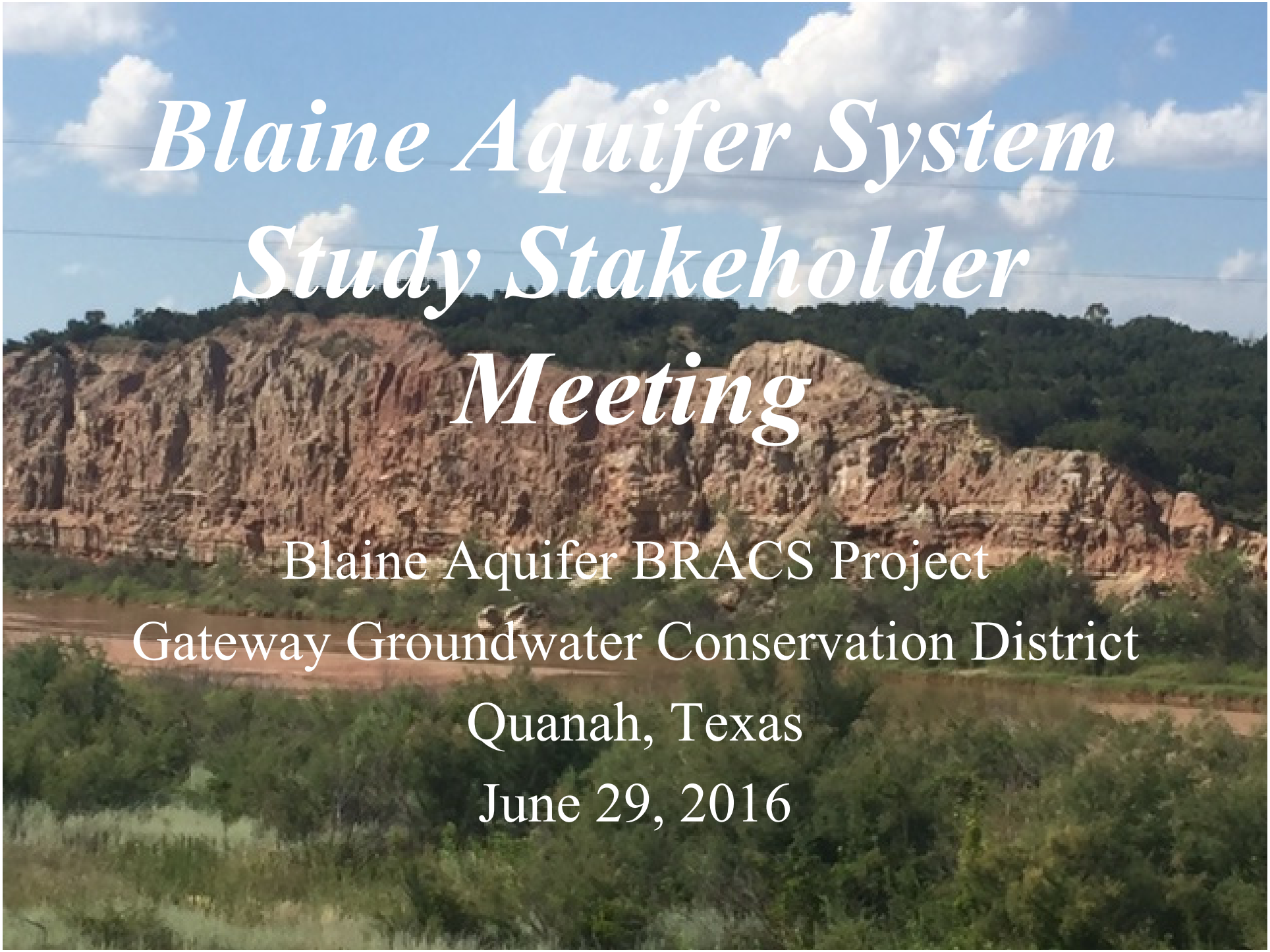

Blaine Aquifer System Study Stakeholder Meeting

Blaine Aquifer BRACS Project

Gateway Groundwater Conservation District

Quanah, Texas

June 29, 2016

Project Details

- Study of Brackish Aquifers in Texas – Project 2: Blaine Aquifer. TWDB Contract Number: 160001948
- Project Team
  - Project Management, Hydrology / Water Quality, Groundwater Modeling, Database / GIS
    - Neil Blandford (Daniel B. Stephens and Associates, Inc.)
  - Hydrogeology / Water Quality, Expert Resources
    - Steve Finch (John Shomaker and Associates, Inc.)
  - Hydrogeology / Water Quality, GIS
    - Allan Standen (ARS, LLC)
  - 3-D Geologic Modeling/Visualization
    - Michelle Sutherland

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Allan R. Standen LLC Groundwater & Natural Resource Consultant

Michelle A. Sutherland, LLC.

House Bill 30

- In 2015, the 84th Texas Legislature passed House Bill 30, directing the Texas Water Development Board (TWDB) to conduct studies to identify and designate brackish groundwater production zones in four aquifers and to report to the legislature by December 1, 2016
- The four aquifers include: part of the Carrizo-Wilcox Aquifer, the Gulf Coast Aquifers, the Blaine Aquifer, and the Rustler Aquifer
- The full text of House Bill 30, and all other materials related to it's implementation, are available on the TWDB House Bill 30 website at

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

Presentation Outline

- Overview of data sources
- Geology and hydrogeology
- Overview of water quality
- Potential brackish groundwater production areas
- Discussion and comment
- Next steps

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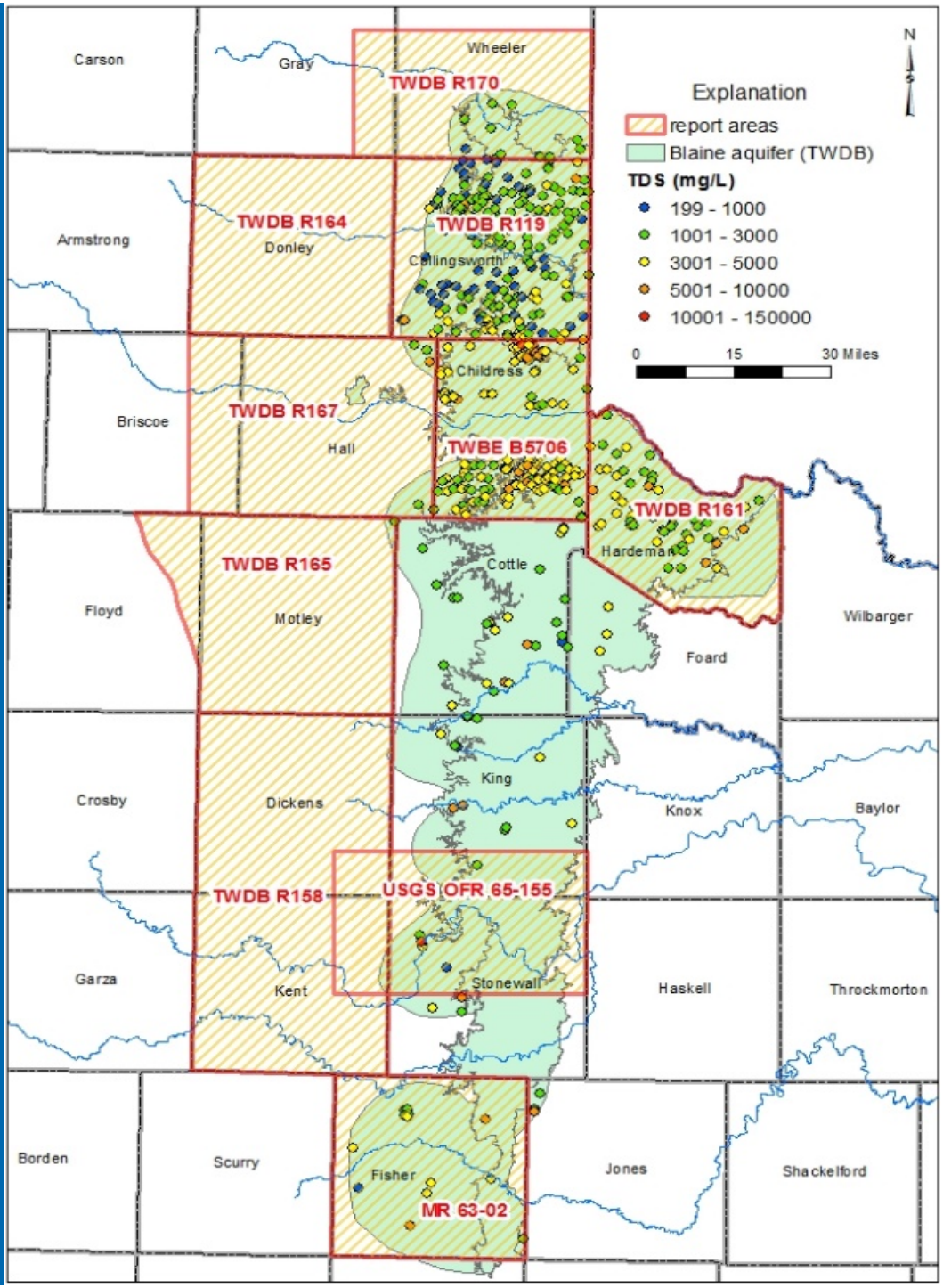
Historical Reports and Data Sources



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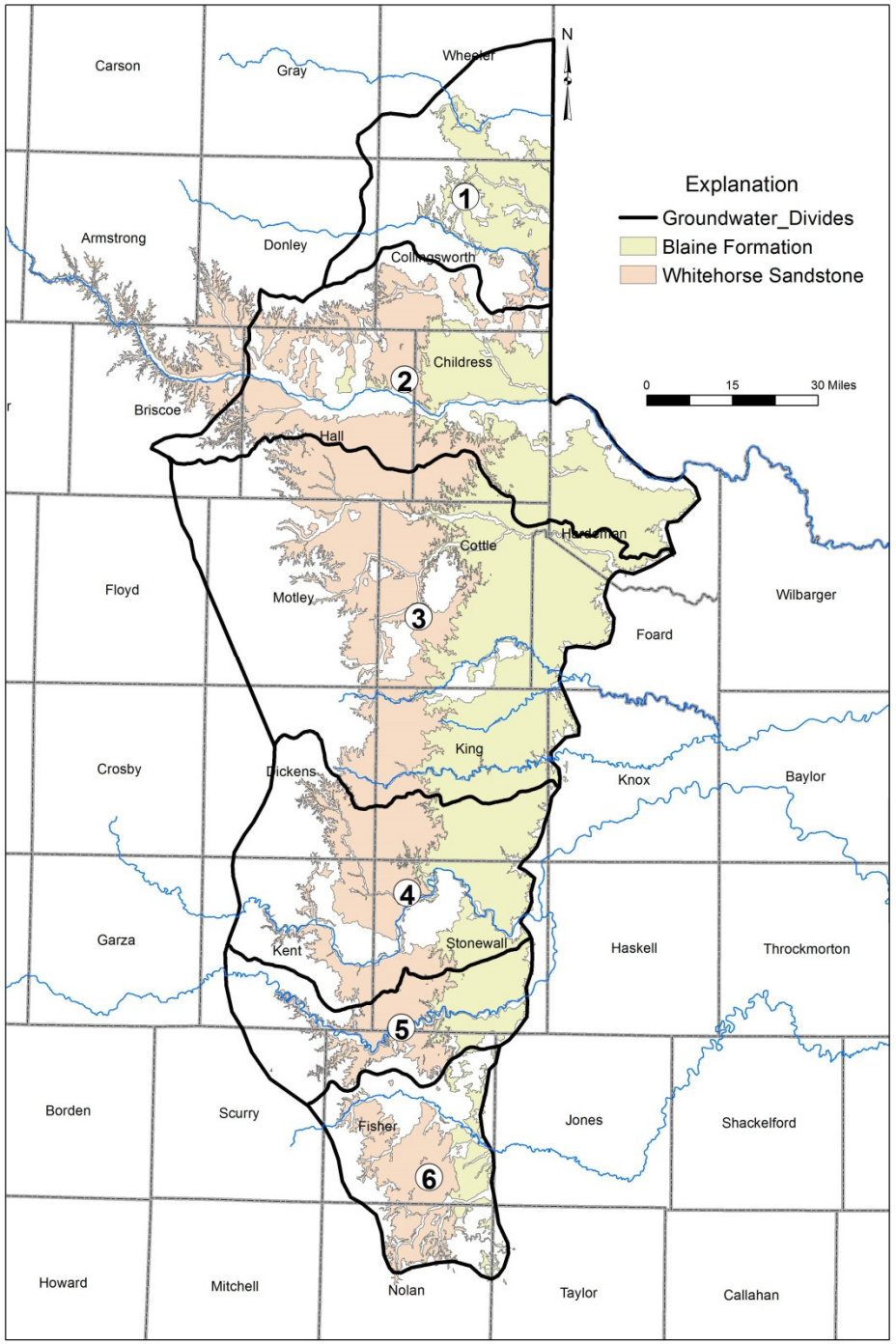
Study Area as Proposed in Statement of Work



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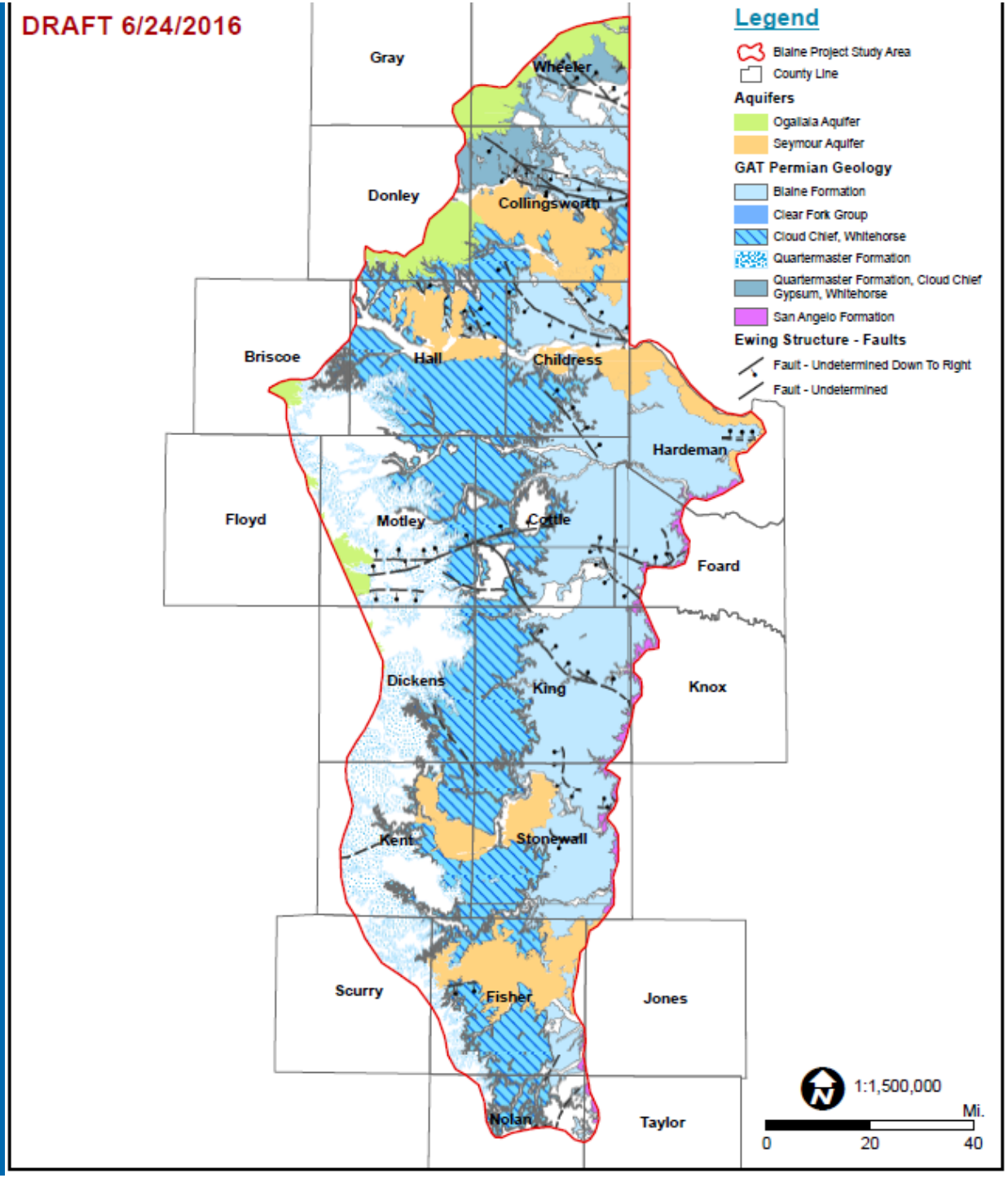
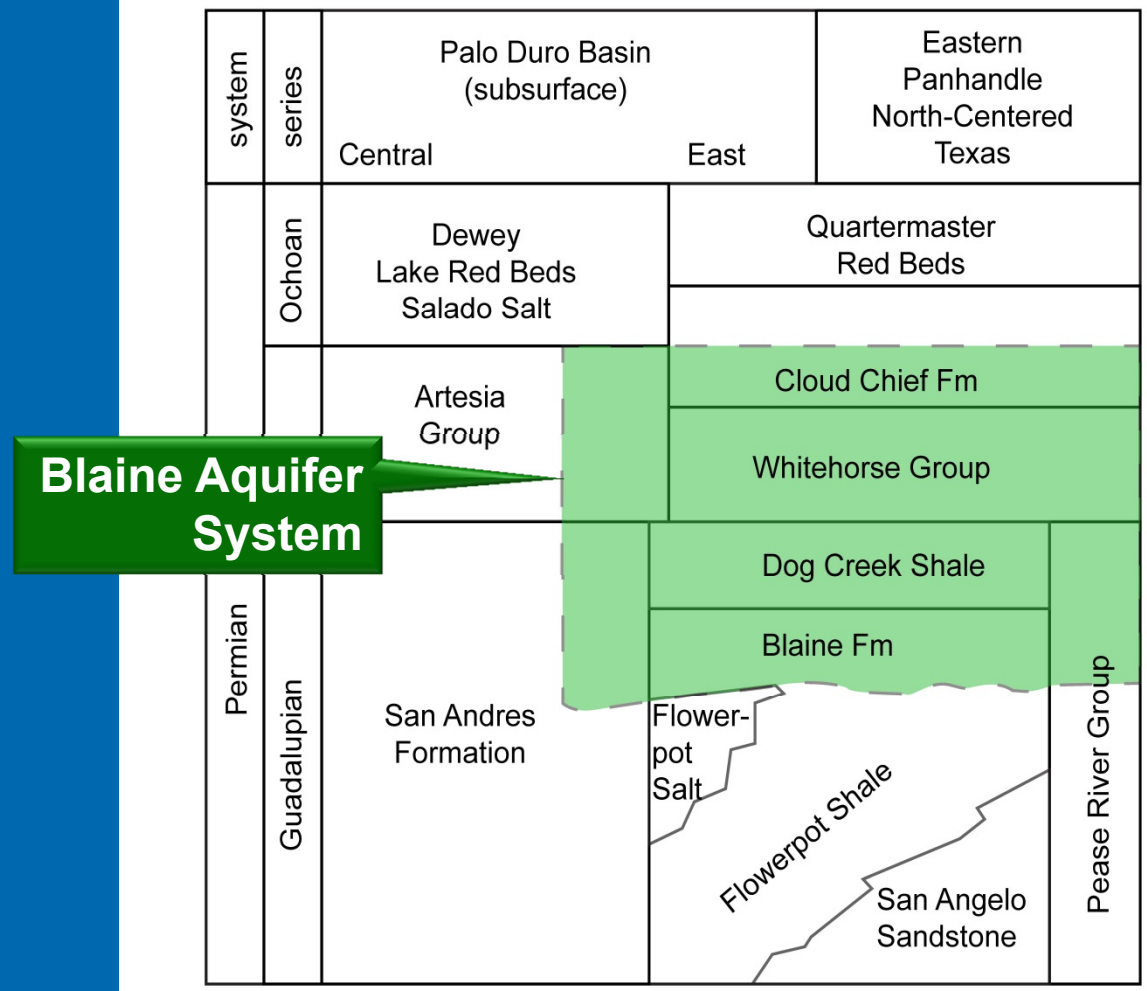
Surface Geology and Structure



Geologic Stratigraphy



modified from J.S. Johnson (1978), Presley (1981), and Barnes (1974)

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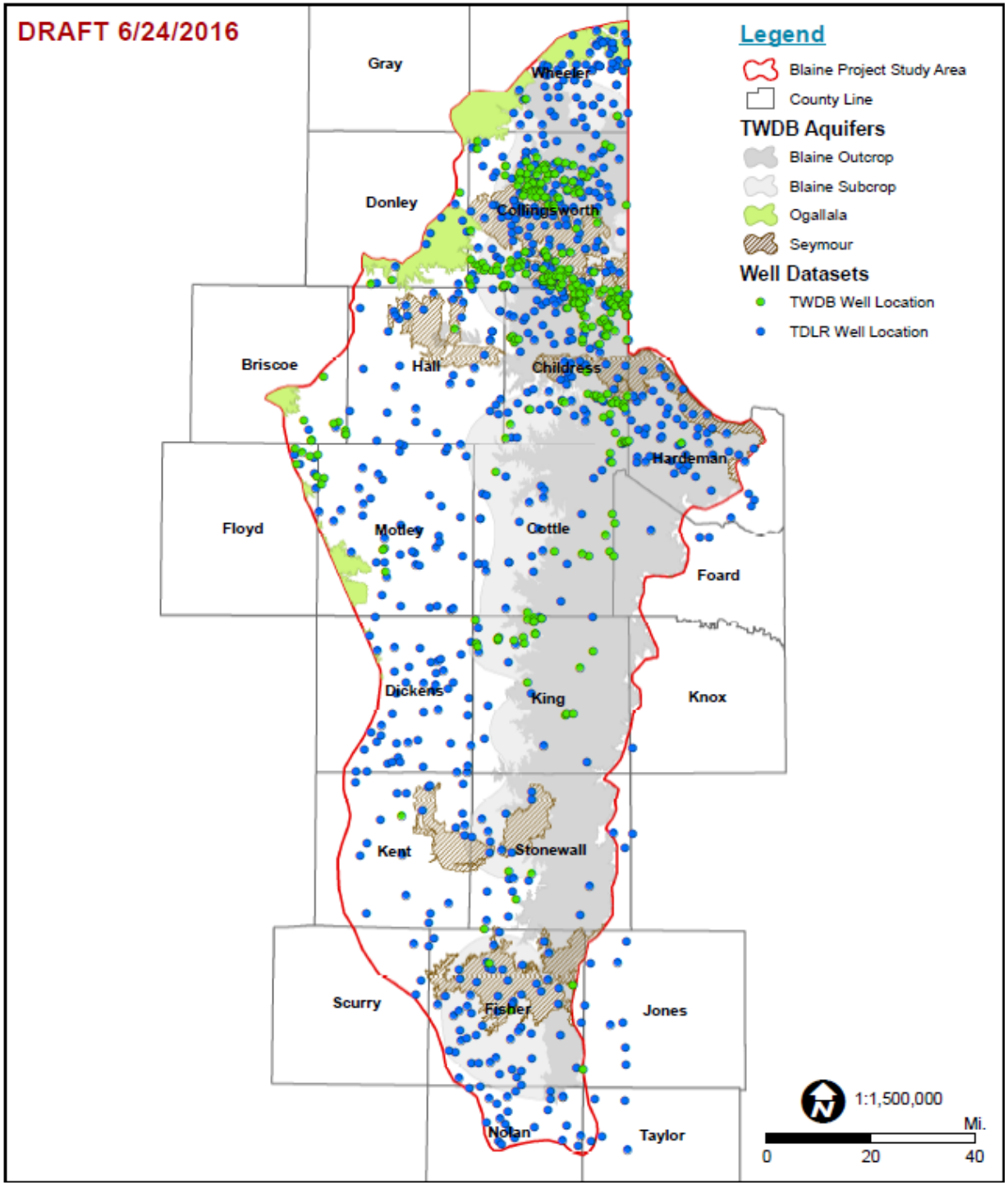
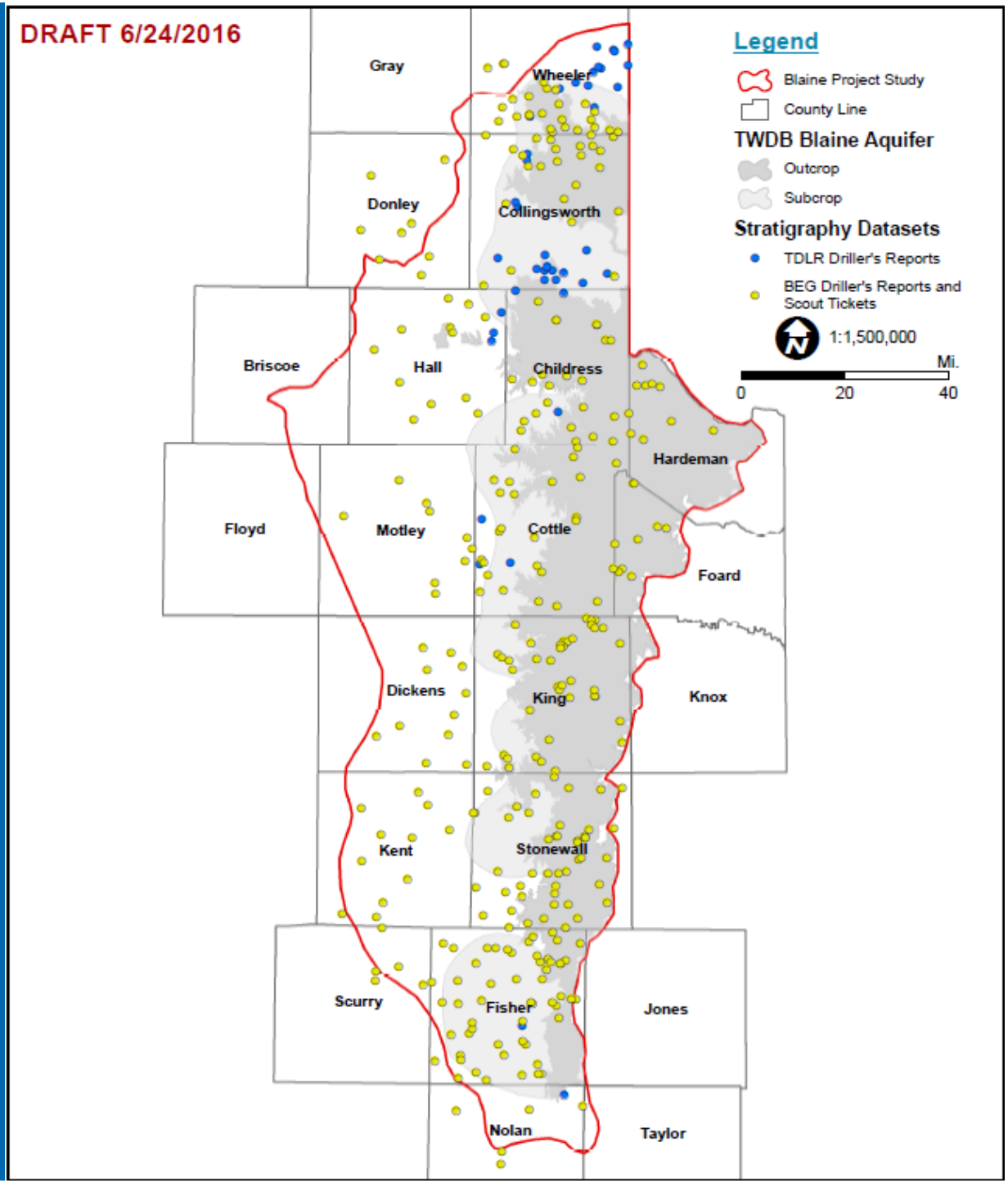
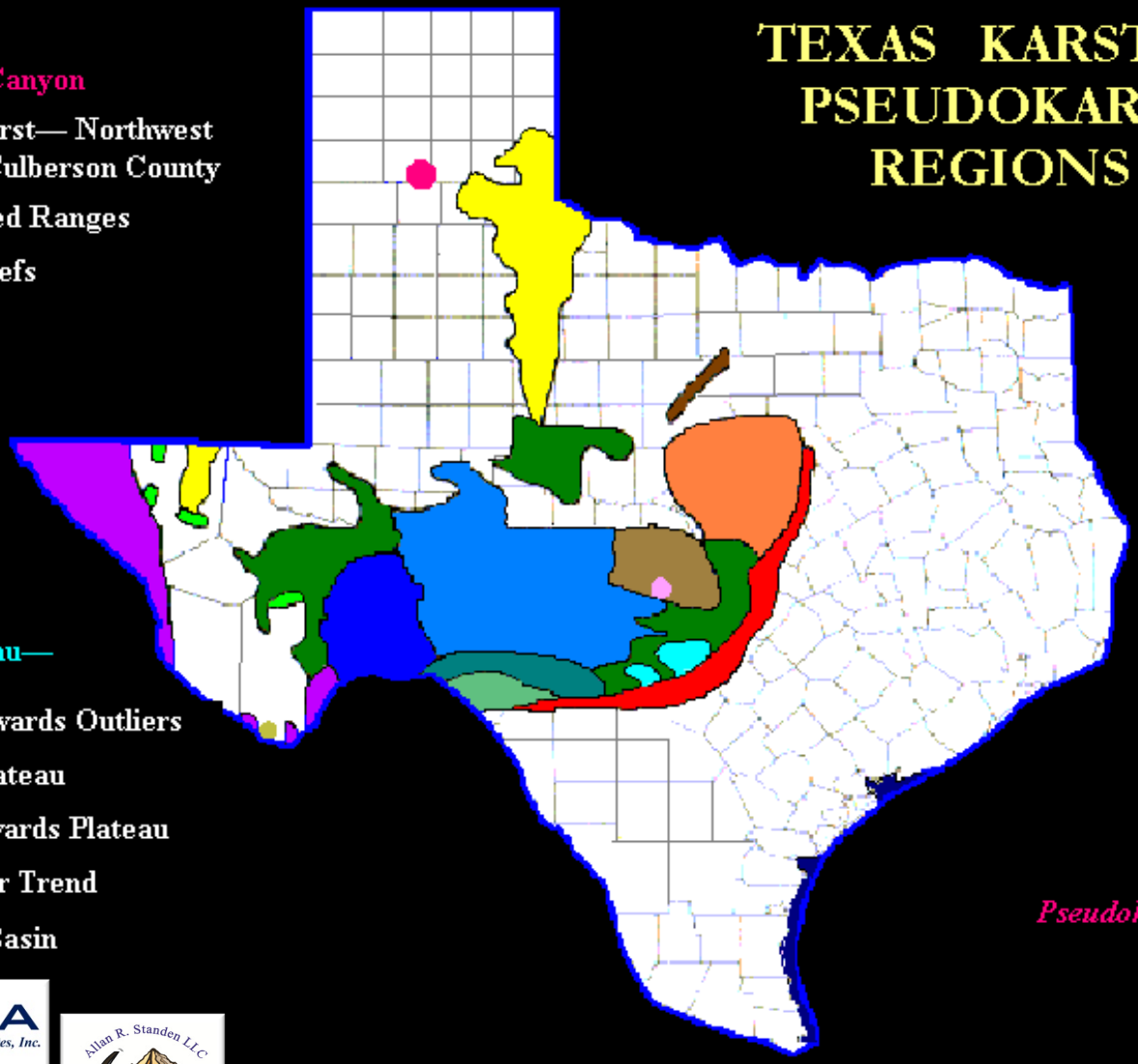
Summary of Water Well Data



Wells Used for Stratigraphic Analysis



Karst Regions of Texas



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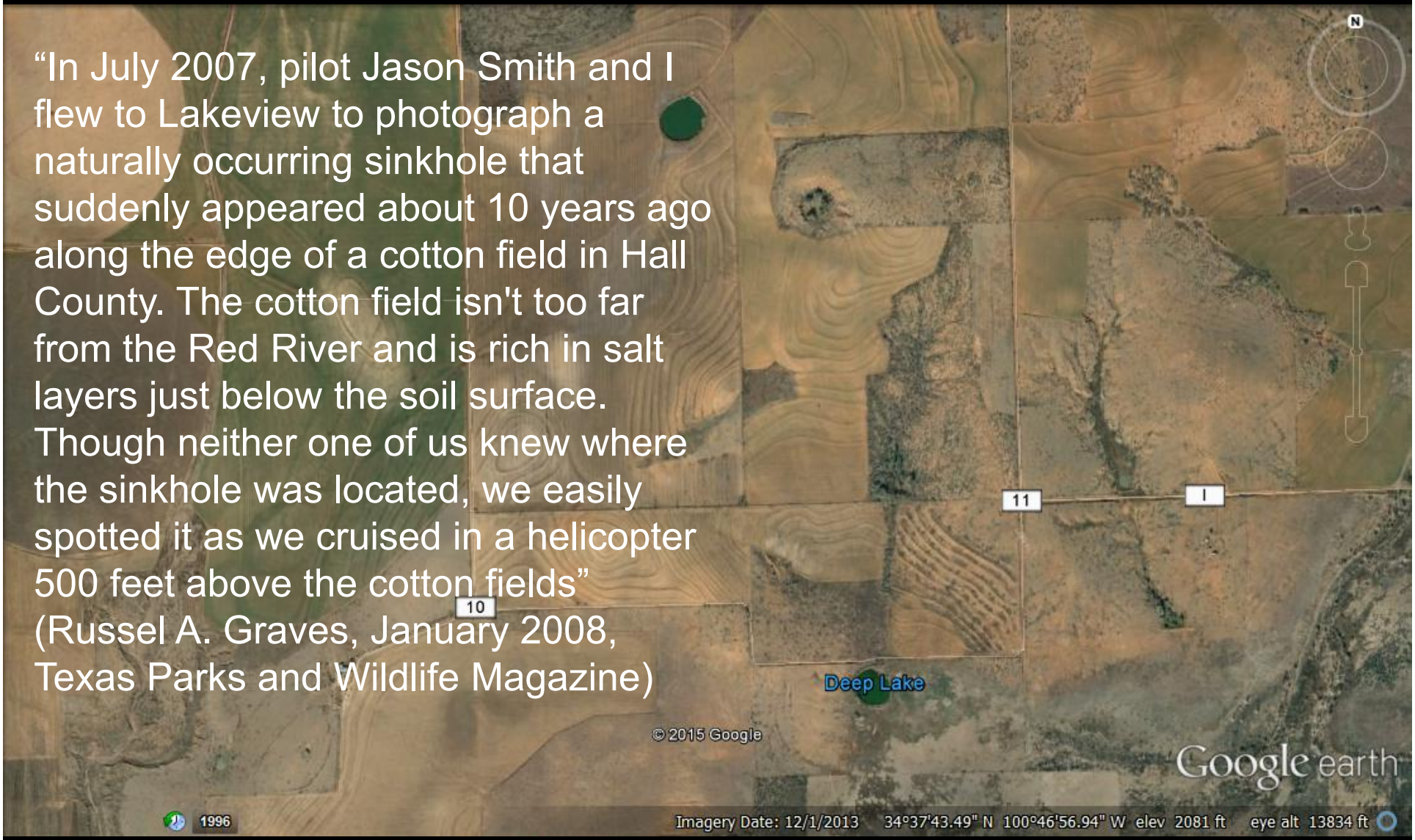
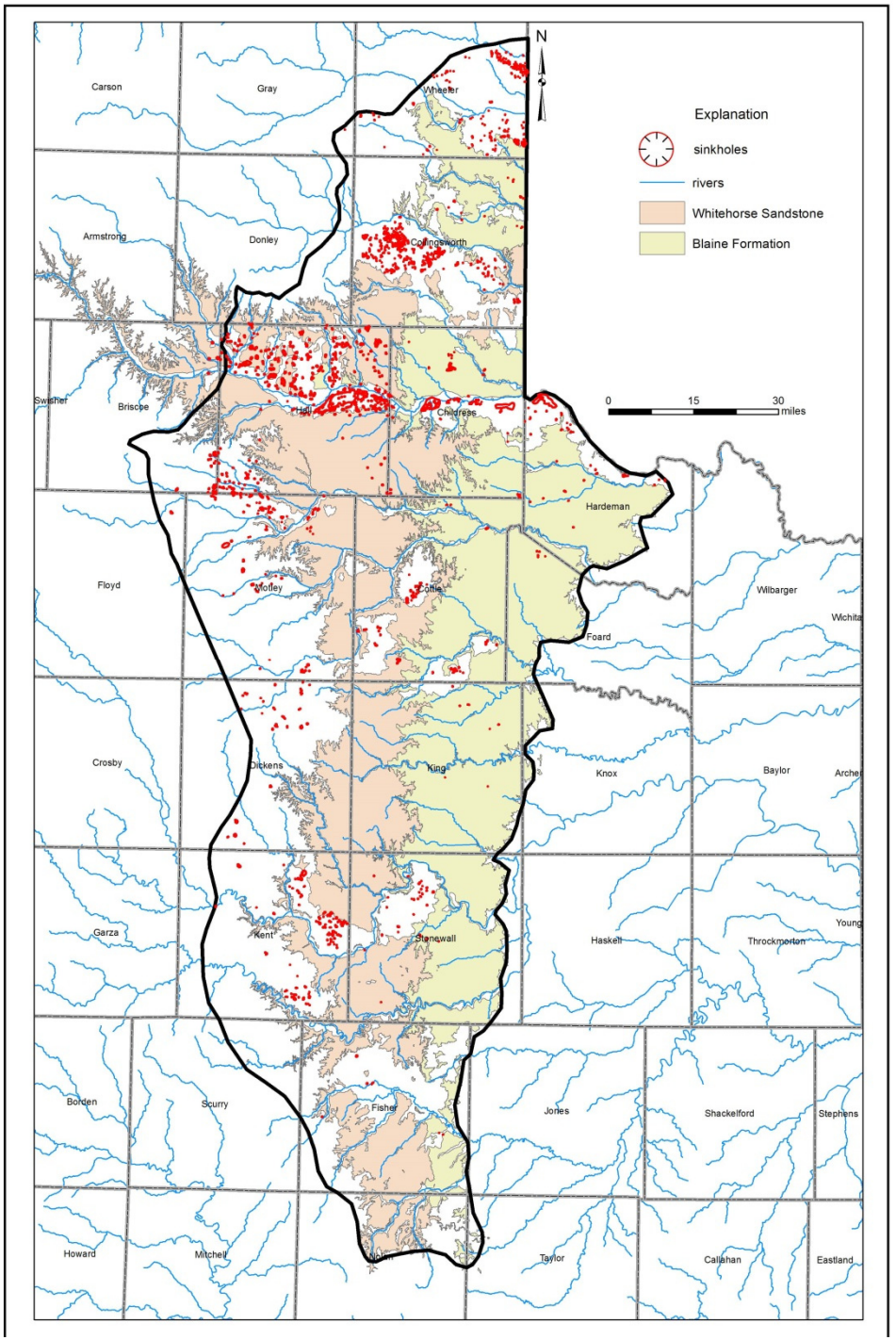
Mapping of Karst Features



Blaine Aquifer System Karst Features



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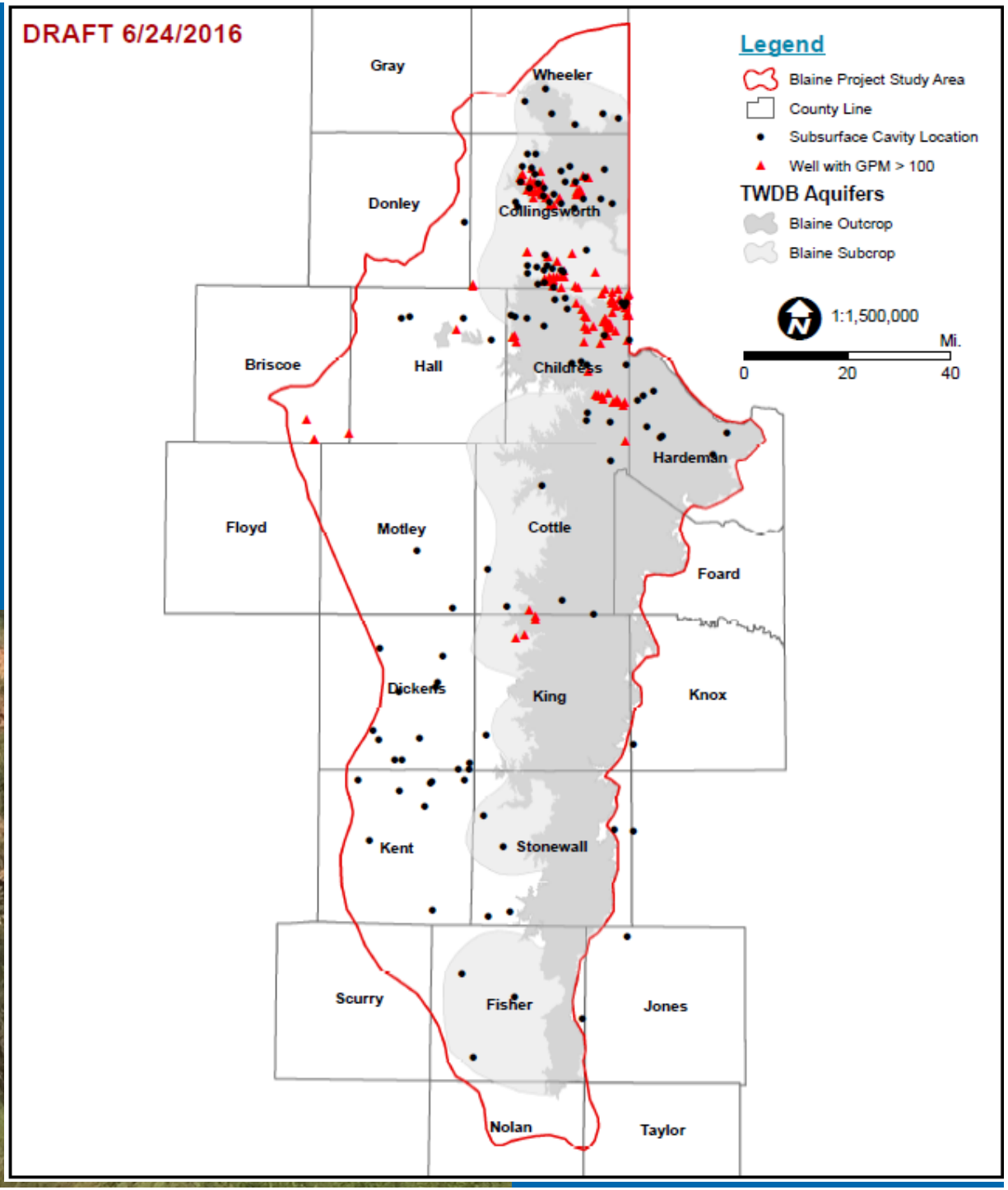
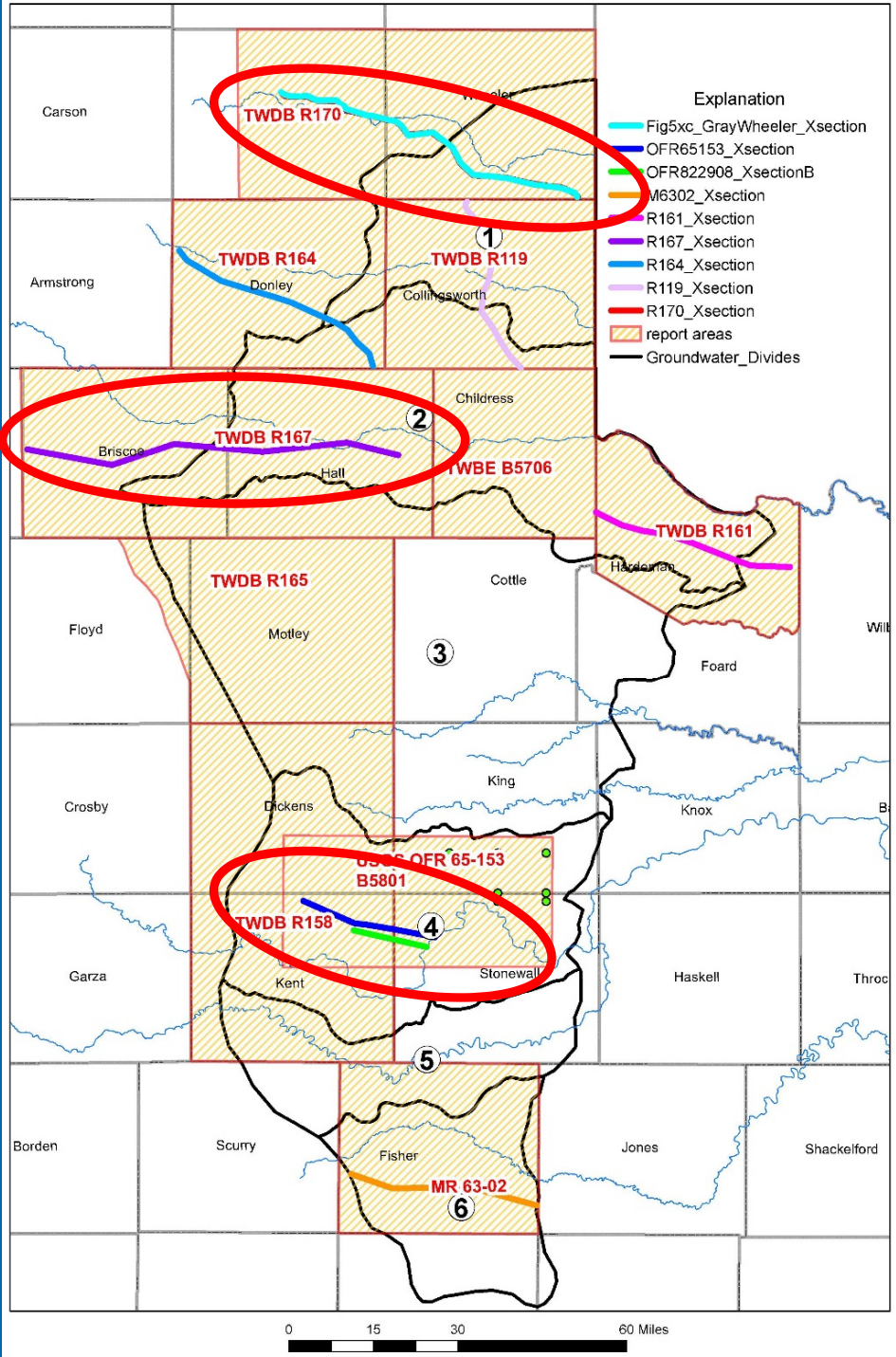
Identified Cavities and Higher Capacity Wells



Cross Section Locations



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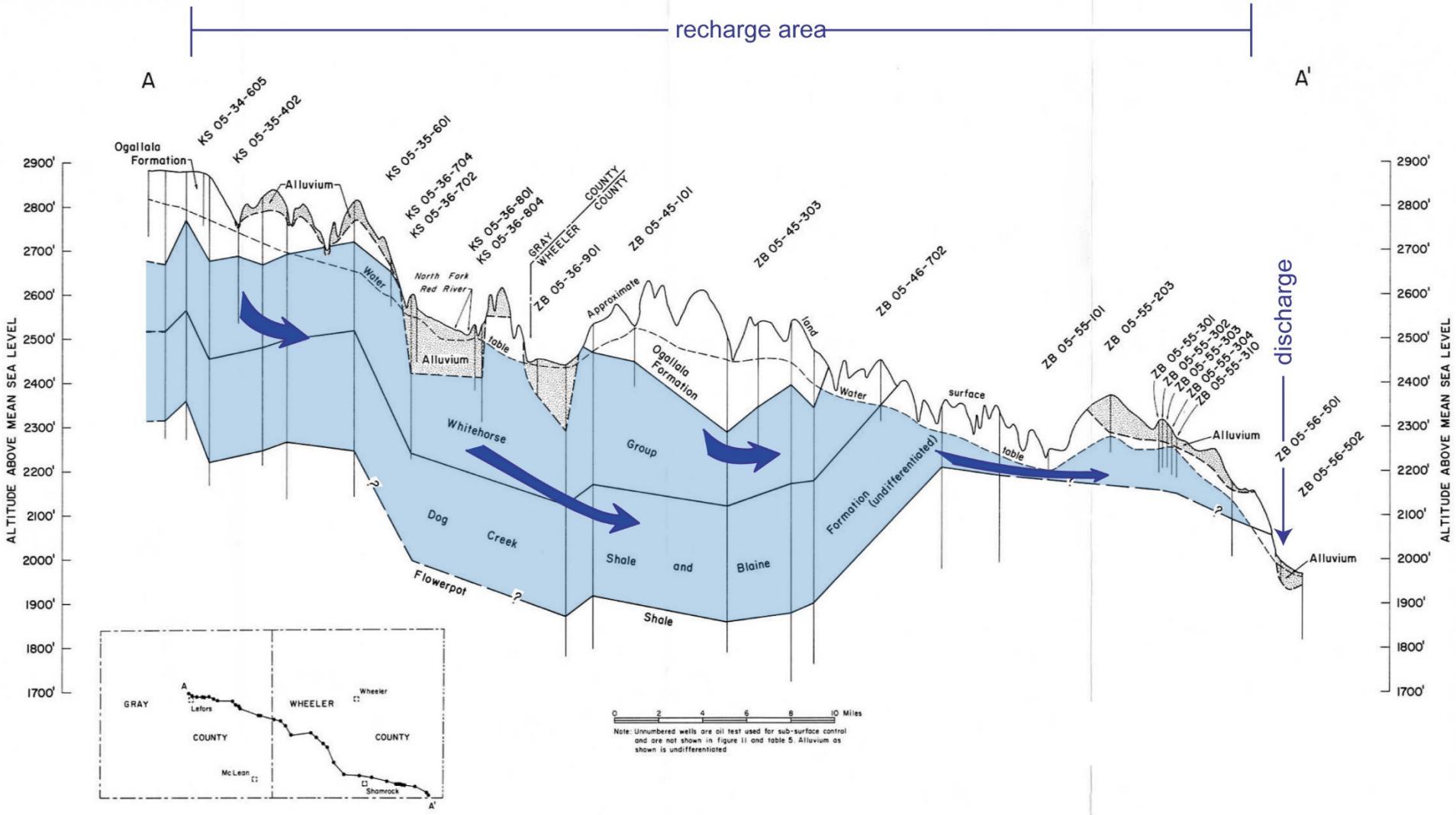
NW to SE Hydrogeologic Cross Section Through Gray and Wheeler Counties, Texas



From Maderak, 1973

Figure 5
Geologic Section A-A'

West to East Hydrogeologic Cross Section Through Briscoe and Hall Counties, Texas

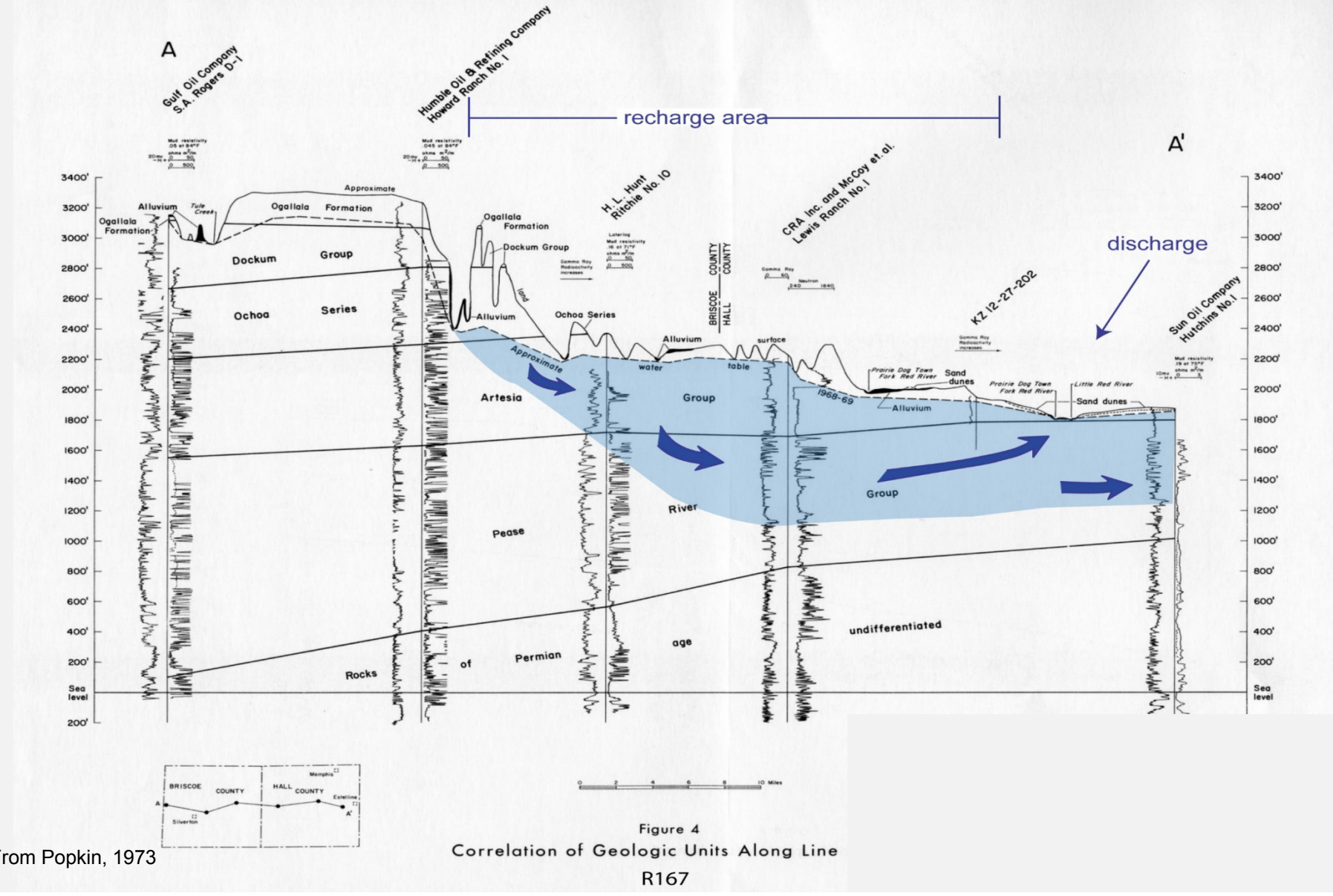
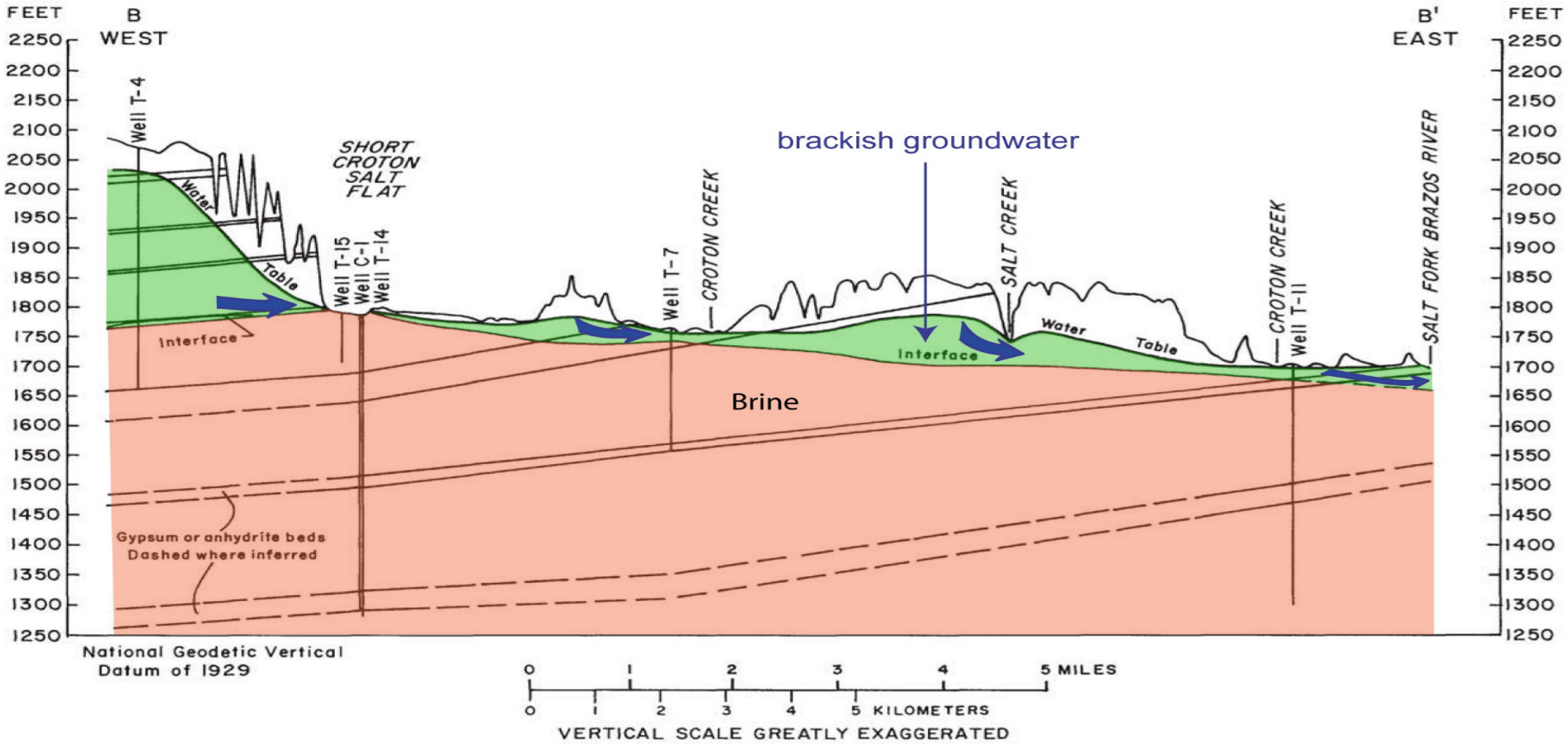


Figure 4
Correlation of Geologic Units Along Line
R167

From Popkin, 1973

West to East Hydrogeologic Cross Section Through Croton Creek, Texas



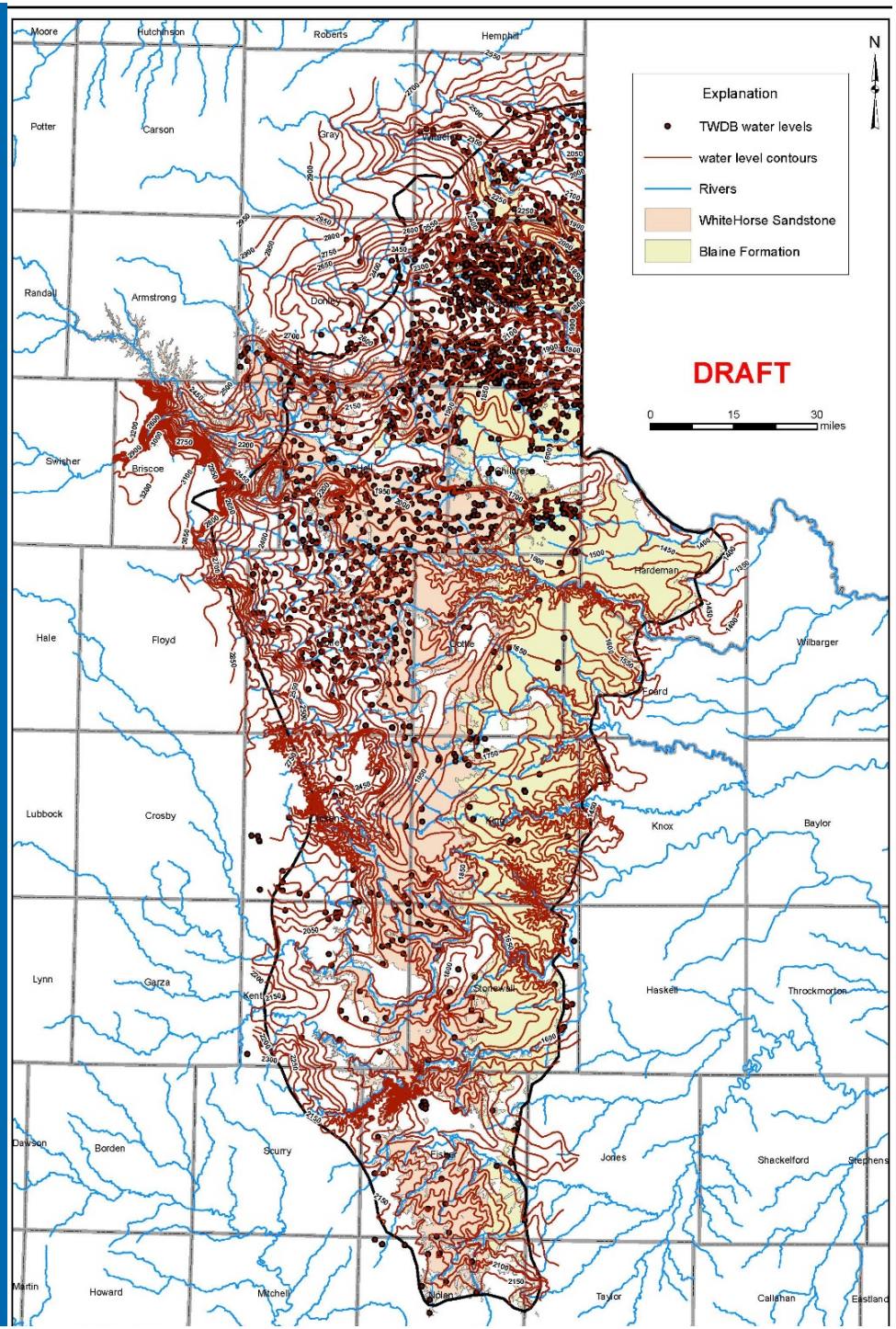
Modified from Stevens and Hardt (1965)

Well Information Summary

County	Average water well depth (ft bgl)	Average depth to water (ft bgl)	Water Column (ft)	Range in depth of O&G surface casing (ft bgl)	Number of Springs
Wheeler	99	60	39	75 to 575	13
Collingsworth	113	62	51	150 to 650	61
Hall	158	50	108	30 to 500	16
Childress	124	73	51	50 to 375	1
Hardeman	148	60	88	100 to 450	1
Motley	158	73	85	170 to 500	0
Cottle	168	114	54	100 to 500	4
Foard	75	20	55	250 to 450	1
Dickens	125	54	71	100 to 300	0
King	163	81	82	50 to 500	4
Kent	184	50	134	100 to 600	1
Stonewall	82	33	49	50 to 500	5
Fisher	107	32	75	50 to 400	0
Nolan	169	90	79	---	0
Average	**134**	**61**	**73**		

Water Level Map

- Determined from:
  - Measured water levels in wells
  - Spring elevations
  - Streambed elevations
  - Land surface constraints



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Aquifer Thickness

- Bottom of aquifer defined by Flowerpot Shale along eastern margin and in the north
- Bottom of aquifer defined by brine interface in south
- Total thickness of fresh to moderately saline groundwater 0 to ~ 500 ft

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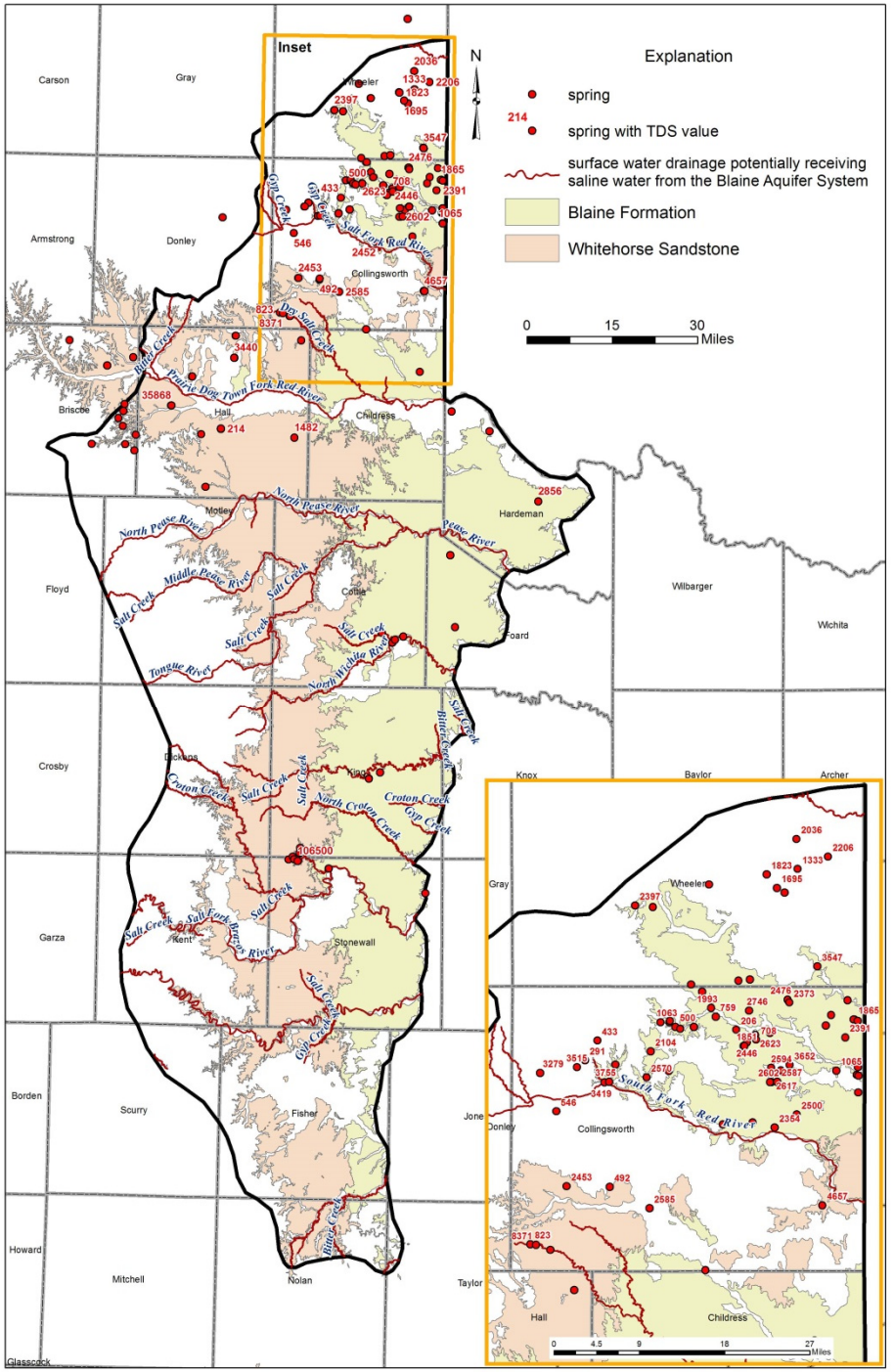
Groundwater Salinity Classification

Groundwater salinity classification	Salinity zone code	Total dissolved solids concentration (units: milligrams per liter)
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

Brackish

U.S. Geological Survey, Winslow and Kister, 1956

Spring /Surface Water Quality



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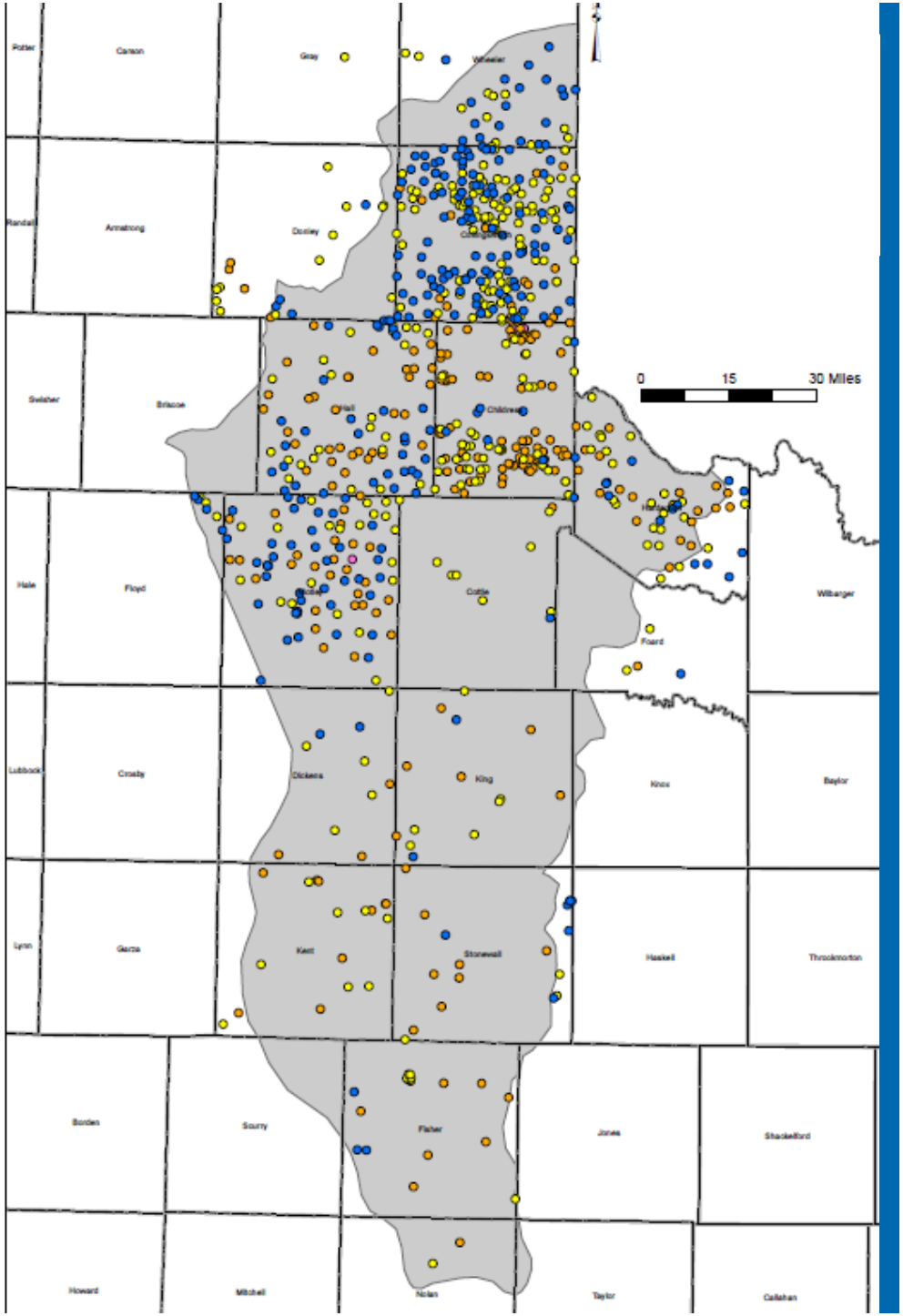
Water Quality from Water Wells



Explanation

	TDS, mg/L
Fresh	0 - 1,000
Slightly saline	1,000 - 3,000
Moderately saline	3,000 - 10,000
Very saline	10 000 - 35,000
Brine	Greater than 35,000

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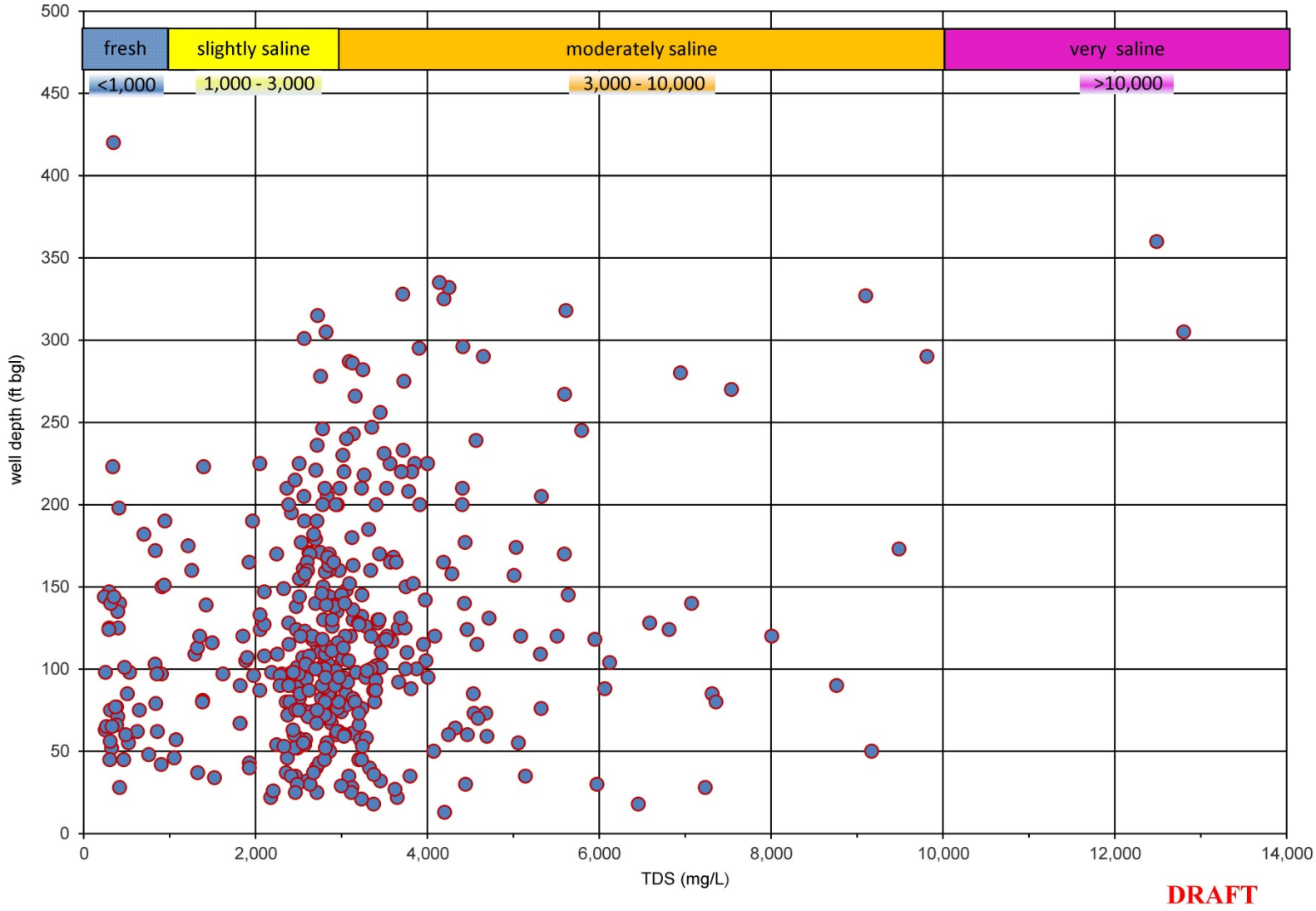
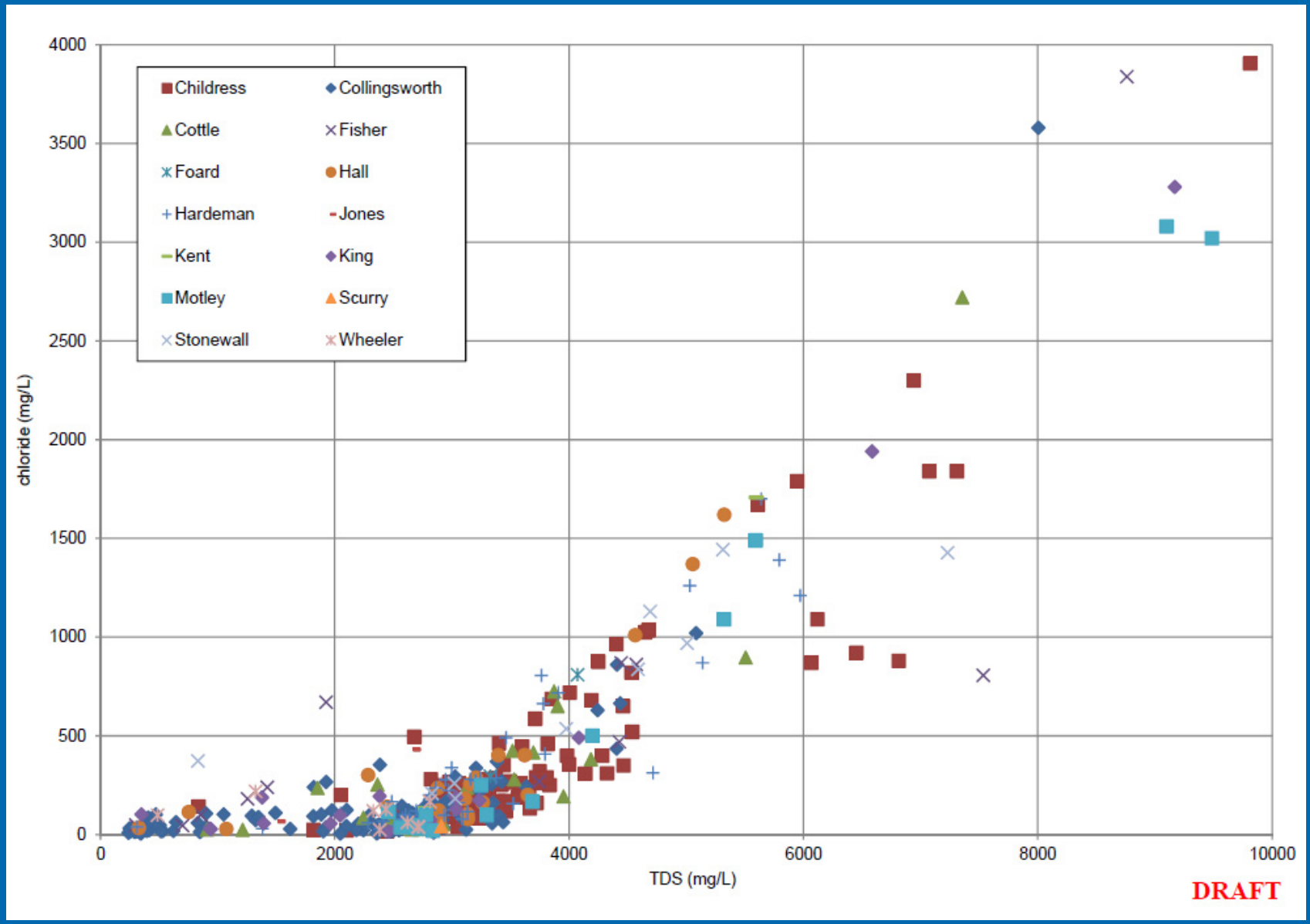
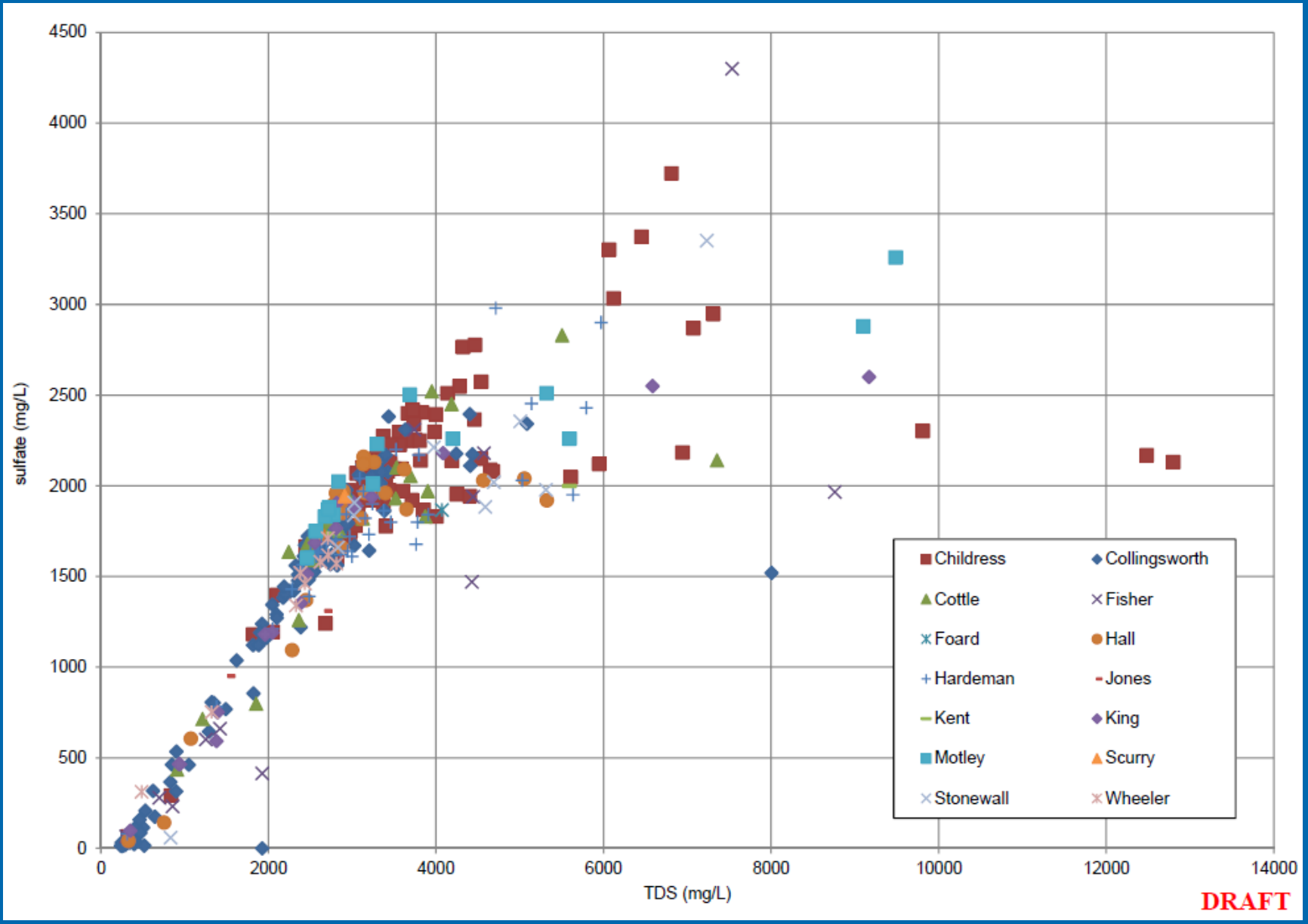
Well Depth Versus TDS



Chloride vs. TDS



Sulfate vs. TDS



Geophysical Log Analysis

1. Identify brine interface
2. Estimate TDS of groundwater in the aquifer

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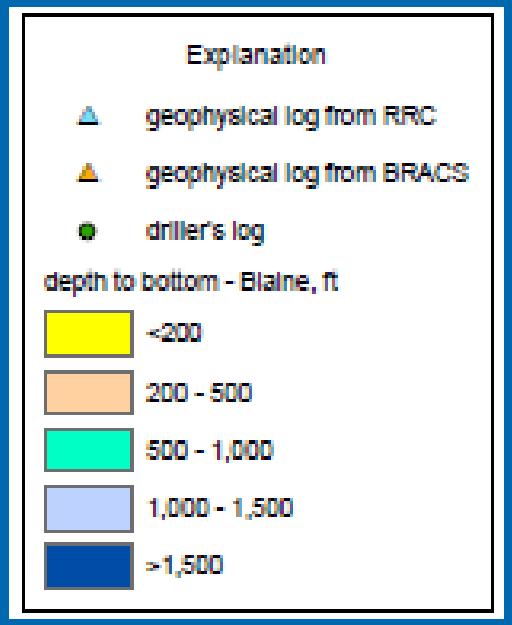
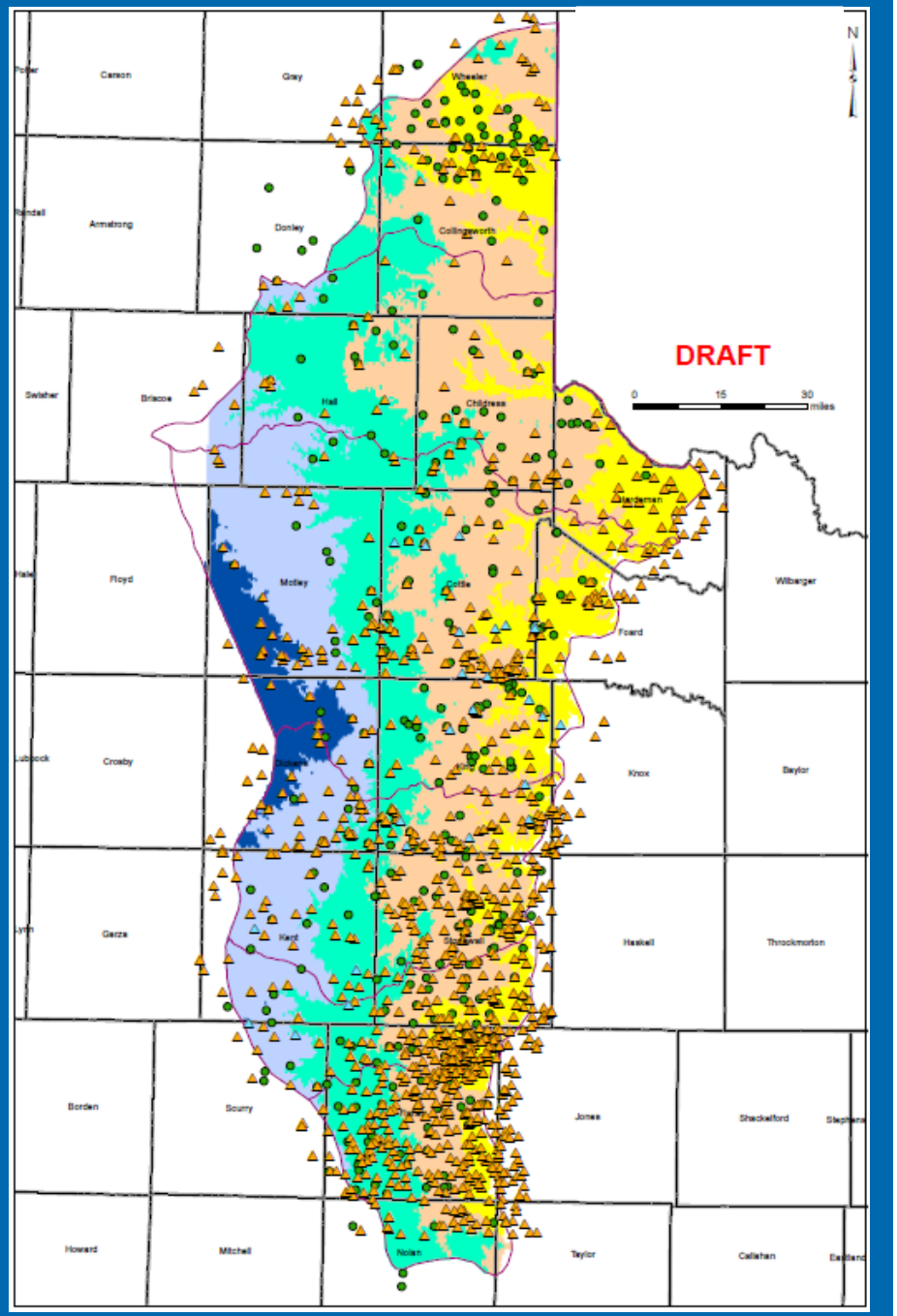
Depth to Base of Aquifer and Well Logs Reviewed





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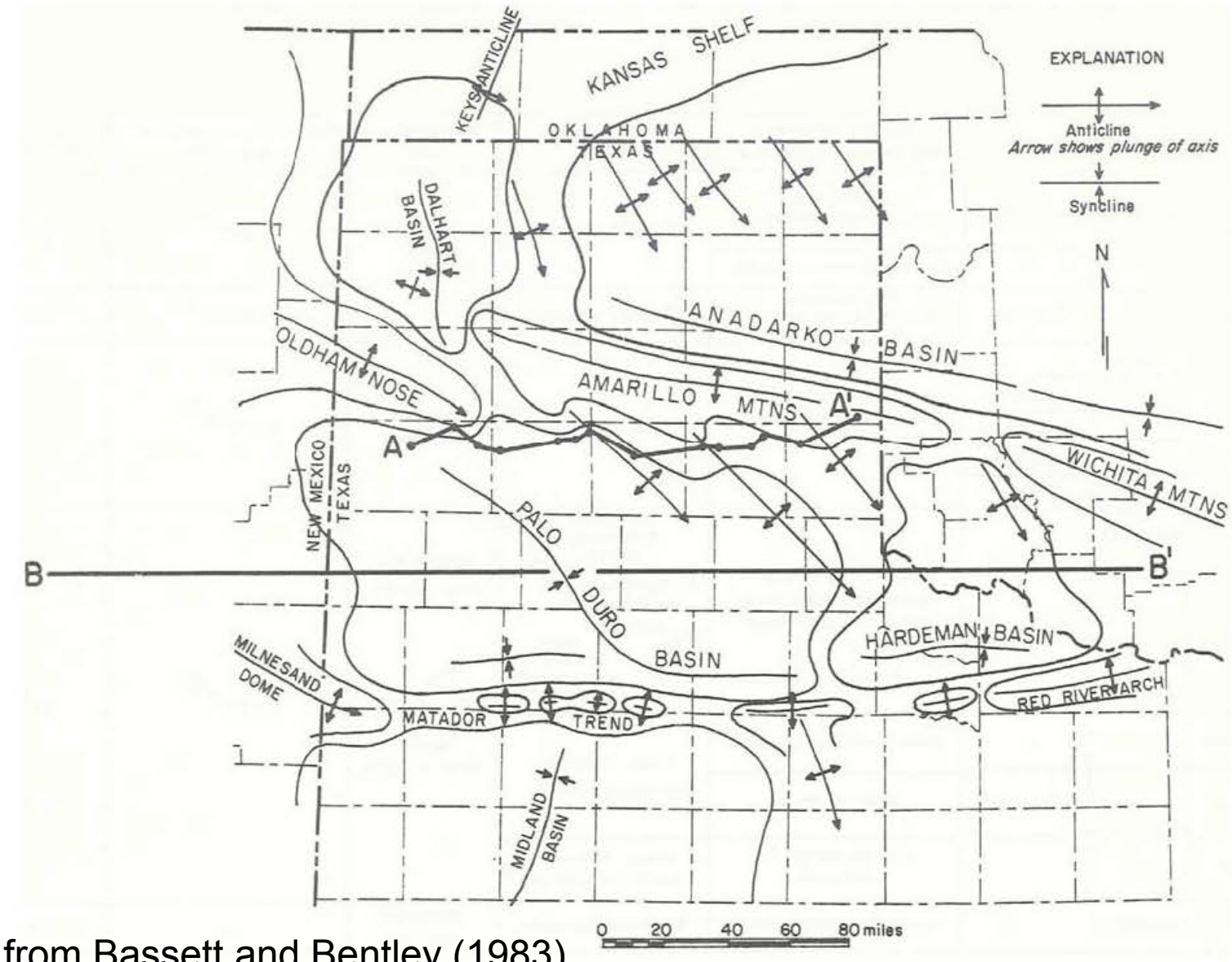
Brine Interface

- Interface defined as fresh to moderately saline groundwater overlying brine (>35,000 mg/L TDS)
- Brine concentration high as 200,000 mg/L TDS
- No brine interface above Flowerpot Shale in northern portion of study area
- Brine interface above Flowerpot Shale in central and southern areas where Permian beds dip to the west
- Source of brine is likely regional discharge from upper Permian rocks of the Palo Duro and Midland Basins

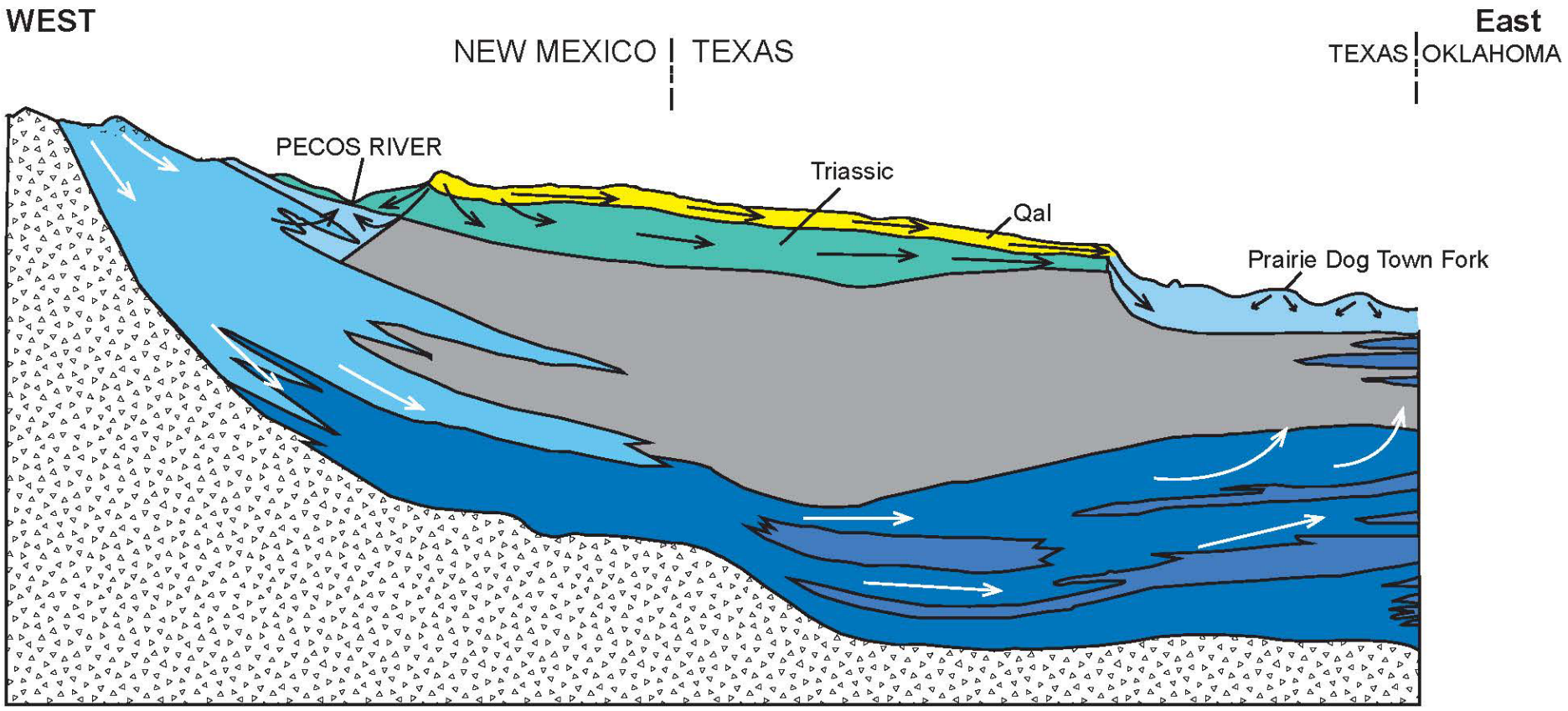
Permian Basins and Structure



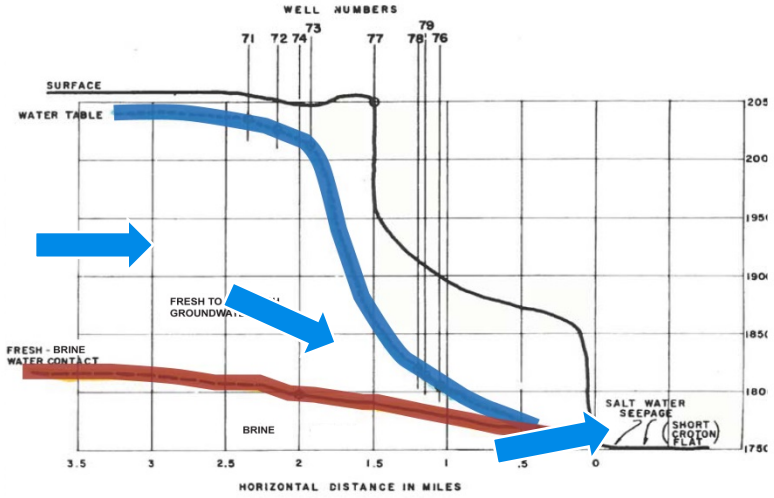
from Bassett and Bentley (1983)

Regional Groundwater Flow in the Palo Duro Basin and Brine Interface

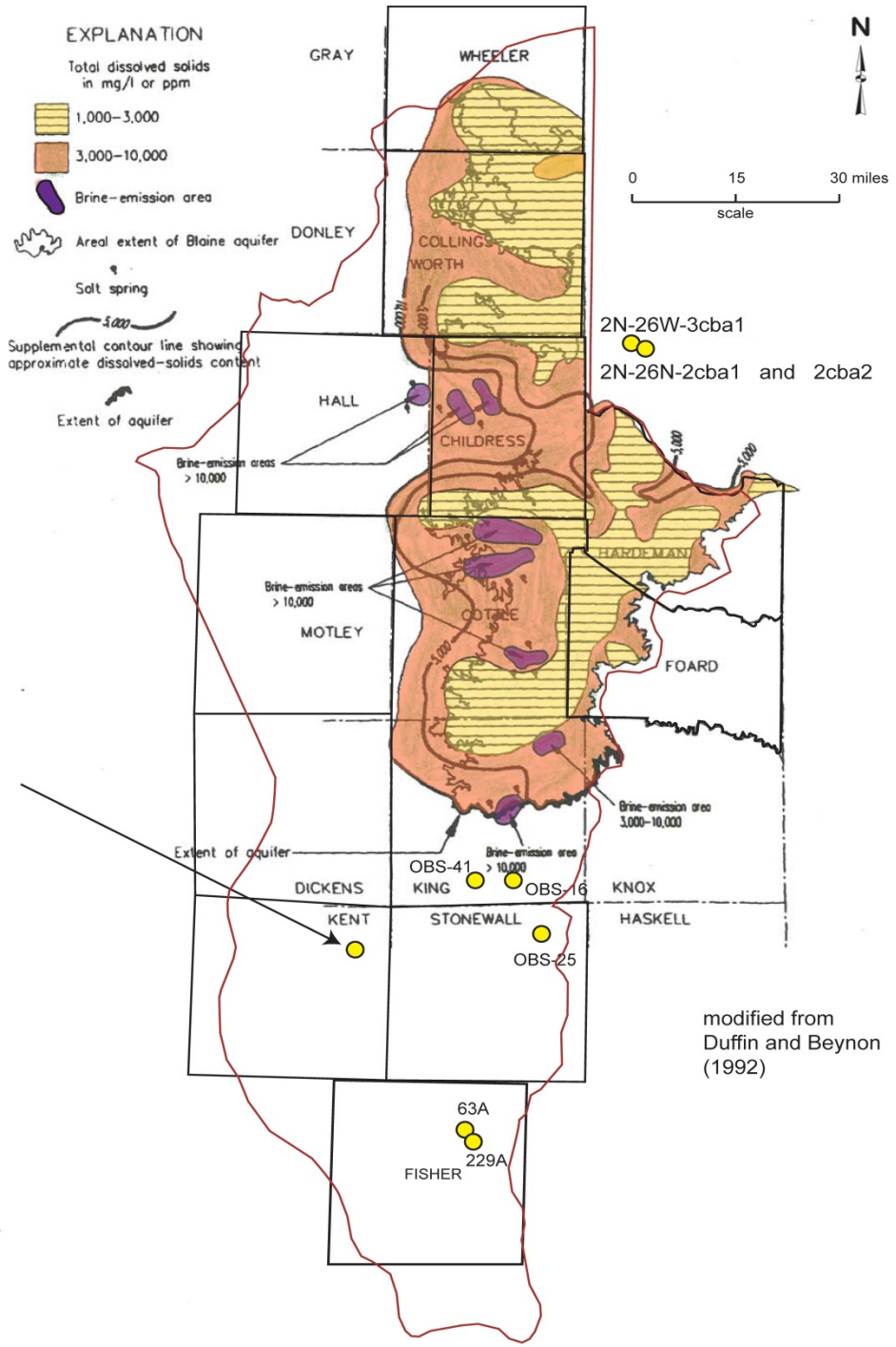
from Bassett and Bentley (1983)



Blaine Formation Water Quality



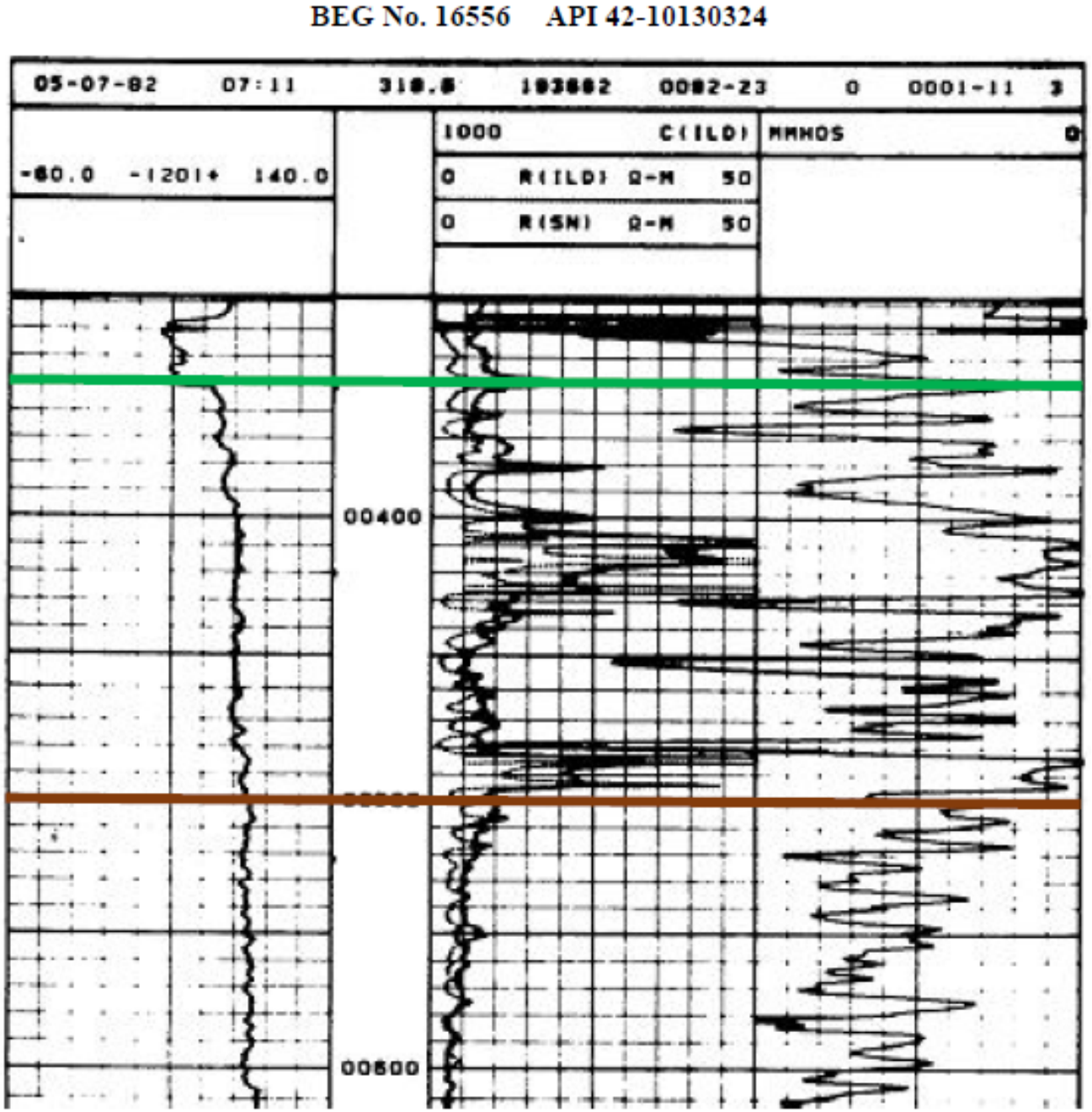
from McMillion (1958)



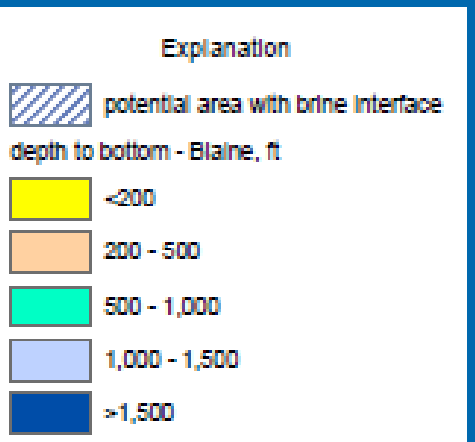
Brine Interface

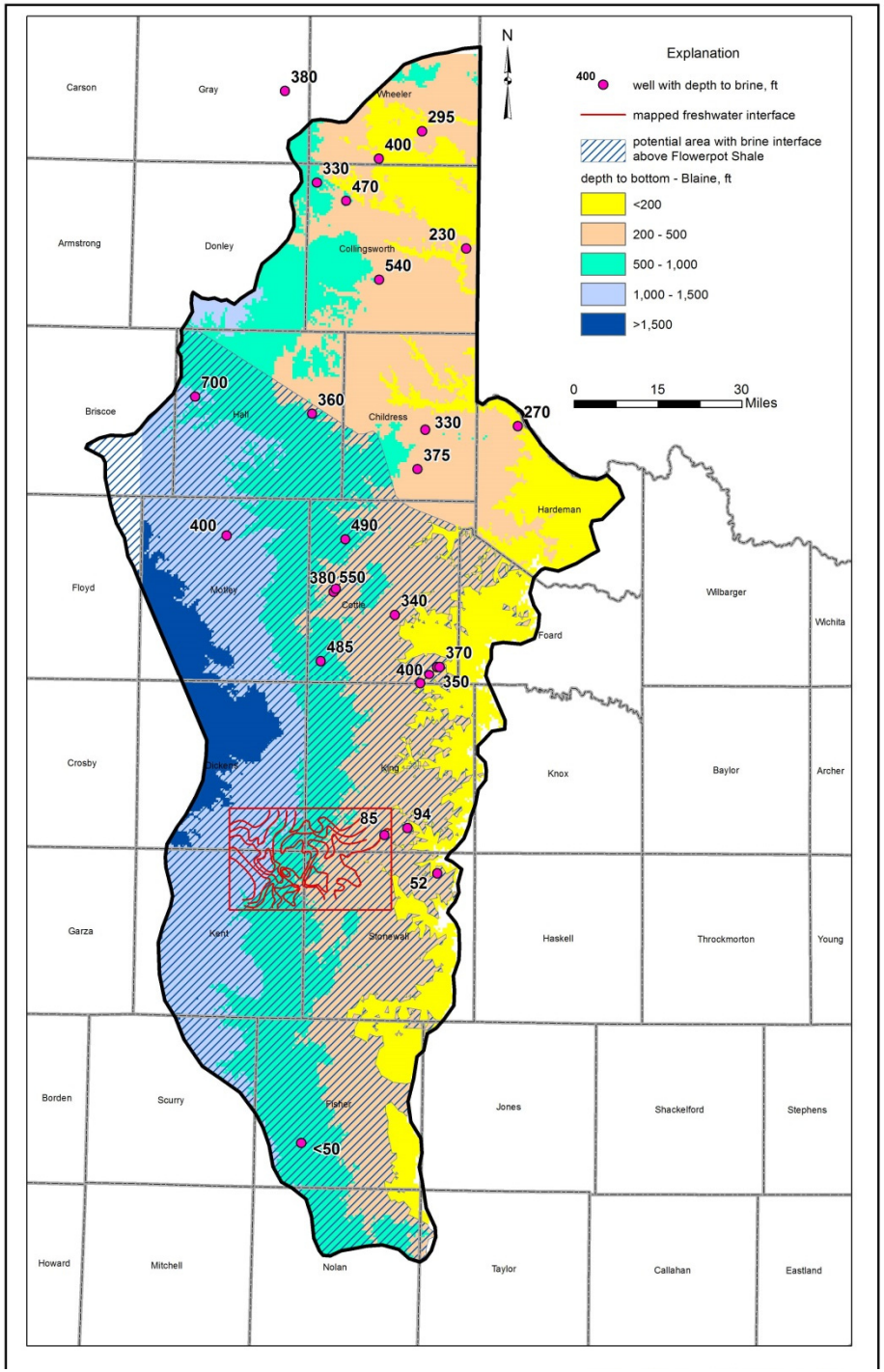
Brine Interface

Base of Blaine Formation



Occurrence of Brine Interface





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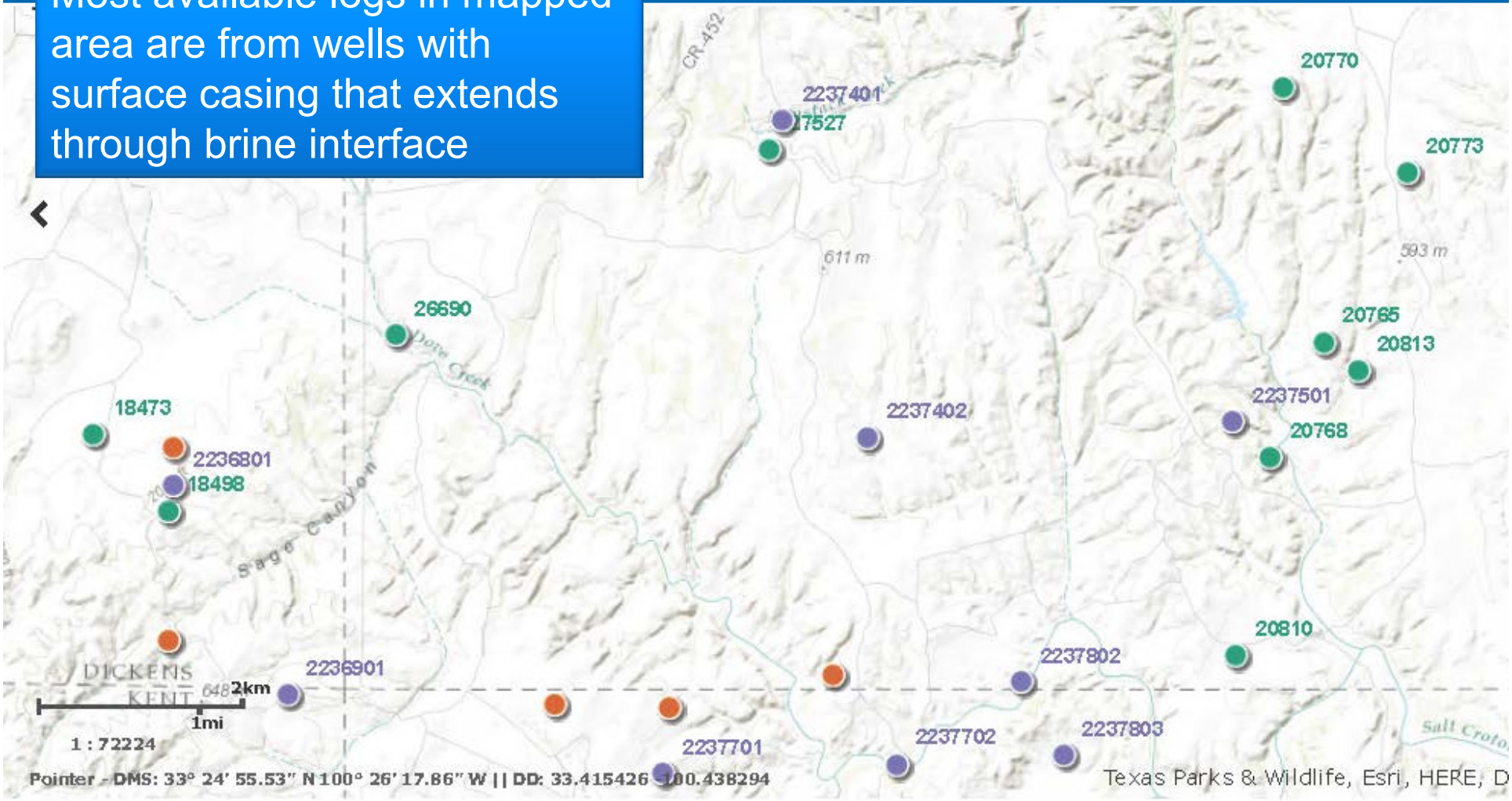
Limits of Geophysical Log Analysis

Most available logs in mapped area are from wells with surface casing that extends through brine interface



Water Quality from Geophysical Logs - Limitations

- Over 1,200 logs reviewed and hundreds evaluated
- Limited good quality logs for the upper few hundred feet of aquifer where water quality interpretation may be useful
- Method requires electrical log of sand bed with adequate thickness
- Nearby lithology and water quality of interval evaluated and needed for method verification is limited

Water Quality from Geophysical logs - Approach

- Aquifer is relatively thin, and water quality does not appear to vary significantly with depth above the brine interface
- Data from water wells will be relied on primarily for determining groundwater quality distribution above brine interface
- Geophysical log analysis most useful for determining depth to brine interface

Show 3-D Visualization

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Identification of Potential Brackish Groundwater Production Areas

Two part process -

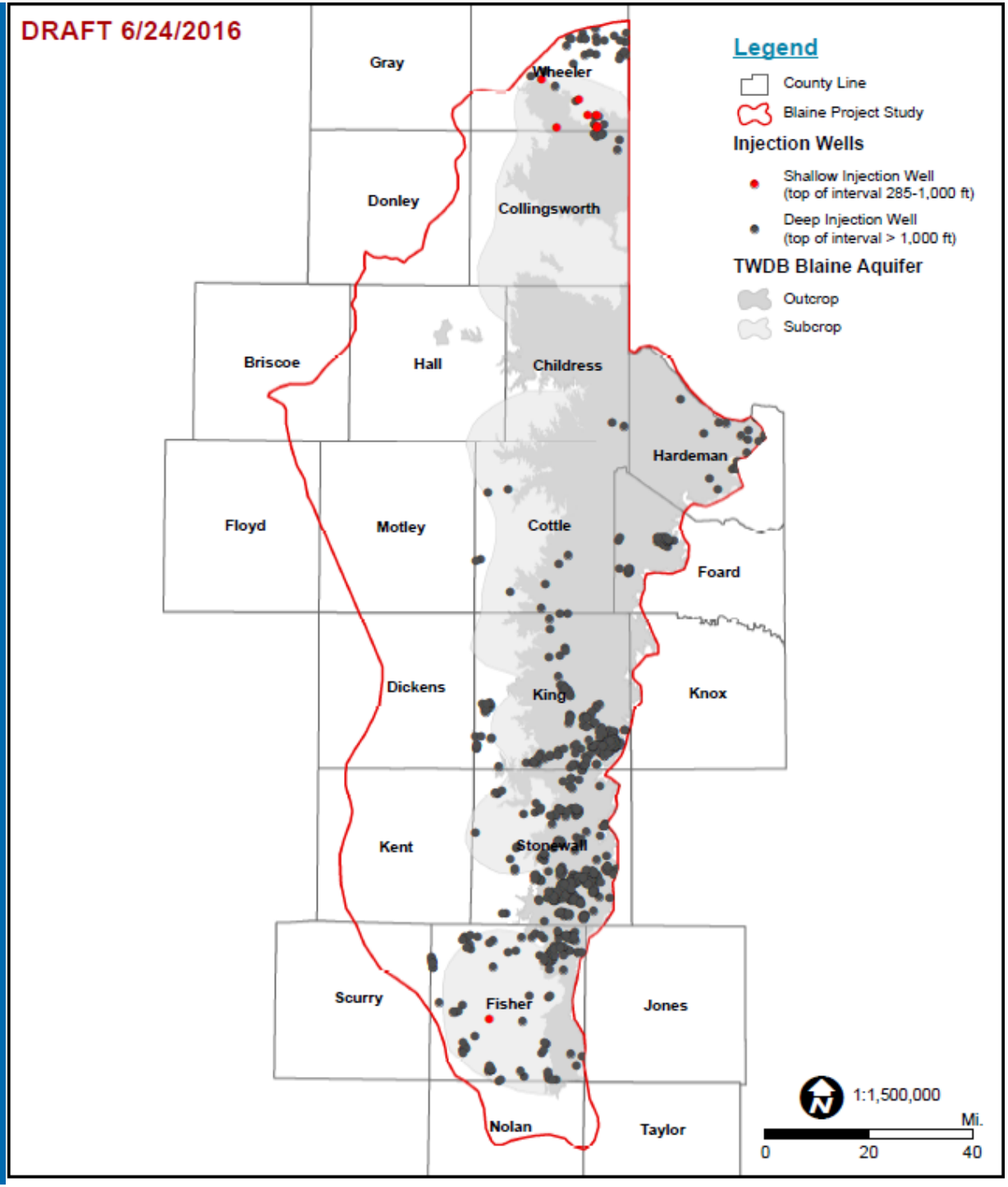
1. Identify exclusion areas and buffer zones

2. Identify remaining regions where moderate groundwater production might be obtained

Identification of Exclusion Areas

- Existing areas of the aquifer serving as a “significant source of water supply for municipal, domestic or agricultural purposes” cannot be significantly impacted
- “Area of geologic stratum that is designated or used for wastewater injection through the use of injection wells or disposal wells ...”
- Comments from first Stakeholder meeting
- Wildlife Management Areas (not required by HB-30)
- Based on existing well control; input?

Injection Wells - Generally Deep Except for Wheeler County



Exclusion Areas

Legend

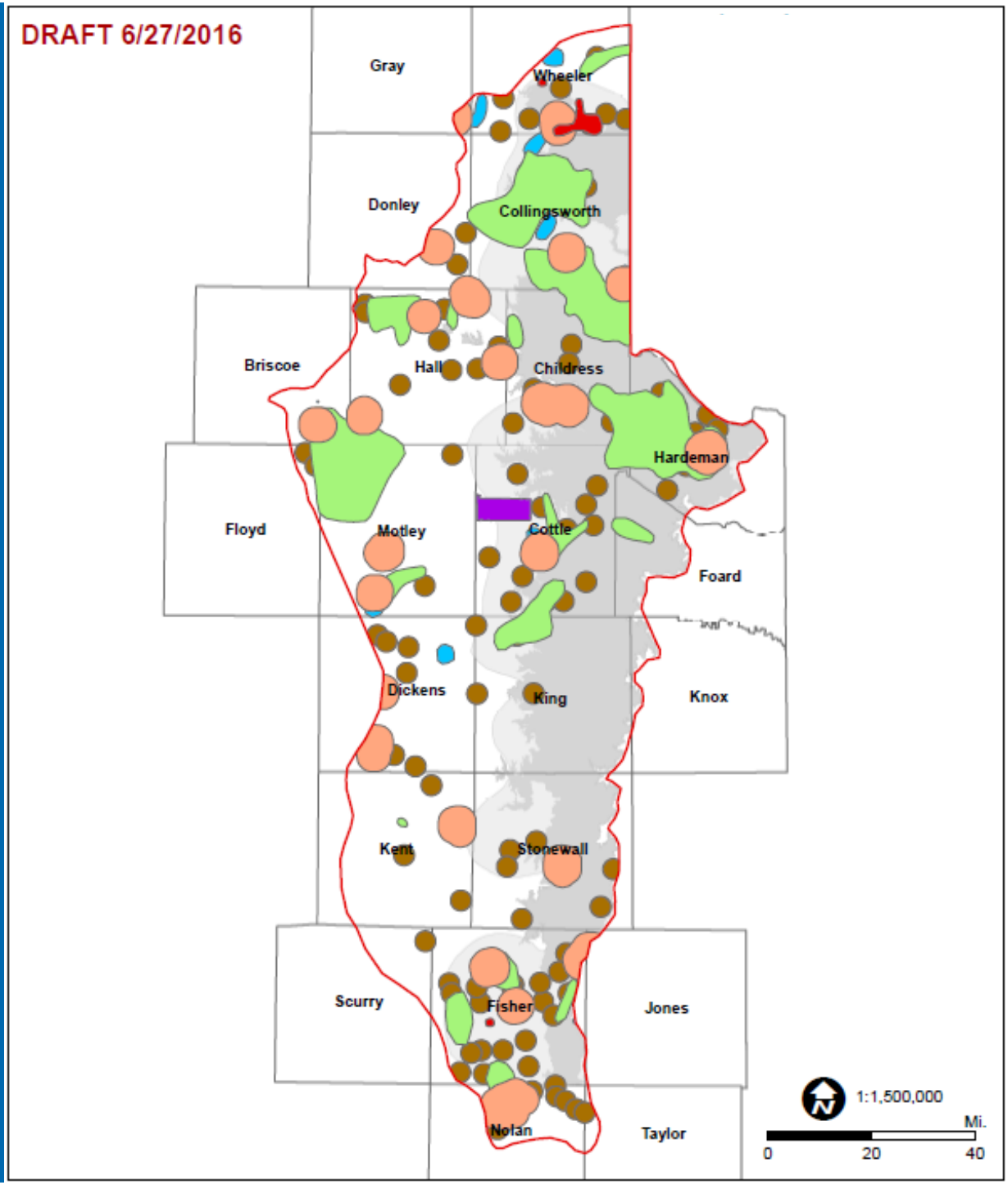
- County Line
- Blaine Project Study Area

Exclusion Areas

- Injection Well Area
- Irrigation Well Area
- Public Supply Area
- City Limit 3-Mile Buffer
- Populated Place 2-Mile Buffer
- Wildlife Management Area

TWDB Blaine Aquifer

- Outcrop
- Subcrop



Identification of Potential Brackish Groundwater Production Areas

- Regions likely to have moderate (>50 - 100 gpm) groundwater production
  - Documented cavities from driller reports
  - Karst features at land surface (sinkholes)
  - Geologic structure
  - Reported well yields
  - Infrastructure distance

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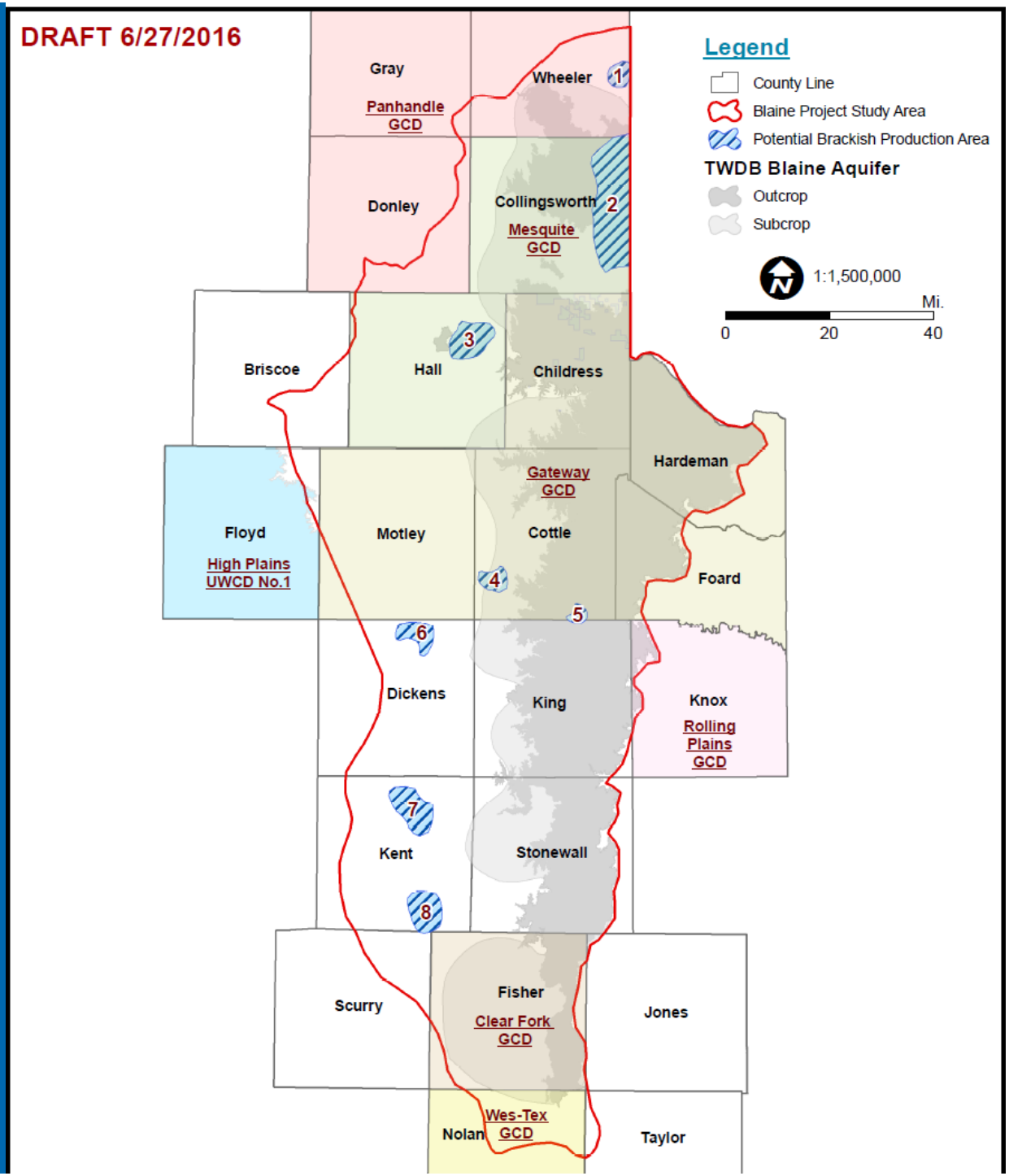
Michelle A. Sutherland, LLC.

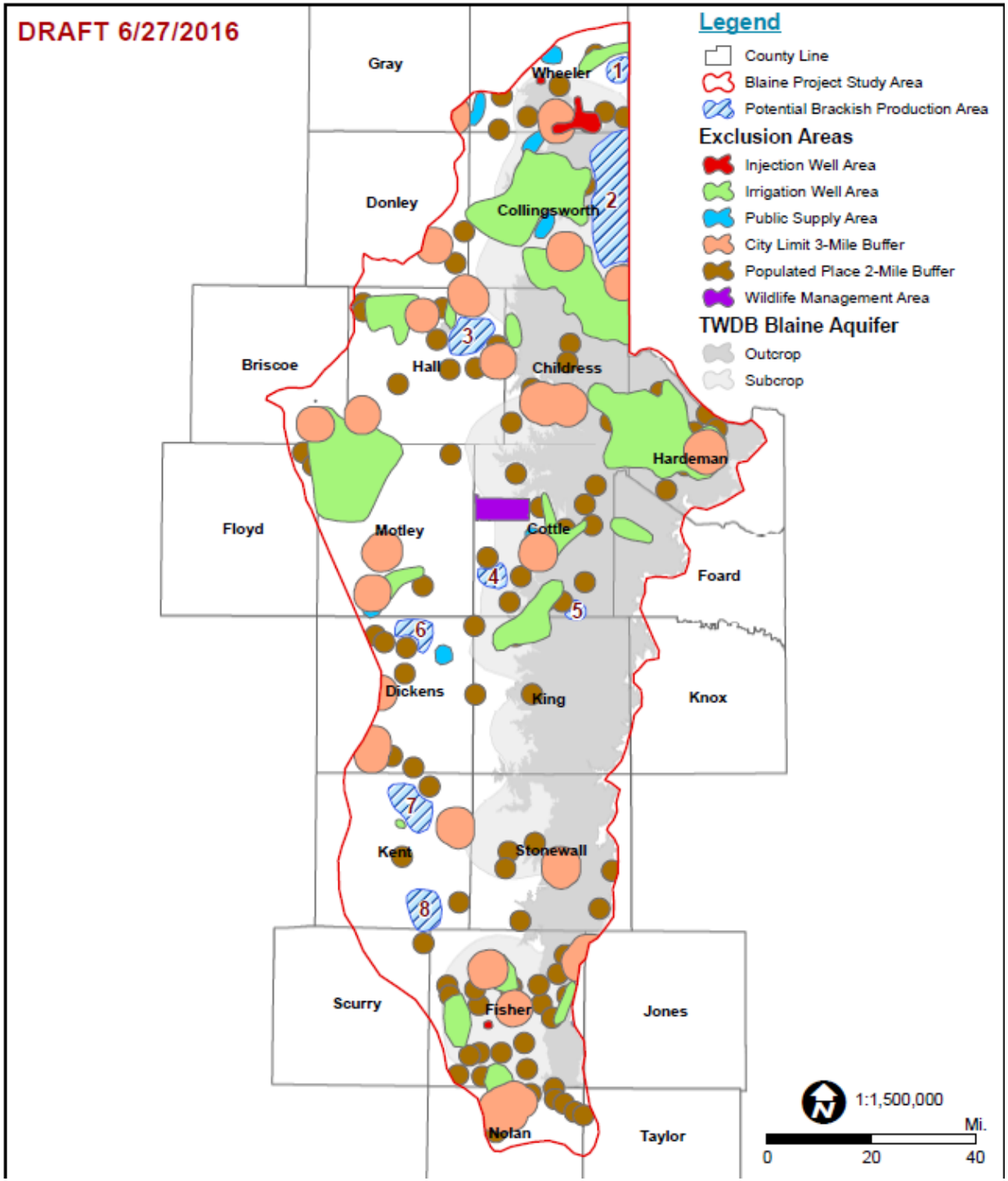
Potential Brackish Groundwater Production Areas



Potential Groundwater Production Areas

Production Area	County	Existing well Yield > 50 gpm	Cavities	Sinkholes	Geologic Structure	Infrastructure Distance (miles)
1	Wheeler	Yes	No	Yes	Yes	10-15
2	Collingsworth	Yes	Yes	Yes	Yes	< 5
3	Hall	Yes	Yes	Yes	Yes	< 5
4	Cottle	No	Yes	Yes	Yes	5-10
5	Cottle	No	No	Yes	No	10-15
6	Dickens	Yes	No	Yes	No	5-10
7	Kent	Yes	Yes	Yes	No	5-10
8	Kent	No	Yes	Yes	No	10-15

Potential Production and Exclusion Areas



Public Comments and Moving Forward

- The delineation of potential production areas presented today are draft and open to public comment
- This presentation will be publicly available at the TWDB Blaine Aquifer BRACS website; Stakeholders will receive an email when it is posted
- Stakeholders should have their comments to the TWDB by August 1st
- 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 in the fall
- Stakeholders will receive an email with the meeting date, time, and location
- The biennial report to the Texas Legislature will be approved at a public board meeting in the fall
- Stakeholders will receive an email with the meeting date, time, and location

Thank You!

DBS&A
Daniel B. Stephens & Associates, Inc.

JOHN SHOMAKER & ASSOCIATES, INC.
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Allan R. Standen LLC
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