DOCKET NO. ________

APPLICATION OF SOUTHWESTERN PUBLIC SERVICE COMPANY FOR AUTHORITY TO CHANGE RATES	**§ § §**	**PUBLIC UTILITY COMMISSION OF TEXAS**

DIRECT TESTIMONY
of
RICHARD BELT

on behalf of

SOUTHWESTERN PUBLIC SERVICE COMPANY

(*Filename:* BeltRRDirect.doc)

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GLOSSARY OF ACRONYMS AND DEFINED TERMS

Acronym/Defined Term	**Meaning**
DSEC	Deaf Smith County Electric Cooperative
gpm	Gallons per minute
HPWD	High Plains Water District
LCEC	Lamb County Electric Cooperative
MW	Megawatt
SPS	Southwestern Public Service Company, a New Mexico corporation
Tolk	Tolk Generating Station
USGS	United States Geological Survey
WSP	WSP USA
Xcel Energy	Xcel Energy Inc.
XES	Xcel Energy Services Inc.

LIST OF ATTACHMENTS

Attachment	**Description**
RLB-RR-1	2019 Groundwater Modeling Results for Tolk Station Wellfield by WSP, dated December 2019 (*Filename*: RLB-RR-1.pdf)
RLB-RR-2(CD)	SPS Water Modeling Spreadsheet (*Workpapers on USB included in Attachment WAG-1(USB) to the Direct Testimony of William A. Grant*)

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, 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, 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 25 years of experience in the water resources field, including 10 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 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 currently pending base rate case before the New Mexico Public Regulation Commission.

II. ASSIGNMENT AND SUMMARY OF TESTIMONY AND RECOMMENDATIONS

Q. What is your assignment in this proceeding?

A. My assignment is to 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: (1) continued year-round economic dispatch of the units, and (2) an "optimized" scenario in which the generating units are economically dispatched only during the on-peak months. Both scenarios are described in the Direct Testimony of Bennie F. Weeks.

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 available to operate Tolk is declining year-over-year. Because those groundwater levels will not allow SPS to continue operating Tolk as it has been operated in the past, SPS has begun to operate the units so that they are economically dispatched only in the peak months. In all other months, the Tolk units are offline unless the Southwest Power Pool ("SPP") directs SPS to dispatch those units. 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 2032 under the seasonal operating scenario in which the units are economically dispatched only during peak months. Under an alternative scenario in which the Tolk units were economically dispatched year-round, the economically recoverable groundwater would be depleted by 2026.

Q. Is Attachment RLB-RR-1 a true and correct copy of the document you represent it to be?

A. Yes.

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

A. Yes.

III. TOLK WATER LIMITATIONS

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

A. SPS is currently operating Tolk as a generating facility on a seasonal basis and will continue to do so until 2032, at which time the facility will cease to generate electricity. Between now and 2032, SPS will offer the output of Tolk for economic dispatch during the on-peak months, and it will use Tolk primarily for voltage support during the off-peak months.[1] During the period from 2033 through 2055, SPS will continue to operate Tolk, but only for voltage support.

Q. What is the primary driver for SPS's plan to generate electricity from Tolk only during the on-peak months between now and 2032 and to cease generating electricity at Tolk in 2032?

A. The primary driver is the shortage of economically-recoverable groundwater in the Tolk area. Steam production generating facilities such as Tolk require reliable sources of water for generation and cooling.

Q. Please generally describe the water limitations affecting Tolk's remaining useful lives.

A. Tolk relies exclusively on groundwater from the Ogallala Aquifer for generation and cooling, and the portion of the Ogallala Aquifer underlying Tolk is in an irreversible decline.

Q. What is the Ogallala Aquifer?

A. The Ogallala Aquifer is a large, connected body of groundwater that underlies most of the central United States, including the Panhandle and South Plains areas of Texas.

[1] Tolk will still be able to generate electricity in the off-peak months if necessary.

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 to support 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. In the late 1940s, which was before the start of widespread irrigated agriculture in the area, there was approximately 170 feet of economically recoverable saturated thickness in the Tolk wellfield.[2] By 2020, the economically-recoverable saturated thickness (i.e., the thickness above 40 feet) had been reduced to approximately 10 feet. In other words, approximately 6% of the economically-recoverable water remains in this area of the aquifer today relative to what was available in the 1940s.

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 enough water to support peak generation demands. When the saturated thickness level of the aquifer declines

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[2] 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.

below 40 feet, wellfield productivity rapidly declines and high well production rates no longer occur, even though there is still water in the aquifer formation.

Q. Why is the groundwater no longer economic to recover when the saturated thickness declines below 40 feet?

A. When the saturated thickness declines below 40 feet, the specific capacity of the aquifer is reduced in the vicinity of the well, as is the difference in elevation between water in the aquifer in the immediate well proximity and that of water outside the direct area of influence of the well. This means that less water flows from the surrounding aquifer to the well for production. At Tolk, this also means that a substantial amount of sand is produced by the failing wells, and they are taken out of service to avoid impacts to the downstream water gathering system and plant water treatment systems. Each of these factors varies according to site-specific geology, individual well and pump characteristics, and other factors. Thus, although wells may continue to produce water when the saturated thickness falls below 40 feet, they will produce less and less water as the saturated thickness decreases.

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

A. In the short-term, yes, but ultimately, no. Drilling more wells allows access to additional water stored in the wellfield in the short-term, but it does not increase the overall amount of water contained in the wellfield, and it only temporarily improves the hydraulic characteristics that cause water to flow towards wells. This effect is apparent in the Tolk wellfield data and groundwater model results, which are discussed in greater detail in response to subsequent questions. As I will explain, since 2007 the overall Tolk wellfield acreage has increased and the number of active wells has grown by over 67%, but peak water production capacity has declined by

12%. In fact, SPS is drilling new wells nearly annually simply 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 50 gpm wells just to maintain equivalent wellfield production.

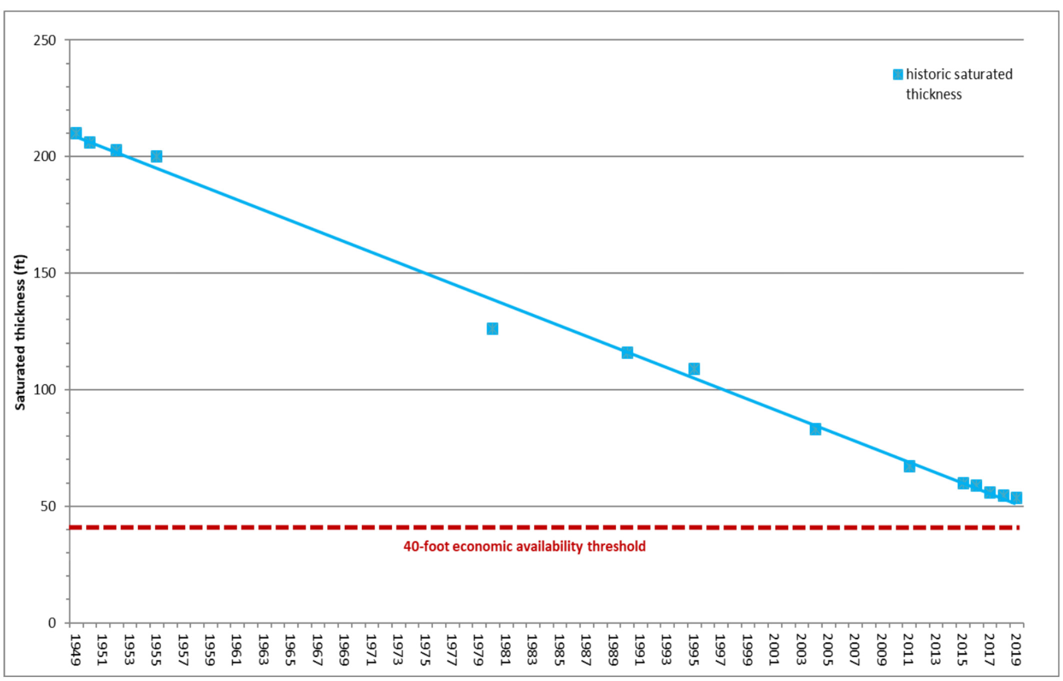
Consequently, SPS would need to make a significant investment in drilling a sufficient number of smaller capacity replacement wells for each existing higher capacity well to maintain the necessary volume of water required for Tolk's current generation cooling needs, but even that would not be a long-term solution. SPS's groundwater modeling, which I discuss later in my testimony, assumes new well additions annually and still demonstrates that the productivity of the Tolk wellfield collapses rapidly after 2024 under historic generation dispatch assumptions as the average saturated thickness of the overall wellfield approaches 40 feet.

To understand why, consider the analogy of drinking a milkshake through a straw. As you begin to drink the milkshake, it flows fairly easily through the straw. However, as you continue to drink (and don't change the straw's position), you ultimately reach a point at which the flow of milkshake into the straw is reduced and, ultimately, only air flows into the straw. With a milkshake, you can shake or tip the cup, redistribute the milkshake, and continue drinking through the straw. That is obviously not possible in a wellfield. To extend the milkshake analogy, to get more of the milkshake without tipping or shaking the cup, you would need to add an additional straw to the milkshake and drink from it until it produces air, and then repeat the process until you have nearly covered the cup with straws. This is effectively what SPS has been doing at the Tolk wellfield. But just as the overall amount of milkshake that is available does not change when new straws are added, the addition of new wells does not create new water in the aquifer. That is why it was necessary for SPS to alter its operations so that it could conserve water and extend the lives of the Tolk generating assets to 2032.

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

A. Yes. By 2020, the saturated thickness in Lamb County had declined to 50 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-RR-1 shows the historical, actual decline in the aquifer's saturated thickness, dating back to widespread development of irrigated agriculture in the area.

Figure RLB-RR-1
Saturated Thickness History of Tolk Wellfield Through 2019



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. That is, even if the number of wells were to increase dramatically in the future, productivity would continue to decline until plant operations can no longer be maintained. That is why SPS has begun seasonal operation at Tolk. If it had not, the economic depletion of the aquifer would occur between 2024 and 2026 based on forecasted generation levels.

Q. Does SPS have empirical evidence demonstrating the aquifer's 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:

- 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 WSP USA ("WSP") since 2007, including studies completed in 2016, 2017, 2018, and 2019.[3]

[3] WSP is SPS's current groundwater consultant. In 2017, WSP acquired LBG-Guyton Associates, the entity that SPS had previously engaged to perform groundwater modeling at Tolk. For ease of reference, I will refer to both of those entities as WSP throughout my testimony.

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 Smith, Parmer, and Lamb Counties.[4] 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-RR-1) had decreased from 1.4 million acre-feet prior to 1950 to 0.52 million acre-feet in 2010.

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

	Estimated Water in Storage (million acre-feet)				
Year	LCEC	DSEC	BCWF	**Xcel Energy**	Five County Area
1950	9.8	59.5	2.5	**1.4**	101.0
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

[4] HPWD commissioned the study in cooperation with the City of Lubbock, Deaf Smith County Electric Cooperative ("DSEC"), Lamb County Electric Cooperative ("LCEC"), 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 water 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 for 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 17.85 feet between 2007 and 2020. The data also shows that, by early 2020, the aquifer had an estimated average saturated thickness of just 50 feet for Lamb County. The HPWD data reinforces the conclusion that SPS has drawn from the results of modeling completed internally and by external consultants, which is that the economically recoverable groundwater in the Tolk wellfield is declining rapidly.

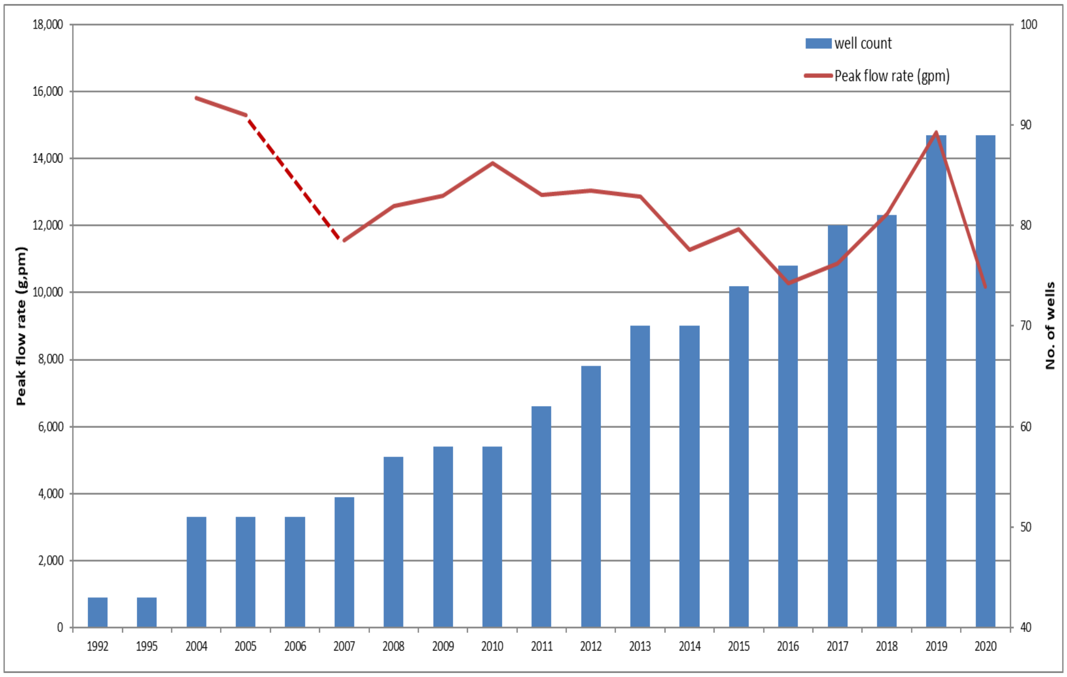
Q. What does the USGS data demonstrate about the water levels in the Ogallala Aquifer?

A. The USGS data also reflects significant groundwater declines throughout the Texas Panhandle and generally corroborate 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-RR-2 (next page). Results since 2016 show that SPS has been maintaining the minimum wellfield productivity necessary to support Tolk's peak operating demand though the addition of new wells. The testing confirms that it has become increasingly critical to add additional wells to the wellfield to offset the annual productivity loss and maintain peak flows to support generation at the Tolk units.

Figure RLB-RR-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 productivity was approximately 700 gpm. Today, a new well's productivity is approximately 200 gpm. 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.

The overall Tolk wellfield averages 50 feet of saturated thickness over the existing 50,000 acre wellfield, but it ranges from 25-30 feet in the western portion of the wellfield to approximately 70 feet in the eastern portion. This is a 70-80% drop in the overall saturated thickness (i.e., including thickness below 40 feet which is not economically recoverable) from predevelopment thickness. Only 5-6% of the economically-recoverable saturated thickness remains.

As the saturated thickness declines, the water flow into each well decreases as described previously in my testimony and the production drops accordingly. As shown by Figure RLB-RR-2 above, although SPS has increased the well count by approximately 207% since 1992, the total wellfield production has declined by approximately 35% 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 is not sustainable long-term. SPS's history with the wellfield demonstrates that this process is occurring in the wellfield, and SPS's groundwater modeling described in subsequent sections of this testimony projects how this process will continue to evolve in the future.

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

A. WSP is a globally recognized professional services firm with expertise in sustainability and water issues. The WSP 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 WSP.

A. WSP conducts groundwater modeling using MODFLOW, the industry standard groundwater modeling software. The WSP 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 WSP.

A. In the mid-2000s, WSP conducted groundwater modeling every few years. In the early-2010s, modeling frequency increased as SPS considered a number of options for Tolk and needed the most recent and best available information to support those decisions. Since 2014, WSP has conducted groundwater modeling annually.

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

A. Yes. When it began modeling, WSP 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 by others) 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 WSP 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. WSP completed new groundwater studies for SPS in 2016, 2017, 2018, amd 2019 using the same general model and updated inputs to account for changed conditions annually.[5] For example, one of the most significant variables in the WSP model relates to the volume of agricultural water use within 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. WSP 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 WSP's groundwater model.

Q. Does the MODFLOW groundwater model address the 40-foot well threshold for economic recovery of groundwater?

A. Yes. The MODFLOW model includes a function that reduces individual well pumping when the saturated thickness reaches a specified level, in this case, 40 feet. The model process is described in Section 2.2, and the function is shown in Figure 2-2 of the 2019 WSP report. As those parts of the report show, wells that reach the 40-foot threshold are not assumed to have zero production; rather, the production

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

declines slightly as saturated thickness declines toward approximately 30 feet, and then declines rapidly as saturated thickness approaches approximately 10 feet.

Q. Please describe the 2019 study and its conclusions.

A. The 2019 WSP report, which is Attachment RLB-RR-1, confirms the overall decline of the Ogallala Aquifer. It also projects how the aquifer would respond to two different Tolk operational scenarios: a "typical" demand scenario and an "optimized" demand scenario.[6] 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. These results have been consistent between recent model updates, and, in response, SPS added eight new wells in the Tolk wellfield between 2018 and early 2019 to help offset the predicted production deficits. Nevertheless, aggregate well productivity has declined approximately 20% since these new wells were added.

Figure 3-2 from the 2019 WSP report, which is reproduced below, shows the difference between the required production to support historical generation demands and modeled wellfield production based on the groundwater model results. The blue line in the referenced chart shows that the deficit between required and actual wellfield production increases exponentially between 2019 and 2024, demonstrating that Tolk would be unable to operate in the years after 2025 under traditional operations.

[6] The "typical" scenario assumes economic dispatch in all months. The "optimized" scenario assumes econonmic dispatch in only the peak months.

Figure 3-2 From 2019 WSP Report: Typical Demand Run

Q. You testified earlier that the 2019 WSP report also addresses an alternative optimized scenario for Tolk. Please describe the results under that scenario.

A. The 2019 WSP report also modeled the impact of optimized operations on the wellfield and demonstrated that this is a viable approach to maintaining Tolk Station's ability to generate until 2032, which is the modeled economic depletion range. Under this scenario, which is how Tolk is being operated now, the units are economically dispatched during the peak season months and operated in synchronous condenser mode during the off-peak months, except when needed to supply power to the grid.

This operational strategy allows water to be conserved within the Tolk wellfield from the implementation of optimized operations in 2019 until the proposed plant retirement in 2032. Figure 3-1 from the 2019 WSP report (reproduced below) shows the difference between the required production to support generation and the modeled wellfield production. The blue line in the referenced chart shows that the deficit between the required and modeled results is unlikely to cause plant derating during the reduced operation period until approximately 2032.

Figure 3-1 From 2019 WSP Report: Optimized Demand Run

Q. What conclusions do you draw from the 2019 groundwater study results?

A. The 2019 groundwater study results confirm the viability of SPS's optimized operational strategy for the Tolk generating units. The results confirm that insufficient water and wellfield capacity would have remained to support Tolk operations beyond approximately 2025 under historical economic dispatch practices.

Q. Is there a more recent WSP report than the 2019 report?

A. Not at this time. WSP is in the process of preparing the 2020 report, but it is not yet final. Based on a preliminary draft that I have reviewed, however, the 2020 WSP report appears to be consistent with the 2019 report.

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 WSP analysis, SPS developed its own spreadsheet model to evaluate Tolk's long-term water supply under various operating scenarios. The model, which is Attachment RLB-RR-2(CD) 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 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 for two operational scenarios with two load sensitivities provided by SPS's Resource Planning group to determine a depletion range for each scenario. Attachment RLB-RR-2(CD) shows the economic water production window for the four scenarios described in Ms. Weeks's direct testimony based on modeled water demand, electric generation, and total water availability predicted by the WSP groundwater model. For example, assuming economic dispatch at Tolk (i.e., without seasonal operations), the model predicts that the economic depletion range of the aquifer (expressed in years of service of Tolk) would be between 2025 and 2027. This is shown as Scenario 1 on the Summary Tab of Attachment RLB-RR-2(CD). Assuming seasonal operations in which Tolk generates only during peak months, the model predicts that the economic depletion range would be between 2030 and 2033. This is shown as Scenario 2 on the Summary Tab of Attachment RLB-RR-2(CD). The load sensitivities are also shown on the Summary Tab of Attachment RLB-RR-2(CD), but they do not affect the depletions windows significantly.

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 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 WSP, HPWD, and the USGS). Put simply, every source confirms that the Ogallala aquifer is in a state of persistent and irreversible decline, and the modeling confirms that optimized operations can extend the useful lives of the Tolk units until the 2030 to 2033 range. Under traditional economic dispatch, the water depletion window is from 2024 to 2027.

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 have changed. Although SPS cannot currently predict the day when water depletion will make water recovery uneconomic, SPS must change the way it operates to conserve the amount of groundwater at Tolk.

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

A. Yes.

AFFIDAVIT

STATE OF COLORADO)
)
COUNTY OF LARIMER)

RICHARD BELT, first being sworn on his oath, states:

I am the witness identified in the preceding testimony. I have read the testimony and the accompanying attachment(s) and am familiar with the contents. Based upon my personal knowledge, the facts stated in the testimony are true. In addition, in my judgment and based upon my professional experience, the opinions and conclusions stated in the testimony are true, valid, and accurate.

RICHARD BELT

Subscribed and sworn to before me this __27th_ day of January, 2021 by RICHARD BELT.

BROCK WICKETT
Notary Public
State of Colorado
Notary ID # 20194004514
My Commission Expires 02-05-2023

Notary Public, State of Colorado

My Commission Expires: 02-05-2023

December 2019

2019 Groundwater Modeling Results

prepared for
Xcel Energy

prepared by
WSP USA
1101 S Capital of Texas Highway, Suite B220
Austin, Texas 78746

Professional Seal

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1. Executive Summary

The groundwater flow model for the Xcel Energy (Xcel) water rights area (XWRA) for Tolk Station and Plant X in Lamb County, Texas was updated with a simplified predictive pumping methodology, nine new wells drilled by Xcel, and using and updated future production demand values.. The model uses the MODFLOW-NWT modified code developed for the High Plains Aquifer System (HPAS) groundwater availability model (GAM) (Deeds and others, 2015), which allows for pumping to be constrained in gridblocks when the saturated thickness decreases to a preset value provided to the model. Two predictive scenario runs were performed: one used the typical demand production which is consistent with scenarios from previous years, and the other used the optimized demand production. Both scenarios used a saturated thickness level of 40 feet as the pumping reduction limit. The results from the predictive runs indicate that Xcel will likely have challenges meeting the average annual groundwater demands throughout both the scenarios.

The "typical demand" scenario produces more groundwater now and less later and the "optimized demand" scenario produces less groundwater overall but at a steadier rate (less production capacity loss through time). The annual Xcel production for each scenario is summarized in Table 1.

As with all models, the updated Xcel model and modeling approach has limitations. Generally, these limitations can be categorized into limits related to (1) supporting data, and (2) the modeling approach, implementation, and applicability. The primary limitations in supporting data for the model include limited water level targets both spatially and temporally, limited hydraulic conductivity and specific yield data, uncertain estimates of pumping by irrigators located close to the XWRA boundary, uncertain estimates of well capacity as water levels decline, and uncertainty about future wellfield operation practices. The limitations regarding the modeling approach include a larger mean error near the end of the historical pumping period than the mean error for the overall model, uncertainty with respect to total irrigation pumping in areas near the XWRA boundary, uncertainty regarding the assumptions of pumping curtailment at each well, and the limitations with respect to optimization imposed by these uncertainties.

2. Groundwater Model Updates and Revisions

2.1. Pumping Updates and Predictive Pumping Estimates

The groundwater model was updated to include estimated 2019 rates by copying over the rates from 2018 (monthly pumping rates were not provided this year). Figure 2-1 provides a schematic overview of the process in which total monthly production data from Xcel water rights area (red block) is broken down between the two major regions within the XWRA, Tolk (blue block) and Plant X (green block), then by section within those regions East, West, and Potable Tolk (light purple blocks) and North and South Plant X (dark purple blocks), and finally by individual wells (orange circles). Well pumping distribution process takes place by first determining the percent contribution to each region. Historical pumping usage in XWRA is about 80% production from Tolk region and 20% from the Plant X region. To determine the sectional contribution to each region the 2015 monthly section pumping information is used to calculate the percent monthly contribution to each region. Looking at Figure 2-1 at the Plant X region to section we see a 100% contribution from the South Plant X and 0% from the North Plant X because in 2015 XWRA did not pump any water from North Plant X for that month. With the sectional contribution determined the individual well contributions come next. The individual well percent contributions are calculated as the total pumping test rates for the section divided by the individual wells pump test rate based on 2015 data. For the nine new wells the maximum yield rate was used, and all wells were designated in the East Tolk area to calculate percent contributions. To perform the predictive scenario runs future pumping rates must be predicted. A simplified approach to predictive pumping was used this year, in which this years estimated pumping rates (2019) were reused for each predictive year, instead of using the linear fit method (WSP USA, 2018). The simplified approach will still produce the monthly high and low production periods, while also not over exaggerating the high and low productions periods that could occur in previous years due to the linear approach. A linear fit did not always capture the complexities of previous pumping rates and could simplify pumping in month as either increasing or decreasing with time only which could cause future pumping to be exaggerated in certain wells at in certain months. This new approach also allows for new wells to be more easily integrated into the model well file that do not have previous pumping and can therefore not use the linear fit approach. While the predictive pumping method did change for this year’s update, most the assumptions remain the same as are additional assumptions used for this year’s update and are detailed below.

The first assumption is that potential future wells (designated “P” wells) will be added to the eastern section of the Xcel property at one per year starting in 2020. These “P” wells will have a constant pumping rate set to the 1st quartile pumping value of all Xcel wells for each month. Due to the addition of the nine new wells within the eastern section of Xcel property, many of the potential future wells were removed at or near the new well locations that were present in last years run. The next assumption is the horizontal well (“H” wells), which is represented by four vertical wells in the model, begins at the start of 2017 and each well is held constant at a pumping rate of 322 acre-feet per year (200 gallons per minute or gpm) or a total of 1,290 acre-feet per year (800 gpm). The third assumption was that all nine new wells began pumping at the beginning of 2019. The last assumption was that wells 70A and 70B, and wells 70C and 70D were considered one large well within the model respectively. This was done as the wells are near one another and are in a single model cell block, and therefore made it easier to assume they were one large well instead of two smaller wells. Once all future pumping is set, there are a series of corrections and assumptions that are performed to insure pumping is the same as the total supply demand. The first assumption is that any well producing less than 45 gpm in the future will be turned off, or set to zero in the model well file. Any well after the final corrections or during the model run that are less than 45 gpm will still be active during the model run. The second correction is that the total pumping per year must equal the desired supply. In order to do this the total pumping is calculated per year during the predictive pumping portion and compared to the desired pumping, per scenario run, and a percent reduction or increase value is calculated. That percent value is then multiplied by all wells during that year to change the pumping to the correct amount. One assumption made during this process is that the horizontal wells will always produce at the constant rate of 1,290 acre-feet per year (800 gpm). Therefore, that amount is subtracted from the total estimated predictive pumping before the percent change is calculated. It is assumed that the horizontal well will not have the same issues as the vertical wells, and should be able to maintain its pumping rate through time.

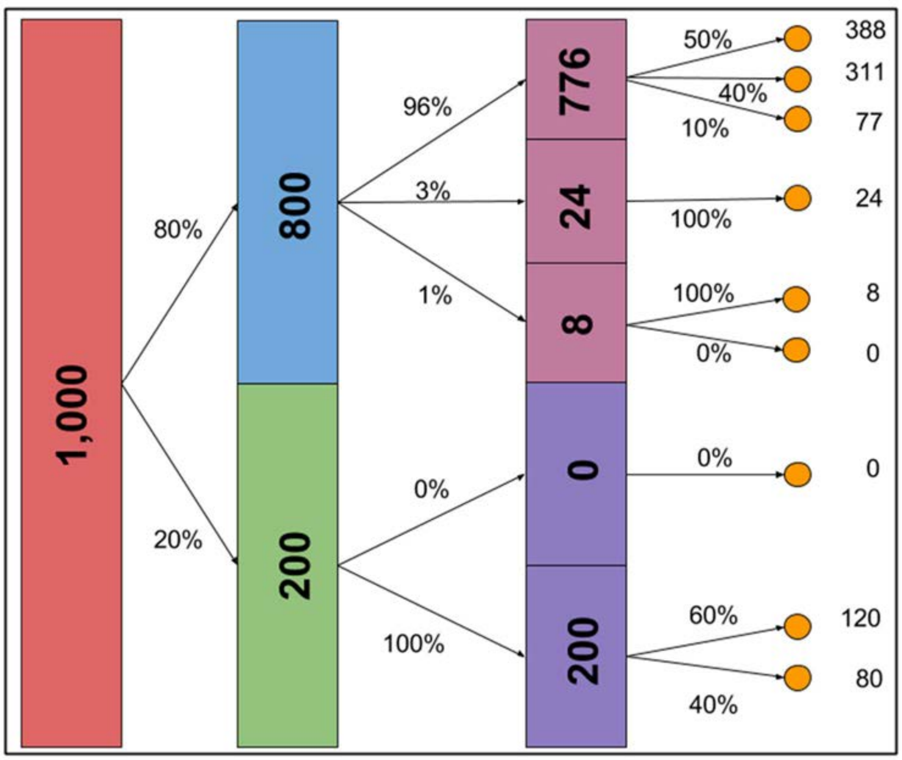

Figure 2-1. Schematic of pumping distribution, values do not represent actual pumping or distributions

Table 1. Xcel Pumping Demand for Typical and Optimized Scenarios

Year	Optimized Demand (Scenario 1) (AFY)	Typical Demand (Scenario 2) (AFY)
2019	11,100	13,100
2020	11,100	13,100
2021	8,150	13,000
2022	8,150	13,000
2023	8,150	13,000
2024	8,150	13,000
2025	8,000	13,000
2026	7,600	12,500
2027	7,600	12,500
2028	7,600	12,500
2029	6,400	11,500
2030	6,000	11,000
2031	6,000	11,000
2032	6,000	11,000

2.2. Groundwater Flow Models

The code used to simulate groundwater flow was MODFLOW-NWT (Niswonger et al., 2011) as modified for the HPAS GAM. The modification allows for pumping in a gridblock to automatically be reduced when saturated thickness reaches a preset value in that gridblock. The saturated thickness cutback threshold is set globally for the entire model. As the simulation progresses, the saturated thickness in each gridblock is calculated at each time step and if the saturated thickness is below the cutback threshold, the pumping is reduced for a well in that gridblock as shown in Figure 2-2 (the values shown in the schematic are for illustrative purposes only). The modification was performed so that the entire model had the same saturated thickness cutoff value for pump curtailment, while the original MODFLOW-NWT could have variable saturated thickness cutoffs due to different aquifer thicknesses throughout the model (Deeds et al., 2015).

As with the 2018 Xcel model update, the global saturated thickness threshold is set at 40 feet. The 40-foot threshold represents the saturated thickness at which large production wells may begin having challenges in maintaining their previous production capacity, irrespective of pumping equipment upgrades. The reduced saturated thickness typically results in lower specific capacity, and the combination of lower head and lower specific capacity is responsible for the decline in the well capacity. The model attempts to adjust for this change by reducing the pumping towards zero as the saturated thickness approaches zero, which is consistent with the observation that wells do not produce at their initial rates as water levels get lower. 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 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.

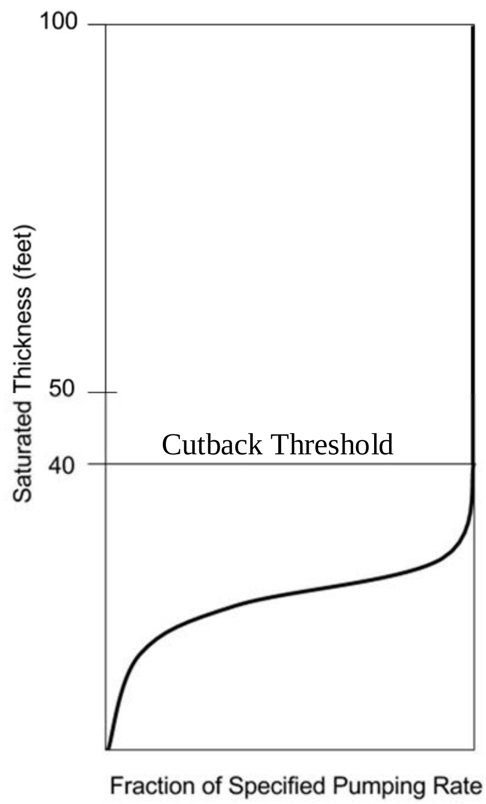

Figure 2-2. Schematic of how MODFLOW-NWT reduces pumping when water level in a gridblock drops below the cutback threshold in the modified HPAS GAM version of the code. Modified from Niswonger et al., 2011.

2.3. General Model Assumptions

As with any groundwater model, there are many assumptions and generalizations regarding aquifer characteristics that must be made to predict the future conditions of the aquifer. Predictive pumping rates must be estimated, and are based on historical use with correction factors to equal future demands in the predictive scenarios. Adding wells to the eastern portion of XWRA through time is also a major assumption in the model, as the future well locations and pumping rates are all estimated. Another key generalization is that pumping is held at a continuous rate for the entire monthly stress period. The model does not simulate the pumping cycles but rather assumes a constant production during the month. Lastly, the horizontal well is modeled as four individual vertical wells. This does a good job approximating the effects of pumping in the horizontal well over time and at the scale of the model, although the actual near-wellbore hydraulics of the horizontal well are different in some respects from vertical wells.

3. Results of Model Scenarios

Two pumping scenarios were simulated with the model in this update. Both scenarios use the same 40-foot pumping reduction threshold and the only difference in the scenarios is the pumping demand. Scenario 1 (Optimized Demand) has an overall reduction in pumping demand as compared to the Typical Demand scenario, as shown in Table 1. Scenario 2 (Typical Demand) used the typical production demand in XWRA, which is more consistent with the historical demands.

3.1. Groundwater Flow Model with 40 feet Saturated Thickness Cutoff

3.1.1 Scenario Modeled Supply Results

The optimized demand scenario production results are presented in Figure 3-1. The first curve (leftmost) is the desired production per month, or the amount that was requested from Xcel wells in the model to meet Xcel's future demand. The second curve (middle) is the amount of supply from the aquifer as simulated by the model. The middle curve is the pumping rate the model simulated based on the model's saturated thickness constraint and automatic curtailment of pumping as water levels drop.

The rightmost curve on Figure 3-1 shows the difference between the modeled supply from the aquifer and the requested demand. This curve illustrates the simulated shortfall from Xcel's wellfields on a monthly basis and indicates shortages throughout the year. Based on the simulated shortfall, Xcel's wellfields may begin to have challenges meeting peak demands in summer starting in 2020 and increase at a steady rate through to the end of the predictive period.

In Scenario 2 (typical demand) predicted production deficits begin around the same time (summer 2020), but show a much steeper increase in shortfall relative to the optimized demand scenario starting in 2021 (Figure 3-2). As stated previously, the typical demand scenario uses the same model and assumptions as the optimized demand scenario except that the production values are higher. Therefore, the results are directly comparable. As expected, the simulated production deficit is much greater in the typical demand scenario and begins earlier because the higher production causes the water levels to fall to the cutback threshold faster, which causes the pumping reduction to begin earlier. Figure 3-3 allows comparison of the demand-modeled supply difference curves from both model scenarios.

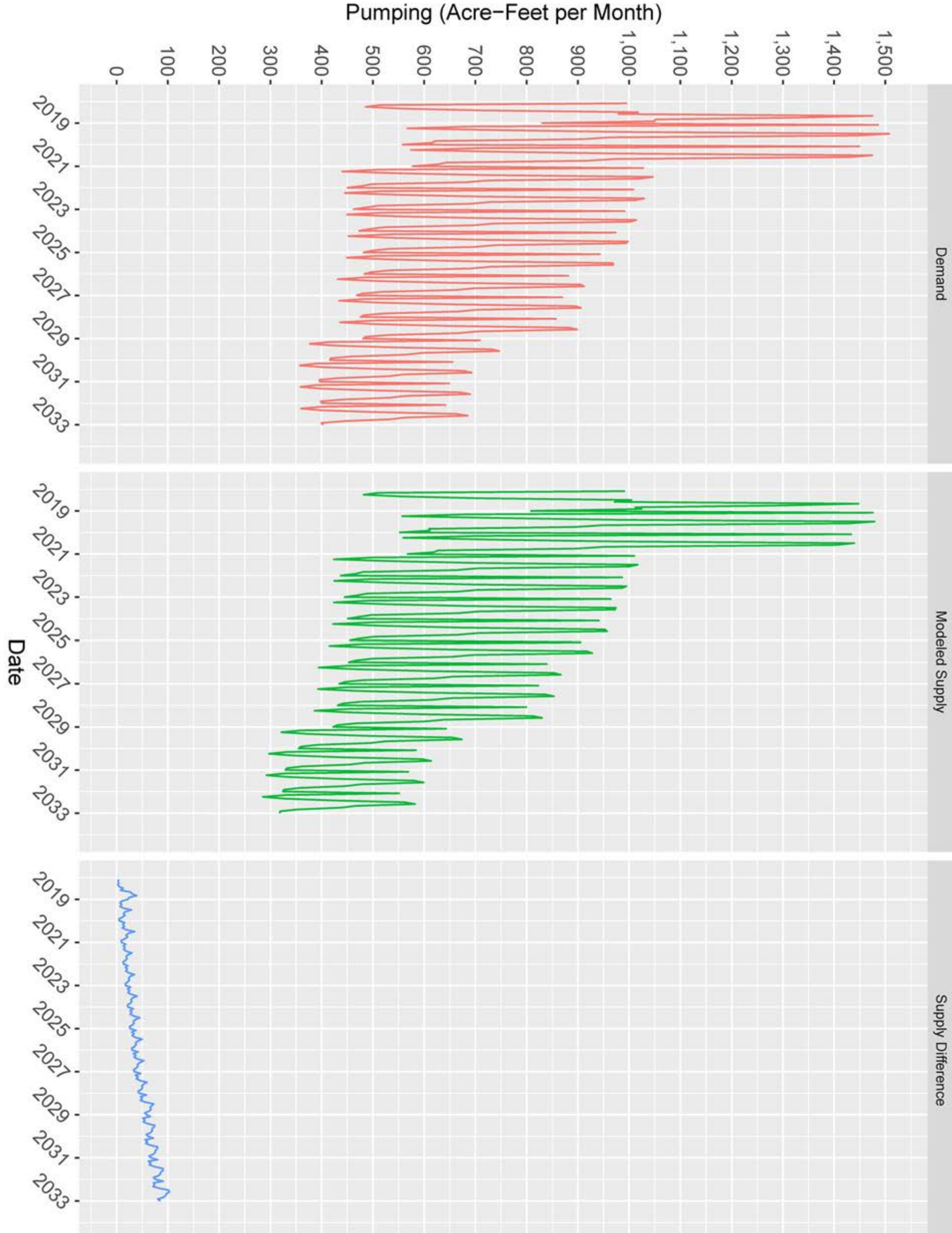

Figure 3-1. Optimized Demand Run Demand, Modeled Supply, and Difference for Xcel Wells

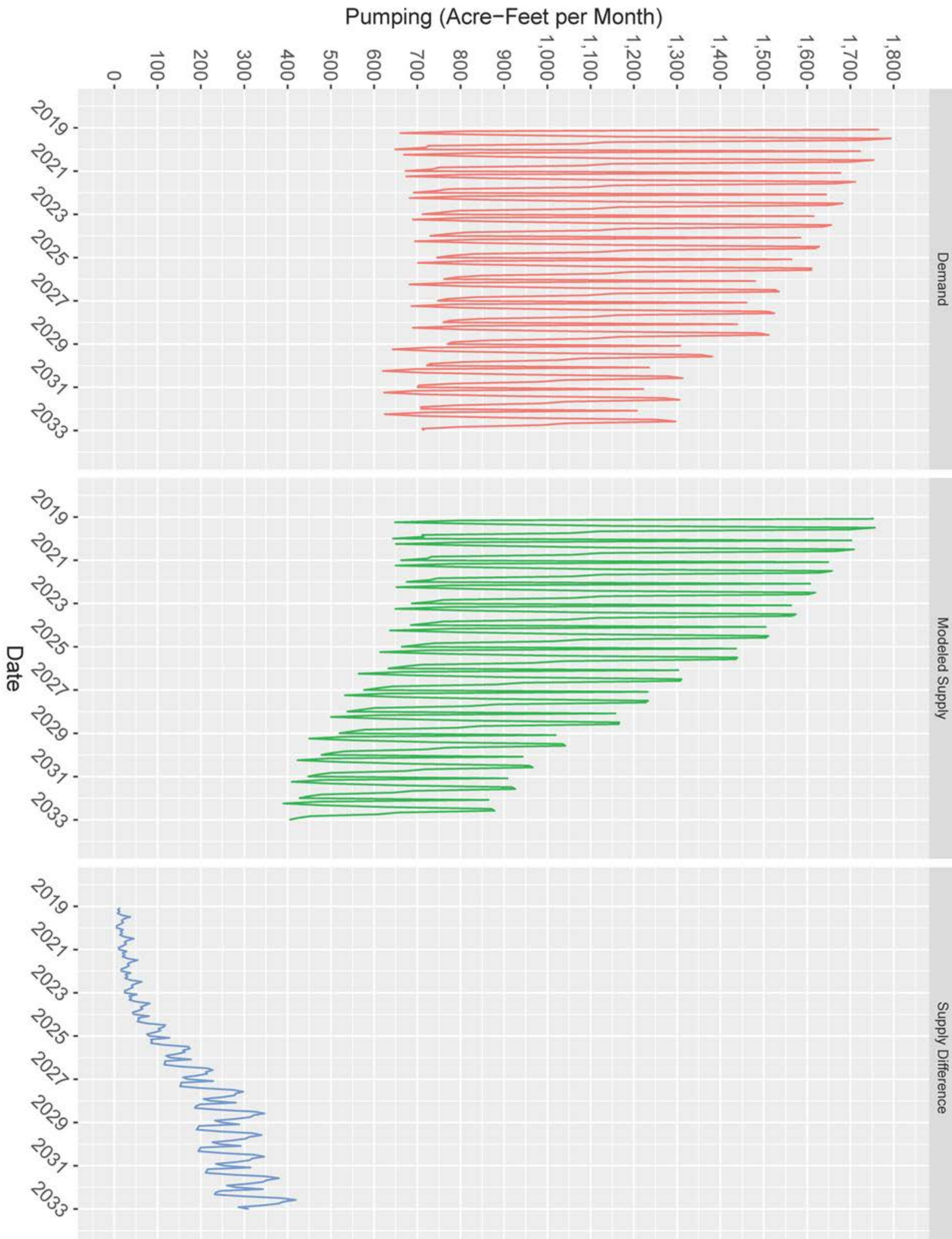

Figure 3-2. Typical Demand Run Demand, Modeled Supply, and Difference in Pumping for Xcel Wells.

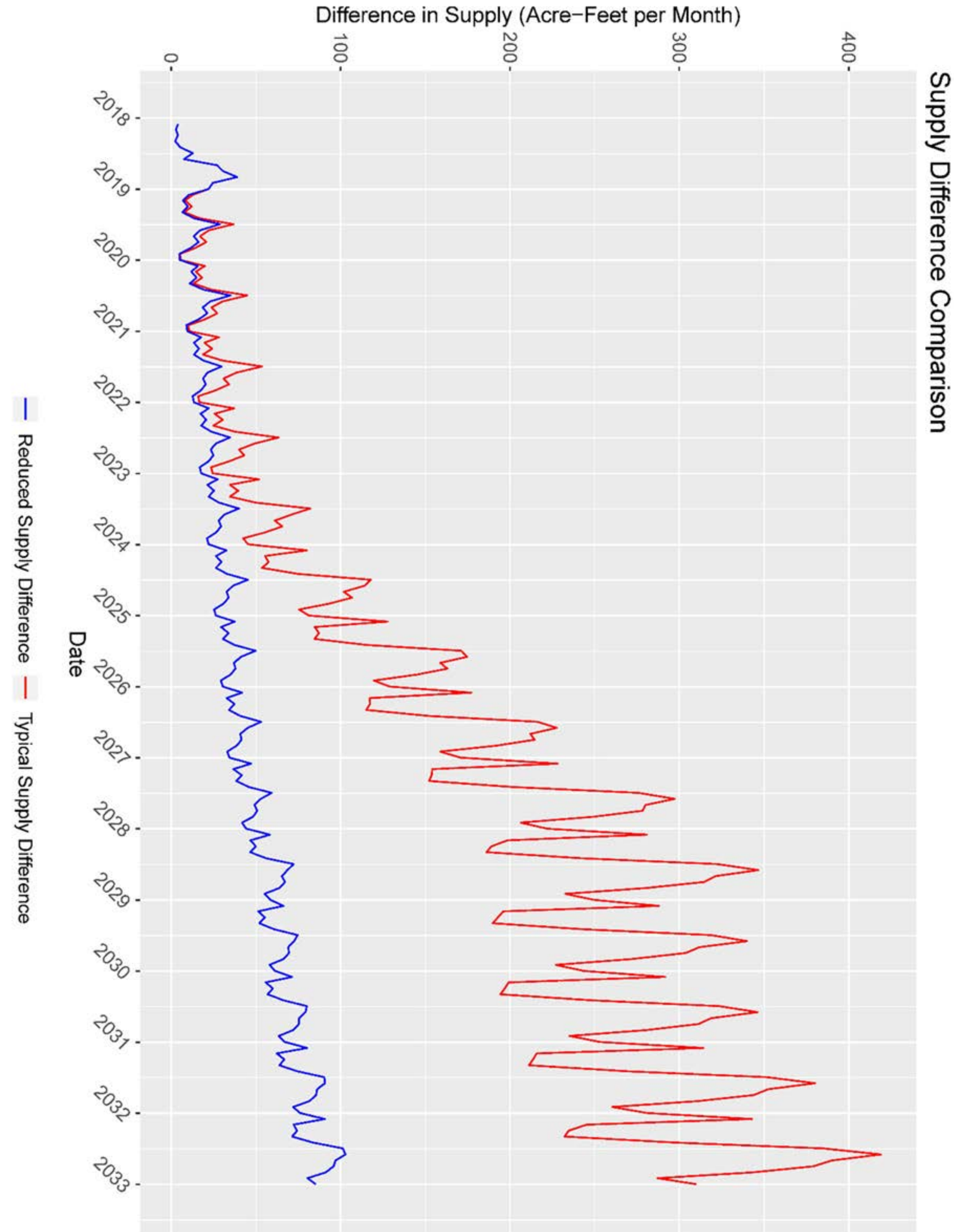

Figure 3-3. Comparison of Simulated Optimized and Typical Scenario Demand-Modeled Supply Deficit (Monthly values plotted)

Looking at the model area as a whole as in Figure 3-4 shows the same three curves as in Figures 3-1 and 3-2, except the values shown are for the area outside of XWRA. Xcel's reduction in pumping capacity is similar to what the rest of the surrounding area is likely to experience, in that projected demand is higher than the ability of the model to produce groundwater, and the deficits increase with time. However, the magnitude of production is much larger in the surrounding irrigation areas (up to 45 times greater) as are the predicted deficiencies. Starting immediately, the model cannot produce enough water for the surrounding irrigation production, with predicted deficits in irrigation production reaching large deficits starting in 2019. The model indicates deficits that are very much dependent on the cyclic nature of high pumping in the summer with recovery in the winter. Both the typical and optimized demand runs have very similar pumping trends outside of the XWRA.

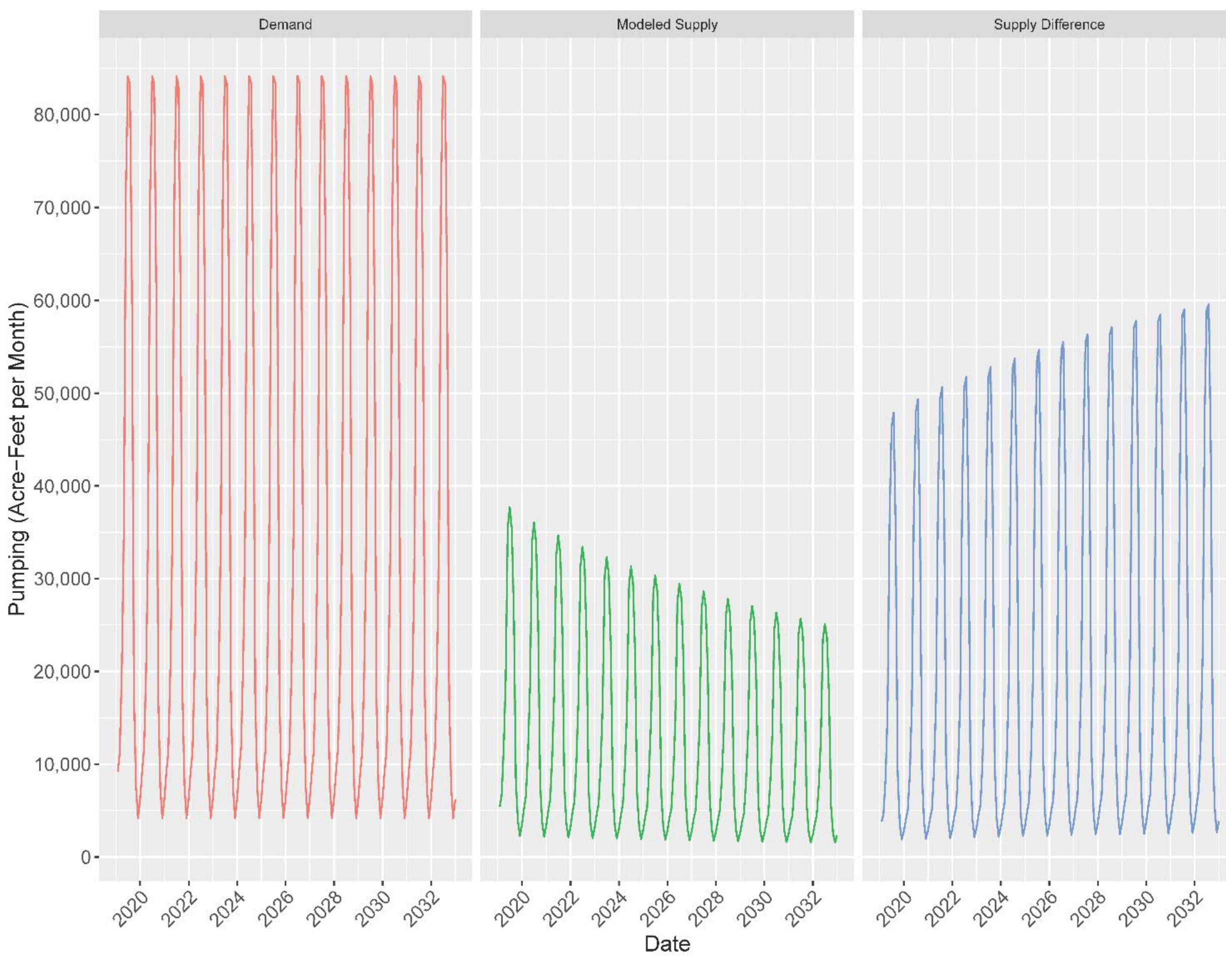

Figure 3-4. Graph of Demand, Modeled Supply, and Difference in Pumping for the Optimized Demand Run for Non-Xcel Wells.

3.1.2 Saturated Thickness Results

Saturated thickness within XWRA will diminish with time due to local and regional pumping, but with large variations depending on the location. Figure 3-5 and Figure 3-6 demonstrate this variation by plotting all the gridblocks within XWRA saturated thickness through time (grey lines) along with the average saturate thickness of XWRA through time (blue line). On average the saturated thickness will go from a high of 52 to 53 feet at the beginning of the model runs in 2019 to 34 feet and 30 feet in 2032 for the Optimized and Typical Scenarios, respectively. The variability in saturated thickness within the Xcel property can range from 70 feet or more, showing that certain areas of the Xcel property will be impacted less through time. Certain portions of the XWRA will have saturated thickness above the 40-foot threshold and still maintain well production, but not enough to make up for the lost production in areas that are below 40 feet.

Generally, the highest declines in water levels occur in the western portion of the Xcel property as seen in the change from the year 2020 saturated thickness map (Figure 3-7) to the year 2032 saturated thickness map (Figure 3-8). See Appendix A for well location maps and Appendix B for additional saturated thickness maps for the optimized demand scenario. Simulations indicate that pumping would be reduced first within the western properties, and then gradually decrease in the eastern portion of XWRA as saturated thickness values reach the 40-foot threshold. This holds true for both scenarios, but with the typical demand scenario, there are larger decreases in saturated thickness overall (Figure 3-9; Figure 3-10; See Appendix C for additional typical demand saturated thickness maps).

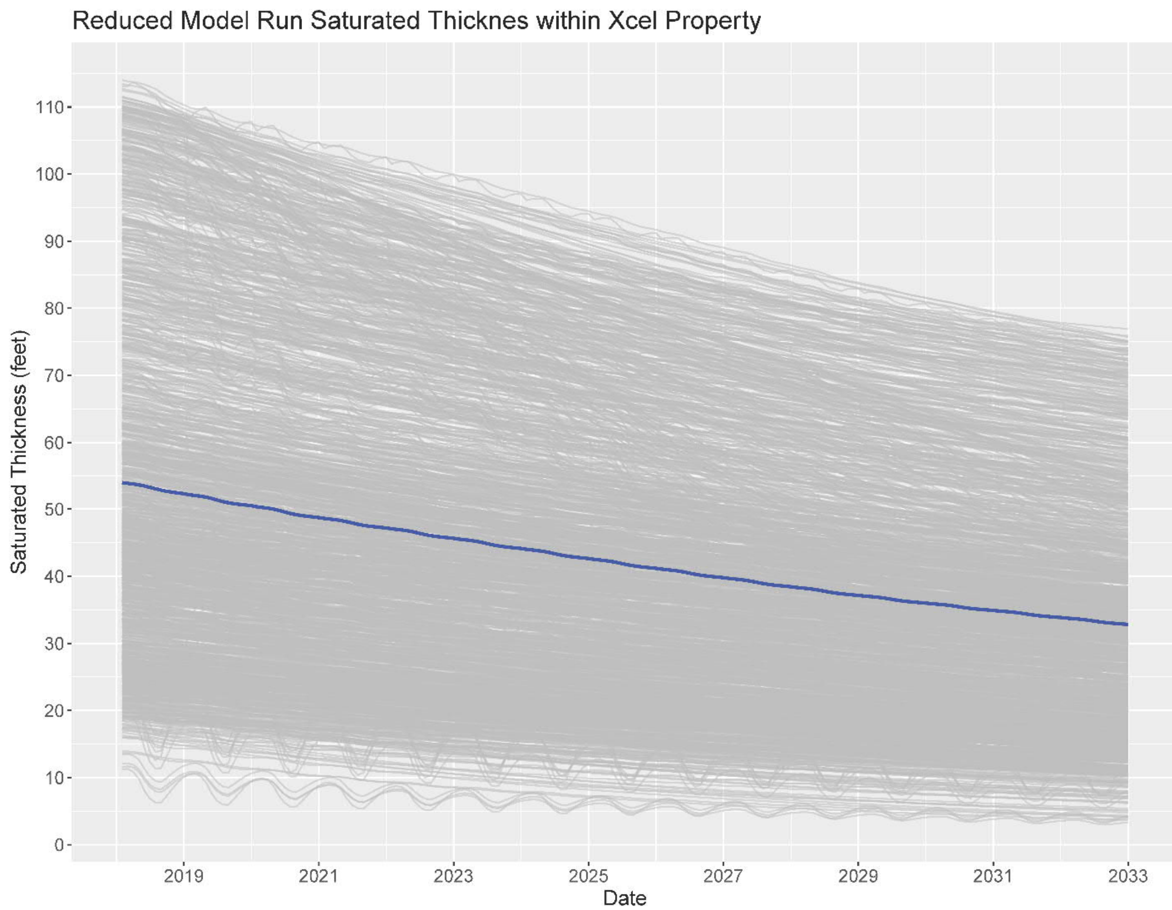

Figure 3-5. Saturated Thickness Results from Optimized Scenario for entire Xcel Property per Model Cell

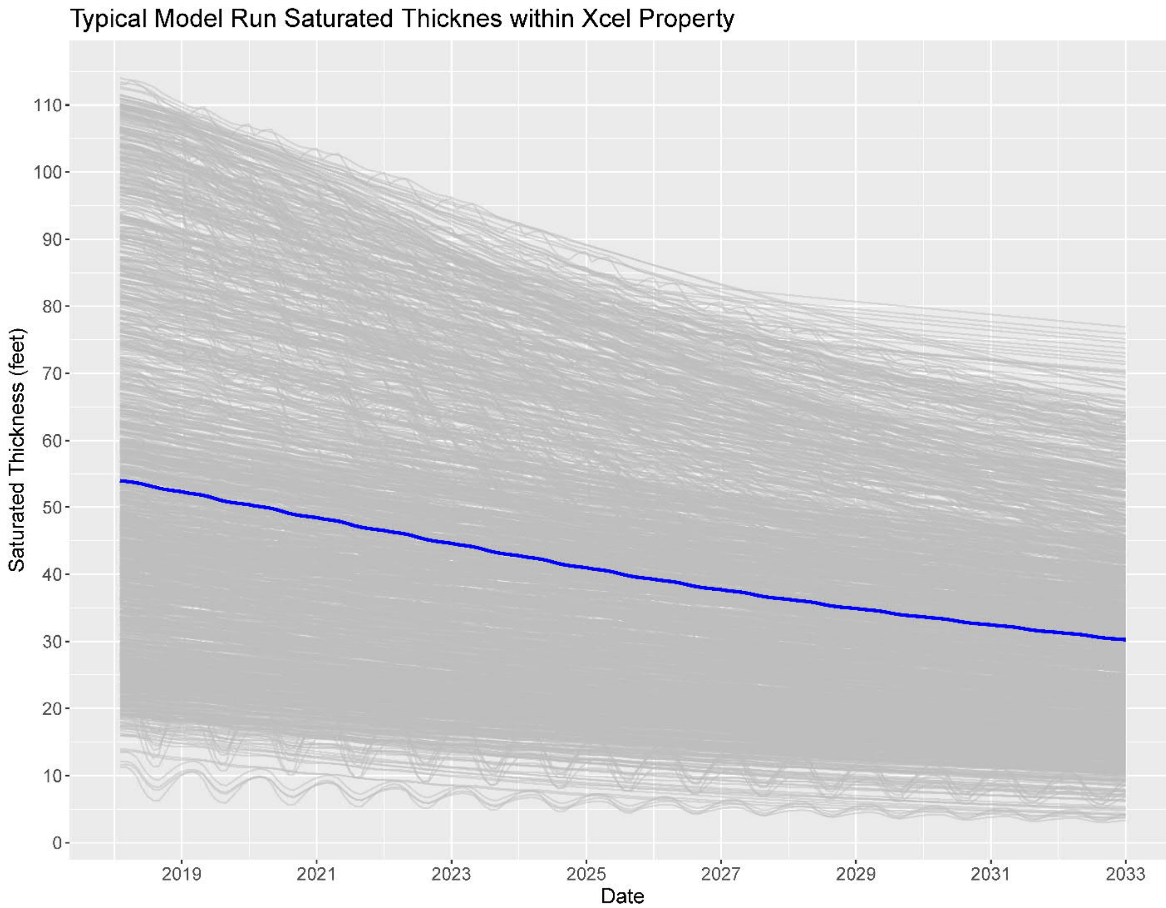

Figure 3-6. Saturated Thickness Results from Typical Scenario for entire Xcel Property per Model Cell

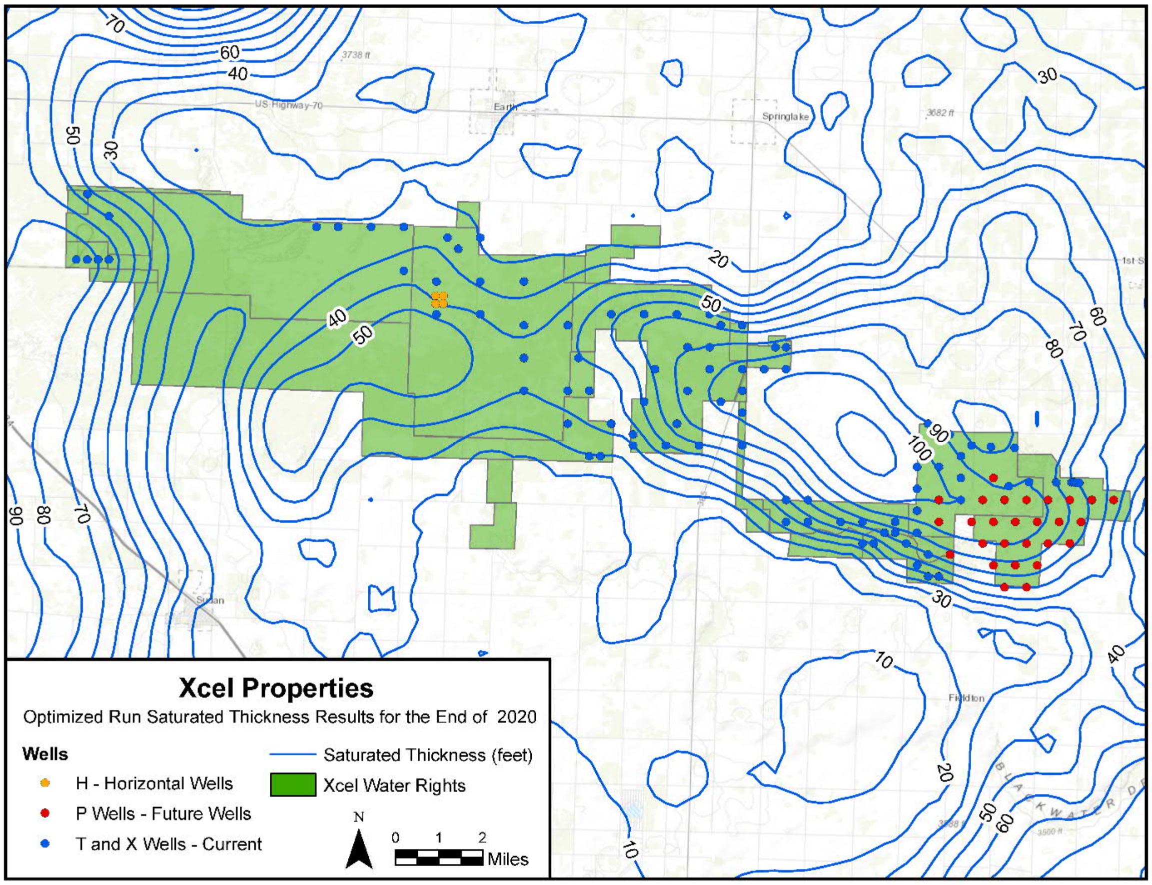

Figure 3-7. Map of Saturated Thickness Contours in 2020 for the Optimized Demand Scenario.

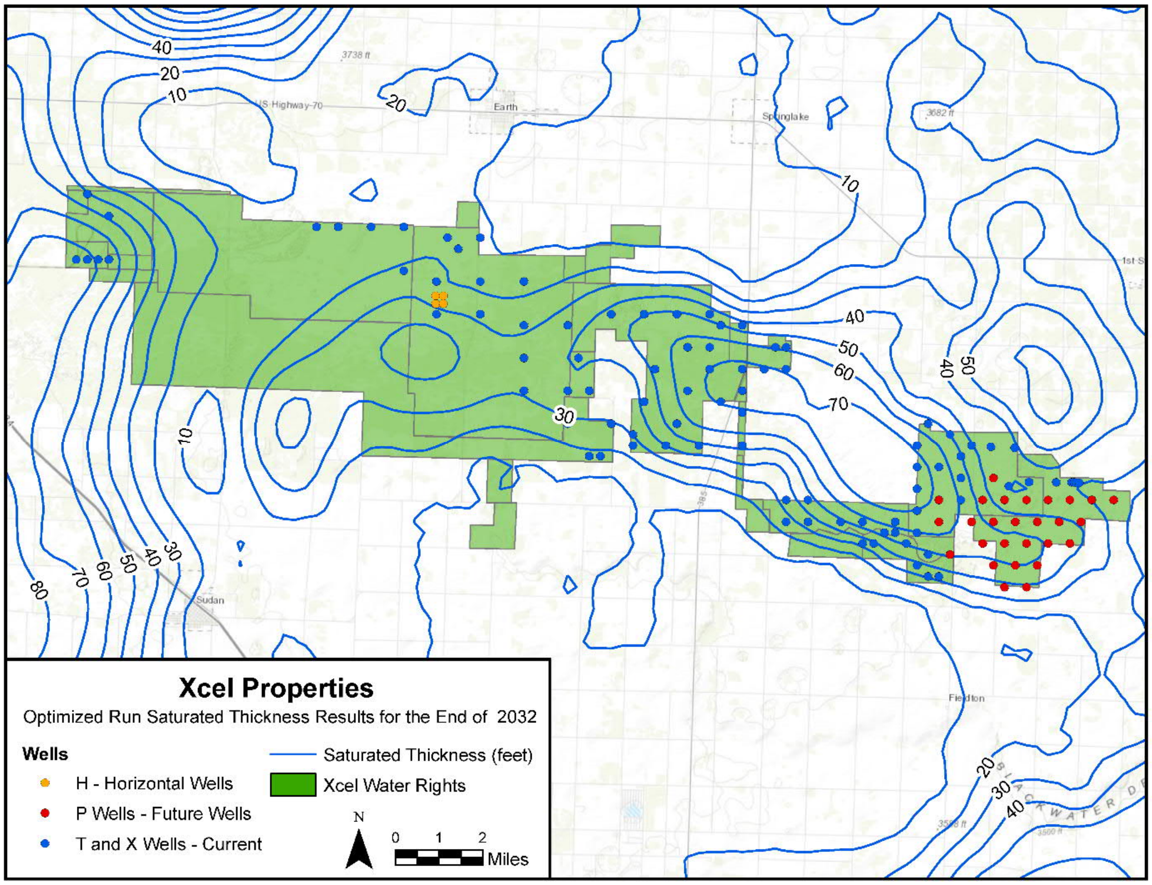

Figure 3-8. Map of Saturated Thickness Contours in 2032 for the Optimized Demand Scenario.

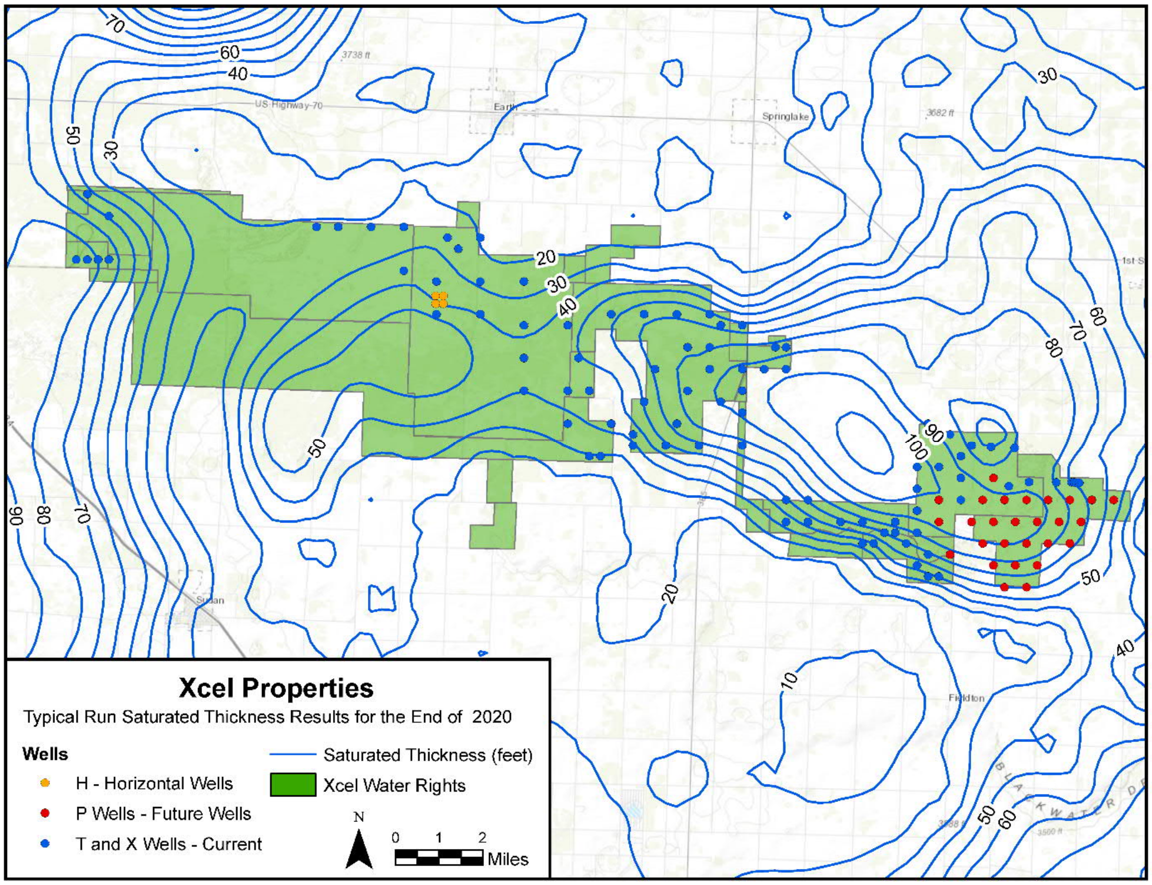

Figure 3-9. Map of Saturated Thickness Contours in 2020 for the Typical Demand Scenario.

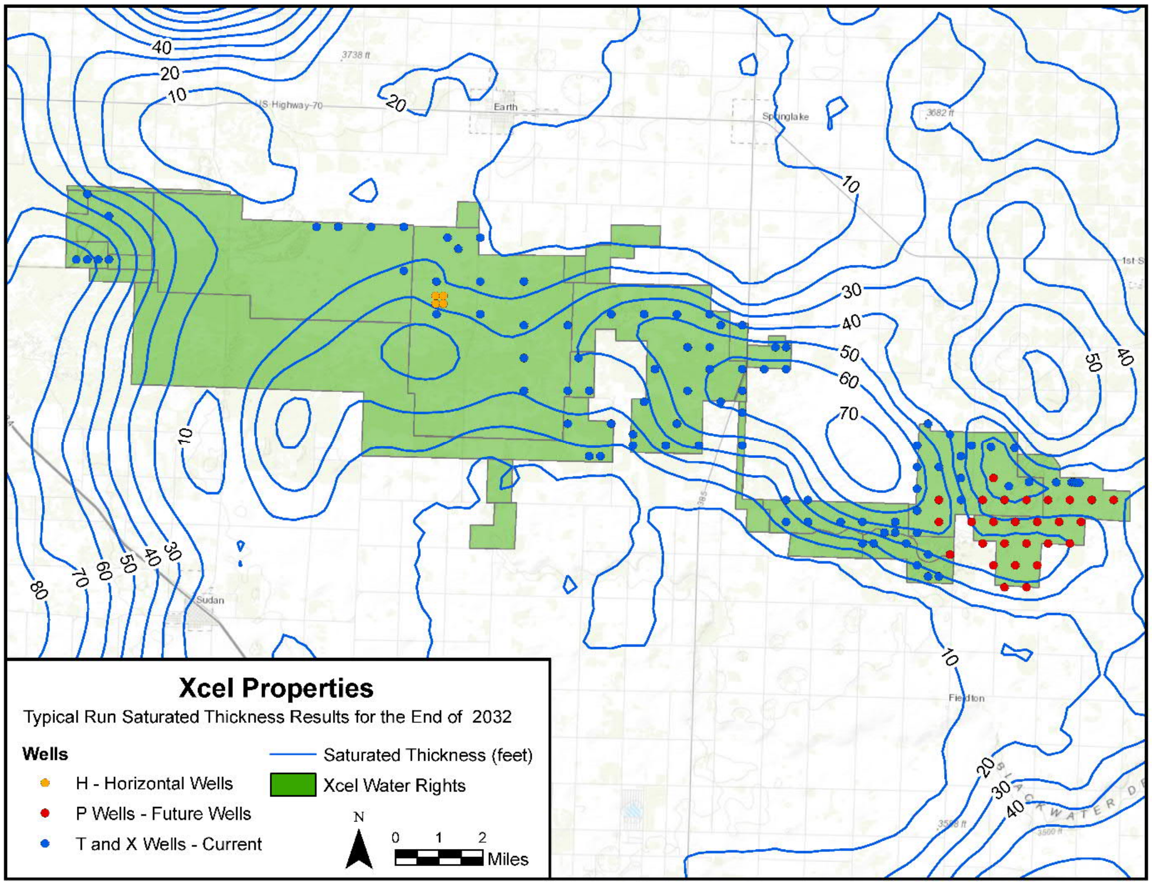

Figure 3-10. Map of Saturated Thickness Contours in 2032 for the Typical Demand Scenario.

3.1.3 Stored Groundwater

Figure 3-11 shows the simulated volume of water in the XWRA that is stored in the ground as available or unavailable. This graph shows the volume of groundwater below the simulated 40-foot saturated thickness threshold, which for this evaluation is assumed to be non-recoverable or unavailable. Figure 3-11 also shows the volume that is above that 40-foot threshold, which is assumed to be available for this evaluation.

As simulation time progresses, the portion of cells that have a simulated saturated thickness above 40 feet decreases, resulting in a decreased extractable volume with time. Comparison of the two scenarios (Figure 3-12, a and b) indicates that there is a noticeable gap between the scenarios with the optimized demand scenario having more available groundwater in storage relative to the typical demand scenario.

It's important to note the difference between what the model considers "unavailable" and what this volumetric calculation considers "unavailable". As shown in Figure 2-2, the model will continue to simulate groundwater production even when water levels drop below 40 feet, but at a decreased pumping rate. This volumetric calculation discussed above (and shown in Figures 3-11 and 3-12) assumes no extraction below the 40-foot threshold, so the simulated volume extracted by the model is greater than the estimated values shown in Figure 3-11.

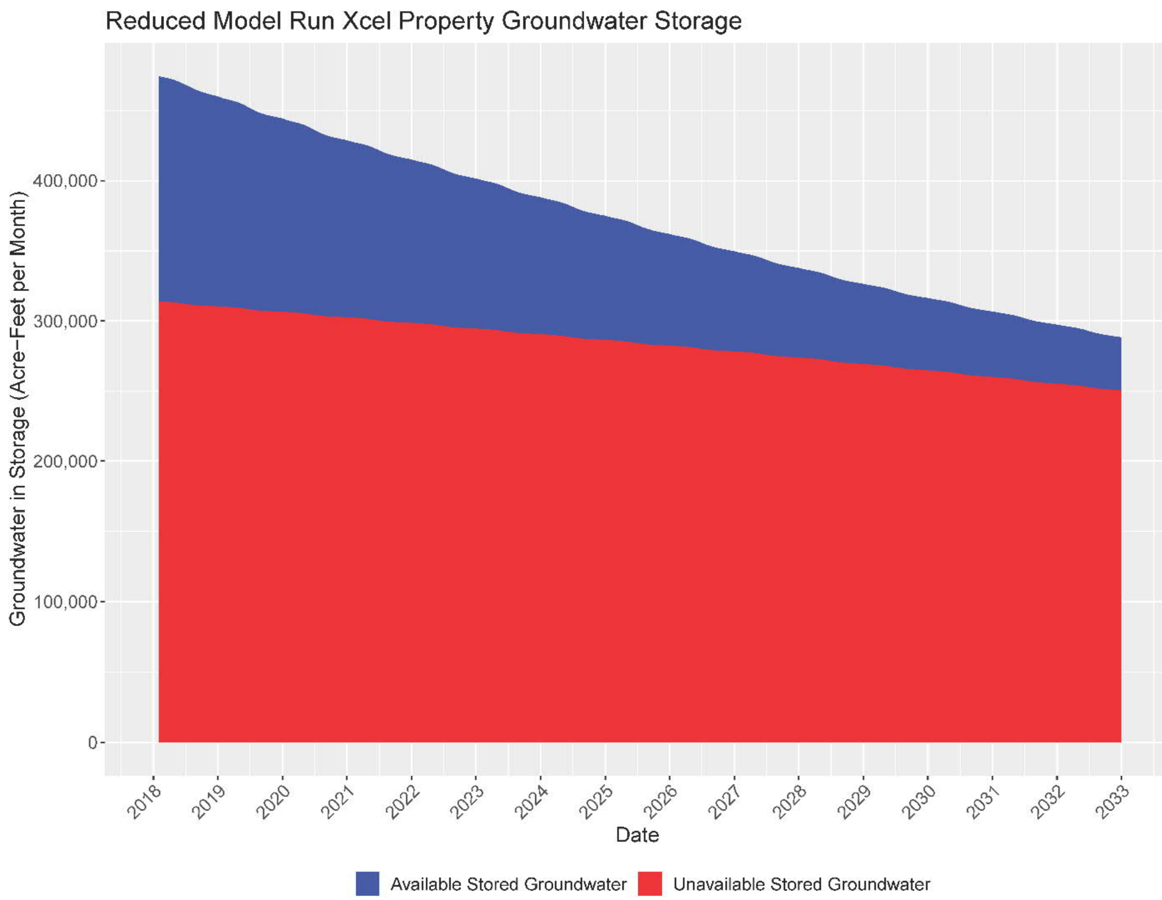

Figure 3-11. Available and Unavailable Stored Groundwater within Xcel Property Assuming No pumping below 40-foot Saturated Thickness for the Optimized Demand Scenario.

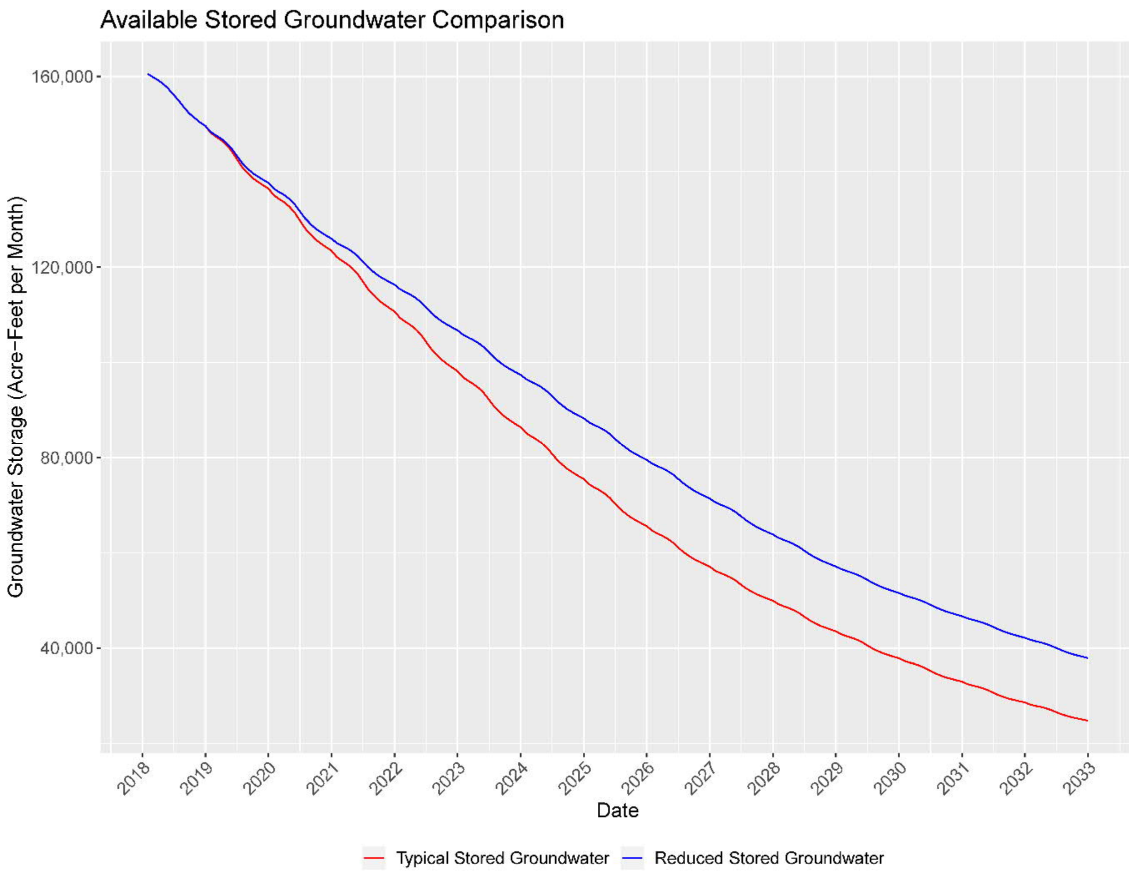

Figure 3-12. (a) Comparison of Groundwater in Storage (above 40-foot limit) for the Typical and Optimized Demand.

4. Conclusions and Recommendations

The 2019 groundwater model for Xcel was updated by simplifying the predictive pumping, incorporating the nine new wells into the model, and running the updated scenario demand values for the optimized and typical runs.

The results from the predictive runs indicate that Xcel will likely have challenges meeting the groundwater demands throughout both the scenarios. Of the two scenarios, the optimized demand scenario comes closer to meeting the average annual demand, with the predicted deficit rising slowly but steadily throughout the modeled period. However, even in the optimized demand scenario summer peak demands may pose challenges to the wellfields. In the typical demand scenario, the simulated deficit rises more rapidly than in the optimized scenario.

The major difference between the scenarios is that the optimized demand scenario will produce less groundwater through time, but will have smaller unmet demands through time. Because these deficits are relatively small, it may be easier to reduce them by optimization of future well placement, and by fine-tuning well production through time in the field operations. The typical demand will produce more groundwater through time because the water at the boundaries is not lost to competitive pumping and because a higher demand is consistently simulated in all areas, but will not meet typical production demands through the model run. The tradeoff between the two scenarios is to produce more groundwater now and less later, or produce less groundwater overall but at a steadier rate (less production capacity loss through time).

5. Limitations of Model and Study

As with all models, the current Xcel model and modeling approach has limitations that should be acknowledged. Generally, these limitations can be categorized into limits related to (1) supporting data, and (2) the modeling approach, implementation, and applicability.

5.1. Limitations of Supporting Data

The primary limitations in supporting data for the model include:

- limited water level targets both spatially and temporally
- limited hydraulic conductivity and specific yield data
- uncertain estimates of pumping by irrigators located close to the XWRA boundary
- uncertain estimates of well capacity as water levels decline
- uncertainty about future wellfield operation practices.

The primary type of calibration target used in most models, including this groundwater availability model, is water level data. Limits in the number of wells monitored and the water level measurements frequency leads to uncertainty in the model calibration and in turn, the predictive modeling results.

Pumping, which is the largest source of discharge from the model, is uncertain because estimates of pumping outside the XWRA are dependent on secondary sources, such as crop areas and application rates, which are themselves uncertain. While change in storage calculations are helpful in estimating long term pumping rates in an area, they also carry uncertainty due to the uncertainty both in regional water level surfaces and specific yield of the aquifer.

5.2. Limitations of Model Approach, 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.

A significant uncertainty in the model is the irrigation pumping near Xcel boundaries, which can have an impact on the predictions made with the model. One way to minimize the impacts of this uncertainty is to continue to update the model annually as water levels decline. As the water levels continue to decline, the amount of groundwater that can be taken from the XWRA becomes smaller due to the limited impact that competitive wells can have on hydraulic gradients near the boundary because of small saturated thickness.

As mentioned in Section 3, it is important to remember that future pumping demand in the model is pre-determined for each well before the simulation begins and is not adjusted throughout the simulation based on water levels and changes in well production capacity through time. As such, if the predetermined pumping demand for a given well in the future is estimated based on conditions that exist in 2019, the estimated pumping demand from a well might be higher or lower than the simulated well capacity due to simulated aquifer conditions. If the pre-determined pumping demand is higher than the simulated well capacity at that simulated time, then the model might be indicating a deficit that could actually be met by shifting pumping to other wells that can produce more than their predetermined pumping amount. In an ideal real-world wellfield, field operators could adjust pumping levels on a quarterly or annual basis to increase production from each well to meet overall demand. This real-time adjustment could possibly eliminate some of the smaller deficits in the early years of the simulated deficits. However, fine tuning the well production in this manner has limits in extending the overall life and production of the wellfield. Nonetheless, the approach used herein does not mean that the model is not helpful for management decisions and assessment of various scenarios.

6. References

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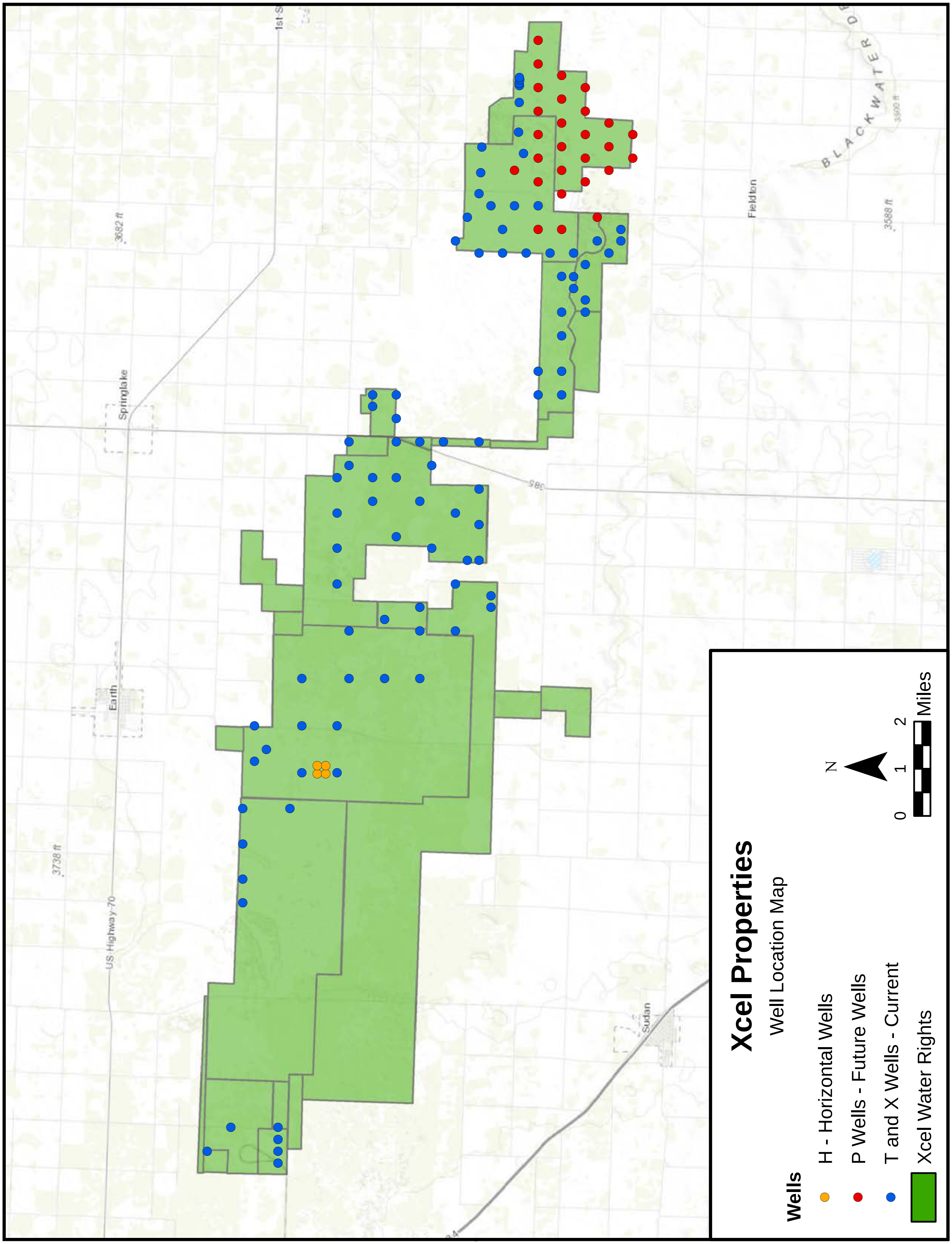
Appendix A —
Xcel Overview Maps


Xcel Properties
Well Location Map
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Xcel Water Rights
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US Highway-70
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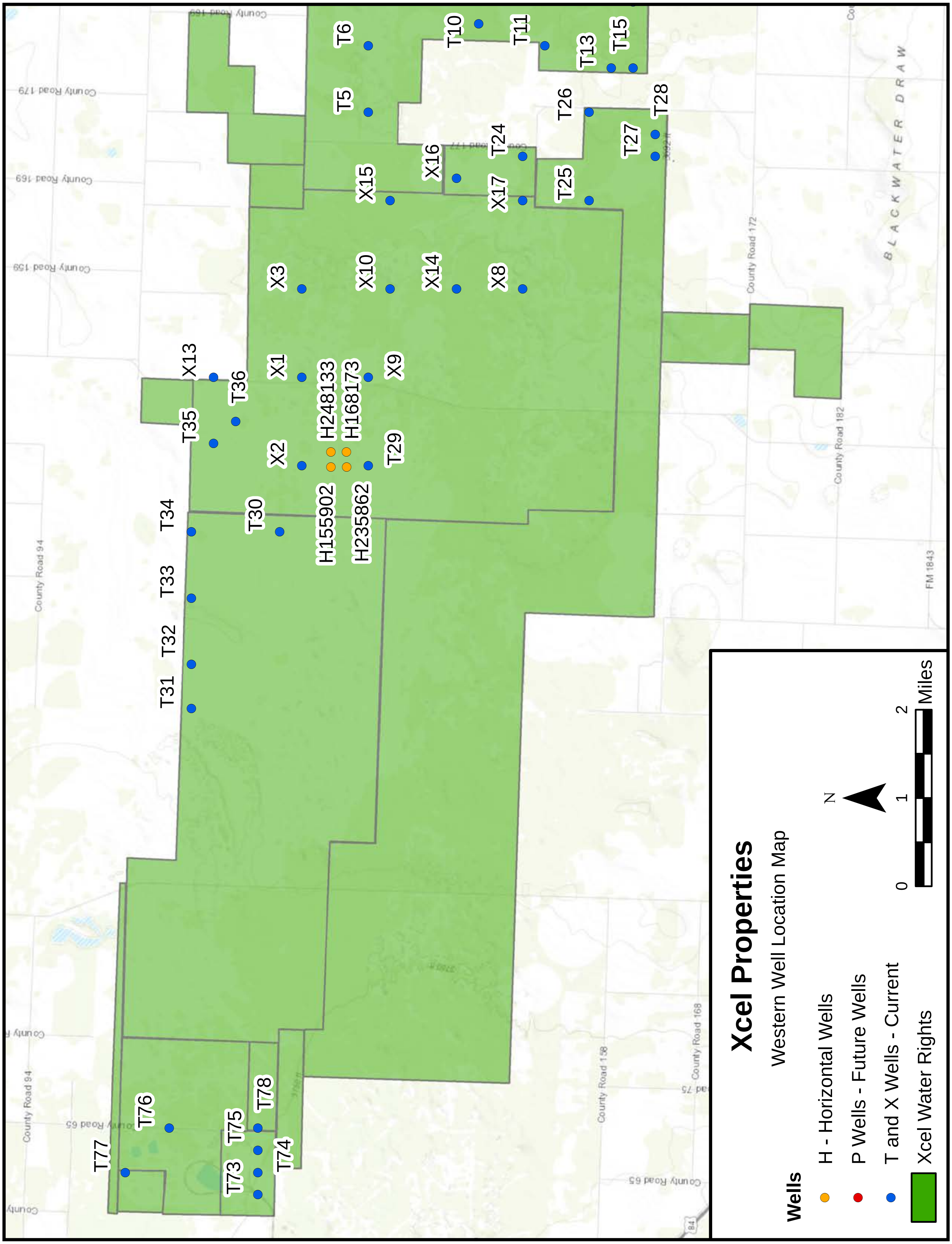
Xcel Properties
Western Well Location Map
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Xcel Water Rights
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H248133
H168173
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County Road 182
County Road 94
County Road 158
County Road 168
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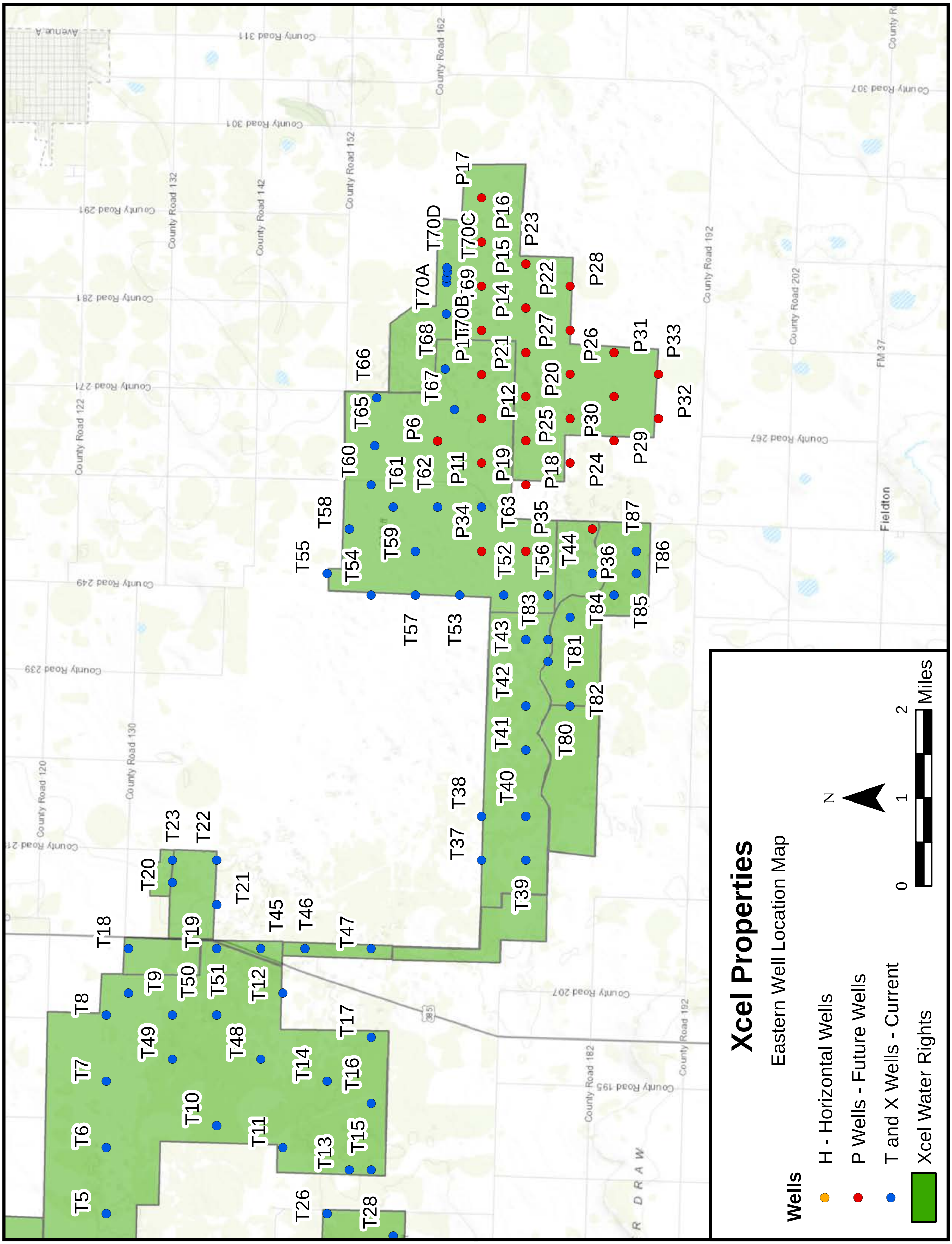
Xcel Properties
Eastern Well Location Map
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Xcel Water Rights
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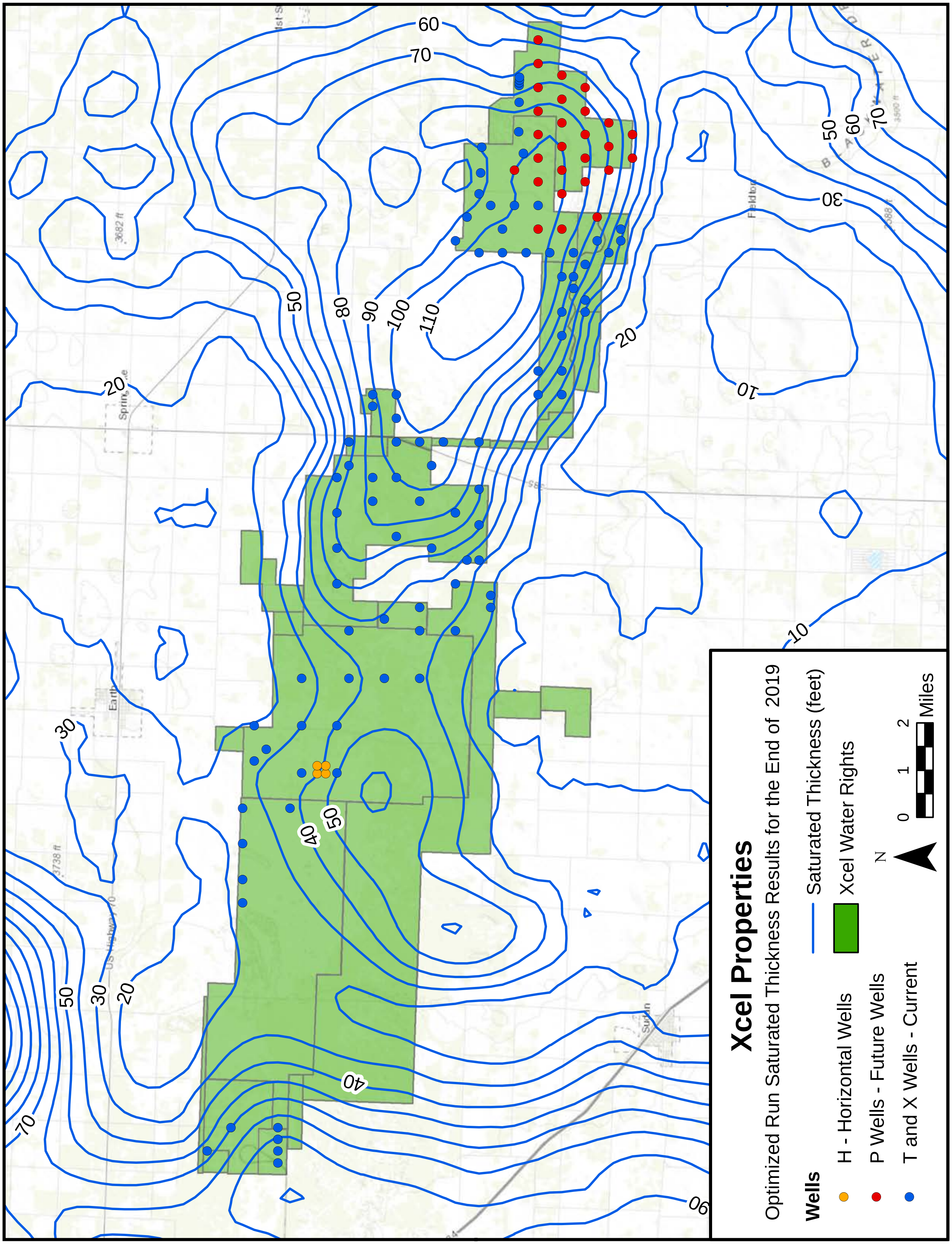
Appendix B —
Saturated Thickness Maps for Optimized Demand Scenario


Xcel Properties
Optimized Run Saturated Thickness Results for the End of 2019
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0 1 2 Miles
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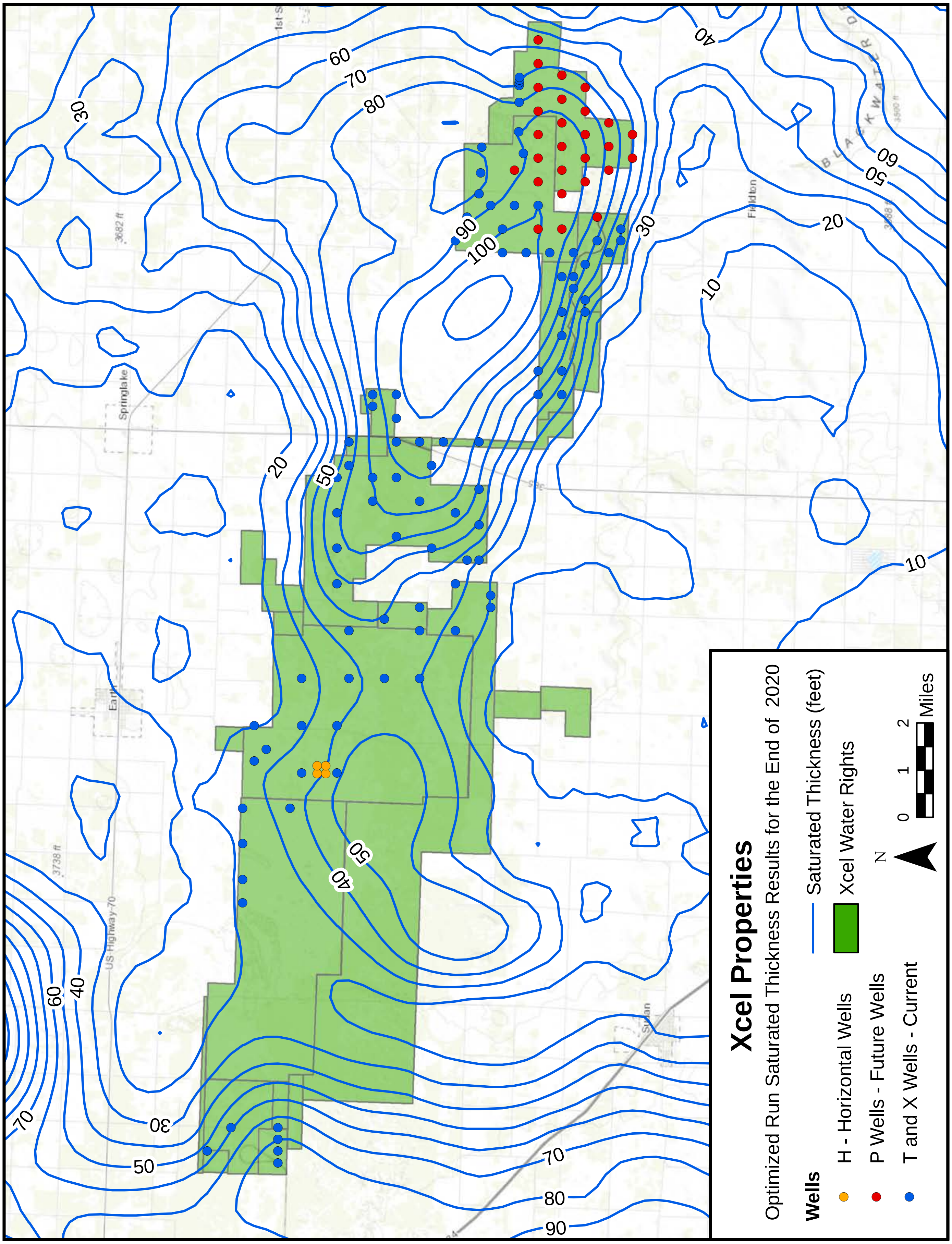
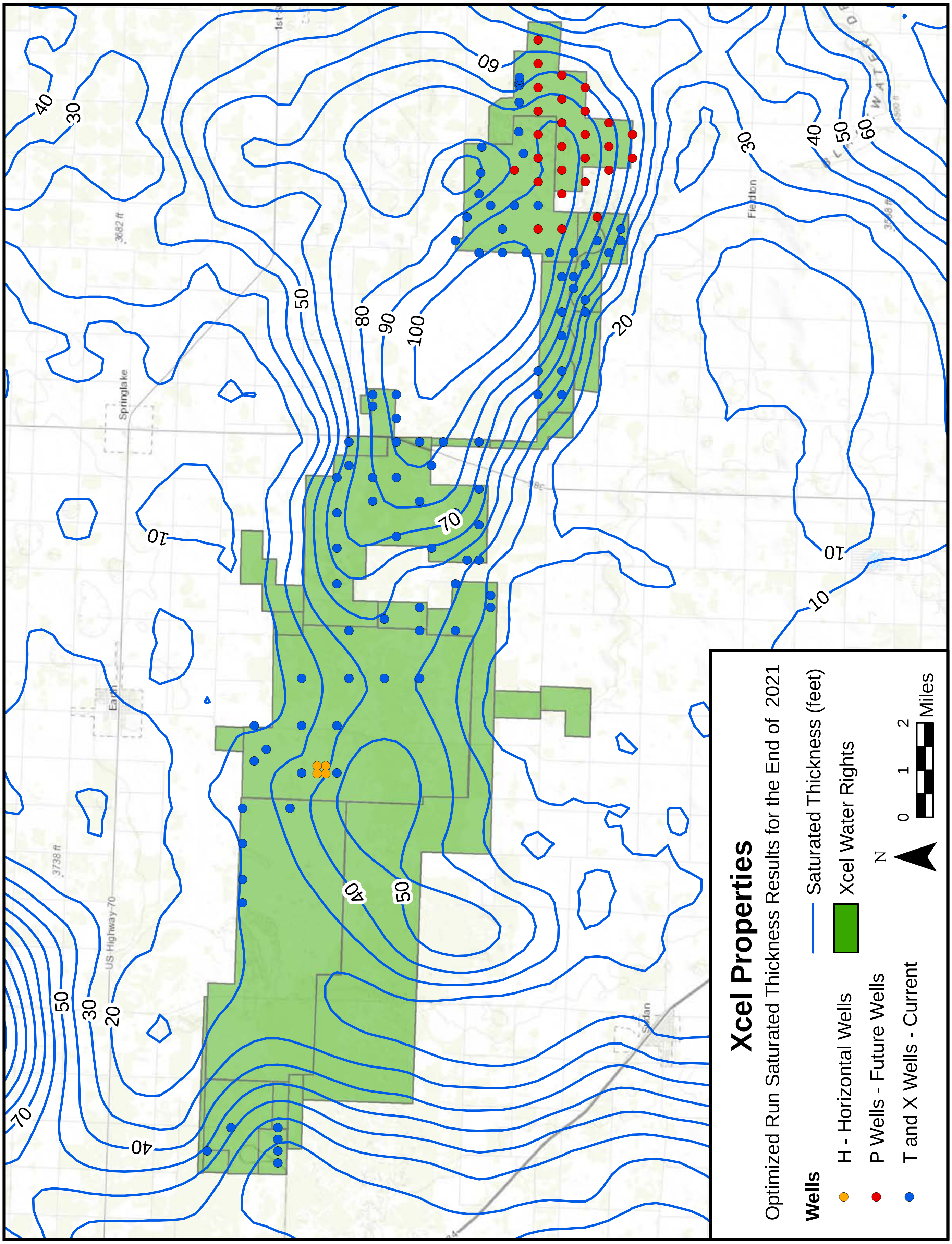
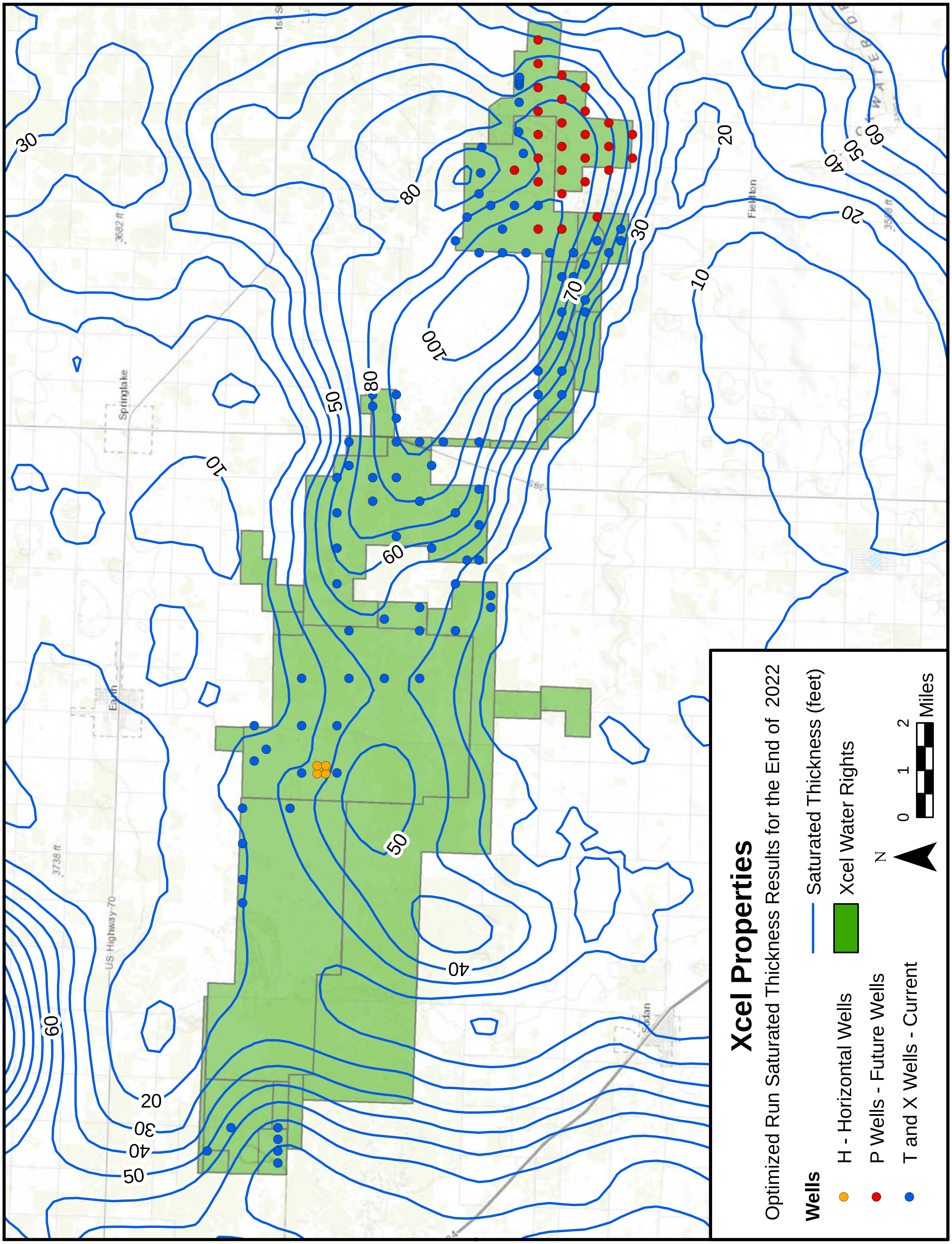
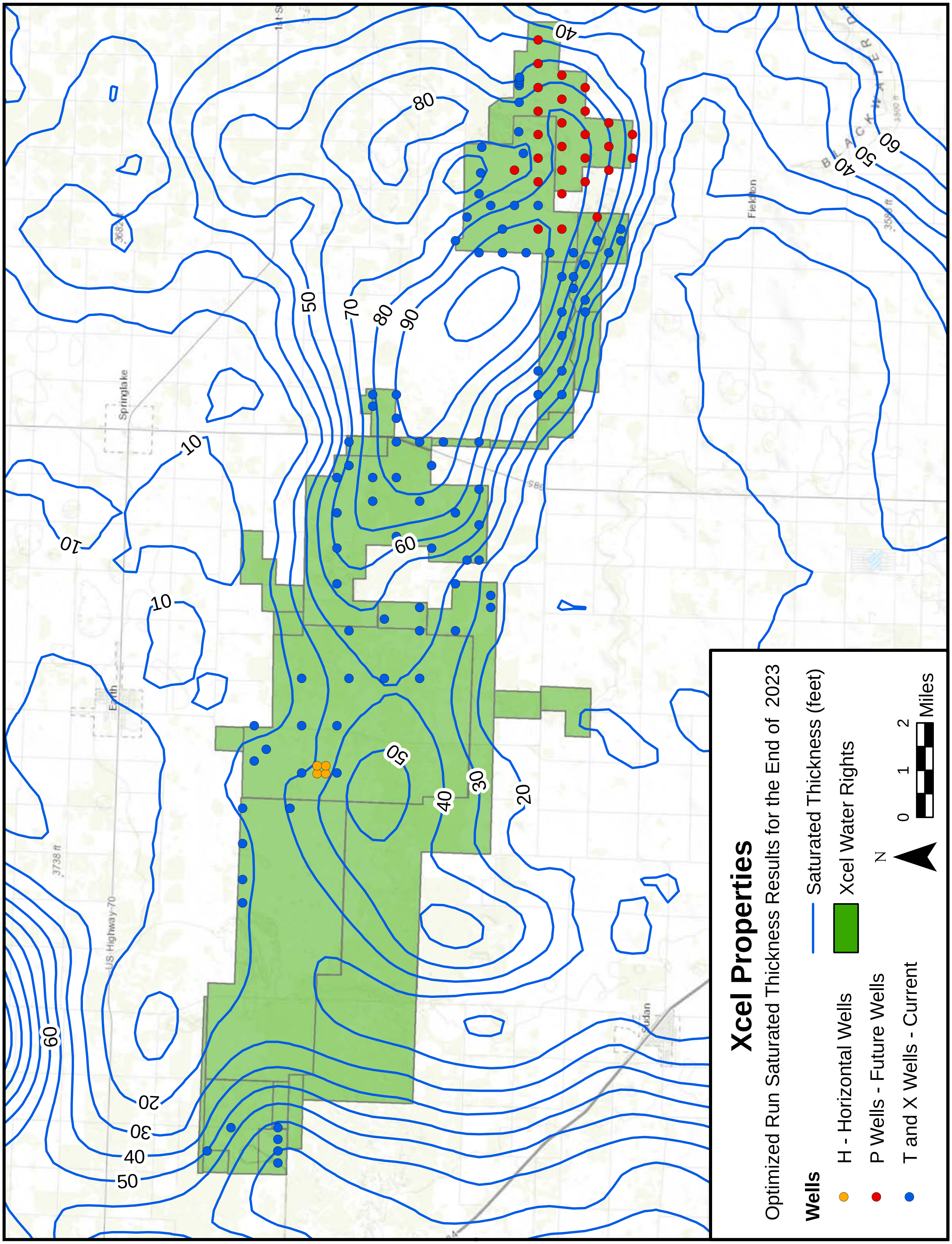
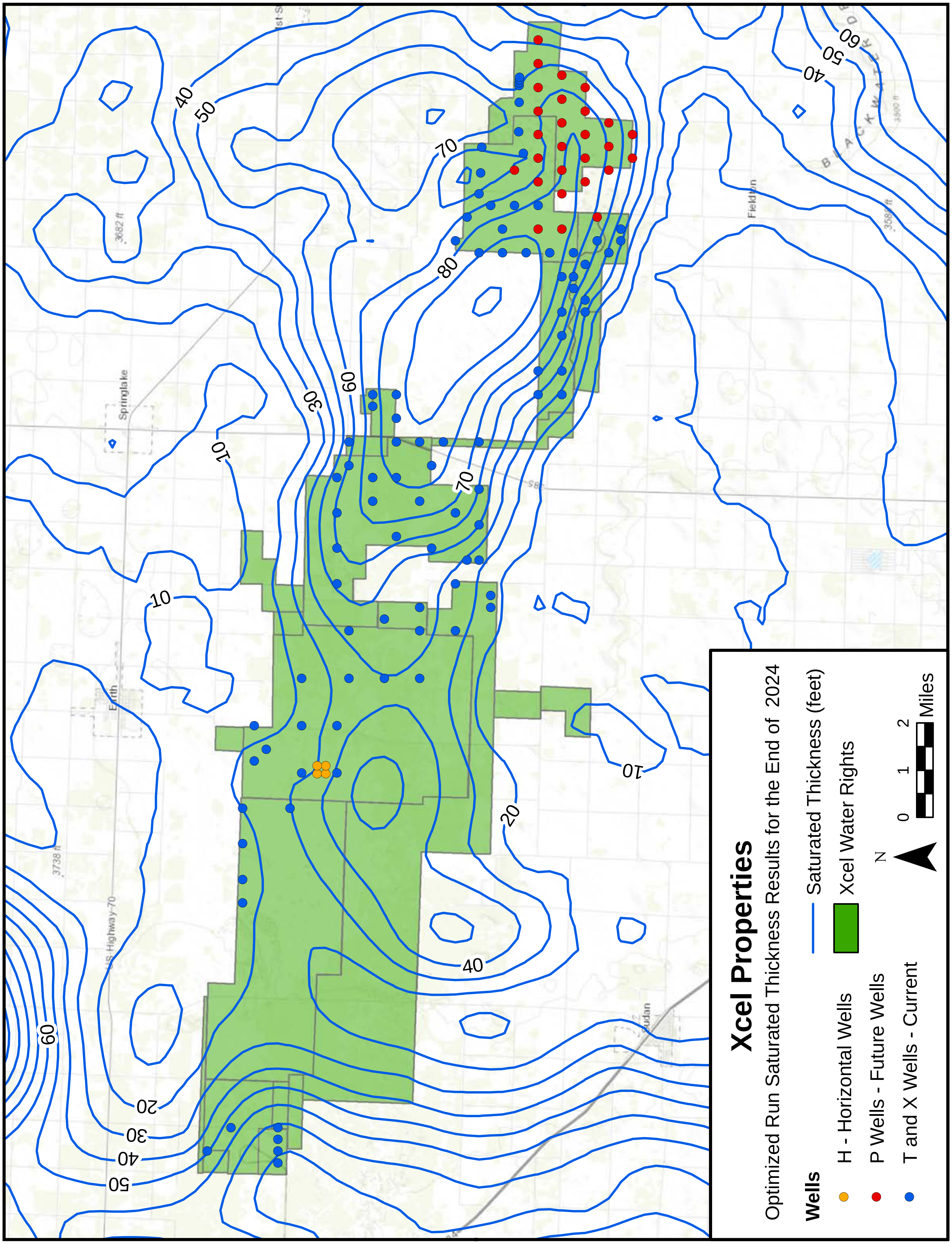
50
60
70
80
90
100
110

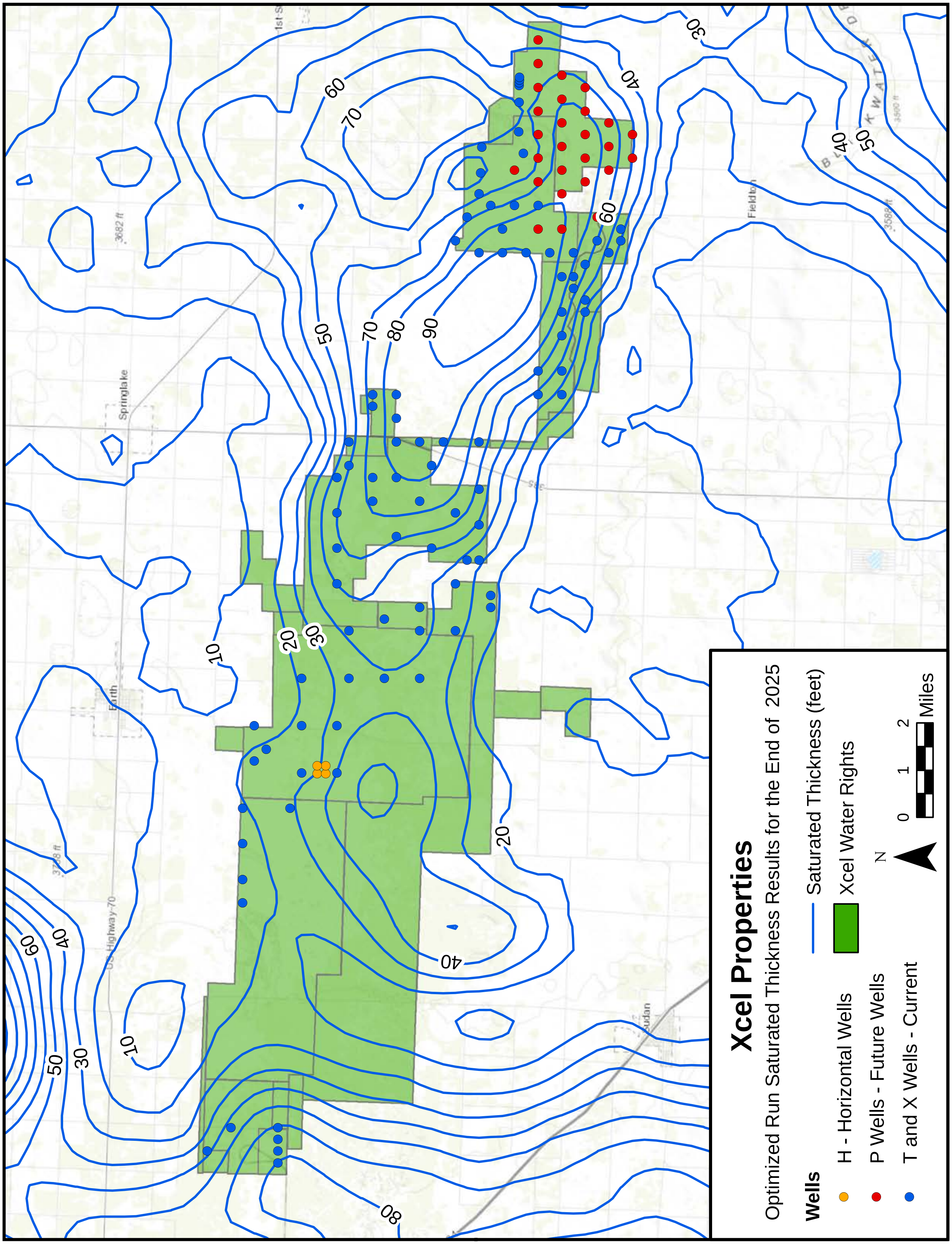

Xcel Properties
Optimized Run Saturated Thickness Results for the End of 2020
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0 1 2 Miles
Springlake
Earth
Sudan
Fieldton
US Highway-70
10
20
30
40
50
60
70
80
90
100

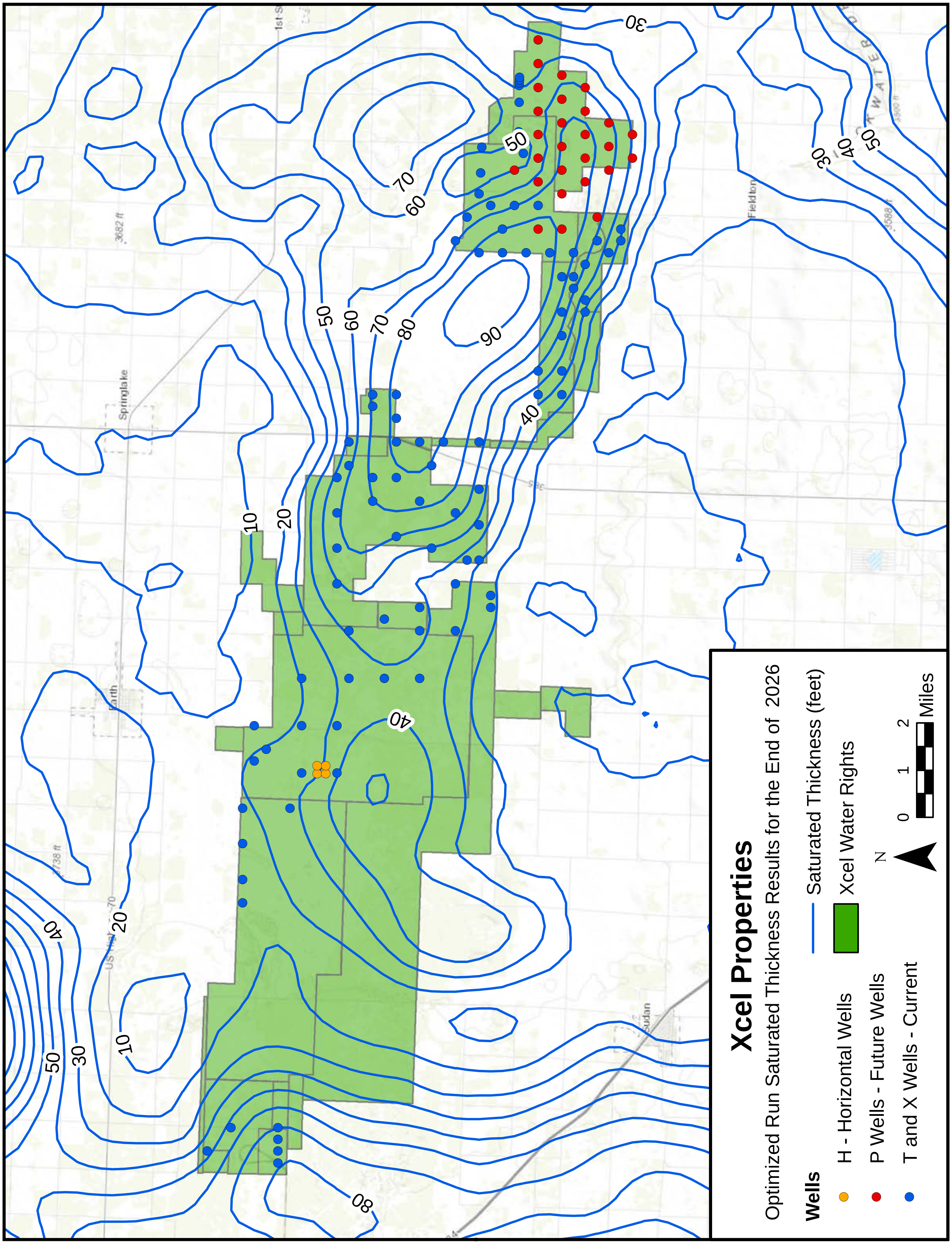

Xcel Properties
Optimized Run Saturated Thickness Results for the End of 2021
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0 1 2 Miles
Springlake
Earth
Sudan
Fieldton
US Highway-70

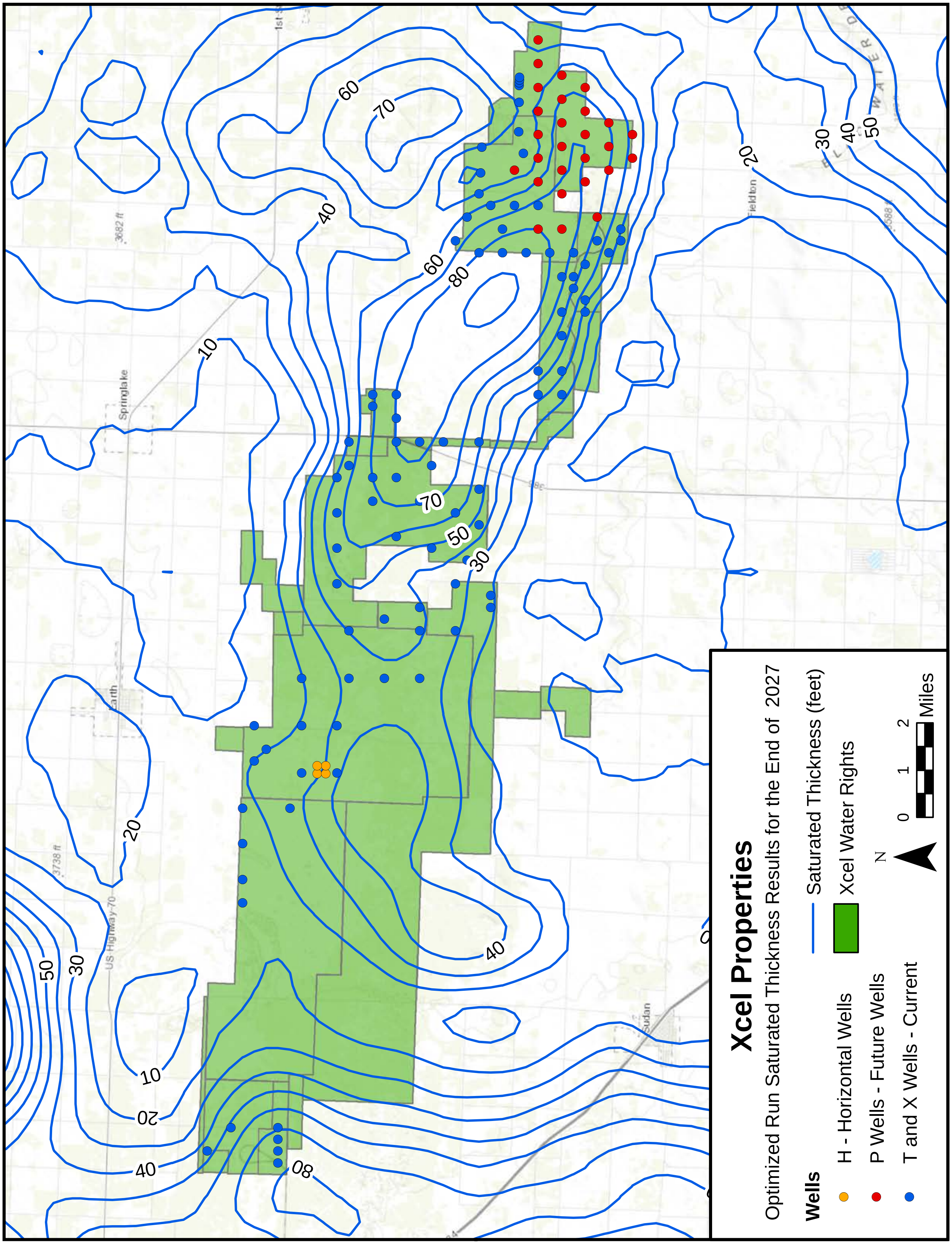

Xcel Properties
Optimized Run Saturated Thickness Results for the End of 2022
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0 1 2 Miles
Springlake
Earth
Sudan
Fieldton
US Highway-70

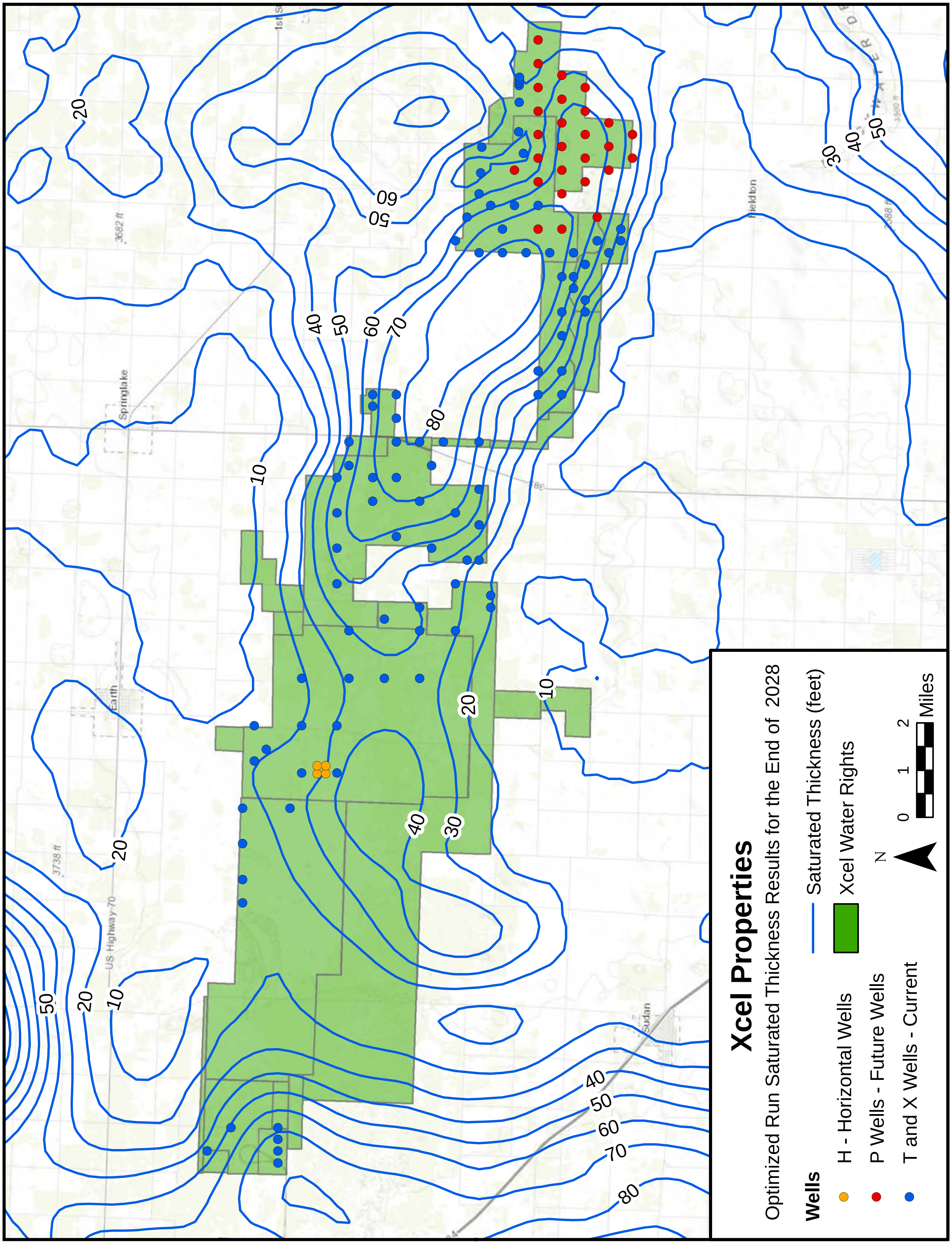

Xcel Properties
Optimized Run Saturated Thickness Results for the End of 2023
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0 1 2 Miles
Springlake
Earth
Fieldton
Sudan
US Highway-70

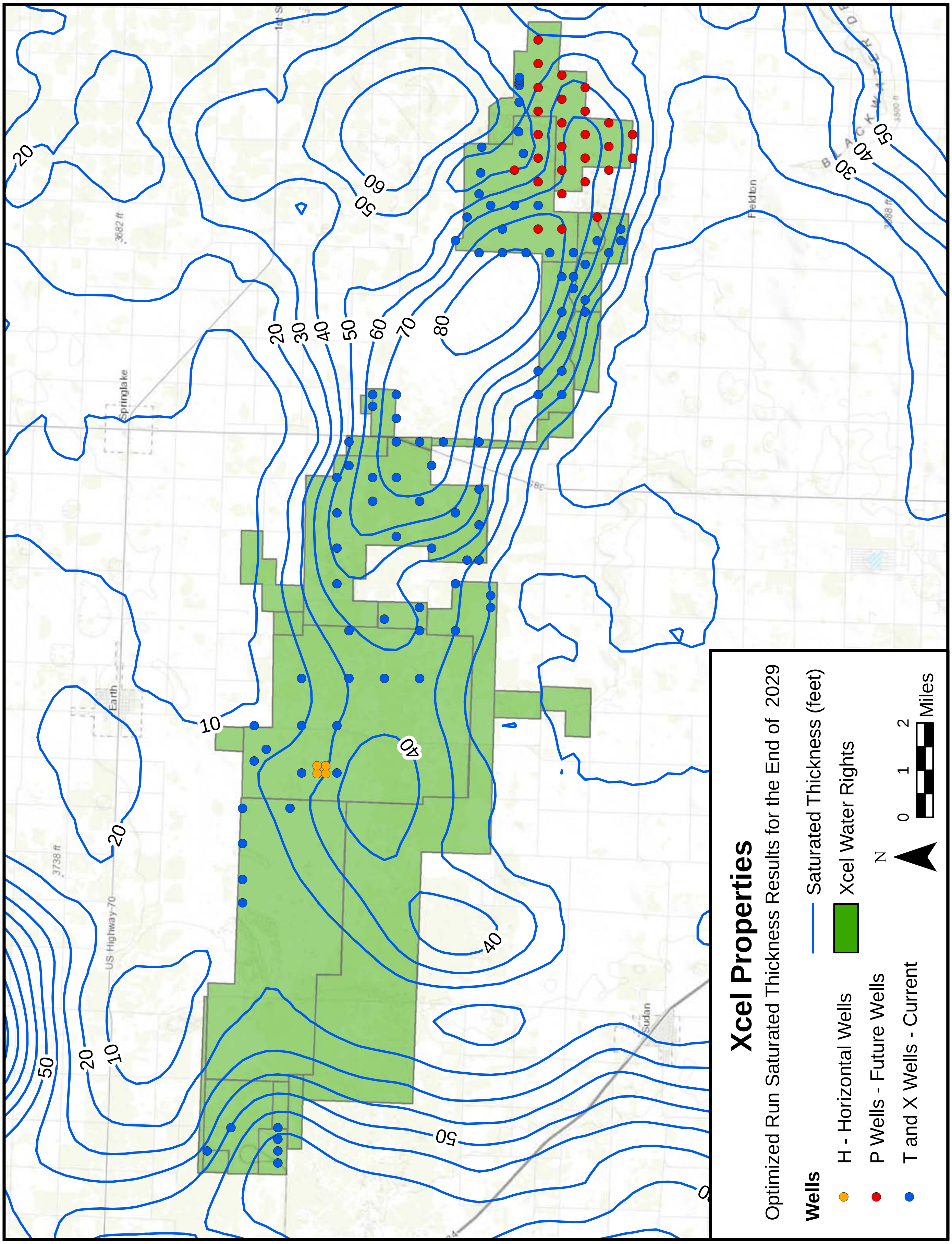

Xcel Properties
Optimized Run Saturated Thickness Results for the End of 2024
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0 1 2
Miles
Springlake
Earth
Sudan
Fieldton
US Highway-70
3682 ft
3738 ft
10
20
30
40
50
60
70
80

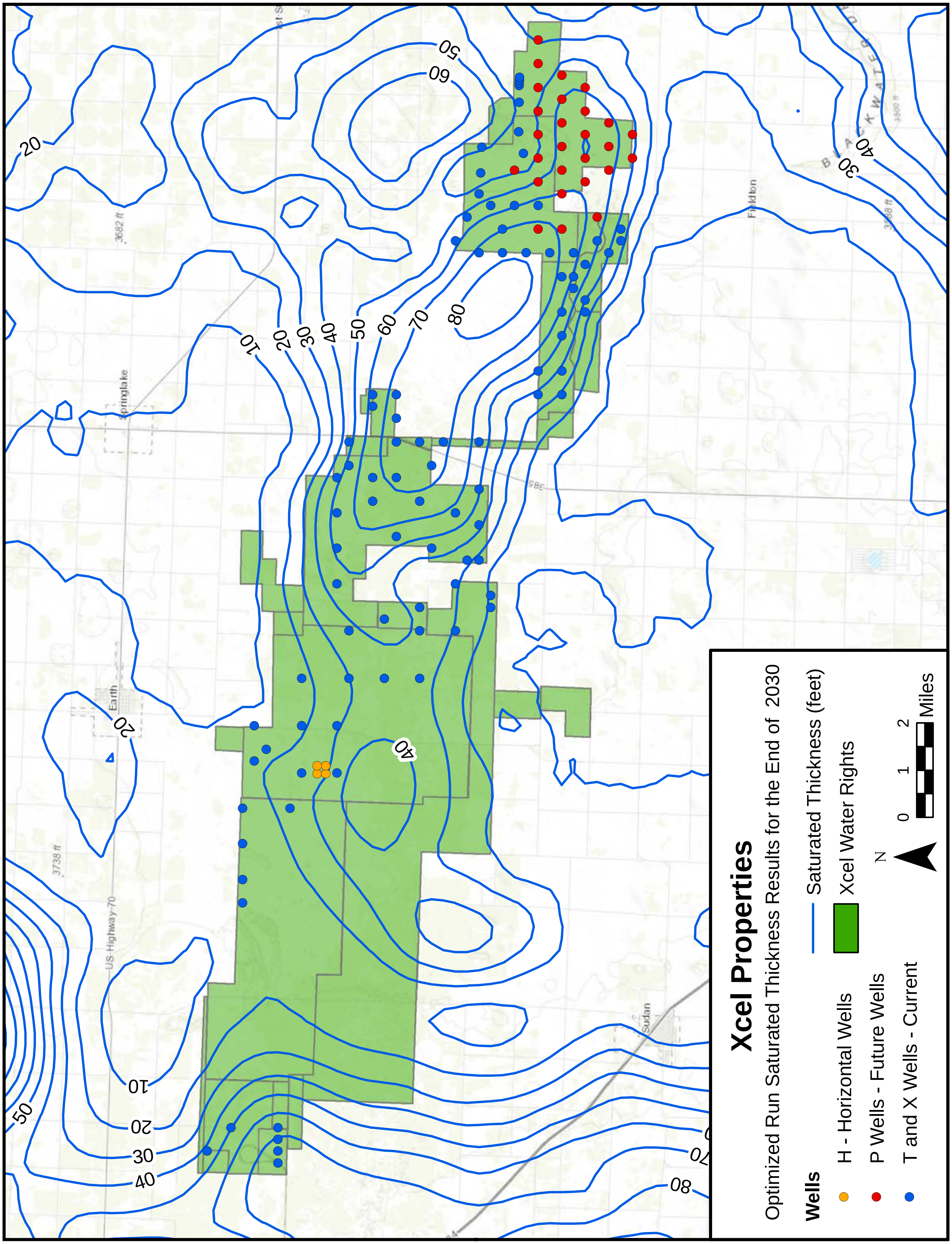

Xcel Properties
Optimized Run Saturated Thickness Results for the End of 2025
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0 1 2 Miles

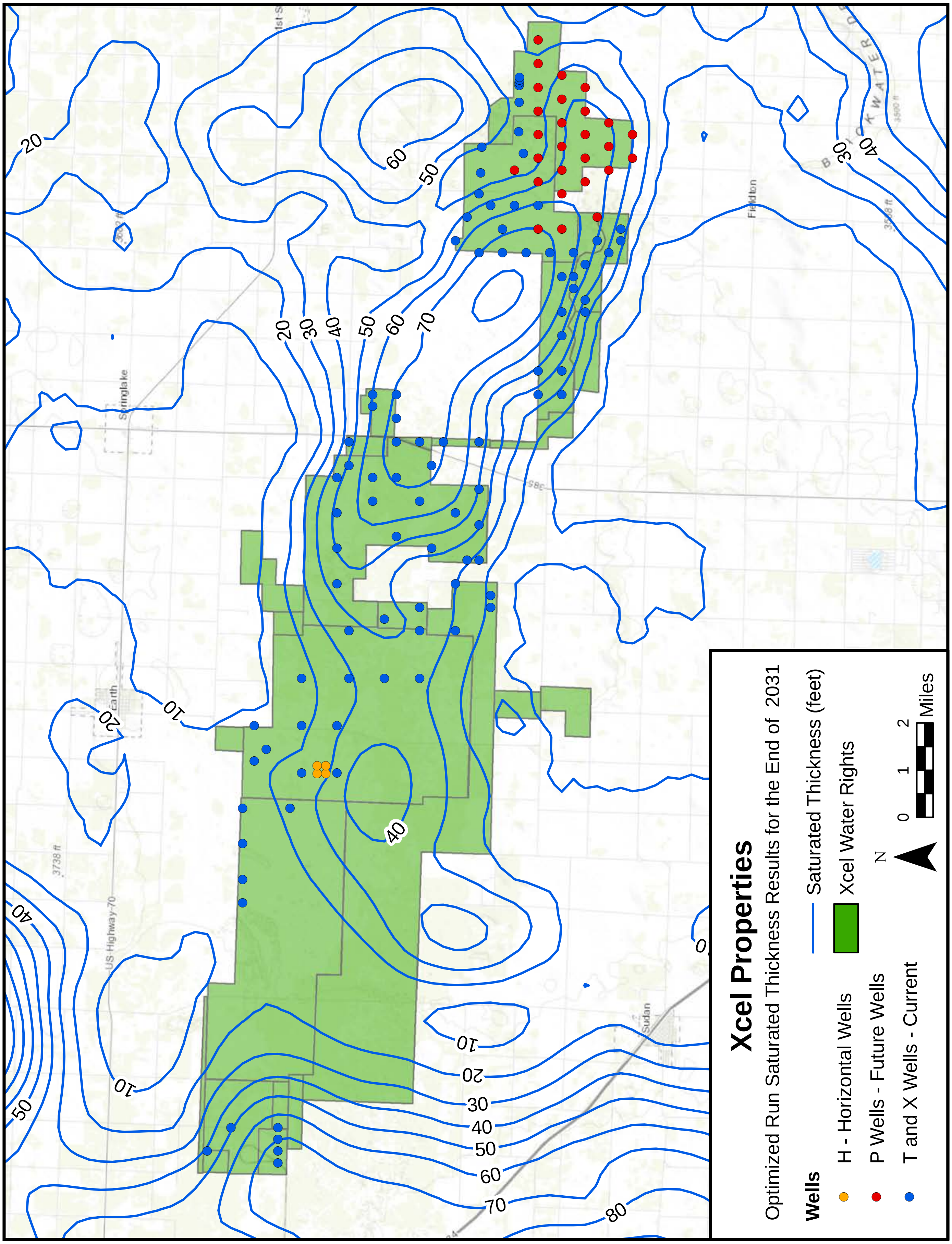

Xcel Properties
Optimized Run Saturated Thickness Results for the End of 2026
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0 1 2 Miles
Springlake
Earth
Fieldton
Sudan

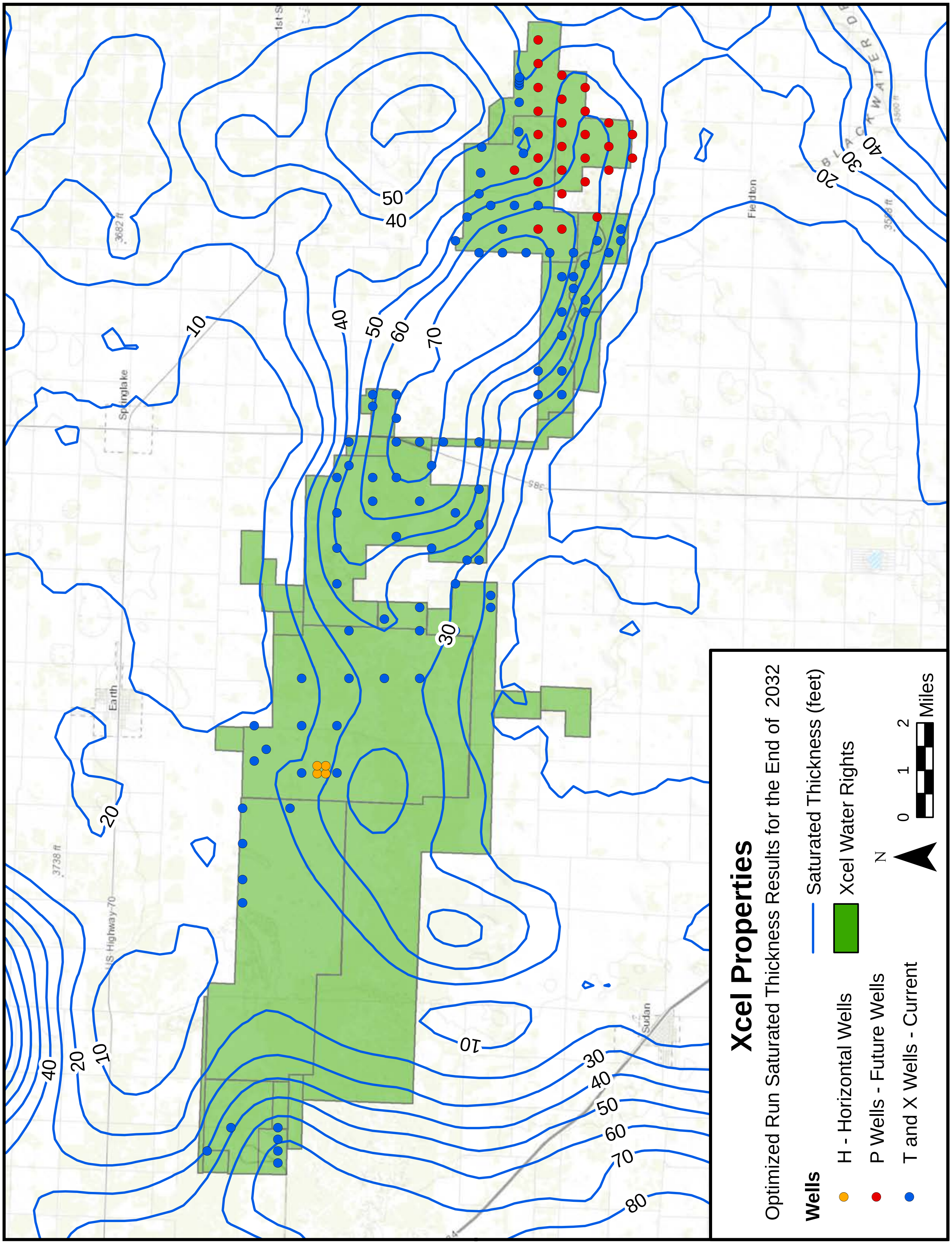

Xcel Properties
Optimized Run Saturated Thickness Results for the End of 2027
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0 1 2 Miles


Xcel Properties
Optimized Run Saturated Thickness Results for the End of 2028
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0 1 2 Miles
Springlake
Earth
Sudan
US Highway-70

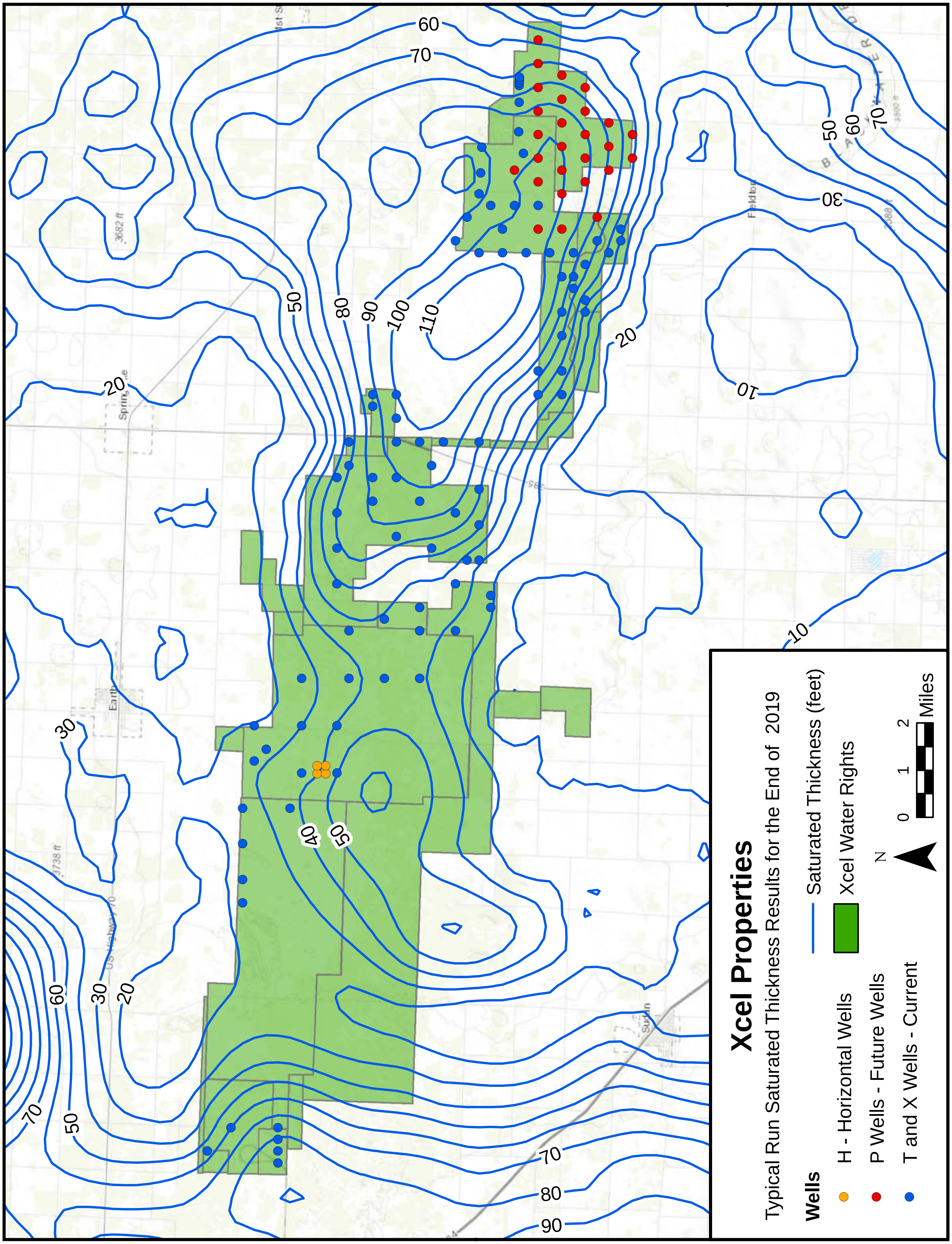

Xcel Properties
Optimized Run Saturated Thickness Results for the End of 2029
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0
1
2
Miles
Springlake
Earth
Sudan
Fieldton
US Highway-70
10
20
30
40
50
60
70
80

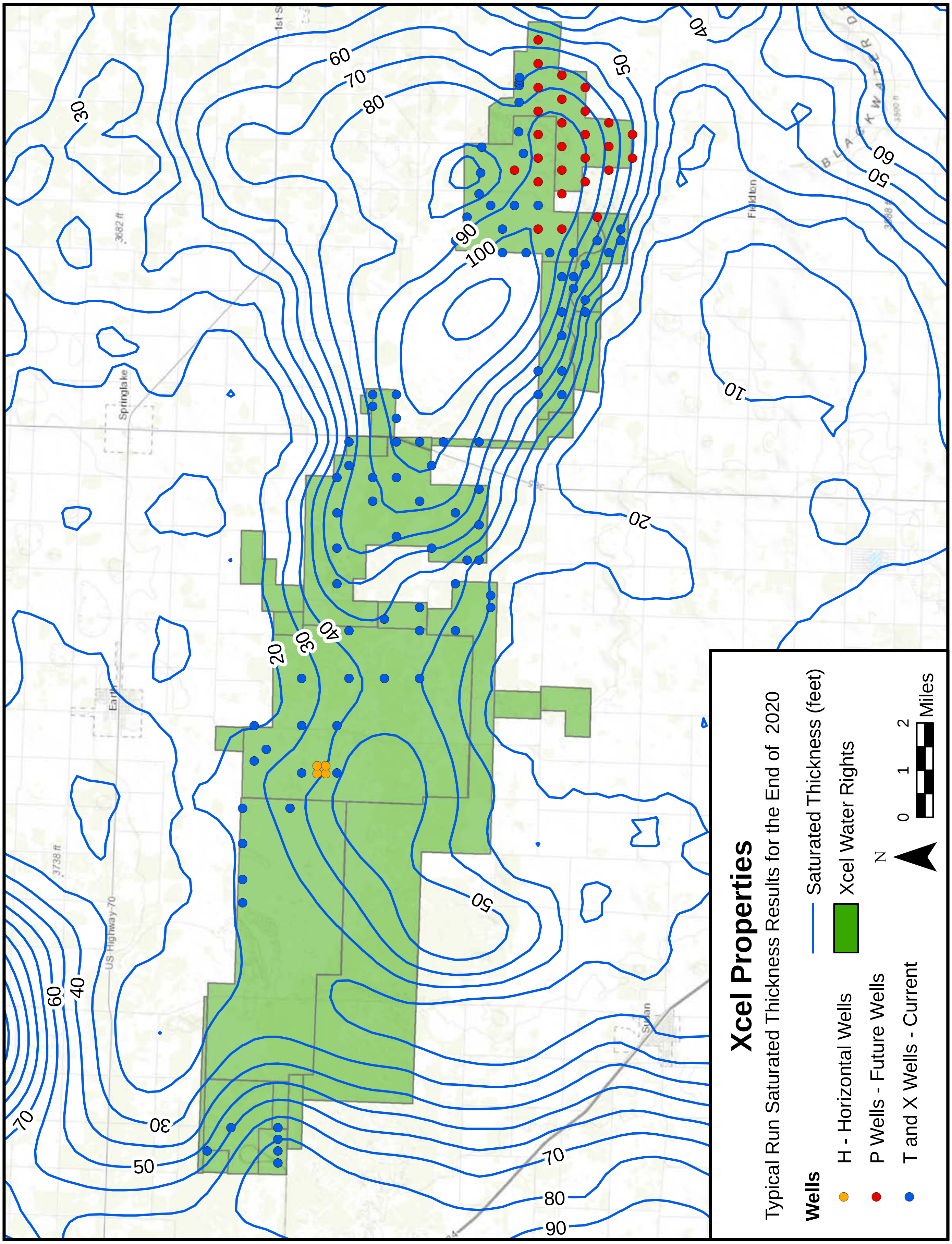

Xcel Properties
Optimized Run Saturated Thickness Results for the End of 2030
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0
1
2
Miles
Springlake
Earth
Sudan
Fieldton
US Highway-70

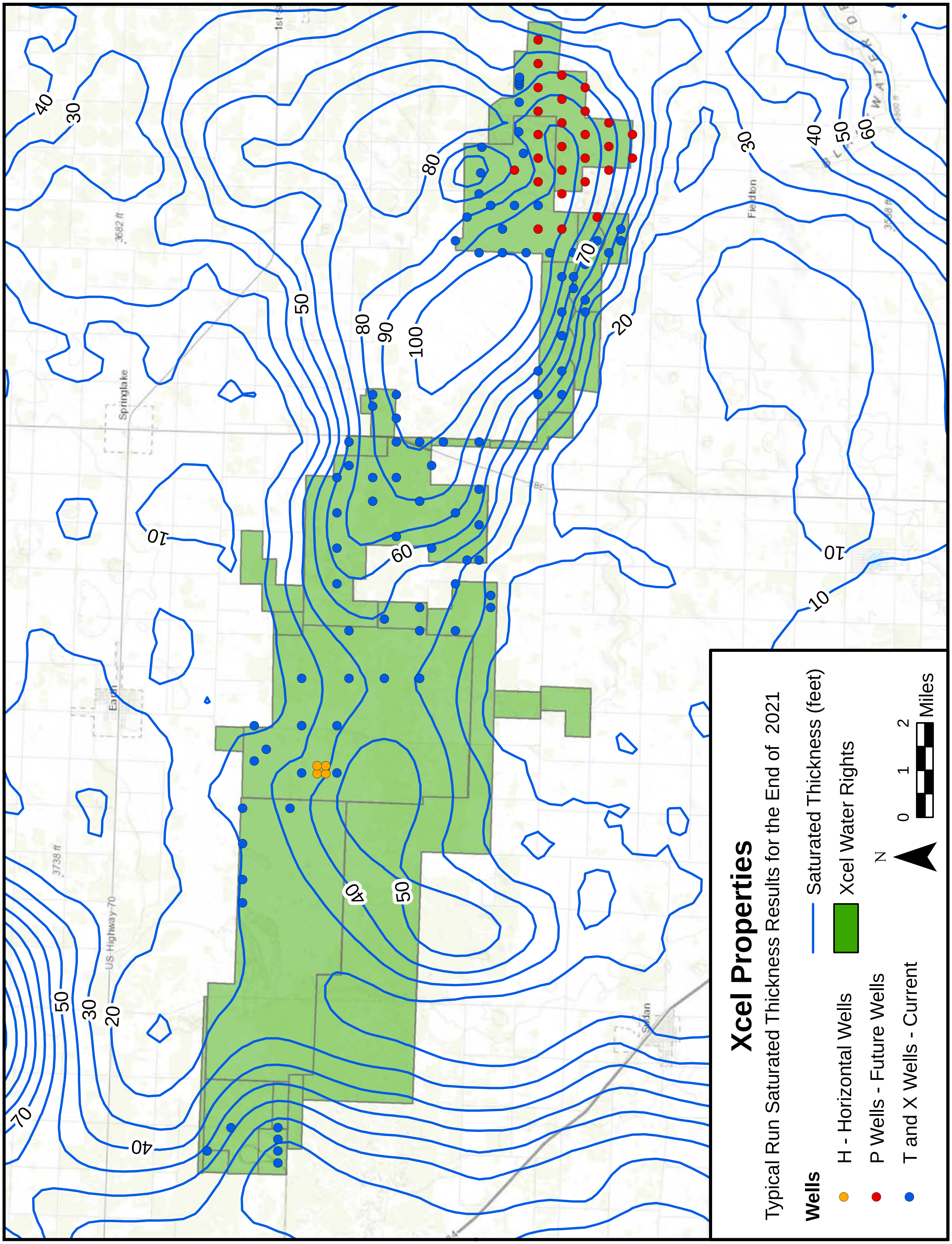

Xcel Properties
Optimized Run Saturated Thickness Results for the End of 2031
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0
1
2
Miles
Springlake
Earth
Sudan
Fieldton
US Highway-70

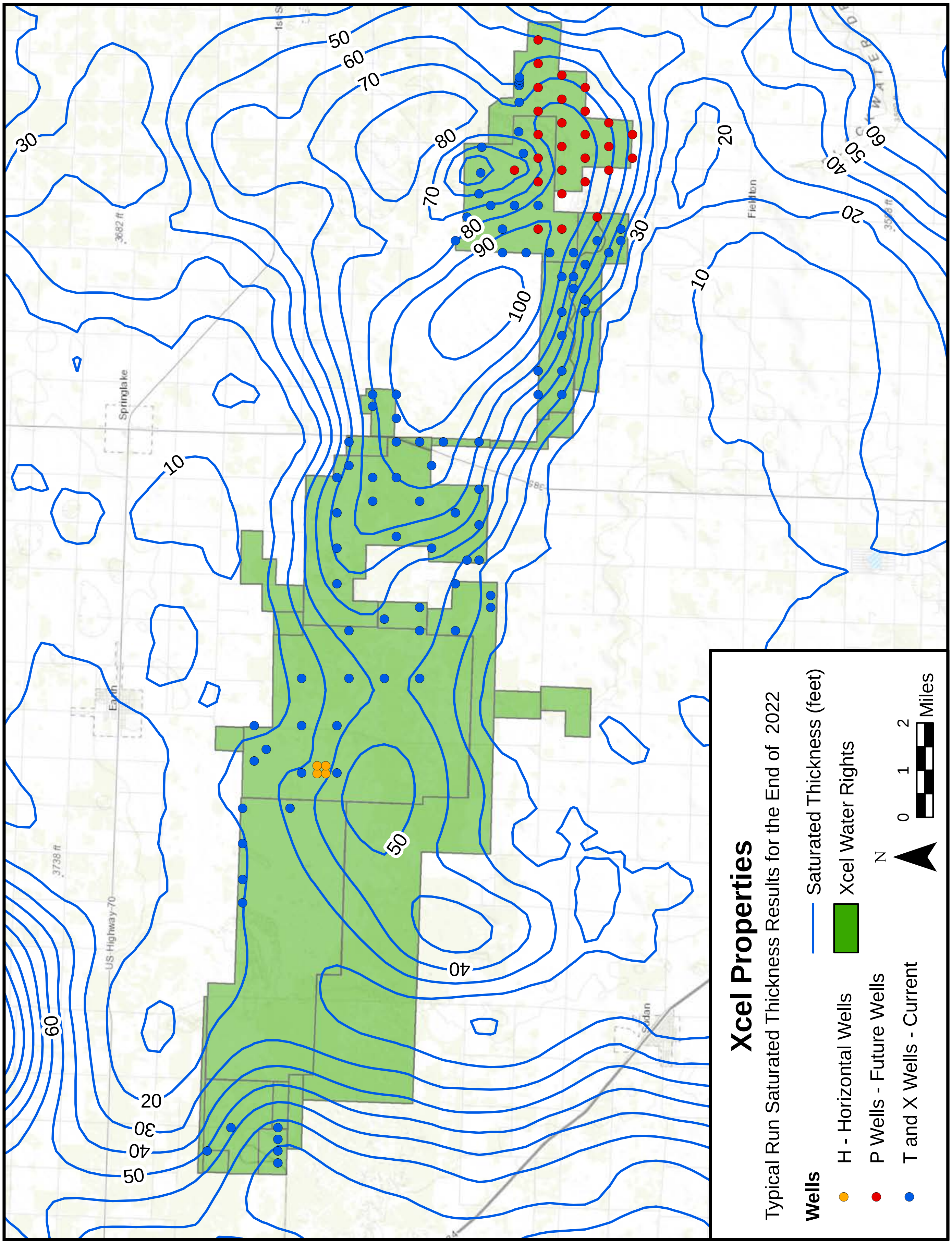

Xcel Properties
Optimized Run Saturated Thickness Results for the End of 2032
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0 1 2 Miles
Springlake
Earth
Sudan
Fieldton
US Highway-70
10
20
30
40
50
60
70
80

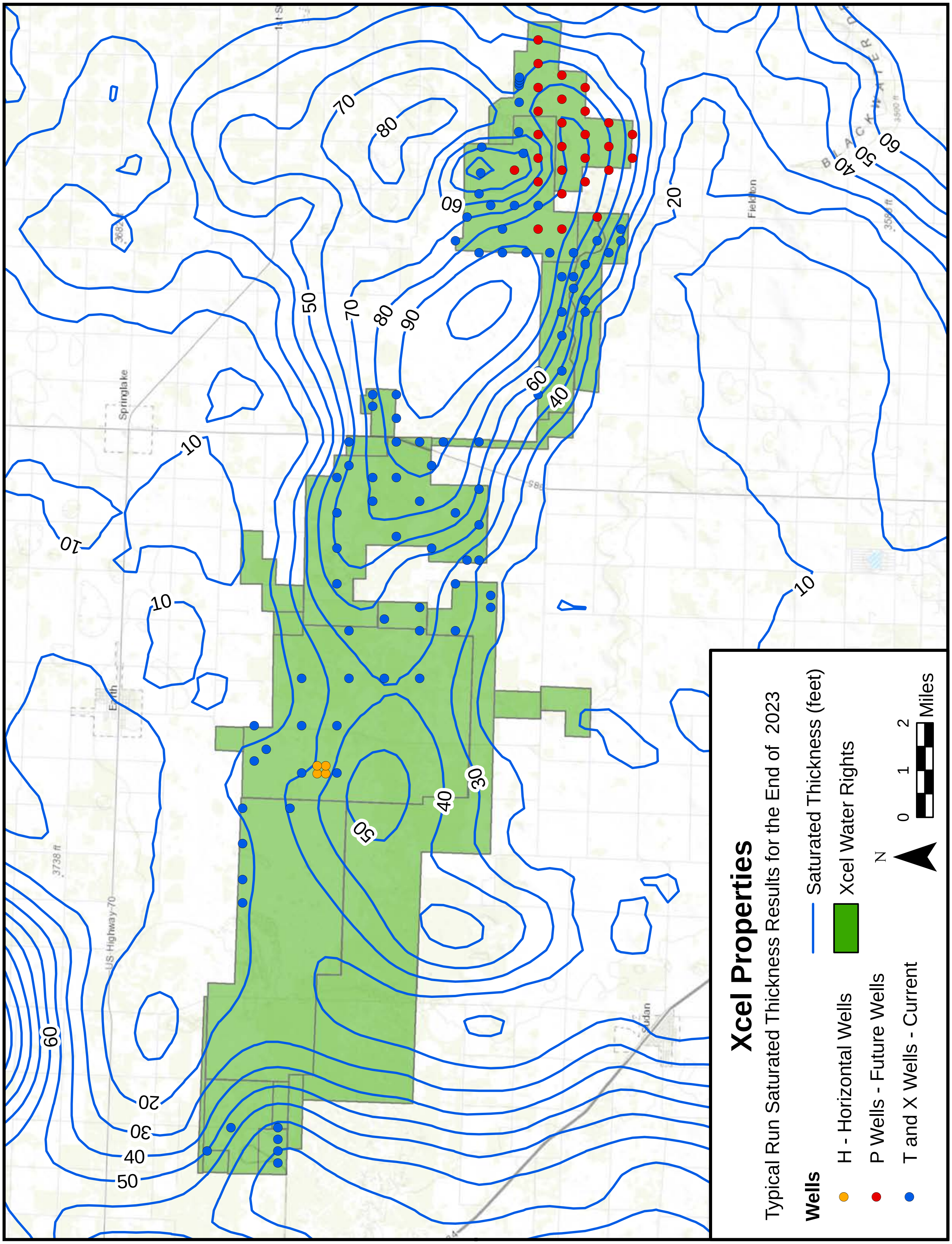
Appendix C —
Saturated Thickness Maps for Typical Demand Scenario

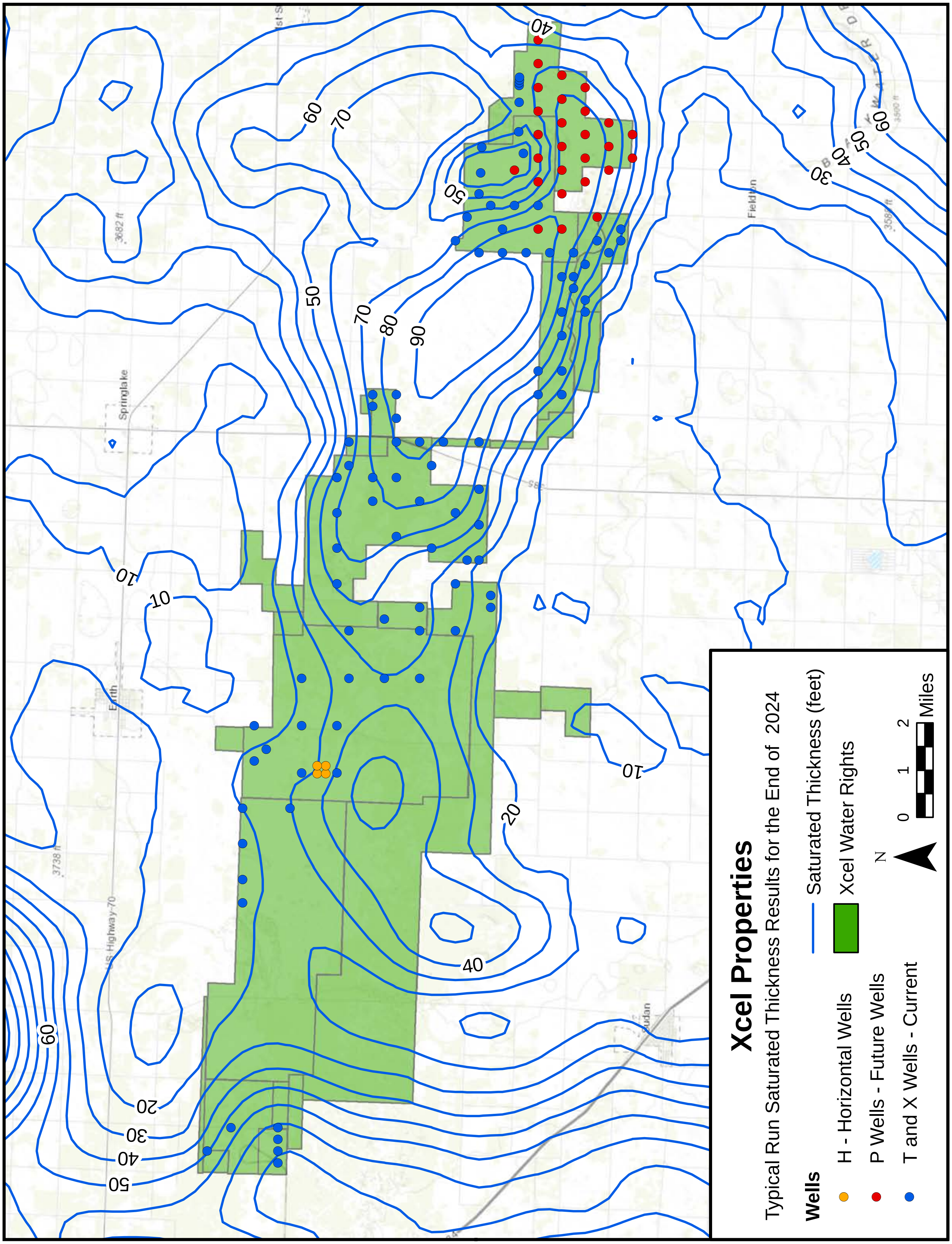

Xcel Properties
Typical Run Saturated Thickness Results for the End of 2019
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0 1 2
Miles

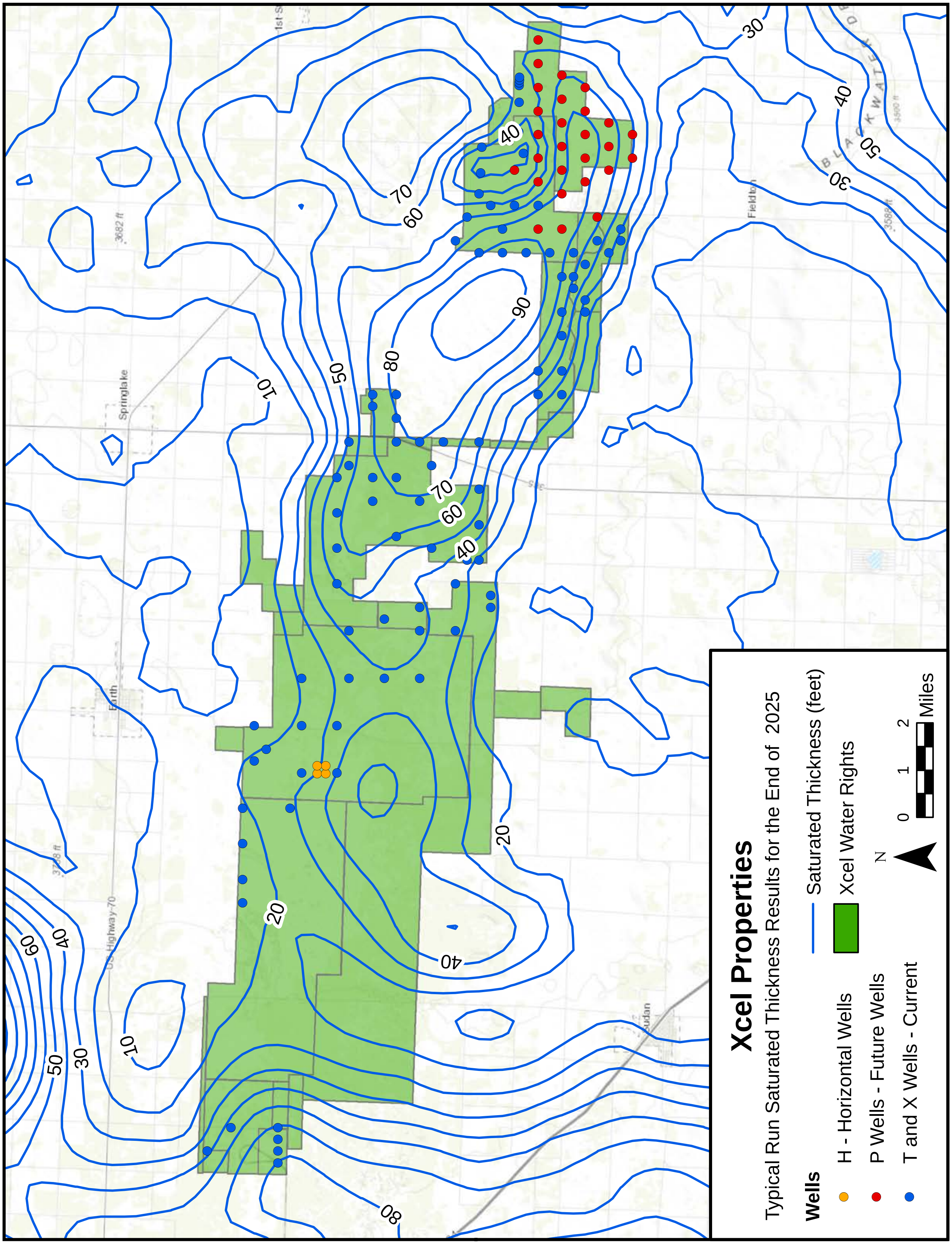

Xcel Properties
Typical Run Saturated Thickness Results for the End of 2020
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0 1 2
Miles
Springlake
Earth
Sudan
Fieldton

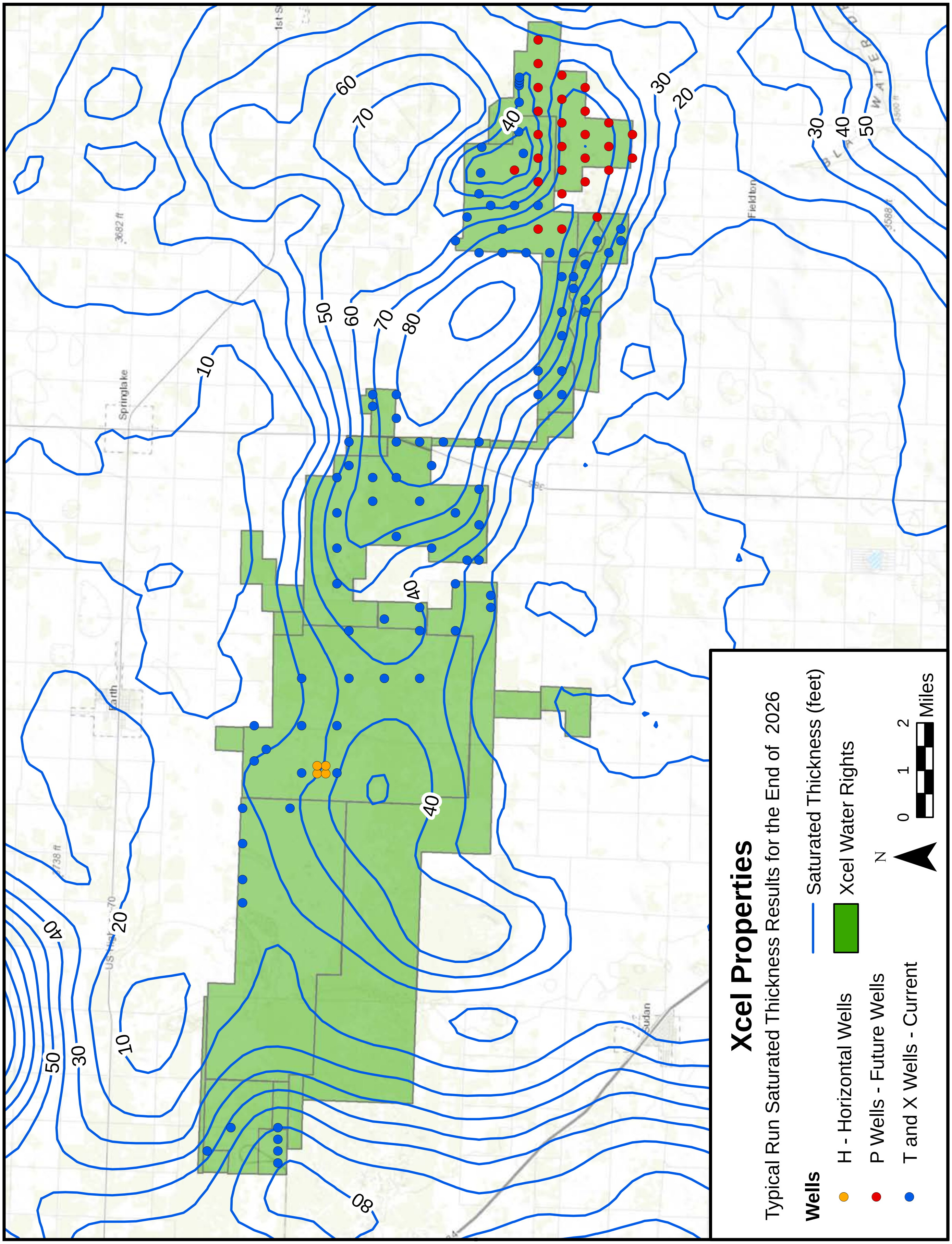

Xcel Properties
Typical Run Saturated Thickness Results for the End of 2021
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0
1
2
Miles
Springlake
Earth
Sudan
Fieldton
US Highway-70

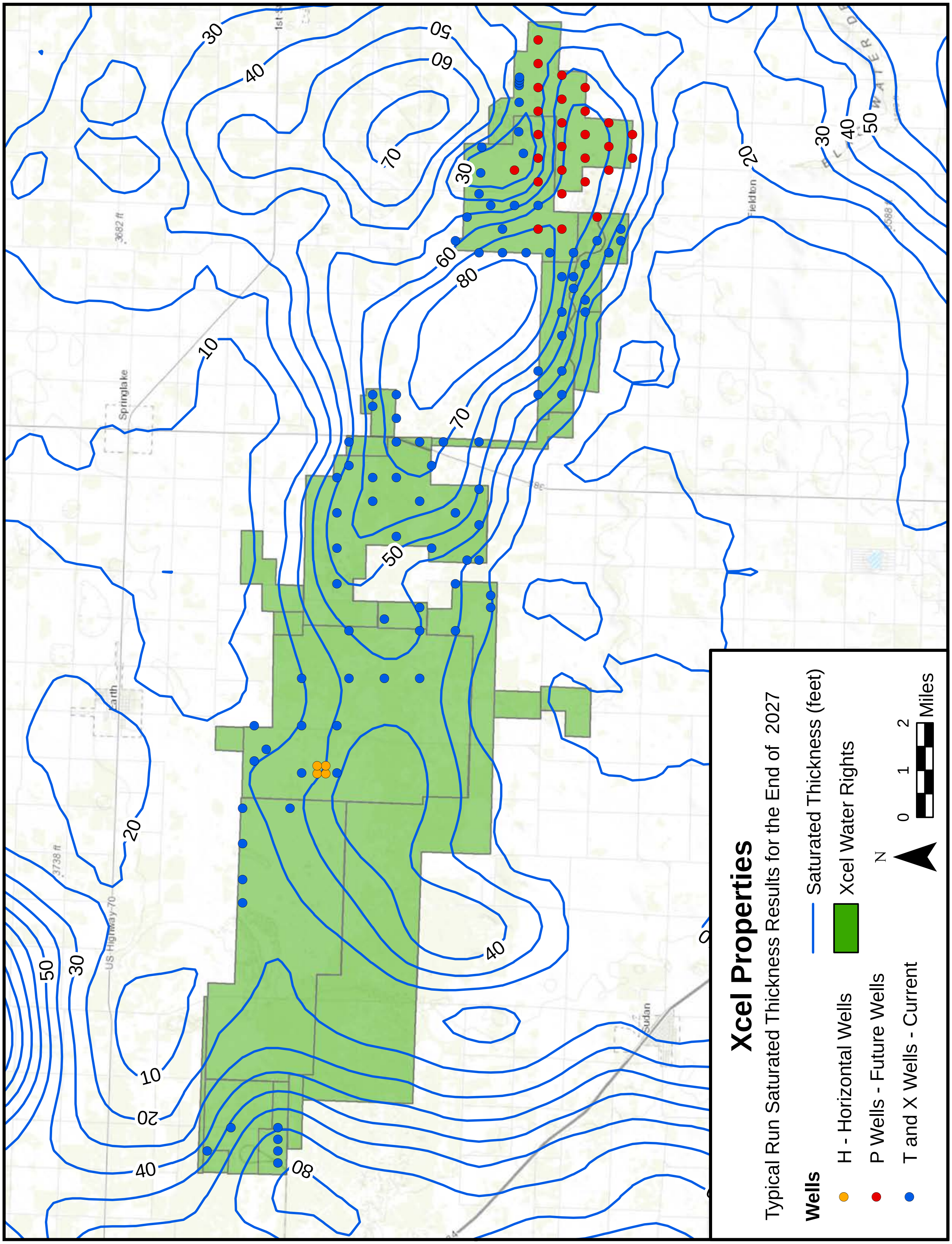

Xcel Properties
Typical Run Saturated Thickness Results for the End of 2022
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0 1 2 Miles
10
20
30
40
50
60
70
80
90
100
Springlake
Earth
Fieldton
Sudan
US Highway-70

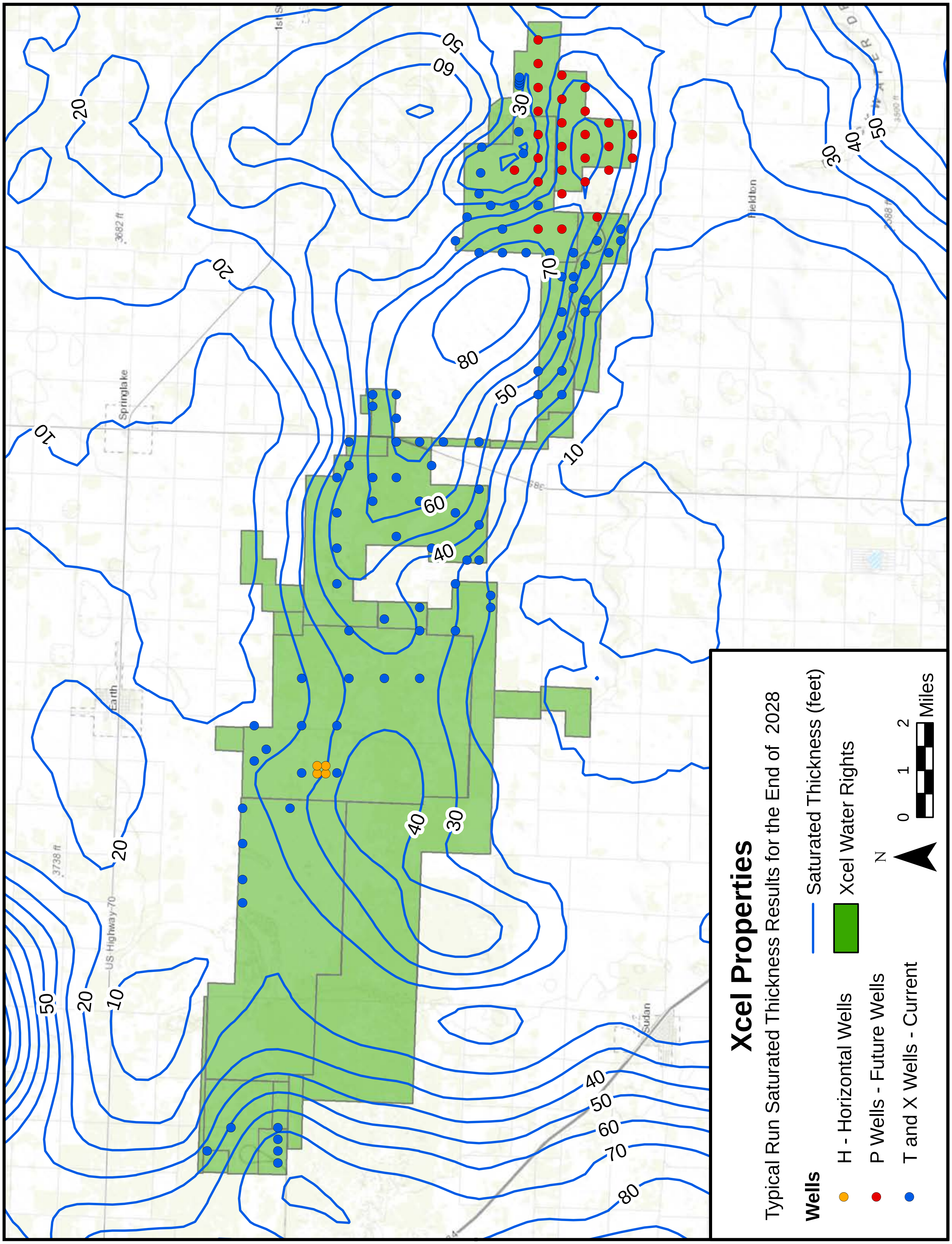

Xcel Properties
Typical Run Saturated Thickness Results for the End of 2023
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0 1 2 Miles
Springlake
Earth
Fieldton
Sudan
US Highway-70

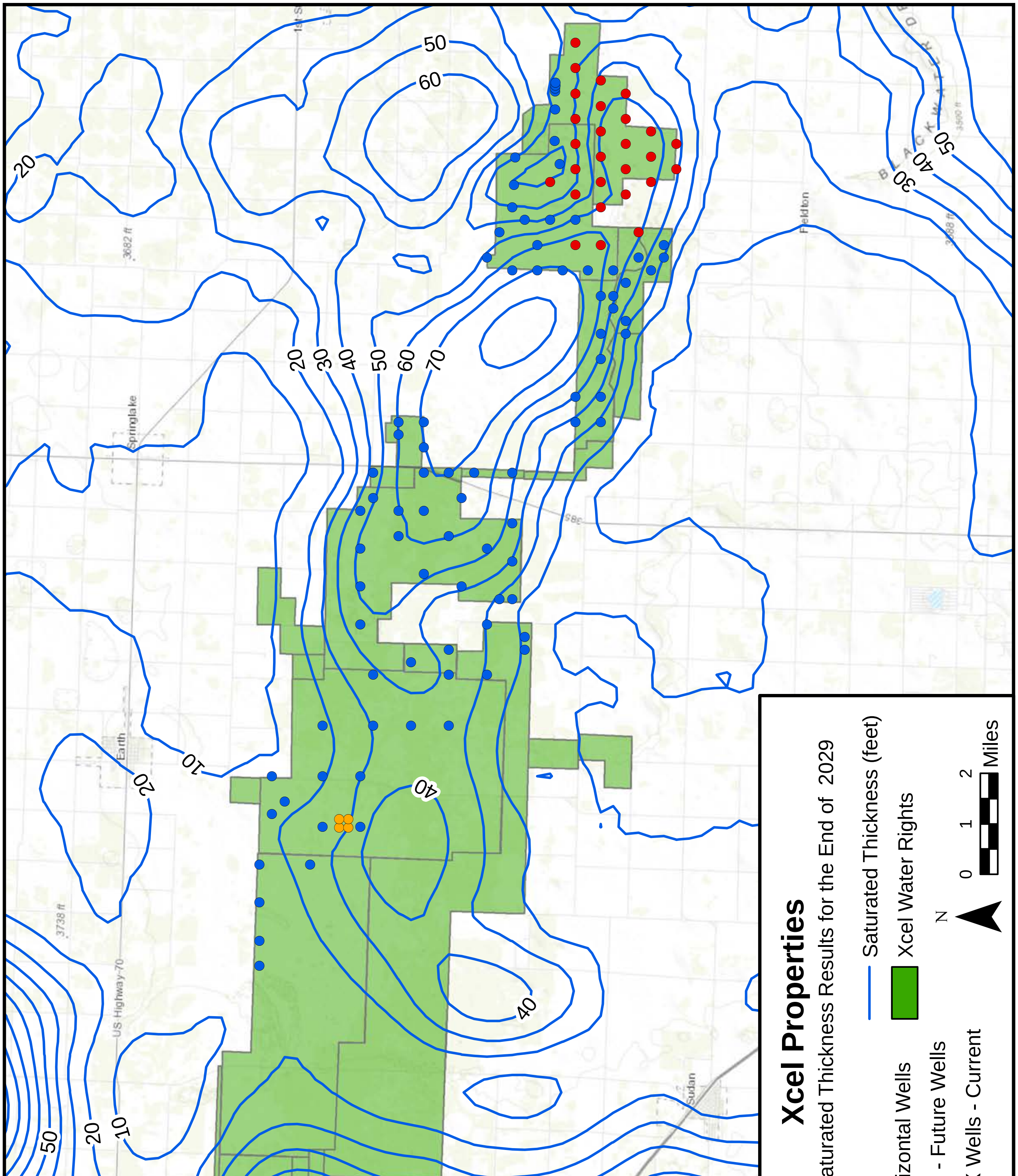

Xcel Properties
Typical Run Saturated Thickness Results for the End of 2024
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0 1 2 Miles
Springlake
Earth
Sudan
Fieldton
US Highway-70

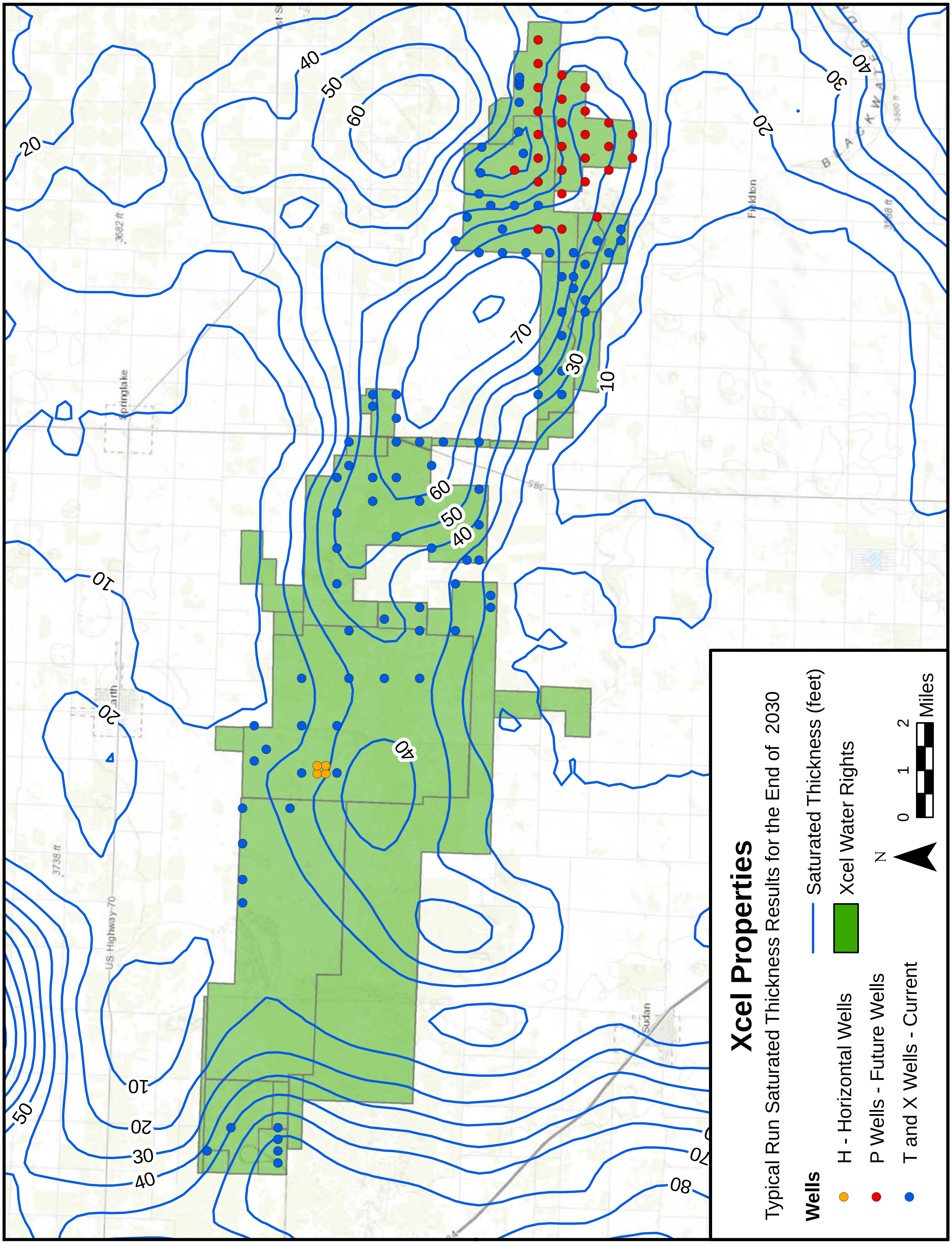

Xcel Properties
Typical Run Saturated Thickness Results for the End of 2025
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0
1
2
Miles
10
20
30
40
50
60
70
80
90
Springlake
Earth
Fieldton
Sudan
US Highway-70
BLACKWATER DRAW

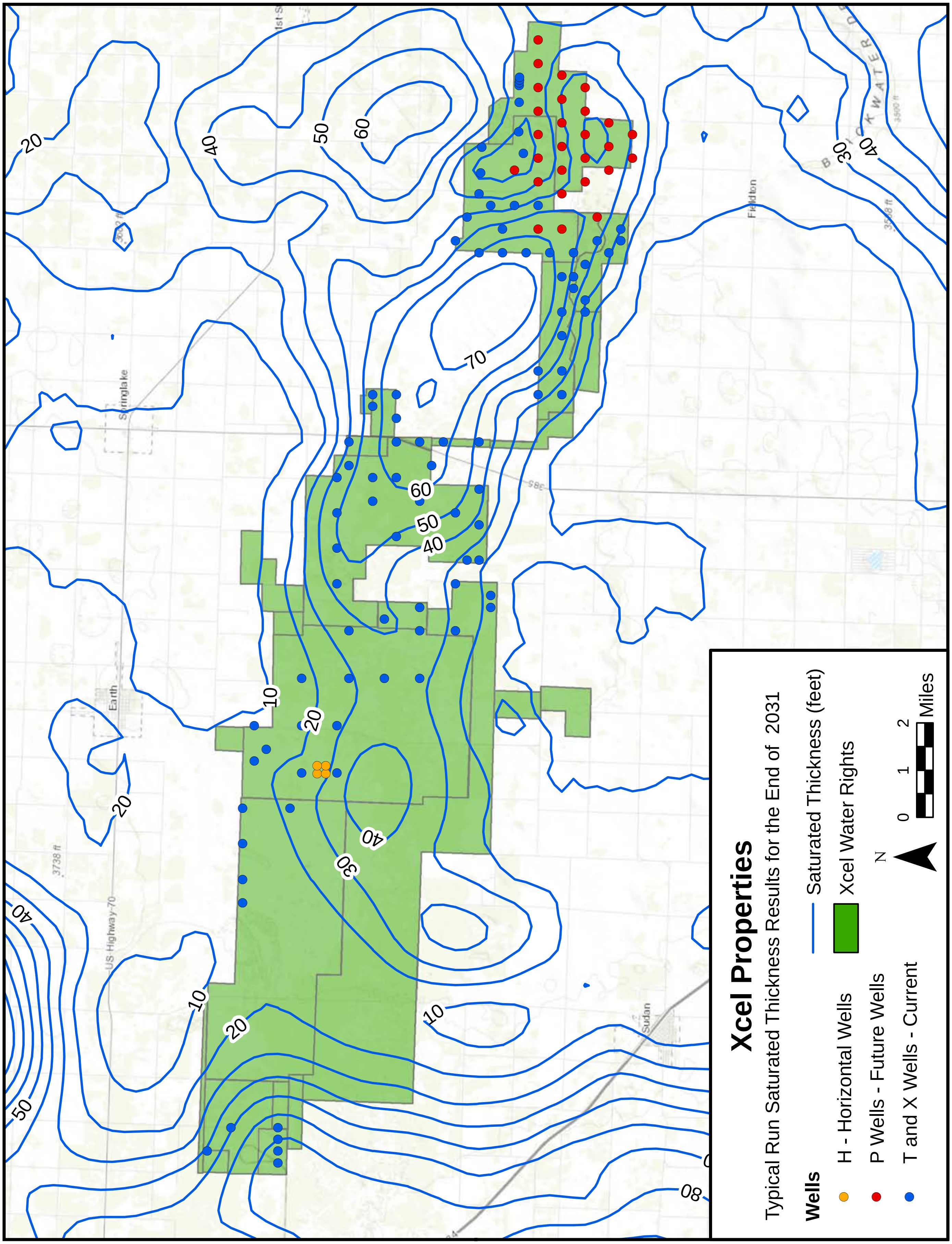

Xcel Properties
Typical Run Saturated Thickness Results for the End of 2026
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0 1 2
Miles
Springlake
Earth
Sudan
Fieldton

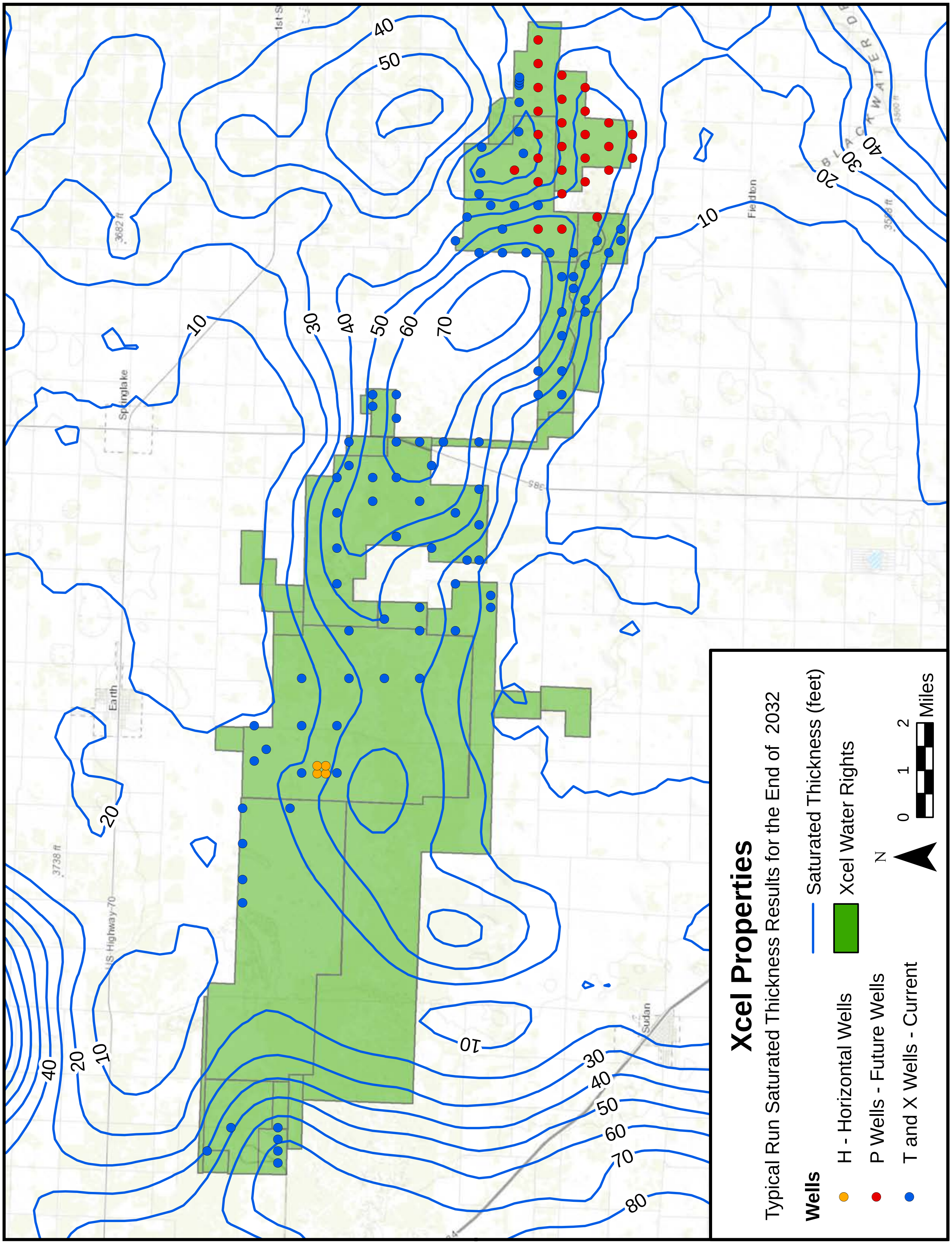

Xcel Properties
Typical Run Saturated Thickness Results for the End of 2027
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0 1 2 Miles


Xcel Properties
Typical Run Saturated Thickness Results for the End of 2028
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0
1
2
Miles
Springlake
Earth
Sudan
US Highway-70
10
20
30
40
50
60
70
80


Xcel Properties
Typical Run Saturated Thickness Results for the End of 2029
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0 1 2 Miles
Springlake
Earth
Sudan
Fieldton
US Highway-70
20
30
40
50
60
70
10


Xcel Properties
Typical Run Saturated Thickness Results for the End of 2030
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0 1 2
Miles
Springlake
Earth
Sudan
Fieldton
US Highway-70
10
20
30
40
50
60
70
80


Xcel Properties
Typical Run Saturated Thickness Results for the End of 2031
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0
1
2
Miles
Springlake
Earth
Sudan
Fieldton
US Highway-70


Xcel Properties
Typical Run Saturated Thickness Results for the End of 2032
Wells
H - Horizontal Wells
P Wells - Future Wells
T and X Wells - Current
Saturated Thickness (feet)
Xcel Water Rights
N
0
1
2
Miles
Springlake
Earth
Sudan
Fieldton
US Highway-70

SPS Water Modeling Spreadsheet

Attachment RLB-RR-2(CD) is provided in electronic format.