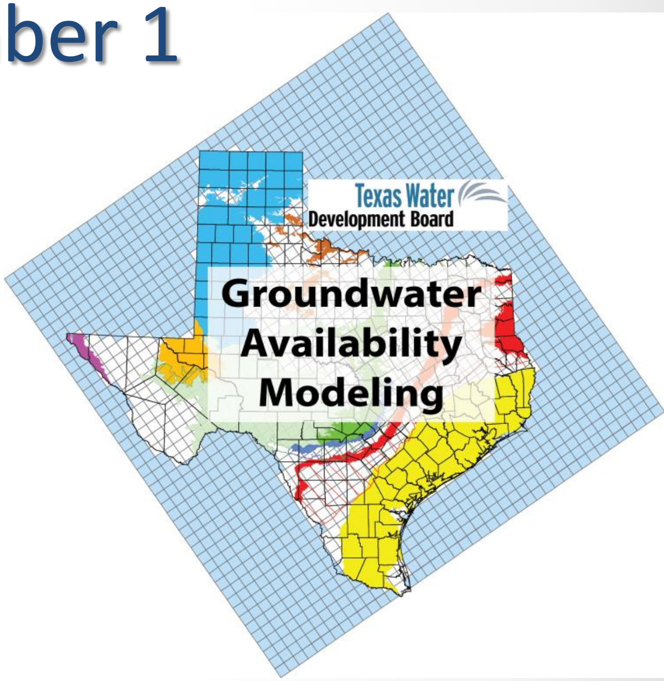
Groundwater Availability Model (GAM) for the Blossom Aquifer

Stakeholder Advisory Forum Number 1

Daingerfield, Texas

June 25, 2014

Cindy Ridgeway and
Shirley C. Wade
Groundwater Resources Division
Texas Water Development Board



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The statements contained in this presentation are my current views and opinions and are not intended to reflect the positions of, or information from, the Texas Water Development Board, nor is it an indication of any official policy position of the Board.

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Thank you

- To Daingerfield State Park for use of their beautiful facilities for our stakeholder meeting

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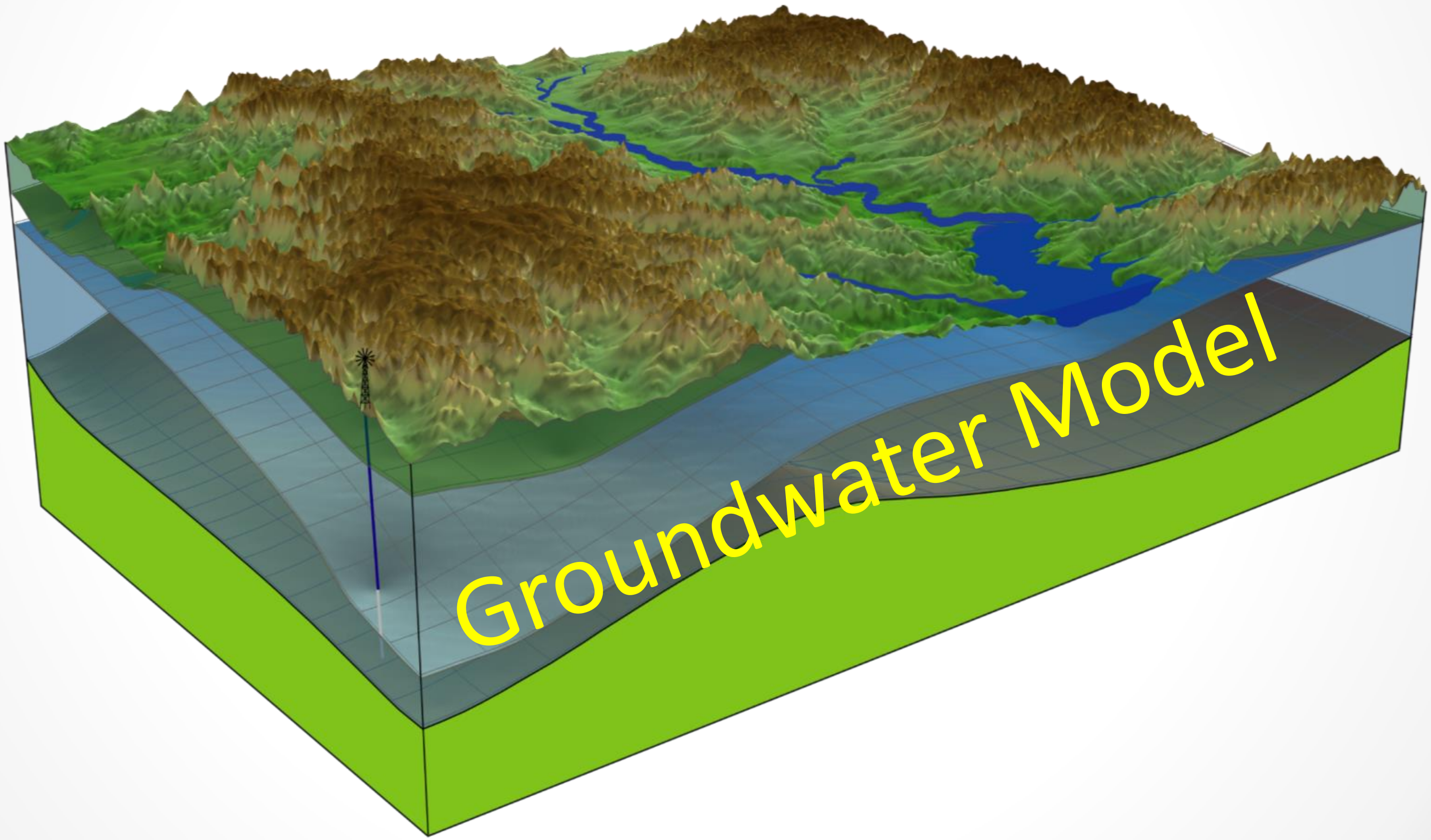
Outline

- Introduction
  - Study Objectives
  - TWDB Groundwater Availability Modeling Program
- Background
  - Aquifers and Groundwater Flow
  - Groundwater Models
- Blossom Aquifer Overview
  - Study Area - maps
  - Climate – average rainfall map, annual rainfall at select stations
  - Geology – stratigraphy, geologic map
  - Historical Water Use - pumping
  - Historical Water Levels – hydrographs
- Request for Data
- Project Schedule

Study Objectives

- To better understand the Blossom Aquifer; the inflows and outflows and aquifer properties and
- To develop a tool to help local and regional water planners make decisions about future water planning

Groundwater Availability Modeling



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GAM Program

- **Purpose:** to develop groundwater flow models to help Groundwater Conservation Districts (GCD), Groundwater Management Areas (GMA), Regional Water Planning Groups (RWPG), and others with managing their groundwater resources
- **Public process**: encourage stakeholder participation in model development and model improvements
- **Freely available**: standardized, thoroughly documented, with reports available over the internet
- **Living tools**: periodically updated

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What is Groundwater Availability?

Policy	+	Science	=	Groundwater Availability
↓		↓		↓
Desired Future Conditions	+	GAM or other tool	=	Modeled Available Groundwater

Goal: informed decision-making

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Modeled Available Groundwater in statute

- Texas Water Code, §36.1084 (b) states that, the Executive Administrator of the TWDB shall provide each district and regional water planning group located wholly or partly in the management area with the modeled available groundwater in the management area based upon the desired future conditions adopted by the districts.

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Modeled Available Groundwater

- Desired future conditions are determined through joint planning of groundwater conservation districts in groundwater management areas
- Modeled available groundwater is then estimated by groundwater availability models where they are available

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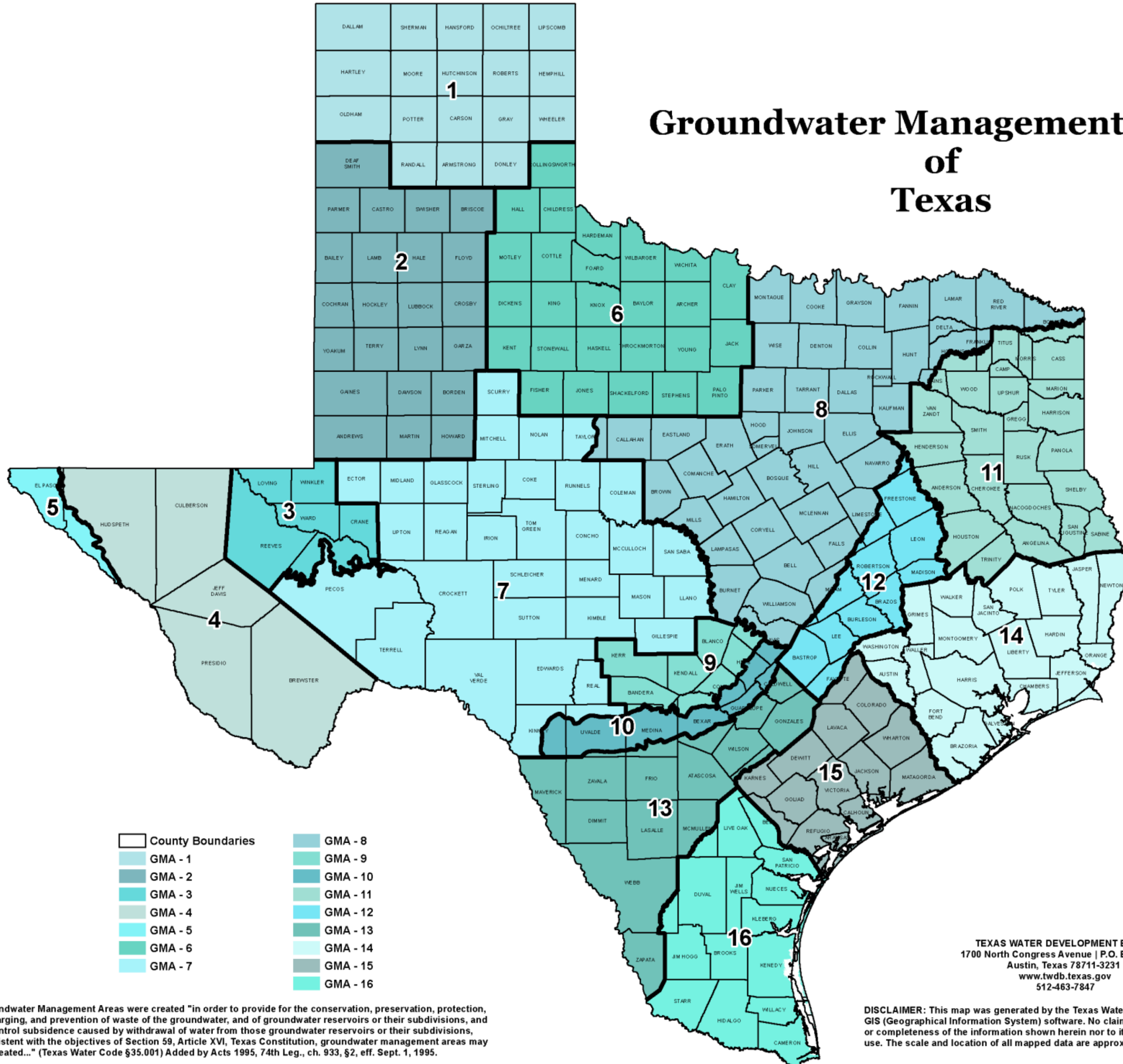
Groundwater Management Areas of Texas



TEXAS WATER DEVELOPMENT BOARD
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www.twdb.texas.gov
512-463-7847

Groundwater Management Areas were created "in order to provide for the conservation, preservation, protection, recharging, and prevention of waste of the groundwater, and of groundwater reservoirs or their subdivisions, and to control subsidence caused by withdrawal of water from those groundwater reservoirs or their subdivisions, consistent with the objectives of Section 59, Article XVI, Texas Constitution, groundwater management areas may be created..." (Texas Water Code §35.001) Added by Acts 1995, 74th Leg., ch. 933, §2, eff. Sept. 1, 1995.

The responsibility for Groundwater Management Area delineation was delegated to the Texas Water Development Board (Section 35.004, Chapter 35, Title 2, Texas Water Code).The initial Groundwater Management Area delineations were adopted on December 15, 2002 (356.23, TWDB Rules).

DISCLAIMER: This map was generated by the Texas Water Development Board using GIS (Geographical Information System) software. No claims are made to the accuracy or completeness of the information shown herein nor to its suitability for a particular use. The scale and location of all mapped data are approximate. Map date: JAN-2014

MISSION: The Texas Water Development Board's (TWDB) mission is to provide leadership, planning, financial assistance, information, and education for the conservation and responsible development of water for Texas.

TNRIS

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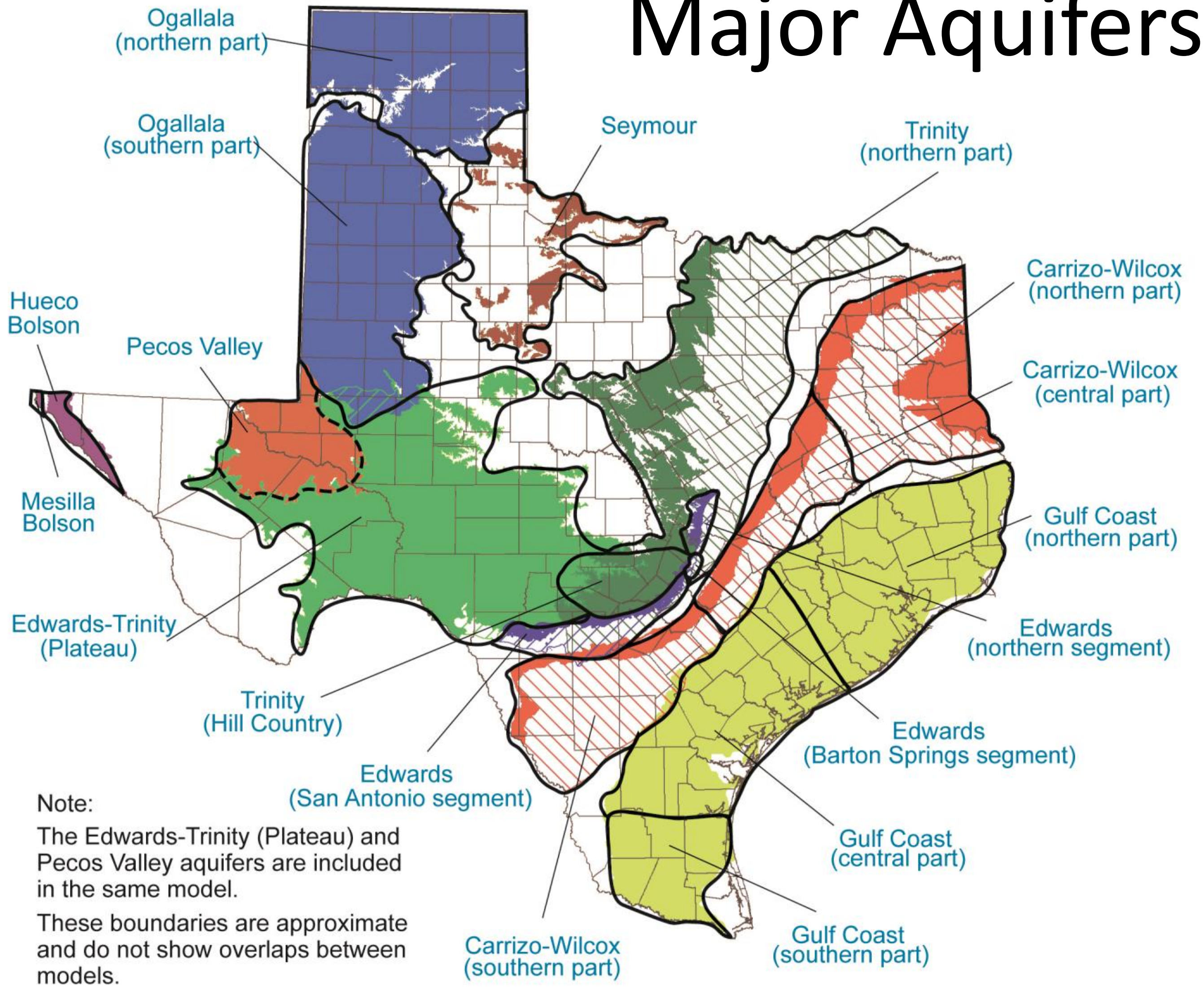
Major Aquifers



Note:

The Edwards-Trinity (Plateau) and Pecos Valley aquifers are included in the same model.

These boundaries are approximate and do not show overlaps between models.

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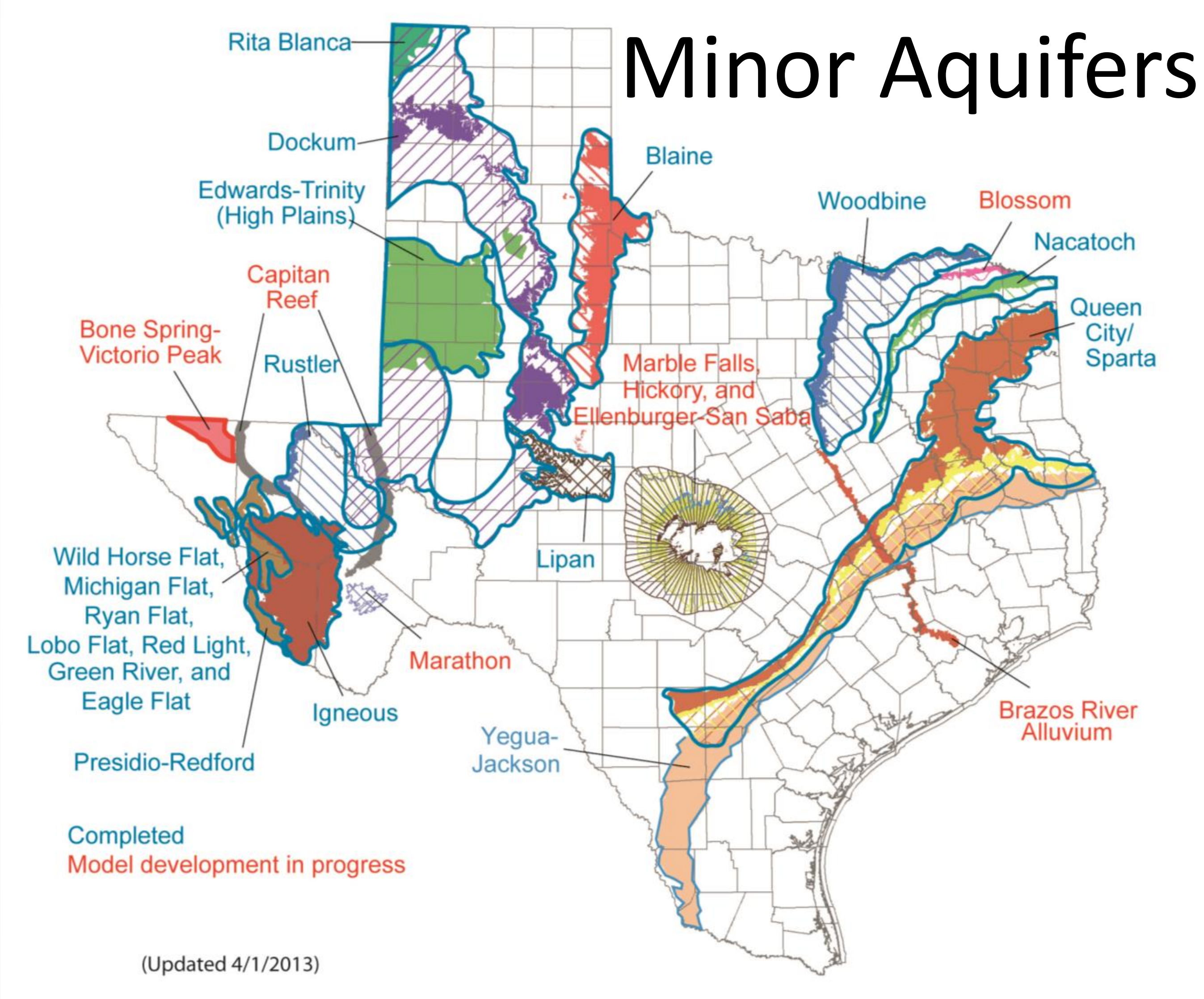
Minor Aquifers



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How we use Groundwater Models

- **Texas Water Code, § 36.1071 (h)**

Inform groundwater districts about historical conditions in the aquifer

Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Edwards-Trinity (Plateau) Aquifer	140,509
	Pecos Valley Aquifer	14,115
	Dockum Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Edwards-Trinity (Plateau) Aquifer	31,222
	Pecos Valley Aquifer	9,804
	Dockum Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Edwards-Trinity (Plateau) Aquifer	32,993
	Pecos Valley Aquifer	3,441
	Dockum Aquifer	554

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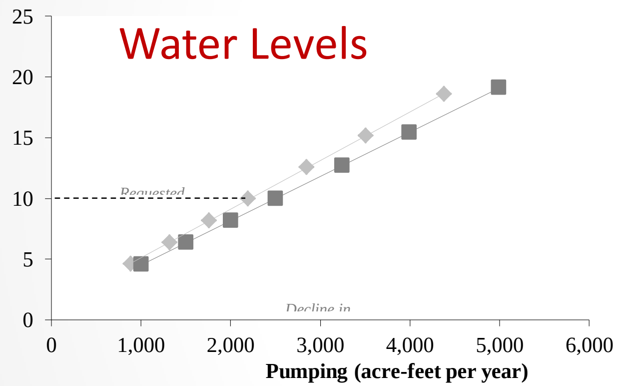
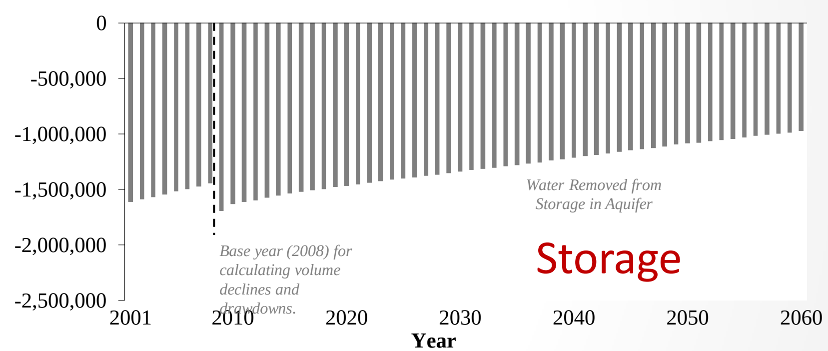
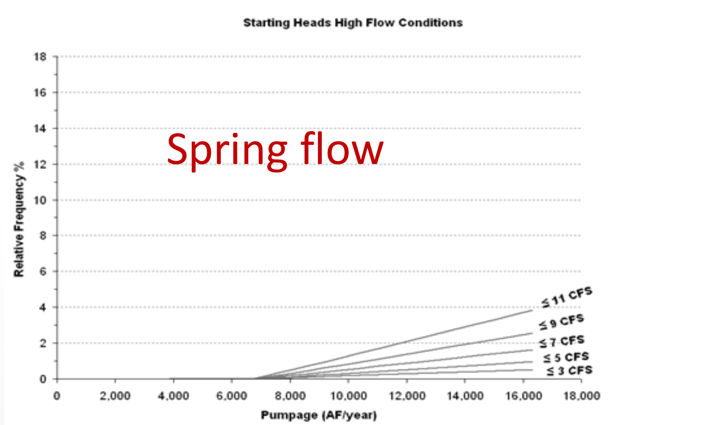
How we use Groundwater Models

- Texas Water Code, § 36.108 (d): the districts shall consider groundwater availability models and other data or information [when developing desired future conditions]





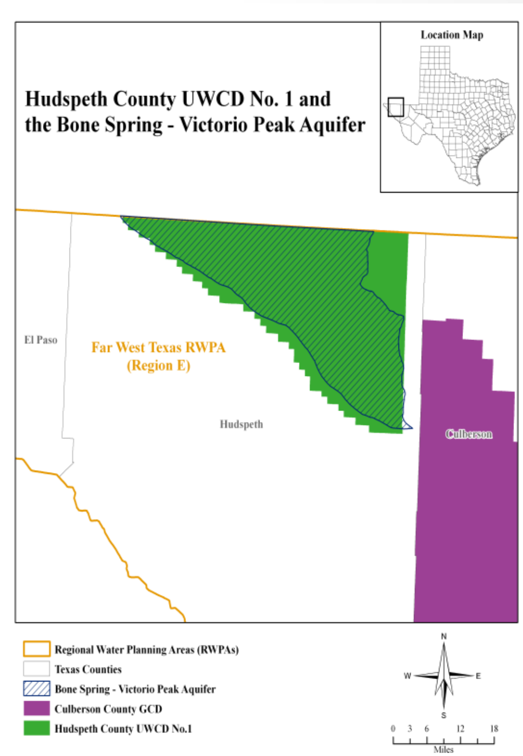


How we use Groundwater Models

- **Texas Water Code, § 36.1084 (b): Estimate modeled available groundwater based on desired future conditions**

County	Regional Water Planning Area	Basin	Year					
			2010	2020	2030	2040	2050	2060
Hudspeth	E	Rio Grande	101,429	101,429	101,429	101,429	101,429	101,429

*Modeled available groundwater is in acre-feet per year



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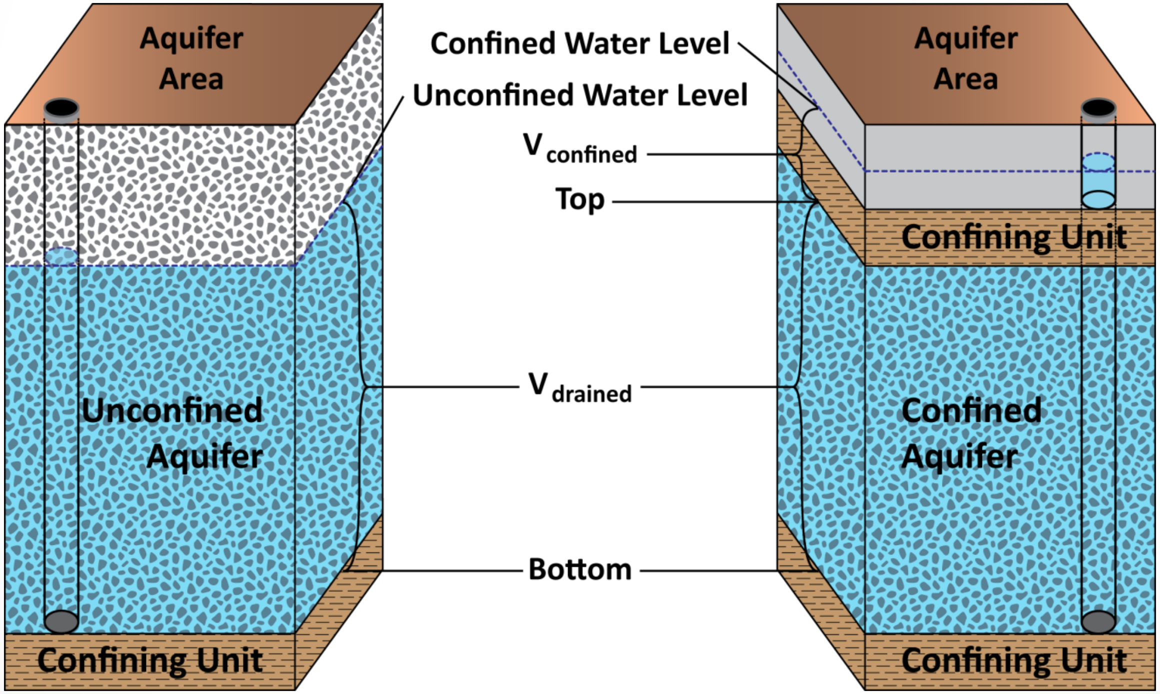
How we use Groundwater Models

- **Texas Water Code, § 36.108 (d) (3)**

Estimating total recoverable storage for explanatory reports



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Stakeholder Advisory Forums

- Keep updated about progress of the model development
- Understand how the groundwater model can, should, and should not be used
- Provide input and data to assist with model development

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An aquifer consists of subsurface layers of rock or dirt that can produce economically usable amounts of water

GROUNDWATER FLOW AND AQUIFERS

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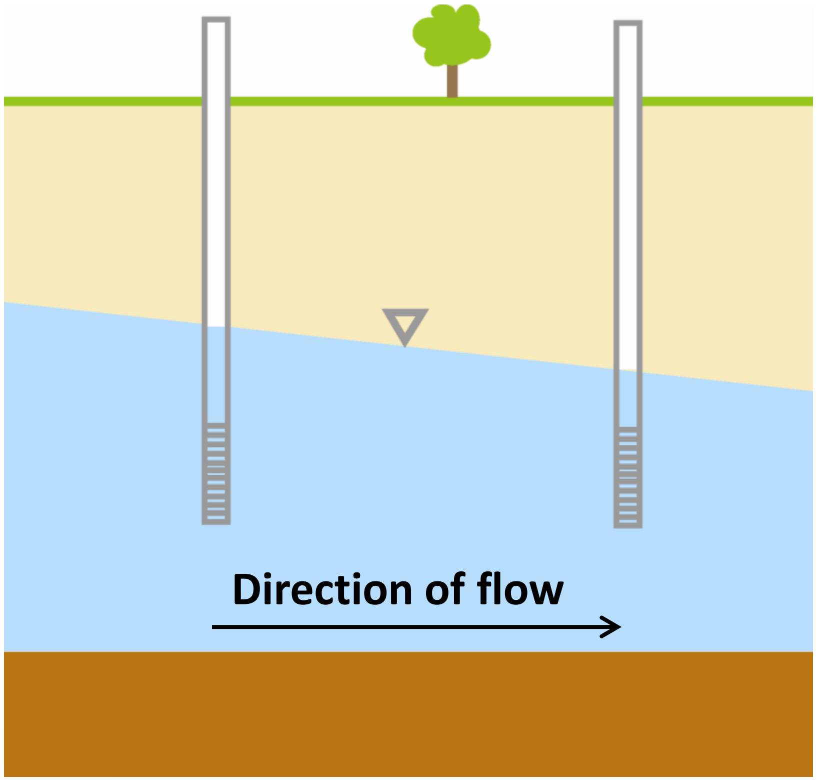
Groundwater flows from higher potential energy (head) to lower potential energy



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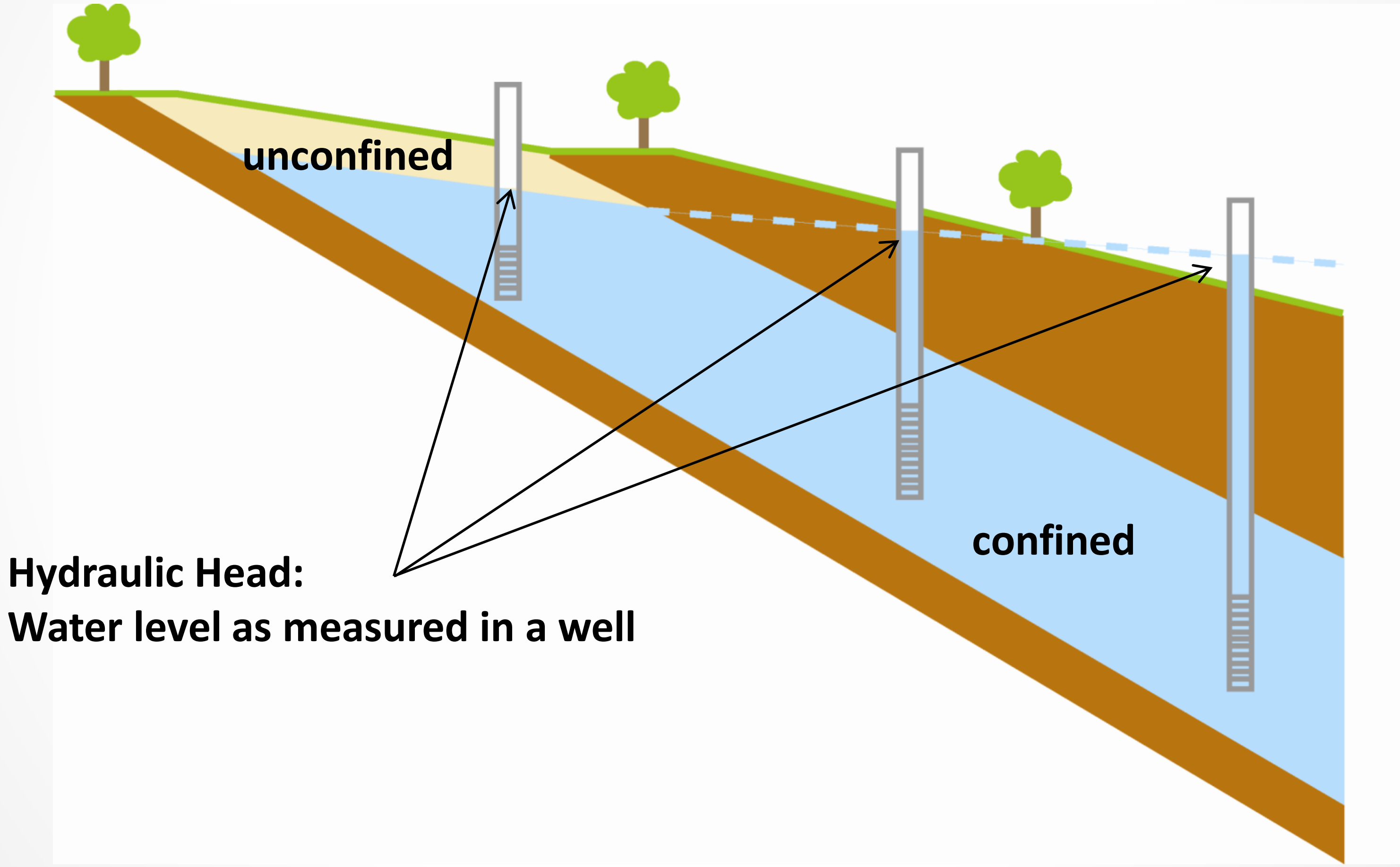
Groundwater Flow

- Hydraulic Conductivity or *K* is a measure of how easily water flows through the aquifer

Water levels can indicate confined or unconfined conditions



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Aquifer Storage Properties

- Storage coefficient and specific yield are measures of the volume of water an aquifer can hold (measured from aquifer tests)
- Storage coefficient is much smaller than specific yield. A unit drop in the water table produces much more water than a unit decline in confined water level.

Groundwater models are simplified representations of underground water systems (aquifers)

GROUNDWATER MODELING

Groundwater Models

- They can be physical models such as sand tank models or they can be mathematical models
- We are using a mathematical modeling computer program called MODFLOW for the Blossom Aquifer groundwater availability model
- MODFLOW is a publicly available computer program developed by the United States Geological Survey

Groundwater Models

- Aquifer data is used by the computer model to predict water levels and groundwater discharge
- History matching also known as model calibration is used to estimate some aquifer properties that are not well known

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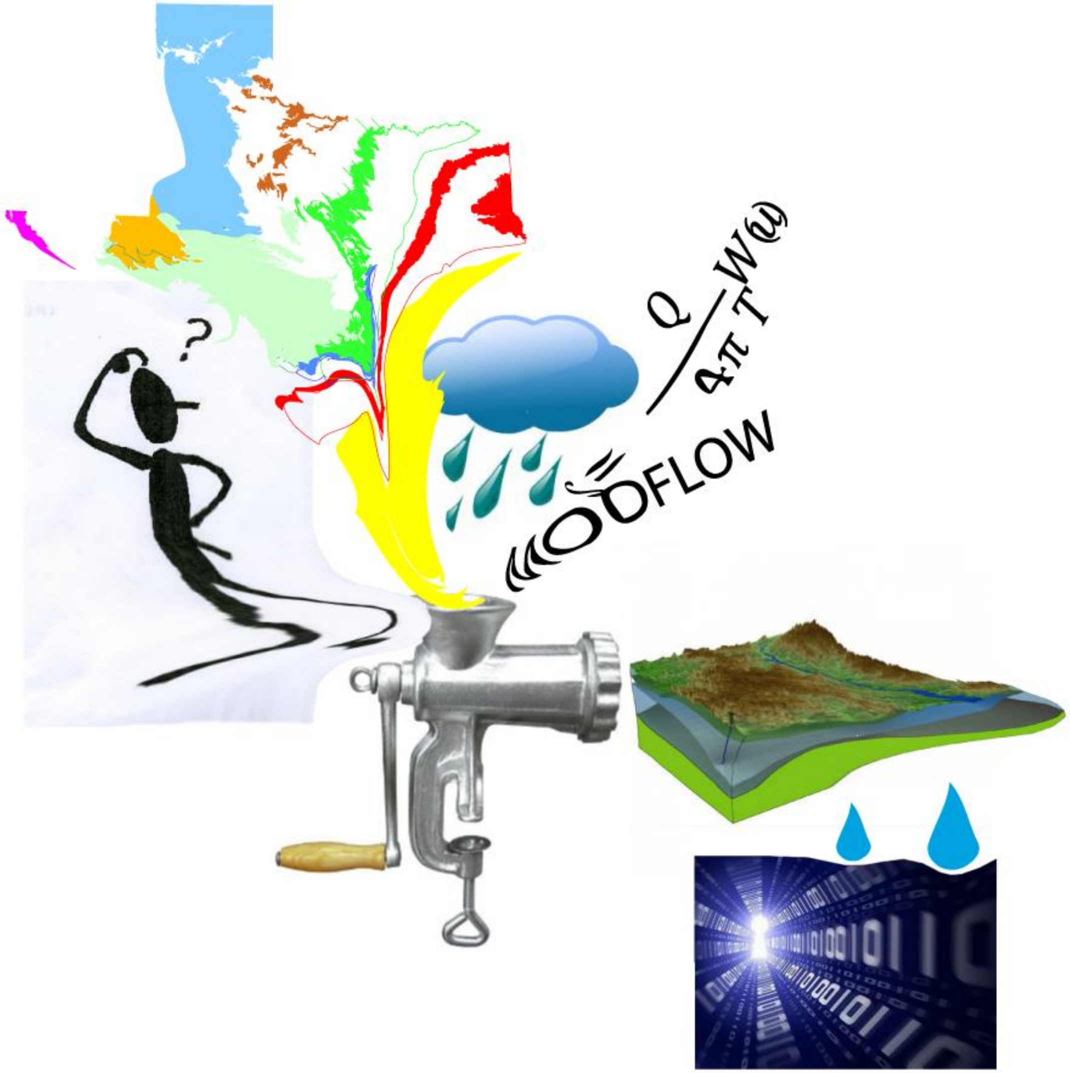
Building a Groundwater Model



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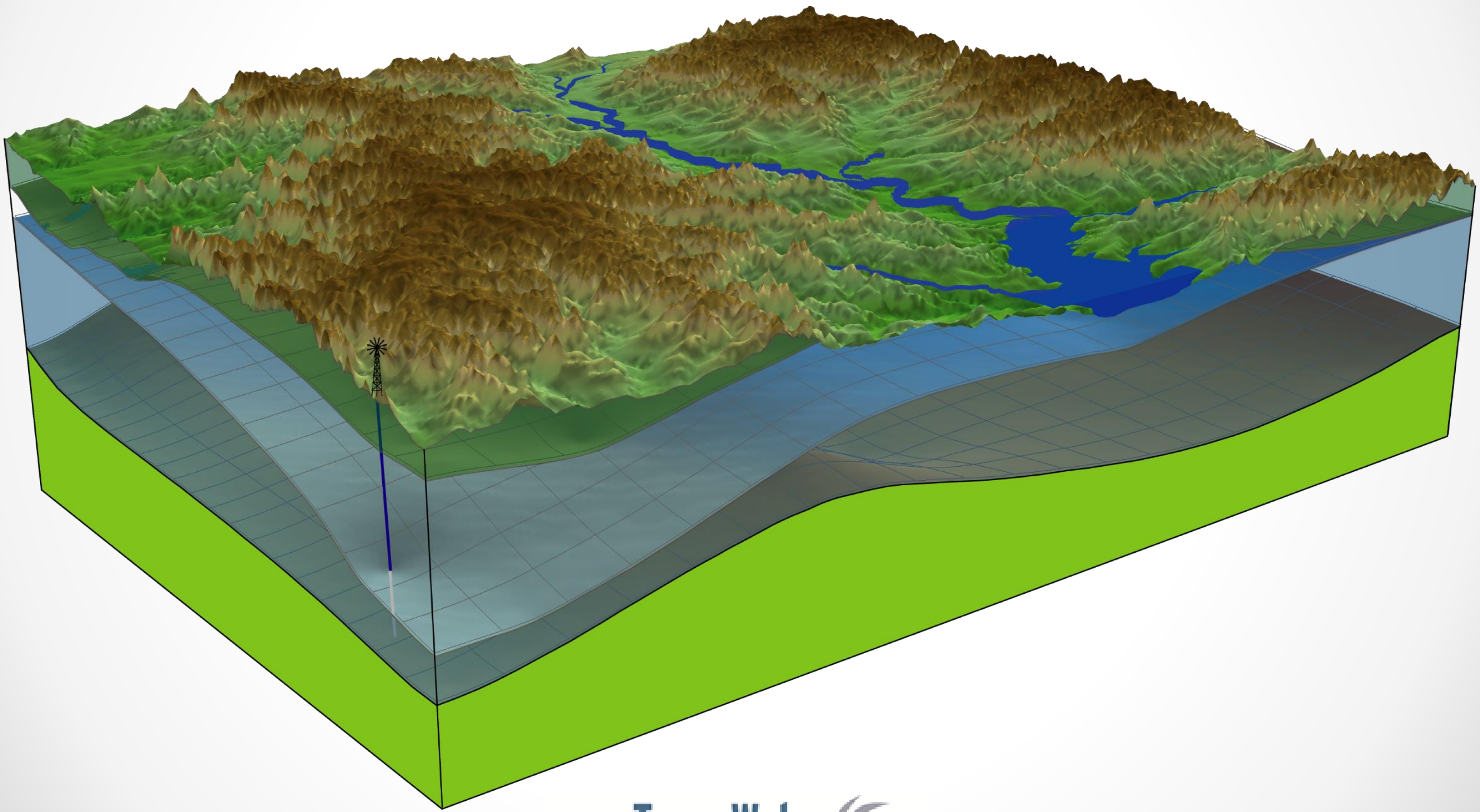
To build a groundwater model we:

1. Characterize aquifer properties
2. Overlay grid
3. Assign aquifer properties to the grid cells
4. Adjust aquifer properties (within limits) to match historical data (water levels and groundwater discharge)

Last step is known as calibration

Characterize Aquifer Geometry and Properties



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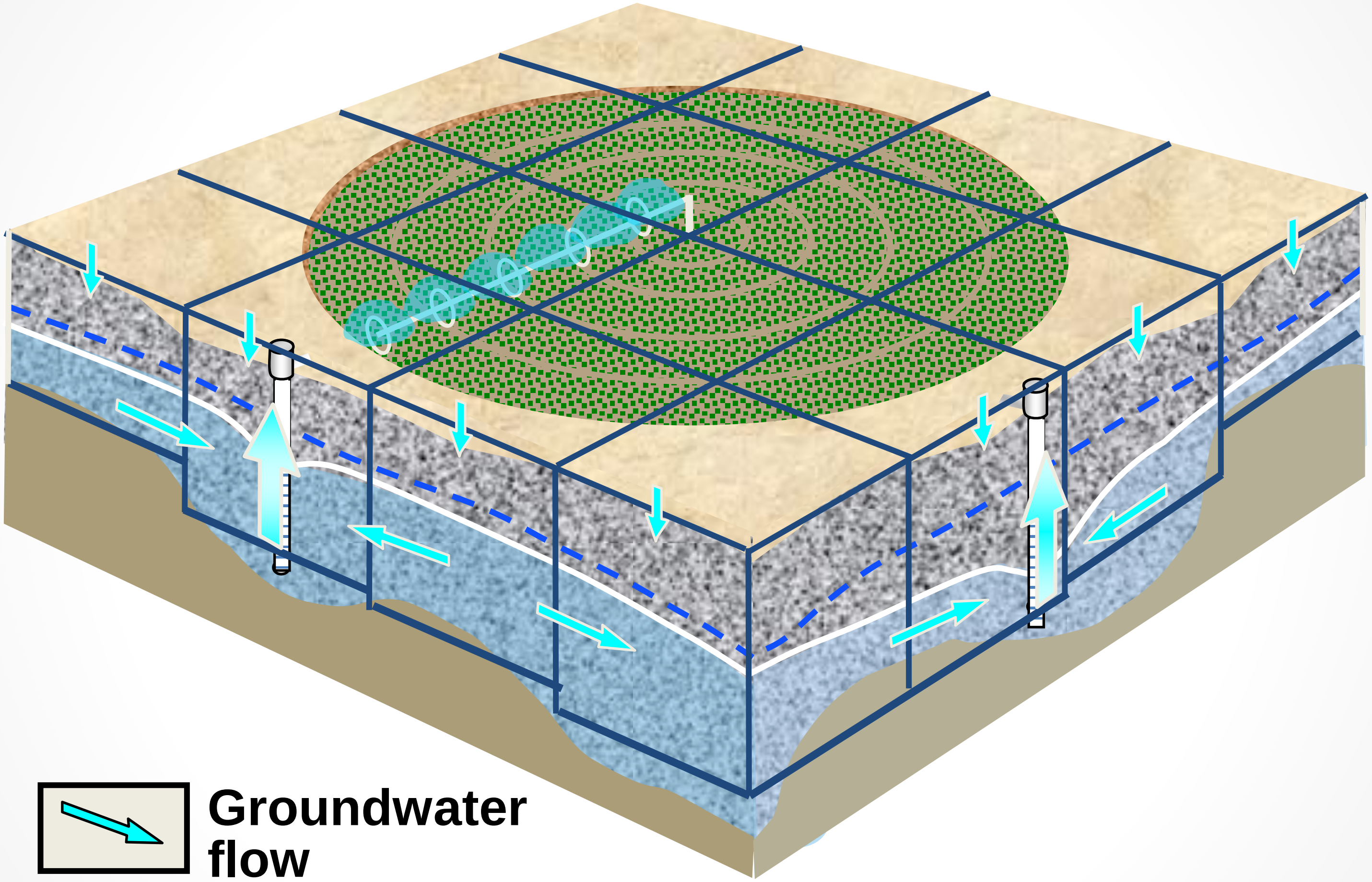
Overlay Grid



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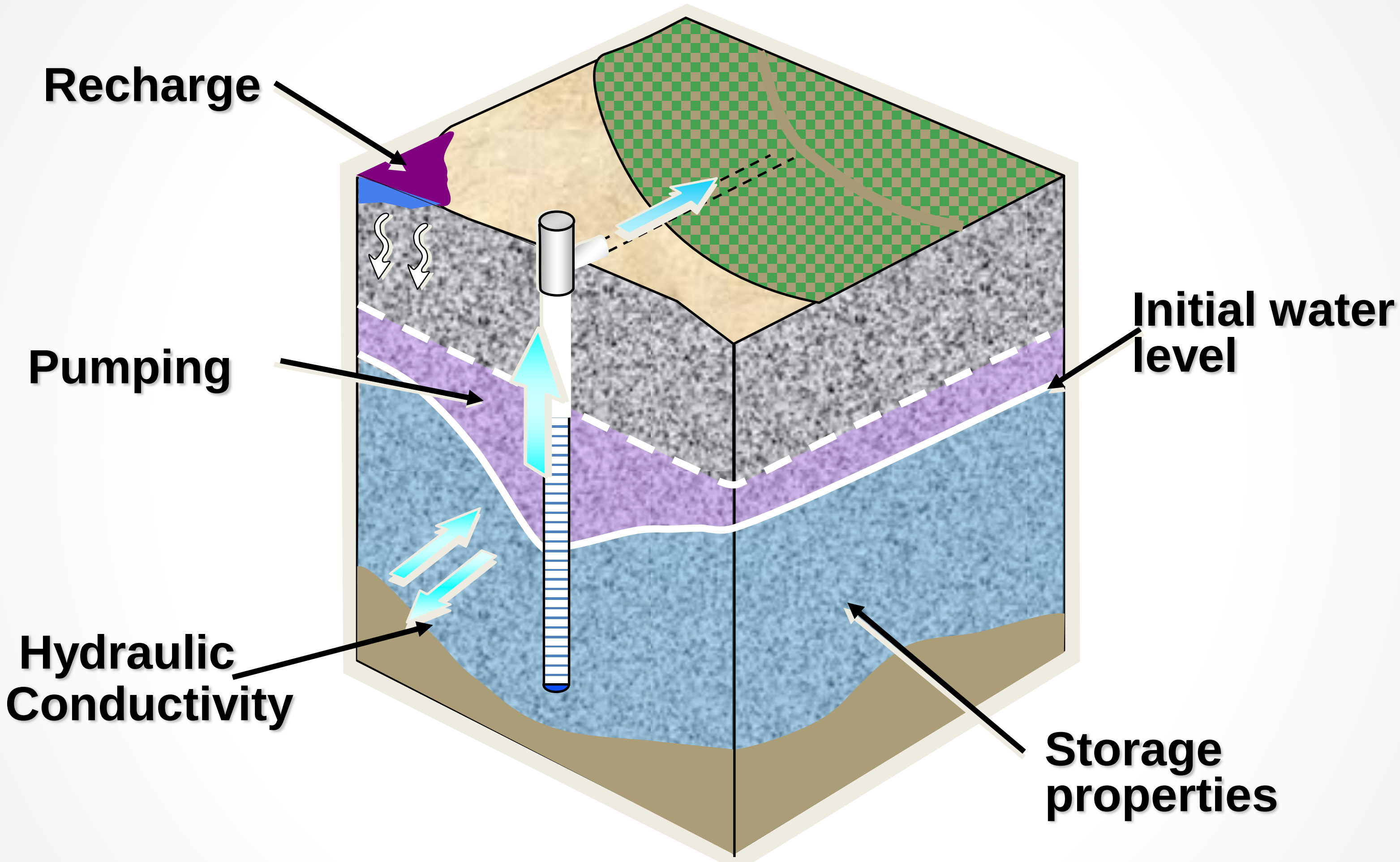
Assign Aquifer Properties



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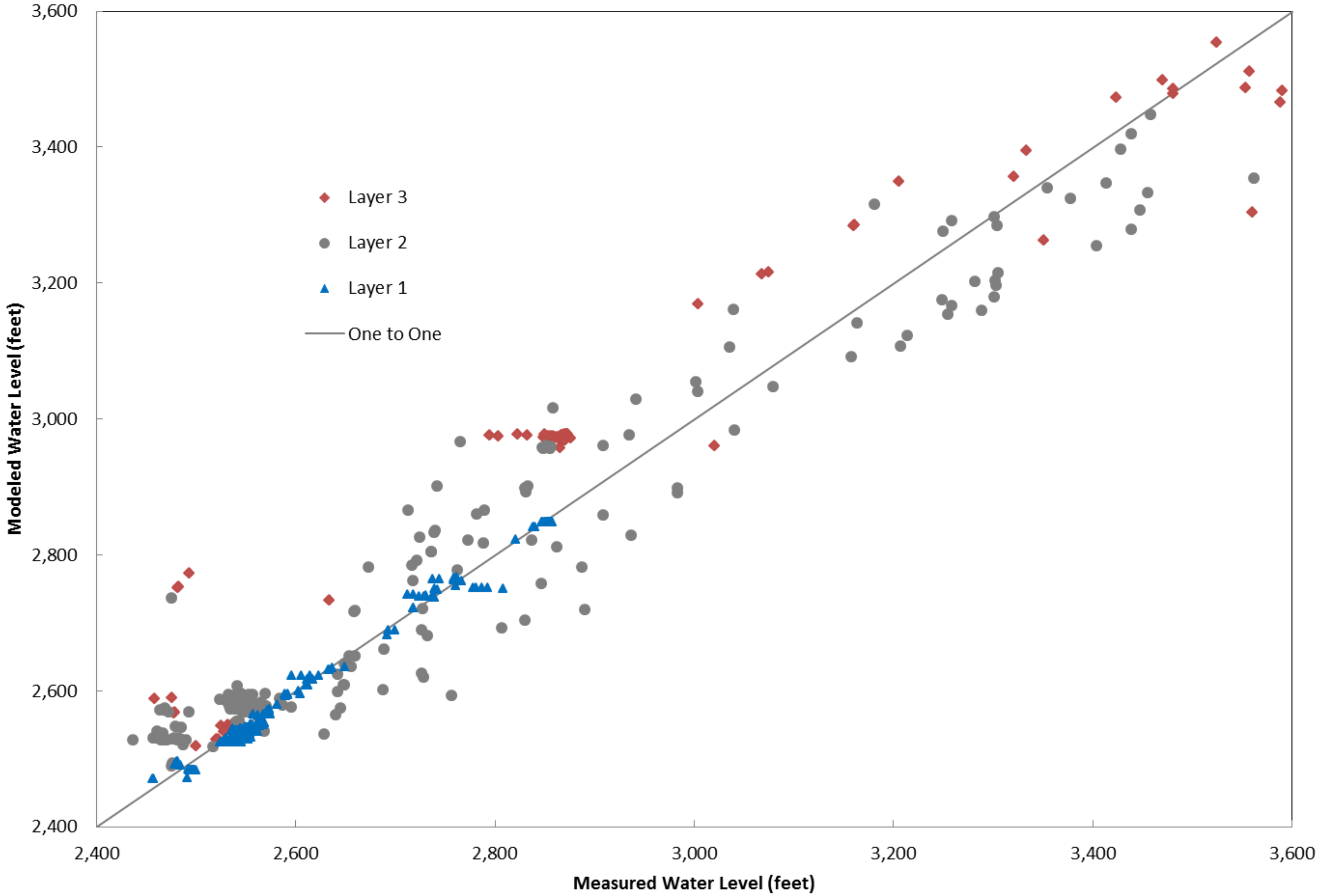
Calibration Example 1: GAM for the Presidio Bolson



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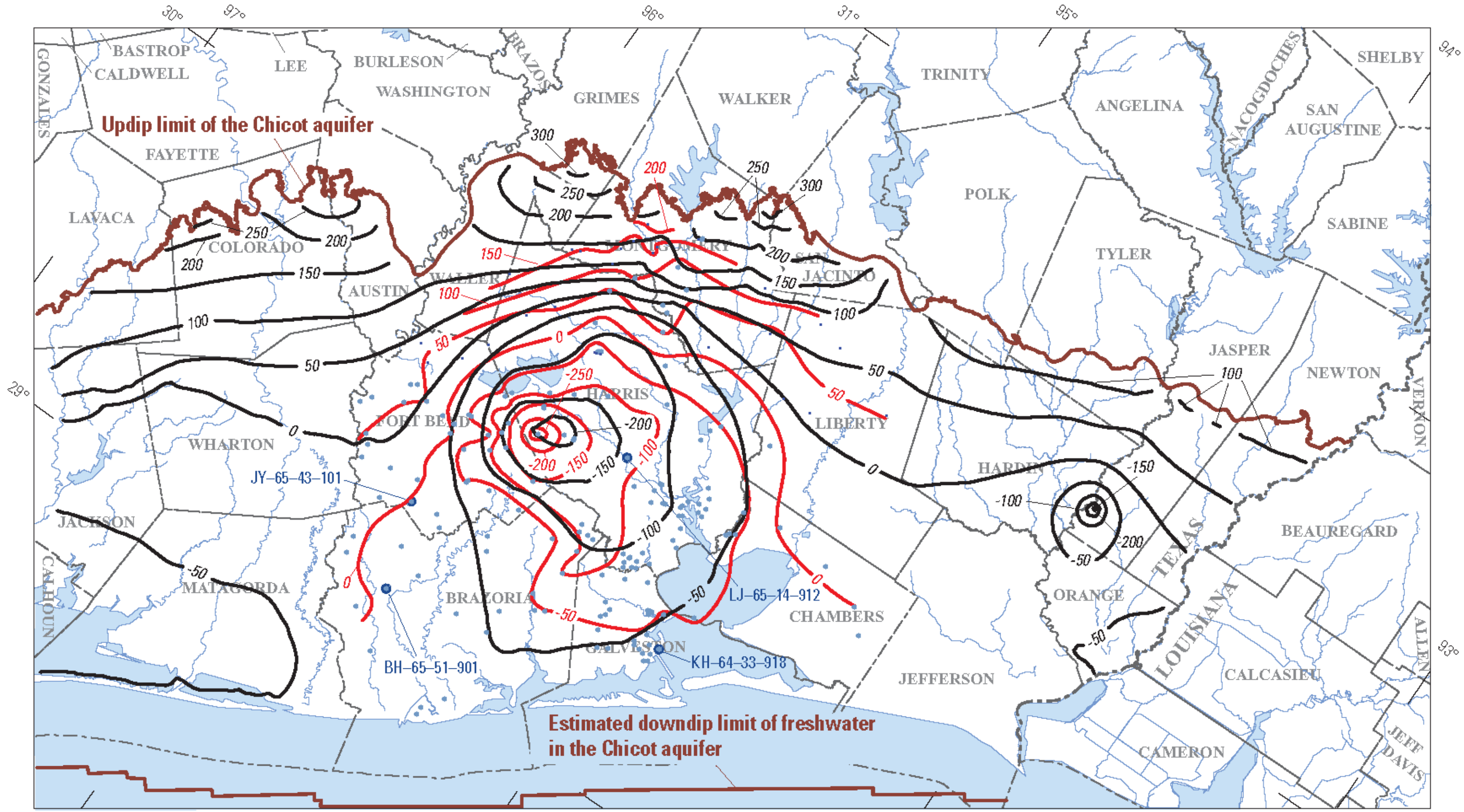


Base modified from U.S. Geological Survey digital data
Scale 1:24,000 (except Louisiana hydrography 1:100,000)
Albers equal-area projection
North American Datum of 1983
Standard parallels 34°55′ and 27°25′, central meridian 100°

0 10 20 30 40 MILES
0 10 20 30 40 KILOMETERS

N

EXPLANATION

–50 **Simulated potentiometric contour**—Shows altitude at which water would have stood in tightly cased well. Interval 50 feet. Datum is NAVD 88

–50 **Measured potentiometric contour**—Shows altitude at which water would have stood in tightly cased well. Interval 50 feet. Datum is NAVD 88

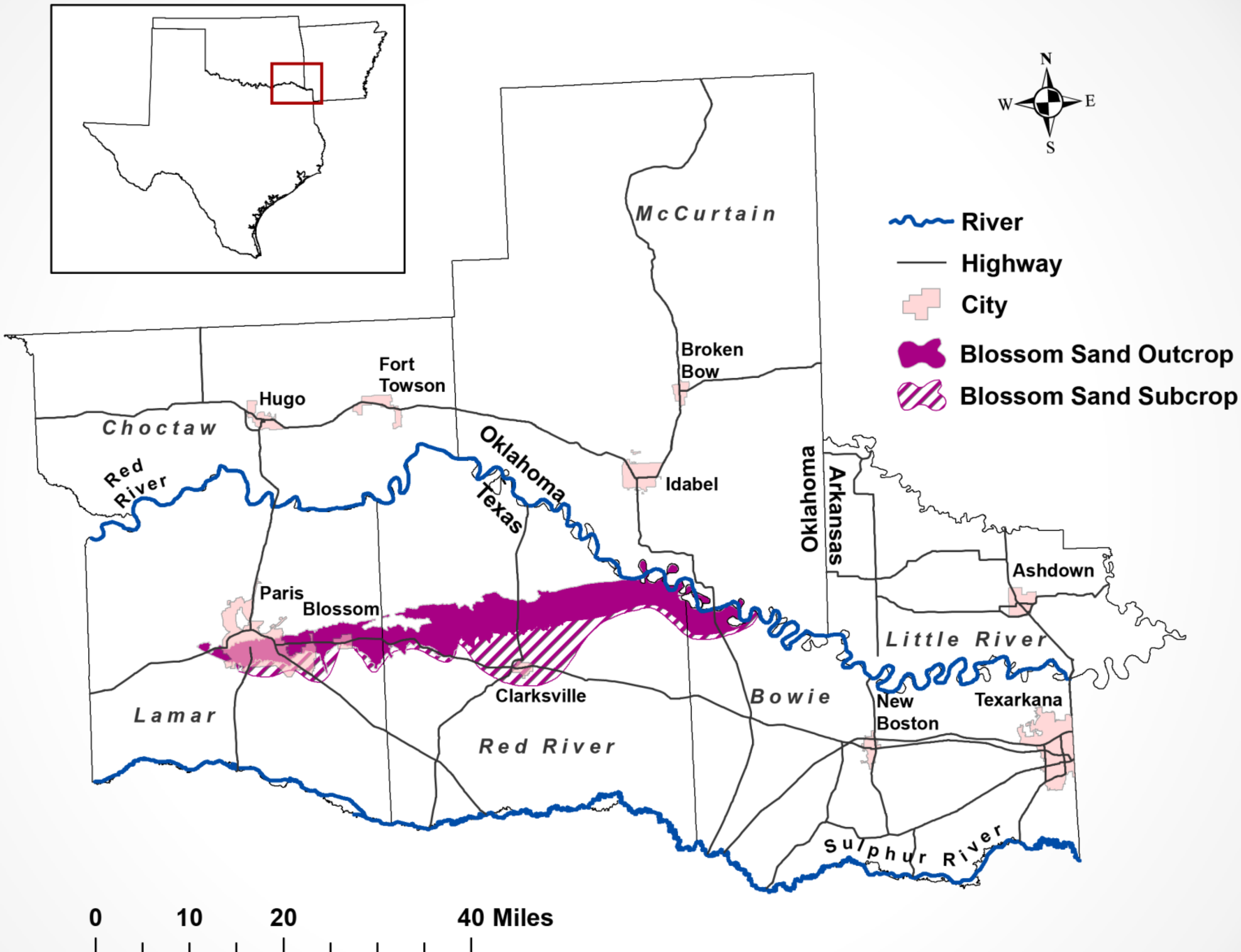
Data point—Well in which water-level measurement was made

LJ–65–14–912 **Data point and well number**—Well in which water-level measurement was made and for which hydrograph is shown on figure 26

NAVD 88, North American Vertical Datum of 1988

Calibration Example 2: Houston Area Groundwater Model (from Kasmarek, 2013)


BLOSSOM AQUIFER



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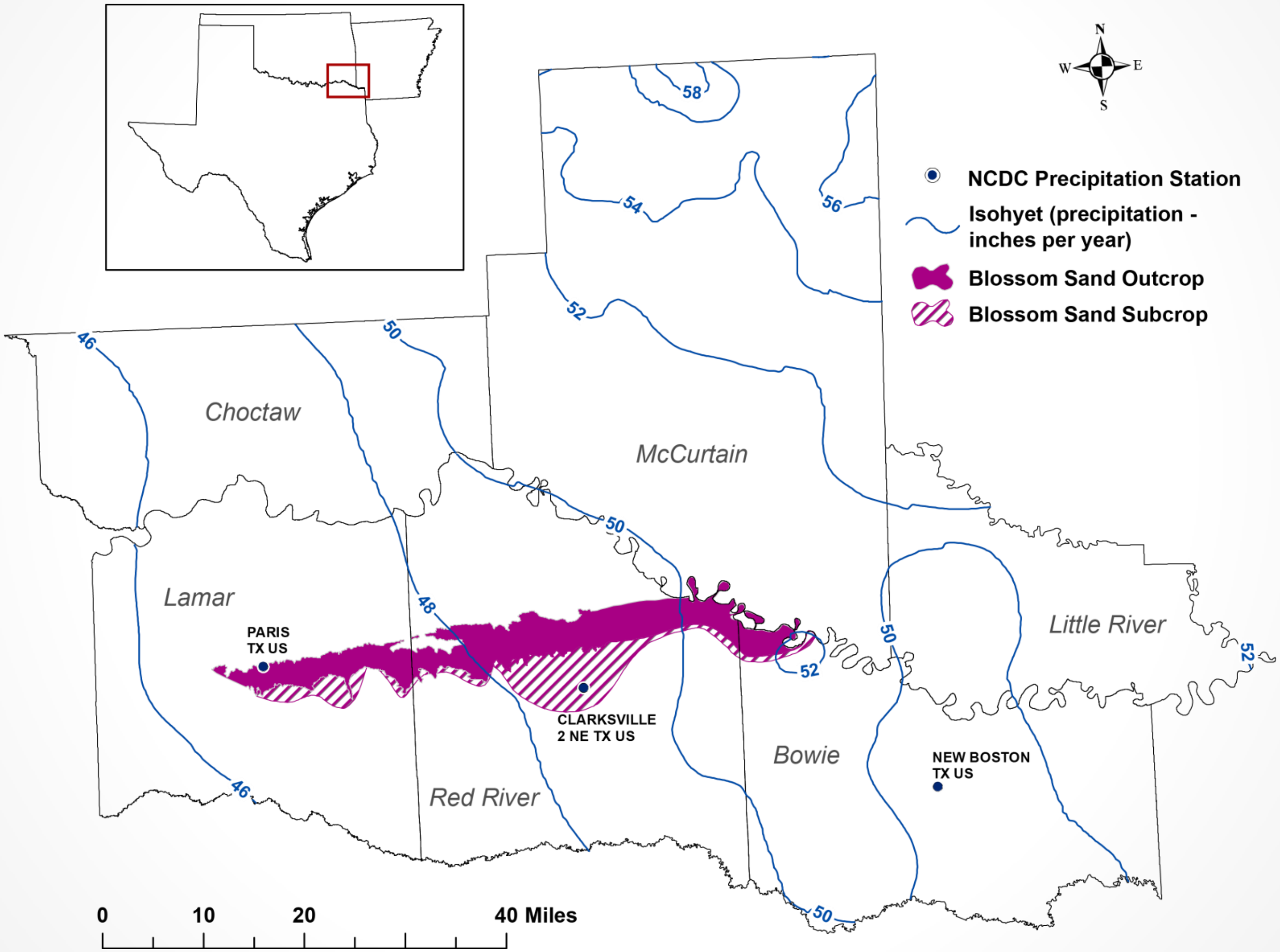
Study Area

1981 – 2010 Average Rainfall

(PRISM Climate Group, Oregon State University, http://prism.oregonstate.edu , created 10 July 2012)



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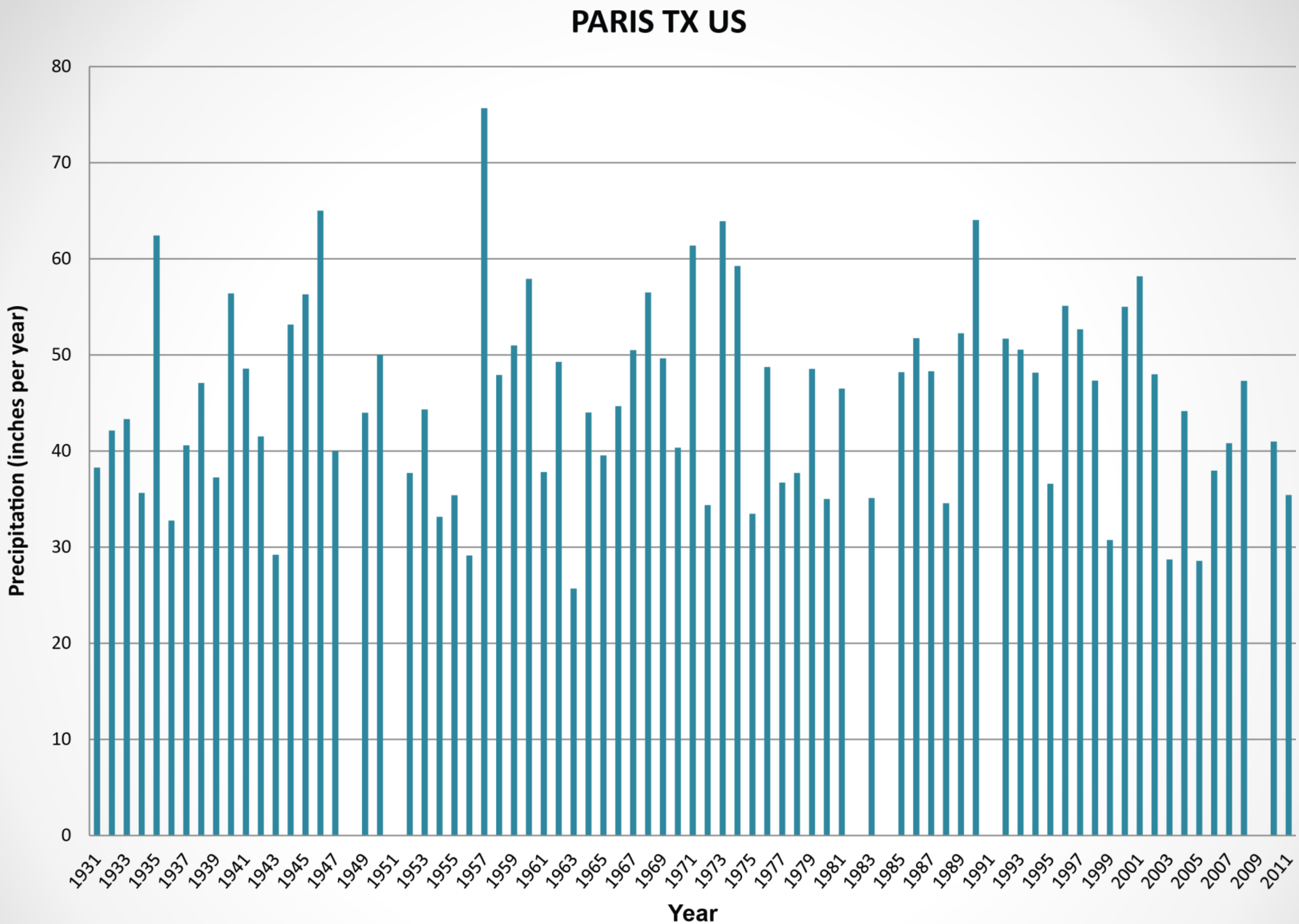

source: National Climate Data Center, online data accessed September 2013

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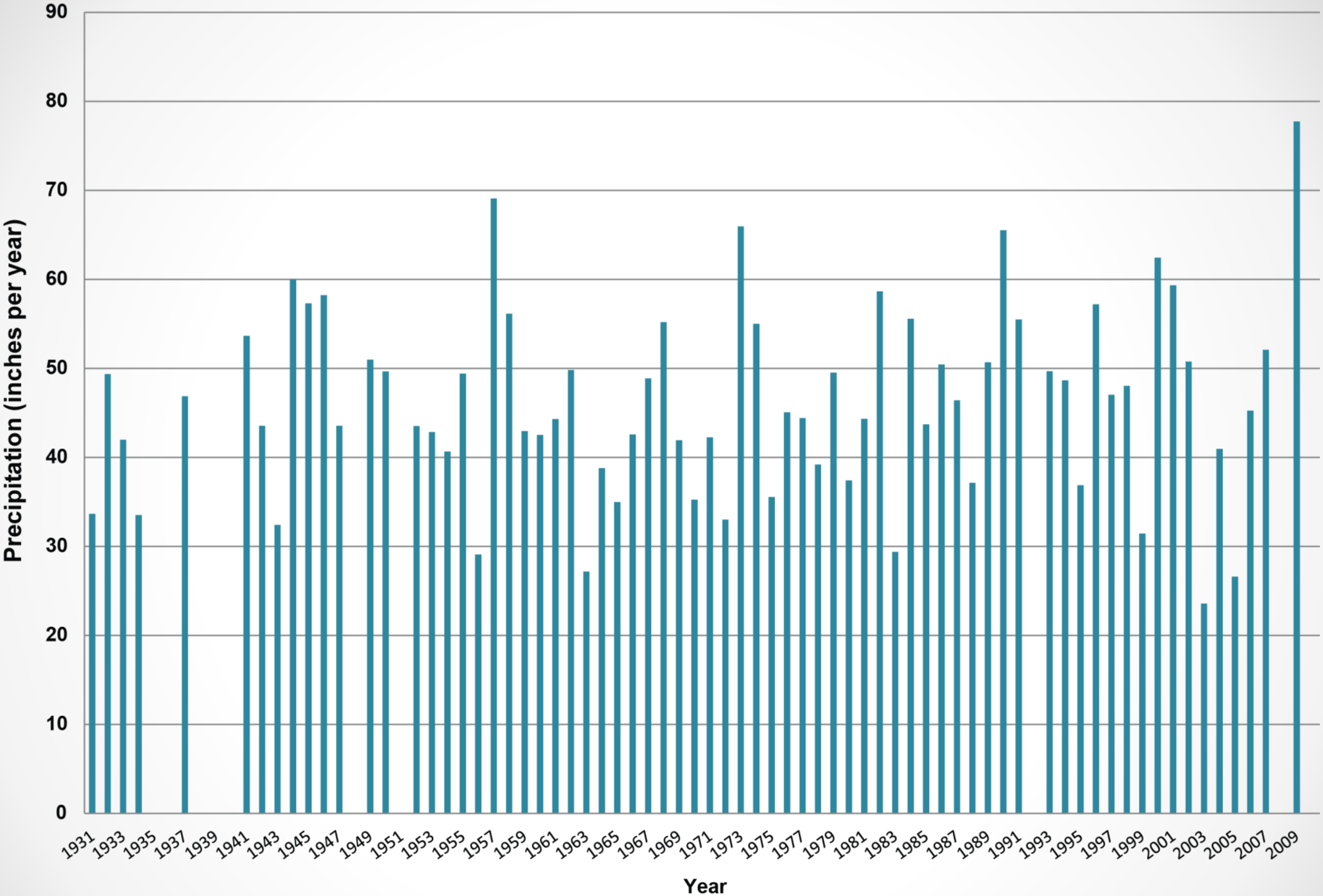
CLARKSVILLE 2 NE TX US



source: National Climate Data Center, online data accessed September 2013

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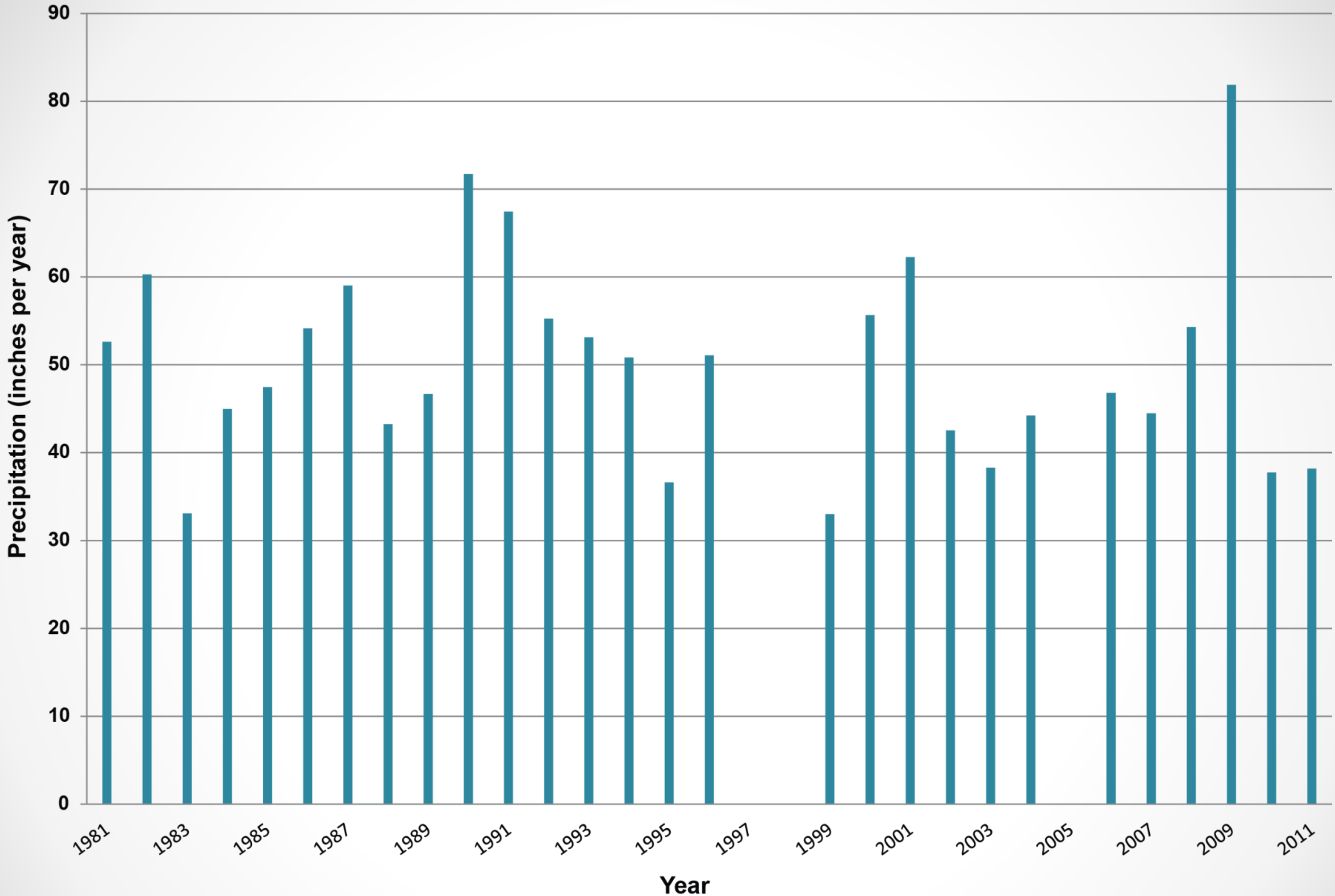
NEW BOSTON TX US



source: National Climate Data Center, online data accessed September 2013

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Stratigraphy and Hydrostratigraphy

(after McLaurin, 1988)

Era	System	Series	Group	Formation	Approximate maximum thickness (ft)	Lithology[1]	Water-bearing characteristics
Cenozoic	Quaternary	Recent		Alluvium	75	Sand, silt, clay, and gravel	Yields small[2] to moderate[3] quantities of water to wells along the Red River
		Pleis-tocene		Fluviatile, terrace deposits			
Mesozoic	Cretaceous	Gulf	Taylor	Marbrook Marl Pecan Gap Chalk Wolfe City-Ozan Formation	1,500	Clay, marl, shale, chalk, mudstone, and sandstone, very fine-grained	Yields small quantities of water to shallow wells
			Austin	Gober Chalk		Chalk, discontinuous	Not known to yield water to wells
				Brownstown		Clay or shale	Not known to yield water to wells
				Blossom Sand	226	Fine to medium sand interbedded with light to dark marl and chalky marl	Yields small to moderate quantities of water to municipal, domestic, and livestock wells
				Bonham	400 / 700	Clay or shale	Not known to yield water to wells
				Ector		Chalk	Not known to yield water to wells
			Eagle Ford		650	Shale with thin beds of sandstone and limestone	Yields small quantities of water to shallow wells

1. Lithology from Wood and Guevara (1981) and Nordstrom (1982).)
2. Small quantities of water are generally less than 100 gallons per minute
3. Moderate quantities of water are generally 100 to 1,000 gallons per minute

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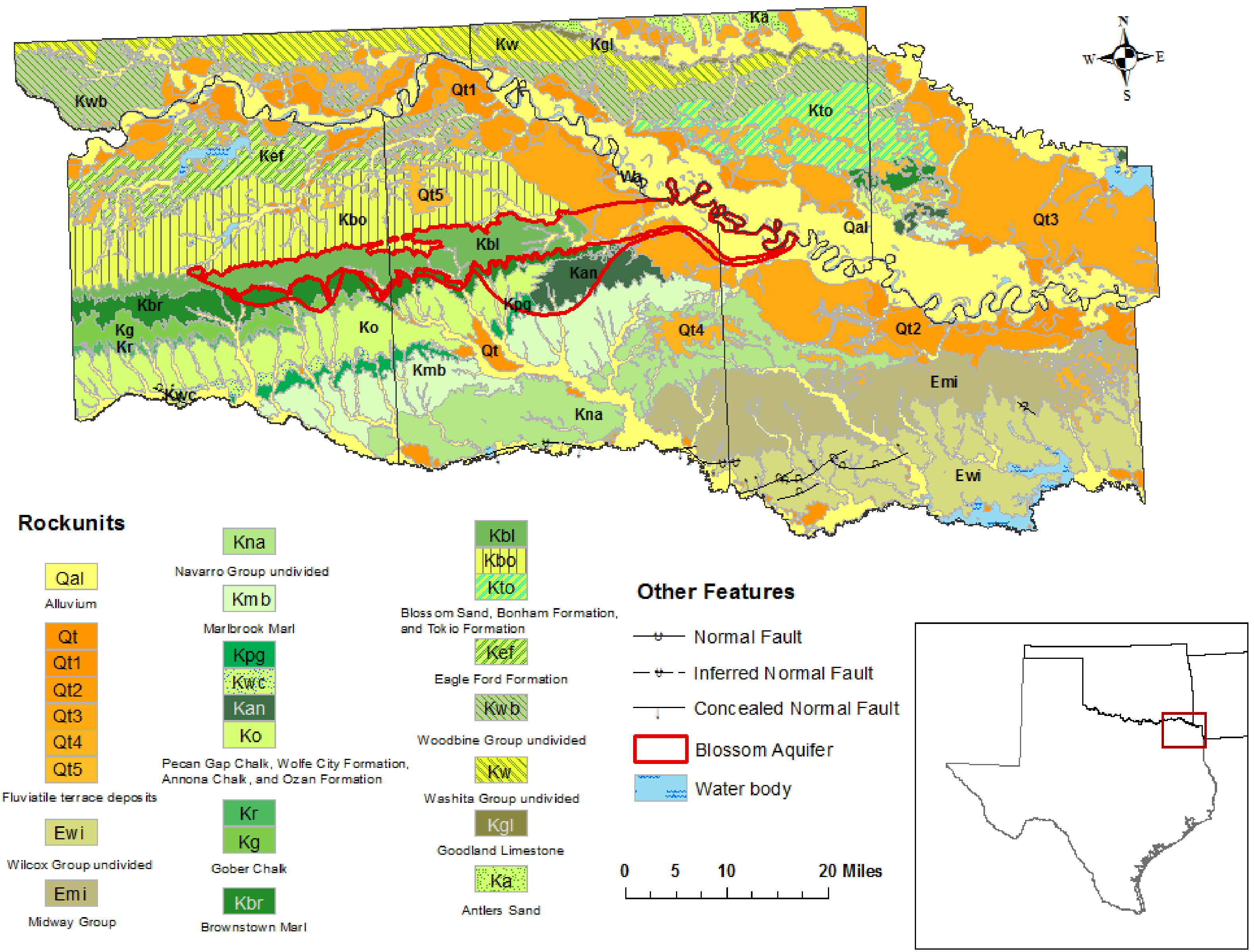
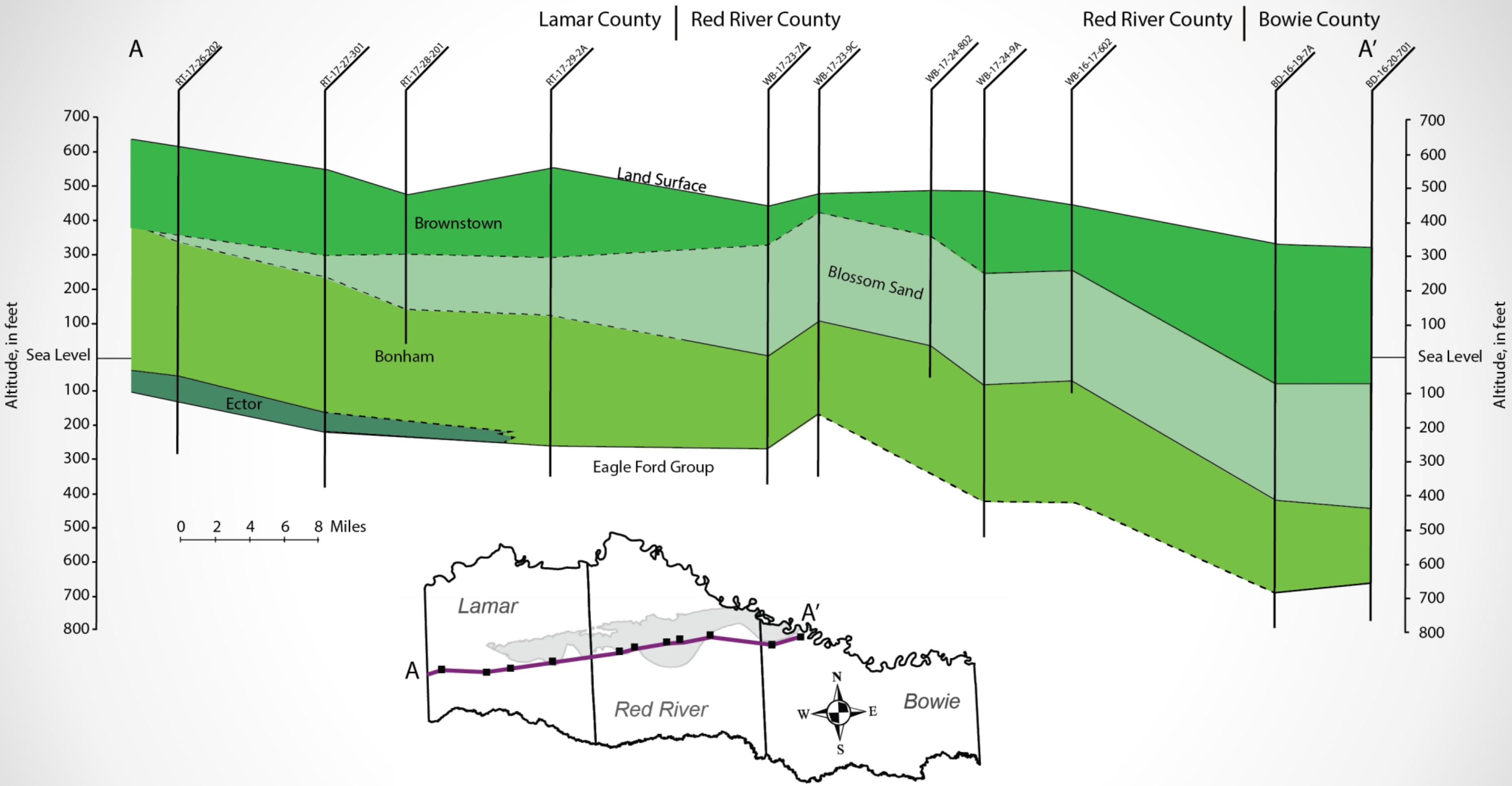
Geology (from University of Texas, Bureau of Economic Geology)



West-East Cross Section (after McLaurin, 1988)



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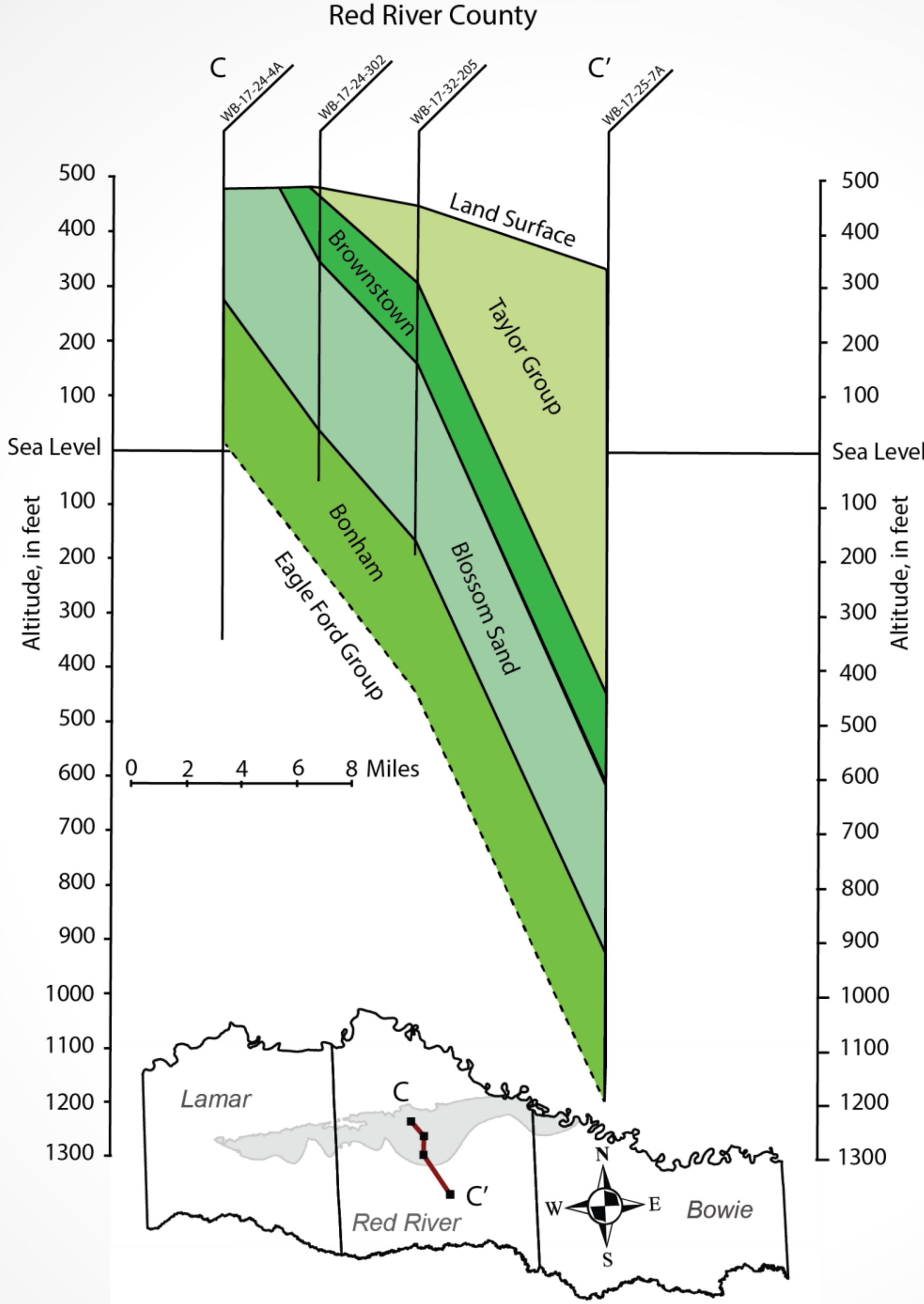
North-South Cross Section

(after McLaurin, 1988)



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Water Use

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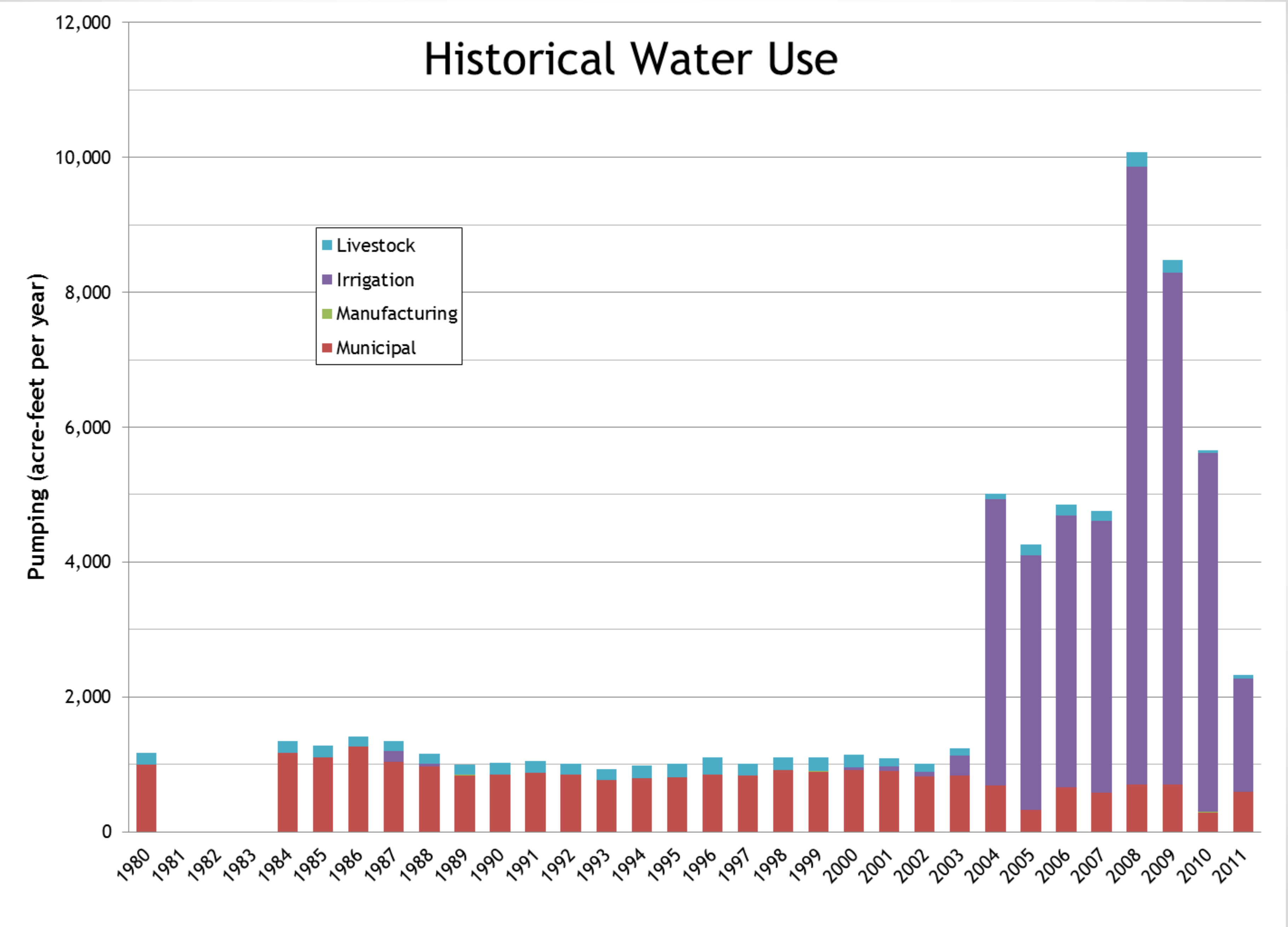
Historical Water Use
Pumping (acre-feet per year)
12,000
10,000
8,000
6,000
4,000
2,000
0
Livestock
Irrigation
Manufacturing
Municipal
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
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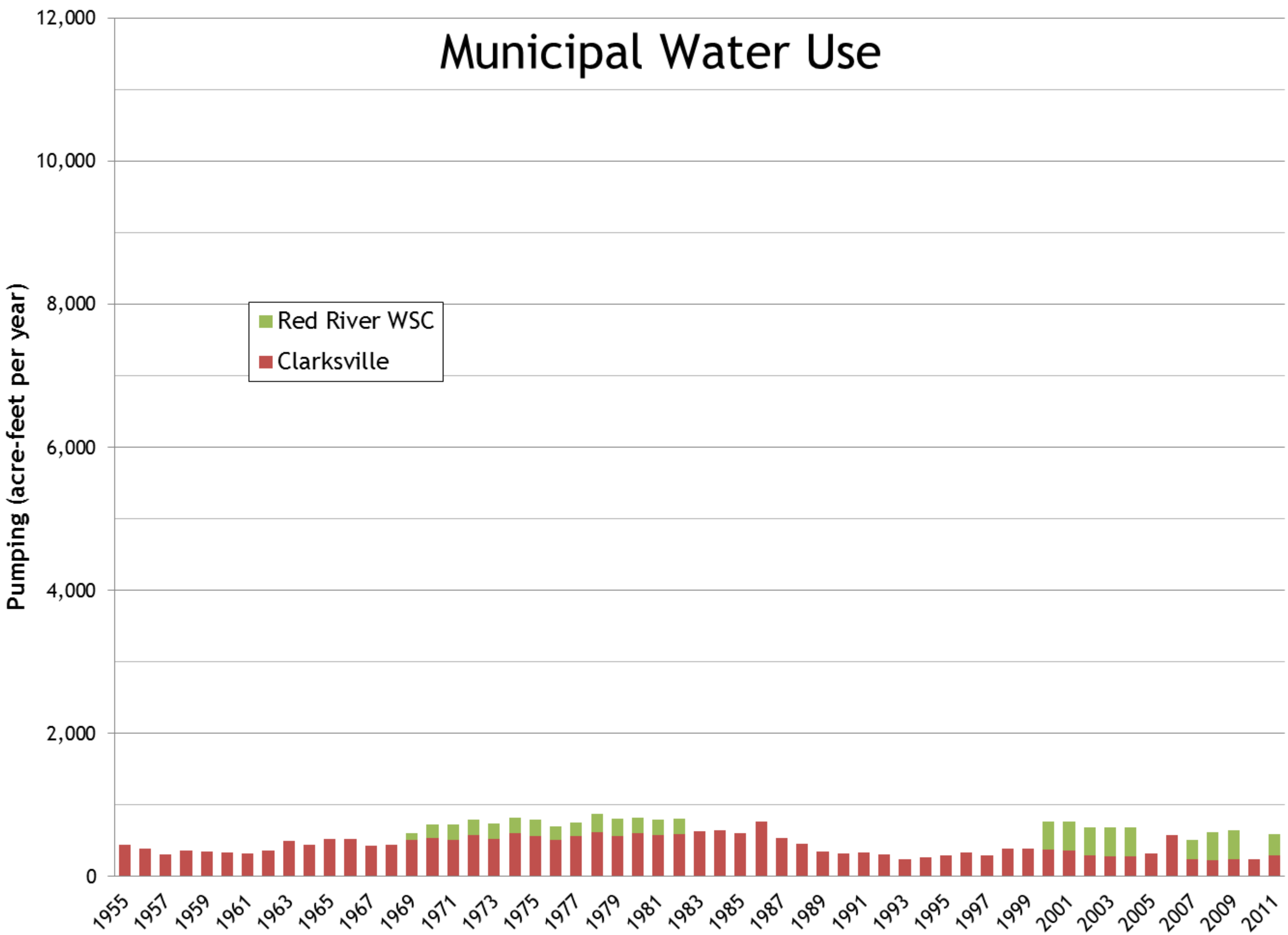
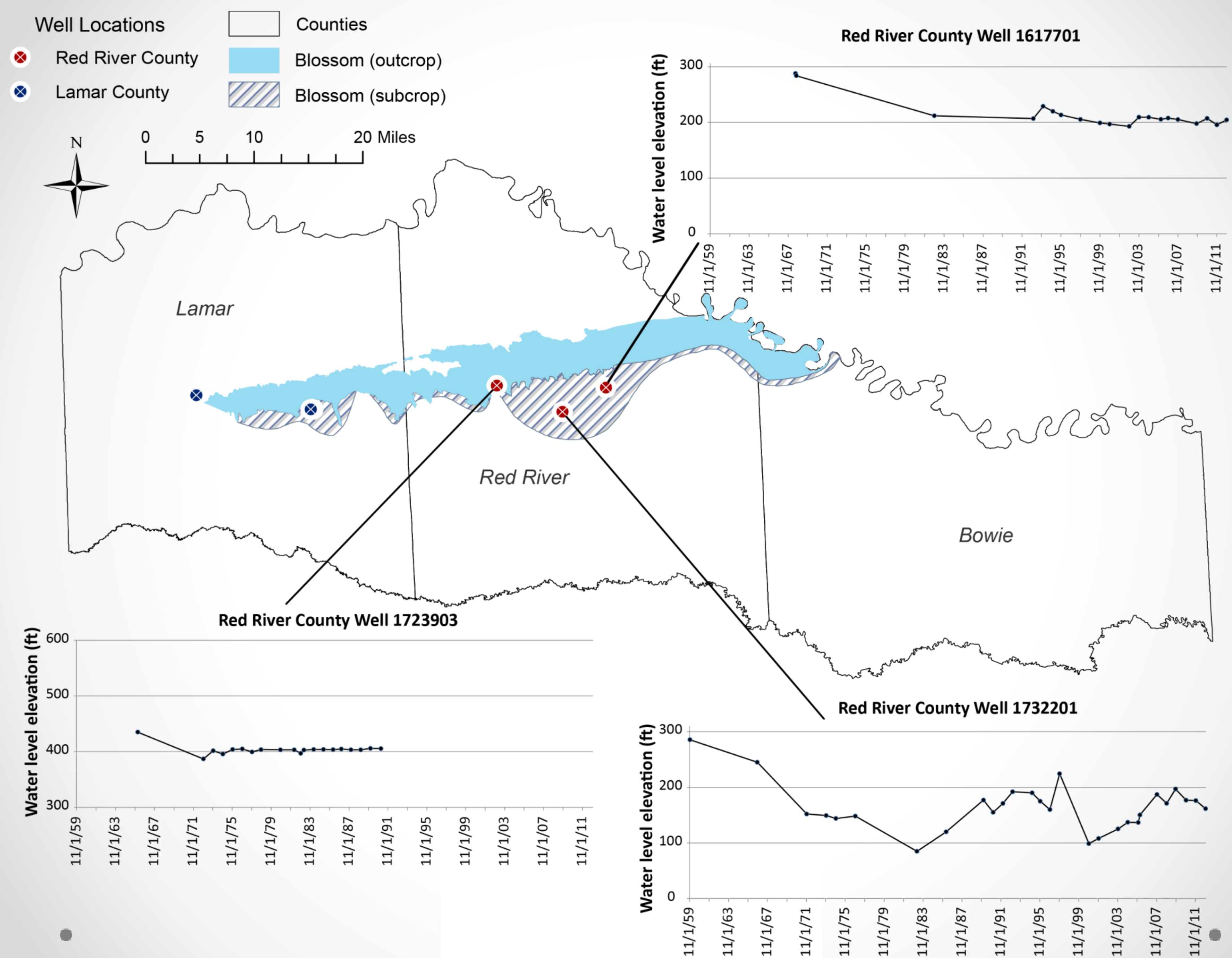
2006
2007
2008
2009
2010
2011



Municipal Water Use
Red River WSC
Clarksville
Pumping (acre-feet per year)
12,000
10,000
8,000
6,000
4,000
2,000
0
1955
1957
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011

Water Levels


Well Locations
Red River County
Lamar County
Counties
Blossom (outcrop)
Blossom (subcrop)
N
0 5 10 20 Miles
Lamar
Red River
Bowie
Red River County Well 1617701
Red River County Well 1723903
Red River County Well 1732201
Water level elevation (ft)
0
100
200
300
400
500
600
11/1/59
11/1/63
11/1/67
11/1/71
11/1/75
11/1/79
11/1/83
11/1/87
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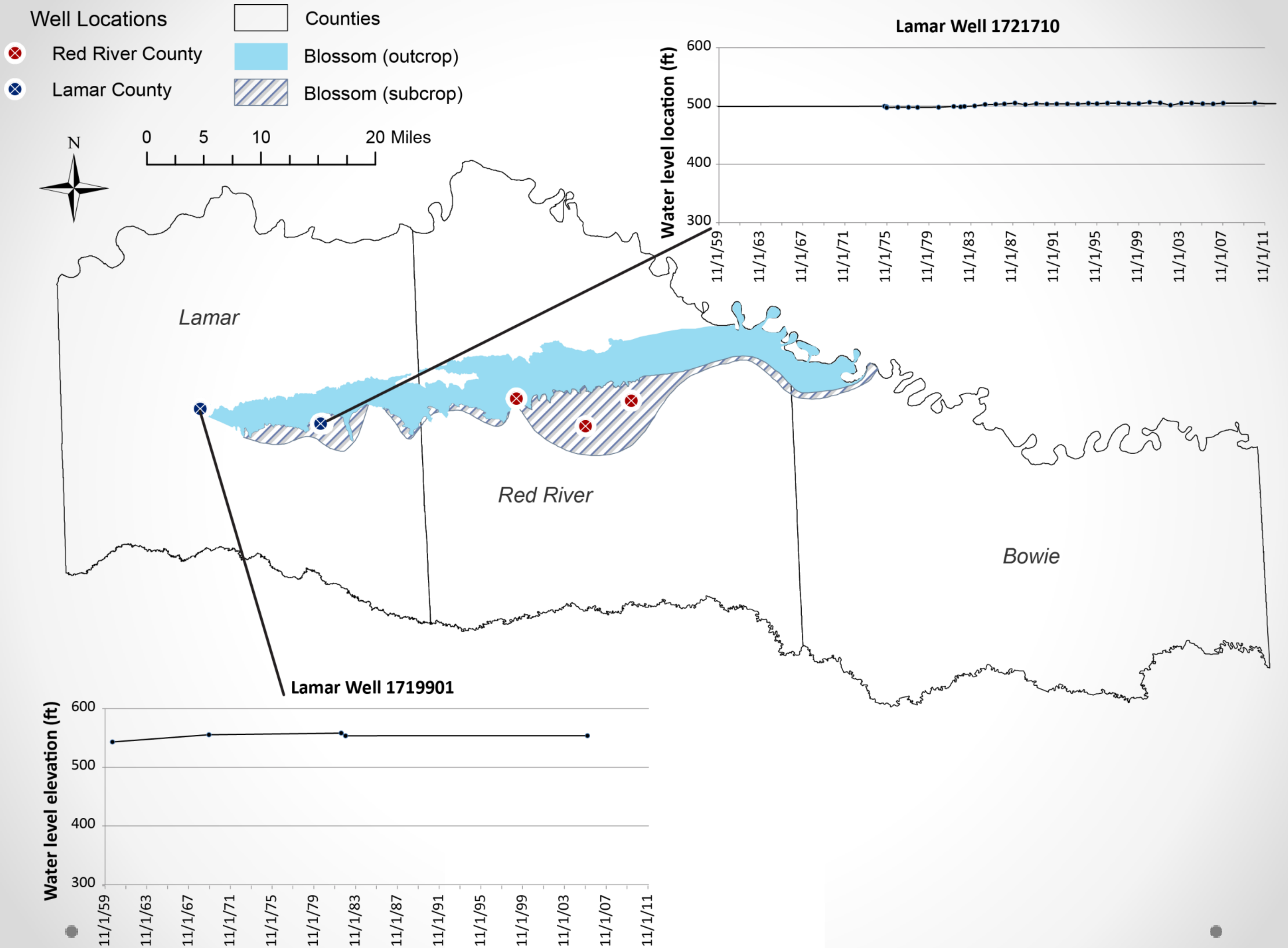
11/1/07
11/1/11



Well Locations
Red River County
Lamar County
Counties
Blossom (outcrop)
Blossom (subcrop)
N
0
5
10
20 Miles
Lamar
Red River
Bowie
Lamar Well 1721710
Water level location (ft)
600
500
400
300
11/1/59
11/1/63
11/1/67
11/1/71
11/1/75
11/1/79
11/1/83
11/1/87
11/1/91
11/1/95
11/1/99
11/1/03
11/1/07
11/1/11
Lamar Well 1719901
Water level elevation (ft)

Data Request

- Any un-published data to support the model
  - Geophysical logs
  - Pump tests
  - Water levels
  - Interpreted aquifer properties
  - Structural picks
  - Pumping information
- Data request by January 31, 2015

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Tentative Schedule

2014

- June – SAF1

2015

- January – deadline for receiving stakeholder data
- May – draft conceptual model report
- June – SAF2
- July – Deadline for stakeholder comments on conceptual model

2016

- August – draft model report
- September – SAF3
- October – deadline for comments on draft model report
- December – final model report posted

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Contact Information

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Web information:
http://www.twdb.texas.gov/groundwater/

http://www.twdb.texas.gov/groundwater/models/gam/blsm/blsm.asp

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Questions

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First Stakeholder Advisory Forum for the Blossom Aquifer Groundwater Availability Model held at Daingerfield State Park Group Recreation Hall on June 25, 2014.

Attendance

Name	**Affiliation**
Wendell Davis	**Red River WSC**
Shirley Wade	**Texas Water Development Board**
Cindy Ridgeway	**Texas Water Development Board**
Radu Boghici	**Texas Water Development Board**

Questions and Answers

Question 1: Is the Blossom Aquifer confined or unconfined?

Response 1: Both, depending on the location.

Question 2: Are these three wells showing on your slide the only ones you'll use in the model?

Response 2: These are the wells that have a good amount of water level data. They (The TWDB Water Sciences and Conservation Groundwater Monitoring Group) definitely monitor more wells, but I wanted to show what the aquifer is doing over a long period of time.

Question 3: Is any of the Red River water getting into the Blossom Sands?

Response 3: We don't know. We're trying to answer this with the model. The geologist who has been working on the model layers believes the Red River Alluvium rests on top of a different geologic unit.

Question 4: Are there other aquifers below the Blossom?

Response 4: There are other geologic layers that could contain groundwater, but are not designated as aquifers due to lower formation productivity and/or salinity problems.

Question 4: Is the high rainfall (shown on the precipitation charts) right after the drought of record?

Response 5: The high rainfall occurred in 1957.

Comment: (Noting water use charts) Alot of the irrigation in the area comes from surface water impoundments.