

Aquifer characterization for brackish groundwater production and **ASR**

Case study: Carrizo-Wilcox aquifer in Central Texas

Groundwater Protection Council Annual Forum

June 22, 2022 – Salt Lake City

Authors and reports



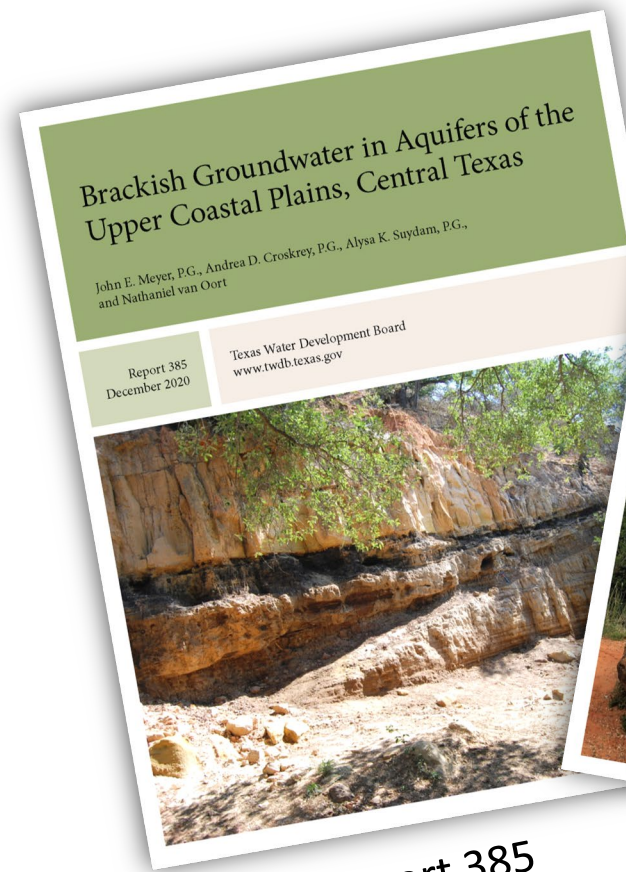
Andrea Croskrey, P.G.

TWDB Aquifer Storage and Recovery (ASR) discipline lead

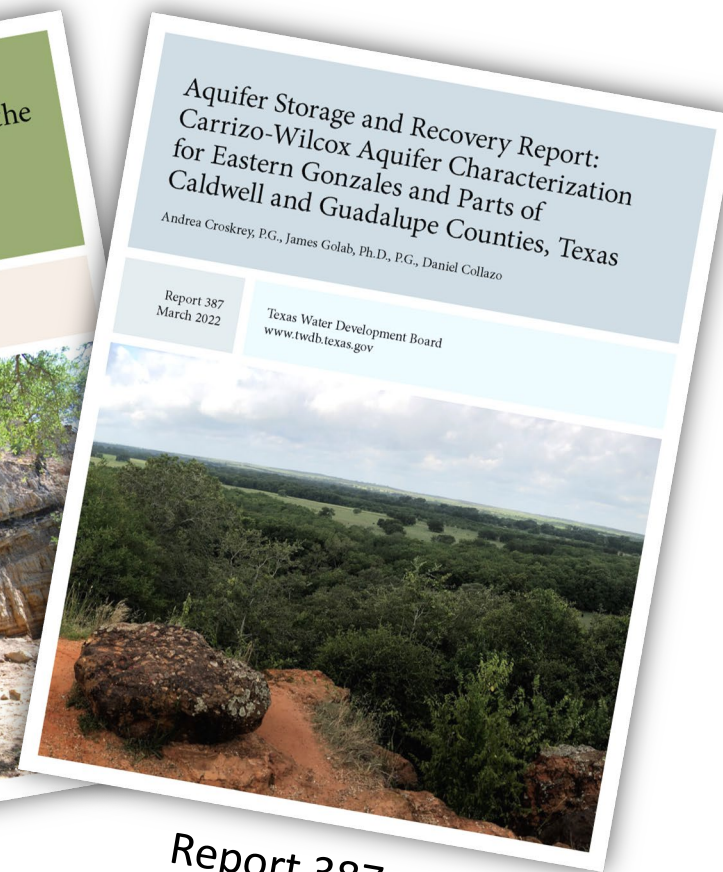


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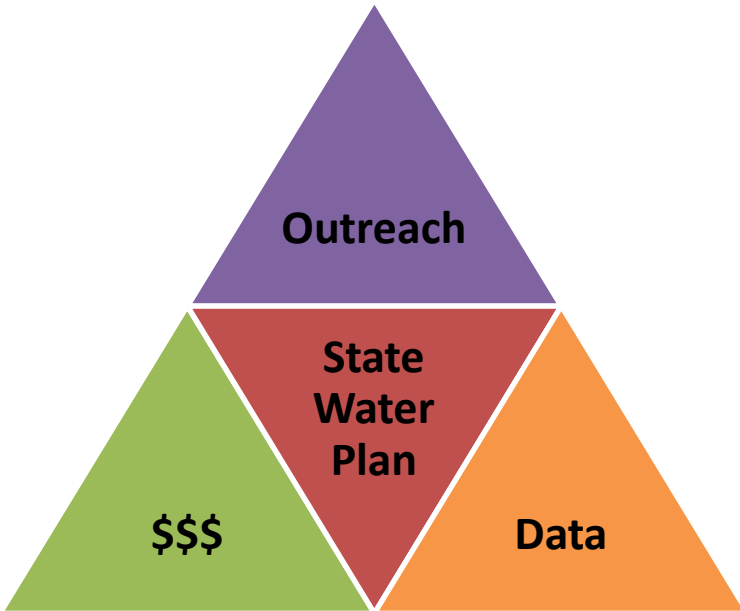


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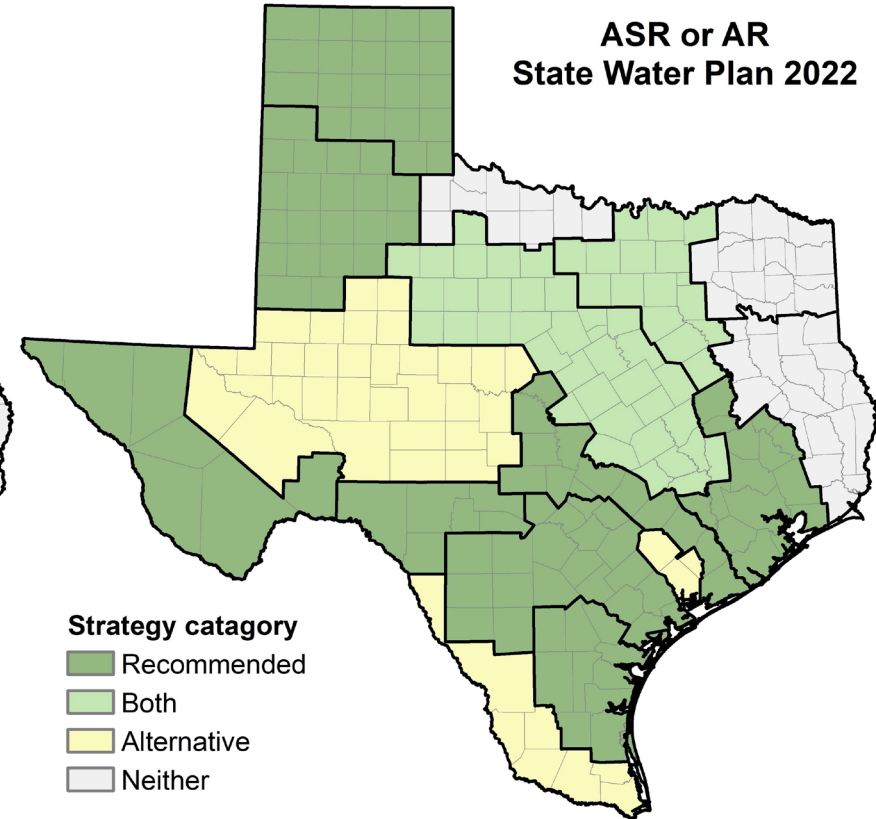
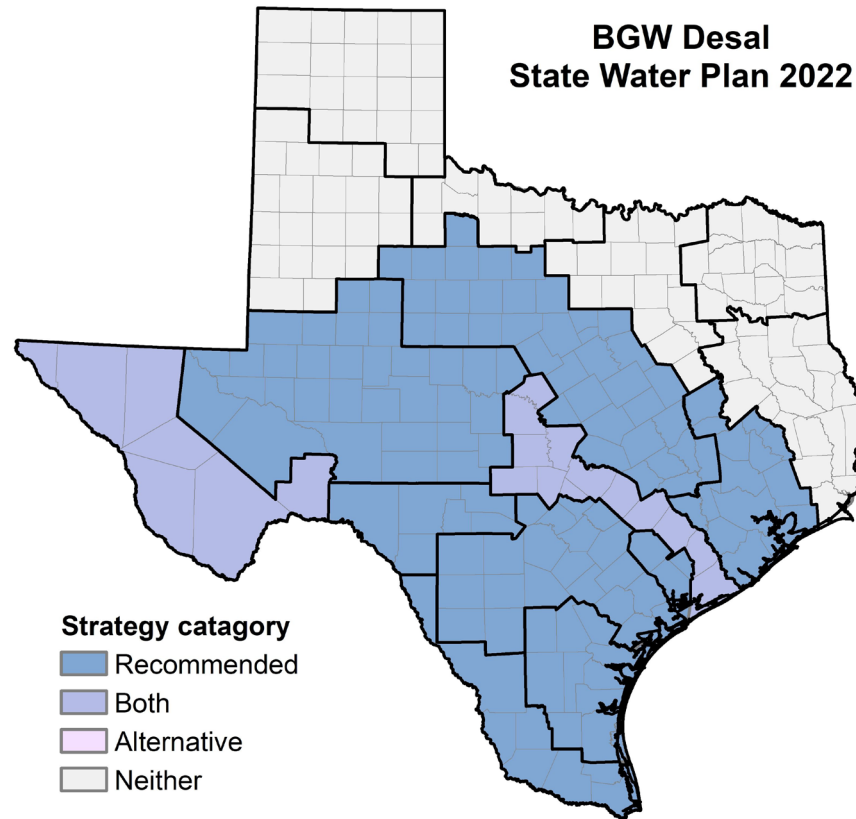


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Texas Water Development Board (TWDB)



50-year State Water Plan
every 5 years



TWDB Study Mandates

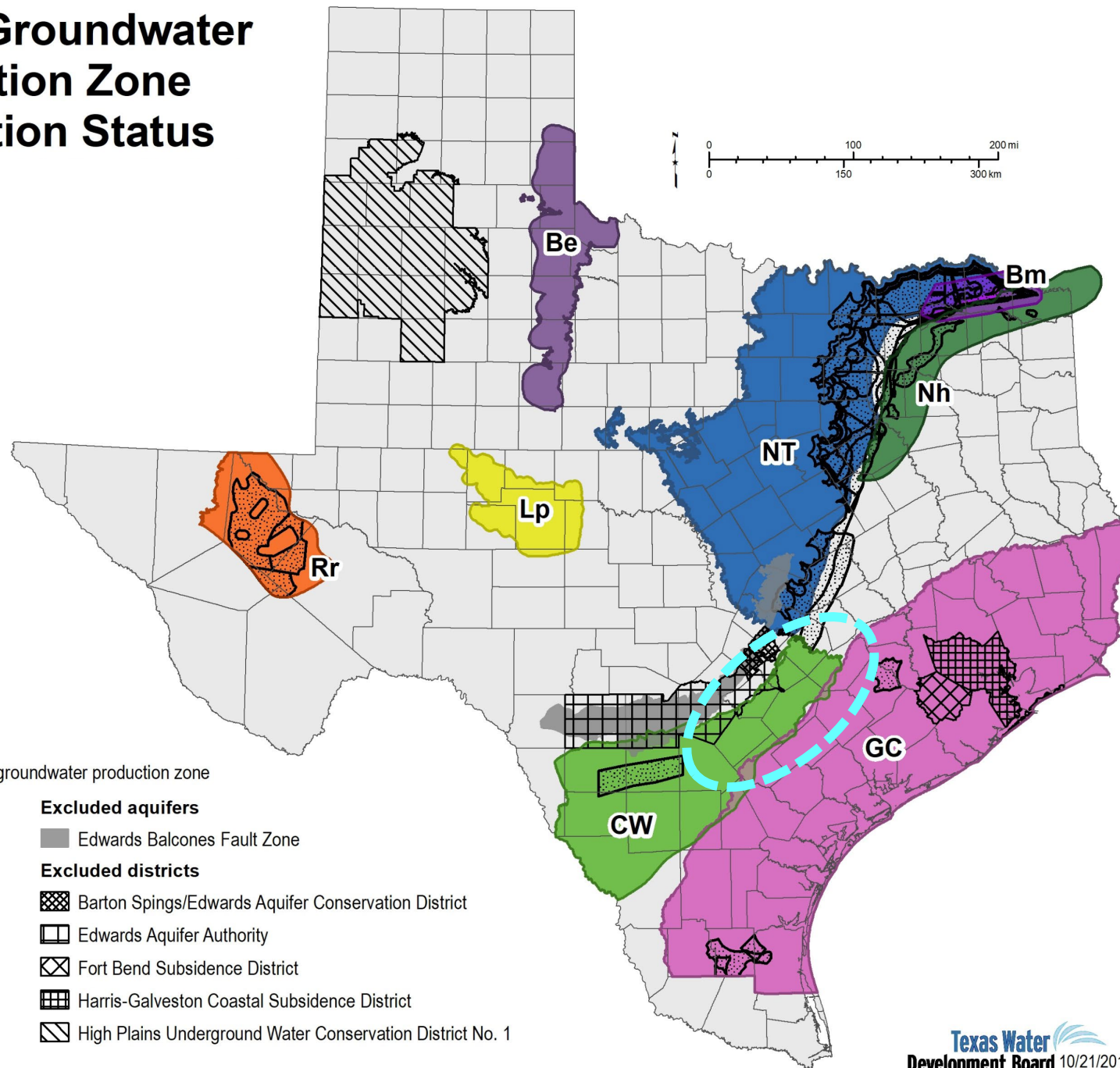
Brackish groundwater

- 2015 Texas House Bill 30
 - Texas Water Code § 16.060
 - Brackish groundwater production zones (BGPZ) criteria
 - Report to the legislature
- 2019 Texas Senate Bill 1041
 - Identify and designate BGPZ for the entire state by December 1, 2032

ASR & AR

- 2019 Texas House Bill 721
 - Texas Water Code § 11.155
 - Statewide survey of aquifer suitability for ASR or AR projects in Texas
 - Conduct ASR and AR studies
 - Report to the regional water planning groups

Brackish Groundwater Production Zone Designation Status



Brackish Groundwater in Aquifers of the Upper Coastal Plains, Central Texas

John E. Meyer, P.G., Andrea D. Croskrey, P.G., Alysa K. Suydam, P.G., and Nathaniel van Oort

Report 385
December 2020

Texas Water Development Board
www.twdb.texas.gov



Area designated as a brackish groundwater production zone

2016 Aquifers

- Be. Blaine Aquifer
- CW. Carrizo-Wilcox Aquifer
- GC. Gulf Coast Aquifer
- Rr. Rustler Aquifer

2019 Aquifers

- Bm. Blossom Aquifer
- Lp. Lipan Aquifer
- NT. Northern Trinity
- Nh. Nacatoch Aquifer

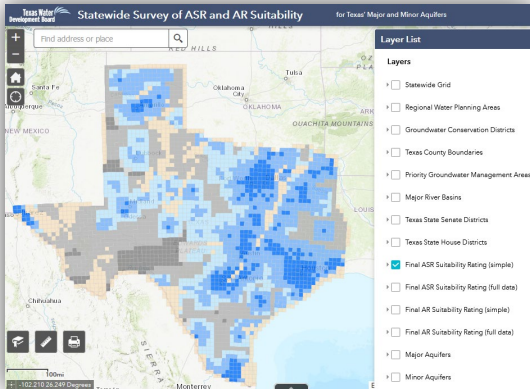
Excluded aquifers

- Edwards Balcones Fault Zone

Excluded districts

- Barton Spings/Edwards Aquifer Conservation District
- Edwards Aquifer Authority
- Fort Bend Subsidence District
- Harris-Galveston Coastal Subsidence District
- High Plains Underground Water Conservation District No. 1

ASR mandate accomplishments



Statewide survey of aquifer suitability for ASR or AR projects in Texas

Webpage

<https://www.twdb.texas.gov/innovativewater/asr/projects/Statewide/index.asp>

StoryMap

<https://twdb-wsc.maps.arcgis.com/apps/MapSeries/index.html?appid=75313de26daf4994bcb590fdb8846b80>

Aquifer Storage and Recovery Report:
Carrizo-Wilcox Aquifer Characterization
for Eastern Gonzales and Parts of
Caldwell and Guadalupe Counties, Texas

Andrea Croskrey, P.G., James Golab, Ph.D., P.G., Daniel Collazo

Report 387
March 2022

Texas Water Development Board
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First completed study is *“Aquifer Storage and Recovery Report: Carrizo-Wilcox Aquifer Characterization for Eastern Gonzales and parts of Caldwell and Guadalupe Counties, Texas”*

Study selection

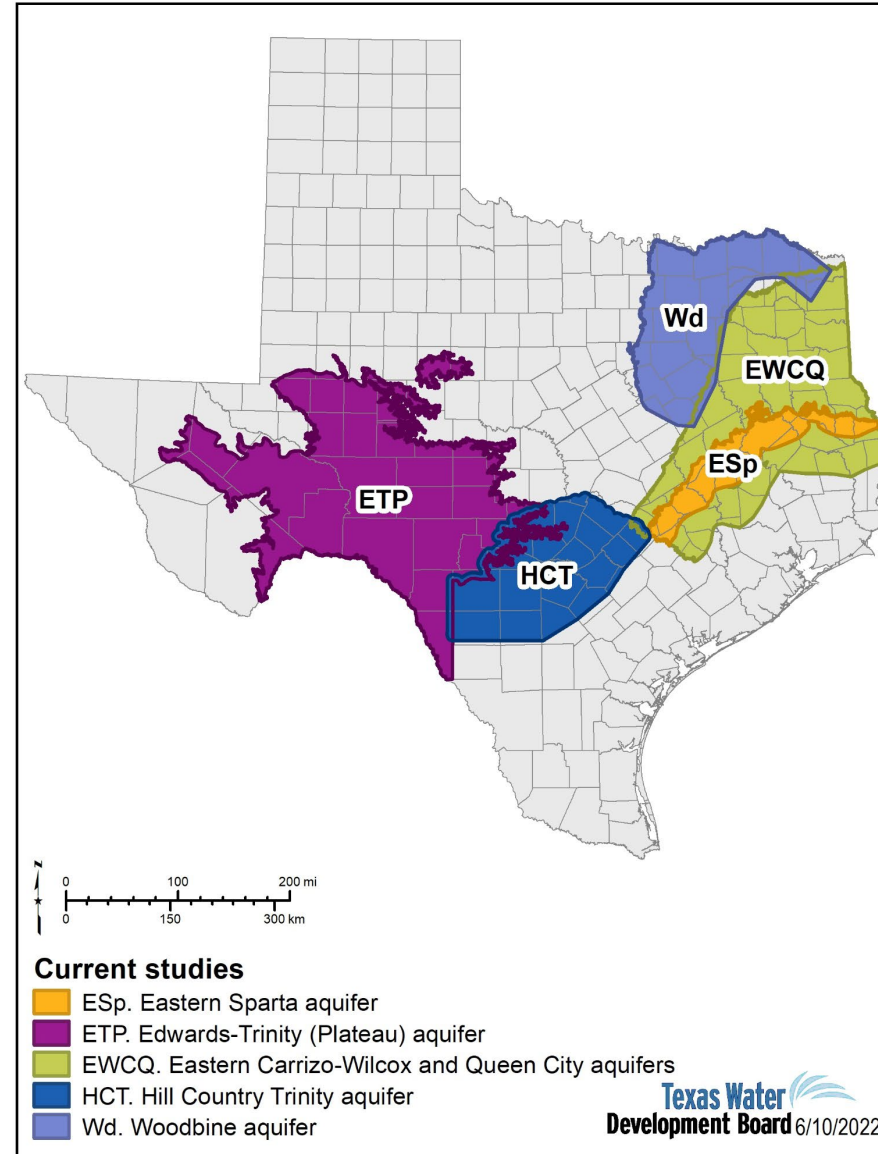
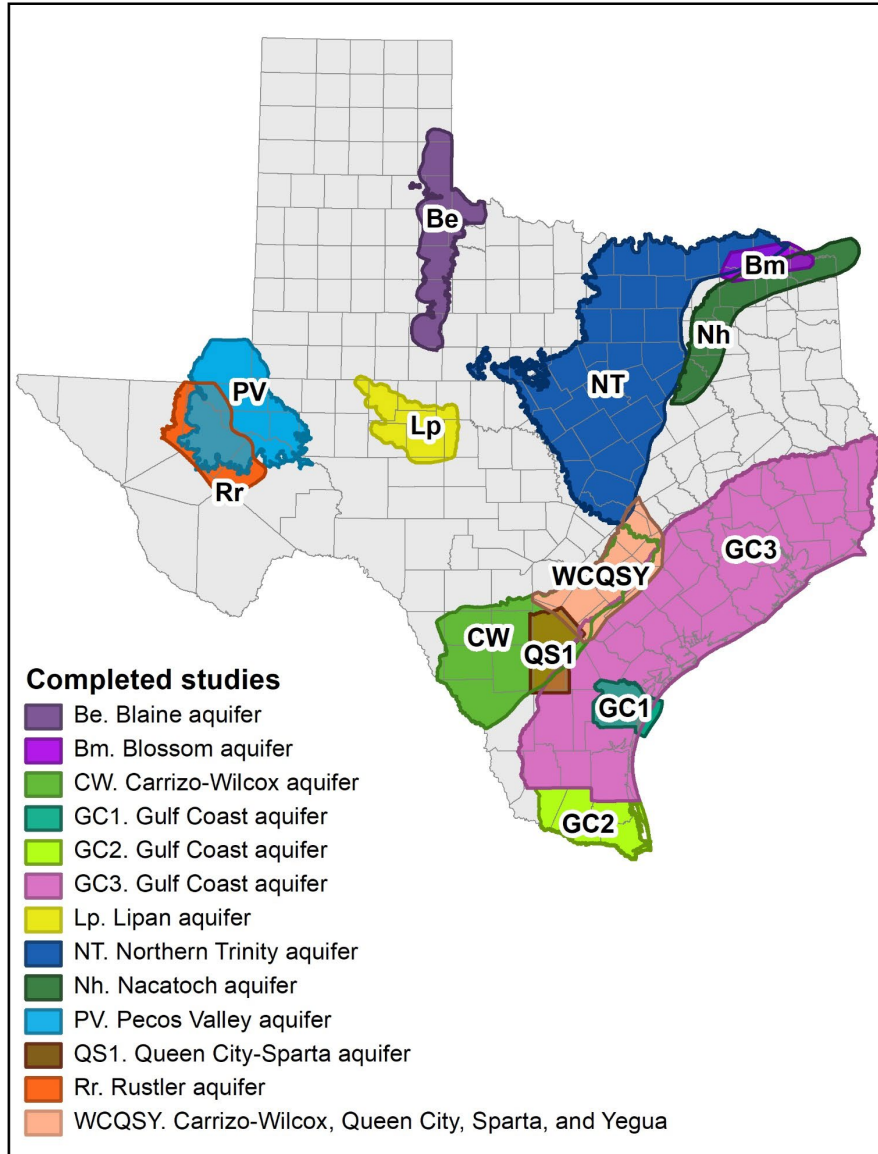
Brackish groundwater

- Prioritized areas with
 - Strategies in the state water plan
 - Data
 - Growing water demands
 - Staff skills and abilities

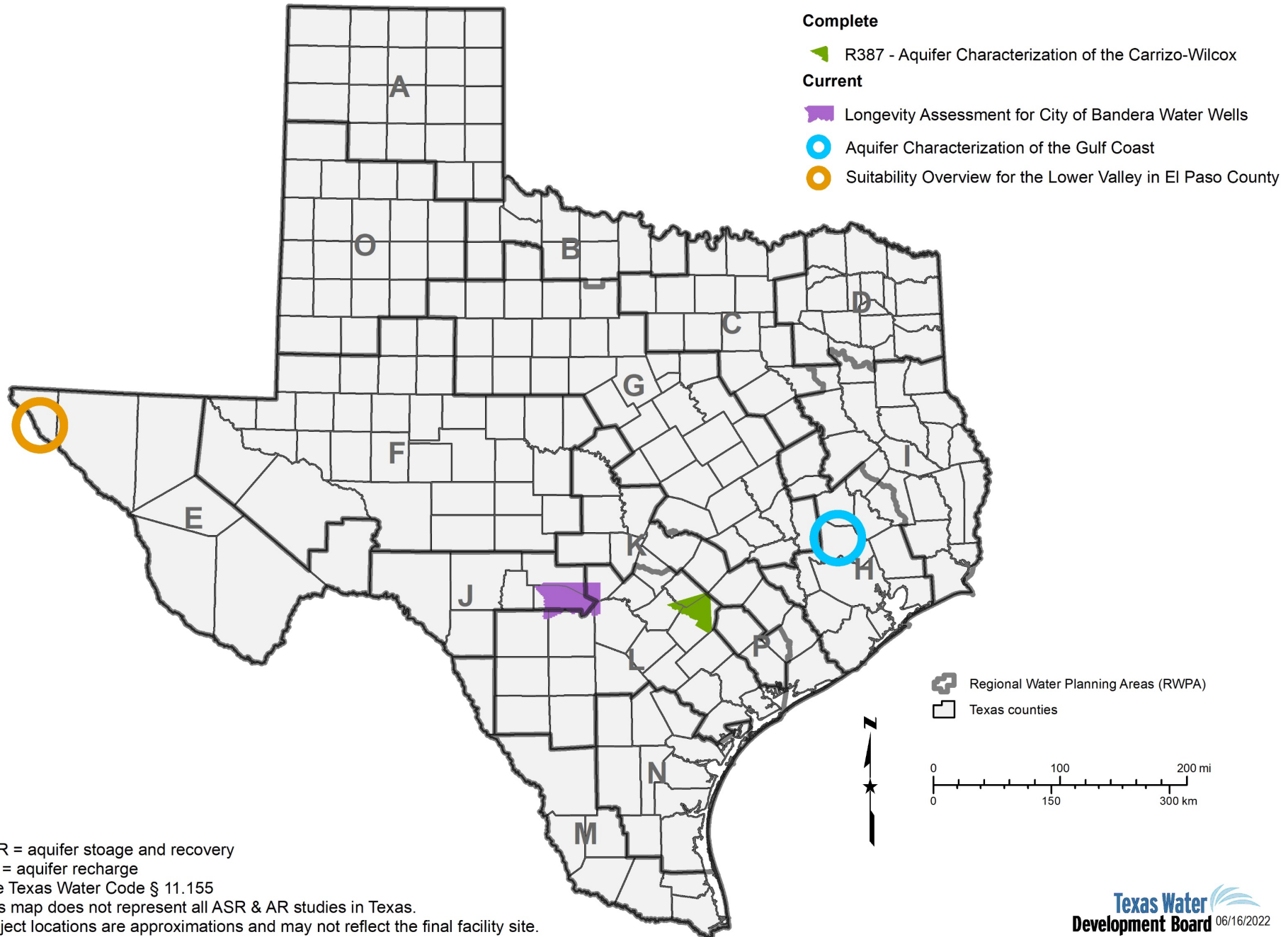
ASR & AR

- Prioritized areas with
 - Strategies in the state water plan
 - Data
 - Staff skills and abilities
 - Sponsor interest
 - Project status, timeline

Brackish Resources Aquifer Characterization System (BRACS) Program - Study Status



TWDB ASR or AR study status



ASR = aquifer storage and recovery
 AR = aquifer recharge
 See Texas Water Code § 11.155
 This map does not represent all ASR & AR studies in Texas.
 Project locations are approximations and may not reflect the final facility site.

Study area

Report 385 - Brackish Groundwater

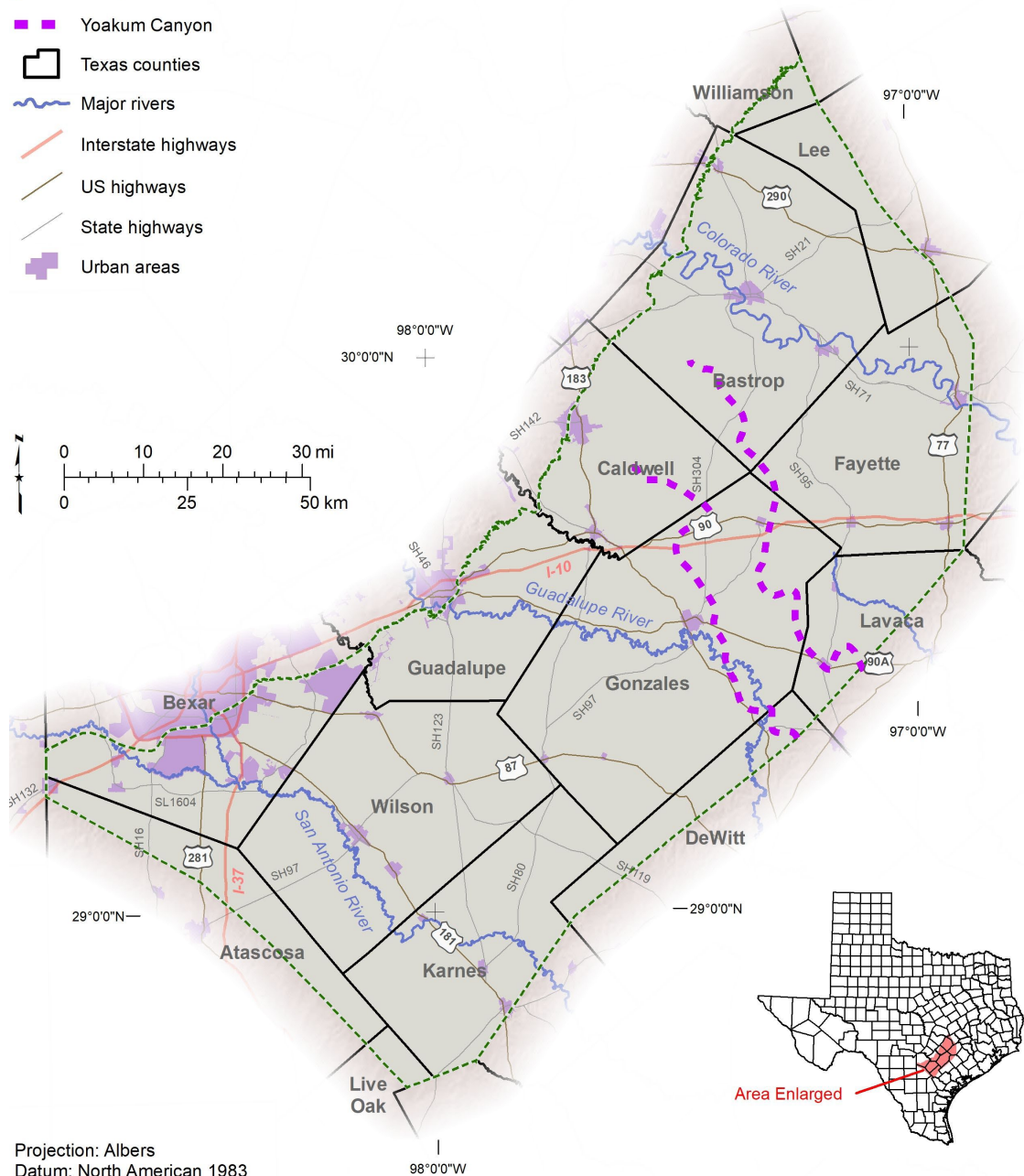
- Regional
- Parts of 14 counties
- 5,900 sq mi
- 4 aquifers
- 1,600 Carrizo Sand wells
- Base of aquifer depth limit
 - Carrizo as deep as ~8,400 ft

Report 387 - ASR

- Sub-regional
- Parts of only 3 counties
- 568 sq mi
- 1 aquifer (Carrizo-Wilcox)
- 662 wells
- 2,000 ft depth limit

Report 385 BGW study area

- Study area outline
- Yoakum Canyon
- Texas counties
- Major rivers
- Interstate highways
- US highways
- State highways
- Urban areas

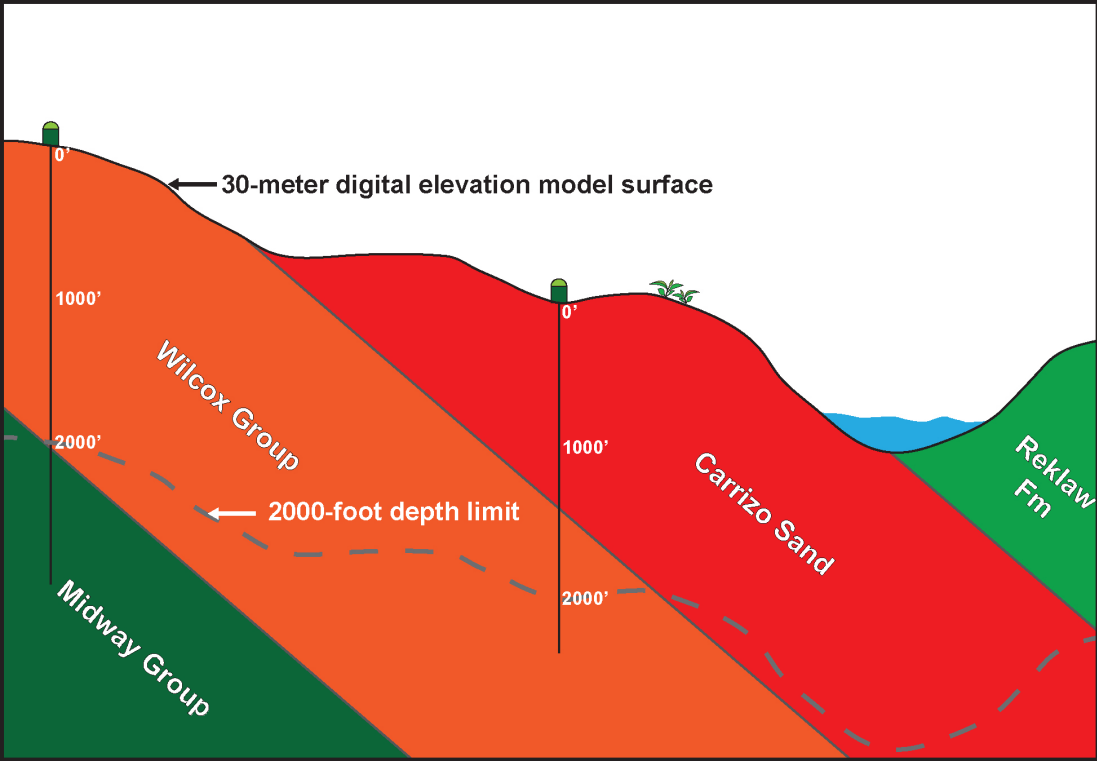
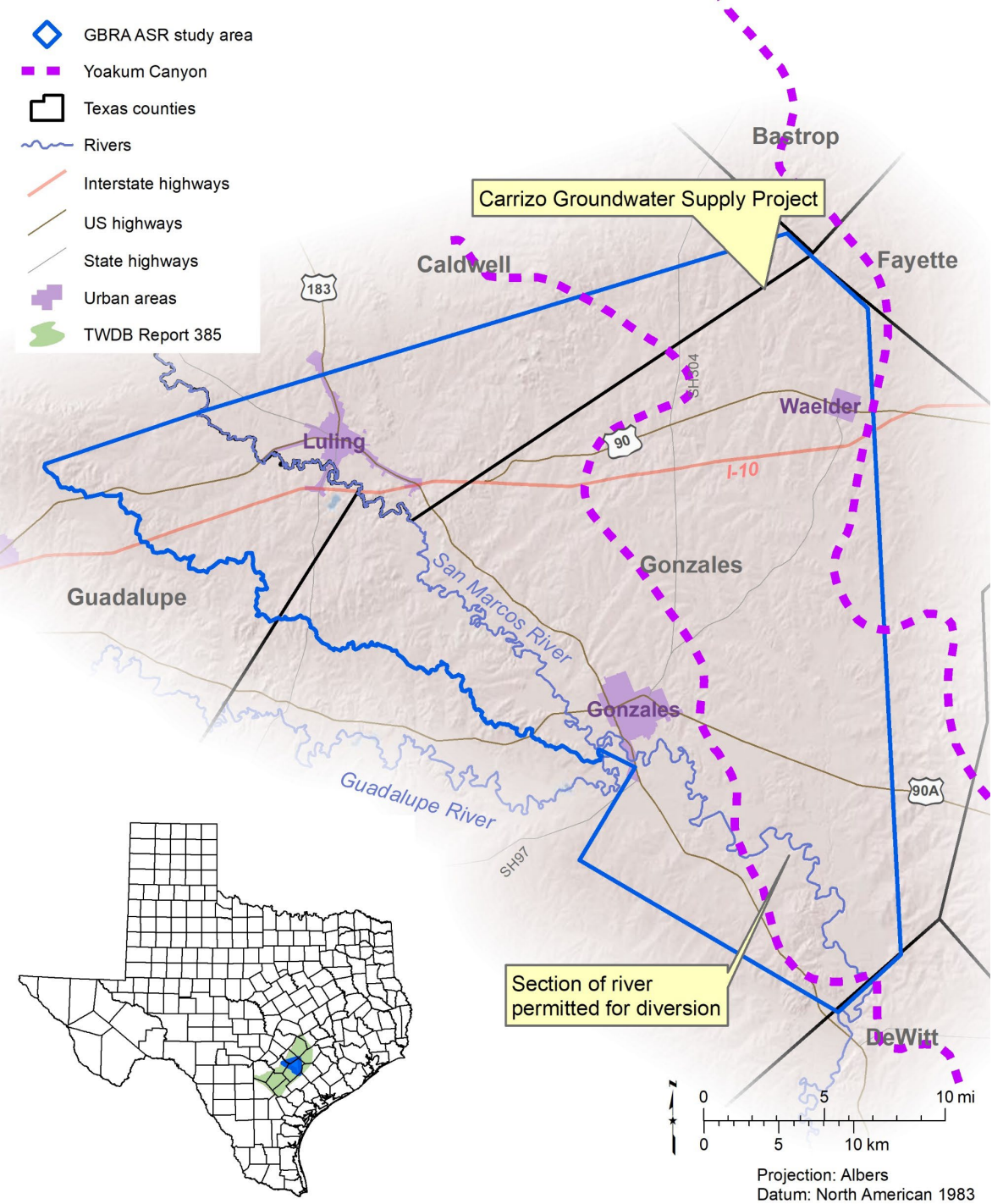


Epoch	Group	Formation	USGS nomenclature	Texas Hydrogeologic unit
Eocene	Jackson	Caddell	Vicksburg-Jackson confining unit	Yegua-Jackson Aquifer
		Moodys Branch		
	Claiborne	Hiatus	Upper Claiborne Aquifer	
		Yegua		
		Cook Mountain	Middle Claiborne Confining unit	
		Hiatus		
		Sparta	Sparta Aquifer	
		Weches	Middle Claiborne Aquifer	
		Hiatus		
		Queen City	Queen City Aquifer	
		Reklaw	Lower Claiborne confining unit	
		Hiatus		
	Wilcox	Carrizo	Lower Claiborne – upper Wilcox Aquifer	Carrizo-Wilcox Aquifer
		Hiatus		
Sabinetown				
Rockdale		Middle Wilcox Aquifer		
Seguin				
Paleocene	Midway	Wills Point	Midway confining unit	Confining unit

Stratigraphic column showing the relationship between the epochs, formations, and hydrogeologic units. The United States Geological Survey (USGS) nomenclature is based on Ryder (1996). Texas hydrogeologic units are based on TWDB (2007) and George and others (2011). This table does not reflect the entire Jackson or Midway stratigraphy. This table is not scaled vertically in uniform units of time.

Report 387 ASR study area

- Existing infrastructure
- 2,000-foot depth limit



Aquifer characterization

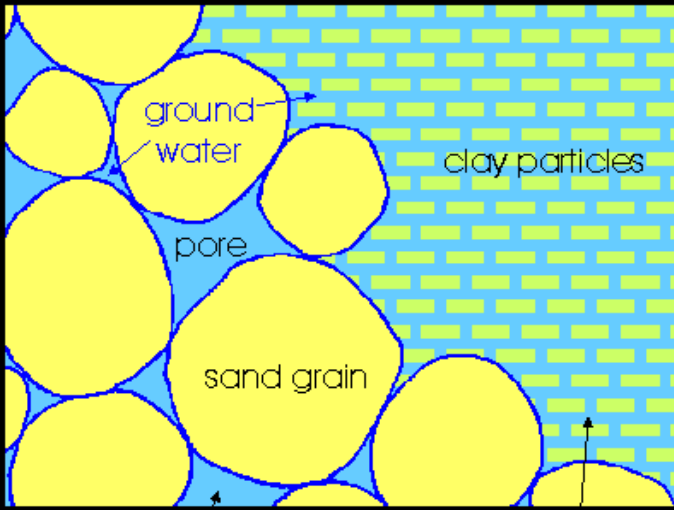
Report 385 - Brackish Groundwater

- WHERE is the water?
- WHAT is the salinity?
- HOW much is there?

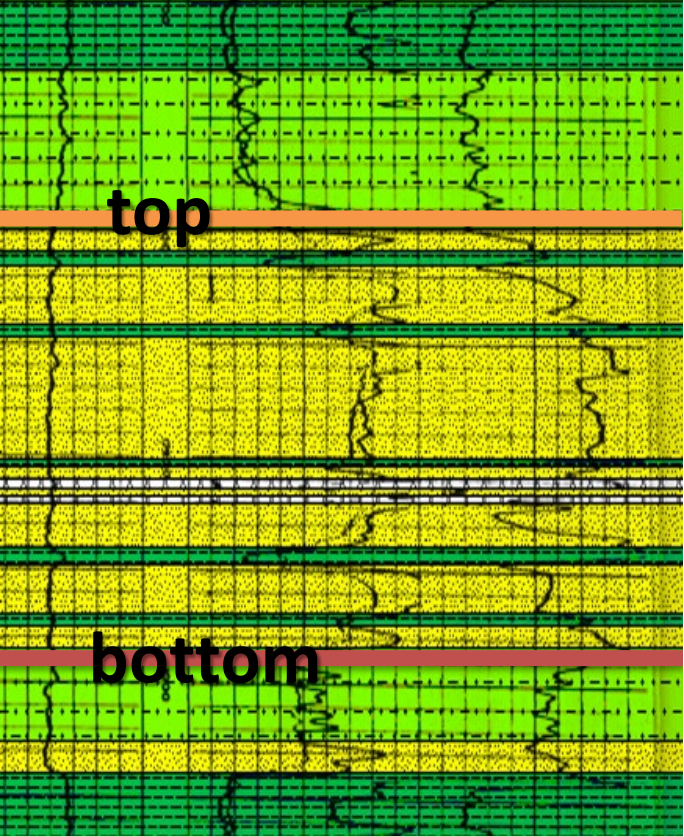
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- WHERE can the water be stored?
 - How deep?
 - How thick?
- WHAT is the host water quality?

Aquifer characterization



moderate porosity, high permeability *high porosity, low permeability*



Stratigraphy – Lithology - Salinity

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	4	BROWN CLAY
4	9	RED CLAY
9	46	WHITE-YELLOW CLAY/IRON ROCK
46	60	SANDY GRAY SHALE/IRON ROCK
60	95	BLACK-GRAY SAND/IRON ROCK
95	170	SWAMPY GREEN-GRAY SHALE
170	198	SANDY BROWN SHALE/SAND
198	230	GRAY SHALE/SMALL ROCKS/LIGNITE
230	267	SANDY GRAY SHALE/LIGNITE/SAND
267	304	FINE TO MEDIUM GRAY SAND/ROCKS
304	358	CRUMBLY GRAY-BROWN SHALE
358	370	ROCKY/CRUMBLY GRAY-BROWN SHALE
370	371	ROCK

Simplified Lithology

Clay (0%)
Sandy clay (35%)
Sand (100%)
Clay (0%)
Sandy clay (35%)
Clay (0%)
Sand (100%)
Shale (0%)
Unknown (0%)

Groundwater Salinity Classification	Salinity Class Code	Total Dissolved Solids (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

ANALYTICAL STATEMENT COUNTY CALDWELL
LAB NO. 85269

Date of collection Dec. 31, 1963

Source (type of well) ----- X
Owner Abner Moore
Houston, Texas

Yield 25+ gpm pmp est
Pt of coll. direct

Sampled after pumping ----- hours
Yield 74.5 gpm stock
Pt of coll. direct

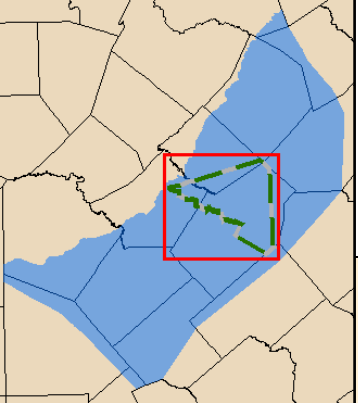
cc. clear
74.5 stock
C. R. Follett
Harvey Kunze
Jan. 8, 1964
by LR
submitted JAN 24 1964

	apm	ppm
Ignition Loss		
Dissolved Solids:		
Calculated (sum)	152	
Residue at 180°C		47
Tons per acre foot	0.21	
Hardness as CaCO ₃	26	
N.C. hardness	26	
T. No. 70	2,3	0.00
Specific conductance (microhos at 25°C)	224	
pH 4.8		
Color		
SiO ₂		
Fe		
FB (total)		
Ca	309	6.2
Mg	214	2.6
Na		
K		
Na+K	1.195	27
HCO ₃	.000	0
CO ₃	.000	0
SO ₄	.666	32
Cl	1.044	37
F	.005	0.1
NO ₃	.003	0.2
	1.718	

Copy to owner.
P. O. Box 13120
Houston 19, Texas

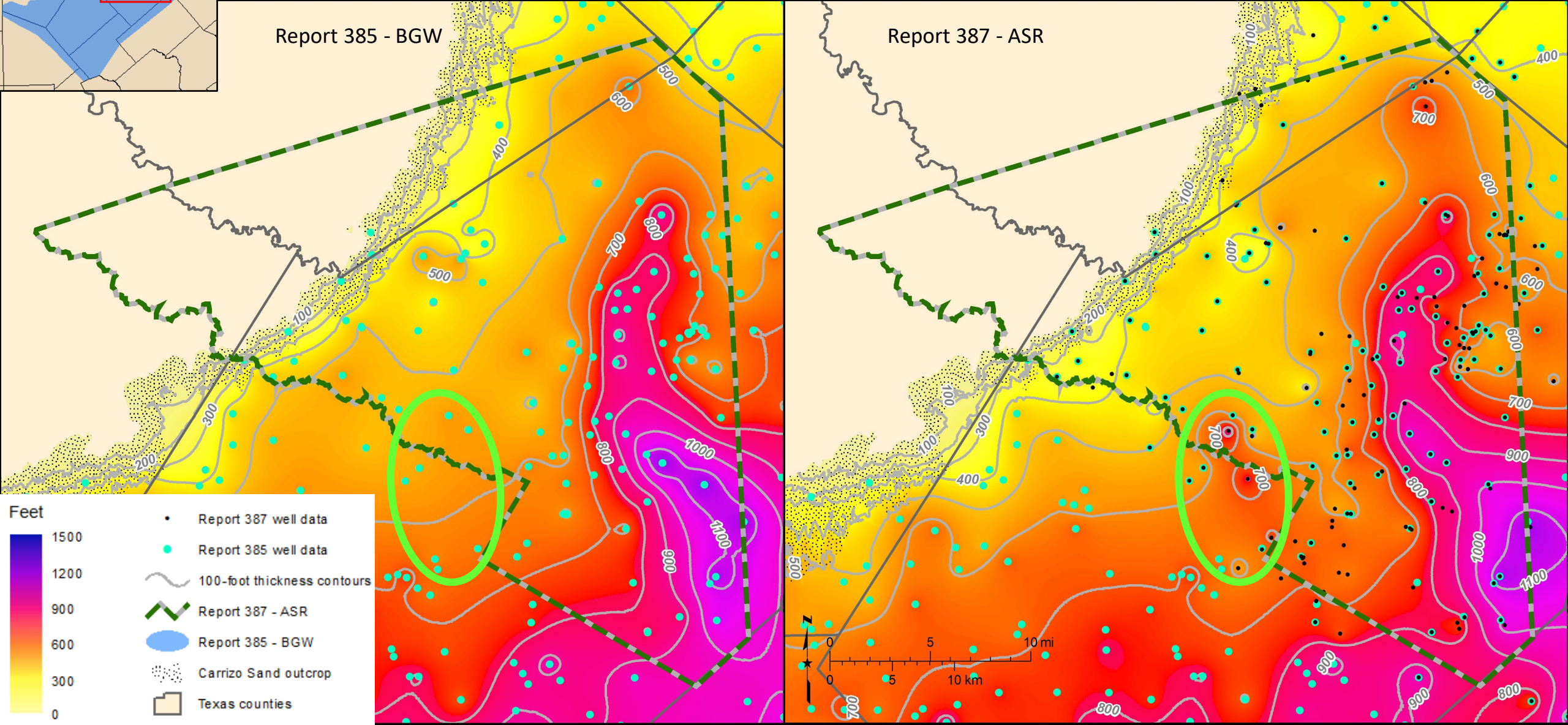
KEY PUNCHED

Carrizo thickness



Report 385 - BGW

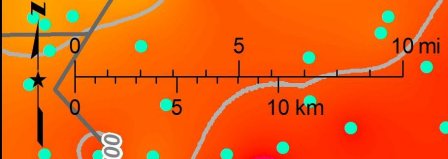
Report 387 - ASR



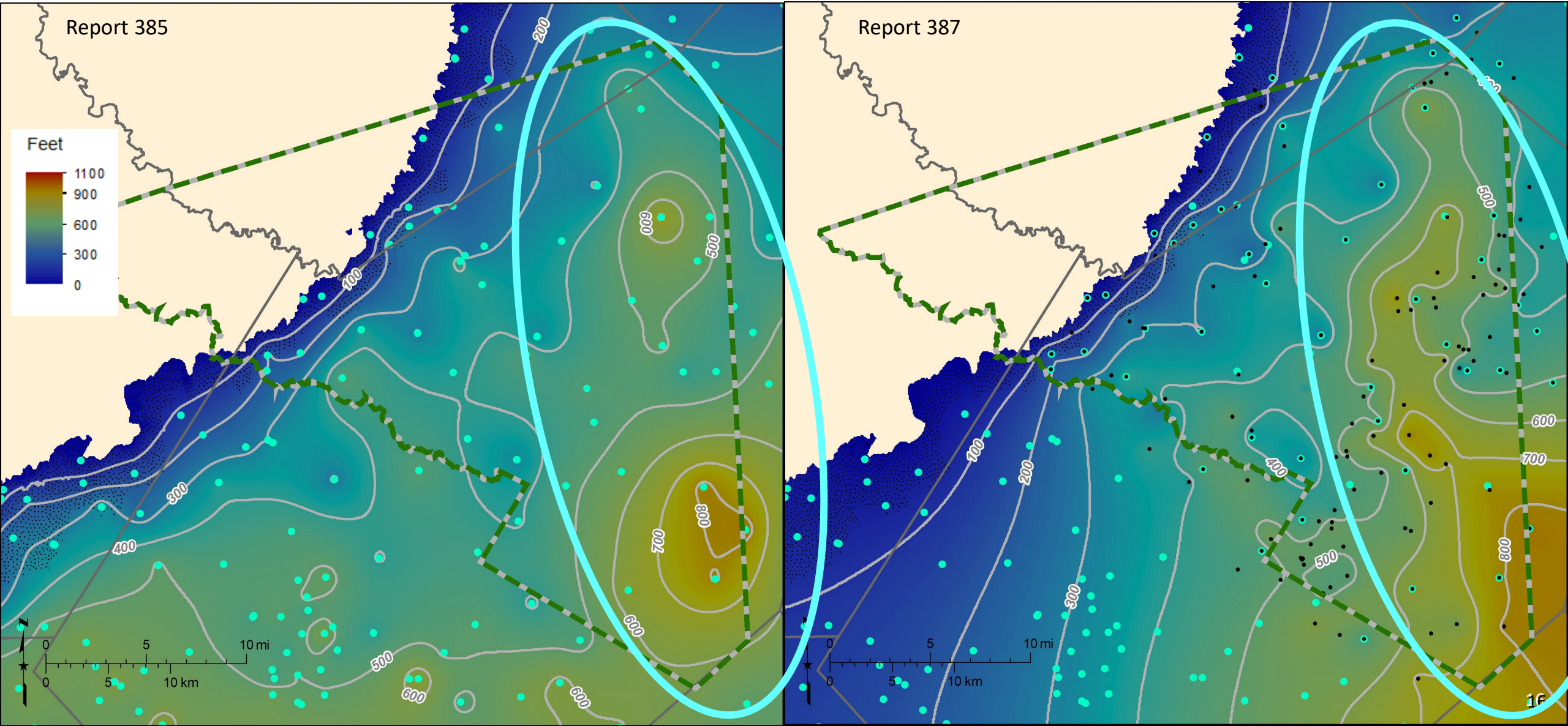
Feet

1500
1200
900
600
300
0

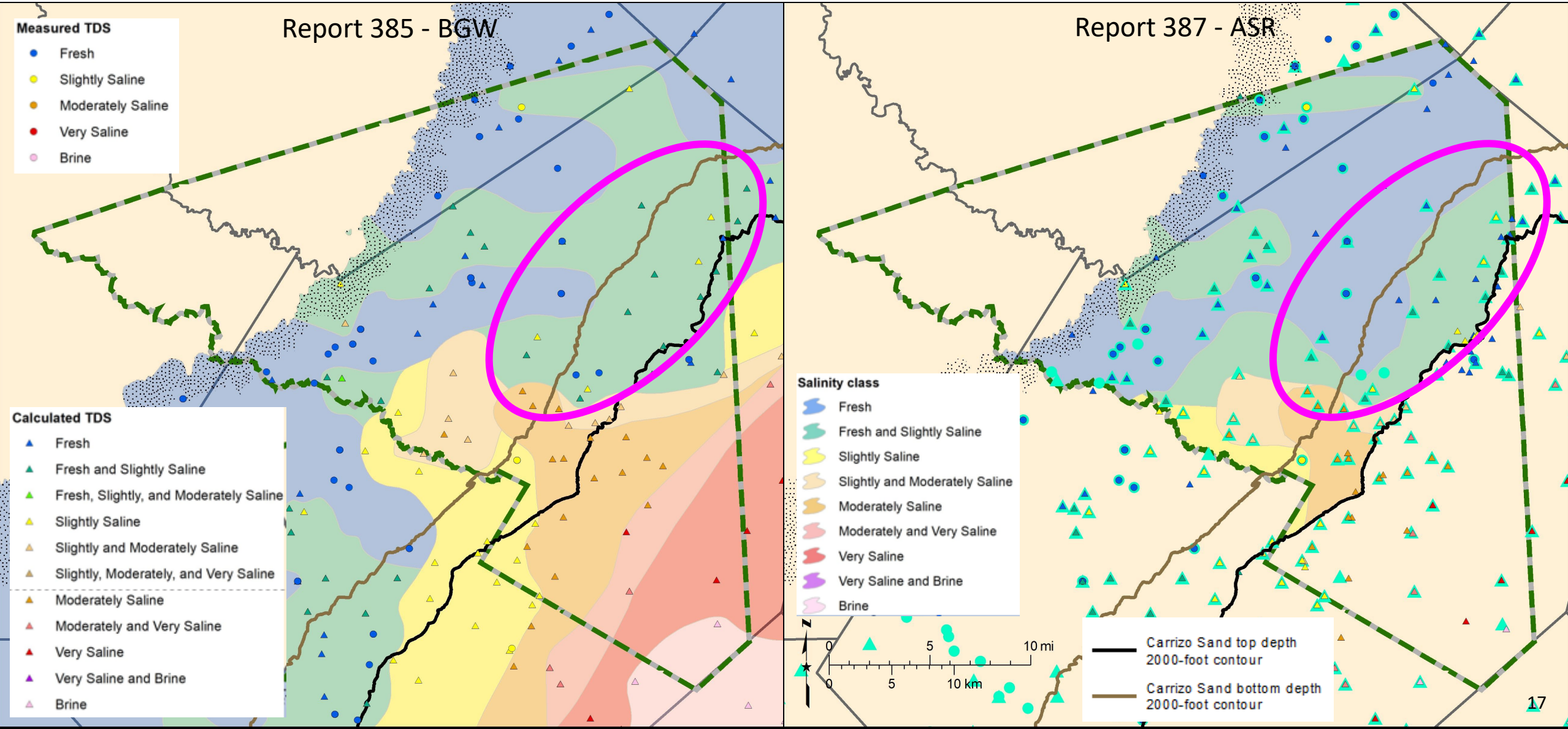
- Report 387 well data
- Report 385 well data
- ~ 100-foot thickness contours
- Report 387 - ASR
- Report 385 - BGW
- Carrizo Sand outcrop
- Texas counties



Carrizo net sand



Carrizo salinity classes



Brackish groundwater results

- >230 million acre-feet of brackish groundwater in the central region of the Upper Coastal Plains aquifers (284 km³)
- Excellent framework for additional studies

ASR results

- Most favorable portion of study area is in a 9-mile x 25-mile swath of Carrizo Sand
- Variability in sand and water quality distribution
- Results delivered in a timeframe to benefit the ASR project moving forward

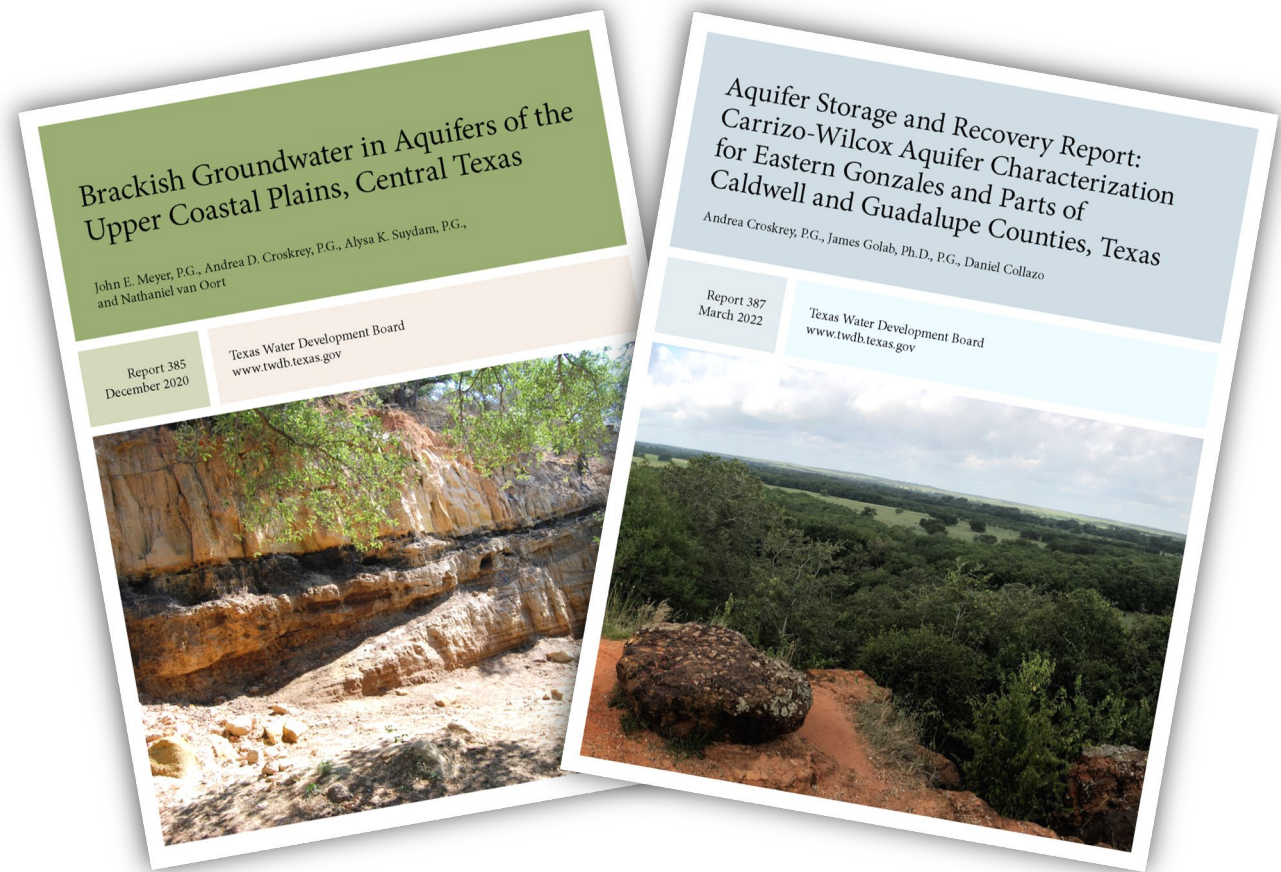
Conclusions

- Texas' water planning process and the state legislature drive the necessity for studying our aquifers
- Study area, data collection, and analysis needs to match objectives
- Different mandates, different results
- Regional BGW study framework expedited the ASR study
- Additional data for ASR study revealed details for site selection and well design

Contact info

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<https://www.twdb.texas.gov/groundwater/bracs/studies/UCPC/index.asp>



<https://www.twdb.texas.gov/innovativewater/asr/projects/GBRA/index.asp>