Status Report:
Monitoring Results and Desired Future Condition Considerations

Post Oak Savannah Groundwater Conservation District Meeting

June 10, 2014

Presented by:

Steve Young

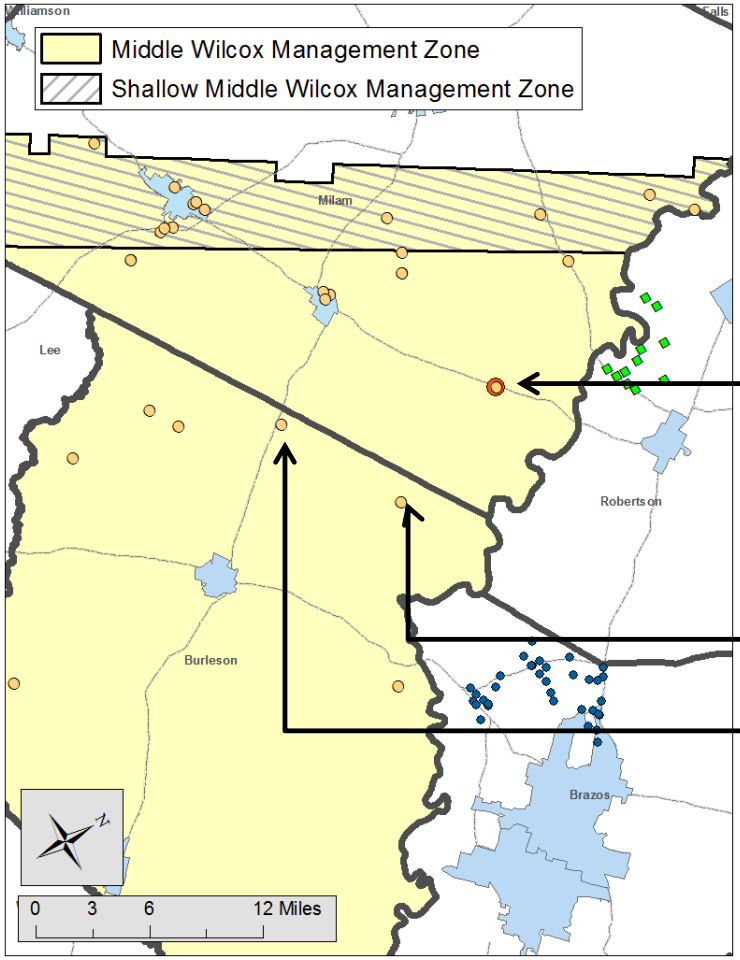
INTERA

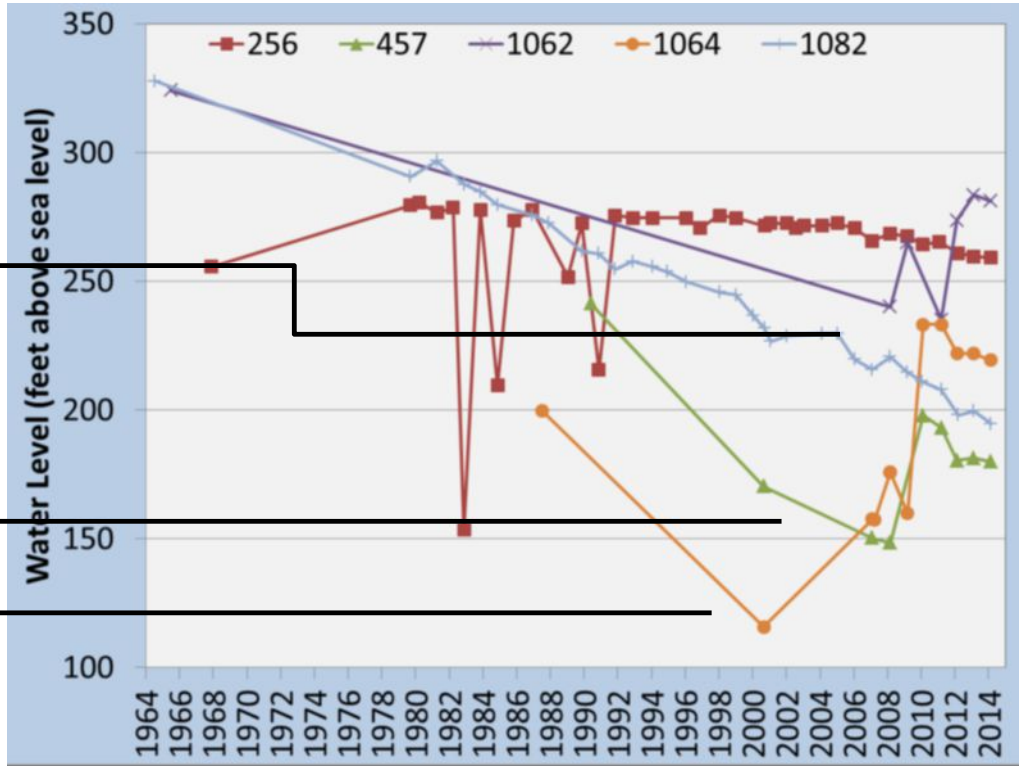
GEOSCIENCE & ENGINEERING SOLUTIONS

Topics

- Monitoring Results from Deep Simsboro
  - Gause Well
  - Other Wells
- Considerations for Desired Future Conditions
  - POSGCD package distributed at GMA 12 meeting
  - Recap of 2010 Key Issues
    - Drawdown calculations based on limits set for unconfined and confined aquifer conditions
    - District water budget
    - Net Drawdown
  - Options and Strategy for Moving Forward

Deep Simsboro Monitoring Well Data from POSGCD





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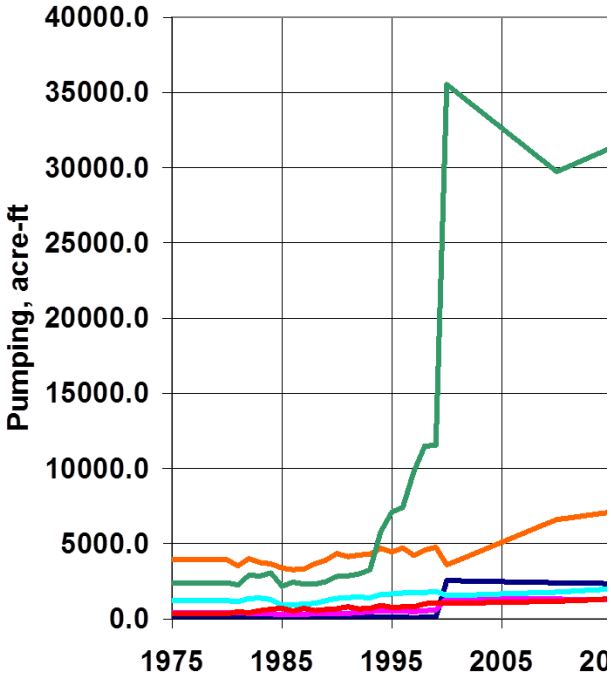
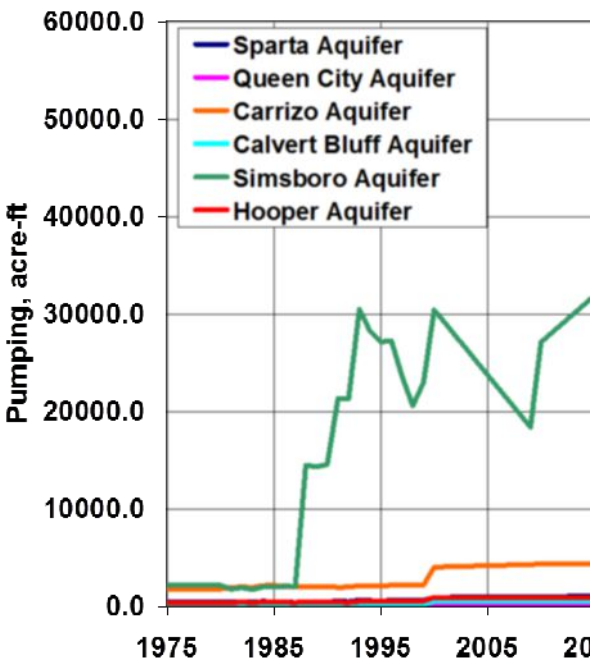
Historical Pumping Estimates

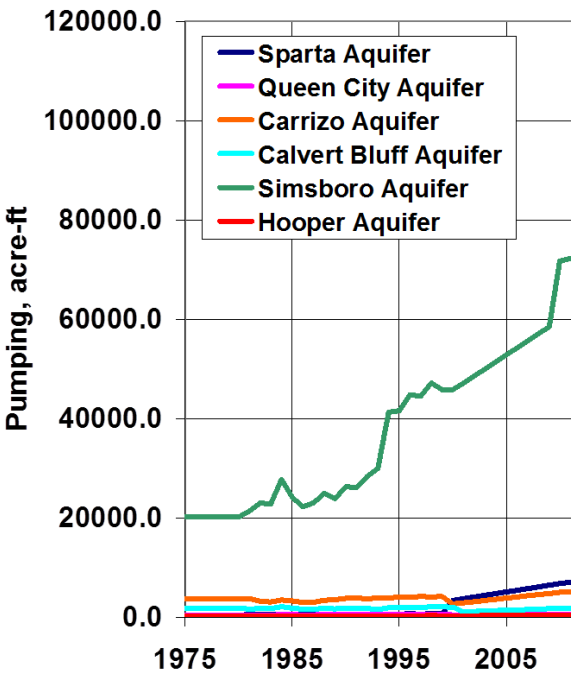
Lost Pines



POSGCD



Brazos Valley



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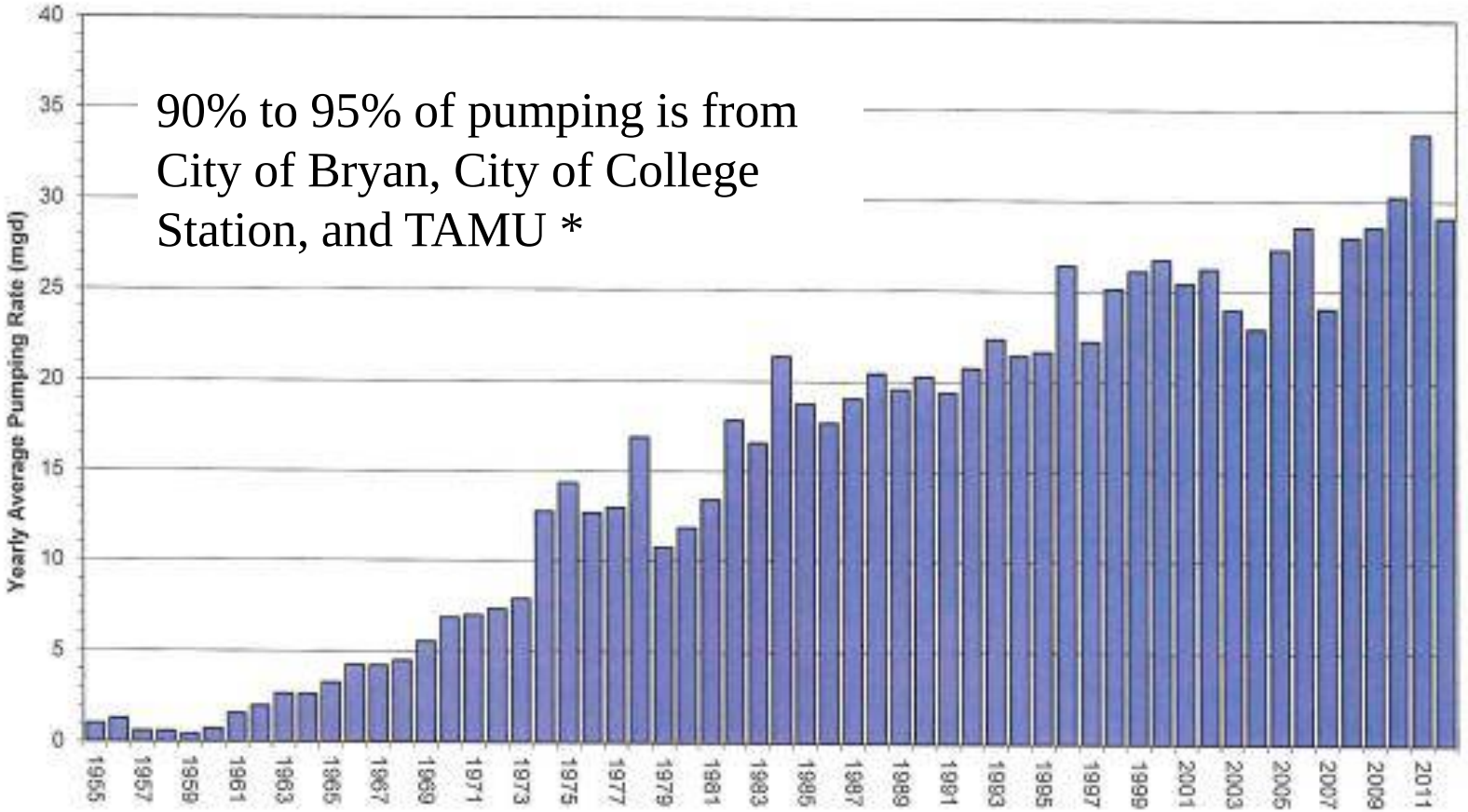
* From GMA 12 August 2008 presentation

Estimated Brazos County Pumping from the Simsboro

1 MGD = 1120 AFY



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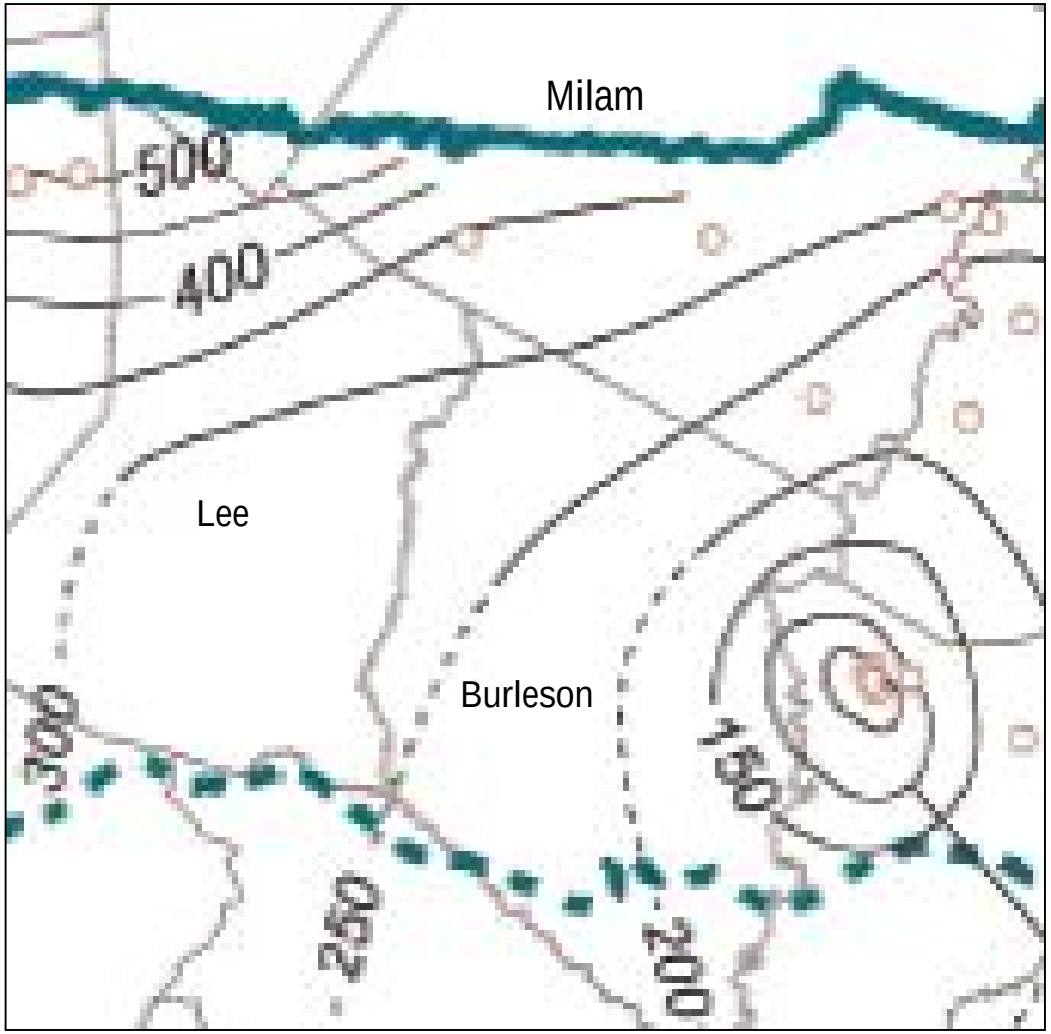
*Note: Courtesy of LGB-Guyton

Estimated 2000 Potentiometric Surface of Simsboro (source: Central C-W GAM)*



- Estimate 2000 Simsboro water level (using GAM potentiometric surface)
- Identify top of screen elevation for selected water supply wells
- Summarize the available drawdown (column of water above top of screen) by area
- **Near Bryan/College Station wells are about 2800 feet deep and initial water levels about 320 ft msl**
- **Near Bryan/College Station there is about 2500 feet of head to work with**
- **Concerns is with impacts to up dip wells**

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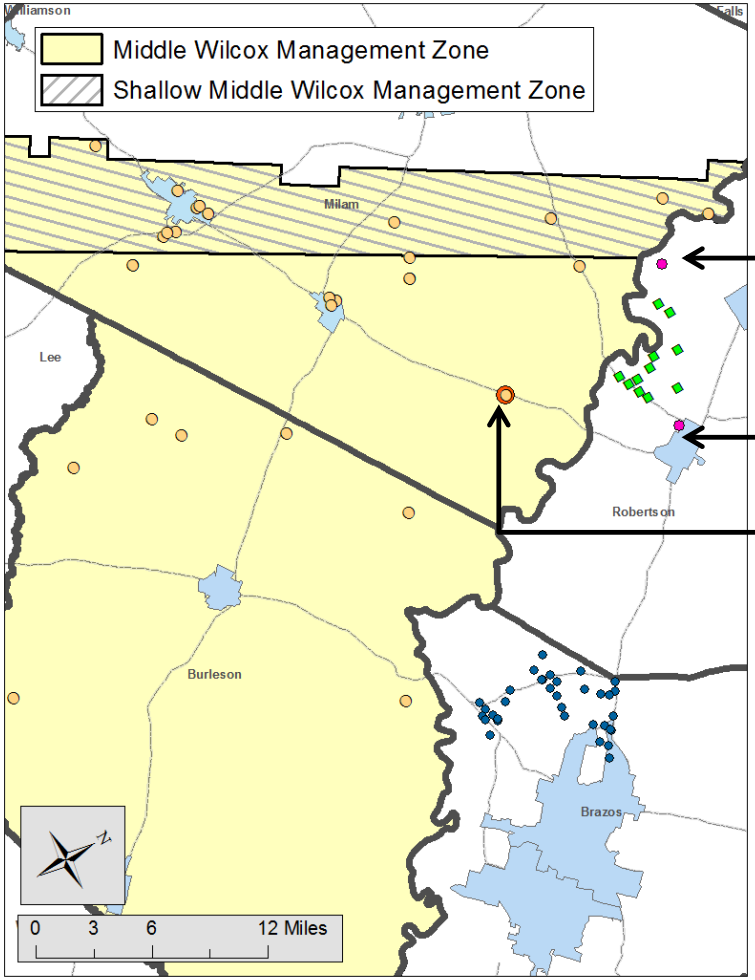
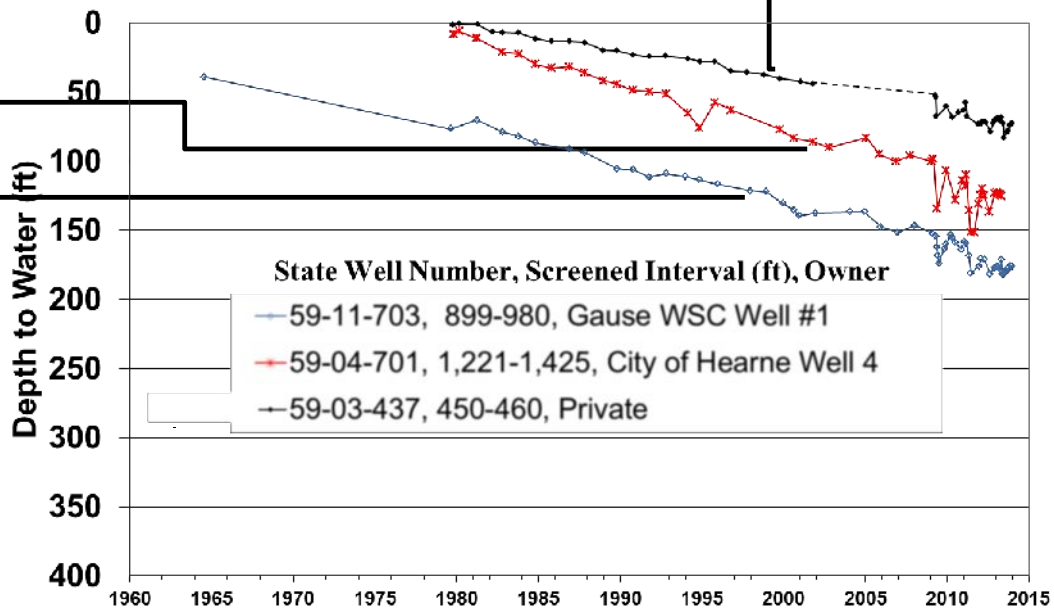
* From April 2006 presentation

Simsboro Aquifer Observation Wells





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Summary of Simsboro Well Responses

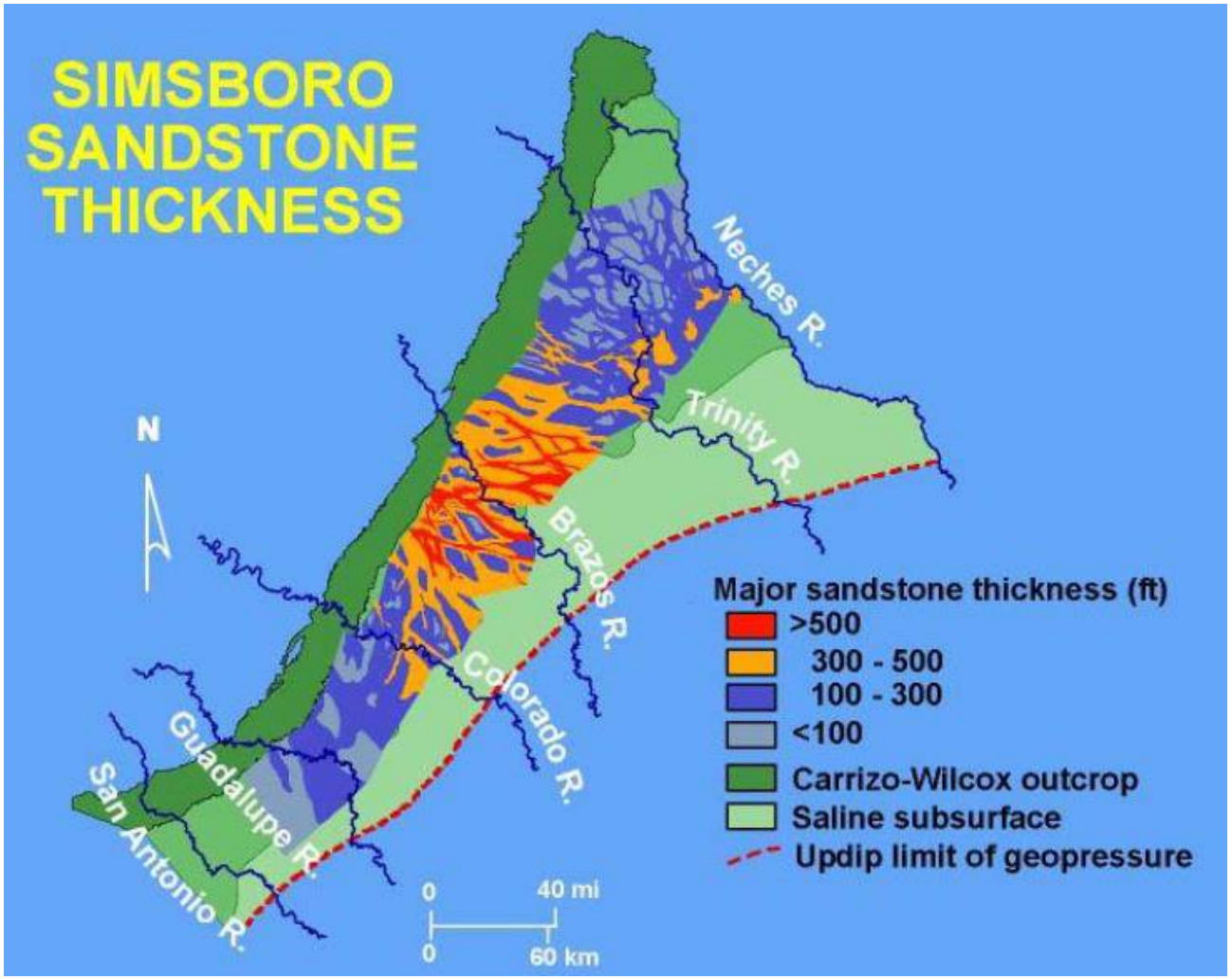
- Gause Well Response
  - Primarily caused by pumping at Bryan and College Station
  - Continual increase over time because pumping at Bryan and College Station continues to increase and because of additional pumping in Robertson County
- Other Wells
  - Primary cause of drawdown is pumping in Brazos Valley
  - Drawdown impacts from Blue Water or Alcoa in 2014 are significantly less than impacts from outside district

DFC Considerations

- Overview of the Simsboro Aquifer
- Considerations
  - Shallow and Deep Thresholds for Drawdown
  - Water Budgets
  - Drawdown versus Net Drawdown
  - Other (POSGCD GMA 12 Package)

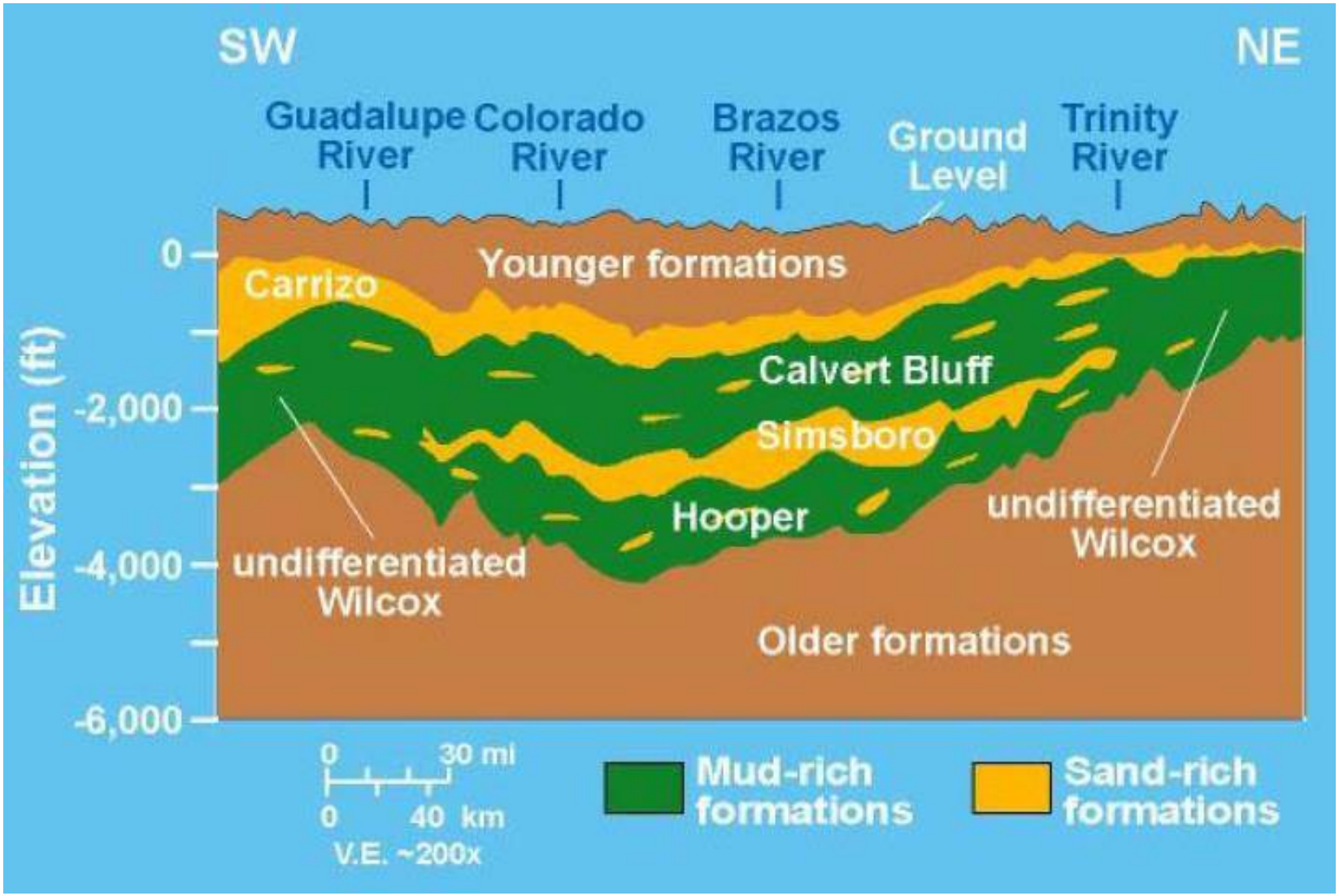
Simsboro Overview

Spatial Variation in Sand Thicknesses of Simsboro Aquifer



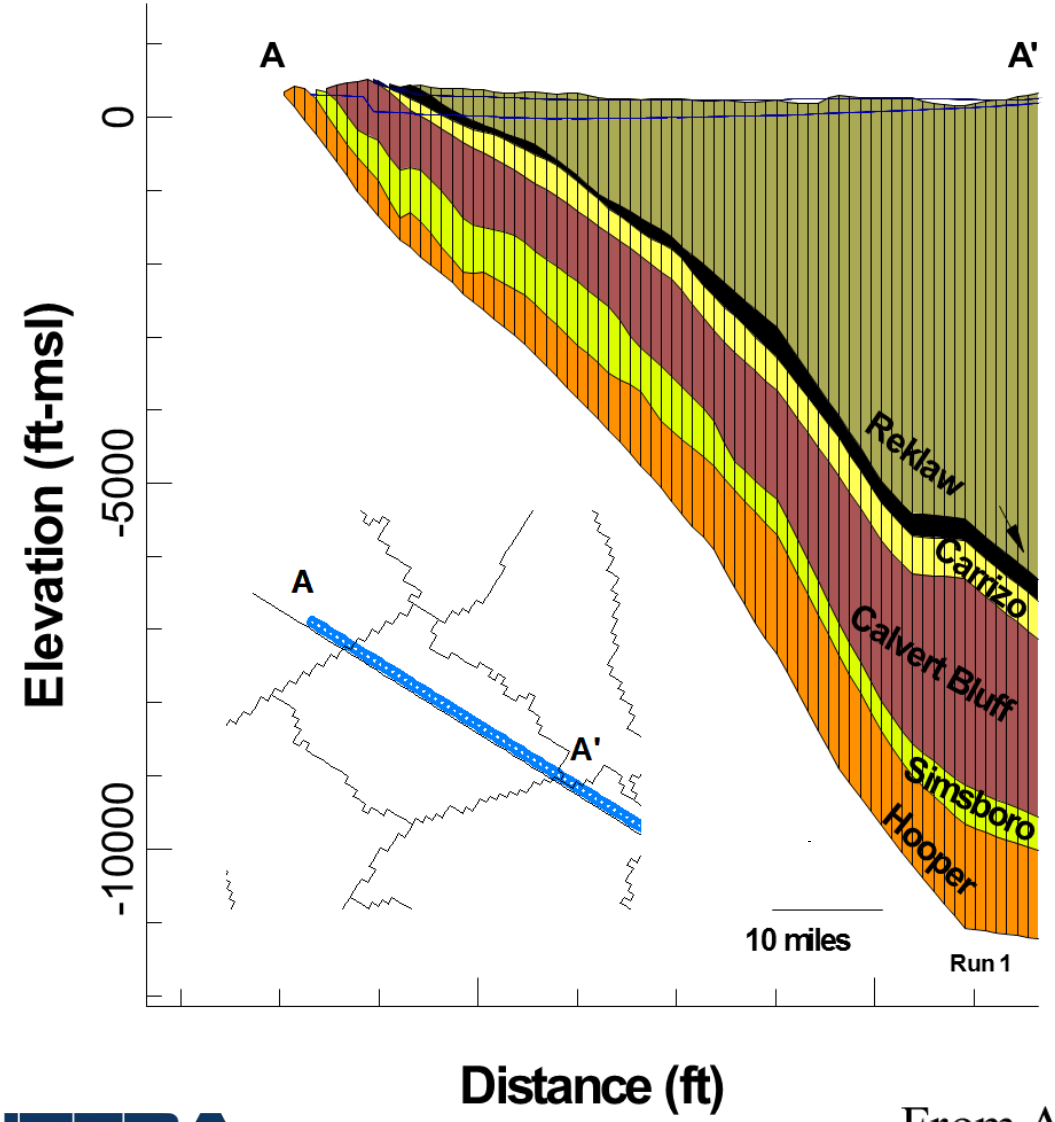
From Alcoa presentation Sept. 2012

Variation of Vertical Structure of Carrizo-Wilcox Aquifer Parallel to Coastline

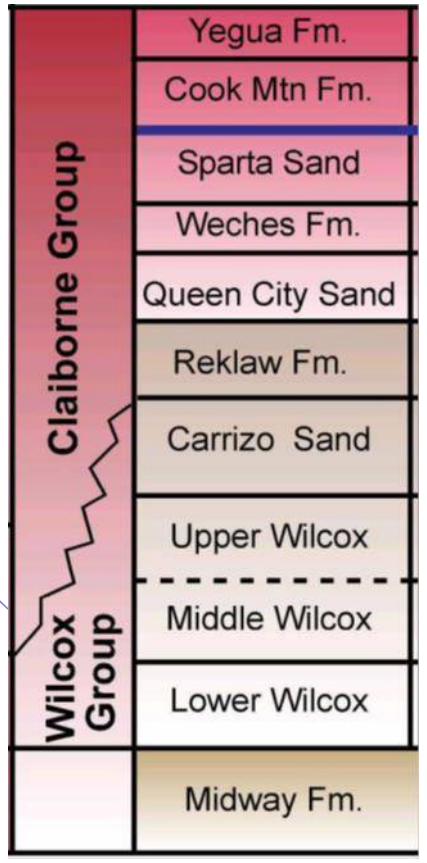


From Alcoa presentation Sept. 2012

Cross-Section Through POSGCD



Geologic Column



From Alcoa presentation Sept. 2012

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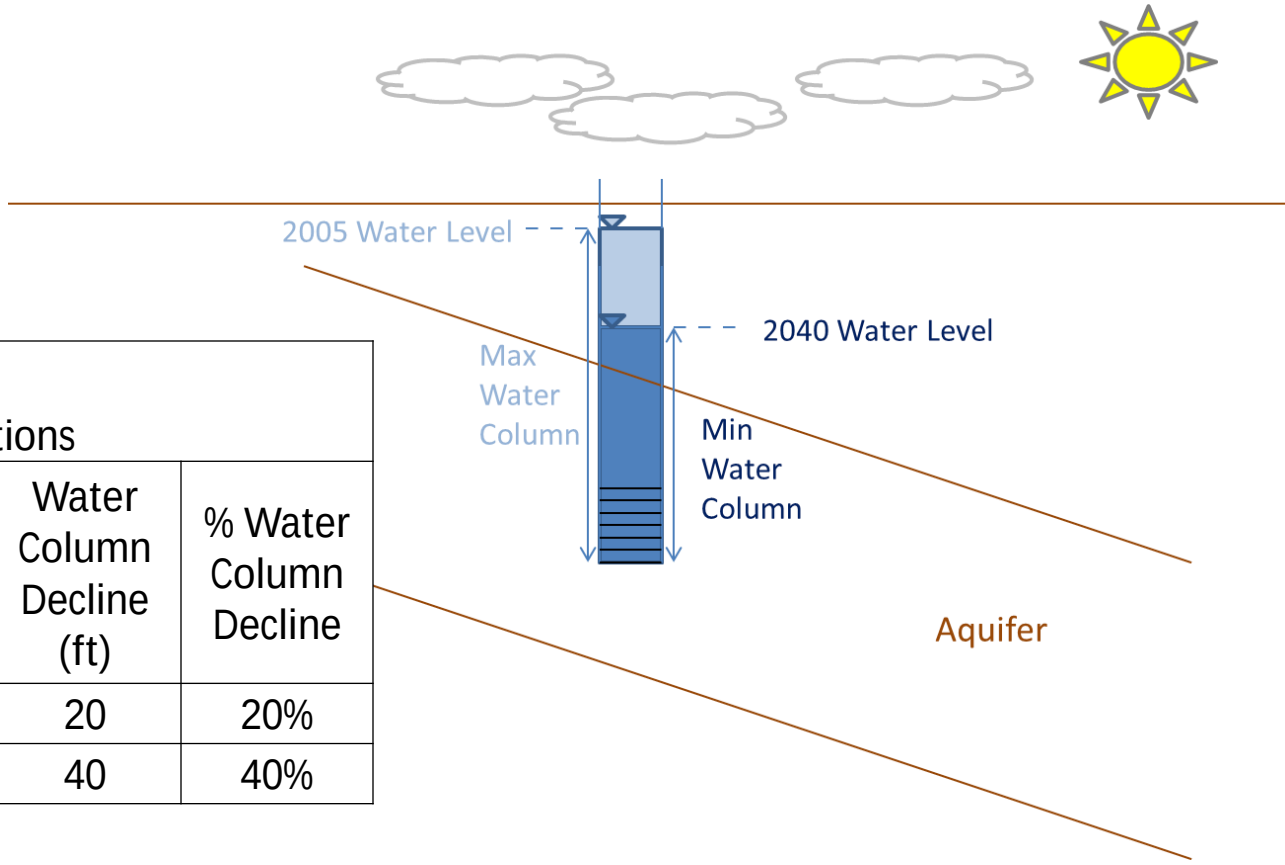
Drawdown Thresholds in Shallow and Deep Zones

Example Calculation of Water Column in Wells

Example Calculations				
Well ID	Max Water Column (ft)	Min Water Column (ft)	Water Column Decline (ft)	% Water Column Decline
Well 1	100	80	20	20%
Well 2	100	60	40	40%



From Alcoa presentation Sept. 2012

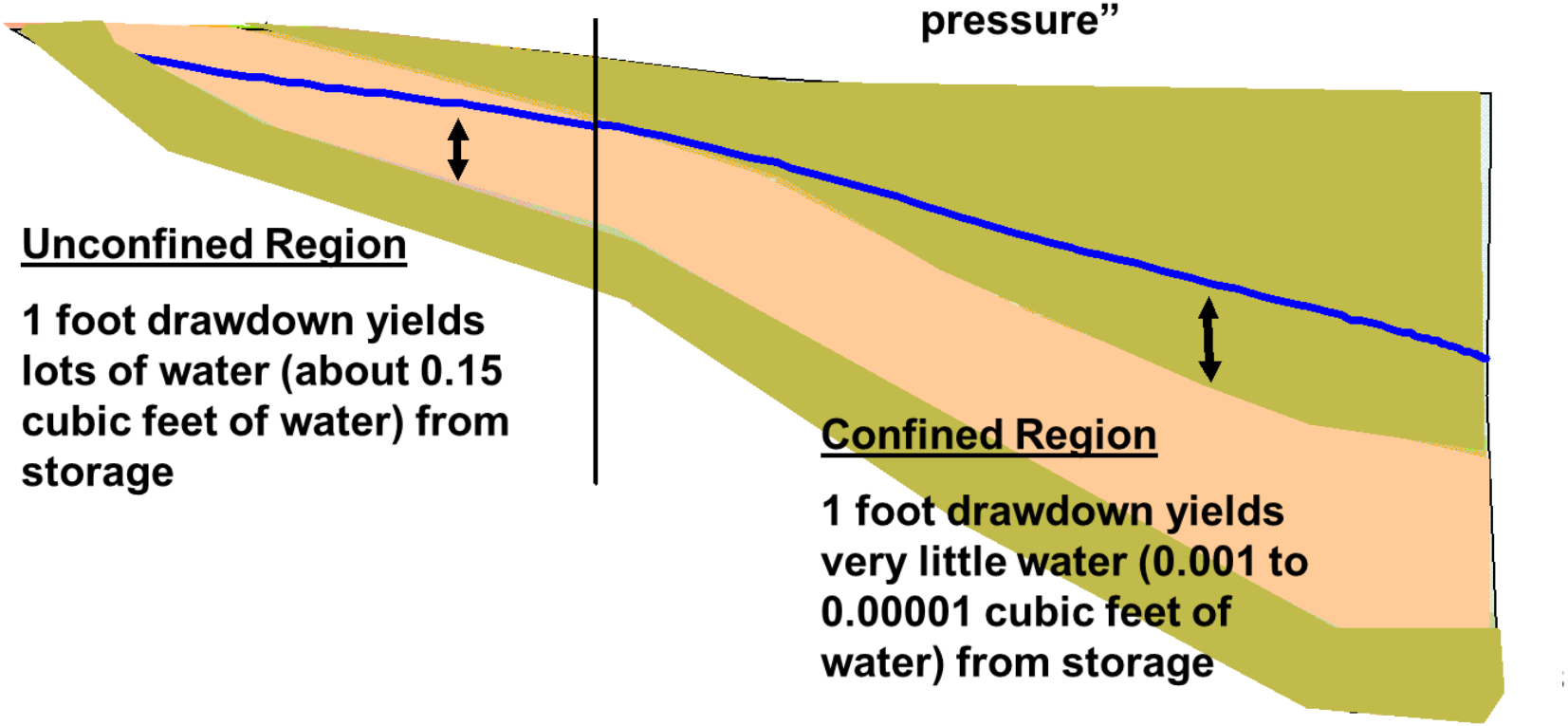
Shallow and Deep Groundwater Zones

Unconfined Region

Water level usually associated with saturated thickness

Confined Region

Water level usually often associated with "artesian pressure"



Unconfined Region

1 foot drawdown yields lots of water (about 0.15 cubic feet of water) from storage

Confined Region

1 foot drawdown yields very little water (0.001 to 0.00001 cubic feet of water) from storage

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From POSGCD DFC committee presentation Feb. 2009

Calculation of Water Column in Existing Monitoring Wells Based on 2014 Measurements

WID	state_well_number	Elevation	Depth	Top screen	2014 Water Depth	total column	TOS column
25	5917409	504	391	226	167	224	59
53	5909901	434	169	109	113	56	-4
170	5824914	495	295	153	127	168	26
234	5902309	297	417	185	30	387	155
236	5902307	415	450	410	126	324	284
268	5832101	474	60	40	8	52	32
1883	5832704	503	180	160	95	85	65
2423	5902904	401	240	180	119	122	62

WID	state_well_number	Elevation	Depth	Top screen	2014 Water Depth	total column	TOS column
107	5925102	411	858	767	127	731	640
256	5902901	370	318	284	112	207	173
457	5919502	463	2018	1832	282	1737	1551
1062	5918101	560	790	689	285	505	404
1063	5918104	550	800	650	271	529	379
1064	5918908	510	1687	1490	300	1387	1190
1082	5911703	369	992	889	172	820	717
6621	5926402	487	2020		267	1753	
7774	5910705	440	560	493	152	408	341
7793	5925103	411	420	400	123	297	277
8388	5943104	325	3988		105	3883	
8658	5910706	422	528	508	186	343	323
8767	5934108	410	2230		190	2041	
9064		241	3255	2400	89	3166	2311
9095	5910707	422	580	550	156	424	394
9166	5918108	505	1240	1178	258	982	920

*TOS = Top of Screen

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Example Calculation of DFC from Threshold Drawdowns for the Simsboro

Conditions			Desired Future Conditions - Drawdown
			Aquifer
DD in Unconfined Area	% Decline in artesian pressure	Max DD in Confined Area	Simsboro
10	0.25	450	312
15	0.25	450	313
20	0.25	450	313
25	0.25	450	314
20	0.25	350	260
20	0.25	400	288
20	0.25	450	313
20	0.25	500	336
20	0.25	550	357
20	0.33	350	273
20	0.33	400	305
20	0.33	450	335
20	0.33	500	364
20	0.33	550	390

From POSGCD DFC committee presentation Feb. 2009

Example Calculation of DFC from Threshold Drawdowns for the Hooper

Conditions			Desired Future Conditions - Drawdown
			Aquifer
DD in Unconfined Area	% Decline in artesian pressure	Max DD in Confined Area	Hooper
10	0.25	200	164
15	0.25	200	164
20	0.25	200	165
25	0.25	200	165
20	0.25	100	88
20	0.25	150	127
20	0.25	200	165
20	0.25	250	201
20	0.25	300	236
20	0.33	100	89
20	0.33	150	129
20	0.33	200	169
20	0.33	250	207
20	0.33	300	243
Area (sq. miles) based on 2000 heads		Confined	1116
		Unconfined	124
Average head (ft) 2000		Confined	312.0
		Unconfined	369.9
Storage Volume (acre-ft) 2000		Confined	53,443,897
		Unconfined	1,401,128
Storage Volume (acre-ft) 2060		Confined	53,412,122
		Unconfined	1,156,350
Total Withdrawn (acre-ft)			276,552

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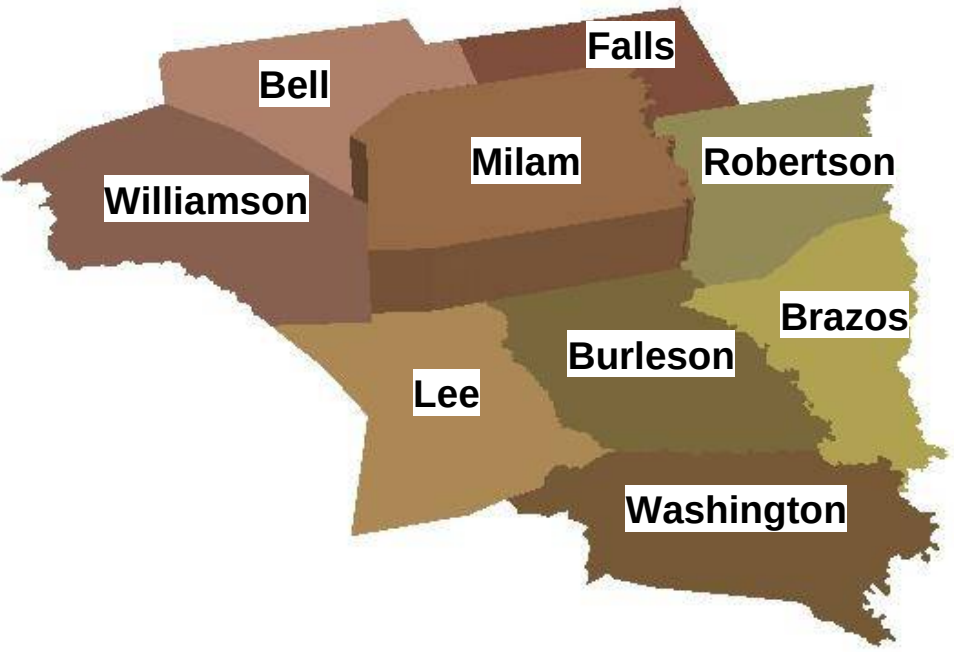
From POSGCD DFC committee presentation Feb. 2009

Water Budgets

Groundwater Flow Balance for Milam County in 2000



Milam County 2000 With HFB			
County	Flux In (acre-ft/yr)	Flux Out (acre-ft/yr)	Flux (acre-ft/yr)
Robertson	5900	12144	-6244
Brazos	0	0	0
Burleson	4907	14515	-9609
Washington	0	0	0
Williamson	337	50	287
Lee	2654	9116	-6462
Bell	0	0	0
Milam	0	0	0
Falls	0	0	0
Source/Sink	Flux In (acre-ft/yr)	Flux Out (acre-ft/yr)	Flux (acre-ft/yr)
Above	0	0	0
Below	0	0	0
Storage	50187	3146	47040
Recharge	31021	0	31021
Well Discharge	0	35617	-35617
General Head	0	0	0
Evapotranspiration	0	3974	-3974
Springs	0	245	-245
Lakes	0	0	0
Rivers/Streams	10134	26333	-16199
Percent Error			0.00

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From POSGCD Board presentation April 2007

Groundwater Flow Balance for Burleson County in 2000

Burleson County Summary 2000 With HFB			
County	Flux In (acre-ft/yr)	Flux Out (acre-ft/yr)	Flux (acre-ft/yr)
Robertson	169	2156	-1987
Brazos	1814	16081	-14267
Burleson	0	0	0
Washington	3508	1214	2294
Williamson	0	0	0
Lee	10449	1868	8581
Bell	0	0	0
Milam	14515	4907	9609
Falls	0	0	0
Source/Sink	Flux In (acre-ft/yr)	Flux Out (acre-ft/yr)	Flux (acre-ft/yr)
Above	0	0	0
Below	0	0	0
Storage	6598	7739	-1140
Recharge	13500	0	13500
Well Discharge	0	4940	-4940
General Head	934	4141	-3206
Evapotranspiration	0	2339	-2339
Springs	0	217	-217
Lakes	0	0	0
Rivers/Streams	309	6195	-5886
Percent Error			0.00

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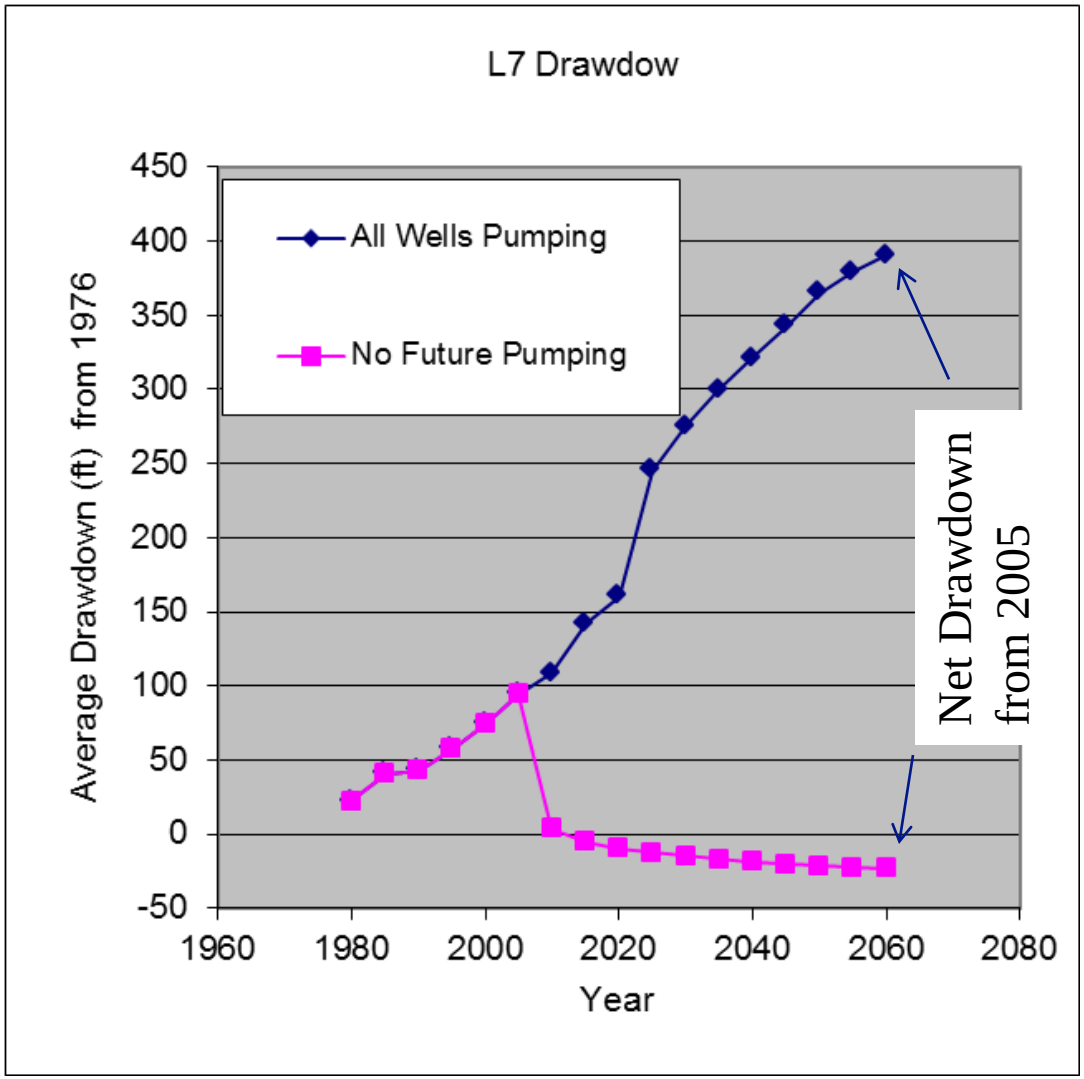
From POSGCD Board presentation April 2007

Net Drawdown Calculations

Analysis Method: Net Drawdown

- Evaluate the Impact of a well or group of wells based on the net drawdown

- Net drawdown is calculated not relative to an existing water table but based on the impact of the difference between a pumping and a non-pumping scenario



From Alcoa presentation Sept. 2012

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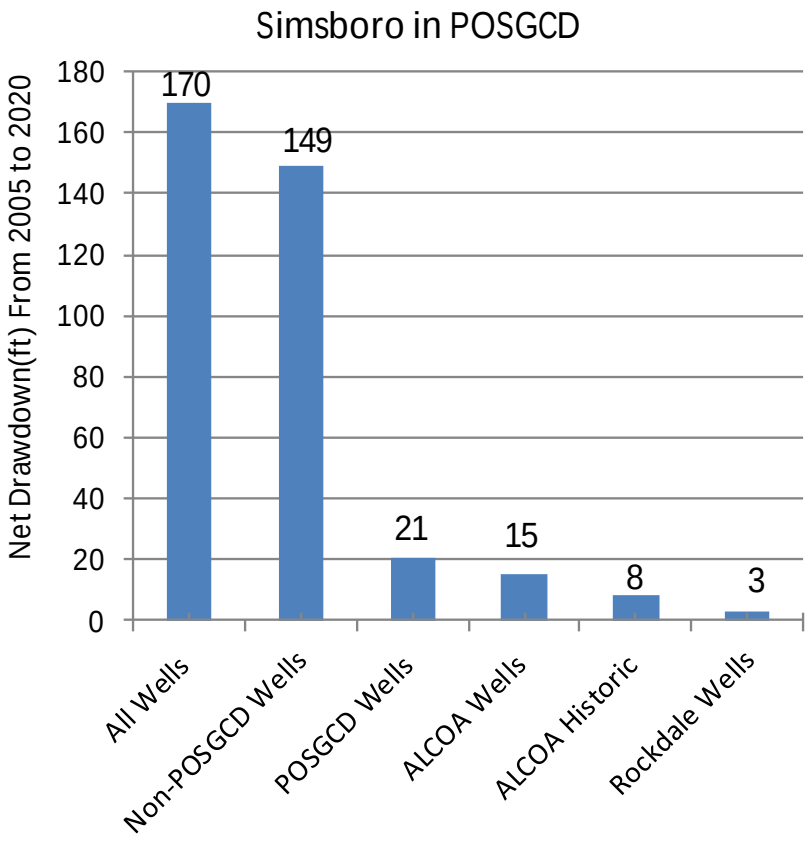
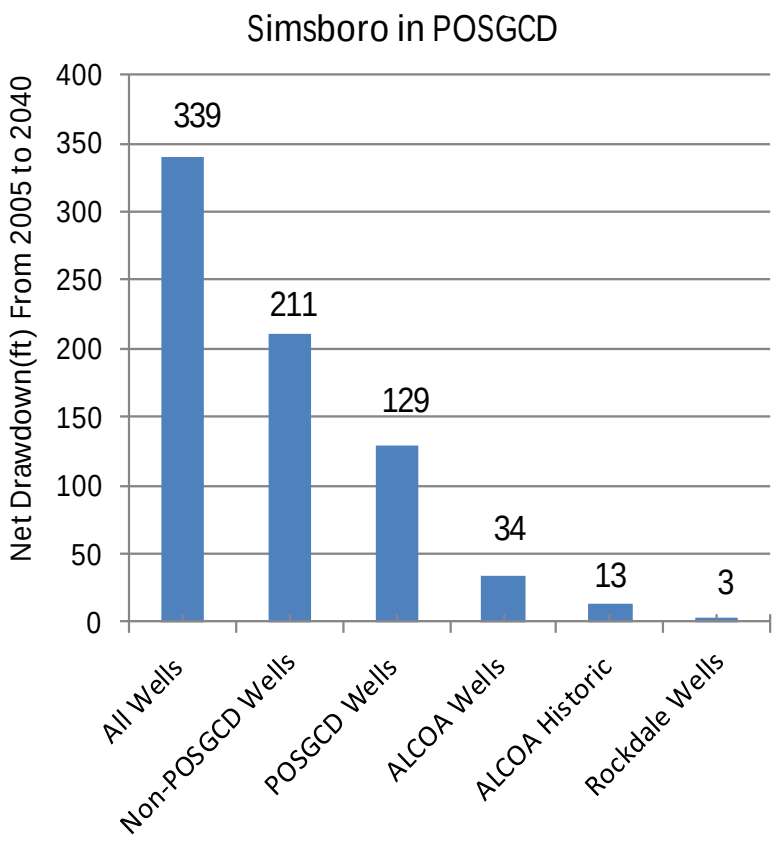
Net Drawdown in POSGCD Simsboro





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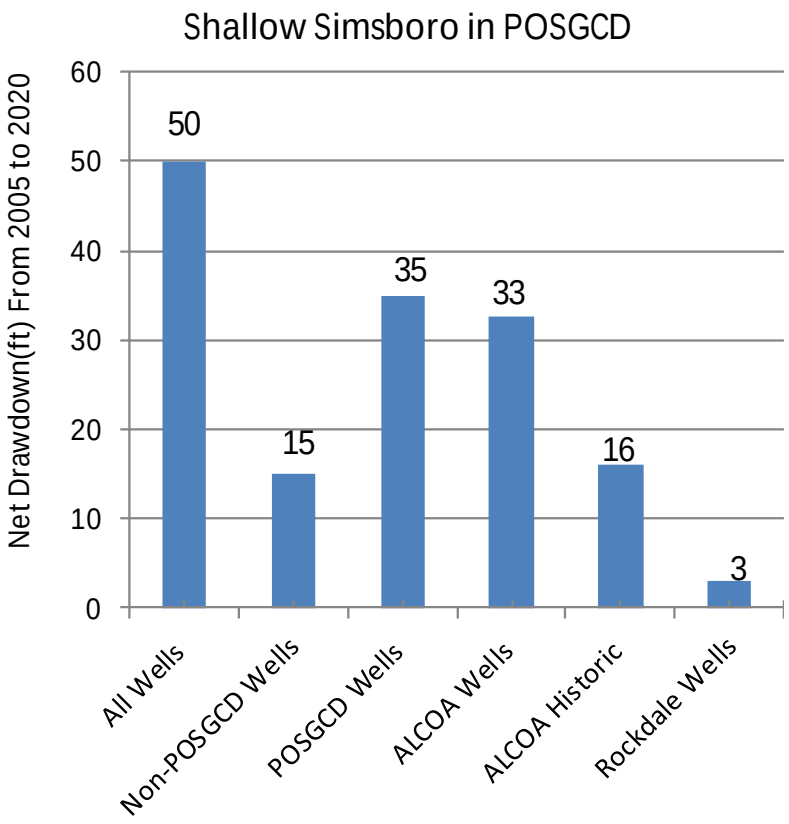
From Alcoa presentation Sept. 2012

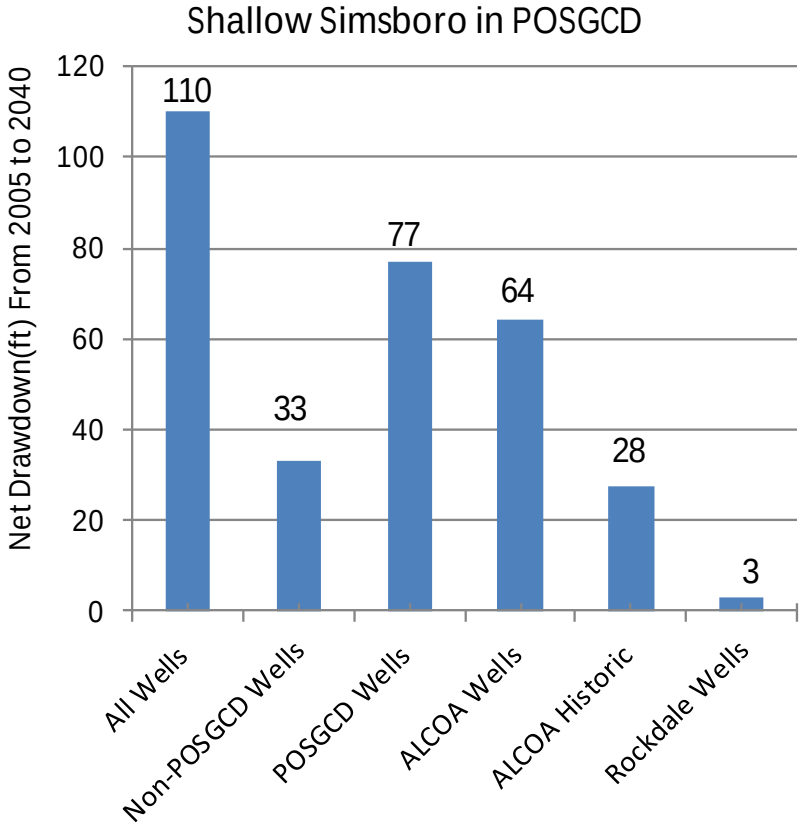
Contribution of Different Well Groups to Net Drawdown in POSGCD Simsboro

Well Group	Simsboro 2020	Simsboro 2040
Net Drawdown (ft)	179	339
Non-POSGCD Wells	87.9%	62.1%
POSGCD Wells	12.1%	37.9%
ALCOA Wells	9.1%	10.0%
ALCOA (Historic)	4.8%	3.9%
Rockdale Wells	1.8%	0.9%
ALCOA Wells (Permit)	4.3%	6.1%

From Alcoa presentation Sept. 2012

Net Drawdown in POSGCD Shallow Simsboro





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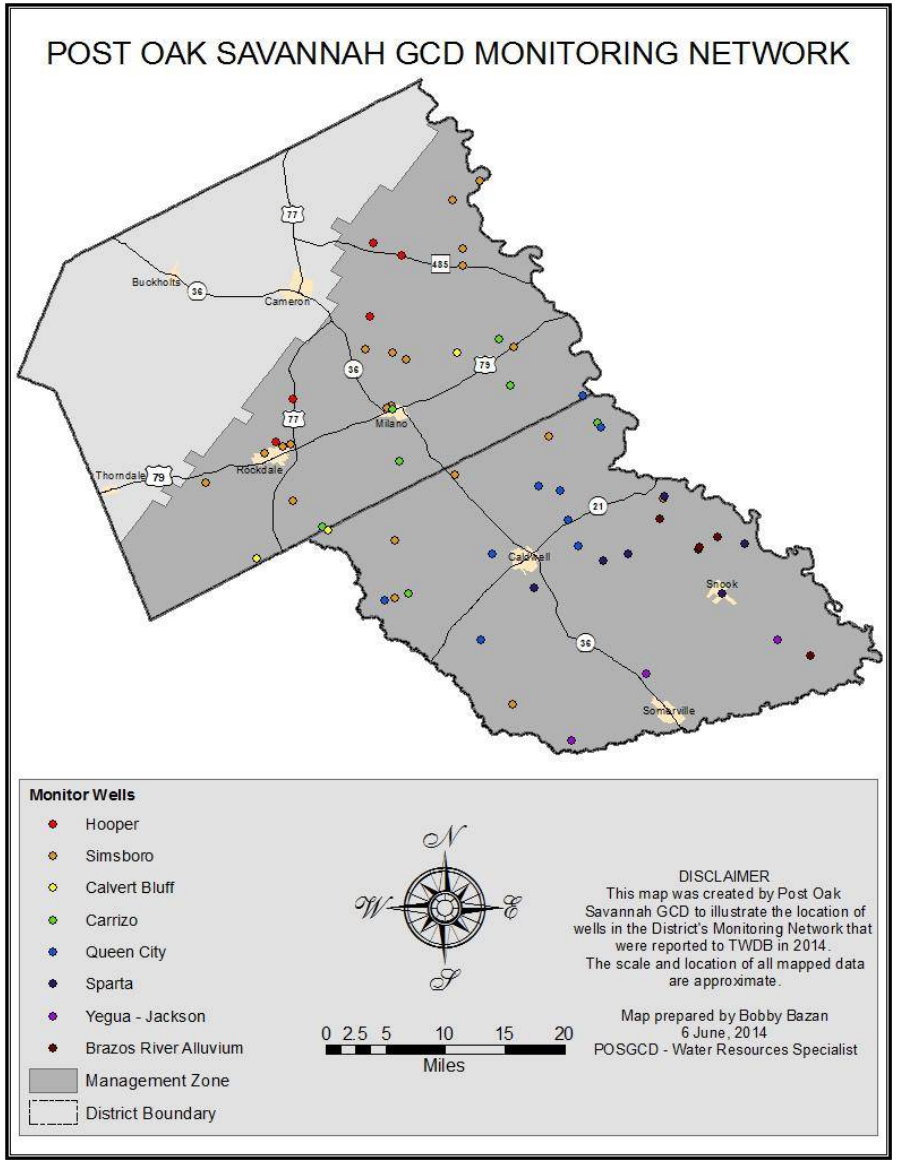
Contribution of Different Well Groups to Net Drawdown in POSGCD Shallow Simsboro

Well Group	Shallow Simsboro 2020	Shallow Simsboro 2040
Net Drawdown(ft)	50	110
Non-POSGCD Wells	30.0%	30.0%
POSGCD Wells	70.0%	70.0%
ALCOA Wells	65.0%	58.6%
ALCOA (Historic)	32.6%	25.0%
Rockdale Wells	6.0%	2.7%
ALCOA Wells (Permit)	32.4%	33.6%

Monitoring Data & Permit Amounts

Monitoring Network: Currently at 85 wells



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Monitoring Network: Currently is 85 wells

Aquifer	Zone	# wells	Water Levels				Trend Last Five (5) Years
			Mean	Max	Min	Range	
Hooper	Shallow	6	354	401	239	162	relatively constant, most wells dropping ~5 ft.
Simsboro	Shallow	12	309	471	212	259	relatively constant, most wells dropping ~2-10 ft, a couple dropped >10 ft
Simsboro	Deep	17	248	328	116	212	some wells dropping, but several raising as much as 30 ft.
Calvert Bluff	Shallow	5	329	411	254	158	Mixed results, No apparent trend
Carrizo	Shallow	4	330	458	268	190	relatively constant, mostly dropping ~2-6 ft.
Carrizo	Deep	4	303	319	273	46	relatively constant, mostly dropping ~2-6 ft.
Queen City	Shallow	5	299	352	251	101	relatively constant, a couple wells dropping ~10 ft.
Queen City	Deep	3	302	321	291	30	need more data, but trending downward
Sparta	Deep	7	251	294	173	121	relatively constant, mostly dropping no more than ~10 ft.
Yegua-Jackson		3	209	220	199	22	Mixed results, No apparent trend
Brazos River Alluvium		7	210	246	172	74	Relavtively constant, dropping ~10 ft.

POSGCD Permit Amounts

Summary of Permitted and Monitoring Wells in Post Oak Savannah GCD (as of 2013)

Aquifer	Number Wells	Number Permits	% Wells in Aquifer that are Permitted	% of Permitted Wells in Aquifer	Monitor Wells
Brazos River Alluvium	773	336	43%	49%	7
Sparta	813	28	3%	4%	7
Queen City	789	10	1%	1%	8
Carrizo-Wilcox	1651	196	49%	29%	48
Carrizo	*261*	*42*	*16%*	*6%*	*8*
Calvert Bluff	*436*	*10*	*2%*	*1%*	*5*
Simsboro	*468*	*123*	*26%*	*18%*	*29*
Hooper	*486*	*21*	*4%*	*3%*	*6*
Yegua-Jackson	1676	29	2%	4%	3
No Assignment	2967	88	3%	13%	-
Total	***8669***	***687***	-	***100%***	***73***

Summary of Permitted and Monitoring Wells in Post Oak Savannah GCD
(note: Carrizo-Wilcox Permits are broken out by individual aquifers)

Permit Type	Little River	BRA	Sparta	Queen City	Carrizo-Wilcox	*Carrizo*	*Calvert Bluff*	*Simsboro*	*Hooper*	Yegua-Jackson	Not Assigned	Total
Historic Use	661	38,525	550	94	26,303	*2,611*	*895*	*21,018*	*1,779*	343	1,425	67,902
Operation	3,914	7,888	1,241	223	99,167	15,911	165	82,245	846	839	8,856	122,128
Total	**4,575**	**46,413**	**1,792**	**317**	**125,470**	**18,522**	**1,060**	**103,263**	**2,625**	**1,182**	**10,282**	***190,030***

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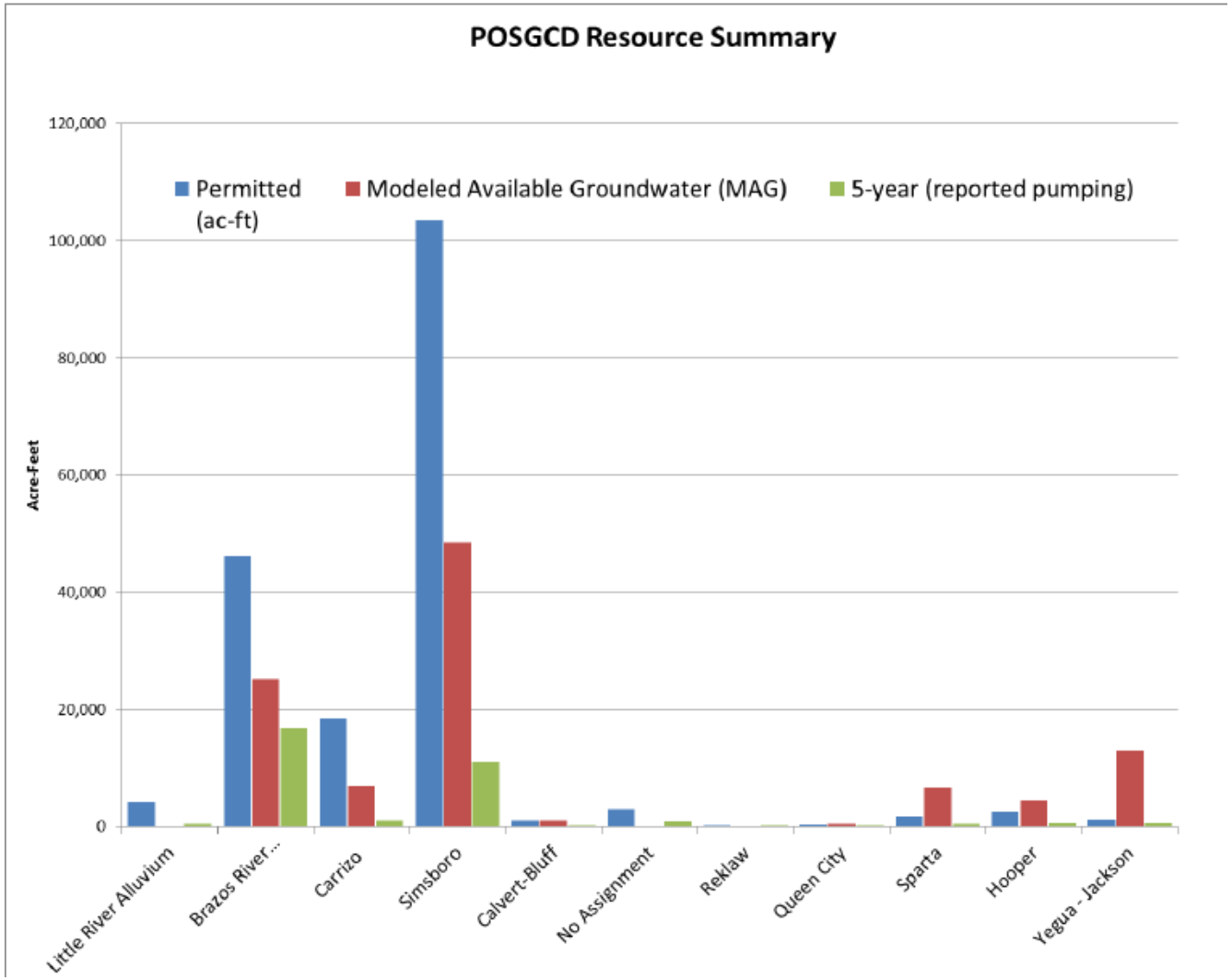
Comparison of Permitted, MAG,and Reported Pumping



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POSGCD Information Package for GMA 12

- 2012 and 2017 State Water Plan Demands
- 2012 State Water Plans Supply and Water M
- TWDB Total Available Storage Estimates
- Historical Pumping from TWDB
- Historical Pumping from POSGCD
- Current POSGCD Permits Amounts
- Summary of POSGCD Water Level Monitoring Data
- 2009 DFC Statement
- Example Calculation of DFC drawdown based on threshold drawdowns in shallow and deep aquifer