texas water development board

Agenda for Stakeholder Advisory Forum (SAF) Meeting No. 2 August 2, 2001

- Introduction
- Data compilation and GIS implementation
- Approach to determining agricultural pumping
- Project schedule

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Agenda for Stakeholder Advisory Forum (SAF) Meeting No. 2 Continued

- Development of hydraulic conductivity data set - explanation and progress to date (Dr. Alan Dutton, BEG)
- Overview of ongoing recharge studies (Dr. Bridget Scanlon, BEG)
- Questions/comments/input

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Purpose of the GAM is to...

"provide reliable, timely data on groundwater availability to the citizens of Texas to ensure adequacy of supplies or recognition of inadequacy of supplies throughout the 50-year planning horizon."

- Pederson, TWDB (1999)

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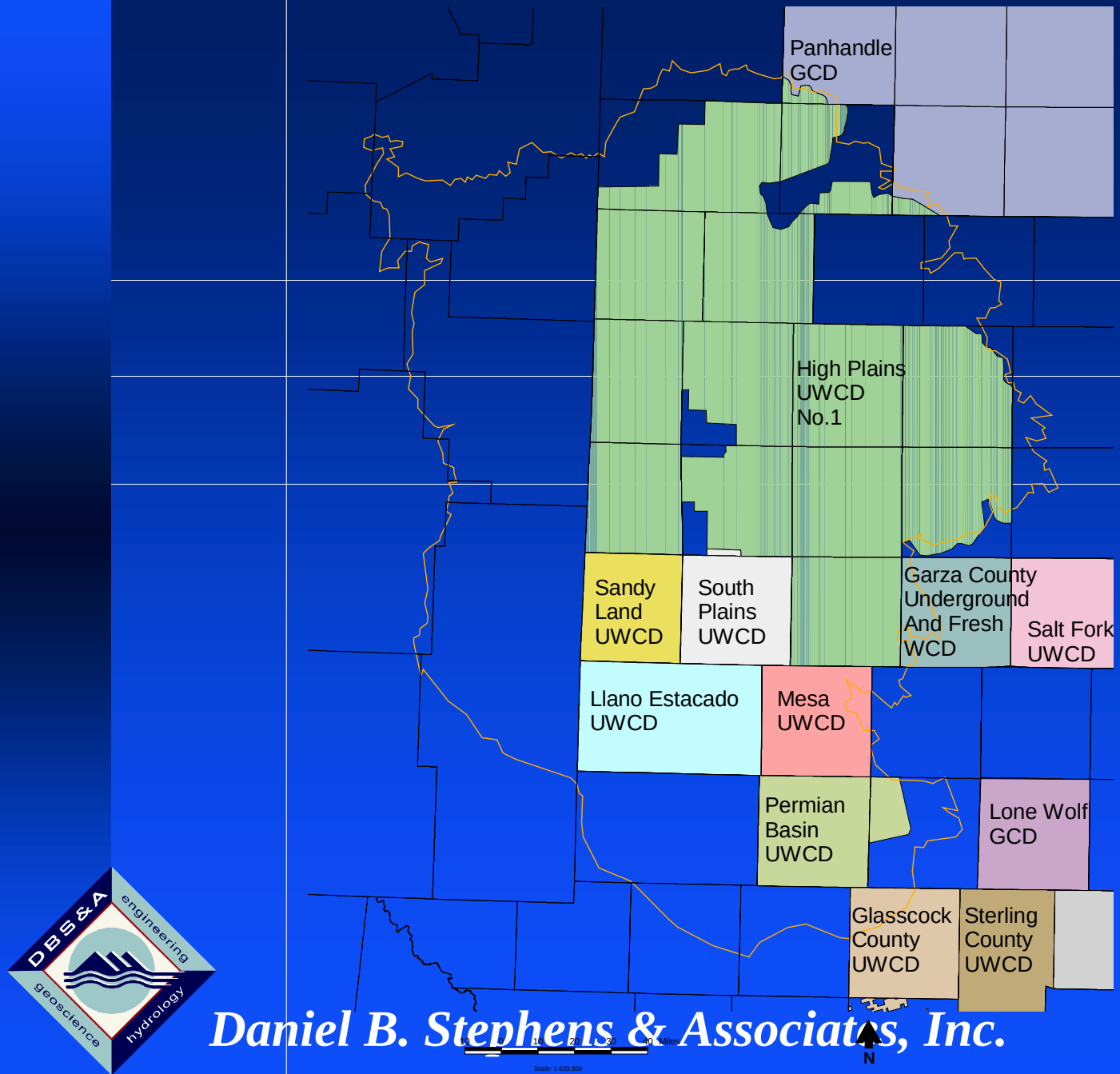

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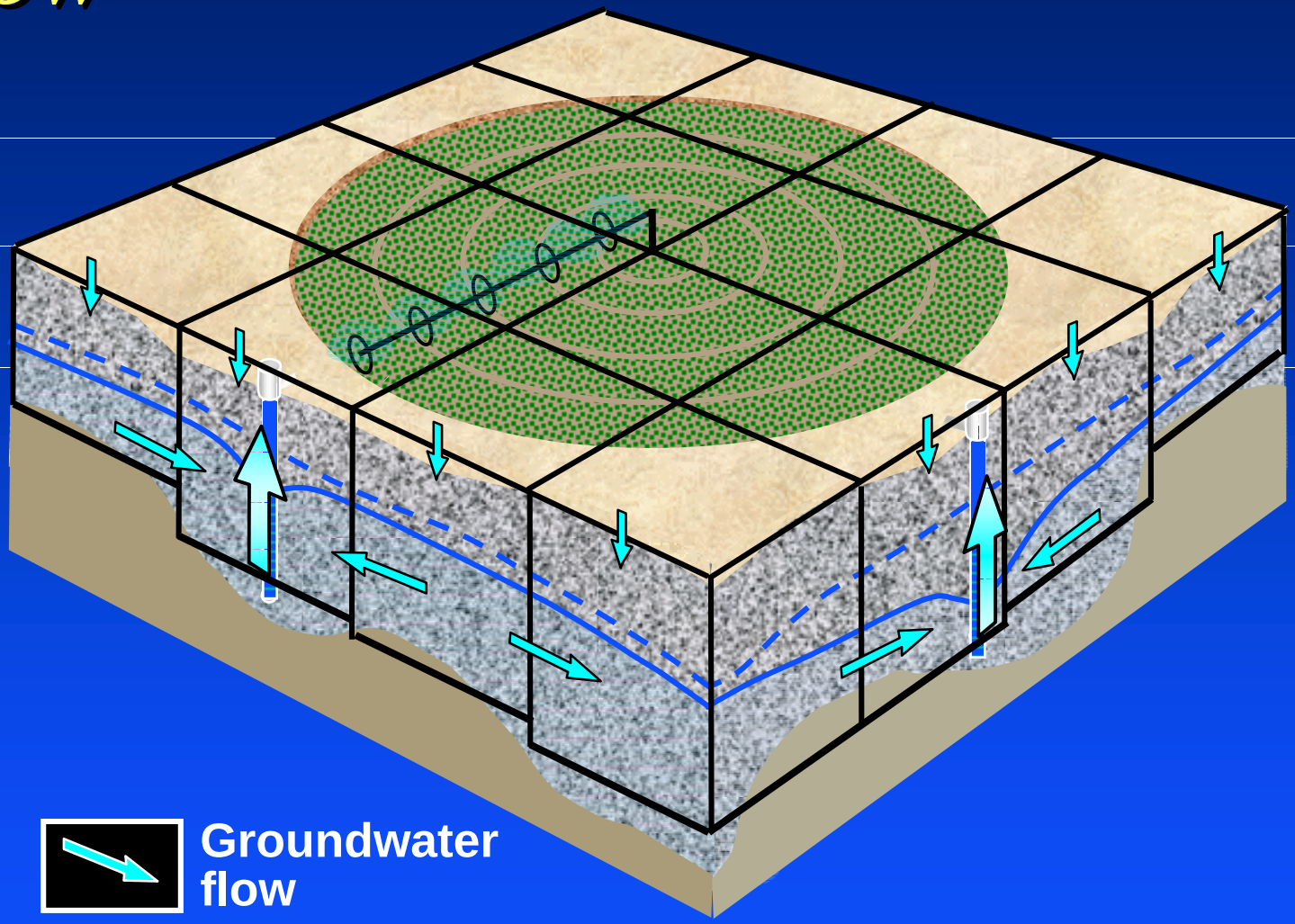
Model Cells and Groundwater Flow



Groundwater flow

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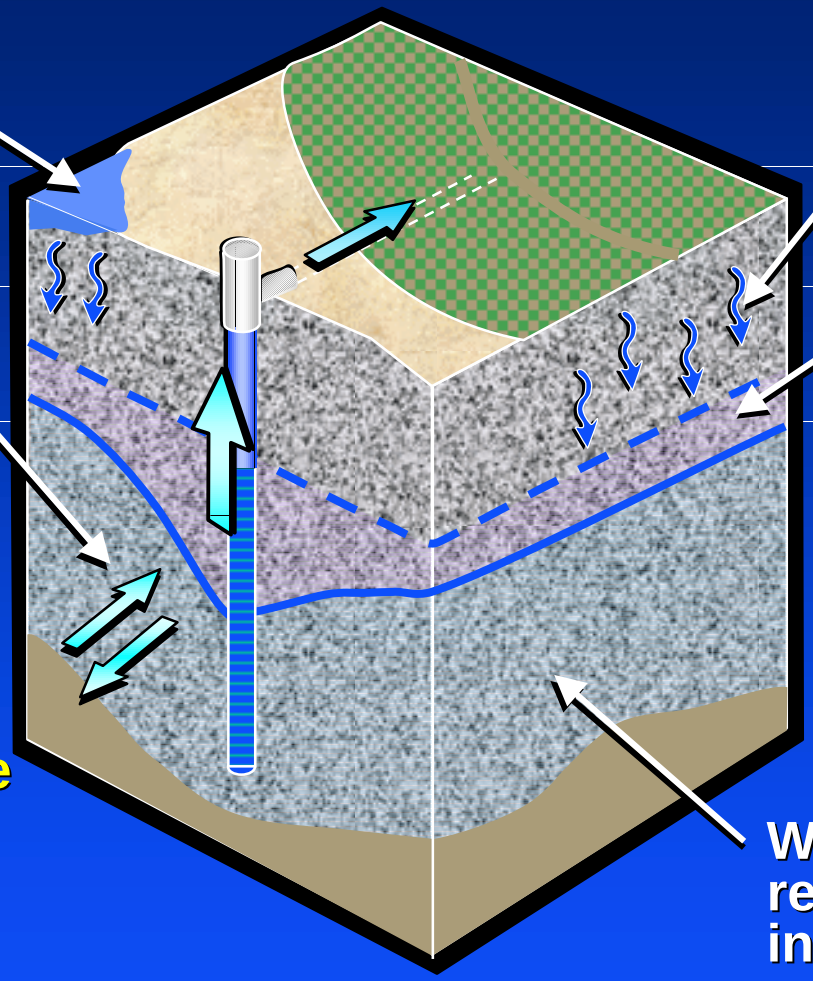
Hydrology of a Cell



Natural recharge

Irrigation return flow

Water removed from storage

Exchange of water with neighboring cells

- Permeability
- Storage value
- Thickness

Water remaining in storage

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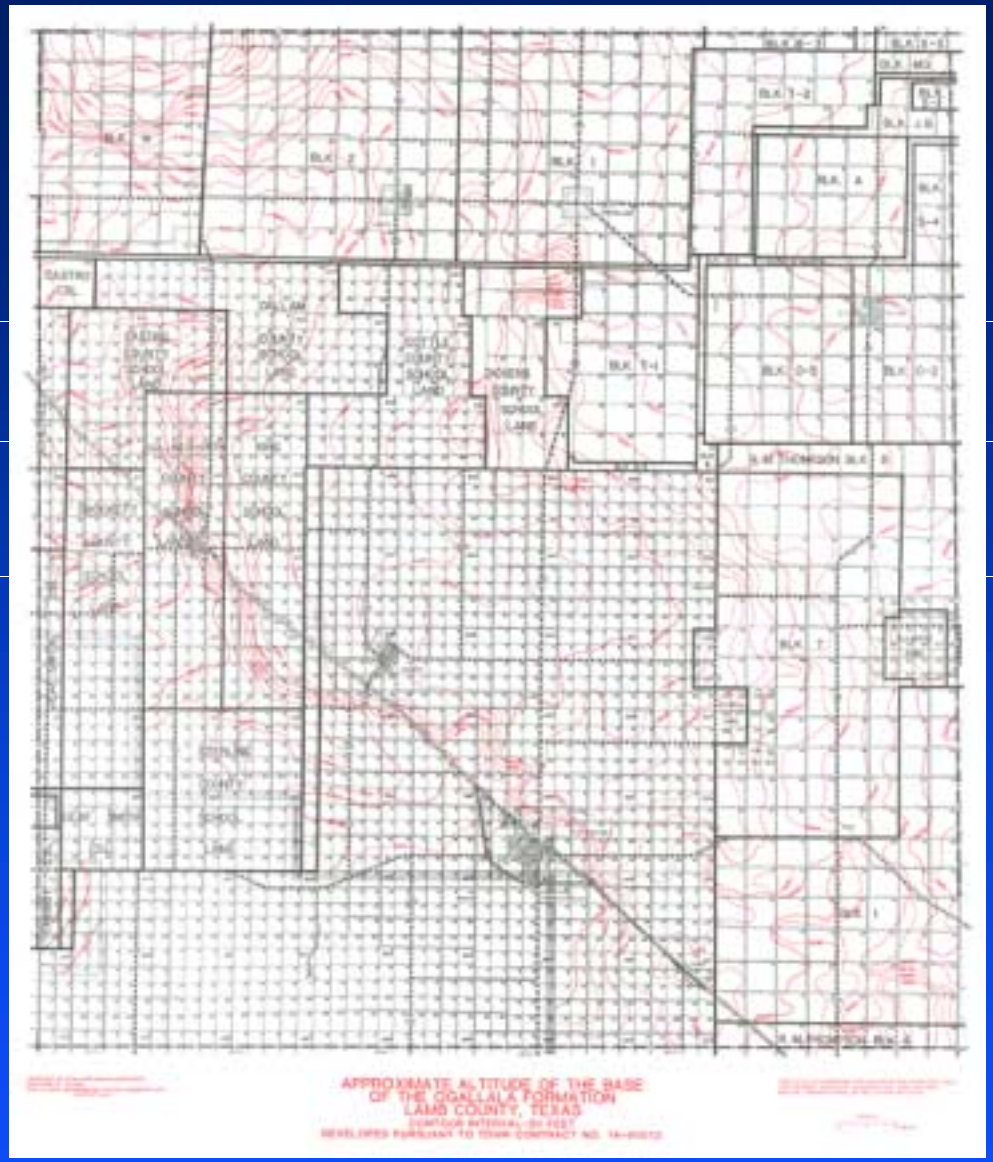
Approximate Altitude of the Base of the Ogallala Formation, Lamb County, Texas



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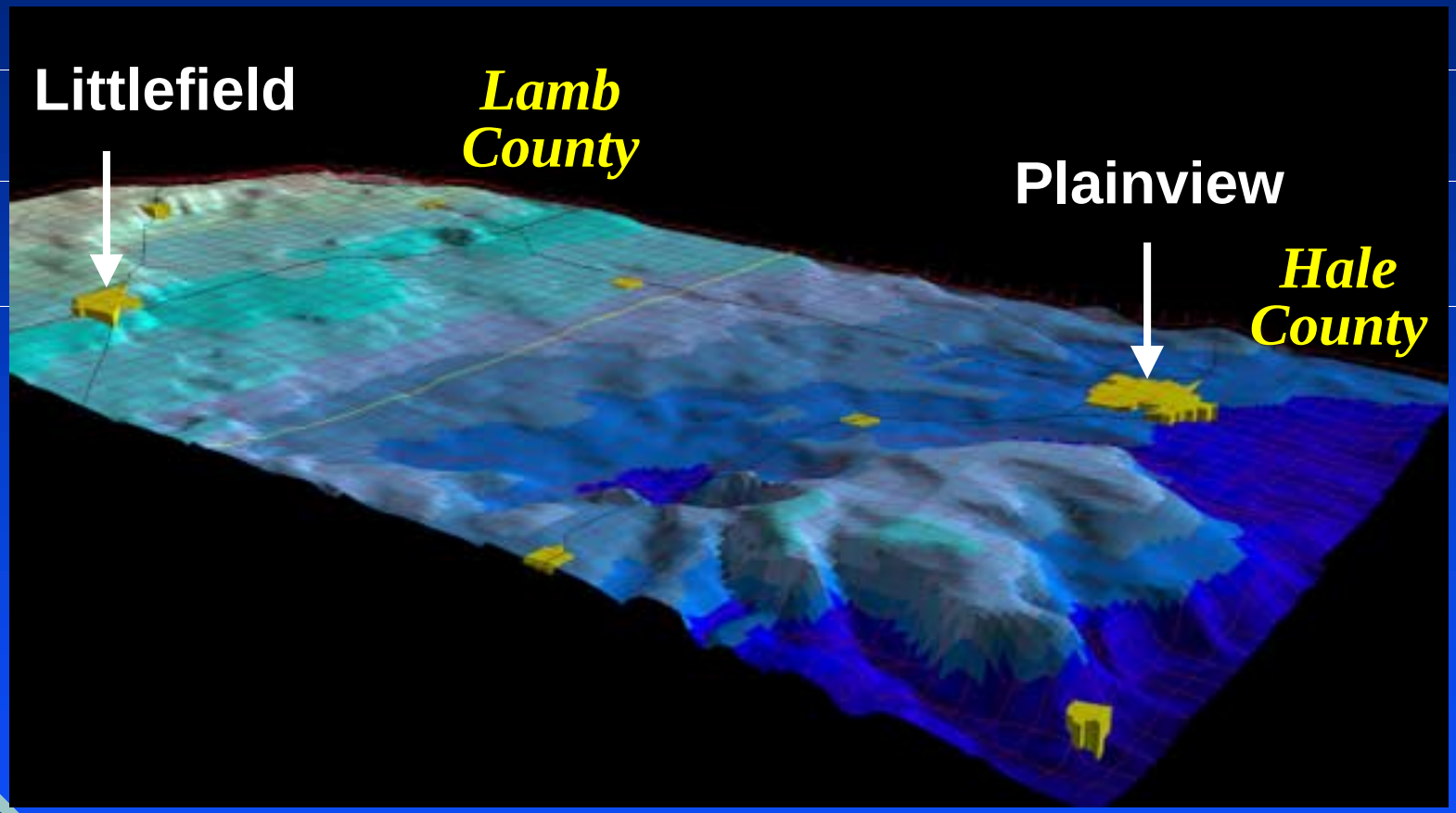
Approximate Altitude of the Base of the Ogallala Formation with Model Grid



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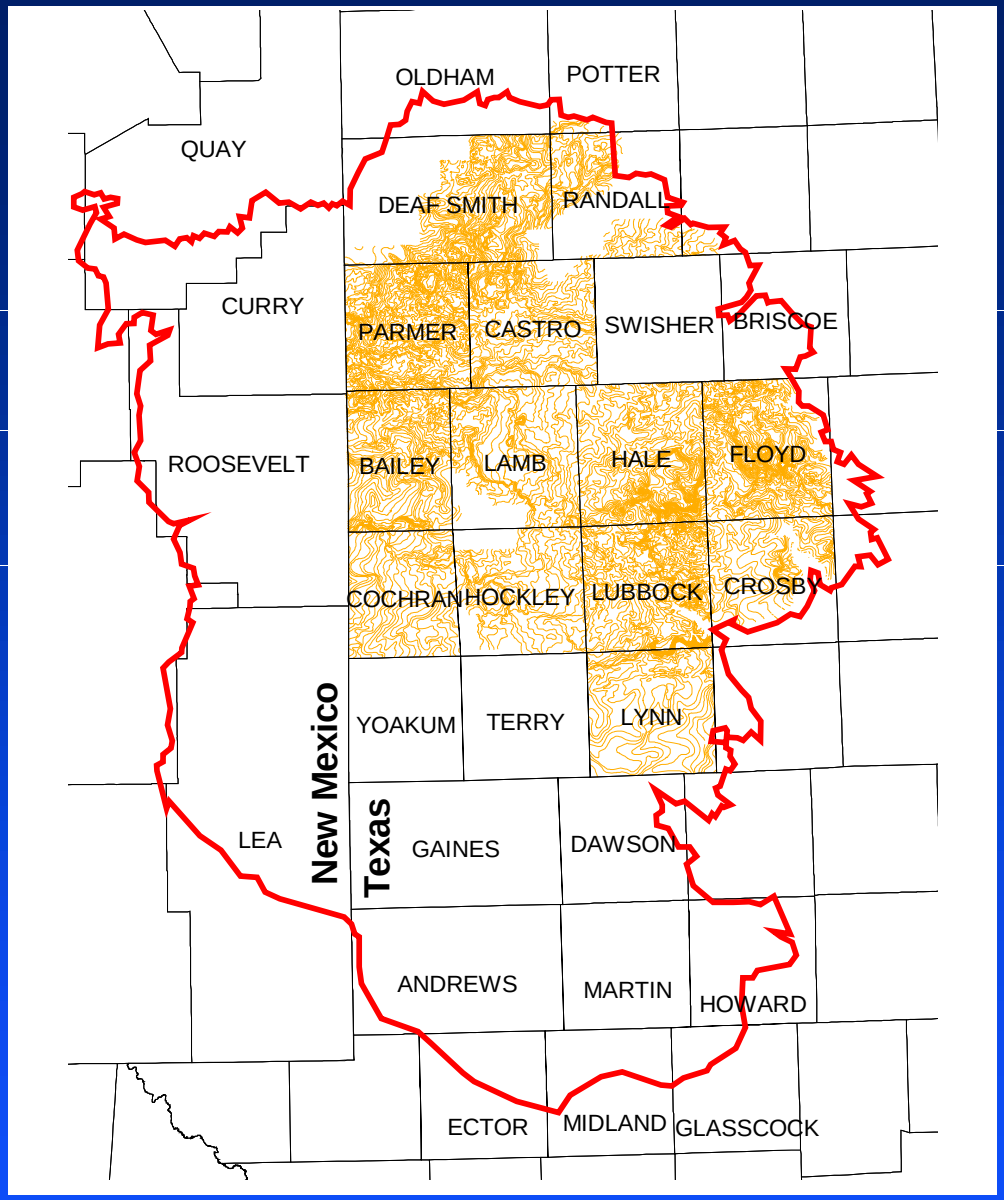
Underground Water Conservation District No.1



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Estimation of Irrigation Pumping

Irrigation Demand = *Crop Water Requirement* − *Effective Rainfall* − *Usable Soil Moisture at Start of Growing Season*

Irrigation Pumping = Irrigation Demand x Irrigated Acreage

Cross-check estimates using groundwater depletion calculations by county for years 1982, 1987, 1992, and 1997.

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Estimation of Irrigation Pumping (Cont'd)

- Crop water requirements calculated from weather data and calibrated using the South and North Plains PET Networks
- Effective rainfall from weather data
- Soil moisture from field measurements
- Irrigated acreage from various sources

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Data Collected to Date

- County irrigated acreage by crop for key years - 95% complete
- Weather data 90% complete
- Data collection for estimation of historical irrigation technology 50% complete
- Soils distribution complete
- Water levels about 70% complete. Depletion computations underway.

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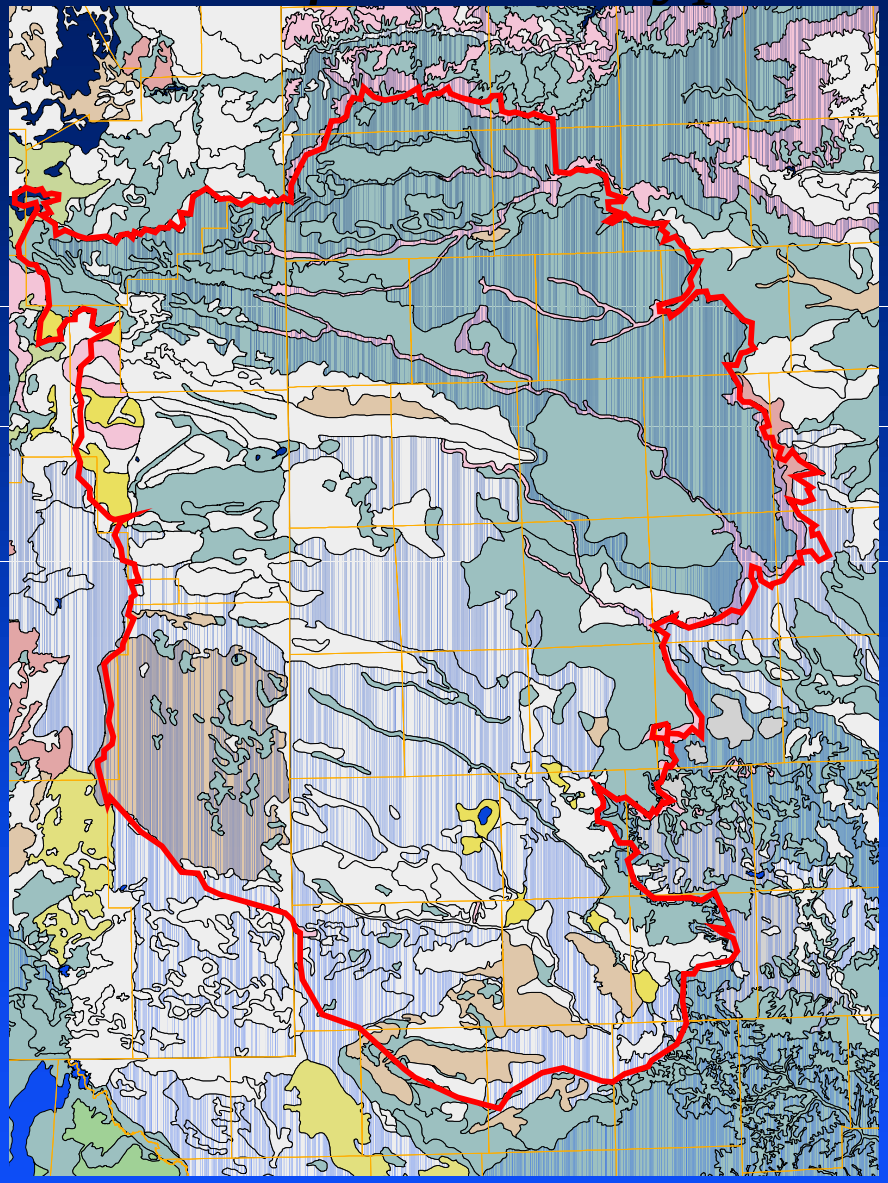
Unified Soil Type



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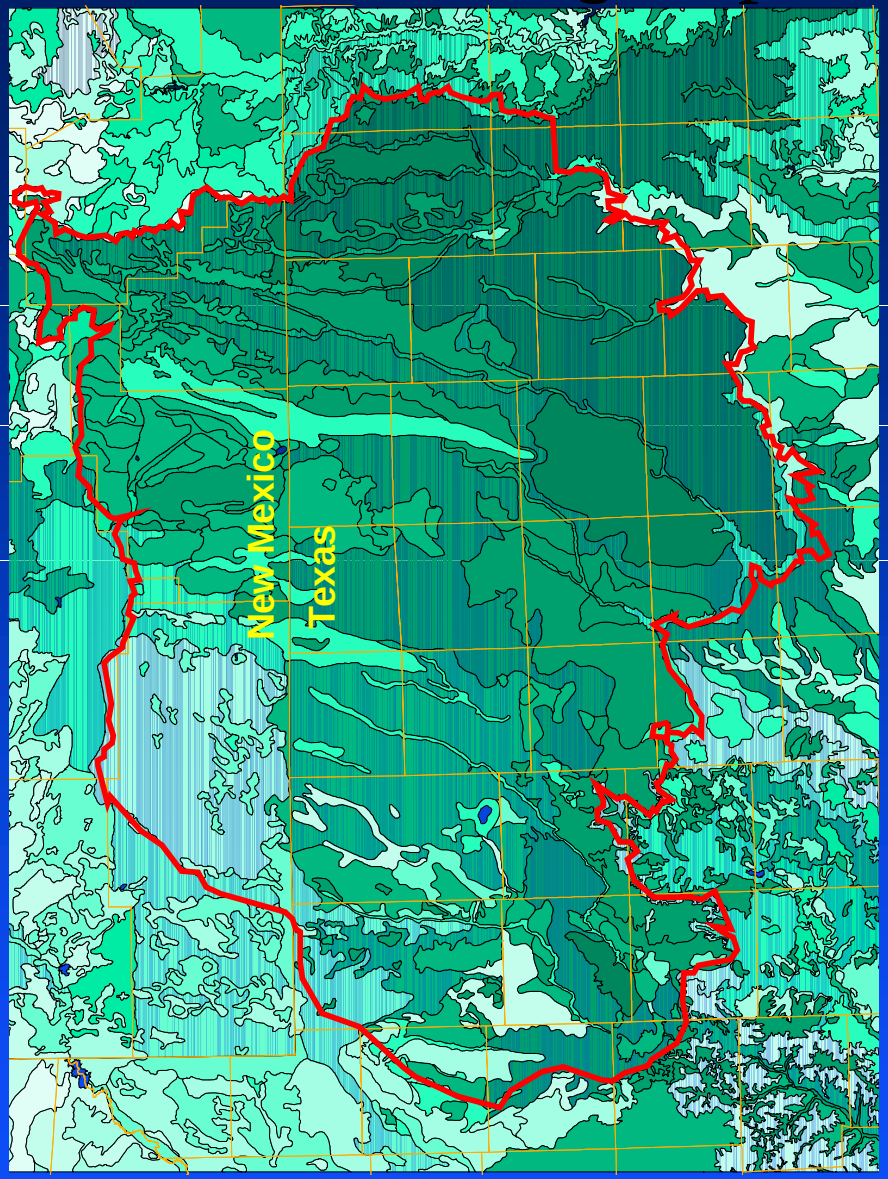
Available Water Holding Capacity in Soil



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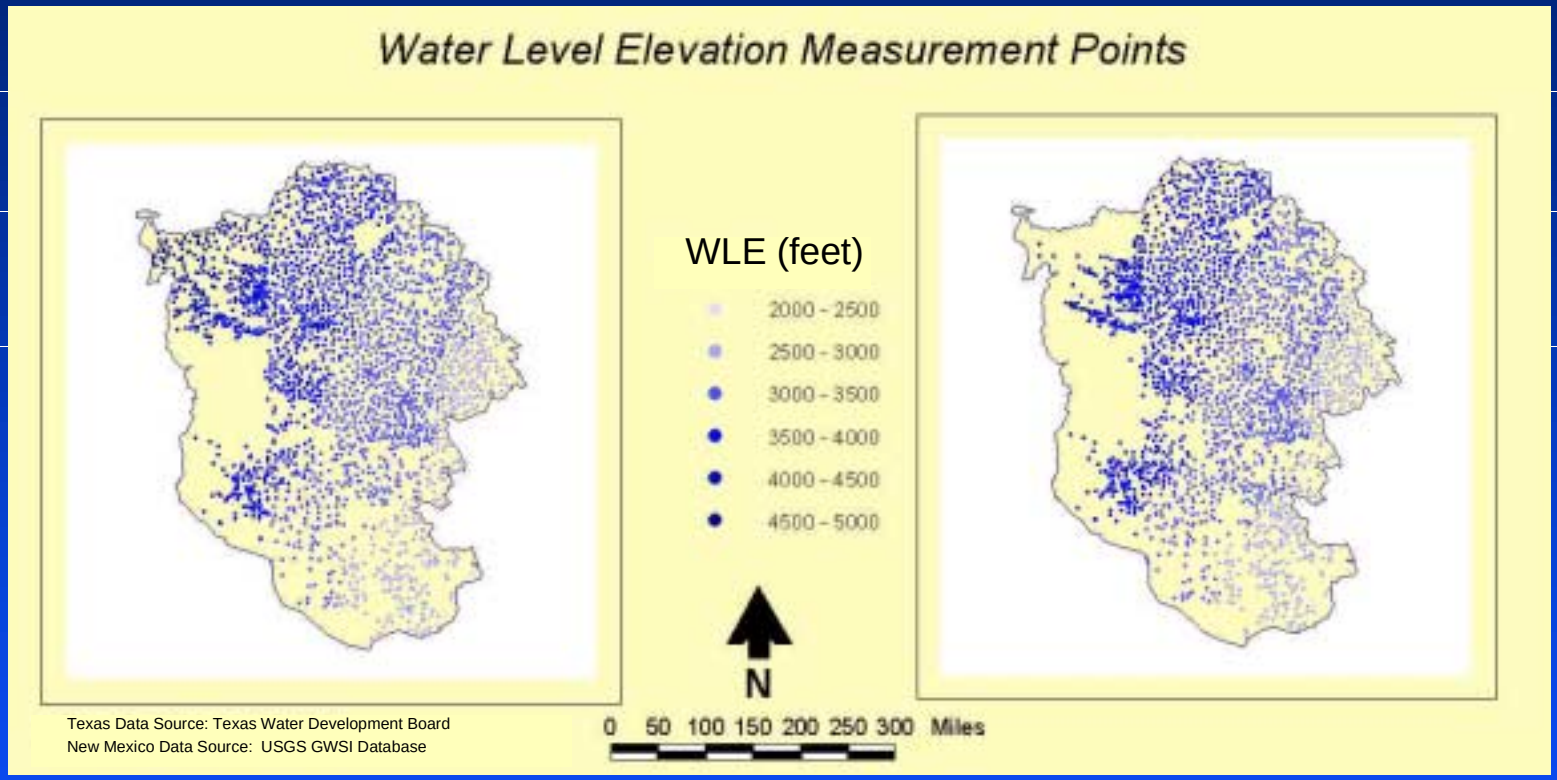
1992 Water Level Measurement Points



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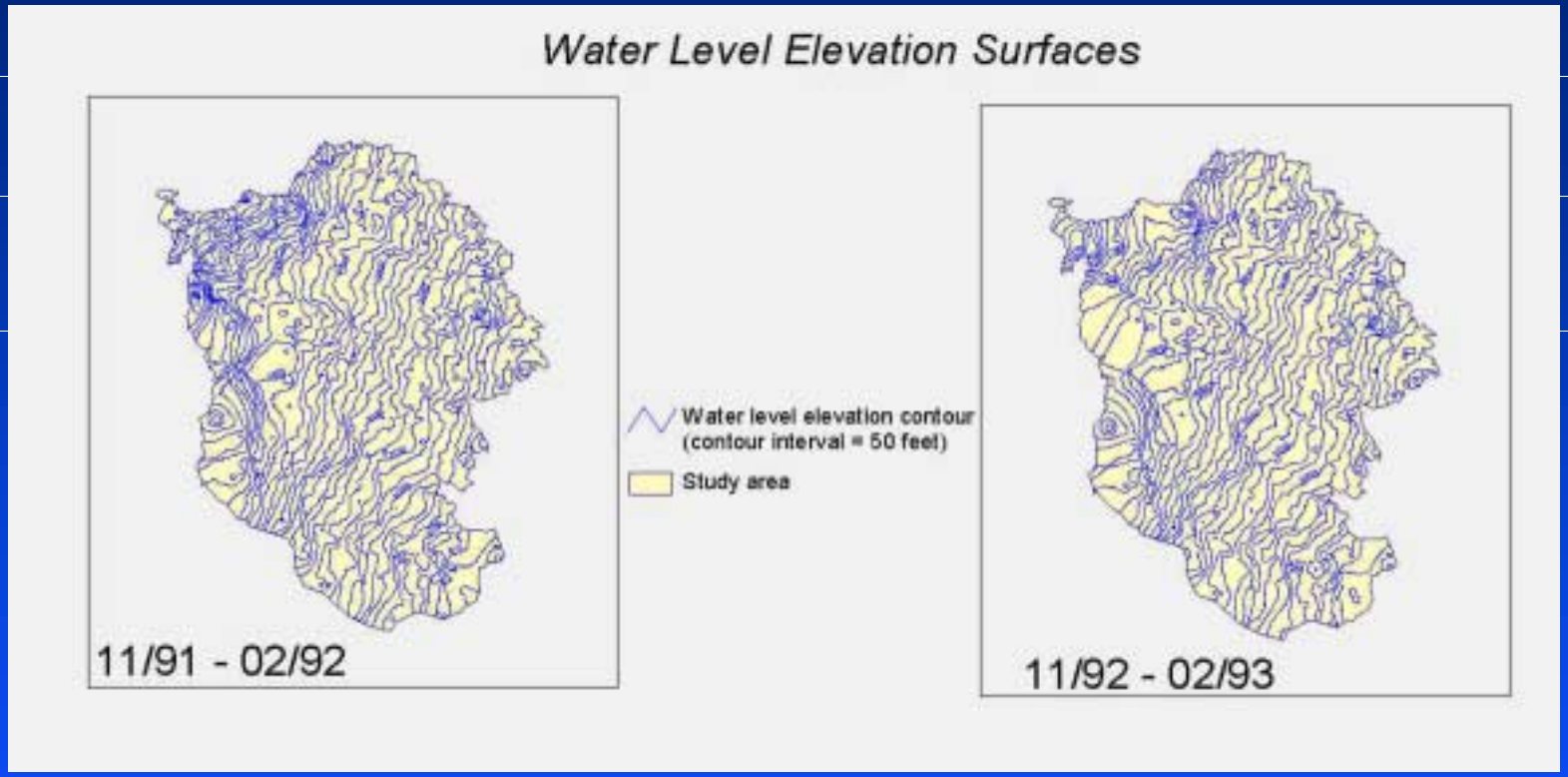
1992 Water Level Elevation Surfaces



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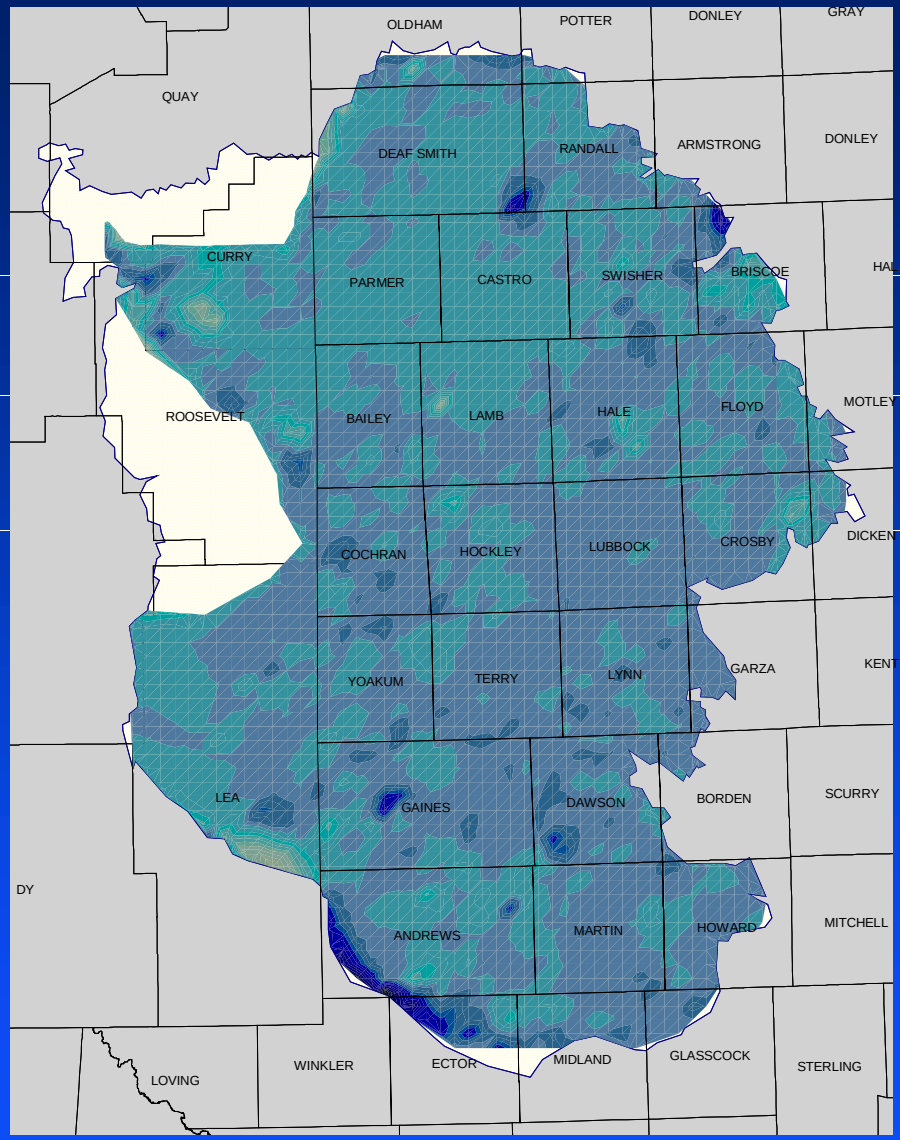
1992 Groundwater Depletion surface



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Project Schedule

We are here

Tasks	Months from Notice to Proceed							
	1 to 3	4 to 6	7 to 9	10 to 12	13 to 15	16 to 18	19 to 21	22 to 24
Stakeholder Input								
Data Collection and GIS								
Recharge Analysis								
Irrigation Water Demand								
Model Development and Application								
Calibration								
Sensitivity Analysis								
Predictive Simulations								
Draft Report								
Technology Transfer								
Final Report								

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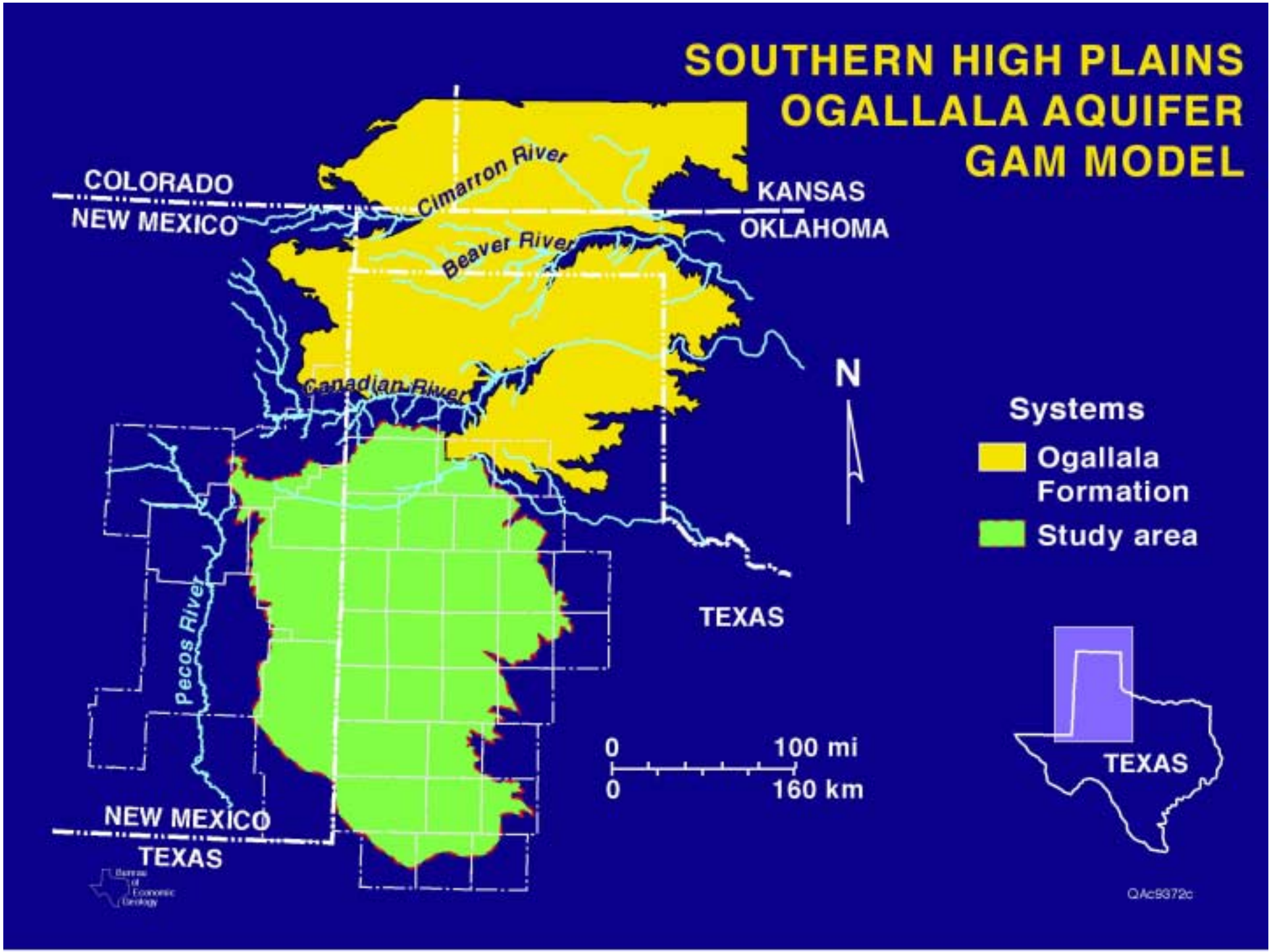
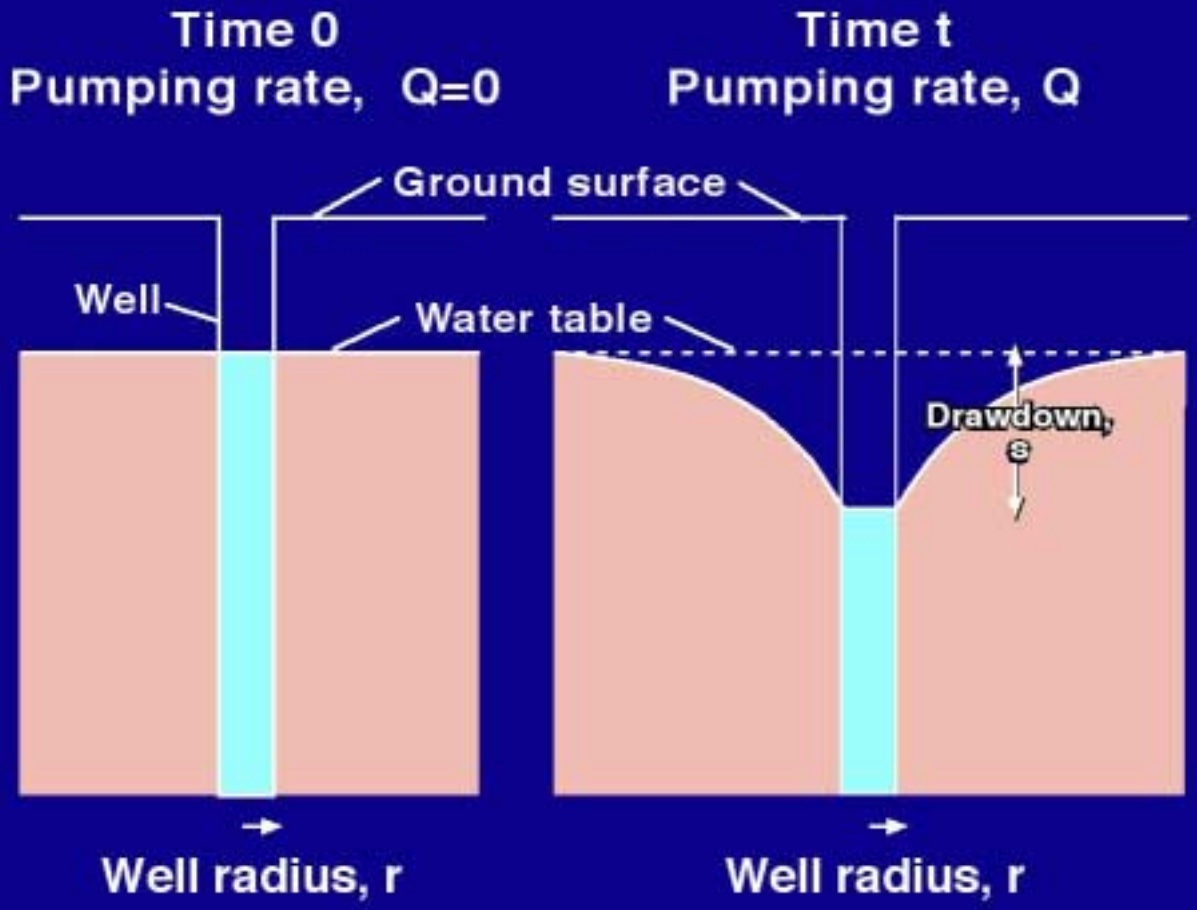
- HYDRAULIC CONDUCTIVITY
- RECHARGE


SOUTHERN HIGH PLAINS
OGALLALA AQUIFER
GAM MODEL
COLORADO
NEW MEXICO
KANSAS
OKLAHOMA
Cimarron River
Beaver River
Canadian River
Pecos River
TEXAS
N
Systems
Ogallala Formation
Study area
0 100 mi
0 160 km
NEW MEXICO
TEXAS
TEXAS
Bureau of Economic Geology
QAc9372c

HYDRAULIC CONDUCTIVITY DATA

- 16 wells with long-term pumping tests (the best data)
- ~820 wells with specific-capacity tests
- Specific capacity is the amount of water yield or unit drawdown
- Hydraulic conductivity can be estimated from specific capacity (Thomasson and others, 1960; Theis, 1963; Eagon and Johe, 1972; Razack and Huntley, 1991; Mace, 2001)

ESTIMATION OF TRANSMISSIVITY
SPECIFIC CAPACITY TEST

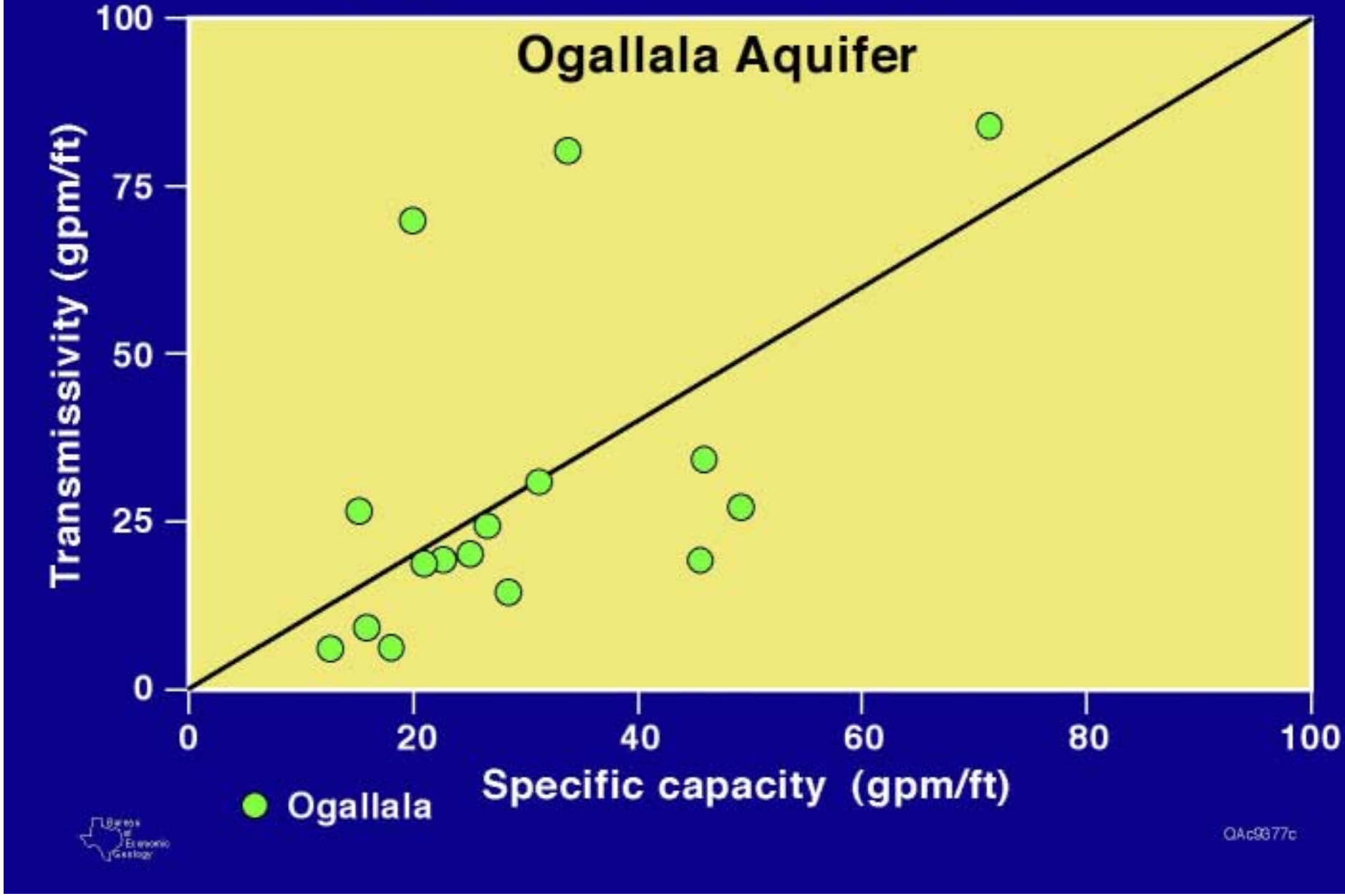


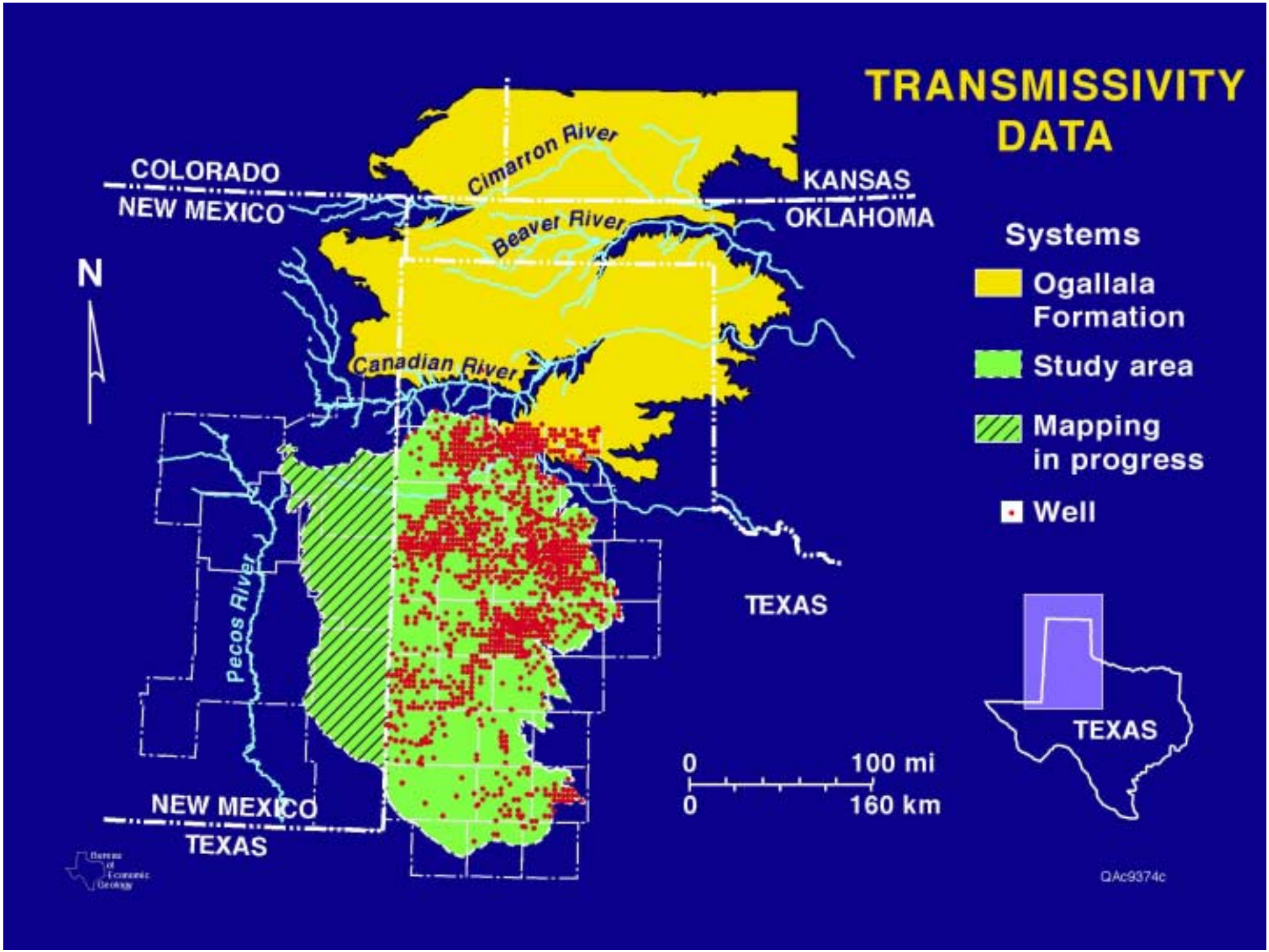
$$T = \frac{Sc}{4\pi} \ln \frac{2.25 \times Tt}{r^2 S}$$

$$Sc = \frac{Q}{s}$$

T	Transmissivity
Sc	Specific capacity
S	Specific storage
Q	Pumping rate
t	Pumping time
s	Drawdown
r	Well radius

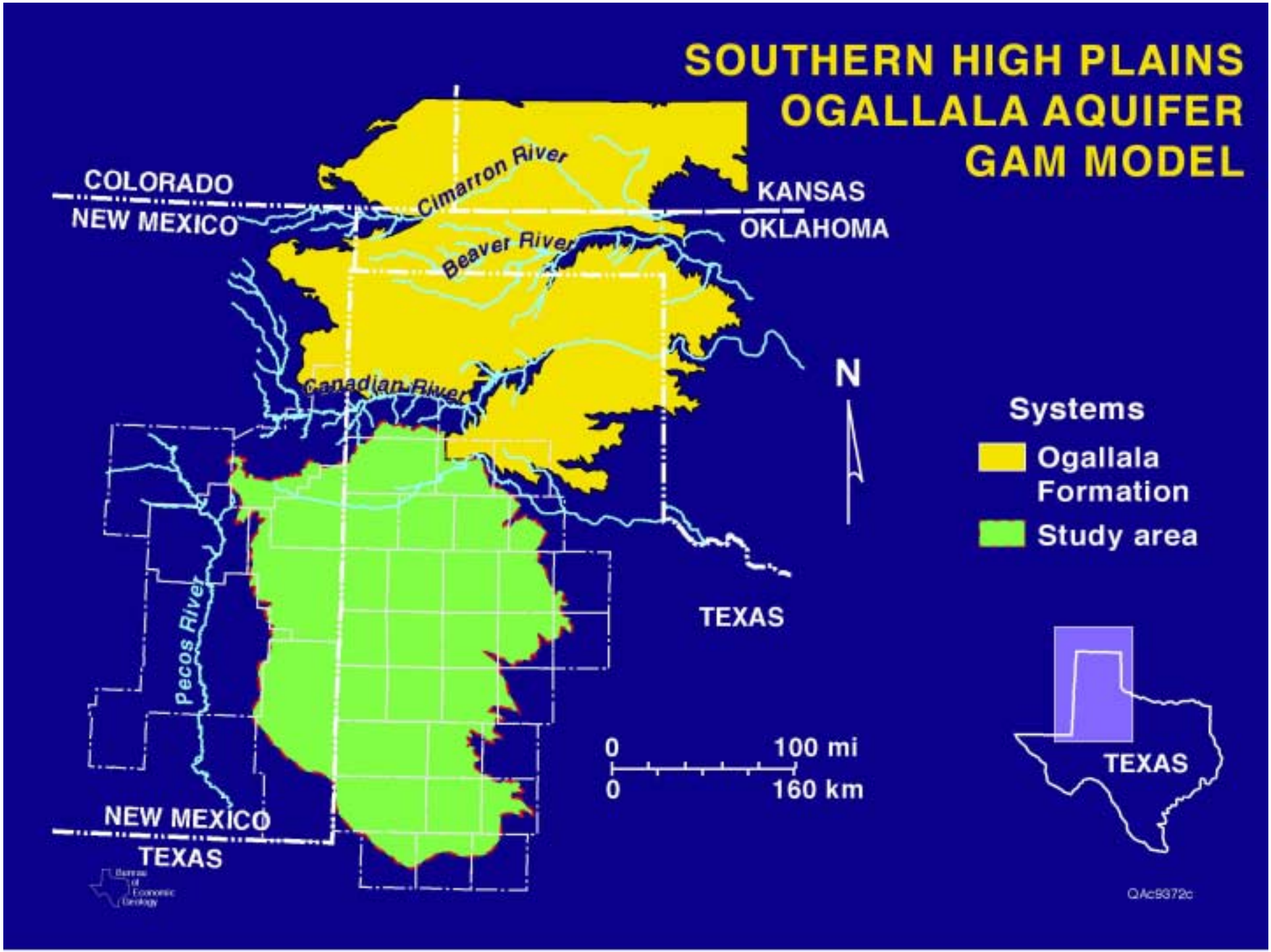
USING SPECIFIC CAPACITY TO ESTIMATE TRANSMISSIVITY




TRANSMISSIVITY DATA
COLORADO
NEW MEXICO
KANSAS
OKLAHOMA
Cimarron River
Beaver River
Canadian River
Pecos River
N
Systems
Ogallala Formation
Study area
Mapping in progress
Well
TEXAS
NEW MEXICO
TEXAS
0 100 mi
0 160 km
TEXAS
Bureau of Economic Geology
QAc9374c

HYDRAULIC CONDUCTIVITY MAPPING

- Assign average value to model area
- Use objective contouring methods
  - Geostatistical analysis
  - Kriging
- Use additional geological data to guide mapping of hydraulic conductivity


SOUTHERN HIGH PLAINS
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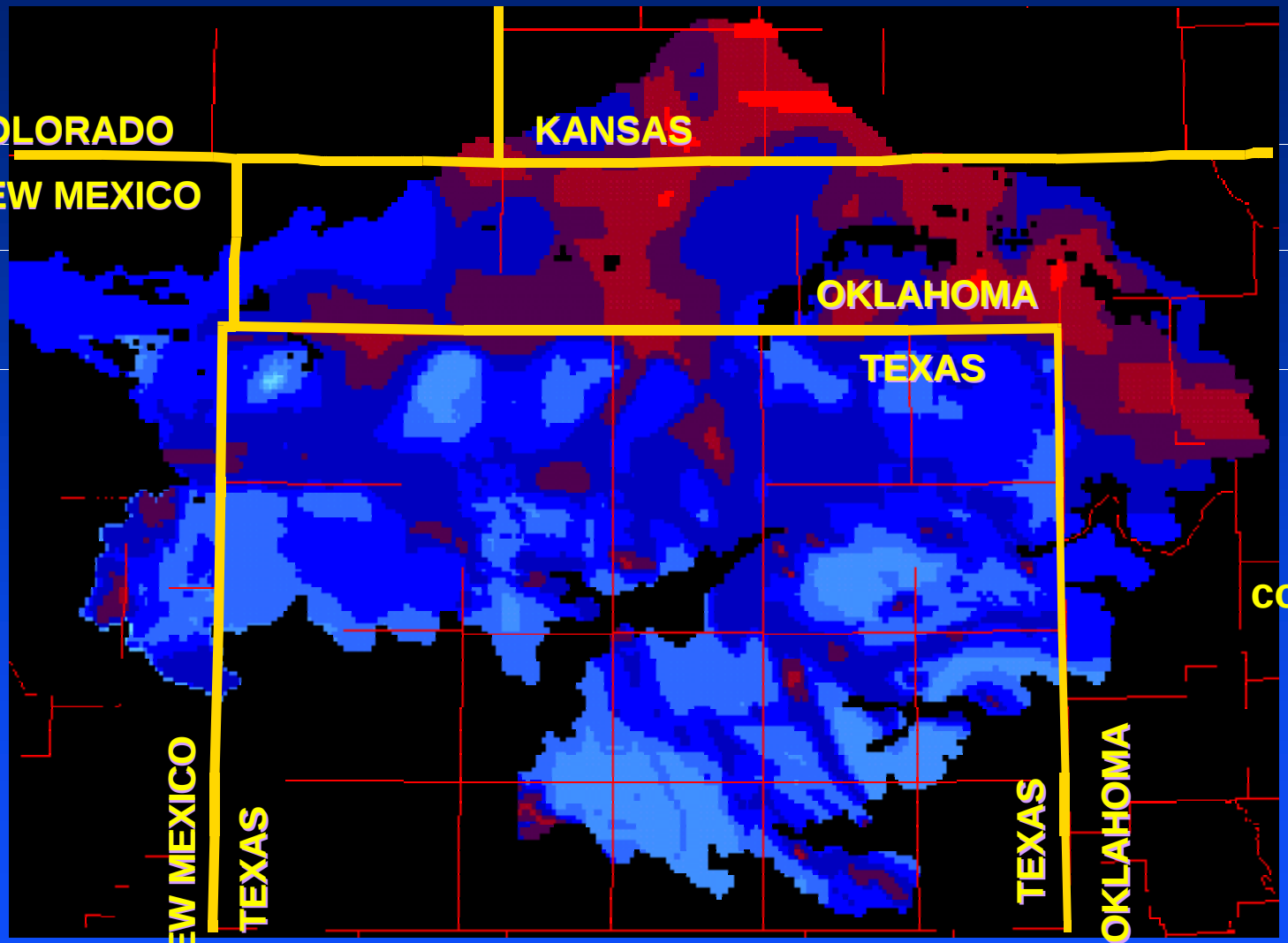
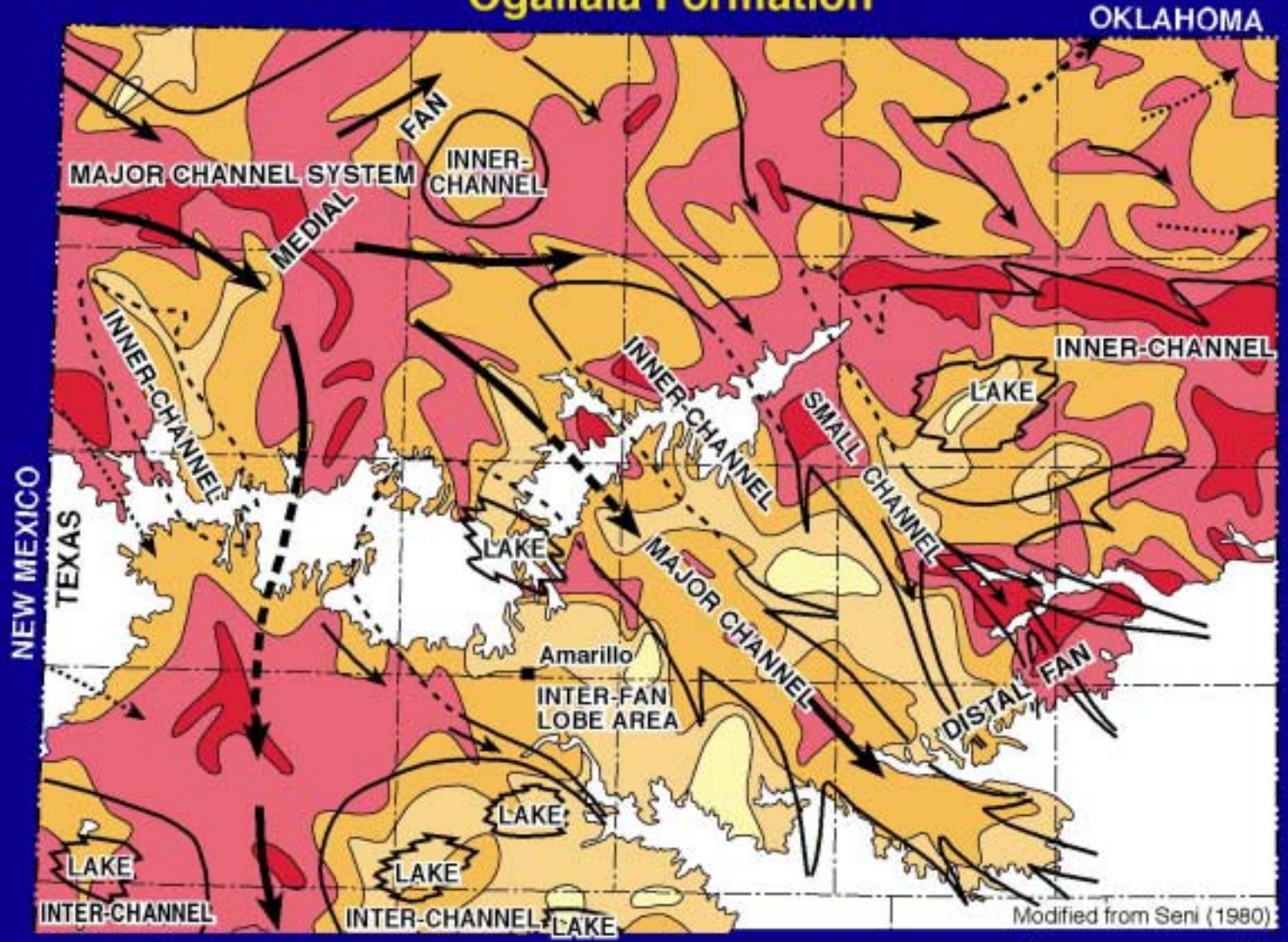
TEXAS
N
Systems
Ogallala Formation
Study area
0 100 mi
0 160 km
NEW MEXICO
TEXAS
TEXAS
Bureau of Economic Geology
QAc9372c

HYDRAULIC CONDUCTIVITY

Geologically contoured on basis of Seni (1980)



PERCENT SAND AND GRAVEL
Ogallala Formation



80 – 100
60 – 80
40 – 60
20 – 40
0 – 20
Ogallala not present

Lower Ogallala contact
dashed where covered
by younger deposits

0 40 mi
0 60 km
Contour interval
20 percent

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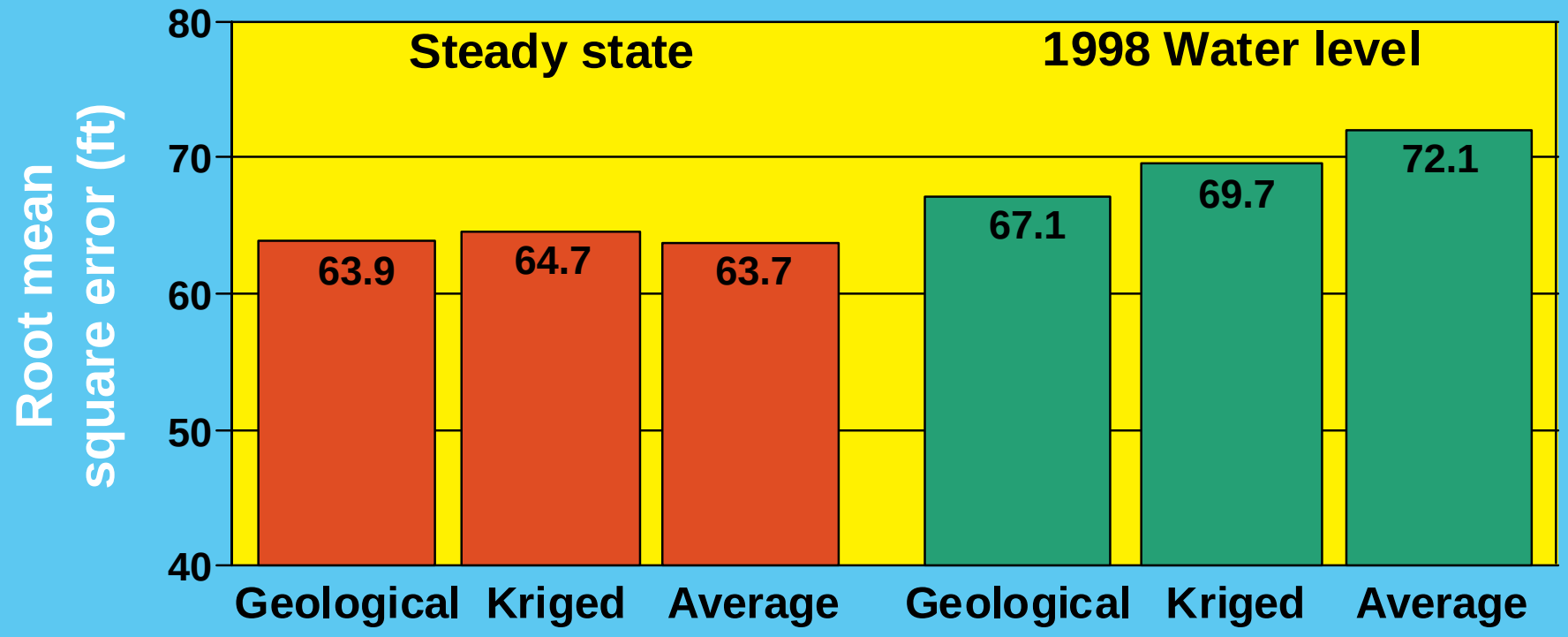
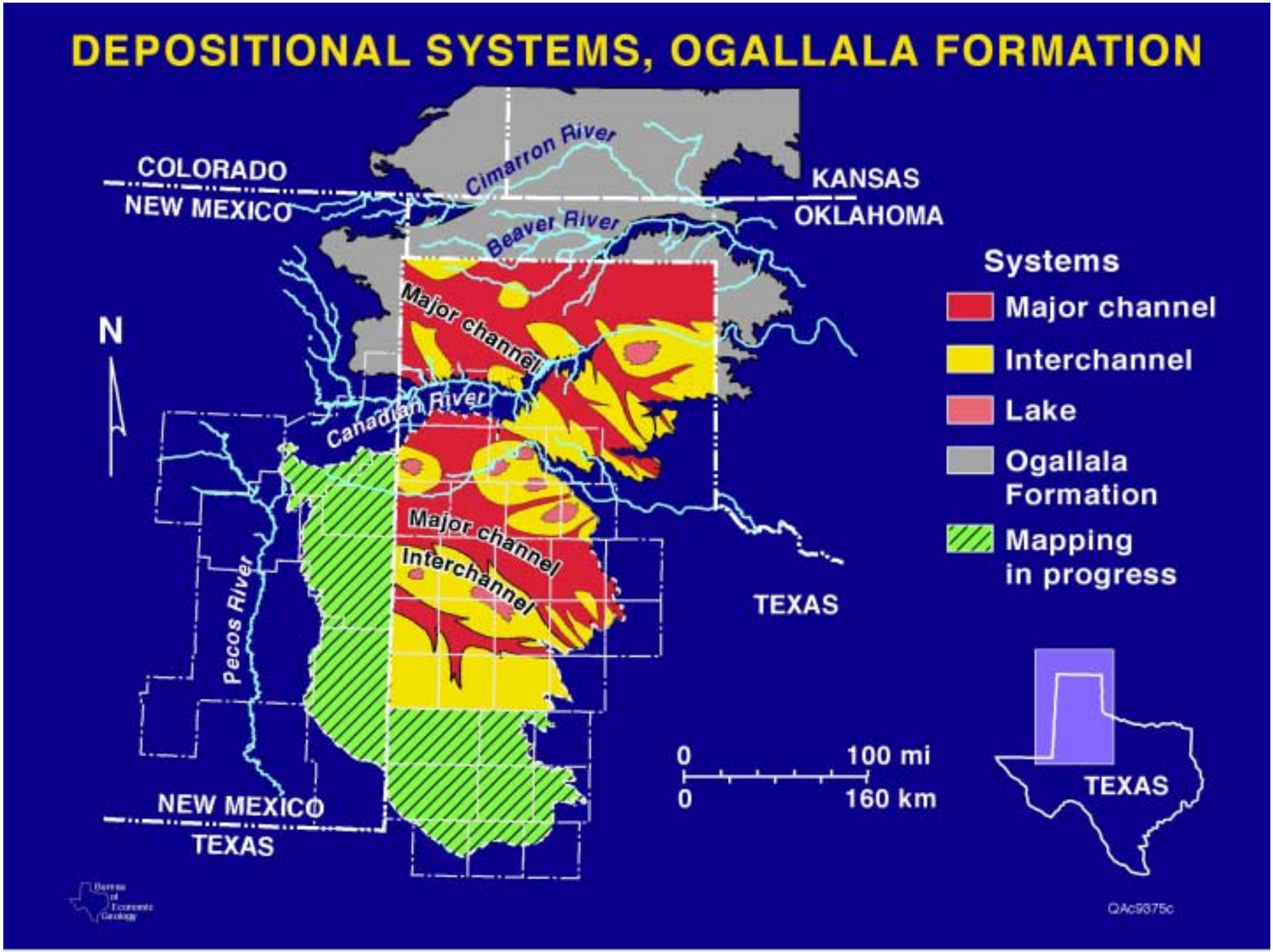
HYDRAULIC CONDUCTIVITY SENSITIVITY



DEPOSITIONAL SYSTEMS, OGALLALA FORMATION



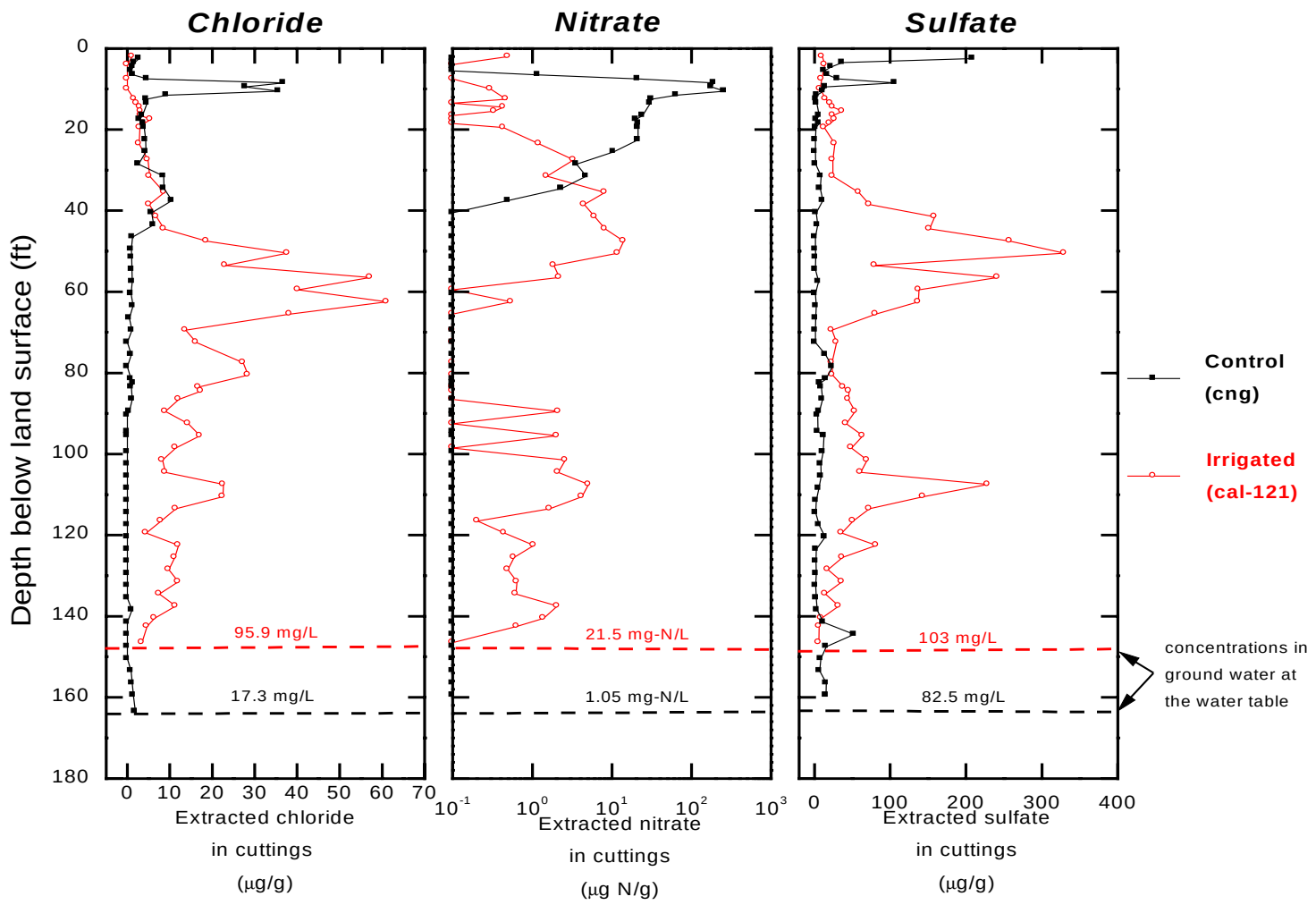
Groundwater Recharge

- The purpose of this study component is to evaluate groundwater recharge and return flow beneath irrigated agriculture

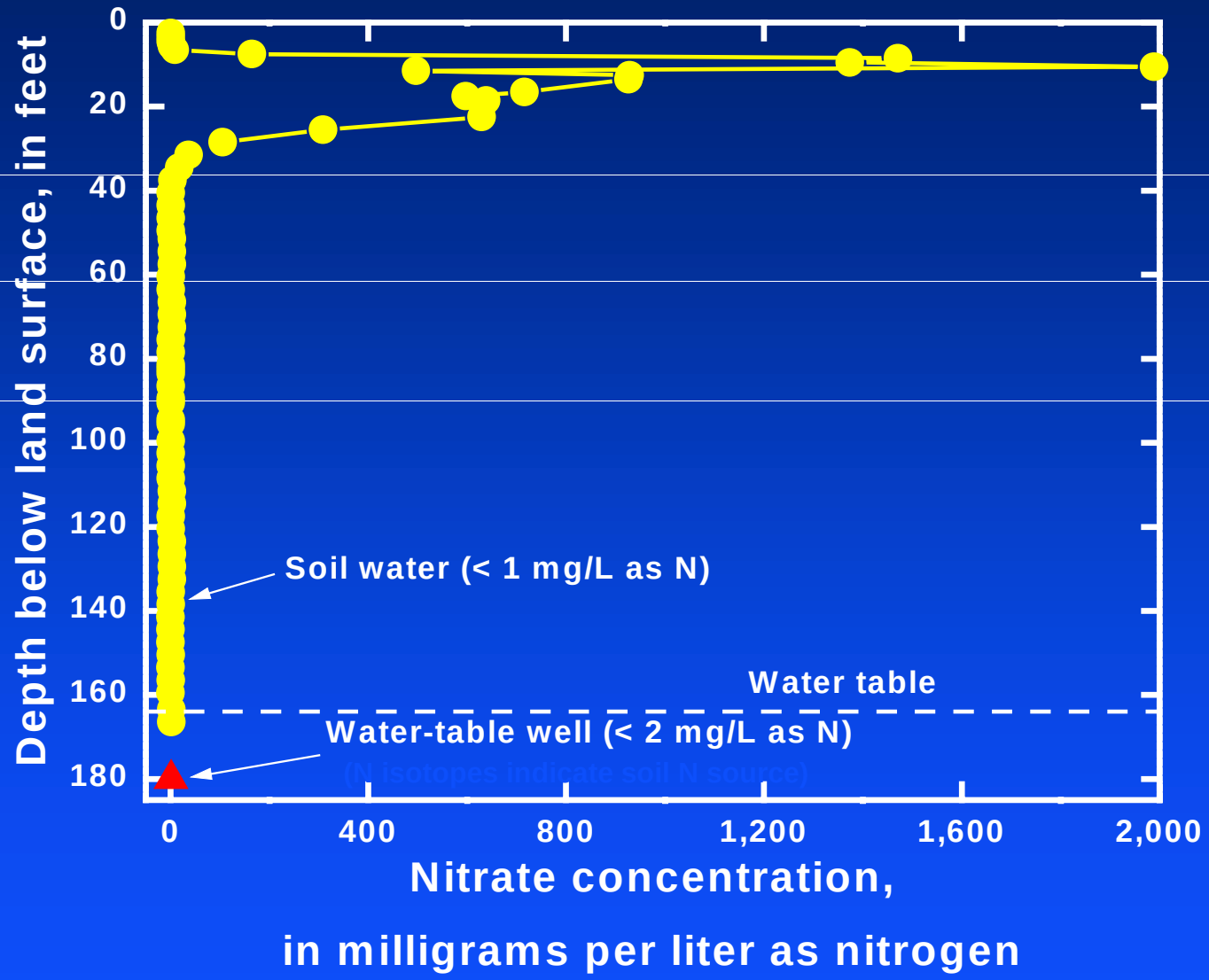
Approach

- Qualitative estimates of recharge in response to irrigation
- Comparison of subsurface data between irrigated and non-irrigated sites
  - soil-water pressure
  - chloride concentration
  - nitrate concentration
  - sulfate concentration
  - bomb pulse tritium

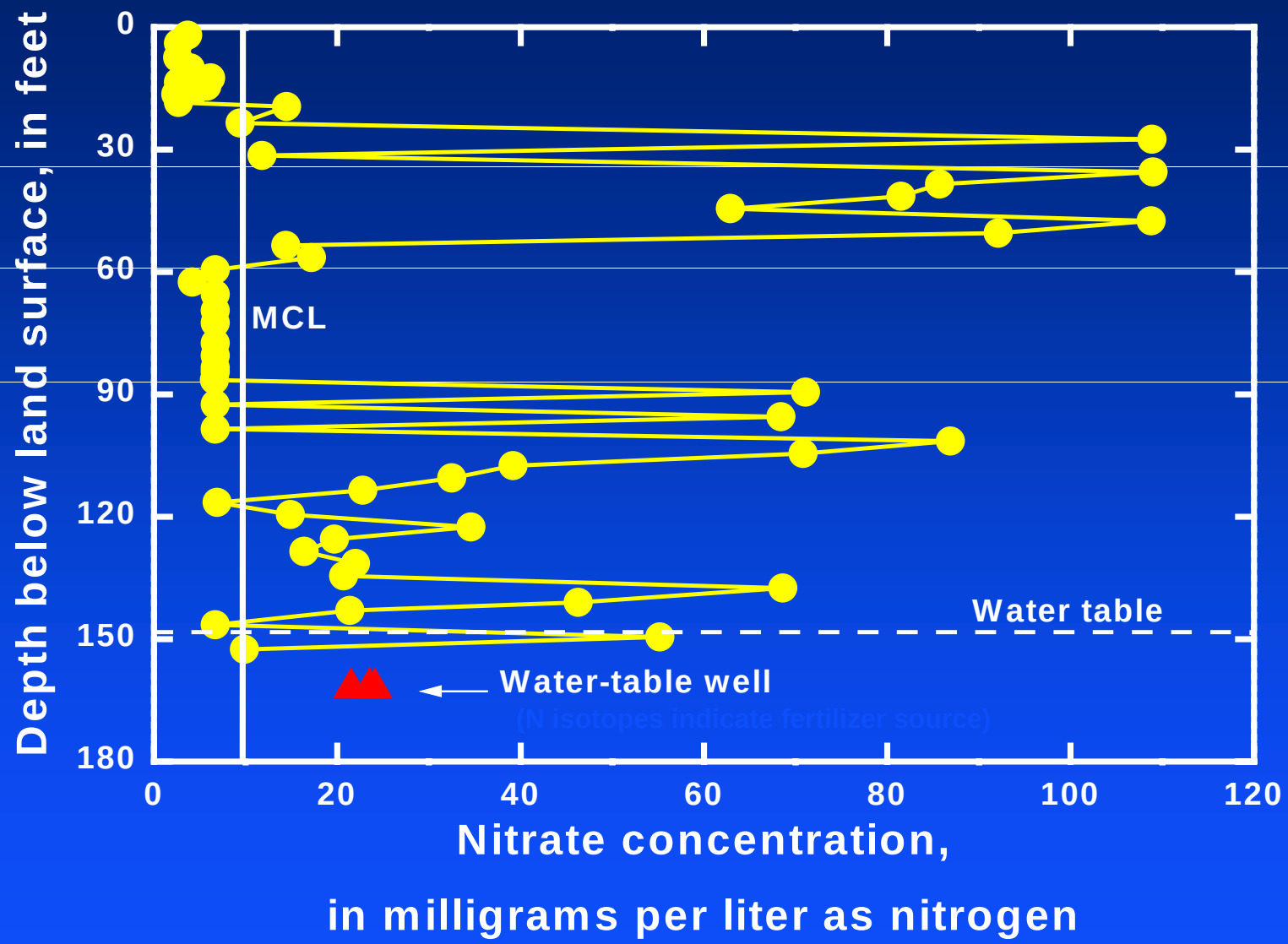
COMPARISON BETWEEN IRRIGATED AND NON-IRRIGATED LAND



Nitrate movement to the aquifer is minimal under grassland, central High Plains Aquifer

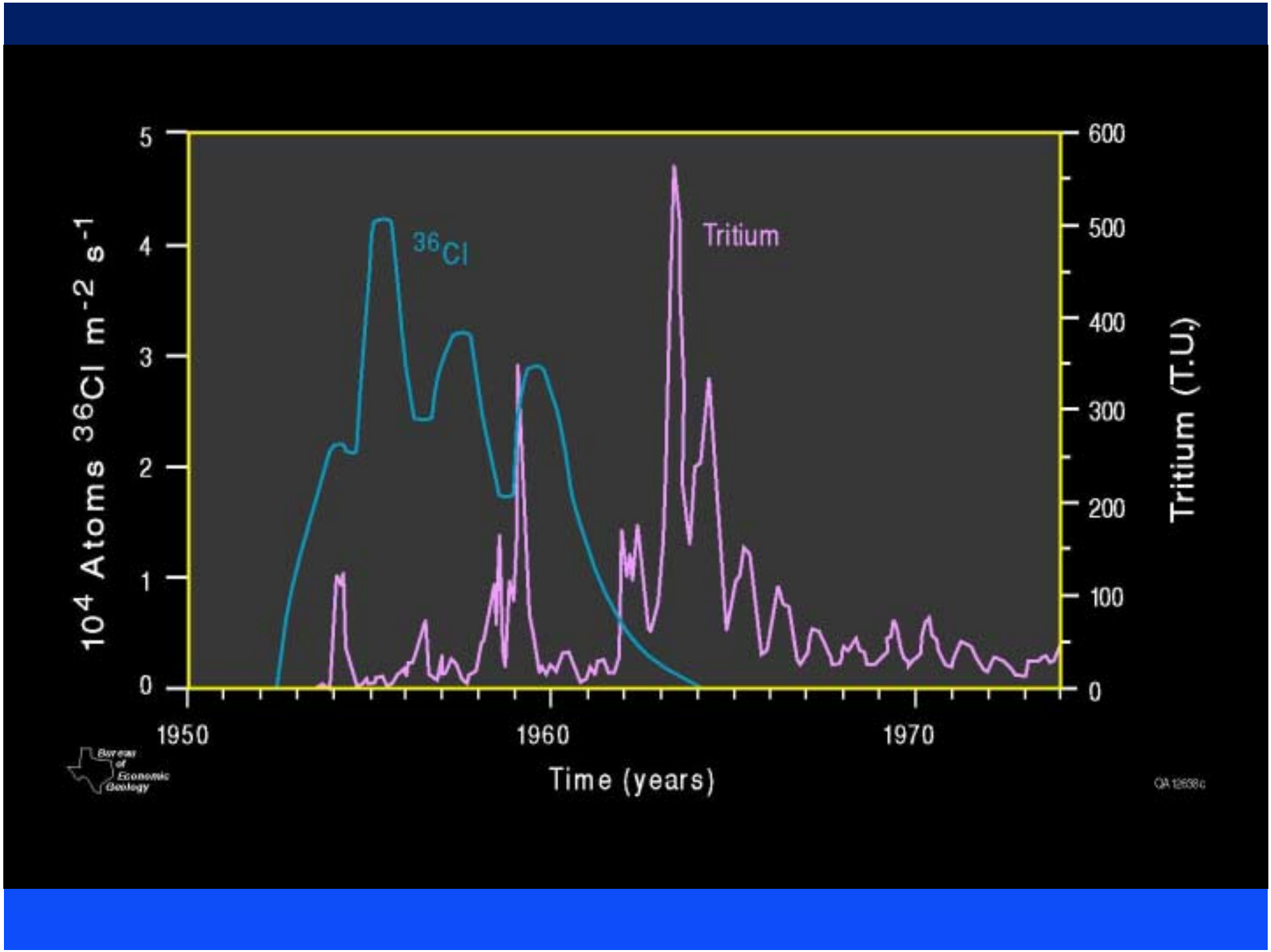


Nitrate can move through a thick unsaturated zone under an irrigated field, central High Plains Aquifer

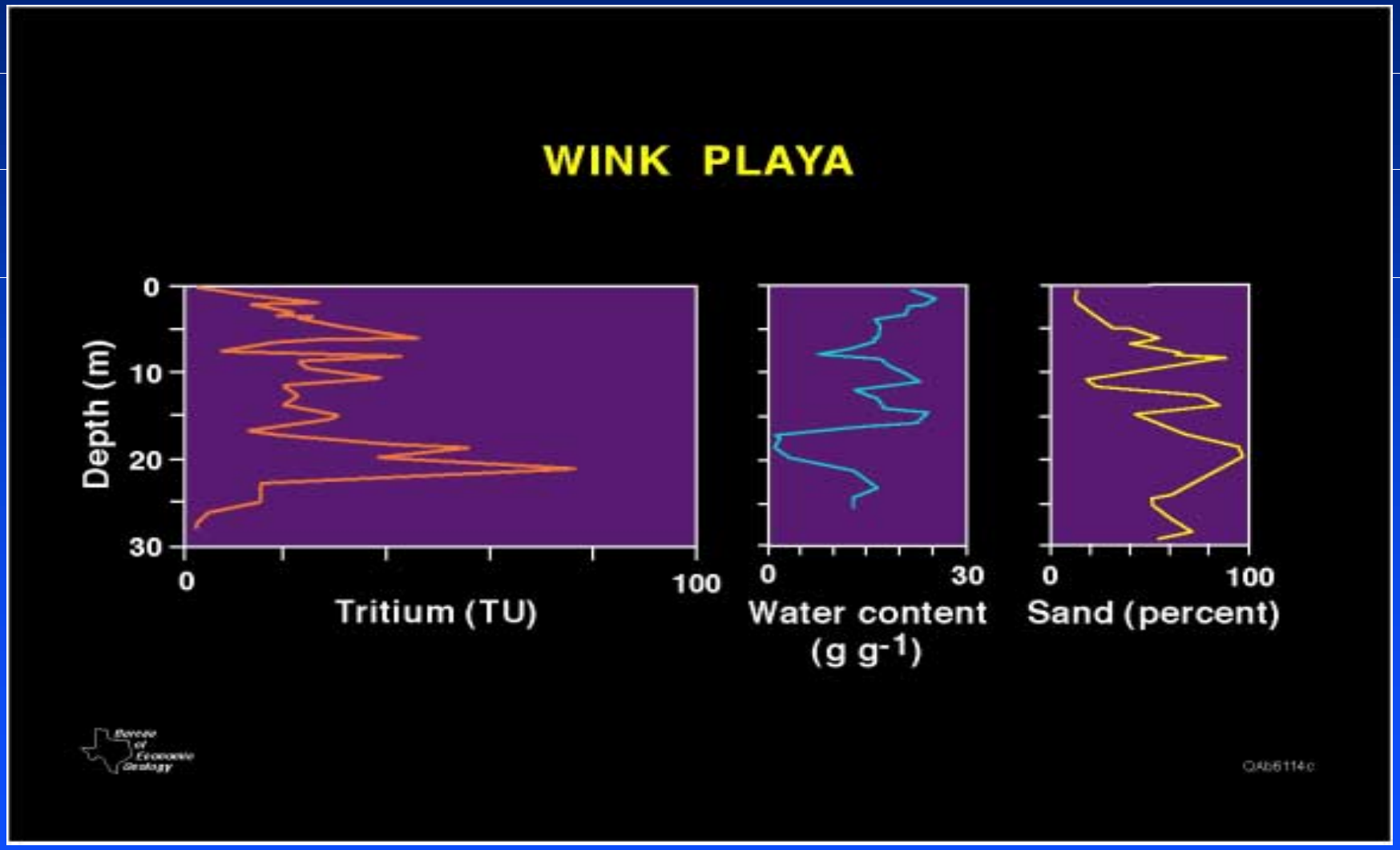


Approach

- Quantitative estimates of recharge in response to irrigation
- Measure the subsurface distribution of bomb pulse tritium in response to irrigation
- Numerically simulate infiltration and recharge in response to irrigation


10^4 Atoms ^{36}Cl m^{-2} s^{-1}
5
4
3
2
1
0
^{36}Cl
Tritium
600
500
400
300
200
100
0
Tritium (T.U.)
1950
1960
1970
Time (years)
Bureau of Economic Geology

Tritium Example from Playa near Amarillo

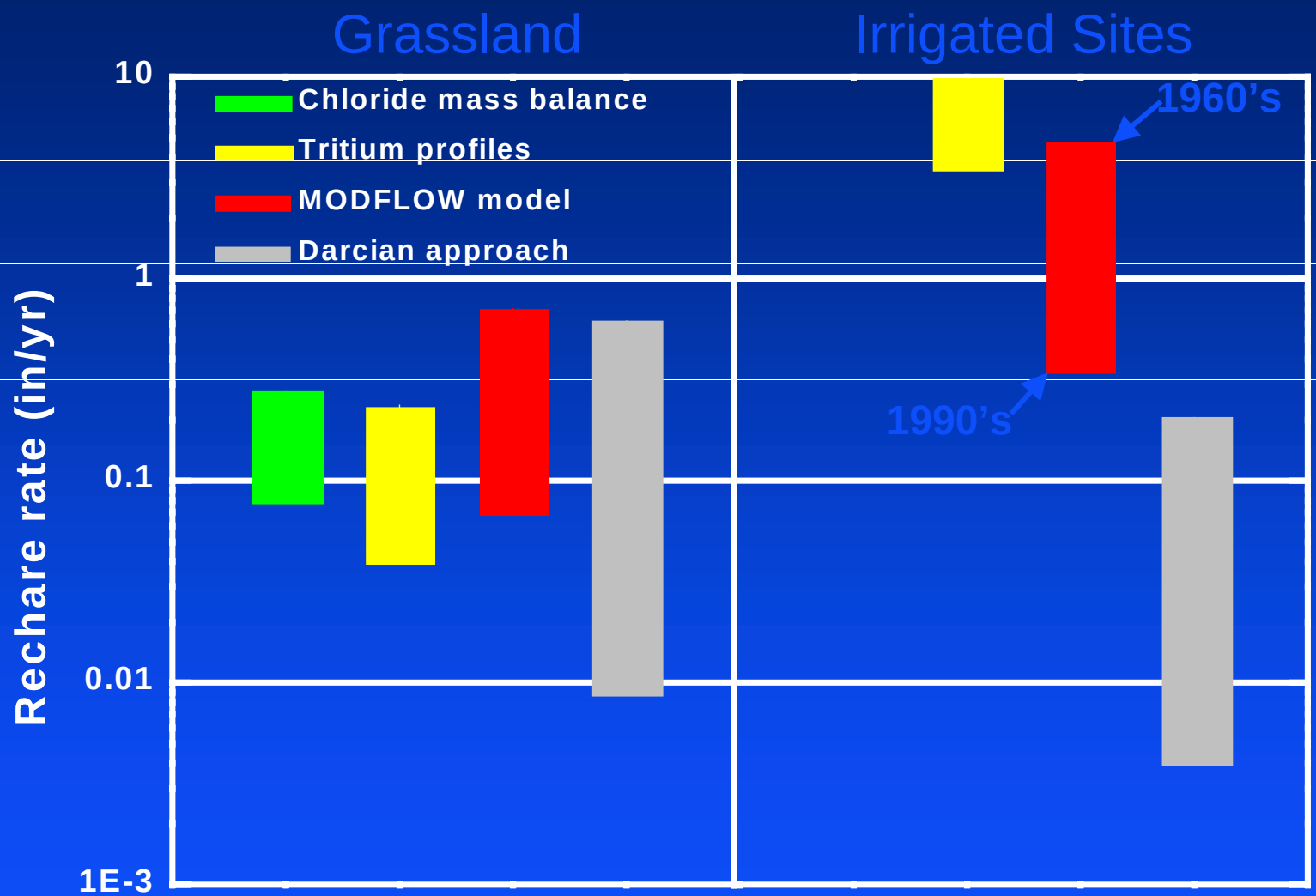


Recharge Calculation Based on Bomb Tritium

- Water velocity = depth of bomb-pulse tritium in subsurface divided by length of time from bomb fallout (1963) to sample date (1993) = 20 m / 30 yr = 0.7 m/yr = ~2 ft/yr

- Recharge rate = water velocity (0.7 m/yr) x average water content (0.2) in soil profile between surface and depth of bomb peak = 0.7 m/yr x 0.2 = 0.14 m/yr = 14 cm/yr
  = 5.5 inches/yr

Recharge Rate Varies with Irrigation Method



Southern High Plains

- Three boreholes have been drilled, sampled, and instrumented
  - depths of 85, 140, 150 ft
  - lysimeters, gas ports, heat-dissipation sensors
  - soil sample analyses include texture, water content, bomb tritium, chloride, sulfate, nitrate, pesticides
- Two boreholes are in irrigated areas and one in nonirrigated areas

Instrumentation at borehole sites includes water level recorders and data loggers for monitoring soil-water pressures

POTENTIAL ENERGY MEASUREMENT

Thermocouple psychrometer sample changer

Water activity meter

0 m 0.13

Tensiometer

Thermocouple psychrometer

Heat dissipation sensor

Bureau of Economic Geology

GAb8553c

Stakeholder Advisory Forum
August 2, 2001

List of Attendees

Name	Affiliation
Richard Smith	TWDB
Joan Glass	TPWD
Larry Sanders	Phillips Petroleum Company
Kraig Gallimore	TWDB
Kent Satterwhite	CRMWD
B.O. Spoonts	TDA
Ches Carthel	City of Lubbock
Jason Coleman	SPUWCD
Jim Conkwright	HPUWCD
Cindy Cawley	LEUWCD
Steve Musick	TNRCC
Stefan Schuster	TWDB
Neil Blandford	Daniel B. Stephens & Associates, Inc. (presenter)

Stakeholder Advisory Forum No. 2
August 2, 2001
High Plains Underground Water Conservation District No. 1
Lubbock, Texas

Questions & Answers Concerning Southern Ogallala Groundwater Availability Modeling (GAM)

1. Is there something specific about the years 1992 and 1993 that interest you? (This was asked in relation to some preliminary 1992 depletion calculations that were presented.)

Response: *The year 1992 is one of the key years the crop demand will be computed by Dr. Amosson and his group. The key years are 1982, 1987, 1992, and 1997.*

2. Are those the years the irrigation surveys were done?

Response: *Yes, that is correct. [The census of agriculture is reported each five years. The last one was in 1997. It identifies all irrigated crops and includes hay, pasture, and other, which are needed. The Texas Agricultural statistics service annual report does not include minor irrigated crops, only major crops. We will use the census of agriculture '82, '87, '92, and '97 reports to obtain more years of data to cross check with TASS on major irrigated crops to verify or potentially improve accuracy.]*

3. Are you aware those surveys are inaccurate?

Response: *Yes we are aware, talking to Dr. Amosson, that there are different surveys that have been done and different types of inaccuracies for various reasons. Could you be more specific on what you believe is inaccurate?*

4. The amounts of pumpage in those surveys are inaccurate.

Response: *Yes. That is the reason we are going to compute the pumpage differently, rather than take it directly from the surveys. We are going to compute the pumpage from the method I went through briefly, using PET networks and weather information.*

5. You still may not get accurate pumping rates based on PET calculations. Many producers may put on a lot more water than would required based on PET calculations.

Response: *That is the reason we are also doing the groundwater depletion calculations based on water level measurements. If producers are applying significantly more water than required, then the depletion volumes should be significantly greater than pumping estimates derived from PET calculations.*

Note: *The point was made and there was some discussion concerning the fact that the method for determining irrigation pumping in the model is different from that used by the Llano Estacado RWPG (Region O). The approach used in the modeling is the same as that used by the Region A Planning Group. There will need to be interaction with the Region O group to confirm the estimates used in the modeling.*

6. When you talk about recharge rates and you say one is 5 1/2 inches, is that saturated thickness or actual water?

Response: *That is the actual water.*

7. Is it possible to make computations (of historical pumping) from depletions?

Response: *It is possible, but what we are trying to do is evaluate why water levels in the aquifer change. There is natural recharge, there could be irrigation recharge (return flow), and there is pumping. We need to sort out those pieces and understand them separately as much as possible, in order to develop a model suitable for making predictions.*

8. Are some of the issues you have been presenting here based upon the A&M report model?

Response: *Yes. The approach used to determine agricultural pumping in this model is the same approach used in the Region A model, which was also used by the Region A RWPG.*