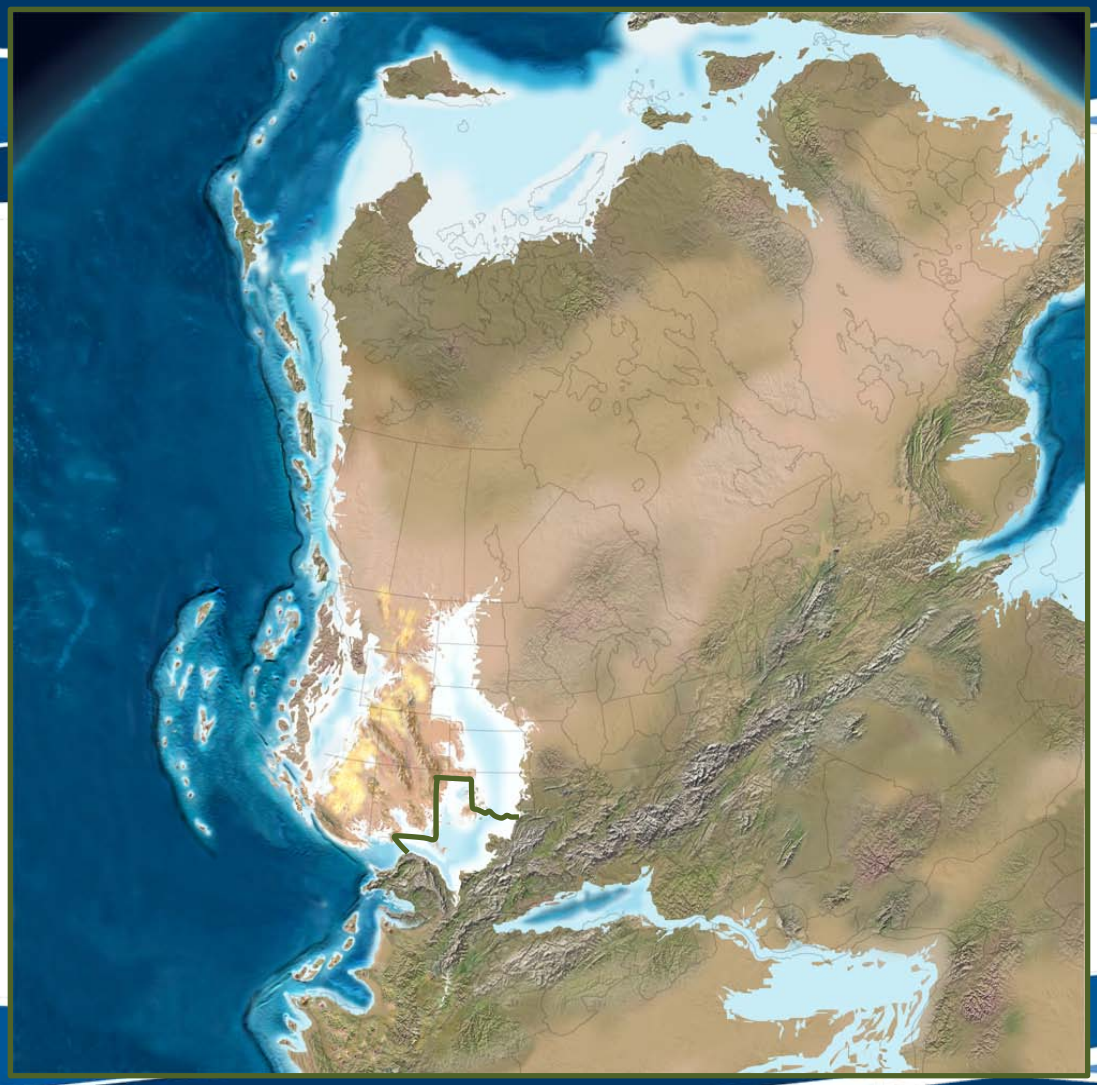
Paleozoic Aquifers Model Recalibration Upper Trinity GCD



UPPER TRINITY GROUNDWATER CONSERVATION DISTRICT

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

July 30th, 2014

Presentation Outline

- **Background on Paleozoic Aquifers**
- **Recalibration and Updates to Groundwater Model**
- **Model Results and Limitations**
- **Evaluating Groundwater Availability for the Paleozoic Aquifers**

Model Status

- **Draft submitted to Upper Trinity GCD on June 25th, 2014**
- **Can contact UTGCD or Wade Oliver at INTERA to obtain copy of draft model and report**
  - **Dr. Bob Patterson**
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    bobpatterson@uwmail.com
  - **Wade Oliver**
    512-425-2058
    woliver@intera.com

Background

- **Paleozoic aquifers (PAs) are a significant resource in UTGCD**
- **No current DFC for PAs in GMA-8**
- **BEG recently created a groundwater model of the PAs to help assess O&G water supplies**
- **Study Objective: Update the BEG model, creating a tool**
  - **to enable the establishment of a DFC for the PAs in GMA-8**
  - **help manage PA water resources**

System	Group	Formation
Permian	Wichita	Nocona
	Bowie	Archer City Markley
Pennsylvanian	Cisco	Thrifty and Graham, undivided
	Canyon	Colony Creek Shale Ranger Ventioner Jasper Creek Chico Ridge Limestone Willow Point
	Strawn	Mineral Wells Brazos River Mingus Buck Creek Sandstone Grindstone Creek Lazy Bend

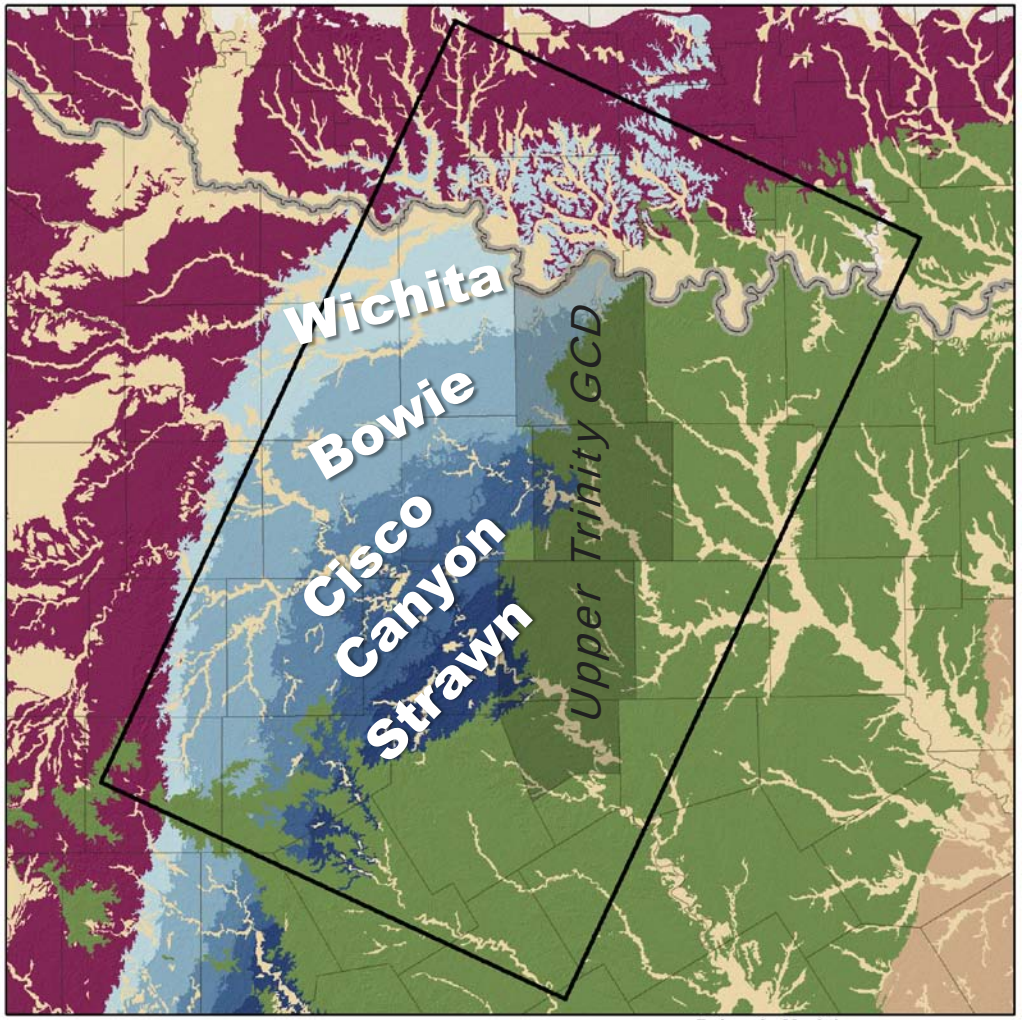
Background – Surface Geology

Palozoic Model Units

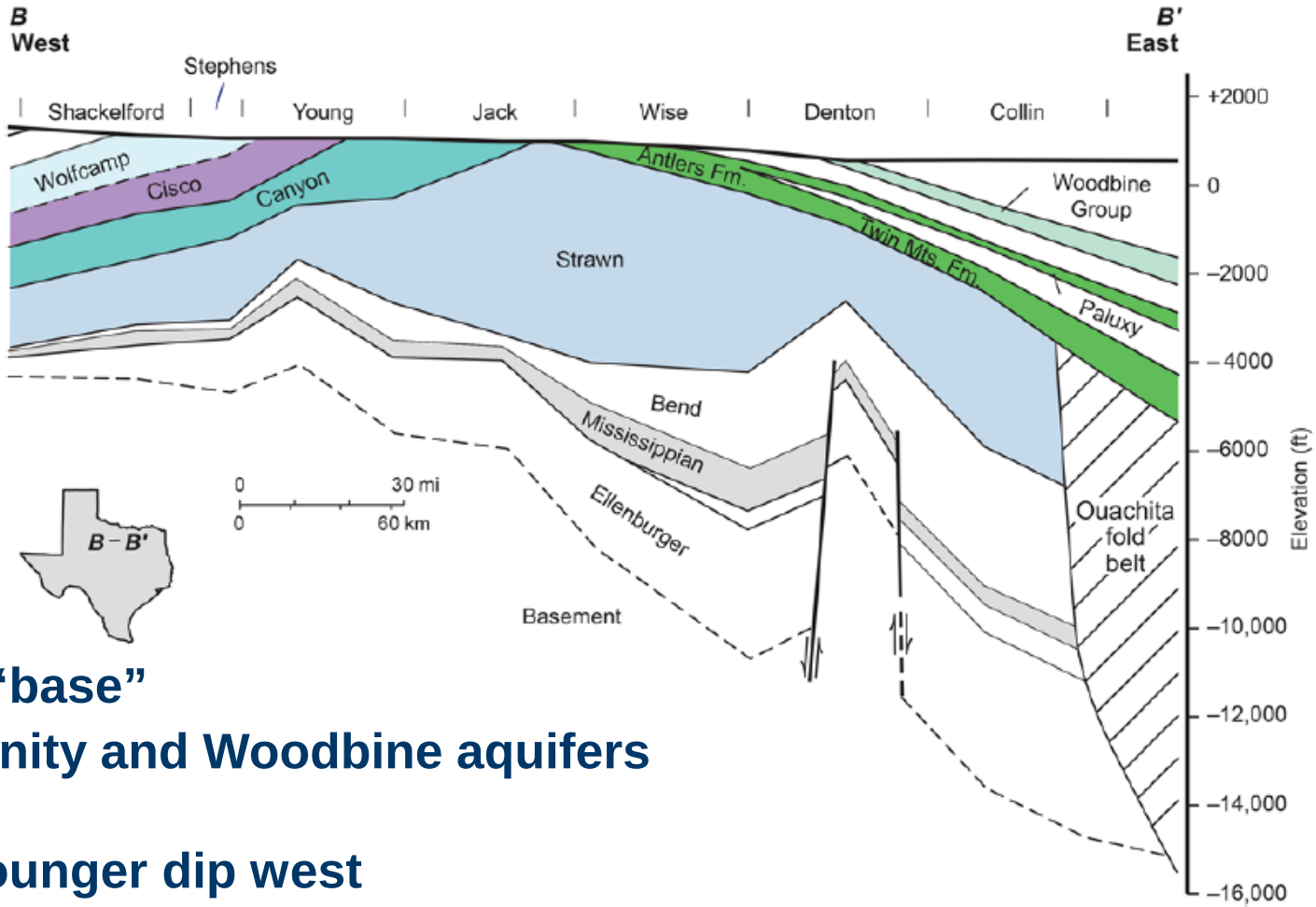
- Wichita
- Bowie
- Cisco
- Canyon
- Strawn

Other Units

- Quaternary
- Tertiary
- Cretaceous
- Paleozoic - Other



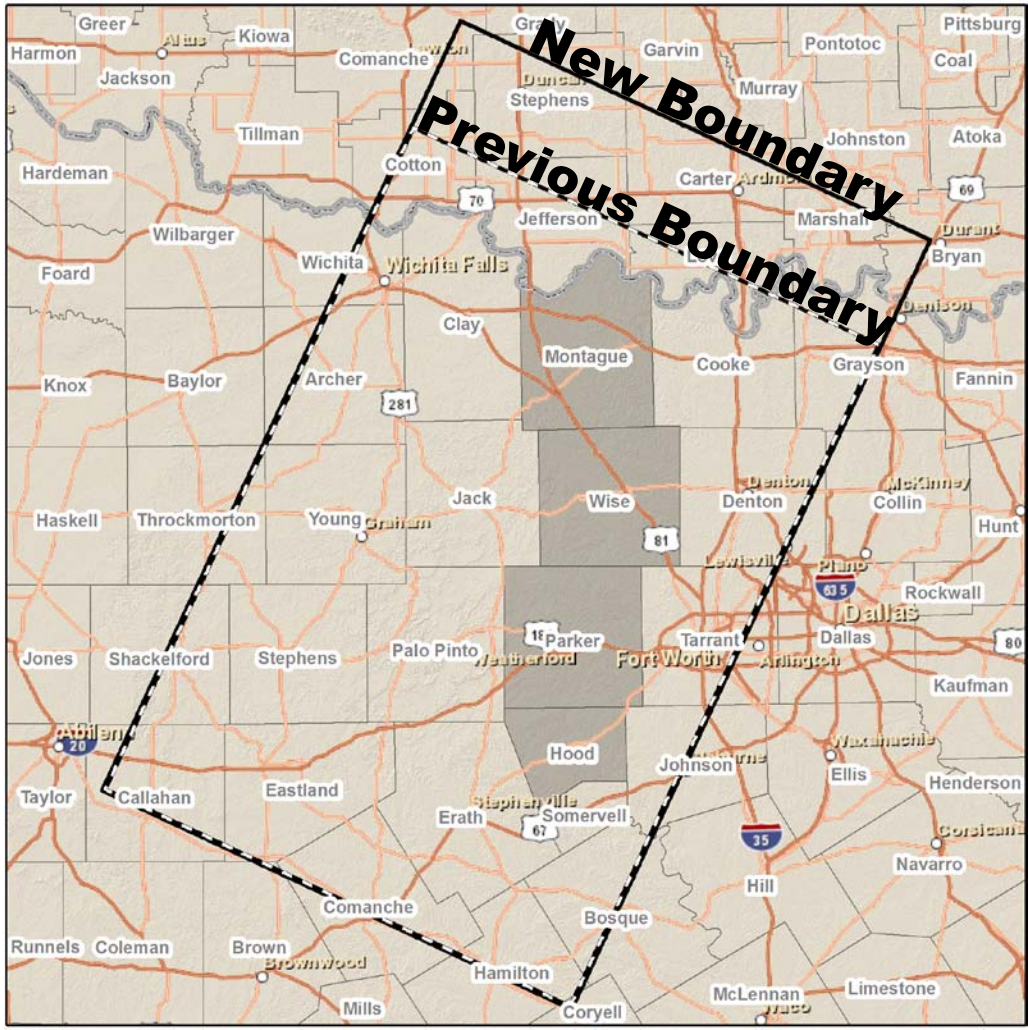
Background – Cross-Section



- **Strawn forms “base”**
- **Cretaceous Trinity and Woodbine aquifers dip east**
- **Canyon and younger dip west**

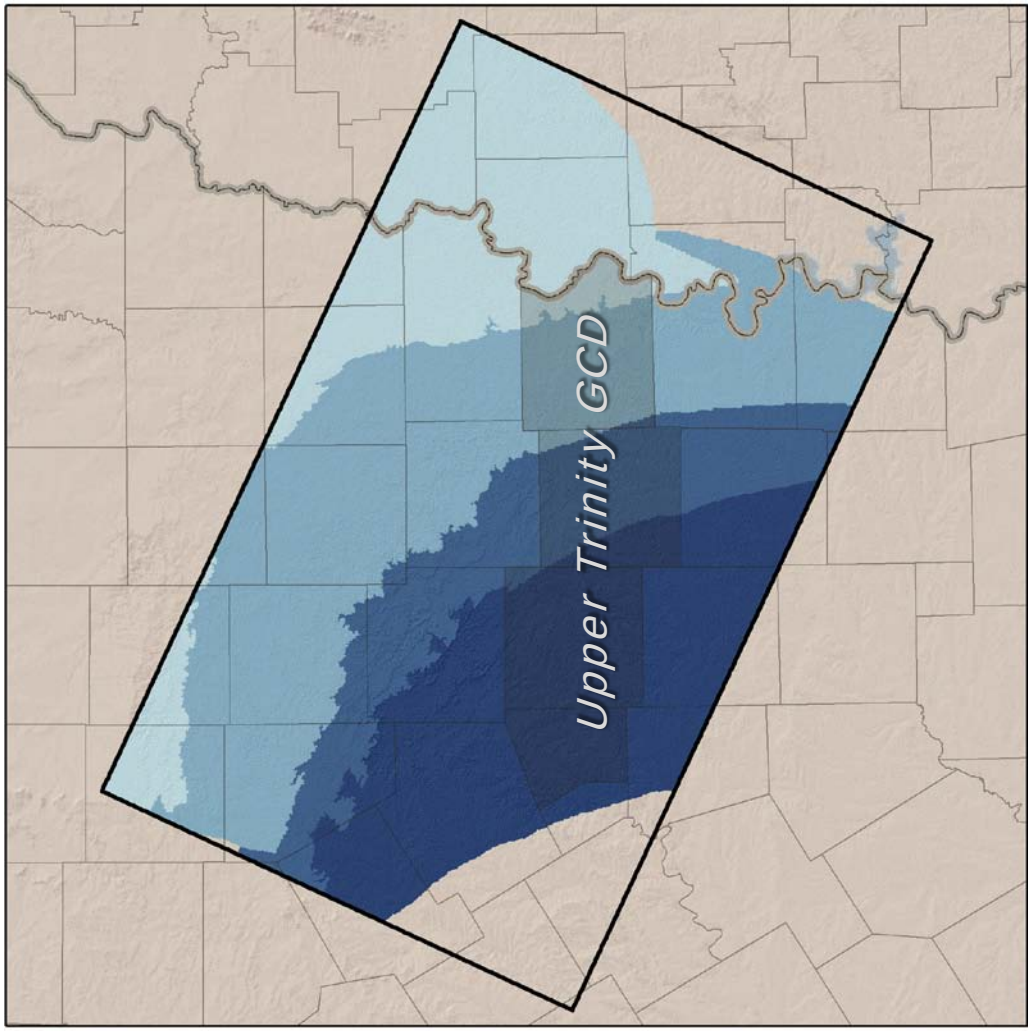
Previous Model

- Previously developed BEG model to assess O&G water supplies
- Model considered an “exploratory tool” and was not formally calibrated
- Historical pumping found to be very low compared to recent estimates
- Predictive simulations used to estimate availability of ~25,000 acre-feet per year under “DFC” of 5 feet of drawdown



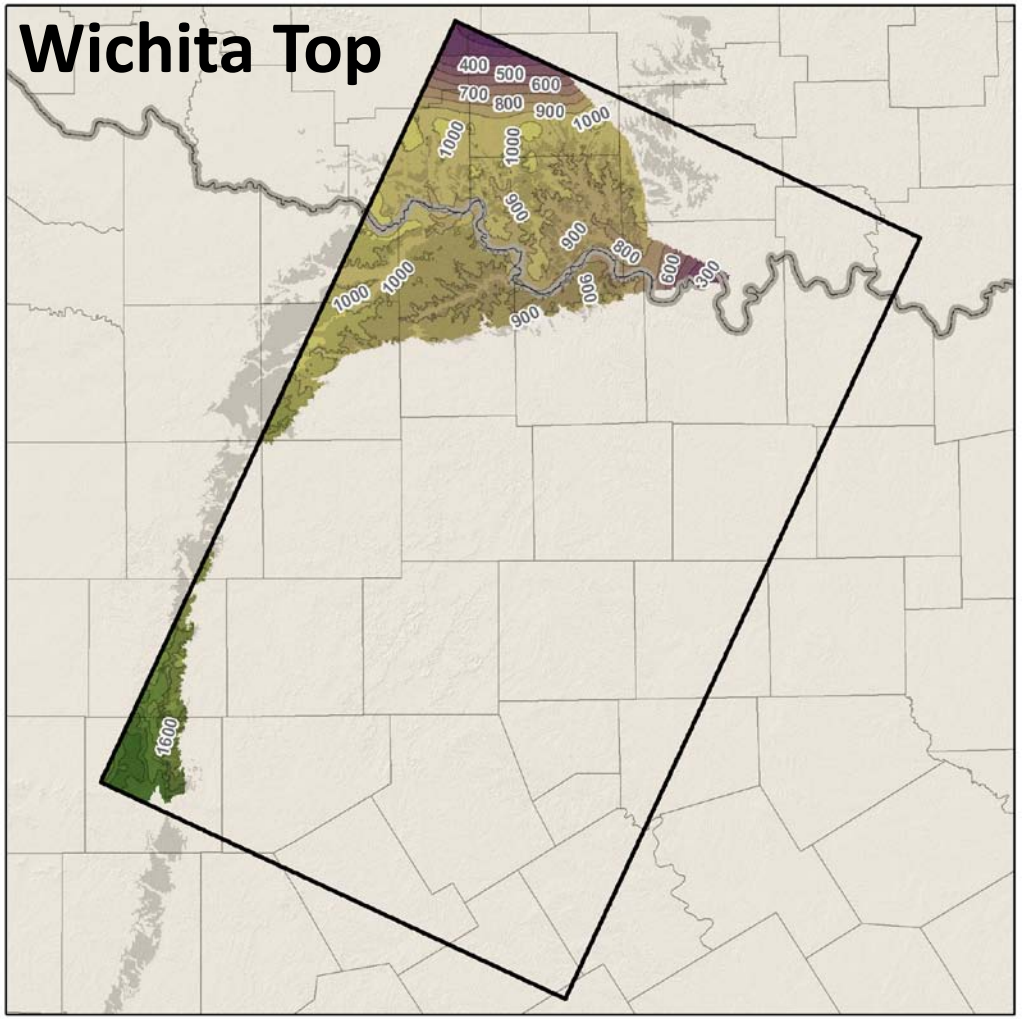
Model Updates – Layers and Grid

- **Extended active model area into Oklahoma**
- **Now 12 model layers**
  - **Originally 4 layers**
  - **Added layers to better represent well impacts vertically**
  - **Layers 1-3: Wichita**
  - **Layers 4-6: Bowie/Cisco**
  - **Layers 7-9: Canyon**
  - **Layers 10-12: Strawn**
- **Cell size: ¼ mile x ¼ mile**
  - **Originally 1 km x 1 km**
- **Calibrated from 1980 to 2012**



Model Updates – Structure

- Extended into Oklahoma
- Incorporated picks within UTGCD from Phase II Monitoring Program
- Made consistent with updated structure for Trinity Aquifer
- Original structure based on previous studies (Wermund and others, 1962; Nordstrom 1982; Wermund and Jenkins, 1969)
- Updating structure outside UTGCD not a key focus of study



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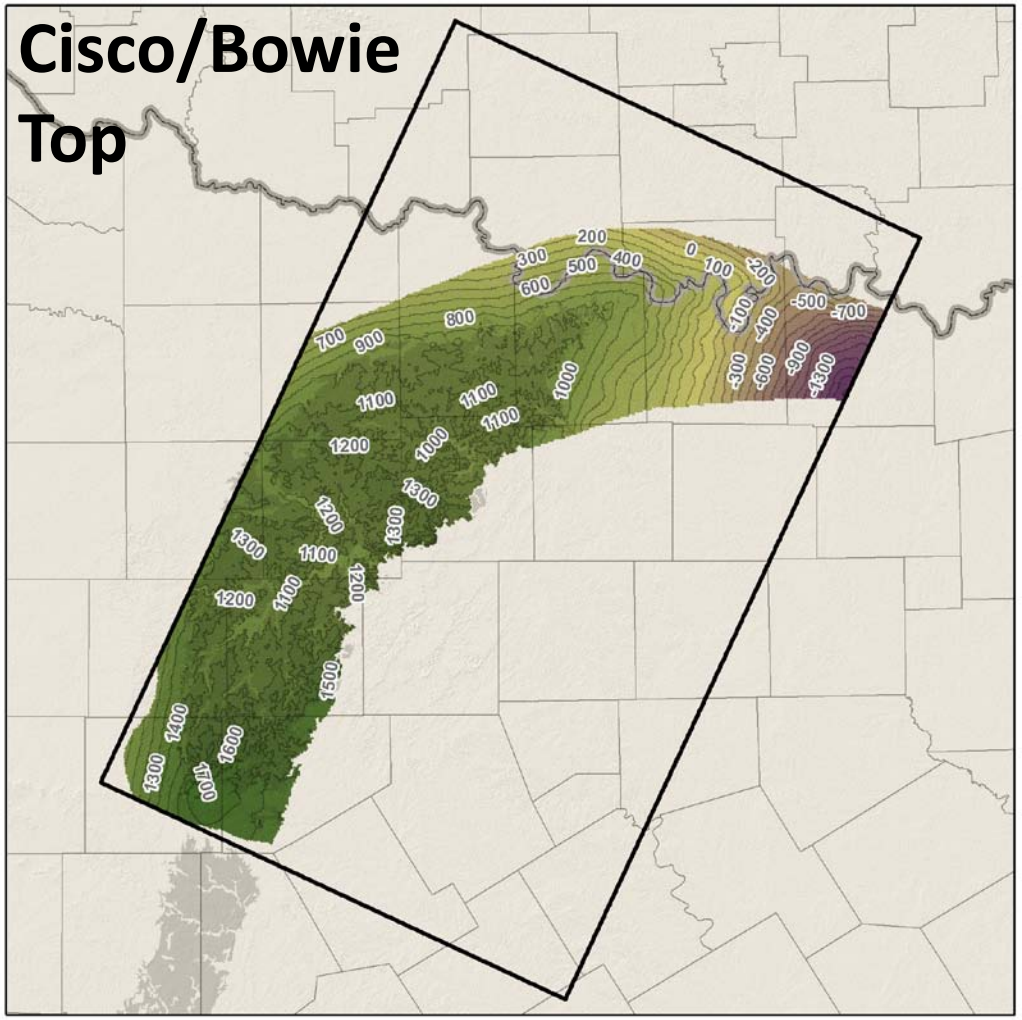

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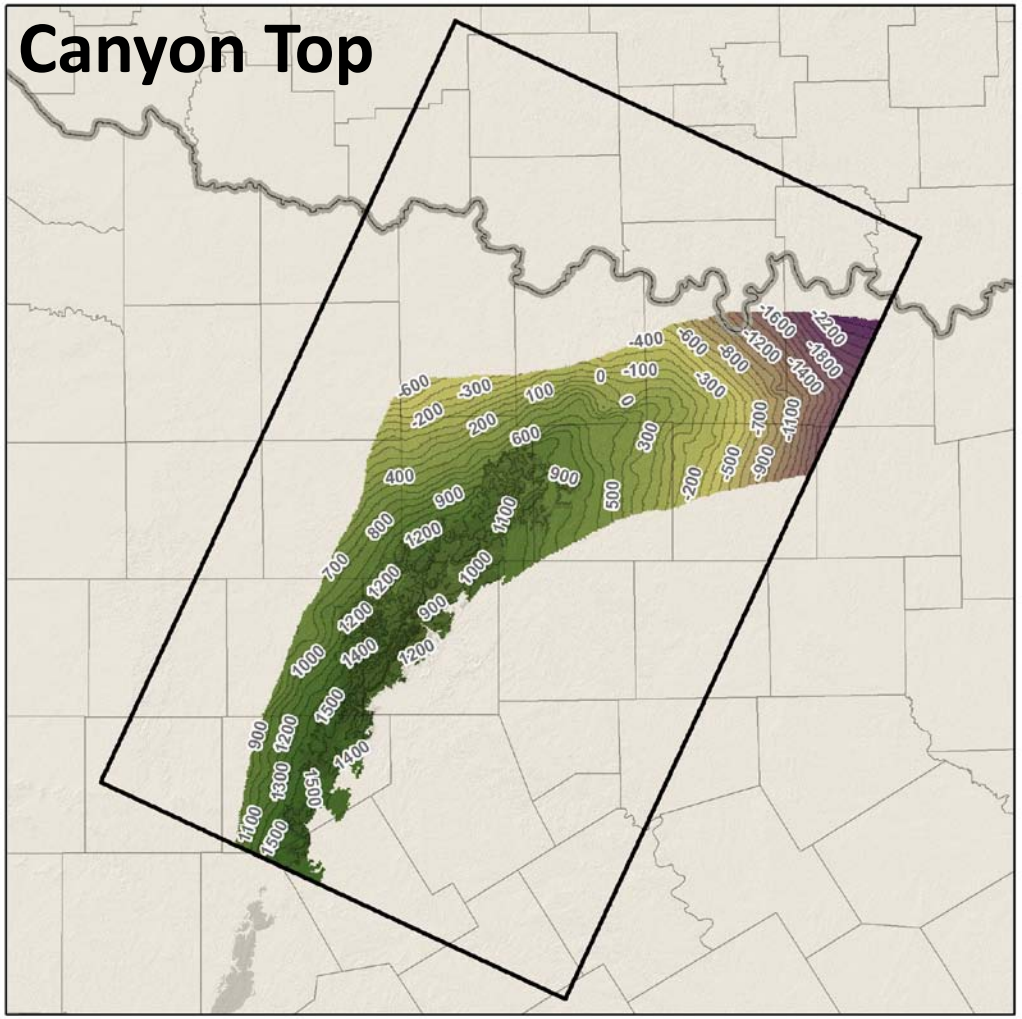

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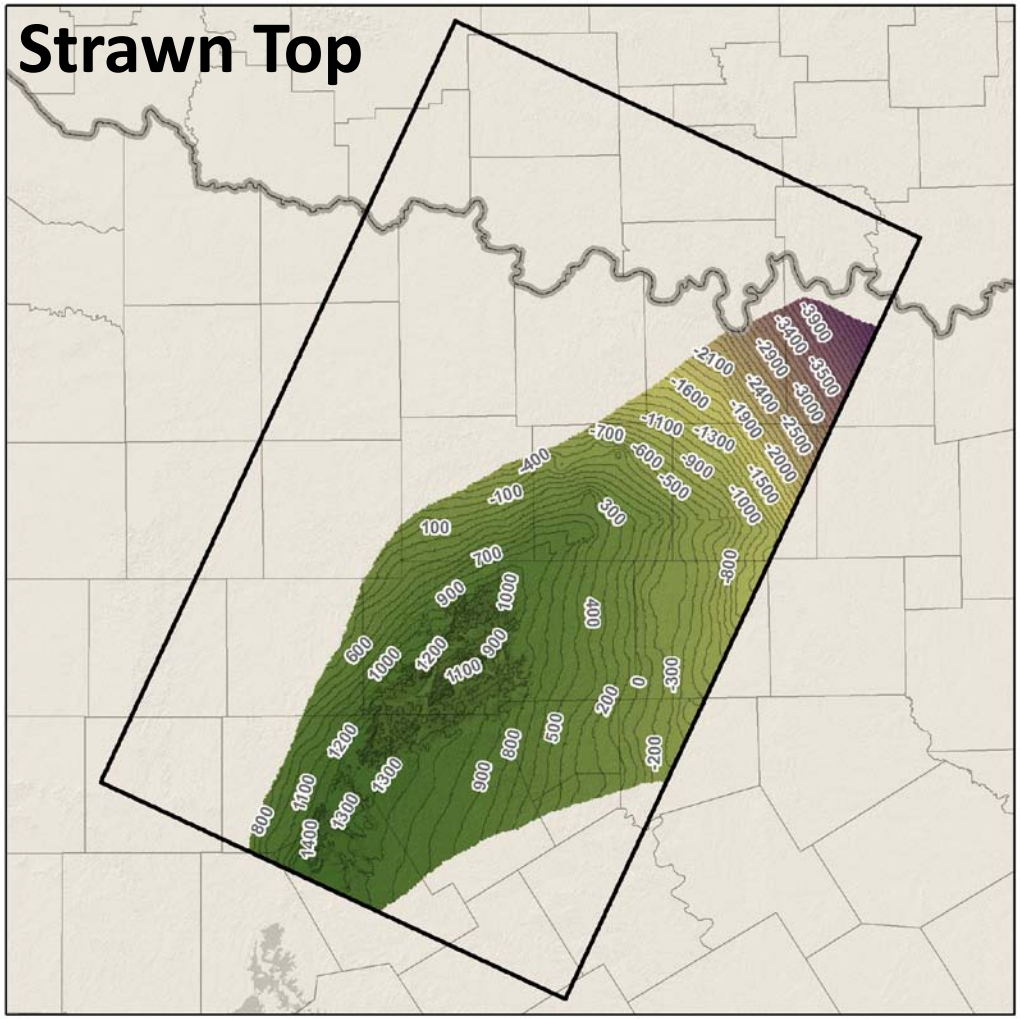
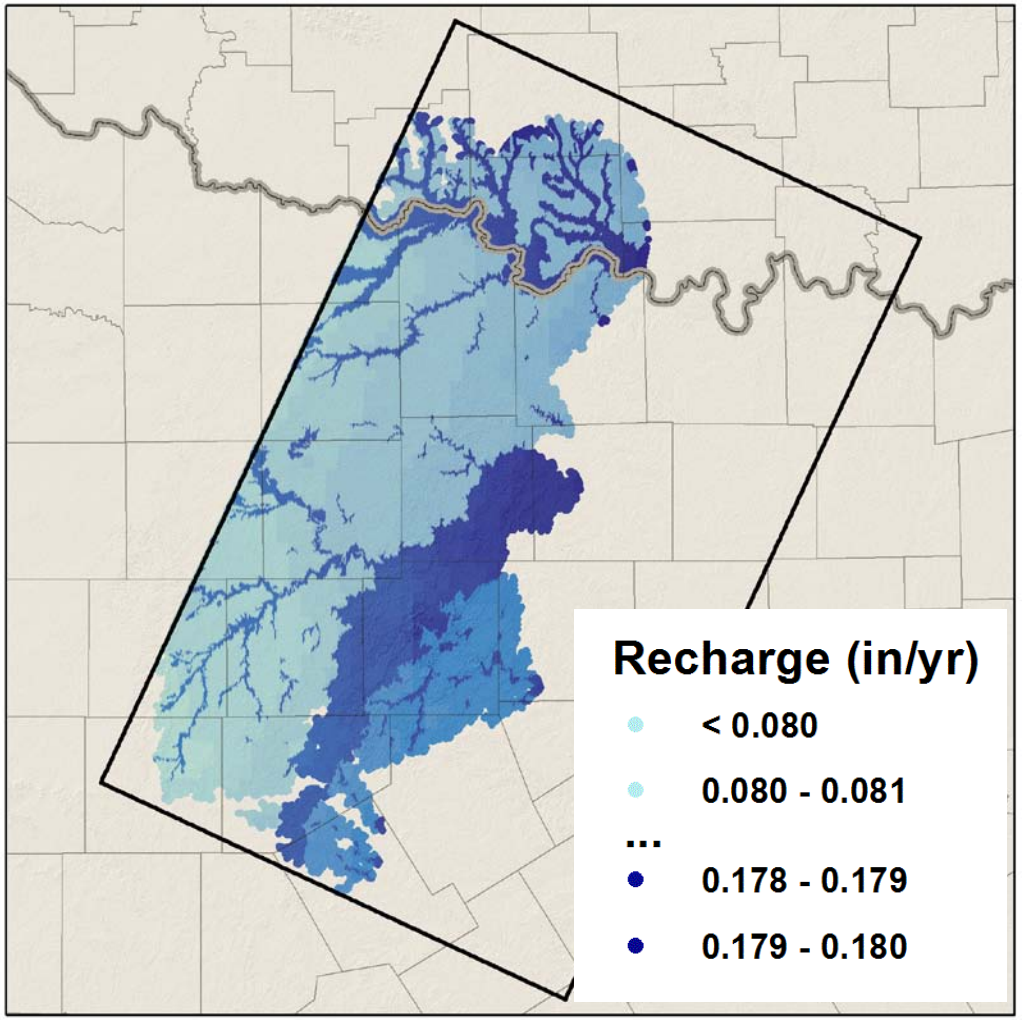


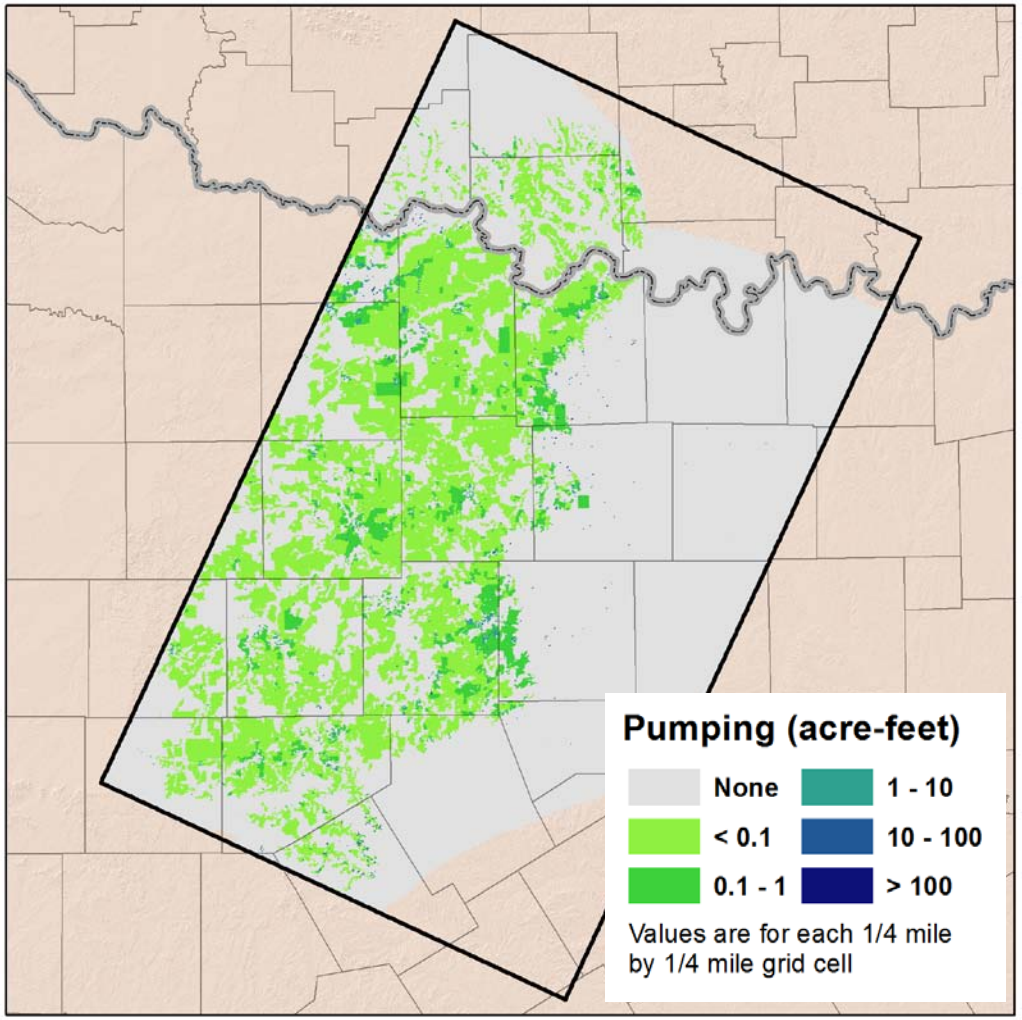
Model Updates – Recharge

- BEG estimated recharge using chloride mass-balance approach
- Recharge estimates from baseflow consistent with BEG approach
- Model-wide average recharge is ~50,000 acre-feet per year
- Much of the recharge quickly discharges to nearby intermittent creeks and streams



Model Updates – Pumping

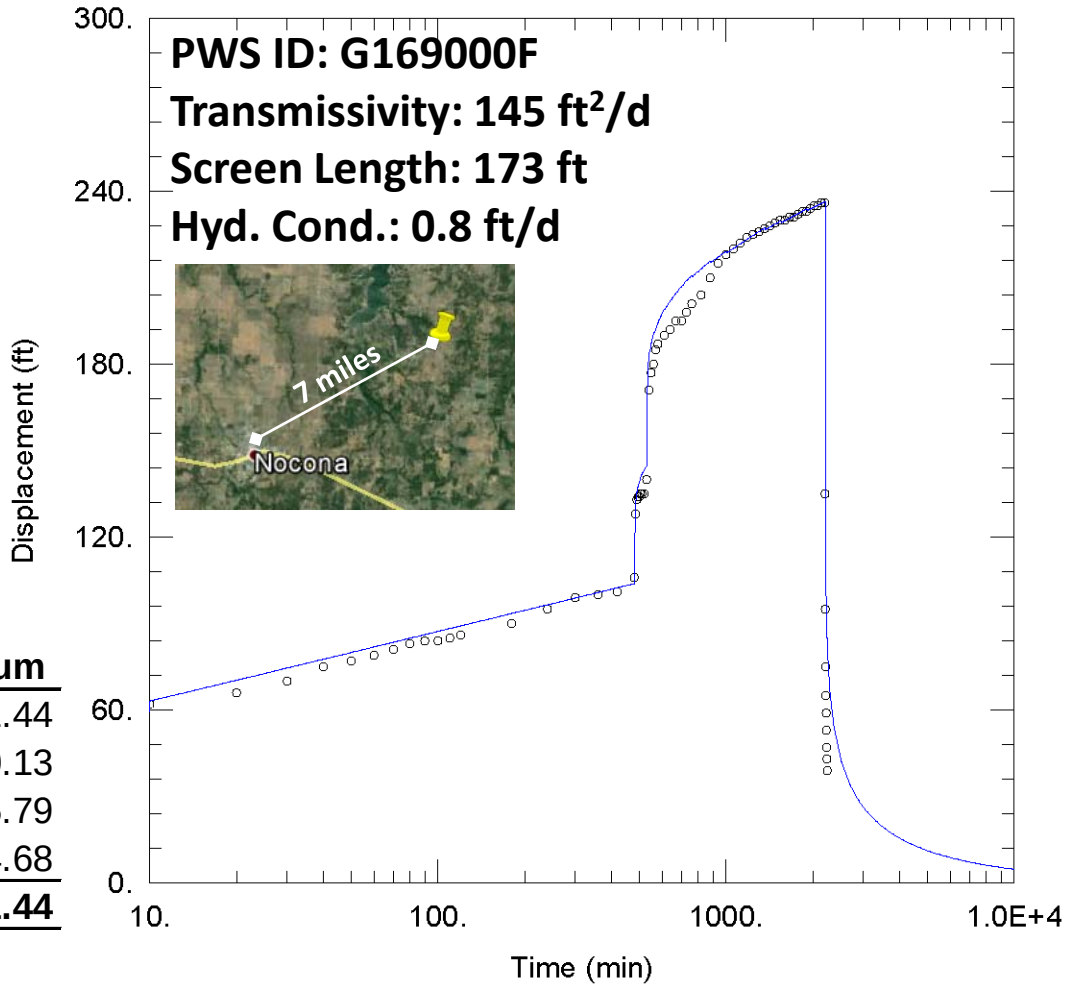
- **Data Sources**
  - **UTGCD metered data**
  - **TWDB Water Use Survey Groundwater Pumpage Estimates**
  - **O&G well activity within each water well numbering grid**
  - **Rural population density for rural domestic**
- **Wells assigned to model layers based on available depth and screen information**
- **Estimated 2012 pumping of ~17,500 acre-feet per year**



Model Updates – Hydraulic Properties

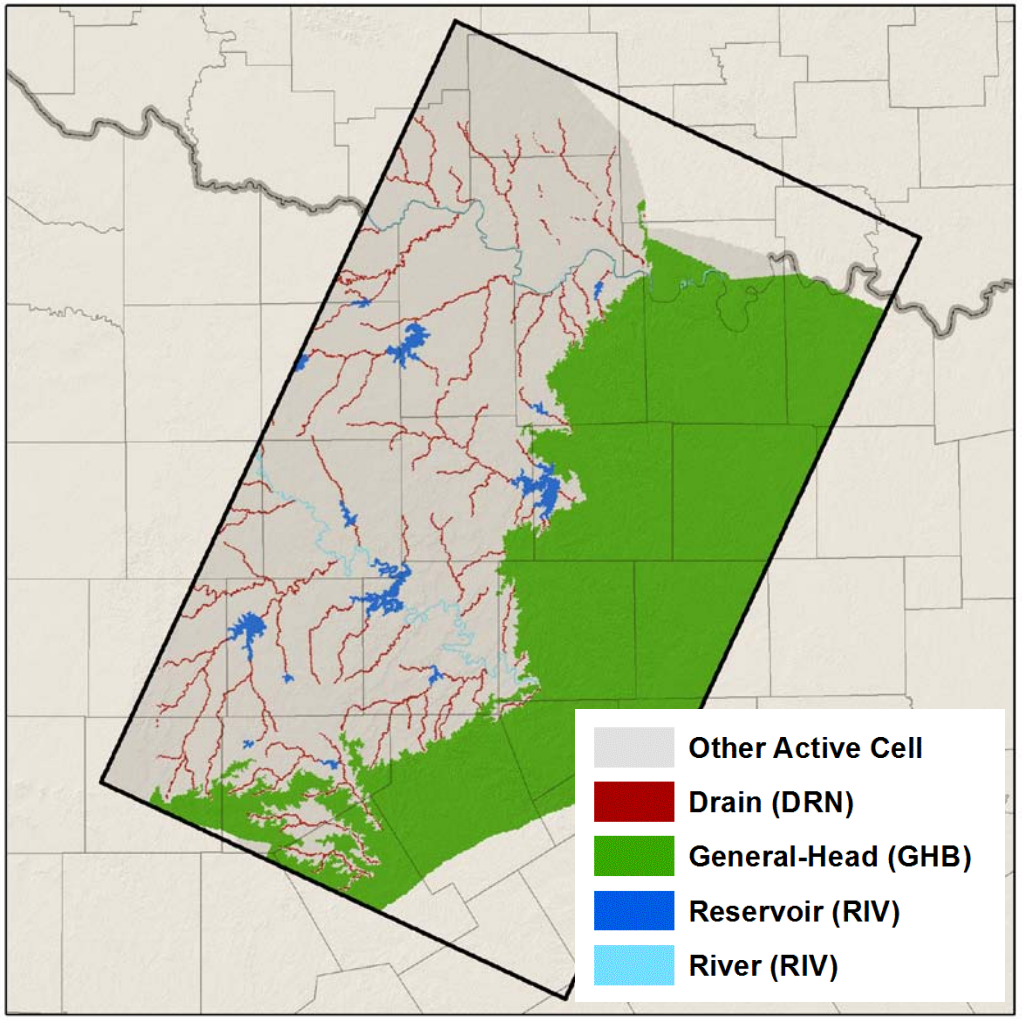
- **Data sources**
  - **Specific capacity (pumping rate divided by drawdown)**
  - **Sand thicknesses developed in BEG study**
  - **Formation depth**
- **Hydraulic conductivity estimated from specific capacity (feet/day):**

	Count	Median	Minimum	Maximum
Canyon	126	0.98	0.024	101.44
Cisco	666	0.35	0.007	50.13
Strawn	183	2.55	0.027	45.79
Wichita	82	0.31	0.009	14.68
Total	**1057**	**1.19**	**0.007**	**101.44**

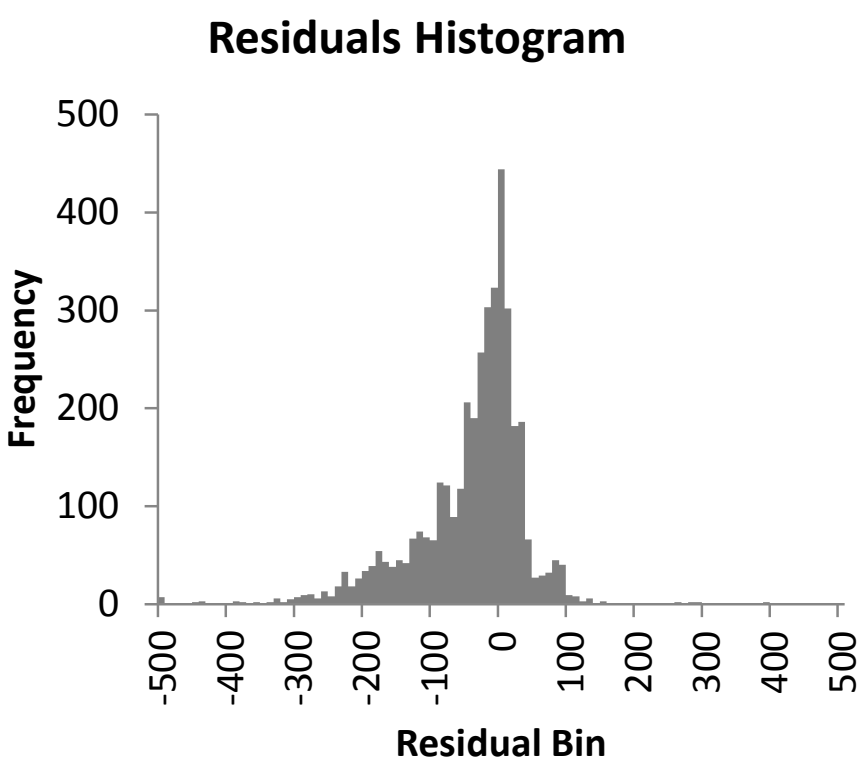


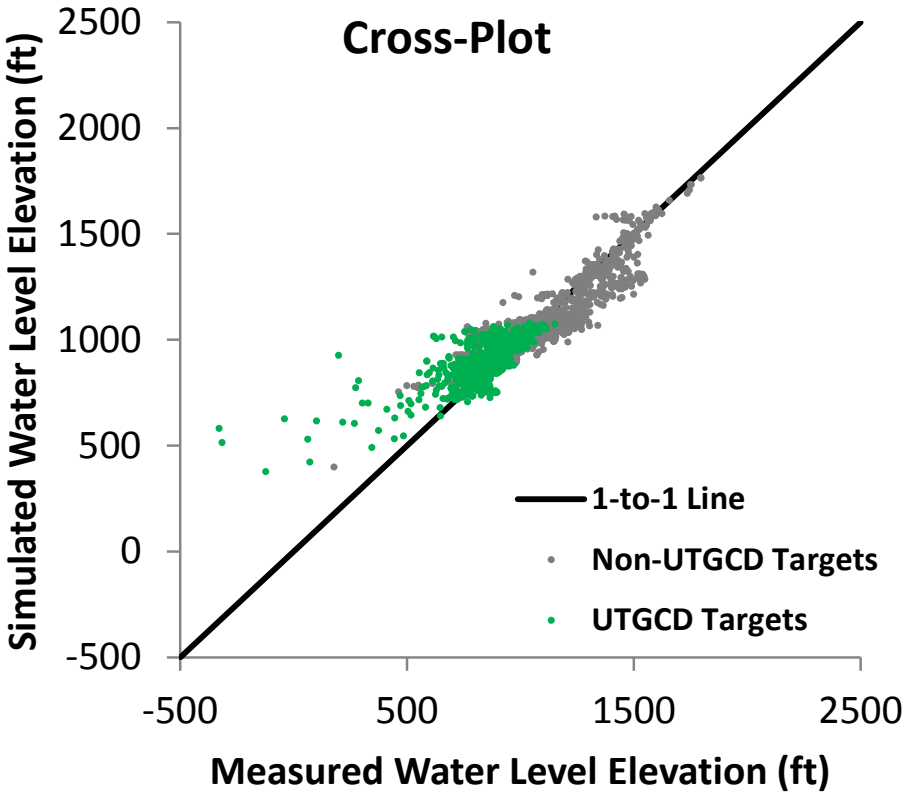
Model Updates – Interaction with the Surface

- Interaction with perennial rivers and reservoirs
- Discharge to intermittent streams and creeks
- Interaction with the Trinity Aquifer
  - One-way link between the models
  - One-to-one relationship between cells in updated Northern Trinity GAM and Paleozoic model
  - Allows water level changes in Trinity to appropriately impact water levels in the Paleozoic Aquifers



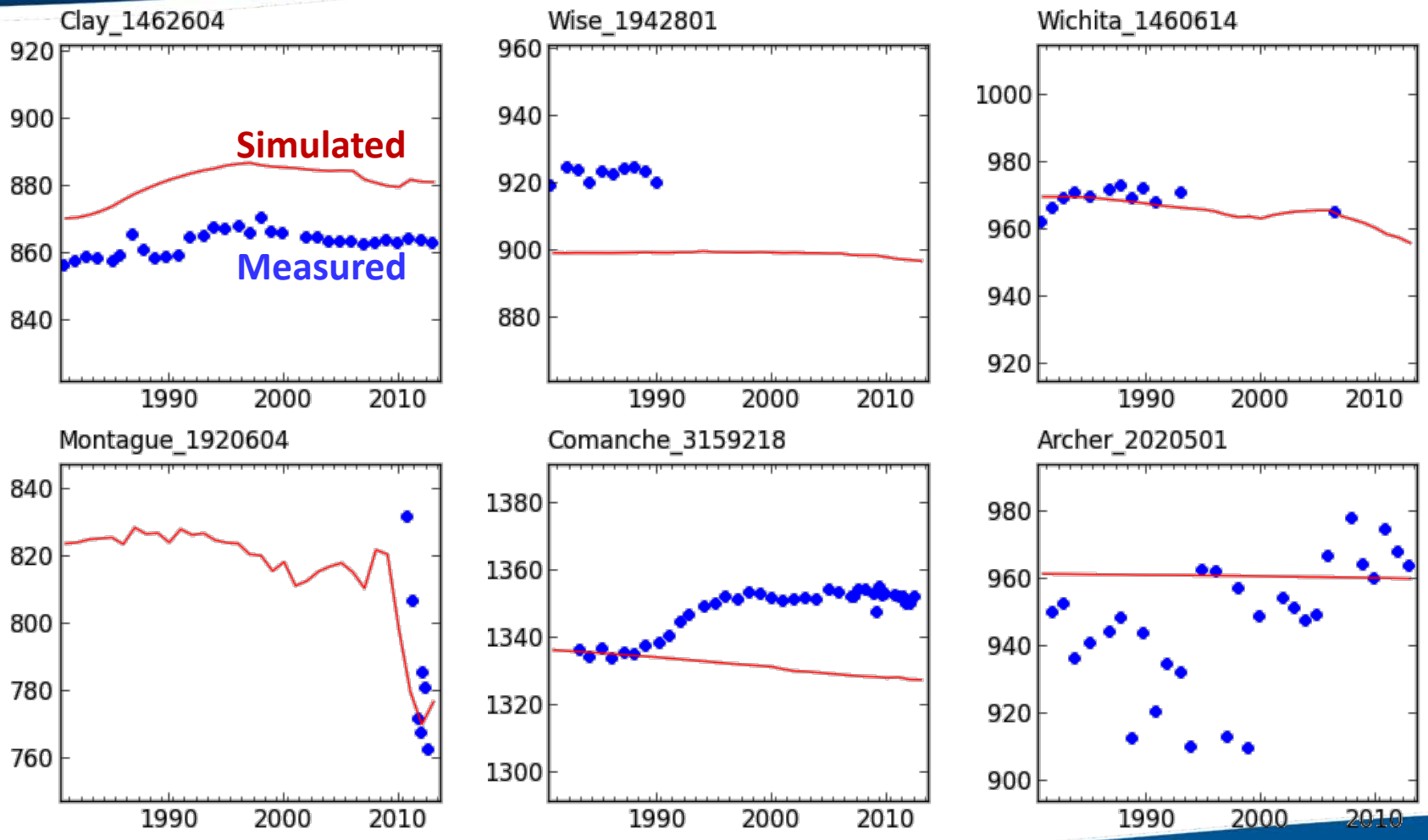
Model Results





Residual = Observed Water Level – Simulated Water Level

Model Results



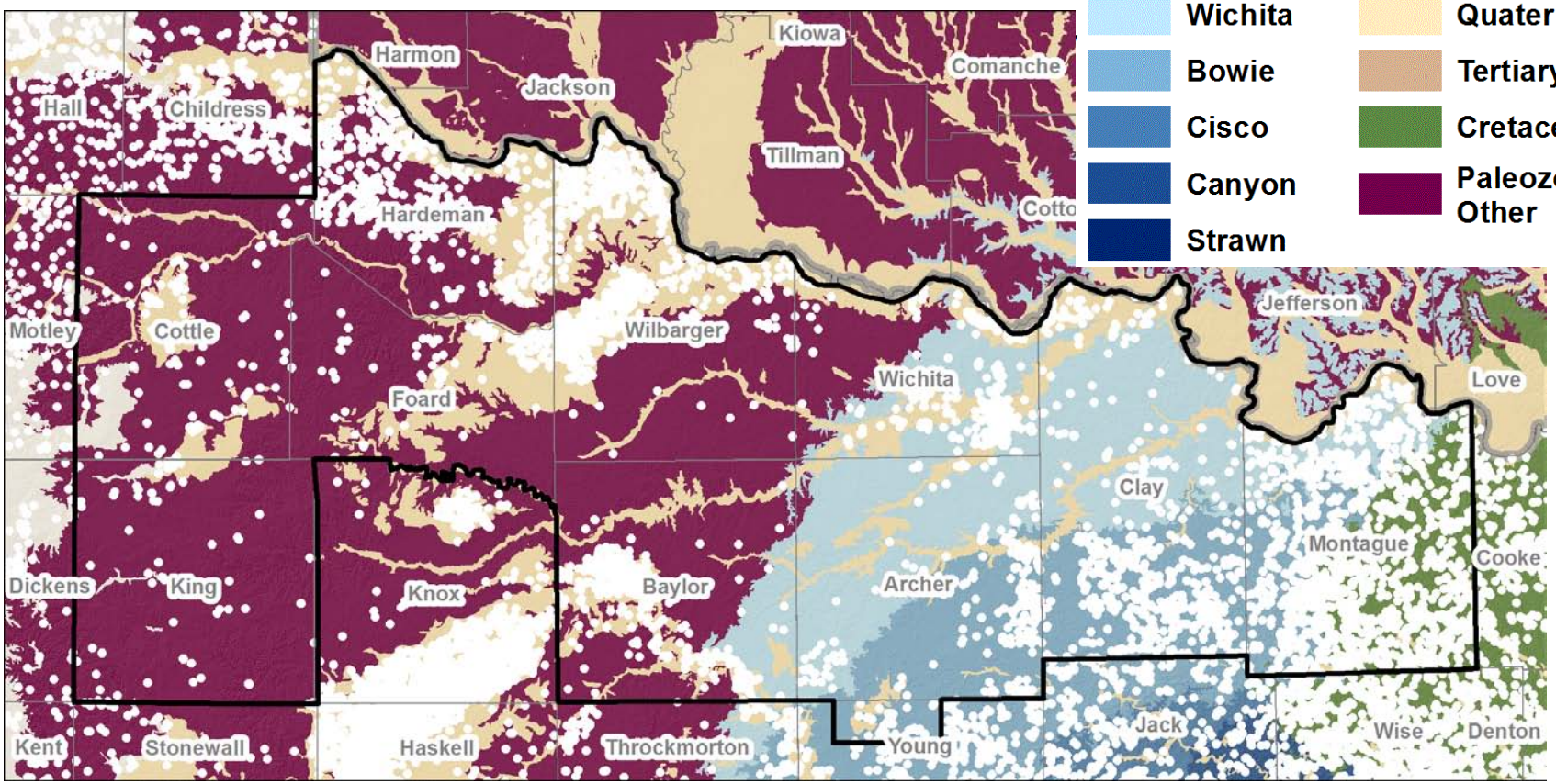
Limitations

- **All models are a simplification of reality**
- **Limited availability and quality of supporting data**
- **Model designed for regional-scale assessments**
  - **¼ mile by ¼ mile grid cells are relatively fine resolution compared to most GAMs, but is still not site-specific**
  - **Better suited for regional-scale assessments of groundwater availability (DFC process and/or Regional Planning) than local-scale assessments such as individual well fields.**
- **Funding source and focus of attention was Upper Trinity GCD**
  - **Users of the model outside UTGCD should review model assumptions and inputs to determine if it is an appropriate tool in their area of interest**

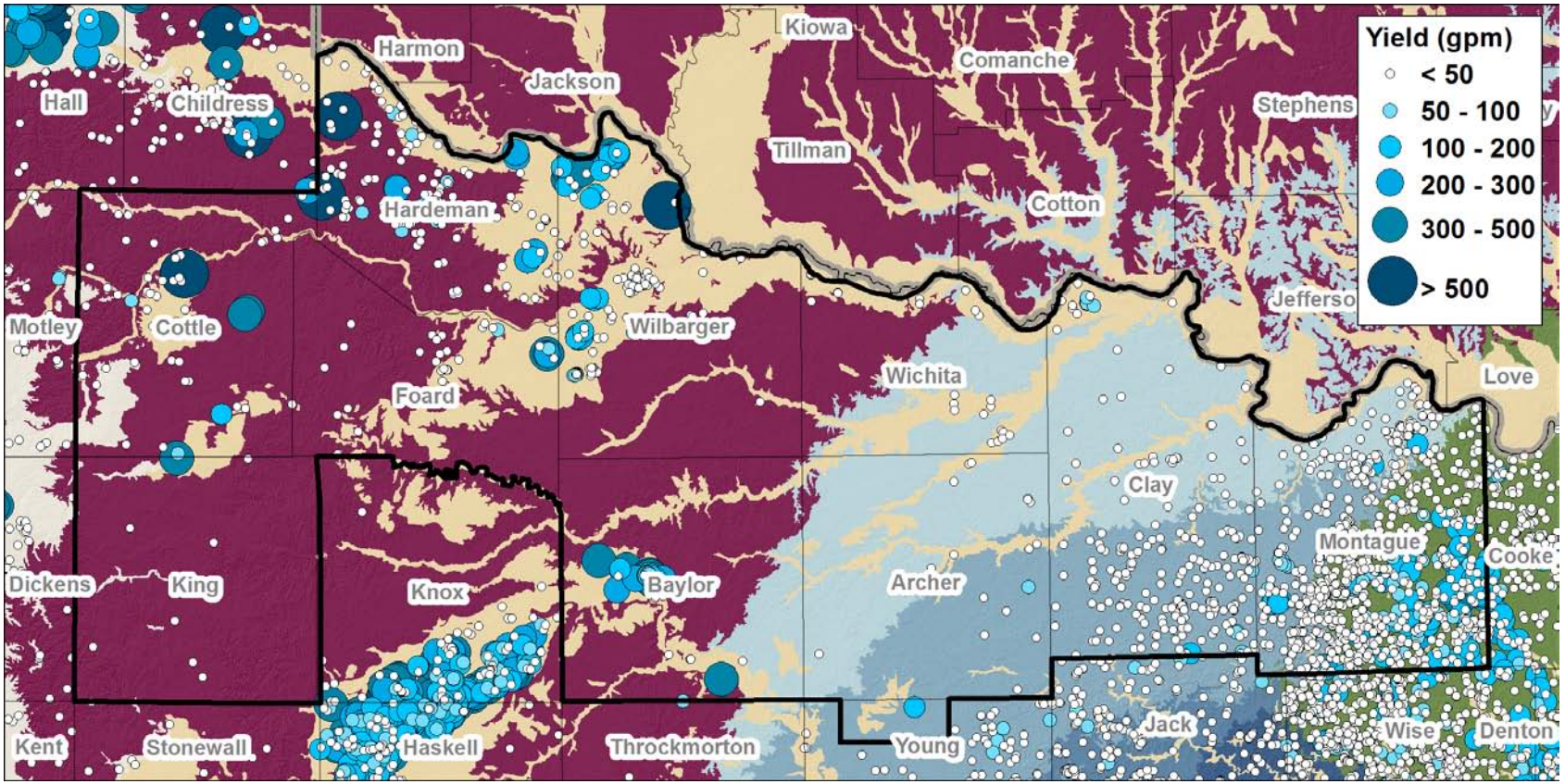
Where we are

- **UTGCD now has the capability to use the model for district- and joint planning-level management decisions**
  - **UTGCD currently undecided on whether to set DFC for the Paleozoic Aquifers in Montague County**
- **Model has been calibrated and documented for acceptance by TWDB as an "alternative model" representing the best available science on the aquifers**
  - **Not an official Groundwater Availability Model**
- **GMAs and RWPGs may choose to use the model as the best available tool for evaluating groundwater availability in areas without DFCs**

Region B Wells in TWDB Databases



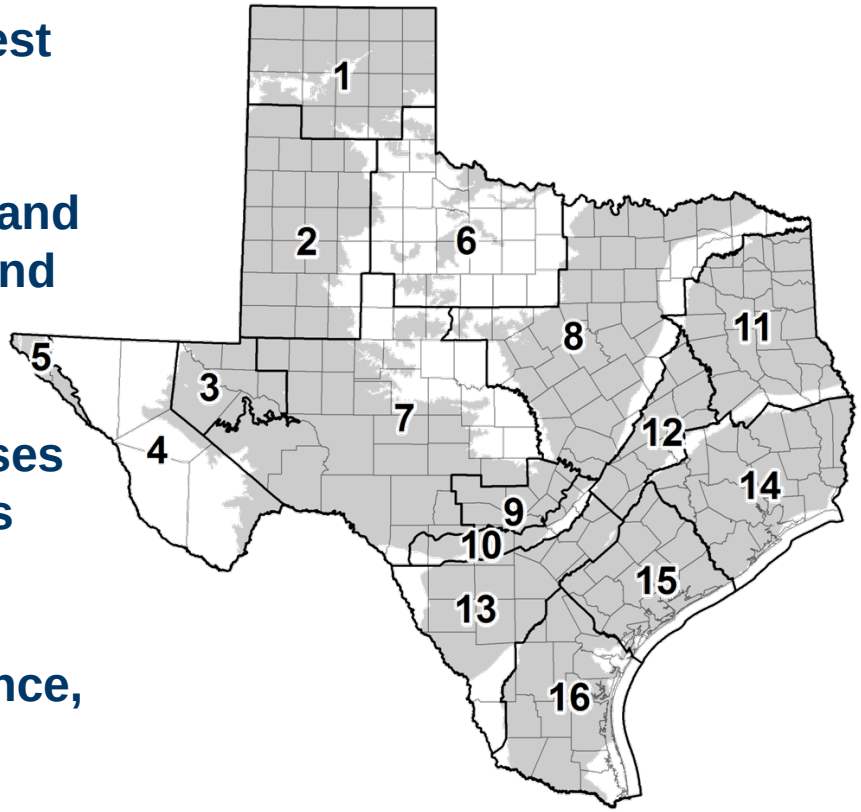
Region B Well Yields (drilled since 2001)



Wells drilled since 2001 in TWDB Submitted Drillers Reports Database with yield information

Required Considerations if DFC Developed

- **Provide a balance between the "highest practicable level of groundwater production and the conservation, preservation, protection, recharging, and prevention of waste of groundwater and control of subsidence in the management area."**
- **Nine "factors" including: 1) aquifer uses and conditions, 2) water supply needs and management strategies, 3) hydrological conditions, 4) environmental impacts, 5) subsidence, 6) socioeconomic impacts, 7) private property rights, 8) DFC feasibility, and 9) any other relevant information.**



Additional Considerations if DFC Developed

- **Appropriate scale of management**
  - Single unit or by aquifer group?
  - Management zones such as counties or areas underlain by Trinity?
- **Feasibility of monitoring**
  - Existing monitoring well network
  - Locations of potential wells for monitoring network expansion
  - Process for checking compliance with DFC
- **DFC Type**
  - Drawdown (most common)
  - Storage volume (only appropriate in very limited circumstances)
  - GW-SW Interaction (often difficult to monitor)
- **Positive DFC Attributes**
  - Clear path to management
  - Provides an appropriate level of flexibility
  - Complex enough to effectively manage the aquifer
  - Simple enough to implement and communicate

Determining Availability

- **Science does not answer the whole question:**

  Groundwater Science → What is Possible?

  Groundwater Policy → What is Best/Feasible?

- **The science informs:**
  - **Relationship between pumping and impacts to the aquifer**
- **The policy informs:**
  - **How to weigh competing goals**
    - **Today vs. Future**
    - **Environment vs. Development**
  - **What is likely to be practical and economical**

Important Dates

- **May 1, 2015:** Initially Prepared Plans due
- **Nov. 2, 2015:** Final Regional Water Plan due
- **May 1, 2016:** Deadline for groundwater conservation districts within a groundwater management area to propose DFC(s) for adoption