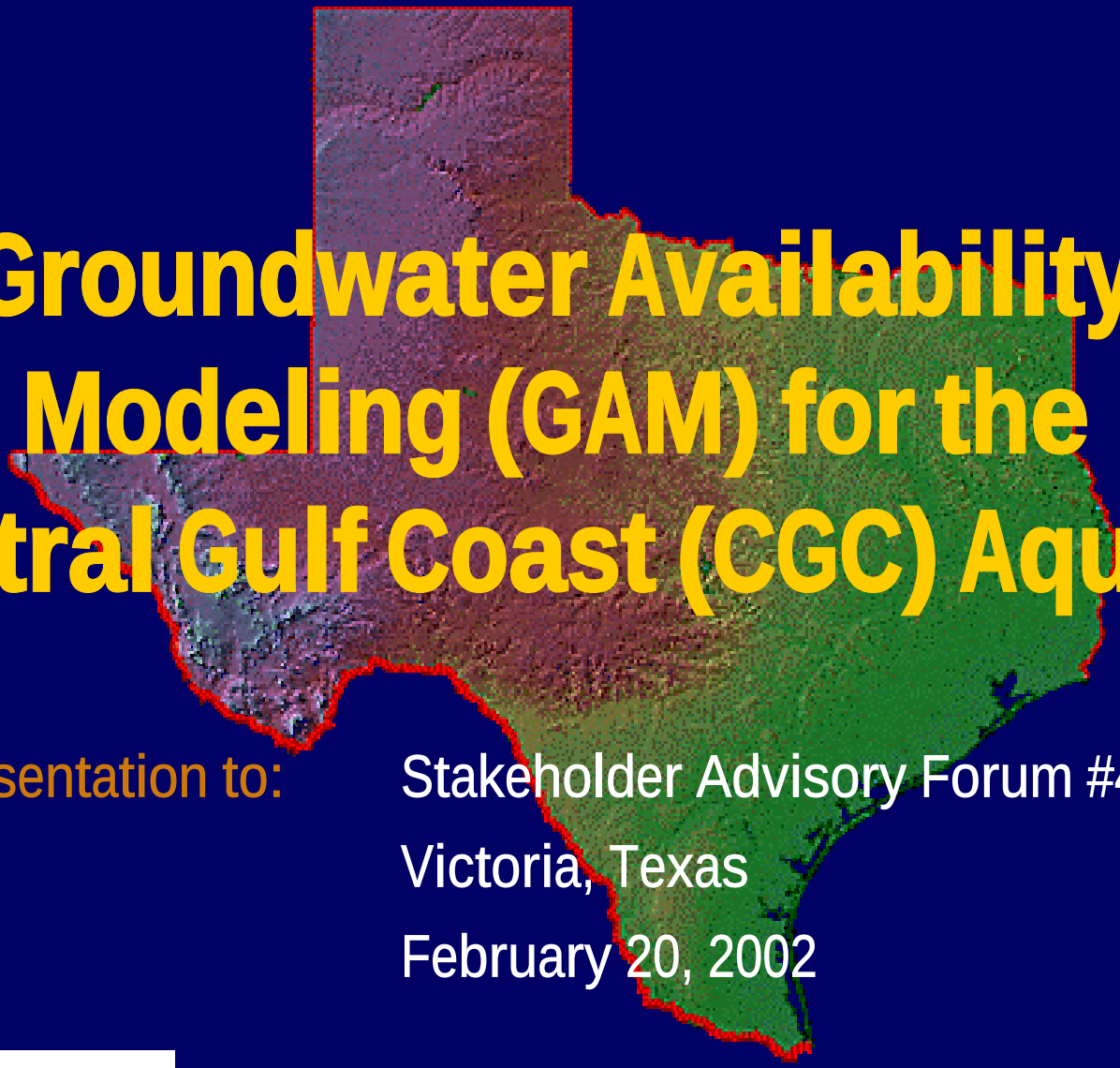
Groundwater Availability Modeling (GAM) for the Central Gulf Coast (CGC) Aquifer



A Presentation to: Stakeholder Advisory Forum #4

Victoria, Texas

February 20, 2002

WATERSTONE
Environmental Hydrology and Engineering, Inc.

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INTERA

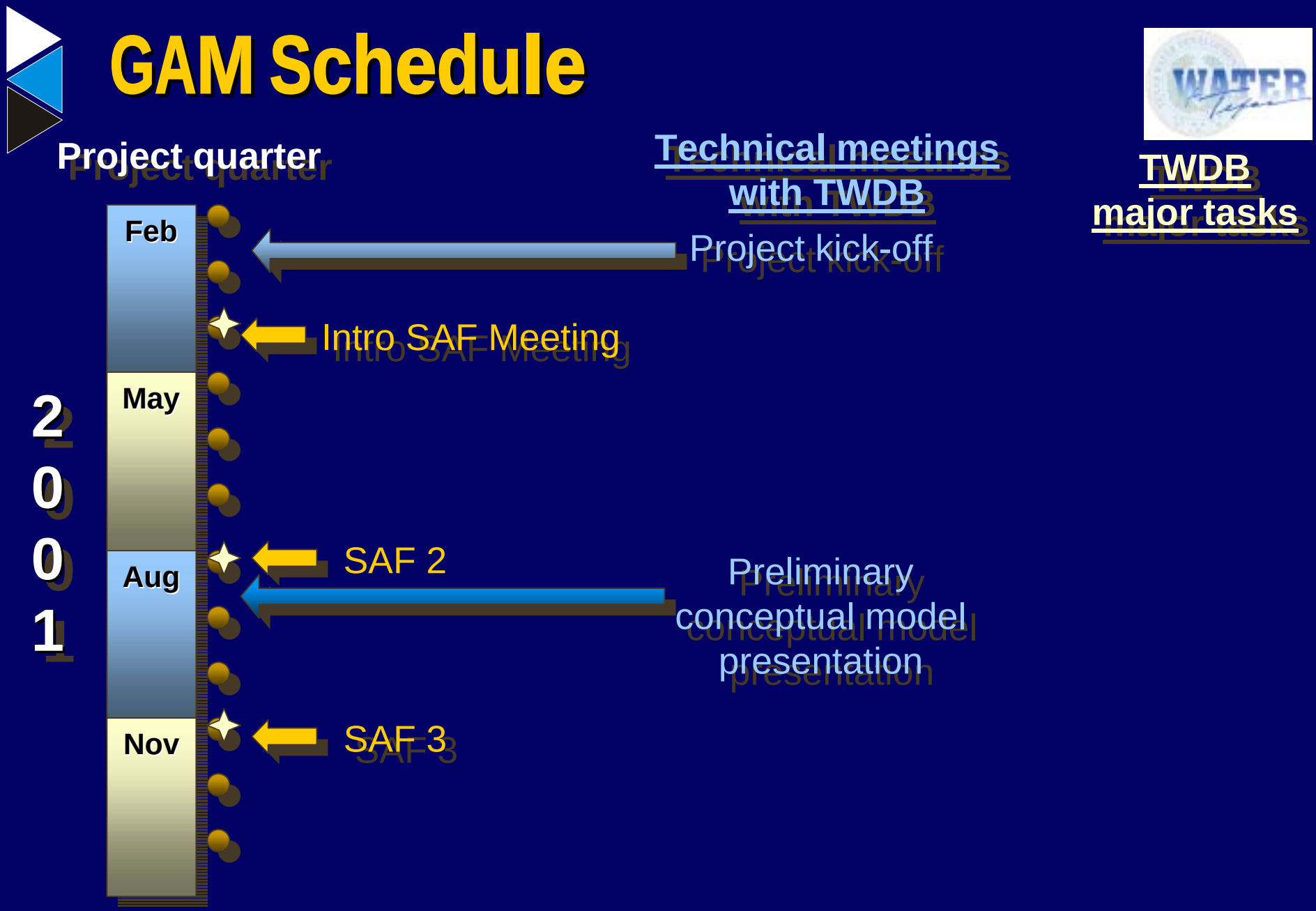
Presentation Outline

- Introduction (GAM Objectives & Expectations, Schedule, Model Region)
- Pumping
- Water Quality
- Modeling Approach
- Topics Planned for Next SAF

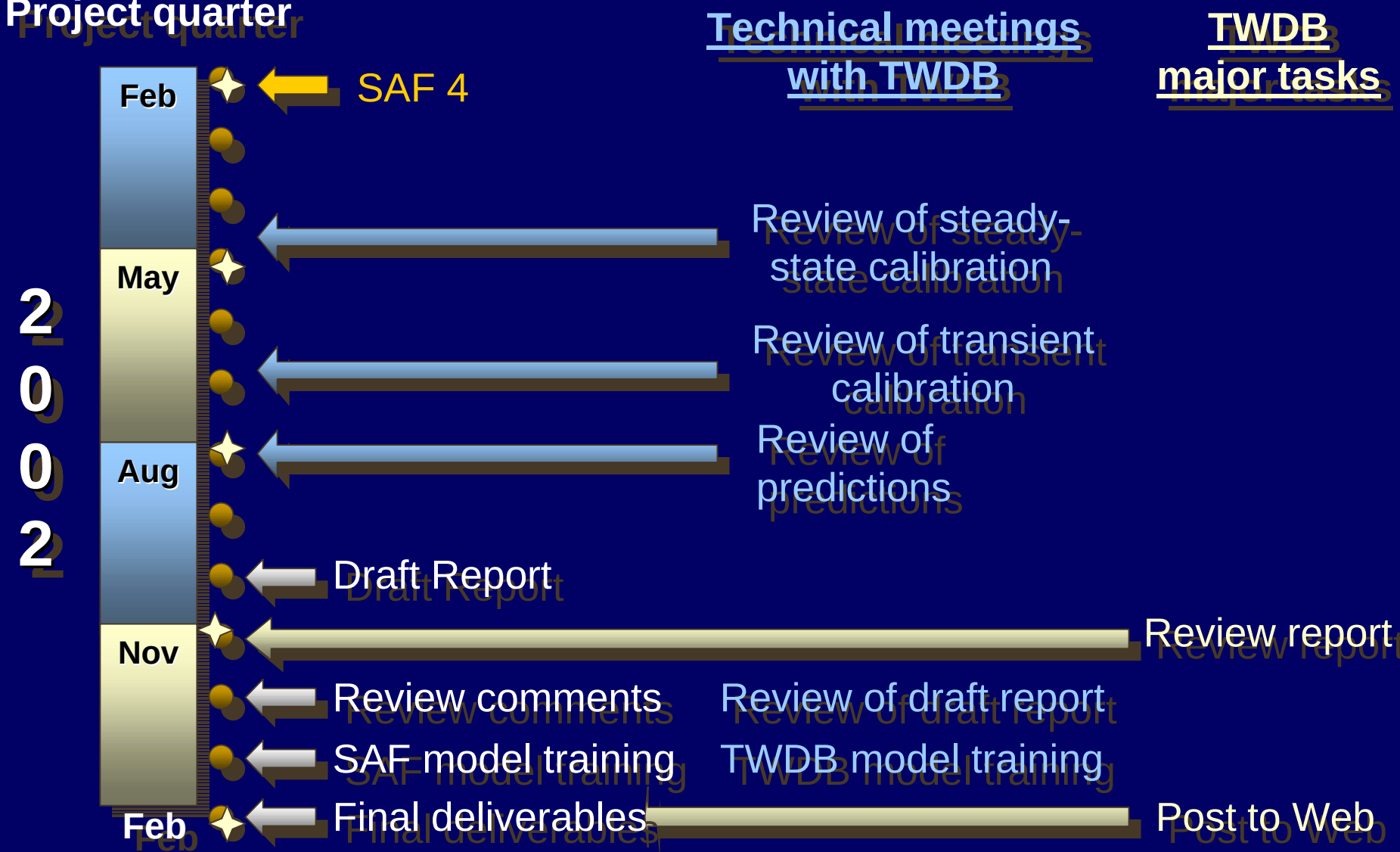
GAM Objectives & Expectations

- Include substantial Stakeholder input
- Result in standardized, publicly available groundwater flow models and supporting data (will be posted to the TWDB website)
- Provide water-management tools for regional water planning

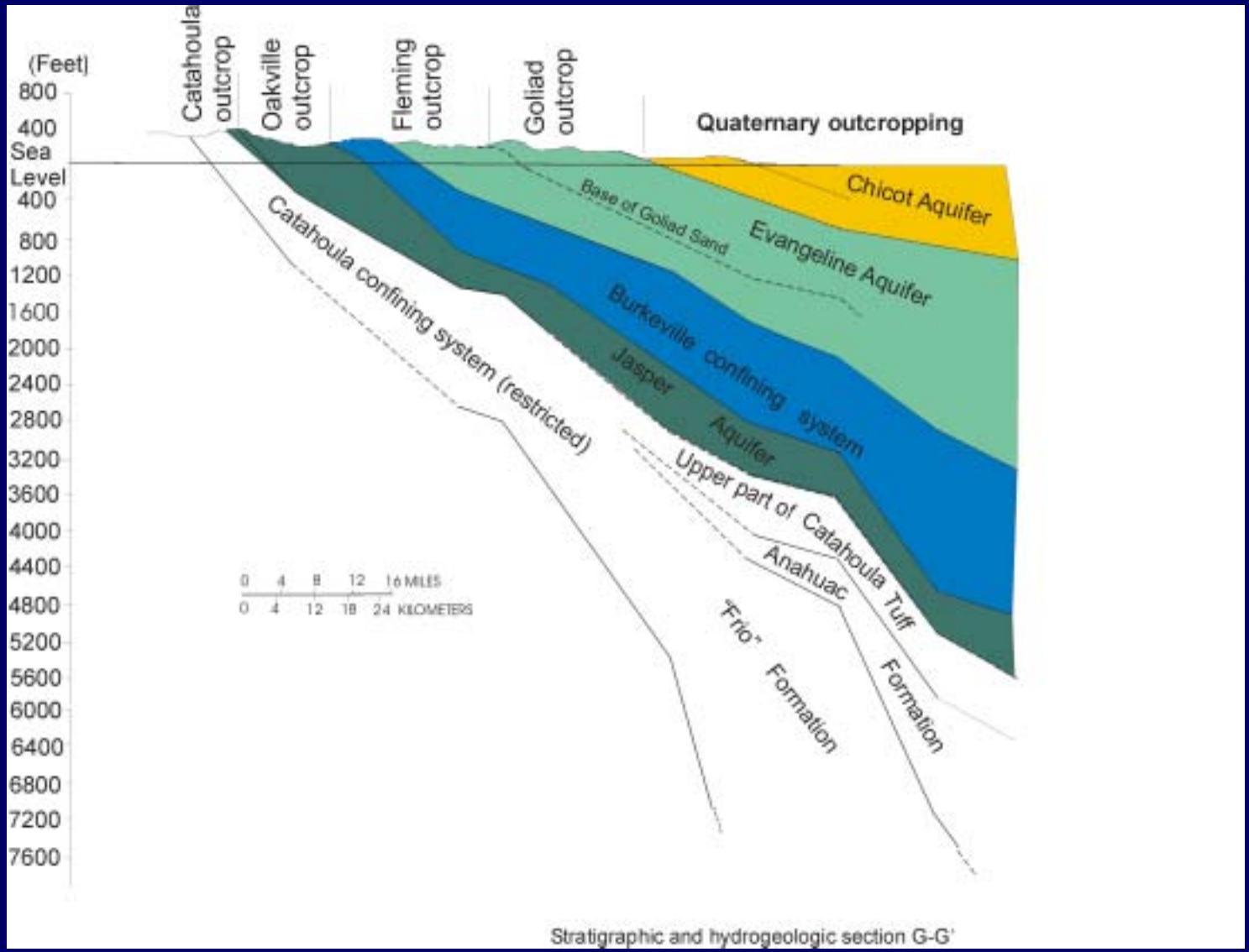
GAM Schedule



GAM Schedule

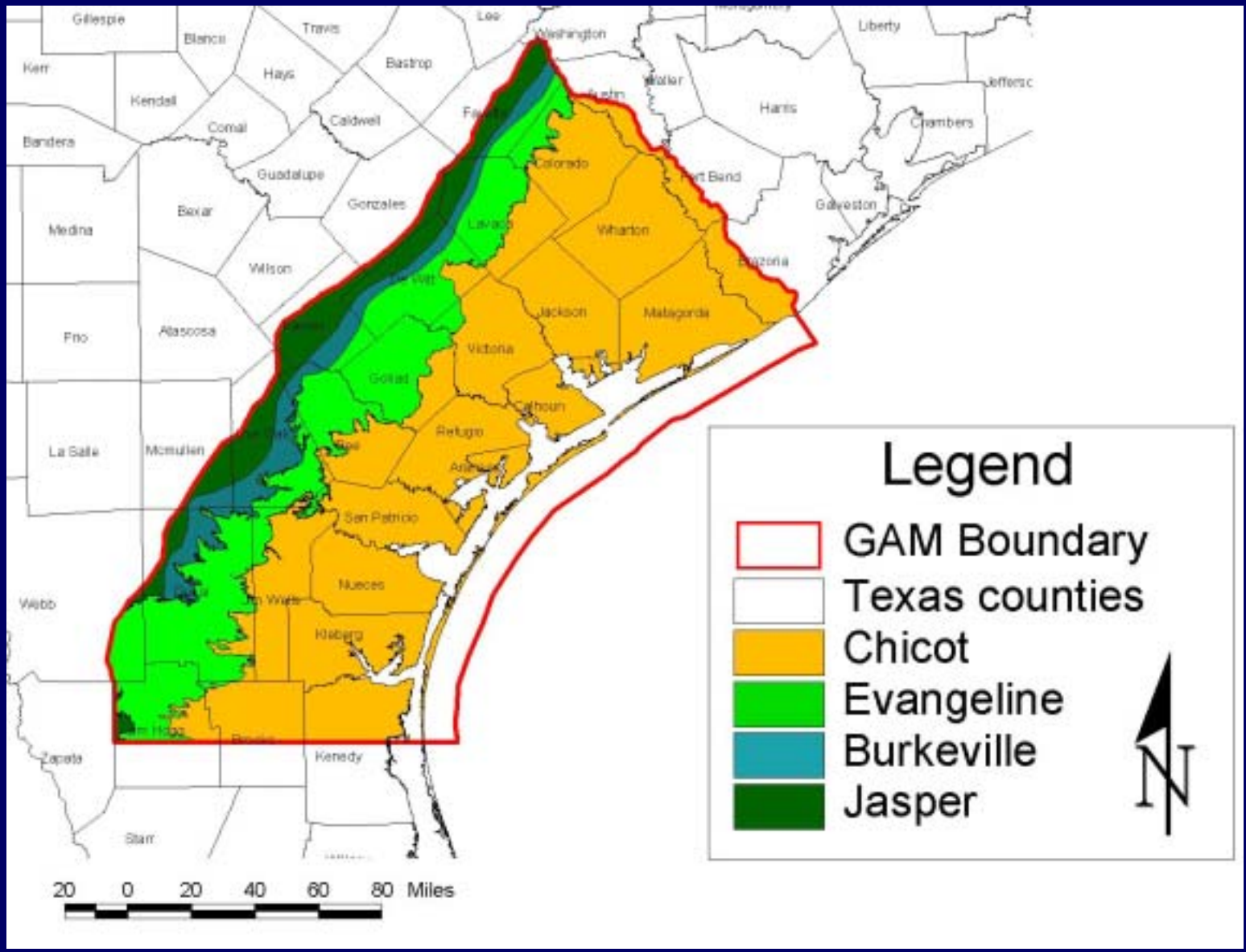


Cross Section

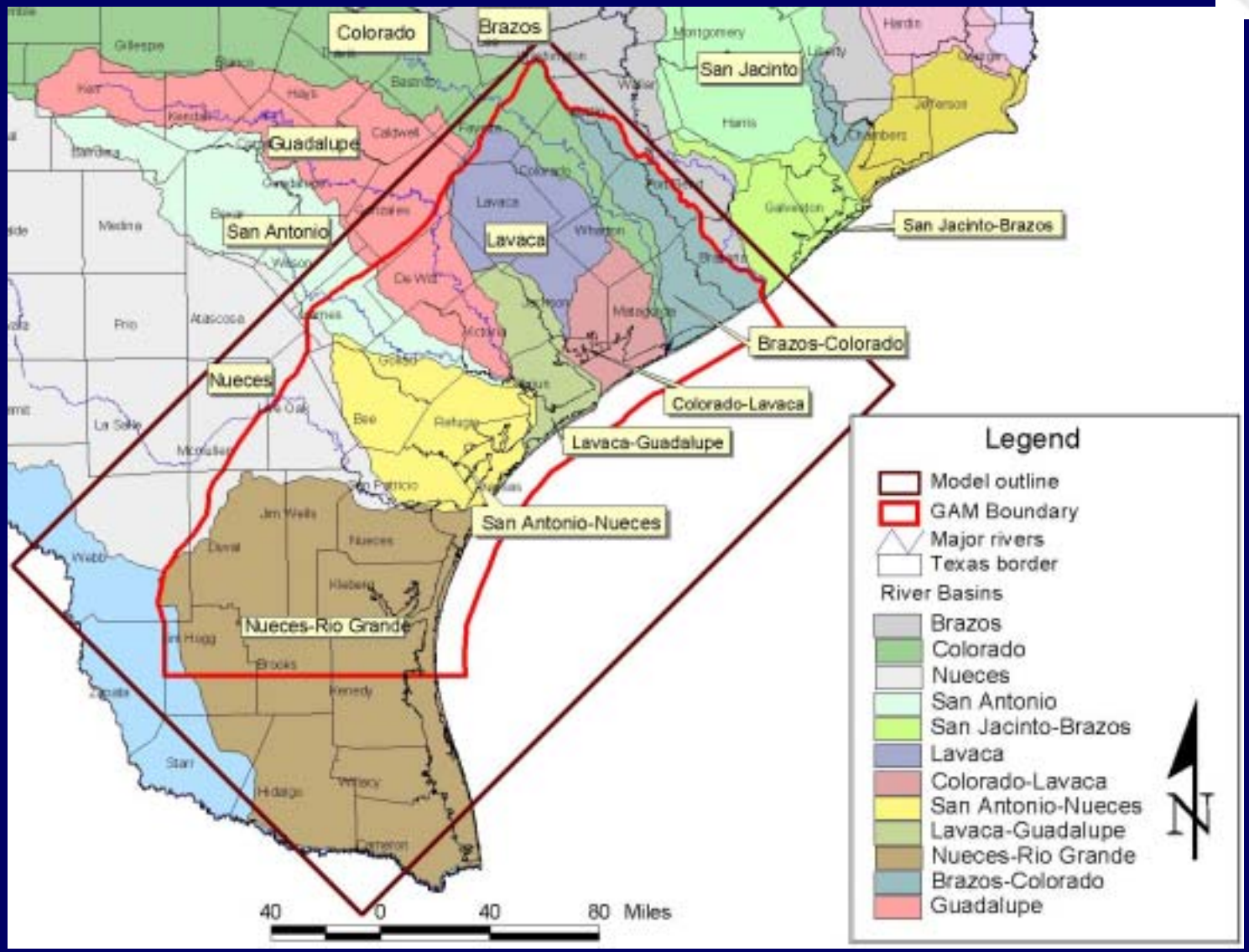


Stratigraphic and hydrogeologic section G-G'

HSU Geologic Outcrops



Model Grid, GAM Region, and River Basins



Central Gulf Coast Groundwater Availability Model (GAM)

Evaluation of Historic Pumping Demand

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

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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

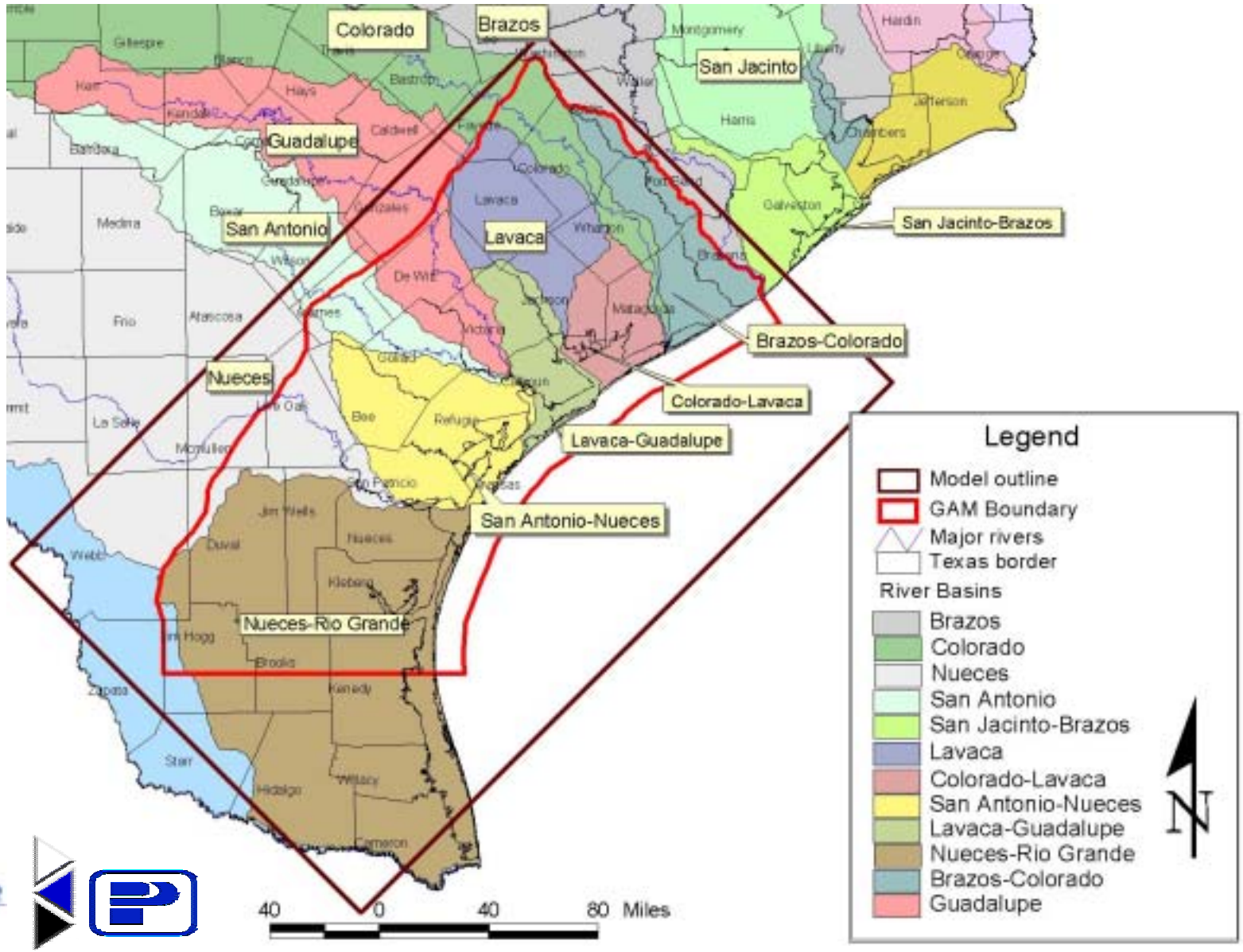
Non-Point Source Data

- Irrigation
- Livestock
- Rural Domestic

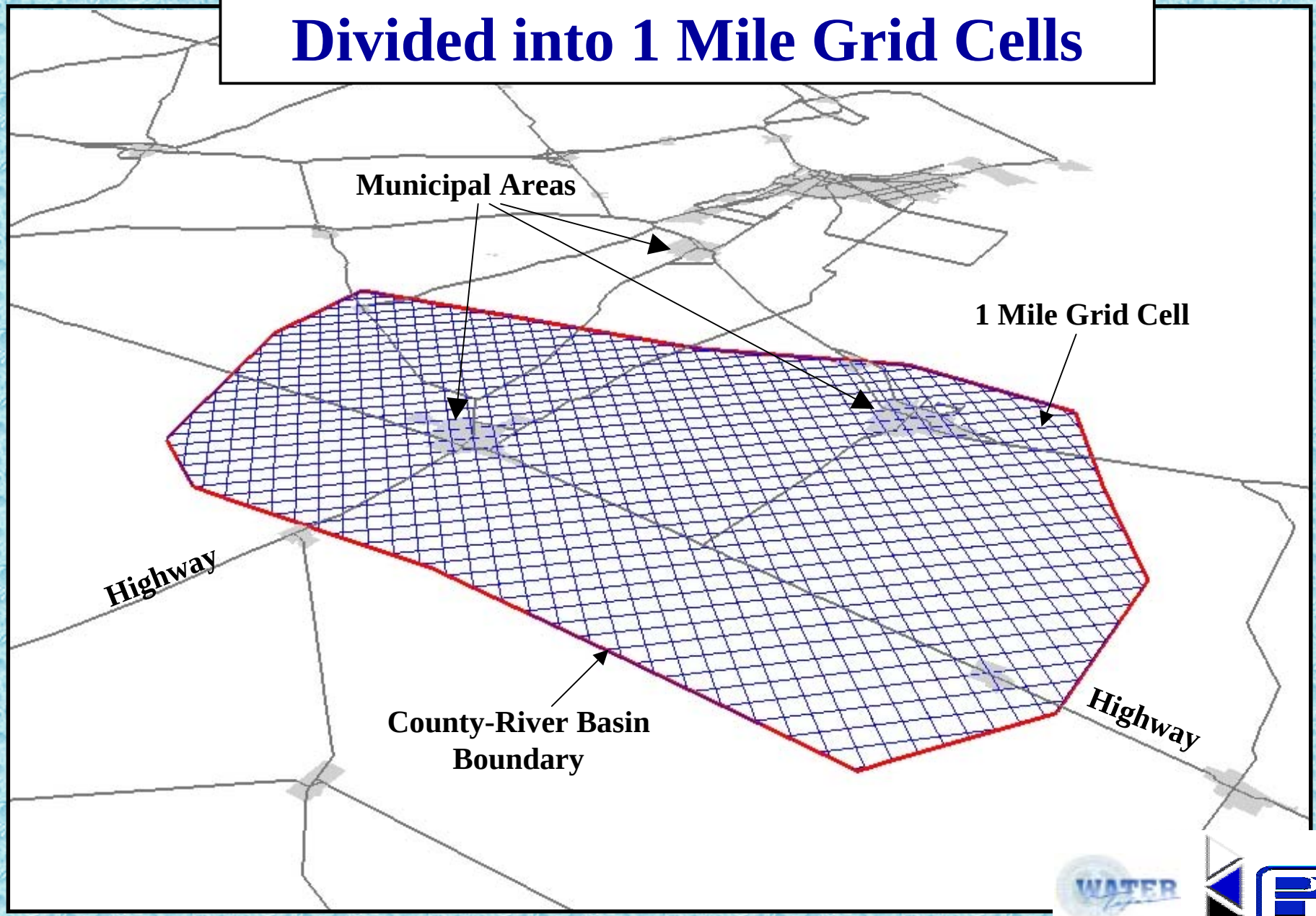
Database Processing

- 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 Central Gulf Coast Region



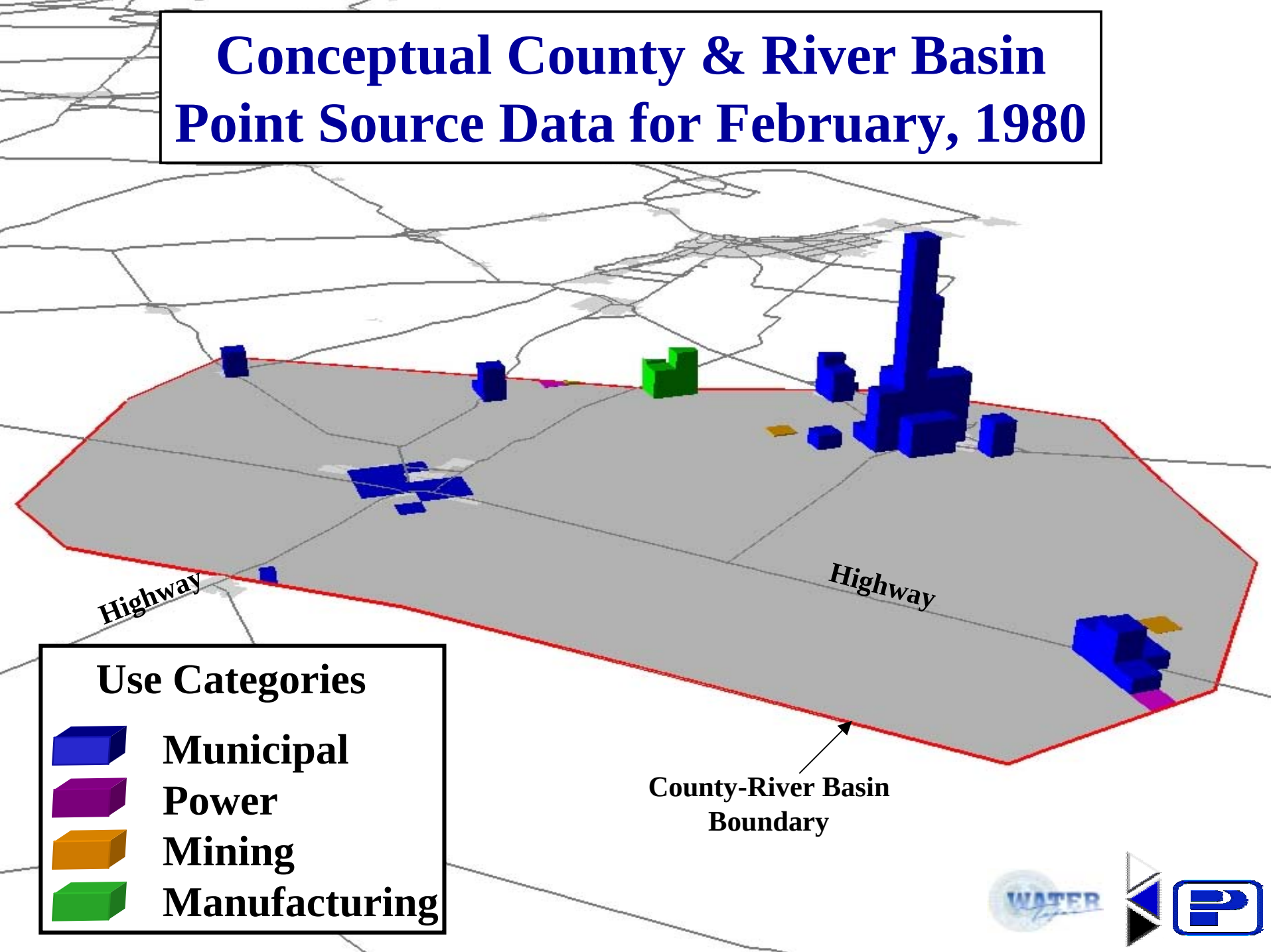
Conceptual County & River Basin Divided into 1 Mile Grid Cells



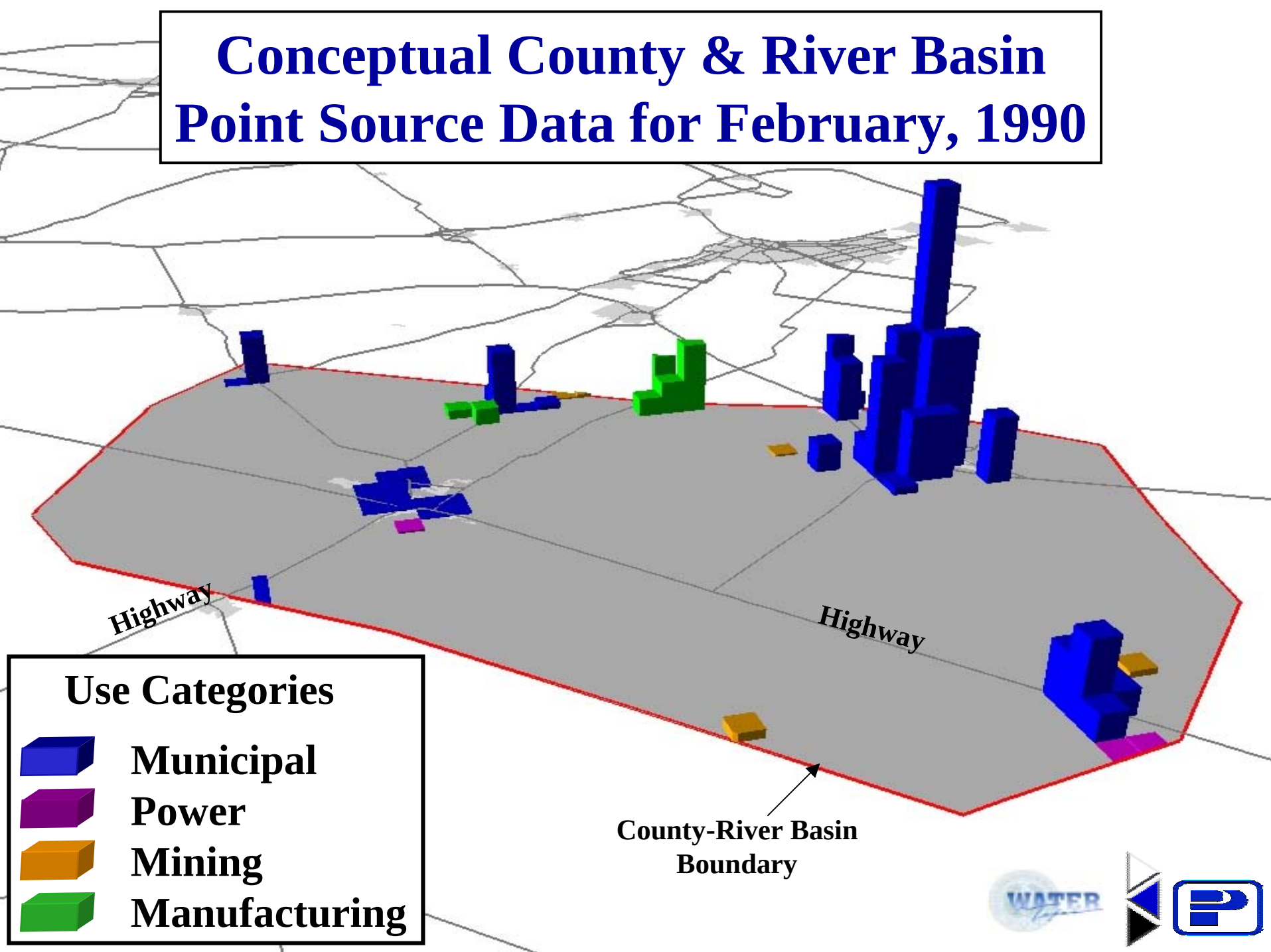
Locate Pumpage Using Point Source Data

- 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

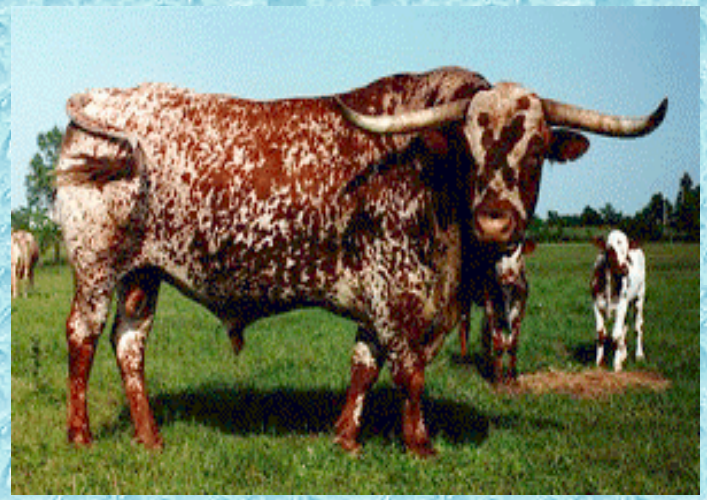
- Locate irrigated areas based on land use and land cover records
- Assign monthly pumpage amounts based on rainfall, temperature, and crop demand data
- Well depths assigned from nearby wells in state well database

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**

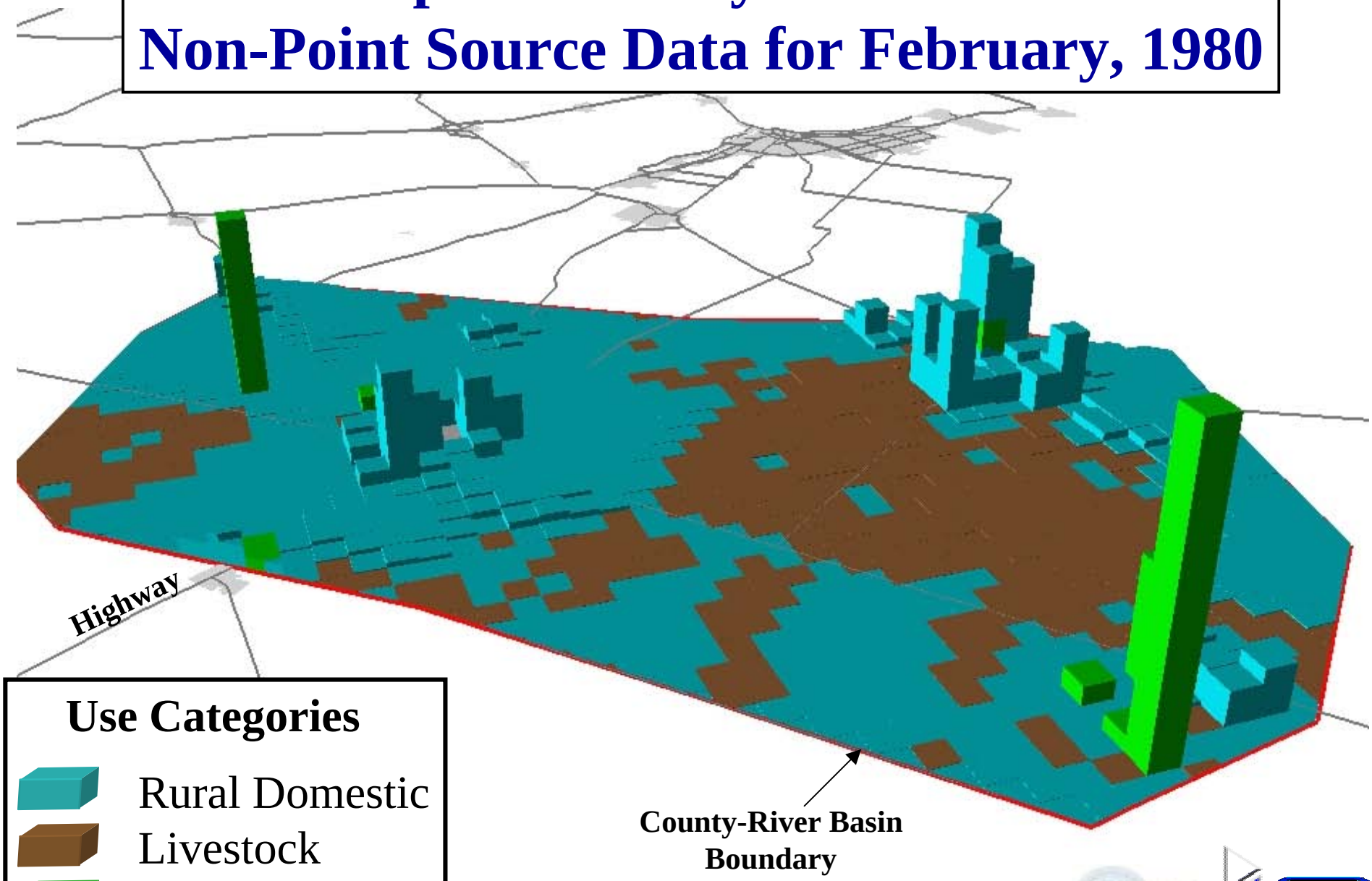
Locate Pumpage Using Non-Point Source Data



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

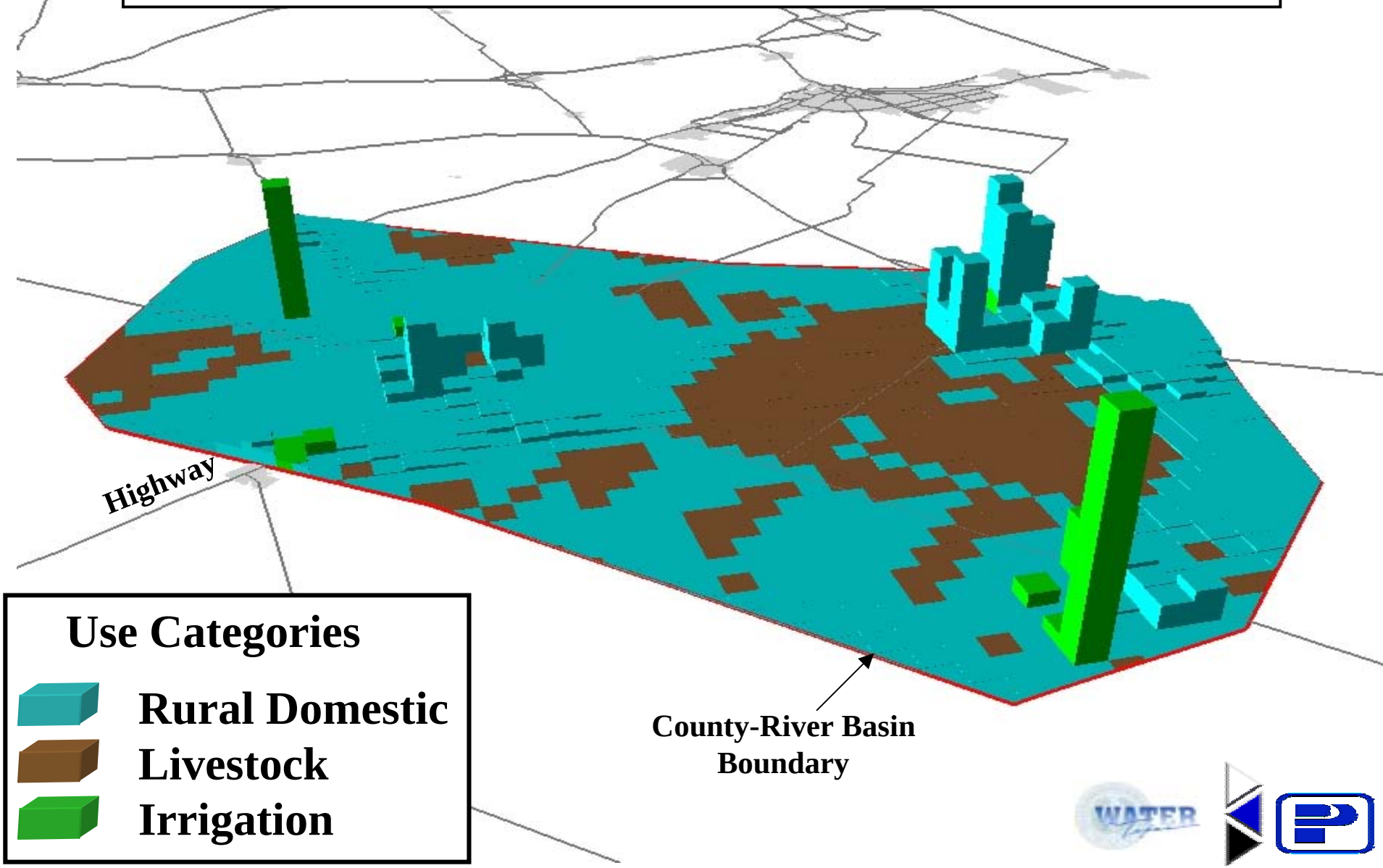
Conceptual County & River Basin Non-Point Source Data for February, 1980



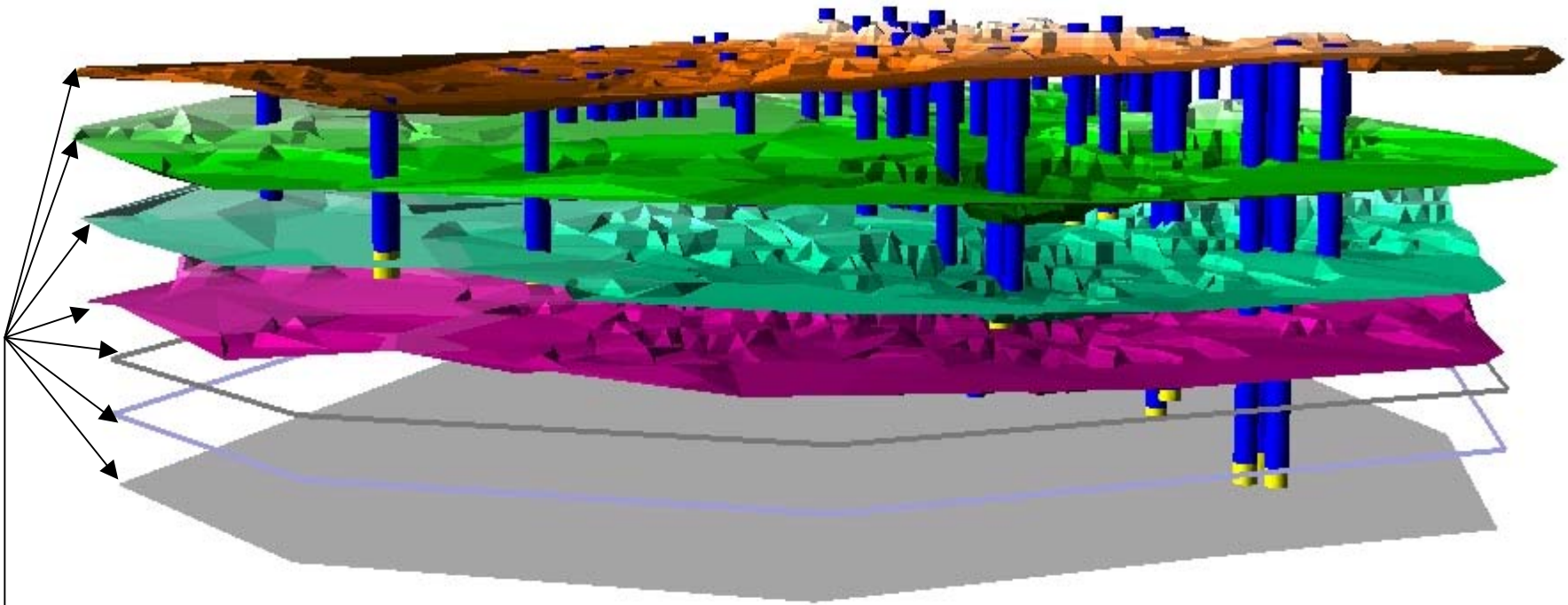
Use Categories

- Rural Domestic
- Livestock
- Irrigation

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

Central Gulf Coast Groundwater Availability Model (GAM)

Water Quality in the Central Gulf Coast Aquifer

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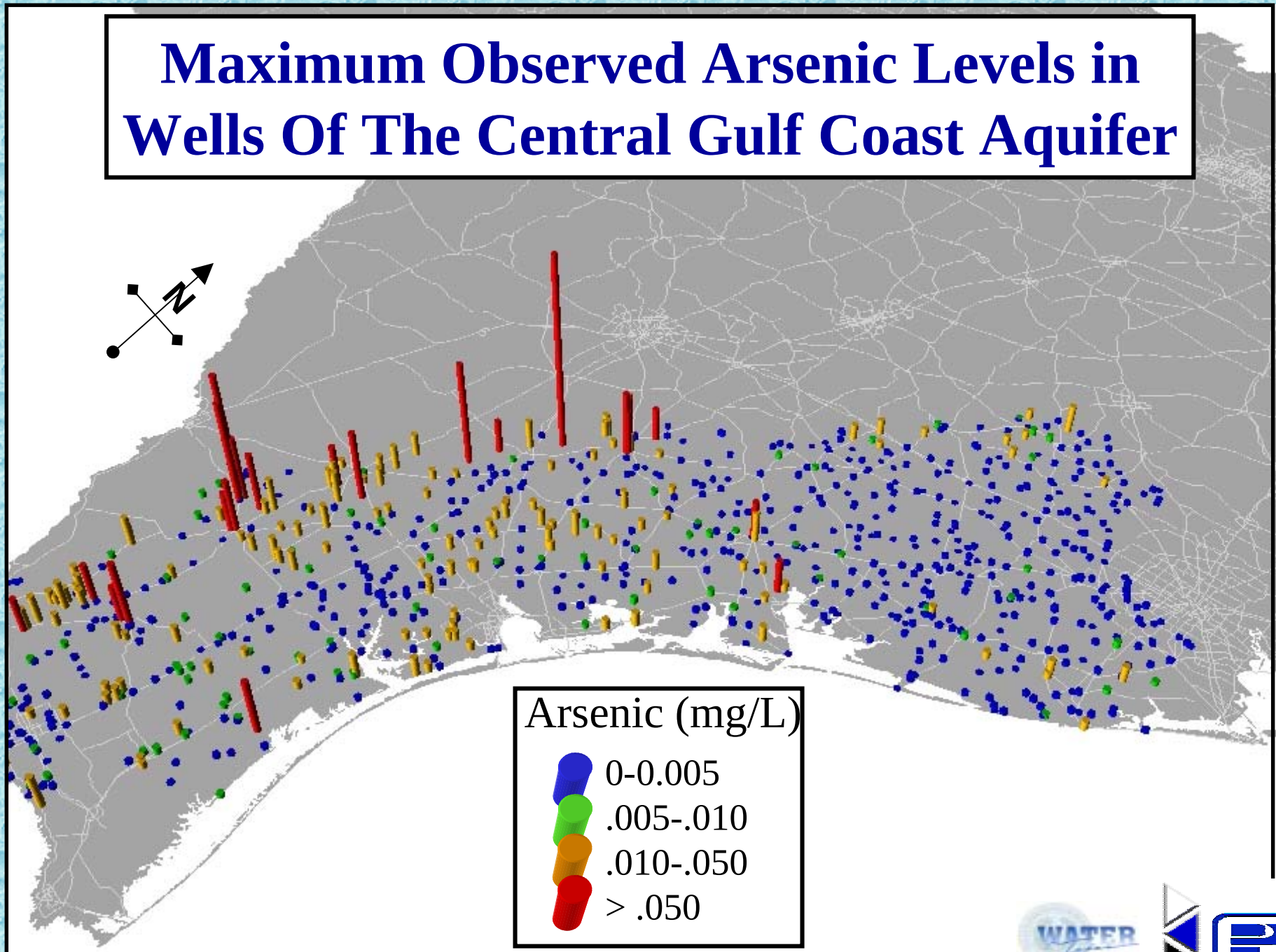
GOOD OR BAD?
Water Quality Screening Levels

- 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

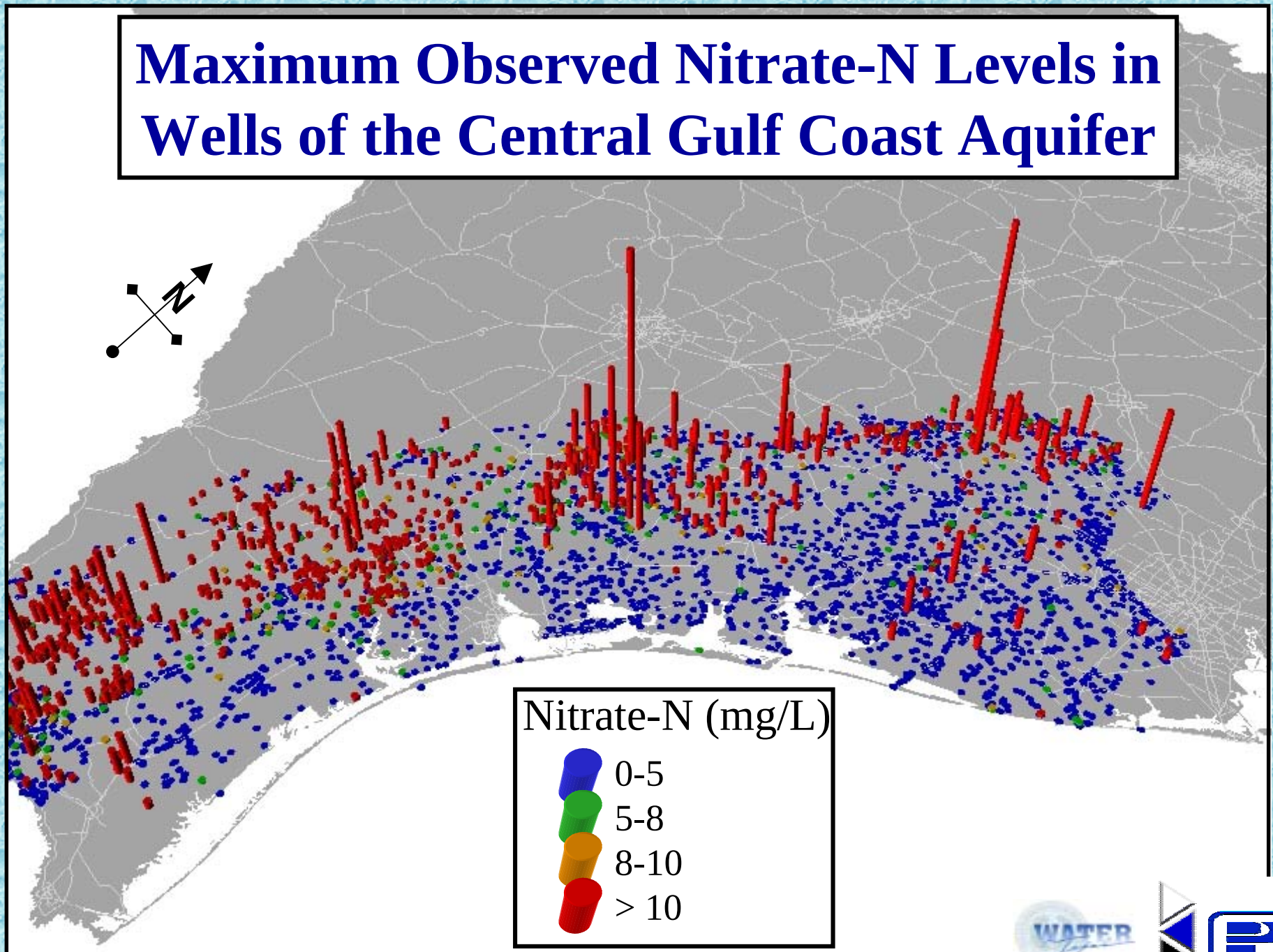
Selected Primary MCLs in the Central Gulf Coast GAM Area

Water Quality Constituent	Wells Monitored	Screening Level	Wells > S.L.
Arsenic	857	.05/.01 mg/L	20%
Nitrate-N	3981	10 mg/L	20%
Alpha Activity	620	15 pCi/L	6.0%
Radium 226 + 228 Activity	53	5 pCi/L	3.8%
Fluoride	3581	4 mg/L	0.8%
Lead	865	.015 mg/L	0.5%

Maximum Observed Arsenic Levels in Wells Of The Central Gulf Coast Aquifer



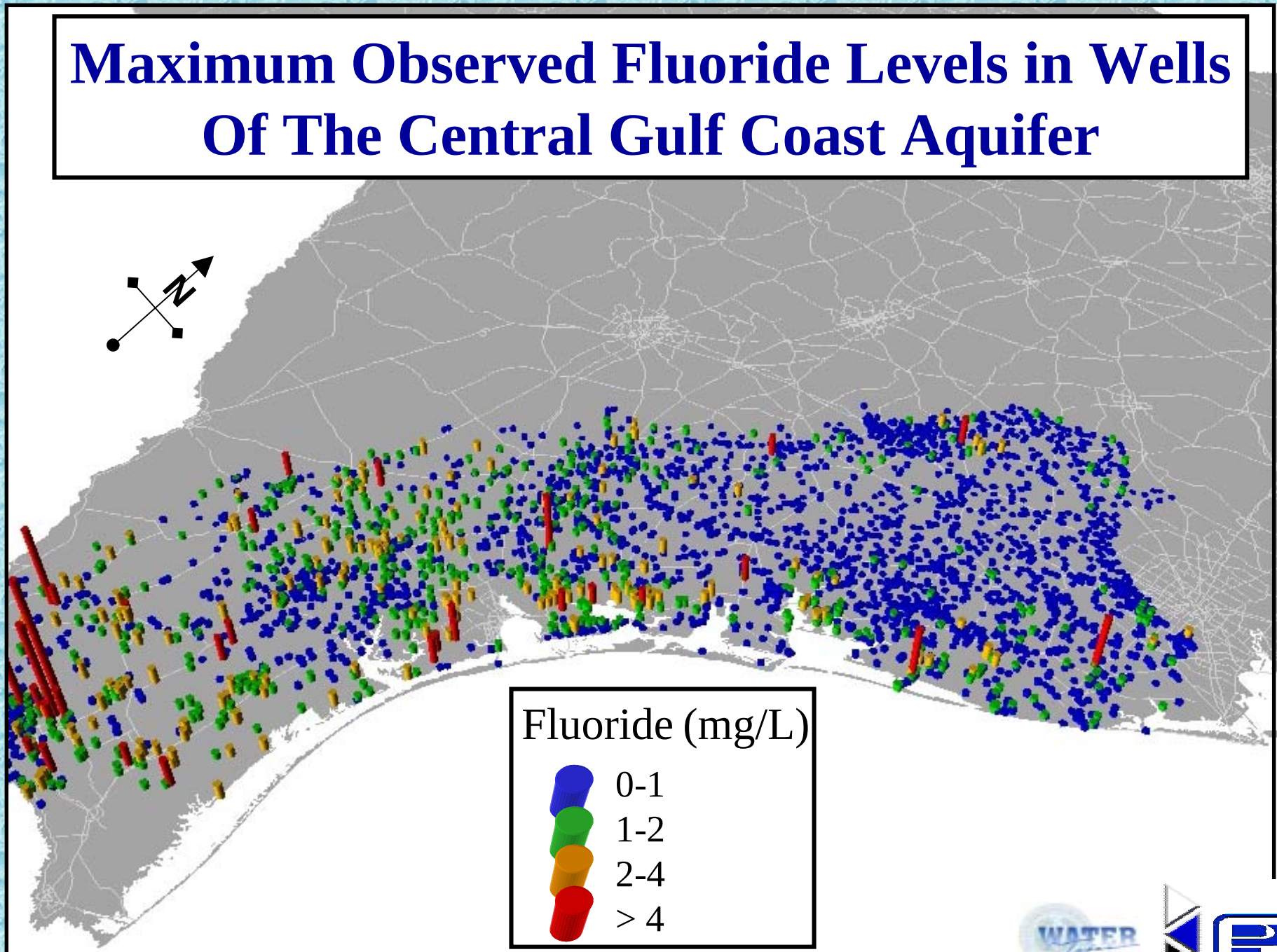
Maximum Observed Nitrate-N Levels in Wells of the Central Gulf Coast Aquifer



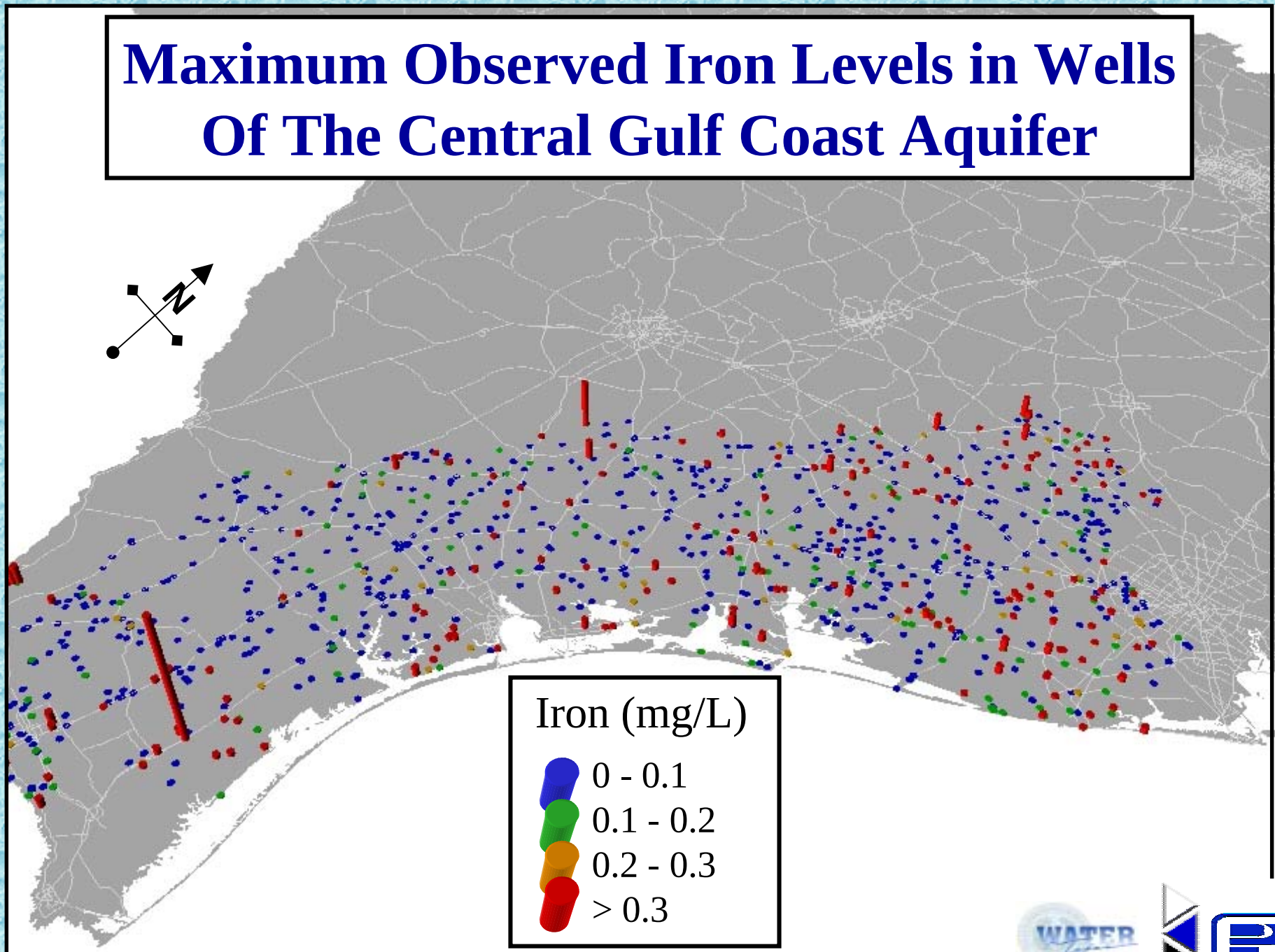
Selected Secondary MCLs

Water Quality Constituent	Wells Monitored	Screening Level	Wells > S.L.
Total Dissolved Solids	4782	500 mg/L	76%
		1000 mg/L	36%
Chloride	4975	250 mg/L	43%
Manganese	851	0.05 mg/L	17%
Iron	1021	0.3 mg/L	16%
Sulfate	4896	250 mg/L	13%
Fluoride	3581	2 mg/L	6.3%

Maximum Observed Fluoride Levels in Wells Of The Central Gulf Coast Aquifer



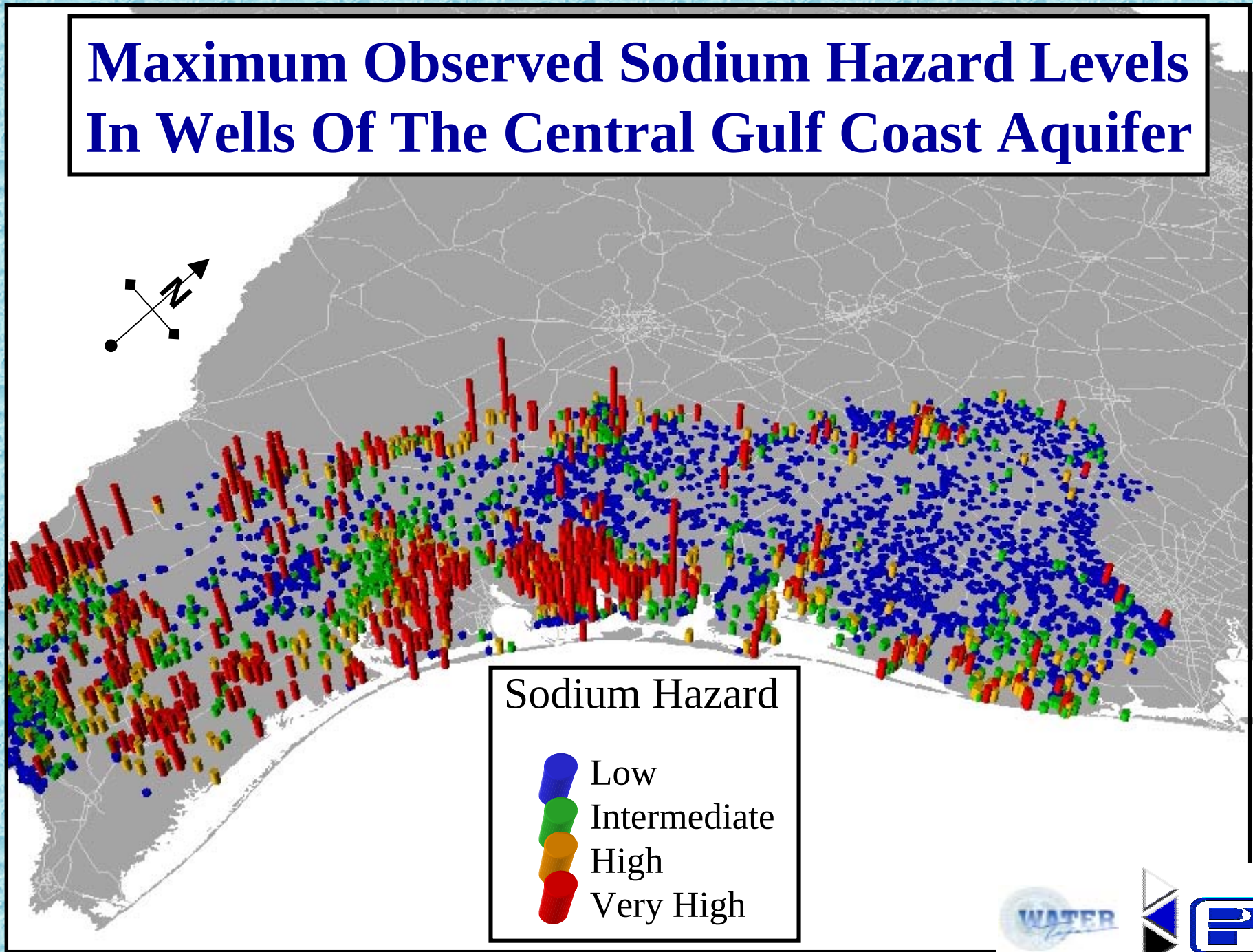
Maximum Observed Iron Levels in Wells Of The Central Gulf Coast Aquifer



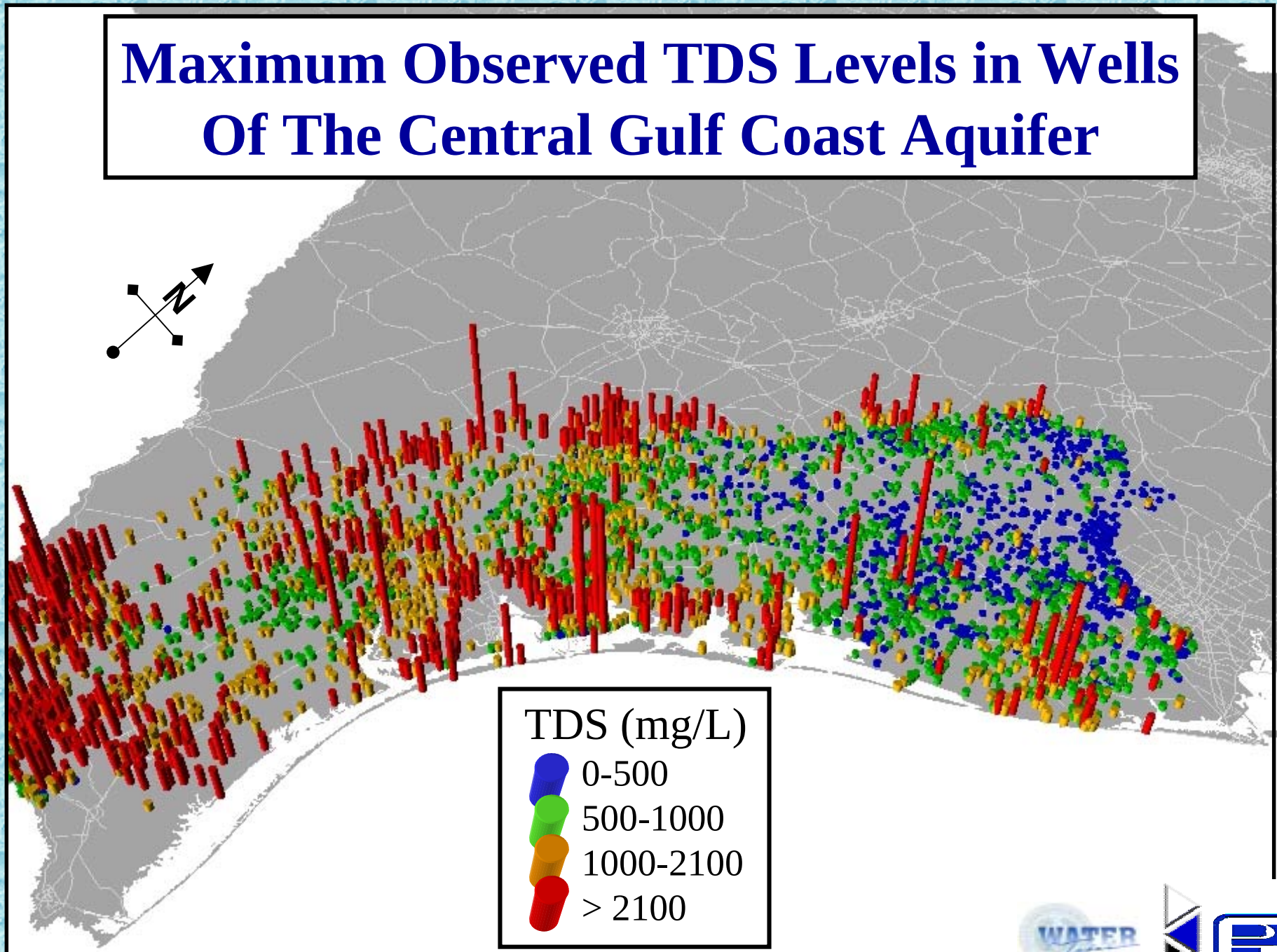
Central Gulf Coast Irrigation Water Supply

Water Quality Constituent	Wells Monitored	Screening Level	Wells > S.L.
Salinity Hazard	3989	Very High	25%
		High	81%
Boron	1318	2 mg/L	22%
Total Dissolved Solids	4782	2100 mg/L	12%
Sodium Hazard	4600	Very High	10%
		High	18%
Chloride	4975	1000 mg/L	8%

Maximum Observed Sodium Hazard Levels In Wells Of The Central Gulf Coast Aquifer



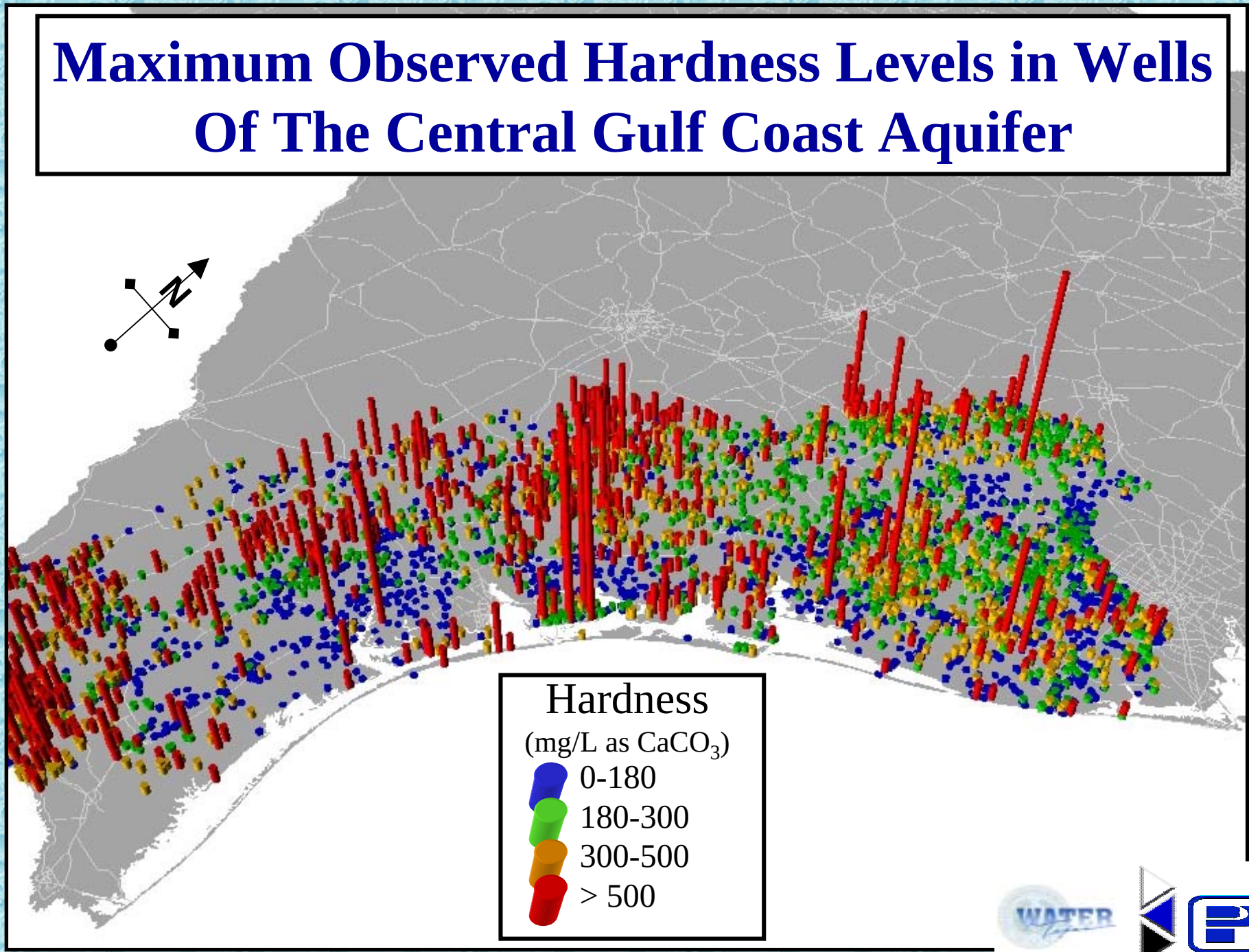
Maximum Observed TDS Levels in Wells Of The Central Gulf Coast Aquifer



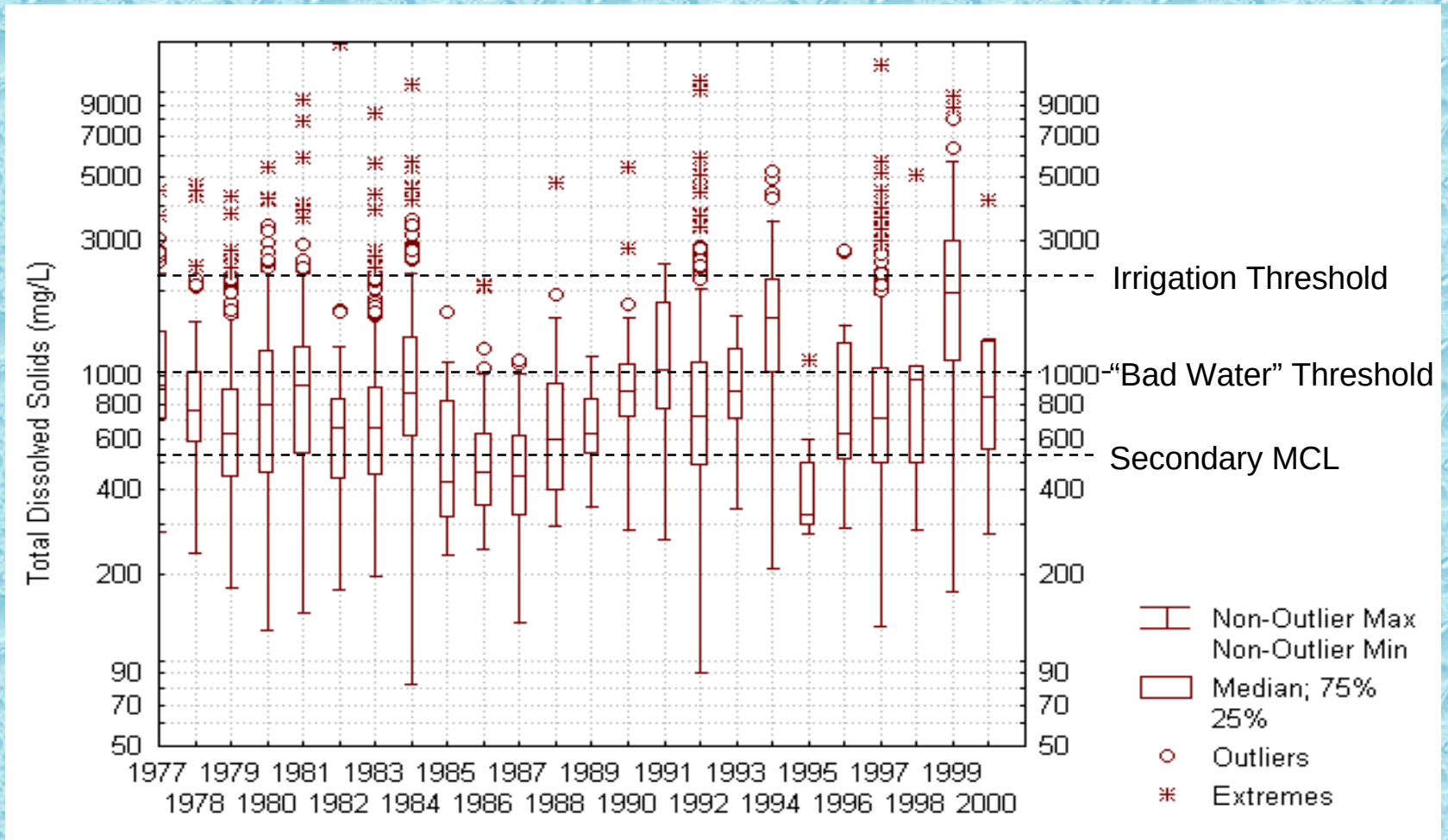
Central Gulf Coast Industrial Water Supply

Water Quality Constituent	Wells Monitored	Screening Level	Wells > S.L.
Hardness (as $CaCO_3$)	5167	180 mg/L	62%
Silica	3791	40 mg/L	23%
pH	4002	<6.5, >8.5	3.3%

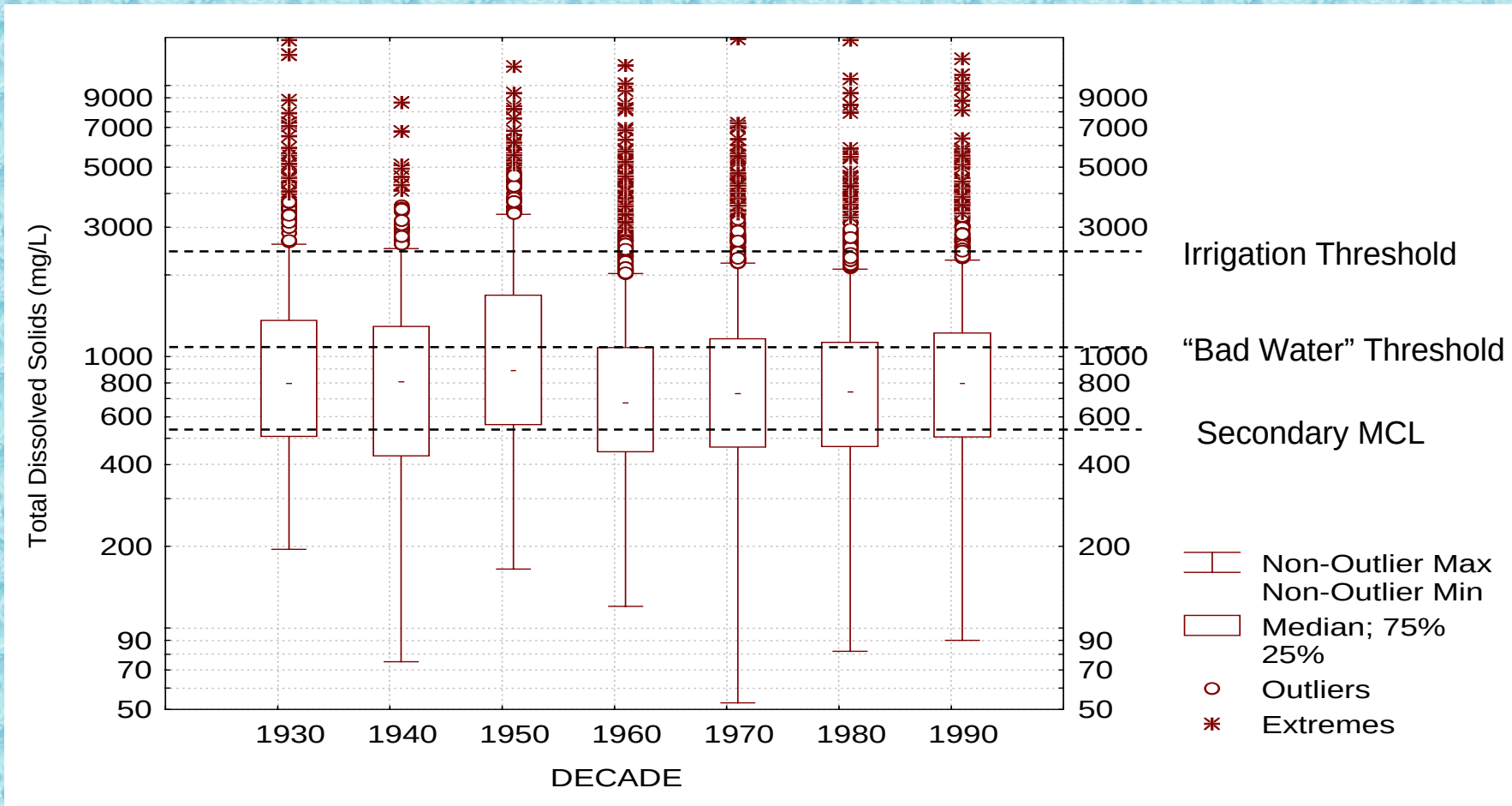
Maximum Observed Hardness Levels in Wells Of The Central Gulf Coast Aquifer



Recent Trends in TDS Levels in the Central Gulf Coast Aquifer

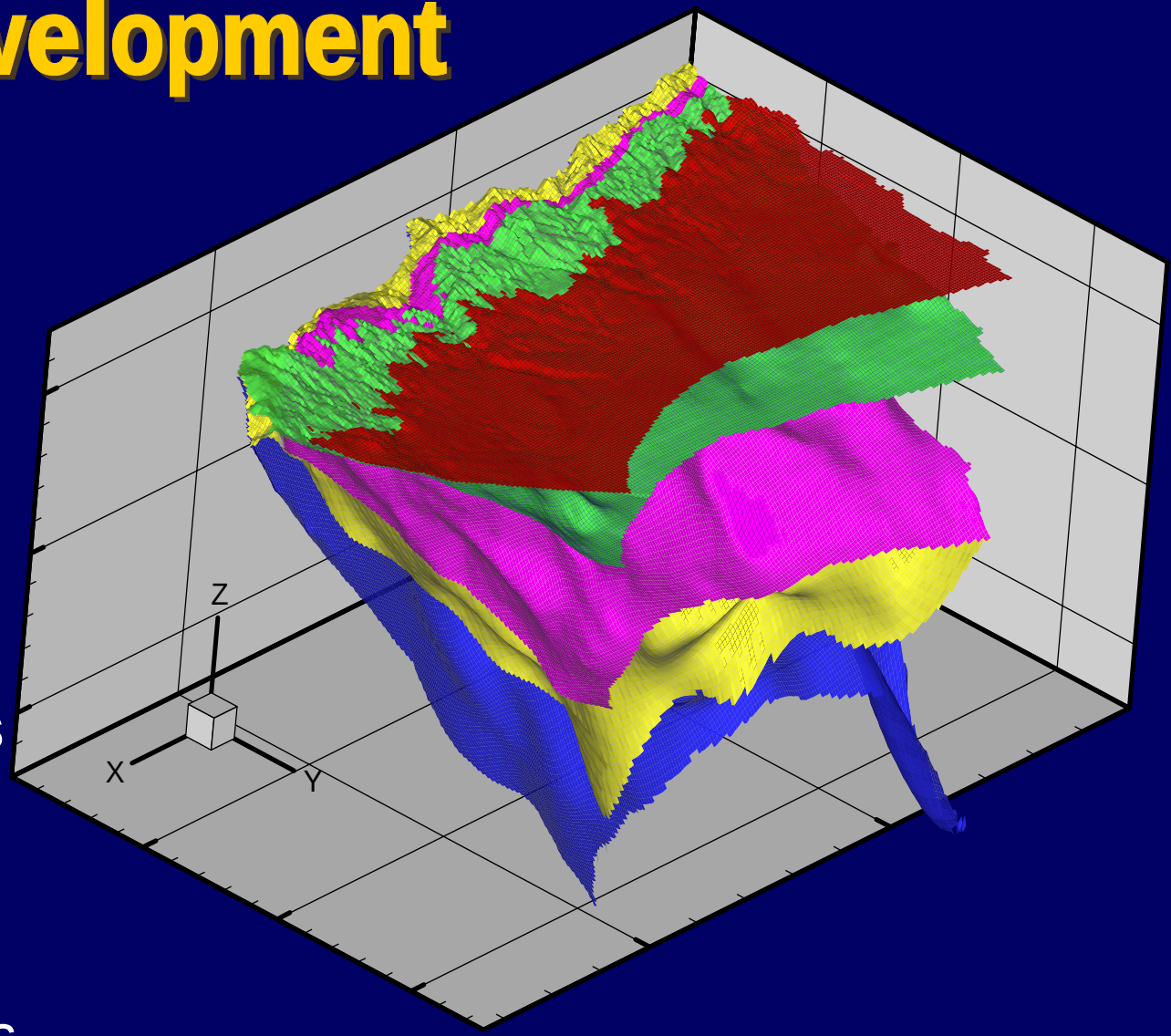


Long-Term Trends in TDS Levels in the Central Gulf Coast Aquifer



Model Development

- Hydrostratigraphic structure (layers)
- Model grid:
  - (1 mile x 1 mile)
- Hydraulic properties
- Recharge
- Boundary conditions



Future Simulations

- Calibrate to predevelopment water levels
- With pumping stresses, calibrate to transient water levels (1980 - 1990)
- Verification to 1990 - 2000 water levels
- Prediction of water levels for 2000 - 2050

Planned for Next SAF

- Completion of model design and finalize model inputs
- Preliminary model calibration to predevelopment water levels
- Identify wells for transient calibration

Name	**Affiliation**
Dorothy Caraway	Personal
Jim Naismith	San Patricio M.W.D
Larry H. Akers	EUWCD
Cliff Lowe	EUWCD
Rick Hay	Texas A&M Corpus Christi
Winfred Kainer	landowner
Cecil McClia, Mr & Mrs	landowner
John Dreier	Goliad Co UGWD
Art Dohman	Goliad Co UGWD
Kenneth Schustereit	Taxpayer - Water Research Group
Simone Tipton	Taxpayer - Water Research Group
Robert T Smith	Home Owner
V. Wood	Home Owner
Robert Gutzmer	Home Owner
Raymond Pilsner	Home Owner with a well
Ken Woodring	Home Owner with a well
Merle West	Home Owner with a well
Larry H. Aduddell	Refugio Cnty UGWD
Greg Bowen	Victoria Advocate
John Kirkpatrick	County Commision Candidate
James Dodson	Nueces River Authority
Karen Dodson	Consultant
Wayne Cockraft	City of Victoria
Lynn Short	City of Victoria
Bob Pickens	Colorado Cnty Post Oak GCD
Ronnie Hernandez	San Antonio River Authority
Bob Keith	DOW/UCC
Robert B. Wilson	COV W Utility
Phillip G Savoy	Murfee Eng Co Inc
Bill Murphy	Rancher
Gary Middleton	City of Victoria
Harrison Stafford II	Jackson Co
Tommy Tijerina	
Arthur L. Bluntzer	GCUGWDB, GCWSE & GC Farm Bureau

Summary of Questions/Responses/Discussion from
Fourth Stakeholder Advisory Forum
Central Gulf Coast GAM
held
February 20, 2001
City of Victoria Community Center

As with postings for previous SAF meetings, this document summarizes the technical questions, answers and discussions.

1. What is the web address?

Response: http://www.twdb.state.tx.us/Gam/ *or* http://www.twdb.state.tx.us *click on data then Groundwater then Groundwater Availability Models (GAM).*

The following questions were discussed after Art Whallon with Parsons presented slides covering the development of the pumpage datasets:

2. On your livestock modeling you depicted a 1/12 of an annual average but during the summer cows consume about 10 to 15 times the amount of water that the same animal will consume during the winter. This seems to be a large flaw in your monthly averaging.

Response: The overall amount of usage of groundwater in any one cell is accumulated by all the uses. We realize that in a one-mile square area you may have rural domestic, irrigation, and a well that supports just livestock. All those uses will be placed in that one model cell. The simplified assumption we made seemed to be best to cover all conditions over all periods of time. We realize rainfall can be greater in the winter months and that stock water consumption varies. It can be very difficult to try to understand how all that fits together, but we felt that, for this phase of the GAM, this would be a fair representation.

3. I really question your assumptions. I feel that the water balance will not add up based on the assumptions you have incorporated.

Response: Every quarter we come back and report to you our progress. Right now these are conceptual slides. This is how we are taking the first big step forward. The model will not be considered successful if a water balance can not be achieved to a certain degree of accuracy. We will rethink these initial steps if we need to.

4. Are you calling all these layers up here the Gulf Coast aquifer?

Response: Conceptually, yes.

5. What do you speculate is going to happen to the shallow aquifers when you start pumping from the deeper aquifers? Do you think water will percolate down to the deeper aquifers?

Response: It depends on how much you pump, how long you wait, where you pump, and how deep you are pumping. It is quite possible that you will see an impact on the shallower from pumping in a deeper aquifer or vice versa.

6. Is that what is happening in Gonzales County now?

Response: We do not have an answer to that since we have not run the model yet. This presentation is to show you how we are trying to put the model together.

7. Do you think we'll be able to determine how rapidly the percolation occurs or whether it goes down to a fault or to a particular layer?

Response: That is one of our objectives on a regional scale. It will not be possible to tell you how results vary on a local scale. It will be possible to use the model to determine what the regional groundwater flow system looks like in the future for a particular pumping scenario.

8. I have a question on the quality of the data that you are using. What do you think it is, plus or minus 20 percent?

Response: It is the best available. Quality varies depending on the measurement method and the level of permitting required. We have accumulated all that has been reported to the TWDB, and the TWDB gave us that data. Through the modeling process over the next half year we will be evaluating various inputs to the model. Pumping being a large stress to the model will be tested in terms of sensitivity. It is not possible to capture everything that is being pumped, we realize that, but we feel like we have captured enough to provide a good indication of the regional system.

9. I want to cover a number of points (a) you are averaging your data, (b) the quality of your data, (c) percolation estimate, and (d) how much do assumptions and uncertainty affect the quality of your predictions. Putting these all together, will you be able to predict when my 150’ deep well goes dry? I want to know how well you can predict this since your model has no mechanism to account for the cost of replacing that water when my well goes dry.

Response: The only response that we can really give you is to say that the model will provide an estimate of the impact on upper layers when lower layers are being pumped. Some of the questions you brought up have to do with how well the physical data that we have on the model itself and how the reported values that have been given to us by water users mesh together. There is some flexibility in being able to round out some of the errors, fill some holes in the data, and still provide a good product. In three and six

months these meetings will be held again giving everyone a chance to look at some of the initial results coming out of this model.

10. Will this model be for the Gulf Coast aquifer only?

Response: Yes.

11. You are using old data. This county is growing. We need to have the data updated annually. Right now you are going back to 1980 and that is obsolete for today's time.

Response: We use historical data so that we can see the actual response of the aquifer to a particular stress. Before we can predict the future, based on regional planning numbers, we have developed a model that can reproduce historic conditions. If we can reproduce the historic conditions then we are reasonably confident that we can predict future conditions.

12. What will the impacts of deep wells be on our wells and water quality.

Response: The model will help you predict what will happen in the future. We are simply providing a tool to help you to be able to look a little more clearly, not perfectly, but a little more clearly into the future. It is just a tool. It is not the final answer and as we continue reporting to you and you see our progress, the goal is to keep you as involved as possible.

The following questions were discussed after Kirk Dean with Parsons presented slides covering Water Quality in the Central Gulf Coast GAM study area:

13. You show some of the wells very isolated with extreme concentrations of various components, for example iron. I would expect an increasing trend going to high concentration areas, not just isolated, extremely high values. Is there an obvious explanation for this?

Response: Iron is a poor example to use because iron has two oxidation states, one of them is very soluble in water and one of them is not. Depending on how that well was sampled, and re-dox conditions, how much oxygen is in the water, the amount of iron can change dramatically. However, we do see the same phenomenon in other areas. Another factor is the way the data are displayed: the slide images show data from all the aquifer layers combined together. The results are not necessarily just from a very deep or shallow portion of the aquifer. It looked like some of the wells for other parameters are really high in the Corpus Christi Bay area, and those may have been getting in some kind of saltwater intrusion. Another factor is the age of the data, although the data has been quality assured to some extent, there may be significant differences in the analytical methods that have been used with some of the older data. I would not trust every single data point on any of these slides, however I feel that the trends indicated are significant. Where a bunch of wells are high, I think the trend probably reflects an area with elevated

concentrations. If you see one isolated value, I do not know if I would worry too much about that or trust it too much.

14. With regard to the TDS slide, is the East one-third getting recharge and the West two-thirds not getting recharge?

Response: I don't know the answer to that.

15. Is it possible that the low values of the eastern one-third are associated with recharge while the higher values you get down in the Rio Grande Valley are due to the limited amount of recharge in the area?

Response: We will not be using water quality explicitly in the model, but it might provide some qualitative indication of recharge areas. Keep in mind that the data represents values that are combined across all layers and this may distort or mask any trends.

16. How will water quality data be factored into the water availability model. The model, as I understand it, will simulate all of the water including water greater than 10,000 mg/L TDS, is that correct?

Response: That is correct.

17. This is just kind of information for us and something [that] will affect the output of the quality not the quantity.

Response: Right, this is information that will be in the report, but it will not be modeled.

18. Is there treatment for all of the contaminants that you have discussed.

Response: There are a wide range of treatment options. Some of them can get pretty expensive though, so they may not be an option for a domestic user. They may not also be an option for a farmer because of the volume that would need to be treated.

19. Have you done any studies that show what the proposed [impact] of pumpage on the quality of water on a local water well?

Response: We have not, perhaps other people have.

20. There is salt water in the bottom of the Gulf Coast aquifer. Do you have an explanation as to its origin, did it leach in from the Gulf? Is it naturally occurring salt water?

Response: It was beyond the scope of this work to assess potential sources and/or mechanisms that resulted in the water quality values reported here today.

21. Do you have a plot that shows the average depth of production on the wells from which the water quality data was obtained?

Response: Not at this time, but we will produce one.

22 Are the underground water districts going to use this as a model to say here is what is going on within our county? Is this the explanation?

Response: The purpose of the model and water quality evaluation is to provide everyone; the stakeholders, regional planning groups, groundwater conservation districts, cities, public utility users, with a modeling tool that they can use to help understand the regional Gulf Coast aquifer system. We are going to have model training sessions at the end of this process to help answer a lot of these questions. Up to this point there has been a lot of "what-if-this-happens". Not everybody really understood the entire aquifer system and so, the State of Texas is modeling the major aquifers throughout the entire state, not just the Gulf Coast. The objective is to produce a tool that everybody can use. It will not just be the state using this and telling you what comes out of the "black box". This is for anybody who wants to use it; we're posting it for public use and enhancement. Keep in mind that this is a regional model so you're not going to get site specific information that can answer the "if-I-pump or I-put-a-well-over-there" kind of questions. However, it will give you a pretty good overview of what's going on in this area. The whole idea about looking at water quality is to encourage the people who make the water quantity decisions to be aware of the quality aspects.

The following questions were discussed during Gil Barth's portion of the presentation:

23. Have you included faults in the model structure?

Response: We have found some references that indicate a certain amount of faulting in the area. However, the water level data does not seem to justify incorporating those faults into the model. The data we have does not seem to indicate a significant impact of the faults on the regional flow pattern.

24. Do the flow paths dip towards Mexico, the water quality data seems to indicate that it does.

Response: It is certainly a possibility. The model has not yet been run.

25. How much money did you spend on this project? Tax dollars?

Response: On average approximately $500,000 per model, some of the larger models may receive slightly more. A lot of that information is found on the TWDB web site [http://www.twdb.state.tx.us/assistance/financial/fin_research/rfpwr.htm]. Up to $1.3 million has been initially authorized for water research assistance from the TWDB's Research and Planning Fund for this research for FY 01. A total of $1.6 million in funds

is anticipated to be appropriated by the 77th Legislature for FY 02. Thus the total anticipated cost of this program is $2.9 million. Following the receipt and evaluation of all applications, the TWDB may adjust the amount of funding initially authorized for water research. Including $300,000 that TWDB contributed to the Northern Gulf Coast model, the total budget for FY 01-02 was $3.2 million. The budgeted amount for the Central Gulf Coast GAM project is $551,326.00.

26. How small a geographic area can the model accurately represent? Would you be able to use it for a 20 square mile area?

Response: Probably a bit larger, something on the order of 10 by 10 grid cells which would be 100 square miles.

27. The half million dollars for Central Gulf Coast, was that 100 percent tax dollars or did Texas Water Development Board accept contributions from a private entity to help fund the work?

Response: 100 percent taxpayer.

28. Can you discuss some of the sources of funding for some of the other models being developed for the state of Texas, and whether those models duplicate efforts of existing models? For example, will the work of the Edwards Authority, working on the Edwards aquifer, be duplicated by the TWDB.

Response: We are trying not to duplicate efforts, however we do want to make sure that all the models developed for the State use a consistent format. We are looking at a minimum of one square mile grids and some other parameters that are important so we have a standardized way of looking at all the aquifers and the inputs are compatible across different models. The USGS and Harris-Galveston Subsidence District are also contributing to the GAM effort, doing the northern Gulf Coast, collaborating both financially and technically with the Texas Water Development Board. There were some other models that were already done in conjunction with the Regional Planning Groups, like the northern Ogallala, which is now being brought up to GAM standards. Finally, there are also a few models being done in-house or we're having consultants do. The TWDB is modeling the lower Gulf Coast, Edwards-Trinity Plateau, Cenozoic Pecos Alluvium, and the Northern Edwards in-house. The southern Edwards Balcones Fault Zone aquifer is not being duplicated by TWDB. The EAA/USGS team is coordinating their efforts with TWDB during the modeling process.

29. I was curious about the funding sources. The early literature passed out at the water conservation district temporary board meeting indicates that solicitations would be made to private corporations and other entities to contribute to the GAM effort. Did the Texas Water Development Board accept money from private corporations or private entities to help fund these studies?

Response: Not for the GAM effort. I can check into that and have that answer posted on our website. Per legal counsel, TWDB can accept private donations (citation 31 Texas Administrative Code Chapter 353.83 - 353.89 Subchapter F http://www.twdb.state.tx.us/publications/rules/353_0202.pdf). In addition, TWDB does perform research for other studies. In other words, someone pays us to do research. So yes TWDB does accept money from outside our agency. Therefore some of our project's funding does not come out of taxpayers' money, someone pays us for these products – to do a study or to do a report.

30. Since you are using a mile square grid, it seems like monitoring wells would be much more accurate or logical method?

Response: All of the wells within the state database will be evaluated. Some of them are monitor wells, so they are there for that exact purpose, but all wells in the database will be reviewed – ranking them depending on the conditions when the water levels were measured and the method of measurement. The flow model does not use any water quality information, the model uses water levels to get up and running. Water quality is a big concern and issue, which is why Parsons went ahead and as part of their sub-contract work looked at water quality and it will be included in the report. To get the model up and running we need to start with the basics. Even though it sounds like it is a lot of money, being able to have models that would predict water transport and water quality issues is cost prohibitive. We just do not have the money to get it up to that level of detail and type of model. What we can do is establish the foundation. We can get a flow model up and running, and with time and additional money and effort and people who want to use it - can enhance and refine it.

31. Once the model is complete how can local groundwater districts access the model and at what cost.

Response: It's free. It's going to be posted on the TWDB website [http://www.twdb.state.tx.us/Gam/]. We are using MODFLOW. All the input that goes into the model itself will be posted on the web site as well as directions on how to get to the MODFLOW model. Most model information, aside from new flashes, will be accessed by clicking data then groundwater then GAM. All the groundwater information we are talking about now will be in that general area of our web site. For example, we do have some models already posted on the website, such as Trinity Hill County. That information can be accessed by anyone who wants it and wants to run the model.

32. What level of computer literacy does one need to run the model?

Response: A pretty high level, it is not just a matter of running the model. Interpretation of the results is also fairly challenging. It does not require a sophisticated background in hydrogeology, it is a matter of absorbing the manual, and getting through the initial part of the learning curve. The manual is a public domain document.

33. What about structural effects on the aquifer with changes in pumping or water levels?

Response: I assume you are referring to subsidence. The Houston area has a lot of data on subsidence so it is possible to try and replicate that process with a model for that area. However, there is not sufficient historic data to create a subsidence model for this region. While the Central Gulf Coast model will not have the capability to simulate compaction, it still can be used to try and identify scenarios that would result in changes conducive to compaction.

34. Why do we need an expensive study? Why not set a rule that says you will not pump more than the maximum recharge

Response: The intent of this modeling effort is to produce a tool that policy-makers can use to determine groundwater availability. The model accounts for recharge and can be used by the policy makers to examine the trade off between changes in pumping and its impact on water levels.

35. Essentially you are doing just a scientific study showing how much groundwater is available, correct? Questions about water quality and whether pumping will cause compaction, that will be left up to someone else?

I would call it a practical study, the term scientific study can often have a stigma of endless research associated with it. We use the best data available, we have a very specific scope dictated by legislation, and we have very specific objectives. We are producing a practical tool, but even if this was a purely scientific-research study, you would still start with the same approach we are using. The first most basic thing to represent is the flow regime. If you capture the flow regime you set the foundation for doing a whole suite of possible simulations or representations of the physical-chemical system. If you do not have the flow system foundation, you have nothing. We are building a foundation. We are building the first tool, one that – depending on whether somebody wants to run regional, or state or local, could be refined or extended. The model will contain the data necessary to calculate or define the maximum amount of water i.e. volume of water in the aquifer. It should be used to help the policy-makers when making their decision on the regional amount of water available for use. The model will show areas of declines or concern. The report will contain water quality information to assist the policy-makers as they adjust the available volume to account for this concern.

36. If I were a water planner and I wanted to know if there were 40,000 acre-feet of groundwater available in Refugio and Victoria Counties for a project I am planning, would the model be able to tell me?

Response: It would be able to tell you, as long as your neighbors did not cause large changes. If every single one of them started pumping a lot more water then you would need to represent those changes. There are boundaries to the model, and you have to

make assumptions about what is happening across the boundary. Now some of those boundaries are fairly static and will not change but there are certain circumstances that can change boundary conditions and all of the sudden the assumptions you made are no longer valid.

37. How are you going to represent stream flow, its contribution to groundwater flow, and what will you use for the streambed conductance?

Response: There is a streamflow routing package by Prudic with the USGS MODFLOW model. It is a package that is a standard part of the MODFLOW model and we will be using that to represent streamflow. It takes into account stream reaches, gaged flow rates, and a few other parameters to try to represent the amount of flow in a stream and the propensity of that flow. For streambed conductance we will probably end up using something pretty close to the vertical conductance of the aquifer.

38. How does the model structure, the layers you have shown us, compare to the aquifers that we draw water from? Many of the people in this room are most concerned with wells that are less than 120’ to 190’ deep. Will this model tell us if deeper pumping will affect these shallower wells?

Response: The impact on wells in this area that are 120’ to 190’ feet deep will be represented within the top model layer. As far as predicting impact you would have to run a “what-if” scenario, you would have to run the model for a set of conditions and see what it predicts.

39. Is your model going to be a tool that we can use to determine our water management plan, for the local groundwater management districts to assess impacts of proposed water exportation? Is it going to be specific enough that we can directly address specific members of the Goliad and other sands, is that too specific?

Response: It gets back to a previous question about what is the minimum area we would be willing to look at. If you are looking at a 100 square mile area and you are wondering about the possible impact of San Antonio's water acquisition upon your 100 square mile area, I think its an appropriate tool. It certainly has potential to be used to demonstrate possible long-term impacts. The model could be used to examine a variety of scenarios including different pumping conditions and changes in precipitation.