Study of Brackish Aquifers in Texas: Nacatoch and Blossom Aquifers

Presented by:
LBG-Guyton Associates

Under Contract to:

Texas Water Development Board

Commerce, Texas
April 18, 2017

HB 30 - Intro

- In 2015, the 84th Texas Legislature passed House Bill 30, directing the TWDB to conduct studies to evaluate potential brackish groundwater production zones in part of the Carrizo-Wilcox Aquifer, the Gulf Coast Aquifers, the Blaine Aquifer, and the Rustler Aquifer and complete those studies by December 1, 2016
- Remaining aquifers in the state required to be mapped by December 1, 2022
- Determine the amount of brackish groundwater that a zone is capable of producing over 30-year and 50-year without causing a significant impact to water availability or water quality in surrounding aquifers
- Make recommendations on reasonable monitoring to observe the effects of brackish groundwater production within the zone
- www.twdb.texas.gov/innovativewater/bracs/HB30.asp

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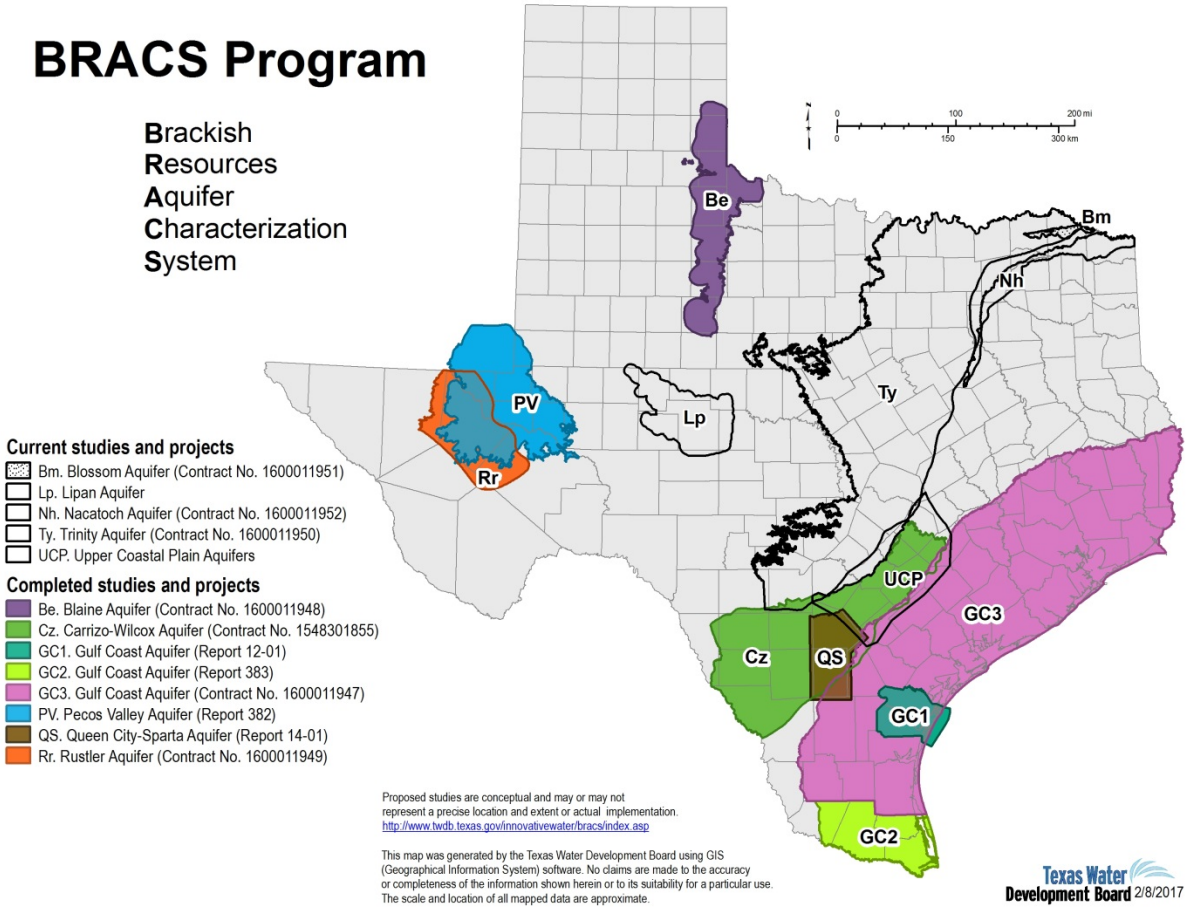

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Project Team

Nacatoch Aquifer

- Project Management
  LBG-Guyton Associates, Kristie Laughlin
- Structure and Stratigraphy
  Bureau of Economic Geology, Scott Hamlin
- Well Log Interpretation
  Collier Consulting, Inc., Lou Fleischhauer

Blossom Aquifer

- Project Management
- Structure and Stratigraphy
- Well Log Interpretation

} LBG-Guyton Associates

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Presentation Outline

- Groundwater Salinity Classification
- Geology
- Hydrogeology
- 2003 Brackish Study
- Geophysical log data
- Water Quality Estimates
- Exclusion Criteria Applied
- Potential Production Areas
- What's next?
- Questions and Comments

Groundwater Salinity Classification

Groundwater salinity classification	Range in TDS[a] (mg/L)[b]	General description
Fresh	Less than 1,000	Drinking Water
Slightly saline	1,001 to 3,000	Downdip Aquifer Limit
Moderately saline	3,001 to 10,000	Downdip Study Area Limit
Very saline	10,000 to 35,000	Outside of Project Scope
Brine	Over 35,000	Seawater

[a] TDS = total dissolved solids.
[b] Mg/L = milligrams per liter.
Source: Modified from Winslow and Kister (1956).

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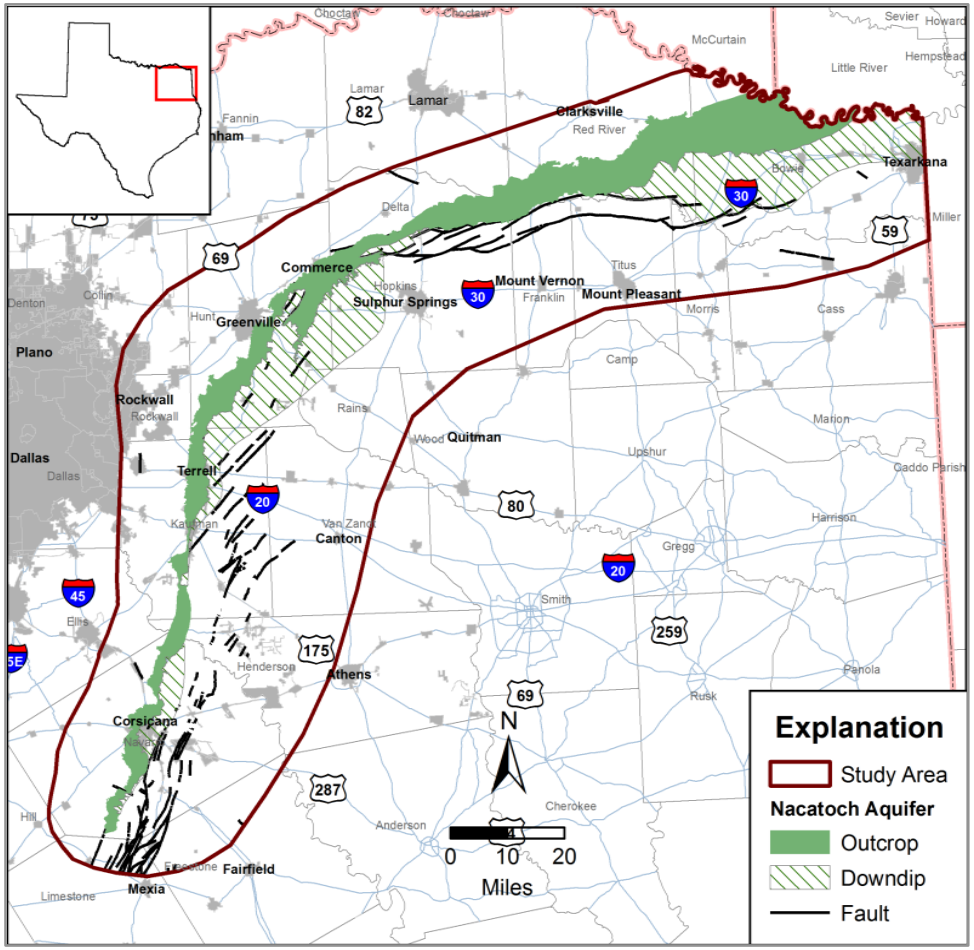
Nacatoch Aquifer Study Area

- Study area from the GAM excluding Oklahoma and Arkansas portions of the aquifer
- Area includes outcrop plus all data locations used to estimate water quality
- Mexia-Talco Fault Zone



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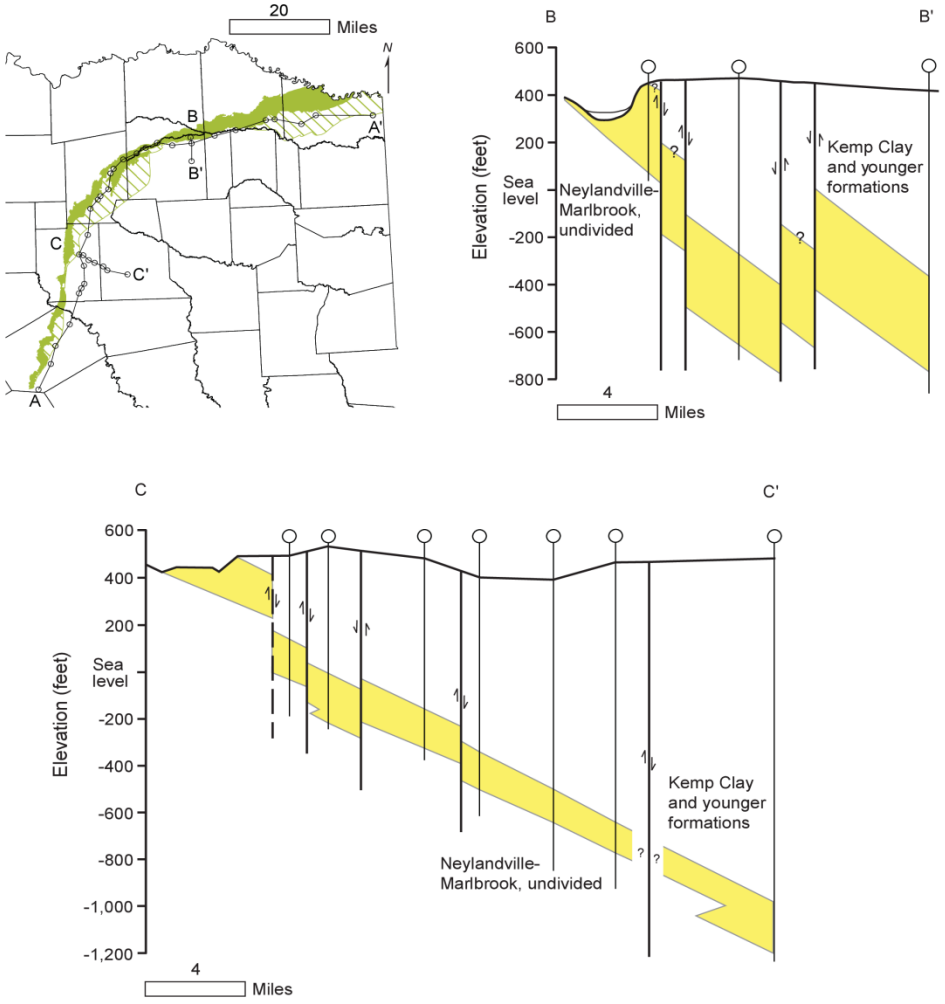
Nacatoch Geology

Source: Texas Water Development Board Report 380, Aquifers of Texas, 2011.



Geologic cross sections along and across the Nacatoch Sand (modified from Knight, 1984; Ashworth, 1988).

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Nacatoch Aquifer Stratigraphy

System	Group	Stratigraphic units		Maximum thickness (feet)	Lithology	Water-bearing properties
Quaternary		Alluvium and fluviatile terrace deposits		80	Sand, silt, clay and gravel.	Yields small to moderate quantities of fresh to slightly saline water.
Cretaceous	Navarro	Upper Navarro Clay	Kemp Clay	400	Clay, calcareous, silty, medium-dark gray.	Not known to yield water.
		Upper Navarro Marl	Corsicana Marl	20	Mudstone, sandy and hard calcareous sandstone and siltstone.	Not known to yield water.
		Nacatoch Sand		450	Alternating sequences of fine-grained quartz sand and mudstone.	Yields small to moderate quantities of fresh to slightly saline water near the outcrop.
		Lower Navarro Clay	Neylandville Marl	125	Clay, calcareous, silty, sandy, medium-gray.	Not known to yield water.
	Taylor	Marlbrook Marl		1,500	Clay, marl, mudstone and chalk.	Not known to yield water.

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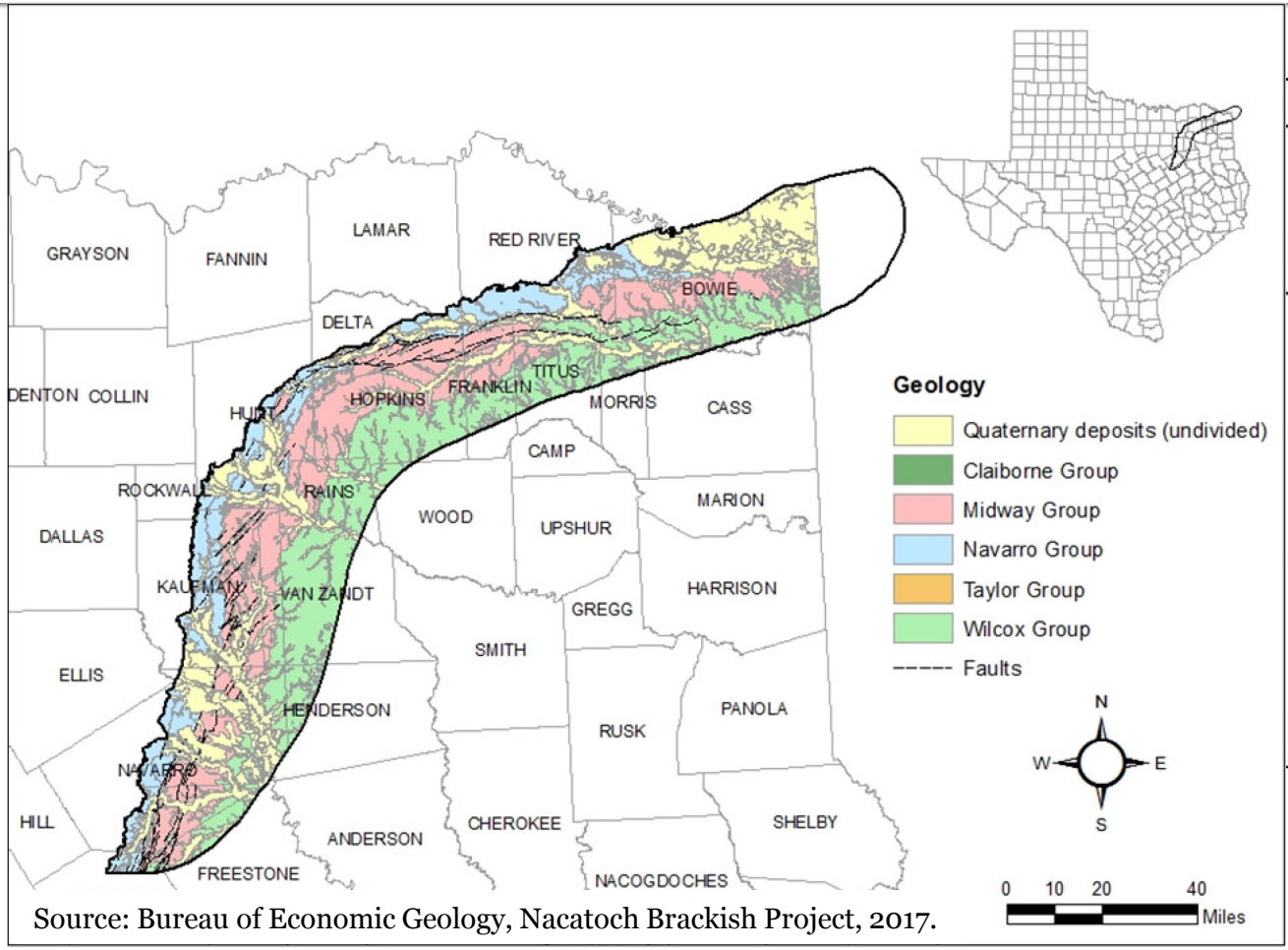
Nacatoch Geology



Source: Bureau of Economic Geology, Nacatoch Brackish Project, 2017.

GROUP	FORMATION	
WILCOX	Calvert Bluff Formation	
	Simsboro Formation	
	Hooper Formation	
MIDWAY	Undifferentiated	
NAVARRO	Kemp Clay	
	Corsicana Marl	
	Nacatoch Sand	
	Lower Navarro / Neylandville Marl	
TAYLOR	Upper part Taylor Marl	
	Pecan Gap Chalk	Annona Chalk
	Wolfe City Sand	
	Lower Taylor	
AUSTIN	Gober Chalk	
	Brownstown Marl	
	Blossom Sand	
	Bonham Marl	
	Ector Tongue	
EAGLEFORD	Eagleford Shale	Sub-Clarksville Member

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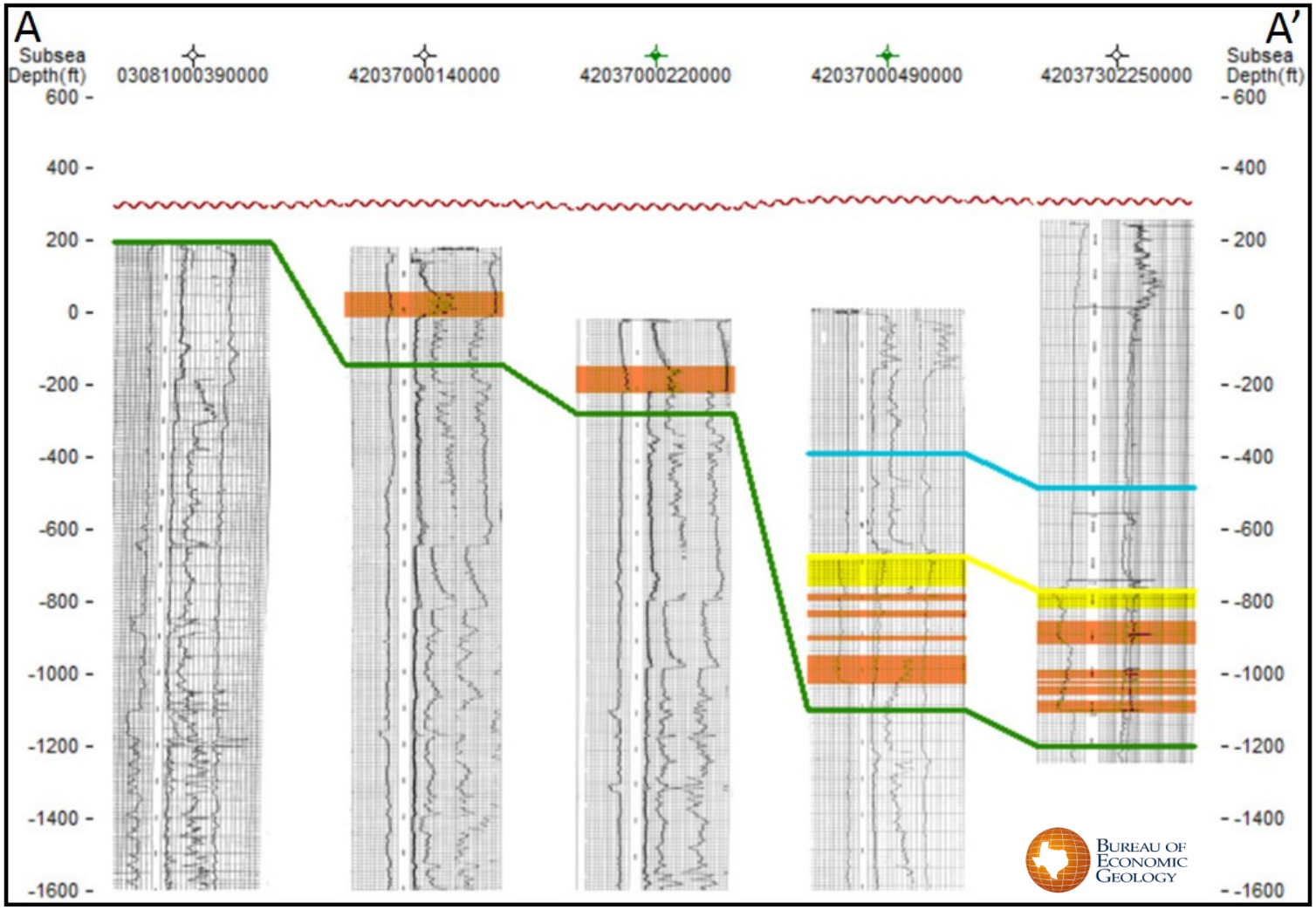
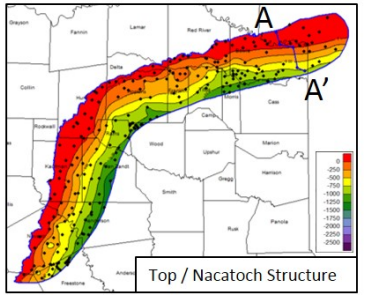
Nacatoch Aquifer Stratigraphy

Source: Bureau of Economic Geology, Nacatoch Brackish Project, 2017.



- The shallow log sections which include the Nacatoch Sand are missing on the north end of section
- Approximately 800-900 feet of offset across the fault zone
- Thickness of downdip section between top of Nacatoch Sand and the top of the Taylor group is about 400 feet.

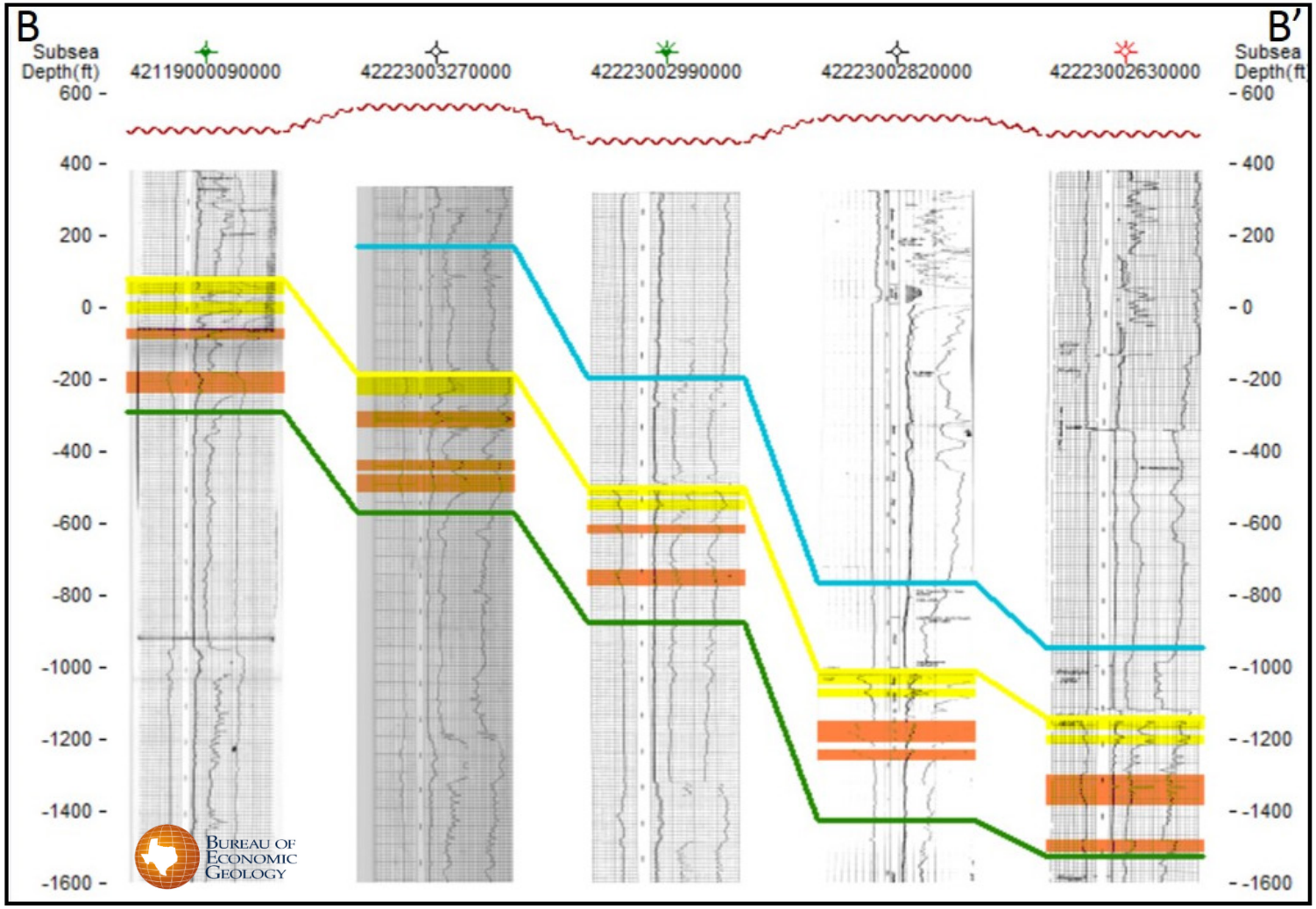


LEGEND

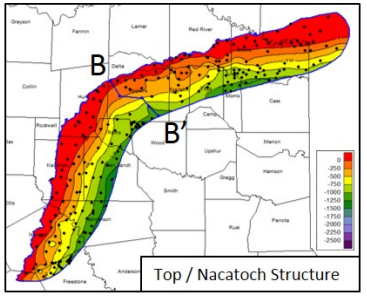
- Ground surface
- Top / Navarro Group
- Top / Nacatoch Sand
- Nacatoch Sand
- Lower Navarro sands
- Top / Taylor Group

Nacatoch Aquifer Stratigraphy

Source: Bureau of Economic Geology, Nacatoch Brackish Project, 2017.



- Two relatively thick Nacatoch sand units in each log
- Approximately 600 feet of offset across the fault zone
- Thickness of downdip section between top of Nacatoch Sand and the top of the Taylor group is about 400 feet.

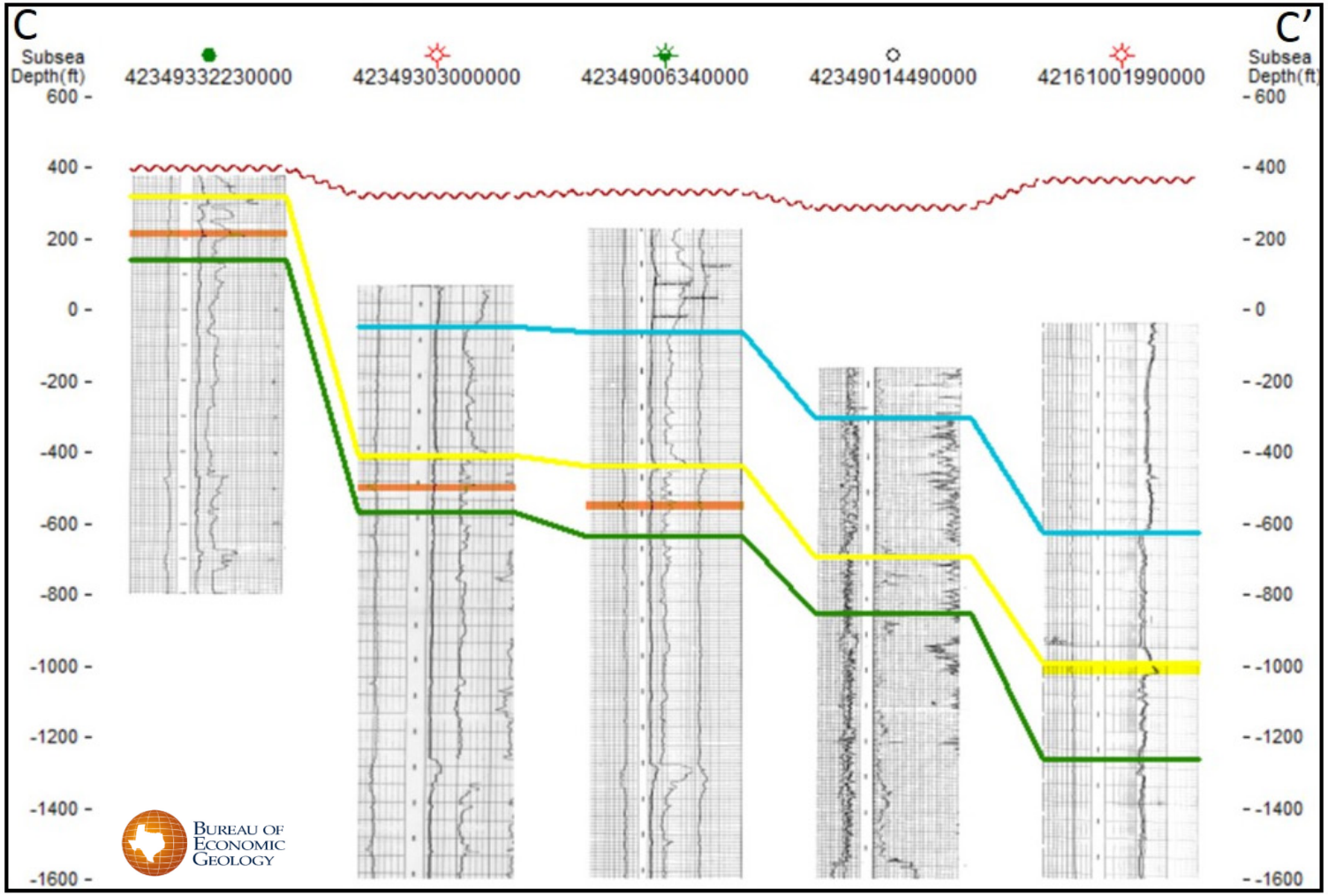


LEGEND

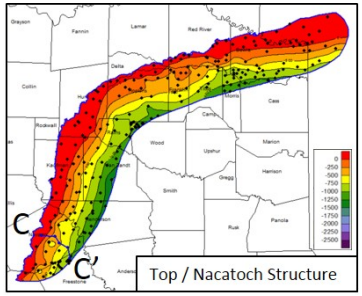
- Ground surface
- Top / Navarro Group
- Top / Nacatoch Sand
- Nacatoch Sand
- Lower Navarro sands
- Top / Taylor Group

Nacatoch Aquifer Stratigraphy

Source: Bureau of Economic Geology, Nacatoch Brackish Project, 2017.



- Relatively thin non-continuous sands in southern extent of the Nacatoch
- Thickness of updip section between top of Nacatoch and top of Taylor Group is about 200 feet.
- Thickness of downdip section between top of Nacatoch Sand and the top of the Taylor group is about 250 feet.



LEGEND

- Ground surface
- Top / Navarro Group
- Top / Nacatoch Sand
- Nacatoch Sand
- Lower Navarro sands
- Top / Taylor Group

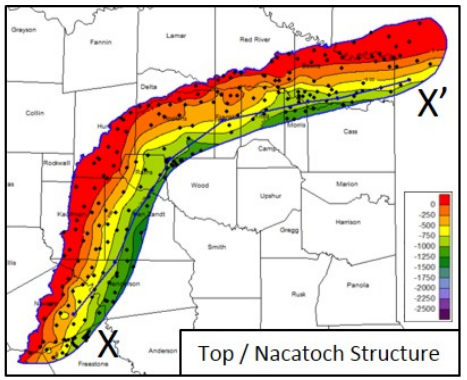
Nacatoch Aquifer Stratigraphy

Source: Bureau of Economic Geology, Nacatoch Brackish Project, 2017.

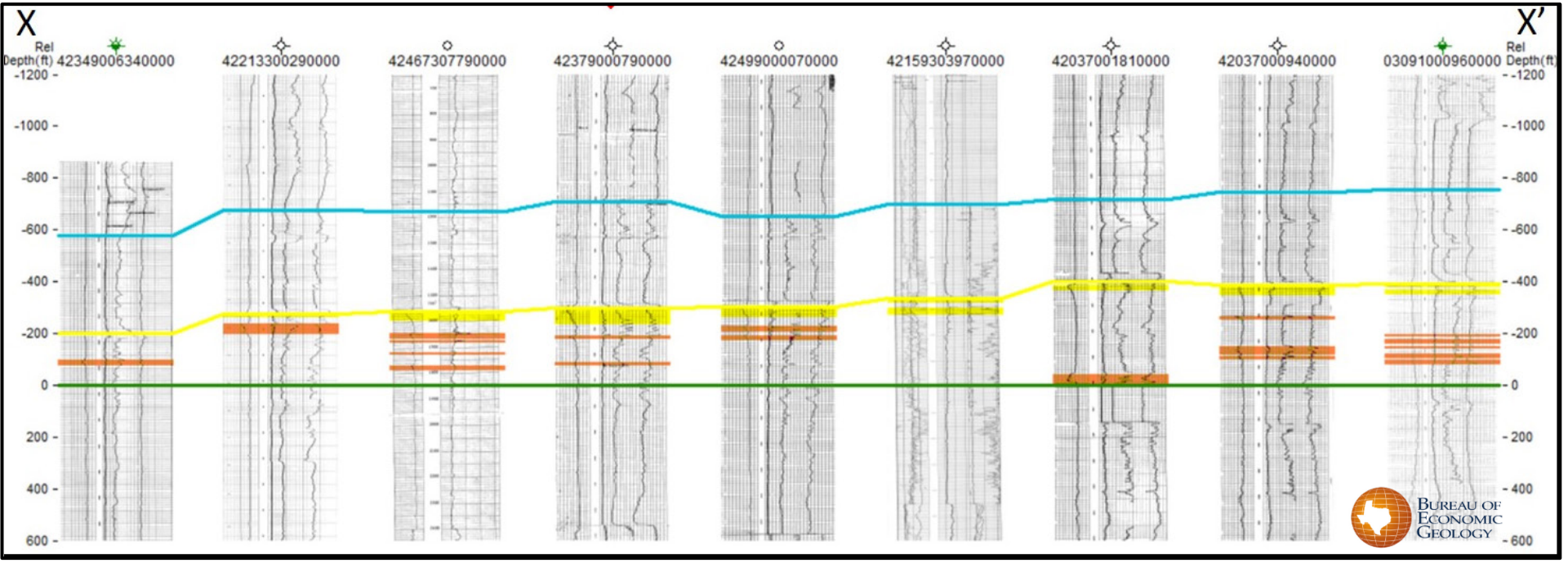
- Generally, there are thicker and more numerous sands to the northeast and thinner sands to the southwest.

LEGEND

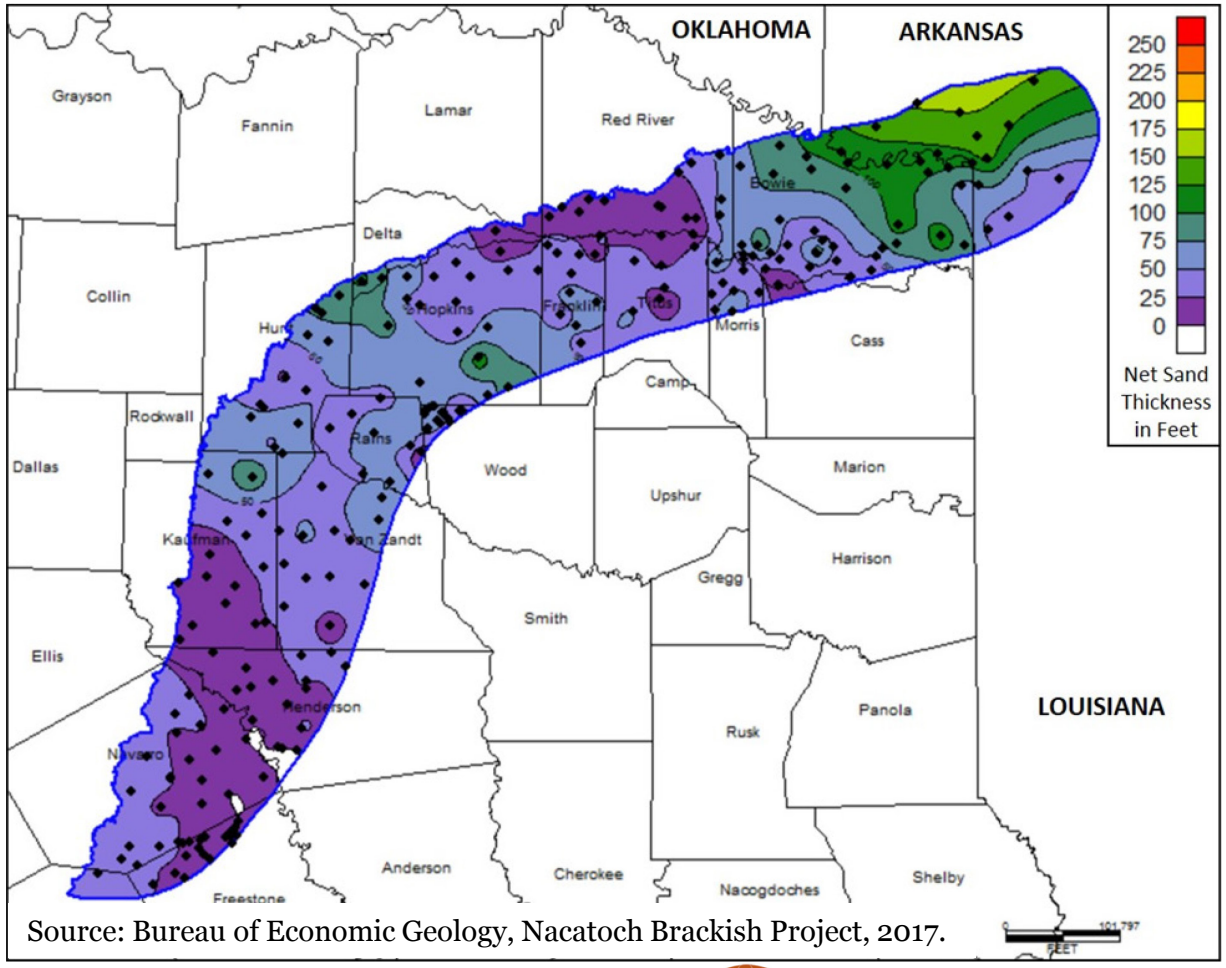
- Ground surface
- Top / Navarro Group
- Top / Nacatoch Sand
- Nacatoch Sand
- Lower Navarro sands
- Top / Taylor Group



Top / Nacatoch Structure



Nacatoch Net Sand Thickness



Source: Bureau of Economic Geology, Nacatoch Brackish Project, 2017.

- Thicker sands occur near the 'bend' in the outcrop and near the Red River (due to the presence of overlying alluvium) - Sections A-A' and B-B'
- Thinner sands occur to the south and between the outcrop 'bend' and the Red River - Section C-C'

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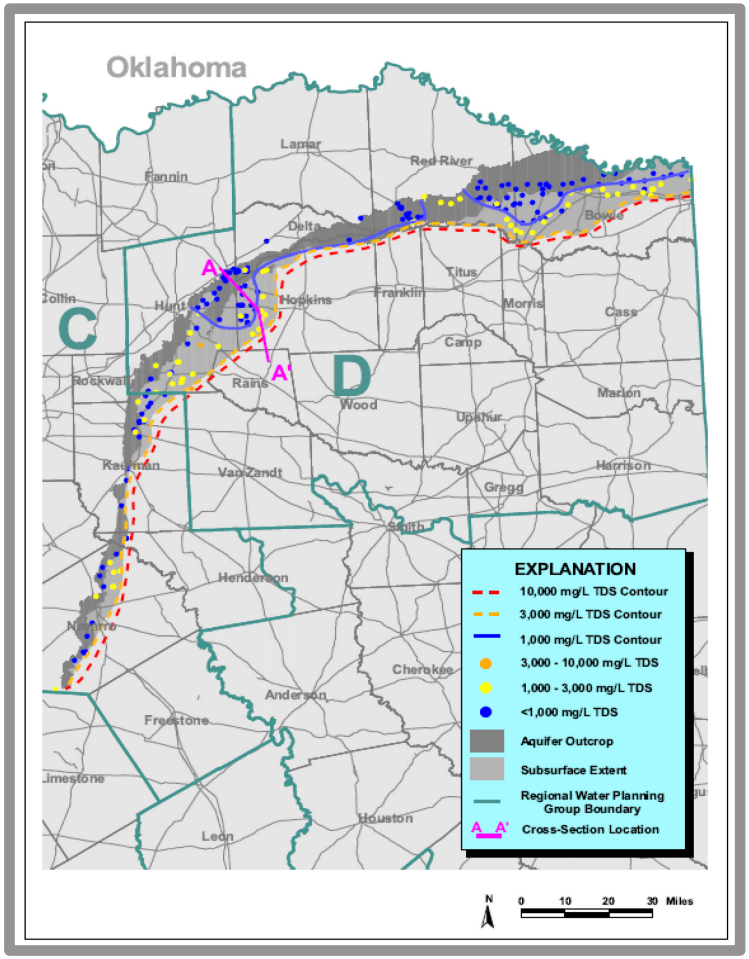
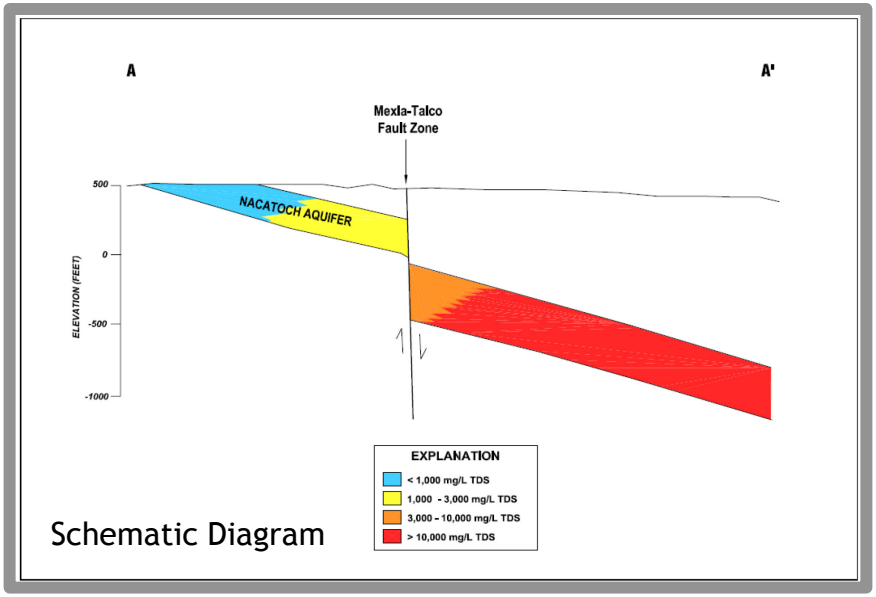
Nacatoch Brackish (2003)





- Each sand is a separate hydrologic unit (due to separation by mudstones)
- Shallower depth sand = lower TDS
- The Mexia-Talco Fault Zone interrupts the normal downdip flow of groundwater and generally controls the 3,000 mg/L TDS line
- Estimated confined availability of slightly to moderately saline water = 14,200 acre-feet

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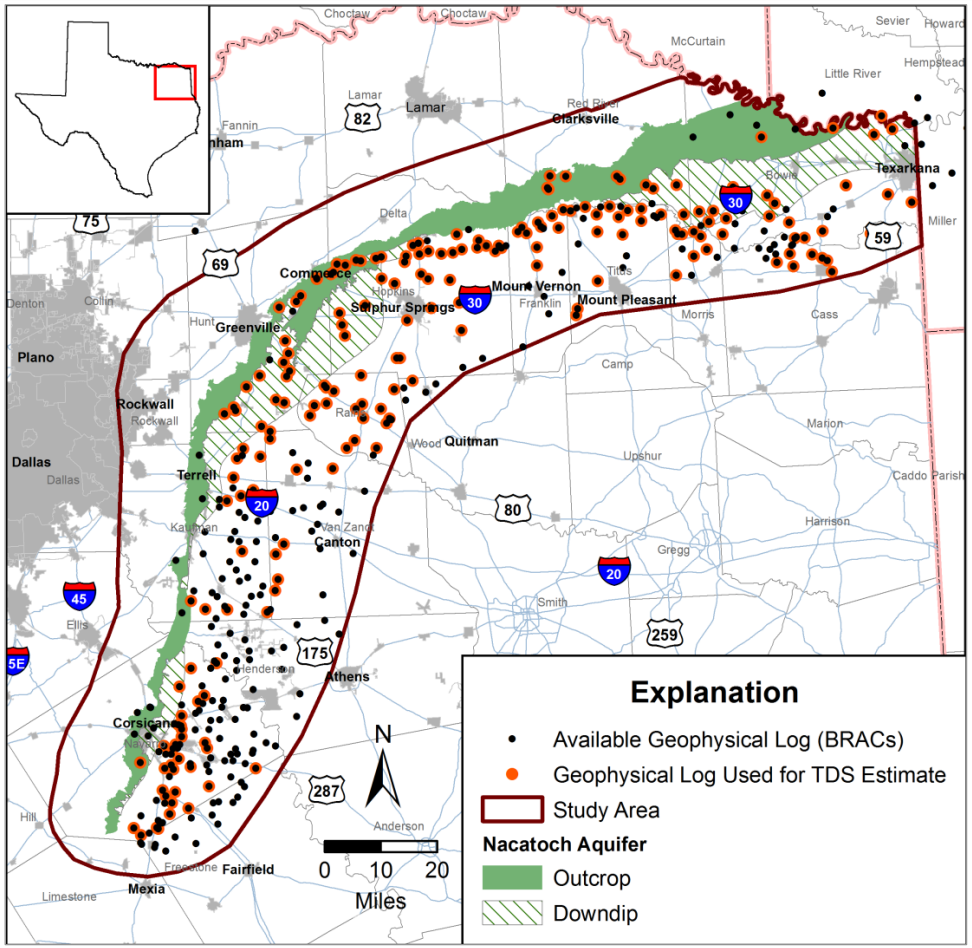
Nacatoch Aquifer Log Data

- 413 geophysical logs were available in the BRACs database
- 324 logs were used to estimate TDS using all available methods
- 309 logs were used to estimate TDS using the Minimum Rwa method



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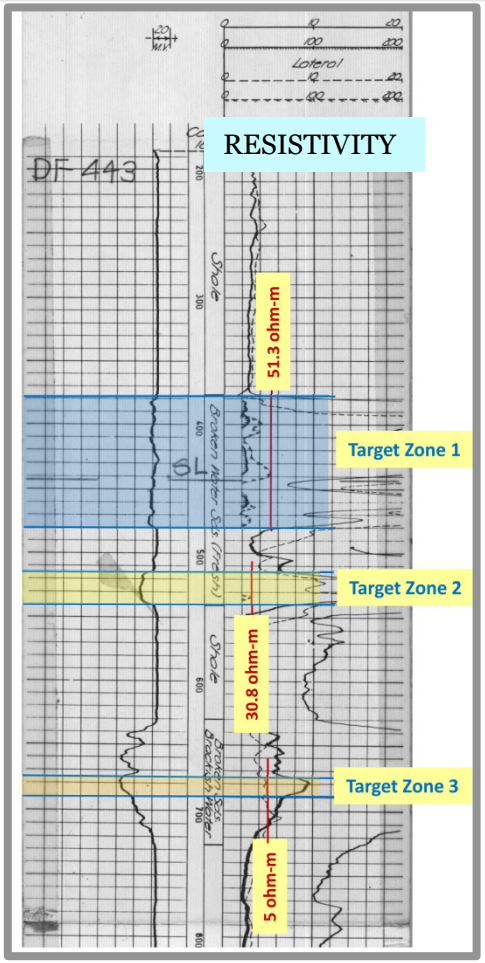
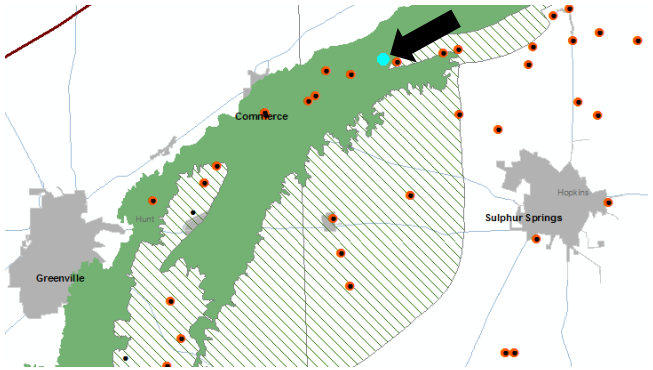
Water Quality from Geophysical Logs - Limitations

- Many logs were eliminated from the analysis due to incomplete log headers or poor log quality
- Methods requires the sand bed to be at least 15-20 feet thick for accurate geophysical logging
- High bicarbonate concentrations in the Blossom can affect estimation in fresh and slightly brackish zones
- Limited availability of good quality logs for the upper few hundred feet of aquifer where water quality estimate from logs may be correlated with analytical sample results (pairs)

Nacatoch Aquifer Log Data

- Three target zones (sands) are shown in this log
- Resistivity decreases from 51.3 to 5 ohm-m with depth (becomes more saline)
- Illustrates increasing TDS (salinity) with depth





660 mg/L - (380-480 ft deep)
Fresh

1,070 mg/L - (515-540 ft deep)
Slightly saline

4,790 mg/L - (675-690 ft deep)
Moderately saline

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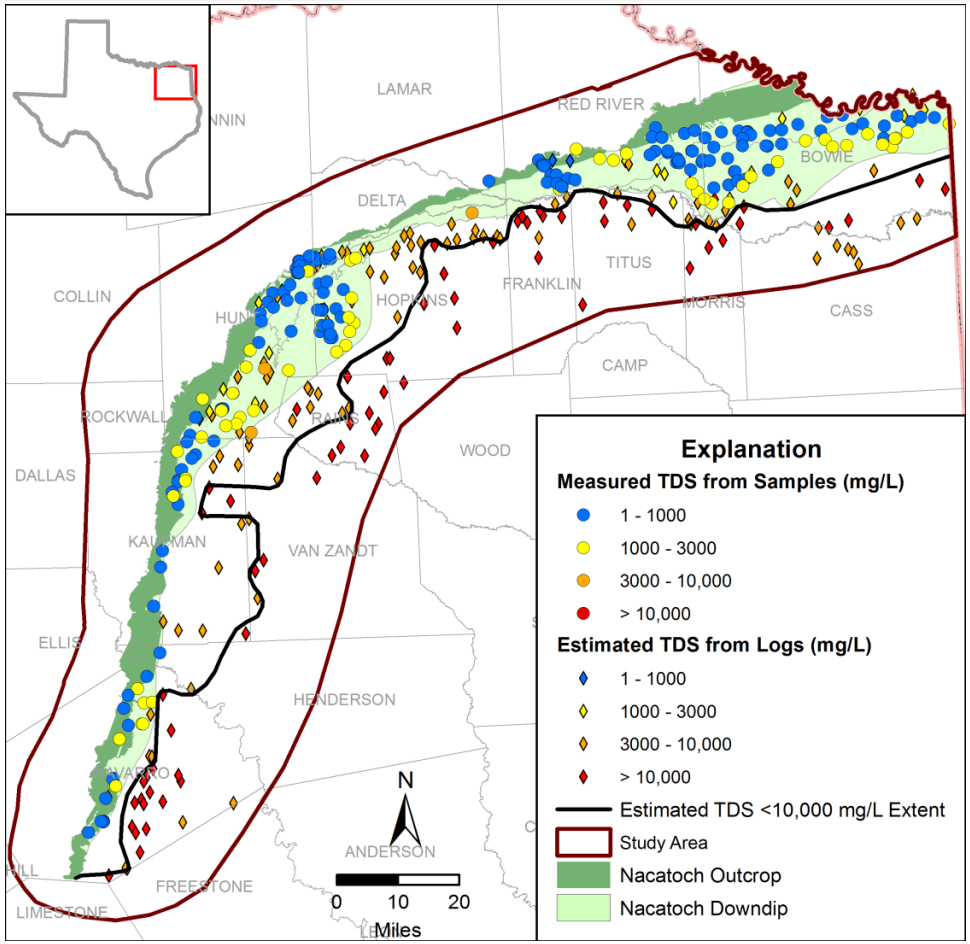
Nacatoch Aquifer TDS (2017)

- Downdip extent of moderately saline waters based on geophysical log estimates
- Best available science



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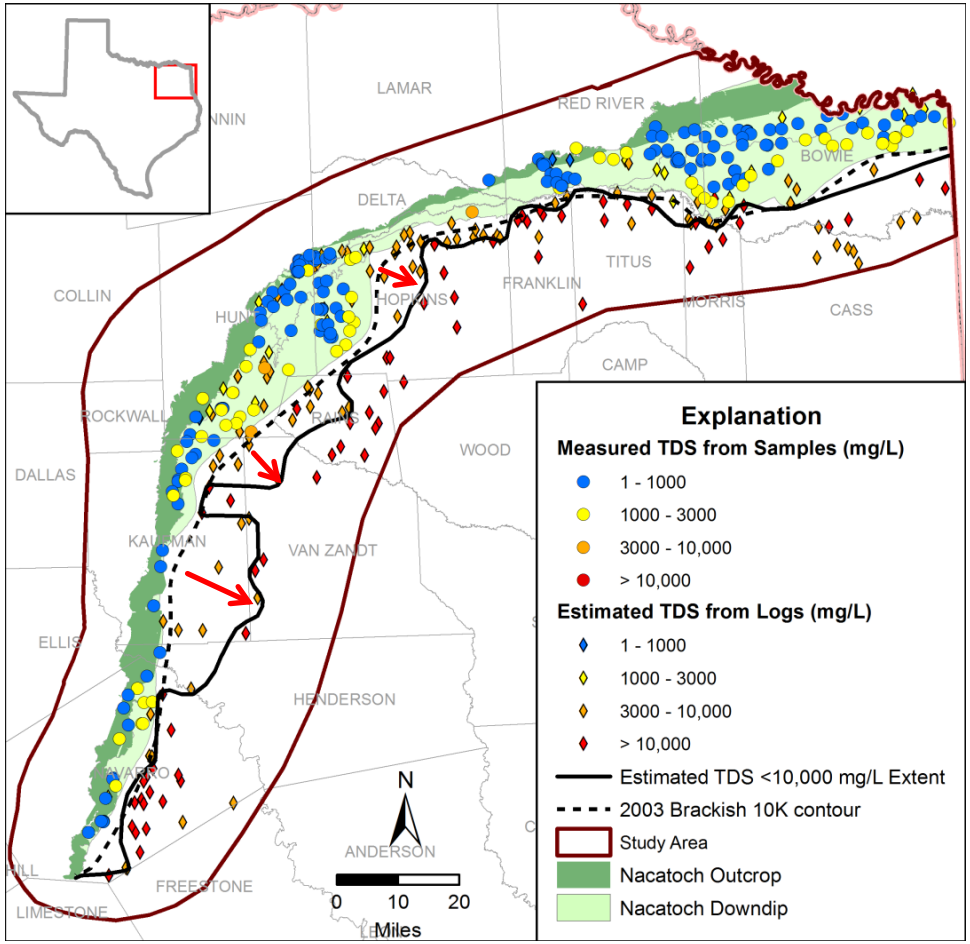
Nacatoch Aquifer 10K Extent

- Comparison of 10,000 mg/L TDS extents between 2003 and 2017
- Current study indicates an expanded area of moderately saline groundwater in some areas (Kaufman, Van Zandt, Henderson, Rains and Hopkins Counties) compared to previous estimate
- Expanded areas suggest that the fault zone does not have as much control on the distribution of groundwater salinity in these areas as it does where the grabens are located



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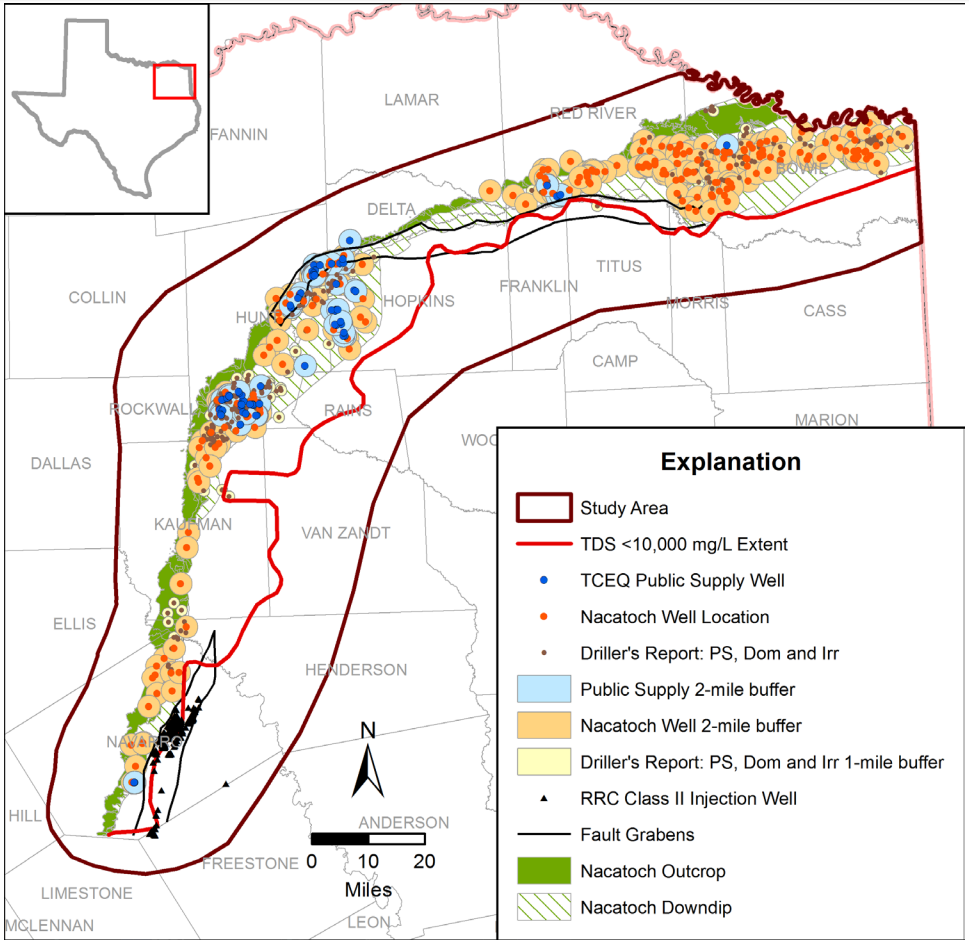
Nacatoch Exclusion Items

Applicable exclusion items include:

- Wells: public supply, irrigation, and domestic use with one to two-mile buffers.
- Wells completed with total depths that leave less than 200 feet of vertical separation from the Nacatoch (alluvium wells)
- Injection wells completed in zones with less than 400 feet of vertical separation from the Nacatoch. These are located in the southern fault graben.



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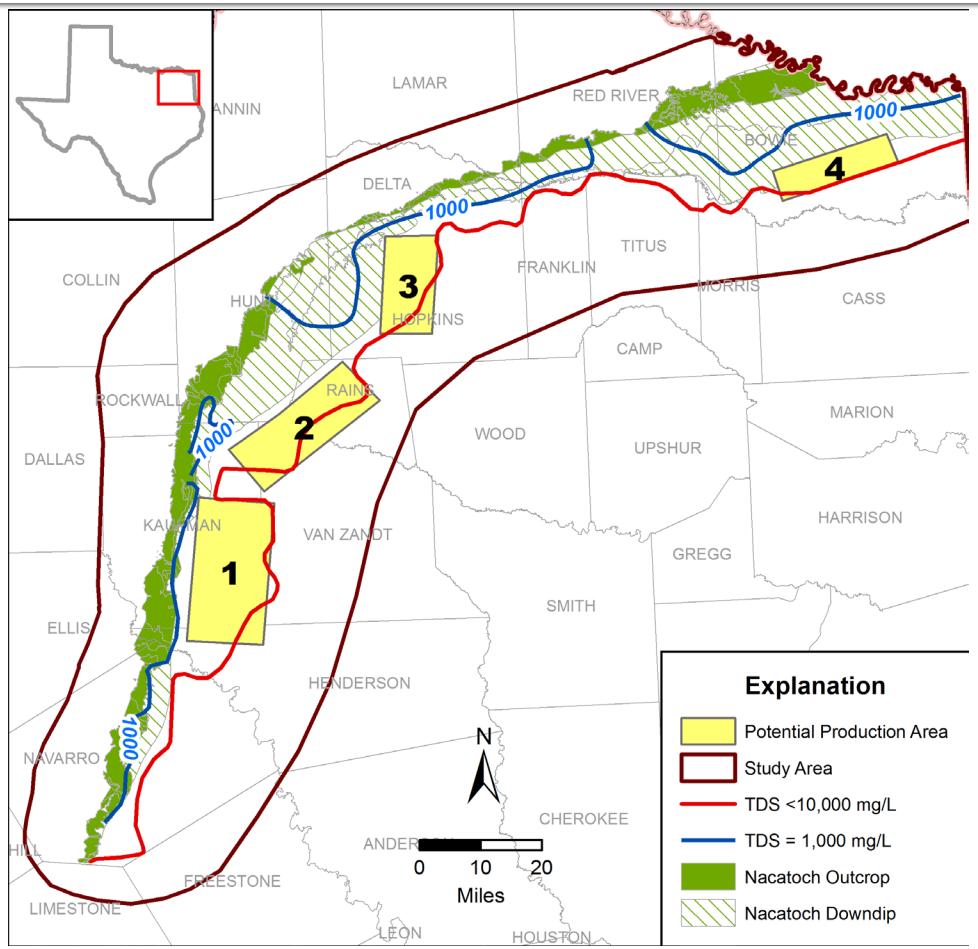
Nacatoch
Potential Production Areas



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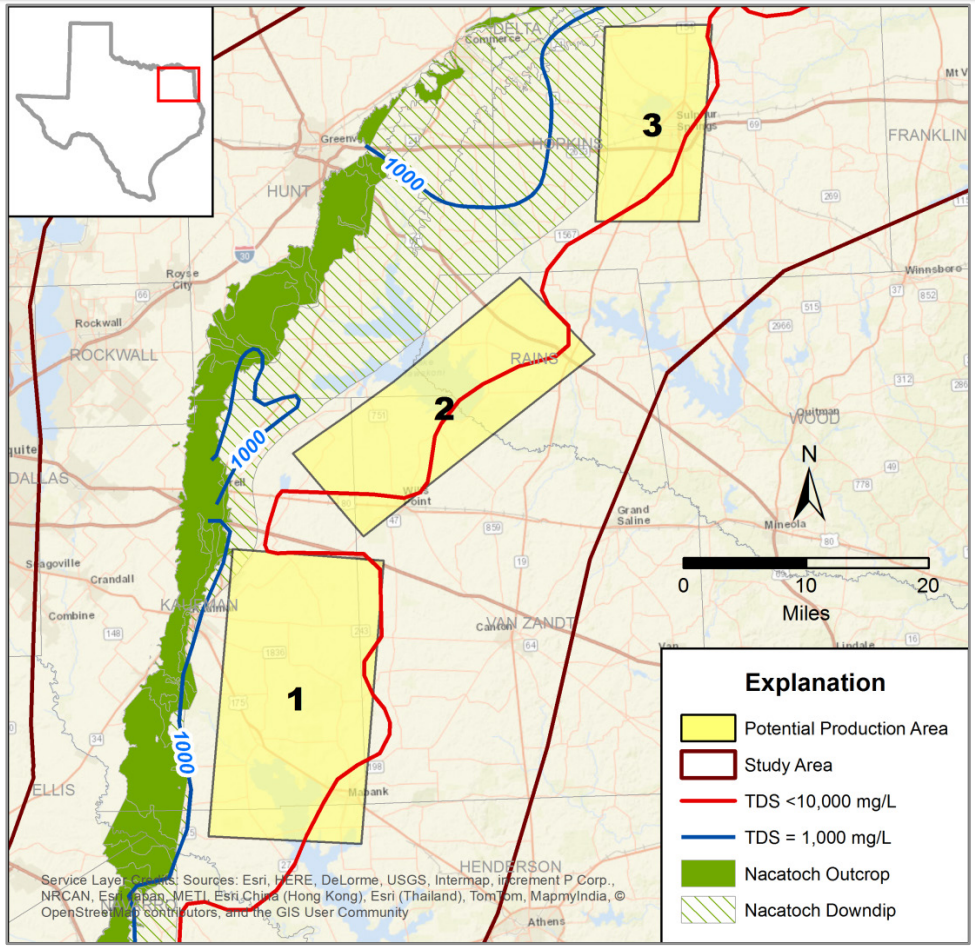
Nacatoch
Potential Production Areas

Estimated Depth to top Nacatoch

1 400 – 1,000 feet
2 450 – 1,350
3 500 - 650

Net Sand Thickness

1 0 - 40 feet
2 30 - 70
3 25 - 65



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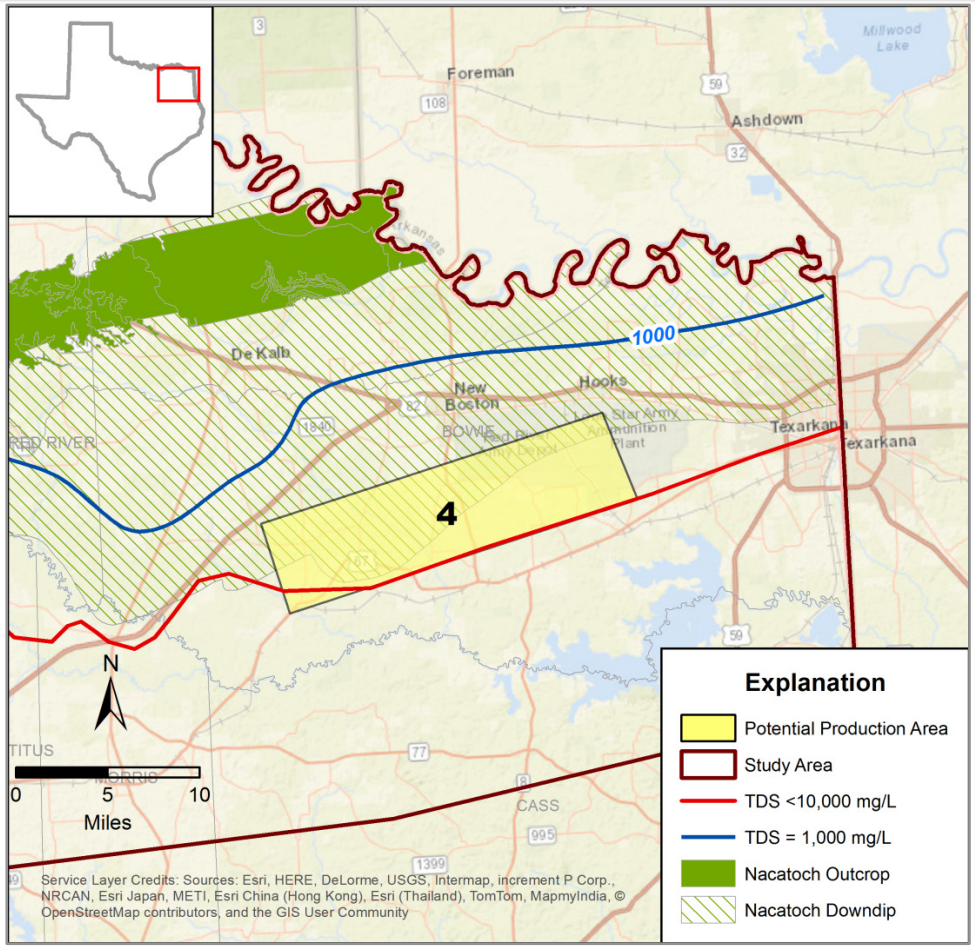
Nacatoch
Potential Production Areas

Estimated Depth to top Nacatoch
700 – 1,000 feet

Net Sand Thickness
30 - 100 feet



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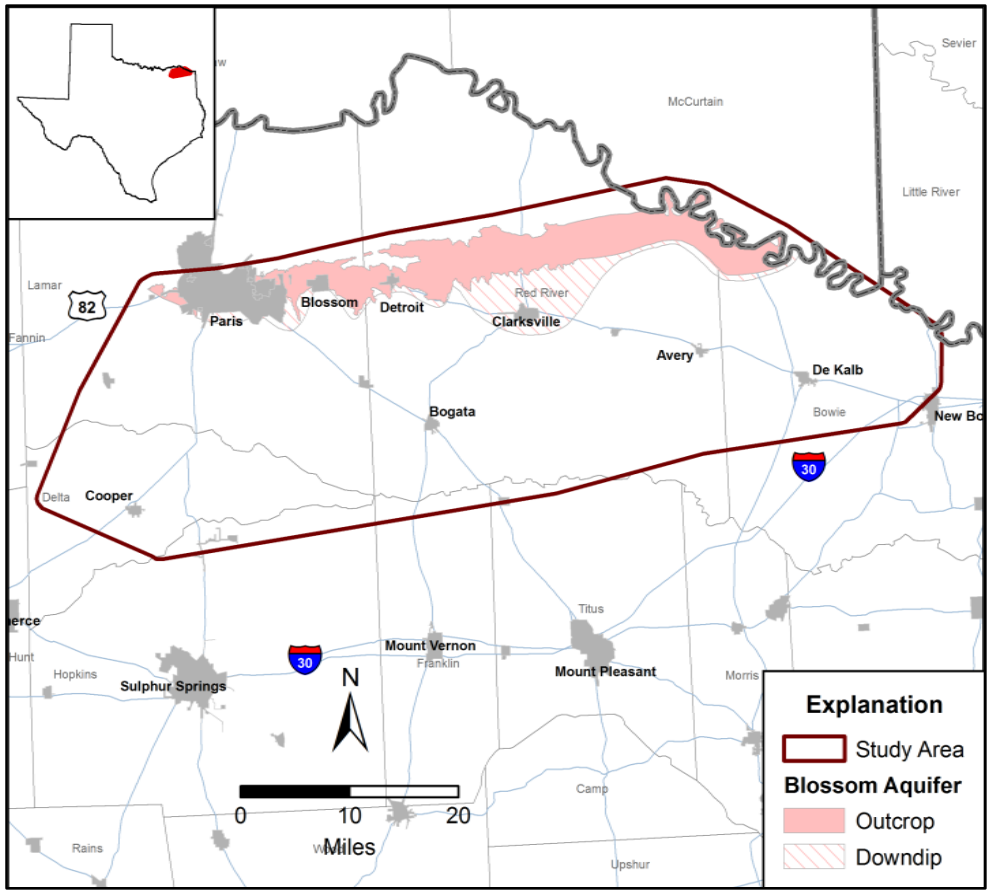
Blossom Aquifer Study Area

- Study area includes eastern Lamar, Red River and western Bowie Counties
- Area includes outcrop plus all data locations used to estimate water quality



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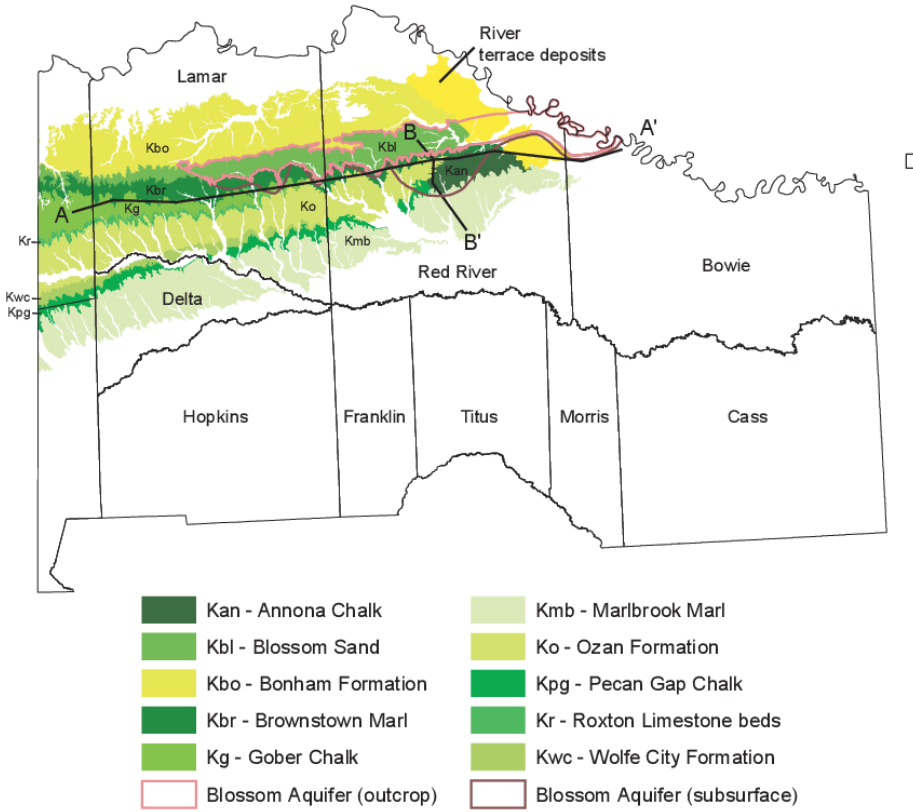
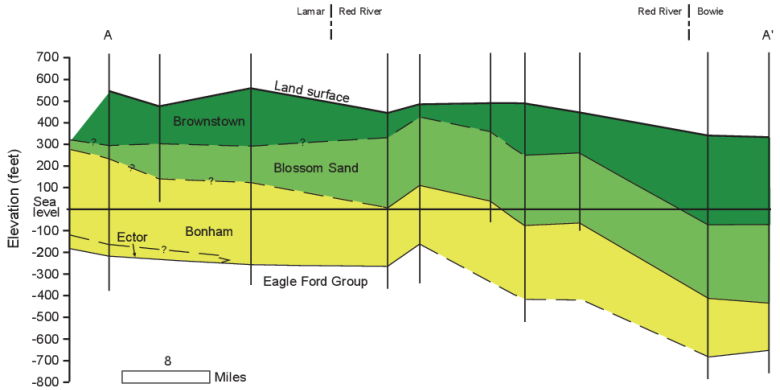
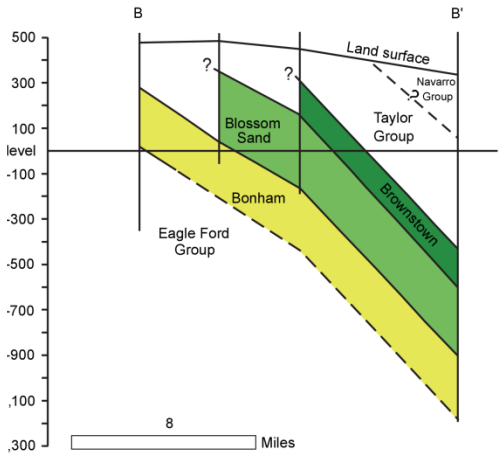
Blossom Aquifer Stratigraphy





East-west geologic cross section along the Blossom Aquifer (modified from McLaurin, 1988).



North-south geologic cross section across the Blossom Aquifer (modified from McLaurin, 1988).

Source: Texas Water Development Board Report 380, Aquifers of Texas, 2011.

Blossom Aquifer Stratigraphy

Era/ System	Series	Group	Formation	Maximum thickness (feet)	Lithology	Water-bearing properties
Cenozoic/ Quaternary	Recent		Alluvium	75	Sand, silt, clay and gravel	Yields small to moderate quantities of fresh to slightly saline water
	Pleistocene		Fluviatile, terrace deposits			
Mesozoic/ Cretaceous	Gulf	Taylor	Marbrook Marl, Pecan Gap Chalk, Wolfe City - Ozan Formation	1,500	Clay, marl, shale, chalk, mudstone, and sandstone, very fine-grained	Not known to yield significant quantities of water
		Austin	Gober Chalk	300	Chalk, discontinuous	
			Brownstown	220	Clay or shale	Not known to yield water
			Blossom Sand	400 (formation) 80 (lower sand only)	Fine to medium sand (upper and lower) interbedded with marl and chalky marl	Yields small to moderate quantities of water
			Bonham	530	Clay or shale	Not known to yield water
			Ector	80	Chalk	
		Eagle Ford		650	Shale with thin beds of sandstone and limestone	Not known to yield water

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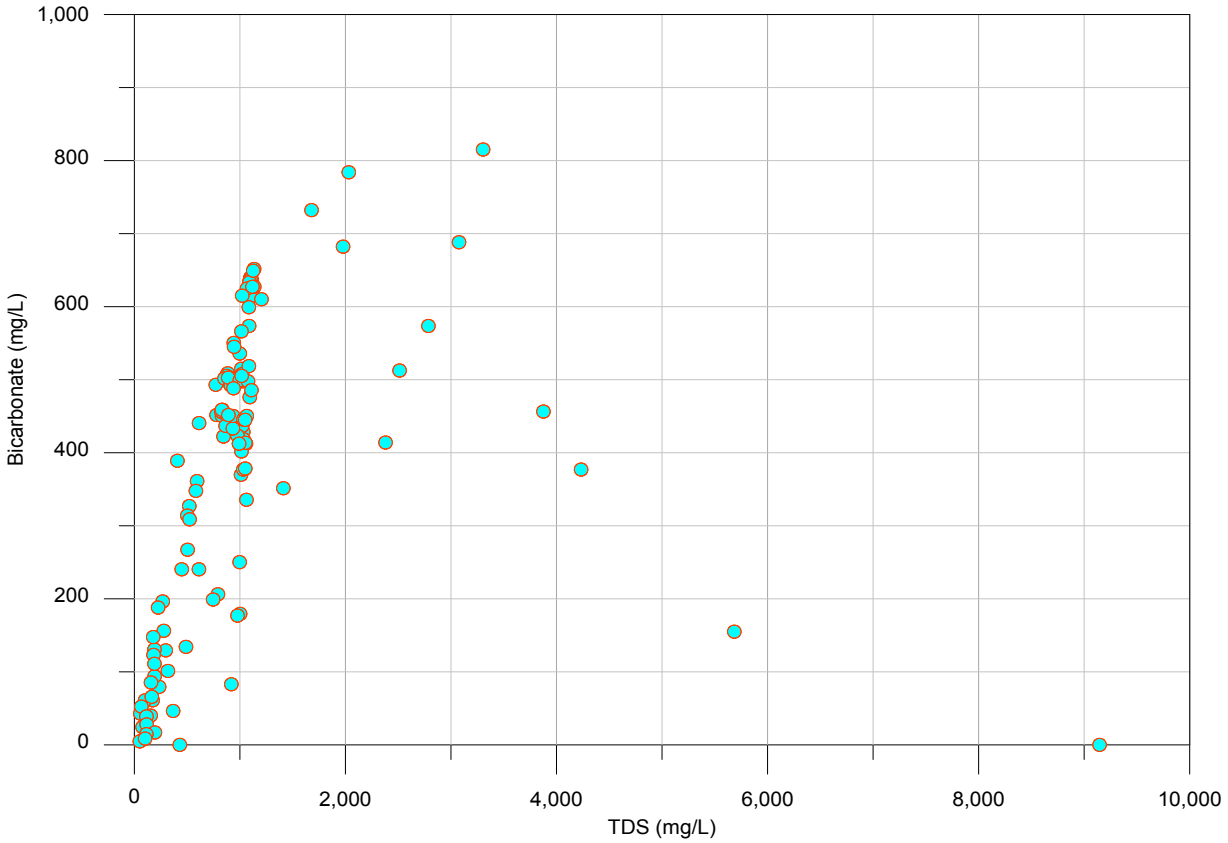
Blossom Water Quality Issues



Bicarbonate vs TDS

- High bicarbonate concentrations (up to 50% of TDS in freshwater and slightly saline groundwater)
- High sodium adsorption ratio (SAR), which indicates unsuitability for irrigation
- Generally unsuitable for irrigation: over half of samples exceeded recommended residual sodium carbonate (RSC), which is indicative of alkalinity hazard and suitability for use in clayey soils

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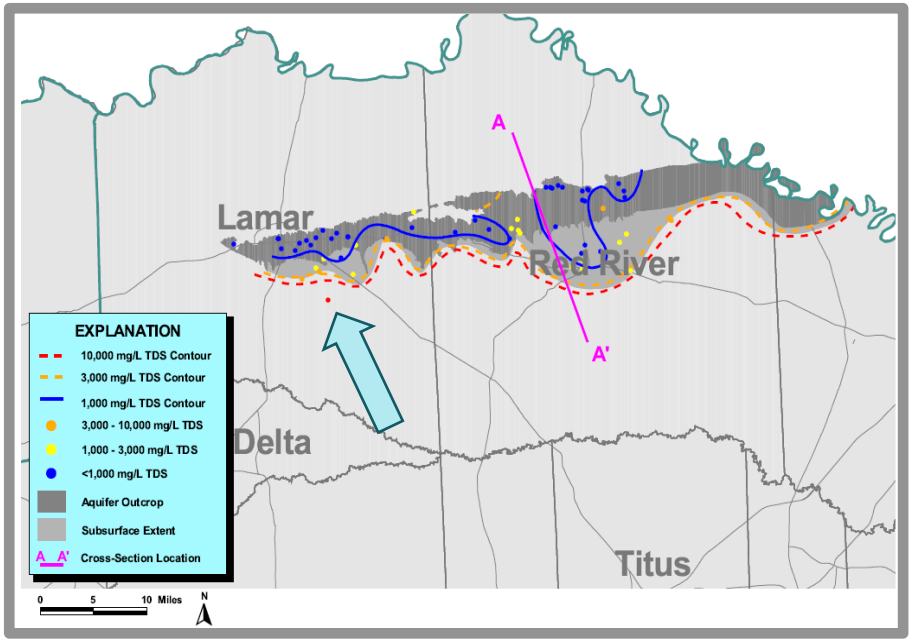
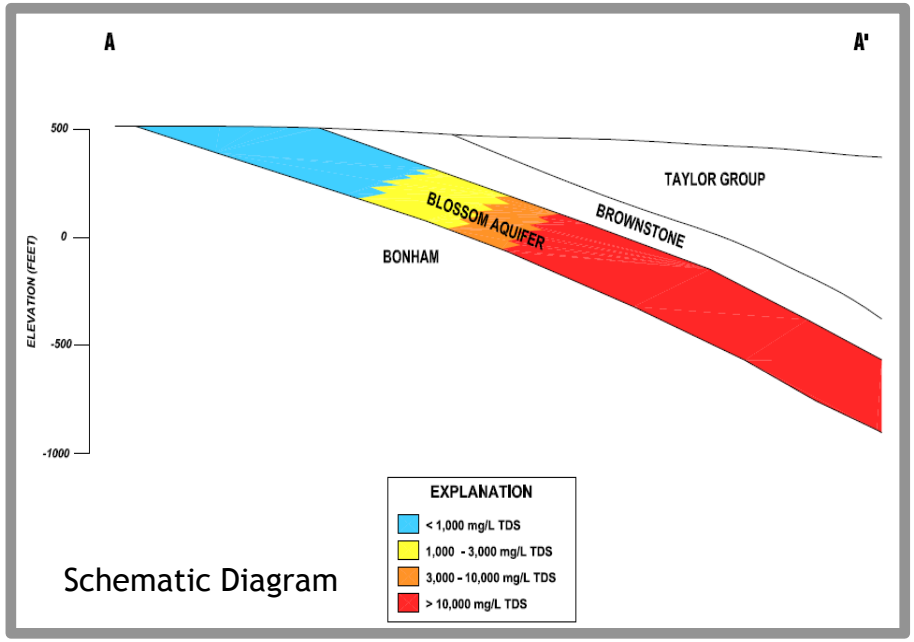
Blossom Brackish (2003)





Schematic Diagram

- One sample with TDS greater than 16,000 mg/L was the only downdip data point, suggesting transition to very saline water quality within a 3-mile distance
- Relatively low production yields, a thin production zone and depths to brackish groundwater suggest the Blossom a viable candidate for small water demands when other sources are not available
- Estimated confined availability of 1,000 – 10,000 mg/L TDS water = 700 acre-feet

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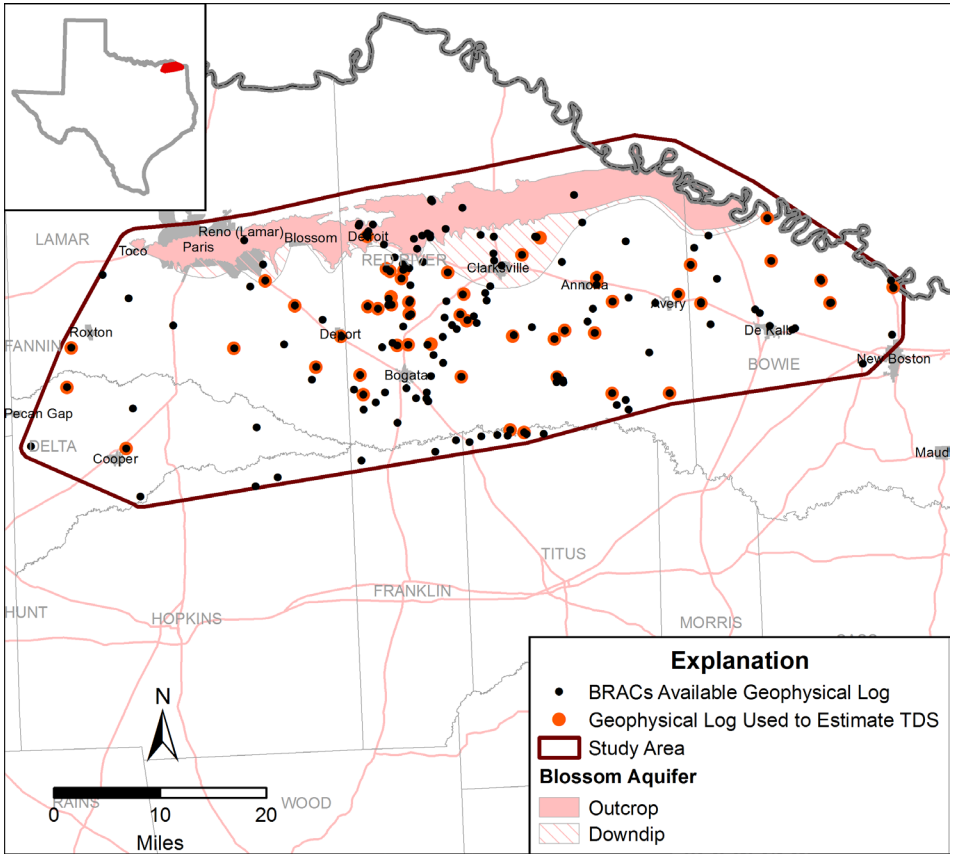
Blossom Aquifer Log Data

- 169 geophysical logs were available from the BRACs database and additional Q-logs
- Many of the logs were not used in this study because there was not adequate information recorded in the log headers to perform any estimates
- 67 logs were used to estimate TDS using primarily the Alger-Harrison method and the SP method where it was considered to be reasonable
- 52 logs were remaining after 15 were omitted due to questionable log header values associated with mud filtrate and mud resistivity



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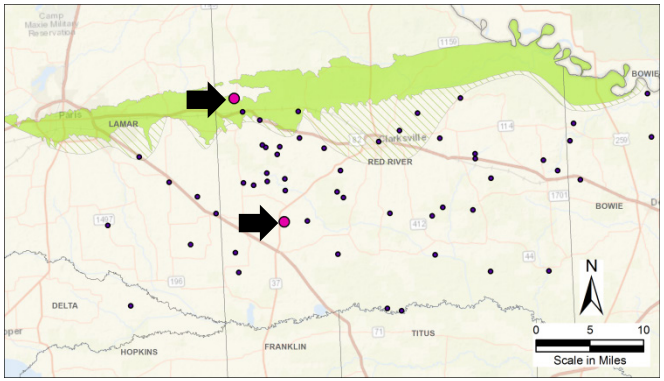
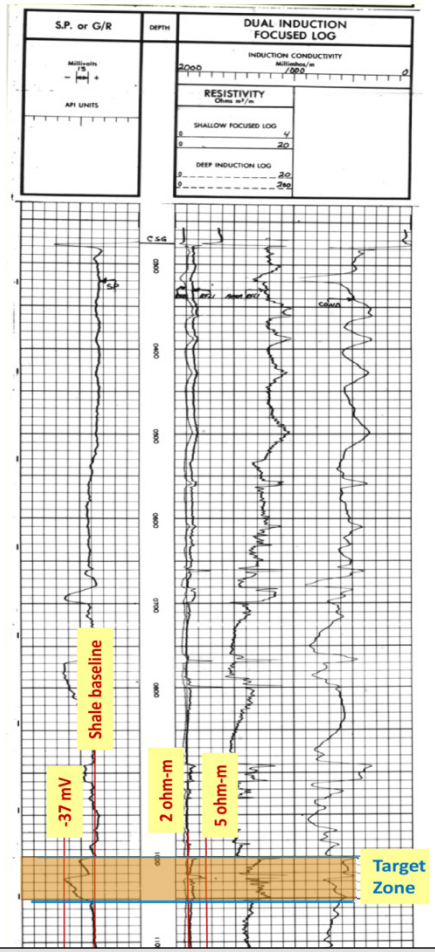
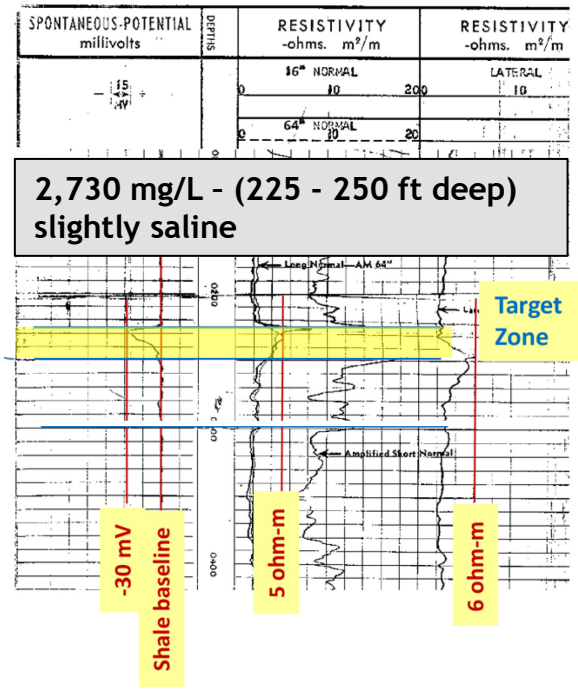
Blossom Aquifer Log Data

- Typically only two sands in the Blossom, one at the top and one at the base of the formation, not much variation (but there is some)
- The deep sand is only sand characterized for this study, the shallower one is not as productive, and it is a more conservative approach





8,958 mg/L - (1,000-1,055 ft deep) moderately saline



2,730 mg/L - (225 - 250 ft deep) slightly saline

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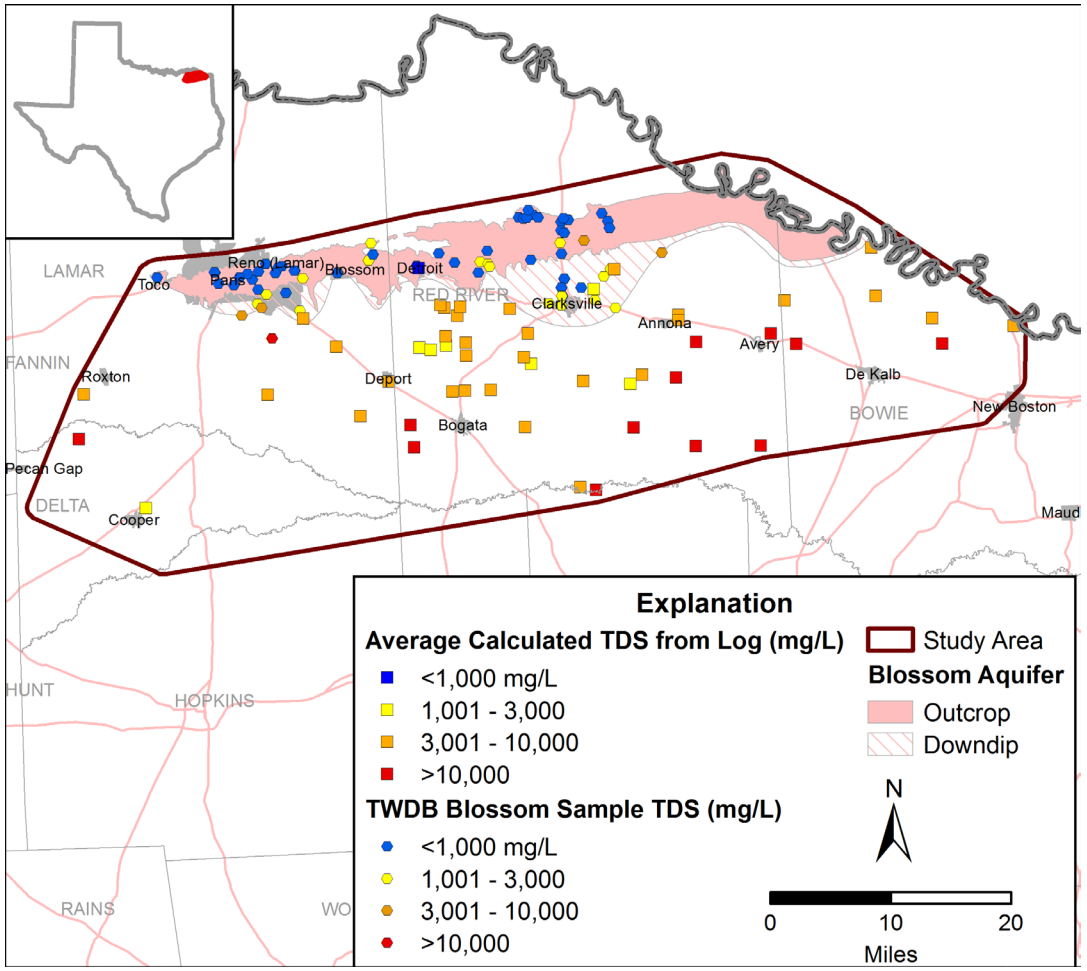
Blossom Aquifer TDS (2017)

- Analytical samples and geophysical log estimates mapped collectively
- These data suggest that TDS can vary quite a bit over short distances



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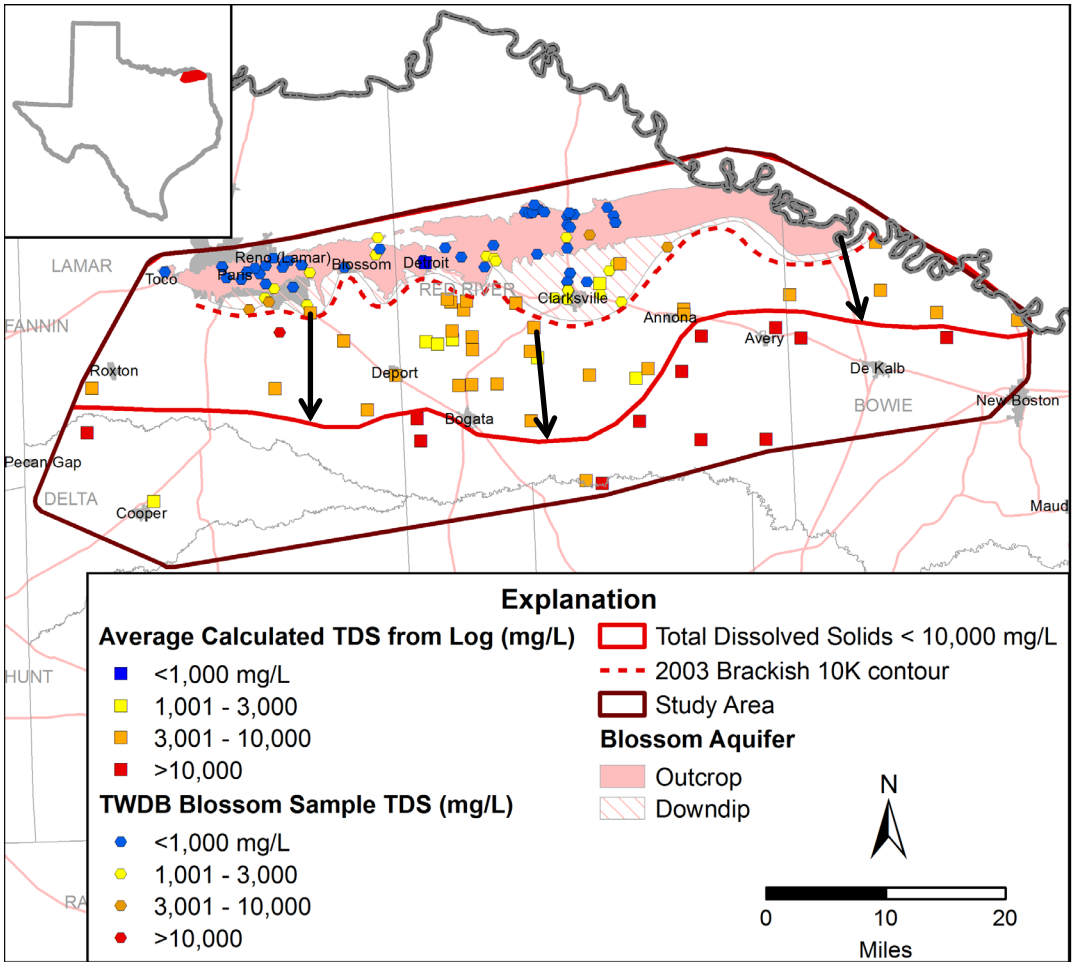
Blossom Aquifer 10K Extent

- Comparison of 10,000 mg/L TDS extents between 2003 and 2017 studies
- Current study indicates an expanded area of moderately saline groundwater compared to previous estimate



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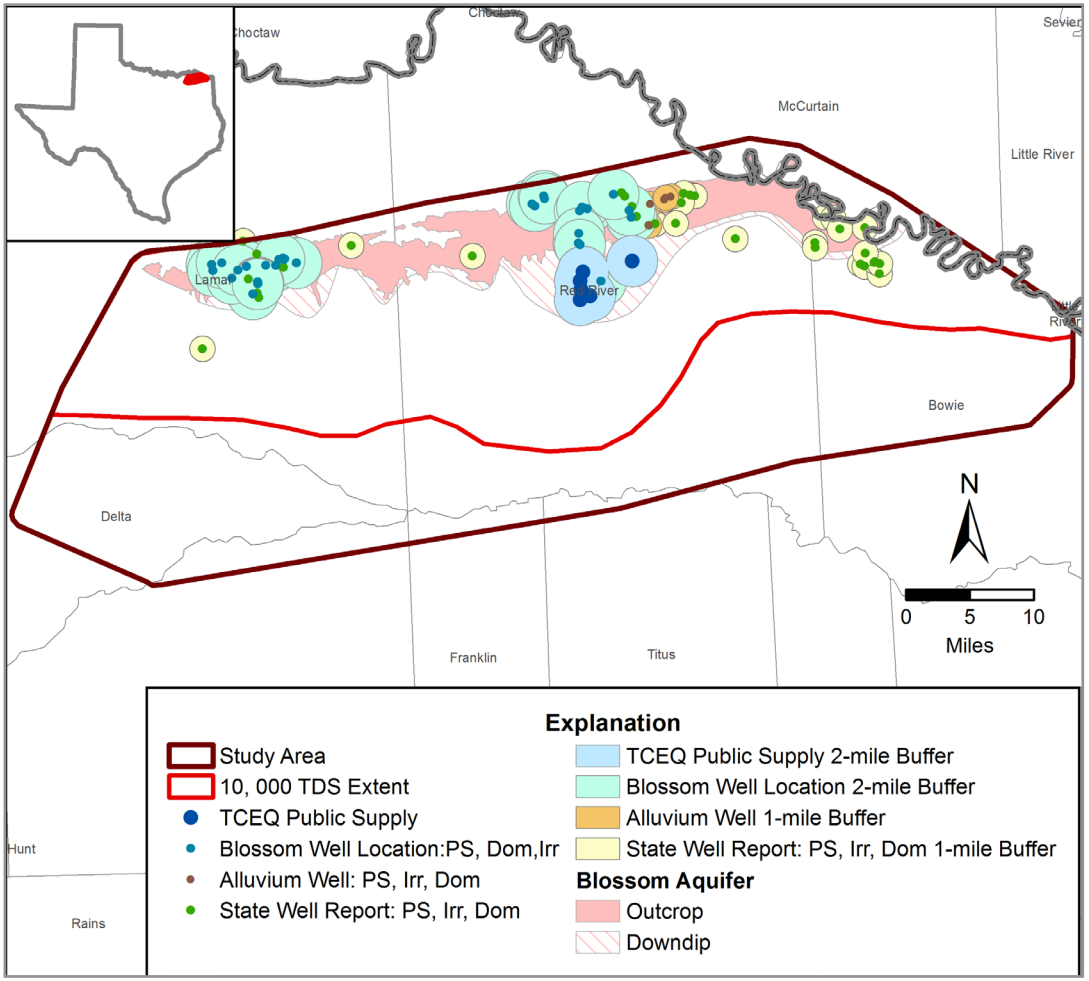
Blossom Exclusion Items

- Wells: public supply, irrigation, and domestic use
- These wells are completed in the Blossom or overlying alluvium



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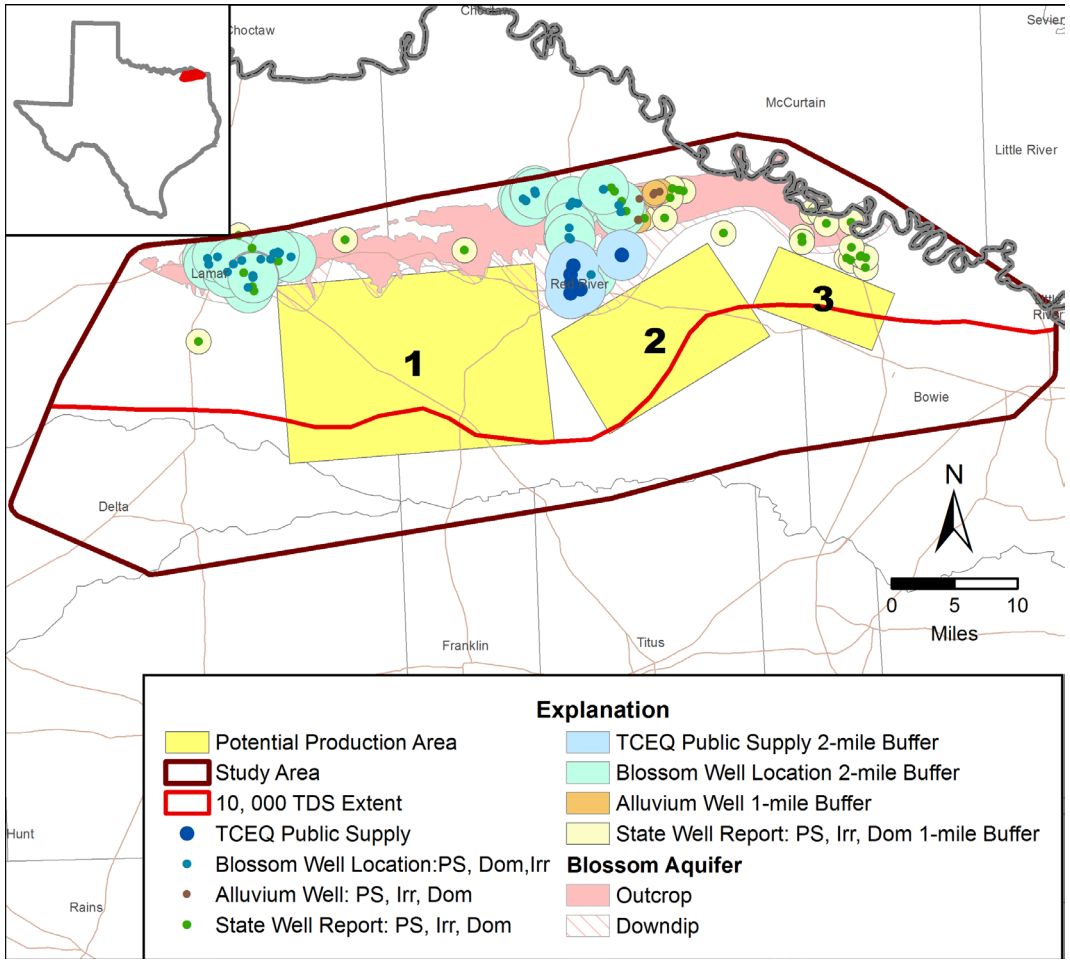
Blossom
Potential Production Areas



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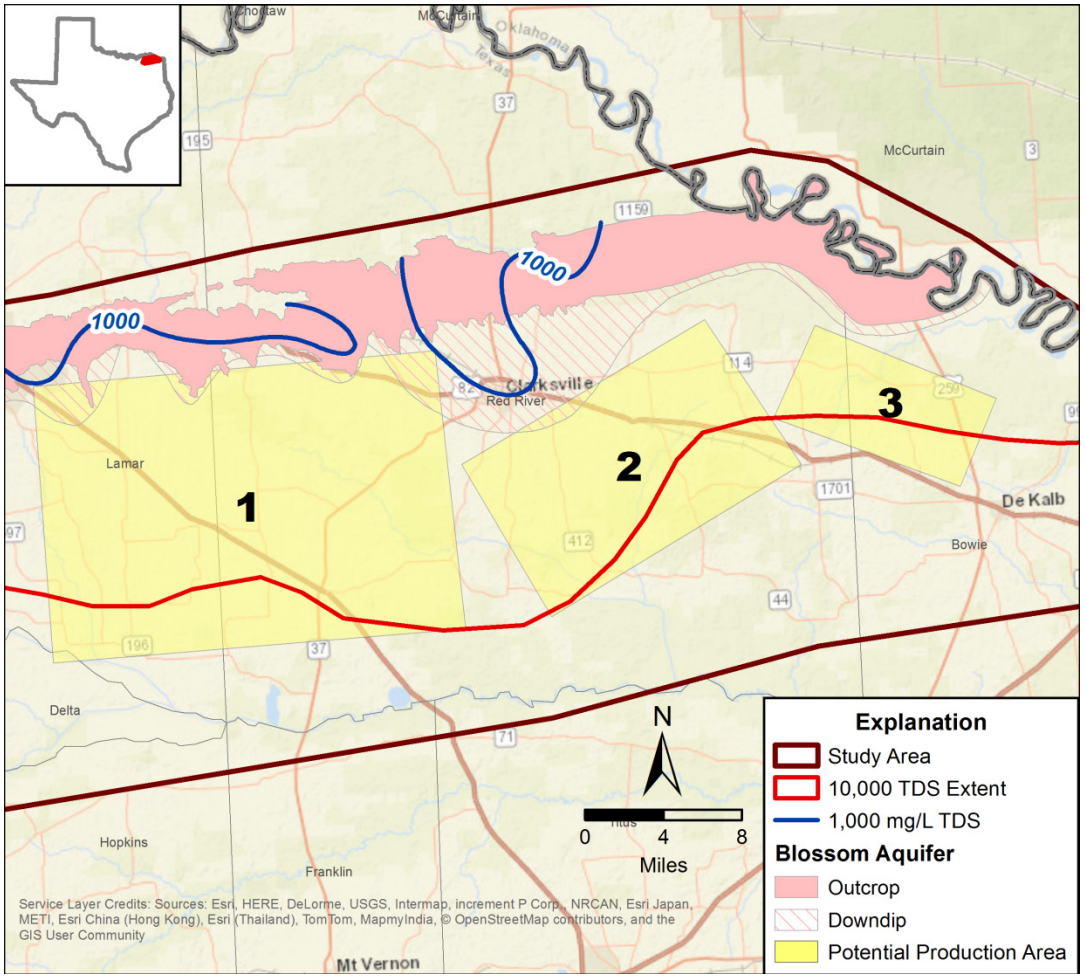
Blossom Potential Production Areas

Depth to Top of Blossom
1 0 - 1,400 feet
2 200 – 1,400
3 150 – 1,050

Depth to Top of Lower Sand
1 50 – 1,500 feet
2 700 – 1,500
3 650 – 1,350

Lower Sand Thickness
1 30 – 70 feet
2 60 – 80
3 45 - 90



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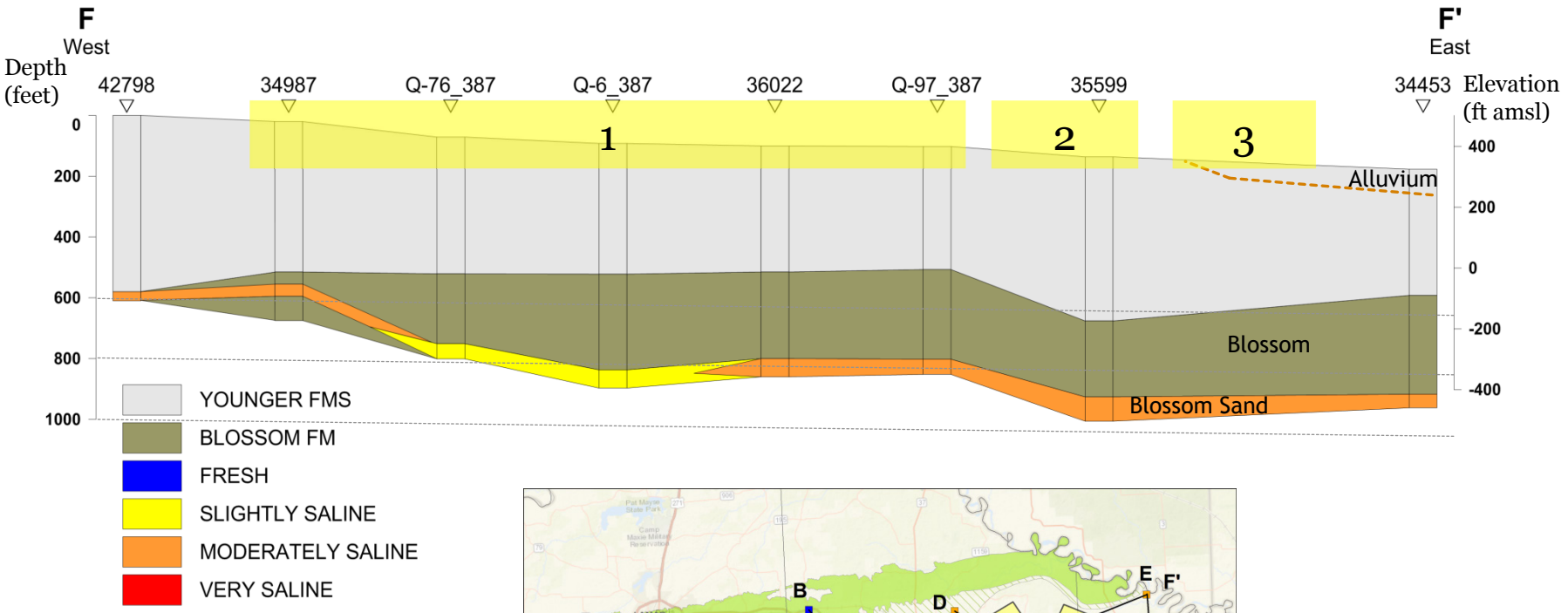
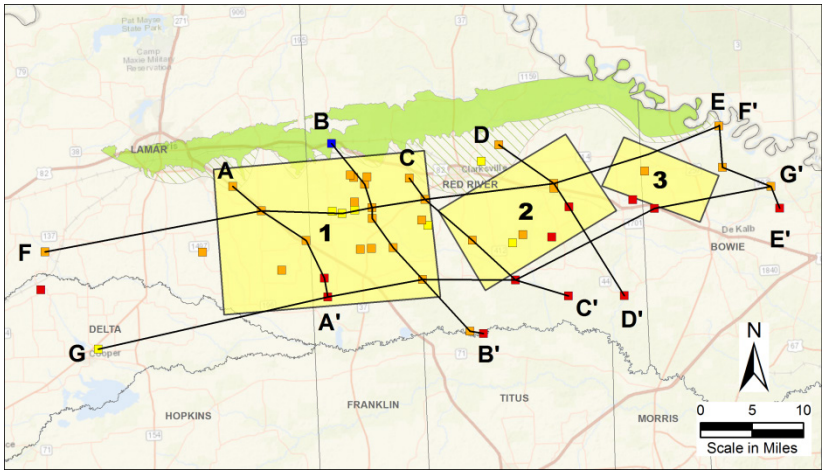
Blossom Potential Production Areas





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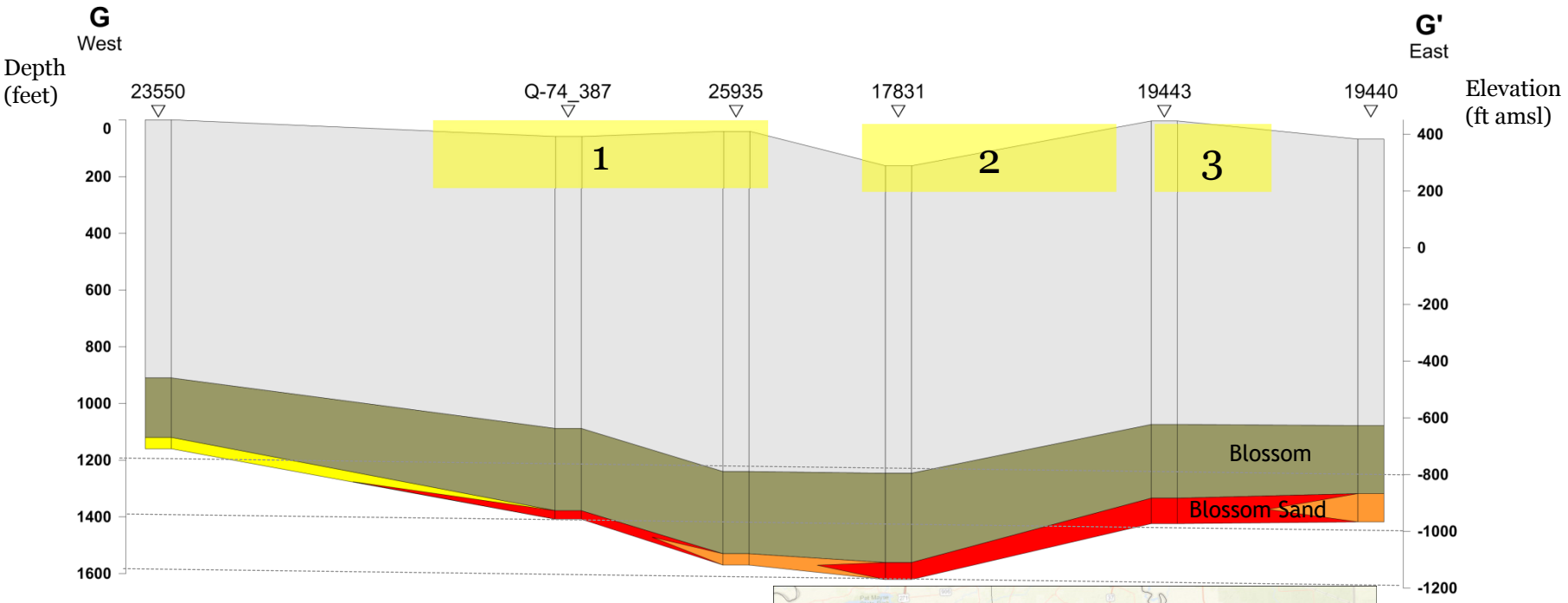
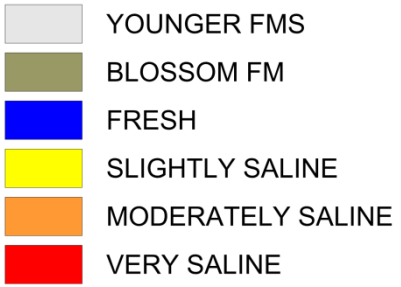
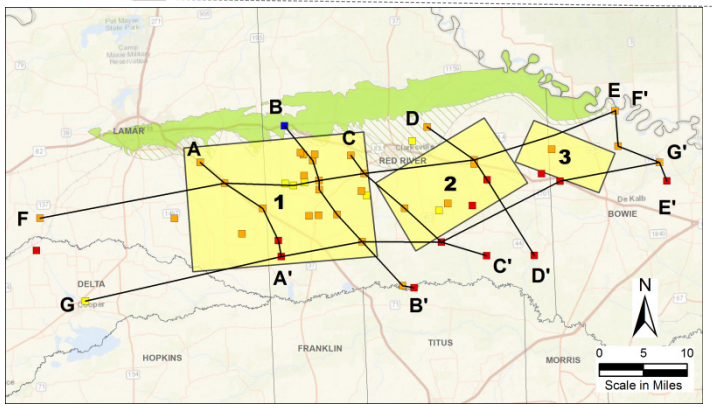
Blossom
Potential Production Areas







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What happens next?

- The delineation of potential production areas presented today are draft and open to public comment
- This presentation will be publicly available at the TWDB BRACS website; Stakeholders will receive an email when it is posted
- Stakeholders should send their comments to the TWDB
- The Final Report will be delivered to the TWDB by August 31st
- Stakeholders will receive an email when the Final Report is posted to the website and will be encouraged to provide comments
- Brackish Groundwater Production Zones will be designated by the TWDB at a public board meeting
- Stakeholders will receive an email with the meeting date, time, and location

Thank You!

Jean Perez
jean.perez@twdb.texas.gov

Alan Andrews
alan.andrews@twdb.texas.gov

John Meyer
john.meyer@twdb.texas.gov

House Bill 30
www.twdb.texas.gov/innovativewater/bracs/HB30.asp

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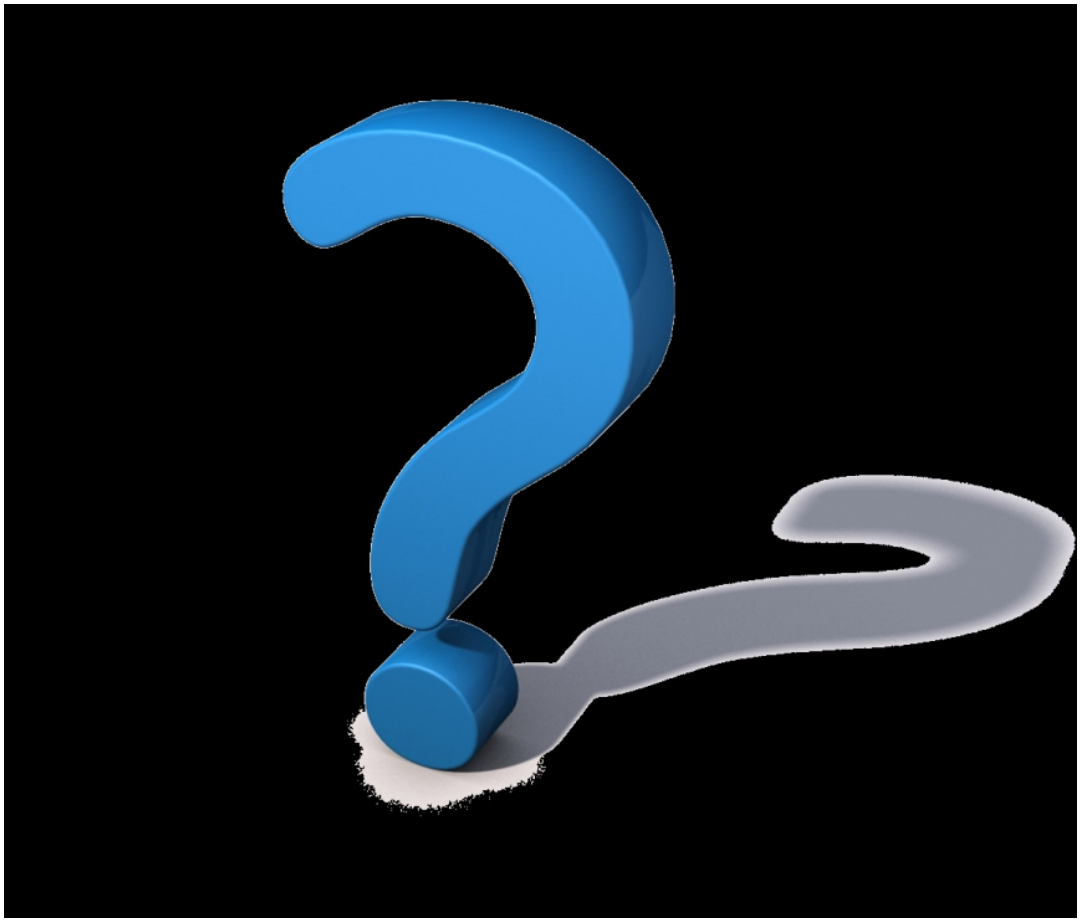
Questions or Comments?



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