Monthly Letter Progress Report #8:
Period 2, Fiscal Year 2017
Study of Brackish Aquifers in Texas – Project No. 4 – Trinity Aquifer
TWDB Contract No. 1600011950

Submitted to

Texas Water Development Board
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Monthly Letter Progress Report #8: October 29, 2016-November 25, 2016 Study of Brackish Aquifers in Texas – Project No. 4 – Trinity Aquifer TWDB Contract No. 1600011950

1.0 Budget and Expenses

This report summarizes the project costs for the billing period from Contract Approval Date (January 6, 2016) through the end of Period 2 of Fiscal Year 2017 (November 25, 2016). The total expenses through this period are $114,894.52. A breakdown of the budget by task is provided in Table 1. A copy of the progress report has been sent to Texas Water Development Board (TWDB) along with the monthly invoice.

2.0 Progress on Tasks

This report summarizes activities on project tasks during Fiscal Year 2017, Period 2 (encompassing October 29, 2016-November 25, 2016) and represents the eighth progress report on this contract.

Task 1: Project Management

During the reporting period, the subcontract setup with INTERA was completed. Progress was made on the agreements with the two in-kind teaming partners, Edwards Aquifer Authority (EAA) and Barton Springs Edwards Aquifer Conservation District (BSEACD).

Based on discussions with our teaming partner INTERA, the Northern Trinity and the Hill Country Trinity Aquifer regions will be divided for the majority of this project. SwRI will be responsible for the Hill Country region and the area between the Hill Country and Northern Trinity Groundwater Availability Models (GAMs). INTERA will be responsible for the Northern Trinity region. At the end of the project, both regions will be combined into one deliverable.

Task 2: Data Acquisition and Method Development

Task 2 has been subdivided into four subtasks. Progress on activities for the subtasks is as follows:

Subtask 2.1 Acquisition and Initial Analysis of Groundwater Samples

Water quality data were gathered from TWDB's groundwater database and reformatted to accommodate future statistical analyses. In addition to the aforementioned water quality database, spatial queries continued on Brackish Resources Aquifer Characterization System (BRACS)/TWDB databases. Other sources of information were evaluated, including

groundwater conservation districts, oil and gas databases, and water supply wells. INTERA staff are assessing screened completions in terms of aquifer units for water wells with water quality measurements in the Northern Trinity region.

Subtask 2.2 Acquisition and Initial Analysis of Geophysical Logs

Development of a database with spatial attributes of all available logs [e.g. BRACS, Information Handling Services Markit (IHS Markit), the Bureau of Economic Geology (BEG)], with care to adhere to BRACS format, continued. There are a total 2,141 wells that are being evaluated from the IHS database that met the criteria for consideration for stratigraphic interpretation (i.e., had a log depth that penetrated part or all of the Trinity Aquifer stratigraphic units). Over the next reporting period, the large number of potentially useful wells in the IHS database will be evaluated to identify wells important for use in this study. For these selected wells, the depth referenced logs will be retrieved from the IHS database for use on this project. Other sources of relevant information including published literature, Groundwater Conservation Districts, Oil and Gas databases, water supply wells, Texas Commission on Environmental Quality (TCEQ) Public Supply, and United Stated Geological Survey (USGS) Produced Water databases are under consideration for use in the project. A project database of water quality data relevant to the project domain and a preliminary hydrochemical facies analysis for the project domain continues to be developed using TWDB's groundwater database. INTERA analyzed existing geophysical logs and datasets in the Northern Trinity footprint from the Northern Trinity GAM development in order to interpret resistivity.

Subtask 2.3 Develop Technical Approach for Estimating Total Dissolved Solids from Geophysical Logs

Efforts have continued towards developing a method for correlating total dissolved solids (TDS) data and geophysical log attributes. Given its technical complexity, work on this task will continue for most of the duration of the project. Interpretation of logs for stratigraphy has begun, as well as estimation of TDS/Salinity from logs. INTERA used a dataset of water wells with resistivity/induction logs, water quality, and screen information to evaluate the potential to use the observed resistivity (Ro) versus Total Dissolved Solids (TDS) method to interpret the relationship between the Ro from the deep sensing resistivity/induction curve and the TDS as reported in the TWDB's groundwater database. Analysis on this dataset is currently ongoing. In addition to the Ro versus TDS method, INTERA also acquired logs necessary to evaluate the resistivity ratio method whereby the resistivity of mud filtrate (Rmf) and shallow resistivity (Rxo) are used to determine the Formation Factor (F) and subsequently solve for the resistivity of the formation fluid (Rw) from the deep sensing resistivity curve. Both of these analysis techniques are currently being evaluated.

Subtask 2.4 Use Geophysical Log Interpretation to Analyze Stratigraphy and Map Fresh, Brackish, and Saline Groundwater

Gamma ray logs are being utilized for interpreting stratigraphy. In addition, resistivity and spontaneous potential (SP) logs are being used for strategically located wells that do not have gamma logs. Also, resistivity and SP logs will be utilized for the salinity analysis. Digitized well logs are being evaluated and the development of our interpretation approach is underway. Significant progress on this subtask has already occurred, and work is expected to continue during the next several reporting periods.

The project team has begun developing the Methods Report. Decision trees are being designed in order to facilitate the decision-making process involved with calculating brackish water volumes.

Task 3: Develop a Stratigraphic Framework Model of the Trinity Aquifer and Calculate Brackish Water Volumes

Task 3 has been subdivided into two subtasks. Progress on activities for the subtasks is as follows:

Subtask 3.1 Extend Stratigraphy for the Hill Country Trinity

Information on stratigraphy is being collected and evaluated based on the extent of the data acquisition domain. Literature has been assessed for useful stratigraphic and structural information (e.g., cross-sections, fence diagrams, structure contour maps, well header information, stratigraphic horizon picks from wells, and fault maps), which can be utilized to fill in data gaps as needed throughout the project

Well logs from the BRACS well database that have stratigraphic information, including stratigraphic horizon picks and lithologic information, have been evaluated and will be quality controlled and re-interpreted as needed. The data are being evaluated to determine whether stratigraphic picks are consistent with those from other logs in the region, and/or with picks from a known reliable source such as a Key Well[1]. Log information from the IHS database is being evaluated and the team is utilizing the database.

Subtask 3.2 Determine Volumes of Fresh, Brackish, and Saline Groundwater

Evaluation of the relationship between electrical resistivity and fluid salinity has continued during this period. It is recognized that defining this relationship will be challenging due to the confounding influences of electrically conductive clay zones, but this work will be central to delineating the extent of brackish water in the Trinity Aquifer because geophysical logs will be the primary source of information used in this subtask.

[1] A key well is a well that is tightly constrained in terms of identification, position information, well geometry, pick information in measured depth, wireline log data tied to interval picks in measured depth, and formational water chemistry.

Task 4: Delineate Potential Production Areas

Progress on this task is contingent on completion of the previous tasks.

Task 5: Determine the Amount of Brackish Groundwater that can be Produced without Causing Impact on Lateral and Vertical Fresh Water

Progress on this task is contingent on completion of the previous tasks.

Task 6: Stakeholder Communication

Progress on this task is contingent on completion of the previous tasks.

Task 7: Reporting

Task 7 has been subdivided into 2 subtasks. Progress on the subtasks is as follows:

Subtask 7.1 Project Monitoring Procedures

The project timeline has been reviewed frequently. The project budget has been monitored on a weekly basis using the SwRI Project Cost System. Project activity for each period is summarized in status reports for review by TWDB.

Subtask 7.2 Project Deliverables

Progress on this task during this reporting period has included preparing and delivering "Monthly Letter Progress Report #7: Period 1, Fiscal Year 2017." Work on the Methods Report has been initiated. A draft outline has been formulated and progress has begun on developing the report.

3.0 Planned Activities for the Next Reporting Period (Fiscal Year 2017, Period 3)

Task 1: Project Management

The agreements with the two in-kind teaming partners, EAA and BSEACD, will continue to be a project-management focus during the next reporting period.

Task 2: Data Acquisition and Method Development

Task 2 has been subdivided into four subtasks. Planned activities for the subtasks are as follows:

Subtask 2.1 Acquisition and Initial Analysis of Groundwater Samples

Groundwater data, including groundwater data from within the data acquisition domain, will continue to be gathered, evaluated, and analyzed during the next reporting period. This evaluation will be ongoing for most of the project.

Subtask 2.2 Acquisition and Initial Analysis of Geophysical Logs

Additional geophysical logs (e.g., spontaneous potential, resistivity), including those from the IHS database, will be evaluated for usefulness in determining an approach for estimating TDS from the logs. Development of a database with spatial attributes of all available logs (e.g., BRACS, IHS, BEG), with care to adhere to BRACS format, will continue. Other sources of relevant information including literature, groundwater conservation districts, oil and gas databases, water supply wells, TCEQ Public Supply, and USGS Produced Water databases will continue to be evaluated as needed throughout the project. A project database of water quality data relevant to the project domain and preliminary hydrochemical facies analysis for the project domain will continue to be developed using TWDB's groundwater database. Staff will continue to utilize the IHS database. INTERA will continue to analyze existing geophysical logs and datasets within the Northern Trinity footprint from the Northern Trinity GAM to interpret resistivity.

Subtask 2.3 Develop Technical Approach for Estimating Total Dissolved Solids from Geophysical Logs

Efforts towards developing a method for correlating TDS data and geophysical log attributes will continue. Interpretation of logs for stratigraphy will continue. Some wells that have both shallow and deep resistivity curves will be selected and digitized. These curves will be cross-plotted so that the resistivity of the fluid can be estimated.

INTERA will continue to analyze their dataset of water wells with resistivity/induction logs, water quality, and screen information to evaluate the potential to use the Ro versus TDS Method to interpret the relationship between the Ro from the deep sensing resistivity/induction curve and TDS as reported in the TWDB's groundwater database. INTERA will continue to evaluate the resistivity ratio method whereby the resistivity of mud filtrate and shallow resistivity are used to determine the Formation Factor and subsequently solve for the resistivity of the formation fluid from the deep sensing resistivity curve.

Subtask 2.4 Use Geophysical Log Interpretation to Analyze Stratigraphy and Map Fresh, Brackish, and Saline Groundwater

Digitized well logs will continue to be evaluated, and the development of an interpretation approach will continue as well. Progress on this subtask is expected to continue during the next several reporting periods. Resistivity and SP curves will be evaluated with regard to potential digitization, to be utilized for salinity analysis in the future.

The Methods Report will continue to be developed. The decision flowcharts and trees will be refined as the intended methods for calculating brackish water volumes are developed.

Task 3: Develop a Stratigraphic Framework Model of the Trinity Aquifer and Calculate Brackish Water Volumes

Task 3 has been subdivided into two subtasks. Planned activities for the subtasks are as follows:

Subtask 3.1 Extend Stratigraphy for the Hill Country Trinity

Progress on this subtask will continue in the next reporting period with the assessment of relevant data.

Subtask 3.2 Determine Volumes of Fresh, Brackish, and Saline Groundwater

Evaluation of the relationship between electrical resistivity and fluid salinity will continue during the next period. It is recognized that defining this relationship will be challenging due to the confounding influences of electrically conductive clay zones, but this work will be central to delineating the extent of brackish water in the Trinity Aquifer because geophysical logs will be the primary source of information used in this subtask.

Task 4: Delineate Potential Production Areas

No work is expected to occur in the next reporting period.

Task 5: Determine the Amount of Brackish Groundwater that can be Produced without Causing Impact on Lateral and Vertical Fresh Water

No work is expected to occur in the next reporting period.

Task 6: Stakeholder Communication

No work is expected to occur in the next reporting period.

Task 7: Reporting

Task 7 has been subdivided into 2 subtasks. Planned activities for the subtasks are as follows:

Subtask 7.1 Project Monitoring Procedures

The project timeline will continue to be reviewed frequently. The project budget will continue to be monitored on a weekly basis using the SwRI Project Cost System. Project activity will continue to be summarized in status reports for review by TWDB.

Subtask 7.2 Project Deliverables

The eighth (current) progress report (covering Period 2, FY 2017) will be submitted to TWDB during Fiscal Year 2017, Period 3. As progress is made toward method development, the Methods Report will continue to be prepared.

4.0 Problems/Issues and Actions Required/Taken

No problems or issues were encountered during this period.

Table 1. Project Budget Versus Expenses

Task	Description	Budget (from SwRI Project Cost System)	Invoices			Remaining Budget
			Current	Previous	Total	
1	Project Management	$22,640.00	$0.00	$99.18	$16,481.94	$6,158.06
2	Data Acquisition and Method Development	$134,555.00	$16,197.03	$12,835.25	$83,229.65	$51,325.35
3	Develop a Stratigraphic Framework Model of the Trinity Aquifer and Calculate Brackish Water Volumes	$116,878.00	$7,242.98	$0.00	$7,242.98	$109,635.02
4	Delineate Potential Production Areas	$40,001.00	$600.57	$0.00	$600.57	$39,400.43
5	Determine the Amount of Brackish Groundwater that can be Produced without Causing Impact on Lateral and Vertical Fresh Water	$56,740.00	$0.00	$0.00	$0.00	$56,740.00
6	Stakeholder Communication	$35,631.00	$0.00	$0.00	$0.00	$35,631.00
7	Reporting	$13,555.00	$1,073.24	$1,731.38	$7,339.38	$6,215.62
Total		$420,000.00	$25,113.82	$14,665.81	$114,894.52	$305,105.48