Texas Water Development Board (TWDB) Groundwater Availability Modeling (GAM) Program

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Texas Water Development Board

Texas Water Development Board

Disclaimer

The following presentation is based upon professional research and analysis within the scope of the Texas Water Development Board's statutory responsibilities and priorities but, unless specifically noted, does not necessarily reflect official Board positions or decisions.

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Agenda

- TWDB Introduction GAM
- Introduce Contract Team
- GSI Environmental Presentation
  - Background and History
  - Project Approach
    - Model Details
    - Schedules
  - Request for Data

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GAM Program

- **Aim**: Develop groundwater flow models for the major and minor aquifers of Texas.
- **Purpose**: Tools that can be used to aid in groundwater resources management by stakeholders.
- **Public process**: Stakeholder involvement during model development process.
- **Models**: Freely available, standardized, thoroughly documented. Reports available over the internet.
- **Living tools**: Periodically updated.

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GAM Program

- So far the models developed for the program are groundwater flow only and do not include water quality or density flow

- This project is to update the existing groundwater model for the Queen City, Sparta and Carrizo-Wilcox aquifers

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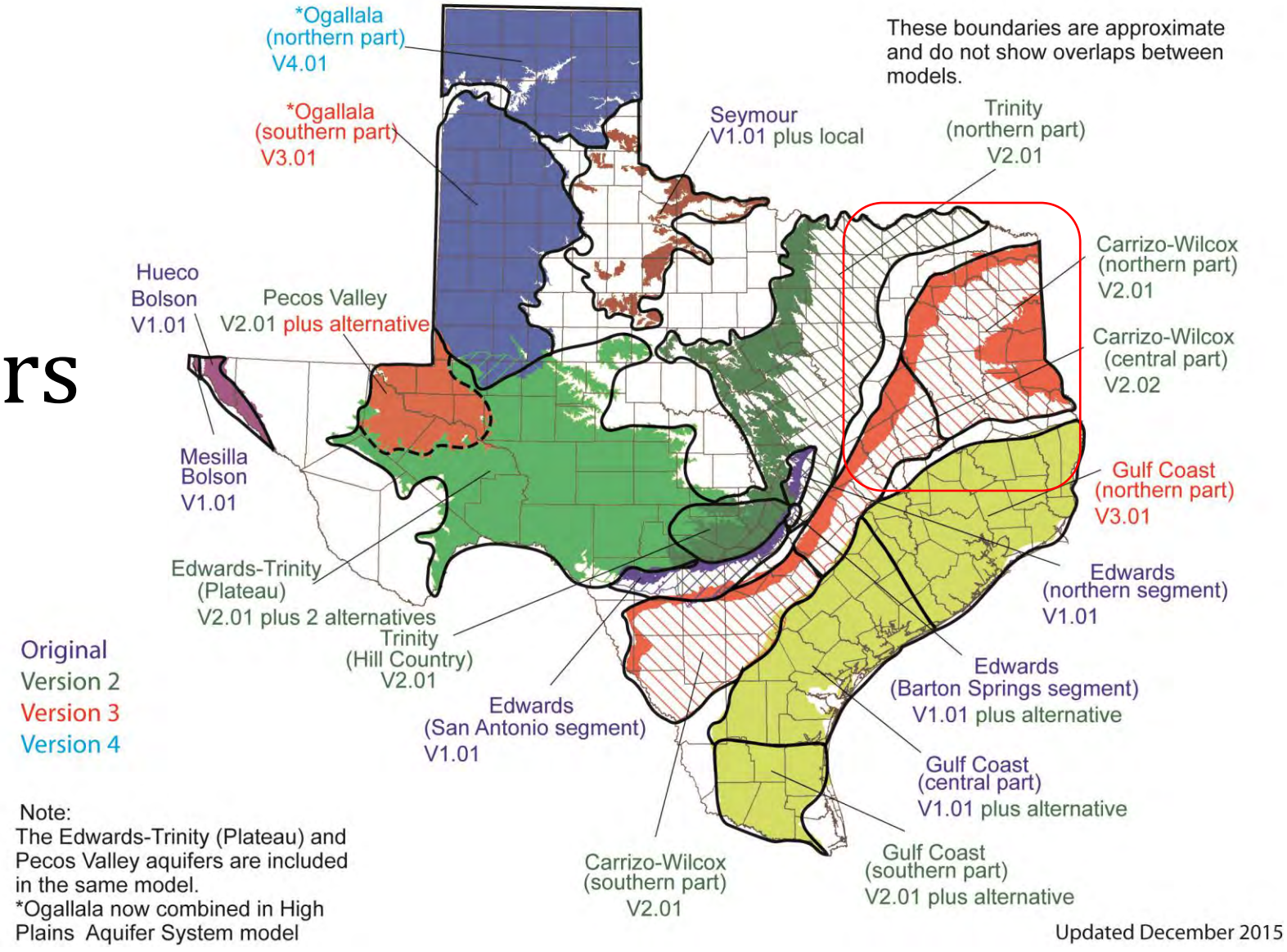
Major Aquifers



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Why Stakeholder Advisory Forums?

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

Texas Water Development Board

Contact Information

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Texas Water Development Board

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Web information:

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

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Project Team

- Includes leaders and pioneers of groundwater modeling
  - GSI Environmental: **Sorab Panday** wrote the code MODFLOW-USG that has been released by U.S. Geological Survey
  - Environmental Simulations: President **James Rumbaugh** recipient of 2014 National Ground Water Association Technology Award. Co-authored Groundwater Vistas (pre- and post- processor of MODFLOW)
  - **Bill Hutchison**: Worked at El Paso Utilities, location of the largest inland desalination plant in the world, Kay Bailey Hutchinson Desalination Plant

Texas Water Development Board

Update of the Existing Groundwater Availability Model for the Northern Portion of Queen City, Sparta, and Carrizo-Wilcox Aquifers

Stakeholder Advisory Forum

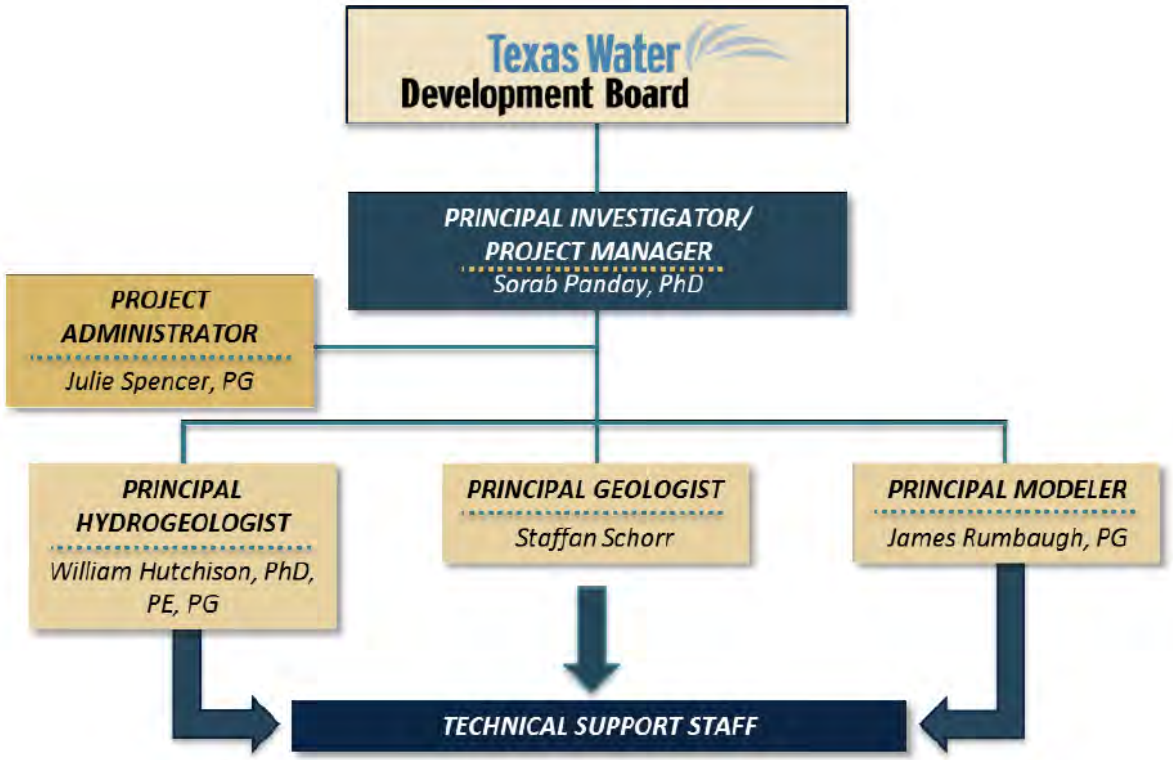
May 9, 2017

Topics

- Introduction to Project Team
- Introduction to Project Objectives
- Project Approach
  - Model Details
  - Schedules
- Request for Data
  - Groundwater well locations and construction details
  - Historic depth to water data
  - Geophysical logs of wells
  - Historic groundwater pumping data
- Questions, Input, Comments from Stakeholders

GSI Environmental Team

- Julie Spencer
- Sorab Panday
- Jim Rumbaugh
- Bill Hutchison
- Staffan Schorr



Team Background

- Sorab Panday
  - Primary author of MODFLOW-USG
  - Second Author on MODFLOW-NWT
- Jim Rumbaugh
  - Developer of Groundwater Vistas
    - Graphic User Interface to MODFLOW models
- Bill Hutchison
  - GMA 11 consultant
- Staffan Schorr
  - Expertise in developing 3-D geologic data for models
    - ArcGIS and Leapfrog Geo software

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History

- July 2016
  - TWDB Published Request for Statement of Qualifications
- August 11, 2016
  - Due date for Statement of Qualifications
- November 2, 2016
  - TWDB Awarded Project to GSI Environmental team
- March 28, 2017
  - Contract signed by TWDB
- May 8, 2017
  - Kick-off Meeting with TWDB and GSI Environmental Team

Background

- Current GAM used in development of desired future conditions
  - Proposed on April 28, 2016
  - Adopted as final on January 11, 2017
- During development attempts to update calibration were not successful (Tech Memo 16-01)
  - Current GAM calibration period: 1975 to 1999
  - Attempted updated period: 2000 to 2013
- Rising groundwater levels
  - Overestimates of recharge?
  - Inability to move water from outcrop areas to subcrop areas?

Potential Issues

- Model code
  - MODFLOW-96
- Steeply dipping aquifers
  - Transition from outcrop to subcrop areas
- Parameter assignment
  - Storativity/Specific Yield

TWDB Requirements/Objectives (1)

- Upgrade existing GAM to either MODFLOW-2005 or MODFLOW-NWT
- Issues regarding streams and reservoirs must be addressed
- Hydrostratigraphic framework must be evaluated and improved by analyzing well logs and/or geophysical logs
- Pinch-outs (e.g. Middle Wilcox) must be carefully analyzed and logically implemented

TWDB Requirements/Objectives (2)

- Must complete careful review and documentation of areas mapped as unconfined, but behave as confined
- Recommendations must be provided prior to implementing the model code
- Calibration period (minimum) must be from 1980 to 2015
  - Could be past 2015, depending on data availability

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Three Elements of a Good Model

- Good conceptual model
  - Code selection based on elements of conceptual model
- Good calibration statistics
- Can be used for intended purpose

Good Conceptual Model

- Hydrogeologic framework
  - Well logs, geophysical logs
- Aquifer parameters
  - Outcrop area
  - Downdip area
- Recharge/Evapotranspiration
- Historic Pumping
- Streams, Springs, and Reservoirs

Geologic Framework Updates

- TWDB identified some areas where the location of outcrops of the Sparta Aquifer needs improvement/updates:
  - Dillard (1963), TWDB Bulletin 6302 (Smith County)
  - Broom (1969), TWDB Report 101 (Gregg and Upshur Counties)
  - Broom (1971), TWDB Report 135 (Cass and Marion Counties)
  - Sandeen (1987), TWDB Report 297 (Rusk County)

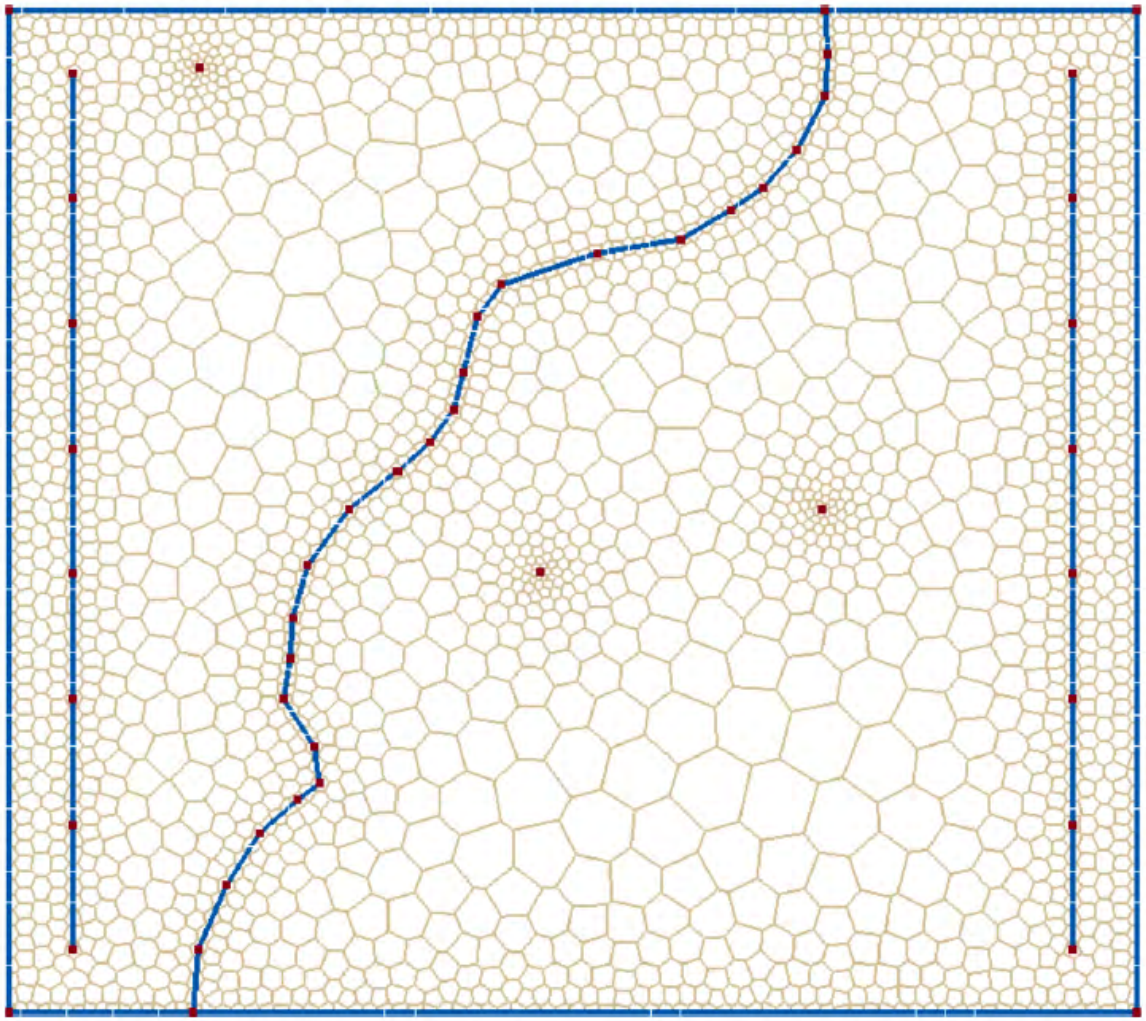
Model Code Update

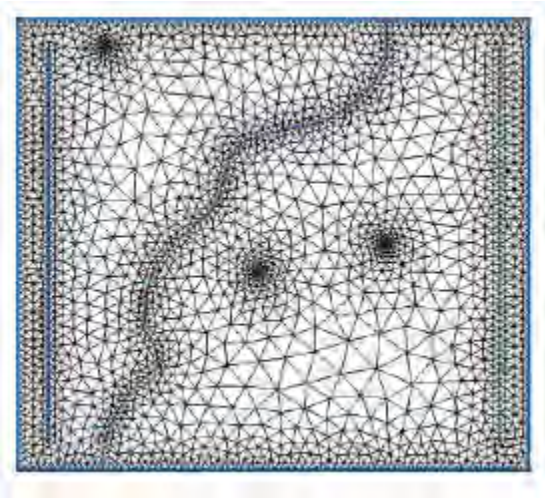
- Better handling of rewetting dry cells
- Proper simulation of wells
  - Wellbore provides conduit for interaction between aquifers
  - Correct apportioning of extraction from multiple aquifers
  - Drawdown in well independent of cell size
- Upgraded capability for streamflow routing
- Efficient solvers
- MODFLOW-NWT and MODFLOW-USG provide these capabilities

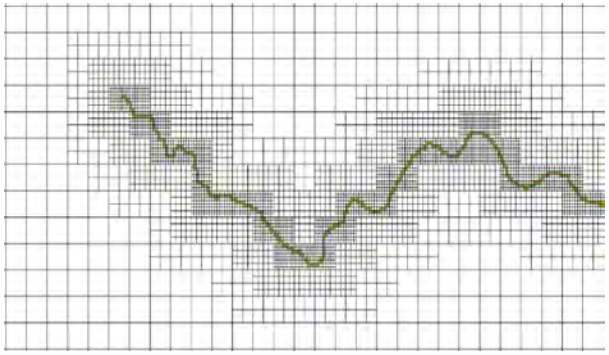
Model Code Selection

- TWDB specifically listed MODFLOW-2005 and MODFLOW-NWT as potential new codes for update
- GSI Environmental Team specifically proposed to test
  - MODFLOW-2005
  - MODFLOW-NWT
  - MODFLOW-USG
- MODFLOW-USG (Unstructured Grids)
  - Better representation of boundary features
  - Better representation for outcrops and pinch-outs
  - Better handling of local cell-size refinement
  - Can have multiple wells in a single cell
    - Well drawdown independent of cell size
  - Robust solution schemes
    - No “dry” cells

Examples of Unstructured Grids







Good Calibration Statistics

- Comparison of actual data with model simulated data (e.g. groundwater elevations)
- Current GAM did not distinguish between outcrop and downdip wells
  - Dominance of downdip wells
  - Poor outcrop calibration was effectively masked in the statistics
- Update will calculate calibration statistics for outcrop and downdip wells separately

Can be Used for Intended Purpose

- Current GAM developed in 2005
  - Prior to HB 1763 (Joint Planning)
- Efforts to use current GAM in DFC development in 2010 and 2016 identified areas where GAM could be improved
- Updated GAM will be tested with current DFCs to assure it can be used for DFC development (i.e. simulation through 2070)
  - Not officially a deliverable

Project Schedules

- Conceptual Model Deadline
  - June 28, 2018
- Calibrated Model Deadline
  - June 27, 2019
- Final Report Deadline
  - October 31, 2019

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Request for Data

- Information for wells
  - Locations and construction
  - Lithologic logs, geophysical logs
  - Pumping, water levels, water quality
- Information for surface water network
  - River and stream flows
  - Locations and construction of main canals, drains
  - Diversions, water quality

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Questions and Discussion

Julie Spencer (Project Administrator)

jaspencer@gsi-net.com

GSI ENVIRONMENTAL

MEMORANDUM

TO: Rohit Goswami, TWDB

CC: Cindy Ridgeway, TWDB

FROM: Julie Spencer, GSI Environmental Inc.

RE: Notes from the kickoff Stakeholder Advisory Forum for the Update to the Existing Groundwater Availability Model for the Northern Portion of the Queen City, Sparta, and Carrizo-Wilcox Aquifers project

The kickoff Stakeholder Advisory Forum for the Update to the Existing Groundwater Availability Model (GAM) for the Northern Portion of the Queen City, Sparta, and Carrizo-Wilcox Aquifers project was held at Nacogdoches City Hall located at 202 E. Pilar Street in Nacogdoches, Texas on May 9, 2017. A summary of the meeting, questions asked and answers provided, and a list of attendees is provided below.

The meeting began at 1:15 PM with an introduction to the project and Texas Water Development Board (TWDB) team by Dr. Rohit Goswami. After TWDB's introduction, Dr. Bill Hutchison, Technical Consultant for the project, gave a presentation summarizing the project background, history, approach, and the types of additional data desired to develop the groundwater availability model (GAM) update. It was stressed that additional data would make the update more accurate and allow for predictions that have less uncertainty. The TWDB and Dr. Hutchison made the following data requests:

- Locations and construction details of groundwater wells in the study area,
- Historic depth to water data,
- Geophysical logs of wells in the study area, and
- Historic groundwater pumping data.

After the presentations were concluded, the floor was opened to questions from the audience. These questions and answers are summarized below:

Q1: Our Groundwater Conservation District (GCD) plans are due to be prepared in 2018. Can I re-adopt the current plan for a year until the new model update is complete?

A1: The GCD plans must be updated within 2 years of when the Groundwater Management Area (GMA) adopted the desired future condition (DFC). . Updated GCD plans need to reflect the latest adopted DFC, and the TWDB will provide you modeled available groundwater (MAG) volumes based on the adopted DFCs. The MAG volumes the TWDB provides as a result of the 2016 round of joint planning will not be calculated using the updated model. However, the updated model will be available for use in the next round of joint planning. Model runs provided by the TWDB for use in GCD plans will use the updated model after it is complete. GCD plans are due every 5 years.

Q2: What format do you need geophysical logs to be provided in? I think we have both paper and electronic.

A2: If you have electronic, that is preferred, but we will take whatever you have available. We will be doing spot-checks on the existing data to ensure the quality of that data.

Q3: We just converted well construction logs to shape files. Is that what you need?

A3: Yes. Shape files would be great. The sooner that we can get the data, the better, so we will have adequate time to do our quality checks.

Q4: How far back do you want to start the data?

A4: Anything related to geophysical and well logs.

Q5: Do the regulatory agencies have any of this data?

A5: Yes, and we have a lot of that, but I know that there are additional data and this is what would be very helpful to access.

Q6: We have a railroad box car that has been used to store data since the 1960's. If the regulatory agencies don't have the data you need, we may be able to find it in this storage area. If you could tell us what data you need, it would make it much easier to try and find it.

A6: Electronic logs are the most important.

Q7: Do you have access to pumping data from the TWDB and Texas Commission on Environmental quality (TCEQ)?

A7: Yes.

Q8: If we have artesian wells, or wells affected by natural gas, is the location data important?

A8: Yes.

Q9: Can you email us a copy of today's presentation?

A9: All the slides from today's presentation will be posted by the TWDB on the Northern Carrizo webpage.

Q10: Are you making any outreach to water well drillers for information?

A10: Not specifically. However, we encourage the GCDs and other stakeholders attending this meeting to provide us with any relevant information.

Q11: What is the strategy for getting information that is not in the TWDB or TCEQ files? There are on the order of 30 counties in this region and not getting data on where drillers found water and where they did not is valuable information. Without this information, the model will lead to incorrect conclusions.

A11: While we welcome these data and will consider them where appropriate, this is a regional-scale model that may not be able to accommodate all local conditions. The model is not intended to or be capable of explaining specific dry spots drilled in the northern Carrizo aquifer.

Q12: Will it be able to help determine areas of confined versus unconfined conditions?

A12: In the current GAM, the outcrop and downdip areas are not distinguished in terms of calibration statistics. In this update, we will include calibration statistics for each separately.

Q13: So is the data from 26 of 30 counties sufficient to update the GAM accurately?

A13: Yes, because the model is on a regional scale. Like any model, it will have some limitations, but used for its intended purpose, that quantity of data should be adequate.

Q14: What is the grid of the model going to be?

A14: This will depend on the code. If we use 2005 MODFLOW or NWT code, it will be a regular grid. If we use MODFLOW-USG it may be an unstructured grid.. As part of the project, we aim to be assess all three codes and working with the TWDB staff to select the most appropriate code for the data.

Q15: So, TWDB can choose USG if that provides the best fit with available data?

A15: Once we assess all three models, TWDB staff will review it and a decision will be made on which code to use going forward.

Q16: When you make the model grids smaller, is the data captured better?

A16: Not necessarily. With USG the model grids are variable and these will be assessed to determine the optimum grid size.

Q17: So, USG does not just to make the cells smaller, it can make them larger too?

A17: Yes. The current contract with TWDB states that the model grid cell size will be 1 mile by 1 mile or smaller. If USG is selected as the preferred model, those cells may become variable in size but the maximum dimensions would still honor the contract requirements.

Q18: In the northern portion of this area, one well in a mile grid is not accurate. I'm fine with smaller grids, but if it's larger I think that there is too much uncertainty in some of these counties. Some wells in this area (in Cass, Marian, Upshur and Gregg counties) pump a lot of groundwater, and putting data from those wells into one model cell may not represent actual conditions.

A18: If there is a lot of pumping in a concentrated area, we may focus on that area with smaller grids. In areas where there is not a lot of pumping, the grid size may be adjusted accordingly. However, because this is a regional model local-scale areas (within a few hundred yards) may still not be characterized to the degree that you are looking for. We will also be incorporating the regional sands.

Q19: So, it's the assumptions that are being made that will dictate cell size?

A19: Groundwater moves regionally. With this update, we are trying to track and understand that regional movement. This issue is to remember what the purpose of the model is and design it towards that objective. Our goal is to figure out how the water moves regionally and what happens when you pump it.

Q20: The regional question that I want to know is how much water is in the ground and subject to development in those counties that are pumping a lot of water. There is currently a lot of conflicting information and disagreements about how much water is available. For example, in Region D, no counties have a conservation district and they rely heavily on groundwater from the Carrizo. We want to figure out how much volume of water is available for extraction. We want this tool to help quantify how much water is available on a regional scale. There are a lot of disagreements about the volume of

water in the ground, and some of those estimates are very conservative and some very liberal.

A20: Are you concerned with volume of water in place or volume of pumping? The model is designed to show what happens when you pump from that volume. In the GMA process, the models are used to test different pumping alternatives and assess those effects. It is a tool to evaluate the regional impact of different amounts of pumping. The updated model, like the previous model, may be able to estimate how much groundwater is in storage. However, that is not the primary purpose of the model.

Q21: For me, volume is a two-sided coin. With the top of the coin for pumping and the bottom for storage. They are interconnected. There are areas where the amount of water in storage is so vast, that effects of pumping and a decrease in the water table are inconsequential. In other areas the effects of pumping are severe. That is what the DFC exercise is. It is not idealistically how much water is stored in the ground; it is a limitation of how much can be removed, right?

A21: Correct, a DFC is a policy statement which leads to modeled available groundwater values that indicate the amount of water that can be pumped to achieve the DFC. Volume is a very small part of the equation. There are areas in the State where there is a large volume of water, but pumping all that water may affect springs and base flow to rivers and streams. These effects are just as important a consideration as the effects of pumping on other people's wells. The updated GAM is a tool to help local districts and policymakers make decisions on groundwater pumping proposals.

Q22: Are you going to re-assess the map area; specifically, the outcrops?

A22: Yes. We are re-evaluating the geologic framework as part of the model update.

Q23: Will you be considering alluvial flows around rivers?

A23: Yes. If we use MODFLOW-USG, inflow and outflow may be refined by using smaller grids in those areas. It is designed to handle these conditions better than other models. If USG is not selected, those flows may not be assessed with refined grids, but they will still be assessed nonetheless. Inflow and outflow are not considered in the current DFC.

Q24: Would recommendations from the GCDs on their DFC's be welcomed by the TWDB and the project team?

A24: Yes, absolutely. In addition, our project team could present our model and findings to Stakeholders at GMA 11 meetings. Keeping the Stakeholders informed is a key part of this project.

Q25: Beyond U.S. Geological Survey (USGS) gauging stations, what data are you using to determine surface water/groundwater interactions?

A25: With the USGS data, you can tell where the gaining and losing areas of streams are and you can add them into the model. We estimate on a regional basis where those areas are and add that information into the model.

Q26: How much difference will this model have over the existing model with regard to gaining/losing streams? Is the difference a function of data or interpretation?

A26: The code improvements will likely make the most difference, followed by the data. The current model has structural deficiencies, and we will be improving that. In addition, the current model was only calibrated for a 20 year period, prior to development of the DFCs. It has been used for functions it was never designed for. The new model will have more robust code and is designed for the intended purpose of developing DFCs.

Q27: Can't you just go back and use the old data and run it through a new model?

A27: Yes, in theory. However, we already tried that and the existing model would not calibrate. There are some fundamental issues with the old model that we will be correcting with this update to the GAM.

Q28: Surface water availability models (WAMs) have an accountability period of 50 years to account for the effects of severe weather patterns. However, the current groundwater model didn't account for drought and periods of heavy precipitation due to the 20 year calibration period. We are trying to find a model that will look at a greater time period than 20 years.

A28: The biggest stress on surface water availability is change in precipitation. With groundwater, the biggest stress is change in pumping. So, we are trying to understand the effects of pumping. However, most of the pumping data that is available only goes back to about 1984. So, it would nice to go back and incorporate historical data, but that is not available.

Q29: So, no matter how good the new model update is, it is still limited in time. So, when would the model be updated to account for this lack of data?

A29: TWDB would make the decision regarding the next update of the model. It is important to note, however, that the model would only need updating if pumping or other conditions changed significantly and the impact of that change is not captured adequately by the current model.

Q30: One of my biggest worries is that you will either over estimate or underestimate the amount of water in the ground due to the lack of historical data. If you underestimate it, you are leaving water in the ground that could be extracted. If you overestimate it, you are restricting the amount of water for removal. The current model became final 15 years ago and has a lot of deficiencies. Are we waiting 15 years for the next update?

A30: The timing of model updates is determined by the TWDB considering statewide priorities, available staff to directly update models, and available funding to support contractor-led updates. You bring up a good point, though. We will be looking at not only historical data that is available, but temporal data. We will also be looking for regional trends of groundwater/surface water interactions.

Q31: How does the model deal with aquifer storage and recovery (ASR)?

A31: Most impacts of ASR are local. The model we are developing is designed to evaluate regional conditions. You would need a local-scale model designed to look at the effects of ASR. This model is not designed for assessing ASR and should not be used to assess the effects of ASR. If you have additional questions about ASR, you may want to contact Matthew Webb at the TWDB at (Matthew.Webb@twdb.texas.gov or 512-463-6929)

Q32: I'm trying to make sure that our management techniques over the next 20 years are not inhibited by ASR.

A32: To assess the effects of ASR, you would need to know the movement and geochemistry of the waters. This model will not answer questions about geochemistry.

Q33: If it is outside the scope of the model update to assess groundwater quality, how do you know if you are pumping fresh versus brackish water?

A33: You can still answer a significant amount of questions by using a flow model. On a regional scale, this update will still give you an idea of the type impacts associated with pumping.

Q34: Is anybody going to look at the Trinity model to see how freshwater and brackish water interact? There are speculators buying up leases in Wood County with plans to sell groundwater to Dallas. How will this be accounted for in the model?

A34: We are setting up a model that will be calibrated to historic conditions. We are using data from about 1984 through 2015 to calibrate our model. The regional planning groups will need to estimate what pumping conditions will be in the future. The model is then a tool used to estimate the effects of those strategies. If a regional model is not calibrated to massive changes in pumping that occur in a given area then those the stresses may not be not be accurately captured on a regional-scale.

Q35: If the conclusion of the model is that there is a lot of water available, it will affect the value of the land, etc. Is the model going to increase or decrease uncertainty?

A35: The model is meant to be used as a tool to guide decision-makers considering possible future pumping. . It is a tool for the GMA to help develop DFCs.

Q36: Are you going to have a confidence interval for the data that is used in the model.

A36: Yes. We are doing an uncertainty analysis as part of our final work.

Q37: Are TERS (total estimated recoverable storage) just for the groundwater districts or are they available for counties without groundwater districts?

A37: There are TERS evaluations for all counties inside and outside of the district and they are available to the public. However, be sure to understand and provide all explanatory reports/data when using those numbers. One of the uses of this model will be to update the existing TERS numbers. We will be sure to look at that as we develop our updated model.

Q38: Are you going to account for TCEQ remediation sites where there are pump/treat/reinjection remedial systems in place?

A38: Not specifically, these systems would not have an effect on a regional scale and simulation of groundwater quality is not an objective of this model update.

Q39: Will you be looking at the effects of the Mount Enterprise Fault and Sparta Islands?

A39: Yes.

Q40: Will the fact that our GMA does not have a lot of groundwater conservation districts affect the accuracy of the model?

A40: It is a challenge, but typically, in non-district areas the pumping is modest and it is not characteristically different from those areas that do have groundwater districts. So, overall, there is not that much difference.

Q41: We have oil and gas issues in the fault areas and there are differences hydrogeologically on both sides. How will this be accounted for?

A41: We will be assessing the existing data from TWDB and any new data to group and layer this area in our model.

Q42: Will you be identifying springs?

A42: Yes, major springs may be identified by looking at water levels along streams and low-lying areas.

Q43: When you see a large rise in withdrawal, from municipal supply corporations (MSC) for example, how are you going to capture it in the model?

A43: We will categorize the water use by group and then use a combination of assessing population and withdrawal. When MSC water usage goes up, you should see a drop in rural/domestic well consumption.

Q44: In Upshur and Harrison Counties, groundwater quality issues drove people to switch to a MSC supplied by surface water. How will the model handle that?

A44: It would show as a decrease in pumping in the model.

Q45: Is the Sparta Aquifer in Arkansas area the same as the Sparta Aquifer in our area?

A45: Geologically, yes.

The audience was reminded that the presentations given today would be available for download from the TWDB website. The meeting was adjourned at approximately 3:30 PM. A list of attendees is provided below:

Name	Affiliation
Rohit R. Goswami	TWDB
Natalie Ballew	TWDB
Sorab Panday	GSI Environmental Inc.
Julie Spencer	GSI Environmental Inc.
Bill Hutchison	Independent Consultant
Jim Rumbaugh	Environmental Simulations, Inc.
Walt Sears	Northeast Texas Municipal Water District
Amanda Maloukis	Rush County Groundwater Conservation District
Leah Adams	Panola County Groundwater Conservation District
Jess Landreneau	Panola County Groundwater Conservation District

Jim Davis	Bi-County Water Supply Corporation
David Alford	Neches & Trinity Valley Groundwater Conservation District
Jackie Risner	Pineywoods Groundwater Conservation District

To provide information for use in updating the Existing Groundwater Availability Model for the Northern Portion of the Queen City, Sparta, and Carrizo-Wilcox Aquifers project, please contact any of the following:

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