Refined Groundwater Availability Model GAM) for the Seymour Aquifer in Haskell, Knox, and Baylor Counties

Stakeholder Advisory Forum 1
Proposed Modeling Plan
October 23, 2008
Outline of Presentation

- General Introduction to the TWDB GAM Program
- Refined Seymour GAM Team and Roles
- Objectives of Stakeholder Advisory Forums
- Brief Overview of Seymour Aquifer
- Basics of Groundwater Flow
- Basics of Groundwater Modeling
- Refined Seymour GAM - Overview
- Existing Seymour GAM vs. Refined Seymour GAM
- Refined Seymour GAM – Tools and Inputs
- Additional Data for the Refined Model
- Refined Seymour GAM – Conceptual Model
- Refined Seymour GAM Modeling Process
- Model Limitations
- Refined Seymour GAM Schedule
Refined Seymour GAM Team and Roles

- INTERA, Inc.
  - Project management
  - SAF meetings
  - Model development
  - GIS
  - Stakeholder communication

- Bureau of Economic Geology, The University of Texas at Austin,
  - Aquifer recharge/discharge data integration

- Water Prospecting and Resource Consulting
  - Data gathering
  - Stakeholder communication

- Dr. Jim Butler, P.G.
  - Senior technical input
    - Pre-development aquifer conditions
    - Current aquifer conditions

- Dr. Graham Fogg
  - Senior technical review
    - Groundwater modeling
    - Surface/groundwater interactions
TWDB GAM Program
TWDB GAM Program (cont)

Groundwater Availability Modeling

Location of completed GAMs for the major aquifers of Texas

Location of Completed and Ongoing Models for GAM: Minor Aquifers

Attachment B: Groundwater Management Areas

Contract Manager
Shirley Wade

Texas Water Development Board
Purpose: To develop tools that can be used to help GCDs, RWPGs, and others assess groundwater availability.

Public Process: You get to see how the model is put together.

Freely Available: Standardized, thoroughly documented, and available upon request.

Living Tools: Periodically updated.
TWDB GAM Program (cont)

Location of completed GAMs for the major aquifers of Texas

- Ogallala (northern part) 12/2001
- Ogallala (southern part) 4/2003
- Cenozoic Pecos alluvium 9/2004
- Hueco Bolson 12/2001
- Mesilla Bolson 9/2004
- Edwards-Trinity (Plateau) 9/2004
- Trinity (Hill Country) 8/2000
- Edwards (San Antonio segment) 9/2004
- Trinity (northern part) 9/2004
- Seymour 9/2004
- Carrizo-Wilcox (northern part) 4/2003
- Carrizo-Wilcox (central part) 5/2003
- Gulf Coast (northern part) 9/2004
- Edwards (northern segment) 12/2003
- Edwards (Barton Springs segment) 12/2001
- Gulf Coast (central part) 9/2004
- Gulf Coast (southern part) 12/2003

Note: The Edwards-Trinity (Plateau) and Cenozoic Pecos Alluvium aquifers are included in the same model.
TWDB GAM Program (cont)
Managed available groundwater (MAG)…the amount of groundwater available for use.

The State does not directly decide how much groundwater is available for use: GCDs will through GMA process.

A GAM is a tool that can be used to assess groundwater availability once GCDs and GMAs decide on the desired future condition of the aquifer.
TWDB GAM Program (cont)

Do we have to use GAM?

- Water Code & TWDB rules require that GCDs use GAM information, if available, for their management plans.
- TWDB rules require that RWPGs use managed available groundwater estimates, if developed in time for the planning cycle.
TWDB GAM Program (cont)

How do we use GAM?

- **The Model**
  - Predict water levels and flows in response to pumping and drought
  - Effects of well fields

- **Data in the Model**
  - Water in storage
  - Recharge estimates
  - Hydraulic properties

- **GMAs and RWPGs can request runs**
GCDs, RWPGs, TWDB, and others collect new information on aquifers. This information can enhance the current GAMs. TWDB plans to update GAMs every five years with new information. Please share information and ideas with TWDB on aquifers and GAMs.
TWDB GAM Program (cont)

Participating in the GAM Process

- **SAF meetings**
  - Hear about progress on the model
  - Comment on model assumptions
  - Offer information (timing is important!)

- **Report review**
  - At end of project

- **Contact TWDB**
  - Contract manager
Comments:

Contract Manager
shirley.wade@twdb.state.tx.us
(512) 936-0883
www.twdb.state.tx.us/gam
Refined Seymour GAM Team Contact Information

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      - The University of Texas at Austin
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      - Austin, TX 78713-8924
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  - Andrew Chastian-Howley
    - 100 East 15th Street
      - Fort Worth, TX 76102
      - (512) 335-5408
    - ach@wprconsulting.com
Objectives of Stakeholder Advisory Forums

- Interaction between the GAM team and interested stakeholders
  - Stakeholder communication and input are critical to the success of the refined Seymour GAM
  - Stakeholders will be relied upon to voice issues and provide information to ensure the model addresses the important water resource questions regarding the Seymour Aquifer
  - SAF meetings will be held periodically to discuss modeling progress and solicit comments

- Future updates
  - TWDB website
  - SAFs (as needed)

- SAF presentations and questions and responses from meetings will be posted at http://www.twdb.state.tx.us/gam/symr/symr.htm
Brief Overview of Seymour Aquifer

Major aquifers in Texas
An unconfined (water-table) aquifer
Composed of clay, silt, sand, and gravel
Gravel and sands occur primarily at base
Basal gravel and sand is the predominate water-bearing zone
Thickness is typically up to 100 feet
Saturated thickness typically less than 60 feet
Basics of Groundwater Flow

**Definitions**

- **Aquifer** – Water saturated permeable geologic unit that can transmit significant quantities of water.
- **Water table** – The level at which water stands in a shallow screened well.
- **Hydraulic head** - The water level in a well expressed as an elevation.
- **Hydraulic conductivity** – A physical property of the geologic media representing its ability to transmit water.
- **Specific yield** – The volume of water that an unconfined aquifer releases from storage per unit surface area of aquifer per unit decline in water table elevation.
- **Storativity** – The volume of water that a confined aquifer releases from storage per unit surface area of aquifer per unit decline in head.
Basics of Groundwater Flow (cont)

Definitions (cont)

- Recharge – The entry of water to the saturated zone at the water table.
  - Recharge equals water inputs at the ground surface (precipitation + irrigation) minus water losses (runoff + evapotranspiration).

- Stream losses or gains – The water that is either lost from an aquifer or gained by an aquifer through the base of the stream.

- Cross-formational flow – Groundwater flow between geologic formations.
Basics of Groundwater Flow (cont)

**Principles**

- The primary observable quantity describing groundwater flow is the water level as measured in a well.
- The water level expressed as elevation is termed the hydraulic head.
- The difference in hydraulic head between wells defines the direction of groundwater flow.
  - Groundwater flows from high hydraulic head to low hydraulic head.
- The water table is typically a subdued replica of the topography.
- The saturated thickness and hydraulic conductivity of the aquifer material define the volumetric flow rates (e.g., pumping).
Schematic Cross Section of Groundwater Flow

Groundwater flows from high hydraulic potential (energy) to low hydraulic potential.
Basics of Groundwater Modeling

Definition of a model
- A representation of reality that attempts to explain the behavior of some aspect of reality and is always less complex than the real system it represents (Domenico, 1972)
- A tool designed to represent a simplified version of reality (Wang and Anderson, 1982)

Why do we model groundwater flow
- Groundwater, unlike surface water, is difficult to directly observe
- Aquifers are typically complex in terms of spatial extent and hydrogeologic characteristics
- Groundwater models provide the only means for integrating available data and predicting groundwater flow at the scale of interest
Basics of Groundwater Modeling (cont)

**Numerical Groundwater Flow Model**

- Is a mathematical representation of a physical aquifer
- Uses the basic laws of physics that govern groundwater flow
- Represents the aquifer using discrete parameters
- Calculates hydraulic heads at discrete locations determined by the model grid
- Values from the model parameters can be modified until the model calculated hydraulic heads match observed hydraulic heads (i.e., model calibration)
- The calibrated model can be used as a tool to calculate future hydraulic heads in the aquifer
Basics of Groundwater Modeling (cont)

**Modeling protocol (steps)**
- Define the model objectives and select the modeling tools best able to meet the objectives
- Gather and analyze the data
  - Model input parameters
  - Calibration targets
- Develop a conceptual model of the physical system
- Design the mathematical model
- Calibrate the model to observed conditions
- Analyze the sensitivity of the model to input values
- Document all aspects of the modeling process in a report
- Use the model to predict future conditions
  - Evaluate water management strategies
  - Evaluate GMA groundwater availability
Basics of Groundwater Modeling (cont)

Gridblock Accounting

- Hydraulic Conductivity
- Storage value
- Thickness

Recharge

Irrigation return flow

Water removed from storage by pumping

Water remaining in storage

Natural recharge

Exchange of water with neighboring cells
Refined Seymour GAM

Model objectives

- Develop a three-dimensional realistic and scientifically accurate groundwater flow model that represents the physical characteristics and relevant processes of the Seymour aquifer in Haskell, Knox, and Baylor counties and is suitable for use by stakeholders (e.g., the Rolling Plains GCD)
Refined Seymour Study Area
Refined Seymour Study Area (cont)
Refined Seymour Study Area (cont)
Refined Seymour Study Area (cont)
Refined Seymour Study Area (cont)
Refined Seymour Study Area (cont)
Refined Seymour Study Area (cont)
Existing Seymour GAM Model Domain

Major Aquifers
- Seymour
- Edwards-Trinity
- Ogallala

Minor Aquifers
- Blaine, Outcrop
- Blain, Downdip
- Dockum, Outcrop
- Dockum, Downdip
- Edward-Trinity

Model Boundary

State Line

County Boundaries

Source: Online: Texas Water Development Board, August 2003
Refined Seymour GAM Model Domain
# Existing versus Refined Model

<table>
<thead>
<tr>
<th>Model Input</th>
<th>Existing Model</th>
<th>Refined Model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grid</strong></td>
<td>1-mile by 1-mile</td>
<td>1/8-mile by 1/8-mile</td>
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<tr>
<td><strong>Structure</strong></td>
<td>used DEM, point data from TWDB &amp; TCEQ, contour maps, and Seymour outline</td>
<td>will apply same data at refined scale</td>
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<tr>
<td><strong>Hydraulic Conductivity</strong></td>
<td>interpolation of measurements and inferred values from specific capacity tests</td>
<td>add any new (&gt;2003) data to interpolation</td>
</tr>
<tr>
<td><strong>Recharge</strong></td>
<td>temporal variability (monthly) and average recharge from SWAT simulations</td>
<td>Use data (Cl, H3/He3, matric potential) in rangeland and dryland and irrigated farmland to describe predevelopment and land use/ recharge relationships and historical land use relationships will investigate irrigation return flow</td>
</tr>
<tr>
<td><strong>Streams</strong></td>
<td>locations and geometry from RF1 monthly streamflows from gauge data</td>
<td>no new information; repeat method under refined conditions</td>
</tr>
<tr>
<td><strong>Pumping</strong></td>
<td>annual data from TWDB monthly factors from Borrelli et al., 1998</td>
<td>no new information; repeat method under refined conditions</td>
</tr>
<tr>
<td><strong>ET</strong></td>
<td>temporal (monthly) and spatial variability from SWAT modeling</td>
<td>follow methods in BEG &amp; INTERA, 2005 and data from Borrelli et al. 1998</td>
</tr>
<tr>
<td><strong>Springs</strong></td>
<td>used spring locations from Brune, TWDB county reports, USGS database</td>
<td>either use fine scale USGS NHD coverage with DEM, place drains in all boundary cells, or both</td>
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</tbody>
</table>
Refined Grid
Refined Grid – X-section Schematic
Interactions Between Model Grid Cells

NOTE: Grid blocks will be 1/8-mile by 1/8-mile not 1-mile by 1-mile.
Refined Seymour GAM – Model Tool

- **MODFLOW-2000**
  - Three-dimensional finite-difference groundwater flow code
  - Most widely accepted groundwater flow code in use today
  - Written and supported by the U.S. Geological Survey
  - Public domain
  - Well documented
  - Large user group
  - Supported by enhanced boundary condition packages to handle recharge, evapotranspiration, streams, springs, and reservoirs

- **Groundwater Vistas for Windows Version 4**
  - Graphical user interface for MODFLOW
Refined Seymour GAM - Input

- **Ground surface elevation**
  - *Digital elevation model (DEM)*

- **Top and bottom elevations of the Seymour aquifer**
  - *TWDB Report 226 (Harden and Associates, 1978)*
  - *Driller’s logs from TWDB website, the Rolling Plains GCD, and TCEQ well records*
Structure Data Sources

Existing GAM

Additional Data from Rolling Plains GCD

Legend
- New Structure Data

County Boundaries
- Driller's Logs on TWDB Website
- Driller's Logs in TCEQ Records
- Seymour Outline
- Contours from Published Reports
Aquifer properties

- Hydraulic conductivity
  - TWDB Report 226 (Harden and Associates, 1978)
  - TWDB Bulletin 6209 (Ogilbee and Osborne, 1962) – Haskell and Knox County report
  - TWDB Report 218 (Preston, 1978) – Baylor County report
  - Driller’s logs from TWDB website, the Rolling Plains GCD, and TCEQ well records

- Specific yield
  - TWDB Report 218 (Preston, 1978) – Baylor County report
Hydraulic Conductivity Data Sources

**Legend**
- **New SC Data**
- **SC data from TCEQ**
- **Field K data from County Reports**

**Existing GAM**

**Additional Data from Rolling Plains GCD**

- County Boundaries
- SC data from TCEQ
- Field K data from County Reports
Older and Younger Deposits

from R.W. Harden & Associates (1978)
Initial elevation of the water table
- TWDB website
- TWDB Report 226 (Harden and Associates, 1978)
- TWDB Bulletin 6209 (Ogilbee and Osborne, 1962) – Haskell and Knox County report
- TWDB Report 218 (Preston, 1978) – Baylor County report

Hydraulic head data for the calibration period (1980 through 1997)
- TWDB website
- TWDB website
- TWDB Report 226 (Harden and Associates, 1978)
- TWDB Bulletin 6209 (Ogilbee and Osborne, 1962) – Haskell and Knox County report
- TWDB Report 218 (Preston, 1978) – Baylor County report
Water Level Data

Locations with Transient Water-Level Data
Refined Seymour GAM - Input (cont)

- Cross-formational flow
  - Water-Level data on the TWDB website

- Recharge
  - TWDB Bulletin 6209 (Ogilbee and Osborne, 1962) – Haskell and Knox County report
  - Chloride concentrations in the unsaturated zone for various land cover (current work by the BEG)
Recharge Estimates

Recharge estimates from water-level rises reported in Ogilbee and Osborne (1962)

<table>
<thead>
<tr>
<th>Location</th>
<th>Rise in Water Level (ft)</th>
<th>Starting Year</th>
<th>Ending Year</th>
<th>Total Time</th>
<th>Specific Yield</th>
<th>Estimated Recharge (in/yr)</th>
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<td>nr</td>
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<td>1900</td>
<td>1933</td>
<td>33</td>
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<td>3.27</td>
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<tr>
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<td>63</td>
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<td>Rochester</td>
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Ogilbee and Osborne (1962) suggest that “the development of the land for cultivation appears to have increased the opportunities for recharge and probably has decreased the amount of water lost by evapotranspiration.”
## Recharge Estimates (cont)

Preliminary estimates based on chloride concentrations in the unsaturated zone – ongoing work by the BEG

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<tr>
<th>Setting Borehole</th>
<th>Precipitation</th>
<th>Cl(P)</th>
<th>Depth</th>
<th>Depth to Water</th>
<th>Flushed Depth</th>
<th>Mean</th>
<th>Minimum</th>
<th>Maximum</th>
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<tr>
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<td>mm/yr</td>
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<td>(\text{Cl}(P + \text{Irr}))</td>
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</table>
Where does recharge go?

- Recharge
- Discharge to Permian
- Baseflow
- Water table
- ET
- Pumping
- Seymour
- Discharge to Permian
- Permian
- Spring discharge
Natural discharge

- Streams
  - Locations
    - TWDB website (major river GIS coverage)
  - Gain-loss
    - TWDB Report 218 (Preston, 1978) – Baylor County report

- Springs
  - Locations and Discharge Rates
    - TWDB website
    - USGS (Heitmuller and Reece, 2003) – Database of Historical Documented Springs and Spring Flow Measurements in Texas
Artificial discharge via pumping

- Locations and Rates
  - TWDB pumping database
Monthly Variation in Irrigation Pumping

Knox County

Baylor County

Haskell County
Additional Data for Refined Model

- **Recharge studies by the BEG**
  - Soil physics
  - Environmental tracers
  - Groundwater age dating

- **Historic development of the saturated interval in the Seymour**
  - Filling up of the Seymour resulting from changes in land use

- **Data not previously publicly available (stakeholder, etc.)**
  - Hydraulic properties
    - Additional data received from the Rolling Plains GCD
  - Water levels
    - Ability to use data since 1997 is limited due to required transient calibration period of 1980 through 1997
  - Soft data
    - Where is the Seymour Aquifer more productive and less productive?
    - Where is recharge into the Seymour Aquifer higher and where is it lower?
    - What is the interaction between the Seymour and underlying Permian-age rocks?
    - Where do the Seymour and Permian-age rocks interact?
A simplified representation of the hydrogeological features that govern groundwater flow in the Seymour

- Hydrostratigraphy
- Hydraulic properties
- Recharge
- Pumping
- Boundaries
Groundwater Flow Direction

from R.W. Harden & Associates (1978)
Refined Seymour GAM Modeling Process

- Collection and analysis of data
- Development of a conceptual model
- Construction of the mathematical model
- Simulate development of the Seymour Aquifer (i.e., filling up of the aquifer)
- Calibrate the model to transient conditions from 1980 through 1997 using monthly time steps
- Conduct a sensitivity analysis on major parameters
- Document all aspects of the model
Model Limitations

- The Seymour aquifer is heterogeneous vertically (sand, gravel, silt, clay), but is represented as one layer with average properties.
- Processes and timing related to the historical development of the Seymour Aquifer are largely unknown.
- Data available (e.g., water levels, pumping) is limited in some regions.
- The GAM is a tool for making groundwater availability assessments on a regional basis only.
- The GAM is not capable of predicting aquifer responses at small scales (e.g., individual wells).
Advantages of the Refined Model

- **Additional data**
  - Well log data from the Rolling Plains GCD
    - Structure
    - Hydraulic conductivity
  - Recharge
    - Work being conducted by the BEG

- **Refined Grid**
  - Improves horizontal to vertical aspect ratio and thus communication between gridblocks
  - Should reduce the number of dry cells
  - Provides ability to incorporate more heterogeneity in structure and hydraulic properties
  - Provides increased resolution of drawdown

- **Considers only one pod of the aquifer**
  - Improves model accuracy
  - Improves model performance
Additional Data to Support Model.

- Additional data is welcomed
- Additional data must be received by November 13, 2008
- All data used in the refined model will become publicly available at the end of the project
- Forward data to
  - Toya Jones
    INTERA, Inc.
    1812 Centre Creek Dr., Suite 300
    Austin, Texas  78754
    (512) 425-2000
    tjones@intera.com
# Refined Seymour GAM Schedule

<table>
<thead>
<tr>
<th>Date</th>
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<tbody>
<tr>
<td>March, 2008</td>
<td>Project Start</td>
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<tr>
<td>January, 2009</td>
<td>Completion of Conceptual Model Development</td>
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<tr>
<td>February 12, 2009</td>
<td>Draft Conceptual Model Report to TWDB</td>
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<tr>
<td>June, 2009</td>
<td>Completion of Steady-State Model Calibration</td>
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<tr>
<td>July, 2009</td>
<td>Completion of Transient Model Calibration</td>
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<td>September 10, 2009</td>
<td>Draft Model Report to TWDB</td>
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<tr>
<td>November, 2009</td>
<td>TWDB Feedback on Draft Model Report</td>
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<tr>
<td>December, 2009</td>
<td>Model Training Seminar</td>
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<tr>
<td>January 7, 2010</td>
<td>Final Model Report to TWDB</td>
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ATTENDANCE LIST

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toya Jones</td>
<td>INTERA, Inc.</td>
</tr>
<tr>
<td>Shirley Wade</td>
<td>Texas Water Development Board</td>
</tr>
<tr>
<td>Wade Oliver</td>
<td>Texas Water Development Board</td>
</tr>
<tr>
<td>Andrew Chastain-Howley</td>
<td>Water Prospecting and Resource Consulting</td>
</tr>
<tr>
<td>Ray Brady</td>
<td>RMBJ Geo, Inc.</td>
</tr>
<tr>
<td>Mendy Shugart</td>
<td>Texas Department of Agriculture</td>
</tr>
<tr>
<td>Joe Shephard</td>
<td>City of Seymour</td>
</tr>
<tr>
<td>Mike McGuire</td>
<td>Rolling Plains Groundwater Conservation District</td>
</tr>
<tr>
<td>Sam Fare</td>
<td>West Central Texas Municipal Water District</td>
</tr>
</tbody>
</table>

PRESENTATION

The Stakeholder Advisory Forum was held on Thursday, October 23, 2008 at 6:30 p.m. at the Perry Patton Community Center located at 131 West Cisco Street in Munday, Texas.

The presentation topics for this form included:
- Groundwater availability modeling overview
- Basics of groundwater flow
- Basics of groundwater modeling
- Comparison of existing Seymour Aquifer groundwater availability model and refined groundwater availability modeling for the Seymour Aquifer in Baylor, Haskell, and Knox counties
- Review of data needed for groundwater modeling
- New well data from Rolling Plains Groundwater Conservation District
- Timelines and request for additional information
- Schedule for the refined groundwater availability model for the Seymour Aquifer in Baylor, Haskell, and Knox counties.
The meeting concluded at 8.45 p.m.

A summary of questions, answers and other discussion is listed below.

QUESTIONS AND ANSWERS

*Question*: Toya Jones: *Where are the springs within the model area?*
*Answer*: Mike McGuire: There are a few springs along the Brazos River, probably more in Baylor County.

*Question*: Toya Jones: *There are data gaps in the southeastern and northwestern parts of the model. Are these areas dry?*
*Answer*: Mike McGuire: These areas are generally weak producers. There is some water production in the southern Baylor County pod. In the western Knox/Baylor pod, there is only windmill water and in southeastern Knox and eastern Haskell county much of this area is dry.

*Question*: Sam Fare: *Why is the model only using pumping data from the period of 1980 to 1997?*
*Answer*: Toya Jones and Shirley Wade: The TWDB has detailed pumping from this period which has been validated.

*Question*: Andrew Chastain-Howley: *Were there ever any pumping tests conducted on the United States Geological Survey monitoring well near Munday?*
*Answer*: Mike McGuire: No. However, the production well (21-35-702) close to this site has a long history of data and it may be possible to use those data for estimation of specific yield.

*Question*: Toya Jones: *Is there any feel for communication between the Seymour Aquifer and the underlying Permian strata?*
*Answer*: Mike McGuire: Little communication is suspected.

*Question*: Toya Jones: *What are the irrigation amounts in each of the counties?*
*Answer*: Numerous: 2,100 acres-feet in Baylor County, 39,000 acre-feet in Haskell and Knox counties.

*Question*: Andrew Chastain-Howley: *Are there any flowing creeks within the aquifer area?*
*Answer*: Mike McGuire: There is no year round surface flow over the Seymour.
**Question:** Ray Brady: Are there similar modeling plans for any of the other pods (such as Collingsworth County)?

**Answer:** Shirley Wade: There are no plans for modeling other pods at this time. If stakeholders wish these other areas to be reviewed then the local Groundwater Conservation Districts should vocalize this need to the TWDB.

**DISCUSSION**

Mike McGuire: Well yields are not generally as strong in the younger sediments to the west of the main pod in Knox and Haskell counties.

Numerous: The native vegetation predating human development was tall grass prairie. There was also some skepticism that the aquifer was completely dry at the beginning of the 20th Century.

Toya Jones: The intention is to simulate the Seymour Aquifer filling up with water. The reports suggest that the aquifer filled up between 1900 and 1930.

**Note:** No other suggested scenarios or methods were put forward at this time.

Mike McGuire: With respect to recharge, the active area is between the cities of Rochester and Rule, where the Altus sandy loam soils are at the surface. The Natural Resources Conservation Service has completed soil surveys which may be of use for the recharge analysis.

Sam Fare: In addition, the best soils for recharge are generally the best soils for agriculture and irrigation. Therefore, these areas will get return flows in addition to high natural recharge rates. The dry land farming is conducted mainly on the black clay soils (which have lower recharge potential).

Toya Jones: Suggested that the consultant estimates recharge and then send it to stakeholders for review.

Mike McGuire: Municipal pumping from the aquifer is only for the city of Seymour today. All other municipalities are supplied by surface water from Miller Creek Reservoir, which filled up in 1978.