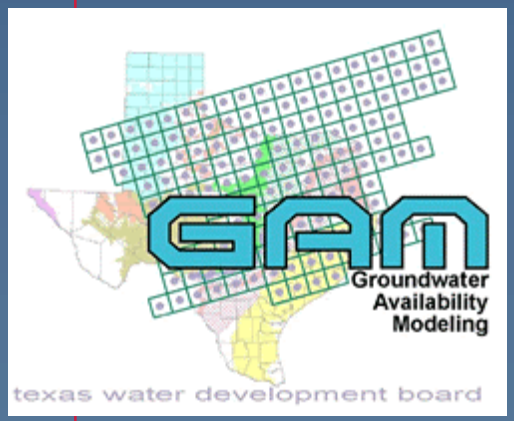
Stakeholder Advisory Forum - 4

Groundwater Availability Modeling (GAM) for the Southern Carrizo-Wilcox Aquifer



Evergreen Underground Water Conservation District

Pleasanton, Texas

March 1, 2002

INTERA

PARSONS

WATERSTONE
Environmental Hydrology and Engineering, Inc.

Presentation Outline

- The INTERA – DE&S Connection
- Introduction to GAM
- Approach to Groundwater Pumping Allocation in the GAM
- Water Quality Evaluations
- Modeling Approach and Progress
- Topics Planned for Next SAF

INTERA Inc.

- 1974 - Founded as INTERA Technologies
- 1995 - Acquisition by DE&S
- 1/2002 – Employee buy-out and formation of INTERA

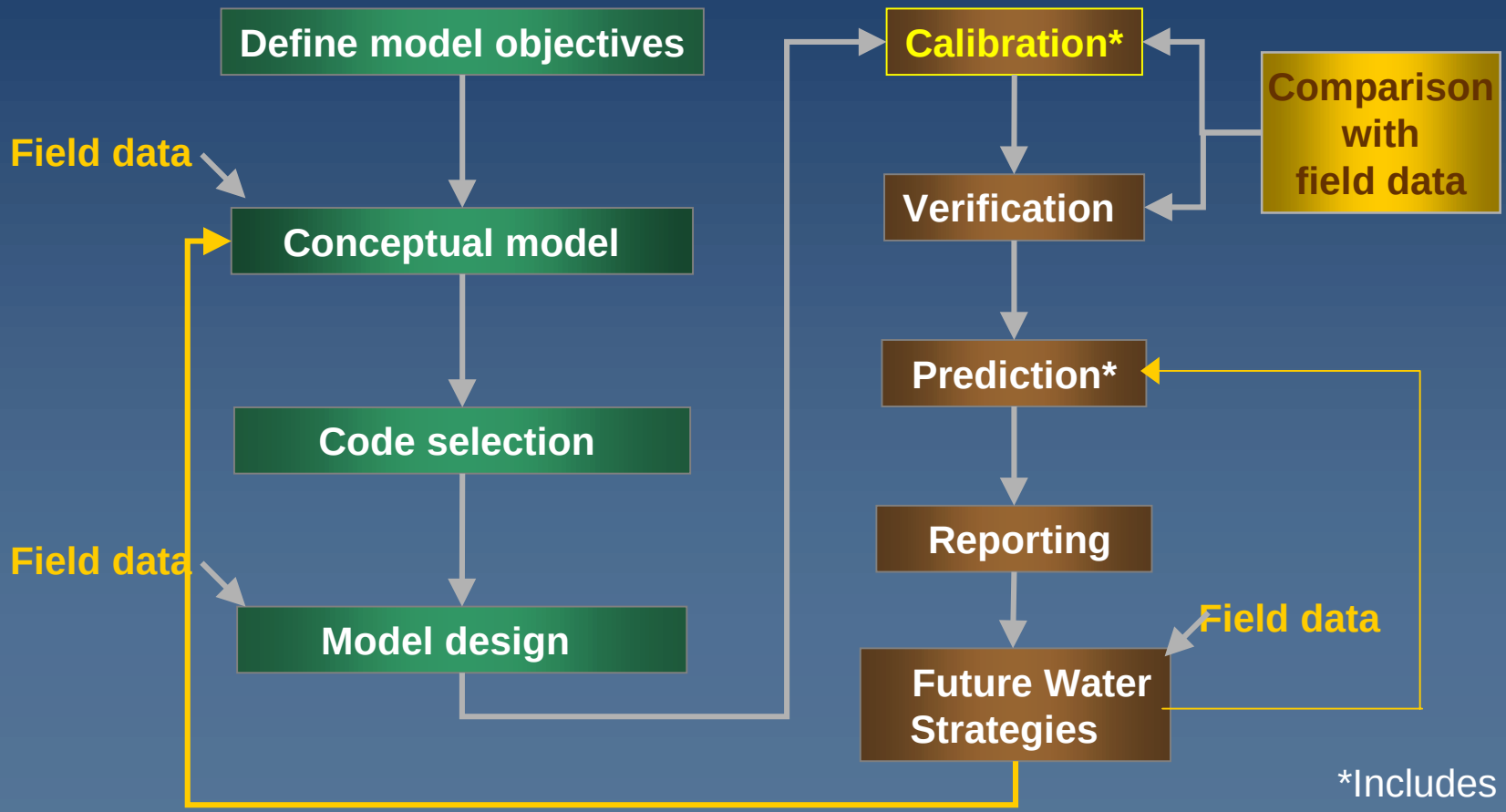
INTERA Inc.

- 70 professionals specialized in groundwater and the earth sciences
- Based in Austin, Texas
- 28 – year track record in the field of groundwater modeling
- Represents continuity of all GAM technical staff

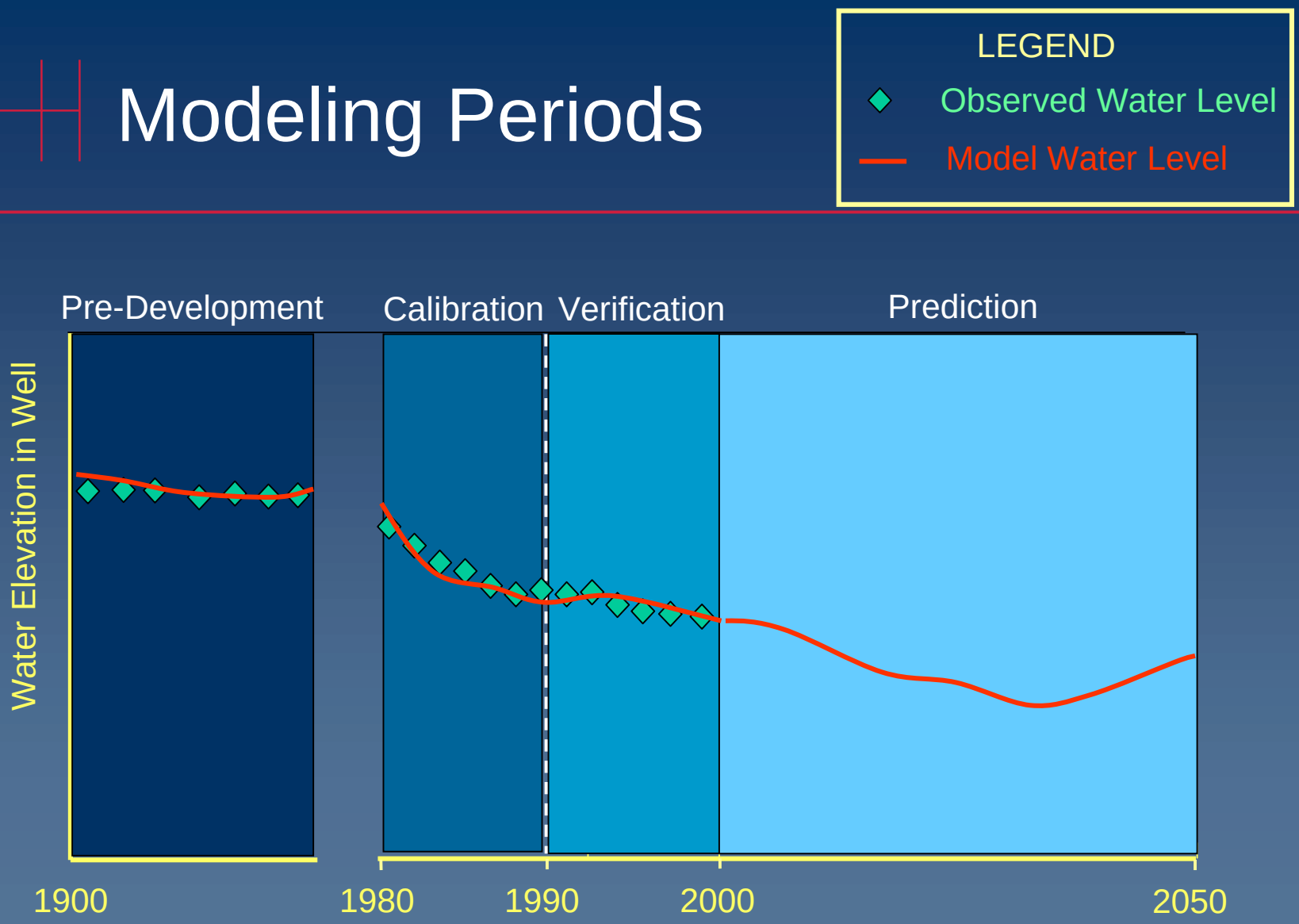
GAM Objectives

- Develop realistic and scientifically accurate GW flow models representing the physical characteristics of the aquifer and incorporating the relevant processes
- The models are designed as tools to help GWCD, RWPGs, and individuals assess groundwater availability
- SAFs are important in GAM development, providing input on local concerns, aquifer characteristics, and data availability

Modeling Protocol



Modeling Periods



Presentation Outline

- The INTERA – DE&S Connection
- Introduction to GAM
- Approach to Groundwater Pumping Allocation in the GAM
- Water Quality Evaluations
- Modeling Approach and Progress
- Topics Planned for Next SAF

Evaluation of Historic Pumping Demand

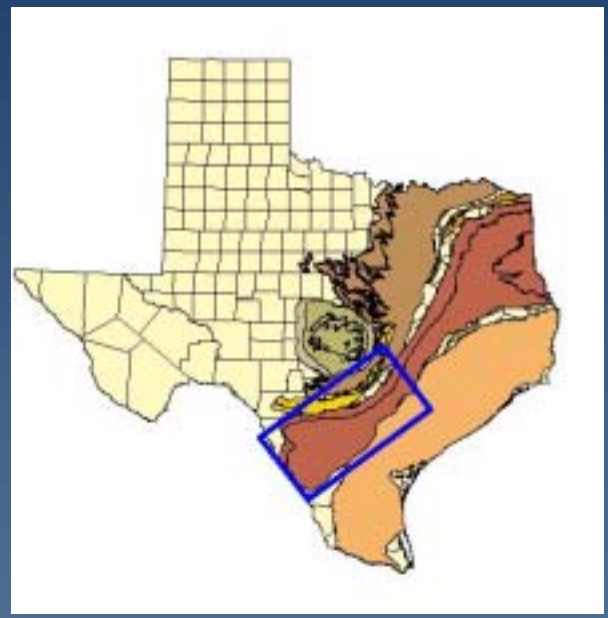
- Standard Operating Procedures
- Processing Historical (1980-1999) Pumpage Data

Data Sources for Groundwater Use Provided by the TWDB (1980-1999)

- **Annual Water Use summary by major aquifer**
- **Annual Water Use summary by individual county and river basin**

3. **Monthly Water Use summary for municipal users**

- **Monthly Water Use summary for manufacturing users (includes manufacturing, power generation, and mining)**



Categories of Groundwater Use

Point Source Data

- **Municipal**
- **Manufacturing**
- **Power**
- **Mining**

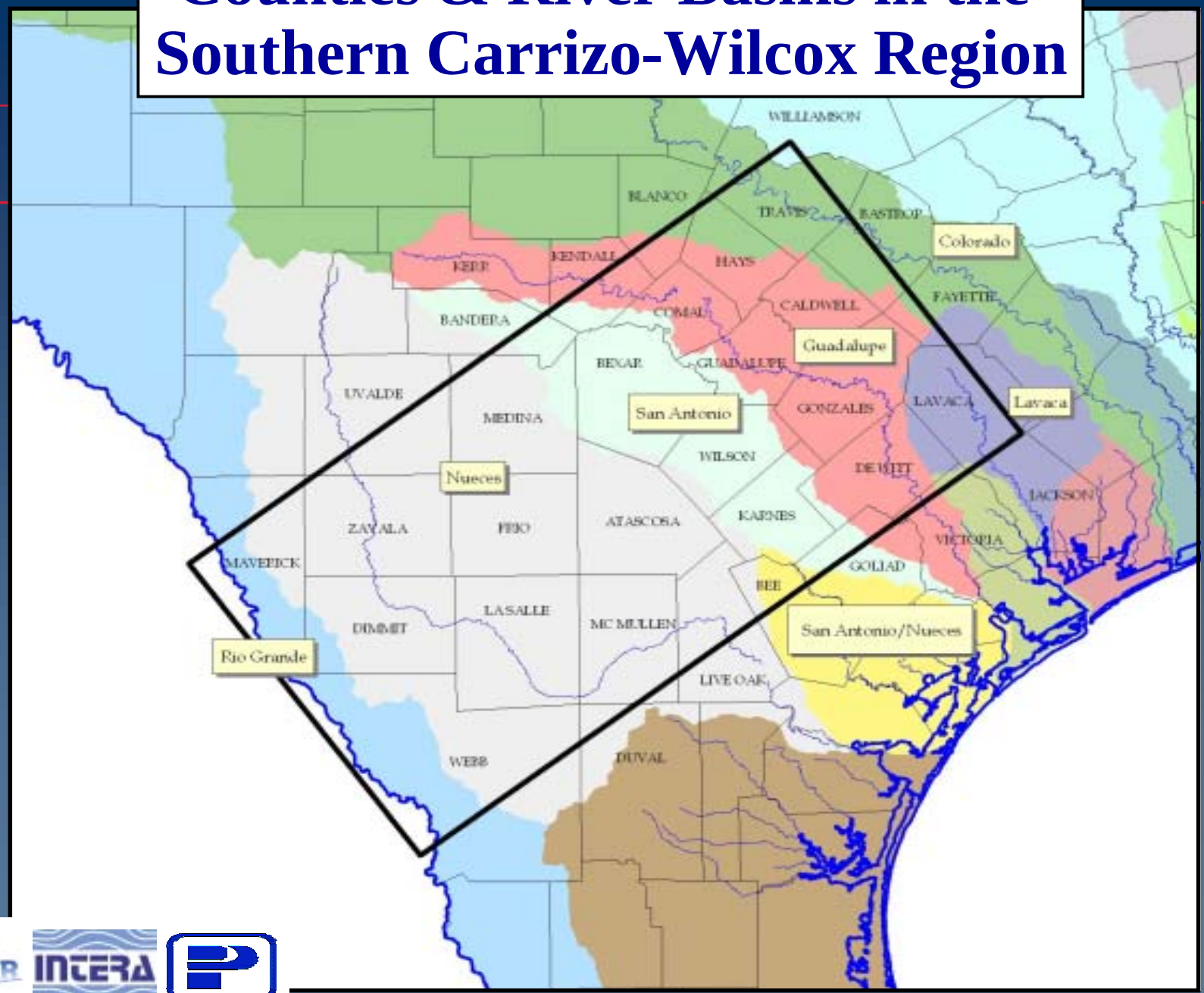
Non-Point Source Data

- **Irrigation**
- **Livestock**
- **Rural Domestic**

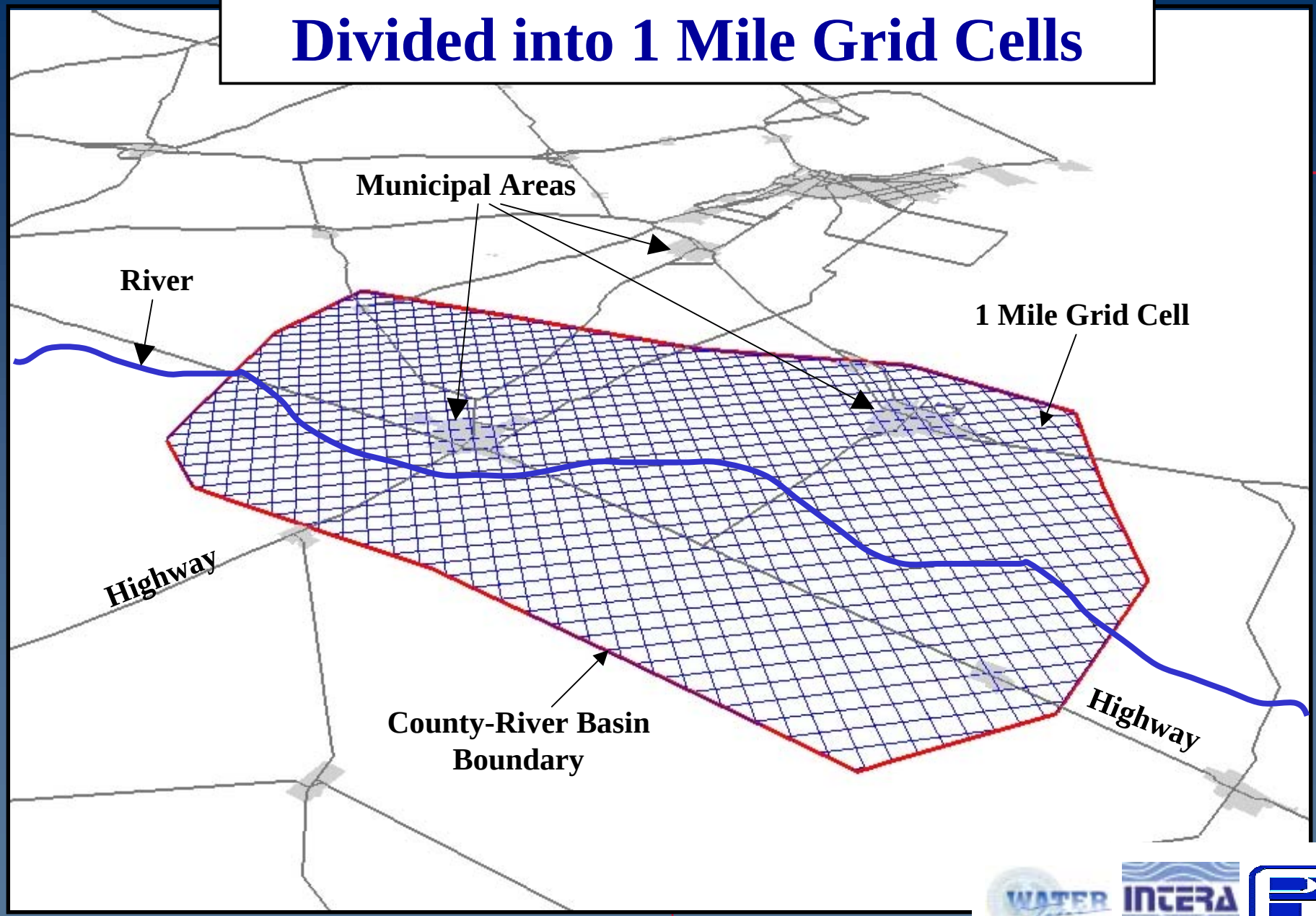
Database Processing

- Utilize TWDB Technical Memorandums
- Prepare 1 mile by 1 mile grid cells using GIS (Geographic Information Systems) computer programs
- Separate point source municipal wells from non-point source rural domestic wells
- Distribute monthly pumpage for each of the 7 groundwater uses across each grid cell

Counties & River Basins in the Southern Carrizo-Wilcox Region



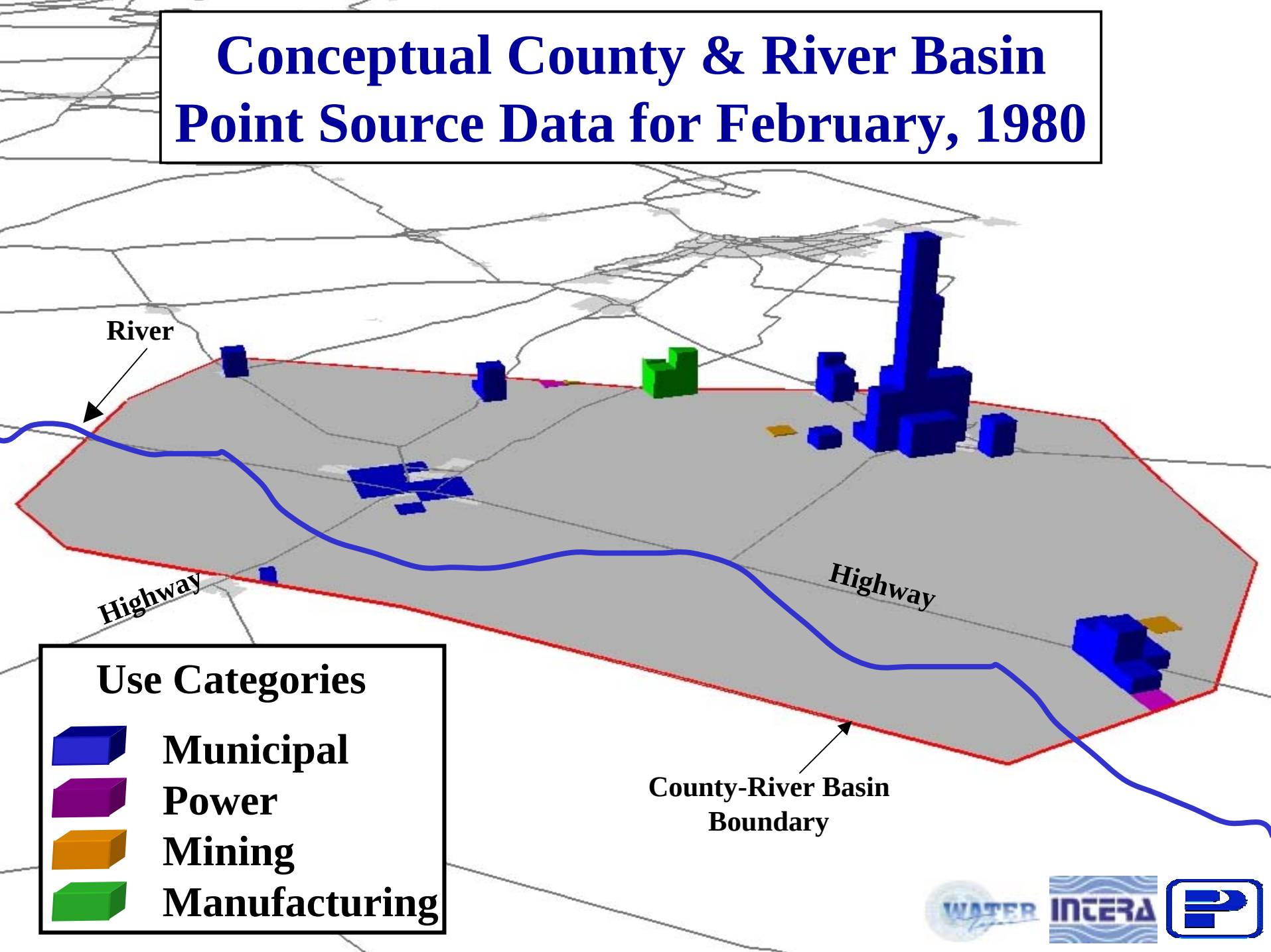
Conceptual County & River Basin Divided into 1 Mile Grid Cells



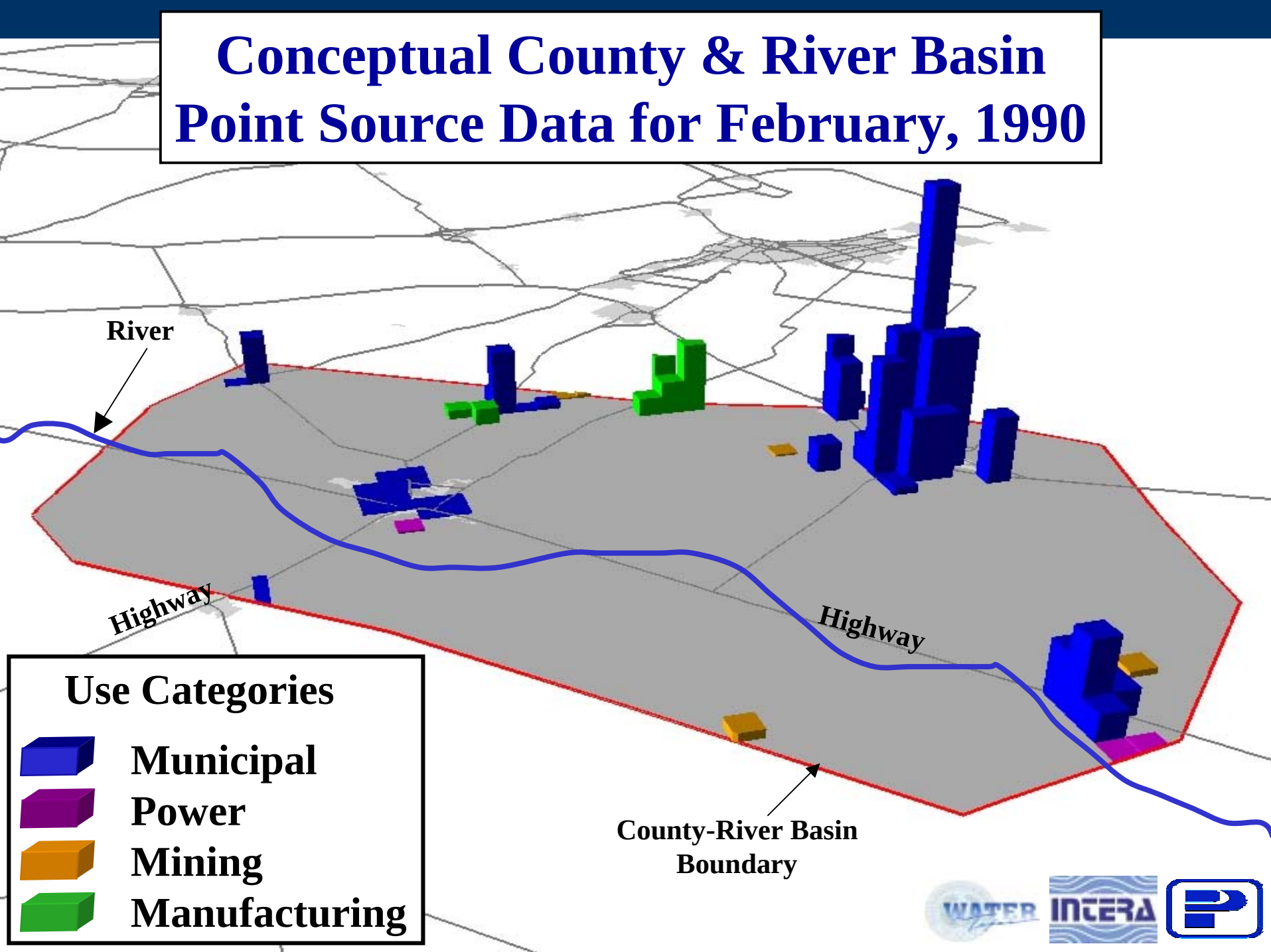
Locate Pumpage Using Point Source Data

- Applicable for municipal, manufacturing, power and mining uses
- Utilize TWDB water use survey and TWDB well database
- Assign well screened intervals (top and bottom) to specific groundwater flow layers within the model
- Label each pumping record with the appropriate grid cell identifier

Conceptual County & River Basin Point Source Data for February, 1980



Conceptual County & River Basin Point Source Data for February, 1990



Locate Pumpage Using Non-Point Source Data

1. Irrigation

- Locate irrigated areas based on land use and land cover records
- Assign monthly pumpage amounts based on rainfall, temperature, and crop demand data
- Well depths assigned from nearby wells in state well database

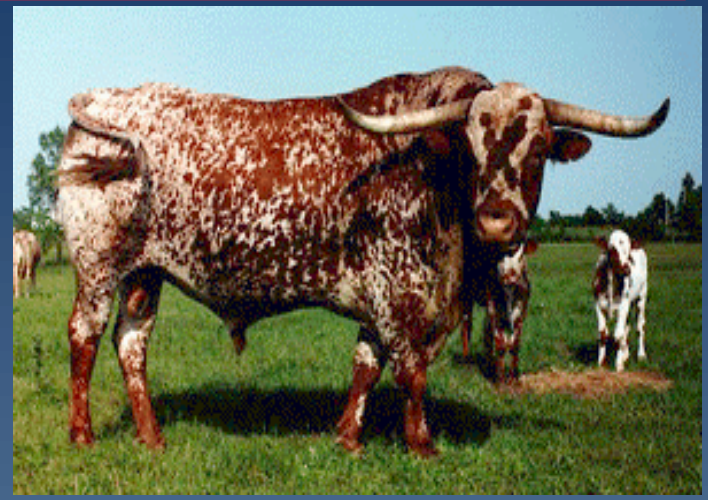
Locate Pumpage Using Non-Point Source Data

- **Rural Domestic Pumpage**

  - **Distribute pumpage data based on population density, excluding municipalities with a Public Water Supply**
  - **Distribute annual pumpage into monthly increments in proportion to nearby larger municipalities**
  - **Well depths assigned from nearby wells in TWDB well database**

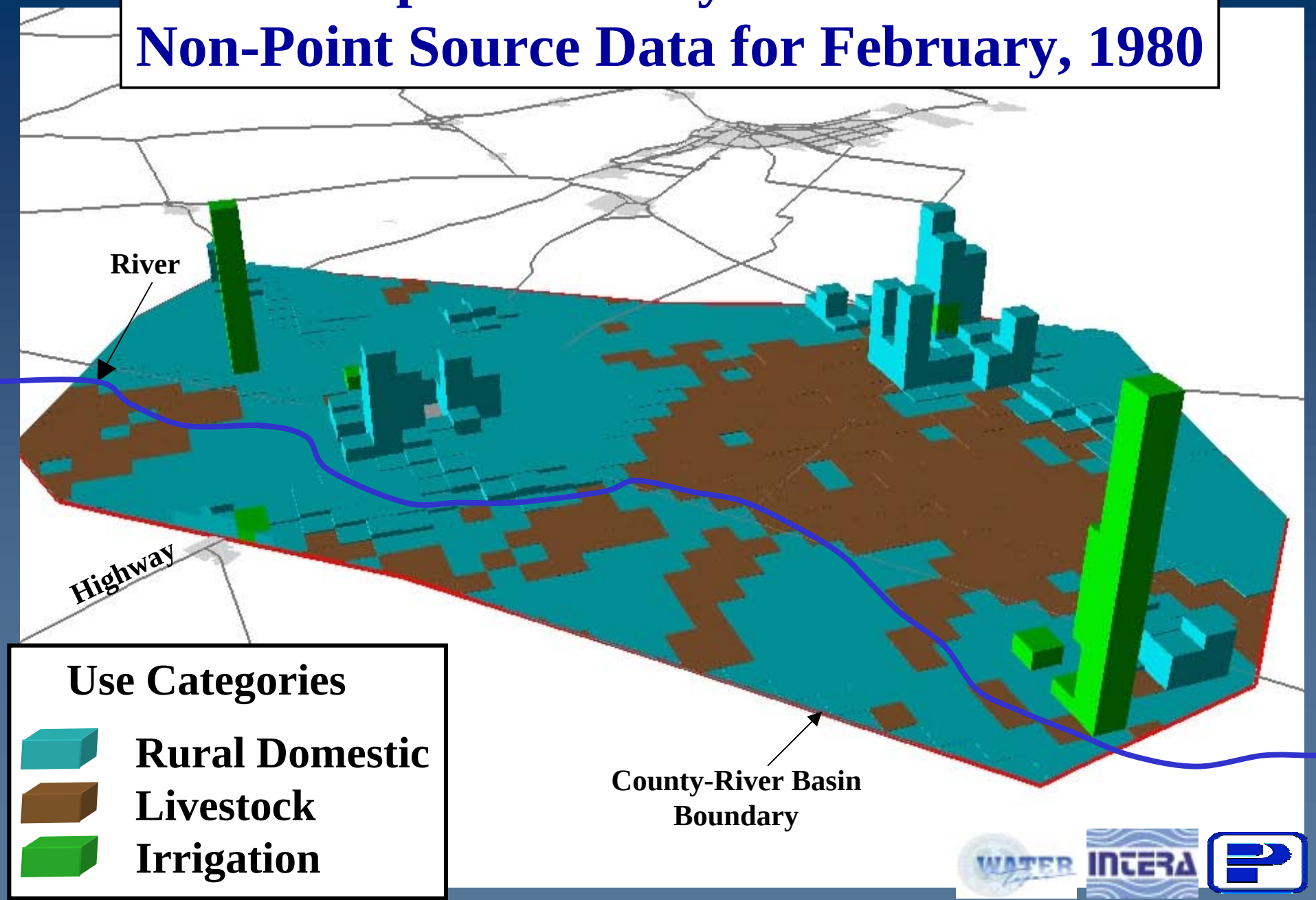
Locate Pumpage Using Non-Point Source Data

3. Livestock Pumpage

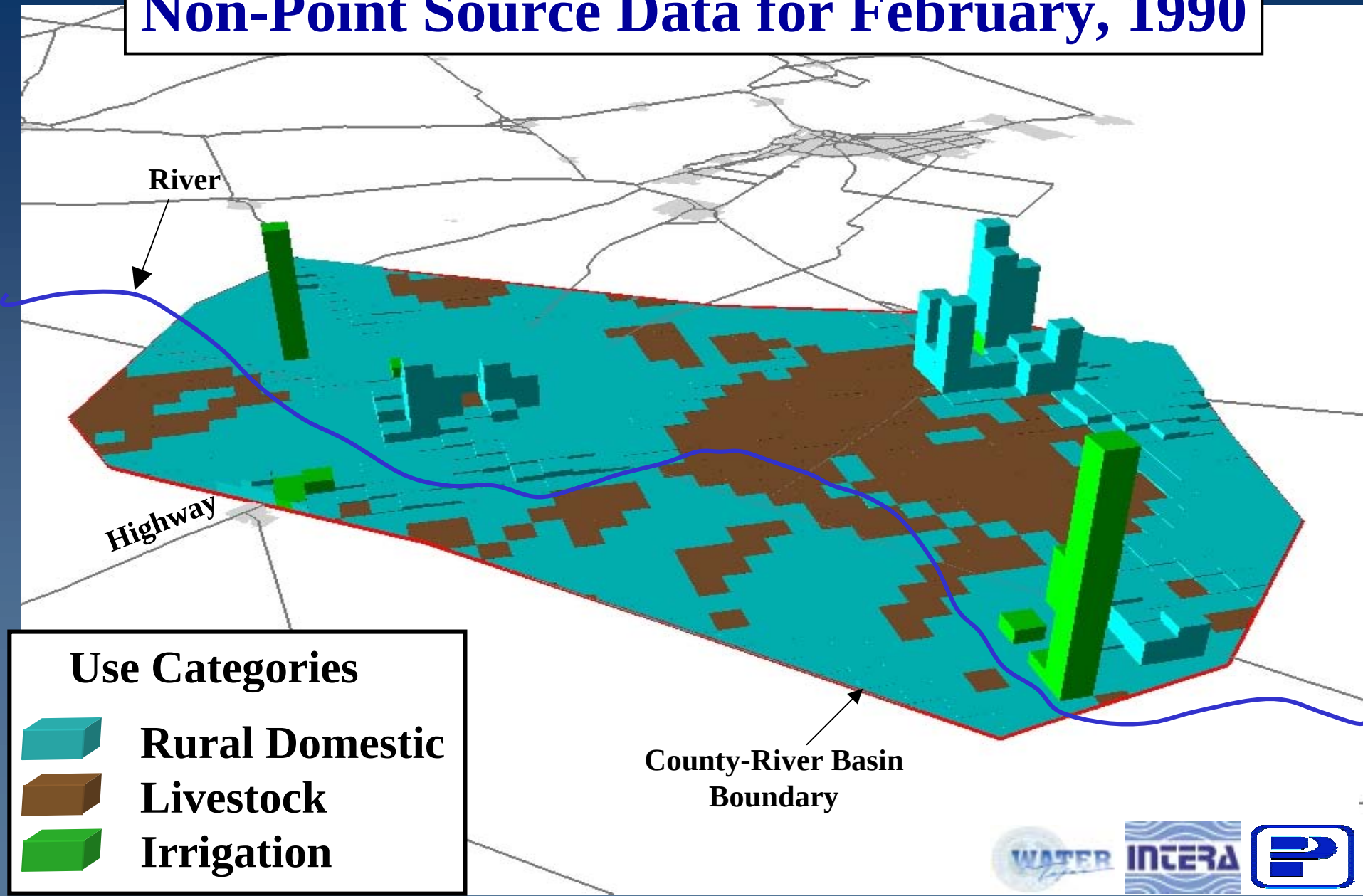


- Locate livestock areas based on land use and land cover records (rangeland and pasture)
- Assign monthly pumpage based on 1/12 of reported annual use
- Well depths assigned to upper-most water bearing unit

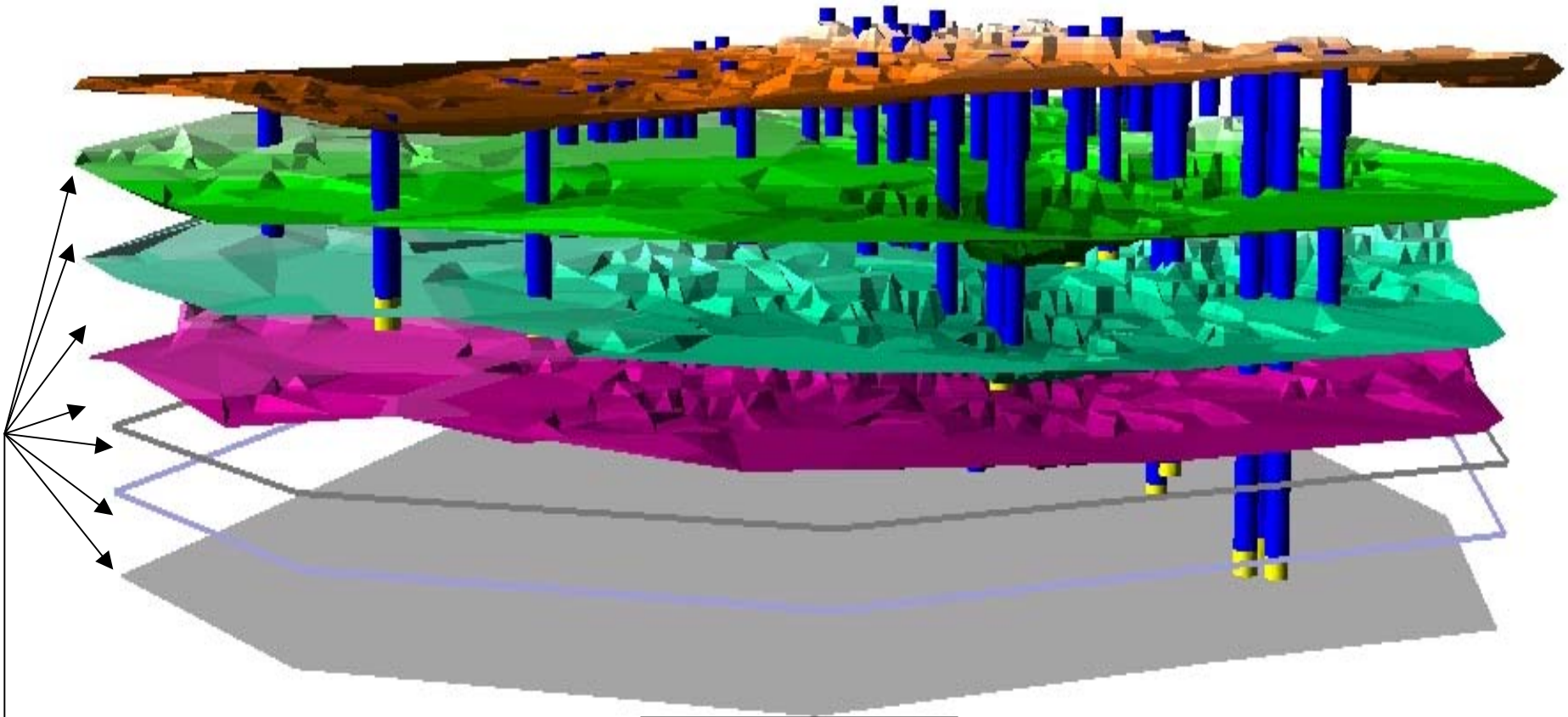
Conceptual County & River Basin Non-Point Source Data for February, 1980



Conceptual County & River Basin Non-Point Source Data for February, 1990



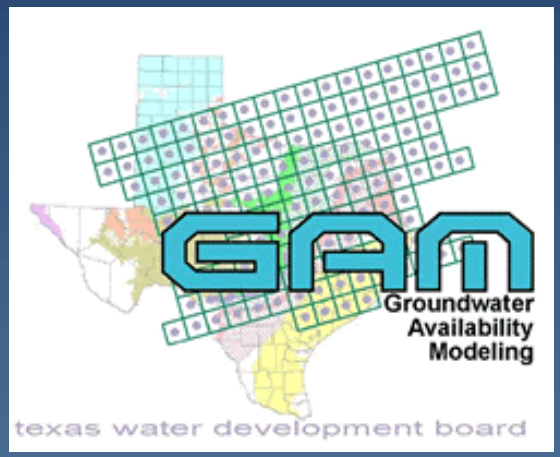
Conceptual County & River Basin Wells with Various Depths in Multiple Aquifer Layers



Top/Bottom of Aquifer Layers

Well Screen
Well Casing

Water Quality in the Southern Carrizo-Wilcox Aquifer



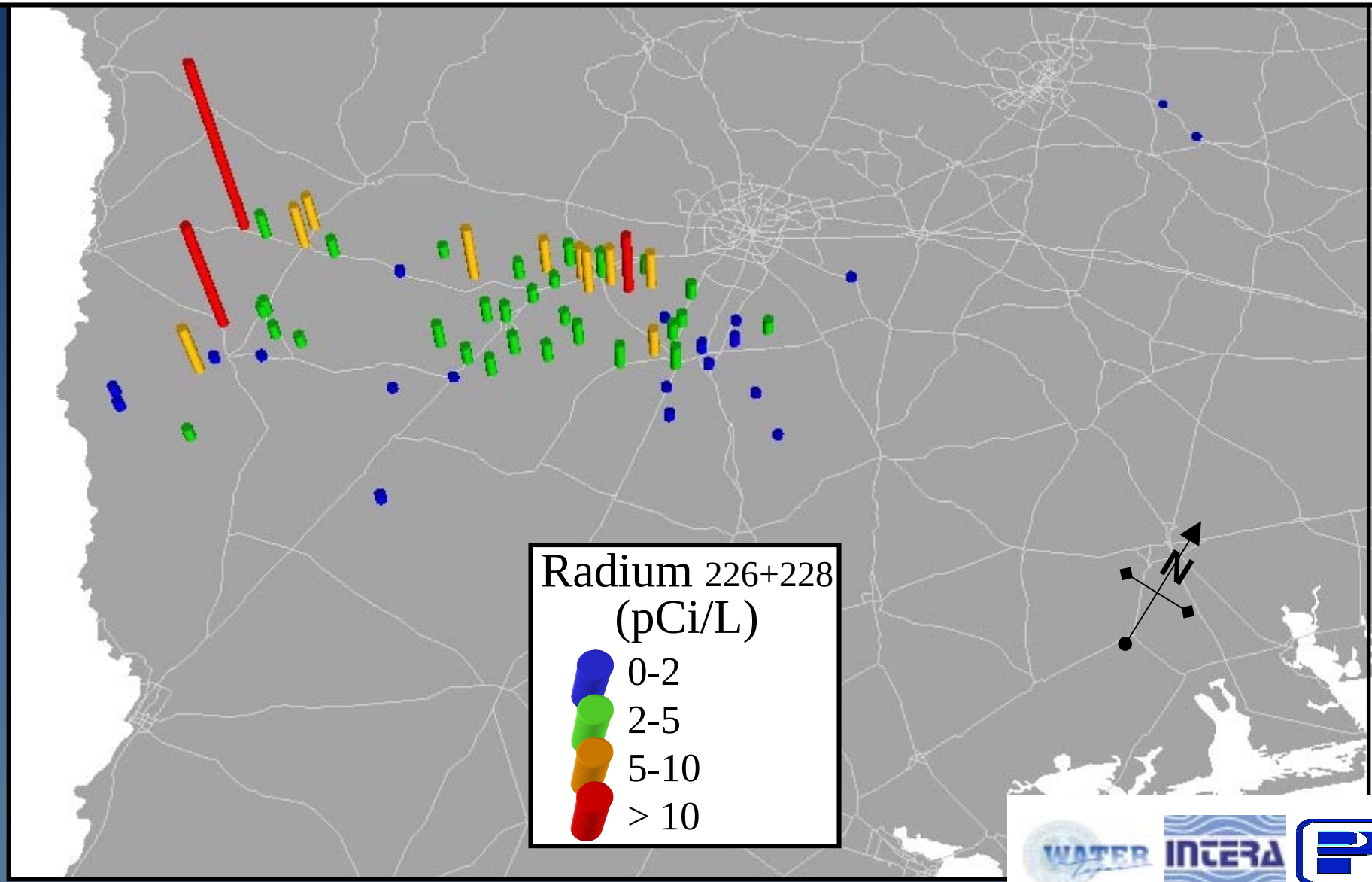
GOOD OR BAD?
Water Quality Screening Levels

- National Primary Drinking Water Regulations – legally enforceable standards to protect human health from contaminants in drinking water
- National Secondary Drinking Water Regulations – guidelines to prevent aesthetic effects (taste, odor, color), cosmetic effects (staining) in drinking water, and technical effects (corrosion, expense of treatment)
- Irrigation Water Supply
- Industrial Water Supply

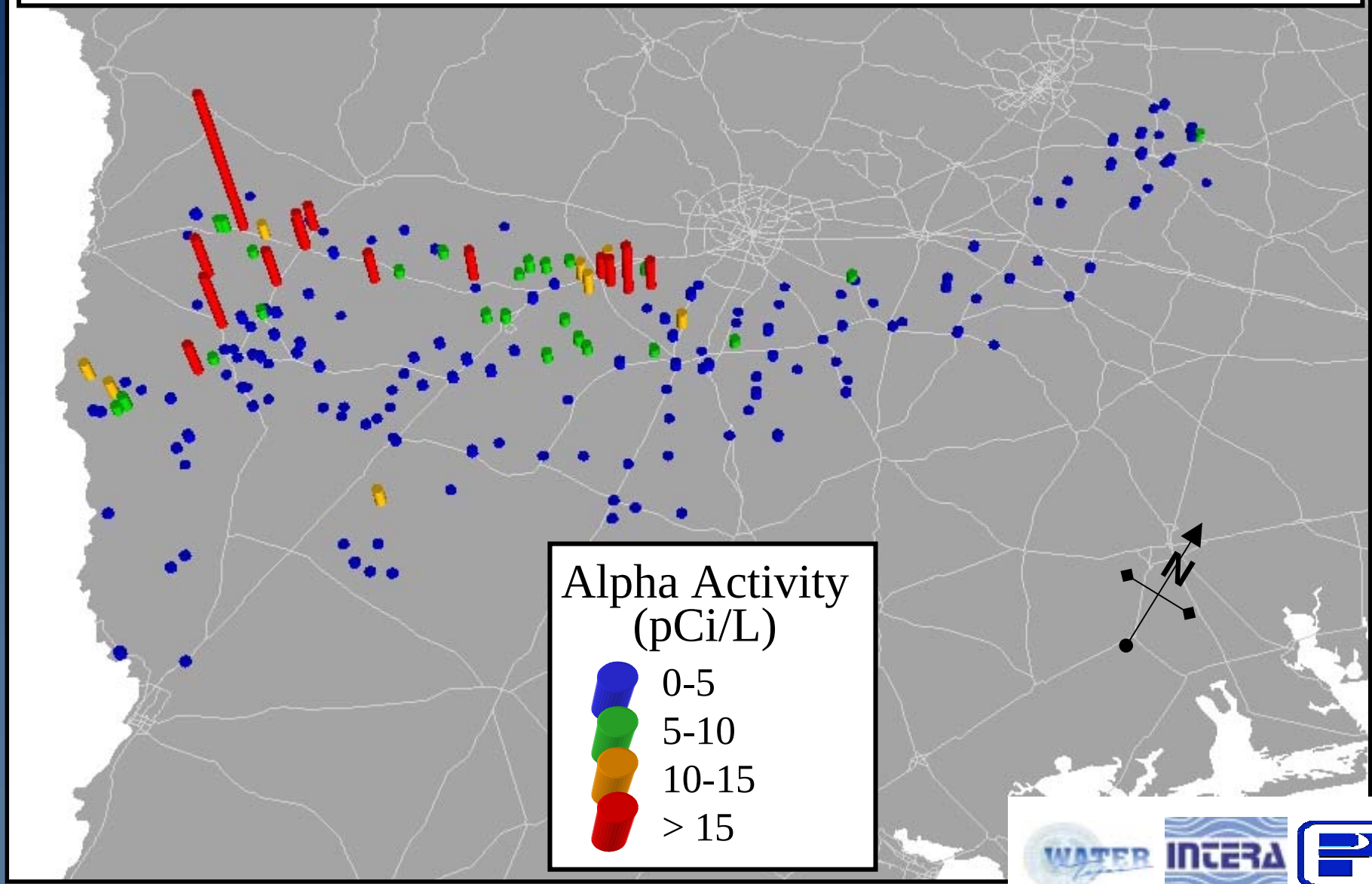
Selected Primary MCLs in the Southern Carrizo-Wilcox GAM Area

Water Quality Constituent	Wells Monitored	Screening Level	Wells > S.L.
Radium 226 + 228 Activity	66	5 pCi/L	20%
Alpha Activity	197	15 pCi/L	7.1%
Nitrate-Nitrogen	1521	10 mg/L	6.4%
Chromium	311	0.1 mg/L	1.0%
Arsenic	318	0.01 mg/L	0.6%
Selenium	319	0.05 mg/L	0.6%

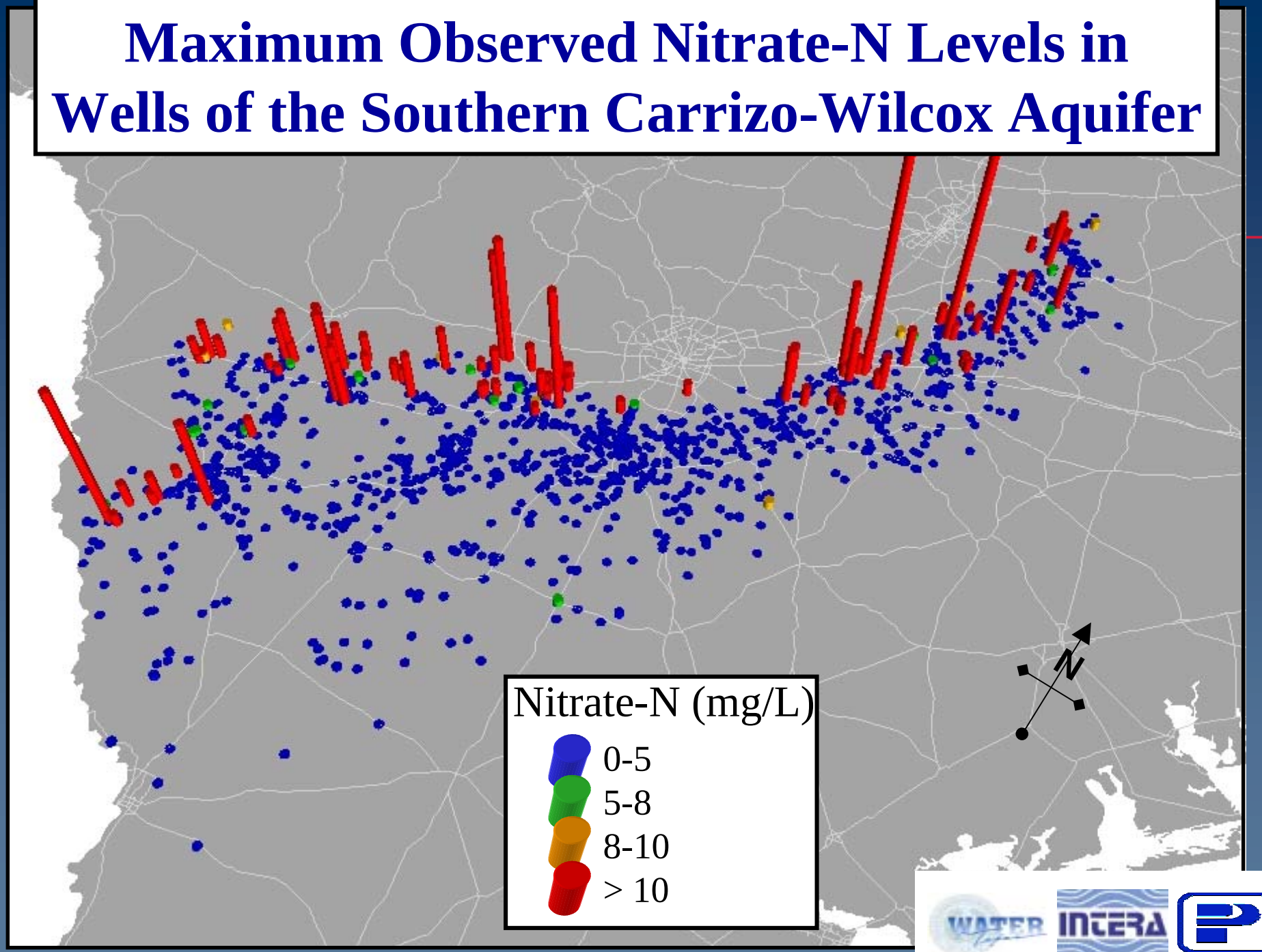
Maximum Observed Radium 226+228 Levels in Wells Of The Southern Carrizo-Wilcox Aquifer



Maximum Observed Alpha Activity Levels in Wells Of The Southern Carrizo-Wilcox Aquifer



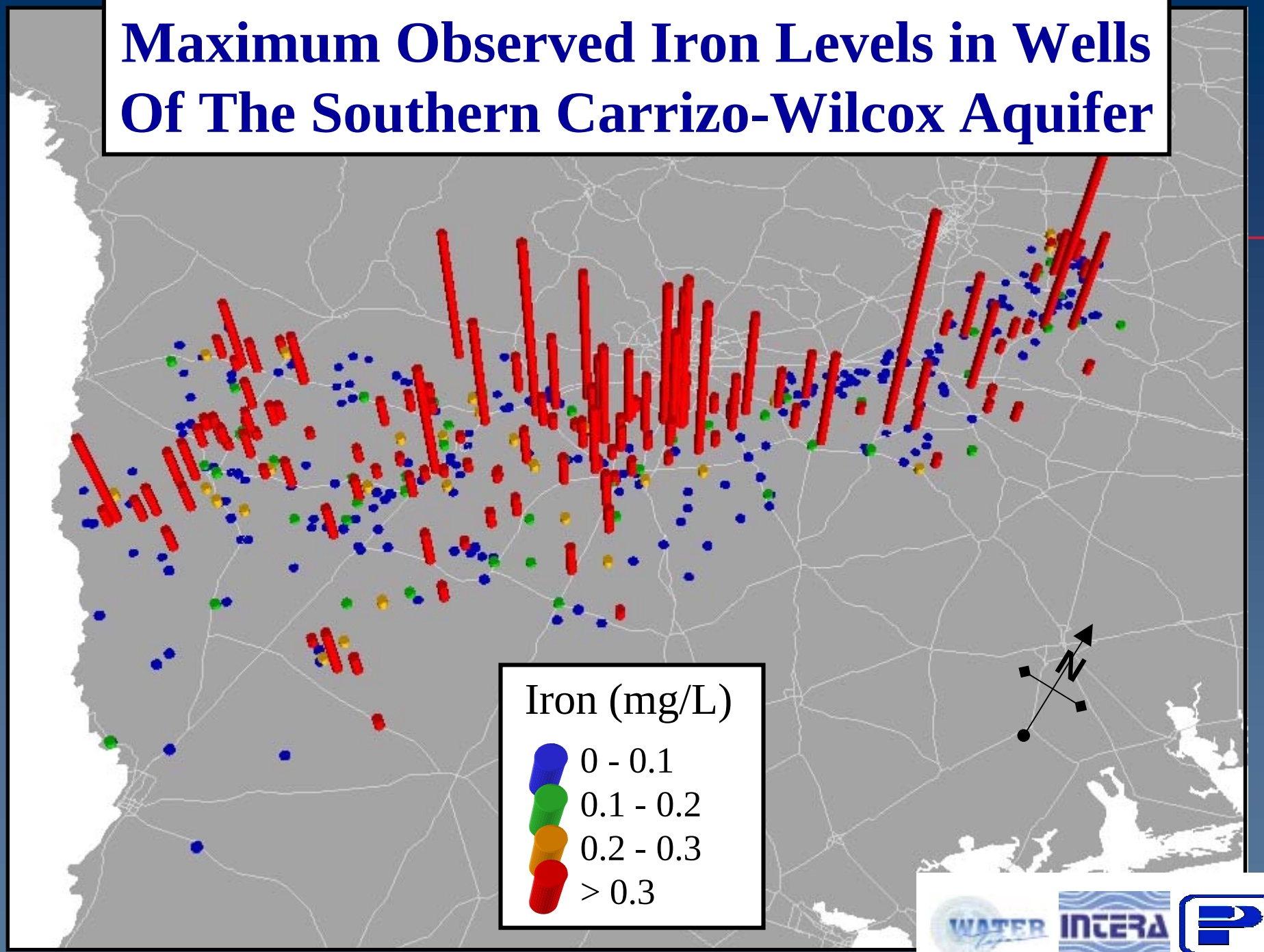
Maximum Observed Nitrate-N Levels in Wells of the Southern Carrizo-Wilcox Aquifer



Selected Secondary MCLs

Water Quality Constituent	Wells Monitored	Screening Level	Wells > S.L.
Total Dissolved Solids	1624	500 mg/L	44%
		1000 mg/L	17%
Iron	553	0.3 mg/L	31%
Manganese	387	0.05 mg/L	27%
Chloride	1659	250 mg/L	15%
Sulfate	1626	250 mg/L	11%
Fluoride	1442	2 mg/L	2.8%

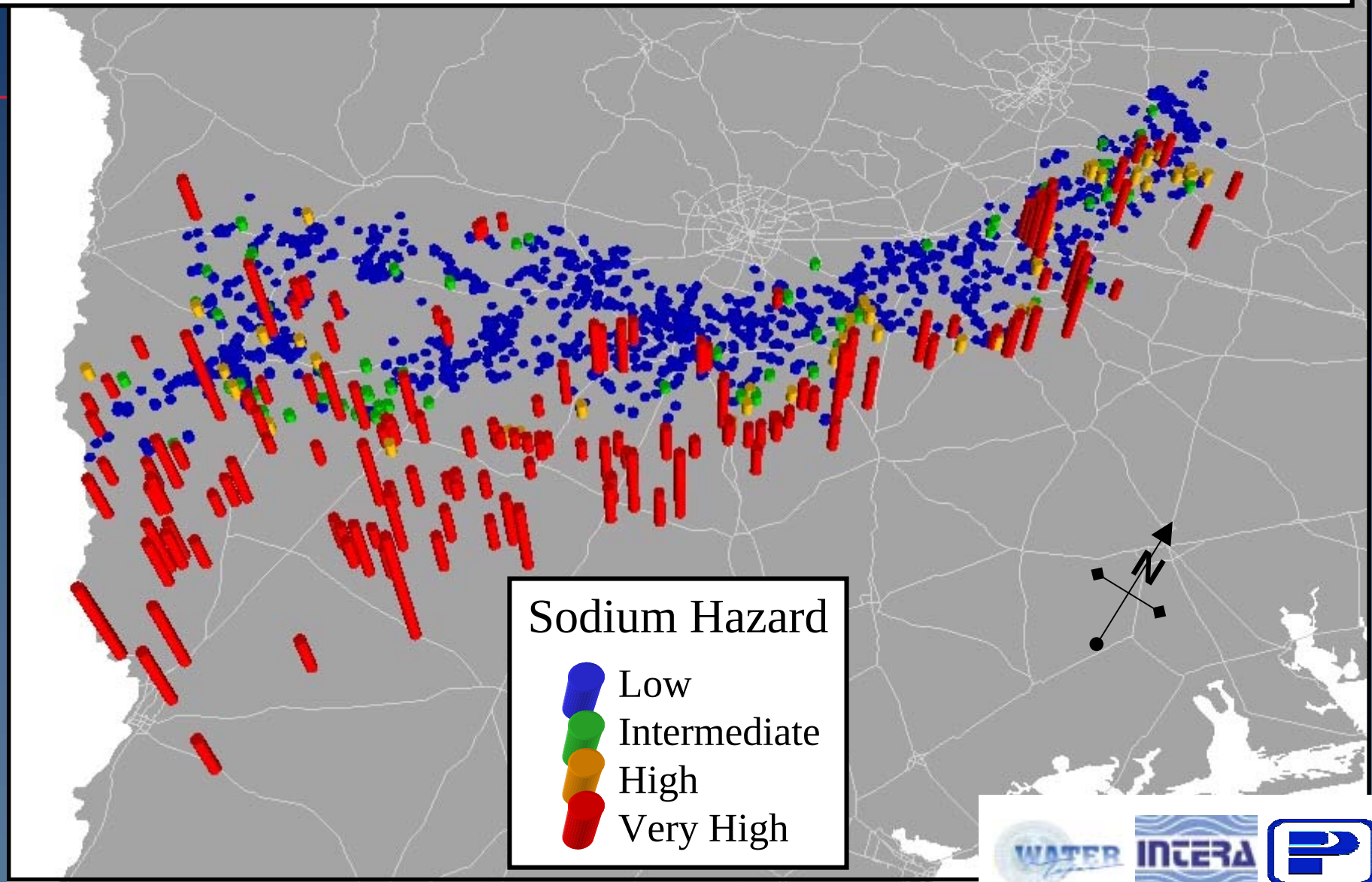
Maximum Observed Iron Levels in Wells Of The Southern Carrizo-Wilcox Aquifer



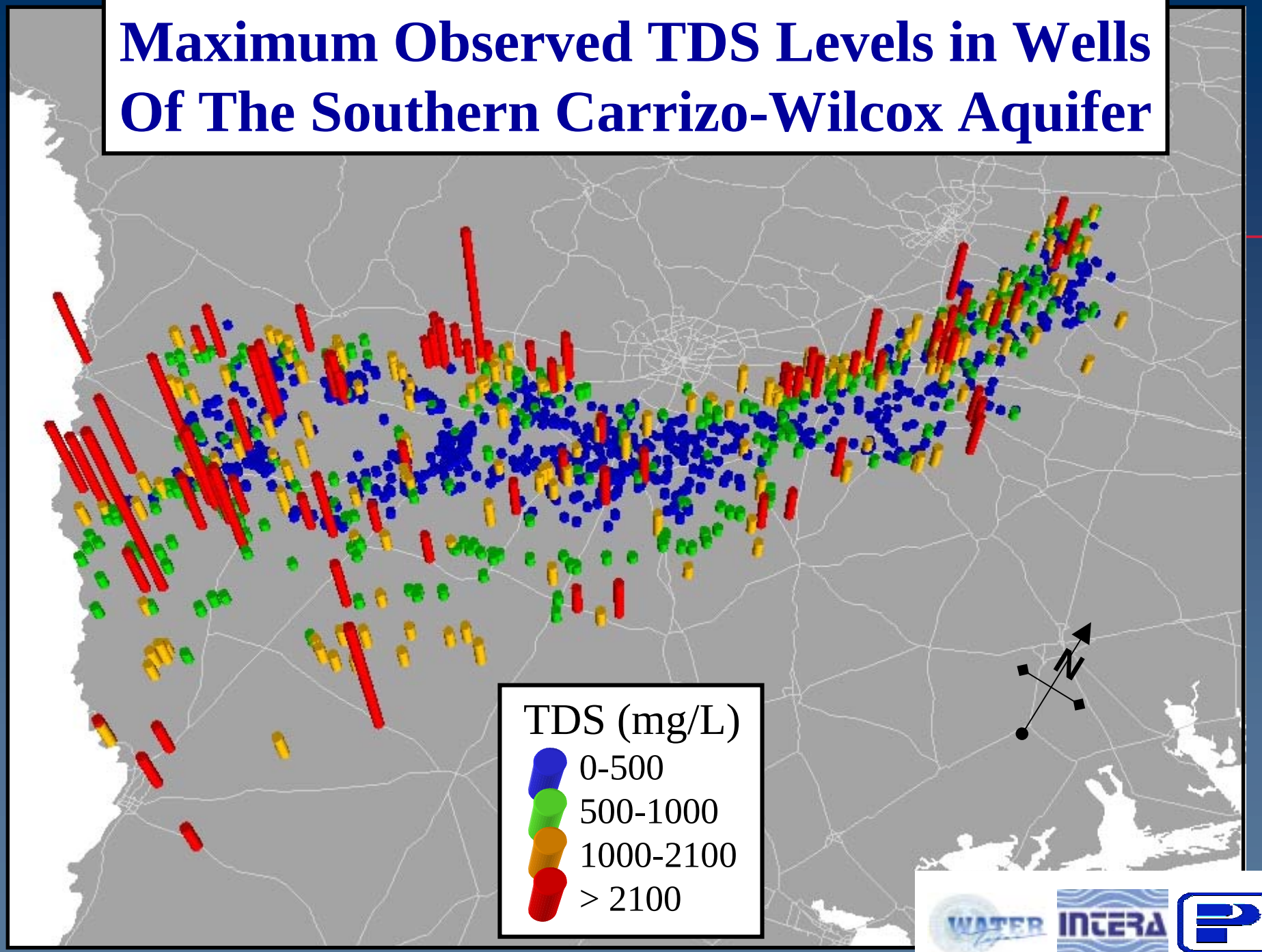
Southern Carrizo-Wilcox Irrigation Water Supply

Water Quality Constituent	Wells Monitored	Screening Level	Wells > S.L.
Salinity Hazard	1499	High	53%
		Very High	12%
Sodium Hazard	1596	High	17%
		Very High	14%
Total Dissolved Solids	1624	2100 mg/L	5.2%
Boron	575	2 mg/L	5.2%
Chloride	1659	1000 mg/L	2.4%

Maximum Observed Sodium Hazard Levels in Wells Of The Southern Carrizo-Wilcox Aquifer



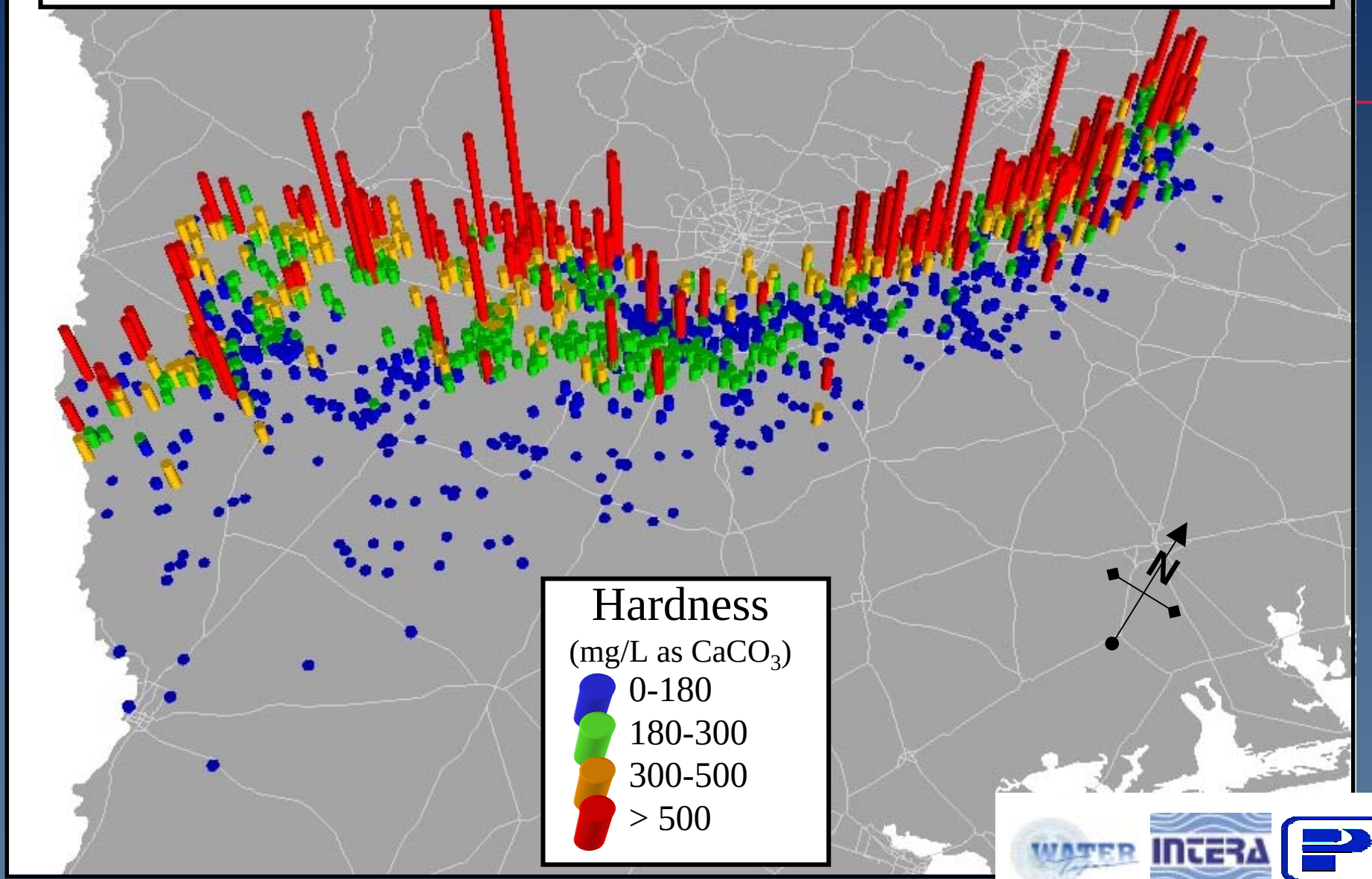
Maximum Observed TDS Levels in Wells Of The Southern Carrizo-Wilcox Aquifer



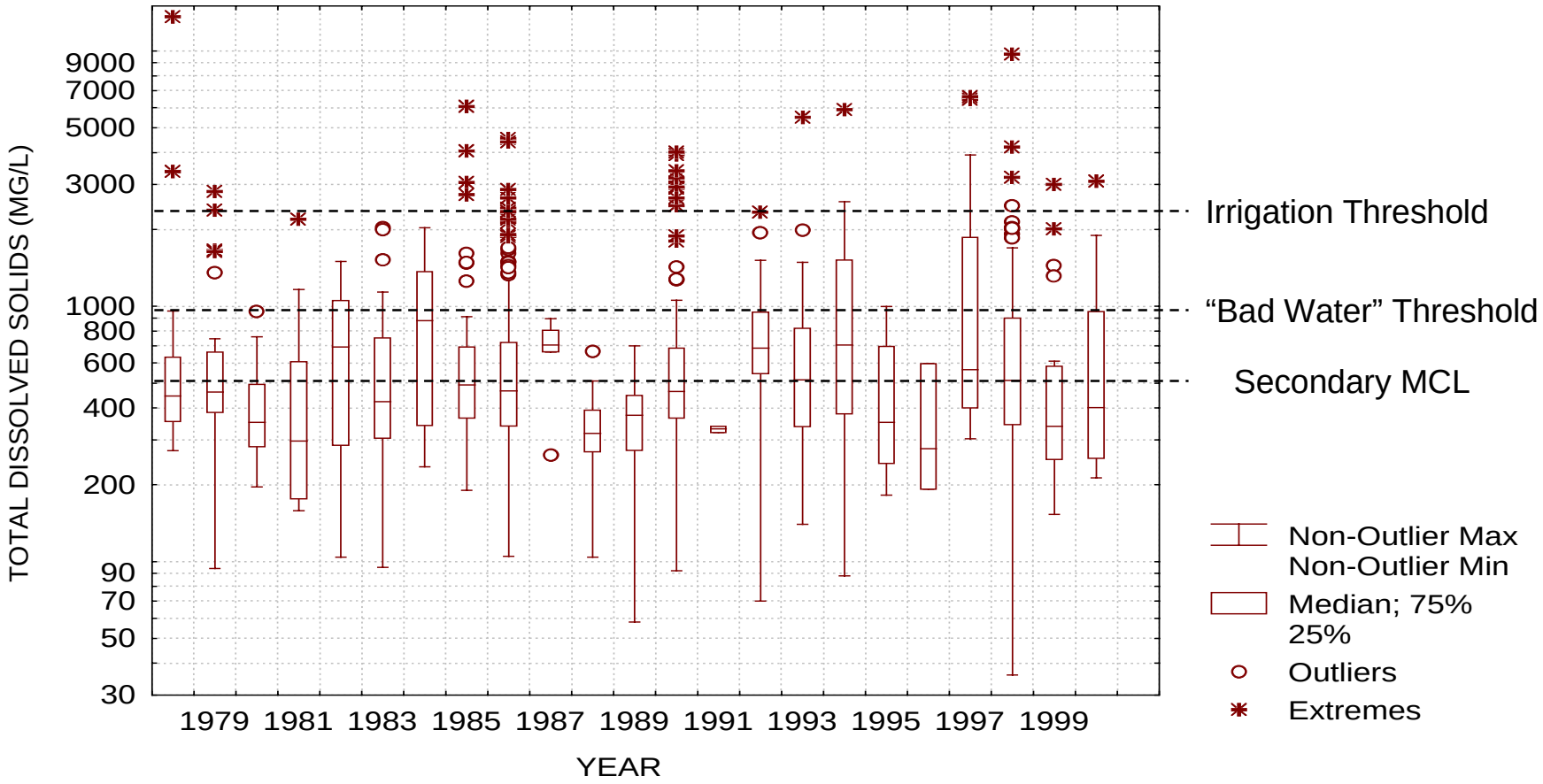
Southern Carrizo-Wilcox Industrial Water Supply

Water Quality Constituent	Wells Monitored	Screening Level	Wells > S.L.
Hardness (as $CaCO_3$)	1783	180 mg/L	50%
pH	1525	<6.5, >8.5	15%
Silica	1529	40 mg/L	9.1%

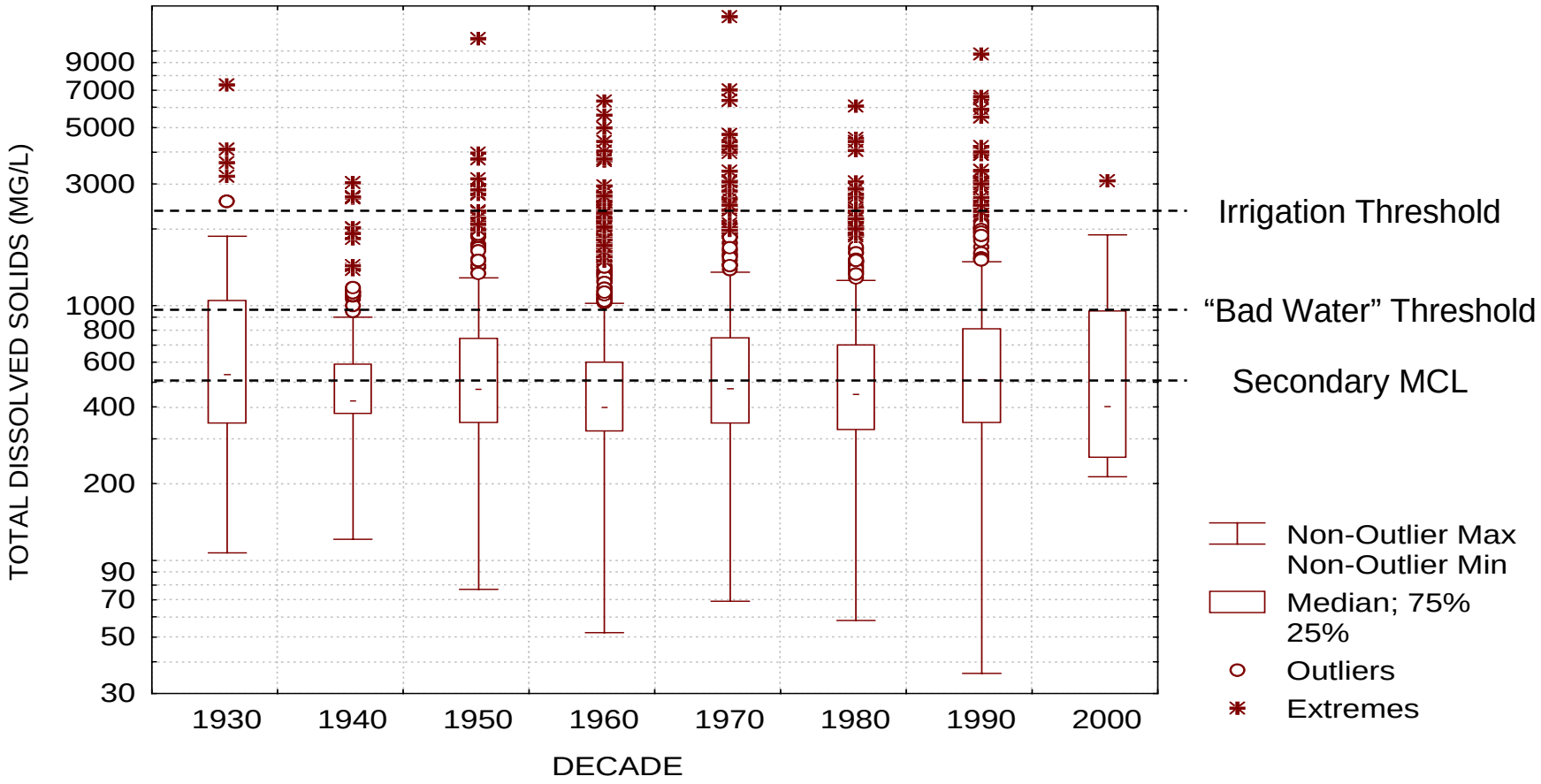
Maximum Observed Hardness Levels in Wells Of The Southern Carrizo-Wilcox Aquifer



Recent Trends in TDS Levels in the Southern Carrizo-Wilcox Aquifer



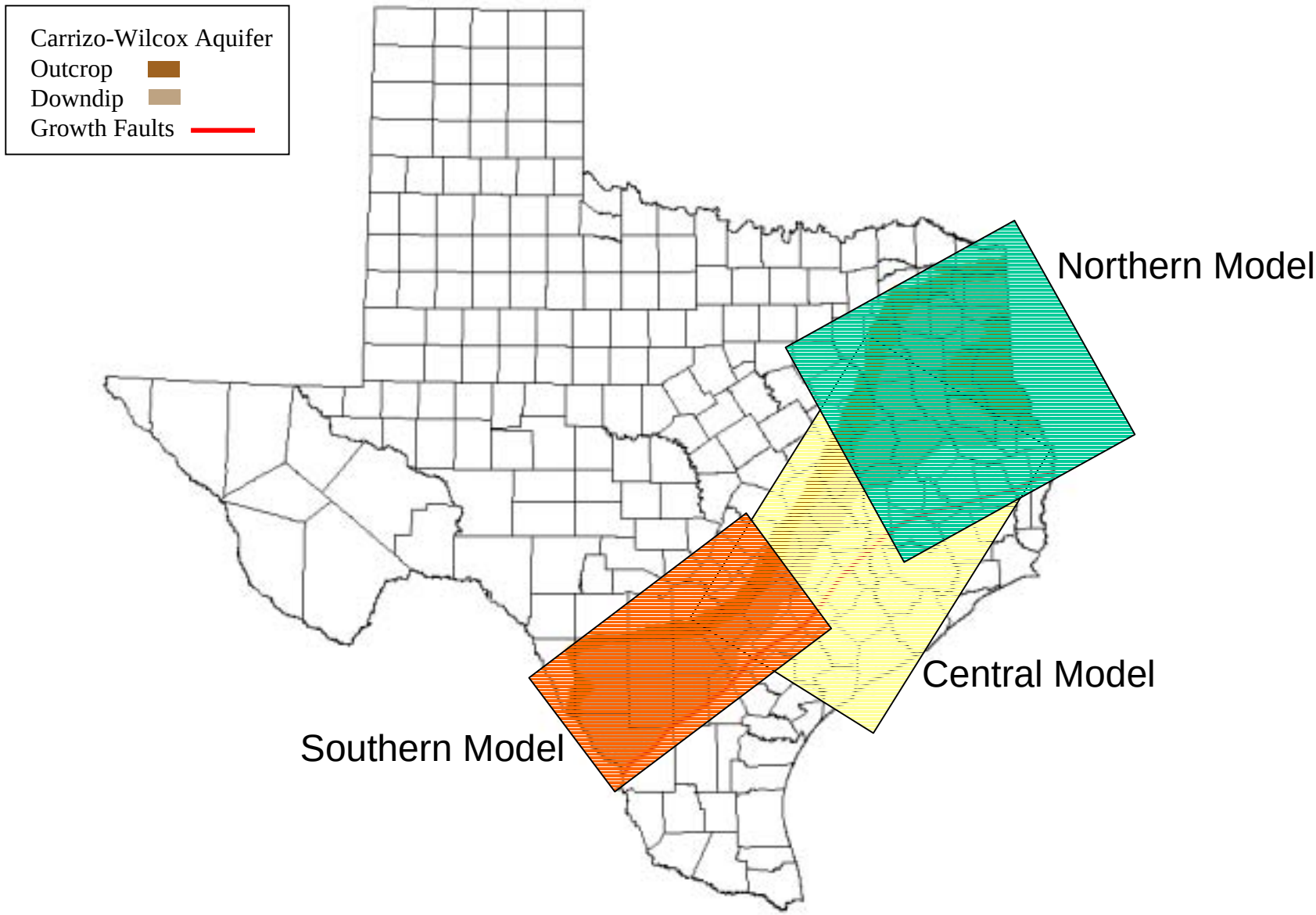
Long-Term Trends in TDS Levels in the Southern Carrizo-Wilcox Aquifer



Presentation Outline

- The INTERA – DE&S Connection
- Introduction to GAM
- Approach to Groundwater Pumping Allocation in the GAM
- Water Quality Evaluations
- Modeling Approach and Progress
- Topics Planned for Next SAF

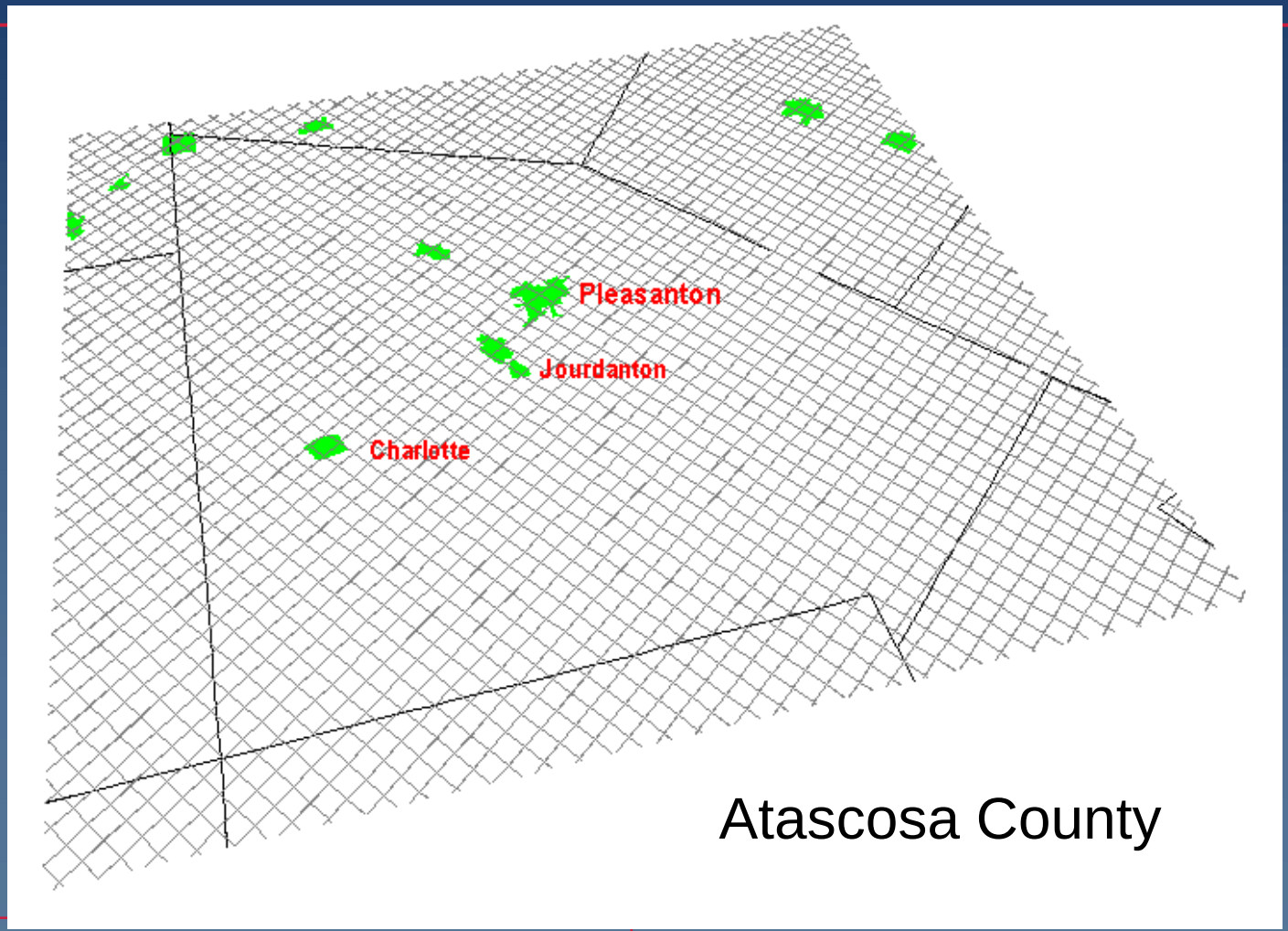
Carrizo-Wilcox GAM Model Domains



Model Specifications

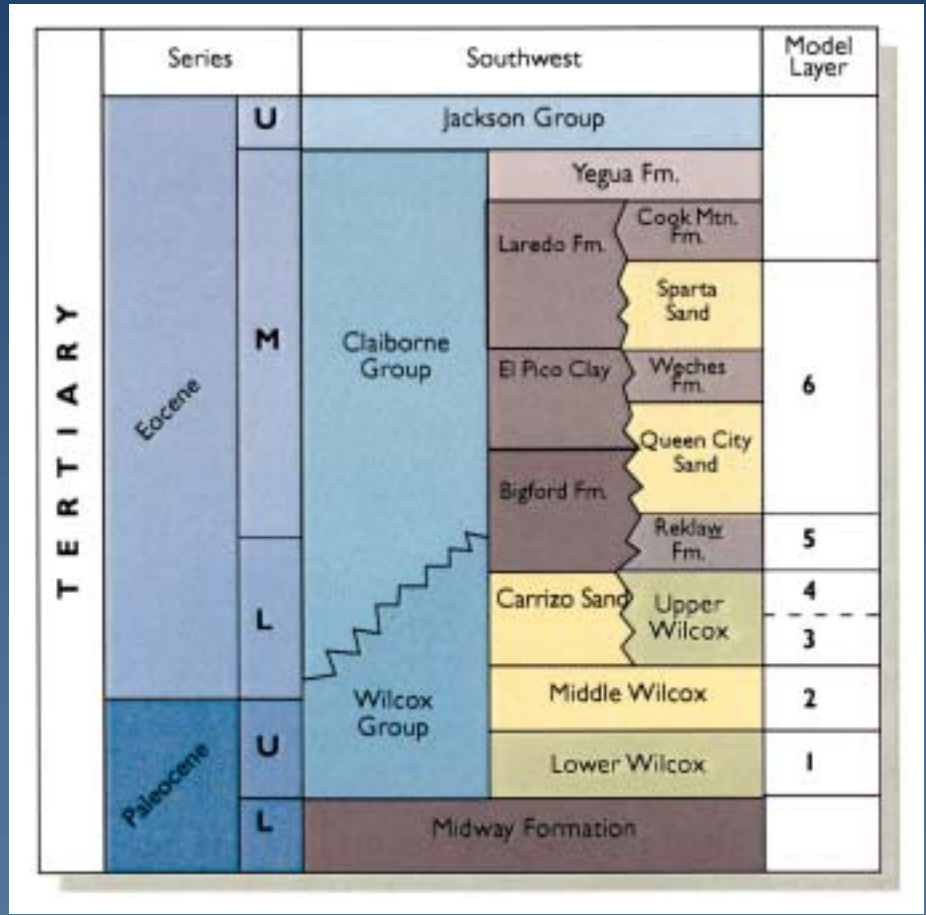
- Three dimensional (MODFLOW-96)
- Regional scale (1000's of mi2)
- Include Groundwater/surface water interaction (Stream routing, Prudic 1988)
- Properly implement recharge via factors
- Grid spacing of 1 square mile
- Stress periods as small as 1 month
- Calibration to within 10% of head drop

Model Grid Scale

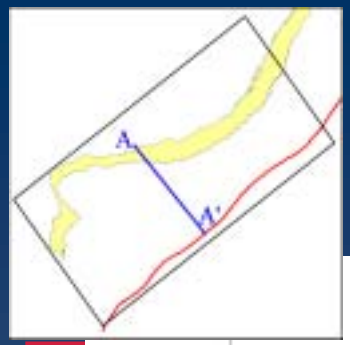


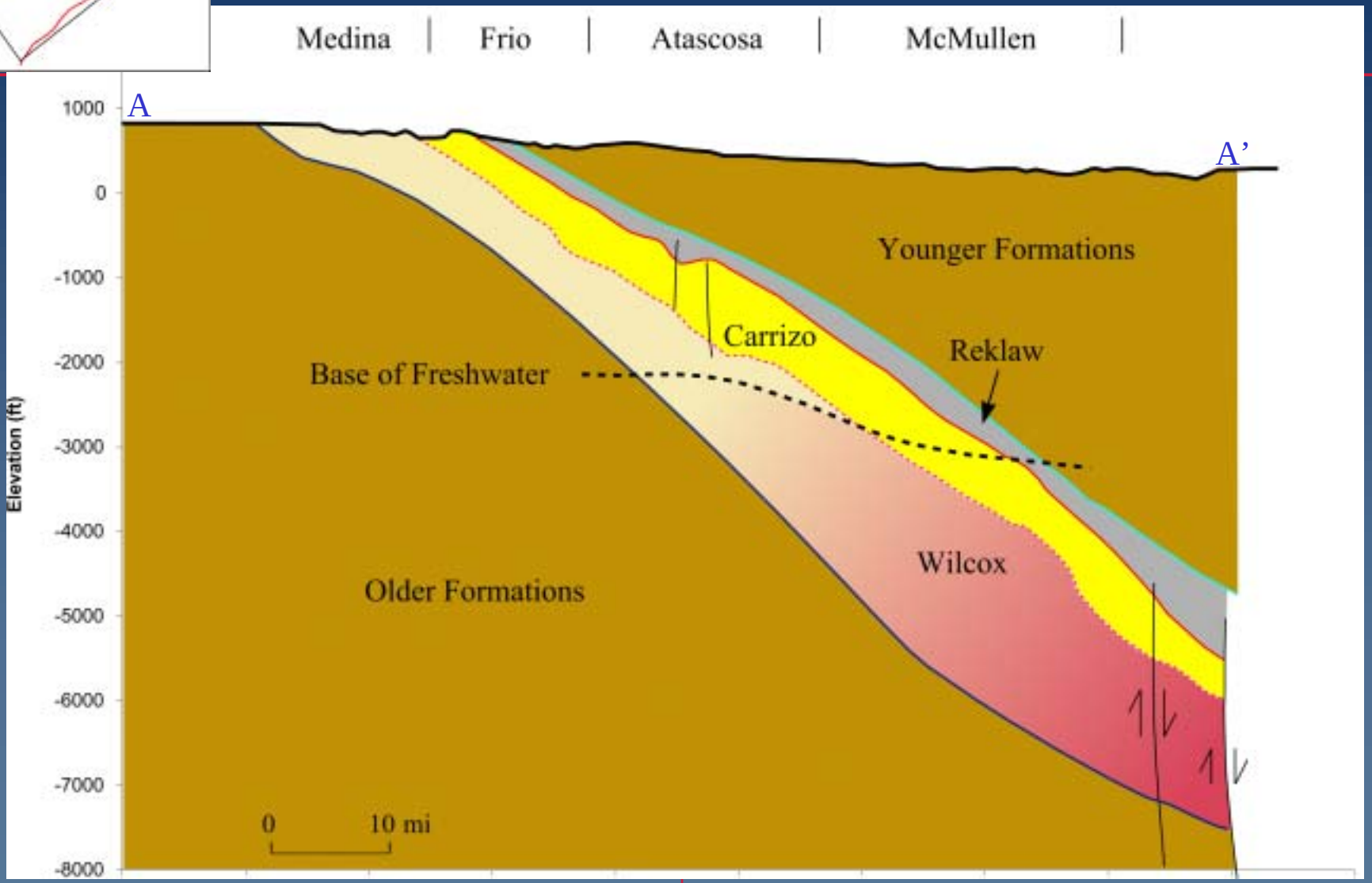
Model Layers

- Total of six layers
  - Carrizo
  - Upper, Middle and Lower Wilcox
  - Reklaw: major confining unit
  - Shallow aquifers above Reklaw
- West of Frio River:
  - Reklaw → Bigford Fm.
  - Queen City/Weches → Bigford/El Pico
  - Sparta → Laredo Fm.



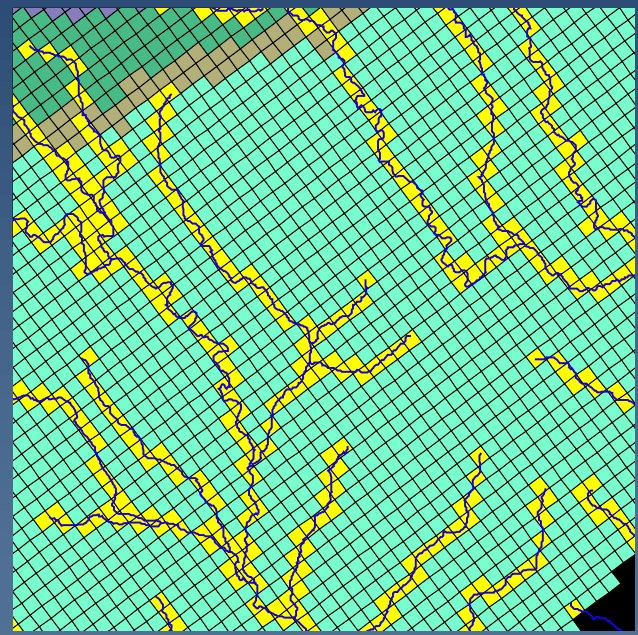
Carrizo-Wilcox Aquifer Down-dip Boundary





Pre-Development Model – Initial Results

- Initial approach:
  - Models streams with drains
    - drain elevation is set at stream elevation
    - assumes streams are gaining streams
  - Use homogeneous properties
  - SWAT Recharge estimates
- Use this simpler model to:
  - Refine boundary conditions
  - Determine parameter sensitivities



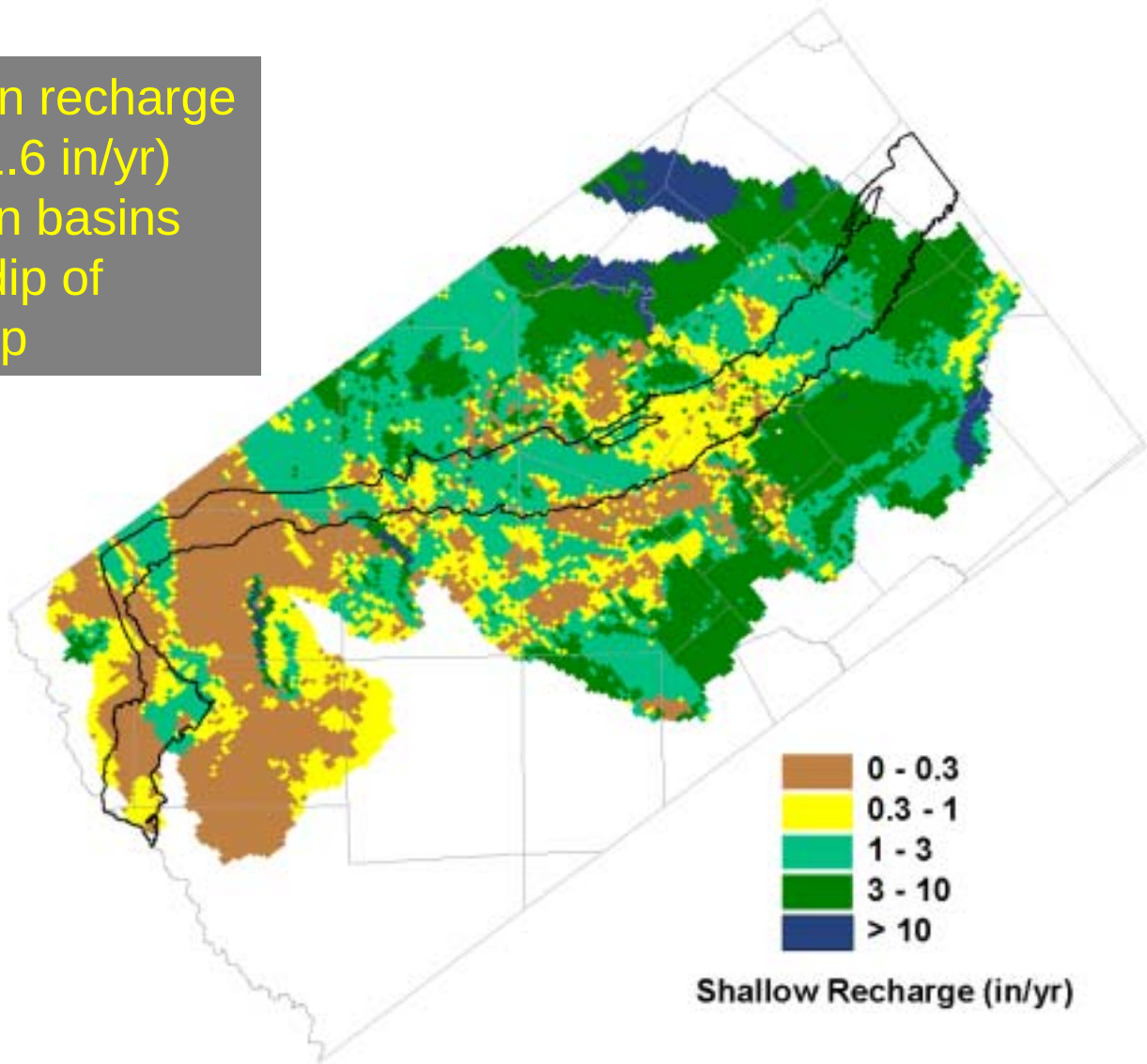
Streams are discretized unto The model grid

Homogeneous Properties

Model Layer	Horiz. K (ft/d)	Kh/Kv
Younger	6.6	1
Reklaw	0.5	100
Carrizo	26	10
Upper Wilcox	1.4	100
Middle Wilcox	1.7	100
Lower Wilcox	0.8	100

SWAT Recharge Estimate

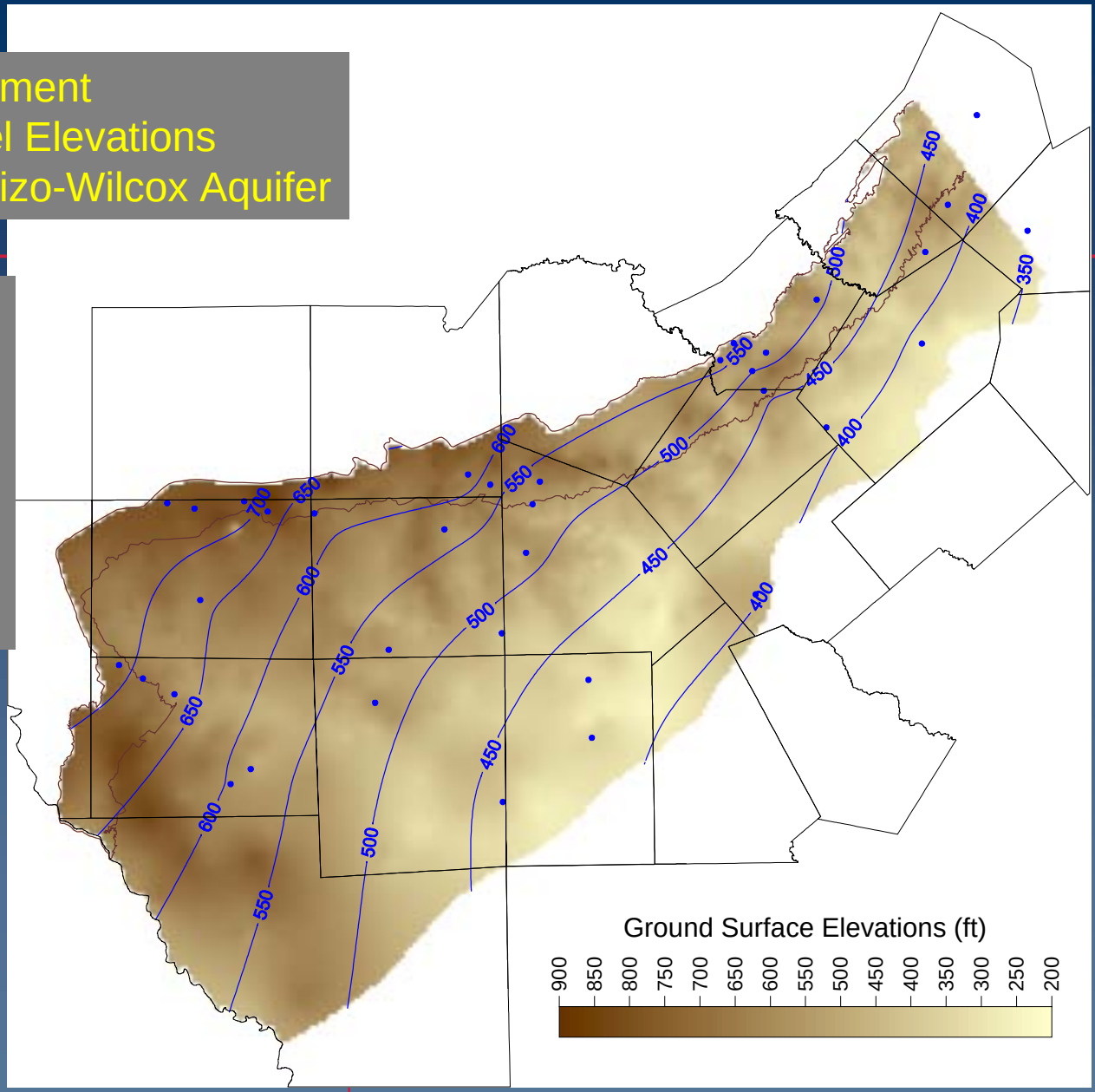
Median recharge rate (1.6 in/yr) used in basins downdip of outcrop



Predevelopment Water-Level Elevations for the Carrizo-Wilcox Aquifer

Levels based upon:

- First and/or maximum measured heads
- Reported areas where Carrizo wells flowed at ground surface in the past



GWVistas - [020226_top_bot_ibnd_drn.gwv]

File Edit View Add Plot Model Grid BCs Props XSect Window Help

Row Number: 11

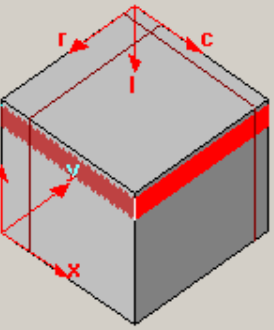
Column Number: 44

Layer Number: 1

Stress Period: 1

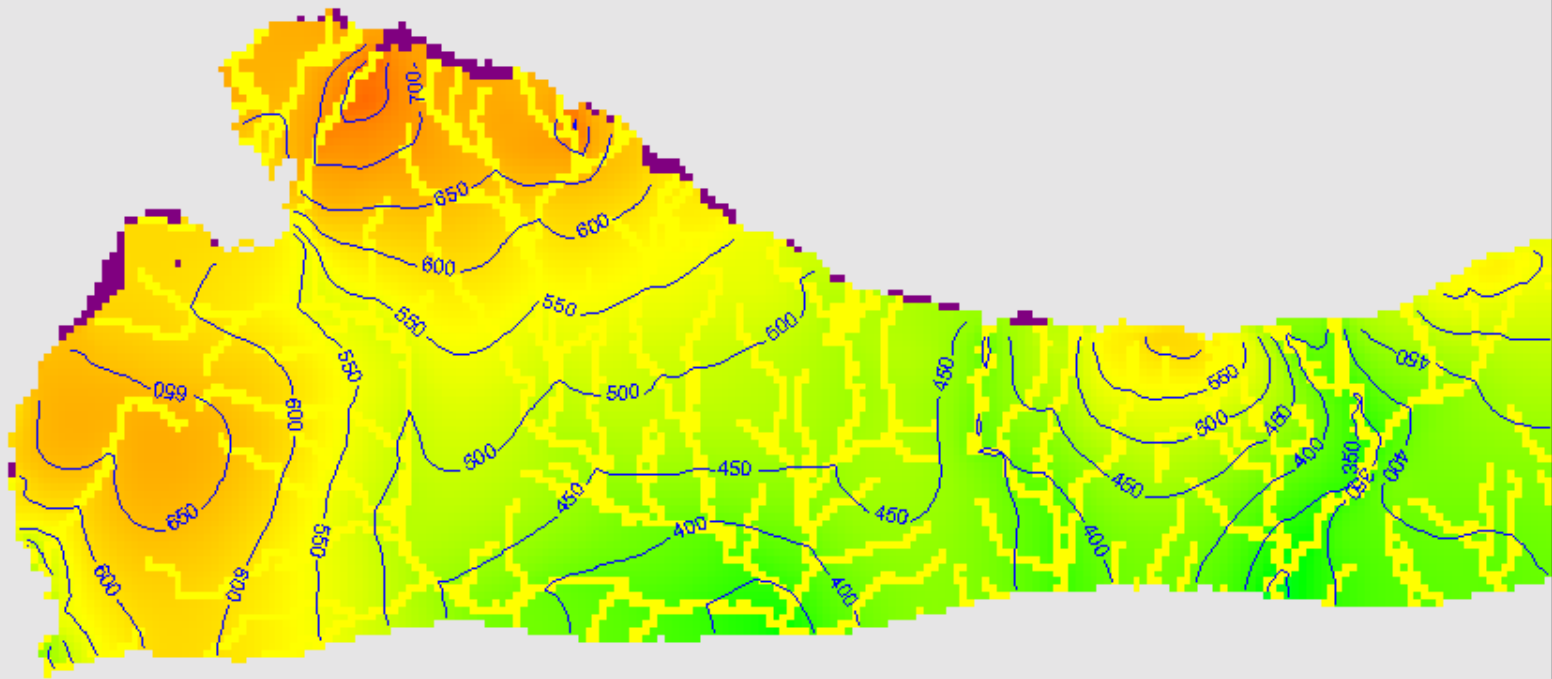
Component Number: 1

Figure Number: 1



Preliminary Results

Simulated Heads (ft) for Younger Sediments



Contour | Cross Section

For Help, press F1

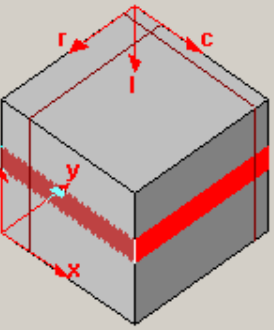
Grid R:1 C:1 L:4 4657099.67 18822243.3 NoFlow

Start 10:26 AM

GWVistas - [020226_top_bot_ibnd_drn.gwv]

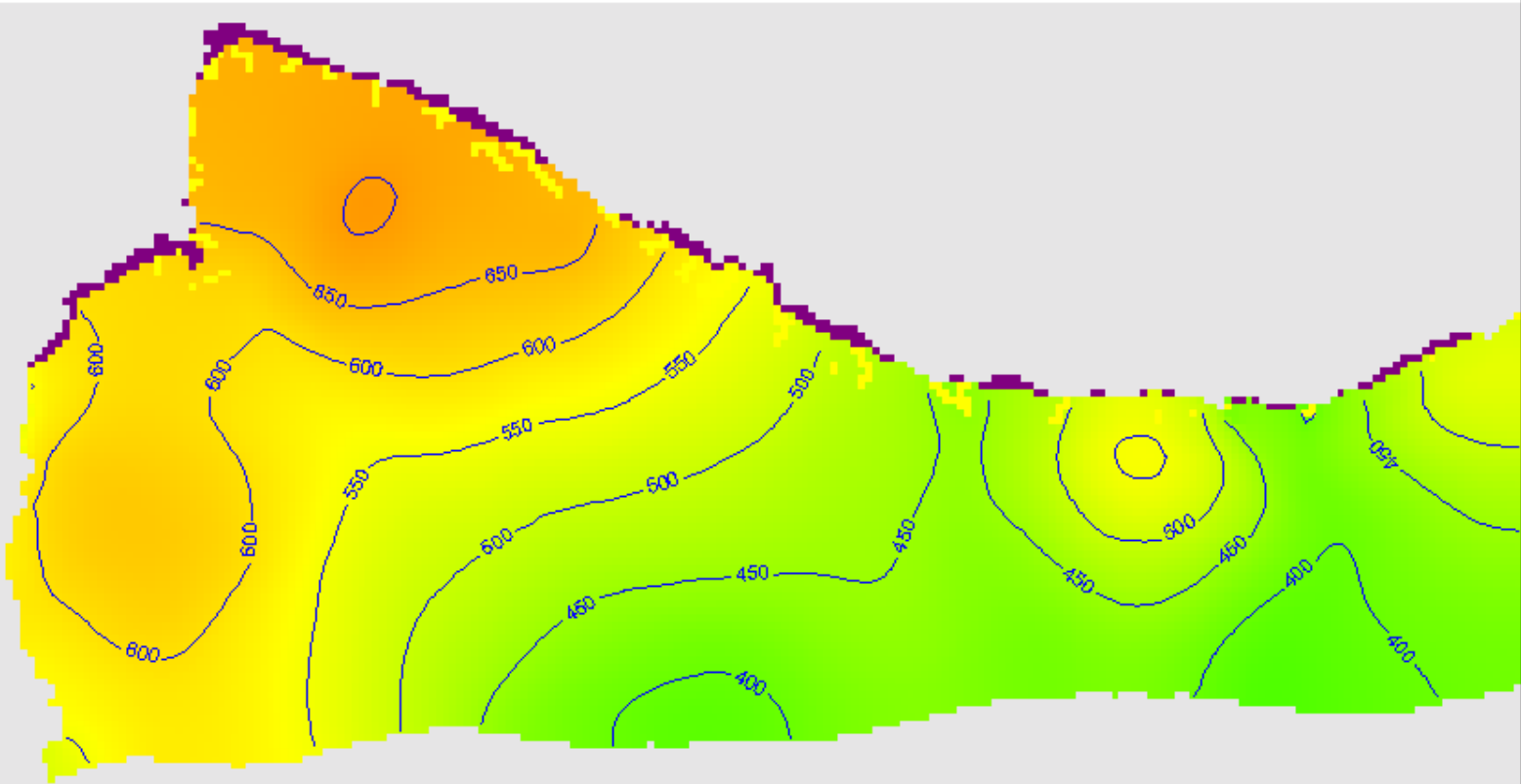
File Edit View Add Plot Model Grid BCs Props XSect Window Help

Row Number: 11
Column Number: 44
Layer Number: 3
Stress Period: 1
Component Number: 1
Figure Number: 1



Preliminary Results

Simulated Carrizo Heads (ft)



Contour | Cross Section

or Help, press F1

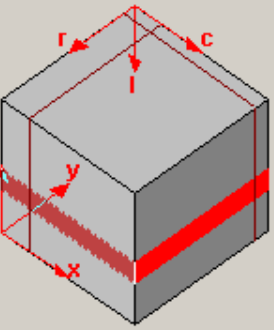
Grid R:18 C:79 L:3 5097637.8 18928049.3 NoFlow

Start 10:27 AM

GWVistas - [020226_top_bot_ibnd_drn.gwv]

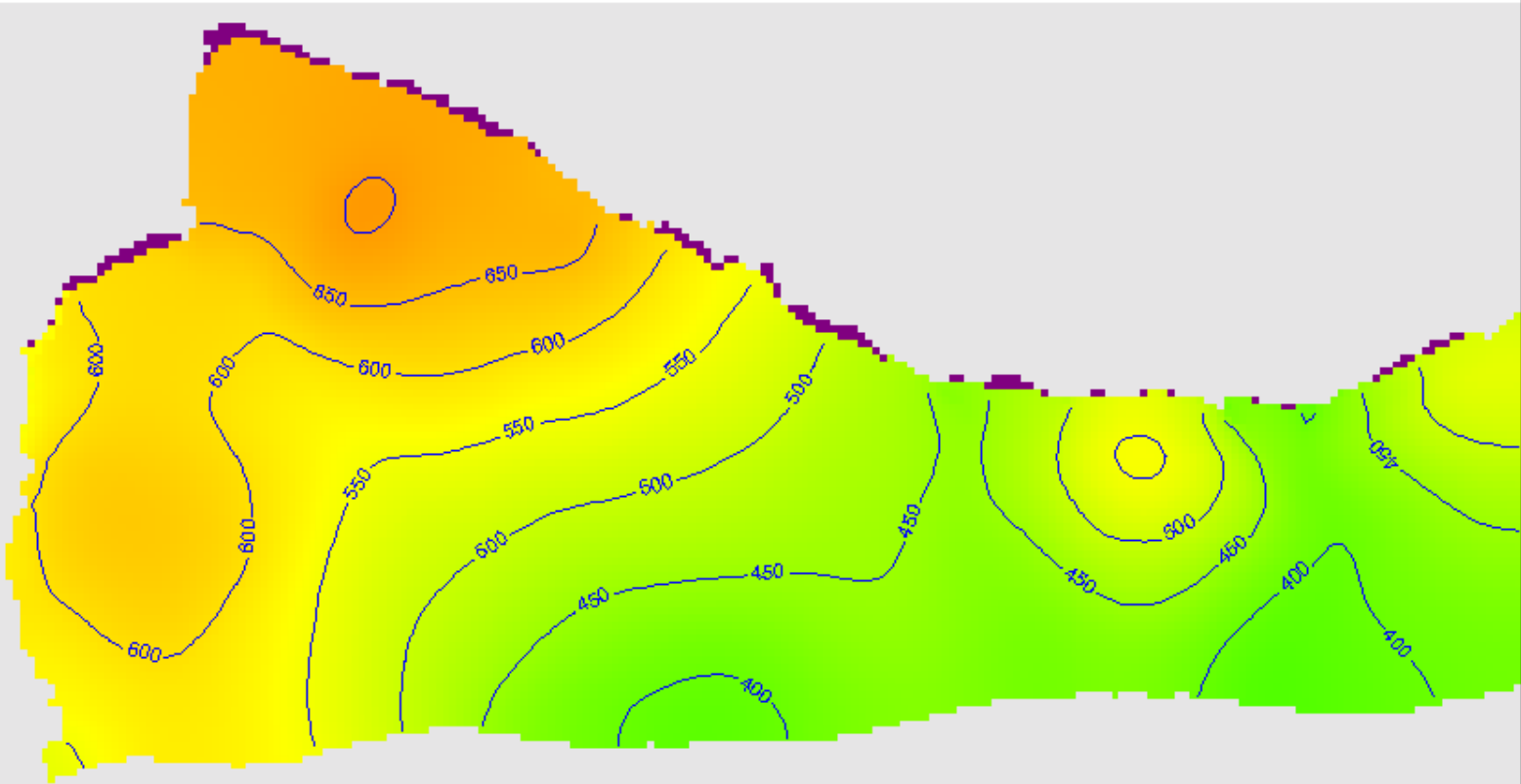
File Edit View Add Plot Model Grid BCs Props XSect Window Help

Row Number: 11
Column Number: 44
Layer Number: 4
Stress Period: 1
Component Number: 1
Figure Number: 1



Preliminary Results

Simulated Wilcox Heads (ft)



Contour | Cross Section

For Help, press F1

Grid R:1 C:50 L:4 4893476.05 18942026.5 NoFlow

Start 10:27 AM

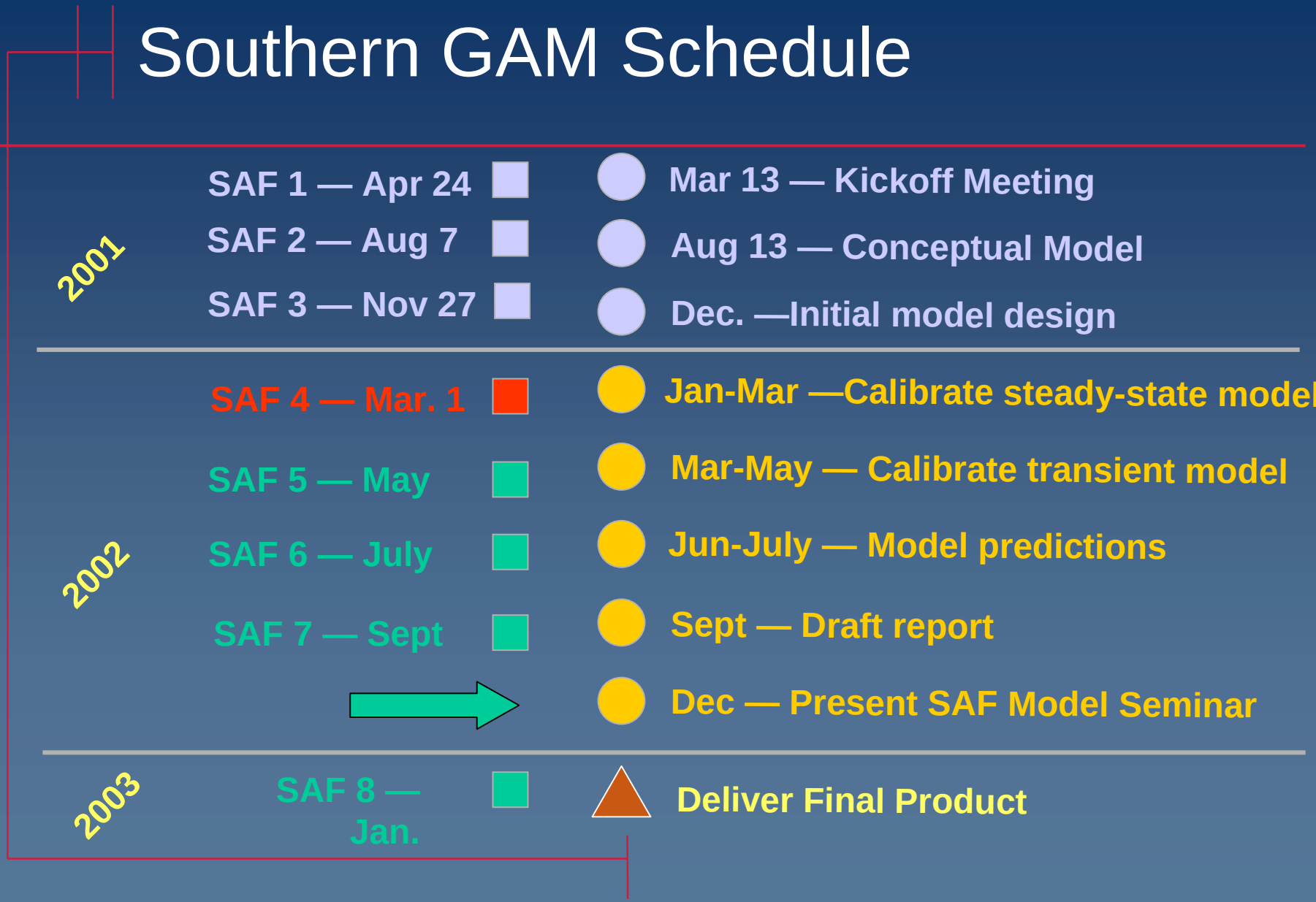
Pre-development – In progress

- Refining hydraulic parameters:
  - Heterogeneity based on aquifer test data
  - Heterogeneity based on net sand for Carrizo-Wilcox
- Implementing steady state stream routing
  - Use average streamflows in the MODFLOW stream-routing package based on EPA RF1 data set

Expected SAF-5 Discussion

- Steady-state model calibration
- Transient model parameterization
- Preliminary transient model calibration
- Stream flow routing

Southern GAM Schedule



Thank You

- www.twdb.state.tx.us/GAM

Meeting Minutes for the

Fourth Southern Carrizo-Wilcox Groundwater Availability Model (GAM) Stakeholder Advisory Forum (SAF) Meeting

March 1, 2002

Evergreen Underground Water Conservation District

Pleasanton, Texas

The fourth Stakeholder Advisory Forum (SAF) Meeting for the Southern Carrizo-Wilcox Groundwater Availability Model (GAM) was held on March 1st, 2002 at 1:30 PM at the Evergreen Underground Water Conservation District Offices in Pleasanton, Texas. Attachment A of these meeting minutes provides a list of all participants who signed up as attending the meeting.

The purpose of the fourth SAF meeting was to review the GAM objectives and expectations, present the approach used to allocate pumping, present the results from water quality evaluations, and to present the model development progress since the last meeting,. The presentation material is available at the TWDB GAM website (www.twdb.state.tx.us/gam).

Meeting Introduction: Edward Angle, TWDB

The meeting was initiated by Edward Angle of the Texas Water Development Board (TWDB). Mr. Angle announced that there will be upcoming SAF meeting pertaining to new GAM projects that will be contracted later in 2002 for several minor aquifers. He noted that the Queen City/Sparta aquifer GAM could be of particular interest to stakeholders for the in the Carrizo-Wilcox aquifer.

Mr. Angle then introduced the speakers of the day, Van Kelley of INTERA Inc., Project Manager for the Southern Carrizo-Wilcox GAM, Art Whallon of Parsons, who is task manager on pumping allocation, and Kirk Dean of Parsons, who is task manager on water quality evaluations.

SAF Presentation: Van Kelley (INTERA), Art Whallon (Parsons), and Kirk Dean (Parsons)

After the introduction by Mr. Edward Angle, members of the Southern Carrizo-Wilcox Team presented a prepared presentation. The presentation was structured according to the following outline:

1. The INTERA – DE&S Connection – Van Kelley
2. Introduction to GAM - Van Kelley
3. Approach to Groundwater Pumping Allocation in the GAM – Art Whallon
4. Water Quality Evaluations – Kirk Dean
5. Model Approach and Progress – Van Kelley

6. Topics Planned for the Next SAF Meeting – Van Kelley

The presentation is available on the GAM website (*www.twdb.state.tx.us/gam)*.

Questions and Answers: Open Forum:

Q. Did point source irrigation well data match the land use data base information?

A. Not always. When available we have used irrigation well locations where they match the irrigation survey data available.

Q. Isn't irrigation a part of the database?

A.: Yes, but point source locations are not always available.

Q. If the well screen depth is not known, how do you assign a screen depth?

A. We use the screen depths of nearby wells to assign the screen depth for wells which do not have screen depths.

Q. Doesn't the water quality data show a concentration bias of radium in certain areas?

A. Yes. An example can be seen comparing radium and alpha concentrations which are higher southwest and west of San Antonio.

Q. Are all of the charts presented today available at the website address provided in your presentation?

A: Yes.

Q. What value is used for stream bed conductance in the stream routing package? We have some losing streams in the Evergreen model (based on the LBG-Guyton/HDR 1998 model).

A. I am not positive what the actual value of conductance being assumed. However, our initial estimates are based upon the conductance of the underlying formation. There are no real data available for a priori estimation of conductance. For the steady-state model, we are employing the RFI 1 files. The stream conductances will be varied during calibration to match stream flows/stages.

Q. Atacosa, San Miguel and Leona Creeks have gone dry during summers. In that area, there is a WWTP discharge permit of 1 MGD, which may be increased up to 2.5 MGD. Have you thought of adding that to the GAM? It may not be significant to the model.

A. We are attempting to consider significant diversions.

Q. Is the GAM taking into account variations in available water introduced to the area?

A. Yes, based on precipitation and stream flows into the model area. SWAT accounts for precipitation variation and land use/land cover. SWAT provides estimates of shallow areal recharge. With the drier basins, there is little areal recharge to the model. Some of

the areal recharge will exit through the streams. Stream bed recharge will be handled in with the stream routing package. Both methods of recharge estimation will account for changes in aquifer conditions on percolation. Estimates in areal recharge could require adjustment during calibration. Likewise, stream bed conductance will require adjustment during calibration.

Q. Is the 1.6 in/year median recharge number greater than current pumping levels?

A. I cannot currently relate the recharge number to area wide pumping estimates until the pumping allocation task is complete.

Q. Are there a lot of contaminants at outcrop?

A. Some constituents concentrations derive from natural interaction between the groundwater and the aquifer materials. For these constituents, we could expect concentrations to increase with depth. However, nitrate is a good example of an anthropological constituent which could have higher concentrations in the outcrop.

ATTACHMENT A - SIGN-UP SHEET

Southern Carrizo-Wilcox Aquifer
Groundwater Availability Modeling (GAM)
4th Stakeholder Advisory Forum

March 1, 2002
Evergreen UWCD, Pleasanton, Texas

Name	Affiliation	Contact Information (including email address, if available)
Barry Miller	Gonzales Co. UWCD	
Tony Mailk	City of Stockdale	stockdal@felpsis.net
Larry French	URS	
Galylon Click	Wilson County Water Action Project	
Robert Gresham	Mid East Texas	Rgresham@BUCOG.org
Richard Hay	Center for Water Supply Studies	rhay@falcon.tamucc.edu
Steve Snider	Evergreen WCD	
Kenneth Stevens	Evergreen WCD	
James Beach	LBG-Guyton and Assoc.	jbeach@lbg-guyton.com

Name	Affiliation	Contact Information (including email address, if available)
Paul Bordovsky	Evergreen WCD	Box 291, Karnes City, 78118
Clarence Littlefield	Southwest Engineering	
John Burke	Aqua Water	
Steve Raabe	SARA	(210) 302 3614 ; sraabe@sara-tx.org