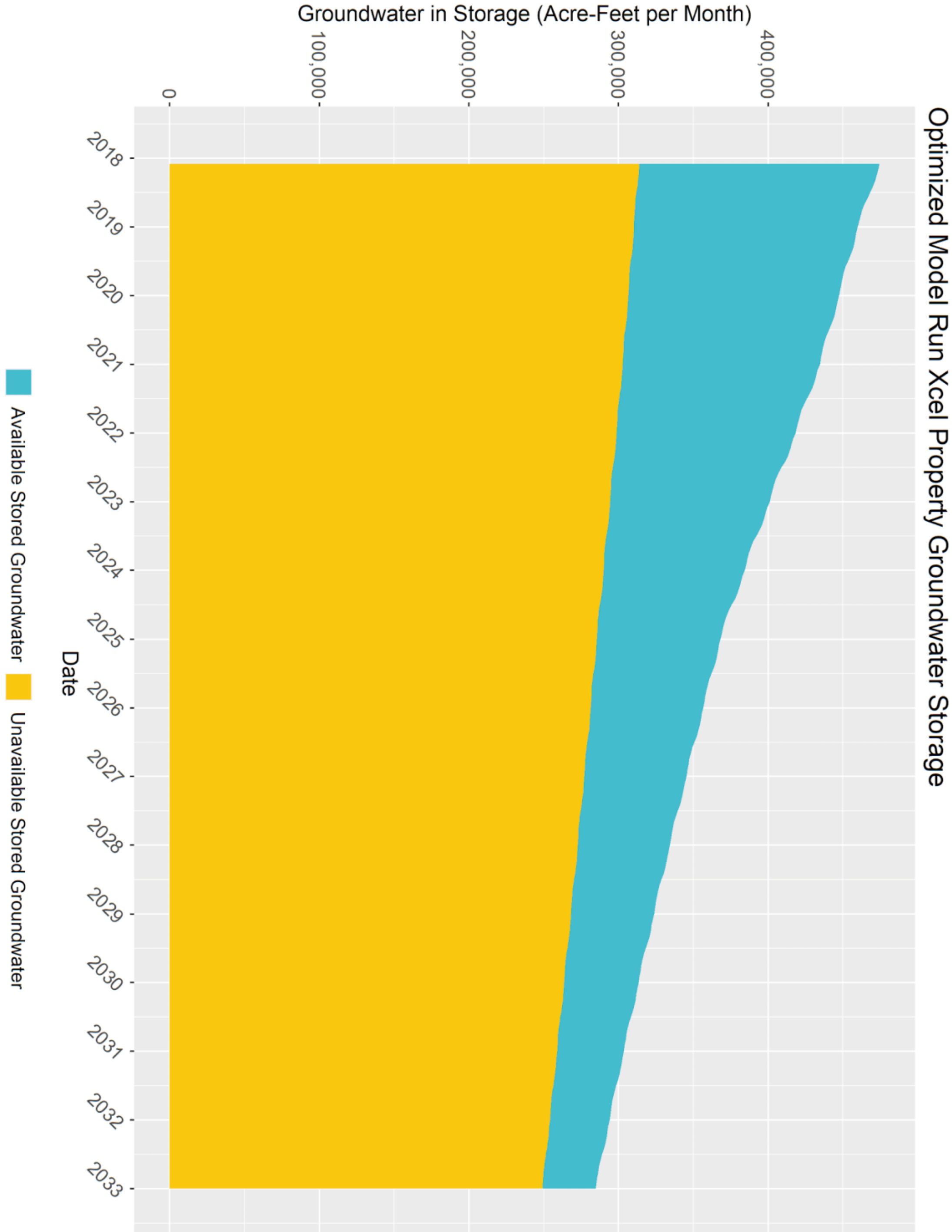

Figure 12. Available and Unavailable stored groundwater within XWRA for the optimized scenarios.

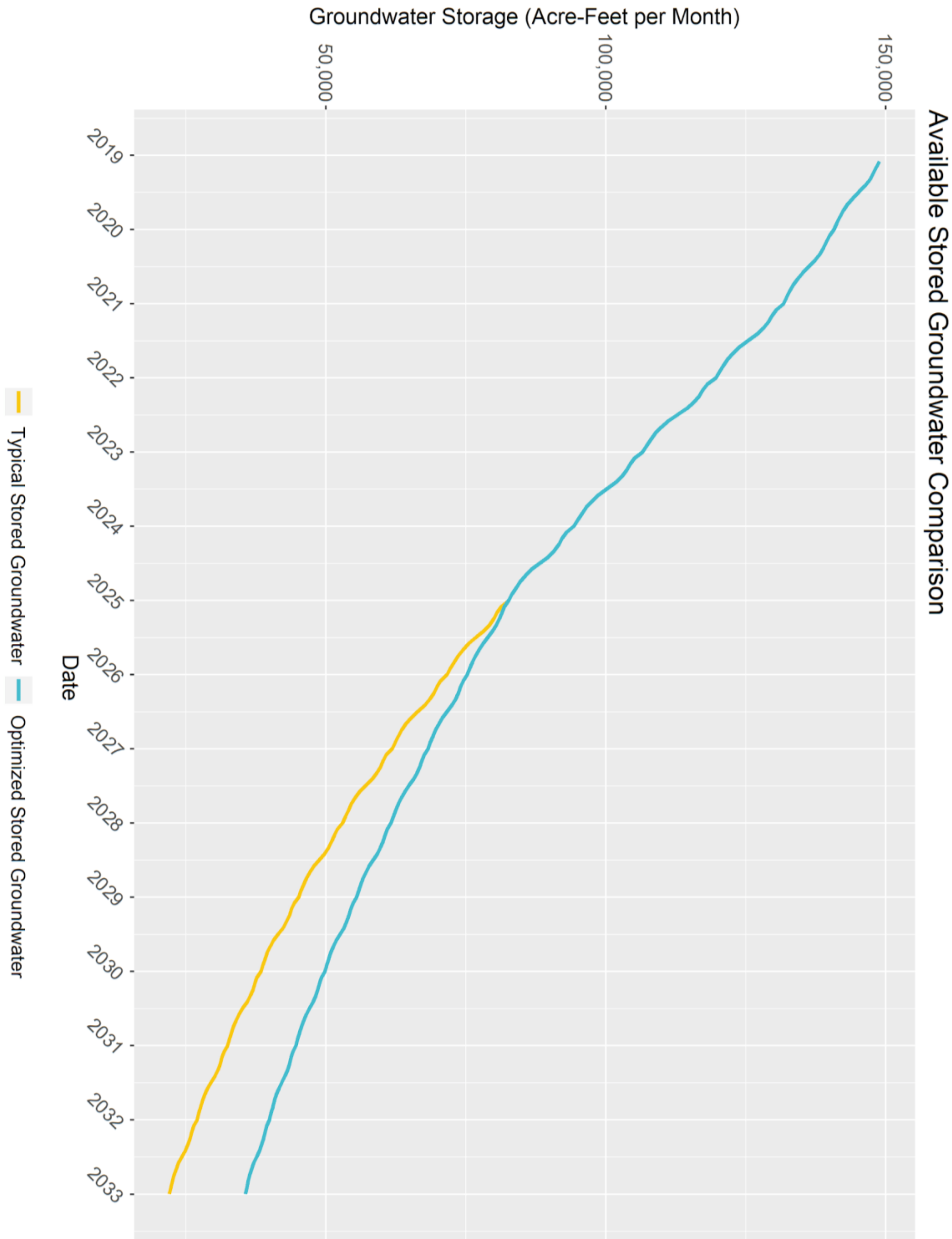

Figure 13. Comparison of available groundwater storage for typical and optimized scenarios

4.0 Conclusions and Recommendations

The Xcel groundwater model was updated and used to predict groundwater availability for two potential pumping scenarios – a "typical" and an "optimized" scenario. The optimized path allows for a larger initial production followed by a phase of lower production while maintaining a lower groundwater supply difference. The modeling indicates that the optimized scenario allows Xcel to produce larger amounts of groundwater in the short term (with some months of higher groundwater deficits), followed by a steady but lower production rate in the following years with a low but steadily growing groundwater deficit.

The second scenario attempts to produce as much groundwater as possible during the model run. The simulated results indicate that the production early in the scenario, but much larger groundwater deficit in the end as well as larger seasonal variations. The take away from these results are that it may be feasible to produce groundwater at pumping rates that would still not meet the full groundwater demand, but limit the deficits (optimized scenario), or to produce much larger quantities of groundwater overall through time but with larger deficits in later years. One item to note is that while the typical demand can produce groundwater at much higher rates relative to the optimized, it may not be possible to shift from an optimized scenario back to the typical demand pumping and get the same results. This is due in part to competitive pumping near Xcel property boundaries that may be moving groundwater out of Xcel properties. Once this movement occurs, the lowered saturated thickness to a level that increasing pumping by Xcel may not be able to recapture the groundwater due to limited available drawdown in wells.

The simulated saturated thickness results show decreasing values with time as expected, and on average in both scenarios the majority of model cells within XWRA will be below the 40-foot limit. Given the assumptions of Xcel production and nearby pumping, both scenarios show the average saturated thickness would reach the 40-foot limit in about 2026, which indicates that the majority of XWRA model cells would not be able to produce at the desired pumping rate. Essentially, this limits the effectiveness of any potential new wells on Xcel property as well. Looking at the saturated thickness in terms of the spatial distribution, the highest saturated thickness values are in the eastern section of XWRA. Because of this relatively higher saturated thickness, the simulated production from these wells is higher also, and thus experience the largest decline in groundwater levels. This is because the wells in that area are able to produce at full pumping capacity for most of the scenario before saturated thickness decreases to a level of significantly reducing simulated pumping rates. The groundwater decline and saturated thickness in the western portion of XWRA is very similar in both scenarios because the saturated thickness values were already low and simulated pumping in the area is very limited. Therefore the model would have already reduced pumping in both scenarios leading to reduced groundwater declines.

Stored groundwater results show that the amount of recoverable groundwater is quickly reduced in both model scenarios and then begins a steady decline with time. While the optimized scenario does have more available stored groundwater relative to the typical scenario, both show that the amount of groundwater becomes smaller with time. This means that there is less groundwater available that can be recovered, but also that the groundwater that does remain may be more difficult to extract.

Recommendations for future model updates would be to evaluate if the pumping rates used from 2019 through this year's model update are the same or similar to the 2018 values. They have been reused during the consecutive model updates and refining those values could change the water levels that lead up to the start of the predictive scenarios.

5.0 Limitations of Model and Study

With all groundwater models there are limits to what the model can tell us. While the model and simulations performed in this analysis can provide insight and assessment of future groundwater supply, it will never be able to exactly replicate the future. The limitations can be generally categorized into two areas, limitations due to data, and how the model is used.

5.1 Data Limitations

The two major datasets that are important in predicting future groundwater trends, and are used in this report groundwater model, are groundwater level measurements and measured pumping rates. Groundwater levels are used as targets to calibrate the model, and can give an indication of how well a model is performing. Limits in the number of wells monitored both in space and through time can cause uncertainty of how the model is performing today which in turn makes the predictive model results also uncertain. Pumping rates are important as they are the fundamental driver in lowering groundwater levels. If current or nearby pumping rates are not known, then they must be estimated. The longer the model runs from the last update of pumping rates means the more uncertain those pumping rates become. This could potentially lead to simulations in which the actual pumping rates are not reflective of the simulated pumping rates.

Other major data limitation for the model include:

- Well capacity as water levels decline
- Future well field operations
- Limited hydraulic conductivity and specific yield data

5.2 Limitations of Model Implementation and Applicability

While the overall mean error of the model has been minimized through the calibration process that was described in the 2017 model (LBG-Guyton Associates, 2017), the mean error for some areas at the end of the historical period may be larger than the mean error. Because the Ogallala Aquifer is unconfined, the areas containing larger errors can translate to large volumes of water when estimating future availability. These errors also affect the predetermined pumping demands incorporated into the model, which might affect the predicted unmet demands estimated by the model with the approach used in this study.

It is important to keep in mind that the future pumping demand in the model is precalculated for each well, and then the model reduces pumping based on the groundwater levels that are simulated. The actual pumping rate at each well may be able to produce more or less than the model simulates, and it may be possible for well field operators to overcome some of the issues by shifting pumping to other wells to reduce or lower the unmet demand.
The pumping near the XWRA boundaries is estimated based on historic average irrigation demands in the area. The estimated demands are incorporated into the model and the model uses

the same pumping reduction assumptions as for the wells in XWRA area. The impact of errors in the demand assumption for the nearby pumping may shorten or extend the groundwater availability or change the seasonal deficits simulated by the model.

6.0 References

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Attachment RLB-2 is provided in electronic format

Tolk Wellfield Map