COMPARTMENTALIZATION IN THE NORTHERN SEGMENT OF THE BRAZOS RIVER ALLUVIUM AQUIFER

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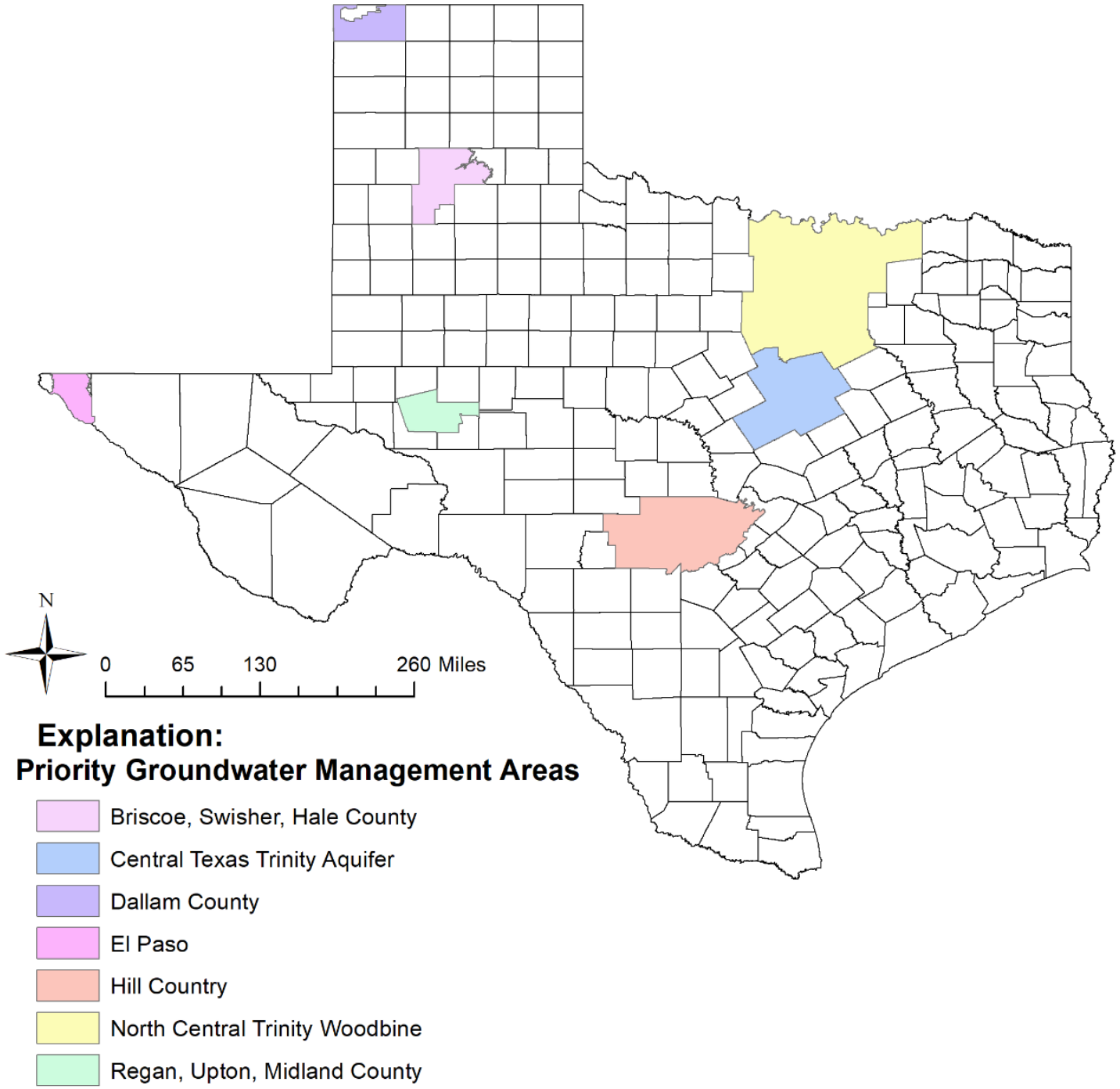
Baylor University - Spring 2019

INTRODUCTION

Background – Geology – Hydrogeology – Purpose

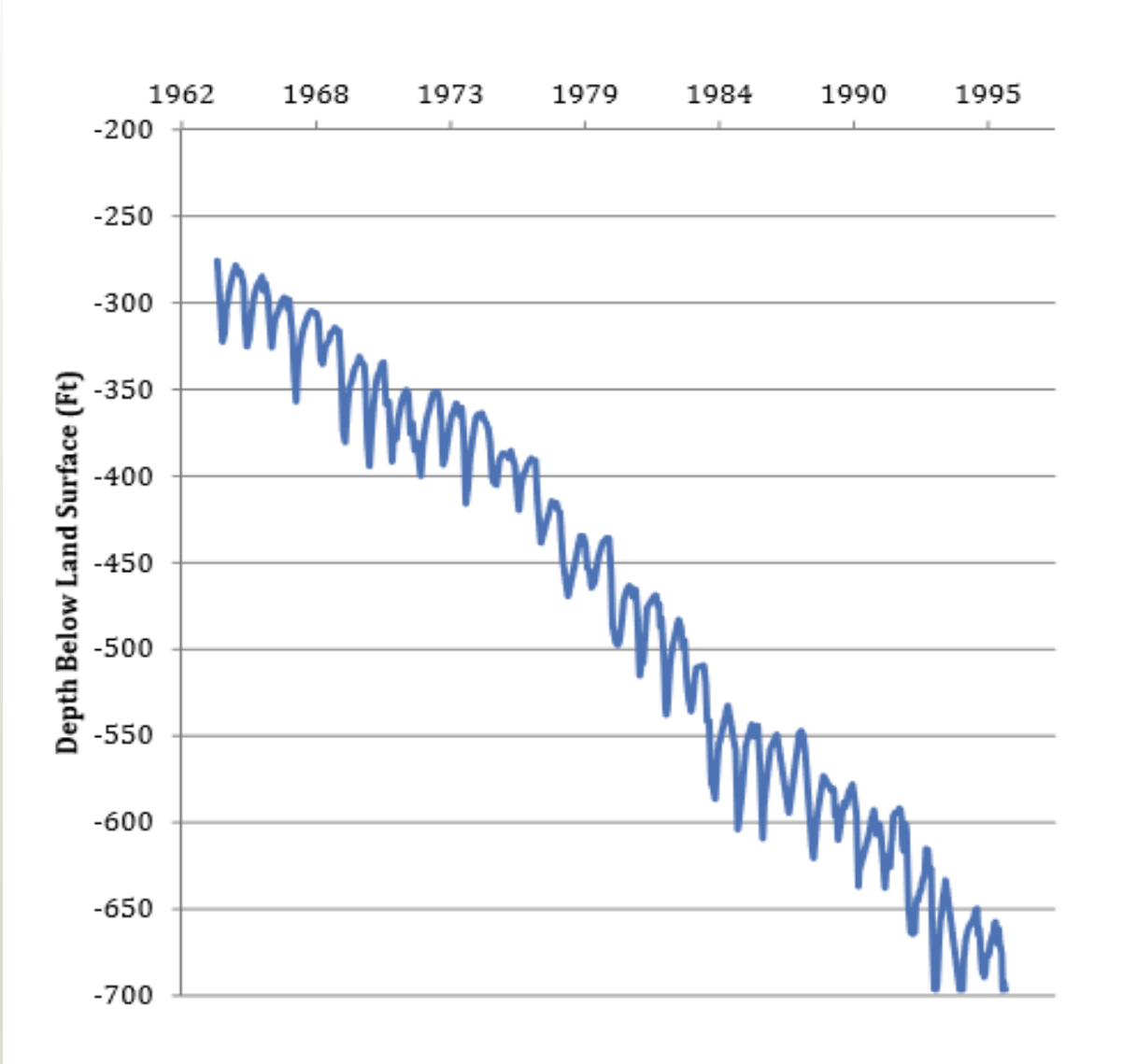
BACKGROUND

- Focused in the groundwater stressed region of central Texas.
- Includes Bosque, Hill, McLennan and Falls counties.
- Groundwater resources include the Trinity and Brazos River Alluvium aquifers.
- In 2005 the areas of McLennan, Bosque, and Hill Counties were deemed Priority Groundwater Management areas by the TCEQ



TRINITY AQUIFER

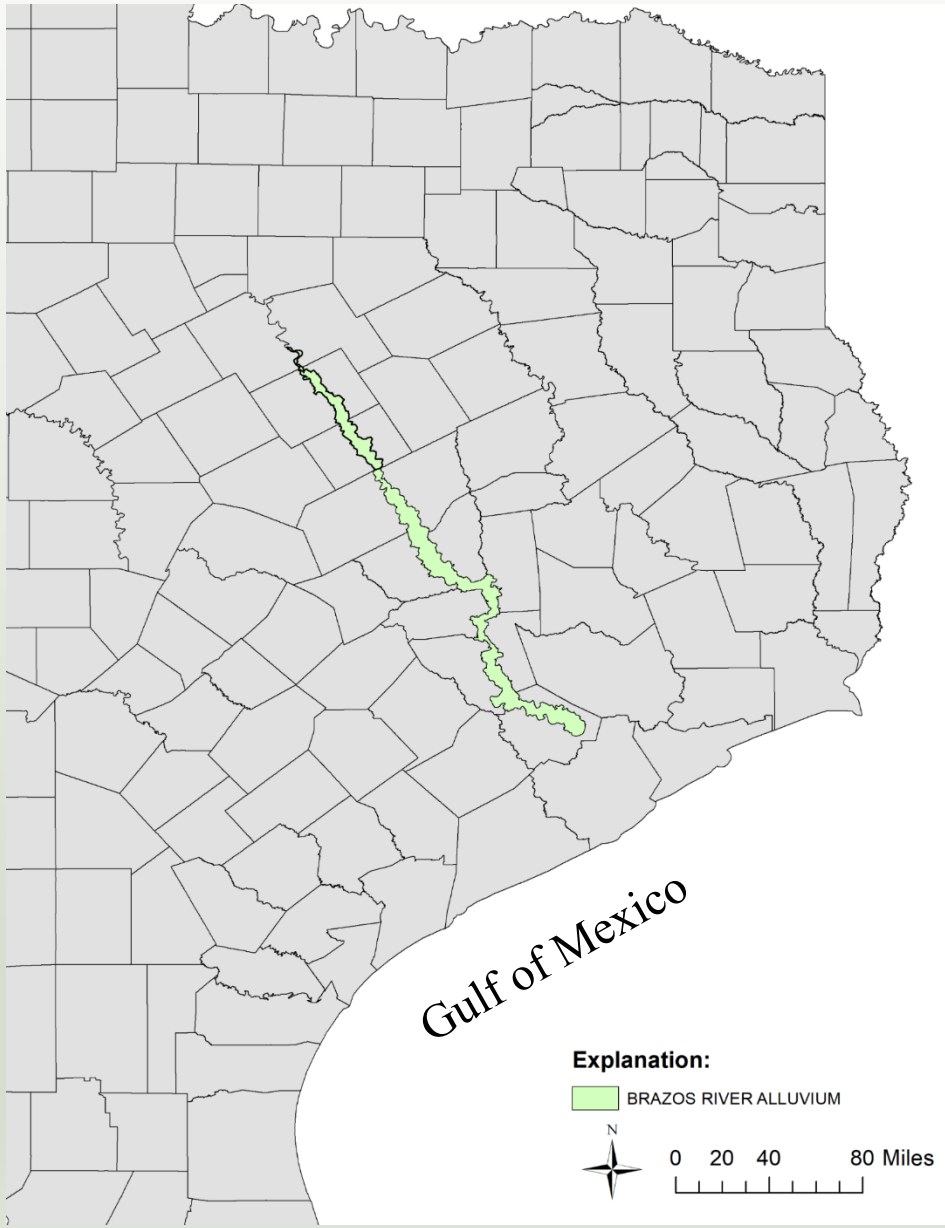
- Historical groundwater source, developing Hensell and Hosston Formations
- Confined aquifer with slow recharge
- Through increased urbanization in the Waco area and increased demand for groundwater by 1970 cones of depression had formed in both units beneath Waco



(Cronin and Wilson 1967; Bene and others 2004; Diehl 2012)

BRAZOS RIVER ALLUVIUM AQUIFER

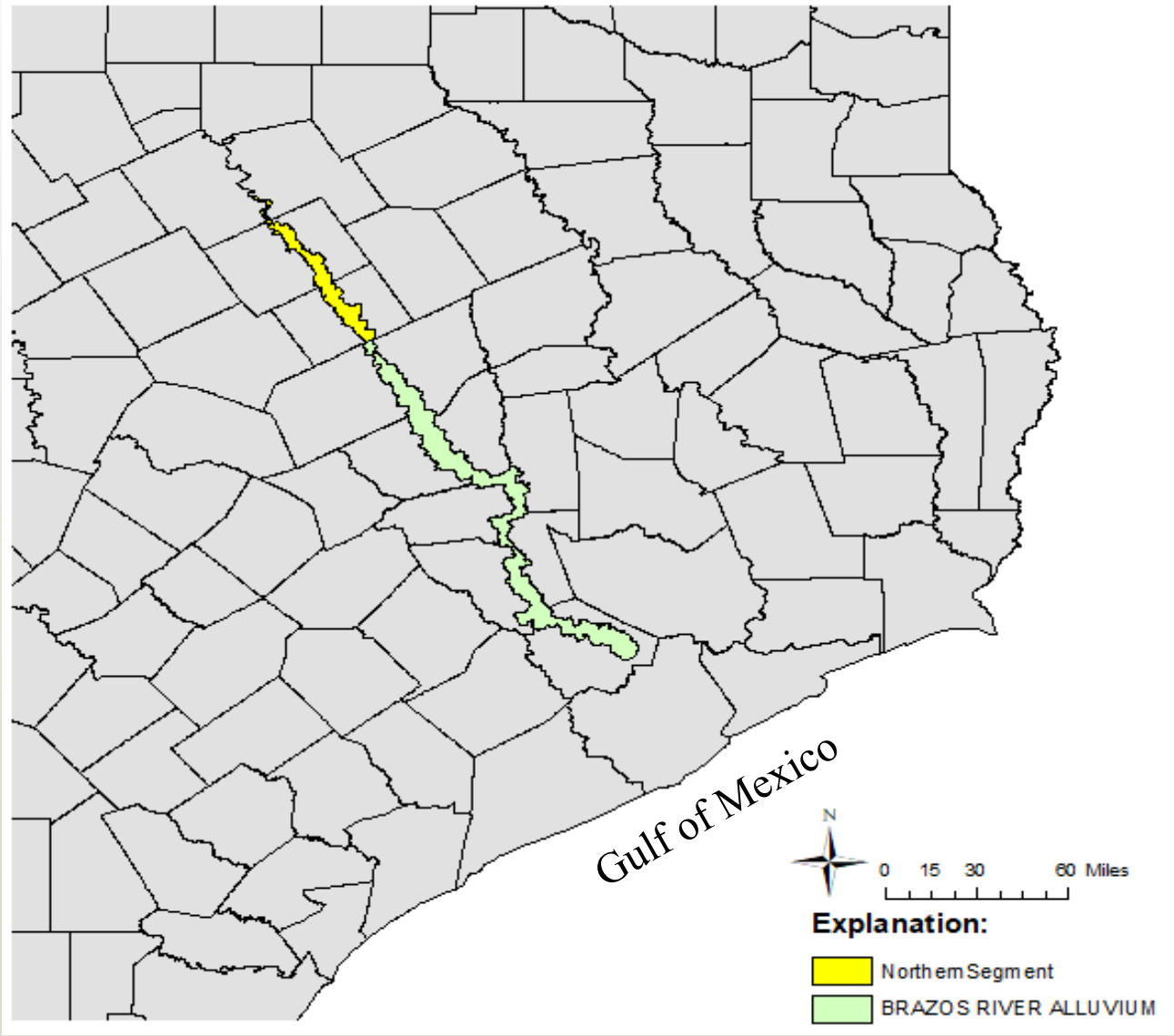
- 1 of 17 minor aquifers in Texas, only alluvium aquifer
- Extends from southern Bosque/Hill counties to eastern Fort Bend County, over 350 river miles
- Has the capability to supply water for irrigation, domestic, stock, and commercial use
- Has the potential for recharge



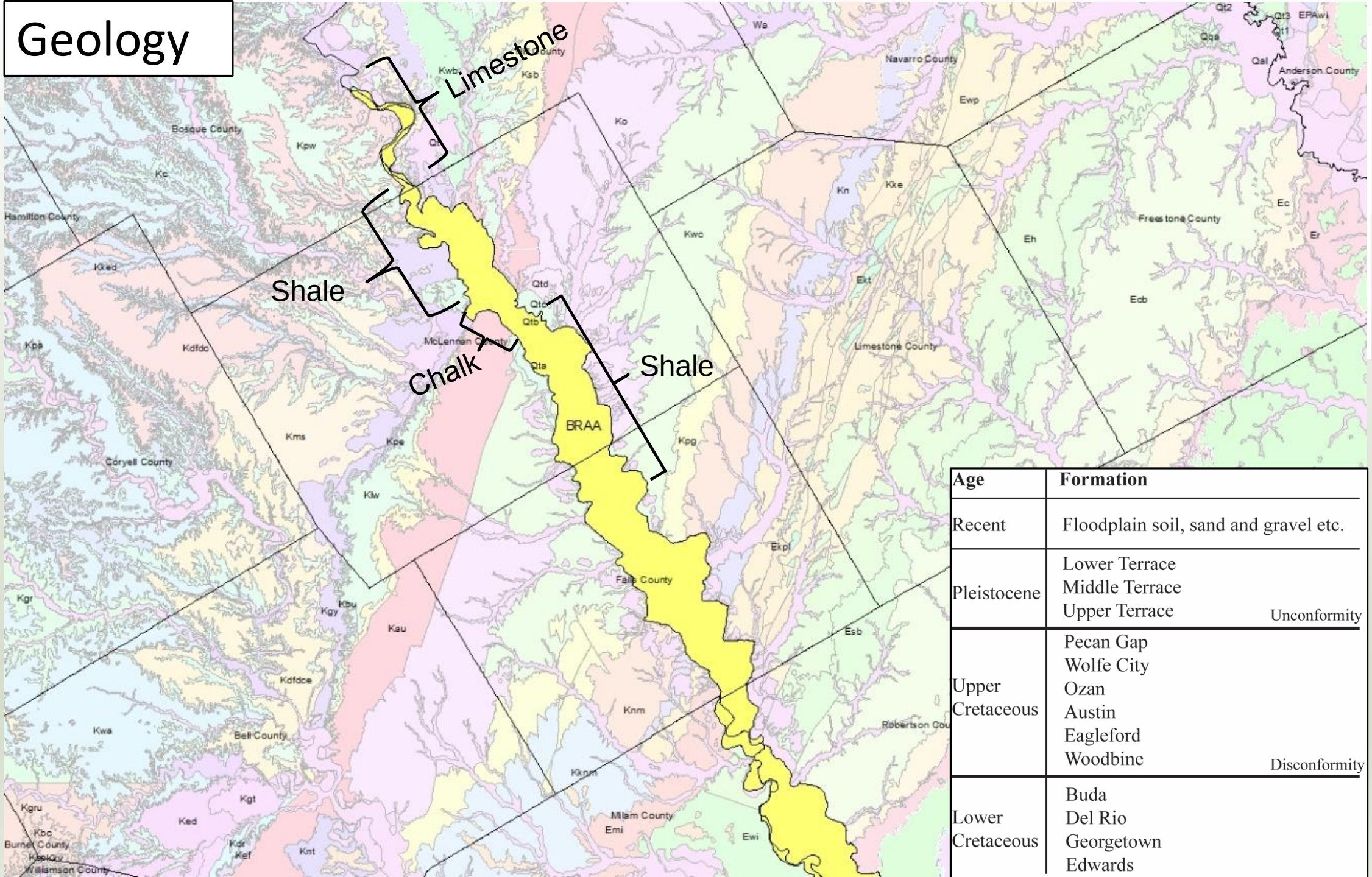
(Shah and others 2007)

STUDY AREA

- Northern Segment
- From Whitney Dam in Bosque/Hill Counties to Southern End of Falls County
- Thinnest and narrowest
- Underlain with confining bedrock units that are not known to contribute significant groundwater



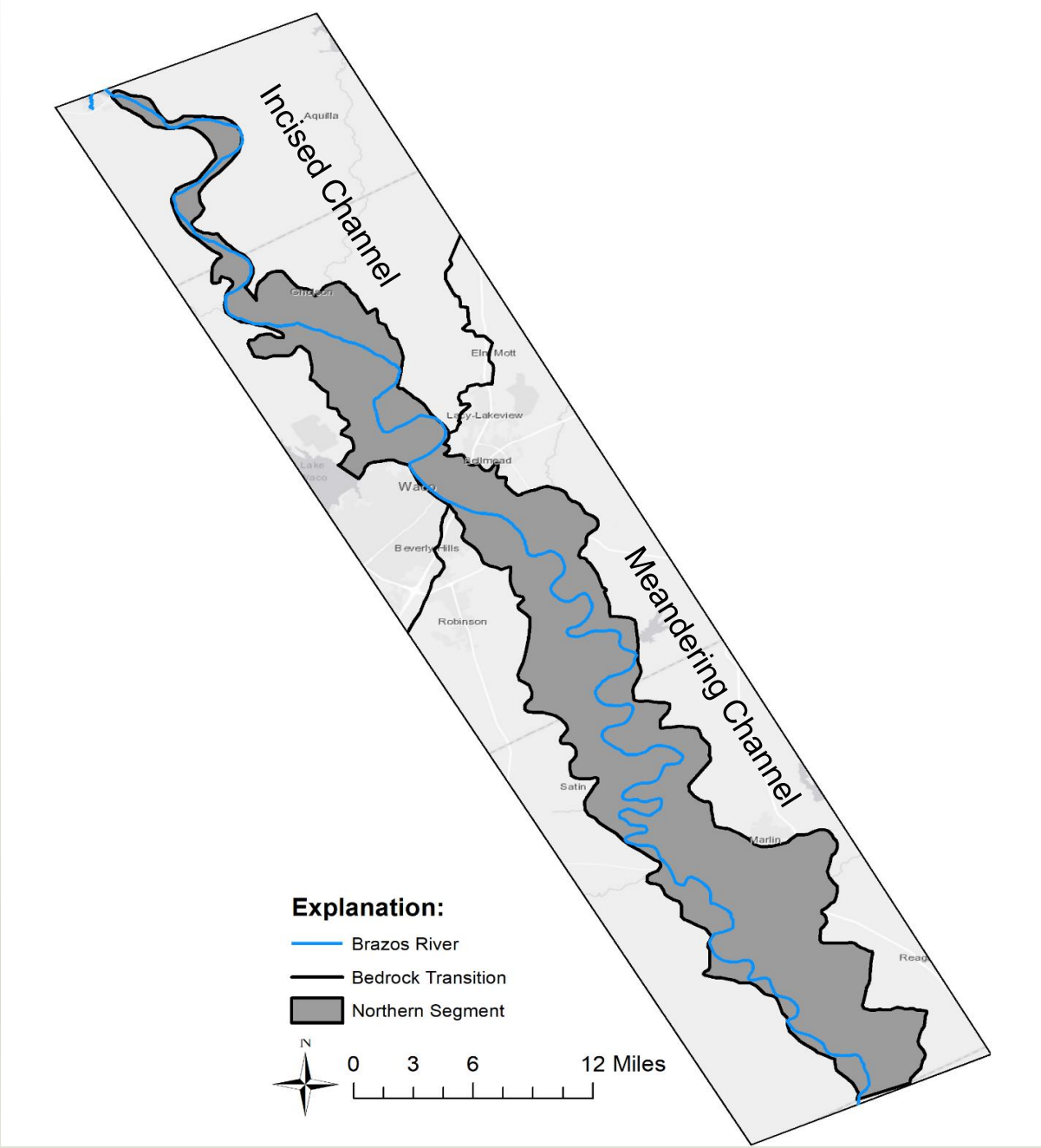
Geology



Age	Formation	
Recent	Floodplain soil, sand and gravel etc.	
Pleistocene	Lower Terrace Middle Terrace Upper Terrace	Unconformity
Upper Cretaceous	Pecan Gap Wolfe City Ozan Austin Eagleford Woodbine	Disconformity
Lower Cretaceous	Buda Del Rio Georgetown Edwards	

BEDROCK INFLUENCES

- Properties of the floodplain are bedrock controlled
- North of the Ozan Formation the bedrock the Brazos River channel is in a system of incised meanders
- Beginning at the Ozan Formation the bedrock has been removed and the Brazos River channel is not confined by bedrock



(Stricklin 1961)

TERRACES AND MODERN ALLUVIUM

- Terraces mark the position of the paleo-Brazos River. Cronin and Wilson (1967) described three major terrace.
- Terraces consist of clay, silt, sand, and gravel in a fining upward sequence.
- Largely hydrologically disconnected from modern alluvium
- The modern alluvium is the major water bearing unit and its composition varies from place to place with individual beds or lenses of sand and gravel truncating laterally and vertically into finer or coarser material.

AQUIFER CHARACTERISTICS

- Confined to the Brazos River alluvial valley, consists of heterogenous fluvial sediments whose aquifer properties range over wide limits
- Groundwater flow is toward the Brazos River
- Baseflow dominates where the channel slope is insignificant compared to the lateral valley slope and the penetration of the stream is greater than 20%.
- In the Brazos River Alluvium the lateral valley slope to be 2.8 - 12.7 times that of the channel slope and the penetration percentage is greater than 80%

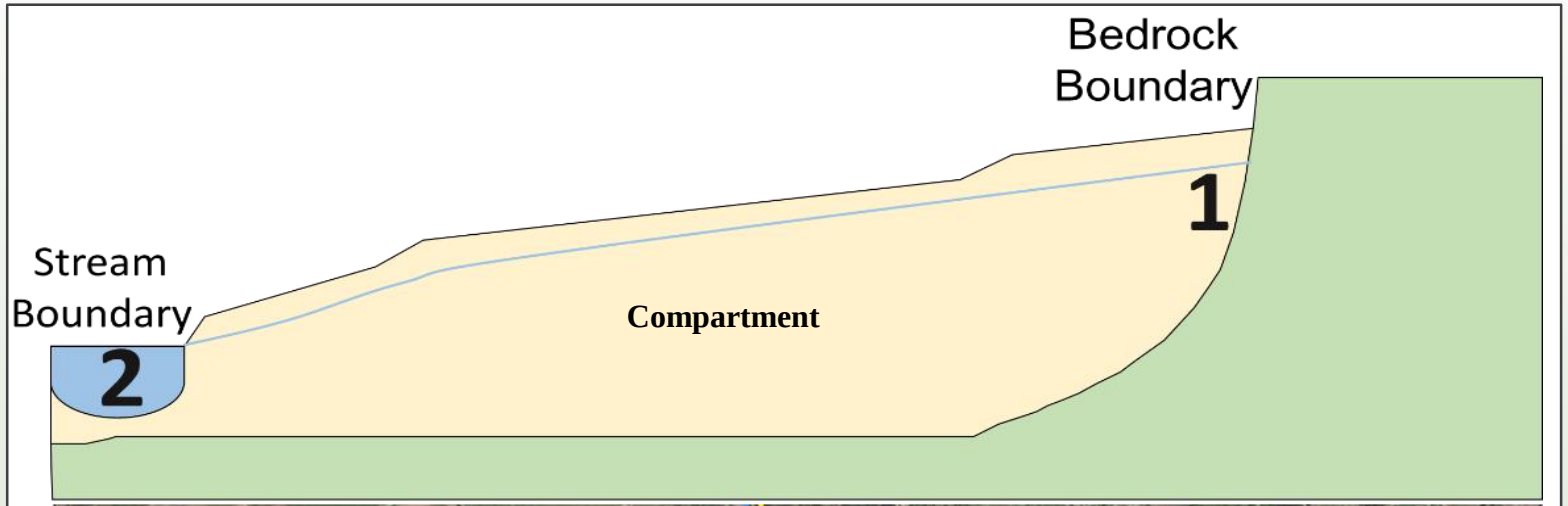
(Larkin and Sharp 1992; Cronin and Wilson 1967)

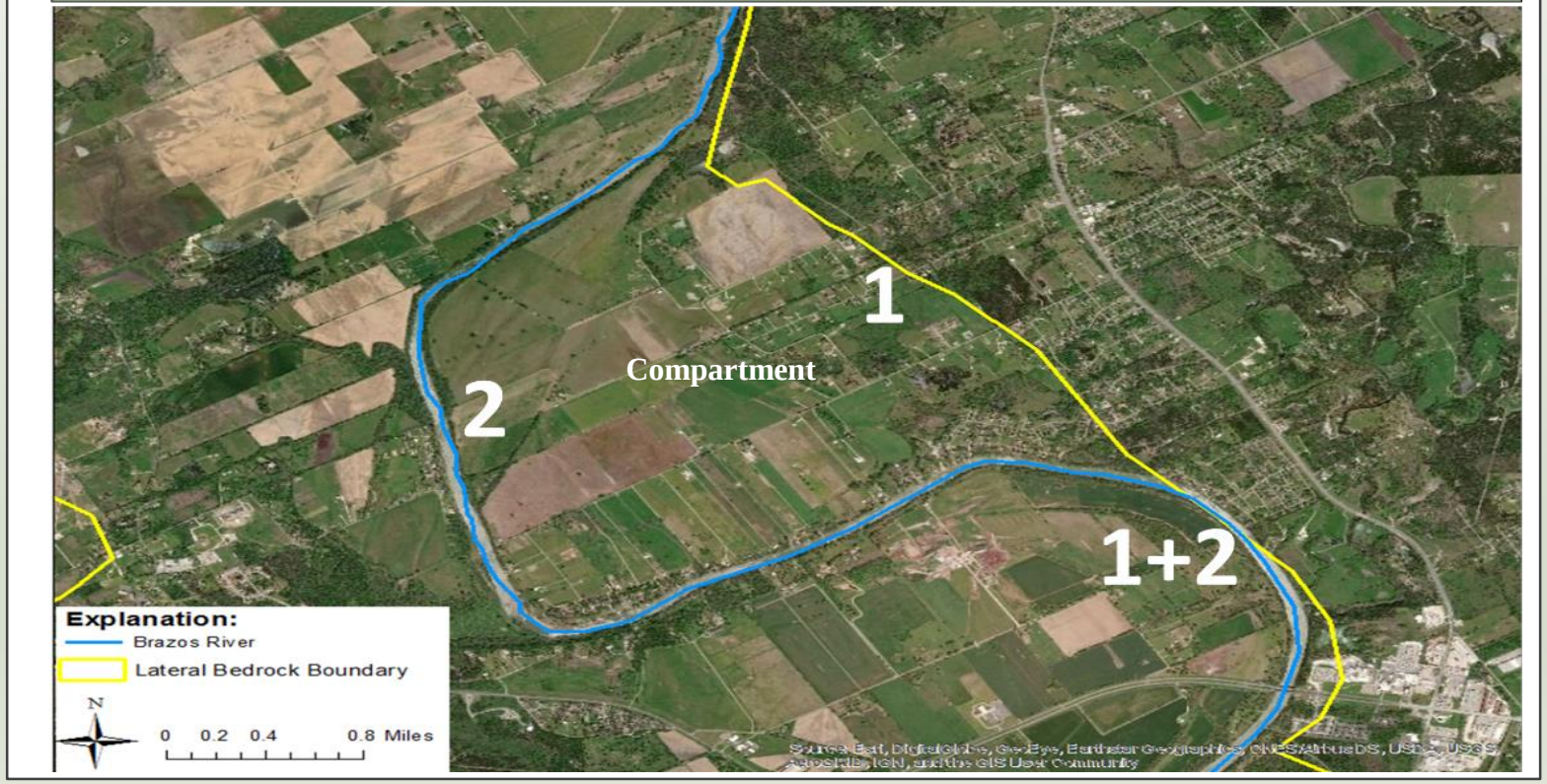
PURPOSE

- To examine the possibility of a compartmentalized aquifer through investigating the spatial relationship of aquifer thickness, aquifer-stream interactions, and stream-bedrock interactions, that may isolate groundwater flow.
- Goals
  - Better characterize flow systems in the aquifer
  - Improve understanding of aquifer continuity
  - Improve aquifer management
  - Benefit groundwater users in the jurisdiction of Southern Trinity Groundwater Conservation District

HYPOTHESIS

The Brazos River is a boundary to groundwater flow. Where the Brazos River interacts with the lateral bedrock boundaries of the aquifer it forms isolated compartments where discrete flow systems are present.





OBJECTIVES

- *Objective 1*: Create a spatial dataset from available published water well and boring data and use spatial analysis tools in ArcGIS to generate surfaces that depict groundwater flow in relation to the Brazos River and bedrock boundaries.
- *Objective 2*: Record changes in bank material along a segment of the Brazos River channel in the northern segment to help understand the river as a boundary.
- *Objective 3*: Core in transects perpendicular to aquifer boundaries and draft cross sections to visualize boundary conditions.

METHODS

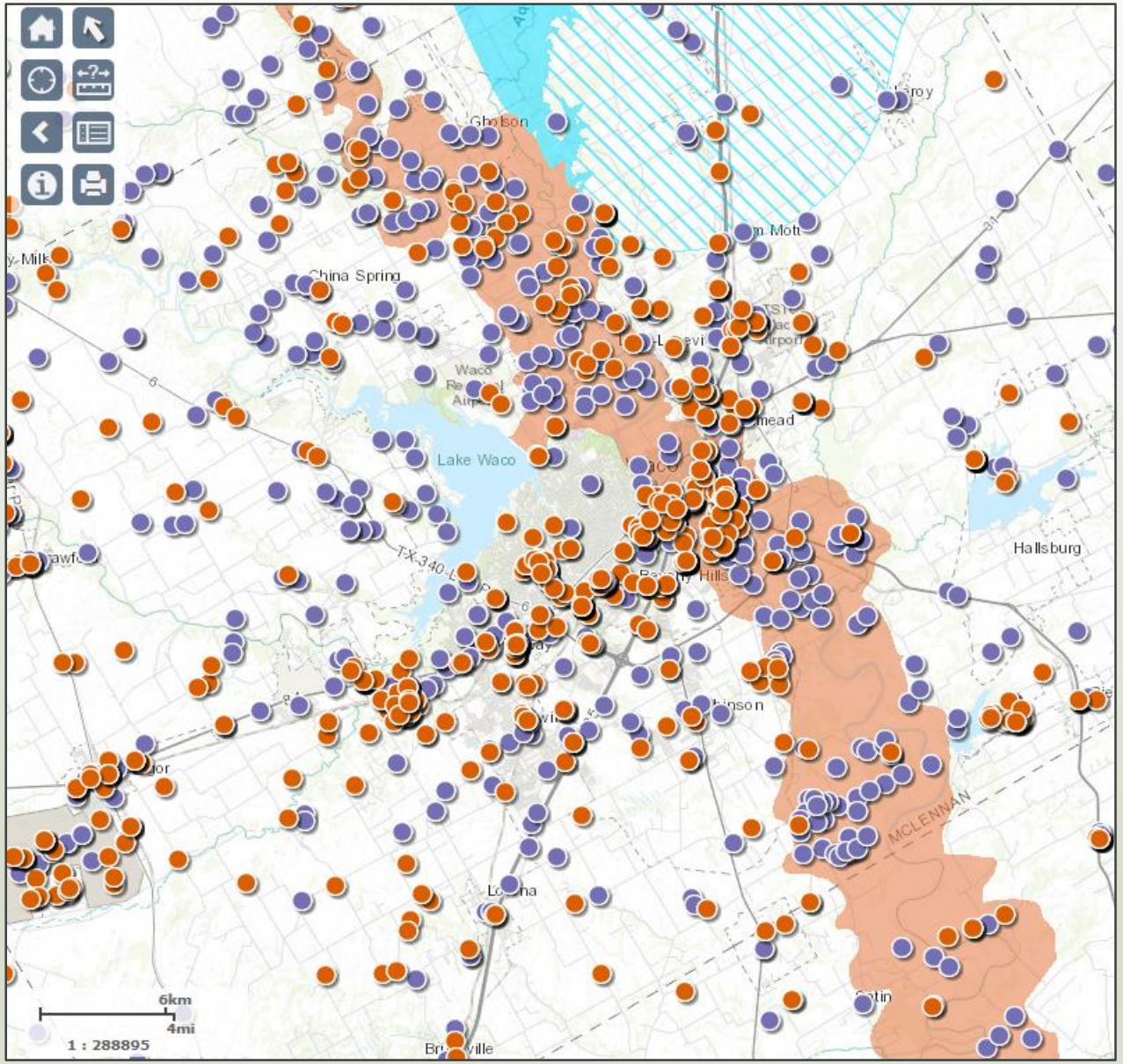
Geospatial Analysis – Brazos River Channel Observations – Coring and Cross Sections

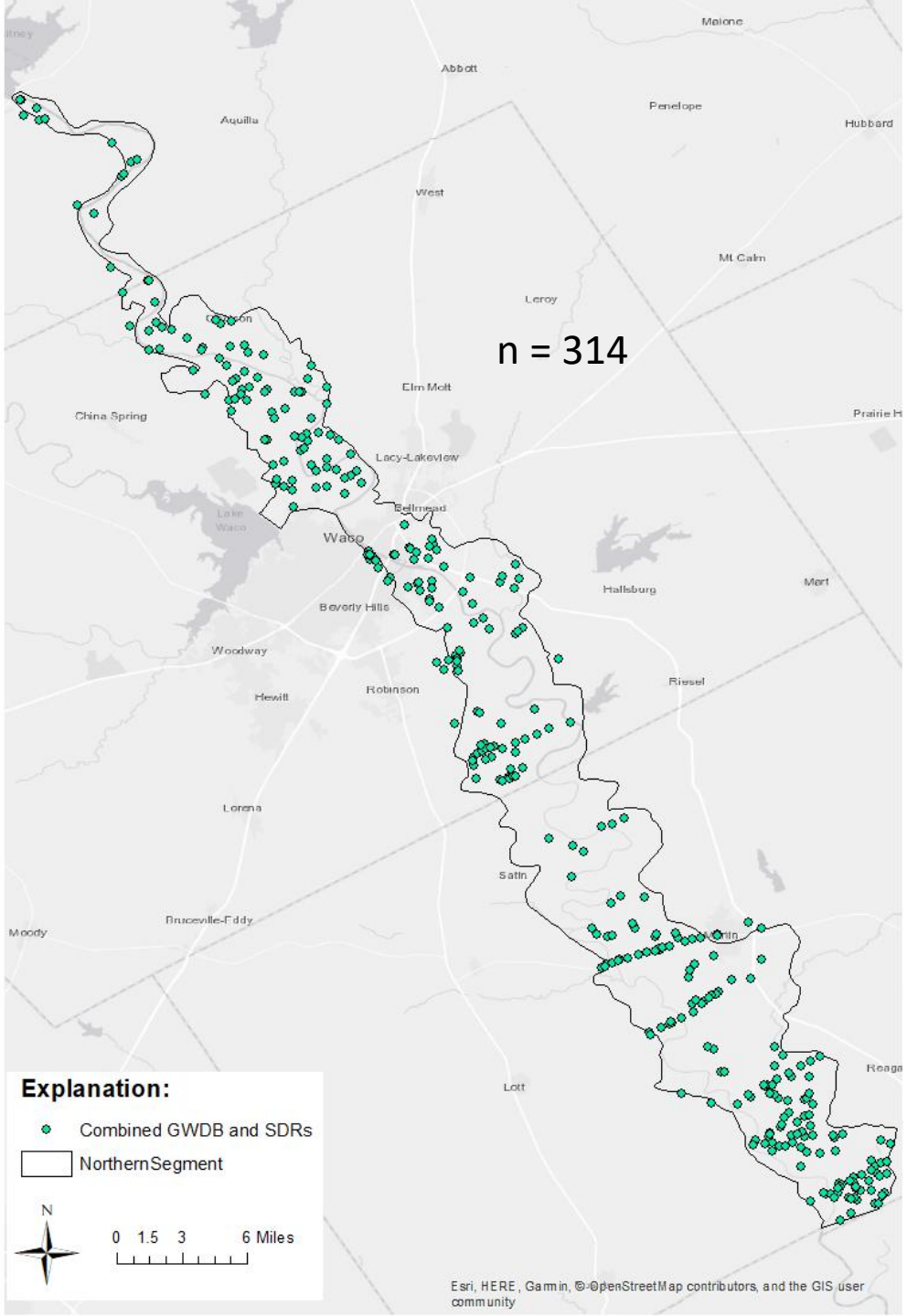
GEOSPATIAL ANALYSIS

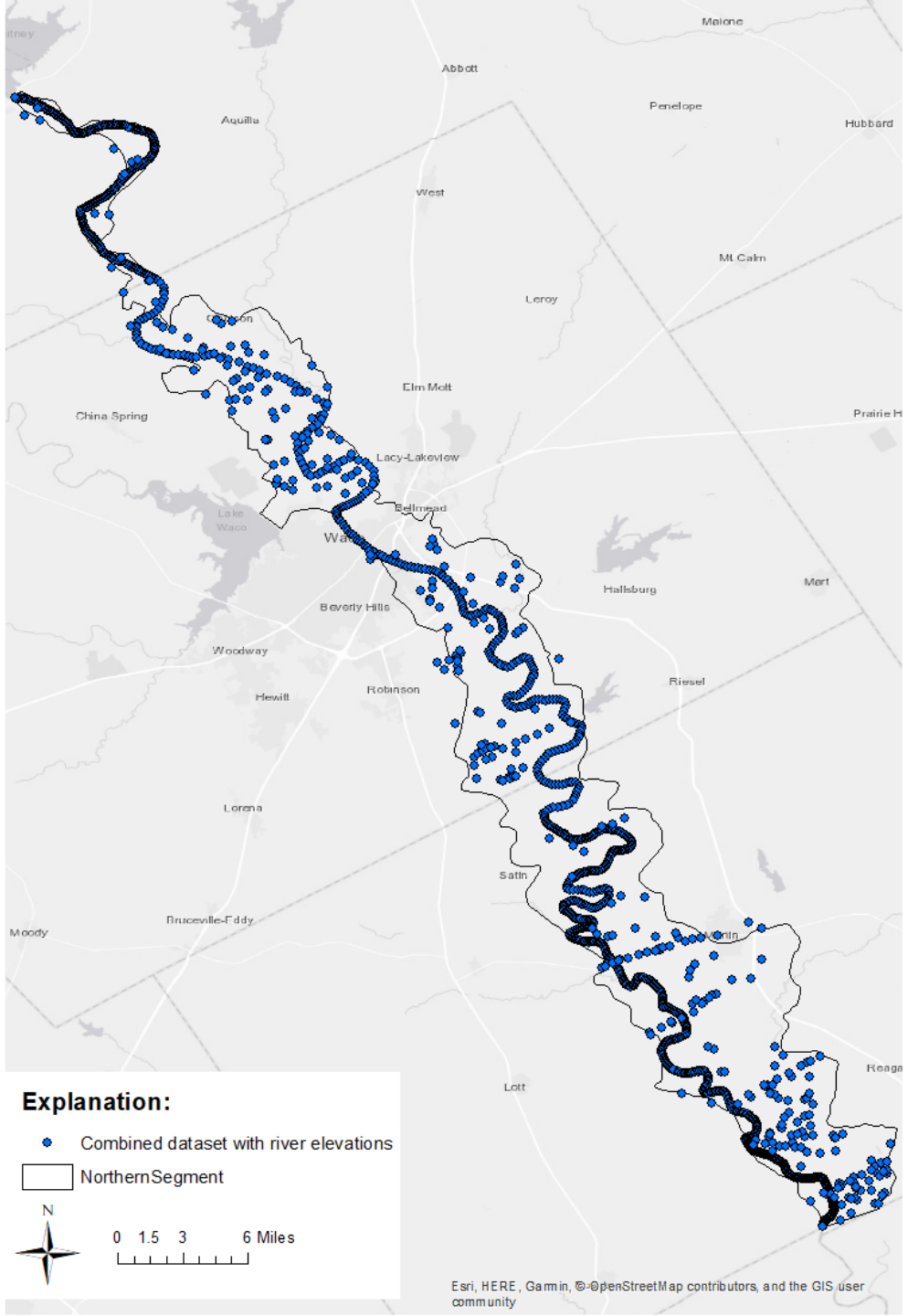
- Compiled published aquifer data from the TWDB online groundwater data

Groundwater Database:
261 data points
Well Elevation
Depth to Water
Well Depth

Submitted Drillers Reports:
53 data points
Lithology
Depth to water
Depth to bedrock

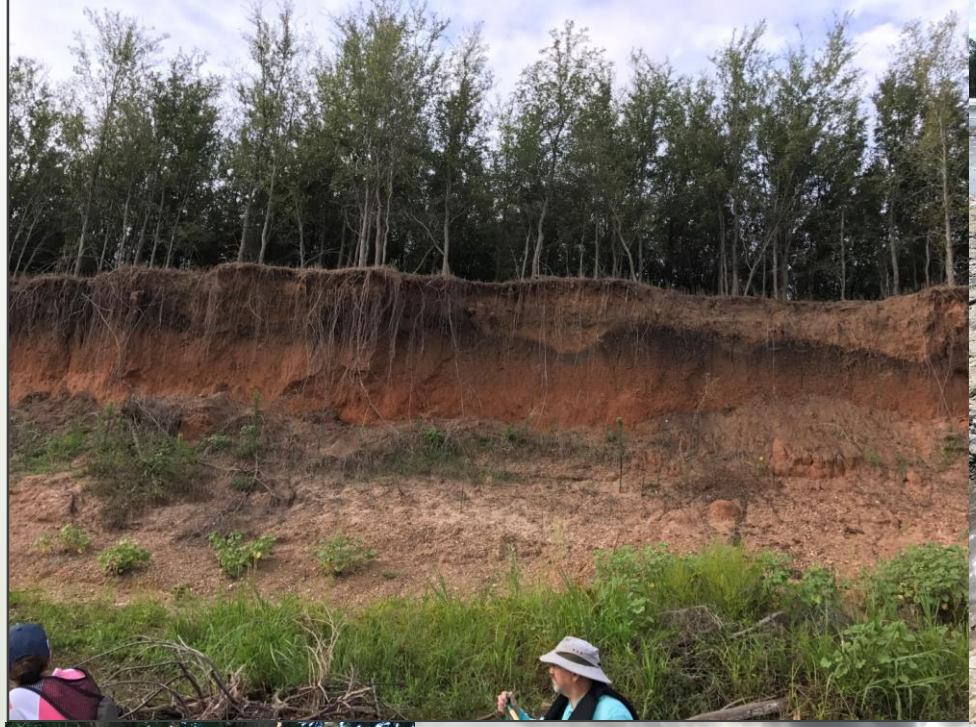



n = 314
Explanation:
Combined GWDB and SDRs
NorthernSegment
N
0 1.5 3 6 Miles
Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community


Explanation:
Combined dataset with river elevations
NorthernSegment
N
0 1.5 3 6 Miles
Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community

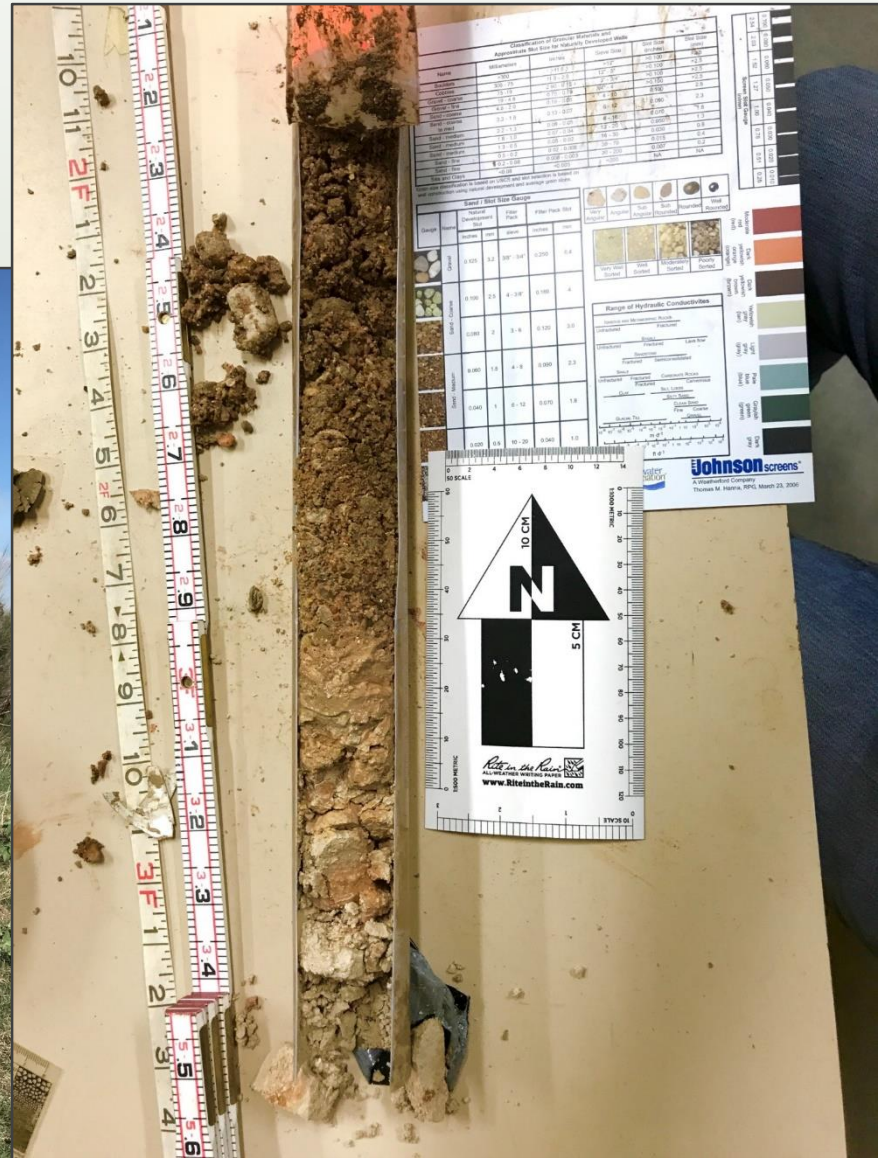
CHANNEL OBSERVATIONS

- Documented 5.28 miles of Brazos River bank from Highway 7 crossing in Falls County to the end of the Falls on the Brazos Park near Marlin, TX
- Recorded changes in bank material with handheld GPS unit
- Helped to identify types of river boundaries and possible connectivity to the aquifer



CORING AND CROSS SECTIONS

- Cores were collected with use of the Baylor Geosciences Geoprobe 6620DT
- Water levels were estimated in the field based on sediment saturation
- National Groundwater Association "Guide for Using the Hydrogeologic Classification System for Logging Water Well Boreholes"

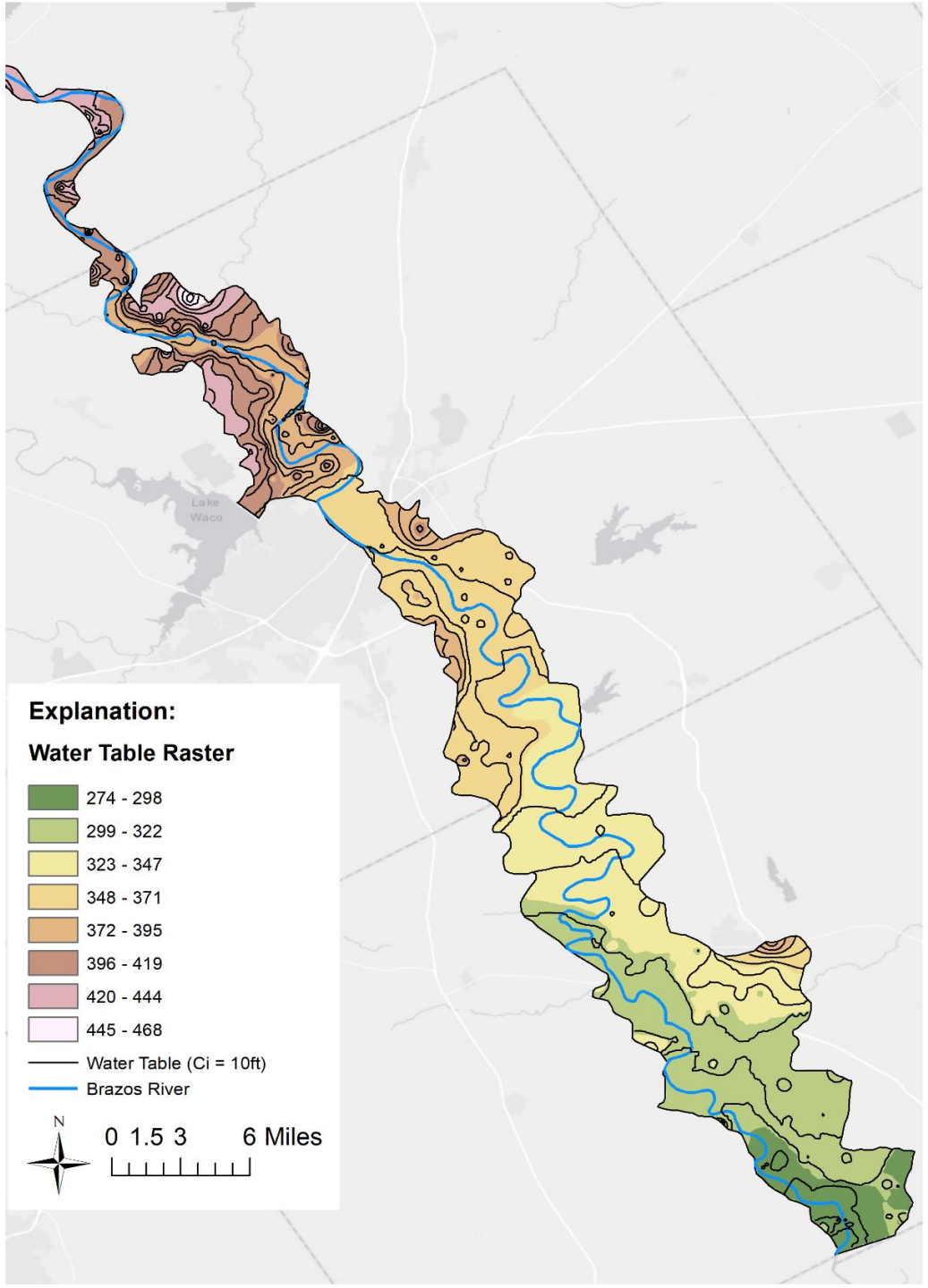


RESULTS AND DISCUSSION

Groundwater Flow and Compartments – River Bank Analysis – Cores and Cross Sections

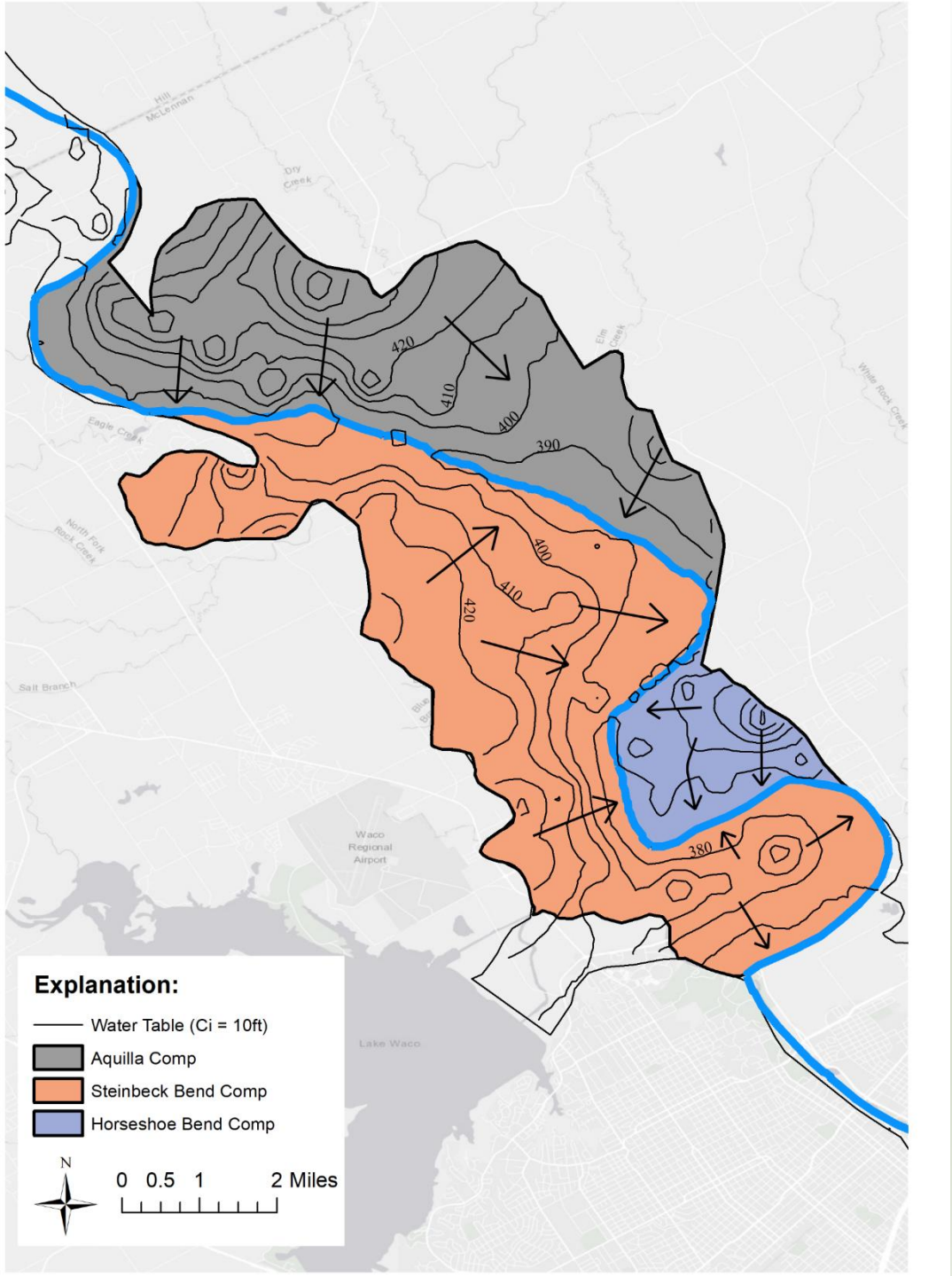
GROUNDWATER FLOW AND COMPARTMENTS

- Generated a raster surface in ArcGIS utilizing using IDW spatial analysis tool
- Contoured the raster surface
- Groundwater flow is perpendicular to contour lines



INCISED MEANDERING COMPARTMENTS

- Contour lines parallel to Brazos River
- Brazos River is the low point of the water table
- Groundwater flow direction shifting with changes in river flow direction



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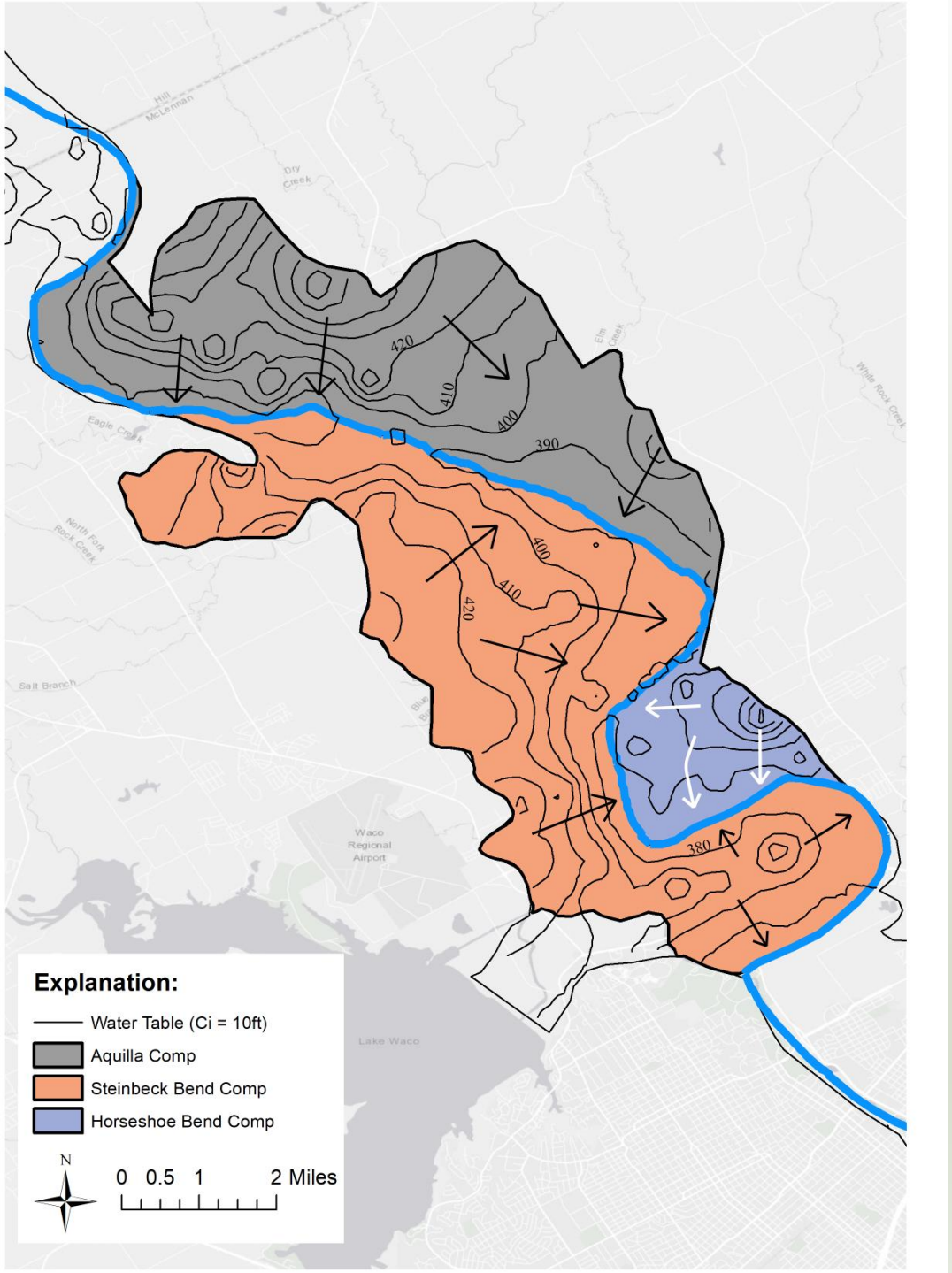
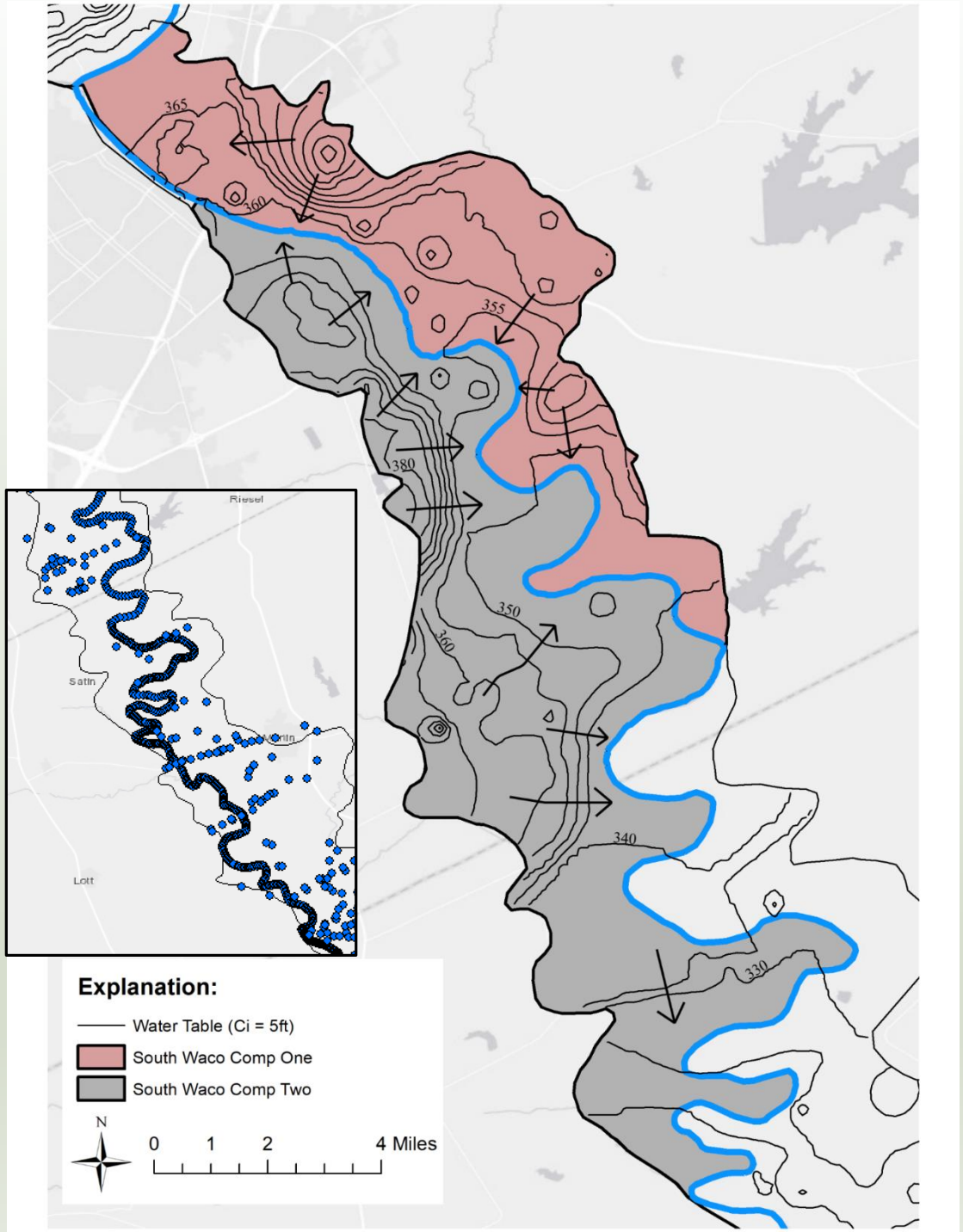
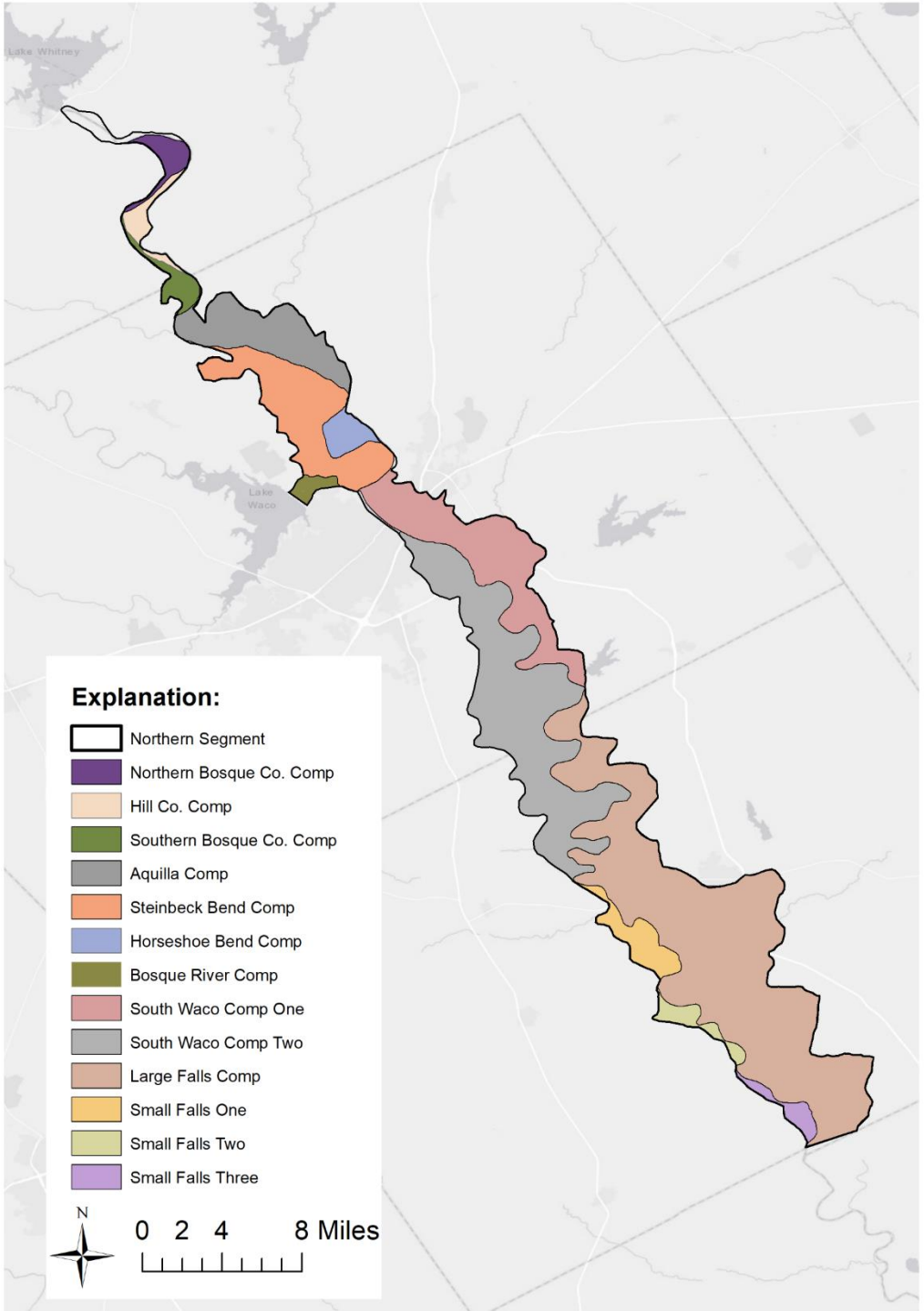


FLOODPLAIN MEANDERING COMPARTMENTS

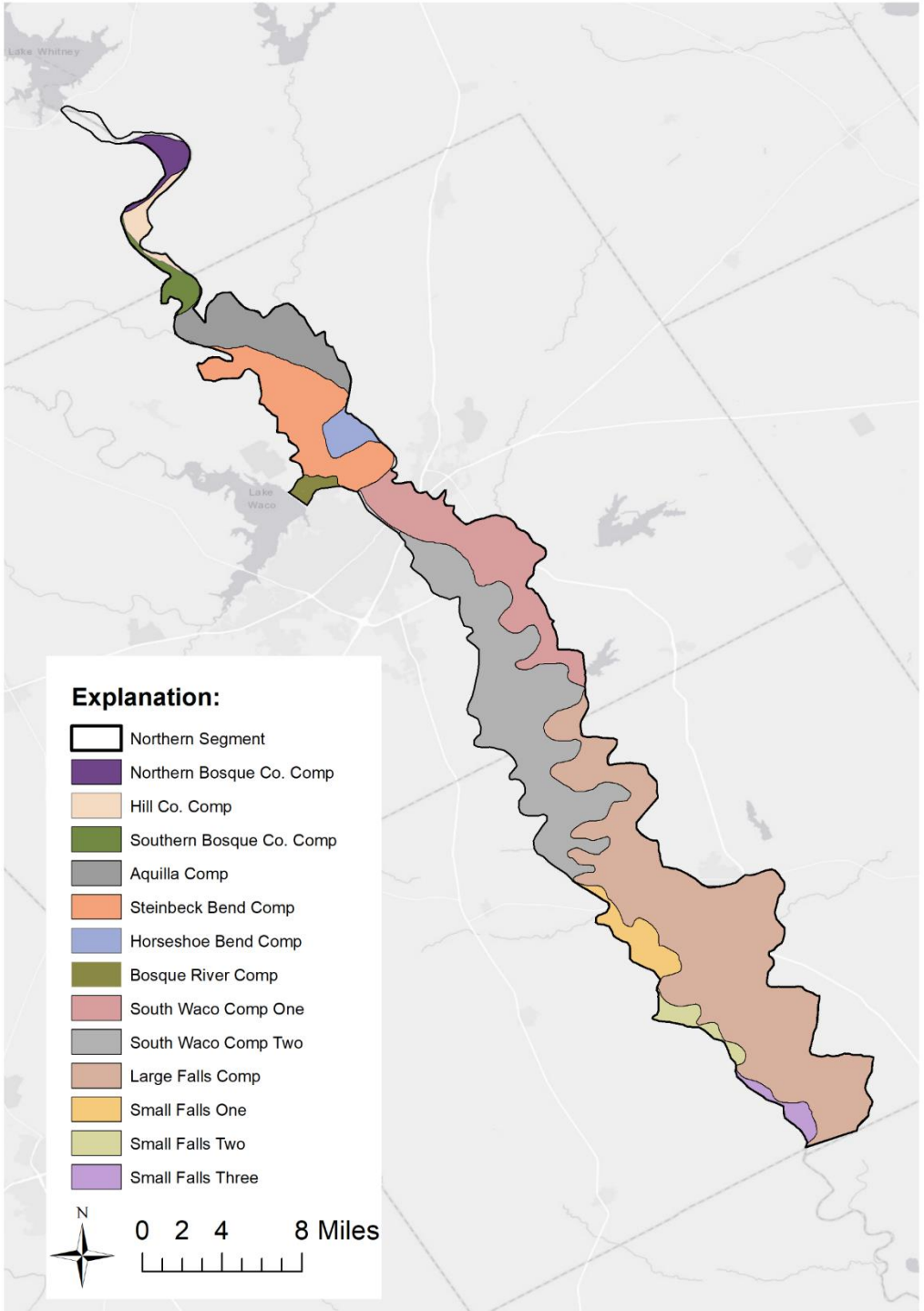
- Contours are still perpendicular to the Brazos River
- Compartments are not outlined as well
- Shortage of data or result of broad meanders





NORTHERN SEGMENT COMPARTMENTS

	Compartment Name	Compartment Number	Area (acres)	% of Northern Segment	
Incised Meandering	Northern Bosque	1	2973	1.55	
	Hill County Comp	2	2589	1.35	⬅
	Southern Bosque	3	2864	1.49	
	Aquilla Comp	4	11059	5.75	
	Steinbeck Bend	5	19072	9.92	
	Horseshoe Bend	6	3105	1.62	
	Bosque Comp	7	1563	0.81	
Floodplain Meandering	Swaco Comp One	8	21736	11.31	
	Swaco Comp two	9	41715	21.70	
	Large Falls Comp	10	75000	39.02	⬅
	Small Falls One	11	5298	2.76	
	Small Falls Two	12	2873	1.49	
	Small Falls Three	13	2364	1.23	



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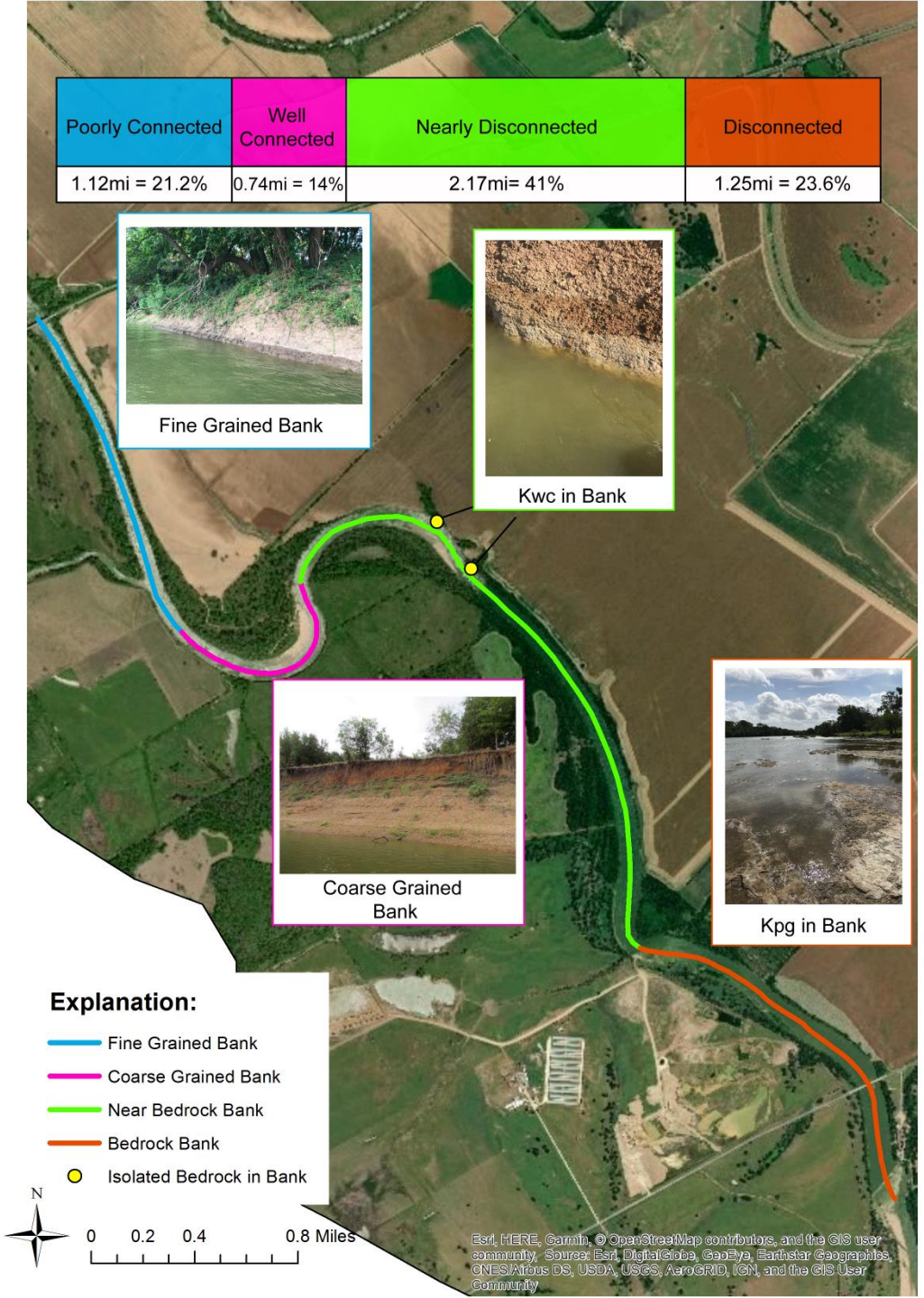
	Southern Bosque	3	2864	1.49	Avg: 6,175 acres
	Aquilla Comp	4	11059	5.75	
	Steinbeck Bend	5	19072	9.92	
	Horseshoe Bend	6	3105	1.62	
	Bosque Comp	7	1563	0.81	
Floodplain Meandering	Swaco Comp One	8	21736	11.31	
	Swaco Comp two	9	41715	21.70	
	Large Falls Comp	10	75000	39.02	Avg: 24,831 acres
	Small Falls One	11	5298	2.76	
	Small Falls Two	12	2873	1.49	
	Small Falls Three	13	2364	1.23	

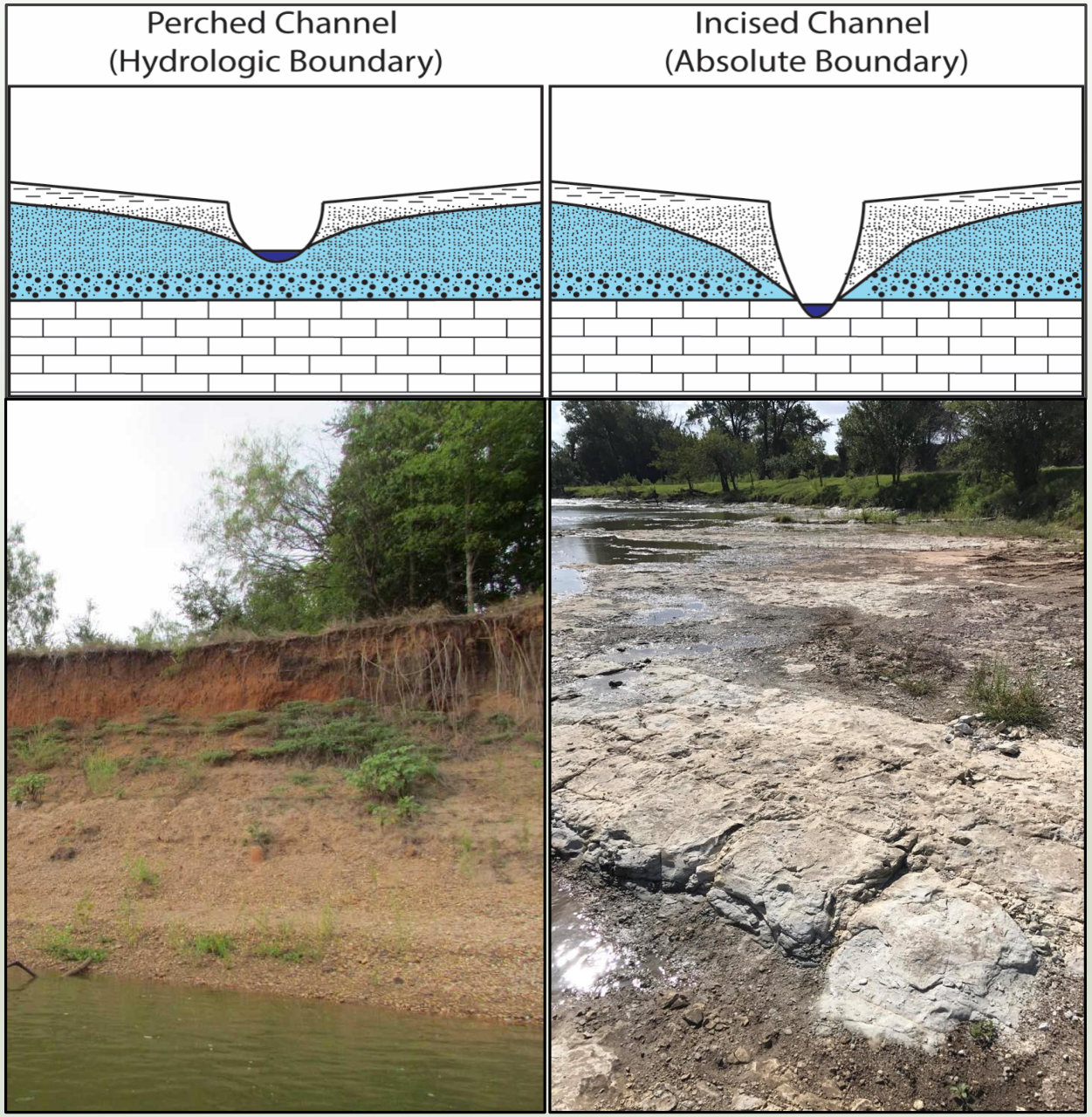
RIVER BANK ANALYSIS

- Bank material transitioned 4 times along the reach
- Bank material consisted of fine grained material, gravels, isolated bedrock, and complete bedrock banks
- Of the 5.28 miles 1.25 miles or 23.6% of the reach had bedrock banks



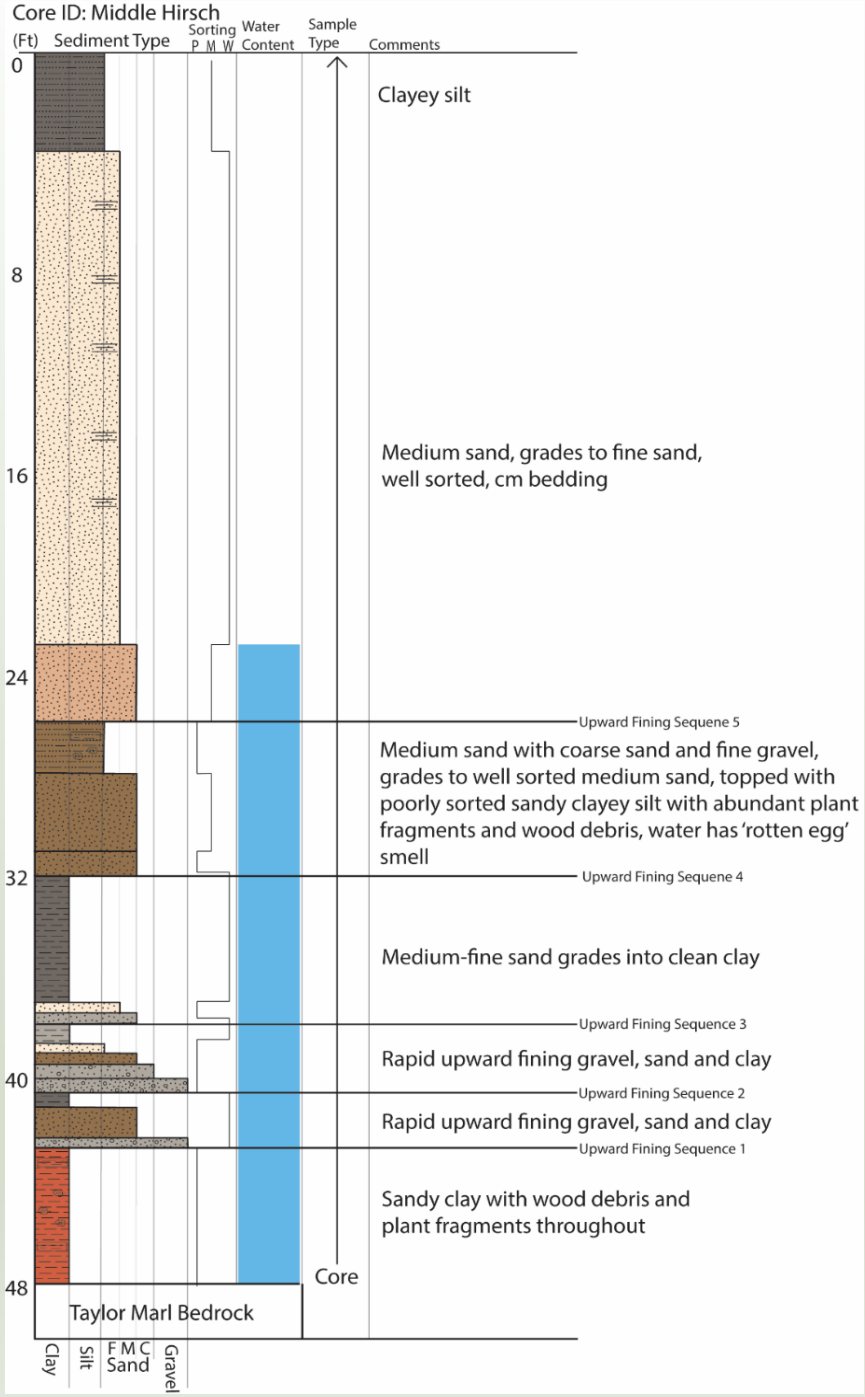
RIVER BANK ANALYSIS

- Perched Channel – River is perched some distance above bedrock bottom
- Incised Channel – River is flowing on bedrock
- Hydrologic and Absolute Boundary

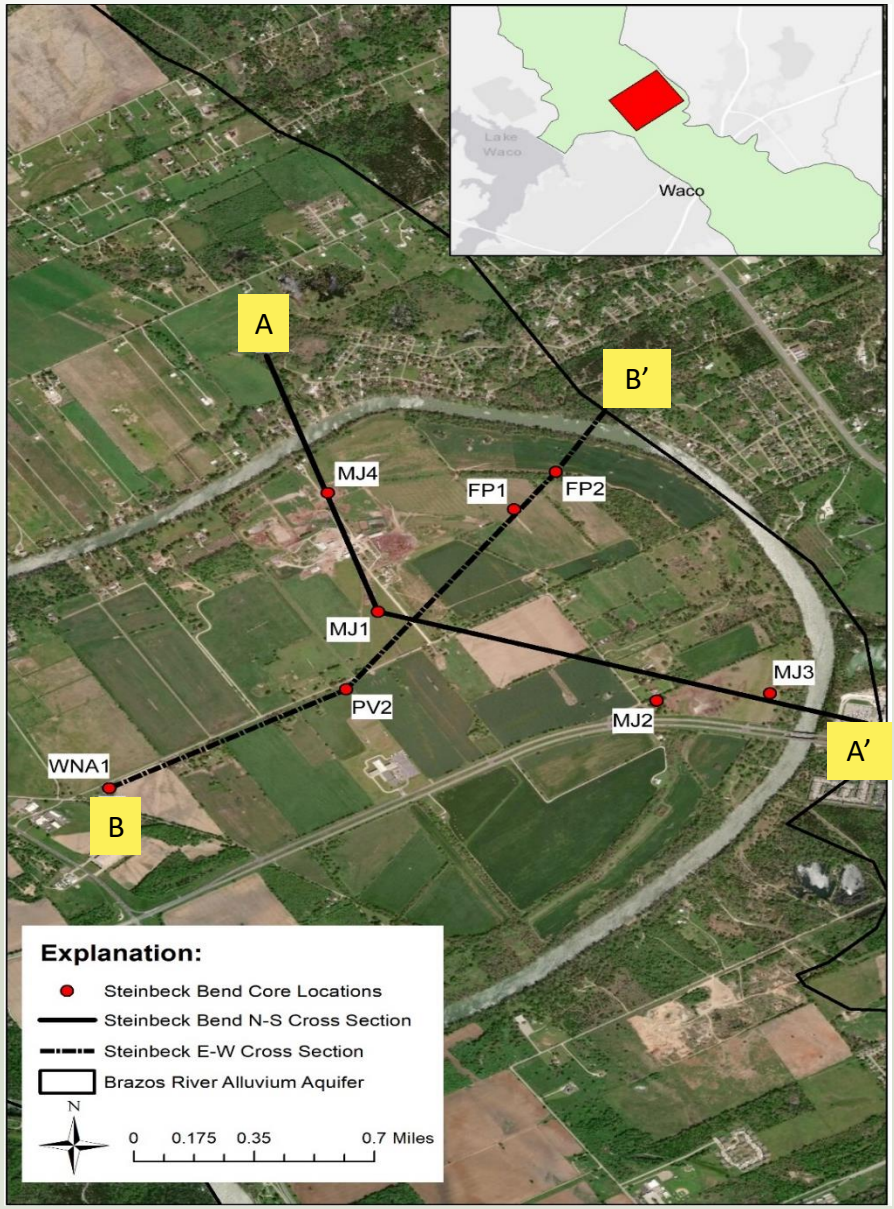


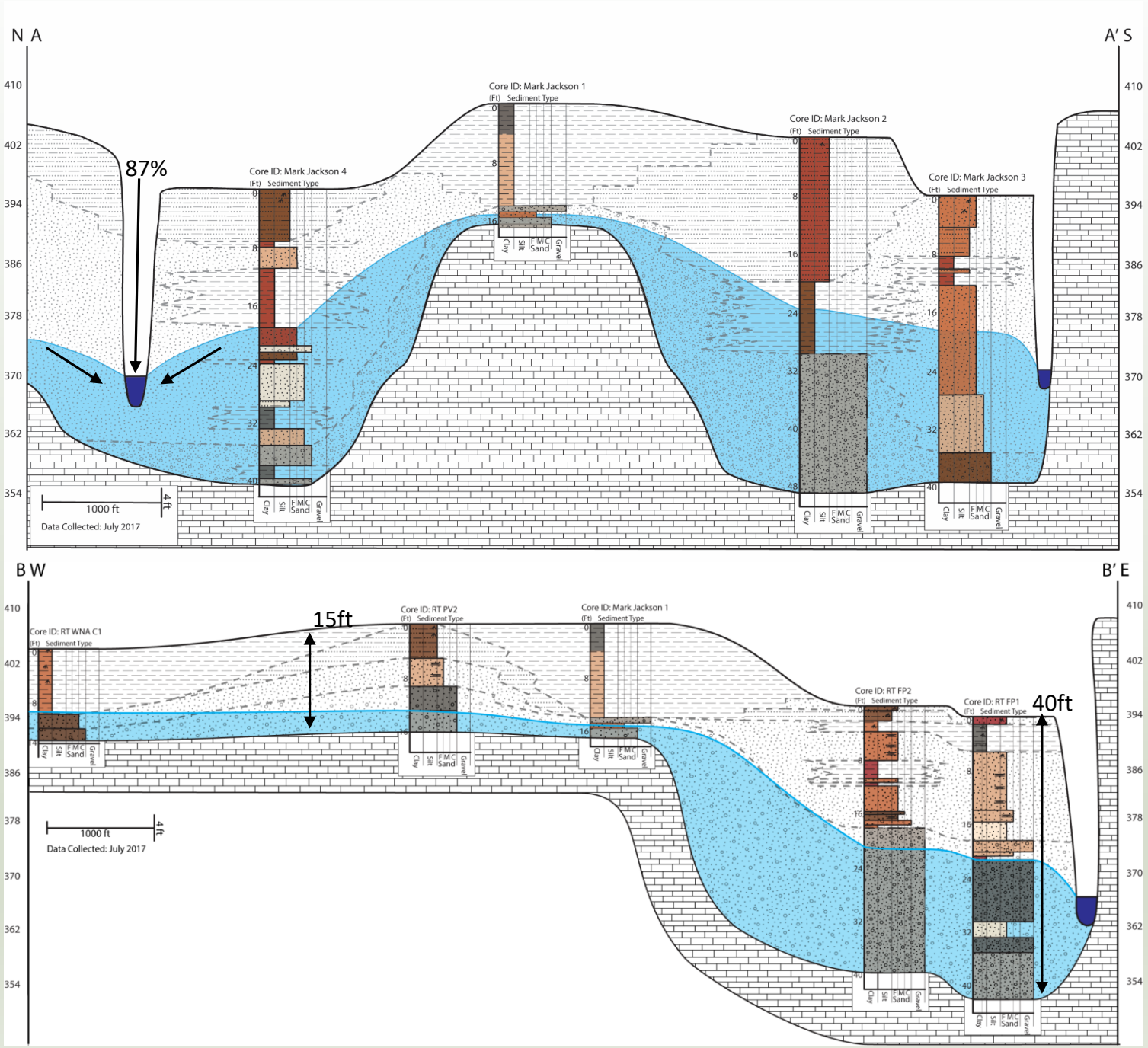
CORES AND CROSS SECTIONS

- A total of 22 cores along 6 transects
- Drafted detailed core log from sediment descriptions
- Used core logs to draft the cross sections and correlate bedrock elevation, water table elevation, and possible sediment distribution



STEINBECK BEND





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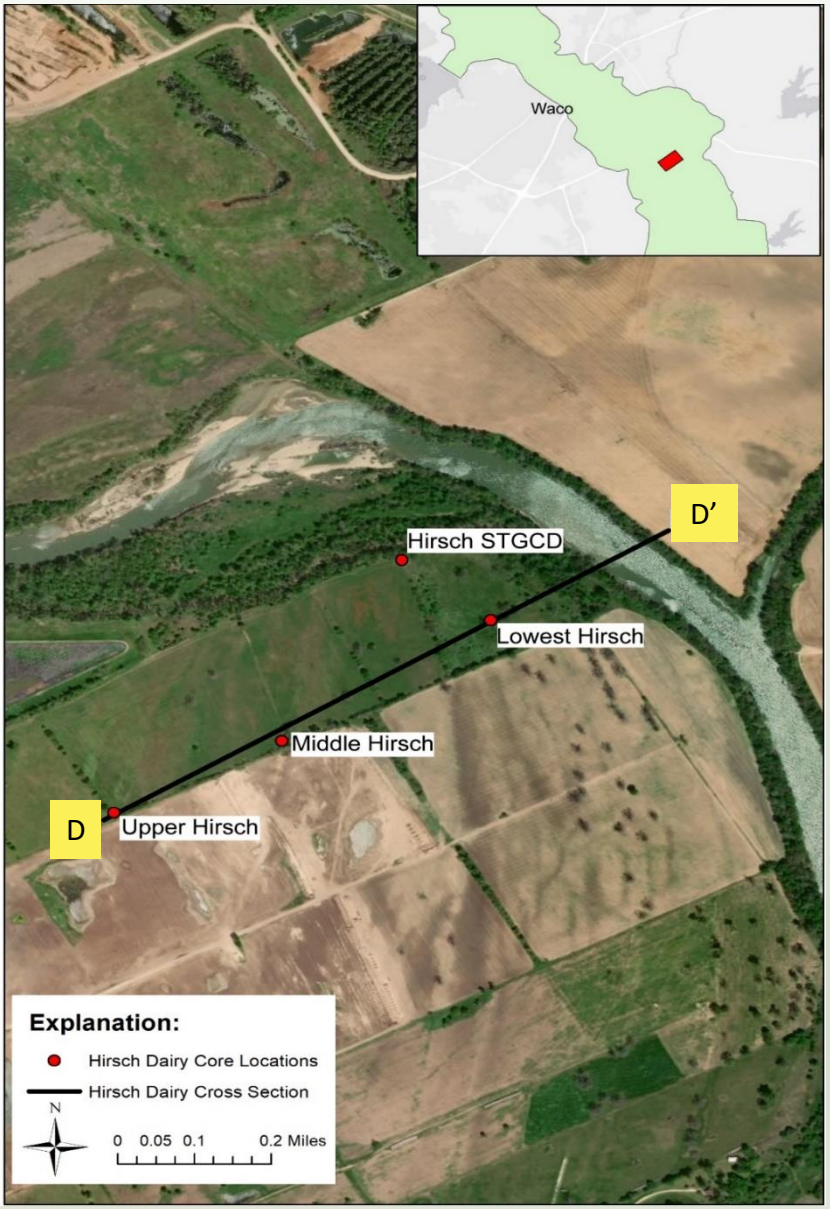

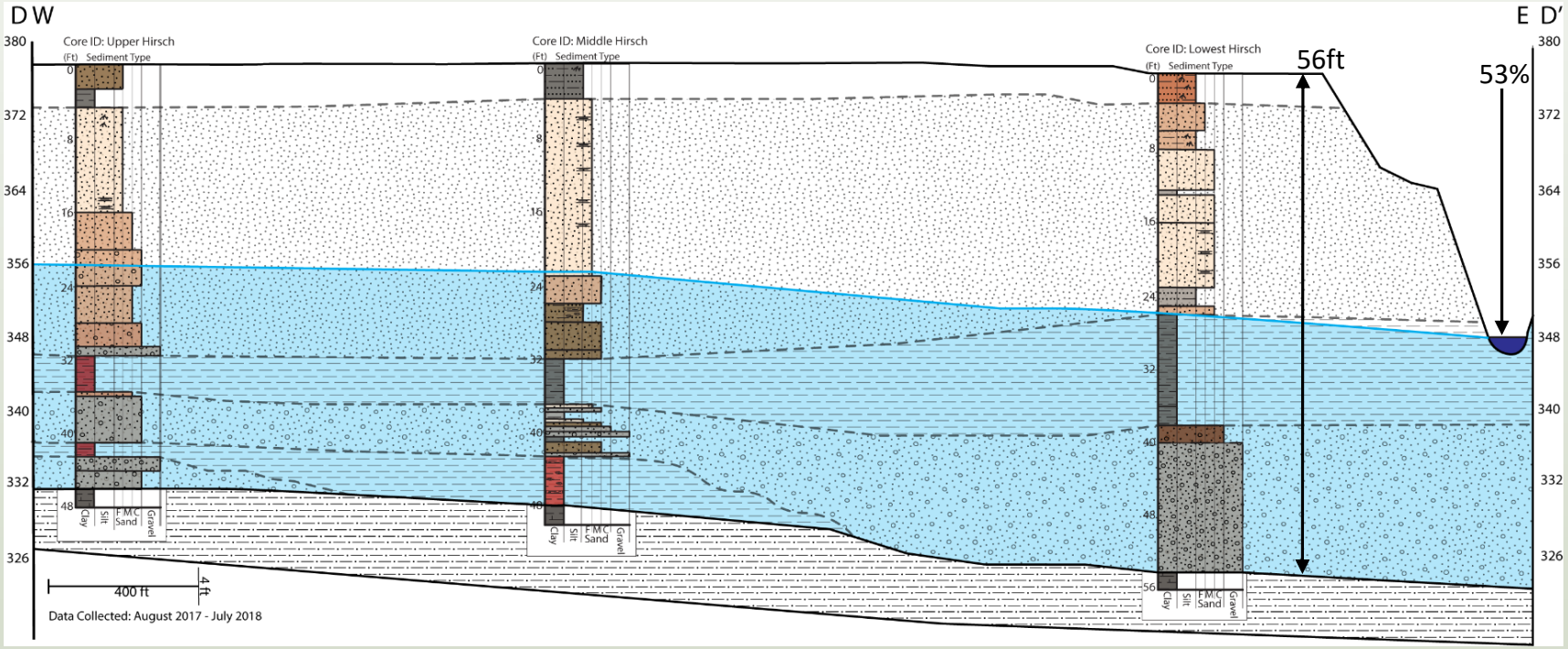

CONCLUSIONS

- The Brazos River is a discharge site and groundwater flow is toward the river.
- Brazos River influences groundwater flow direction, and serves a boundary.
- There are two types of boundaries; hydrologic boundary and absolute boundary.
- Interactions between the Brazos River and lateral bedrock boundaries forms compartments.
- Compartments vary greatly in size. Compartmentalization is more prominent in the incised meandering portion.
- The northern segment could be divided into incised meandering portion and the floodplain meandering portion.

ACKNOWLEDGMENTS

Southern Trinity Groundwater Conservation District, Scooter Radcliffe, and Baylor University: Thank you for supplying the funding, data, and support needed to complete this project.

Dr. Yelderman and members of the hydrogeology lab: Thank you for the guidance, assistance, and encouragement.

Committee members, Dr. Dworkin and Dr. Rowatt: Thank you for taking time from your busy schedule to review and provide feedback of my work.

Land Owners: Mark Jackson, Dannis Russell, Lewis Hirsch ,and Glen and Mary Maurcek

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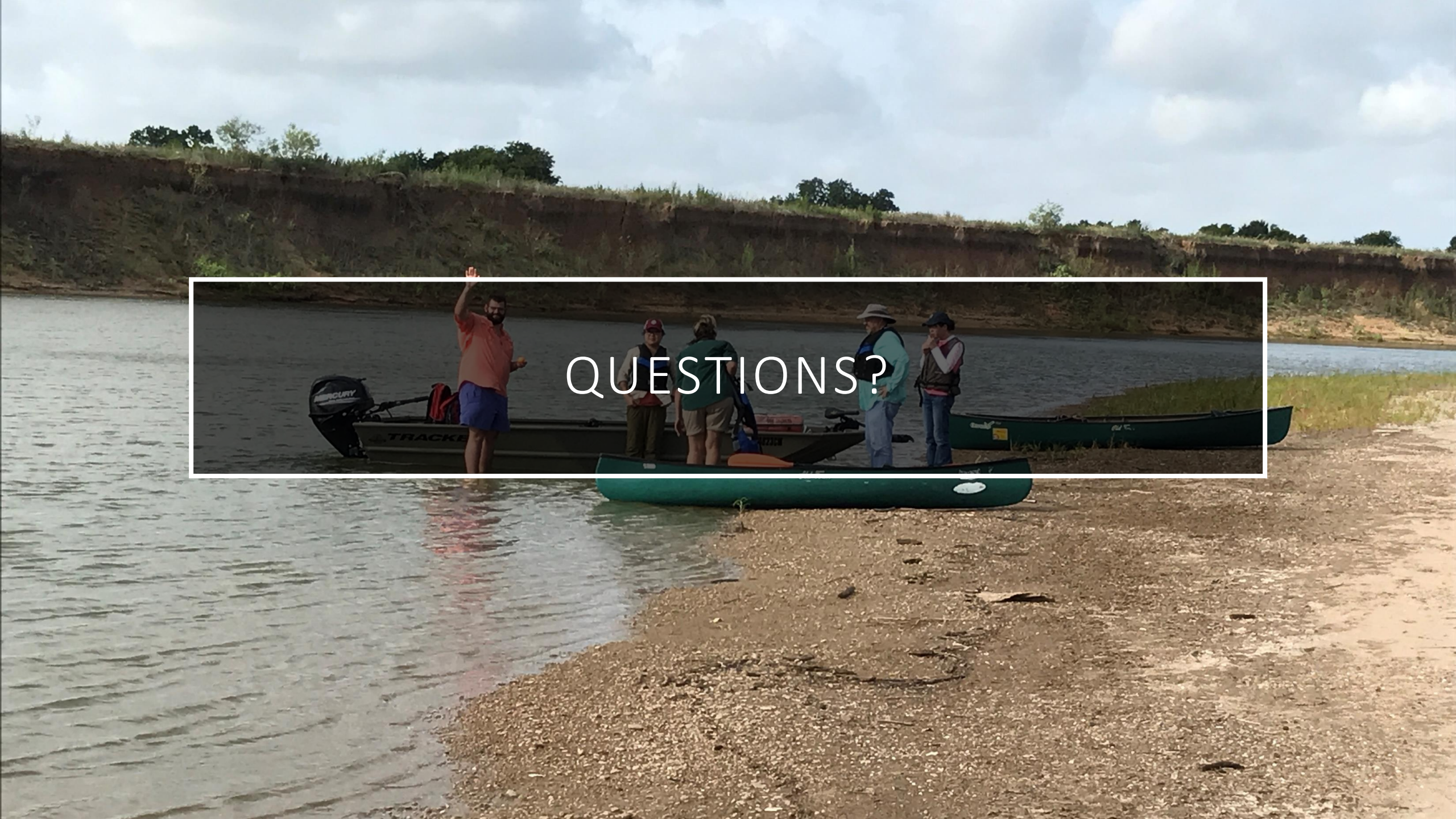
QUESTIONS?