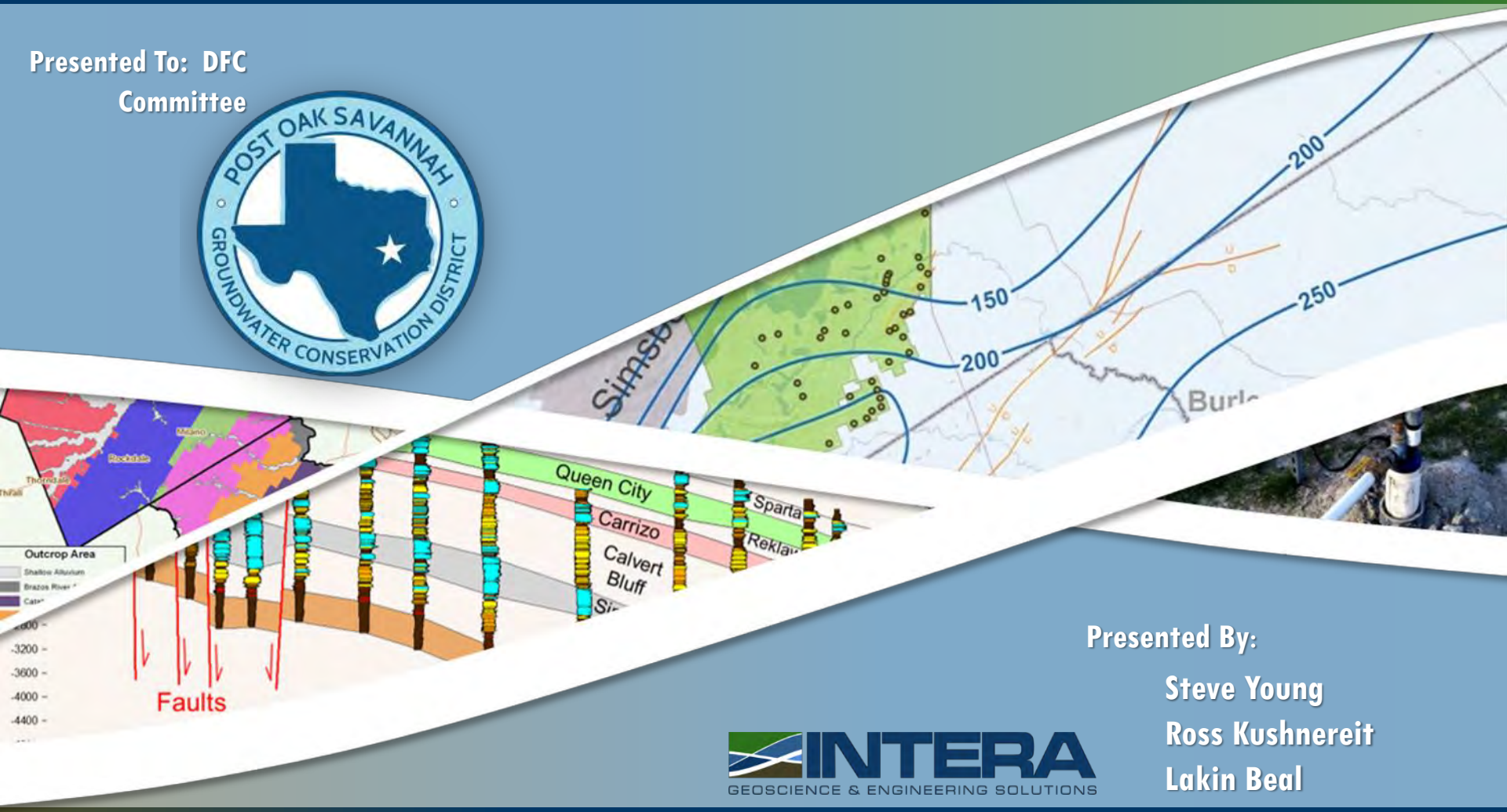
Desired Future Conditions Committee Update

Presented To: DFC Committee



Presented By:

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INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

October 11, 2022

Agenda

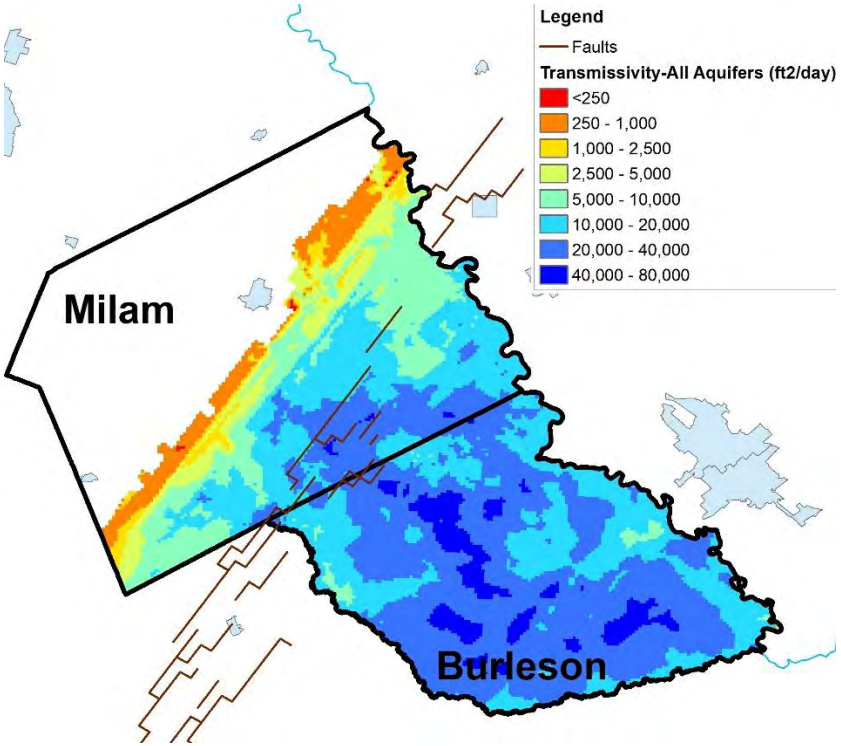
- Fair Share
- Preliminary 2022 DFC & PDL Compliance Evaluations
- Updates to Tops and Bottoms for the Carrizo Wilcox Aquifer
- Guidance for Drilling Water Wells in the Carrizo Wilcox Aquifer
- Post Oak Savannah Operational Model

Fair Share

Production Capacity in POSGCD

Aquifers	Production Capacity		Aquifer Property	
	Amount*	Percent	Area (mi^2)	Average Transmissivity (ft^2/day)
Upper Trinity	17	1	807	211
Lower Trinity	14	1	807	591
Sparta	62	3	577	1,066
Queen City	97	4	753	1,286
Carrizo	181	8	832	2,178
Calvert Bluff	179	8	1,025	1,747
Simsboro	1,583	68	1,128	14,035
Hooper	109	5	1,234	885
Yegua Jackson	90	4	368	2,440

* area x average transmissivity

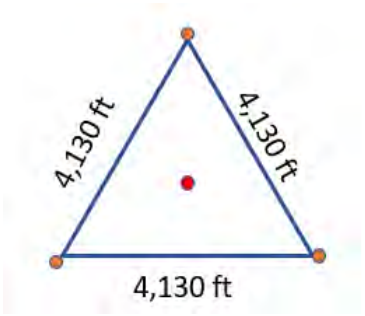


Key Observations

- Average production capacity among aquifers varies by a factor of 10
- Within each aquifer the production capacity can vary by a factor of 5
- A 2 acre-ft/ac production allotment is not physical possible for aquifers
- Prudent aquifer management includes adjusting the production allotment to the aquifer different hydrogeologic conditions

Approach to Estimate Maximum Production Allotment

- Hypothesize a well field of 5,000 acres
  - 2 ac-ft/ac = 10,000 AFY (6,195 gpm)
  - Three wells pumping 2,065 gpm spaced 2 ft/gpm



- Extract Aquifer Properties from Operational Model (August 2021)
- Simulate Drawdown Impact for the Hypothetical Well Field using a Theis-based Groundwater Model
- Compare Simulated Drawdown obtain from Model Simulation to Estimated Water Column Above Top of Aquifer

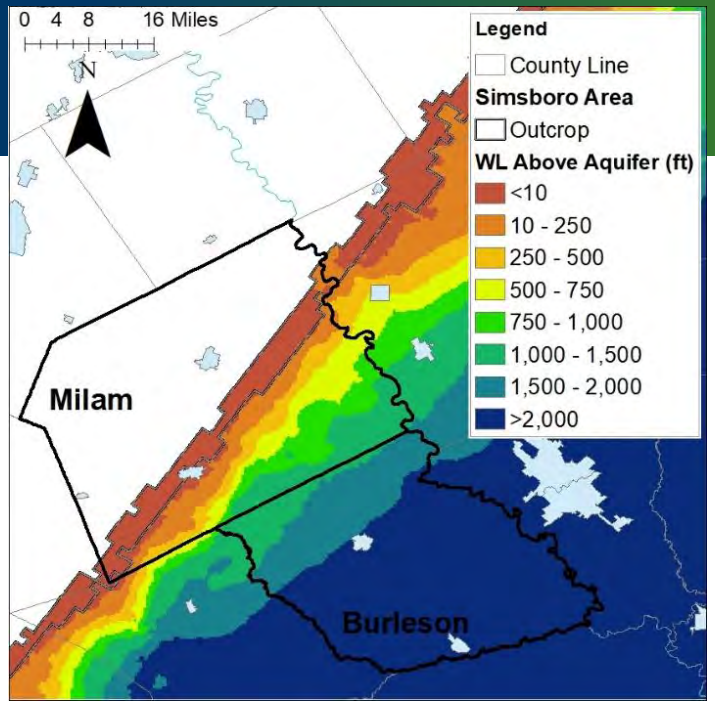
$$\text{Ratio} = \frac{\text{Drawdown}}{\text{Available Drawdown}}$$

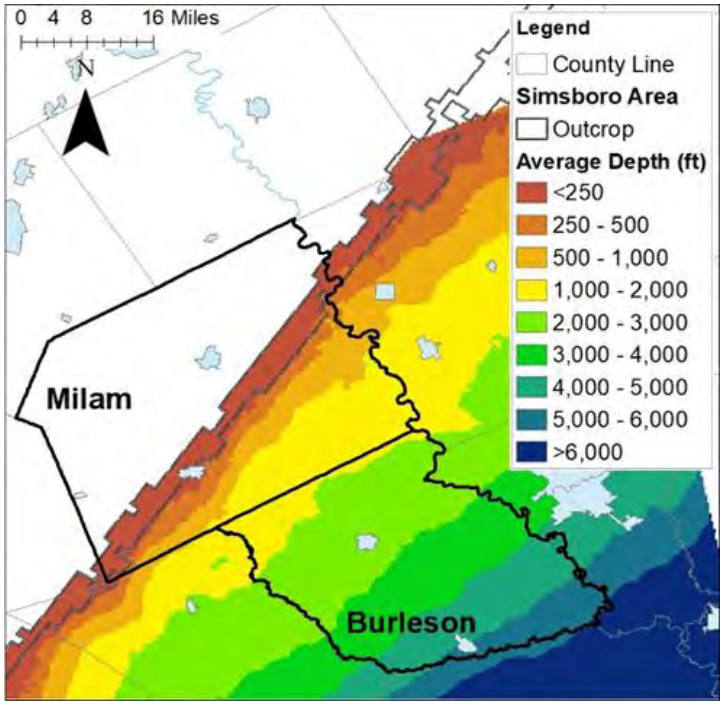
Ratio << 1 Well field is viable

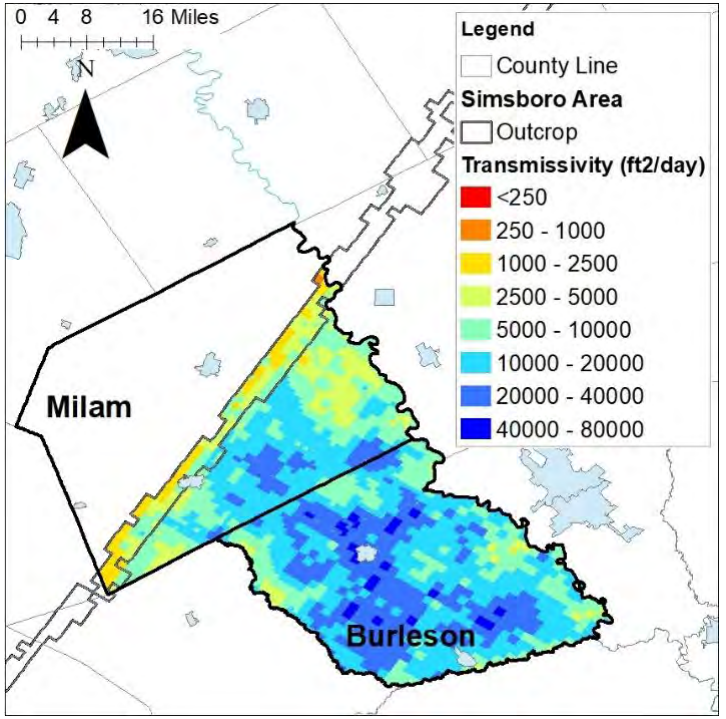
Ratio >> 1 Well field is not viable

Obtaining Aquifer Properties from Operational Model

- Partition into Each Aquifer int Zones based on Depth(ft)
  - < 250 ft
  - 250 to 500
  - 500 to 1000
  - 1000 to 2000
  - 2000 to 3000
- Each Zone
  - Transmissivity
  - Storativity
  - Water level above top of Aquifer



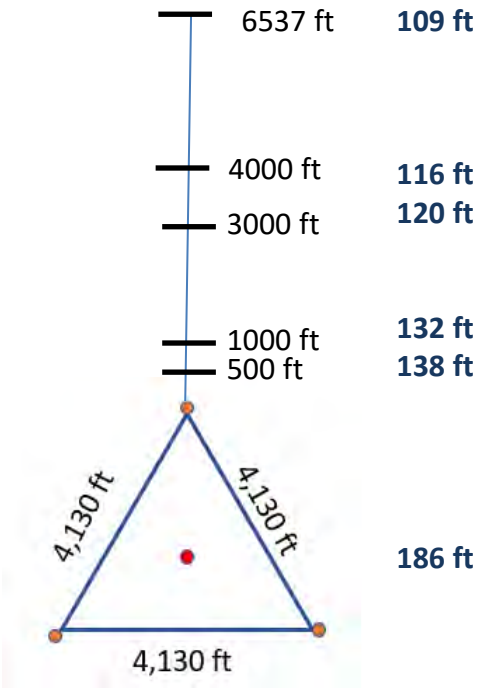


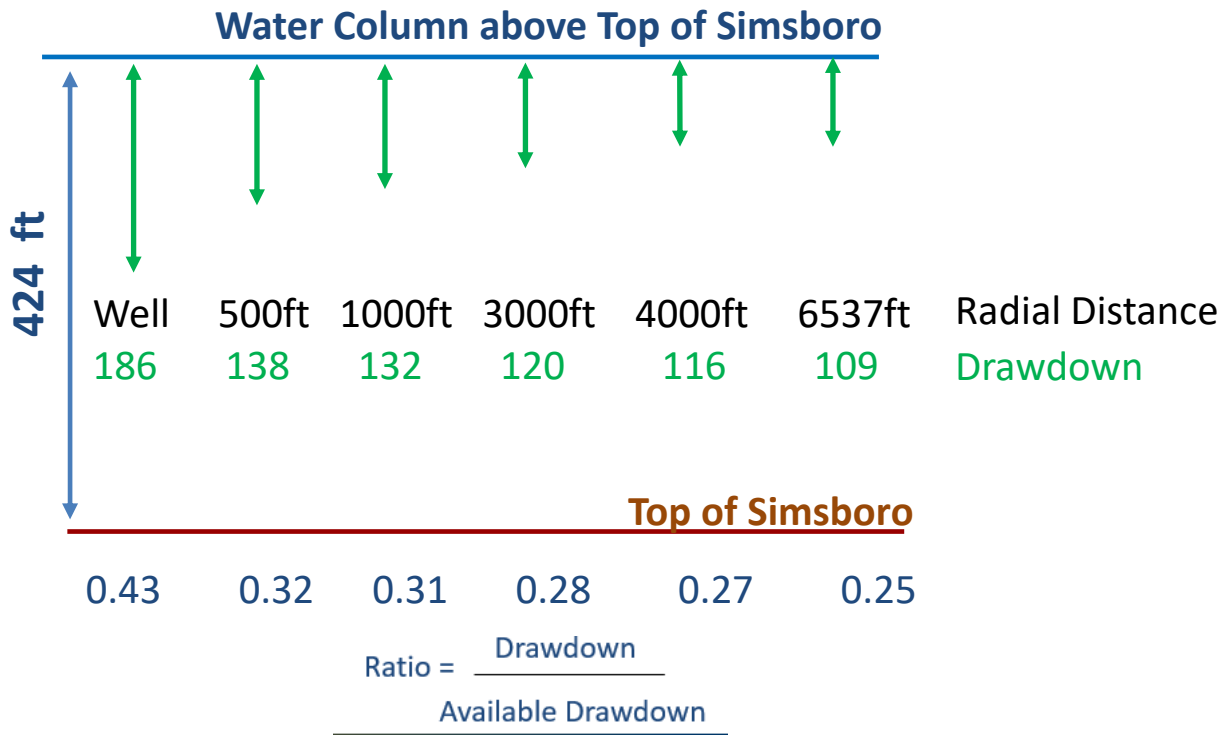


Simulate Drawdown After 5-years of Pumping: Simsboro Example @ 2 Acre-ft/Acre

Aquifer	Depth of Aquifer	Available Drawdown (ft)	Simulated Drawdown					
			Pumping Well	Radial Distance from Well				
				500 ft	1000 ft	3000 ft	4000 ft	6537 ft
Simsboro	0 to 250	-61	223	145	135	116	110	99
	250 to 500	67	154	111	105	95	91	85
	500 to 1000	424	186	138	132	120	116	109
	1000 to 2000	1089	125	95	91	84	82	78
	2000 to 3000	2026	105	81	78	72	71	67

Simulated Drawdown for Simsboro (depth= 500 to 1000 ft)





Impact Matrix for 5-years of Pumping based on Different Maximum Production Allocations

Aquifer	Depth (ft)	2 af/ac			1 af/ac			0.5 af/ac			0.25 af/ac			0.125 af/ac		
		Well	3000 ft	6537 ft	Well	3000 ft	6537 ft	Well	3000 ft	6537 ft	Well	3000 ft	6537 ft	Well	3000 ft	6537 ft
Sparta	0 to 250	8.1	3.9	***3.2***	4.1	1.9	***1.6***	2.0	1.0	0.8	1.0	0.5	0.4	0.5	0.2	0.2
	250 to 500	25.1	13.6	***11.7***	12.6	6.8	***5.9***	6.3	3.4	***2.9***	3.1	1.7	***1.5***	1.6	0.9	0.7
	500 to 1000	6.4	3.7	***3.3***	3.2	1.9	***1.6***	1.6	0.9	***0.8***	0.8	0.5	***0.4***	0.4	0.2	0.2
	1000 to 2000	2.2	1.3	***1.2***	1.1	0.7	***0.6***	0.5	0.3	0.3	0.3	0.2	0.1	0.1	0.1	0.1
	2000 to 3000	2.3	1.4	***1.3***	1.2	0.7	***0.6***	0.6	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0.1
Queen City	0 to 250	8.4	4.0	***3.3***	4.2	2.0	***1.7***	2.1	1.0	0.8	1.1	0.5	0.4	0.5	0.3	0.2
	250 to 500	12.8	7.1	***6.2***	6.4	3.6	***3.1***	3.2	1.8	***1.6***	1.6	0.9	0.8	0.8	0.4	0.4
	500 to 1000	2.9	1.8	***1.6***	1.5	0.9	***0.8***	0.7	0.4	0.4	0.4	0.2	0.2	0.2	0.1	0.1
	1000 to 2000	1.7	1.1	***0.9***	0.9	0.5	***0.5***	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1
	2000 to 3000	1.5	0.9	***0.9***	0.8	0.5	***0.4***	0.4	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
Carrizo	0 to 250	8.9	4.2	***3.4***	4.4	2.1	***1.7***	2.2	1.1	0.9	1.1	0.5	0.4	0.6	0.3	0.2
	250 to 500	4.5	2.6	***2.2***	2.2	1.3	***1.1***	1.1	0.6	0.6	0.6	0.3	0.3	0.3	0.2	0.1
	500 to 1000	1.7	1.1	***0.9***	0.9	0.5	***0.5***	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1
	1000 to 2000	0.6	0.4	0.4	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
	2000 to 3000	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Calvert Bluff	0 to 250	7.9	3.8	***3.1***	3.9	1.9	***1.6***	2.0	0.9	0.8	1.0	0.5	0.4	0.5	0.2	0.2
	250 to 500	8.1	4.7	***4.1***	4.1	2.3	***2.1***	2.0	1.2	1.0	1.0	0.6	0.5	0.5	0.3	0.3
	500 to 1000	2.3	1.4	***1.3***	1.2	0.7	***0.7***	0.6	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0.1
	1000 to 2000	1.1	0.7	***0.6***	0.6	0.3	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.0	0.0
	2000 to 3000	1.5	0.9	***0.8***	0.7	0.5	***0.4***	0.4	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
Simsboro	0 to 250	3.0	1.5	1.3	1.5	0.8	***0.7***	0.7	0.4	0.3	0.4	0.2	0.2	0.2	0.1	0.1
	250 to 500	2.1	1.3	1.1	1.0	0.6	***0.6***	0.5	0.3	0.3	0.3	0.2	0.1	0.1	0.1	0.1
	500 to 1000	0.4	0.3	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
	1000 to 2000	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2000 to 3000	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hooper	0 to 250	12.3	5.7	***4.6***	6.2	2.8	***2.3***	3.1	1.4	1.1	1.5	0.7	0.6	0.8	0.4	0.3
	250 to 500	17.3	9.5	***8.2***	8.6	4.8	***4.1***	4.3	2.4	***2.1***	2.2	1.2	1.0	1.1	0.6	0.5
	500 to 1000	4.0	2.4	***2.1***	2.0	1.2	***1.1***	1.0	0.6	***0.5***	0.5	0.3	0.3	0.2	0.1	0.1
	1000 to 2000	1.6	1.0	***0.9***	0.8	0.5	***0.4***	0.4	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
	2000 to 3000	1.0	0.6	***0.6***	0.5	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.0	0.0

$$\text{Ratio} = \frac{\text{Drawdown}}{\text{Available Drawdown}}$$

Color								
Ratio	0 - 0.25	0.25 - 0.5	0.5 - 0.75	0.75 - 1	1.0 - 2.0	2.0 - 4.0	4.0 - 8.0	8.0 - 16.0	16.0 - 32.0

Possible Implementation Approach: Technical

Maximum Production Allocation for any parcel is 2.5 acre-ft/acre

Maximum production allocation can vary among aquifers and can vary spatially within an Aquifer

- Production Allocations for Carrizo-Wilcox Aquifers
  - Outcrop and less than 250 feet thickness: minimum rate
  - Increase allocations based on aquifer depth and aquifer thickness
  - Include a threshold production rate
  - Perform additional evaluations with different productions other than 10,000 AFY

Aquifer	Production Allocation (ac-ft/acre)	
	Minimum	Maximum
Yegua Jackson	0.25	0.25
Sparta	0.25	0.25
Queen City	0.25	0.25
Carrizo	0.25	0.75
Calvert Bluff	0.25	0.5
Simsboro	0.5	2
Hooper	0.25	0.5

Possible Implementation Approach: Legal

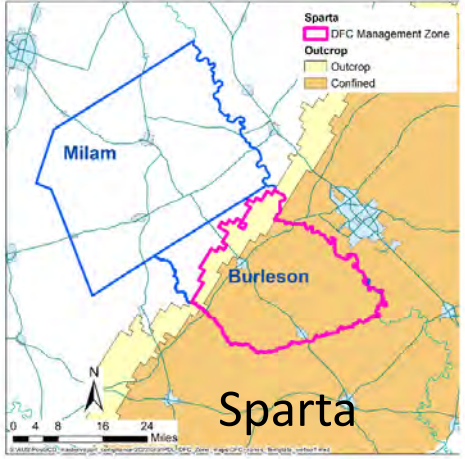
- Incorporate modifications as part of the curtailment actions in response to Threshold exceedances for DFC
- Incorporate modifications as part readjustments during 5-renewal process
- Establish a future time when modifications will go into effect based on termination of most recent 40-year permit

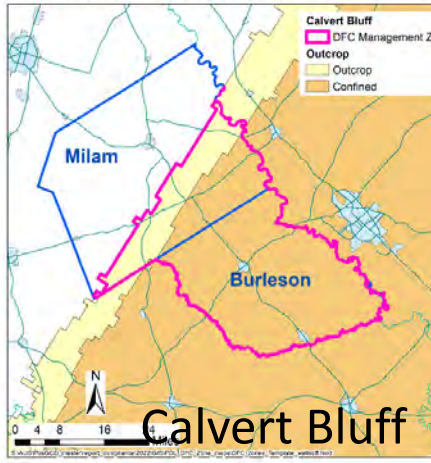
Preliminary 2022 DFC & PDL Compliance Evaluations

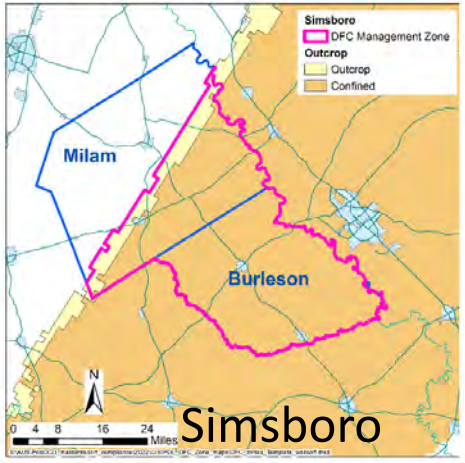
DFC Management Zones

- Spans the aquifer footprint within the District
- Yegua-Jackson and Brazos Valley Alluvium not shown

Aquifer	2070 Drawdown
Sparta	32
Queen City	30
Carrizo	146
Upper Wilcox (Calvert Bluff Fm)	156
Middle Wilcox (Simsboro Fm)	278
Lower Wilcox (Hooper Fm)	178



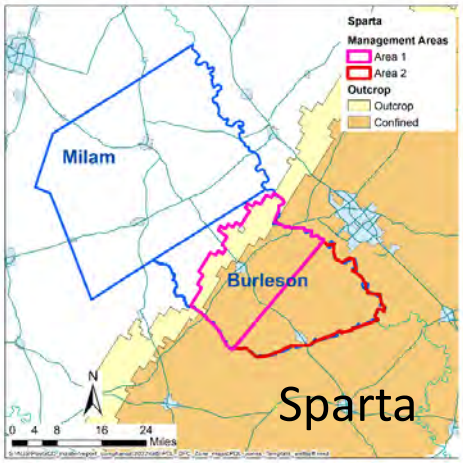


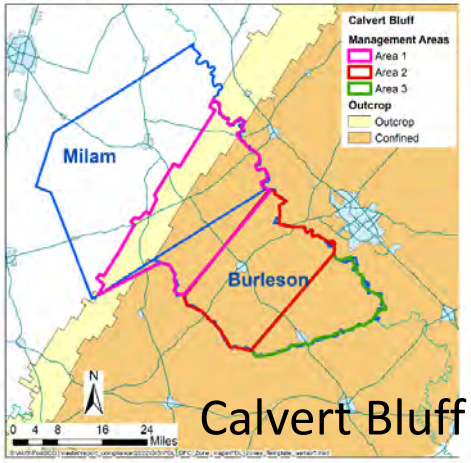


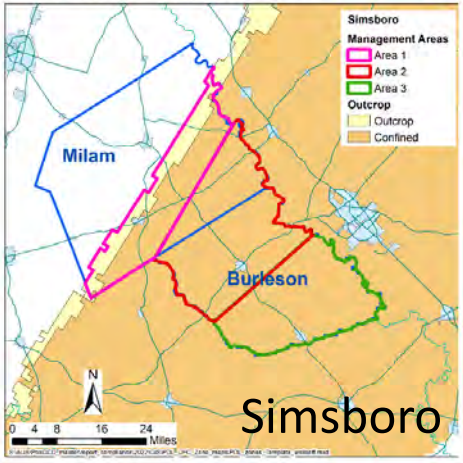
PDL Management Areas

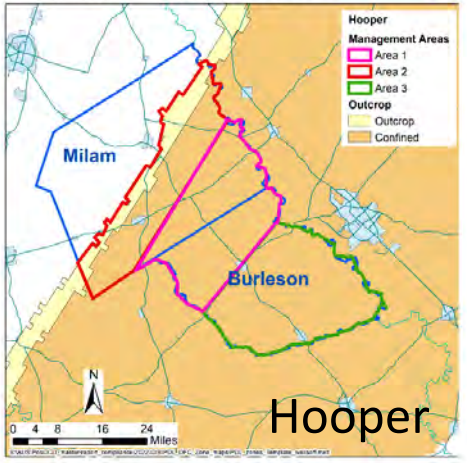
- Management Zones has been partitioned into Management Areas
- Only Management Areas with sufficient monitoring wells are have PDLs

Management Area		2070 Drawdown
Sparta	Area 1	28
Queen City	Area 1	75
Carrizo	Area 1	75
	Area 2	175
Calvert Bluff (Upper Wilcox)	Area 1	88
	Area 2	223
Simsboro (Middle Wilcox)	Area 1	91
	Area 2	335
Hooper (Lower Wilcox)	Area 1	210



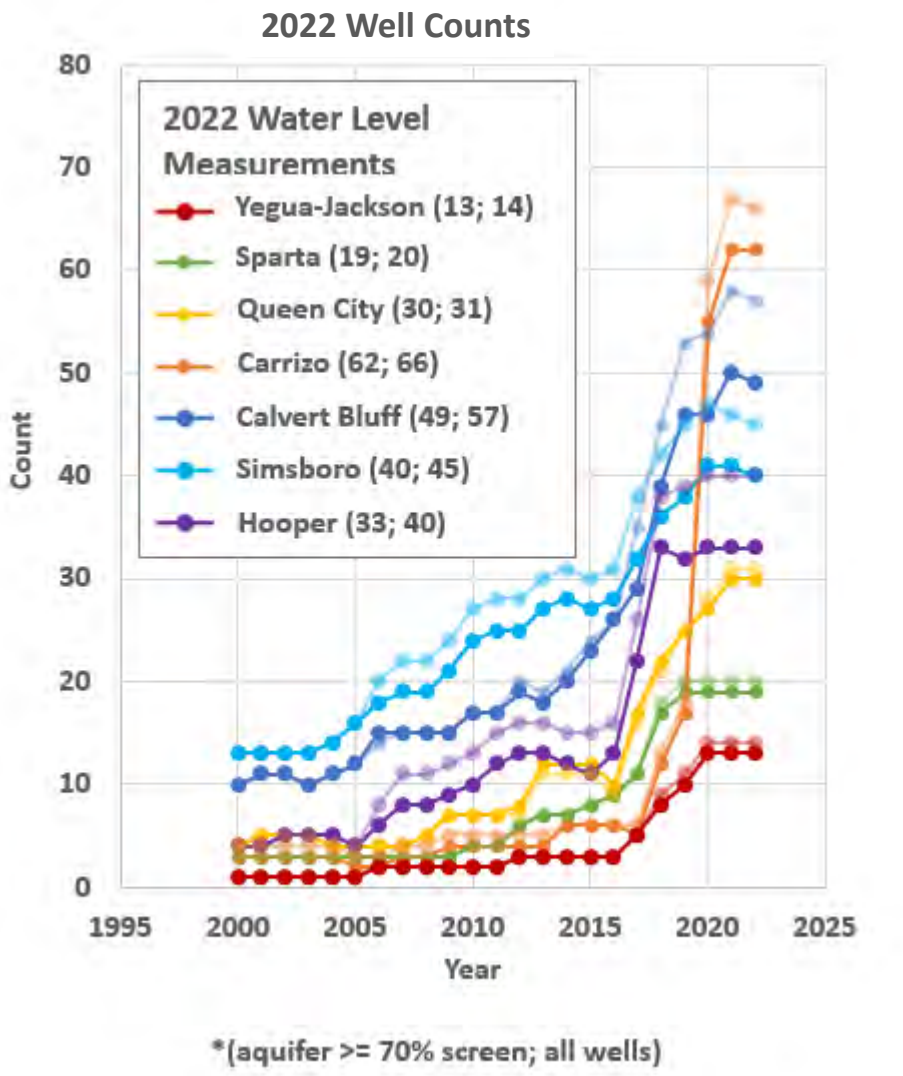






POSGCD Wells Used in Current Analysis

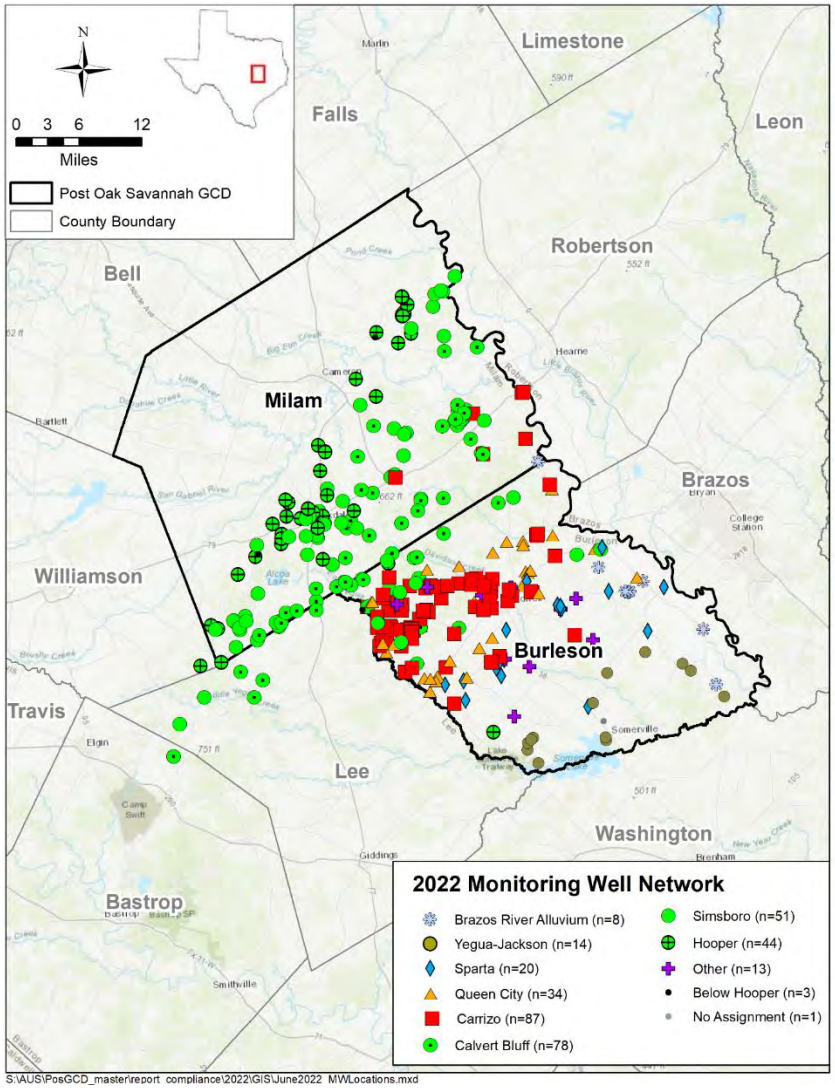
- Primary aquifers are based on the amount (>=70%) that the screen intervals intercept an aquifer
- Only wells with a primary aquifer assignment are used in DFC/PDL evaluations
- Well Count for Aquifers*
  - >70% (246)
  - All wells with WLs (273)



* Excludes Yegua Jackson, Brazos River, Cook Mountain, Reklaw, & Weches

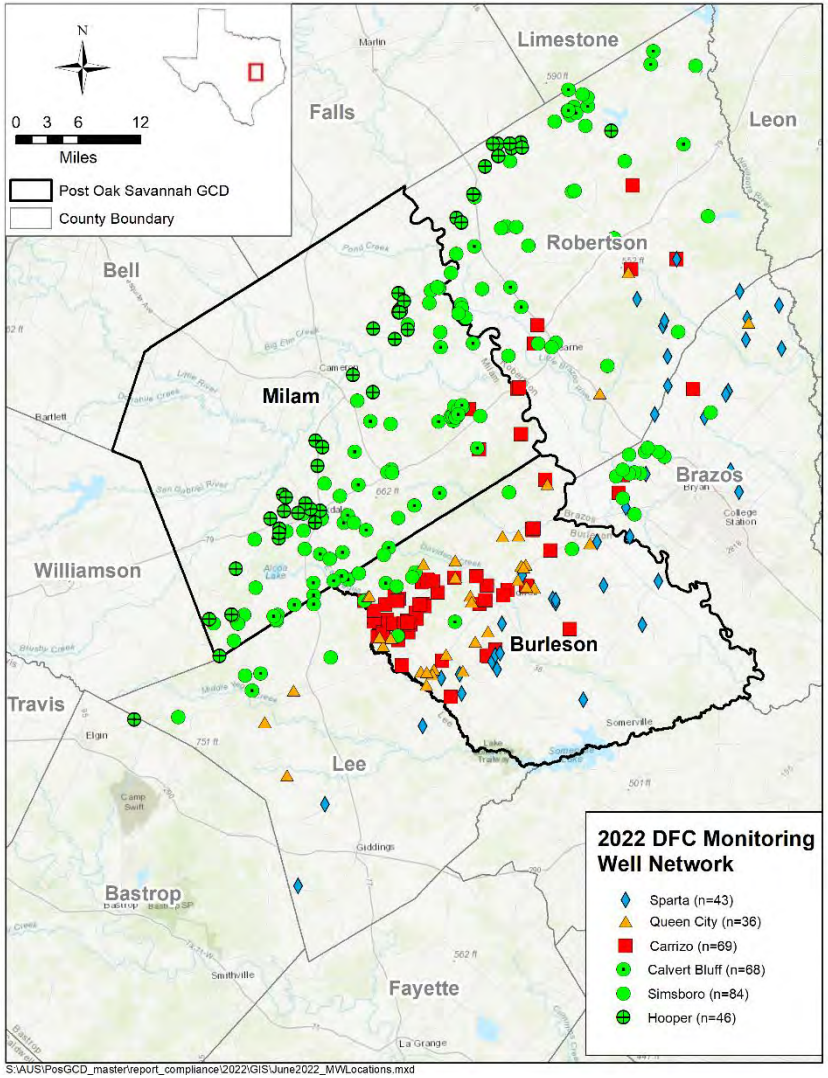
2022 Monitoring Network

2022 POSGCD (353 Count)*



* Active monitoring well

2022 POSGCD, LPGCD, BVGCD (349 Count*)



* POSGCD wells >70% coverage , well used for DFC/PDF calculations

Interpolation of Measured Water Levels to Generate Continuous Surfaces

- Water Level Measurements
  - Measurements limited to January 1 to April 31st
  - Includes continuous measurements from transducer and WellIntel

- Data Interpolation Methods
  - Topo2Raster (method for land surface) [1]
  - Kriged Water Levels (method with no spatial trend)[2]
  - Kriged Residuals (method that accounts for spatial trend)[3]

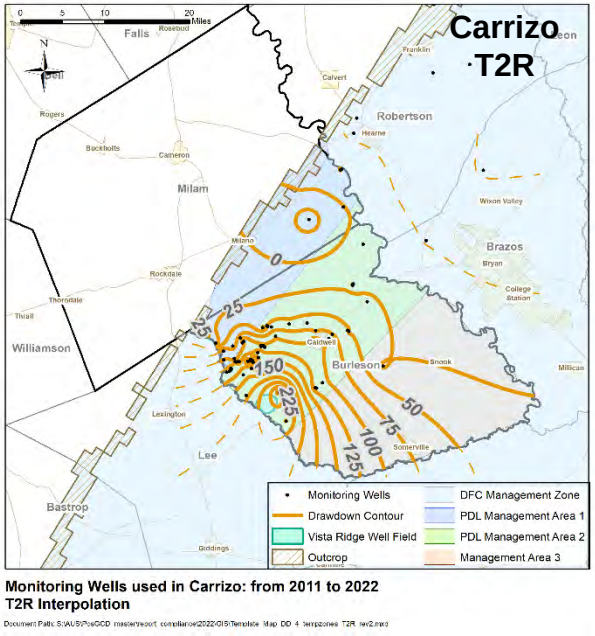
[1] Previous Methos method

[2] Kriged Water Levels are based on geostatistical analysis of data

[3] Kriged Residuals is based on geostatistical analysis of data and groundwater modeling

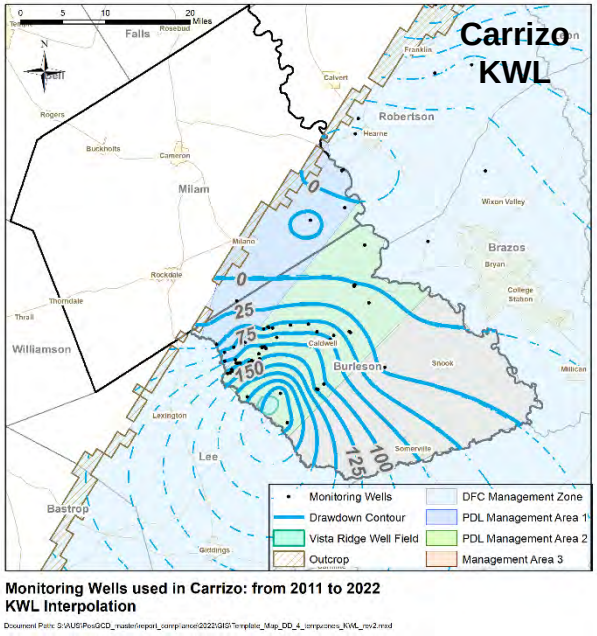
Three Methods to Estimate Drawdown Surface

Topo to Raster (T2R)



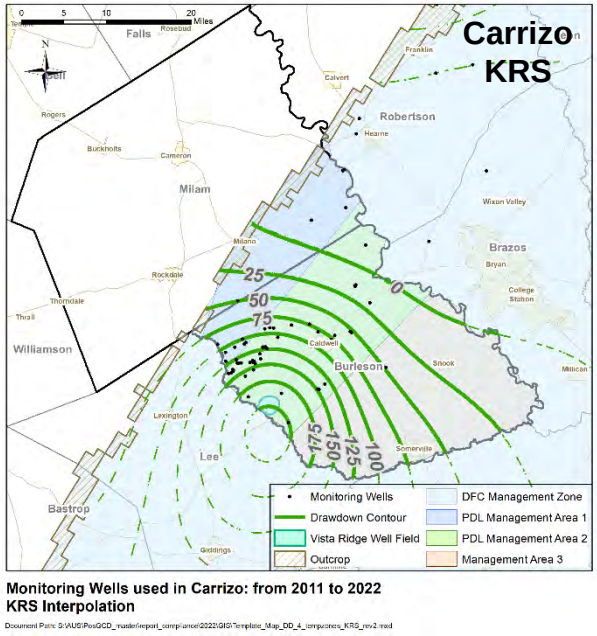
Monitoring Wells used in Carrizo: from 2011 to 2022
T2R Interpolation

Kriged Water Levels (KWL)



Monitoring Wells used in Carrizo: from 2011 to 2022
KWL Interpolation

Kriged Residuals (KRS)

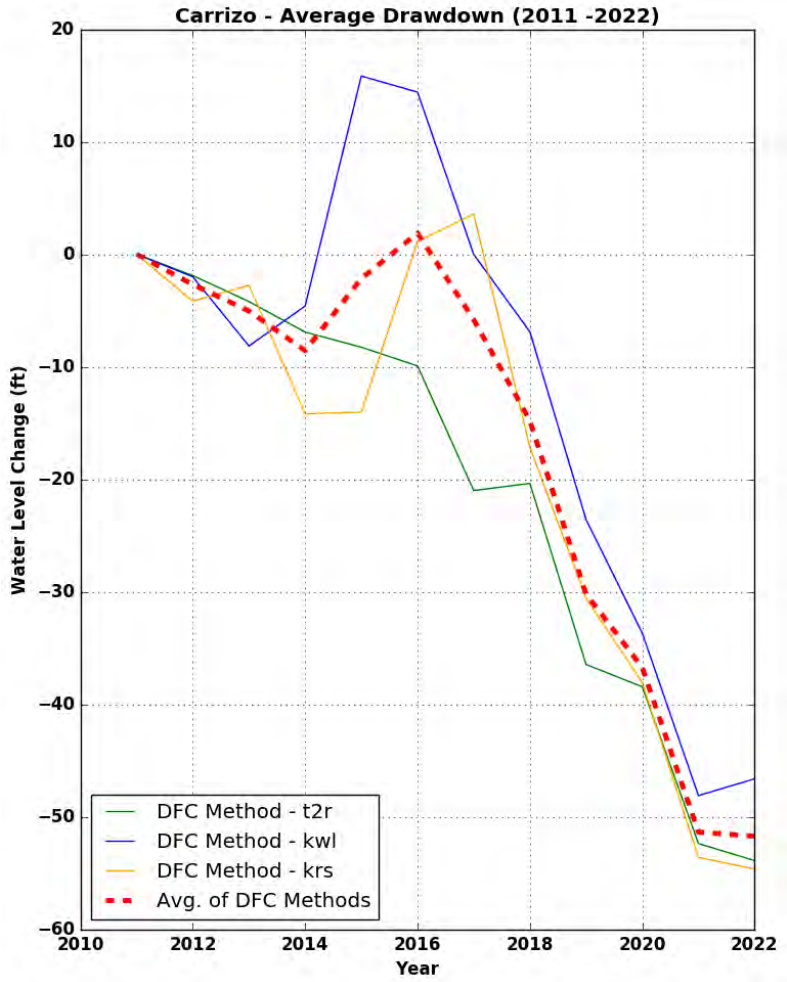


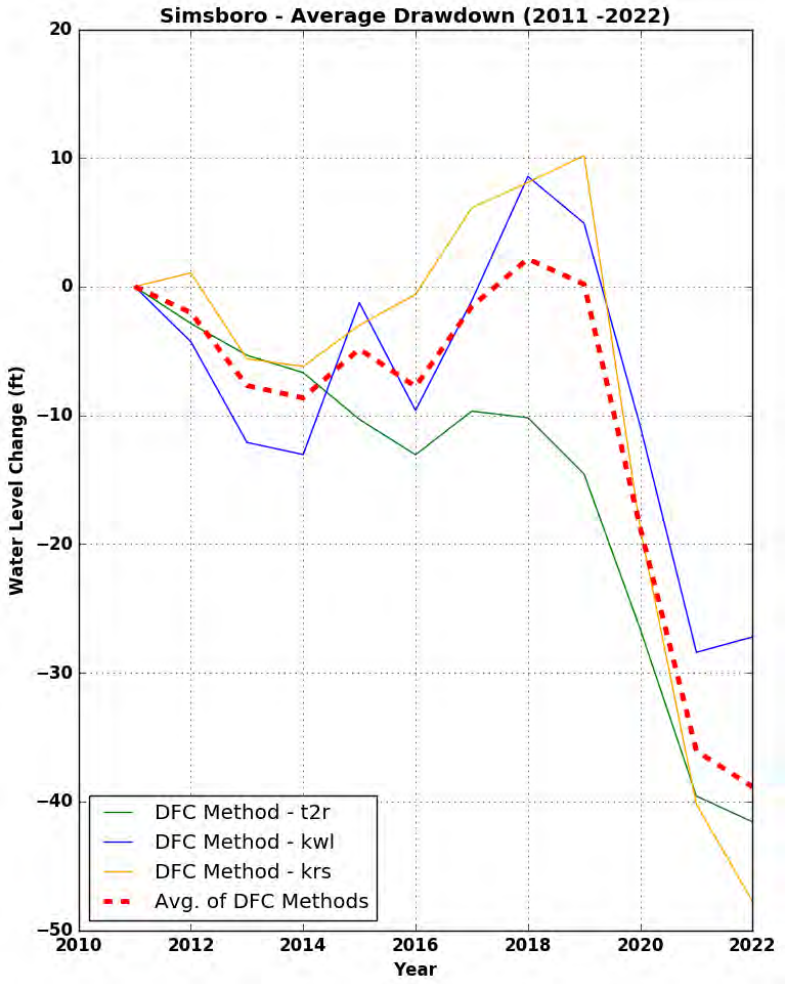
Monitoring Wells used in Carrizo: from 2011 to 2022
KRS Interpolation

The average drawdown surface value is taken for each method over the period from 2011 to 2020

Three Methods to Estimate Drawdown from 2011

The average drawdown of all three method is used to determine the compliance





Criteria For Exceedance

- Average Drawdown Exceeds a Threshold Value
- Drawdowns for Two out Three Methods Exceed a Threshold Value

Two Hypothetical Examples to Demonstrate Criteria

DFC	Example 1			Overall Complaince
	Method	Determined Value	Exceedance	
100	#1	59.0	Theshold 1	No Threshold is Exceeded
	#2	48.0	None	
	#3	47.0	None	
	Average Value	51.3	Theshold 1	
	% of DFC	51.3%	Theshold 1	

DFC	Example 2			Overall Complaince
	Method	Determined Value	Exceedance	
100	#1	59.0	Theshold 1	Threshold 1 is Exceeded
	#2	48.0	None	
	#3	52.0	Theshold 1	
	Average Value	53.0	Theshold 1	
	% of DFC	53.0%	Theshold 1	

Threshold 1 = 50% DFC
Threshold 2 = 60% DFC
Threshold 3 = 75% DFC

Preliminary DFC Compliance 2022 Evaluation

Management Zone	DFC	Drawdown Calculations	Threshold Criteria	Compliant With DFC
		Avg. Drawdown (ft) / % of DFC	Avg Drawdown	
		# Methods > Threshold 1	# Methods	
Sparta	32	12.0 (37.6%)	No Threshold Reach	Yes
		1	No Threshold Reach	
Queen City	30	11.3 (37.8%)	No Threshold Reach	Yes
		1	No Threshold Reach	
Carrizo	146	41.2(28.2%)	No Threshold Reach	Yes
		0	No Threshold Reach	
Calvert Bluff (Upper Wilcox)	156	44.3 (28.4%)	No Threshold Reach	Yes
		0	No Threshold Reach	
Simsboro (Middle Wilcox)	278	32.2 (11.6%)	No Threshold Reach	Yes
		0	No Threshold Reach	
Hooper (Lower Wilcox)	178	20.7 (11.6%)	No Threshold Reach	Yes
		0	No Threshold Reach	

Threshold 1 = 50% DFC Threshold 2 = 60% DFC Threshold 3 = 75% DFC

Preliminary PDL Compliance 2022 Evaluation

Management Area		PDL	Drawdown Calculations	Threshold Criteria	Compliant with PDL
			Avg. Drawdown (ft) / % of DFC	Avg. Drawdown	
			# Methods > Threshold 1	# Methods	
Sparta	Area 1	28	2.9 (10.2%)	No Threshold Reached	Yes
			0	No Threshold Reached	
Queen City	Area 1	75	0.1 (0%)	No Threshold Reached	Yes
			0	No Threshold Reached	
Carrizo	Area 1	75	29.7 (40%)	No Threshold Reached	Yes
			0	No Threshold Reached	
	Area 2	175	54.5 (31%)	No Threshold Reached	Yes
			0	No Threshold Reached	
Calvert Bluff (Upper Wilcox)	Area 1	88	43.6 (<50%)	No Threshold Reached	Yes
			1	No Threshold Reached	
	Area 2	223	38.0 (17%)	No Threshold Reached	Yes
			0	No Threshold Reached	
Simsboro (Middle Wilcox)	Area 1	91	17.5 (19%)	No Threshold Reached	Yes
			0	No Threshold Reached	
	Area 2	335	40.7 (12%)	No Threshold Reached	Yes
			0	No Threshold Reached	
Hooper (Lower Wilcox)	Area 1	210	11.9 (6%)	No Threshold Reached	Yes
			0	No Threshold Reached	

Threshold 1 = 50% PDL Threshold 2 = 60% PDL Threshold 3 = 75% DFC

Preliminary Compliance 2022 Report Evaluation

- Summary
  - Methodology in Revised Guidance Document Being Used
  - No DFCs exceedance for 2022
  - No PDLs exceedances for 2022
  - Three interpolation methods used for evaluation
    - Agreement is very good for Carrizo and Simsboro
    - Results suggest that compliance criteria could switch from drawdown to average water levels Carrizo and Simsboro

- Yegua-Jackson Aquifer not yet Evaluated
  - DFC is 61 feet (Jan 2010 to Dec 2069)

Updates to Tops and Bottoms for the Carrizo Wilcox Aquifer

Reason for Update

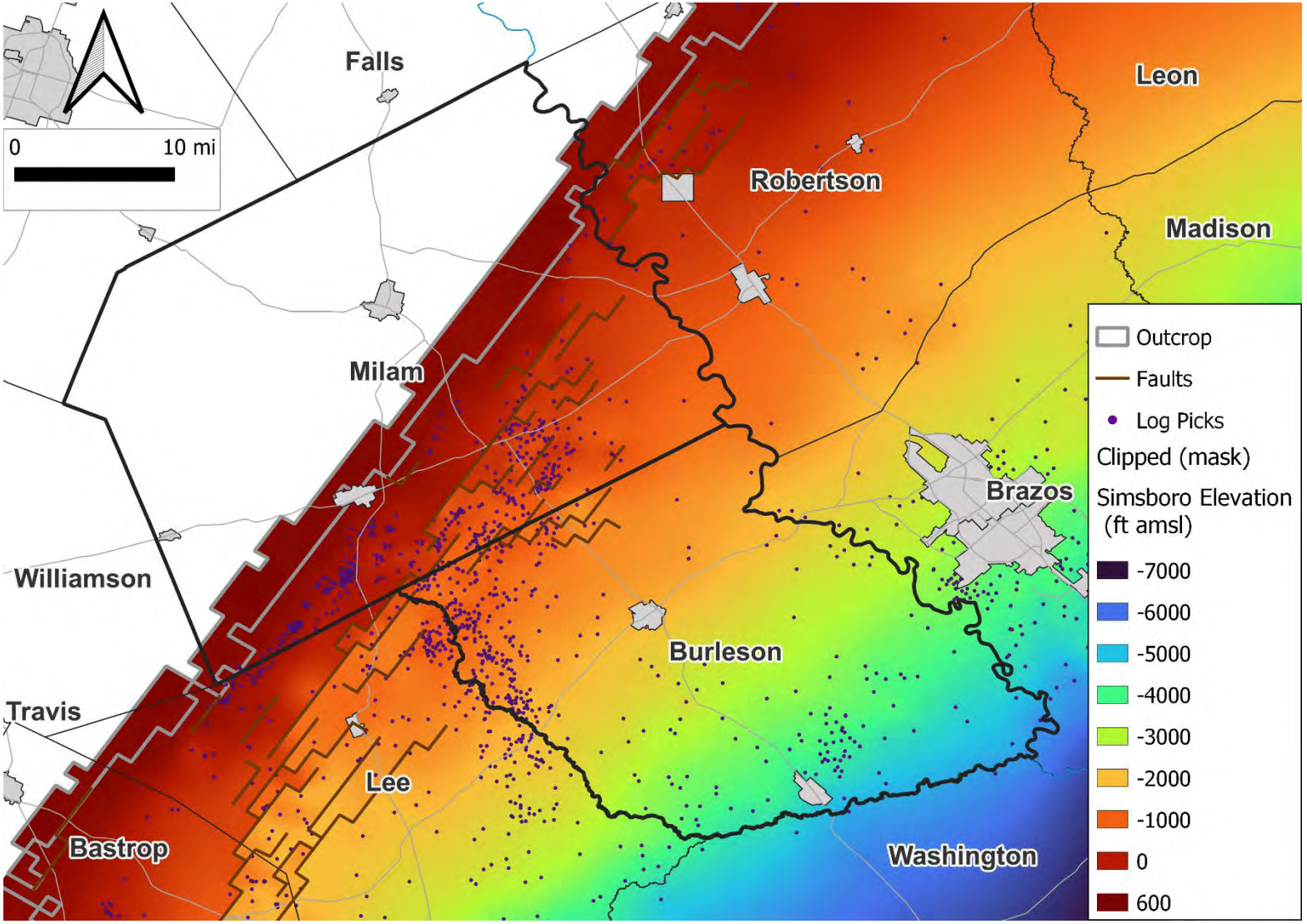
- Existing GAM
  - No documentation on construction of aquifer surfaces from geophysical logs
  - About 300 ft increase in Simsboro thickness in Vista Ridge well field, Gauze Well , and other areas to account for bias is GAM layers
  - Alcoa 0148 permit indicated that numerous Simsboro wells are classified as Calvert Bluff wells based on GAM layering

Analysis of Geophysical Logs

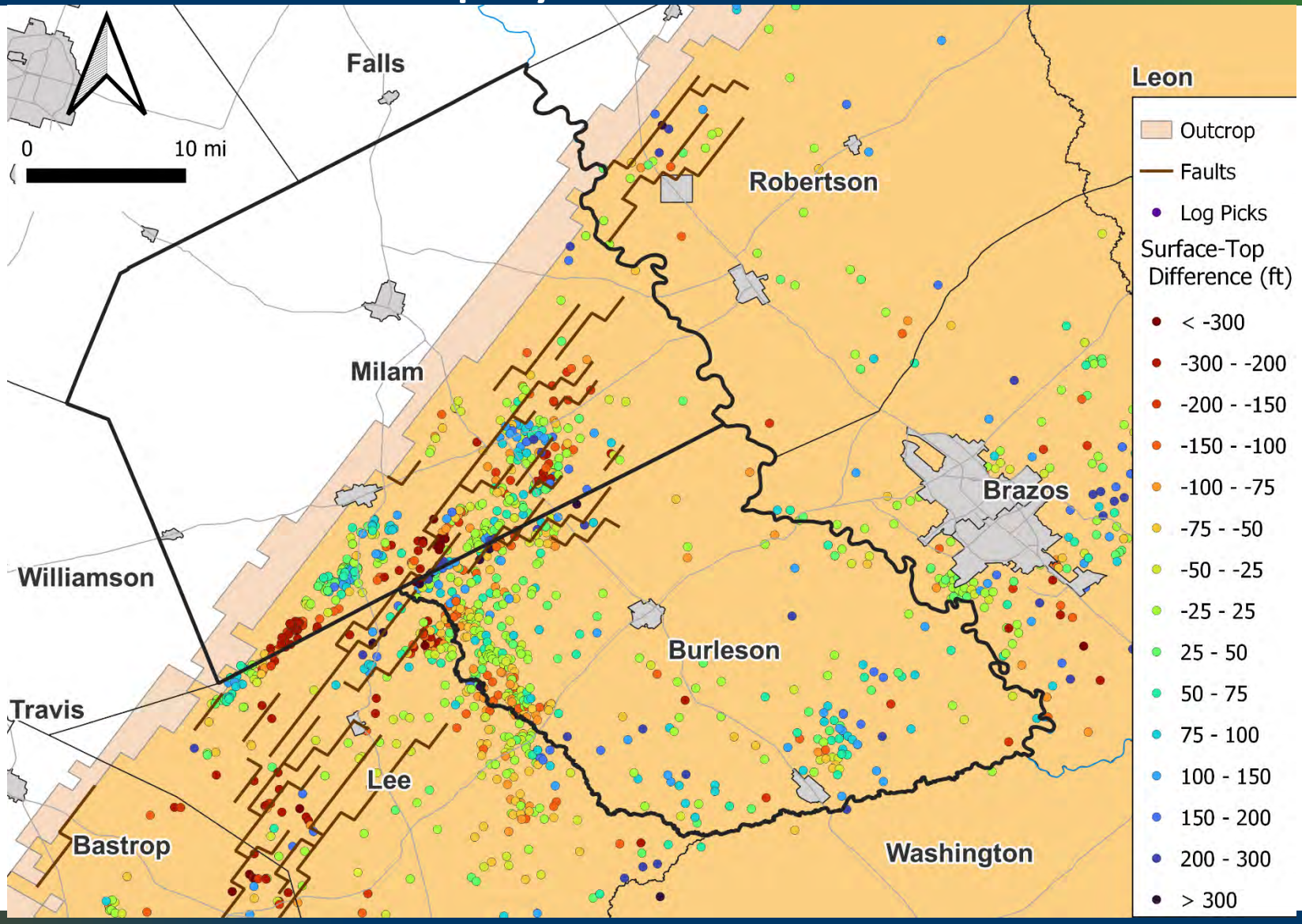
Top of Aquifer	Count as of September 2022
Carrizo	1457
Calvert Bluff	1238
Simsboro	1825
Hooper	1780
Midway	2221

- Builds on Aquifer Stratigraphy Used to Identify Faults for Updated GAM
- Considerable Historical Logs Provided by ALCOA/SLR in 2021
- Reviewed Railroad Commission GW Model for Dewatering the Sandow Mine Region
- Surface geology map from Bureau of Economic Geology
- Recent Hutto wells and SLR Test wells provided key data to fill in major data gaps

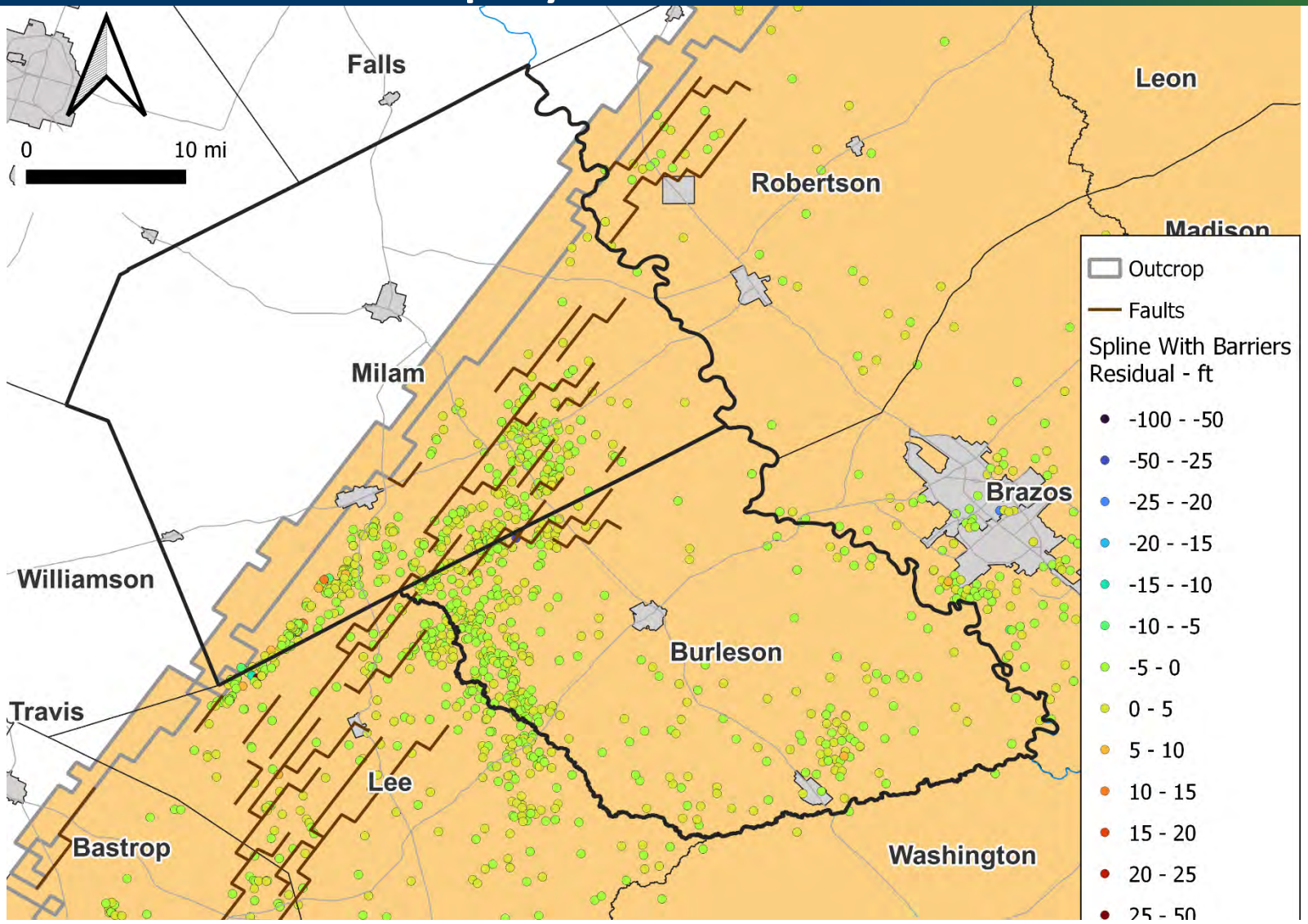
Top of Simsboro Based on Geophysical Logs



Difference between GAM Surface and Geophysical Surface



Difference between GAM Surface and Geophysical Surface



Updated Geology

- Application
  - Re-evaluate and check aquifer assignments for permitted wells to the geology model for consistency (example: SLR 0148 D&O Permit)
  - Update POSGCD Operational Model
  - Assist with review of Future D&O Permits
  - Develop sand thickness maps to assist with characterizing aquifer transmissivity properties

- On-going Work
  - Assemble logs from GCDs
  - Coordinate with TWDB on updating well assignments in TWDB Groundwater Database
  - Continually identify and evaluate geologic faults
  - Review Driller logs
  - Characterize multiple major sand bodies in Simsboro & Hooper

Guidance for Drilling Water Wells in the Carrizo Wilcox Aquifer

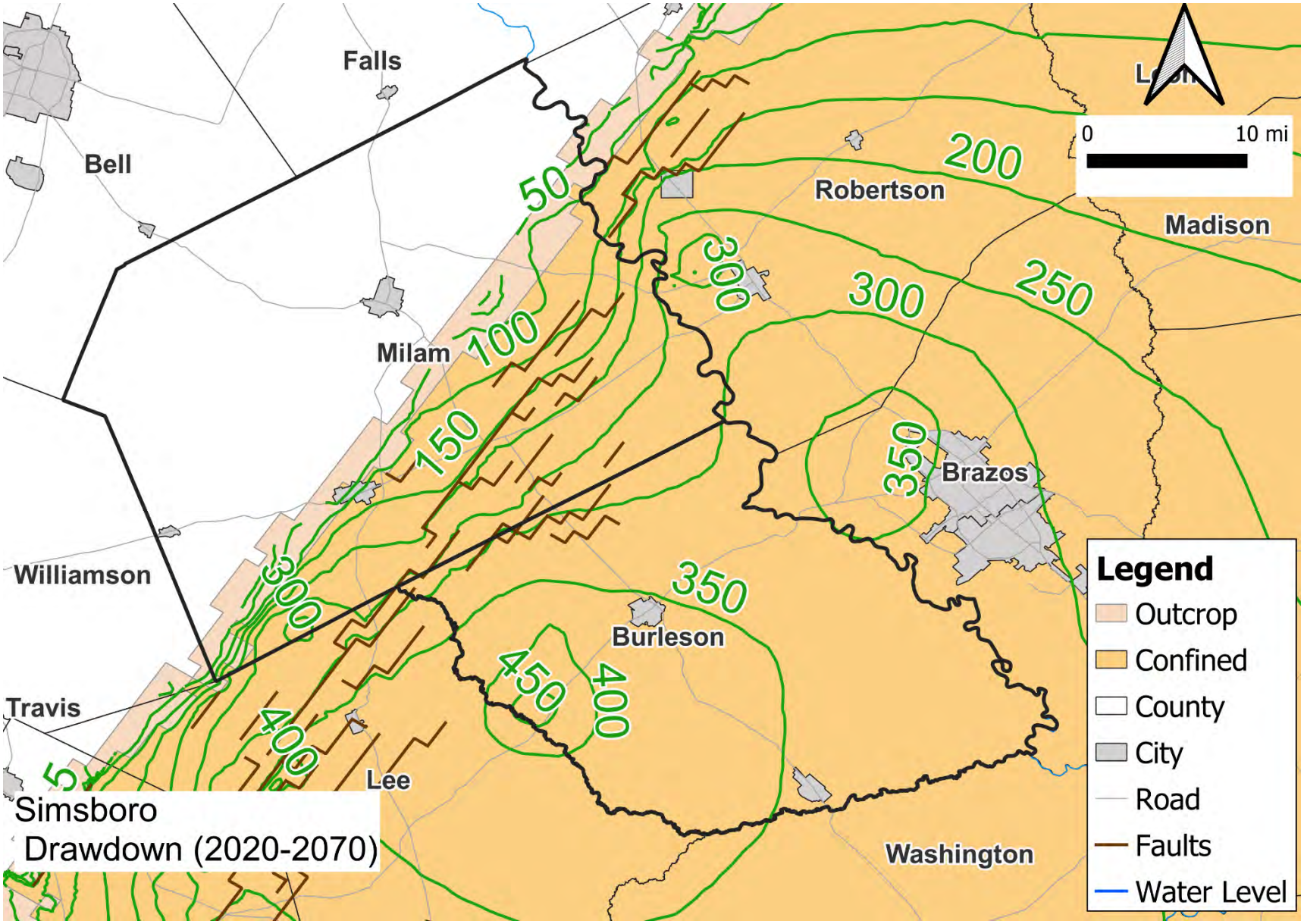
Driller's Guidance Document

- Purpose
  - Prevent newly drilled wells from having water levels drop below elevation of pump in the next 50 years
- Proposed Approach
  - Simulate future water levels based of best available science, and then calculate depth

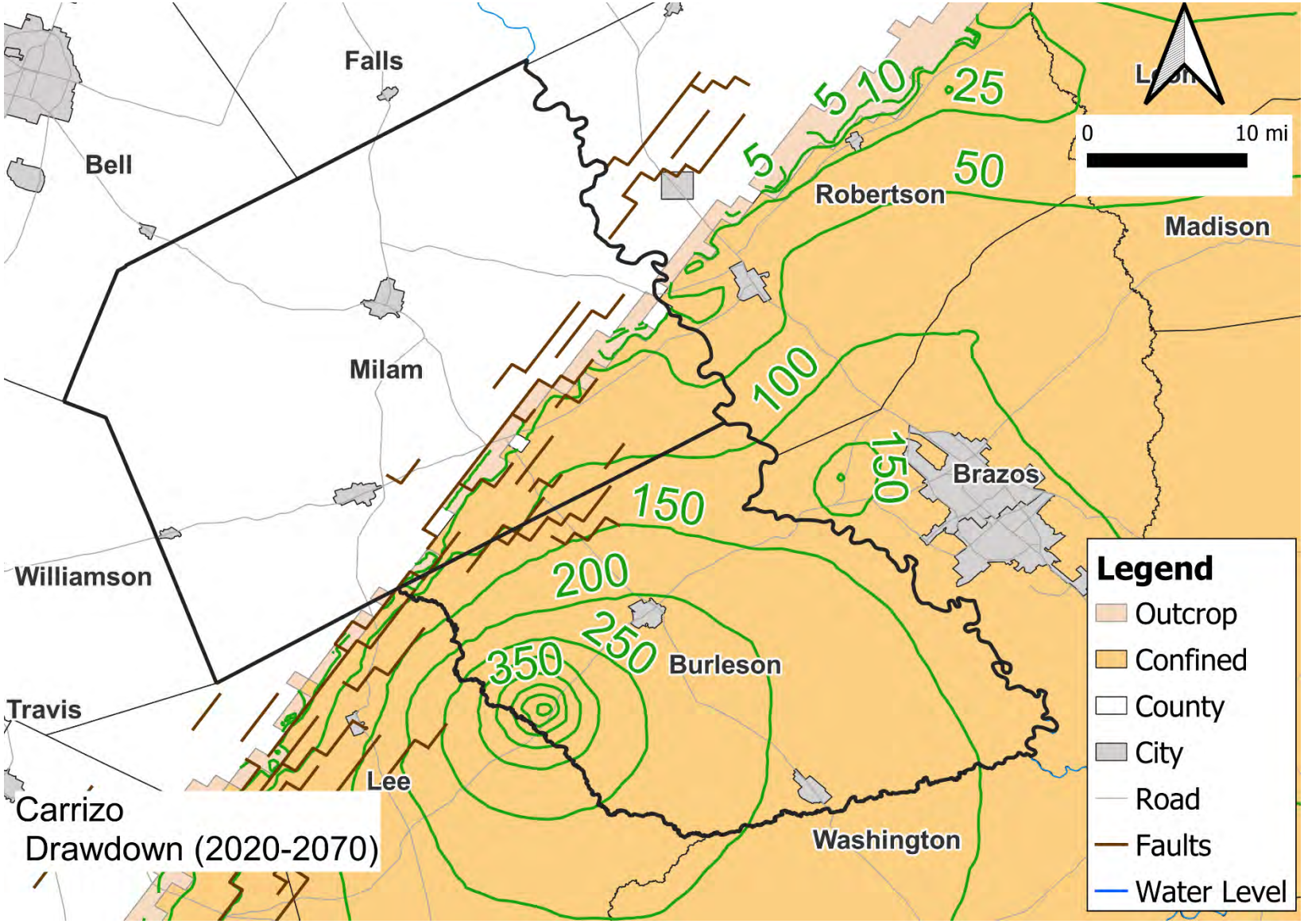
Depth of Pump (ft, bgs) = Ground Surface (ft, msl) - Simulated 2070 Water Level (ft, msl) - 100 feet

  - Develop a Driller Guidance Document & Map
  - POSGCD will provide depth to driller/well owner as part of registration process
  - Complete process by December 31, 2022

Simulated Water Simsboro Drawdown (2020 – 2070)

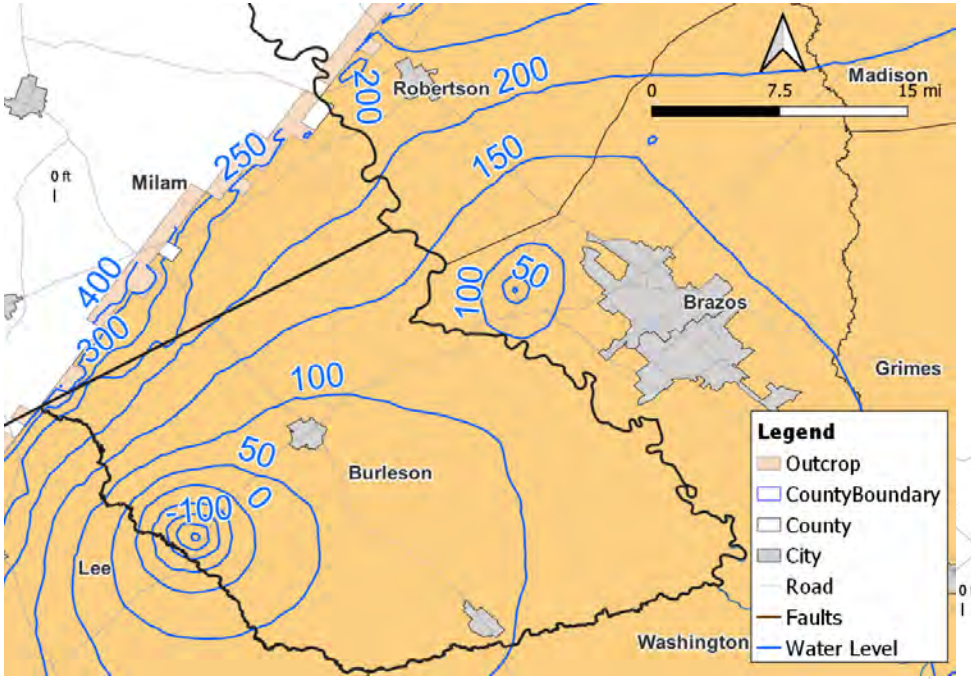


Simulated Water Carrizo Drawdown (2020 – 2070)

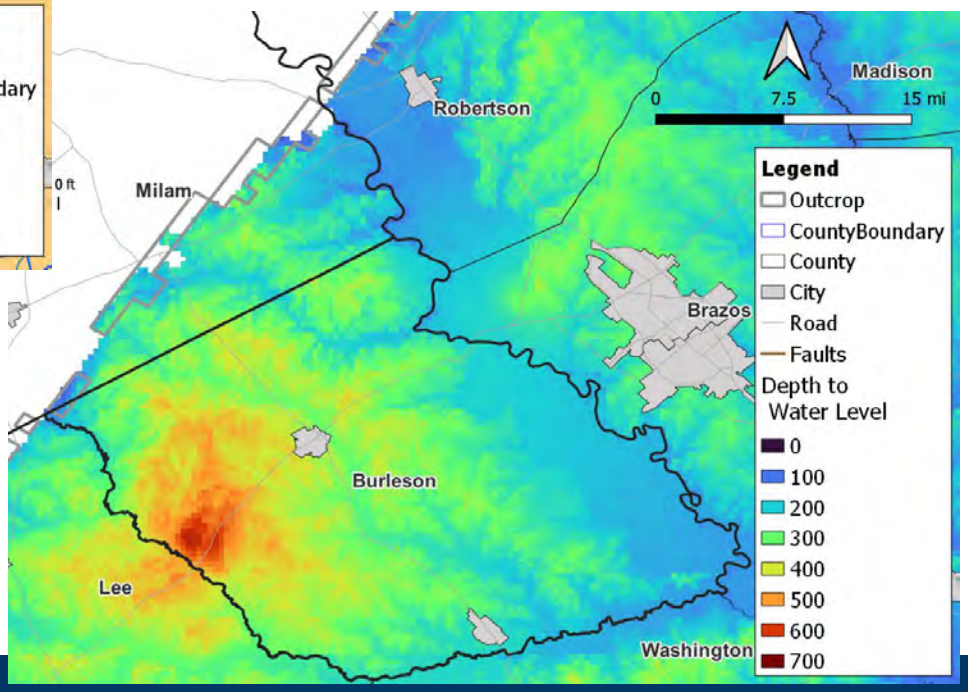


Elevation and Depths for Pump Settings: Carrizo

Elevation (ft, mean sea level)

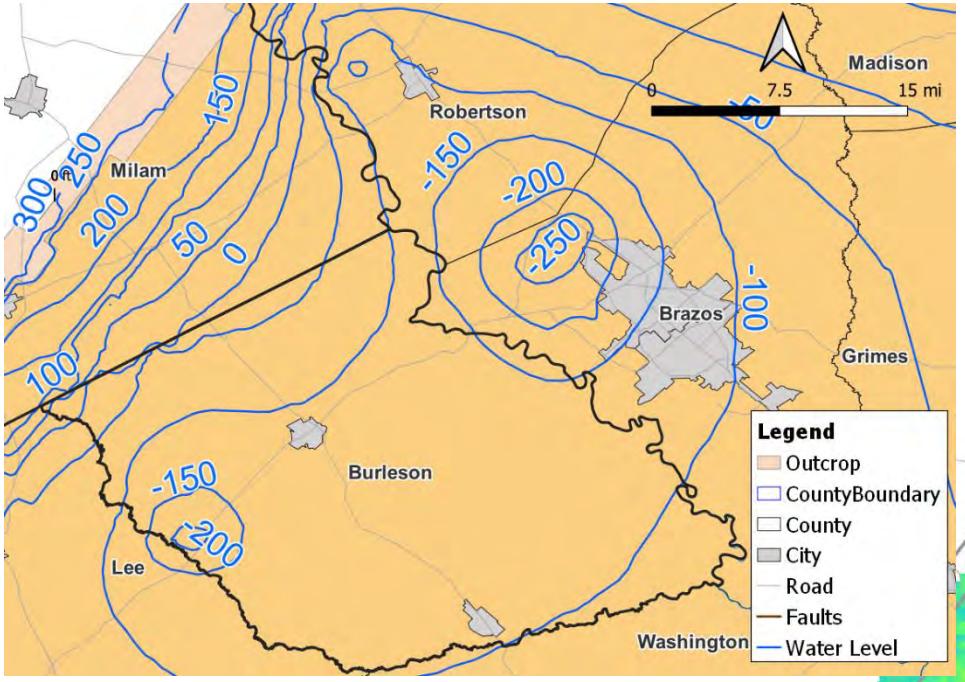


Depth (ft, below ground surface)

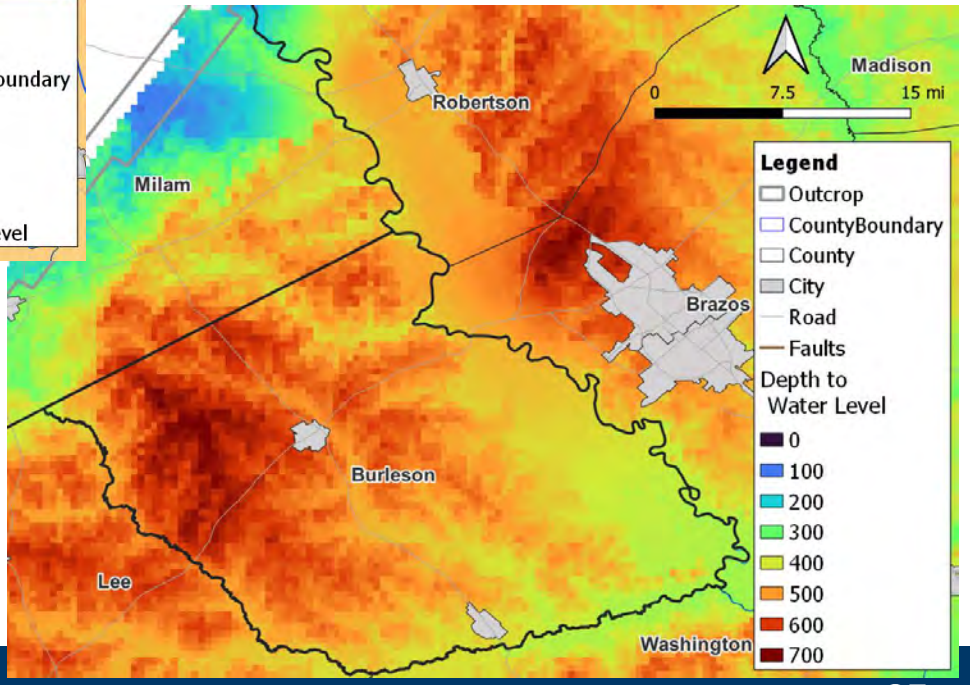


Elevation and Depths for Pump Settings: Simsboro

Elevation (ft, mean sea level)



Depth (ft, below ground surface)



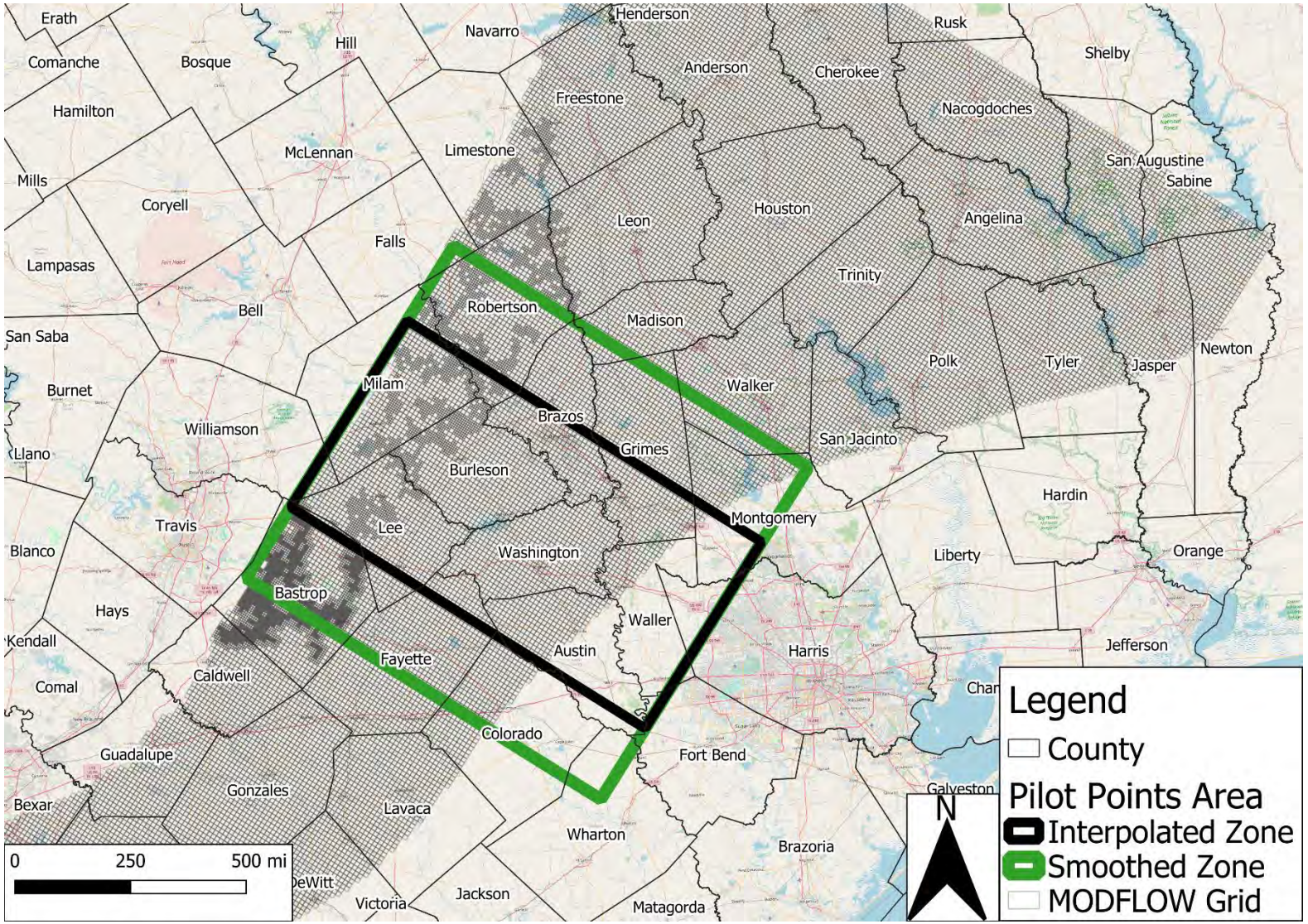
POSGCD Operational Model

POSGCD Operational Model

Generate a Technical Defensible GW Model to Support District Decisions Related to:

- Permit Renewals
- Long-term aquifer sustainability
- Improved climate resiliency
- Desired Future Conditions
- Curtailment of production
- Fair share allocations
- Drought management

GAM Recalibration Area for Aquifer Hydraulic Properties

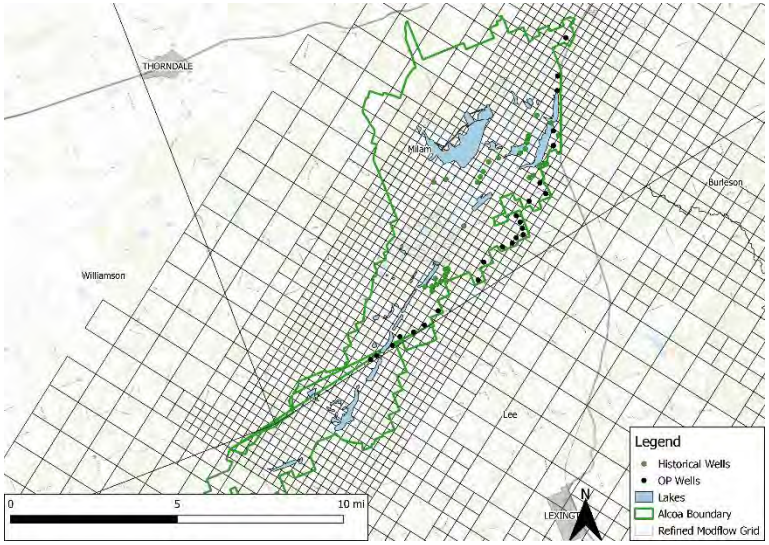


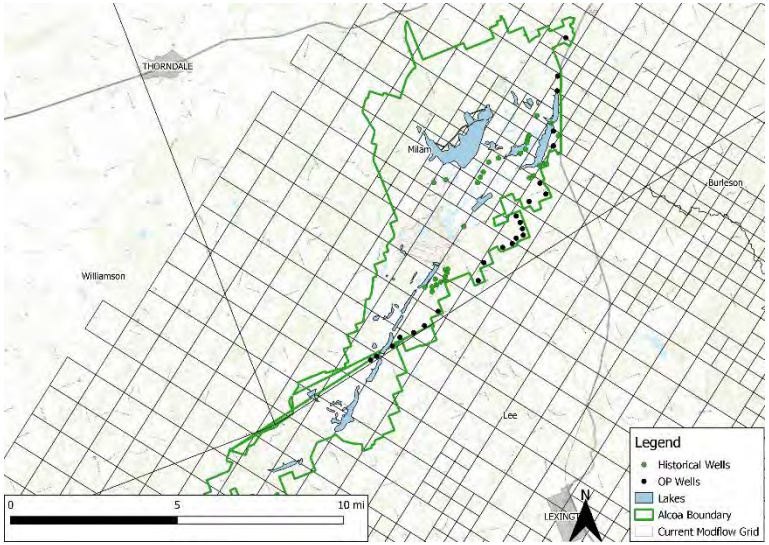
Modeling Approach

- Refined Grid in POSGCD to Better Define Location of Pumping wells and Surface Water Bodies
- Update model layering to better reflect the site geology
- Extend GAM calibration from 2010 to 2022 (present)
- Improved simulation of surface water /groundwater interactions
- Incorporate results of large-scale pumping tests
- Quantify uncertainty in model predictions

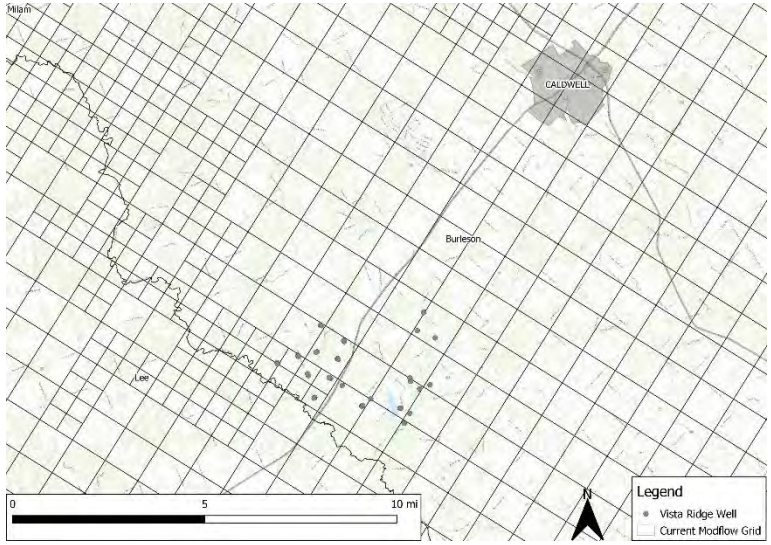
Example of Grid Refinement

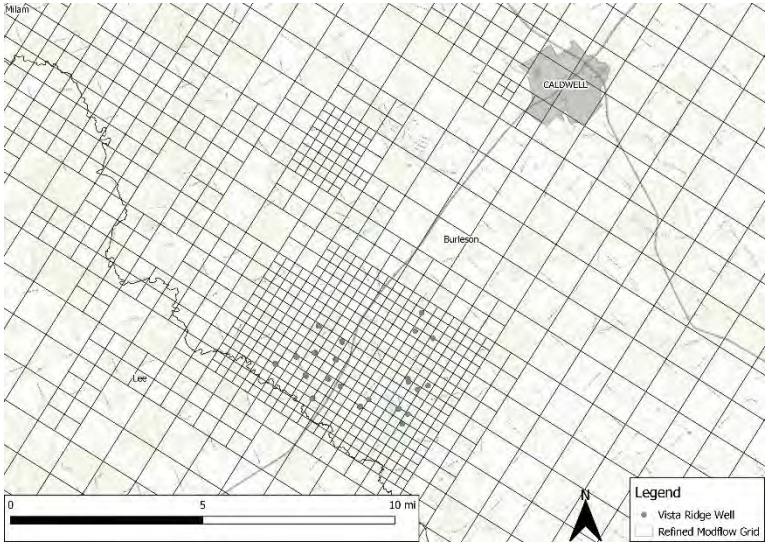
Area near SLR





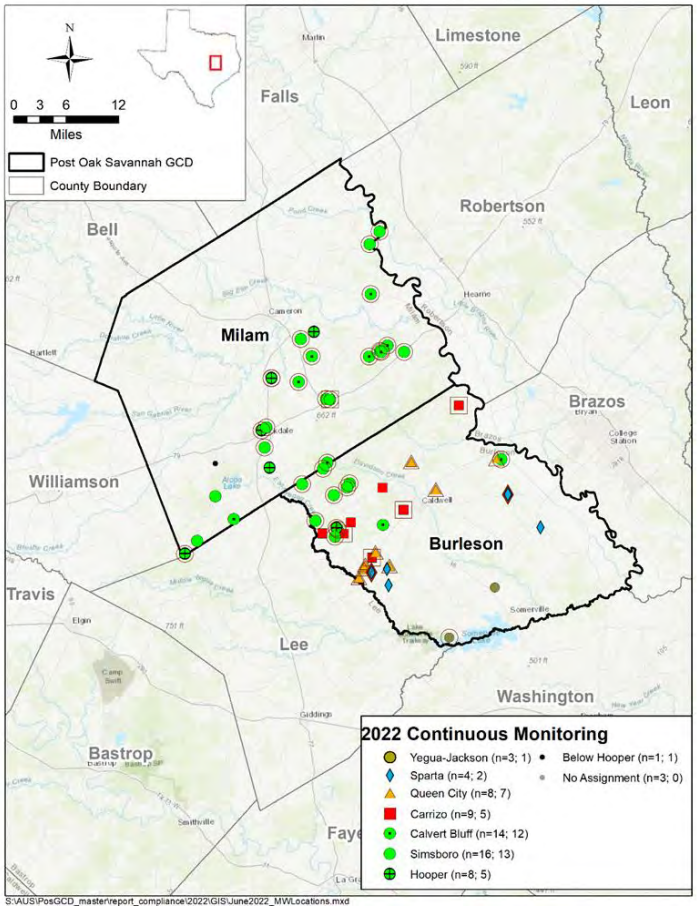
Area near Vista Ridge

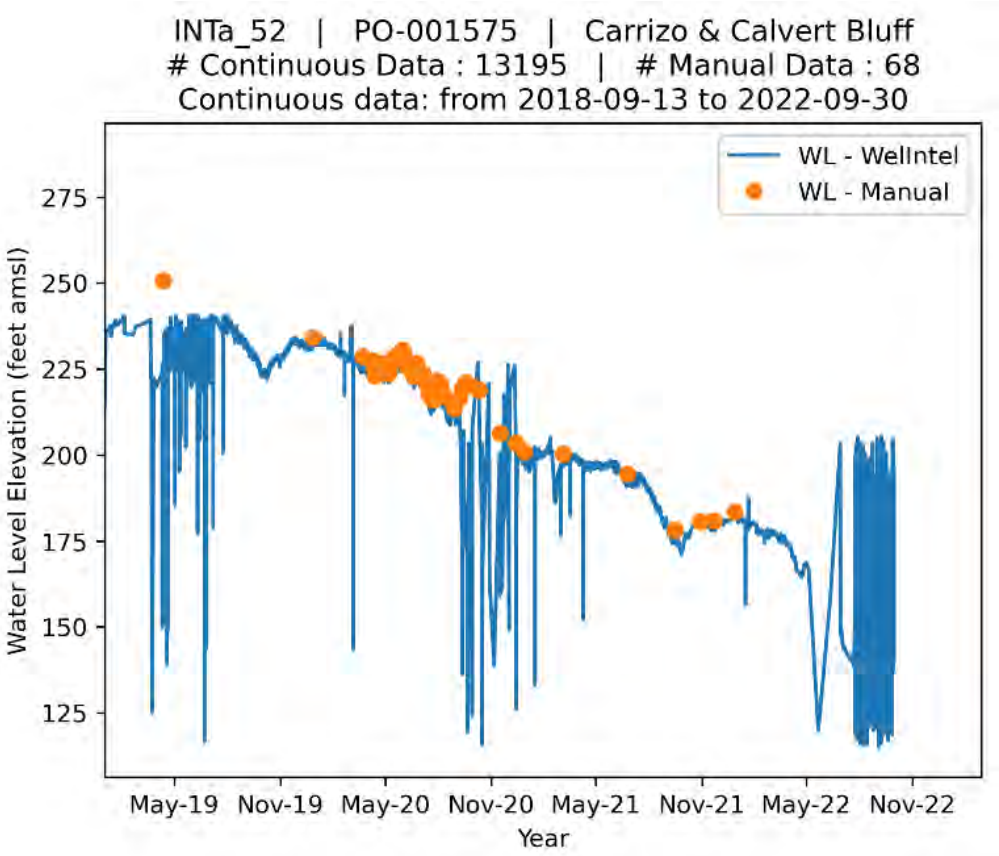




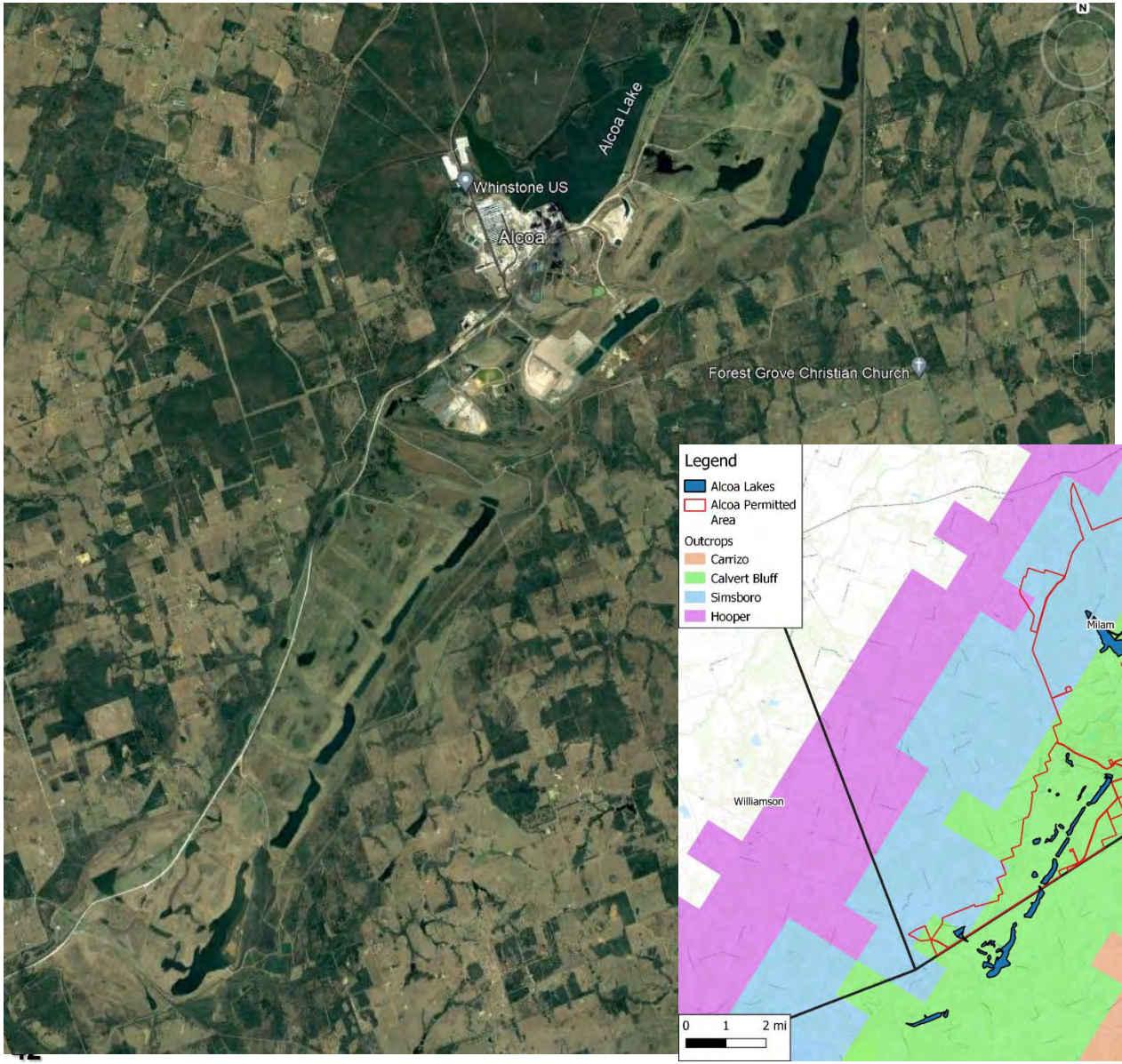
Transducer and WellIntel Data

- Separate Presentation
  - Continuous water level measurements at POSGCD transducers
  - Continuous water level and pumping rates at Vista Ridge and 130 Project wells





SLR Lakes



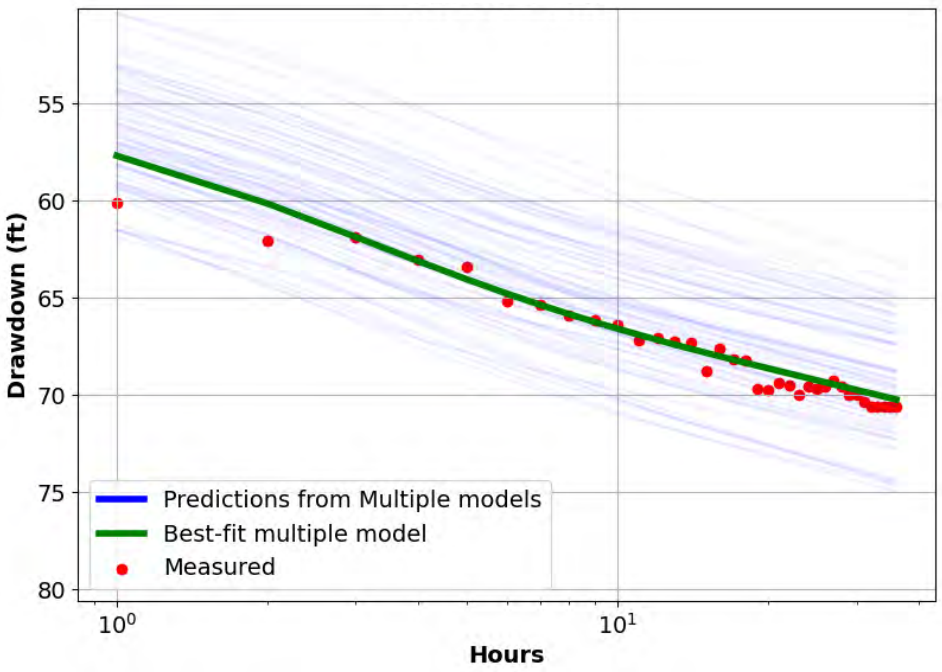
- approximately 150 feet deep
- Lakes created as part of mining operations
- Lakes were created in Calvert Bluff outcrop
- serve as a water source & pressure boundary for groundwater

Aquifer Pumping Tests

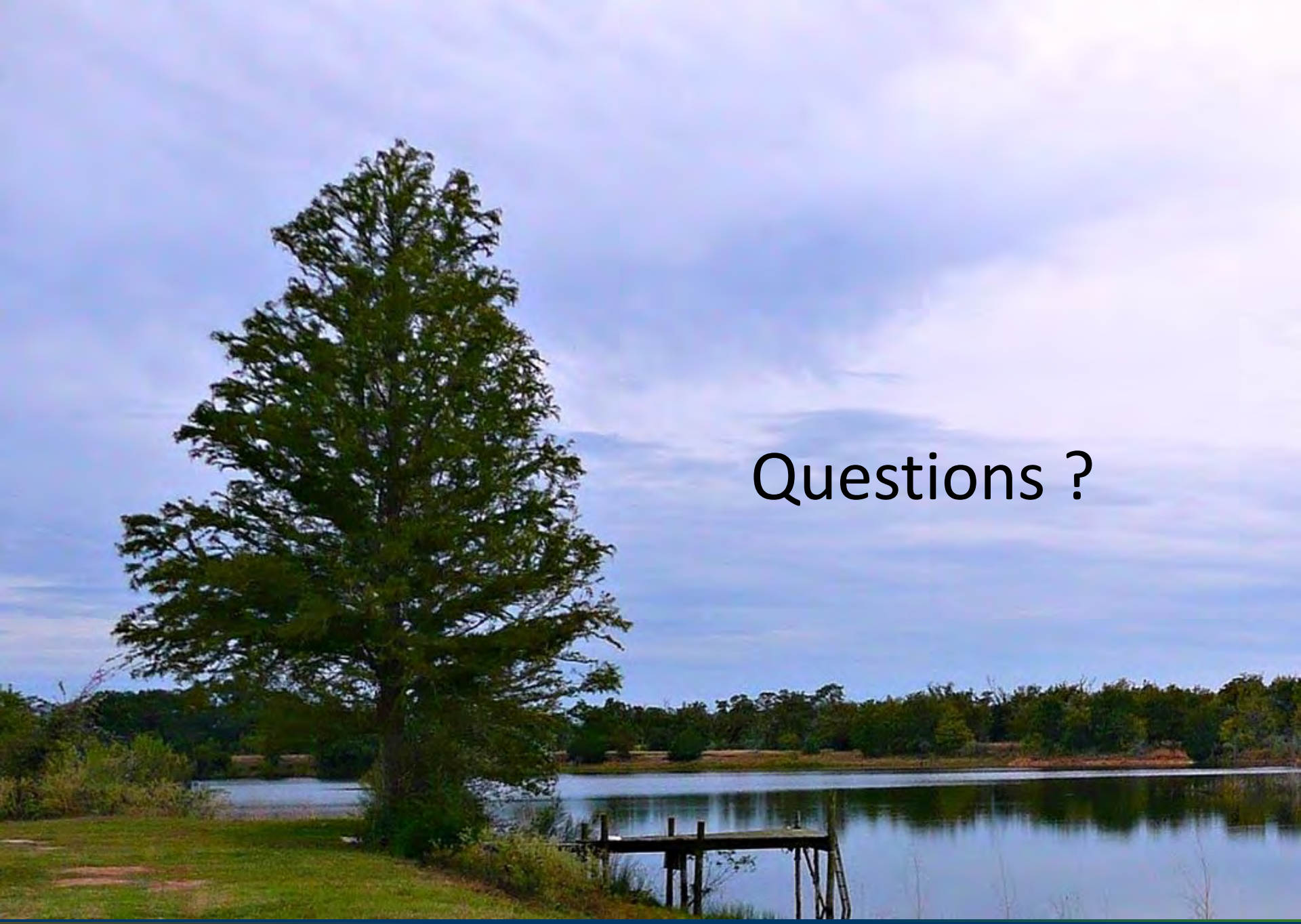
Aquifer Pumping Tests provide an excellent data set to test the ability of a model to simulate drawdown impacts caused by local pumping

- Vista Ridge wells
- SLR/ALCOA wells
- City of Bryan
- municipal

Pumping Vista Well PW 10 at 3,000 GPM* for 36 hours



* gallons per minute


Questions ?