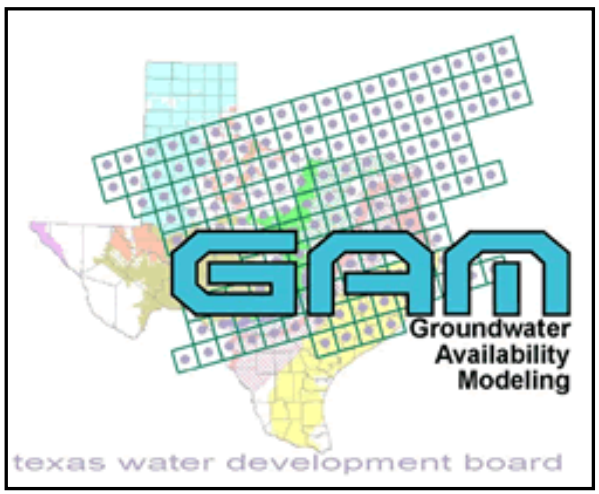
# Seymour GAM Review



- **Technical Overview**
  - Emphasis on Data and Model Inputs



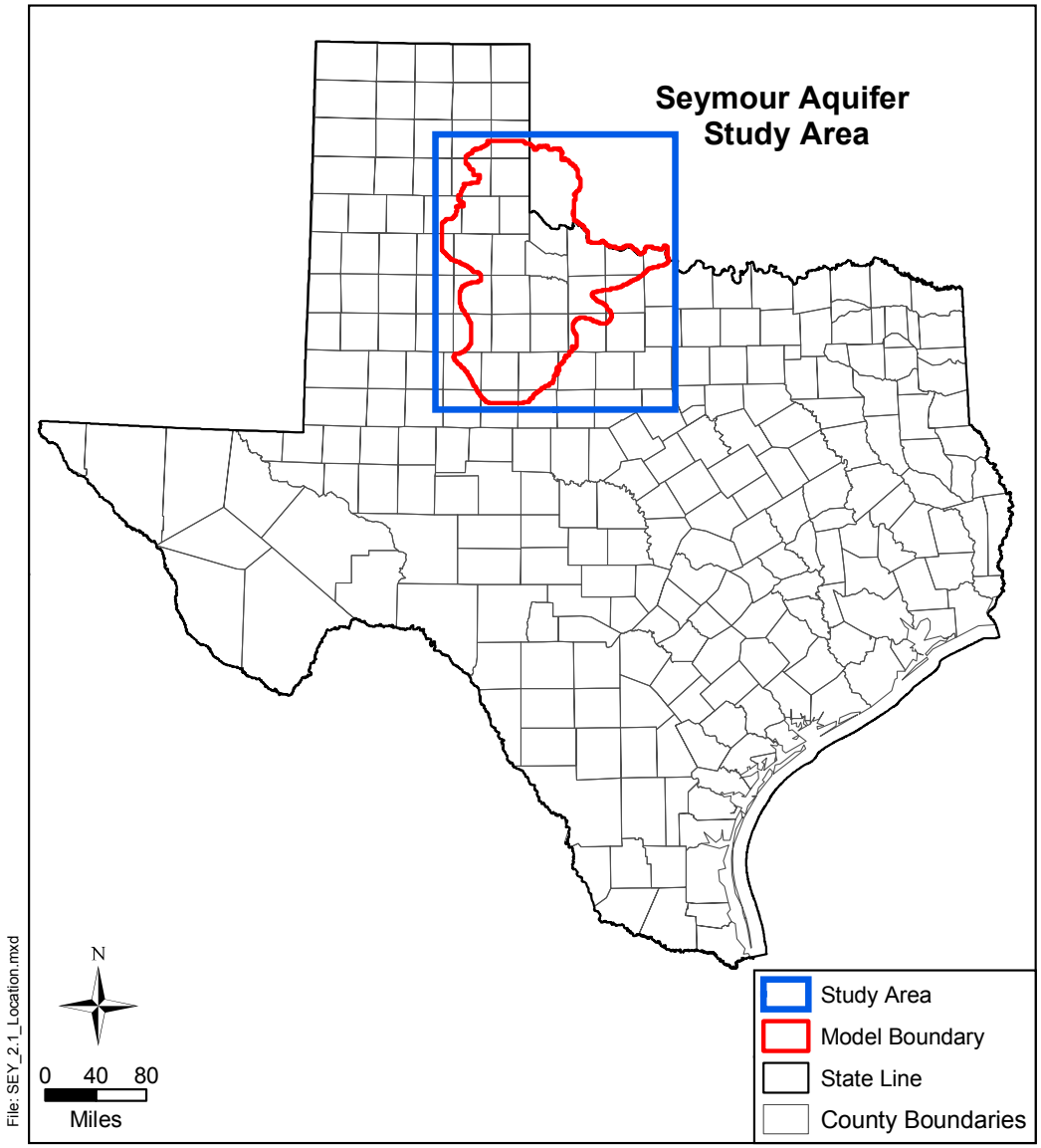

INTERA

WPRC

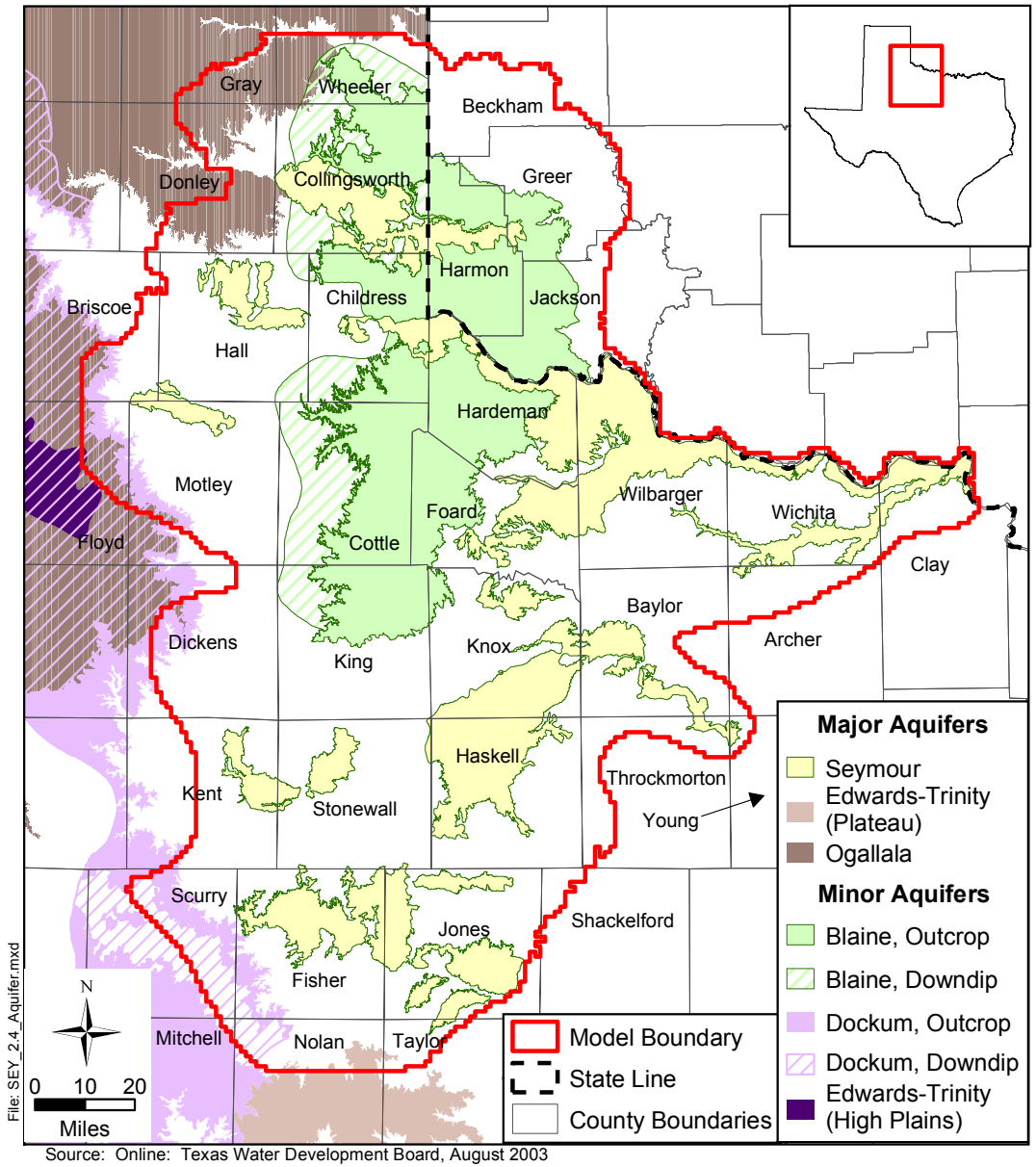
ENPROTEC
Engineering solutions with a view for tomorrow.

PARSONS

# Model Area

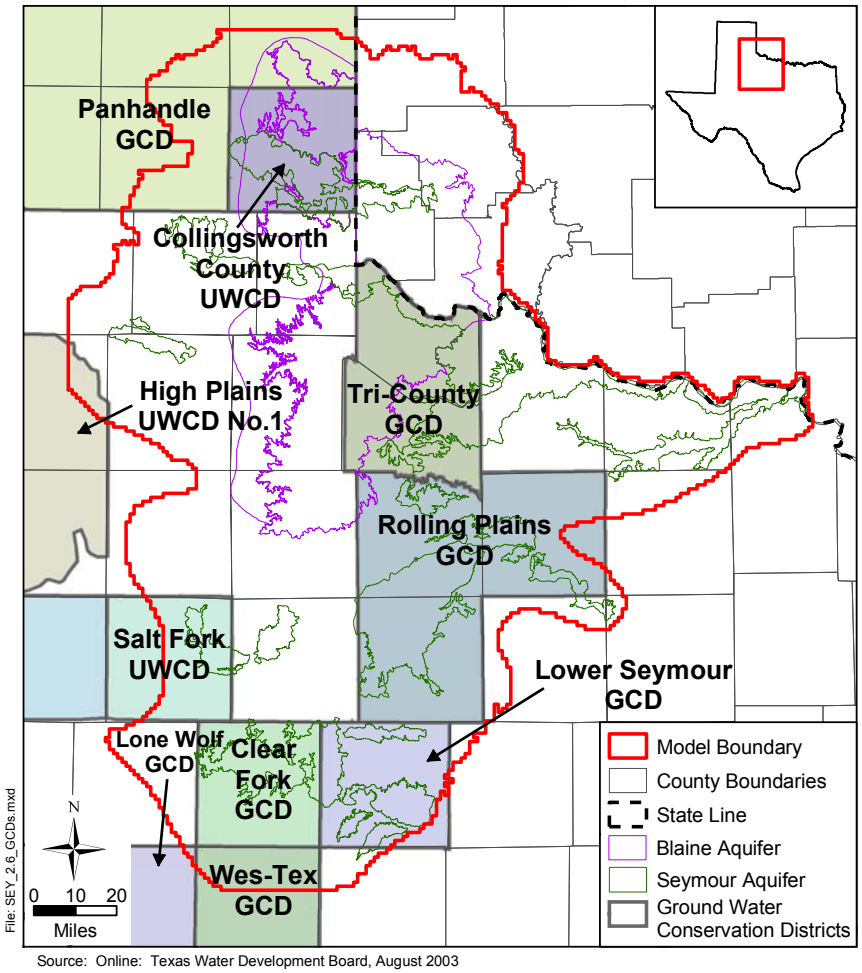

Seymour Aquifer
Study Area
N
0 40 80
Miles
Study Area
Model Boundary
State Line
County Boundaries
File: SEY_2.1_Location.mxd
Source: N/A

# Major and Minor Aquifers

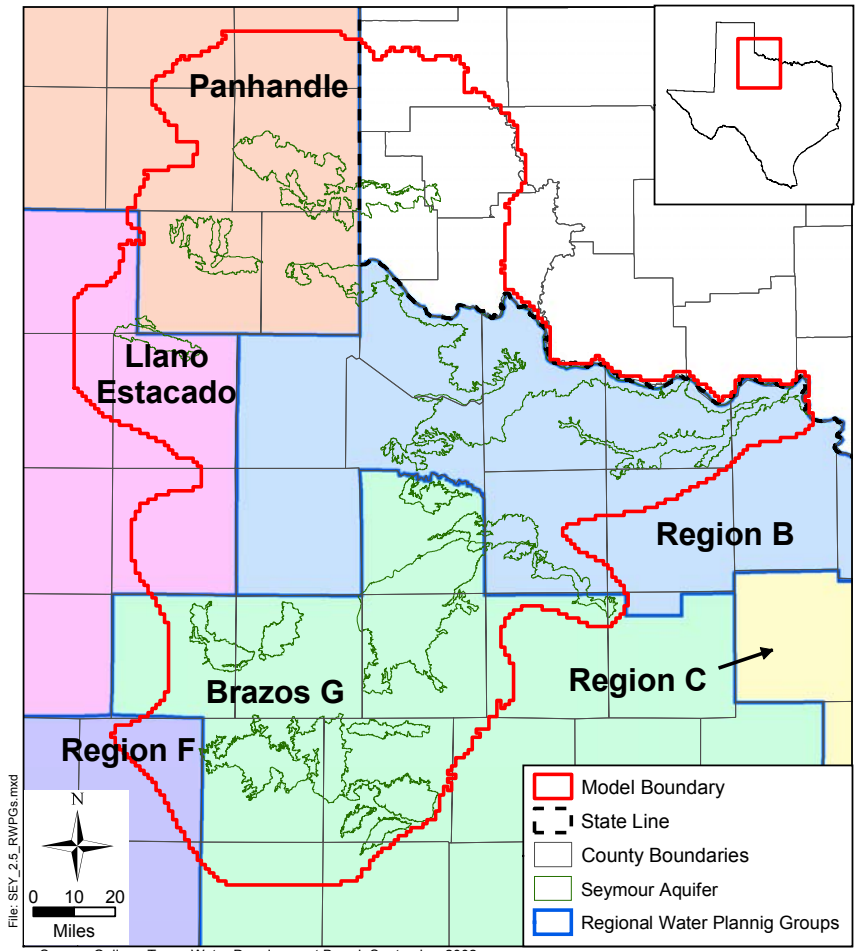



Source: Online: Texas Water Development Board, August 2003

# GCDs, UWCDs, and RWPGs

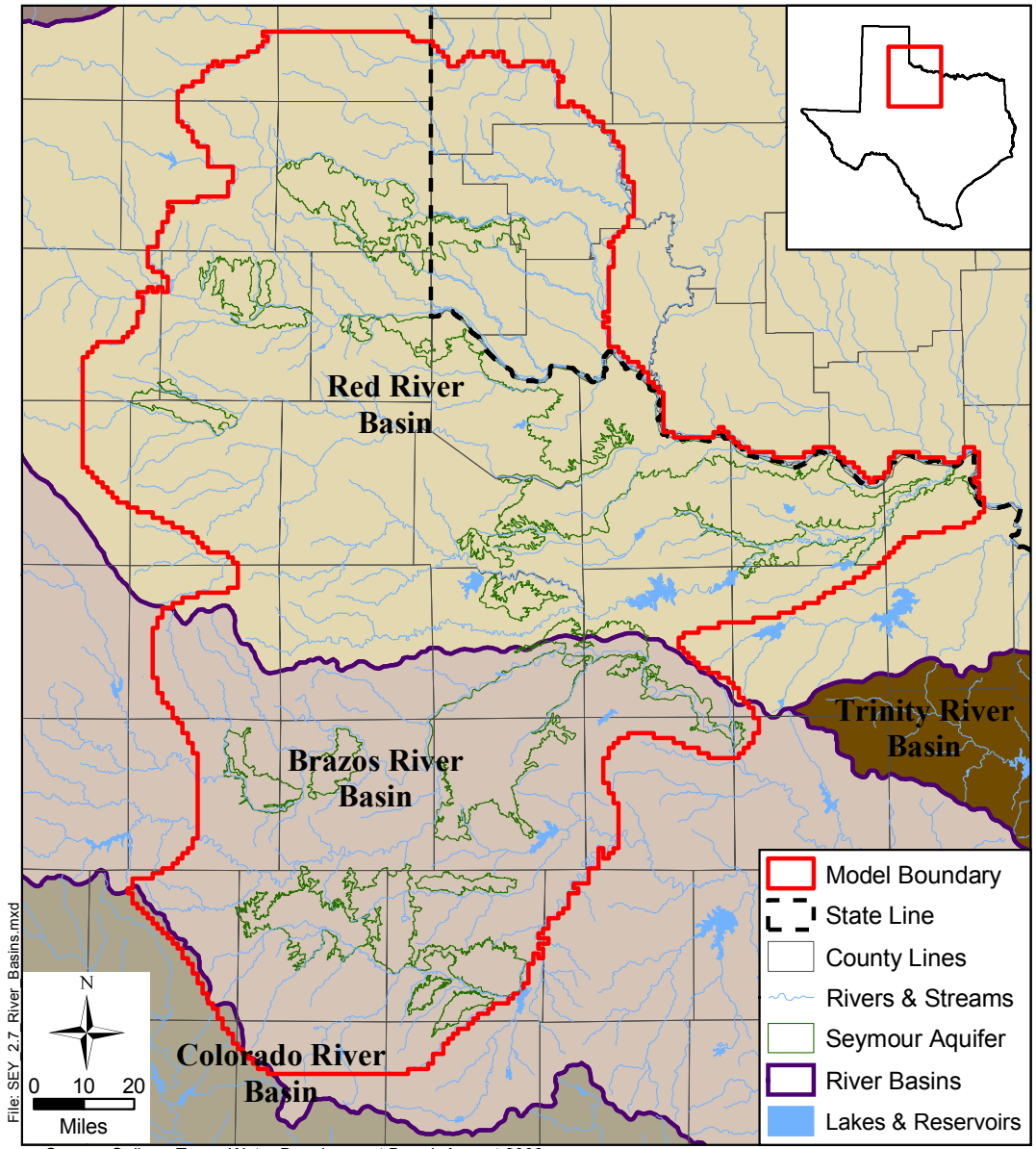



Source: Online: Texas Water Development Board, August 2003




Source: Online: Texas Water Development Board, September 2002

# River Basins




Source: Online: Texas Water Development Board, August 2003

# General Stratigraphy

Seymour/Alluvium
Quartermaster – Ochoa Group
Whitehorse – Artesia Group

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| | |
|---|---|
| | Dog Creek Shale |
| Pease River | Blaine Formation |
| Group | Flowerpot Shale |
| | San Angelo Sandstone |

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| | |
|---|---|
| | Choza Formation |
| Clear Fork Grp | Vale Formation |
| | Arroyo Formation |

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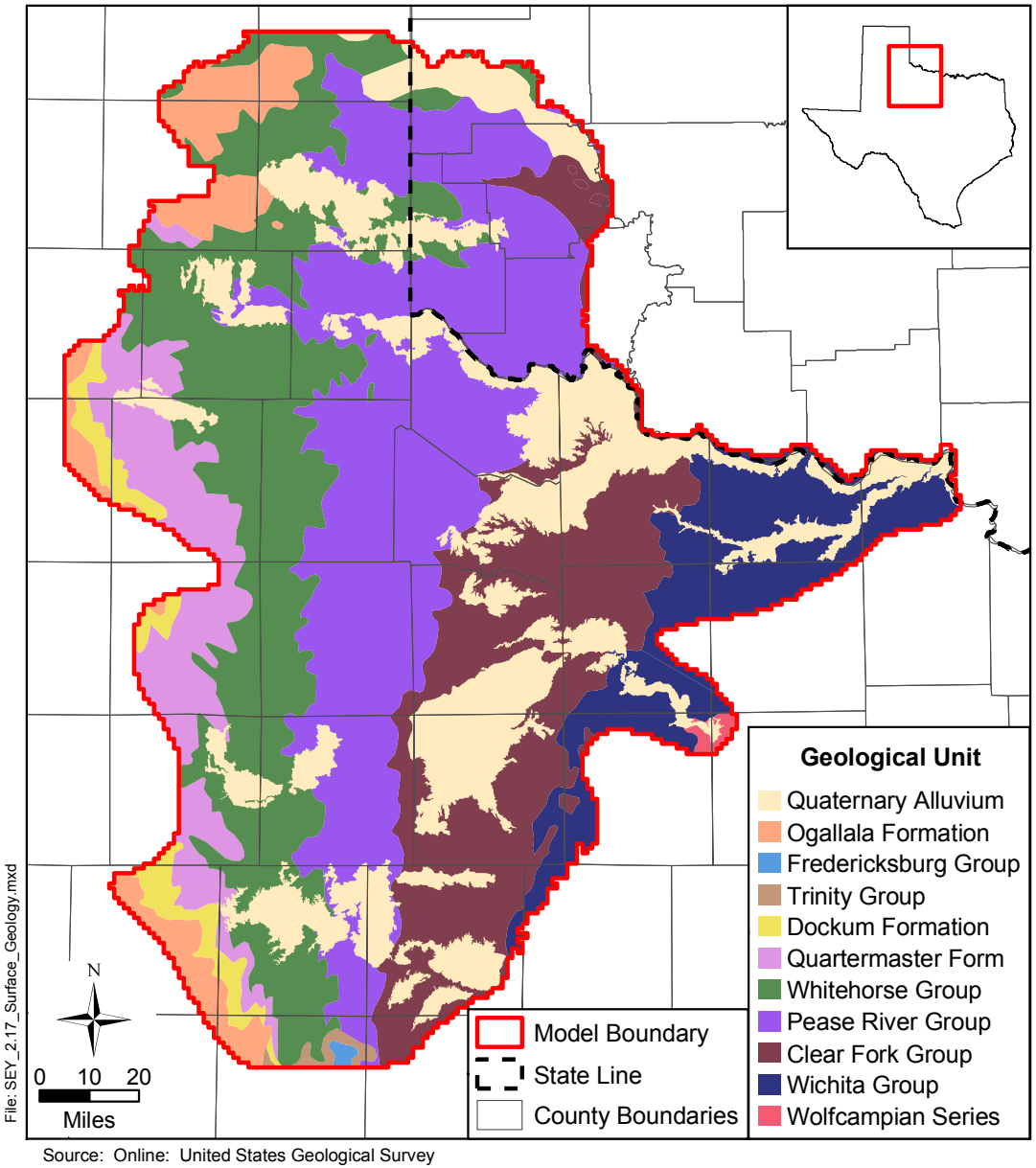
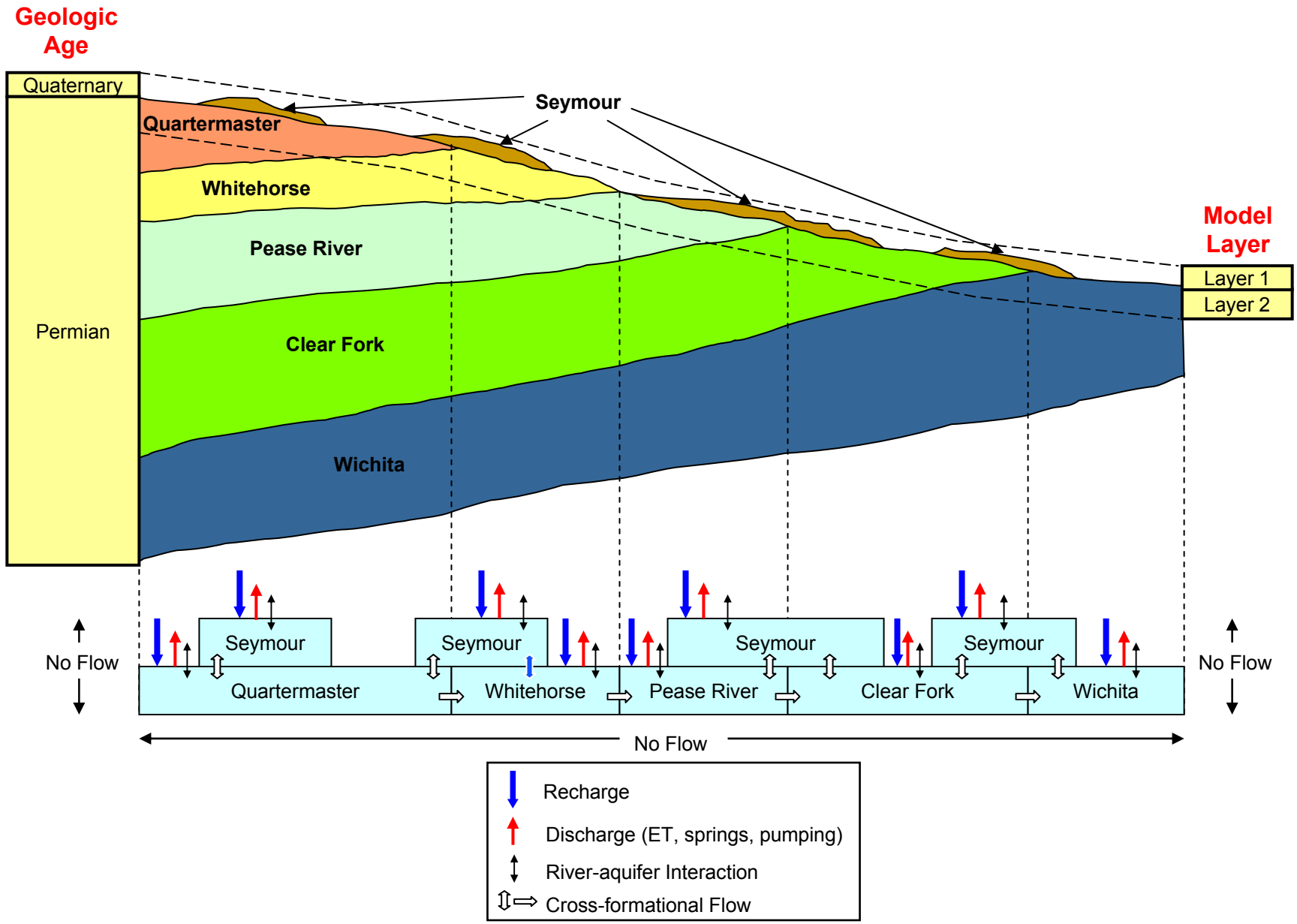
Wichita Group

# Surface Geology

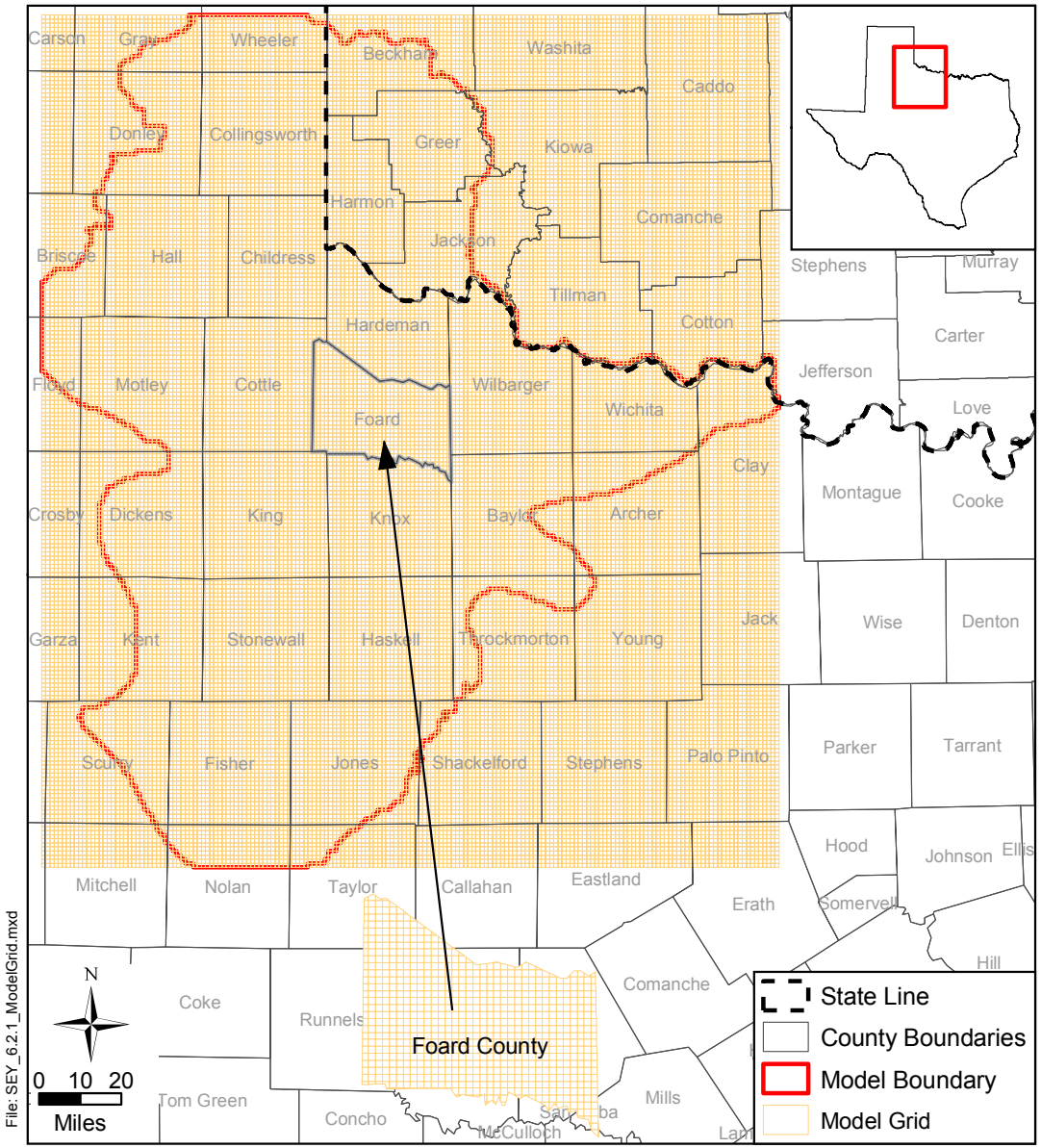



Source: Online: United States Geological Survey

# Model Flow Conceptualization



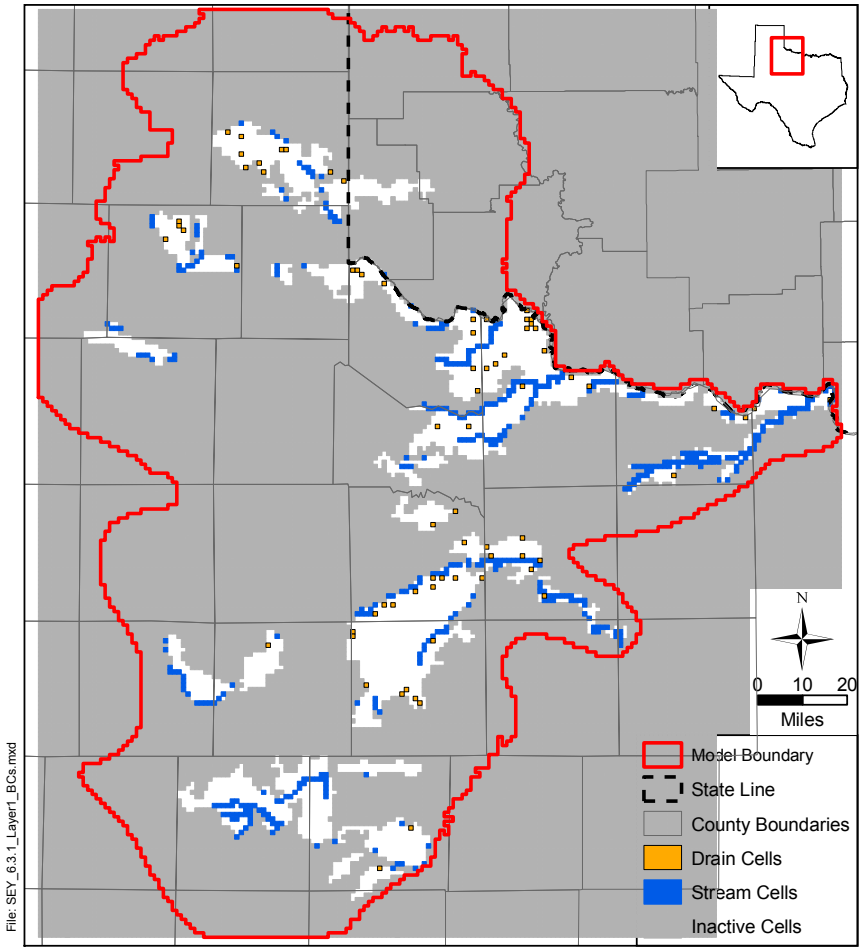
# Model Grid



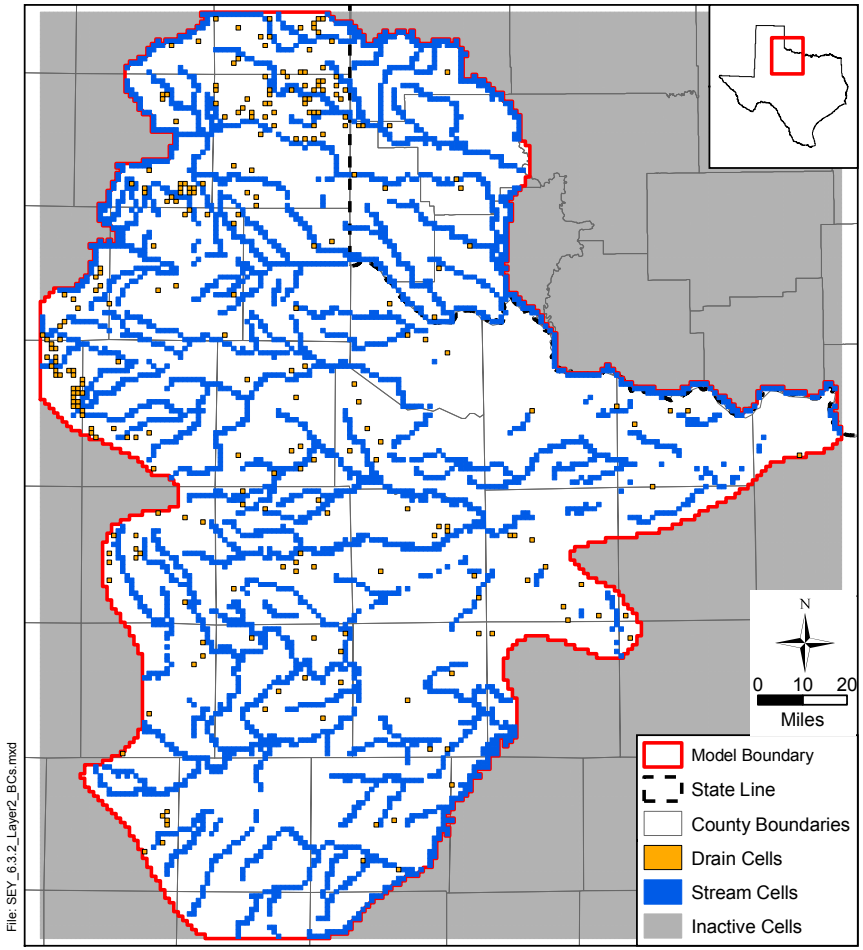

1 square mile grid blocks
180 columns and 208 rows
3,436 active cells in layer 1
20,001 active cells in layer 2

# Boundary Conditions

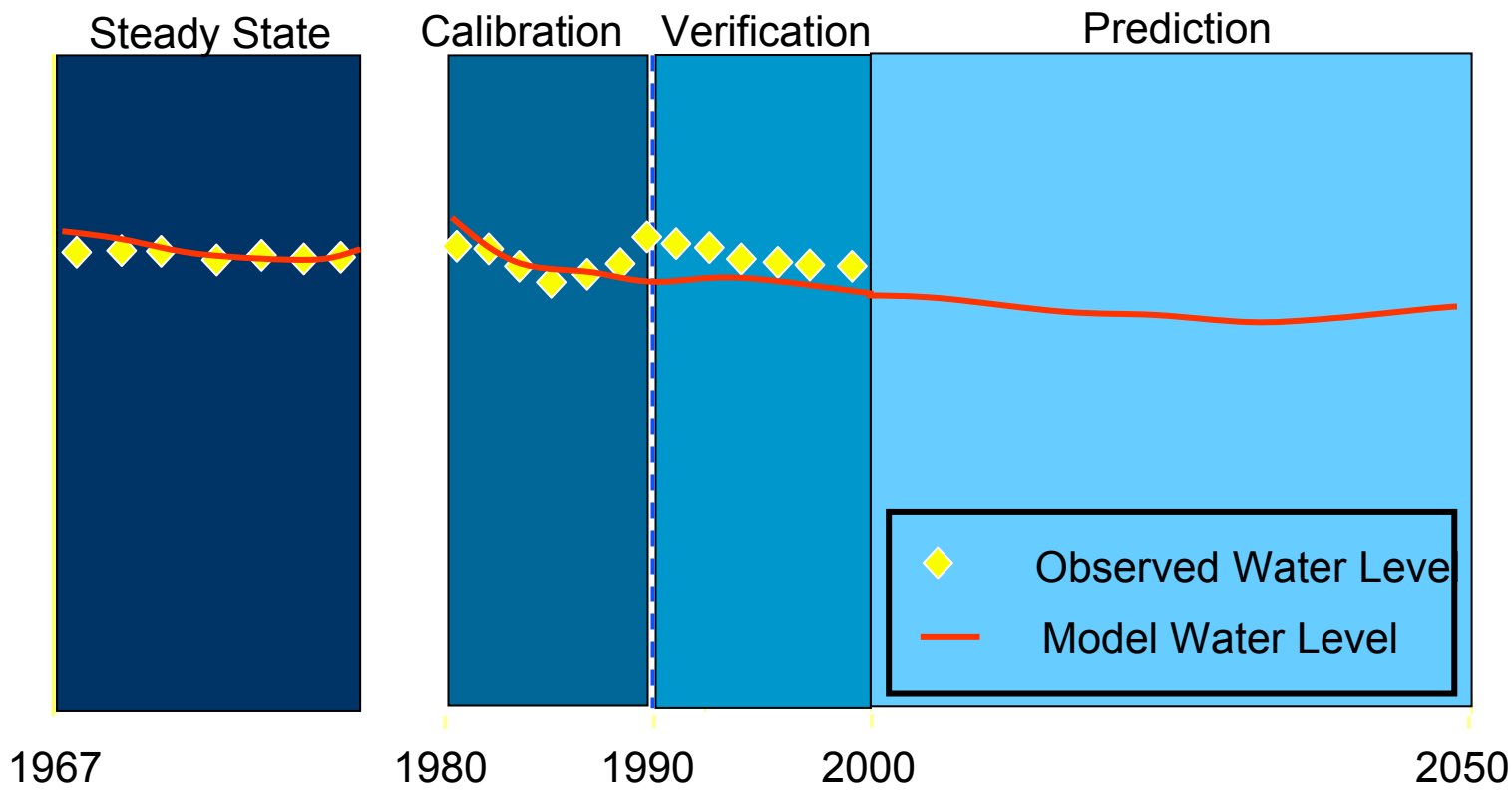
## Layer 1 - Seymour




## Layer 2 - Permian



# Schematic of Modeling Periods

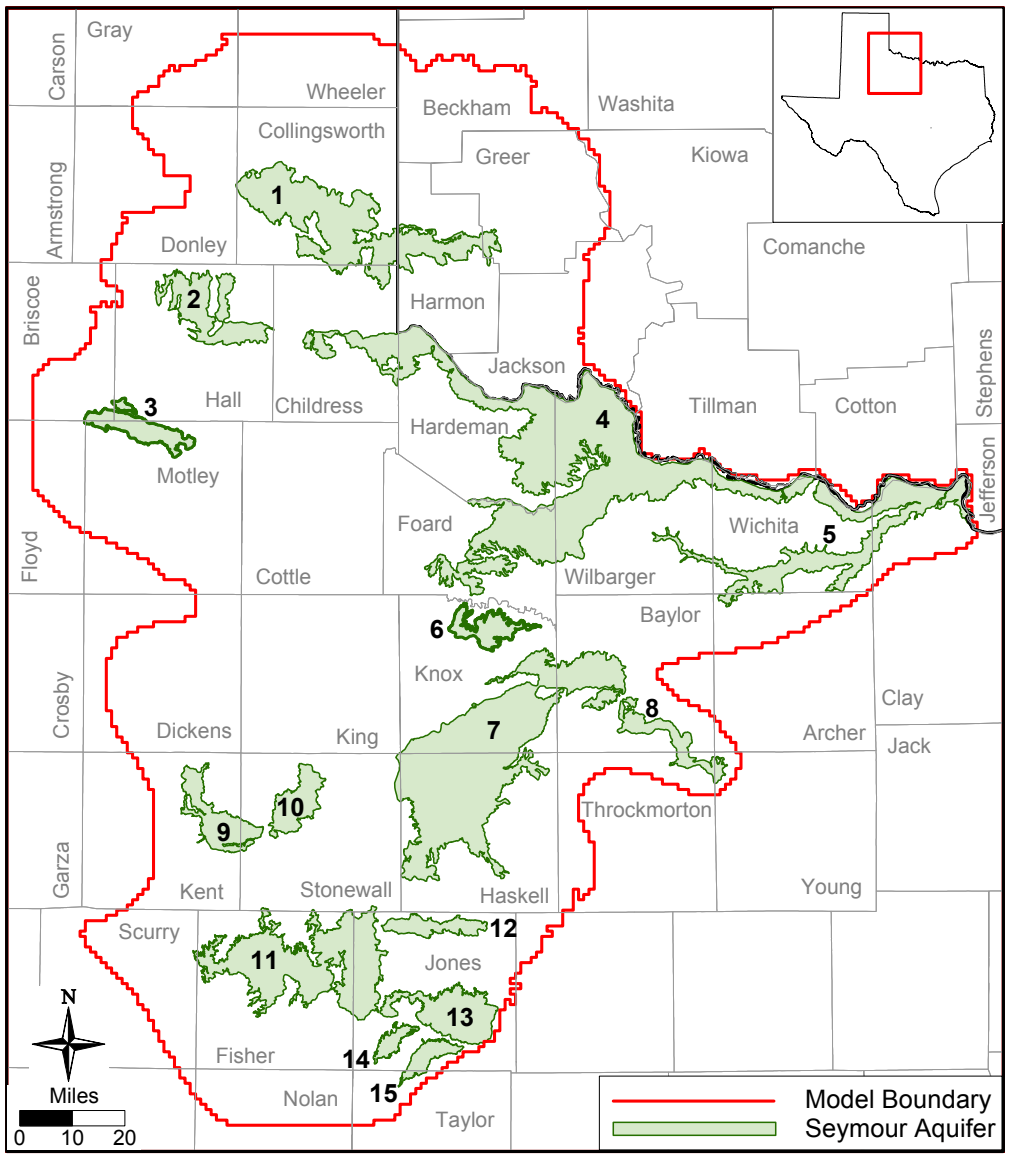


# Model Input – Supporting Data

- Hydrostratigraphic surfaces for each layer
- Hydraulic properties
  - Hydraulic Conductivity
  - Storativity (transient)
- Recharge
- ET
- Stream Flow
- Pumpage

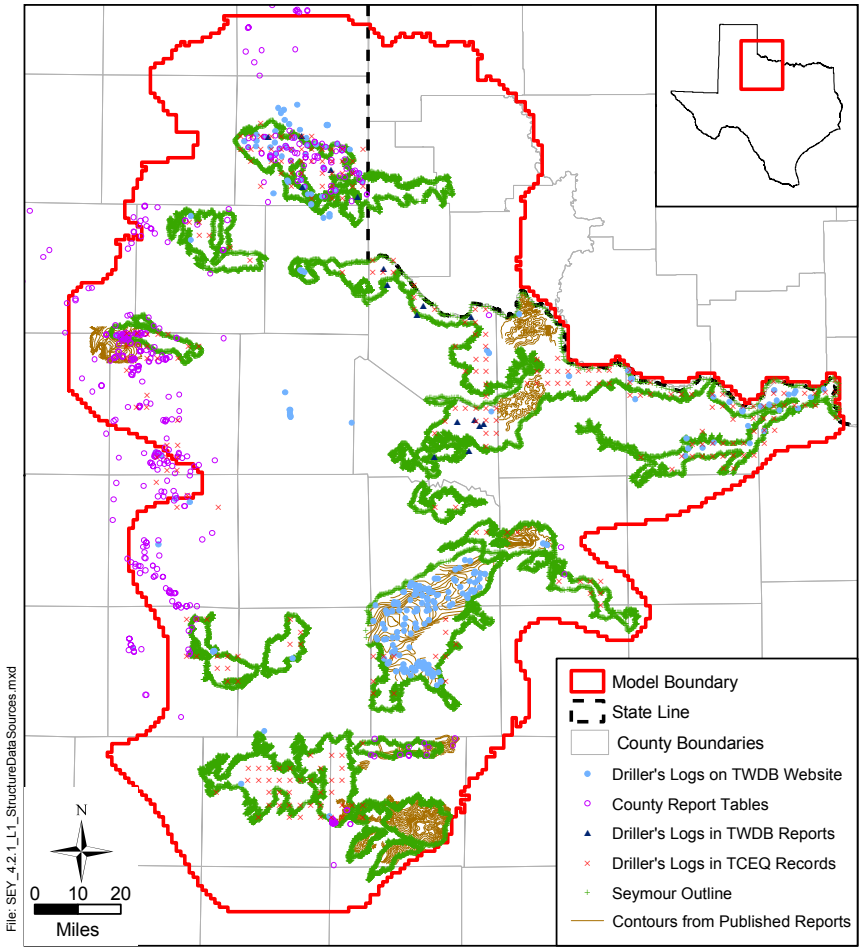
**All model data, source and derived, was delivered to the TWDB and will be available to the public**

# Seymour Pods

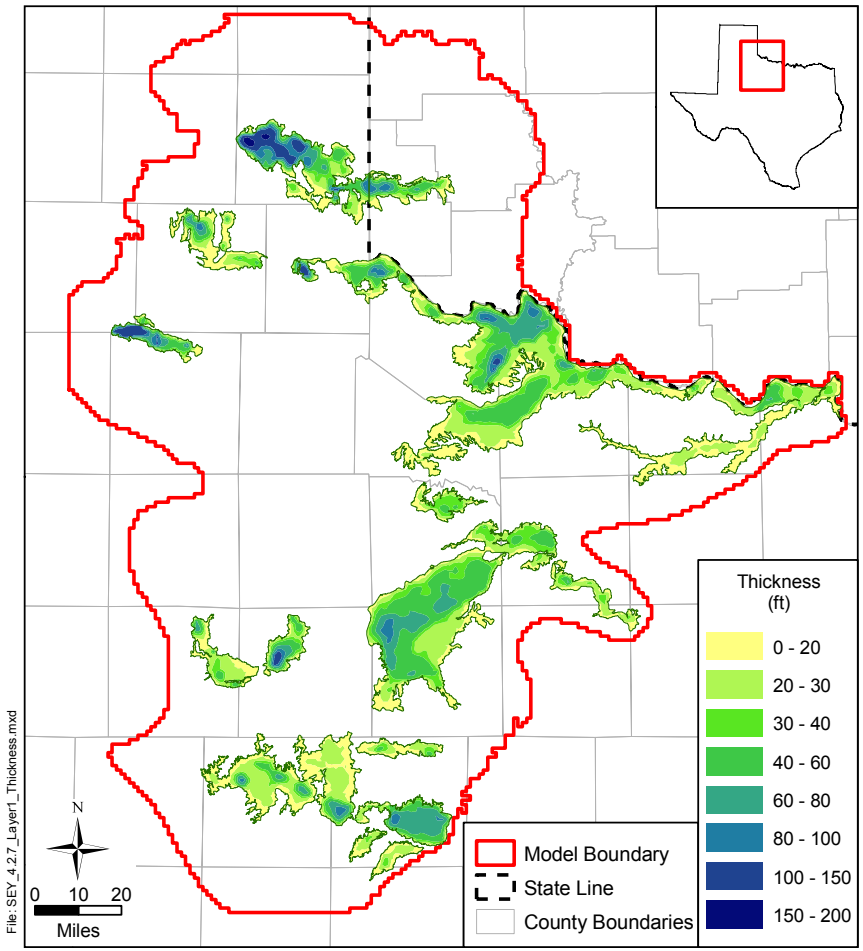


# Structure - Seymour

## Data Sources

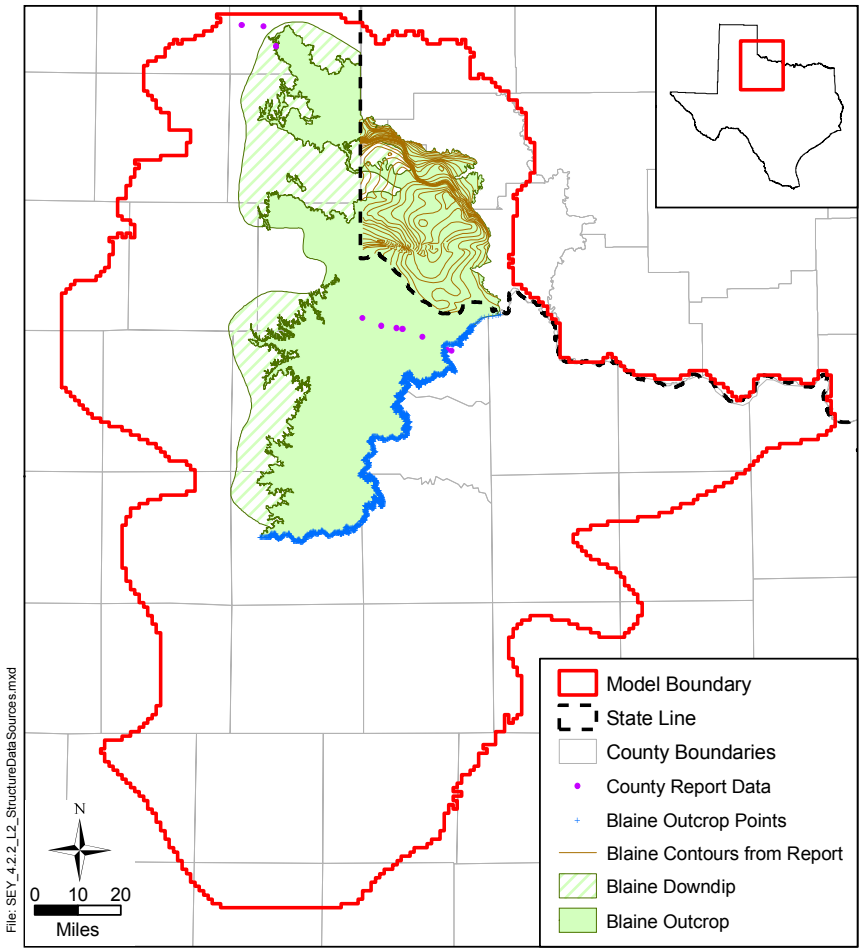



## Thickness Map

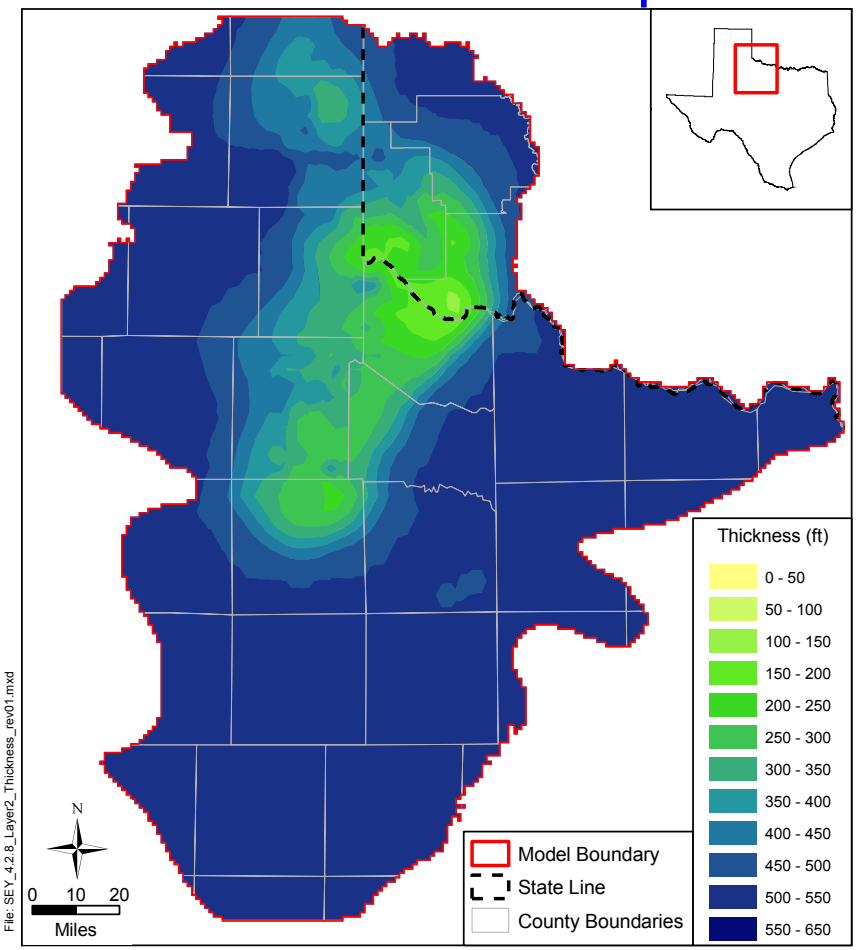


# Structure - Blaine

## Data Sources

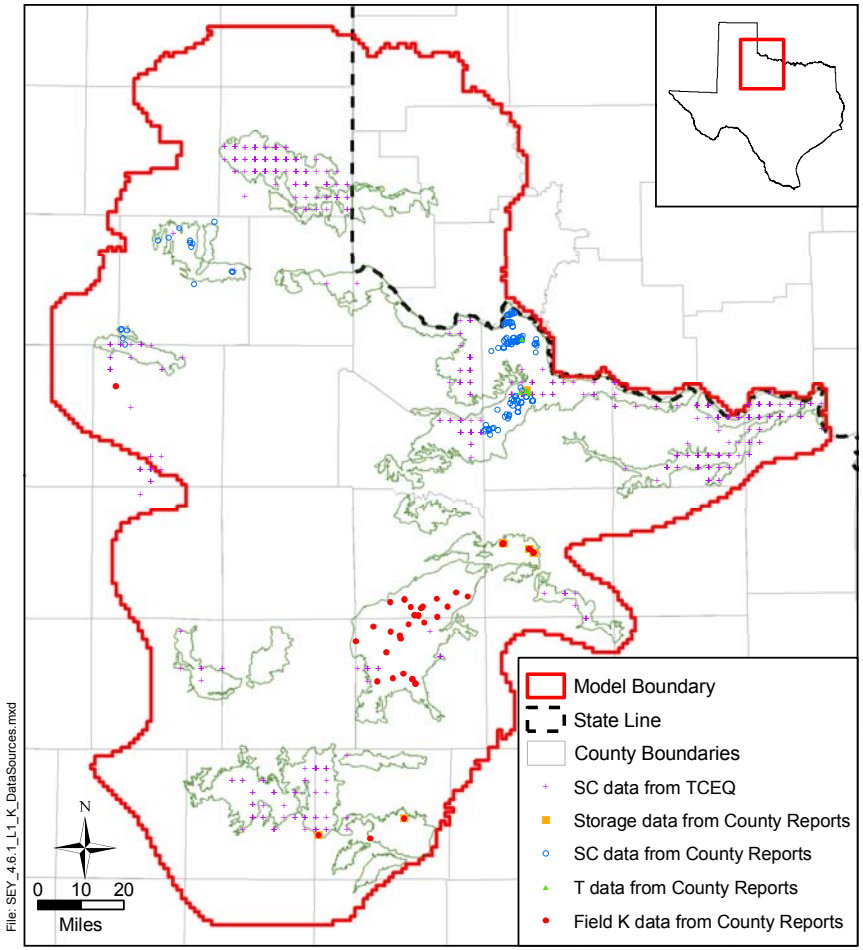



## Thickness Map

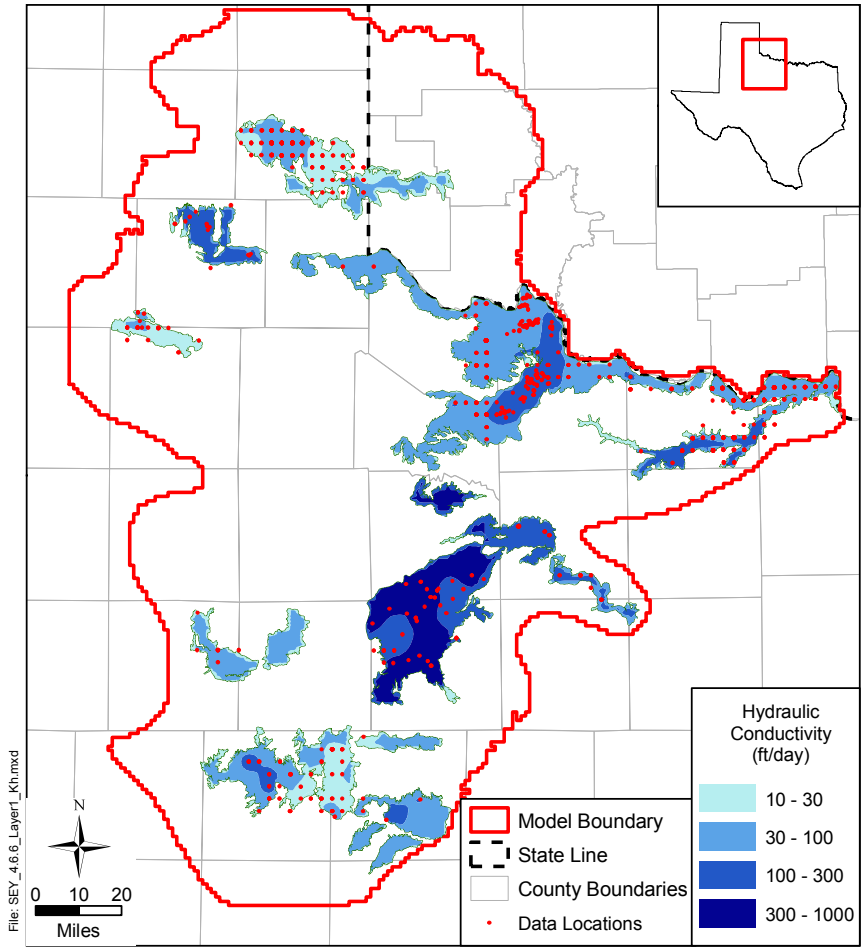


# Hydraulic Conductivity - Seymour

## Data Sources



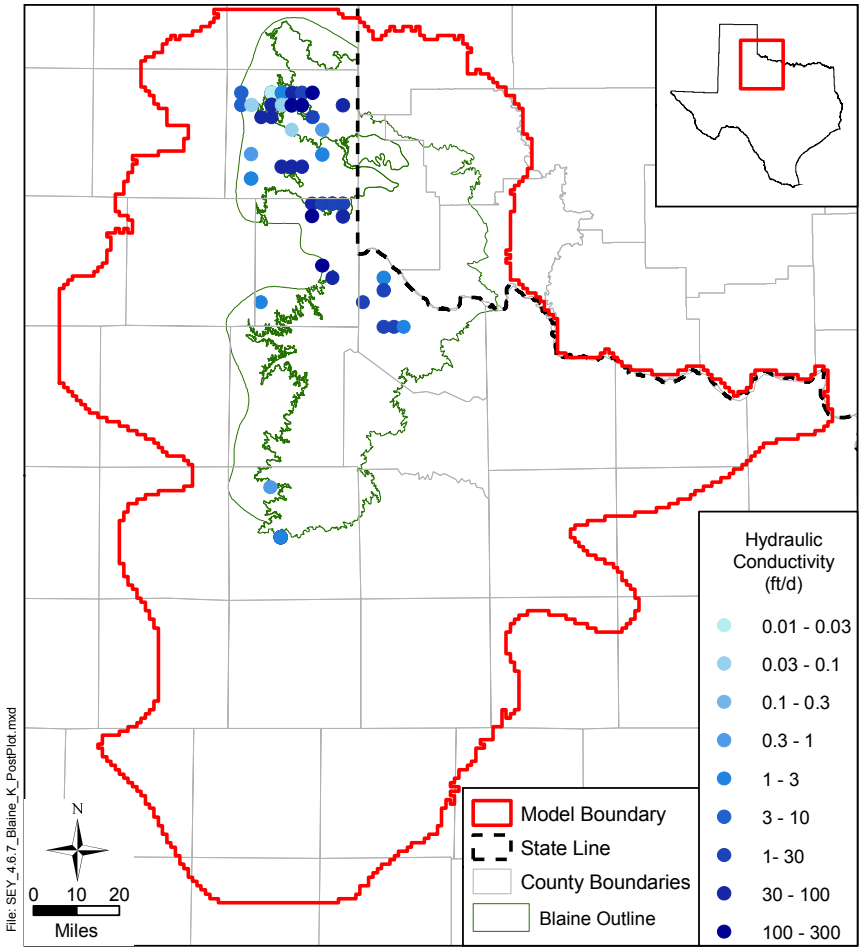

## Hydraulic Conductivity Values



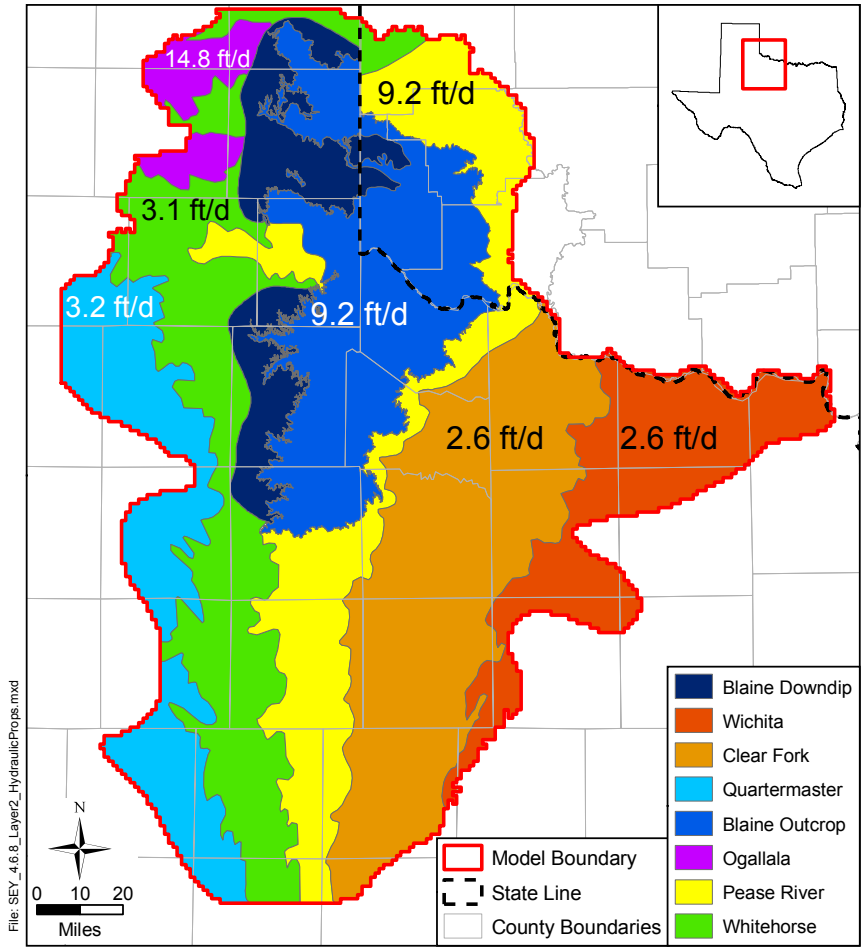

Source:

# Hydraulic Conductivity - Permian

## Blaine Data Sources & Values




## Hydraulic Conductivity Values

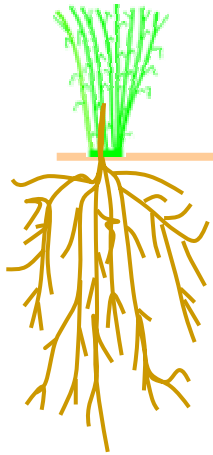



Source:

# Recharge Estimates

| County/Area | Aquifer | Recharge (in/yr) | Reference | Technique |
|---|---|---|---|---|
| Haskell and Knox Counties | Seymour | 2.2 | R.W. Harden & Associates (1978) | Water budget |
| Hardeman County | Seymour | 1.0 | Maderak (1972) | Darcy's Law |
| Baylor County | Seymour | 2.6 | Preston (1978) | Baseflow discharge |
| Jones County | Seymour | 1.8 | Price (1978) | Baseflow discharge |
| Wilbarger County | Seymour | 2.5 | Willis and Knowles (1953) | Baseflow discharge |
| Haskell County | Seymour | 0.20 to 1.18 | Scanlon et al. (2003) | Field study |
| Fisher/Jones counites | Seymour | 0.28 | Scanlon et al. (2003) | Unsaturated flow modeling |
| Greer and Jackson counties, OK | Blaine | 1.1 to 1.5* | Muller and Price (1979) | Water budget |
| Greer, Harmon, Jackson counties, OK and Childress, Collingsworth, Hardeman counties, TX | Blaine | 1.5 | Runkle and McLean (1995) | Numerical model calibration parameter |

# 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

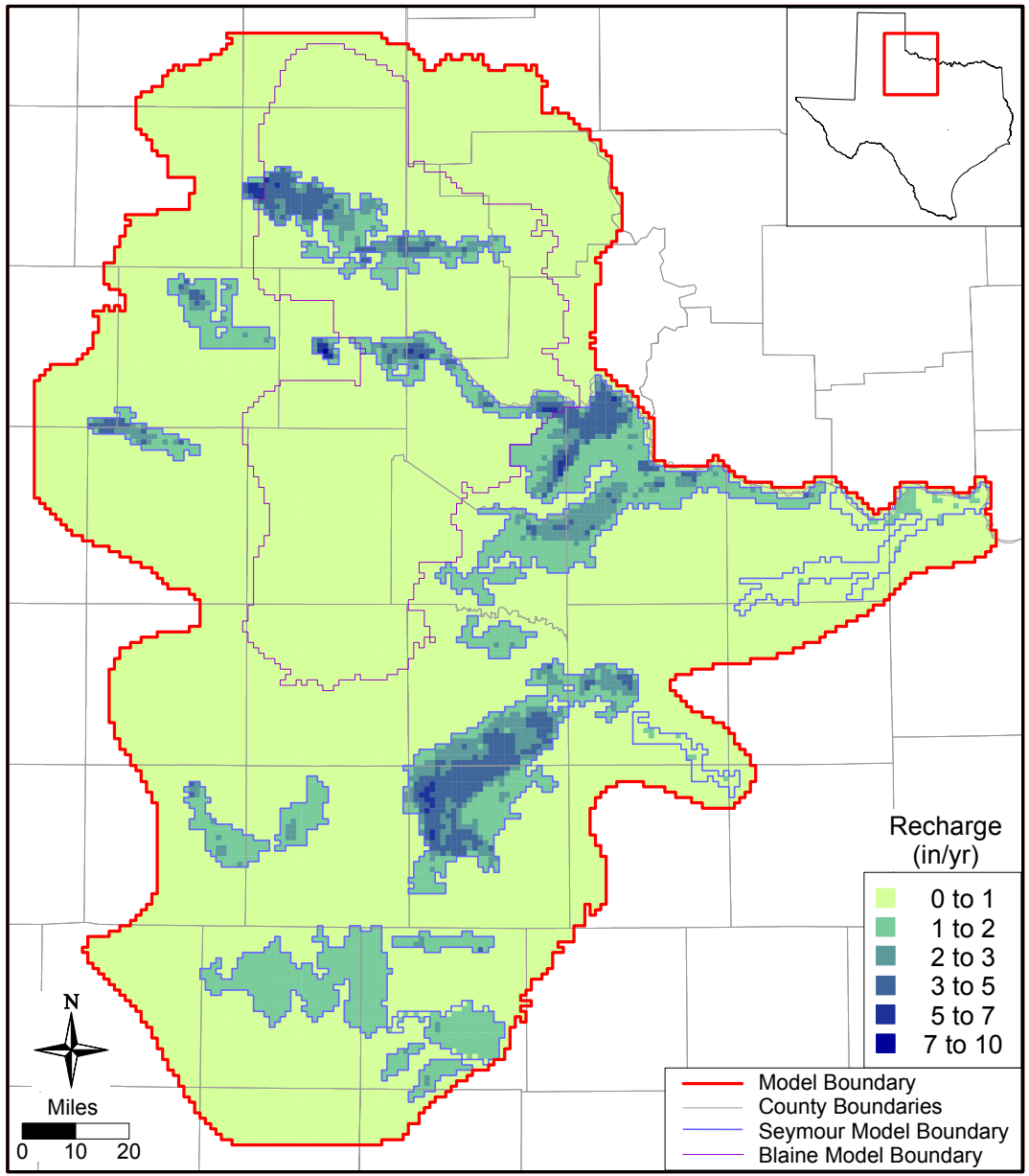
Recharge Package

ET Package

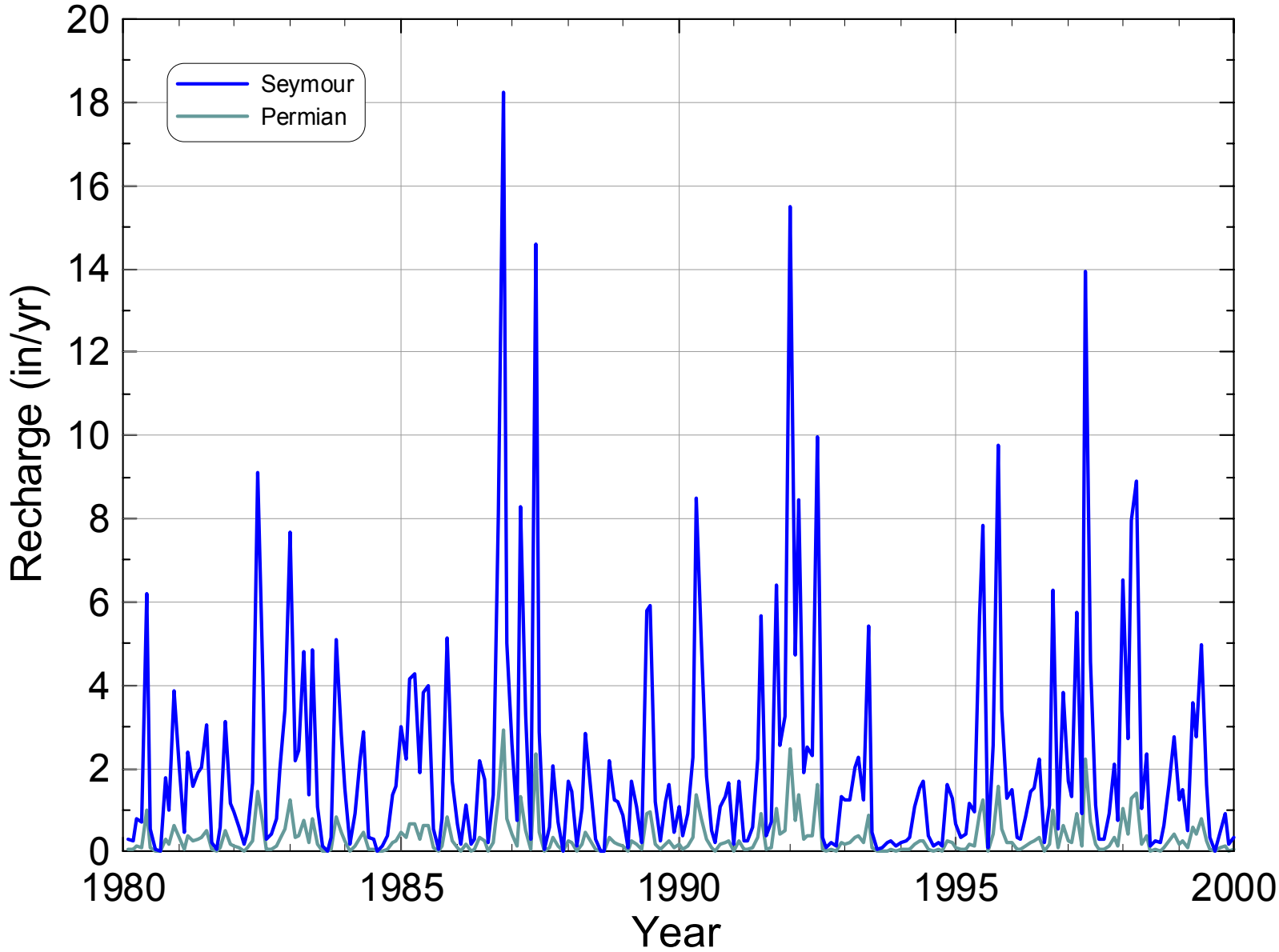
**MODFLOW**

Run on a monthly stress period

# Calibrated Average Recharge

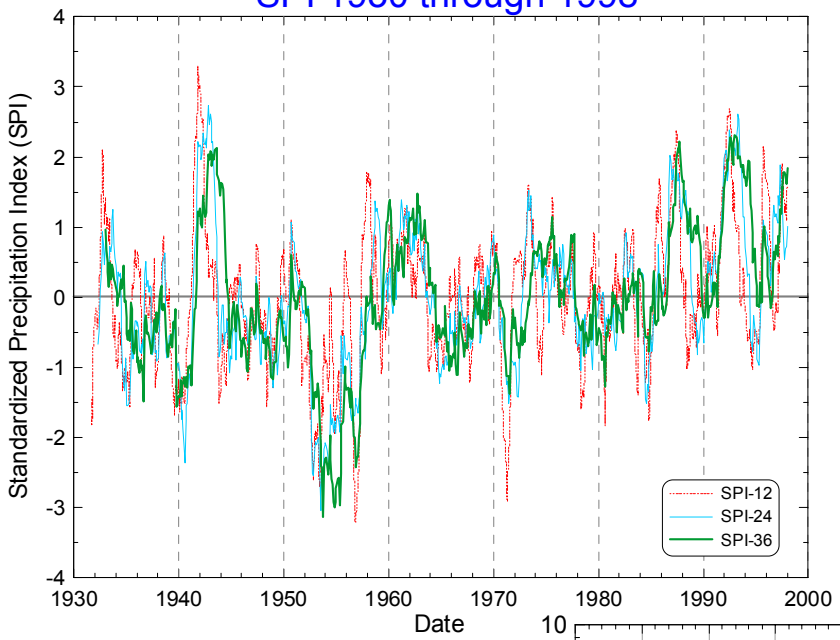


# Temporal Distribution of Average Recharge

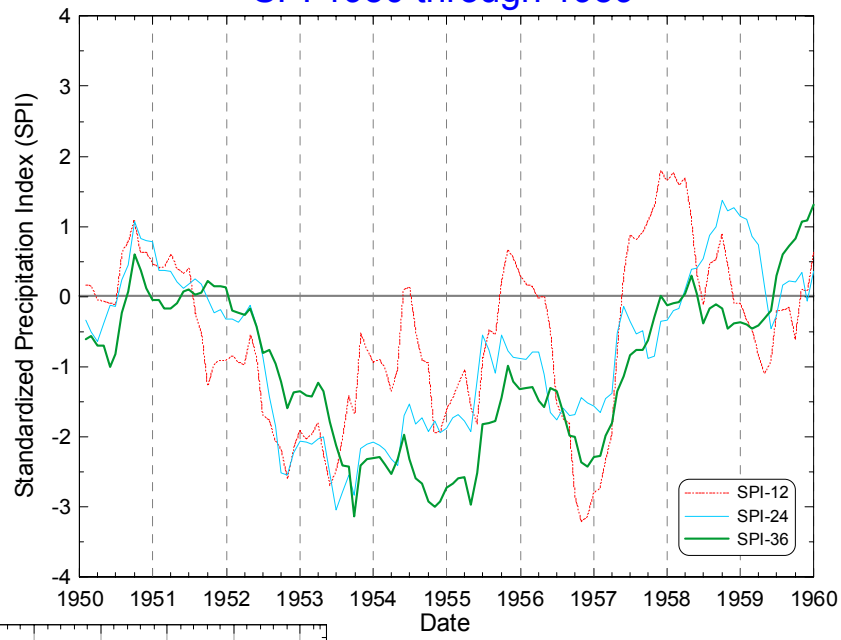


# Drought Indices

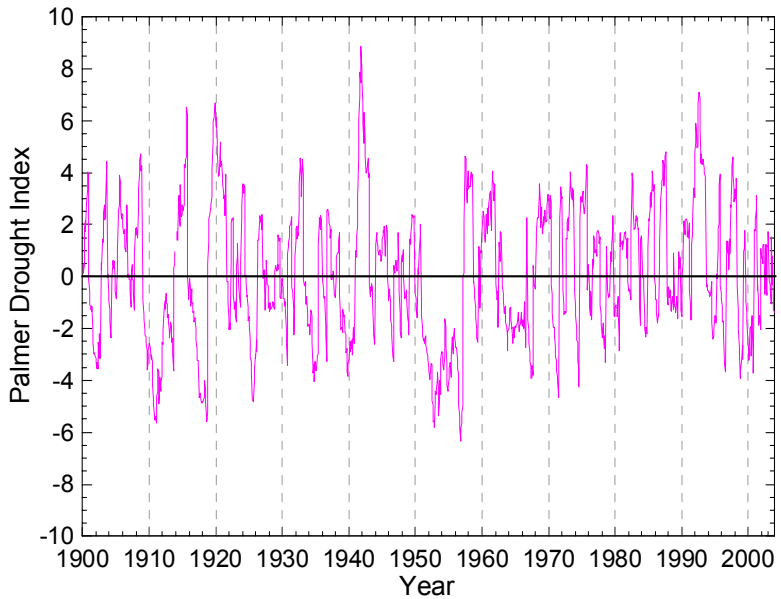
SPI 1930 through 1998



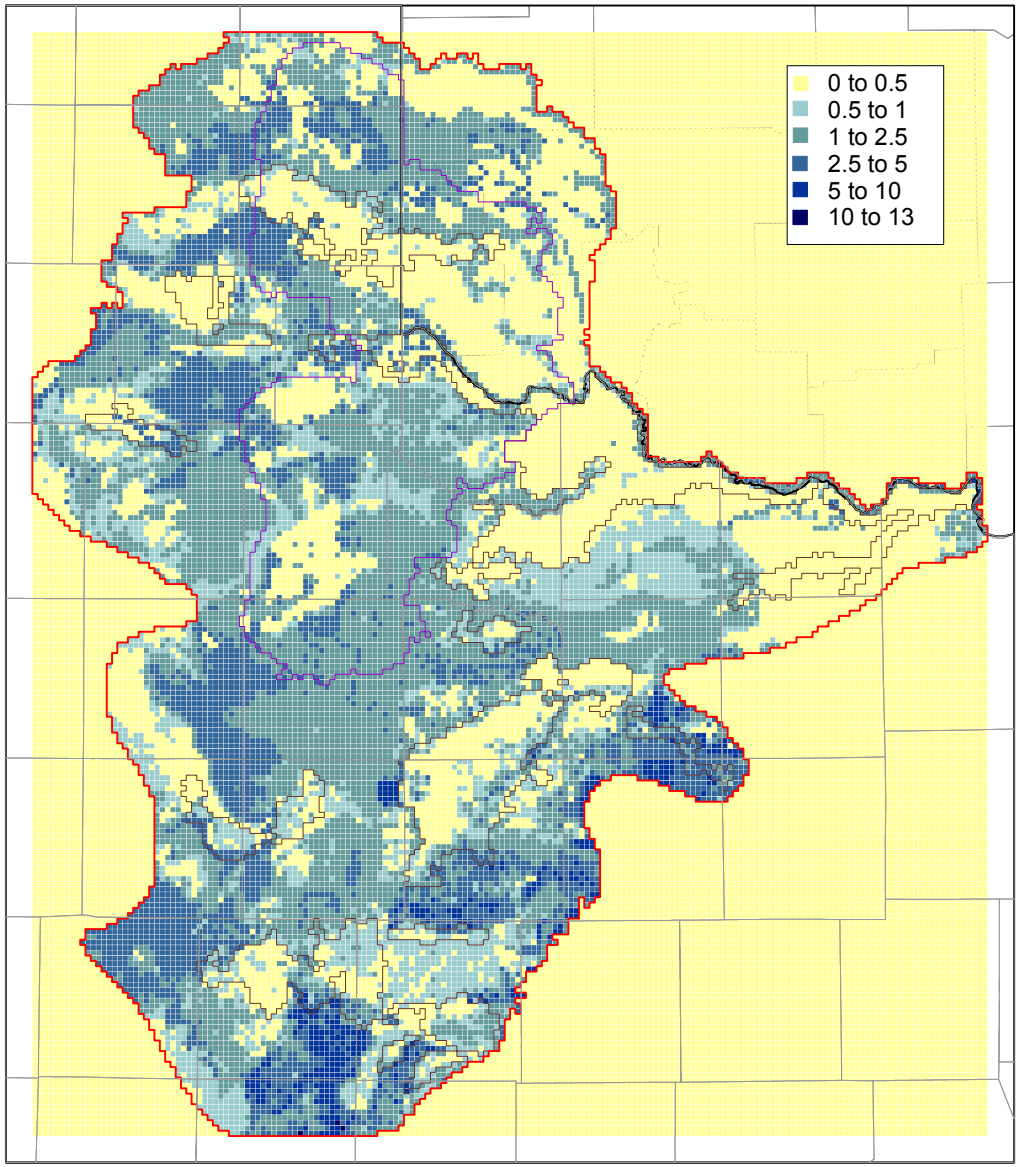

SPI 1950 through 1959



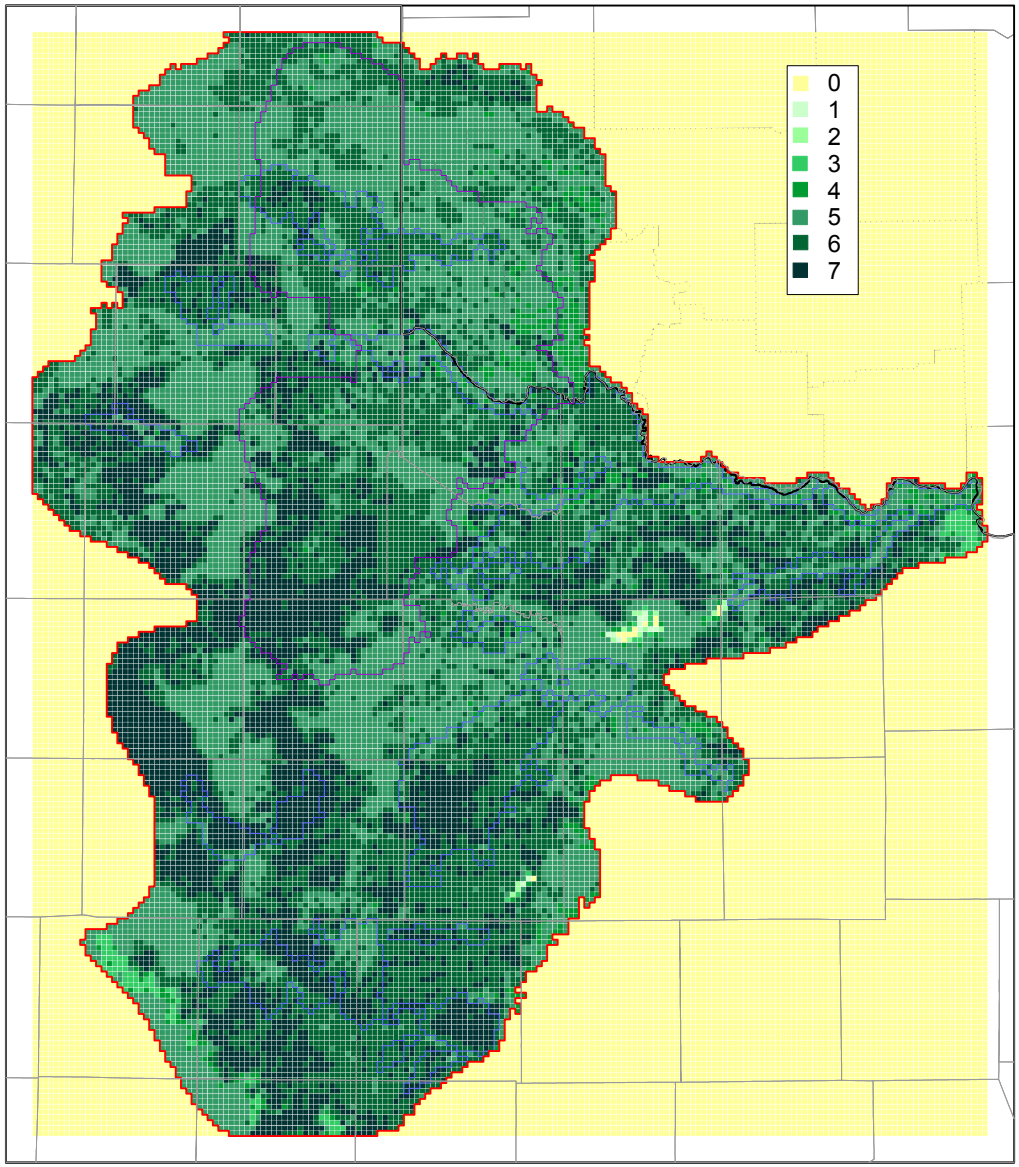

Palmer Drought Index
1900 through 2003



# ET Max (in/yr) Estimated by SWAT



# ET Extinction Depth (ft) Estimated by SWAT



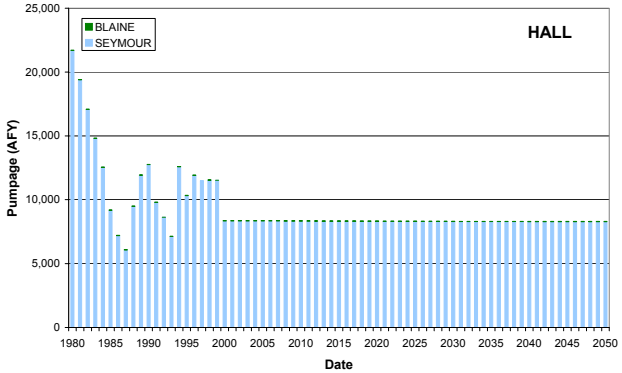
# Aquifer Discharge Through Pumping

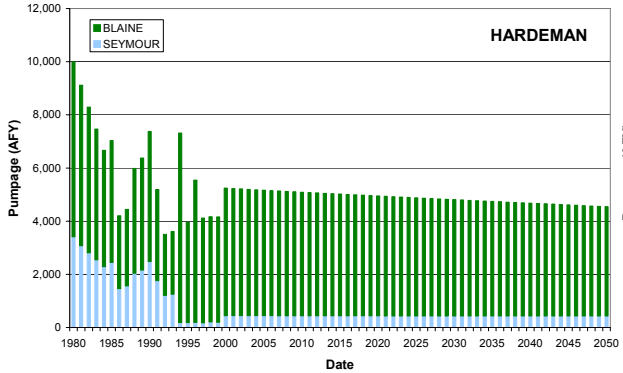
- Point Source Data
  - Municipal, power, mining, manufacturing
- Non-Point Source Data
  - Irrigation, livestock, county-other (domestic)
- Steady State (approx. 1967-1970)
  - Literature sources or assumed to be the same as 1980 historical pumpage
- Historical (1980-1997)
  - TWDB water use survey database
- Predictive (2000-2050)
  - TWDB estimates based on projected water demand reported by RWPGs

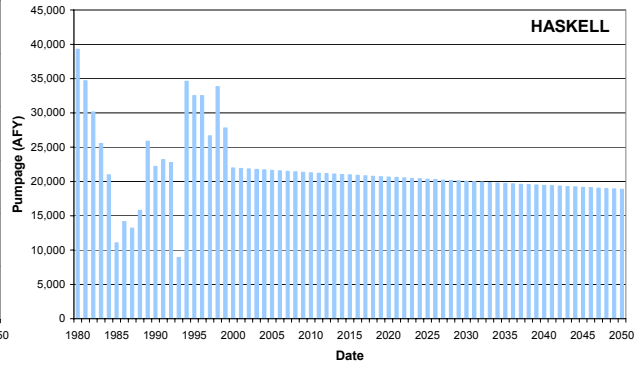
# Uses of Water (%) – 1980-1999 Average

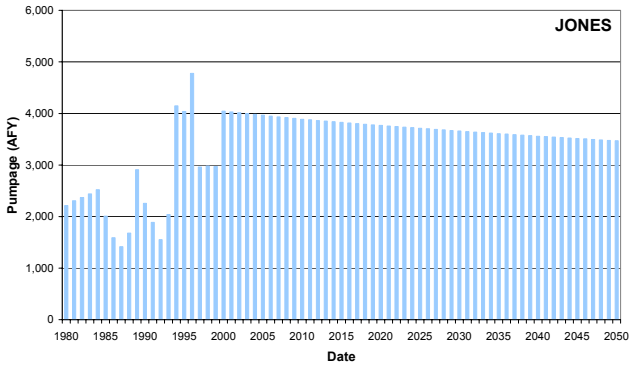
| Water Use Category | Seymour | Blaine |
|---|---|---|
| Irrigation | 93 % | 95 % |
| Municipal | 5 % | 0 |
| Manufacturing | 0 | 0 |
| Mining | 0 | 0 |
| Power | 0 | 0 |
| Livestock | 0.4 % | 1 % |
| Rural Domestic | 1.6 % | 4 % |

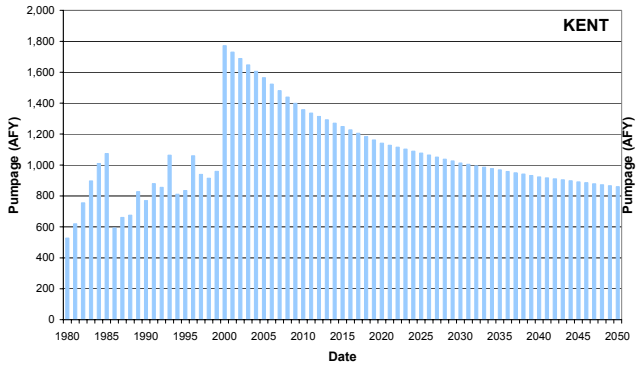
# Yearly Pumpage from 1980 - 2050

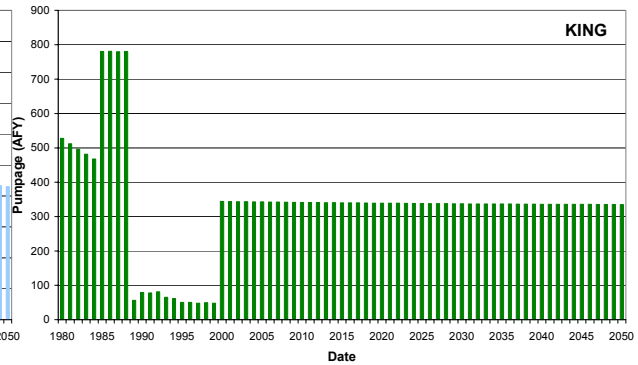


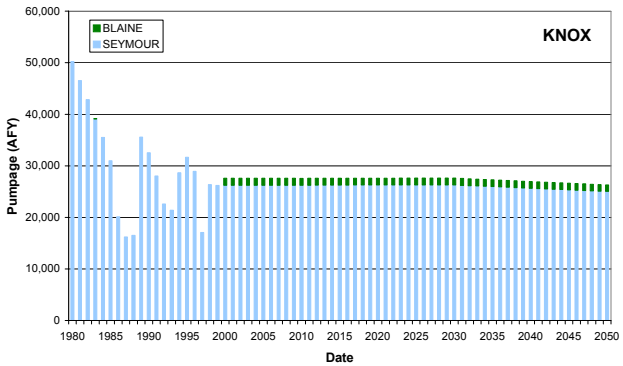



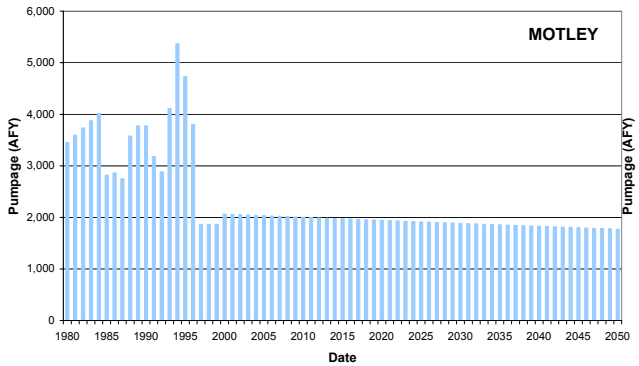



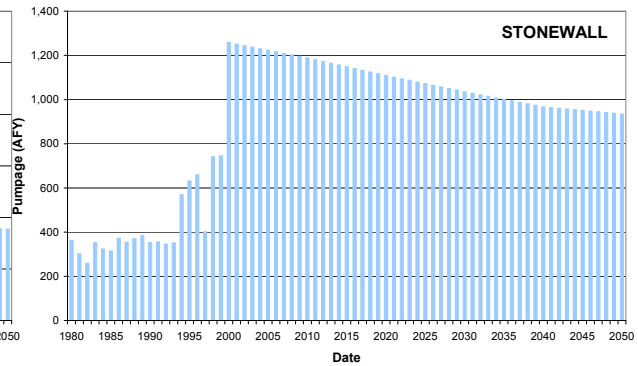



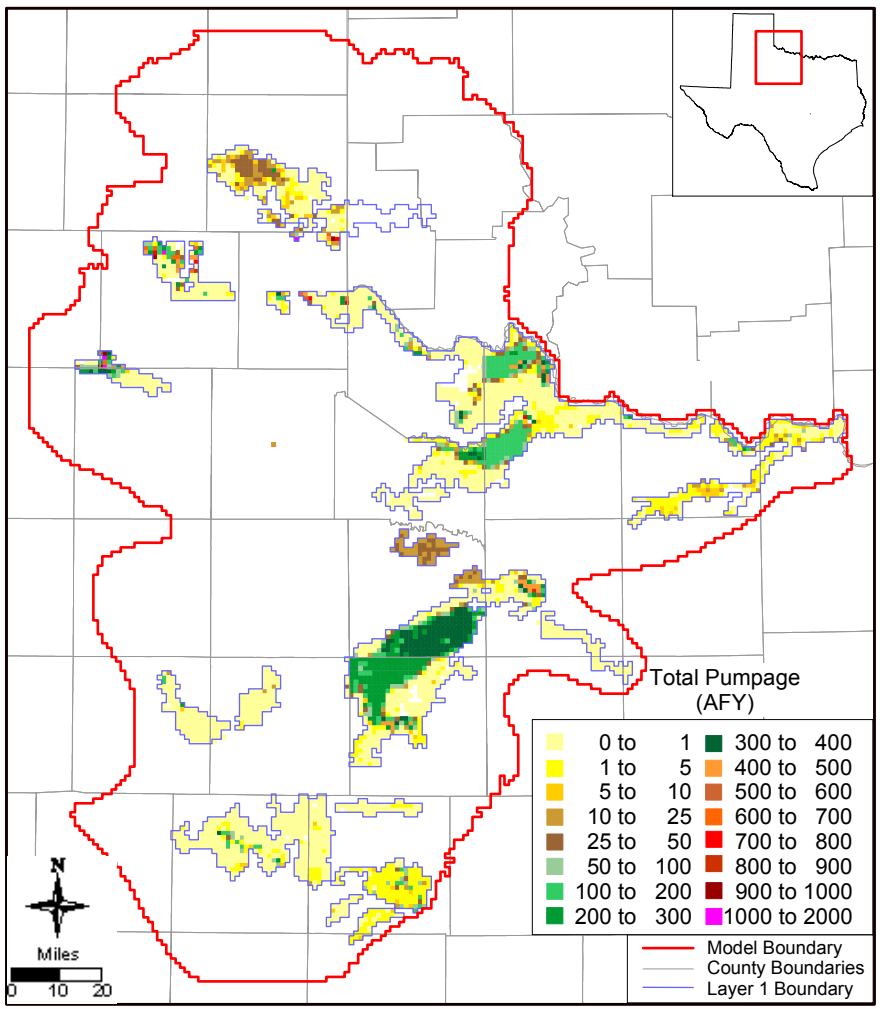



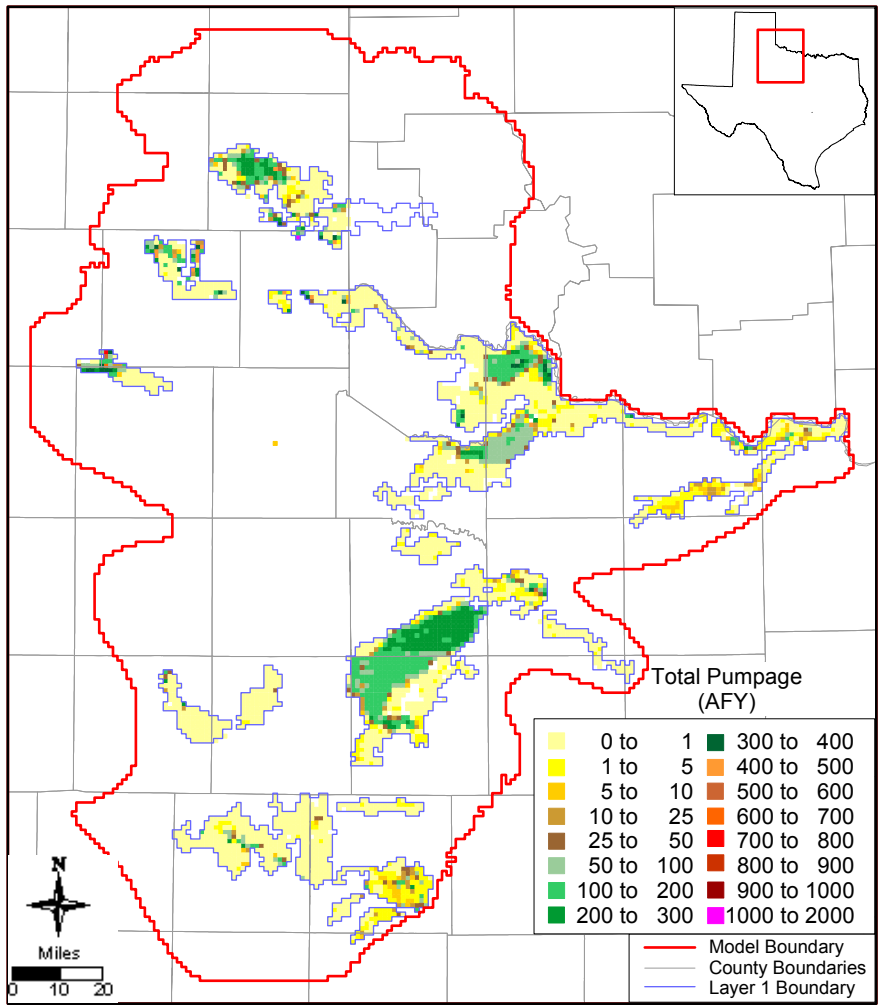



# Pumpage (AFY) – Layer 1

## 1980

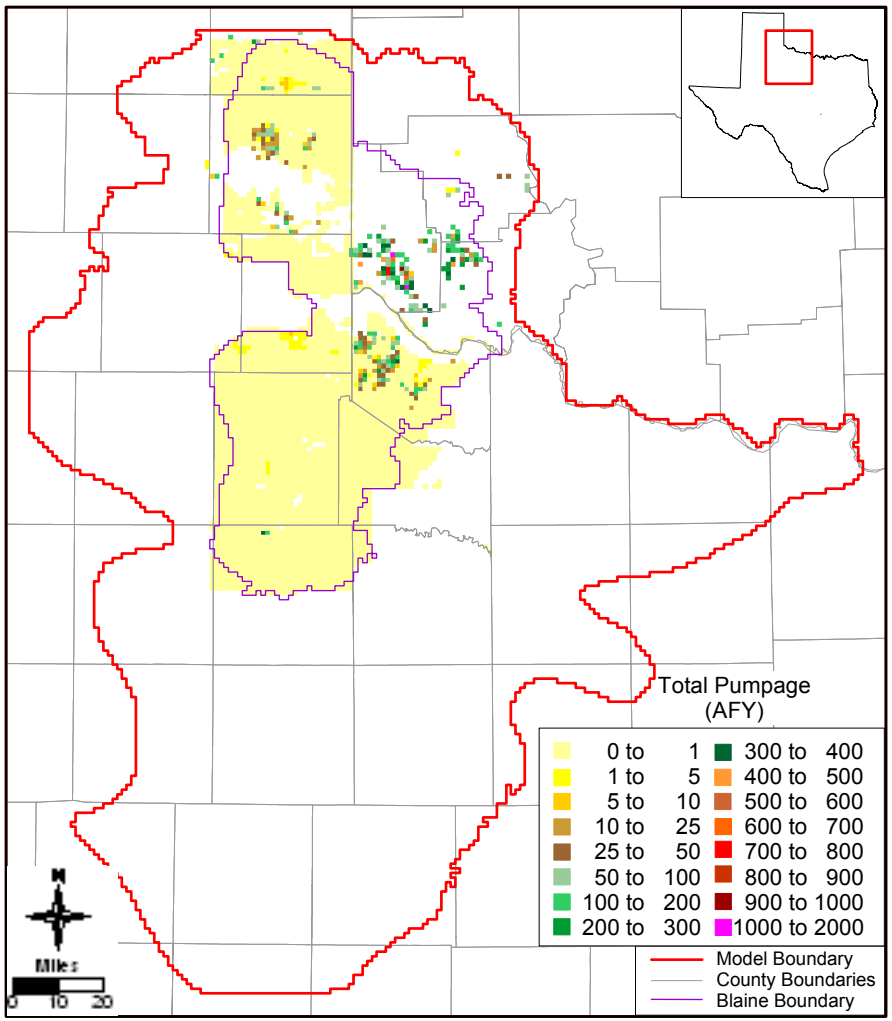



## 1990

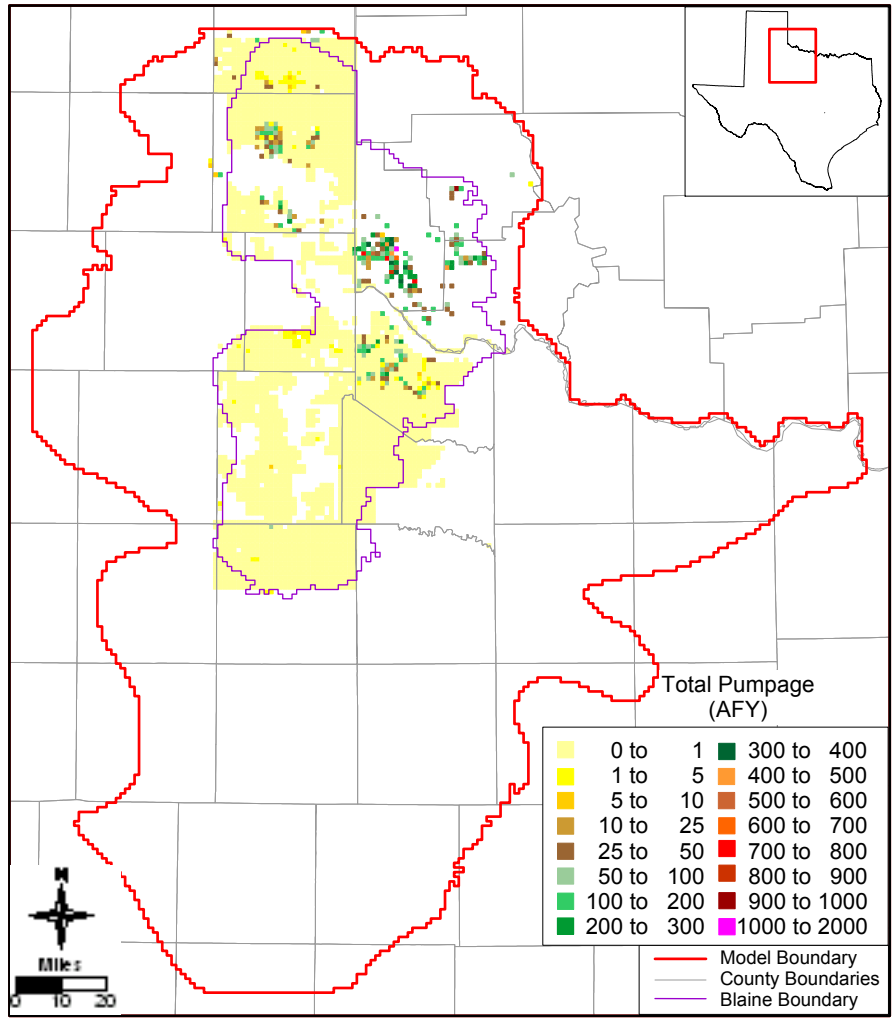


# Pumpage (AFY) – Layer 2

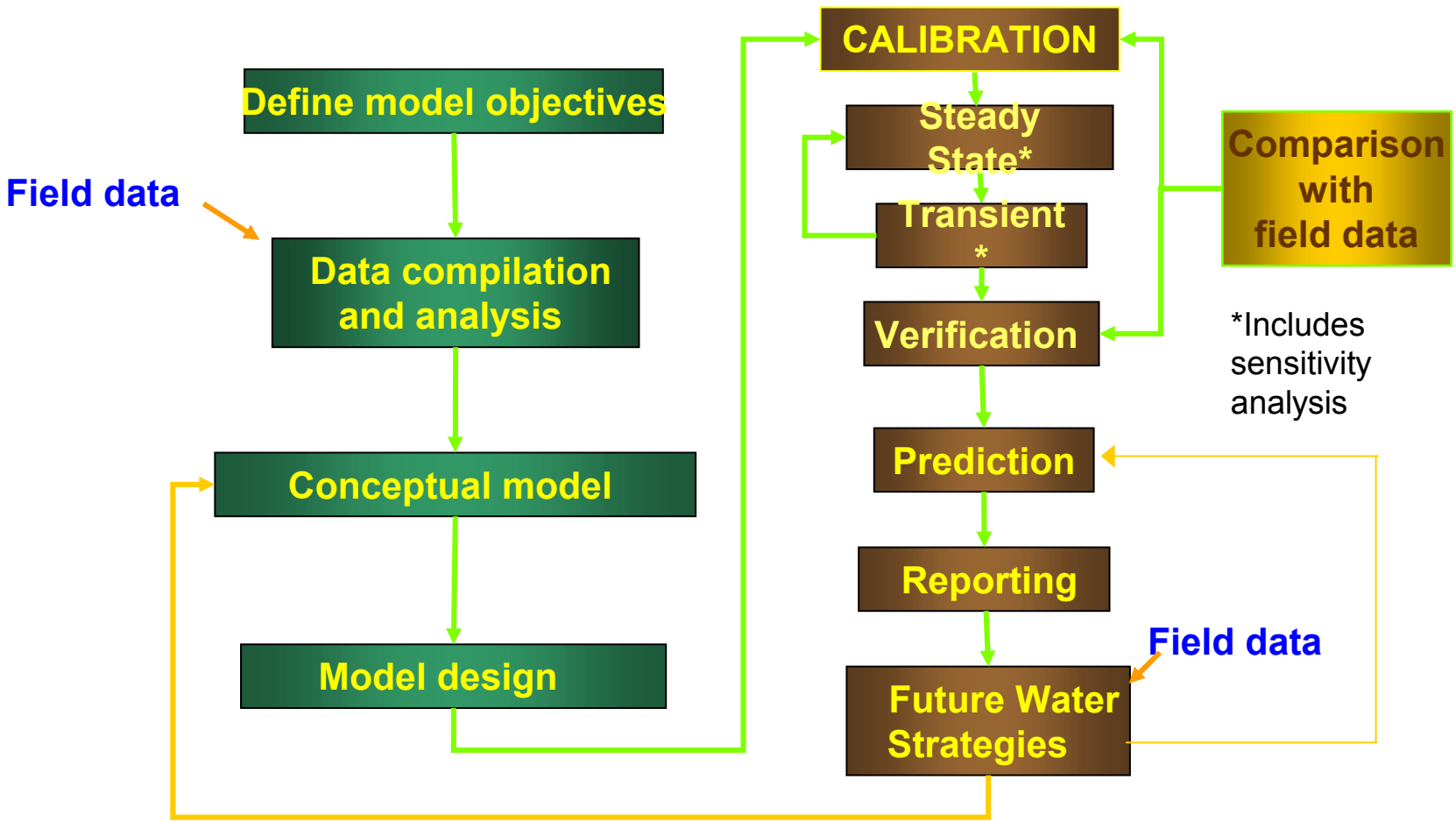
## 1980




## 1990



# Calibration Approach

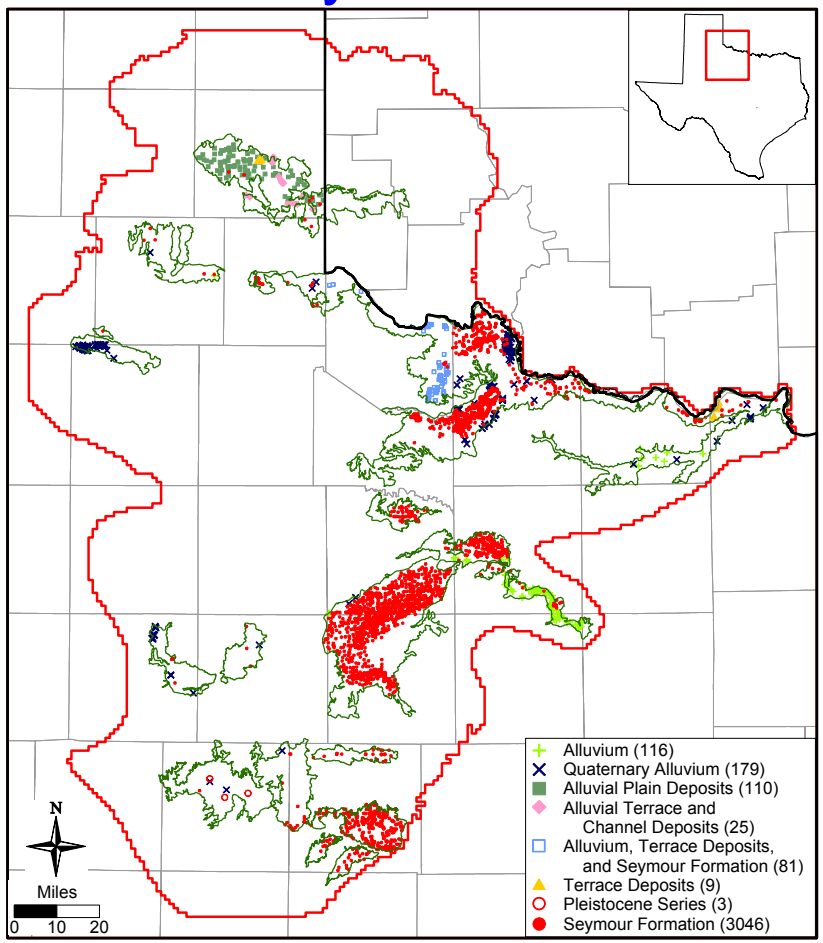


# Model Evaluation

- Model results compared to observed data
  - Observed water levels
  - Stream flow
- Model results evaluated against literature data
  - Recharge
- Model results evaluated against conceptual model

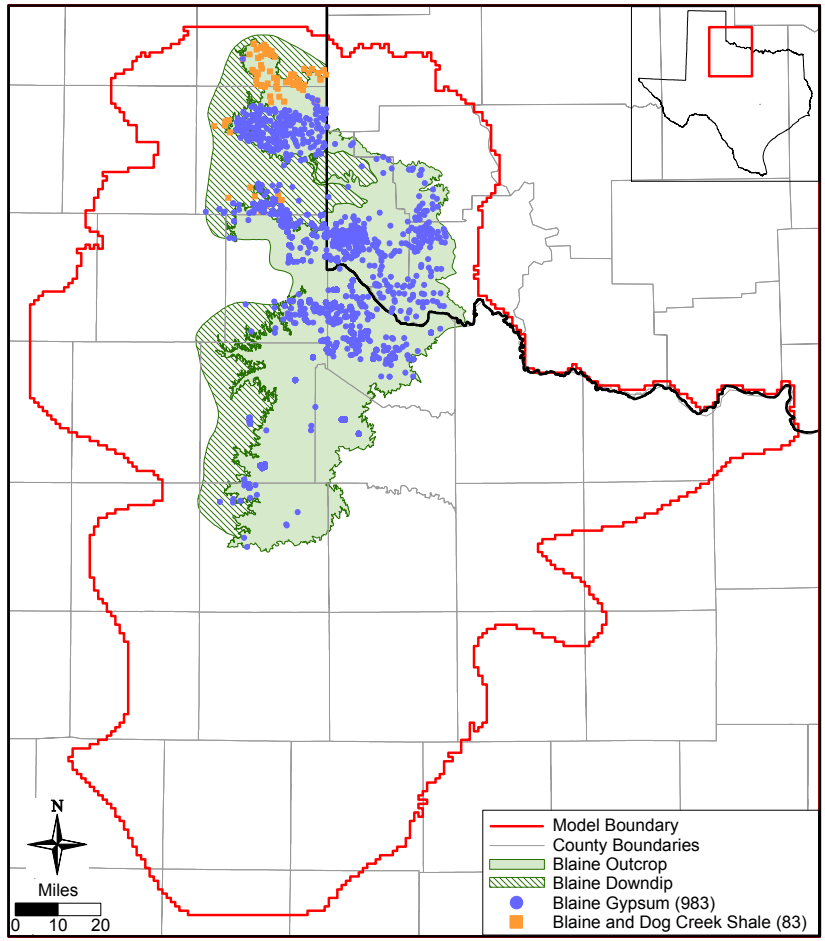
# Water-Level Measurement Locations

## Seymour



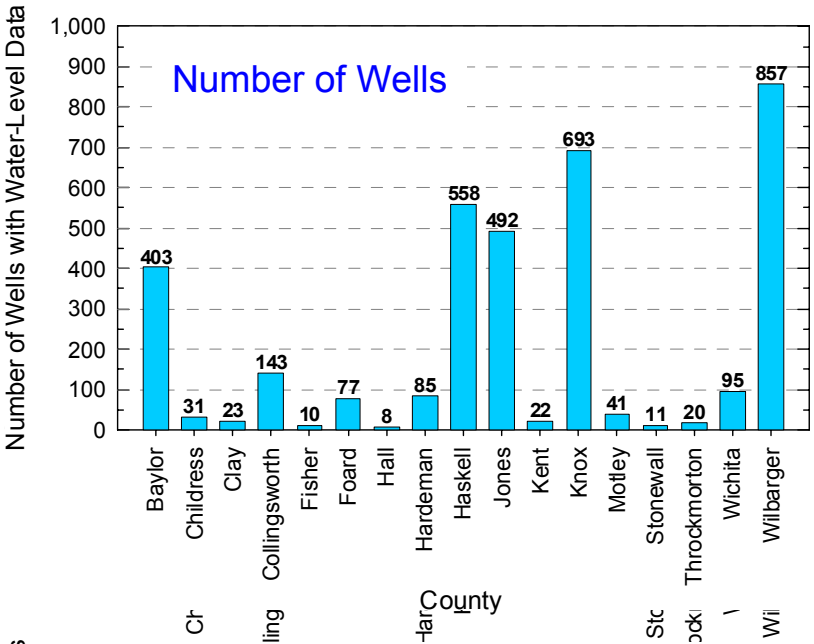

11,855 water-level measurements
in 3,569 wells

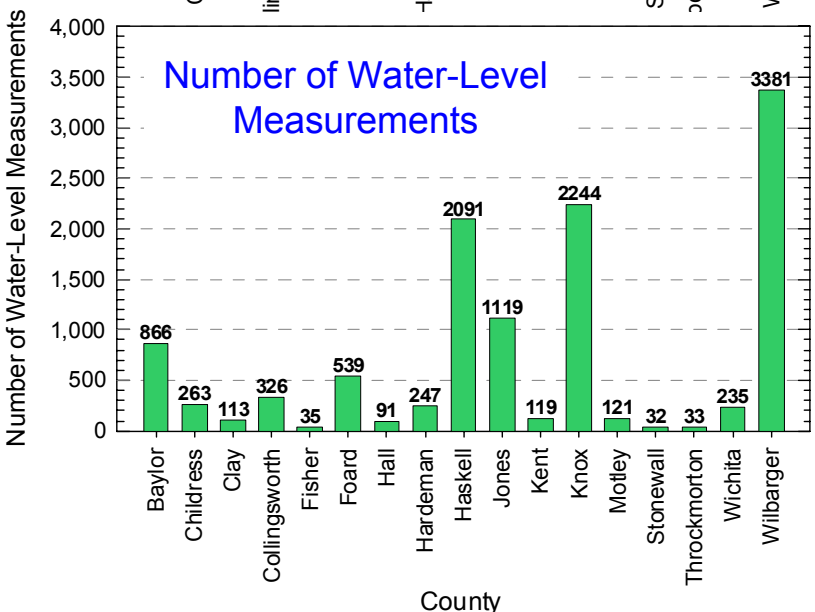
## Blaine

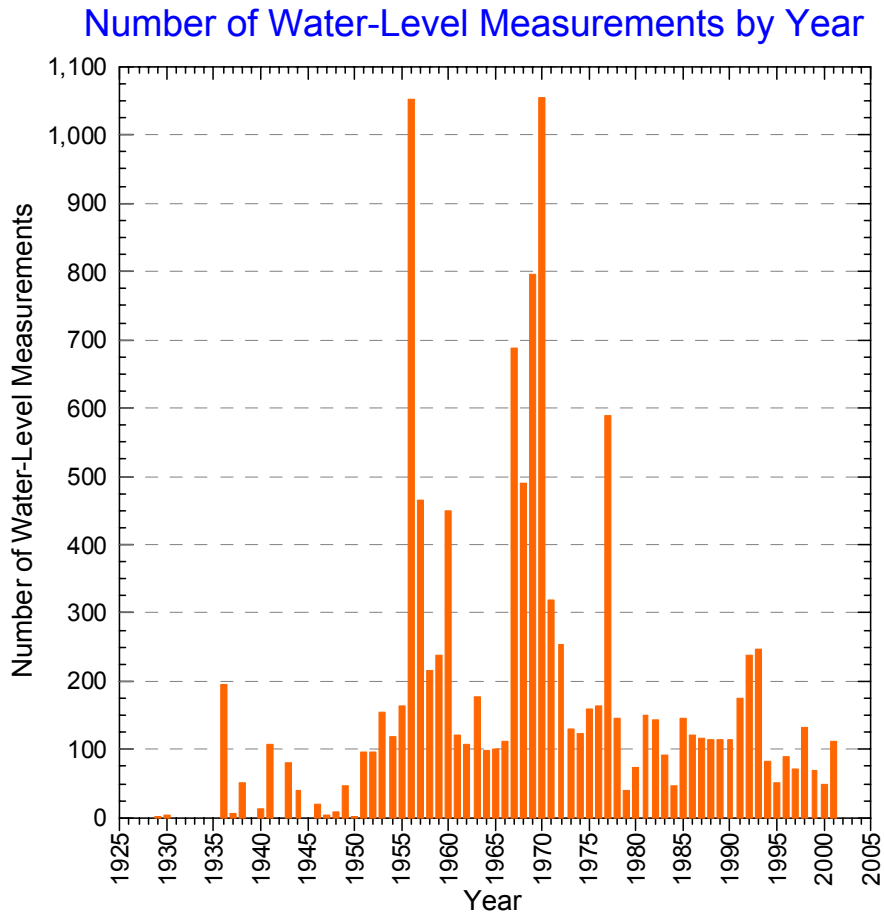



2,941 water-level measurements
in 782 wells

# Seymour WL Data by County & Year

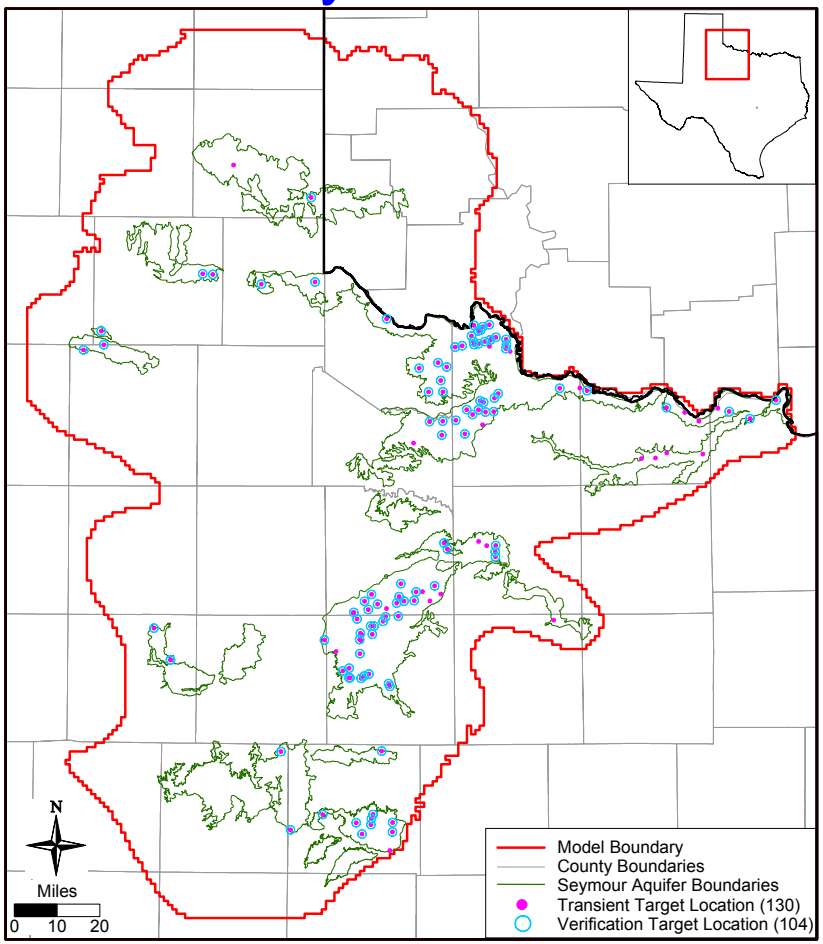


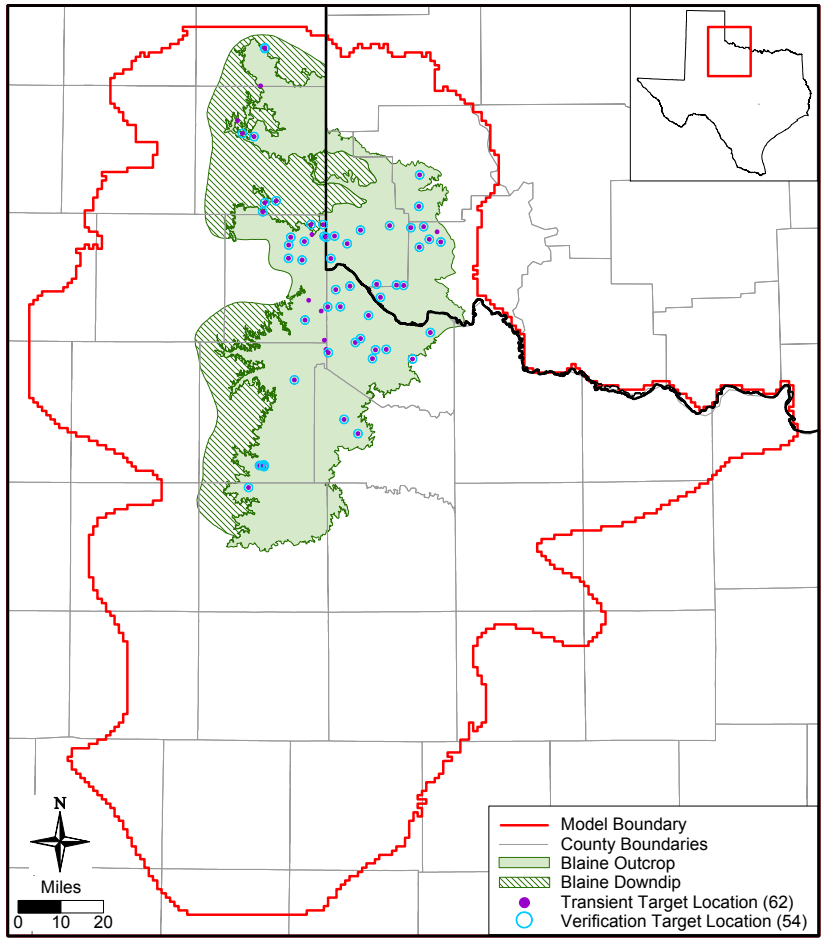



# Transient Target Locations

## Seymour

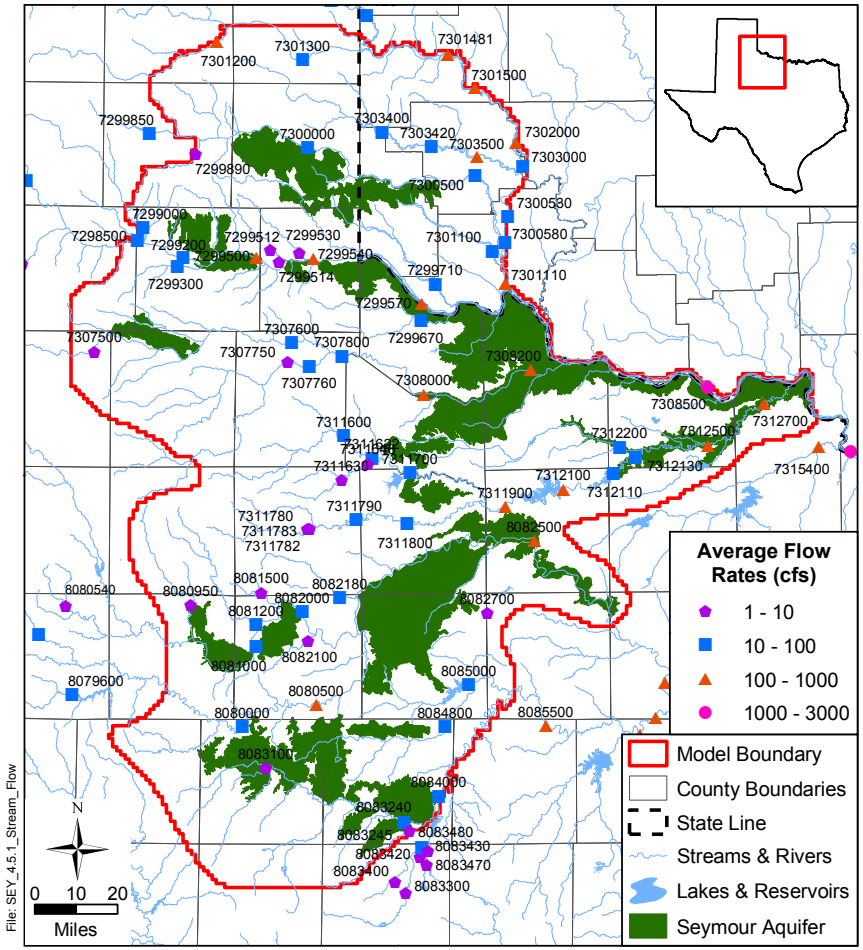



## Blaine



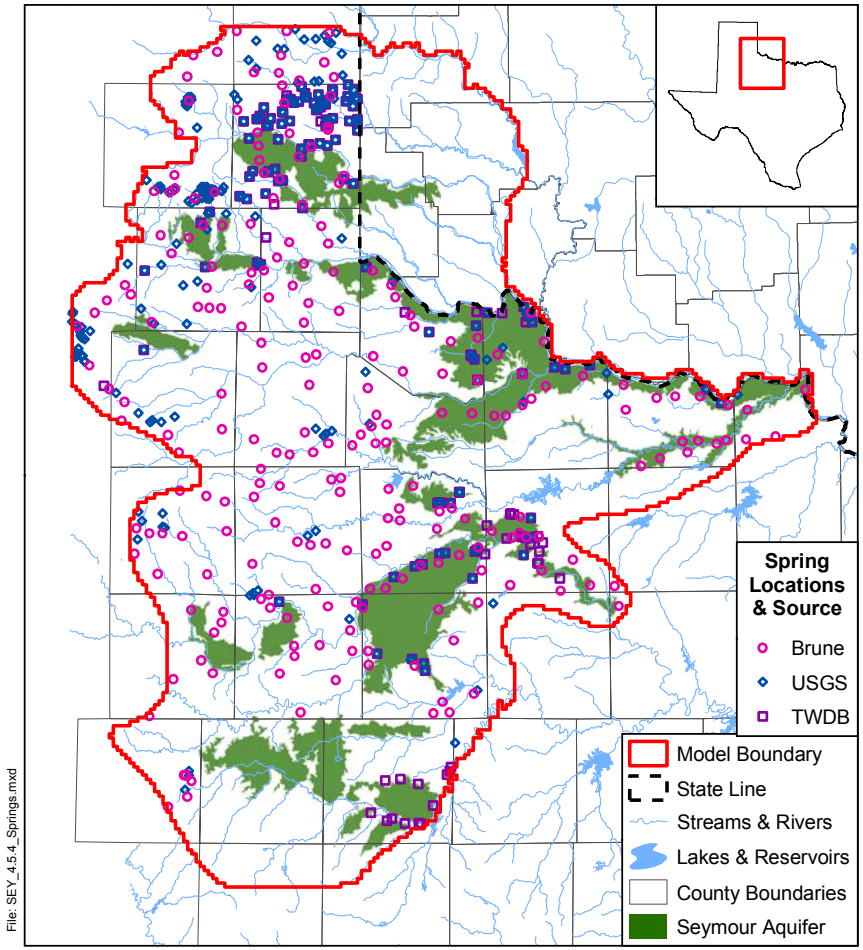
# Natural Aquifer Discharge

## Streams




Source: USGS website: March, 2003

## Springs

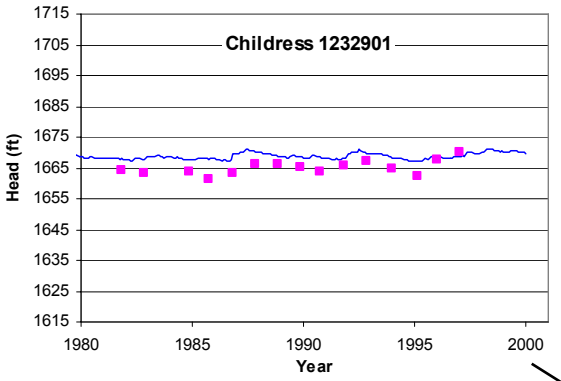


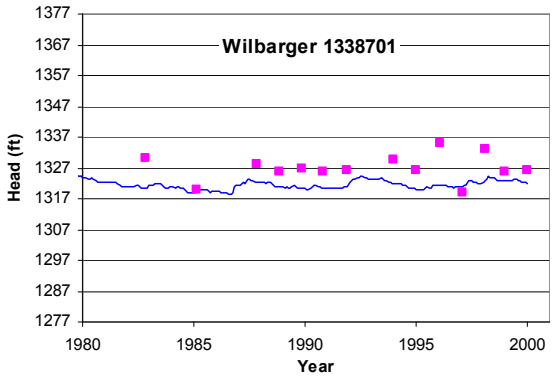

Source:

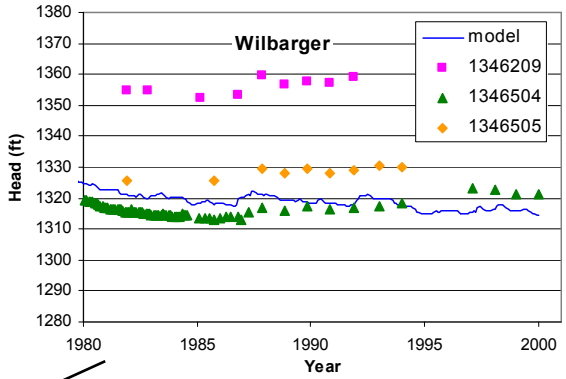
# Transient Model Calibration

- **Transient calibration required:**
  - Reducing $K_h$ of the Permian units
  - Adjusting recharge on a Seymour pod basis
  - Adjusting streambed conductances

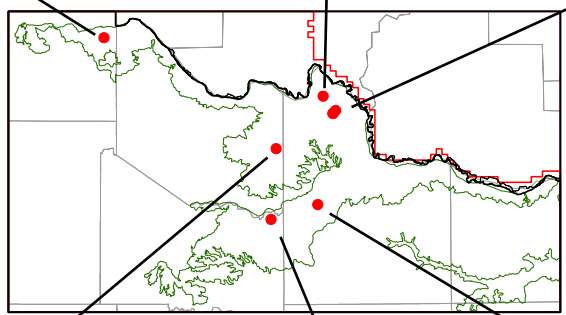
# Selected Hydrographs - Seymour

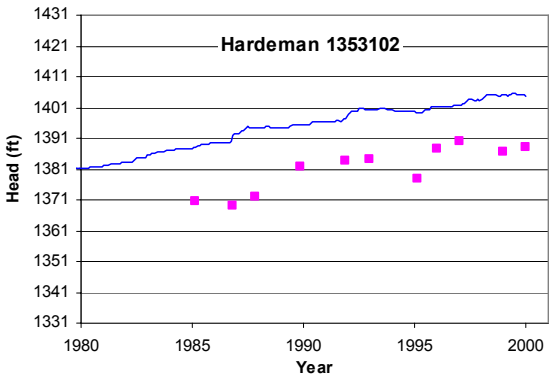


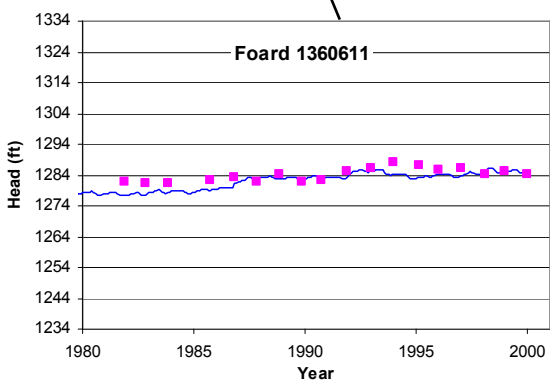



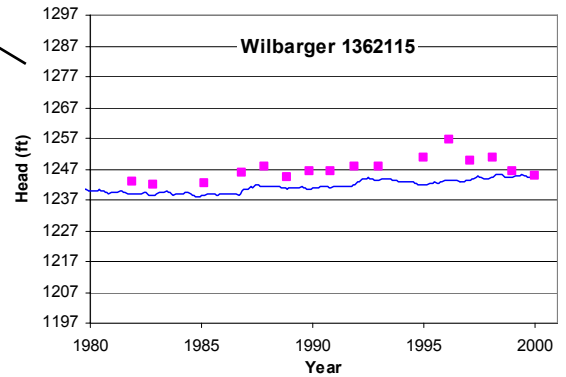




Pod 4

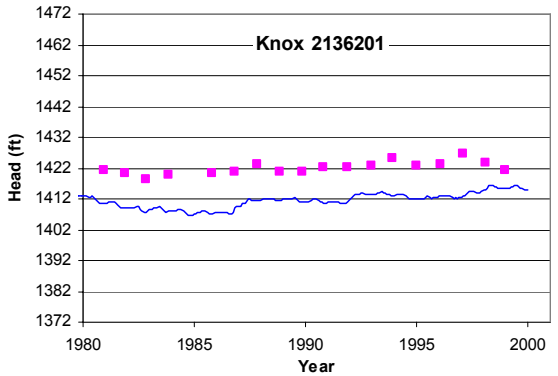


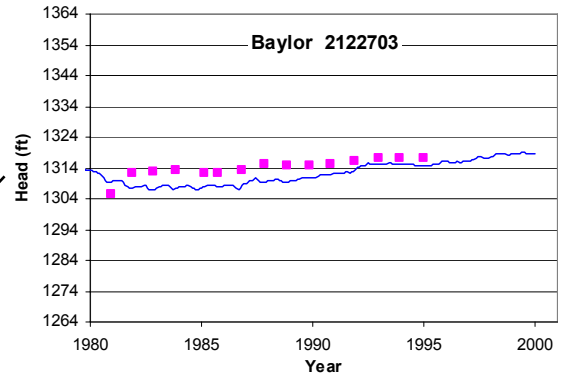


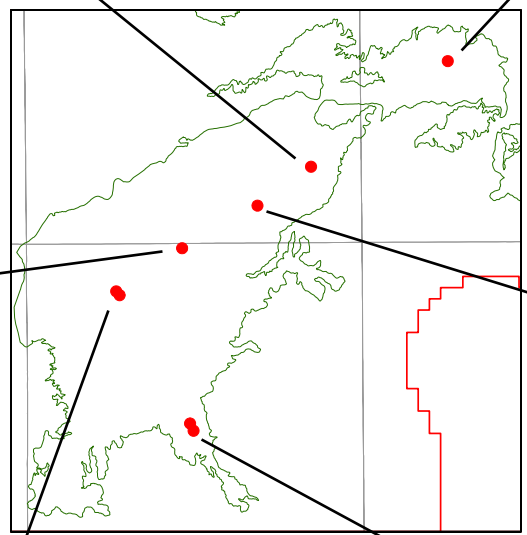



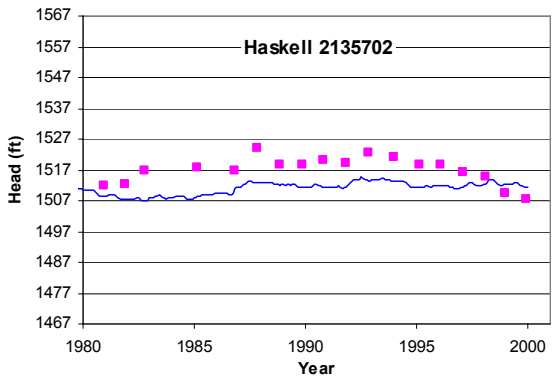
# Selected Hydrographs - Seymour

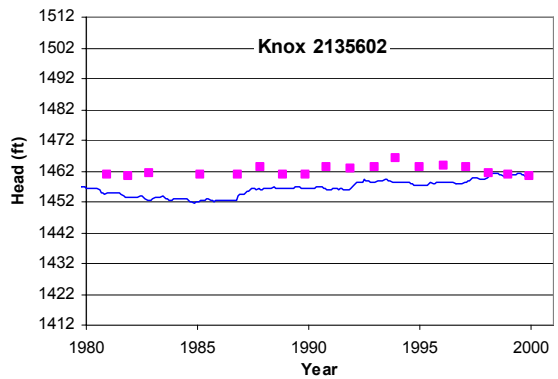


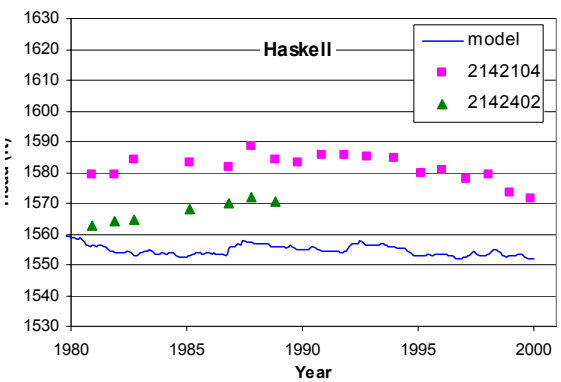



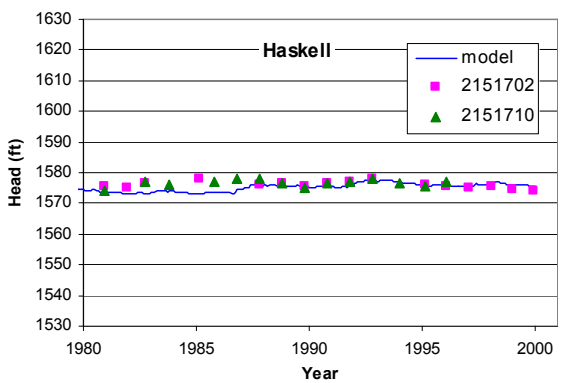

Pod 7



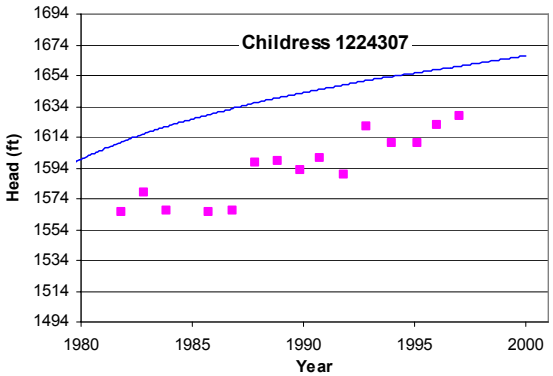


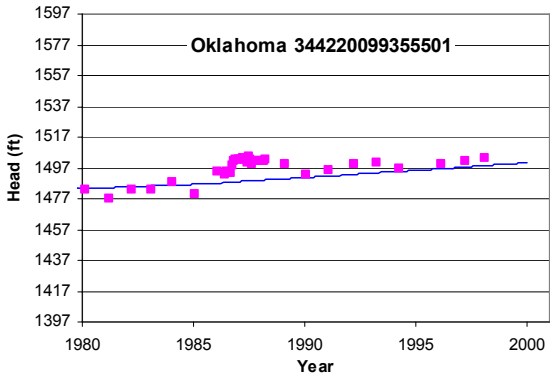



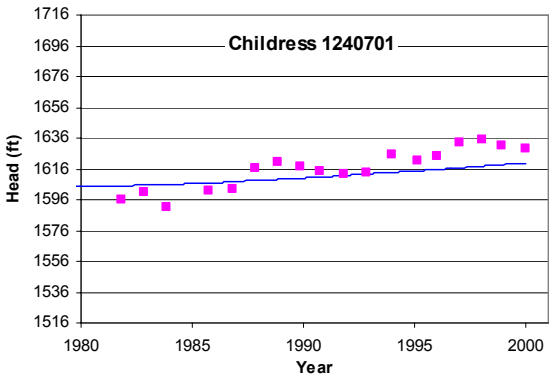



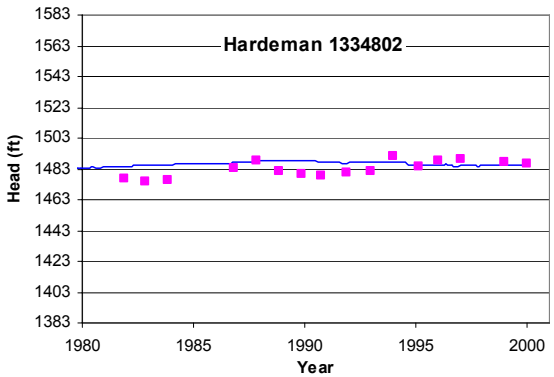



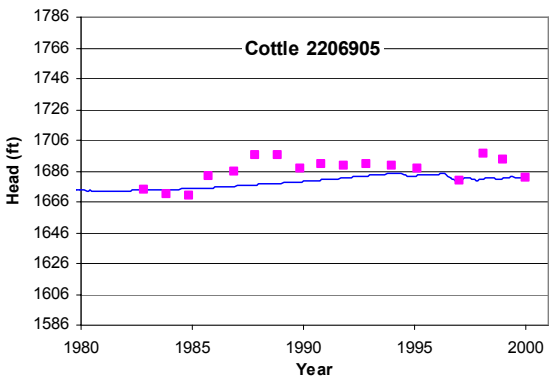
# Selected Hydrographs - Blaine

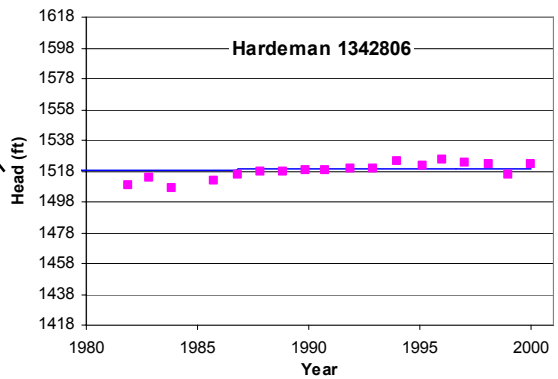


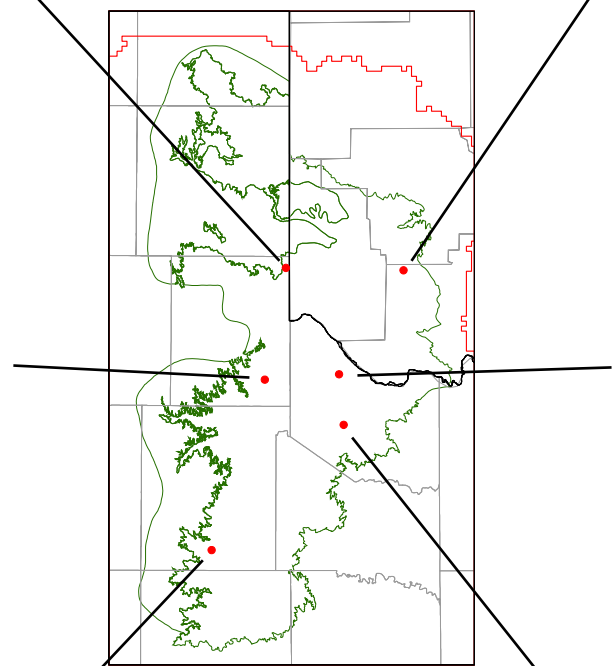



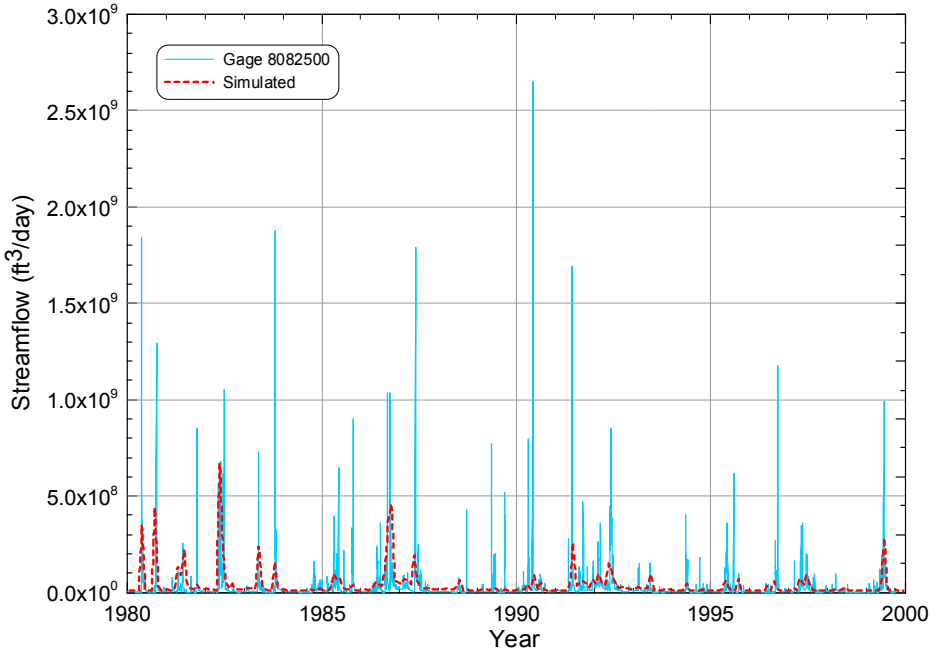



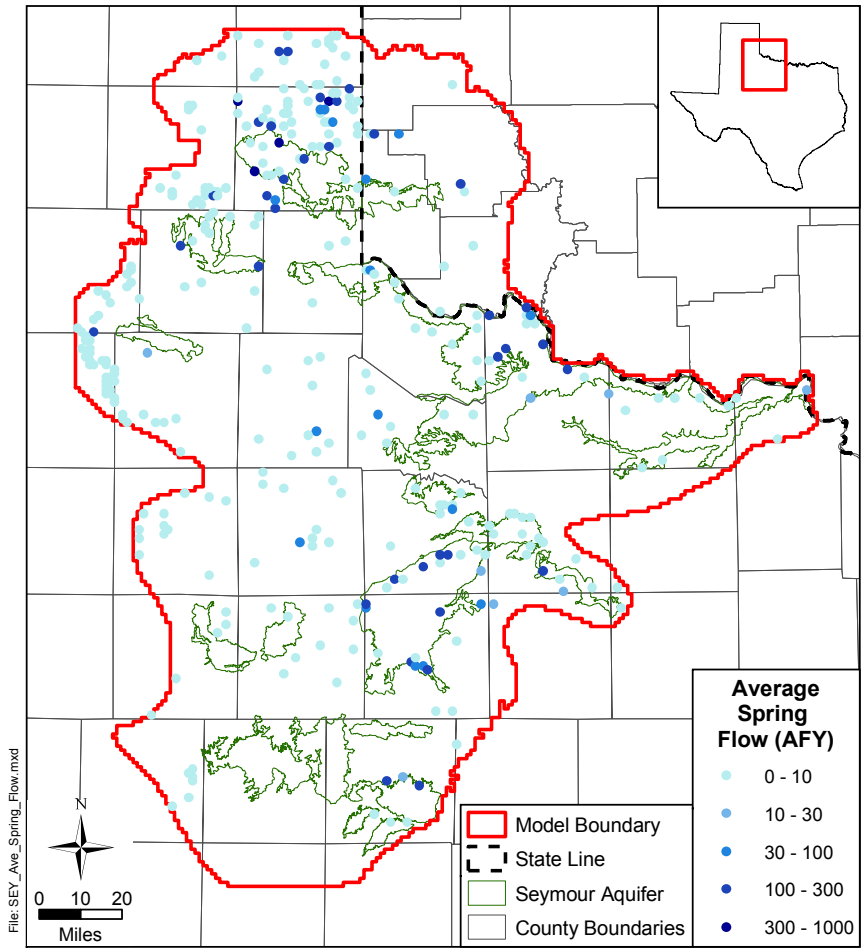



# Stream and Spring Results

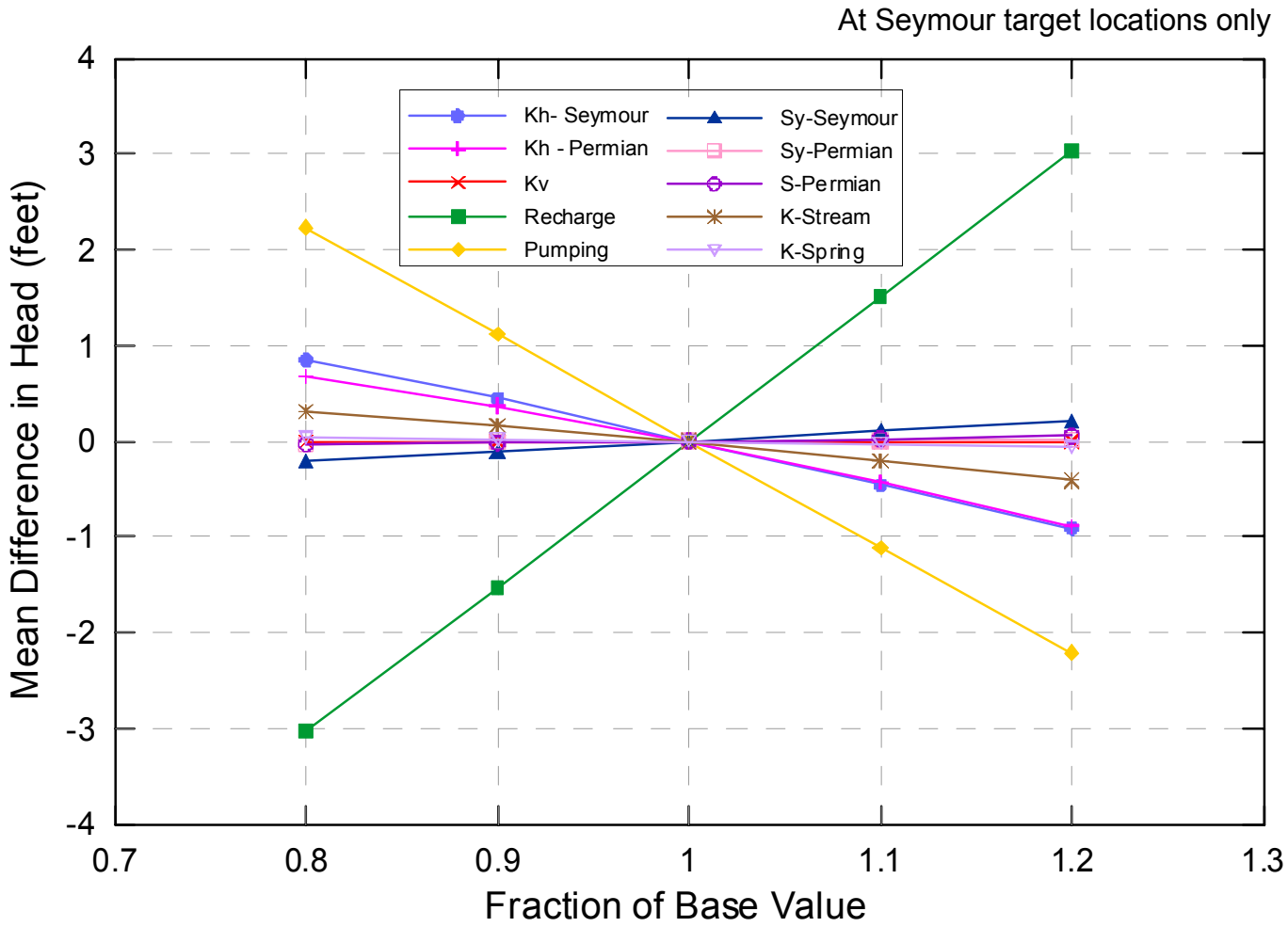
## Stream Flow on Brazos River




## Average Spring Leakance



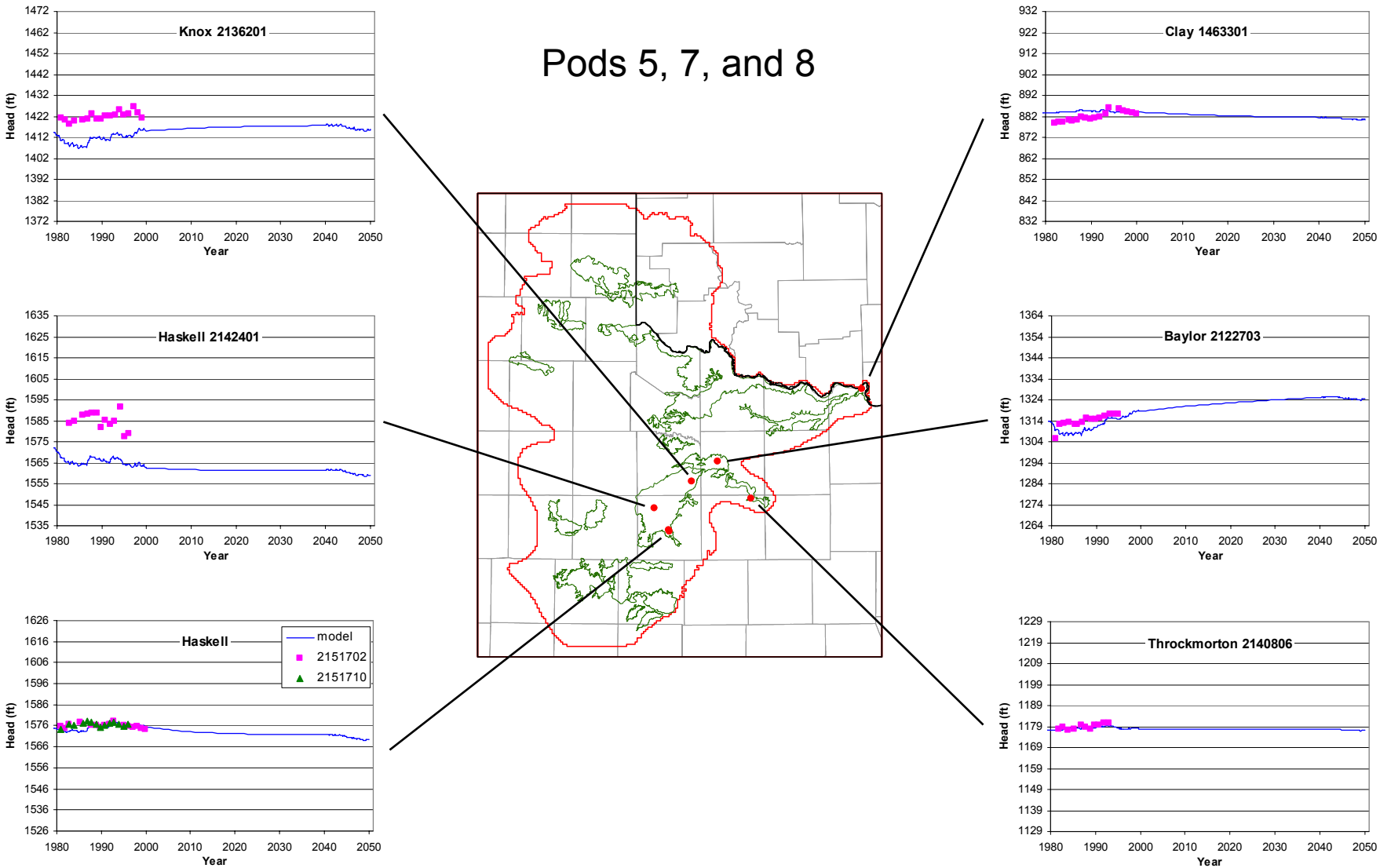
# Sensitivity Results – Seymour



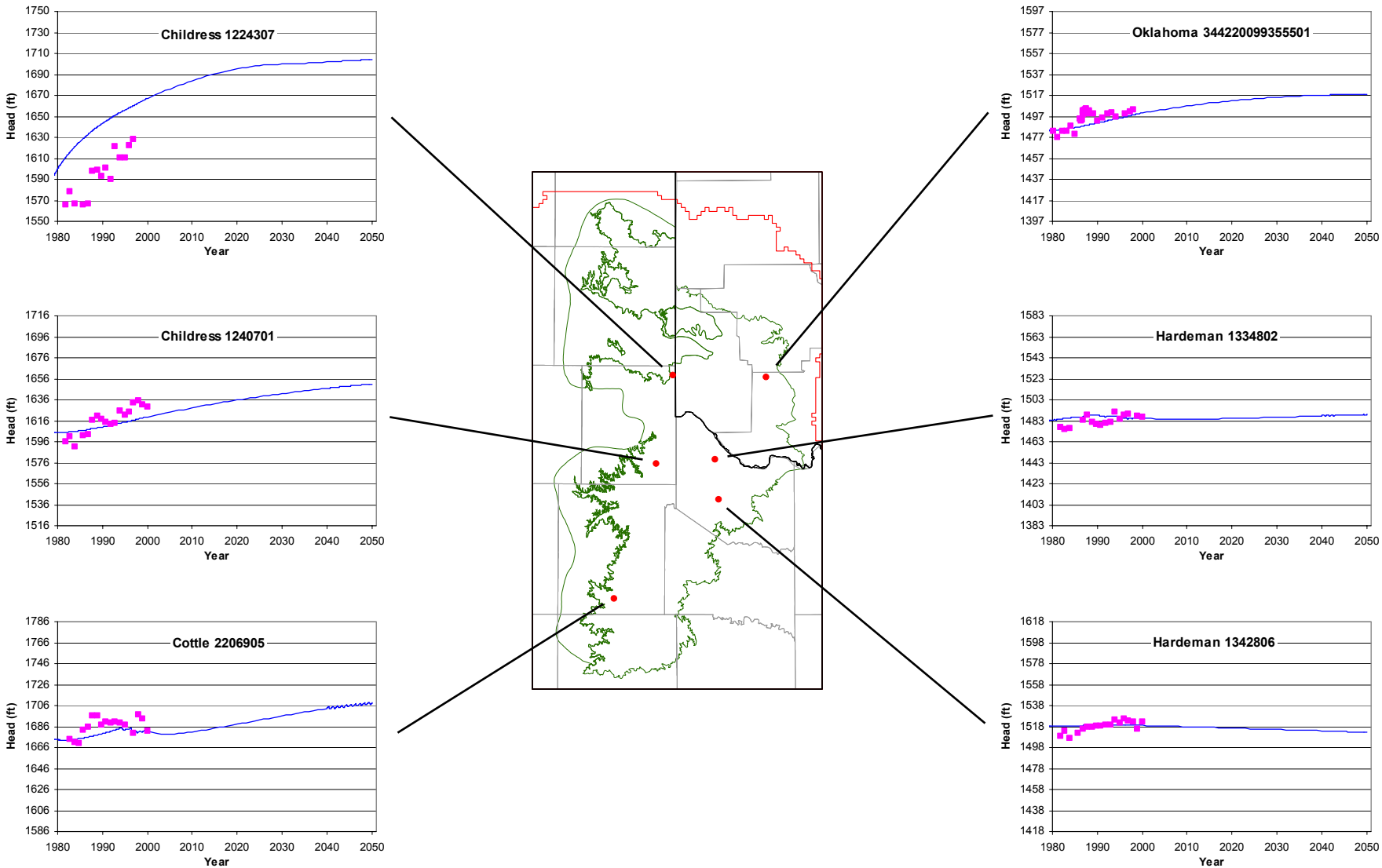
# Predictive Simulation (2000-2050)

- **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.

# Predicted Hydrographs – Seymour



# Predicted Hydrographs – Blaine



# Conclusions

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

# Data Models

background

- Consistent methodology for storage of GAM data
- Facilitates future improvements or modifications of current work
- Available to the general public as an addition to the final reports

# Data Models

## basic structure

- srcdata – **contains the source and some derived data used to generate the model input data sets**
- grddata – **contains all of the model input parameter and stress data by (r,c,l,sp)**
- modflow – **contains all of the actual model input and output data files**

# Data Models

## srcdata - examples

- geol – **subsurface geology, outcrop delineation**
- soil – **STATSGO data, runoff numbers**
- subhyd – **pumping rates, hydraulic conductivities, water levels, hydrographs**
- surhyd – **streamflows, stream/aquifer interaction, springflows**

# Data Models

## grddata - examples

- hydraul – **hydraulic properties such as horizontal and vertical conductivities**
- storage – **specific yield, storativity**
- stress – **pumping rates, recharge, et, streamflows**
- struct – **structure information (layer tops and bottoms)**

# Data Models modflow

## modflow

- Input -- ASCII input data sets for running modflow from the command line
- Output – All output data sets for ststate, trans, 2010, 2020, 2030, 2040, 2050 models

## pmwin

- Input -- Data sets for running the models from pmwin interface
- Output – All output data sets