LRE WATER
CONNECTING WATER TO LIFE

November 18, 2024

Penny Hanson, General Manager
Neches and Trinity Valleys GCD
501 Devereaux Street
Jacksonville, TX 75766

RE: Addendum to Hydrogeological Report for the Neches and Trinity Valleys GCD Carrizo Sand Wellfield – Redtown Ranch Property, Anderson County, TX

Dear Ms. Hanson,

LRE Water ("LRE") is pleased to submit this Addendum to the Hydrogeological Report prepared for the Neches and Trinity Valleys Groundwater Conservation District ("NTVGCD" or District) on behalf of Redtown Ranch Holdings, LLC. The purpose of this Addendum is to provide the requested information as specified in the Letters from the District's consultant (Mr. James Beach, Advanced Groundwater Solutions "AGS") on October 28, 2024, and the District's attorney (Mr. John Stover) on October 21, 2024. For ease of reference, the letters with requested information are provided in Appendix A and the NTVGCD Hydrogeologic Report prepared by LRE (dated September 10, 2024) is provided in Appendix B of this Addendum. The proposed wellfield will be located on an approximately 7,465-acre property (herein referred to as the "Redtown Ranch Property") in Anderson and Houston County, Texas. The proposed wellfield will consist of five (5) wells producing a total combined production capacity of 3,700 gallons per minute (gpm), or 5,983 acre-feet per year (ac-ft/yr) from the Carrizo Sand in Anderson County. There are also three (3) proposed wells located on the Redtown Ranch Property in Houston County (outside of the jurisdiction of the NTVGCD) that are planned to produce 2,650 gpm (4,286 ac-ft/yr) from the Carrizo Sand.

Analytical Groundwater Modeling

LRE conducted analytical groundwater modeling using the Cooper-Jacob (1946) equation to assess local drawdown impacts within each proposed well and surrounding wells within 5-miles of the Redtown Ranch Property. To calculate drawdown, LRE developed proprietary excel-based software utilizing the Cooper-Jacob (1946) modified nonequilibrium equation:

$$s = \frac{264Q}{T}\log\left(\frac{0.3Tt}{r^2S}\right)\left(\frac{1}{WE}\right)$$

Where s is drawdown (in ft), Q is pumping rate (in gpm), r is the radial distance from the center of a pumped well to a point where drawdown is computed (in ft), S is storativity (dimensionless), T is transmissivity (in gallons per day per foot [gpd/ft]), t is elapsed time since pumping began (in days), and WE is well efficiency, expressed as a decimal (dimensionless). Table 1 summarizes the input parameters used to calculate drawdown in the analytical modeling, which are based on

estimated hydraulic properties from site-specific and surrounding well data. The modeling includes production of 3,700 gpm (5,983 ac-ft/yr) from proposed wells in Anderson County and 2,650 gpm (4,286 ac-ft/yr) from proposed wells in Houston County for a total combined production of 6,350 gpm for the wellfield (Table 1). A well efficiency of 70% was applied to the drawdown calculations for only the pumping wells (Table 1). The radial distance between the proposed wells (r) are presented in Table 2.

Table 1. Input parameters for analytical modeling

Proposed Well	Pumping Rate, Q (gpm)	Storativity, S	Transmissivity, T (gpd/ft)	Well Radius, r (ft)	Well Efficiency, WE (%)
CZ-1	750	0.00009	54,995	0.5	70
CZ-2	650	0.00009	48,330	0.5	70
CZ-3	950	0.00009	53,330	0.5	70
CZ-4	600	0.00009	48,330	0.5	70
CZ-5	750	0.00009	51,660	0.5	70
CZ-6	750	0.00009	56,660	0.5	70
CZ-7	750	0.00009	56,660	0.5	70
CZ-8	1,150	0.00009	56,660	0.5	70

Note: "gpm" indicates gallons per minute, "ft" indicates feet, "gpd/ft" indicates gallons per day per foot, cells highlighted in gray indicate non-permitted wells located in Houston County (outside NTVGCD boundary).

Cumulative drawdown in each proposed well was calculated by superposition of drawdown effects and is equal to the sum of the individual drawdowns caused by each pumping well. The cumulative drawdown in the proposed wells after five years is presented in Table 3. A drawdown contour map after five years of pumping is provided in the Hydrogeologic Report (Appendix B). Cumulative drawdown in the proposed wells after 50 years of pumping is presented in Table 4. Illustrations showing the cone of depression depicting the contours for impacts for all wells listed in Appendix B of the LRE Report (Appendix B) after 50 years of pumping is presented in Figure 1 (as requested by Mr. John Stover – See Appendix A).

Table 2. Distance between proposed wells, r, in feet

Pumping Wells	CZ-1	CZ-2	CZ-3	CZ-4	CZ-5	CZ-6	CZ-7	CZ-8
CZ-1	0.5	12,351	9,069	15,130	13,263	7,466	11,362	18,234
CZ-2	12,351	0.5	11,171	5,123	10,650	18,533	18,935	21,982
CZ-3	9,069	11,171	0.5	10,430	4,746	10,317	8,149	11,224
CZ-4	15,130	5,123	10,430	0.5	7,767	19,855	18,567	19,692
CZ-5	13,263	10,650	4,746	7,767	0.5	15,008	11,854	11,925
CZ-6	7,466	18,533	10,317	19,855	15,008	0.5	6,305	14,275
CZ-7	11,362	18,935	8,149	18,567	11,854	6,305	0.5	7,971
CZ-8	18,234	21,982	11,224	19,692	11,925	14,275	7,971	0.5

Note: Distance in pumping well is equal to the well radius of 0.5 feet. Cells highlighted in gray indicate non-permitted wells located in Houston County (outside NTVGCD boundary).

Table 3. Approximate drawdown, s, after five years of pumping ($t = 1,825\ days$), in feet

Pumping Wells	CZ-1	CZ-2	CZ-3	CZ-4	CZ-5	CZ-6	CZ-7	CZ-8
CZ-1	62	12	13	11	12	14	12	11
CZ-2	12	61	12	14	12	10	10	10
CZ-3	17	16	81	16	20	16	17	16
CZ-4	10	13	11	57	12	9	10	9
CZ-5	12	13	16	14	66	12	13	13
CZ-6	13	10	12	10	11	61	14	11
CZ-7	12	10	13	10	12	14	61	13
CZ-8	16	15	18	16	18	17	20	93
s	**155**	**152**	**177**	**149**	**163**	**154**	**157**	**176**

Note: Cells highlighted in gray indicate non-permitted wells located in Houston County (outside NTVGCD boundary).

Table 4. Approximate drawdown, s, after 50 years of pumping ($t = 18,250\ days$), in feet

Pumping Wells	CZ-1	CZ-2	CZ-3	CZ-4	CZ-5	CZ-6	CZ-7	CZ-8
CZ-1	68	16	17	15	15	17	16	14
CZ-2	15	66	16	18	16	14	14	13
CZ-3	22	21	88	21	24	21	22	21
CZ-4	13	17	15	61	15	13	13	13
CZ-5	16	17	20	18	72	16	17	17
CZ-6	17	14	16	14	15	66	17	15
CZ-7	15	14	16	14	15	17	66	17
CZ-8	22	21	24	21	23	23	25	101
s	**188**	**185**	**210**	**182**	**196**	**186**	**190**	**210**

Note: Cells highlighted in gray indicate non-permitted wells located in Houston County (outside NTVGCD boundary).

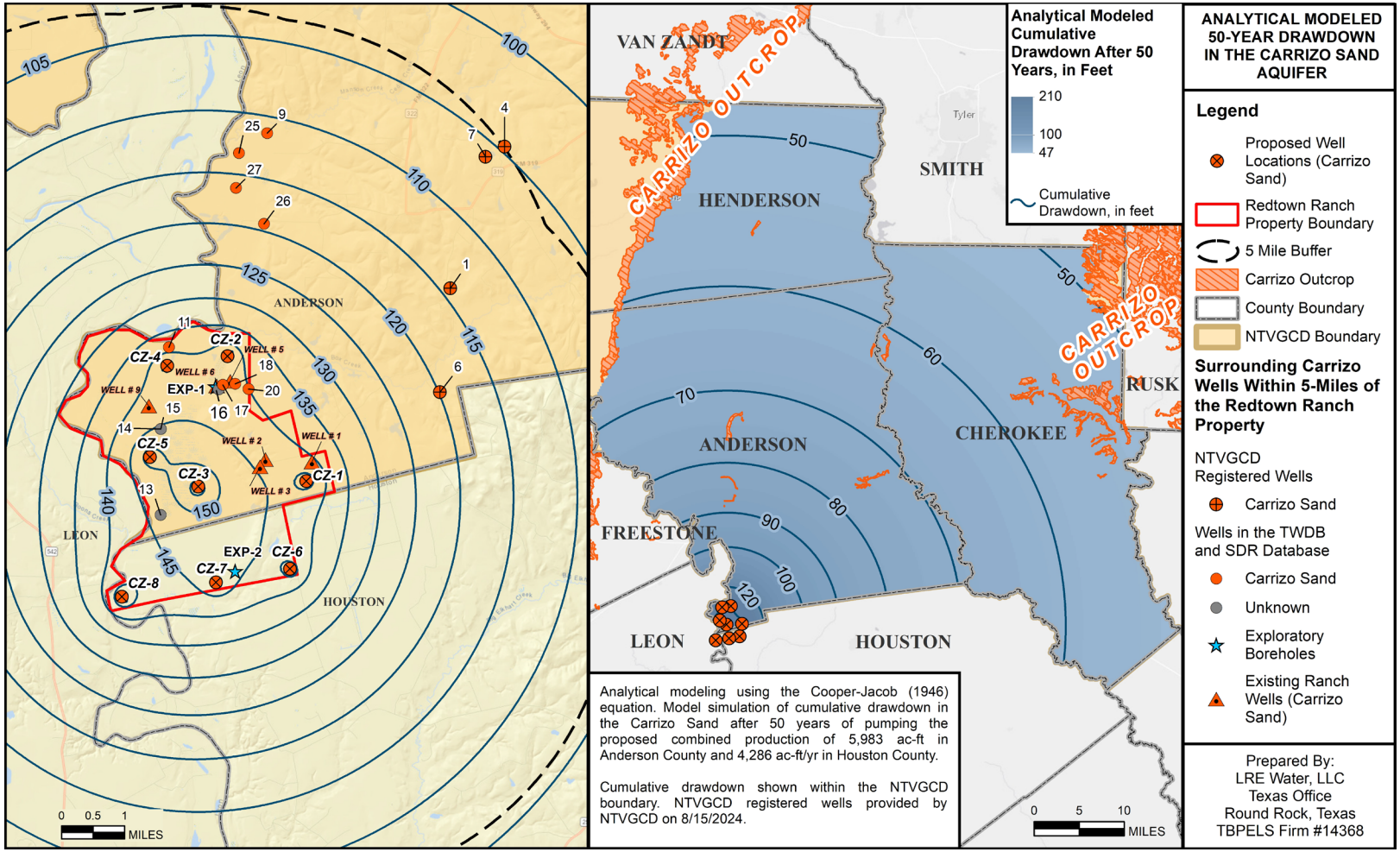


Figure 1. Analytical modeled cumulative 50-year drawdown in the Carrizo Sand

The use of the Cooper-Jacob (1946) equation to calculate drawdown is appropriate where the value of u in the Theis (1935) well function, $W(u)$, is sufficiently small (Driscoll, 1986). To verify the appropriateness of using the Cooper-Jacob (1946) equation in the analytical modeling (as requested by AGS – See Appendix A), the critical value of u was solved using the following equation (Theis, 1935):

$$u = \frac{1.87\, r^2 S}{Tt}$$

Where r is the radial distance from the center of a pumped well to a point where drawdown is computed (in ft), S is storativity (dimensionless), T is transmissivity (gpd/ft), and t is elapsed time since pumping began (in days). Table 1 provides the values of transmissivity (T) and storativity (S) values and Table 2 provides the distances between the proposed wells (r). The determinations of u after pumping for five years (t = 1,825 days) and 50 years (t = 18,250 days) are presented in Table 5 and Table 6, respectively.

According to Kruseman and de Ridder (1994), the Cooper-Jacob (1946) approximation is appropriate where the value of u is less than 0.01. Driscoll (1986) suggests that the Cooper-Jacob (1946) approximation can be used where the value of u is less than approximately 0.05. Table 5 and Table 6 show that all determinations of u are less than 0.05 and 0.01, and therefore the methodology presented herein is appropriate for use in the analytical modeling. However, it is important to note that at a certain distance from the pumping well, where u becomes greater than 0.05, the Cooper-Jacob (1946) modified nonequilibrium equation is no longer applicable. This occurs approximately 30 miles from the proposed wellfield after five years of pumping, and approximately 100 miles from the proposed wellfield after 50 years of pumping. Therefore, drawdown calculations beyond these distances from the proposed wellfield are not valid.

Table 5. Determination of u for 5 years of pumping (t = 1,825 days)

Pumping Wells	CZ-1	CZ-2	CZ-3	CZ-4	CZ-5	CZ-6	CZ-7	CZ-8
CZ-1	0.0000	0.0003	0.0001	0.0004	0.0003	0.0001	0.0002	0.0006
CZ-2	0.0003	0.0000	0.0002	0.0001	0.0002	0.0007	0.0007	0.0009
CZ-3	0.0001	0.0002	0.0000	0.0002	0.0000	0.0002	0.0001	0.0002
CZ-4	0.0004	0.0001	0.0002	0.0000	0.0001	0.0008	0.0007	0.0007
CZ-5	0.0003	0.0002	0.0000	0.0001	0.0000	0.0004	0.0003	0.0003
CZ-6	0.0001	0.0006	0.0002	0.0006	0.0004	0.0000	0.0001	0.0003
CZ-7	0.0002	0.0006	0.0001	0.0006	0.0002	0.0001	0.0000	0.0001
CZ-8	0.0005	0.0008	0.0002	0.0006	0.0002	0.0003	0.0001	0.0000

Note: Cells highlighted in gray indicate non-permitted wells located in Houston County (outside NTVGCD boundary).

Table 6. Determination of u for 50 years of pumping (t = 18,250 days)

Pumping Wells	CZ-1	CZ-2	CZ-3	CZ-4	CZ-5	CZ-6	CZ-7	CZ-8
CZ-1	0.00000	0.00003	0.00001	0.00004	0.00003	0.00001	0.00002	0.00006
CZ-2	0.00003	0.00000	0.00002	0.00001	0.00002	0.00007	0.00007	0.00009
CZ-3	0.00001	0.00002	0.00000	0.00002	0.00000	0.00002	0.00001	0.00002
CZ-4	0.00004	0.00001	0.00002	0.00000	0.00001	0.00008	0.00007	0.00007
CZ-5	0.00003	0.00002	0.00000	0.00001	0.00000	0.00004	0.00003	0.00003
CZ-6	0.00001	0.00006	0.00002	0.00006	0.00004	0.00000	0.00001	0.00003
CZ-7	0.00002	0.00006	0.00001	0.00006	0.00002	0.00001	0.00000	0.00001
CZ-8	0.00005	0.00008	0.00002	0.00006	0.00002	0.00003	0.00001	0.00000

Note: Cells highlighted in gray indicate non-permitted wells located in Houston County (outside NTVGCD boundary).

Numerical Groundwater Modeling

The purpose of the numerical modeling was to assess the regional impacts of the combined production of 5,983 ac-ft/yr from the Carrizo Sand (North QCSCW GAM; Layer 6) in Anderson County and 4,286 ac-ft/yr in Houston County. The information requested for the numerical modeling by AGS is provided in Appendix A. Additional email correspondence with AGS providing clarification for the numerical modeling is also provided in Appendix A of this Addendum. Based on the requested information, LRE modeled the impacts of the proposed production for 50 years from 2025 through December 31, 2074 (2075), and recovery for five years after modeled pumping was discontinued, from 2075 through December 31, 2079 (2080).

For the numerical modeling, LRE used predictive Scenario 33, as documented in Technical Memo 21-01 (Hutchinson, 2021b), to assess the regional impacts to the aquifer. Drawdown was calculated for Scenario 33 TM 21-01 ("Base Run") and proposed pumping of 3,700 gpm (5,983 ac-ft/yr) in Anderson County and 2,650 gpm (4,286 ac-ft/yr) in Houston County from the Carrizo Sand ("Proposed CZ"). LRE calculated "marginal drawdown" from the "Proposed MWLX" as the difference in head from the "Base Run" and the combined "Base Run" and "Proposed MWLX" pumping.

As requested by AGS (Appendix A), LRE modeled drawdown for the following scenarios:

- Drawdown from the "Proposed CZ" after five years from 2025 to 2030 (Figure 2)
- Drawdown from the "Proposed CZ" after 50 years from 2025 to 2075 (Figure 3)
- Residual drawdown (recovery) five years after "Proposed CZ" stopped from 2075-2080 (Figure 4).

The most recent DFCs were approved by GMA-11 on August 11, 2021, based on Scenario 33, TM 21-01 (Hutchinson, 2021a). As described in the GMA-11 Desired Future Conditions Explanatory Report (Hutchinson, 2021c), average drawdown across the county represents the regional average drawdown occurring due to pumping during the period of interest. The recently

adopted DFCs for Anderson County are an average drawdown of 155 feet in the Carrizo-Wilcox Aquifer (Layers 6-9) from 2013 to 2080 (Hutchinson, 2021a). Cumulative drawdown from the numerical modeling was computed and compared to the average drawdown in Anderson County pumping from the Carrizo Sand (Layer 6). LRE calculated the average drawdown for all layers of the Carrizo-Wilcox Aquifer (North QCSCW GAM Layers 6-9), as the DFCs are presented as average drawdown in all layers of the Carrizo-Wilcox Aquifer System (Wade, 2022). Table 7 summarizes the average drawdown in in the Carrizo-Wilcox Aquifer in Anderson County from the "Base Run" and the "Proposed CZ" pumping for five years (2025 to 2030) and 50 years (2025 to 2075). Table 8 presents the estimated average recovery in the Carrizo-Wilcox Aquifer in Anderson County five years after the "Proposed CZ" pumping stops (2075-2080). The additional drawdown due to the "Proposed CZ" pumping only, averaged across the Carrizo-Wilcox Aquifer in Anderson County, is approximately 13.71 feet after five years (2025-2030) and 16.89 feet after 50 years (2025-2075), as shown in Table 7. Recovery in the Carrizo-Wilcox Aquifer in Anderson County after the "Proposed CZ" pumping stops is approximately 1.89 feet after five years (2075-2080) (Table 8).

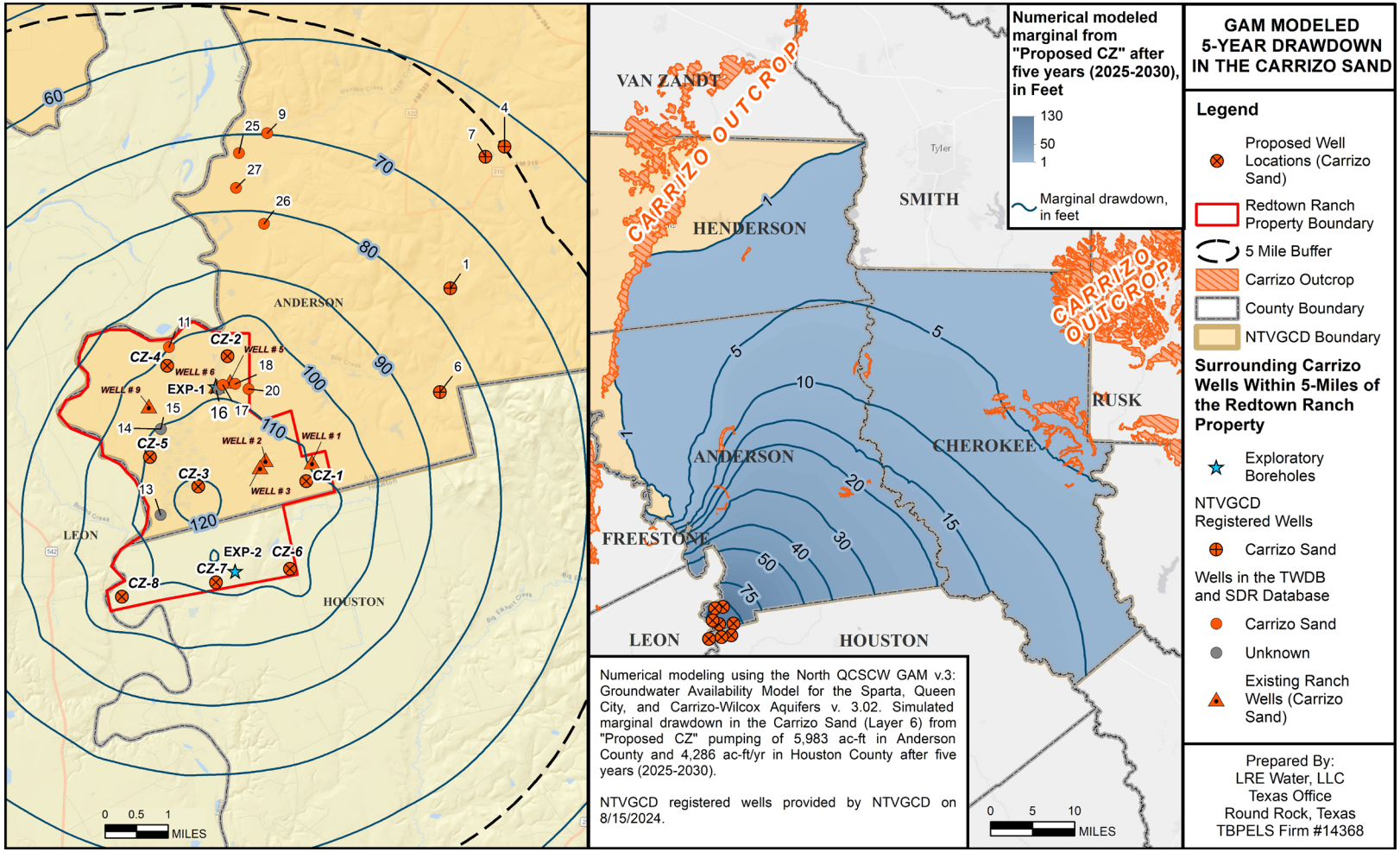


Figure 2. Numerical modeled marginal drawdown in the Carrizo Sand (Layer 6) from "Proposed CZ" after 5 years (2025-2030)

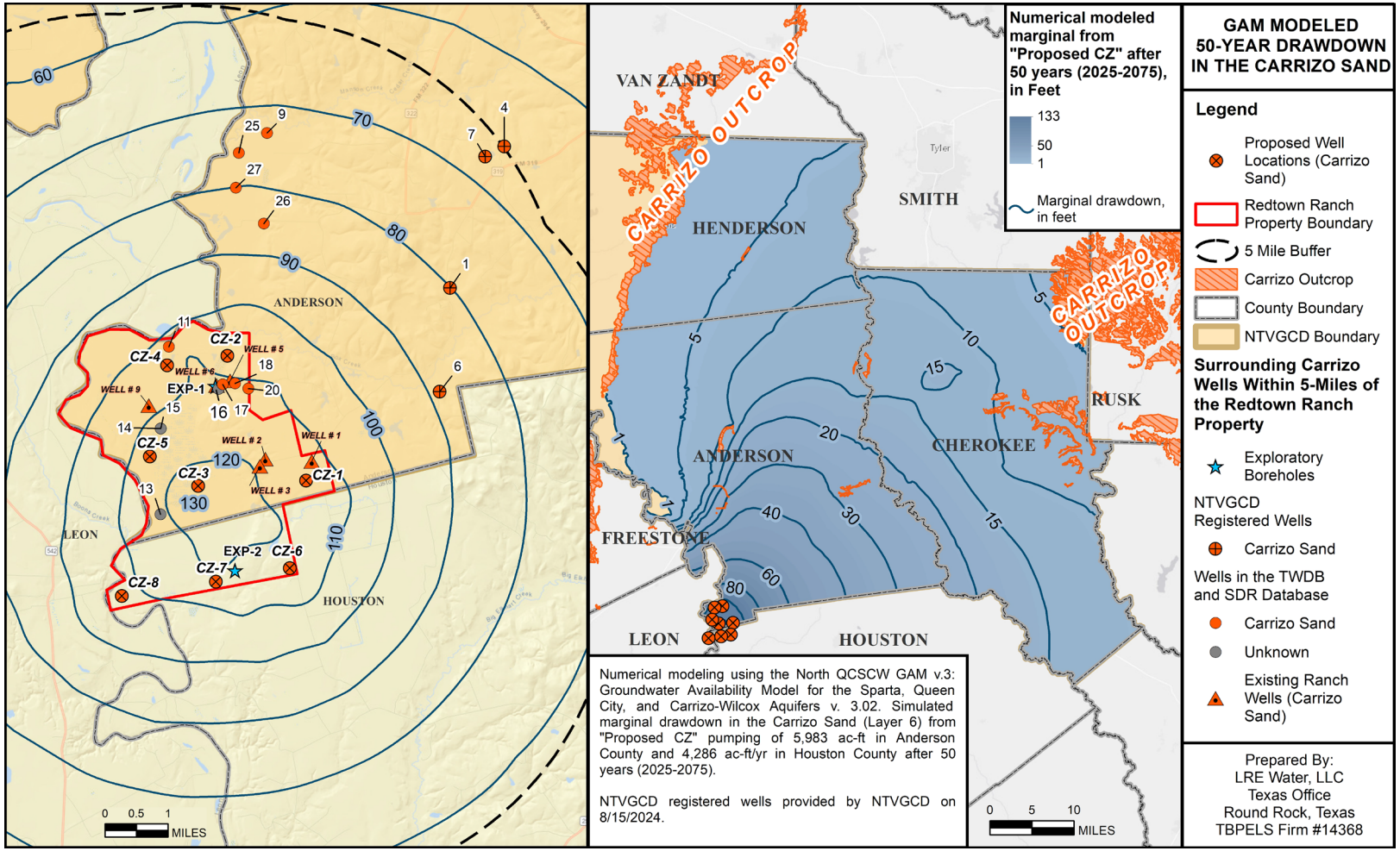


Figure 3. Numerical modeled marginal drawdown in the Carrizo Sand (Layer 6) from "Proposed CZ" after 50 years (2025-2075)

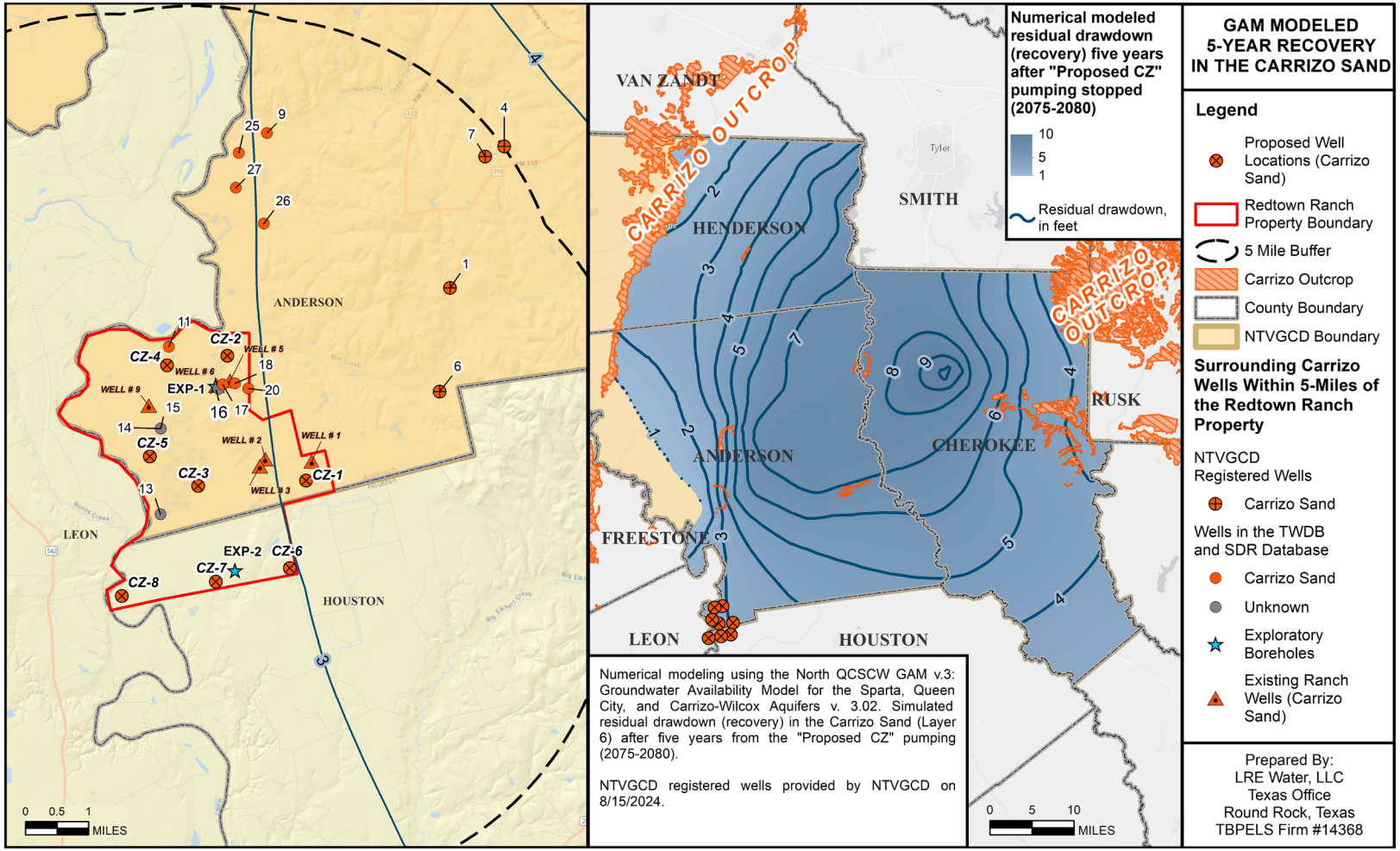


Figure 4. Numerical modeled recovery (residual drawdown) in the Carrizo Sand (Layer 6) from "Proposed CZ" after 5 years (2075-2080)

Table 7. Numerical model-predicted average drawdown in Anderson County

Aquifer	Model Layer	Average Drawdown in Anderson County, in Feet					
		5-Year Drawdown (2025-3030)			50-Year Drawdown (2025-2075)		
		"Base Run" (TM 21-01)	"Base Run" + "Proposed CZ"	"Proposed CZ" Only	"Base Run" (TM 21-01)	"Base Run" + "Proposed CZ"	"Proposed CZ" Only
Carrizo Sand	6	108.49	121.68	**13.19**	118.28	134.07	**15.79**
Upper Wilcox	7	117.58	131.46	**13.88**	127.87	144.39	**16.51**
Middle Wilcox	8	141.14	155.02	**13.89**	153.22	170.79	**17.56**
Lower Wilcox	9	175.95	190.12	**14.17**	189.17	207.77	**18.59**
Avg CZ-WLX	6-9	130.40	144.11	**13.71**	141.45	158.33	**16.89**

Note: "Base Run" indicates the Groundwater Availability Model (GAM) Scenario 33, TM 21-01 (Hutchinson, 2021b), "Proposed CZ" indicates proposed production of 3,700 gpm (5,983 ac-ft/yr) in Anderson County and 2,650 gpm (4,286 ac-ft/yr) in Houston County in the Carrizo Sand (Layer 6), "Avg CZ-WLX" indicates average of drawdown in the Carrizo-Wilcox Aquifer (Layers 6-9).

Table 8. Numerical model-predicted average 5-year residual drawdown (recovery) from 2075-2080 in Anderson County

Aquifer	Model Layer	Average Residual Drawdown in Anderson County, in Feet			
		"Base Run" (TM 21-01)	"Base Run" + "Proposed CZ"	"Proposed CZ" Only	Recovered Head from "Proposed CZ" Only
Carrizo Sand	6	108.49	121.63	**13.13**	**2.66**
Upper Wilcox	7	117.58	131.41	**13.83**	**2.68**
Middle Wilcox	8	141.14	157.62	**16.49**	**1.08**
Lower Wilcox	9	175.95	194.29	**18.34**	**0.25**
Avg CZ-WLX	6-9	130.40	145.40	**15.00**	**1.89**

Note: "Base Run" indicates the simulated average drawdown from 2025-2075 in the Groundwater Availability Model (GAM) Scenario 33, TM 21-01 (Hutchinson, 2021b), "Proposed CZ" indicates only proposed production of 3,700 gpm (5,983 ac-ft/yr) in Anderson County and 2,650 gpm (4,286 ac-ft/yr) in Houston County in the Carrizo Sand (Layer 6), Recovered Head" is the difference between drawdown after 50 years from the "Proposed CZ" pumping only and recovery after five years from the "Proposed CZ" pumping only, "Avg CZ-WLX" indicates average of drawdown in the Carrizo-Wilcox Aquifer (Layers 6-9).

Groundwater Availability Models (GAMs) are regional-scale numerical tools designed to simulate the effects of groundwater pumping on aquifers and estimate current and future groundwater availability for groundwater resource management and water planning purposes. The TWDB emphasizes that the GAM grid cell sizes are generally too large to accurately depict localized impacts from pumping. Therefore, for site-specific evaluations, the TWDB recommends that analytical models be used where site specific aquifer properties are available. When evaluating the impacts of the proposed production on the aquifer based on the results presented above, it is crucial to understand the assumptions and limitations associated with both analytical models (Cooper-Jacob, 1946) and numerical models (GAMs, MODFLOW).

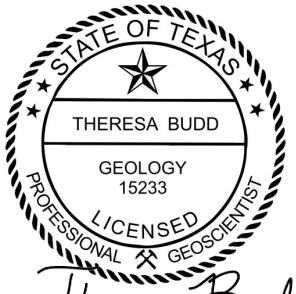
This analysis highlights the limitations of analytical modeling, including boundary conditions imposed on the aquifer from recharge and faulting, and variability in aquifer properties, such as hydraulic conductivity. While the numerical modeling can account for these factors, its resolution is constrained by grid size, which may inadequately represent site specific parameters without further modification. In addition, discrepancies between local aquifer properties and the generalized hydraulic properties used in the GAM can lead to overestimation or underestimation of drawdown in numerical models. Therefore, these limitations and assumptions in the analytical and numerical modeling should be carefully considered when evaluating the impacts of pumping to the aquifer.

As requested, the TWDB GAM modeling files used to develop the numerical modeling results will be provided with this Addendum.

LRE appreciates the opportunity to provide you with this Addendum to the Hydrogeologic Report on behalf of Redtown Ranch Holdings, LLC. If you have any questions, please do not hesitate to contact us.

Sincerely,

LRE Water



11/18/2024
TBPG Firm #50516

Theresa Budd, PG
Senior Project Hydrogeologist

TBPE Firm #14368

Gretchen Miller, PhD, PE, PG
Senior Project Manager

References

Cooper, H.H. and C.E. Jacob, 1946, A generalized graphical method for evaluating formation constants and summarizing well field history, Am. Geophys. Union Trans., vol. 27, pp.526-534.

Hutchison, W.R., 2021a, GMA 11 Technical Memorandum 21-01, Adjusted Pumping Simulations for Joint Planning with Updated Groundwater Availability Model for the Sparta, Queen City, and Carrizo-Wilcox Aquifers, 31 p.

Hutchison, W.R., 2021b, Base Scenario Pumping Factors using Updated Groundwater Availability Model for the Sparta, Queen City, and Carrizo-Wilcox Aquifers.

Hutchinson, W.R., 2021c, Desired Future Conditions Explanatory Report (Final) Carrizo Wilcox/Queen City/Sparta Aquifers for Groundwater Management Area 11.

Kruseman, G.P., and N.A. de Ridder, 1994, Analysis and Evaluation of Pumping Test Data (2nd ed.), Publication 47, Intern. Inst. for Land Reclamation and Improvement, Wageningen, The Netherlands, 370 p.

Theis, C.V., 1935, The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage, Am. Geophysics. Union Trans., vol 16, pp. 519-524.

Wade, Shirley, 2022, GAM Run 21-016 MAG: Modeled Available Groundwater for the Carrizo-Wilcox, Queen City, and Sparta Aquifers in Groundwater Management Area 11. Texas Water Development Board.

Appendix A –

Response Letters provided by AGS (Dated October 28, 2024)
and Mr. John Stover (Dated October 23, 2024)

Email correspondence between LRE and AGS
(Dated November 1, 2024 and November 6, 2024)

SSBWW Skelton Slusher Barnhill Watkins Wells
ATTORNEYS AT LAW PLLC

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October 21, 2024

Quinn McColly, PhD, Managing Director, Water Resources
Conservation Equity Management
Parkland Hall at Old Parkland
3889 Maple Avenue, 6th Floor
Dallas, Texas 75219
Via Email: qm@cem-tx.com

RE: Neches and Trinity Valleys Groundwater Conservation District
Well Applications

Dear Mr. McColly:

This is to clarify our discussions concerning the hydrology report for your applications to the Neches and Trinity Valleys Groundwater Conservation District. You indicated that your engineering team could put together reports that look forward for 50 years. I agreed that it would be a sufficient period of time. I did not specify the contents of that report, not being a hydrologist. Reports are not needed on the individual wells, but for the two well fields.

While the decisions about the completeness of the report will be up to our groundwater hydrologist, there are several things that I would like to see included, such as illustrations or maps showing the cone of depression depicting the contours for impacts for all of the wells listed in Appendix B in the LRE Water Report of September 5, 2024 for the well fields. The hydrologist has indicated that I will receive a response from him on this, this week.

I do not recall suggesting or agreeing to a report limited to a five year period. I have reviewed my notes and did not find anything in them that addresses the length of time that the report should cover. You must have misunderstood me. A five year period is not adequate for legal and scientific use.

As to the other items listed in the deficiencies that we previously submitted to you, all have been satisfied except for the hydrology report.

Please let me know if you have other questions.

Yours very truly,

John D. Stover
JDS/jsa
Clio: 1347225

cc: Penny Hanson

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October 29, 2024

Quinn McColly, PhD, Managing Director, Water Resources
Conservation Equity Management
Parkland Hall at Old Parkland
3889 Maple Avenue, 6th Floor
Dallas, Texas 75219
Via Email: qm@cem-tx.com

RE: Neches and Trinity Valleys Groundwater Conservation District-
Applications from Pine Bliss, LLC and Redtown Ranch Holdings, LLC

Dear Mr. McColly:

Attached is a letter from the District's consulting hydrologist, James Beach, containing the results of his review of the hydrology report you submitted with the above referenced applications. Please have your hydrologist address these matters and supplement their reports.

Please let me know if there are any questions.

Yours very truly,

John D. Stover
JDS/jsa
Clio: 1350311

Attachment

cc: Penny Hanson

cc: Holli Pryor-Blaze

cc: Scott Skelton

AGS
Advanced Groundwater Solutions, LLC
www.advancedgw.com

October 28, 2024

John D. Stover
Skelton Slusher Barnhill Watkin Wells
1616 South Chestnut
Lufkin, Texas 75901

Dear Mr. Stover,

As requested by Neches Trinity Valley Groundwater Conservation District (NTVGCD, the District), Advanced Groundwater Solutions, LLC (AGS) has reviewed the hydrogeologic reports provided for the proposed Pine Bliss LLC wellfield (also known as Bluebonnet) in Henderson County and Redtown Ranch wellfield in Anderson County and Houston County. As per your direction, AGS has not completed a quantitative assessment of the groundwater modeling completed by LRE to confirm the modeling results contained in the September 5, 2024 hydrogeological report addendum. However, we do have the following general comments.

District rule 5.4(k) provides the following requirements for hydrogeological reports – "a hydrogeological report addressing the area of influence, draw down, recovery time, and other pertinent information required by the district." The hydrogeologic reports developed by LRE discuss the geologic and hydrogeologic setting, results of pumping tests, hydraulic properties estimated in the wellfields from available data, and the estimated impacts of pumping as required by rule 5.4(k).

LRE used two methods to evaluate water level decline from the proposed wells, (1) an analytical method known as the Cooper-Jacob solution, and (2) the Texas Water Development Board Groundwater Availability Model (the TWDB GAM). The two approaches provide significantly different results regarding drawdown.

The Cooper-Jacob solution is an approximation of the Theis (1935) solution. The critical value of u required to achieve reasonable accuracy with the Cooper and Jacob approximation is alternately given as $u \leq 0.05$ (Driscoll 1986) and $u \leq 0.01$ (Kruseman and de Ridder 1994). A smaller value for the critical value of u leads to a more accurate approximation of the Theis well function. Therefore, the drawdowns shown in the hydrogeological reports at some combinations of variables (r, T, S) may not meet the criteria. We request that LRE show the value of the Cooper and Jacob "u" value for the calculations. In addition, it is unclear how the Cooper and Jacob solution was applied to estimate drawdowns when the transmissivity varies from well to well. We assume the principle of superposition was employed, but it was not described in the report. We ask that LRE explain the approach and speak to the validity of the approximation.

For the numerical modeling using the TWDB GAM, the recovery time was not documented in the hydrogeologic reports. We ask that LRE document the recovery time using the TWDB GAM.

LRE compares the water level decline after 5 years from the project to the DFC drawdown noted in the tables as "Simulated "Base Run" Scenario 33 (TM 21-01)". The DFC drawdown noted in the comparisons is the simulated water level decline in 2080. We request that LRE provide a comparison with the simulated water level decline from the project in 2080.

We also ask that LRE provide the TWDB GAM modeling files used to develop the results in the hydrogeologic reports.

Please let me know if you have any questions.

Best regards,

Advanced Groundwater Solutions, LLC

James Beach, PG

References:

Cooper, H.H. and C.E. Jacob, 1946. A generalized graphical method for evaluating formation constants and summarizing well field history, Am. Geophys. Union Trans., vol. 27, pp. 526-534.

Driscoll, F.G., 1986. Groundwater and Wells (2nd ed.), Johnson Filtration Systems, Inc., St. Paul, Minnesota, 1089p.

Kruseman, G.P. and N.A. de Ridder, 1994. Analysis and Evaluation of Pumping Test Data (2nd ed.), Publication 47, Intern. Inst. for Land Reclamation and Improvement, Wageningen, The Netherlands, 370p. [pdf]

Theis, C.V., 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage, Am. Geophys. Union Trans., vol. 16, pp. 519-524.

Outlook

Re: Neches Trinity Valley GCD - Comments

From James Beach <james.beach@advancedgw.com>
Date Wed 11/13/2024 10:09 AM
To Gretchen Miller <gretchen.miller@lrewater.com>
Cc Jordan Furnans <jordan.furnans@lrewater.com>; John Stover <jstover@ssbww.law>; Theresa Budd <theresa.budd@lrewater.com>

Gretchen,

Sorry for the confusion on item 2.
Please model 5 years of recovery with the existing model out to 2080.

thanks.

James Beach
(512) 796-8636

On Tue, Nov 12, 2024 at 2:53 PM Gretchen Miller <gretchen.miller@lrewater.com> wrote:

> Hi James,
>
> Just to clarify item 2 on your email below, for the recovery calculations, we planned to present a plot and table of drawdown at the 5-year mark after pumping ceases (e.g., recovery obtained by 2080). Based on my notes from our conversation, that was sufficient, but I'm seeing some ambiguity in your email below. Just want to make sure that we fully understood what was needed.
>
> Thanks,
> Gretchen
>
> **Gretchen Miller, Ph.D., P.E., P.G.**
> **Senior Project Manager**
> LRE Water | A Spheros Environmental Company
> Office: 512-300-0435 | Direct: 979-676-1273
> gretchen.miller@lrewater.com

LREWATER.COM
600 Round Rock West Dr. #601, Round Rock, TX 78681

From: James Beach <james.beach@advancedgw.com>
Sent: Wednesday, November 6, 2024 7:53 AM
To: Gretchen Miller <gretchen.miller@lrewater.com>
Cc: Jordan Furnans <jordan.furnans@lrewater.com>; John Stover <jstover@ssbww.law>; Theresa Budd <theresa.budd@lrewater.com>
Subject: Re: Neches Trinity Valley GCD - Comments

Gretchen,

1. Yes, the 2025-2075 is fine for the 50-year run.
2. Yes, repeating the 2080 stress period is fine. Please show recovery results after 5 years (2080) also.
3. If the auto-flow reduction is required for convergence, that is fine. I obviously cannot speak to how the District will receive changes to the model or other approaches for estimating impacts, but I am open to considering your technical approaches to addressing model limitations.

James Beach
(512) 796-8636

On Fri, Nov 1, 2024 at 1:28 PM Gretchen Miller <gretchen.miller@lrewater.com> wrote:

> James,
>
> We are working on generating these model runs and need to clarify the following details with you:
>
> 1) For the previous analyses, we used predictive Scenario 33 generated by Bill Hutchison as part of the GMA-11 planning process (i.e., GR21-016 MAG). This scenario models years 2013 to 2080. Can you confirm that you are requesting that we model the intended pumping in that version of the GAM for 50 years, presumably from 2025 to 2075?
>
> 2) Given the above, we can only model recovery for an additional 5 years after 2075, given the model's current structure. If we were to continue for an additional 25 years (to 2105), what would you consider an acceptable model modification? Should we repeat the last (2080) stress period for those additional years?
>
> 3) The current parameters in the GAM do not allow for pumping at the rates requested in the permit(s), as we based those on site-specific field data. Thus, the pumping simulated in the

GAM must be reduced in order for the model, as originally constructed and approved, to converge. Do you concur with our use of the auto-flow reduction routines in MODFLOW to adapt for that? Or do you have another preferred method for handling this limitation?

As you can see, there are multiple technical complications associated with the GAM that make your requests less than straightforward to accomplish. Before we set about trying to meet them, I want to make sure we agree as to the approach.

Also, if you have any other suggestions or preferred methods you'd like for us to use for this analysis, please let us know now before we commence.

Thank you,
Gretchen

Gretchen Miller, Ph.D., P.E., P.G.
Senior Project Manager
LRE Water | A Spheros Environmental Company
Office: 512-300-0435 | Direct: 979-676-1273
gretchen.miller@lrewater.com

LREWATER.COM
600 Round Rock West Dr. #601, Round Rock, TX 78681

From: James Beach <james.beach@advancedgw.com>
Sent: Friday, November 1, 2024 9:40 AM
To: Jordan Furnans <jordan.furnans@lrewater.com>
Cc: John Stover <jstover@ssbww.law>
Subject: Re: Neches Trinity Valley GCD - Comments

Jordan,

Thanks for your email. Good to see you at TWCA as well.
I'm copying John Stover on this email to keep him in the loop.

Regarding documentation of recovery with the GAM, it seems reasonable to document water level decline for the 50-year period simulated for each "project" as indicated in your hydrogeologic reports. Please illustrate contours of water level decline 1, 2, 5, 10, and 30 years after pumping stops.

Please make the TWDB GAM files available on a shared site, and we can download them to confirm the results in the hydro report. We would like to get all the files needed to complete the runs (i.e., not just the WEL file) for each project (Pine Bliss and Redtown).

Let me know if you have any questions.

thank you,

James Beach
(512) 796-8636

On Tue, Oct 29, 2024 at 12:53 PM Jordan Furnans <jordan.furnans@lrewater.com> wrote:

> Hey James -
>
> Good to see you last week at TWCA.
>
> I just got your 2-pg letter to Mr. Stover regarding our hydrogeological reports for Pine Bliss and Redtown Ranch.
>
> Question:
> How would you like recovery modeled and documented using the GAM? We did recovery modeling using Theis, and provided those results. It is frustrating that the district does not have explicit rules/requirements for hydrogeological reporting, such that we could just do what is needed once, rather than have to keep responding to requests.
>
> That being said, we'll do what you ask in your letter. Do you believe the GAM is accurate enough in this region to provide the district with useful information regarding the proposed projects?
>
> Thanks,
>
> Jordan
>
> **Jordan Furnans, PhD, PE, PG**
> **Vice President - Texas Operations**
> LRE Water | A Spheros Environmental Company
> Office: 512-300-0435 Direct: 512-736-6485
> Jordan.Furnans@LREwater.com
> LREWATER.COM
> 600 Round Rock West Dr. #601, Round Rock, TX 78681

Appendix B –

Hydrogeologic Report Prepared for the NTVGCD for the Proposed Carrizo Sand Wellfield on the Redtown Ranch Property (Dated September 10, 2024)

LRE WATER
CONNECTING WATER TO LIFE

September 10, 2024

Penny Hanson, General Manager
Neches and Trinity Valleys GCD
501 Devereaux Street
Jacksonville, TX 75766

RE: Hydrogeological Report for the Neches and Trinity Valleys GCD
Carrizo Sand Wellfield – Redtown Ranch Property, Anderson County, TX

Dear Ms. Hanson,

LRE Water ("LRE") is pleased to submit this Hydrogeological Report to the Neches and Trinity Valleys Groundwater Conservation District ("NTVGCD" or District) on behalf of Redtown Ranch Holdings, LLC. The purpose of this Hydrogeological Report is to assess the potential impacts associated with a proposed wellfield on an approximately 7,465-acre property (herein referred to as the "Redtown Ranch Property") in Anderson and Houston County, Texas. According to District Rule 5.4(k), an applicant requesting to drill and operate a proposed new well or well system with a daily maximum capacity of more than 2 million gallons or requests to modify to increase production or production capacity of a non-exempt well with an outside casing diameter greater than 10 inches is required to submit a Hydrogeological Report with the permit application. This Hydrogeologic Report addresses the area of influence, estimated drawdown, recovery time, relation of proposed pumping to the "modeled available groundwater" and the desired future conditions (DFCs), and water usage for the proposed production as it relates to the current Regional Plan. The information provided herein is intended to supplement the Groundwater Availability Study prepared by LRE for Redtown Ranch Holdings, LLC, dated May 31, 2024, and to address deficiencies in the permit application, as noted in the District's letter to Redtown Ranch Holdings, LLC, dated August 8, 2024.

The proposed wellfield in Anderson County consists of five (5) wells producing a total combined production capacity of 3,700 gallons per minute (gpm), or 5,983 acre-feet per year (ac-ft/yr) from the Carrizo Sand of the Carrizo-Wilcox Aquifer System. The intended use for which production is requested includes all beneficial purposes as those terms are defined in Section 36.001(9) of the Texas Water Code (2011) and NTVGCD Rule 1(c). The water produced from this wellfield is planned to be used within Regional Water Planning Areas C, G, H, K, and/or L.

Background

For this work, LRE compiled and reviewed publicly available information pertaining to the geologic structure, lithology, and hydraulic properties of the Carrizo Sand beneath the Redtown Ranch Property. This included a review of geologic and hydrogeologic data from published groundwater studies, geologic maps, state well reports, well drilling reports, and other applicable information from published literature. Data sources included the Texas Commission on Environmental Quality (TCEQ), the Texas Water Development Board (TWDB) Groundwater Database, the Submitted Drillers Report (SDR) Database, and LRE files. LRE's literature review included the TWDB Report No. 150 ("R-150") "Ground-Water Conditions in Anderson, Cherokee, Freestone, and Henderson Counties, Texas by Guyton & Associates (1972) and TWDB Report No. 18 ("R-18") "Ground Water Resources of Houston County, Texas" by G.E. Tarver (1966). Hydraulic properties for the Carrizo Sand were extracted from the Northern Portion of the Queen City, Sparta, and Carrizo-Wilcox Aquifer Groundwater Availability Model ("North QCSCW GAM") Conceptual Report by Schorr and others (2020).

Appendix A provides the latitude and longitude coordinates and pumping rates for the proposed wells on the Redtown Ranch Property. The proposed wellfield in Anderson County to be permitted by the District includes five (5) wells completed in the Carrizo Sand, and the proposed wellfield in Houston County (outside the jurisdiction of the NTVGCD) consists of three (3) wells completed in the Carrizo Sand. Each proposed well will be completed with an outer casing diameter greater than 10 inches and will be equipped with a pump capable of producing the proposed pumping rates provided in Appendix A. On August 15, 2024, the District provided LRE (via email) a list of all exempt and non-exempt wells registered with the NTVGCD in Anderson County. LRE compiled all publicly available well data from the NTVGCD, the TWDB, and the SDR Databases to identify wells in Anderson County within a 5-mile radius of the Redtown Ranch Property, as shown in Figure 1 and in the table provided in Appendix B. All proposed well locations within the District boundaries are at least a ¼-mile radial distance from the nearest property boundary and other surrounding wells (Figure 1). The proposed well locations in Anderson County meet the minimum well spacing requirements outlined in District Rule 7(a) and adhere to the TCEQ's well setback requirements from potential sources of contamination or flood-prone areas, as specified in Title 30 of the Administrative Code (30 TAC) §290.41(c)(1).

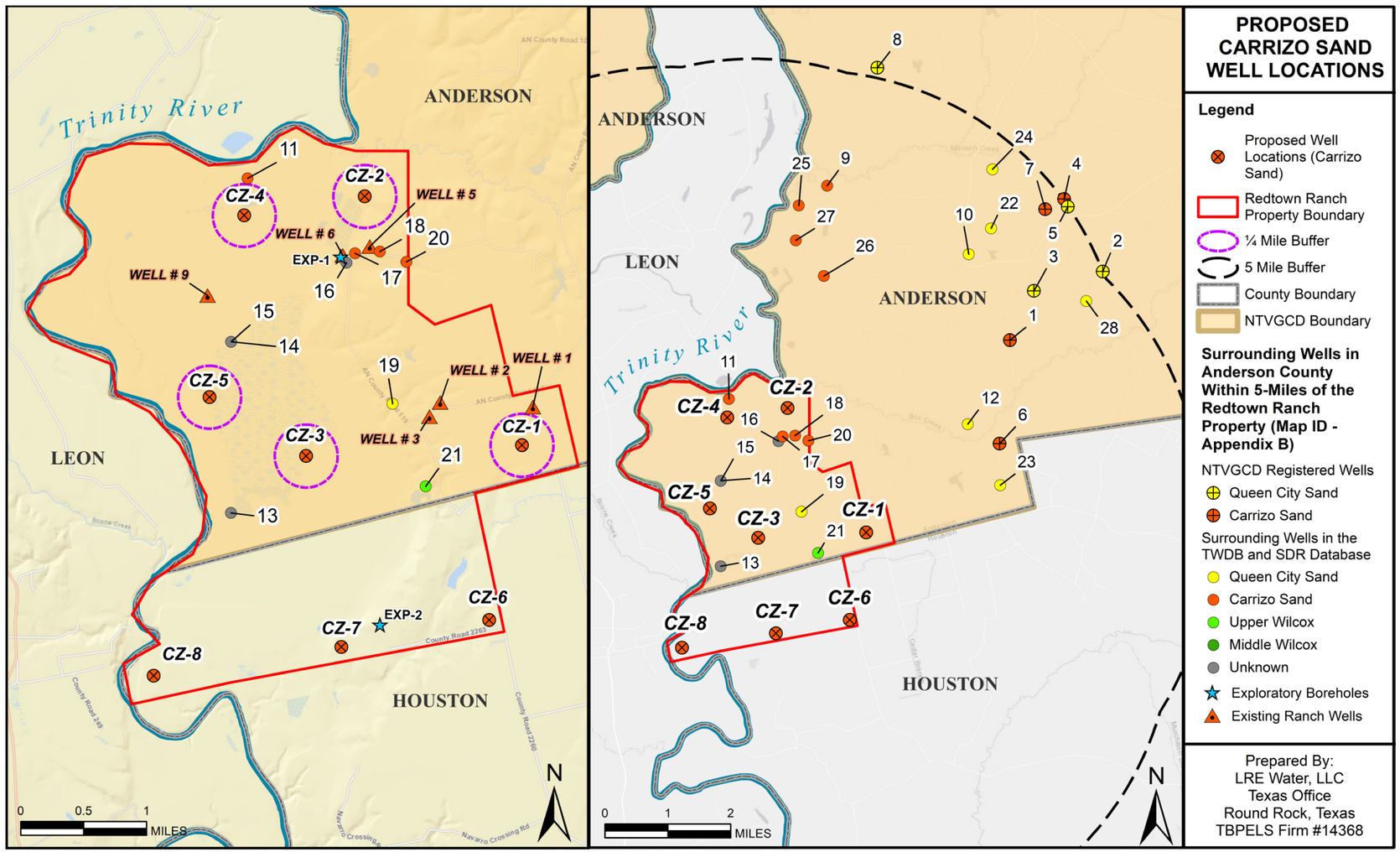


Figure 1. Proposed Carrizo Well Locations on the Redtown Ranch Property

Hydraulic Aquifer Properties

Andrews & Foster Drilling Company (A&F) drilled two 7.875-inch exploratory boreholes ("EXP-1" and "EXP-2") to determine formation depths and sand thickness of the aquifers beneath the Redtown Ranch Property. Exploratory borehole EXP-1 was drilled in Anderson County at Latitude 31.540694, Longitude -95.716917 to approximately 1,197 feet below land surface (ft bls), and exploratory borehole EXP-2 was drilled in Houston County at Latitude 31.498361, Longitude -95.710417 to approximately 1,307 ft bls, as shown in Figure 1.

There are two existing wells on the Redtown Ranch Property, identified as "Well #2" and "Well #3" in Figure 1. Well #2 is located at Latitude 31.524167, Longitude -95.703056 in Anderson County, and Well #3 is located approximately 750 feet from Well #2 at Latitude 31.5225, Longitude -95.704444 in Anderson County (Figure 1). According to available well construction information, Well #2 was constructed with 10-inch diameter casing and was completed to a depth of 386 feet, and Well #3 was constructed with 6-inch diameter casing to an unknown depth. Although the screen intervals for both wells are unknown, these wells are likely completed in the Carrizo Sand of the Carrizo-Wilcox Aquifer.

A&F started a 27-hour pumping test at Well #2 on March 9, 2023, at an average pumping rate of 590 gpm. The static water level in Well #2 was 64.06 ft bls prior to starting the test. After pumping Well #2 for 27 hours at 590 gpm, the pumping water level was 126.82 feet bls, which equates to 62.76 feet of drawdown in the wellbore. Therefore, the specific capacity of Well #2 is 9.4 gallons per minute per foot (gpm/ft). LRE analyzed the pumping test data from Well #2 using the Cooper-Jacob (1946) solution for the pumping portion of the test and the Theis (1935) residual drawdown solution for the non-pumping (recovery) portion of the test. Based on the pumping test results and recovery data for Well #2, transmissivity for the Carrizo Sand was calculated to be approximately 22,250 gallons per day per foot (gpd/ft). The time-drawdown and residual drawdown graphs used to plot the pumping test data and calculate transmissivity are provided in Appendix C.

Water levels were measured in Well #3 during the 27-hour pumping test to calculate a storage coefficient for the Carrizo Sand beneath the Redtown Ranch Property. Static water levels in observation Well #3 were approximately 70 ft bls prior to starting the test, and the total drawdown in observation Well #3 at the end of the pumping test was approximately 13 feet. The storage coefficient (or storativity) for the Carrizo Sand was calculated using the Cooper-Jacob (1946) equation by fitting a straight line through the zero-drawdown intercept of the observed drawdown data plotted against time on a semi-

logarithmic graph (See Appendix C). The storativity of the Carrizo Sand beneath the Redtown Ranch Property was calculated to be 0.00009 or 9 x 10^{-5} (Appendix C).

Hydraulic conductivity can be calculated by dividing transmissivity (in gpd/ft) by the screen length or net sand thickness (in feet). Due to the absence of screen interval data for Well #2 and Well #3, it was not possible to directly determine the hydraulic conductivity of the Carrizo Sand from the calculated transmissivity of 22,250 gpd/ft (Appendix C). Therefore, surrounding well data was obtained from the TWDB and SDR Databases to estimate the hydraulic conductivity of the Carrizo Sand. The specific capacity of a nearby public supply well (Well Report Tracking Number 606462) was reported to be 13 gpm/ft, which corresponds to an estimated transmissivity of 26,000 gpd/ft using the Driscoll (1986) estimation method. This well had a reported screen length of 78 feet, which results in an estimated hydraulic conductivity value of 333.3 gpd/ft^2. Transmissivity values for fully-penetrating wells completed in the Carrizo Sand were estimated by multiplying the net sand thickness of the Carrizo Sand (in feet) beneath the Redtown Ranch Property by a constant hydraulic conductivity value of 333.3 gpd/ft^2.

Table 1 summarizes the input parameters used in the analytical modeling, which are based on estimated hydraulic properties from site-specific aquifer tests, surrounding well data, interpretation of geophysical logs, and data obtained from the Conceptual North QCSCW GAM Report by Schorr and others (2020).

Table 1. Input Parameters for Analytical Modeling

Proposed Well	Top of Screen (ft bls)	Bottom of Screen (ft bls)	Aquifer Thickness (ft)	Net Sand Thickness (ft)	Pump Setting (ft bls)	Static Water Level (ft bls)	S	K (gpd/ft^2)	T (gpd/ft)
CZ-1	335	500	165	165	295	70	0.00009	333.3	54,995
CZ-2	280	425	145	145	225	0	0.00009	333.3	48,330
CZ-3	300	460	160	160	250	0	0.00009	333.3	53,330
CZ-4	265	420	155	145	215	0	0.00009	333.3	48,330
CZ-5	280	440	160	155	230	0	0.00009	333.3	51,660
CZ-6	330	500	170	170	285	65	0.00009	333.3	56,660
CZ-7	300	470	170	170	250	25	0.00009	333.3	56,660
CZ-8	300	470	170	170	250	0	0.00009	333.3	56,660

"ft bls" indicates feet below land surface; land surface elevation from NED (USGS, 2004), "ft" indicates feet, "gpd/ft^2" indicates gallons per day per foot squared, "gpd/ft" indicates gallons per day per foot, S = Storativity (confined aquifer), K = hydraulic conductivity, T = Transmissivity, cells highlighted in gray indicate wells located in Houston County (located outside NTVGCD boundary).

Analytical Groundwater Modeling

LRE conducted analytical groundwater modeling to assess local drawdown impacts, recovery time, and well interference between proposed wells on the Redtown Ranch Property. Proposed well locations and pumping rates were selected based on considerations of the hydrogeologic conditions, including aquifer depths, net sand thickness, aquifer productivity, hydraulic characteristics, and well spacing requirements. The input parameters used in the analytical modeling are based on estimated hydraulic properties from site-specific aquifer tests, surrounding well data, interpretation of geophysical logs, and data obtained from the Conceptual North QCSCW GAM Report by Schorr and others (2020) (Table 1). The results of the analytical modeling simulating the proposed production of 5,983 ac-ft/yr from the Carrizo Sand in Anderson County and 4,286 ac-ft/yr from the Carrizo Sand in Houston County after five years is summarized in Table 2.

Table 2. Five-Year Analytical Modeling Results

Proposed Well	County	Well Yield (gpm)	Proposed Production (ac-ft/yr)	Drawdown from Pumping Well (ft)	Drawdown Imposed from Surrounding Wells (ft)	Cumulative Drawdown (ft)	Recovery Time (Days)
CZ-1	Anderson	750	1,213	62	93	155	931
CZ-2	Anderson	650	1,051	61	91	152	960
CZ-3	Anderson	950	1,536	81	96	177	762
CZ-4	Anderson	600	970	56	93	149	981
CZ-5	Anderson	750	1,213	66	97	163	862
CZ-6	Houston	750	1,213	61	93	154	943
CZ-7	Houston	750	1,213	61	96	157	911
CZ-8	Houston	1,150	1,860	93	83	176	780

"gpm" indicates gallons per minute, "ft" indicates feet, "ac-ft/yr" indicates acre-feet per year, "*" indicates average, cells highlighted in gray indicate wells located in Houston County (outside of NTVGCD boundary), "NA" indicates information not applicable, as wells are located in Houston County.

The cumulative drawdown calculated using the Cooper-Jacob (1946) equation includes drawdown in the wellbore from both the pumping well and additional drawdown imposed from surrounding proposed wells producing from the Carrizo Sand on the Redtown Ranch Property (Table 2). This modeling includes production from proposed wells located on the Redtown Ranch Property in Houston County (outside of the NTVGCD boundaries) to accurately depict the well interference and cumulative drawdown in the wellfield. Figure 2 illustrates the cumulative drawdown in the Carrizo Sand within the District boundaries after five years of pumping, based on the analytical modeling using the Cooper-Jacob (1946) equation and input parameters in Table 1.

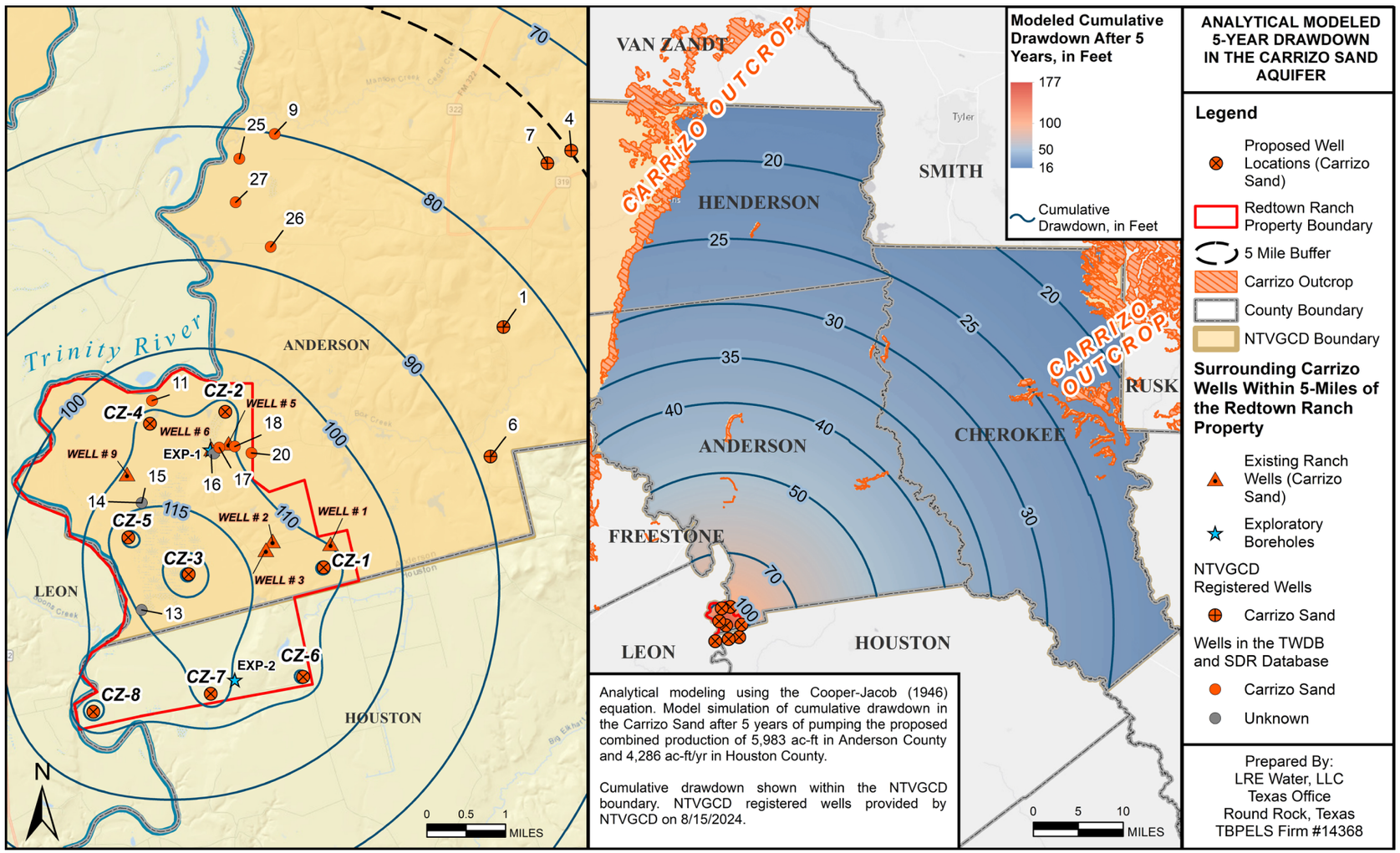


Figure 2. Analytical Modeled Cumulative 5-Year Drawdown in the Carrizo Sand

Based on the proposed pumping rates and estimated hydraulic properties (Table 1), cumulative drawdown in the proposed wells in Anderson County ranges from 149 to 177 feet after five years (Table 2). Recovery time was calculated as the length of time for water levels to recover 90% of the drawdown after pumping for five years. The time for water levels to recover 90% of the drawdown in the Carrizo Sand in Anderson County after pumping for five years ranges from 762 to 981 days (Table 2). Hydrographs of the simulated pumping and recovery water levels in each proposed well due to the combined production of 5,983 ac-ft/yr in Anderson County and 4,286 ac-ft/yr in Houston County are presented in Appendix D.

It is important to note the analytical modeling does not take into account any boundary conditions, such as faults or additional water supply from recharge, which may result from the infiltration of water from precipitation in the aquifer outcrop, or by vertical and lateral movement of water between formations. Therefore, actual aquifer conditions and impacts to the Carrizo Sand may differ from the results presented herein.

Numerical Groundwater Modeling

LRE conducted numerical modeling of the combined production of 3,700 gpm (5,983 ac-ft/yr) from the Carrizo Sand in Anderson County and 2,650 gpm (4,286 ac-ft/yr) from the Carrizo Sand in Houston County (North QCSCW GAM; Layer 6) to evaluate the regional impacts of the proposed production on the adopted DFCs after five years of pumping. This modeling includes production from proposed wells located in Houston County on the Redtown Ranch Property (outside of the NTVGCD boundaries) to accurately depict the impacts from the proposed wellfield. The results of the numerical modeling showing the cumulative drawdown from the proposed production in the Carrizo Sand is illustrated in Figure 3. It is important to note that the numerical modeling uses hydraulic properties for the Carrizo Sand (Layer 6) from the North QCSCW GAM Numerical Report by Panday and others (2020). The hydraulic properties obtained from site-specific aquifer tests and surrounding well data for the Carrizo Sand on the Redtown Ranch Property, specifically estimates of transmissivity and storativity, are higher than those from the North QCSCW GAM Numerical Report for the Carrizo Sand (Panday and others, 2020; Layer 6). Therefore, the drawdown and projected impacts from the proposed production in the numerical modeling are greater than the drawdown and impacts from the analytical modeling. To more accurately reflect current aquifer conditions and regional impacts from the proposed combined production, updates to the hydraulic properties of the Carrizo Sand (Layer 6) in the North QCSCW GAM will be necessary.

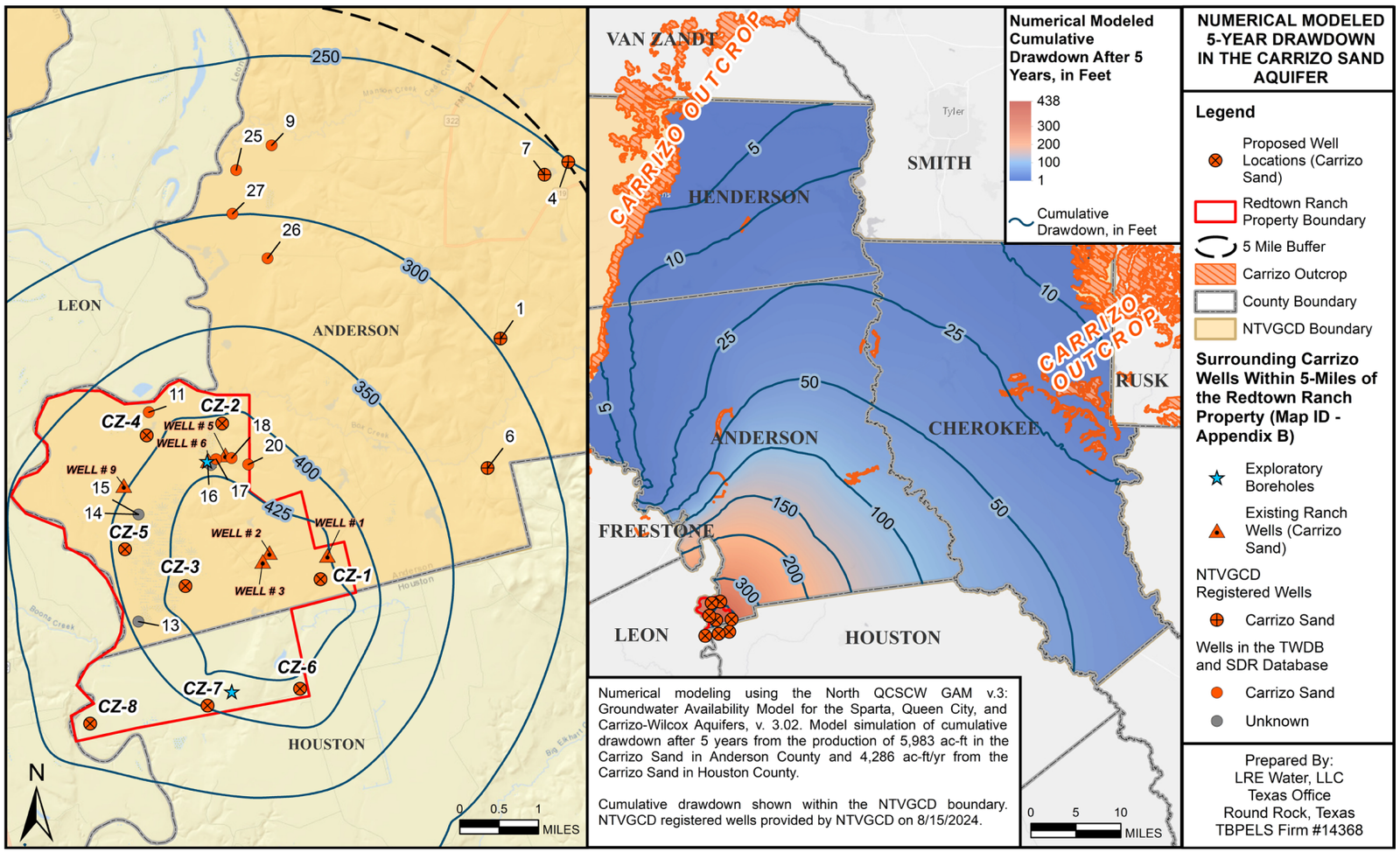


Figure 3. Numerical Modeled Cumulative 5-Year Drawdown in the Carrizo Sand (North QCSCW GAM; Layer 6)

While GAMs are useful tools for predicting regional changes within aquifer systems, their size and complexity can limit their ability to accurately represent local hydrogeologic conditions. More specifically, GAMs may lack detailed localized data, such as results from pumping tests, current water level measurements, and specific aquifer depths. The analytical and numerical models can be refined using site-specific hydraulic parameters upon drilling and testing the proposed wells.

Modeled Available Groundwater

Modeled available groundwater (MAG), as defined in Chapter 36 of the Texas Water Code (2011), is the estimated average amount of water that may be produced annually to achieve a DFC. The MAG, as set forth in Section H of the District's Groundwater Management Plan (Amended August 15, 2019), is based on the model run GAM Run 17-024 MAG from June 19, 2017 (Wade, 2017). The MAG for the Carrizo-Wilcox Aquifer is 29,088 ac-ft in Anderson County from 2010 to 2070 based on the GAM Run 17-024 MAG (Wade, 2017). The TWDB issued the most recent GAM Run-21-016 MAG Report for the Carrizo-Wilcox, Queen City, and Sparta Aquifers in GMA-11 on February 17, 2022 (Wade, 2022). This report used the North QCSCW GAM and documented development of the estimated modeled available groundwater associated with the DFCs adopted by GMA-11 on August 11, 2021. According to the 2021 Joint Planning Cycle GAM Run 21-016 MAG, the MAG for the Carrizo-Wilcox Aquifer is 27,024 ac-ft in Anderson County from 2020 to 2080 (Wade, 2022).

The most recent DFCs were approved by GMA-11 on August 11, 2021, based on Scenario 33, as documented in Technical Memorandum 21-01 (Hutchinson, 2021a). As described in the GMA-11 Desired Future Conditions Explanatory Report (Hutchinson, 2021c), average drawdown across the county represents the regional average drawdown occurring from pumping during the period of interest. The most recently adopted DFCs for the Carrizo-Wilcox Aquifer are 155 feet in Anderson County from 2013 to 2080 (Hutchinson, 2021a).

Cumulative drawdown from the numerical modeling was computed and compared to the drawdown from the "Base Run" used to calculate the 2021 DFC's for the Carrizo Sand (Hutchison, 2021b). Table 3 presents the MODFLOW modeling results comparing the simulated "Base Run" average drawdown in Anderson County after five years, based on Scenario 33 documented in Technical Memorandum 21-01 (Hutchinson, 2021b), and the simulated model-predicted average drawdown in Anderson County after five years of pumping from the Carrizo Sand (Layer 6).

Table 3. Five-Year Model Predicted Average Drawdown in Anderson County

Aquifer	Model Layer	Simulated "Base Run" Scenario 33 (TM 21-01)	Simulated "Base Run" & "Proposed CZ"	Simulated "Proposed CZ" Only
Average Drawdown in Anderson County, in Feet				
Queen City	4	32.05	64.84	32.79
Carrizo Sand	6	93.77	193.51	99.74
Upper Wilcox	7	102.10	210.66	108.56
Middle Wilcox	8	122.18	253.17	130.99
Lower Wilcox	9	154.60	319.77	165.17
Wt. Avg CZ-WLX	6-9	116.24	240.10	123.86

"Base Run" indicates the Groundwater Availability Model (GAM) Scenario 33, TM 21-01 (Hutchinson, 2021b), "Proposed CZ" indicates proposed production in the Carrizo Sand (Layer 6)

The average drawdown in the Carrizo Sand (Layer 6) from the "Base Run" scenario is 93.77 feet in Anderson County after five years (Hutchinson, 2021b) (Table 3). The additional drawdown in the Carrizo Sand as a result of the combined production of 6,350 gpm from the Redtown Ranch Property is approximately 99.74 feet in Anderson County after five years (Table 3).

Regional Water Plan

The place of use for the proposed water will be in areas that are currently experiencing significant water challenges, specifically in counties that are part of Regional Water Planning Areas C, G, H, K, and/or L. Detailed and board-approved water plans are accessible at the following links: https://www.twdb.texas.gov/waterplanning/rwp/regions/ and https://texasstatewaterplan.org/statewide. Based on the 2021 Interactive State Water Plan Viewer, the following deficits are projected:

- Region C: A shortfall of 250,000 acre-feet by 2030, increasing to a 1.24 million acre-feet deficit by 2070.
- Region G: A shortfall of 100,000 acre-feet by 2040, increasing up to a 300,000 acre-feet deficit by 2070.
- Region H: A shortfall of 210,000 acre-feet by 2030, increasing to 700,000 acre-feet deficit by 2070.
- Region K: A shortfall of 40,000 acre-feet by 2040, increasing to a 100,000 acre-feet deficit by 2070.
- Region L: A shortfall of 50,000 acre-feet by 2030, increasing to a 210,000 acre-feet deficit by 2070.

Based on the planning data for 2026, which is currently under development, greater deficits are expected in these Regional Planning Areas. However, according to the 2021 Interactive State Water Plan Viewer, Anderson County is projected to have no water deficit from now until 2070. The water to be produced from the Carrizo Sand is crucial for serving populations in regions of Texas that are expected to face significant water shortages.

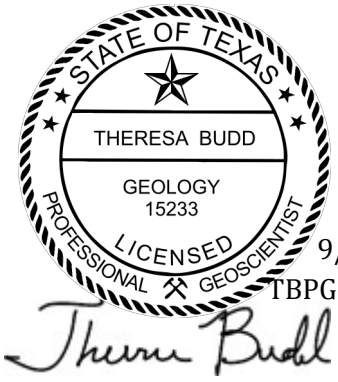
LRE appreciates the opportunity to provide you with this Hydrogeologic Report on behalf of Redtown Ranch Holdings, LLC. If you have any questions, please do not hesitate to contact us.

Sincerely,

LRE Water

9/10/2024
TBPELS Firm #14368

Jordan Furnans, PhD, PE, PG
Vice President TX Operations



9/10/2024
TBPG Firm #50516

Theresa Budd, PG
Senior Project Hydrogeologist

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Appendix A

Location of Proposed Carrizo Wells on the Redtown Ranch Property

Appendix A – Location of Proposed Carrizo Wells on the Redtown Ranch Property

Proposed Well	Latitude (NAD83) Decimal Degrees	Longitude (NAD83) Decimal Degrees	Latitude (NAD83) Degrees Minutes Seconds	Longitude (NAD83) Degrees Minutes Seconds	Proposed Pumping Rate (gpm)	Proposed Production (ac-ft/yr)
CZ-1	31.5195	-95.6919	31° 31' 10.054" N	95° 41' 30.815" W	750	1,213
CZ-2	31.5477	-95.7139	31° 32' 51.705" N	95° 42' 49.965" W	650	1,051
CZ-3	31.5176	-95.7209	31° 31' 3.339" N	95° 43' 15.243" W	950	1,536
CZ-4	31.5452	-95.7300	31° 32' 42.580" N	95° 43' 48.169" W	600	970
CZ-5	31.5241	-95.7341	31° 31' 26.771" N	95° 44' 2.731" W	750	1,213
Total Combined Production in Anderson County					3,700	5,984
CZ-6	31.49921	-95.6957	31° 29' 57.142" N	95° 41' 44.578" W	750	1,213
CZ-7	31.49568	-95.7155	31° 29' 44.463" N	95° 42' 55.847" W	750	1,213
CZ-8	31.49182	-95.7407	31° 29' 30.566" N	95° 44' 26.430" W	1,150	1,860
Total Combined Production in Houston County					2,650	4,286

"NAD83" indicates North American Datum of 1983, "gpm" indicates gallons per minute, "ac-ft/yr" indicates acre-feet per year, cells highlighted in gray indicate proposed wells located in Houston County (outside NTVGCD boundary).

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Appendix B

Surrounding Wells in Anderson County Within 5-Miles of the Redtown Ranch Property

Appendix B – Surrounding Wells in Anderson County Within 5-Miles of the Redtown Ranch Property

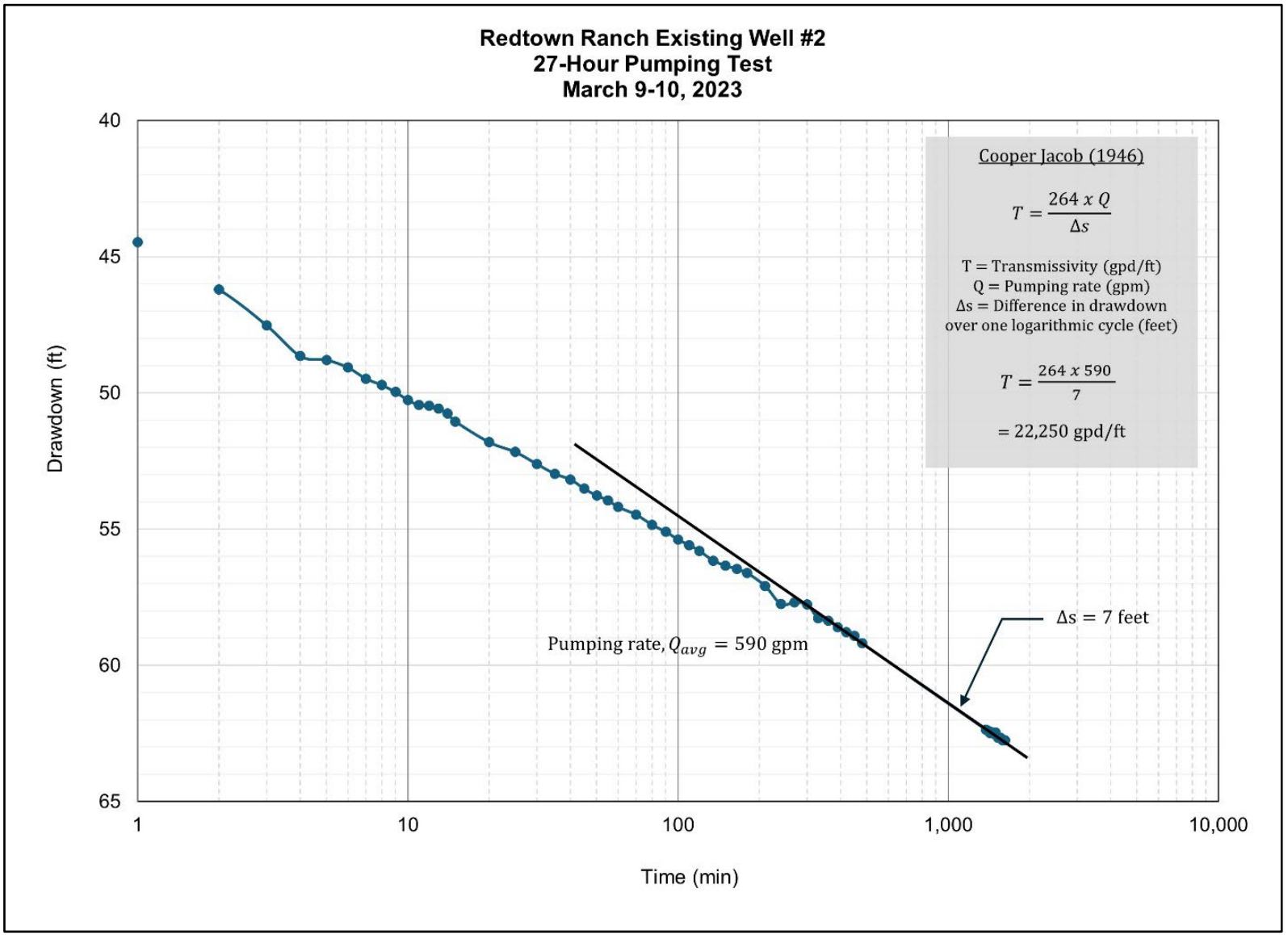
Map ID	Well ID (Well Report Tracking Number, or State Well Number)	Source ID (NTVGCD, SDR, TWDB Database)	Latitude (NAD83)	Longitude (NAD83)	Well Name/Owner	Well Depth/ Borehole Depth (ft)	Well Use	LRE-Designated Aquifer
1	402572	NTVGCD	31.56461	-95.65446	LINH HOANG LE'S HOPE FARM LLC 1	600	Domestic	Carrizo
2	661718	NTVGCD	31.58095	-95.62991	KERRY JAMES LOCKE	200	Domestic	Queen City
3	561846	NTVGCD	31.576111	-95.648334	JESSE JAMES	178	Domestic	Queen City
4		NTVGCD	31.59744	-95.64077	REYNALDO VERA	640	Domestic	Carrizo
5	441813	NTVGCD	31.59569	-95.63975	MIKE TROCKO	255	Domestic	Queen City
6		NTVGCD	31.54069	-95.65656	LEON BARTON, JR	460	Domestic	Carrizo
7	403727	NTVGCD	31.595	-95.645833	MIKE FRANKS	695	Domestic	Carrizo
8		NTVGCD	31.626667	-95.691944	JERALD UNDERWOOD	110	Domestic	Queen City
9	3827201	TWDB	31.599167	-95.704723	Emmett Coleman	565	Irrigation	Carrizo
10	3827304	TWDB	31.584167	-95.666112	Emmett Coleman	330	Stock	Queen City
11	3827401	TWDB	31.549445	-95.729722	Moore & Wardlaw	417	Irrigation	Carrizo
12	3827602	TWDB	31.545	-95.665278	Mary Johnson	36	Domestic	Queen City
13	3827702	TWDB	31.510834	-95.730833	Moore & Wardlaw	0	Irrigation	Unknown
14	3827703	TWDB	31.530555	-95.731389	Moore & Wardlaw	0	Irrigation	Unknown
15	3827704	TWDB	31.530555	-95.731389	Moore & Wardlaw	0	Irrigation	Unknown
16	3827705	TWDB	31.54	-95.716111	Vernon Calhoun	0	Irrigation	Unknown
17	3827706	TWDB	31.541111	-95.715001	Moore & Wardlaw	425	Irrigation	Carrizo
18	3827707	TWDB	31.541389	-95.711667	Vernon Calhoun	350	Domestic	Carrizo
19	3827708	TWDB	31.523889	-95.709445	Vernon Calhoun	50	Unused	Queen City
20	3827804	TWDB	31.540278	-95.708056	Ronald Burke	300	Domestic	Carrizo
21	3827805	TWDB	31.514445	-95.704723	Vernon Calhoun	600	Domestic	Upper Wilcox
22	43690	SDR	31.590278	-95.660278	Carl Rutledge	144	Domestic	Queen City
23	223632	SDR	31.531111	-95.656112	Cook, D.	161	Domestic	Queen City
24	337816	SDR	31.603889	-95.660278	D. Criswell	223	Domestic	Queen City
25	47021	SDR	31.594445	-95.712223	Nat Coleman	500	Irrigation	Carrizo
26	47058	SDR	31.578333	-95.705001	Gary Gunnels	455	Irrigation	Carrizo
27	262950	SDR	31.586389	-95.712778	Ronnie Steadman	485	Irrigation	Carrizo
28	410138	SDR	31.574056	-95.634167	CHARLES RYLEE	182	Irrigation	Queen City

"NAD83" indicates North American Datum of 1983, "ft" indicates feet, LRE-designated aquifer classification based on well depth and/or screen intervals.

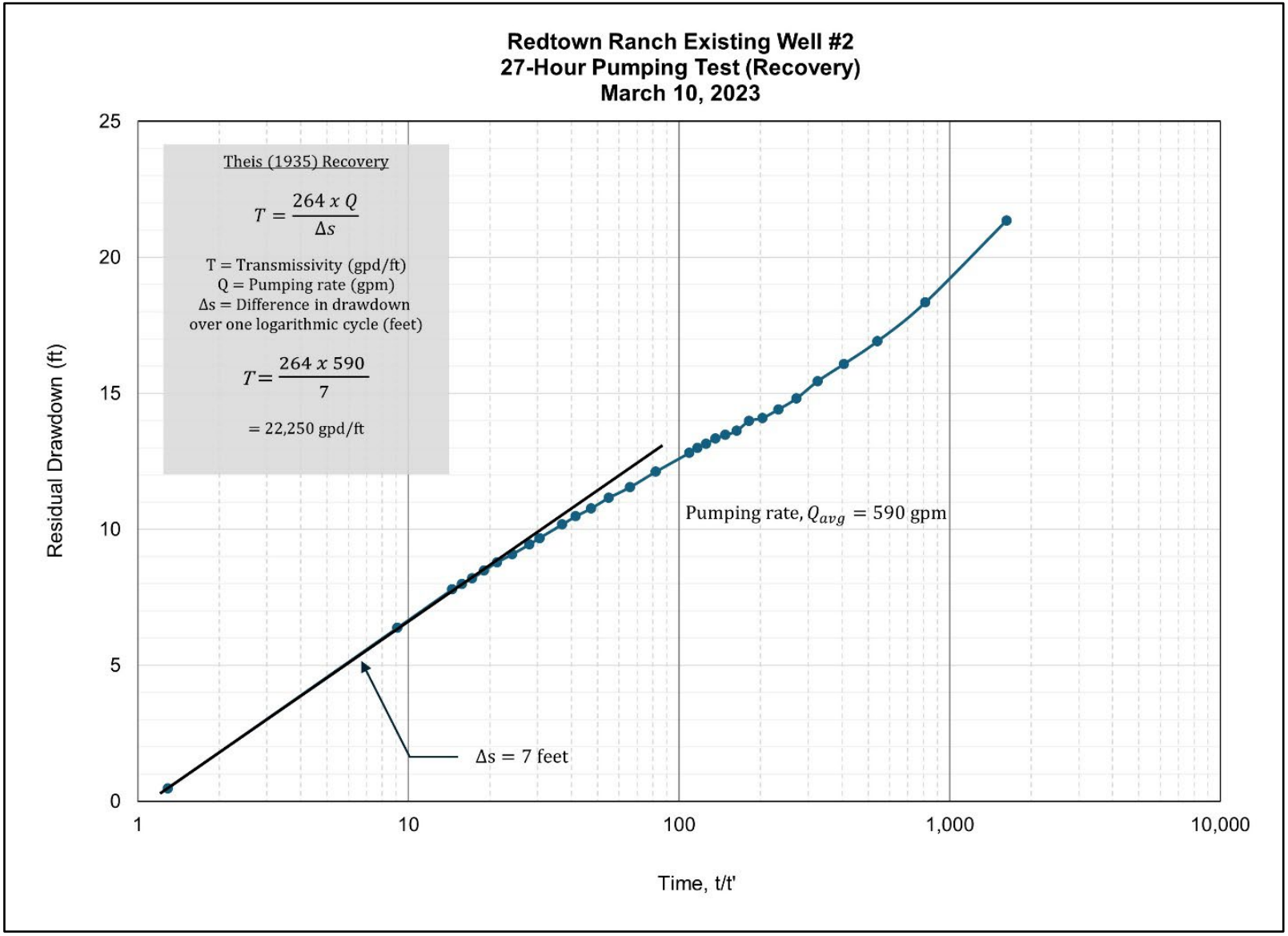
Appendix C

Aquifer Test Results from Redtown Ranch Well #2 and #3

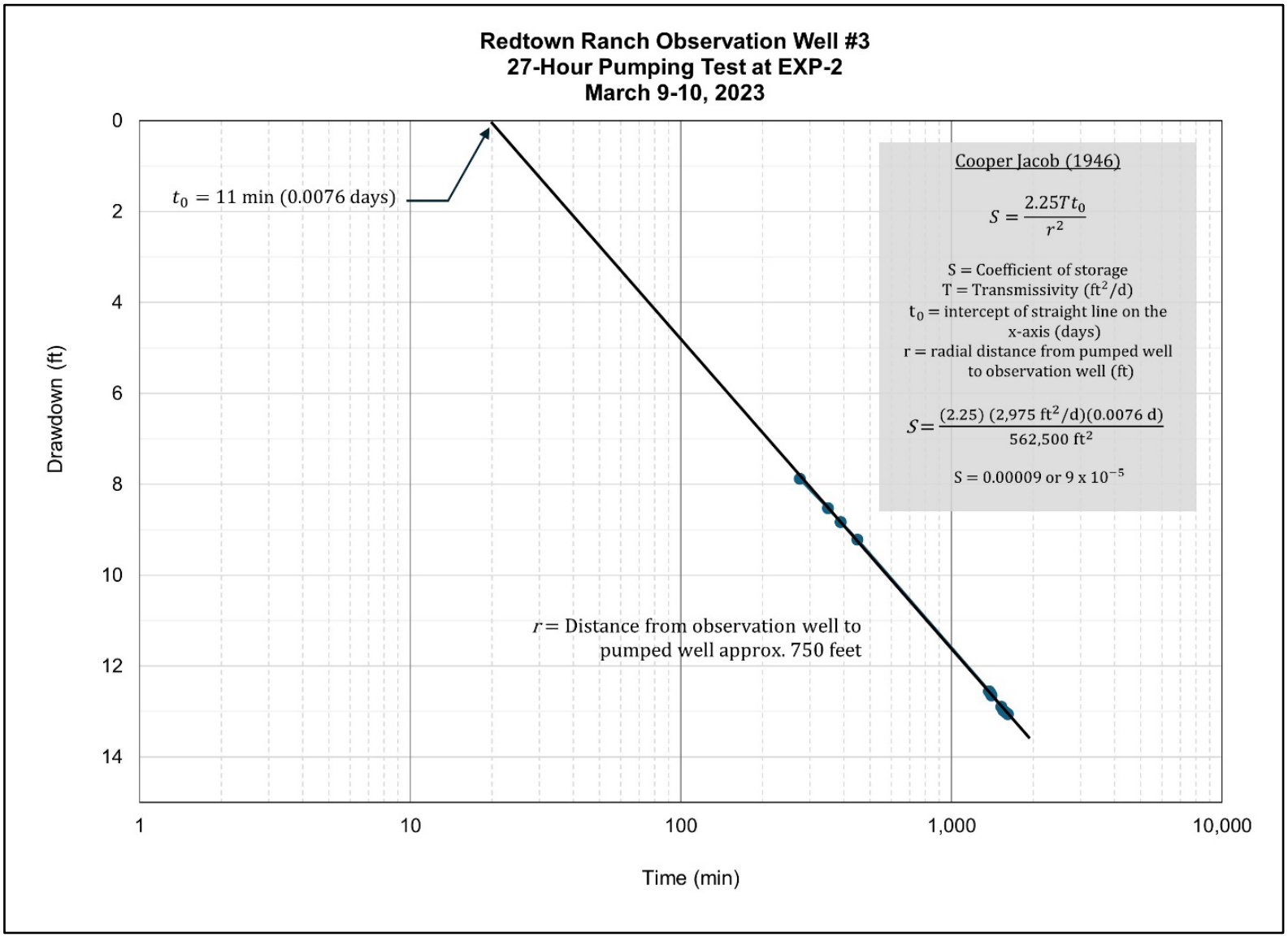
Appendix C – Time-Drawdown Graph for Redtown Ranch Well #2



Appendix C – Recovery Graph for Redtown Ranch Well #2



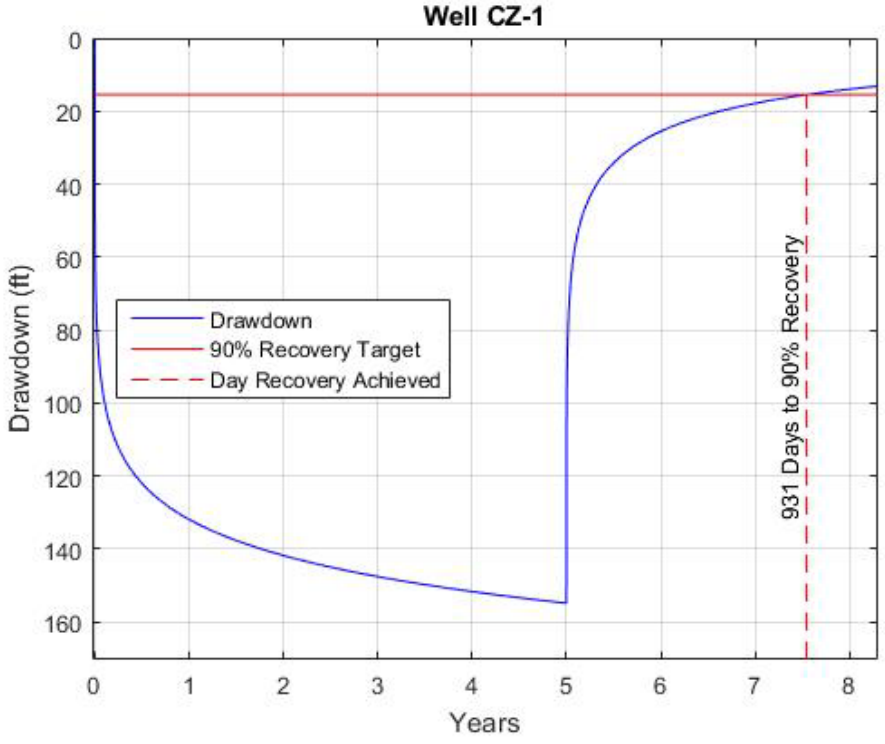
Appendix C – Time-Drawdown Graph for Redtown Ranch Well #3 (Observation Well)

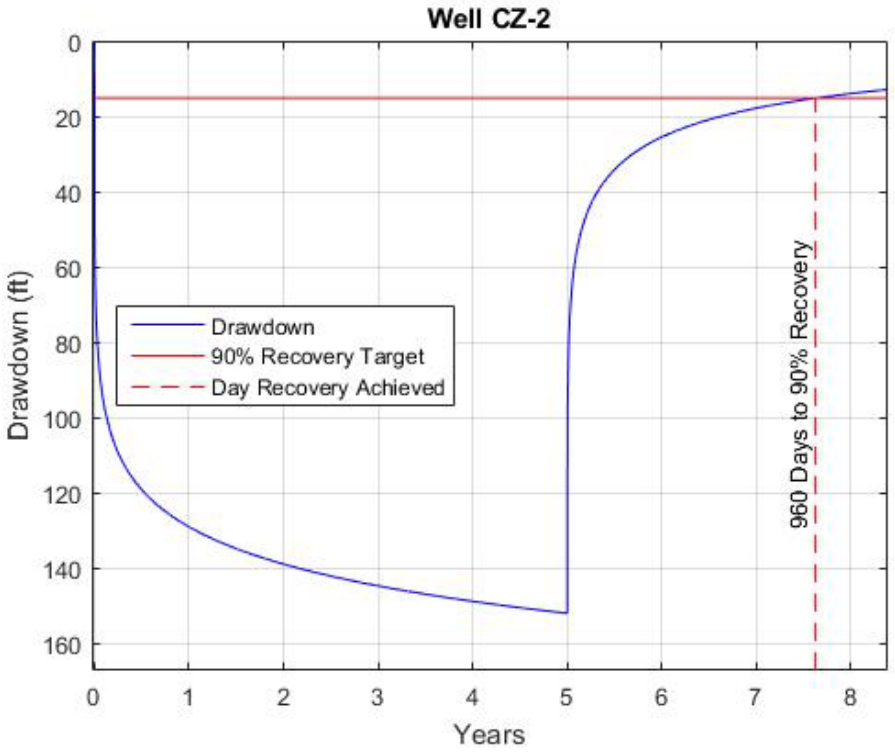


Appendix D

Pumping and Recovery Hydrographs from Analytical Modeling

Appendix D – Pumping and Recovery Hydrographs





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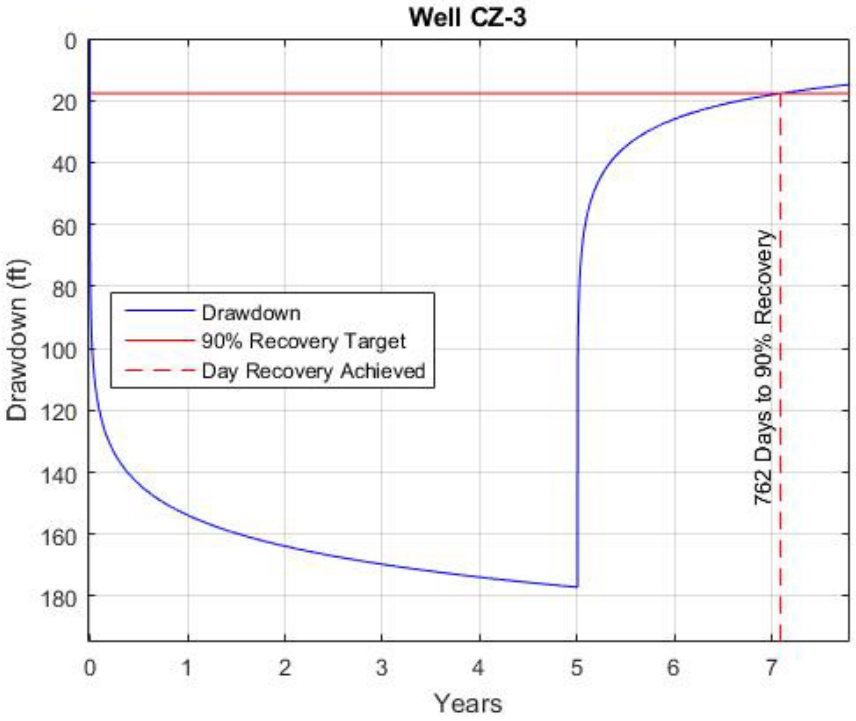

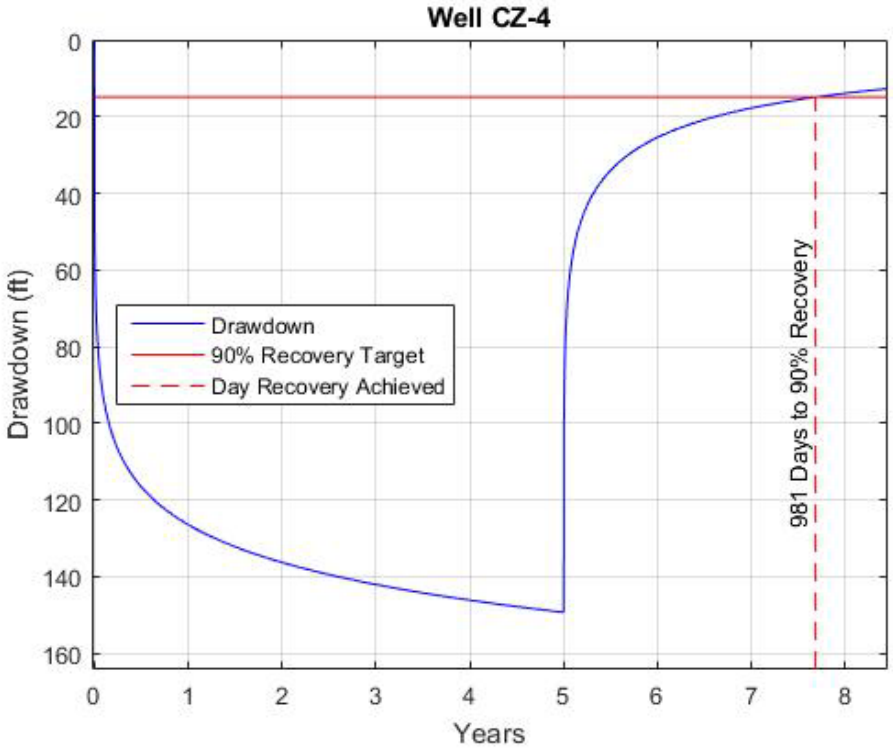

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