



Brackish Groundwater Characterization

by

Sanjeev Kalaswad, P.G.

John Meyer, P.G.

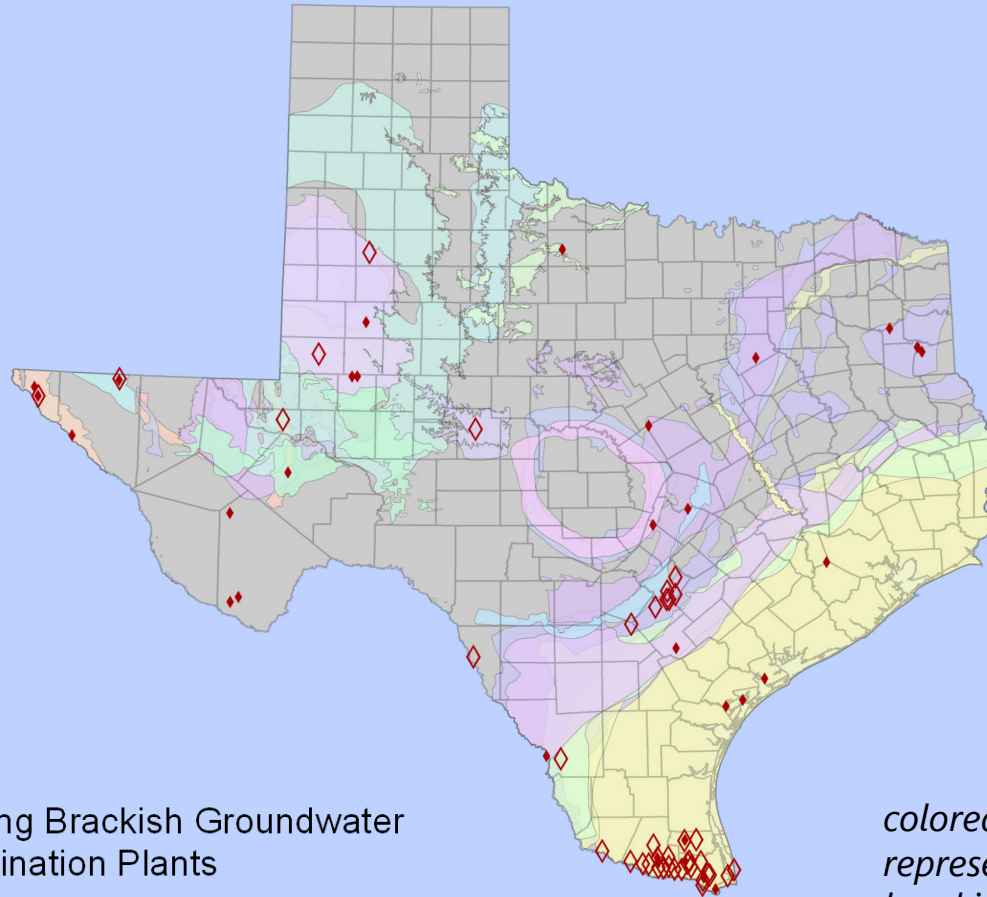
May 30, 2013

Texas Alliance of Groundwater Districts

A decorative graphic at the bottom of the slide consisting of several overlapping, wavy lines in various shades of blue, creating a sense of movement and depth.

Why study brackish water?

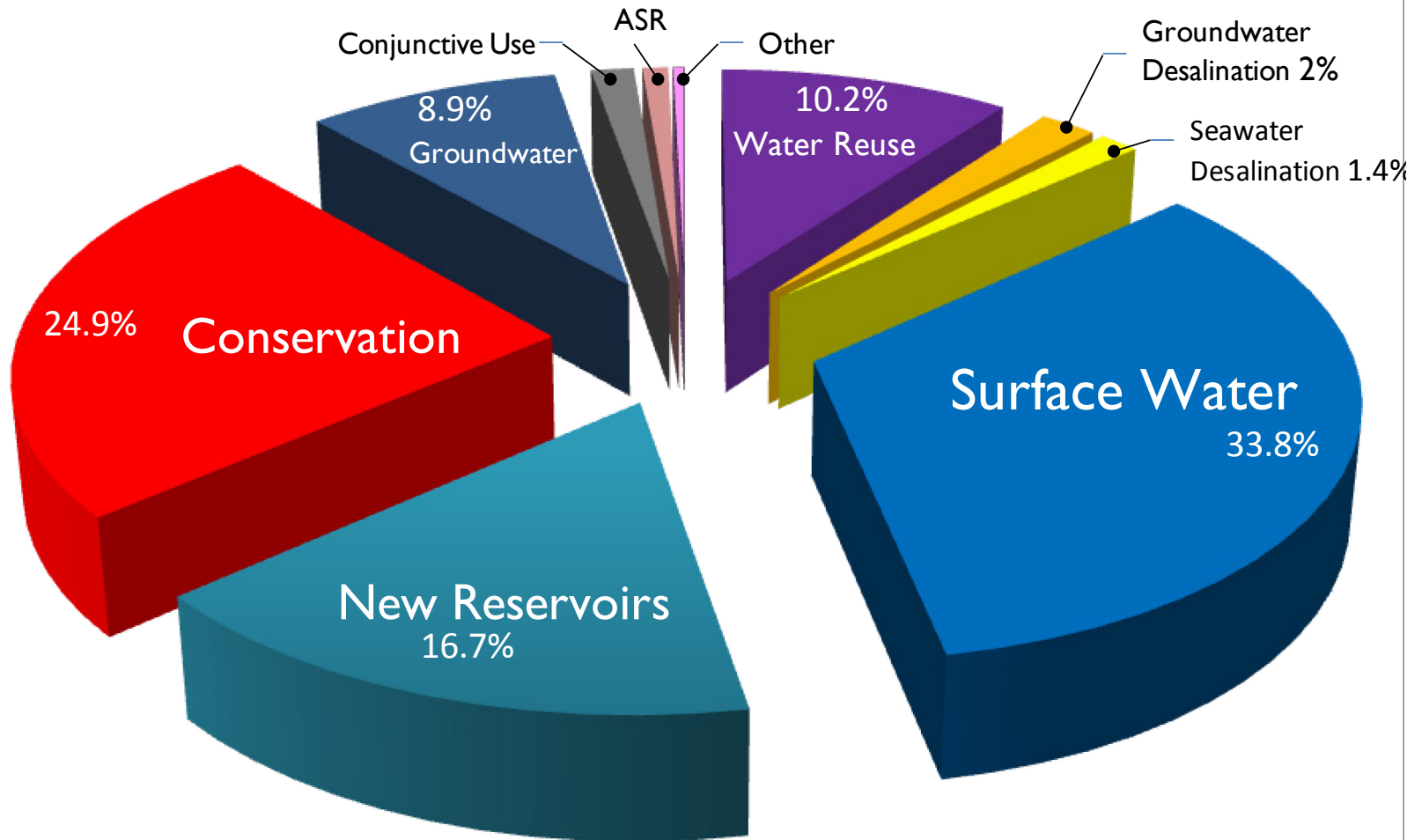
- 2.7 billion acre-feet brackish groundwater
- Need detailed information
- Growing interest in desalination



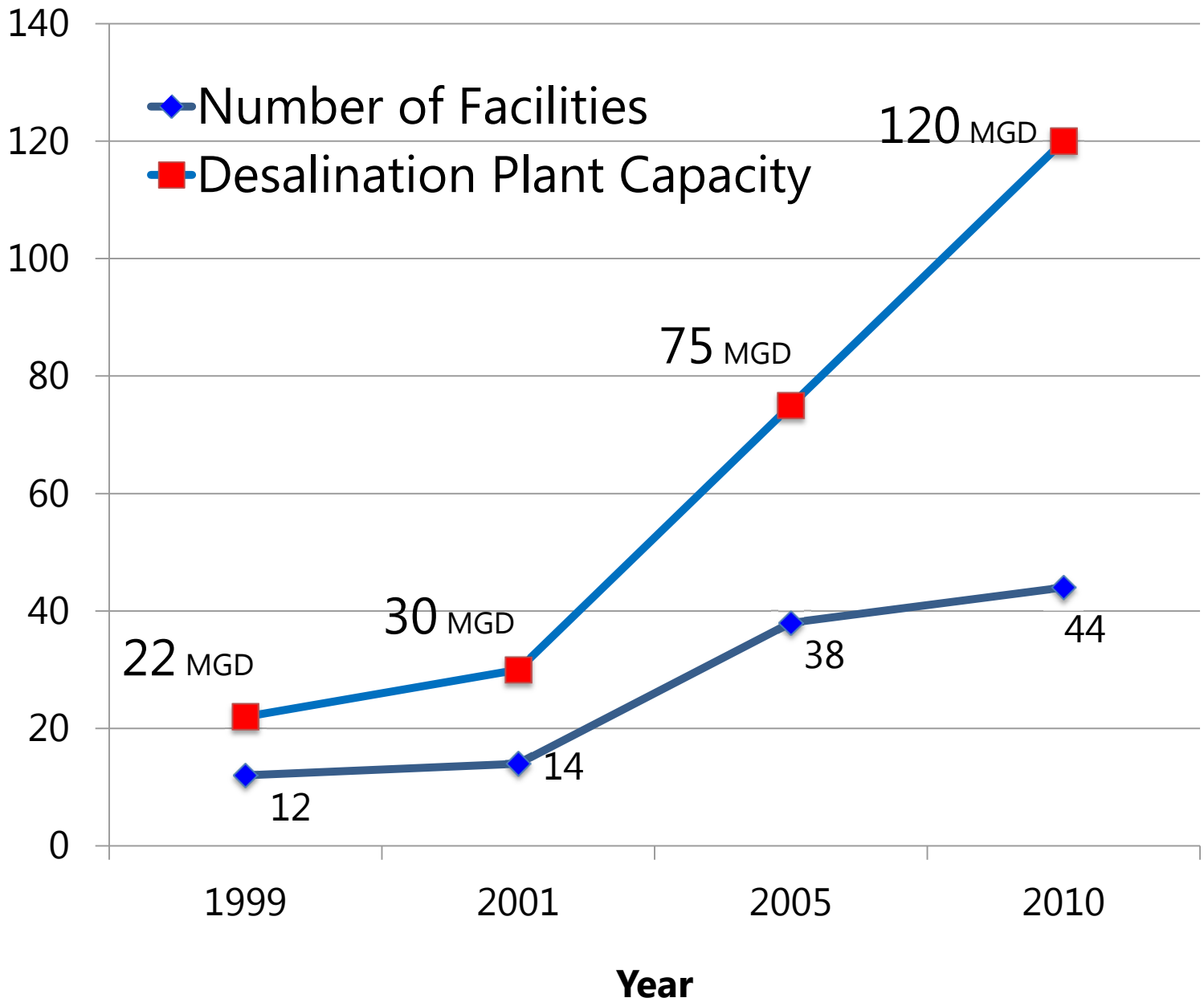
- ◆ Existing Brackish Groundwater Desalination Plants
- ◇ Recommended Brackish Groundwater Desalination Projects (2012 SWP)

colored regions represent estimated brackish extent of major-minor aquifers

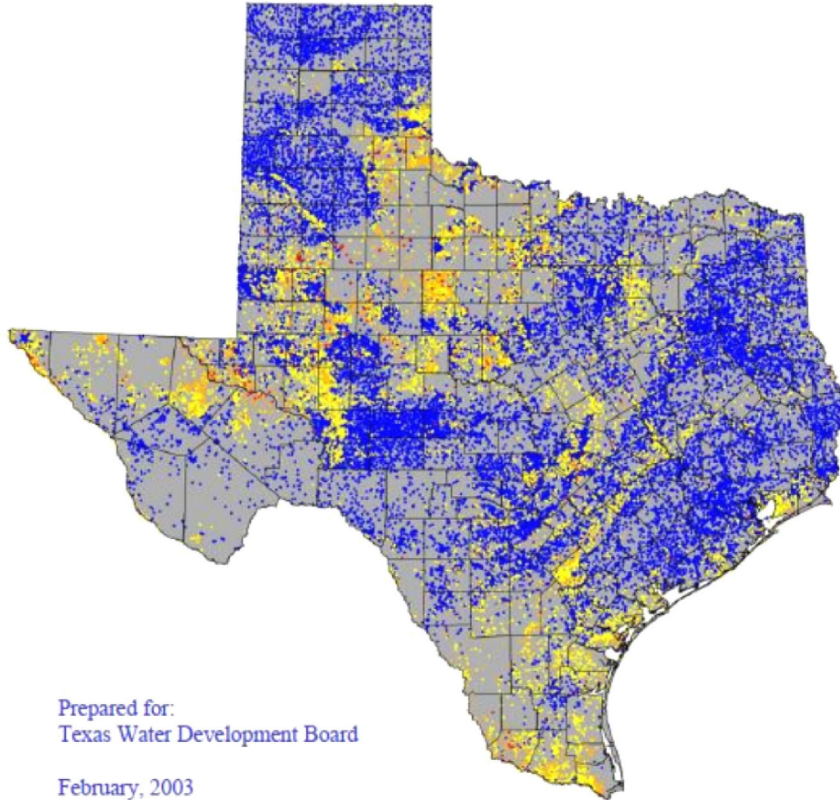
Cumulative Water Management Strategies by 2060



Number of Facilities Plant Capacity (MGD)



Brackish Groundwater Manual for Texas Regional Water Planning Groups



Prepared for:
Texas Water Development Board

February, 2003

LBG-GUYTON ASSOCIATES
in association with
NRS Consulting Engineers

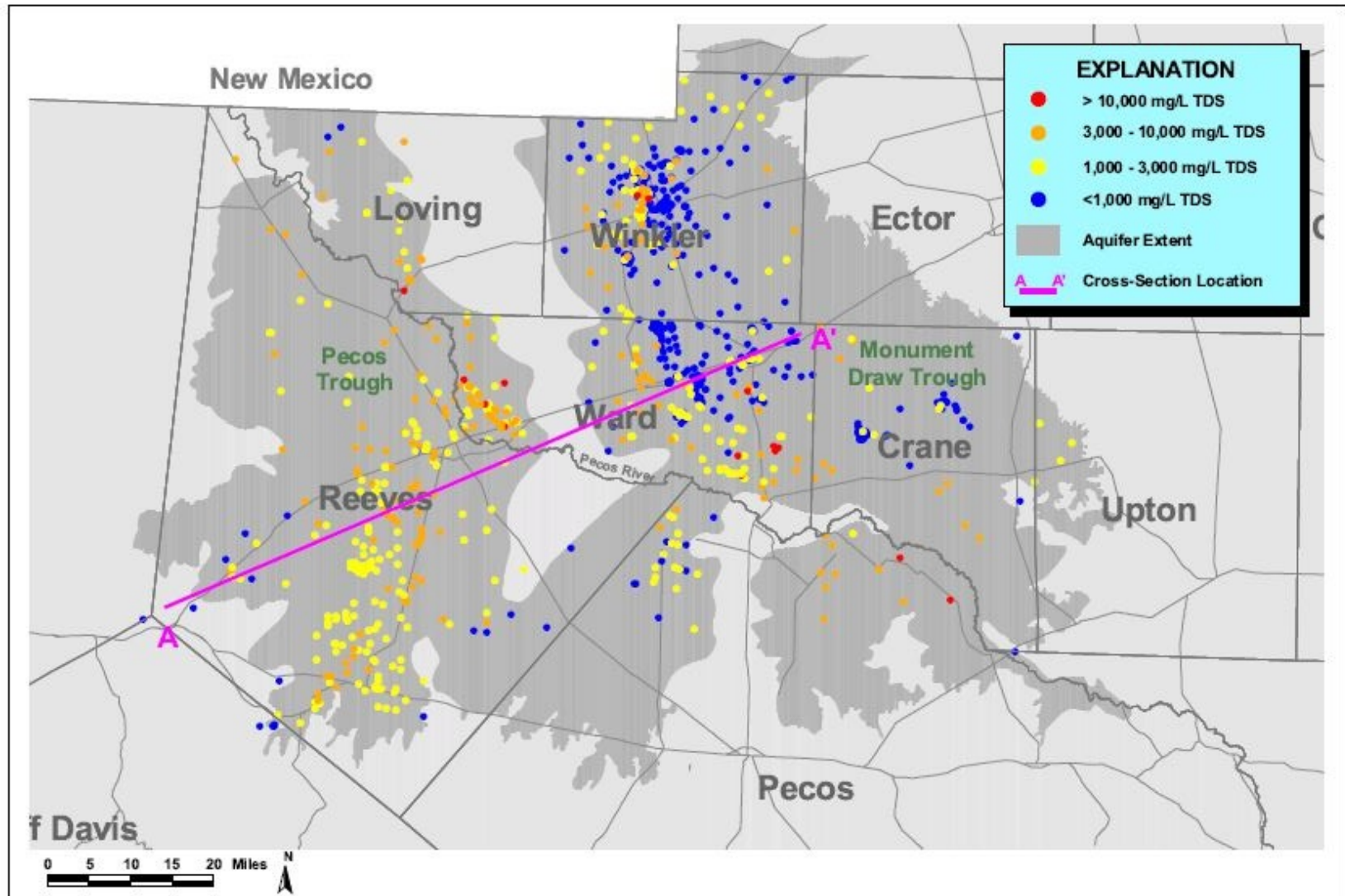


Regional assessment of
brackish groundwater volume

Limited scope and data

Limited project timeframe

LBG-Guyton Map of Pecos Valley Aquifer

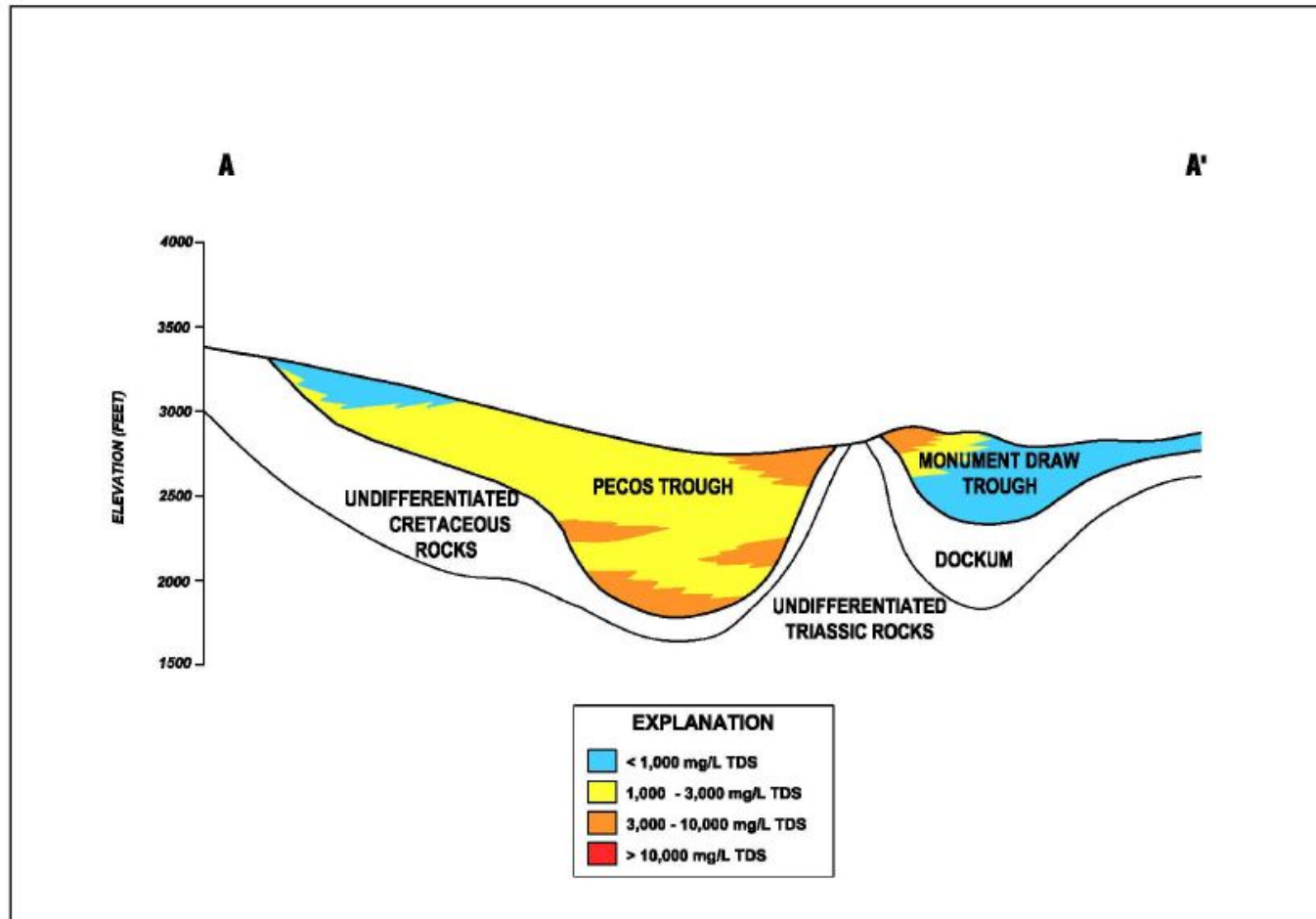


GROUNDWATER QUALITY IN THE
CENOZOIC PECOS ALLUVIUM AQUIFER

FIGURE 5
LBG-GUYTON ASSOCIATES

Source: *Brackish Groundwater Manual for Texas Regional Water Planning Groups*

LBG-Guyton Simplified Cross-section of the Pecos Valley Aquifer



**SIMPLIFIED CROSS SECTION OF THE CENOZOIC PECOS ALLUVIUM
AQUIFER WITH GENERALIZED WATER QUALITY RANGES**
(Modified from Ashworth, 1990)

FIGURE 6

LBG-GUYTON ASSOCIATES

How does TWDB characterize brackish water?

BRACS: Brackish Resources Aquifer Characterization System

- build datasets (database, GIS) of project information
- collect well logs (water, oil/gas) for interpretation
- compile aquifer properties
- map aquifer extent to 10,000 mg/L TDS
- map key desalination parameters
- calculate volumes of water
- each aquifer may require unique analysis based on data availability and local hydrogeology
- provide ***all*** information to interested stakeholders

TWDB Database Tables

TWDB Groundwater Database

Well Data
Remarks
Water Levels
Water Chemistry (2 tables)
Casing

TWDB BRACS Database

Well Data (location, depth, owner, ...)
Water Levels
Water Chemistry (2 tables)
Casing

New
Tables

Foreign Keys (well ids)
Well Geology (lithology\stratigraphy)
Net Sand and Sand Percent
Interpreted TDS from Geophysical Logs
Aquifer Determination Analysis
Digital Water Well Reports
Digital Geophysical Well Logs
Geophysical Well Log Suites
Aquifer Test Information

BRACS Database

- MS Access relational design
- Contains all the new information we are collecting
- Designed to process information (Visual Basic Code)
- Link to additional databases through key fields
- Available on our website (with data dictionary)
- Will be merged with the TWDB Groundwater Database in MS SQL Server

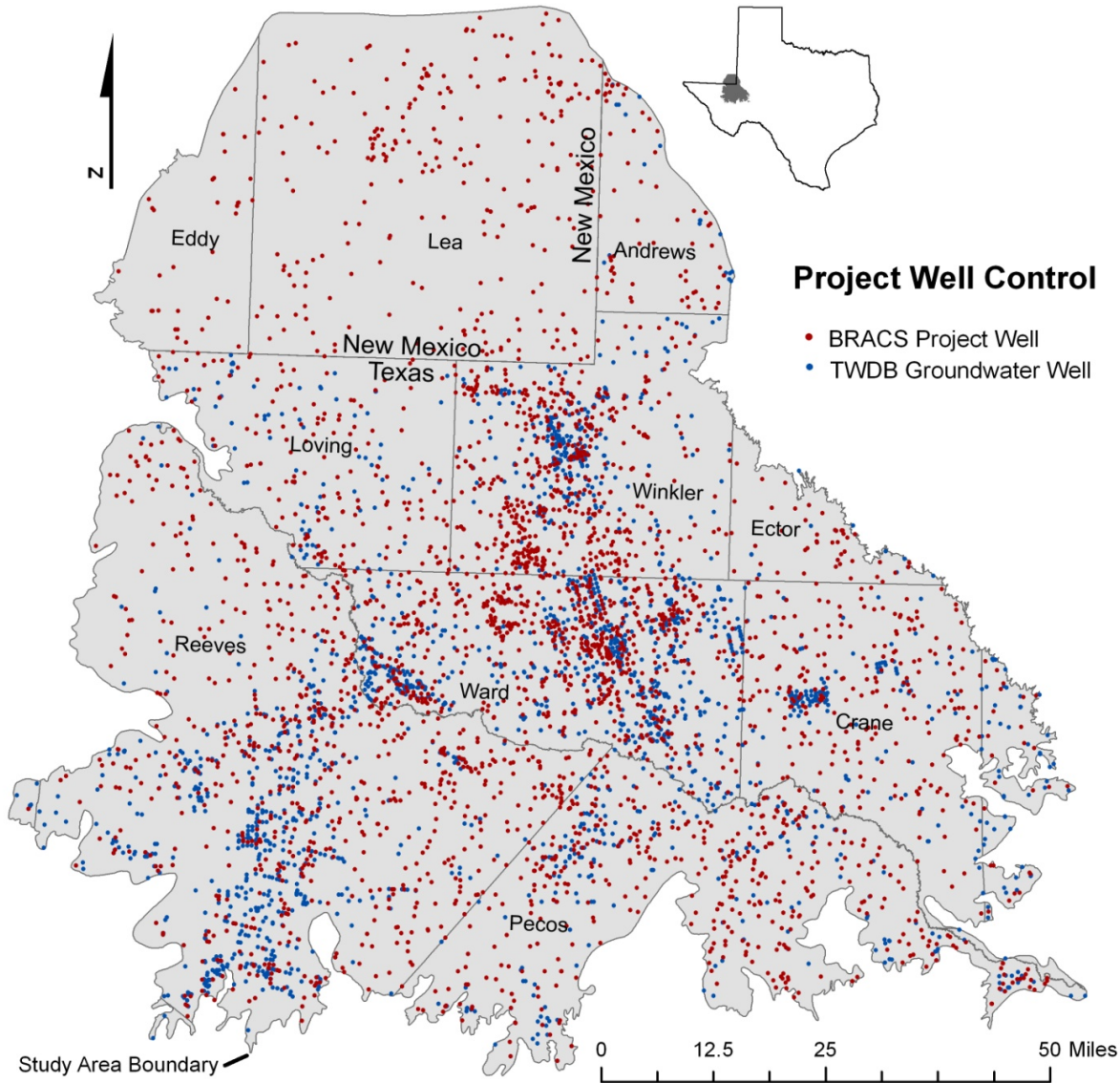
BRACS Database

Foreign Key Table

- Well name(s)
- Number(s)
- State Well Number
- API Number
- Q-number
- Public Water ID
- Report numbers
- Cross-Section IDs

ID Name ID Agency	Foreign Key Id (Text) Foreign Key Id (Numeric)	Remarks
Dodge_Posey_1981 BEG	16-3	Cross section 16, well no. 3
INT_GulfCoast_Proj INT	17,1	Dip Section, Position; Strike Section, Position
API_NUMBER API	4249301747	
STATE_WELL_NUMBER TWDB	7807704	
USGS_OF_87-677 USGS	851	TXWN03, log number
Baer_YeguaJackson BAER	DP16-3	
WELL_NUMBER OWNER	J 12	TWDB Bull 5710 well number, X-section B-B'
Q_NUMBER RRC	Q-11	N/A
WELL_NUMBER	S.V. Houston 1	

Project Well Control: oil/gas and water wells



Source: Pecos Valley Aquifer Project

BRACS Geophysical Well Log Collection

**Locating, Scanning, and Delivering
Digital Geophysical Well Logs and
Associated Data for Brackish Resources
Aquifer Characterization System (BRACS)**

by
Daniel H. Ortuño, Aaron R. Averett, Sigrid J. Clift, and Jeffrey G. Paine

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(512) 471-7139

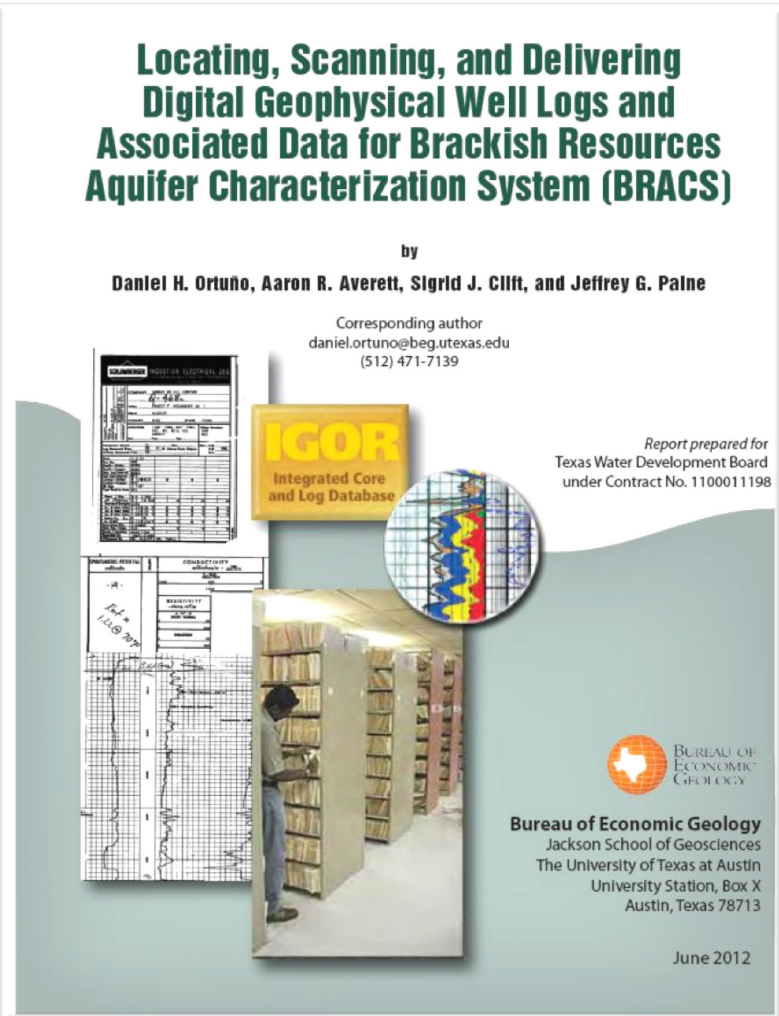
Report prepared for
Texas Water Development Board
under Contract No. 1100011198

IGOR
Integrated Core
and Log Database

**BUREAU OF
ECONOMIC
GEOLOGY**

Bureau of Economic Geology
Jackson School of Geosciences
The University of Texas at Austin
University Station, Box X
Austin, Texas 78713

June 2012



Scan paper logs into TIFF format

Obtain digital oil and gas well logs

Scan TWDB paper log collection

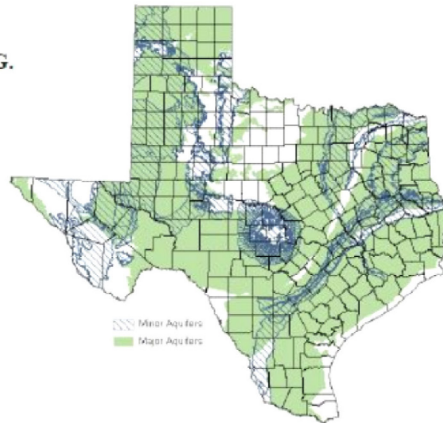
Leverage work of other geologists

Aquifers of Texas Bibliography to Support the Brackish Resources Aquifer Characterization System (BRACS) Program

Final Report

Prepared by

Steven C. Young, Ph.D., P.E., P.G.
Bridget Ronayne

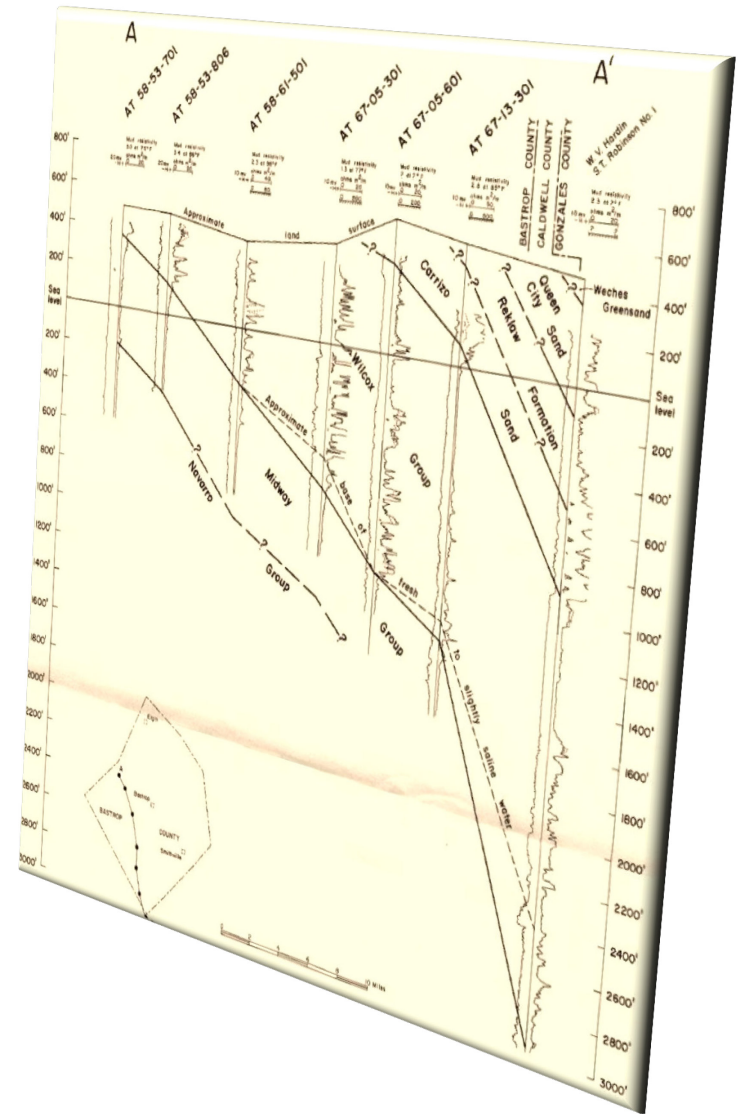


Prepared for:

Texas Water Development Board
P.O. Box 13231, Capitol Station
Austin, Texas 78711-3231



November 2011



Formation Lithology

Geophysical well log interpretation

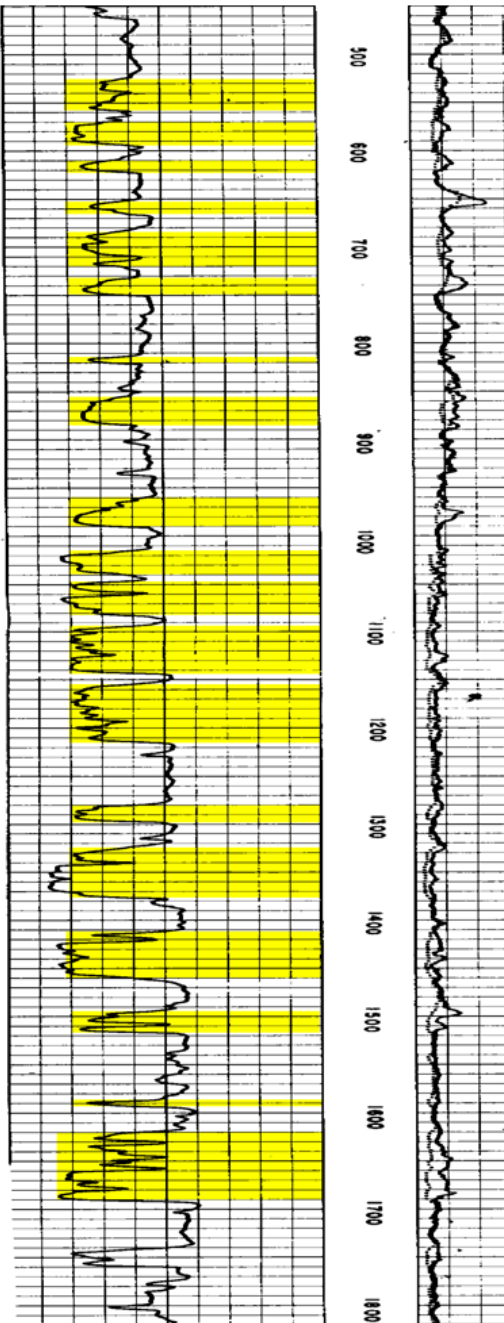
Driller formation descriptions from well reports

Used for:

Water volume calculations

Sand thickness and occurrence

Clay thickness



Source: Gulf Coast Aquifer Project, Corpus Christi ASR

Formation Stratigraphy

Geophysical well logs

Water well reports

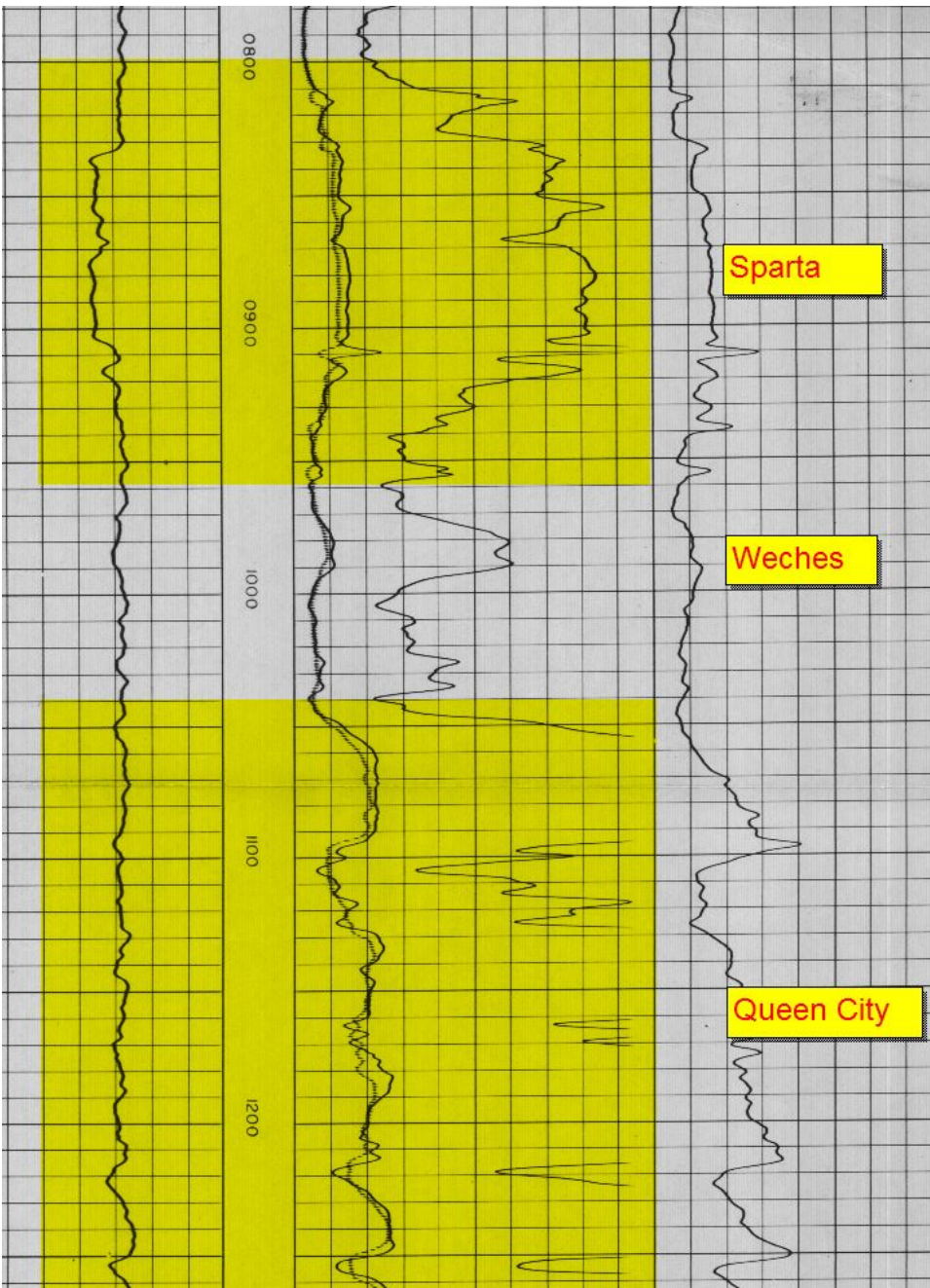
Used for:

Formation top and bottom

Formation extent

Formation sand content

Correct aquifer assignment of
water quality and aquifer properties



Source: Sparta – Queen City Aquifer Project

Lithologic and Stratigraphic Data in the BRACS Database

Lithologic Description

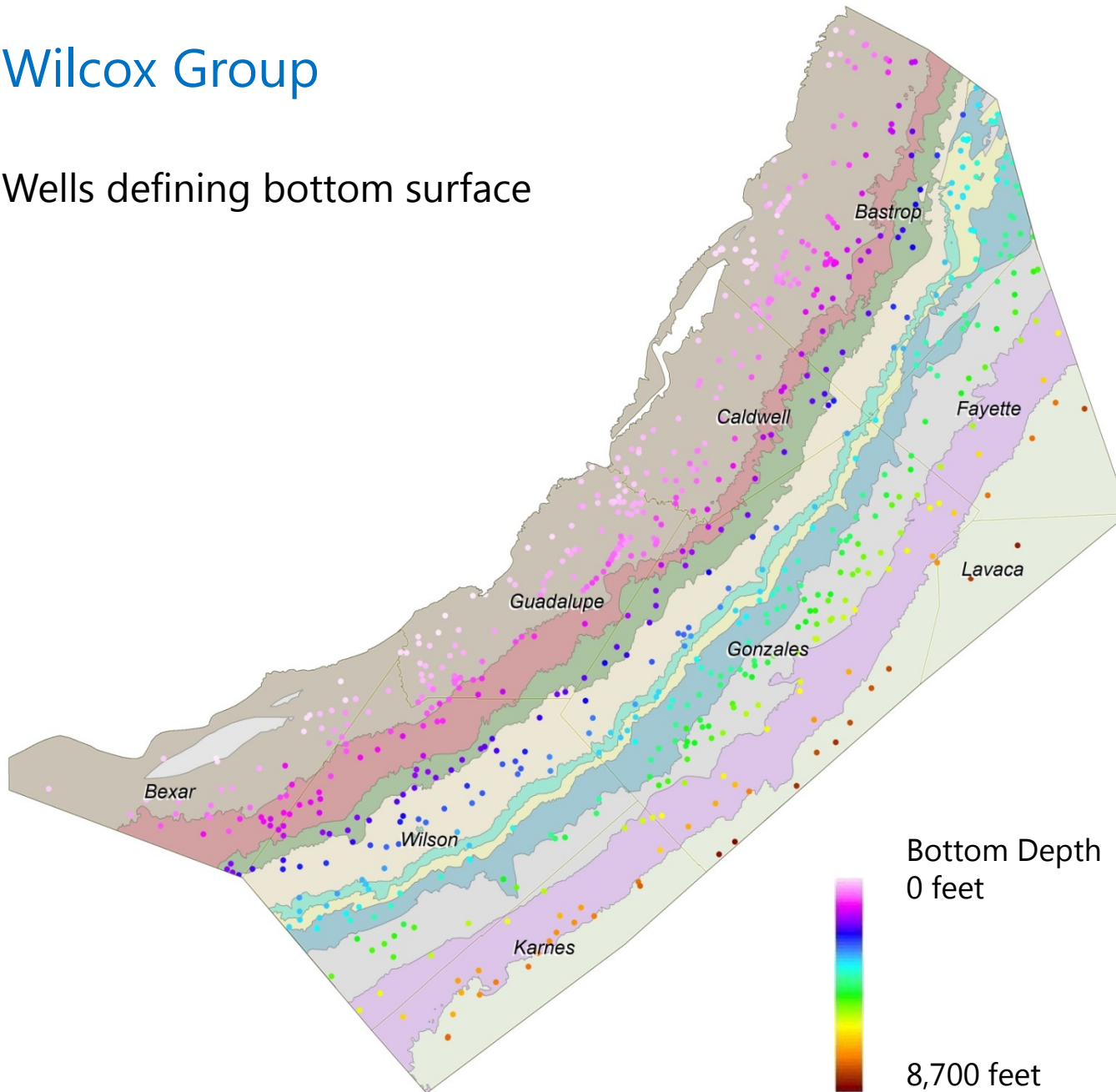
Record Number	Geologic Pick	Top Depth Bottom Depth Thickness	Lithologic Description	Source of Data	
				Initials	Last Change
10	Lithologic	0	Sand		1/17/2013
		10			
		10	GEOPHYSICAL WELL LOG		
11	Lithologic	10	Clay		1/17/2013
		120			
		110	GEOPHYSICAL WELL LOG		
12	Lithologic	120	Sand		1/17/2013
		145			
		25	GEOPHYSICAL WELL LOG		
13	Lithologic	145	Clay		1/17/2013
		166			
		21	GEOPHYSICAL WELL LOG		
14	Lithologic	166	Clay		1/17/2013
		409			
		142	GEOPHYSICAL WELL LOG		
15	Lithologic	308	Clay		1/17/2013
		320			
		12	GEOPHYSICAL WELL LOG		
16	Lithologic	320			

Stratigraphic Description

Record Number	Geologic Pick	Top Depth Bottom Depth Thickness	Stratigraphic Description	Source of Data	
				Initials	Last Change
1	Stratigraphic	0	Yegua Formation		10/1/2012
		745			
		745	Geophysical Well Log		
2	Stratigraphic	745	Cook Mountain Formation		3/11/2013
		1163			
		418	Geophysical Well Log		
3	Stratigraphic	1163	Sparta Formation		3/11/2013
		1375			
		212	Geophysical Well Log		
4	Stratigraphic	1375	Weches Formation		3/11/2013
		1430			
		55	Geophysical Well Log		
5	Stratigraphic	1430	Queen City Formation		3/11/2013
		2050			
		620	Geophysical Well Log		
6	Stratigraphic	2050	Reklaw Formation		2/8/2013
		2260			
		210	Geophysical Well Log		
7	Stratigraphic	2260	Carrizo Formation		2/8/2013
		2965			
		705	Geophysical Well Log		
8	Stratigraphic	2965	Wilcox Group		10/1/2012
		5860			
		2895	Geophysical Well Log		
9	Stratigraphic	5860	Midway Formation		10/1/2012
			Geophysical Well Log		
*					

Wilcox Group

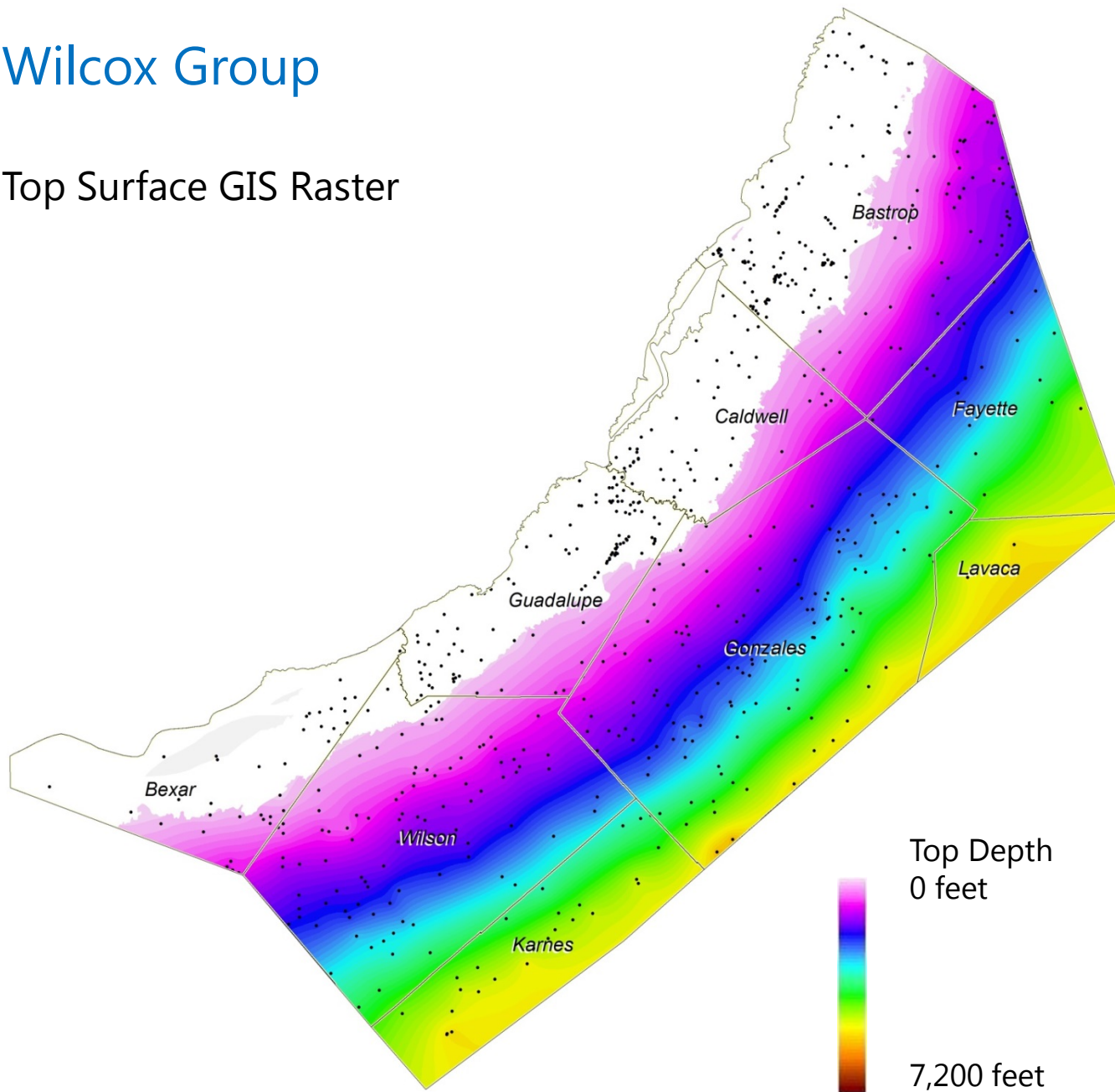
Wells defining bottom surface



Source: Carrizo – Wilcox Aquifer Project

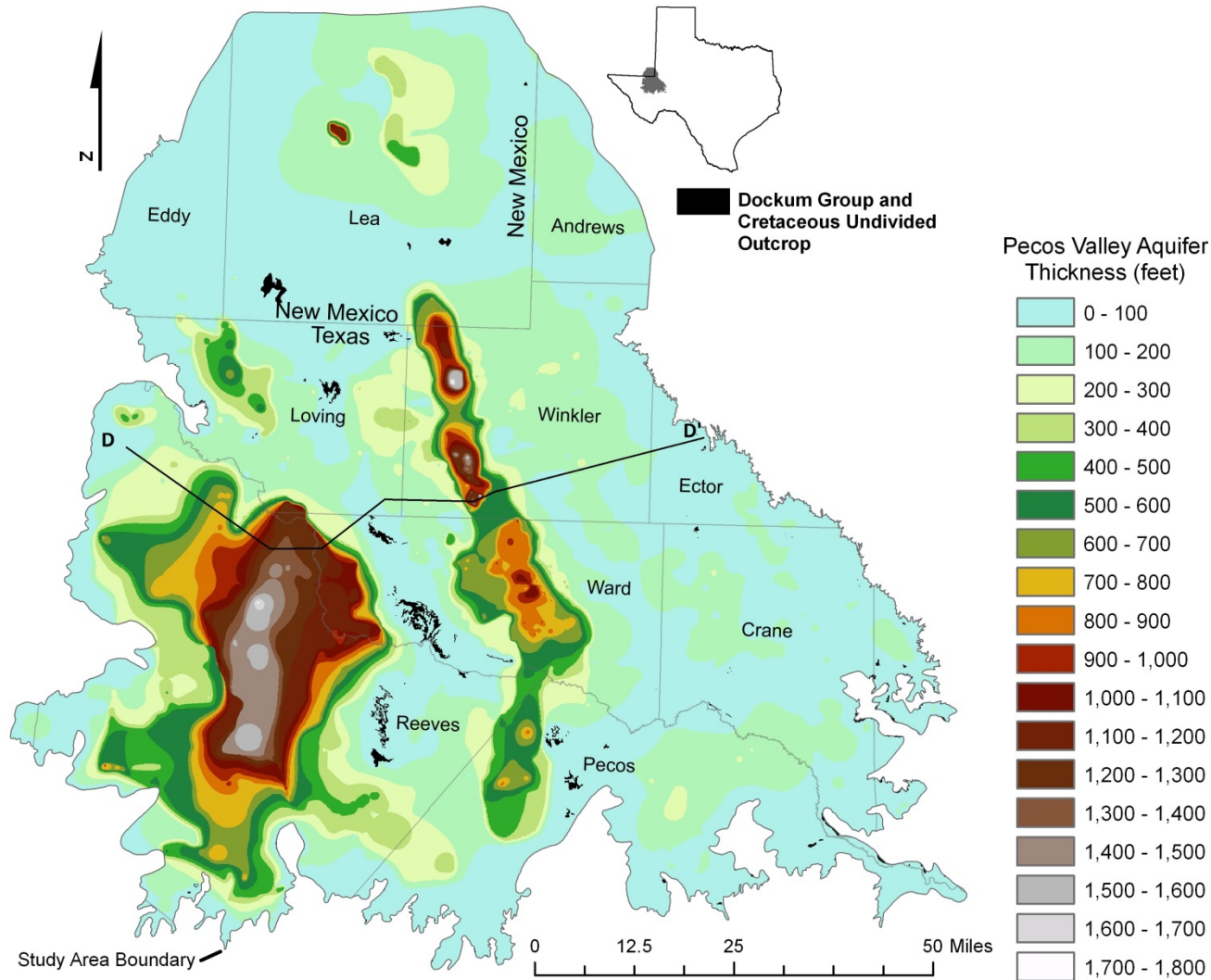
Wilcox Group

Top Surface GIS Raster



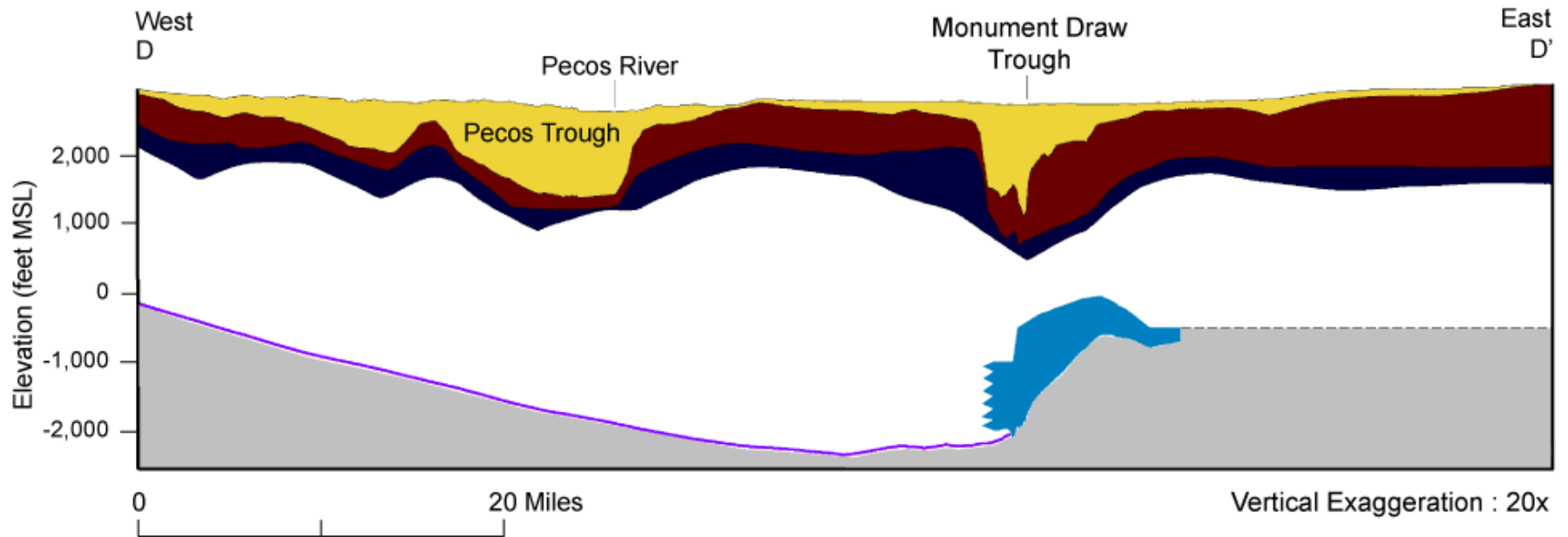
Source: Carrizo – Wilcox Aquifer Project

Pecos Valley Aquifer Thickness, based on > 2,000 wells



Source: Pecos Valley Aquifer Project

Cross-section Pecos Valley Aquifer based on GIS Surfaces



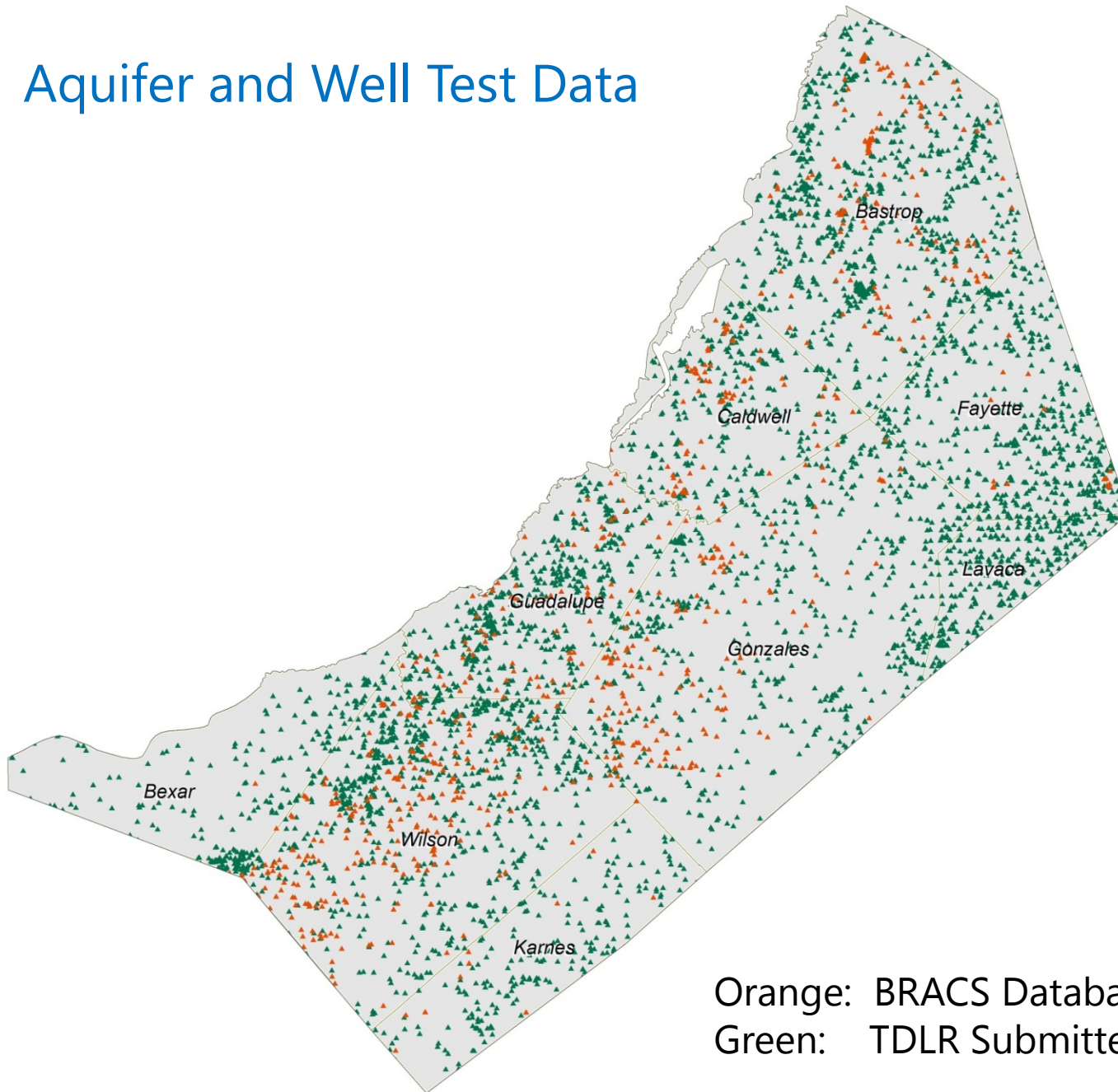
Aquifer Determination

- Assign aquifer(s) to each well in the project area
- Use screen top/bottom *or* well depth *or* total depth of hole
- Use the GIS-derived 3-D formation surfaces as vertical control

Why?

- Compare wells completed in same aquifer
- Consistent evaluation of aquifer water quality and properties
- Many new wells do not have TWDB aquifer code
- Some TWDB wells have incorrect aquifer code

Aquifer and Well Test Data



May include:

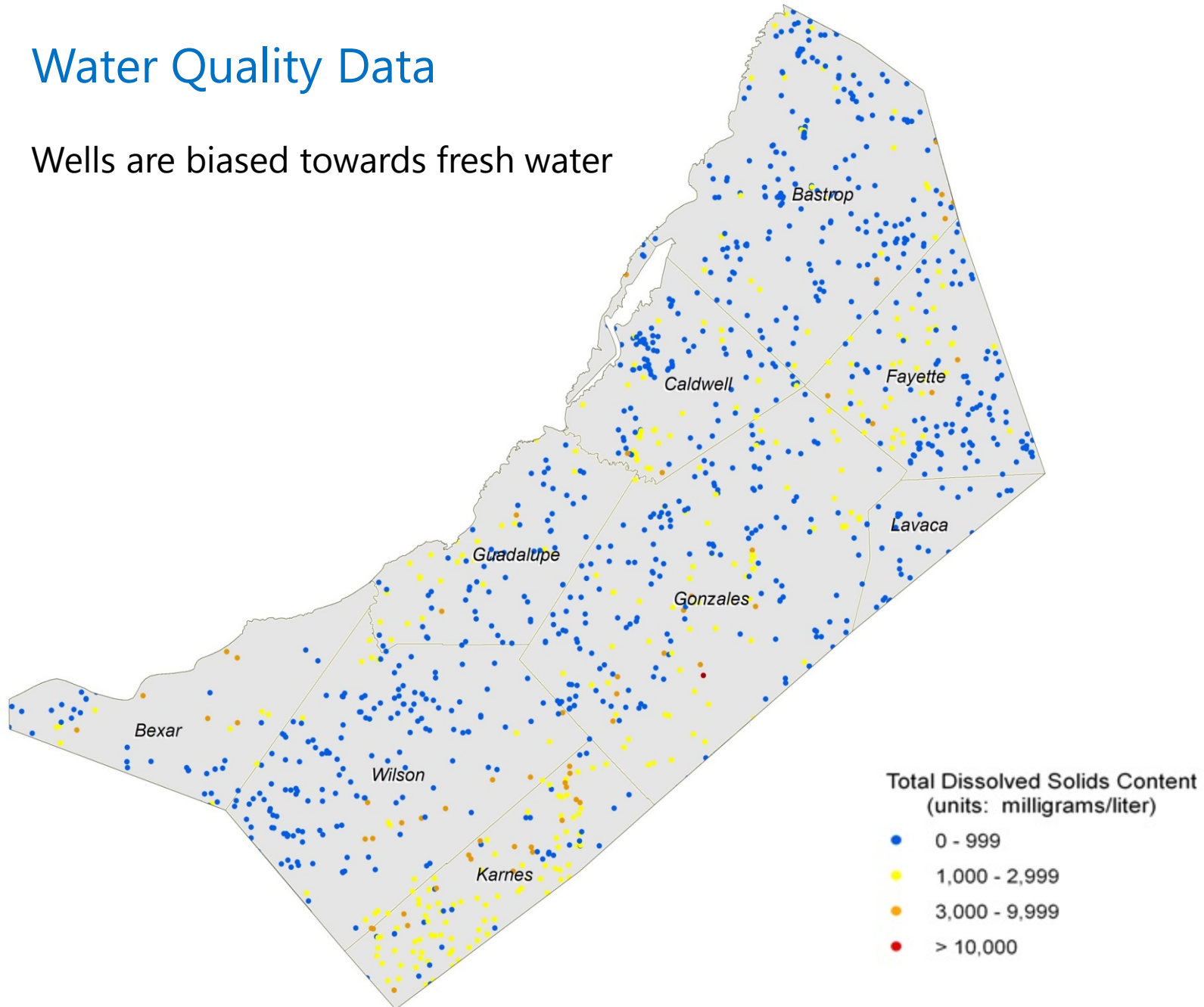
- Well yield
- Specific capacity
- Hydraulic conductivity
- Transmissivity
- Storativity
- Specific yield
- Test length
- Drawdown
- Report Reference (Myers, R 98)

Orange: BRACS Database

Green: TDLR Submitted Driller Logs

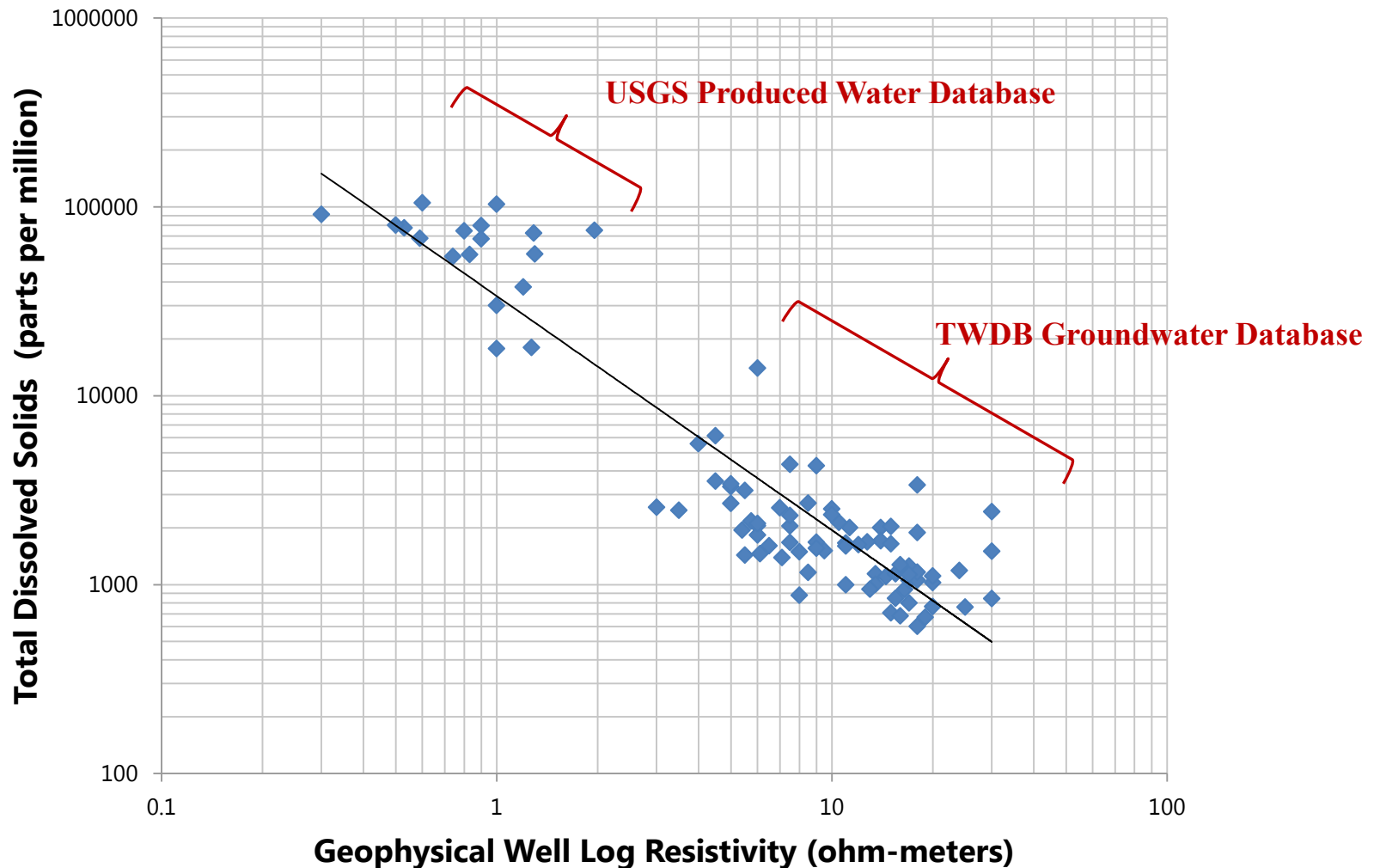
Water Quality Data

Wells are biased towards fresh water



Source: Carrizo – Wilcox Aquifer Project

Geophysical well log resistivity compared with water quality data



Source: Gulf Coast Aquifer Project, Corpus Christi ASR

Interpreted TDS from Geophysical Well Logs

TWDB Water Science and Conservation Innovative Water Technologies Brackish Resources Aquifer Characterization System

BRACS Geophysical Log Analysis for TDS Calculations

Well Id: 1376
 GL Number: 844
 Depth Formation (Df): 530
 Thickness Lithologic Unit: 30

White Field: fill in
 Blue Field: Auto Loaded
 Gray Field: Calculated by CPU

Buttons: SP Method, Mean Ro, Alger - Harrison, Rwa Method, Estepp

Initials: JEM

TDS Interpreted: 3428
 Consensus TDS Method: SP Method

Ts: 63 Dt: 1015
 Tf: 69.2660 Rmf: 1.7
 Tbh: 75 Rmf Tf: 1.546213

Remarks: High sulfate water in the Pecos Valley Aquifer, Reeves County, Tx

TDS Method: SP Method
 Rwe: 2.010062 Rw: 2.211068 Rw75: 2.042024 Cw: 4897.101 TDS: 3428
 Initials: JEM

Geophysical Log Used: SPONTANEOUS POTENTIAL

Correction Factors

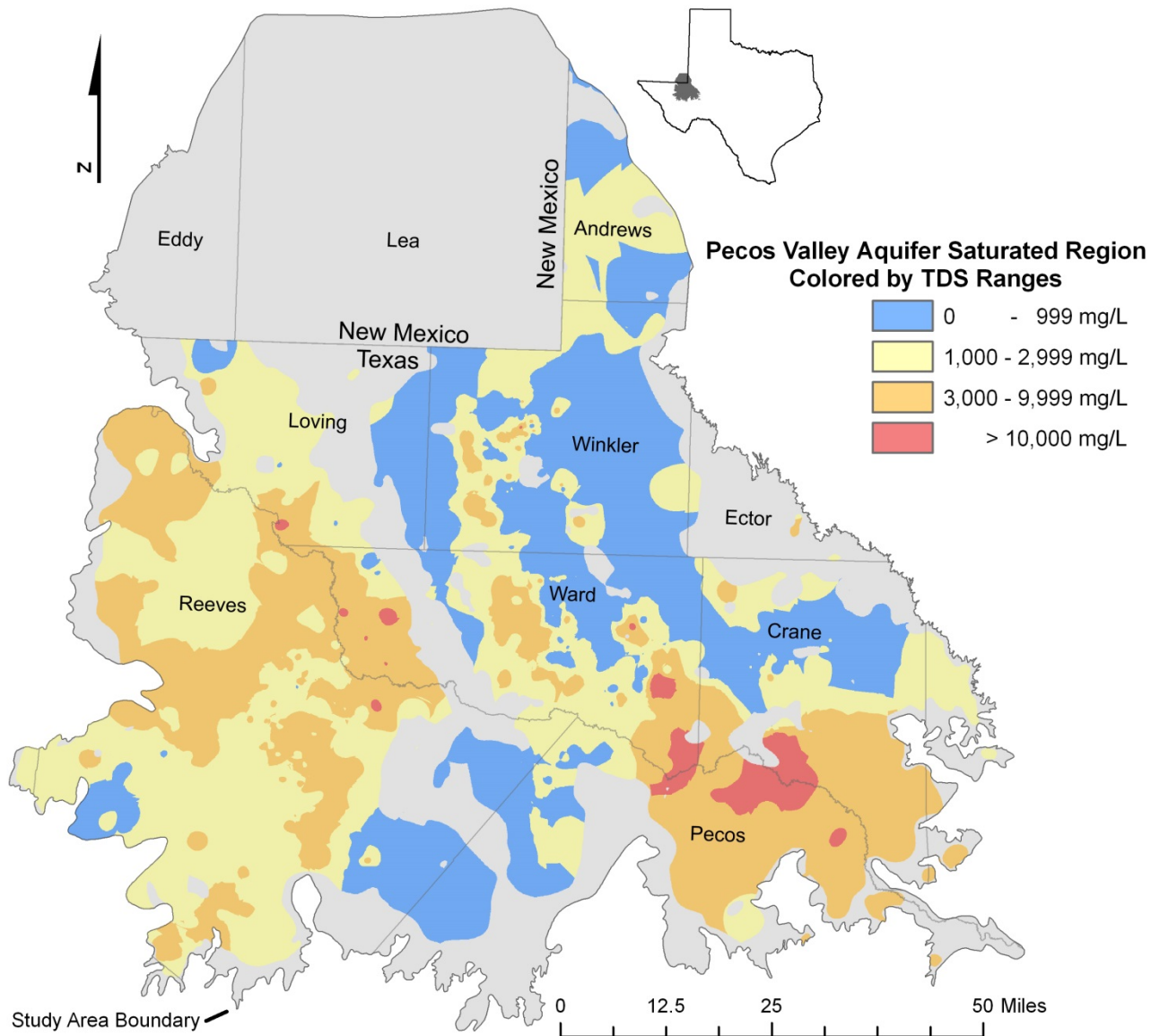
SP: 8
 Rxo: 0
 Ro: 0
 Rxo / Ro: []
 m: 0
 Source m: N/A
 Porosity: .0
 Source Porosity: N/A

70.21238 K (Temperature): SP Method
 1.1 Rwe Rw: Sp, Alger Harrison, and Rwa Minimum Methods
 1 Rmf: SP and Alger Harrison Methods
 0.7 ct: Many Methods
 99 Invasion Zone: Alger Harrison Method
 1 m correction factor: Estepp Method high anion waters
 1 Ro: Mean Ro Method [Mean Ro Nomograph](#)

Chart: N/A
 Remarks: N/A

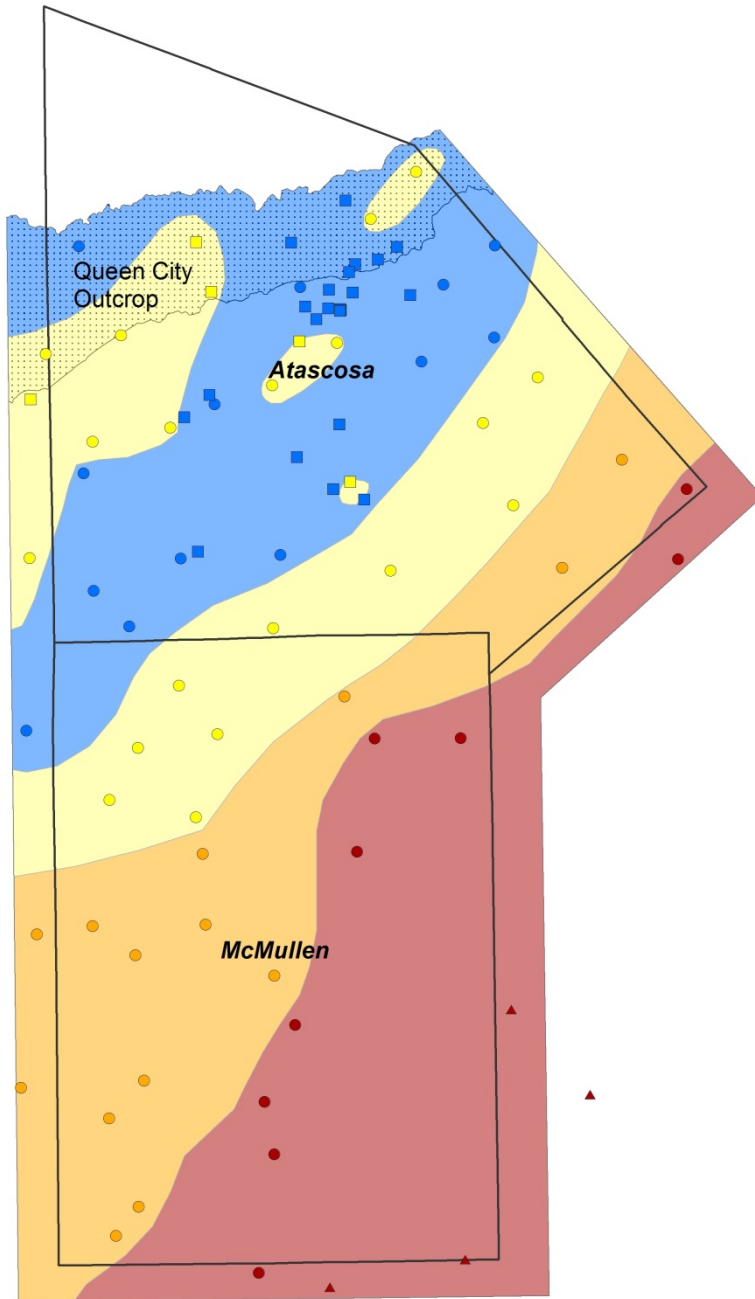
Record: 1 of 1

Pecos Valley Aquifer Water Quality Zones



Source: Pecos Valley Aquifer Project

Queen City Aquifer Water Quality Zones



Queen City Total Dissolved Solids (milligrams/Liter)

0 - 999
1,000 - 2,999
3,000 - 10,000
>10,000

- Water Quality, TWDB Groundwater Database
- △ Water Quality, USGS Produced Water
- Geophysical Well Log Analysis

Source: Sparta – Queen City Aquifer Project

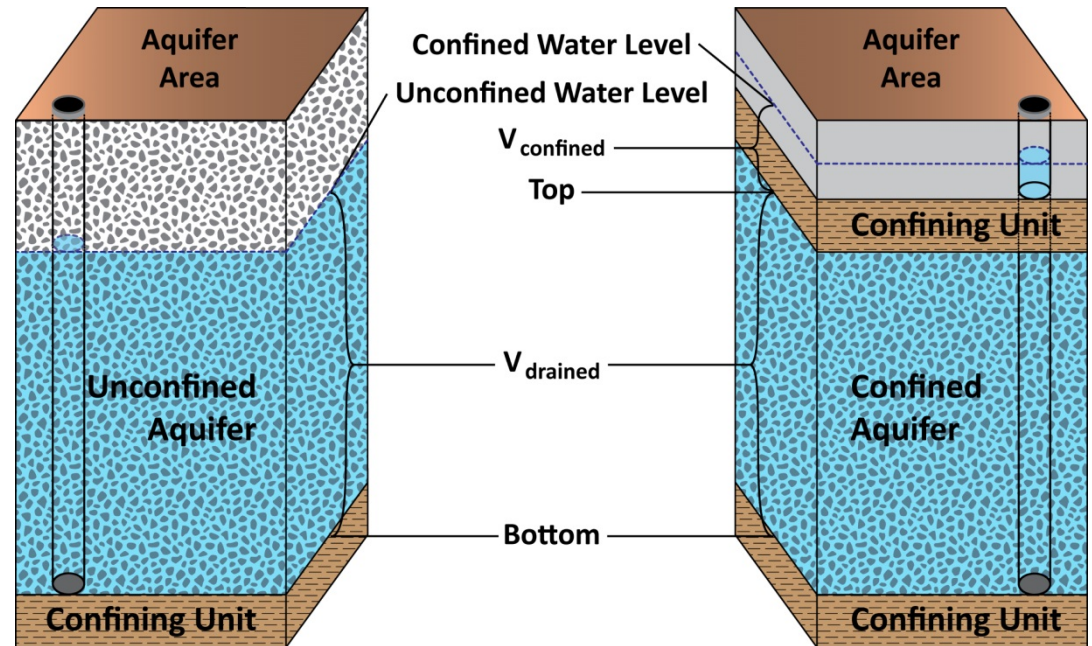
Estimated Groundwater Volumes

Total Estimated Recoverable Storage:

- per aquifer
- per county
- per TDS Range

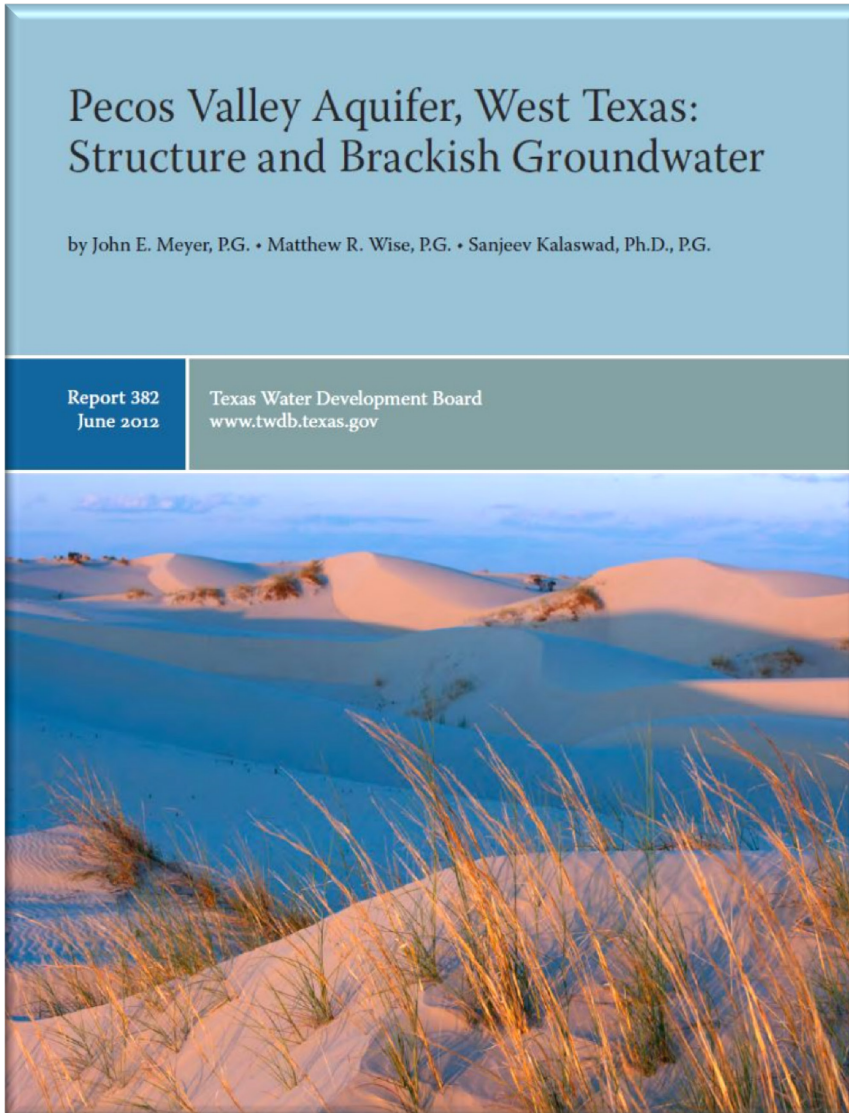
Four TDS Ranges (mg/L):

- Fresh 0-999
- Brackish 1,000 -2,999
3,000 – 9,999
- Very Saline > 10,000



Similar method as TWDB Groundwater Resources Division

Project Deliverables



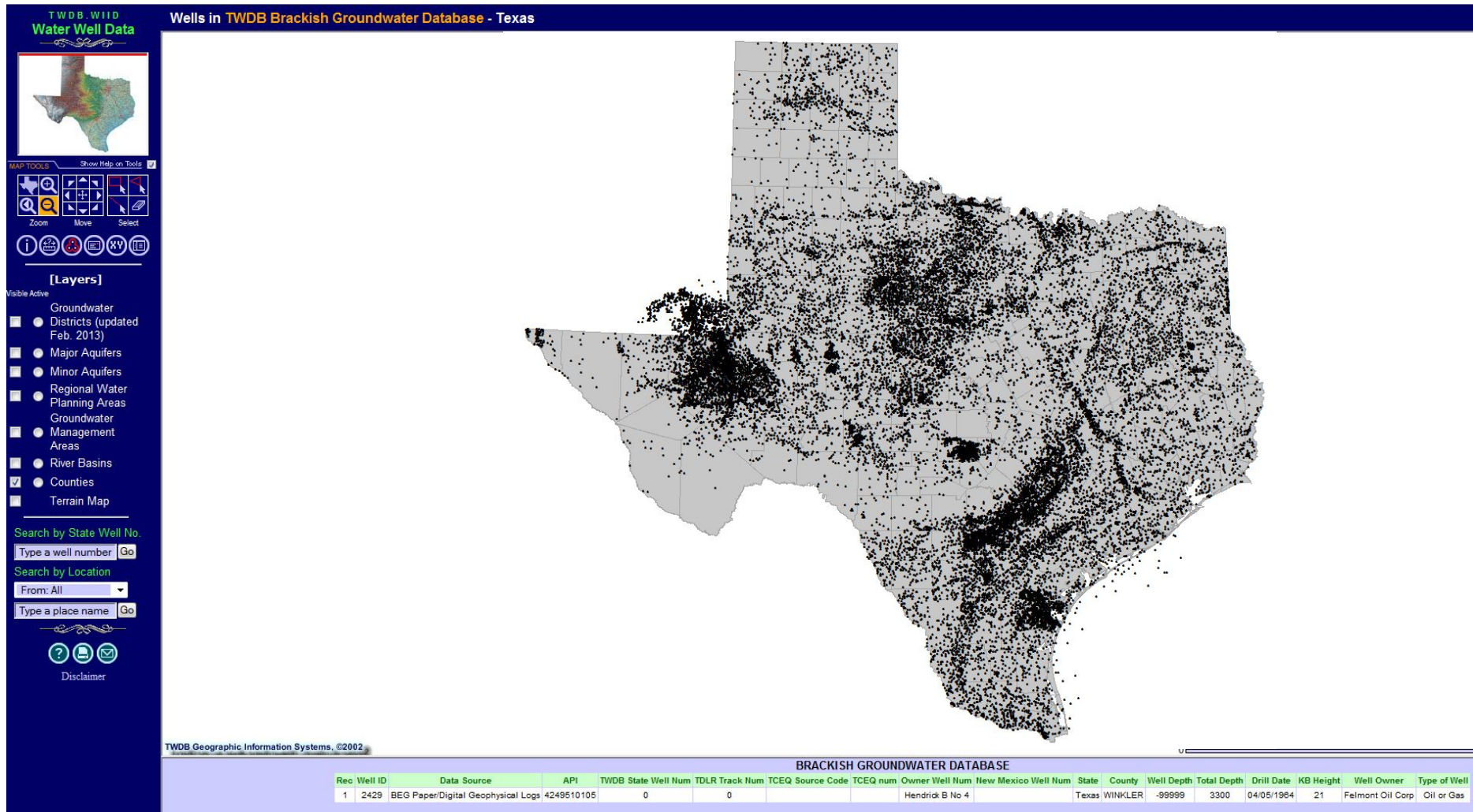
- Published, peer-reviewed report
- GIS Datasets
- BRACS Database
- Raw well data

Request for Information

Non-confidential data:

- Groundwater reports
- Water quality data
- Well testing and aquifer parameters
- Geophysical well logs
- Water well reports

BRACS well locations in WIID(*)



(*) WIID: Water Information Integration & Dissemination

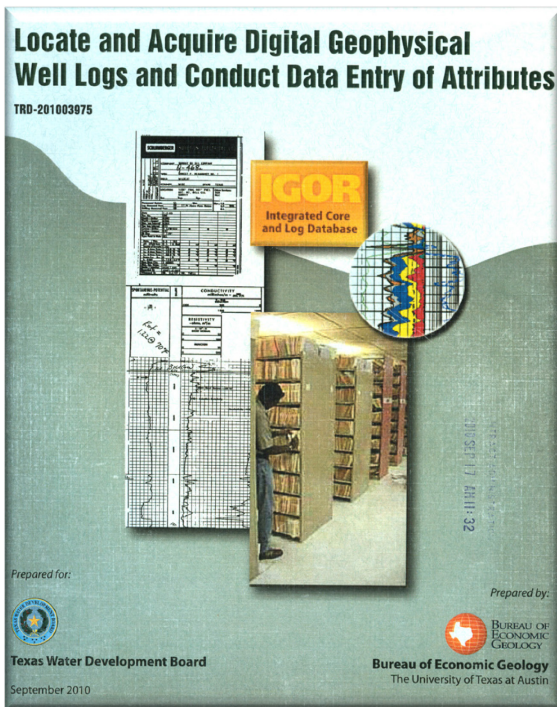
BRACS Projects

- Pecos Valley Aquifer, West Texas (*completed August 2011*)
- Gulf Coast Aquifer, Corpus Christi ASR Conservation District (*completed March 2012*)
- Queen City – Sparta Aquifer, Atascosa and McMullen counties (*final review in progress*)
- Carrizo – Wilcox Aquifer, Central Texas (*in progress*)
- Gulf Coast Aquifer, Lower Rio Grande Valley (*in progress*)

BRACS Contracted Studies

Well Log Collection

Locate and Acquire Digital Geophysical Well Logs and Conduct Data Entry of Attributes
TRD-201003975



IGOR
Integrated Core and Log Database

Prepared for:
Texas Water Development Board
September 2010

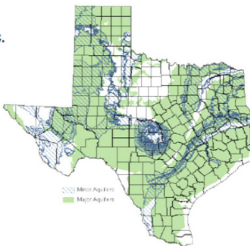
Prepared by:
BUREAU OF ECONOMIC GEOLOGY
The University of Texas at Austin

Geologic Bibliography

Aquifers of Texas Bibliography to Support the Brackish Resources Aquifer Characterization System (BRACS) Program

Final Report

Prepared by
Steven C. Young, Ph.D., P.E., P.G.
Bridget Ronayne



Prepared for:
Texas Water Development Board
P.O. Box 13231, Capitol Station
Austin, Texas 78711-3231

November 2011

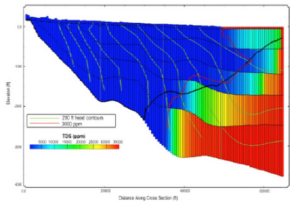
Texas Water Development Board

Variable Density Modeling

Assessment of Groundwater Modeling Approaches for Brackish Aquifers

Final Report

Prepared by
Neil E. Deeds, Ph.D., P.E.
Toya L. Jones, P.G.



Prepared for:
Texas Water Development Board
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Austin, Texas 78711-3231

November 2011

Texas Water Development Board

Desalination Studies and Demonstration Projects

Seawater pilot

FINAL Pilot Study Report Texas Seawater Desalination Demonstration Project



October 2008

Concentrate Management

Improving Recovery: A Concentrate Management Strategy for Inland Desalination



Report

by
Desmond F. Lawler, Ph.D., P.E.
Michael Cobb
Benny Freeman, Ph.D.
Lauren F. Greenlee, Ph.D.
Lynn Katz, Ph.D., P.E.
Kerry Kinney, Ph.D.
W. Shane Walker, Ph.D.

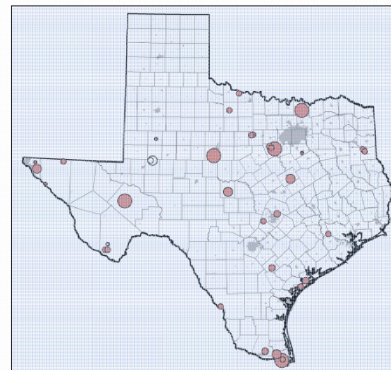
Texas Water Development Board

P.O. Box 13231, Capitol Station
Austin, Texas 78711-3231
August 2010



Information

A Desalination Database for Texas



Prepared for
Texas Water Development Board

Bureau of Economic Geology
Scott W. Tinker, Director
John A. and Katherine G. Jackson School of Geosciences
The University of Texas at Austin
Austin, Texas 78713-8924

Source Characterization

Brackish Groundwater Exploration Guidance Manual



Prepared for:

Upper Colorado River Authority and
Texas Water Development Board

April 2008

LBG-GUYTON ASSOCIATES
in association with
Freese and Nichols, Inc.



Summary

- Detailed brackish groundwater resource evaluation
- Evaluating techniques of geophysical well log interpretation
- BRACS project deliverables available on TWDB website
- Geophysical well log files available upon request
- Contract reports and deliverables available on TWDB website

Texas Water Development Board



www.twdb.texas.gov

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