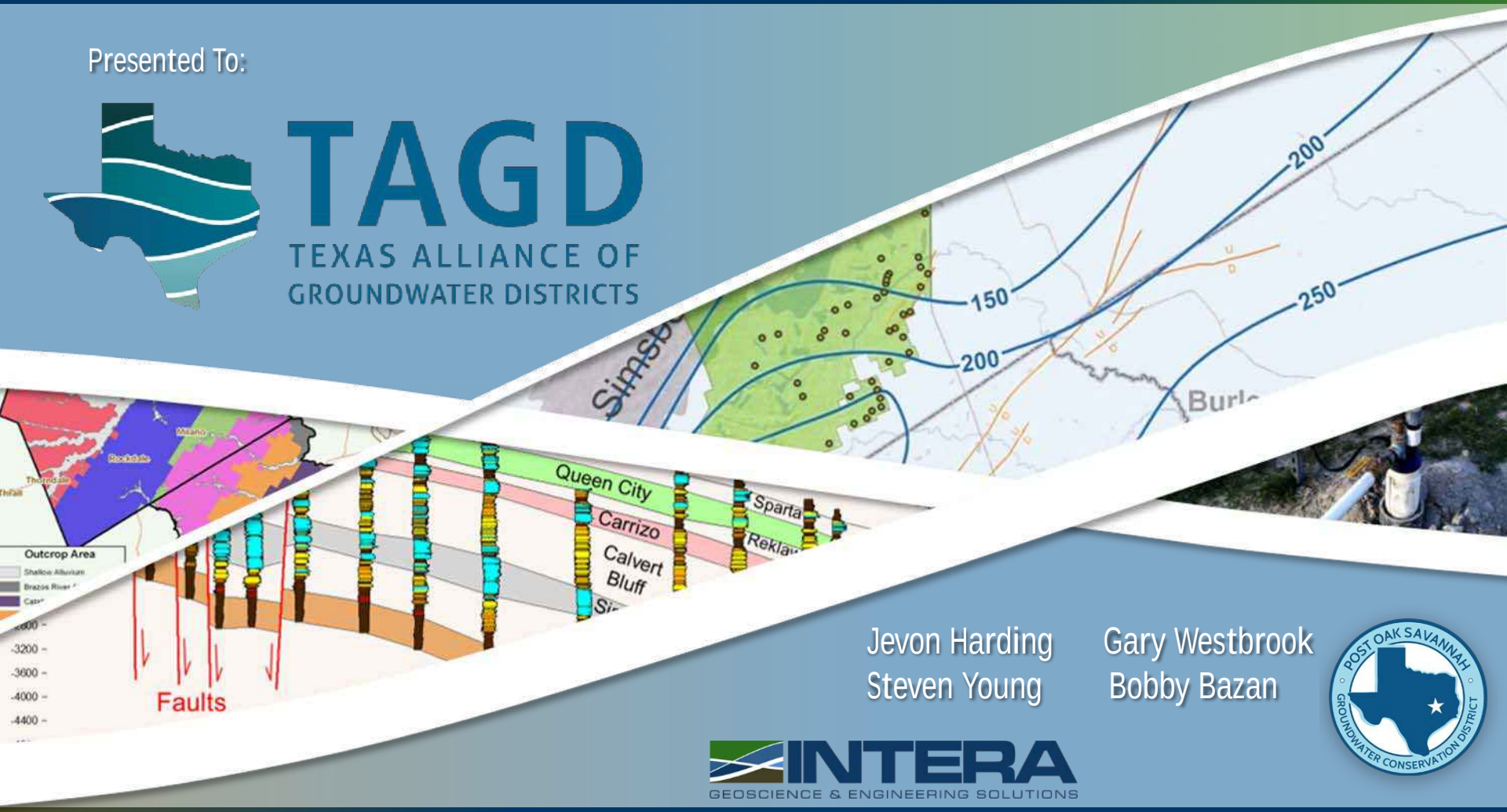
Water Level Monitoring Networks & Analysis of Data for Assessing DFCs

Presented To:

TAGD
TEXAS ALLIANCE OF GROUNDWATER DISTRICTS



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INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

POST OAK SAVANNAH GROUNDWATER CONSERVATION DISTRICT

August 30, 2017

OUTLINE

- Monitoring Network Design & Implementation
  - Coverage
  - Defensibility
- Role of Monitoring Network
  - GCD Management Strategies
  - Analysis of Monitoring Data

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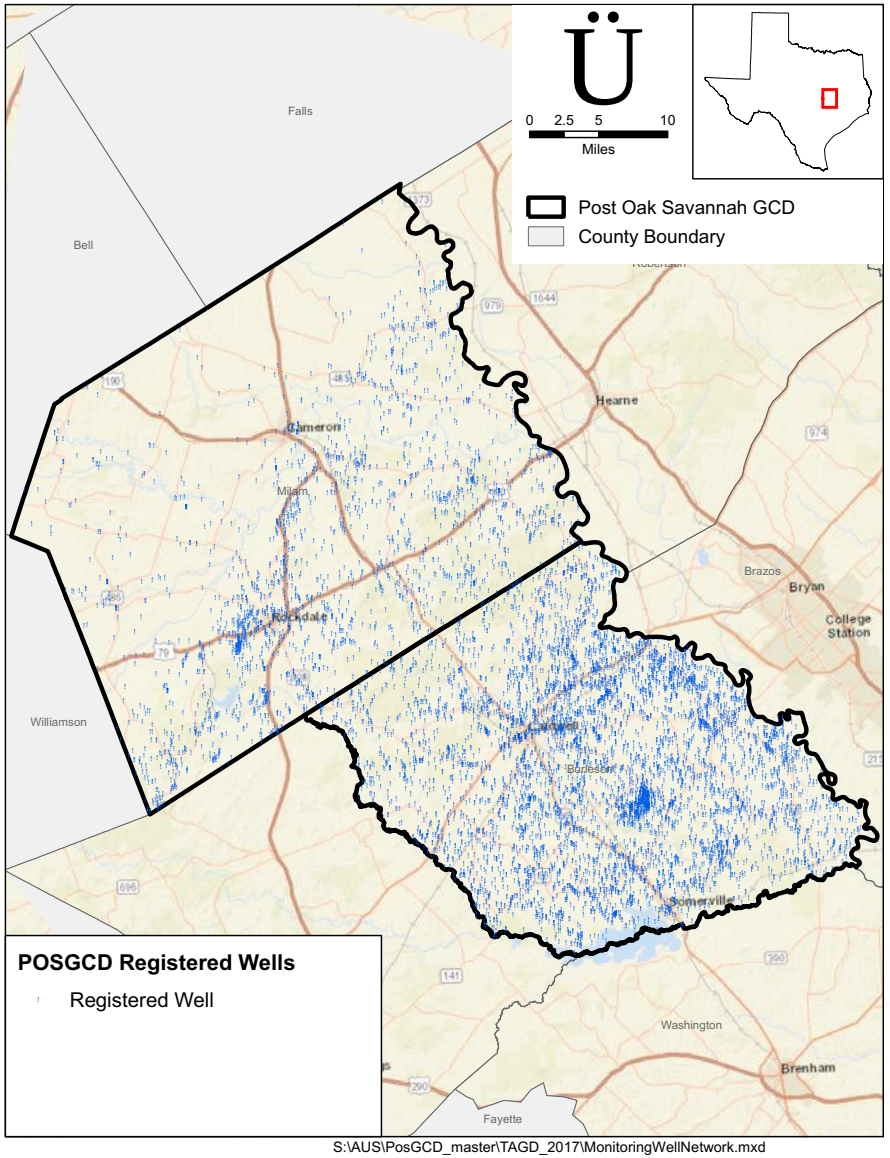
How do you get Good Coverage with your Monitoring Network?

Monitoring Network Coverage

In a perfect world....



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Monitoring Network Coverage

Strategy #1: **Maximize Stakeholder Participation**

- Awareness
  - Advertisements
- Incentives
  - Groundwater Well Assistance Program
  - Conversion of abandoned/plugged O & G wells

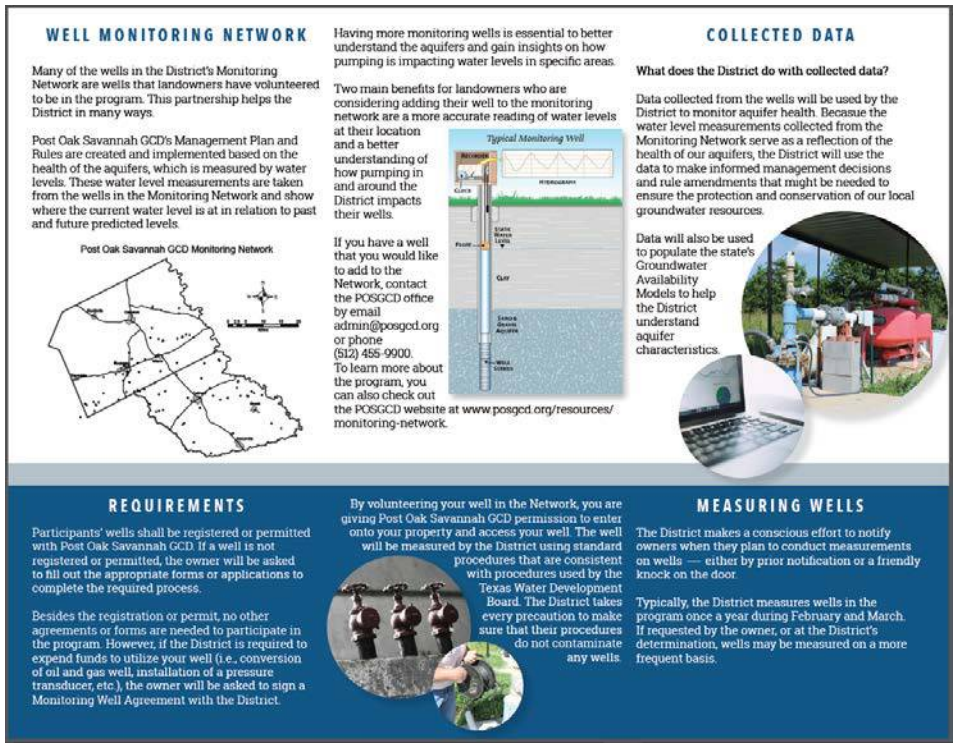
Issues to Consider

- Monitoring agreement
- Long-term access to well
- Maintenance of equipment
- Changes in well ownership
- Cost & liability (P13 forms for O & G conversions)

Monitoring Network Coverage

Social Media

Brochures & Handouts



WELL MONITORING NETWORK

Many of the wells in the District's Monitoring Network are wells that landowners have volunteered to be in the program. This partnership helps the District in many ways.

Post Oak Savannah GCD's Management Plan and Rules are created and implemented based on the health of the aquifers, which is measured by water levels. These water level measurements are taken from the wells in the Monitoring Network and show where the current water level is at in relation to past and future predicted levels.

Post Oak Savannah GCD Monitoring Network

Having more monitoring wells is essential to better understand the aquifers and gain insights on how pumping is impacting water levels in specific areas.

Two main benefits for landowners who are considering adding their well to the monitoring network are a more accurate reading of water levels at their location and a better understanding of how pumping in and around the District impacts their wells.

Typical Monitoring Well

If you have a well that you would like to add to the Network, contact the POSGCD office by email admin@posgcd.org or phone (512) 455-9900. To learn more about the program, you can also check out the POSGCD website at www.posgcd.org/resources/monitoring-network.

COLLECTED DATA

What does the District do with collected data?

Data collected from the wells will be used by the District to monitor aquifer health. Because the water level measurements collected from the Monitoring Network serve as a reflection of the health of our aquifers, the District will use the data to make informed management decisions and rule amendments that might be needed to ensure the protection and conservation of our local groundwater resources.

Data will also be used to populate the state's Groundwater Availability Models to help the District understand aquifer characteristics.

REQUIREMENTS

Participants' wells shall be registered or permitted with Post Oak Savannah GCD. If a well is not registered or permitted, the owner will be asked to fill out the appropriate forms or applications to complete the required process.

Besides the registration or permit, no other agreements or forms are needed to participate in the program. However, if the District is required to expend funds to utilize your well (i.e., conversion of oil and gas well, installation of a pressure transducer, etc.), the owner will be asked to sign a Monitoring Well Agreement with the District.

By volunteering your well in the Network, you are giving Post Oak Savannah GCD permission to enter onto your property and access your well. The well will be measured by the District using standard procedures that are consistent with procedures used by the Texas Water Development Board. The District takes every precaution to make sure that their procedures do not contaminate any wells.

MEASURING WELLS

The District makes a conscious effort to notify owners when they plan to conduct measurements on wells — either by prior notification or a friendly knock on the door.

Typically, the District measures wells in the program once a year during February and March. If requested by the owner, or at the District's determination, wells may be measured on a more frequent basis.

INTERA GEOSCIENCE & ENGINEERING SOLUTIONS

Monitoring Network Coverage

Strategy #1: **Maximize Well Owner Participation**

- Awareness
  - Advertisements
- Incentives
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Issues to Consider

- Monitoring agreement
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- Maintenance of equipment
- Changes in well ownership
- Cost & liability (O & G conversions)

Monitoring Network Coverage

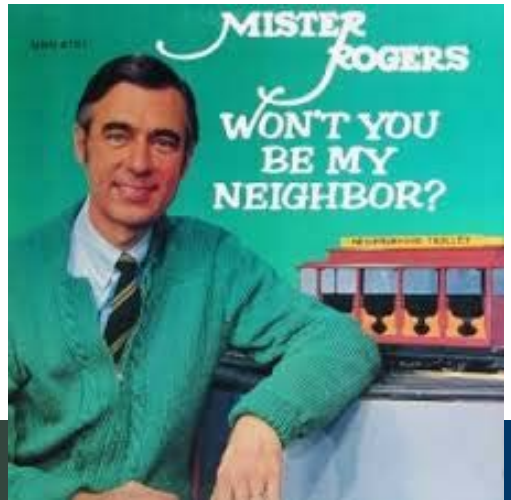
Strategy #2:

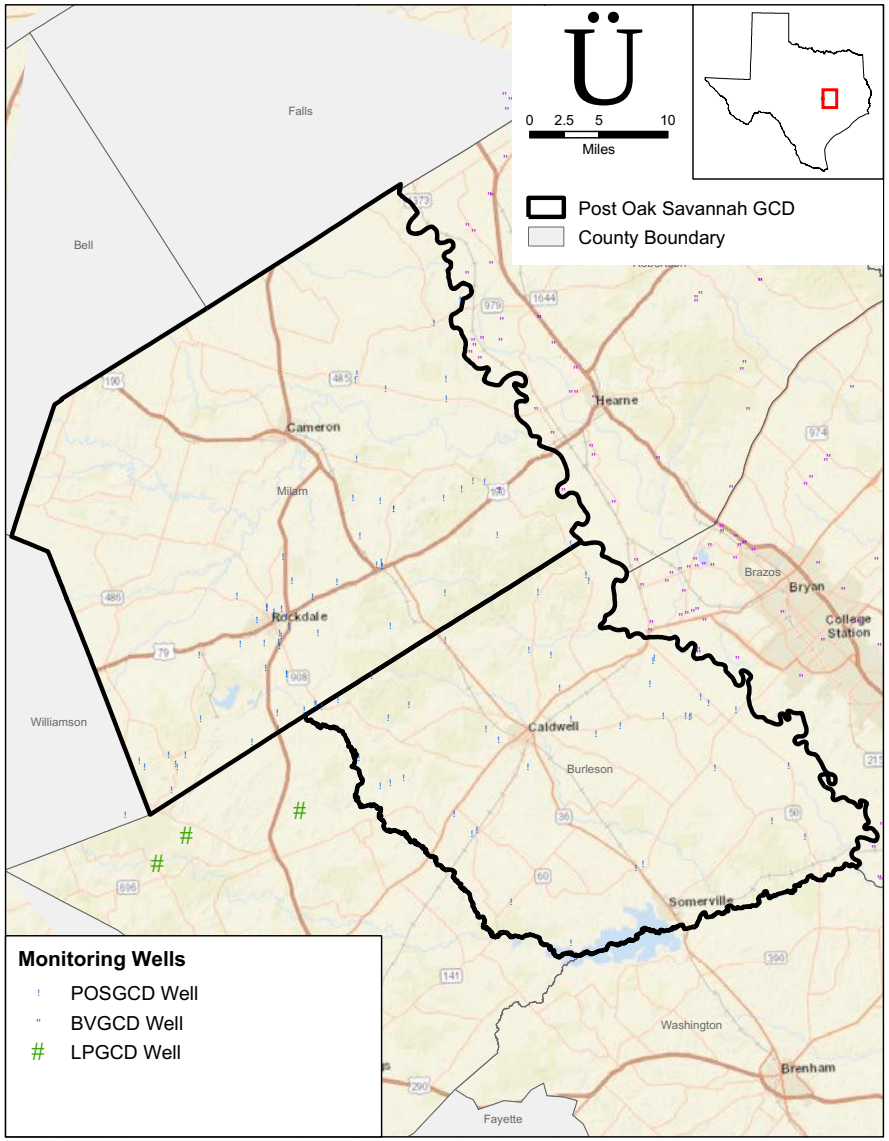
Cooperation with Other GCDs

- GMA-wide participation
- more Aquifer coverage

Issues to Consider

- Differences in sampling schedules or procedures
- Access to wells & data





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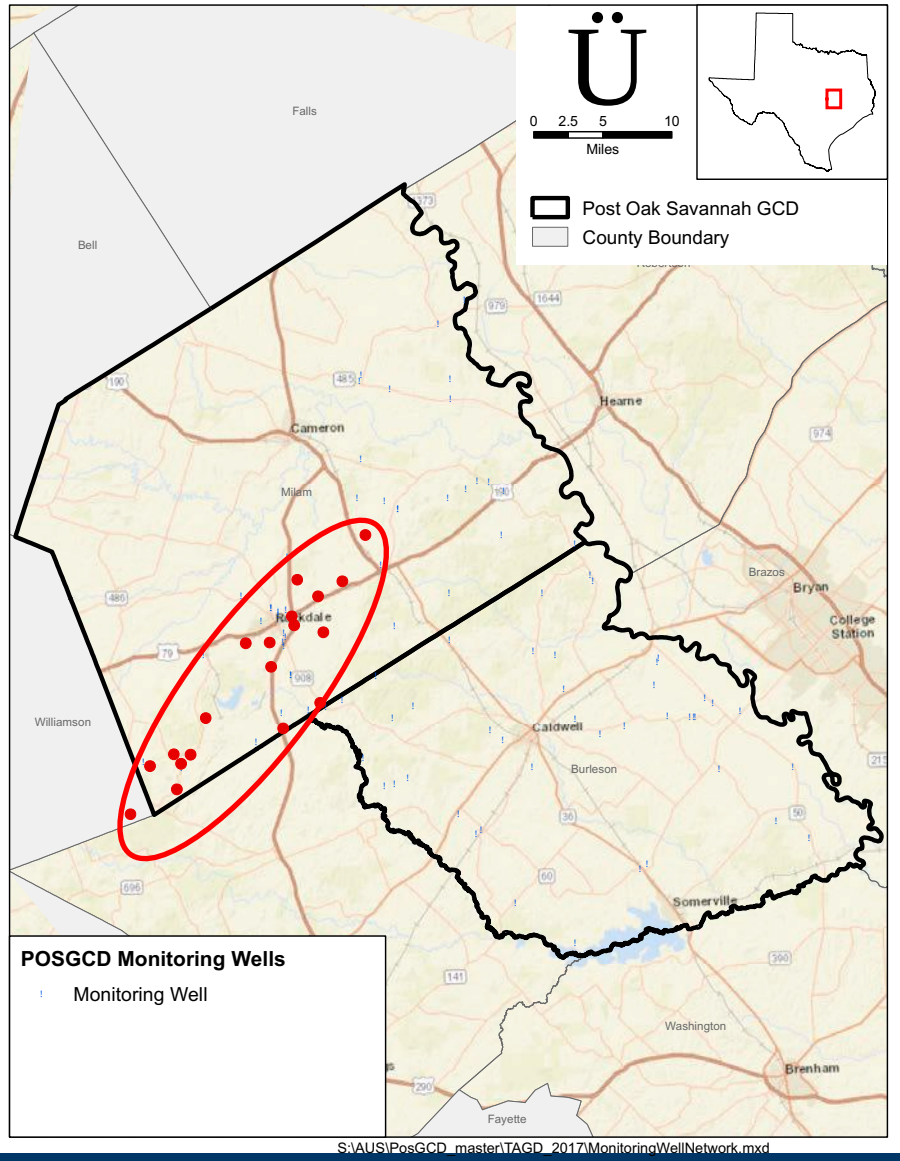
Monitoring Network Coverage

Strategy #3: **Use wells from other existing regulatory programs**

- TCEQ
- Railroad Commission (ex. wells from Alcoa Mine closure

Issues to Consider

- Transition period
- Access to wells & data



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Monitoring Network Coverage

Strategy #4: **Drill your own wells**

- Work with stakeholders for land/access:
  - County / City → roads, parks, buildings
  - TxDoT → road easements
- O & G well conversions
- 2” non-pumping Monitoring wells

Issues to Consider

- Drilling costs
- Maintenance & monitoring costs
- Long-term access to wells & equipment

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- Role of Monitoring Network
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OUTLINE

- Monitoring Network Design & Implementation
  - Coverage
  - **Defensibility**

Is your Monitoring Network defensible?

Scientific **Legal**

Public Perception

- Role of Monitoring Network
  - GCD Management Strategies
  - Analysis of Monitoring Data

Monitoring Network Defensibility

Strategy #1 : **Monitoring Protocols**

- Official forms & record-keeping
- Standardized procedures by Measurement Type

  Air line E-line Steel tape Acoustic Transducers

Issues to Consider:

Consistency across GMAs & TWDB

Snapshot vs. Continuous Measurements

Training – role of TAGD?

Monitoring Network Defensibility

POSGCD Measurement Form

Aquifer(s) Choose One... State Well No. _____

Owner _____ Address : _____

Land Surface Elevation : _____ County: _____

Well Location: Lat: _____ Phone: _____
Long: _____

Pump: Type: Choose One... Depth: _____ ft.
Setting: _____ ft.

M.P. _____

Remarks: _____

Date of Current Measurement MO. | DAY | YR	Current Dept to Water From Land Surface	Change in Level Since Last Static Measurement	Dept to Water From MP	MP	Measuring Agency	Measuring Method	Use	Field Observations	User I.D.	Called Ahead?	When was Well last pumped?

Monitoring Network Defensibility

Strategy #1 : **Monitoring Protocols**

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  Air line E-line Steel tape Acoustic Transducers

Issues to Consider:

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Snapshot vs. Continuous Measurements

Training – role of TAGD?

Monitoring Network Defensibility

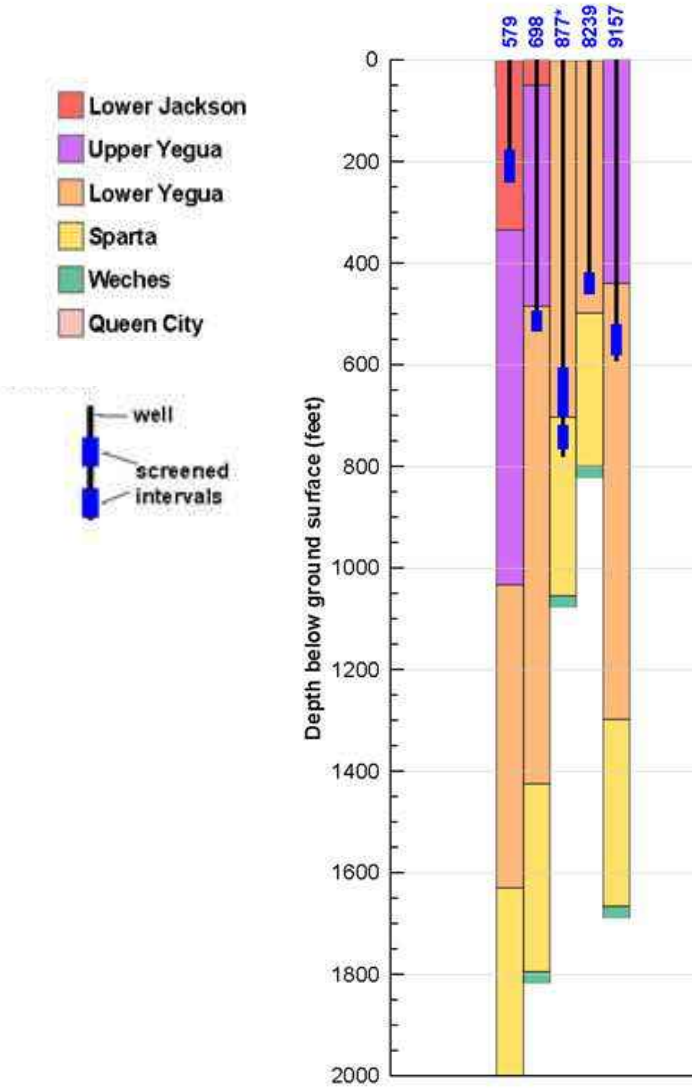
Strategy #2 : **Aquifer Assignment Methodology**

- Methodology for assigning wells to aquifers
  - GAM surfaces
  - Well logs
  - TWDB assignments
  - Aquifer response
- Transparent & accessible documentation of aquifer assignments

Issues to Consider:

Consistency across GMAs
Consistency with TWDB
Multi-screen wells

Monitoring Network Defensibility



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Monitoring Network Defensibility

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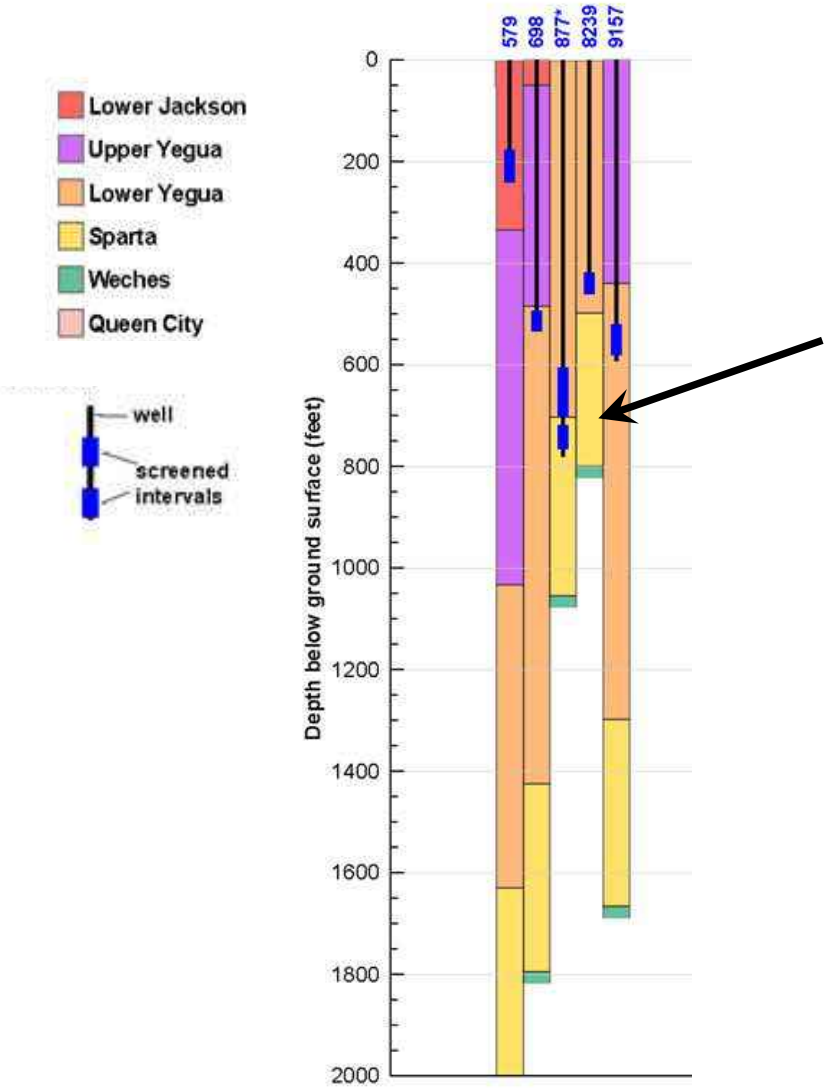

Well screened in both Lower Yegua & Sparta

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Monitoring Network Defensibility

Strategy #3 : **Well Information Confirmation**

- Correct well location
- Accurate depth and screen information from drillers logs and/or video logs
- Confirmation that well is working and not contaminated (water quality)

Issues to Consider:

Unavailable/unreliable well logs

Additional GCD mapping needs/costs

Monitoring Network Defensibility

Monitoring Network Defensibility

Down-hole View:
Verify Depth to Screen

360° view:
Verify Condition of Screen

Monitoring Network Defensibility

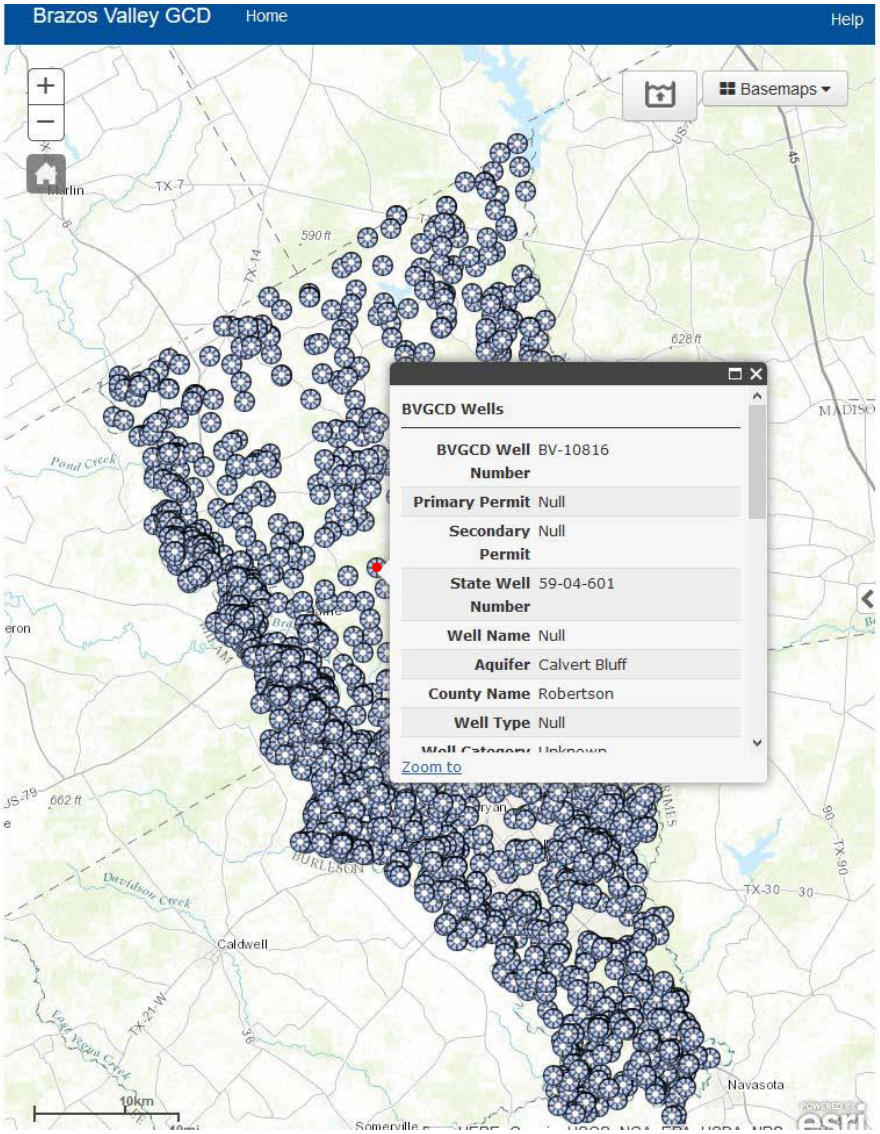
Strategy #3 : **Well Information Confirmation**

- Correct well location (ex. geo-tagging)
- Accurate depth and screen information from drillers logs and/or video logs
- Confirmation that well is working and not contaminated (water quality)

Issues to Consider:

- Unavailable/unreliable well logs
- Additional GCD mapping needs/costs

Monitoring Network Defensibility



Online mapping allows :

- Stakeholders to verify well locations & information
- Transparency in GCD Monitoring
- Easy distribution of Monitoring Data

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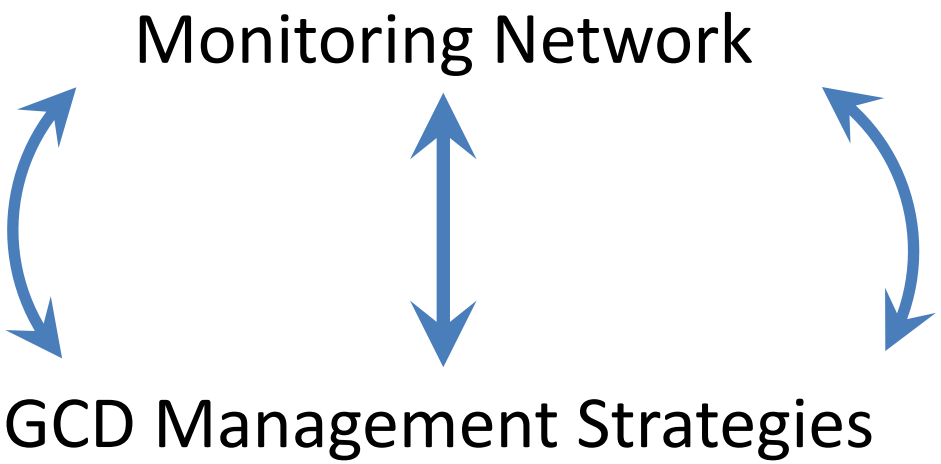
How is your Monitoring Network used for GCD Management ?

Monitoring & GCD Management Strategies



Monitoring & GCD Management Strategies

Role #1 : **Development of DFCs**

- Feasibility/defensibility of demonstrating DFC compliance
- Determine realistic aquifer subdivisions
- Help identify reasonable DFC ranges
- Identify GAM improvements

Issues to Consider:

- Consistency across GMA

Monitoring & GCD Management Strategies

Role #2 : **Identify additional District issues**

- Streams, surface water/groundwater interaction
- Hydrologically sensitive areas
- Local stakeholder concerns

Issues to Consider:

- Non-DFC protections (ex. shallow Protective Drawdown Limits or PDLs)
- Additional monitoring needs & costs

Monitoring & GCD Management Strategies

Role # 3 : **Determine DFC compliance**

- Specified in District Management Plan/Rules
- Monitoring thresholds

Issues to Consider:

- Consistency across GMA
- Insufficient monitoring coverage
- Uncertainty analysis
- Costs
- Enforceability

Monitoring & GCD Management Strategies

From POSGCD Management Plan

15. MANAGEMENT GOALS, OBJECTIVES, & PERFORMANCE STANDARDS

15.9 Desired Future Conditions (DFCs)

Management Objective:

1. At least once every three years, the District will monitor water levels and evaluate whether the change in water levels is in conformance with the DFCs adopted by the District. The District will estimate total annual groundwater production for each aquifer based on the water use reports, estimated exempted use, and other relevant information, and compare these production estimates to the MAGs listed in Table 8-1.

Performance Standard:

1. 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.
2. At least once every three years, the general manager will report to the Board the total permitted production and the estimated total annual production for each aquifer and compare these amounts to the MAGs listed in Table 8-1 for each aquifer.

Monitoring & GCD Management Strategies

Role # 3 : **Determine DFC compliance**

- Specified in District Management Plan/Rules
- Monitoring thresholds

Issues to Consider:

- Consistency across GMA
- Insufficient monitoring coverage
- Uncertainty analysis
- Costs
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  - **Analysis of Monitoring Data**

How can you analyze & use Monitoring Data effectively ?

Using Monitoring Data

Goal # 1 : **Sound Science**

- Account for data availability
- Consider several different methods (+/-)
- Test for sensitivity and bias

Issues to Consider:

- Missing data
- Anomalous data
- Consistency across GMA

Using Monitoring Data

- Different Spatial Analyses

  Points vs. Groups vs. Areas

- Different Time Periods

  Seasons vs. Years vs. Moving averages

- Different Well Selection

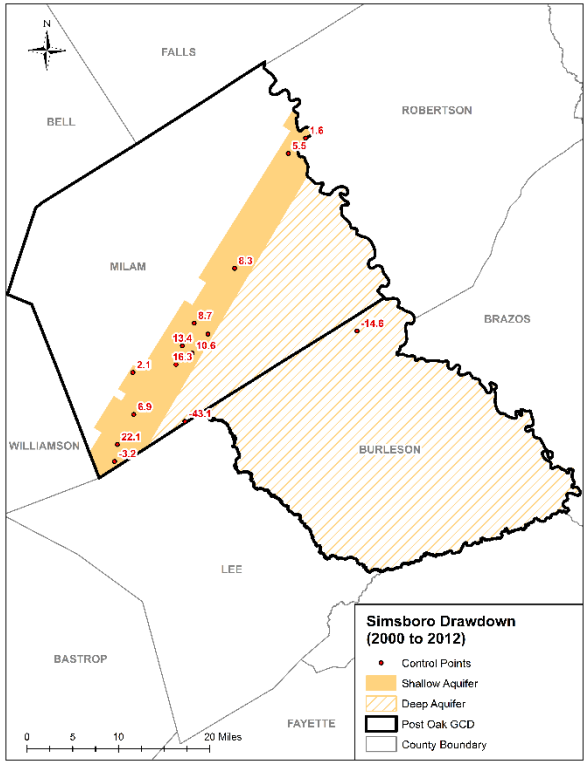
  All wells with water levels in either endpoint year

  vs.

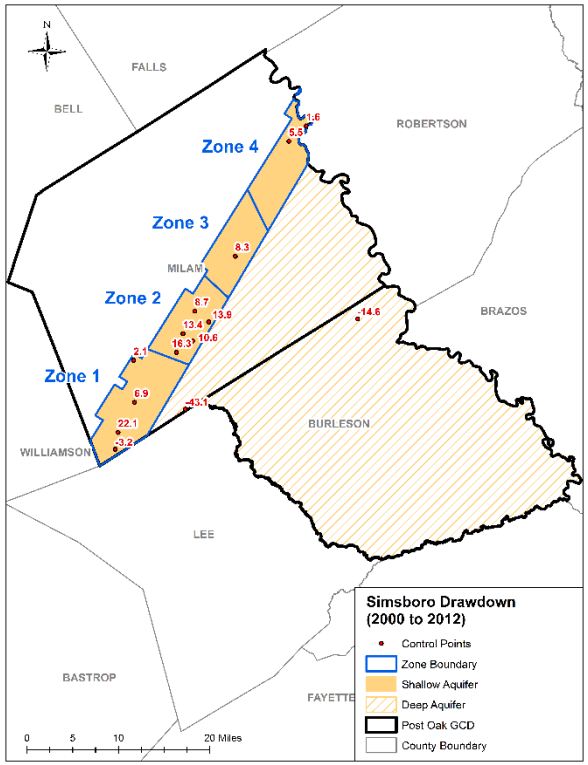
  Only wells that overlap between endpoint years

Using Monitoring Data

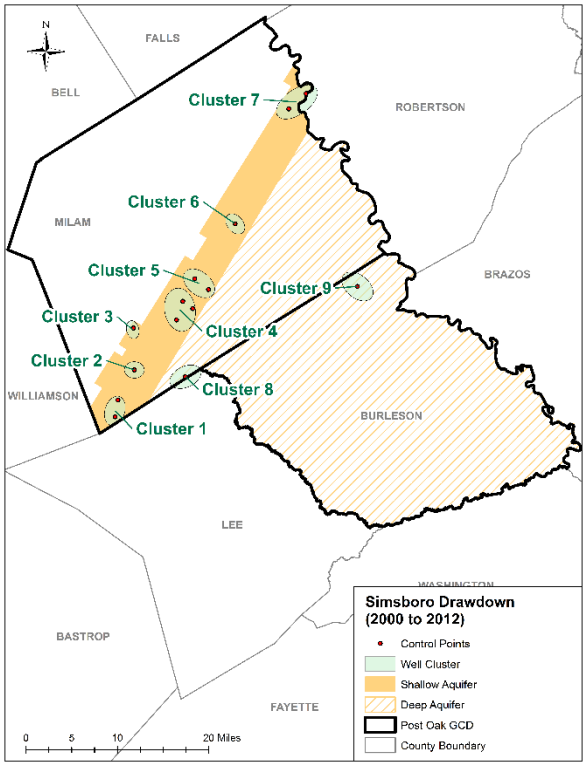
By Points



By Zones



By Clusters



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Using Monitoring Data

- Different Spatial Analyses

  Points vs. Groups vs. Areas

- Different Time Periods

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- Different Well Selection

  All wells with water levels in either endpoint year

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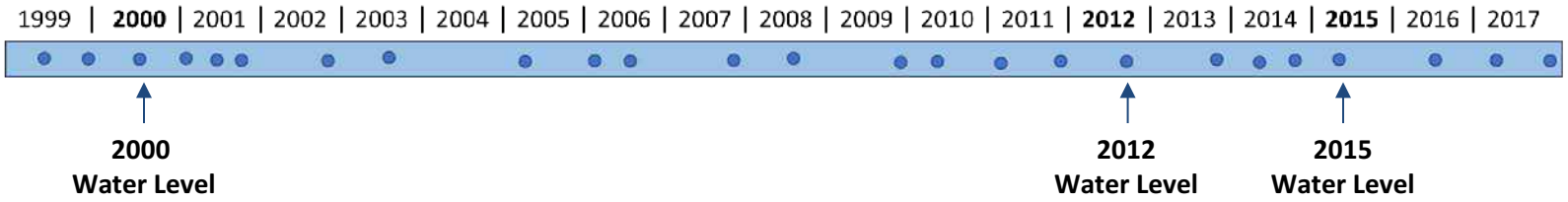
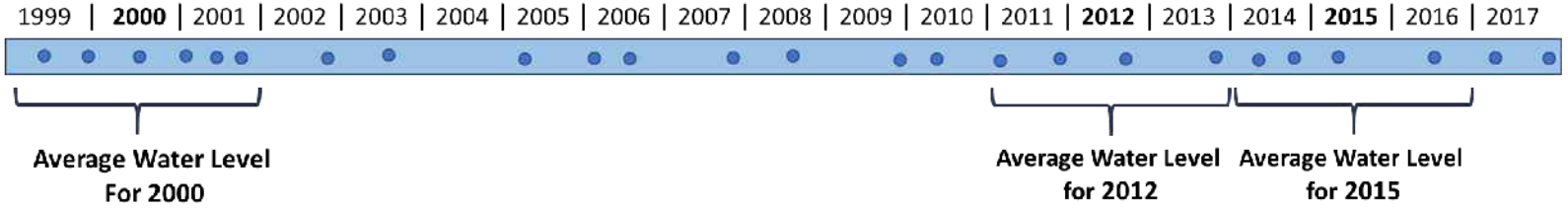
Using Monitoring Data

Yearly:



3-year Moving Average:



Using Monitoring Data

- Different Spatial Analyses

  Points vs. Groups vs. Areas

- Different Time Periods

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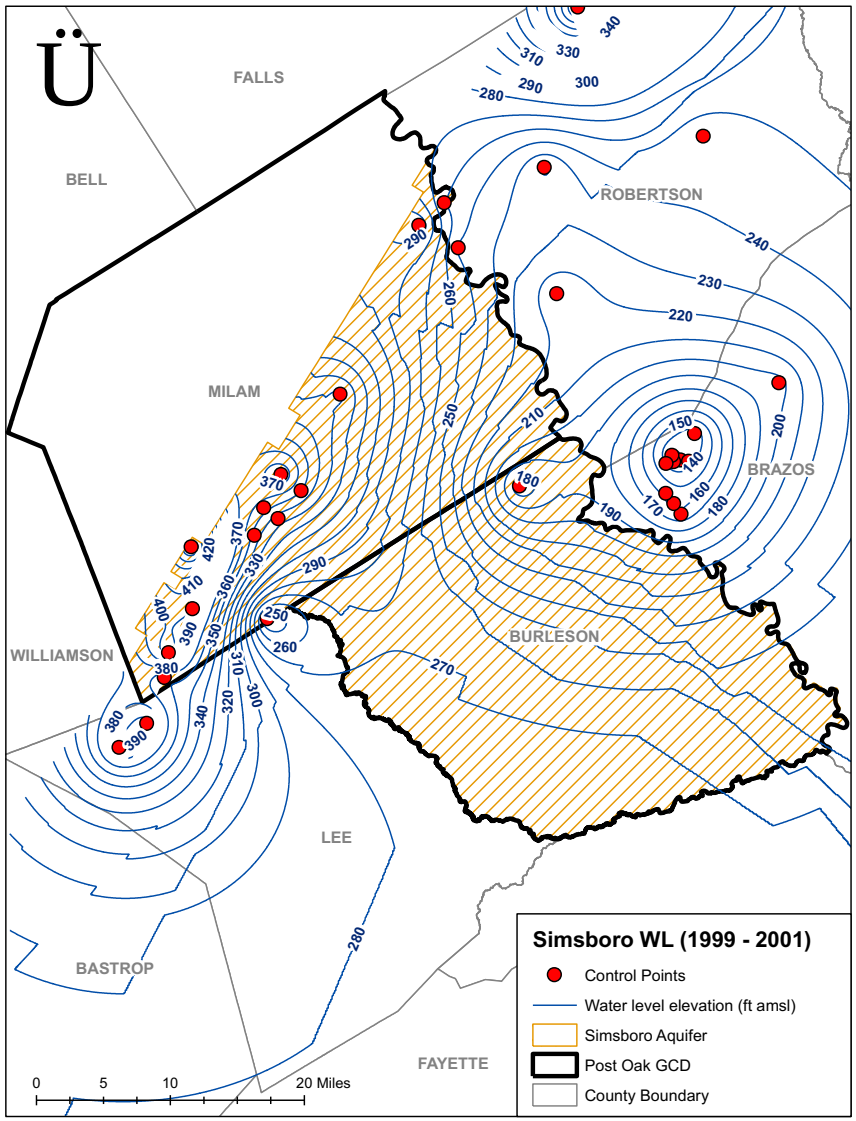
- Different Well Selection

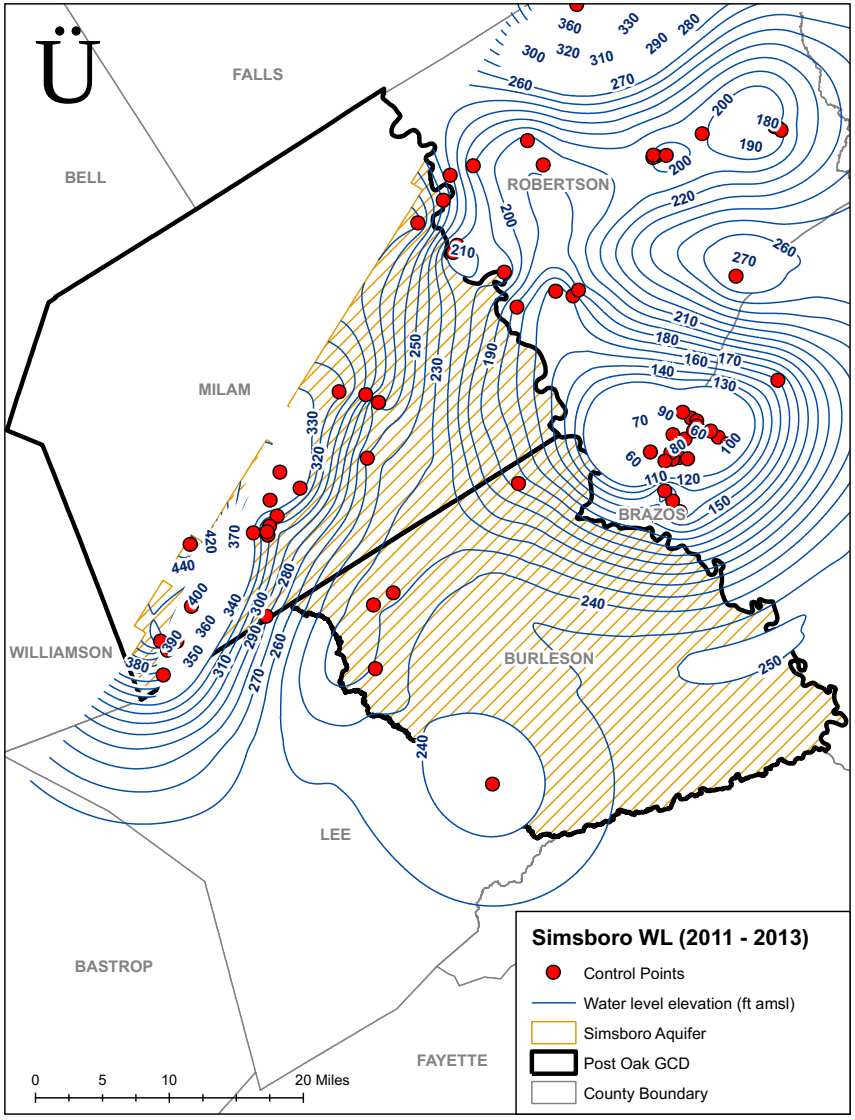
  All wells with water levels in either endpoint year

  vs.

  Only wells that overlap between endpoint years

Interpolating Values Across Areas: Simsboro (more wells in 2012 than in 2000)





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Comparison Between DFC and Calculated Average Drawdown from 2000 to 2012

Selected Method

1) Area Averages
2) 3-year Period
3) 2000 & 2012 Water Levels

Aquifer	Management Zone	Desired Future Condition Average[1]	Number of Wells with Three-year Average				Average Based on Measured Water Levels in Same Wells in POSGCD from 2000 to 2012				Average Based on Interpolated Points		DFC Compliant[4]	Percent of Average Drawdown of DFC[5]
			2000		2012									
			POSGCD	All	POSGCD	All	Number of Wells	Straight Average	Group by Cluster	Four Zones in Shallow	All 2000 Wells and All 2012 Wells	Only Wells Common to 2000 and 2012[2]		
Sparta	Shallow	10	0		0		0	na	na	na	22.2	**3.6**	yes	36.0%
	Entire	30	3	12	6	27	3	4.6	4.6		33.6	**3.5**	yes	11.7%
Queen City	Shallow	10	4		5		4	2.5	3.0	3	12	**3.1**	yes	31.0%
	Entire	30	5	12	9	24	5	2.8	3.2		17.3	**3.1**	yes	10.3%
Carrizo	Shallow	20	0		1		0	na	na	na	7.7	**6.5**	yes	32.5%
	Entire	65	1	7	4	11	1	10.1	10.1		33.9	**6.7**	yes	10.3%
Calvert Bluff (Upper Wilcox)	Shallow	20	8		17		7	9.2	9.1	11.2	-11.1	**0**	yes	0.0%
	Entire	140	11	18	20	33	11	-1.7	-7.5		-6	**-11.4**	yes	-8.1%
Simsboro (Middle Wilcox)	Shallow	20	12		19		12	8.9	7.8	6	12	**9.6**	yes	48.0%
	Entire	300	14	31	29	71	14	3.5	-0.4		20.3	**11.1**	yes	3.7%
Hooper (Lower Wilcox)	Shallow	20	4		9		4	5.9	5.9	5.6	40	**6.2**	yes	31.0%
	Entire	180	5	6	11	25	5	7.4	7.4		84.5	**7.1**	yes	3.9%
Yegua Jackson	Shallow	15	0		0		0	na	na	na	na	**na**	unknown	unknown
	Entire	100	1	9	4	27	1	7.3	7.3		12.3	**16.4**	yes	16.4%
Brazos River Alluvium	Milam	5					0	na					unknown	unknown
	Burleson[3]	6					7	4.5	5.0	5.1			yes	81.1%

[1] all DFCs are from Jan. 2000 to Dec. 2059 except the BRAA DFC, which is from Jan. 2010 to Dec. 2059

[2] best estimate of calculated average drawdown from 2000 to 2012

[3] number of wells from 2010 to 2014

[4] likely is based on review of all available data; insuff. data requires additional information

[5] Threshold Level 1 criteria is 60%

Using Monitoring Data

Goal # 2 : **Simple & Reproducible Analysis**

- Clear methodology defined by District
- Transparent decision-making
- Possible for independent checks

Issues to Consider:

- Stakeholder involvement
- Easiest ≠ Best

Using Monitoring Data

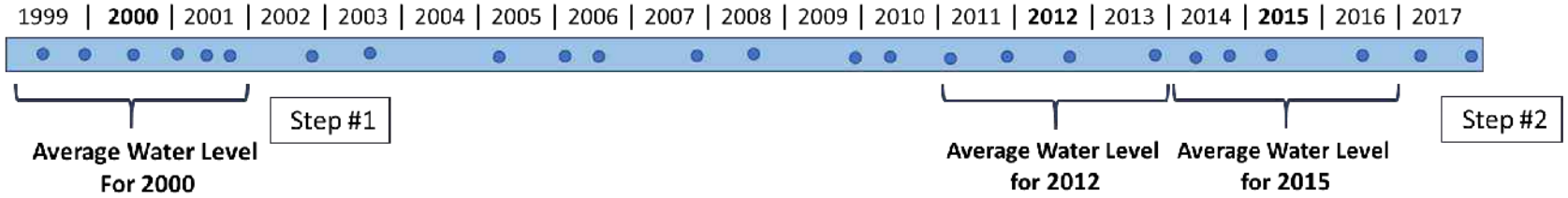
Goal # 3 : **Evaluation of District Goals**

- Role of monitoring network defined in Rules or Management Plan
- Thresholds for action

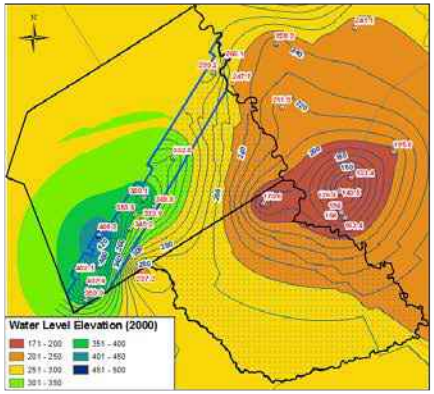
Issues to Consider:

- Non-ideal datasets
- Action after meeting threshold

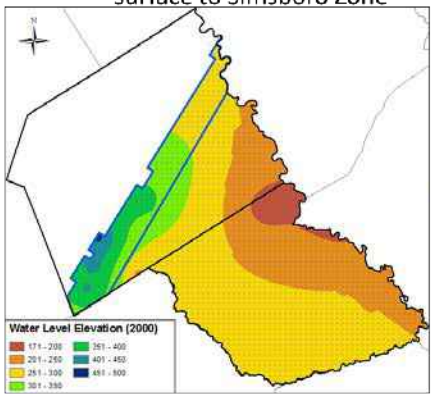
Using Monitoring Data



Step #3a Interpolate Baseline Simsboro Water Level surface

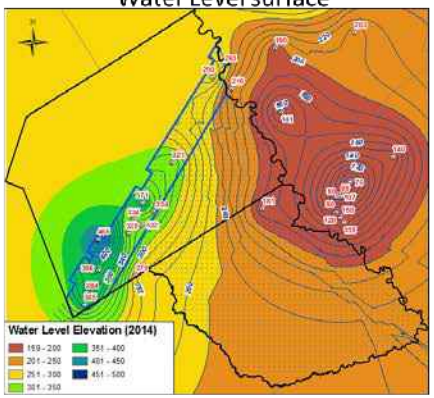


Step #4a Clip Baseline Water Level surface to Simsboro Zone

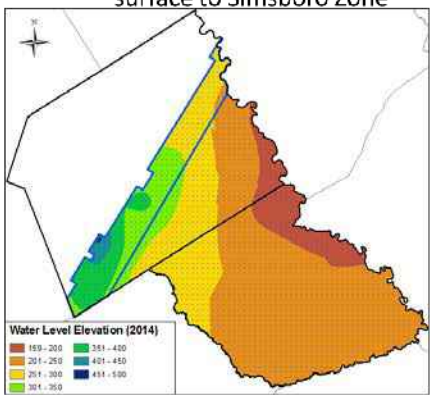


Step #5a : Calculate Average *Baseline* Simsboro Water Level from clipped surface

Step #3b Interpolate Current Simsboro Water Level surface



Step #4b Clip Current Water Level surface to Simsboro Zone



Step #5b : Calculate Average *Current* Simsboro Water Level from clipped surface

Step #6:
Drawdown = *Baseline – Current Water Level*

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Using Monitoring Data

Goal # 3 : **Evaluation of District Goals**

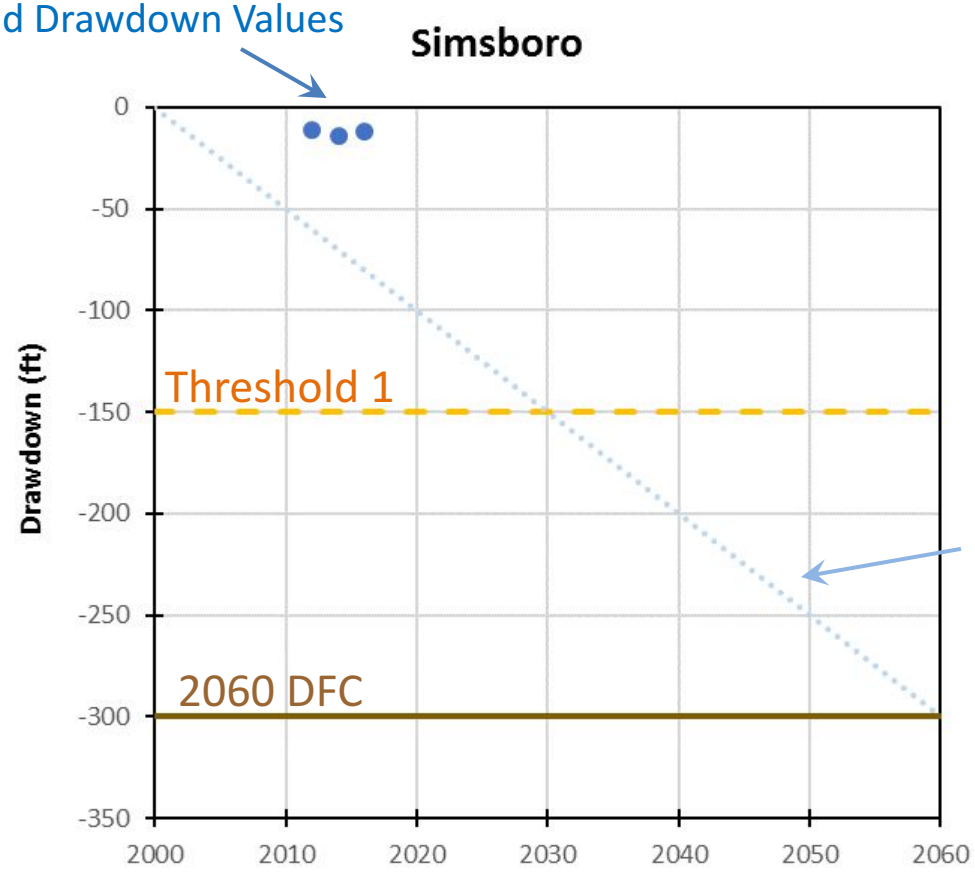
- Role of monitoring network defined in Rules or Management Plan
- Thresholds for action

Issues to Consider:

- Non-ideal datasets
- Action after meeting threshold

Using Monitoring Data

Calculated Drawdown Values



Expected Drawdown if DFC is achieved

Using Monitoring Data

Goal # 3 : **Evaluation of District Goals**

- Role of monitoring network defined in Rules or Management Plan
- Thresholds for action

Issues to Consider:

- Non-ideal datasets
- Action after meeting threshold

Using Monitoring Data

Goal # 4 : **Enforcement of District Goals**

- GCD Rules

  Well spacing Production rates Management zones

- Board Actions

  Permitting Well Assistance Legal Decisions

- Mitigation

Issues to Consider:

- Consistency within GMAs
- 3rd party review