Gulf Coast Aquifer Hydrology and Update on Development of Nueces County Groundwater Model

Presentation to Corpus Christi City Council
October 21st, 2025

by:
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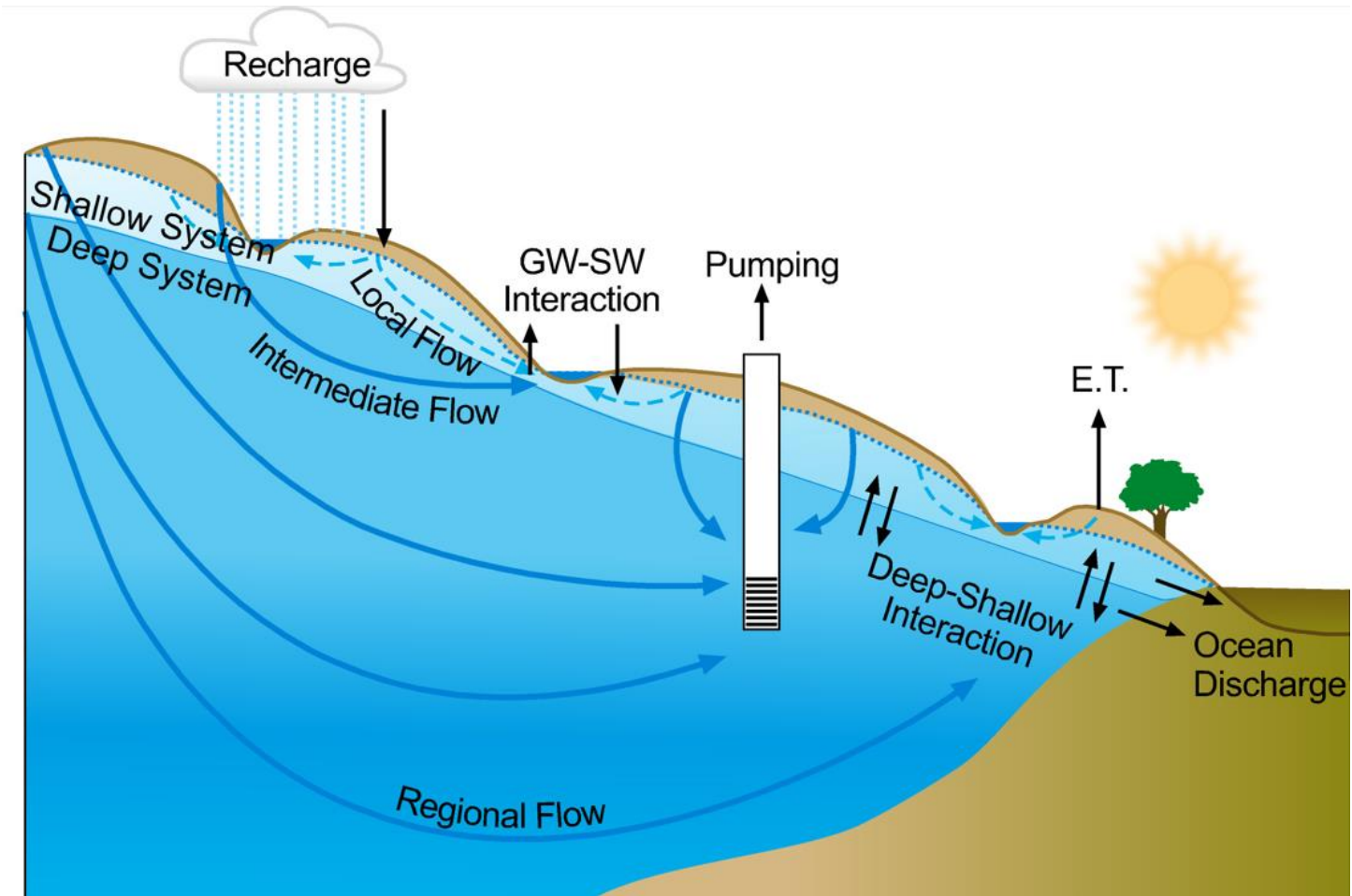
Gulf Coast Discussion Items

- Gulf Coast Aquifer Overview

- Previous Work in San Patricio and Nueces County

- Groundwater Model for Nueces County

- Interim Model Calibration Results

- Review Well Design for Nueces Brackish Wellfields

- Summary of Model Development, Performance, and Planned Improvements

- Model Applications

Gulf Coast Aquifer System
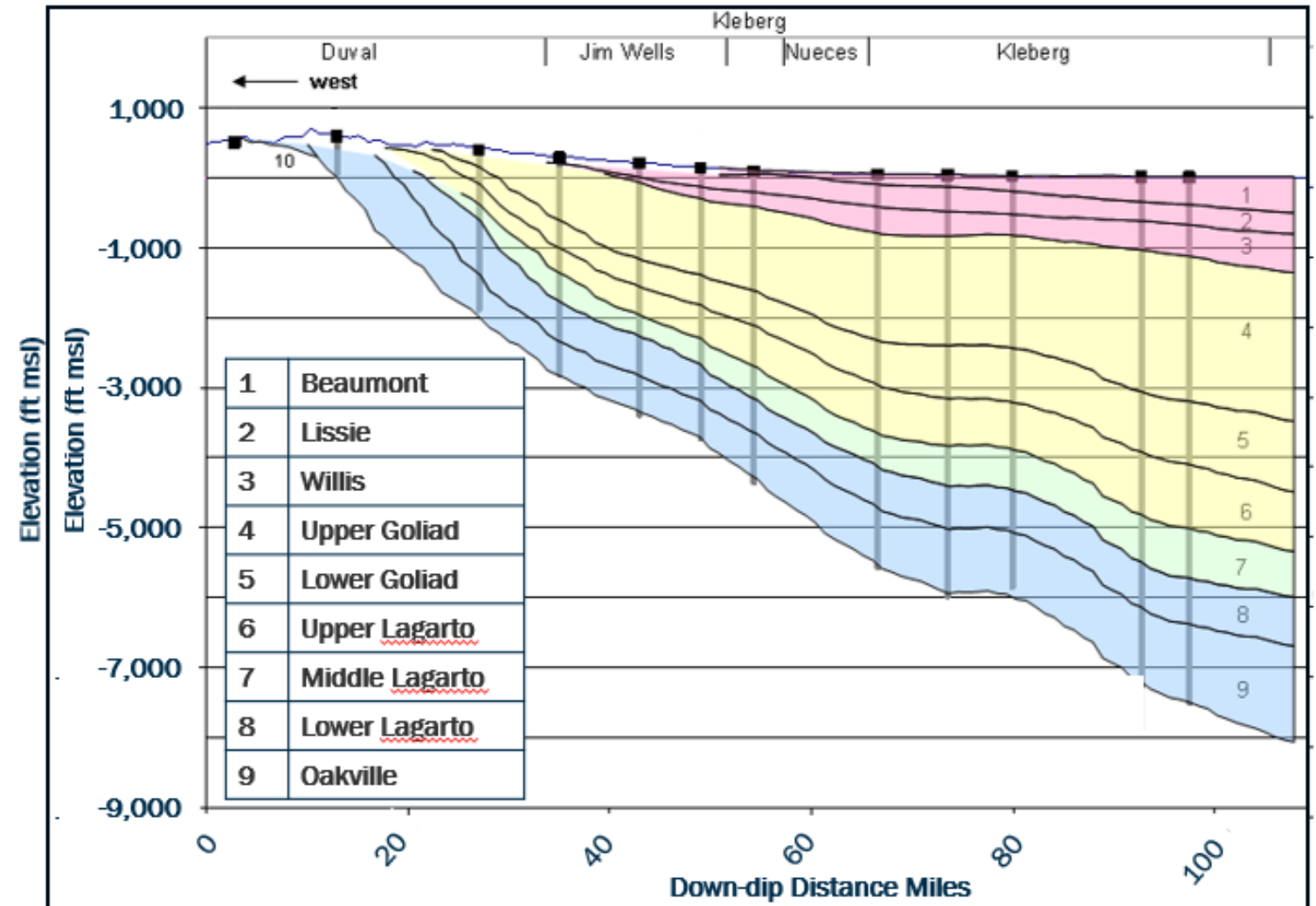
Location & Groundwater Management Areas
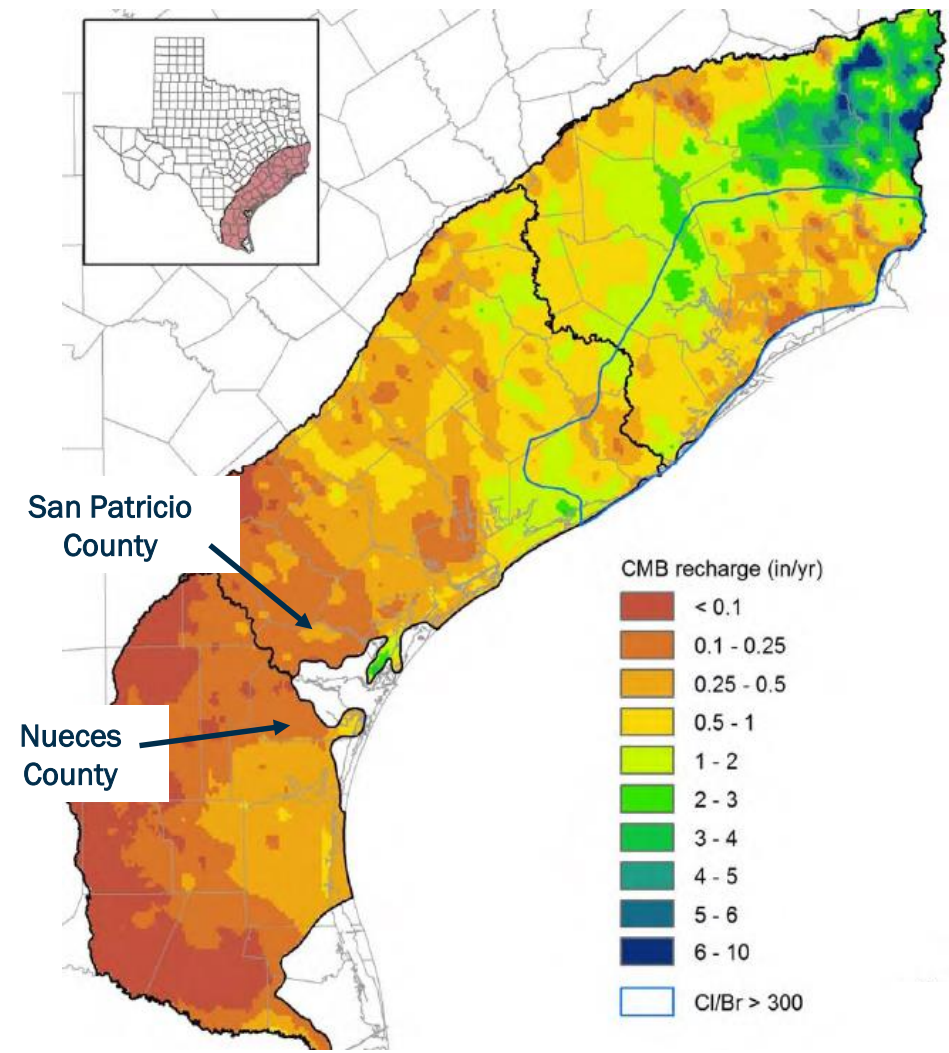

Generalized Groundwater Flow System

Gulf Coast Aquifer System: South Texas

Gulf Coast Aquifer: Recharge and Water Quality

Estimated Recharge (in/yr)*

Occurrence of Fresh Water in Chicot

* BEG Study based on chloride mass balance
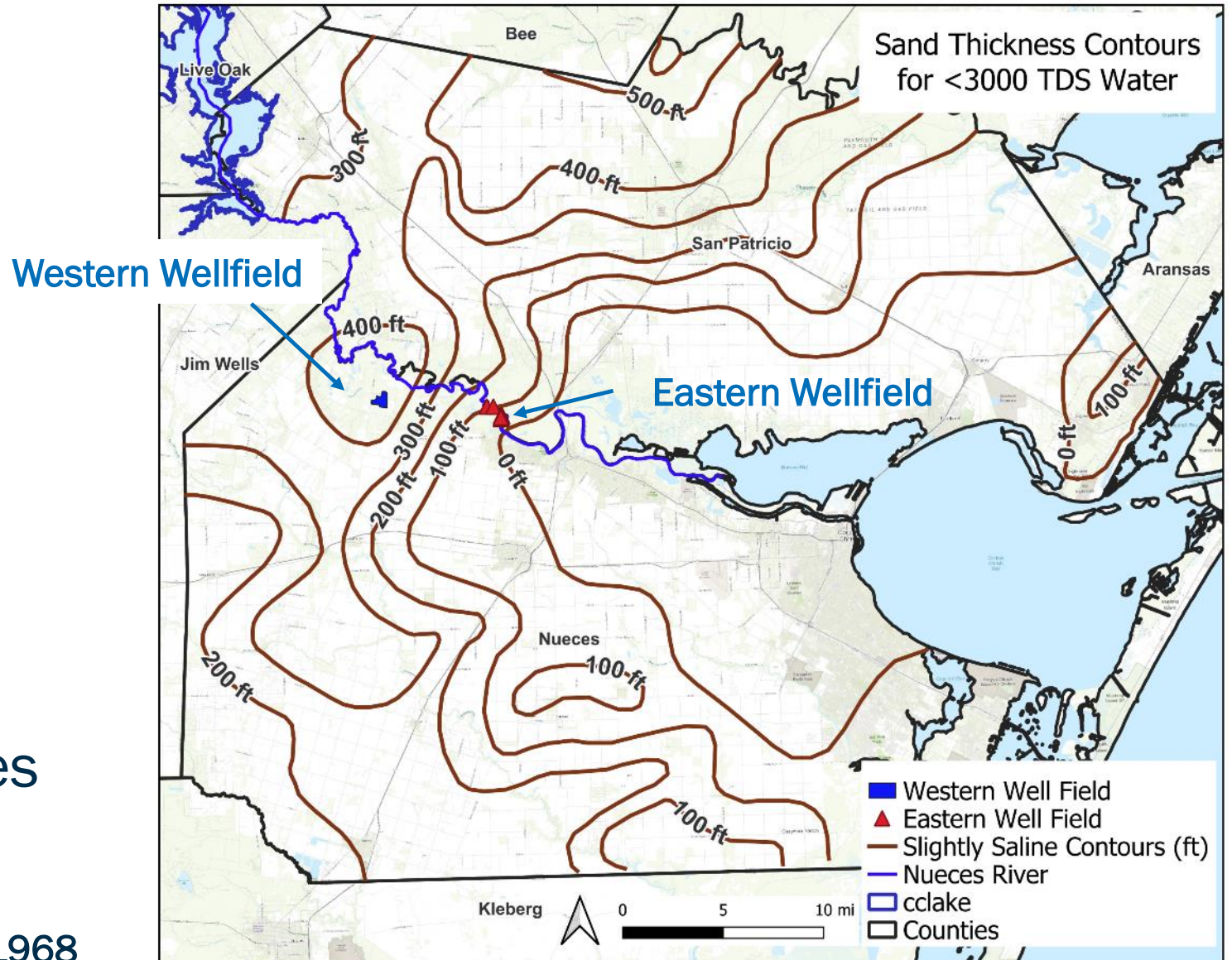
INTERA's Previous Work: 2012-2013

- Map Sand Thicknesses

- Map Water Quality

- Review Aquifer Tests

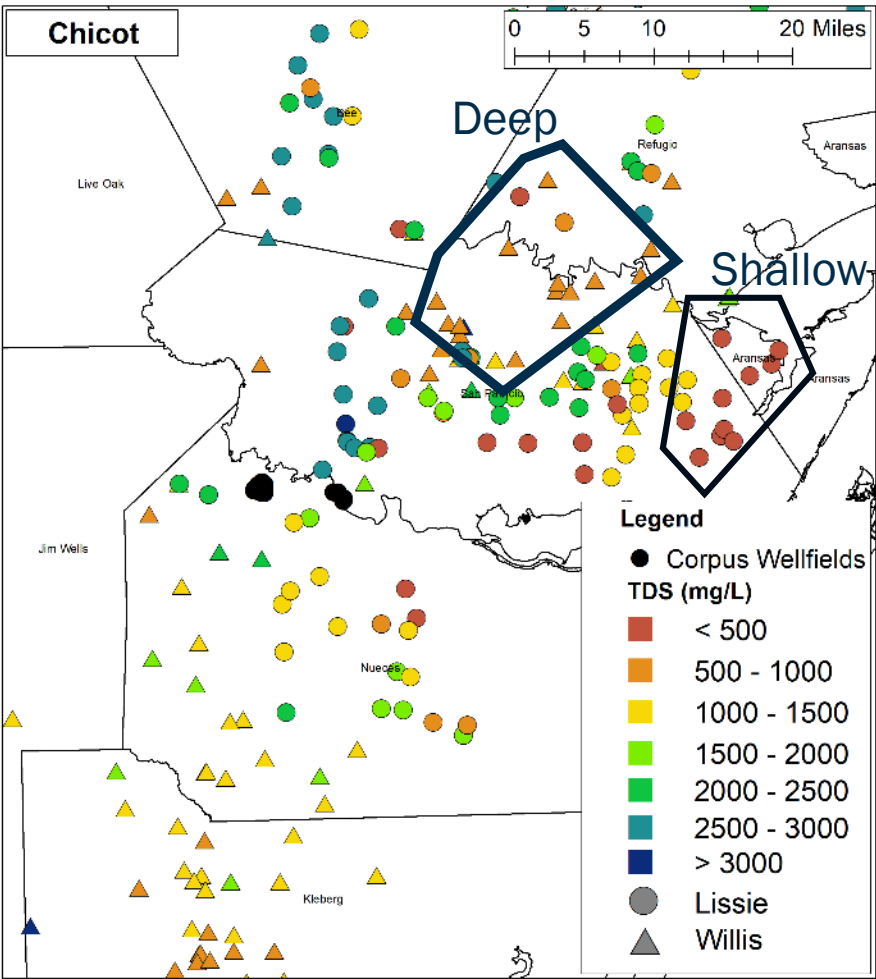- Review GW Regulations

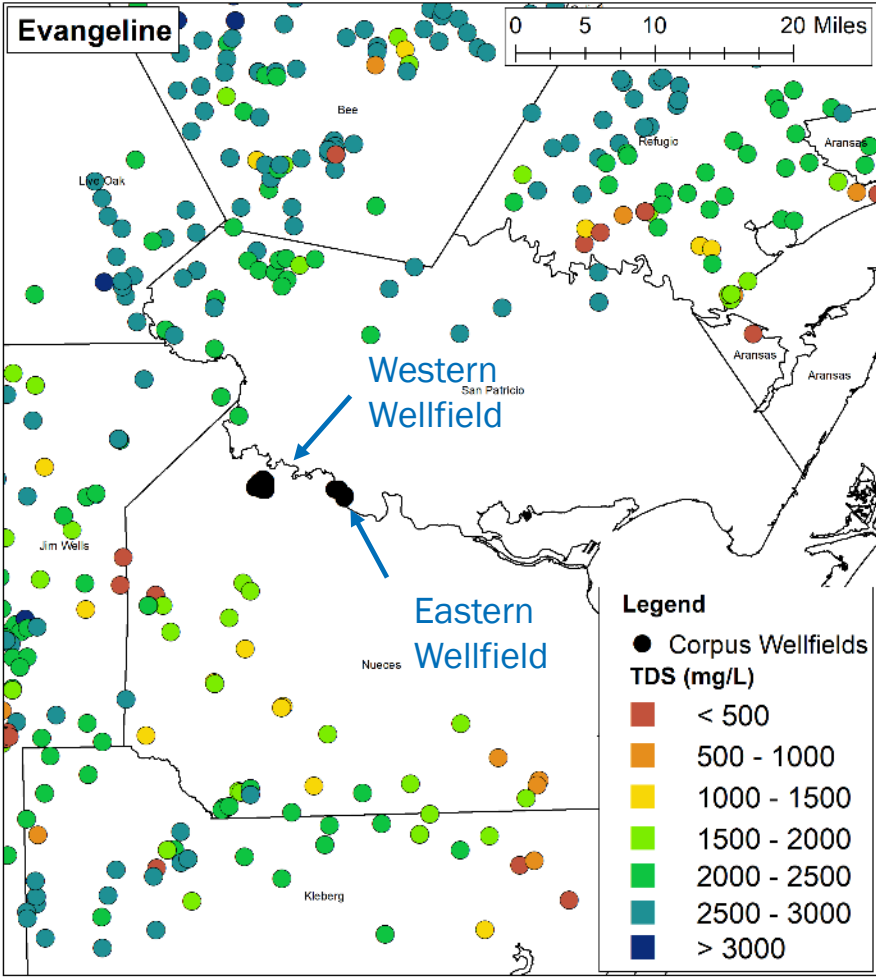- Recommend Potential Sites

From Shafter, 1968

Measured Total Dissolved Solids (mg/L)

- Freshwater (<1000 mg/L)

  - 🟥 < 500
  - 🟧 500 - 1000

- Slightly Saline (1000 – 3000 mg/l)

  - 🟨 1000 - 1500
  - 🟩 1500 - 2000
  - 🟩 2000 - 2500
  - 🟦 2500 - 3000

- Moderately Saline (3000–10000 mg/l)

  - 🟦 > 3000

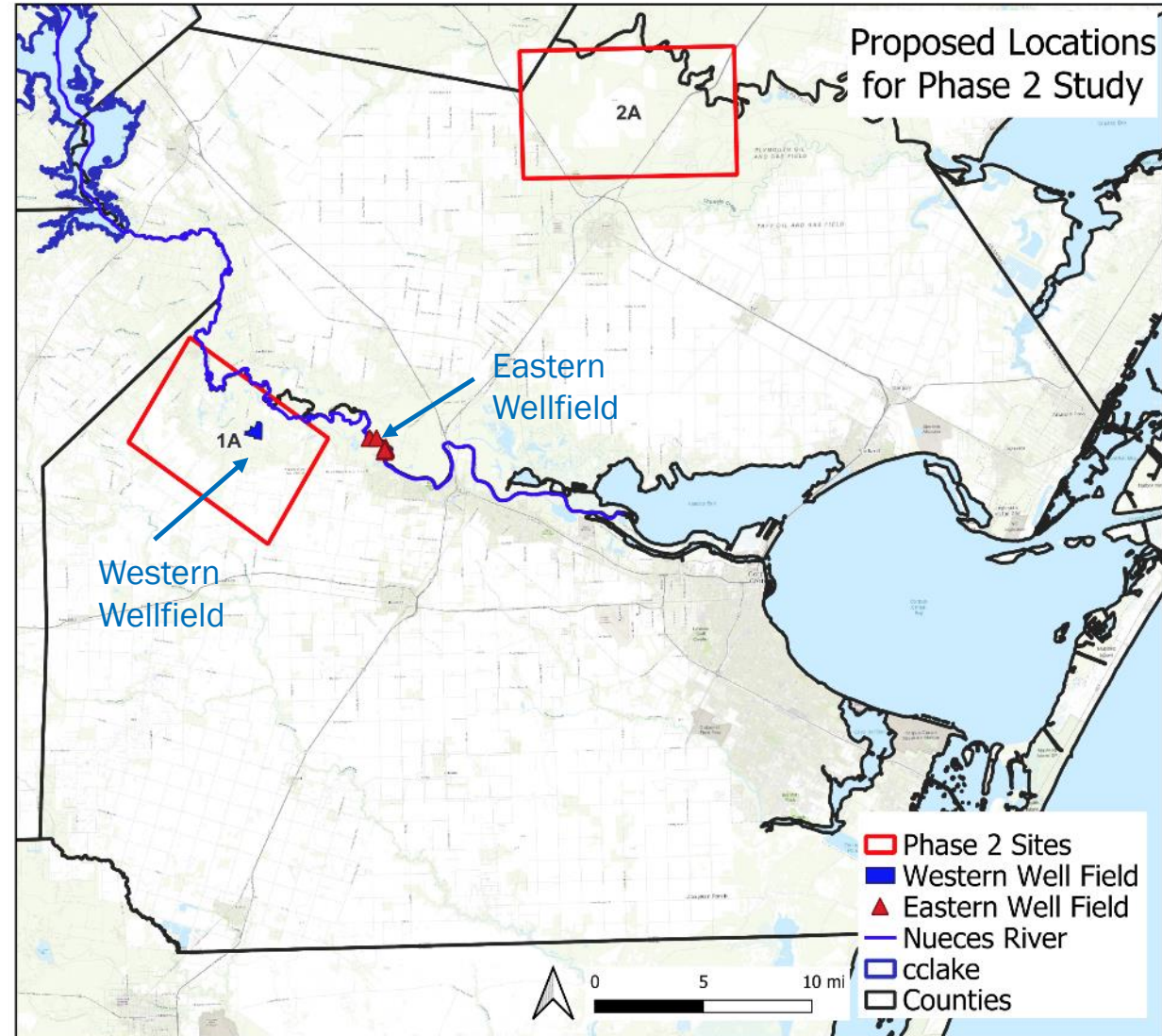Chicot – Two Freshwater Regions

Evangeline – No Freshwater Regions

Proposed Six Location of Phase 2 Study (2013)

- 1A
  - No GCD regulations
  - Slightly Saline Water
  - 7,000 to 20,000 AFY

- 2A
  - Fresh water in Lower Chicot
  - 10,000 to 20,000 AFY
  - Away from injection wells
  - Close to Mary Rhodes pipeline
  - GCD regulations

Proposed Locations for Phase 2 Study

Eastern Wellfield

Western Wellfield

Legend:
- Phase 2 Sites
- Western Well Field
- Eastern Well Field
- Nueces River
- cclake
- Counties

0   5   10 mi

Conceptualization of Regional Groundwater Flow

- Horizontal Flow Controlled by Sands
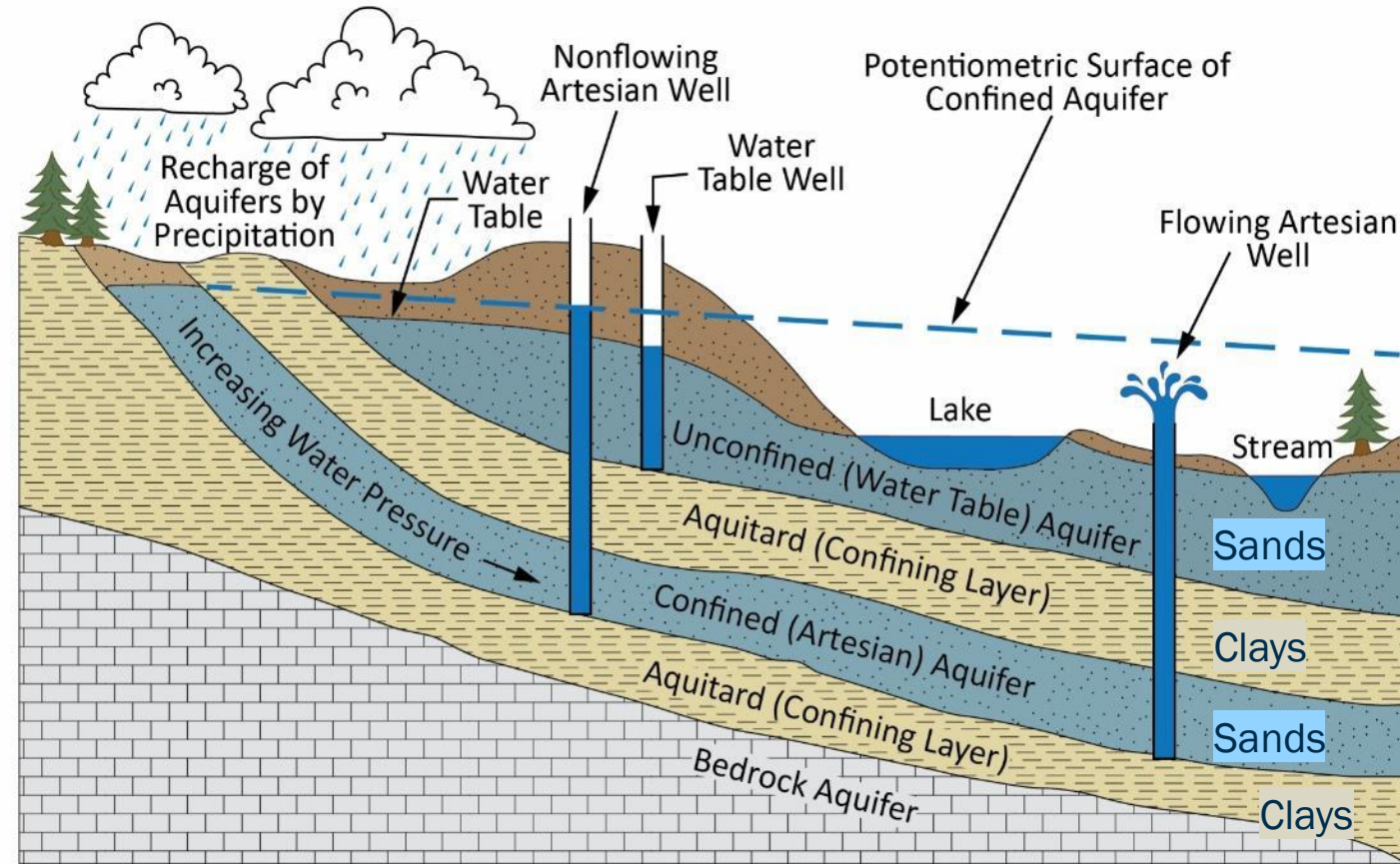 - Sand percent – horizontal hydraulic conductivity
  - Sand thickness & percent– transmissivity

- Vertical Flow Controlled by Clays
  - Clay percent – vertical hydraulic conductivity
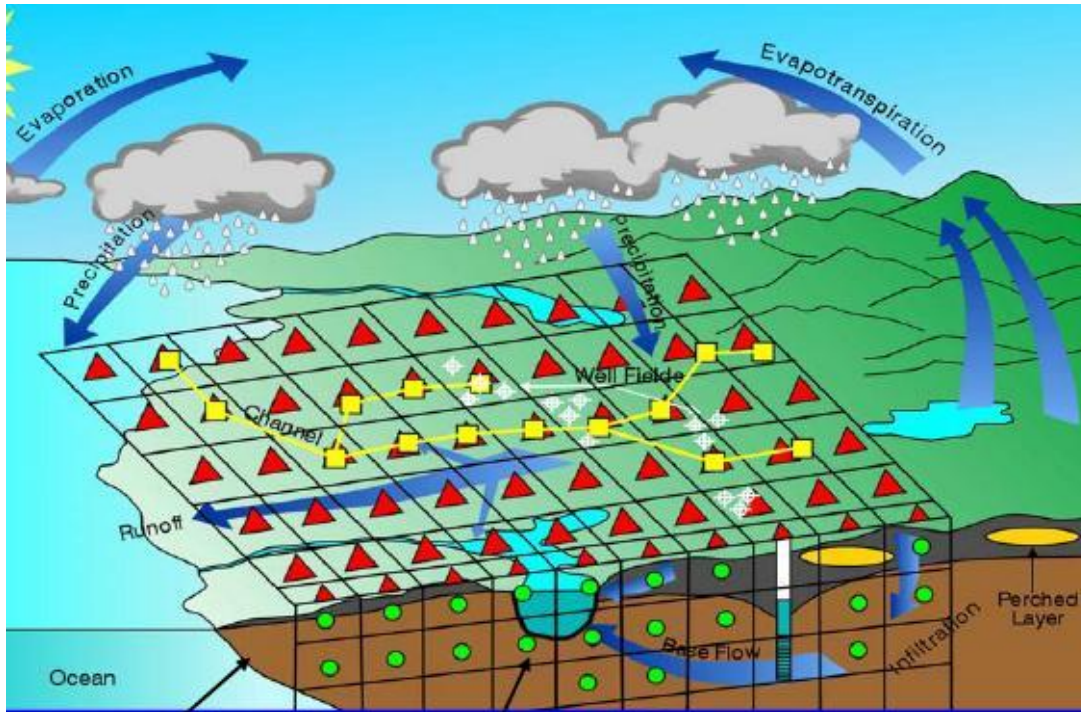 - Clay thickness & percent – vertical conductance

- Available Drawdown
  - Height of water column in a well above the top of the aquifer
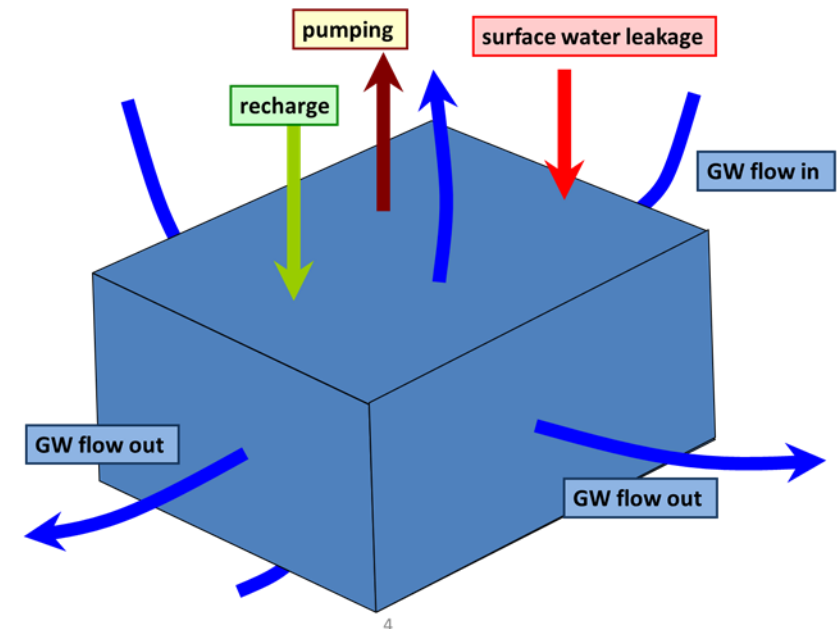 - Sometimes call the pressure head
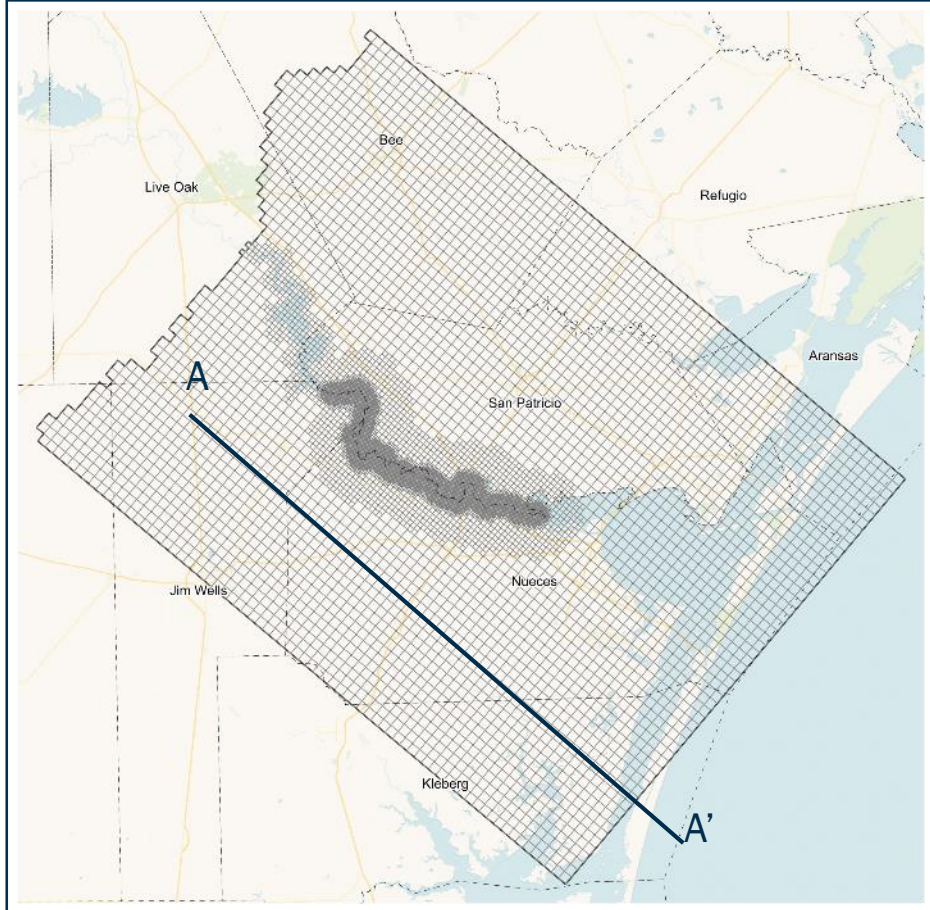
Description of a Groundwater Model

- A tool that integrates data and hydrology to predict groundwater flow

- The tool acts like a big Excel spreadsheet where grid cells physically represent "blocks" of aquifer material

- Water levels are predicted by solving for a water balance at each block using equations describing groundwater flow
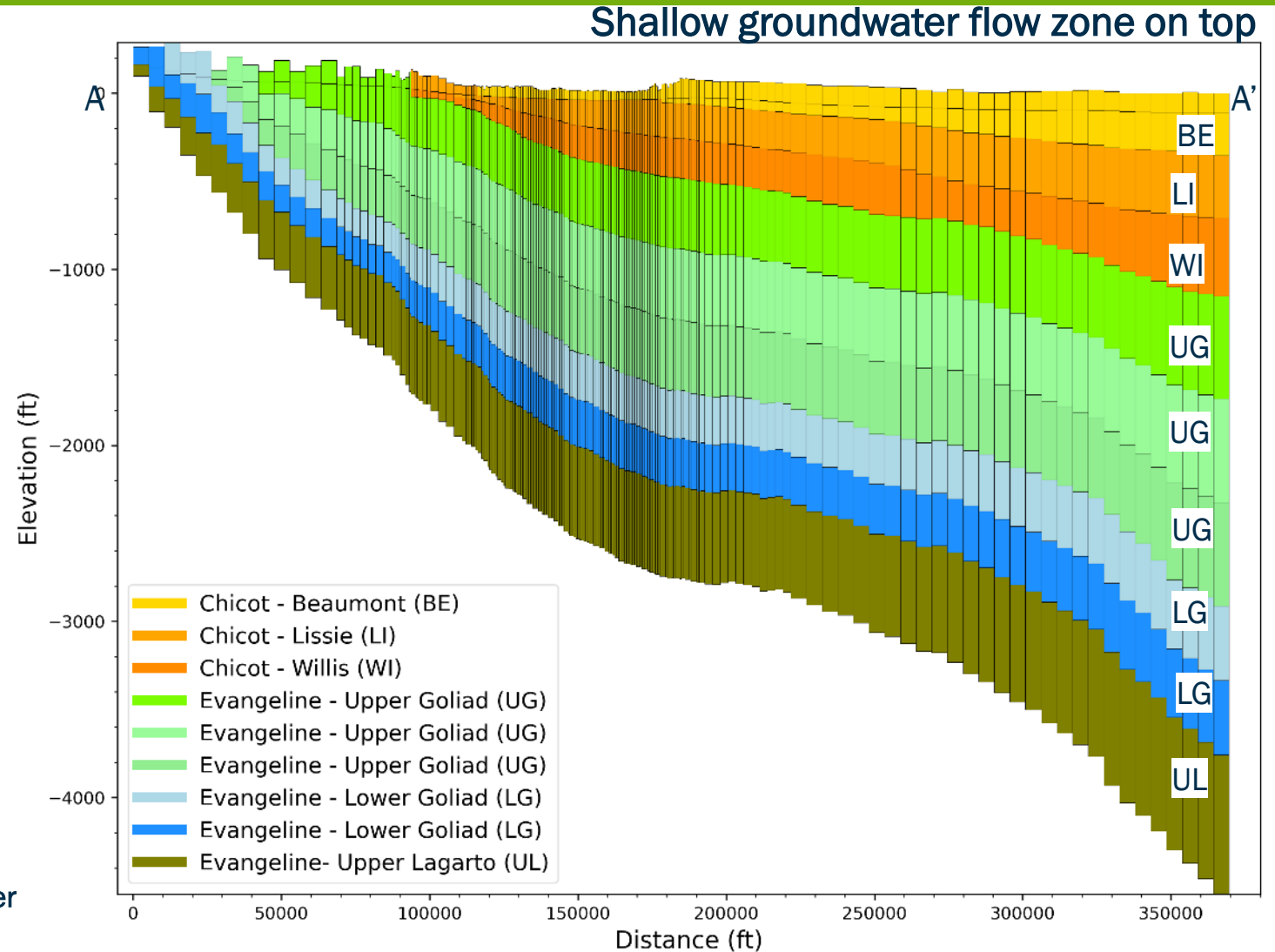

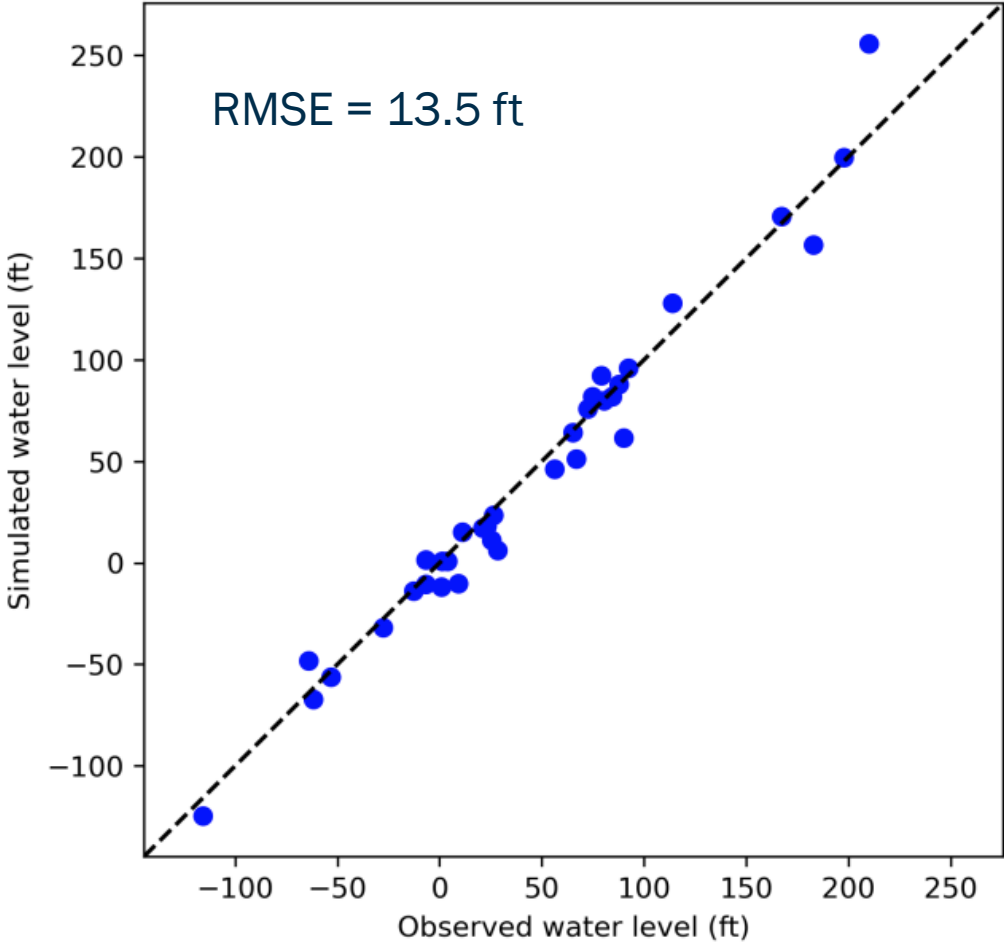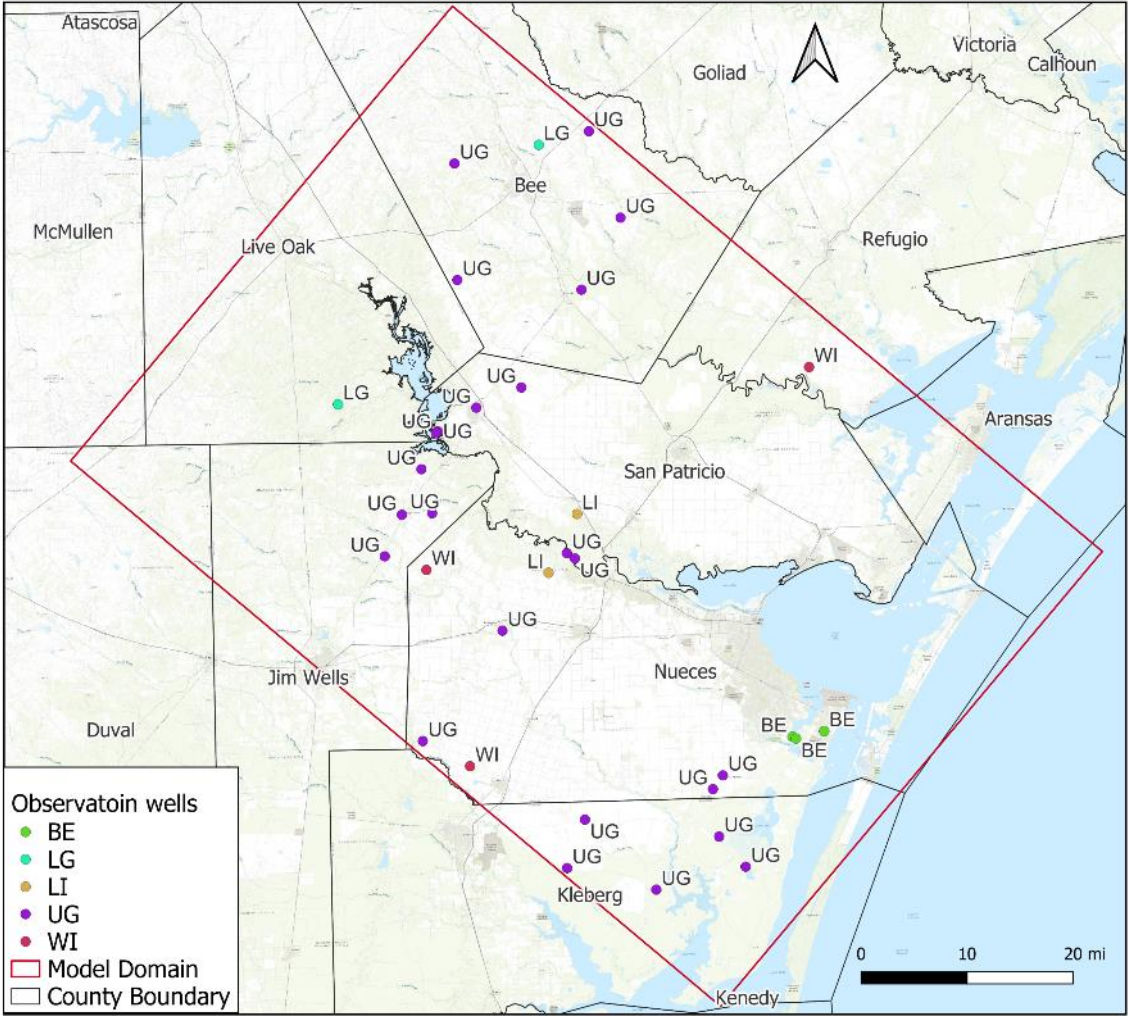Note: Schematic from MODHMS MODFLOW Manual

Nueces GW Model: Numerical Grid and Layers

Shallow groundwater flow zone on top

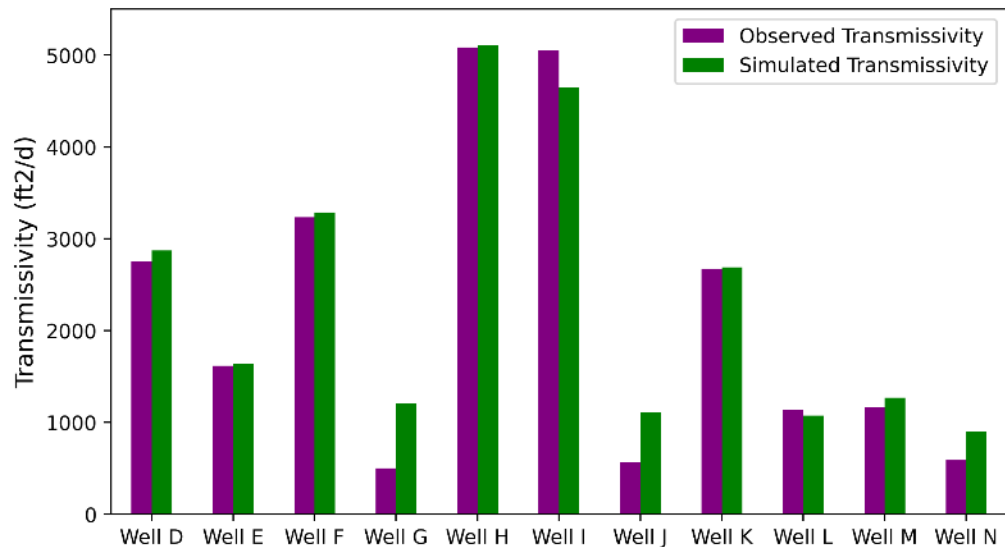Note: Model developed to evaluate wellfields along the Nueces River
Evangeline Laguana model includes ~95% of Refugio County

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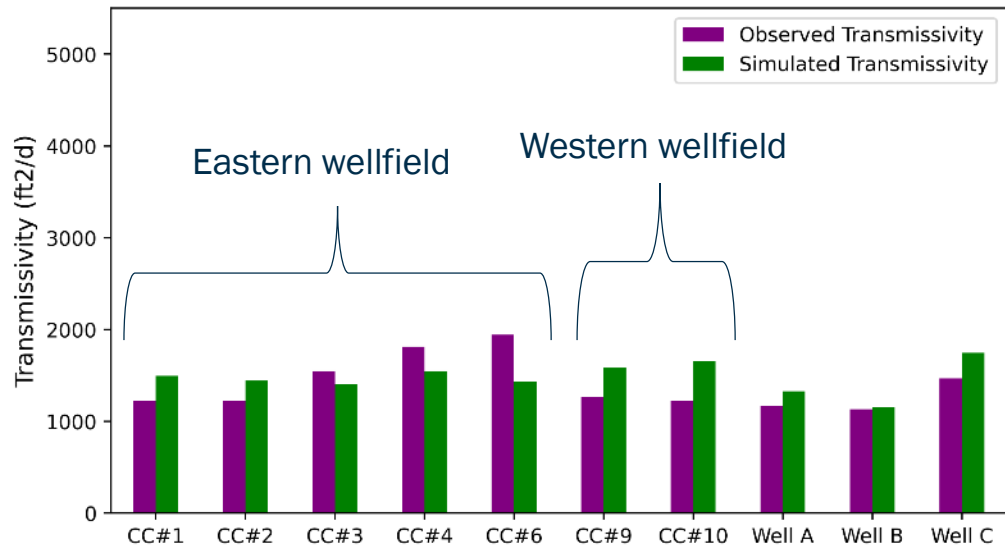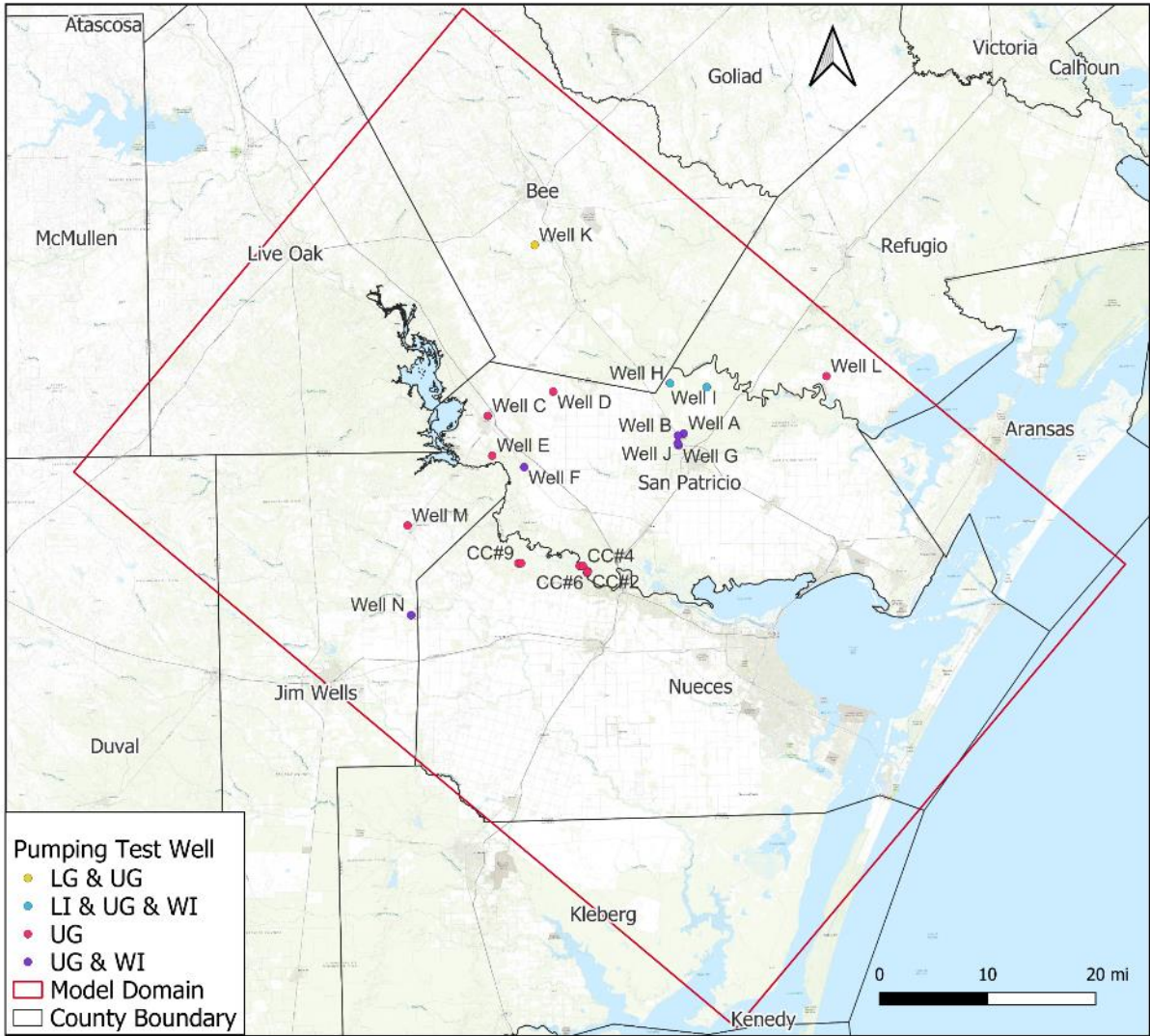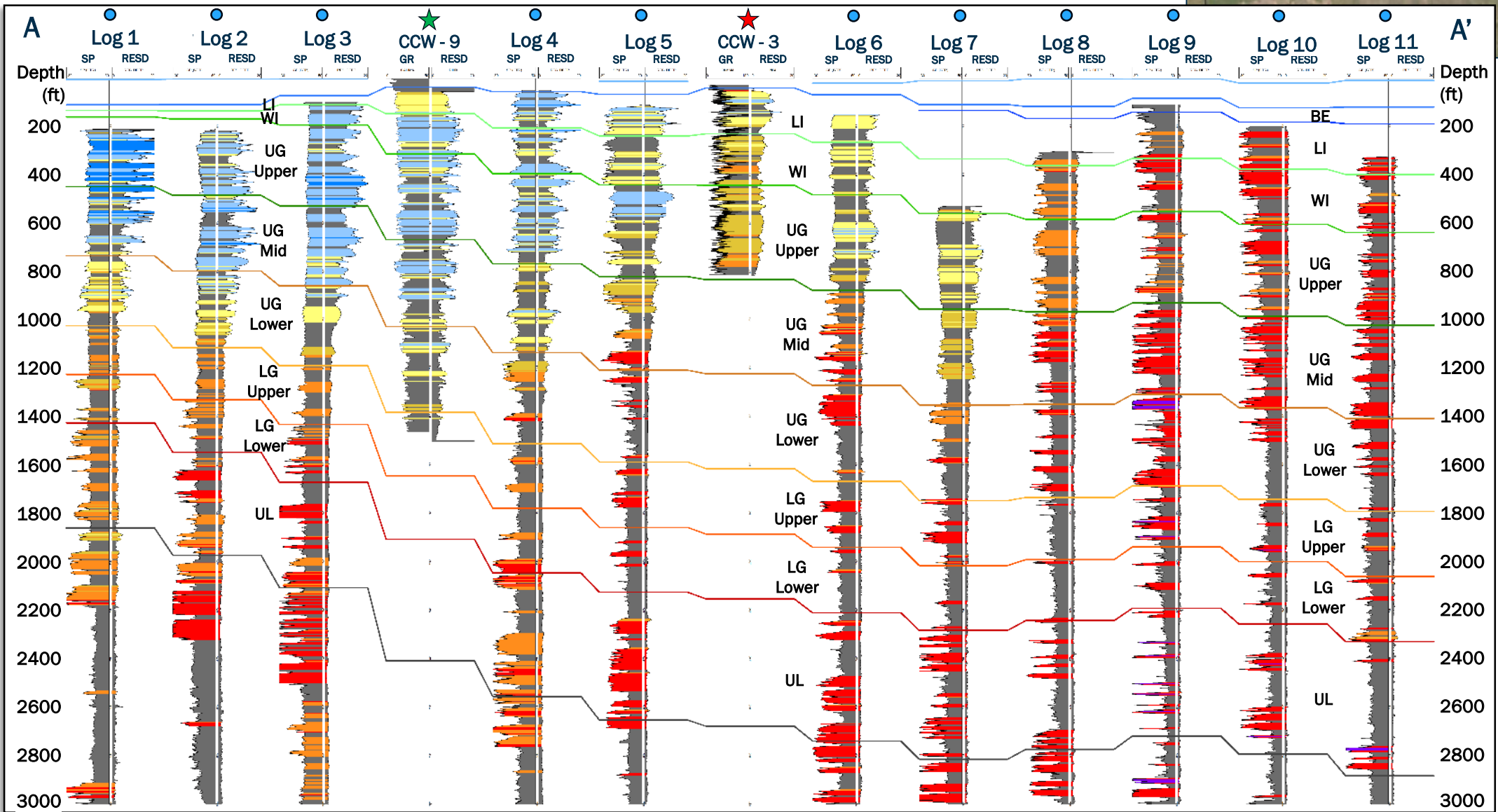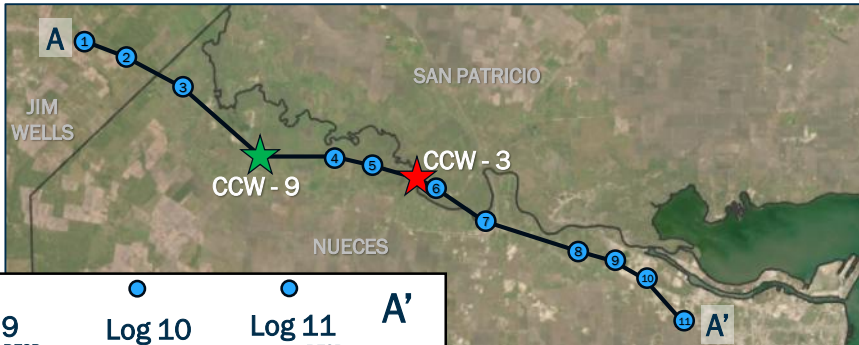# Water Levels: Simulated vs Observed

RMSE = 13.5 ft

INTERA Model – Water Level Fitting
at Steady State.

Transmissivity: Simulated versus Observed

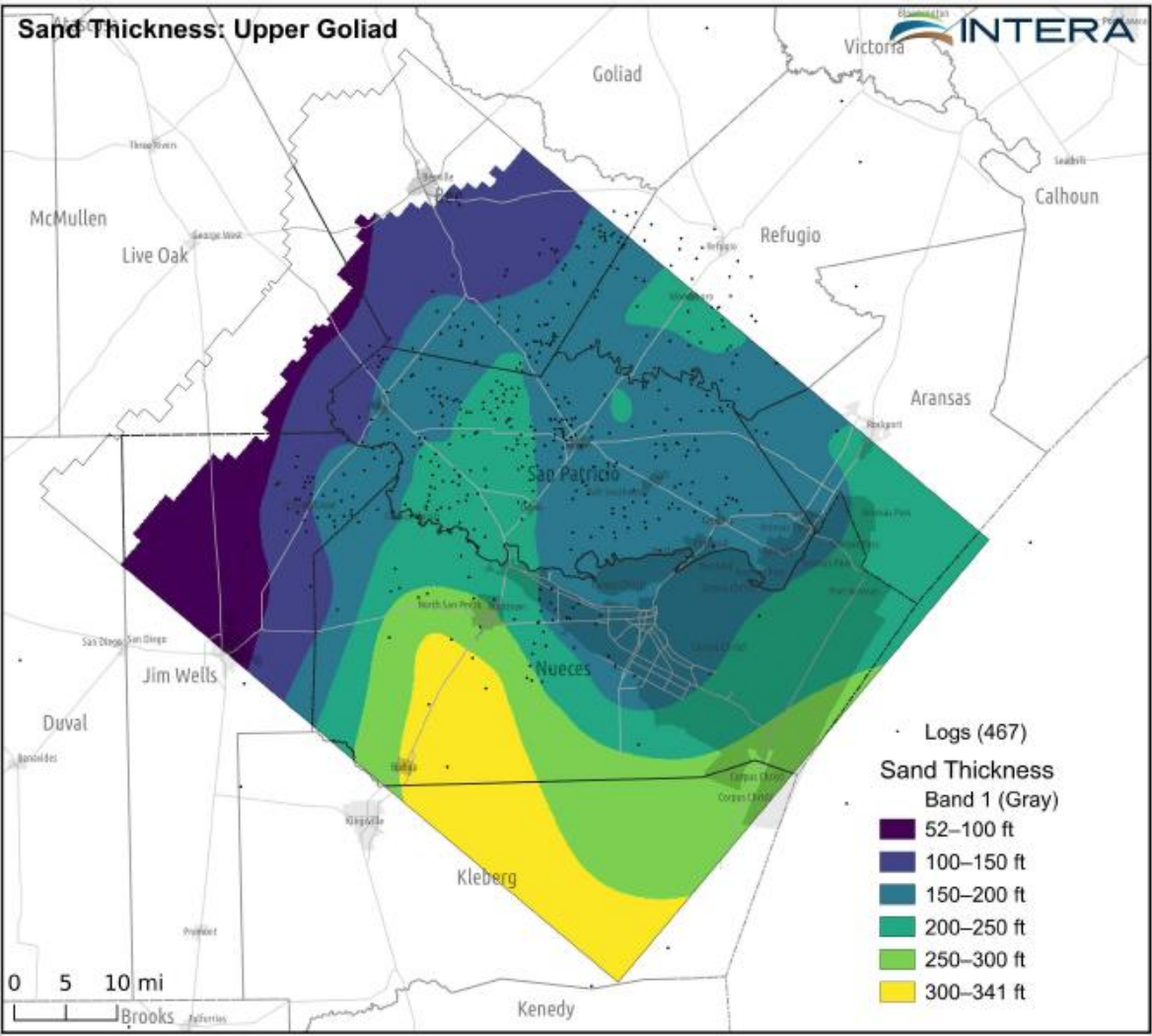# Nueces County Cross Section

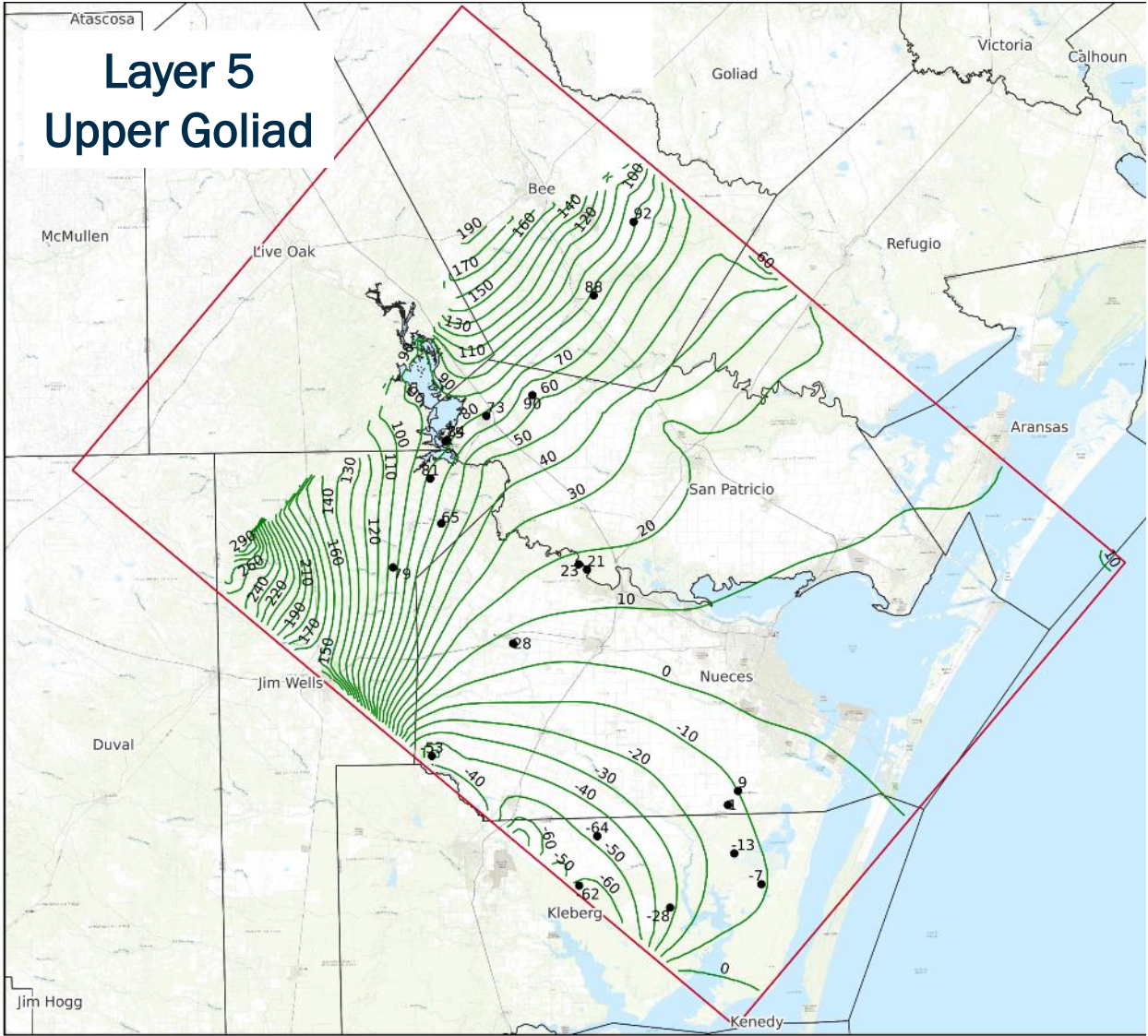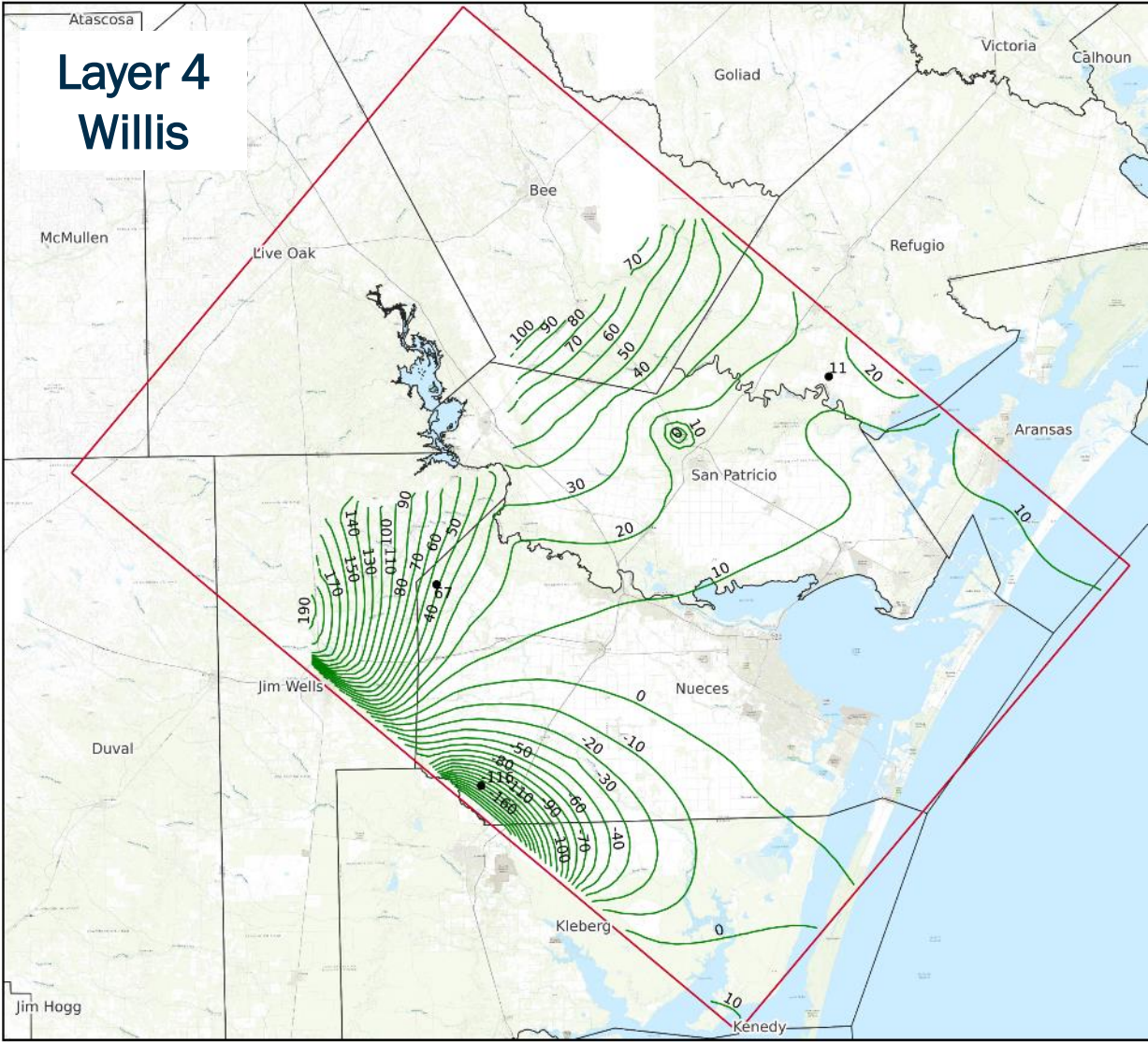# Geophysical Logs & Sand Percents & Thicknesses

Simulated Water Levels: Preproduction Conditions

Layer 4
Willis

Layer 5
Upper Goliad

Design of Production Wells

Eastern Well Field

Western Well Field

Summary: Groundwater Model for Nueces County

- ## Nueces County Groundwater Model
  - Uses 10 layers to represent Chicot and Evangeline aquifers in order to accurately locate pumping intervals and the location of existing well (TWDB GAM has 2 layers)
  - Shallow groundwater flow zones separate deep pumping wells from river cells
  - Uses innovative methods to constrain aquifer hydraulic properties based on result of aquifer pumping tests
  - Sand maps and clay maps to constrain aquifer properties to reasonable values in areas between aquifer pumping tests
  - Model calibration to water levels is very good – groundwater flow directions appear to be well constrained
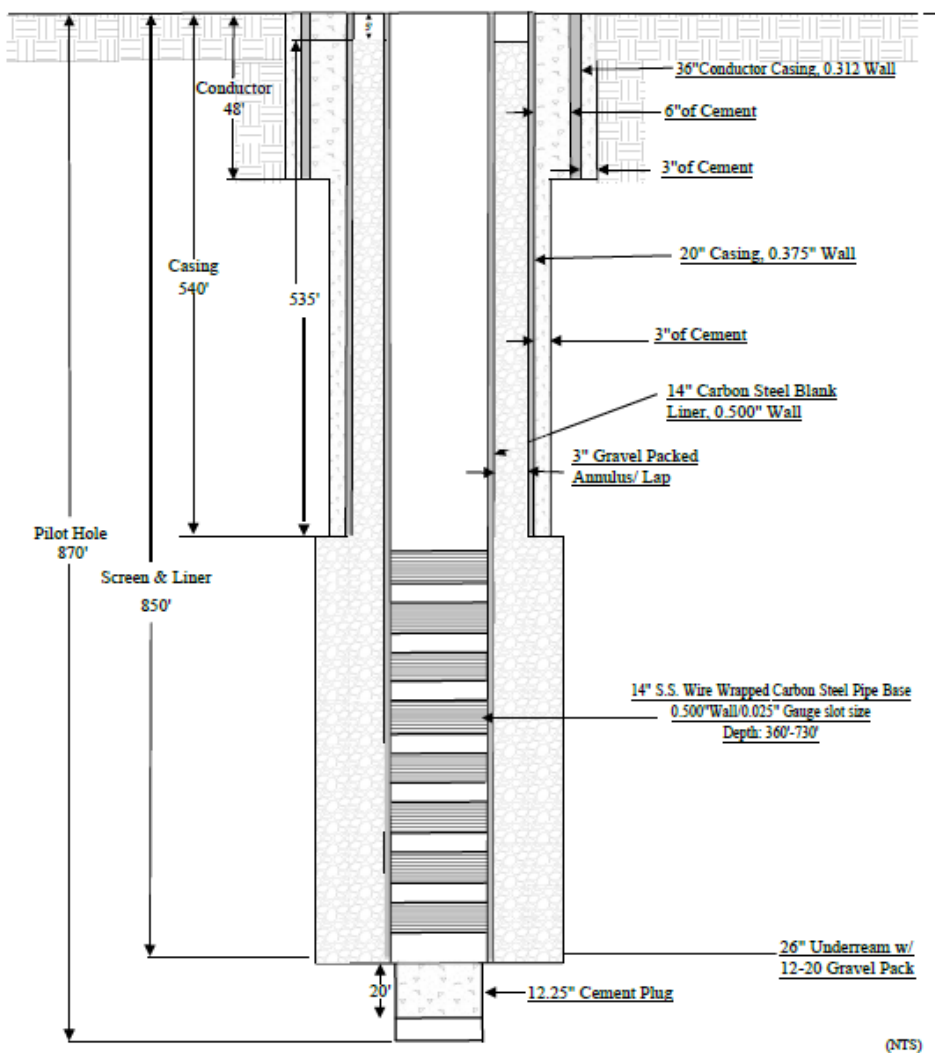 - The Nueces County Groundwater model was developed to simulate both short-term and long-term pumping conditions for the two well fields in Nueces County.

- ## On-going Work
  - Plans to include additional aquifer pumping tests in Nueces county
  - Adding additional sand picks and vetting existing sand picks to create an improved constrains for aquifer properties
  - Add additional measured water levels including those measured at Evangeline Laguan Test Wells
  - Incorporate a land subsidence package

Approach to Simulating Land Subsidence

Response to Stress/Additional Weight

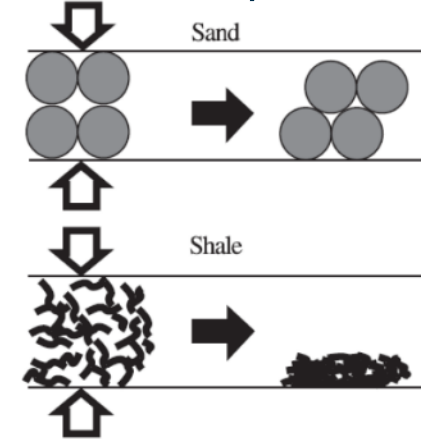
$$\Delta b = \Delta d * \alpha_{eff} * C_t$$

Δb = the thickness that the aquifer has compacted (L)

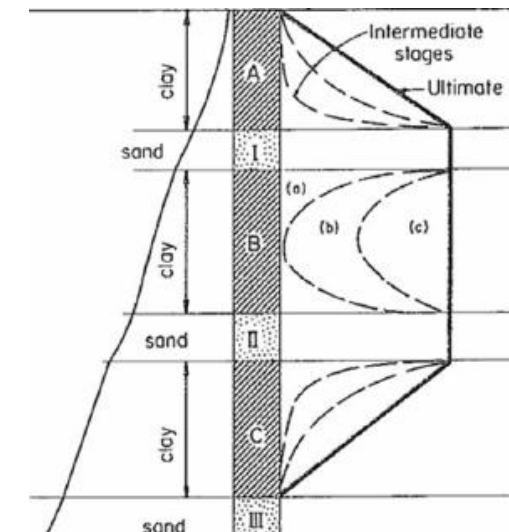Δd = Amount of drawdown in the aquifer since predevelopment (L)

α_{eff} = Effective compressibility coefficient for clays in the aquifer (L^{-1})

C_t = Total thickness of the clay units in the aquifer (L)

Process that Causes a Delayed Response

Discussion of Model Application

- Available drawdown above well screen is about 450 ft for Eastern Wellfield and about 530 ft for Western Wellfield

- Model produces >20 MGD for 3-years with keeping about 100 feet of water column above top of screen

- Evaluated drawdown impacts at 3,000 wells in San Patricio and Nueces Counties.

  - 22 wells with simulated drawdowns between 50 to 100 ft

  - 6 well with simulated drawdown between 100 and 150 ft

- Work on-going to adjust spatial distribution of pumping to reduce drawdown impacts

- Existing Monitoring wells that will allow Corpus Christi staff to monitoring shallow formations

- Modeling and monitoring data will provide information for wellfields to be managed properly

- Model will be updated as field information becomes available