NOTICE OF OPEN MEETING

Notice is given that a **Regular Meeting** of the Board of Directors of the Barton Springs/Edwards Aquifer Conservation District will be held at the **District office**, located at 1124 Regal Row, Austin, Texas, on **Thursday, August 24, 2017,** commencing at **6:00 p.m.** for the following purposes, which may be taken in any order at the discretion of the Board.

Note: The Board of Directors of the Barton Springs/Edwards Aquifer Conservation District reserves the right to meet in Executive Session at any time during the course of this meeting to discuss any of the matters listed on this agenda, as authorized by the Texas Government Code Sections §551.071 (Consultation with Attorney), 551.072 (Deliberations about Real Property), 551.073 (Deliberations about Gifts and Donations), 551.074 (Personnel Matters), 551.076 (Deliberations about Security Devices), 551.087 (Economic Development), 418.183 (Homeland Security). No final action or decision will be made in Executive Session.

1. **Call to Order.**

2. **Citizen Communications (Public Comments of a General Nature).**

3. **Routine Business.**

   a. **Consent Agenda.** *(Note: These items may be considered and approved as one motion. Directors or citizens may request any consent item be removed from the consent agenda, for consideration and possible approval as a separate item of Regular Business on this agenda.)*

      1. Approval of Financial Reports under the Public Funds Investment Act, Directors' Compensation Claims, and Specified Expenditures greater than $5,000. **Not for public review**

      2. Approval of minutes of the Board's August 10, 2017 regular Meeting and Public Hearing. **Not for public review at this time**

      3. Approval of out-of-state travel for Brian Hunt to attend training on geologic software (RockWorks17) in Golden Colorado in September 2017. **Pg. 18**

   b. **General Manager's Report.** *(Note: Topics discussed in the General Manager's Report are intended for general administrative and operational information-transfer purposes. The Directors will not take any action unless the topic is specifically listed elsewhere in this agenda.)*

      Topics.

      i. Personnel matters and utilization
      ii. Upcoming public events of possible interest
      iii. Aquifer conditions and status of drought indicators
      iv. Update on team activities and highlights
      v. Update on area roadway projects
      vi. Update on the District HCP and ITP application
      vii. Update on legislative activity of interest to the District

4. **Discussion and Possible Action.**

   a. Discussion and possible action related to selection of the first-choice firm to provide technical services related to development of an integrated groundwater data management and reporting system and authorization to initiate contract negotiations. **Pg. 21**

   b. Discussion and possible action related to the revision and update of the District's Management Plan. **Pg. 45**

   c. Discussion and possible action related to the City of Dripping Springs TPDES permit application to authorize direct discharge of treated wastewater to Onion Creek in the contributing zone of the Barton Springs segment of the Edwards Aquifer. **NBU**

5. **Directors' Reports.** *(Note: Directors' comments under this item cannot address an agenda item posted elsewhere on this agenda and no substantive discussion among the Board Members or action will be allowed in this meeting. Communications reported under this item may be used to support Performance Standard 4-1 of the District's Management Plan related to demonstration of effective communication with District constituents.)*

   Directors may report on their involvement in activities and dialogue that are of likely interest to the Board, in one or more of the following topical areas:

   - Meetings and conferences attended or that will be attended;
   - Committee formation and updates;
   - Conversations with public officials, permittees, stakeholders, and other constituents;
   - Commendations; and
   - Issues or problems of concern.

6. **Adjournment.**

Please note: This agenda and available related documentation have been posted on our website, www.bseacd.org. If you have a special interest in a particular item on this agenda and would like any additional documentation that may be developed for Board consideration, please let staff know at least 24 hours in advance of the Board Meeting so that we can have those copies made for you.

The Barton Springs/Edwards Aquifer Conservation District is committed to compliance with the Americans with Disabilities Act (ADA). Reasonable accommodations and equal opportunity for effective communications will be provided upon request. Please contact the District office at 512-282-8441 at least 24 hours in advance if accommodation is needed.

Item 1

Call to Order

Item 2

Citizen Communications

Item 3

Routine Business

a. Consent Agenda

(Note: These items may be considered and approved as one motion. Directors or citizens may request any consent item be removed from the consent agenda, for consideration and possible approval as a separate item of Regular Business on this agenda.)

1. **Approval of Financial Reports under the Public Funds Investment Act, Directors' Compensation Claims, and Specified Expenditures greater than $5,000.**

2. **Approval of minutes of the Board's August 10, 2017 regular Board Meeting and Public Hearing.**

3. **Approval of out-of-state travel for Brian Hunt to attend training on geologic software (RockWorks17) in Golden Colorado in September 2017.**

Barton Springs
Edwards Aquifer
CONSERVATION DISTRICT

MEMORANDUM

TO: BOARD OF DIRECTORS

FROM: BRIAN B. HUNT

SUBJECT: OUT OF STATE TRAVEL

DATE: 8/18/2017

I am requesting permission to attend a training titled "RockWorks17 Workshop" in Golden, CO on Sept 20 and 21, 2017. This hands-on short course will be focused on the management, analysis, and visualization of geological data. I plan on purchasing the software in FY18 and using it to develop an enhanced hydrogeologic database, visualization, and analyses capability.

The cost of the trip is within our budget for training and professional development. Below is an estimated breakdown of costs:

Estimated budget	
Workshop Registration	free
Airfare	$ 300
Car rental	$ 200
Hotel	$ 450
Meals	$ 150
	$ 1,100

Item 3

Routine Business

b. General Manager's Report. *(Note: Topics discussed in the General Manager's Report are intended for general administrative and operational information-transfer purposes. The Directors will not take any action unless the topic is specifically listed elsewhere in this agenda.)*

Topics.

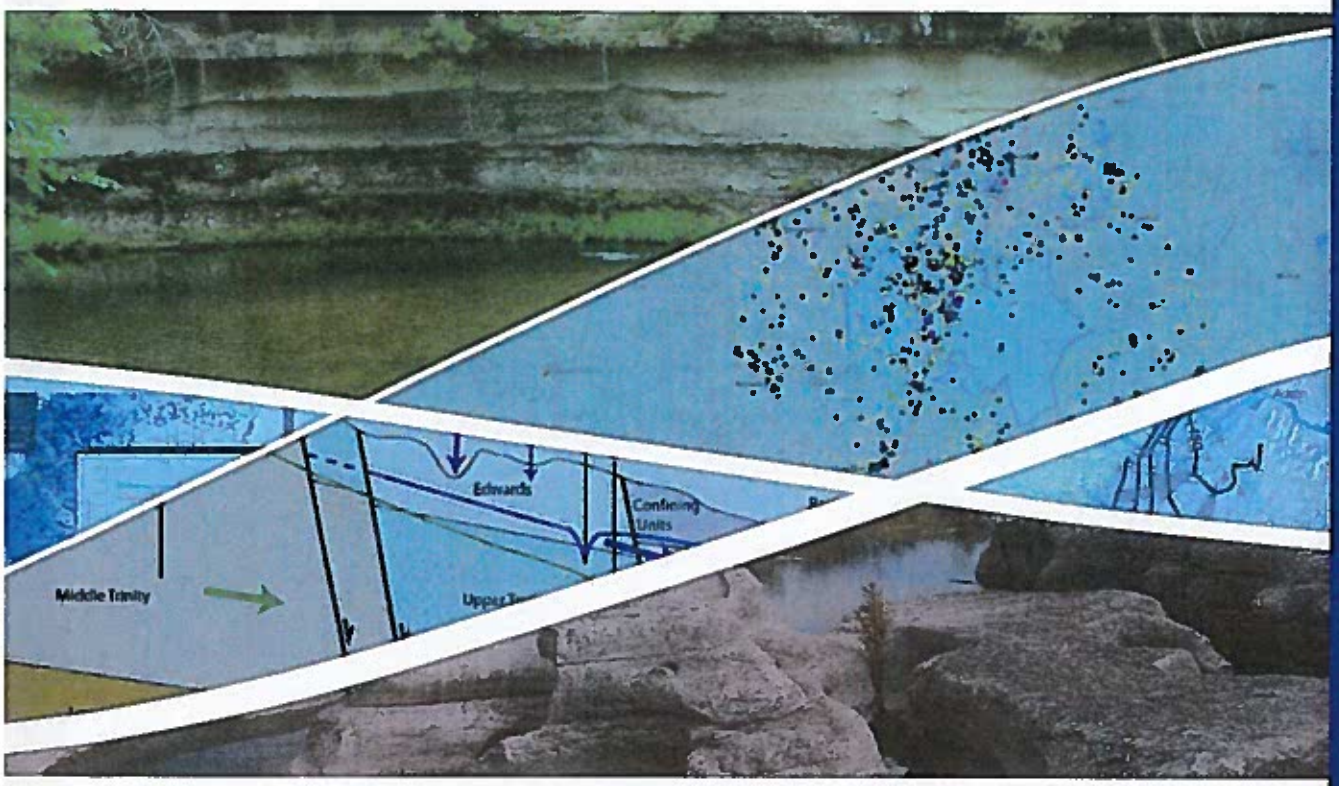
i. **Personnel matters and utilization**
ii. **Upcoming public events of possible interest**
iii. **Aquifer conditions and status of drought indicators**
iv. **Update on team activities and highlights**
v. **Update on area roadway projects**
vi. **Update on the District HCP and ITP application**
vii. **Update on legislative activity of interest to the District**

Item 4

Board Discussions and Possible Actions

a. Discussion and possible action related to selection of the first-choice firm to provide technical services related to development of an integrated groundwater data management and reporting system and authorization to initiate contract negotiations.

2.0 INTERA'S BACKGROUND AND EXPERIENCE



INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

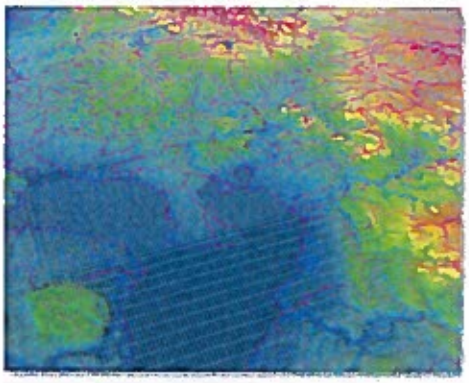
2.0 BACKGROUND AND EXPERIENCE

INTERA is a Texas corporation, based in Austin, focused on providing geoscience and engineering solutions to water resources, environmental, coastal, and waste isolation challenges. This section describes our overall qualifications and expertise, as well as our specific experience in the areas required to successfully develop an integrated groundwater management and reporting system for the Barton Springs Edwards Aquifer Conservation District.

2.1 Professional Qualifications and Areas of Expertise

INTERA is a geoscience and engineering consulting firm with over 40 years of experience in providing solutions to water resource, environmental, and waste management challenges. While our initial services focused on the development and application of hydrogeologic models and other quantitative tools to support environmental and waste isolation issues, in the late 1990s we began focusing our quantitative skills on hydrologic, hydraulic, hydrodynamic, and water quality modeling, GIS, and remote sensing to support the development, management, and protection of water resources.

INTERA was founded in 1974 as an environmental consulting firm focused on the development and application of numerical models and other quantitative tools to support the investigation and remediation of sites impacted by past or current industrial operations and the evaluation of sites being proposed as deep geologic repositories for radioactive wastes. Airborne remote sensing for applications such as evaluating the impacts of sulfur dioxide emissions on the natural environment and determining ice sheet thickness to support shipping transportation in the Arctic was also a major part of INTERA's early work. After 21 years of growth and expansion of services, INTERA was acquired by Duke Engineering & Services (DE&S) in 1995, and operated as the Geosciences Business Unit of DE&S for the next six years. In late 2001, several of the former INTERA staff initiated a buyout of DE&S's Geosciences Business Unit, and in January of 2002, INTERA was formally re-incorporated.



For the last 18 years, INTERA has focused our quantitative skills on applying numerical models and other tools to support the development, management, and protection of water resources. Our work has included the development of customized web-based GIS applications for regional water management agencies.

Today, INTERA focuses on providing services and delivering solutions in five key areas—water resources, environmental, coastal engineering, radioactive waste, and GIS and data management. Our water resources services include planning and policy, water supply, alternative water strategies, regulatory support and permitting, and remote sensing. Our environmental areas of expertise include assessments and investigations, groundwater modeling, human health and ecological risk assessments, site remediation and reclamation, permitting and compliance, and geoenvironmental engineering. INTERA's coastal engineering services encompass shore protection, transportation infrastructure, inlets and waterways, flood risk management, and coastal resources management. In support of radioactive waste isolation projects, we provide hydrogeologic characterization; near- and far-field flow, transport, and coupled process modeling; performance and risk assessment; and review, licensing, and regulatory compliance. Lastly, and most importantly for this project with the Barton Springs Edwards Aquifer Conservation District, our GIS and data management services include geodatabase design and implementation; custom GIS software tools; web-based database interfaces, mapping, and visualization; mobile mapping using ArcGIS Mobile and other platforms; characterization of spatial distributions of data; prediction of spatial patterns using interpolation; and definition of relationships between multiple overlapping datasets.

From an operational perspective, INTERA is organized by geographical groups (Southeastern, Southern, Southwestern, Midwestern, Western, Northwestern, and European). However, because we are committed to providing clients with the expertise needed to deliver the highest quality solutions, these groups are not operated as separate profit centers. Accordingly, all of INTERA's geographical groups use the complete spectrum of the company's capabilities and services. The development of an integrated groundwater data management and reporting system for the District will be managed under INTERA's Southern Group with key support from our Northwestern Group. Our focus is on bringing the best resources from across the company to deliver the highest quality products and services.

INTERA has a staff of 150 scientists, engineers, and support personnel. Our technical staff bring expertise in the areas of geology; hydrogeology; geochemistry; hydrology; water resources, coastal, and environmental engineering; environmental science; GIS and remote sensing; and computer programming. The graphs in **Figure 2-1** show the primary technical disciplines and education levels of our staff. Of particular importance to this project with the District, INTERA has six full-time software engineers dedicated to software development, including web-based GIS and database applications.

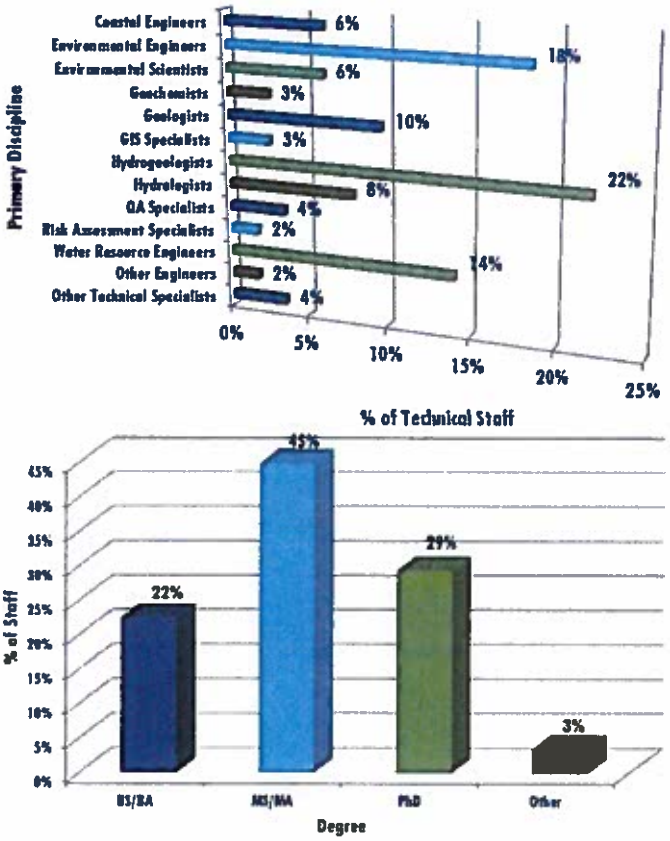
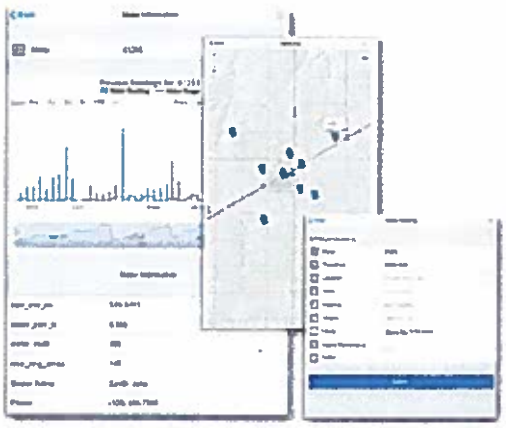


Figure 2-1. Summary of INTERA staff disciplines and educational levels

2.2 Experience in Developing Data Management, Mapping, and Reporting Systems

INTERA has developed many products and services for clients facing challenges similar to the District's—formulating a strategy for collecting large, disparate datasets and designing software solutions for collecting, visualizing and working with data, as well as integrating an existing database into a more robust one. Nearly every project we work on requires the analysis and management of large volumes of data. GIS provides an excellent means of storing, organizing, managing, analyzing, and sharing both spatial and non-spatial information. Most of our clients use basic GIS tools on the desktop in their day-to-day operations, and INTERA's geospatial technology professionals understand how to create, manage, and transfer GIS data in a way that supports or enhances existing workflows. INTERA designs and creates databases that meet the exact functional requirements of a project, and are easy for clients to manage and use.

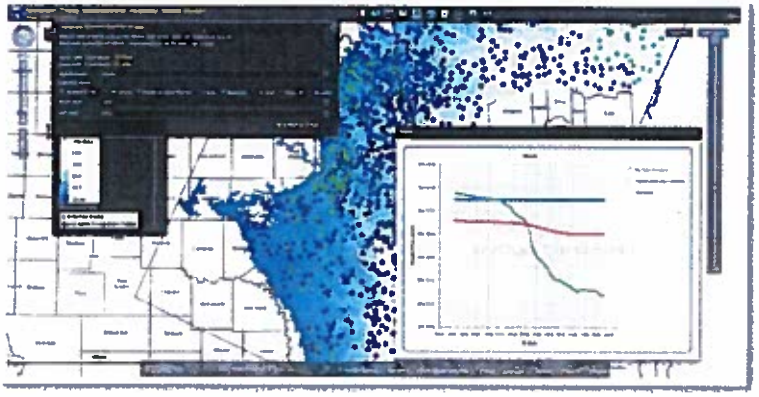
Data management system solutions require customized applications to perform project-specific spatial modeling and analysis. These applications can be developed for the desktop user, using ArcObjects® or other spatial analysis libraries, or for web and/or mobile user interfaces. INTERA develops web applications using modern JavaScript-based APIs, such as Leaflet.js or ArcGIS API for JavaScript, and mobile applications for both iOS and Android. On the server side, we have developed geodatabases using PostGIS and Microsoft SQL Server® with services provided by Geoserver or ArcGIS for server. Our software developers use their expertise to implement the database capabilities for scalability, reliability, and security. INTERA's goal for customized application development is to ensure that end users have the tools to lower operational costs and improve overall organizational efficiency.



MeterMaid, a database-backed web application server very similar in design to DripDrop, was developed by INTERA to allow PGCD staff to log and view water meter readings in the field with a mobile device.

Several recent examples of our experience developing data management, mapping, and reporting systems are provided below. To ensure that the experience and lessons learned from these projects are successfully transferred to our work for the District, members of our proposed team have actively participated on each of the projects.

Online Visualization Tool for the Northern Trinity Groundwater Availability Model, Texas. The Northern Trinity Groundwater Availability Model (NTGAM) Visualization Web Interface was developed by INTERA for eight GCDs within Groundwater Management Area (GMA) 8 to allow stakeholders to investigate and visualize data and results from the updated model (also developed by INTERA). The NTGAM Viewer is a web-based interactive tool that allows spatial visualization of model parameters (geology, transmissivities, storage coefficients or pumping distribution, etc.) as well as simulation results (hydraulic heads, drawdowns and hydrographs) for both the calibration and predictive simulation periods of the NTGAM.



The viewer also enables the identification of the values of non-time-sensitive model properties (hydraulic conductivities, model structure elevations and specific storage, etc.) as well as the trend visualization of time-sensitive model parameters data (hydraulic heads) and model results data (pumping and recharge, etc.). The NTGAM Visualization tool consists of an "Online Model Viewer" developed using the model geodatabase and ArcGIS Viewer for Flex as the graphical user interface (GUI), such that it can be accessed via any web browsers that support Flash. The data contained in NTGAM Viewer is composed of four basic types: overlay data, observation data, model parameters data and model results data. The data can be visualized across different geologic units as well as for different times across the simulation time period. The Model Viewer is composed of a variety of visual interactive elements called "widgets" that provide different functionalities to the user. These functionalities include:

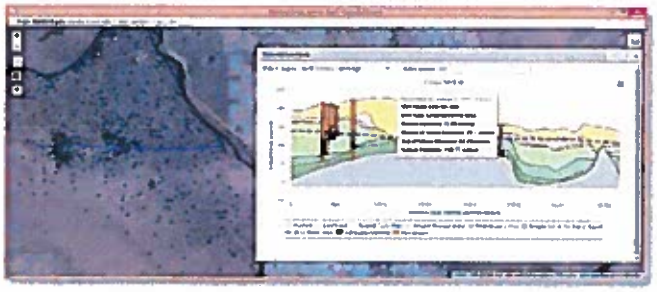
- Navigating through the map by dragging, panning, zooming and save/go to specific extents.
- Adding data layers to the viewer map and toggling their visibilities.
- Viewing legends of existing data layers on the viewer map.
- Identifying model property values or all values of different model layers on the map at a specific location.
- Querying and visualizing time series data from observations and model simulations in the form of a line chart at a specific location.
- Viewing electronic bore log documents associated with certain observation wells.

Mobile Applications for Collecting and Verifying Water Well Meter Data, White Deer, Texas. INTERA developed an application called MeterMaid for the Panhandle Groundwater Conservation District (PGCD) to improve the process and quality of collecting water usage data from water wells managed by the PGCD. MeterMaid is aimed at mobile devices but also works on standard computers and helps field technicians input readings from water well meters into the PGCD's database while they are on site. The production version is behind a password-protected firewall and includes a server, a database, and the web application itself, but a demo version is available at https://metermaid.intera.com. The District can login to review this demo with the username "bseacd_demo" and password "texasgw1".

PGCD employees log into the site, view and inspect wells, and post new meter readings to the database from their mobile devices. They can also post pictures that they take on site and link them to particular measurements. This was done to eliminate the need for return trips to the field to verify meter readings with questionable values. MeterMaid uses the geocodes embedded in the images to ensure that each reading is assigned to the correct meter. INTERA also implemented additional quality checks to flag unusual readings in the field based on historical usage patterns. MeterMaid includes an administrative website that employees with "admin" accounts can use to review, modify, and edit database records.

MeterMaid was developed as a Django application front end (written in Python, HTML, and JavaScript) and a PostgreSQL geospatial database backend, served with an Apache2 web server

hosted on a Linux server (Ubuntu 14.04). The application server was physically deployed as a stand-alone server (Lenovo ThinkServer) and is hosted by the PGCD. MeterMaid was launched in August 2016. INTERA provides maintenance and security updates remotely. Based on the success of MeterMaid, PGCD has asked INTERA to develop and deploy a similar system for collecting and assuring the quality of groundwater level measurements. This task was completed in 2017.



Development of Automated Tools for GIS Applications at the U.S. Department of Energy's Hanford Site, Richland, Washington. INTERA's expertise in designing, programming, and maintaining database-backed web applications is being used to develop multiple work enhancement and communication tools at the Hanford Site. INTERA has added new and improved functionalities to the Hanford Site GIS through the development of several customized computer programs and scripts. We designed and coded an ArcGIS-based tool that allows users to multi-select a series of parameters from a graphical interface within ArcMap. The tool automates the generation of large numbers of hard-copy maps needed for regulatory reporting based on user selected parameters and draws on data stored in an MS Access database. The customization was programmed in ArcObjects using Visual Basic for Applications (VBA) and included functionality to convert map layouts to saved image files. This tool has significantly improved spatial analysis capability and workflow for site GIS activities, particularly in the areas of modeling, engineering analysis, and regulatory reporting.

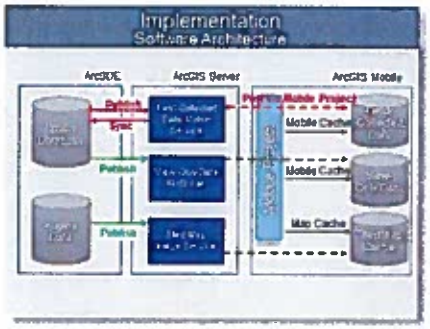
The application provides an interface for reading and downloading report content, and hosts a number of web-based geospatial tools for exploring groundwater chemistry, contaminant remediation, and the geological model of the Hanford site. Other tools in the application include well locations, cross-sections, water-level time series, and contaminant concentrations through time. Because the report content is used to demonstrate compliance with the Resource Conservation and Recovery Act (RCRA), INTERA designed the applications to emphasize cyber security, as directed by Mission Support Alliance, a Hanford Site contractor. For this product, INTERA used ArcGIS Server as the database/server backend, and developed the interactive mapping tools with Leaflets, a JavaScript library for rendering geospatial data.

We also developed the Plume Visualization Tool (PVT), a desktop application for Windows that helps make decisions about pump and treat remediation activities at the Hanford site. Our clients needed a method for tracking, managing, and viewing very large data sets (>6 Gigabytes, each). The PVT allows scientists to visualize the time evolution of contaminant plumes and identify optimal pump and treat scenarios by automatically solving a coupled groundwater/transport numerical model. The PVT makes heavy use of geospatial analysis, memory management, and numerical computing techniques and, given the very large data sets involved, is designed for computational efficiency. These tools can be accessed through the 2015 Hanford Annual Report here: http://higrv.hanford.gov/Hanford_Reports_2015/Hanford_GW_Report/.

Development of a GIS System and Web-Based Water Use Reporting Tool, Lubbock, Texas. The High Plains Underground Water Conservation District (HPWD) is the largest and oldest GCD in Texas, and oversees approximately 1.7 million irrigated acres. Rule changes motivated HPWD to develop a more automated system for allowing water well owners and operators to report well locations, meter locations, meter readings, the association between meters and wells, and contiguous acres. To address this need, INTERA developed a web-based system that includes user accounts so that information can be managed on an individual operator basis. Once logged in, an operator uses a map-based system, complete with cache-based imagery, to indicate which properties they are farming. The operator can then use a meter tool to enter the location of the water meters (or alternative methods) that are being used to track water production. A second tool allows the operator to show which wells are connected to

each meter, and the mapping tool shows those associations in real-time. Once the meters have been entered into the geodatabase via the mapping tool, the operator can select any meter and report meter readings to help manage water use.

Additional tools allow the operator to indicate missing wells (i.e., wells that are active on the property, but missing from HPWD records, and hence, do not appear on the map). The technology behind this system includes Esri ArcGIS Server running on a virtual Windows Server 2008 installation through Amazon EC2, a cloud-computing system. Using a cloud-based system allows superior uptime, bandwidth, and ease of maintenance compared to a local server, in cases where local resources do not include significant IT infrastructure. Both the HPWD relational database (containing all district data on wells, water levels, etc.) and the geodatabase (containing feature classes with location information specific to GIS tasks) reside in a Microsoft SQL server database structure. On the client side, the web account system was developed in ASP.NET MVC, using a look and feel that integrates seamlessly into the current HPWD website. The client-side mapping system and tools were developed on the foundation of FlexViewer, with all of the custom tools written in Flex. Communication between the client and server side is accomplished through ArcSDE and custom APIs.



Mobile Application for Querying, Updating, and Recording New Field Data, New Mexico. Working with the New Mexico State Land Office (NMSLO), INTERA provided an efficient means for District Resource Managers (DRMs) to access, use, and contribute back to the agency's enterprise GIS information in their daily visits to the field. The NMSLO manages more than 13 million acres for the benefit of schools and public institutions in New Mexico, and has the unique challenge of ensuring the "highest and best use" for generating revenues in perpetuity. As all transactions are tied to the land, it is critical that each DRM have current and accurate geospatial information at their fingertips while traveling to the remote corners of their Districts. Approximately 1 million acres of Trust land is monitored by each DRM, but that acreage is distributed over 16-20 million acre Districts. The scope of the project was to implement an ArcGIS for Mobile Project on the agency's Trimble Yuma GPS devices, allowing DRMs to query, update, and create new data while in the field and then dock into the network opportunistically to synchronize content with the GIS Server. INTERA's implementation included an analysis of the end-user requirements in relation to the NMSLO's existing spatial server and geodatabase infrastructure and data maintenance protocols.

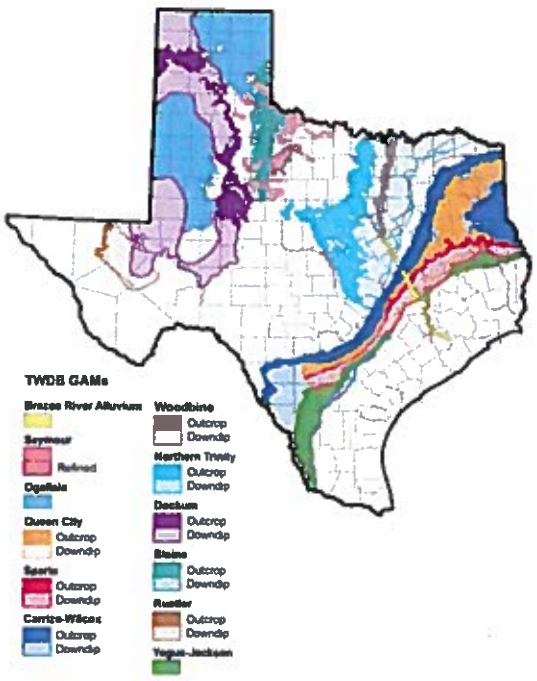
INTERA provided data modeling, assembly, and formatting as well as application interface configuration and project deployment to the devices. End-user training as well as technology transfer and documentation for the system administrators were also provided. An important aspect of this implementation was that the system be standardized and simplified so as to best encourage adoption by users with varying skill sets and field task priorities. The aim was to maintain database integrity in the simplest form until, with regular use, the priority datasets, workflows, and organizing principals surfaced organically. INTERA brought the right combination of technological expertise along with business understanding to implement the entire solution within the client's short timeline.

Database and Visualization Tools for Aquifer Tests in Groundwater Management Area 8, North Central Texas. Under contract to the Texas Water Development Board, INTERA developed a database and suite of visualization tools to support the analysis of information from approximately 1,000 aquifer tests and 4,000 public water supply (PWS) wells located in Groundwater Management Area 8 in Texas. Information was obtained from the Texas Commission on Environmental Quality (TCEQ) PWS Program. The well information includes more than 100,000 scanned pages, which were assembled into seven PDF document types that include driller's logs, well construction sheets, tabulations of borehole lithology, aquifer test results, laboratory reports of water quality, and geophysical logs. From the tabulated pumping rates and drawdown values in the aquifer test documents, text files for over 900 aquifer tests were generated. In addition to the PDF documents and the aquifer test data files, project data includes a version of

the Access database that TCEQ maintains to identify and characterize PWS wells, which are located across 45 counties. To facilitate the analysis of the project information, the project deliverables include shapefiles, visualization tools, and analysis tools that are compatible with ArcMap—the main component of Esri's ArcGIS suite of geospatial processing programs, which is commonly used to view, edit, create, and analyze geospatial data. The shapefiles can be used to identify wells with different sets of information and attributes. The analysis tools provide the capability to develop charts showing well construction, lithology, layers in groundwater models, and measured drawdowns from aquifer tests. The visualization tool can be used to view the PDF documents as well as charts generated by the analysis tools.

2.3 Knowledge of and Experience with Hydrogeology, Aquifers, and Relevant Data Sources and Data Management Practices

Through the completion of hundreds of water resource projects across the state, INTERA is intimately familiar with the hydrogeology, aquifers, and relevant sources of hydrogeologic data in Texas. Much of this knowledge comes from supporting the TWDB's GAM and Brackish Resources Aquifer Characterization System (BRACS) programs. In the area of groundwater availability modeling, INTERA has developed 12 GAMs that include the southern and northern Carrizo-Wilcox Aquifer (2 models); the Queen City Aquifer and Sparta Aquifer (3 models); the Yegua-Jackson Aquifer; the Dockum Aquifer; the Rustler Aquifer; the Seymour Aquifer which also includes the Blaine Aquifer in a first order treatment; a refined Seymour Aquifer model for a specific portion of the aquifer; the High Plains Aquifer System; and the Brazos River Alluvium Aquifer. We also developed an updated GAM for the Northern Trinity and Woodbine aquifers that has subsequently been accepted by the TWDB as the "official" model for use by GCDs in water planning. Through this work, we bring in-depth knowledge and understanding of the data sources, groundwater geodatabase schema for documenting source data, and the requirements for developing GAMs. We also offer more than 15 years of experience in working with stakeholders during the development of GAMs and subsequently transferring the modeling technology to the TWDB and other interested users.

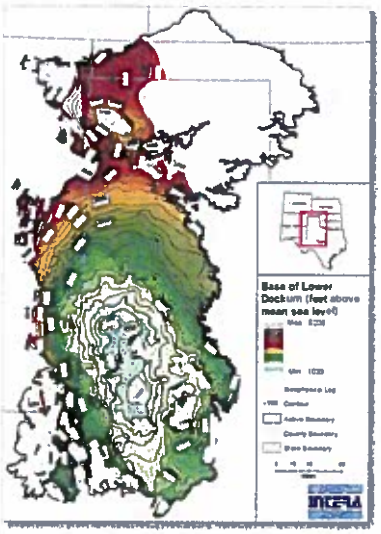


The TWDB has used INTERA's modeling expertise to lead the development of more GAMs of major and minor aquifers in Texas than any other contractor.

INTERA has also worked with numerous municipalities, river authorities, and commercial companies to conduct studies on hydrogeology, stratigraphy, depositional systems, and important hydrologic processes (e.g., recharge, groundwater-surface water interaction, water quality, pumping, etc.). This work has supported water resource planning, development, and management efforts across Texas. Examples of several projects, that demonstrate our knowledge of and experience with Texas hydrogeology, aquifers, and hydrologic data sources are provided below.

Groundwater Availability Model of the High Plains Aquifer System, Texas. INTERA led the development of a model of the High Plains Aquifer System (HPAS), which includes the Ogallala Aquifer, and three minor aquifers, including the Edwards-Trinity (High Plains), the Rita Blanca, and the Dockum. Our efforts included completing and delivering a conceptual model report that synthesized all of the data and analyses required to describe the primary aquifer characteristics, including structure, aquifer properties, water levels and groundwater flow, water quality, natural recharge and discharge to springs and streams, and pumping. The largest effort for the conceptual model was the development of regional structural surfaces. To accomplish this, we worked with the Bureau of Economic Geology to analyze and correlate more than 2,000 geophysical logs to provide point elevations and regional cross-sections for all of the High Plains Aquifer System units, including the Edwards-Trinity Plateau and Pecos Valley Alluvium aquifers. INTERA used the point stratigraphic elevations to create regional surfaces. The challenge in creating these surfaces was not the basic interpolation, but in enforcing the pinchouts, outcrops, and subcrops, and avoiding surface inversions. The geophysical log data and correlations were

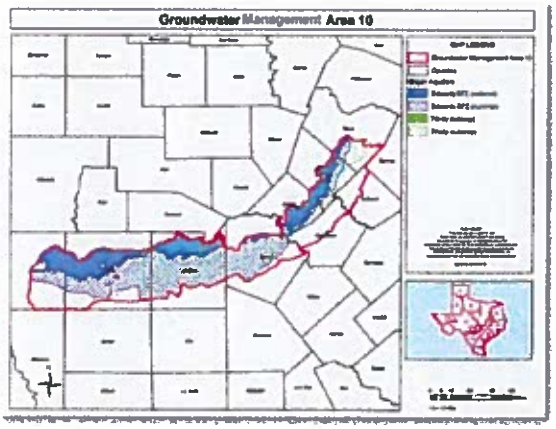
delivered as part of the conceptual model formatted for direct import to the TWDB BRACS database. The second most significant component of the conceptual model development was the estimates of recharge and discharge in the HPAS. INTERA worked with BEG to create both pre-development and current-day estimates of recharge in High Plains aquifers, the most significant of which is the Ogallala. Because agricultural development significantly affected recharge in the southern portion of the region due to breaking up surface soils and adding irrigation return flow, an approach for implementing recharge had to include a gradual transition between the predevelopment and current-day fluxes. The "breakthrough" to the water table of agriculturally enhanced recharge was timed based on the appearance of nitrates and higher TDS in measurements in the region. This allowed a spatially dependent breakthrough time to be implemented model-wide.



The third large component of the conceptual model development was estimating historical pumping in the Ogallala Aquifer. Because the irrigation surveys of the earlier decades are considered highly uncertain, INTERA developed a unique automated tool for interpolating water levels across various time periods and estimating groundwater production based on change in volume in place. Because recharge in the Ogallala Aquifer is dwarfed by pumping rates, this volume-based calculation proved very useful in constraining early pumping estimates. INTERA also compiled a large, master database of well locations in the region, using the TWDB Groundwater Database, TCEQ PWS database, several of the large groundwater district databases, and well driller databases.

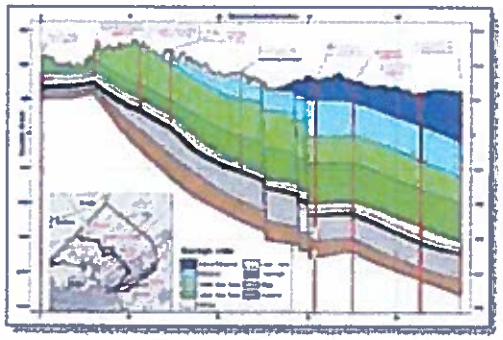
Development and calibration of the HPAS GAM was performed with the help of PEST. Pilot points were used to allow PEST to adjust both recharge and hydraulic conductivities within carefully chosen bounds, to modify our initial estimates of these parameters and result in a well-calibrated model. PEST was run in parallel on INTERA's Austin-based 88 node cluster, as well as on INTERA's Gainesville-based 96-node computing cluster. Because the HPAS GAM will be used for predictive simulations, INTERA performed several "proof of concept" predictive simulations with the model. This includes predictive simulation of the "50/50 rule" that is in place for much of the Ogallala Aquifer, and has the goal of 50% of the aquifer saturated thickness remaining after 50 years. INTERA held six public stakeholder meetings as part of the HPAS GAM project. In coordination with TWDB staff, we set up the meeting locations and dates, informed stakeholders, led the meetings, and delivered the results from these meetings (accessible presentation compliant with state regulations, notes, signup sheets, etc.) to the TWDB. INTERA met all of the project milestones and delivered the final report in August 2015.

Technical Support for Managing Aquifers in Groundwater Management Area 10, Texas. INTERA supported the development of the information needed by the GCDs within GMA 10 to adopt DFCs for the Trinity and Northern Saline Edwards aquifers. This information includes water supply needs and management strategies, estimates of historical groundwater uses, hydrological conditions (e.g., recharge, aquifer storage, inflows, and discharge), and potential environmental impacts of proposed management strategies. We helped document the information in explanatory reports for proposed DFCs of the Trinity and Northern Saline Edwards aquifers that were submitted to the TWDB. Our efforts also included developing and calibrating an analytical model for the Trinity Aquifer in Hays County to evaluate the potential impacts of expanded groundwater development.



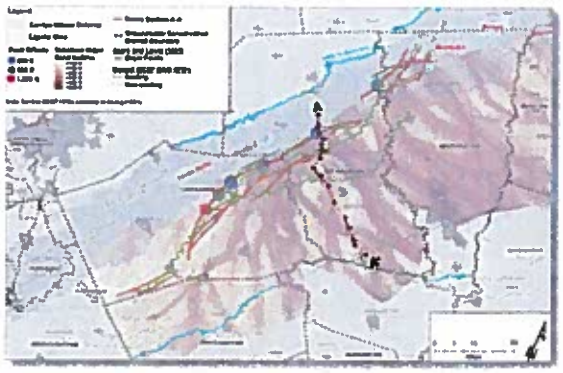
Evaluation of Well Locations for a Potential Aquifer Storage and Recovery Facility, Comal County, Texas. INTERA was a key member of a project team that conducted a feasibility assessment of the potential for aquifer storage and recovery (ASR) to serve as a water management strategy for New Braunfels Utilities (NBU). INTERA's primary role was providing the hydrogeologic analyses necessary to conduct the study. NBU has a diverse inventory of surface and groundwater supplies, but most of the supply sources are subject to cutbacks during times of drought. In fact, the annual supply can be reduced by

as much as 50% during a repeat of the drought of record (DOR). This project evaluated ASR as a means for firming up the various NBU supply sources through a repeat of the DOR. INTERA performed a study of the hydrogeology of the region to provide guidance as to the productivity and suitability of aquifers and other formations. This included a survey of the characteristics of existing wells in the area and a review of geophysical logs to help evaluate deeper units (such as the Hosston-Sligo) not currently being pumped.



In the potential project area, the Edwards Aquifer is considered to be the most productive aquifer, and is the primary source of water supply in south-central Texas. The Edwards is also one of the most highly regulated aquifers in Texas. Therefore, although the Edwards Aquifer has proven productivity in the area, the Middle and Lower Trinity (the Lower Glen Rose and Sligo and Lower Glen Rose formations) were also considered as potential ASR storage locations. Moving along dip, from northwest to southeast across NBU's service area, the water quality in the Edwards Aquifer changes from fresh (<1000 mg/L total dissolved solids ([TDS]) to slightly saline (>1000 mg/L TDS) and continues to get more brackish moving down-dip. INTERA's recommendation from the hydrogeologic analysis was that the Edwards Aquifer be considered as the best candidate for ASR, due to its productivity, depth, thickness, and confinement. Because of regulatory considerations, the brackish Edwards was considered to be the most likely location for a pilot program. The study is currently moving to Phase II, where a test well will be drilled.

Groundwater Availability Model Update to Incorporate the Effect of Faults in the Carrizo-Wilcox Aquifer, Texas. The central portion of the Queen City, Sparta, and Carrizo-Wilcox aquifers is one of the most productive aquifer regions in Texas. The manner in which the Mexia-Talco Fault zone and other faults are represented in the GAM for the central portions of these aquifers has been a major concern in GMA 12. The degree to which the faults are sealing has a minor effect on the model calibration but a major impact on predicted drawdowns because future pumping is anticipated in the vicinity of the faults. Permitting of groundwater from the central Simsboro Formation will likely be impacted by the GMA 12 member GCD's interpretations of results from the model. Since the existing GAM was developed (the original central Carrizo-Wilcox model was completed in 2003 and an updated version that incorporated the Queen City and Sparta aquifers was completed in 2005), additional information on the faults has been gathered via interpretation of pumping tests and analyses of geophysical logs. Under contract to the TWDB, INTERA is collecting and analyzing additional data to provide GCDs and other interested parties in GMA 12 with a technical basis to update the model using recent site characterization information by examining the sensitivity of model calibration metrics and multiple fault assumptions. We are using recently (after the GAM for the central portion of the Carrizo-Wilcox Aquifer was created) developed subsurface and drawdown information to better define the role that faults have in affecting groundwater flow.



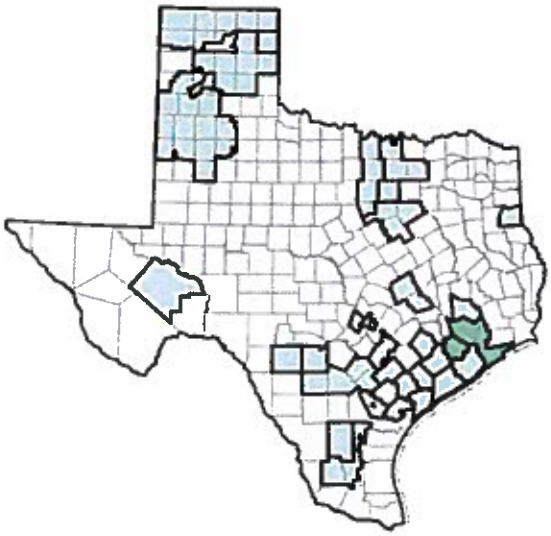
Our first task involved updating the conceptual groundwater flow model for the GAM with regard to the regional fault zones, and hydraulic properties for the Carrizo-Wilcox, Queen City, and Sparta aquifers. To accomplish this, we analyzed and correlated 1,200 geophysical logs to map the Mexia-Talco fault zone and the offsets in the Simsboro Formation. The logs were interpreted to provide information relating to the upper and lower formation boundaries, sand and clay thickness maps, and estimates of TDS concentrations and locations of faults by GAM layer. Log correlations were performed using the log analysis software, Petra®. Aquifer test data from single-well and multiple-well pumping tests were analyzed to evaluate the sealing nature of the Mexia-Talco faults, determine aquifer transmissivity and storage properties, and subsequently help in recalibrating the GAM. To provide a set of general rules and specific equations for estimating the transmissivity and storativity of the Carrizo-Wilcox Aquifer at a specific location based on depth, depositional environment, lithology, and other physical and geotechnical properties, we developed and documented a geohydrostratigraphic (GHS) model. This model enables the estimation of aquifer hydraulic properties for portions of the GAM area where lithology data exist, but little or no aquifer test data exist. The GHS model also provides appropriate constraints during the model calibration process to avoid unrealistic hydraulic parameterization

and minimize the generation of non-unique solutions developed from calibration. Additional tasks have included performing a literature review to characterize the physical and hydraulic properties of the Colorado Alluvium in the GMA 12 area and conducting workshops with stakeholders to request information, discuss approaches to modeling, and solicit input and feedback.

We are currently incorporating data from the revised conceptual model into the GAM, updating the historical pumping included in the model from the years 2000 to 2010, and extending the model calibration period to the year 2010. The extended calibration period will help GMA 12 move their baseline, or reference year, from 2000 to 2010 which is important since the member GCDs of GMA 12 did not all begin to actively monitor water levels until after the year 2000. Ultimately, the improved representation of faults in the updated GAM will enhance the model's predictive capabilities and the decisions made by GCDs and other stakeholders regarding groundwater management based on these predictions.

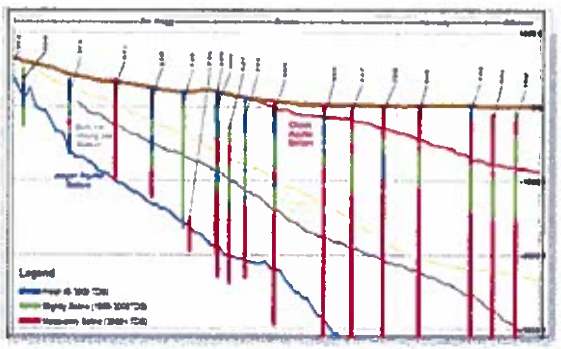
2.4 Experience Working with Groundwater Conservation Districts

Over the last decade, INTERA staff have provided direct technical support services to 30 different GCDs and two subsidence districts in Texas. In addition, we have worked with dozens of other GCDs as stakeholders on a variety of other water resources projects across the state. Our services on these projects have included: preparing management plans, groundwater rules, and guidance documents; designing monitoring well networks; providing GCD representation during GMA meetings; reviewing application permits; developing groundwater databases; organizing and conducting public meetings; directing and implementing field studies and well construction; evaluating alternative DFCs; responding to GMA petitions; and conducting technical and public workshops. Several representative examples of our project work with GCDs are provided below.

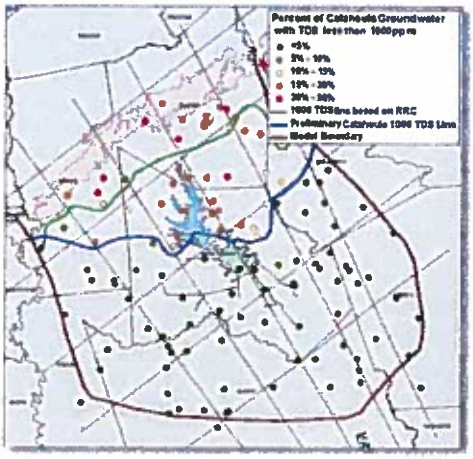


As a leader in hydrogeologic modeling and analyses in Texas, INTERA provides technical services to a growing list of GCDs and subsidence districts across the state. To date, this includes over 30 of these water management organizations.

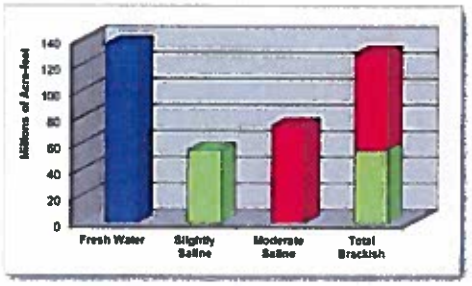
Characterization of Groundwater Resources and Evaluations of Desired Future Conditions and Groundwater Availability Models, Texas. INTERA provided technical support to the Brush County GCD to characterize its groundwater resources, delineate regional aquifer stratigraphy and lithology, and water quality. We constructed a 6,000-well database that included water level measurements and well screen information, interpreted over 200 geophysical logs to develop vertical profiles of TDS concentrations, clay beds, and sand beds, and developed a conceptual model for the District's groundwater system that included recharge estimates, aquifer hydraulic properties, and the location of fresh and brackish groundwater. We also provided technical support to the District to establish DFCs and evaluate modeling results produced by GMA 16. This included estimating current and future pumping for the District and applying the GMA 16 GAM to estimate drawdown impacts over a 60-year period. We evaluated the potential for water quality change and subsidence based on estimated drawdowns, and presented results to GMA 16 and helped develop modeling scenarios for use by the GMA for constructing DFCs. The GAM used by GMA 16 was evaluated for its applicability and accuracy relative to previous regional model and hydrogeological data. INTERA designed a groundwater monitoring program for a three-county area (Jim Wells, Brooks, and Jim Hogg counties) based on an analysis of groundwater modeling results, measured water levels, and measured groundwater chemical concentrations. This program serves to demonstrate compliance with regional and local management goals. We also performed groundwater modeling to evaluate the capability of the well network to monitor regional changes in groundwater elevations in the Chicot, Evangeline, and Jasper aquifers. INTERA staff have also supported Brush County GCD in developing management plans.

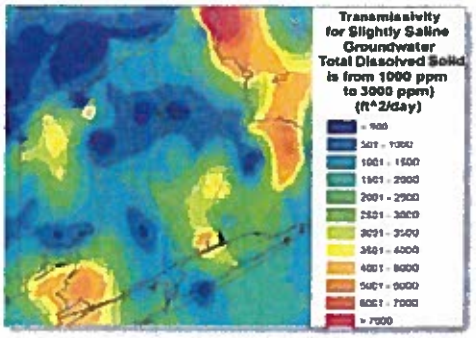


Impact Assessments and Groundwater Flow Modeling for the Jasper, Catahoula, and Jackson Aquifers, Texas. INTERA has worked in the Yegua–Jackson Aquifer and used the Northern Gulf Coast Aquifer GAMs to support the Lone Star GCD's water planning efforts since 2009. A primary focus of our work has been to assess how pumping in the Catahoula Aquifer impacts the water levels in the overlying Jasper Aquifer. We applied analytical models based on aquifer properties extracted from the GAM models to predict the impacts of pumping in the Catahoula Aquifer. In collaboration with two other consulting firms, we developed a regional model for groundwater flow in the Jackson, Catahoula, and Jasper aquifers across a six-county area. This work consisted of four phases. Phase 1 included developing a hydrogeologic conceptual model of the study area based on the analysis of more than 300 geophysical logs. The conceptual model incorporates a detailed map of sands and clays, a map of water quality zones based on concentrations of total dissolved solids, and estimates of aquifer hydraulic properties. Phase 2 involved the development and calibration of a numerical groundwater model that provides better representation of local groundwater flow conditions in Montgomery County than do the GAMs for the region. One of the primary goals of our Phase 2 work was to develop a method for predicting changes in water quality. To accomplish this, we investigated alternative methods for predicting water quality change using solute transport and particle tracking approaches to determine the most cost-effective option. Phases 3 and 4 of the project involved applying the numerical model to evaluate specific pumping scenarios and documenting the model development and application process.



Characterization of Fresh and Brackish Groundwater Resources in Matagorda County, Texas. For the Coastal Plains GCD, INTERA estimated the availability of fresh and brackish groundwater in Matagorda County by integrating the results from total dissolved solids (TDS) concentrations measured at 200 water wells with calculated TDS from 100 geophysical logs. To help evaluate where brackish waters can be economically developed, we develop transmissivity fields for designated brackish zones. The transmissivity values are based on empirical equations for estimating hydraulic conductivity based on total sand thicknesses, depositional environments, depth of burial, and distribution of sand and clay beds. These empirical equations were vetted and verified by using them to calibrate a numerical model of the groundwater flow system. Based on transmissivity values generated for aquifer regions containing slightly saline (1,000 to 3,000 ppm TDS) waters, we estimated that 41 million AFY of the brackish water can be economically developed. INTERA also developed several approaches for predicting the impacts that pumping brackish water would have on the freshwater resources and recommended an approach for developing the brackish resource. In addition, INTERA mapped the locations of approximately 200 waste injection wells that could impact groundwater quality. These wells are located near the boundary of the moderately saline waters, which have a TDS concentration of less than 10,000 ppm. INTERA also mapped the salt domes in the area and demonstrated how their formation affects both the salinity and the stratigraphy of the Gulf Coast Aquifer. INTERA is currently performing a series of regional model runs, using a regional groundwater model to evaluate the compatibility of the current management objectives and rules with the development of brackish groundwater. The result of this evaluation will provide the district with alternative strategies for developing brackish groundwater based on the level of costs and impacts deemed acceptable by the County.



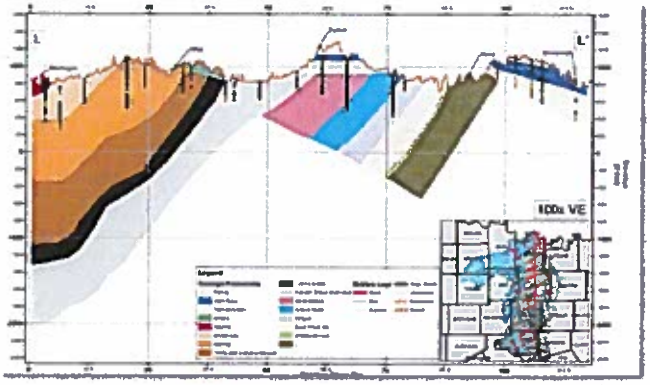


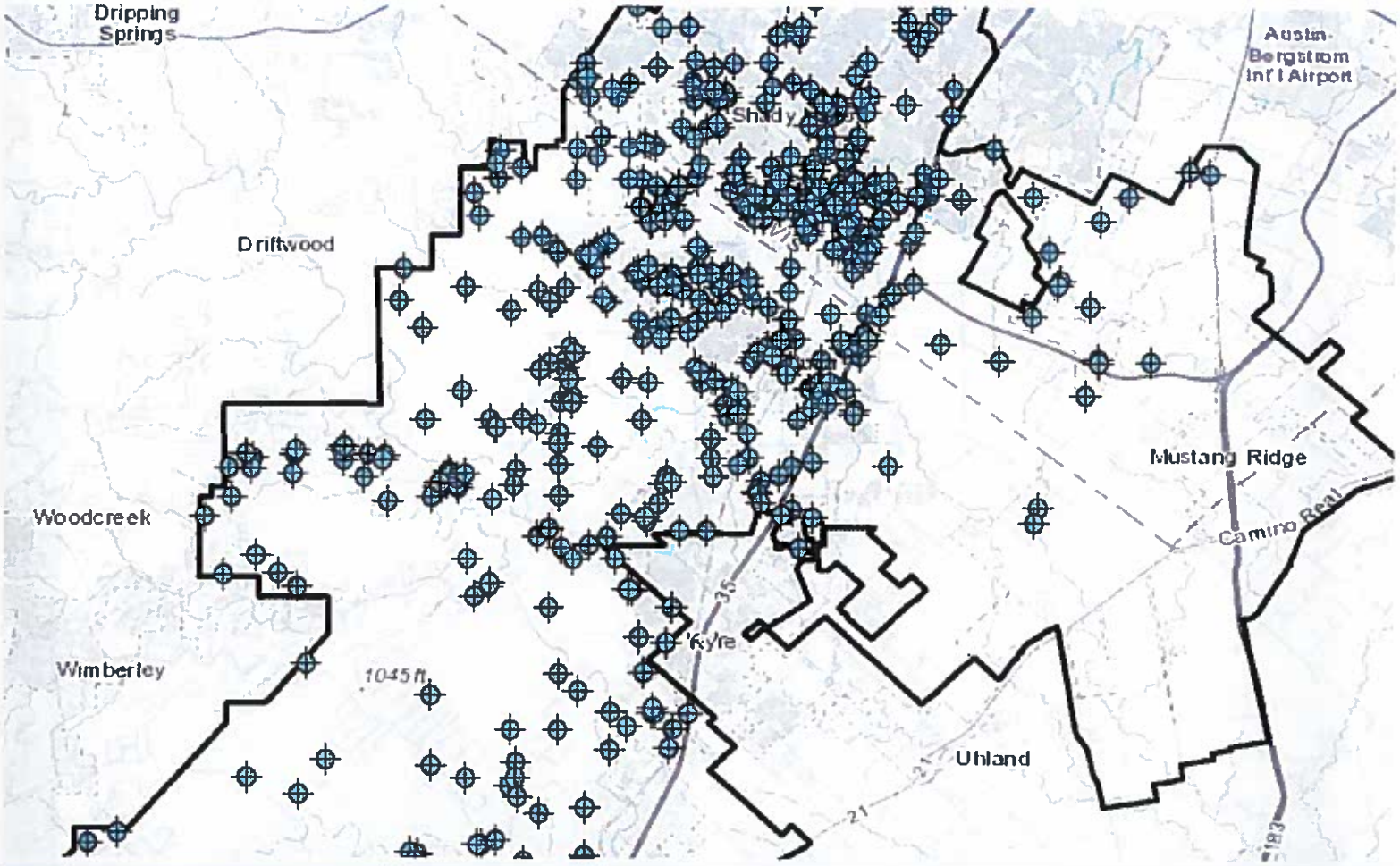
Characterization of Wilcox Aquifer Structure, Composition, and Hydraulic Properties, Panola County, Texas. For the Panola County GCD, INTERA performed an analysis focused on characterizing the composition and properties of the upper and lower units of the Wilcox Aquifer in sufficient detail to allow evaluation of local- and regional-scale impacts of existing

and new production wells. Panola County is located in an area known as the Sabine Uplift—a geologic feature that has been present since the deposition of the sediments of the Wilcox group. Due to the uplift, sediments of the Wilcox are thinner in Panola County than in areas of the aquifer to the west. Some faulting occurs in the southern and southwestern portions of the Wilcox in Panola County with offsets of 200 to 400 feet in some areas. The Wilcox is divided into upper, middle and lower units throughout much of Texas, but only into upper and lower units in East Texas. The lower Wilcox typically contains shaley thin sands and lignite while the upper Wilcox contains blockier sands interbedded with clays. The Carrizo formation overlying the Wilcox is almost entirely eroded away in Panola County leaving the upper Wilcox exposed at land surface.

INTERA updated the Wilcox structure and delineated the boundary between the upper and lower Wilcox in Panola County through the analysis of 115 publicly available geophysical logs. We developed surfaces for the base of the Wilcox and the contact between the upper and lower Wilcox, and then interpreted resistivity logs to evaluate the sand and clay composition (lithology) of the aquifer. We evaluated lithology using 79 geophysical logs and rock type descriptions provided by drillers in water well drilling reports. Geophysical logs, which are typically completed for oil and gas wells, are more reliable than drilling reports but often do not extend into the shallow portions of the aquifer. Of the 2,063 drilling reports in the county available for analysis, we used the 695 that were deep enough to represent at least half of the aquifer thickness. The resulting distribution of percent sand is consistent with the north-to-south axis of sediment deposition. Hydraulic properties such as hydraulic conductivity and storativity are key to defining how water flows through an aquifer and how it responds to pumping. We evaluated the hydraulic properties of the Wilcox in Panola County though the interpretation of aquifer tests from publicly available sources and the development procedures for monitoring water levels near oil and gas rig supply water wells. Publically available aquifer tests were compiled from the TCEQ Public Water Supply Well database, from hydrogeologic studies completed for Panola County GCD well permitting, and estimated from specific capacity. A total of 30 aquifer tests were evaluated for both hydraulic conductivity and storativity. Hydraulic conductivity was estimated from specific capacity information in 1,950 additional wells. Most storativity estimates indicate confined conditions in the aquifer.

Hydrostratigraphic Mapping to Support Developing a Ground-water Monitoring Program, Texas. To support establishing DFCs, INTERA provided technical services for the Upper Trinity GCD to help develop a district-wide groundwater monitoring program. The monitoring program consists of two parts; one for the Trinity Aquifer system and one for the Paleozoic units. The process of creating/augmenting the monitoring well system included: establishing a full set of potential monitor wells, developing DFC zones, investigating monitor well locations based on DFC methods, taking into account water level trends, determining initial monitor well locations based on previous analyses, and screening monitor well locations based on updated hydrogeology and the depth of zones to be monitored. One of the key components to the proper design of a groundwater monitoring network was developing a detailed understanding of the hydrostratigraphic units that comprise the resource. This, in conjunction with an understanding of the groundwater use patterns by hydrostratigraphic unit (sub-aquifer), provided the data needed to ensure that the correct horizons are being monitored. To develop an understanding of the hydrostratigraphy, INTERA integrated subsurface information from numerous data sources and types. A total of 102 driller's reports and scout tickets were selected to construct 13 cross-sections across the district. We also mapped the top surfaces of four Cretaceous formations (Paluxy Sand, Glen Rose Limestone, Twin Mountain Formation, and Antlers Sand) and 12 Paleozoic formations (Nacona, Archer City, Markely, Thrifty and Grahm, Colony Creek Shale, Canyon Group Undivided, Mineral Wells, Brazos River, Mingus, Buck Creek Sandstone, Gridstone Creek, and Lazy Bend).





BARTON SPRINGS/EDWARDS AQUIFER CONSERVATION DISTRICT

Technical Services Related to Development of an Integrated Groundwater Data Management and Reporting System

RFQ No. 033017-001

APRIL 14, 2017

GROUNDWATER DATA MANAGEMENT AND REPORTING SYSTEM

Firm Information

Halff is pleased to submit our qualifications to provide consulting services, design planning, custom programming and integration services related to developing a web-based integrated Groundwater Data Management and Reporting System for the Barton Springs/Edwards Aquifer Conservation District. We have extensive experience providing similar services and currently provide custom development and hosting for seven other groundwater conservation districts.

Halff has a history of providing quality work since our founding in 1950. Our staff of more than 640 includes GIS specialists, computer programmers, IT professionals, licensed engineers, surveyors, right-of-way specialists, architects, planners, landscape architects and environmental scientists. Halff offers the following services:

- **GIS**
- **Process Management Tools**
- Architecture
- Environmental
- Land and Site Development
- Landscape Architecture And Planning
- MEP Engineering
- Oil and Gas
- Public Works
- Right of Way
- Structural Engineering
- Subsurface Utility Engineering/Utility Coordination
- Surveying
- Transportation
- Visualization
- Water Resources

LOCAL OFFICE

Services for the Integrated Groundwater Data Management and Reporting System project will be provided out of Halff's Fort Worth office under the direction of Erin Atkinson, PE, CFM, GISP, Vice President and GIS Practice Leader. The Fort Worth office has a staff of more than 70, including a nine-person GIS team, and offers services in transportation, water and wastewater design, H&H and survey in addition to GIS and Process Management Tools.

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817/764-7495
eatkinson@halff.com

Branch: Fort Worth

Type of ownership: Texas corporation

Year firm established: 1950

Firm Principals: Halff is managed by the following six-person management team whose responsibilities include firm management, design production and quality, business development and finance:

Pat Kunz, PE – President
Roman Plugge, PE – Chief Operating Officer
Russell Killen, PE, CFM – Executive Vice President
Mark Edwards, PG – Executive Vice President
Greg Kuhn, PE – Chief Marketing Officer
Russell Zapalac, PE – Chief Strategy Officer

Former Company Names: Albert H. Halff Consulting Sanitary Engineers, Hundley and Halff, Albert H. Halff Associates, Albert H. Halff Associates, Inc., Halff Associates, Inc.

Office locations:

Fort Worth	Flower Mound	San Antonio
Richardson	Frisco	Tyler
Austin	Houston	Little Rock, AR
Conroe	McAllen	Shreveport, LA
Dallas	Midland	Oklahoma City, OK

GROUNDWATER DATA MANAGEMENT AND REPORTING SYSTEM

GIS & TECHNOLOGY RESOURCES

The Halff Team brings extensive knowledge and skill sets related to the GIS and technology needs of both public and private sector clients. Halff has experience with GIS database design, building custom interfaces to meet the needs of the client, creating asset inventories through streamlined data collection, developing integrated database management systems, providing GIS and database hosting services, developing custom applications for workflow automation and supporting our clients and stakeholders with training and technical support. Halff's GIS analysts, many of whom are Certified GIS Professionals (GISPs), use the latest GIS technology to provide solutions through spatial analysis and efficient workflows.

As an Esri Partner, Halff is standardized on the ArcGIS suite of desktop and server applications. Halff uses the latest versions of Esri products, including ArcGIS for Desktop and ArcGIS for Server 10.5, and maintains access to historical versions through the use of Citrix as necessary. Since 2001, Halff has been developing custom GIS applications to extend and automate the core Esri software and is part of the Esri Developer Network (EDN), giving us the ability to develop custom applications and solutions for all of Esri's software. Halff is also an authorized Esri Application Service Provider (ASP). The ASP license allows Halff to host and serve data for our clients through interfaces like web maps, dashboards, mobile devices and geodata services.

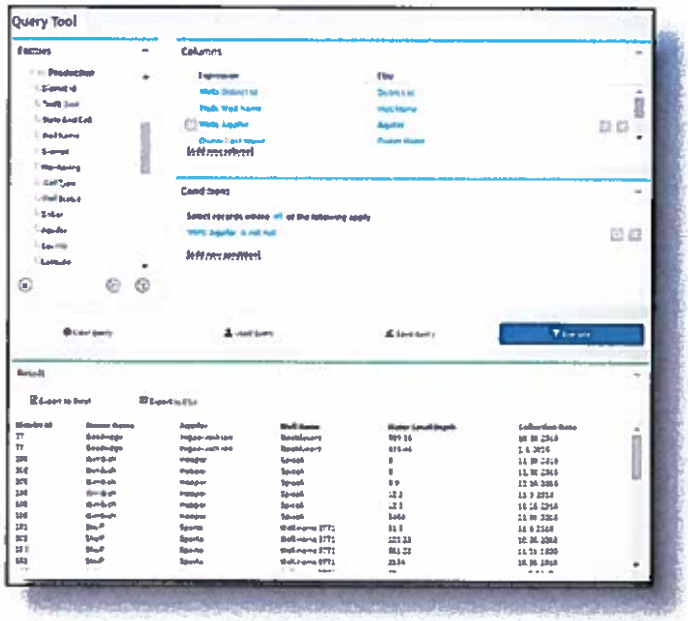
The Halff information technology development team consists of seven developers with a broad range of experience. The technology and database solutions Halff provides are called Process Management Tools (PMT). PMT solutions are custom computer applications designed to meet the needs of each individual client. Halff works with our clients to understand their internal workflows and available data and then designs a system that meets their specific needs. These systems use the latest database and web technologies to provide responsive, platform-independent solutions. Our current development environment includes JavaScript, MVC, Visual Studio .NET, ASP.NET, Bootstrap, Microsoft SQL Server, Microsoft Azure, ArcGIS Server, Crystal Reports, Entity Framework, Angular, Web API, iOS, Objective-C and Automated Unit Testing. Our development team uses the Agile Development methodology which allows Halff to incrementally deploy components of the system for review by our clients. This ensures that the system meets our client's expectations without waiting until the end of the project.

The investment in an integrated database and GIS system pays off when the information stored within the geodatabase becomes accessible to all stakeholders, not just the GIS analysts who developed the data. Halff finds innovative ways to put the GIS data in the hands of as many users as possible. One of the best ways to do this is through a modern web browser. By using a modern browser like Internet Explorer or Chrome, many users who may not have access to a software package like ArcGIS can still access and work with the GIS data. Custom web mapping applications are designed to make working with the data easy and intuitive by providing similar navigation and functionality to Google Earth, which is familiar to most users. Halff has software programmers and resources available to design and host web maps for our clients. Each custom web application is designed to meet our client's specific needs, from simple viewers to the more complex that allow for editing and integration with other databases.

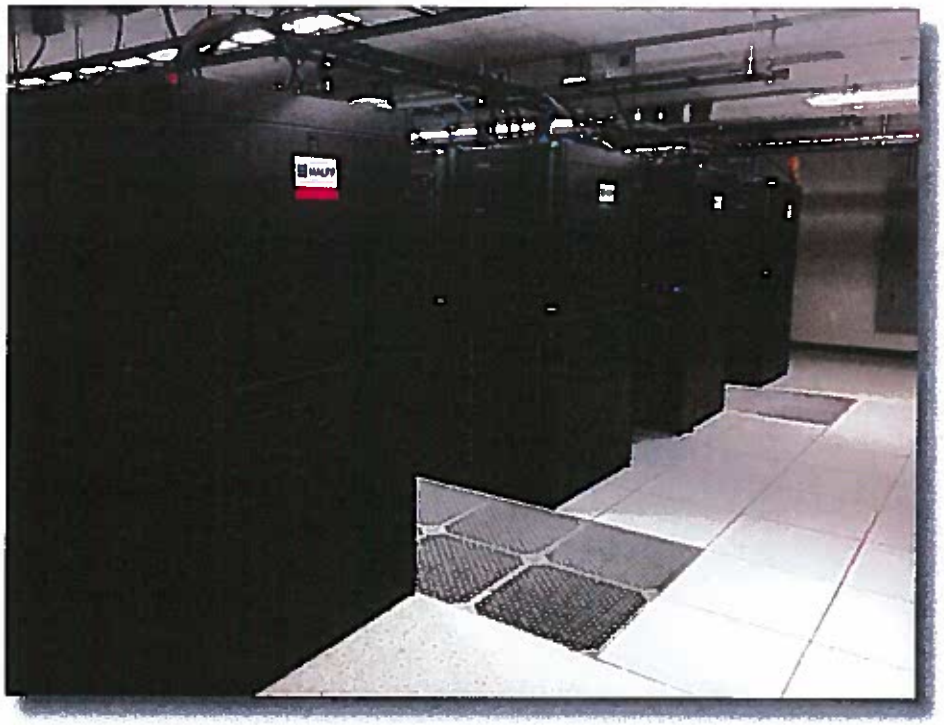
Halff has developed a wide variety of PMT solutions to meet the specific needs of our clients. We are hosting databases and PMT solutions for nearly 30 different entities, including groundwater conservation districts, municipalities, counties, state agencies and private organizations. Although each client is treated as an individual, they all benefit from the broad range of technology solutions developed by Halff. For example, the ability to automatically consume real-time precipitation data from the National Weather Service for a flood control agency ultimately resulted in building a precipitation deficit index tool for a groundwater conservation district. Halff prides itself on being able to provide our clients with creative solutions, and serving multiple clients over a broad range of needs helps us design beyond traditional approaches by collaborating on a wide spectrum of projects.

GROUNDWATER DATA MANAGEMENT AND REPORTING SYSTEM

Our PMT solutions team has the depth of resources to provide information technology solutions and integrate traditional databases with GIS services for multiple projects at the same time giving us the ability to respond to both existing clients and new clients in a timely manner. The hosting environment used for our clients is owned and maintained by Halff at our corporate headquarters in Richardson. Maintaining our own server environment allows Halff to increase our server capacity as needed, add additional functionality to our servers and quickly deploy new enhancements. Halff's IT department has a formal backup and disaster recovery plan in place which includes offsite virtualized servers, emergency power backup (short and long term) and redundant internet connections. Client databases are backed up nightly, and monthly archives are placed on digital media for offsite storage.



Halff provides the training and support needed to work with and maintain the integrated database systems. The levels of support range from onsite hands-on training to simple process workflow documentation that users are able to refer to when needed. Technical support is provided through onsite visits, conference calls, and dedicated email lists which ensure the client will be able to reach someone in the case of technical challenges.



GROUNDWATER DATA MANAGEMENT AND REPORTING SYSTEM

PROJECT EXPERIENCE

Halff has extensive experience providing services similar to the needs of the Groundwater Data Management and Reporting System sought by the Barton Springs/Edwards Aquifer Conservation District. We encourage you to contact our references for additional information about Halff's qualifications with regards to creating a database management system. Individual project descriptions outlining our experience on similar projects are provided on the following pages.

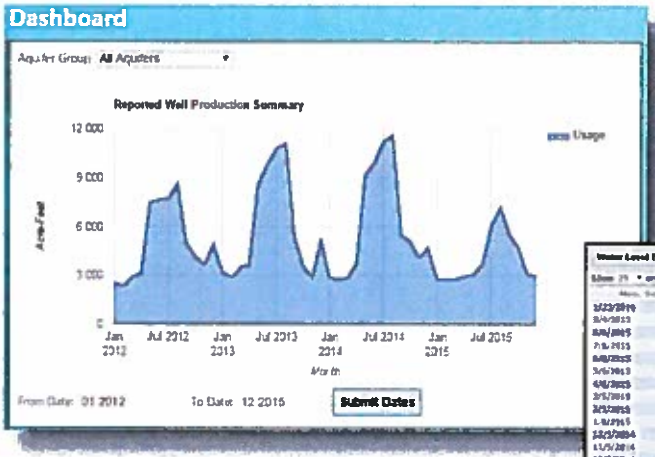
GROUNDWATER DATABASE MANAGEMENT

BRAZOS VALLEY GROUNDWATER CONSERVATION DISTRICT; HEARNE, TEXAS

The Brazos Valley Groundwater Conservation District (BVGCD) is tasked with managing the groundwater resources for Brazos and Robertson Counties. In 2012, BVGCD asked Halff to convert the Microsoft Access database they were using to manage the wells into a GIS geodatabase. This database contained the latitude and longitude for each well. These coordinates were used to convert the well information from a traditional database to a point feature class within a geodatabase. Halff worked with BVGCD to determine their GIS needs, including internal datasets, external datasets, and website functionality. This data conversion process started the GIS system for the District. In addition to the wells, the geodatabase stores parcel, topographic, aquifer, rainfall, owner, well production, water level, and meter reading data. The GIS data for the District and their permitting database are hosted on Halff's servers. BVGCD is able to access and manage their data through web maps, integrated database web forms, and the Halff GIS iOS App.

Water Well Management System Features:

- Public and secured web maps
- Integrated database management system
- User account management system
- Mobile data access with the Halff GIS iOS App
- Registered well owner reporting system
- Monitoring well tracking
- Management dashboard
- Search interfaces for wells, permits, owners and well types
- Well data tracking for production, water level, and meter readings
- Automated reporting for permits, production, production fees and water levels
- Ad-hoc query interface for entire well database and rainfall data
- Integration with QuickBooks

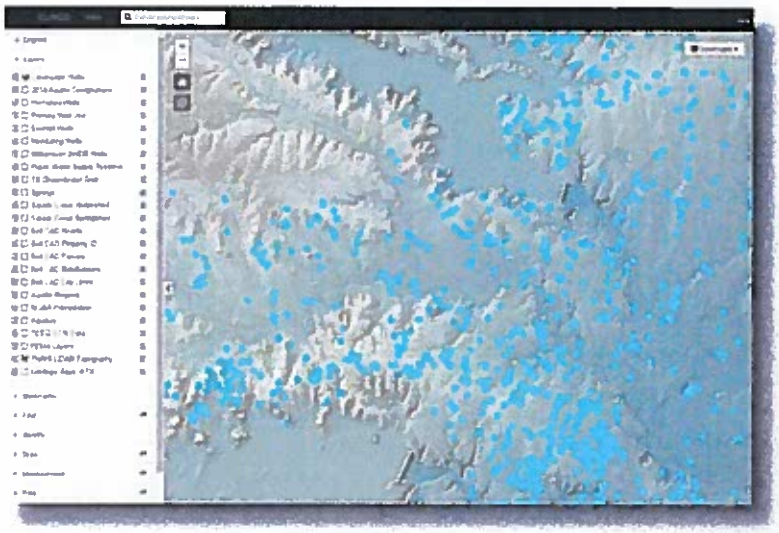


Firm role: Prime
Services: Development environment included JavaScript, ArcGIS Server, ArcSDE, SQL Server, ASP.NET, MVC, C#, Crystal Reports, Entity Framework
Reference: Alan Day, General Manager, 979/279-9350, aday@brazosvalleygcd.org
Hosted site: https://brazosvalleygcd.halff.com

GROUNDWATER DATA MANAGEMENT AND REPORTING SYSTEM

GIS Data Hosting and Web Map Development

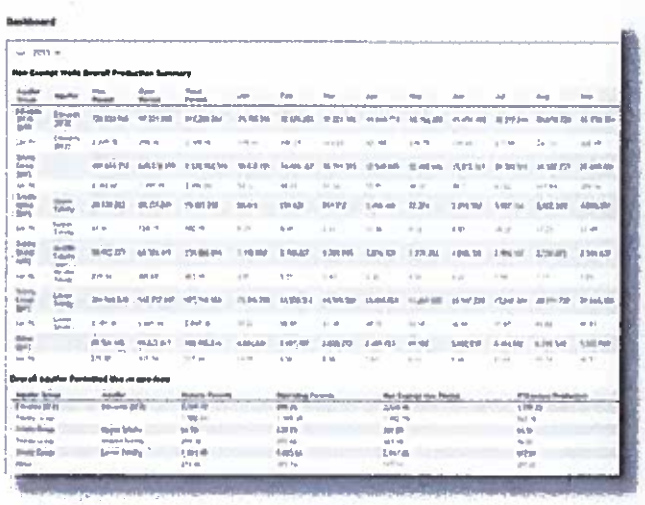
Clearwater Underground Water Conservation District; Belton, Texas



The Clearwater Underground Water Conservation District (CUWCD) is tasked with managing the groundwater resources for Bell County. CUWCD had a collection of shapefiles, Microsoft Excel files and Microsoft Access database for managing their groundwater wells. The District asked Halff to develop a comprehensive database from this information that could be accessed and managed from standard web browsers. Halff imported all of the District's data into a Microsoft SQL Server database and established relationships between the tables that allowed the district to associate the permits, owner information, aggregated systems, production, and water level data to each well. Automated reporting of well production data and precipitation deficit index tools have also been added to the hosted solution provided by Halff.

Water Well Management System Features:

- Public and secured web maps
- Integrated database management system
- User account management system
- Mobile data access with the Halff GIS iOS App
- Registered well owner reporting system
- Management dashboard
- Search interfaces for wells, permits and owners
- Well data tracking for production and water levels
- Automated reporting for production
- Precipitation deficit index monitoring
- Ad-hoc query interface for entire well database and rainfall data
- Virtual bore logs from web maps



Firm role: Prime
Services: Development environment included JavaScript, ArcGIS Server, ArcSDE, SQL Server, ASP.NET, MVC, C#, Crystal Reports, Entity Framework
Reference: Dirk Aaron, General Manager, 254/933-0120; dirk.aaron@clearwaterdistrict.org
Hosted site: https://clearwaterdistrict.halff.com

GROUNDWATER DATA MANAGEMENT AND REPORTING SYSTEM

GIS Data Hosting and Web Map Development

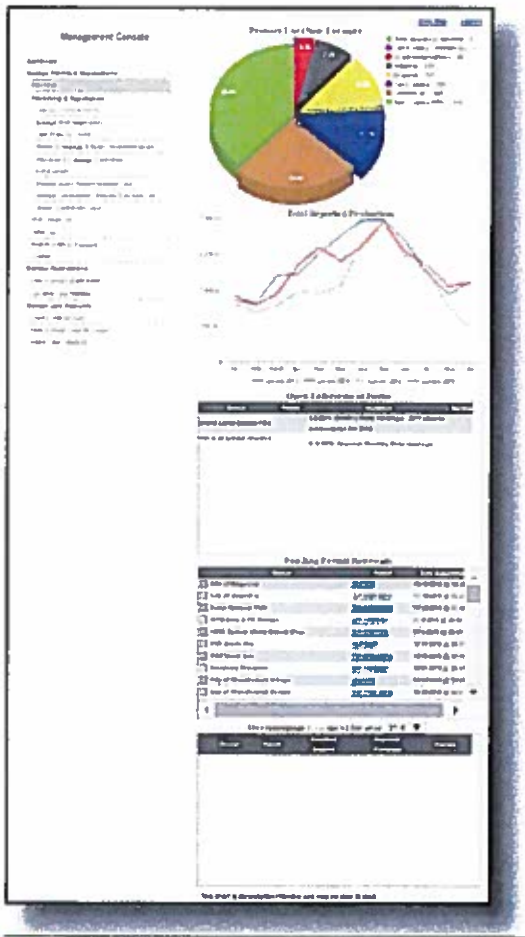
Lone Star Groundwater Conservation District; Conroe, Texas

The Lone Star Groundwater Conservation District (LSGCD) is tasked with managing the groundwater resources for Montgomery County. In 2010, LSGCD asked Halff to convert the Microsoft Access database they were using to manage the wells into a GIS geodatabase. The Access database had a wealth of data that the District had collected for many years. This data was converted to a Microsoft SQL Server database the latitude and longitude coordinates associated with the wells were used to create a GIS point data layer. The well points were used, along with additional GIS reference layers, to create publicly accessible and secured access web maps. An integrated database management system was also put in place to help track and manage the permitting and pumpage information associated with the wells. Halff worked with the District staff to understand their internal workflows and then provided them with a hosted web-based solution to enter, track, and report the information associated with the day-to-day management activities of the District.

Water Well Management System Features:

- Public and secured web maps
- Integrated database management system
- User account management system
- Mobile well inspections with the Halff GIS iOS App
- Registered well owner reporting system
- Monitoring well tracking
- Management dashboard
- Online permitting and permit renewal system
- Search interfaces for wells, permits, owners and enforcements
- Well data tracking for production, water level and meter readings
- Automated reporting for permits, production, fees and payments and well inspections
- Notification system for enforcement actions, permit renewals and over pumpage

Firm Role: Prime
Services: Development environment included JavaScript, ArcGIS Server, ArcSDE, SQL Server, ASP.NET, MVC, C#, Crystal Reports, Entity Framework
Reference: Kathy Turner Jones, General Manager, and Samantha Reiter, Permitting Director, 936/494-3436, kjones@lonestargcd.org, sreiter@lonestargcd.org
Hosted site: https://lonestar.halff.com

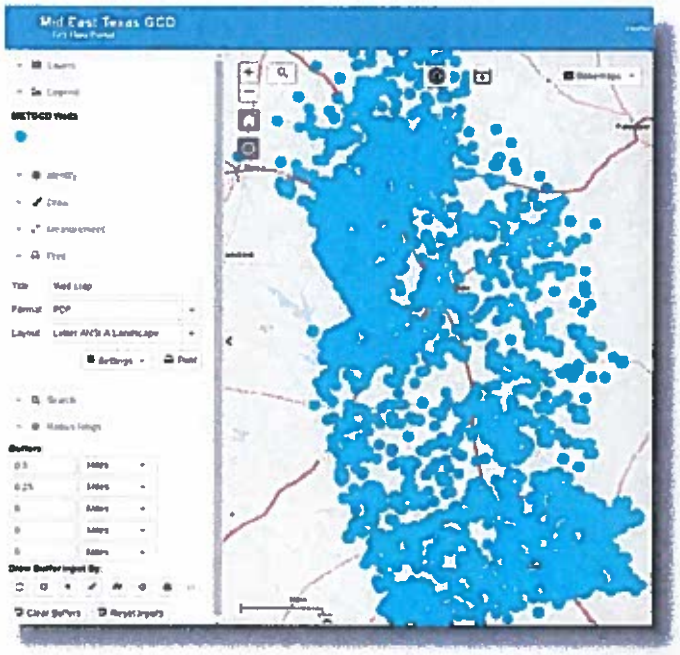


GROUNDWATER DATA MANAGEMENT AND REPORTING SYSTEM

INTEGRATED GROUNDWATER MANAGEMENT SYSTEM

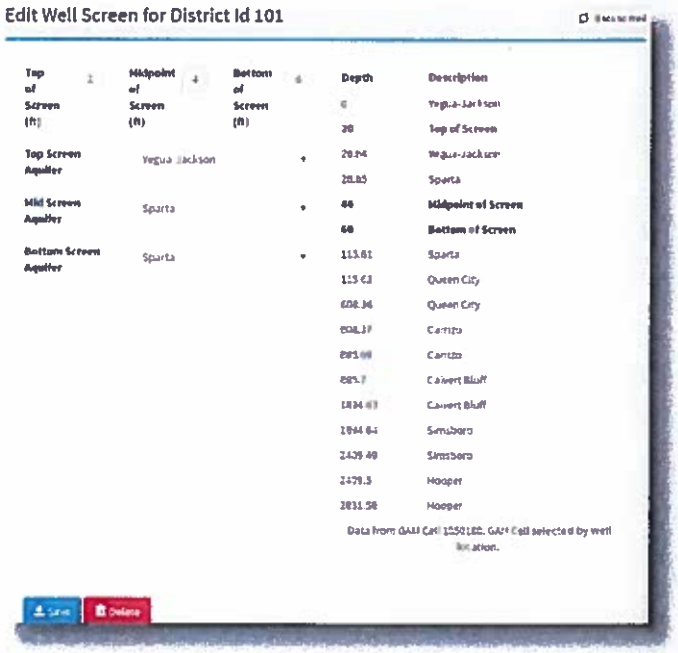
MID-EAST TEXAS GROUNDWATER CONSERVATION DISTRICT; MADISONVILLE, TEXAS

The Mid-East Texas Groundwater Conservation District (METGCD) is responsible for managing the groundwater resources of Freestone, Leon, and Madison Counties. Historically the District had managed their wells and associated production and water level information using Microsoft Excel spreadsheets and basic desktop GIS mapping applications. In September of 2016, the District approached Halff to have an Integrated Groundwater Management System developed that would utilize the District's existing data and provide enhanced management and reporting capabilities. In March of 2017, Halff deployed the completed Integrated Groundwater Management System into a web-based production environment that contained all of the Districts pre-existing data as well as supporting automated aquifer designations based on screening intervals.



Integrated Groundwater Management System Features:

- Management dashboard summarizing reported production
- Database components for wells, permits, owners and inspections
- Detailed well information including screening, water levels, inspections and production
- Public and Secured web maps
- User account management system
- Document management
- Mobile-ready design
- Predictive aquifer designation based on screen intervals and GAM data
- Lookup table management
- Ad-hoc query interface for comprehensive reporting



Firm role: Prime
Services: Development environment includes Microsoft SQL Server, Esri ArcGIS Server, Enterprise Geodatabase, JavaScript, ASP.NET, MVC, C#, Crystal Reports, Entity Framework, Angular, Microsoft Azure, HTML5
References: David Bailey, General Manager METGCD, 936/348-3212, david_metgcd@att.net
Hosted sites: https://metgcd.halff.com;
Public web map: https://metgcd.halff.com/map/public

GROUNDWATER DATA MANAGEMENT AND REPORTING SYSTEM

Water Well Management System

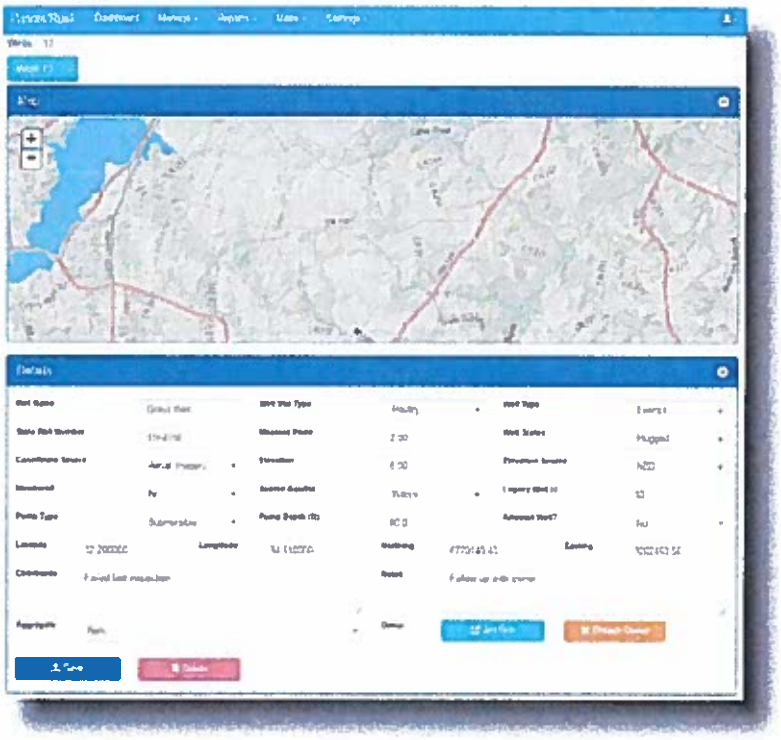
Panola County Groundwater Conservation District; Carthage, Texas
Rusk County Groundwater Conservation District; Henderson, Texas

The Panola County Groundwater Conservation District (PCGCD) and Rusk County Groundwater Conservation District (RCGCD) are each tasked with managing the groundwater resources in their respective counties. In 2016, PCGCD and RCGCD issued a joint Request for Qualifications (RFQ) seeking a professional services provider that would be able to develop a Water Well Management System that met the needs of both Districts but could be separated into independent applications once the initial system was developed. PCGCD and RCGCD selected Halff to develop their web-based Water Well Management System to support their permitting and registration activities, track well production and water quality, support field inspections, automate the reporting processes, and provide GIS-based mapping and analysis. Halff was awarded contracts in August of 2016 and deployed testing environments for each District in January 2017.

Water Well Management System Features:

- Public and Secured web maps
- Integrated database management system
- User account management system
- Mobile-ready design of all application interfaces
- Permitting and registration tracking
- Field inspection support
- Production, water level, and water quality reporting
- Support for well completion reports
- Fee tracking
- Support for aggregated systems
- Ad-hoc query interface for the complete management database

Firm role: Prime
Services: Development environment includes SQL Server, ArcGIS Server, Enterprise Geodatabase, JavaScript, ASP.NET, MVC, C#, Crystal Reports, Entity Framework
References: Leah Adams, General Manager PCGCD, 903/690-0143, ladams@pcgcd.org; Amanda Maloukis, General Manager RCGCD, 903/657-1900, amanda@rcgcd.org
Hosted sites: https://pcgcd.halff.com (coming soon); https://rcgcd.halff.com (coming soon)



Hays County GIS Stream Data Management and Web Map

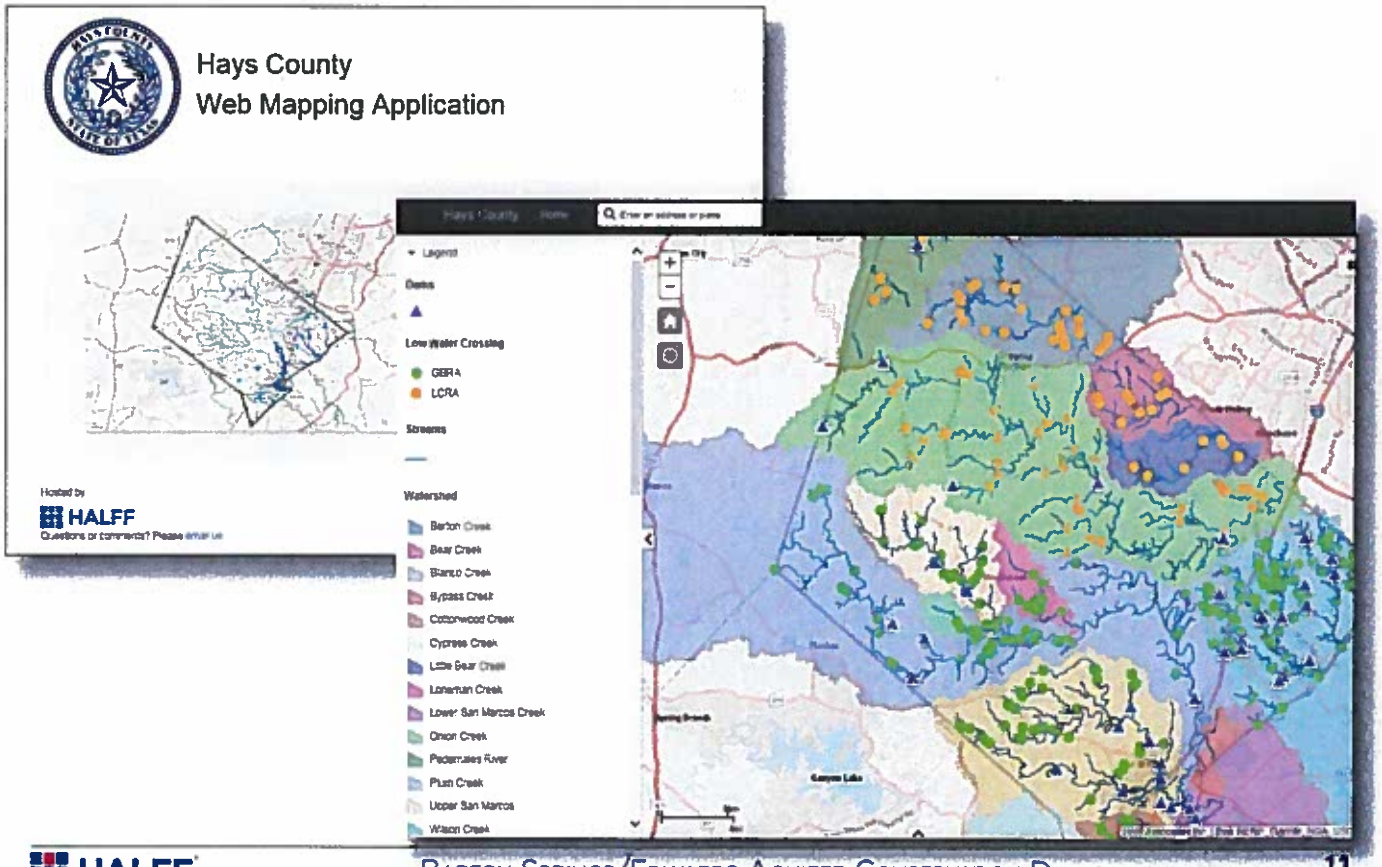
Hays County, Texas

Hays County is tasked to identify flood risk and dam analysis for over 700 stream-miles and seventeen dams within their jurisdiction. In 2016, the County asked Halff to develop a comprehensive plan to create and manage this information in a geodatabase and a web map allowing public and secure access to the data. After performing a stream analysis identifying the current flood study and model, Halff associated all data with stream centerlines to be displayed spatially on a web map. This allowed County employees to easily identify relevant stream names, study year, type and hydrologic models. This data was combined with existing county and national datasets such as address points, low water crossings and national flood hazard layers to provide a more complete picture of Hays County's geography and hydrologic infrastructure. A web based system allows users across multiple departments and platforms to access important information simultaneously. Additionally, a public version of the web map is available for residents and businesses to view and understand their flood risk. The website is designed to incorporate future needs, such as new stream gauges or other improvements as the County adds additional information and infrastructure.

Water Well Management System Features:

- Public and secured web maps
- Create a data inventory of studied and modeled streams
- User account management system
- Search interfaces for dams, streams and low water crossings
- Capacity for additional infrastructure and geospatial needs

Firm role: Prime
Services: Development environment included JavaScript, ArcGIS Server, ArcSDE, SQL Server
References: Clint Garza, Development Services Director, (512) 393-2150, james.garza@co.hays.tx.us
Hosted sites: https://haysco.halff.com



GROUNDWATER DATA MANAGEMENT AND REPORTING SYSTEM

Tarrant Regional Water District Real Time As-Built (RTAB)

Fort Worth, Texas

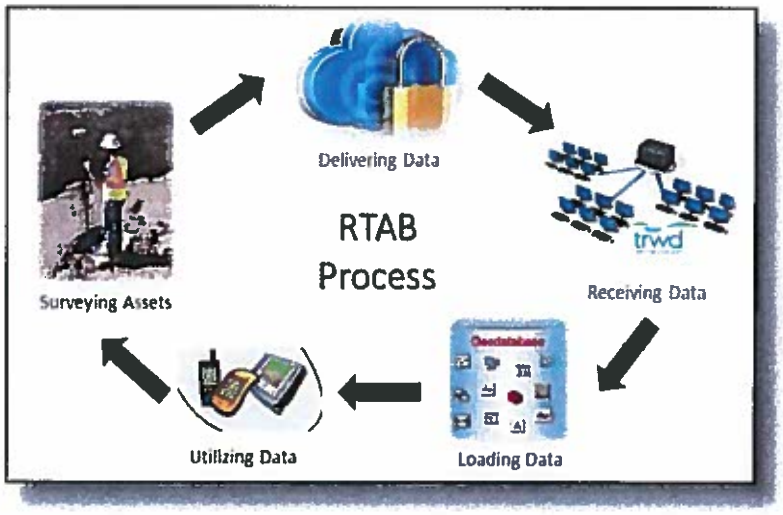
The Tarrant Regional Water District (TRWD) and the City of Dallas Water Utilities (DWU) have partnered to develop the Integrated Pipeline (IPL), a 150-mile pipeline and various ancillary stations and apparatus that will provide up to an additional 350 million gallons per day of raw water capacity to North Central Texas when complete. More than 99 percent of the project will be underground. TRWD has implemented a Real Time As Built (RTAB) program to ensure that the pipeline's assets are surveyed at the time of construction with the goal of reducing future costs associated with trying to locate buried assets for operation and maintenance activities. The RTAB program is used to check the placement of the asset as compared to the original design and pipe manufacturer specifications, and corrections can be made as appropriate. The survey location is stored directly within the District's GIS, which increases the efficiency of the data collection, ensures that the survey data is not lost and makes it available in real-time to all the stakeholders whether in the field or the office.

TRWD contracted with Halff to develop methods to collect location and feature information in real-time, collect location coordinates with sub-decimeter accuracy for both horizontal and vertical measurements and utilize a data collection workflow that did not require the District to change their enterprise GIS system. Halff proposed an innovative solution customized to meet TRWD's specific needs:

- **Collect the data** – Halff's solution leveraged survey grade GPS equipment already in use by TRWD.
- **Transfer the data** – The District's GPS equipment utilized a virtual reference station (VRS) network to receive real-time kinematic (RTK) corrections to achieve the high accuracy GPS coordinates. Utilizing a VRS network requires a cellular network connection, and this connection provided the mechanism to transfer the asset data in real-time via cloud storage synchronization (i.e. Dropbox, Box, etc.)
- **Process the data into the District's existing enterprise geodatabase schema for the IPL project** – Halff developed the "GPS Listener," an innovative, custom application that automated the process of transferring the pipeline asset information from the field data collector directly to the GIS database. The application runs all the time and "listens" for new data files to arrive through the cloud storage synchronization process. When a new file arrives the GPS Listener processes the field data and creates new features within the GIS database. The time to process each feature is approximately 1 second, which meets TRWD's goal of having the field data available within the GIS in real time.

The TRWD RTAB Program developed by Halff was awarded the Silver Medal for the 2016 annual ACEC Texas Engineering Excellence Awards Competition.

Firm role: Prime
Services: Development environment included C#, SQL Server, ArcGIS Sever, Trimble, DropBox
Reference: Mark McGuire, Geospatial Services Coordinator, 817/720-4246



Item 4

Board Discussions and Possible Actions

b. Discussion and possible action related to the revision and update of the District's Management Plan.

BSEACD Groundwater Management Plan
Pre-Review 1 Recommendation Report
08/04/2017 (SA, DT, RB)

This recommendation report lists two types of changes: **required,** to meet the test of administrative completeness, and **suggested,** to improve readability, accuracy, or understanding. If a district disagrees with any of the **required** elements please contact us to discuss. If a district disagrees with any of the **suggested** items they are free to disregard them. Contact information: Rima Petrossian, rima.petrossian@twdb.texas.gov (512) 936-2420 or Stephen Allen, stephen.allen@twdb.texas.gov (512) 463-7317.

The following items are required changes to the groundwater management plan (listed by checklist item). The checklist can be seen here:
http://www.twdb.texas.gov/groundwater/docs/GCD/GMPChecklist0113.pdf

- Checklist item 1- Is an estimate of the modeled available groundwater (MAG) in the district based on the desired future condition …included?
  On page 27, table 2-2, please indicate in each row which MAG report is the source for values in the MAG column. For the GMA 10 Saline Edwards Aquifer please use the current MAG. For the GMA 10 Trinity Aquifer use the current MAG which does not include the annexed area. Later, when new MAGs are issued by the TWDB, the plan can be amended with those values.

- Checklist items 39c, 39d, 39e- Addressing rainwater harvesting, precipitation enhancement, and brush control
  These three goals are either missing or hard to find in the plan. Please add them to the plan or restate them so they can be easily seen if an audit of the plan is performed. If any of the three are not applicable please add them to section 3.4 on page 56.

The following items are suggested changes. They are not required for TWDB approval but are intended to improve the readability and/or accuracy of the plan.

- Please consider adding a few landmarks to your maps (figures 1-1, 1-2, 1-3, 1-5, 1-6, 1-7, and 2-2, similar to figure 1-8). For example, the locations of one or more of the following: Sunset Valley, San Marcos, Dripping Springs, I-35, and or Buda. Also, please consider adding the footprint of the future Southwest Travis County GCD.

- On page 36, section 2.6, please consider referencing GAM Run 08-37 similar to the way you've done it in sections 2.4 and 2.5.

- On page 38, paragraph 3, please consider changing "Appendix III" to "Appendix II."

- On page 41, paragraph 1, please consider changing "2012" to "2017."

Item 4

Board Discussions and Possible Actions

c. Discussion and possible action related to the City of Dripping Springs TPDES permit application to authorize direct discharge of treated wastewater to Onion Creek in the contributing zone of the Barton Springs segment of the Edwards Aquifer.

Item 5

Director's Reports

Directors' Reports. *(Note: Directors' comments under this item cannot address an agenda item posted elsewhere on this agenda and no substantive discussion among the Board Members or action will be allowed in this meeting. Communications reported under this item may be used to support Performance Standard 4-1 of the District's Management Plan related to demonstration of effective communication with District constituents.)*

Directors may report on their involvement in activities and dialogue that are of likely interest to the Board, in one or more of the following topical areas:

- **Meetings and conferences attended or that will be attended;**
- **Committee formation and updates;**
- **Conversations with public officials, permittees, stakeholders, and other constituents;**
- **Commendations; and**
- **Issues or problems of concern.**

Item 6

Adjournment