DRAFT: INTERIM REPORT DOCUMENTING THE DEVELOPMENT OF THE POST OAK SAVANNAH GCD GROUNDWATER MONITORING PROGAM TO EVALUATE COMPLIANCE WITH DESIRED FUTURE CONDITIONS

Post Oak Savannah Groundwater Conservation District
310 East Avenue C
Milano, TX 76556

June 6, 2017

Version 1

Introduction

This technical memo summarizes the work completed since November 2015 regarding water level monitoring, drawdown calculations and DFC compliance in POSGCD.

Section 1 provides a brief overview of the role of the POSGCD monitoring network in measuring DFC compliance.

Section 2 describes the methodology used to calculate the average measured drawdown from the water levels of the monitoring well network.

Section 3 compares the average measured drawdown to the DFCs by Management Zone, indicating whether or not POSGCD is in compliance with DFCs.

Section 4 provides recommendations for improving both the drawdown calculation methodology and the monitoring well network.

I. Water Level Monitoring & DFCs

A. DFC Performance Standards defined in Management Plan

As outlined in the POSGCD Management Plan (adopted 2012), the monitored water levels are used as a performance standard for DFCs as follows:

> *"At least once every three years, the general manager will report to the Board the measured water levels obtained from the monitoring wells within each Management Zone, the average measured drawdown for each Management Zone calculated from the measured water levels of the monitoring wells within the Management Zone, a comparison of the average measured drawdowns for each Management Zone with the DFCs for each Management Zone, and the District's progress in conforming with the DFCs."*

To meet this requirement, POSGCD reviewed 2012 drawdown values (calculated from monitoring network data) and compared them to DFCs. This presentation was given at a meeting held on November 10, 2015 and is included as **Attachment A**. For all Management Zones with sufficient monitoring data to make the drawdown calculation, the district was in compliance with DFCs. Some Management Zones could not be evaluated due to lack of data, such as the Shallow Yegua-Jackson Management Zone.

B. Current Status of the Monitoring Network

The POSGCD monitoring network currently consists of 111 wells that are measured on an approximately annual basis. Monitoring well locations are shown in **Figure 1** and additional well info is provided in **Appendix A**. Most wells are screened in the Carrizo-Wilcox Aquifer. For the purposes of water level monitoring and drawdown calculations, the POSGCD database is supplemented with well data from neighboring Brazos Valley GCD and Lost Pines GCD. These locations are also indicated in **Figure 1**.

The aquifer assignment for each monitoring well is based on the well screen interval, if that information is available, or the well depth, if not. The wells were compared to the structural surfaces from the groundwater availability models (GAMs) in GMA 12 and assigned to the aquifer with which the well screen intersects or in which the bottom of the well terminates. The results of this analysis were presented November 10, 2015 and shown in **Figures 2** and **3**. Some aquifer assignments for wells differ from the aquifer assignments provided in the TWDB groundwater database. POSGCD is currently coordinating with TWDB to update these well assignments (**Appendix B**).

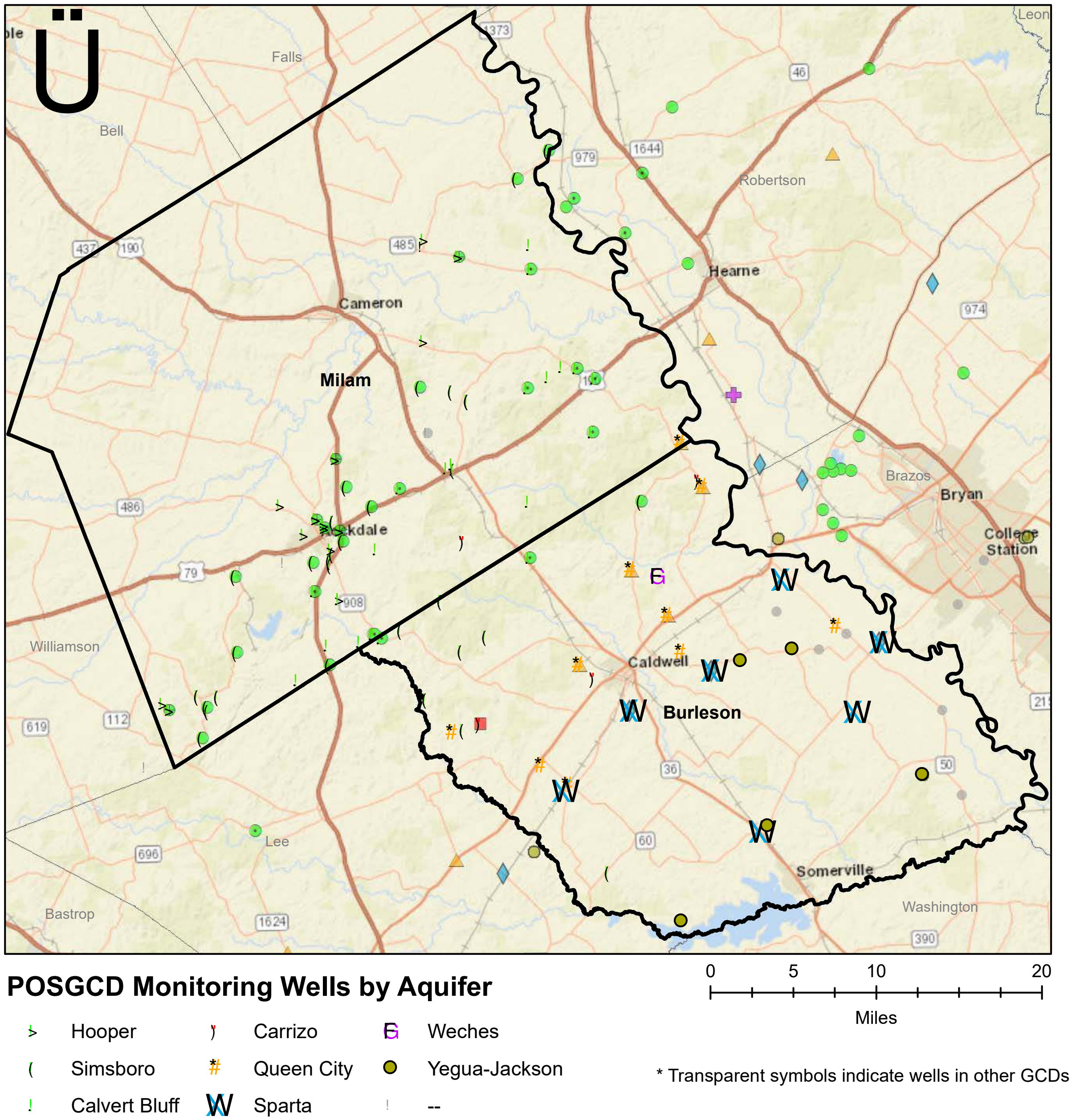

Figure 1. Monitoring well locations used in the drawdown calculations

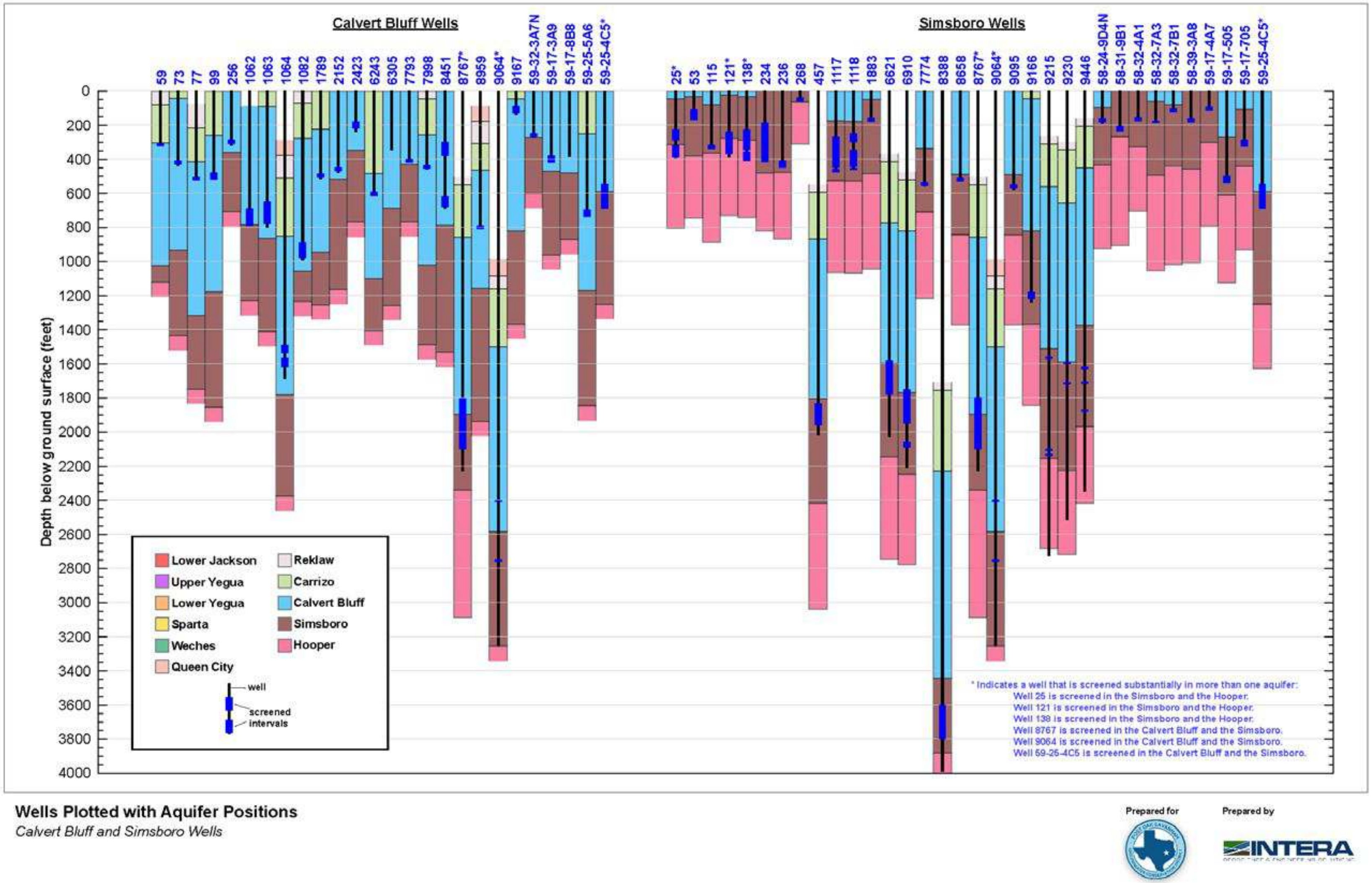

Figure 2. Monitoring wells with aquifer assignments in Calvert Bluff and Simsboro Aquifers.

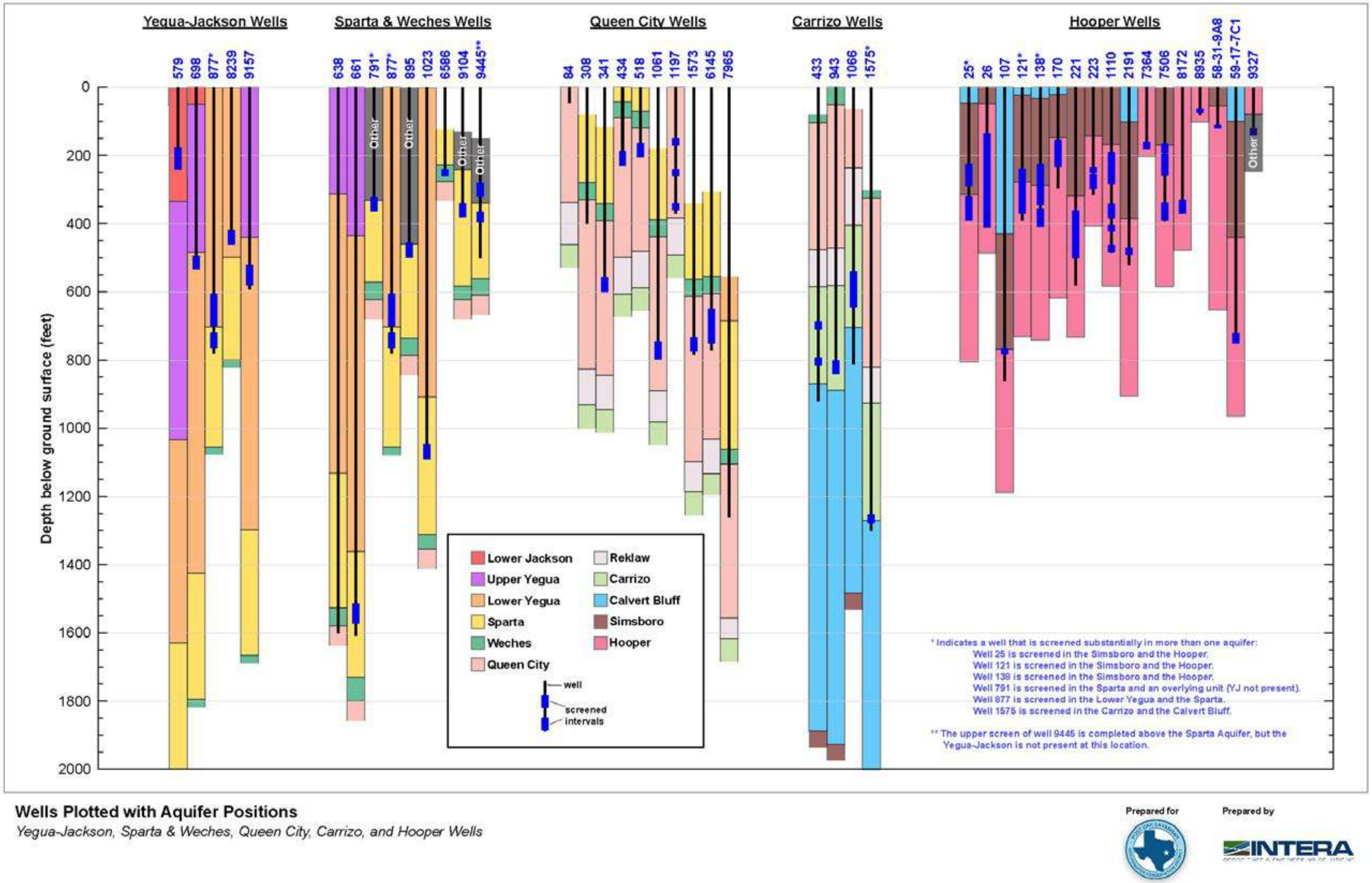

Figure 3. Monitoring wells with aquifer assignments in Calvert Bluff and Simsboro Aquifers

II. Methodology for Calculating Drawdown

A. Motivation

The Management Plan does not specify the methodology for calculating an average drawdown so POSGCD considered different calculation methods before adopting a "best-practices" method. Several presentations were provided to the DFC Committee on this topic, beginning in 2015. These presentations are summarized in **Table 1** and included as Attachments to this memo.

Meeting Date	Discussion Topic	Attachment
November 10, 2015	- Presentation of drawdown results for 2012, using different calculation methods. - Selection of "best-practices" calculation method - POSGCD shown to be in compliance with DFCs, as of 2012	A
January 12, 2016	- comparison of MAG and pumping permits. - Presentation of drawdown calculated from GAM model - Discussion about appropriateness of Shallow Zones	B
March 8, 2016	- Presentation of drawdown results for 2014 - POSGCD shown to be in compliance with DFCs, as of 2014 - Shallow Management Zones shown to be inappropriate, due to large depths	C
May 10, 2016	- Presentation of drawdown results for all shallow wells in POSGCD, using different shallow cut-off depths - Selection of "best-practices" cut-off depth	D
May 3, 2017	- Presentation of drawdown in Shallow Management Zones, using different extents	E

B. "Best-Practices" for Calculating Drawdown

Based on the discussions summarized in **Table 1**, POSGCD decided on the following "best-practices" for calculating drawdown from water level monitoring data.

1) Use 3-year moving average to determine annual water levels at wells

Pros: Provides continuous data series even if there are missing measurement years.
Smooths out spikes in data and provides a more realistic water level

Cons: Not a true annual value

2) Only use wells that have a calculated 3-year moving average water level for *both* the baseline year (2000) and the current year in question (ex. 2012).

Pros: Provides an "apples-to-apples" comparison of water levels in different years
Prevents bias caused by the absence/presence of wells in one year of the comparison

Cons: Can't use full dataset of available monitoring data for each year

3) Calculate drawdown using water level *surfaces* interpolated from monitoring wells, rather than just the point values at individual monitoring wells.

Pros: Provides a more realistic representation of drawdown across the *entire* aquifer
Allows evaluation of areas with no/sparse monitoring data.

Cons: Requires additional interpretation of data, rather than just water level collection

4) Use water level monitoring data from neighboring Brazos Valley GCD and Lost Pines GCD, as available.

Pros: Increase temporal and spatial coverage of water level monitoring data.

Cons: Requires coordination between GCDs in order to acquire and combine datasets. Different GCDs have different measurement times and sampling protocols.

C. Drawdown Calculation Method

The following methodology incorporates the "best practices" described above and was used to calculate drawdown in the Management Zones for each aquifer. The methodology consists of several steps which are explained below. **Figure 3** has been constructed to illustrate the analyses associated with several of the steps.

Step 1:

For each monitoring well in the aquifer, determine the average *baseline* water level by averaging all water levels recorded at that well during a 3-year window around 2000 (1999 to 2001), including available monitoring data from neighboring Brazos Valley GCD and Lost Pines GCD.

Step 2:

For each monitoring well in the aquifer, determine the average *current* water level by averaging all water levels recorded at that well during a 3-year window around the *current* year, including available monitoring data from neighboring Brazos Valley GCD and Lost Pines GCD.

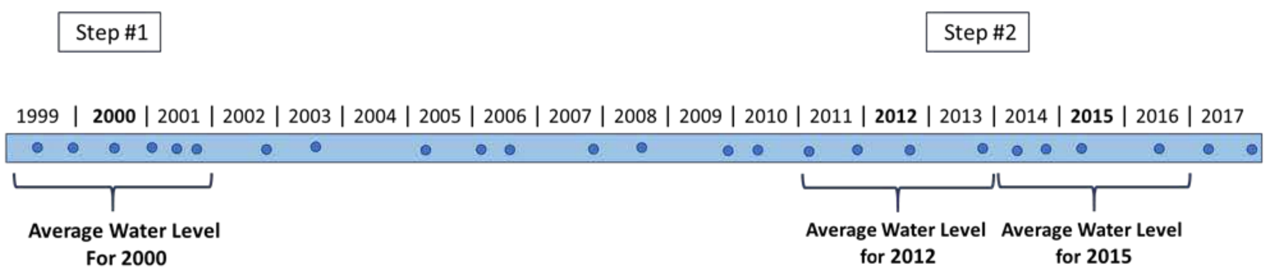

Figure 2. Diagram of 3-year moving average calculation. Dots represent water level measurements.

Step 3a:

Using only those wells with a water level value in both the *baseline* year (2000) and the *current* year, interpolate a *baseline* (2000) water level surface with 500-foot grid cell size for the aquifer using the Kriging toolbox in ArcGIS.

Step 3b:

Using only those wells with a water level value in both the *baseline* year (2000) and the *current* year, interpolate a *current* water level surface with 500-foot grid cell size for the aquifer using the Kriging toolbox in ArcGIS.

Step 4a:

Clip the *baseline* water level surface (Step 3a) to the Management Zone extent using the Clip Raster toolbox in ArcGIS

Step 4b:

Clip the *current* water level surface (Step 3b) to the Management Zone extent using the Clip Raster toolbox in ArcGIS.

Step 5a:

Determine the average *baseline* water level value from the Raster Properties of the clipped *baseline* water level surface (Step 4a). This represents the average value of all grid cells falling within that Management Zone.

Step 5b:

Determine the average *current* water level value from the Raster Properties of the clipped *current* water level surface (Step 4b). This represents the average value of all grid cells falling within that Management Zone.

Step 6:

Calculate drawdown by subtracting the *current* water level value (Step 5b) from the *baseline* water level value (Step 5a).

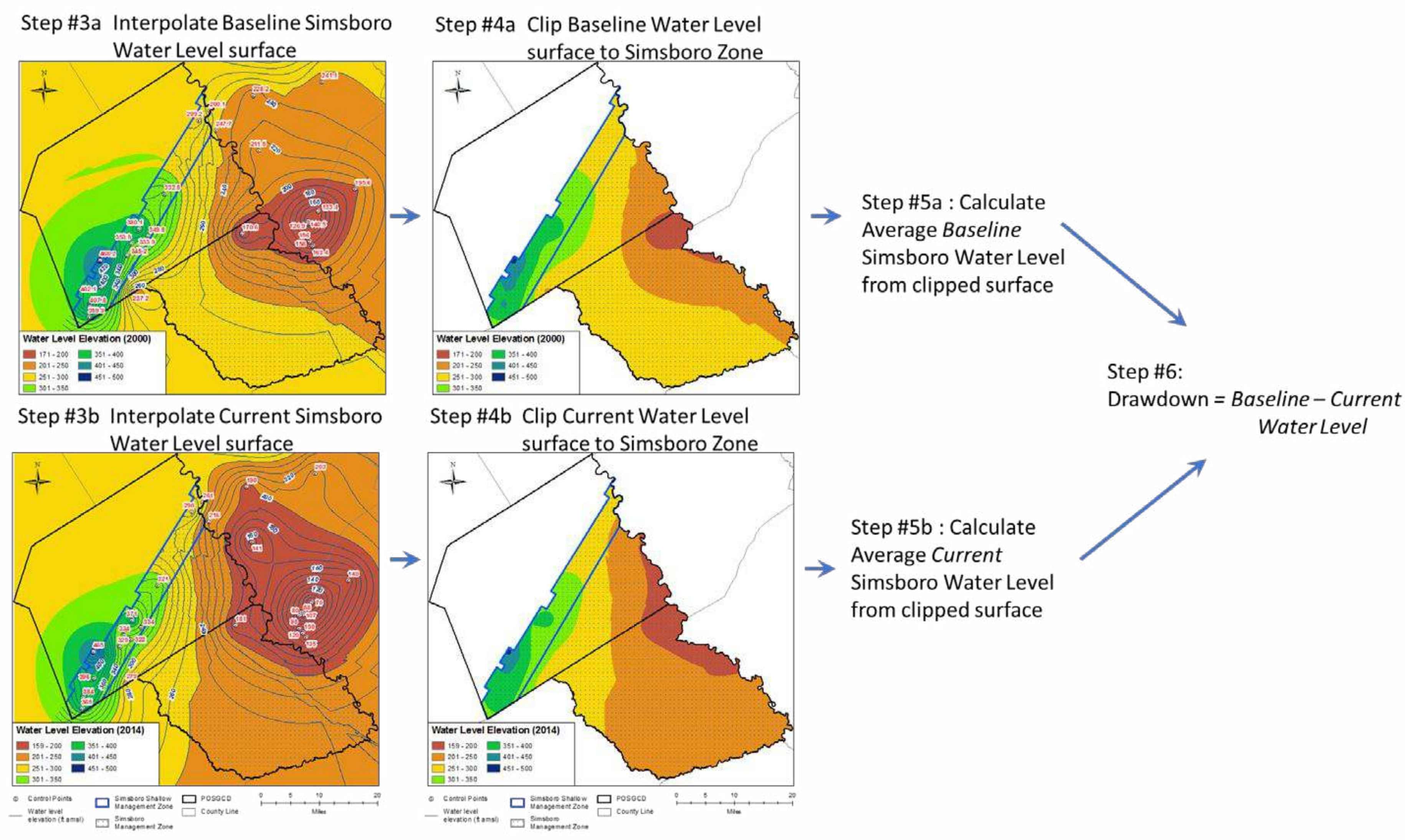

Figure 3. Diagram of Drawdown Calculation Method

III. Status of DFC Compliance based on Calculated Drawdown from Monitoring Network

Average drawdowns for the years 2012 and 2014 were calculated using the methodology in Section 2. Calculated 2012 values for all POSGCD Management Zones were presented November 10, 2015. Calculated 2014 values for the Wilcox aquifers were presented March 8, 2016. Calculated 2012 and 2014 values for all Management Zones are provided in **Table 2** and illustrated in **Figure 4**. The DFCs for all Management Zones, as defined in the POSGCD Management Plan (adopted 2012) are also provided in **Table 2**.

Aquifer	Management Zone	Desired Future Condition	2012			2014		
			Calculated Drawdown	Percent of DFC	DFC Compliant?	Calculated Drawdown	Percent of DFC	DFC Compliant?
Sparta	Shallow	10	**4**	36%	yes	**4**	44%	Yes
	Entire	30	**4**	12%	yes	**5**	15%	Yes
Queen City	Shallow	10	**3**	31%	yes	**4**	36%	Yes
	Entire	30	**3**	10%	yes	**3**	11%	Yes
Carrizo	Shallow	20	**7**	33%	yes	**--**	--	unknown
	Entire	65	**7**	10%	yes	**--**	--	unknown
Calvert Bluff (Upper Wilcox)	Shallow	20	**0**	0%	yes	**1**	7%	Yes
	Entire	140	**-11**	-8%	yes	**-12**	-8%	Yes
Simsboro (Middle Wilcox)	Shallow	20	**10**	48%	yes	**11**	54%*	Yes
	Entire	300	**11**	4%	yes	**14**	5%	Yes
Hooper (Lower Wilcox)	Shallow	20	**6**	31%	yes	**7**	36%	Yes
	Entire	180	**7**	4%	yes	**8**	5%	Yes
Yegua Jackson	Shallow	15	**--**	--	unknown	**--**	--	unknown
	Entire	100	**16**	16%	yes	**17**	17%	Yes
Brazos River Alluvium	Milam	5	**--**	--	unknown	**--**	--	unknown
	Burleson	6	**--**	--	yes	**--**	--	unknown

Table 2. Calculated average drawdowns for the years 2012 and 2014

* Threshold 1 was reduced to 50% as of May 3, 2017.

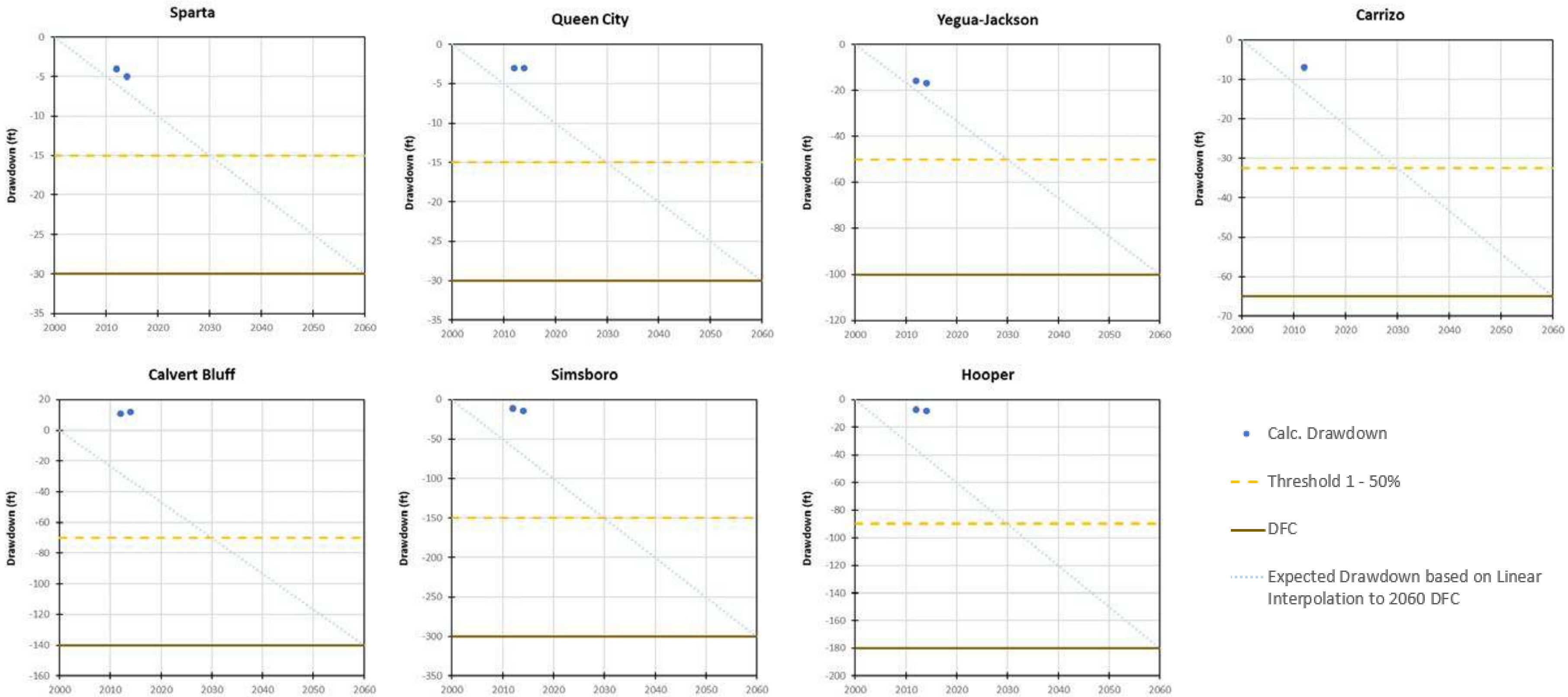

Figure 4. Status of DFC compliance by Aquifer Management Zone.

In both 2012 and 2014, all evaluated POSGCD Management Zones were in compliance with DFCs. Note that some Management Zones could not be evaluated due to insufficient data. The Shallow Management Zones show the largest drawdown as a percentage of DFCs. As discussed during the March 8, 2016 meeting however, these drawdowns do not necessarily represent the true water levels in the shallow POSGCD aquifers. The Shallow Management Zones are unscientifically drawn and can include very deep sections of the aquifer, as shown in **Figure 5**. Recommendations for adjusting the Shallow Management Zones are included in **Appendix C**.

IV. Recommendations

A. Technical Recommendations:

1) Increase monitoring wells in Management Zones where there is currently sparse or even insufficient data to evaluate DFCs
2) Evaluate Shallow Management Zones based on district-wide shallow aquifer drawdown rather than on drawdown in individual aquifers (discussed in further detail in Appendix C)
3) Work with neighboring Brazos Valley GCD and Lost Pines GCD to develop sampling/ measurement protocols, including establishing regular time periods for measurement and standardized documentation for the time lag between the water level measurement and when the well was last pumped.
4) Define the areal extent of each aquifer to be included in calculating DFC compliance. Two possible criteria are the areal extent of the aquifer represented in a GAM or a cut-off water quality value such as a total dissolved solids (TDS) concentration of 3,000 mg/L or 10,000 mg/L. The EPA defines the upper limit of TDS concentrations for groundwater as 10,000 mg/L.
5) Reduce the maximum depth of the wells used to define the shallow zone from 400 feet to 300 feet or less after sufficient shallow wells with depth less than 300 feet have been included in the monitoring system. Investigate option for POSGCD to install shallow 2-inch monitoring wells along county roads.
6) Evaluate alternative calculation methods to use as "reasonability tests" for values calculated using current method. For instance, use "smart" contouring programs that account for groundwater flow and pumping, rather than the direct Kriging used in the current method.
7) For the drawdown-based DFCs that have a base year of 2000, evaluate the benefits of changing the base year to a later time such as 2010 so that more monitoring wells can be paired to existing monitoring wells.

B. Administrative Recommendations

1) Re-define extents of Shallow Management Zones in Management Plan to better represent actual shallow aquifer regions (discussed in further detail in Appendix C).
2) Produce a guidance document for calculating drawdown that can serve as a companion document to the District Management Plan.
3) Coordinate with TWDB regarding POSGCD monitoring wells that have aquifer designations recorded in TWDB state-wide groundwater database that are different than the aquifer designation determined by POSGCD.
4) Adopt sampling/measurement protocols and document in a manual or guidance document. This should be created in coordination with neighboring Brazos Valley GCD and Lost Pines GCD.
5) Work with GMA-12 districts to adopt a shallow zone DFC for GMA 12.

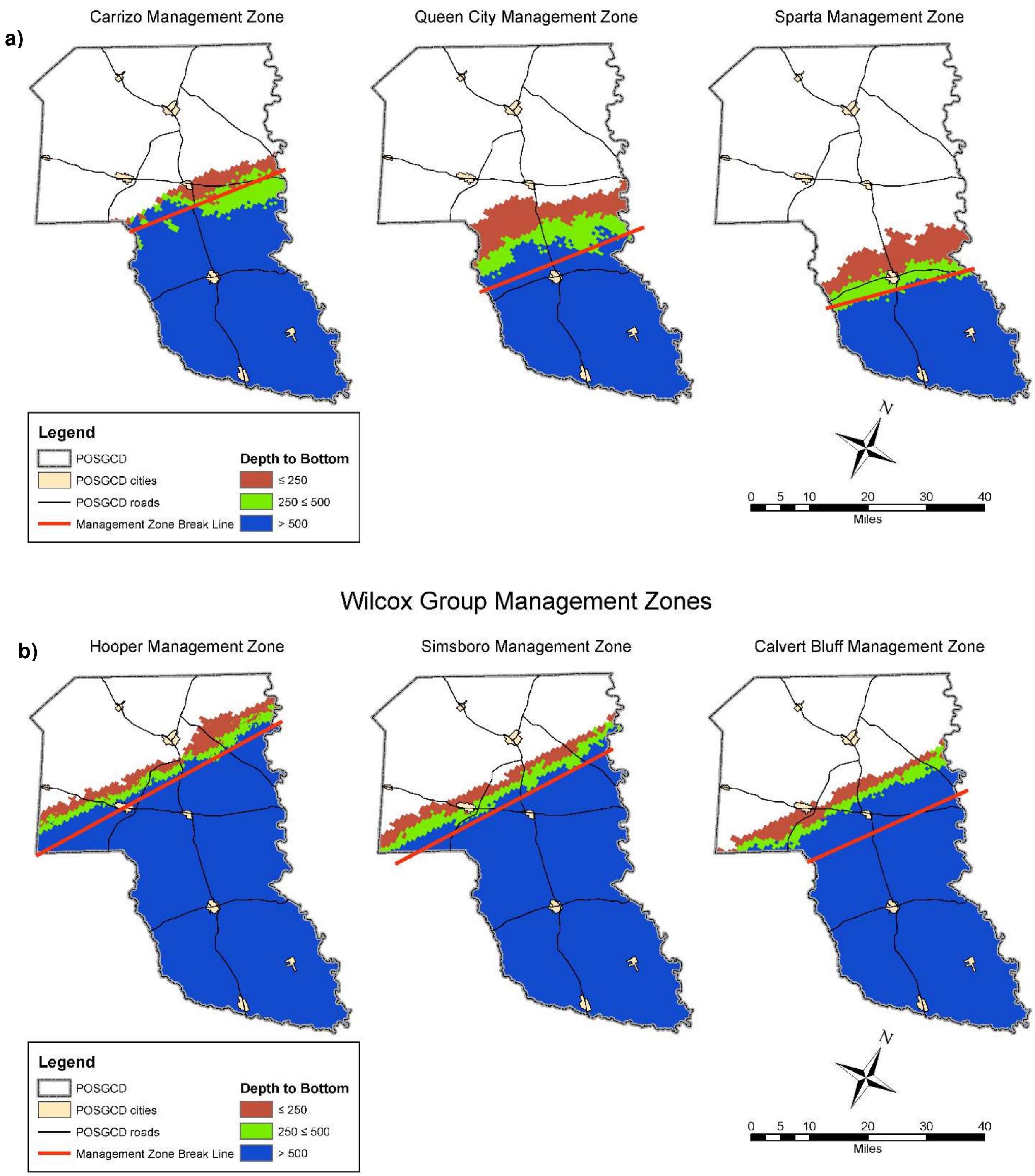

Figure 5. Current Shallow Management Zone extents compared to actual depth of aquifer

APPENDIX A:
Monitoring Well Information

POSGCD Well Number	State Well Number	Owner	Latitude *(decimal degrees)*	Longitude *(decimal degrees)*	Surface Elevation *(ft amsl)*	Depth *(ft)*	Screened Intervals	TWDB Aquifer	POSGCD Aquifer (First Unit)	POSGCD Aquifer (Second Unit)	Inconsistent with TWDB?
25	5917409	City of Rockdale (Belton)	30.668888	-96.986388	505	391	226-290, 320-390	124HOOP - Hooper	Simsboro	Hooper	Aquifer
26	5917103	Ralph Summers- Mary Jane Boyd	30.723888	-96.982777	457	410	136-410	124HOOP - Hooper	Hooper	--	OK
53	5909901	Richard Frock	30.784166	-96.895555	434	169	109-169	124SMBR - Simsboro	Simsboro	--	OK
59	5911402	Harold Lange	30.796944	-96.734444	426	323	307-323	124CABF - Calvert Bluff	Calvert Bluff	--	OK
73	5910907	Willard Kornegay	30.780832	-96.784999	383	440	410-430	124CABF - Calvert Bluff	Calvert Bluff	--	OK
77	5919103	Charles Hoppe	30.740555	-96.720832	433	522	507-522	124CABF - Calvert Bluff	Calvert Bluff	--	OK
84	5919302	James Ayers	30.728610	-96.632221	340	45	--	124QNCT - Queen City	Queen City	--	OK
99	5925508	Larry Sexton	30.569443	-96.947777	410	520	480-520	124CABF - Calvert Bluff	Calvert Bluff	--	OK
107	5925102	Noack Family Partnership, Ltd.	30.600833	-96.982499	412	860	767-782	124SMBR - Simsboro	Hooper	--	Depth , Screen , Aquifer
115	5917715	L.B. Kubiak	30.640833	-96.987777	443	337	316-337	124SMBR - Simsboro	Simsboro	--	Depth , Screen
121	5917714	City of Rockdale (Texas)	30.663611	-96.995833	475	390	238-370	124SMBR - Simsboro	Hooper	Simsboro	Depth, Aquifer
138	5917713	City of Rockdale (Tracy)	30.666388	-96.995833	485	408	226-346, 356-408	124SMBR - Simsboro	Hooper	Simsboro	Aquifer
170	5824914	Rockdale ISD	30.658333	-97.016666	495	295	153-233	124SMBR - Simsboro	Hooper	--	Aquifer
221	5909605	Marlow WSC	30.824443	-96.889721	424	503	340-500	124HOOP - Hooper	Hooper	--	Depth , Screen
223	5902706	North Milam WSC	30.897499	-96.851944	359	315	235-250, 256-298	124WLCX - Wilcox	Hooper	--	Screen, Aquifer
234	5902309	Wendy Breck	30.987777	-96.757777	299	417	185-417	124SMBR - Simsboro	Simsboro	--	OK
236	5902307	Jared & Heather Campbell	30.964166	-96.790555	416	450	410-450	124WLCX - Wilcox	Simsboro	--	Aquifer
256	5902901	North Milam WSC	30.884999	-96.778332	371	318	284-308	124WLCX - Wilcox	Calvert Bluff	--	Aquifer
268	5832101	Wayne Diver	30.623332	-97.088055	474	60	40-60	124HOOP - Hooper	Simsboro	--	Aquifer
308	5927716	R. B. Wilkens	30.537221	-96.741666	452	400	--	124QNCT - Queen City	Queen City	--	OK
341	5927606	Rudy Steck	30.578054	-96.650555	394	600	558-600	124QNCT - Queen City	Queen City	--	Screen
433	5920410	Milano WSC- Rita Test	30.695555	-96.614444	299	920	688-710, 794-815	124SMBR - Simsboro	Carrizo	--	Depth , Screen , Aquifer
434	5920409	L. C. Hall, Sr.	30.689721	-96.611388	299	230	188-230	124QNCT - Queen City	Queen City	--	Screen
457	5919502	Milano WSC - Well 4	30.679166	-96.673610	462	2018	1832-1958	124CZSB - Carrizo and Simsboro	Simsboro	--	Screen, Aquifer
518	5927204	Dale Hill	30.618888	-96.686388	315	205	163-205	124QNCT - Queen City	Queen City	--	Screen
579	5937611	Camilla J. Godfrey	30.432221	-96.397777	233	240	177-240	124JCKSL - Lower Jackson	Lower Jackson	--	OK
596	5937329	Finley Company	30.488610	-96.375554	215	58	--	111ABZR - Alluvium, Brazos River	BRAA	--	OK
638	5937101	Snook well #1	30.489166	-96.465000	240	1600	--	124QNCT - Queen City	Sparta	Weches/QC	Aquifer
661	5936802	Lyons Water Supply	30.386944	-96.564722	342	1609	1513-1573	124SPRT - Sparta	Sparta	--	OK
698	5943608	Birch Creek Recreation	30.310833	-96.646388	270	533	494-533	124YEGUL - Lower Yegua	Lower Yegua	--	OK
787	5938701	Burnside Services, Inc.	30.413611	-96.358333	205	56	--	111ABZR - Alluvium, Brazos River	BRAA	--	OK
791	5935208	Juanita Amidon	30.496354	-96.691918	379	364	322-364	124SPRT - Sparta	Sparta	Above Sparta	Screen
859	5929456	Marion Malazzo	30.543633	-96.493766	231	60	--	111ABZR - Alluvium, Brazos River	BRAA	--	OK
860	5929457	Marion Malazzo	30.544533	-96.492043	231	60	--	111ABZR - Alluvium, Brazos River	BRAA	--	OK
877	5928619	Tunis Water Supply	30.545555	-96.525554	267	780	605-700, 719-765	124SPRT - Sparta	Lower Yegua	Sparta	Screen, Aquifer
894	5928601	P. G. Haines	30.579166	-96.540555	240	58	--	111ABZR - Alluvium, Brazos River	BRAA	--	OK
895	5928702	Sarah Engleman	30.529166	-96.608333	346	498	456-498	124SPRT - Sparta	Sparta	--	Screen
943	5934106	Nathan Ausley	30.488610	-96.843610	441	840	800-840	124CRRZ - Carrizo	Carrizo	--	OK
1023	5929537	Texas A & M University	30.549166	-96.436944	225	1090	1048-1090	124SPRT - Sparta	Sparta	--	Screen

POSGCD Well Number	State Well Number	Owner	Latitude *(decimal degrees)*	Longitude *(decimal degrees)*	Surface Elevation *(ft amsl)*	Depth *(ft)*	Screened Intervals	TWDB Aquifer	POSGCD Aquifer (First Unit)	POSGCD Aquifer (Second Unit)	Inconsistent with TWDB?
1061	5934607	Deanville Water Supply Corporation 2	30.450000	-96.783333	404	797	745-797	124QNCT - Queen City	Queen City	--	OK
1062	5918101	Milano WSC - Well # 1	30.716233	-96.863433	565	790	689-790	124CABF - Calvert Bluff	Calvert Bluff	--	OK
1063	5918104	Milano WSC - Well # 2	30.712780	-96.868890	549	800	650-780	124CABF - Calvert Bluff	Calvert Bluff	--	Screen
1064	5918908	Milano WSC - Well # 3	30.632283	-96.788067	520	1687	1490-1534, 1564-1620	124CZSB - Carrizo and Simsboro	Calvert Bluff	--	Aquifer
1066	5918705	Milano WSC - Buer Well	30.648217	-96.854650	581	813	540-645	124SMBR - Simsboro	Carrizo	--	Depth , Screen , Aquifer
1082	5911703	Gause Water Supply # 1	30.787222	-96.716667	367	992	889-980	124SMBR - Simsboro	Calvert Bluff	--	Aquifer
1110	5824611	Southwest Milam Water Supply Corp.	30.671417	-97.004500	490	485	190-283, 343-383, 403-423, 463-483	124HOOP - Hooper	Hooper	--	OK
1117	5917712	City of Rockdale (runway)	30.631200	-96.990100	460	475	270-450, 460-475	124SMBR - Simsboro	Simsboro	--	OK
1118	5917711	City of Rockdale (airport)	30.634917	-96.991033	462	463	250-300, 345-443, 453-463	124SMBR - Simsboro	Simsboro	--	OK
1166	5929410	Holland Porter	30.557917	-96.470083	225	71	--	111ABZR - Alluvium, Brazos River	BRAA	--	OK
1197	5934107	Nathan C. Ausley	30.481100	-96.872100	440	370	150-170, 240-260, 340-360	124QNCT - Queen City	Queen City	--	Screen
1573	5934601	Deanville Water Supply Corporation 1	30.432499	-96.756388	383	784	734-774	124QNCT - Queen City	Queen City	--	OK
1575	5927718	Deanville Water Supply Corporation 4	30.525554	-96.726660	447	1300	1252-1277	124CZCB - Carrizo and Calvert Bluff	Carrizo	Calvert Bluff	OK
1789	--	Terry & Sheryl Hall	30.798454	-96.748917	436	515	487-507	--	Calvert Bluff	--	n/a
1883	5832704	Martin Hobbs	30.506500	-97.118558	482	180	160-180	124SMBR - Simsboro	Simsboro	--	OK
2152	5925409	Glynn Phillips	30.560960	-96.995140	467	480	450-470	124CABF - Calvert Bluff	Calvert Bluff	--	OK
2191	5917716	L.B. Kubiak	30.644744	-96.989442	464	520	470-490	124HOOP - Hooper	Hooper	--	OK
2423	5902904	Gary & Deryl Emola	30.905951	-96.778042	401	240	180-220	124SMBR - Simsboro	Calvert Bluff	--	Aquifer
6145	5927611	Alvin J. Kutach	30.545711	-96.637995	397	770	650-750	ND	Queen City	--	Aquifer
6243	5925502	Birdie Kristoff	30.565500	-96.941000	427	614	593-614	124CZCB - Carrizo and Calvert Bluff	Calvert Bluff	--	Aquifer
6305	5832908	Charles Lee McDaniel	30.531240	-97.026850	438	344	--	124CABF - Calvert Bluff	Calvert Bluff	--	OK
6586	5927309	Francis Joseph Landry, Jr.	30.613416	-96.660202	381	260	240-260	ND	Weches	--	Aquifer
6621	5926402	Frederick A. Jackson	30.552496	-96.860040	489	2020	1580-1780	124SMBR - Simsboro	Simsboro	--	Depth , Screen
6910	5926403	Charles & Jacqulin Stone Revocable Living Trust	30.564870	-96.834660	496	2200	1750-1950, 2060-2090	124SMBR - Simsboro	Simsboro	--	Depth , Screen
7364	5824612	Richard H. Griffith	30.684551	-97.040073	432	180	160-180	124HOOP - Hooper	Hooper	--	OK
7506	5824610	Southwest Milam Water Supply Corp.	30.671633	-97.003883	492	392	165-193, 196-259, 339-390	124HOOP - Hooper	Hooper	--	OK
7774	5910705	Jay Wise	30.780000	-96.862300	442	560	535-555	124CABF - Calvert Bluff	Simsboro	--	Screen, Aquifer
7793	5925103	Noack Family Partnership, Ltd.	30.600880	-96.982490	412	420	400-420	124WLCX - Wilcox	Calvert Bluff	--	Aquifer
7965	--	Heirs of Mary Anne oliver	30.563800	-96.479600	231	1260	--	--	Queen City	--	n/a
7998	--	Walter D. Fischer	30.789912	-96.763097	490	460	435-455	--	Calvert Bluff	--	n/a
8172	--	Norbert B. Zeschke	30.513820	-97.164501	579	370	330-370	--	Hooper	--	n/a
8239	5928804	Providence Baptist Church	30.536717	-96.578450	304	460	418-460	124SPRT - Sparta	Lower Yegua	--	Depth , Screen , Aquifer
8388	5943104	Wayne Edwards	30.355200	-96.717300	326	3988	3600-3800	124SMBR - Simsboro	Simsboro	--	Screen
8415	5929433	Portee FLP	30.544721	-96.498610	233	59	--	111ABZR - Alluvium, Brazos River	BRAA	--	OK
8451	5925408	Antonio E. Cantu	30.563228	-96.962233	382	690	300-380, 620-680	124CABF - Calvert Bluff	Calvert Bluff	--	Depth
8658	5910706	Randal C. Leo	30.771300	-96.846400	420	528	508-528	124SMBR - Simsboro	Simsboro	--	OK

POSGCD Well Number	State Well Number	Owner	Latitude *(decimal degrees)*	Longitude *(decimal degrees)*	Surface Elevation *(ft amsl)*	Depth *(ft)*	Screened Intervals	TWDB Aquifer	POSGCD Aquifer (First Unit)	POSGCD Aquifer (Second Unit)	Inconsistent with TWDB?
8767	5934108	Terry Ausley	30.483595	-96.860039	411	2230	1800-2100	124SMBR - Simsboro	Simsboro	Calvert Bluff	Screen, Aquifer
8935	5901904	Donald R. Schuerman	30.913160	-96.886300	390	80	64-74	124HOOP - Hooper	Hooper	--	Depth
8959	--	John Pruett	30.681466	-96.786821	442	810	790-810	--	Calvert Bluff	--	n/a
9064	--	Royalty Pecan Farms	30.603240	-96.536250	241	3255	2400-2410, 2750-2760	--	Calvert Bluff	Simsboro	n/a
9095	5910707	Randal C. Leo	30.771301	-96.846388	420	580	550-570	124SMBR - Simsboro	Simsboro	--	OK
9104	5928342	David L. Hodges	30.606600	-96.534440	243	380	340-380	124SPRT - Sparta	Sparta	--	OK
9157	5936809	Burleson County Pct. 4	30.391670	-96.556110	294	592	520-580	124JKYG - Jackson and Yegua	Lower Yegua	--	Aquifer
9166	5918108	Post Oak Savannah	30.711389	-96.862500	505	1240	1178-1220	124SMBR - Simsboro	Simsboro	--	OK
9167	5918109	Post Oak Savannah	30.711389	-96.862500	505	140	90-130	124CRRZ - Carrizo	Calvert Bluff	--	Aquifer
9215	--	Linda Garrison	30.511139	-96.897167	386	2724	1560-1570, 2100-2110, 2130-2140	--	Simsboro	--	n/a
9230	--	David Pawlowski	30.596886	-96.878937	526	1720	1590-1600, 1710-1720	--	Simsboro	--	n/a
9327	--	Naomi White	30.906660	-96.888880	368	140	120-140	--	Below Hooper	--	n/a
9346	--	David L. Hancock	30.540583	-96.907083	0	80	--	--	Reklaw	--	n/a
9372	--	David Hancock	30.541111	-96.904850	0	120	--	--	Queen City	--	n/a
9445	--	Burleson County Pct 1	30.427742	-96.762821	0	400	--	--	Sparta	--	n/a
9446	--	Walter Wentzel	30.572378	-96.920656	0	2350	--	--	Simsboro	--	n/a
58-24-9D4N	--	Rodgers	30.634119	-97.008415	464	188	163-183	--	Simsboro	--	n/a
58-24-9V7	--	Bocenegra (Simmons)	30.633943	-97.037523	500	--	--	--	--	--	n/a
58-31-9A8	--	Ansley	30.507962	-97.158012	544	120	110-120	--	Hooper	--	n/a
58-31-9B1	--	Hirt	30.519604	-97.128551	552	235	205-235	--	Simsboro	--	n/a
58-32-3A7N	--	Young	30.608502	-97.007428	435	271	250-270	--	Calvert Bluff	--	n/a
58-32-4A1	--	R. Crump	30.556658	-97.088541	495	174	154-174	--	Simsboro	--	n/a
58-32-7A3	--	K. Biehle	30.509591	-97.120047	493	185	175-185	--	Simsboro	--	n/a
58-32-7B1	--	Smith	30.518687	-97.108176	477	123	103-123	--	Simsboro	--	n/a
58-39-3A8	--	Jordan	30.482943	-97.126022	476	182	162-182	--	Simsboro	--	n/a
59-17-3A9	--	L. Warren	30.696090	-96.918013	450	418	378-418	--	Calvert Bluff	--	n/a
59-17-3B8	--	J. Denio	30.743985	-96.888371	433	--	--	--	--	--	n/a
59-17-4A7	--	Caywood	30.698952	-96.972804	430	113	93-113	--	Simsboro	--	n/a
59-17-505	--	Ed Garner	30.681059	-96.948042	432	540	498-540	--	Simsboro	--	n/a
59-17-705	--	Keys	30.651470	-96.978145	490	326	286-326	--	Simsboro	--	n/a
59-17-7C1	--	Brahm	30.660943	-96.980573	491	750	720-750	--	Hooper	--	n/a
59-17-8B8	--	Wigginton	30.643409	-96.942916	478	385	--	--	Calvert Bluff	--	n/a
59-25-4C5	--	David Cork	30.543583	-96.994972	443	690	545-690	--	Simsboro	Calvert Bluff	n/a
59-25-5A6	--	E. Crump	30.569386	-96.949069	401	734	694-734	--	Calvert Bluff	--	n/a
UNK_01	--	Burleson County Pct. 1	30.427742	-96.762821	361	500	280-320, 365-395	--	Sparta	Above Sparta	n/a
UNK_02	--	Walter Wentzel	30.572378	-96.920656	423	2350	1620-1630, 1706-1716, 1870-1880	--	Simsboro	--	n/a

APPENDIX B:
Correspondence with TWDB regarding
Well Aquifer Assignments

INTERA Incorporated
1812 Centre Creek Drive, Suite 300
Austin, Texas, USA 78754
512.425.2000

August 18, 2015

Mr. Larry French
Director, Groundwater Resource Division
Texas Water Development Board
1700 North Congress Avenue
Austin, Texas 78711-3231

Dear Mr. French:

This letter responds to statements that Dr. Curtis Chubb has provided to TCEQ concerning differences in the TWDB groundwater database and the POSGCD monitoring well database regarding aquifer assignments to wells. On August 19, POSGCD will response to Dr. Chubb's statements at TCEQ offices. Prior to their meeting with TCEQ, POSGCD would like to discuss with TWDB staff several key points presented in this letter.

Mr. Chubb submitted his concerns in a petition reply to the TCEQ on August 6, 2015 (TCEQ Docket No. 2015-0844-MIS). At the time of Dr. Chubb's submission, POSGCD listed 88 wells in its monitoring program. Exhibit A lists 19 wells that Dr. Chubb identified as having different source aquifers between the TWDB and the POSGCD databases.

Based on my conversation with you on August 14, I understand that TWDB is aware of Dr. Chubb's reply and has reviewed the aquifer classifications listed in Exhibit A. Because TWDB has Dr. Chubb's reply I have not included any more than Exhibit A. POGCD's rebuttal consists of the seven points discussed in Exhibit B and summarized below in Table 1.

Table 1. Points of POSGCD Rebuttal

Key Point of Rebuttal	Implication
1. POSGCD assigns wells to aquifers per guidelines in its management plan and rules	POSGCD has authority to classify aquifers as part of their well inventory and this authority is acknowledged by the TWDB.
2. POSGCD tracks aquifers assigned to wells by the TWDB	Dr. Chubb's statement that the District does not know the TWDB's aquifer assignment is false. The District includes the TWDB aquifer assignments in the District's well database.
3. Several of the TWDB aquifer assignments cannot be used by POSGCD	For eight of the 19 wells in Exhibit A, the TWDB assigned aquifer names to wells that are not appropriate for the POSGCD monitoring program and therefore need to be changed.
4. TWDB acknowledges that some wells in its database have inappropriate aquifer assignments	TWDB database website states that some aquifer assignments need refinement and that this process is ongoing.
5. TWDB supports GCDs' efforts to refine aquifer assignments to wells	TWDB understands that in some cases, GCDs may have better science and information for well classification.
6. POSGCD uses a wide range of data to assign an aquifer to a well	Aquifer assignment to wells can be significantly more e difficult than the level of effort implied by Dr. Chubb
7. POSGCD continually re-evaluates its monitoring well network	POSGCD will improve the documentation associated with its monitoring program to help avoid future misunderstandings by concerned stakeholders

POSGCD and I would appreciate an opportunity to discuss this letter at your earliest convenience.

Sincerely,

Steven C Young

Steve Young, PG, PE. Ph.D
Principal Hydrogeologist

Exhibit A
List of 19 Monitoring Wells With Source Aquifer Assignments Differences Between POSGCD and the TWDB Data Files

Petitioner's Reply Brief - Appendix 4 *Petition for Inquiry – Chubb* *6 August 2015*

LIST OF 19 MONITORING WELLS WHOSE SOURCE AQUIFER IDENTITIES DIFFER BETWEEN DISTRICT AND TWDB DATA FILES

(TWDB well identification numbers are in parentheses)

Well ID Numbers	Source Aquifer – *District*	Source Aquifer – *TWDB*
25 (5917409)	Simsboro	Hooper
59 (5911402)	Carrizo	Calvert Bluff
77 (5919103)	Carrizo	Calvert Bluff
99 (5925508)	Carrizo	Calvert Bluff
223 (5902706)	Hooper	Wilcox
236 (5902307)	Simsboro	Wilcox
256 (5902901)	Simsboro	Wilcox
268 (5832101)	Simsboro	Hooper
433 (5920410)	Carrizo	Simsboro
457 (5919502)	Simsboro	Carrizo/Simsboro
638 (5937101)	Sparta	Queen City
1062 (5918101)	Simsboro	Calvert Bluff
1063 (5918104)	Simsboro	Calvert Bluff
1064 (5918908)	Simsboro	Carrizo/Simsboro
1066 (5918705)	Carrizo	Simsboro
1575 (5927718)	Carrizo	Carrizo/Calvert Bluff
6243 (5925502)	Calvert Bluff	Carrizo/Calvert Bluff
7774 (5910705)	Simsboro	Calvert Bluff
7793 (5925103)	Simsboro	Wilcox

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GEOSCIENCE & ENGINEERING SOLUTIONS

Exhibit B
Key Points of POSGCD Rebuttal

1. POSGCD Assigns Wells to Aquifer Per Guidelines in Management Plan and Rules
   Management plans and rules

   In Section 9 "Water Well Inventory", the POSCD Management Plan states:

   > "The District will assign permitted wells to a management zone and to an aquifer based on the location of the well's screen or well depth using the Rules of the District. If no well screen information is available then a permitted well will be assigned to a management zone and to an aquifer based on the total depth of the well. The assignment of the permitted well will be made at the time of permit. The District will assign exempt wells to a management zone and to an aquifer based on available information for the exempt well. The District will use the assignments to help track the permitted pumping and production for each aquifer and for each management zone."

   In Section 4 'Groundwater Resources", the POSGCD Management Plan provides references to the surfaces that the District uses to define the top and bottom of the Trinity, Wilcox, Sparta, Queen City, and Yegua/Jackson aquifers. POSGCD groundwater Rule 7.11(4) and Rule 7.12(8) discuss the District's approach to assigning an aquifer to exempted and permitted wells.

   The TWDB has reviewed and has approved the District's management plan.

2. POSGCD Tracks Aquifers Assigned to Wells by TWDB
   In his reply to the TCEQ, Dr. Chubb states:

   > "I know of no valid excuse/reason for having 19 monitoring wells that appear to be measuring water levels in aquifers different from those identified by the District. It doesn't matter what excuse the District provides, the fact is that the District didn't even know that TWDB reports those 19 wells as monitoring aquifers different from those identified by the District. The rules must be changed to prevent monumental failures such as not knowing what your monitoring network is monitoring."

   Dr. Chubb statement that the District didn't even know that the TWDB reports those 19 wells as monitoring aquifers different from those identified by the District is false. As part of its ACCESS well inventory, the District explicitly lists and compares the aquifer assigned to the well by both POSGCD and TWDB. This comparison can be found in several tables and forms in the ACCESS database. Figure 1 shows an example of such a comparison using the Individual Well Data Sheet Form in the POSGCD database for POSGCD Well ID 236. Included in the Well Data Sheet Form in Figure 1 are information blocks that list the aquifer coded assigned to the well by the TWDB and by POSGCD.

3. Several of the TWDB's Aquifer Assignments Cannot be used by the POSGCD

   Currently, the POSGCD assigns a well to a single aquifer. The TWDB database supports the options of assigning a well to multiple formations or to a generic aquifer system. An example of a generic aquifer system is the Wilcox. As explained by the POSGCD management plan:

   > "The Wilcox Aquifer refers to three geological formations that are considered to be relevant aquifers by GMA 12. These three geologic formations are the Hooper, the Simsboro, and the Calvert Bluff. The top and bottom surfaces for these three geological formations are defined by their model layer in the Central Carrizo GAM (Kelley and others, 2004). The Upper Wilcox Aquifer is associated with the Calvert Bluff Formation. The Middle Wilcox Aquifer is associated with the Simsboro Formation. The Lower Wilcox Aquifer is associated with the Hooper Formation. (pg, 2)".

In Exhibit A, eight of the 19 wells listed by Dr. Chubb are assigned to two or more aquifers defined by POSGCD and GMA 12 as relevant. As a result, the TWDB assignments are not transferable to the aquifer naming convention used by POSGCD and therefore must be changed to meet our management duties that we are statutorily required to perform

4. TWBD Acknowledges that Potential Problems Exist with Some of its Aquifer assignments

The TWDB groundwater database represents many years of data collection efforts. As of March 2013, it contains information for nearly 140,000 sites and includes data on water wells, springs, oil/gas tests, water levels, and water quality. The TWDB encourages users of the database to review issues regarding development and the accuracy of its groundwater database at http://www.twdb.texas.gov/groundwater/faq/faqgwdb.asp. Listed below are two screenshots from the TWDB URL listed above regarding accuracy of the database entry.

> ## Data Accuracy
>
> The information in the GWDB has a variable range of accuracy as data collection methods and data maintenance have changed over the years. Knowledge of this information can help ensure appropriate interpretation and application of the data. Data inaccuracies that might exist are constantly being corrected, as staff time allows, in order to provide the highest possible quality data to users.
>
> Please take a moment to review this explanation that describes some of the possible idiosyncrasies associated with specific database fields.

> **Aquifer:** Most aquifer IDs are correct; however, aquifer codes in some areas are in need of refinement. Many of these codes were assigned prior to a redefinition of aquifer names.

The screenshots above recognizes the TWDB's position that the aquifer assignment in its groundwater database are not regarded by TWDB as absolute and that refinement of these assignments should be performed as information becomes available.

5. TWDB Supports GCD Efforts to Refine Aquifer Assignments to Wells

The TWDB has stated publicly that it recognizes groundwater conservation districts (GCDs) as the State's preferred method of groundwater management. The TWDB has also stated publically stated that it welcomes GCDs assistance and information to promote and improve groundwater science. Based on our discussions with the TWDB, we understand that the TWDB supports GCD efforts to assemble water well information and to refine aquifer assignments.

The TWDB estimates that less than 10% of the state wells are included in their groundwater database (http://www.twdb.texas.gov/groundwater/faq/faqgwdb.asp). The TWDB does not have the resources nor is it in their mission to assign all wells in GCDs or POSGCD to aquifers. Therefore, the TWDB supports GCDs like POSGCD who are developing the appropriate data and methodology to operate a groundwater monitoring program that includes assigning wells to aquifers.

6. POSGCD Uses a Comprehensive Data Set to Assign an Aquifer to a Well

In his reply, Dr. Chubb (pg 14) states:

> "When I found the source aquifer identification problems, I contacted TWDB's groundwater technical assistance division to inquire about how difficult it is to distinguish the different aquifers. They replied that it is not difficult. For an example, they said to differentiate the Simsboro and Hooper; it is as simple as differentiating sand (Simsboro) from mud (Hooper). (pg 14)"

The above paragraph greatly oversimplifies the potential difficulty with assigning an aquifer to some wells and it may not be an accurate representation of the TWDB position regarding the boundary between the Simsboro and the Hooper aquifers.

Most importantly, it appears that Dr. Chubb is confusing the process of identifying an aquifer with the process of assigning a well to an aquifer. Whereas the former process often involves the analysis based on measured properties based on the analysis geophysical and hydrogeological data across a region, the latter process often involves the placement of a well screen that can span several aquifers into a single aquifer based on just the well depth or, at best, the interpretation of a single driller's log. In short, the two processes are not comparable and neither is as simple as implied by Dr. Chubb's statement.

As a company who is well versed in defining aquifers for the State, INTERA would like to provide the TCEQ with some of its experience with aquifer definition. INTERA was the prime contractor who developed the three GAMs currently used by GAM 12. These include the Northern Trinity and Woodbine GAM, the Queen City and Sparta GAM (this includes the Carrizo & Wilcox aquifers), and the Yegua-Jackson GAM. Also, INTERA is currently working on the Brazos River Alluvium GAM for GMA 12 and has been selected to update and revise the Queen City and Sparta GAM for GMA 12.

INTERA would like to state for the record that considerable funding and effort has been invested by the TWDB, the Bureau of Economic Geology, and other agencies to analyze geophysical logs to define the aquifers in GMA 12. A review of these studies will show that although there are conceptual differences in the aquifers, the actual practice of defining the boundary between two aquifers such as the Hooper and Simboro can be difficult as a result of unconformities (erosion surfaces), faulting, and spatial variations and overlaps of depositional environmental among adjacent aquifers. In short, there can be difficulty in picking aquifer boundaries because the Hooper aquifer ,which is conceptualized generally as being more clayey than the Simsboro, can contain sand layers that are in contact with the Simsboro. And similarly, because the Simsboro Aquifer can contain clayey layers that are in contact with the Hooper aquifer. Based on INTERA's and POSGCD's experience, it should be noted that differences of several hundred feet in the location of these aquifer surfaces between comparable studies is more the rule than the exception.

Moreover, the process of assigning a well to a single aquifer can be significantly more difficult than identifying aquifer boundaries because the well may be screened across multiple aquifers, the well documentation may not contain well screen information, and the well driller logs for the well may be of poor quality.

For the record, the POSGCD does not agree that assigning an aquifer to a wells is inherently a simple process. In order to help properly assigned an appropriate aquifer to a well, the POSGCD currently uses numerous types of data to determine appropriate aquifer assignments. This data includes the following:

- TWDB aquifer assignments;
- well driller log aquifer assignments;
- well depth and well screen information;
- aquifer elevation provided by GAM MODFLOW model files;
- continuous aquifer surfaces generated from GAM aquifer elevations;
- vertical profiles of sands interpreted from geophysical logs;
- vertical profiles of total dissolved solids (TDS) concentrations interpreted from geophysical logs;
- analysis of measured hydraulic head from the well; and

- proximity of the well to identified faults,

Because of the comprehensive evaluation of multiple information used by the POSGCD to assign a well to an aquifer, the POSGCD expects that some of its aquifer assignments will differ from the aquifer assignments provided in the TWDB's groundwater database.

7. POSGCD Continually Re-evaluates Its Monitoring Well Network

Within the last several years, interested parties have requested POSGCD Microsoft ACCESS well database and POSGCD has provided it along with appropriate explanations. Several of Dr.Chubb's concerns would have been addressed if he had met with POSGCD to discuss their Microsoft ACCESS database and attempted to understand the logic and work that underlies it. To facilitate the transfer of information to the public, POSGCD has been working to transition the entire monitoring database and related data to a web-based application. This application is expected to go live by early November 2015. To help citizens like Dr. Chubb better understand our monitoring well network and monitoring data, POSGCD will expand the web application to address issues discussed in this memo.

In addition to improving the communication of monitoring data via a web-based application, POSGCD has recently expanded its monitoring well network by 21 wells. This expansion occurred by including 21 wells that were formally monitored by ALCOA for the Texas Railroad Commission (TRC).

As part of updating its monitoring program, POSGCD will be reviewing guidelines for well aquifer assignments, well aquifer assignments, and monitoring data as part of the development of the web-based application. When this process is completed, POSGCD will solicit comments from the public on its updated and web-based monitoring program to guide our next phase of improvements.

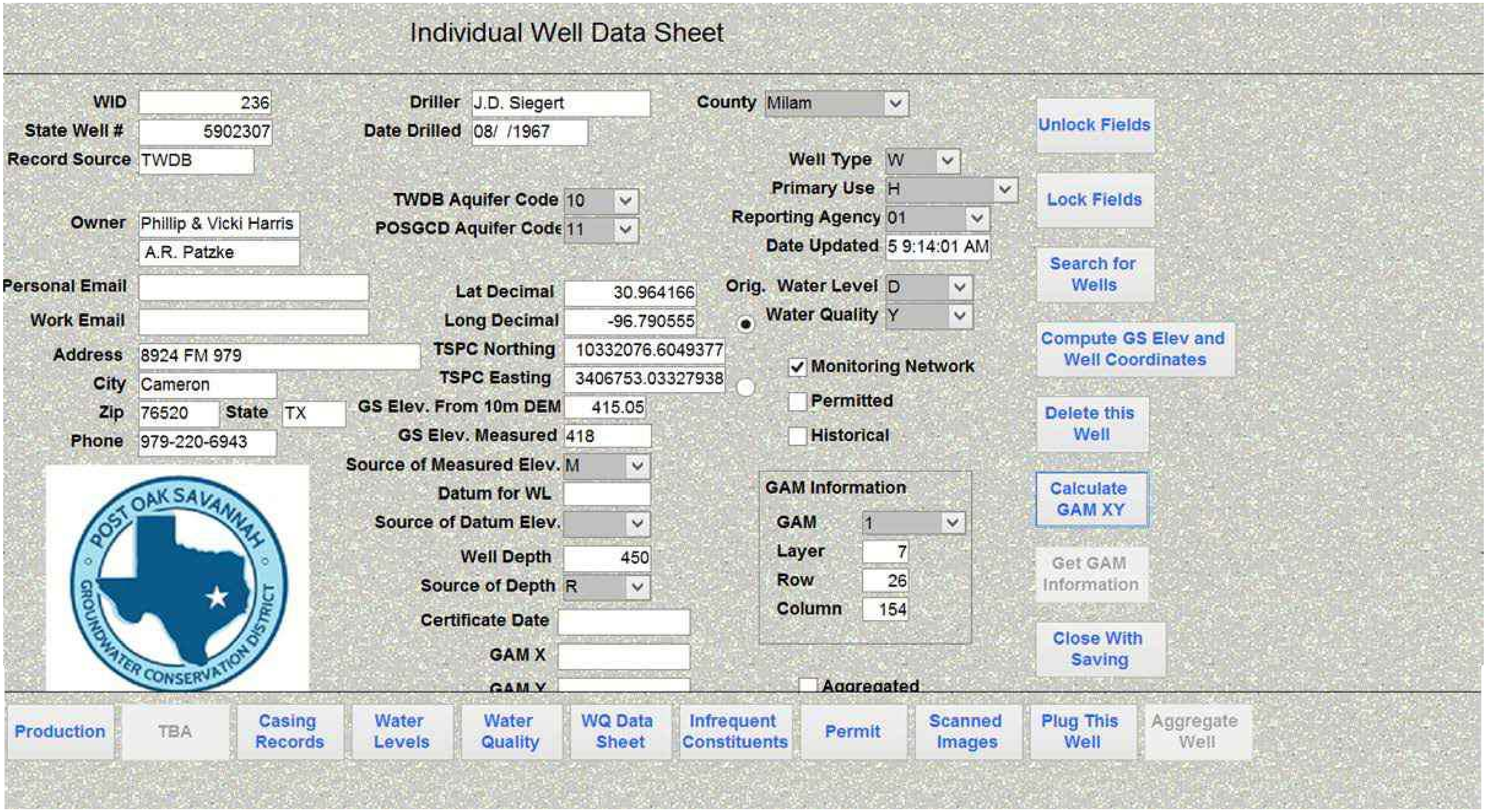


Figure 1. Screen shot from POSGCD ACCESS Well Database for Well ID 236

Texas Water Development Board

P.O. Box 13231, 1700 N. Congress Ave.
Austin, TX 78711-3231, www.twdb.texas.gov
Phone (512) 463-7847, Fax (512) 475-2053

November 24, 2015

Steve Young, Ph.D., P.G., P.E.
Principal Hydrogeologist
INTERA Incorporated
1812 Centre Creek Drive, Suite 300
Austin, TX 78754

Re: Response to your letter dated August 18, 2015

Dear Dr. Young:

This is in response to your letter of August 18, 2015, and to subsequent conversations as recently as October 29, 2015, in connection with use of the Texas Water Development Board's (TWDB) groundwater database by the Post Oak Groundwater Conservation District in developing and implementing groundwater monitoring programs.

As a general principle, and to summarize our conversations in our recent meeting with Gary Westbrook, Bobby Bazan, and Neil Deeds, TWDB staff recognizes the responsibility of local groundwater conservation districts, armed with site-specific knowledge of their groundwater resources and conditions, to develop groundwater monitoring programs for a variety of purposes, including monitoring compliance with adopted desired future conditions.

TWDB Groundwater Database – Aquifer Assignments

The TWDB groundwater database is one resource that is available to districts (as well as the general public) to support achievement of their groundwater management goals. Within the database, screened intervals of groundwater wells have been assigned wherever possible to specific aquifers or geologic formations using agency-defined codes. These assignments have been made over time through a variety of approaches, including input from individual water well drillers, scientific publications, and TWDB geologists. In some cases, initial aquifer designations were based on limited supporting data or were made to general formation names, so we understand that as new data become available it is reasonable that interpretations of existing data may be re-evaluated. These re-evaluations may revise existing or introduce new aquifer designations to take advantage of aquifer sub-units or updated interpretations made through stakeholder-driven processes such as TWDB's Groundwater Availability Modeling Program. If a district proposes to revise aquifer classifications in the TWDB groundwater database, we request that the district submit the proposed revision and rationale to the TWDB for review by our staff geologists.

Our Mission

To provide leadership, information, education, and support for planning, financial assistance, and outreach for the conservation and responsible development of water for Texas

Board Members

Bech Bruun, Chairman | Kathleen Jackson, Member

Kevin Patteson, Executive Administrator

TWDB Comments on Exhibit B – Key Points of POSGCD Rebuttal

The remainder of this letter addresses your key points of rebuttal made by the Post Oak Savannah Groundwater Conservation District (POSGCD) (Exhibit B of your August 18, 2015, letter) related to the TWDB groundwater database.

1. POSGCD assigns wells to aquifers per guidelines in its management plan and rules

   TWDB does not review or comment on a district's approach to interpreting well data or screened intervals of wells. As noted above, if a district wishes to reinterpret a well's aquifer assignment in the TWDB database, we request that the district provide supporting details for our review. The TWDB approval of a groundwater management plan is limited by statute (Texas Water Code Section 36.1072) to administrative completeness.

2. POSGCD tracks aquifers assigned to wells by the TWDB

   The TWDB recognizes the individual groundwater conservation districts will use information in the TWDB groundwater database to facilitate groundwater resources management according to their groundwater management plans. In some cases the TWDB may have assigned wells to aquifer systems that may also include sub-aquifers monitored specifically by districts according to their management plans.

3. Several of the TWDB's aquifer assignments cannot be used by POSGCD

   We understand that past aquifer assignments in the TWDB groundwater database may not currently relate well to ongoing groundwater resources management performed at a different scale and/or for different purposes than when the assignments were initially made. As previously noted, any proposed changes to an aquifer assignment in the TWDB groundwater database should be brought to TWDB's attention for review.

4. TWDB acknowledges that some wells in its database have inappropriate aquifer assignments

   The TWDB intends to update and improve the contents of the database, including redesignating aquifer assignments, as needed and appropriate, whenever inaccuracies are identified or improved aquifer interpretations are made.

5. TWDB supports GCD's efforts to refine aquifer assignments to wells

   The TWDB supports and partners with groundwater conservation districts on gathering and storing groundwater data to support the variety of groundwater management initiatives across the state.

6. POSGCD uses a wide range of data to assign an aquifer to a well

   While TWDB staff is quoted as stating that differentiating between the Simsboro and Hooper is an effort to distinguish sand from mud – and in a regional sense that is true – we are well aware that the job of assigning aquifers or sub-aquifers using geophysical or lithologic logs is usually complex and involves considerable professional geologic judgment and experience. This is particularly true for a geologic setting such as the Wilcox Group, where the fluvial-deltaic depositional environment produces significant lithologic changes over short lateral and vertical distances.

7. POSGCD continually re-evaluates its monitoring well network

   As in any monitoring network, it is appropriate to evaluate and re-evaluate monitoring activities to ensure that the network is meeting the stated goals and objectives.

Please let me know if you have any questions about this information or TWDB's role in supporting groundwater conservation districts in their mission to conserve and responsibly develop groundwater resources.

Sincerely,

Larry French, P.G.
Director
Groundwater Resources

c: Gary Westbrook, General Manager, Post Oak Savannah Groundwater Conservation District
Robert Mace, Deputy Executive Administrator, Water Science and Conservation

INTERA Incorporated
1812 Centre Creek Drive, Suite 300
Austin, Texas, USA 78754
512.425.2000

December 1, 2015

Mr. Larry French
Director, Groundwater Resource Division
Texas Water Development Board
1700 North Congress Avenue
Austin, Texas 78711-3231

Dear Mr. French:

I am writing on behalf of Post Oak Savannah GCD (POSGCD) to ask for TWDB's assistance with three tasks. The first task is to review and comment on a methodology for assigning aquifer classifications to wells for the purpose of monitoring water levels, water quality, and pumping amounts. The second task is to investigate a procedure to resolve differences in aquifer assignments in the POSGCD and TWDB well database for the same well. The third task is to amend the TWDB well database to include POSGCD monitoring wells that are not currently in the TWDB well database.

My request is motivated for two reasons. POSGCD desires to cooperate with the TWDB on their well-aquifer assignments and desires to make sure common wells have consistent data. Secondly, in the Summer of 2015 several POSGCD stakeholders expressed concerns that the TWDB and POSGCD well databases had different aquifer classifications for some wells. Although the POSGCD well database documents these differences, the potential importance of the differences was not fully understood until a citizen of Milam County filed a protest with the Texas Commission on Environmental Quality (TCEQ) that questioned the reliability of POSGCD monitoring program because the POSGCD aquifer classifications were not the same as the TWDB aquifer classifications for several wells.

Exhibit A explains the methodology used by POSGCD to assign wells to aquifers. This methodology focuses on comparing the aquifer tops and bottoms (based on groundwater availability model surfaces) to screened intervals at a well location. The methodology includes preparing figures similar to Figures A-1 and A-2, which show diagrams for the POSGCD monitoring wells. The information in Figures A-1 and A-2 is also presented in Tables A-1 through A-3. Table A-1 lists seventy-three POSGCD monitoring wells for which the POSGCD and the TWDB well databases have similar well completion information. In Table A-1, twenty-three of the seventy-three wells have different aquifer classifications in the POSGCD and the TWDB databases. Table A-2 lists three POSGCD monitoring wells for which the POSGCD and the TWDB well databases do not have matching well construction information. In Table A-2, two of the three wells have different aquifer assignments in the POSGCD and the TWDB databases. Table A-1 lists thirty-one of the POSGCD monitoring wells that are not currently in the TWDB database. In summary, out of the 107 POSGCD monitoring wells, twenty-five monitoring wells have different aquifer assignments in the TWDB and POSGCD well databases and thirty-one monitoring wells are not in the TWDB groundwater database.

In order to help improve the consistency between the TWDB and the POSGCD well databases, POSGCD would like to begin working with TWDB in December with the goal that all 107 POSGCD monitoring wells will be in the TWDB and POSGCD well databases with the same aquifer assignments. We would like our work to be collaborative and based on science and the TWDB GAM Program.

Sincerely,

Steve C Young

Steve Young, PG, PE. Ph.D
Principal Hydrogeologist

Cc/Gary Westbrook, General Manager, POSGCD
Robert Mace, Deputy Executive Administrator

EXHIBIT A
GENERAL METHODOLOGY USED BY POSGCD TO ASSIGN A WELL TO AN AQUIFER

Step1 . Extract the top and bottom of aquifer surfaces from groundwater available models (GAMs) at the center of the GAM grid cells

Step 2. Develop rasters for the tops and bottoms of aquifers of interest using the information from Step 1

Step 3. At a well location designated by a latitude and longitude extract the elevation of the tops and bottom of aquifers of interest. Convert the aquifer elevations to depths below ground surface elevation

Step 4. Using information from driller logs, the TWDB groundwater well database, field-measured values, or data tables in state reports, record the depth of the well and depth to each of the well's screened intervals in an electronic file.

Step 5 Run a script to calculate how screened intervals at a well are partitioned among the different aquifers and to calculate the aquifer in which the well terminates. Determine whether the well screen intervals reside in a single aquifer or multiple aquifers. If the well screens span multiple aquifers, then determine the portion of the well screens that intersect the different aquifers.

Step 6 Construct figures similar to Figures A-1 and A-2 that shows the bottom of the well and the vertical location of the well screens relative to the tops and bottoms of the aquifers that exist at the well location

Step 7 Construct a table similar to Table A-1that lists the aquifers that the well screens intersect and the thickness of each intersected aquifer

Step 8 For wells with screens that intersect only one aquifer, assign the well to the aquifer intersect by the well screen

Step 9 For wells with screens that intersect more than one aquifer, assign the well to all aquifers intersected with priority given to the aquifer contains the largest screened interval.

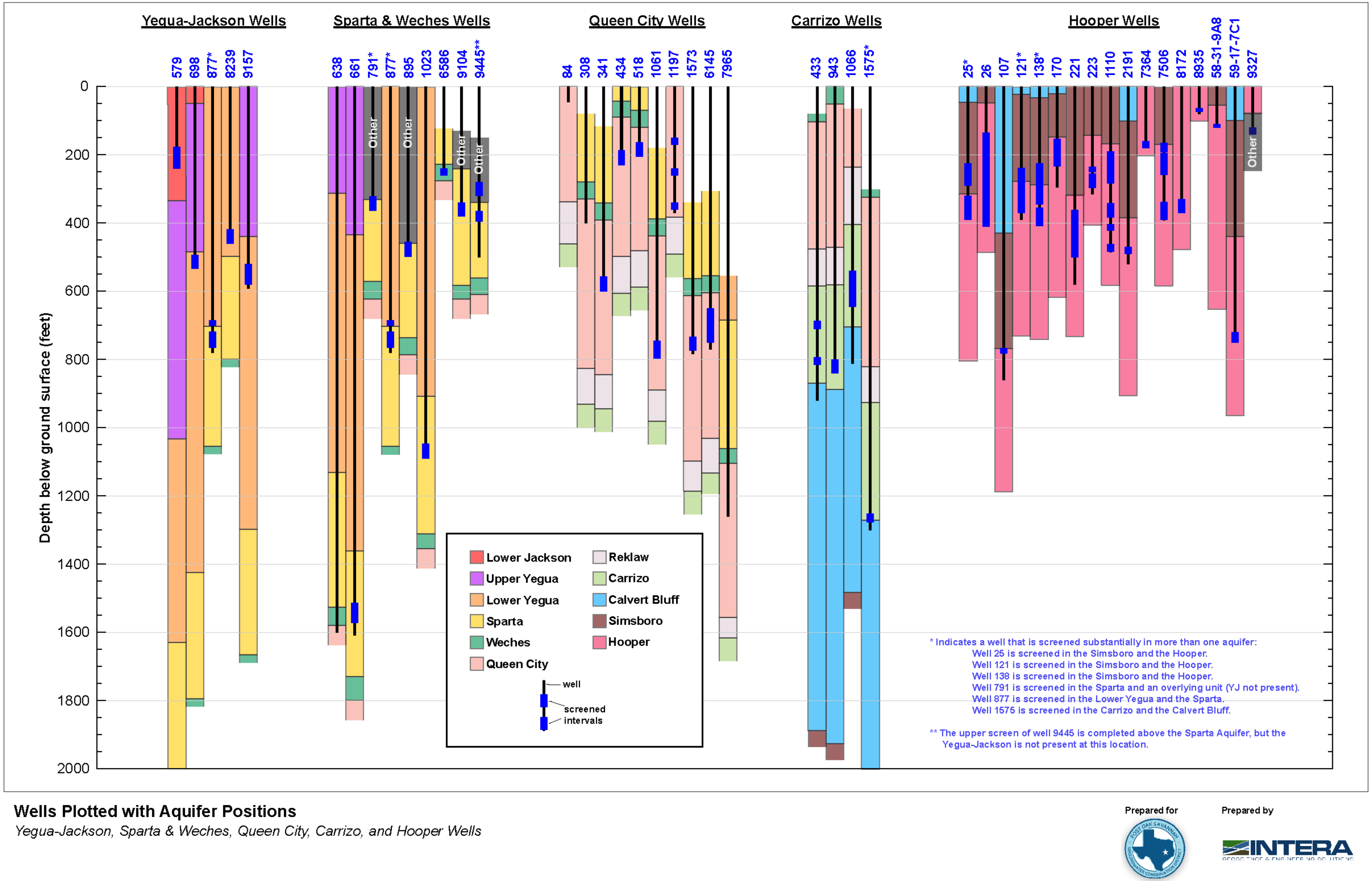
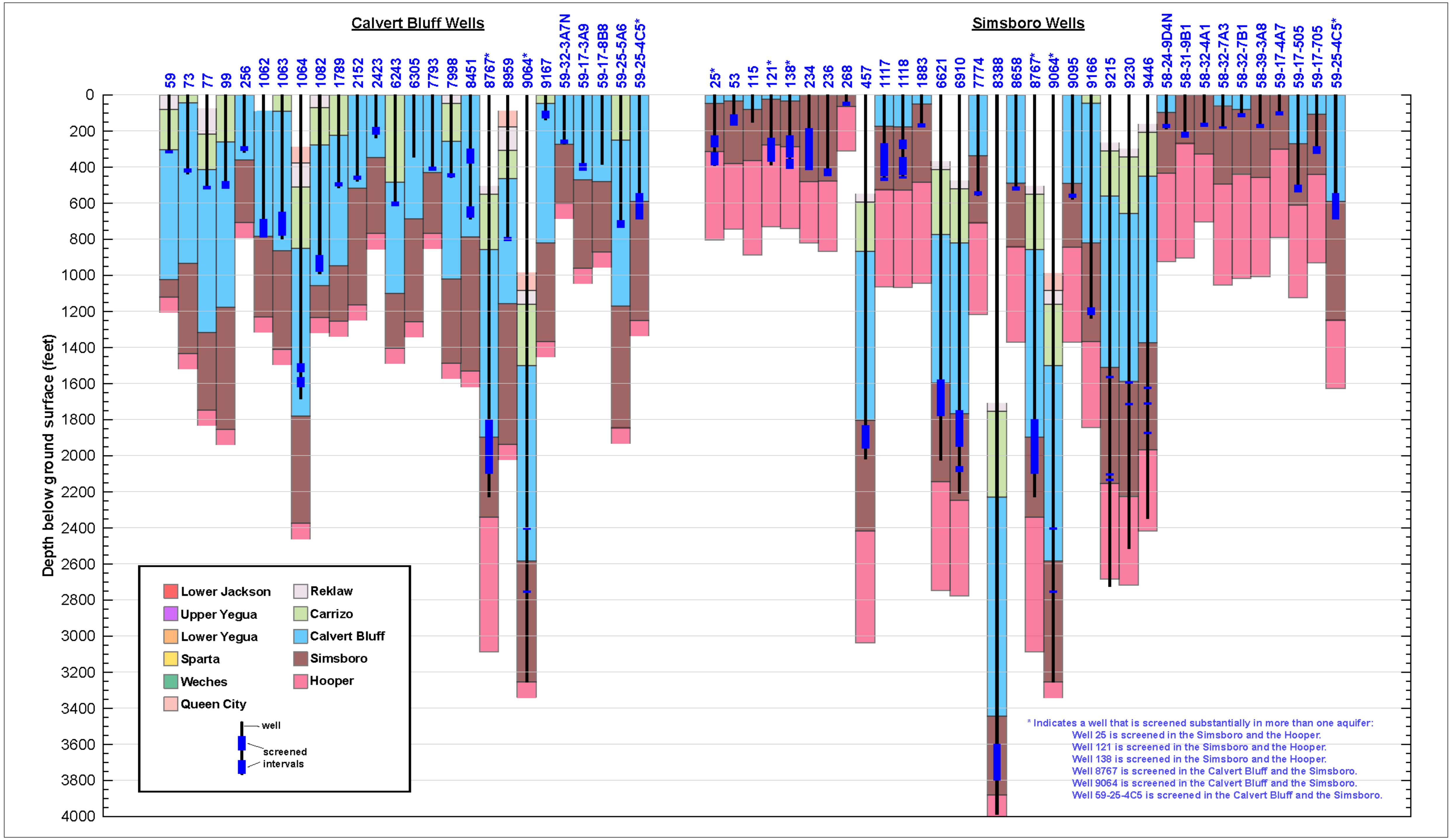


Figure A-1. Diagram showing the depth to the bottom and to the screened intervals for POSGCD monitoring wells assigned to the Yegua-Jackson, Sparta, Queen City, Carrizo, and Hooper aquifers along with the tops and bottoms of aquifers at each well location



Wells Plotted with Aquifer Positions
Calvert Bluff and Simsboro Wells

Prepared for

Prepared by

Figure A-2. Diagram showing the depth to the bottom and screened intervals for POSGCD monitoring wells assigned to the Calvert Bluff and Simsboro aquifers along with the tops and bottoms of aquifers of interest at each well location

Table A-1 Comparison of Aquifer Assignments in the POSGCD and the TWDB Well Databases for Seventy-three POSGCD Monitoring Wells with Similar Well Completion Information in the POSCD and TWDB Well Databases

Well ID	State Well No.	Latitude	Longitude	DEM Elev. (ft MSL)	POSGCD Well Depth (ft)	TWDB Well Depth (ft)	Identical Well Depth	POSGCD Screened Intervals Depth (ft)	Total Length of Screened Intervals (ft)	TWDB Casing Table Data Consistent with POSGCD Screened Intervals	TWDB Aquifer	First Unit	Second Unit	POSGCD aquifer classification	Agrees with TWDB	Screened Interval in First Unit (ft)	Screened Interval in Second Unit (ft)
26	5917103	30.7239	-96.9828	457.38	410	410	TRUE	136-410	274	Yes	124HOOP - Hooper	Hooper	--	single aquifer	Yes	274	NA
53	5909901	30.7842	-96.8956	434.27	169	169	TRUE	109-169	60	Yes	124SMBR - Simsboro	Simsboro	--	single aquifer	Yes	60	NA
59	5911402	30.7969	-96.7344	426.24	323	323	TRUE	307-323	16	Yes	124CABF - Calvert Bluff	Calvert Bluff	--	single aquifer	Yes	16	NA
73	5910907	30.7808	-96.7850	382.88	440	440	TRUE	410-430	20	Yes	124CABF - Calvert Bluff	Calvert Bluff	--	single aquifer	Yes	20	NA
77	5919103	30.7406	-96.7208	432.56	522	522	TRUE	507-522	15	Yes	124CABF - Calvert Bluff	Calvert Bluff	--	single aquifer	Yes	15	NA
84	5919302	30.7286	-96.6322	339.87	45	45	TRUE	ND	ND	NA, but well depth is the same	124QNCT - Queen City	Queen City	--	single aquifer	Yes	ND	NA
99	5925508	30.5694	-96.9478	409.58	520	520	TRUE	480-520	40	Yes	124CABF - Calvert Bluff	Calvert Bluff	--	single aquifer	Yes	40	NA
115	5917715	30.6408	-96.9878	-96.99	443.21	152	152	ND	ND	NA, but well depth is the same	124SMBR - Simsboro	Simsboro		single aquifer	Yes	ND	ND
234	5902309	30.9878	-96.7578	298.75	417	417	TRUE	185-417	232	Yes	124SMBR - Simsboro	Simsboro	--	single aquifer	Yes	232	NA
308	5927716	30.5372	-96.7417	451.90	400	400	TRUE	ND	ND	NA, but well depth is the same	124QNCT - Queen City	Queen City	--	single aquifer	Yes	ND	NA
341	5927606	30.5781	-96.6506	394.17	600	600	TRUE	558-600	42	No casing data in GWDB; well depth is the same	124QNCT - Queen City	Queen City	--	single aquifer	Yes	42	NA
434	5920409	30.6897	-96.6114	299.39	230	230	TRUE	188-230	42	No casing data in GWDB; well depth is the same	124QNCT - Queen City	Queen City	--	single aquifer	Yes	42	NA
518	5927204	30.6189	-96.6864	314.70	205	205	TRUE	163-205	42	No casing data in GWDB; well depth is the same	124QNCT - Queen City	Queen City	--	single aquifer	Yes	42	NA
579	5937611	30.4322	-96.3978	233.14	240	240	TRUE	177-240	63	Yes	124JCKSL - Lower Jackson	Lower Jackson	--	single aquifer	Yes	63	NA
596	5937329	30.4886	-96.3756	214.82	58	58	TRUE	ND	ND	NA, but well depth is the same	111ABZR - Alluvium, Brazos River	BRAA	--	single aquifer	Yes	ND	NA
661	5936802	30.3869	-96.5647	342.26	1609	1609	TRUE	1513-1573	60	Yes	124SPRT - Sparta	Sparta	--	single aquifer	Yes	60	NA
698	5943608	30.3108	-96.6464	269.53	533	533	TRUE	494-533	39	Yes	124YEGUL - Lower Yegua	Lower Yegua	--	single aquifer	Yes	39	NA
787	5938701	30.4136	-96.3583	205.07	56	56	TRUE	ND	ND	NA, but well depth is the same	111ABZR - Alluvium, Brazos River	BRAA	--	single aquifer	Yes	ND	NA
791	5935208	30.4964	-96.6919	379.14	364	364	TRUE	322-364	42	No casing data in GWDB; well depth is the same	124SPRT - Sparta	Sparta	Above Sparta	multi-aquifer	Yes	33	9
859	5929456	30.5436	-96.4938	230.89	60	60	TRUE	ND	ND	NA, but well depth is the same	111ABZR - Alluvium, Brazos River	BRAA	--	single aquifer	Yes	ND	ND
860	5929457	30.5445	-96.4920	230.95	60	60	TRUE	ND	ND	NA, but well depth is the same	111ABZR - Alluvium, Brazos River	BRAA	--	single aquifer	Yes	ND	ND
894	5928601	30.5456	-96.5406	240.11	58	58	TRUE	ND	ND	NA, but well depth is the same	111ABZR - Alluvium, Brazos River	BRAA	--	single aquifer	Yes	ND	NA
895	5928702	30.5292	-96.6083	345.69	498	498	TRUE	456-498	42	No casing data in GWDB; well depth is the same	124SPRT - Sparta	Sparta	--	single aquifer	Yes	42	NA
943	5934106	30.4886	-96.8436	441.01	840	840	TRUE	800-840	40	Yes	124CRRZ - Carrizo	Carrizo	--	single aquifer	Yes	40	NA
1023	5929537	30.5492	-96.4369	224.64	1090	1090	TRUE	1048-1090	42	No casing data in GWDB; well depth is the same	124SPRT - Sparta	Sparta	--	single aquifer	Yes	42	NA
1061	5934607	30.4500	-96.7833	403.93	797	797	TRUE	745-797	52	Yes	124QNCT - Queen City	Queen City	--	single aquifer	Yes	52	NA
1062	5918101	30.7162	-96.8634	565.50	790	790	TRUE	689-790	101	Yes	124CABF - Calvert Bluff	Calvert Bluff	--	single aquifer	Yes	101	NA
1110	5824611	30.6714	-97.0045	489.95	485	485	TRUE	190-283, 343-383, 403-423, 463-483	173	Yes	124HOOP - Hooper	Hooper	--	single aquifer	Yes	173	NA
1117	5917712	30.6312	-96.9901	459.69	475	475	TRUE	270-450, 460-475	195	Yes	124SMBR - Simsboro	Simsboro	--	single aquifer	Yes	195	NA
1118	5917711	30.6349	-96.9910	462.24	463	463	TRUE	250-300, 345-443, 453-463	158	Yes	124SMBR - Simsboro	Simsboro	--	single aquifer	Yes	158	NA
1166	5929410	30.5579	-96.4701	225.29	71	71	TRUE	ND	ND	NA, but well depth is the same	111ABZR - Alluvium, Brazos River	BRAA	--	single aquifer	Yes	ND	ND
1197	5934107	30.4811	-96.8721	440.12	370	370	TRUE	150-170, 240-260, 340-360	60	No casing data in GWDB; well depth is the same	124QNCT - Queen City	Queen City	--	single aquifer	Yes	60	NA
1573	5934601	30.4325	-96.7564	382.71	784	784	TRUE	734-774	40	Yes	124QNCT - Queen City	Queen City	--	single aquifer	Yes	40	NA
1575	5927718	30.5256	-96.7267	446.70	1300	1300	TRUE	1252-1277	25	Yes	124CZCB - Carrizo and Calvert Bluff	Carrizo	Calvert Bluff	multi-aquifer	Yes	19	6
1883	5832704	30.5065	-97.1186	482.31	180	180	TRUE	160-180	20	Yes	124SMBR - Simsboro	Simsboro	--	single aquifer	Yes	20	NA
2152	5925409	30.5610	-96.9951	466.98	480	480	TRUE	450-470	20	Yes	124CABF - Calvert Bluff	Calvert Bluff	--	single aquifer	Yes	20	NA
2191	5917716	30.6447	-96.9894	464.47	520	520	TRUE	470-490	20	Yes	124HOOP - Hooper	Hooper	--	single aquifer	Yes	20	NA
6305	5832908	30.5312	-97.0268	438.22	344	344	TRUE	ND	ND	NA, but well depth is the same	124CABF - Calvert Bluff	Calvert Bluff	--	single aquifer	Yes	ND	ND
6621	5926402	30.5525	-96.8600	488.52	2025	2020	FALSE	1580-1780	200	No casing data in GWDB; GWDB well depth = 2020 ft	124SMBR - Simsboro	Simsboro	--	single aquifer	Yes	200	NA
6910	5926403	30.5649	-96.8347	495.96	2210	2200	FALSE	1750-1950, 2060-2090	230	No casing data in GWDB; GWDB well depth = 2200 ft	124SMBR - Simsboro	Simsboro	--	single aquifer	Yes	230	NA
7364	5824612	30.6846	-97.0401	431.89	180	180	TRUE	160-180	20	Yes	124HOOP - Hooper	Hooper	--	single aquifer	Yes	20	NA
7506	5824610	30.6716	-97.0039	491.51	392	392	TRUE	165-193, 196-259, 339-390	142	Yes	124HOOP - Hooper	Hooper	--	single aquifer	Yes	142	NA
8388	5943104	30.3552	-96.7173	325.66	3988	3988	TRUE	3600-3800	200	No casing data in GWDB; well depth is the same	124SMBR - Simsboro	Simsboro	--	single aquifer	Yes	200	NA
8415	5929433	30.5447	-96.4986	233.12	59	59	TRUE	ND	ND	NA, but well depth is the same	111ABZR - Alluvium, Brazos River	BRAA	--	single aquifer	Yes	ND	ND
8451	5925408	30.5632	-96.9622	382.38	690	680	FALSE	300-380, 620-680	140	Yes; well depths differ by 10 ft	124CABF - Calvert Bluff	Calvert Bluff	--	single aquifer	Yes	140	NA
8658	5910706	30.7713	-96.8464	420.03	528	528	TRUE	508-528	20	Yes	124SMBR - Simsboro	Simsboro	--	single aquifer	Yes	20	NA
8935	5901904	30.9132	-96.8863	390.07	80	74	FALSE	64-74	10	Yes; well depths differ by 6 ft	124HOOP - Hooper	Hooper	--	single aquifer	Yes	10	NA
9095	5910707	30.7713	-96.8464	420.03	580	580	TRUE	550-570	20	Yes	124SMBR - Simsboro	Simsboro	--	single aquifer	Yes	20	NA
9104	5928342	30.6066	-96.5344	242.80	380	380	TRUE	340-380	40	Yes	124SPRT - Sparta	Sparta	--	single aquifer	Yes	40	NA
9166	5918108	30.7114	-96.8625	504.85	1240	1240	TRUE	1178-1220	42	Yes	124SMBR - Simsboro	Simsboro	--	single aquifer	Yes	42	NA
25	5917409	30.6689	-96.9864	504.61	391	391	TRUE	226-290, 320-390	134	Yes	124HOOP - Hooper	Simsboro	Hooper	multi-aquifer	No	64	70
107	5925102	30.6008	-96.9825	411.93	860	858	FALSE	767-782	15	No casing data in GWDB; GWDB well depth = 858 ft	124SMBR - Simsboro	Hooper	--	single aquifer	No	15	NA
121	5917714	30.6636	-96.9958	474.92	390	380	FALSE	238-370	132	Yes; well depths differ by 10 ft	124SMBR - Simsboro	Hooper	Simsboro	multi-aquifer	No	92	40
138	5917713	30.6664	-96.9958	484.60	408	408	TRUE	226-346, 356-408	172	Yes	124SMBR - Simsboro	Hooper	Simsboro	multi-aquifer	No	58	62
170	5824914	30.6583	-97.0167	495.33	295	295	TRUE	153-233	80	Yes	124SMBR - Simsboro	Hooper	--	single aquifer	No	80	NA
223	5902706	30.8975	-96.8519	359.03	315	315	TRUE	235-250, 256-298	57	No screened intervals in GWDB; well depth is the same	124WLCX - Wilcox	Hooper	--	single aquifer	No	57	NA
236	5902307	30.9642	-96.7906	416.21	450	450	TRUE	410-450	40	Yes	124WLCX - Wilcox	Simsboro	--	single aquifer	No	40	NA
256	5902901	30.8850	-96.7783	370.90	318	318	TRUE	284-308	24	Yes	124WLCX - Wilcox	Calvert Bluff	--	single aquifer	No	24	NA
268	5832101	30.6233	-97.0881	473.53	60	60	TRUE	40-60	20	Yes	124HOOP - Hooper	Simsboro	--	single aquifer	No	20	NA
457	5919502	30.6792	-96.6736	461.63	2018	2018	TRUE	1832-1958	126	No casing data in GWDB; well depth is the same	124CZSB - Carrizo and Simsboro	Simsboro	--	single aquifer	No	126	NA
638	5937101	30.4892	-96.4650	240.17	1600	1620	FALSE	ND	ND	NA; GWDB well depth = 1620 ft	124QNCT - Queen City	Sparta	Weches/QC	multi-aquifer	No	ND	ND
877	5928619	30.5792	-96.5256	266.66	780	780	TRUE	685-700, 719-765	61	Yes	124SPRT - Sparta	Sparta	Lower Yegua	multi-aquifer	No	46	15
1064	5918908	30.6323	-96.7881	519.71	1687	1687	TRUE	1490-1534, 1564-1620	100	Yes	124CZSB - Carrizo and Simsboro	Calvert Bluff	--	single aquifer	No	100	NA
1066	5918705	30.6482	-96.8547	580.82	813	800	FALSE	540-645	105	No screen info in GWDB; GWDB well depth = 800 ft	124SMBR - Simsboro	Carrizo	--	single aquifer	No	105	NA
1082	5911703	30.7872	-96.7167	366.51	992	992	TRUE	889-980	91	Yes	124SMBR - Simsboro	Calvert Bluff	--	single aquifer	No	91	NA
2423	5902904	30.9060	-96.7780	400.73	240	240	TRUE	180-220	40	Yes	124SMBR - Simsboro	Calvert Bluff	--	single aquifer	No	40	NA
6243	5925502	30.5655	-96.9410	426.93	614	614	TRUE	593-614	21	Yes	124CZCB - Carrizo and Calvert Bluff	Calvert Bluff	--	single aquifer	No	21	NA
7793	5925103	30.6009	-96.9825	411.93	420	420	TRUE	400-420	20	Yes	124WLCX - Wilcox	Calvert Bluff	--	single aquifer	No	20	NA
8767	5934108	30.4836	-96.8600	410.63	2230	2230	TRUE	1800-2100	300	No casing data in GWDB; well depth is the same	124SMBR - Simsboro	Simsboro	Calvert Bluff	multi-aquifer	No	205	95
9157	5936809	30.3917	-96.5561	293.88	592	592	TRUE	520-580	60	Yes	124JKYG - Jackson and Yegua	Lower Yegua	--	single aquifer	No	60	NA
9167	5918109	30.7114	-96.8625	504.85	140	140	TRUE	90-130	40	Yes	124CRRZ - Carrizo	Calvert Bluff	--	single aquifer	No	40	NA
6145	5927611	30.5457	-96.6380	397.47	770	770	TRUE	650-750	100	Yes	ND	Queen City	--	single aquifer	No	100	NA
6586	5927309	30.6134	-96.6602	381.01	260	260	TRUE	240-260	20	Yes	ND	Weches	--	single aquifer	No	20	NA

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Table A-2 Comparison of Aquifer Assignments in the POSGCD and the TWDB Well Databases for Three POSGCD Monitoring Wells with Differ Well Completion Information in the POSGCD and TWDB Well Databases

Well ID	State Well No.	Owner	Latitude	Longitude	DEM Elev. (ft MSL)	POSGCD Well Depth (ft)	TWDB Well Depth (ft)	Identical Well Depth	Screened Intervals (ft)	Total Length of Screened Intervals (ft)	TWDB Casing Table Data Consistent with POSGCD Screened Intervals	Shallow Management Zone	TWDB Aquifer	First Unit	Second Unit	POSGCD classification	Agrees with TWDB	Screened Interval in First Unit (ft)	Screened Interval in Second Unit (ft)
1063	5918104	Milano WSC - Well # 2	30.71278	-96.86889	548.57	800	800	TRUE	650-780	130	INCONSISTENT: GWDB indicates casing at this interval	FALSE	124CABF - Calvert Bluff	Calvert Bluff	--	single aquifer	Yes	130	NA
433	5920410	Milano WSC- Rita Test	30.695555	-96.614444	298.75	920	800	FALSE	688-710, 794-815	43	No casing data in GWDB; GWDB well depth = 800 ft	FALSE	124SMBR - Simsboro	Carrizo	--	single aquifer	No	43	NA
7774	5910705	Jay Wise	30.78	-96.8623	441.54	560	560	TRUE	535-555	20	INCONSISTENT: GWDB indicates screens from 493 to 535 ft	FALSE	124CABF - Calvert Bluff	Simsboro	--	single aquifer	No	20	NA

Table A-3 List of Thirty-one POSGCD Monitoring Wells that are not in the TWDB Well Database

Well ID	State Well No.	Latitude	Longitude	DEM Elev. (ft MSL)	POSGCD Well Depth (ft)	TWDB Well Depth (ft)	Screened Intervals (ft)	Total Length of Screened Intervals (ft)	Shallow Management Zone	TWDB Aquifer	First Unit	Second Unit	POSGCD classification	Agrees with TWDB	Screened Interval in First Unit (ft)	Screened Interval in Second Unit (ft)
221	ND	30.824443	-96.8897	423.5690002	580	ND	340-500	160	TRUE	ND	Hooper		single aquifer	NA	160	NA
8239	**ND**	30.536717	-96.5785	303.6489868	460	ND	418-460	42	FALSE	ND	Lower Yegua		single aquifer	NA	42	NA
1789	ND	30.798454	-96.748917	436.3250	515	ND	487-507	20	TRUE	ND	Calvert Bluff	--	single aquifer	NA	20	NA
7965	ND	30.5638	-96.4796	230.6980	1260	ND	ND	ND	FALSE	ND	Queen City	--	single aquifer	NA	ND	NA
7998	ND	30.789912	-96.763097	490.4770	460	ND	435-455	20	TRUE	ND	Calvert Bluff	--	single aquifer	NA	20	NA
8172	ND	30.51382	-97.164501	579.4980	370	ND	330-370	40	TRUE	ND	Hooper	--	single aquifer	NA	40	NA
8959	ND	30.681466	-96.786821	441.9340	810	ND	790-810	20	TRUE	ND	Calvert Bluff	--	single aquifer	NA	20	NA
9064	ND	30.60324	-96.53625	241.3860	3255	ND	2400-2410, 2750-2760	20	FALSE	ND	Calvert Bluff	Simsboro	multi-aquifer	NA	10	10
9215	ND	30.511139	-96.897167	386.4340	2724	ND	1560-1570, 2100-2110, 2130-2140	30	FALSE	ND	Simsboro	--	single aquifer	NA	30	NA
9230	ND	30.596886	-96.878937	526.2840	2515	ND	1590-1600, 1710-1720	20	FALSE	ND	Simsboro	--	single aquifer	NA	20	NA
9327	ND	30.90666	-96.88888	367.5140	140	ND	120-140	20	TRUE	ND	Below Hooper	--	single aquifer	NA	20	NA
UNK_01	ND	30.427742	-96.762821	361.2660	500	ND	280-320, 365-395	70	FALSE	ND	Sparta	Above Sparta	multi-aquifer	NA	30	40
UNK_02	ND	30.572378	-96.920656	422.6510	2350	ND	1620-1630, 1706-1716, 1870-1880	30	FALSE	ND	Simsboro	--	single aquifer	NA	30	NA
58-24-9D4N	ND	30.634119	-97.008415	464.4250	188	ND	163-183	20	ND	ND	Simsboro	--	single aquifer	NA	20	NA
58-24-9V7	ND	30.633943	-97.037523	499.7260	ND	ND	ND	ND	ND	ND	NA	--	ND	NA	ND	ND
58-31-9A8	ND	30.507962	-97.158012	544.3710	120	ND	110-120	10	ND	ND	Hooper	--	single aquifer	NA	10	NA
58-31-9B1	ND	30.519604	-97.128551	552.4010	235	ND	205-235	30	ND	ND	Simsboro	--	single aquifer	NA	30	NA
58-32-3A7N	ND	30.608502	-97.007428	434.6790	271	ND	250-270	20	ND	ND	Calvert Bluff	--	single aquifer	NA	20	NA
58-32-4A1	ND	30.556658	-97.088541	494.8870	174	ND	154-174	20	ND	ND	Simsboro	--	single aquifer	NA	20	NA
58-32-7A3	ND	30.509591	-97.120047	492.5130	185	ND	175-185	10	ND	ND	Simsboro	--	single aquifer	NA	10	NA
58-32-7B1	ND	30.518687	-97.108176	476.9240	123	ND	103-123	20	ND	ND	Simsboro	--	single aquifer	NA	20	NA
58-39-3A8	ND	30.482943	-97.126022	476.4680	182	ND	162-182	20	ND	ND	Simsboro	--	single aquifer	NA	20	NA
59-17-3A9	ND	30.69609	-96.918013	450.2240	418	ND	378-418	40	ND	ND	Calvert Bluff	--	single aquifer	NA	40	NA
59-17-3B8	ND	30.743985	-96.888371	433.4980	ND	ND	ND	ND	ND	ND	NA	--	ND	NA	ND	ND
59-17-4A7	ND	30.698952	-96.972804	430.3900	113	ND	93-113	20	ND	ND	Simsboro	--	single aquifer	NA	20	NA
59-17-505	ND	30.681059	-96.948042	432.0560	540	ND	498-540	42	ND	ND	Simsboro	--	single aquifer	NA	42	NA
59-17-705	ND	30.65147	-96.978145	490.1760	326	ND	286-326	40	ND	ND	Simsboro	--	single aquifer	NA	40	NA
59-17-7C1	ND	30.660943	-96.980573	491.4810	750	ND	720-750	30	ND	ND	Hooper	--	single aquifer	NA	30	NA
59-17-8B8	ND	30.643409	-96.942916	478.0520	385	ND	ND	ND	ND	ND	Calvert Bluff	--	single aquifer	NA	ND	ND
59-25-4C5	ND	30.543583	-96.994972	443.2710	690	ND	545-690	145	ND	ND	Simsboro	Calvert Bluff	multi-aquifer	NA	100	45
59-25-5A6	ND	30.569386	-96.949069	400.6010	734	ND	694-734	40	ND	ND	Calvert Bluff	--	single aquifer	NA	40	NA

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LF

Larry French <Larry.French@twdb.texas.gov>

Steve Young; Robert Mace; gwestbrook@posgcd.org

12/11/2

RE: POSGCD Monitoring Wells

You replied to this message on 12/12/2015 1:02 AM.

Rectangular Snip

Steve,

I have reviewed your request concerning POSGCD monitoring wells and discussed our response with Robert Bradley of the Groundwater Technical Assistance section. Here's what the TWDB will be able to do:

Task 1 - The first task is to review and comment on a methodology for assigning aquifer classifications to wells for the purpose of monitoring water levels, water quality, and pumping amounts.

TWDB Response: *The Texas Water Development Board understands that, in some cases, groundwater conservation districts may need to develop methodologies to assign aquifer classifications to wells for implementing their groundwater management plans. Because of the wide range of possible methods, available data, and uses for these classification approaches we do not review or comment on a specific aquifer classification methodology employed by a district.*

Task 2 – The second task is to investigate a procedure to resolve differences in aquifer assignments in the POSGCD and TWDB well database for the same well.

TWDB Response: *If a district requests that the TWDB evaluate differences between the district's database and the TWDB Groundwater Database for the same well, the TWDB staff (a Texas licensed professional geoscientist) will review the differences and determine if a change needs to be made in the TWDB well/aquifer assignment. We request that the district provide relevant data such as well logs, well construction data, and monitoring data necessary to perform the evaluation.*

Task 3 – The third task is to amend the TWDB well database to include POSGCD monitoring wells that are not currently in the TWDB well database.

TWDB Response: *If the district has identified wells that are not currently in the TWDB Groundwater Database, then we request that the district provide relevant data for the evaluation of the well(s). A TWDB geoscientist (a Texas licensed professional geoscientist) will review the submitted data and, if appropriate, recommend that TWDB staff make the necessary addition(s) to the TWDB Groundwater Database. This review and evaluation may also include comparison of the data with information in the Submitted Driller's Reports database.*

Feel free to call me if you or Gary Westbrook have any questions.

Larry French, P.G.

APPENDIX C:
Re-defining Shallow Monitoring Zones

Redefining Shallow Zones & Calculating Shallow Drawdown

The POSGCD Management Plan (adopted 2012) defines separate DFCs for Shallow Management Zones. These are meant to constrain drawdown in the up-dip regions of aquifers and "*help protect the production capacity of existing wells in the unconfined portions of the aquifer where the water level above the well screen tends to be less than in the confined portions of the aquifer.*"

A. Motivation

As discussed during the March 8, 2016 meeting, the current Shallow Management Zones are unscientifically drawn and can include very deep confined sections of the aquifer. This is at odds with the District's goal to protect shallow unconfined wells. POSGCD considered different shallow delineations and calculation methods before adopting a "best-practices" method for the Shallow Management Zones.

B. "Best-Practices" for Calculating Shallow Drawdown

Based on the discussions summarized in **Table 1**, POSGCD decided on the following "best-practices" for calculating drawdown in Shallow Management Zones from water level monitoring data.

1) Calculate shallow drawdown across whole POSGCD area, rather than using drawdown in particular aquifers

   Pros: Provides more realistic shallow water level behavior.
   Removes bias caused by interpolating deep wells with shallow wells in an aquifer.

   Cons: Assumes all shallow aquifers in district behave similarly

2) Use 400 feet depth as definition of "Shallow" aquifer or well. Locations shown in **Figure 1**.

   Pros: Enough POSGCD monitoring wells < 400 feet deep to allow drawdown evaluation
   Removes bias from deep confined wells

   Cons: 400 feet is still too deep and this cut-off likely includes some confined wells

3) Instead of using a Shallow Management Zone extent, re-define drawdown in a Shallow Management Zone as the average value of drawdown in the aquifer outctop and drawdown in the aquifer's "400-crop" *

   Pros: Provides a happy medium between the drawdown in outcrop (too shallow) and the 400-foot cut-off (too deep)

   Cons: Requires additional interpretation rather than simple water level collection

* "400-crop" : up-dip edge defined as where *bottom* aquifer surface is 400 ft below land surface and down-dip edge defined as where *top* aquifer surface is 400 ft below land surface (**Figure 2**)

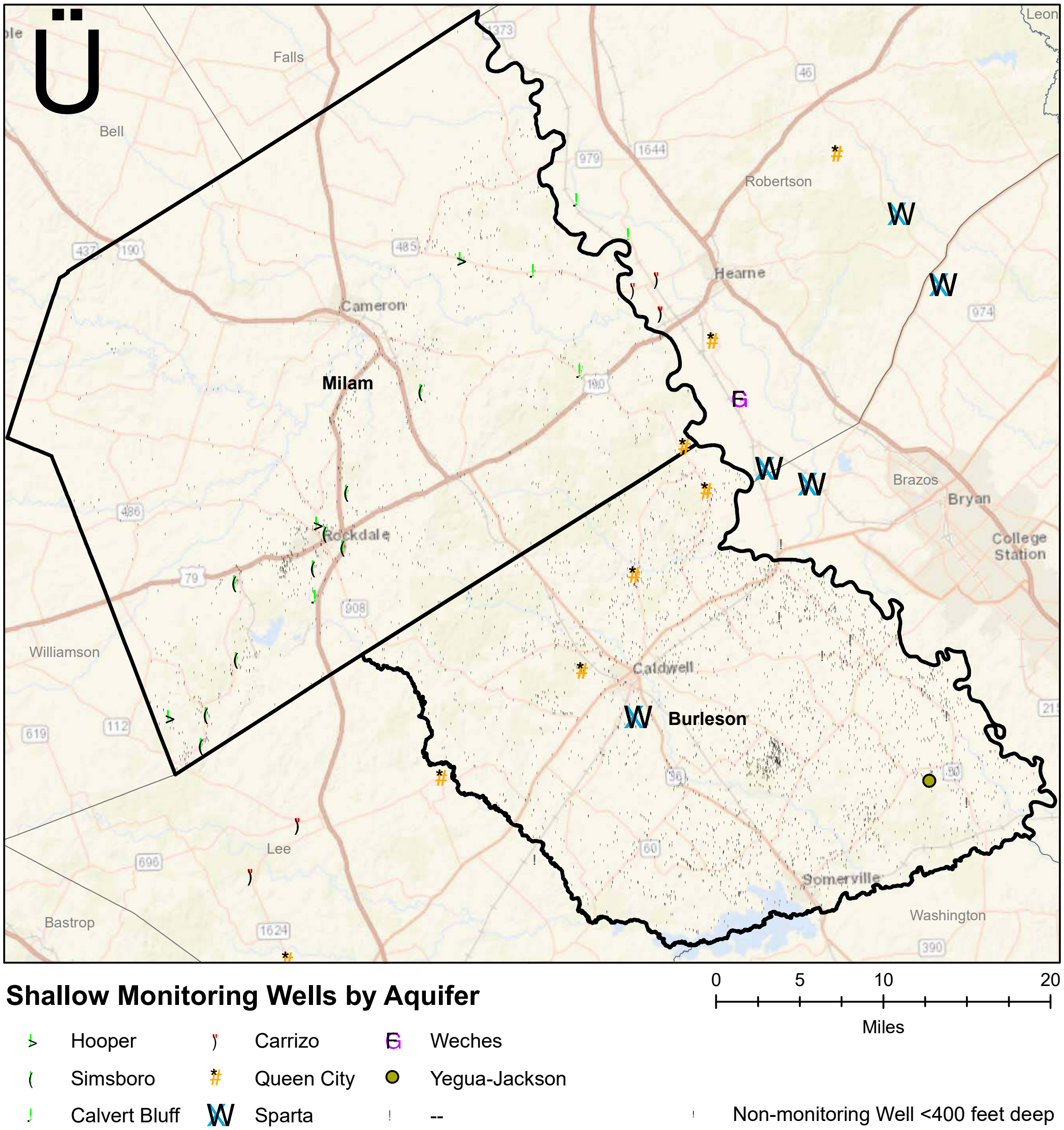

Figure 1. Locations of wells less than 400 feet deep.

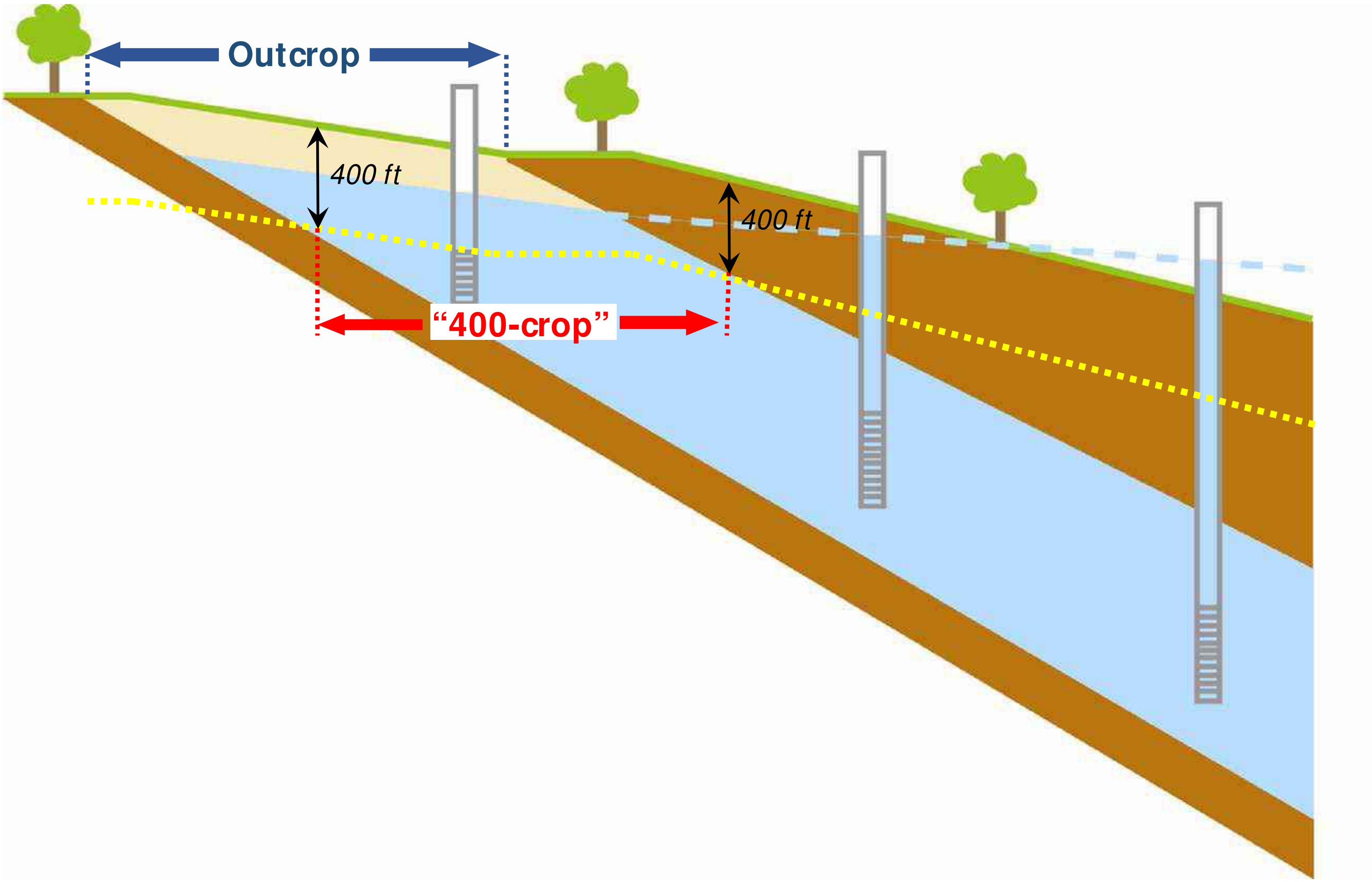

Figure 2. Schematic of Outcrop vs "400-Crop"

C. Drawdown Calculation Method

The following methodology incorporates the "best practices" described above and was used to calculate drawdown in the Management Zones for each aquifer:

Step 1:

For each monitoring well < 400 feet deep in the District, determine the average *baseline* water level by averaging all water levels recorded at that well during a 3-year window around 2000 (1999 to 2001).

Step 2:

For each monitoring well < 400 feet deep in the District, determine the average *current* water level by averaging all water levels recorded at that well during a 3-year window around the *current* year.

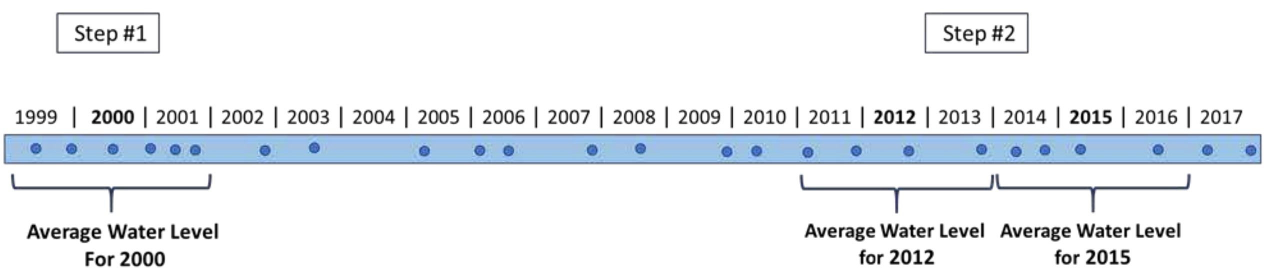

Figure 2. Diagram of 3-year moving average calculation. Dots represent water level measurements.

Step 3a:

Using only those wells with a water level value in both the *baseline* year (2000) and the *current* year, interpolate a *baseline* (2000) Shallow water level surface using Kriging toolbox in ArcGIS.

Step 3b:

Using only those wells with a water level value in both the *baseline* year (2000) and the *current* year, interpolate a *current* Shallow water level surface for the aquifer using Kriging toolbox in ArcGIS.

Step 4:

Calculate drawdown by subtracting the *baseline* water level surface (Step 3a) from the *current* water level surface (Step 3b) using the Map Algebra toolbox in ArcGIS.

Step 5a:

Clip the drawdown water level surface (Step 4) to the *outcrop* extent using the Clip Raster toolbox in ArcGIS.

Step 5b:

Clip the drawdown water level surface (Step 3b) to the *"400-crop"* extent using the Clip Raster toolbox in ArcGIS.

Step 6a:

Determine the average *outcrop* drawdown value from the Raster Properties of the clipped drawdown surface for the *outcrop* (Step 5a).

Step 6b:

Determine the average *"400-crop"* drawdown water level value from the Raster Properties of the clipped drawdown water level surface for *"400-crop"* (Step 5b).

Step 7:

Calculate average drawdown for Shallow Management Zone by averaging *outcrop* drawdown (Step 6a) and *"400-crop"* drawdown (Step 6b)

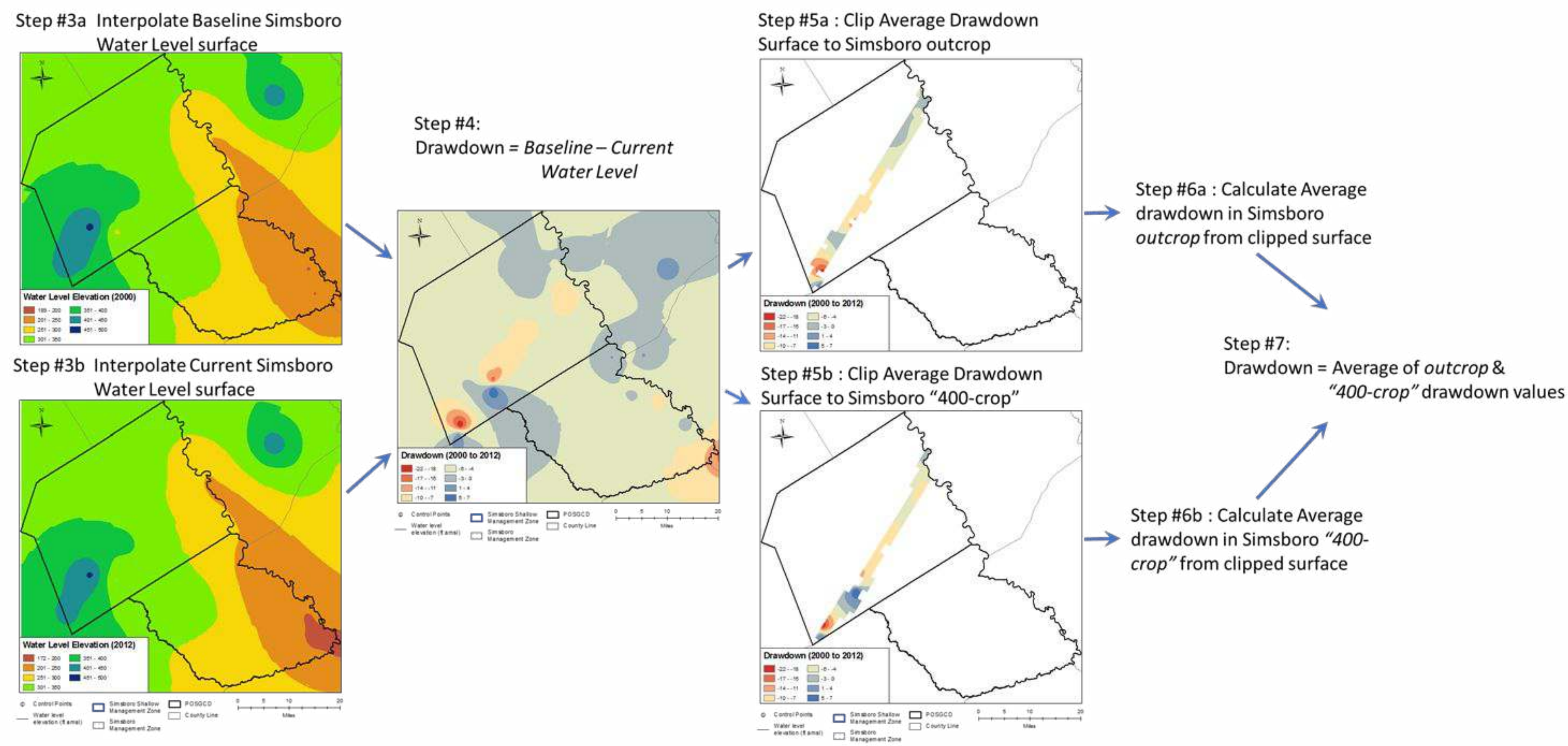

Figure 3. Diagram of Drawdown Calculation Method

III. Status of DFC Compliance based on Calculated Drawdown from Monitoring Network

Average drawdowns for the years 2012 and 2016 were calculated using the methodology in Section 2. Calculated values were presented May 3, 2017and are provided in **Table 2** and shown in **Figure 4**. The DFCs for the Shallow Management Zones, as defined in the POSGCD Management Plan (adopted 2012) are also provided in **Table 2**.

In all years from 2012 through 2016, all evaluated Shallow Management Zones were in compliance with DFCs. The Sparta & Queen City and the Yegua-Jackson Shallow Management Zones show the largest drawdown as a percentage of DFCs.

IV. Recommendations

A. Technical Recommendations:

8) Evaluate Shallow Management Zones based on district-wide shallow aquifer drawdown rather than on drawdown in individual aquifers (discussed in further detail in Appendix E)

B. Administrative Recommendations

6) Re-define extents of Shallow Management Zones in Management Plan to better represent actual shallow aquifer regions (discussed in further detail in Appendix E)

Shallow Management Zone	DFC	2012[1]		2013		2014		2015		2016[1]	
		Calculated Drawdown	Percent of DFC	Calculated Drawdown	Percent of DFC	Calculated Drawdown	Percent of DFC	Calculated Drawdown	Percent of DFC	Calculated Drawdown	Percent of DFC
Sparta/ Queen City	10[2]	4	40%	4	40%	5	50%	4	40%	3	30%
Carrizo	20	5	25%	6	30%	6	30%	6	30%	4	20%
Calvert Bluff (Upper Wilcox)	20	6	30%	7	35%	7	35%	7	35%	6	30%
Simsboro (Middle Wilcox)	20	6	30%	6	30%	6	30%	6	30%	6	30%
Hooper (Lower Wilcox)	20	6	30%	6	30%	6	30%	6	30%	6	30%
Yegua Jackson	15	6	40%	7	47%	7	47%	8	53%	5	33%

Table 2. Calculated average drawdowns for the years 2012 through 2016

[1]This is not a final calculation because the 3-year window includes an incomplete year (2017).

[2] This value represents the individual DFCs defined for the Sparta and Queen City, and assumed to be valid for the combined extent.

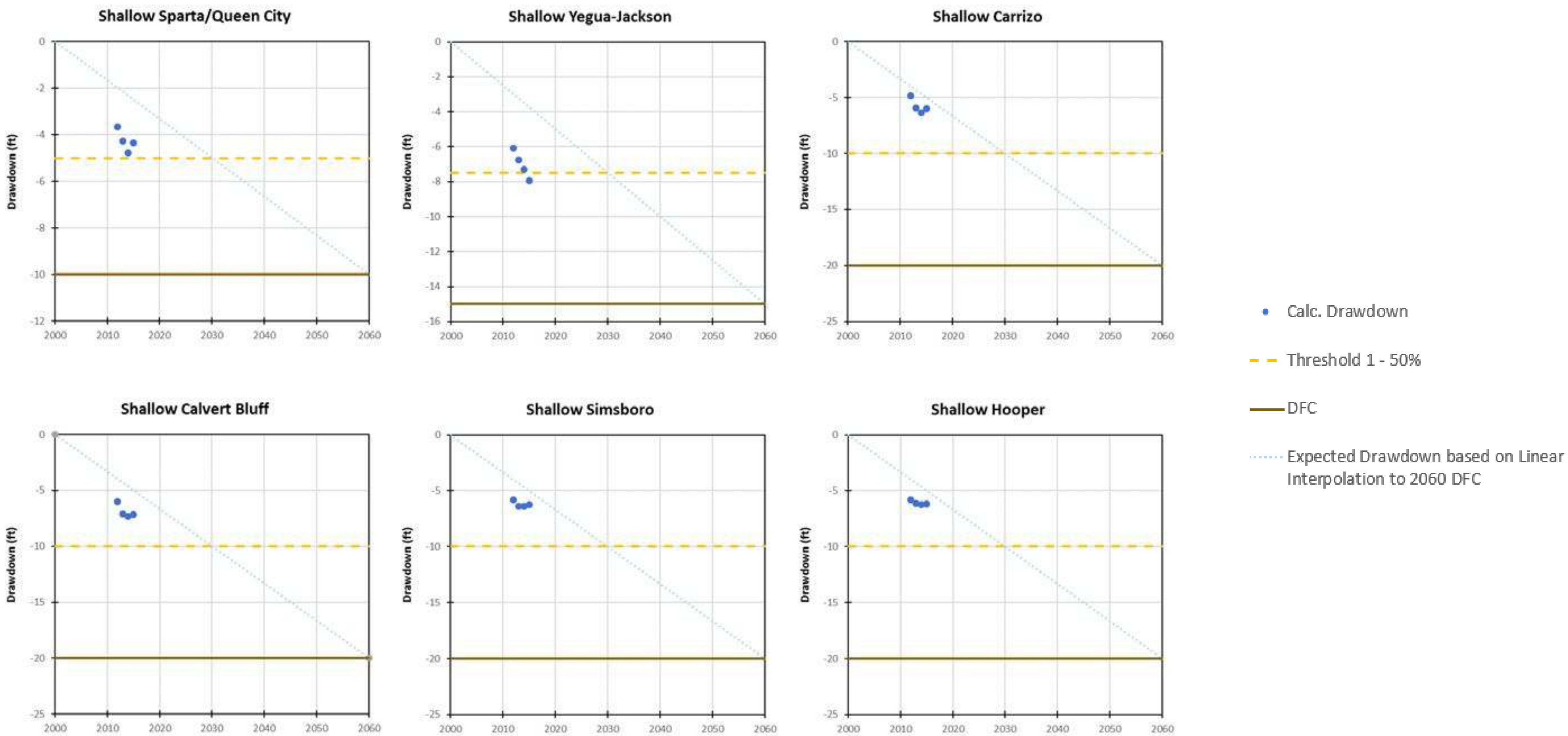

Figure 4. Status of DFC compliance by Shallow Aquifer Management Zone.