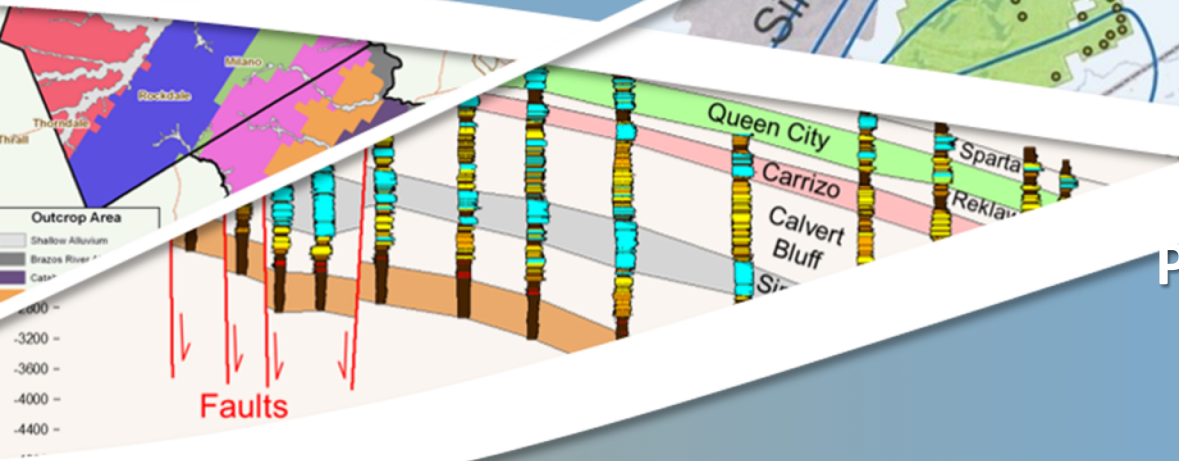


Application of Updated Sparta/Queen City/ Carrizo-Wilcox GAM for Simulating Water Levels near Public Water Supply Wells

Presented : POSGCD Offices
Milano, TX



Presented By:

Steve Young
Jevon Harding

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

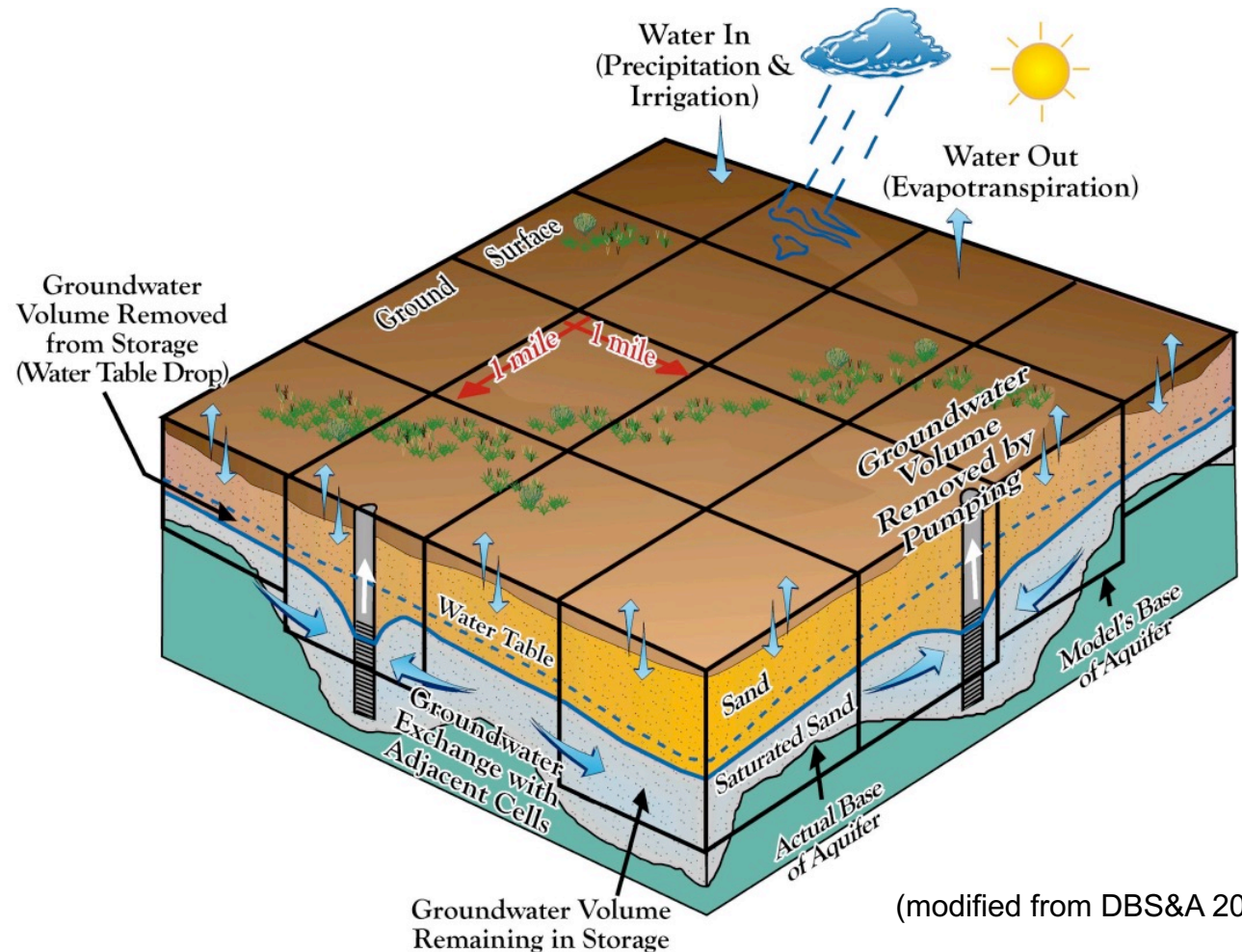
October 25, 2018

Outline

- **Groundwater Availability Model for the Carrizo-Wilcox Aquifer**
- **Simulated Water Level Changes at Public Water Supply Wells**
- **POSGCD Rules for Aquifer Protection**

What is a Groundwater Availability Model

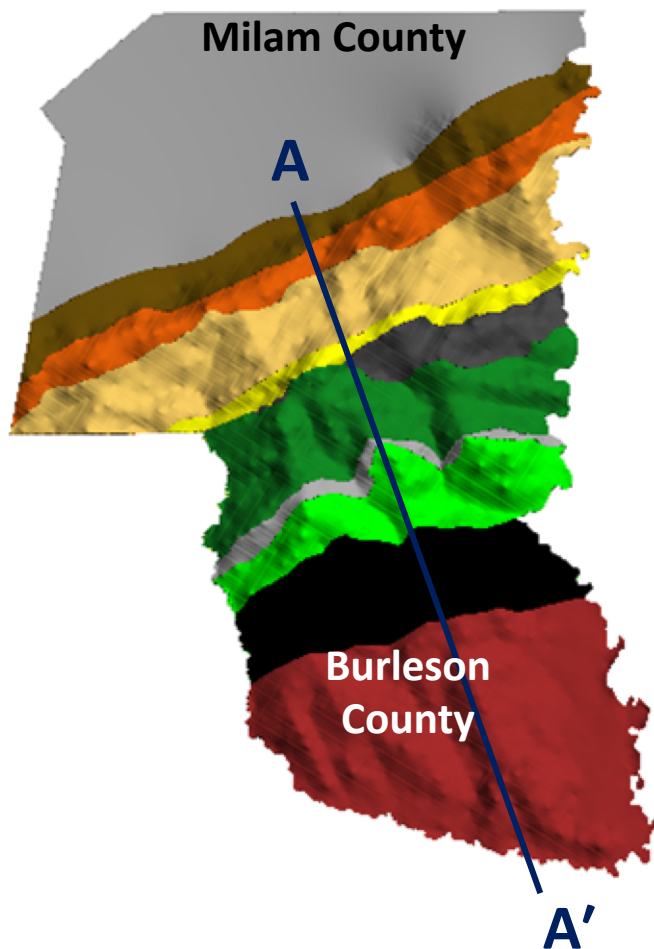
- Simplified Representation of Real System
- Consists of grids representing blocks of aquifer
- Flow equations link blocks together like an Excel Spreadsheet



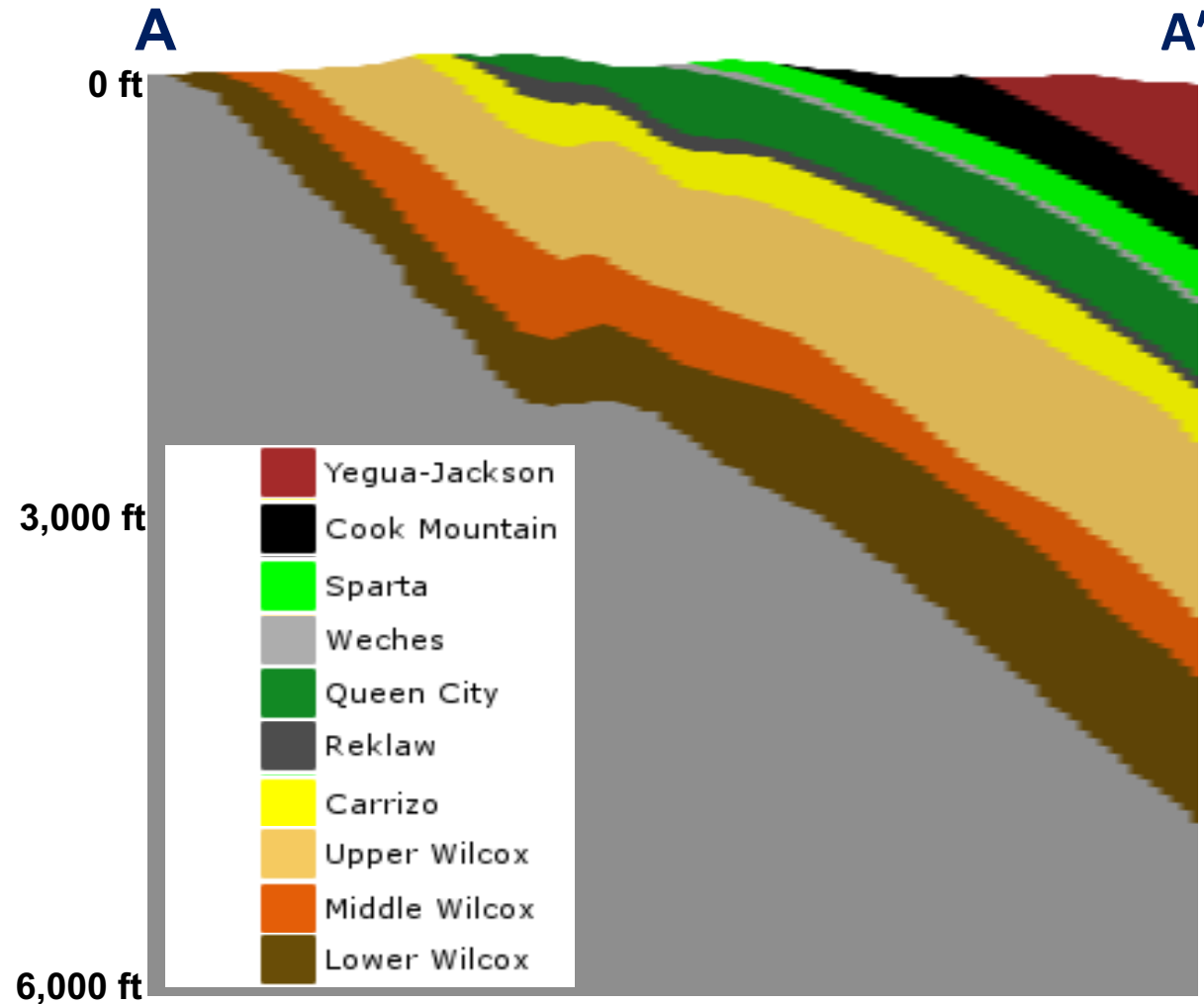
(modified from DBS&A 2001)

POSGCD Aquifers

**Aerial View
Outcrop of Different Aquifers**

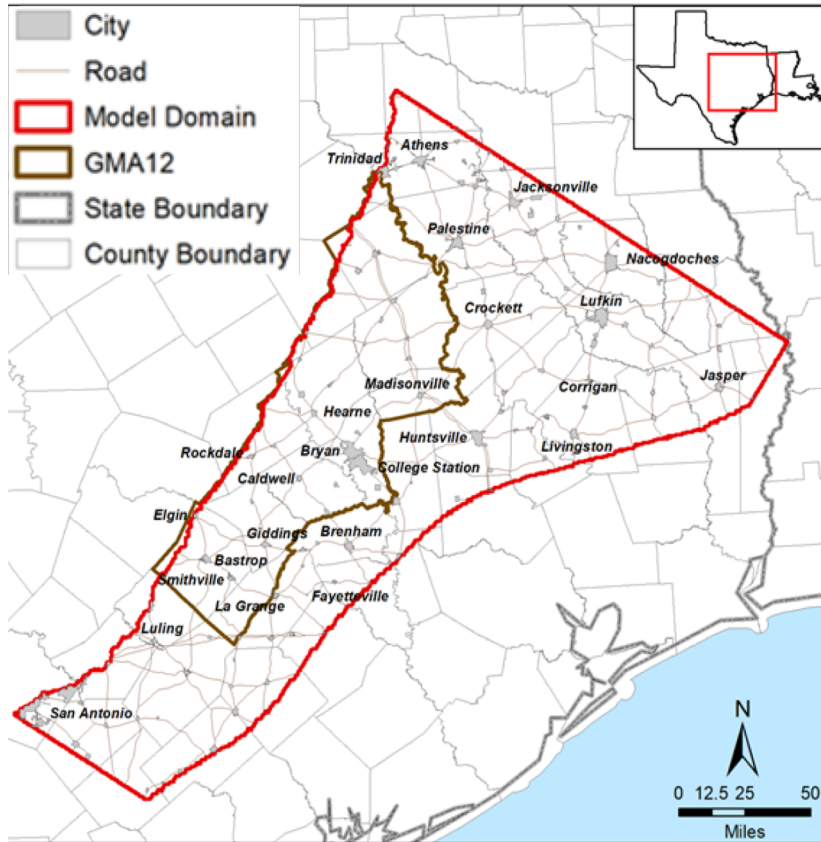


Vertical Cross-Section View Looking From Side

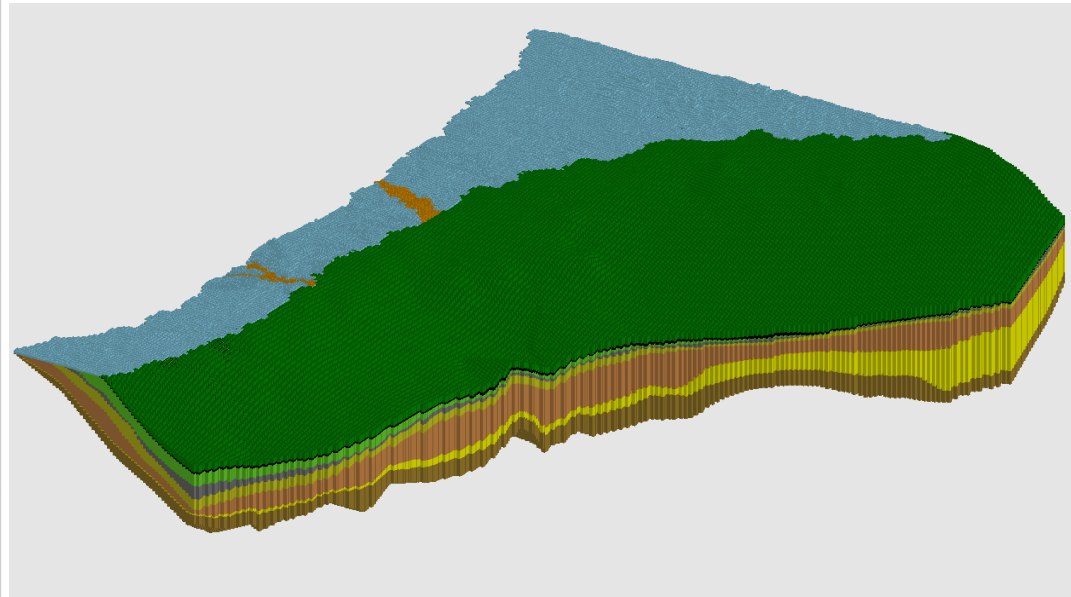


Model Construction

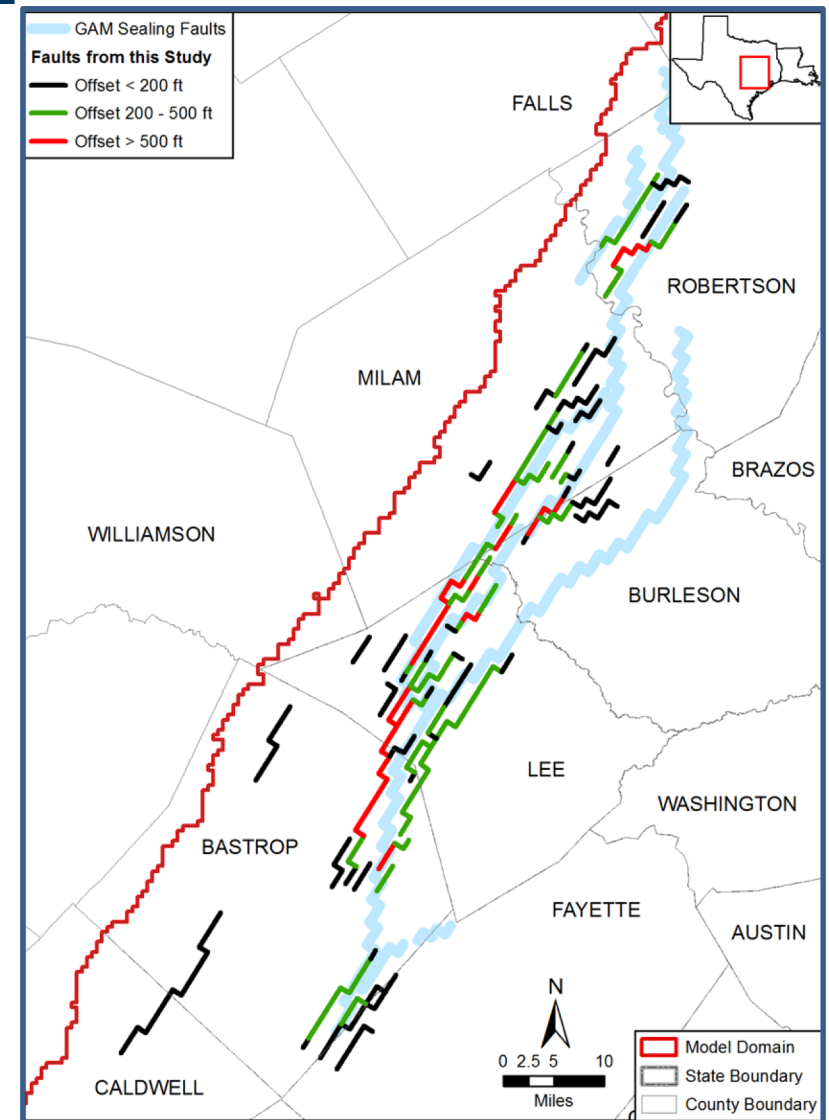
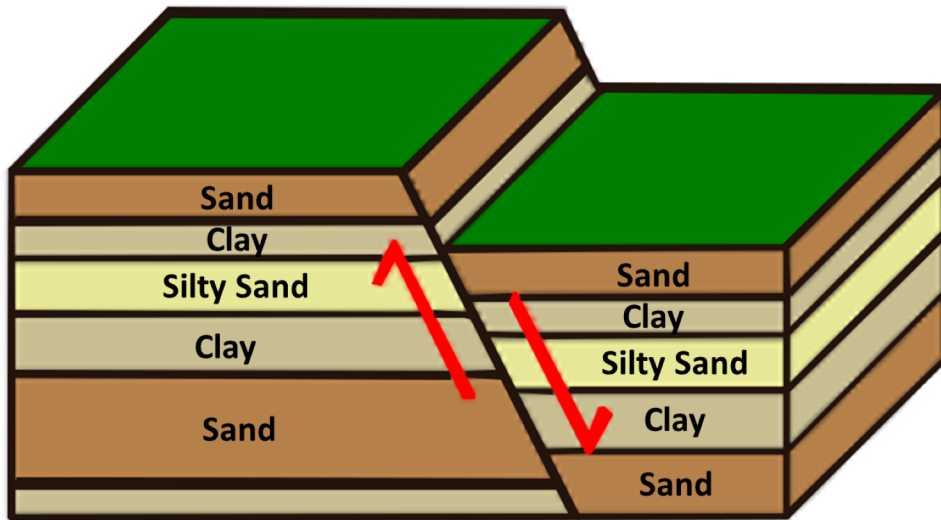
Areal Extent



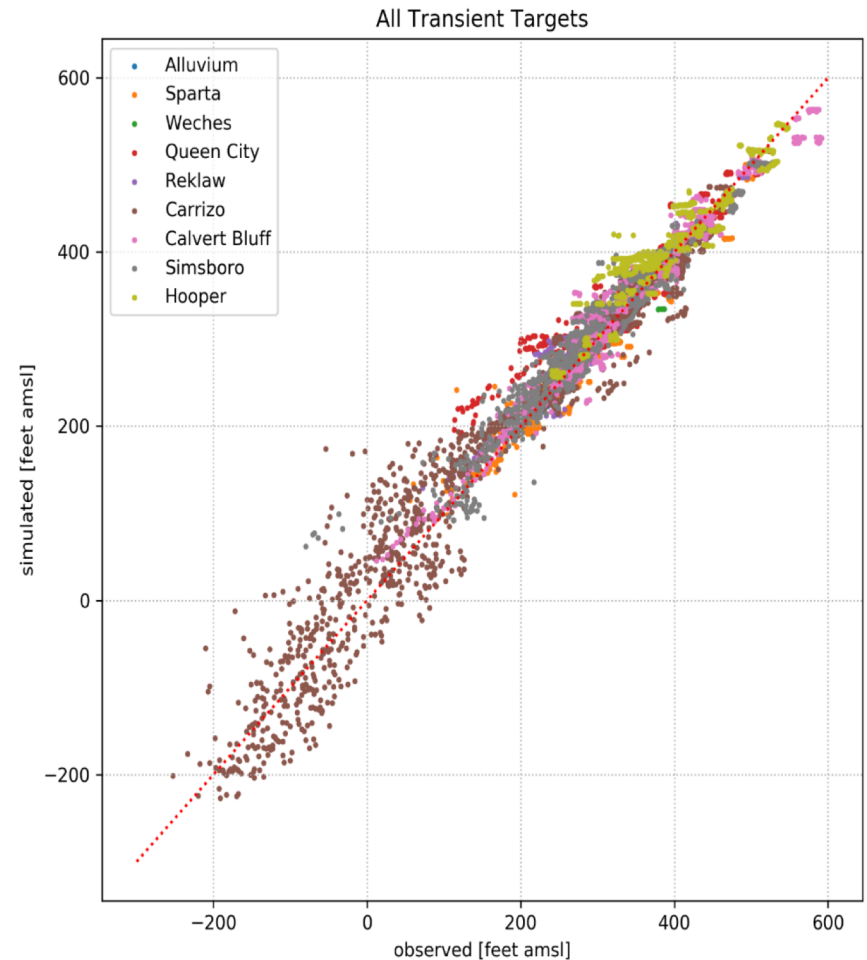
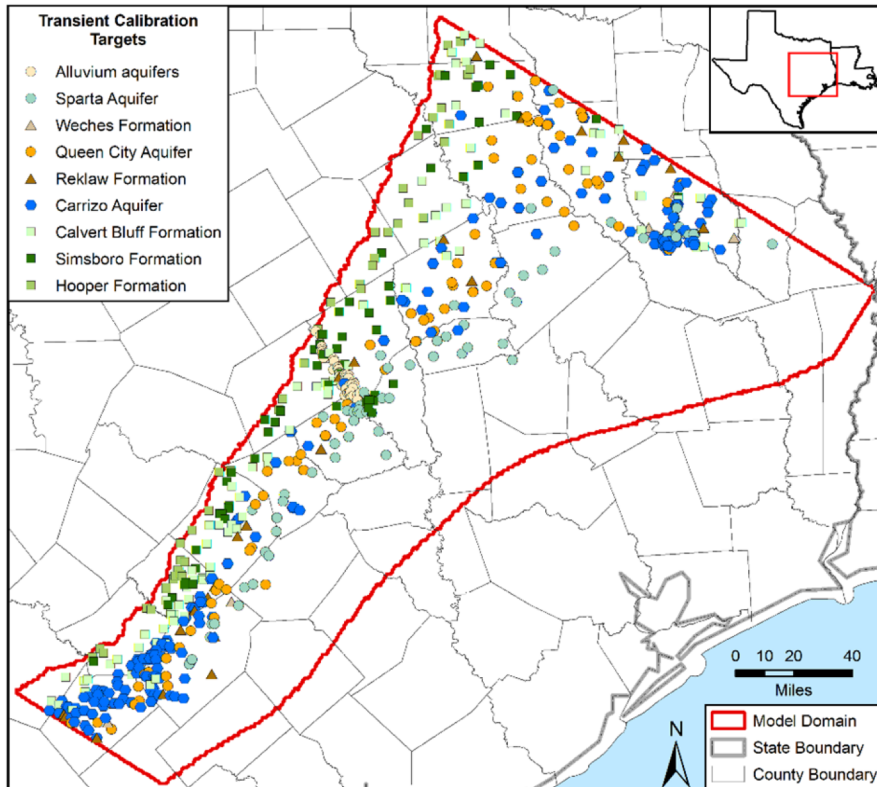
Three-Dimensional View



Revised GAM Included Remapping of Faults

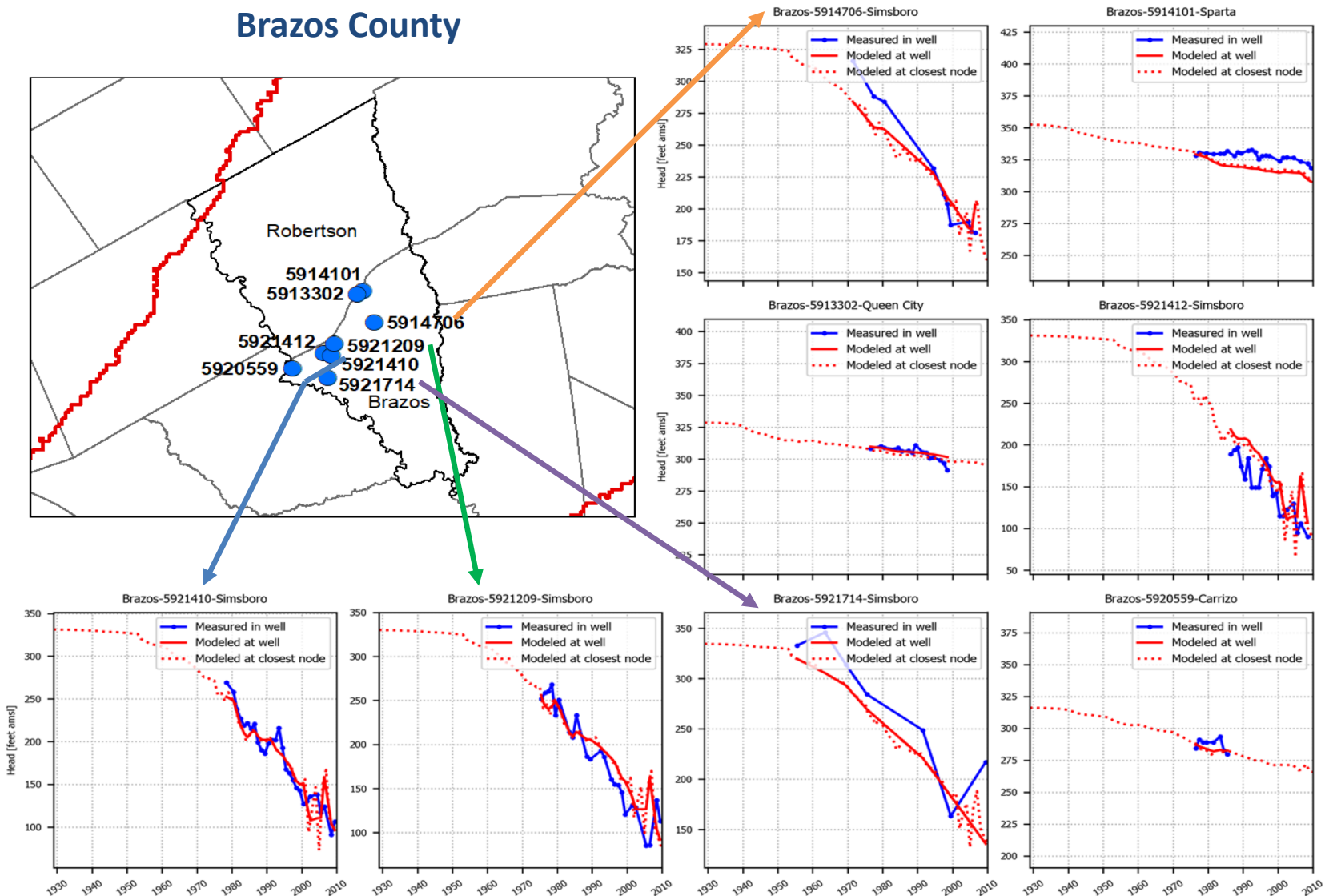


Modeled versus Measured Water Levels



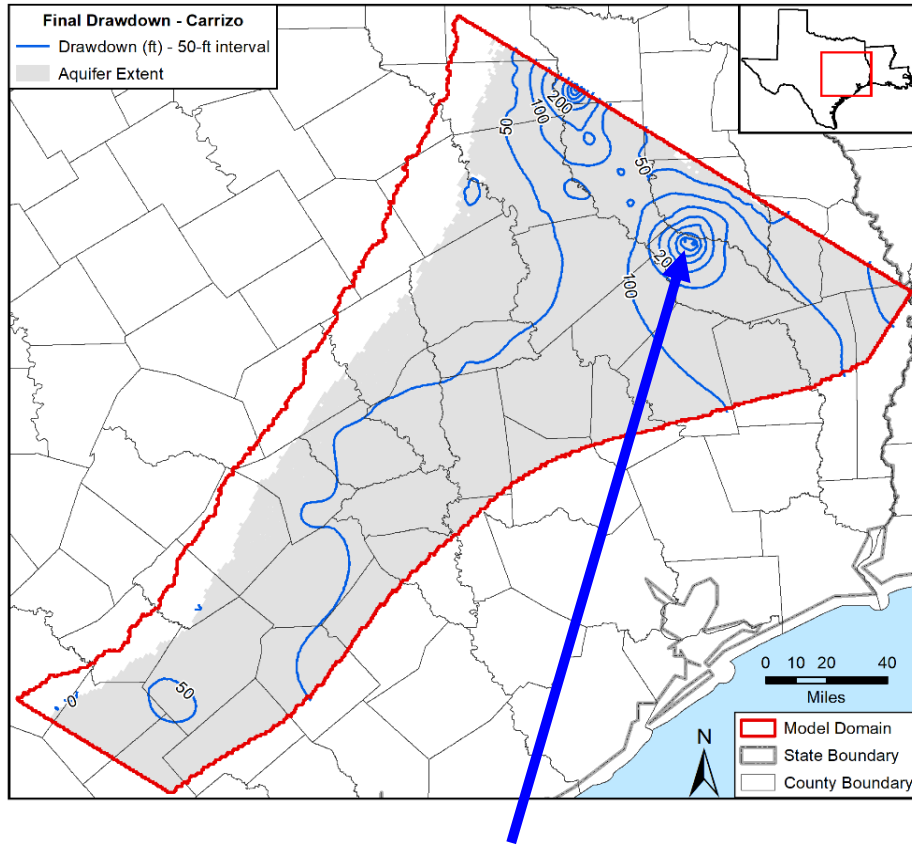
Updated GAM Provides Good Matches to Historical Water Levels in Regions of High Pumping in Simsboro Aquifer

Brazos County



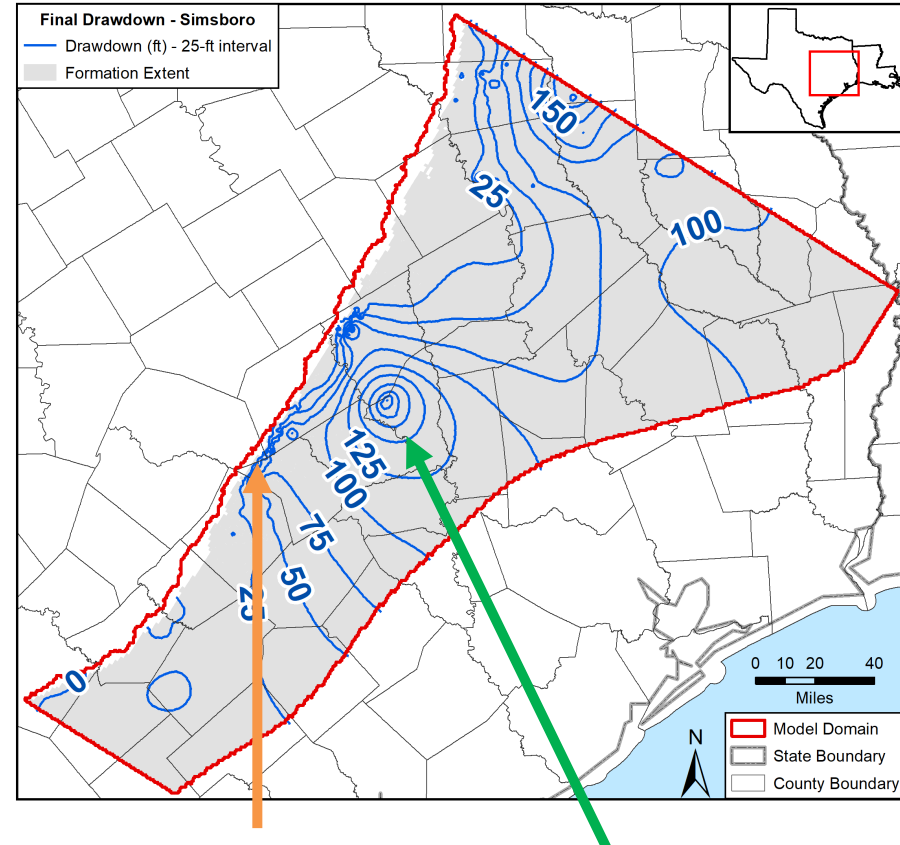
Simulated Drawdown from 1930 to 2010

Carrizo Aquifer



Lufkin

Simsboro Aquifer

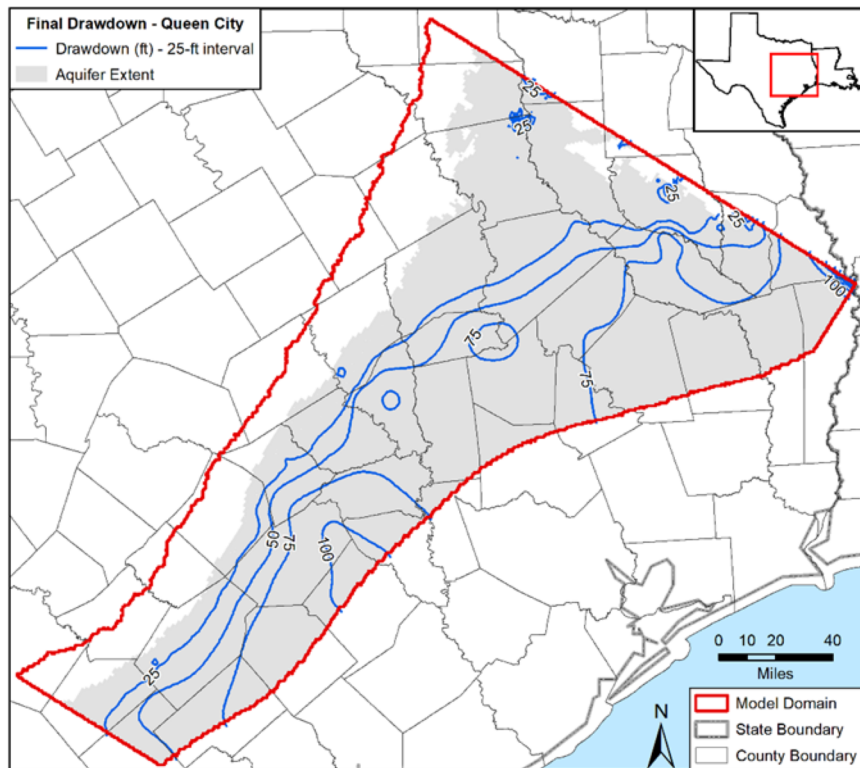


Alcoa

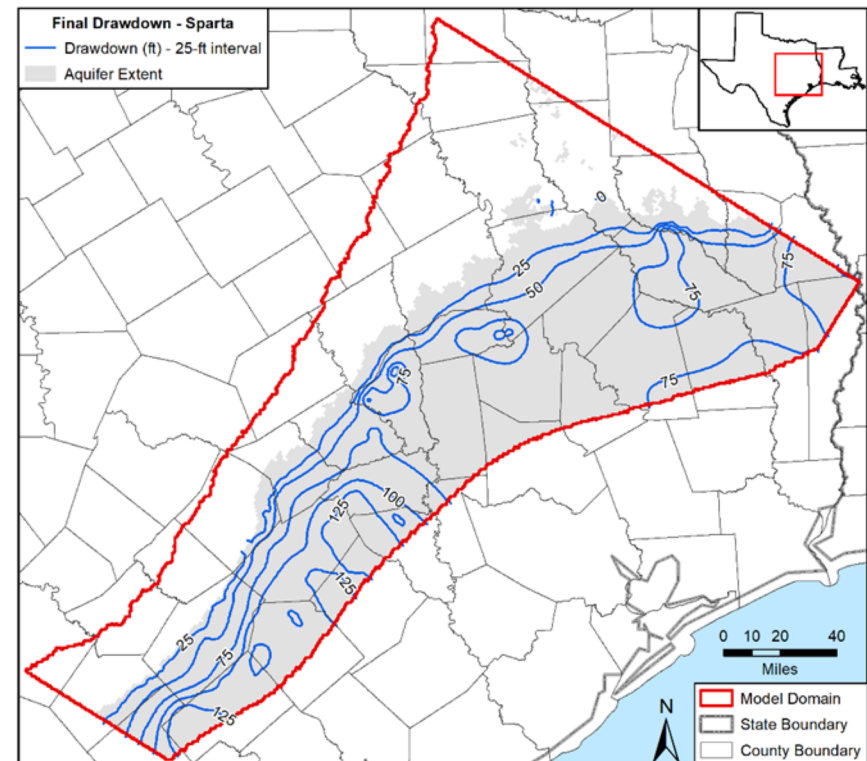
City of Bryan

Simulated Drawdown from 1930 to 2010

Queen City Aquifer



Sparta Aquifer



Public Water Supply wells in POSGCD

Wells analyzed using updated GMA 12 model:

Name	Latitude	Longitude	Aquifer	Well Depth		Name	Latitude	Longitude	Aquifer	Well Depth
Caldwell - WL2	30.536	-96.6882	Carrizo	1210		Milano WSC - WL1	30.7161	-96.8634	Sims/CB	790
Caldwell - WL3	30.5272	-96.7143	Carrizo	1314		Milano WSC - WL2	30.7128	-96.87	Sims/CB	800
Caldwell - WL5	30.5298	-96.7171	Carrizo	1303		Milano WSC - WL3	30.6322	-96.7877	Sims/CB	1687
Caldwell - WL6	30.5431	-96.681	Carrizo	1252		Milano WSC - WL4	30.6793	-96.6738	Simsboro	2018
City of Rockdale (Airport)	30.6348	-96.9911	Sims/Hoop	463		Milano WSC - WL5	30.6481	-96.8547	Simsboro	1715
City of Rockdale (Runway)	30.6313	-96.9901	Sims/Hoop	475		Minerva WSC - WL1	30.7588	-96.9853	Hooper	218
City of Rockdale (Texas)	30.6636	-96.9958	Sims/Hoop	380		Minerva WSC - WL2	30.7602	-96.9818	Hooper	252
City of Rockdale (Tracy)	30.6664	-96.9958	Sims/Hoop	408		North Milam - WL1	30.9011	-96.8657	Hoop/Below	300
City of Rockdale (Well 11)	30.6331	-96.9904	Sims/Hoop	470		North Milam - WL2	30.8976	-96.852	Hooper	313
Cooks Point WSC	30.5969	-96.6098	Carrizo	1252		North Milam - WL3	30.8849	-96.7783	Calvert Bluff	318
Deanville WSC - WL1	30.4327	-96.7571	Queen City	784		North Milam - WL4	30.8878	-96.8166	Simsboro	334
Deanville WSC - WL3	30.3861	-96.6887	Queen City	1352		North Milam - WL5	30.8879	-96.8166	Hooper	523
Deanville WSC - WL4	30.5254	-96.7271	Carrizo	1300		North Milam - WL6	30.8849	-96.7784	Calvert Bluff	357
Deanville WSC - WL5	30.456	-96.7836	Queen City	797		Snook WSC - WL2	30.4884	-96.4683	Sparta	1332
Gause WSC - WL1	30.7872	-96.7169	Simsboro	992		Somerville - WL5	30.3803	-96.5608	Sparta	1612
Gause WSC - WL2	30.7812	-96.7141	Simsboro	1210		Somerville - WL6	30.3794	-96.5619	Sparta	1620
Lyons WSC - WL2	30.3845	-96.569	Sparta	1595		SW Milam - Anthi	30.6432	-96.9266	Simsboro	1000
Lyons WSC - WL3	30.3869	-96.5644	Sparta	1602		SW Milam - Birkhead	30.5935	-96.9672	Sims/Hoop	1030
Marlow WSC - WL2	30.8262	-96.9067	Hooper	428		SW Milam - Milano	30.6913	-96.8999	Calvert Bluff	598
Marlow WSC - WL3	30.8271	-96.9137	Hooper	424		SW Milam - Rockdale	30.6713	-97.004	Hooper	485
Marlow WSC - WL4	30.8244	-96.8897	Sims/Hoop	501		Tunis WSC	30.4789	-96.5531	Sparta/CM	1038

* Blue highlight = POSGCD Monitoring well

Public Water Supply wells in POSGCD

Wells omitted for this presentation:

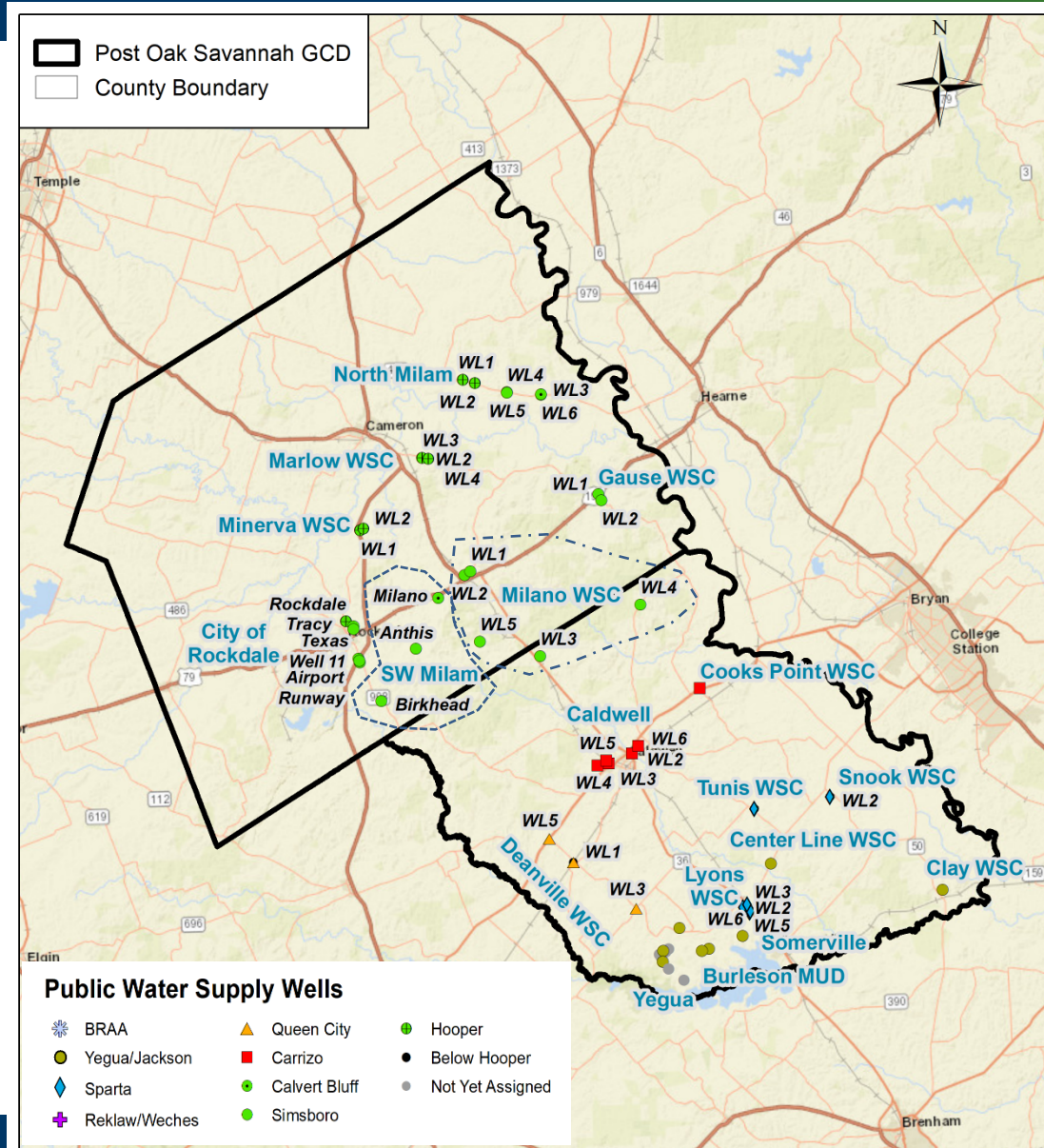
Name	Latitude	Longitude	Aquifer	Well Depth
Center Line WSC	30.4256	-96.5365	Yegua-Jackson	235
Clay WSC	30.3951	-96.3457	Yegua-Jackson	513
Lakeview North	30.3453	-96.6085	Yegua-Jackson	513
Somerville	30.3433	-96.6167	Yegua-Jackson	524
Little Oak Forest	30.3444	-96.66	Yegua-Jackson	325
Whispering Woods	30.3662	-96.6408	Yegua-Jackson	180
Apache Hills	30.3568	-96.5705	Yegua-Jackson	480
Yegua - WL2	30.334	-96.6605	Yegua-Jackson	390
Yegua - WL1	30.3336	-96.6607	-	-
Yegua - WL3	30.3271	-96.6546	-	-
Burleson MUD - WL1	30.3161	-96.6377	-	-
Burleson MUD - WL2	30.3414	-96.6639	-	-
Burleson MUD - WL5	30.339	-96.6623	-	-
Burleson MUD - WL3	30.3437	-96.657	-	-
Burleson MUD - WL4	30.3464	-96.6539	-	-

Yegua-Jackson is not included in updated GMA 12 model

Well depth not available

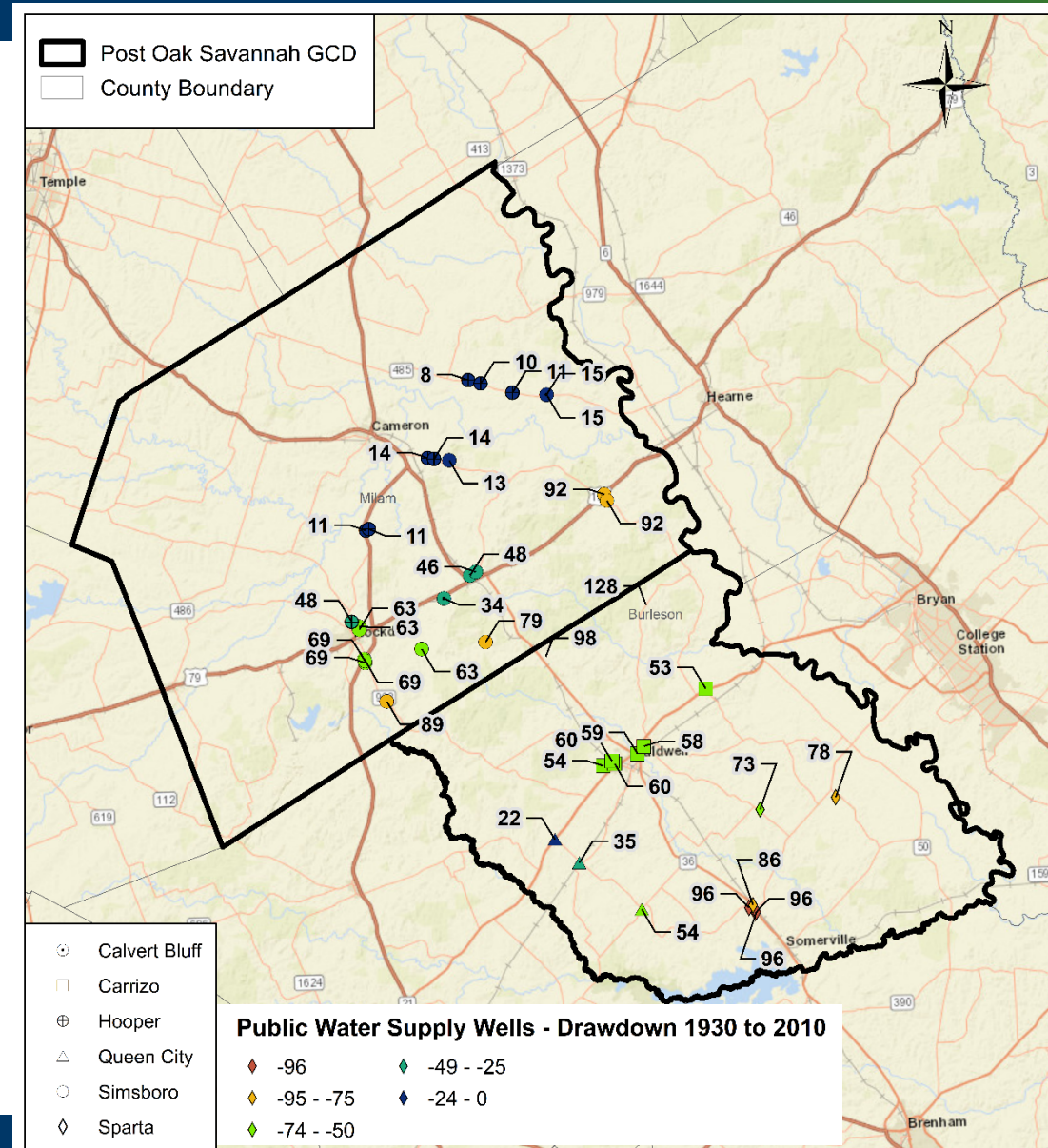
Public Water Supply wells in POSGCD

- Yegua-Jackson wells (southeast) were not analyzed
- Some neighboring WSC wellfields are outlined for clarity



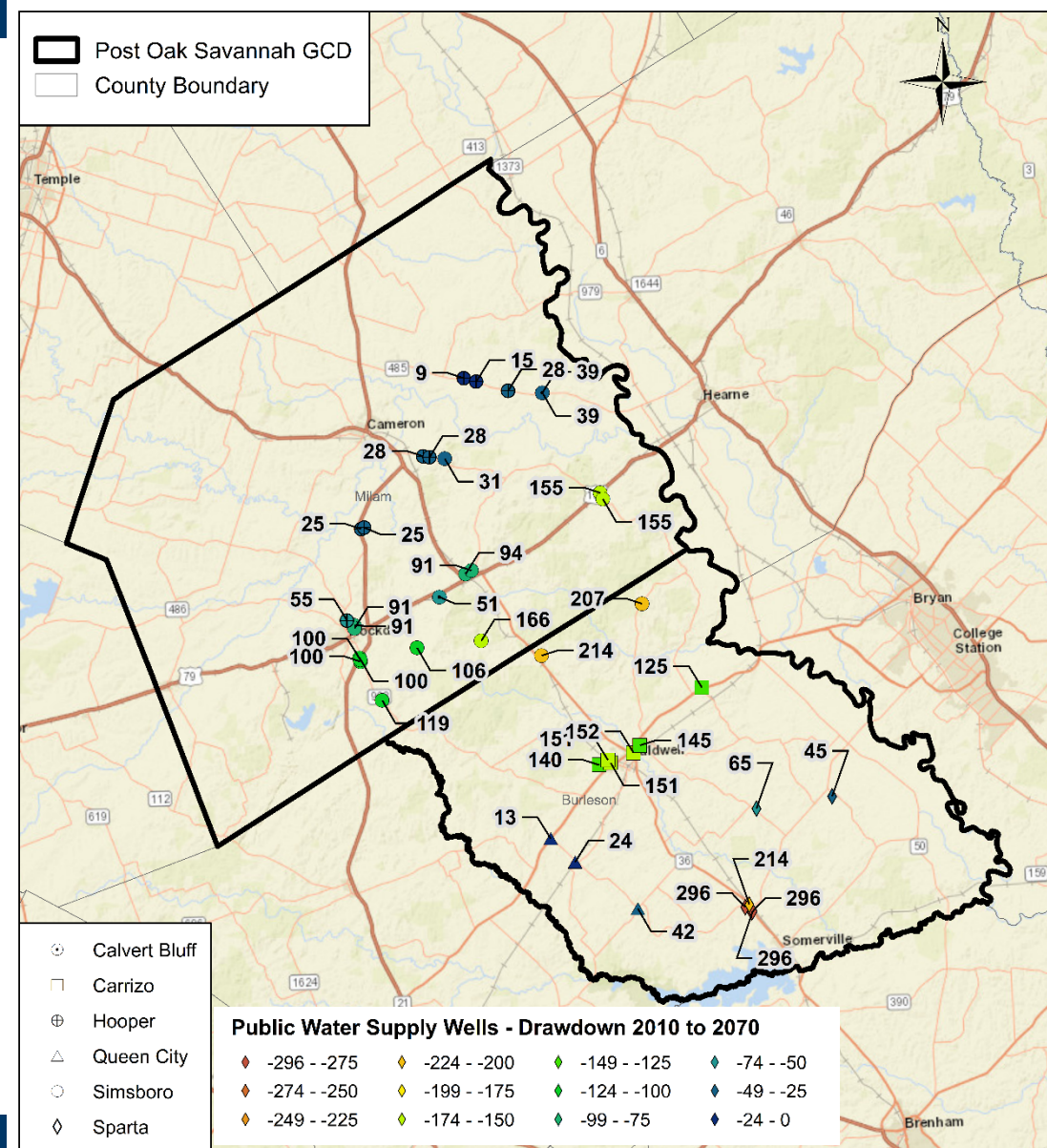
Historical Drawdown from 1930 to 2010

- Updated GMA 12 Groundwater Availability Model
- Decline in water level from 1930 to 2010



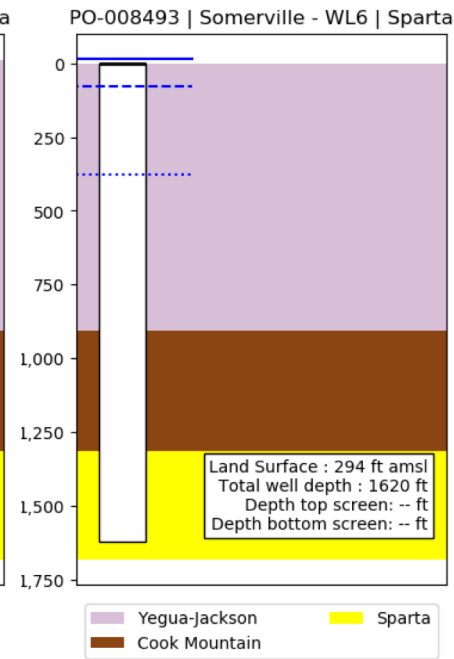
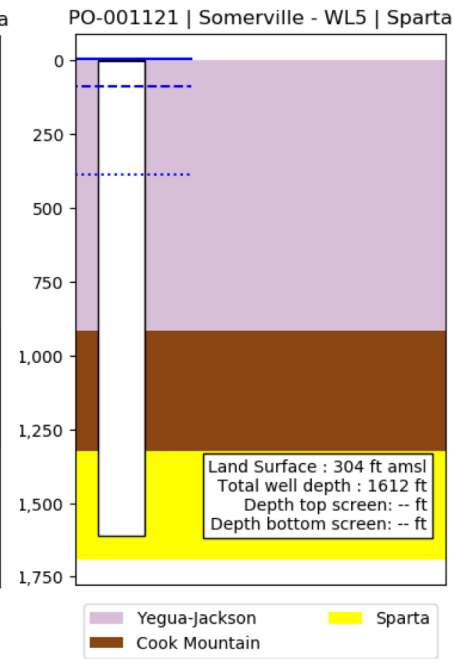
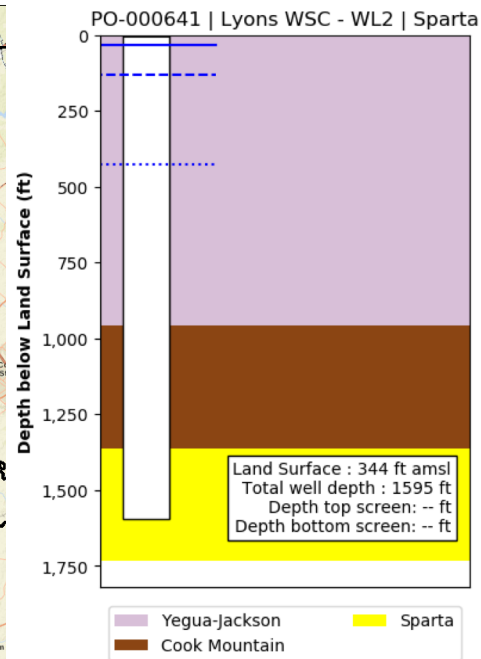
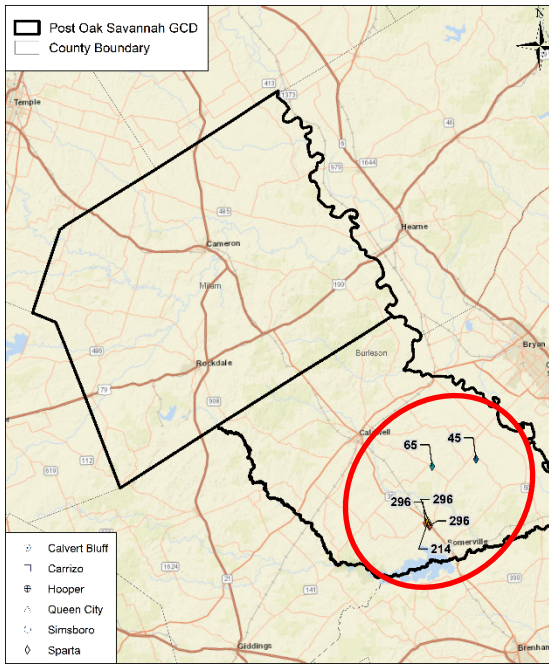
Drawdown from 2010 to 2070

- Updated GMA 12 Groundwater Availability Model
- Decline in water level from 2010 to 2070



Sparta

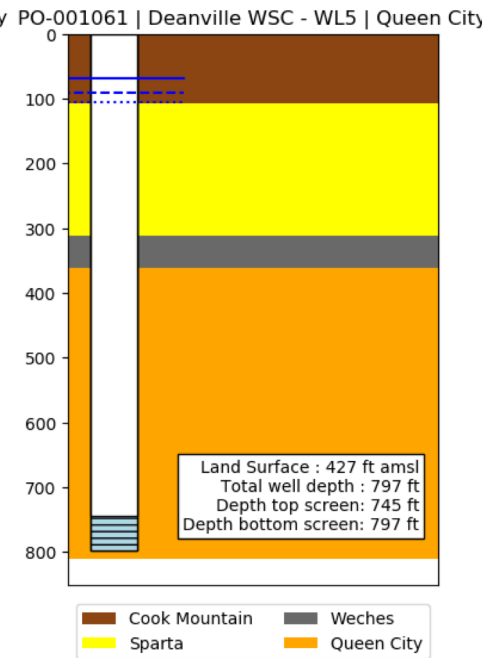
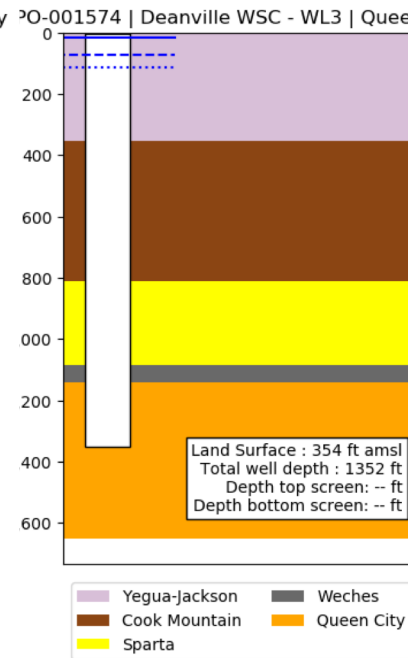
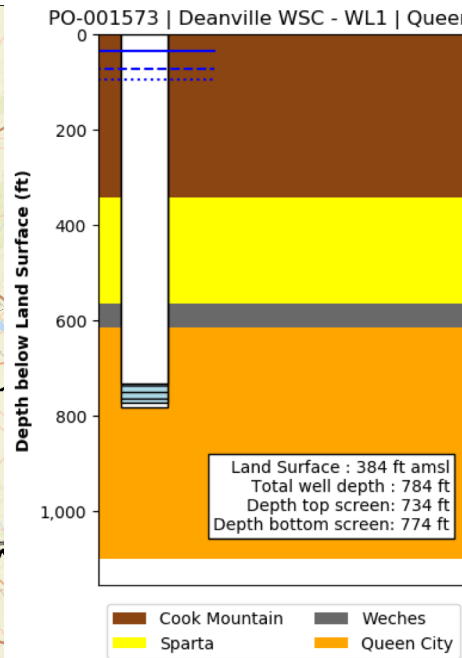
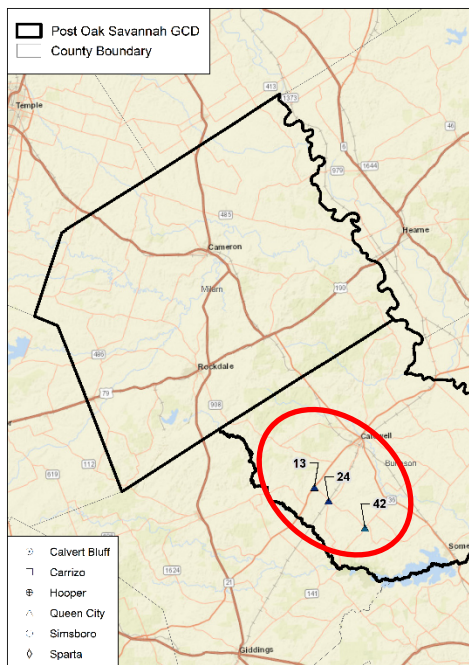
Example Sparta Well Diagrams & Water Levels



Water Levels: — 1930 --- 2010 2070

Queen City

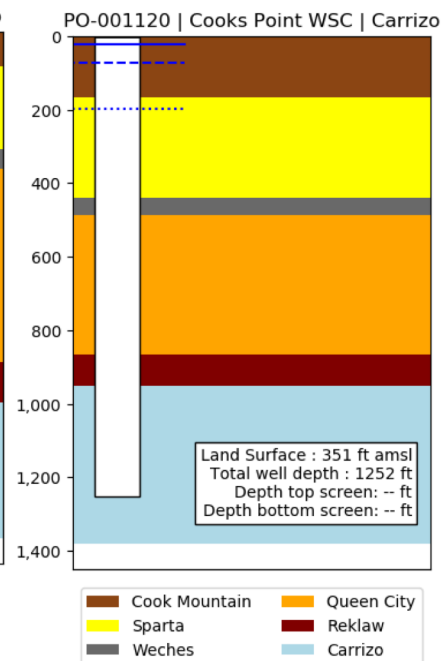
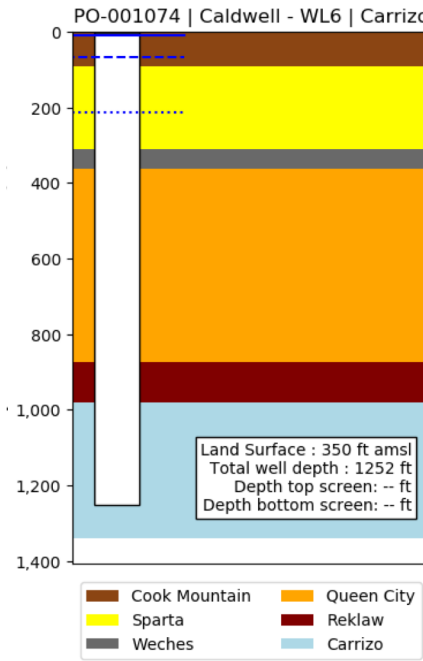
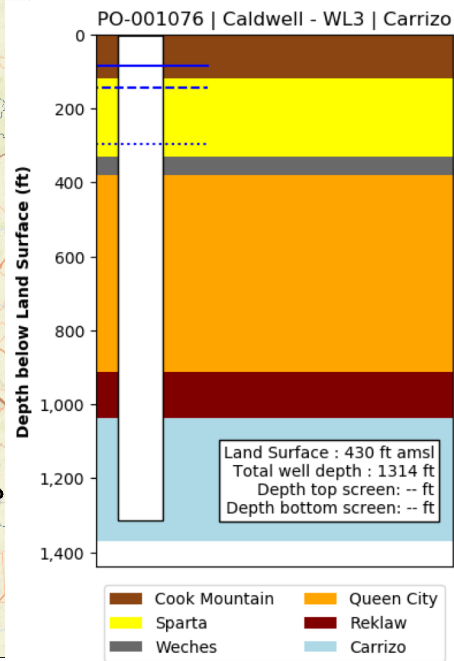
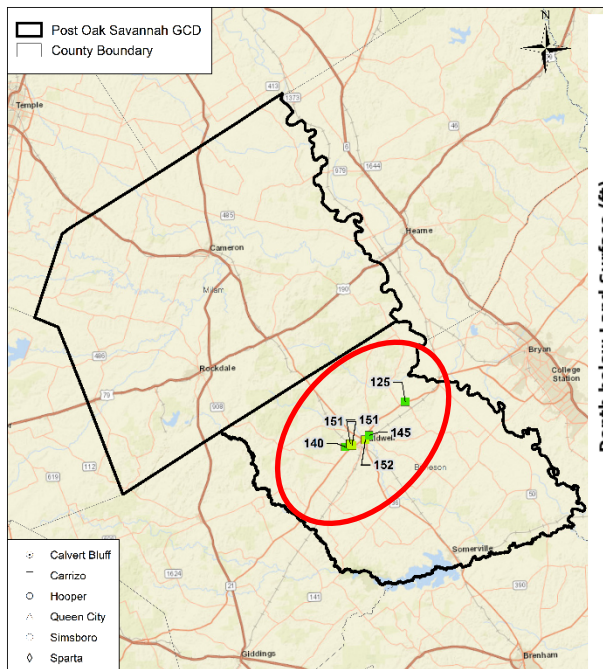
Example Queen City Well Diagrams & Water Levels



Water Levels: — 1930 --- 2010 2070

Carrizo

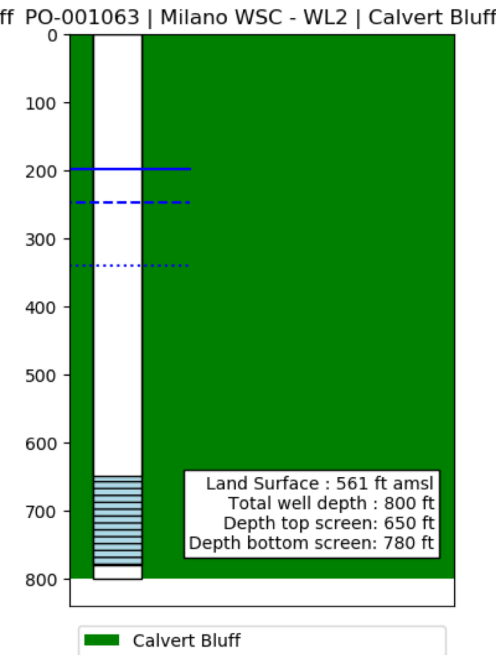
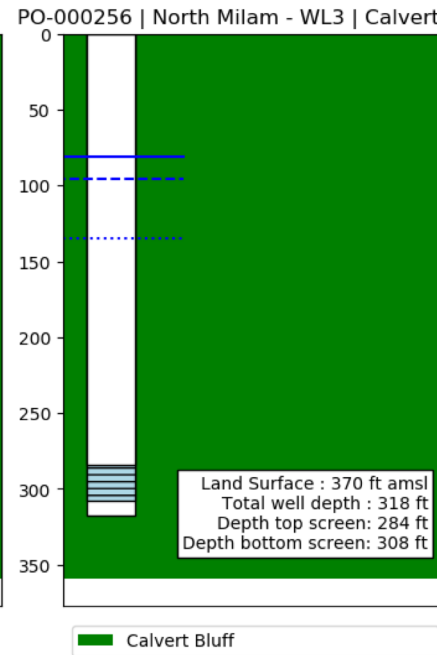
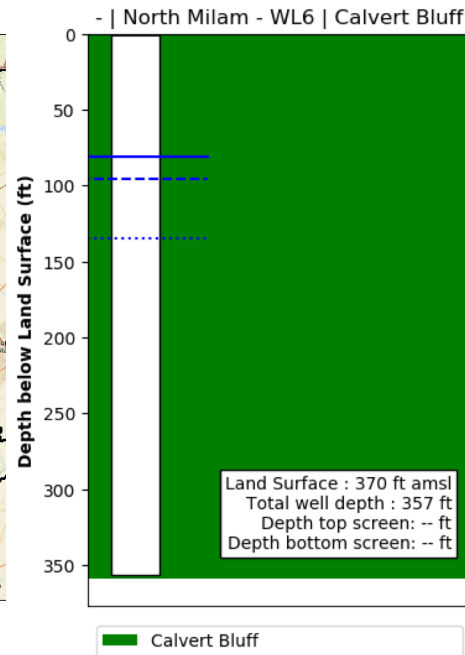
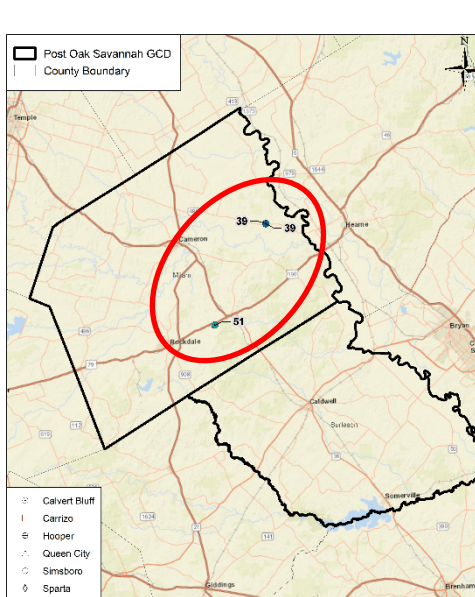
Example Carrizo Well Diagrams & Water Levels



Water Levels: — 1930 --- 2010 2070

Calvert Bluff

Example Calvert Bluff Well Diagrams & Water Levels

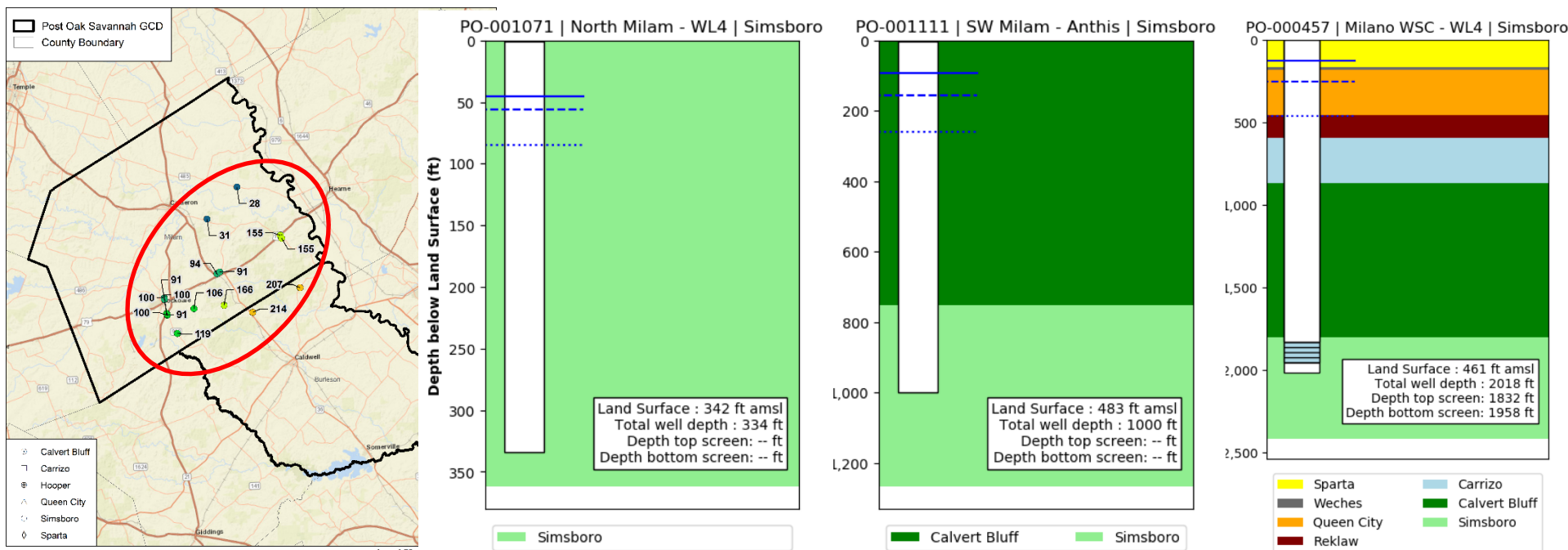


*If only one aquifer layer, indicates an **outcrop** well*

Water Levels: — 1930 --- 2010 2070

Simsboro

Example Simsboro Well Diagrams & Water Levels

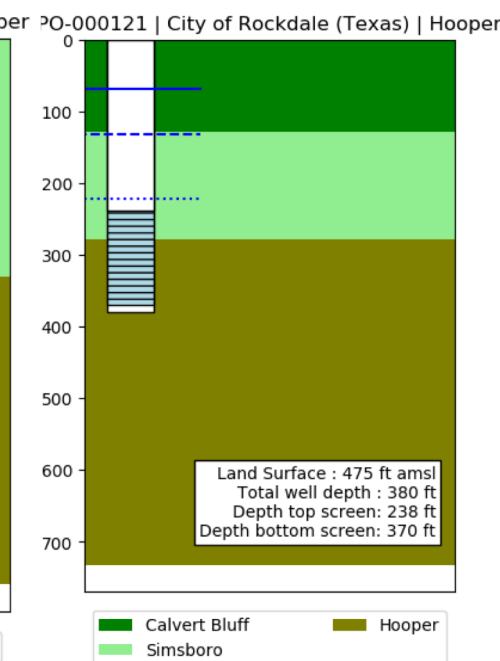
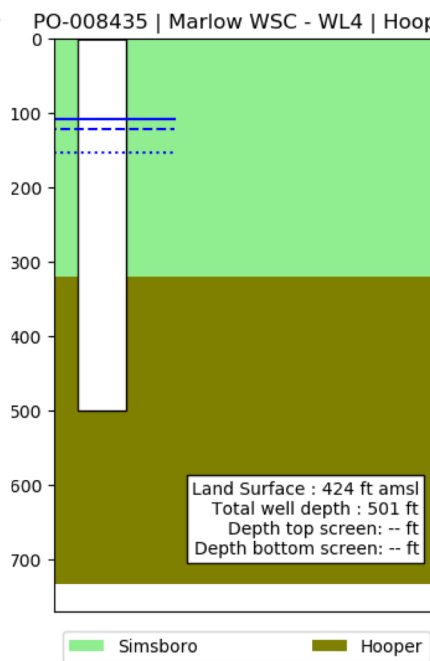
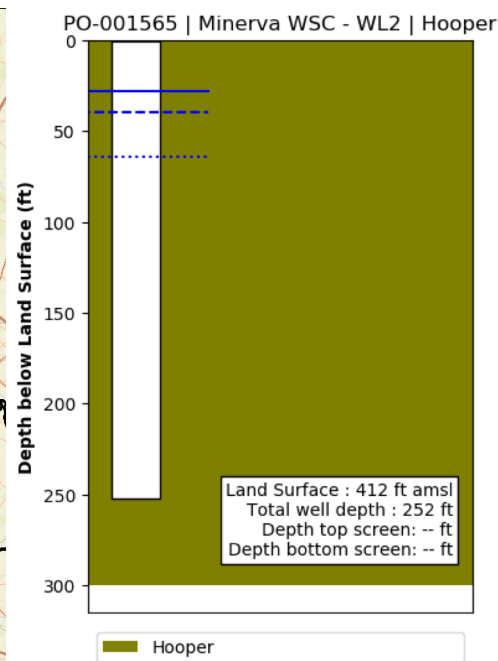
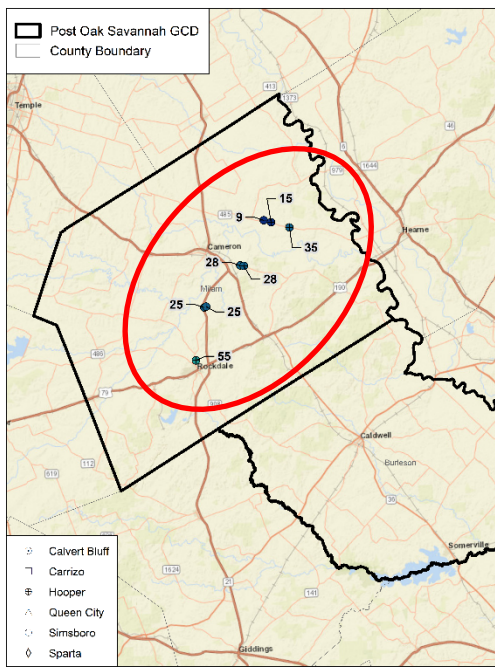


*If only one aquifer layer, indicates an **outcrop well***

Water Levels: — 1930 --- 2010 2070

Hooper

Example Hooper Well Diagrams & Water Levels



*If only one aquifer layer,
indicates an **outcrop** well*

Water Levels: — 1930 --- 2010 2070

POSGCD Approach for Aquifer Protection

- Groundwater Management Zones
- Groundwater Monitoring Program
- POSGCD Rules for Aquifer Protection

5. Management Zones

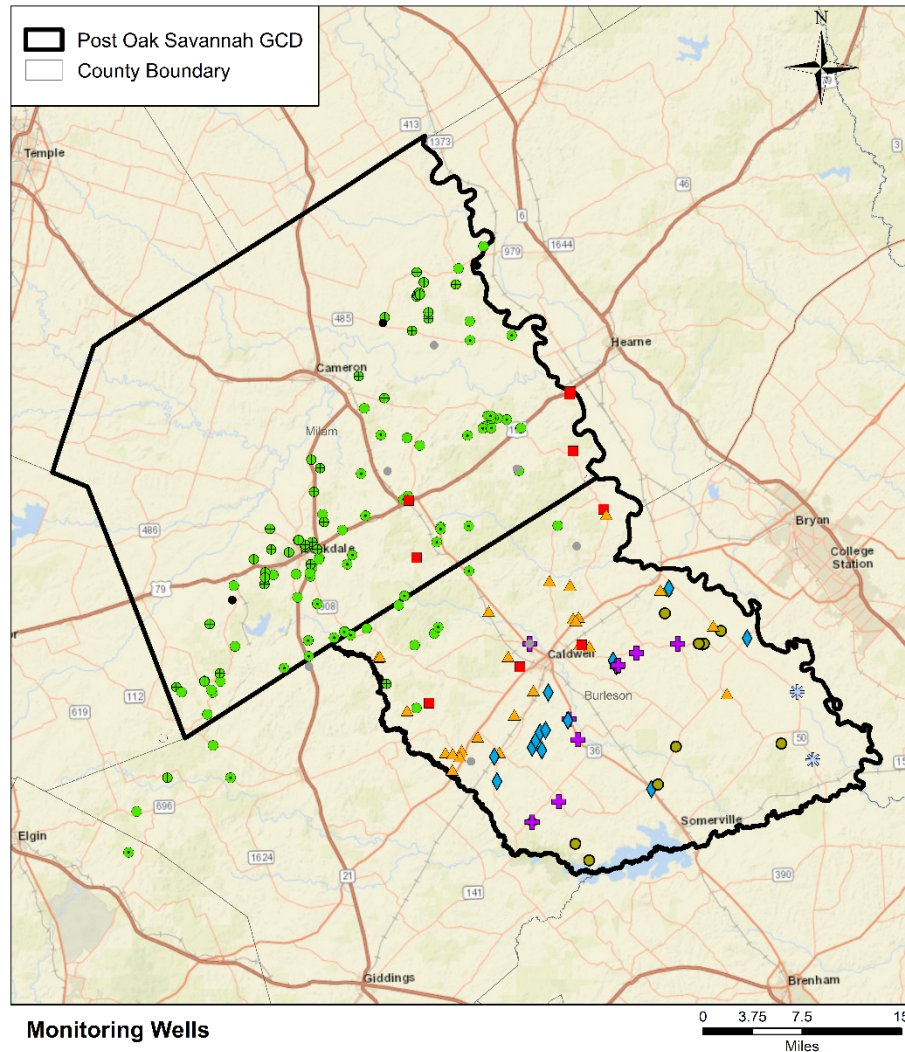
The District is divided into groundwater management zones for the purpose of evaluating and managing groundwater resources recognizing the different characteristics and anticipated future development of the aquifers in the District.

The District will establish and enforce Rules for the spacing of wells, the maximum allowable production of groundwater per acre of land located over an aquifer, require permits for production, regulate drawdown and provide for a reduction in the maximum allowable production and permitted production of groundwater per acre of land based on the different surface and subsurface characteristics and different evaluation and monitoring within the Management Zones.

Designated Management Zones

- **Aquifers:** Brazos River Alluvium, Trinity, Sparta, Queen City, Carrizo, Upper Wilcox, Middle Wilcox, Lower Wilcox, Yegua/Jackson Management Zone
- **Shallow Zones for Aquifers:** All deposits that occur at a depth of 400 feet or less for aquifers above except for Brazos River Alluvium ... purpose is to characterize the water levels in the unconfined portions of the aquifers

Monitoring Well Network



Guidance Document for Collection and Analysis of Monitoring Data

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Appendix A: POSGCD Groundwater Monitoring Well Network

Appendix B: POSGCD Aquifer Assignment Methodology

Appendix C: POSGCD Monitoring Protocols

Appendix D: POSGCD Health and Safety Plan

Appendix E: POSGCD Water Level Measurement Form

Appendix F: Determining Average Drawdown in POSGCD Aquifer Management Zones for GMA 12 DFCs

Appendix G: Determining Average Drawdown in Shallow Aquifer Management Zones for POSGCD PDLs

Post-Oak-Savannah-Guidance-Document-for-Evaluating-Compliance-with-Desired-Future-Conditions-and-Protective-Drawdown-Limits-¶

¶

¶

Prepared-for:¶



¶

Post-Oak-Savannah-Groundwater-Conservation-District¶
310-E-Ave-C¶
Milano,TX-76556¶

¶

¶

Prepared-by:¶



9600-Great-Hills-Trail¶
Suite-300W¶
Austin,TX-78759¶

¶

¶

¶

¶

August-2018¶

Status of PDF Compliance

Management Zone	PDL	Drawdown from 2000 to 2012	Drawdown from 2000 to 2013	Drawdown from 2000 to 2014	Drawdown from 2000 to 2015	Drawdown from 2000 to 2016	Drawdown from 2000 to 2017
		Calculated Drawdown (% of DFC)	Calculated Drawdown (% of DFC)	Calculated Drawdown (% of DFC)	Calculated Drawdown (% of DFC)	Calculated Drawdown (% of DFC)	Calculated Drawdown (% of DFC)
Yegua Jackson	20	5.7 (29%)	6.4 (32%)	6.8 (34%)	7.3 (36%)	4.1 (21%)	3.1 (15%)
Sparta	20	4 (20%)	4.5 (22%)	4.9 (25%)	4.5 (22%)	3.1 (15%)	2.4 (12%)
Queen City	20	3.4 (17%)	4.1 (20%)	4.6 (23%)	4.1 (20%)	2.2 (11%)	1.2 (6%)
Carrizo	20	4.7 (23%)	5.8 (29%)	6.2 (31%)	5.6 (28%)	3.5 (18%)	2.2 (11%)
Calvert Bluff (Upper Wilcox)	20	5.9 (29%)	7 (35%)	7.2 (36%)	6.7 (34%)	5.5 (27%)	4.5 (22%)
Simsboro (Middle Wilcox)	20	6 (30%)	6.6 (33%)	6.7 (33%)	6.1 (31%)	5 (25%)	4 (20%)
Hooper (Lower Wilcox)	20	6 (30%)	6.2 (31%)	6.3 (32%)	6.2 (31%)	5.1 (26%)	4.3 (22%)

Rule 16.4- Actions Based on Monitoring Results

- Threshold 1
 - Criteria (60% of MAG, 50% of DFC or PDL, DFC projected using GAM to be exceeded in 15 years)
 - Initial Required Action (addition study to identify the source of impacts and/or improve site data or analysis tools)
- Threshold 2
 - Criteria (70% of MAG, 60% of DFC or PDL)
 - Initial Required Action (review of MP and rules, initiation of public process to discern preventive and/or protective actions including but limited to Rules 16.5 and 16.6, initiate development of response and action workplan)

Rule 16.4- Actions Based on Monitoring Results (con't)

- Threshold 3
 - Criteria (75% of DFC or PDL)
 - Initial Required Action(consider and adopt amendments to MP and rules, conduct public hearings, develop and implement a Response and Action Workplan)
 - Reduce permitted production and/or maximum allowable production

Rule 16.5 Reductions Required by Regulatory Action

- “Board may proportionately reduce the maximum amount of water that may be permitted per acre and the volume of water authorized to be produced under any permit issued by the District”
- “Board will adjust the thresholds established in Rule 16.4...”

Rule 16.6 Adjusting Maximum Production Permitted

- “District shall adjust the maximum groundwater production permitted per acre and/or the permitted production under any permit issued by the District as follows:”
 - “the maximum water production permitted per acre for the Management Zone and the water authorized to be produced under any permit issued by the District for that zone will be reduced”
 - “production in a Management Zone may be reduced to the extent that production in that Management Zone is impacting water drawdown levels in any Management Zone in the District”
 - “The maximum allowable production of 2 acre feet of groundwater per acre of land, provided in Rule 5.1.2, may be reduced, and the maximum allowable production may be established or reduced for any one, or more than one, Management Zone”

Adjustments to the 2 AFY/acre Maximum Production Rate

- Factors that Could be used for Basis of Fair Share
 - Surface acreage
 - Groundwater in storage underlying acreage
 - Aquifer production capacity underlying acreage
 - A combination of the three factors above
- Review Several Mathematical Options for Transforming (or Scaling) Factors to Production Rate (af/acre)
- Example Maps of Production Rates
 - Single aquifers
 - All aquifers

A landscape photograph showing a shallow, rocky pool of water. The water is calm and reflects the sky and the surrounding rocky terrain. The sky is filled with large, white, fluffy clouds against a blue background. The rocks are reddish-brown and have a rough, textured surface. The pool is situated in a valley or a depression between the rocks. The overall scene is serene and natural.

Questions ?