texas water development board

STAKEHOLDER ADVISORY FORUM (SAF)

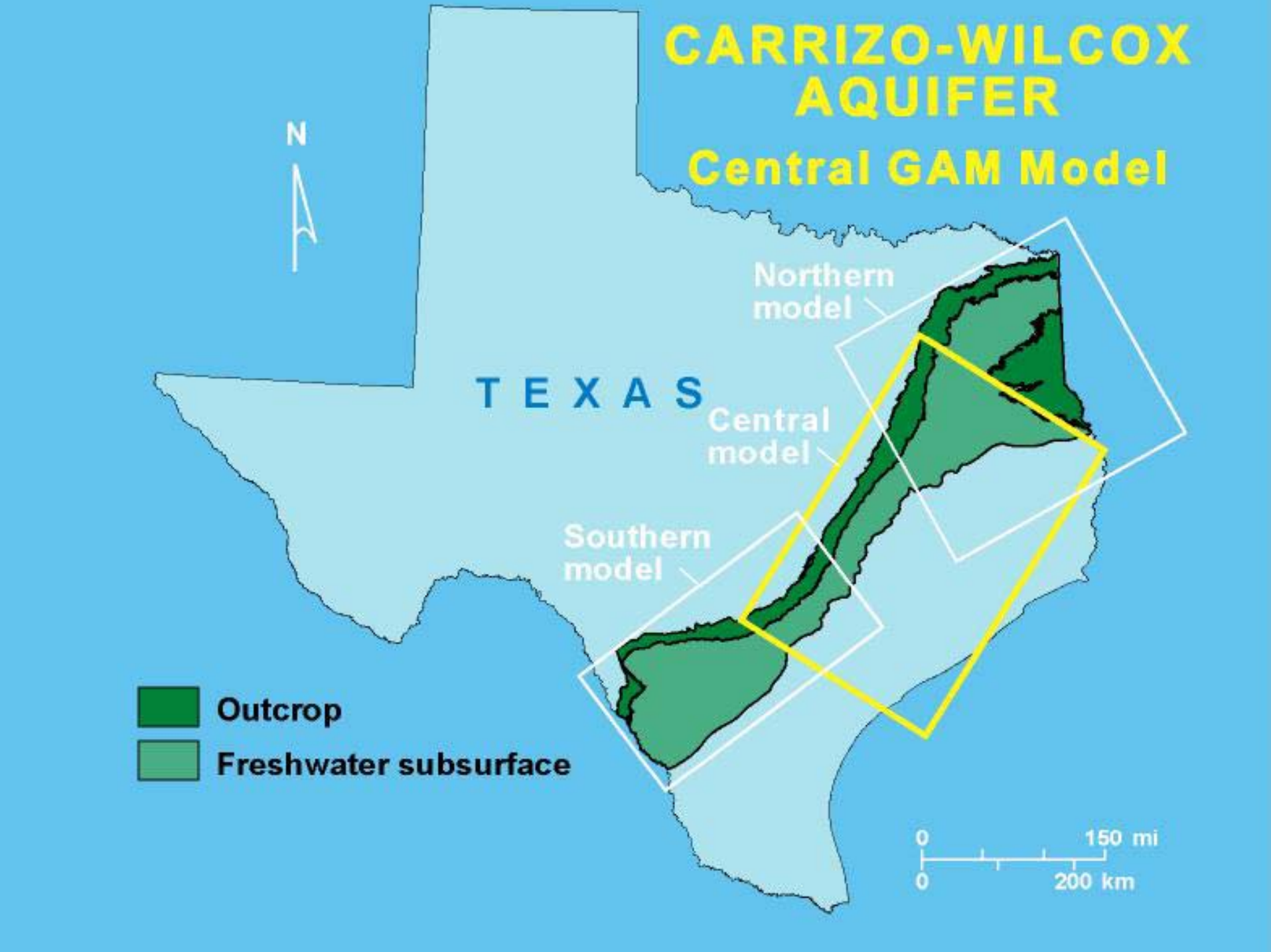
Central Carrizo-Wilcox Aquifer GAM Model

August 28, 2002

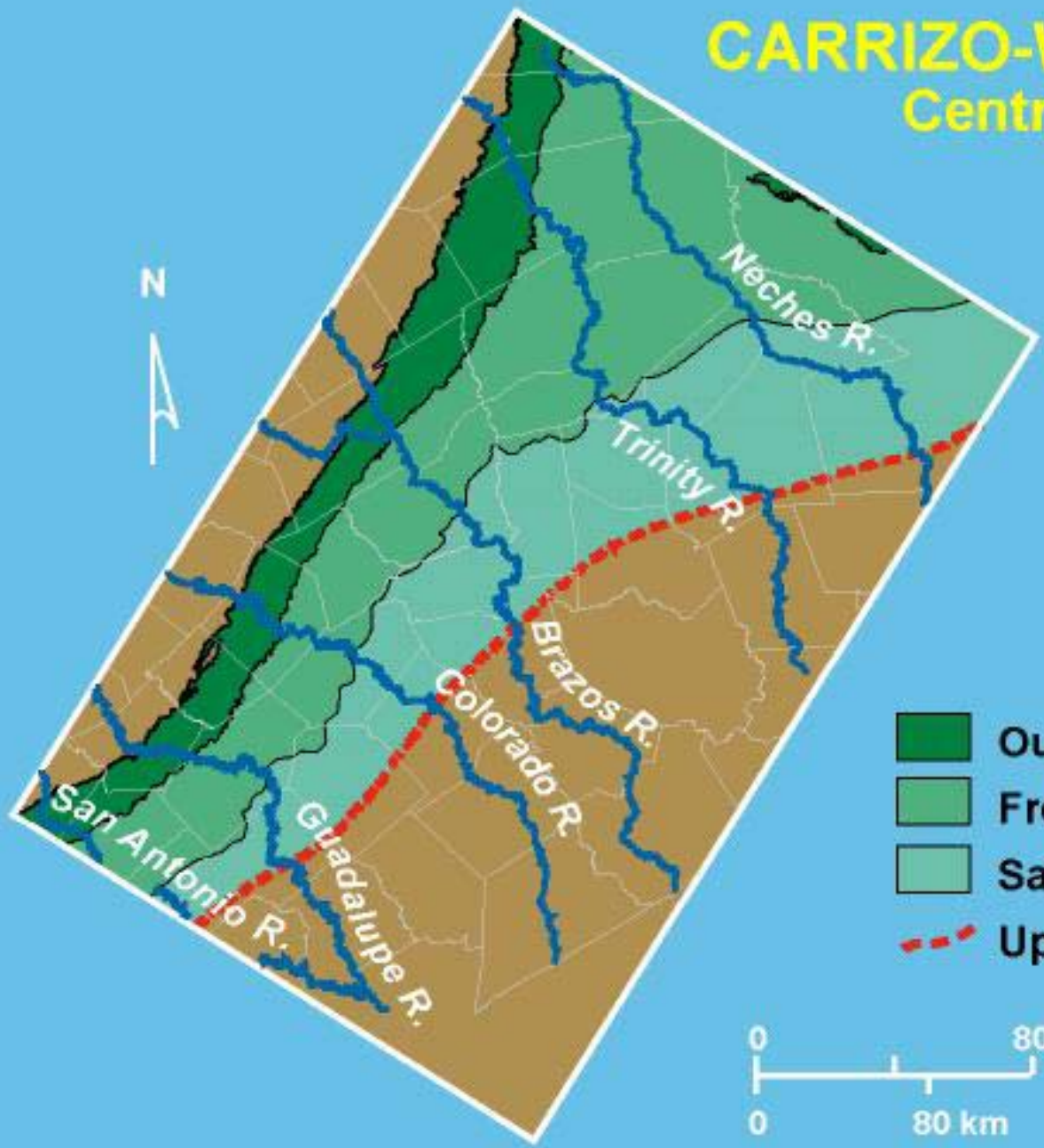
- Welcome and introductions
- Steady-state model calibration
- Recharge estimates
- Historical calibration and verification
- Projected groundwater demands for 2000 to 2050 period
- Schedule

ROLE OF GAM MODEL

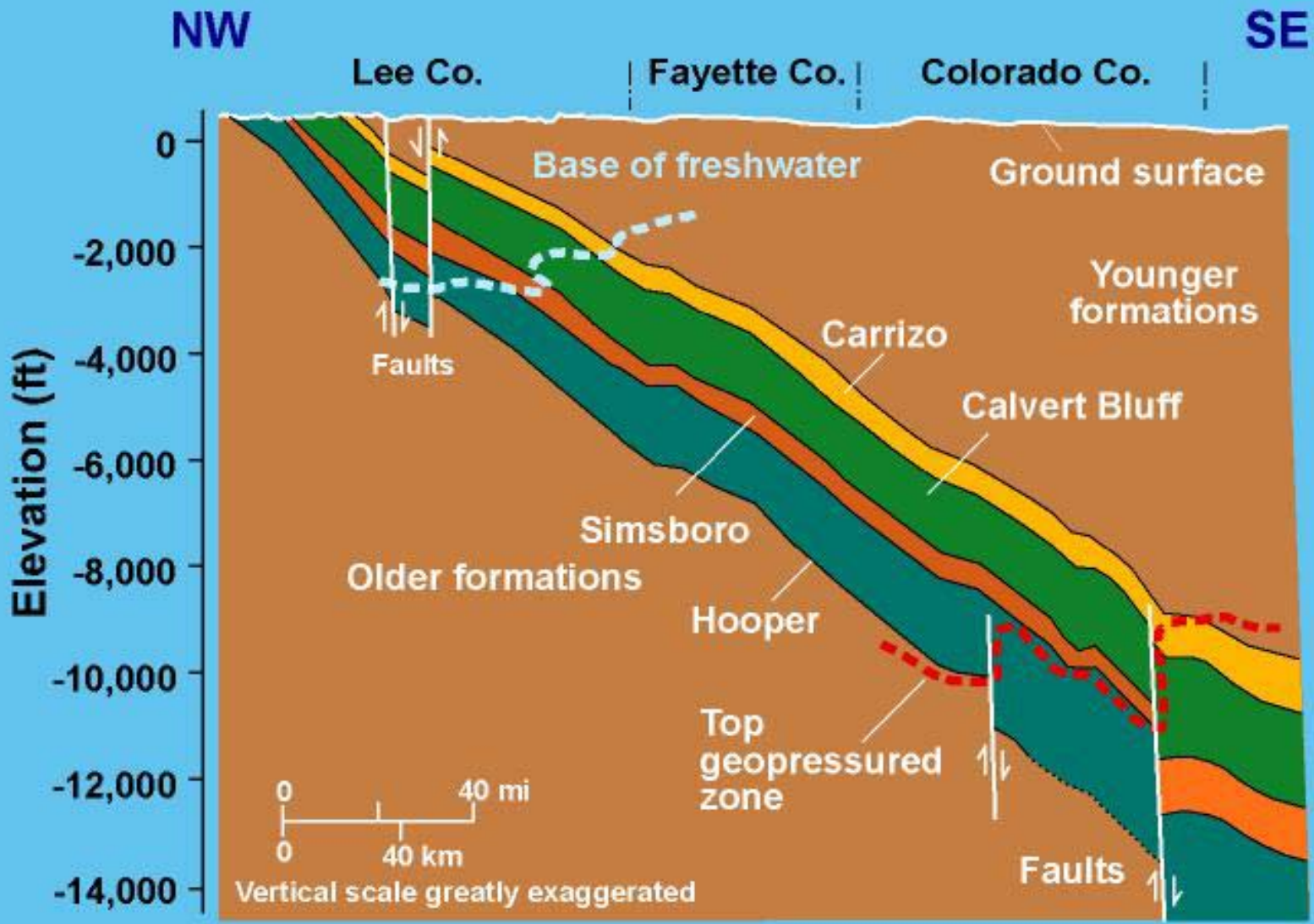
- Goal of GAM project is to develop a scientifically accurate and realistic computer model
- Model will represent the aquifer's water budget and groundwater processes such as recharge, discharge, and pumping
- Model will be used by groundwater conservation districts (GWCD), regional water planning groups (RWPG), TWDB, and individuals to evaluate the hydrologic effects of various water use alternatives
- Stakeholder participation is important to ensure the model is accepted as a valid representation of the aquifer
- Once the model is developed, it can be used to assess availability of groundwater


CARRIZO-WILCOX AQUIFER
Central GAM Model
N
TEXAS
Northern model
Central model
Southern model
Outcrop
Freshwater subsurface
0
150 mi
0
200 km

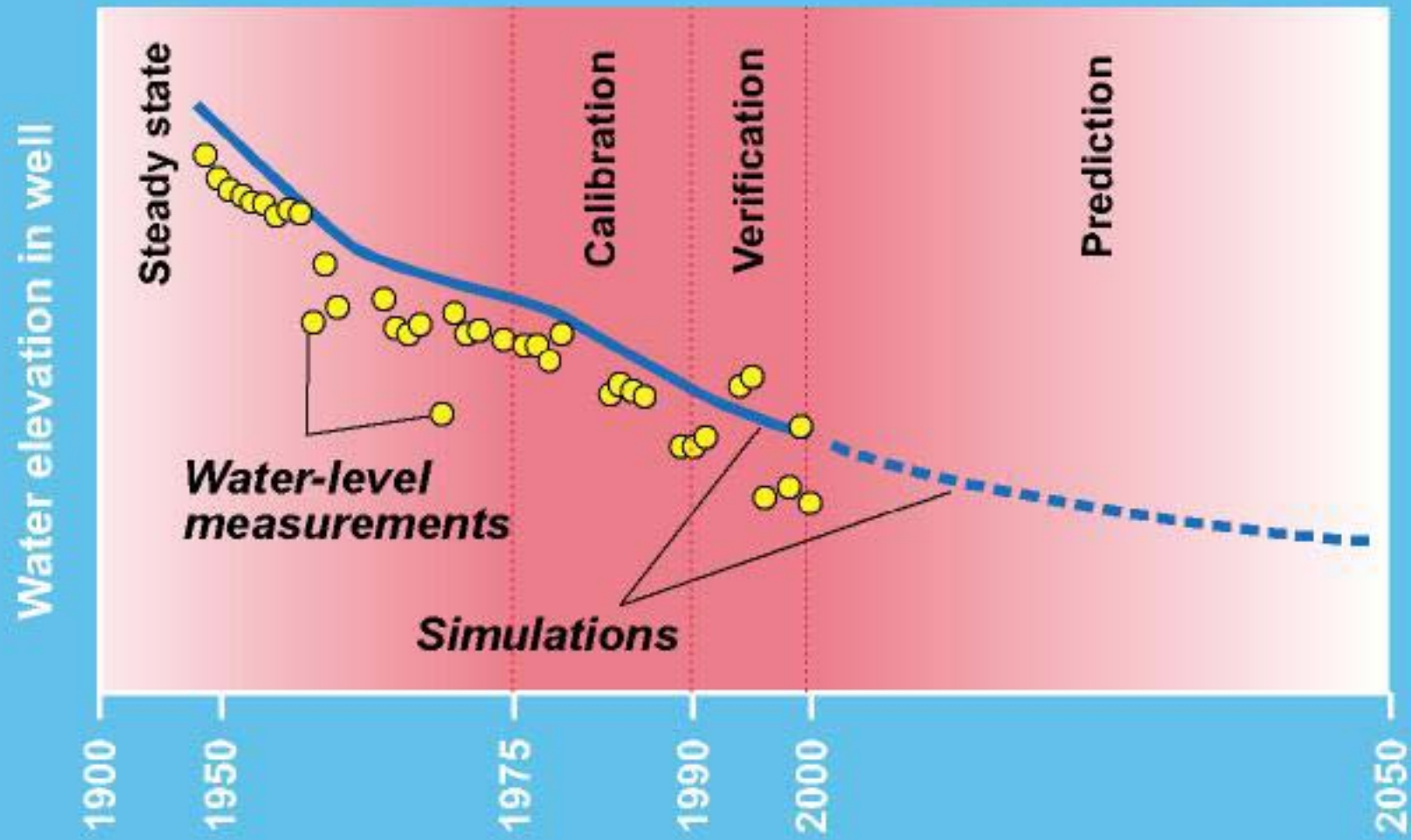
CARRIZO-WILCOX AQUIFER
Central Model Area



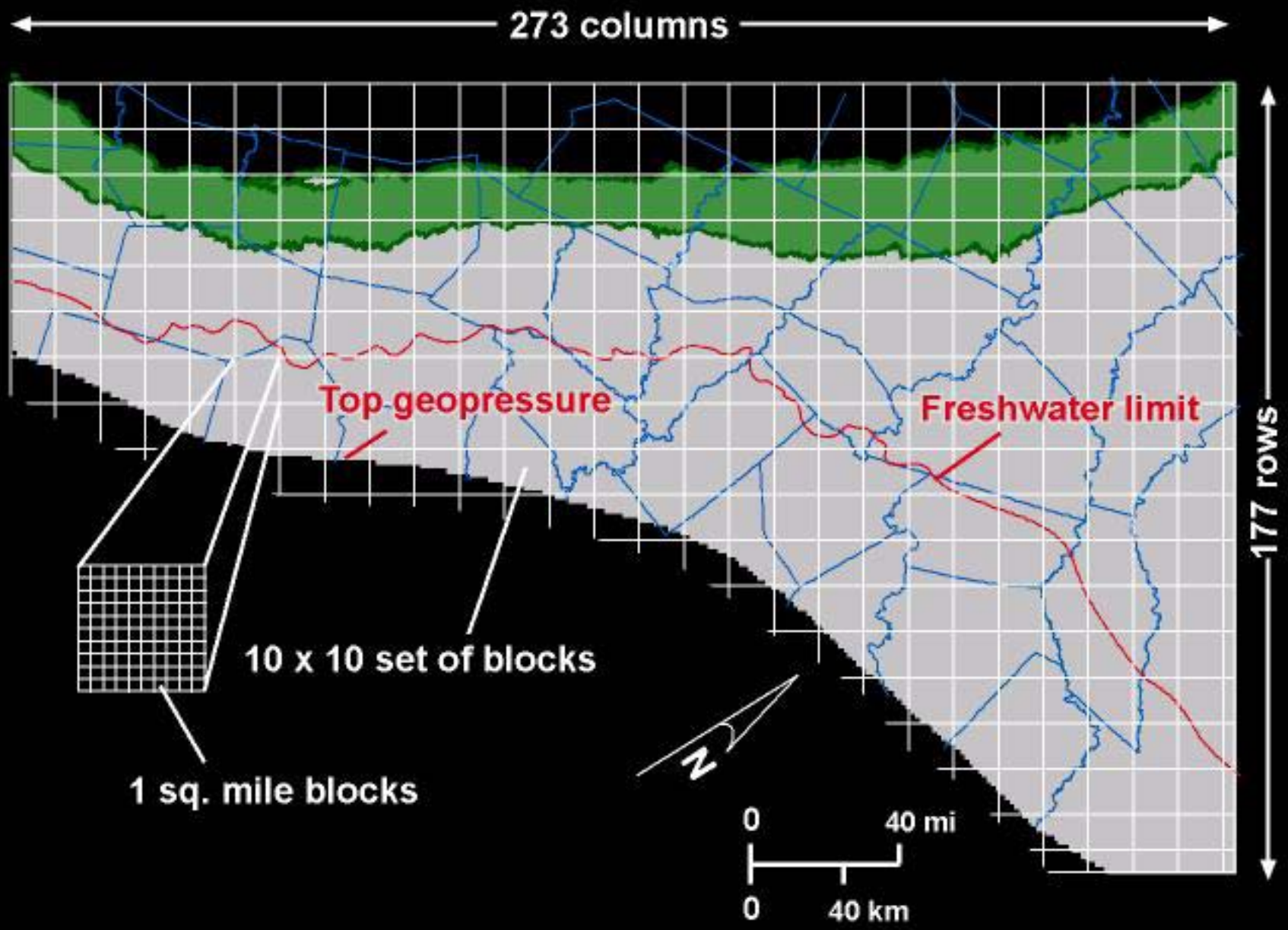
CARRIZO-WILCOX HYDROGEOLOGY
Central Part of Model Area



MODELING PERIODS



MODEL GRID


273 columns
177 rows
Top geopressure
Freshwater limit
10 x 10 set of blocks
1 sq. mile blocks
N
0
40 mi
0
40 km

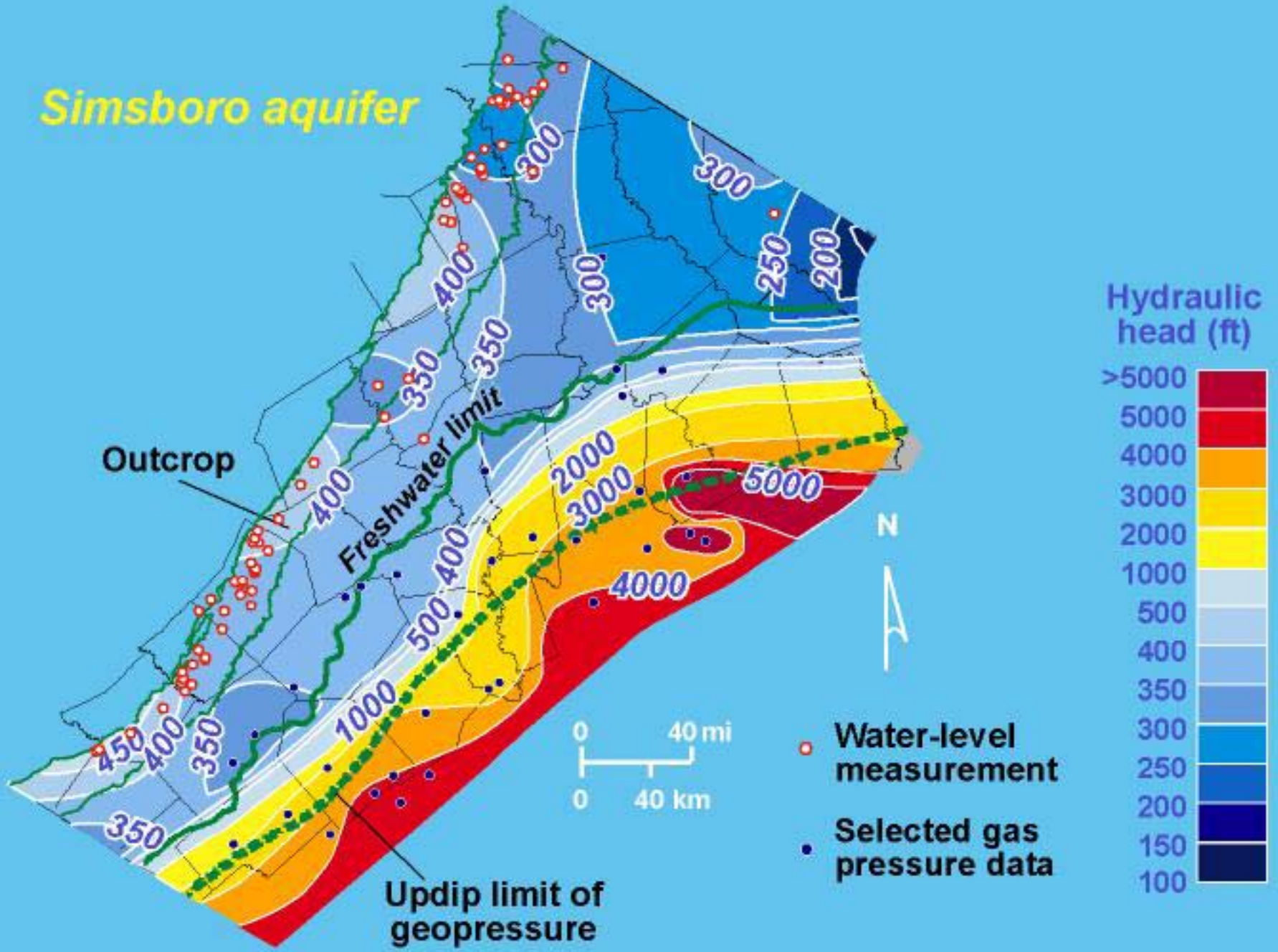
GAM MODEL INFORMATION REQUIREMENTS

- **Aquifer geometry**
  - Model grid
  - Model perimeter and extent
  - Top elevation of layers
  - Bottom elevation of layers
  - Calibration water levels
- **Aquifer properties**
  - Hydraulic conductivity (horizontal and vertical)
  - Storage coefficient
- **Boundary conditions and fluxes**
  - Recharge
  - Pumping rates
  - Surface water (rivers, creeks, and springs)
  - Groundwater evapotranspiration
  - Lateral boundaries–exchange with other models
  - Downdip boundary

CALIBRATION

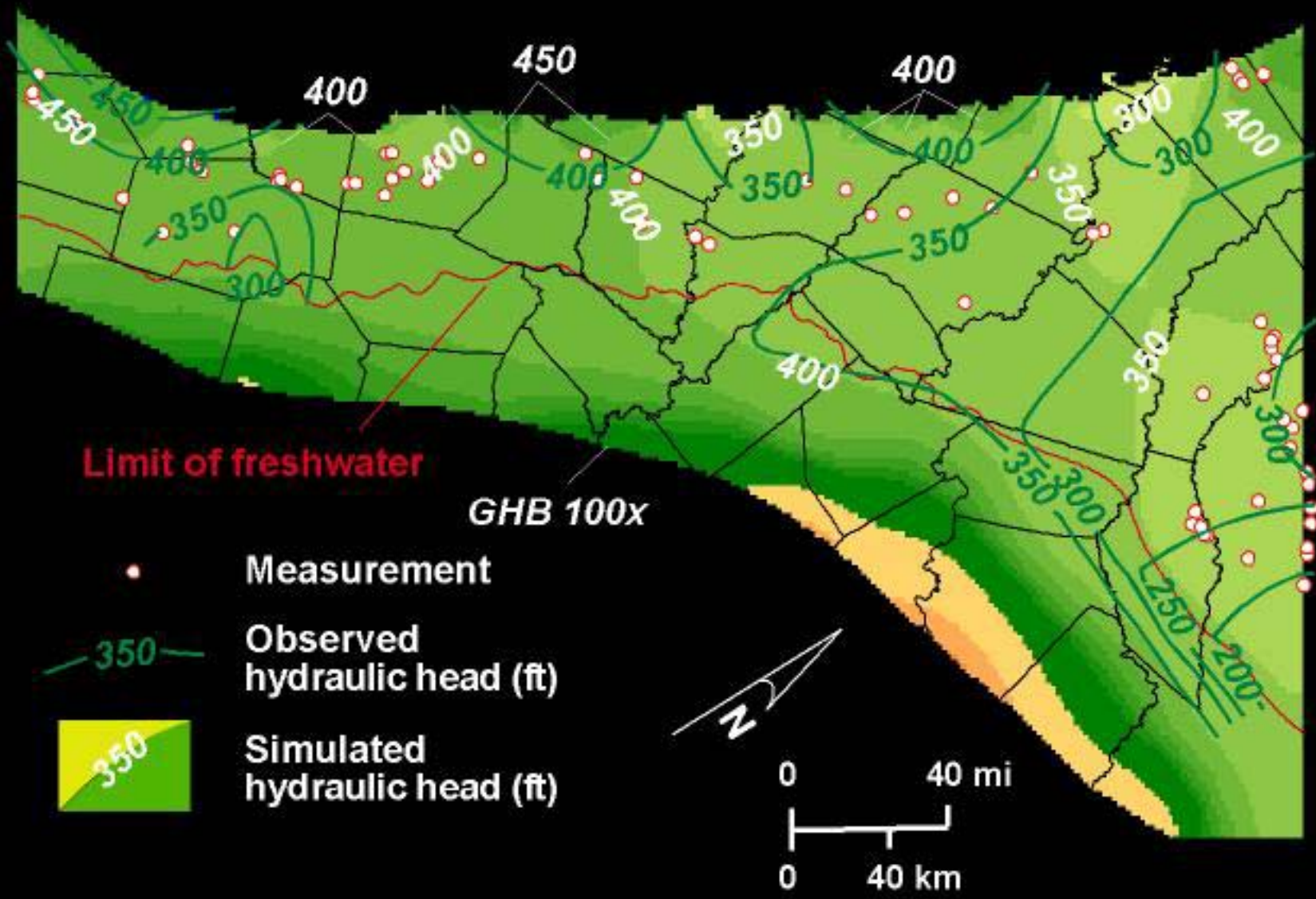
- Maps and graphs comparing simulated and observed hydraulic heads
- Comparison of estimated and simulated groundwater discharge to rivers and creeks

PREDEVELOPMENT POTENTIOMETRIC SURFACE



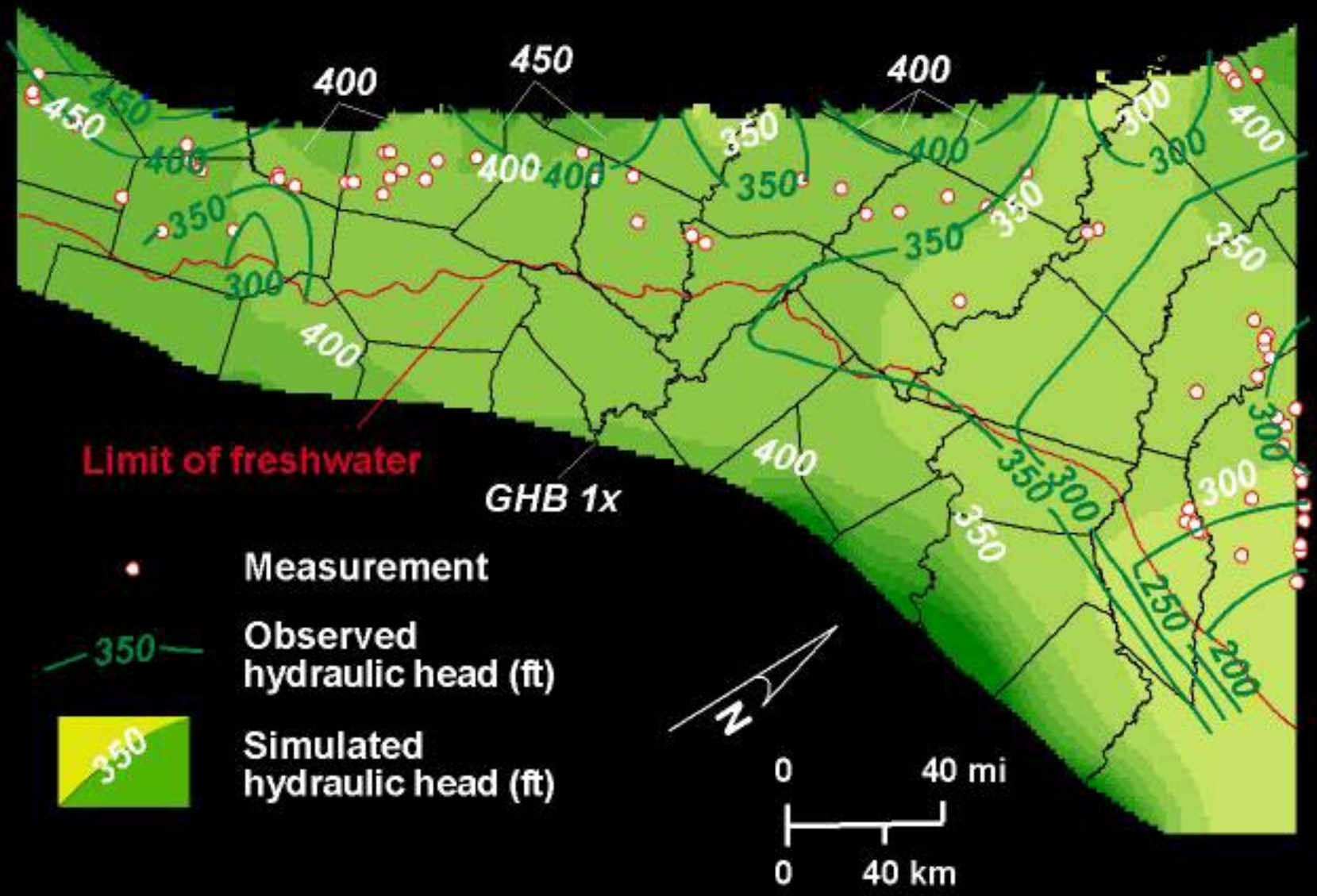
STEADY-STATE CALIBRATION

Simsboro Potentiometric Surface

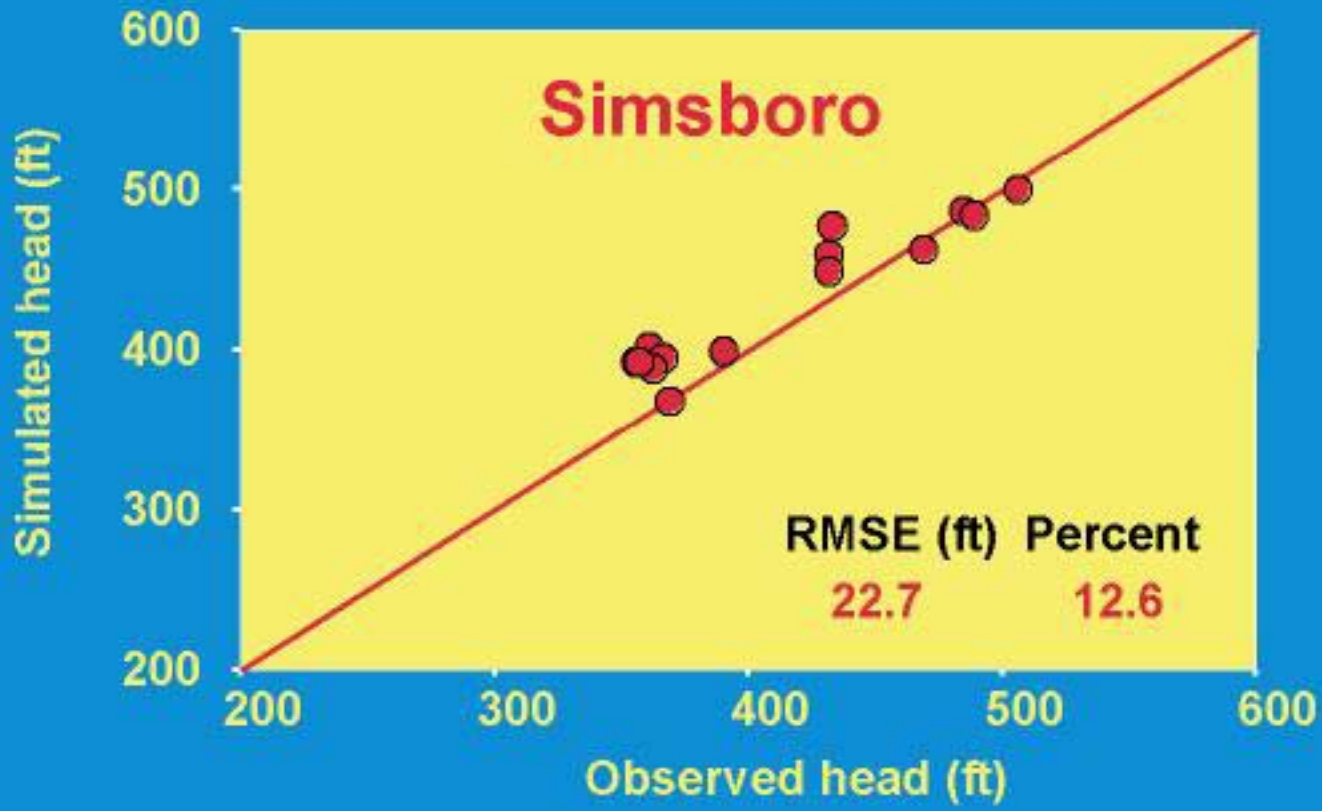


STEADY-STATE CALIBRATION

Simsboro Potentiometric Surface

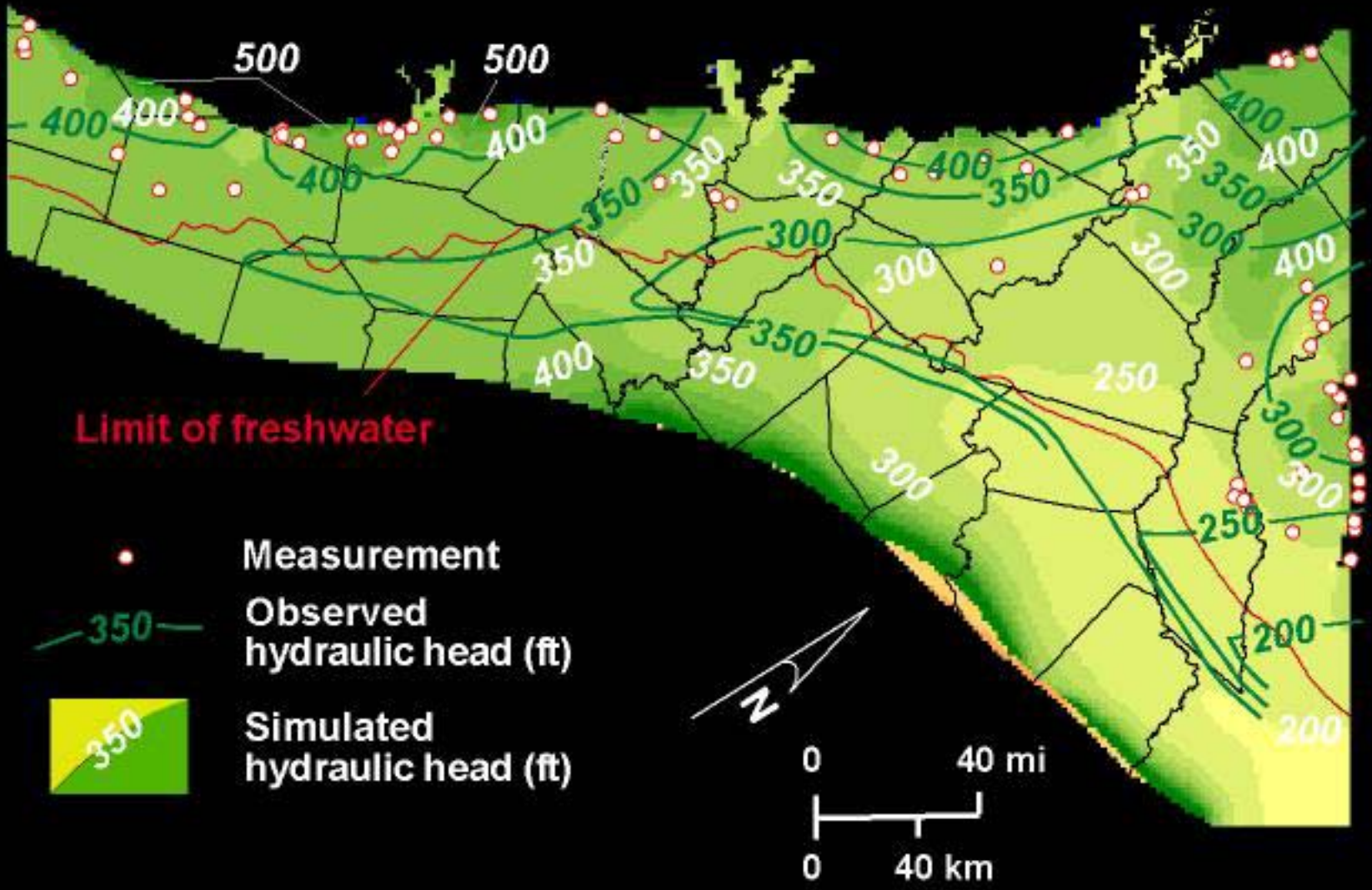


Comparison of Simulated versus Observed Water Levels (Steady state)

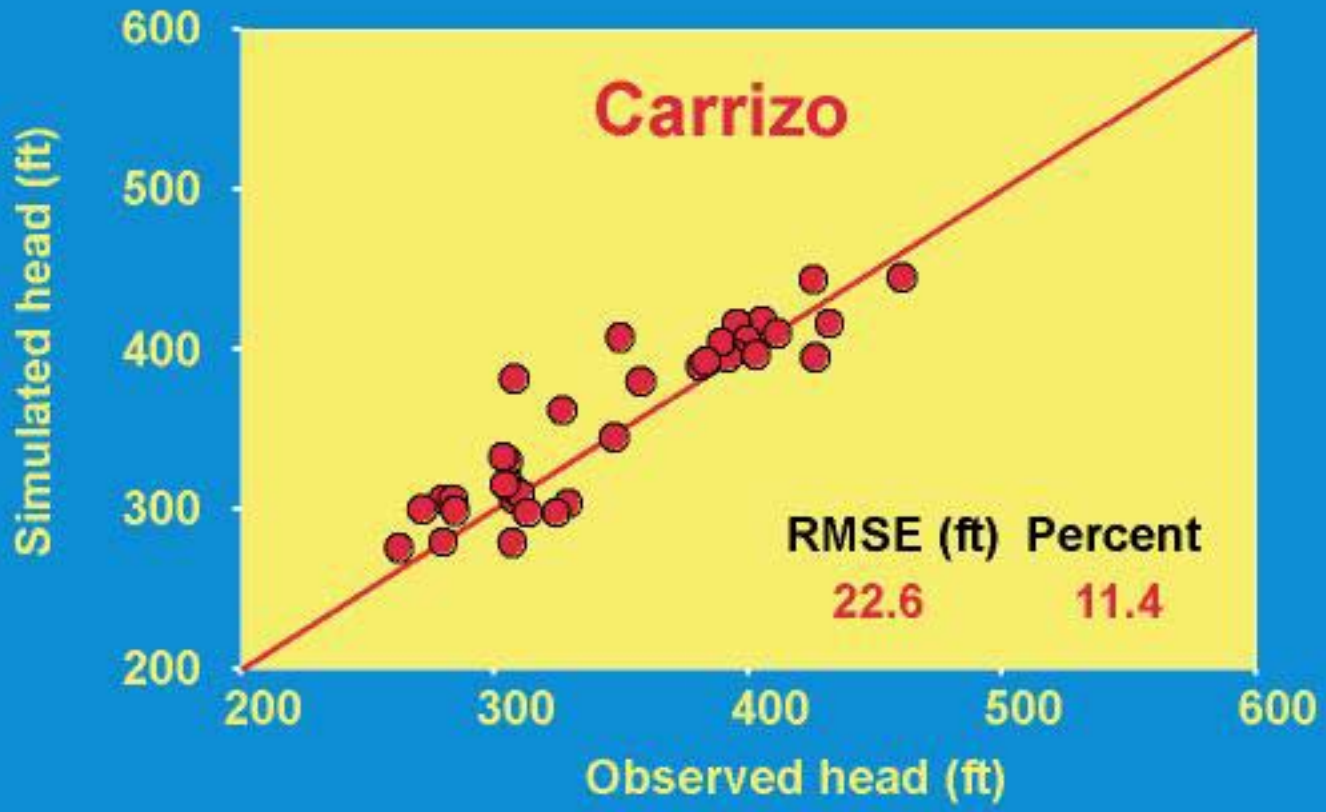


STEADY-STATE CALIBRATION

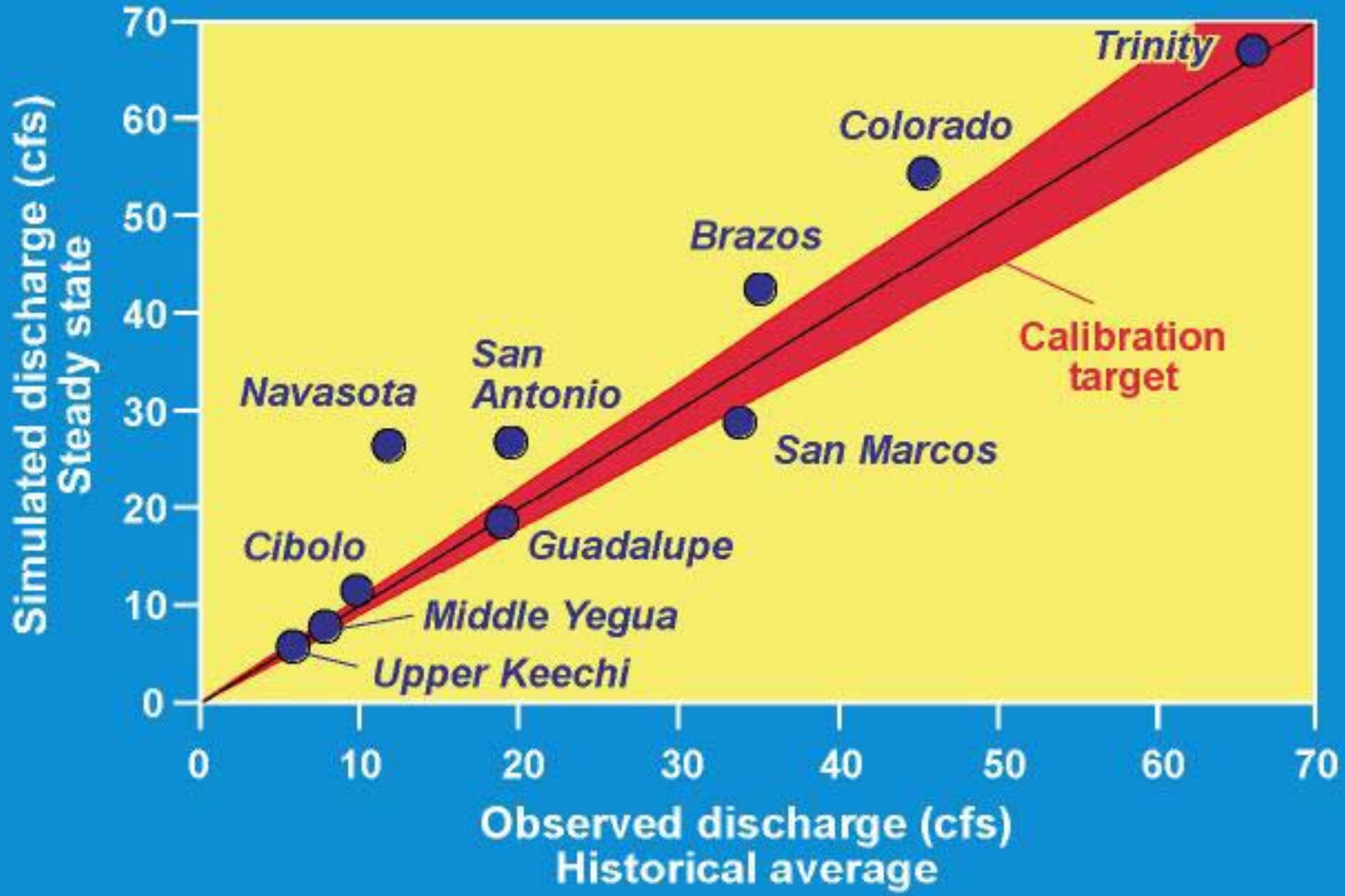
Carrizo Potentiometric Surface



Comparison of Simulated versus Observed Water Levels (Steady state)



RIVER CALIBRATION
Groundwater Discharge

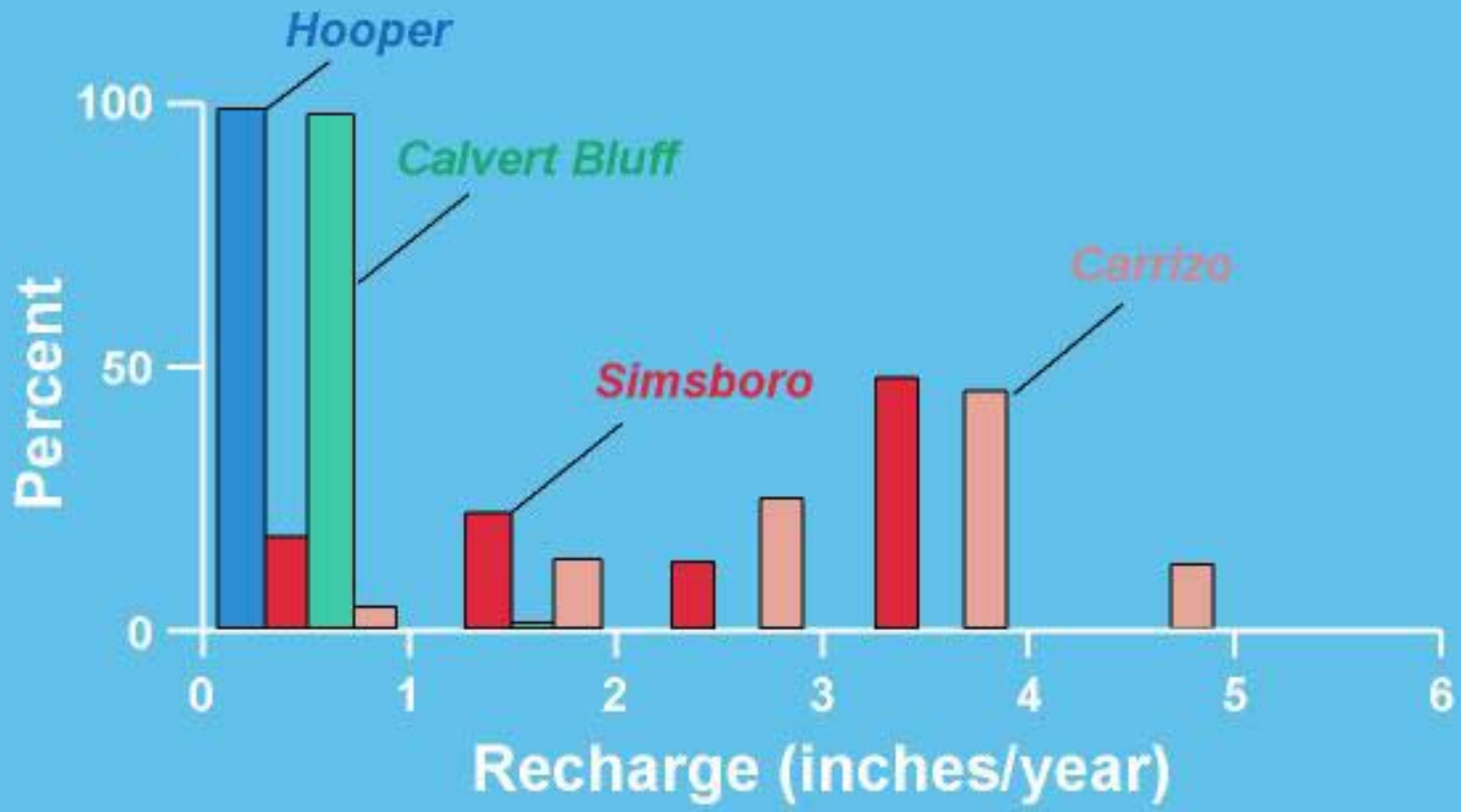


RECHARGE RATE

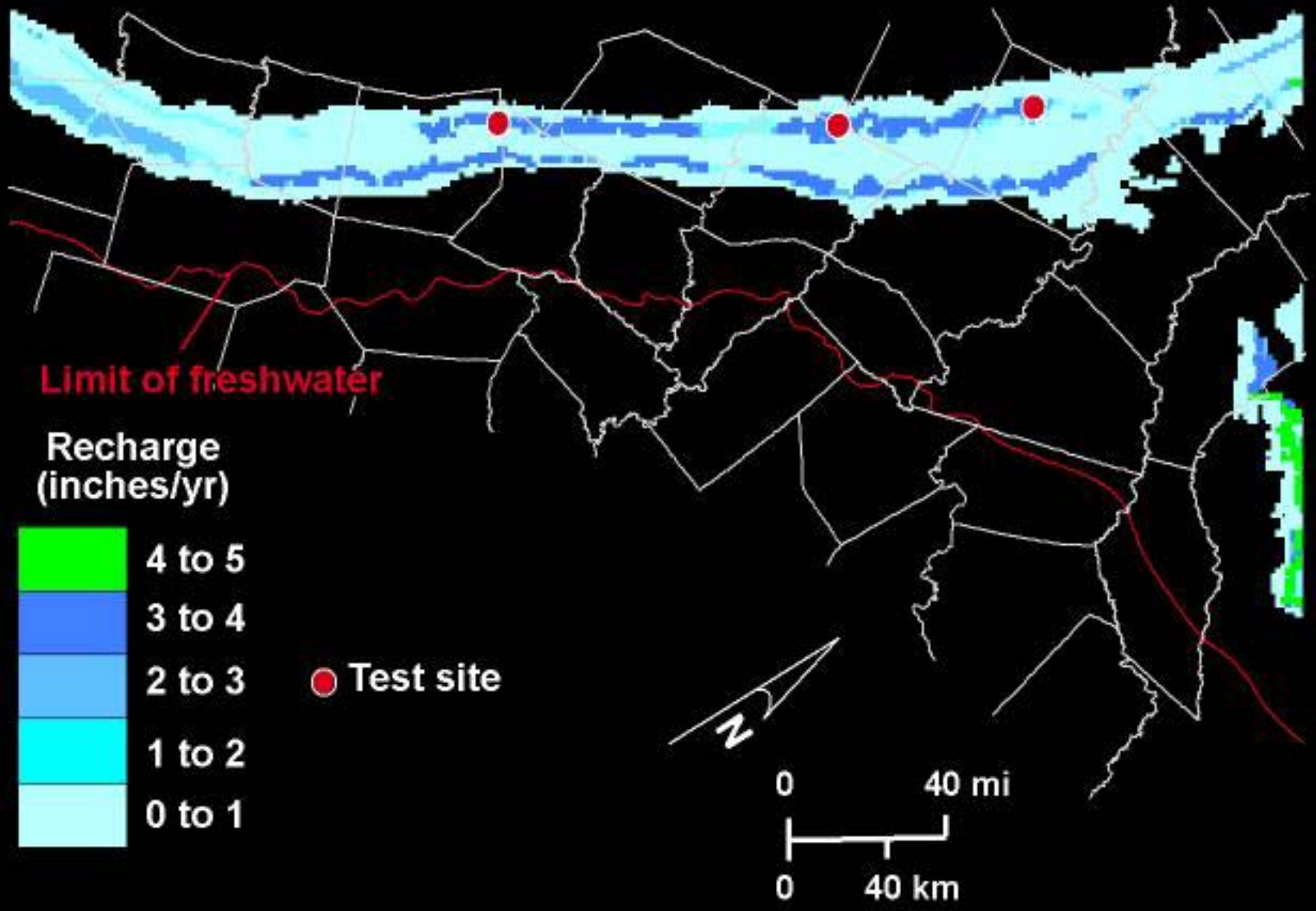
Estimates from previous studies (from Scanlon and others, 2002)

RECHARGE RATES

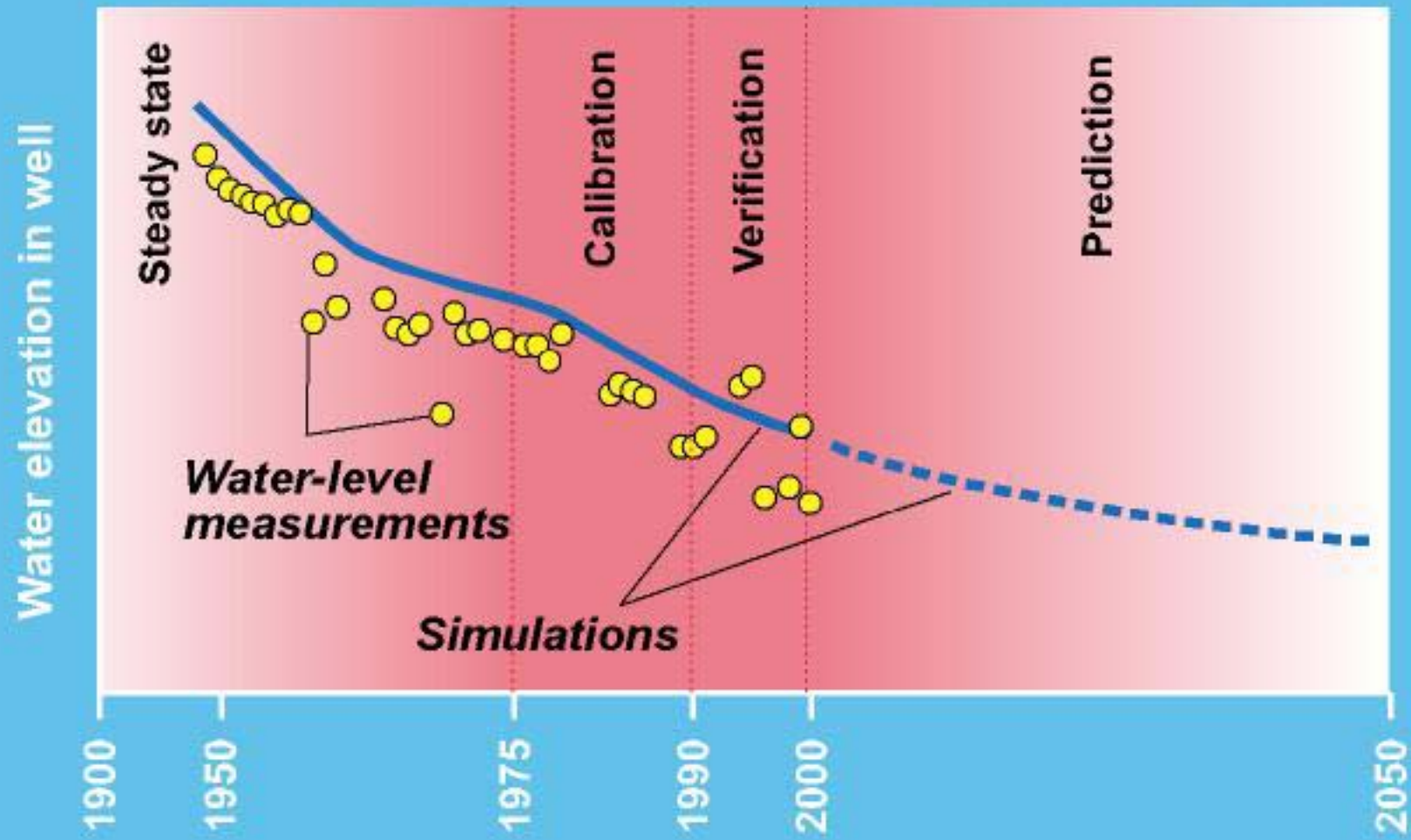
Applied in Central Carrizo-Wilcox GAM Model



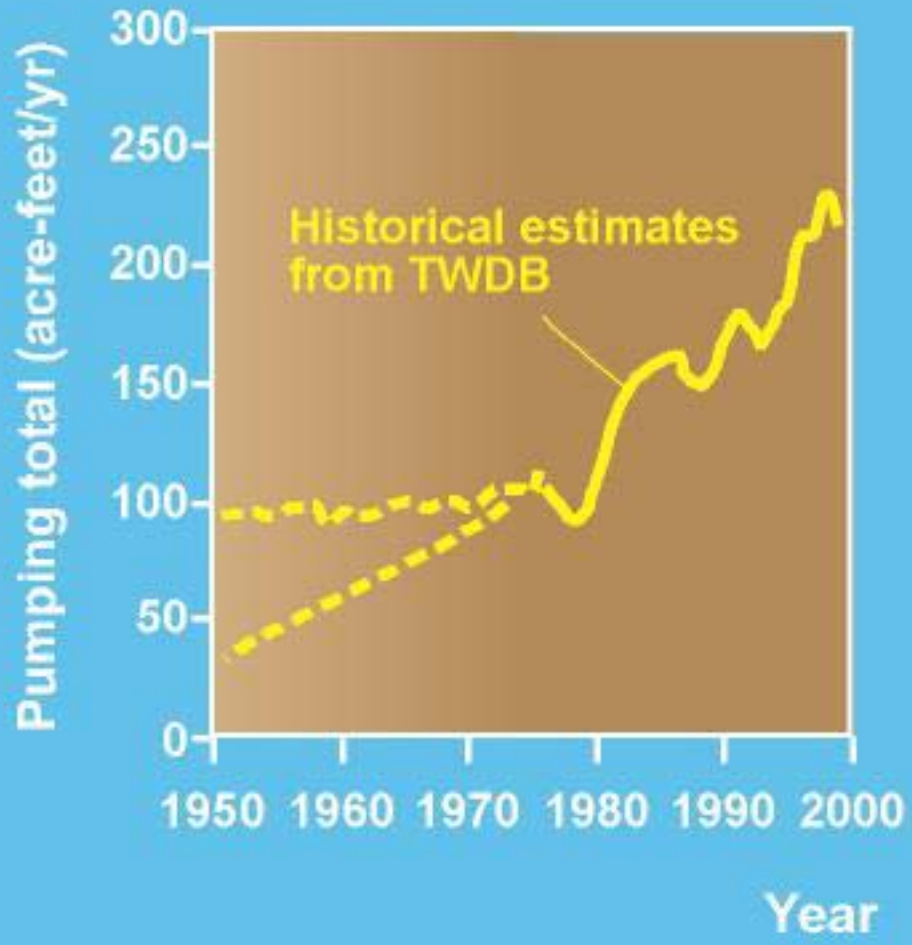
RECHARGE RATES



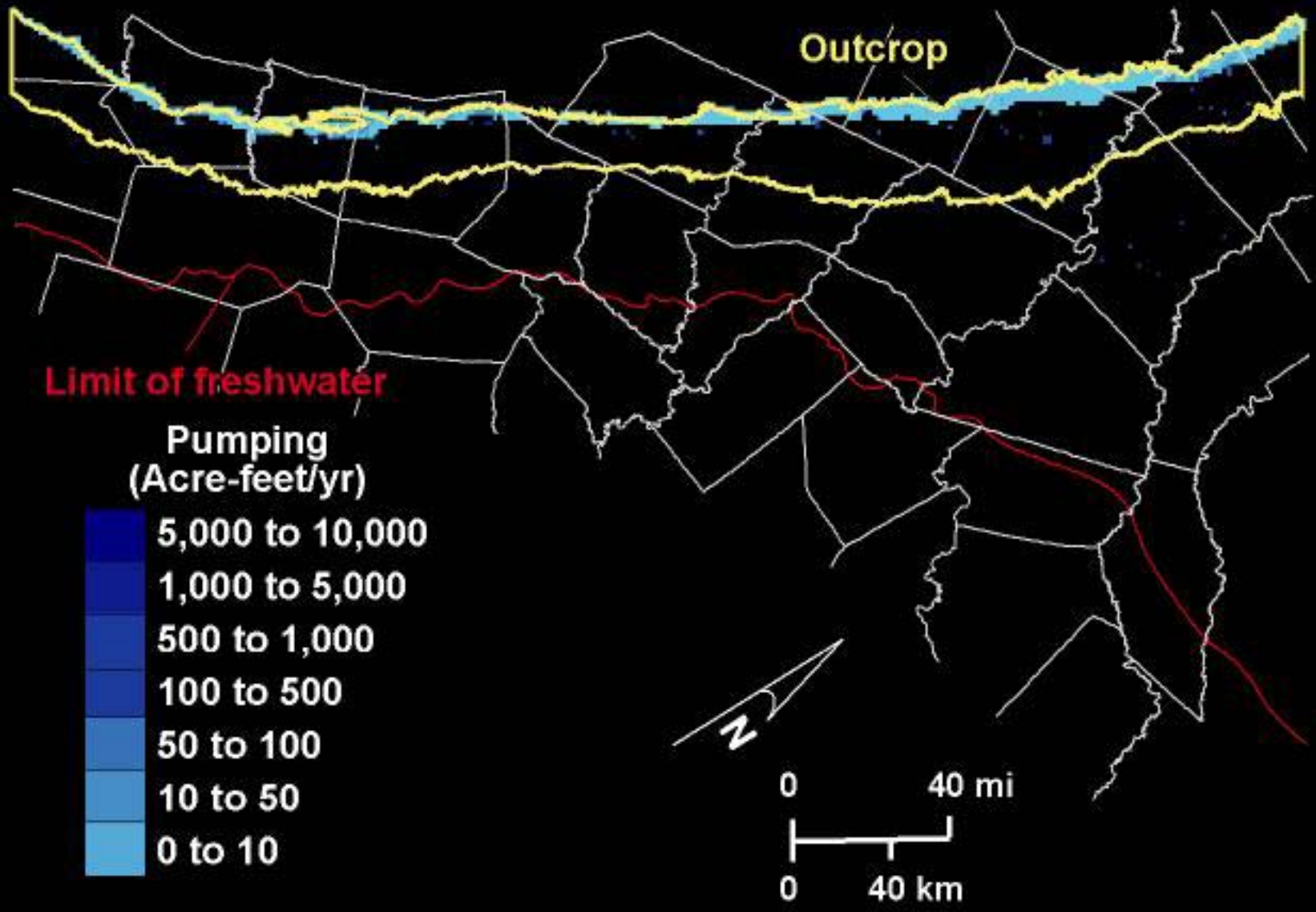
MODELING PERIODS



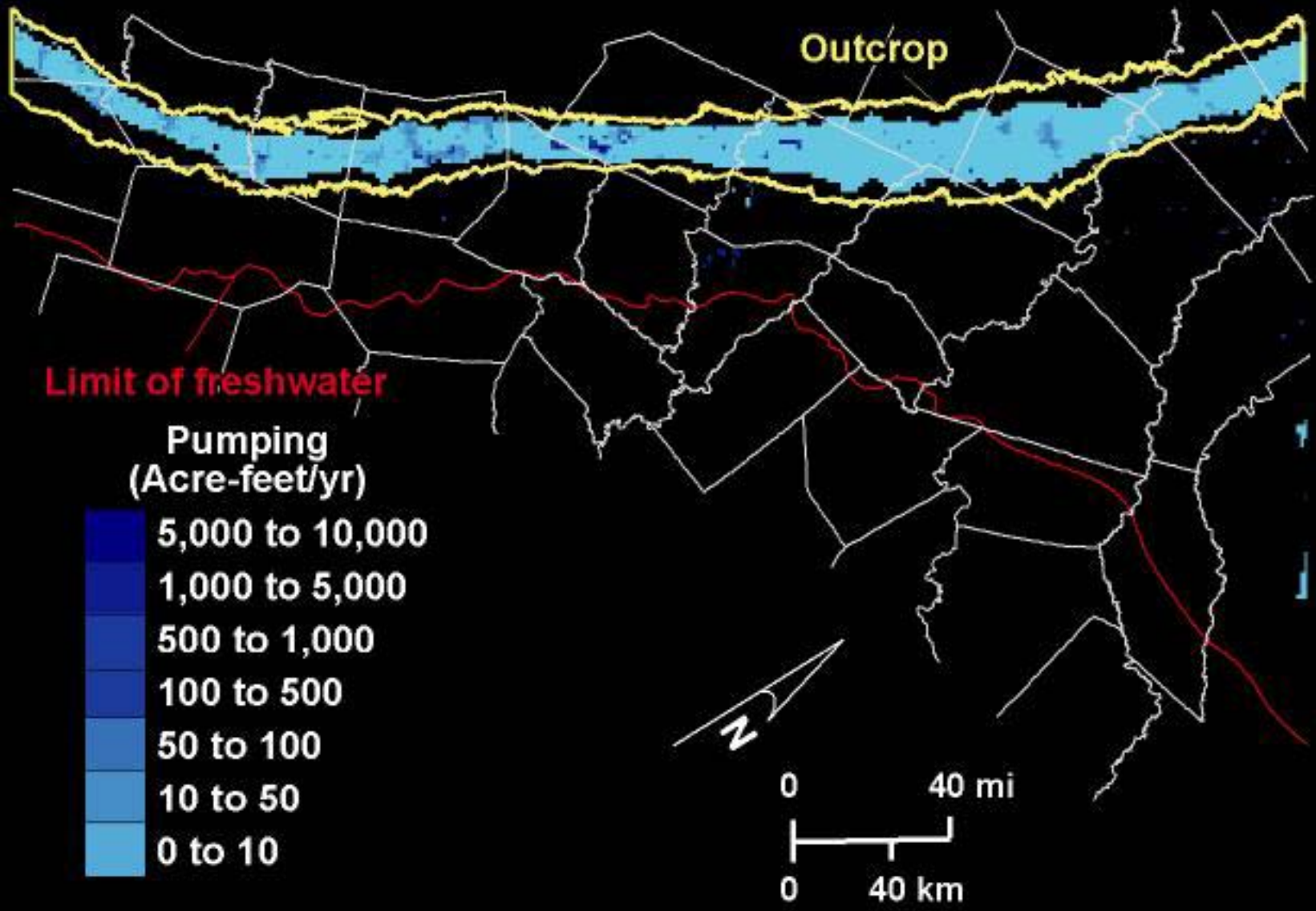
PUMPING RATE
Applied in Central Carrizo-Wilcox GAM Model



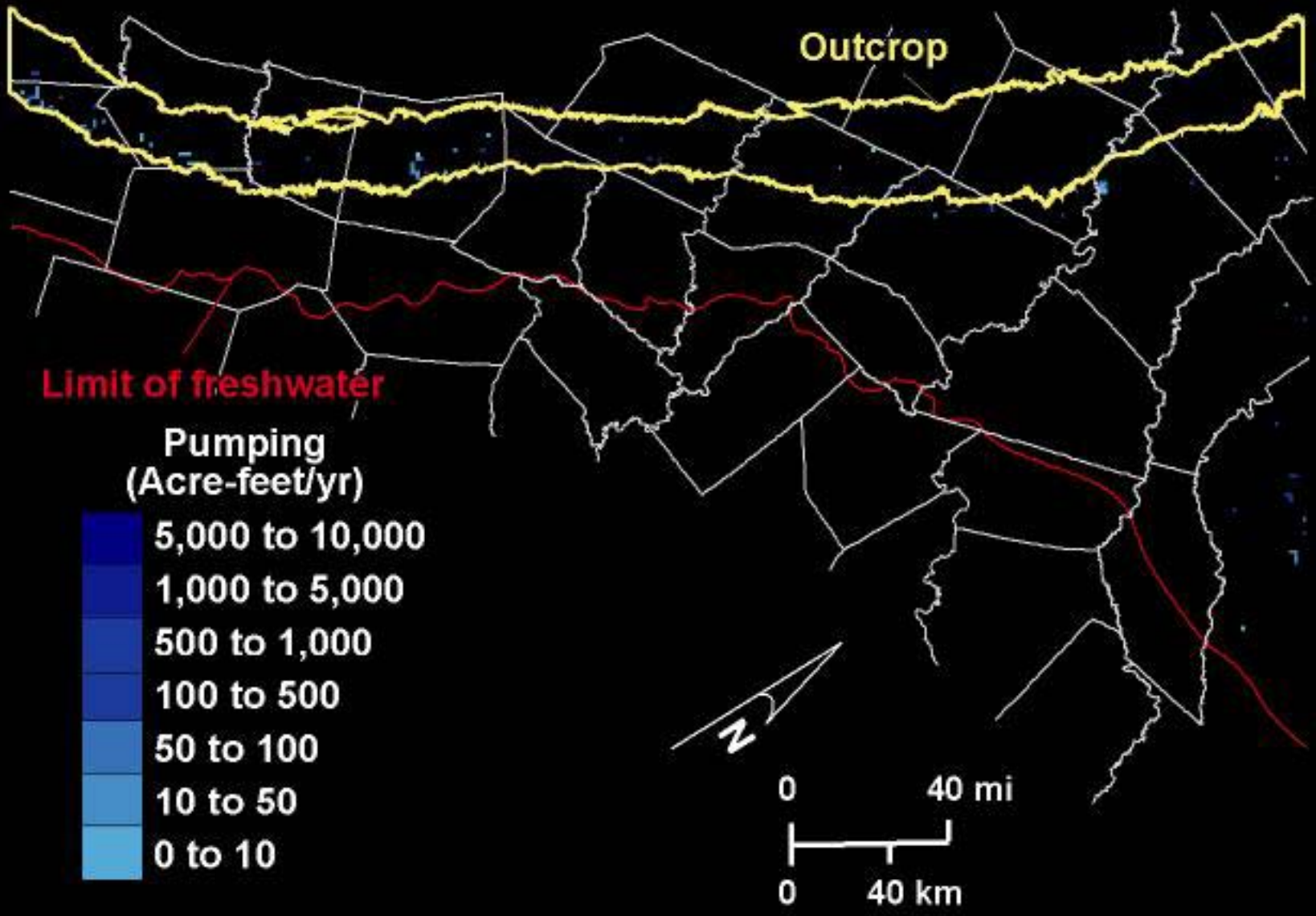
PUMPING RATES
Hooper (Layer 6) in 2000



PUMPING RATES
Simsboro (Layer 5) in 2000

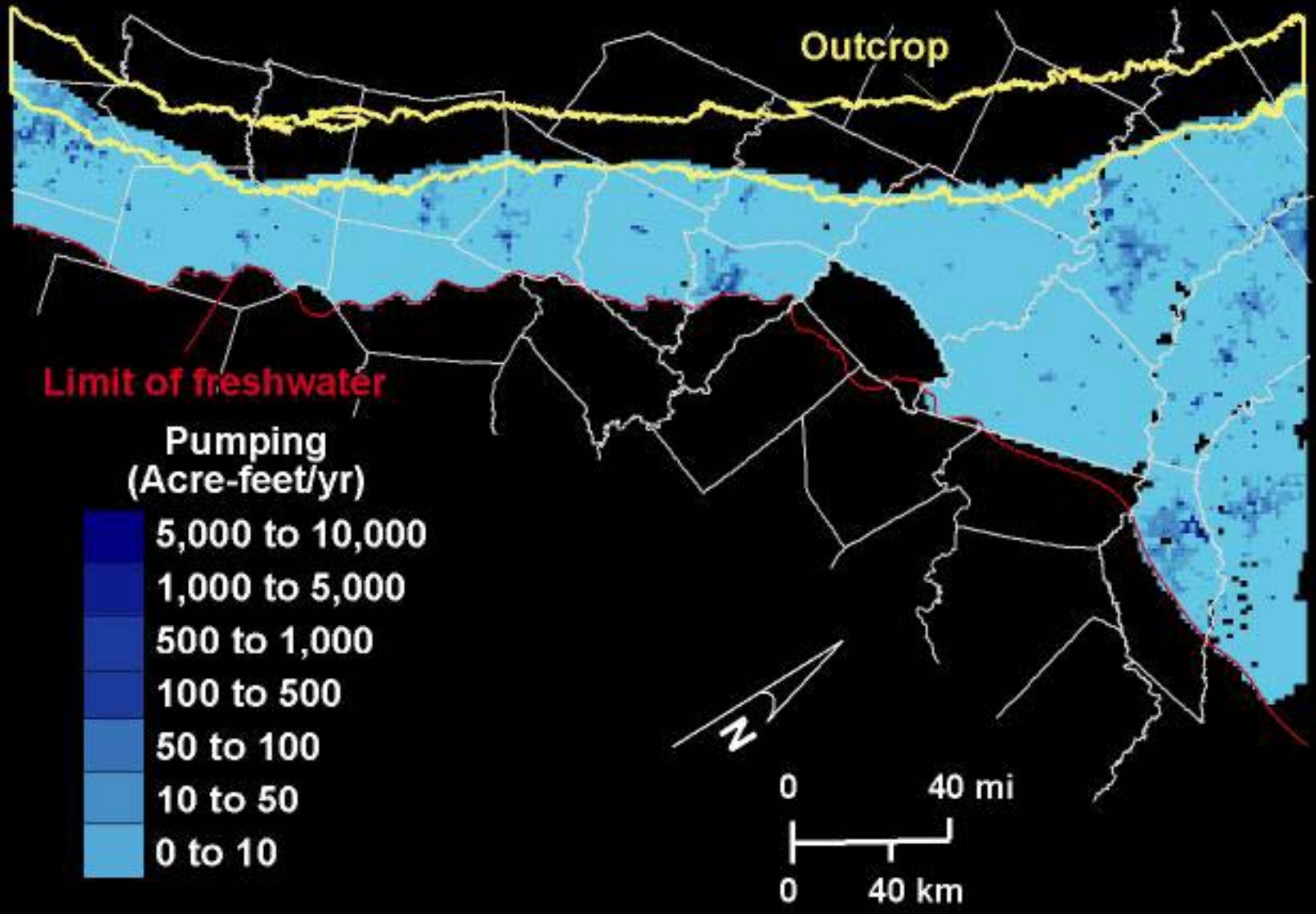


PUMPING RATES
Calvert Bluff (Layer 4) in 2000



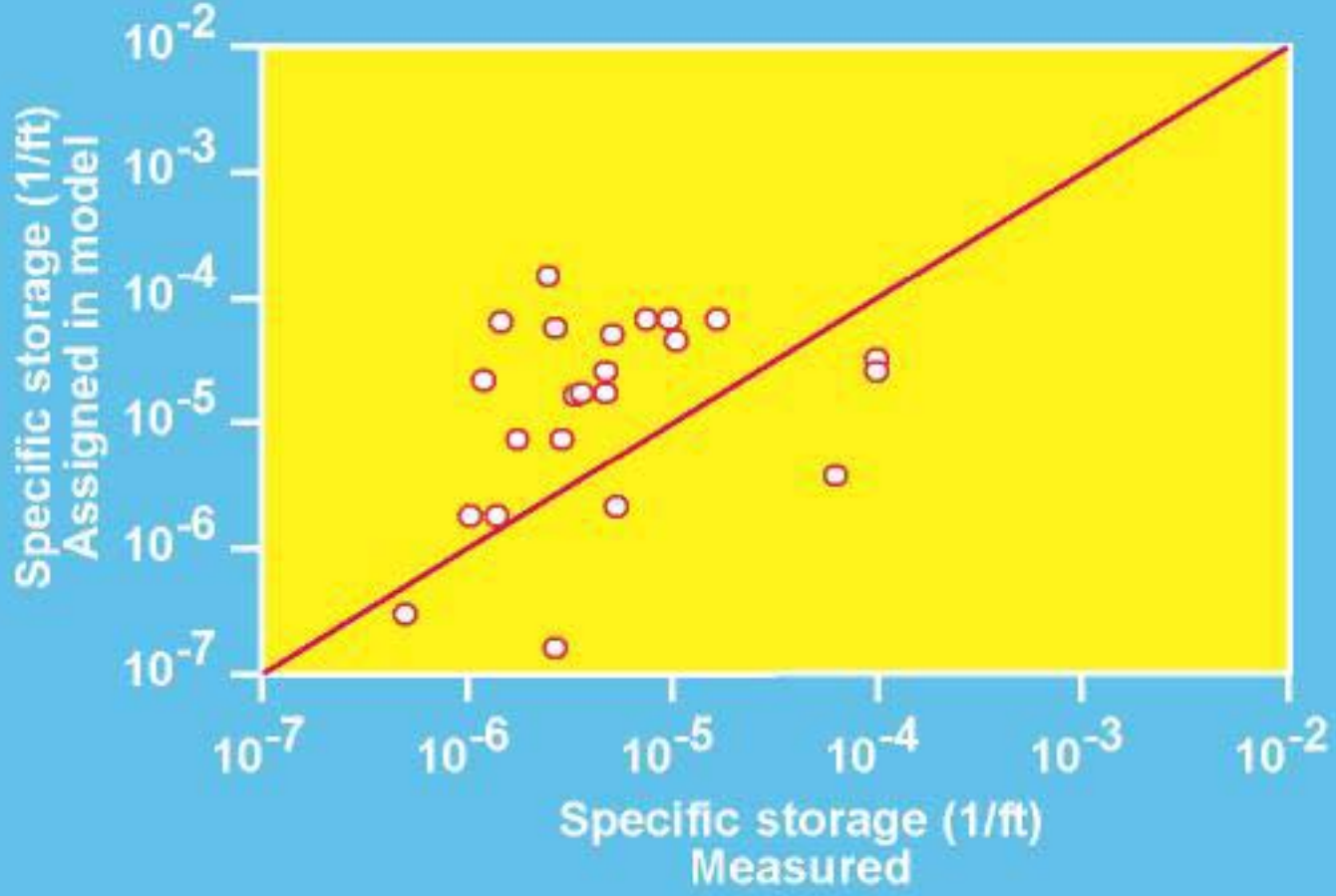
PUMPING RATES

Carrizo (Layer 3) in 2000



SPECIFIC STORAGE

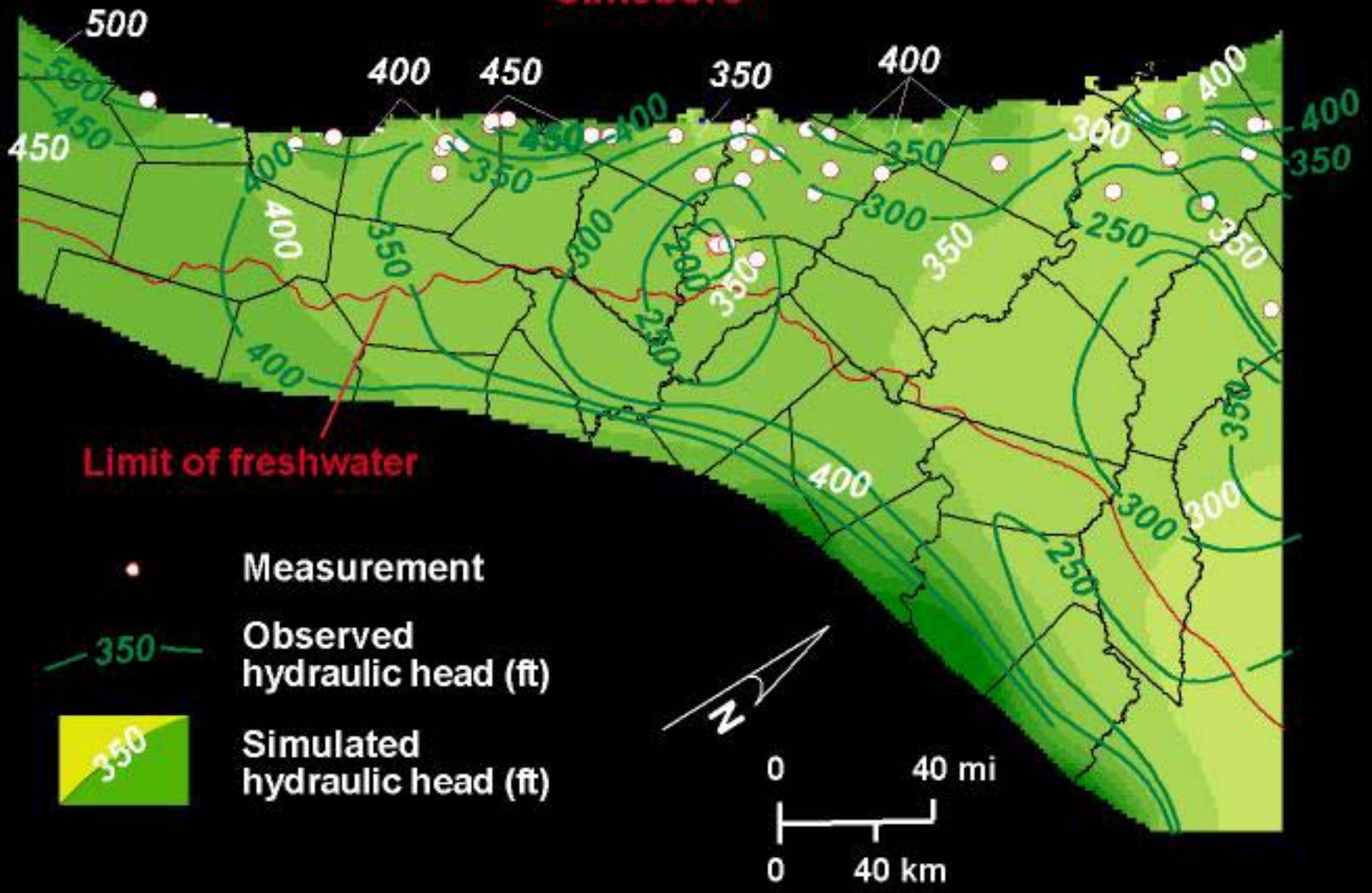
Relation between discharge and change in water level



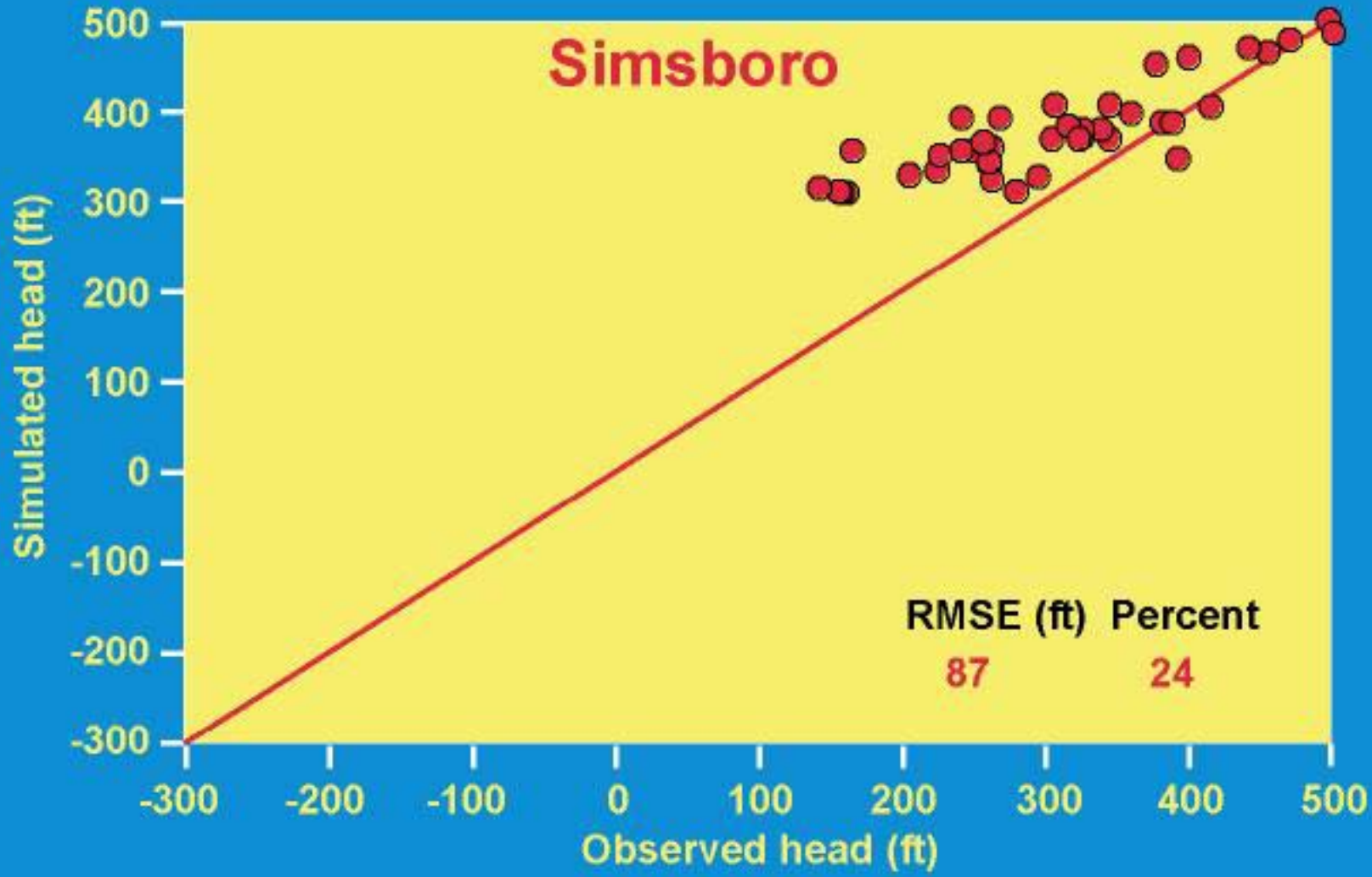
1990 INTERIM CALIBRATION

Comparison of Simulated and Estimated Potentiometric Surface

Simsboro



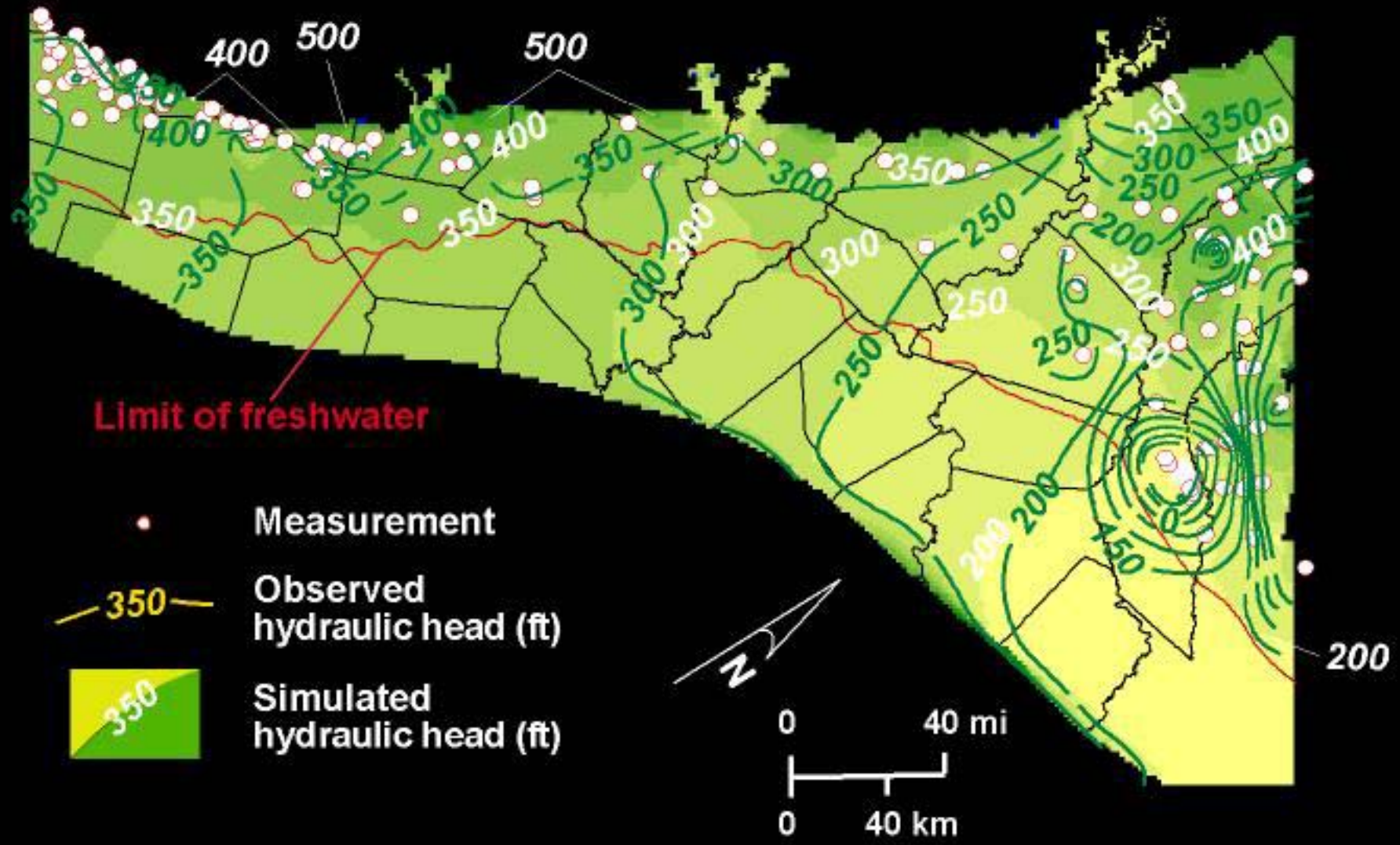
Comparison of Simulated versus Observed Water Levels (1990)



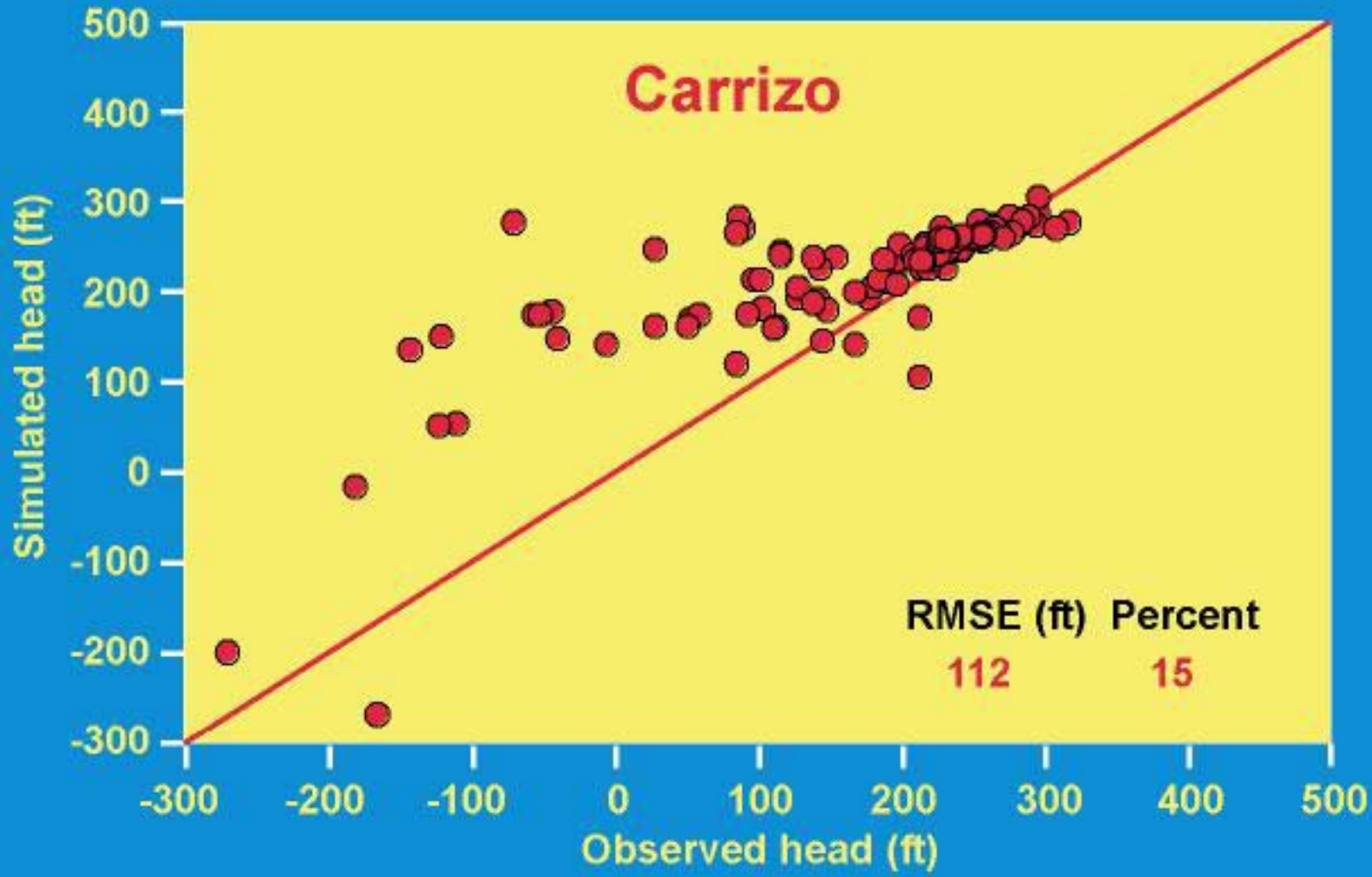
1990 INTERIM CALIBRATION

Comparison of Simulated and Estimated Potentiometric Surface

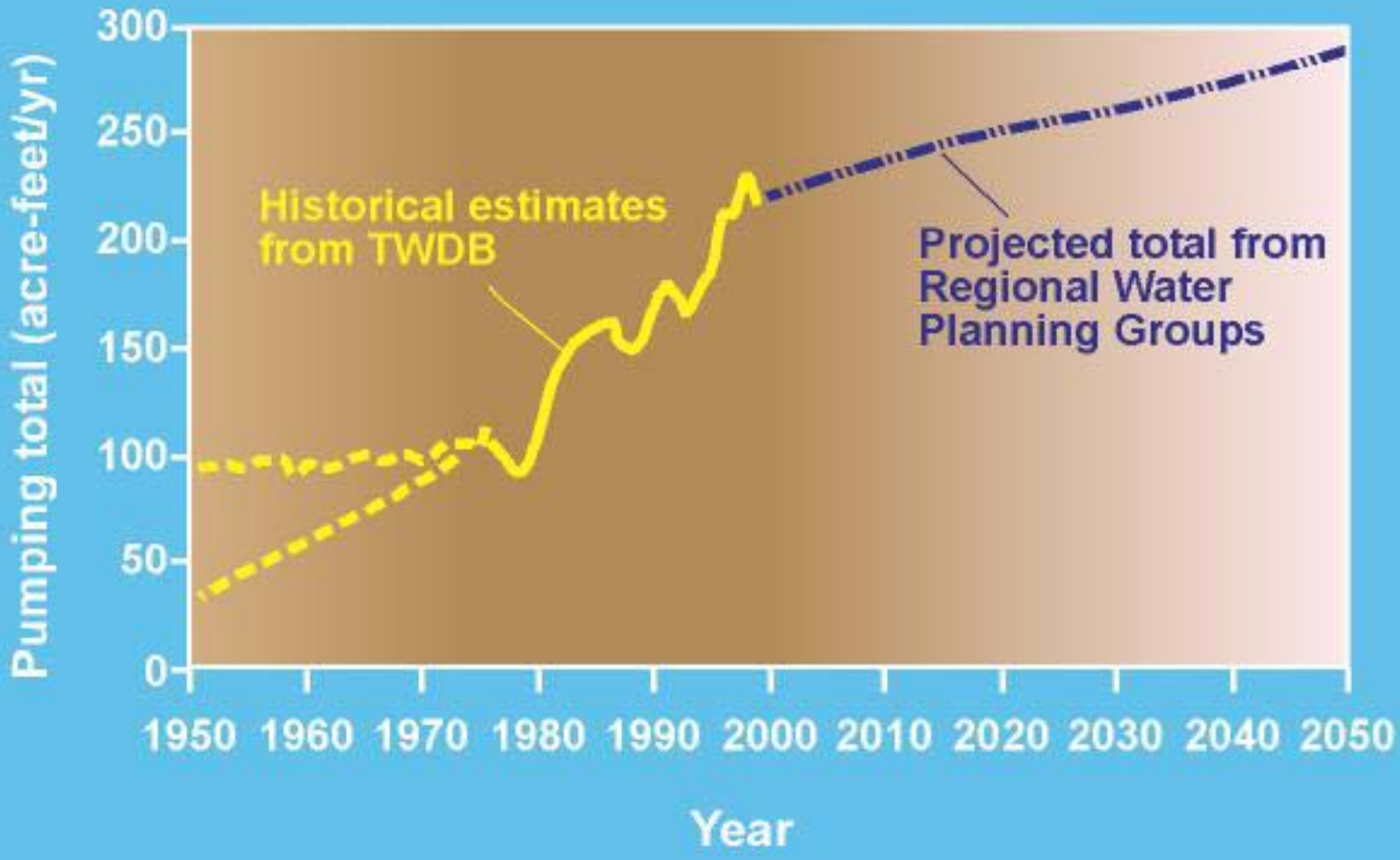
Carrizo



Comparison of Simulated versus Observed Water Levels (1990)



PUMPING RATE
Applied in Central Carrizo-Wilcox GAM Model



STATUS OF WORK

- Calibration and verification analysis
- Sensitivity analyses
- Predictive (2000 to 2050) simulation
- Data model documentation
- Report preparation
- Report review and revision
- Model training workshop

Stakeholder Advisory Forum (SAF)
Central Carrizo-Wilcox Aquifer Groundwater Availability Model

Forum Meeting No. 6
Wednesday, August 28, 1 p.m.

Hearne, TX

Attendees

Name	Affiliation
Phoebe Allen	Lost Pines GWCD
James Bene	RW Harden & Assoc
Pete Brien	Brazos Valley GCD
Dick Burns	Alcoa
Larry Conn	
Reece deGraffenried	Twin Creek Water
Leon A. Denena	Land Owner
Andy Donnelly	LBG-Guyton
Alan Dutton	BEG
Jim Florence	Adv. Comm.
Jan Hanson	
Keith Hansberger	Lost Pines GWCD
Bob Harden	RW Harden & Assoc
Bob Kier	Robert S. Kier Consulting
Dan Kowalski	Walnut Creek Mining Co.
James Kowis	Alcoa
R. Brent Locke	Bistone M.W.S.D.
Robert Mace	TWDB
Ann Mesrobian	Lost Pines GWCD
Kevin Morrison	SAWS
Jean-Philippe Nicot	BEG
Rodney O'Connor	
Jay Raney	BEG
George Rice	
Joe Tipton	
Darren Thompson	SAWS

Stakeholder Advisory Forum (SAF)
Central Carrizo-Wilcox Aquifer Groundwater Availability Model

Forum Meeting No. 6
Thursday, August 28, 2002, 1:30 p.m.
Hearne Community Center

Notes from Discussion, Questions, and Answers

The sixth Stakeholder Advisory Forum (SAF) for the Central Carrizo-Wilcox Aquifer Groundwater Availability Model (GAM) was held on August 28, 2002, from 1:30 to 3:45 p.m. at the Hearne Community Center, 809 W. Davis St., Hearne, Texas.

The purpose of the sixth SAF Forum was to discuss recharge rates used in the calibration of the steady state version of the model, review the development and calibration of the transient model, and summarize the predicted pumping rates being assigned in the simulations for the period from 2000 to 2050. The forum also was to discuss the status of work and schedule for project completion, and other issues and questions raised by Stakeholders. The presentation material (SAF6_CW-c.pdf) is available at the TWDB's GAM website (www.twdb.state.tx.us/GAM/czwx_c/czwx_c.htm). A list of attendees (SAF6_CW-c_a.pdf) is also posted at that website.

Meeting Introduction
Alan Dutton (UT Bureau of Economic Geology[BEG]) opened the Forum and introduced other modeling team members present, including Bob Harden and James Bene (R. W. Harden and Associates, Inc.), and Jean-Phillipe Nicot (BEG). Dr. Robert Mace, project manager for the TWDB, summarized the process and schedule for the review of the draft reports. The time from the draft to the final report will be four months. There is a period for public comment to be addressed to the TWDB.

Forum Presentation by Alan Dutton
After the introductions, Alan Dutton reviewed the project and made the presentation contained in the document "SAF6_CW-c.pdf." During and following the presentation, questions were asked by the stakeholders, which are summarized as follows.

Questions and Answers: Open Forum

Q: As more groundwater is produced, will that allow more recharge?
A: Production of groundwater from the down-dip confined part of the aquifer will draw more water from the outcrop deeper into the subsurface. This may cause less groundwater to be discharged to rivers and streams and wetlands in the outcrop area. Thus a greater proportion of the aquifer recharge may move deeper into the aquifer than did previously.

Q: Does freshwater flow into the area of salt water?
A; While there is not much data on the zone between the developed, freshwater part of the aquifer, mainly at depths of less than 2,500 ft, and the very saline zone at depths of more than 8,000 ft, we expect aquifer water (under natural conditions) to eventually exit the aquifer by moving upward. The deep saline water also moves upward, at very slow rates. So freshwater does not flow into the area of saltwater. Rather, there may be a broad zone between depths of 3,000 ft and 8,000 ft where there is little groundwater movement.

Q: Will change in water pressure effect water resources?

A: Most of the aquifer is under artesian or pressured conditions. Water pressure in most areas still reaches high above the top of the aquifer layers. Production of groundwater results in a pressure reduction in nearby parts of the aquifer. The pressure reduction is associated with a slight decrease in storage of water in the aquifer, mainly because of extremely small changes in stress between the sand grains that make up the aquifer. That is, water pressure in part holds up the aquifer; when pressure decreases the aquifer matrix takes up some of the load. The reduction in storage is extremely small and insignificant in the Carrizo-Wilcox aquifer compared to the absolute volume of water stored in the aquifer. Drop in pressure may also have a slight effect on the efficiency of pumping, requiring the pump to do more work to lift water from depth.

Q: What are the units shown on the slides (referring to figures 11 through 13 and others in SAF6_CW-c.pdf)?

A: Hydraulic head or water level is shown in units of length (feet) expressed relative to mean sea level.

Q: What is the status of calibration shown here; is it good enough?

A: The illustrations are labeled (for example, figure 28) as interim calibration. Calibration phase of work at this point is about 95 percent complete. Additional work is planned to meet the calibration goal.

Q: What recharge rates are valid for this model of the Carrizo-Wilcox aquifer (referring to figure 18)?

A: We collected original field estimates of recharge rate based on chemical constituents. Should this prove successful it will provide a low-cost way to estimate recharge rates. But many additional measurements and further evaluation are needed to prove up these techniques for this area (east-central Texas). The various chemical techniques we used gave a range of rates that bound the range of previous estimates. Therefore the most reasonable approach to assign recharge is to build on the results of previous studies. Most of the previous estimates are from models. So while our 7 field tests were not definitive, we think that additional field work is justified in the future to further develop this technique for estimating recharge rates.

The approach for estimating recharge used soil information to distribute recharge spatially within each aquifer unit (for example, Simsboro, Calvert Bluff). Calvert Bluff model cells are assigned less recharge than Simsboro model cells because of soil permeability.

Q: It would be helpful for the report to include a number of disclaimers pointing out what information or conclusions are strong and what are more tenuous. Also, have the report include a discussion of what additional information needs to be collected to improve understanding of the aquifer and model performance.

A: We will try to do so, and to further improve the report in response to reviewers' questions and comments.

Q: If a lot of groundwater is pumped 25 miles from the outcrop but salinity does not change, does that say there is a change in recharge rate?

A: Movement of water in the deep saline section most likely is very slow. This negligible rate of movement may be little affected by recharge rate.

Q: What is the TWDB review status on this model--where does TWDB say the model is today?

A: [Answered by Robert Mace] The TWDB has not officially accepted the steady-state version of the model; the model had not met the 10 percent calibration goal as of an earlier TWDB review. But TWDB allowed BEG to continue model development expecting that further adjustments during transient model calibration would allow the steady-state calibration to meet the goal.

Q: Stakeholders need to have a model that is reliable, non-biased, etc.; this is very important. But there is concern about whether remaining time schedule will allow the BEG team to complete the model on time without sacrificing quality. There is some opinion that meeting the schedule is less important than obtaining a quality model.

A: [Answered by Robert Mace] The TWDB is unwilling for contractors to cut corners to meet time line.

Q: What changes were made in the model design since the initial conceptual model?

A: The greatest change in model design involves how recharge is assigned. We initially expected to vary recharge rate across the model along with both precipitation and soil permeability. As it turned out, the model could not be calibrated if recharge increased with increasing precipitation from south-to-north across the outcrop. This may mean that although East Texas gets more rainfall, there is more runoff and more evapotranspiration, so recharge is about the same. We do vary recharge with respect to precipitation through time, but not in space.

Q: How much water is in each aquifer? In other words, how much is in the bank?

A: We will include water budget numbers in the report. The water budget expresses how much is going in and out of the aquifer; more like deposits and withdrawals than balance, to use the bank analogy. We might be able to provide an estimate of the amount of water in storage. Most groundwater use in the Carrizo-Wilcox aquifer, however, does not involve draining of porosity but drawing off the pressure head. So the "balance in the bank" may be misleading.

Q: With water marketers trying to lease water rights, it is important to know how much water can be safely taken out. Is the amount of recharge the safe amount to pump without harming the aquifer?

A: [Alan Dutton] Historically many people have equated safe yield with the recharge rate.

[Robert Mace] It is more complicated than that. Pumping can change, for example, the amount of stream flow. What is an acceptable amount of withdrawal may take into account not only water levels in the aquifer and stream flow, but also non-aquifer considerations such as the usefulness of the water and requirements for maintaining and growing the local economy. A discussion of considerations about groundwater availability, "Estimating groundwater availability in Texas," by Robert E. Mace, William F. Mullican, III, and Ted (Shao-Chih) Way, is included in a paper on the website at http://www.twdb.state.tx.us/GAM/GAM_documents/gw_avail.pdf.

Q: There is a discrepancy between recharge units shown on the histogram and map.
A: The version of figure 20 included in SAF6_CW-c.pdf on the website has been corrected since the SAF forum. The histogram (figure 19) included the right numbers but the map (figure 20) shown at the meeting was an incorrect version. The correct version included in SAF6_CW-c.pdf shows more recharge in the Carrizo aquifer across the Sabine Uplift area.

Q: Has it occurred to the State to regulate the entire aquifer as one entity? Water conservation boards need to know that what occurs or is allowed in one county may impact others.
A: [Robert Mace] Groundwater Management Areas promote joint planning among groundwater districts.

Q: Where does pumping by water supply corporations get assigned in the model?
A: The TWDB guidance for model development and the TWDB data base distinguishes pumping by municipalities serving more than 500 people from other public-water supplies. The latter are included in a category labeled 'county-other.' Pumping to represent this 'county-other' category in the model is assigned according to population in census tracts in 1990 and 2000. Individual wells used to supply 'county-other' pumping are not separately mapped or identified in the model.

Q: How much drawdown is shown for the Bryan-College Station and Lufkin well fields?
A: The interim model estimates drawdown of about 200 ft for Bryan-College Station and about twice as much for the Lufkin wellfield. These two municipal well fields are examples of where the artesian or pressure head of the aquifer has been decreased by pumping while the aquifer remains full of water.

Q: Is the cone of depression static or does it grow at some rate?
A: In general, with a constant pumping rate in an extensive aquifer, one would expect the rate of growth of the cone of depression to decrease with time.

Following the presentation there was additional discussion.

Q: The model is very large. Will small (1, 2, or 3 county districts) be able to plug in proposals from local water developers and see how they affect a small area?

A: The model has 1-square mile cells. This gives 500 to 1,000 model cells in most counties.

Q: Is there enough time remaining in the schedule for BEG to complete the scope of work with expected quality? It looks like you are expecting to do 9 months of scheduled work in the next 3 months. How will this be done? Is there any latitude for more time to be allowed to ensure quality?

A: [Alan Dutton] The original time schedule includes less than fulltime effort. We are now in overtime mode.
[Robert Mace] More time may be allowed if necessary. TWDB must feel confident that results meet quality goals before TWDB will accept the product.

Q: Is pumping related to lignite mines included?

A: The model includes both the historical estimates of pumping for mining and also the predicted amounts identified in the regional water plans.

Q: Once model is finished, will it be useful as a tool to provide consistent answers or will it provide whatever answers you want?

A: [Bob Harden] For some questions, the model will need additional site specific data. Using such data may give different details to answers than the regional model.
[Alan Dutton] As long as only pumping forecasts are changed, results will be consistent.
[Robert Mace] The official version of the model will reside on the TWDB website. Results can be evaluated by running one model against the official version. Users will need to document whatever changes are made in their version.

Q: Will TWDB update the model?

A: [Robert Mace] TWDB will add new data and fix problems as they are discovered.