Monthly Letter Progress Report #7:
Period 1, 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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November 11, 2016

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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 1 of Fiscal Year 2017 (October 28, 2016). The total expenses through this period are $89,780.70. 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 1 (encompassing October 1, 2016-October 28, 2016) and represents the seventh progress report on this contract.

Task 1: Project Management

During the reporting period, progress was made on setting up the subcontract with INTERA, as well as on the agreements with the two in-kind teaming partners, Edwards Aquifer Authority (EAA) and Barton Springs Edwards Aquifer Conservation District (BSEACD). Importantly, an authorization-to-proceed (ATP) that SwRI had previously transmitted to INTERA was signed by INTERA, and they have officially begun work on the project.

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 initiated an inventory of water wells with water quality measurements in the Northern Trinity region and started assessing screened completions in terms of aquifer units.

Subtask 2.2 Acquisition and Initial Analysis of Geophysical Logs

Nineteen additional gamma ray logs were sent to Well Green Tech for digitization. These were processed by Well Green Tech, and the digitized logs have been received by SwRI. Digitized logs are being evaluated to support development of an interpretation approach. In all, there were 167 gamma logs from the BRACS log database that were digitized. After evaluation, 140 of those were selected for use for stratigraphic interpretation.

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. Including the 140 wells that were recently selected for digitization, there are a total of 213 wells from the BRACS 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). In addition, 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 have continued to be gathered and evaluated. A project database of water quality data relevant to the project domain and a preliminary hydrochemical facies analysis for the project domain has continued to be developed using TWDB's groundwater database. INTERA evaluated existing geophysical logs in the Northern Trinity footprint from the North Trinity Groundwater Availability Model (NTGAM) development, determined which logs have sand/limestone/shale picks, and determined which logs have been digitized to LAS files. They also inventoried other geophysical well logs (i.e., short/long resistivity, spontaneous potential, others).

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

Efforts towards developing a method for correlating total dissolved solids (TDS) data and geophysical log attributes have been initiated. 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.

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.

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 continues to be 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).

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 (QC'd) 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.

Task 4: Delineate Potential Production Areas

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

[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 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 #6: Period 13, Fiscal Year 2016." 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 2)

Task 1: Project Management

Subcontracts with the subcontractor, INTERA, as well as 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. In particular, it is anticipated that the subcontract with INTERA will be finalized before the end of Period 2, FY 2017.

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

Data on water quality from within the data acquisition domain will continue to be gathered during the next reporting period. This evaluation will be ongoing for most of the project. Spatial queries will continue on BRACS/TWDB databases. Analysis of the groundwater data will continue. Collection of data on water quality will continue, as will evaluation of other potential

sources of information, such as groundwater conservation district well databases, oil and gas databases, and water supply well databases.

Subtask 2.2 Acquisition and Initial Analysis of Geophysical Logs

Additional geophysical logs (e.g., spontaneous potential, resistivity) 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 gathered and evaluated. 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 be trained on how to use the IHS database. Key well information will continue to be reviewed. INTERA will work to determine if there are sufficient water well/geophysical log pairings within their dataset.

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. INTERA will create cross sections with paired geophysical log(s) in an attempt to determine which of the sandstones and/or limestones, as picked on the geophysical logs, best correspond to the screened interval of the water well. They will work to compare deep resistivity values from the geophysical logs and the total dissolved solids from the corresponding water well. INTERA will use statistical methods to determine correlations between these two parameters in order to use the approach on other well logs. Vertical heterogeneities in calculated TDS will be evaluated to better understand resistivity/calculated water quality within a geologic formation.

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.

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.

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 progress report (covering Period 2, FY 2017) will be submitted to TWDB during Fiscal Year 2017, Period 3. Work on the Methods Report will continue. As progress is made toward method development, the Methods Report will continue to evolve. Assuming that the techniques INTERA intends to use (described in 3.0 under 2.3) are successful, these will be documented in the Methods Report.

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	$29.63	$99.18	$16,481.94	$9,903.05
2	Data Acquisition and Method Development	$134,555.00	$14,667.14	$12,835.25	$67,032.62	$77,522.38
3	Develop a Stratigraphic Framework Model of the Trinity Aquifer and Calculate Brackish Water Volumes	$116,878.00	$0.00	$0.00	$0.00	$126,878.00
4	Delineate Potential Production Areas	$40,001.00	$0.00	$0.00	$0.00	$40,001.00
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	$774.16	$1,731.38	$6,266.14	$3,543.87
Total		$420,000.00	$15,470.93	$14,665.81	$89,780.70	$350,219.30