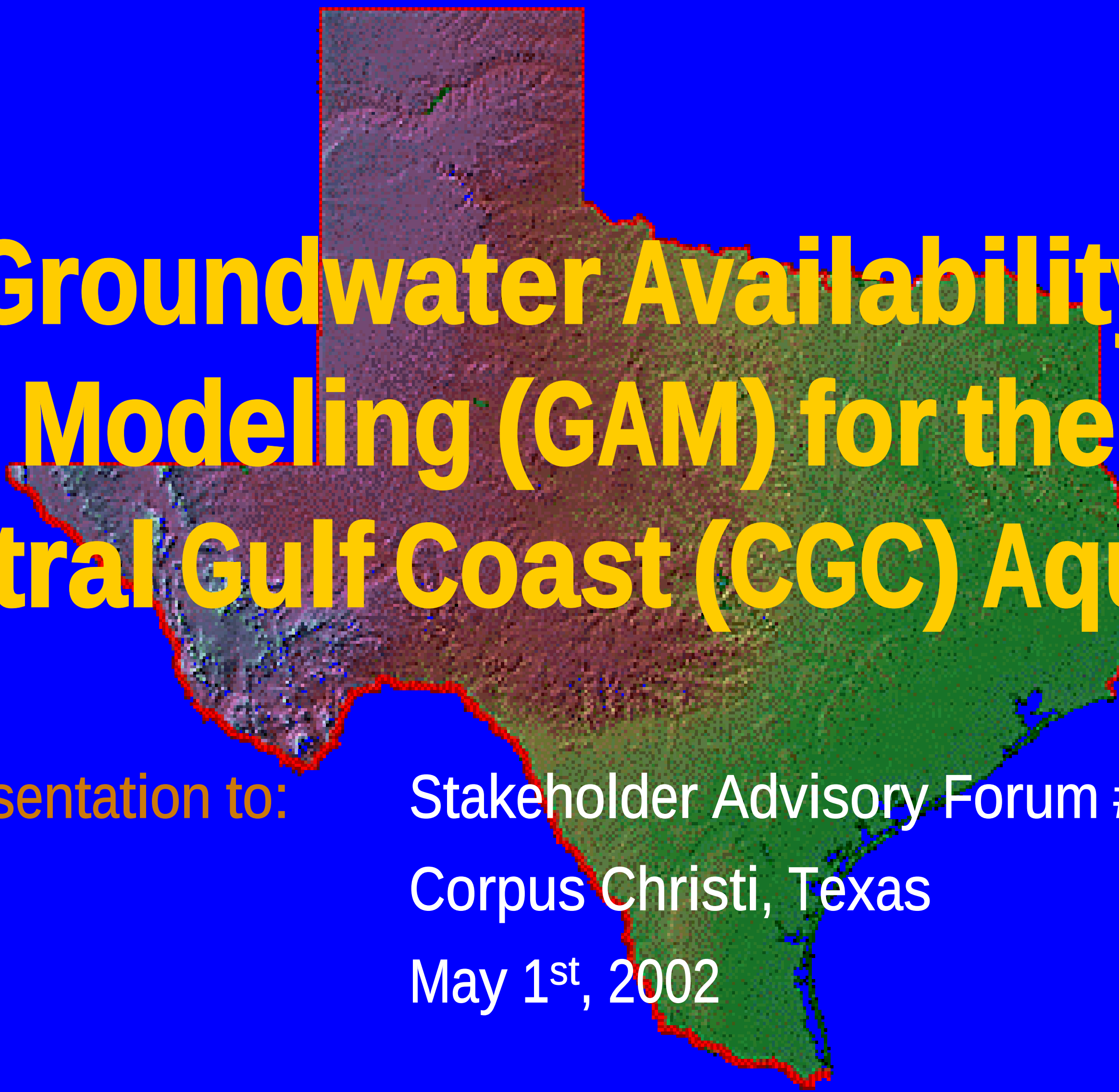


Groundwater Availability Modeling (GAM) for the Central Gulf Coast (CGC) Aquifer

A Presentation to:

Stakeholder Advisory Forum #5

Corpus Christi, Texas

May 1st, 2002

WATERSTONE
Environmental Hydrology and Engineering, Inc.

PARSONS

Presentation Outline

- GAM Objectives & Expectations
- GAM Schedule
- Creating the pre-development Central Gulf Coast GAM
  - Data incorporated into the model
  - Initial run results
- Topics Planned for Next SAF

GAM Objectives & Expectations

- Incorporate substantial Stakeholder input
- Produce standardized, publicly available groundwater flow models and supporting data (posted to the TWDB website)
- Provide water-management tools for regional water planning

GAM Schedule

Project quarter

2001

Feb

May

Aug

Nov

Technical meetings with TWDB

TWDB major tasks

Project kick-off

Intro SAF Meeting

SAF 2

Preliminary conceptual model presentation

SAF 3

GAM Schedule

Project quarter

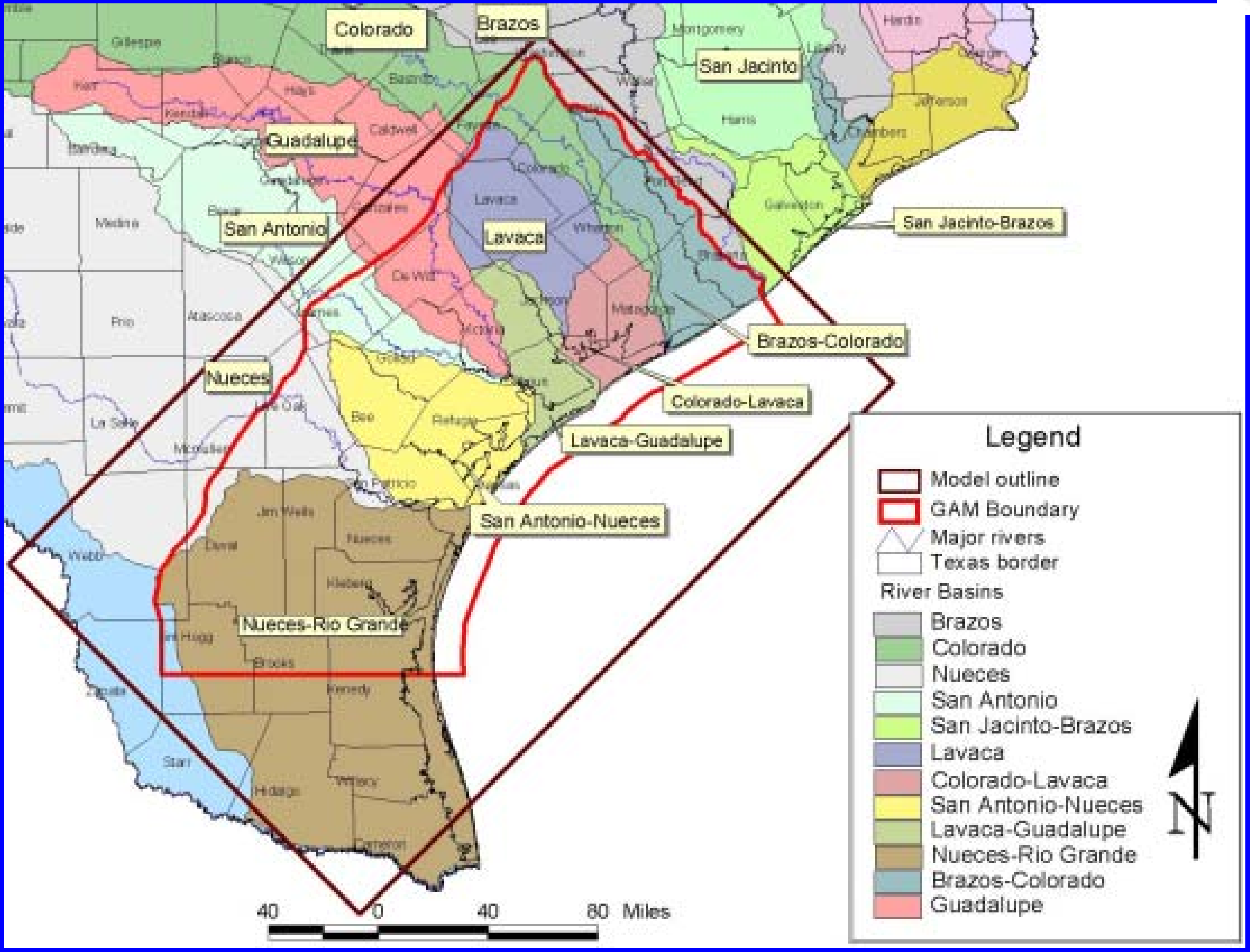
Technical meetings with TWDB

TWDB major tasks

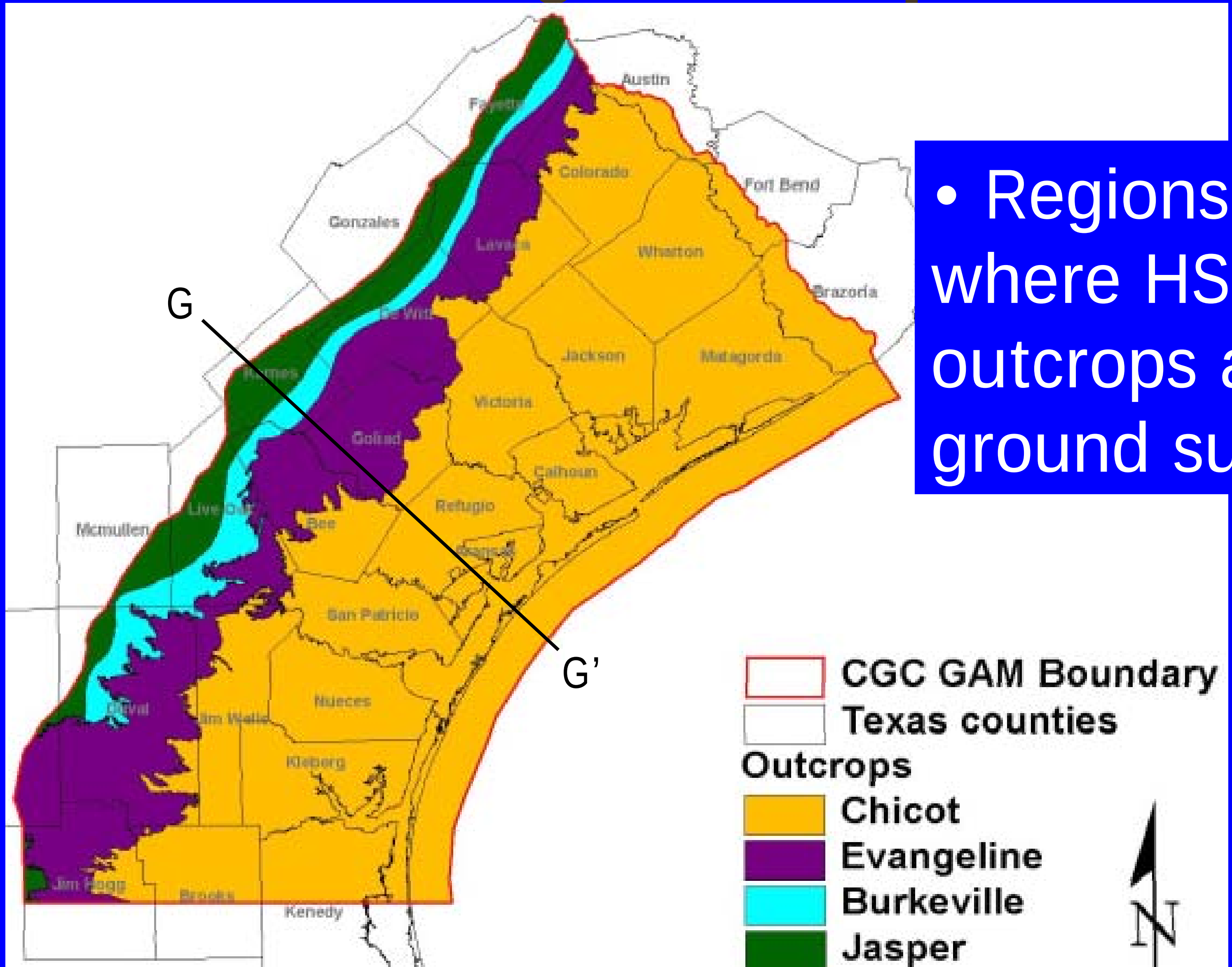
2002

Quarter	Milestone	Technical meetings with TWDB	TWDB major tasks
Feb	SAF 4		
May		Review of steady-state calibration	
		Review of transient calibration	
Aug	SAF 6		
		Review of predictions	
	Draft Report		
Nov			Review report
	Review comments	Review of draft report	
	SAF model training	TWDB model training	
Feb	Final deliverables		Post to Web

Model Grid, GAM Region, and River Basins



Hydrostratigaphic Unit (HSU) Geologic Outcrops



- Regions where HSU outcrops at ground surface

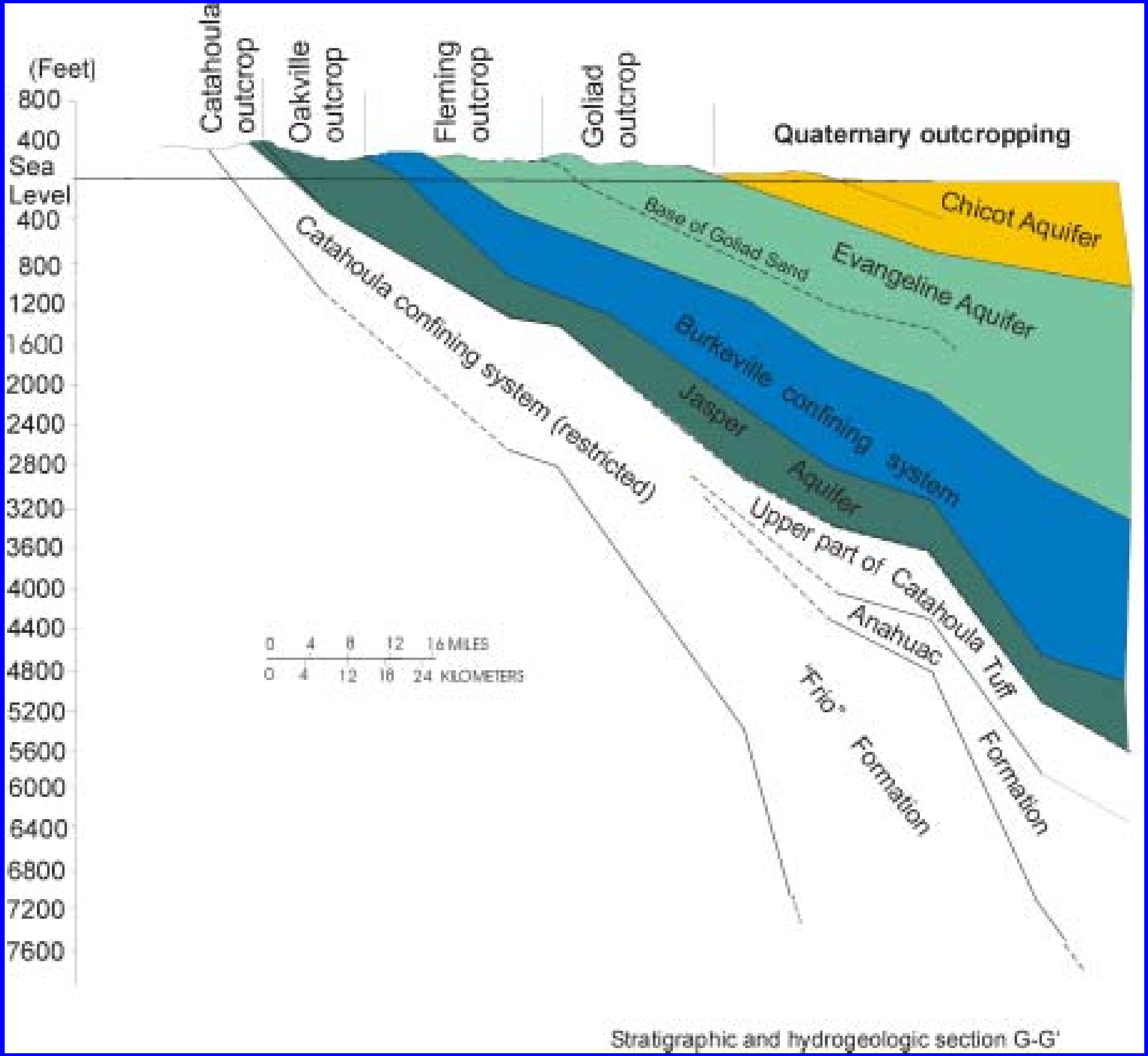
Vertical Cross Section

Jasper outcrop may include:
- Oakville sandstone
- Catahoula sandstone and tuff

Burkeville:
- typically lower Fleming

Evangeline:
- Goliad sand
- upper Fleming

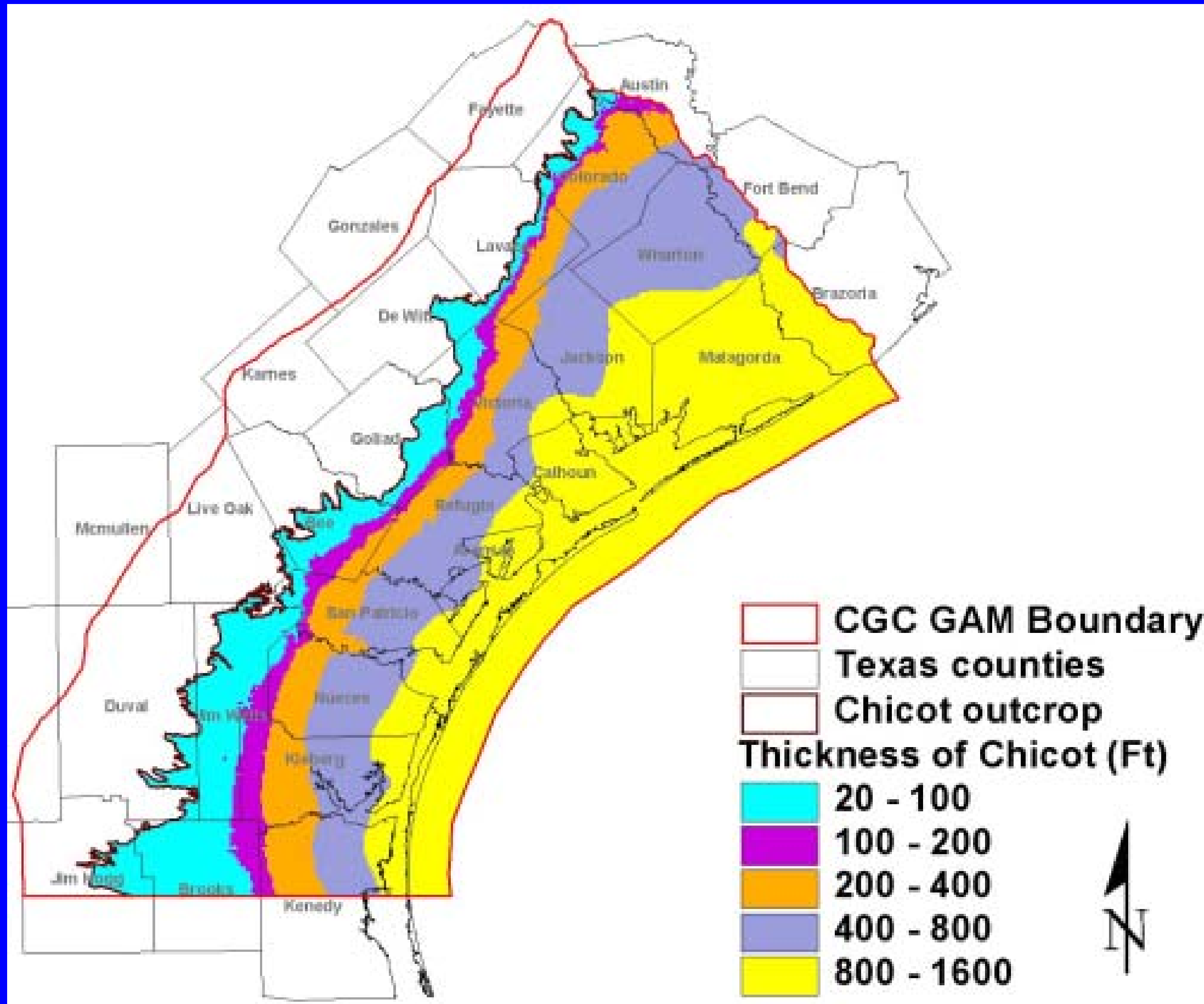
Chicot
- surface alluvium
- shallow units overlying Evangeline



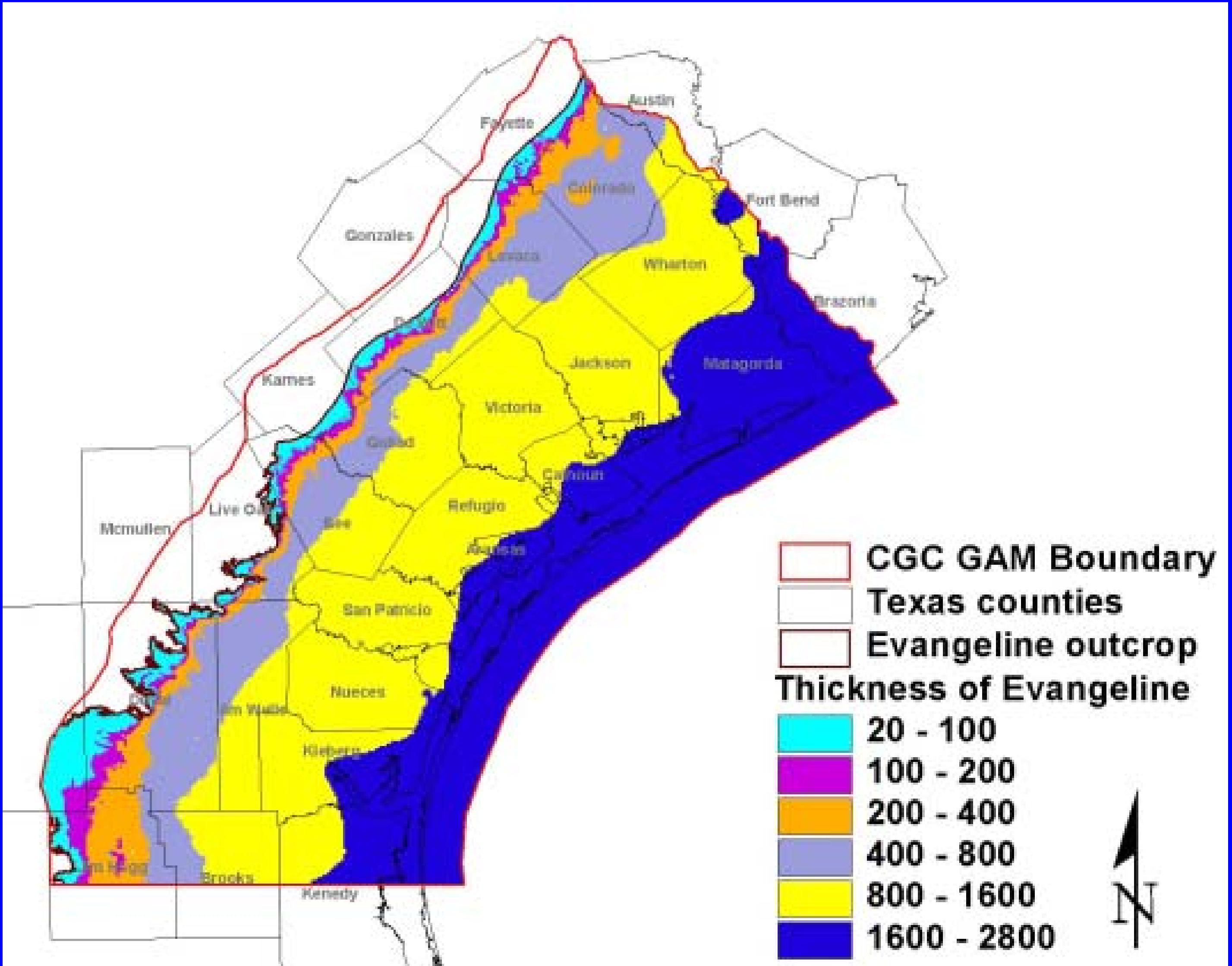
Vertical Exaggeration ~ 30x's

Chicot Aquifer Thickness

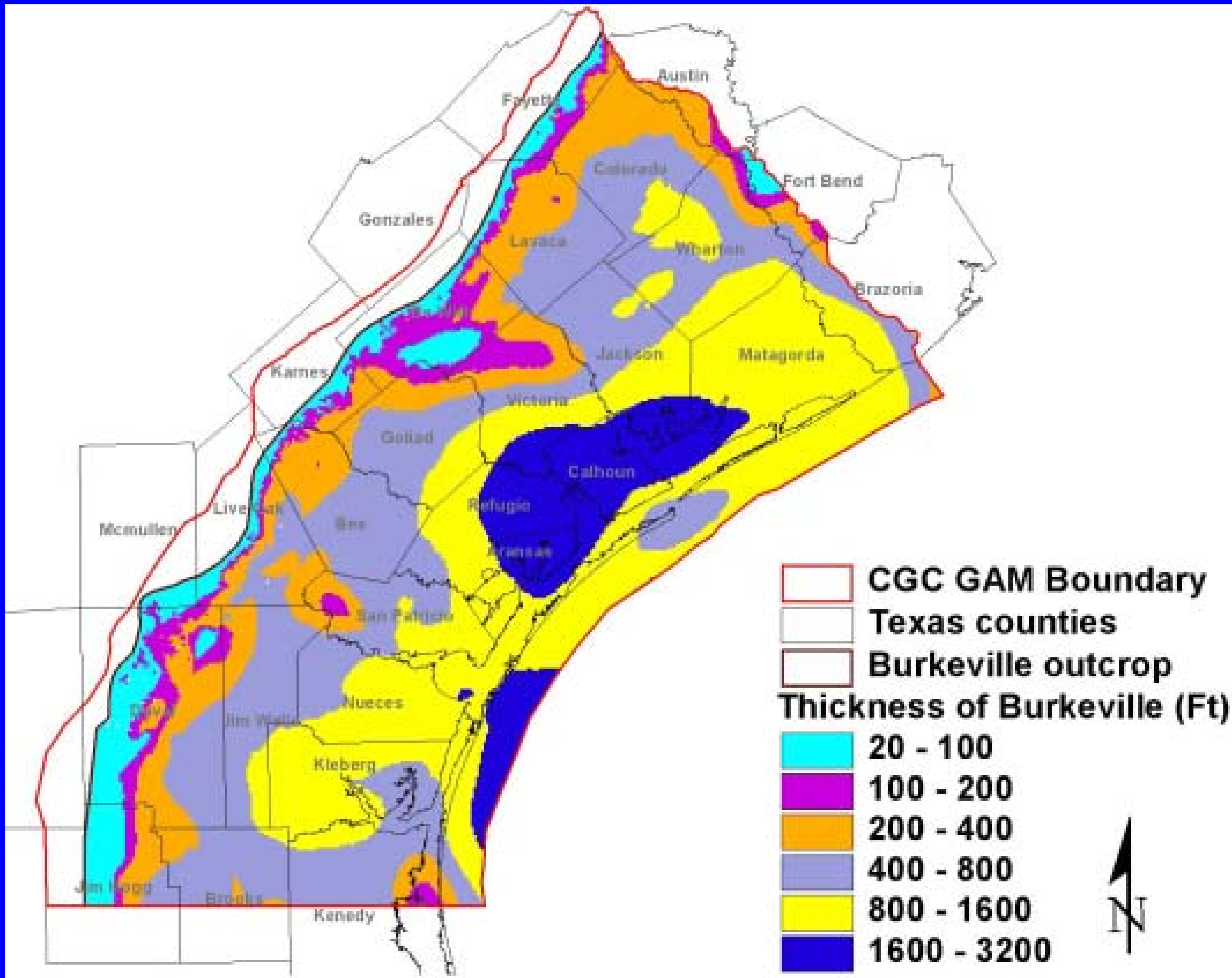
- Cross section information taken from:
  - Baker (1979),
  - Carr (1985),
  - Kasmarek and Strom (1996).



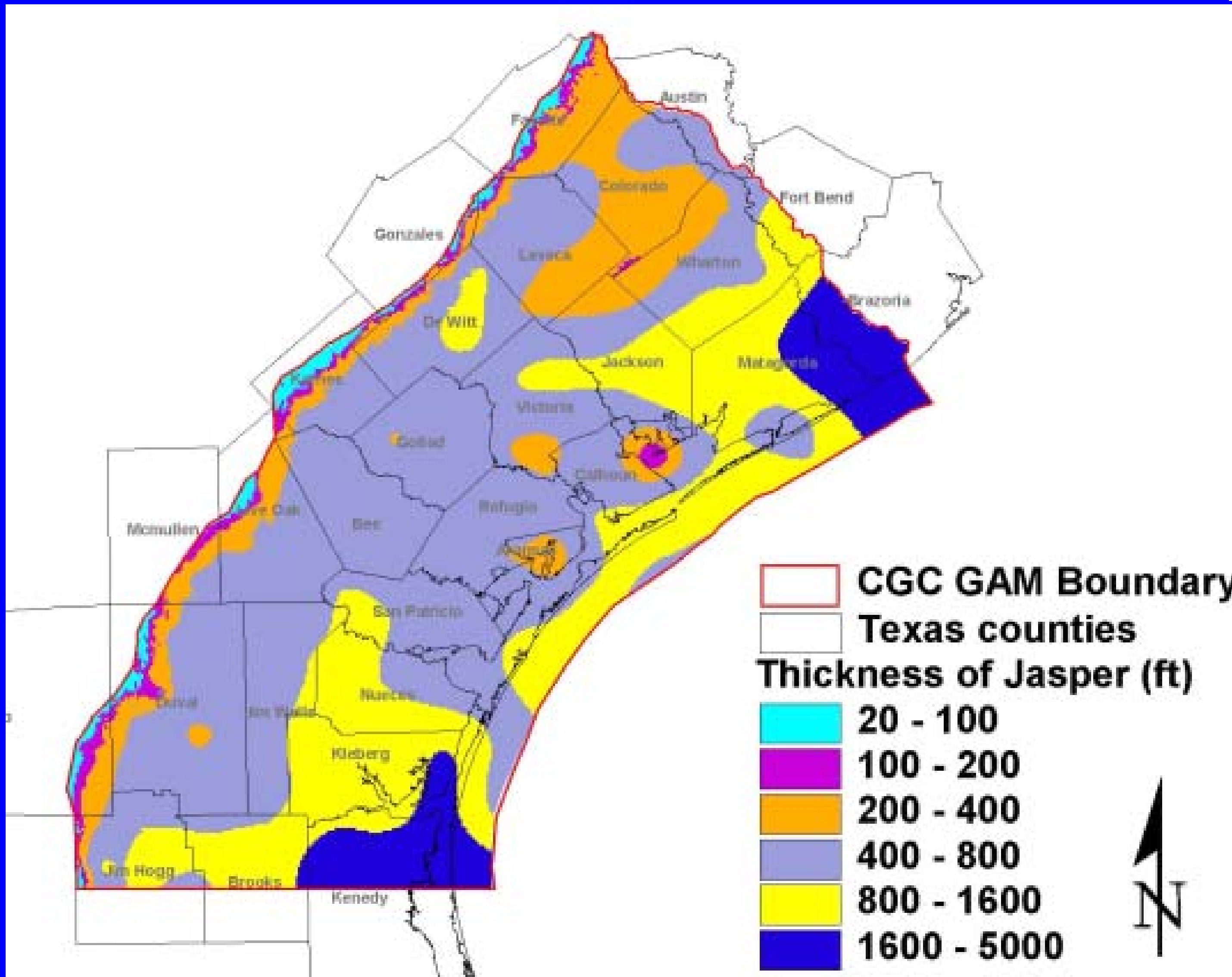
Evangeline
Aquifer Thickness



Burkeville
Confining-System Thickness

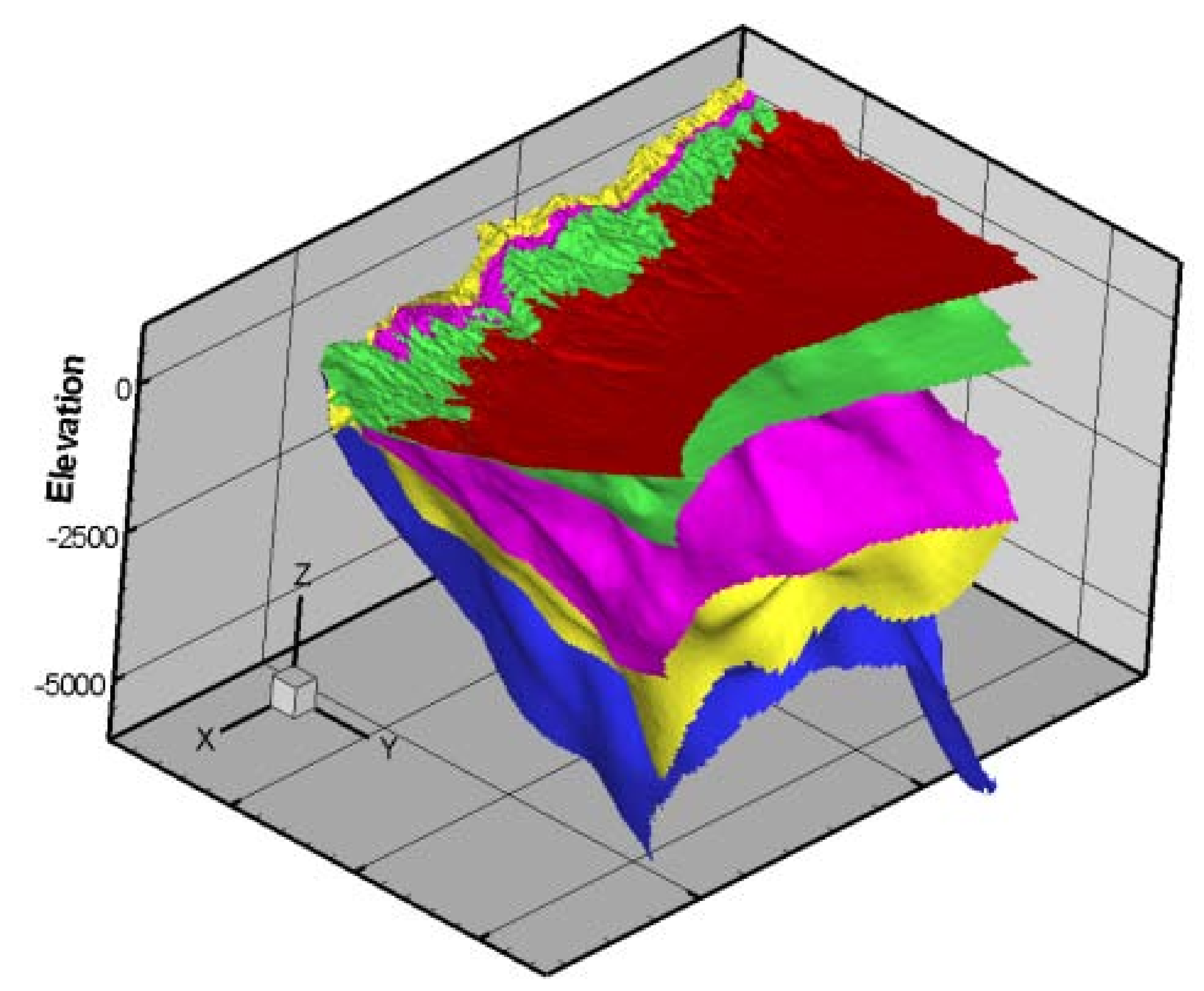


Jasper
Aquifer Thickness



Steady-State Model Development

- Hydrostratigraphic structure (layers)
- Next:
  - Discretize structure into model grid (1 mile x 1 mile)
  - Incorporate Hydraulic properties, recharge, evapotranspiration, and surface water.
- Assign Boundary conditions

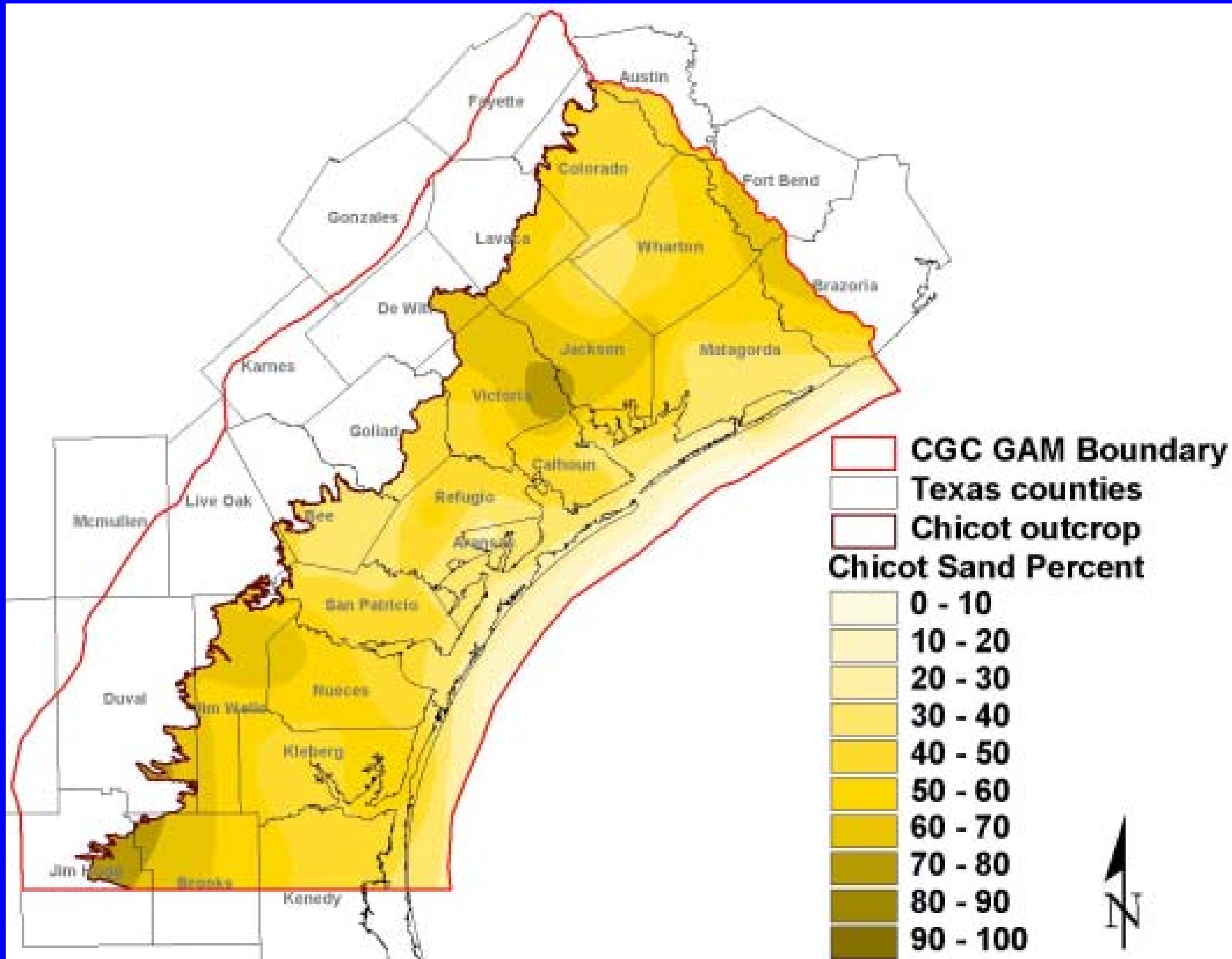


Flow Potential (Transmissivity)

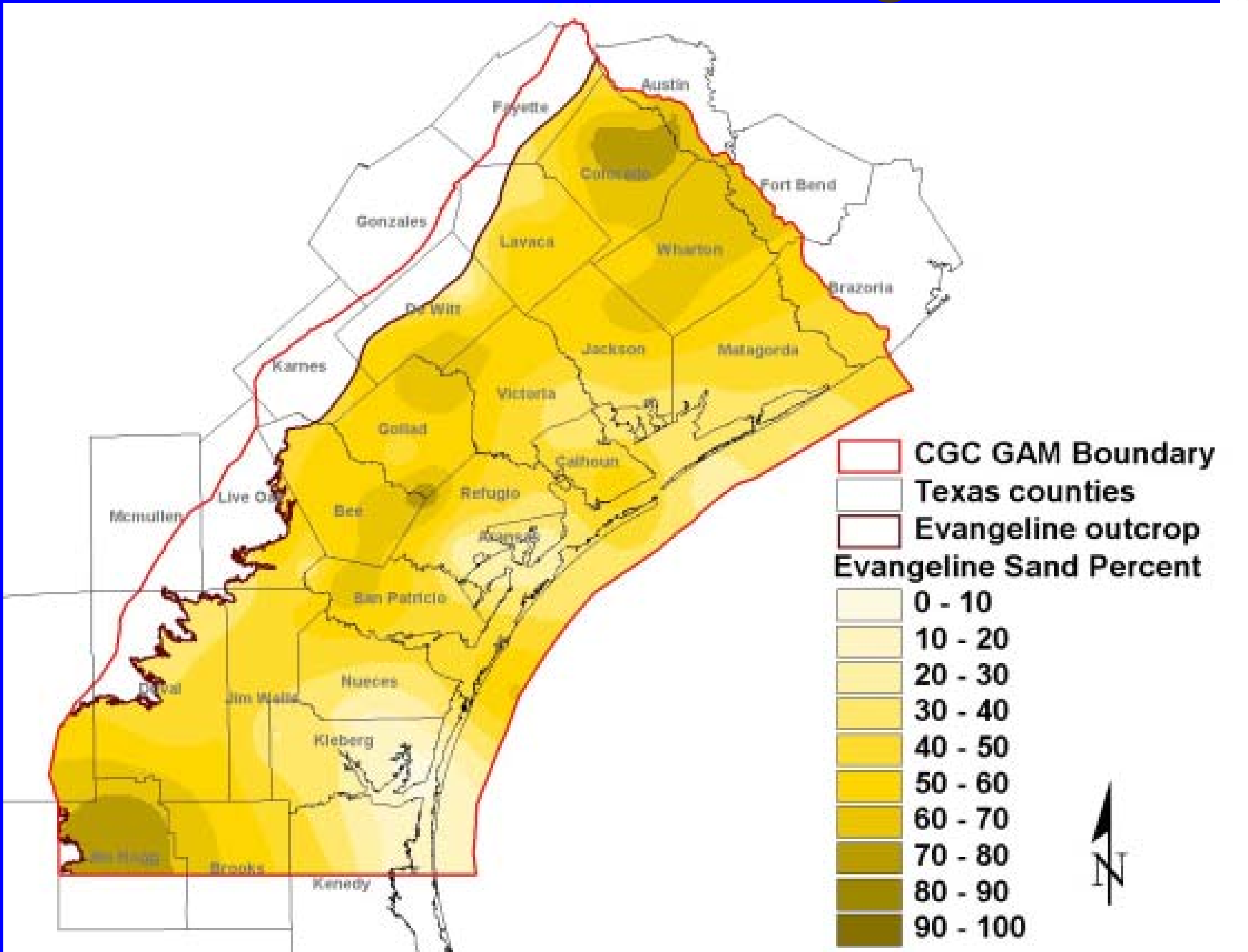
- Water comes primarily from the sand lenses.
- To characterize flow potential, need to characterize spatial distribution of sands:
- Transmissivity calculations:
  - pump-test transmissivity
  - screened interval → hydraulic conductivity of sands
  - sand percentage and aquifer thickness → sand thickness
  - aquifer transmissivity

Chicot
Sand Percentage

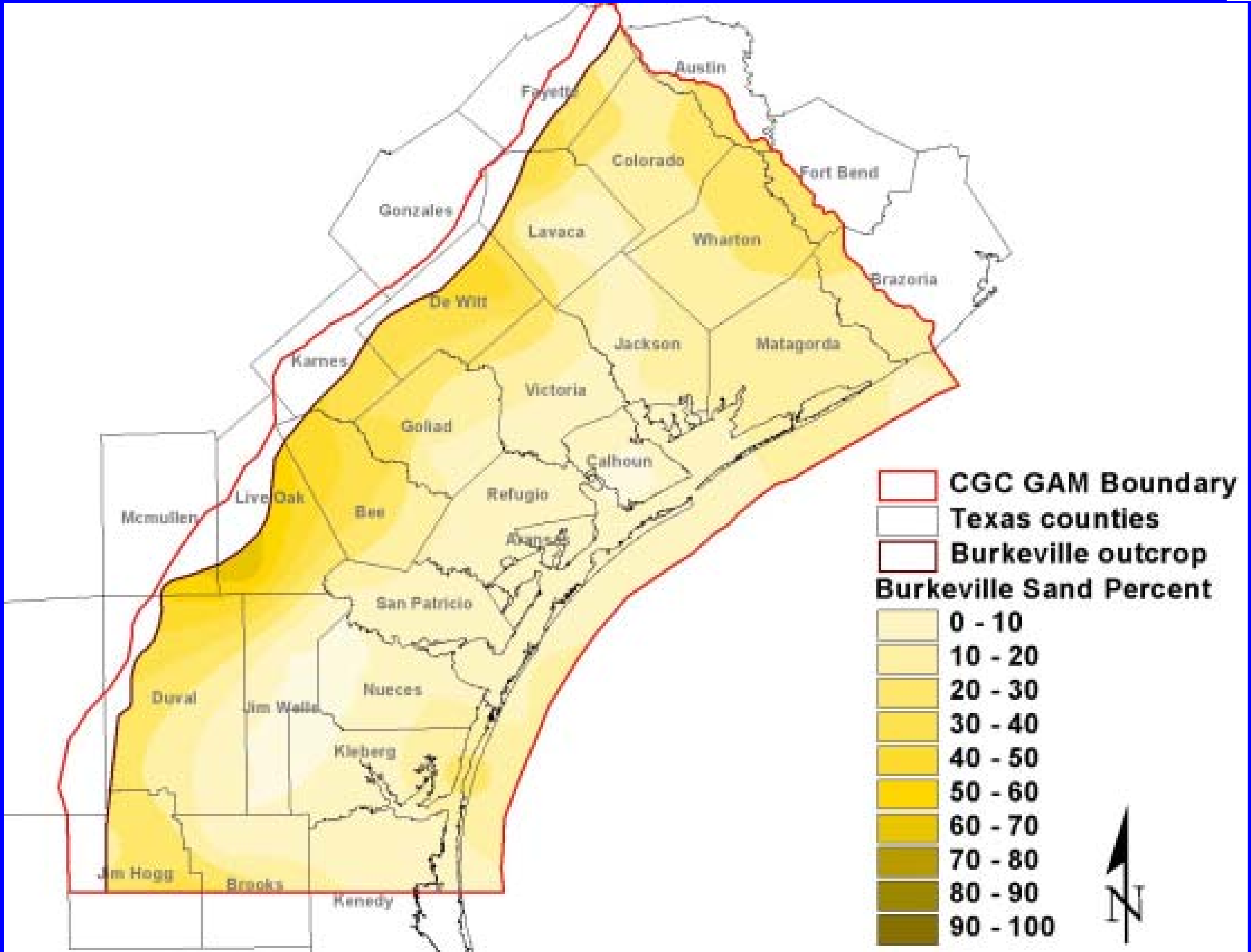
- Sand percentages based on point values from:
  - Baker (1979),
  - Wilson and Hosman (1987).



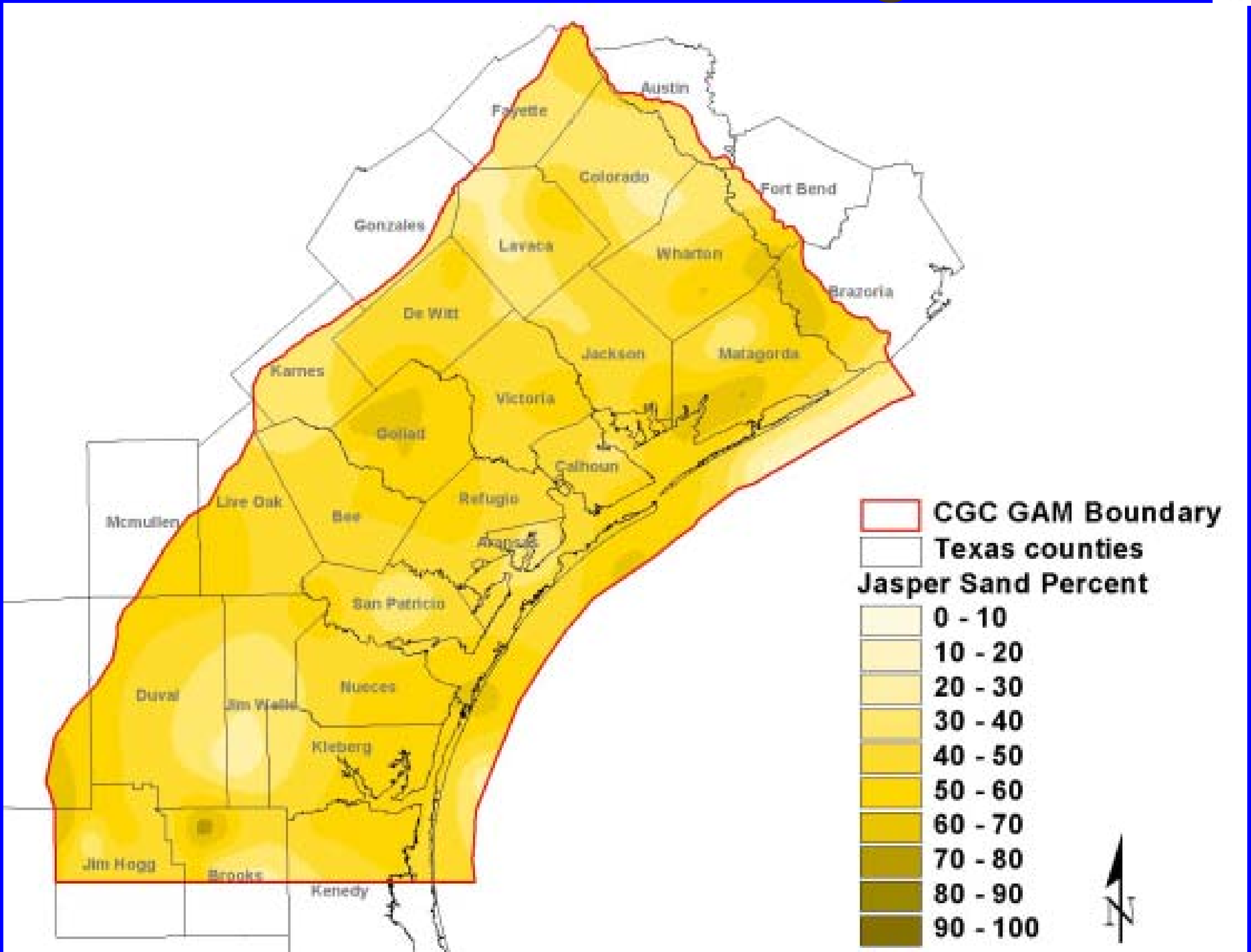
Evangeline Sand Percentage



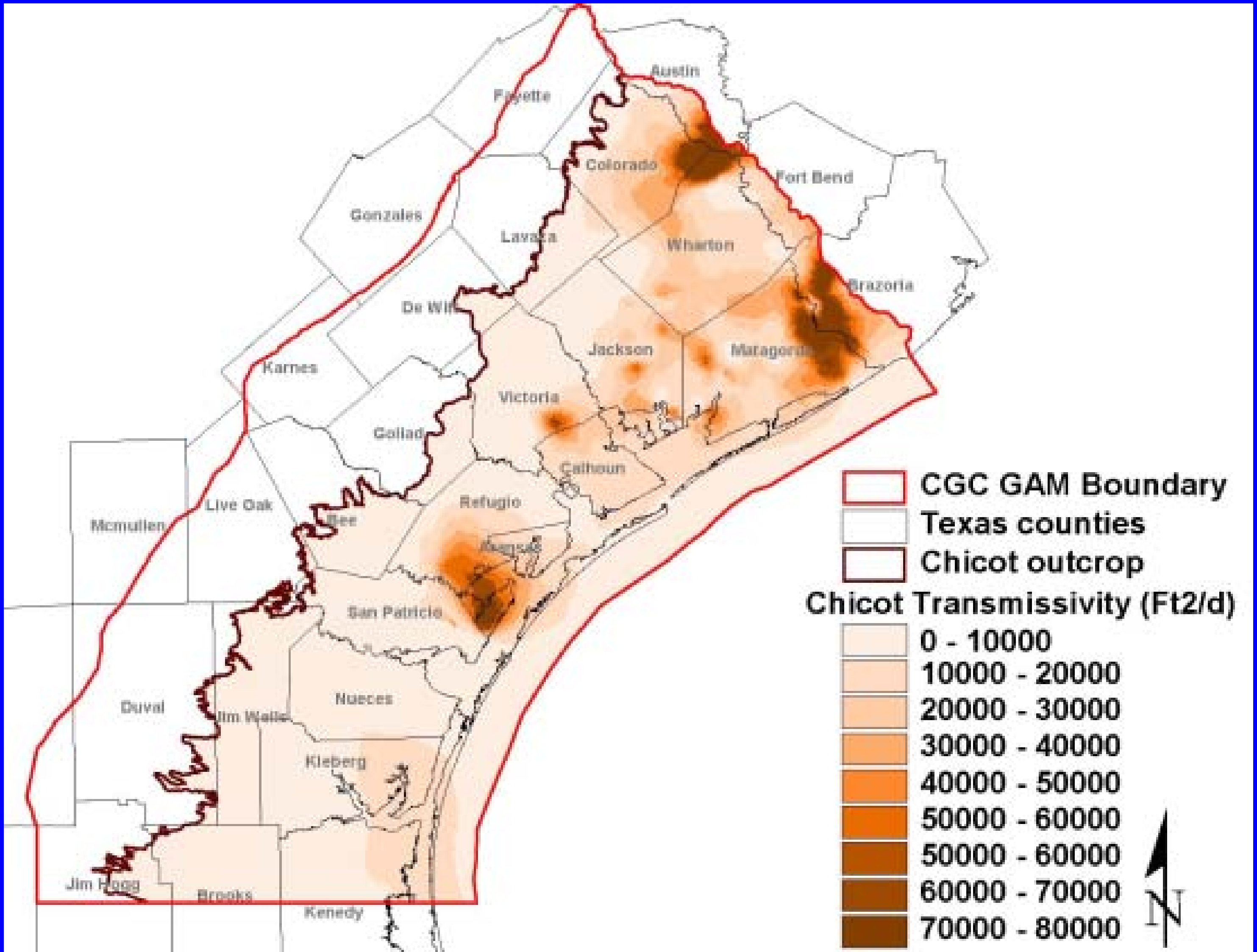
Burkeville
Sand Percentage



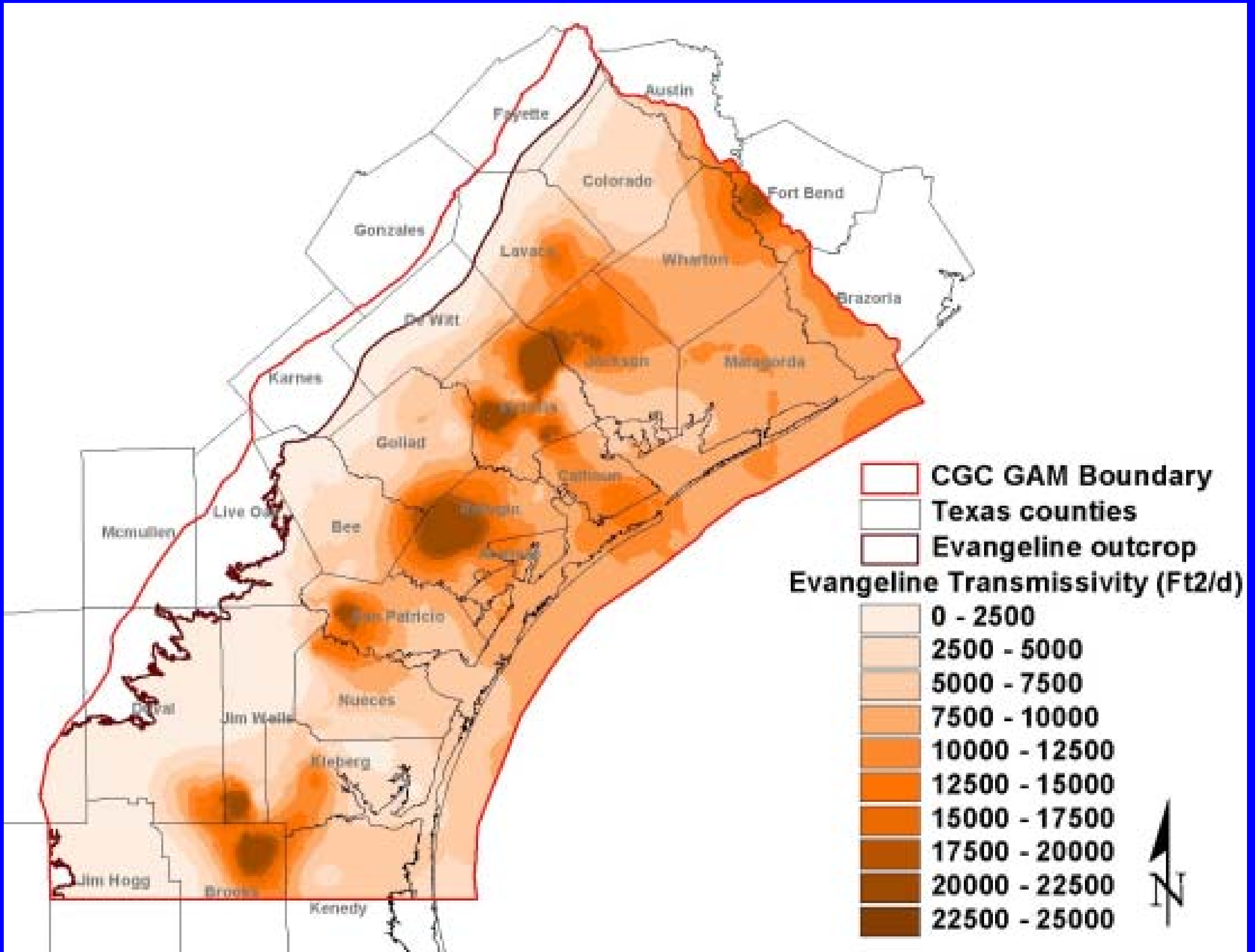
Jasper
Sand Percentage



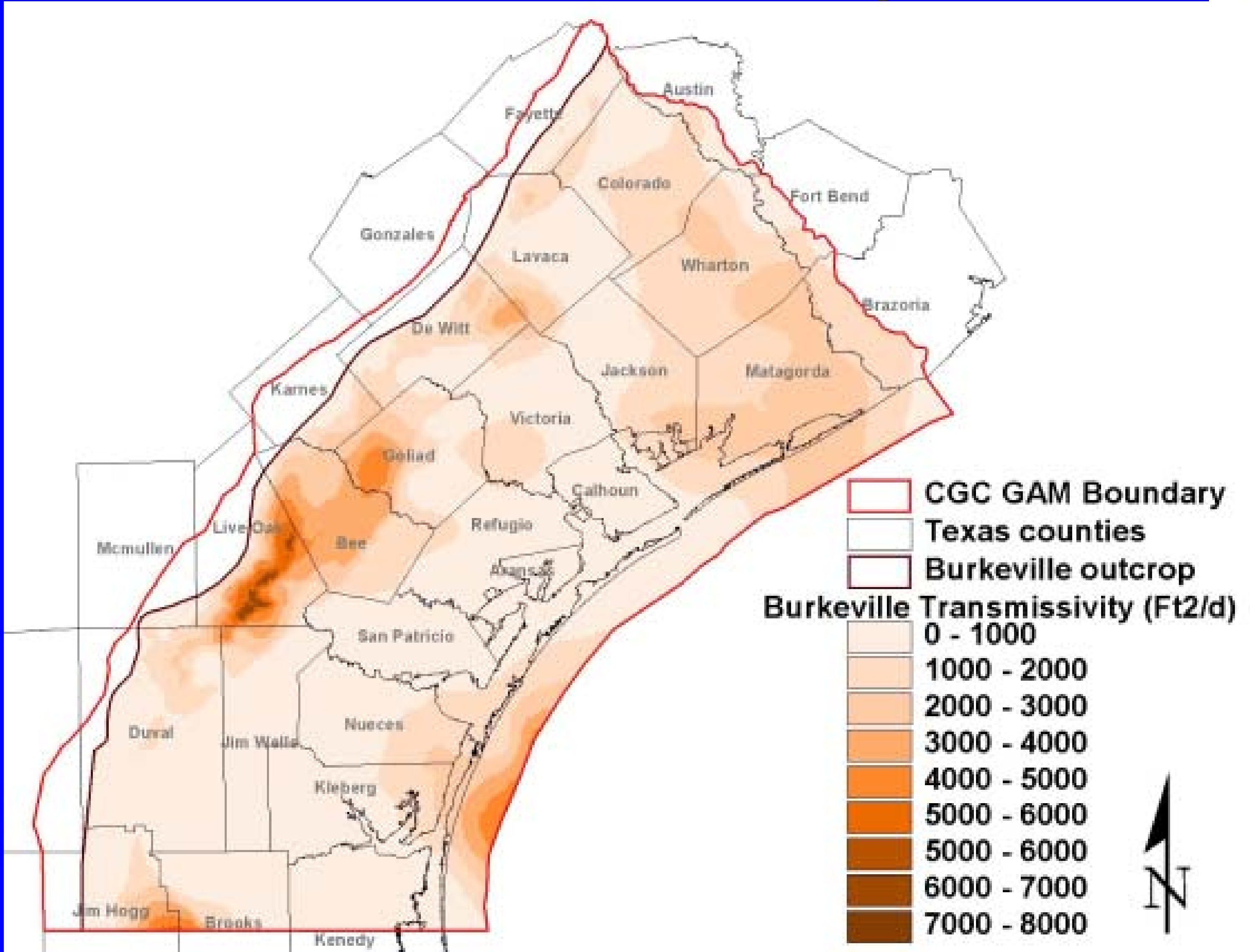
Chicot Transmissivity



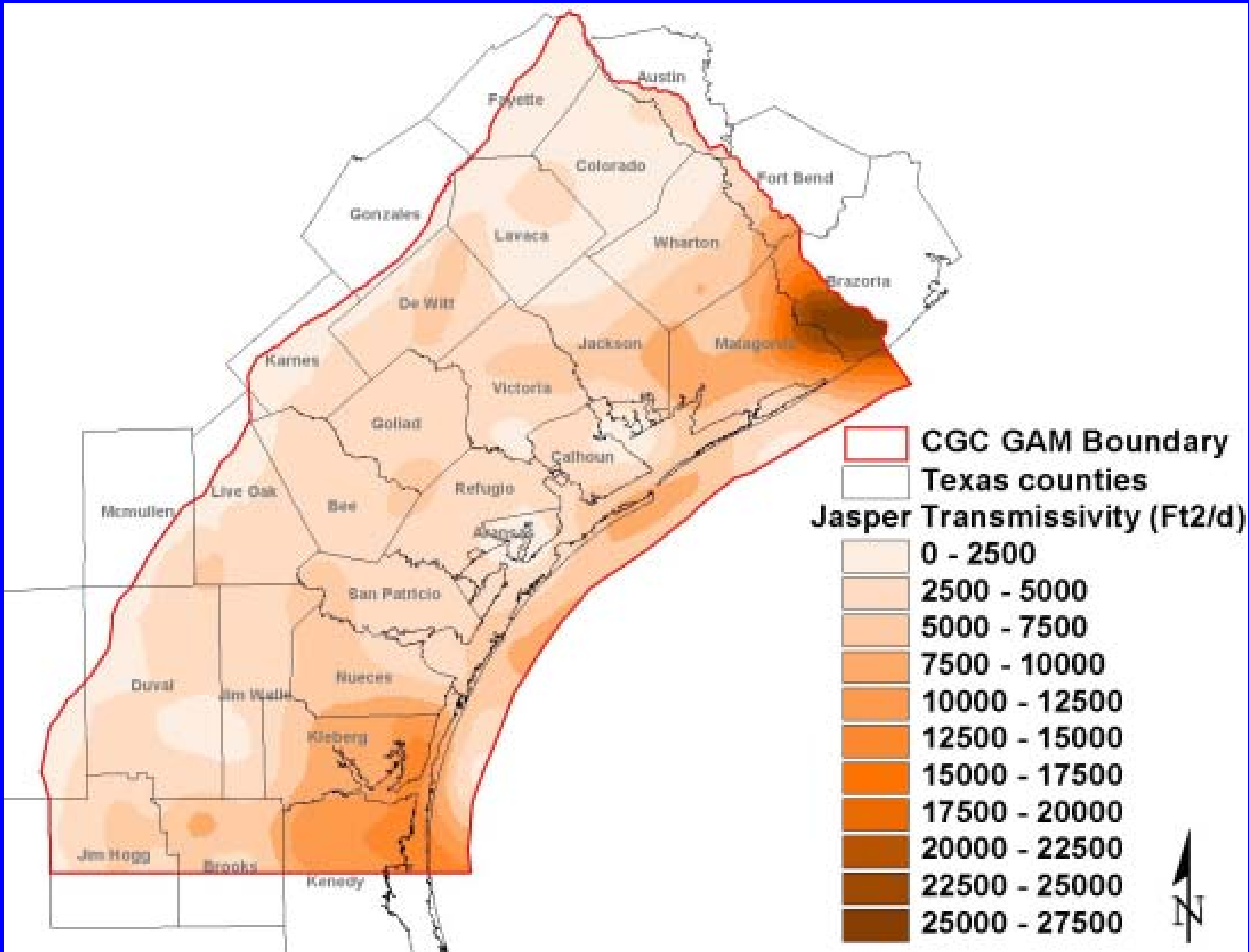
Evangeline Transmissivity



Burkeville Transmissivity

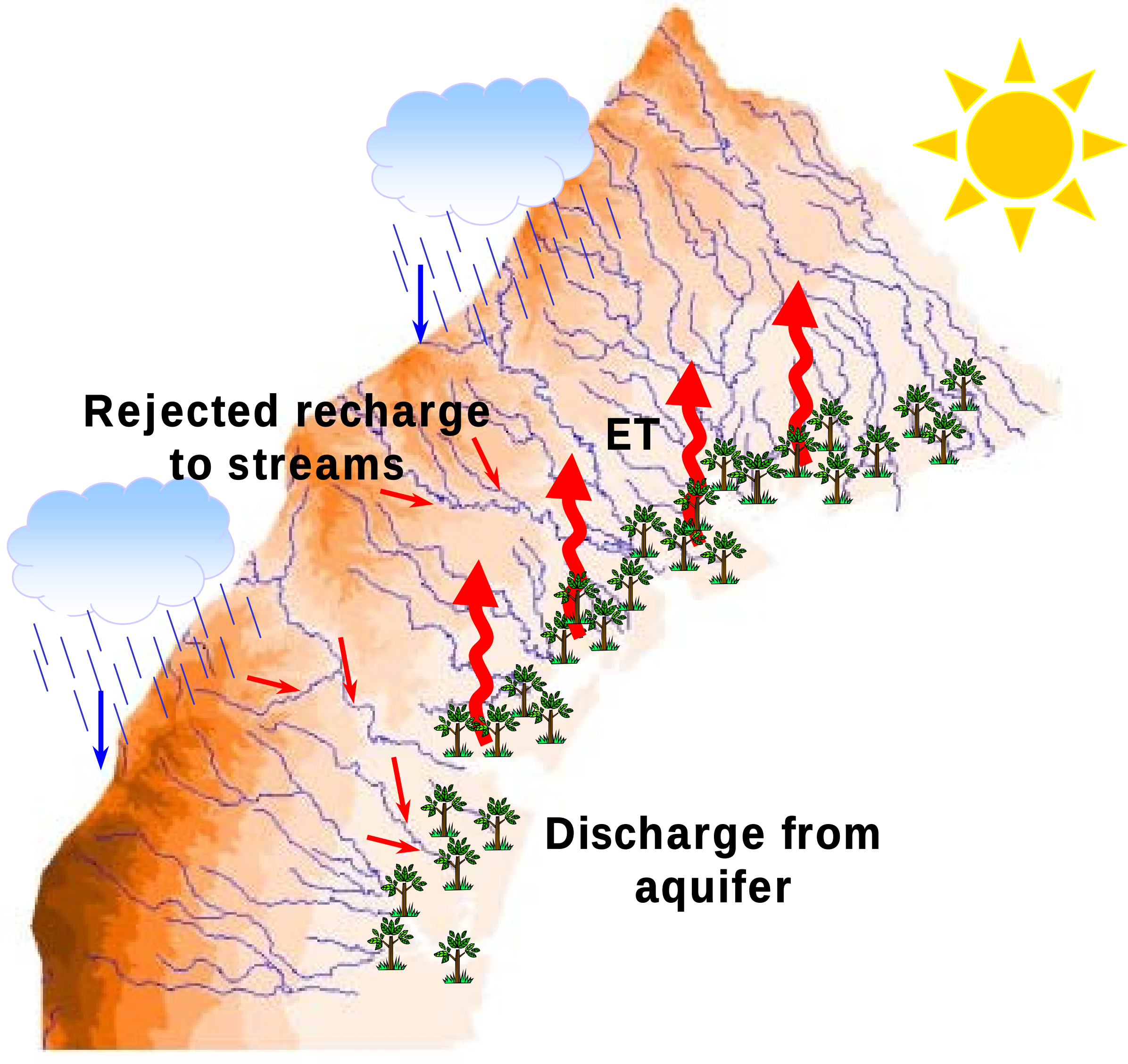


Jasper Transmissivity



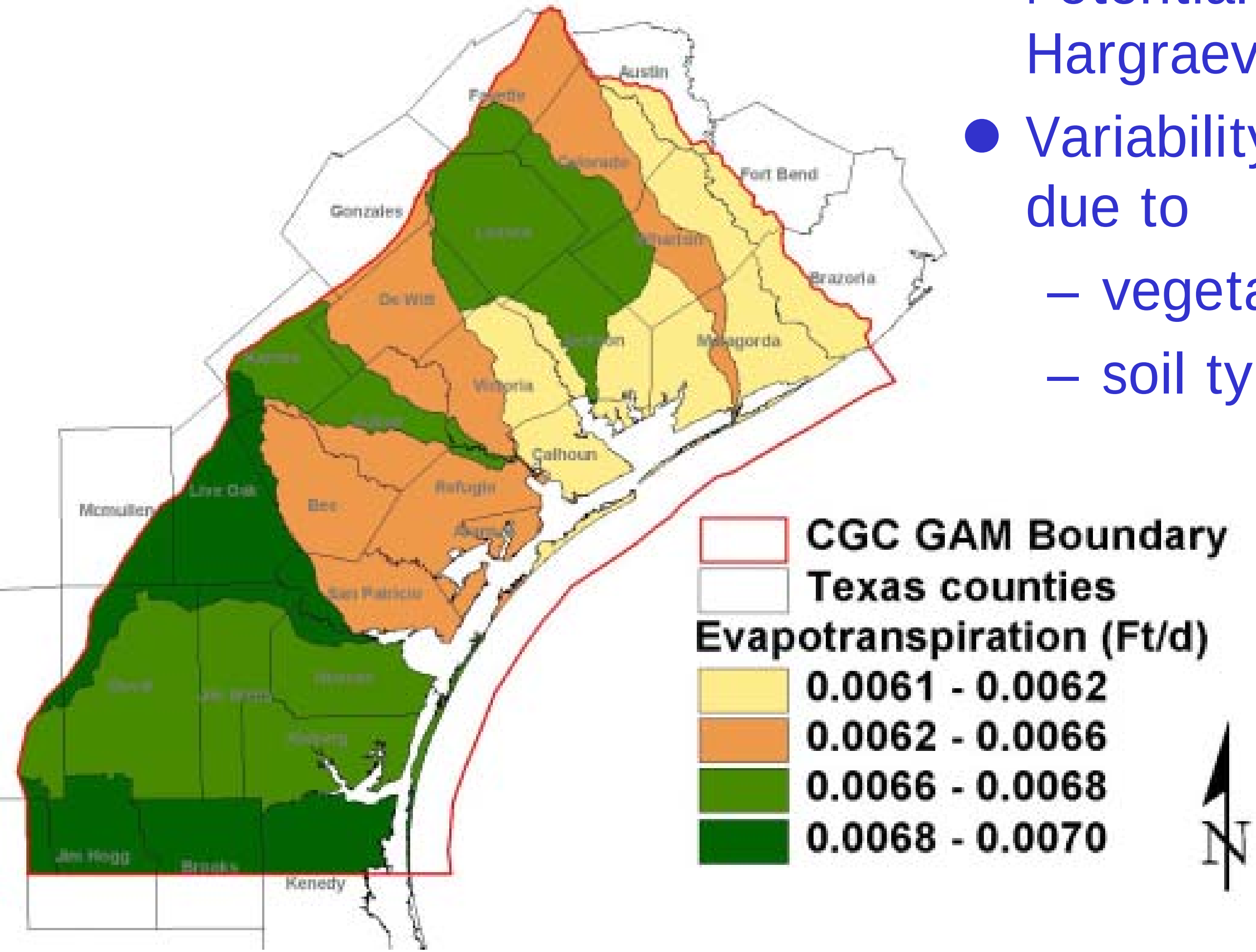
Hydrologic Cycle

- Water enters and leaves the aquifers as part of the hydrologic cycle
- Need to tell the model how much water is entering and leaving
  - Recharge
  - Rejected recharge
  - Discharge
  - Evapotranspiration



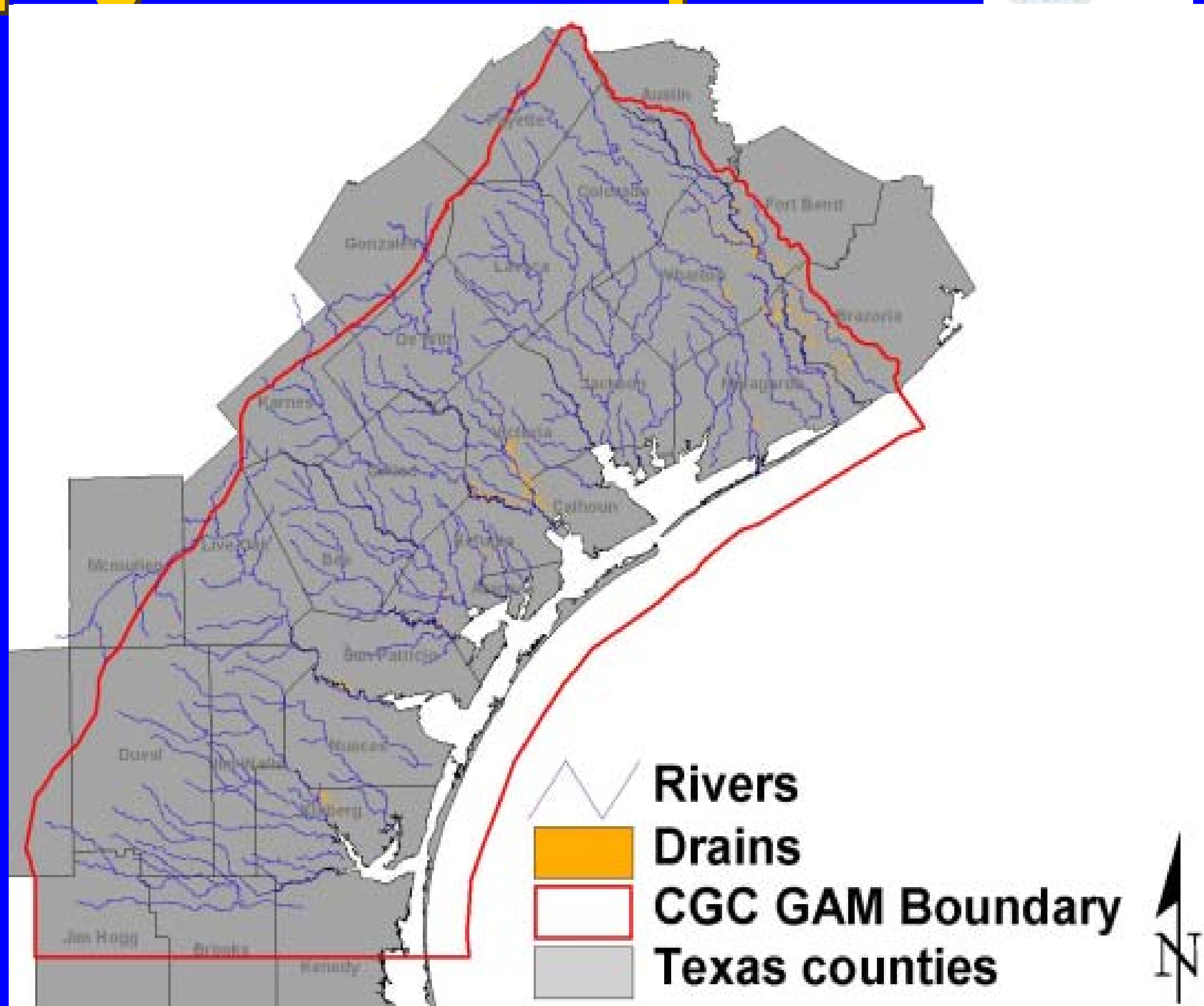
Evapotranspiration (ET)

- Potential ET from Hargraeves.
- Variability of actual ET due to
  - vegetation type and,
  - soil type.



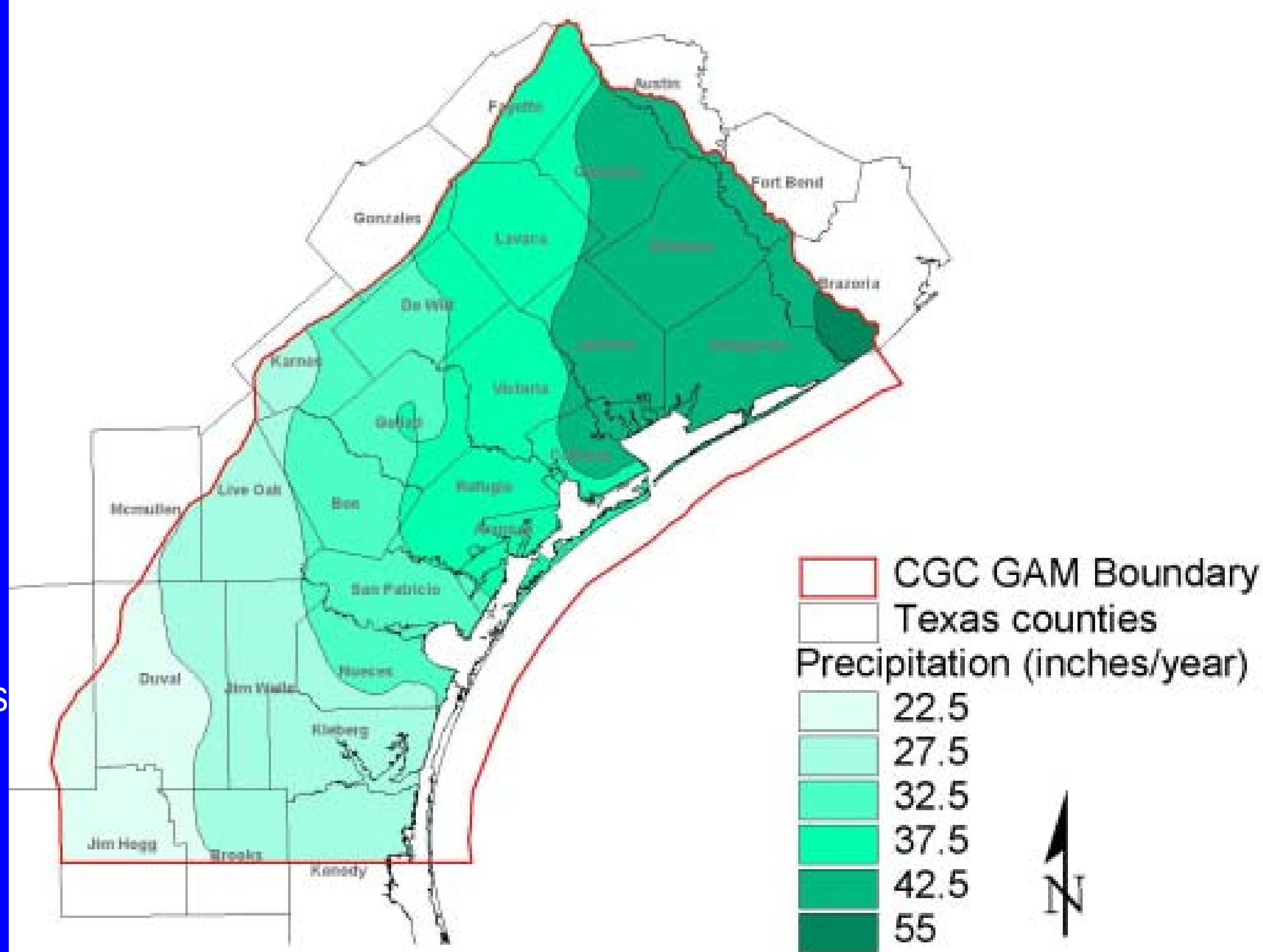
Seepage from the Aquifer

- Water leaves the aquifer through springs, seeps and wetlands
- Wetlands indicate high potential for discharge from the aquifer

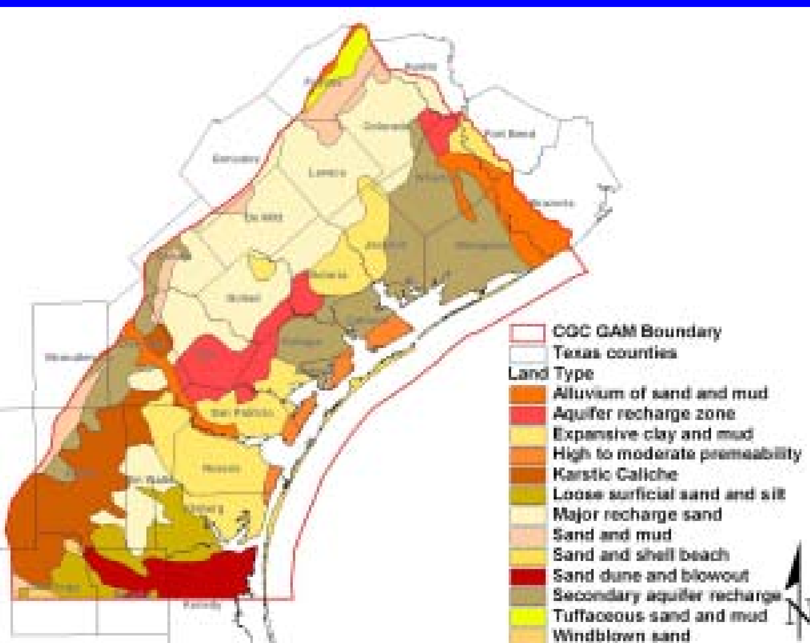


Precipitation: Potential Recharge

- A primary source of water to the aquifer
- Data are mean annual averages from 1961-1990
  - PRISM (Parameter-elevation Regressions on Independent Slopes Model)

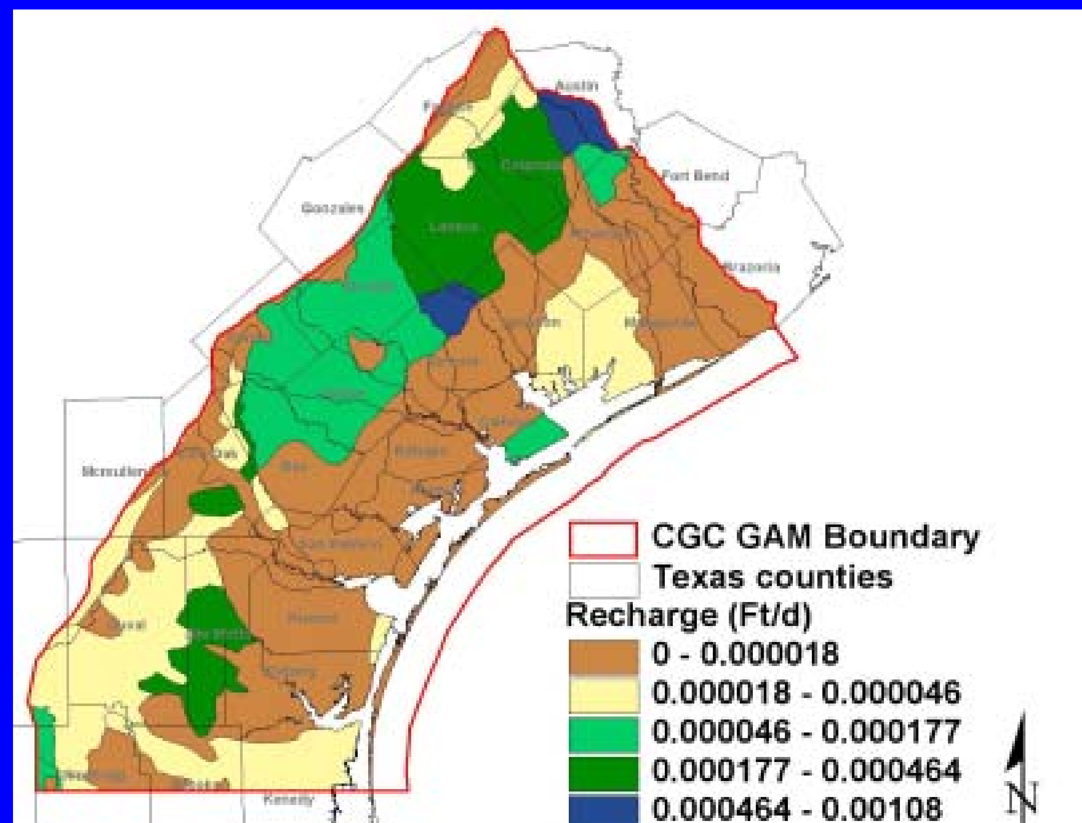


Recharge Potential



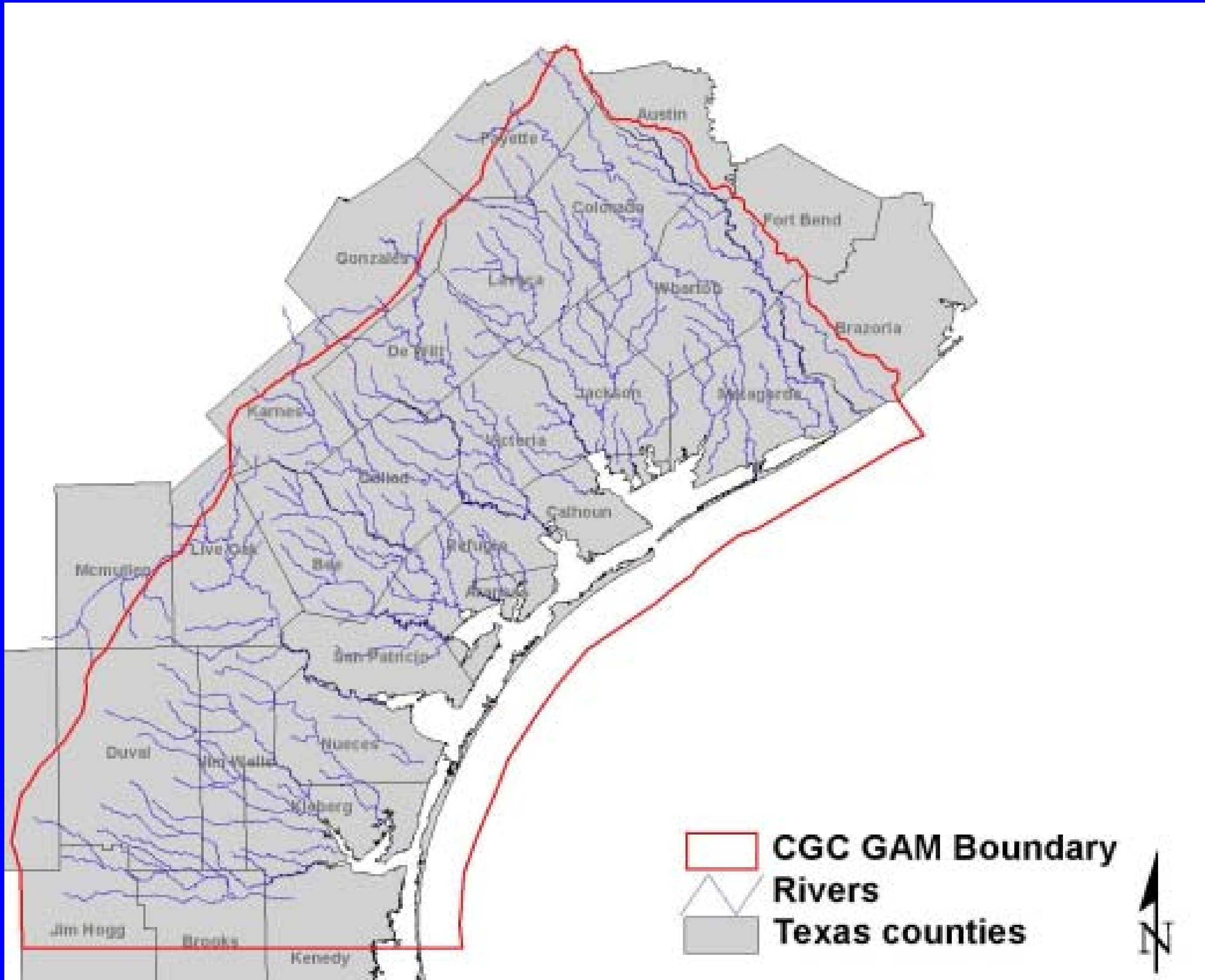
Land-resource map (Bureau of Economic Geology)

Combine land-resource types and lumped river basin recharge estimates (Muller and Price, 1979)

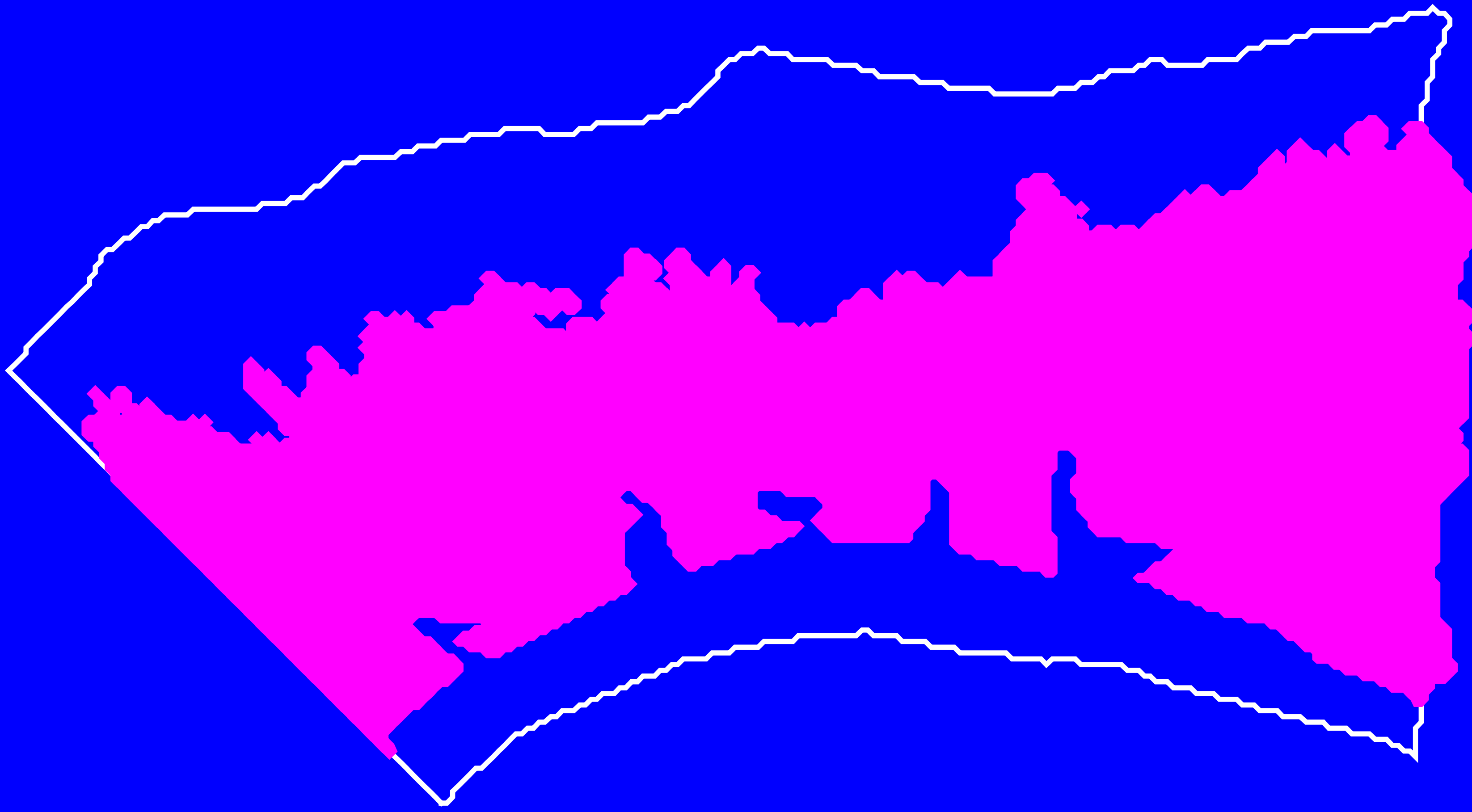


Streamflow

- Dense network of rivers and streams throughout the CGC
- Streams can function in two roles:
  - discharge
  - recharge



Chicot - Active Boundary

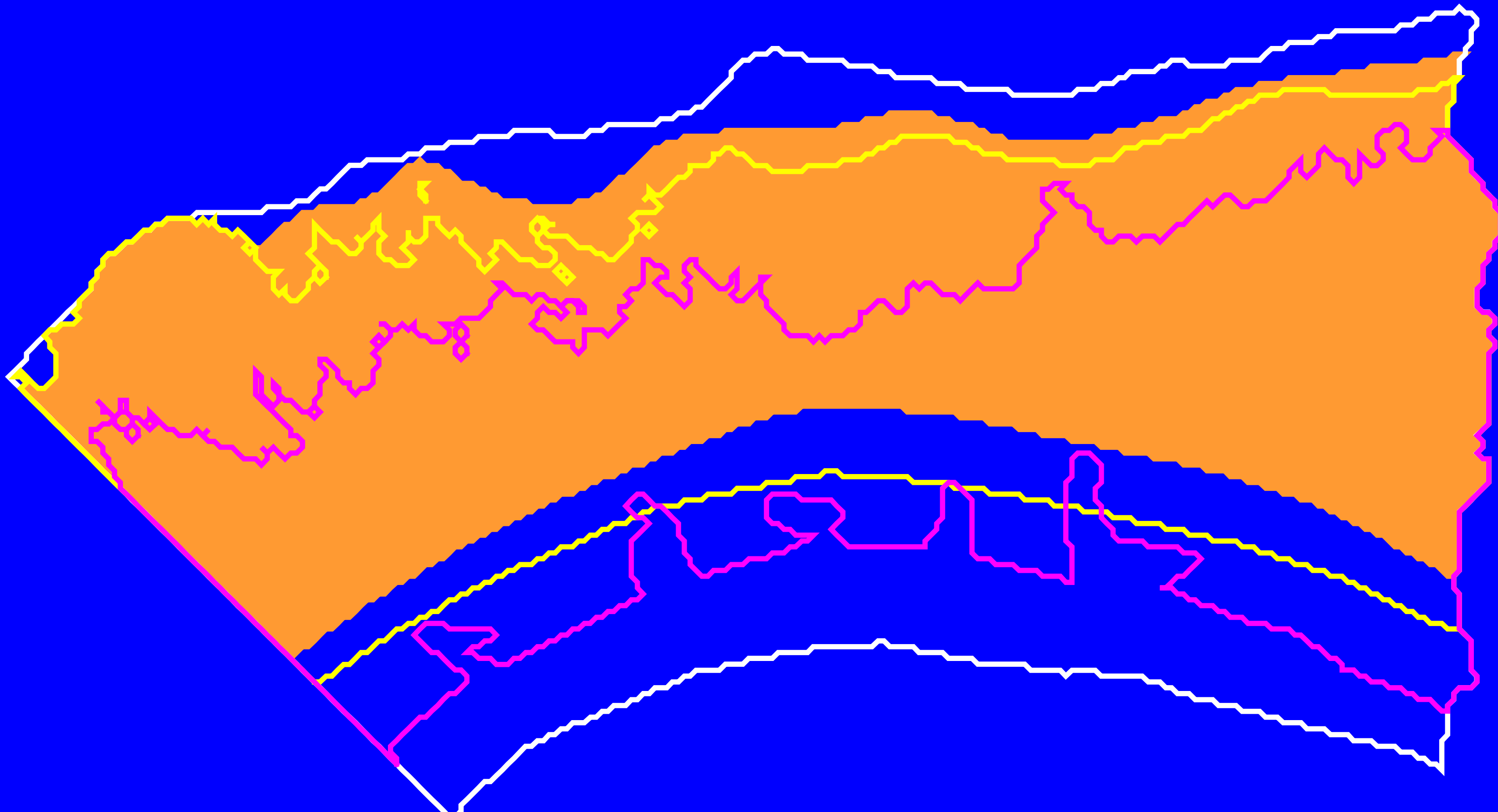


• Layer 1 downdip uses constant head at coastline: required to replicate observed heads at coastline

Evangeline - Active Boundary

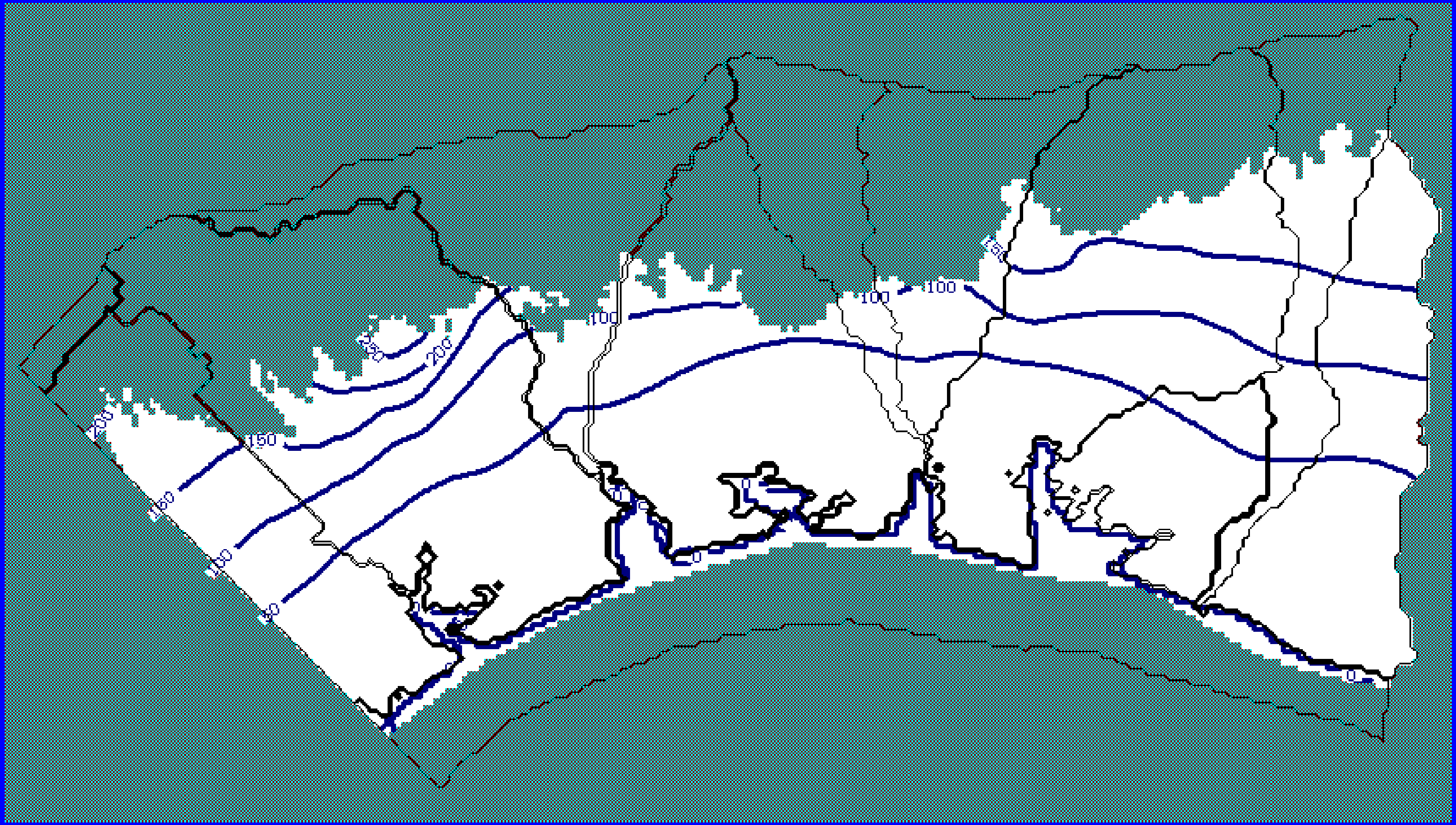
• No-flow boundary at downdip follows conceptual model of Baker (1986).

Burkeville - Active Boundary

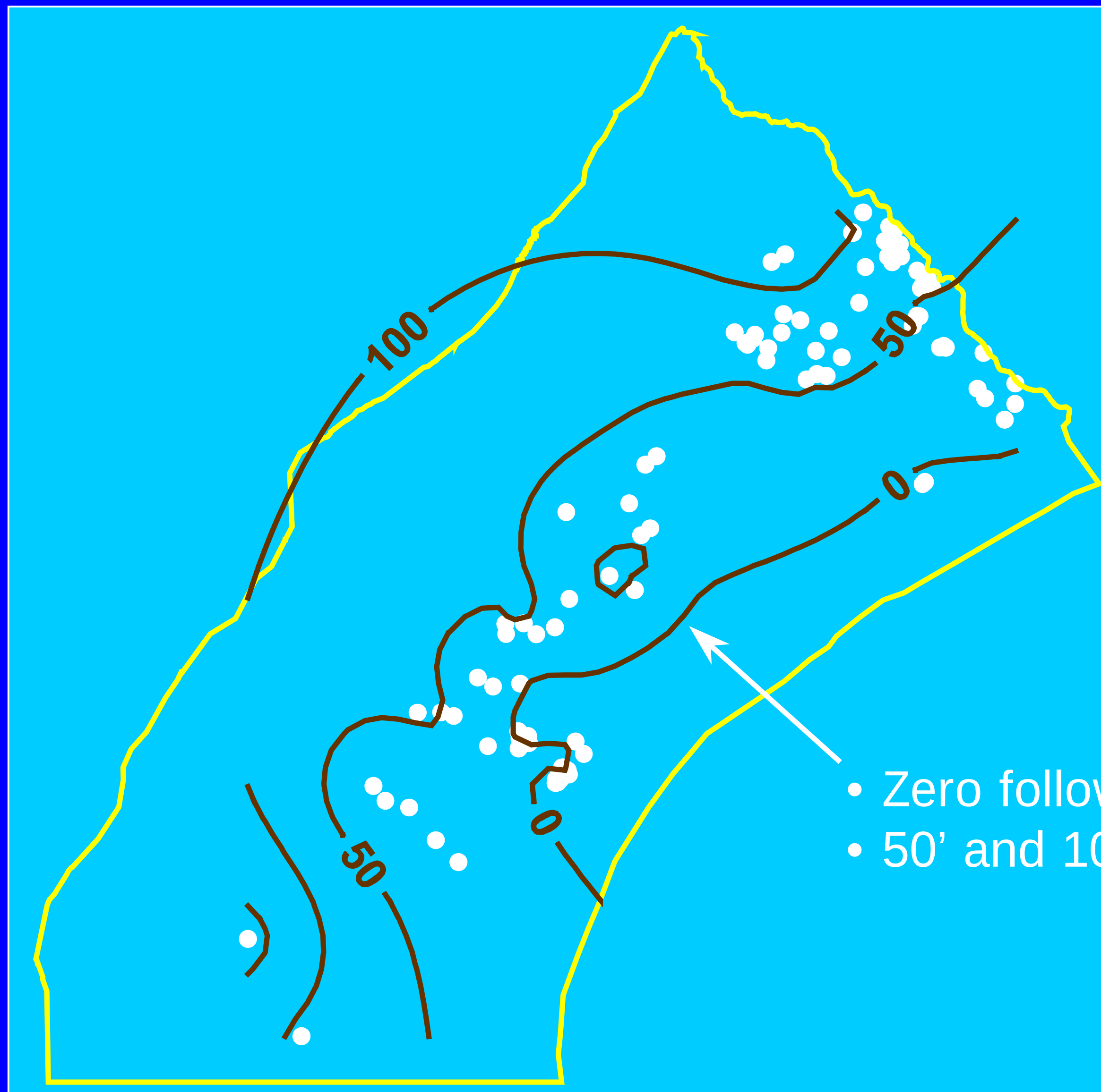


Jasper - Active Boundary

Simulated Water-Level Contours
Chicot

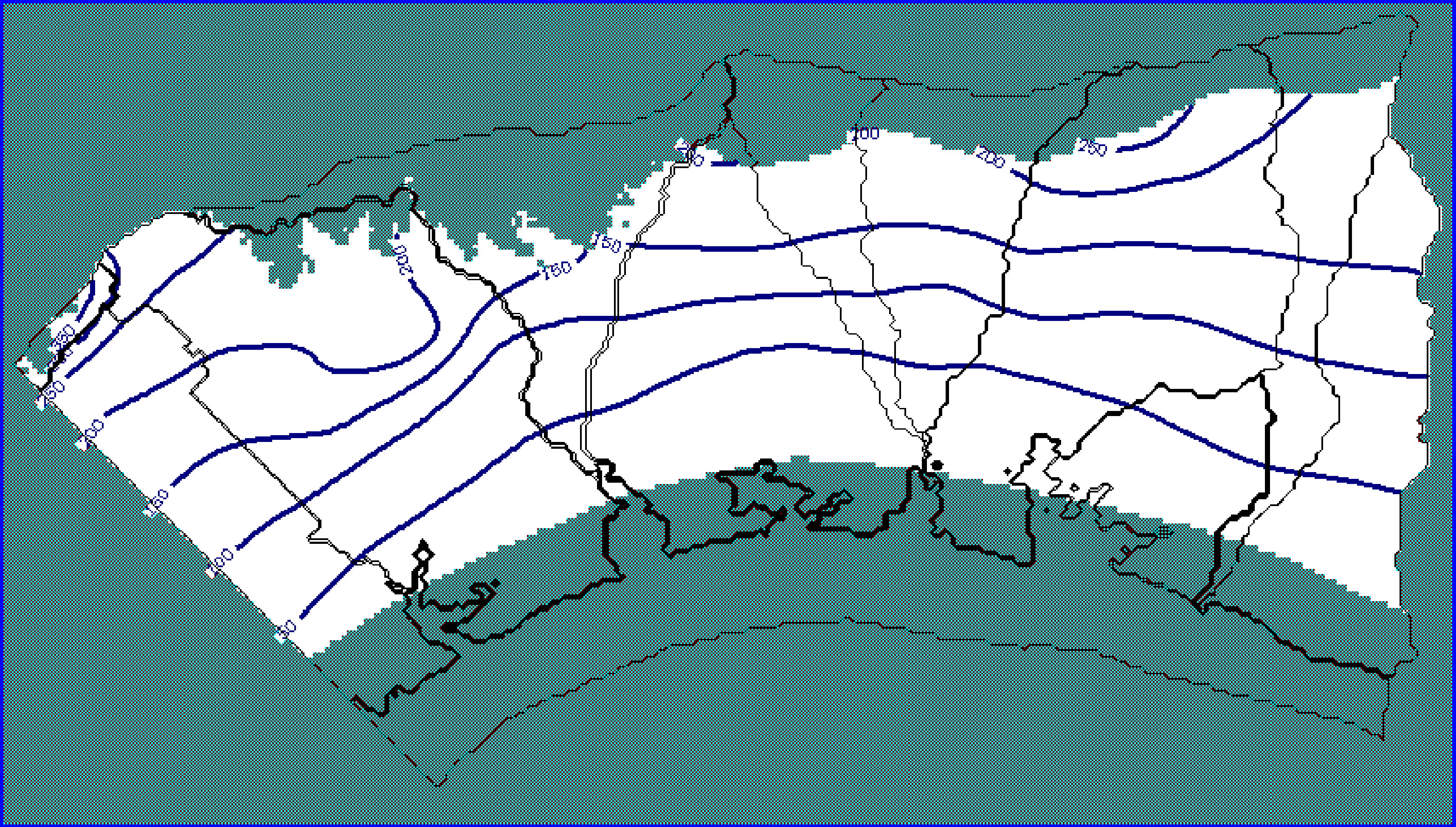


Observed Water-Level Contours
Chicot

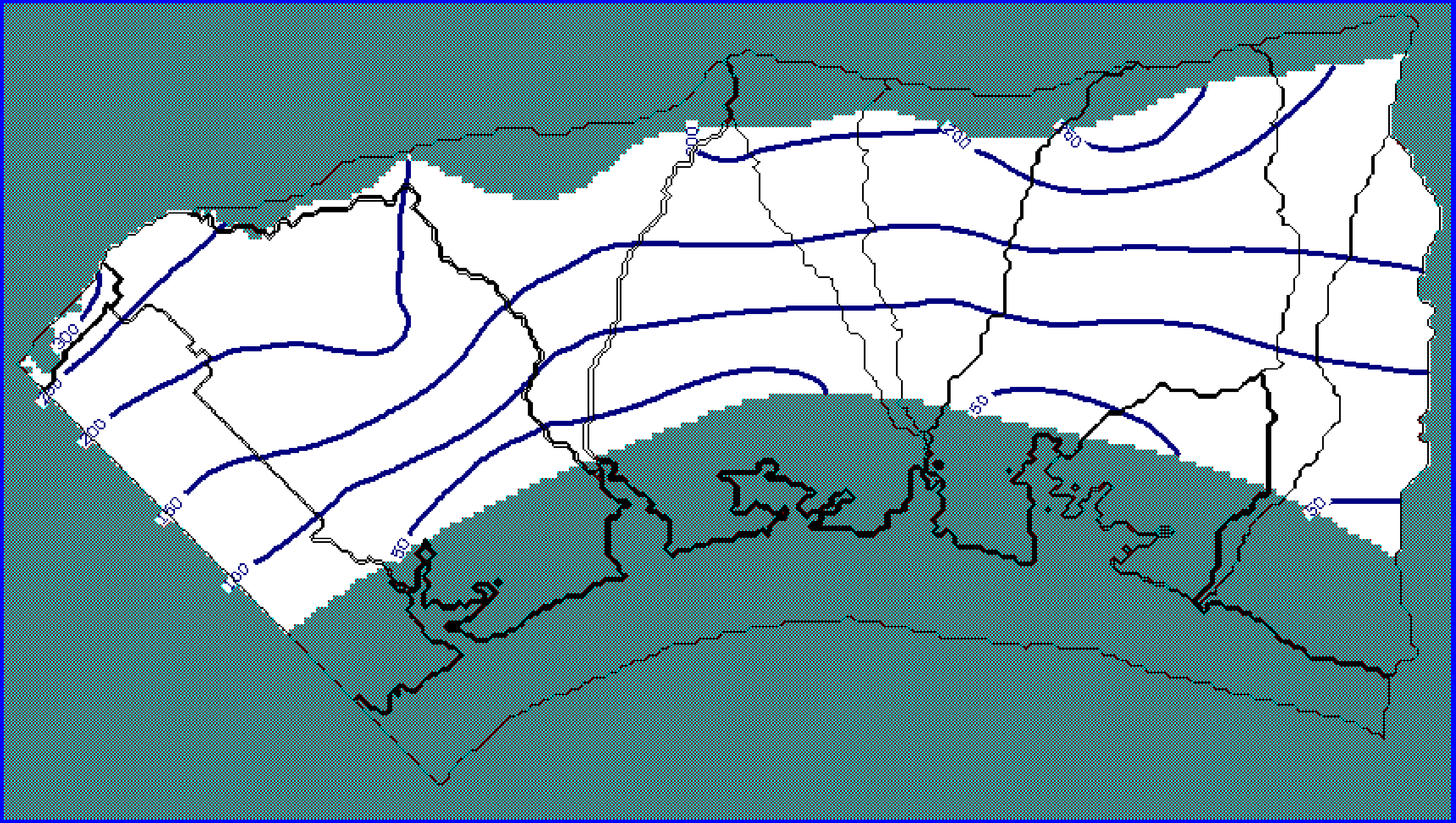


- Zero follows coastline
- 50’ and 100’ contours

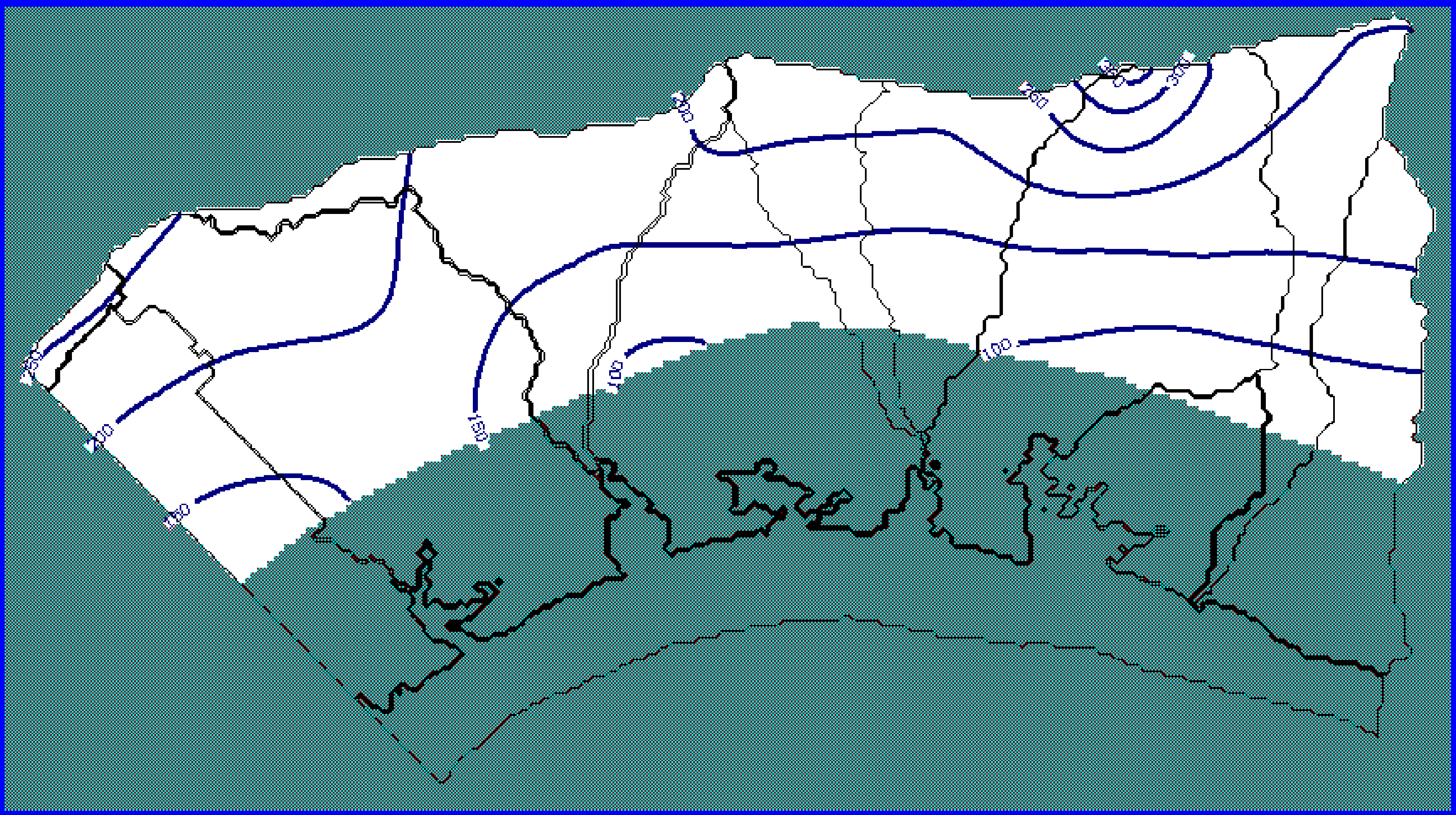
Simulated Water-Level Contours Evangeline



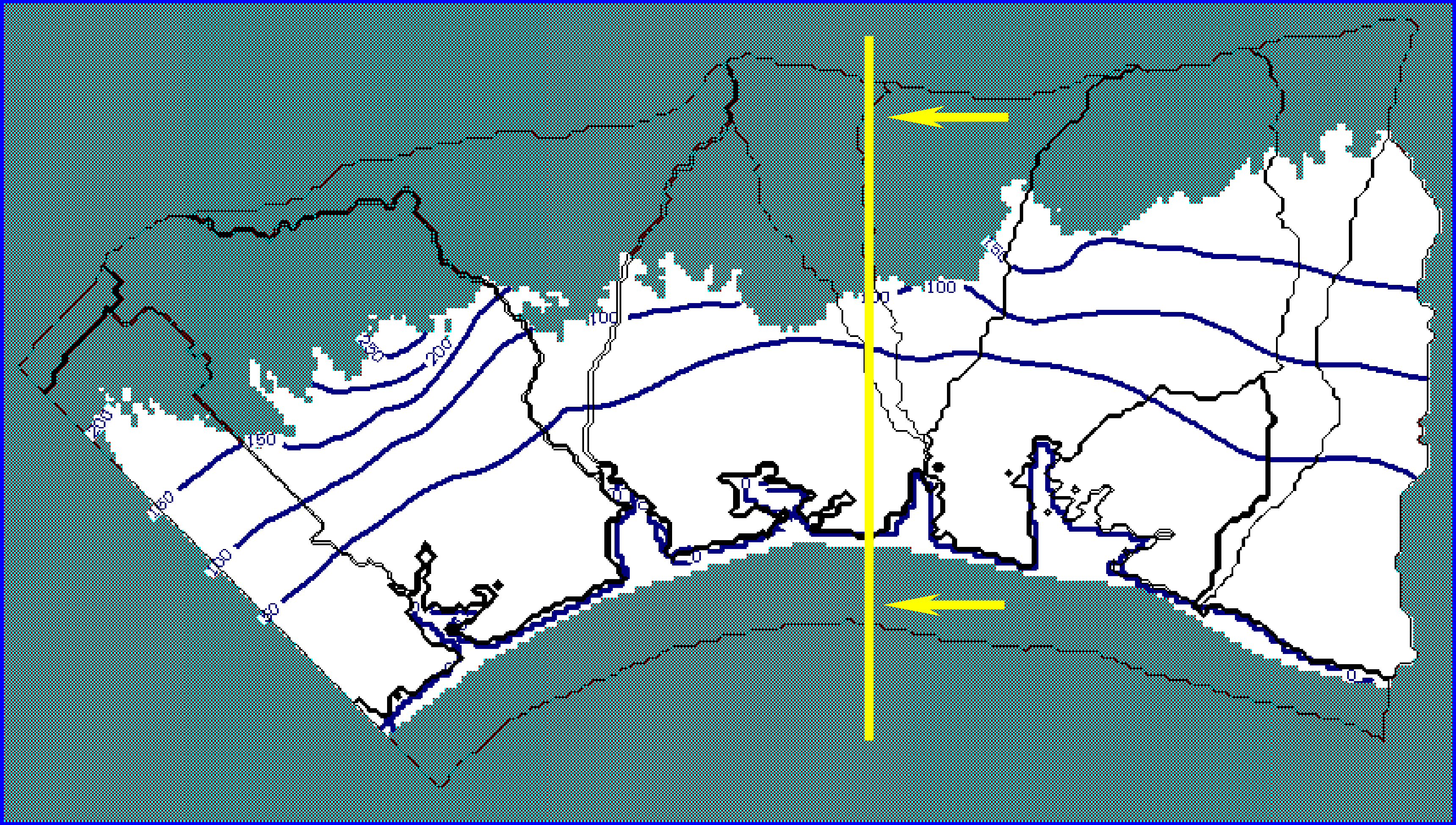
Simulated Water-Level Contours
Burkeville



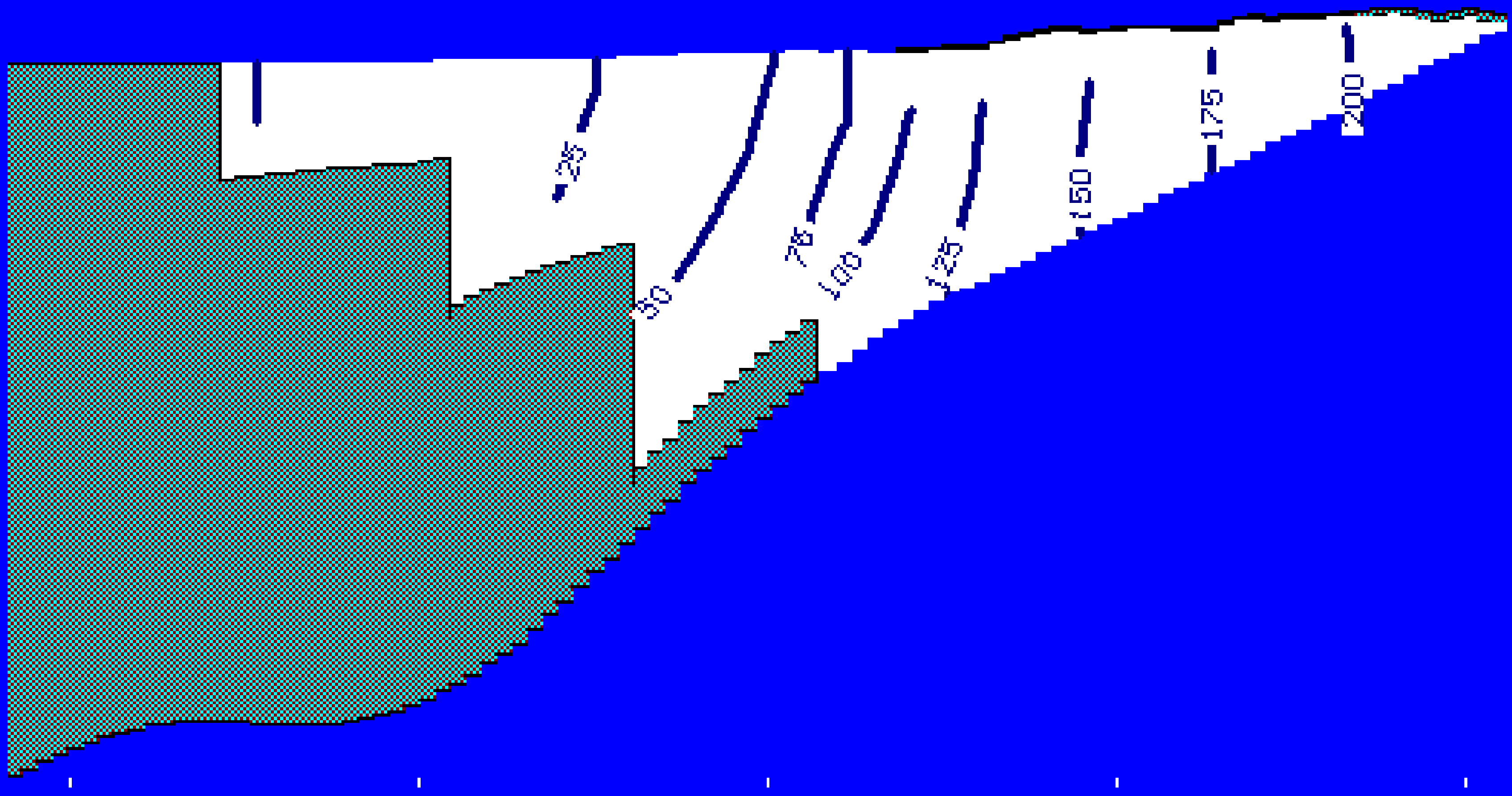
Simulated Water-Level Contours
Jasper



Cross-Section Location

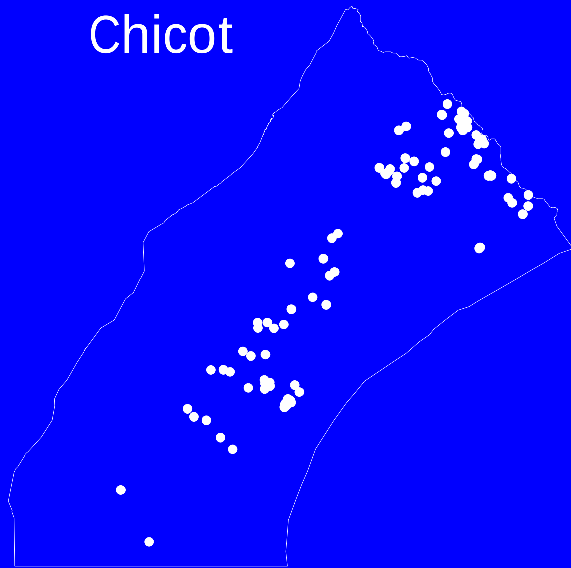


Simulated Water-Level Contours Cross-Section

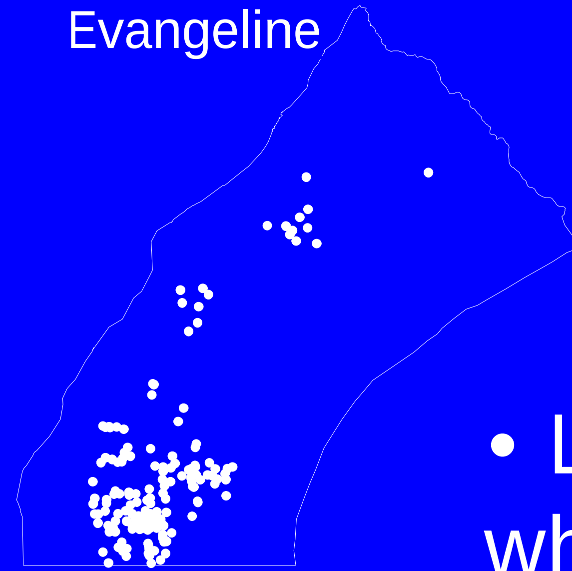


Monitoring Well Locations

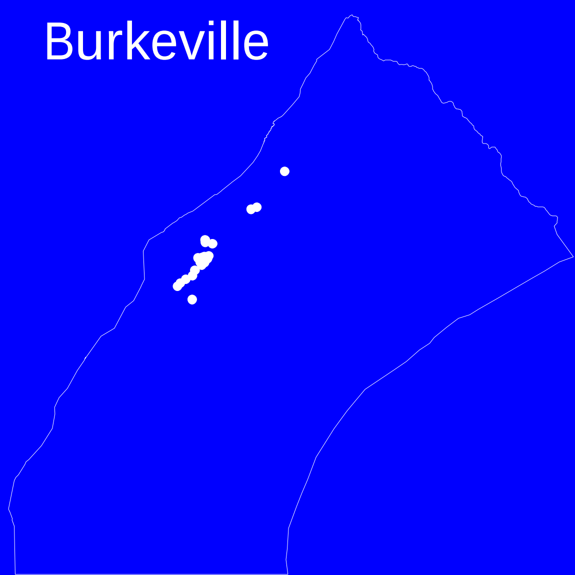
Chicot



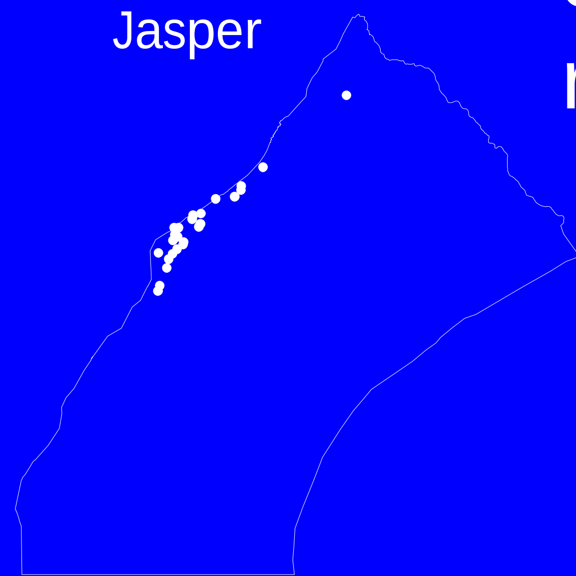
Evangeline



Burkeville

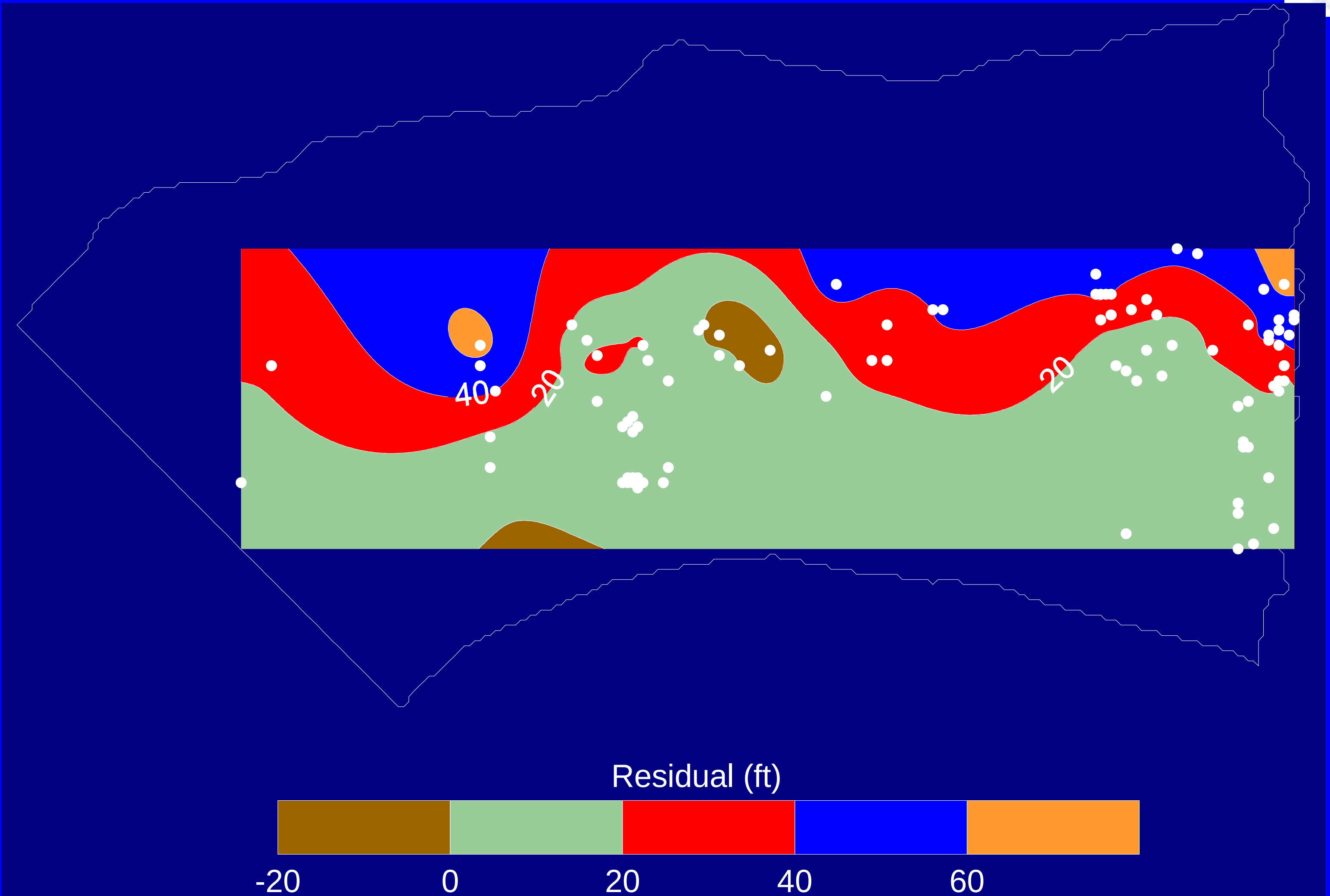


Jasper



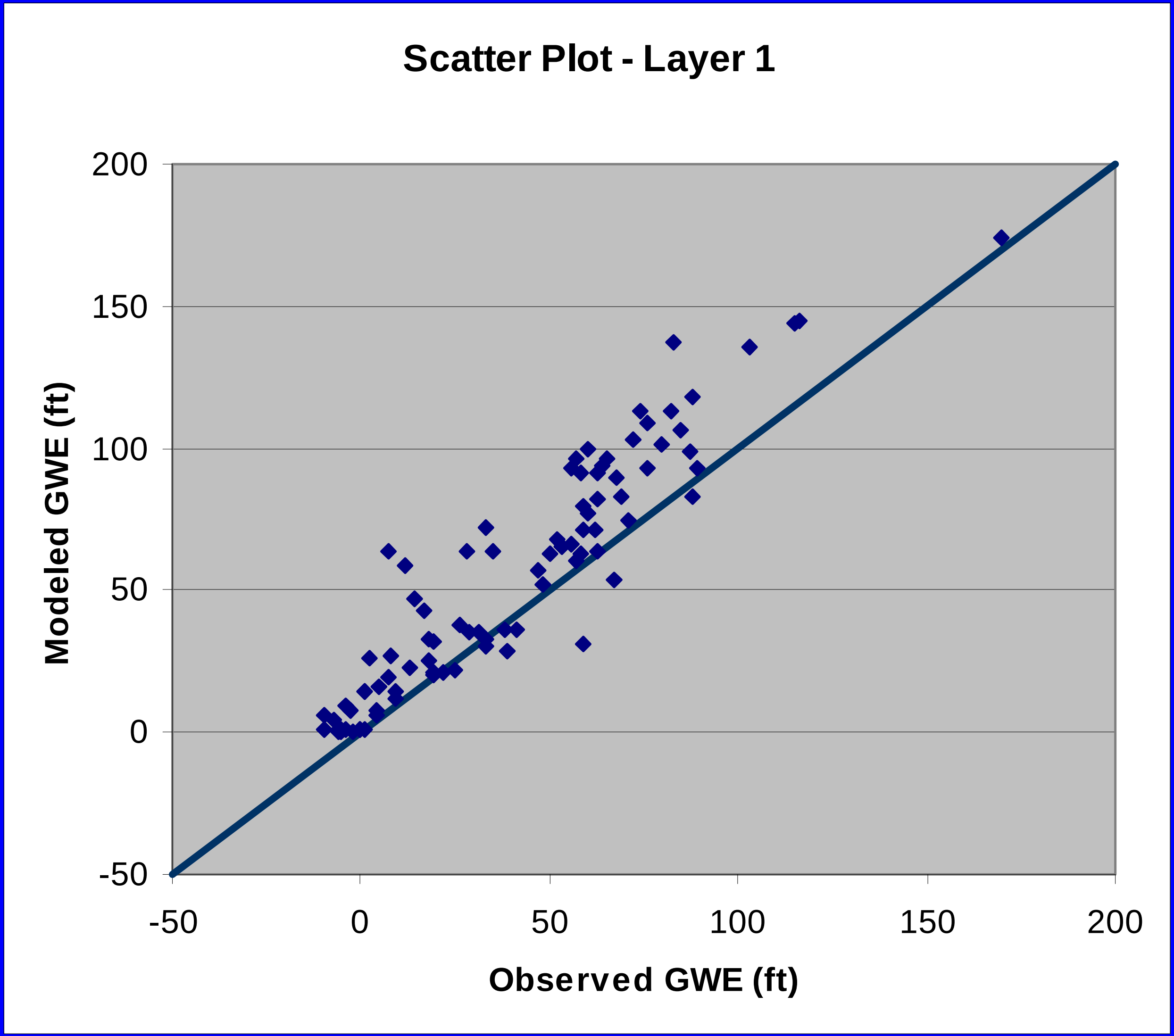
- Locations where we can get residuals

Residuals - Chicot

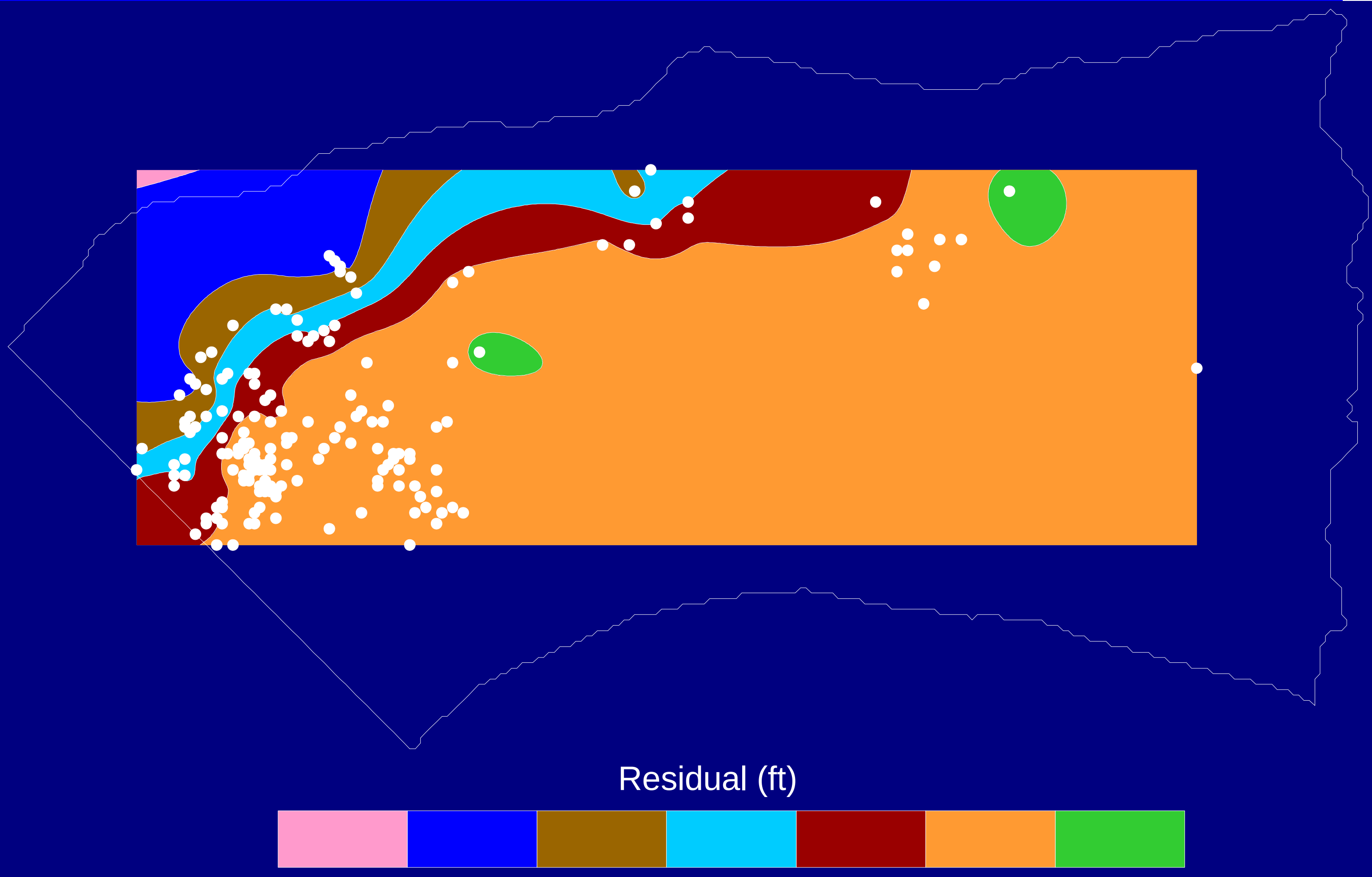


Note - a positive residual indicates that the modeled elevation is higher than the observed elevation.

Chicot
Water-Level Residuals

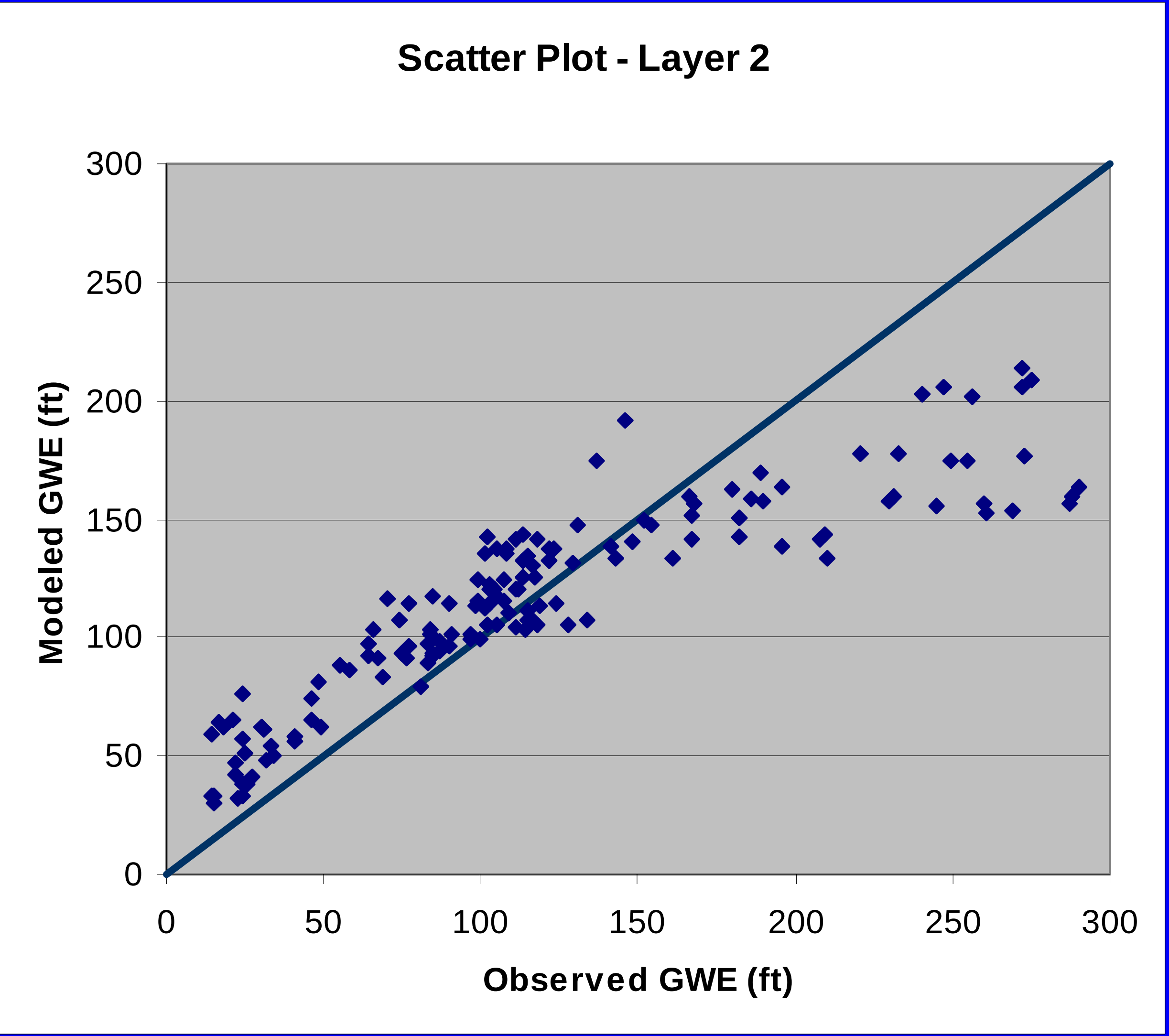


Residuals - Evangeline



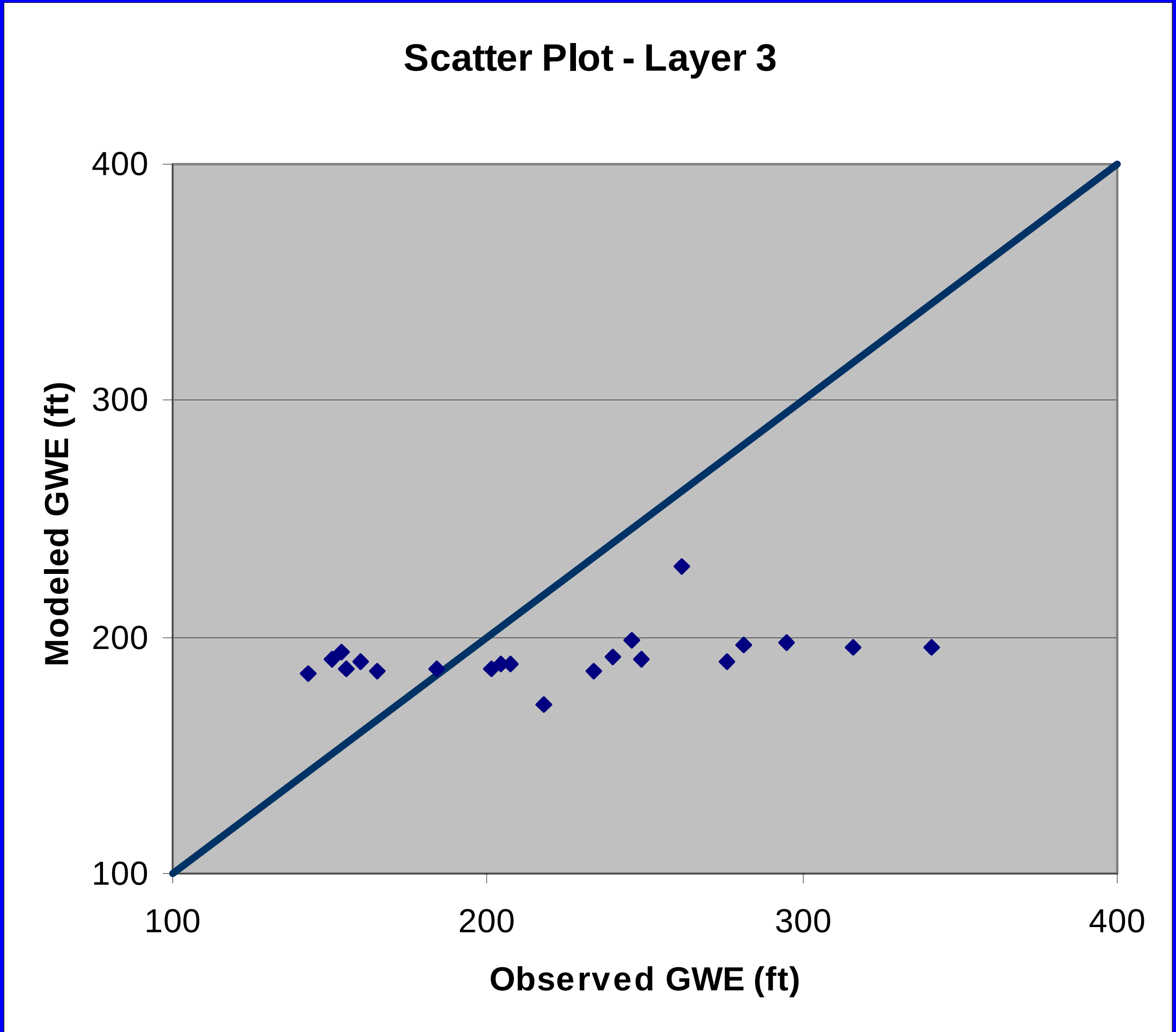
Note - a positive residual indicates that the modeled elevation is higher than the observed elevation.

Evangeline
Water-Level Residuals



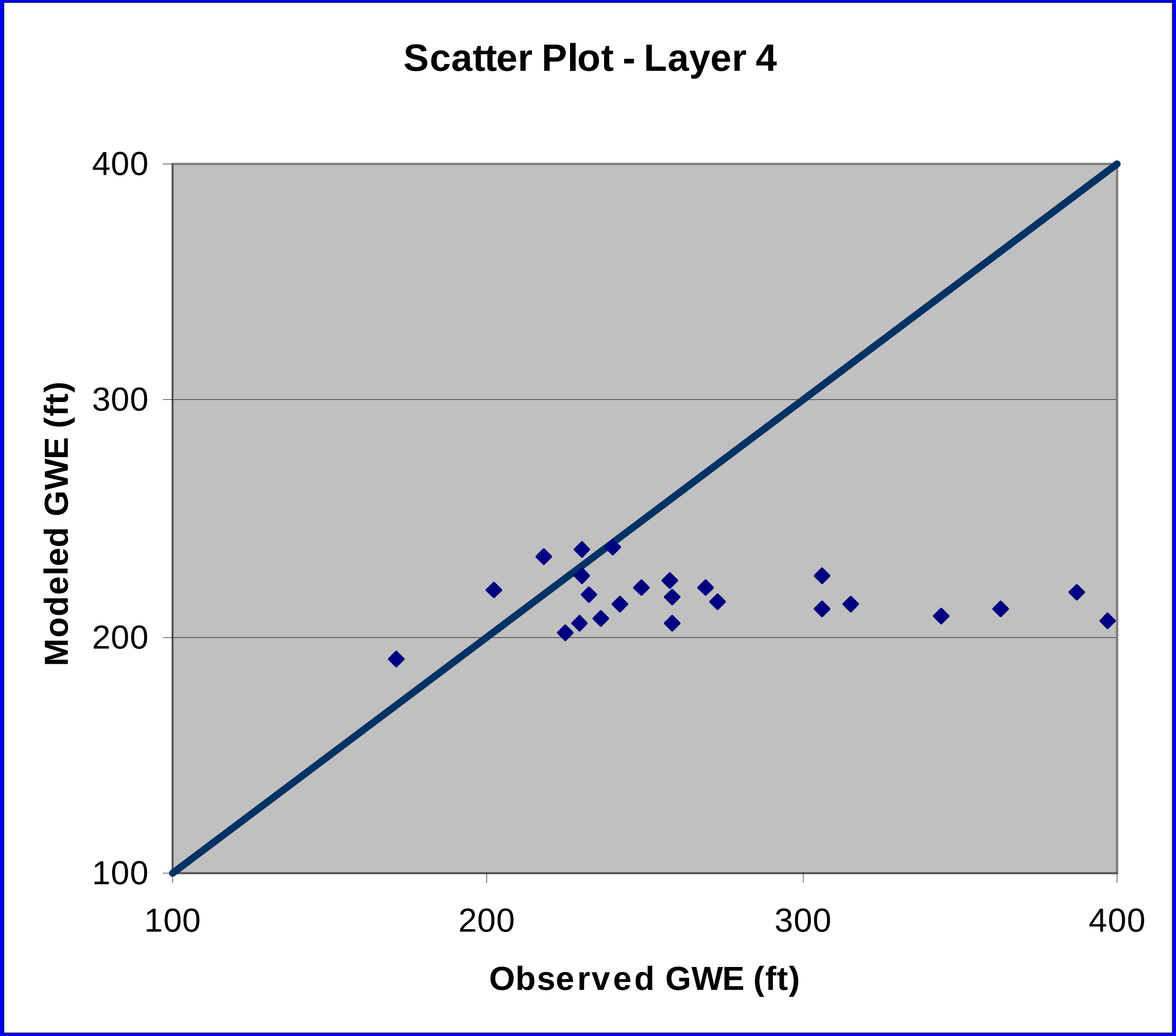
Observed Water-Level Contours
Burkeville

Burkeville
Water-Level Residuals



Observed Water-Level Contours
Burkeville

Jasper
Water-Level Residuals



Calibration Statistics

Layer	No. Targets	ME (ft)	RMSE (ft)
Chicot	89	14	21
Evangeline	165	-19	63
Burkeville	21	-31	62
Jasper	25	-46	79
All	**300**	**-12**	**56**

Future Simulations

- Finalize steady-state calibration
- With pumping stresses, calibrate to transient water levels (1980 - 1990)
- Verification to 1990 - 2000 water levels
- Simulation of water levels for 2000 – 2050
  - Different scenarios with droughts

Planned for Next SAF

- Finalized steady-state model
- General overview of stresses for the period from 1980 – 2000
- Presentation of simulations:
  - transient period (1980-1990)
  - verification (1990 – 2000)

Central Gulf Coast GAM
Fifth Stakeholder Forum,
May 1st, 2002, Corpus Christi, TX
List of attendees that signed the attendance list.

Name	Affiliation
Gilbert Barth	Waterstone
Art Dohmann	Goliad County GWCD
Jose DeLeon	Smith Russo & Merrek
Darren Thomeson	San Antonio Water System
Cindy Ridgeway	TWDB
Richard Preston	TWDB
Thomas D. Hill	GBBA
Cliff Lane	EVWCD
Rick Hay	CWSS-TAMU-CC
Alan Berkebile	CWSS-TAMU-CC
Jim Tolan	TPWD
Greg Carter	AEP
James Dodson	J.F. Welder Heirs
Karen Dodson	private

Summary of Questions/Responses/Discussion from
Fifth Stakeholder Advisory Forum
Central Gulf Coast GAM
held
May 1st, 2001
Natural Resources Center, Texas A&M University-Corpus Christi Campus

As with postings for previous SAF meetings, this document summarizes the technical questions, answers and discussions.

1. How did you get the values of transmissivity?

Response: The transmissivities were calculated by taking the pump-test value of transmissivity and dividing by the screen interval for the well on which the pump test was performed. This provided a value of hydraulic conductivity for the sands from which the well was drawing water. The sand hydraulic conductivity was then multiplied by the total thickness of sand in the aquifer at that location to produce the transmissivities shown.

2. So, those are aquifer transmissivities?

Response: Yes.

3. Did you specify different types of vegetative cover, for example did you specify areas that had a lot of mesquite? What was the source of your data?

Response: We used the USGS National Land Cover Data (NLCD) dataset. This data from the 1990s so we there are a number of cover types, such as urban, industrial and cropland that we replaced with grassland coverage. It was inappropriate to have significant amounts of urban or industrial areas for the predevelopment model, and, with respect to the model, differences between cropland and grassland were minimal.

4. Is the location of the salinity interface based on 10,000 ppm or 3000 ppm?

Response: These are more of a conceptual representation and are qualitative interpretation of the Baker reports and county specific records. Baker's report used 3000 ppm, but the no-flow boundaries used are not intended to represent a particular level of salinity, just the tendency for flow to be forced towards the surface as it moves downdip and encounters salt water.

5. Are you comparing the heads to ground surface?

Response: At this point no. We are using our calibration targets. For the predevelopment scenario the ground surface does provide a good qualitative check, and we will probably use that but not report it in terms of the calibration.

6. What kind of adjustments do you make for rainfall rate?

Response: We are looking at steady-state system data from a 30-year period. For the predevelopment model we are interested in the long-term average. That average will be different for different amounts of rainfall, storm durations and even the land type.

7. Rainfall can come at very different rates. We go through a 6-month drought followed by an 18-inch rainfall. That ends up looking like an average year, but in most of that rainfall probably just ran off since it all came in one storm.

Response: The predevelopment model represents an average condition over long periods of time. If, in general this area has storms that are less likely to lead to infiltration, then that kind will be reflected in the average infiltration. The average over many years.

8. But for the model to have any degree of accuracy it needs to deal with the differences between different precipitation events.

Response: Yes, and the transient simulation will do that. Recharge will be evaluated on a month to month basis using daily observations of precipitation. Short duration, high intensity precipitation will result in a lower proportion of the precipitation infiltrating.

9. I'm still concerned that an 18-inch per hour rain will only result in a very small fraction infiltrating into the aquifer. Only a small fraction is actually captured.

Response: Yes, I agree. I mentioned an initial value of 1% to provide a bulk estimate of recharge volume. Keep in mind that the recharge rates I showed you varied over two orders of magnitude. If, for example, 1% was the high end, than the infiltration rates could go down to 0.01%. I think this kind of range captures a lot of the potential variability in the effective recharge.

10. Are you using SWAT?

Response: Yes, we are still in the process of getting it up and running but we are excited about having the SWAT runs to provide us with insight to the transient recharge and evapotranspiration. For the transient we will use daily data. Doing so allows SWAT to account for the potential for runoff as a function of the land cover, soil type and the intensity of the precipitation.

11. I still think you need some sort of factor to account for the rainfall intensity in the predevelopment model.

Response: We have a wide range of infiltration and we will use our observations to try and determine if the values that we have are appropriate. We will adjust recharge, within reasonable limits and evaluate if the amount of recharge produces appropriate results. As an example, the Evangeline-residuals slide indicated there is either not enough recharge or the hydraulic conductivity is too low. The observations that we have provide feedback for adjusting parameters such as recharge.

12. What kind of interaction are you looking for from the stakeholders? It seems to me as though there is not a lot of opportunity to provide feedback. For example, at this meeting we are seeing some preliminary results, and at the next meeting the steady-state and the transient models will be finished. The only review between now and then being an internal review.

Response: Initially it was intended that there would have been the opportunity for stakeholder interaction after each phase but there were some delays. There was some discussion of distributing the stakeholder meeting dates differently for the next round of GAMs: setting the dates only when the modeling had reached certain stages. However, the consensus seemed to be that a regular interval was the best approach. Even though it is difficult to time the stakeholder meetings perfectly with the various milestones of developing the model, the meetings still provide the opportunity for some general checks and balances and give the public the opportunity to learn and provide feedback.

13. I have concerns about level of understanding by the people who will be using the model. It seems like a lot of people have misconceptions, or that it would be easy to have misconceptions about how much they can use the regional GAM models for their own local purposes.

Response: The TWDB is engaged in a number of efforts, including these stakeholder meetings, to educate the public on the use and limitations of the model.

14. What parameter values do we have to work with? What kind of simulations will we be able to look at when we want to run the final model and come up with our own predictions of water availability?

Response: We know that there are definite limits, the volume of water contained in the aquifer is a definite limit, but within that there are a whole range of possible scenarios that could be examined. Those scenarios could include examining adjustments to both policy and/or parameter values. Users could investigate an entire range of possibilities, from mining all the water to a no-mining scenario. Regardless of the scenarios examined, the simulations will provide numbers that are better than any values used in the past.

15. Will the model be in a final form? Will there be any chance to modify the model?

Response: We are stuck with some limitations. For example, the grid resolution is fixed just for consistency on the statewide level. We are also faced with a limited budget, but the philosophy is not that this is a static, fixed product. The intent is to produce a representation of the physical system. If there is sufficient evidence to warrant a change then we will need to consider modifying the model.

16. How do I know if the data used in the model is reasonable? How will I know if the vegetative cover for a region seems appropriate? What data will be available? What form will it be in? Will we be able to figure out how the data was derived?

Response: The complete data including raw data, processed-georeferenced data, and model input files will be available. The GAM contract specifies a complete directory structure that contains all the data.

17. How will the streams be represented? Will you use the drain package? What values of conductance are you using?

Response: We are required to use the MODFLOW stream package. It is possible that on smaller streams, or streams that do not connect with the larger network, that we will use the drain package, but the majority of the network will be represented with the stream package. Initial estimates of streambed conductance are proportional to the vertical hydraulic conductivity of the cell containing each stream reach. We may need to adjust conductance, within reasonable limits, to improve the match between simulated and observed water levels. This is a reasonable approach considering that direct measurement of streambed conductance is virtually non-existent.

18. What kind of Stakeholder input are you looking for?

Response: Most of the major input came early on. We want to continue to share ideas and educate the public on the function and limitations of the model. At this phase we are looking for more general feedback or concerns you have about the overall model as presented.

19. What if we want to have information on a local scale? It seems like there is a lot of effort being expended on a model that does not answer the questions that affect us locally. What is involved for a local modeling effort? How can we look at scenarios specific to our areas?

Response: In broad terms you could consider three levels of effort to get information more specific to you local policy conditions or local physical system. A low level of effort would be to develop the scenarios of interest and provide the details to the TWDB. The TWDB will perform the simulations, but you must realize that the TWDB has limited resources. It may take a significant amount of time to provide you with the results. The medium level of effort would be for you to run the model, or hire someone to do it. This would still be the regional model, but you would have the opportunity to try a wide range of scenarios on a more interactive basis. The high level of effort would be to locally refine the grid, capturing much more of the details affecting your area and use the regional model as boundary conditions for your refined model. This level of effort would require considerable data collection, assimilation, and additional modeling