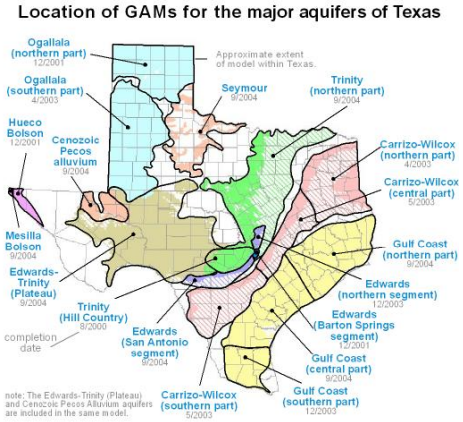
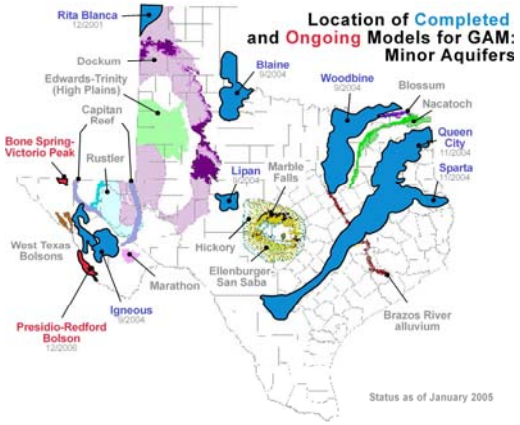
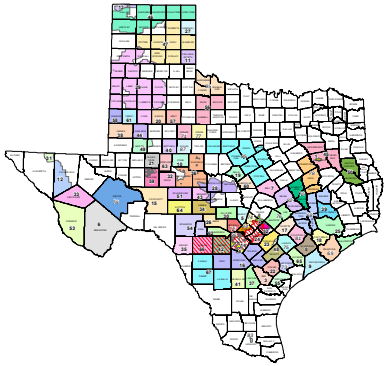
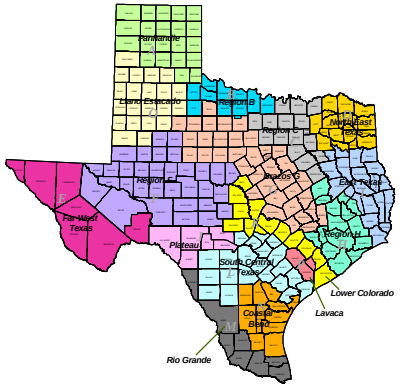
Groundwater Availability Modeling









Texas Water Development Board

Groundwater Availability Model (GAM) for the Presidio-Redford Bolsons

Stakeholder Advisory Forum #1

November 4, 2005

Shirley Wade

Ali Chowdhury

Doug Coker

Acknowledgements

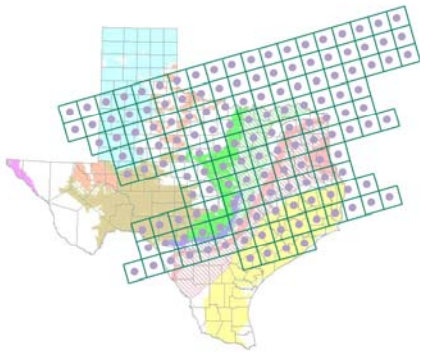
- Janet Adams and the Presidio County UWCD Board Members
- The City of Presidio
- IBWC staff including Rong Kuo and Hector Hernandez
- Luis Armendariz - TPWD
- David Lewis - American Legion Hall
- Many individual landowners

Contributors to the project at TWDB

- Doug Coker
- Ali Chowdhury
- Jorge Arroyo
- Adolph Sticklebault
- Miguel Pavon
- Rima Petrossian
- Sarah Davidson
- Roberto Anaya
- Roger Quincy

Agenda for Stakeholder Advisory Forum (SAF) Meeting No. 1 November 4, 2005

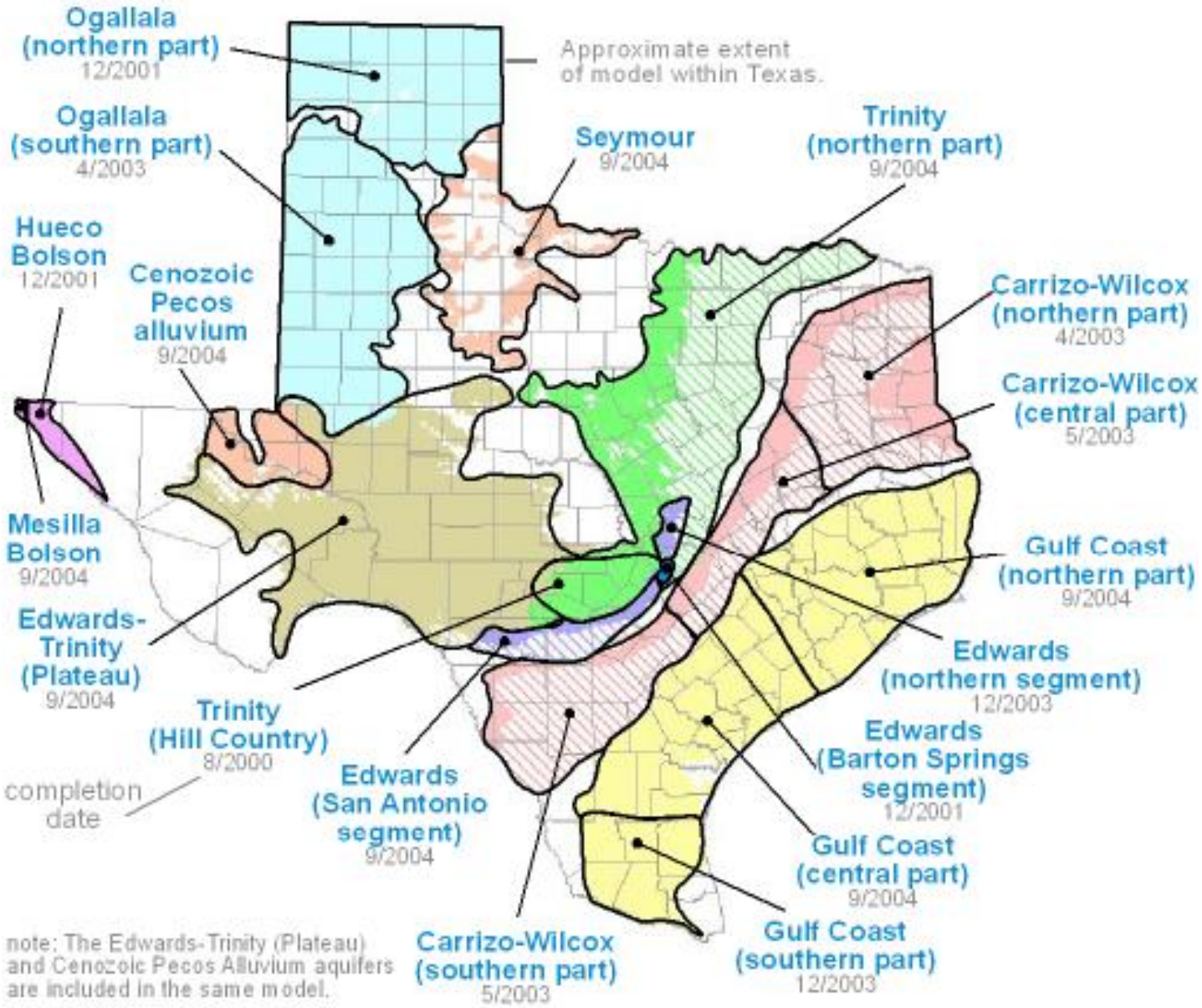
- Purpose of Groundwater Availability Models (GAMs) and the Stakeholder Advisory Forum
- Groundwater modeling
- Hydrogeology
- Modeling approach
- Data Needs
- Project schedule



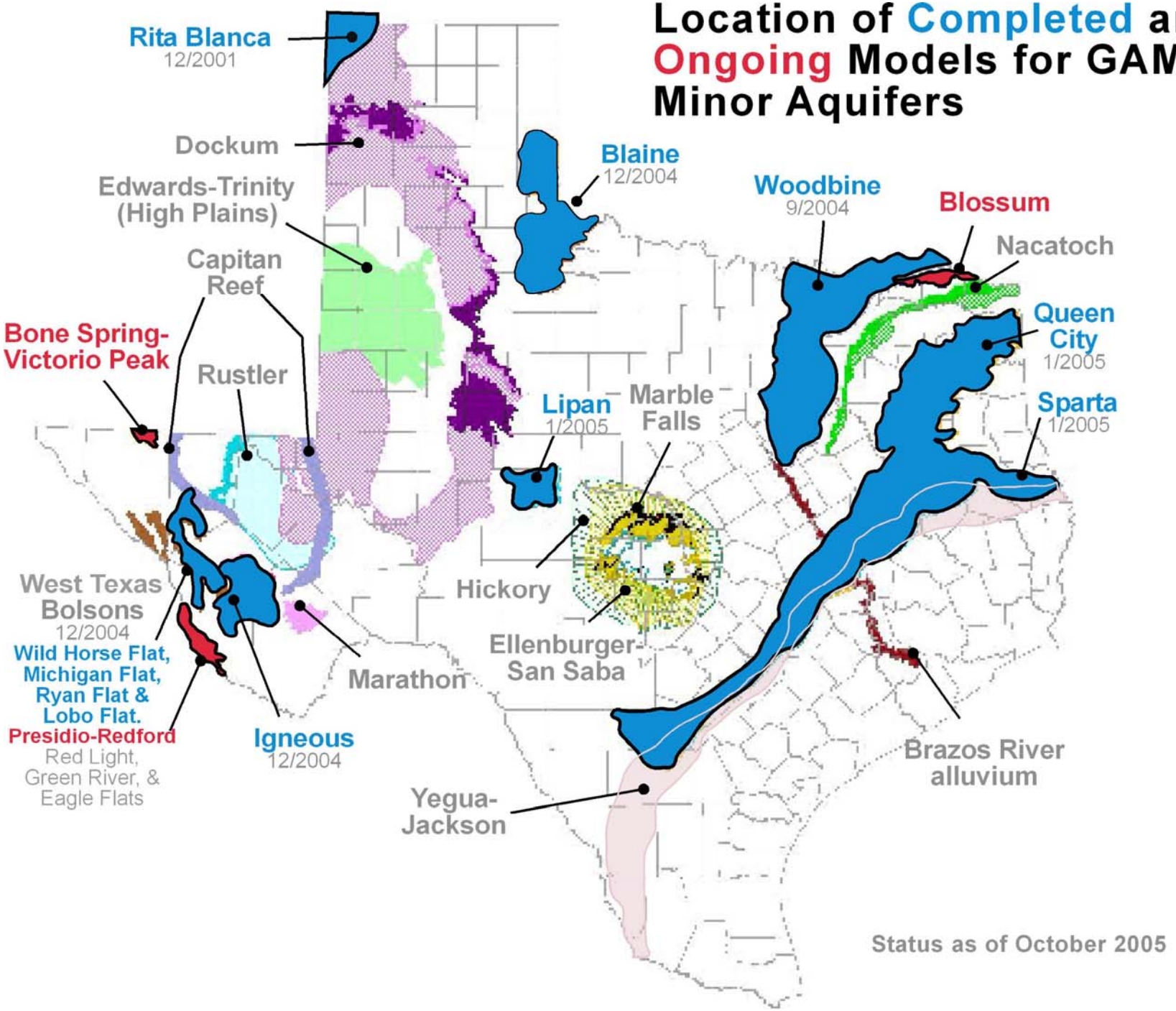
GAM

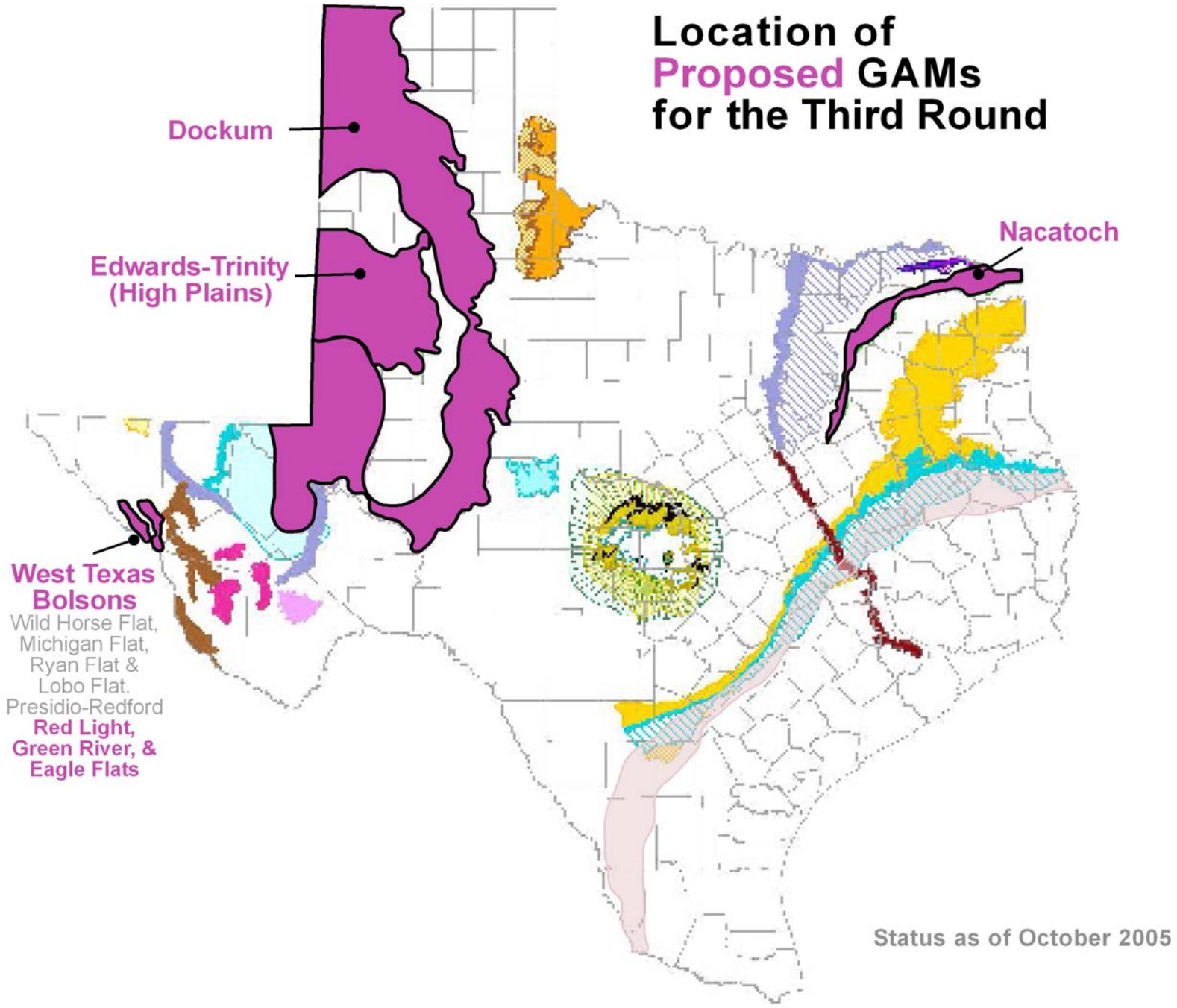
- **Purpose:** to develop tools that can be used to help evaluate groundwater
- **Public process:** you get to see how the model is put together.
- **Freely available:** standardized, thoroughly documented, with reports available over the internet.
- **Living tools:** periodically updated.

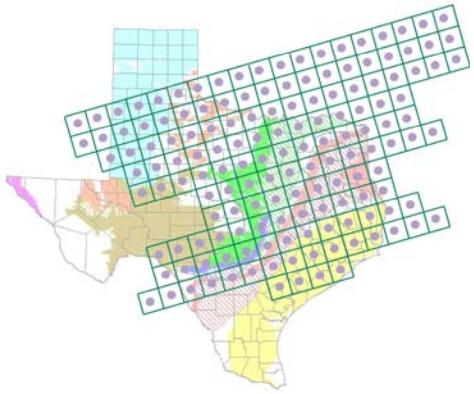
Location of GAMs for the major aquifers of Texas



Location of Completed and Ongoing Models for GAM: Minor Aquifers

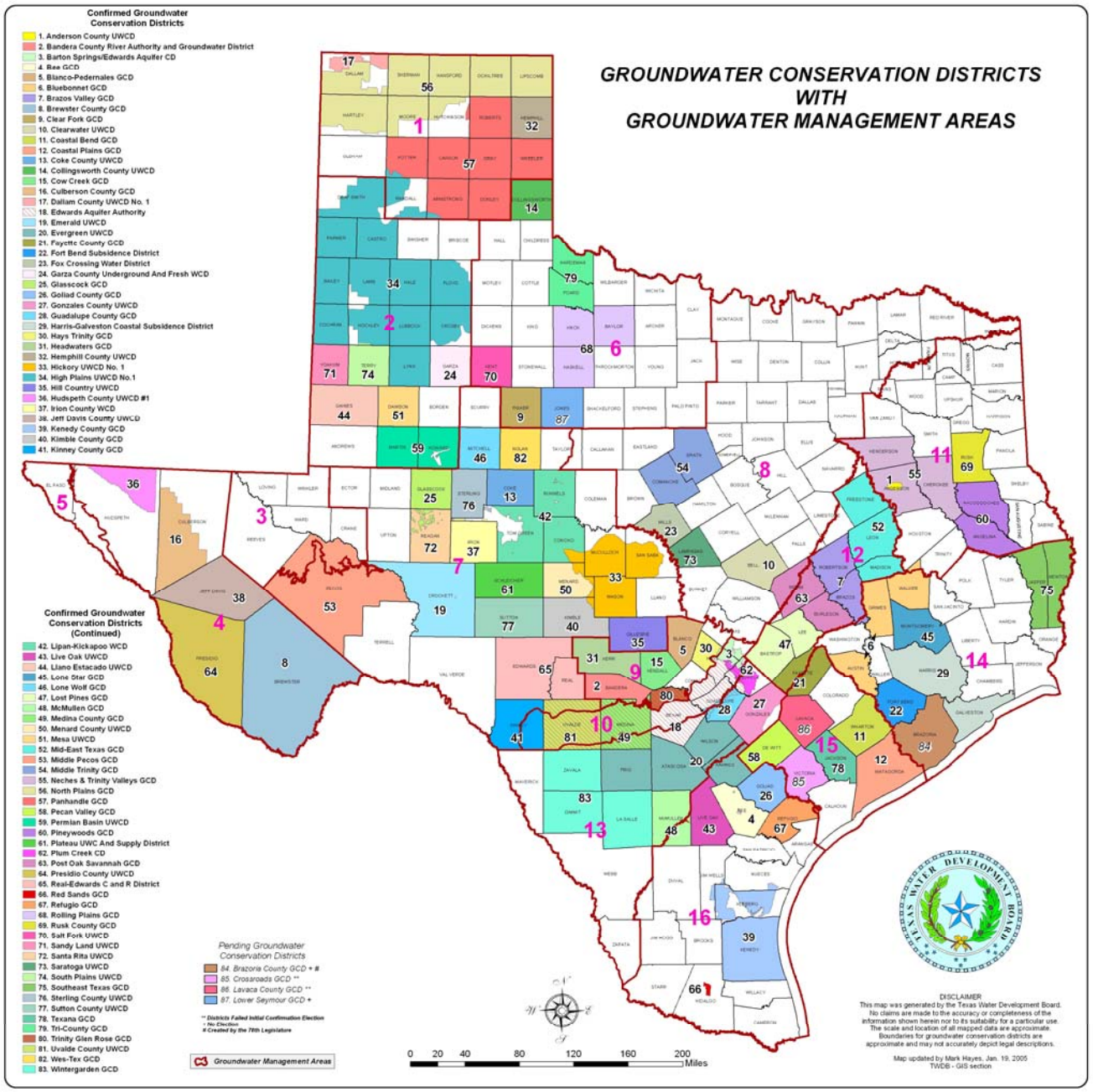


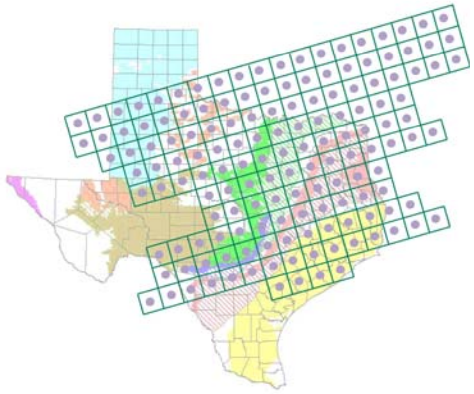

Location of
Proposed GAMs
for the Third Round
Dockum
Edwards-Trinity
(High Plains)
Nacatoch
West Texas
Bolsons
Wild Horse Flat,
Michigan Flat,
Ryan Flat &
Lobo Flat.
Presidio-Redford
Red Light,
Green River, &
Eagle Flats
Status as of October 2005



What is managed available groundwater?

- …the amount of groundwater that may be permitted by a district for beneficial use in accordance with the desired future condition of the aquifer (HB 1763)
- A GAM is a tool that can be used to assess groundwater availability once the GMAs decide the desired future condition of their aquifer(s).


GROUNDWATER CONSERVATION DISTRICTS
WITH
GROUNDWATER MANAGEMENT AREAS
Confirmed Groundwater Conservation Districts
1. Anderson County UWCD
2. Bandera County River Authority and Groundwater District
3. Barton Springs/Edwards Aquifer CD
4. Bee GCD
5. Blanco-Pedernales GCD
6. Bluebonnet GCD
7. Brazos Valley GCD
8. Brewster County GCD
9. Clear Fork GCD
10. Clearwater UWCD
11. Coastal Bend GCD
12. Coastal Plains GCD
13. Coke County UWCD
14. Collingsworth County UWCD
15. Cow Creek GCD
16. Culberson County GCD
17. Dallam County UWCD No. 1
18. Edwards Aquifer Authority
19. Emerald UWCD
20. Evergreen UWCD
21. Fayette County GCD
22. Fort Bend Subsidence District
23. Fox Crossing Water District
24. Garza County Underground And Fresh WCD
25. Glasscock GCD
26. Goliad County GCD
27. Gonzales County UWCD
28. Guadalupe County GCD
29. Harris-Galveston Coastal Subsidence District
30. Hays Trinity GCD
31. Headwaters GCD
32. Hemphill County UWCD
33. Hickory UWCD No. 1
34. High Plains UWCD No.1
35. Hill Country UWCD
36. Hudspeth County UWCD #1
37. Irion County WCD
38. Jeff Davis County UWCD
39. Kenedy County GCD
40. Kimble County GCD
41. Kinney County GCD
Confirmed Groundwater Conservation Districts (Continued)
42. Lipan-Kickapoo WCD
43. Live Oak UWCD
44. Llano Estacado UWCD
45. Lone Star GCD
46. Lone Wolf GCD
47. Lost Pines GCD
48. McMullen GCD
49. Medina County GCD
50. Menard County UWCD
51. Mesa UWCD
52. Mid-East Texas GCD
53. Middle Pecos GCD
54. Middle Trinity GCD
55. Neches & Trinity Valleys GCD
56. North Plains GCD
57. Panhandle GCD
58. Pecan Valley GCD
59. Permian Basin UWCD
60. Pineywoods GCD
61. Plateau UWC And Supply District
62. Plum Creek CD
63. Post Oak Savannah GCD
64. Presidio County UWCD
65. Real-Edwards C and R District
66. Red Sands GCD
67. Refugio GCD
68. Rolling Plains GCD
69. Rusk County GCD
70. Salt Fork UWCD
71. Sandy Land UWCD
72. Santa Rita UWCD
73. Saratoga UWCD
74. South Plains UWCD
75. Southeast Texas GCD
76. Sterling County UWCD
77. Sutton County UWCD
78. Texana GCD
79. Tri-County GCD
80. Trinity Glen Rose GCD
81. Uvalde County UWCD
82. Wes-Tex GCD
83. Wintergarden GCD
Pending Groundwater Conservation Districts
84. Brazoria County GCD + #
85. Crossroads GCD **
86. Lavaca County GCD **
87. Lower Seymour GCD +
** Districts Failed Initial Confirmation Election
+ No Election
# Created by the 78th Legislature
C3 Groundwater Management Areas
0 20 40 80 120 160 200 Miles
TEXAS WATER DEVELOPMENT BOARD
DISCLAIMER
This map was generated by the Texas Water Development Board. 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. Boundaries for groundwater conservation districts are approximate and may not accurately depict legal descriptions.
Map updated by Mark Hayes, Jan. 19, 2005
TWDB - GIS section



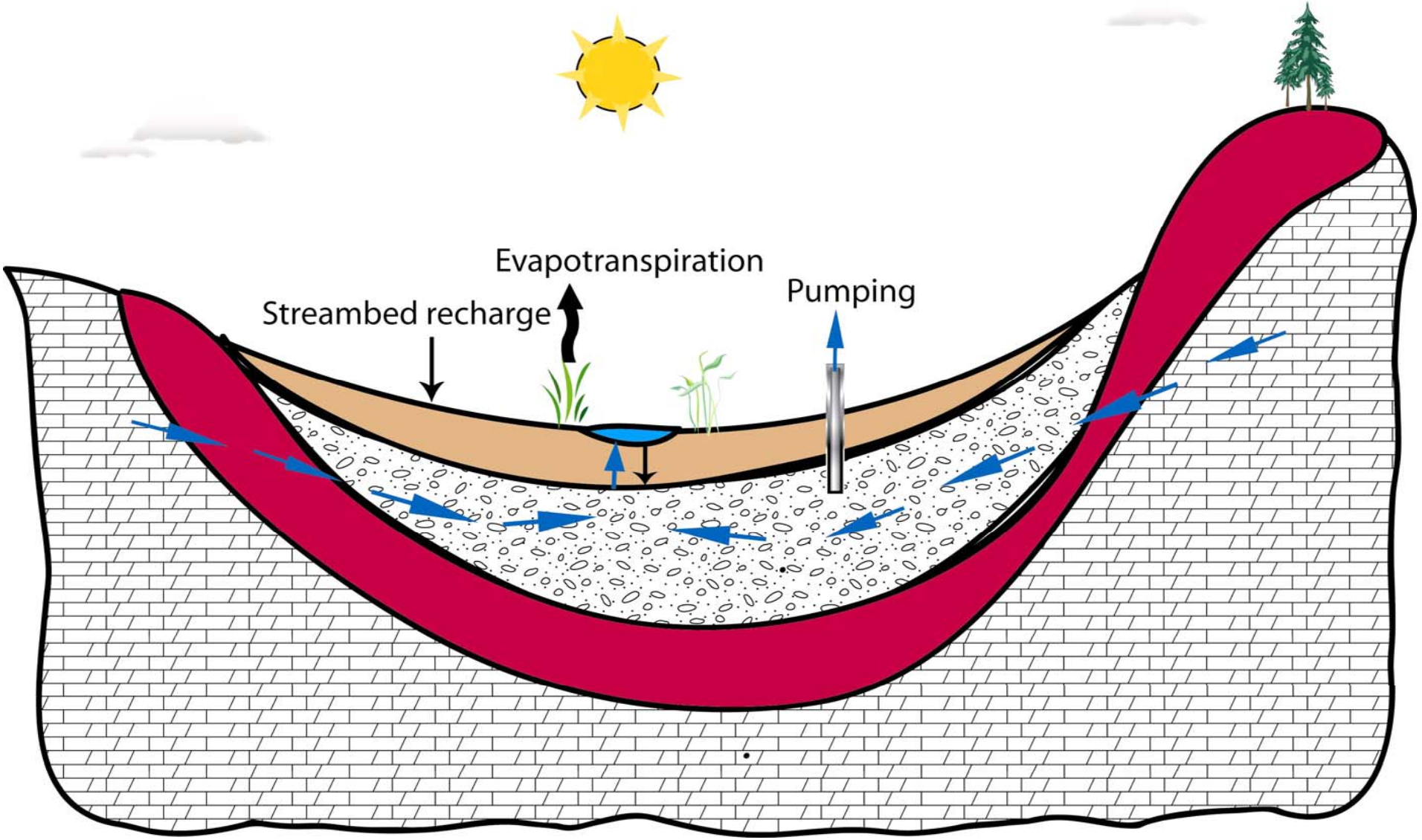
How do we use GAM?

- **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
- **Data Storehouse**

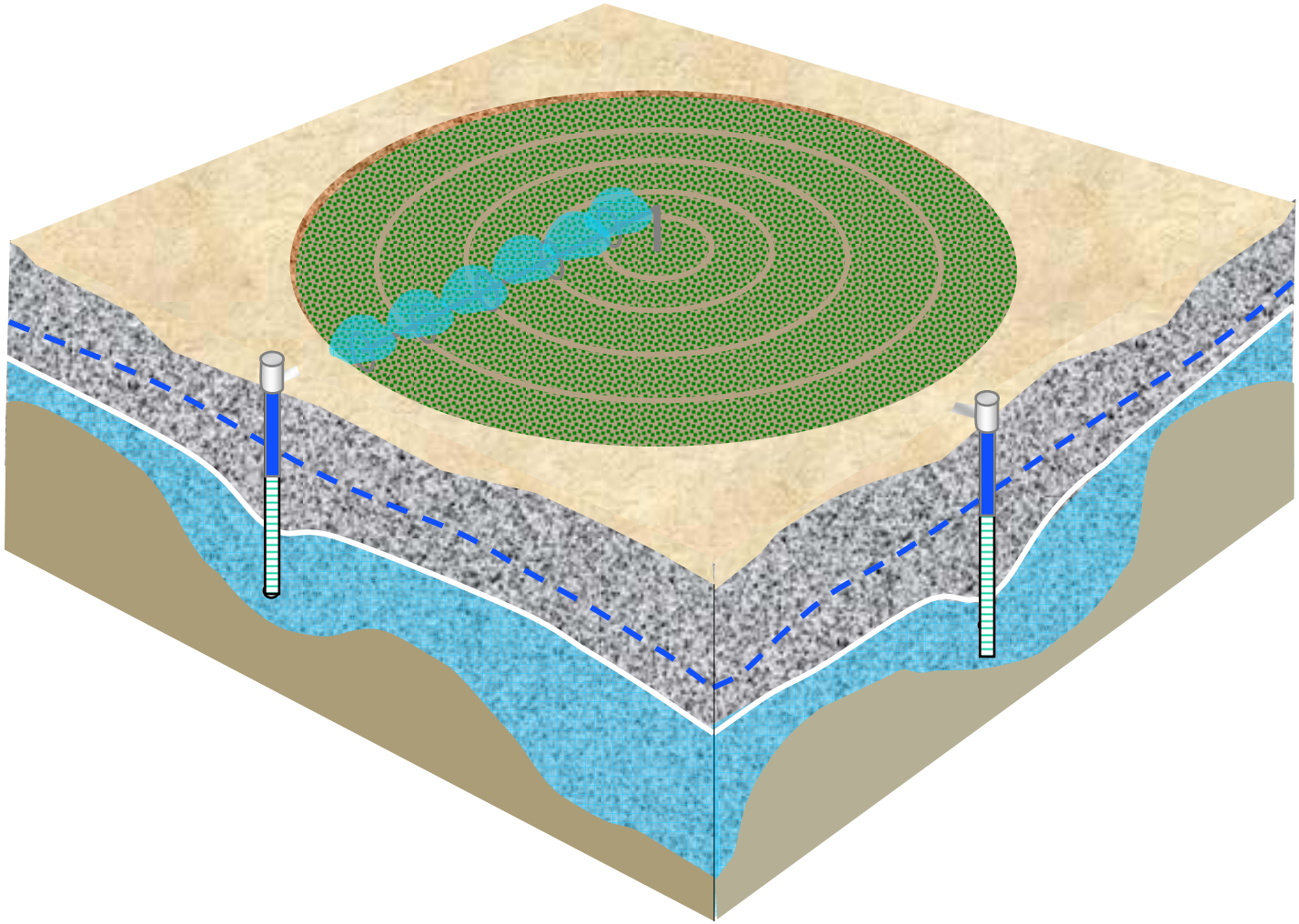
Groundwater Modeling

- We model the aquifer by dissecting or dividing it into squares.
- Each square is called a “grid cell”.
- Water flowing in and out of each grid cell is calculated and balanced.
- Inflows and outflows can include:
  - cross formational flow (up and down flows),
  - lateral inflow and outflow (side to side),
  - Pumping (water taken out of aquifer),
  - Infiltration (water being added to aquifer),
  - Evapotranspiration, and
  - stream inflows and outflows.

Conceptual view of a groundwater flow system

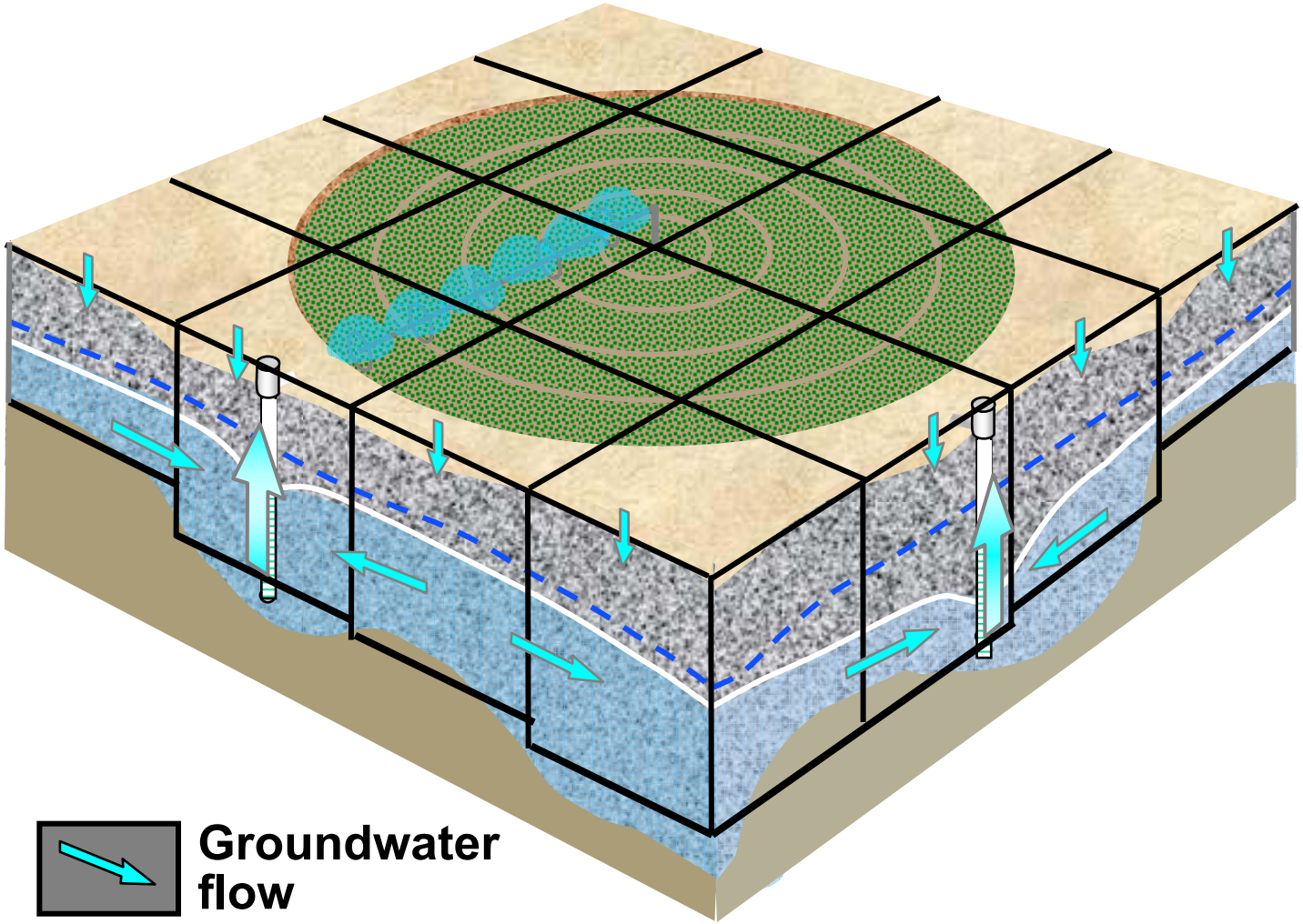


Cutout of an aquifer



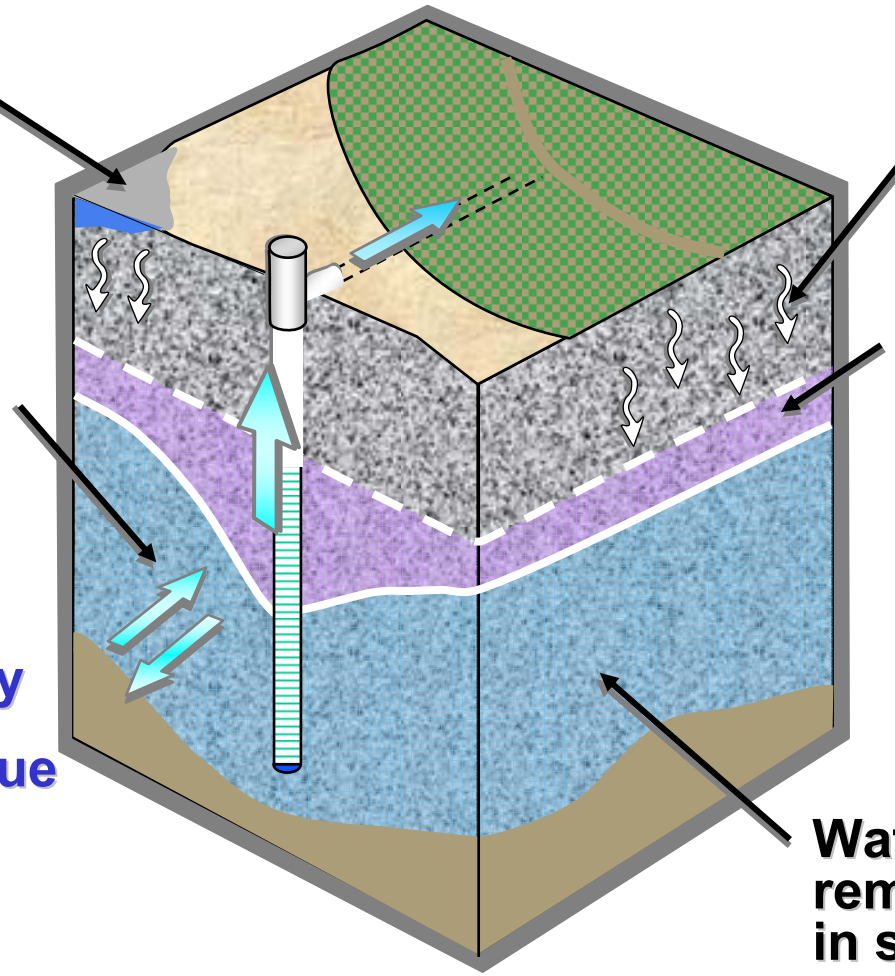
From, Daniel B. Stephens & Associates, Inc.

Cutout of aquifer dissected into grid cells



From, Daniel B. Stephens & Associates, Inc.

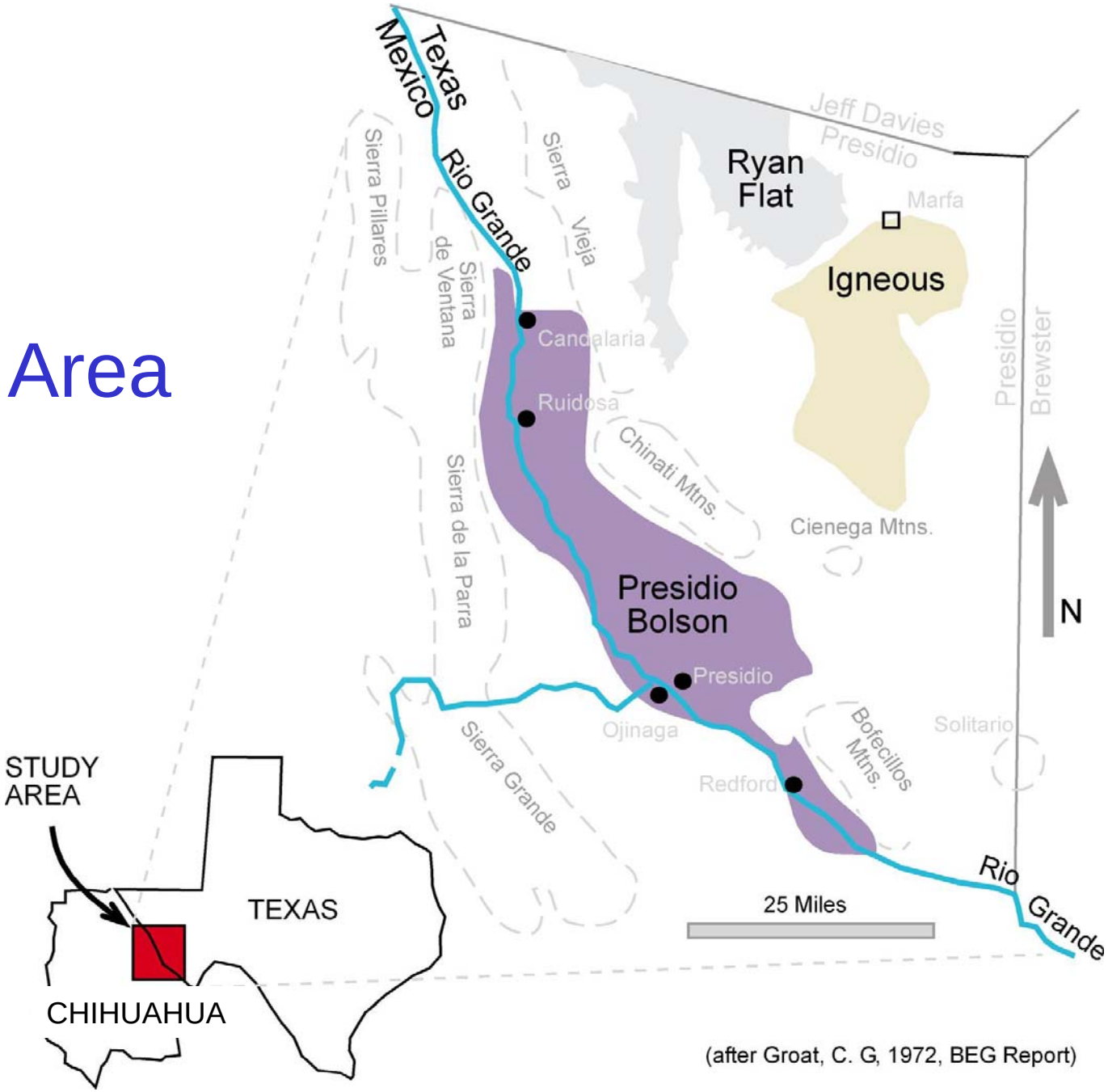
Flow in one cell



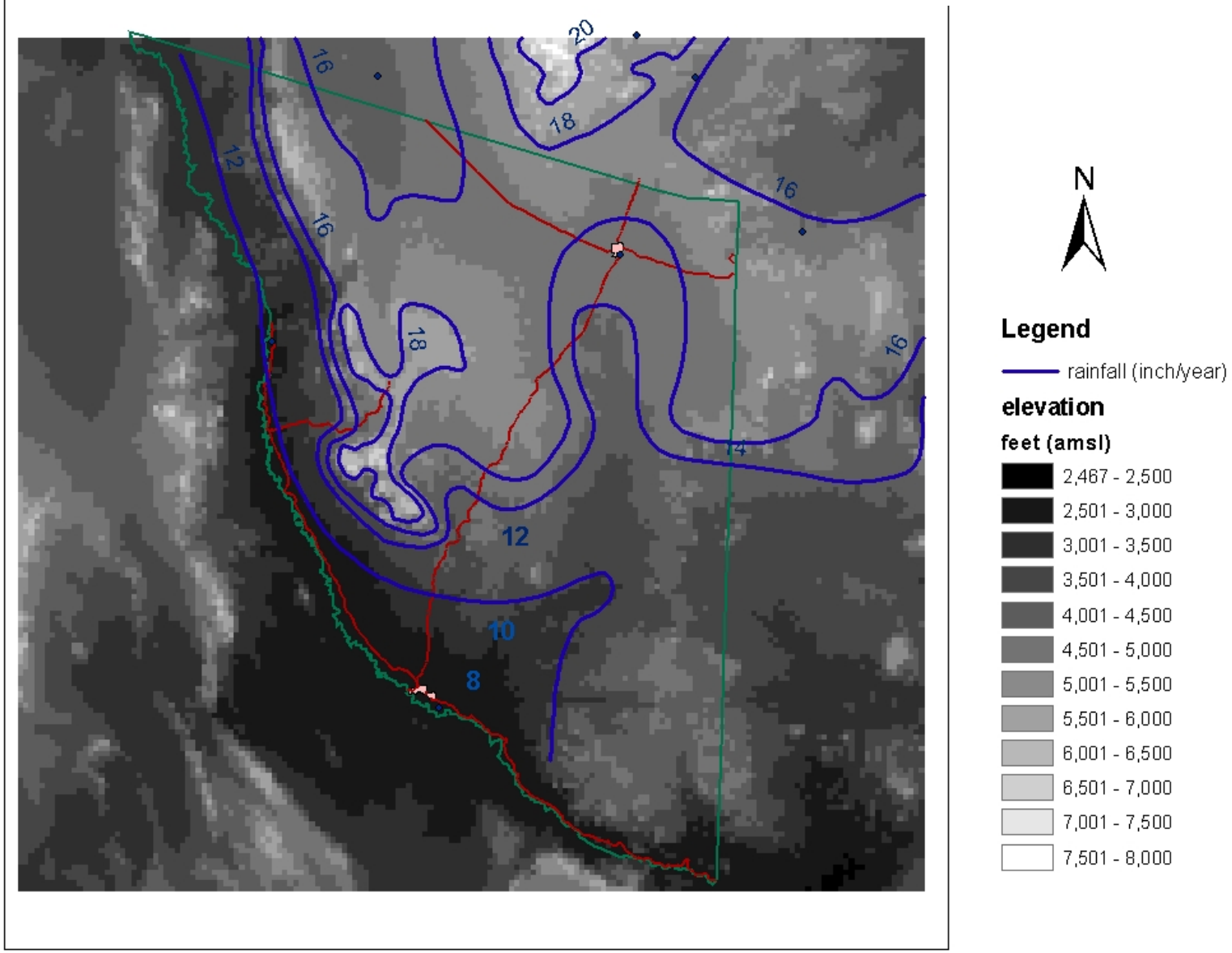
- Permeability
- Storage value
- Thickness

From, Daniel B. Stephens & Associates, Inc.

Study Area


Texas
Mexico
Rio Grande
Sierra Pillares
Sierra de Ventana
Sierra Vieja
Jeff Davies
Presidio
Ryan Flat
Marfa
Igneous
Presidio
Brewster
Candelaria
Ruidosa
Chinati Mtns.
Cienega Mtns.
Sierra de la Parra
Presidio Bolson
N
Presidio
Ojinaga
Sierra Grande
Bofecillos Mtns.
Solitario
Redford
Rio Grande
25 Miles
STUDY AREA
TEXAS
CHIHUAHUA
(after Groat, C. G, 1972, BEG Report)

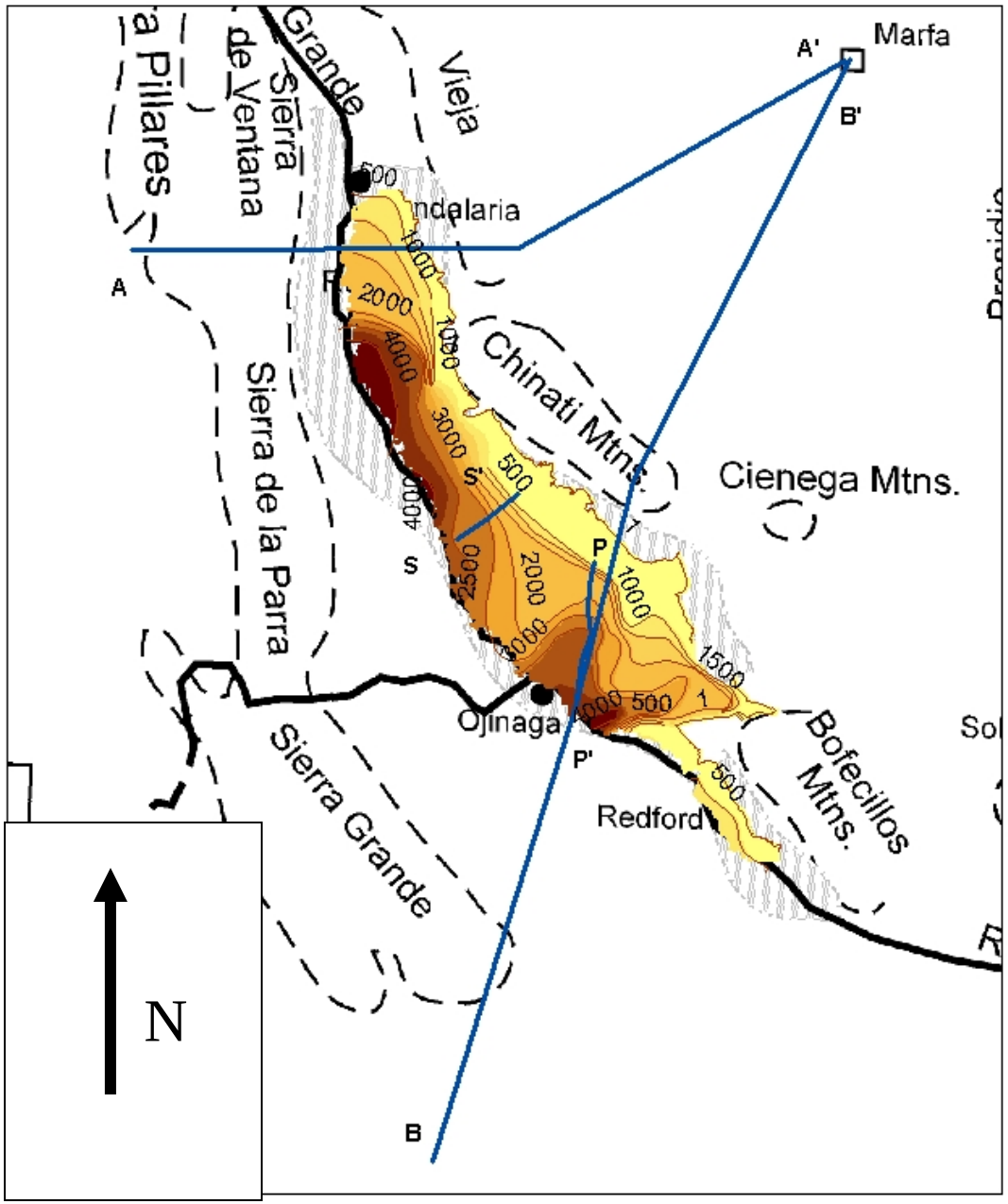
Land surface elevation and average rainfall



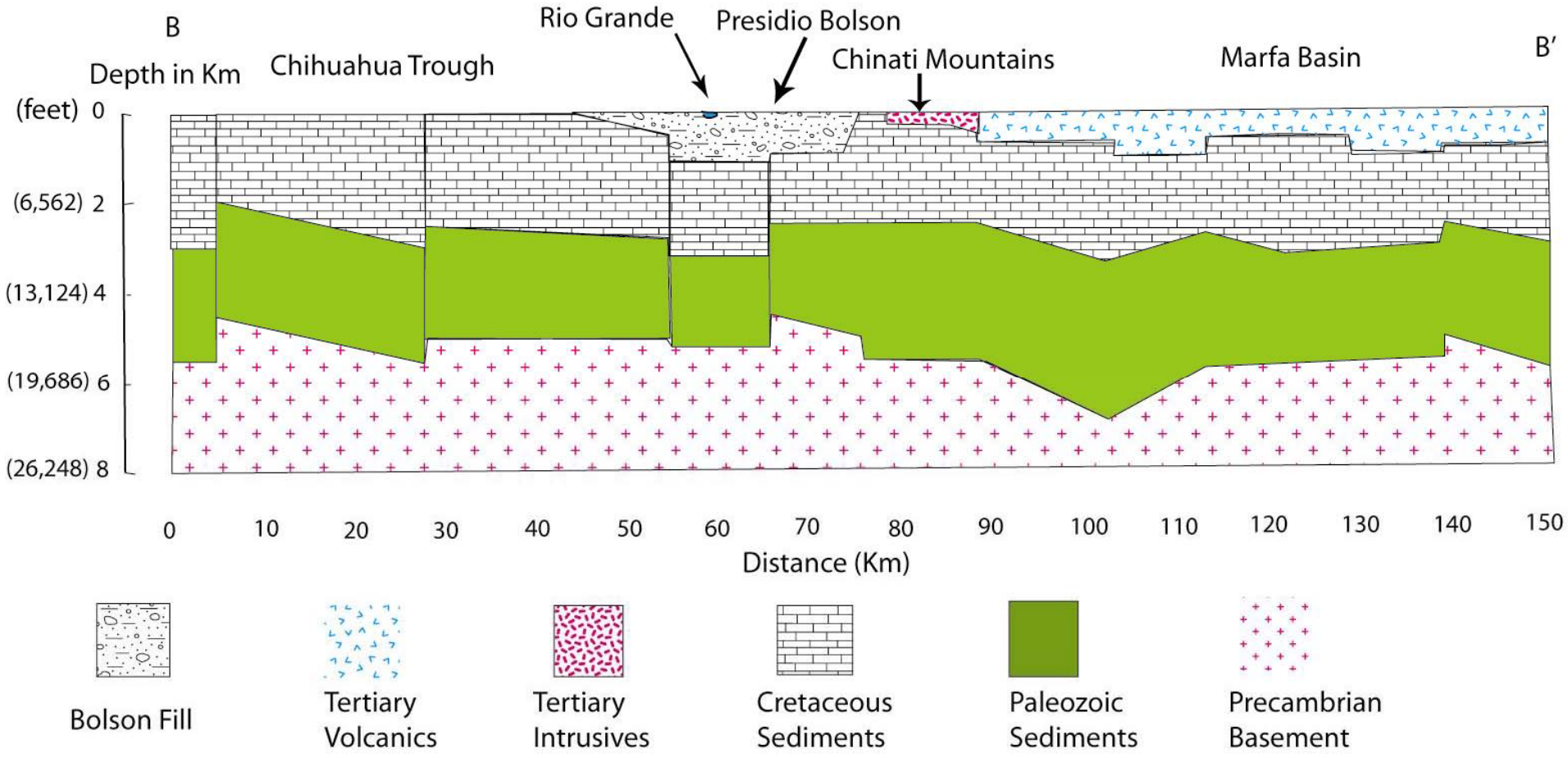
(rainfall map (Beach and others, 2004)

Structure Data: Bolson Thickness in Feet from geophysical surveys

(Based on USGS SWAP data and Gates and others, 1980)



Structure profile based on Gravity Survey



(From Mraz and Keller, 1980, Figure 5)

Collecting River Samples

Geochemistry Findings

- Groundwater composition is mainly controlled by varying lithology (rocks), evaporation, mixing, and chemical processes.

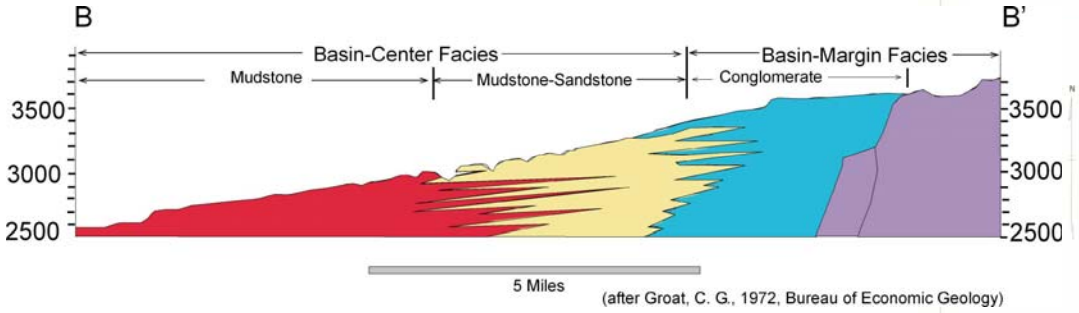
- Deeper saline groundwater from the mountains discharges below into the Presidio Bolson.

- Modern recharge is minimal, episodic, and localized. Recharge occurs across the bolsons mainly through stream beds.

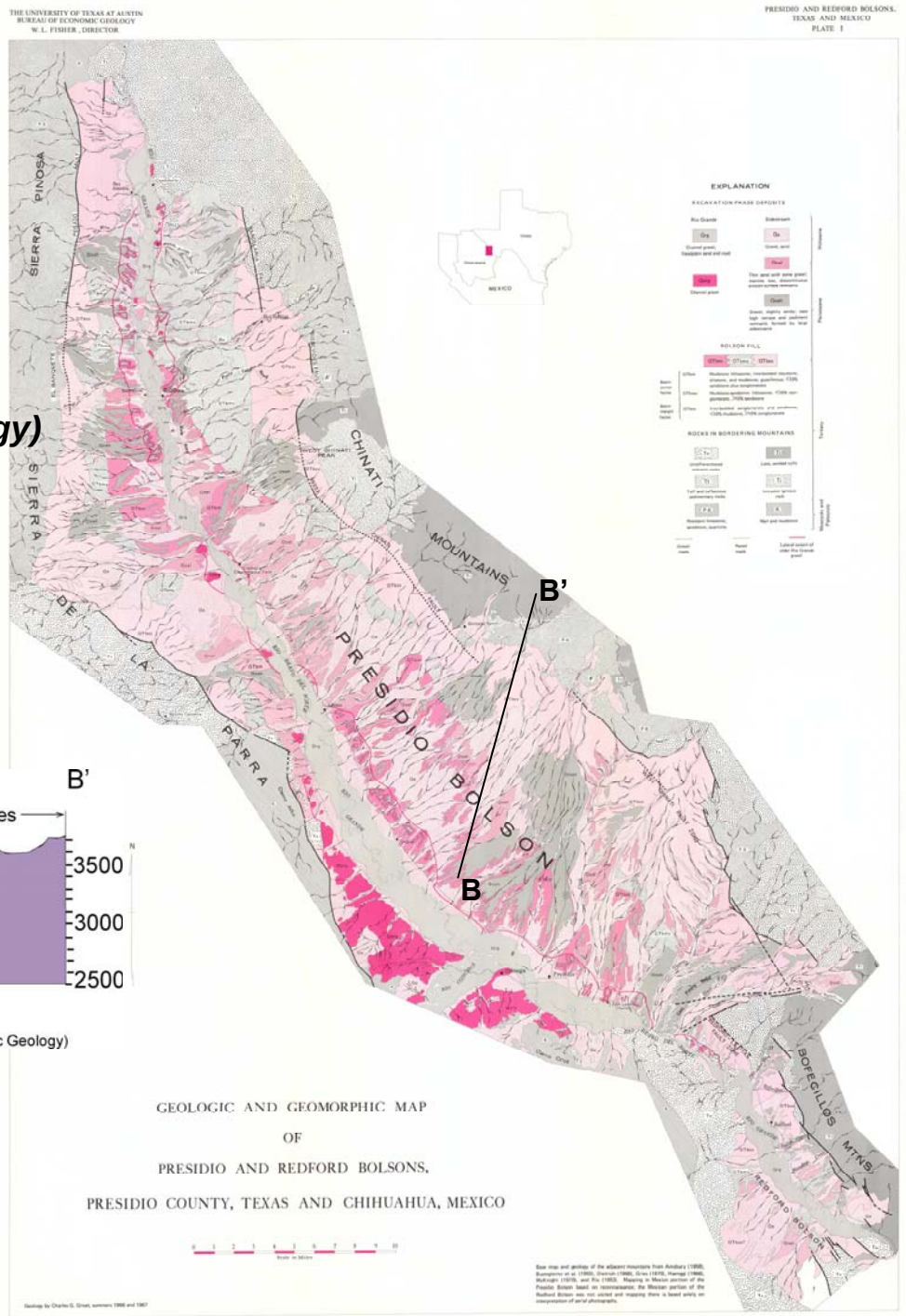
- Groundwater movement through the Bolsons is extremely slow and groundwater ultimately discharges at the Rio Grande.

Surface Geology of Presidio Bolson

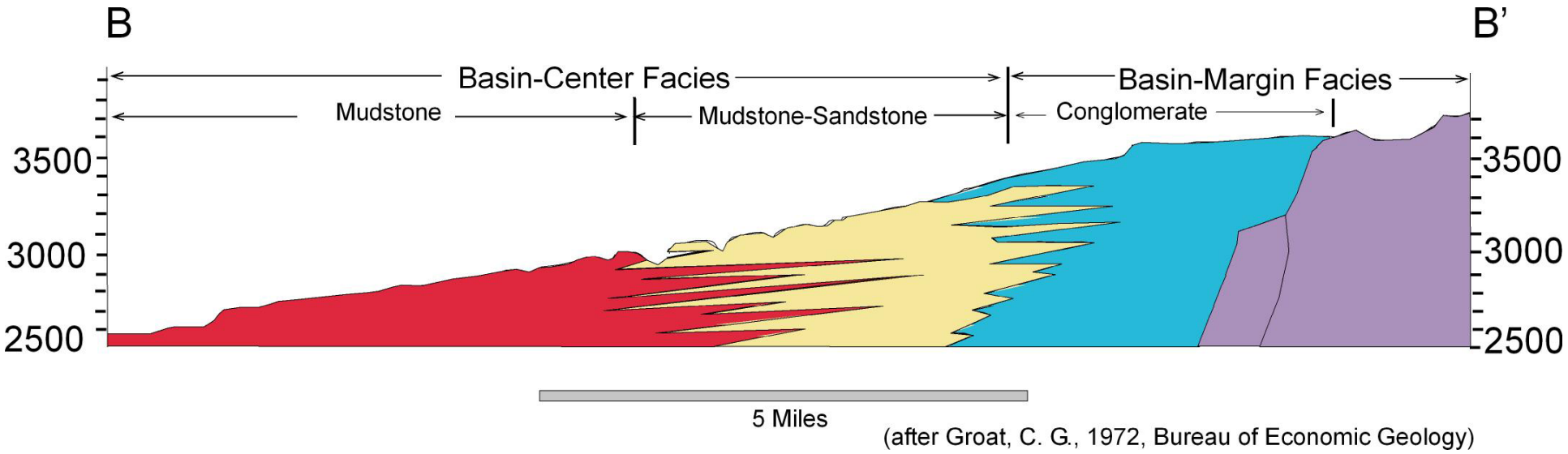
(from Groat C.G., 1972, Bureau of Economic Geology)



(after Groat, C. G., 1972, Bureau of Economic Geology)



Cross Section along Highway 67



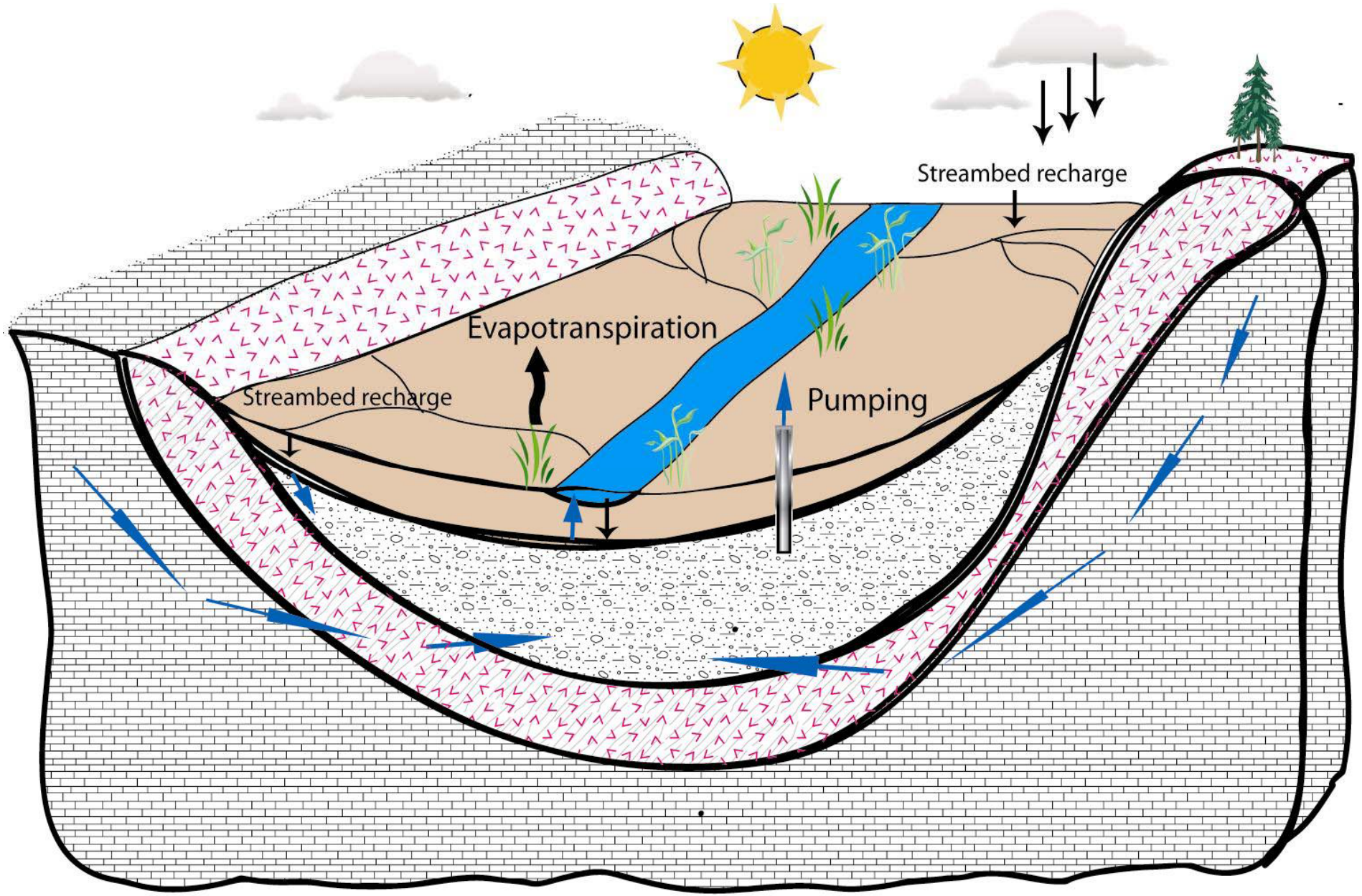
(after Groat, C. G., 1972, Bureau of Economic Geology)

Conglomerate

Sandstone

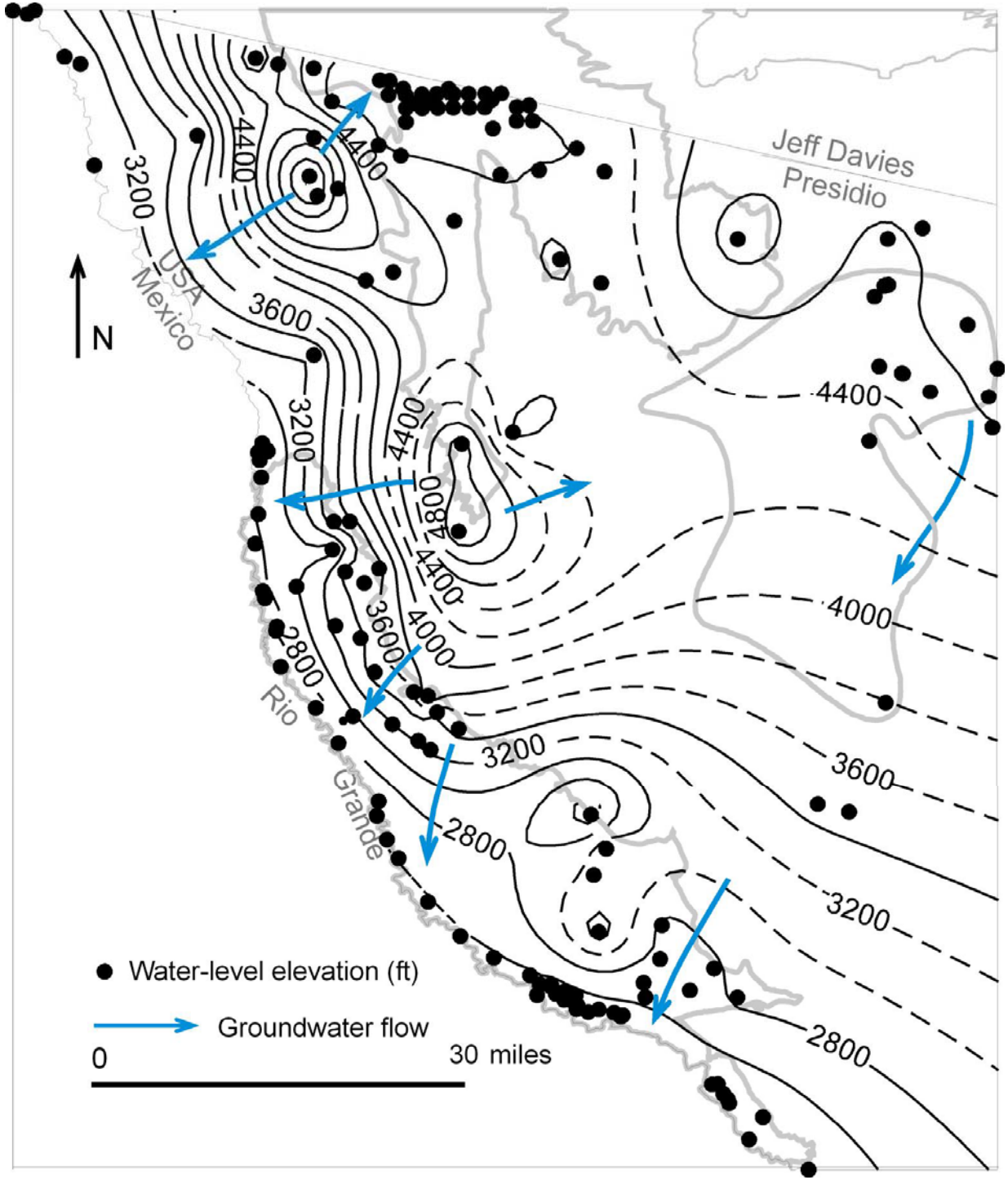
Mudstone

Conceptualized flow system, Presidio Bolson

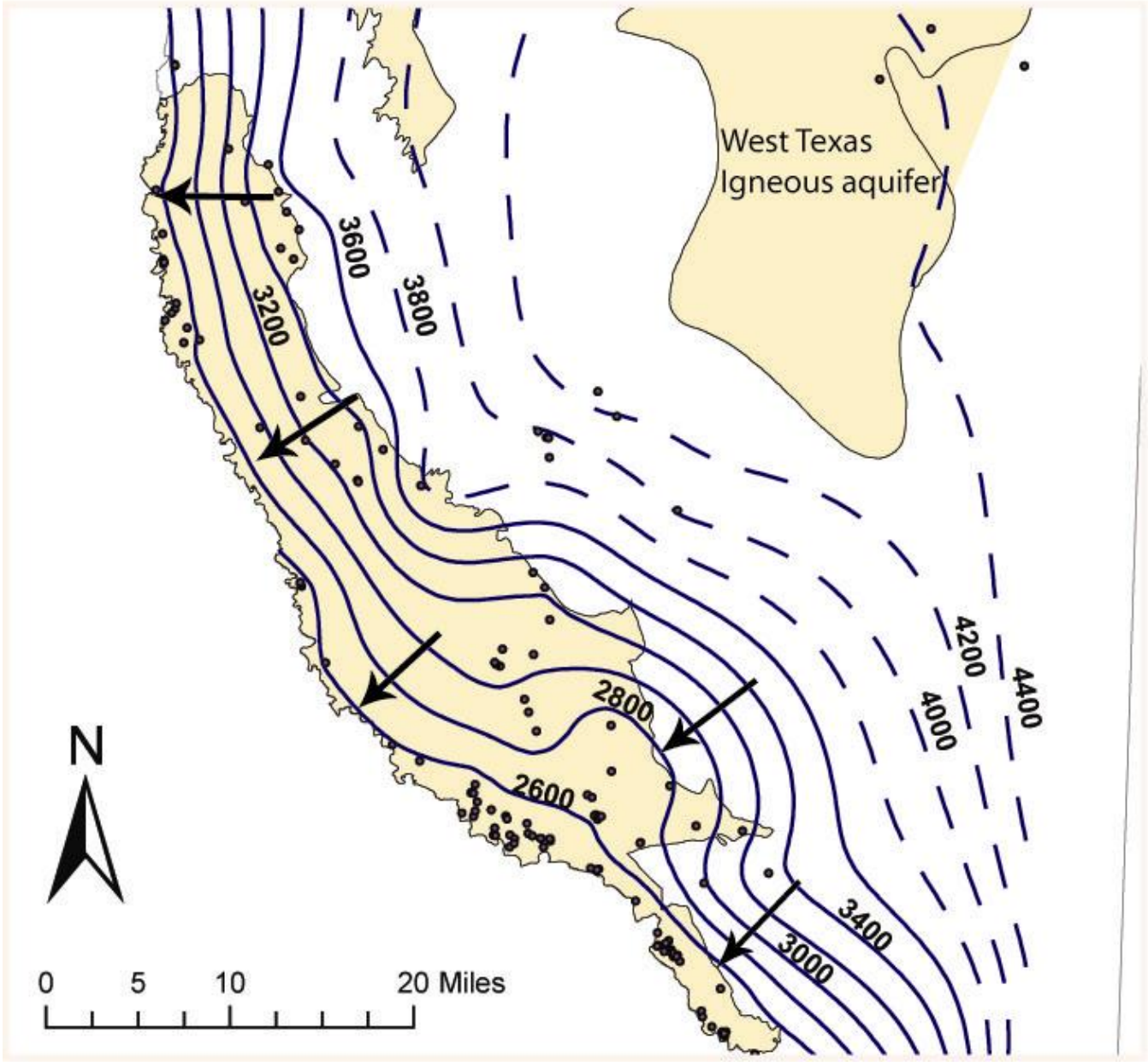


Water Levels

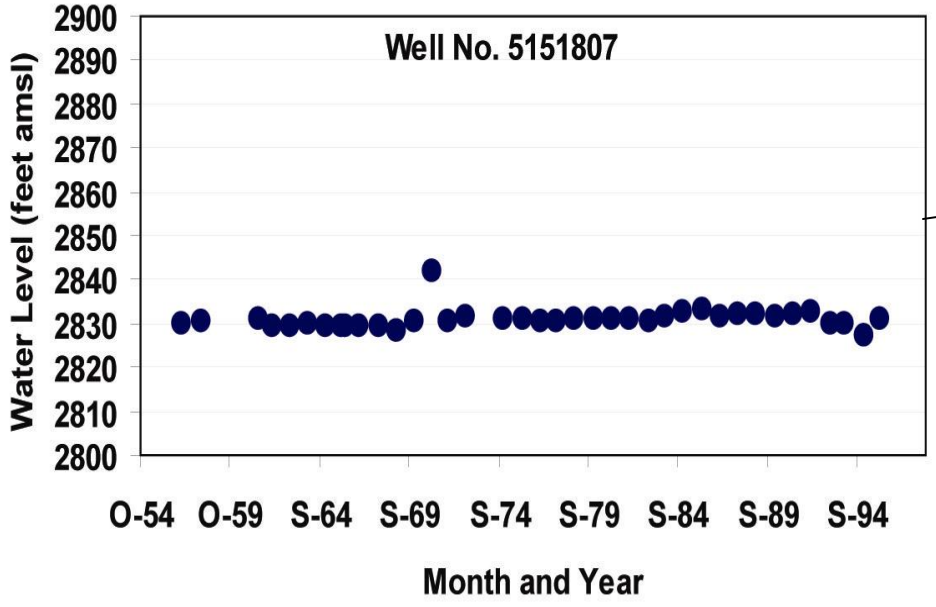
Composite of regional water level data from 1950 through 2004

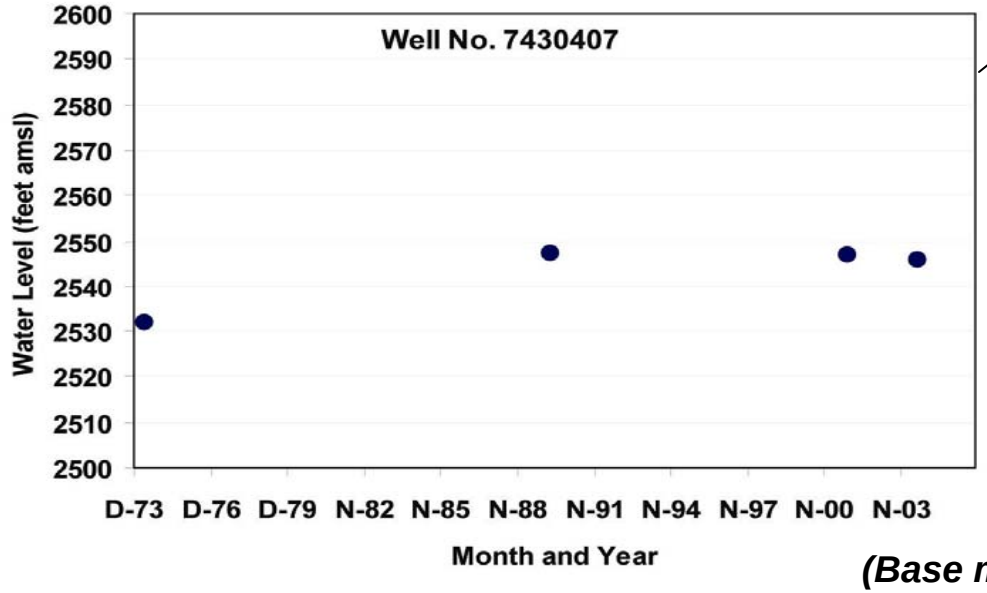


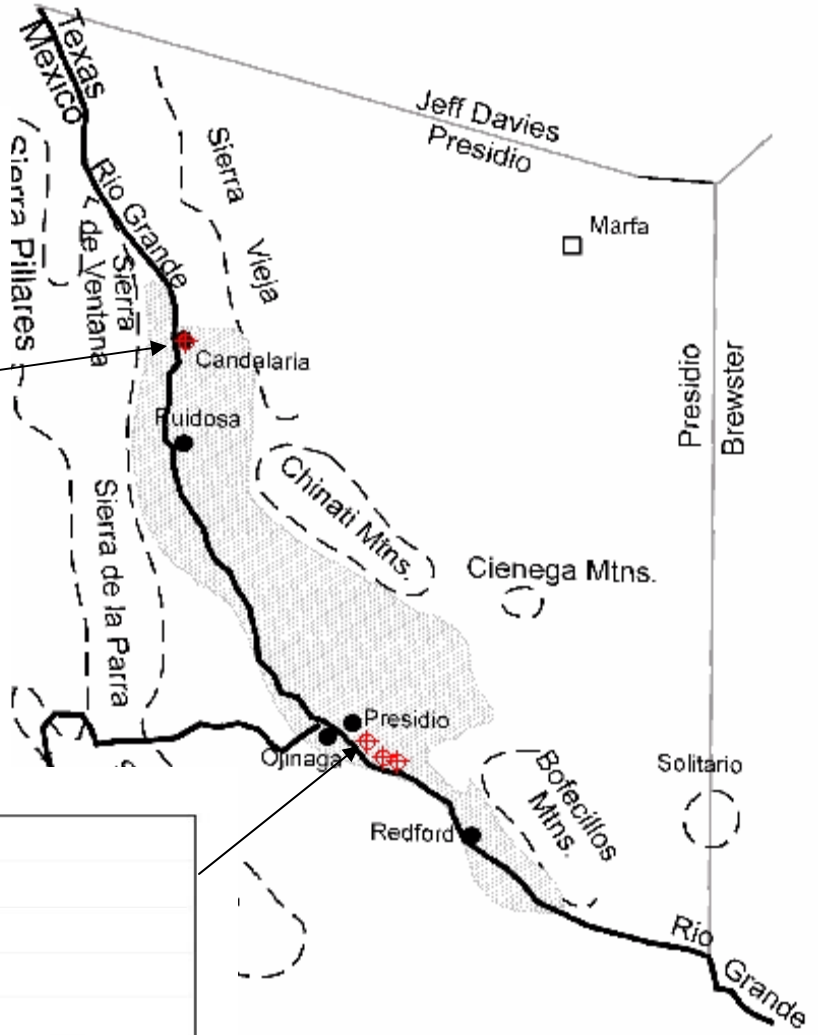
2004 through 2005 Water Levels from Presidio and Redford Bolsons



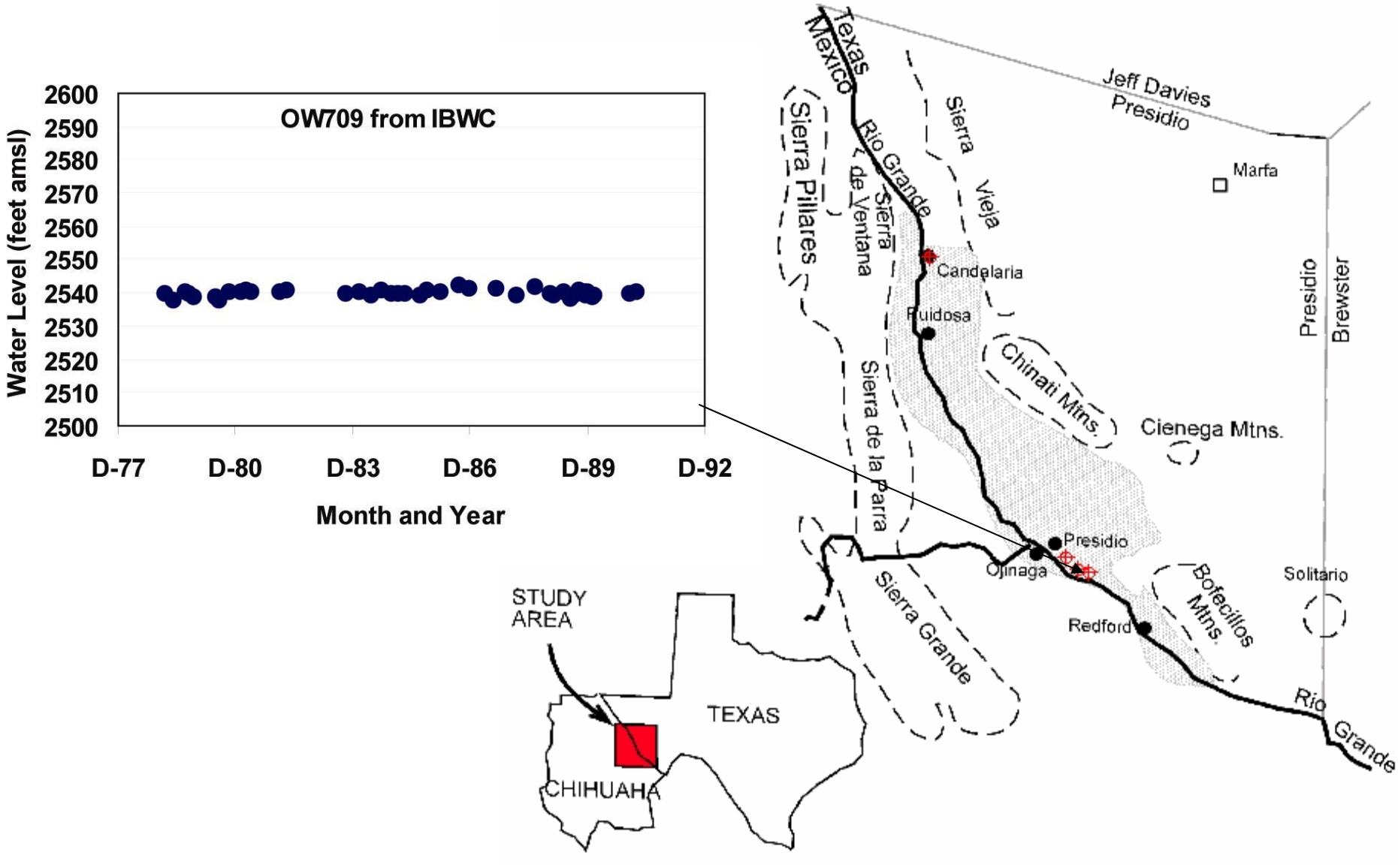
Hydrographs







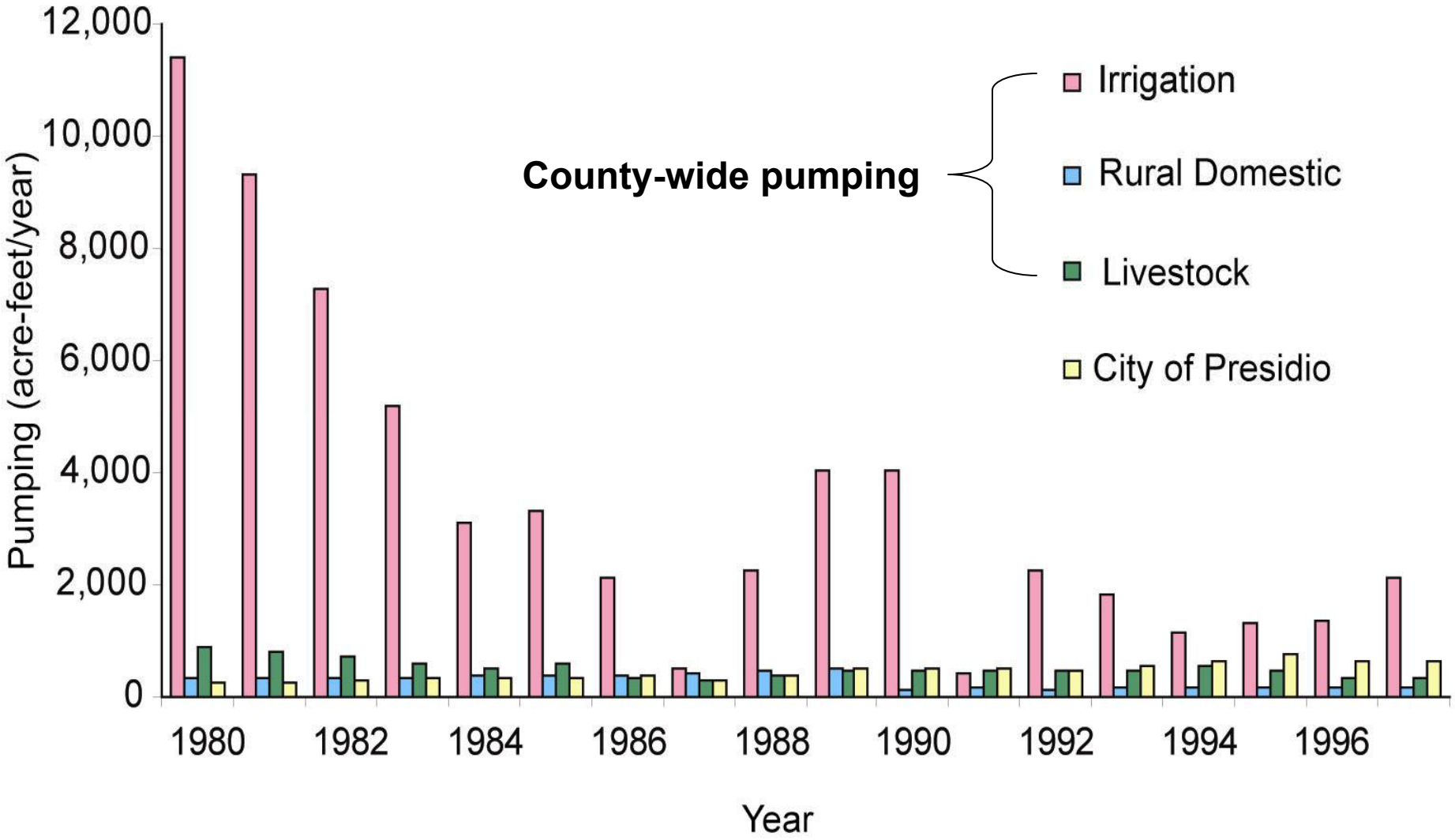
(Base map from Groat C. G., 1972, BEG)

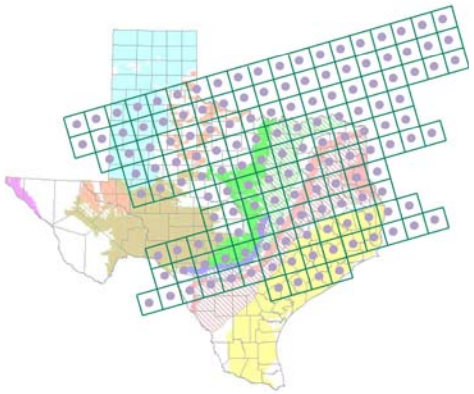


Hydrographs

(Base map from Groat C. G., 1972, BEG)

County-wide Pumping Data





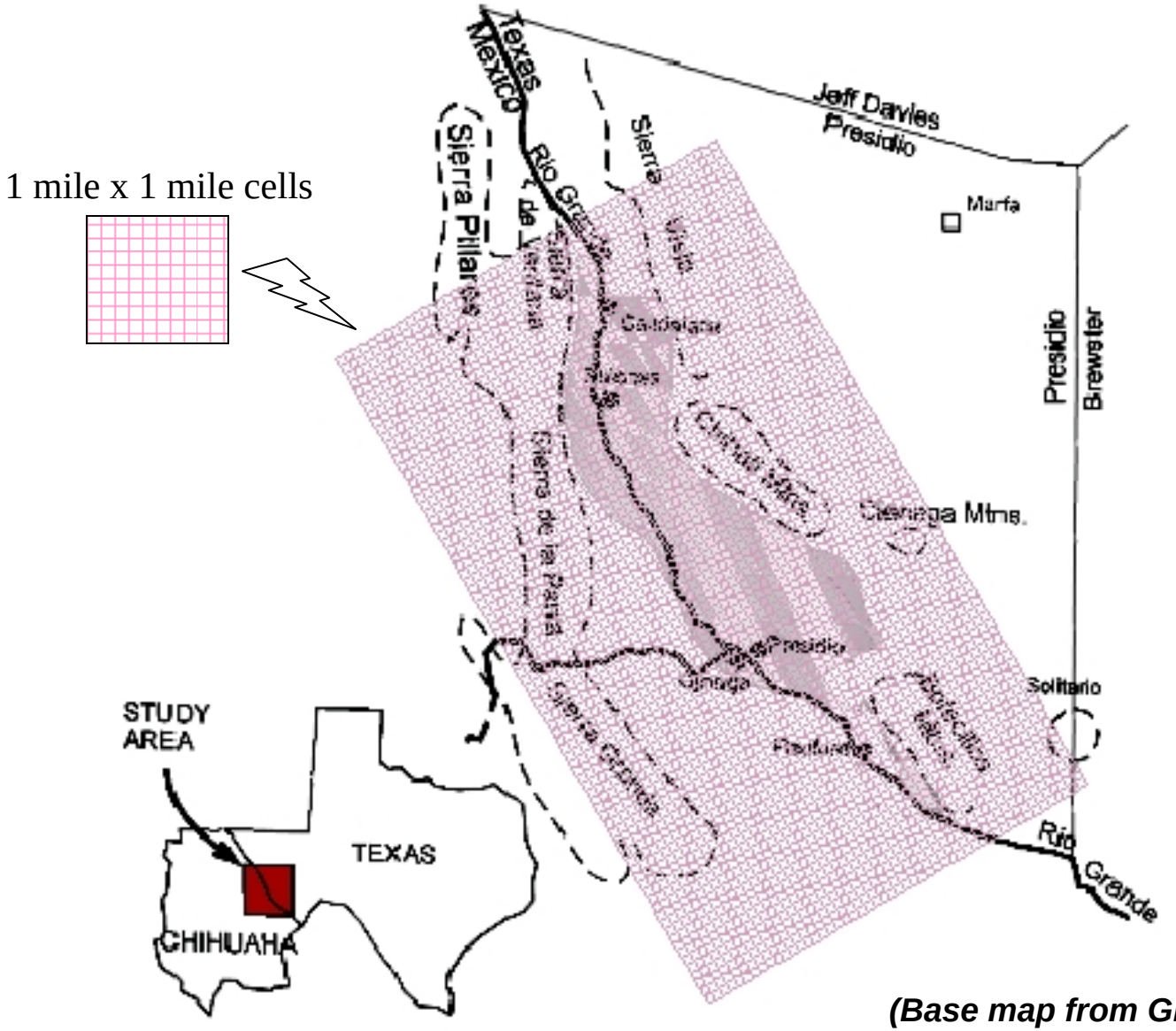
Additional Data

In addition to the data we've presented we will also be using:

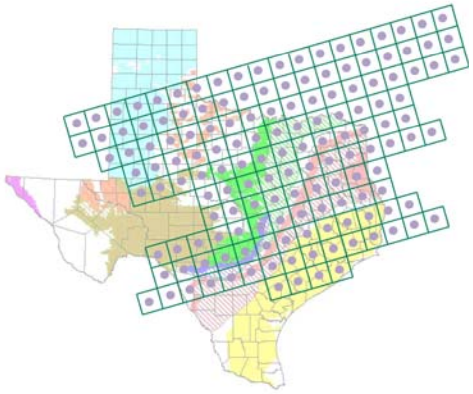
- IBWC Stream gauge data to calibrate interaction with the river
- Hydraulic properties from pump tests
- Landuse coverage for assigning pumping
- Plant coverage to estimate evapotranspiration

Model Grid

1 mile x 1 mile cells



(Base map from Groat C. G., 1972, BEG)



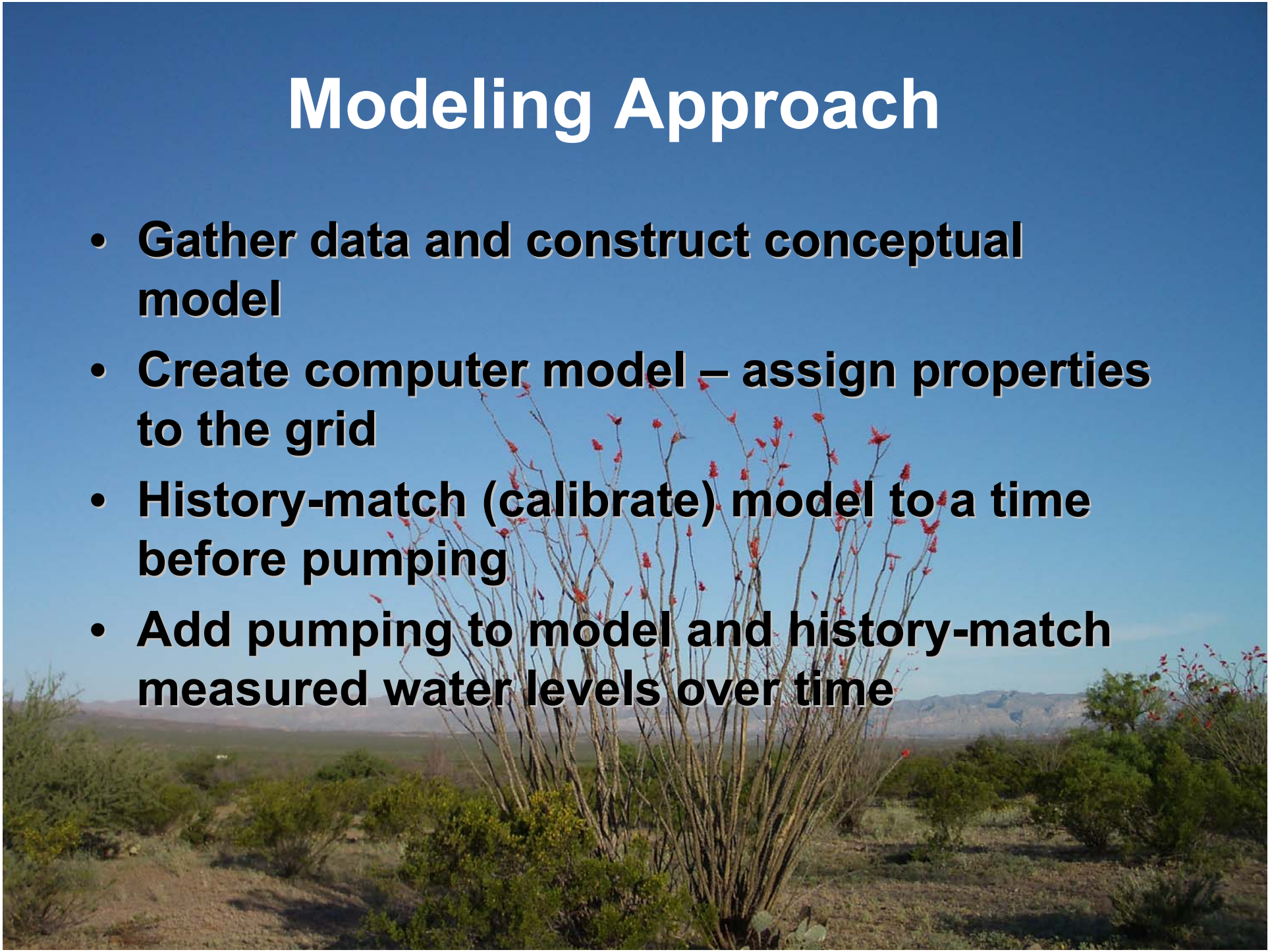
Data Needs

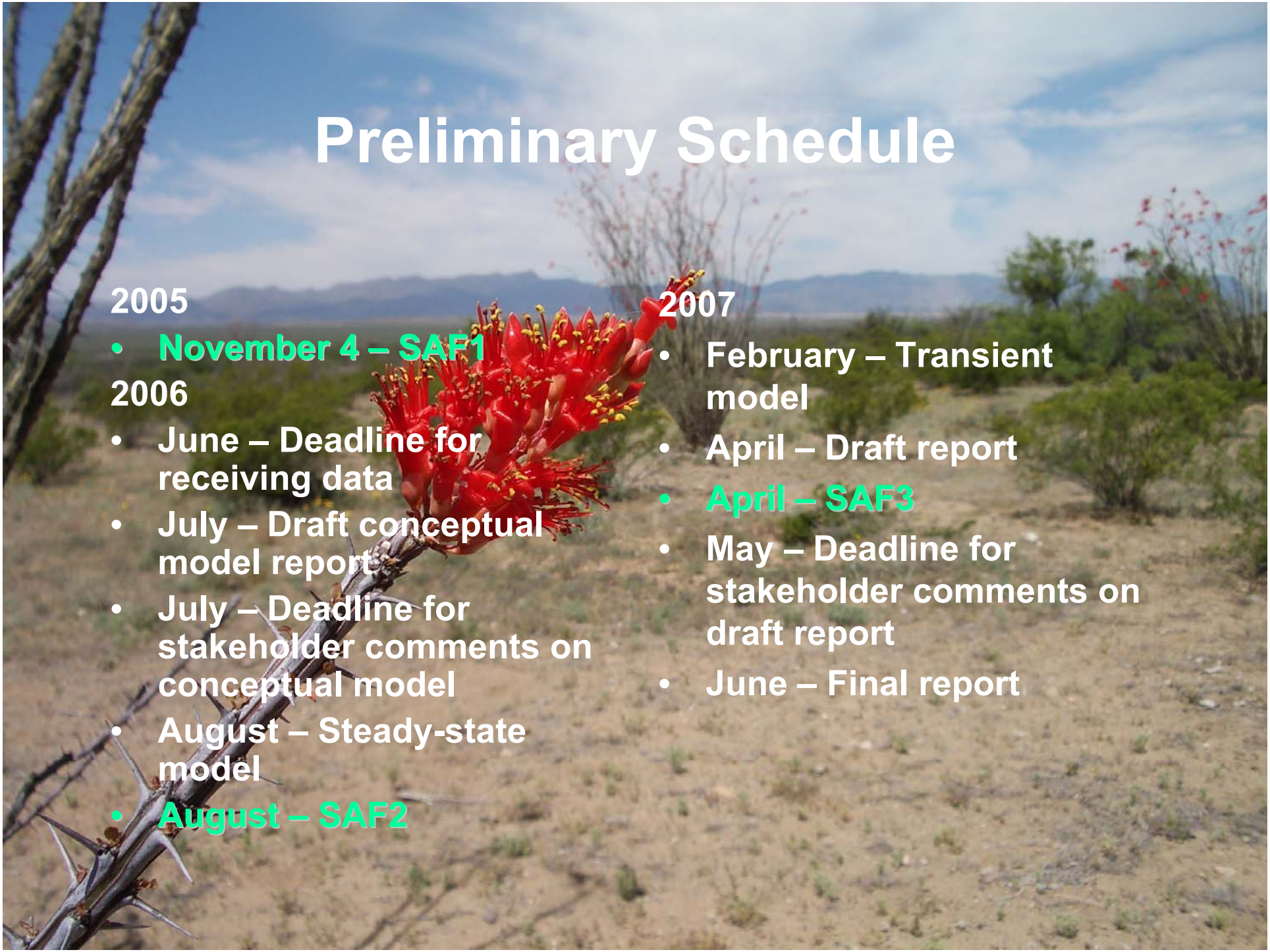
Although we have collected a lot of information over the last year additional data, particularly from Mexico, that would benefit our project includes:

- Structural data showing the thickness of the Presidio Bolson
- Water levels from wells
- Hydraulic properties from pump tests (Hydraulic conductivity, transmissivity, and storage)
- Groundwater chemistry
- Pumping volumes
- Stream flow

Modeling Approach

- Gather data and construct conceptual model
- Create computer model – assign properties to the grid
- History-match (calibrate) model to a time before pumping
- Add pumping to model and history-match measured water levels over time





Preliminary Schedule

2005

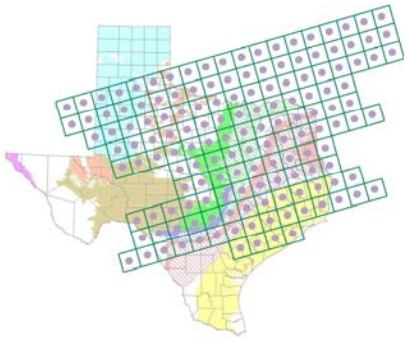
- November 4 – SAF1

2006

- June – Deadline for receiving data
- July – Draft conceptual model report
- July – Deadline for stakeholder comments on conceptual model
- August – Steady-state model
- August – SAF2

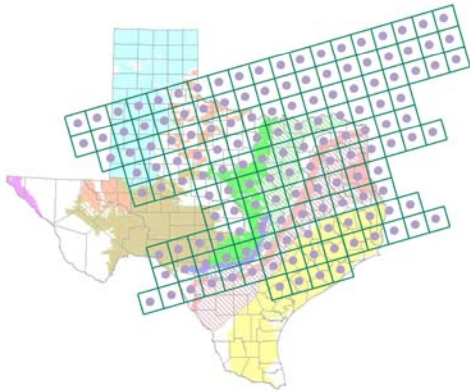
2007

- February – Transient model
- April – Draft report
- April – SAF3
- May – Deadline for stakeholder comments on draft report
- June – Final report



Living tools

- Groundwater Conservation Districts (GCDs), Regional Water Planning Groups (RWPGs), TWDB, and others collect new information on aquifer.
- 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.



Participating in the GAM process

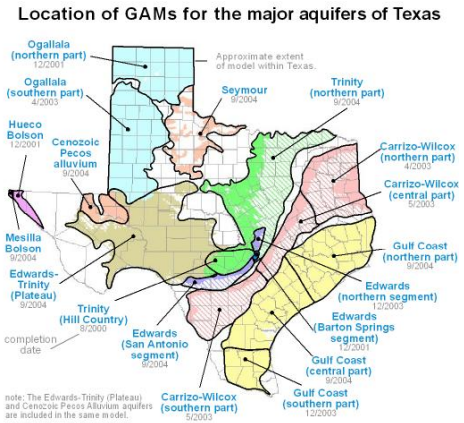
- **SAF meetings**
  - hear about progress on the model
  - comment on model assumptions
  - offer information (timing is important!)
- **Report review**
  - at end of project
- **Contact TWDB**
  - Shirley Wade

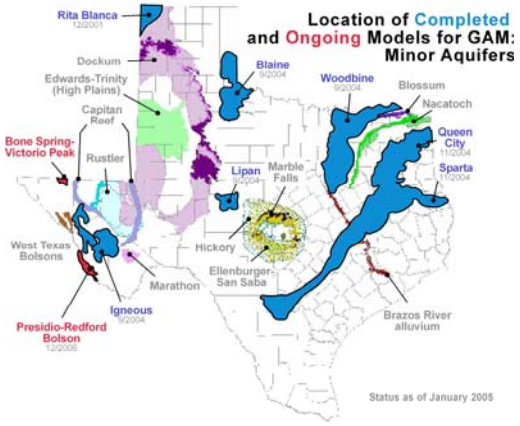
Comments:

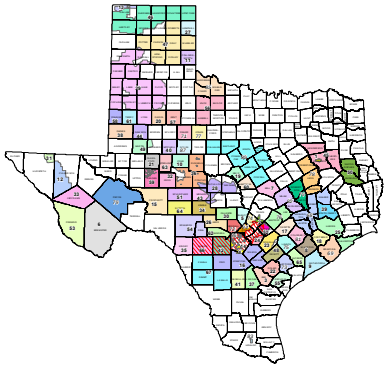
Shirley Wade
shirley.wade@twdb.state.tx.us
(512)936-0883
www.twdb.state.tx.us/gam

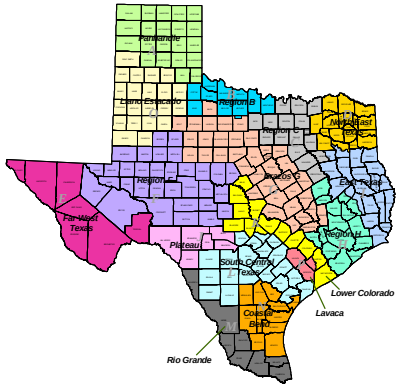
Groundwater Availability Modeling

Modelo de Disponibilidad de Agua Subterranea









Texas Water Development Board

Groundwater Availability Model (GAM) for the Presidio-Redford Bolsons

Modelo de Disponibilidad de Agua en en el Acuifero Bolson Presidio-Redford

Primer Foro de Interesados

4 de noviembre del 2005

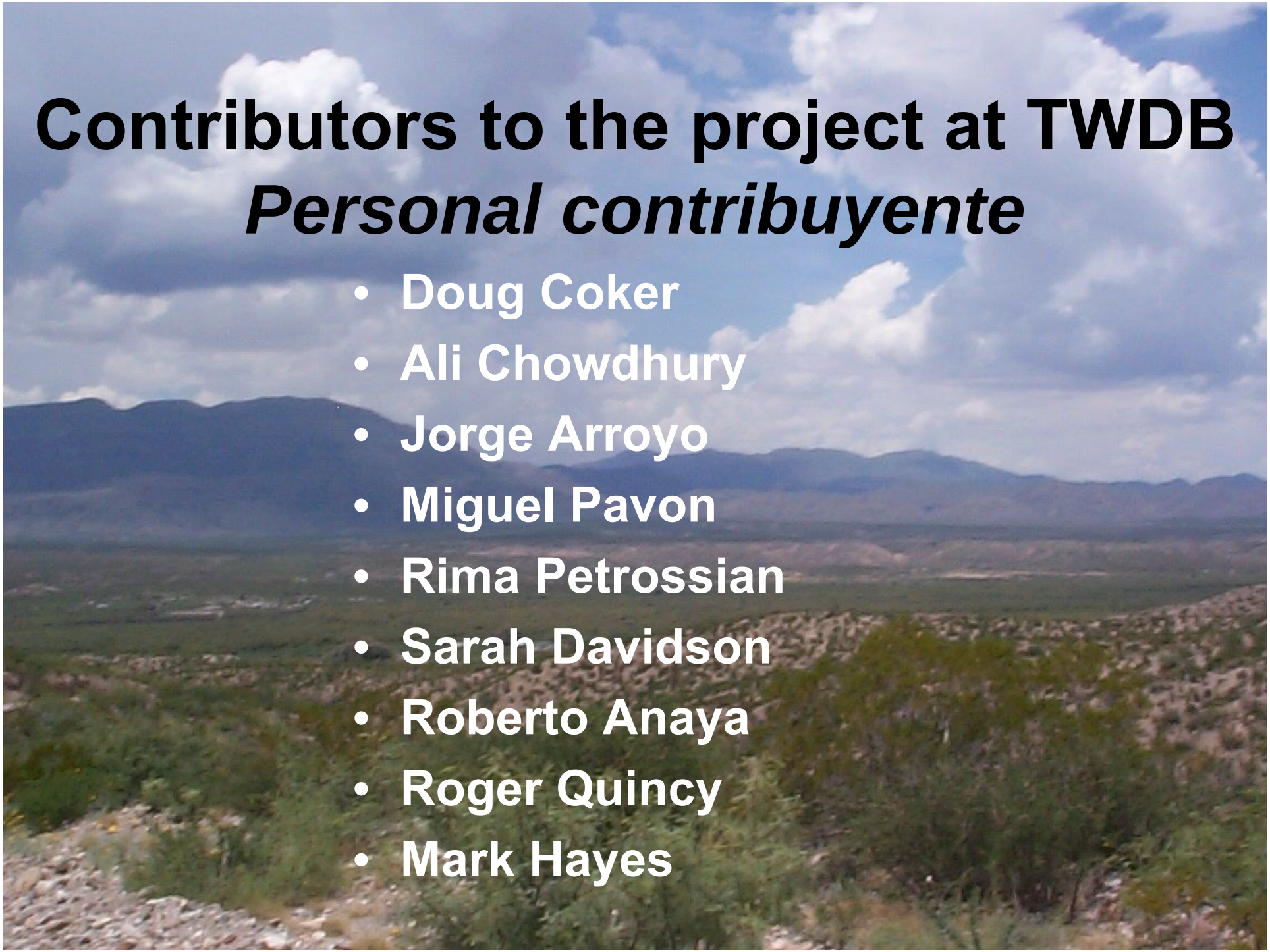
Shirley Wade

Ali Chowdhury

Doug Coker

Acknowledgements
Reconocimientos

- Janet Adams y directores de la junta del GCD de Presidio
- Ciudad de Presidio
- Personal de la CILA Rong Kuo and Hector Hernandez
- Luis Armendariz - TPWD
- David Lewis - American Legion Hall
- Propietarios



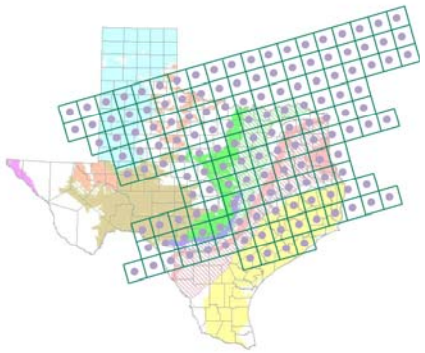
Contributors to the project at TWDB

Personal contribuyente

- Doug Coker
- Ali Chowdhury
- Jorge Arroyo
- Miguel Pavon
- Rima Petrossian
- Sarah Davidson
- Roberto Anaya
- Roger Quincy
- Mark Hayes

Agenda para la primera reunion de interesados
4 de noviembre del 2005

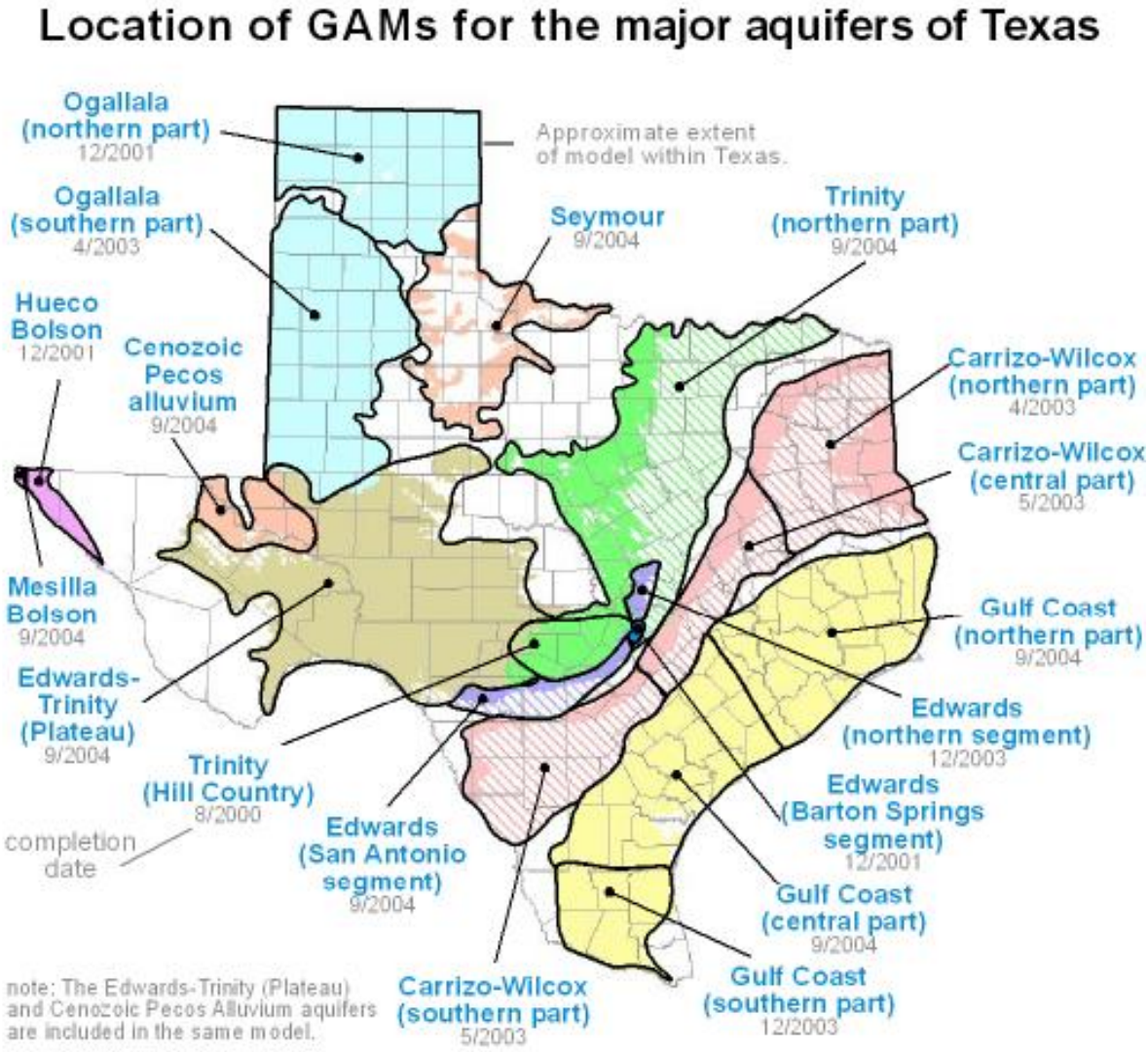
- Propósito del modelo (GAM) y del foro de interesados
- Modelos de acuíferos
- Hidrogeología
- Enfoque del modelo
- Informacion necesaria
- Plan del proyecto

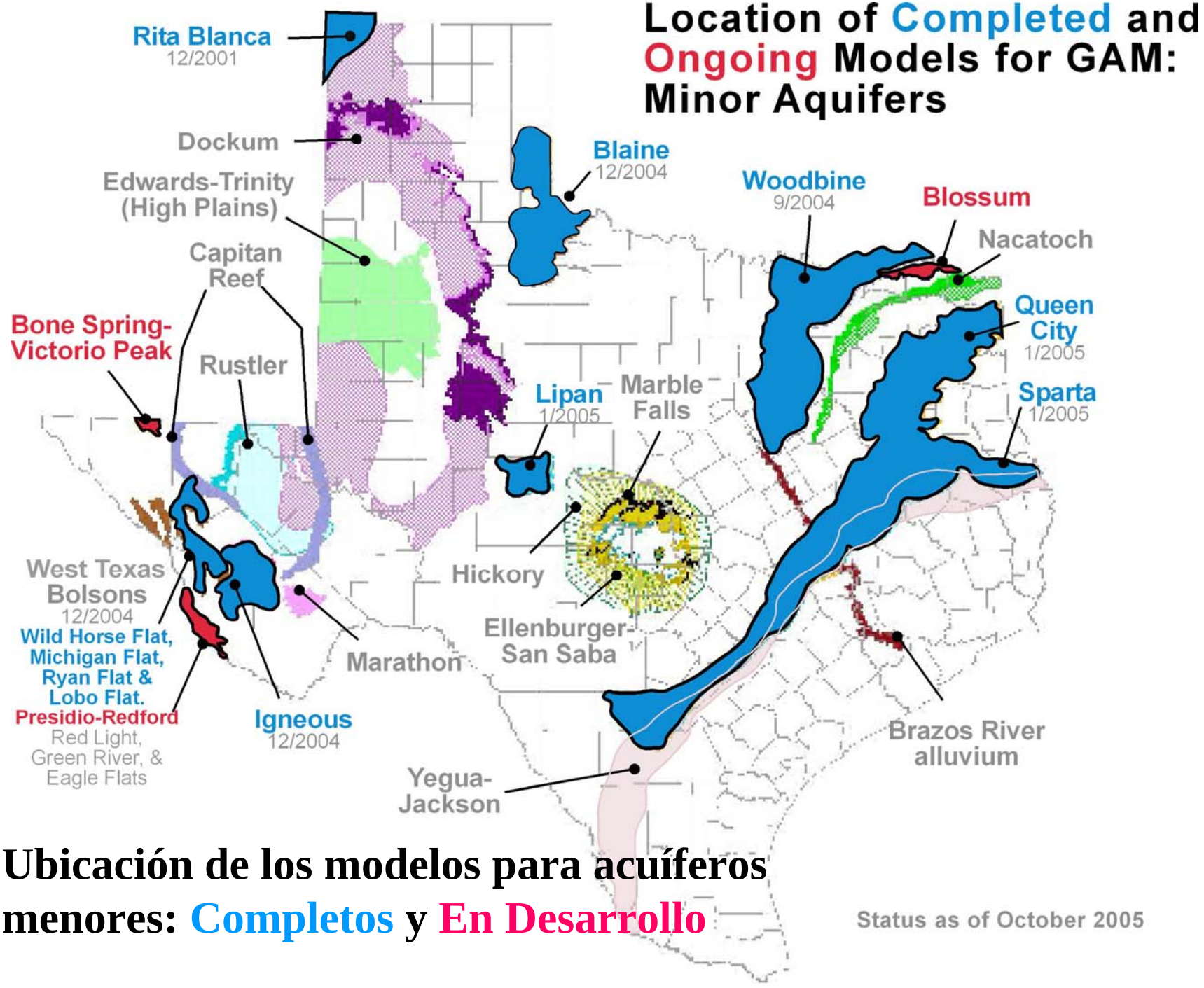


GAM-Modelo de disponibilidad del Acuifero

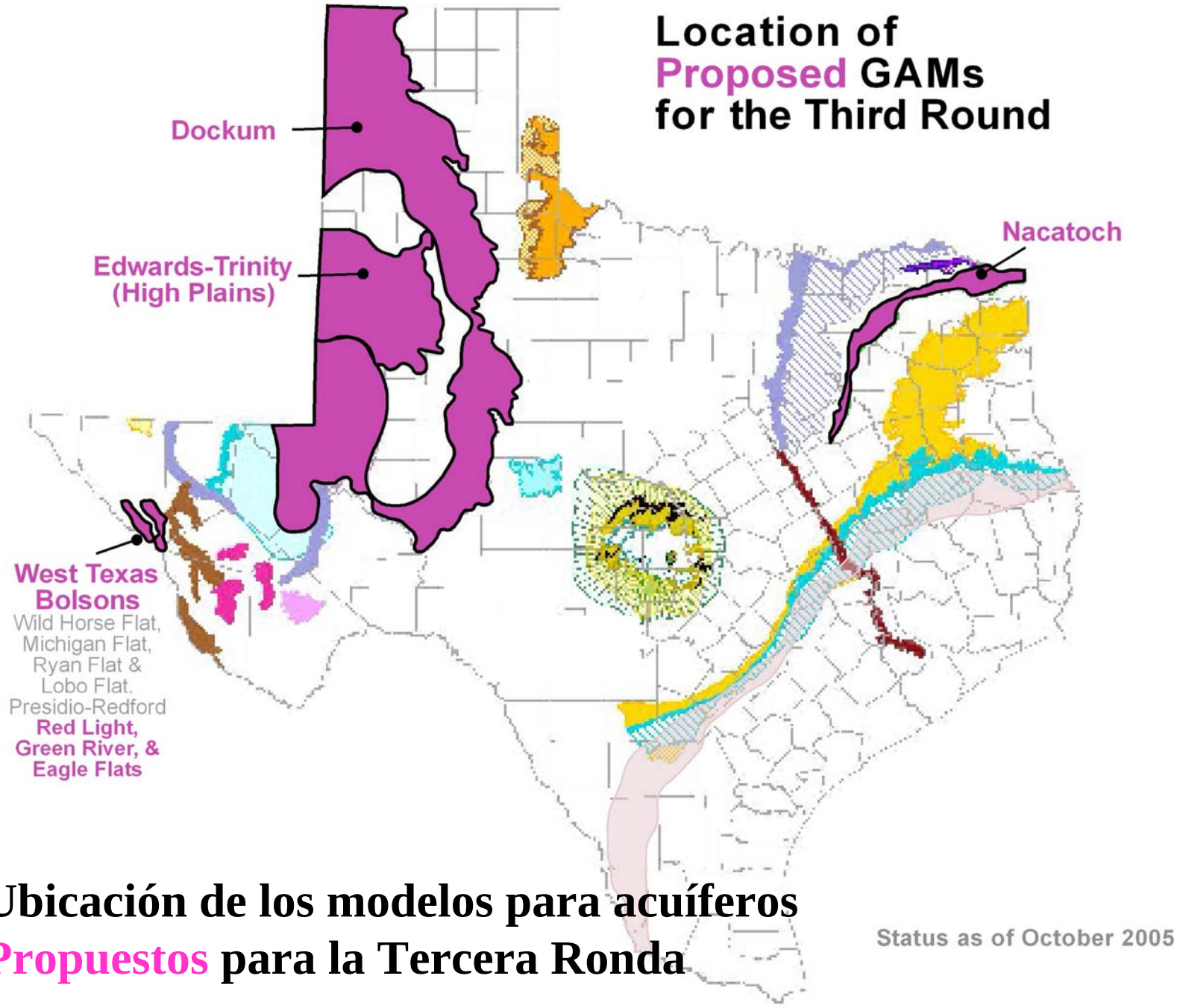
- **Propósito: crear una herramienta para evaluar el acuífero**
- **Proceso Público: Usted observa comoe se desarrolla el modelo**
- **Gratuito: Estandarizado, completamente documentado, disponible via Internet**
- **Dinámico: Se revisa y actualiza periódicamente**

Ubicación de los Modelos para Acuíferos Mayores

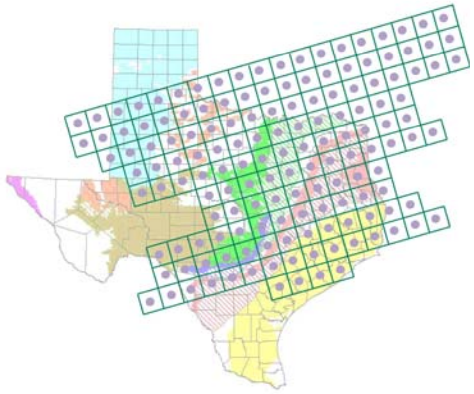




Ubicación de los modelos para acuíferos menores: Completos y En Desarrollo

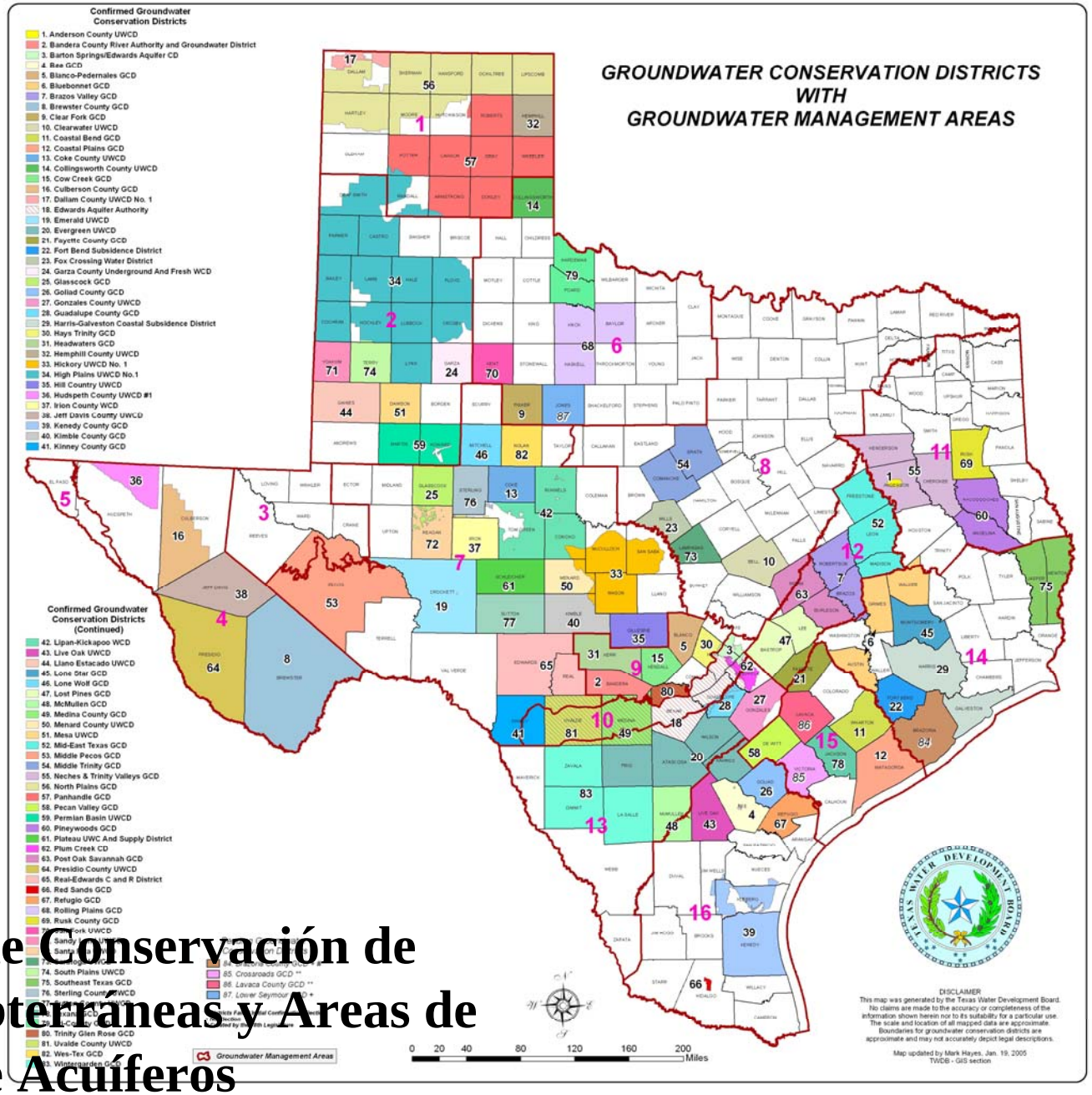


Ubicación de los modelos para acuíferos Propuestos para la Tercera Ronda

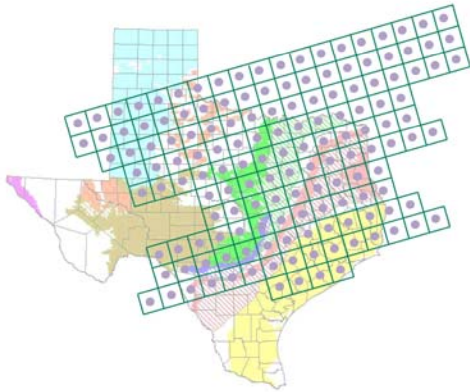


Qué es el manejo de disponibilidad de agua subterránea?

- …La cantidad de agua sobre la cuál el distrito de manejo puede otorgar permisos para uso beneficioso y que cumple con la condición futura deseada para el acuífero (HB 1763)
- El modelo es una herramienta para evaluar la disponibilidad de agua una vez que se ha decidido cuál es la condición deseada para el futuro del acuífero



Distritos de Conservación de Aguas Subterráneas y Áreas de Manejo de Acuíferos



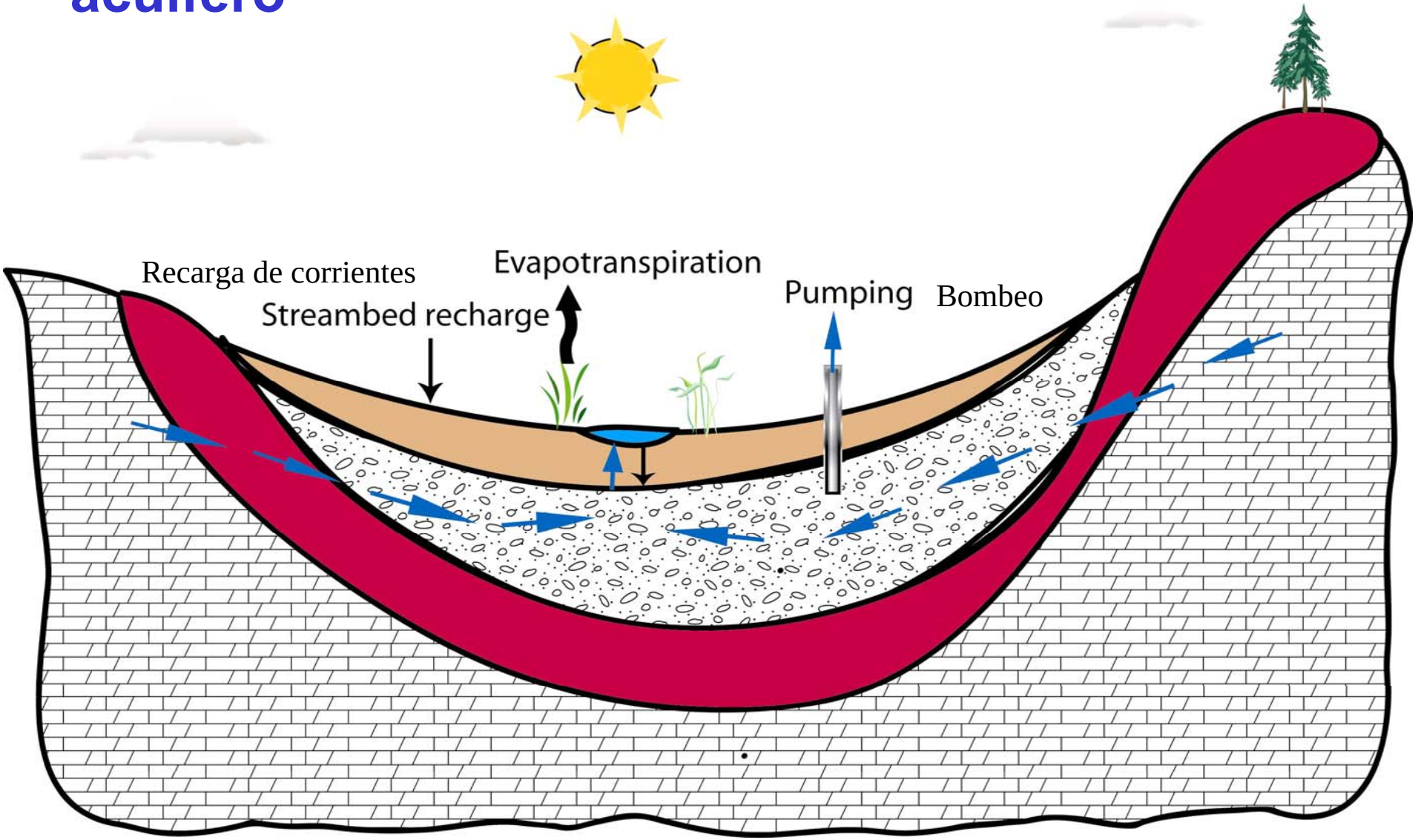
Cómo usamos el modelo?

- **Modelo**
  - **Predictor de caudales y niveles de agua en el acuífero**
  - **Efectos de campos de pozos**
- **Información en el modelo**
  - **Agua almacenada**
  - **Estimación de recarga**
  - **Propiedades hidráulicas**
- **Almacenamiento de información**

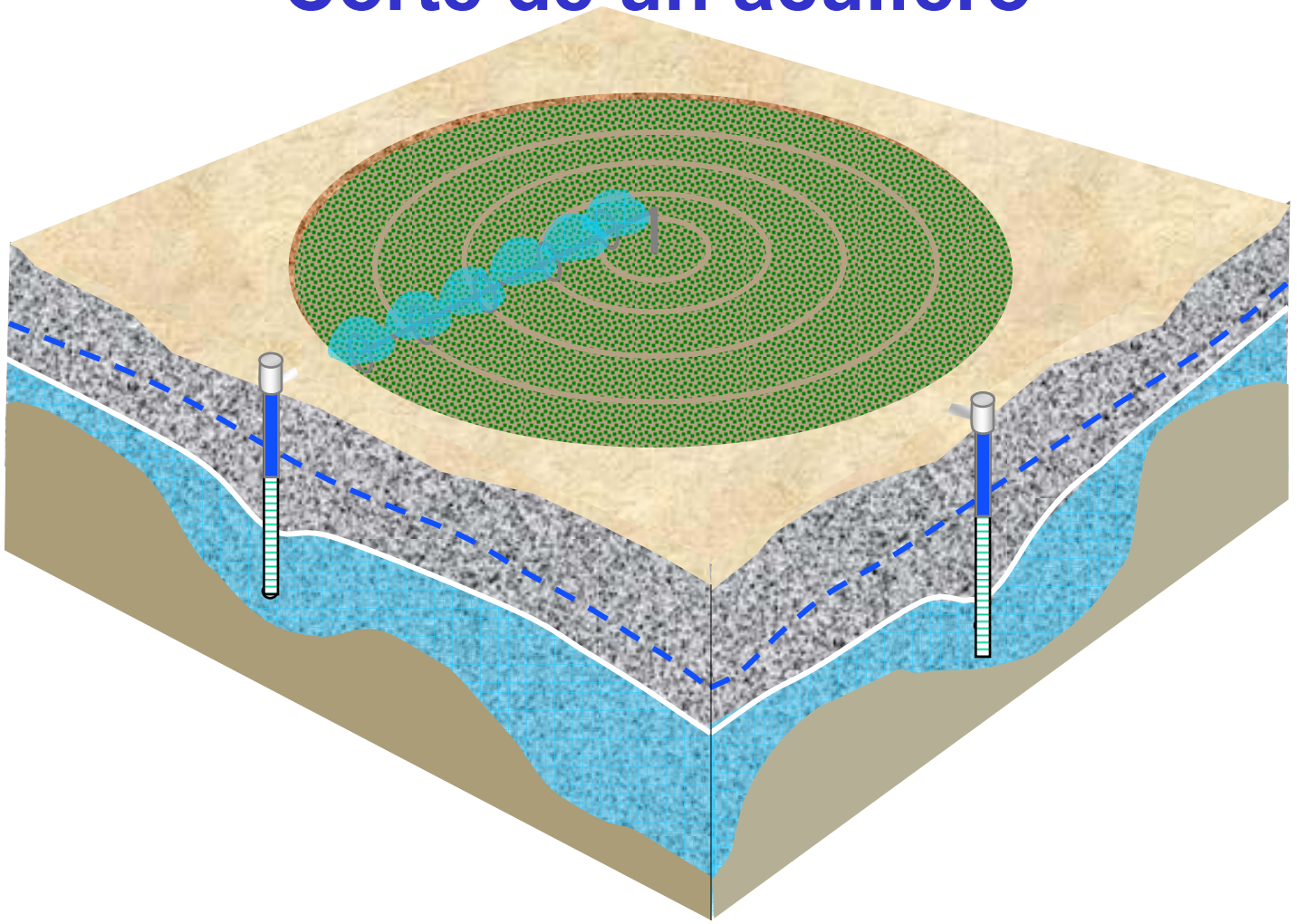
Modelamiento de Acuíferos

- Se divide el acuífero en una cuadrícula
- Cada cubito en la cuadrícula se denomina "celda"
- Se hace un balance del agua que entra con el agua que sale de cada celda
- Flujos entrantes/salientes incluyen
  - Flujo horizontal/vertical de otras formaciones
  - Flujos laterales
  - Bombeo
  - Infiltración (agua que se añade al acuífero)
  - Evapotranspiración
  - Recarga/descarga a corrientes superficiales

Conceptual view of a groundwater flow system
Vista conceptual de un sistema de flujo en un acuífero

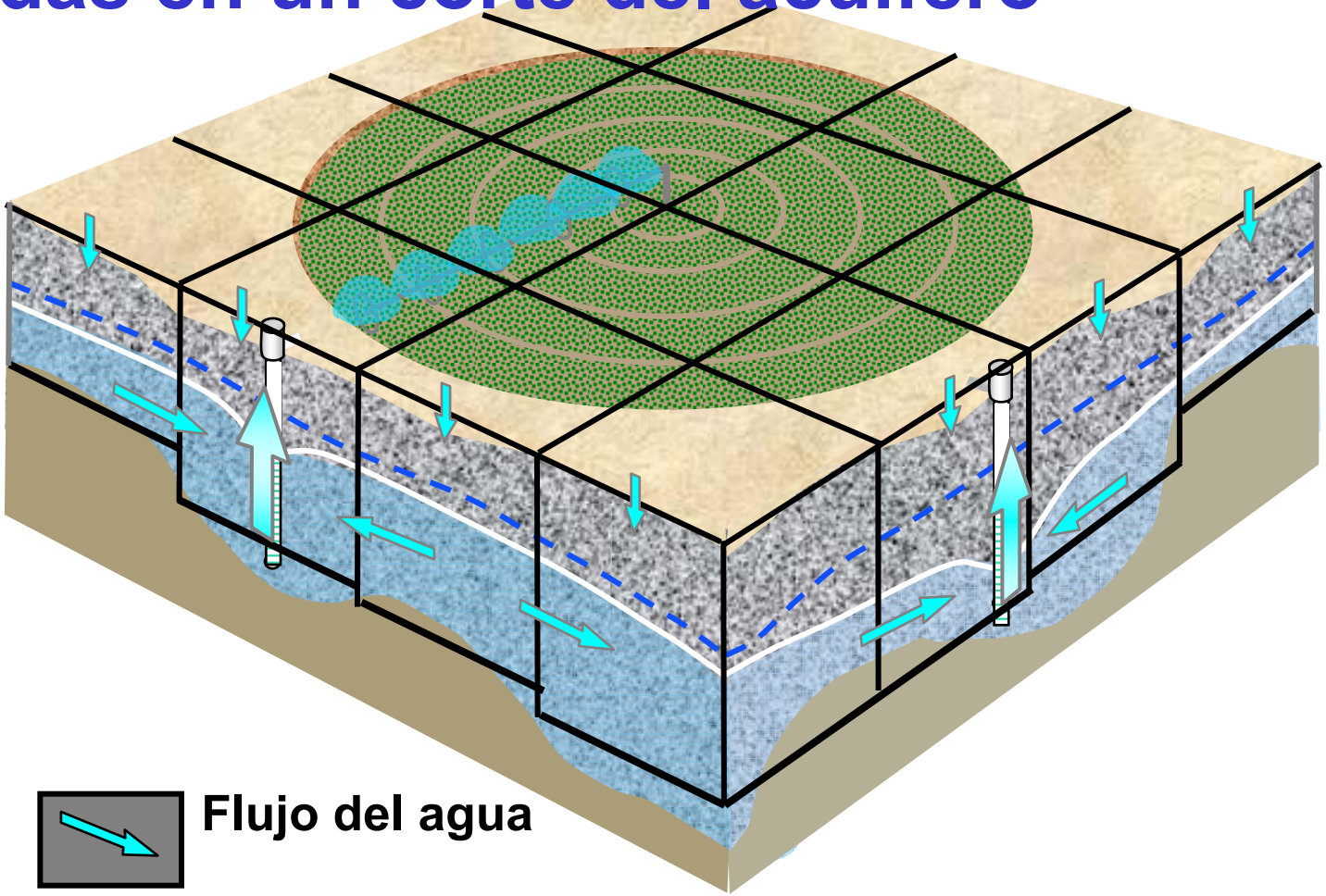


Cutout of an aquifer
Corte de un acuífero



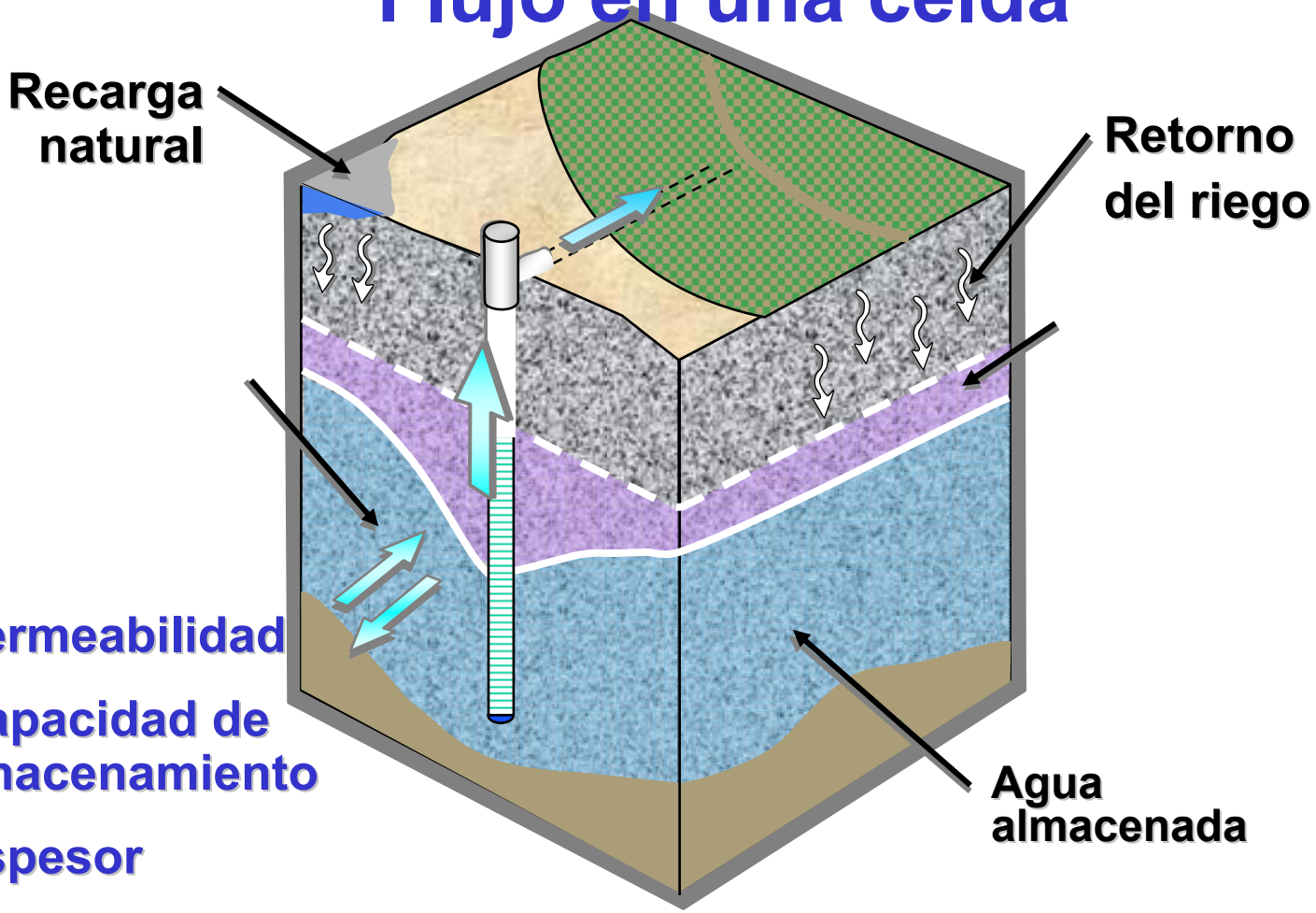
From, Daniel B. Stephens & Associates, Inc.

Cutout of aquifer dissected into grid cells
Celdas en un corte del acuífero



From, Daniel B. Stephens & Associates, Inc.

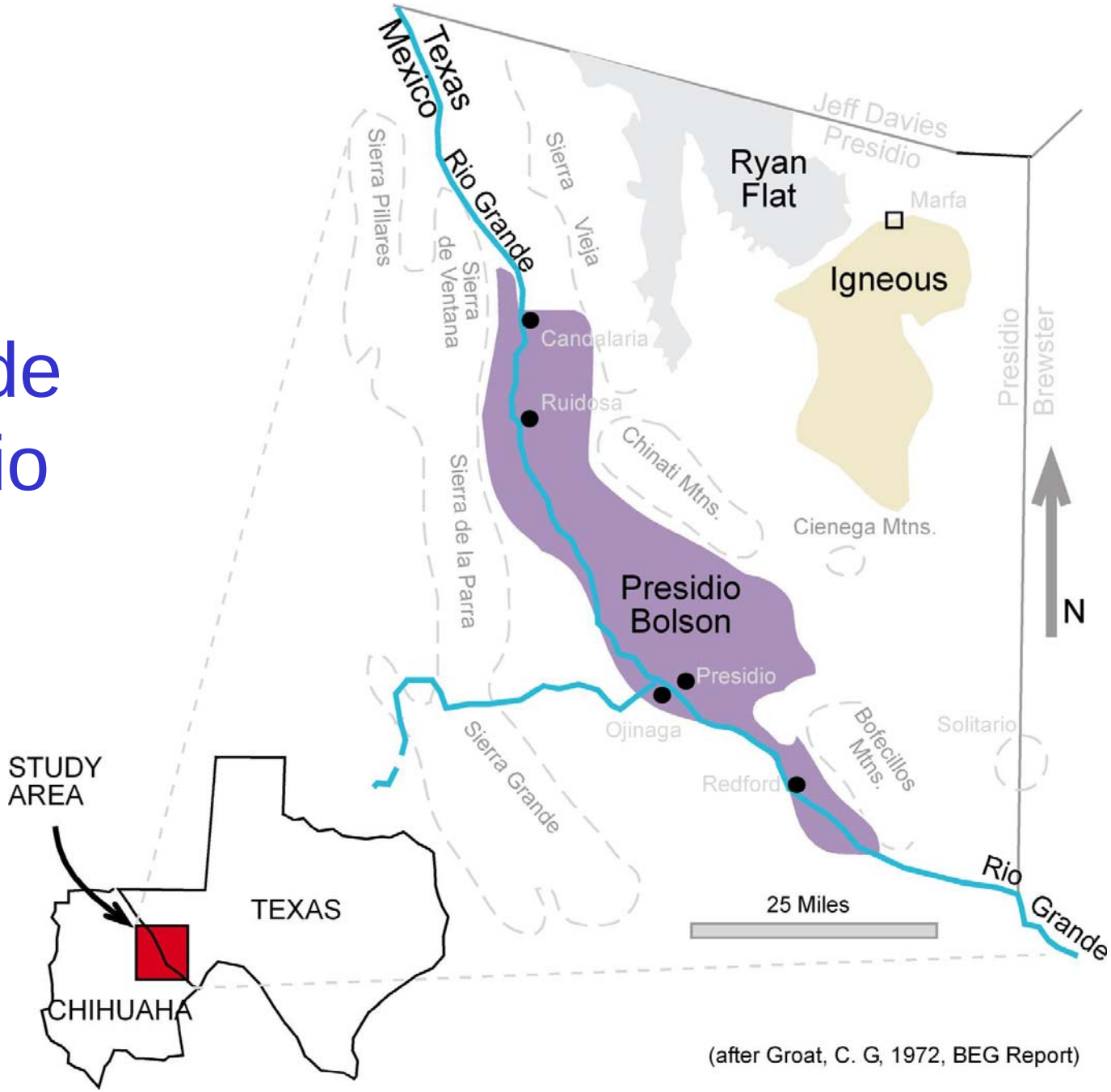
Flow in one cell
Flujo en una celda



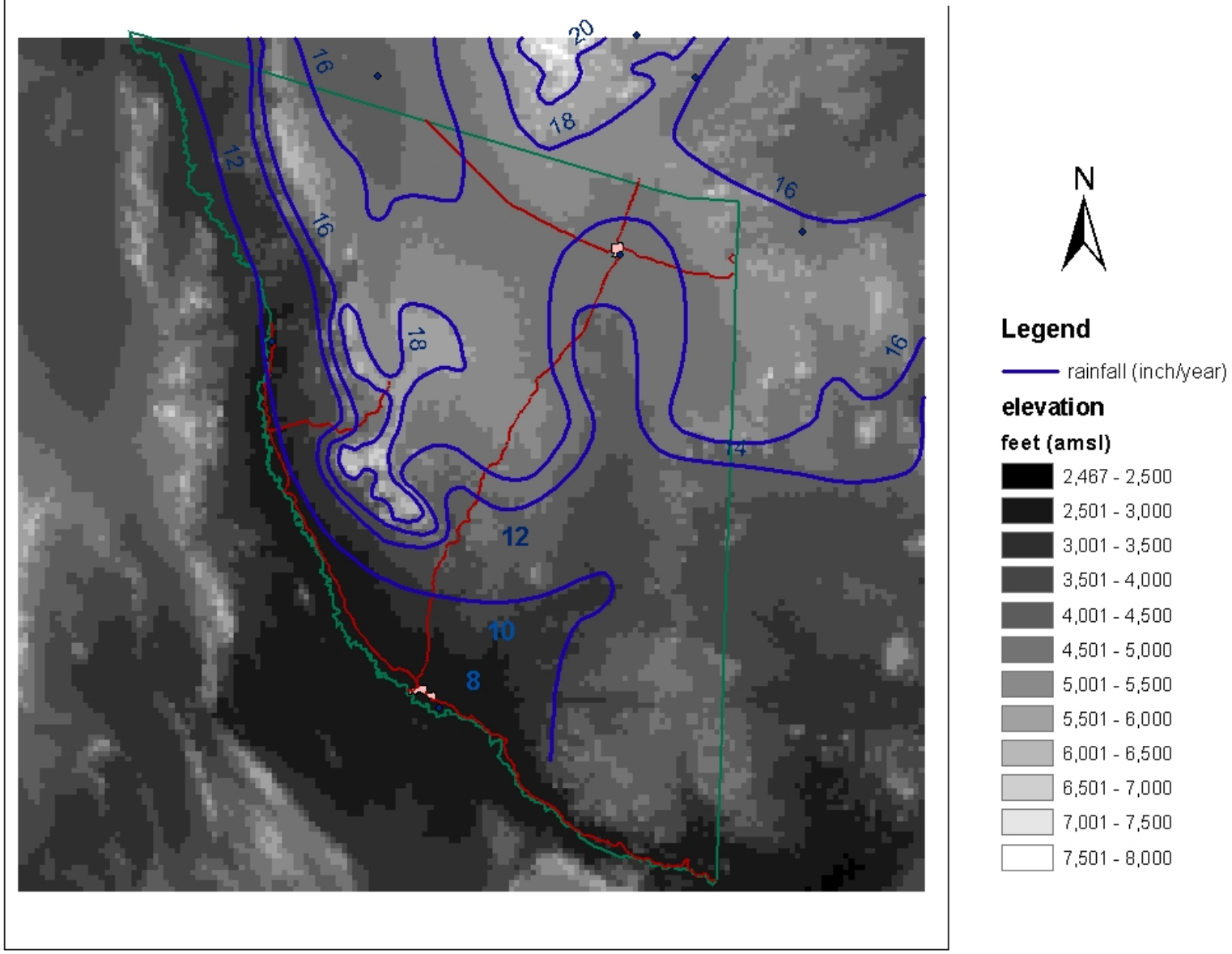
- Permeabilidad
- Capacidad de almacenamiento
- Espesor

From, Daniel B. Stephens & Associates, Inc.

Area de Estudio



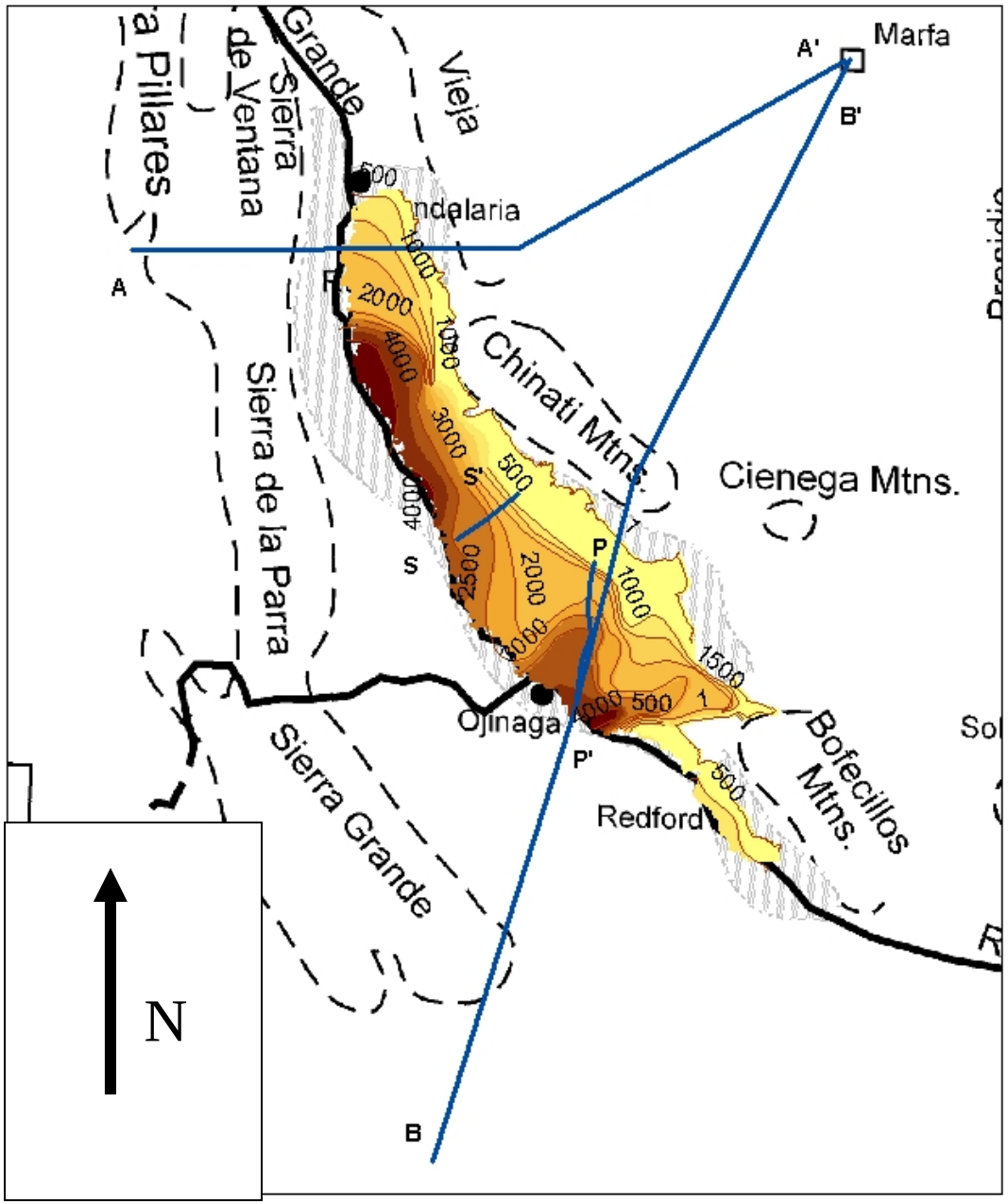
Topografía y promedios de lluvia



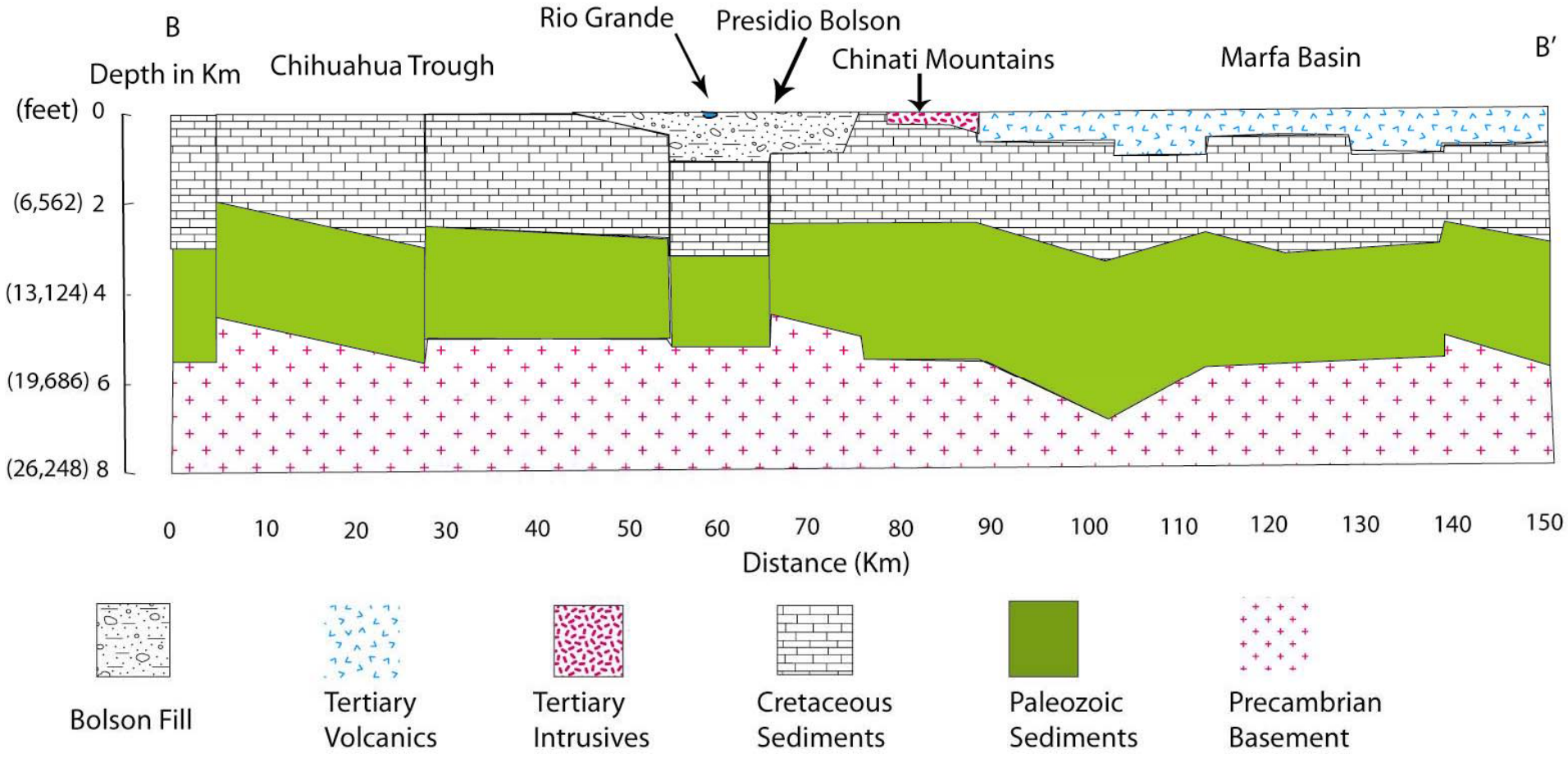
(rainfall map (Beach and others, 2004)

Información sobre estrucutura del acuífero: Espesor en pies obtenido de levantamiento geofísico

(Based on USGS SWAP data and Gates and others, 1980)



Pérfil del acuífero con base a levantamiento gravitacional



(From Mraz and Keller, 1980, Figure 5)

Toma de muestras del rio

Determinaciones geofísicas

- La composición del agua es controlada principalmente por la litología (rocas), evaporación, mezcla y procesos químicos

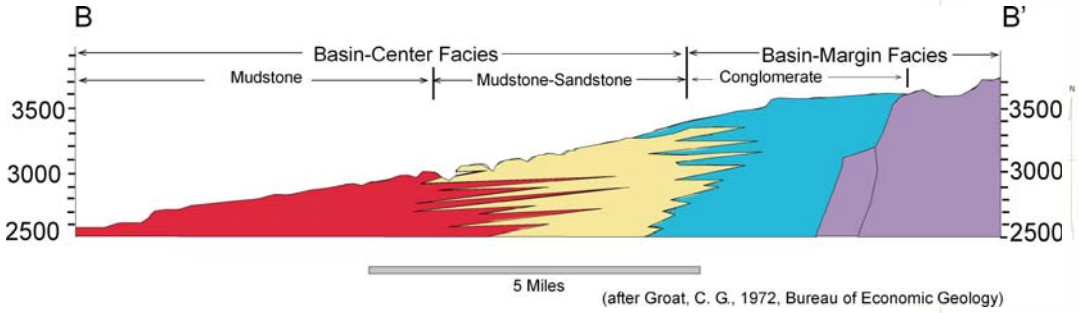
- Agua salobre –de las montañas- más profunda descarga debajo del Bolsón de Presidio

- Recarga moderna es mínima, episódica y radicada. La recarga ocurre a lo largo de los bolsones principalmente por los cauces de las corrientes

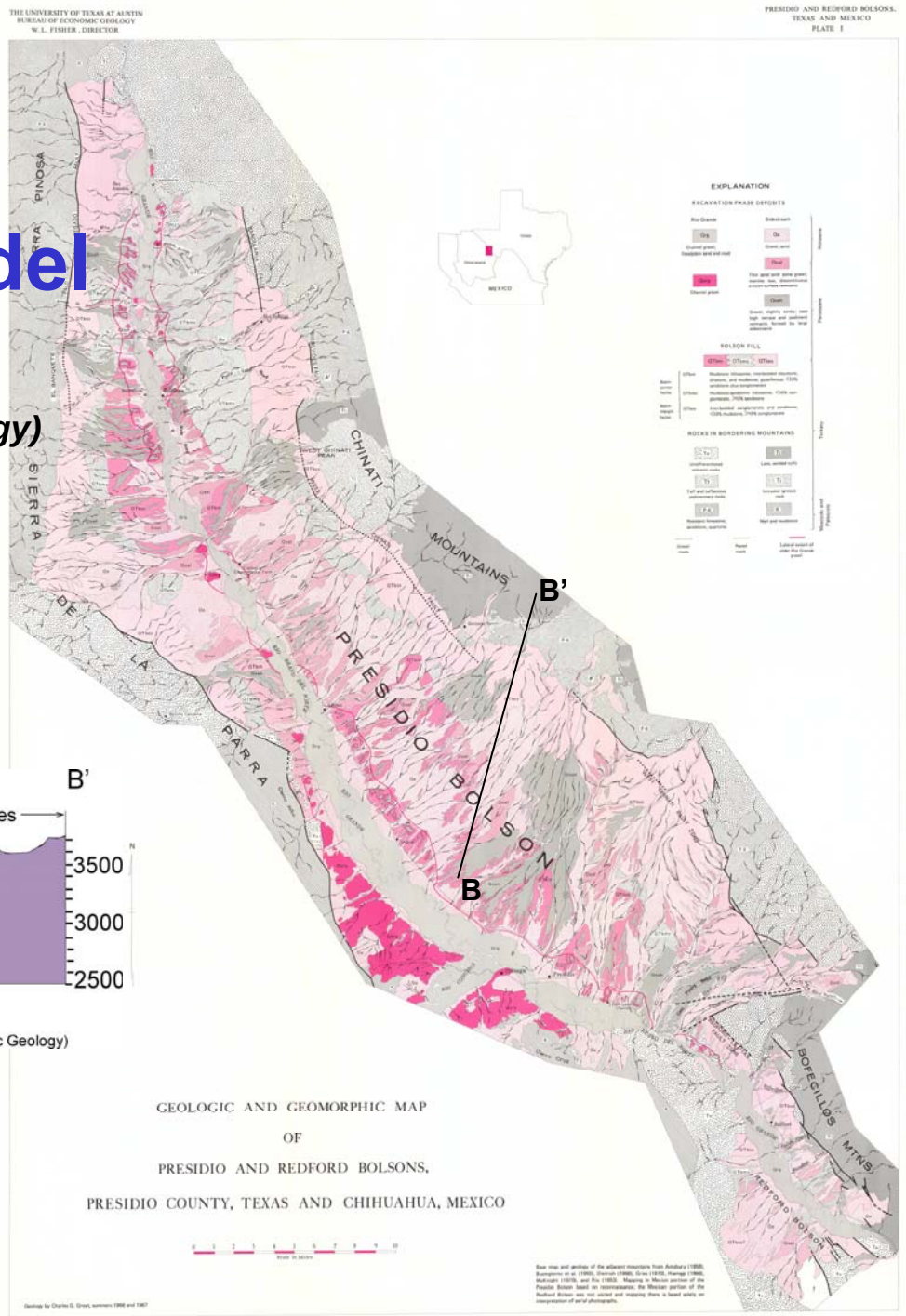
- El movimiento del agua en los bolsones es extremadamente lento y el agua finalmente descarga en el Río Grande

Geología Superficial del Bolsón de Presidio

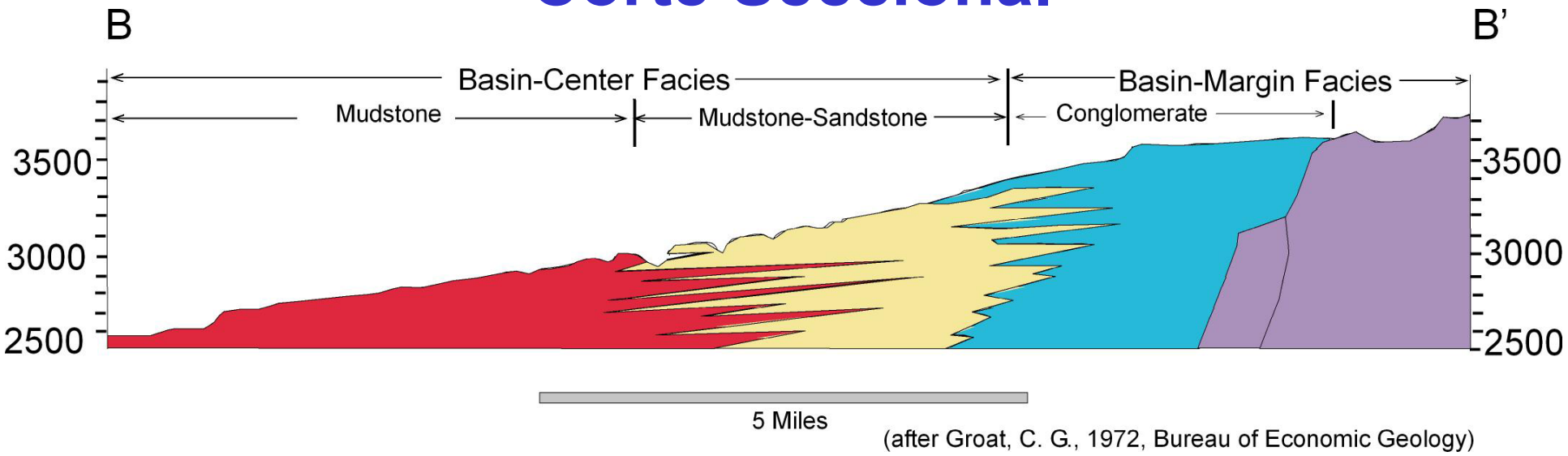
(from Groat C.G., 1972, Bureau of Economic Geology)



(after Groat, C. G., 1972, Bureau of Economic Geology)



Cross Section along Highway 67
-Corte Seccional-



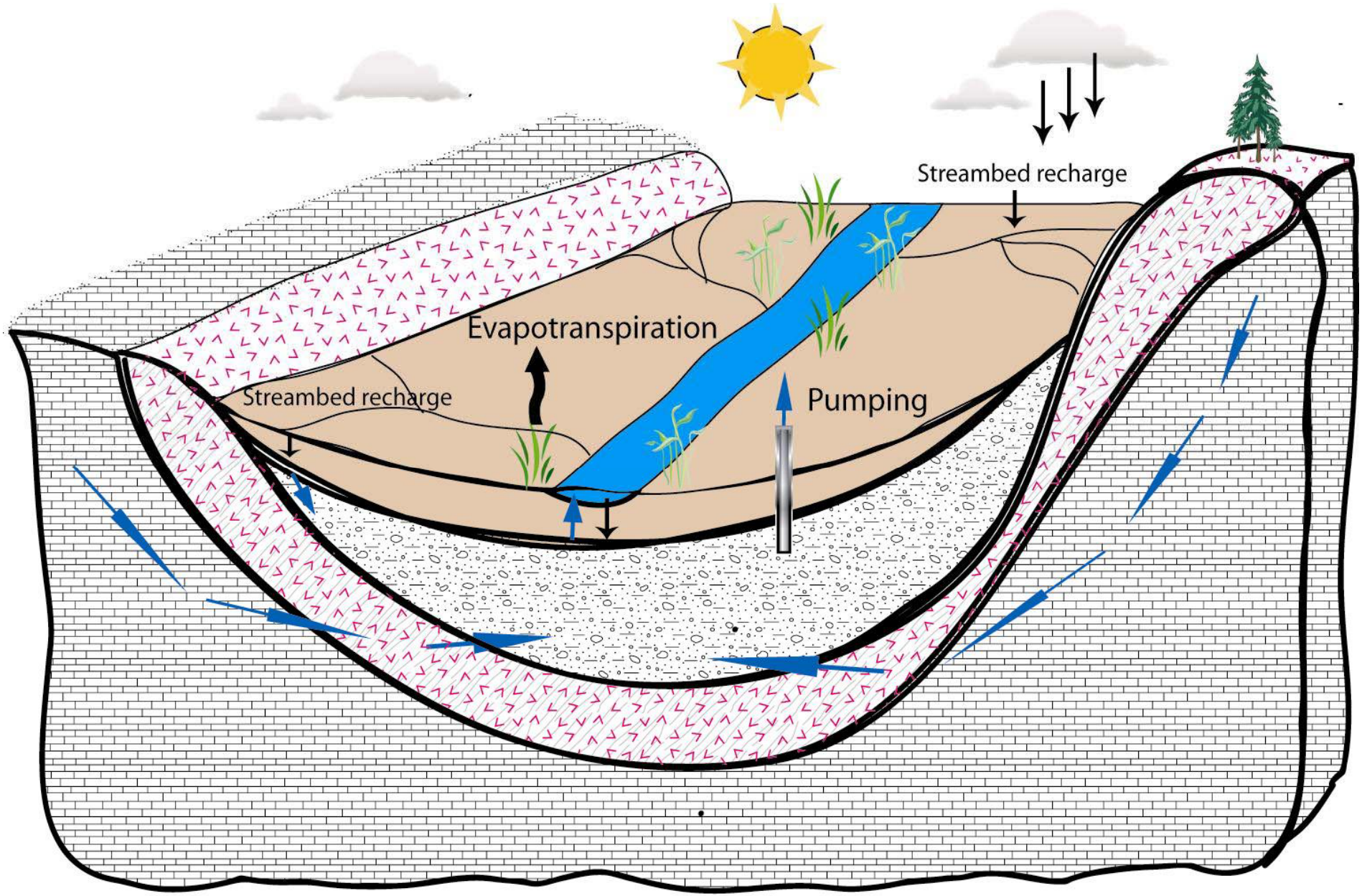
(after Groat, C. G., 1972, Bureau of Economic Geology)

Conglomerado

Roca arenosa

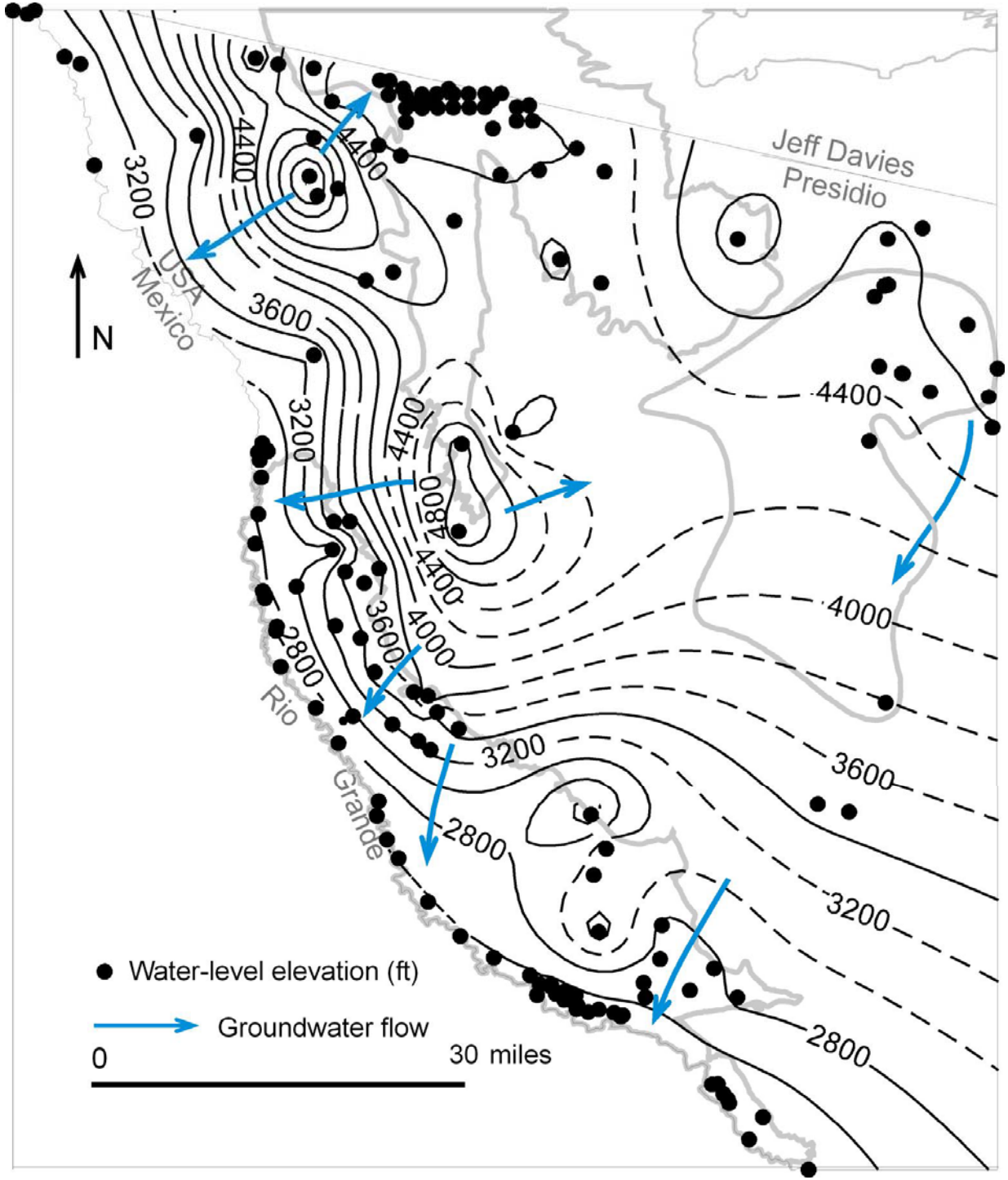
Mudstone

Flujo conceptualizado del Bolsón de Presidio

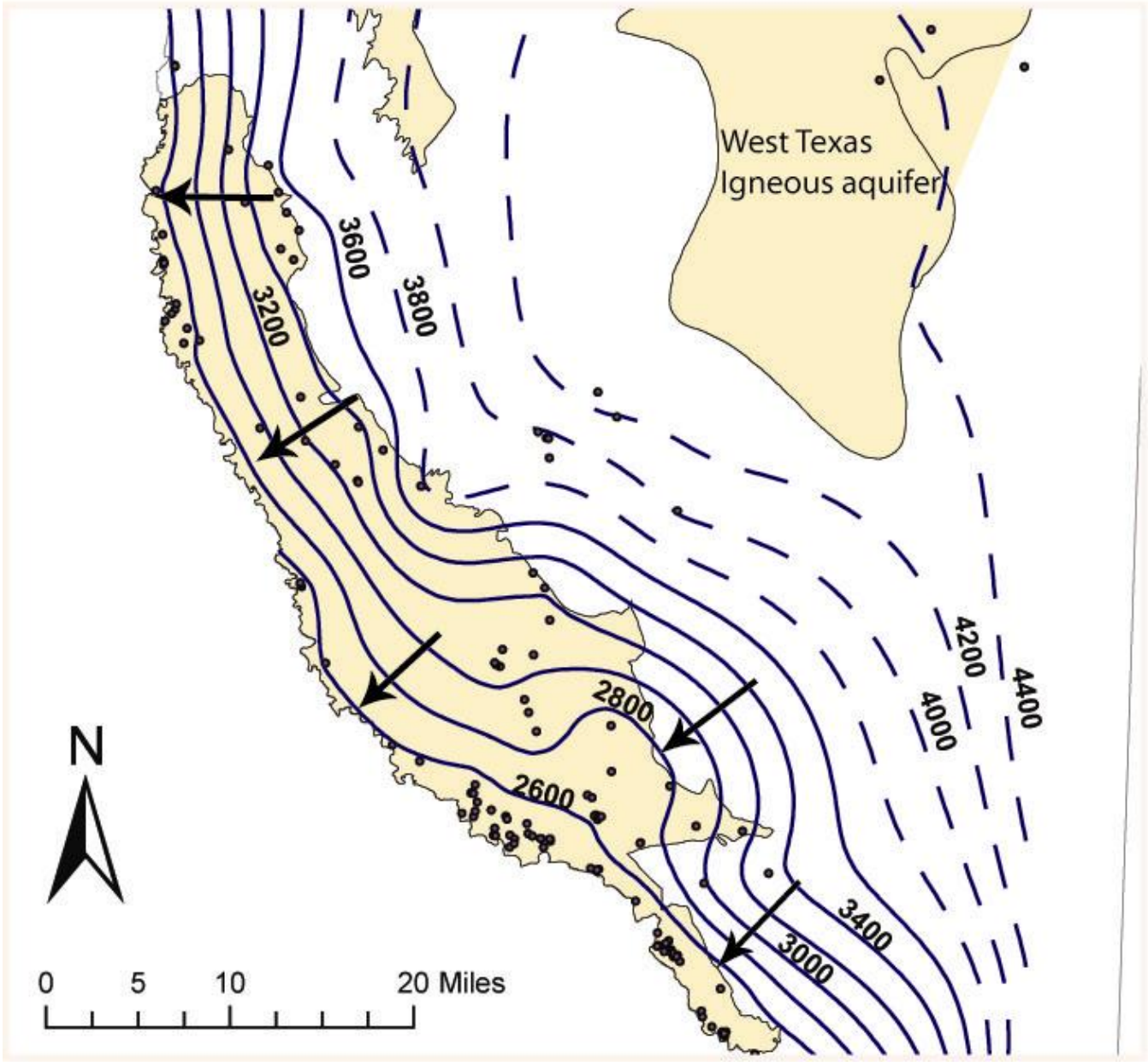


Niveles del agua

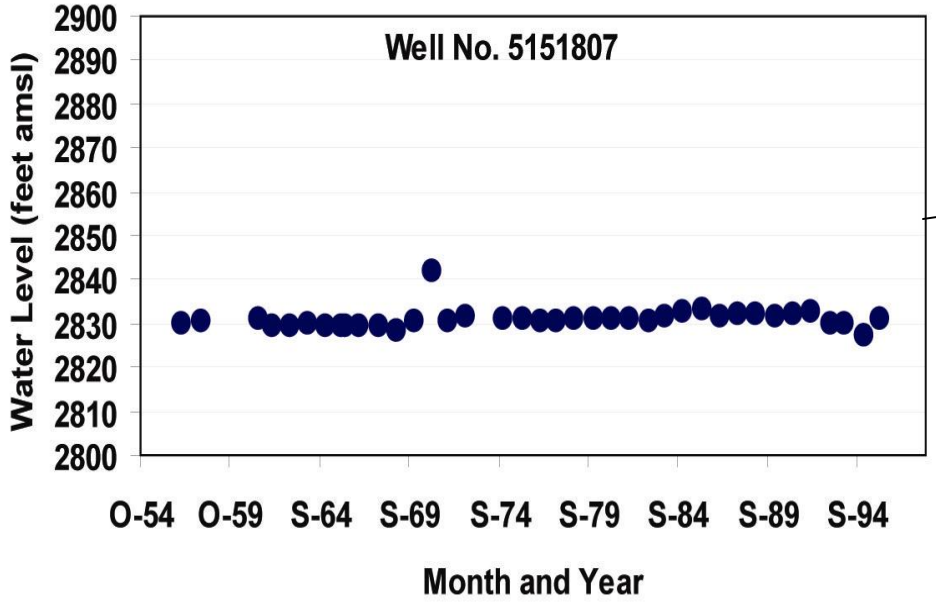
Composite of regional water level data from 1950 through 2004

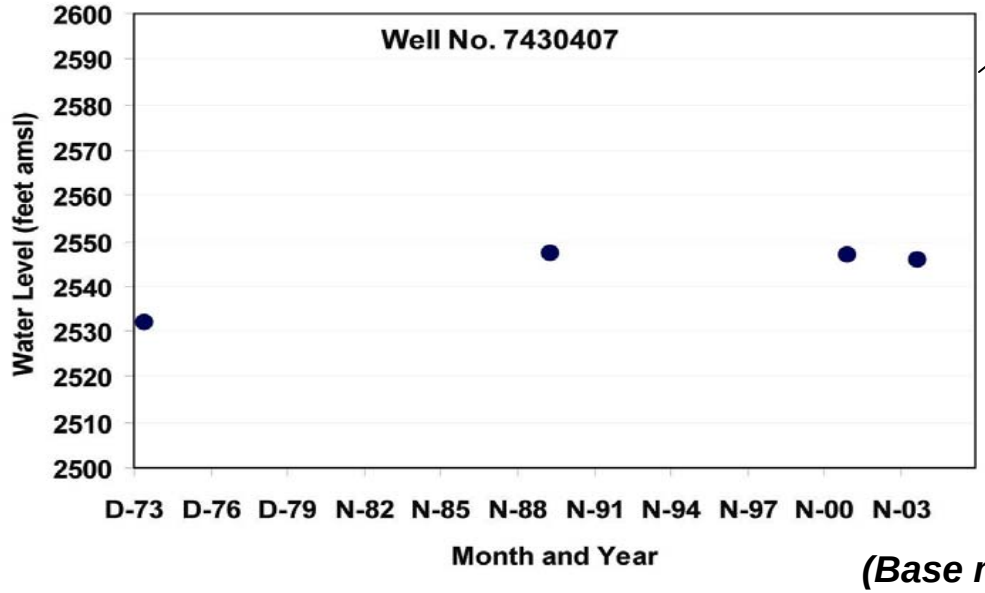


2004-2005
Niveles de agua de los Bolsones de Redford y Presidio

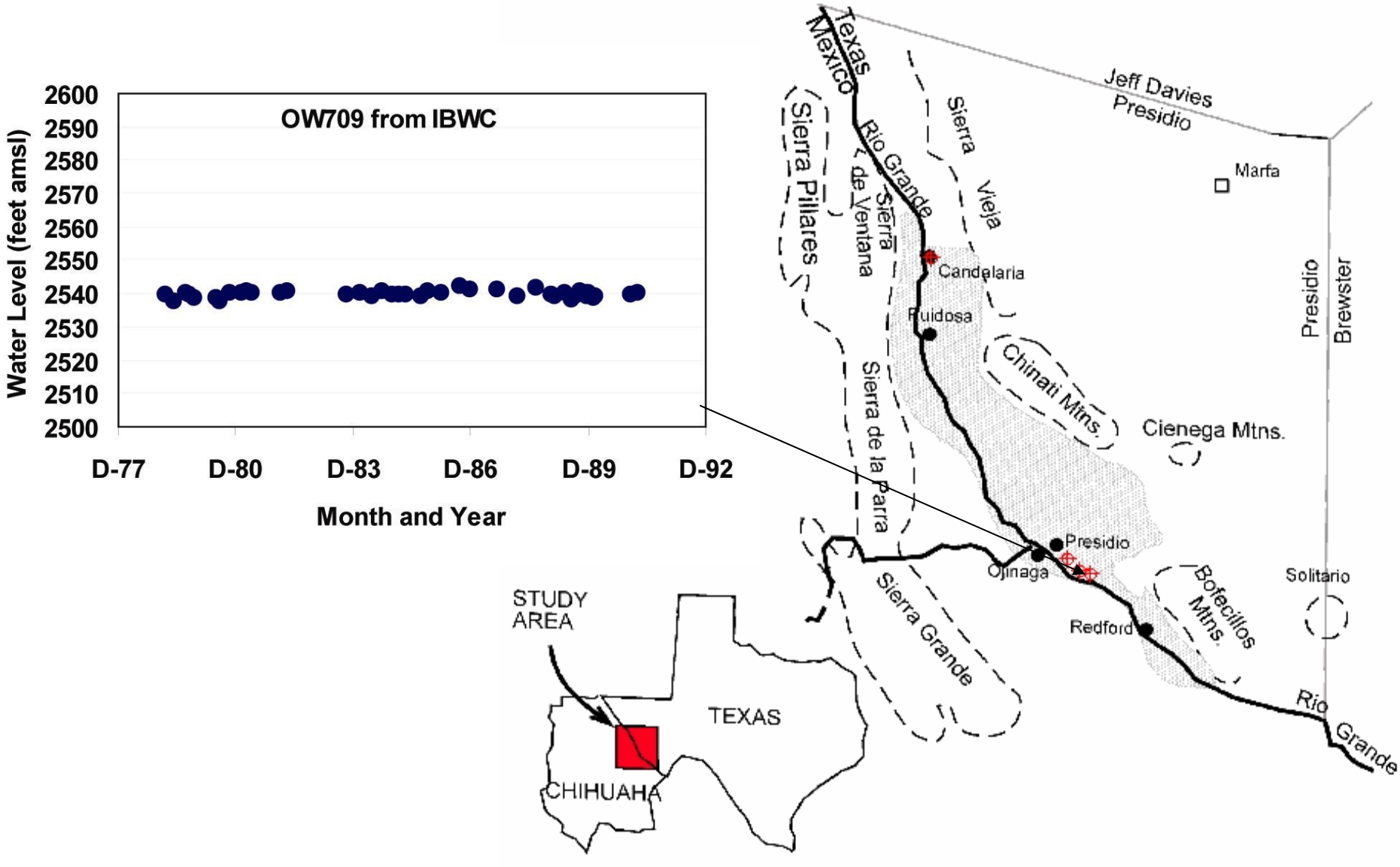


Hidrogramas





(Base map from Groat C. G., 1972, BEG)

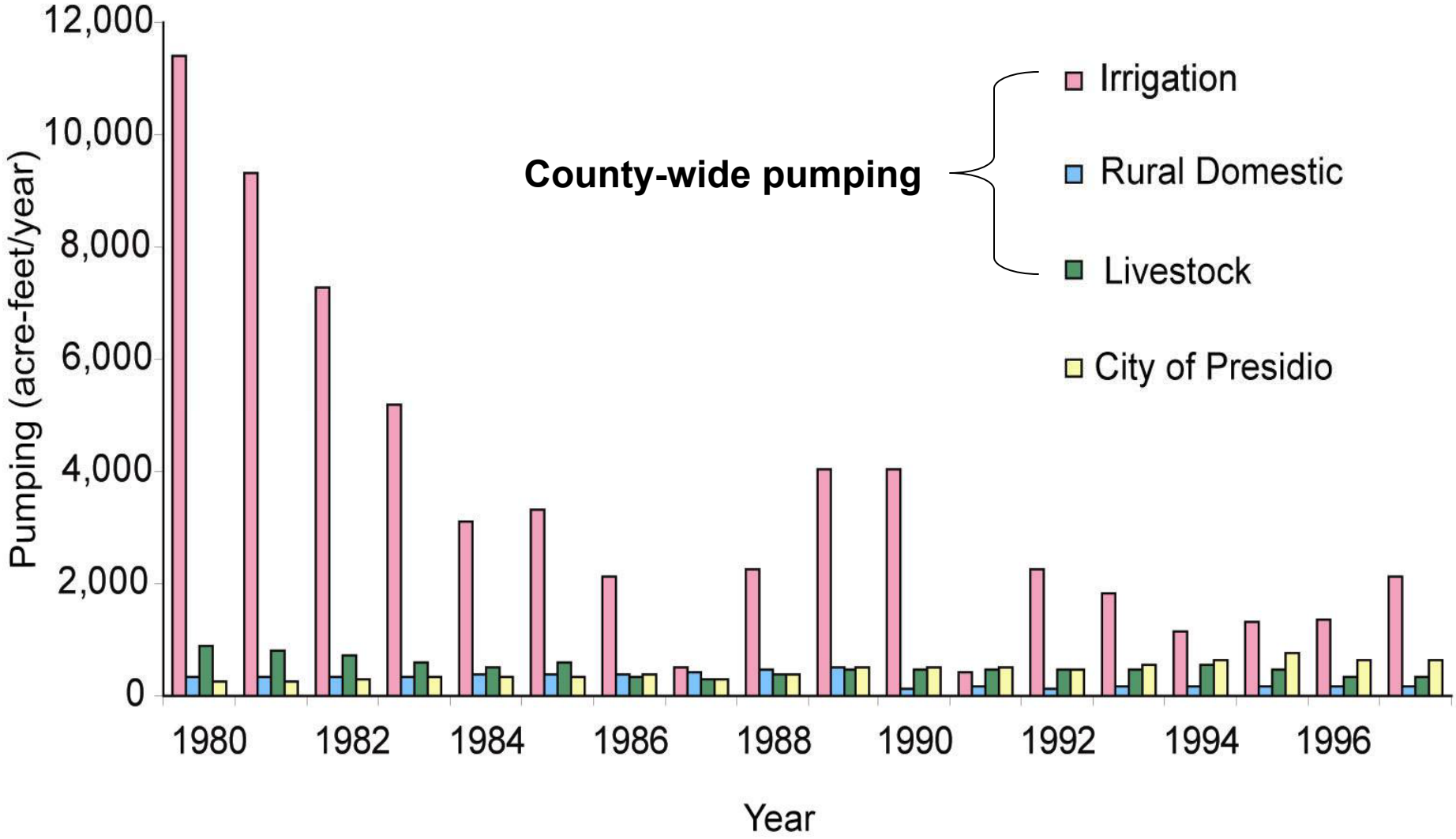


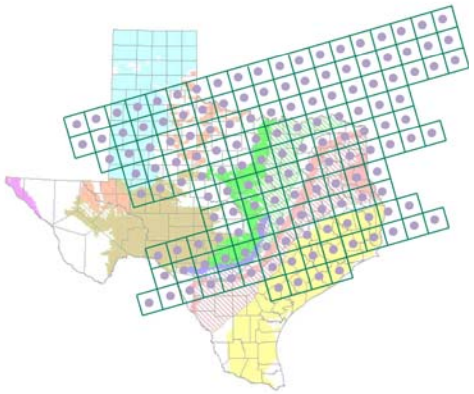
Hidrogramas

(Base map from Groat C. G., 1972, BEG)

Información de bombeo en todo el Condado

-Riego, doméstico rural, ganado, Ciudad de Presidio-





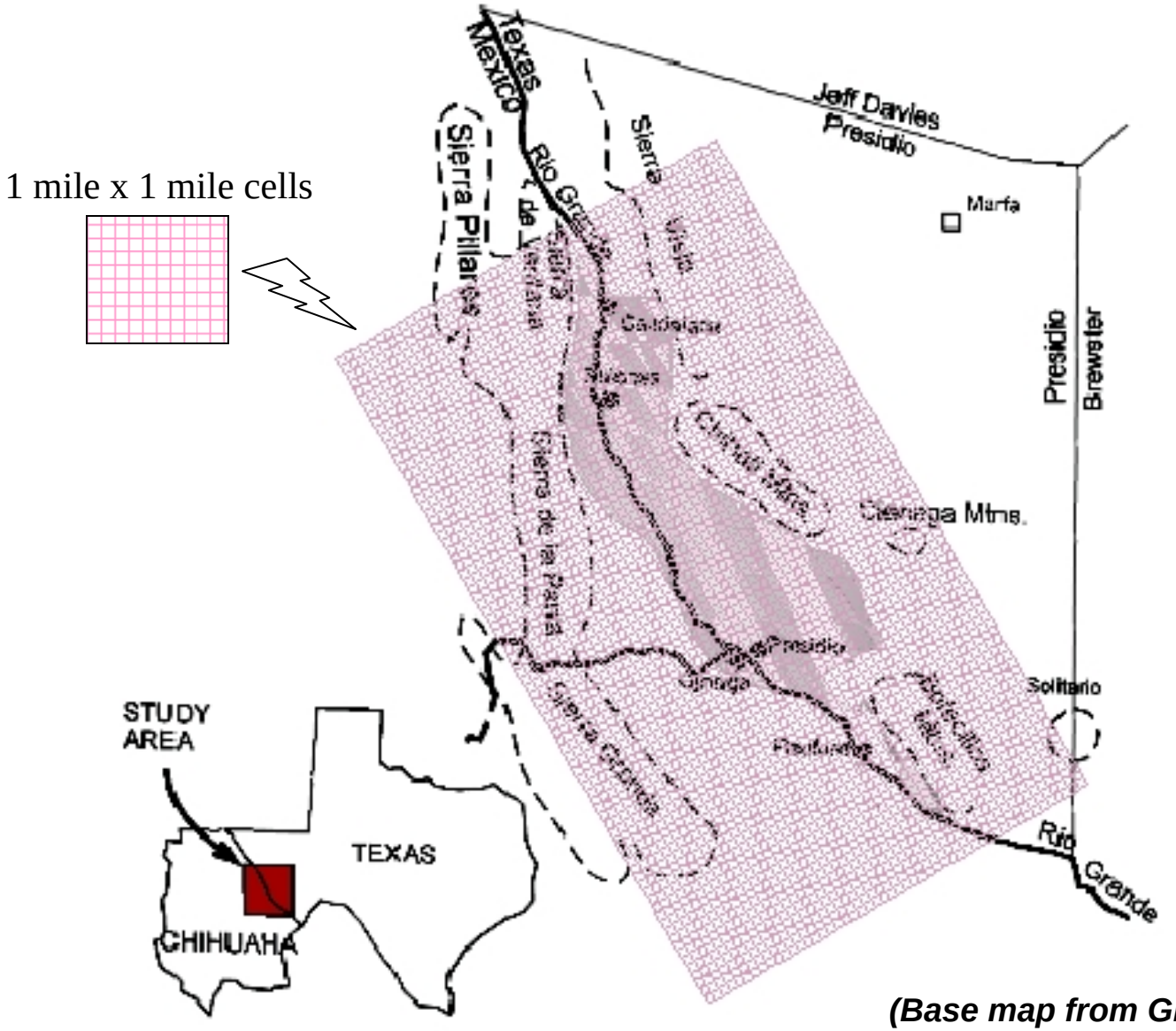
Información adicional

Además de lo descrito, usaremos

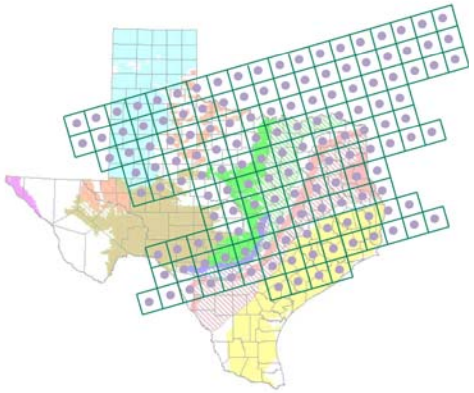
- **Mediciones de cauces de la CILA para calibrar interacciones con el río**
- **Propiedades hidráulicas de las pruebas de bombeo**
- **Coberture de usos de suelo para asignar bombeo**
- **Cobertura vegetal para estimar evapotranspiración**

Cuadrícula del modelo

1 mile x 1 mile cells



(Base map from Groat C. G., 1972, BEG)



Información necesaria

Otra información, especialmente de México, sería muy beneficiosa:

- **Información estructural para determinar el espesor del acuífero**
- **Niveles de agua en los pozos**
- **Características hidráulicas a partir de pruebas de bombeo**
- **Características químicas del agua**
- **Volúmen de bombeo**
- **Caudales (flujos) en los ríos**

Enfoque del modelo

- Recolectar información y construir modelo conceptual
- Crear modelo computarizado basado en el modelo conceptual –Asignar las características de la cuadrícula.
- Calibrar el modelo a los niveles observados en condiciones de flujo estable antes del bombeo
- Calibrar el modelo a condiciones transitorias con base a la información de bombeo

Programa Preliminar

2005

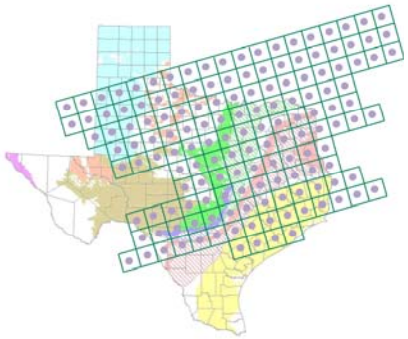
- November 4 – Primer Foro

2006

- Junio- Recibir información
- Julio- Preparar concepto de modelo
- Julio- Comentarios de interesados
- Agosto- Modelo de flujo estable
- Agosto- Segundo Foro

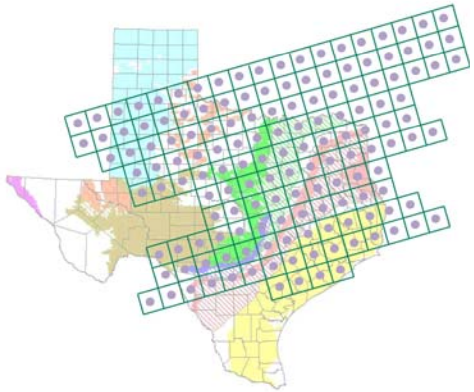
2007

- Febrero- Modelo transitorio
- Abril- Reporte borrador
- Abril- Tercer Foro
- Mayo – Comentarions públicos sobre el borrador
- Junio- Reporte Final



Herramienta dinámica

- **Distritos de Manejo del Acuífero (GCDs), Grupos Regionales de Planificación del Agua (RWPGs), TWDB, y otros reúnes información sobre el acuífere**
- **Dicha información puede mejorar el modelo**
- **TWDB planea actualizar el modelo cada 5 años**
- **TWDB agradece su información e ideas sobre el acuífero y el modelo**



Participación en el proceso de modelamiento

- **Reuniones de Interesados**
  - **Escucha acerca de avances en el modelo**
  - **Comentar sobre las suposiciones del modelo**
  - **Otra información (importante presentarla a tiempo)**
- **Revisión del reporte**
  - **Al final del proyecto**
- **Contacto en TWDB**
  - **Shirley Wade**

Comentarios:

Shirley Wade
shirley.wade@twdb.state.tx.us
(512)936-0883
www.twdb.state.tx.us/gam

Presidio – Redford Bolson aquifer GAM

Stakeholder Advisory Forum 1

November 4, 2005

Name	Affiliation
Rima Petrossian	Texas Water Development Board
Shirley Wade	Texas Water Development Board
Doug Coker	Texas Water Development Board
Adolph Stickelbault	Texas Water Development Board
Sarah Davidson	Texas Water Development Board
Caroline Runge	FWTRWPG and local landowner
Billy D. Roberts	Trans-Pecos Water Trust
Janet Adams	Presidio County UWCD
Tony Giles	SRSU
Hector Morales	Redford Water Supply
Jeff Bennett	National Park Service, Big Bend National Park
Rafael Realivasquez	Texas Cooperative Extension
Rong Kuo	USIBWC
Armando Reyes	CILA
Andres J. Bañuelas	CILA
Jessica A. Nuñez	USIBWC
E.M. Nieto	Land owner
Mike Mecke	Texas Water Resources Extension
Mark Dobson	DNA Geosciences
Zhuping Sheng	Texas A&M University
Rebecca Wainright	Texas Department of State Health Services
Cynthia Clarke	City of Presidio
Sterry Butcher	Big Bend Sentinel, Presidio International Newspapers
Patt Sims	Presidio High School
David Lewis	Texas Parks and Wildlife Department

Questions and Answers from the Stakeholder Advisory Forum for the Groundwater Availability Model of the Presidio-Redford Bolson aquifer. The meeting was held on the afternoon of November 4, 2005 at the American Legion Hall in Presidio Texas.

Question: How will the models be used in areas where there is not a Groundwater Management Area? Can they be used by planning areas?

Answer: The Groundwater Management Areas (GMAs) cover the entire state. The models can also be used by Regional Water Planning Groups (RWPGs). Use of the models by GMAs, RWPGs, and Groundwater Conservation Districts (GCDs) is complimentary and should lead to parallels in management and planning strategies by the different groups.

Question: How big are the grid cells in the model?

Answer: In this model, each grid cell is 1 mile by 1 mile. Smaller grid cells are better only if data are available; if enough data are not available, making smaller grid cells will not improve the model.

Question: Do you have pumping data from the Mexican side of the aquifer?

Answer: No, but any data from the Mexican side that individuals or groups could provide us would be very helpful!

Question: Is pumping in small communities and unincorporated towns incorporated into the pumping for the model, and if so, how is it estimated?

Answer: We used statewide estimates of average per capita use and distributed this value per rural population based on census data. Where possible, water supply corporations will be separated out for newer models.

Question: Do irrigation pumping numbers come from the state plan provided by TCEQ?

Answer: The irrigation use numbers are from the Texas Water Development Board (TWDB)'s state water plan.

Comment: We think that the state's irrigation numbers are wrong.

Response: We will find out exactly how the irrigation numbers are estimated and get back to you. *{The source of the irrigation use data is from the local and regional soil conservation service offices. The offices estimate use, crop types, and irrigated area and report those numbers to the TWDB. We expect that the City of Presidio use and livestock use will be the major groundwater pumping categories in the Presidio – Redford Bolson GAM. The large amount of Presidio County irrigation shown in the SAF presentation may be from Ryan Flat Bolson. We will try to have the pumping input data for the model*

prepared before the next stakeholder meeting so that stakeholders will have the opportunity to review it.}

Comment: That drop [in pumping] might be because of drought during the mid- to late 1980s, when there was no water in the river or the alluvium.

Response: We have to distribute the pumping numbers, to find out how much pumping occurs in different places within the aquifer, in order to see how much pumping is from the alluvium.

Question: Do we know how far the aquifer goes into Mexico?

Answer: We are relying on structural data, data from a gravity survey, Charles Groat's study map of the geology of the bolson, and Digital Elevation Model (DEM) from ESRI (North America DEM)

Question: Could you use water chemistry data or isotopes?

Answer: *{Ideally it is possible to use isotopes and geochemistry to identify an aquifer; however, in this case you may not necessarily be able to use chemical data by itself to define the extent of the aquifer. Well logs or other geologic or geophysical data may be necessary.}*

Question: You update the models every five years. If a lot of new information becomes available in less than five years, do you have to wait five years before you update?

Answer: Not necessarily. If the information becomes available, and if it will significantly improve the model and be more useful to users, we can update the model earlier. This has been done with the model for the northern part of the Ogallala aquifer.

Question: Has Charles Groat's Bureau of Economic Geology 1972 study been reconciled with Chris Henry's new geological information? He was hired by Parks and Wildlife during the 80s and spent ten years studying the geology of the area, and his findings are very different.

Answer: We will find Chris Henry's study and compare them.

Question: You say that this model is the same as the one used for the Ogallala and other aquifers in Texas. Could you use models done for aquifers in New Mexico or Arizona that are more similar to the Presidio-Redford Bolson aquifer?

{To clarify- the figures that were shown as an example were from a presentation for the Ogallala aquifer GAM. We will not be using the same model as was used for the Ogallala. We will be developing a new model for the Presidio Bolson using the modeling software MODFLOW}

Answer: We will use the same software, MODFLOW, to input our data, but for each aquifer model we use only field data collected within that aquifer. The MODFLOW software is used to model all kinds of aquifers in and outside of Texas.

Question: Has the MODFLOW software been tested?

Answer: Yes, the MODFLOW program has been tested. However, each model will have limitations based on the amount of data that are available to put into the model.

Question: Have you decided how you will estimate recharge for the model?

Answer: We will use isotope data collected in the Presidio-Redford Bolson, along with recharge estimates made for similar bolson aquifers, to come up with a range of possible recharge rates. We will then adjust the recharge estimates in the model until the model matches the field data we have collected.

Comment: So you can just change the recharge until it makes the model work?

Response: This is one of several variables that can be adjusted to make the model work, but we will keep it within the realistic range that we come up with.

Question: How will evapotranspiration (ET) be estimated? Do you have a multiplier?

Answer: The agency is working on an ET study that which involves reviewing and compiling data from previous studies to come up with statewide estimates. The study report will be posted on our website.

Question: Will the vegetation studies just look at acres of land with vegetation, or will it distinguish vegetation by type?

Answer: We want to be able to distinguish vegetation by type. We will try to determine this using vegetation maps.

Question: Will you also be predicting the groundwater quality?

Answer: The model doesn't use water chemistry. We use water chemistry data to help determine the geology of the area and groundwater movement.

Question: How bad is water chemistry in the aquifer?

Answer: In some areas it is probably not drinkable. Texas Department of Water Resouces Report #256 (Gates and others) quantified water quality within the bolson. This report is available on our website at http://www.twdb.state.tx.us/publications/reports/GroundWaterReports/GWReports/GWreports.asp.

Question: It is probably too early to ask, but how many layers will you use in the model? How will you account for present and future stress on the aquifer?

Answer: We have records from shallow wells and from some deep wells, but no hydrographs [water level measurements over time] from deep wells. If more pumping occurs in the deep part of the aquifer, we will have to add data and recalibrate the model.

Comment: The Presidio groundwater study is important because it is a transboundary aquifer. I am Rong Kuo from the International Boundary and Water Commission (IBWC) in El Paso. We have representatives here from the Mexican section of the IBWC [Comisión Internacional de Limites y Aguas, or CILA]. The US section will go through the proper channels to request data from Mexico.

Comment: The Comisión Nacional del Agua (CNA) has a database of groundwater information for Mexico. We [the CILA representatives] will see if they are interested and want to participate.