EXHIBIT B

SCOPE OF WORK

Task 1. Project Management, Meetings, and Communication

The project will require coordination between TWDB staff, and interested stakeholders. To monitor work efficiently, the project manager will use GanttProject, an open source project planning and tracking software, as the tool for tracking and managing tasks and deadlines. As part of this coordination with TWDB staff and stakeholders, the CONTRACTOR will provide updates on the project status in the form of a Gantt chart with each monthly progress report. The progress report shall be formatted per the requirements of Exhibit E of this contract.

The project will be complete prior to the STUDY COMPLETION DATE.

Task 1.1. Meetings with TWDB Staff

The CONTRACTOR anticipates at least four meetings with TWDB staff during the course of the project. The following tasks describe the anticipated meetings.

Task 1.1.1. Project Kickoff Meeting

The CONTRACTOR shall meet with the TWDB within two weeks following CONTRACT EXECUTION for a project kickoff meeting. The CONTRACTOR anticipates this meeting to focus on schedule refinements, TWDB interaction, and data acquisition and evaluation.

Task 1.1.2. Discussion and Approval of Project Methodology Meeting

After completing 75 percent of Task 2, the CONTRACTOR shall meet with TWDB staff to discuss the status of the compiled data. The CONTRACTOR shall submit to the TWDB staff a draft report documenting the techniques and approaches selected for geophysical well log interpretation of aquifer total dissolved solids concentration (see Task 2.5).

This report shall include information on the types of geophysical well logs available, how the interpreted total dissolved solids concentration relates to existing aquifer water chemistry as determined by direct measurements, how the log correction factors are determined, and how the technique(s) will be applied across the entire salinity range within the aquifer. TWDB will have up to 10 business days to review the draft report, and the Contractor will schedule a meeting to discuss the techniques.

The project methodology meeting will allow the CONTRACTOR and the TWDB to collaborate on the identification of potential data gaps that the CONTRACTOR can address prior to completion of the project. In addition, the CONTRACTOR can discuss revised or additional evaluation that the compiled data may dictate.

During this meeting, the CONTRACTOR will discuss the proposed methods of evaluating the potential production areas to determine the 30 and 50-year volumes of brackish groundwater production and the effect that production may have on other areas or aquifers.

Task 1.1.3. Discussion of Potential Production Areas Meeting
Immediately following the stakeholder meeting where the project results and information are presented and the TWDB solicits input on the potential production areas (see Task 1.3.2), the CONTRACTOR shall meet with the TWDB staff to discuss the potential production areas and prioritization for production calculations. During this meeting, the CONTRACTOR anticipates focusing on the apparent water quality at specific locations within the study area, the spatial and temporal trends in water quality with regard to salinity, the areas that meet criteria for potential production areas, and the application of methods for evaluating the potential production areas.

Task 1.1.4 Final Draft Report Completion
This meeting will involve presentation of the final report and project results. During this meeting, the CONTRACTOR will demonstrate the three-dimensional GIS datasets developed during the project that illustrates the salinity zones. The CONTRACTOR will also discuss the results of the evaluations conducted for the defined potential production areas.

Task 1.2. Stakeholder Meetings
Stakeholders will be able to provide data and important insights that the data may not readily reflect. The CONTRACTOR anticipates at least one stakeholder meeting as described below. TWDB staff will organize the meetings and invite the stakeholders. The CONTRACTOR will attend and present information and results at the second stakeholder meeting.

Task 1.2.1. Solicitation of Input on Potential Production Areas
Following completion of Task 4, the TWDB will schedule a stakeholder meeting to present the results of the salinity delineations and solicit input on the potential production areas. The CONTRACTOR shall provide 30-day notice to the TWDB prior to the meeting. The CONTRACTOR shall also provide presentation material to the TWDB one week prior to the meeting. During this meeting, The CONTRACTOR will present a summary of the data collected, the methodology for evaluating the salinity of the groundwater in the aquifer, and the three-dimensional datasets developed that quantify the estimated groundwater salinity throughout the aquifer.

Task 1.3. Internal Project Monitoring
The CONTRACTOR will submit the information communicated in monthly status reports submitted with project invoices to the TWDB. These monthly status reports will include an outline of the progress on the project relative to the original schedule timeline as well of other requirements as indicated in Exhibit E. In addition, the status report will include a detailed description, consistent with the budget description, of the progress made on each task. Should any issues develop, the project manager will report the issue to the TWDB contract manager immediately. For public presentation, the CONTRACTOR shall illustrate task and project completion status on a project website. A Gantt chart on the website may be updated at least monthly to provide interested stakeholders with an avenue to keep track of the project.

The CONTRACTOR will summarize progress by providing the TWDB with monthly status reports for the duration of the project. The project manager will document any problems or unexpected data shortfalls in each report, and if necessary, call the TWDB project manager to discuss problems.

Task 2. Hydrogeologic Data Acquisition and Compilation
In addition to data available from the TWDB, the CONTRACTOR shall evaluate other data sources such as the Railroad Commission of Texas, the Texas Commission on Environmental Quality, Bureau of Economic Geology, The Texas General Land Office, U.S. Geological Survey, U.S. Environmental Protection Agency, log libraries, and local stakeholders (such as municipalities, public water suppliers, etc.). During this task the CONTRACTOR will compile all data obtained into the Brackish Resources Aquifer Characterization System (BRACS) Database format (Meyer 2014) and geodatabase format per the requirements of Exhibit G of this contract. Details regarding incorporation into the geodatabase format are discussed in Task 4.

The CONTRACTOR will prepare and implement a quality control plan that will include specific checklists for use during work progression and shall address the following:

- **Verification** – Part of the standard quality control procedure is to verify data entered into a database against the original source data, if available. Data imported from an internal agency database or an outside database shall be compared against the post-imported database to check records for accuracy and ensure that duplication of data has not occurred.
- **Level of confidence** – Mapping and visualization requires significant data which may be limited in some areas. Therefore, it is critical to include a quantitative measure of confidence with all new data points as databases often contain uncertainties with regard to data collection techniques. The CONTRACTOR will develop procedures to screen the validity of these data collection techniques and rank them according to specified levels of confidence in data accuracy. The CONTRACTOR can then use these confidence rankings during interpolation and mapping to help estimate potential errors associated with low-confidence data. The CONTRACTOR will coordinate with the TWDB in this effort.
- **Self-validation** – The CONTRACTOR shall build a series of automated checks into the system for self-validation. Examples include instrument reporting ranges, historic data for a sampling location (where available), expected ranges of values, correlations between measurements (for example, chlorides and total dissolved solids), missing data fields, consistency of units, or the identification of duplicate records. This is an efficient method proven for validating data and identifying outliers.

Task 2.1. Brackish Resources Aquifer Characterization System Database
The BRACS Database will be the starting point for data acquisition and compilation. The work will focus on enhancing and building upon the work conducted by others to develop and maintain the current database (Ortuño, et al., 2012; Meyer, 2014). The CONTRACTOR will work with the TWDB BRACS group to maintain synchronization with the most recent BRACS Database format as this and other projects alter the database; the CONTRACTOR anticipates that this synchronization will be handled through the GIS application.

Task 2.2. Groundwater Availability Model and Model Datasets
A numerical groundwater model will be developed for the Blossom Aquifer in the project area. Work associated with the development of the model includes compilation of data used to define the geologic structure, lithology, and movement of groundwater. The CONTRACTOR will compile the model data with the compiled BRACS data. The CONTRACTOR shall use publically available data to enhance this study.

Two key components to the volumetric calculation of groundwater are the static water level and specific yield of the aquifer. The CONTRACTOR shall incorporate the specific yield data compiled for and included in the numerical model into the project database for re-interpolation, if needed, during evaluations.

Task 2.3. Water Quality Sample Data

The TWDB Groundwater Database is a regularly updated database containing groundwater quality data. In addition, the BRACS Database may contain data not found in the TWDB Groundwater Database. For public water systems, the CONTRACTOR shall review the TCEQ Safe Drinking Water Information System to obtain source water quality data and the CONTRACTOR will also contact the public water system to request additional water quality data if available. Where possible, the CONTRACTOR shall supplement these datasets with water quality data available from the U.S. Geological Survey National Water Information System. The CONTRACTOR will work with local districts, water authorities, and well owners to collect any additional data for inclusion in the dataset.

The CONTRACTOR shall review data from the U.S. Geological Survey Produced Water Database. It may be possible to use the total dissolved solids (TDS) data to aid in calibrating salinity calculations from geophysical logs.

For these datasets, the CONTRACTOR will use well identification numbers, well location, well completion, and sample results to identify duplicate samples. The CONTRACTOR will remove duplicates from the dataset, and the well identifier from the non-BRACS Database will be added to the BRACS foreign key table to relate it back to the BRACS well ID.

Task 2.4. Geophysical Logs

There are several opportunities for obtaining non-proprietary geophysical logs. For public supply wells, the CONTRACTOR shall work to obtain geophysical logs from TCEQ. In addition, the CONTRACTOR shall explore obtaining well logs from well owners when available. The CONTRACTOR shall also gather logs for oil and gas wells from the Railroad Commission of Texas and Bureau of Economic Geology (Groundwater Advisory Unit and Integrated Core and Log Database, respectively) that are additional to those previously delivered to the TWDB as part the work by Ortuño, et al. (2012).

For logs obtained that the CONTRACTOR believes to be in addition to those already in the BRACS Database, the CONTRACTOR will catalog the well logs and relate the log to the BRACS well ID in the database. For logs not currently in digital format, the CONTRACTOR shall scan the log to allow rapid access via hyperlink in the BRACS Database. The CONTRACTOR shall incorporate all geophysical well logs and interpretation data values documented in BRACS Database table format with links to well numbers, log numbers, depths, and names of geological formations and any other data linkage activity required by Exhibit G of this contract.

Task 2.5. Draft Evaluation Technique and Approach Report

While acquiring and compiling data for evaluating the brackish groundwater resource, the CONTRACTOR will prepare a draft report documenting the techniques and approaches proposed for geophysical well log interpretation of aquifer total dissolved solids concentration. The report shall include information on the types of geophysical well logs available in the project area, how the interpreted total dissolved solids concentration from geophysical well log analysis relates to existing aquifer water chemistry as determined by direct measurements, how the log correction factors are determined, and how the interpretation techniques are applied across the entire salinity range within the aquifer. The draft shall also include identification of potential data gaps that the CONTRACTOR can address prior to completion of the project.

This draft shall also include proposed methods of evaluating the potential production areas to determine the 30 and 50-year volumes of brackish groundwater production and the effect that production may have on other areas or aquifers.
The CONTRACTOR will submit this draft report to TWDB staff for review at least four weeks prior to the Discussion and Approval of Project Methodology Meeting (Task 1.1.2). Task 3.3 provides a brief discussion of anticipated evaluation methods to be included in the evaluation.

Task 3. Hydrogeologic Evaluation
During and subsequent to compilation of available data, the CONTRACTOR will apply knowledge of the Blossom Aquifer in the area as it assimilates newly acquired data into its current understanding.

Task 3.1. Geologic Framework
The Blossom Aquifer is a small aquifer in a three county area in northeast Texas. The aquifer consists of a Cretaceous sand formation in the Austin Group and can be up to a total of 400 feet thick. However, only a portion of that thickness is producible sand. Yield of wells decrease and total dissolved solids of the water increase with distance from the outcrop. Historically, The City of Clarksville and the Red River Water Supply Corporation have pumped the greatest volume of water from the aquifer.

Task 3.2. Water Quality Sample Data
The CONTRACTOR shall use the following criteria as the standard for eliminating potentially erroneous information:
- A well must have total depth estimate or documented completion intervals;
- A site must have a location accuracy of one minute or better; and,
- A water quality analysis must have a charge balance within five percent.

The CONTRACTOR will follow these established protocols to assess the reliability of all data acquired to supplement the existing dataset. Importantly, the CONTRACTOR will not remove any of the compiled data from the database; rather, the CONTRACTOR shall assign a reliability indicator to the sample in order to eliminate potential duplication of data compilation and assessment work in the future.

Once the CONTRACTOR has evaluated the reliability of the data, the CONTRACTOR will have a final XYZCt water quality sample dataset. That is, the CONTRACTOR will have a value (C) for various constituents and TDS at a spatial location (XYZ – latitude, longitude, elevation) at a specified time (t) for each reliable water quality sample. While the focus of this project is the TDS of the groundwater resources, the CONTRACTOR may use this final dataset to prepare Piper diagrams and Stiff diagram maps that will illustrate spatial changes in overall water quality and TDS.

If data are sufficient, the CONTRACTOR shall prepare these illustrations for time intervals that will provide insight into the temporal changes in water quality throughout the study area. In addition, the CONTRACTOR will use the most recent and reliable data available to identify the representative TDS values for use in future modeling and analyses, including volumetric calculations.

Task 3.3. Geophysical Logs

The CONTRACTOR shall use geophysical log signatures to develop estimates of the salinity concentration of water in the aquifer. There are several methods for developing estimates of salinity from geophysical logs (Turcan, Jr., 1966; Guyod, 1972; Ken E. Davis Associates, 1988; Collier, 1993; Estepp, 2010). As listed in the BRACS Database, these methods include (Estepp, 2010):

- The SP (Spontaneous Potential) Method
- The Alger Harrison Method
- The Estepp Method
- The Mean Ro Method
- The Rwa Method

The BRACS Database notes that these methods, as applied within the BRACS Database, are most applicable to waters with TDS concentrations less than 10,000 milligrams per liter (mg/L).

During geophysical log analysis, the CONTRACTOR shall conduct all calculations to determine the concentration in parts per million (ppm) of an equivalent NaCl solution. By focusing on the determination of an equivalent NaCl solution salinity, the CONTRACTOR can make a direct calculation of the salinity from the formation water resistivity as calculated from log signatures. That is, the CONTRACTOR can use derived formulas, such as those used to create reference charts (Schlumberger, 2009, p. 8), for calculating formation water salinity in ppm using methods discussed below. For each geophysical log, the CONTRACTOR can use as many methods as are applicable. The curves available for each log will dictate the methods used. As discussed by Ortuño, et al. (2012), the majority of the geophysical signatures provided as a deliverable for their project contained an SP curve followed by conductivity then resistivity curves. When porosity curves are available, the CONTRACTOR can incorporate those measurements into the formation factor calculations (see below). The CONTRACTOR anticipates being able to develop resistivity of water estimates throughout the sand zones identified during Task 3.1 using these three curves. The CONTRACTOR can then convert the water resistivity to salinity of a NaCl solution.

All calculations will begin with the information provided on the log header. If it is available, from the header for each well the CONTRACTOR will obtain its identification, location, elevation, measuring point, total depth, mud resistivity and temperature, mud filtrate resistivity and temperature, mud density, and bottom hole temperature. For the resistivity of the mud filtrate, the CONTRACTOR can crosscheck the value entered on the log header by recalculating the filtrate resistivity based on the mud density and resistivity (Schlumberger, 2009, p. 4). These data can be critical for subsequent calculations.

One drawback of the SP method is its sensitivity to clay or shale in and near a sand zone. To overcome some of the sensitivity, the CONTRACTOR will apply a bed thickness correction factor to the SP reading. While charts are available for determining the correction factor (Schlumberger, 2009, pp. 52-55), for expediency and increased precision the CONTRACTOR will apply a formula using the mud resistivity, flushed zone resistivity, and bed thickness to determine the correction factor. To determine the static SP, the correction factor is multiplied by the SP deflection, which the CONTRACTOR can then use to calculate the resistivity of the water at the formation temperature (Asquith & Gibson, 1982, p. 29).

The CONTRACTOR can use the deep conductivity and resistivity curves in 100 percent water saturated sand zones to calculate the resistivity of the formation water directly. The CONTRACTOR anticipates calibrating porosity, tortuosity, and cementation factors versus measured TDS values to obtain specific coefficients for the aquifer.
Where data permit, the CONTRACTOR can prepare plots of the salinity calculations versus the TDS values from water quality samples. These plots allow for developing equations relating salinity of the equivalent NaCl solution to TDS that are applicable to specific aquifers, sand zones, or geographic areas, as appropriate. In addition, the plots allow the CONTRACTOR to crosscheck and calibrate the constants in the salinity calculations. These equations allow the CONTRACTOR to translate the salinity derived from the geophysical log to an estimate of the TDS (LBG-Guyton Associates, 2006).

An advantage of calculating salinity from geophysical logs is the opportunity to calculate salinity at multiple points within the sand zones. The many calculations allow the CONTRACTOR to apply a statistical analysis to the multiple values for later use in volumetric calculations. Following verification of the results, the CONTRACTOR shall compile the calculated values in the BRACS database format. In addition, the CONTRACTOR can prepare box-and-whisker plots to illustrate the statistical salinity characteristics at various locations in the aquifer.

Task 4. Geographic Information System Application Development
The CONTRACTOR shall routinely integrate well data within ArcGIS-based applications and develops custom applications for data users to analyze data easily and efficiently within the GIS application.

Task 4.1. Convert BRACS Database to ESRI Geodatabase Format
The CONTRACTOR shall use relational data models to organize and structure data entered into the geodatabase. Working closely with the TWDB, the CONTRACTOR shall develop and implement the relational data gathered during data acquisition and standardization phases of the project.

The CONTRACTOR shall compile and integrate pertinent geologic and hydrogeologic data from the BRACS Database and numerical model datasets into a GIS geodatabase to facilitate technical analysis and organize, store, and document the information used to delineate fresh, brackish, and saline groundwater in the aquifer. The CONTRACTOR shall use the standard data model framework developed by the TWDB for geologic structure and groundwater modeling projects to accomplish this task. All source data currently in and added to the BRACS Database and derivative data shall be included in the geodatabase.

To facilitate the transfer of data from the BRACS Database to a geodatabase, the CONTRACTOR shall develop a code based data management tool. This tool will be included with the GIS application to allow rapid updating of geodatabase as the BRACS team adds new information to the database. The data management will be implemented within ArcGIS using the Python programming language. Within the geodatabase, a geology feature dataset will contain all of the point, line, and polygon feature classes and a water quality dataset will contain sample results, calculated salinity of an equivalent NaC1 solution, and calculated TDS values as point data. The CONTRACTOR shall manage raster data, such as scanned geologic maps, cross sections, digital elevation models (DEMs), and gridded surfaces, in particular the numerical model layer surfaces, within the geodatabase as a raster catalog. Hardcopy geologic and water quality maps shall be georeferenced and managed within the geodatabase raster catalog. The CONTRACTOR shall project all data per requirements as noted in Exhibit G of this contract.

The stratigraphic GIS data sets shall include well location, well depth, log type, and aquifer top and bottom elevations and depth from land surface.

The CONTRACTOR shall develop metadata for each data layer that documents data descriptions, spatial characteristics, attribute information, data structure, data reliability, relevant dates, sources, and contact information. The CONTRACTOR shall develop the metadata within the editor in ESRI ArcCatalog and will comply with Exhibit G of this contract.

Task 4.2. Interpolate Data to Enable Water Volume Calculations

The CONTRACTOR will need to develop estimates of the water quality at all locations in the geologic unit. Performing an interpolation will enable the assignment of probable TDS concentrations over large geographic regions from the comparatively small number of data points.

The CONTRACTOR anticipates focusing on the inverse distance weighted (IDW) and kriging interpolation methods. The CONTRACTOR assumes that vertical variations in TDS within a given aquifer are 1) minor and can be neglected or 2) are substantial and can be handled by splitting the aquifer into discrete units and performing the computations on each unit or 3) need to be investigated further.

For each aquifer, the CONTRACTOR shall apply multiple interpolation approaches to the measured or calculated TDS concentrations. The CONTRACTOR shall compare the interpolations to the measured and calculated values at the input points to determine the most appropriate method for the data. The CONTRACTOR shall save the final interpolations as rasters in the geodatabase for future querying by the ArcGIS toolbox. Similarly, the CONTRACTOR shall interpolate and store the thickness, specific yield, and static water level of each aquifer within the geodatabase.

Task 4.3. Quantification of the Fresh, Brackish, and Saline Groundwater Volume

Following interpolation of the point data to raster datasets in Task 4.2, the CONTRACTOR will use these datasets to calculate the volume of fresh, brackish, and saline groundwater. To ensure the process is repeatable and consistent, the CONTRACTOR shall develop tools in ArcGIS Model Builder for performing the calculations. Calculations shall result in a raster dataset with each cell representing the volume of water within each area defined by the raster resolution.

The process shall include calculating the volumes according to salinity classification zones per Exhibit G of this contract. The volumes within each salinity category will be summarized by county, groundwater conservation district, groundwater management area, regional water planning area, and river basin.

Task 4.4. Delineate Potential Production Areas

Using guidance from the TWDB and additional criteria from House Bill 30, the CONTRACTOR will use the developed datasets to delineate potential production areas. The following is a summary of the requirements that an area must meet to be designated:

- Average TDS concentration is more than 1,000 milligrams per liter;
- Sufficient hydrogeologic separation from areas in the same or another aquifer with an average TDS concentration of 1,000 milligrams per liter or less;
- Not currently used as a significant source of water supply for municipal, domestic, or agricultural purposes;
- Not part of a geologic stratum that is designated or used for wastewater injection through the use of injection or disposal wells permitted under Texas Water Code Chapter 27; and,
- Not within the Harris-Galveston Subsidence District and the Fort Bend Subsidence District.

The CONTRACTOR shall use the criteria to define the three-dimensional spatial extent of potential production areas within the aquifer. Each potential production area will be assigned a unique ID for relation to production area attributes (such as, hydraulic properties, volume of brackish groundwater subdivided by salinity classification zones, 30-year and 50-year production calculation estimates). These production area attributes shall be populated with values in a Microsoft Access database table, in supporting GIS files (top, bottom, and lateral extent), and in groundwater modeling files during later evaluation work.

The potential production areas will be presented to the TWDB staff for discussion during Task 1.1.3. During this meeting, the areas will be prioritized for performing 30-year and 50-year production calculations.

Task 5. Evaluation of Potential Production Areas

The CONTRACTOR will present the data acquisition, evaluation, and interpolation results at a stakeholder meeting coordinated by the TWDB (see Task 1.2.1). The presentation will provide information to stakeholders in the form of Microsoft PowerPoint slides and discussion by the CONTRACTOR. During the stakeholder meeting, the TWDB will solicit input on the potential production areas for conducting evaluations during this task.

Using the defined and prioritized potential production areas, the CONTRACTOR shall perform model simulations to determine the potential effects of the pumping from the area on other groundwater resources. The CONTRACTOR anticipates applying the numerical models to evaluate the pumping effects for many, if not all, of the defined potential production areas. In areas that may not reasonably represent a production area or where the production area is outside of the model boundary, the CONTRACTOR will develop a simple numerical model that reasonably represents the conceptual understanding of the local aquifer conditions.

Evaluation of the areas shall focus on developing the estimated volumes of brackish groundwater production in 30 and 50-year timeframes. During the evaluations the CONTRACTOR shall populate the production area attribute tables developed during Task 4.3. The CONTRACTOR shall develop complete metadata for all new GIS dataset developed during the evaluation of the production areas.

Task 6. Draft Project Report

The project report will detail the work conducted during the acquisition and evaluation of the geologic and water quality data. The report will also provide detailed documentation of the GIS application developed during the course of the project unless provided other guidance from the TWDB staff, we will use the Scientific Style and Format: The CONTRACTOR shall follow the writing guide noted in Exhibit D and content as required in Exhibit H of this contract.

The draft report will include maps and other visuals of salinity zone delineations and calculated volumes of groundwater within the defined salinity categories by aquifer, county, groundwater conservation district, and groundwater management area within the study area. The CONTRACTOR will provide seven hard copies of the draft report to the TWDB. In addition to the hard copies of the draft project report, the CONTRACTOR will provide a digital copy of the draft report in Word 2010 format and PDF format, the draft project geodatabase, and the draft GIS application.. Following delivery of the project report there will be a 30day comment period during which the TWDB will be able to provide feedback on the project results.

Task 7. Final Project Report

At the end of the draft project report 30-day comment period, the CONTRACTOR will address the submitted comments within a final project report. The CONTRACTOR will complete the final project report within30 days after the end of the draft project report comment period. The format of the report will be in accordance with the requirements of Exhibit D and Exhibit H of this contract. The CONTRACTOR will identify individual authors responsible for the report and those individuals will sign and seal the report per Professional Engineer or Professional Geoscientist requirements, as applicable.

Task 8. TWDB Training

The CONTRACTOR will provide instruction to TWDB staff to demonstrate specific methodologies and/or techniques utilized to determine volume calculations, salinity zones extents, or anything deemed necessary and appropriate for presentation within a training venue. This training will be provided at the request of TWDB, on an as-needed basis.