DRAFT CONCEPTUAL MODEL

Lower Rio Grande Valley Groundwater Transport Model

Stakeholder Advisory Forum #2

July 13, 2016

Tim Bayley and Bill Hutchison

MONTGOMERY & ASSOCIATES

GSI ENVIRONMENTAL

esi Environmental Simulations Inc.

Introduction of Texas Water Development Board (TWDB) Groundwater Availability Modeling (GAM) Program

Rohit R. Goswami, PhD

Groundwater Availability Modeling

Texas Water Development Board

Disclaimer

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.

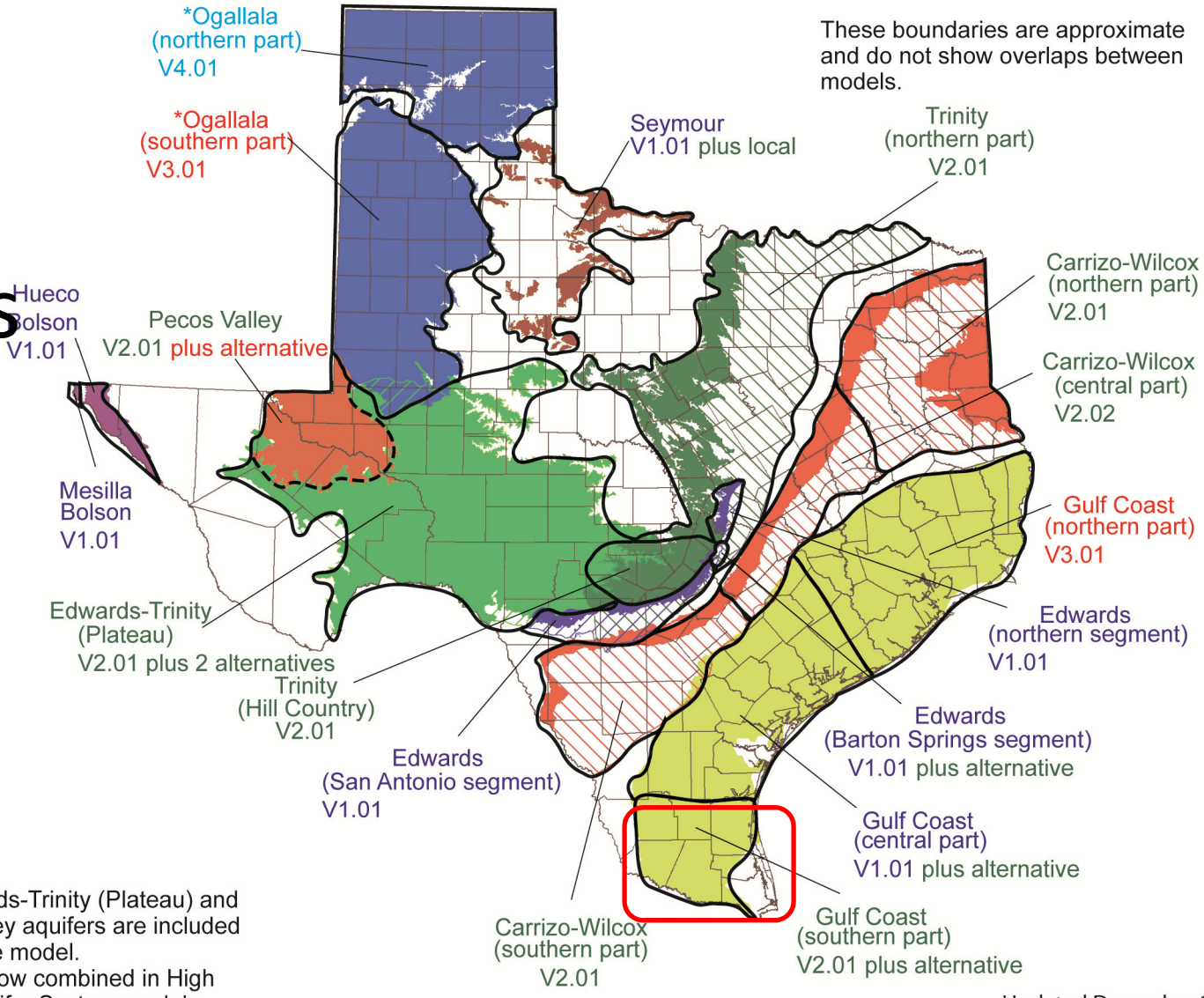
Groundwater Availability Modeling Program

- **Aim**: Develop groundwater flow models for the major and minor aquifers of Texas.
- **Purpose**: Tools that can be used to aid in groundwater resources management by stakeholders.
- **Public process**: Stakeholder involvement during model development process.
- **Models**: Freely available, standardized, thoroughly documented. Reports available over the internet.
- **Living tools**: Periodically updated.

Groundwater Availability Modeling Program

- So far the models developed for the program are groundwater flow only and do not include water quality or density flow
- This project is a new feasibility study into upgrading models and the data used to develop them for analyzing density flow/water quality
- Goal of this project to evaluate impacts of desalination in Region M

Major Aquifers



Note:
The Edwards-Trinity (Plateau) and Pecos Valley aquifers are included in the same model.
*Ogallala now combined in High Plains Aquifer System model

Updated December 2015

Why Stakeholder Advisory Forums?

- Keep stakeholders updated about progress of the model
- Inform how the groundwater model can, should, and should not be used
- Provide stakeholders with the opportunity to provide input and data to assist with model development

Contact Information

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Web information:
http://www.twdb.texas.gov/groundwater/models/research/lrgv_t/lrgv_t.asp#saf

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Topics

- Brief Overview of Project
- Project Status
  - Tasks Completed
- Overview of Conceptual Model
  - Aquifer Framework
  - Inflows and Outflows
  - Groundwater Salinity
- Next Steps
  - Numerical Model
  - Schedule

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Background

- LRGV has ten brackish groundwater desalination plants
  - Three of these are operated by the military
- 2016 Region M water plan recommends an additional 14 brackish groundwater desalination plants in LRGV
  - Supply an additional 24,000 AF/yr by 2070
  - Several alternative locations are also suggested in the water plan and are described in the final conceptual model report
- Model is needed to:
  - Evaluate groundwater level changes
  - Evaluate groundwater quality changes
  - Evaluate impacts to surface water
  - Evaluate potential for subsidence

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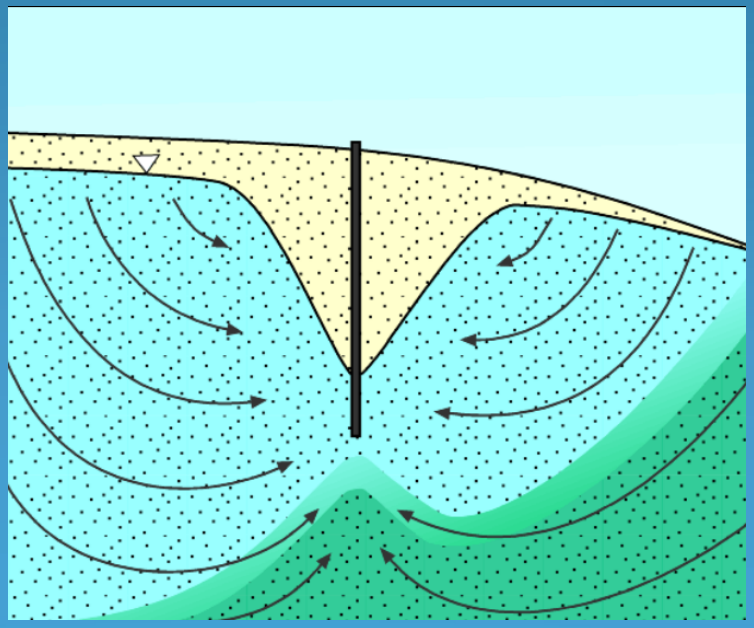
Objective

- The primary objective of this project is to develop a numerical groundwater model to simulate impacts of brackish water withdrawal by the current and recommended desalination plants in the Lower Rio Grande Valley



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Current GAM of LRGV

- Does not provide the ability to simulate water quality changes that are likely with increased pumping
- Does not account for the density effects of brackish groundwater
- Uses a coarse grid (1 sq. mi.)
  - Insufficient resolution in critical locations
  - Limited ability to simulate groundwater-surface water interactions

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History

- December 19, 2014
  - TWDB Published Request for Statement of Qualifications
- February 17, 2015
  - Due date for Statement of Qualifications
- April 15, 2015
  - TWDB Awarded Project to GSI Environmental Team
- **August 18, 2015**
  - Contract signed by TWDB
- September 10, 2015
  - Kick-off Meeting with TWDB and GSI Environmental Team
- **November 4, 2015**
  - Stakeholder Advisory Forum #1
- **May 31, 2016**
  - Draft Conceptual Model Report submitted to TWDB
- **July 13, 2016**
  - Stakeholder Advisory Forum #2

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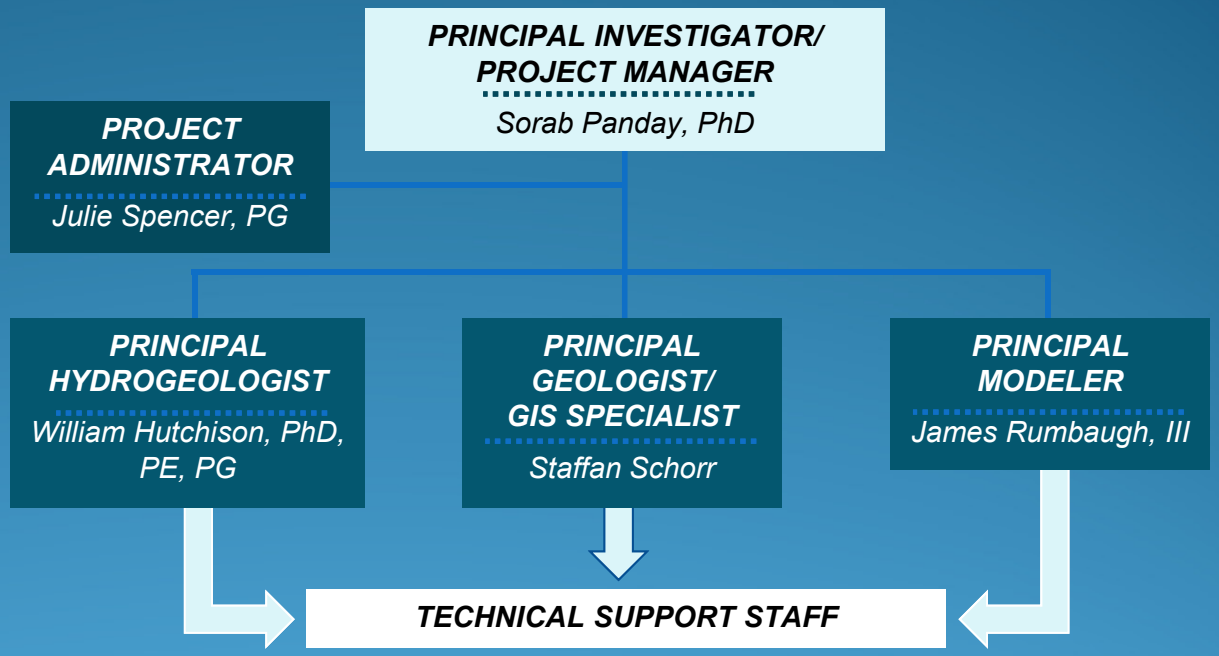
GSI Environmental Team

- Sorab Panday
- Julie Spencer
- Jim Rumbaugh
- Bill Hutchison
- Staffan Schorr



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Overview of Conceptual Model

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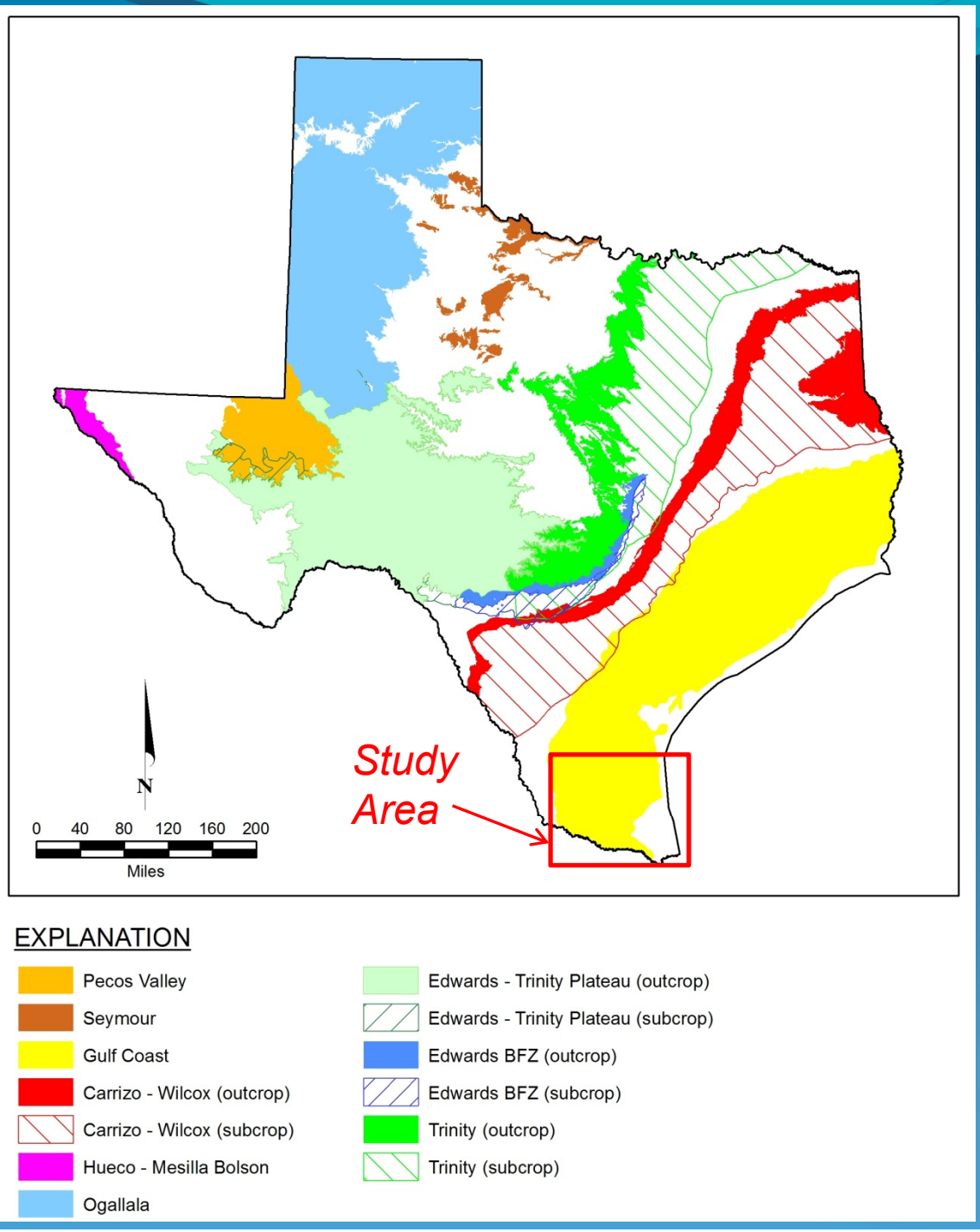
Major Aquifers



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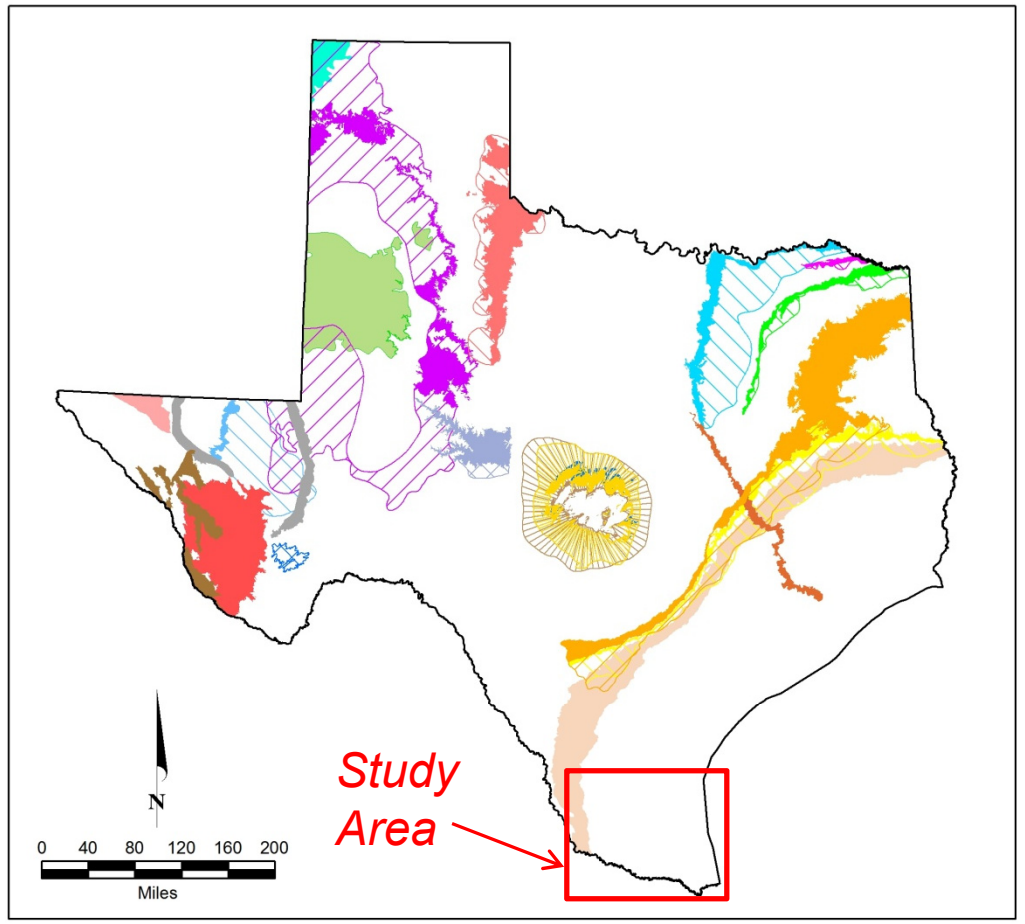
Minor Aquifers



EXPLANATION

- Brazos River Alluvium
- West Texas Bolsons
- Lipan (outcrop)
- Lipan (subcrop)
- Yegua Jackson
- Igneous
- Sparta (outcrop)
- Sparta (subcrop)
- Queen City (outcrop)
- Queen City (subcrop)
- Nacatoch (outcrop)
- Nacatoch (subcrop)
- Blossom (outcrop)
- Blossom (subcrop)
- Woodbine (outcrop)
- Woodbine (subcrop)
- Rita Blanca
- Edwards -Trinity (High Plains)
- Dockum (outcrop)
- Dockum (subcrop)
- Rustler (outcrop)
- Rustler (subcrop)
- Capitan Reef Complex
- Blaine (outcrop)
- Blaine (subcrop)
- Bone Spring - Victorio Peak
- Marble Falls
- Marathon
- Ellenburger - San Saba (outcrop)
- Ellenburger - San Saba (subcrop)
- Hickory (outcrop)
- Hickory (subcrop)

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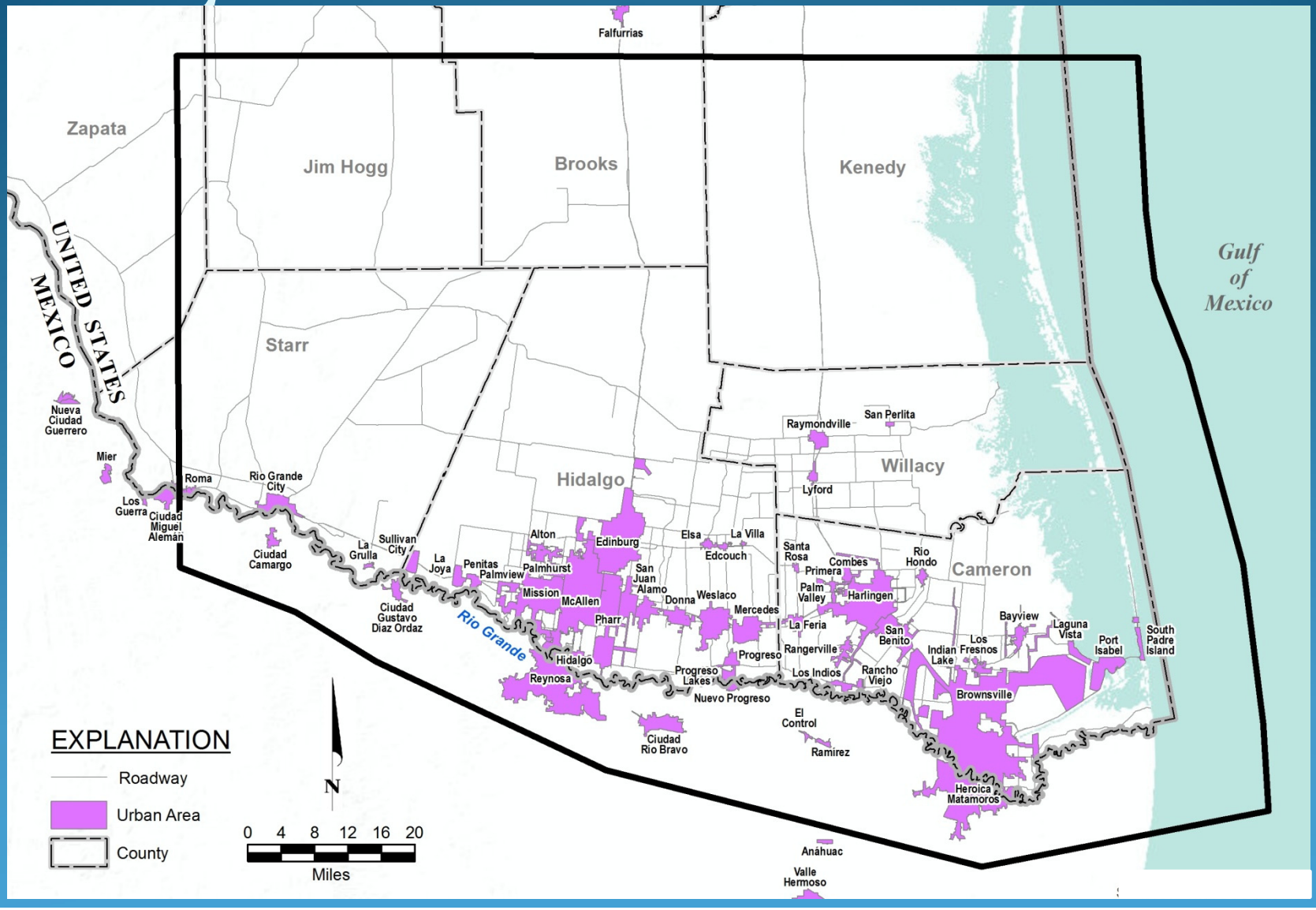
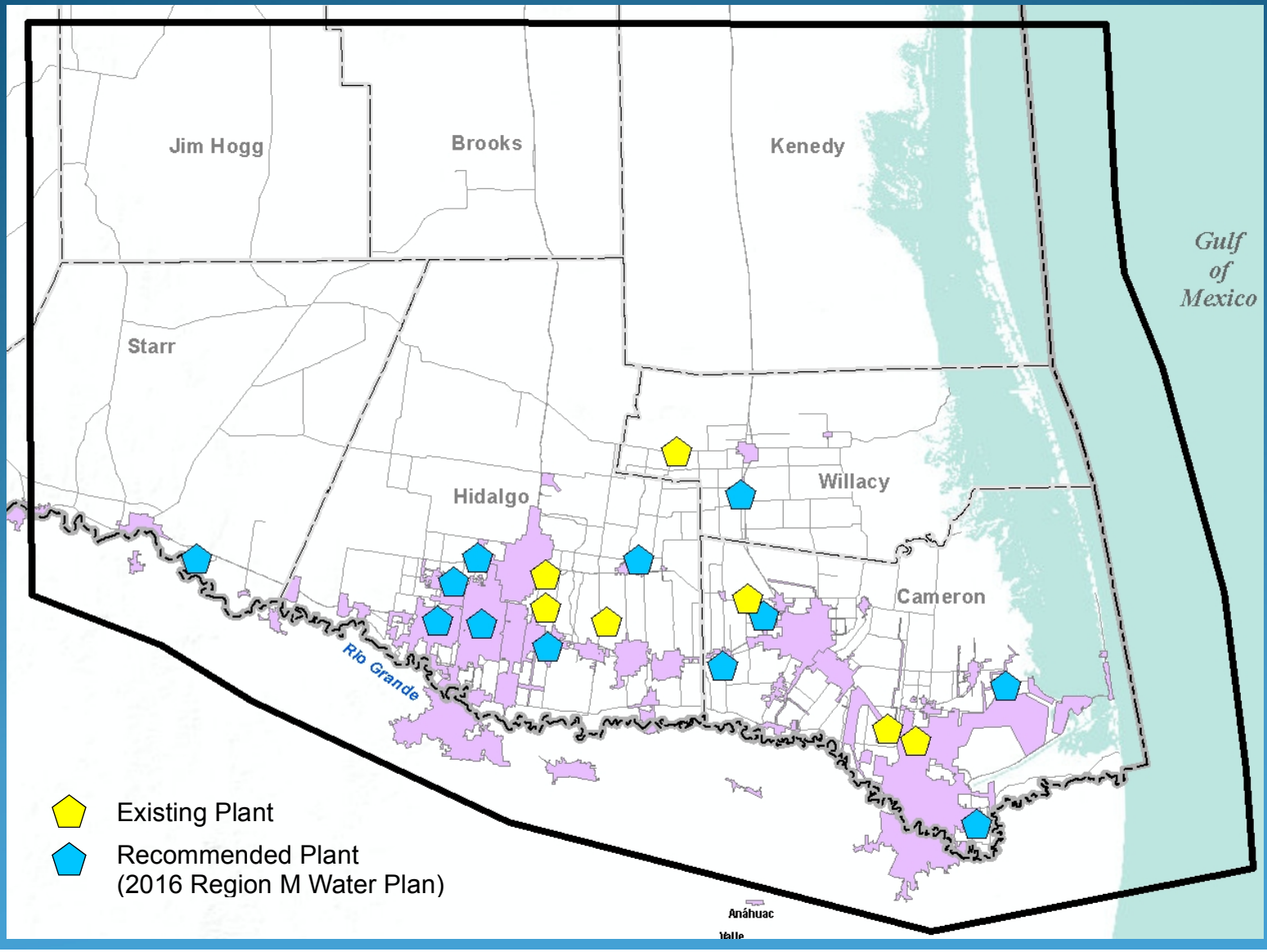
Study Area


Falfurrias
Zapata
Jim Hogg
Brooks
Kenedy
Gulf of Mexico
UNITED STATES
MEXICO
Starr
Nueva Ciudad Guerrero
Mier
Roma
Rio Grande City
Los Guerra
Ciudad Miguel Alemán
Ciudad Camargo
La Grulla
Sullivan City
La Joya
Penitas
Palmview
Palmhurst
Alton
Edinburg
Hidalgo
Mission
McAllen
San Juan
Alamo
Donna
Weslaco
Pharr
Ciudad Gustavo Diaz Ordaz
Rio Grande
Hidalgo
Reynosa
Progreso Lakes
Nuevo Progreso
Ciudad Rio Bravo
El Control
Ramirez
Raymondville
San Perlita
Willacy
Lyford
Elsa
La Villa
Edcouch
Santa Rosa
Combes
Primera
Rio Hondo
Cameron
Palm Valley
Harlingen
Mercedes
La Feria
Rangerville
Progreso
Los Indios
Rancho Viejo
San Benito
Bayview
Laguna Vista
Los Fresnos
Indian Lake
Port Isabel
South Padre Island
Brownsville
Heroica Matamoros
Anáhuac
Valle Hermoso
EXPLANATION
Roadway
Urban Area
County
N
0 4 8 12 16 20
Miles

Desalination Plants



Climate

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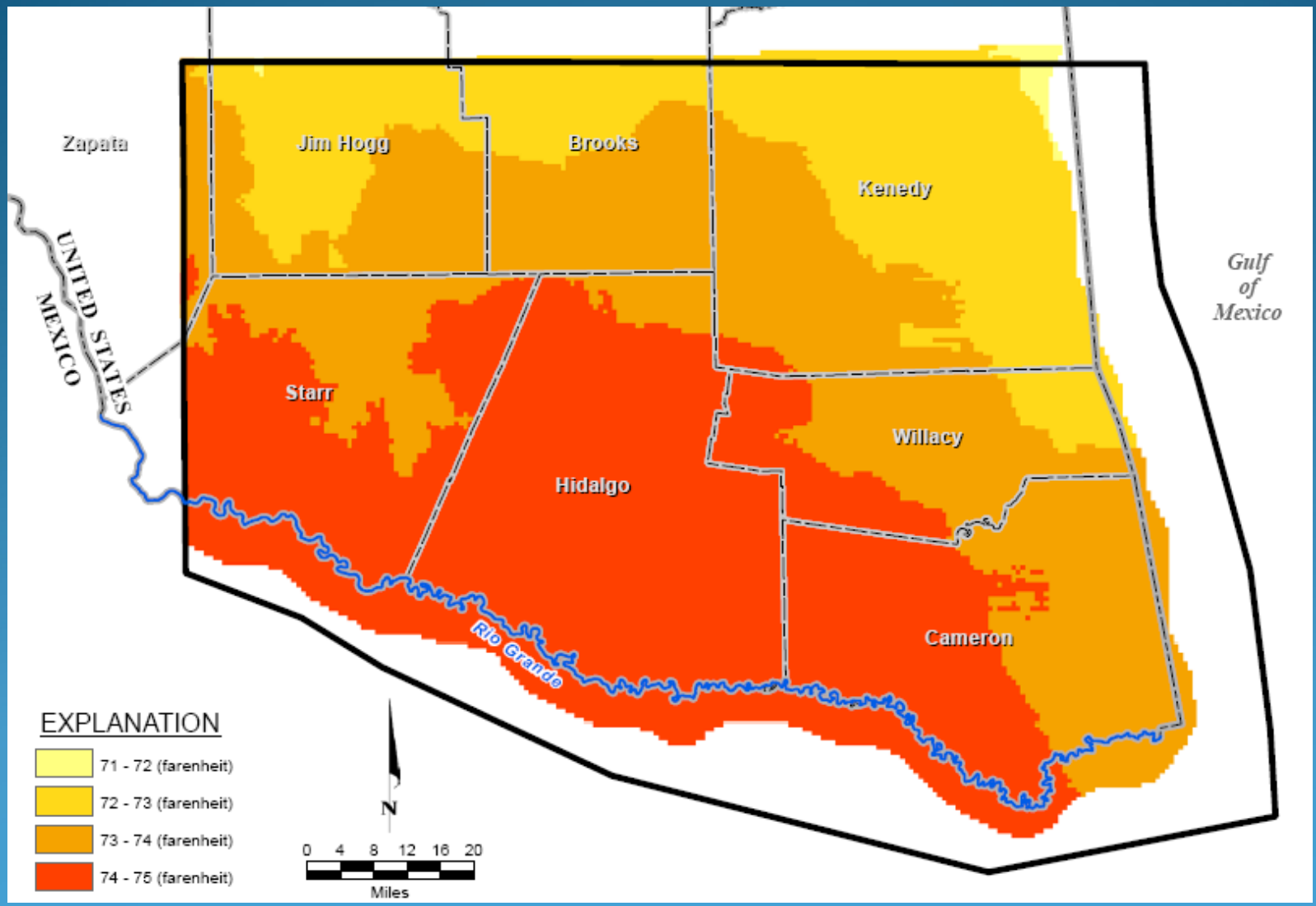
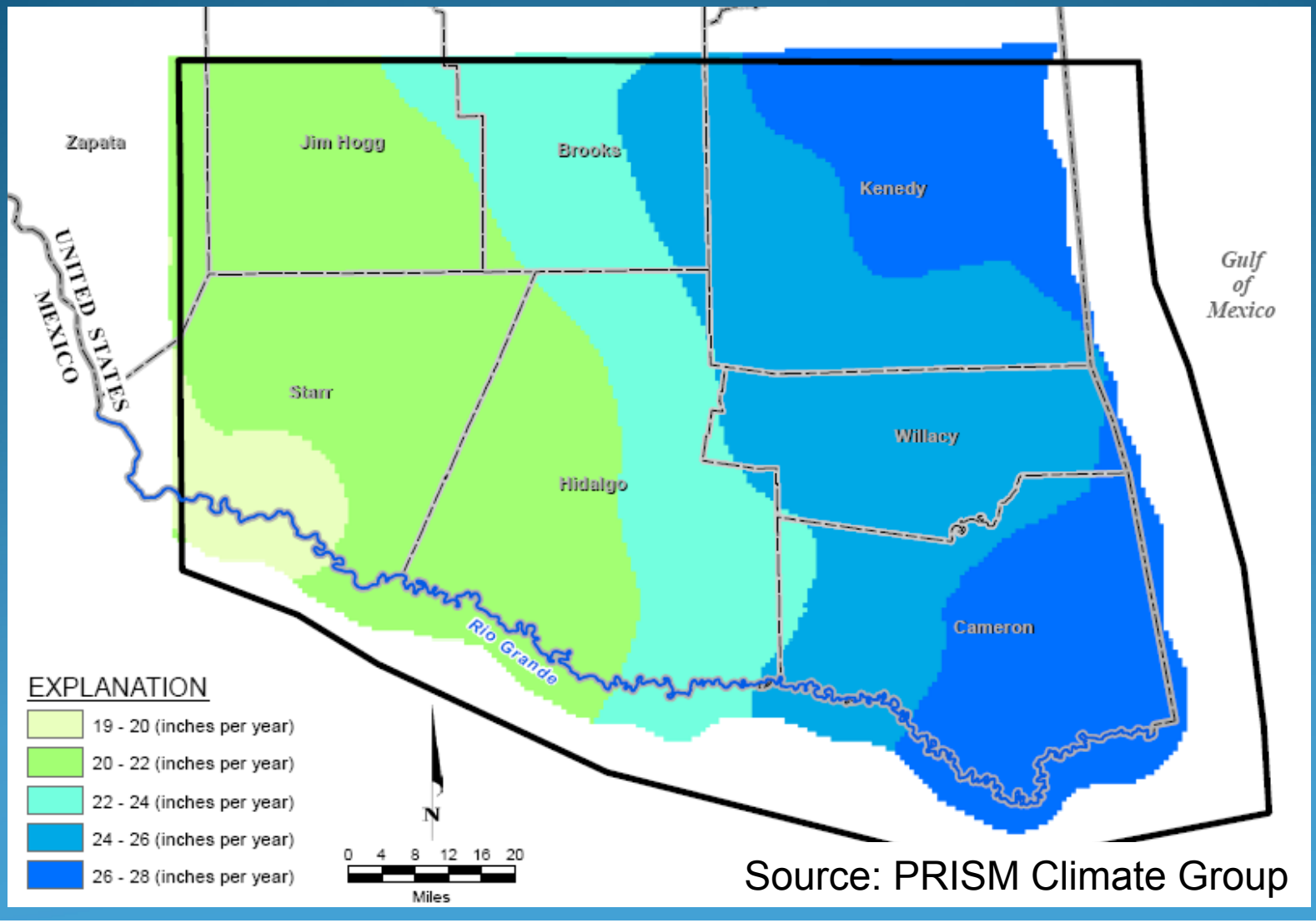
Average Annual Air Temperature

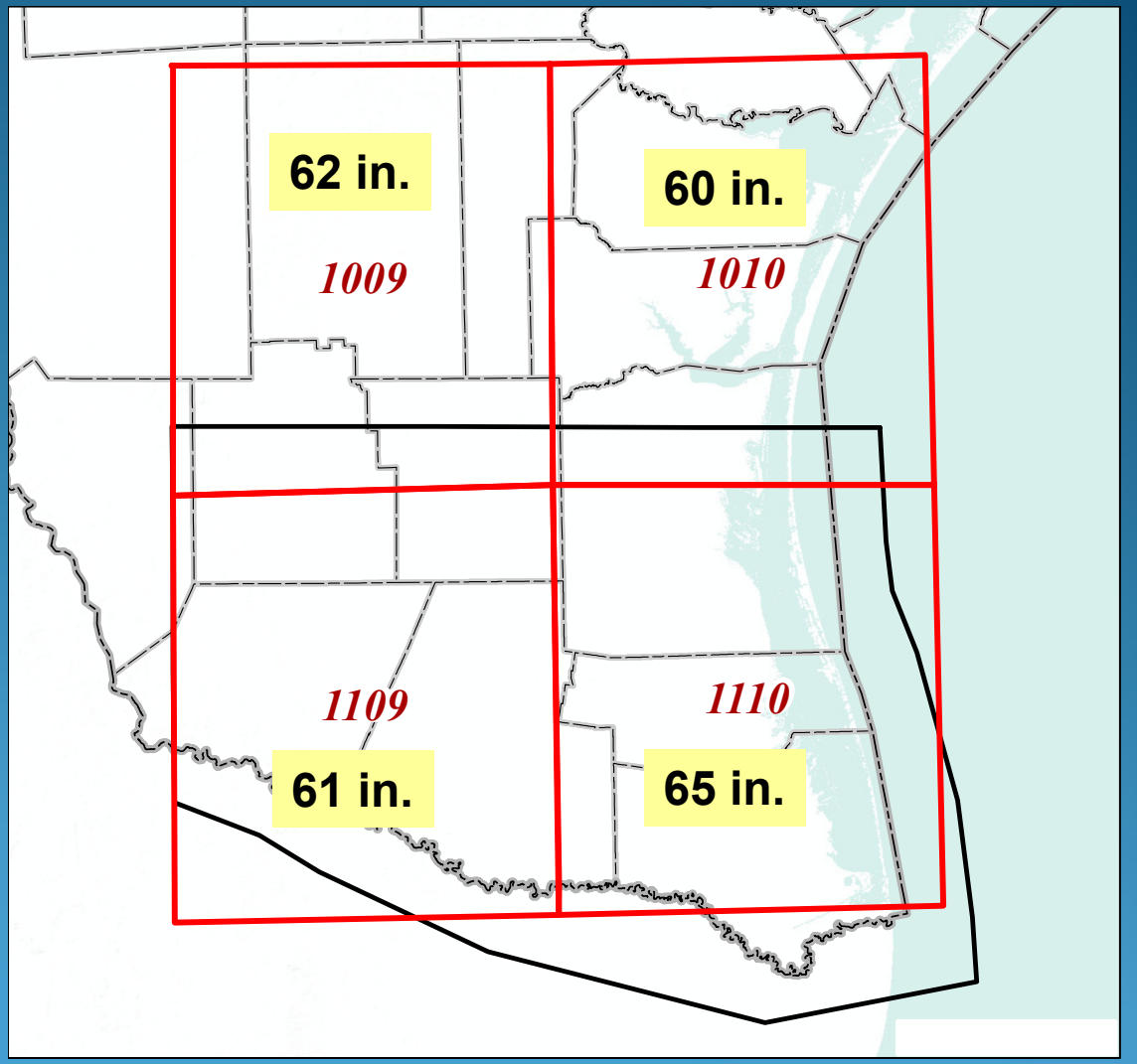


Average Annual Precipitation



Source: PRISM Climate Group

Average Annual Lake Evaporation



EXPLANATION

1009 TWDB Climate Data Quadrangle

Study Area

County

Source: TWDB (2016b), dated August 2014

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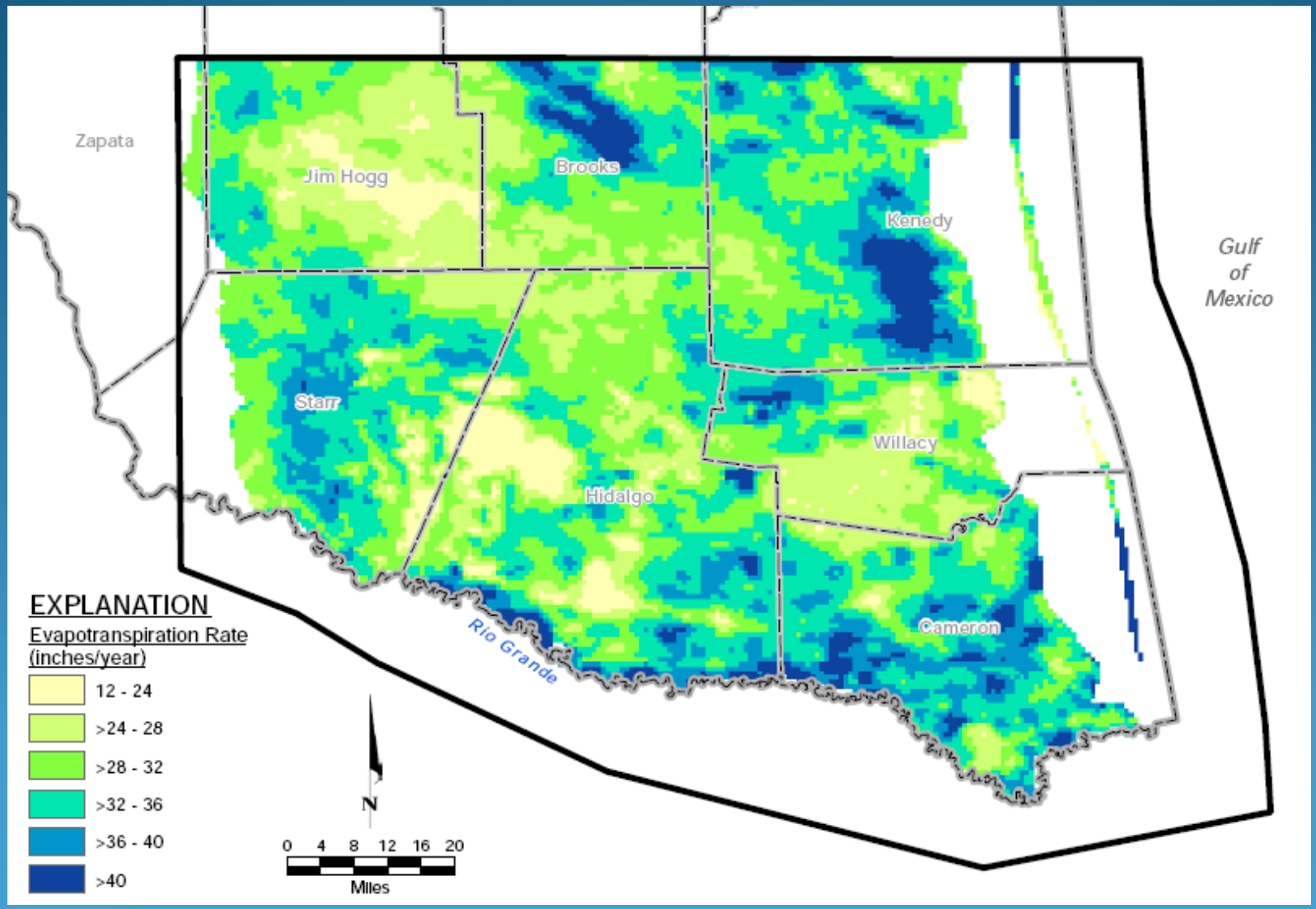
Evapotranspiration (ET)



Geology

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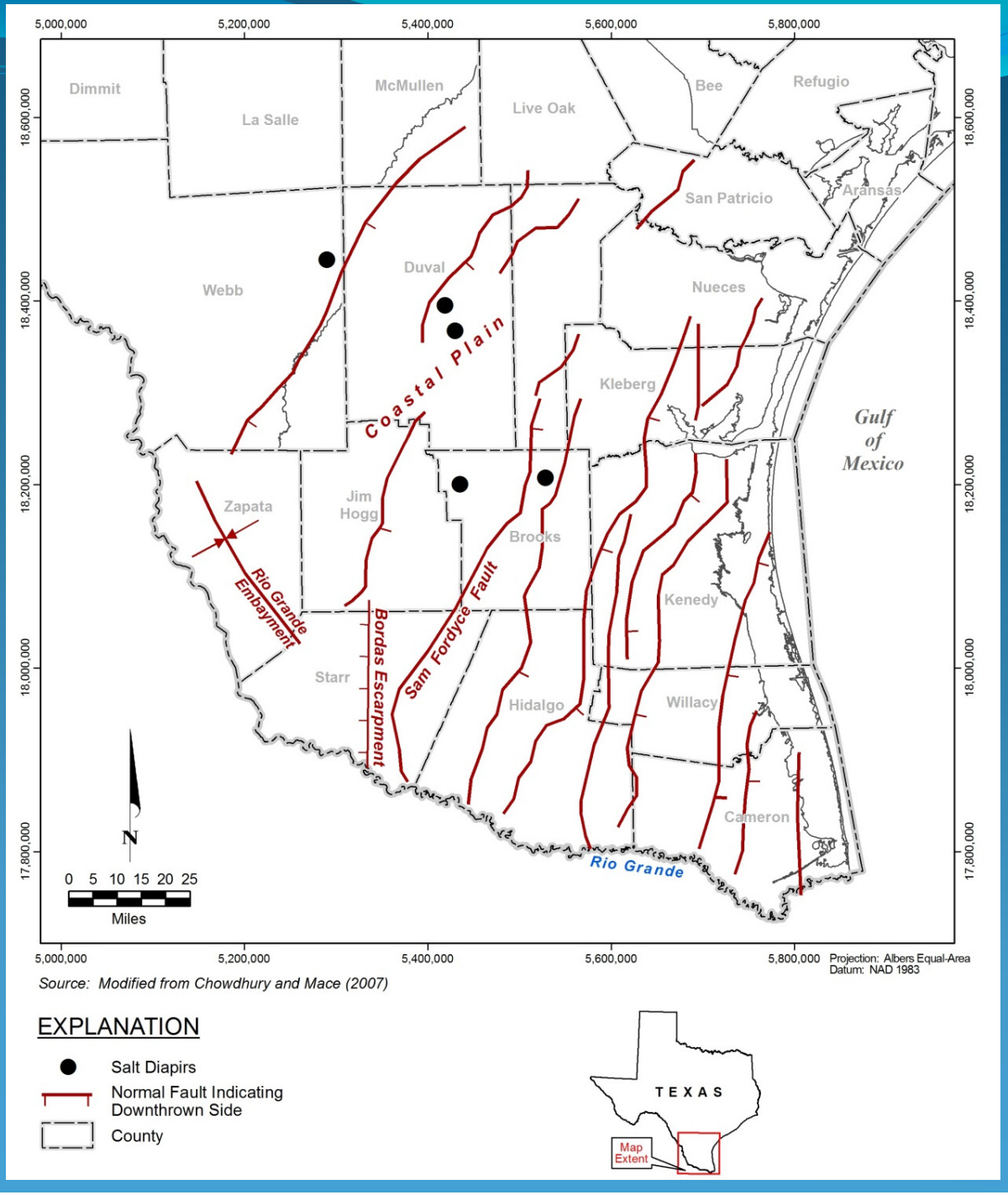
Faults



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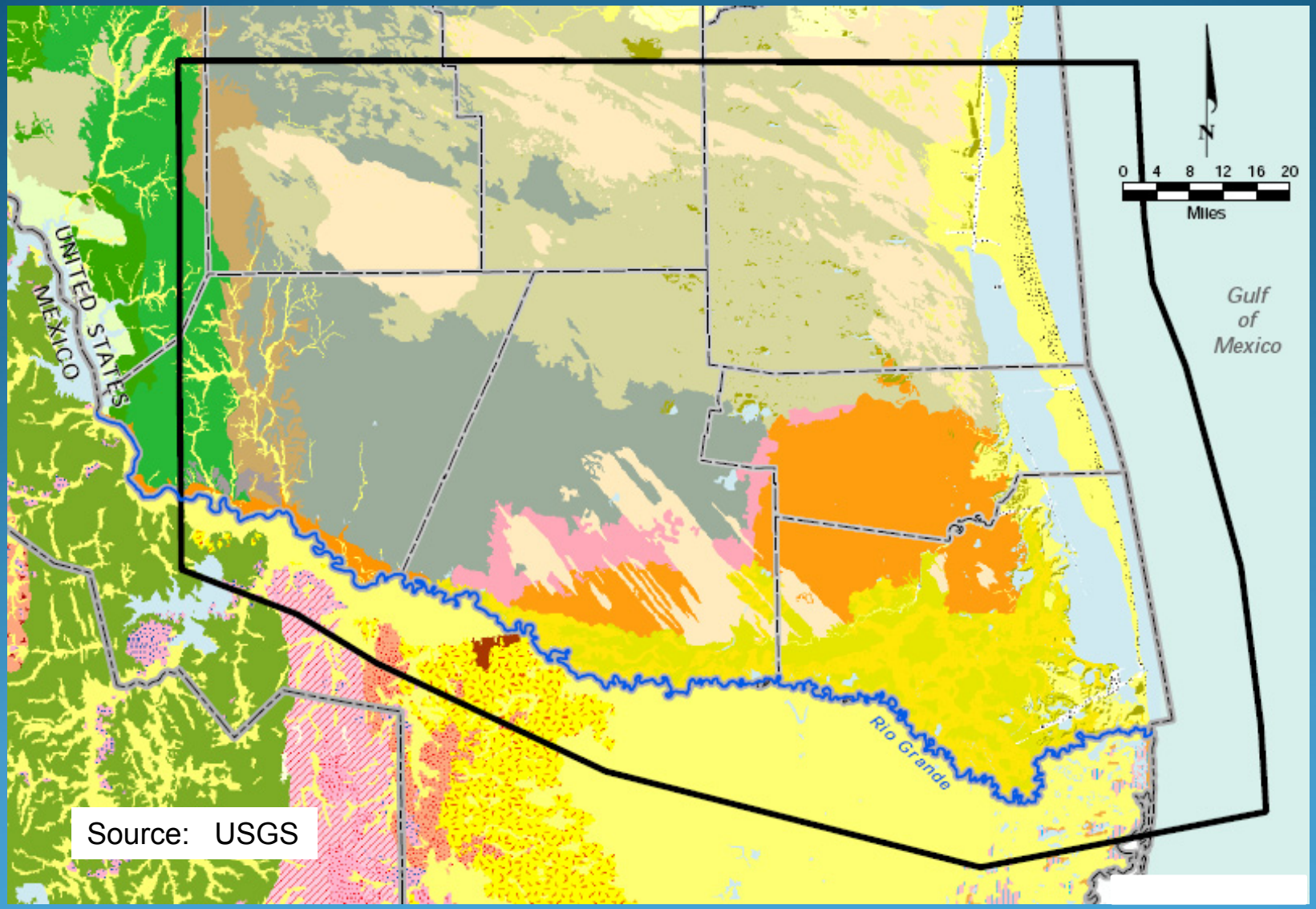
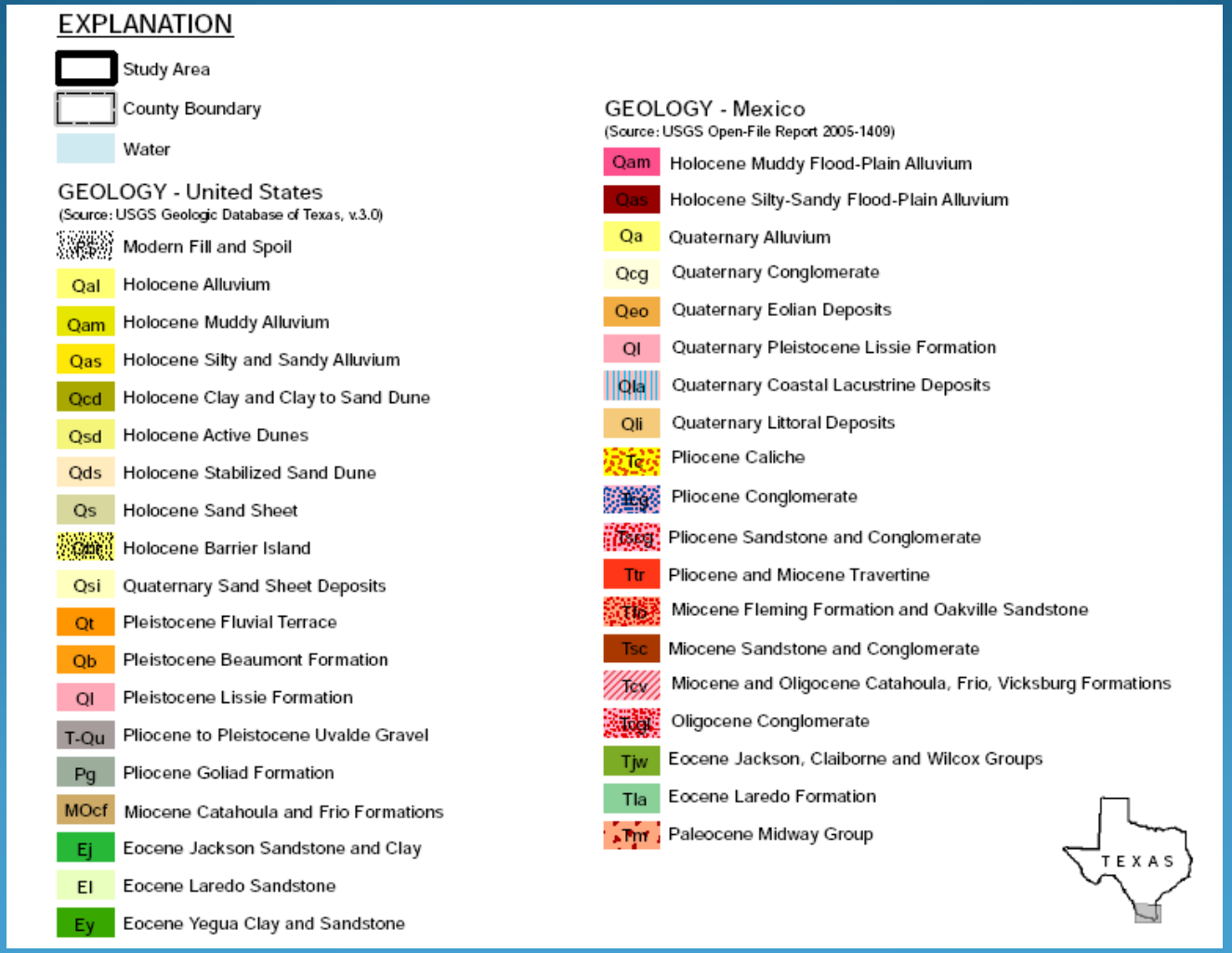
Surface Geology



Source: USGS

Surface Geology Continued



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Previous Work

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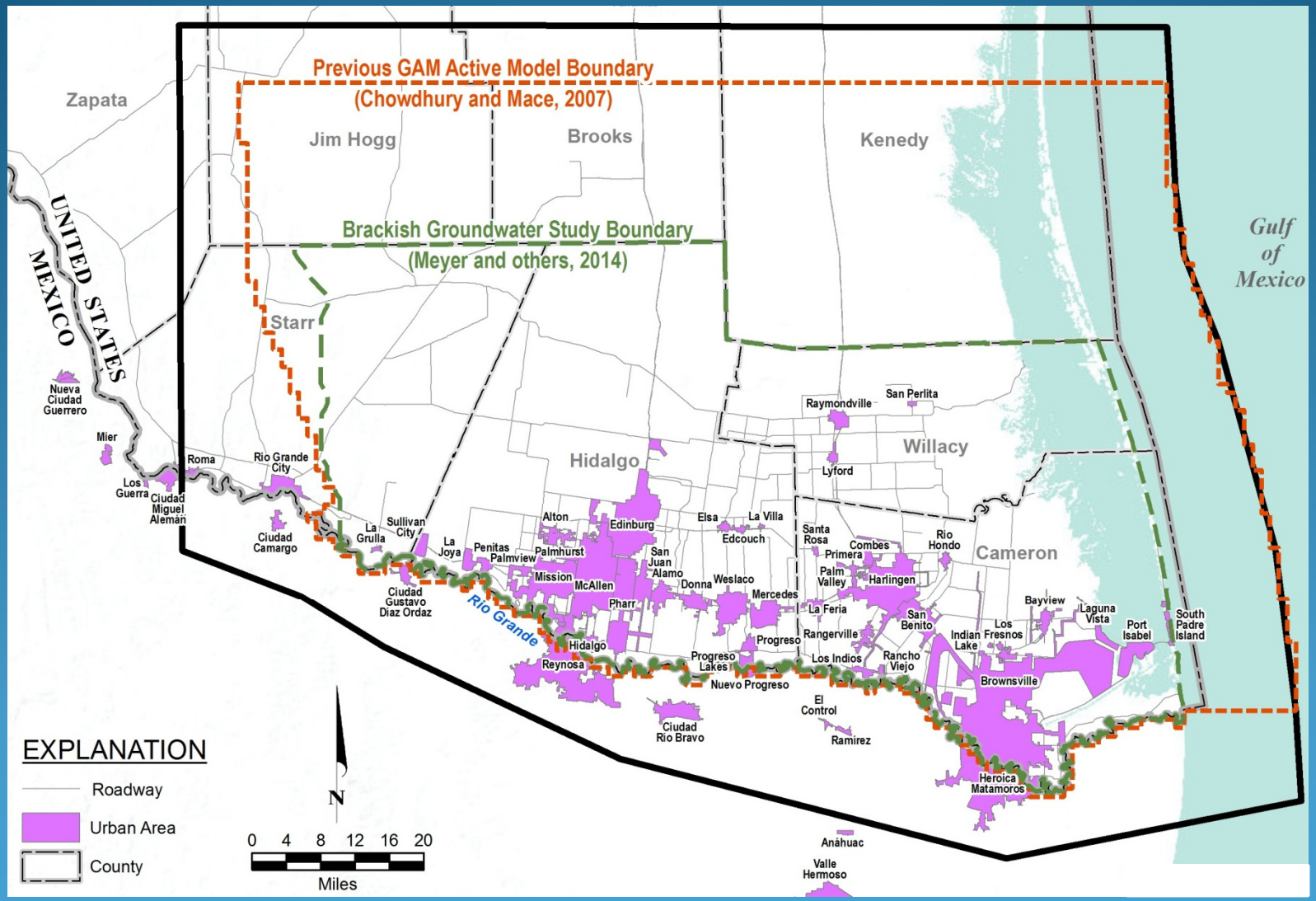
Previous Groundwater Studies



Hydrostratigraphy-Framework

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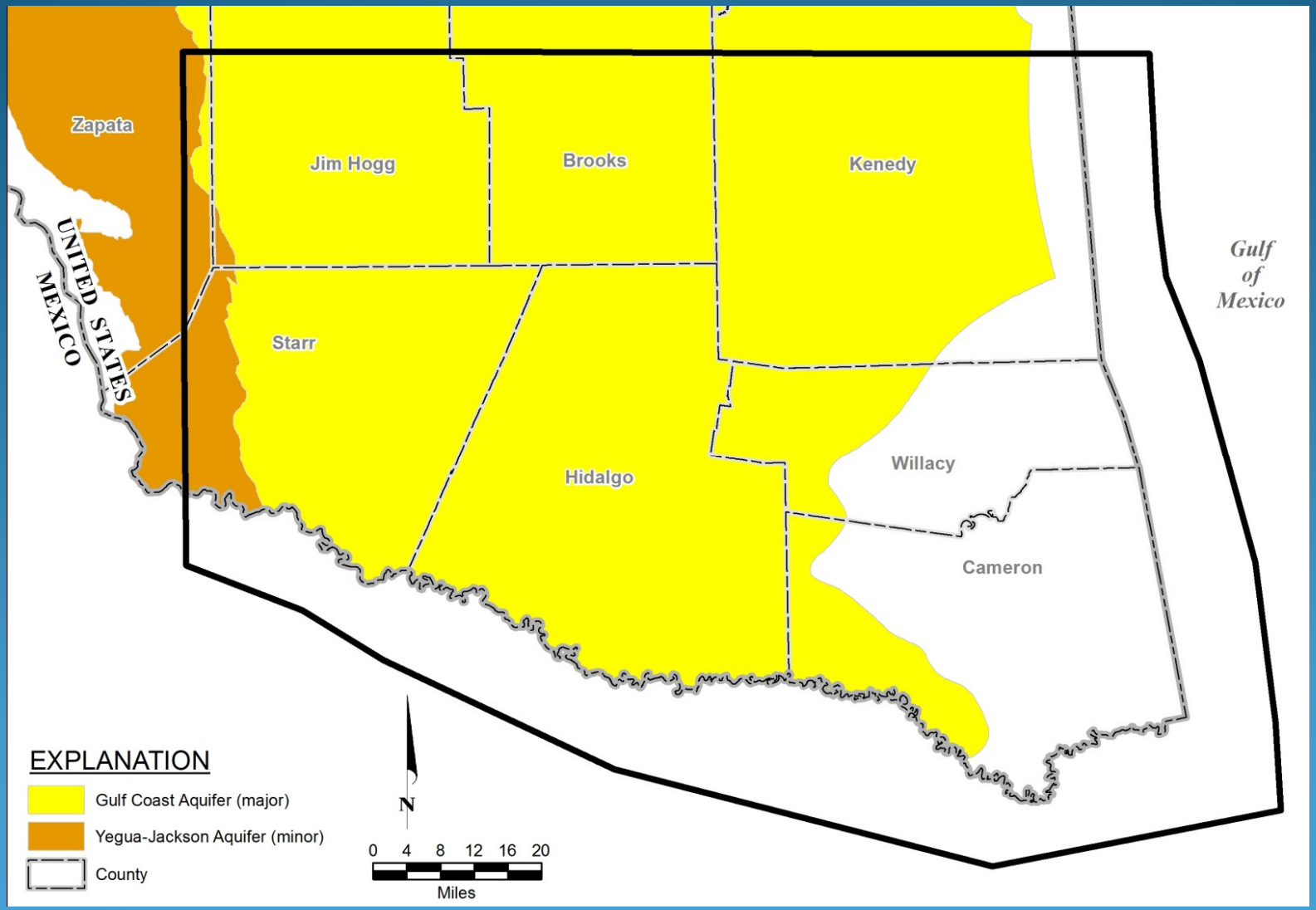
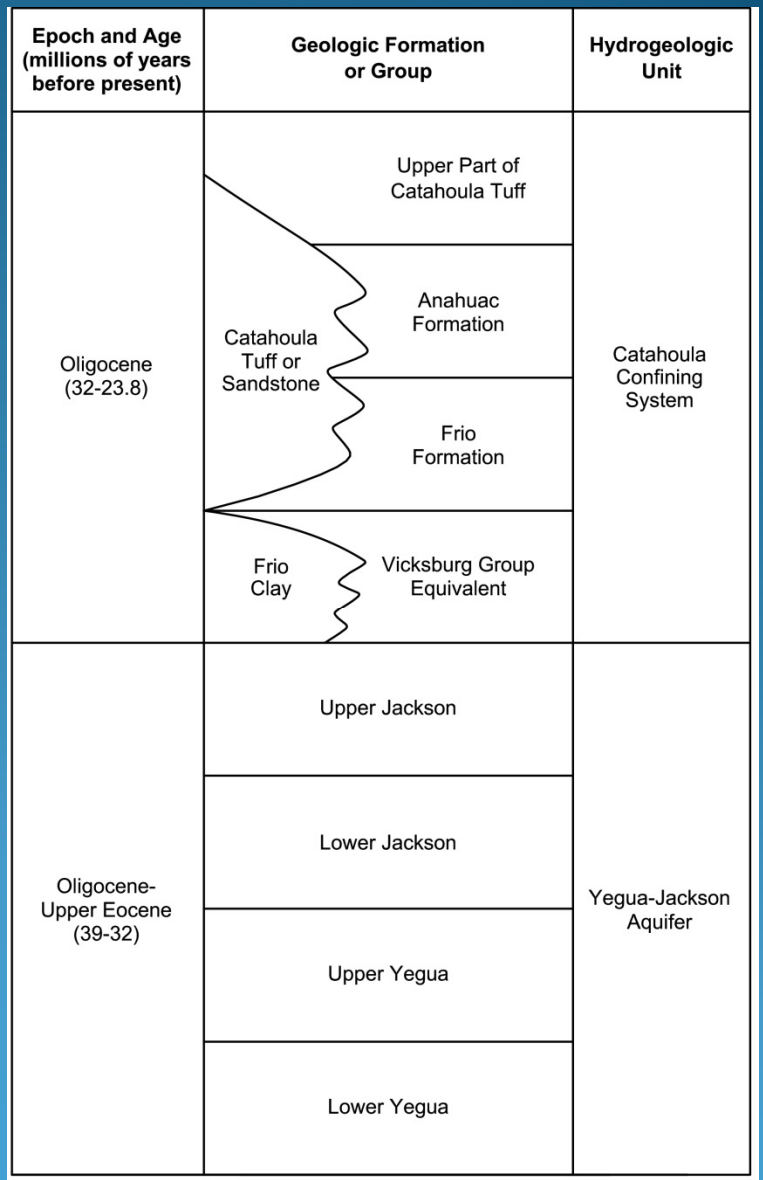
Aquifers in Lower Rio Grande Valley



Generalized Hydrostratigraphy

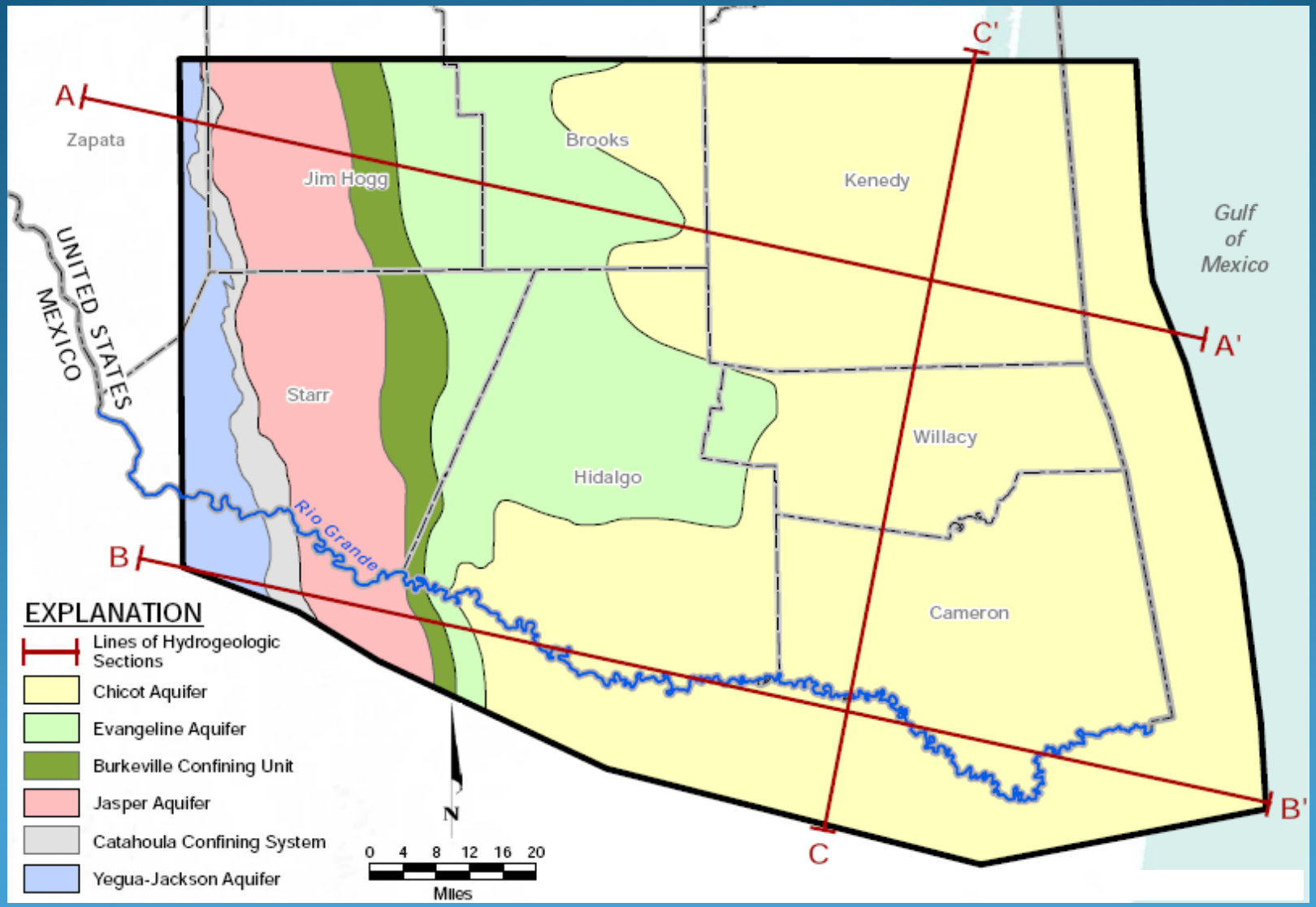
Epoch and Age (millions of years before present)	Geologic Formation or Group	Hydrogeologic Unit	
Pleistocene (1.8-present)	Beaumont	Chicot Aquifer	Gulf Coast Aquifer
	Lissie		
Pliocene (5.6-1.8)	Willis		
Miocene (23.8-5.6)	Upper Goliad	Evangeline Aquifer	
	Lower Goliad		
	Upper Lagarto		
	Middle Lagarto	Burkeville Confining Unit	
	Lower Lagarto	Jasper Aquifer	
	Oakville		
Oligocene	(Upper) Catahoula		

Source: Modified from Young and others (2010)

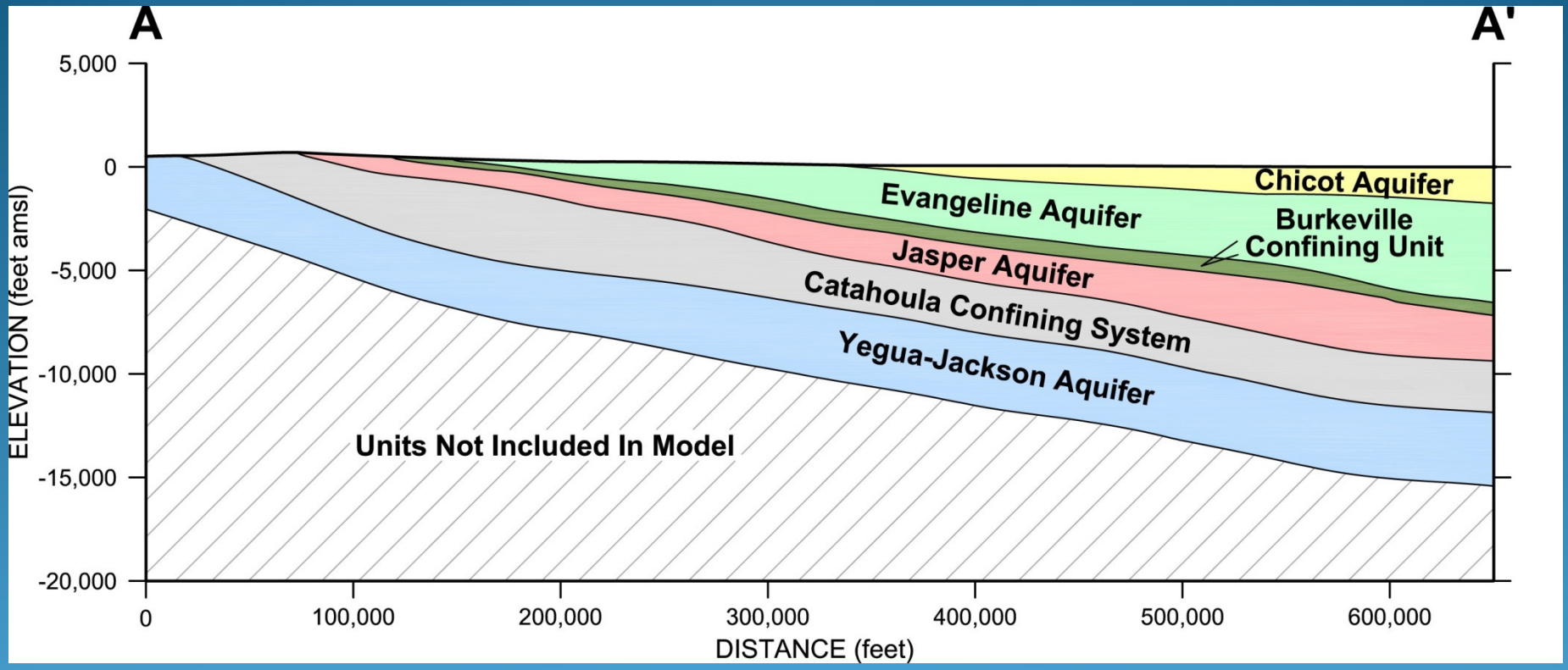


Source: Knox & others (2007), Deeds & others (2010), & Young & others (2010)

Aquifer Outcrop Areas



Cross-Section A-A’



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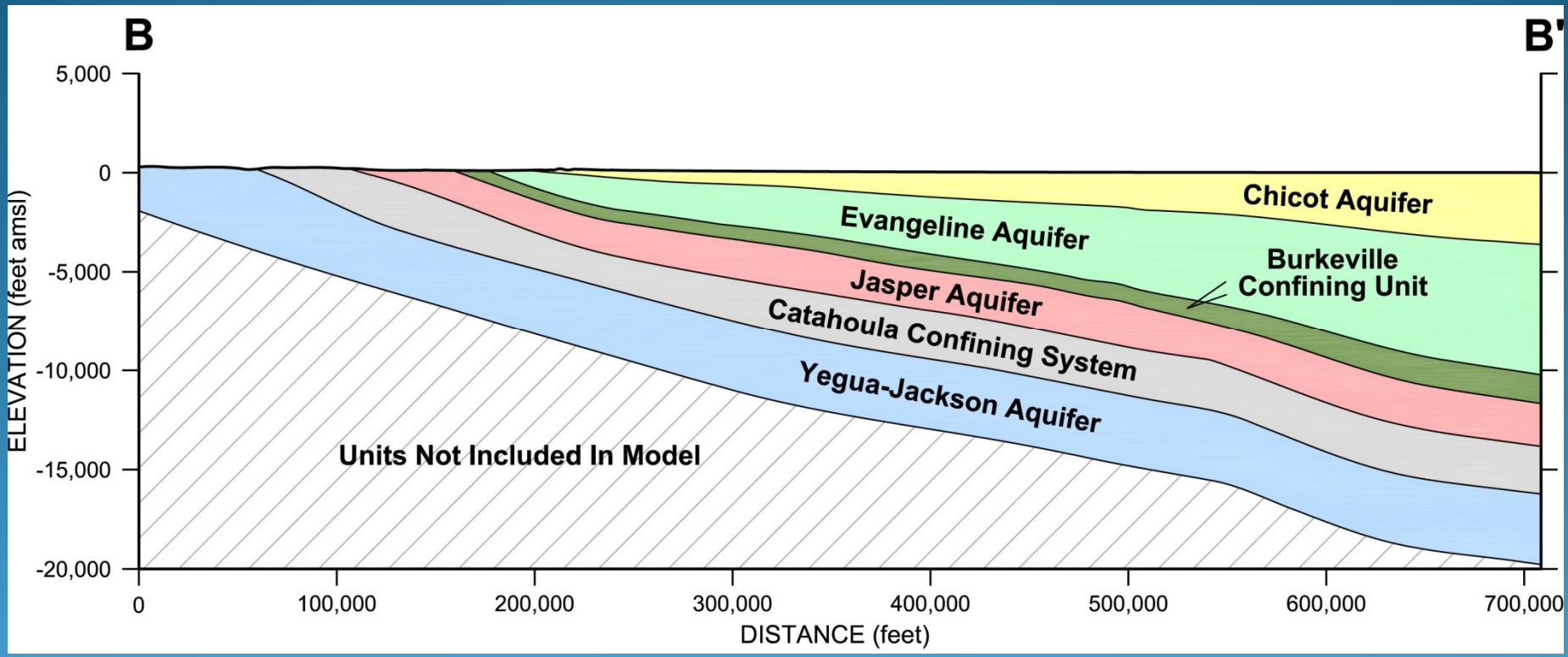
Cross-Section B-B’



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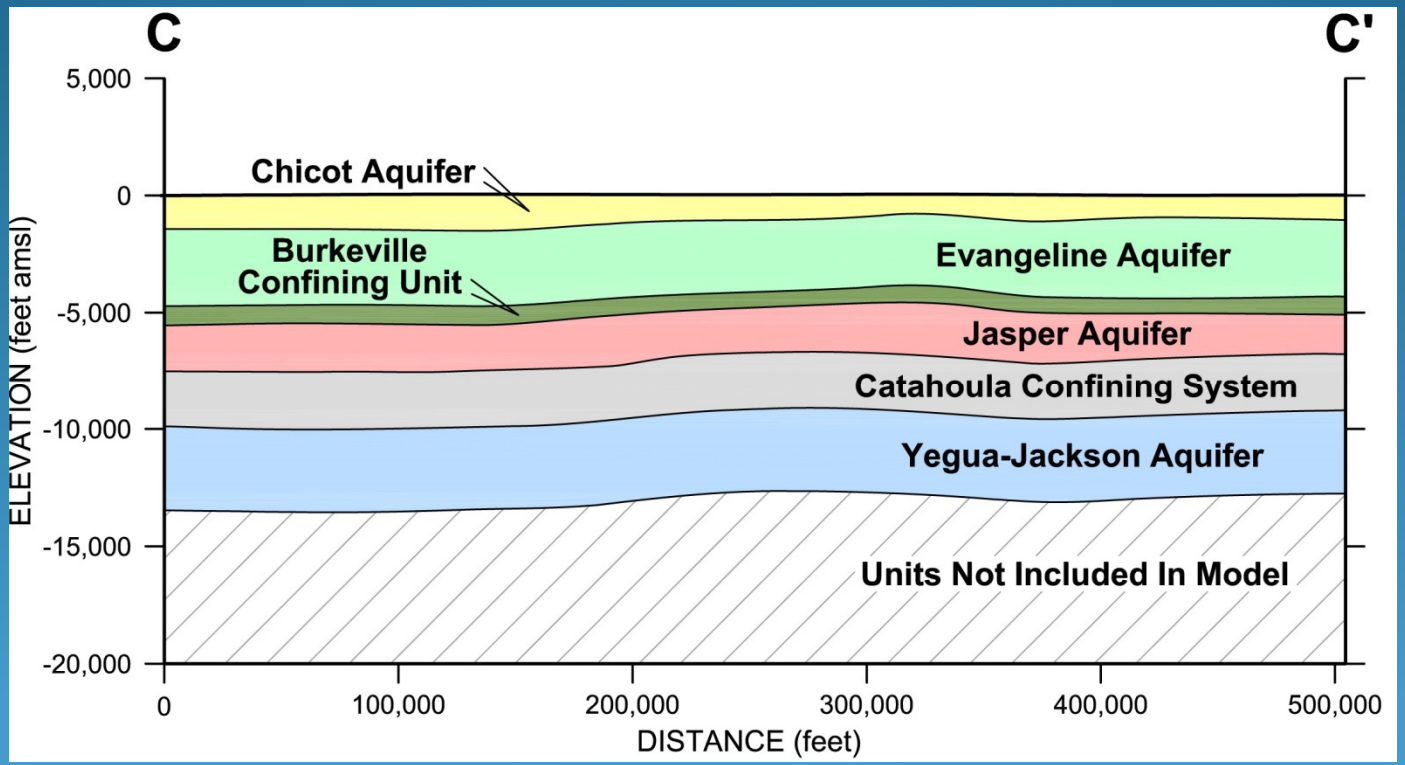
Cross-Section C-C’



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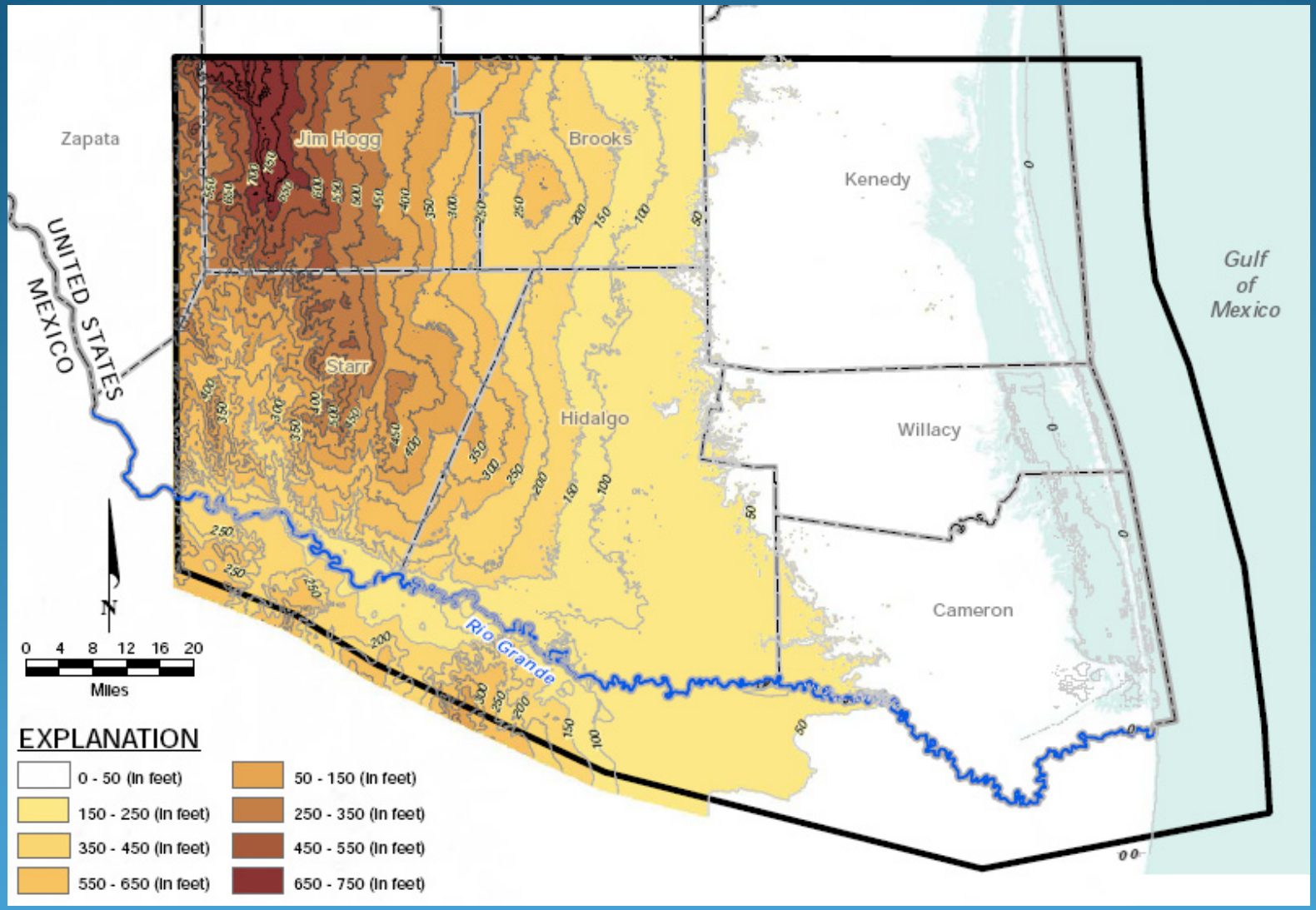
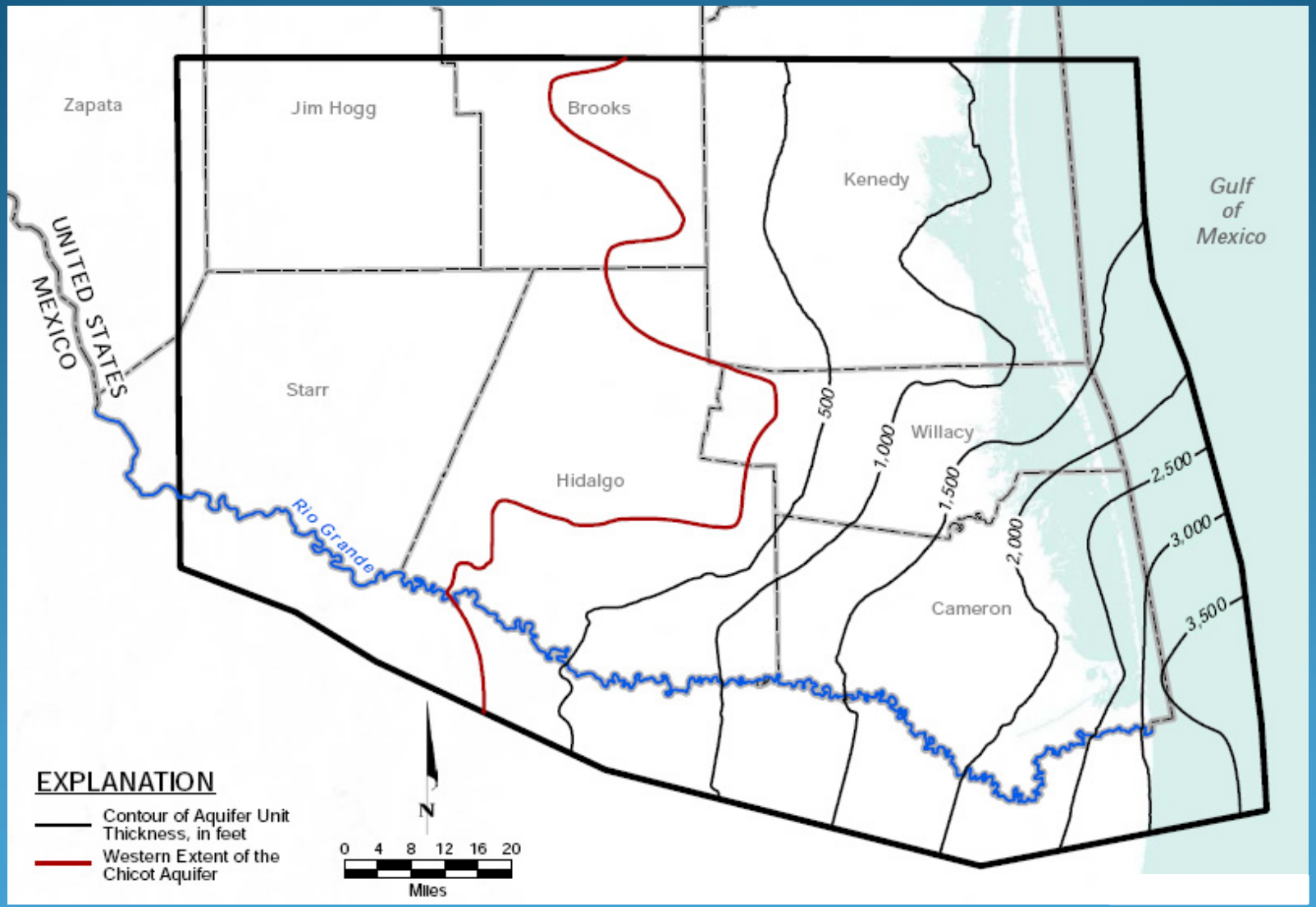
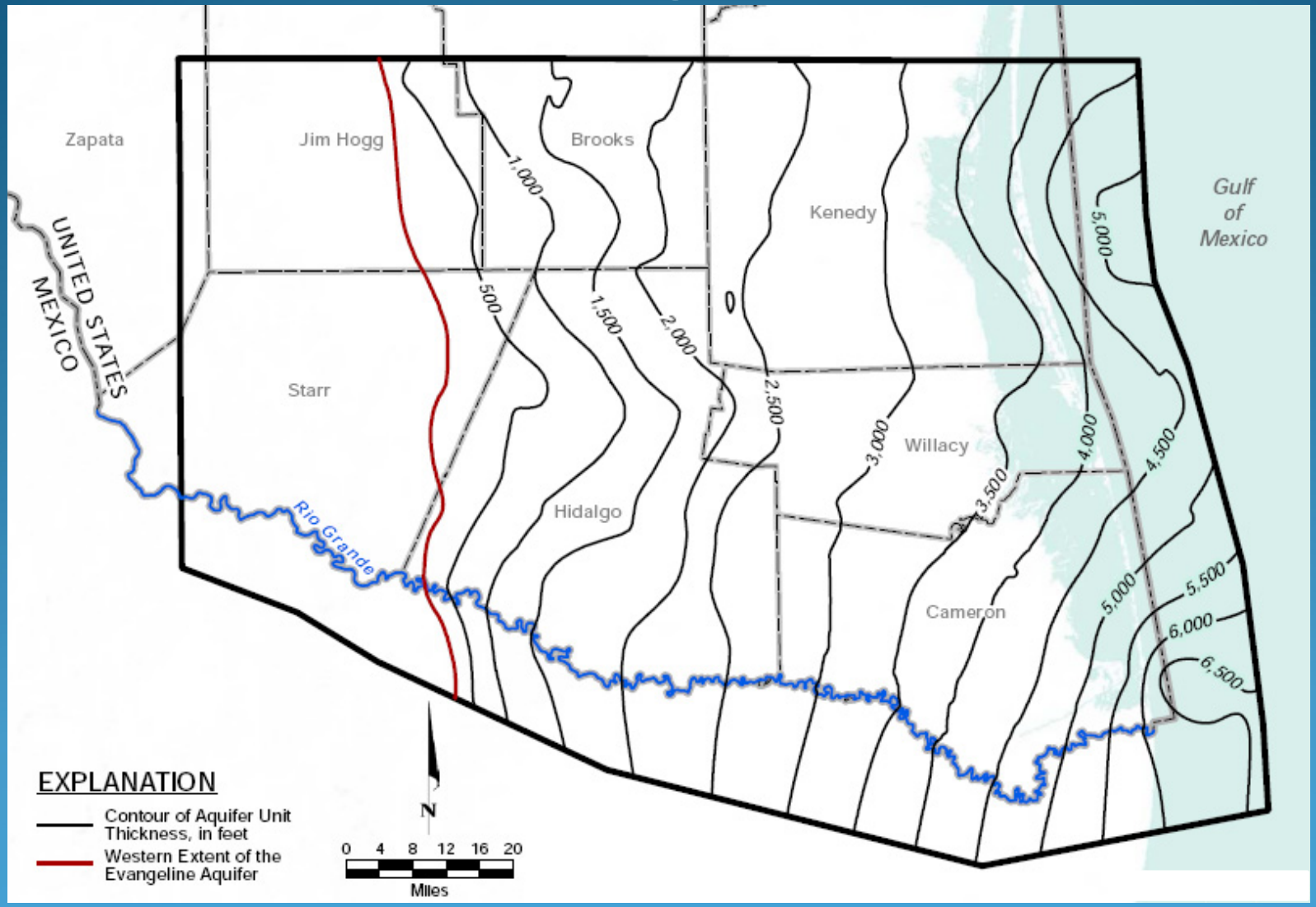
Land Surface Elevation



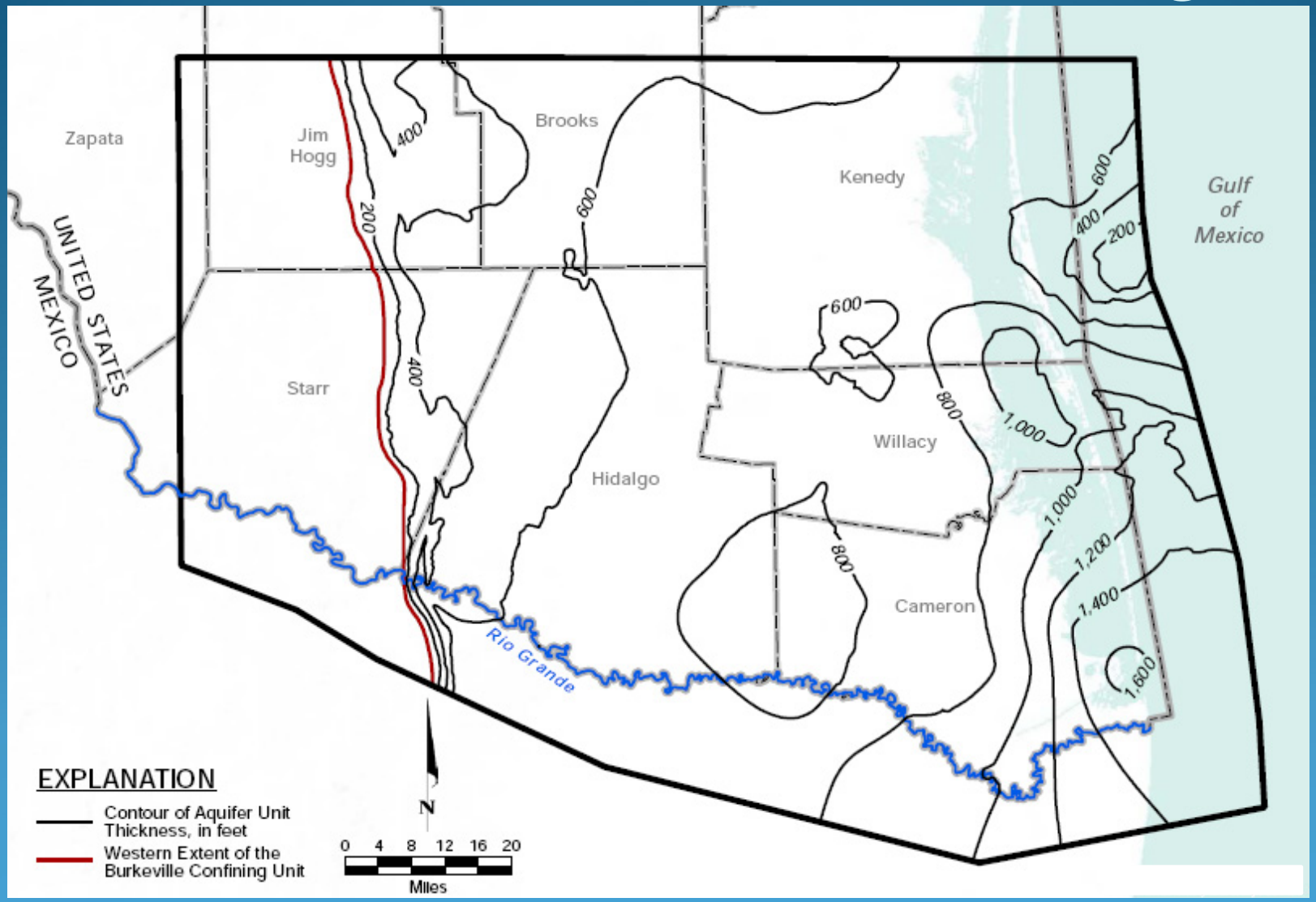
Thickness of Chicot Aquifer



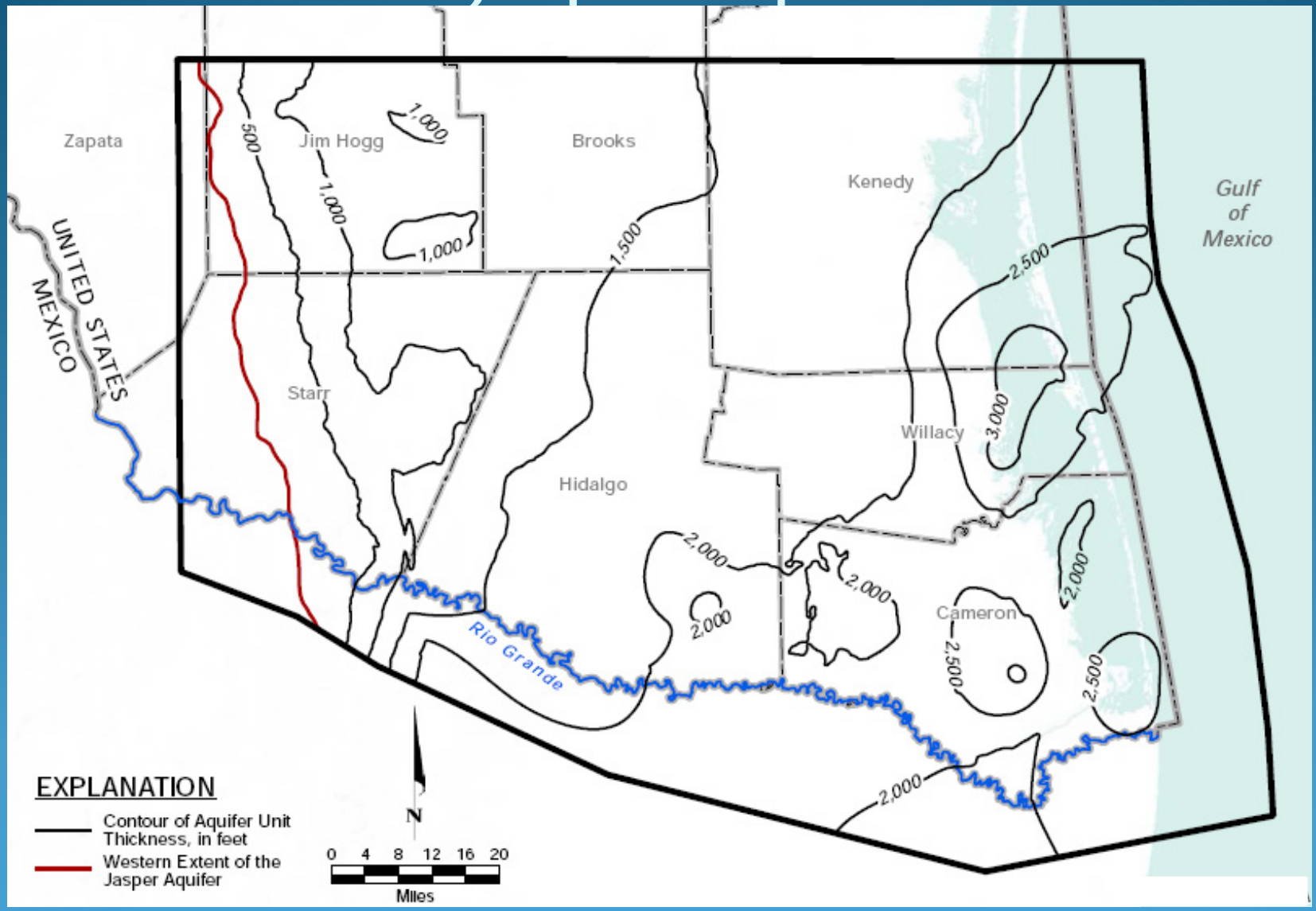
Thickness of Evangeline Aquifer



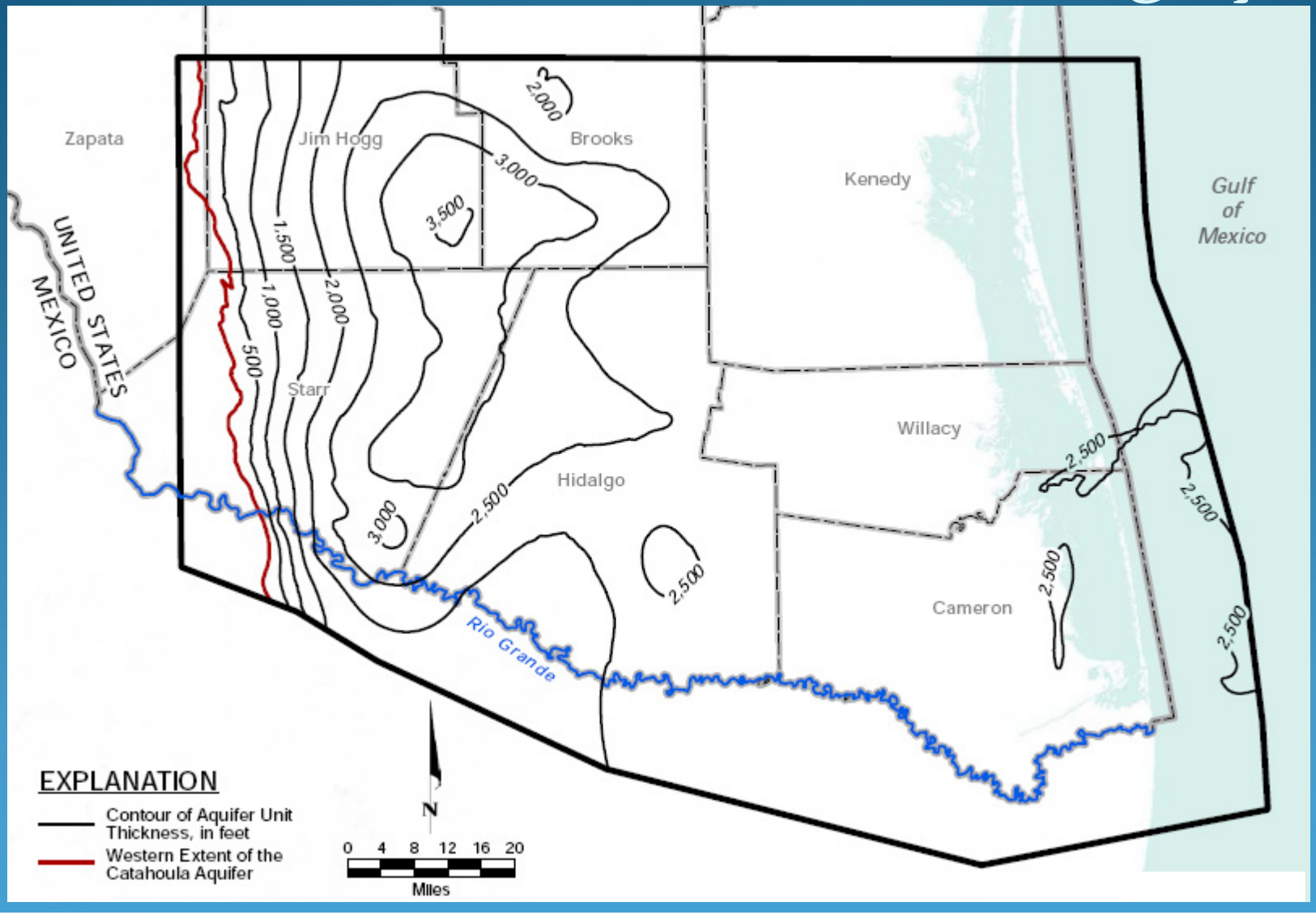
Thickness of Burkeville Confining Unit



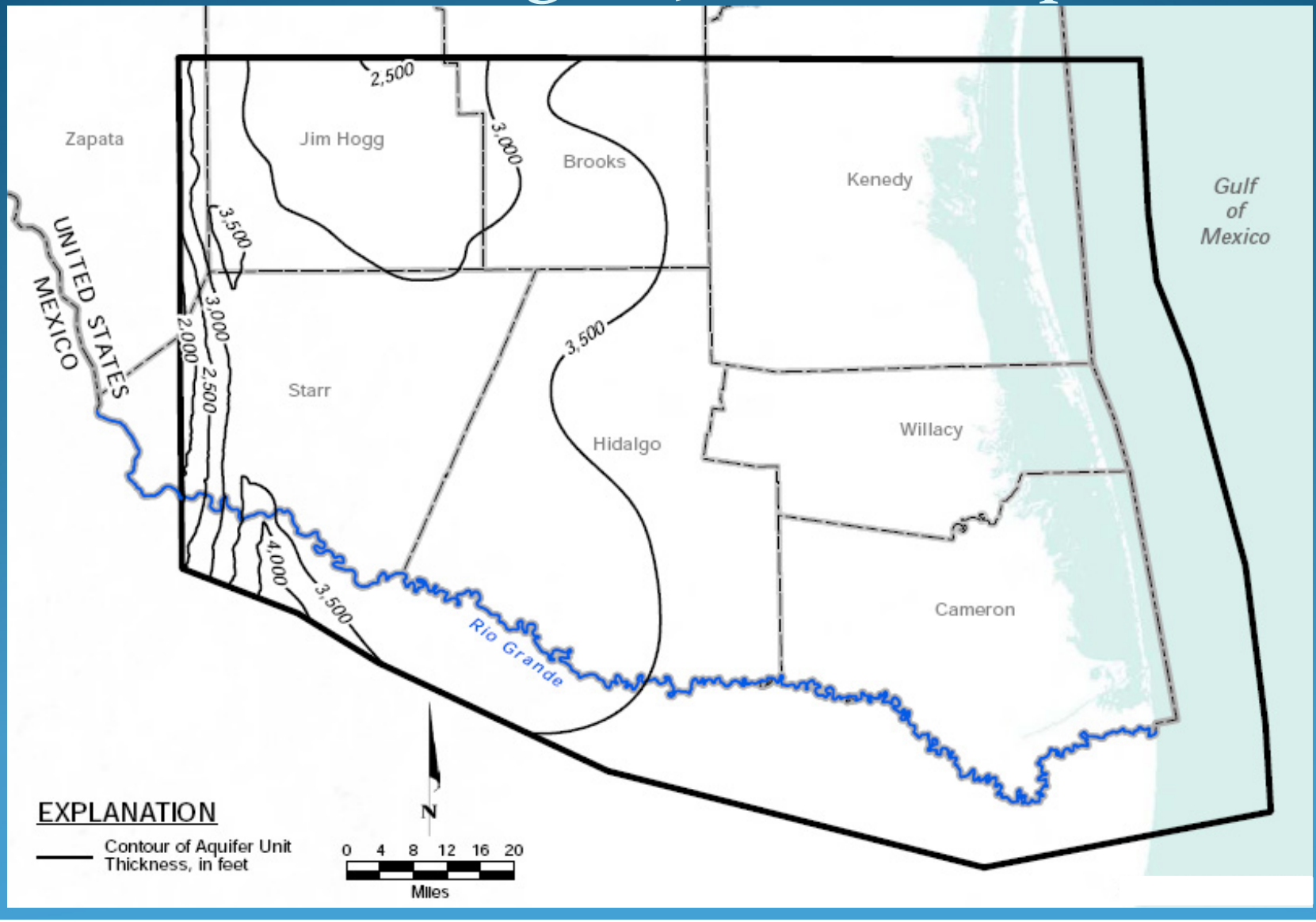
Thickness of Jasper Aquifer



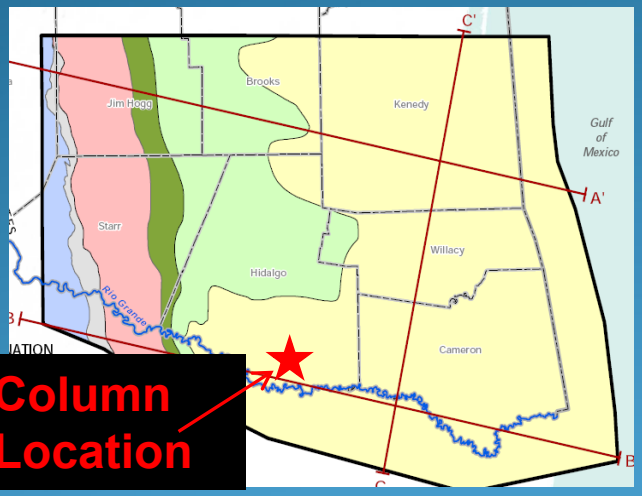
Thickness of Catahoula Confining System

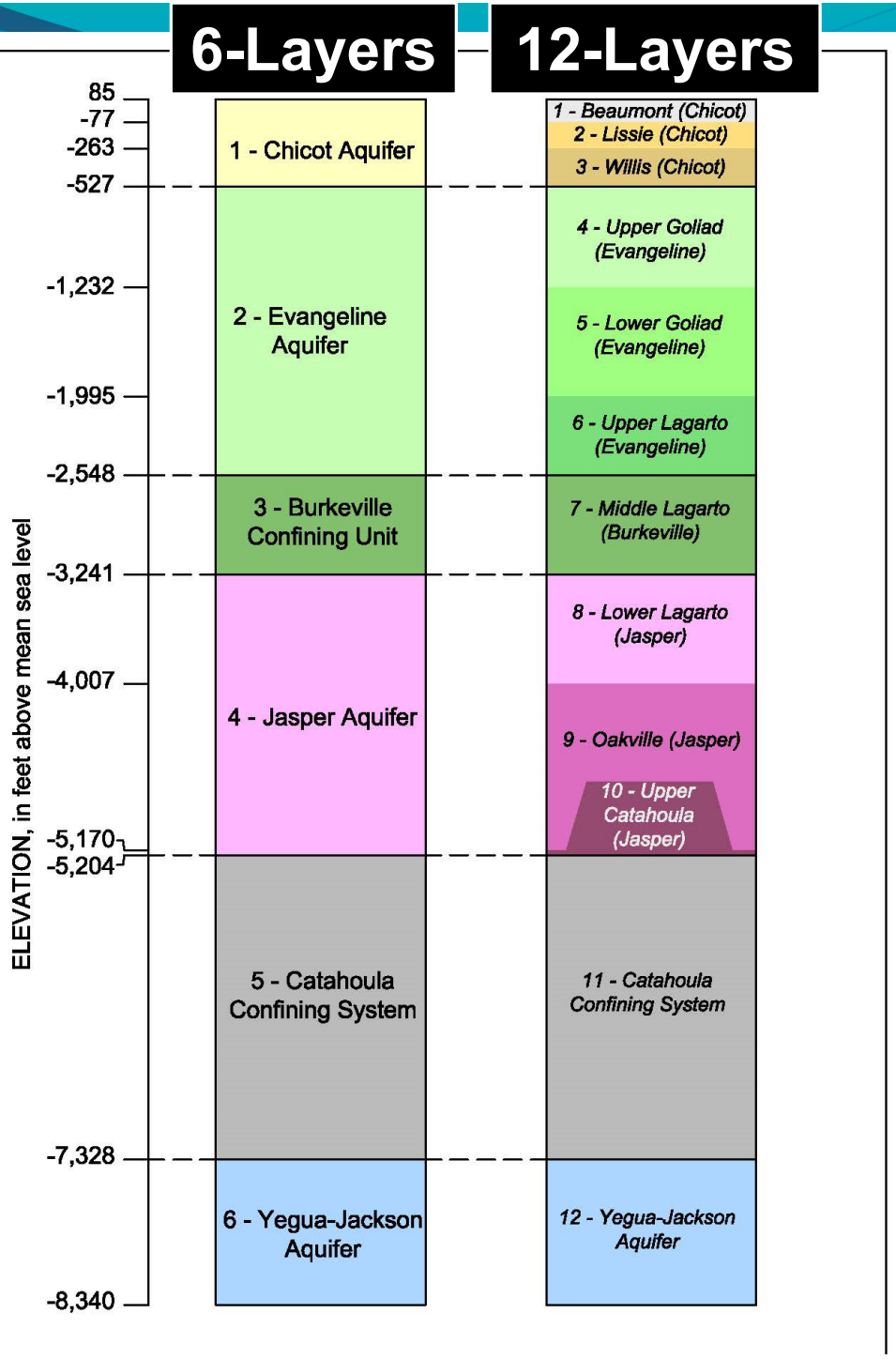


Thickness of Yegua-Jackson Aquifer



Hydro-stratigraphy





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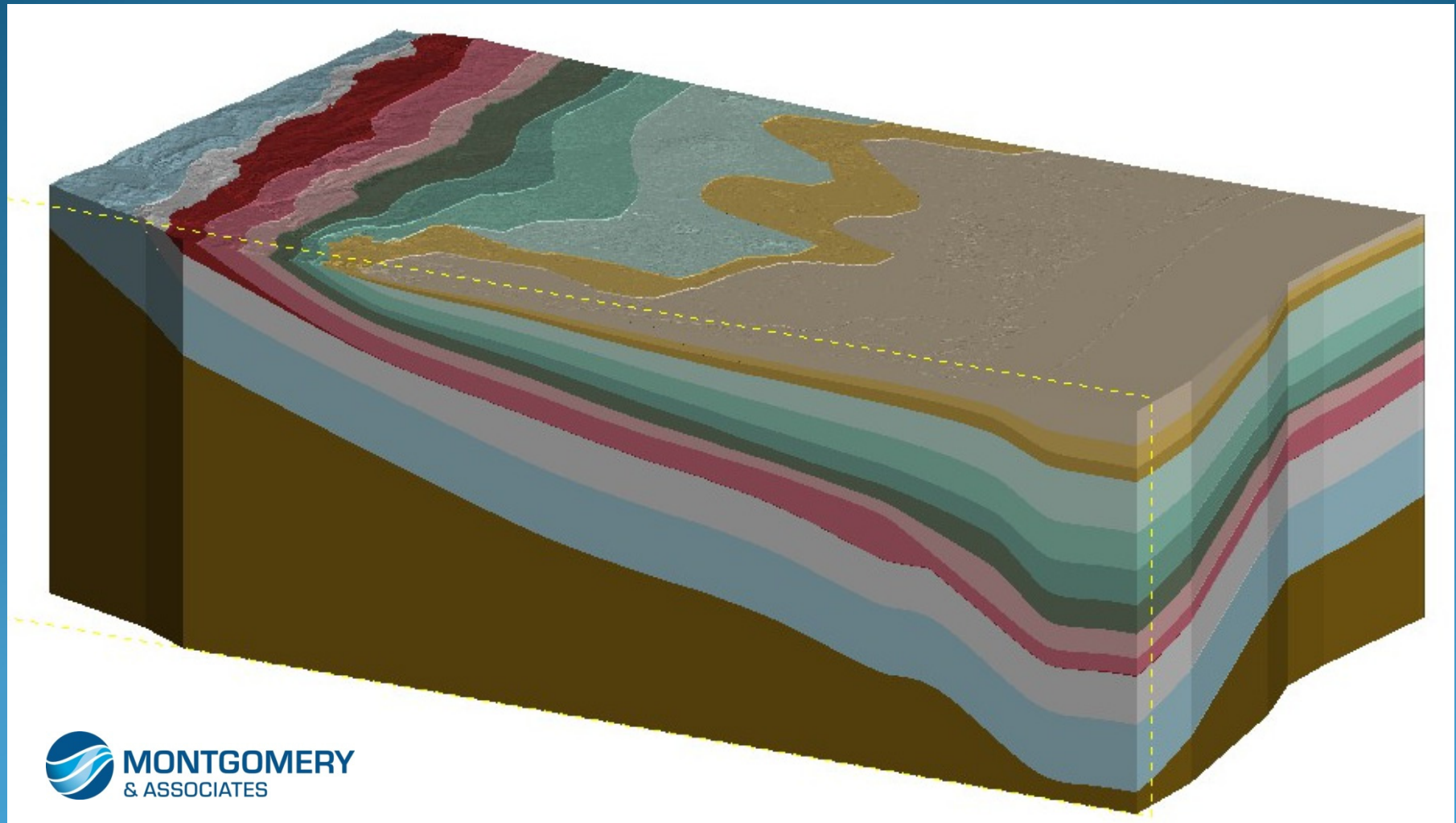
3D Geologic Model of 12-Layer Aquifer System



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Groundwater Levels and Regional Groundwater Flow

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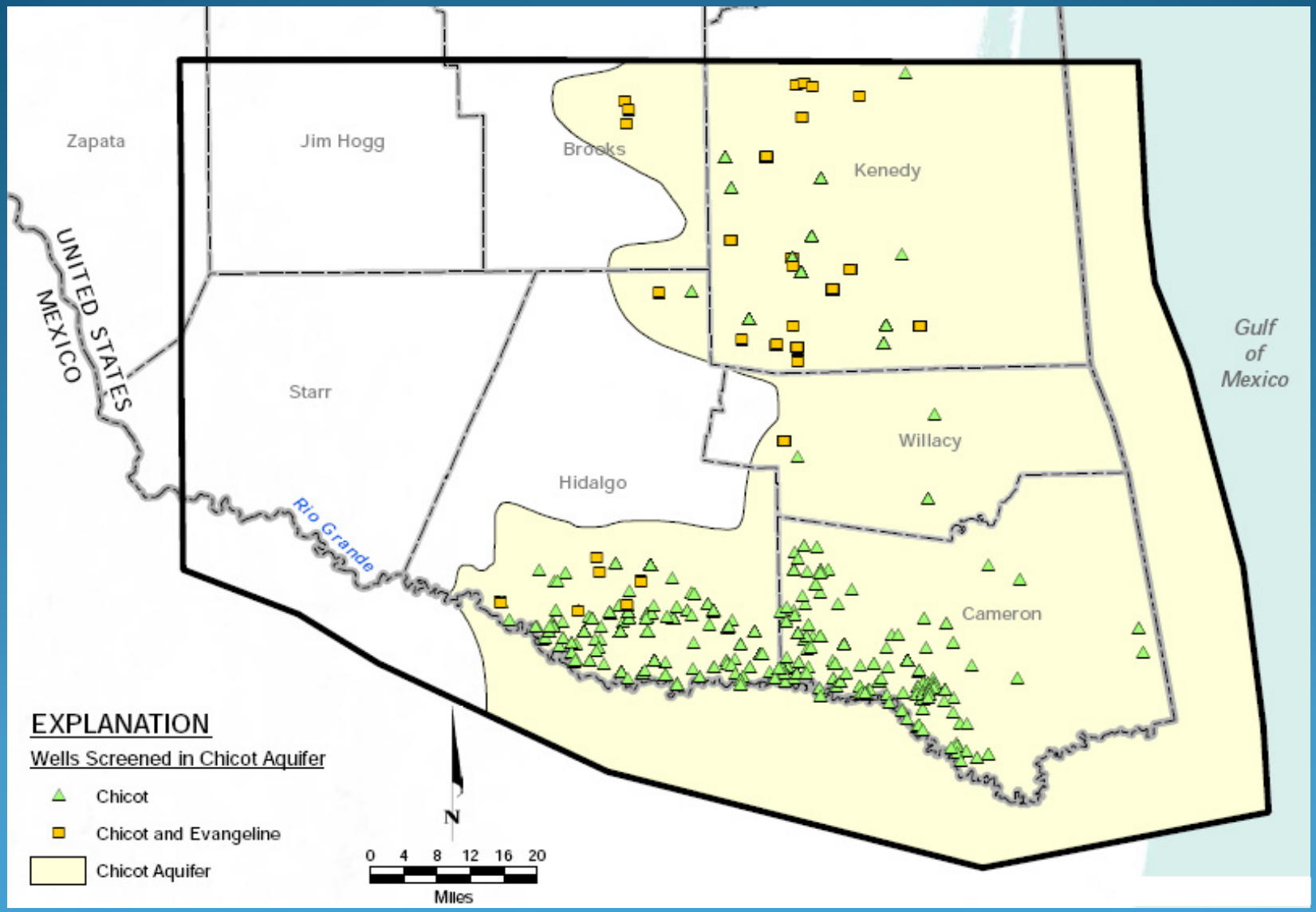
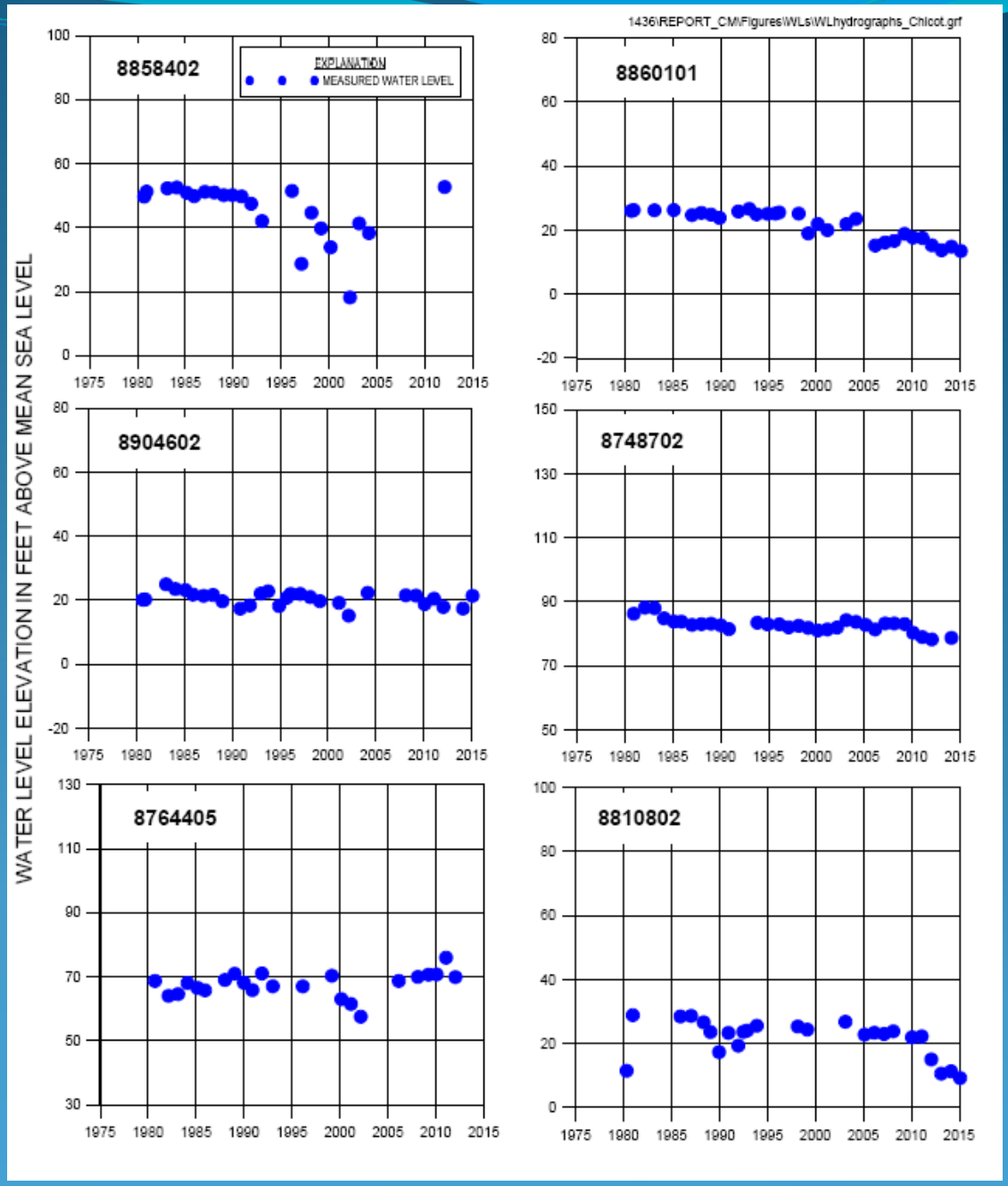
Chicot Aquifer:
Wells with Water Level Data



Chicot Aquifer: Water Level Time Series



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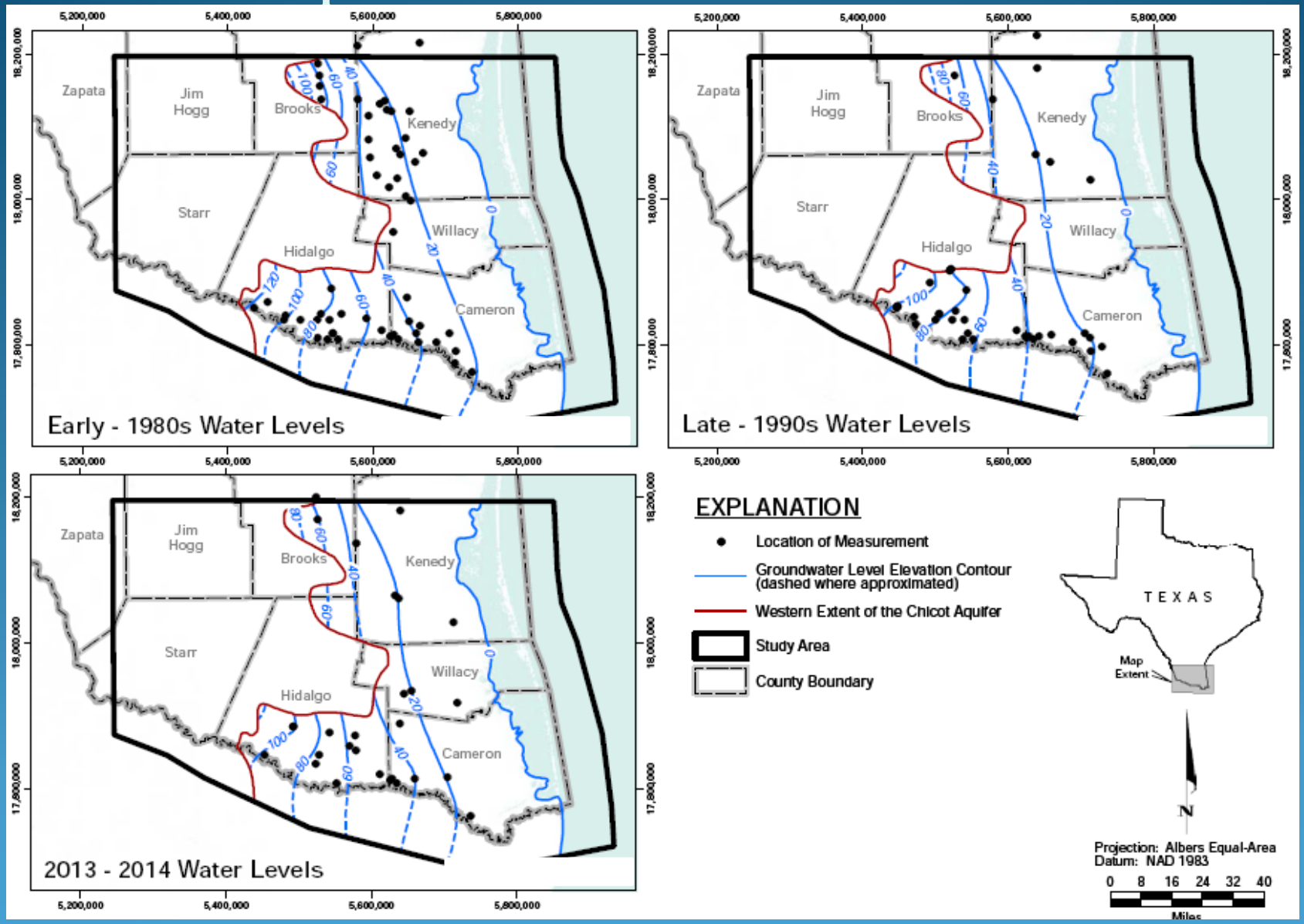
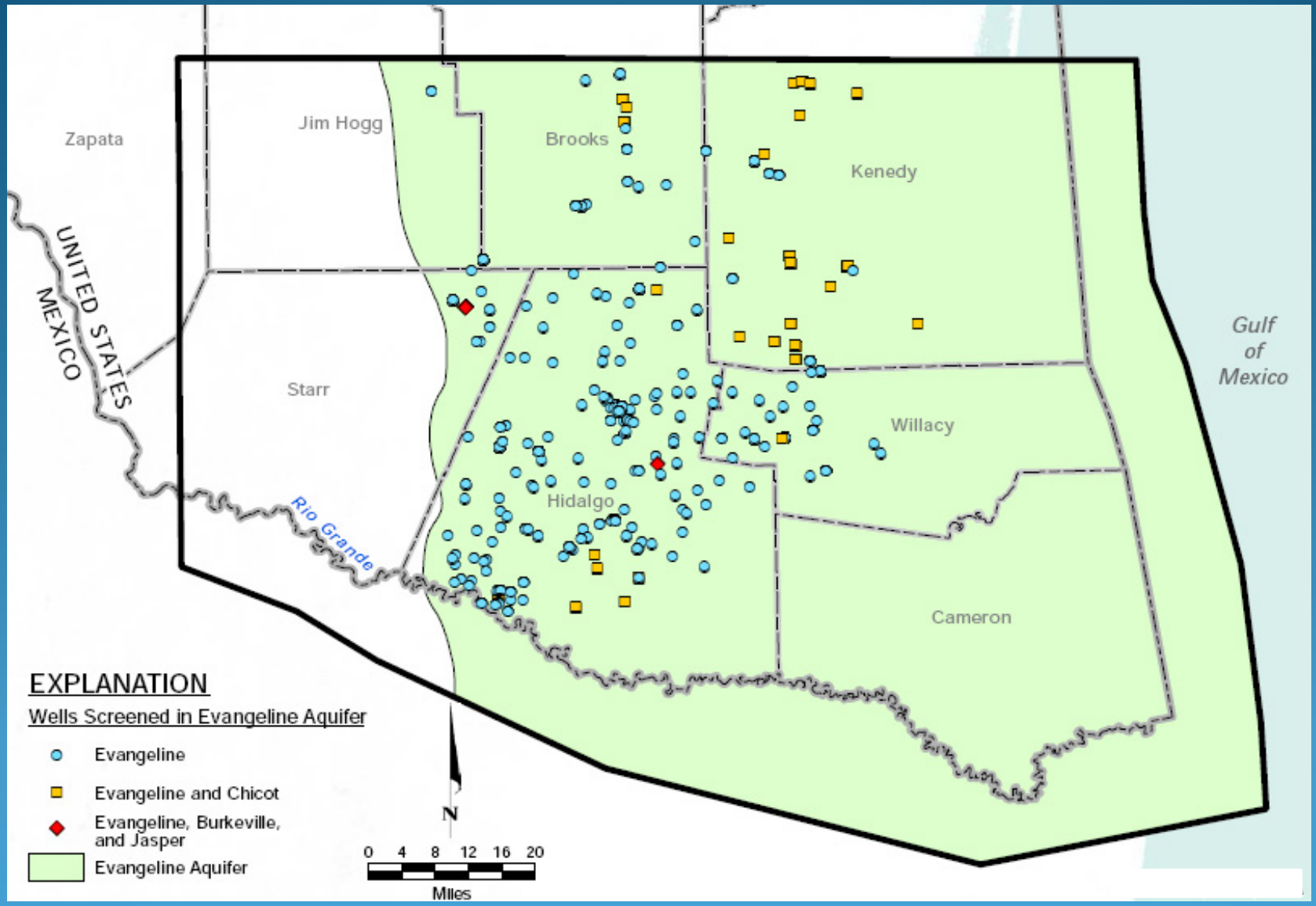
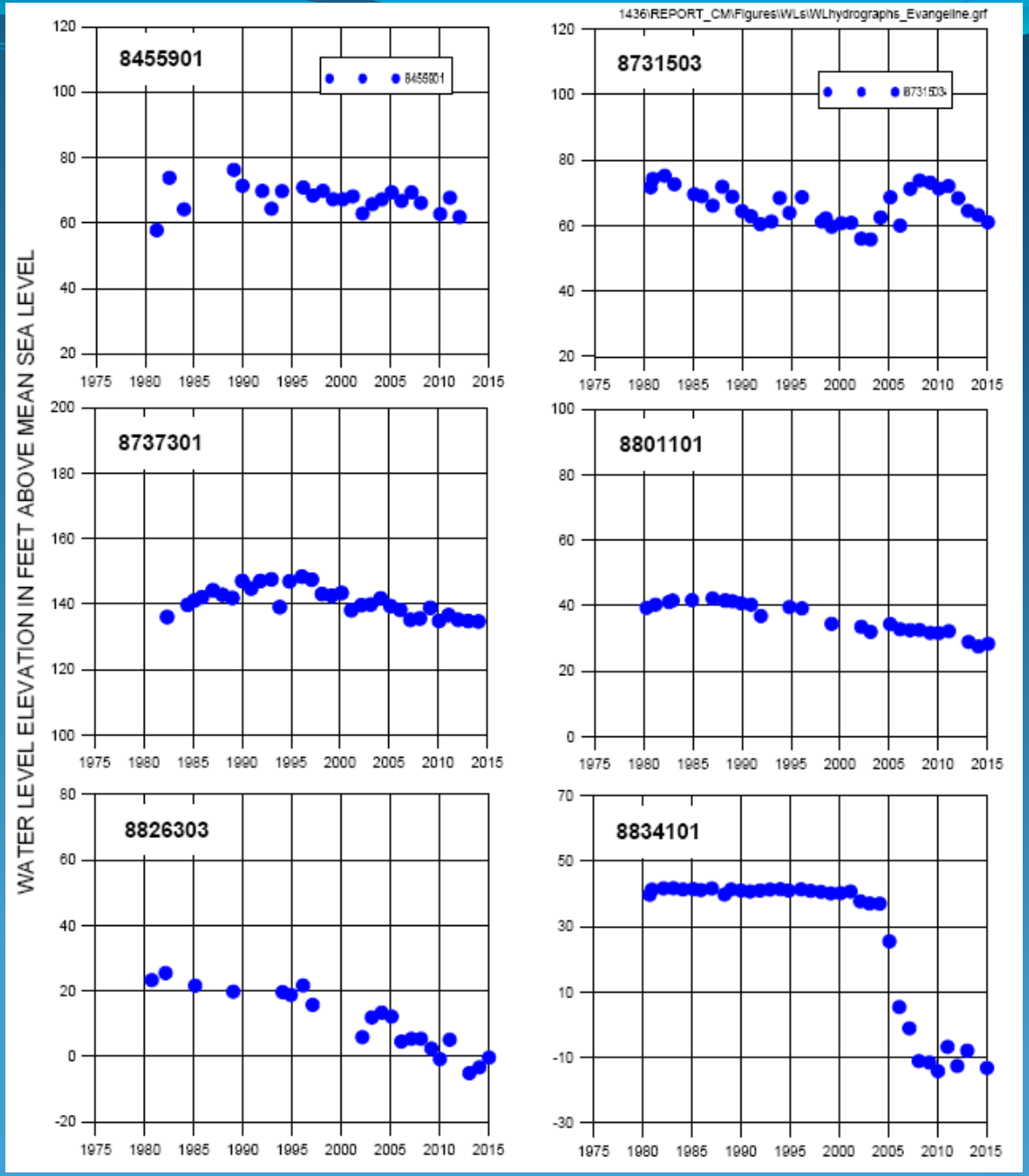
Chicot Aquifer: Water Level Contours



Evangeline Aquifer: Wells with Water Levels



Evangeline Aquifer: Water Level Time Series



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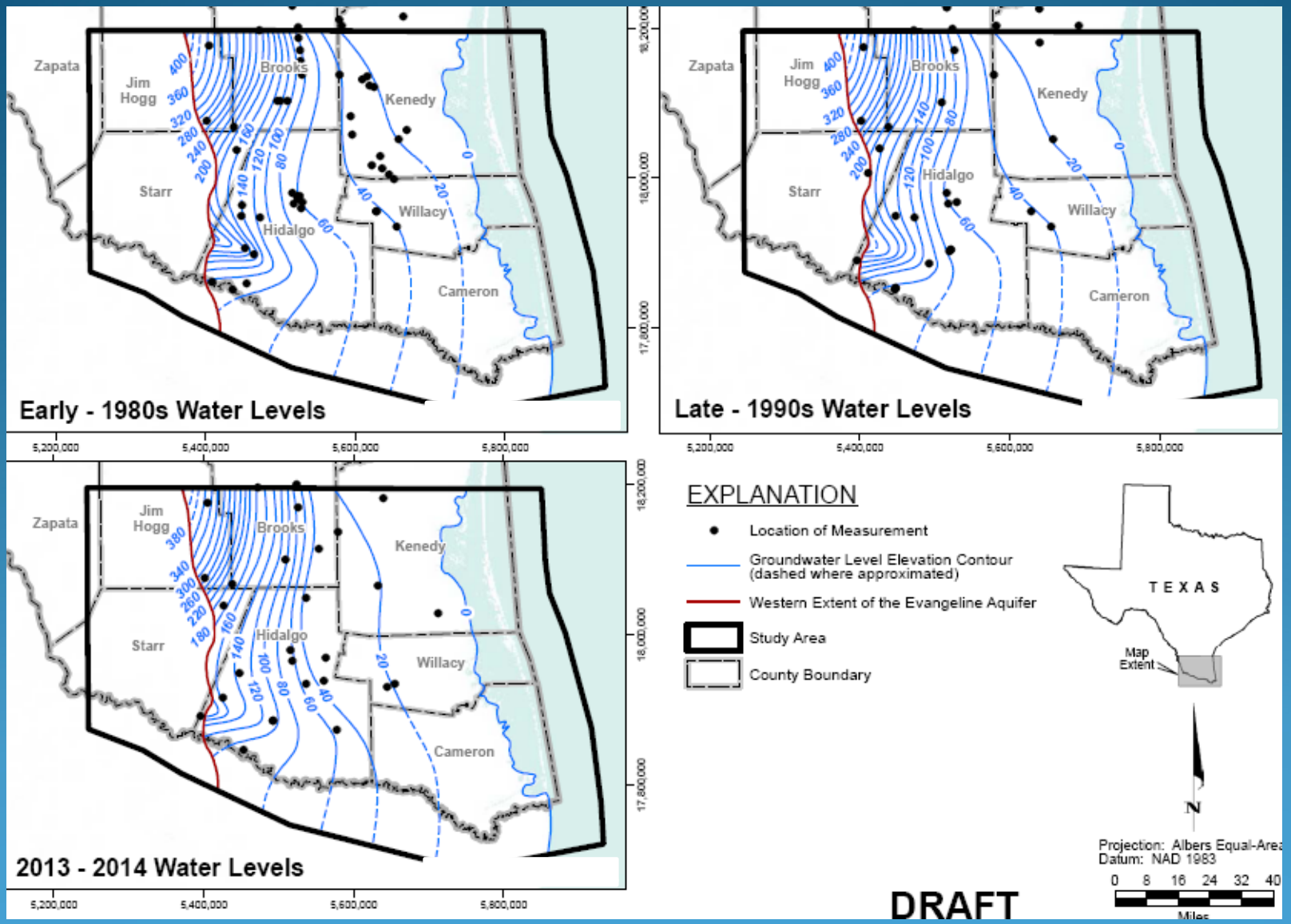
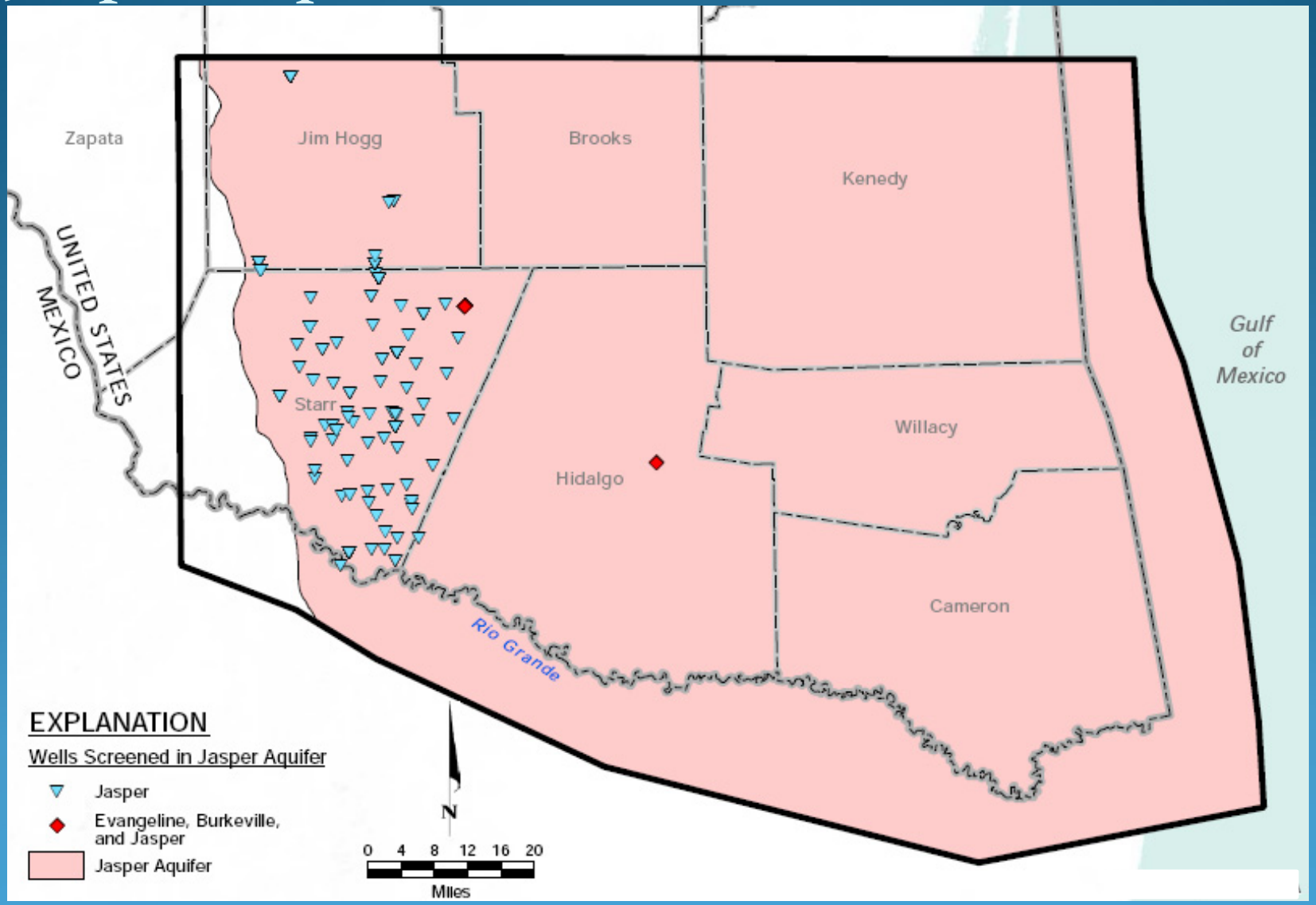
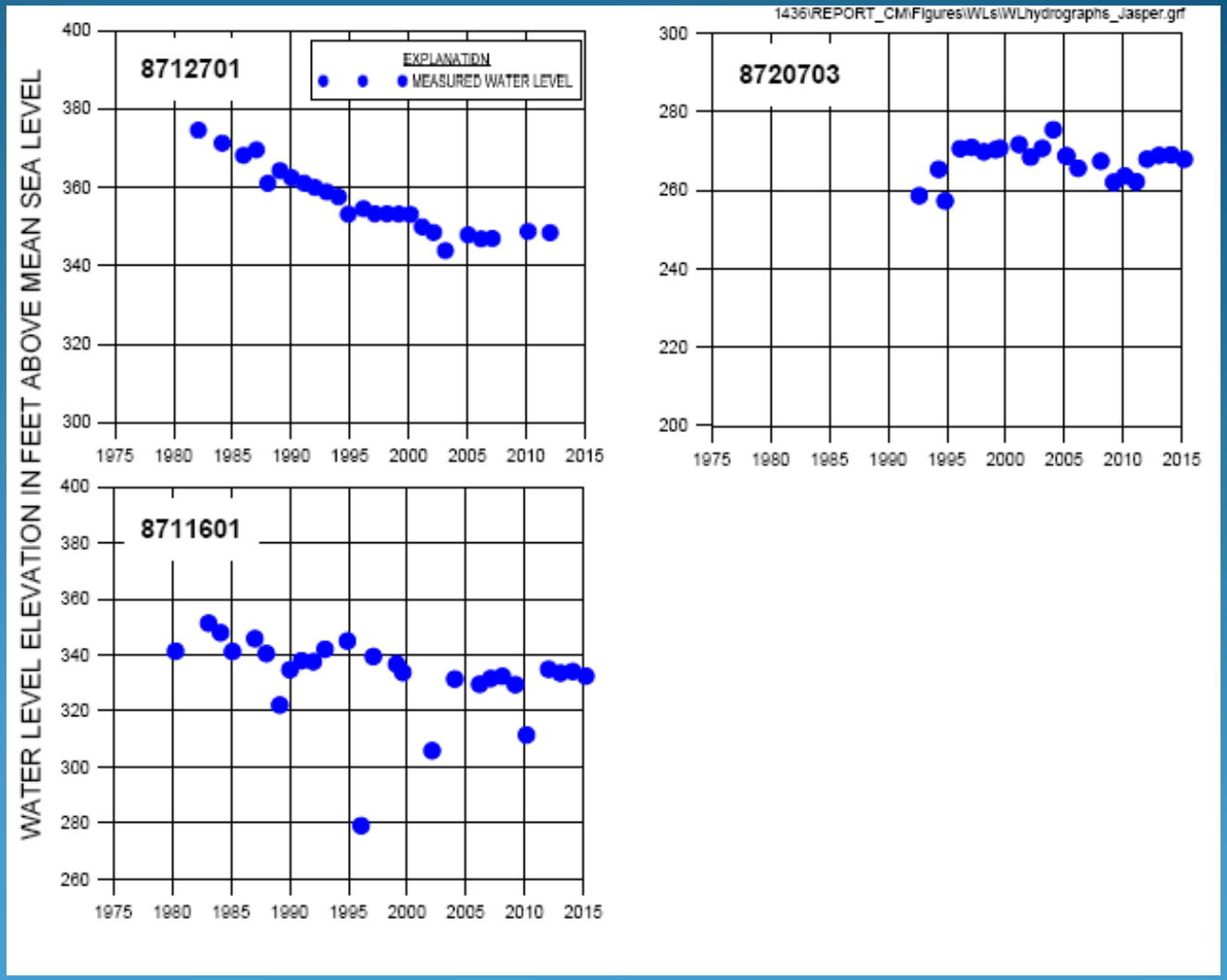
Evangeline Aquifer: Water Level Contours



Jasper Aquifer: Wells with Water Levels



Jasper Aquifer: Water Level Time Series



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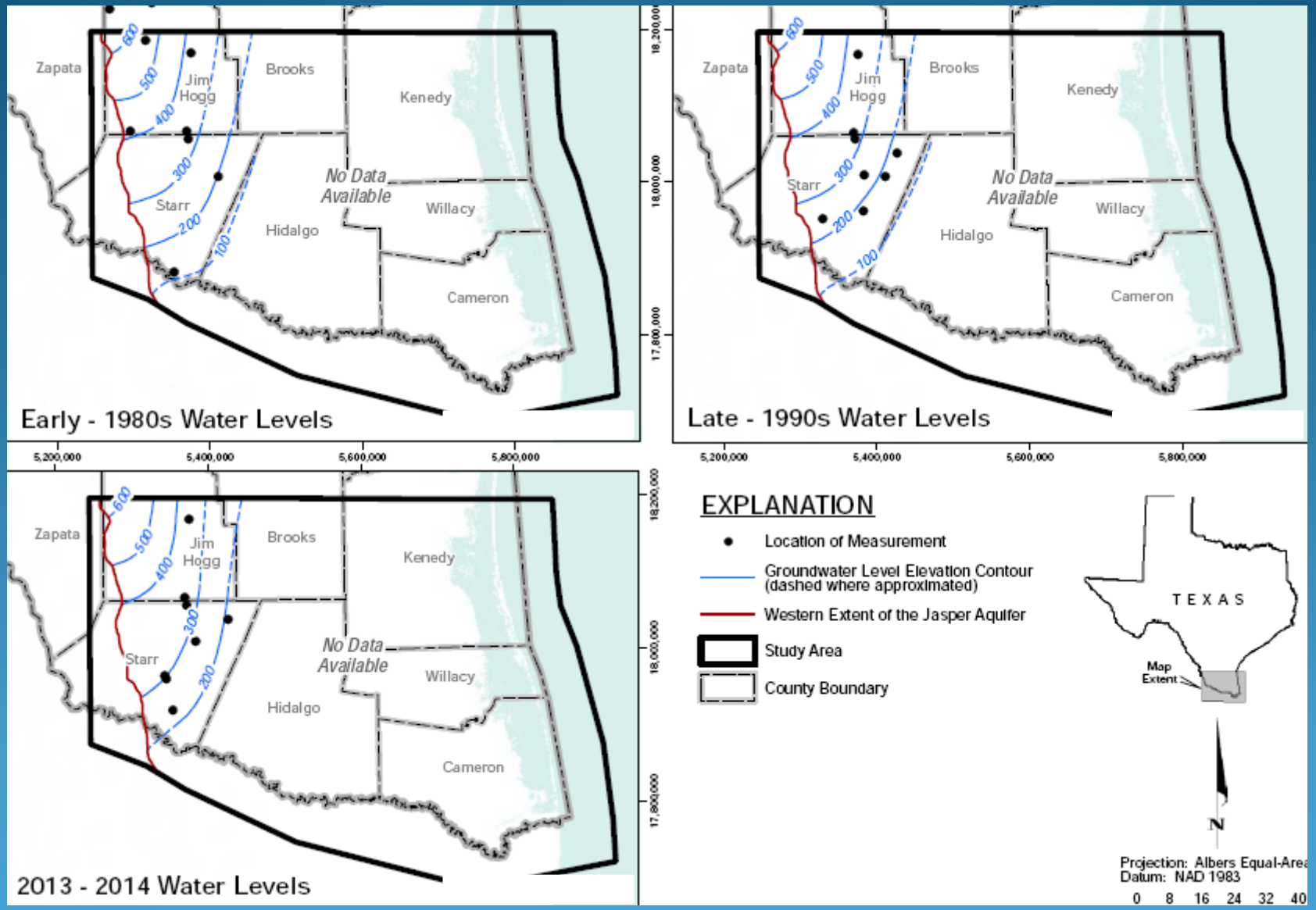
Jasper Aquifer: Water Level Contours



Recharge

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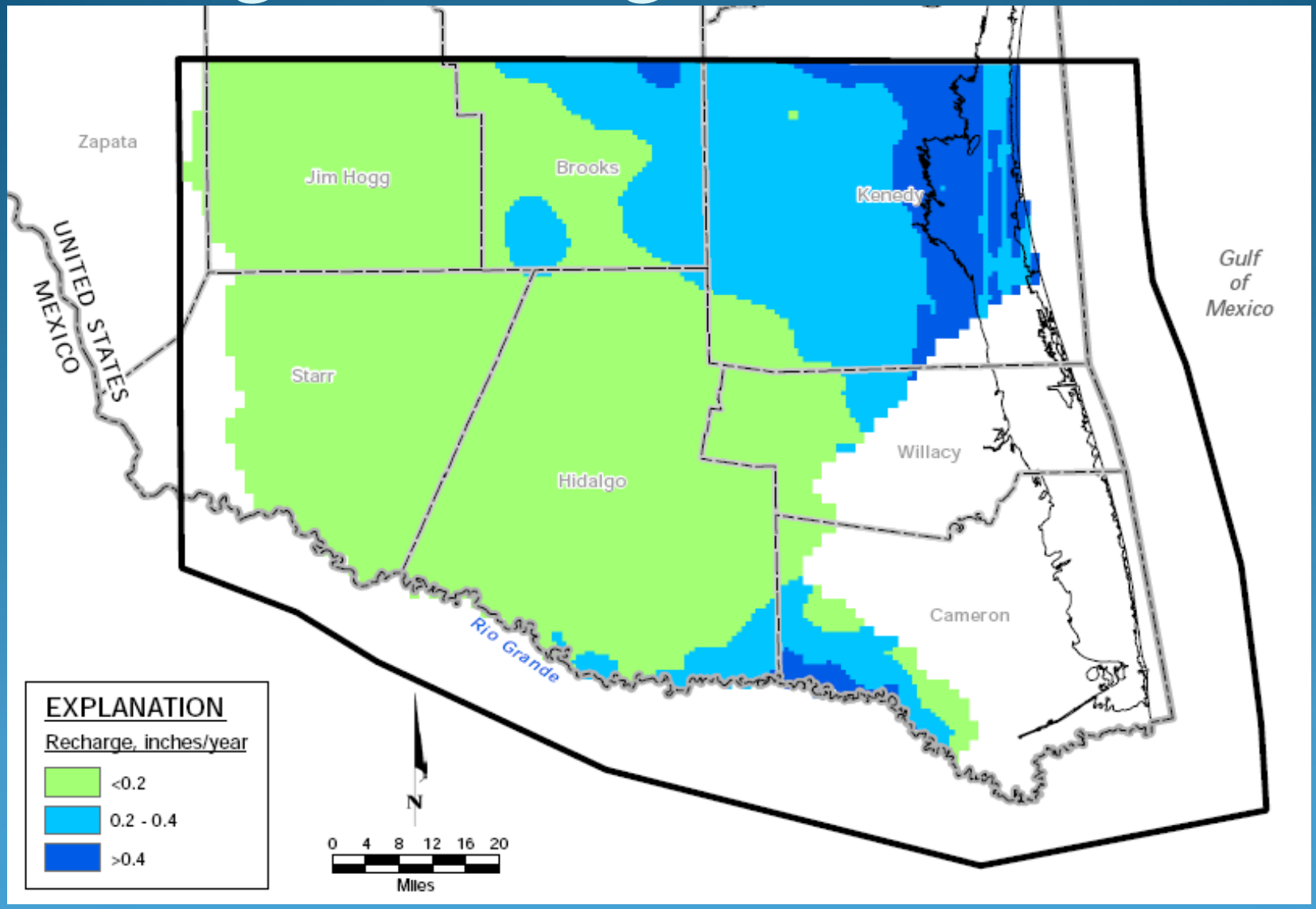
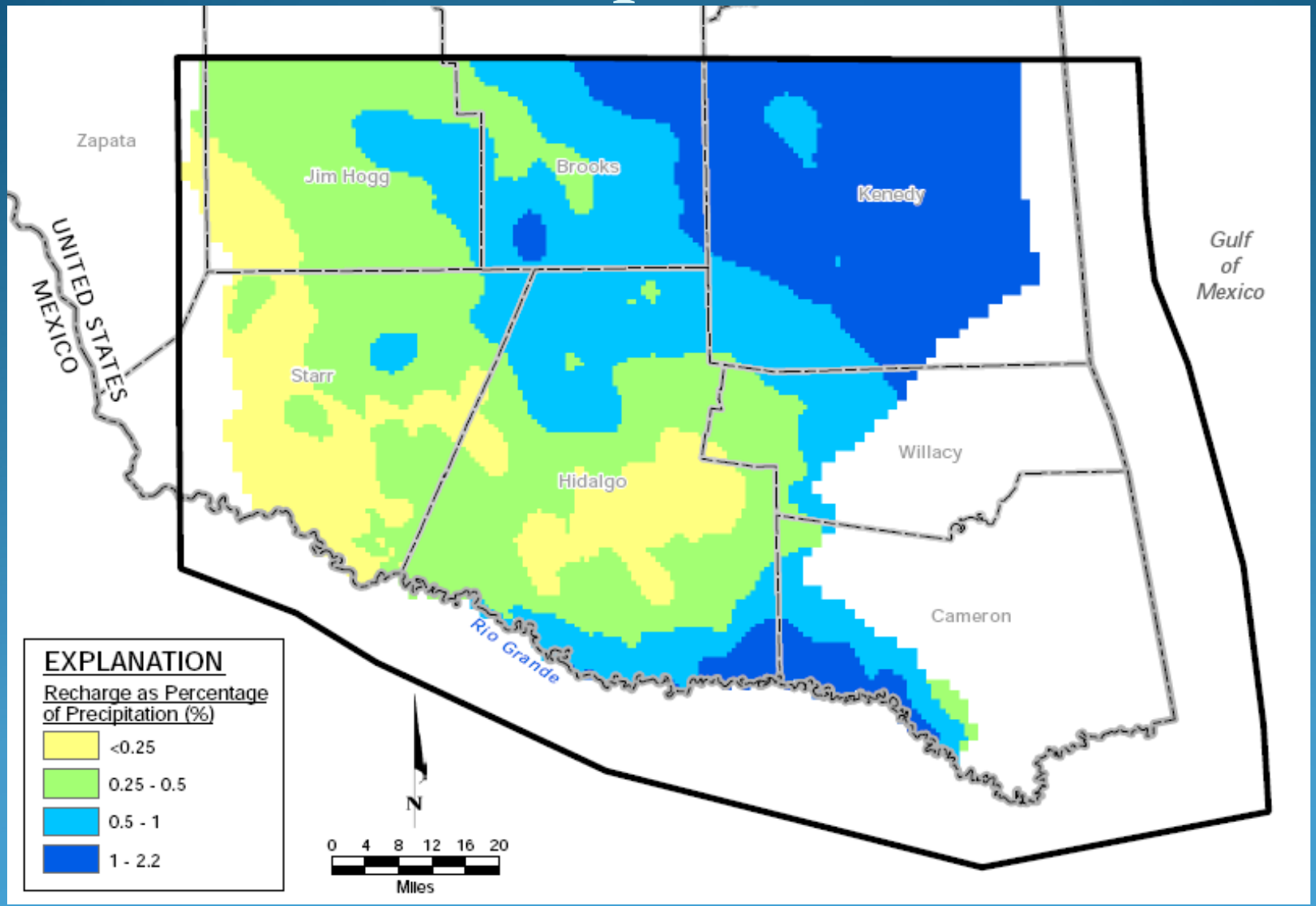
Distribution of Long Term Average Recharge



Long Term Average Recharge as Percent of Precipitation



Surface Water

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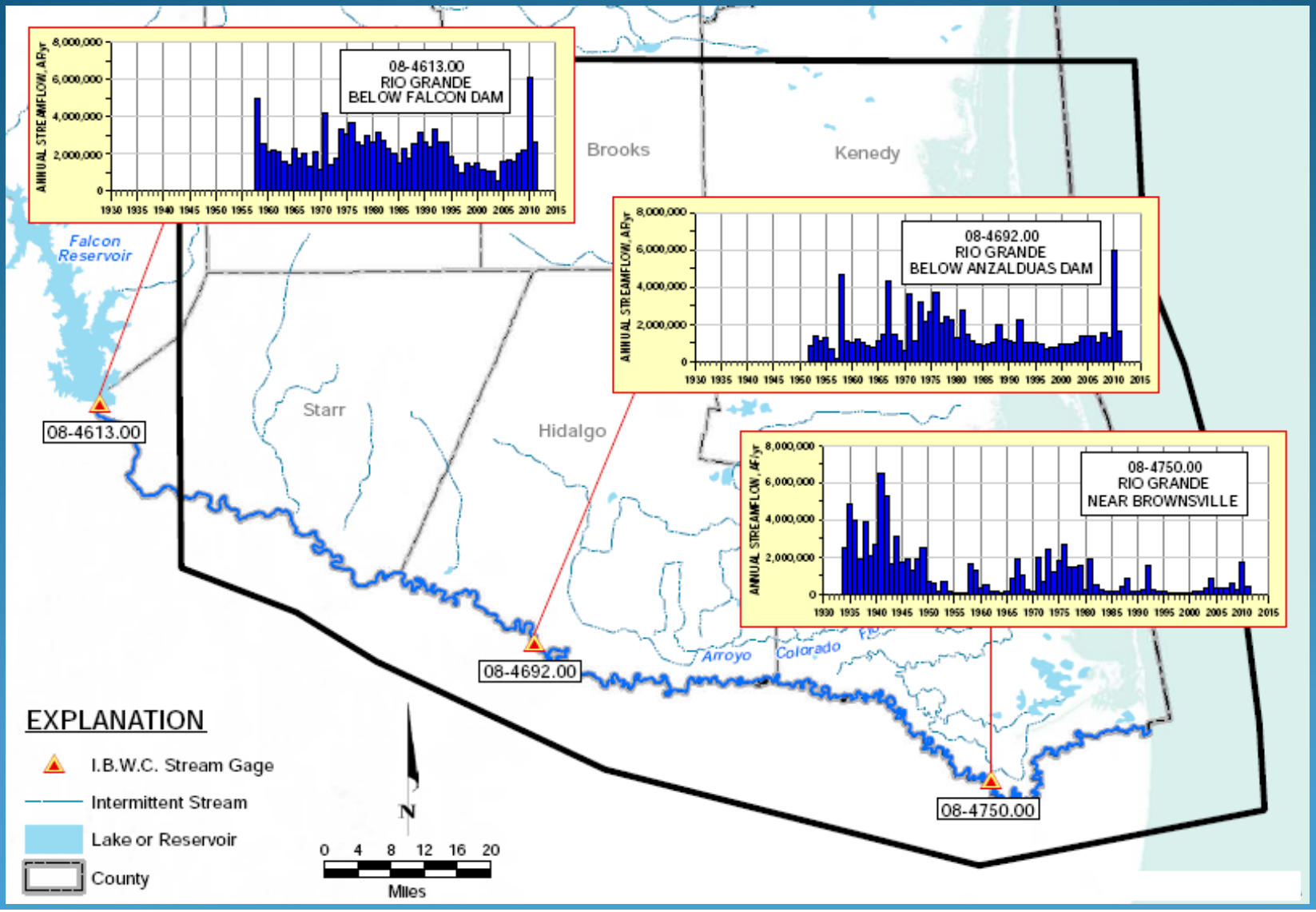
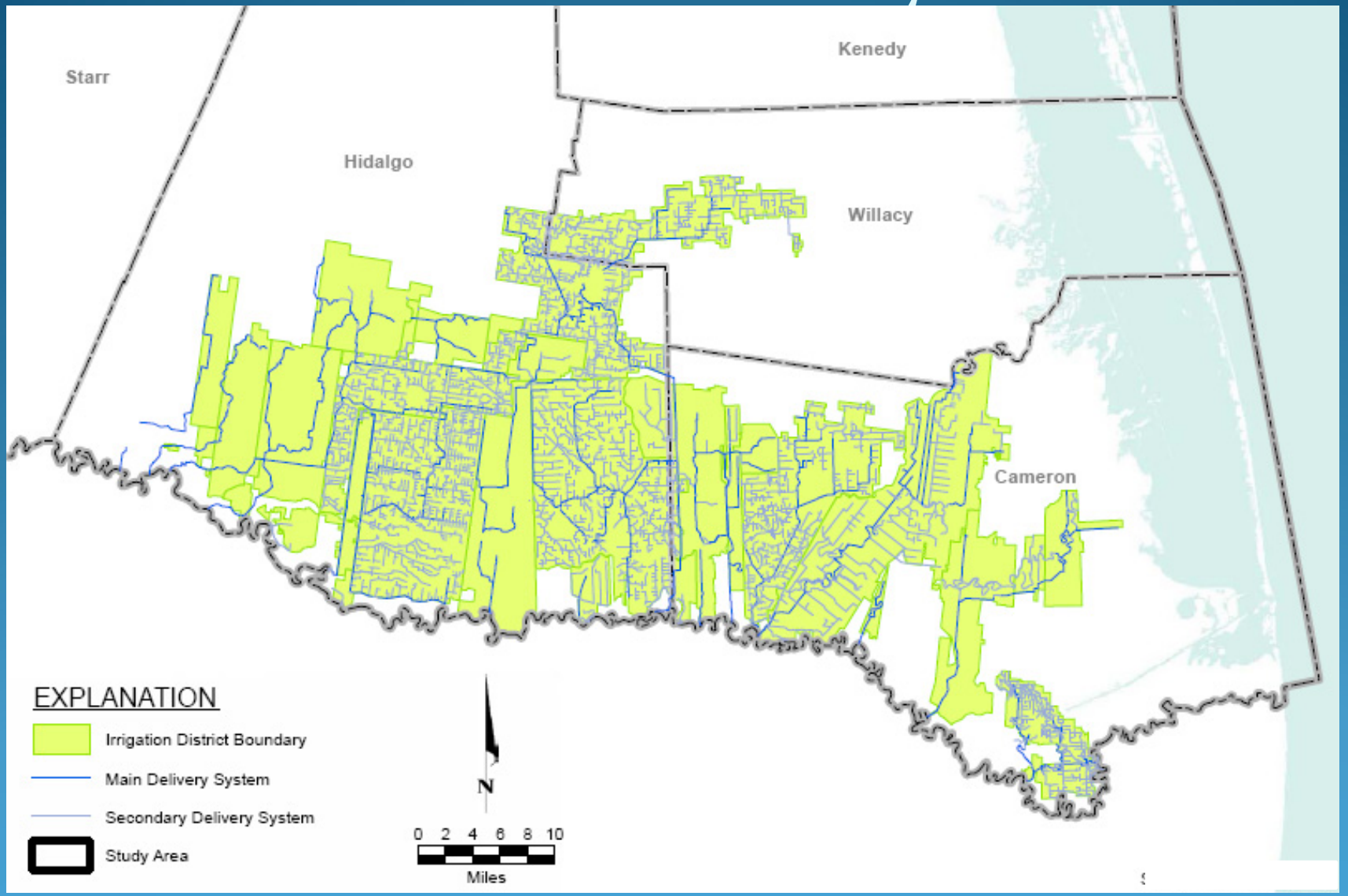
Streamflow Rio Grande

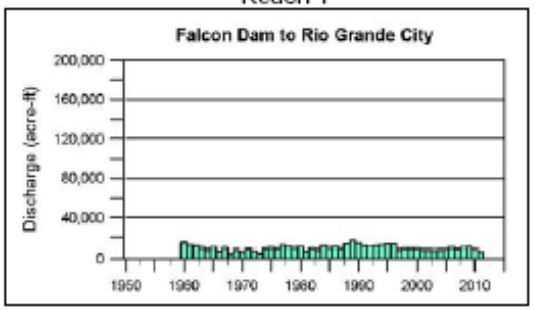


Surface Water Delivery Network

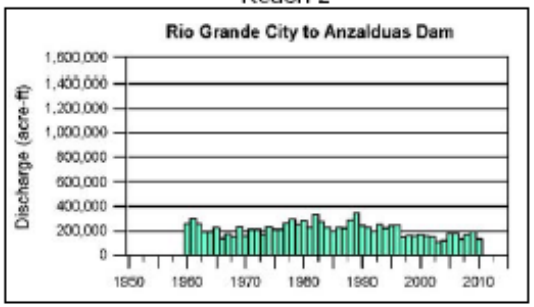


Diversions from Rio Grande

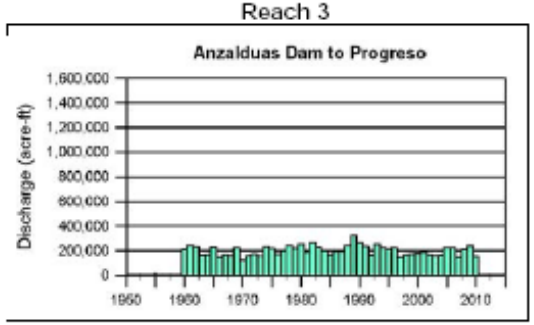
Reach 1



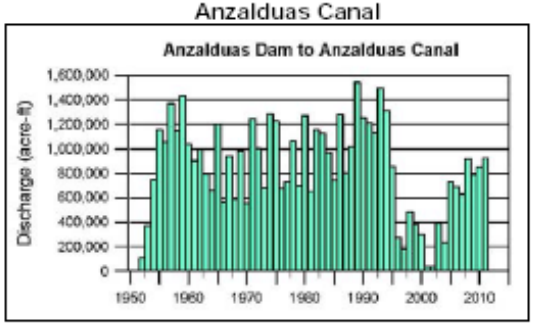
Reach 2



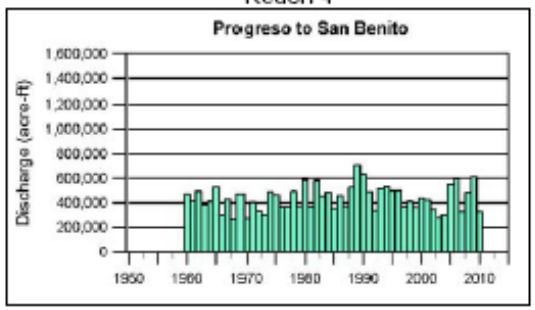
Reach 3



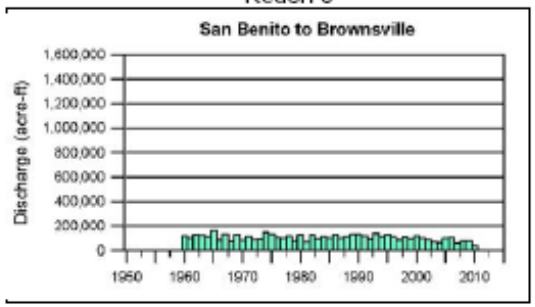
Anzalduas Canal



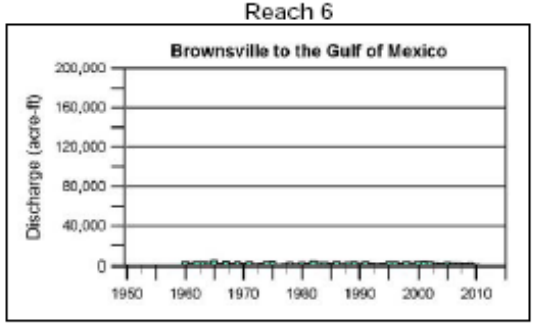
Reach 4



Reach 5

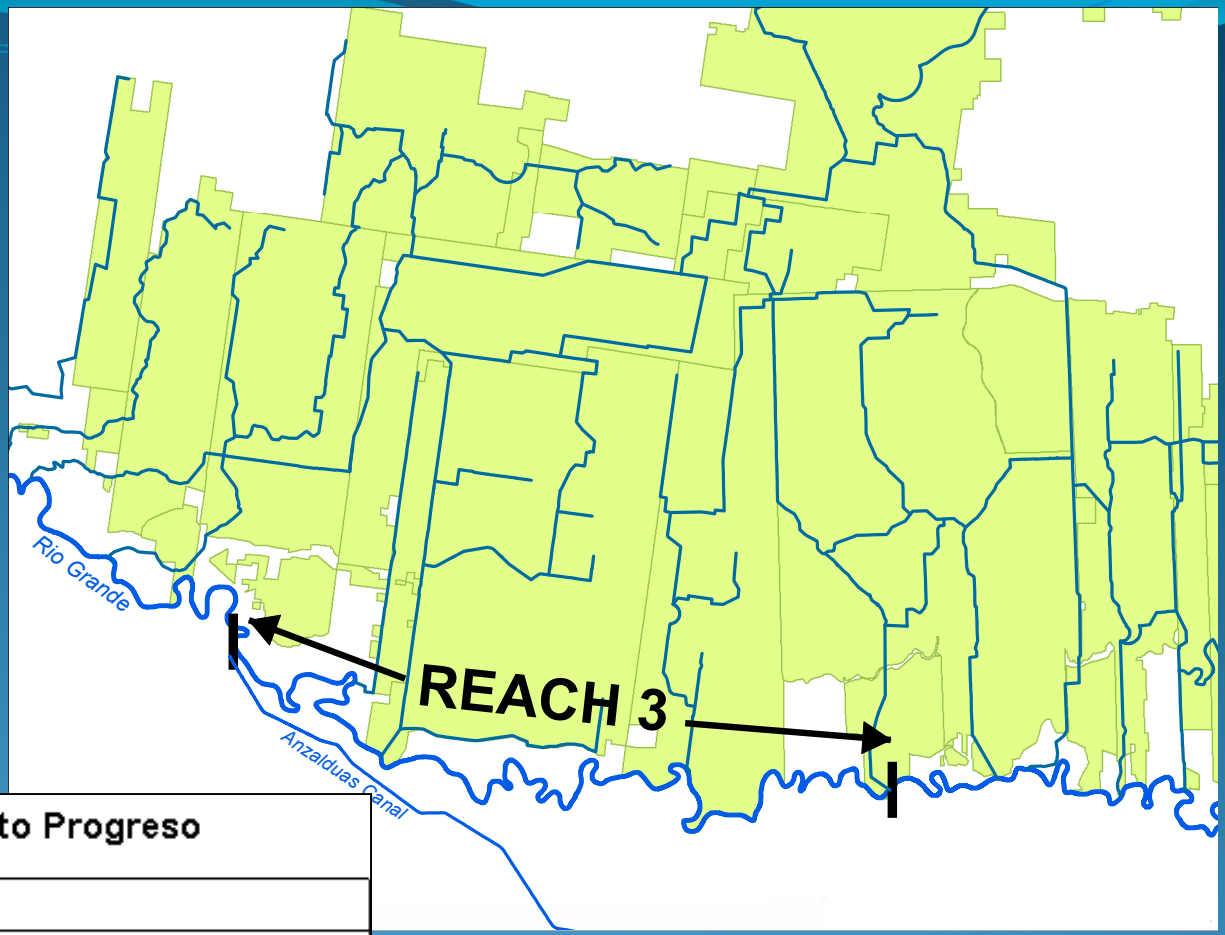


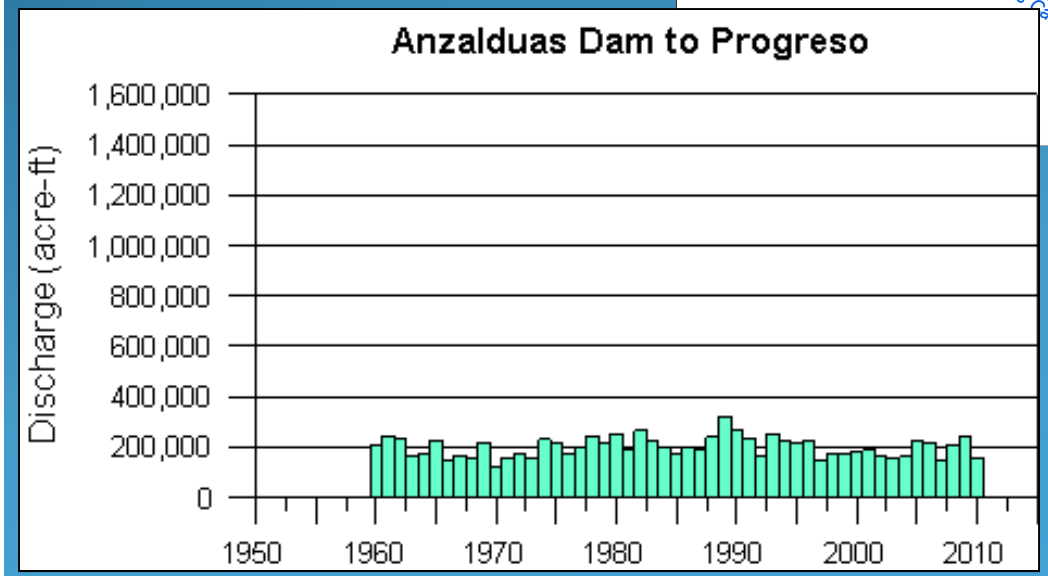
Reach 6



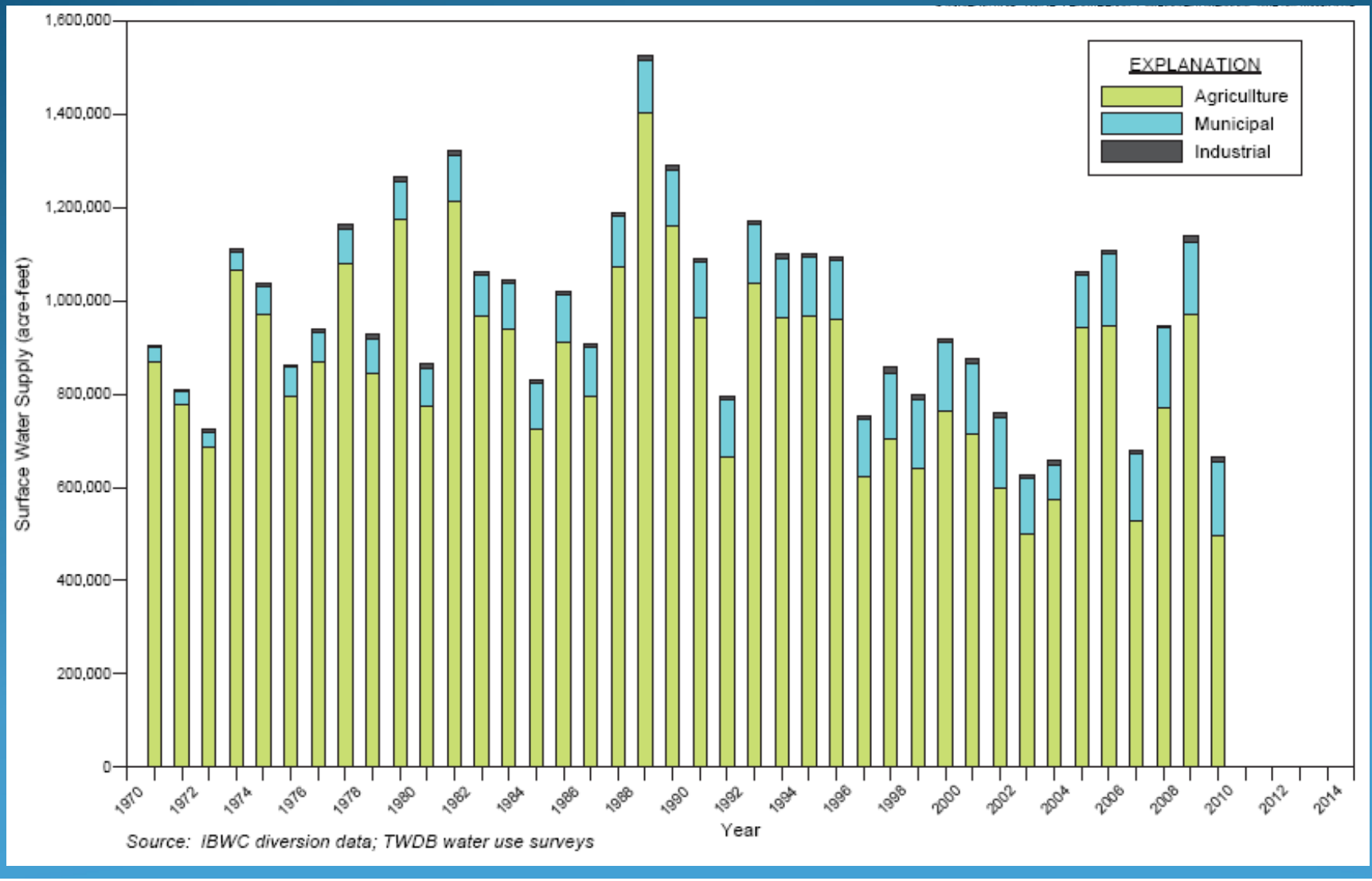
Source: IBWC, reported total diversions to U.S. along six specified river reaches, and diversion to one major canal to Mexico.

Diversions from Rio Grande





Surface Water Use



Aquifer Hydraulic Properties

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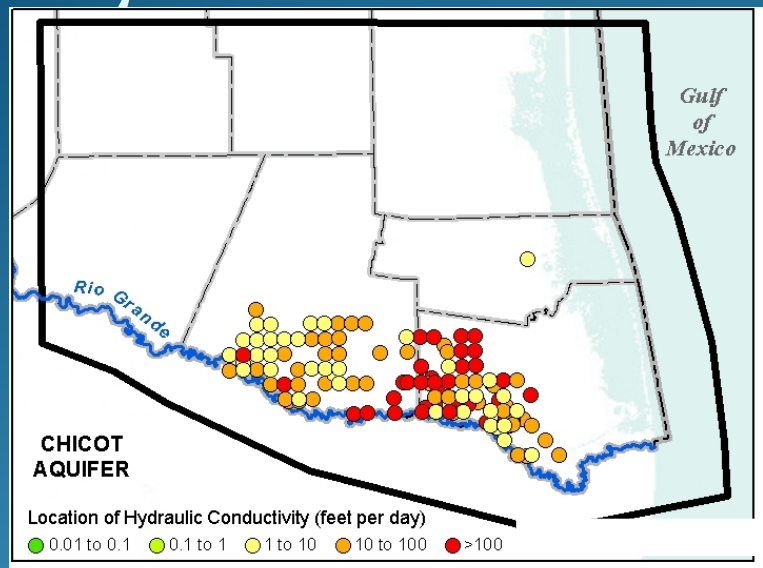
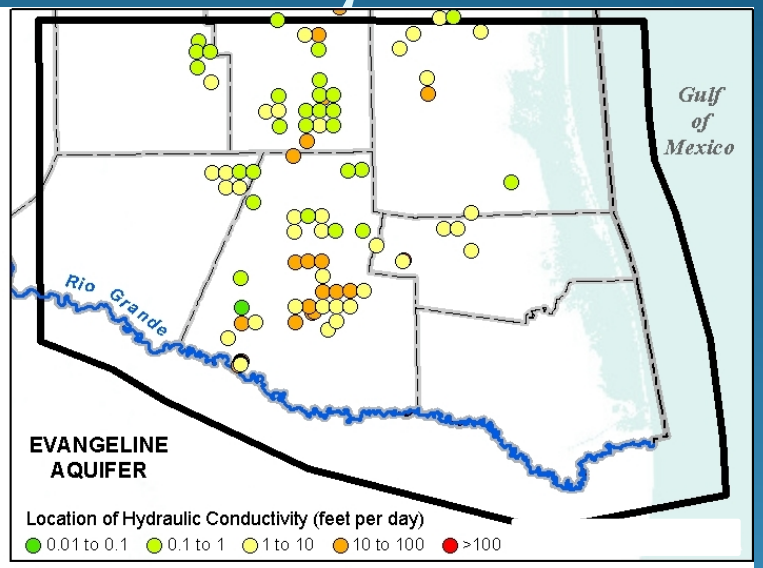
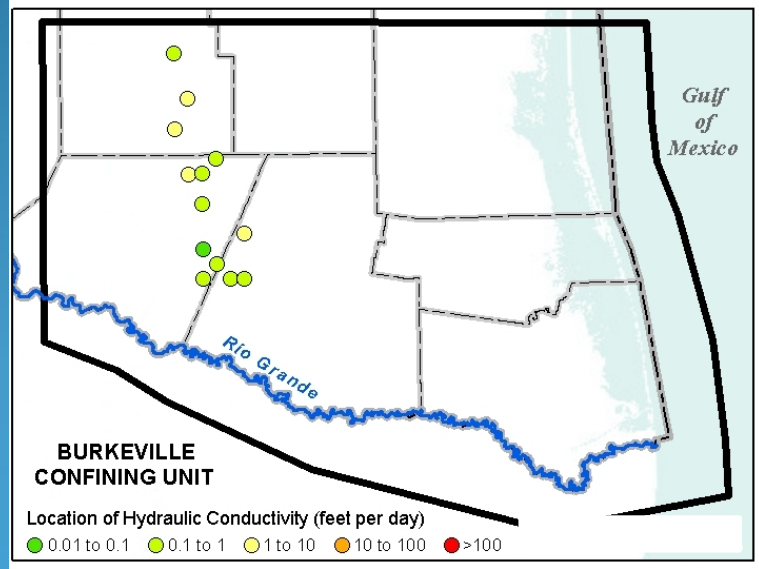
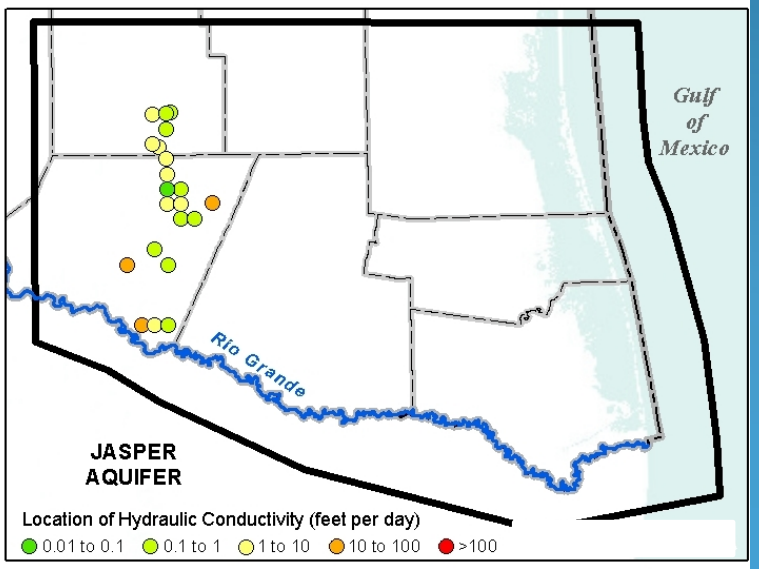
Hydraulic Conductivity

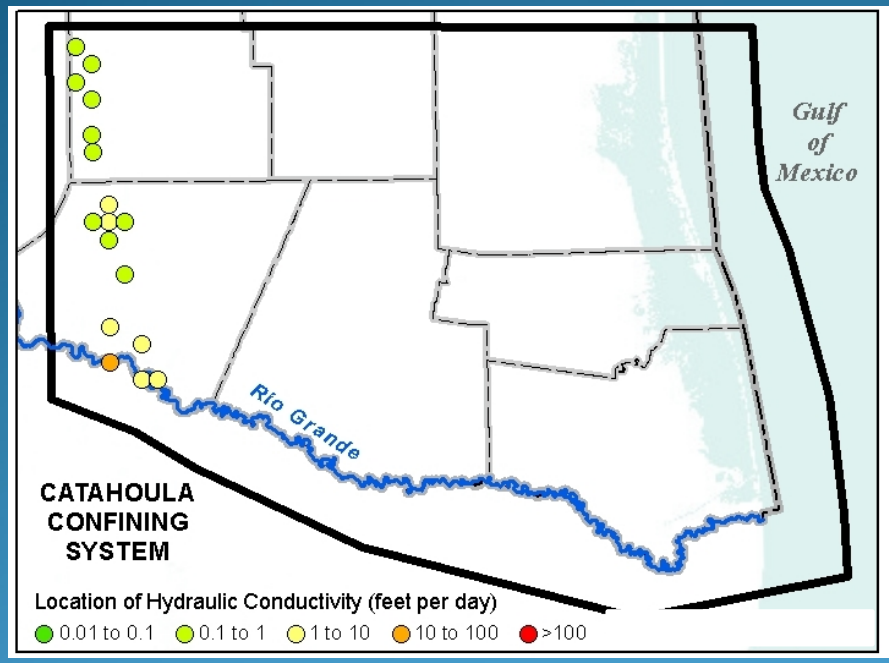


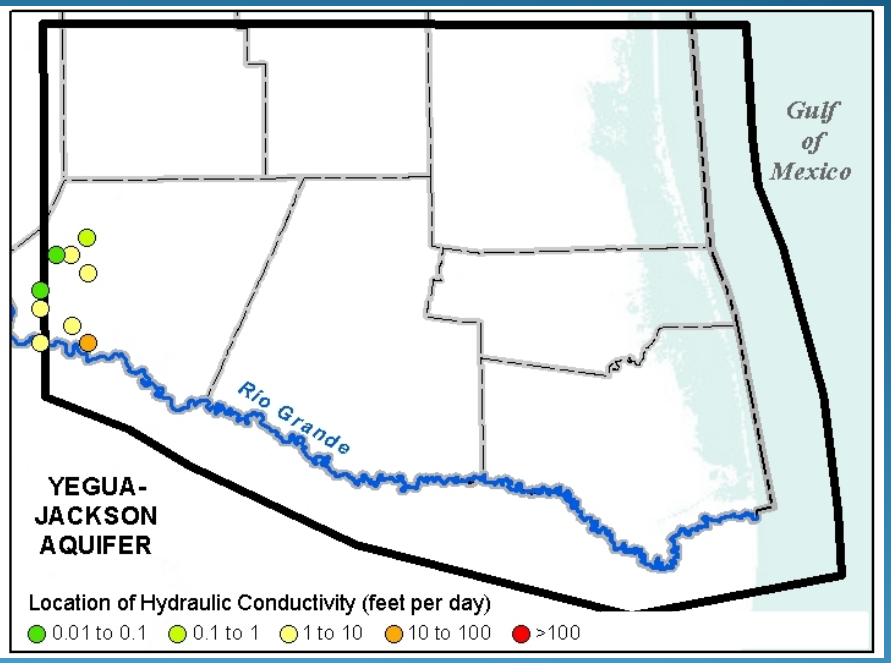






Hydraulic Conductivity - Continued





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Groundwater Discharge

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Evapotranspiration (ET)

- Riparian ET
  - Approximately 1,500 AF/yr of groundwater in current GAM
    - Only areas where mesquite exist (northern portions of valley)
    - Rates adjusted during model calibration
- Crop ET
  - Crops likely not groundwater dependent due to shallow root zone and relatively deep groundwater levels
  - For determining net recharge from deep percolation of excess agricultural irrigation

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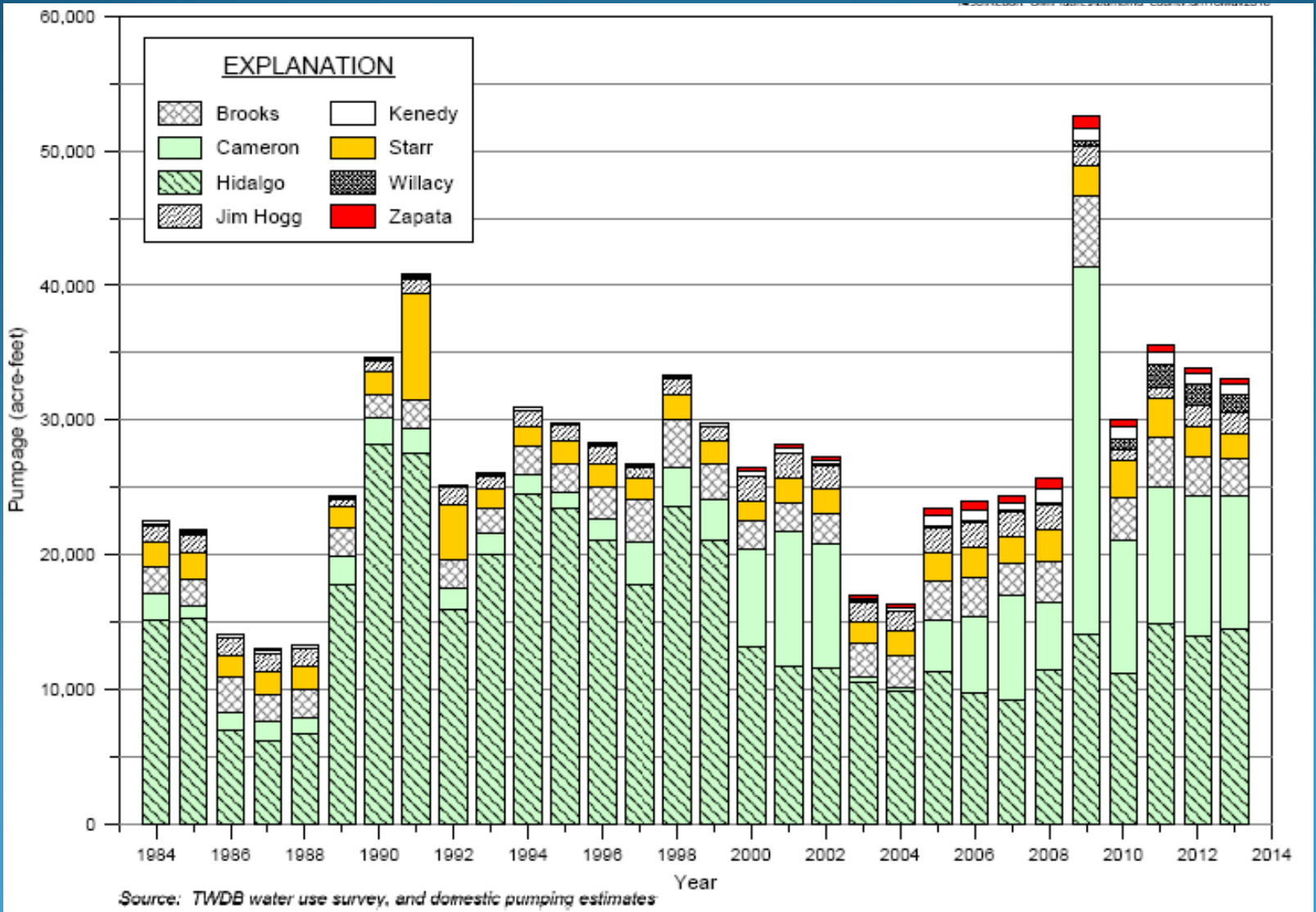
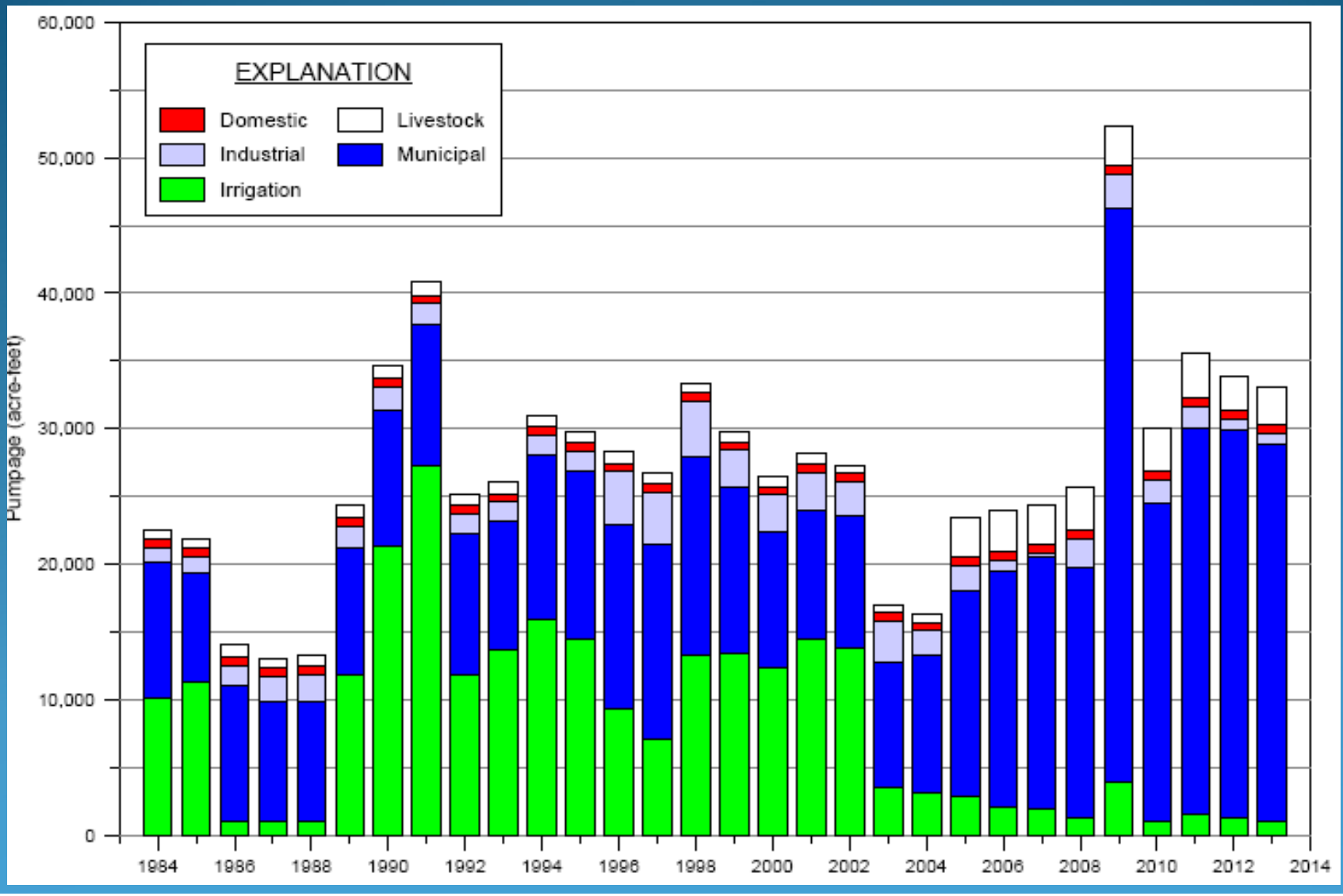
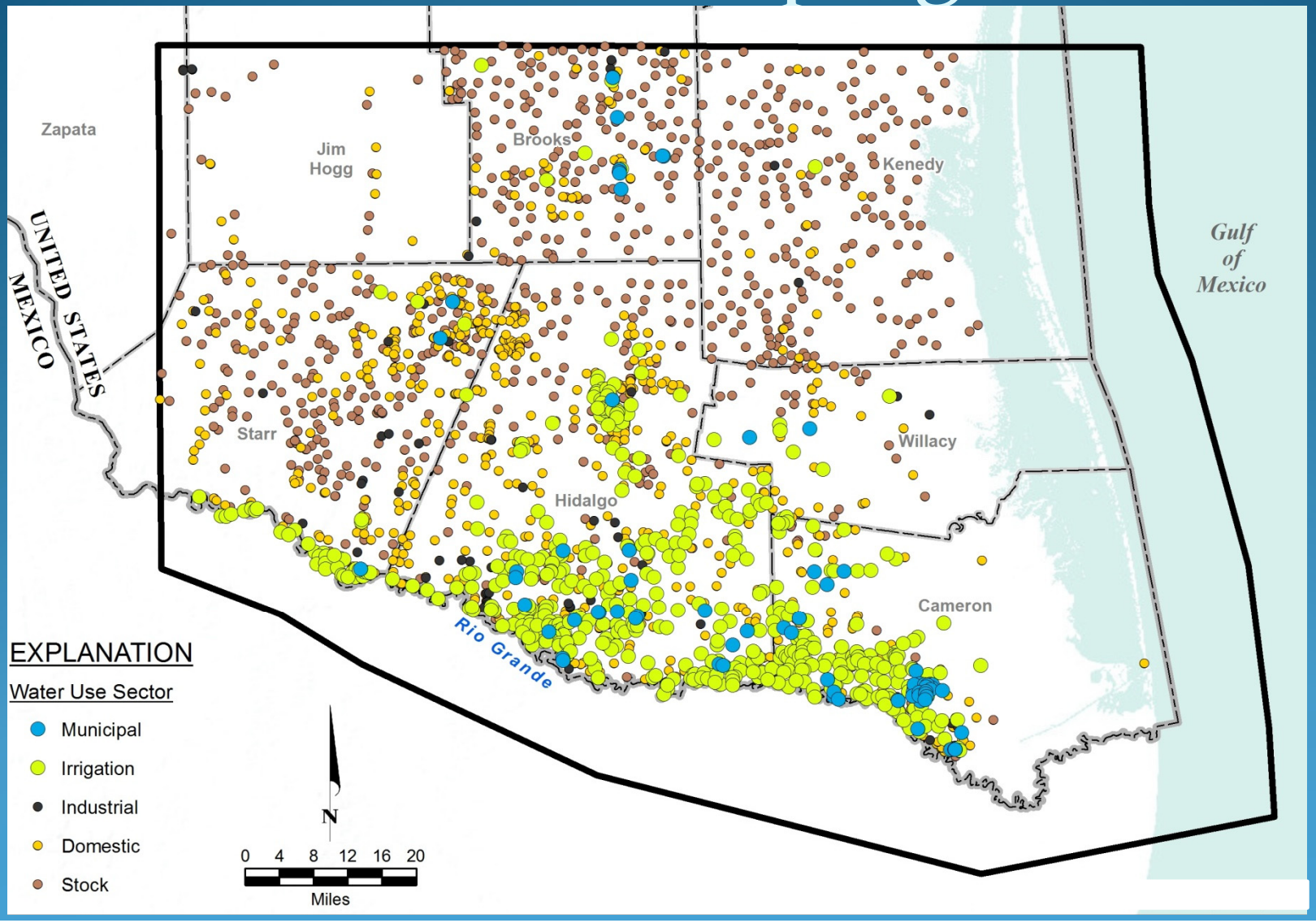
Groundwater Pumping by County Based on TWDB Water Use Survey



Groundwater Pumping by Sector Based on TWDB Water Use Survey



Groundwater Pumping Wells



Water Quality

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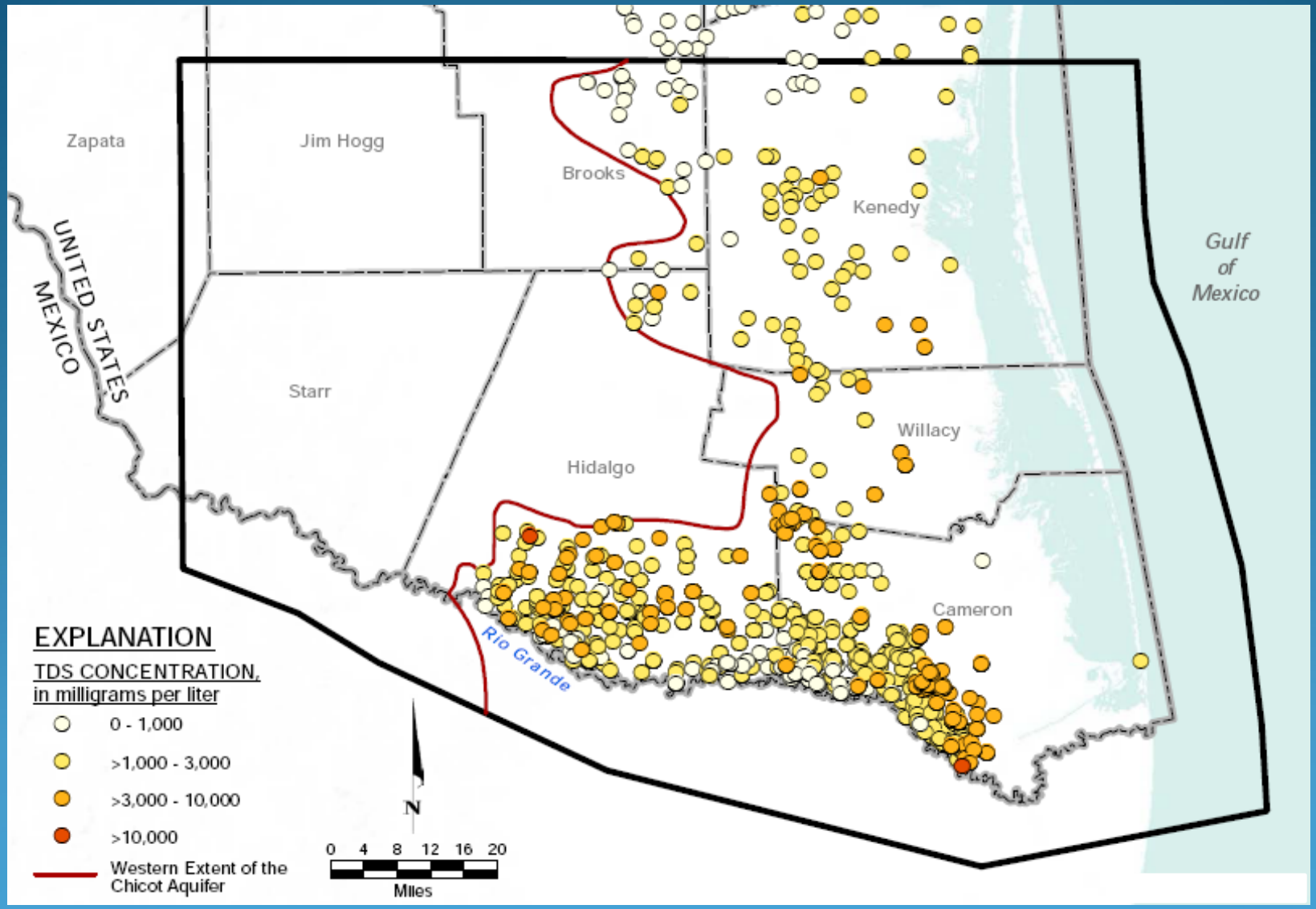
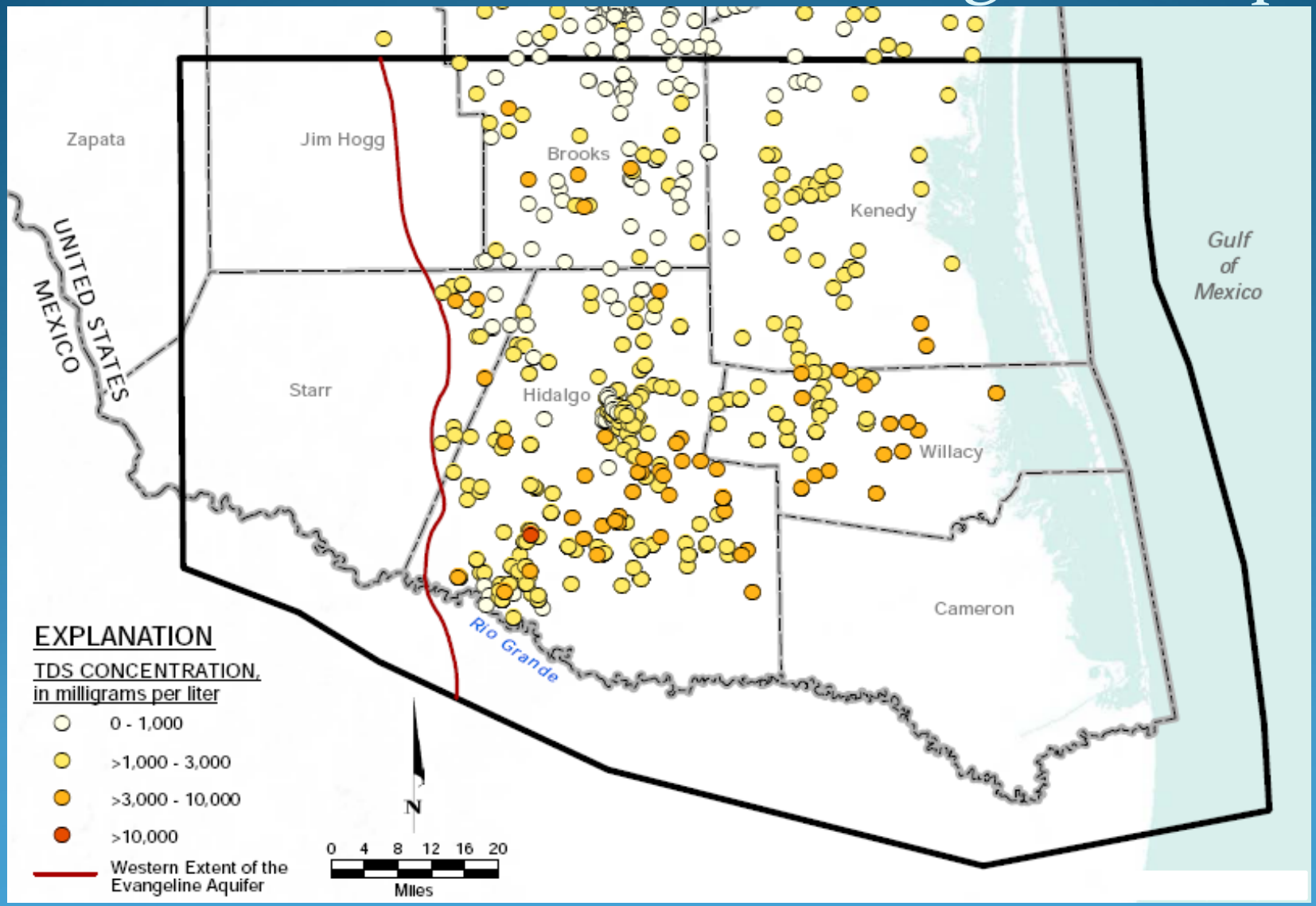
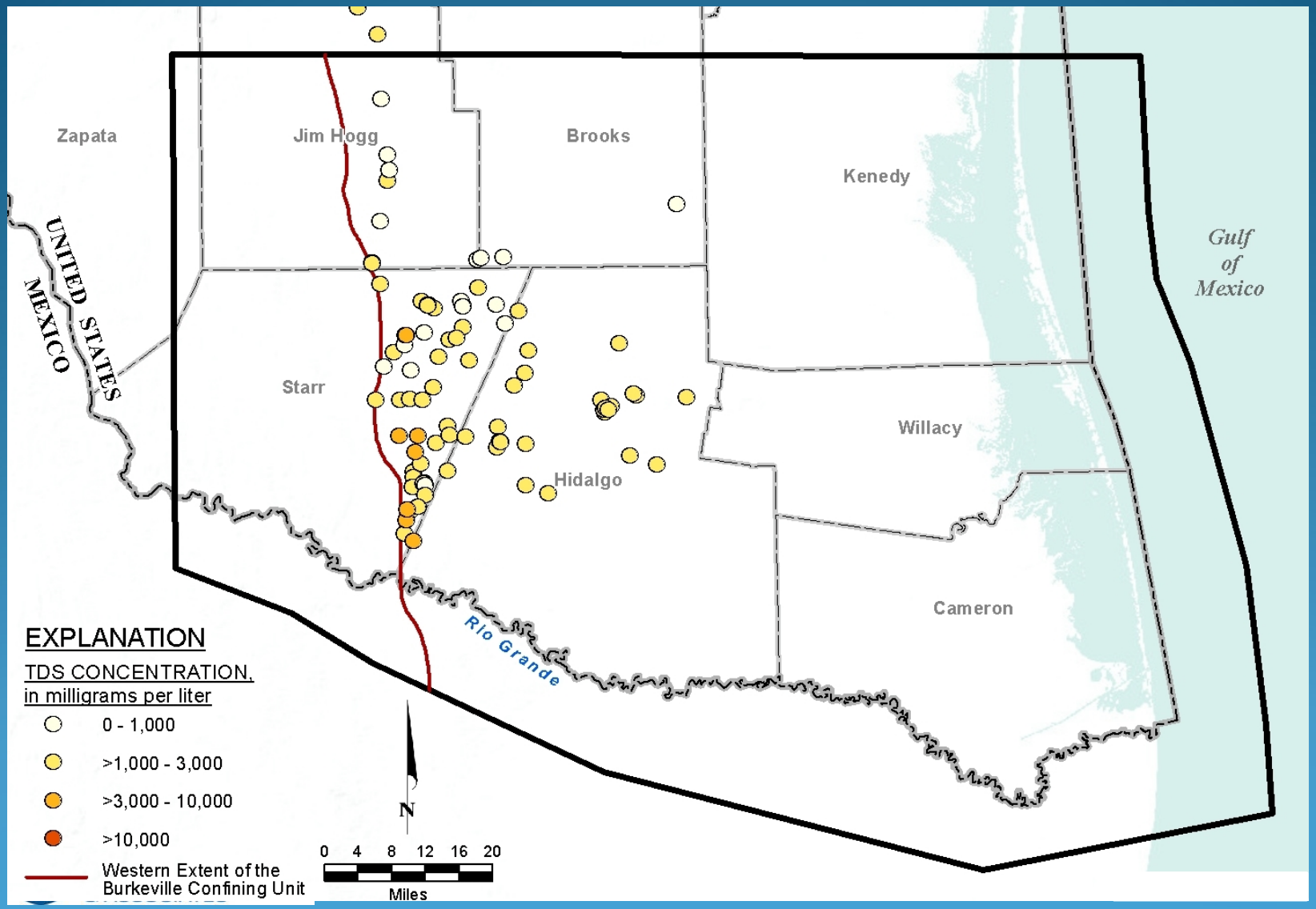
Total Dissolved Solids – Chicot Aquifer



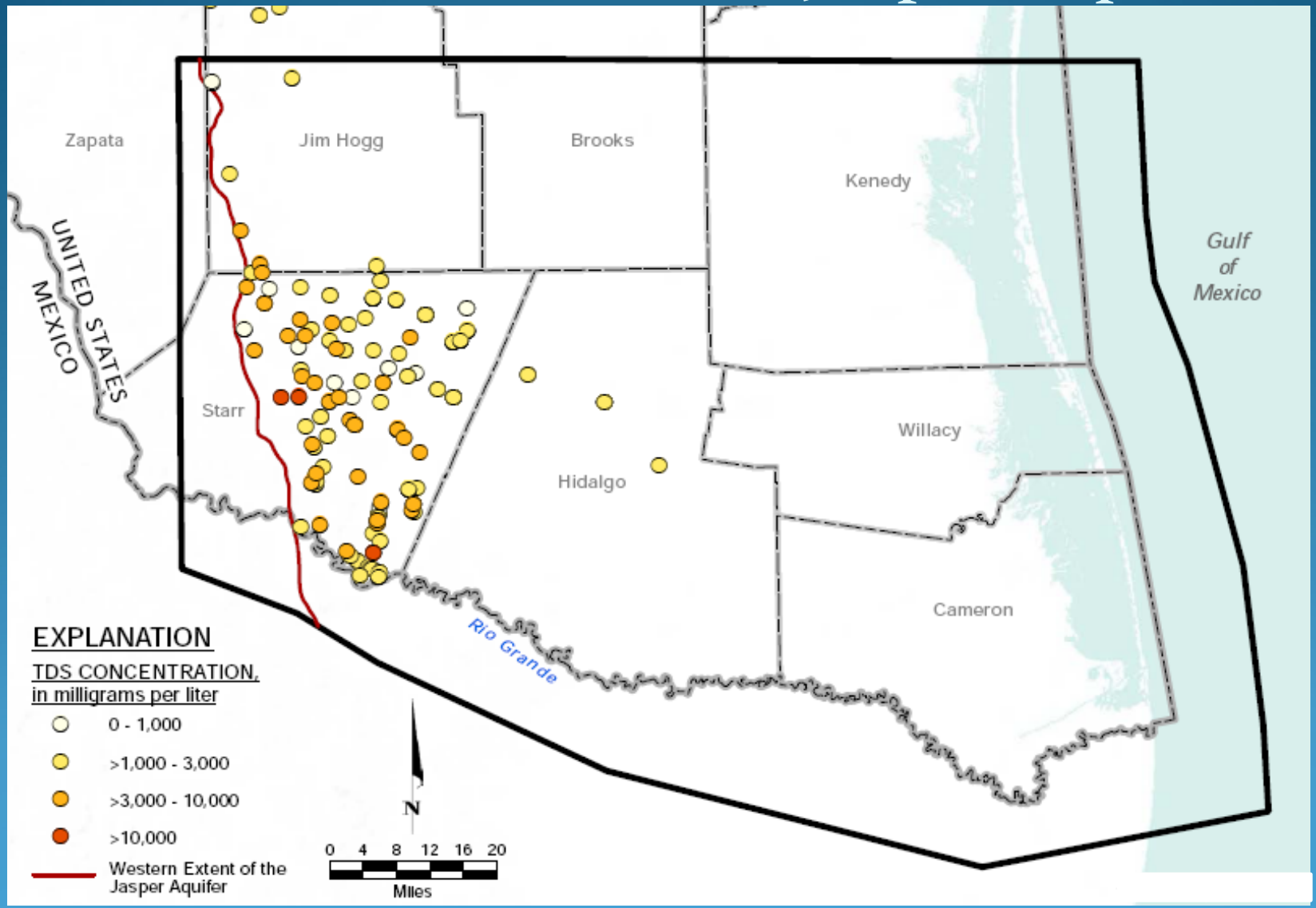
Total Dissolved Solids – Evangeline Aquifer



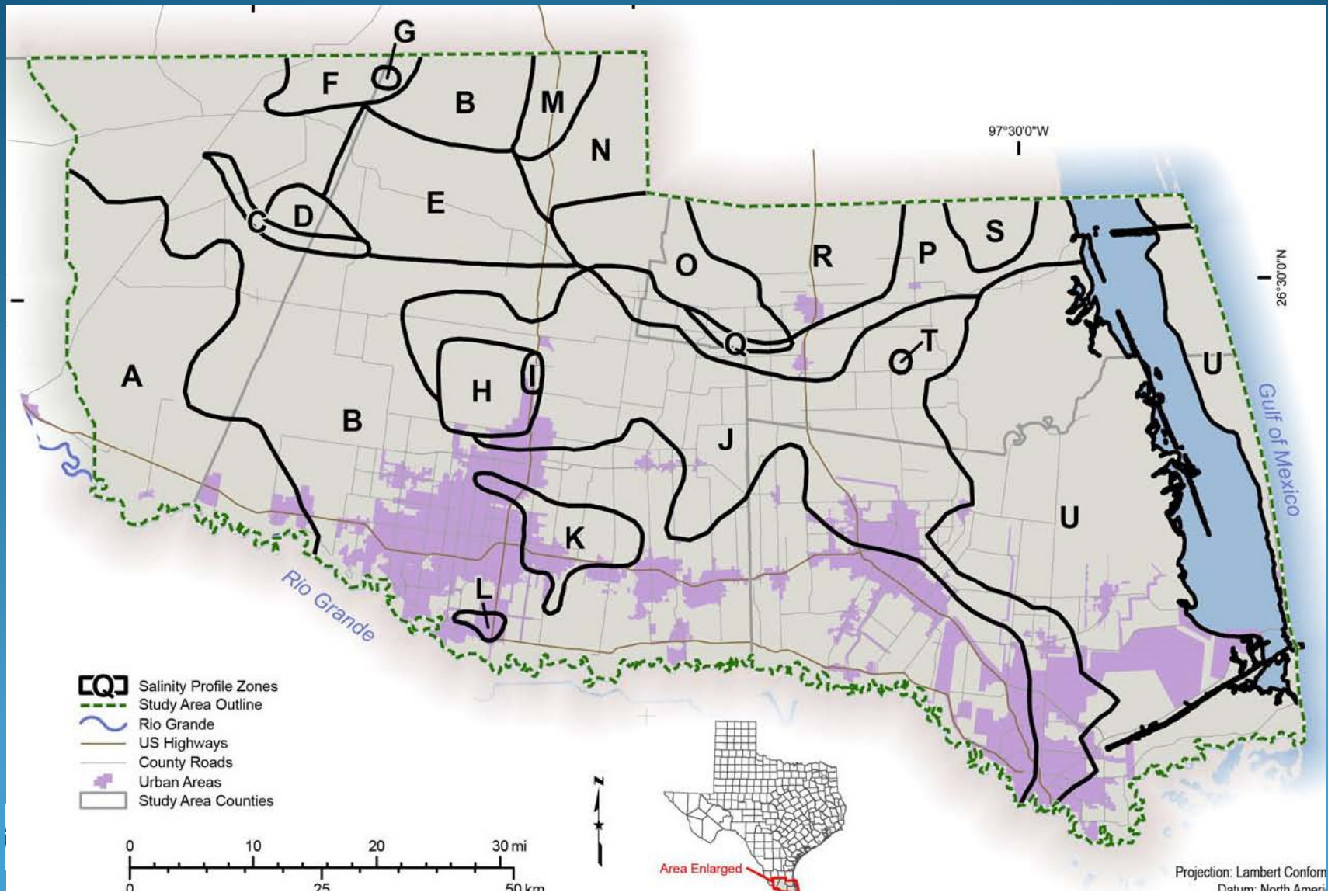
Total Dissolved Solids – Burkeville CU



Total Dissolved Solids – Jasper Aquifer



TWDB BRACS Study



A	B	C	D	E	F	G
				SS Shallow 2		VS Shallow 1
		MS Shallow 5		MS Intermediate 1	MS Shallow 4	MS Shallow 4
	SS Deep	SS Deep		SS Deep	SS Deep	SS Deep
MS Deep	MS Deep	MS Deep	MS Deep	MS Deep	MS Deep	MS Deep
VS Deep	VS Deep	VS Deep	VS Deep	VS Deep	VS Deep	VS Deep
BR Deep	BR Deep	BR Deep	BR Deep	BR Deep	BR Deep	BR Deep

H	I	J	K	L	M	N
	VS Shallow 3			SS Shallow 1	VS Shallow 2	
MS Shallow 2	MS Shallow 2		MS Shallow 1	MS Intermediate 2	MS Intermediate 1	MS Intermediate 1
SS Intermediate	SS Intermediate		SS Deep	SS Deep	SS Deep	SS Deep
MS Deep	MS Deep	MS Deep	MS Deep	MS Deep	MS Deep	MS Deep
VS Deep	VS Deep	VS Deep	VS Deep	VS Deep	VS Deep	VS Deep

O	P	Q	R	S	T	U
VS Shallow 4			VS Shallow 4			
MS Intermediate 1			MS Intermediate 1	MS Shallow 3	Brine Shallow	
SS Deep	VS Shallow 4		SS Deep	VS Shallow 4	VS Intermediate	
MS Deep	MS Deep	MS Deep	MS Deep	MS Deep	MS Deep	
VS Deep	VS Deep	VS Deep	VS Deep	VS Deep	VS Deep	VS Deep
BR Deep	BR Deep	BR Deep	BR Deep	BR Deep	BR Deep	BR Deep

Conceptual Model

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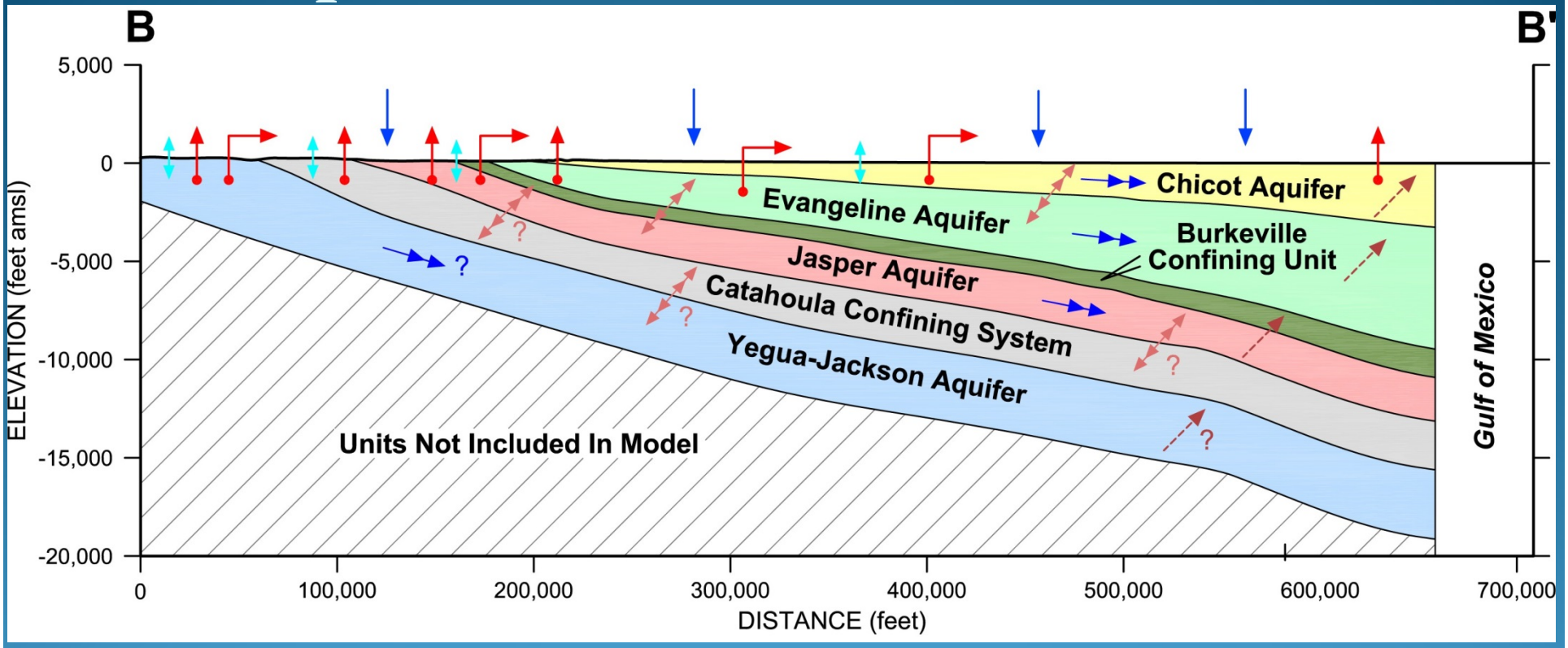
Conceptual Model



EXPLANATION

- No Flow
- Constant Head
- Recharge
- Cross-Formational Flow
- Groundwater-Surface Water Interaction
- Pumping
- Evapotranspiration
- Groundwater Flow
- Discharge to Gulf of Mexico

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Project Schedule

- Public Comment Deadline for draft Conceptual Model Report: July 29, 2016
- Currently developing the groundwater flow and transport model
- Calibrated Model Deadline: January 31, 2017
- Study Completion Date: June 30, 2017
  - Predictive simulations
  - Analysis of model results
- Final Report Deadline : October 31, 2017

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Draft Conceptual Model Report

- Available online:

http://www.twdb.texas.gov/groundwater/models/research/lrgv_t/lrgv_t.asp

- Submit comments on the report and presentation to:

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Questions and Discussion

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