

# Investigation of Brackish Resources in the Gulf Coast Aquifer and Determination of the Potential Subsidence Risk From Resource Development

A Presentation to the Lone Star  
Groundwater Conservation District



Presented By:

**INTERA**  
GEOSCIENCE & ENGINEERING SOLUTIONS



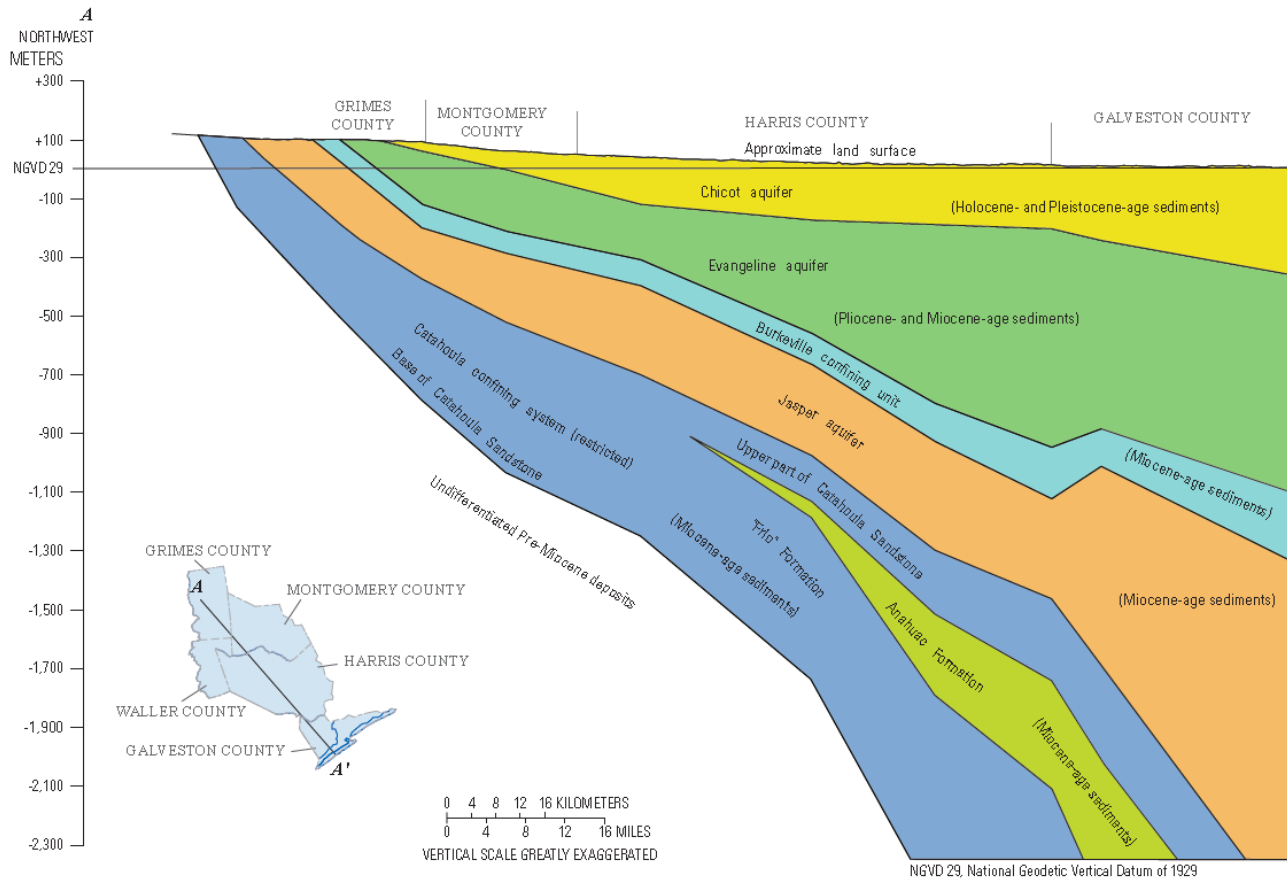
September 11, 2018

# Study Motivation & Products

- The Districts' Science and Research Plan calls for the determination of the occurrence and hydrogeologic characteristics of the brackish resources within the District and surrounding areas
- Two Primary Work Products
  - Report and data delineating brackish groundwater resources with the Harris-Galveston and Fort Bend Subsidence Districts
  - Risk Analysis for Subsidence from Development of the Brackish Jasper Aquifer
- This study: (1) provides foundational information to inform future subsidence studies; (2) provides an improved understanding of the historically undeveloped brackish resources; and informs potential regulation of brackish resources



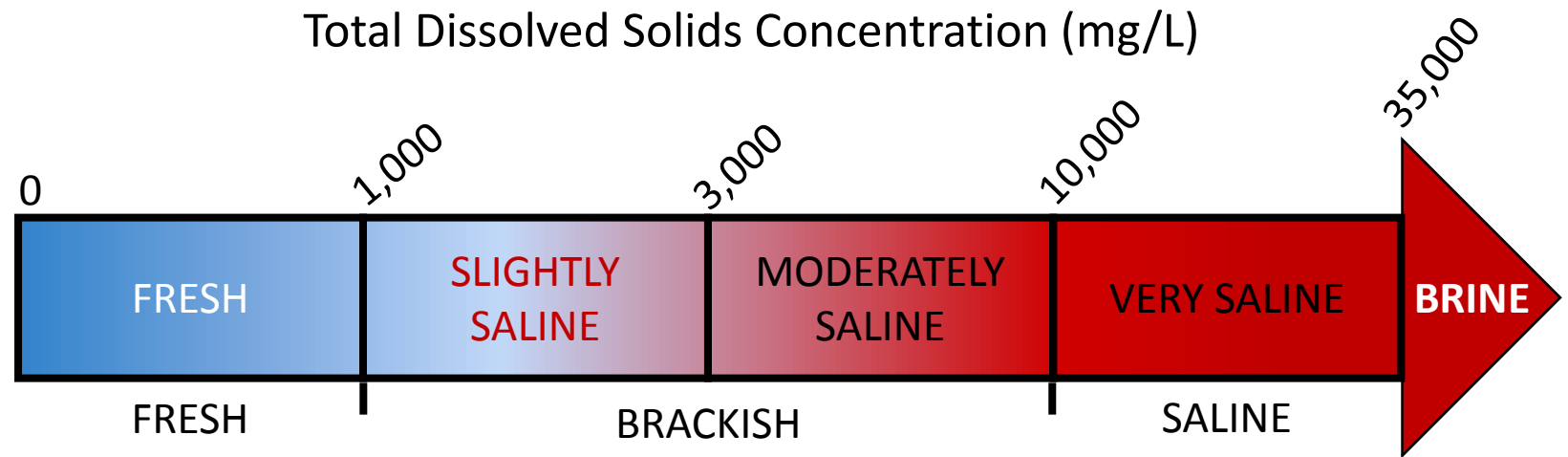
# Gulf Coast Aquifer System Hydrogeology



Geologic Unit	Hydrogeologic Unit
Beaumont	CHICOT AQUIFER
Lissie	
Willis	
Upper Goliad	EVANGELINE AQUIFER
Lower Goliad	
Upper Lagarto	
Middle Lagarto	BURKEVILLE
Lower Lagarto	JASPER AQUIFER
Oakville	
Frio	CATAHOULA
Vicksburg	

After SIR 2012-5211 (Bowden and others, 2012)

# Salinity Terminology



Salinity Classification after Winslow and Kister (1956)

Brackish Groundwater definition is consistent with the Texas Water Development Board (TWDB) Brackish Resources Aquifer Characterization System

# Brackish Resources Delineation Report

- Study Area - the Harris-Galveston and Fort Bend Subsidence Districts and surrounding counties
- Study builds on the analysis begun by the TWDB HB-30 work increasing the resolution of the analysis
- Performed a detailed assessment of aquifer structure, lithology and salinity in Gulf Coast Aquifer System
- Fully digital dataset of aquifer lithology (sand/clay) and salinity
  - 299 geophysical logs — Salinity
  - 294 geophysical logs — Lithology
  - 209 geophysical logs - Stratigraphy

## FINAL REPORT ON THE DELINEATION OF FRESH, BRACKISH AND SALINE GROUNDWATER RESOURCES BASED ON INTERPRETATION OF GEOPHYSICAL LOGS

Prepared for:



Harris-Galveston Subsidence District



Fort Bend Subsidence District

Prepared by:



INTERA Incorporated



LBG-Guyton & Associates

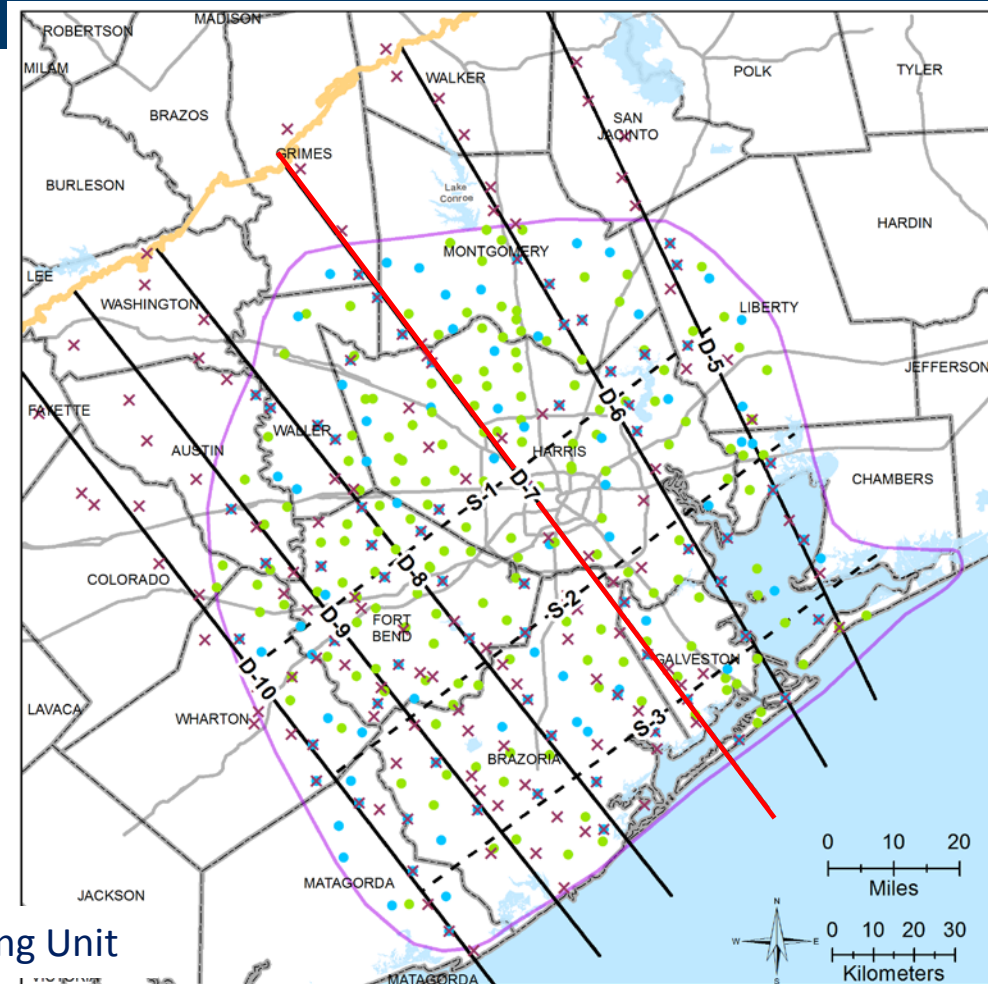
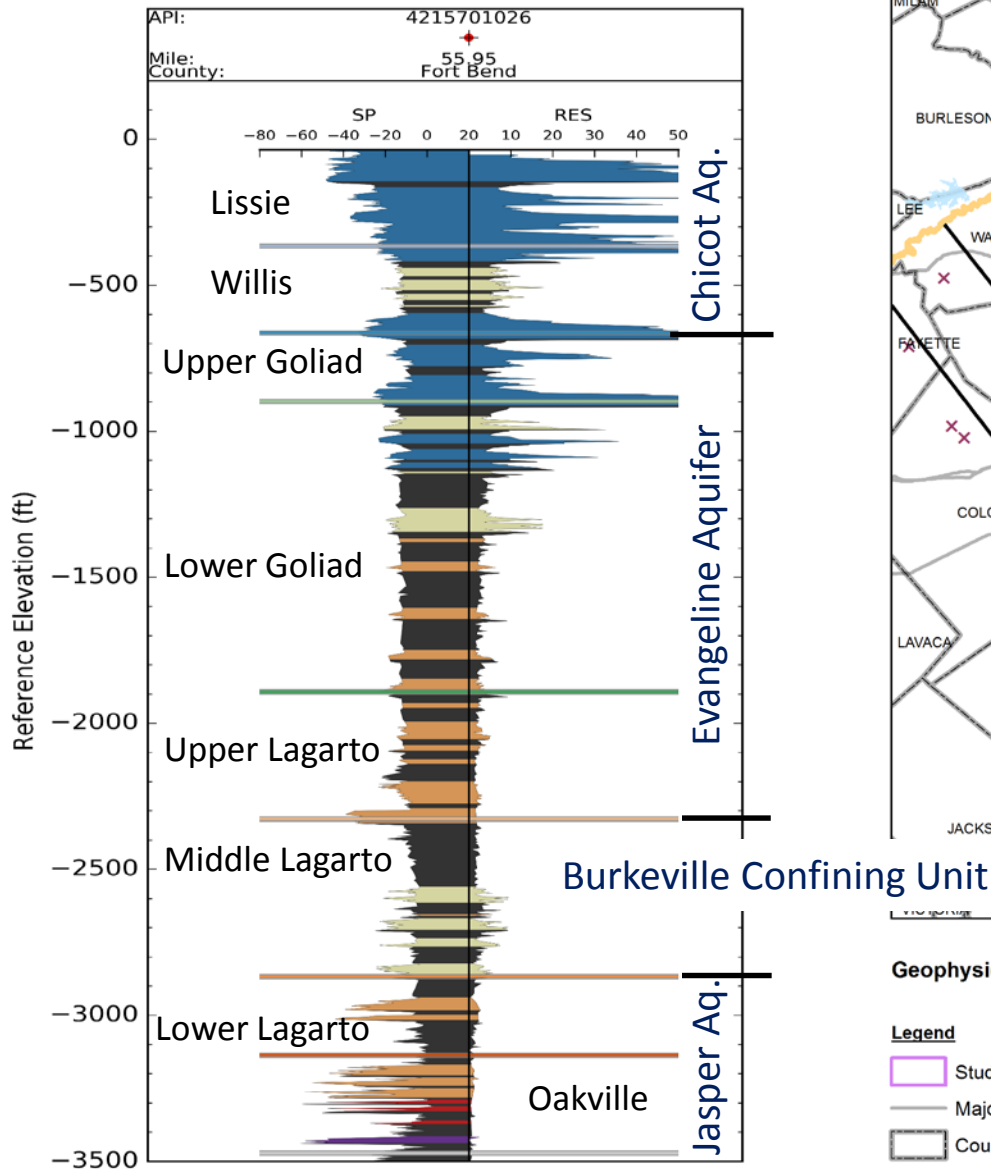


Bureau of Economic Geology

December 2017



# Example Digitized Geophysical Log and Cross Section Base Map



## Geophysical Well Log Locations.

### Legend

- Study Area
- Major Highway
- County Line

- Cross Section Dip Line
- Cross Section Strike Line
- Catahoula Updip Extent
- Logs with Updated Stratigraphic Picks

### Logs with Sand Picks in the Study Area

- TWDB Study (Young et al., 2016)
- This Study



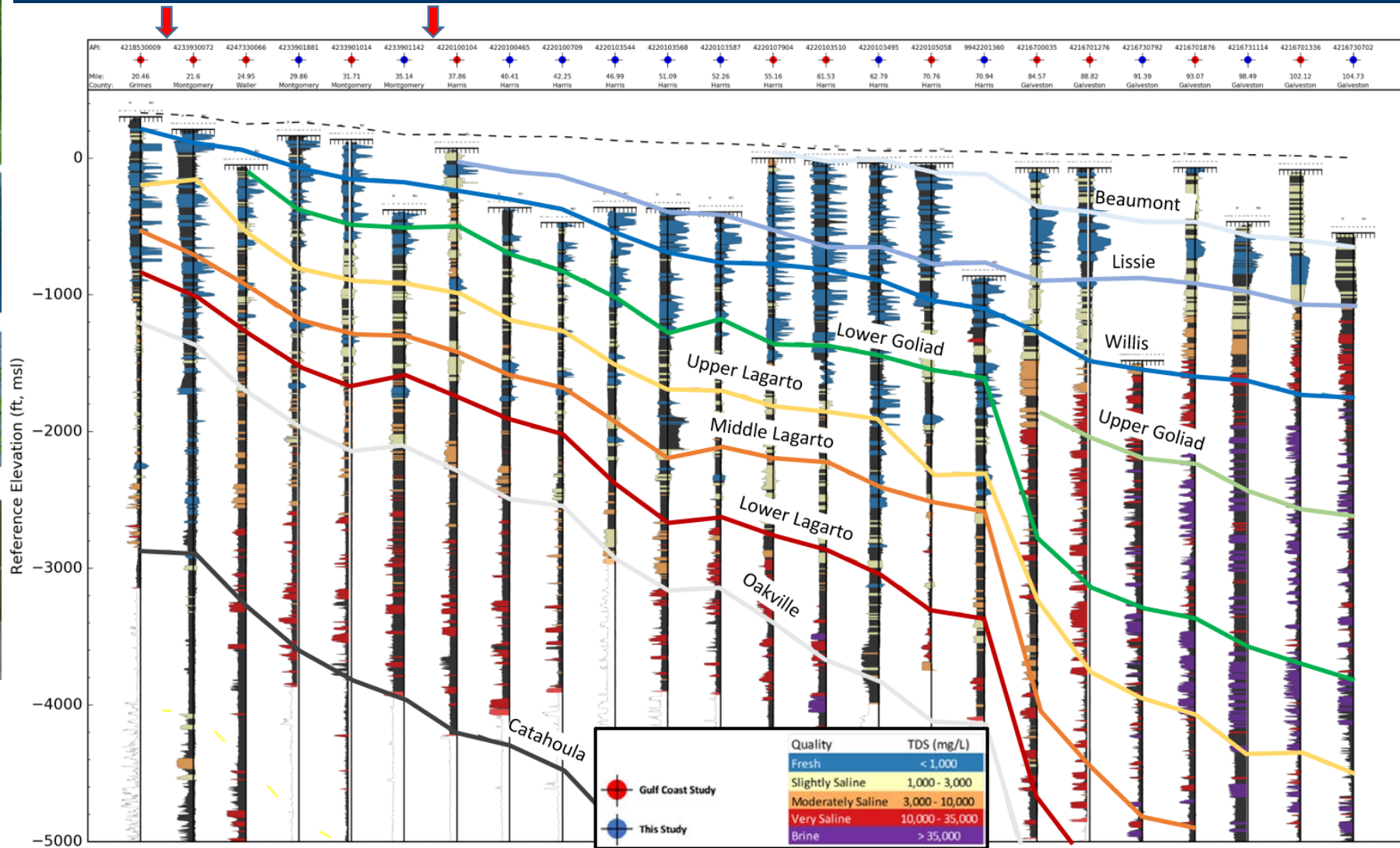
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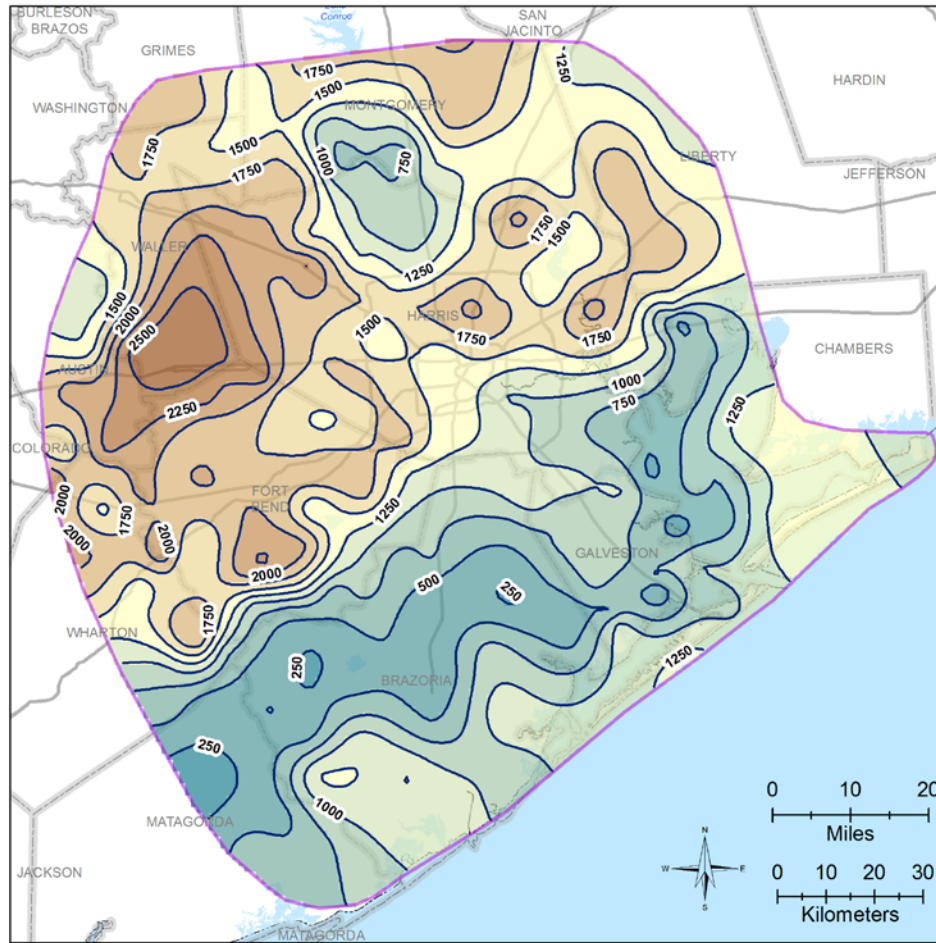
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# Dip Cross-Section D-7 Showing Structure, Lithology and Salinity



# Characterization of Water Quality and Lithology (Clay and Sand)

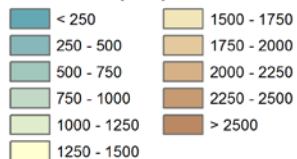


**Thickness of Brackish Zone**  
(Total Dissolved Solids 1,000 - 10,000 mg/L)

## Legend

- Study Area
- County
- Major Highway

## Thickness (feet)

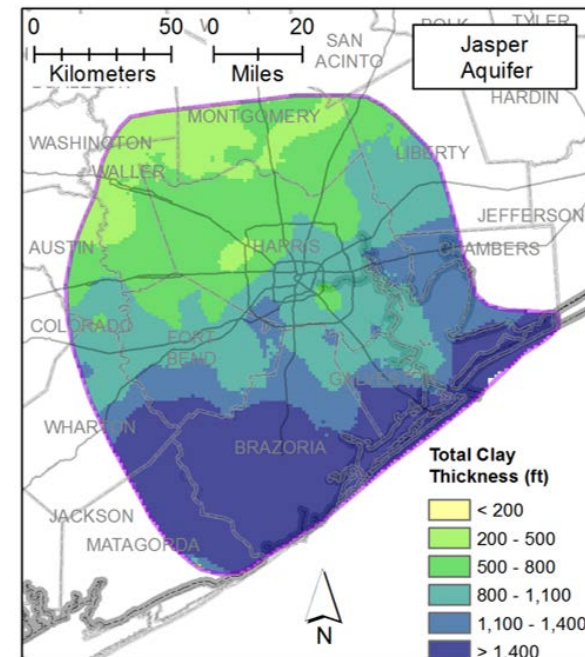
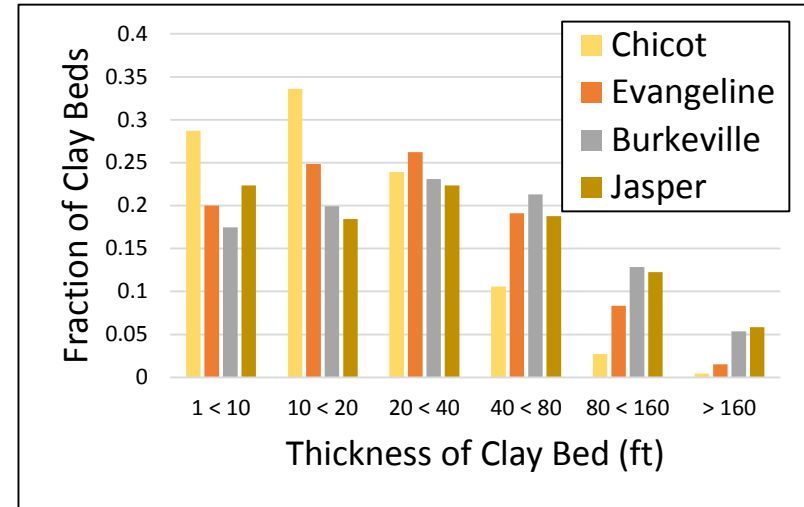


Map Location

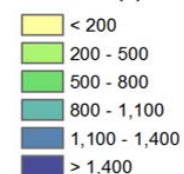
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## Total Clay Thickness (ft)





# Characterization of Subsidence Risk in the Jasper Aquifer

- Performed a Risk Assessment for groundwater development from the Jasper Aquifer
  - Study area focused on brackish portions of the Jasper Aquifer (generally  $> 2,000$  feet)
  - Developed a conceptual model and base-case parameters for assessment of compaction in the Jasper Aquifer
  - Normalized Risk Methodology based upon three performance metrics:
    - Compaction in the Jasper Aquifer
    - Land subsidence from Jasper compaction
    - Consequence from subsidence (flood plain)

## SUBSIDENCE RISK ASSESSMENT AND REGULATORY CONSIDERATIONS FOR THE BRACKISH JASPER AQUIFER

Harris-Galveston and Fort Bend Subsidence Districts

Final Report

Prepared for:



Harris-Galveston Subsidence District



Fort Bend Subsidence District

Prepared by:

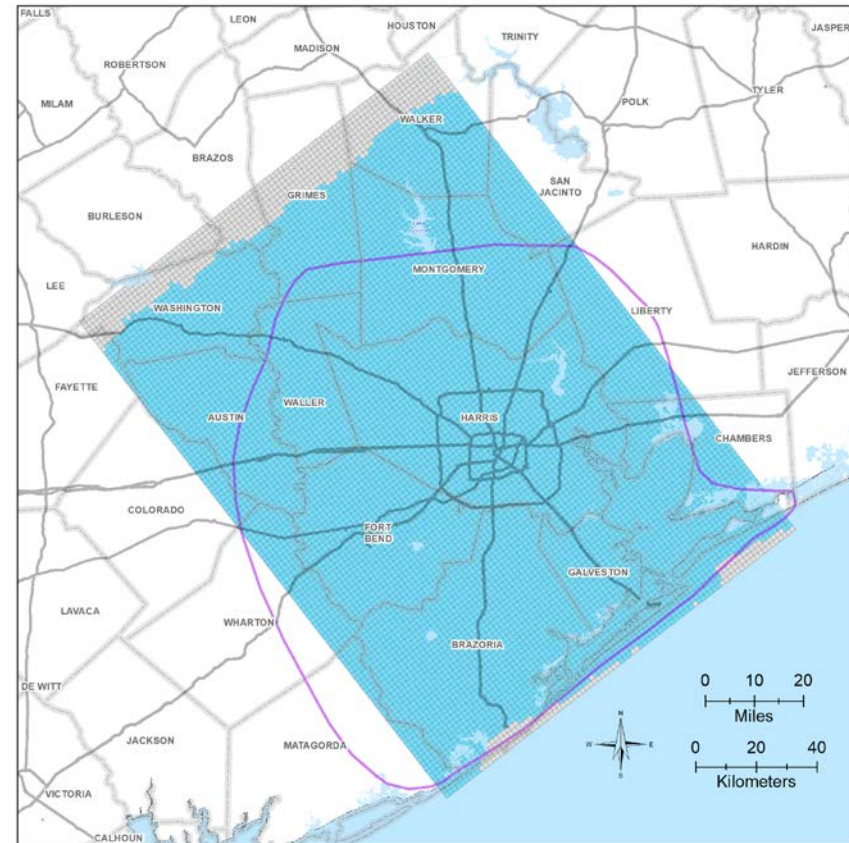


INTERA Incorporated  
9600 Great Hills Trail  
Suite 300W  
Austin, TX 78759  
512.425.2000

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# Numerical Simulation of Jasper Aquifer Compaction - JCM

- A numerical model (JCM) of the Jasper Aquifer was developed to estimate compaction from a hypothetical brackish groundwater project
- Used the USGS flow model — **MODFLOW-SUB**
- The model can predict both the timing and amount of compaction that can occur accounting for the variability in clay bed occurrence and thickness
- 117 different models were developed - each representing an approximate 9 square-mile area to account for variability in clay properties and the depth of the Jasper Aquifer



## Legend

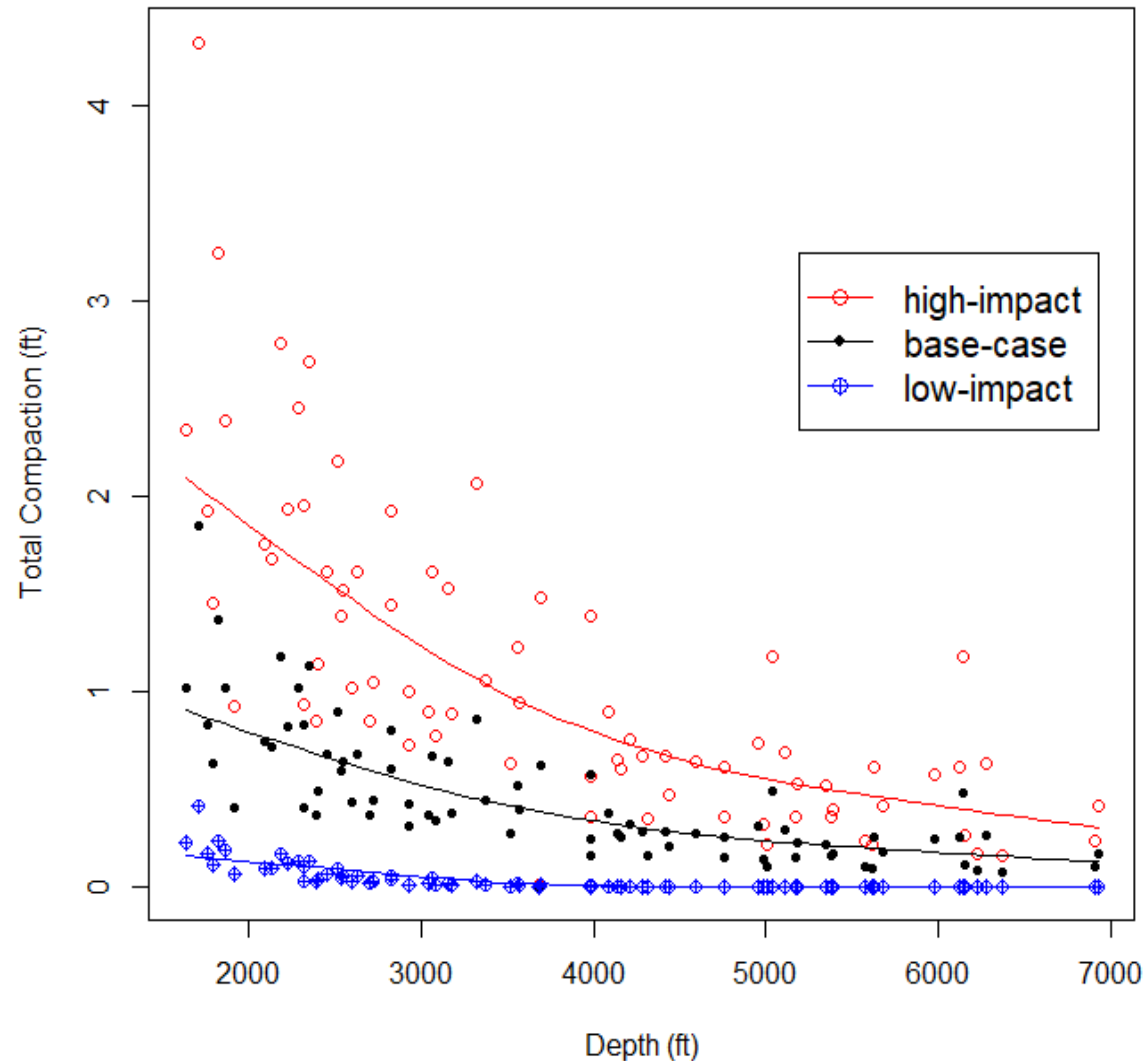
- Study Area
- County Lines
- Major Highways

## Layer 4

- Inactive
- Active

# Simulated Variability in Compaction (ft) after 10 Years for Three Parameter Sensitivity Case

- Because there is uncertainty in best estimate Jasper Aquifer compaction properties, sensitivity simulations were developed
  - High-Impact Case
  - Low-Impact Case
- At shallower depths  $< 2,000$ , an average of 1 foot of cumulative compaction occurs after 10 years of production for the base case



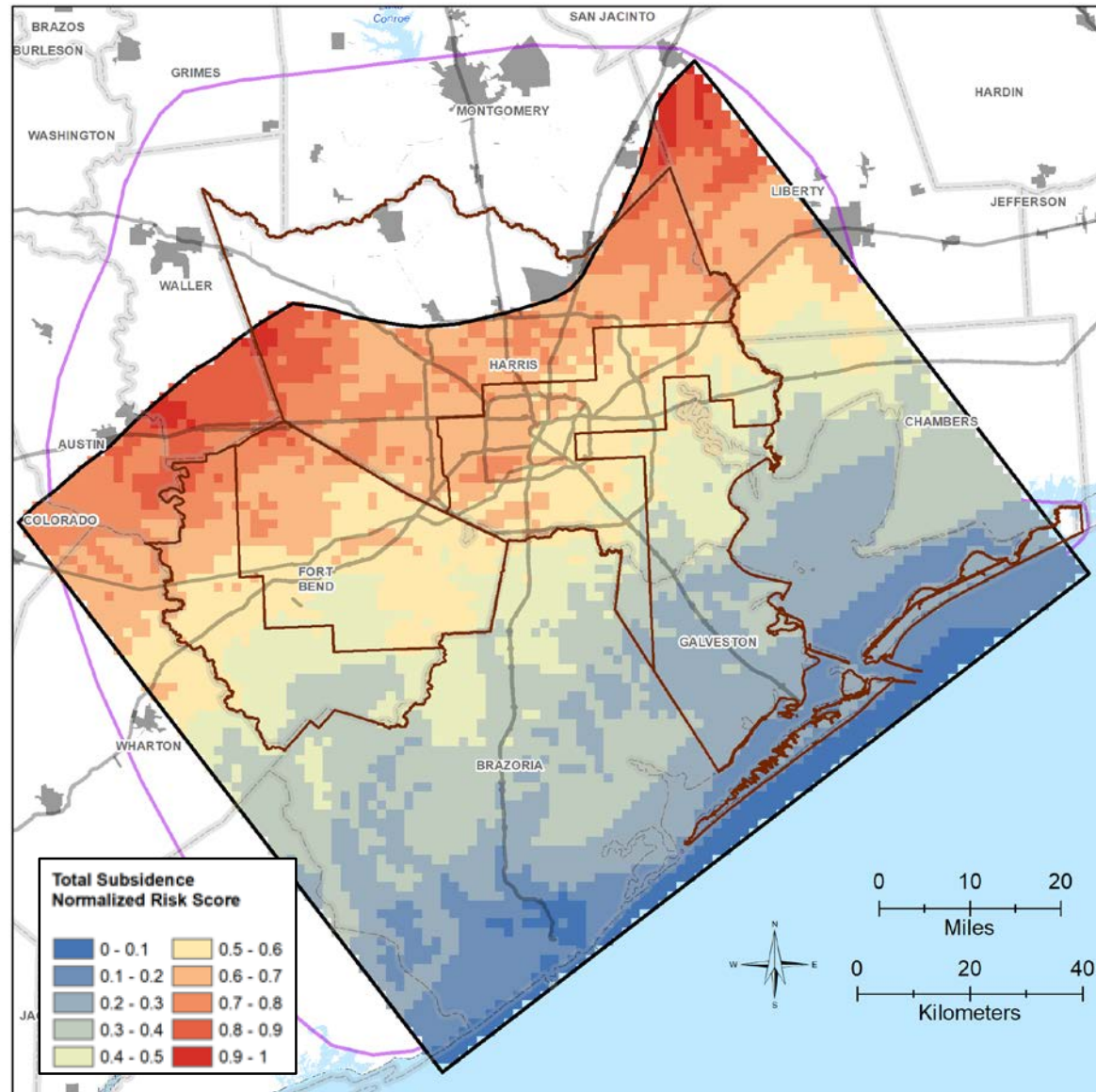
# Jasper Aquifer Total Subsidence Normalized Risk Score (TSNRS)

## ■ Normalized Risk

Methodology based upon three performance metrics:

- Compaction in the Jasper Aquifer (JCM)
- Land subsidence from Jasper compaction (depth)
- Consequence from subsidence (flood plain)

- The TSNRS is a relative measure of risk from Jasper brackish development relating one location from another





# Conclusions and Potential Impact on Future Regulation

- The study has successfully developed a conceptual model for studying compaction in the brackish portions of the Jasper Aquifer.
- The study provides a basis to inform the potential regulation of brackish groundwater development in the Jasper Aquifer and provides a means to communicate relative risk of such development within the District
- The study provides recommendations for the collection of data and the performance of analyses based upon a general lack of deep data and a need to better understand and manage subsidence risk
- A two-tiered system of data collection and analysis activities were recommended for potential future brackish Jasper aquifer development projects consistent with the District's Mission and the need for additional data
  - Tier 1 activities are recommended activities
  - Tier 2 activities could be considered when a project is considered of higher risk



Dr. Zhuping Sheng TAMU