

Brackish Groundwater Production Zones Stakeholder Meeting: Dockum and Edwards-Trinity Plateau Aquifers

August 16, 2017

Midland, TX

Presented by Andrea Croskrey and Mark Robinson



The following presentation is based upon professional research and analysis within the scope of the Texas Water Development Board's statutory responsibilities and priorities but, unless specifically noted, does not necessarily reflect official Board positions or decisions.

Meeting Agenda

Time	Item	Facilitator
10:00– 10:15 a.m.	Introductions, overview of TWDB previous studies	Andrea Croskrey
10:15-10:45 a.m.	Introduction to mapping brackish groundwater in the Dockum Aquifer	Mark Robinson
10:45-11:00 a.m.	Open for public comment	Mark Robinson
11:00-11:30 a.m.	Introduction to mapping brackish groundwater in the Edwards-Trinity Plateau Aquifer	Andrea Croskrey
11:00-11:30 a.m.	Open for public comment	Andrea Croskrey
11:45-12:00 p.m.	Closing Remarks, summary of next steps	Andrea Croskrey
12:00 p.m.	Adjourn	

Brackish Groundwater

- Saltier than fresh water, less salty than seawater

Groundwater Salinity Classification	Salinity Zone Code	Total Dissolved Solids Concentration in milligrams per liter (mg/L)
Fresh	FR	0 to 1,000
Slightly Saline	SS	1,000 to 3,000
Moderately Saline	MS	3,000 to 10,000
Very Saline	VS	10,000 to 35,000
Brine	BR	Greater than 35,000

Drinking Water Limit

Major/Minor Texas Aquifers Mapped Limit*

Seawater

Texas Water Development Board

Primary Responsibilities:

- State Water Plan
- Funding
- Water Resource Data
- Outreach

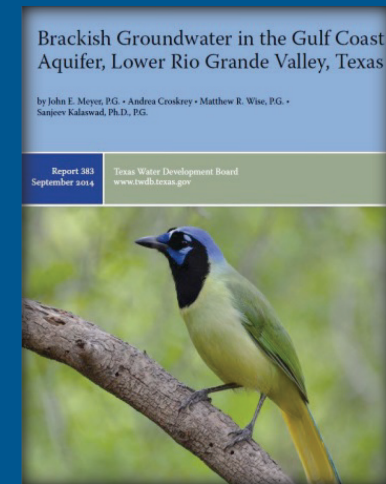
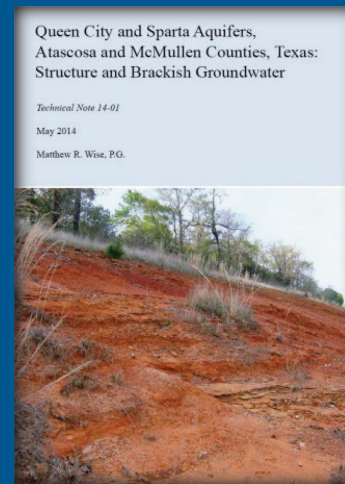
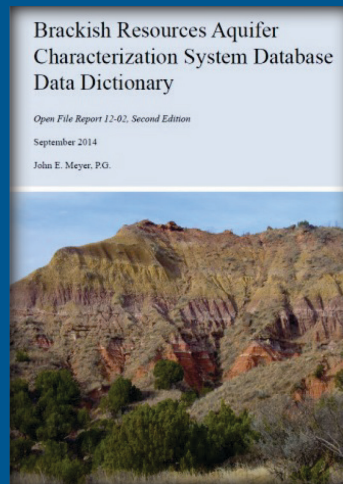
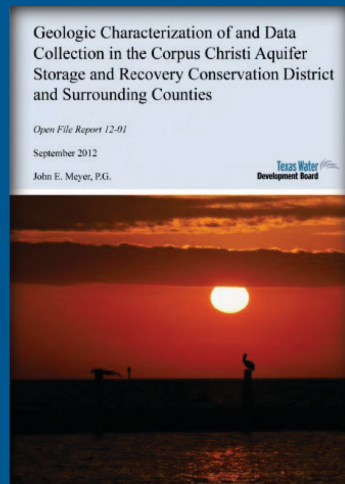
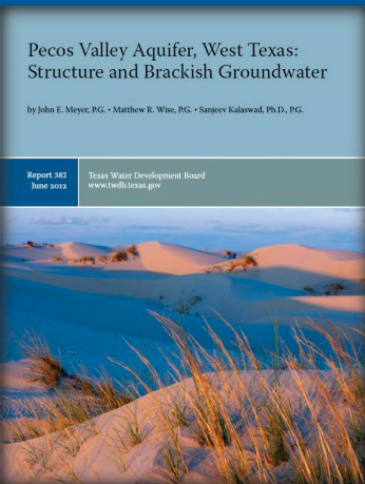


“To provide leadership, information, education, and support for planning, financial assistance, and outreach for the conservation and responsible development of water for Texas”

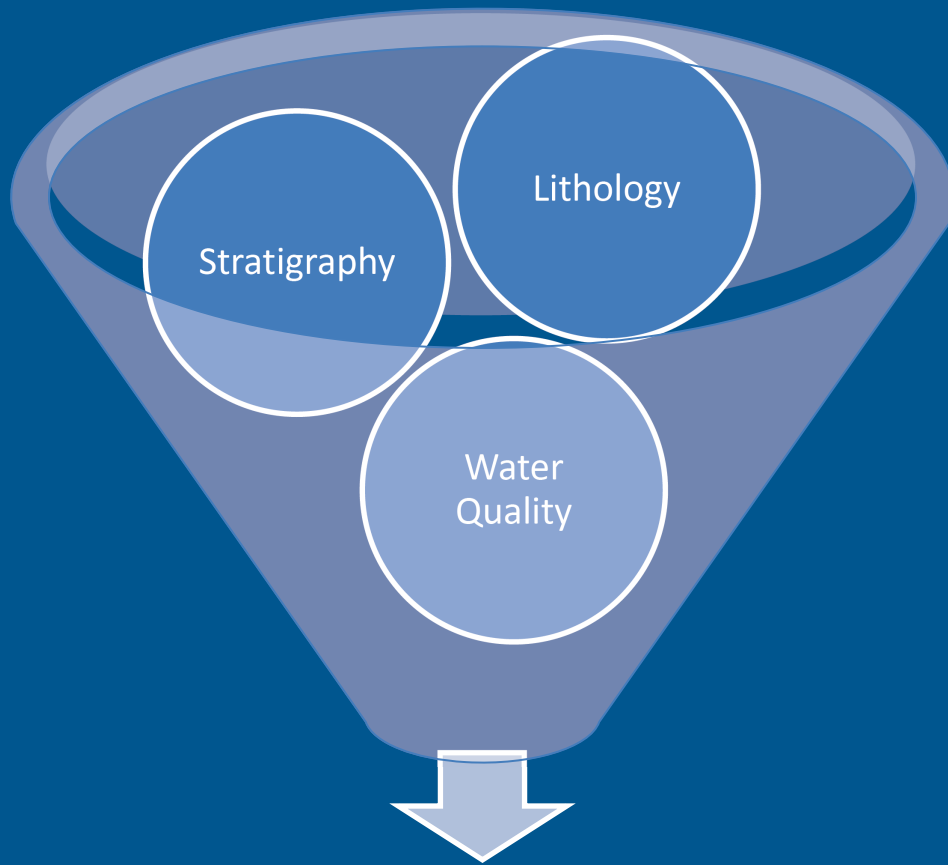
Brackish Resources Aquifer Characterization System (BRACS)

- 2003 contracted study estimated 2.7 billion acre-feet brackish groundwater and prompted funding

LBG-Guyton Associates, 2003, Brackish groundwater manual for Texas Regional Planning Groups: LBG-Guyton Associates, Inc., contract report to the Texas Water Development Board, 188 p.
- BRACS program started in 2009 to map brackish aquifers and address knowledge gap



General Methodology



Area (Extent)

X

Thickness (Net Sand)


X

Porosity (Specific Yield)

=

Volume (acre-feet)

**Volume and Quality of
Brackish Groundwater**



Brackish Groundwater Production Zones (BGPZ) 84th Texas Legislature, 2015

Directed TWDB to:

- ✓ Define brackish groundwater production zones
- ✓ Estimate productivity over 30 & 50 year periods
- ✓ Recommend groundwater monitoring
- ✓ Work with stakeholders and groundwater conservation districts
- ✓ Complete four aquifers December 2016
- ✓ Complete all aquifers December 2022

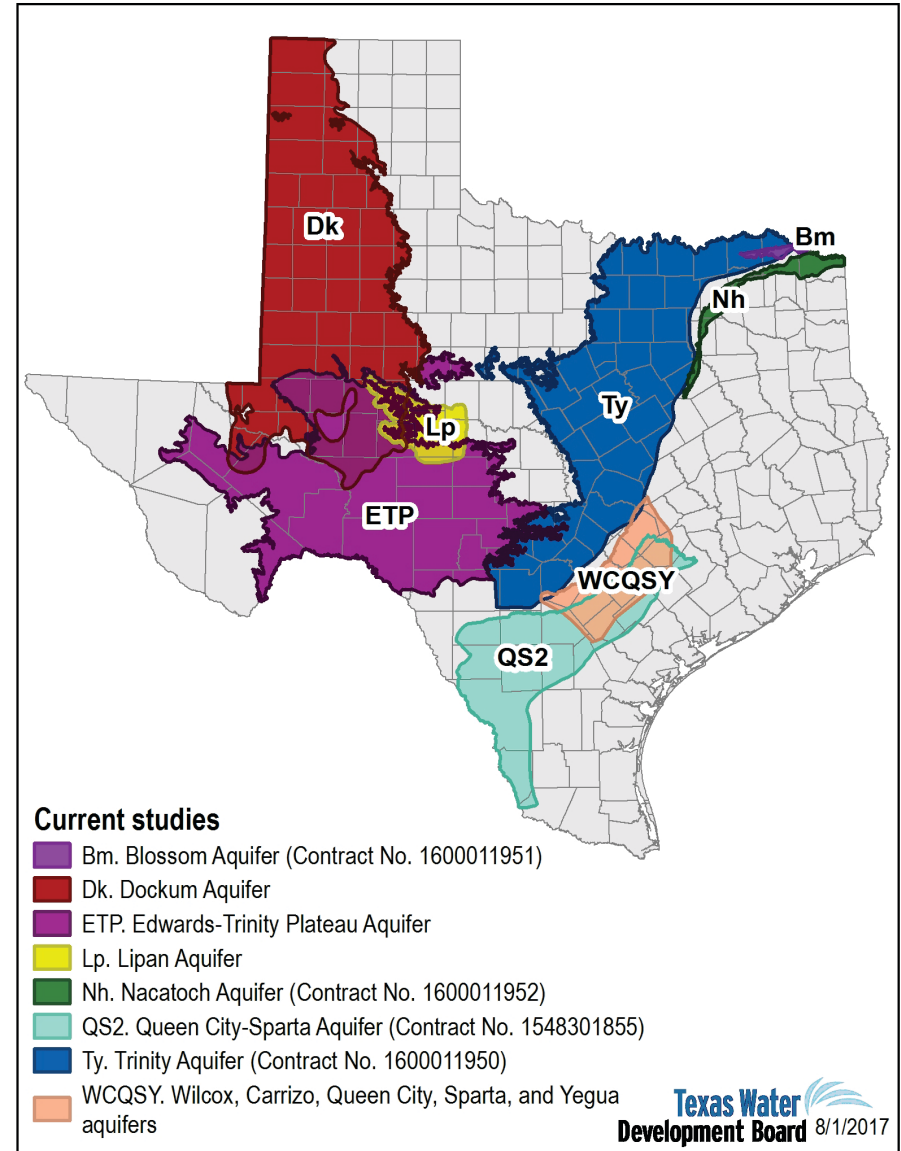
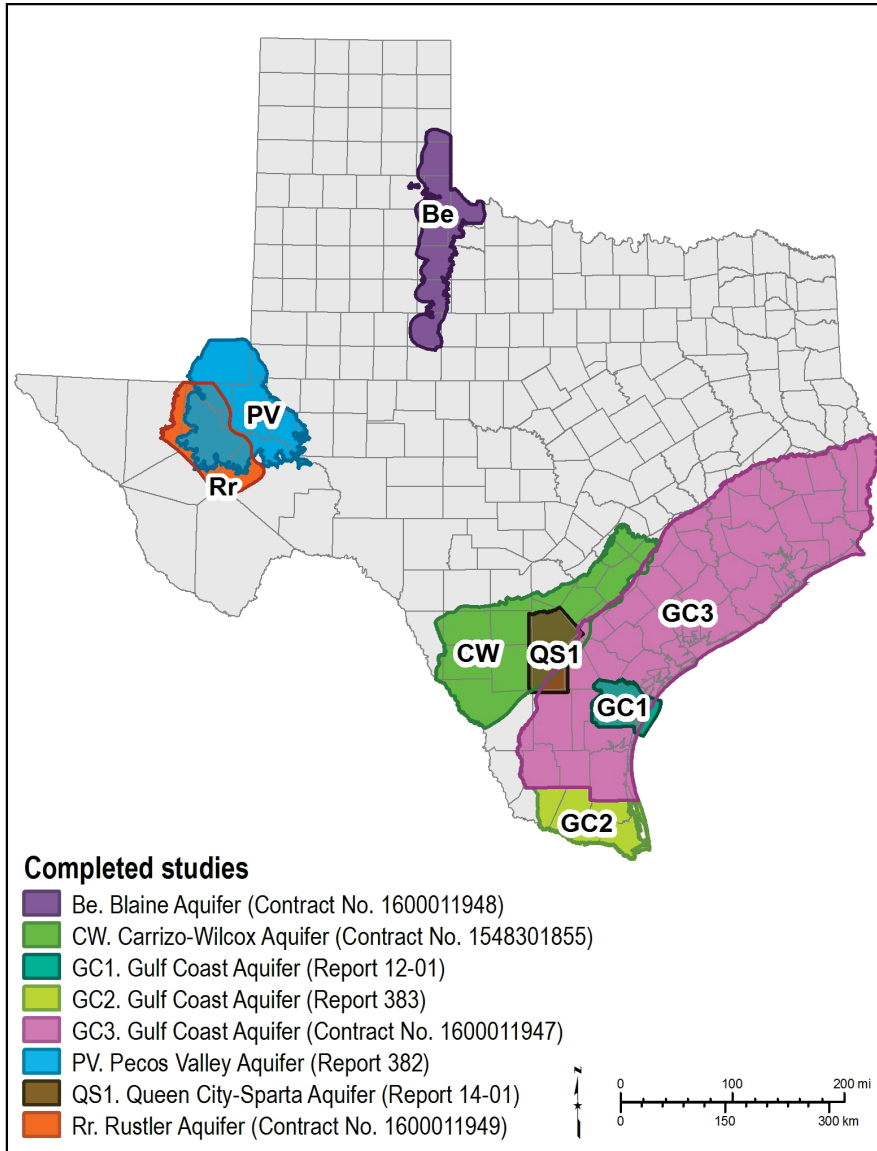
<http://www.twdb.texas.gov/innovativewater/bracs/HB30.asp>

Brackish Groundwater Production Zones

Criteria designation:

Must have brackish water	In areas of the state with moderate to high availability and productivity
Must have hydrogeologic barriers	sufficient to prevent significant impacts to fresh water availability or quality
Cannot be within these boundaries	Edwards Aquifer within the Edwards Aquifer Authority, Barton Springs-Edwards Aquifer Conservation District, Harris-Galveston Subsidence District, or Fort Bend Subsidence District
Cannot be already in use	Brackish water already serving as a significant source of water supply for municipal, domestic, or agricultural
Cannot be used for wastewater injection	permitted under Title 2 of Texas Water Code, Chapter 27

Brackish Resources Aquifer Characterization System (BRACS) Program



Outline for Presentations

- Proposed study areas
- Hydrogeology overview
- Data collected and data gaps
- Anticipated challenges
- Questions, comments, and input from stakeholders

Dockum Aquifer

- Dockum Group extends into four States

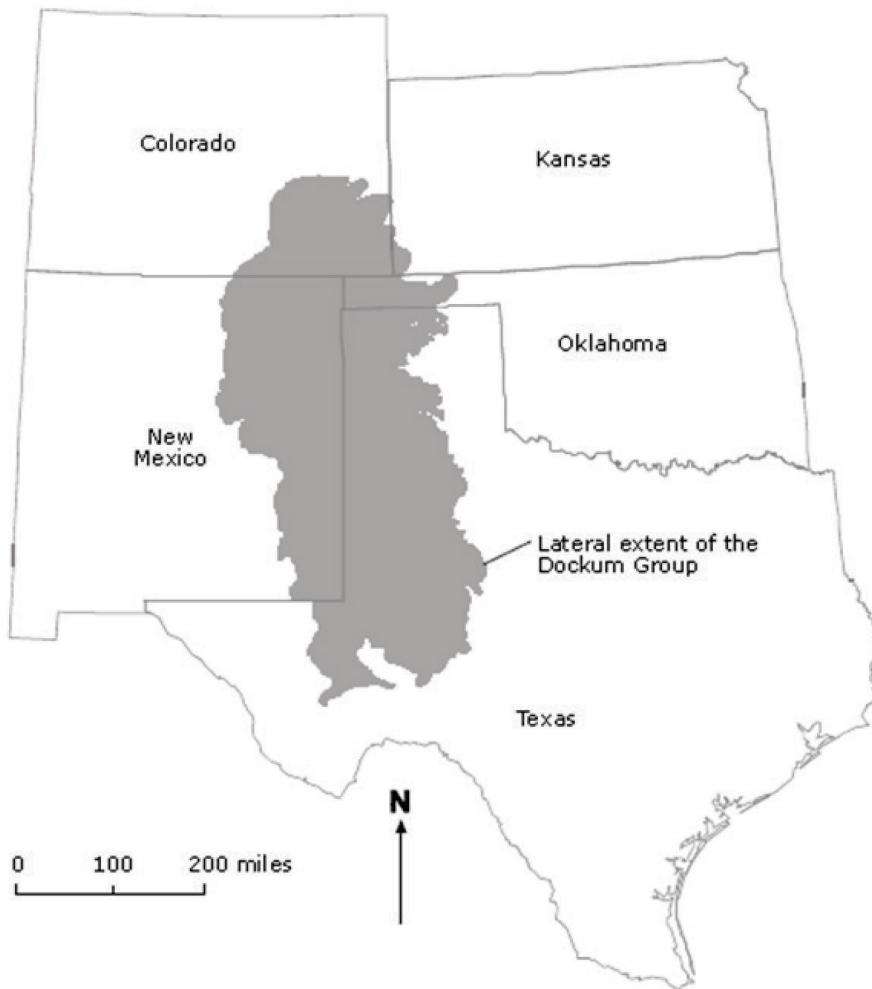
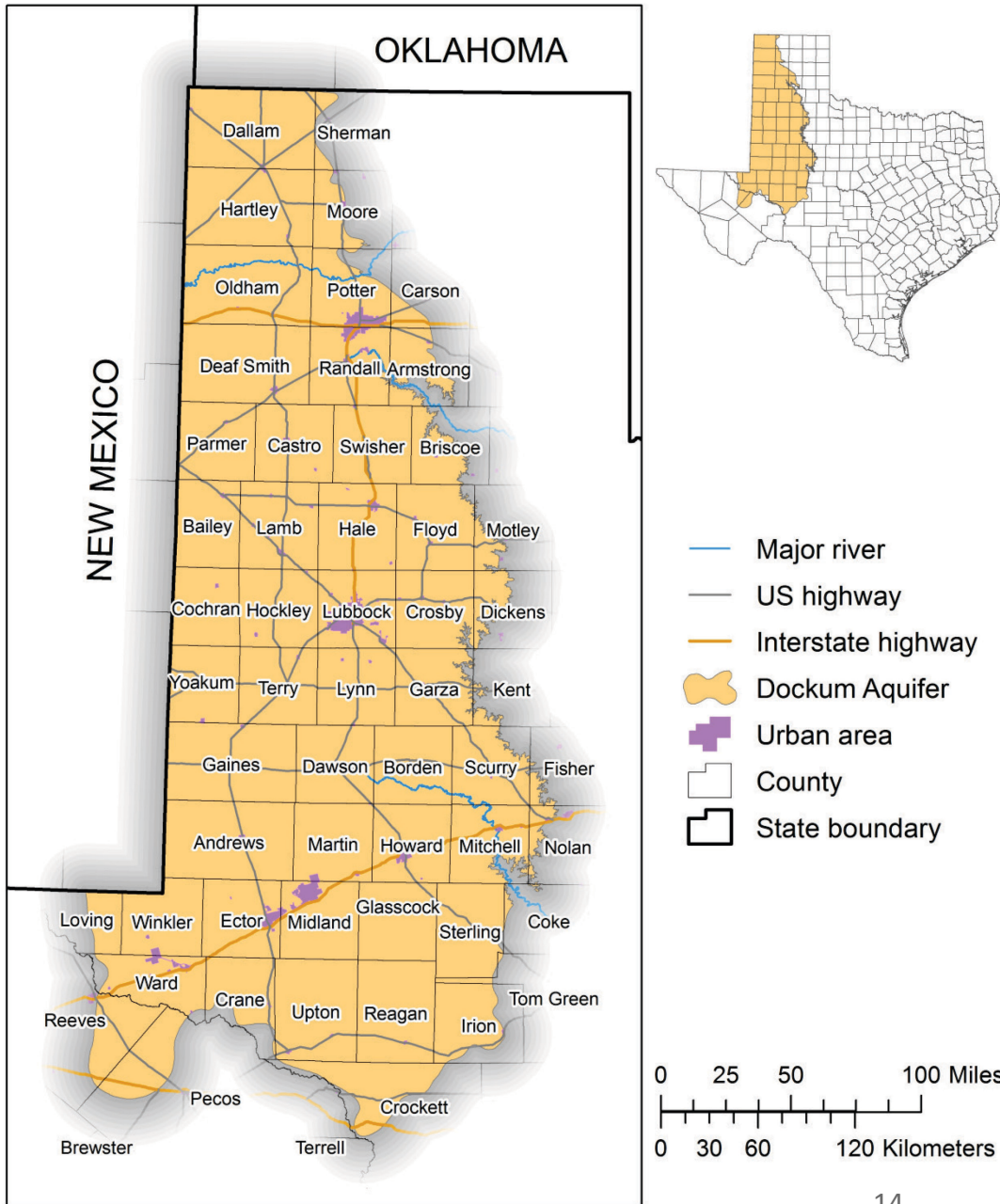


Figure 2-1. Lateral extent of the Dockum Group in southwestern United States (modified from McKee and others, 1959; Bureau of Economic Geology, 1967, 1968, 1969, 1974, and 1983; McGowen and others, 1977).

Dockum Aquifer BRACS Study Extent

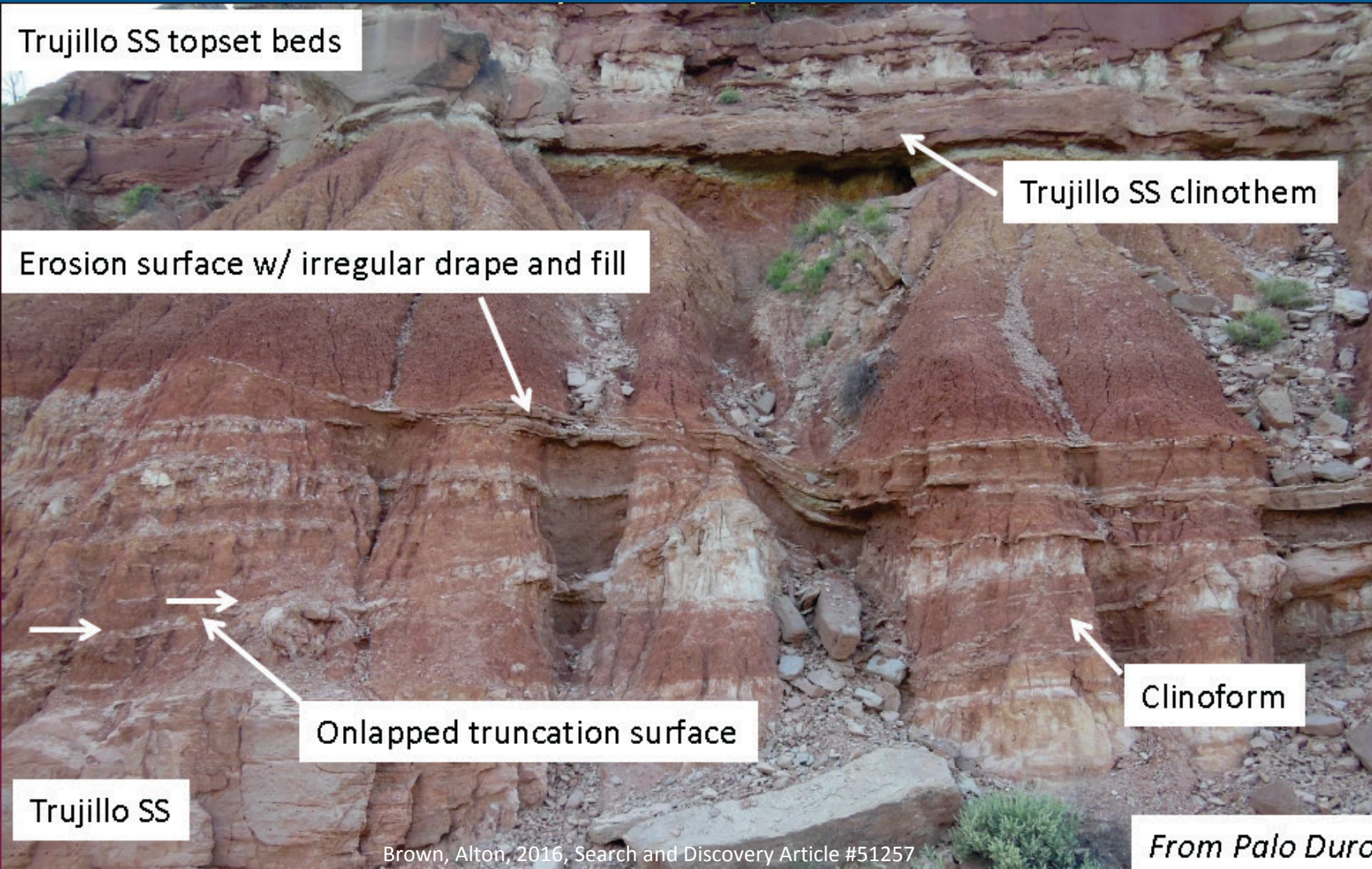


- 57 Texas Counties
- 20 Groundwater Conservation Districts
- 5 Groundwater Management Areas
- 4 Regional Water Planning Groups

Previous Study Results

- Dockum is classified as a minor aquifer
- Covers approximately 26,000 square miles of Texas
- 109 million acre-feet of brackish groundwater with total dissolved solids from 0 to 5,000 milligrams per liter.
- 27 million acre-feet of brackish groundwater with total dissolved solids from 5,000 to 10,000 milligrams per liter.

Dockum Hydrogeology



Stratigraphic Controversy

Table 3.0.1 Summary of Triassic Dockum Group nomenclature (modified from Bradley and Kalaswad, 2003).

Author	Cummins (1890)	Gould (1907)	Hoots (1926)	Darton (1928)	Adams (1929)	McGowen and others (1975; 1977; 1979)	Hart and others (1976)	Granata (1981)	Lucas and Anderson (1992; 1993; 1994; 1995)	Lehman (1994a; 1994b)	
Region	Southern High Plains Texas & New Mexico	Northern Texas Panhandle	Southern Texas Panhandle	Eastern New Mexico	Southern Texas Panhandle	Southern High Plains Texas & New Mexico	Oklahoma Panhandle	Northern New Mexico		Southern High Plains Texas & New Mexico	
Dockum subunit distinctions vertically	Dockum Redbeds	(thin or absent)	Upper red clay	Chinle Formation	Chinle Formation	Upper Dockum ⁽²⁾	Upper Dockum ⁽²⁾	Redonda Formation	Chinle Group Dockum Formation	Bull Canyon Member	Redonda Formation ⁽¹⁾
		Trujillo sandstone and shale						Chinle Formation			
			Tecovas basal shale	Basal red clay and sandstone	Santa Rosa Sandstone	Santa Rosa Sandstone	Tecovas Member	Trujillo Sandstone		Tecovas Formation	
		(generally absent)		(generally absent)	Basal shales		Camp Springs Member			Santa Rosa Sandstone	

⁽¹⁾ in New Mexico only

⁽²⁾ not intended as a formal stratigraphic name

Dockum is considered a group designation by all researchers except Lucas and Anderson.

Lateral stratigraphic correlation between units depicted on this table is not intended.

Bradley and Kalaswad (2003) refer to the more prolific parts of the Dockum Aquifer as simply the "Best Sandstone".

Simplified Lithologic Model

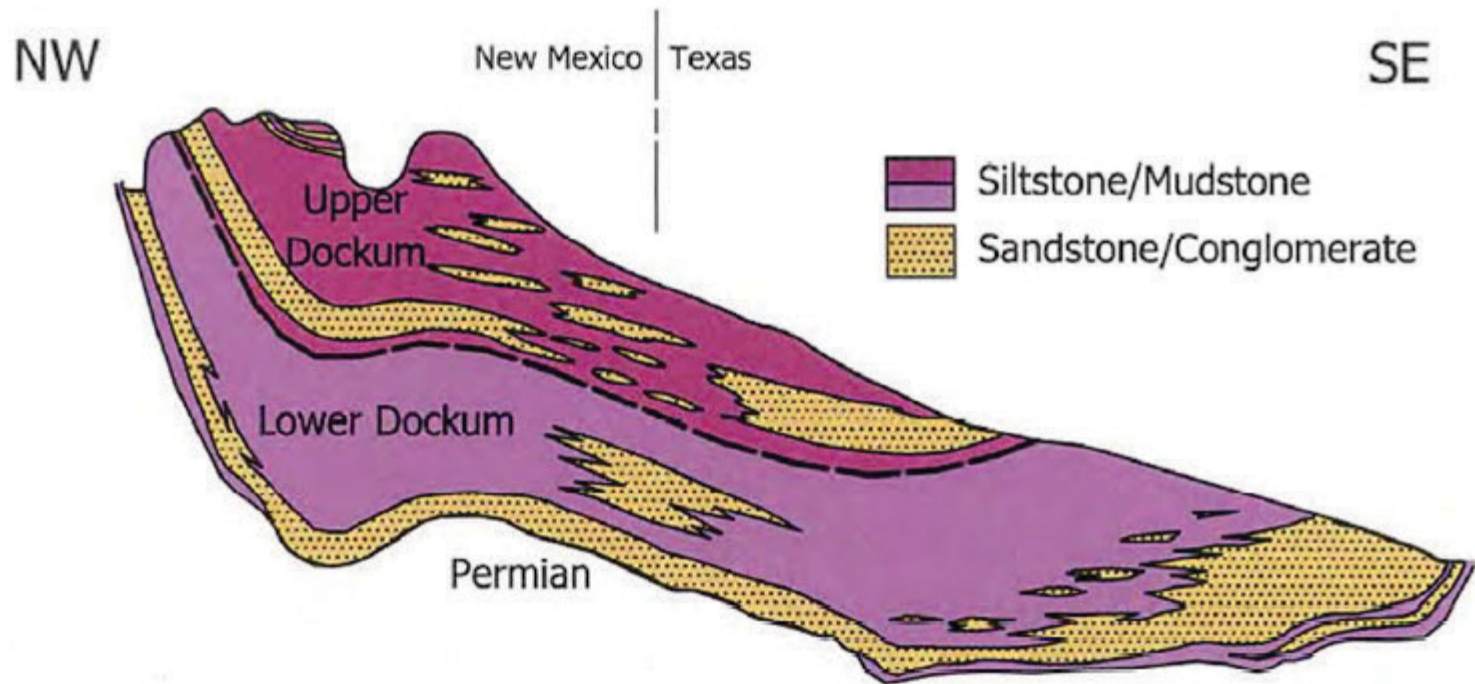


Figure 2.2.4 Schematic cross section of the Dockum Aquifer in New Mexico and Texas (modified from Ewing and others, 2008).

Geophysical Well Logs

Texas Tech University, *Jeffrey W. Martz, May 2008*

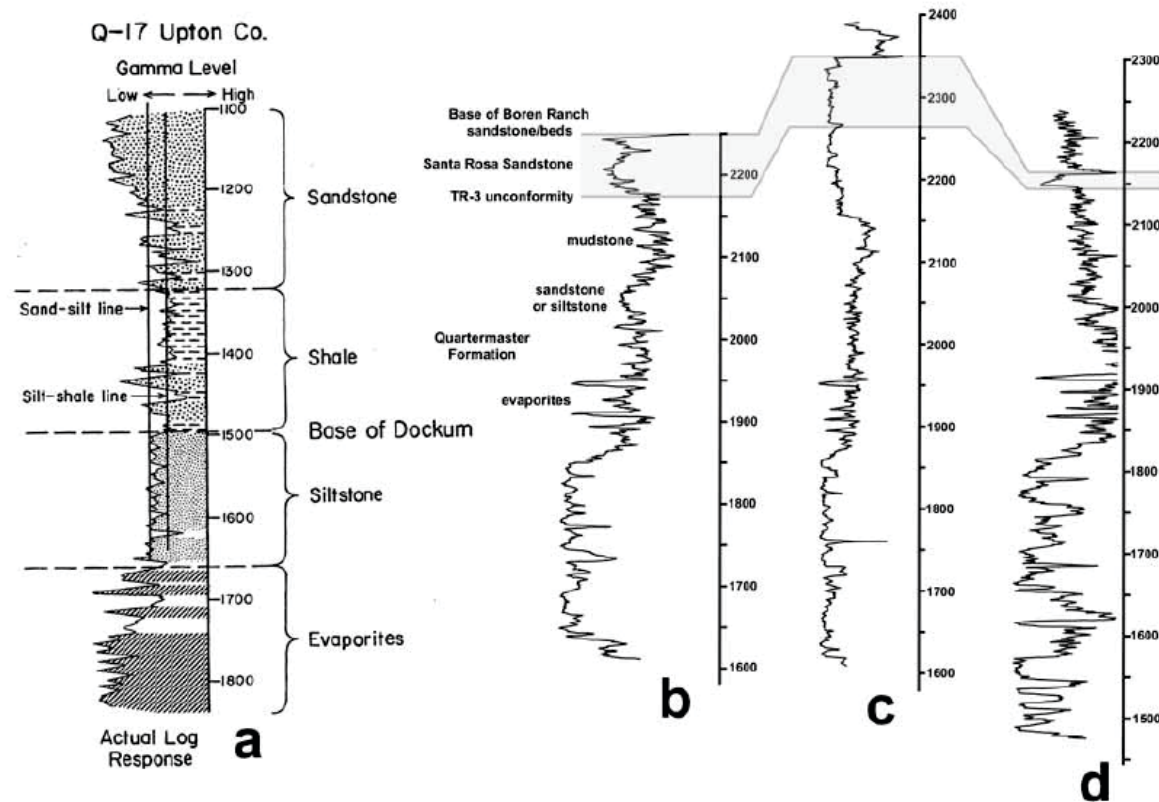


Fig. 2.32. The base of the Dockum Group in gamma-ray well logs: *a*, McGowan et al.'s (1979, fig. 32) identification of the base of the Dockum Group; *b-d* gamma-ray well logs in southern Garza County showing interpreted TR-3 unconformity, Santa Rosa Sandstone, and base of Boren Ranch Sandstone/beds; *b*, America Liberty Oil Company No. 7 I.N. McCrary; *c*, Bush Exploration No. A-2 Beggs 45; *d*, Humble Oil and Refining Company No. 1 Irene Rodgers.

Complex Lithologic Model

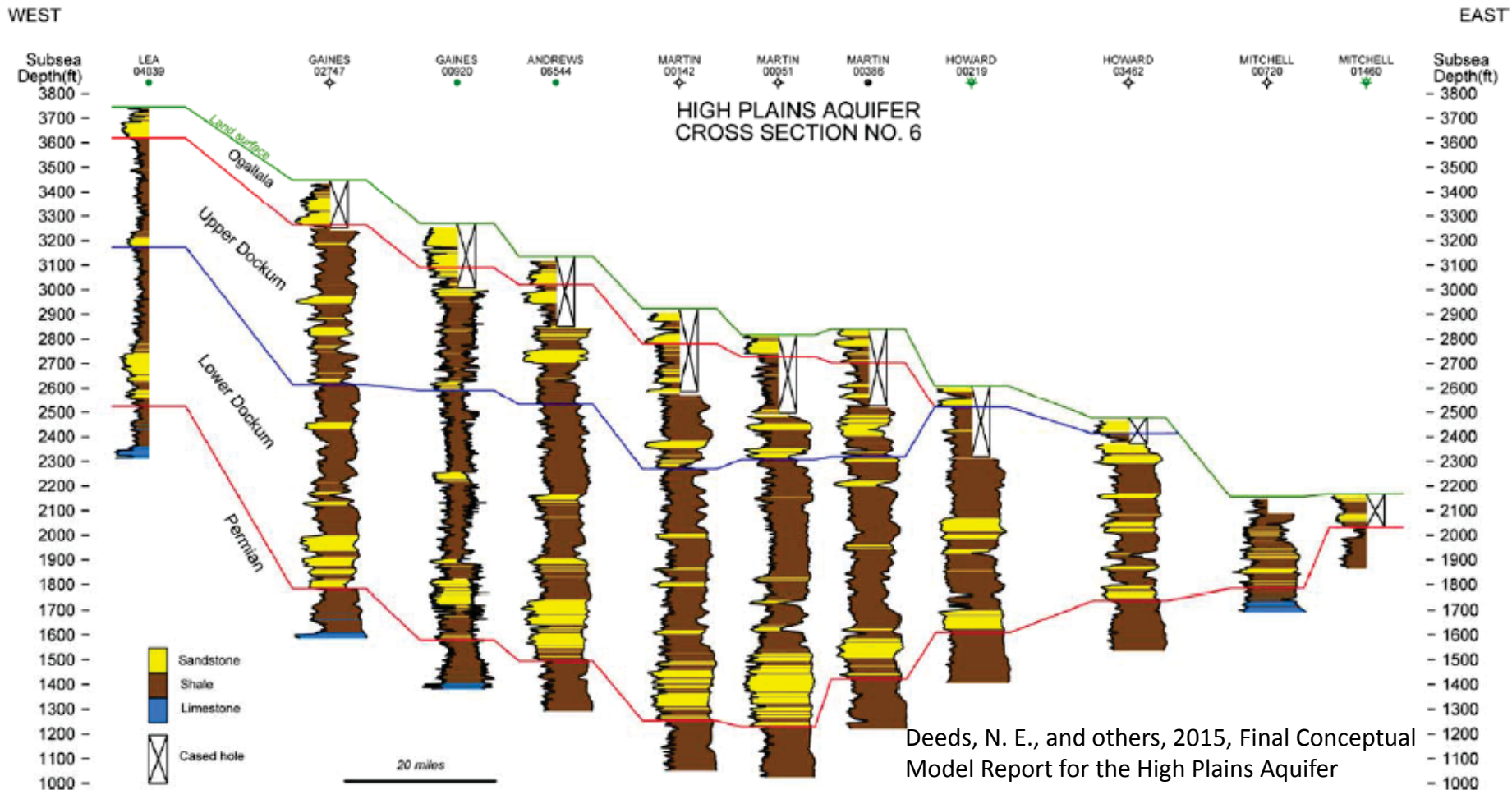
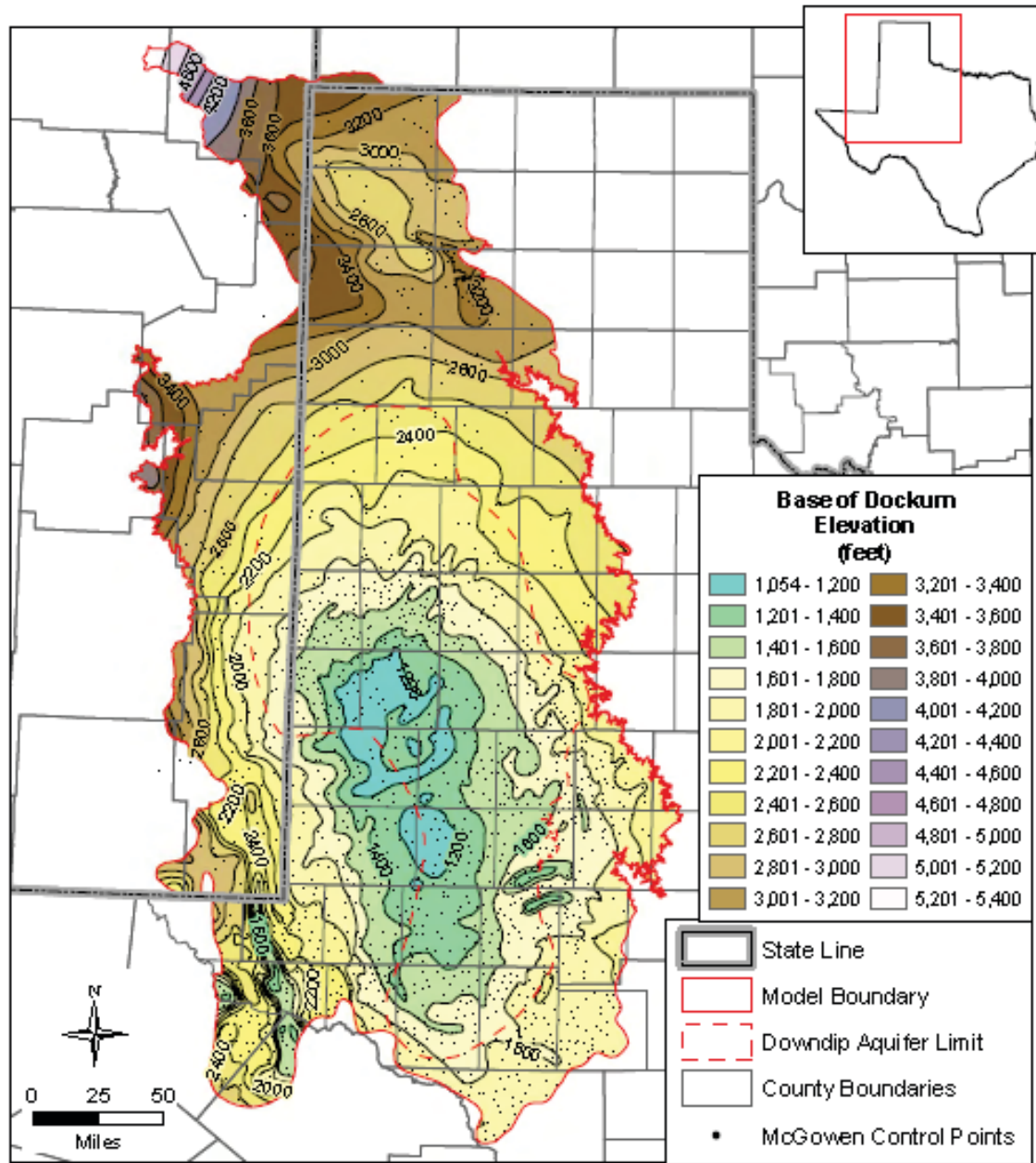


Figure 4.2.8 Cross-section #6.

Deeds, N. E., and others, 2015, Final Conceptual Model Report for the High Plains Aquifer System Groundwater Availability Model: report prepared for the TWDB.



Source: McGowen and others (1977)

Figure 4.2.2 Base of Dockum Aquifer.

- Base of Dockum generally follows trend of Permian Basin structural low

- Thickness of Dockum does not align with Permian Basin structure

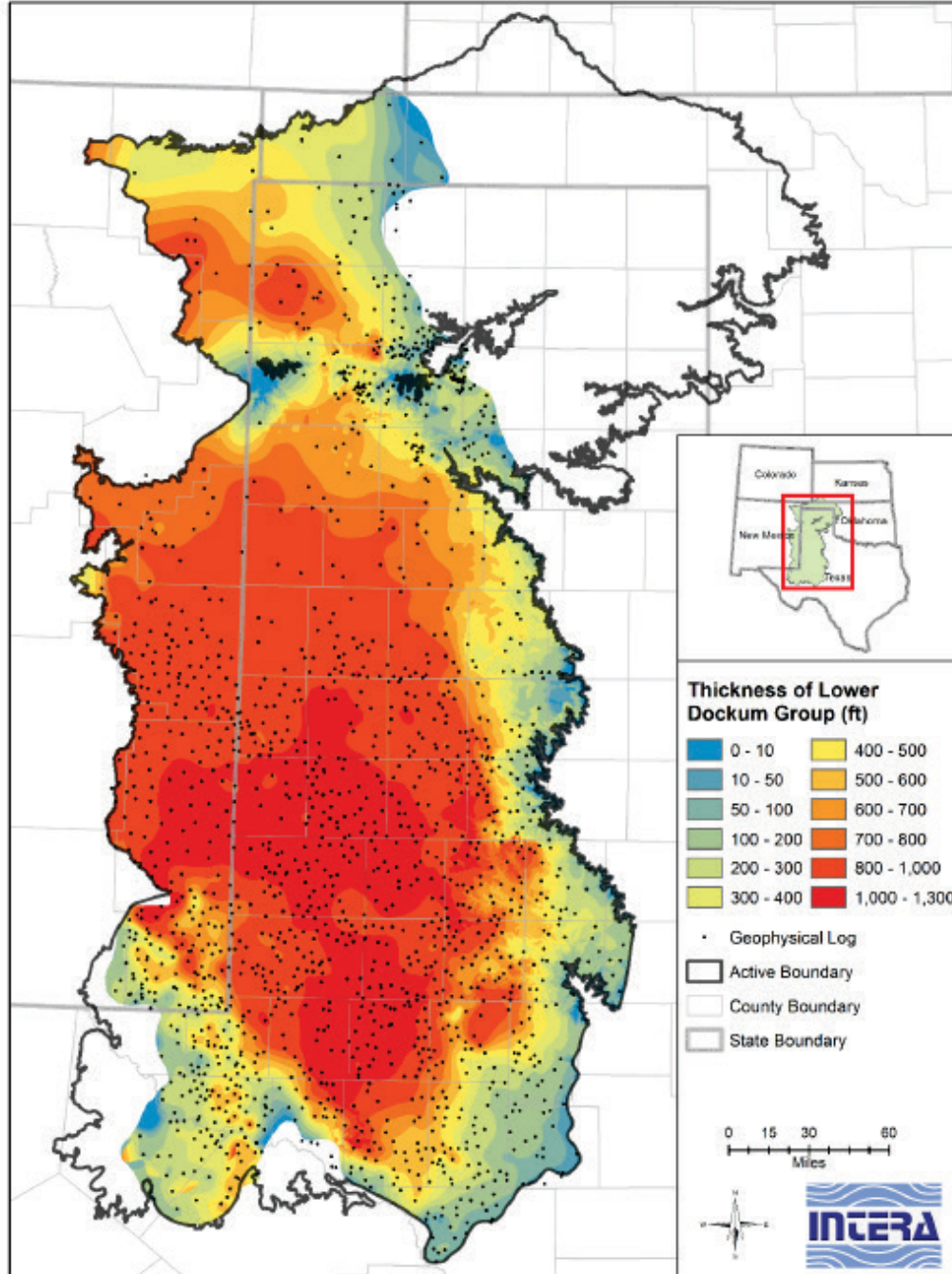


Figure 4.2.19 Thickness of the lower Dockum Group in feet

- Net sand map of “Upper Dockum”

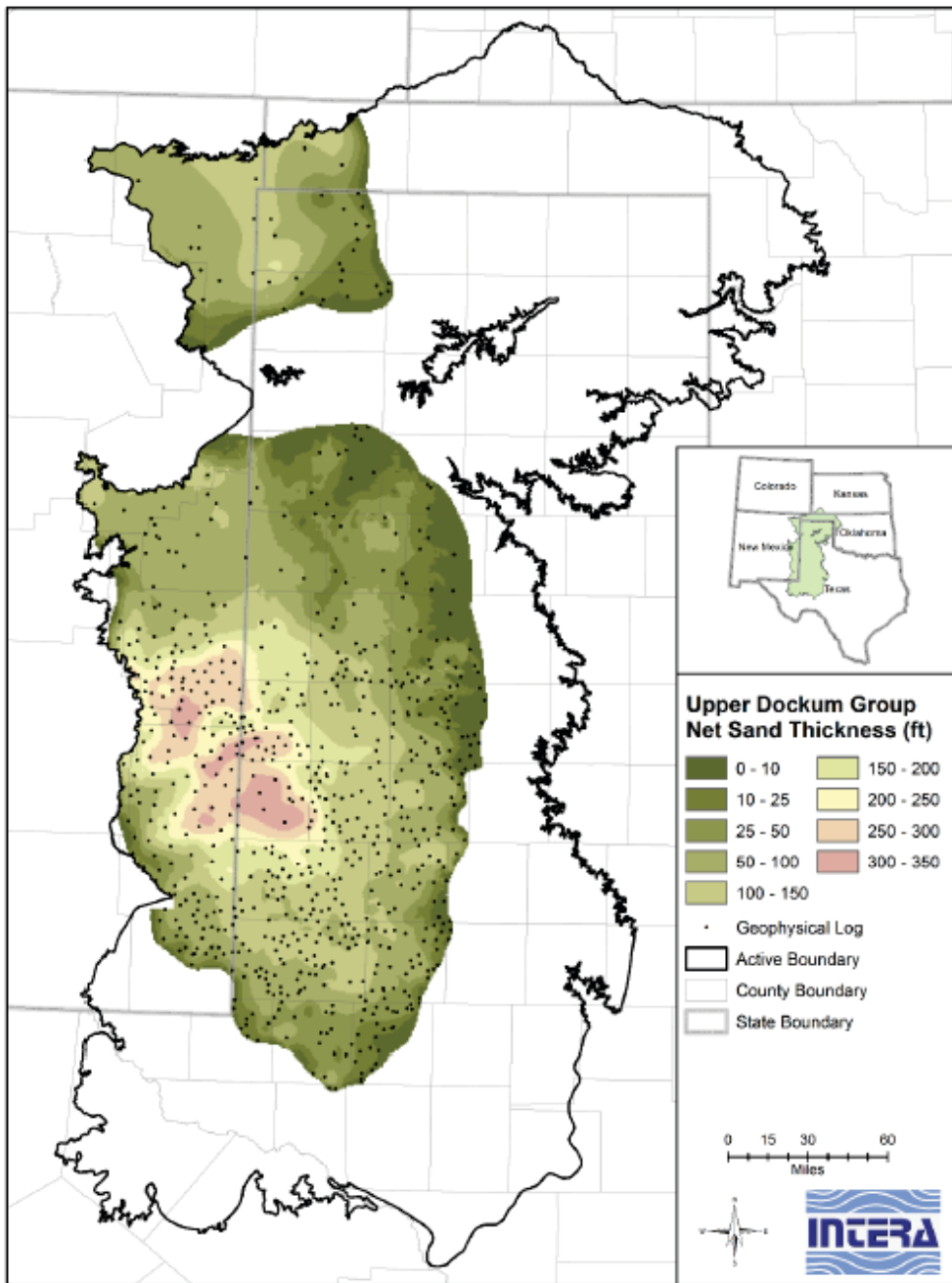
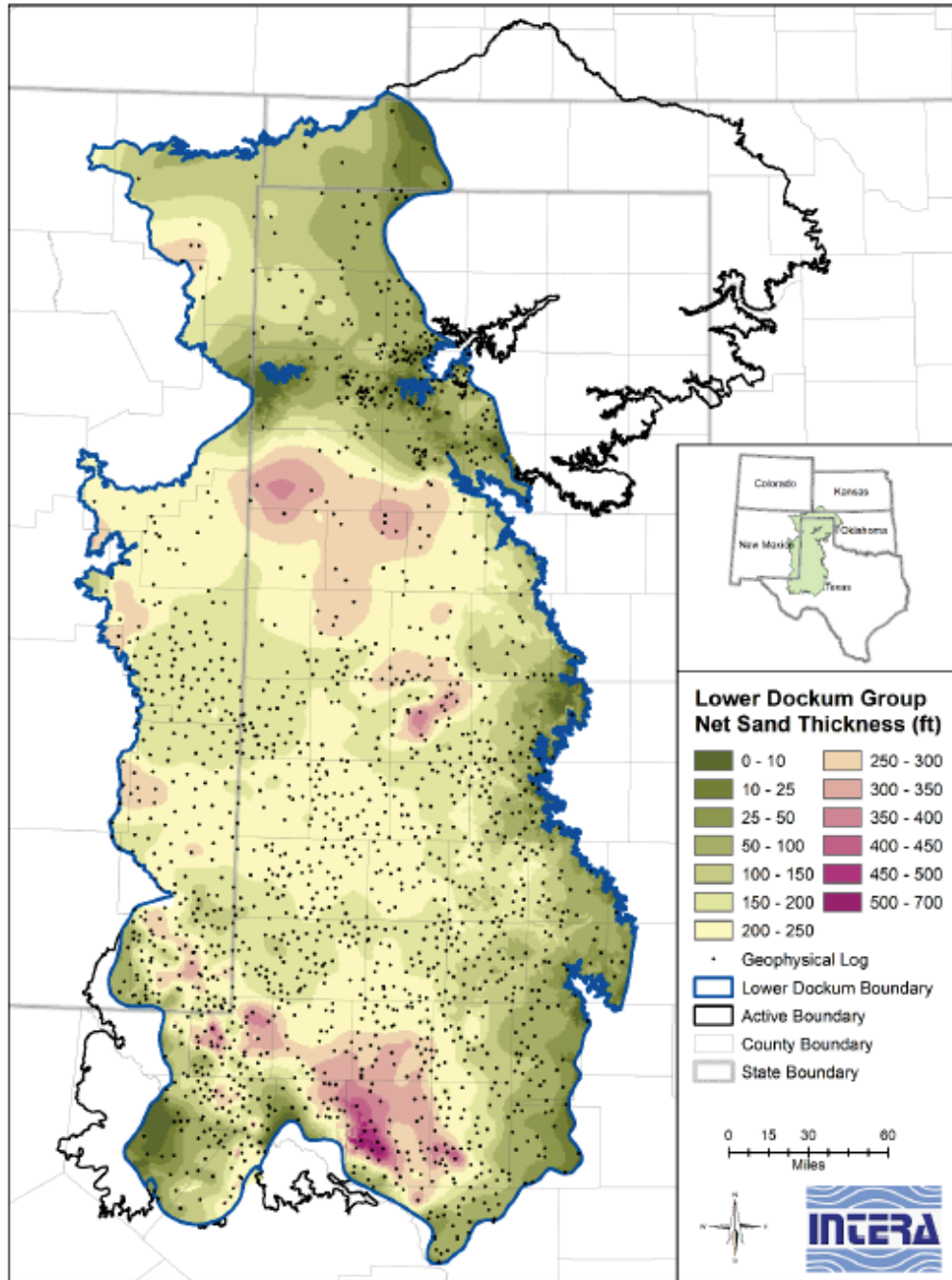


Figure 4.2.28 Net sand thickness of the upper Dockum Group in feet.

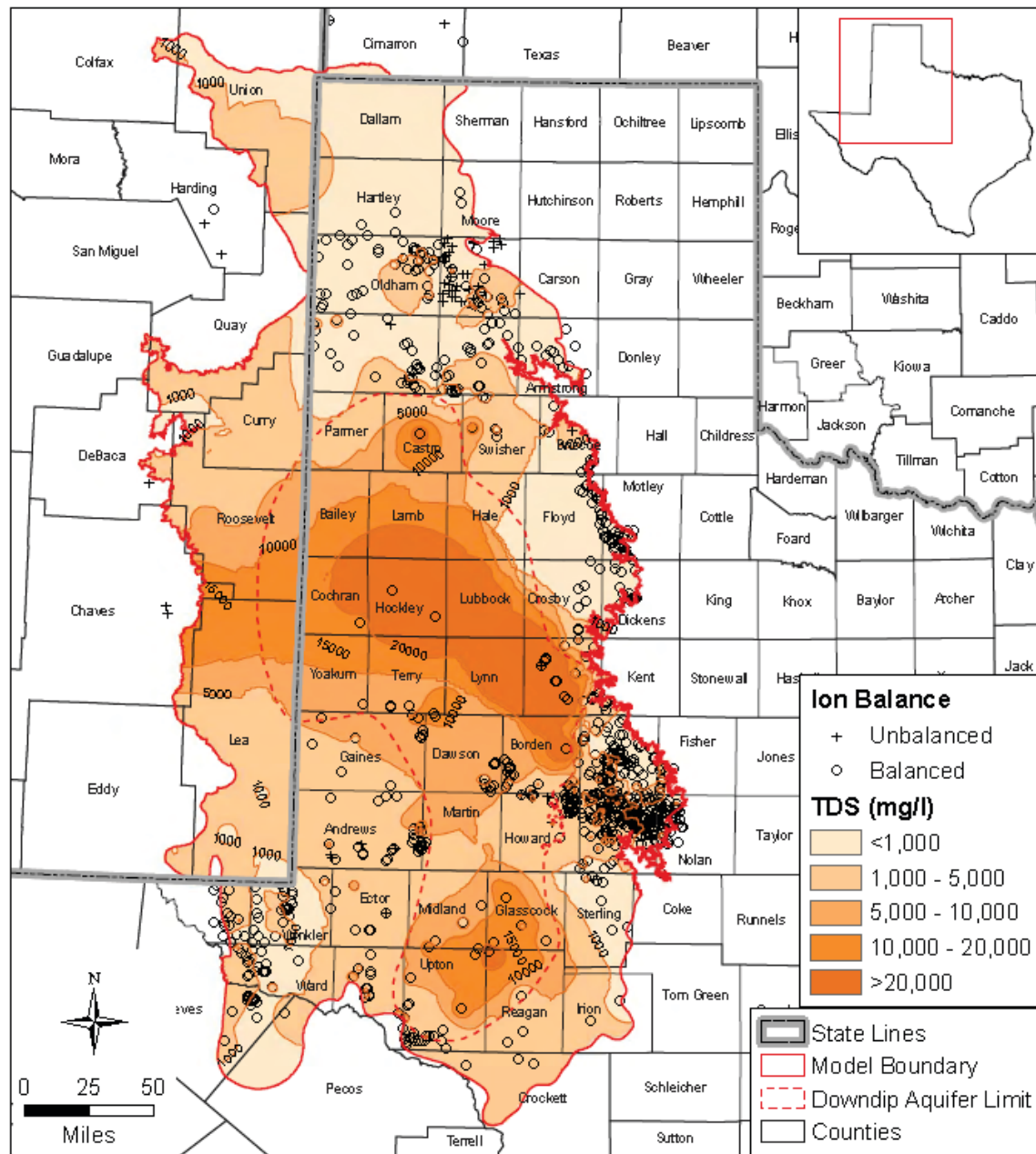
- Net sand map of “Lower Dockum”



Deeds, N. E., and others, 2015, Final Conceptual Model Report for the High Plains Aquifer System Groundwater Availability Model: report prepared for the TWDB.

Figure 4.2.29 Net sand thickness of the lower Dockum Group in feet.

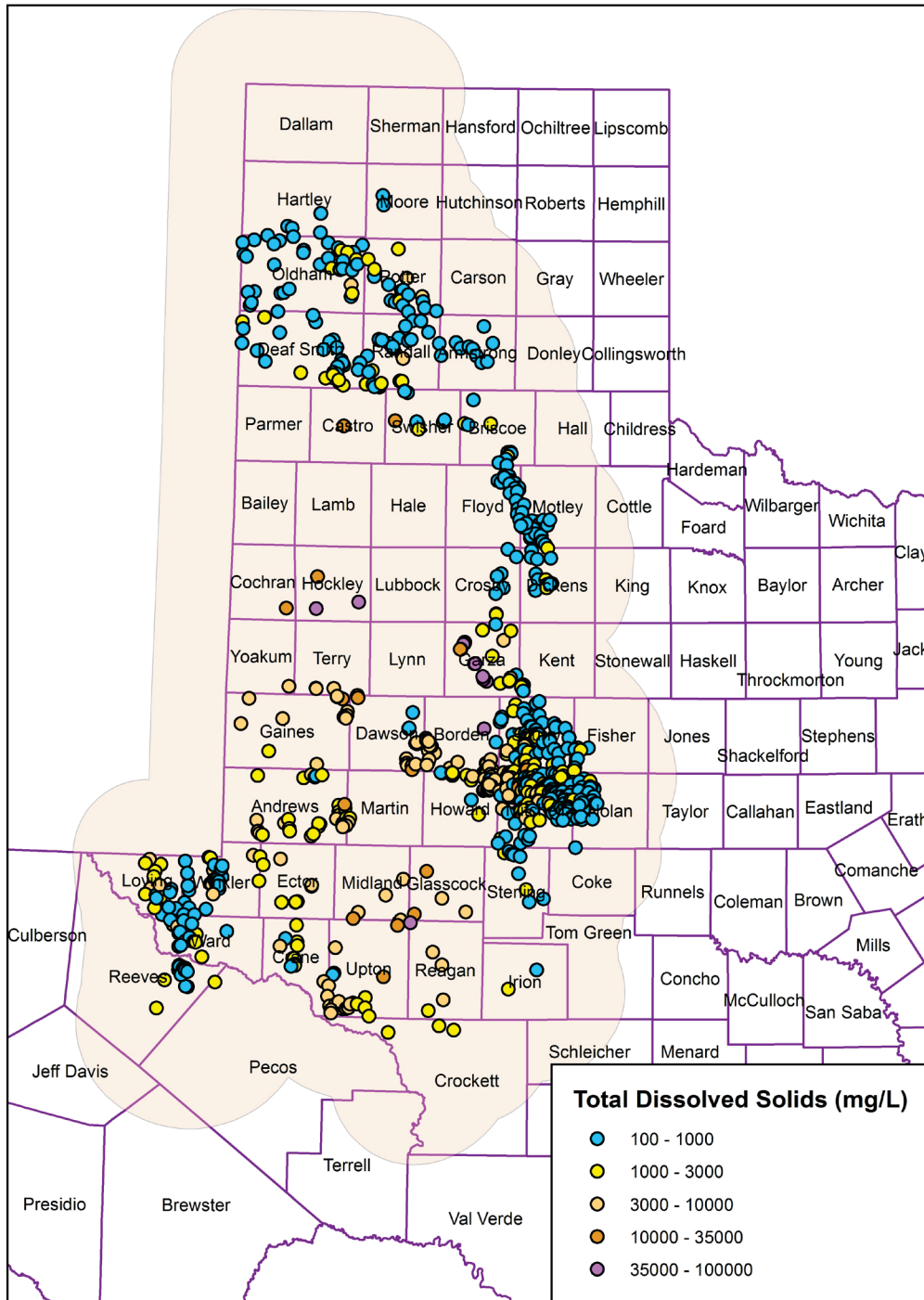
- Total dissolved solids from GAM study



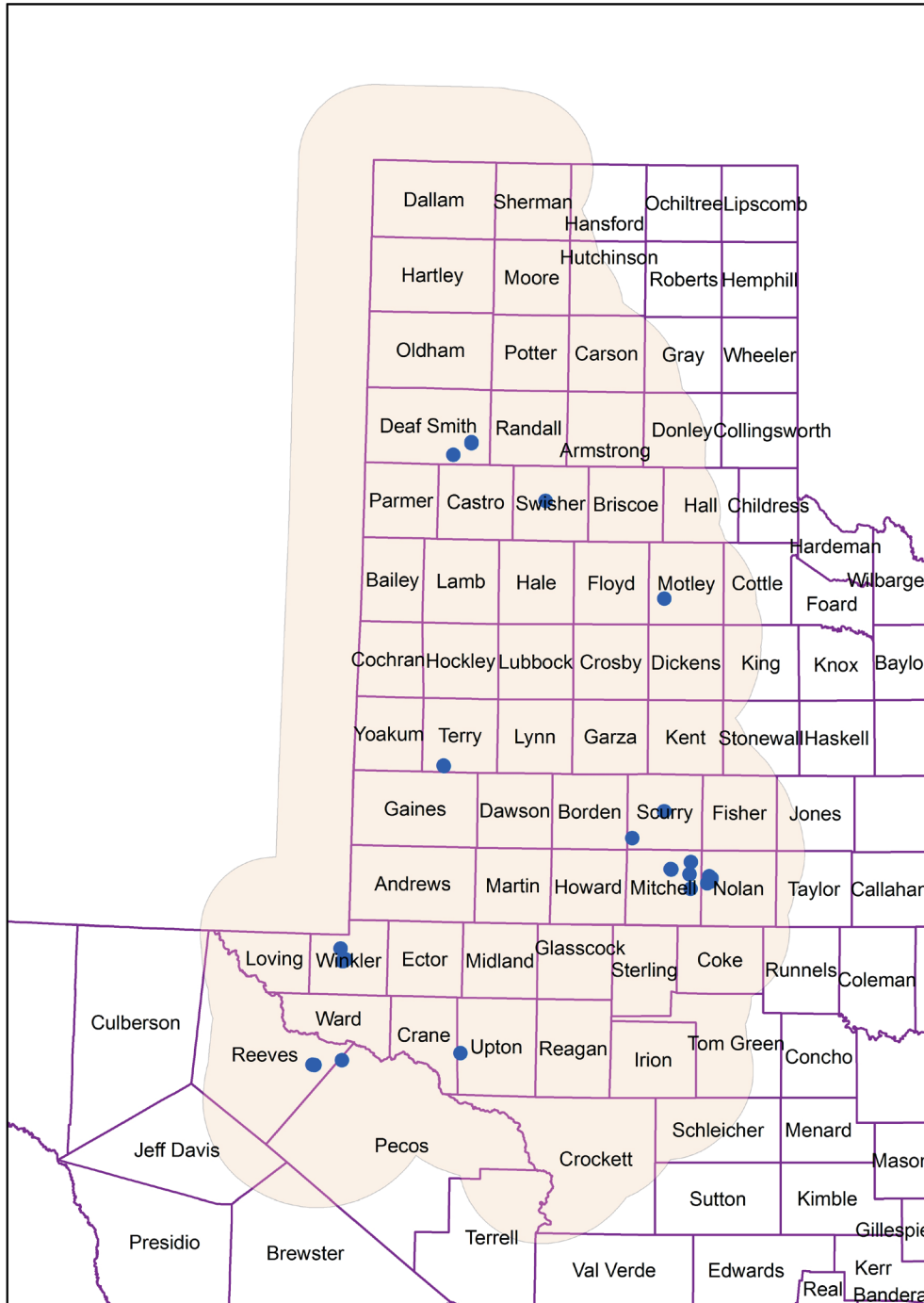
Source: TWDB, Panhandle GCD; USGS/New Mexico; Hart and others (1976)

Figure 4.8.1 Total dissolved solids concentrations in milligrams per liter in groundwater in the Dockum Aquifer.

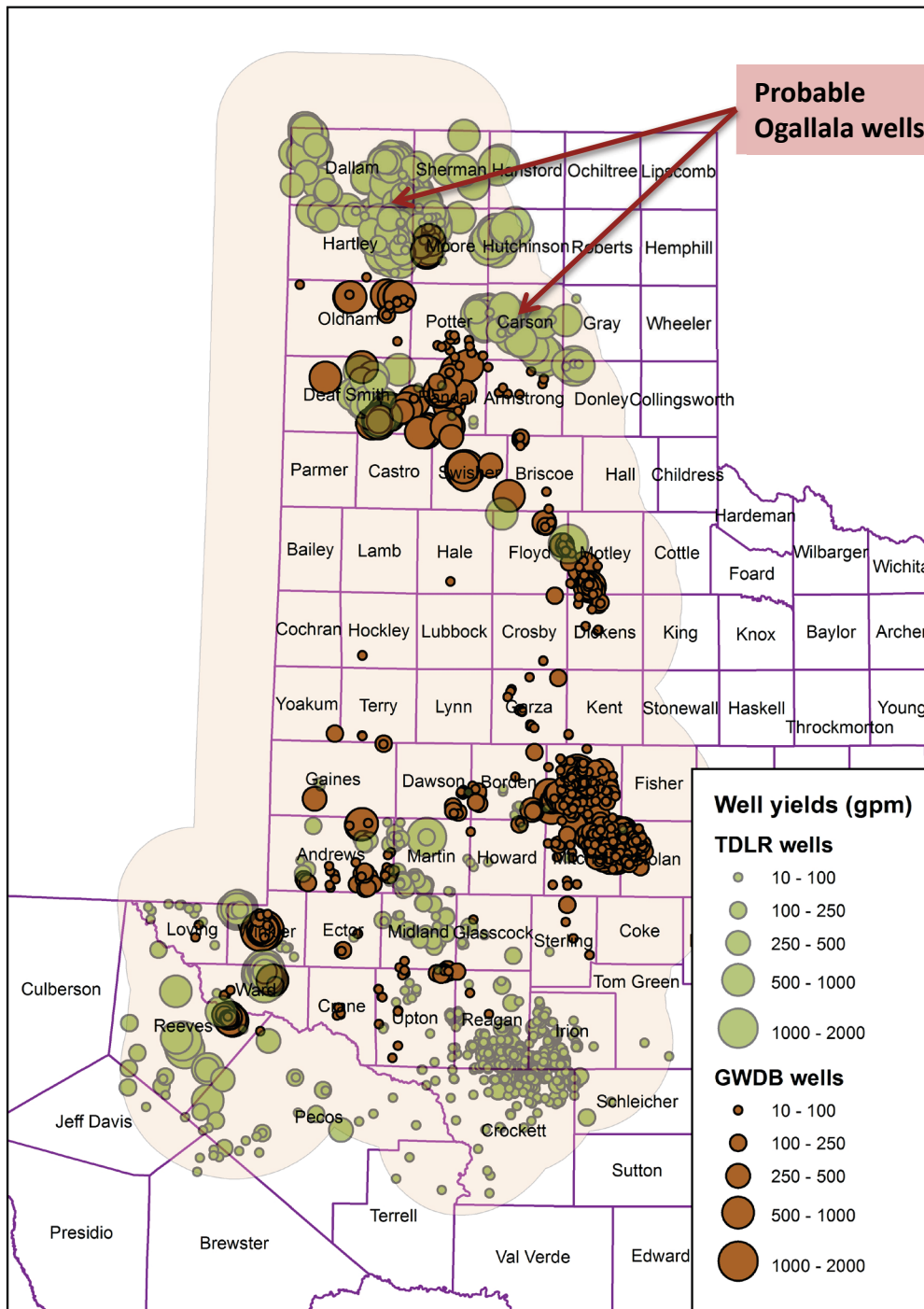
- Total dissolved solids from TWDB Groundwater Database



- Transmissivities derived from aquifer tests in the TWDB Groundwater Database



- Yields derived from aquifer tests in the TWDB Groundwater Database



Stakeholder Input

- Additional Dockum Well Data
 - Aquifer Tests
 - Water chemistry
- Injection well data
- Current use

Next Steps:

~1.5-2 year study

- Additional Kickoff stakeholder meeting (Lubbock)
- Map stratigraphy, lithology, measured water quality, calculated water quality, aquifer properties, and existing use
- Calculate the volume of fresh, slightly saline, moderately saline, and very saline groundwater
- Proposed production area (PPA) analysis stakeholder meeting
- PPA impact analysis (modeling)
- Final report(s), study completion meeting, and stakeholder comment solicitation
- Board possibly designates brackish groundwater production zones (BGPZ)

Edwards-Trinity Plateau Aquifer

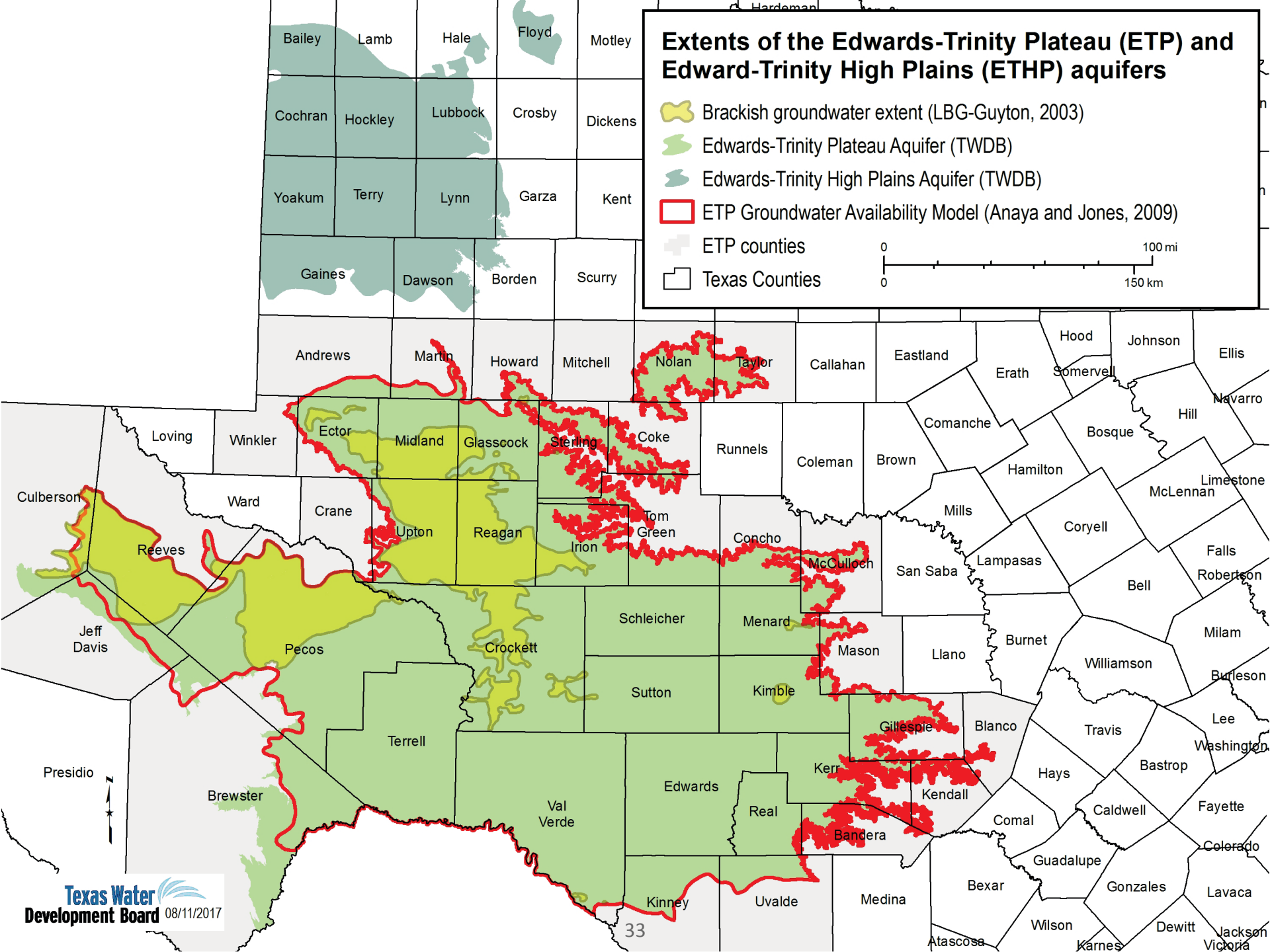
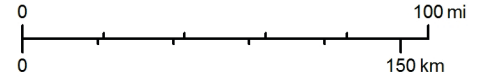


Aquifer Overview

- Limestones and Dolostones of the Edwards Group and sands of the Trinity Group
- Elevation from <1,000 to >4,500 feet above mean sea level
- Average freshwater thickness 433 feet
- Current extent TDS 100-3,000 mg/L
- Intersects:
 - 41 Texas Counties
 - 30 Groundwater Conservation Districts
 - 6 Groundwater Management Areas
 - 6 Regional Water Planning Groups

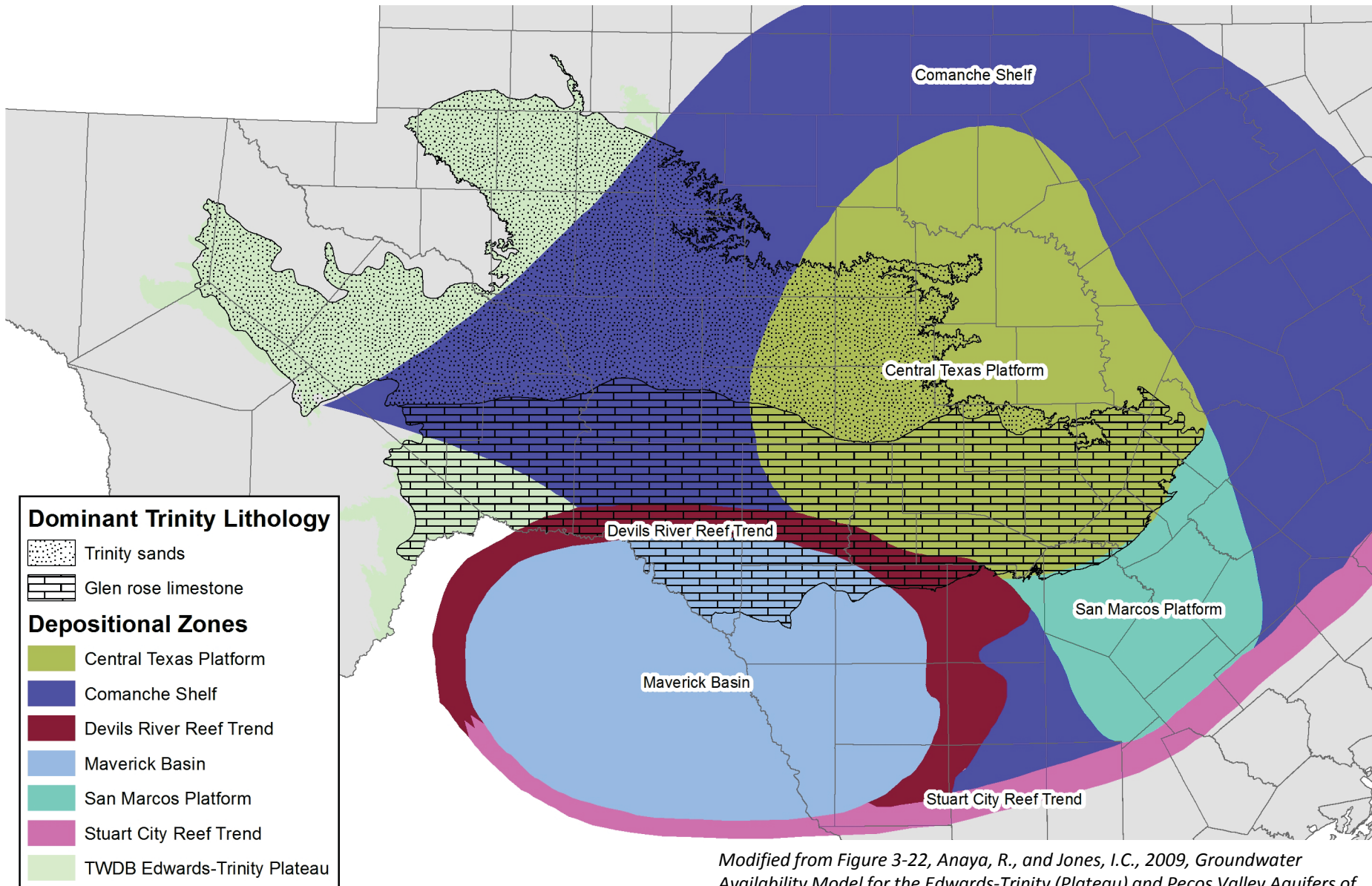
Extents of the Edwards-Trinity Plateau (ETP) and Edward-Trinity High Plains (ETHP) aquifers

- Brackish groundwater extent (LBG-Guyton, 2003)
- Edwards-Trinity Plateau Aquifer (TWDB)
- Edwards-Trinity High Plains Aquifer (TWDB)
- ETP Groundwater Availability Model (Anaya and Jones, 2009)
- ETP counties
- Texas Counties



Hydrogeology Overview

Depositional Zones



Modified from Figure 3-22, Anaya, R., and Jones, I.C., 2009, Groundwater Availability Model for the Edwards-Trinity (Plateau) and Pecos Valley Aquifers of Texas, Texas Water Development Board Report 373

Regional Stratigraphic Nomenclature

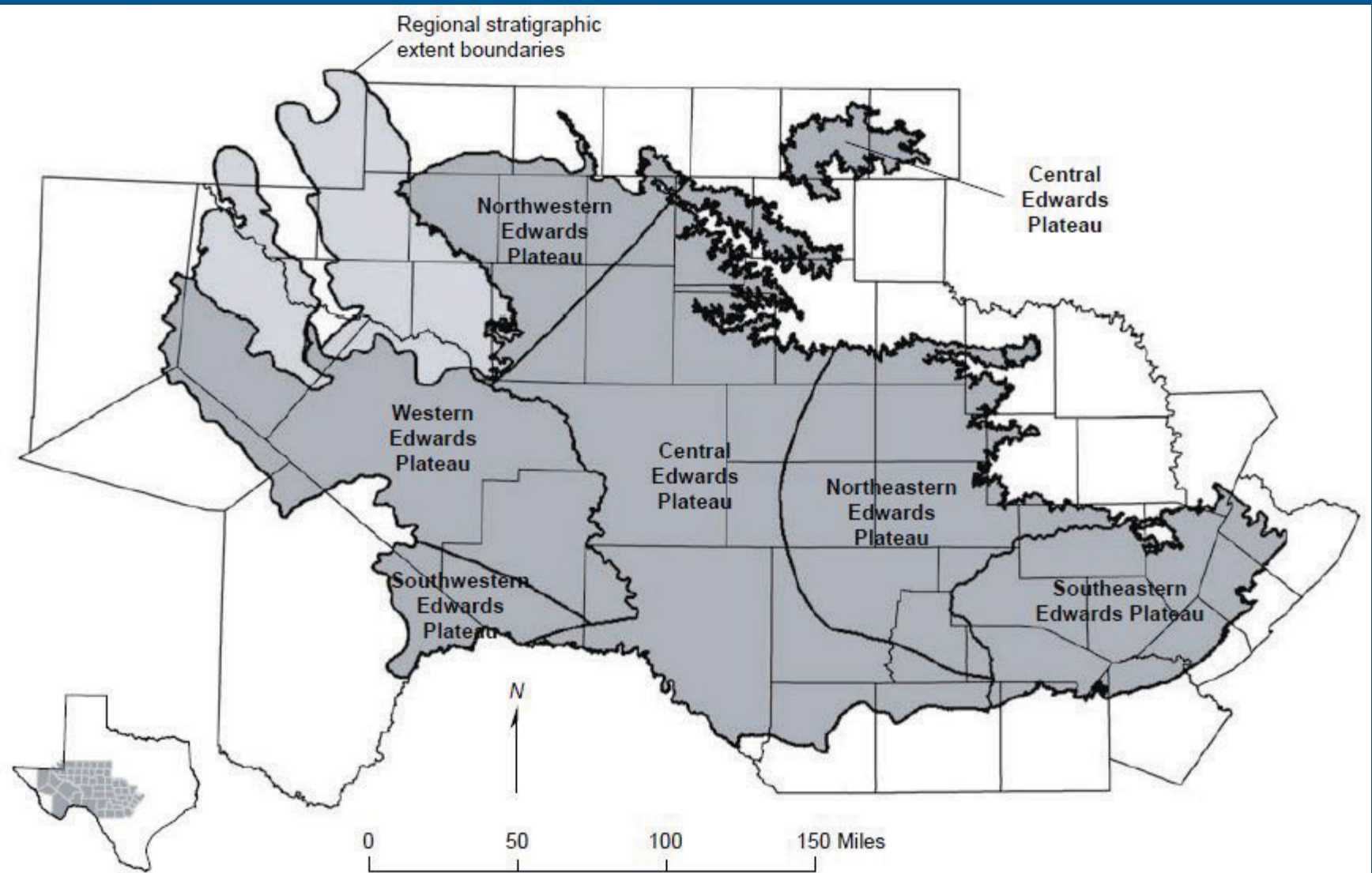


Figure 5-1. Regional extents of stratigraphic nomenclature for the Edwards-Trinity (Plateau), Pecos Valley, and Trinity (Hill Country) aquifer systems.

Regional Stratigraphic Nomenclature

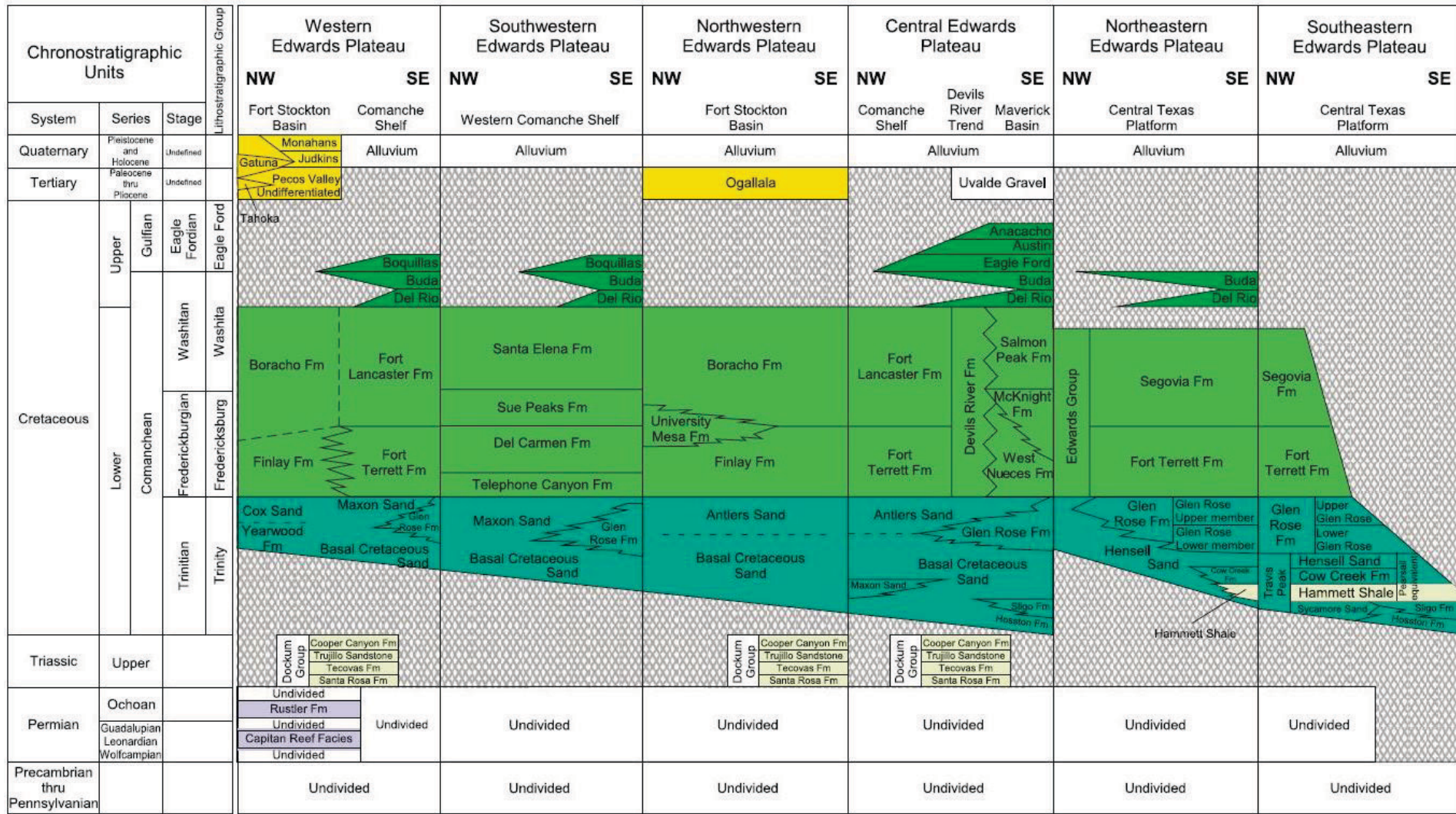
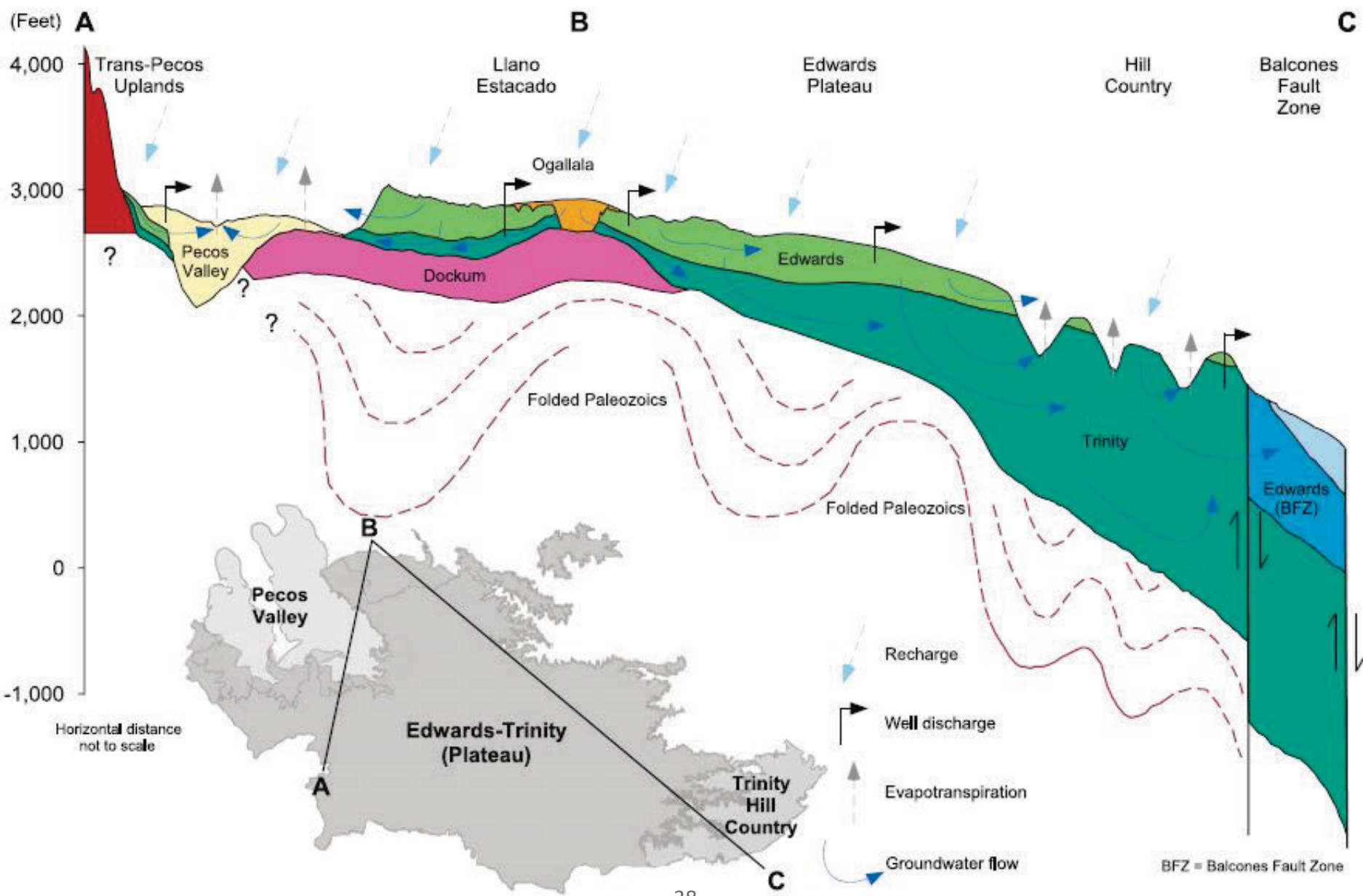


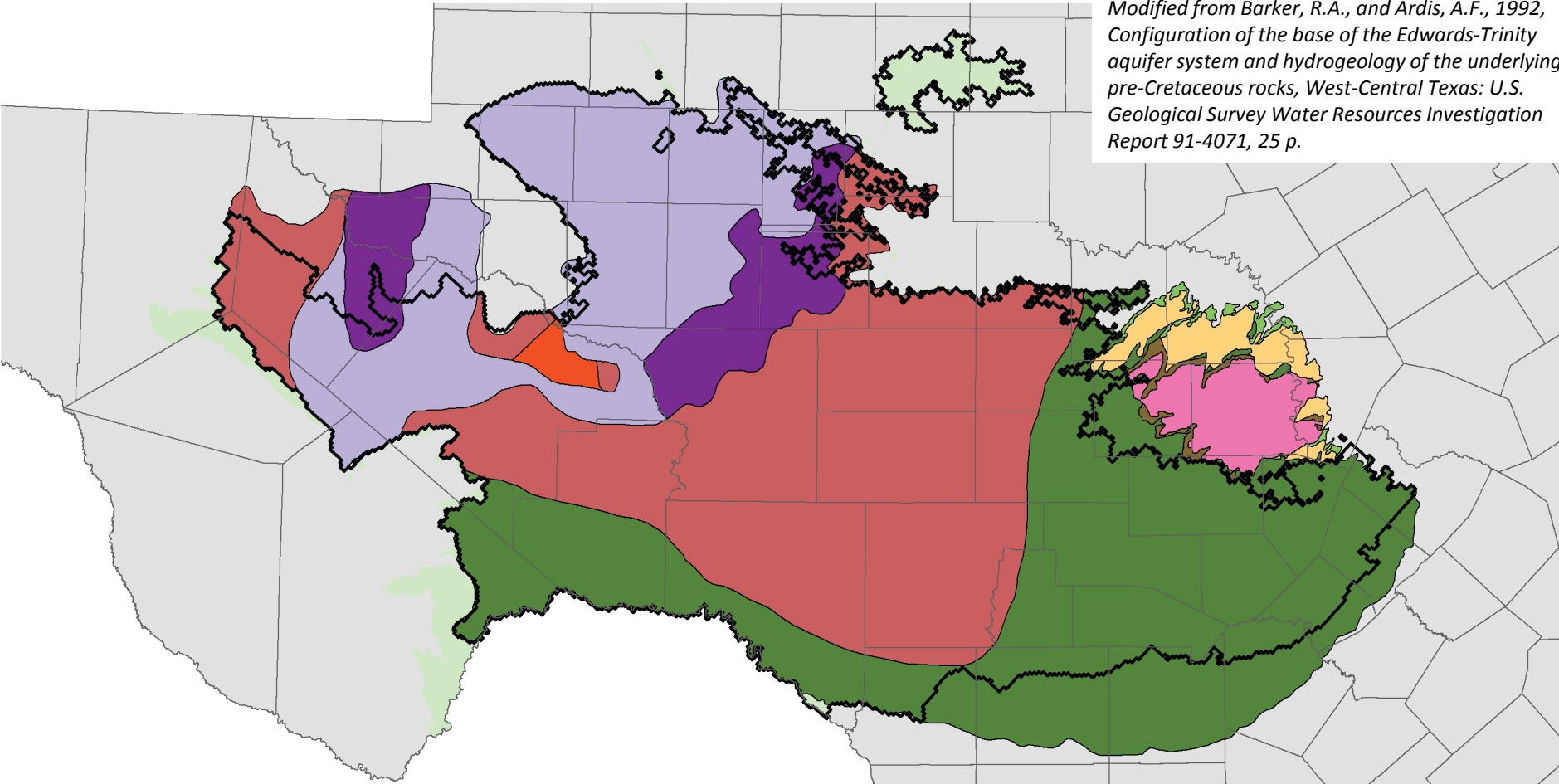
Figure 5-2. Stratigraphic chart of the Edwards-Trinity (Plateau) and Pecos Valley aquifers and the Hill Country part of the Trinity Aquifer (modified from Barker and Ardis, 1996). Fm= formation

Conceptual Cross Section: Report 373














Variable Platform Base

Modified from Barker, R.A., and Ardis, A.F., 1992, Configuration of the base of the Edwards-Trinity aquifer system and hydrogeology of the underlying pre-Cretaceous rocks, West-Central Texas: U.S. Geological Survey Water Resources Investigation Report 91-4071, 25 p.

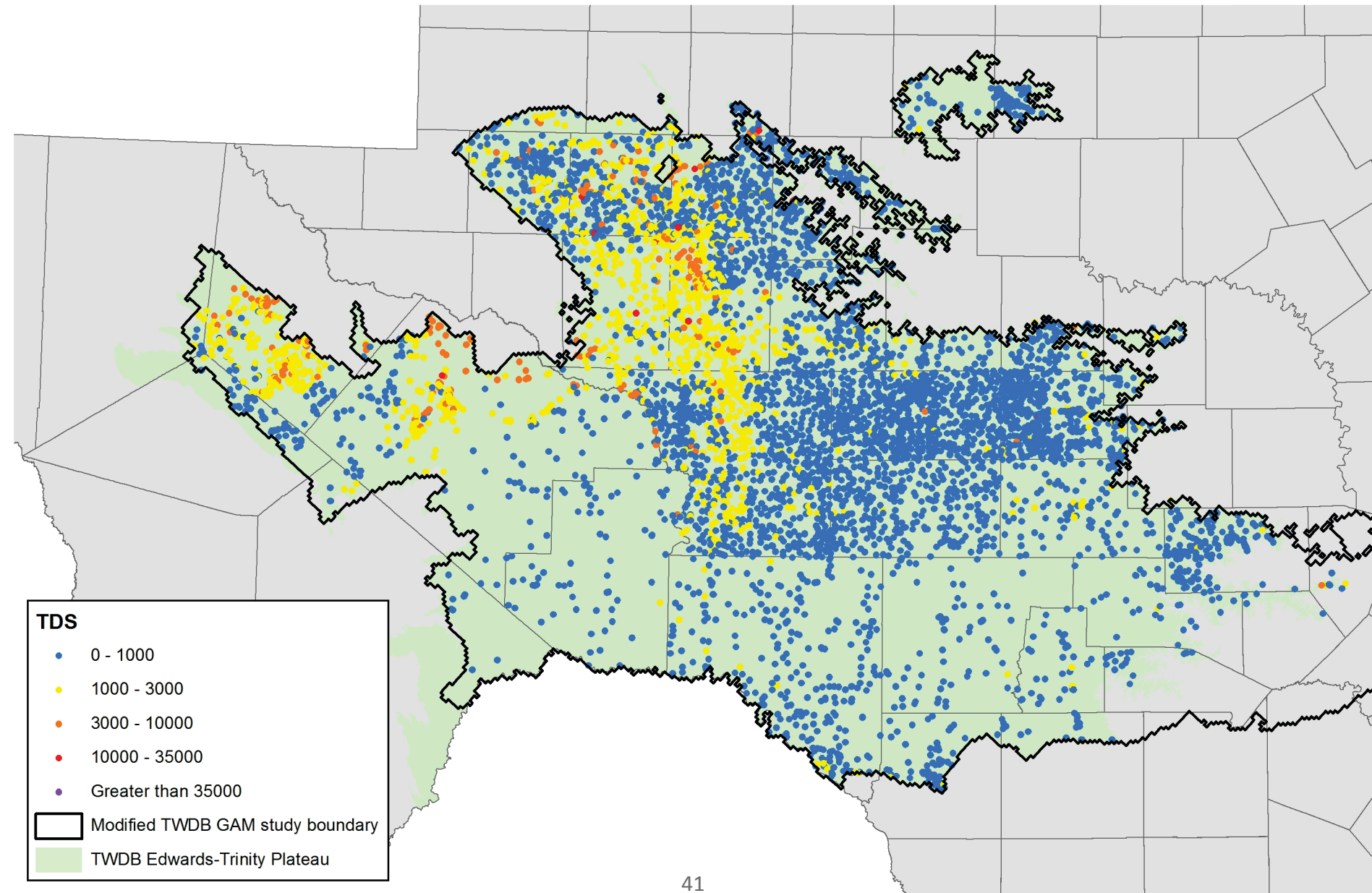


Cretaceous base contacts

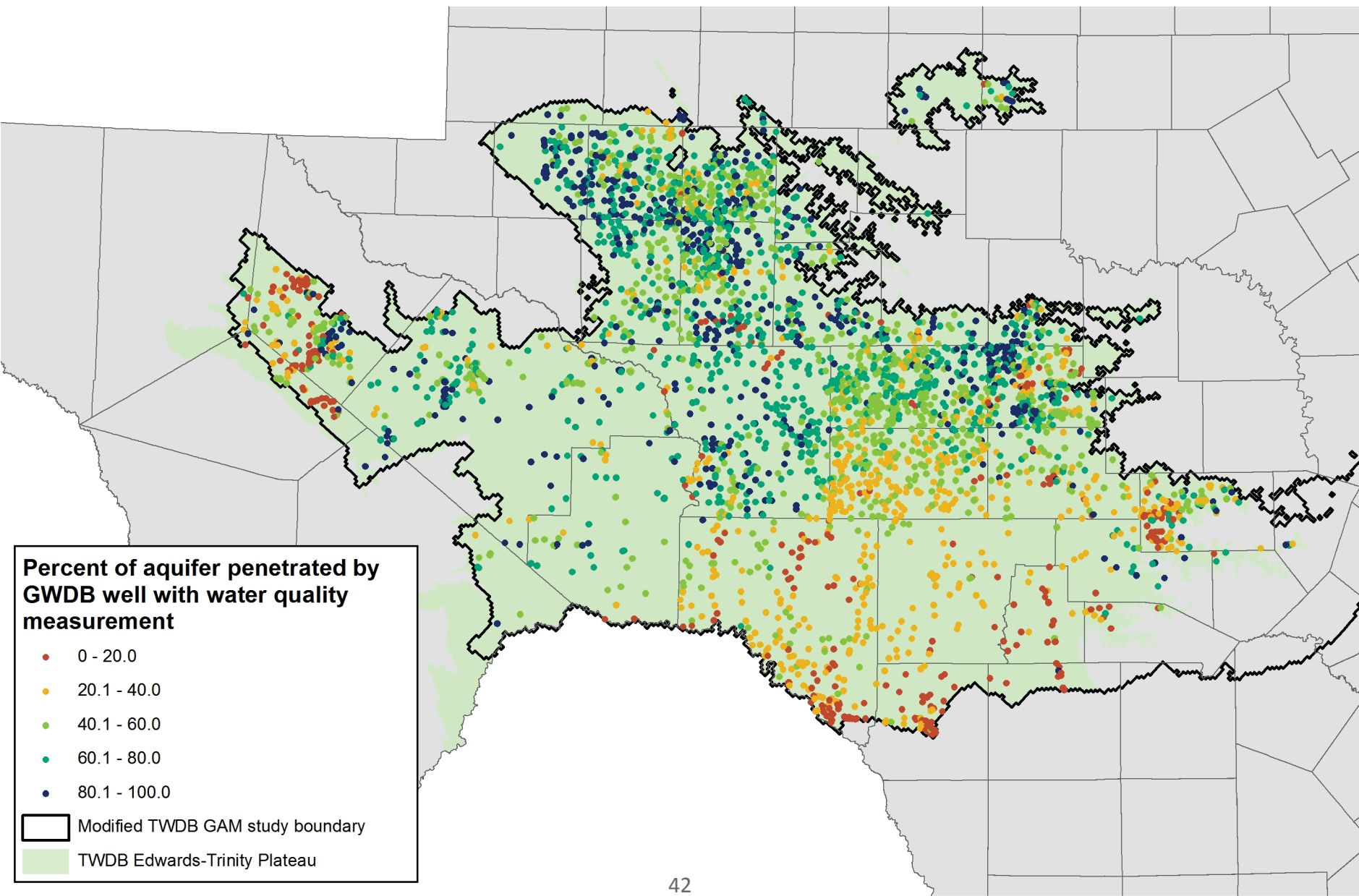
- | | | |
|--|---|--|
|  Triassic rocks |  Cambrian through Pennsylvanian rocks |  Modified TWDB GAM study boundary |
|  Triassic Rocks - Dockum Aquifer |  Cambrian through Pennsylvanian rocks - Ellenburger San-Saba Aquifer |  TWDB Edwards-Trinity Plateau |
|  Permian rocks |  Cambrian through Pennsylvanian rocks - Hickory Aquifer | |
|  Permian rocks - Salado or Rustler Aquifer |  Cambrian through Pennsylvanian rocks - Marble Falls Aquifer | |
| |  Precambrian Rocks | |

Data Collected and Data Gaps

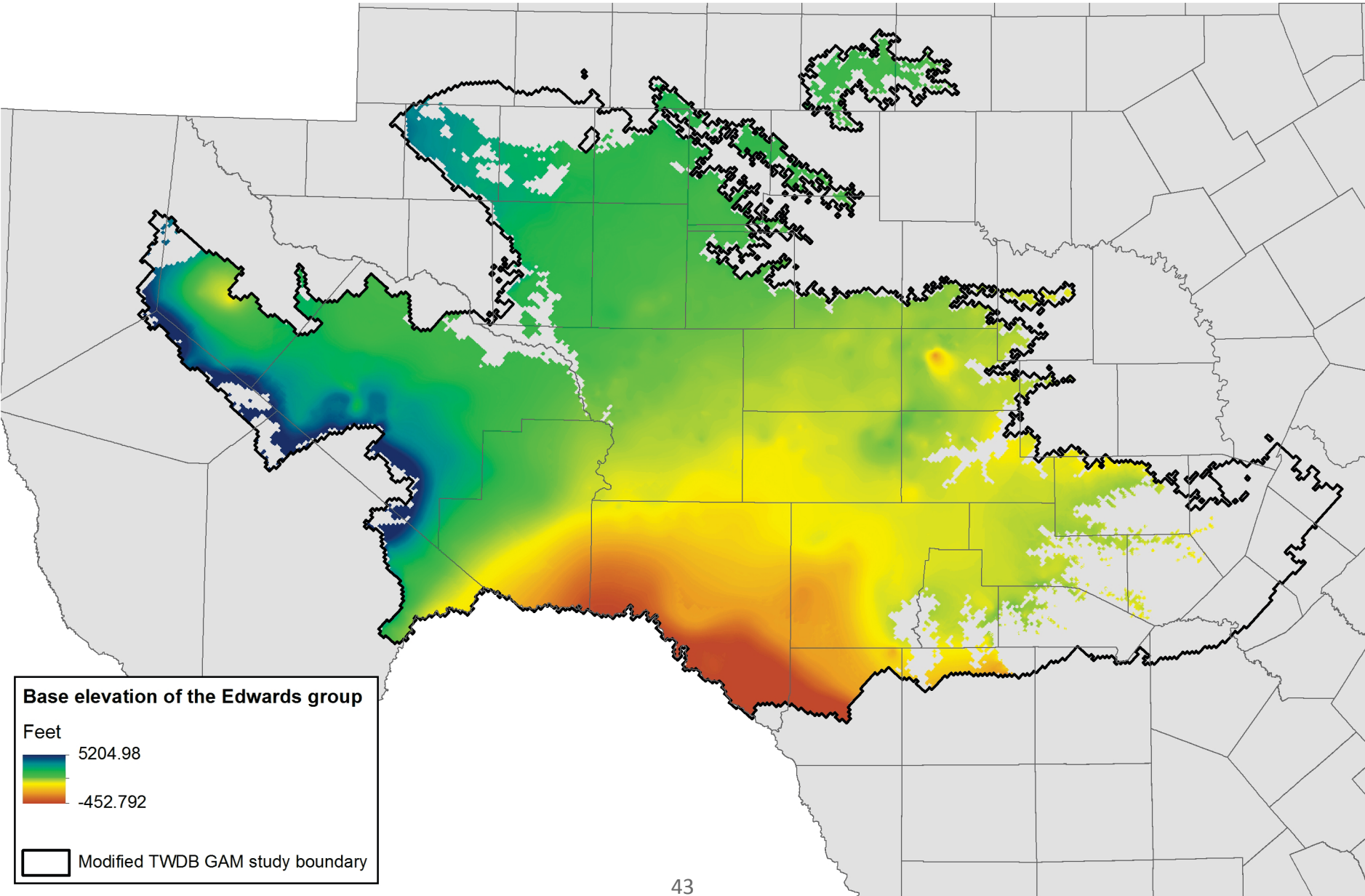
TWDB Groundwater Database



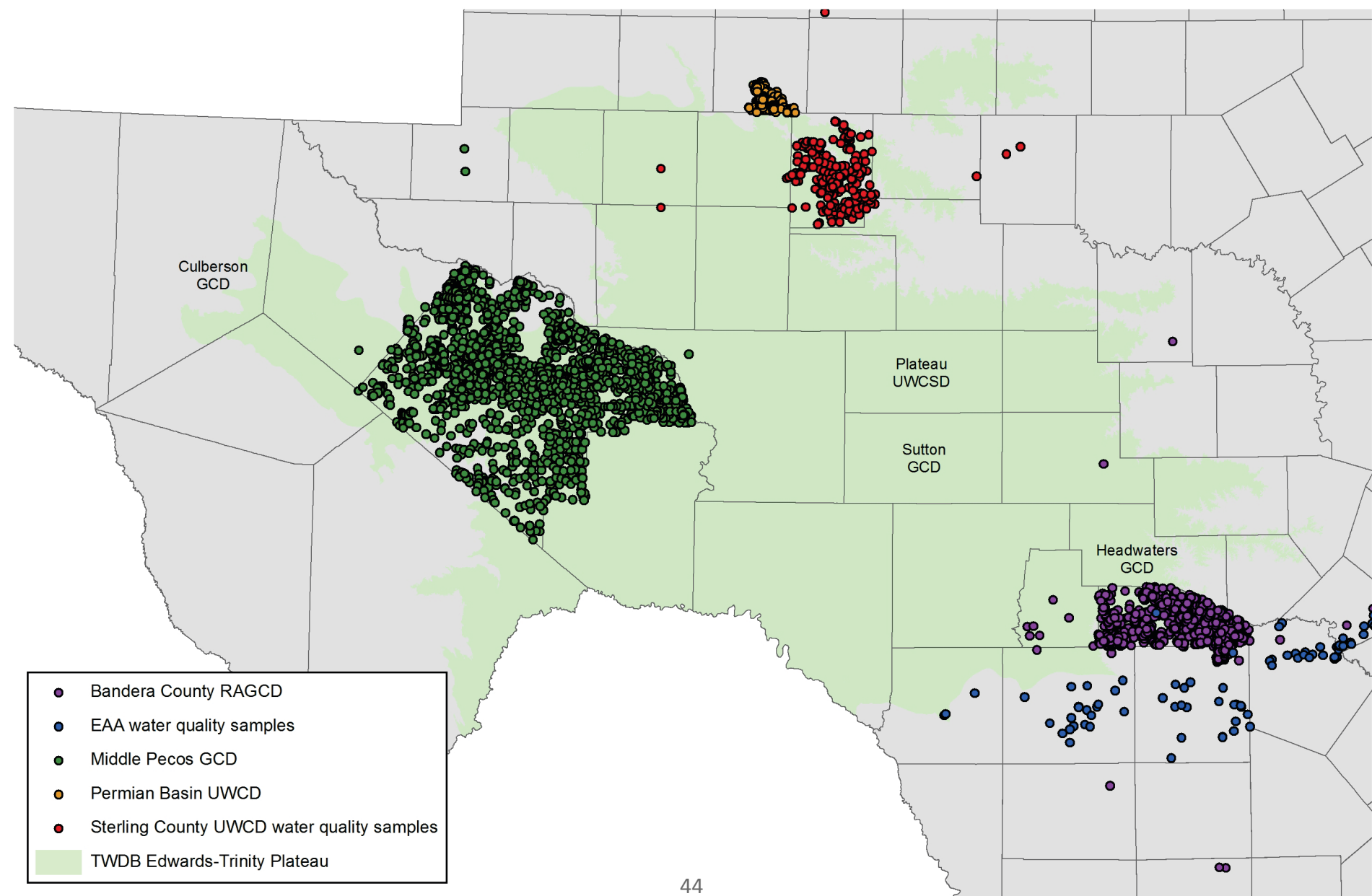
TWDB Groundwater Database



TWDB Groundwater Availability Model

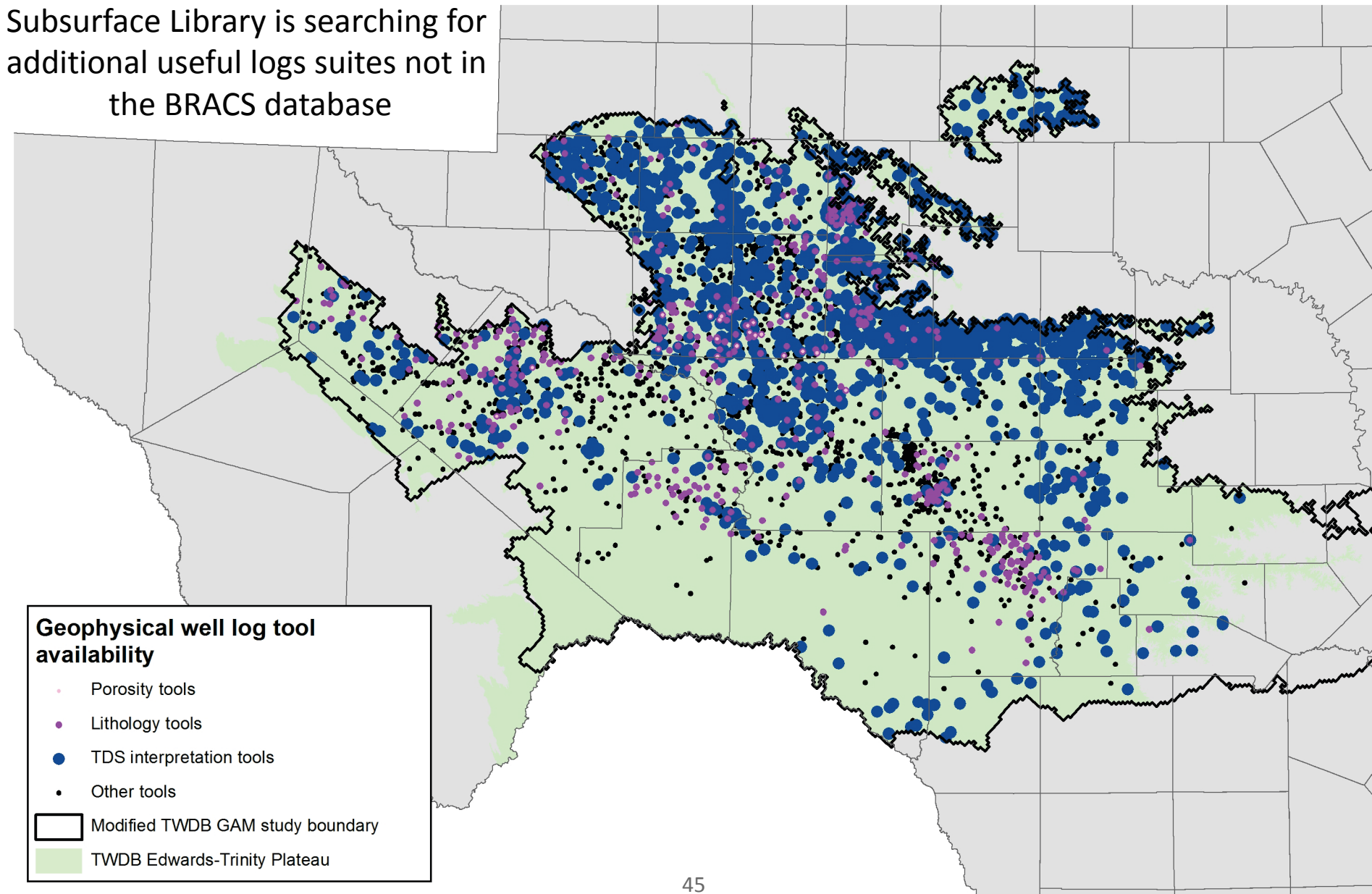


Submitted Stakeholder Data

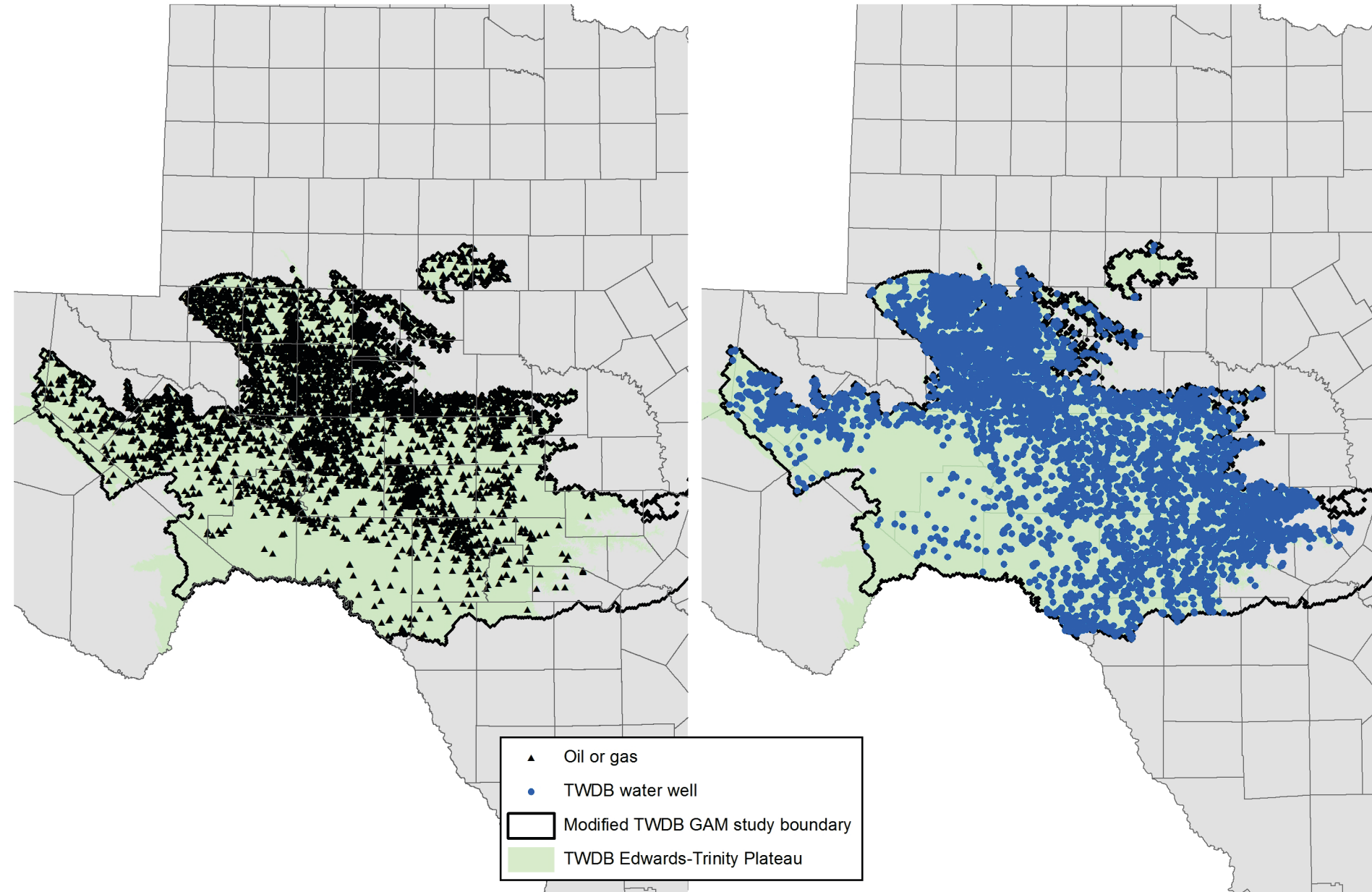


Public Geophysical Well Logs

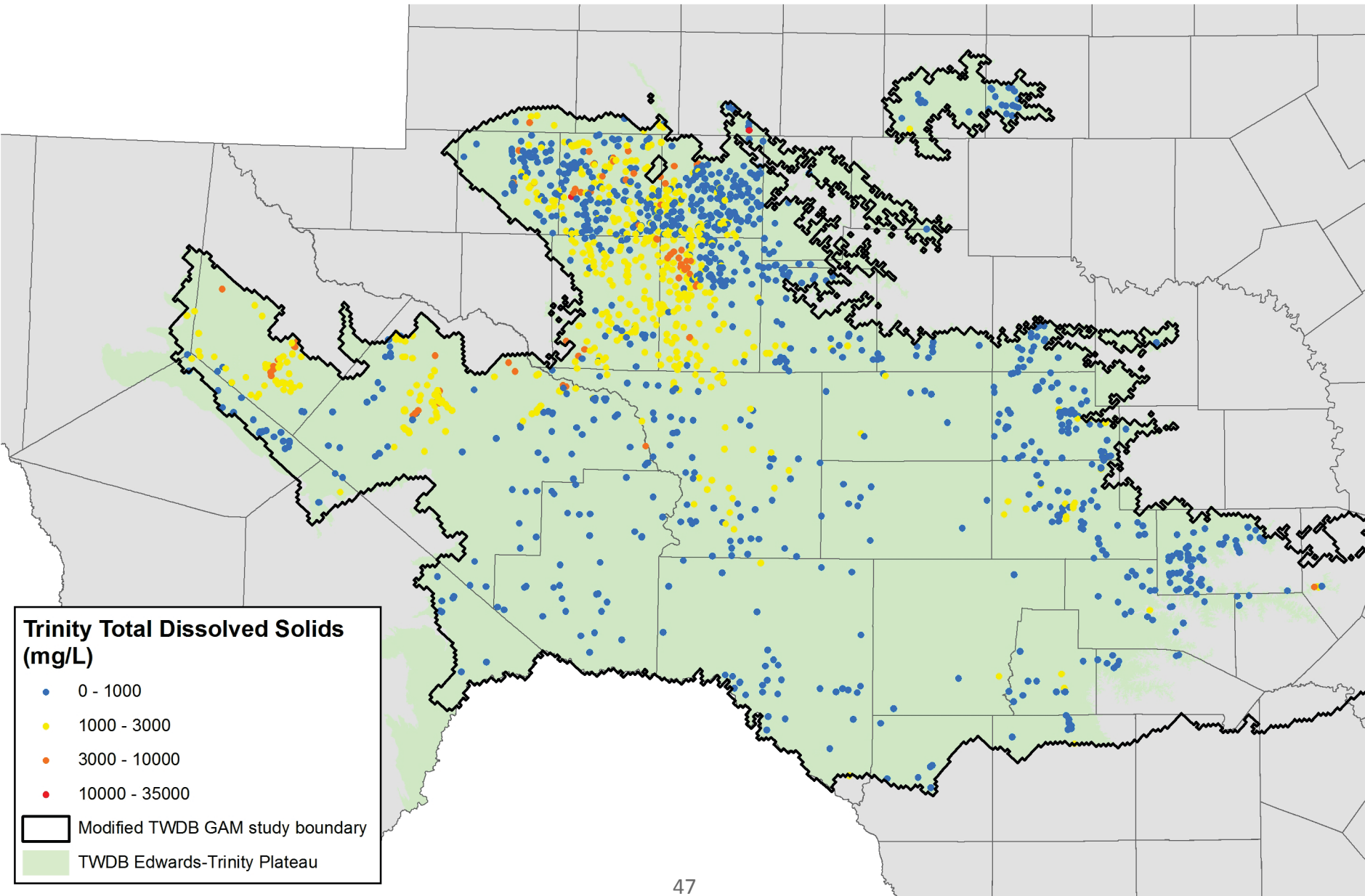
Subsurface Library is searching for additional useful logs suites not in the BRACS database



Data Gap: Southern and downdip portions of the aquifer



Data Gap: Trinity Group water well samples



Anticipated Challenges

- Stratigraphy and lithology needs to match logs
 - *Review hydrostratigraphy/geophysical well log correlations by Allan Clark (USGS)*
- Variability of aquifer characteristics in karst aquifers
- Few measured brackish groundwater quality with anion/cation balance error +/-5% and known well construction
- Calculated TDS methodology
 - *Test Schultz, A.L., 1992, Using Geophysical Logs in the Edwards Aquifer to Estimate Water Quality Along the Freshwater/Saline-water Interface (Uvalde, Texas to San Antonio, Texas), Prepare for the Edwards Underground Water District, San Antonio, Texas, 59p. methodology*
- Few geophysical log suites (G, R, P) at shallow depth
- Shaley limestones (strat picks, WQ calc, aquifer properties)

Next Steps:

~1.5-2 year studies

- Host other kickoff stakeholder meeting before October 16, 2017
- Map stratigraphy, lithology, measured water quality, calculated water quality, aquifer properties, and existing use
- Calculate the volume of fresh, slightly saline, moderately saline, and very saline groundwater
- Host stakeholder meetings to discuss potential production area analysis
- PPA impact analysis
- Final report(s), study completion meeting(s), and stakeholder comment solicitation
- Board possibly designates brackish groundwater production zones (BGPZ)

<http://www.twdb.texas.gov/innovativewater/bracs/studies/Dockum/index.asp>

http://www.twdb.texas.gov/innovativewater/bracs/studies/Edwards_Trinity/index.asp

Andrea Croskrey

512-463-2365

andrea.croskrey@twdb.texas.gov

Mark Robinson

512-463-7657

mark.robinson@twdb.texas.gov

Questions, Comments, and Input from Stakeholders

Measured Water Quality Opportunity!

TWDB Water Quality Program

- TWDB's ambient groundwater quality sampling program is designed to monitor the quality of groundwater in the State.
- Major and minor aquifers in Texas are monitored for groundwater quality on a 4-year cycle.
- TWDB also conducts water-quality evaluations for groundwater studies, Groundwater Management Areas, well control activities, and through cooperative agreements with other entities.

Desired Well Characteristics for Measured Water Quality

Required:

- Brackish water wells tend to be deeper
- Accessible by TWDB staff
- Well has to be in good working condition
- Competent casing throughout
- Has to have a pump
- Has to have an untreated collection point as close to the wellhead as possible
- Area to discharge purge water for 15-30 minutes to obtain a representative sample



Desired:

- Lithology
- Well construction information
- Publicly available geophysical well logs

Benefits to Cooperating with TWDB to collect Measured Water Quality

- Free lab analysis (costs are normally about \$400)
- Broad suite of analytes run including:
 - Calcium, magnesium, potassium, iron, sulfate, chloride, fluoride, silicate, phosphate
 - Parameters are tailored to each aquifer and may differ accordingly
- Improving community's scientific knowledge of the aquifer
- Great starting point to treat well water
- Data for science, not regulation
- For more information consult TWDB User manual 51



<http://www.twdb.texas.gov/innovativewater/bracs/studies/Dockum/index.asp>

http://www.twdb.texas.gov/innovativewater/bracs/studies/Edwards_Trinity/index.asp

Andrea Croskrey
512-463-2365
andrea.croskrey@twdb.texas.gov

Mark Robinson
512-463-7657
mark.robinson@twdb.texas.gov

www.twdb.texas.gov

 www.facebook.com/twdbboard  [@twdb](https://twitter.com/twdb)