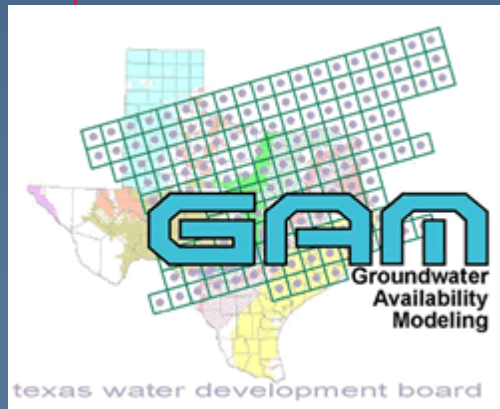


# Stakeholder Advisory Forum – 7

## Groundwater Availability Modeling (GAM) for the Southern Carrizo-Wilcox Aquifer



San Antonio River  
Authority  
San Antonio, Texas  
November 4, 2002



# Presentation Outline

- **GAM Review**
- **Model Review and Issues**
- **Transient Modeling**
- **Predictive Modeling**
- **Conclusions/Issues**
- **GAM Schedule**

# GAM Objectives

- Develop realistic and scientifically accurate GW flow models representing the physical characteristics of the aquifer and incorporating the relevant processes
- The models are designed as tools to help GWCD, RWPGs, and individuals assess groundwater availability
- Stakeholder participation is important to ensure that the model is accepted as a valid model of the aquifer

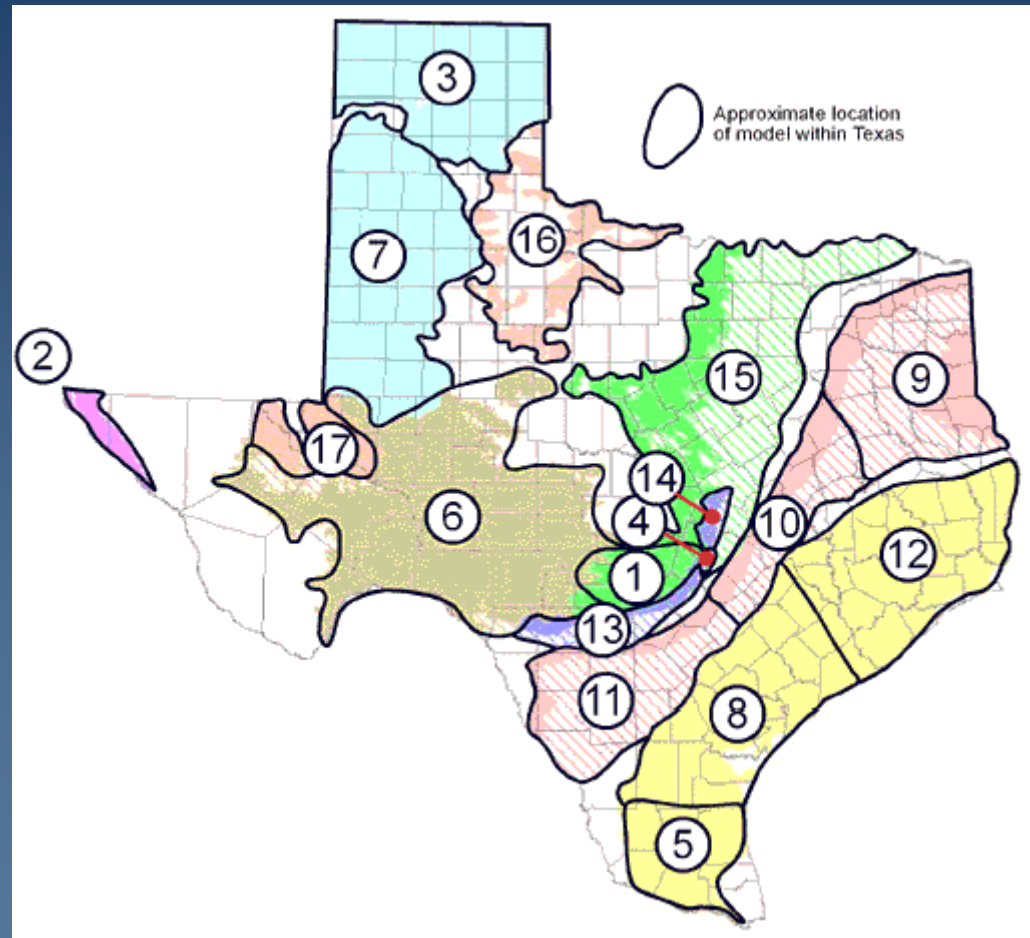
# GAM Models

## ■ Ongoing:

- Carrizo-Wilcox (9-11)
- Ogallala south (7)
- Gulf Coast central (8)
- Gulf Coast north (12)
- Lower Rio Grande (5)
- Edwards Trinity (6)

## ■ Completed:

- Trinity HC (1)
- Hueco Bolson (2)
- Ogallala north (3)
- Edwards - BS (4)



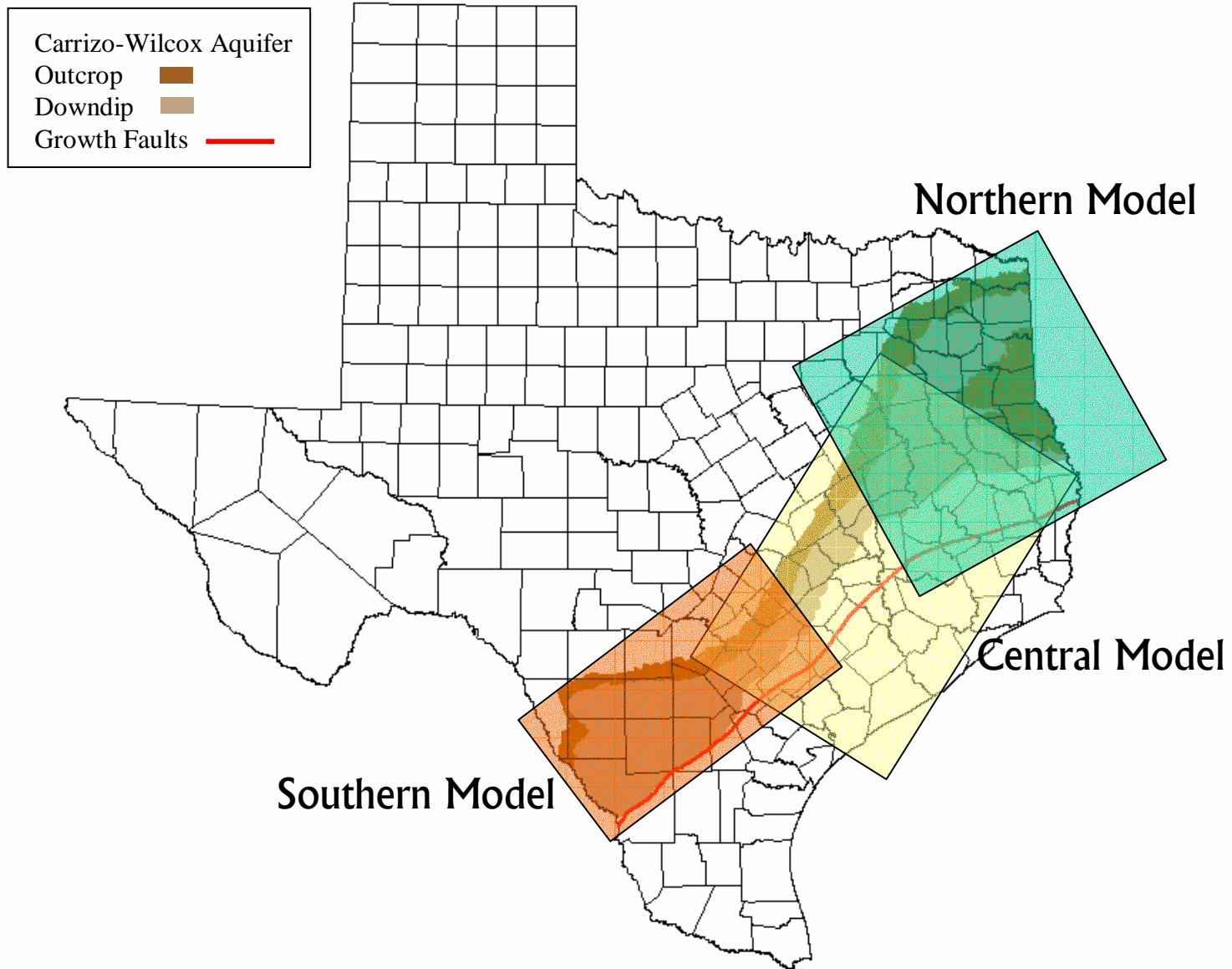
# Model Specifications

- Three dimensional (MODFLOW-96)
- Regional scale (100's of mi<sup>2</sup>)
- Grid spacing of 1 square mile
- Include Groundwater/surface water interaction (Stream routing, Prudic 1988)
- Properly implement recharge
- Stress periods as small as 1 month
- Calibration to within 10% of head drop

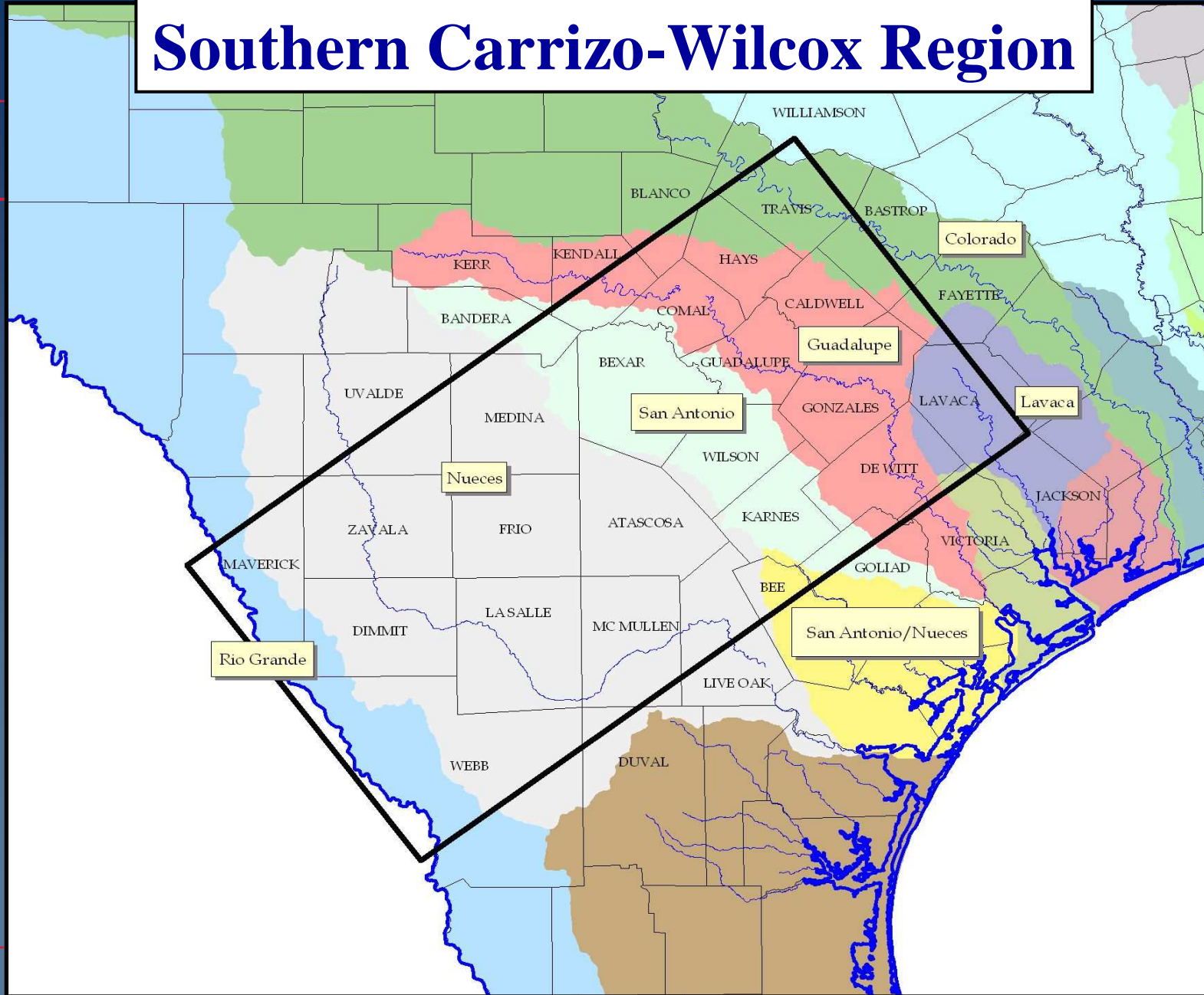
# Presentation Outline

- **GAM Review**
- **Model Review**
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# Carrizo-Wilcox GAM Model Domains

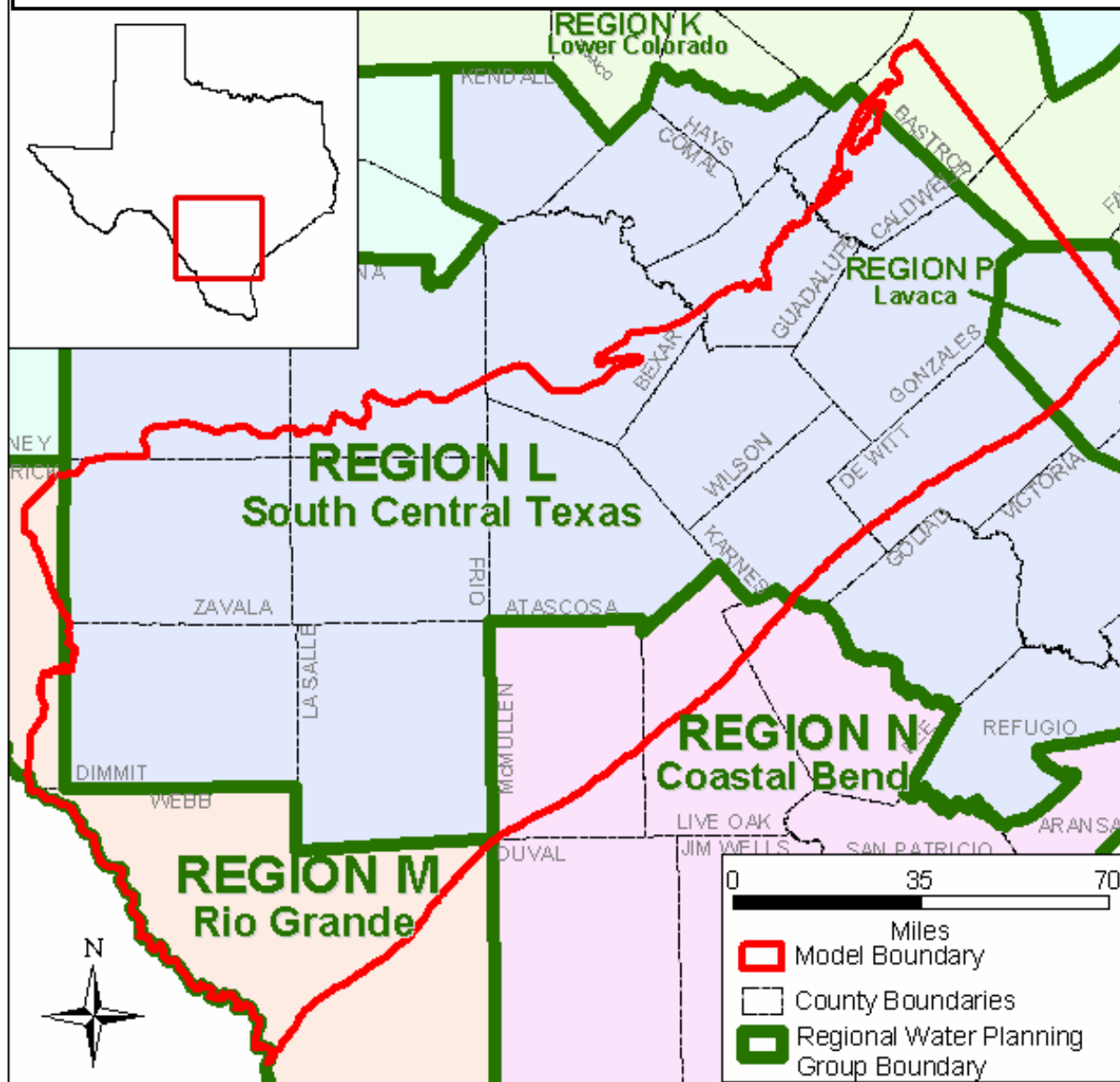


# Counties & River Basins in the Southern Carrizo-Wilcox Region





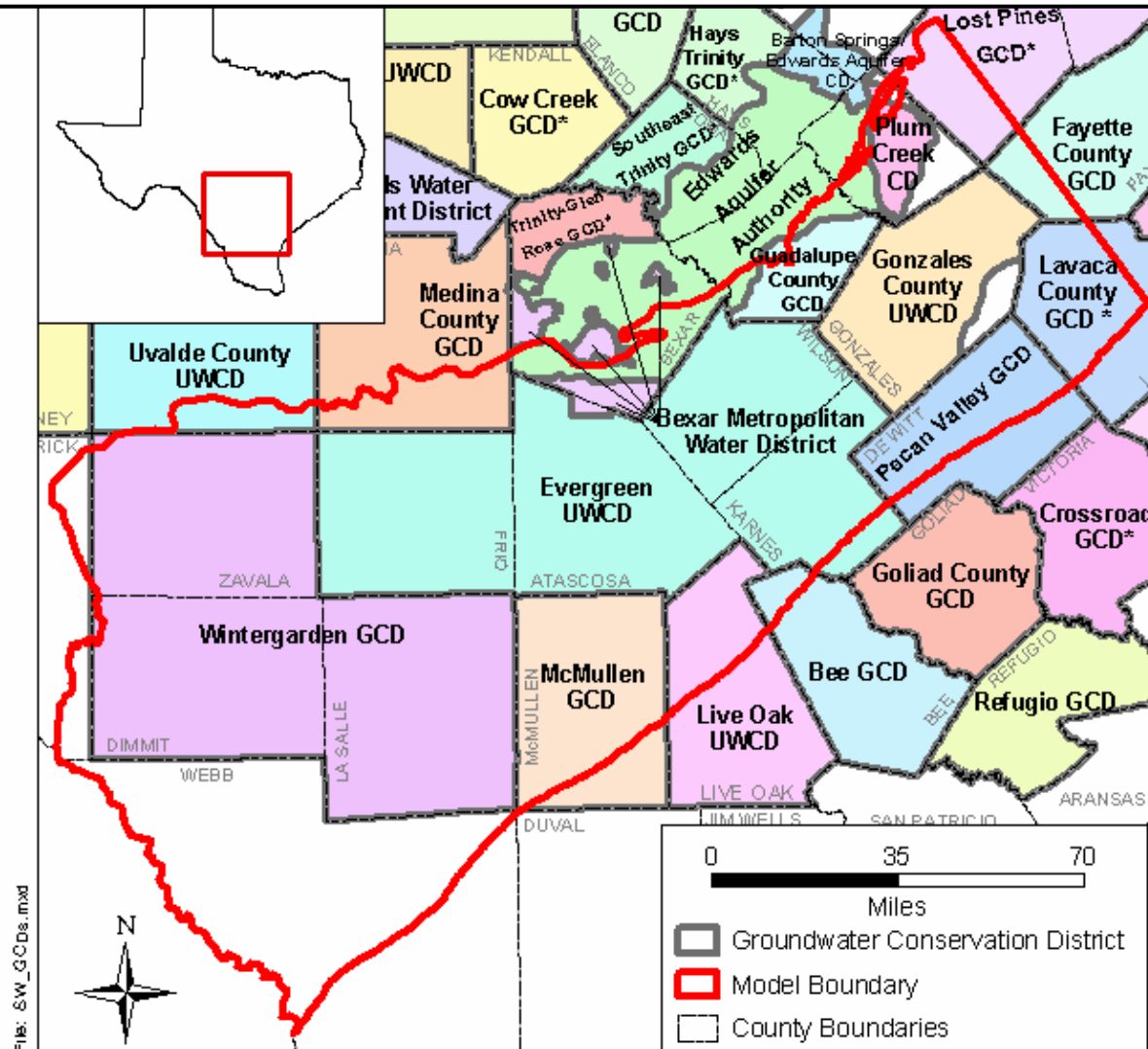
# Regional Water Planning Groups



File: SW\_RWPGs.mxd

Source: Online: Texas Water Development Board, September 2002

# Groundwater Conservation Districts



\*=Pending Confirmation

C and R District=Conservation and Reclamation District

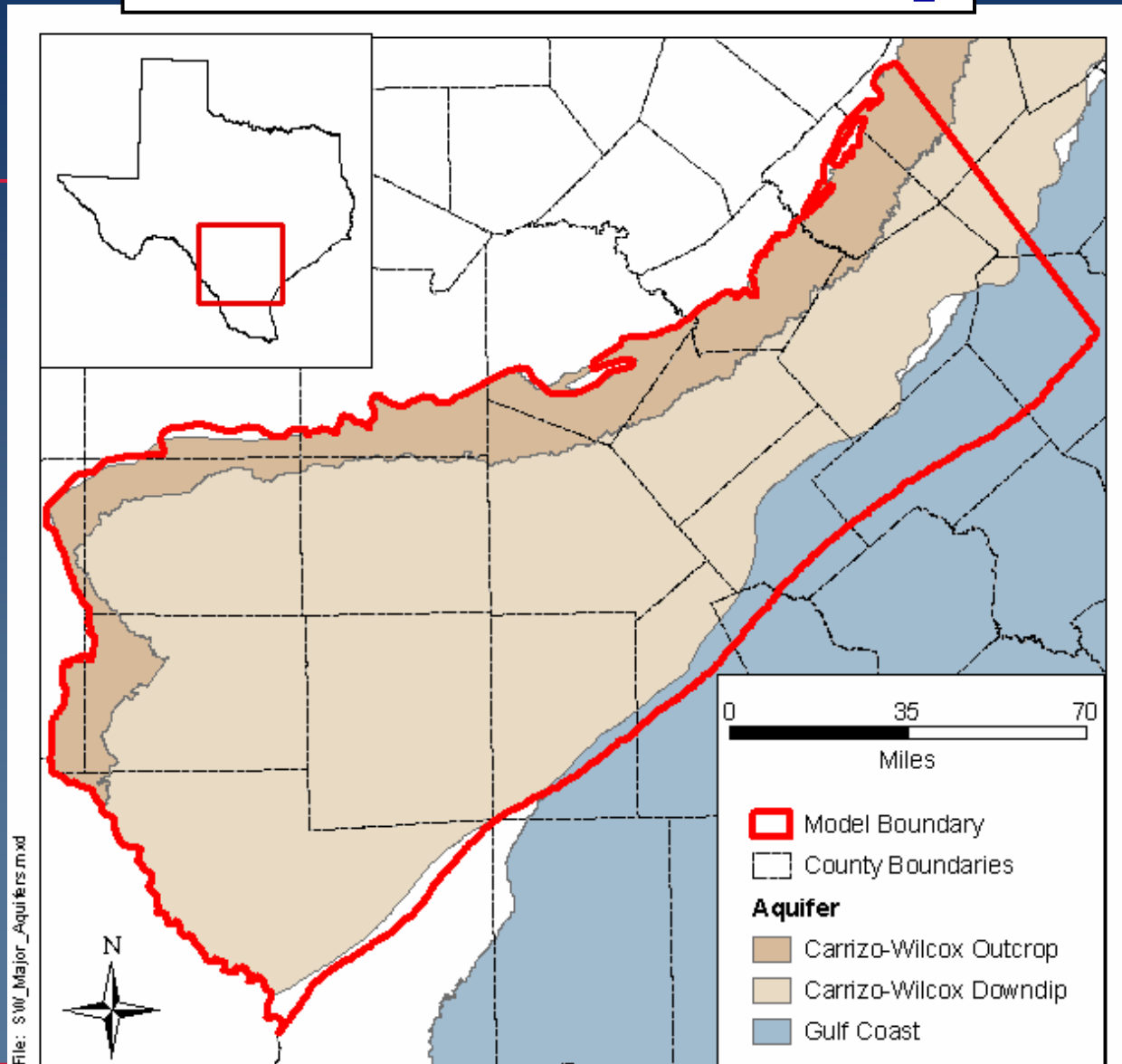
UWCD=Underground Water Conservation District

GCD=Groundwater Conservation District

CD=Conservation District

Source: Online: Texas Water Development Board, August 2002

# Carrizo-Wilcox Outcrop



Source: Online: Texas Water Development Board, September 2002

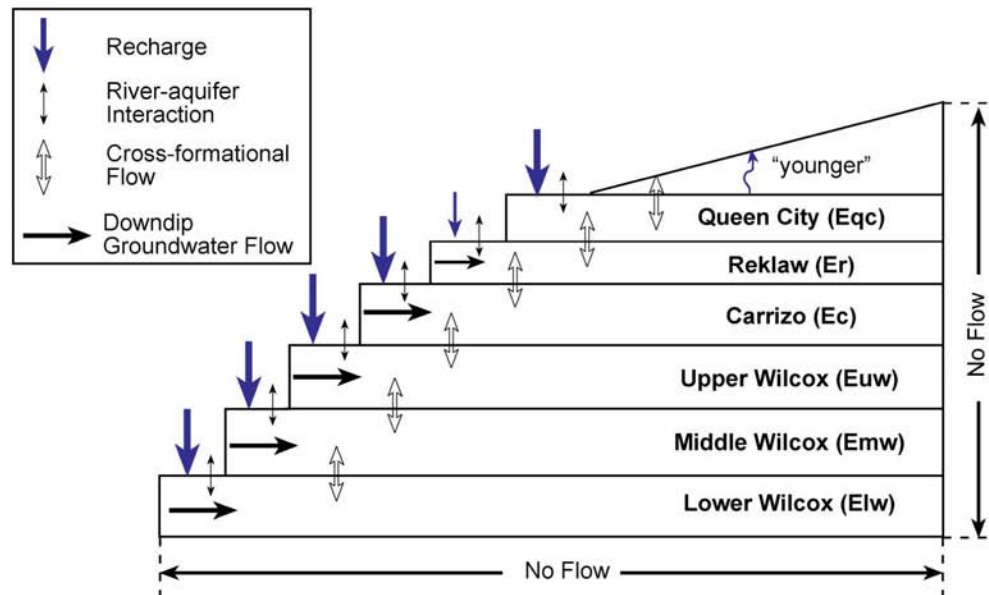
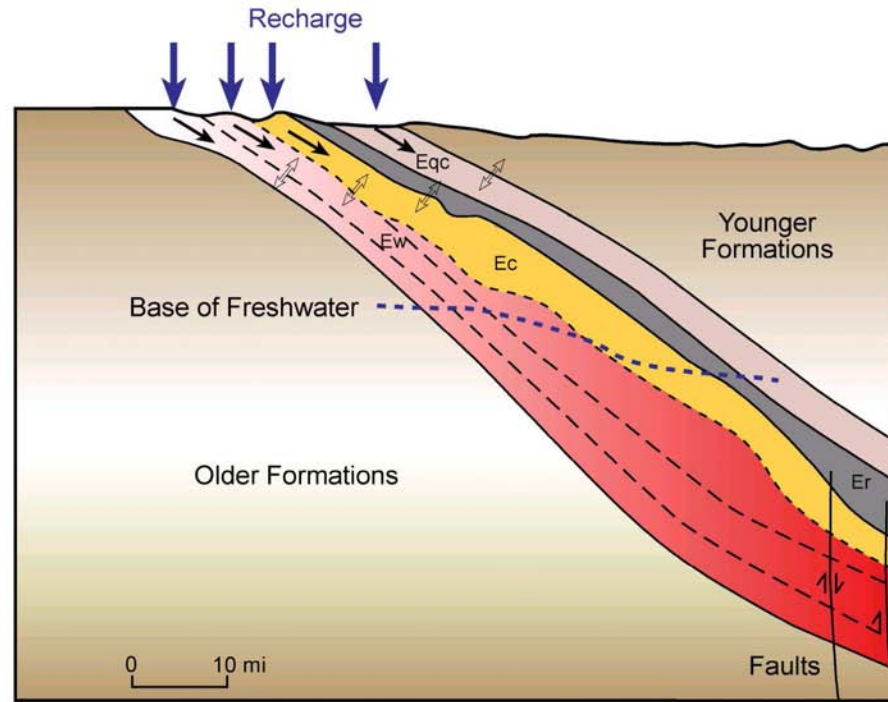
# Model Layers

| Series       |        | South Texas |                 |              |         |
|--------------|--------|-------------|-----------------|--------------|---------|
| Tertiary     | Eocene | U           | Jackson Group   |              |         |
|              |        | M           | Yegua Fm.       |              |         |
|              |        |             | Cook Mtn Fm.    |              |         |
|              |        |             | Sparta Sand     | Laredo Fm.   |         |
|              |        |             | Weches Fm.      |              |         |
|              |        |             | Queen City Sand | El Pico Clay | Layer 1 |
|              |        |             | Recklaw Fm.     | Bigford Fm.  | Layer 2 |
|              |        | L           | Carrizo Sand    |              | Layer 3 |
|              |        |             | Upper Wilcox    |              | Layer 4 |
|              |        |             | Middle Wilcox   |              | Layer 5 |
| Lower Wilcox |        |             | Layer 6         |              |         |
| Paleocene    | U      |             |                 |              |         |
|              | L      |             | Midway Fm.      |              |         |

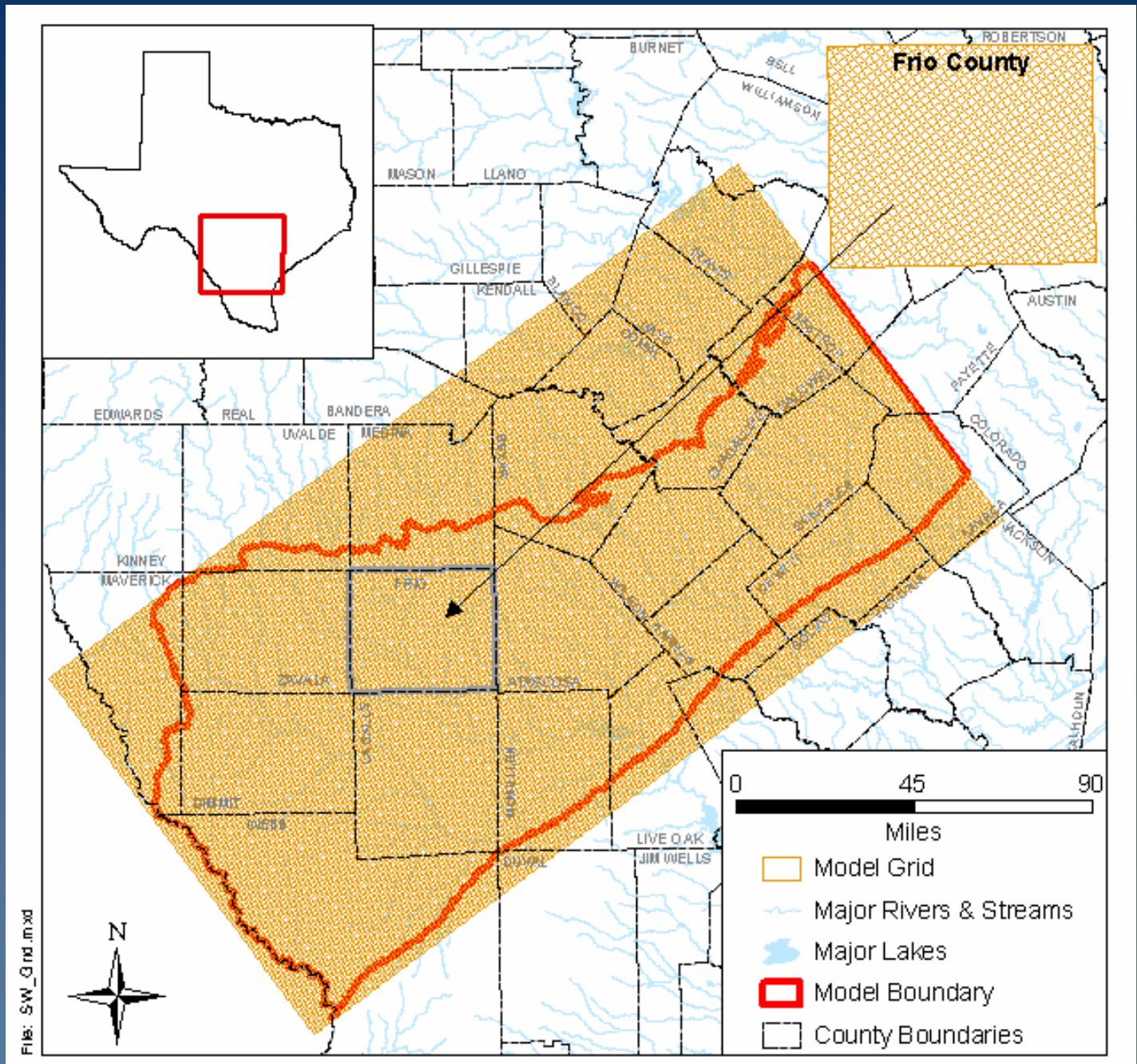


File: Geologic Stratigraphy.fh8

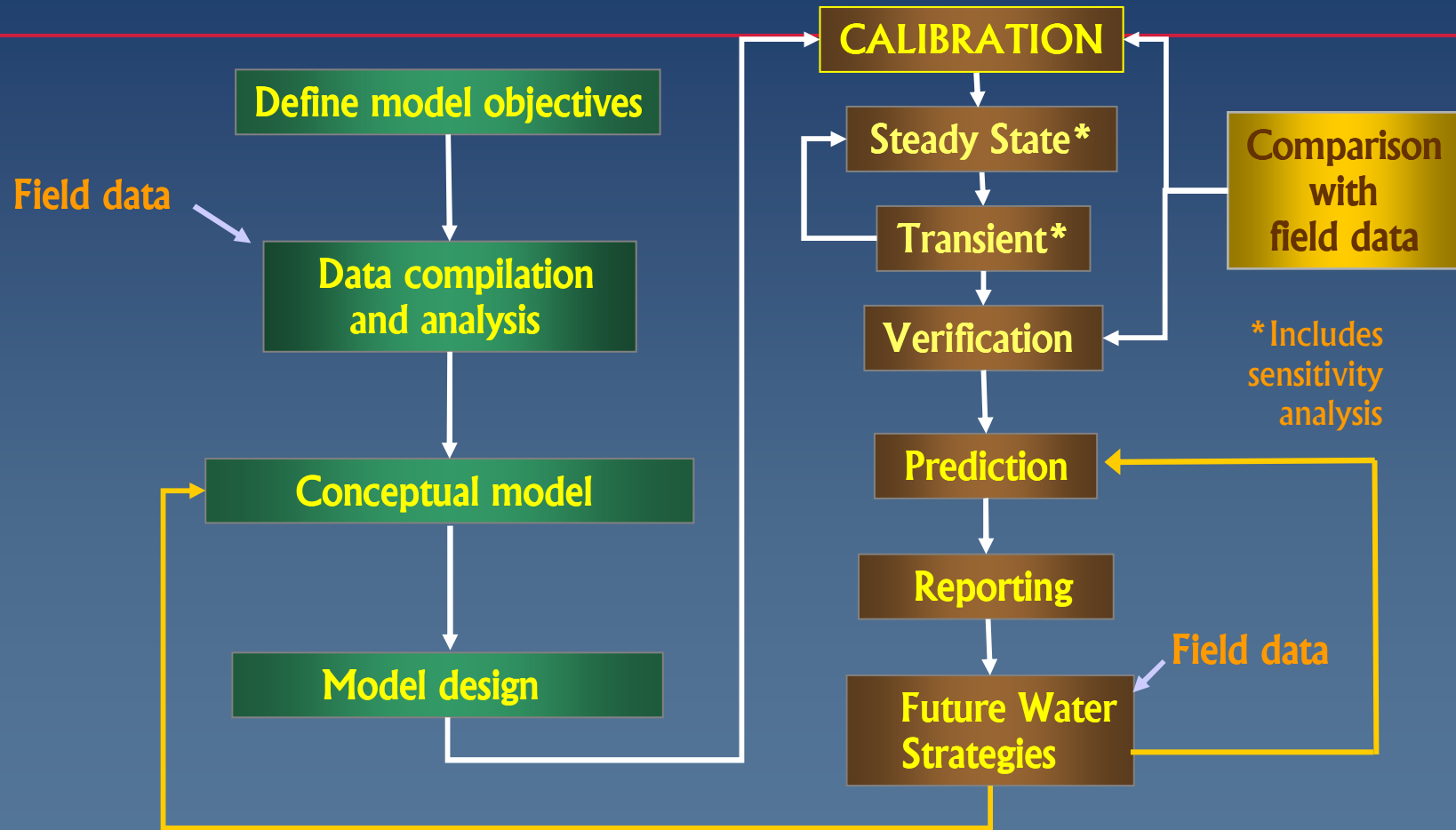
# Conceptual Groundwater Flow Model



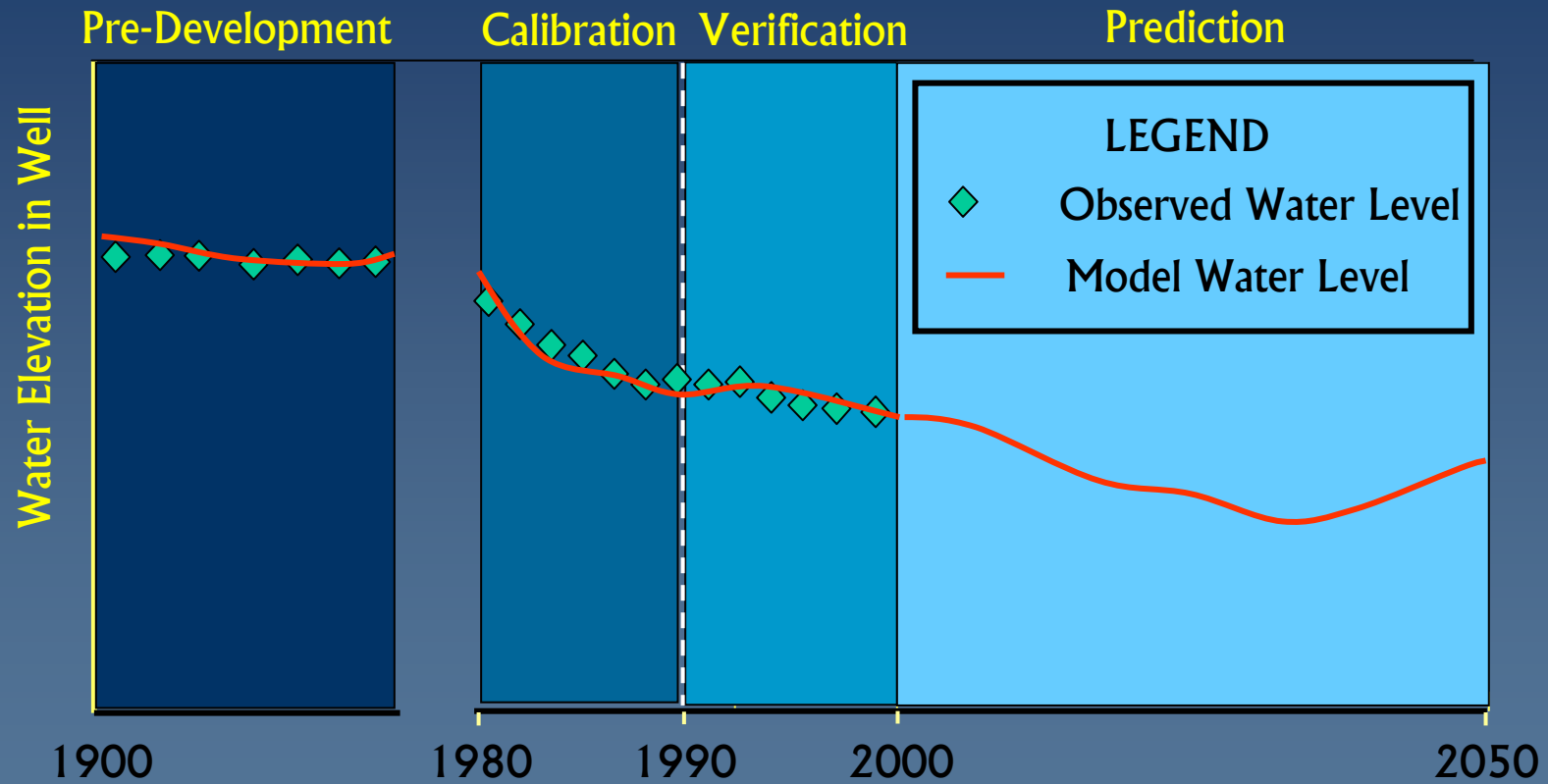
# Model Grid



# Modeling Protocol



# Modeling Periods

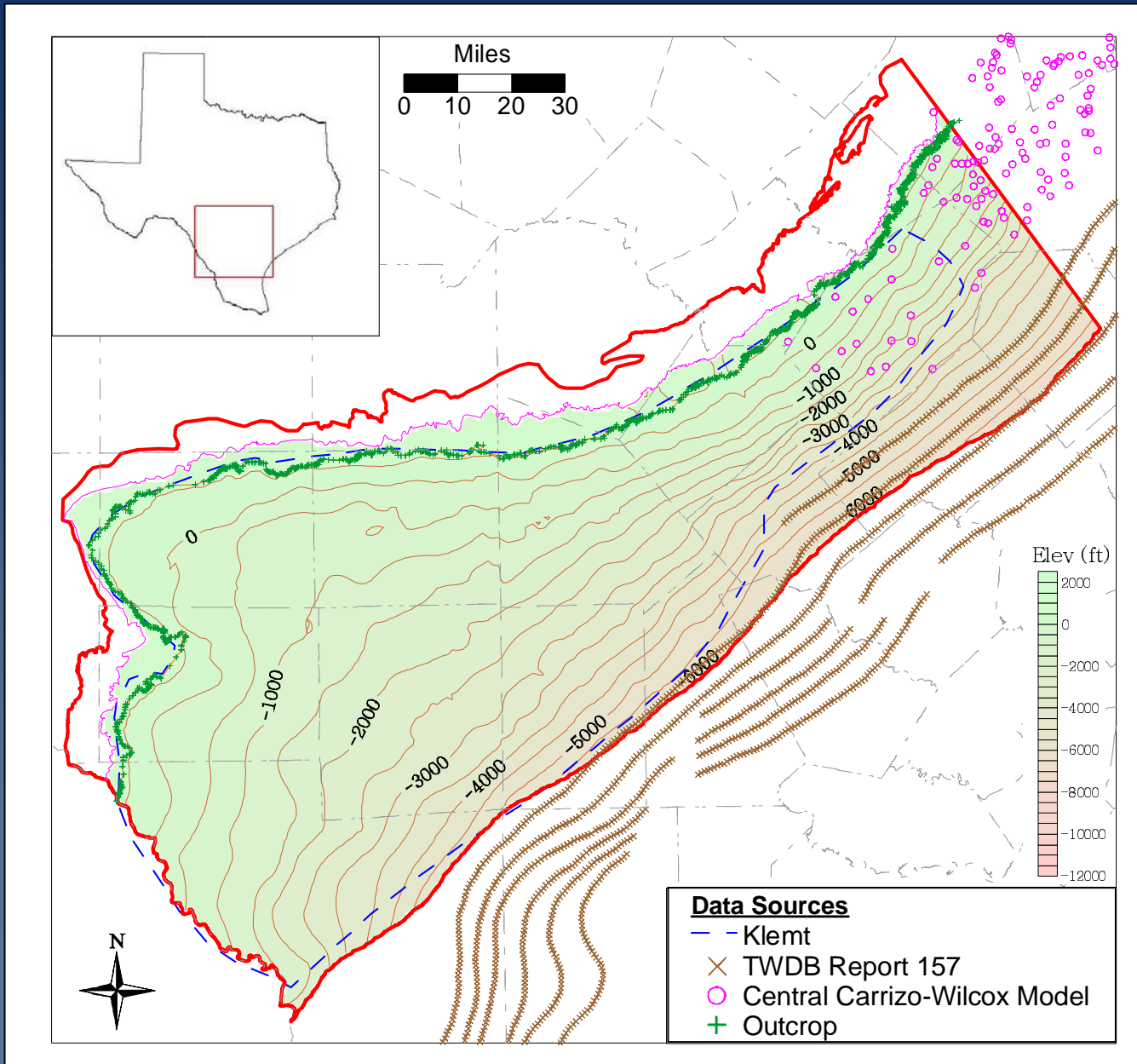




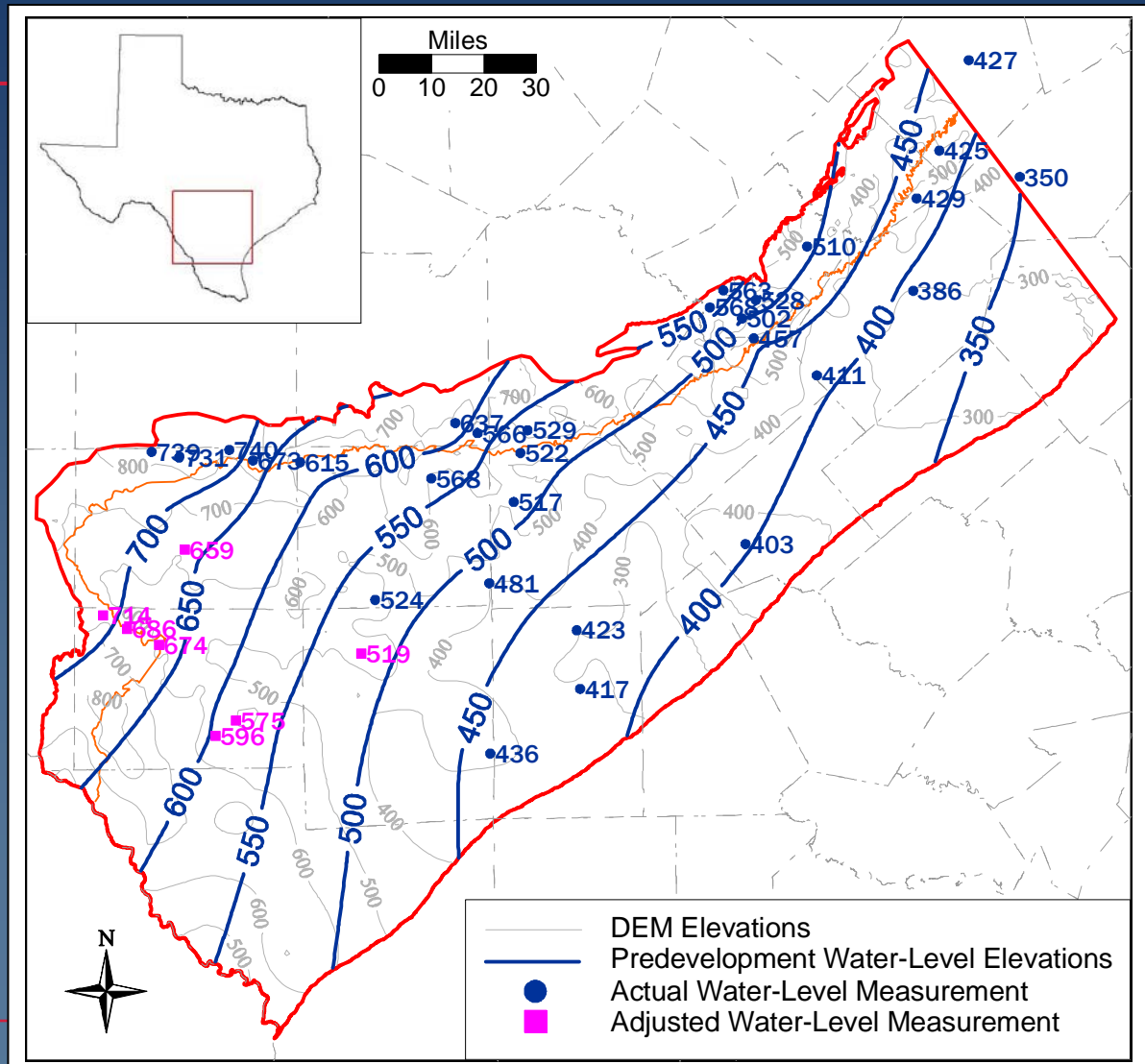
# Model Input

- Hydrostratigraphic Surfaces for each Layer
- Hydraulic Properties:
  - Hydraulic Heads
  - Sand Thickness
  - Hydraulic Conductivity
  - Storativity (transient)
- Recharge
- Stream Flow
- Pumpage (transient)

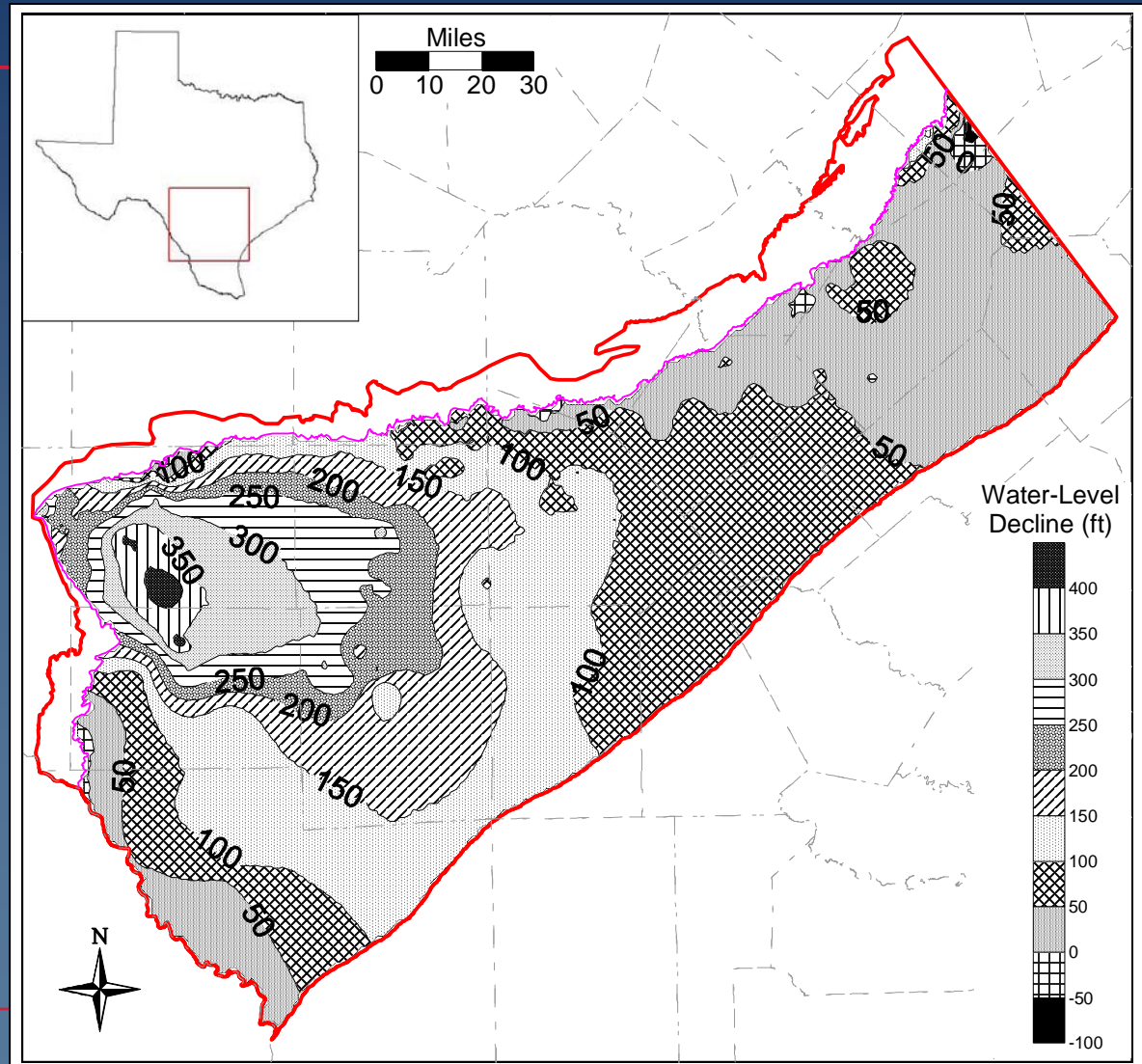
# Structure - Top of Carrizo



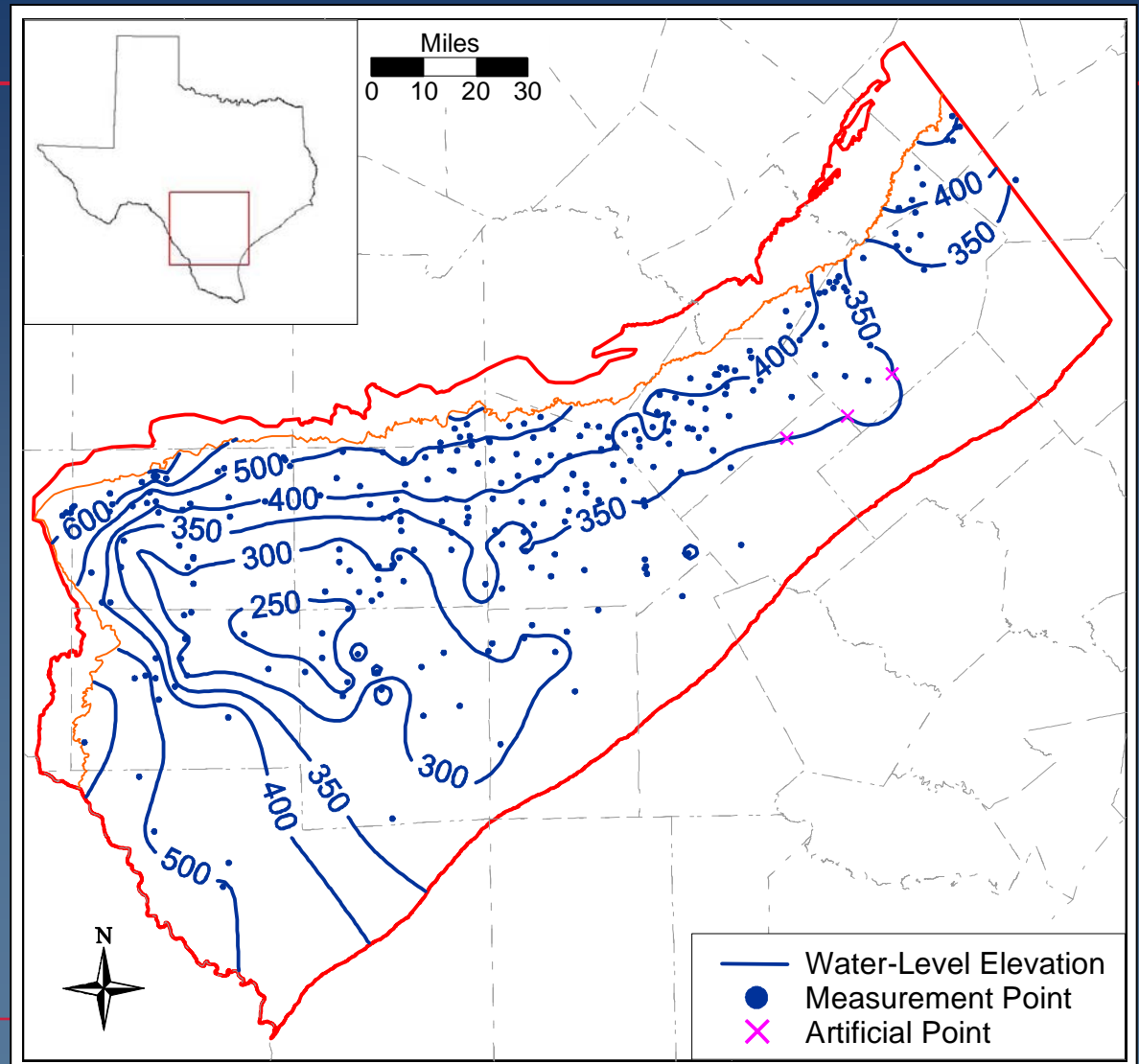
# Pre-development heads



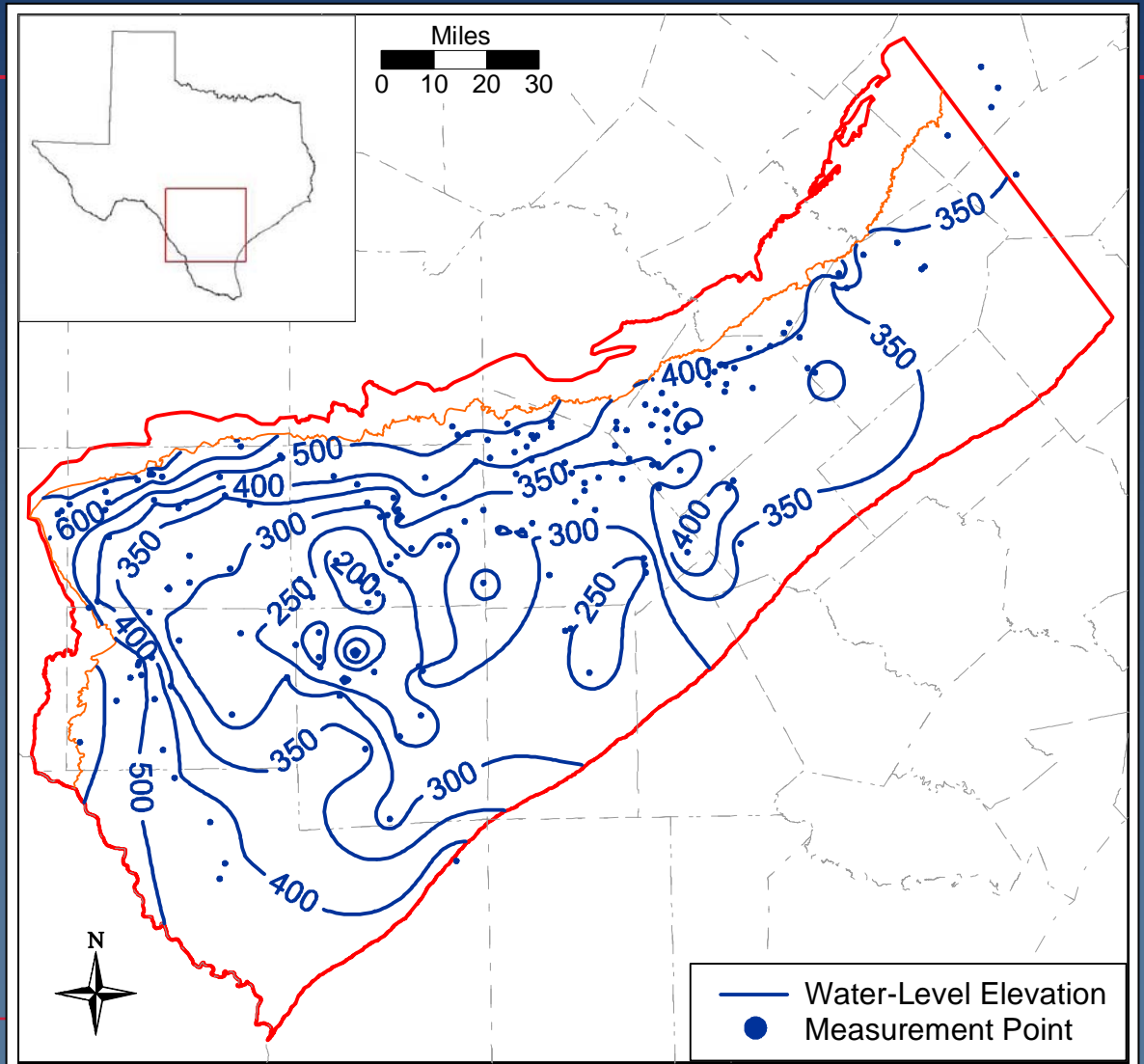
# Drawdown (Predevelopment – 1980)



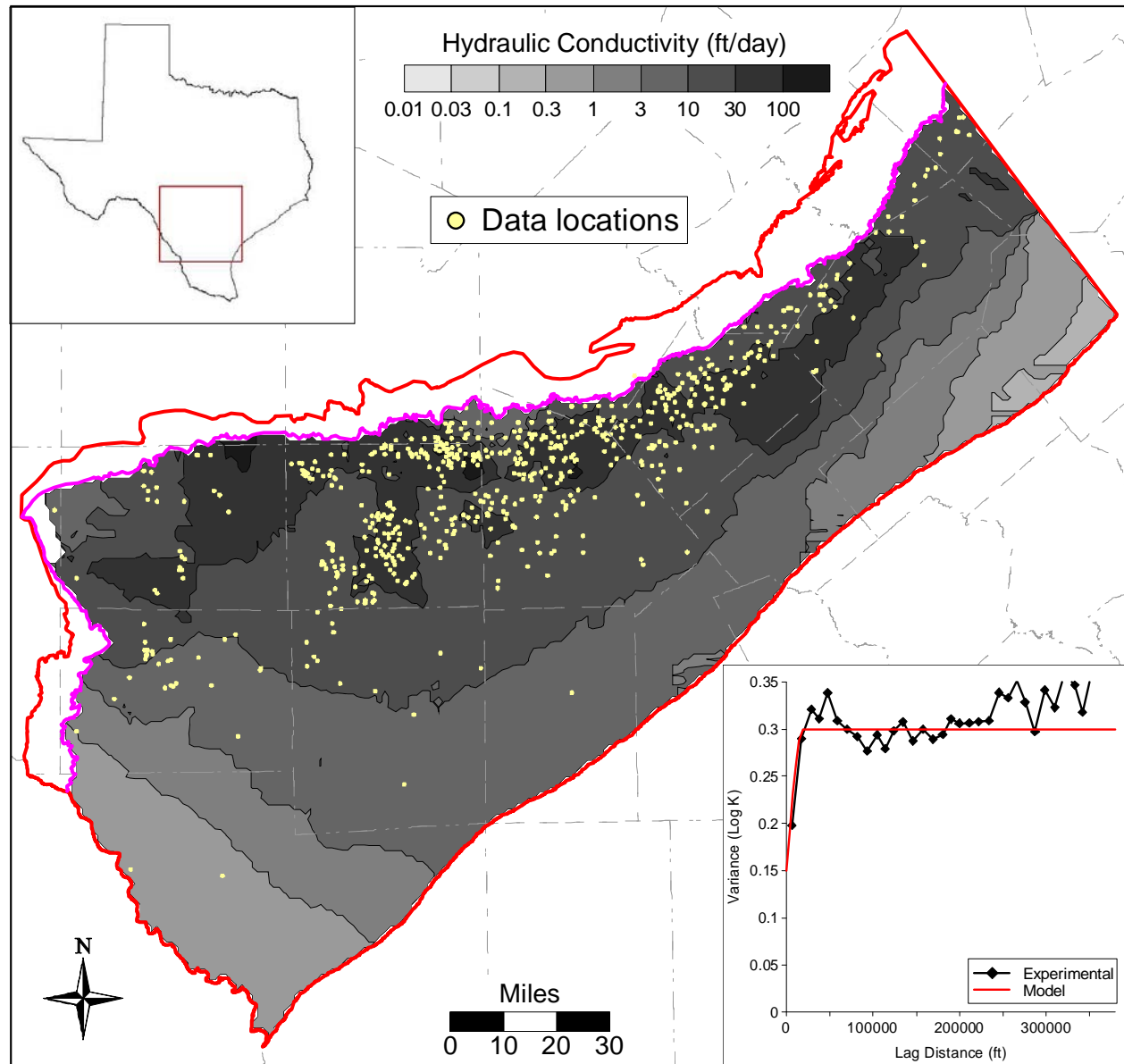
# Carrizo Heads (1980)



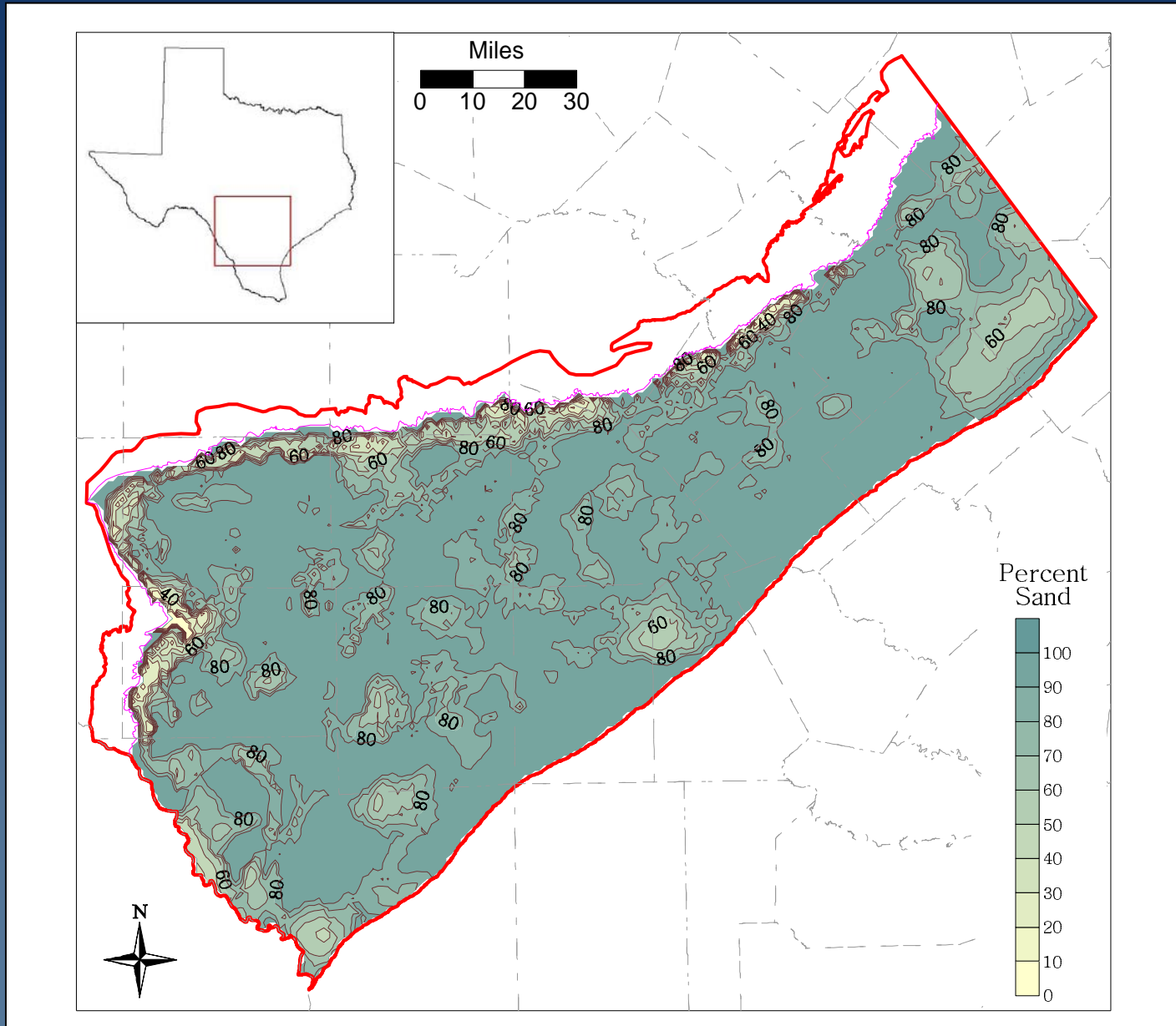
# Carrizo Heads, 1999



# Carrizo Hydraulic Conductivity



# Carrizo Sand Percent

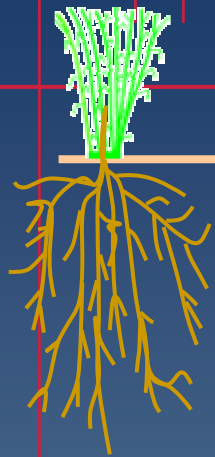




# Recharge Estimation: SWAT (Soil and Water Assessment Tool)

- SWAT developed by Blacklands Research Center
- Physically based (primarily) watershed scale model
- Infiltration/runoff based on SCS Curve Number method (daily timestep)
  - Land use
  - Soil type
  - Antecedent soil condition
- $\text{Recharge} = \text{Infiltration} - \text{Evapotranspiration}$

# SWAT-MODFLOW one-way couple



Run on a daily timestep

**SWAT**

- Daily Estimates of
- Precipitation,
  - Temperature,
  - Land use/cover,
  - Soil type,
  - Curve number
  - Solar radiation

Daily Calculation of:

- (1) The recharge rate for the recharge package,
- (2) Groundwater ET for the ET package,
- (3) the extinction depth for the ET package

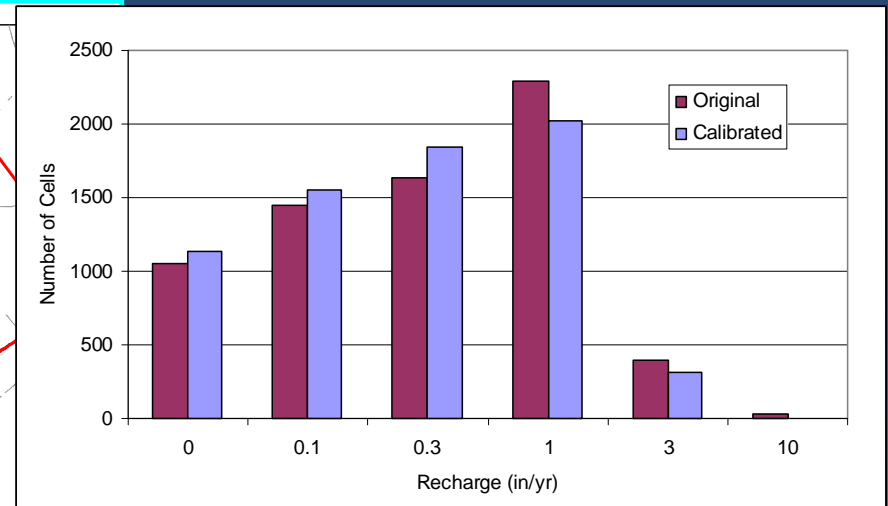
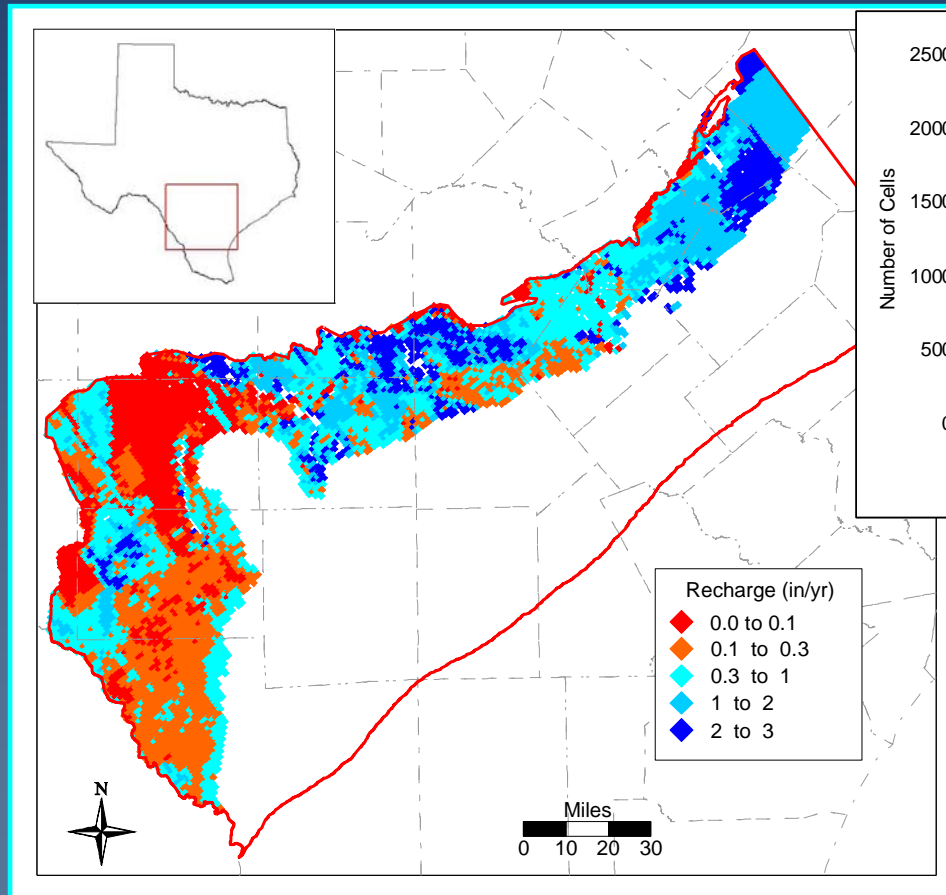
Recharge  
Package

ET  
Package

**MODFLOW**

Run on a monthly stress period

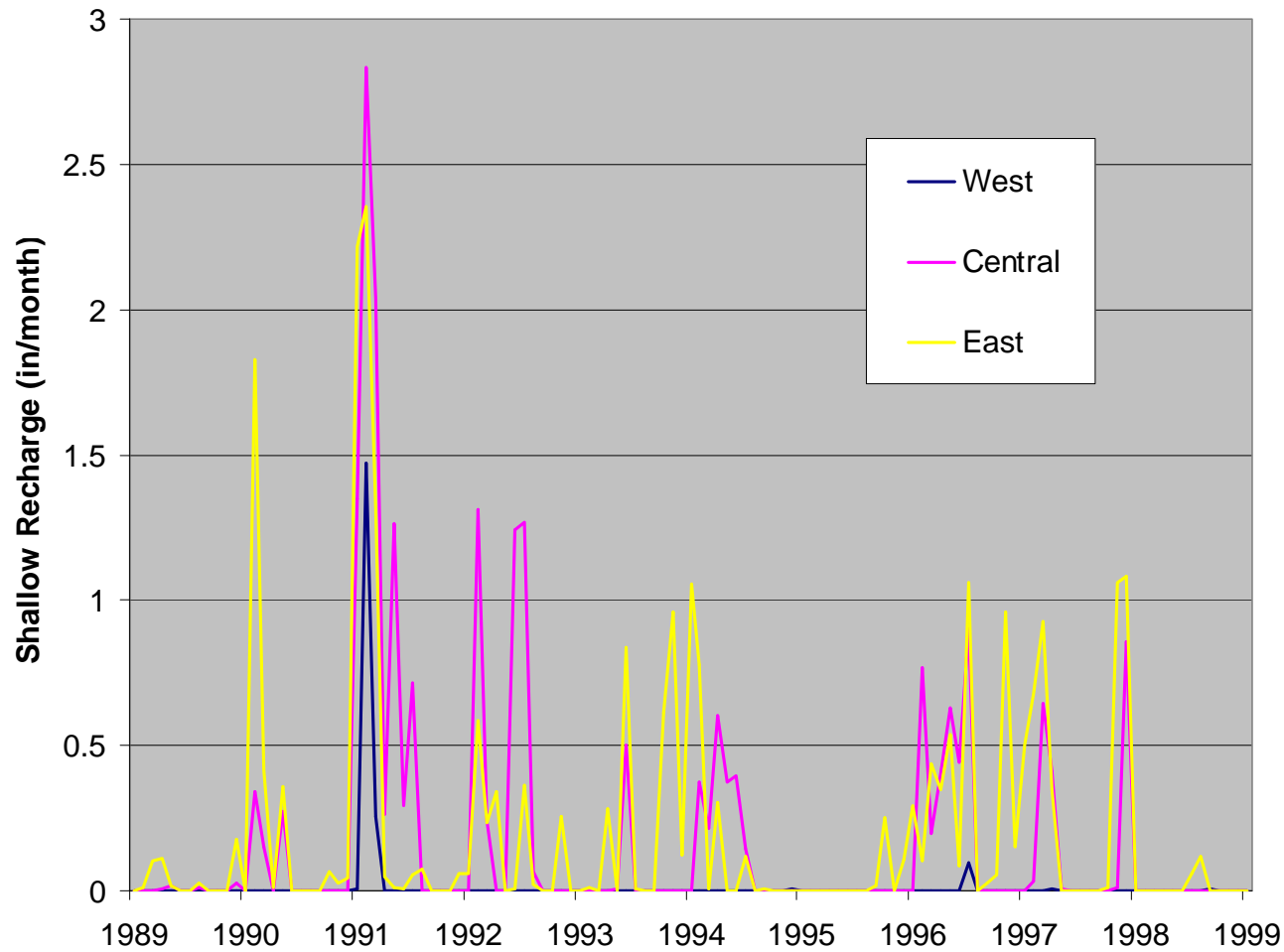
# Calibrated Steady-state Recharge



Recharge varies from nearly 0 to 3 in/yr

Median = 0.5 in/yr

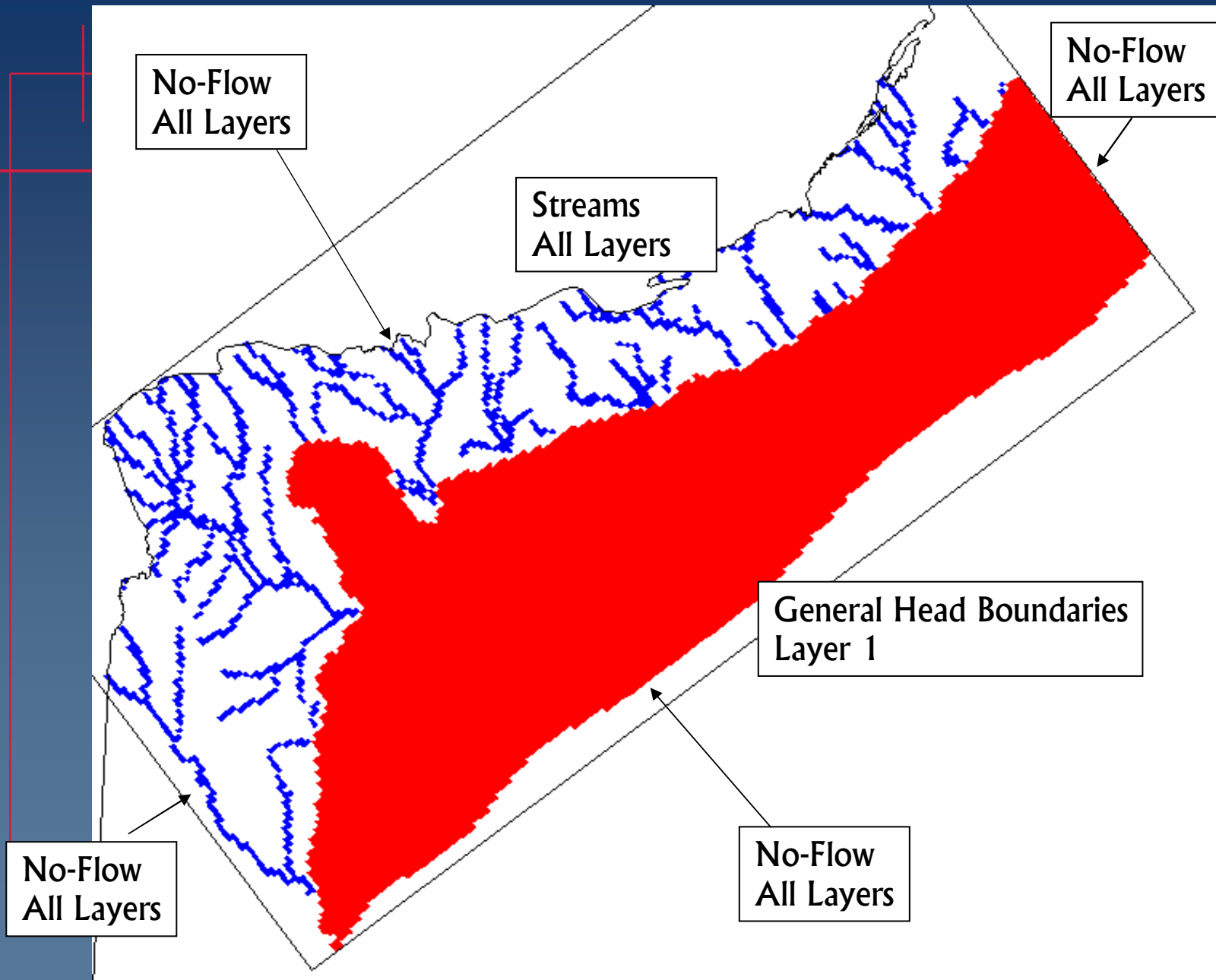
# Transient Recharge Functions



Shallow Recharge

Representative  
5 square mile areas

# Model Boundaries



# Categories of Groundwater Use

## Point Source Data

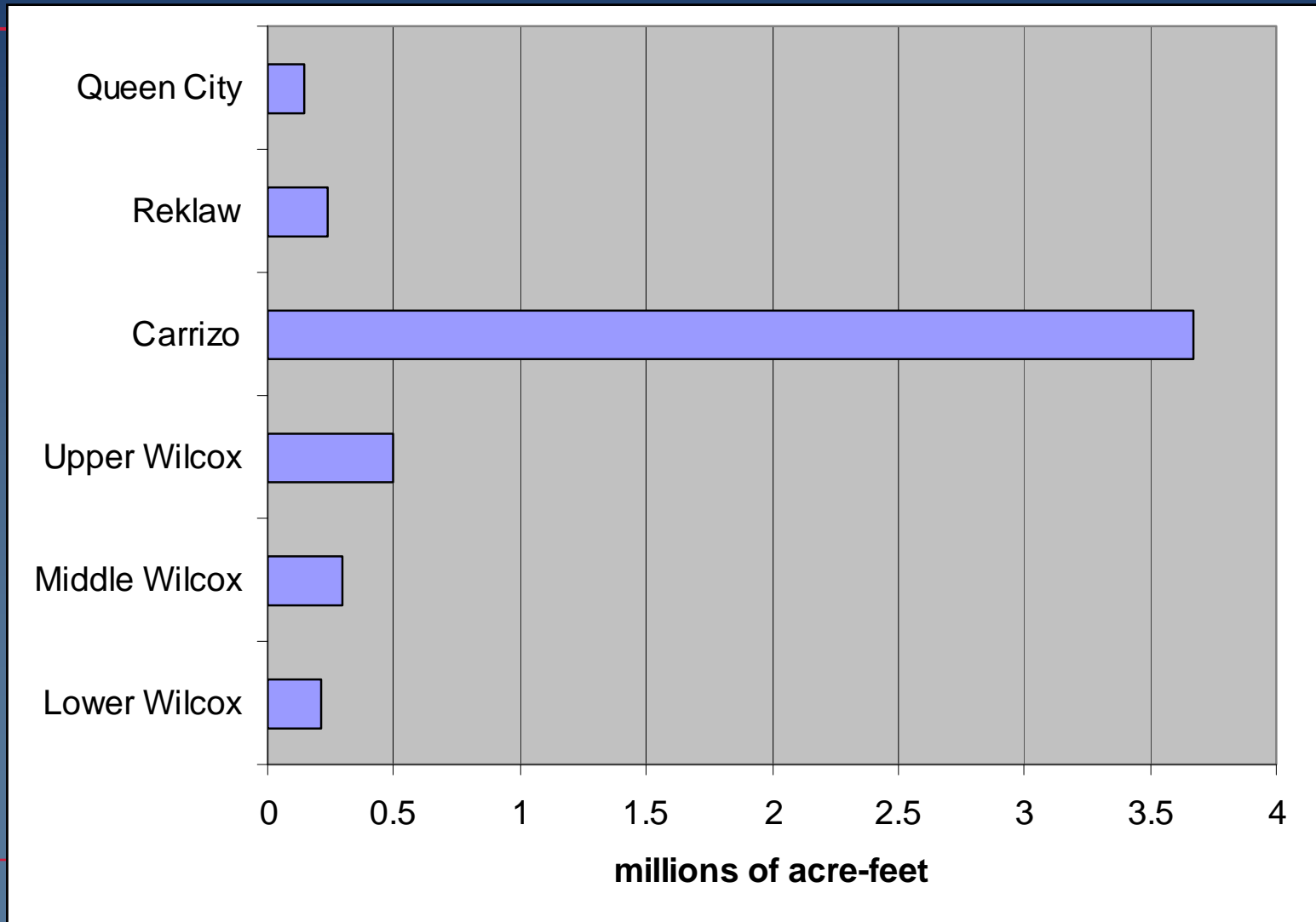
- **Municipal**
- **Manufacturing**
- **Power**
- **Mining**

## Non-Point Source Data

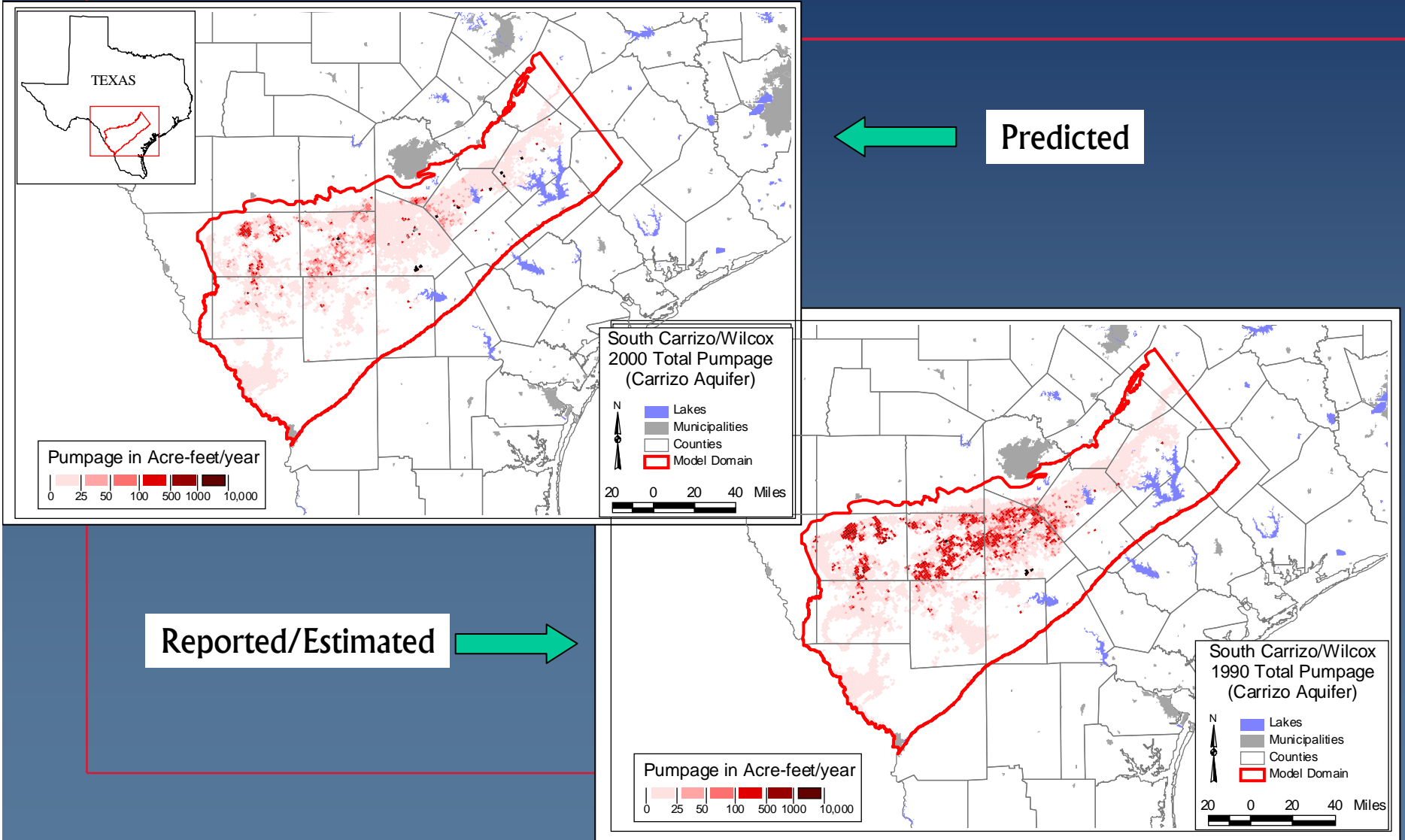
- **Irrigation**
- **Livestock**
- **Rural Domestic**

Preliminary Results  
Not Final

# Cumulative Pumping – 1980 to 1999



# Pumping – Carrizo 1990 & 2000





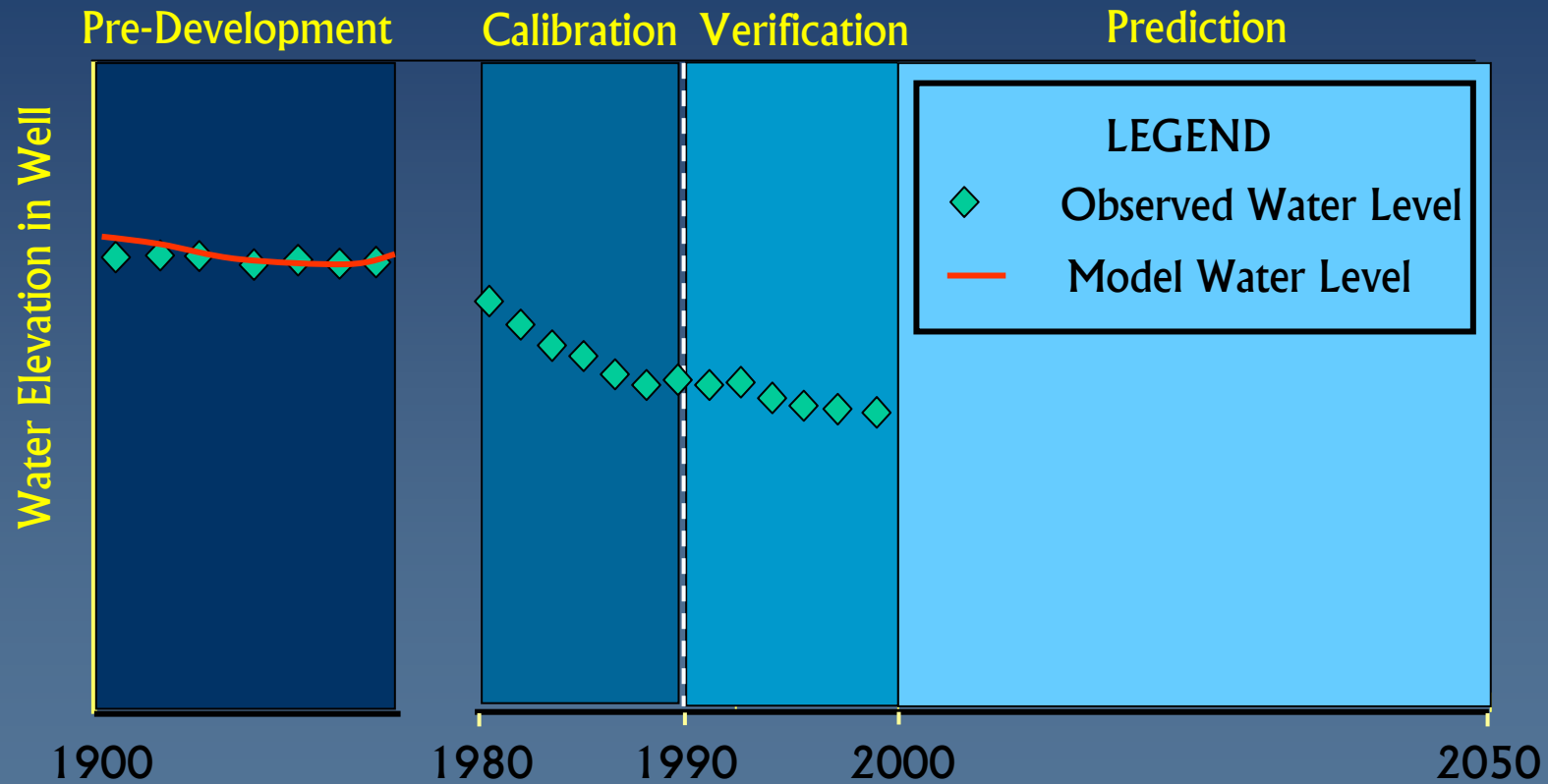
# Assessment of parameter measurements

| Hydraulic Parameter | Supporting Data |
|---------------------|-----------------|
| Horizontal          | Meas            |
| Vertical            | es              |
| Recharge            | el              |
| Storage             | measurements    |
| Stream              |                 |
| Gain loss estimates | Limited         |

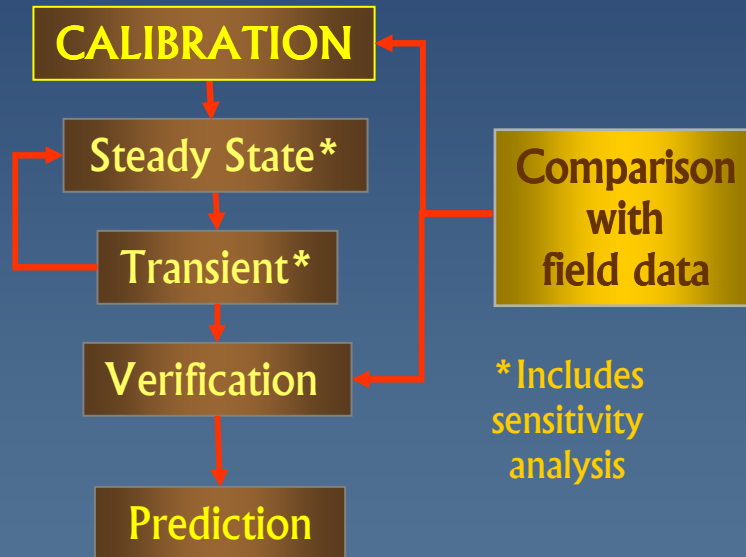
## Calibration Strategy

1. Pre-development (steady-state)
  - Fix  $K_h$  and Recharge
  - Estimate  $K_v$
2. Transient
  - Fix Pumping and Recharge
  - Estimate Storage,  $K_v$
3. Iterate between SS and transient

# Modeling Periods (Steady-state)

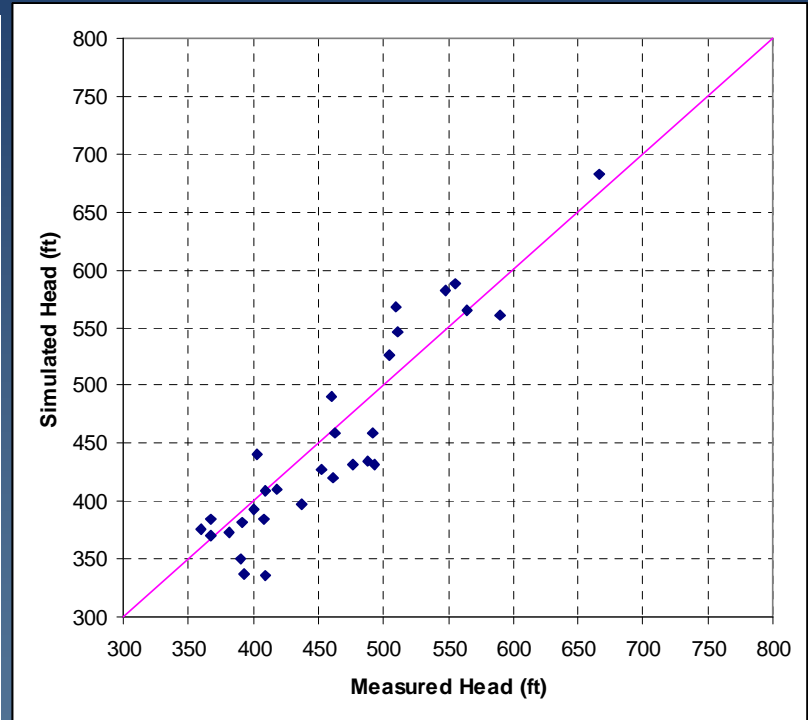
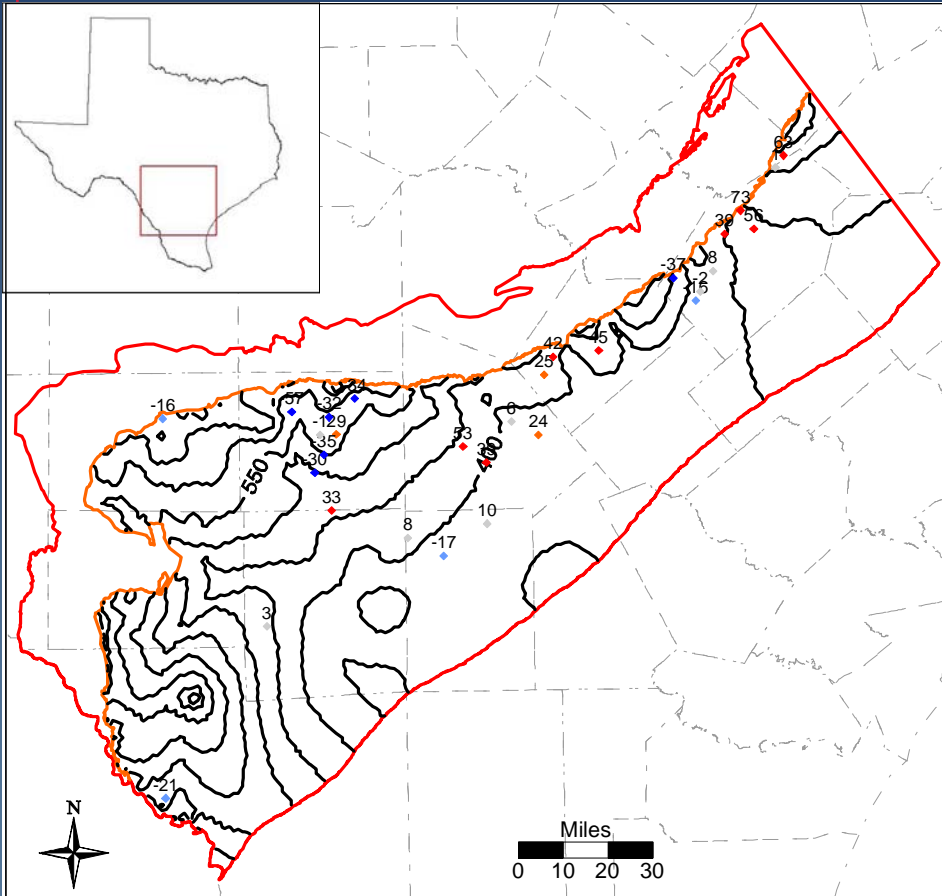


# Calibration Approach



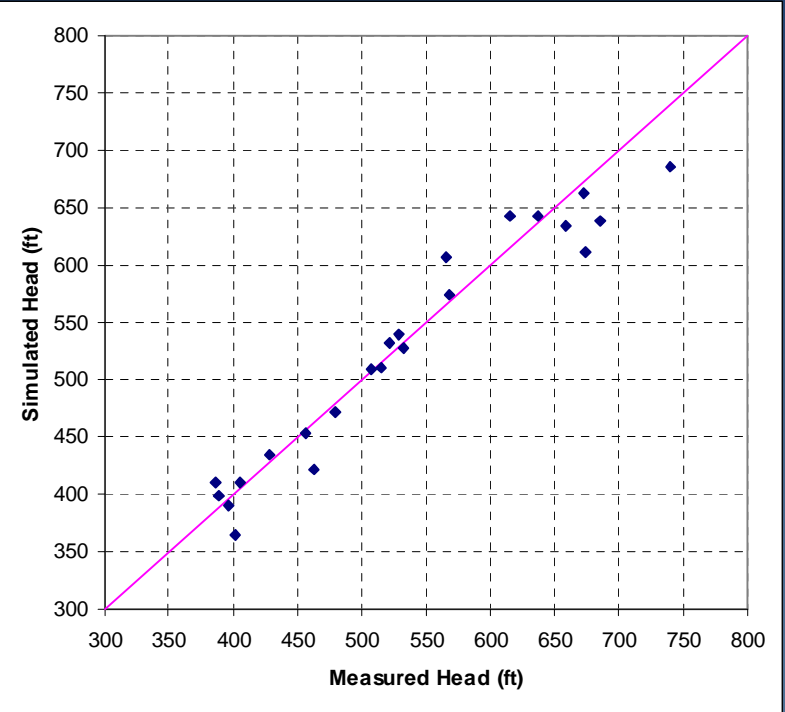
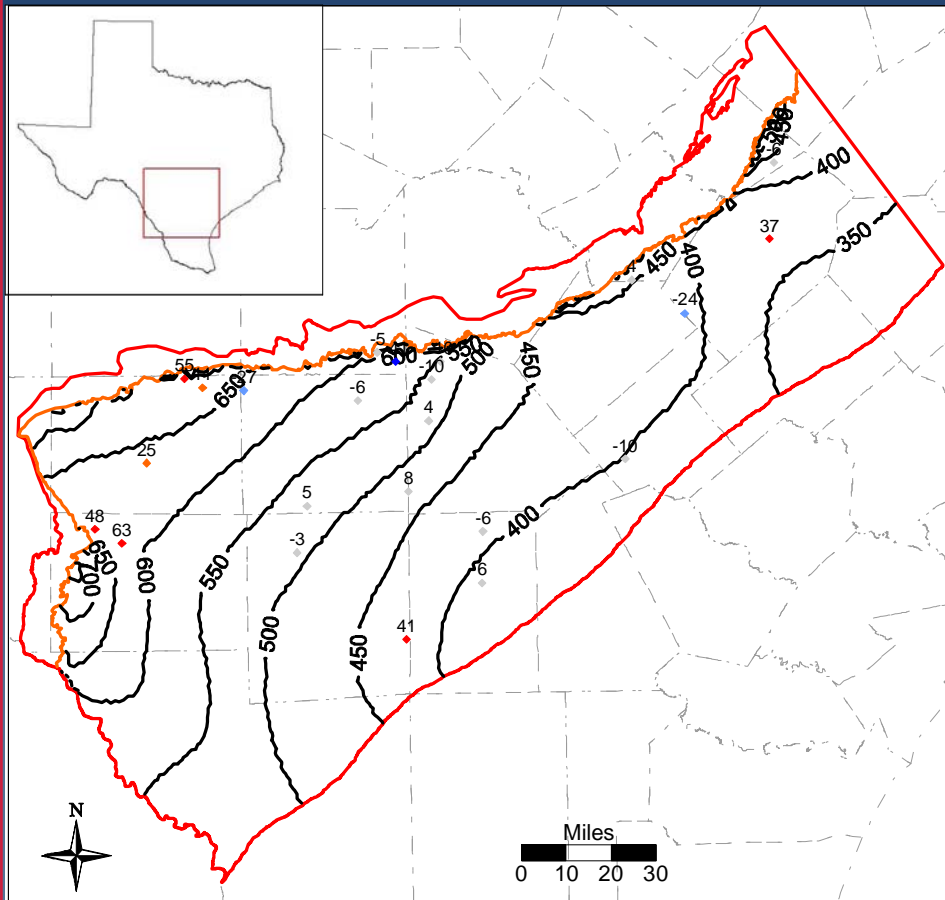
The calibration approach iterates between the steady-state (predevelopment) and the transient calibrations to reach a consistent set of physical parameters that match both sets of observation.

# Pre-development Calibration: Queen City



| RMS  | Range | RMS/Range |
|------|-------|-----------|
| 34.5 | 306.0 | 0.11      |

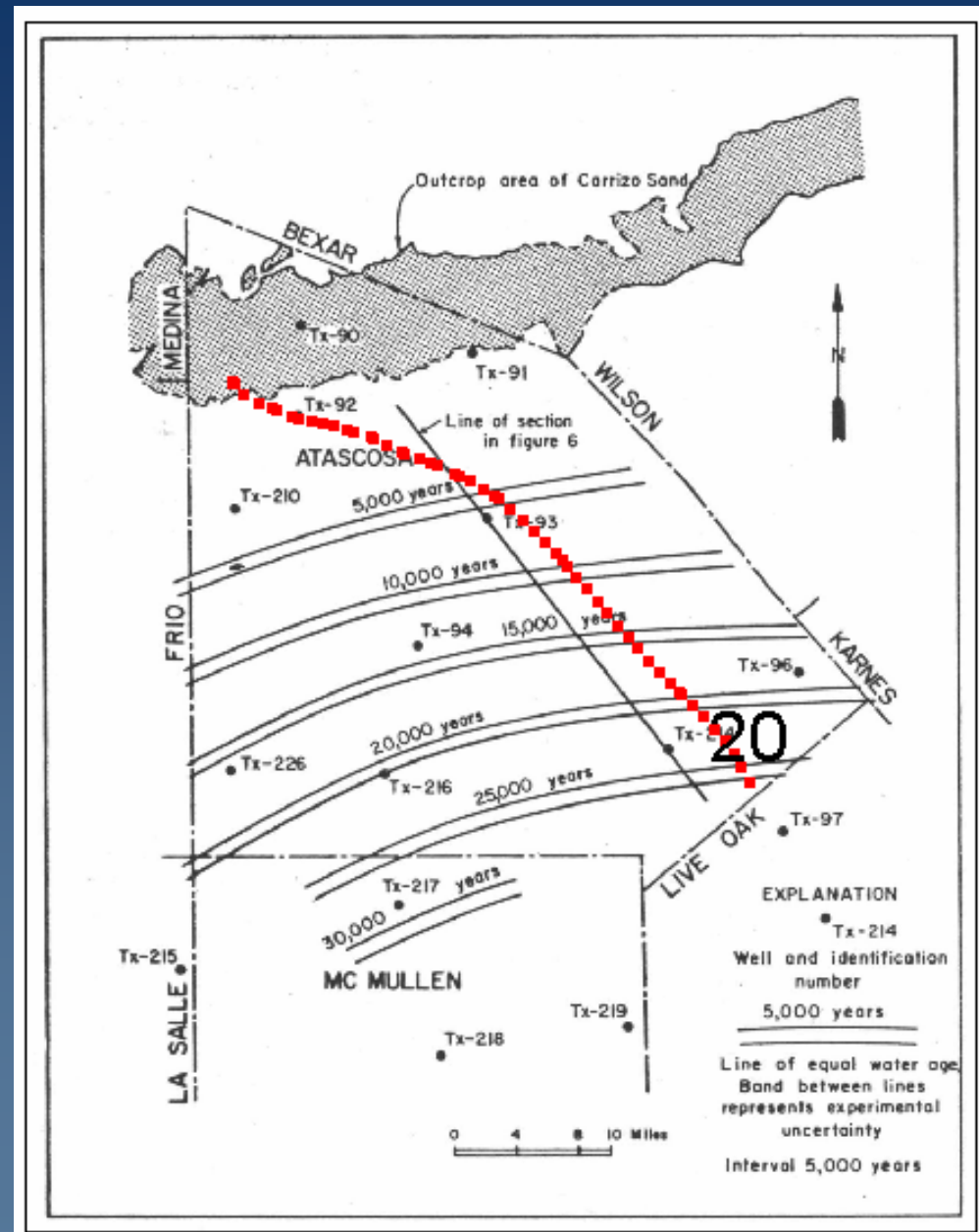
# Pre-development Calibration: Carrizo



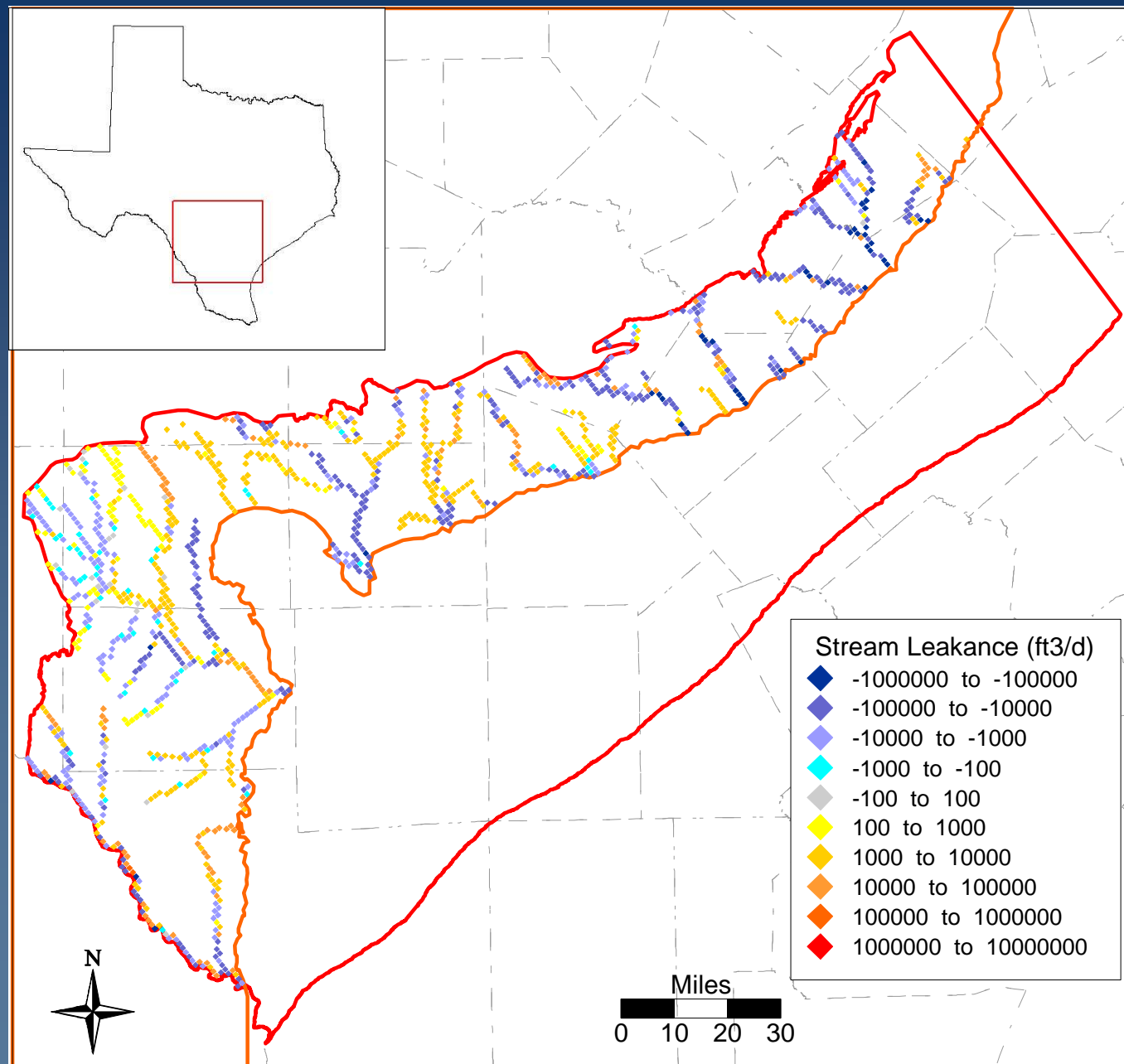
| RMS  | Range | RMS/Range |
|------|-------|-----------|
| 26.9 | 353.4 | 0.076     |

# Steady-State Calibration: Particle Tracking

Steady-state particle travel path and travel time compared to the groundwater age dating study of Pearson and White (1967).



# Steady-State Calibration: Stream Gain/Loss



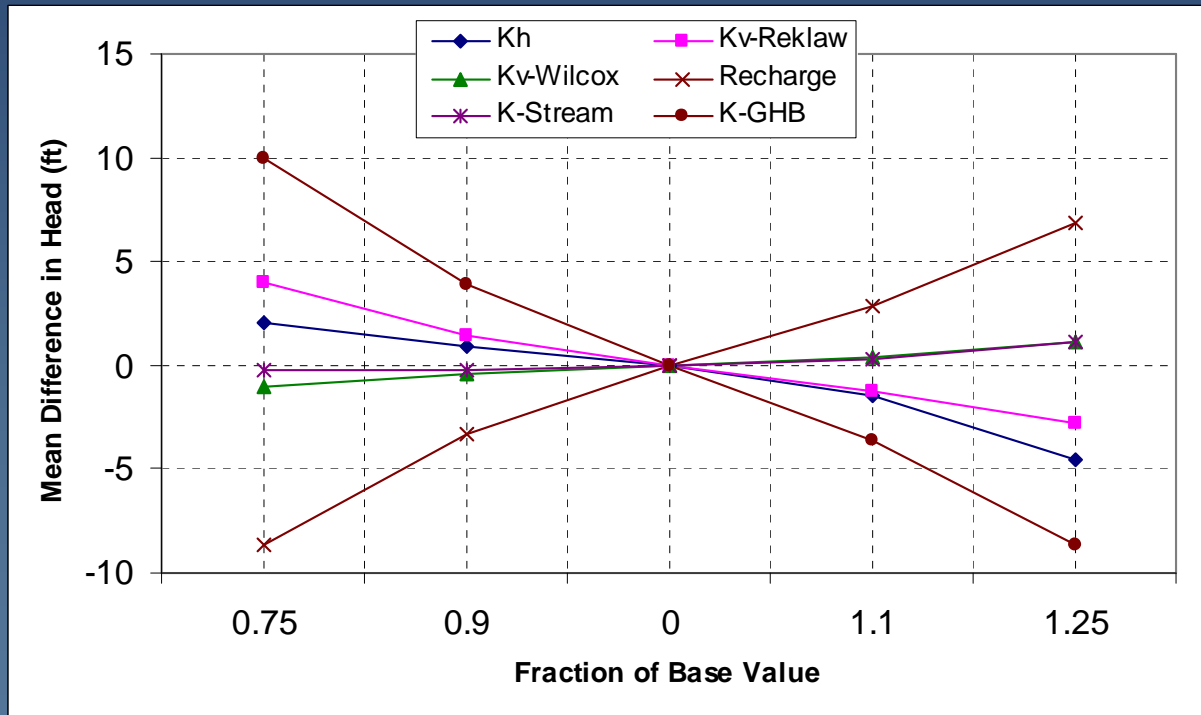
# Water Balance (AFY)

| <b>IN</b>  | <b>Layer</b> | <b>GHBs</b> | <b>Recharge</b> | <b>Streams</b> | <b>Top</b> | <b>Bottom</b> |
|------------|--------------|-------------|-----------------|----------------|------------|---------------|
|            | <b>1</b>     | 7,892       | 125,096         | 16,681         |            | 95,491        |
|            | <b>2</b>     |             | 37,677          | 11,341         | 18,610     | 99,316        |
|            | <b>3</b>     |             | 71,137          | 6,544          | 30,852     | 23,118        |
|            | <b>4</b>     |             | 893             | 105            | 9,350      | 16,390        |
|            | <b>5</b>     |             | 58,061          | 3,922          | 1,981      | 19,841        |
|            | <b>6</b>     |             | 33,852          | 3,607          | 8,683      |               |
|            | <b>Sum</b>   | 7,892       | 326,716         | 42,199         | 69,477     | 254,156       |
|            |              |             |                 |                |            |               |
| <b>OUT</b> | <b>Layer</b> |             | <b>ET</b>       |                |            |               |
|            | <b>1</b>     | 100,523     | 57,496          | 68,937         |            | 18,610        |
|            | <b>2</b>     |             | 17,958          | 22,757         | 95,491     | 30,852        |
|            | <b>3</b>     |             | 7,200           | 17,256         | 99,316     | 9,350         |
|            | <b>4</b>     |             | 896             | 935            | 23,118     | 1,981         |
|            | <b>5</b>     |             | 19,934          | 38,736         | 16,390     | 8,683         |
|            | <b>6</b>     |             | 14,054          | 12,810         | 19,841     |               |
|            | <b>Sum</b>   | 100,523     | 117,539         | 161,431        | 254,156    | 69,477        |



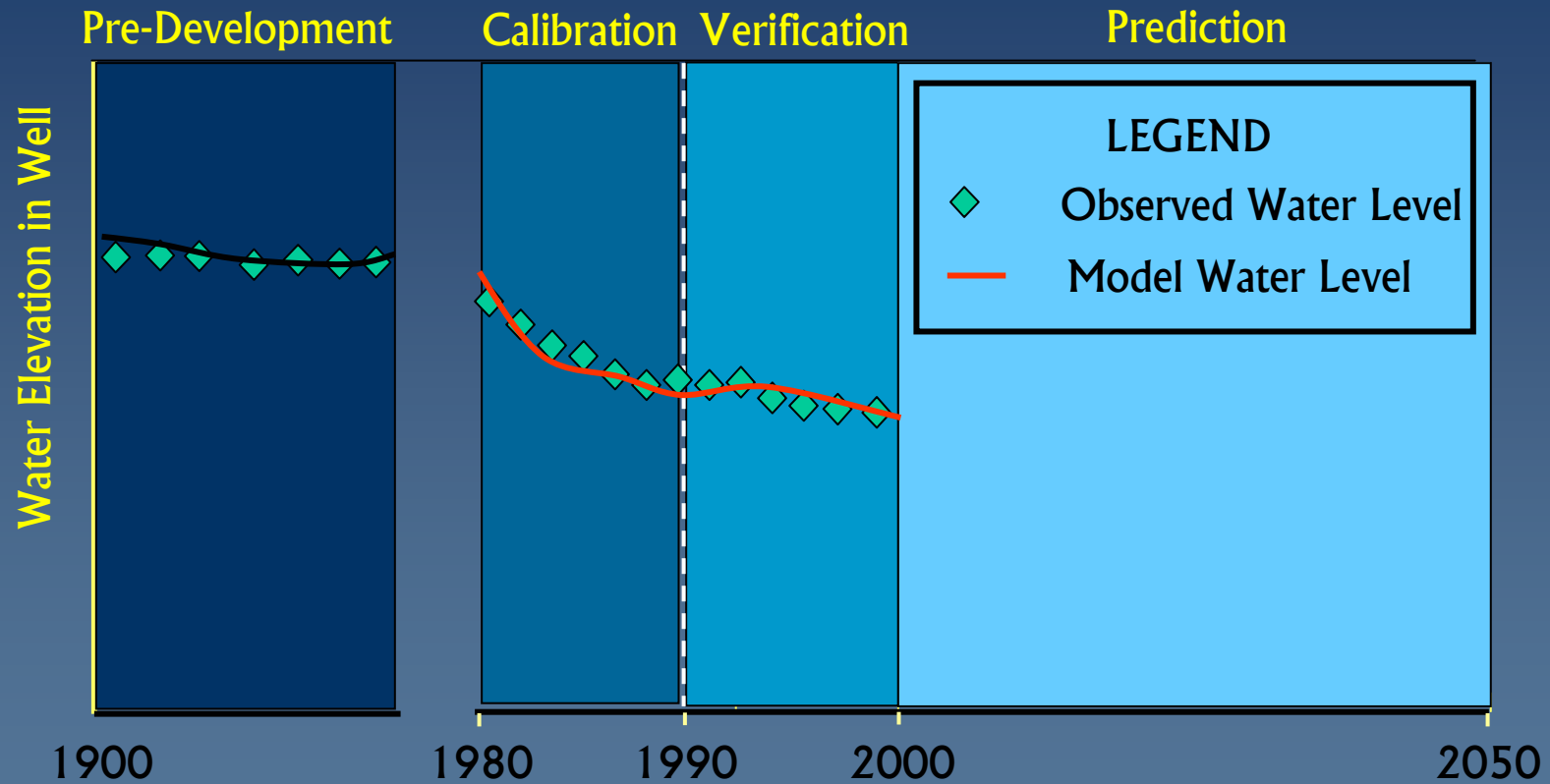
# Pre-development sensitivity results, Carrizo

## Carrizo Sensitivity Analysis

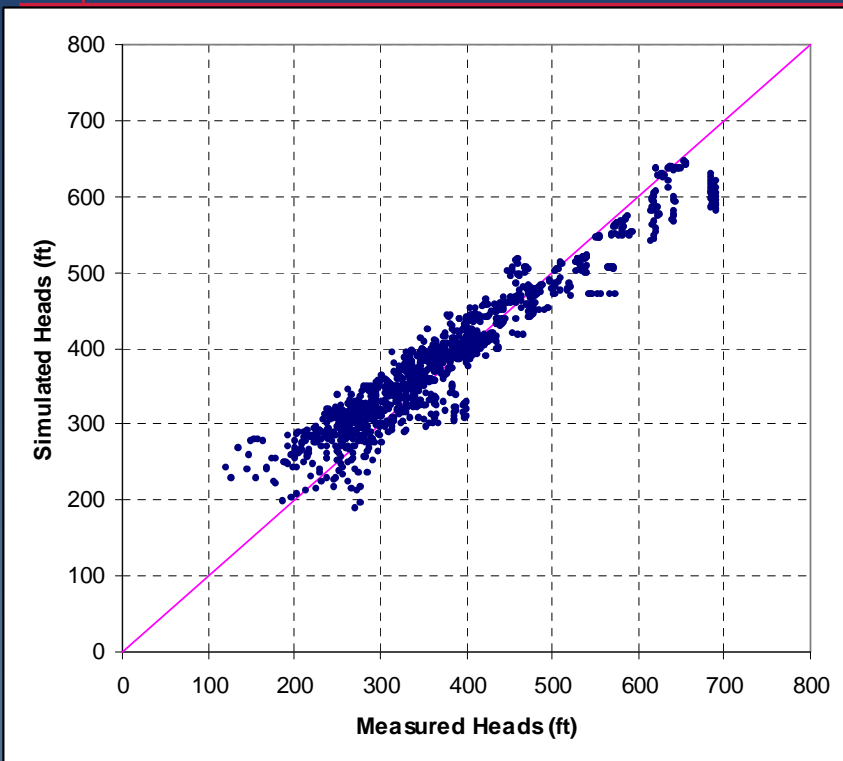


1. Kv Younger (-)
2. Recharge (+)
3. Kv Reklaw (-)
4. Kh (-)
5. Kv Wilcox (+)
6. K-Stream (+)

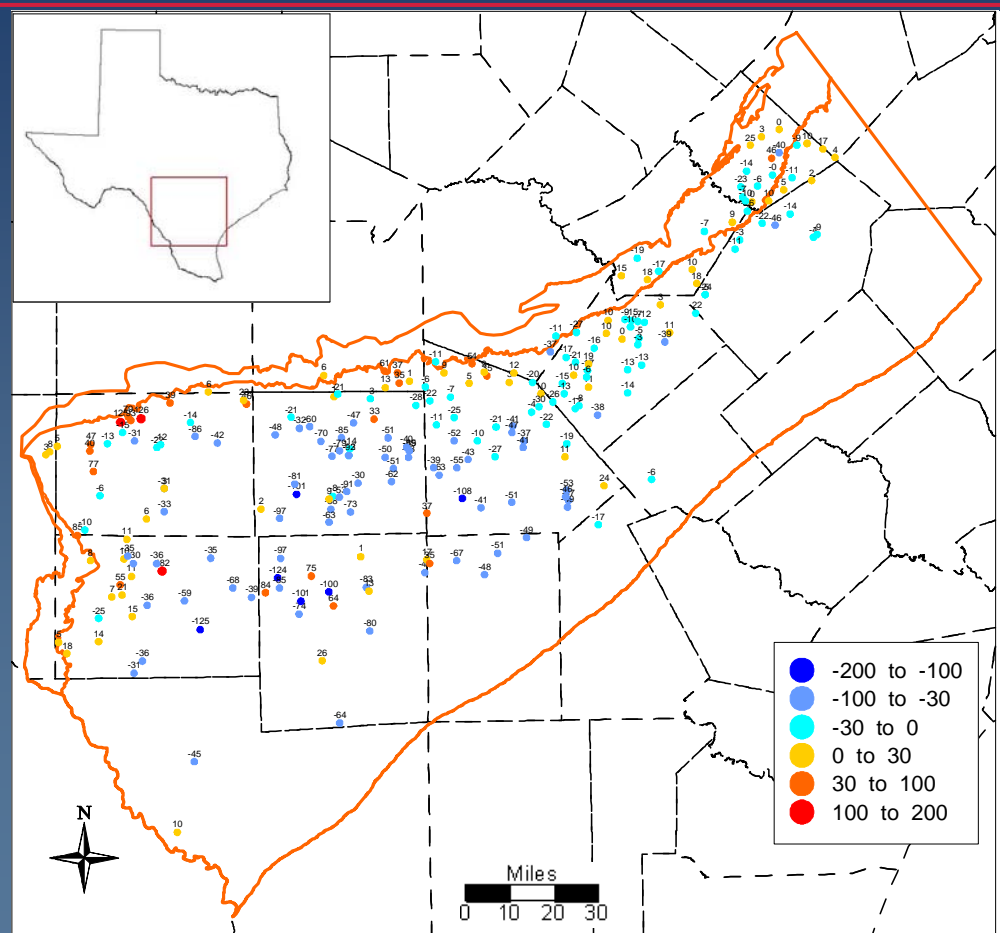
# Modeling Periods (Transient)



# Transient Calibration: Carrizo

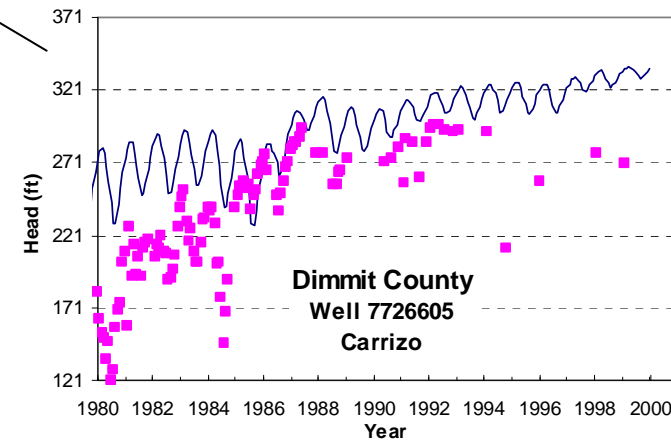
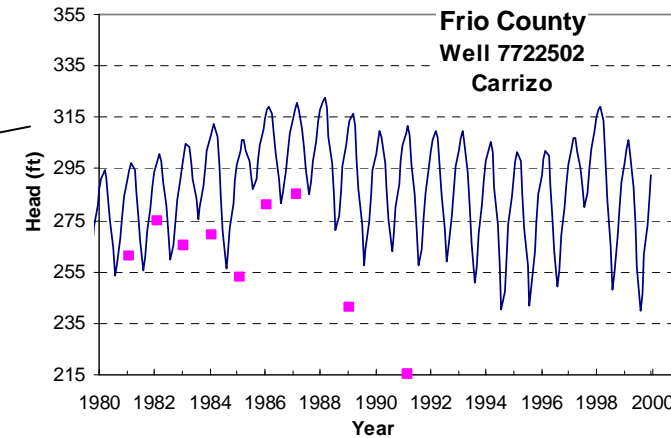
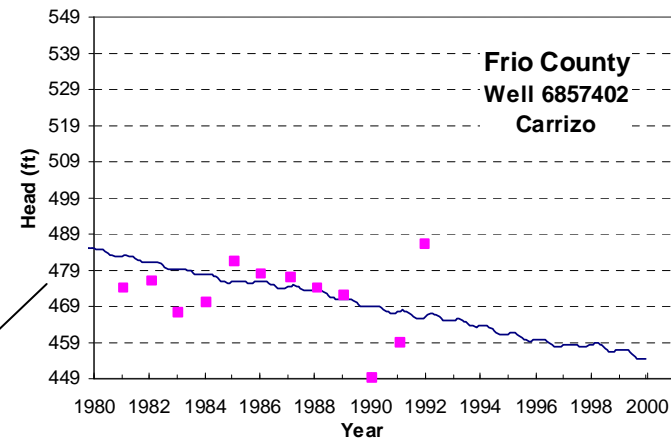
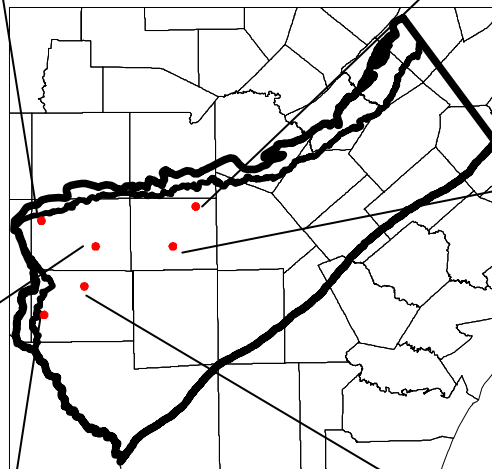
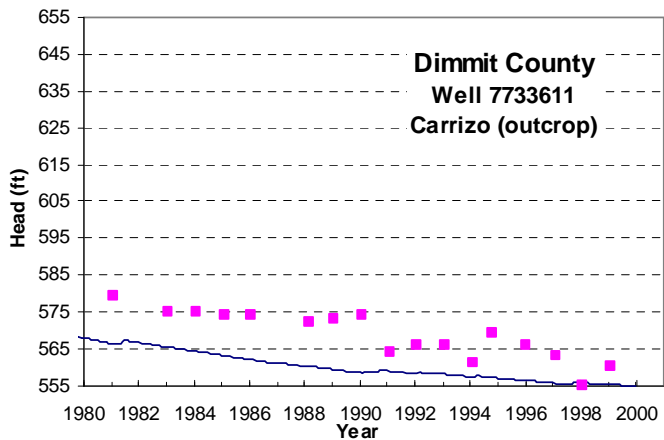
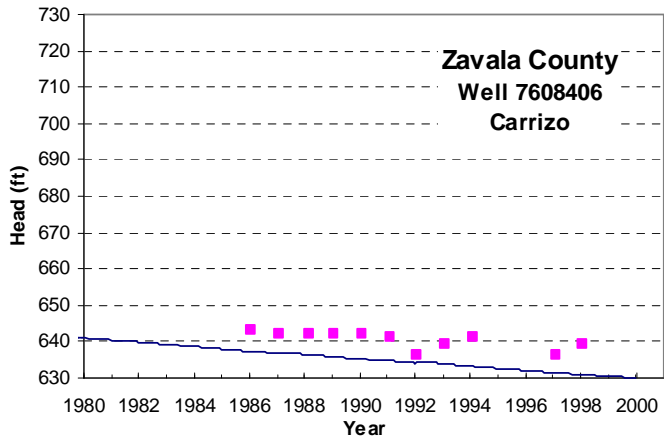
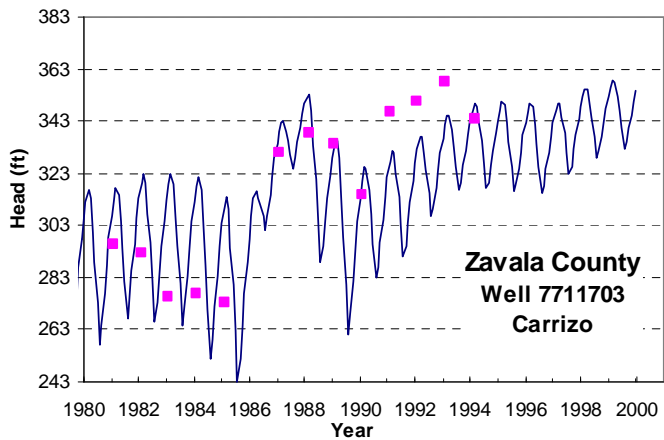


Crossplot – Calibration Period

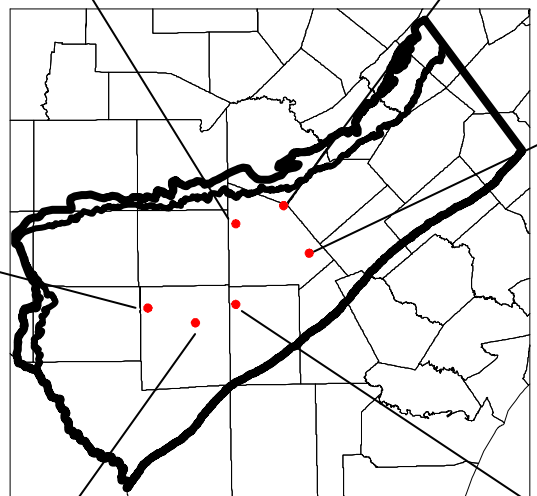
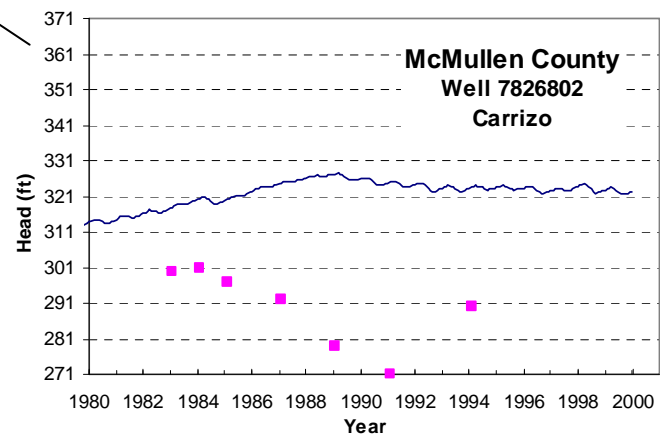
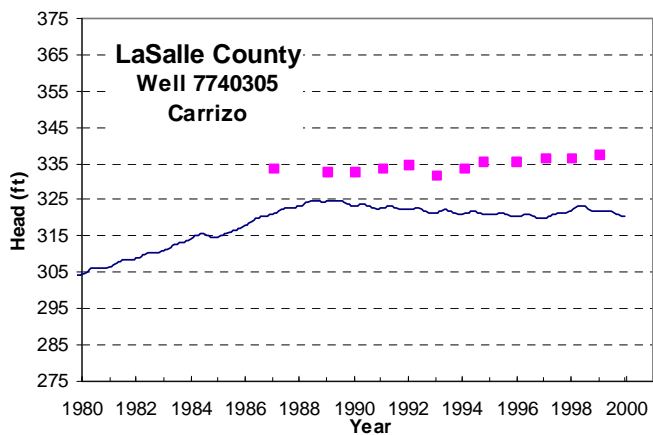
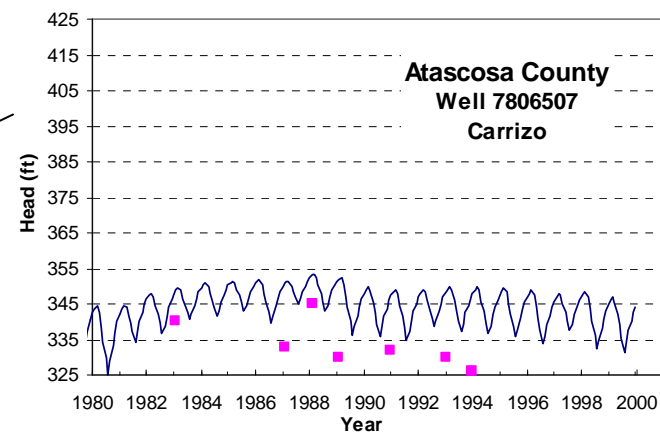
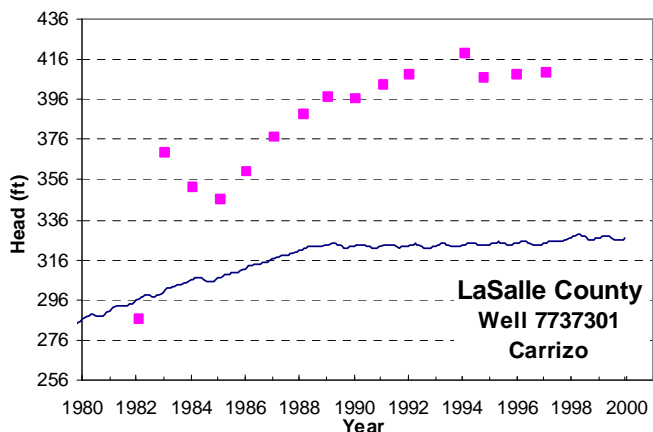
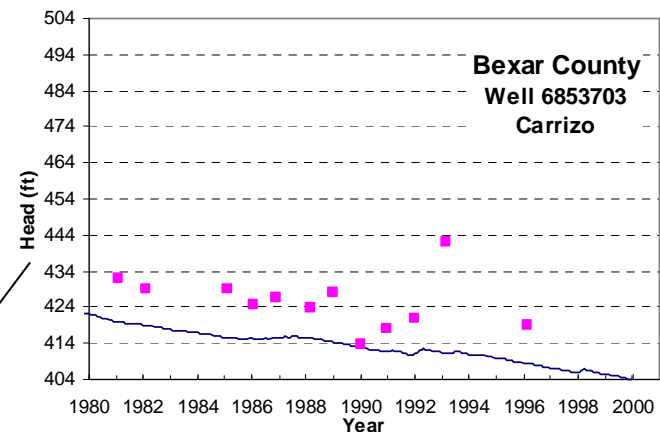
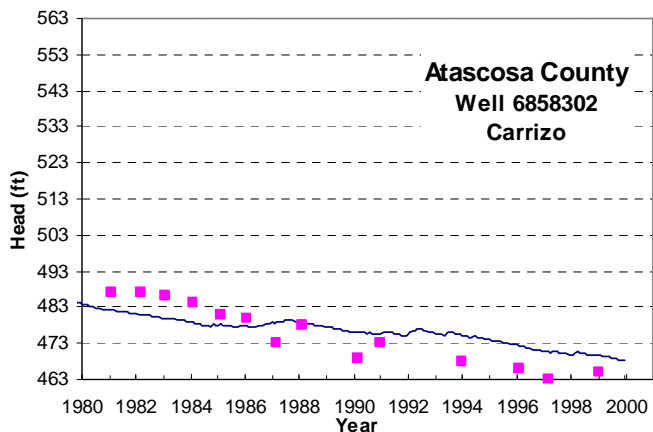


Residuals – Verification Period

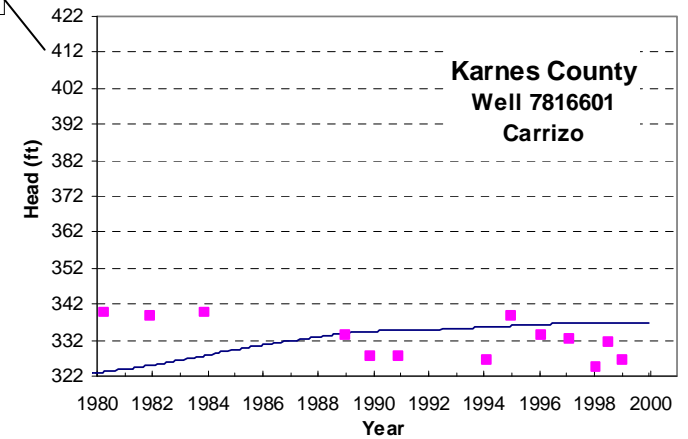
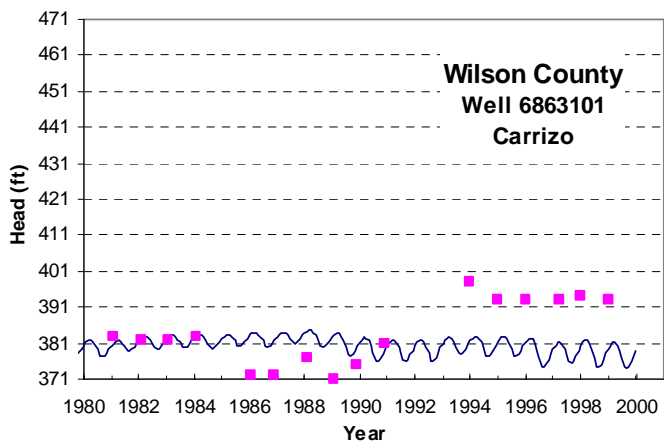
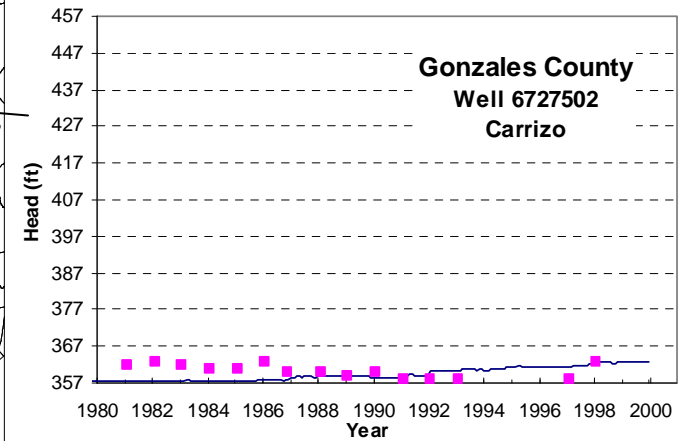
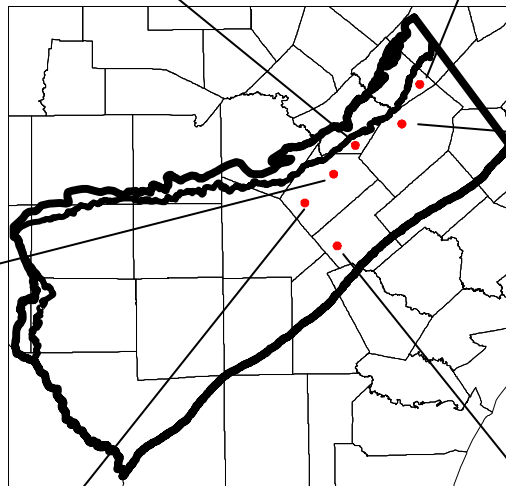
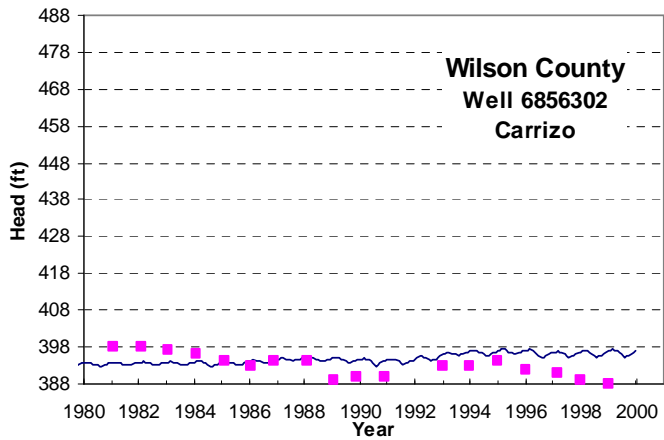
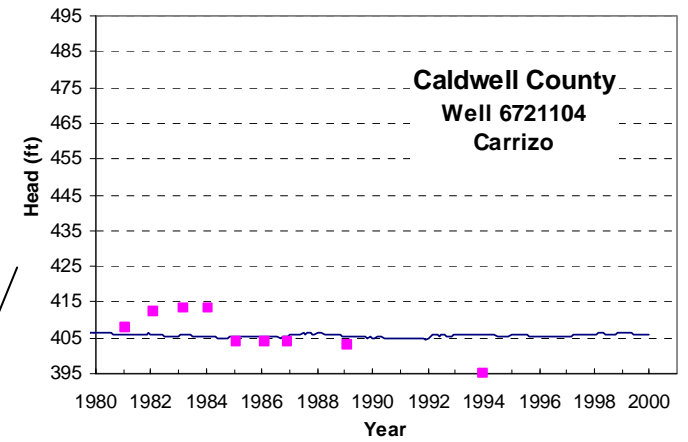
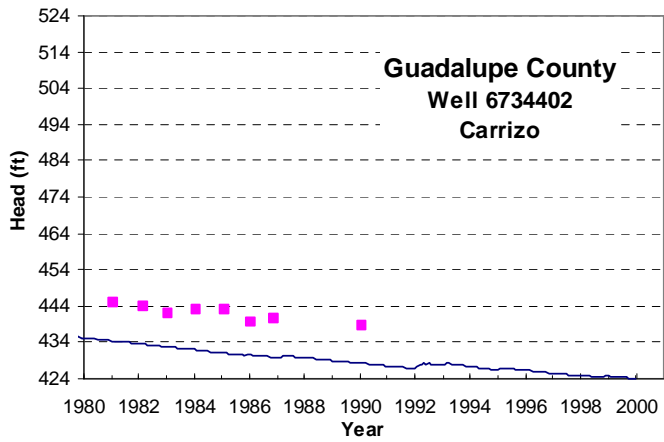
# Hydrographs Carrizo



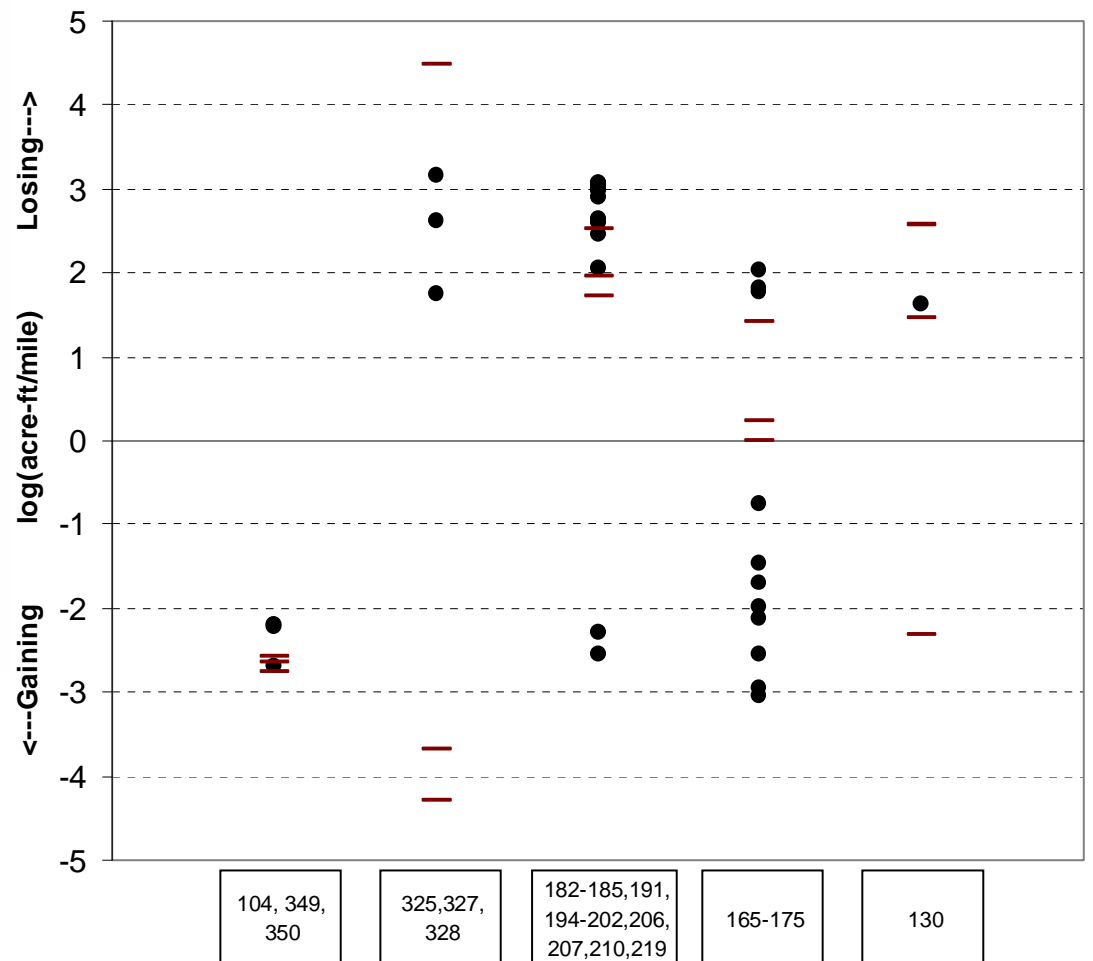
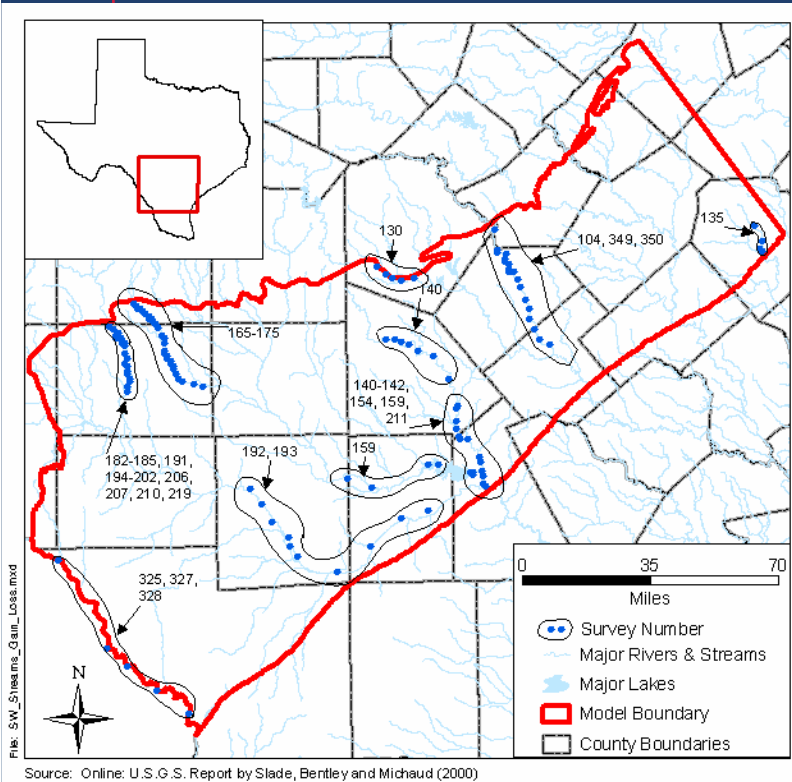
# Hydrographs Carrizo



# Hydrographs Carrizo



# Transient Calibration: Stream Gain/Loss Comparison



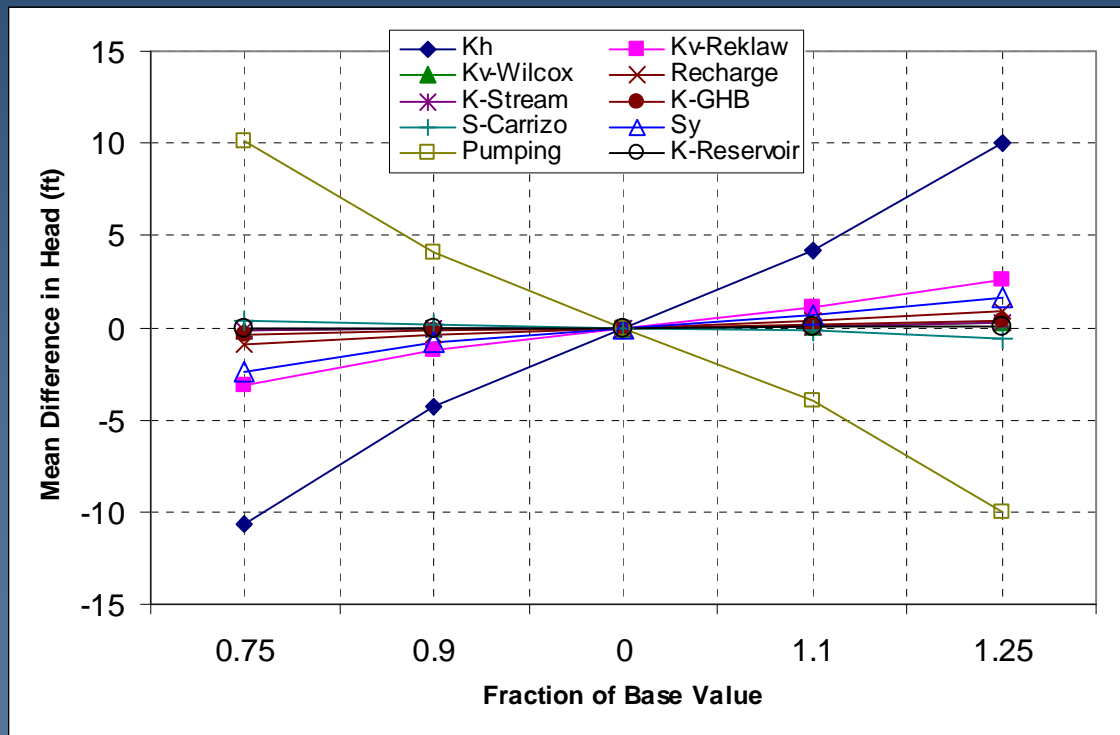
# Transient Calibration: Water Balance

| Year        | Layer      | GHBs   | Reserv. | Wells    | ET       | Top     | Bottom  | Rech.    | Streams  | Storage  |
|-------------|------------|--------|---------|----------|----------|---------|---------|----------|----------|----------|
| <b>1980</b> | <b>1</b>   | 37,679 | 0       | -7,142   | -51,703  | 0       | -54,293 | 115,689  | -193,735 | 152,555  |
|             | <b>2</b>   | 0      | 0       | -13,264  | -3,325   | 54,293  | -30,954 | 18,379   | -60,455  | 33,974   |
|             | <b>3</b>   | 0      | 0       | -215,491 | -76      | 30,954  | -27,502 | 20,912   | 932      | 190,281  |
|             | <b>4</b>   | 0      | 0       | -32,896  | -139     | 27,502  | 2,797   | 1,055    | -3,635   | 5,245    |
|             | <b>5</b>   | 0      | 3,050   | -16,833  | -2,761   | -2,797  | 1,659   | 22,499   | -23,679  | 18,851   |
|             | <b>6</b>   | 0      | 0       | -14,748  | -4,269   | -1,659  | 0       | 14,476   | -22,301  | 28,500   |
|             | <b>Sum</b> |        | 37,679  | 3,050    | -300,373 | -62,272 | 108,293 | -108,293 | 193,009  | -302,872 |
| <b>1989</b> | <b>1</b>   | 21,253 | 0       | -8,335   | -6,683   | 0       | -56,068 | 171,951  | 171,766  | -294,074 |
|             | <b>2</b>   | 0      | 0       | -12,570  | -680     | 56,068  | -50,911 | 81,838   | 297,279  | -371,279 |
|             | <b>3</b>   | 0      | 0       | -199,913 | -11      | 50,911  | -18,423 | 91,366   | 15,830   | 60,249   |
|             | <b>4</b>   | 0      | 0       | -25,799  | 0        | 18,423  | 7,067   | 20,882   | 21,287   | -41,871  |
|             | <b>5</b>   | 0      | 4,065   | -16,131  | -2,337   | -7,067  | 3,196   | 54,406   | 15,526   | -51,679  |
|             | <b>6</b>   | 0      | 0       | -10,944  | -1,591   | -3,196  | 0       | 38,095   | 41,684   | -64,060  |
|             | <b>Sum</b> |        | 21,253  | 4,065    | -273,693 | -11,302 | 115,138 | -115,138 | 458,539  | 563,372  |
| <b>1999</b> | <b>1</b>   | 16,219 | 0       | -7,963   | -24,002  | 0       | -60,527 | 78,495   | -285,584 | 283,289  |
|             | <b>2</b>   | 0      | 0       | -10,184  | -3,339   | 60,527  | -61,059 | 14,684   | -303,657 | 302,899  |
|             | <b>3</b>   | 0      | 0       | -201,371 | -119     | 61,059  | -8,445  | 16,206   | -49,437  | 182,117  |
|             | <b>4</b>   | 0      | 0       | -19,319  | -36      | 8,445   | 9,695   | 1,922    | -24,294  | 23,583   |
|             | <b>5</b>   | 0      | 1,742   | -13,936  | -2,193   | -9,695  | 2,920   | 11,188   | -65,572  | 75,528   |
|             | <b>6</b>   | 0      | 0       | -10,788  | -1,654   | -2,920  | 0       | 8,517    | -55,197  | 62,032   |
|             | <b>Sum</b> |        | 16,219  | 1,742    | -263,560 | -31,342 | 117,416 | -117,416 | 131,013  | -783,740 |



# Transient sensitivity results, Carrizo

## Carrizo Sensitivity Analysis

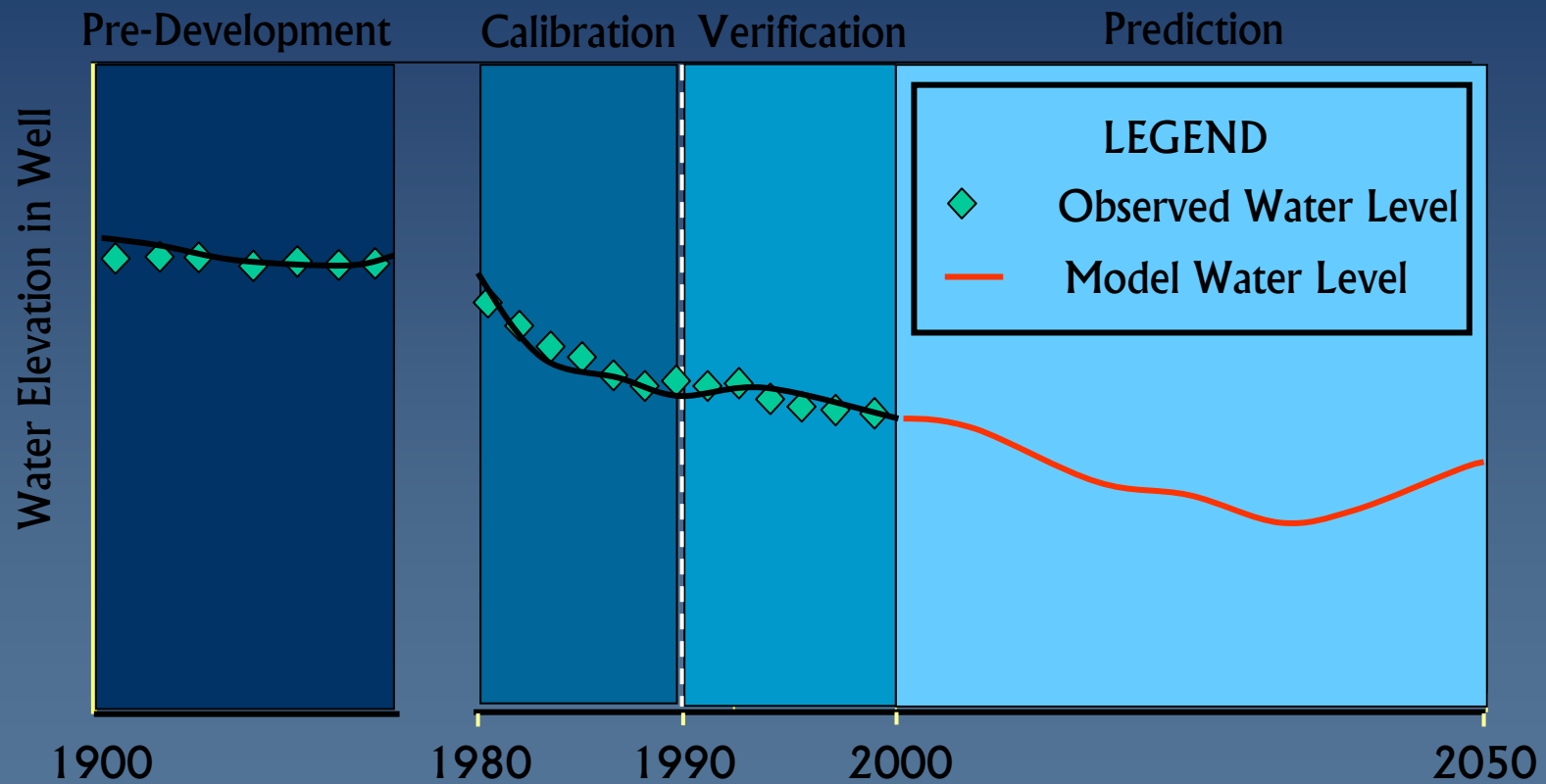


1. K horiz. (+)
2. Pumping (-)
3. Kv Reklaw (+)
4. Sy (+)
5. Recharge (+)
6. Kv Younger (+)
7. Storage (-)
8. Kv Wilcox (+)
9. K-stream (+)
10. K-res (+)

# Transient Model Calibration

- **Transient calibration required:**
  - Reduced  $K_v$  of the Reklaw/Bigford, particularly west of the Frio river
  - Reduced  $K_v$  of the Wilcox layers
  - Adjusted conductivity of the GHBs attached to the Queen City

# Modeling Periods - Predictive



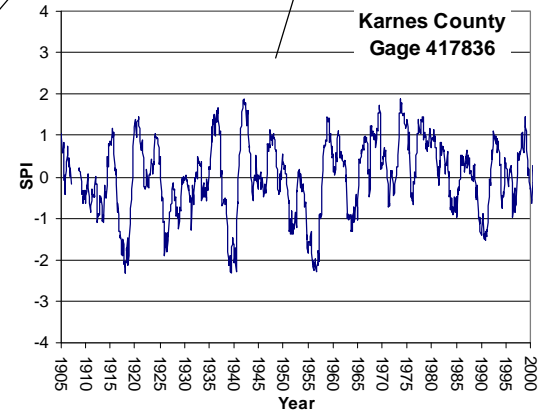
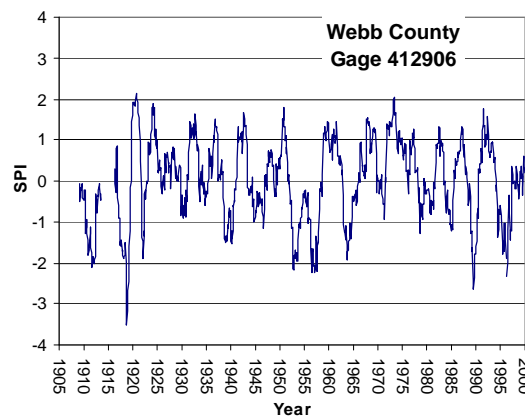
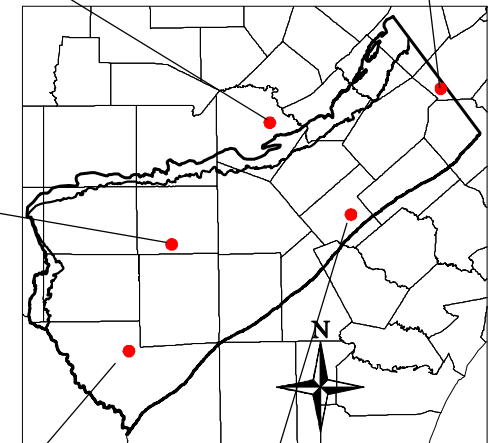
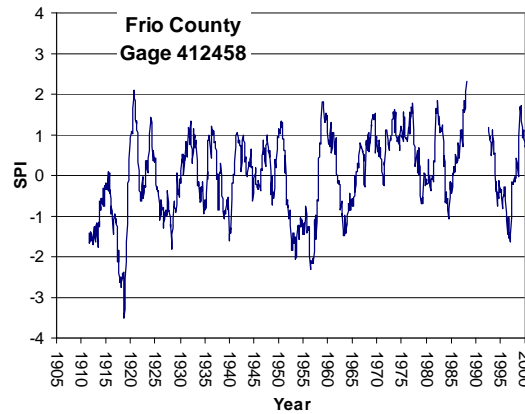
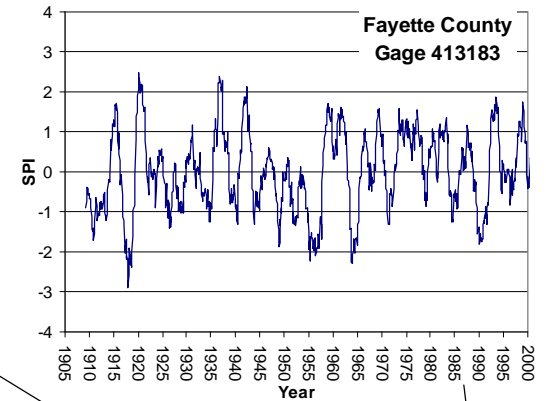
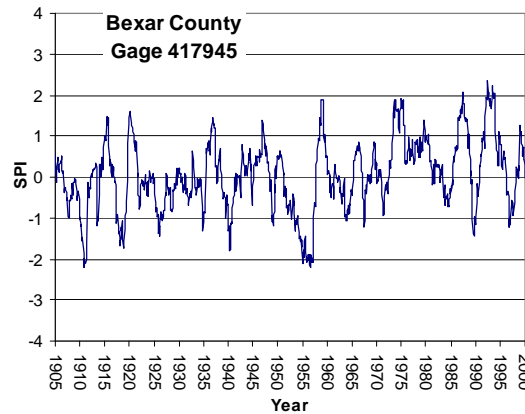
# Predictive Simulation (2000-2050)

- Predictive Pumpage based on RWPGs
- Six Model Scenarios:
  - Average Recharge Conditions through 2050
  - Average Recharge Conditions ending with the drought of record (DOR) in 2010
  - Average Recharge Conditions ending with the drought of record (DOR) in 2020.
  - Average Recharge Conditions ending with the drought of record (DOR) in 2030.
  - Average Recharge Conditions ending with the drought of record (DOR) in 2040.
  - Average Recharge Conditions ending with the drought of record (DOR) in 2050.

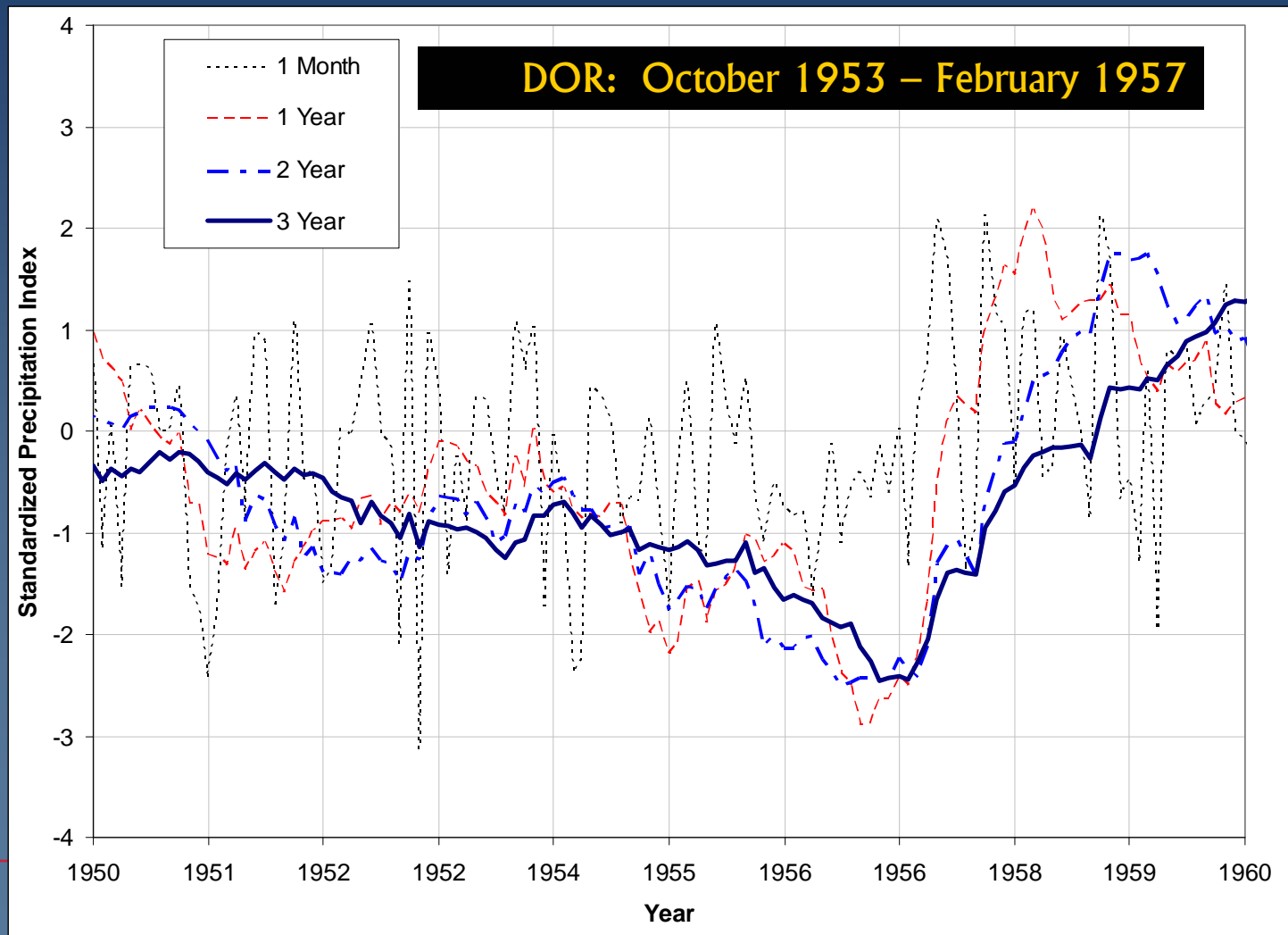
# Drought of Record: SPI

Standardized precipitation index (SPI) normalizes precipitation through space and time

| Year          | Percent of Normal |
|---------------|-------------------|
| 1917 (1 year) | 42%               |
| 1950-1956     | 70%               |
| 1954-1956     | 56%               |
| 1988 (1 year) | 55%               |



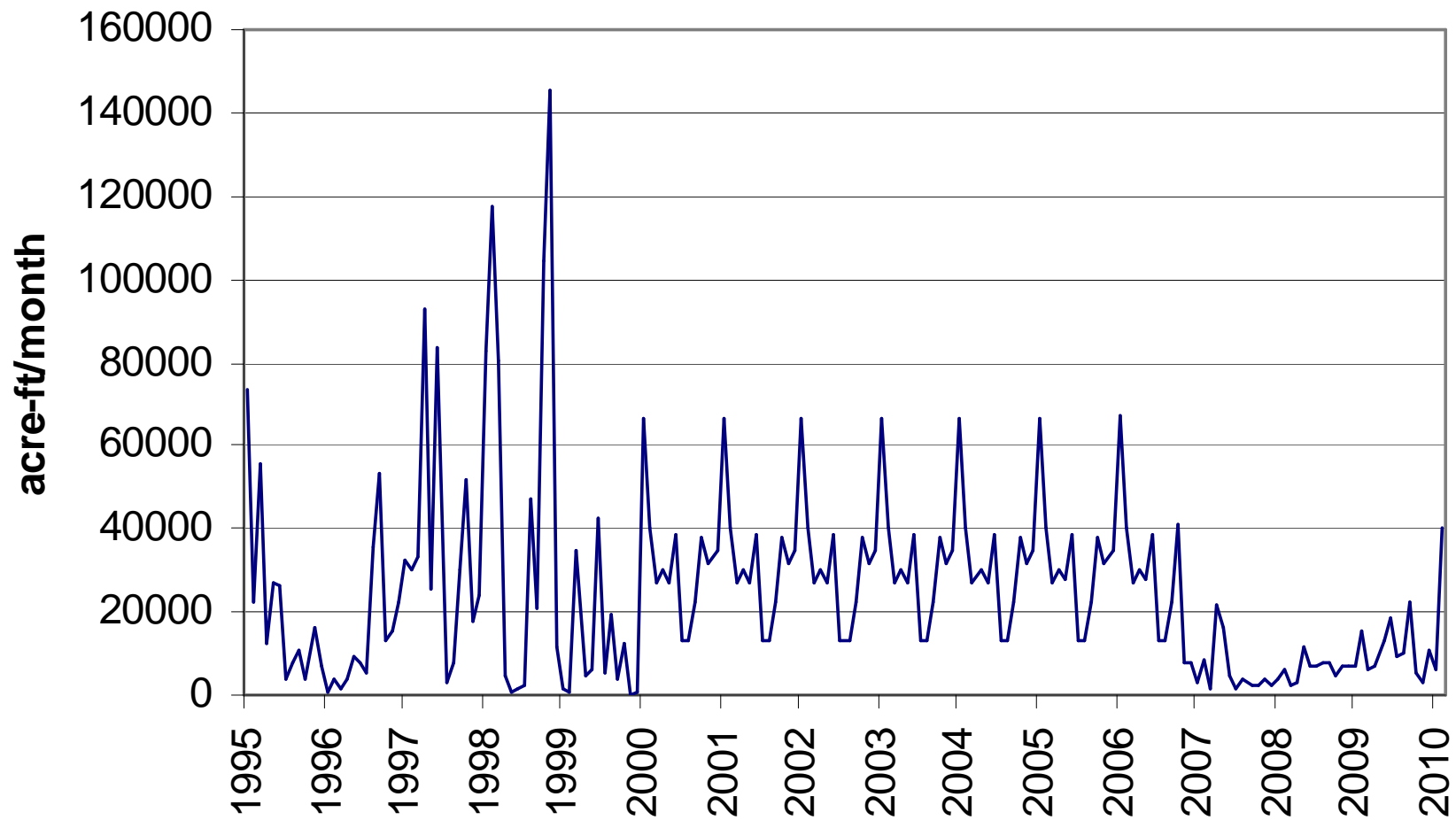
# Drought of Record: 1950s



# Pumping Estimates (AFY)

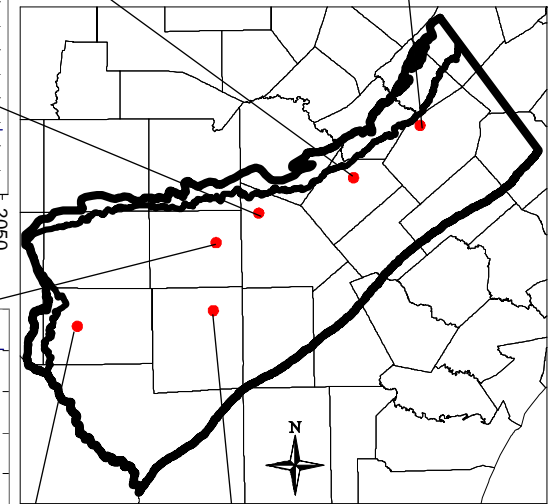
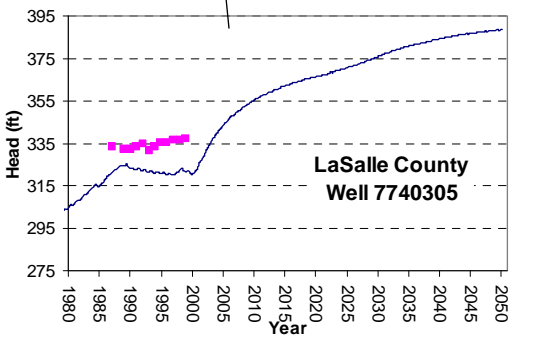
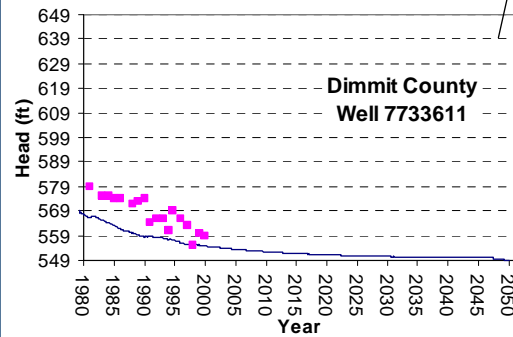
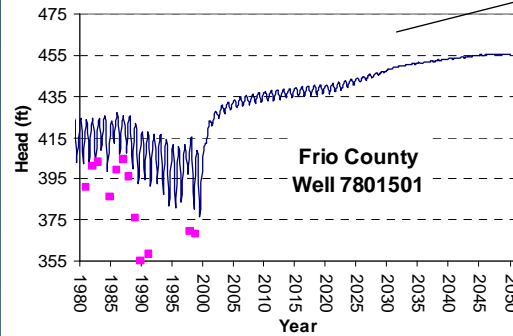
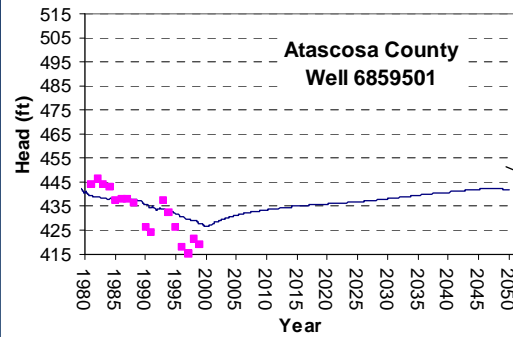
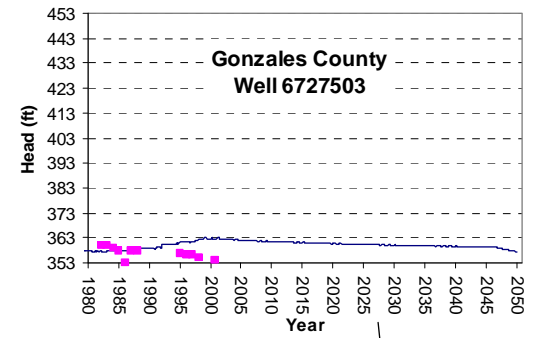
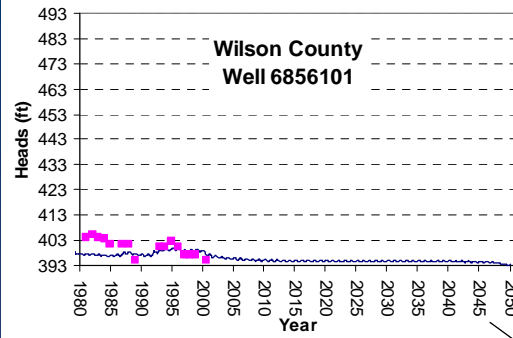
| COUNTY    | 1980   | 1990   | 2000   | 2010   | 2020   | 2030   | 2040   | 2050   |
|-----------|--------|--------|--------|--------|--------|--------|--------|--------|
| ATASCOSA  | 72676  | 56463  | 18938  | 19388  | 19916  | 8905   | 11365  | 18926  |
| BASTROP   | 830    | 1233   | 5612   | 6655   | 7698   | 8829   | 10259  | 12793  |
| BEE       | 0      | 0      | 80     | 81     | 80     | 82     | 84     | 88     |
| BEXAR     | 7658   | 6681   | 36709  | 37699  | 37688  | 32316  | 32882  | 31340  |
| CALDWELL  | 2184   | 3163   | 7245   | 7608   | 7972   | 8312   | 8363   | 8390   |
| DEWITT    | 9      | 10     | 0      | 0      | 0      | 0      | 0      | 0      |
| DIMITT    | 22321  | 9350   | 10360  | 10070  | 10111  | 10476  | 10562  | 10704  |
| FAYETTE   | 87     | 105    | 8      | 8      | 7      | 7      | 6      | 6      |
| FRIO      | 77550  | 83623  | 20587  | 20680  | 20736  | 5614   | 5723   | 5808   |
| GONZALES  | 3516   | 4589   | 3174   | 2998   | 2837   | 2688   | 2640   | 2607   |
| GUADALUPE | 2060   | 2680   | 12761  | 14176  | 15769  | 18001  | 19879  | 21254  |
| KARNES    | 1650   | 841    | 3266   | 2932   | 2782   | 2591   | 2556   | 2532   |
| LA SALLE  | 9068   | 7320   | 4922   | 4752   | 4552   | 4116   | 3979   | 3839   |
| LAVACA    | 4      | 2      | 0      | 0      | 0      | 0      | 0      | 0      |
| LIVE OAK  | 115    | 80     | 171    | 171    | 171    | 171    | 171    | 171    |
| MAVERICK  | 1203   | 3625   | 576    | 1061   | 1601   | 1505   | 1367   | 1244   |
| MCMULLEN  | 433    | 1560   | 578    | 510    | 470    | 440    | 414    | 395    |
| MEDINA    | 8433   | 1630   | 6556   | 6612   | 6650   | 2422   | 2476   | 2570   |
| UVALDE    | 4740   | 366    | 4442   | 4388   | 4345   | 1544   | 1533   | 1512   |
| WEBB      | 347    | 712    | 2580   | 7430   | 9096   | 12597  | 12599  | 12628  |
| WILSON    | 10031  | 15879  | 13679  | 13570  | 12370  | 11276  | 11901  | 12613  |
| ZAVALA    | 85741  | 80449  | 26771  | 26789  | 26744  | 7465   | 7704   | 8005   |
| Total     | 312636 | 282351 | 181015 | 189588 | 193615 | 141387 | 148503 | 159475 |

# Transient Recharge (1995-2010)

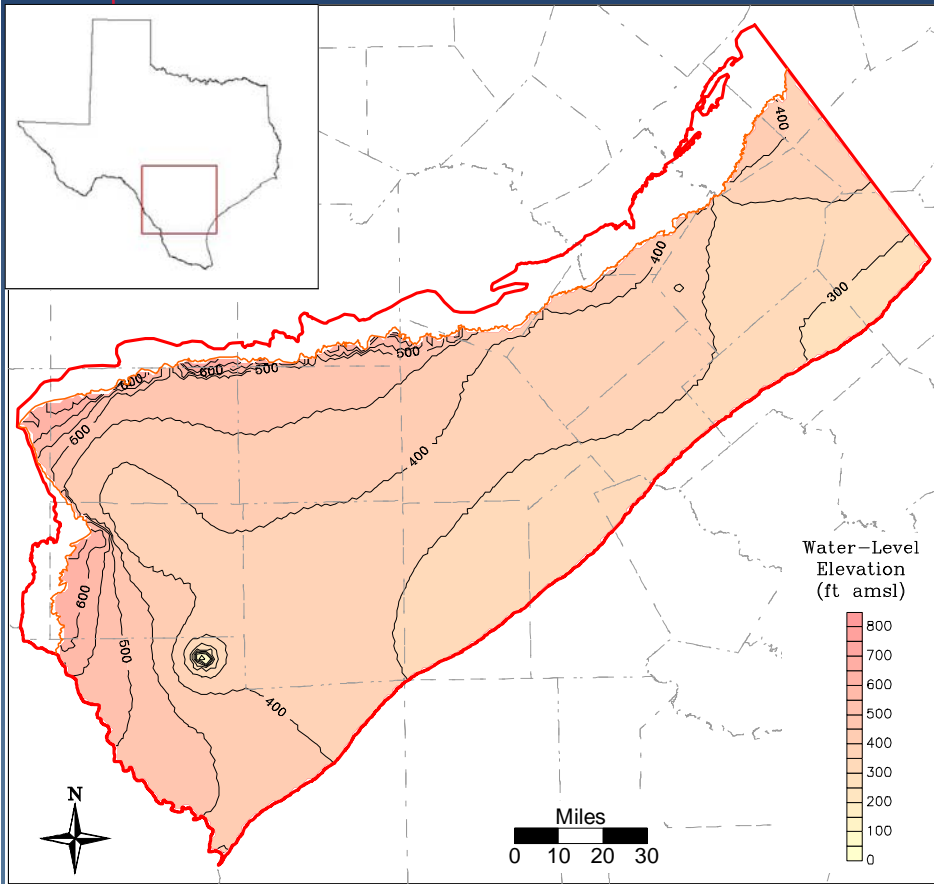




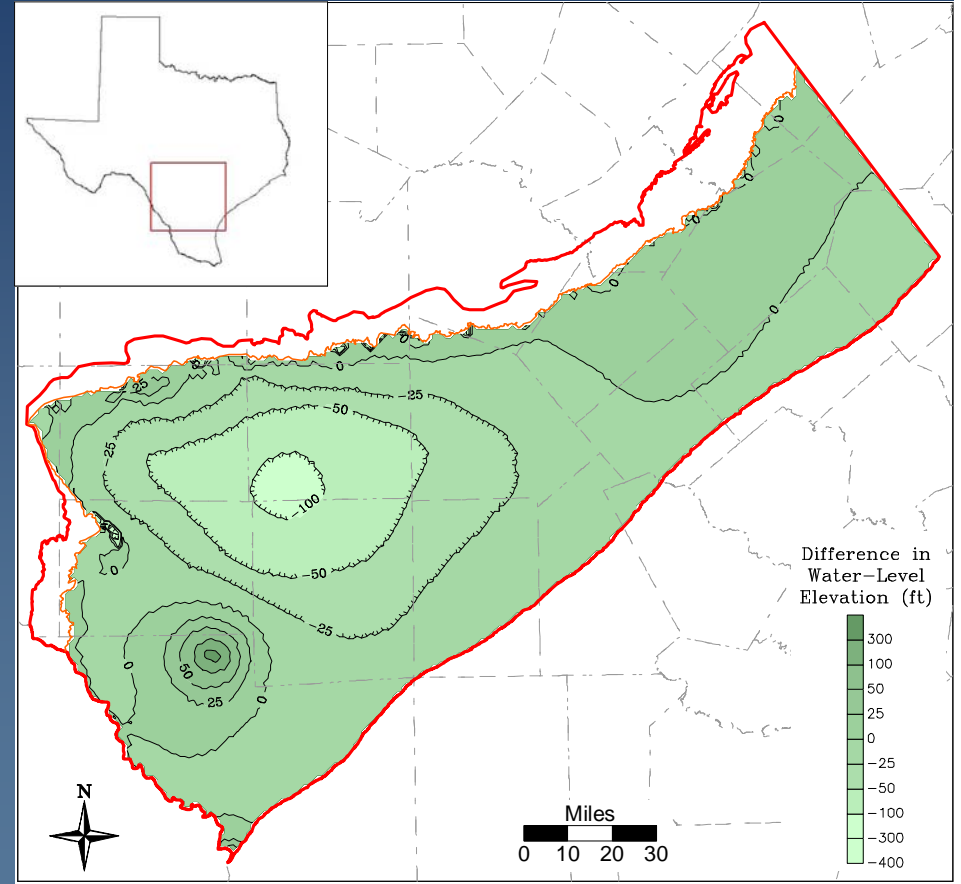
# Predictive Simulations: Hydrographs



# Predictive Simulations: 2030

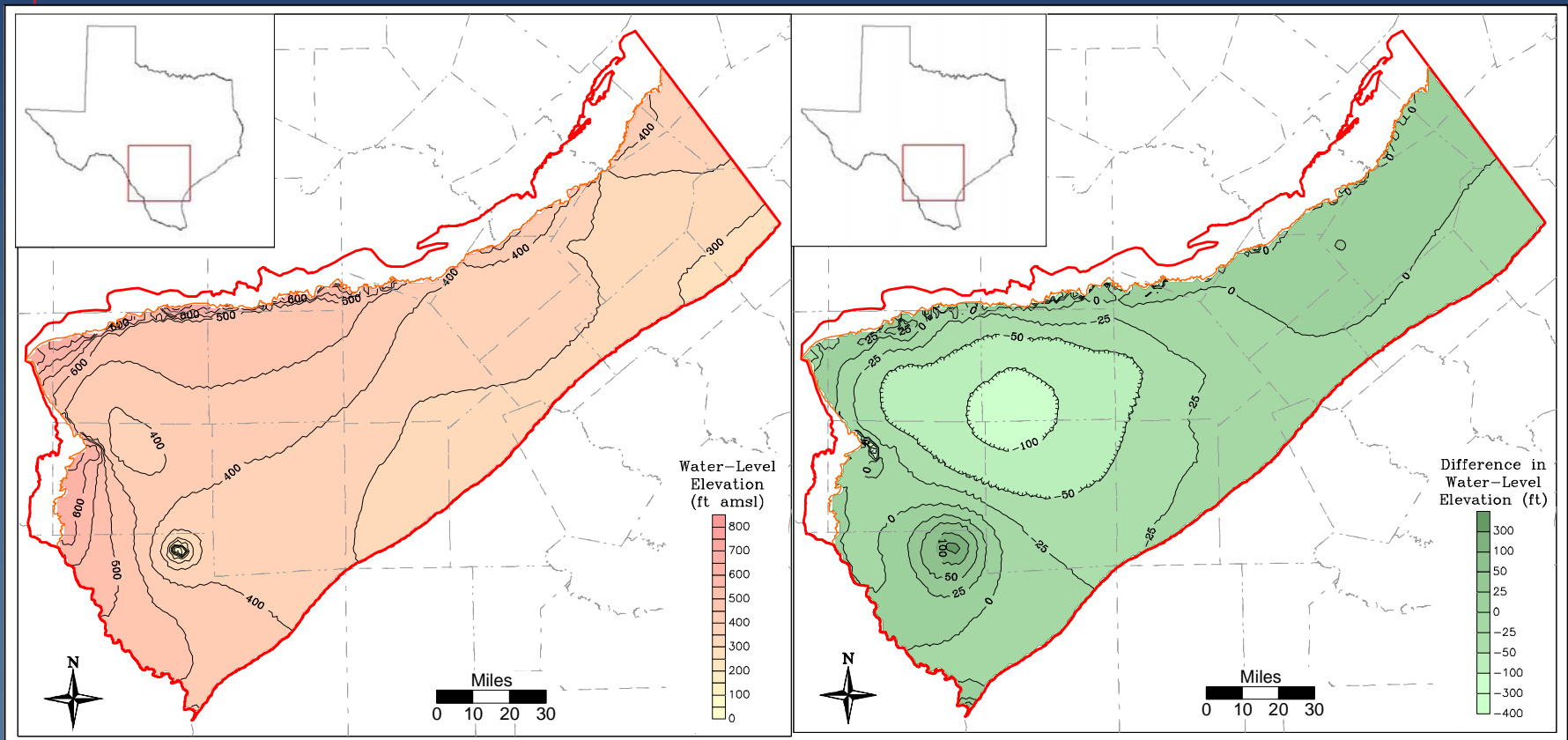


Carrizo Head Surface 2030

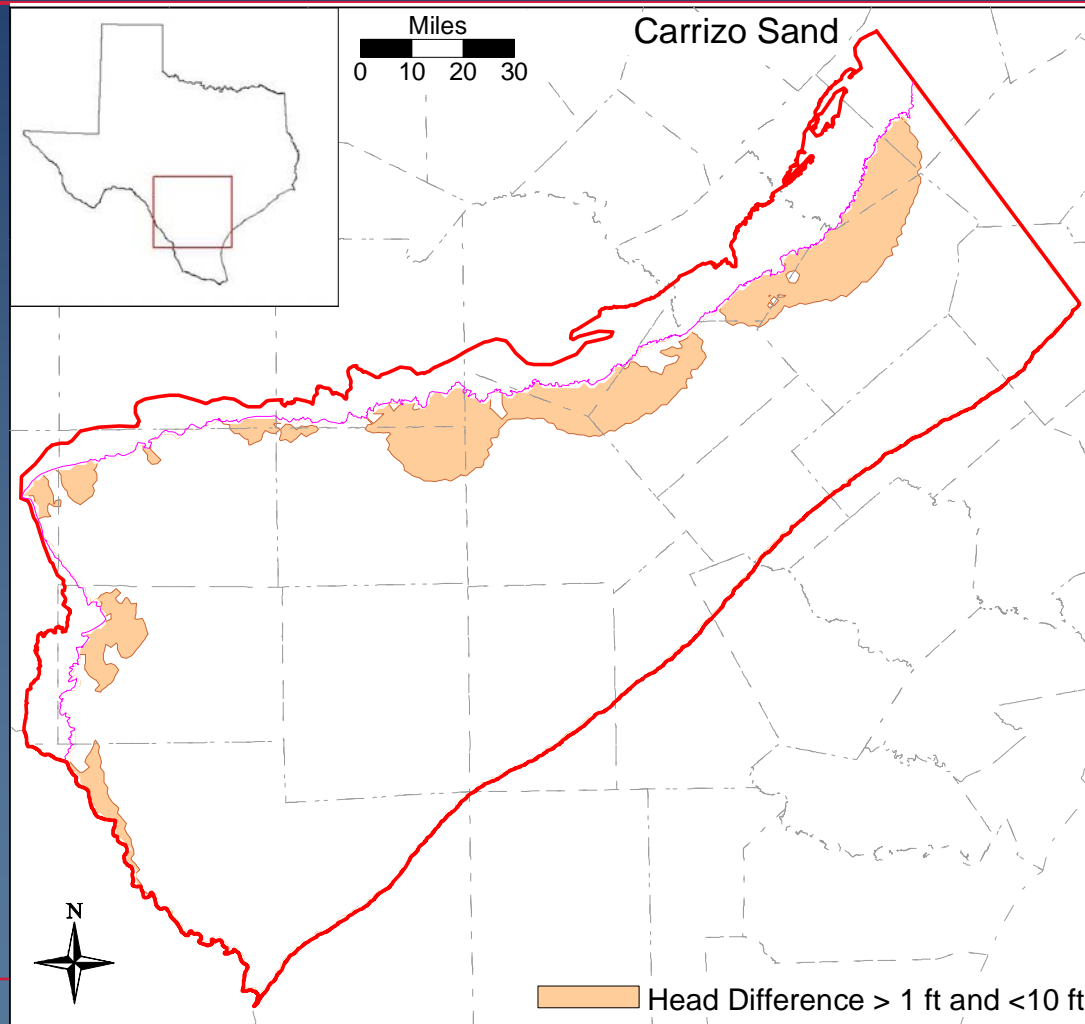


Carrizo Drawdown 2000 - 2030

# Predictive Simulations: 2050



# Effect of Drought of Record: 2050



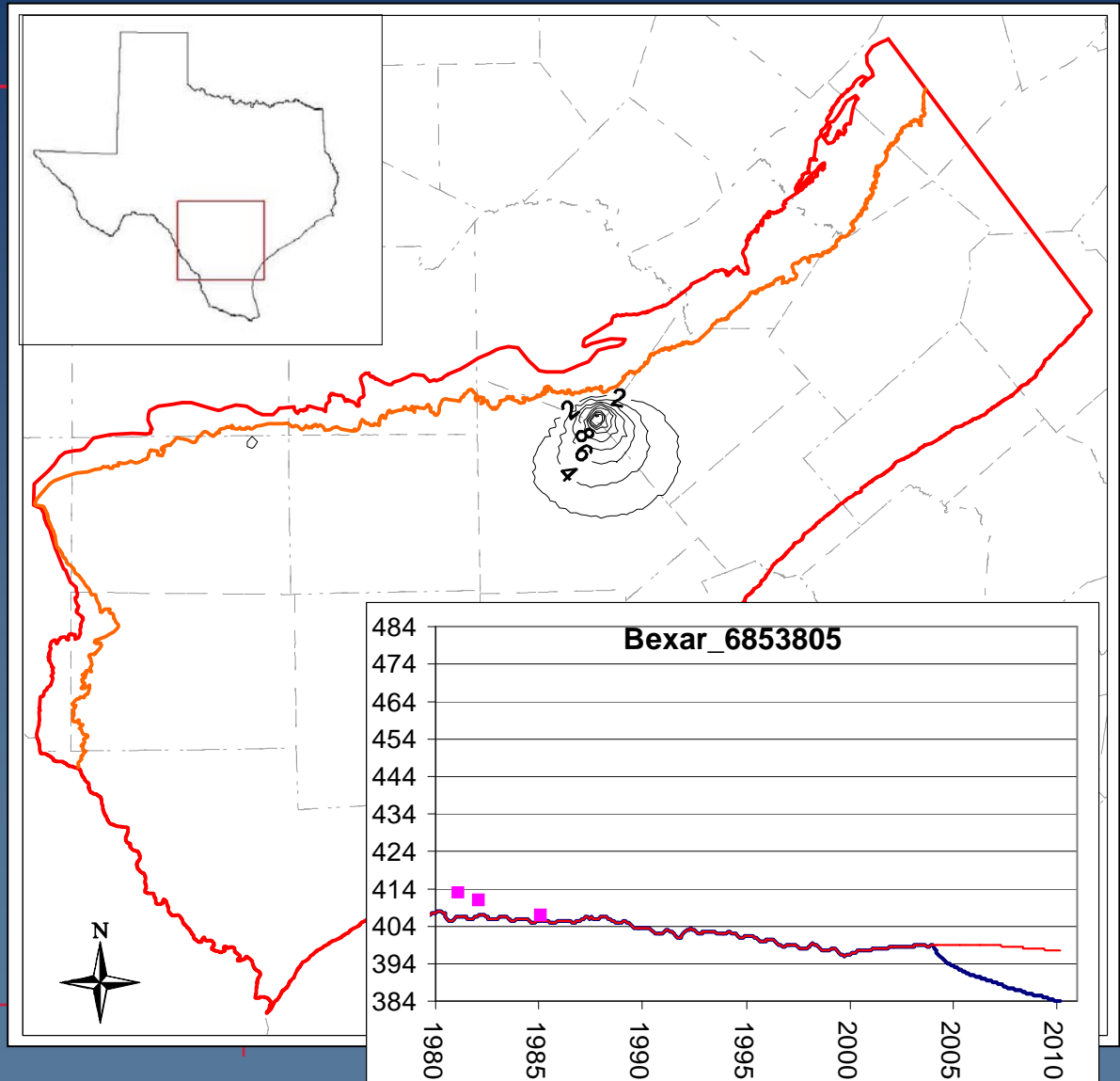
# Predictive Simulations: Water Balance

| Year        | Layer      | GHBs   | Reservoirs | Wells    | ET       | Top     | Bottom  | Recharge | Streams  | Storage  |
|-------------|------------|--------|------------|----------|----------|---------|---------|----------|----------|----------|
| <b>1990</b> | 1          | 21,575 | 0          | -7,228   | -31,897  | 0       | -54,422 | 102,478  | -97,276  | 64,941   |
|             | 2          | 0      | 0          | -13,989  | -1,742   | 54,422  | -50,412 | 21,747   | -31,279  | 19,029   |
|             | 3          | 0      | 0          | -223,628 | -20      | 50,412  | -16,618 | 25,865   | 4,246    | 159,753  |
|             | 4          | 0      | 0          | -29,546  | -10      | 16,618  | 7,338   | 5,676    | -1,783   | 1,569    |
|             | 5          | 0      | 4,925      | -17,754  | -4,210   | -7,338  | 3,002   | 24,736   | -24,670  | 21,288   |
|             | 6          | 0      | 0          | -11,009  | -3,144   | -3,002  | 0       | 17,914   | -7,972   | 7,204    |
|             | <b>Sum</b> |        | 21,575     | 4,925    | -303,154 | -41,023 | 111,112 | -111,112 | 198,416  | -158,734 |
| <b>2000</b> | 1          | 16,185 | 0          | -7,884   | -24,002  | 0       | -60,693 | 116,840  | -231,968 | 191,441  |
|             | 2          | 0      | 0          | -10,030  | -3,339   | 60,693  | -61,387 | 27,310   | -237,867 | 224,480  |
|             | 3          | 0      | 0          | -200,091 | -119     | 61,387  | -8,705  | 36,551   | -28,422  | 139,411  |
|             | 4          | 0      | 0          | -19,299  | -36      | 8,705   | 9,778   | 4,192    | -19,224  | 15,879   |
|             | 5          | 0      | 2,255      | -15,077  | -2,193   | -9,778  | 2,984   | 30,349   | -57,843  | 49,289   |
|             | 6          | 0      | 0          | -11,671  | -1,660   | -2,984  | 0       | 20,006   | -45,922  | 42,224   |
|             | <b>Sum</b> |        | 16,185     | 2,255    | -264,053 | -31,348 | 118,023 | -118,023 | 235,247  | -621,245 |
| <b>2010</b> | 1          | 6,854  | 0          | -6,885   | -57,704  | 0       | -39,843 | 89,581   | -135,466 | 142,334  |
|             | 2          | 0      | 0          | -6,227   | -4,241   | 39,843  | -29,817 | 13,514   | -111,055 | 96,531   |
|             | 3          | 0      | 0          | -104,592 | -118     | 29,817  | -6,119  | 15,994   | -1,414   | 66,498   |
|             | 4          | 0      | 0          | -13,145  | -745     | 6,119   | 6,370   | 531      | -7,670   | 8,398    |
|             | 5          | 0      | 3,104      | -22,516  | -2,607   | -6,370  | 1,129   | 22,721   | -33,354  | 37,871   |
|             | 6          | 0      | 0          | -17,382  | -3,436   | -1,129  | 0       | 10,460   | -17,167  | 28,640   |
|             | <b>Sum</b> |        | 6,854      | 3,104    | -170,747 | -68,851 | 68,280  | -68,280  | 152,800  | -306,126 |

# Twin Oaks

Twin Oaks Project in  
Southern Bexar County

Approximately 14,000 AFY  
of pumping was added to a 5  
square mile area in Southern  
Bexar County



# Conclusions

- **GAM for Southern Carrizo-Wilcox Aquifer:**
  - Incorporated all relevant features, data on aquifer properties, recharge estimates, and pumpage
  - Calibrated to specifications:
    - pre-development
    - transient conditions (1980-1989)
    - verified from (1990-1999)
  - Required some adjustment of properties during transient calibration (not beyond measured data)

## Conclusions (cont.)

- Predictive pumping estimates are considerably less than historical pumpage
- Predictive simulations indicate:
  - No noticeable effect of DOR
    - DOR only reflects recharge but not potential increase in pumpage
  - Significant recovery in Winter Garden area as a result of a predicted decrease in pumping
  - General head decline in eastern model area and in Webb County



## Conclusions (cont.)

- The GAM is a tool capable of being used to make groundwater availability assessments on a regional scale

# Southern GAM Schedule

2001

SAF 1 — May 9 ■

● Mar. 13 — Kickoff Meeting

SAF 2 — Aug. 1 ■

● Aug. 13 — Conceptual Model

SAF 3 — Nov. 19 ■

● Dec. — Initial model design

SAF 4 — Feb. 28 ■

● May 7 — Steady-state model review

SAF 5 — May 21 ■

● Aug. 20 — Transient model review

2002

SAF 6 — Aug. 1 ■

● Sep. 13 — Model predictions review

SAF 7 — Nov. 4 ■

● Dec. — Draft report review



SAF 8 Seminar

● Jan — Present SAF Model Seminar

2003



Jan. 31 **Deliver Final Product**

**Meeting Minutes for the  
Seventh Carrizo-Wilcox Groundwater Availability Model (GAM) Stakeholder  
Advisory Forum (SAF) Meeting**

**November 4, 2002**

**San Antonio River Authority**

**San Antonio, Texas**

The seventh Stakeholder Advisory Forum (SAF) Meeting for the Southern Carrizo-Wilcox Groundwater Availability Model (GAM) was held on November 4<sup>th</sup> from 1:30 until 4:00 PM at the San Antonio River Authority Board Room in San Antonio, Texas. Attachment A of these meeting minutes provides a list of all participants who signed up as attending the meeting.

The purpose of the sixth SAF meeting was to present the draft calibrated model (predevelopment and transient) and to present the draft predictive simulations for the time period from 2000 through 2050. Model assumptions, limitations, and applicability were also discussed. As in all SAF presentations, the GAM objectives and expectations were also reviewed.

**SAF Presentation: Van Kelley, INTERA**

Van Kelley, Project Manager for the INTERA Southern Carrizo-Wilcox Team presented a prepared presentation. The presentation was structured according to the following outline:

1. Review of the GAM Project, Objectives, and Expectations
2. Conceptual Model Review
3. Model Design Review
4. Steady-State Model Review
5. Transient Model Review
6. Model Limitations and Applicability
7. GAM Schedule and Project Milestones

The presentation is available on the GAM website ([www.twdb.state.tx.us/gam](http://www.twdb.state.tx.us/gam)).

**Questions and Answers: Open Forum:**

- Q. The pumping figures show reservoirs that are proposed. Will you correct this in the final report?
- A: Yes, this error has already been brought to our attention and we will make that correction.

- Q: You said in your presentation that the vertical hydraulic conductivity within the Wilcox and the Reklaw required changing during the transient calibration from the initial values used in the initial steady-state calibration. How did you change them?
- A: The vertical resistance to flow in the model generally had to be increased by decreasing the hydraulic conductivity of the aquifers and aquitards. As we moved from the steady-state calibration to the transient calibration we found we had to decrease the vertical hydraulic conductivity. However, we did not need to decrease the horizontal conductivity from our initial estimates. Changes to vertical hydraulic conductivity were generally performed in zones no prevent over-parameterization.
- Q: The predictive pumping estimates do not seem to agree with the Regional Water Plan.
- A: The predictive pumping data was based upon the Regional Water Planning Group databases. INTERA used the predictive data as provided by the TWDB allocated by County-Basin. It appears to be true that predictive pumping estimates seem low in certain areas of the model. However, the data being used is provided by the TWDB and the RWPGs. Keep in mind that the purpose of the GAM Program is to develop tools to predict groundwater availability. This goal has been met.
- Q: Will SWAT be delivered with the model?
- A: SWAT is public domain. The data sets can be delivered. The MODFLOW recharge package can be used without re-running SWAT and a monthly varying average year recharge condition has been developed for use in predictive simulations and this has been submitted to the TWDB.
- Q: What stream gain-loss studies were used in calibration?
- A: We used the gain-loss study survey results from the USGS (Slade et al., 2002) which was published this year. This study is available at the TWDB GAM website. We also used the LBG-HDR (1998) surface water/groundwater model predictions for gain and loss. Finally, we used stream gages to make sure we were predicting proper stream flow rates.
- Q: What is the content of the report regarding stream gain and loss?
- A: The report content is similar to what we have presented today. The report presents the applicable gain and loss studies in the area and also presents gain/loss estimates from other reports. Our calibration then focuses on how well the model is agreeing with these measurements or predictions in the case of prior modeling results.
- Q: How does the model structure and other properties agree in the overlap?
- A: We worked closely with the Central model team to make sure that the model structure agreed. Properties are using the same database but there may be differences in how we distributed the property to the square mile grid cells.

- Q: How do the recharge estimates from SWAT compare with other studies?
- A: In previous SAF meetings we have shown that the SWAT results compare well to the various studies summarized in the recent TWDB report on Recharge in Texas (Scanlon et al. 2002).
- Q: How many time steps have been taken per stress period.
- A: I am not certain how many time steps were taken per stress period. We kept a stress period of 1 month throughout the calibration, verification and predictive model times.
- Q: Once the GAM models are available for public use, how will the TWDB respond to suggested modifications? How will the models be maintained?
- A: The TWDB has budgeted for the maintenance of the GAM models. At this time, we do not have a detailed description of how this maintenance program will work internal and external to the TWDB.
- Q: Will there be an accepted protocol for model modifications such that the modified GAM will still be “sanctioned” or “accepted” by the TWDB.
- A: This is a good question and unfortunately we do not have the answer to this question today. It might be that the TWDB will have to review any changes to the model. This issue of maintenance will be raised with Robert Mace so that a protocol can be developed.
- Q: Will the report be circulated and is there a process for commenting.
- A: The draft report is available on the GAM website ([www.twdb.state.tx.us/gam](http://www.twdb.state.tx.us/gam)) . The TWDB is accepting stakeholder comments on the reports and the details are also available at the GAM website listed above.
- Q: Will the report discuss model imitations?
- A: Yes, the modeling report does discuss the model imitations and the model scale of application.

---

LBG-Guyton Associates and HDR Engineering Inc., 1998. Interaction between ground water and surface water in the Carrizo-Wilcox aquifer.

Scanlon, B.R., A. Dutton, and M. Sophocleus, 2002. Groundwater recharge in Texas.

Slade, R.M., Jr., J.T. Bentley, and D. Michaud, 2002. Results of streamflow gain-loss studies in Texas, with emphasis on gains from and losses to major and minor aquifers, Texas, 2000. U.S. Geological Survey, Open-File Report 02-068.

### ATTACHMENT A: SIGN-UP SHEET

| Name             | Affiliation | Contact Information (including email address, if available)        |
|------------------|-------------|--|
| Steve Raabe      | SARA        | <a href="mailto:sraabe@sara-tx.org">sraabe@sara-tx.org</a>         |
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| Larry Land       | HDR         | <a href="mailto:lland@hdrinc.com">lland@hdrinc.com</a>             |
| Rick Hay         | CWSS        | <a href="mailto:rhay@falcon.tamucc.edu">rhay@falcon.tamucc.edu</a> |
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| Ronnie Hernandez | SARA        | <a href="mailto:ronnieh@sara-tx.org">ronnieh@sara-tx.org</a>       |
| Diane Savage     | WCWAP       |  |
| Gaylon Click     | WCWAP       |  |
|                  |             |  |