



HYDROGEOLOGICAL AND GEOCHEMICAL STUDY OF THE LOWER TRINITY AQUIFER

Prepared for:

Barton Springs-Edwards Aquifer Conservation District

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EXECUTIVE SUMMARY

As population and demand for water continues to grow in Central Texas, the Lower Trinity Aquifer (LTA) has been increasingly targeted for groundwater development. As a result, improved understanding of groundwater quality, quantity, and recharge dynamics is necessary to support groundwater policy that balances beneficial groundwater use and conservation of the groundwater resources within the Barton Springs Edwards Aquifer Conservation District (BSEACD or “District”). This report summarizes the work LRE Water (LRE) completed under the BSEACD Hydrogeological and Geochemical Study of the Lower Trinity Aquifer (RFP dated July 19, 2024). The purpose of the study was to improve understanding of groundwater quality and stratigraphy of the Lower Trinity Aquifer (LTA) based on currently available geological, hydrogeological, and geochemical information. The results of this study support the BSEACD’s ultimate objective of identifying qualitative and quantitative conditions that lead to unreasonable negative impacts for groundwater users. This study builds on previous Trinity Aquifer work in Hays and Travis counties and specifically advances current knowledge about the LTA beneath BSEACD by generating new rock geochemistry data and extending the local stratigraphic model towards the eastern extent of the District.

Geochemical analysis indicates an evolution in water chemistry along inferred flow paths from the southwest towards the northeast, generally consistent with potentiometric mapping completed by Hunt and others (2020). Upgradient (southwest) waters are dominated by calcium–magnesium–bicarbonate, while downgradient (northeast) waters exhibit increasing sulfate and chloride concentrations, although substantial local variability in TDS and major ion chemistry occur in the southwestern portion of the study area. These trends reflect carbonate buffering and gypsum dissolution as primary geochemical controls. Isotopic analyses indicate a range of apparent groundwater ages, with younger groundwater occurring primarily in the southwestern portion and generally older groundwater occurring farther northeast, consistent with the interpreted flow direction. Local variability in both isotopic signatures and major ion chemistry indicate potential mixing among multiple flow paths and possible hydraulic compartmentalization associated with the Balcones Fault Zone (BFZ). Examination of historical water level measurements, in combination with geochemistry, supports the idea that there is minimal regional recharge to the LTA and that groundwater mining is likely occurring in some areas of the District.

Refinement of the LTA stratigraphic model (Hunt and others, 2020) integrated information from Texas Water Development Board databases, BSEACD logs, and the Texas Railroad Commission. These additional data sources facilitated extension of the stratigraphic model towards the eastern boundary of the District where historical data is sparse. The stratigraphic model indicates that aquifer thickness ranges from 384 to 1,104 feet,

thickening towards the east. Even with additional data, the spatial distribution of LTA data is still concentrated towards the north and west sides of the District. Increased geologic, water level, and hydraulic properties data availability across the District, particularly to the east and south, could improve the hydrogeologic understanding of the LTA within the District.

The results of this study highlight the need for data collection, especially in the eastern and southern portions of the BSEACD. Stratigraphic and potentiometric surfaces, and the spatial distribution of water quality could be improved with additional data. Continued water level and quality monitoring as well as additional monitoring locations would provide understanding of aquifer behavior and a basis for change detection in the District. Additionally, data collection within the Balcones Fault Zone would help characterize aquifer compartmentalization. Recharge estimates could be refined through investigating surface water-groundwater interactions along the Colorado and Pedernales Rivers. Due to limited recharge and recent water level data indicating groundwater mining, data-supported management of the LTA is critically important to balance meeting current water supply needs with conserving groundwater for future needs.

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- APPENDIX D Constant Rate Pumping Test Summary Table
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LIST OF ABBREVIATIONS

BEG – Bureau of Economic Geology
BFZ – Balcones Fault Zone
BRACS – Brackish Resources Aquifer Characterization System
BSEACD – Barton Springs-Edwards Aquifer Conservation District
GWDB - Texas Water Development Board Groundwater Database
HTGCD – Hays Trinity Groundwater Conservation District
LRE – LRE Water
LTA – Lower Trinity Aquifer
RRC DICE – Texas Railroad Commission’s Drilling Insight and Casing Estimator
SDR Database – Submitted Drillers Report Database
TWDB – Texas Water Development Board
WIA – Well Impact Assessment
WD-XRF – Wavelength-dispersive X-ray fluorescence
XRD – X-ray diffraction

ac-ft – acre-feet
ft – feet
ft bg – feet below ground
ft amsl – feet above mean sea level
TD – total depth
WL – water level

SECTION 1: INTRODUCTION

1.1 SCOPE OF WORK

The Trinity Aquifer is a primary groundwater resource in Texas, providing water of suitable quality for several uses including public supply, domestic, irrigation, commercial, and livestock. In Hays and Travis Counties, the Lower Trinity Aquifer (LTA) has been increasingly targeted for groundwater development in the region because of declining water levels within the Middle Trinity Aquifer. Although development and knowledge of the LTA have been generally hampered by depth, geologic uncertainty, and poor water quality compared to the Middle Trinity Aquifer, more wells being drilled into the LTA within the Barton Springs-Edwards Aquifer Conservation District (BSEACD or District) and Hays Trinity Groundwater Conservation District (HTGCD) has allowed the collection of more hydrogeological data.

The study described in this report was completed to support the BSEACD's objective to balance the beneficial use of groundwater with conservation and to manage total groundwater production over the long-term while avoiding unreasonable impacts. This study compiled, synthesized, and interpreted the best available geological, hydrogeological, and geochemical information on the LTA to increase the understanding of LTA groundwater quality and quantity within the District.

The work undertaken by LRE was divided into four main tasks. Task 1, "Data Compilation and Analysis", consisted of compiling and reviewing available data related to the LTA, and conducting a literature review to summarize previous work on the LTA in Central Texas. Efforts under Task 2, "Geochemical Analysis", enhanced understanding of the geochemical makeup of LTA groundwater, potential sources of recharge, and potential vertical mixing between the LTA and the Middle Trinity Aquifer using existing and newly-collected water quality and geochemical data. During Task 3, "Stratigraphy and Structural Evaluation", data compiled in Task 1 was utilized to refine the stratigraphic surfaces of the LTA, focusing on extrapolating towards the eastern portion of the District and accounting for fault locations and offsets. Finally, within Task 4, "Groundwater Availability and Recharge Assessment", available data on hydraulic properties were summarized and discussed.

1.1.1 Scope of Work Adjustment

After a thorough survey of available literature and datasets, we concluded that elemental composition data from the Lower Trinity Aquifer (Sligo and Hosston formations) did not exist within or near the study area. To develop a geochemical model to evaluate groundwater recharge and mixing in the LTA, generating elemental composition data through X-ray diffraction (XRD) and wavelength-dispersive X-ray fluorescence (WD-XRF)

analysis was a necessary and valuable addition to the scope. Through discussions with the BSEACD, LRE was made aware of LTA core stored at the Texas Bureau of Economic Geology and received approval from the BSEACD to add to the scope of work through collecting core and cutting samples for XRF and XRD analysis. Change Order No. 1, which authorized this added scope of work, was executed on November 13, 2025, and a copy is provided in Appendix A.

1.2 STUDY AREA

The main area of focus for this study is the LTA beneath the BSEACD. BSEACD covers 430 square miles in parts of Travis, Hays, and Caldwell counties. The hydrostratigraphic units making up the LTA completely underlie the area of the District and extend beyond the District boundaries. Because the aquifer extent is outside the District and data for the LTA is more abundant towards the west, data outside the District boundaries (especially data from HTGCD), were considered in this study. A three-mile buffer was drawn around BSEACD and HTGCD to include as much relevant data as possible. Figure 1.1 presents a map of the study area (BSEACD) and the boundary within which data were included in this study. The extent of the LTA outcrop is to the northwest of HTGCD as illustrated in Figure 1.3.

1.3 TRINITY AQUIFER OVERVIEW

The Trinity Aquifer is a key groundwater resource in Travis and Hays counties, providing water of suitable quality for several uses including public supply, domestic, irrigation, commercial, and livestock. The Trinity Aquifer also provides recharge to artesian springs and the Barton Springs segment of the Edwards (Balcones Fault Zone) Aquifer. The geochemistry of the Lower Trinity Aquifer is discussed in detail in Section 3 of this report.

The Trinity Aquifer is routinely subdivided into three units (from youngest to oldest): the Upper Trinity, the Middle Trinity, and the Lower Trinity. Stratigraphically, from highest to lowest, the Upper Trinity is comprised of the Upper Glen Rose Formation, the Middle Trinity is comprised of the Lower Glen Rose, Hensel, and Cow Creek formations, and the Lower Trinity is composed of the Sligo and Hosston Formations. The LTA has been targeted for increasing groundwater development in recent years because of the lowered water table within the Middle Trinity Aquifer in the study area. However, the LTA remains generally undeveloped due to depth, geologic uncertainty, and poor water quality.

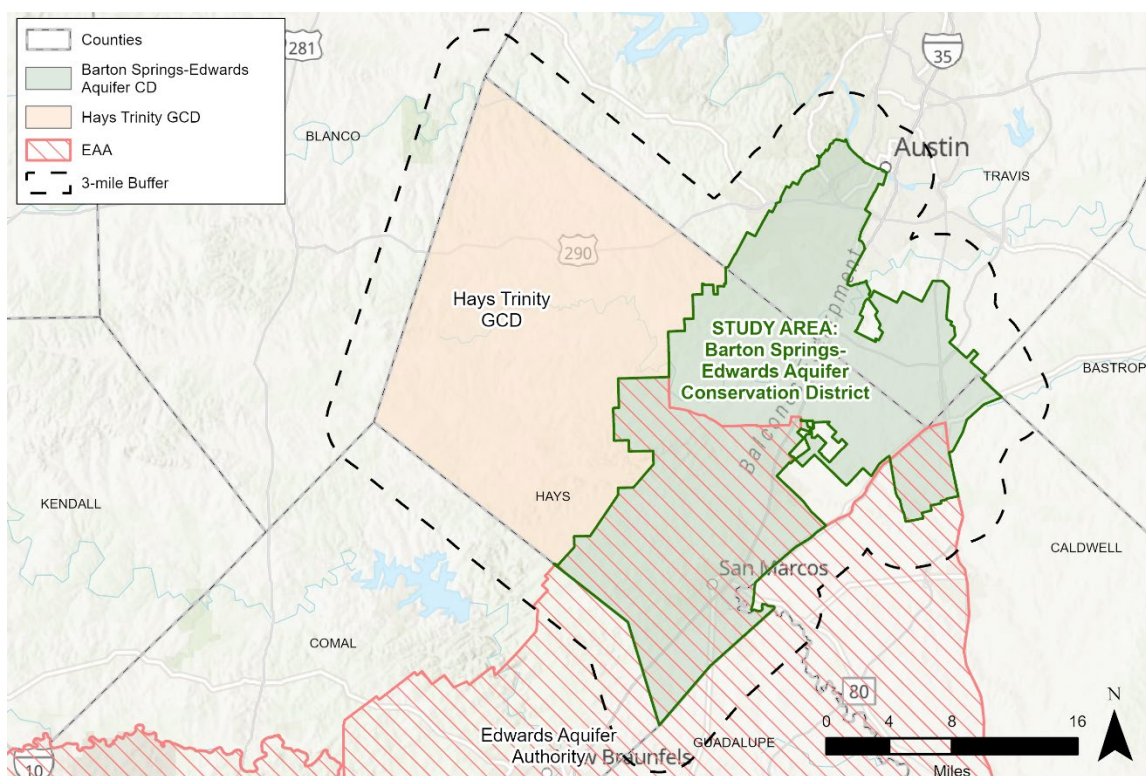


Figure 1.1 Map of study area.

The geology of the Trinity Aquifer in the area around the BSEACD is described in detail by Toll and others (2018) and Hunt and others (2020). The stratigraphy and structure of the Lower Trinity Aquifer is discussed in detail in Sections 1.4 and 4 of this report.

1.4 HYDROGEOLOGIC SETTING

The Trinity Aquifer consists of three parts: the Upper Trinity, Middle Trinity, and Lower Trinity (Figure 1.2). This study focuses on the Lower Trinity Aquifer (LTA), which is comprised of the Hosston Formation and overlying Sligo Formation. The LTA is overlain by the Hammett Shale, also known as the Pine Island Shale in older literature. This shale layer is a ubiquitous aquitard that regionally separates the Middle and Lower Trinity aquifers. The unit resulted from Cretaceous Period (~120 million years before present) flooding of the carbonate shelf and deposition of offshore clay and silty shale over the underlying LTA sediments (Hunt and others, 2020). The Hammett thins to nearly zero feet updip and thickens to greater than 100 feet downdip in the study area. The bottom confining unit of the LTA in the study area consists of the Ouachita Facies of the Paleozoic Basement. Northwest of the District, the Llano Uplift region was a topographic high during the deposition of the Trinity Group and eroded into the Trinity depositional basin. The topographic high and variable erosion of the Llano Uplift contributed to the uneven terrain

at the time of Trinity deposition and greatly affected the lateral and horizontal distributions of the Trinity Group (Toll and others, 2018).

Lower Trinity sediments represent a shallowing upwards sequence that was deposited directly on the eroded Paleozoic surface. The base of the LTA is the Hosston Formation, which unconformably overlies the older Paleozoic rocks. Northwest of the District, the Llano Uplift provided the sediment influx that composed the basal conglomerate and sandstone of the Hosston Formation. Alluvial fan, delta plain, and shoreline sediments were deposited seaward towards the proto-Gulf of Mexico and became increasingly more marine eastward (Wierman and others, 2010). Fluvial and deltaic sandstones and red/brown siltstones and shale are common in these locations (Wierman and others, 2010). Surface outcrops of the Hosston Formation, referred to in the literature as the Sycamore Formation, are present along the Pedernales and Colorado River valleys in western Travis County (Figure 1.3 and Figure 1.4). The Sycamore Formation has been described as a coarse conglomerate grading upward into a tan and red cross bedded sand not exceeding 50 feet thick, which directly correlates with the basal conglomerate of the subsurface Hosston Formation (Figure 1.5; DeCook, 1963; Hunt and others, 2020). In the District, the Hosston Formation varies in thickness from less than 200 feet to greater than 600 feet based on data from geophysical logs.

The Sligo Formation overlies the Hosston Formation and is composed of carbonate, siltstone, and shale. The Sligo Formation is a shallow-water, high-energy carbonate and is represented by a clastic facies to the west that becomes predominantly more carbonate to the southwest (Camp and others, 2020; Wierman and others, 2010). The formation is usually described as an upper tight grain-skeletal limestone with a micrite matrix overlying a commonly water-bearing, fine crystalline and porous dolomite interbedded by shale (Wierman and others, 2010; Toll and others, 2018). When fractured, the dolomite is a good aquifer target that produces water in several wells within Hays County (Wierman and others, 2010). The Sligo does not occur at the surface but is present in the subsurface beyond the Sligo pinchout near the Blanco-Hays County line north of the District. Updip of this surface northwest of the District, the Hammett directly overlies the Hosston Formation. The Sligo Formation thickens to the southeast and may reach 100 feet in eastern and southeastern Hays County (Wierman and others, 2010).

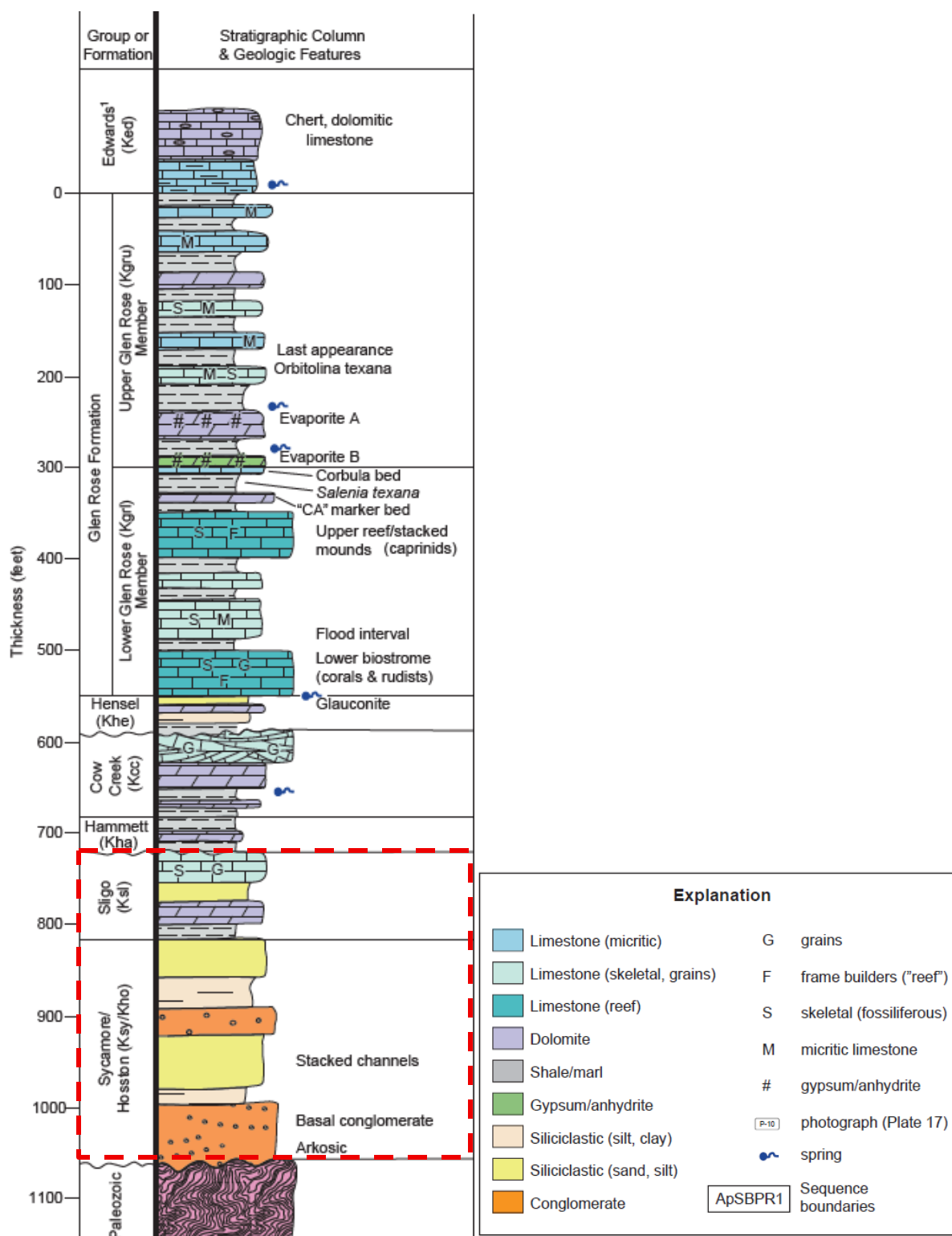


Figure 1.2 Stratigraphic column of Edwards and Trinity Aquifers with the Lower Trinity Aquifer highlighted in red (modified from Wierman and others, 2010).

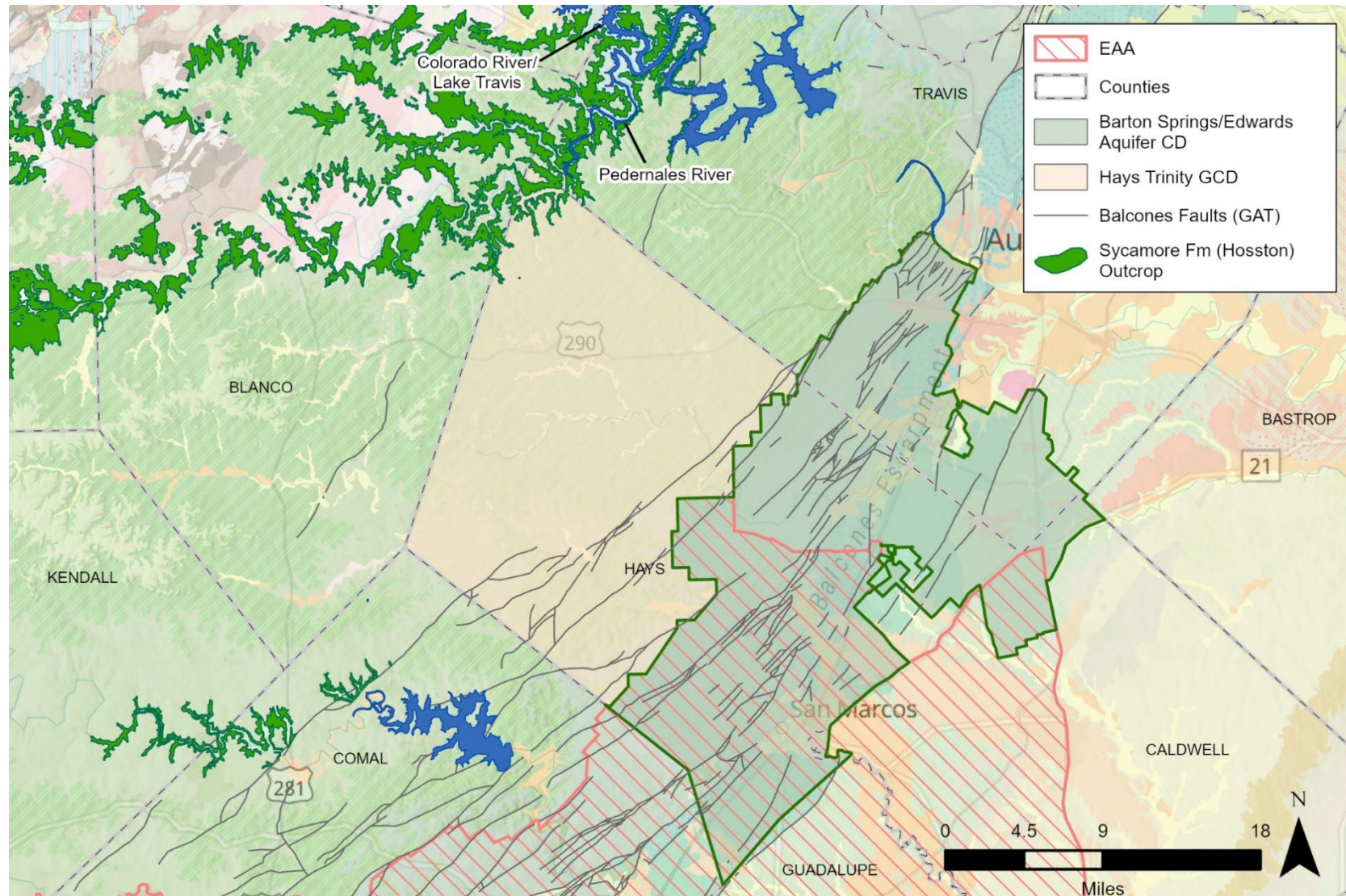


Figure 1.3 Surface exposure of the Sycamore Formation (Hosston) northwest and west of the District. GAT = “Geologic Atlas of Texas”.



Figure 1.4 Sycamore outcrop at Pedernales Falls. The “Sycamore Conglomerate” represents the outcrop nomenclature of the Hosston Formation, particularly the basal conglomerate unit (modified from Hunt and others, 2020). The dashed line indicates the unconformity between the Sycamore Conglomerate and underlying Paleozoic rocks.



Figure 1.5 Sycamore Sand (Hosston equivalent) near Shaffer Bend on the Colorado River in western Travis County (Hunt and others, 2020). Rock hammer for scale.

1.4.1 Structure

The Trinity sediments in BSEACD follow the regional structural grain of the Central Texas Hill Country. They rest upon a structural basement of Paleozoic rocks that were shaped by the Llano Uplift and deformed by post-Pennsylvanian orogeny and erosion (DeCook, 1963; Wierman and others, 2010). Intermittent uplift and erosion continued into the Mesozoic era so that when Cretaceous deposition began the regional slope was to the southeast. A shallow, transgressive sea extended over the entire Central Texas region and deposited sediments that comprise the Lower Trinity Aquifer. Mostly continuous deposition along the Gulf Coast from the Cretaceous period to present time has been accompanied by normal faulting along the Balcones Fault Zone, which transects the study area.

The Lower Trinity Aquifer in the study area occurs within the Balcones Fault Zone. The fault zone extends southeastward from Waco through Austin and San Antonio and then westward towards Del Rio. The fault zone formed in the Cenozoic Era, where subsidence of the northwest margin of the Gulf of Mexico basin resulted in a series of normal faults of regional extent that parallels the southeastern margin of the Llano Uplift in Hays County and follows the Ouachita structural grain (DeCook, 1963; Hunt and others, 2020). Faults in this zone are within a 15- to 18-mile-wide area and are closely spaced, subparallel and step-like with a southeastern dip (Foley, 1926; Collins, 2000). The Balcones Fault Zone has a maximum total displacement of 1,500 feet across its extent and its individual faults have displacement of 100 to 1,000 feet or more (Weeks, 1945; Collins, 2000). The system marks the boundary between the flat-lying strata of Central Texas and the gently coastward-dipping sedimentary rocks of the coastal plains. Though the tectonic and structural history of the Central Texas Balcones Fault Zone has been extensively documented, a detailed study of the fault zone on the LTA has not yet been completed.

Faults of the Balcones Fault Zone exert important controls on fluid flow within the Trinity Aquifer. However, detailed hydraulic properties for the region are a source of uncertainty. Extensional deformation in the Balcones Fault Zone includes a network of faults that likely influences intra-aquifer permeability and flow paths. The faults juxtapose both permeable and relatively impermeable hydrogeological units and cause substantial thinning of lower Cretaceous strata. They also provide potential pathways for infiltration of surface water into the groundwater systems and for lateral and vertical movement of groundwater (Ferrill and Morris, 2008; McGinnis and others, 2015; Toll and others, 2018). Additionally, fractures associated with structural stress during these events shattered the brittle carbonate rocks and provided solution conduits and pathways for groundwater movement (Wierman and others, 2010). Displacement along the faults can thin the Trinity Aquifer units by 50-100 percent of their total thickness, compartmentalize LTA units, and juxtapose LTA strata against Pre-Cretaceous strata or younger aquifer units (Figure 1.6). This leads to the potential for water-bearing formations to be thin, absent, or have intra-aquifer communications in certain areas.

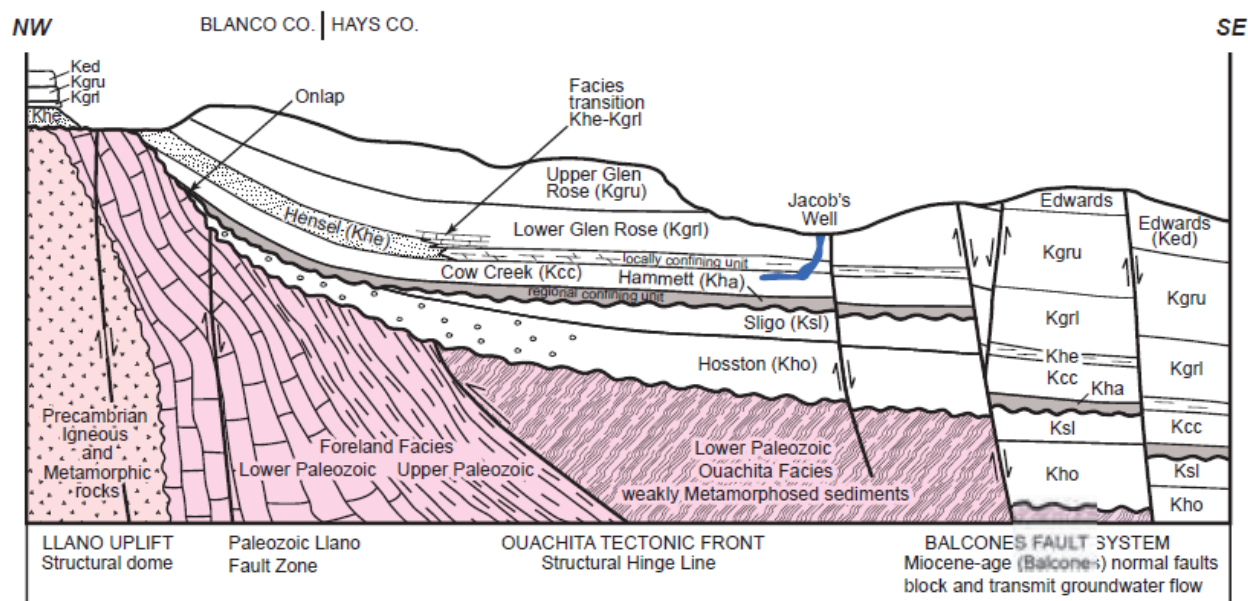


Figure 1.6 Schematic cross section of the Trinity Aquifer in Central Texas, roughly drawn from northwest (Blanco County) to southeast (Hays County), highlighting the compartmentalization of the LTA (Wierman and others, 2010).

1.4.2 Recharge

Groundwater within the LTA is thought to be within a deeply confined and compartmentalized aquifer system containing old groundwater (thousands of years) that moves very slowly through a fine-grained, poorly defined matrix (Camp and others, 2020). The Balcones Fault Zone compartmentalized the LTA and further limits recharge to the aquifer. The primary source of recharge to the LTA is thought to be from leakage in the updip area northwest of the District where the Hammett is thin or absent. Previous reports have identified the Balcones Fault Zone as a potential pathway for additional leakage from the Middle Trinity Aquifer in downdip areas near the District (Ashworth and others, 2001). Faults and fractures within the zone may locally interrupt the continuity of the Hammett Shale, however, no direct evidence of flow through the Hammett Shale has been documented. Additionally, faults may juxtapose LTA units with Middle Trinity Aquifer units and allow lateral flow (Wierman and others, 2010).

Regionally, recharge to the LTA from precipitation is limited because only a small portion of the aquifer is exposed at the surface. In addition, the Hammett Shale acts as a regionally extensive, low-permeability confining unit that restricts vertical recharge to the aquifer, particularly in the vicinity of the District. Recharge potential exists from the Pedernales and Colorado rivers along the LTA outcrop, although it is believed that the aquifer provides discharge under normal conditions through a number of seeps and springs (Hunt and others, 2020). However, as extended periods of drought and increased

pumping in the LTA have induced significant water level declines regionally and lowered water tables adjacent to the rivers, the LTA has increased potential for recharge from the Colorado River and Lake Travis east of the Bee Creek Fault zone (Figures 1.8 and Figure 1.9; Hunt and others, 2020).

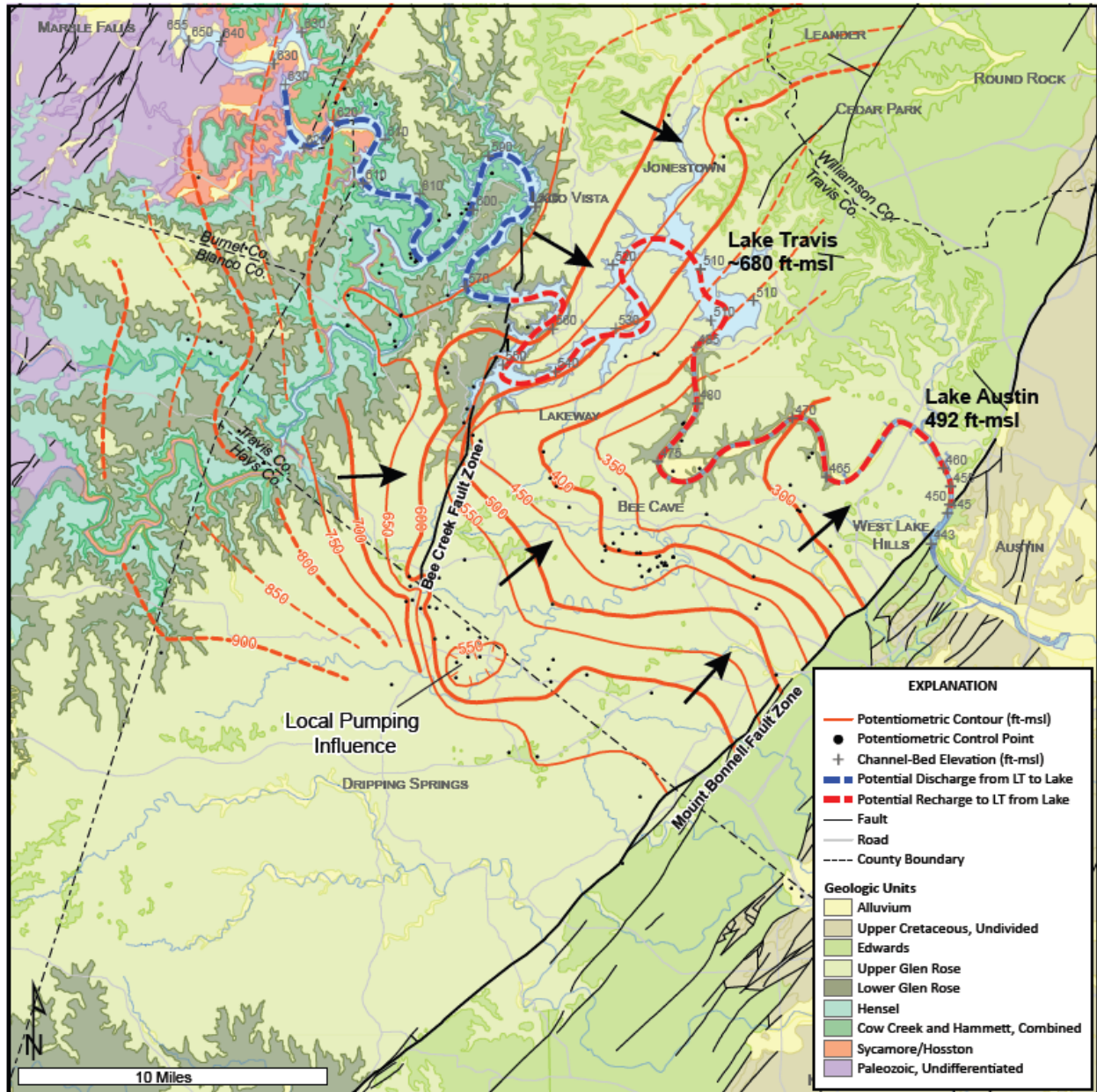


Figure 1.7 Potentiometric surface of the LTA in the Fall of 2018, indicating potential recharge and discharge areas along the Colorado River and Lake Travis (Hunt and others, 2020).

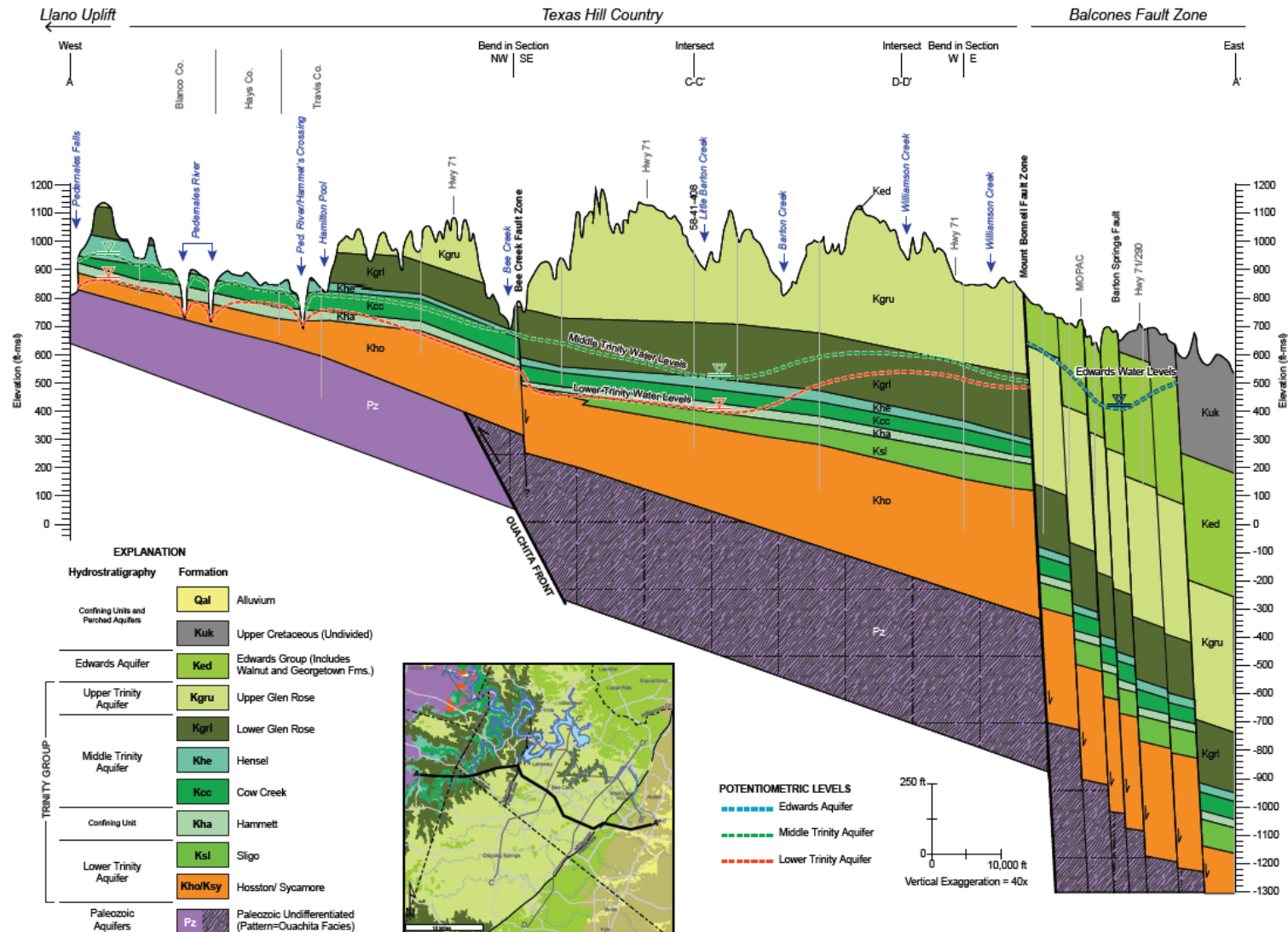


Figure 1.8 Structural cross section from west to east showing the connectivity of the Pedernales River to the LTA in Blanco County (from Hunt and others, 2020).

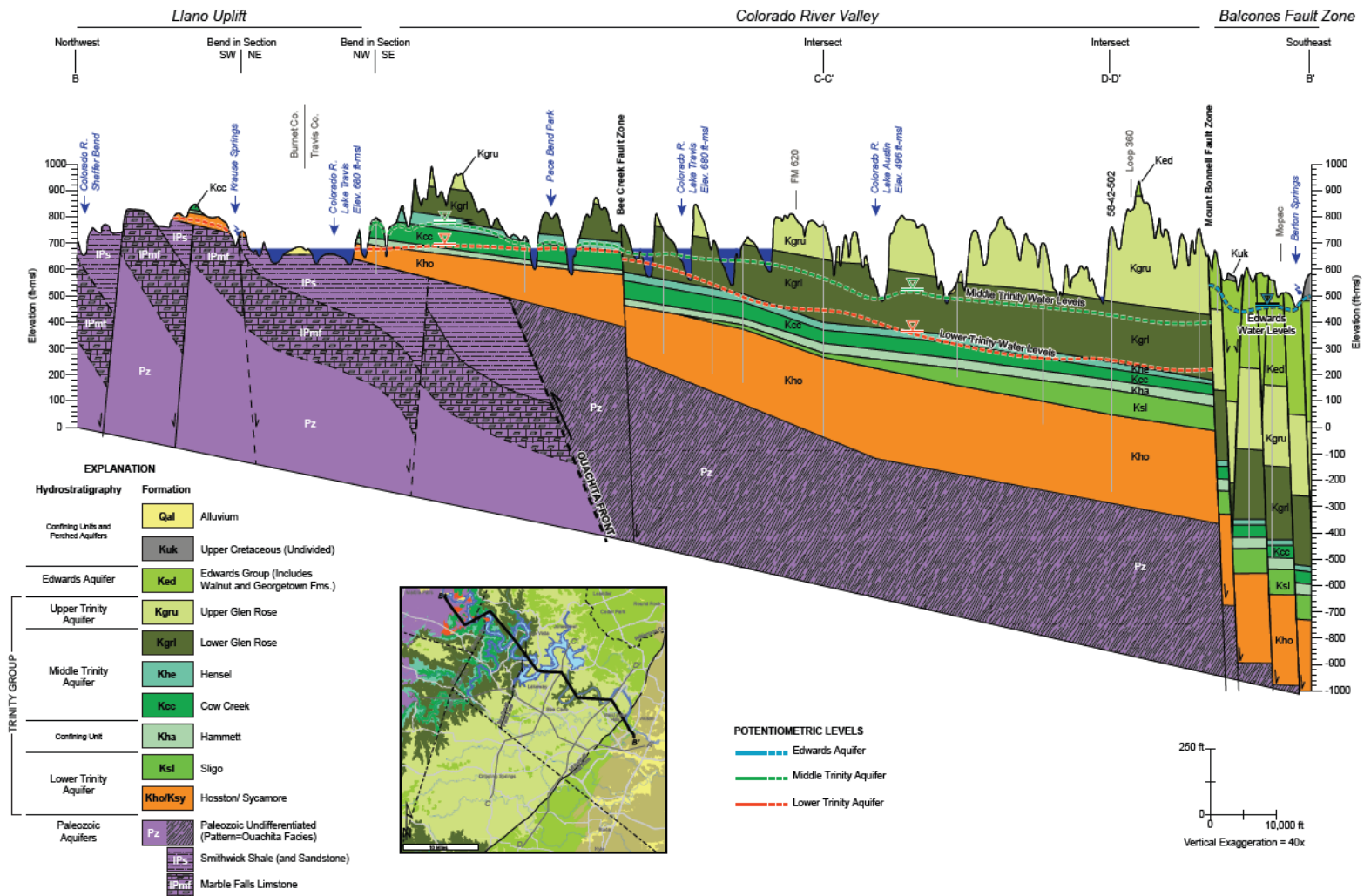


Figure 1.9 Structural cross section from west to east showing the connectivity of the Colorado River and Lake Travis to the LTA in Burnet and Travis counties (from Hunt and others, 2020).

SECTION 2: DATA COMPILATION AND ANALYSIS

This task consisted of data compilation and review of all available data on the Lower Trinity Aquifer (LTA) from the Texas Water Development Board Groundwater Database (TWDB GWDB), and Submitted Drillers Reports (SDR). Considering the scarcity of data in the eastern portion of the Lower Trinity Aquifer in the District, the TWDB Brackish Resources Aquifer Characterization System (BRACS) and the Texas Railroad Commission's Drilling Insight and Casing Estimator (RRC DICE) databases were queried for available geophysical logs to increase data coverage in the area. This task also included a literature review to summarize previous works related to the LTA with a focus on Central Texas. The literature review is presented in Section 1.4 of this report.

2.1 METHODOLOGY

On August 6, 2026, the latest TWDB Groundwater Database (GWDB) and Submitted Drillers Reports (SDR) were downloaded and processed using custom Python scripts. These scripts read the raw TWDB files, joined related tables, and produced master spreadsheets containing essential well attributes (e.g., State Well Number, location, use, owner, depth, elevation). The full GWDB and SDR tables were imported into ArcGIS Pro and a spatial filter was applied to limit the study area to the BSEACD and the HTGCD plus a three-mile buffer. State Well Numbers were used as a filter to create separate GWDB datasets to preserve multiple water-level and water-quality records for potential time-series analysis. Filtered water-level data, cation/anion concentrations, and isotopic data were exported for use in subsequent tasks.

After completion of the stratigraphic analysis (Section 4), the finalized raster surfaces of the top and bottom of the Lower Trinity Aquifer were used to confirm well completions in the aquifer to create a final Lower Trinity Aquifer dataset. The top and bottom elevations of the Lower Trinity Aquifer were extracted from their rasters at each well location using "Extract Multi Values to Points" in ArcGIS Pro (version 3.5.2). Wells were then assigned to the LTA based on the relationship between the formation depths and well construction depth information. Assumptions used in the aquifer assignment process are listed in Section 2.1.1. Of the 6,442 wells in the originally downloaded dataset 339 wells were confirmed to be completed within the LTA; the majority of LTA wells are located within the HTGCD (Figure 2.2).

Simultaneously, the TWDB BRACS database was queried for appropriate geophysical logs. Logs were chosen only if they captured the Sligo and/or Hosston formations. In particular, the query focused on geophysical logs in the eastern part of the BSEACD. The TWDB BRACS database yielded 48 geophysical logs for inclusion in the present scope

of work. The RRC DICE database was also queried for appropriate geophysical logs, but none were found for the study area.

2.1.1 Assumptions

The following assumptions were used when designating a well as completed in the LTA. Wells assigned to the LTA were designated “Lower Trinity” and included in the final Lower Trinity Aquifer dataset. During the review process, wells not assigned to the LTA were designated “Outside of LTA” and removed from the final Lower Trinity Aquifer dataset:

1. Where screen intervals were reported and set entirely within the extent of the LTA, the well was assigned to the LTA;
2. Where multiple screen intervals were reported, the well was assigned to the LTA only if the entire interval was set within the extent of the LTA;
3. Where screen intervals were not reported, the well depth and/or borehole depth and an assumed screen interval were used to assign aquifer completions. It was assumed that screen was set within the bottom 50 feet of a well;
4. Wells with reported or assumed screen intervals that started within 20 feet of the top of the LTA and bottom out within the LTA extent were flagged for manual review; and
5. If no well or borehole depth information were provided, the well was removed from the final Lower Trinity Aquifer dataset.

2.2 RESULTS

The results of the data compilation efforts are summarized in Table 2.1 and Figure 2.2.

Table 2.1 Summary of Lower Trinity Wells by data category.

Data Category	Number of Wells
Final LTA Dataset	339
Final LTA Dataset: Wells with Water Quality Data	55
Final LTA Dataset: Wells with Water Level Data	259
BRACS Geophysical Logs: Wells Extending to or past LTA	48

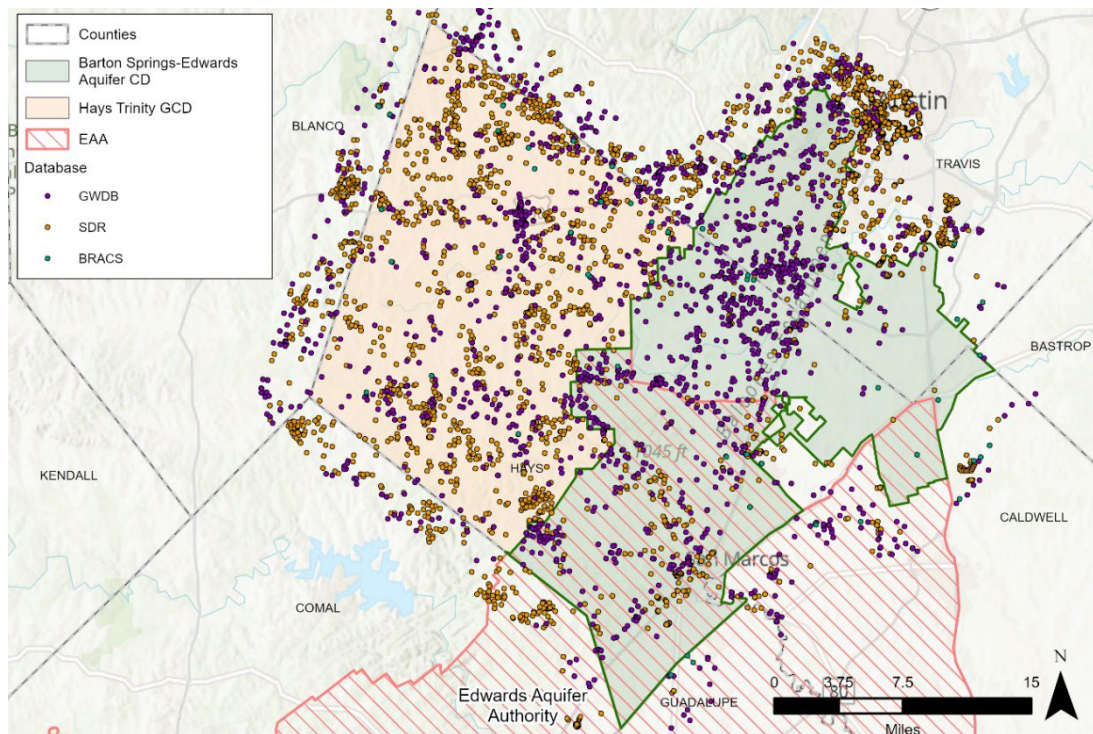


Figure 2.1 Distribution of wells in the original dataset.

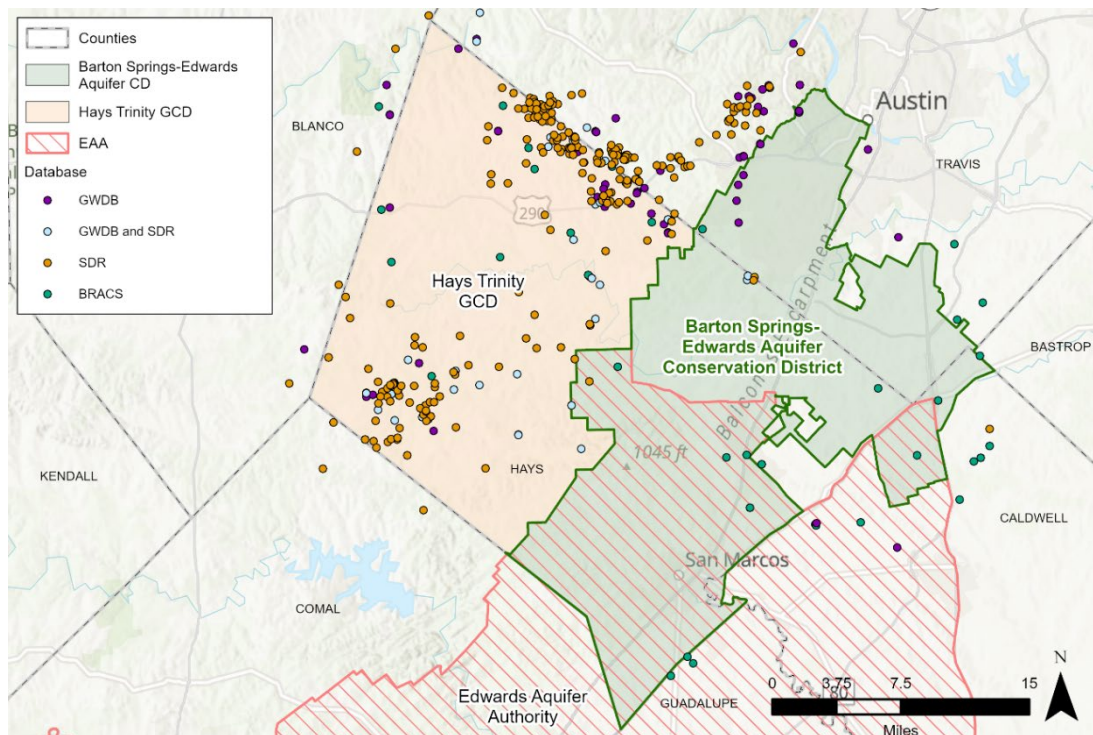


Figure 2.2 Distribution of wells in the final LTA dataset.

SECTION 3:GEOCHEMICAL ANALYSIS

3.1 DATA COMPILATION AND QUALITY CONTROL

We compiled publicly available groundwater-quality datasets from the TWDB and nearby GCDs. All available major-ion chemistry and isotopic data for the LTA were aggregated for subsequent analysis. In regard to major ion composition, the most recent water quality data from 55 independent wells were analyzed, with most wells completed in the Hosston Formation (one from the Sligo Formation). Eleven samples were obtained with isotopic analyses, all collected from the Hosston formation. Years of record range from 1986 to 2024, with most samples analyzed obtained during the early 2000s. Sample records were standardized to consistent units (e.g., mg/L, meq/L) and screened for charge-balance ($\leq \pm 5\%$). Samples that failed this screening were flagged and removed from further interpretation, with special considerations made for the TDS ranges of the samples that affect ionic strength and charge-balance (e.g., charge-balance tolerance increased to $\pm 10\%$ when TDS was greater than 800 mg/L). Of the 55 independent wells, 51 had valid water quality analyses within the charge-balance error.

3.2 BEG CORE RESEARCH CENTER SAMPLING

Historical geochemical data for the LTA is very limited within the study area. To determine rock geochemistry for this study, rock core and drill cuttings from sources within the LTA were sampled for XRD and XRF analysis. On September 23, 2025, LRE accessed the BEG Core Research Center in Austin, Texas to collect core samples from two recently completed wells. The first sample was from the Reimers Ranch MW#3 core, completed within the Sycamore Sand (Hosston Formation), and the second sample was from the Spillar Well 1, which is drilled within both the Sligo and Hosston Formations. Geographic coordinates of these wells are 30.3378, -98.1282 and 30.1751, -97.9104, respectively. The collected samples were logged, packaged, and delivered to the UT XRF and XRD labs on September 25, 2025 (see Section 3.3).

A total of ten samples were collected from LTA units within the MW#3 and Spillar Well 1 cores. A sample log and lithologic descriptions of the samples can be found in Appendix B. Eight rock core samples were selected from the Sycamore Formation of MW#3. Samples were selected to characterize lithologic changes within the Sligo Formation in intervals no greater than 20 ft. The core from MW#3 indicates the Sycamore Sand (Hosston Formation) is composed of an upper fine sandstone with mudstone intervals and a lower coarse-grained siliciclastic interval dominated by pebble to cobble conglomerate (Figure 3.1 through Figure 3.4). The lower conglomerates are very poorly sorted and well-cemented, thus having very little observable primary or secondary porosity (Camp and others, 2020).

Two samples were selected from the drilling cuttings of the Spillar Well 1. One sample was taken of the Sligo Formation within bag 910-920 and one sample was taken of the Hosston formation within bag 1090-1100 (Figures 3.5 through Figure 3.7). The bags represent an aggregated sample from a 10-foot section collected and logged during drilling. The samples were chosen at the selected intervals by reviewing the associated geophysical log and sample bags to select representative samples of both LTA units, and where abundant sample material was available. As indicated by the cuttings, the LTA at this location consists of a silty dolomitic limestone with coated grains and skeletal material (within the Sligo Formation) and a reddish brown silty fine-grained sandstone (within the Hosston Formation).



Figure 3.1 Upper sandstone unit of MW#3 illustrating selected samples (yellow sample bags).

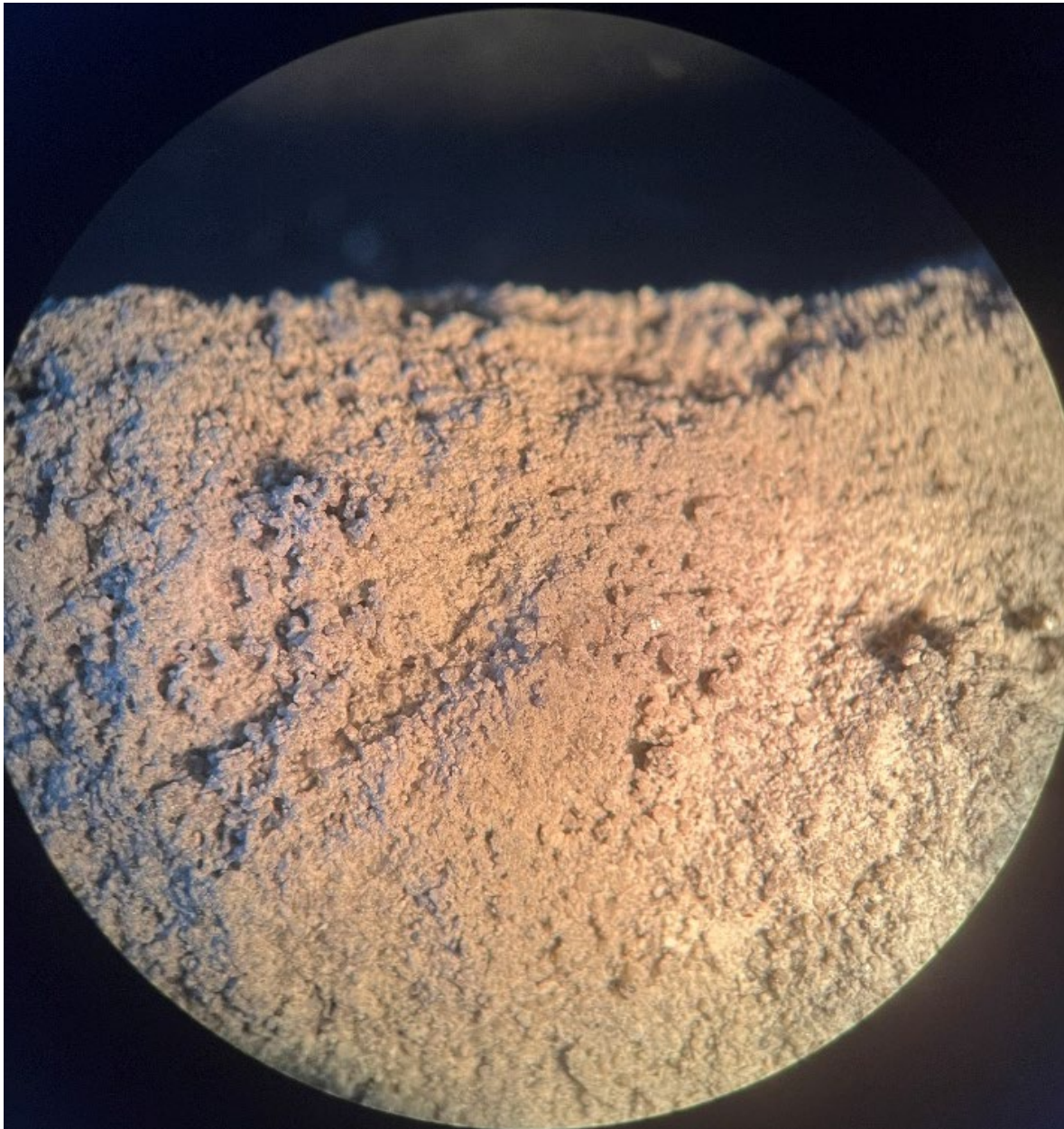


Figure 3.2 Microscope view of the upper fine sandstone unit of the Hosston Formation from the sample collected at 118.5 ft. The subangular quartz grains are visible within the carbonate cement.



Figure 3.3 Mudstone interval within the Sycamore Sand (Hosston Formation) of MW#3.



Figure 3.4 Lower pebble to cobble conglomerate interval at the base of the Sycamore Sand (Hosston Formation) of MW#3. Note the tight cementation and very poorly sorted clasts. The bottom of the core is at 217.5 ft, where the black foam spacer begins.



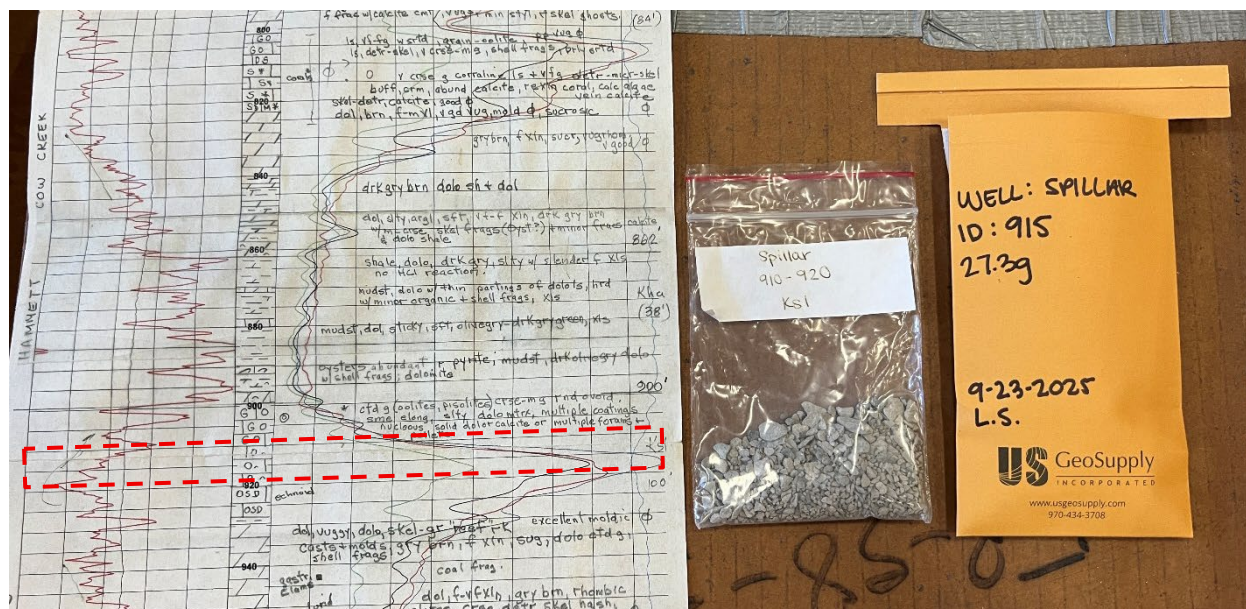


Figure 3.6 Cutting bag sampled for the Sligo Formation adjacent to the geophysical log interval. Dashed area shows the interval archived within the cutting bag and sampled for this study.

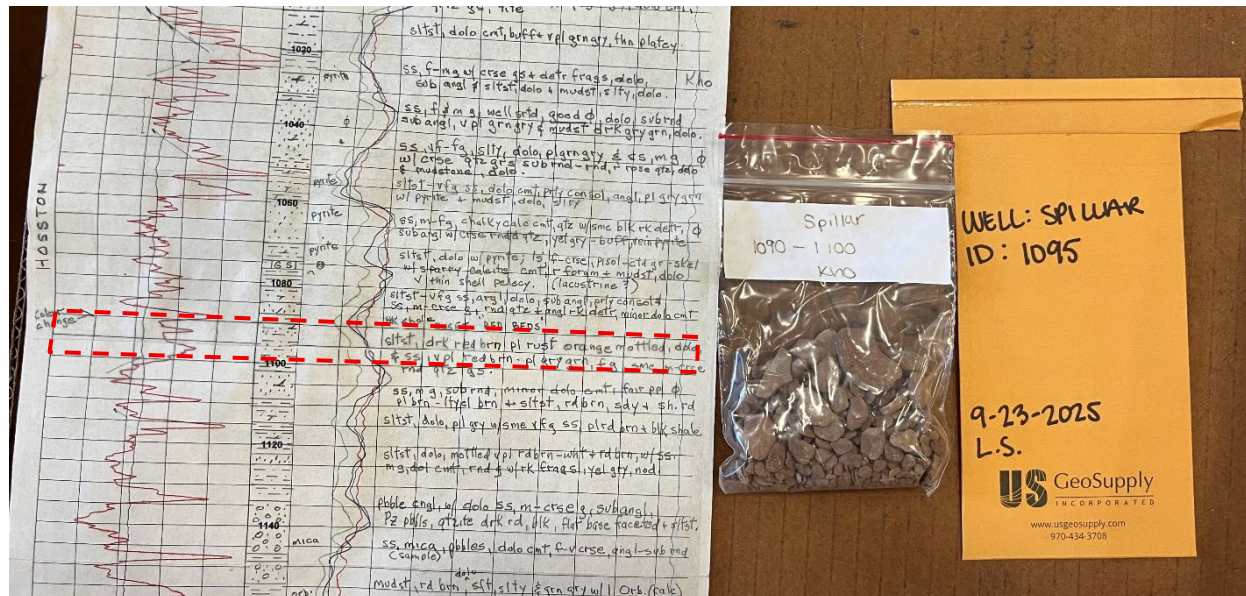


Figure 3.7 Cutting bag sampled for the Sycamore Sand (Hosston Formation) adjacent to the geophysical log interval. Dashed area shows the interval archived within the cutting bag and sampled for this study.

3.3 MINERALOGICAL ANALYSES

Bulk mineralogy and solid-phase elemental composition of the LTA were assessed using X-ray diffraction (XRD) and wavelength-dispersive X-ray fluorescence (WD-XRF) techniques, respectively. For MW#3, eight sampling depths were obtained at the following: 118.5, 137.5, 146.0, 166.0, 199.0, 217.0, 239.5, and 254.0 ft. Spillar Well #1 samples were obtained at depth ranges of 910-920 ft (Sample 915) and 1090-1100 ft (Sample 1095). Samples from both locations represent the variable mineralogy of the Sligo and Hosston Formations.

Samples were prepared for XRD/XRF analyses by UT staff in the E-beam Laboratory in the Department of Earth and Planetary Sciences at The University of Texas at Austin in Austin, Texas. The samples were pulverized into a homogeneous powder of approximately 60 μm grain size using a Bico Braun Pulverizer. Normalized solid-phase major element composition and trace element concentration was analyzed on a Rigaku wavelength-dispersive XRF spectrometer by a pressed powder method (Takahashi, 2015) in the E-beam Laboratory. The bulk mineralogy of the samples was analyzed via XRD analysis on a Rigaku Miniflex 600 Diffractometer at the Materials Analysis and Spectroscopy Facility in the Texas Materials Institute at The University of Texas at Austin in Austin, Texas. Supplementary analysis for relative inorganic and organic carbon composition was conducted via loss-on-ignition (LOI) analysis, also at the E-beam Laboratory.

Table 3.2 shows the results of the whole-rock analysis conducted via WD-XRF. The highest normalized major oxide mass percentages across all samples were SiO_2 (3.9-63.5%), MgO (2.1-26.1%), and CaO (11.8-78.0%), indicating that the major composition of the aquifer was carbonates and silica. Relatively low percentages of Al_2O_3 (1.4-9.1%) and K_2O (0.14-3.9%) provide some indication for the presence of secondary silicates and feldspars in the aquifer matrix. There were primarily undetectable (below-detection-limit) or relatively low solid-phase concentrations of trace elements that pose a risk to human health, which include arsenic (As), molybdenum (Mo), and lead (Pb). Strontium (Sr) was particularly enriched in the samples (92.8-1245.3 ppm), which typically exchange with Ca and Mg in carbonate minerals, forming minerals such as strontianite.

Carbonate composition was interpreted from the LOI analyses, which were supplementary to the XRD analyses. Mass loss at 550°C is associated with organic carbon, while most inorganic carbon combust at 1000°C. Across all samples, 1.9-3.7% mass was lost at 550°C, indicating relatively small concentrations of organic carbon. Mass loss at 1000°C ranged from 12.9-38.9% across the samples, with lower percentages in samples in which SiO_2 percentages were relatively high in XRF analysis (e.g., MW#3 at

118.5 ft). These patterns corroborate that these samples were primarily a mixture of carbonates and silicas, which is further supported in our XRD analyses.

The XRD analyses indicated that carbonate and silicate minerals dominate the mineralogy across all sampled intervals, as shown in Table 3.1. Dolomite and calcite together generally account for the majority of the mineral composition in most samples, though their relative abundances vary substantially with depth and the sampling locations. Several intervals were strongly calcite-rich (e.g., MW#3 146 ft, MW#3 217 ft, and Spillar 915 ft), whereas others were dominated by dolomite (e.g., MW#3 199 ft, Spillar 1095 ft). Quartz is present in all samples, and in one sample, it is the dominant phase (MW-3 166 ft). Feldspars, including microcline/orthoclase and albite, occurred at lower abundances and were restricted to select depths, with albite only observed at MW#3 118.5 ft. Minor amounts of gypsum were detected at a single depth, MW#3 239.5 ft.

Table 3.1 Bulk mineralogy determined by X-ray diffraction (wt%).

Mineral name	MW#3 118.5	MW#3 137.5	MW#3 146	MW#3 166	MW#3 199	MW#3 217	MW#3 239.5	MW#3 254	Spillar 915	Spillar 1095
Dolomite (CaMgCO_3)	40.8	34.2	11.1	32.8	79.0	20.2	2.5	36.7	10.4	50.9
Calcite (CaCO_3)	7.7	25.3	85.6	0.0	0.0	71.8	62.0	59.0	87.0	0.3
Quartz (SiO_2)	39.6	32.4	3.3	59.6	21.0	7.9	32.3	4.3	2.5	34.4
Microcline/Orthoclase (KAlSi_3O_8)	8.8	8.2	0.0	7.5	0.0	0.0	0.0	0.0	0.0	14.5
Albite ($\text{NaAlSi}_3\text{O}_8$)	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$)	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0	0.0

Table 3.2 Whole-rock analysis via WD-XRF and Loss-on-ignition (LOI)

		MW#3 118.5	MW33 137.5	MW#3 146	MW#3 166	MW#3 199	MW#3 217	MW#3 239.5	MW#3 254	Spillar 915	Spillar 1095
Normalized major elements (oxide mass %)											
Oxide	Uncertainty										
Al ₂ O ₃	±0.46	6.01	4.74	1.47	9.09	4.37	2.07	4.17	1.37	2.00	7.35
SiO ₂	±2.2	56.7	46.6	3.9	63.5	29.3	10.7	33.7	5.3	4.5	51.7
P ₂ O ₅	±0.014	0.100	0.084	0.036	0.054	0.046	0.042	0.048	0.056	0.071	0.098
K ₂ O	±0.11	2.89	2.66	0.14	2.76	0.55	0.28	0.82	0.14	0.60	3.94
CaO	±0.55	21.861	33.576	88.184	11.751	37.508	78.034	57.176	80.851	86.401	18.587
Fe ₂ O ₃	±0.32	1.38	1.23	0.31	3.19	1.61	0.73	1.65	0.14	0.71	3.19
Na ₂ O	±0.049	0.637	0.336	0.077	0.206	0.190	0.097	0.127	0.114	0.121	0.206
MgO	±0.23	10.190	10.462	5.827	8.887	26.084	7.930	2.068	11.817	5.463	14.370
MnO	±0.0046	0.0433	0.0323	0.0260	0.0214	0.0509	0.0636	0.0325	0.2707	0.0474	0.0795
TiO ₂	±0.046	0.248	0.291	0.028	0.510	0.287	0.059	0.198	0.000	0.043	0.484
Loss-on-ignition (LOI)											
wt% LOI, 550°C		2.32	3.07	1.87	3.73	5.18	2.22	2.29	1.88	2.03	3.71
wt% LOI, 1000°C		17.77	21.56	39.66	12.89	30.04	37.54	27.11	40.37	38.86	17.76
wt% LOI, Total		20.09	24.63	41.52	16.62	35.23	39.75	29.40	42.26	40.89	21.47
Trace elements (ppm)											
Element	Uncertainty										
S	±113	7196	109	0	0	0	0	0	0	3555	1607
Sc	±0.5	12.9	7.2	0.0	9.0	8.4	0.0	0.0	0.0	0.0	10.9
V	±4.8	5.0	5.5	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0
Cr	±3.8	27.1	12.9	0.0	11.7	0.0	0.0	0.0	0.0	0.0	32.5
Co	±2.9	35.7	27.8	23.9	10.6	0.0	14.6	15.0	22.3	12.4	17.4
Ni	±4.2	15.7	14.0	0.0	11.7	5.9	0.1	4.1	0.0	0.0	19.8
Cu	±2.7	16.9	37.7	25.3	11.9	12.5	15.6	15.6	18.7	22.8	11.0
Zn	±4.4	11.7	13.9	11.5	20.7	15.3	11.8	17.3	14.8	12.4	21.4
As	±4.4	0.0	4.2	0.0	3.0	4.6	1.5	7.1	4.1	3.1	9.0
Rb	±4.9	38.3	36.7	0.0	66.2	19.3	3.7	15.8	0.0	9.7	53.7
Sr	±2.7	208.3	520.4	258.6	365.2	1245.3	153.7	77.9	92.8	410.9	185.0
Y	±2.3	20.9	14.4	2.2	11.8	17.4	4.2	14.8	5.7	3.0	19.3
Zr	±13	94	113	23	277	115	21	57	13	17	212
Mo	±0.25	0.93	0.00	0.00	0.67	0.00	0.00	0.00	0.00	0.00	1.17
Ba	±12	201	132	59	143	87	51	65	129	61	206
La	±3.3	11.4	13.8	17.2	9.2	7.6	13.5	21.1	15.1	9.1	12.5
Ce	±5.8	45.2	31.5	16.5	32.1	27.4	16.6	23.7	8.0	12.3	36.4
Nd	±3.2	22.3	14.6	1.3	18.2	17.8	6.6	5.4	10.2	6.4	15.7
Sm	±1.2	2.2	1.7	0.0	1.7	0.8	0.1	1.2	0.0	0.0	2.1

		MW#3 118.5	MW33 137.5	MW#3 146	MW#3 166	MW#3 199	MW#3 217	MW#3 239.5	MW#3 254	Spillar 915	Spillar 1095
Eu	±0.02	0.96	0.98	0.60	0.84	1.01	0.60	0.76	1.08	0.61	0.83
Yb	±0.28	2.55	1.63	0.39	1.23	1.44	0.52	2.00	0.75	0.22	2.36
Lu	±0.14	0.84	0.80	1.24	0.71	0.12	1.36	1.18	1.71	1.15	1.07
Hf	±0.07	2.34	3.27	5.38	7.10	0.00	7.60	6.50	5.05	6.74	6.51
Pb	±6.0	4.7	4.5	6.8	9.3	7.5	6.3	5.1	2.9	5.4	2.3
U	±2.5	4.9	4.6	0.0	6.1	12.0	0.0	0.0	0.0	0.0	1.0

3.4 MAJOR ION COMPOSITION

The major ion chemistry was characterized to define the range in hydrogeochemical facies for the LTA and to determine its spatial variability. To define the hydrogeochemical facies, we analyzed the relative proportions of the major cations (calcium, magnesium, sodium, and potassium) and anions (bicarbonate, carbonate, sulfate, and chloride) using Piper diagrams. To assess the relationship between facies and salinity, samples were categorized by total dissolved solids (TDS) into the bins of “<500 mg/L”, “500-1000 mg/L”, and “>1000 mg/L”. Potential concentration gradients were also evaluated by mapping Stiff diagrams of samples with their well locations. The facies classification and spatial mapping of major ion chemistries provided a baseline framework to generating insight into the primary geochemical processes that influence the chemistry of water from the LTA.

The Piper diagram illustrates the variations in major-ion chemistry that correspond with increasing TDS (Figure 3.8). Low-TDS waters (<500 mg/L) clustered toward Ca–HCO₃–dominated compositions, reflecting calcium–magnesium and bicarbonate as the dominant cation and anion groups. Samples with intermediate TDS (500–1,000 mg/L) fell into mixed-type regions in the Piper diagram, showing increasing contributions from sulfate and chloride alongside calcium and magnesium. The highest-TDS samples (>1,000 mg/L) plotted towards mixed Ca–Mg–SO₄ and Ca–Mg–Cl facies, with a pronounced shift away from bicarbonate dominance. Collectively, these trends indicated progressive geochemical evolution along a flowpath from relatively dilute, carbonate-buffered waters to more mineralized compositions enriched in sulfate and chloride trending northeast (based on the potentiometric map in Figure 5.2).

Spatial patterns in major-ion chemistry and TDS are further illustrated by the mapped Stiff diagrams, which show substantial local heterogeneity superimposed on broader regional flow trends influencing the aqueous geochemistry (Figure 3.9). In the southwestern portion of the study area, the data indicate that relatively fresh and high-TDS groundwater occurs in close proximity, suggesting locally distinct groundwater flow paths and high subsurface heterogeneity. Northeast of this area, groundwater transitions to generally fresher conditions before TDS increases along the interpreted northeast-trending regional flow path. The Stiff diagrams indicate that the higher-TDS samples throughout the study are commonly characterized by pronounced sulfate concentrations, in some cases accompanied by increased calcium and magnesium. This is consistent with water-rock interactions, including the dissolution of sulfate-bearing minerals and/or mixing with sulfate-rich groundwater, which may be important controls on salinity in the study area. The sharp gradient of low- and high-TDS groundwater in the southwestern part of the

study area in Hays Trinity GCD may further indicate structural controls on groundwater flow, including possible hydraulic compartmentalization or preferential flow associated with faulting.

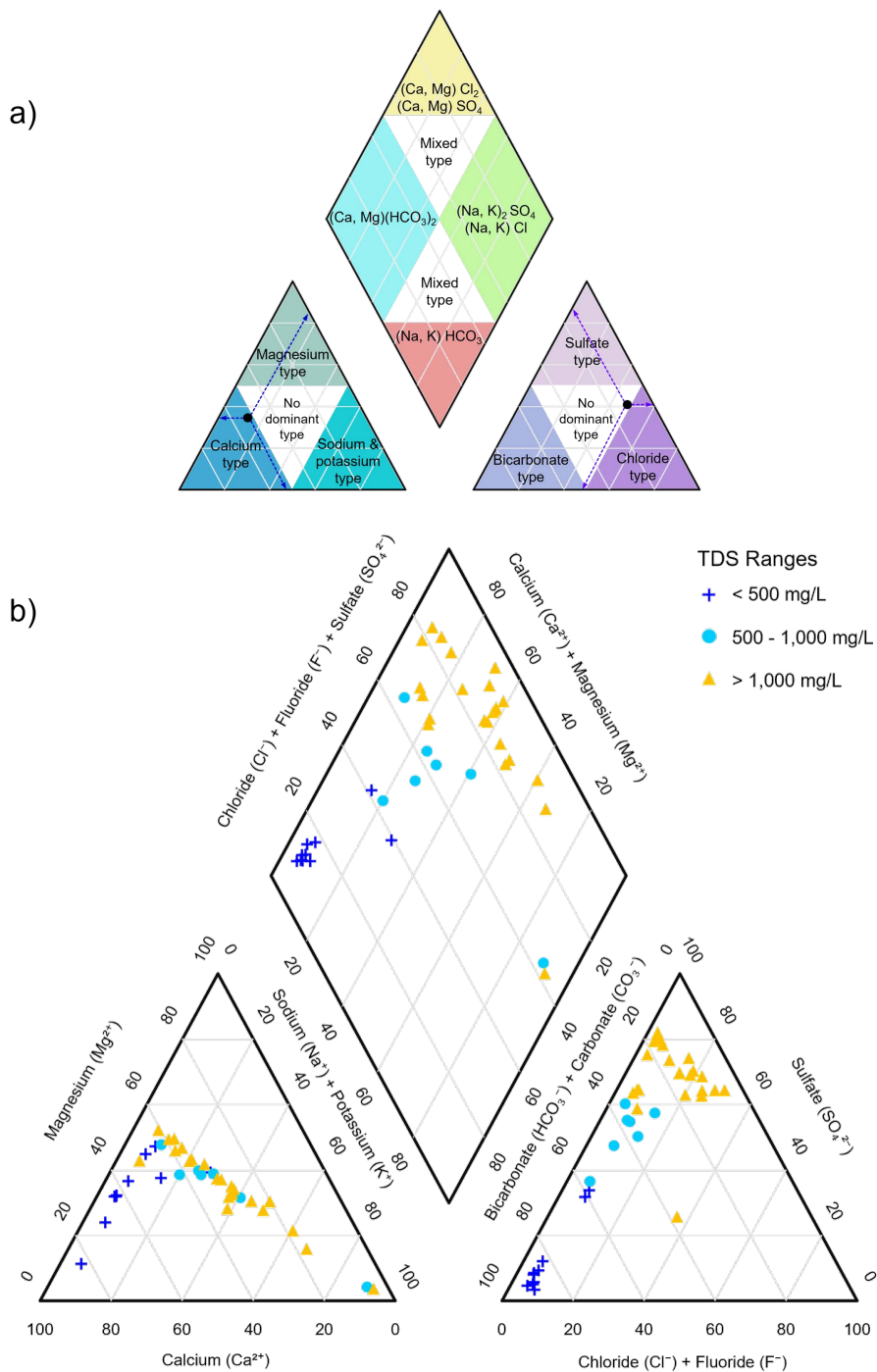


Figure 3.8 Piper diagram of water quality samples.

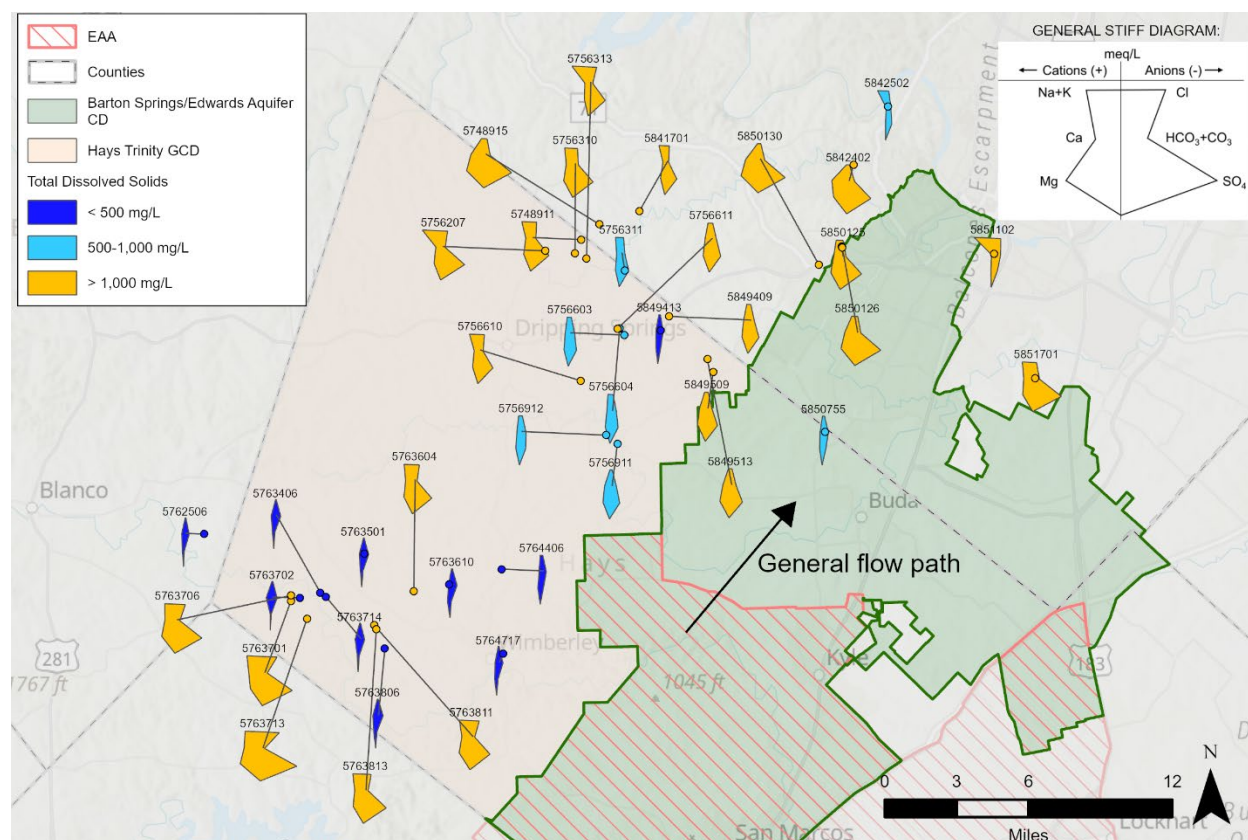


Figure 3.9 Spatial mapping of Stiff diagrams for individual wells.

3.5 GEOCHEMICAL EQUILIBRIUM MODELING

Aqueous speciation and mineral saturation indices were calculated using the geochemical computer code PHREEQC (v 3.6.8; Parkhurst and Appelo, 2013). Our thermodynamic database, which includes temperature-, pressure-, and ionic strength-dependent parameters for calculating chemical equilibria, was wateq4f.dat (Ball and Nordstrom, 1991). The major mineral groups that were targeted for saturation index calculations were carbonates, sulfates, and silicas, along with less-abundant, but geochemically-important phases such as iron and manganese oxides.

Modeled saturation indices (SIs) indicated variable influences of major mineral groups and specific phases on water quality (Figure 3.10). The results are broadly consistent with the mineral assemblages identified by XRD and XRF analyses. Carbonate minerals clustered near equilibrium, with calcite and dolomite exhibiting median SI values near zero and a relatively narrow interquartile range, highlighting the homogeneity of the samples. The water samples were generally undersaturated with respect to sulfate minerals, with gypsum and anhydrite showing negative SI values across most samples, while strontianite approached equilibrium in a few samples. Silicate and clay minerals

display broader variability, with quartz near equilibrium, feldspars and aluminosilicates mostly undersaturated, and kaolinite was mostly supersaturated. In contrast, iron and manganese oxides and hydroxides exhibit the widest SI range, with ferrihydrite and goethite strongly supersaturated in many samples, while pyrolusite was consistently undersaturated.

These results suggest that carbonate phases were close to thermodynamic equilibrium and likely exert strong control on alkalinity and pH buffering in the aquifer, whereas sulfate and silicates are unlikely to precipitate or preferentially dissolve under the observed conditions. The supersaturation of iron oxides and hydroxides indicates favorable conditions for Fe (III) mineral precipitation, which indicate a strong potential for sorption (or co-precipitation) of redox-sensitive trace elements that may be introduced to the water column via dissolution or pollution. Overall, the SI results highlight the importance of carbonate buffering in governing the aqueous geochemistry and water-rock interactions within the LTA.

Spatial patterns in saturation indices were consistent with the mineral dissolution trends indicated by the Stiff and Piper diagrams along the interpreted northeast-trending flowpath. The Stiff diagrams (Figure 3.9) showed that increases in TDS were accompanied by a stronger Ca-Mg-SO₄ signature, with sulfate becoming progressively more dominant down-gradient. From the spatial saturation indices map of gypsum (Figure 3.11), it remains undersaturated, but trends towards equilibrium in the down-gradient direction, which is consistent with continued gypsum dissolution adding Ca²⁺ and SO₄²⁻ to solution and driving the water towards supersaturation as residence time, and consequently, water-rock interactions increase.

Calcite and dolomite were generally near equilibrium to supersaturated spatially, which indicated strong carbonate buffering throughout the study area (Figure 3.12 and Figure 3.13). Quartz SI was near equilibrium to slightly supersaturated across much of the area, consistent with long residence times and the slow dissolution of silicate phases (Figure 3.14). These geochemical patterns aligned with the solid-phase XRD/XRF analyses, which indicated that carbonate-rich and silicate-rich minerals dominated the sampled LTA lithology. Gypsum was detected in one sample, supporting the plausibility of sulfate-bearing phases being present and contributing to the sulfate enrichment (and overall increase in TDS) in the aquifer in the downgradient direction.

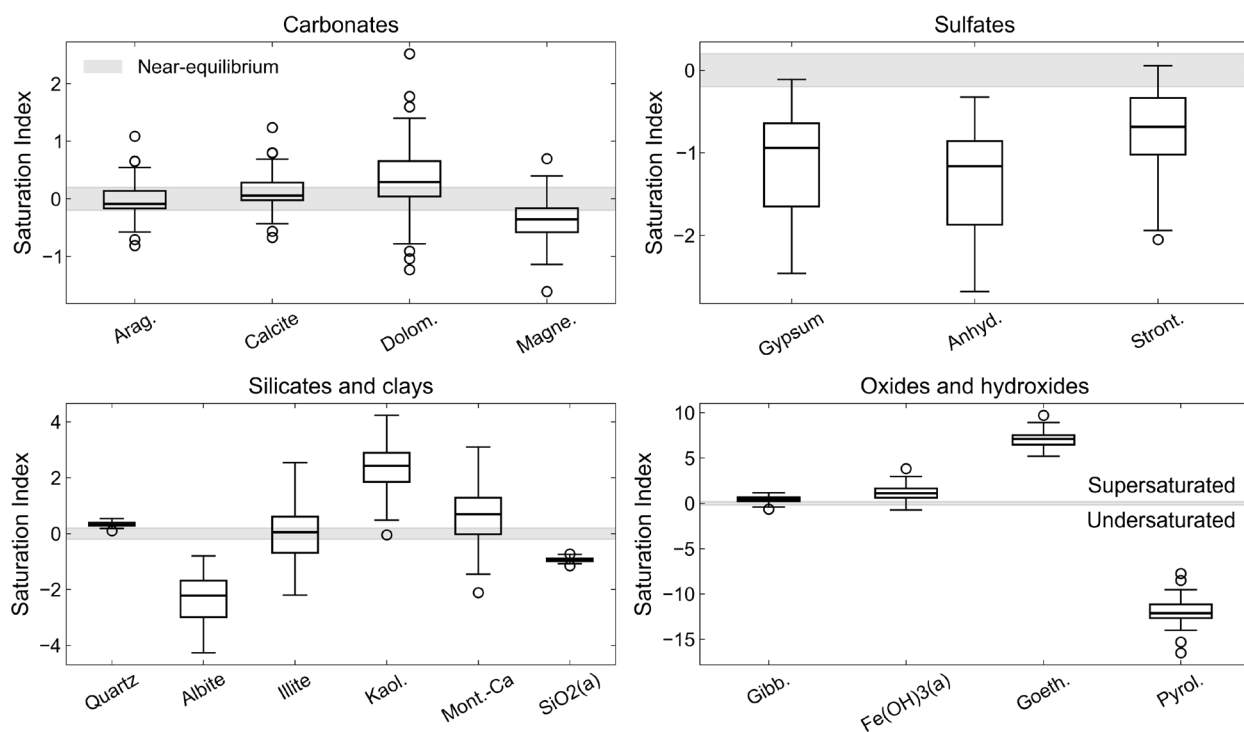


Figure 3.10 Selected results of saturation indices of major mineral groups based on water quality samples.

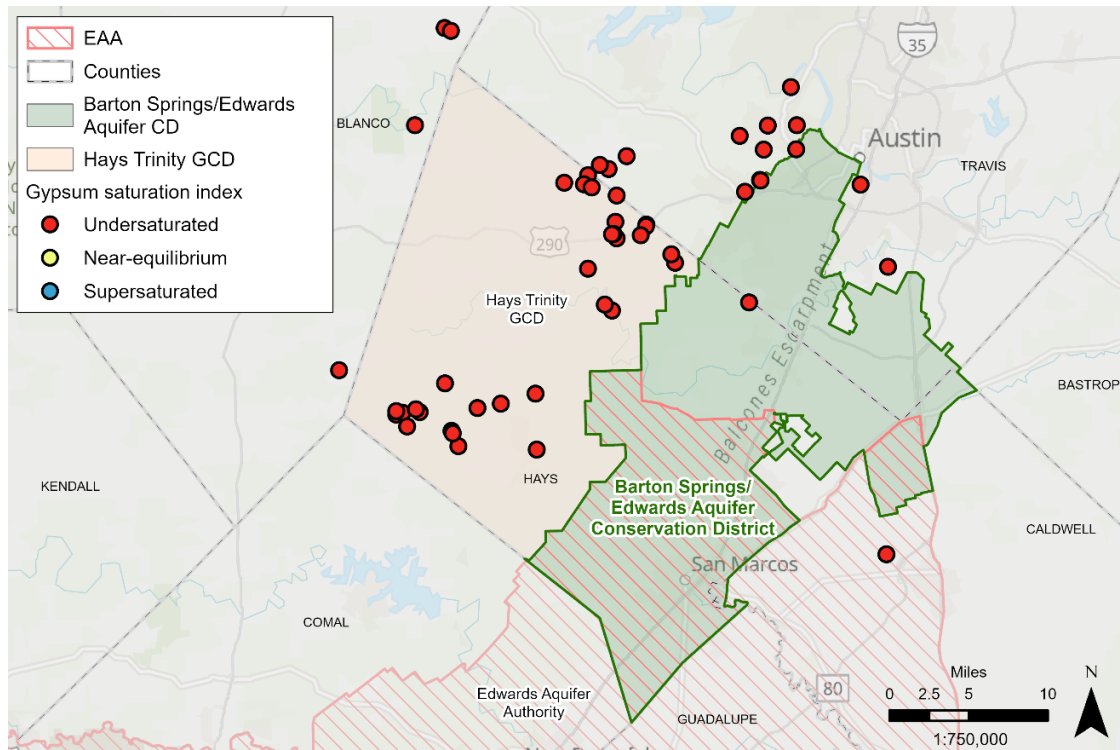


Figure 3.11 Spatial distribution of gypsum saturation indices.

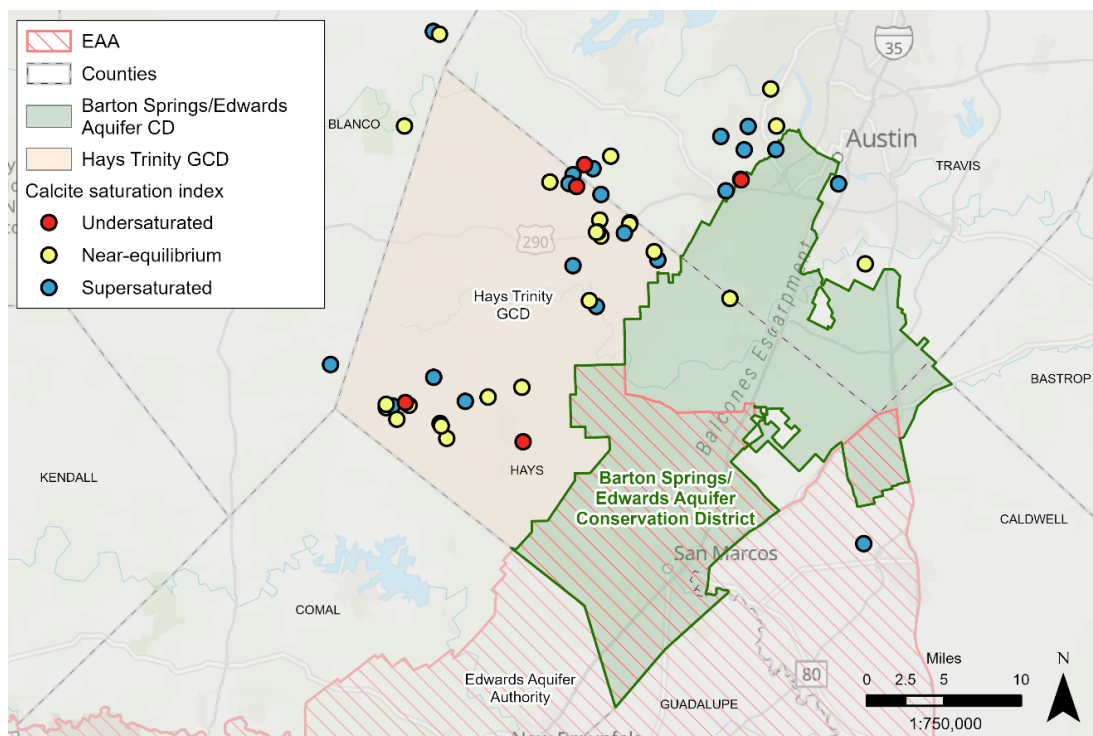


Figure 3.12 Spatial distribution of calcite saturation indices.

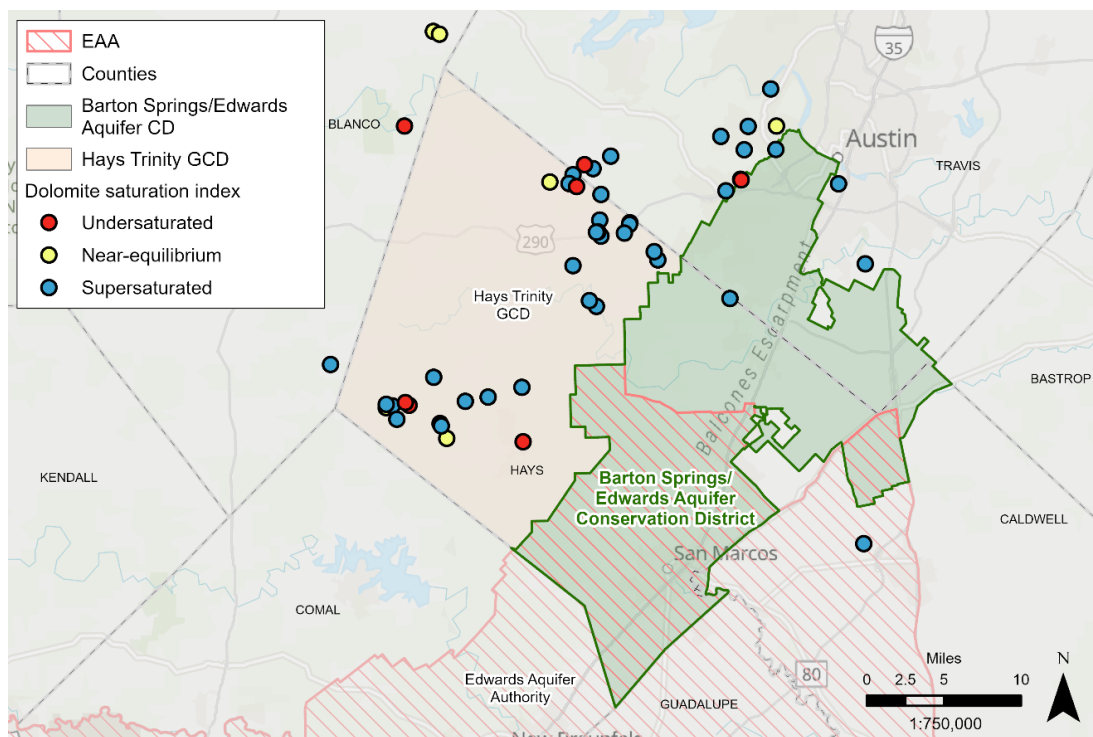


Figure 3.13 Spatial distribution of dolomite saturation indices.

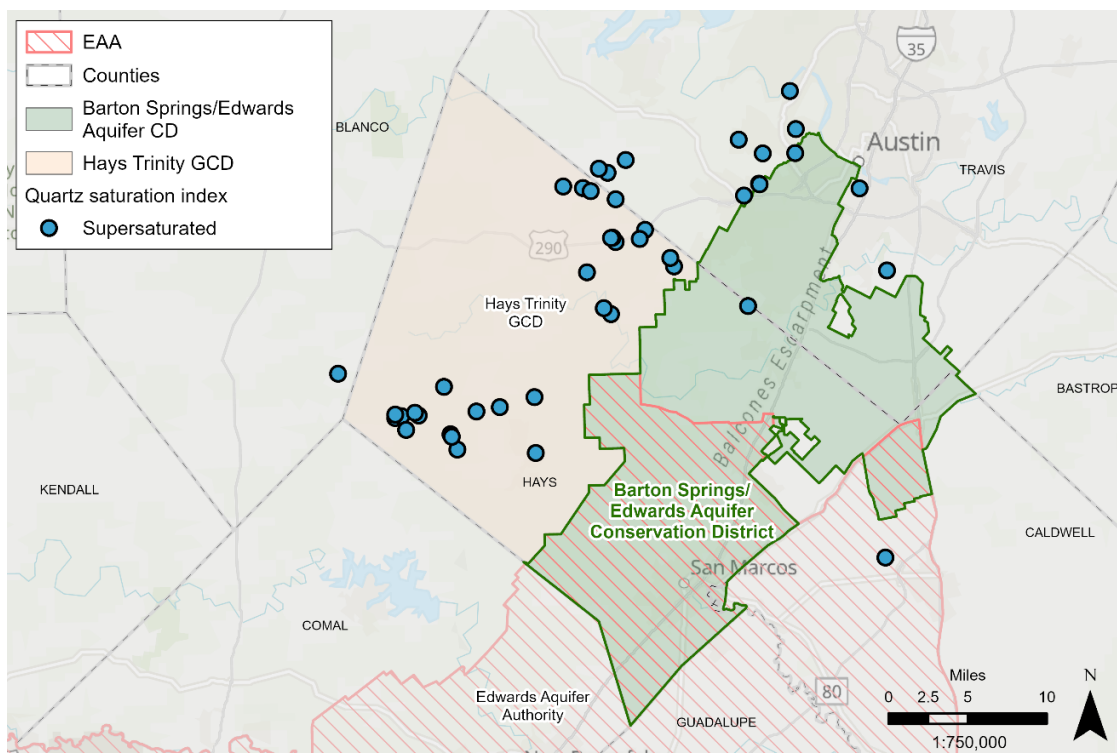


Figure 3.14 Spatial distribution of quartz saturation indices.

3.6 ISOTOPIC ANALYSES

Stable isotope ratios of oxygen and hydrogen (O-18 and D) for the water samples plotted tightly along both the Global Meteoric Water Line (GMWL; Craig, 1961) and the Local Meteoric Water Line (LMWL; Pape and others, 2010), indicating a predominantly meteoric origin with minimal evidence of evaporative enrichment (Figure 3.15). The relatively limited spread (approximately -4.8 to -3.7‰ for O-18 and -29 to -18‰ for D) implies generally similar recharge sources across the sampled wells. Although minor variability is present, there is not a clear separation in stable isotope composition corresponding to the differences in apparent groundwater age identified from the radioactive isotope data.

Tritium and radiocarbon (C-14) results revealed substantial variability in groundwater age, with most samples indicating old water and limited modern recharge influence (Figure 3.16 and Figure 3.17). Low C-14 activity (0.00–0.20 PMC) combined with low or nondetectable tritium (-0.11 – 0.50 TU) is consistent with groundwater having a relatively small contribution from recent recharge. However, several samples exhibited intermediate C-14 activity (0.21–0.50 PMC) or younger C-14 signatures (0.51–0.87 PMC), including samples with younger tritium signatures (0.51–1.70 TU), indicating contributions from comparatively younger recharge. These younger signatures are concentrated primarily in the southwestern portion of the study area, whereas samples

farther northeast are dominated by older C-14 and low-tritium. This spatial distribution is generally consistent with increasing apparent groundwater age along the interpreted regional flow direction toward the northeast.

Although a regional trend is present, there is additional local variability in the radioactive isotope signatures, particularly in the southwestern portion of the study area. In this area, younger C-14 and tritium signatures occur in close proximity to samples characterized by older or intermediate apparent ages. This spatial variability corresponds with similarly strong contrasts in major-ion chemistry and TDS, where relatively fresh groundwater occurred near high-TDS waters characterized by pronounced sulfate enrichment. The co-occurrence of these distinct major ion and isotope groundwater types is consistent with contributions from multiple flow paths, mixing between waters of different residence times and geochemical evolution, and localized hydraulic compartmentalization. Despite the local complexity, the broader spatial distribution of the isotope data still retains a regional gradient towards older apparent groundwater ages to the northeast, generally consistent with the interpreted regional groundwater flow path.

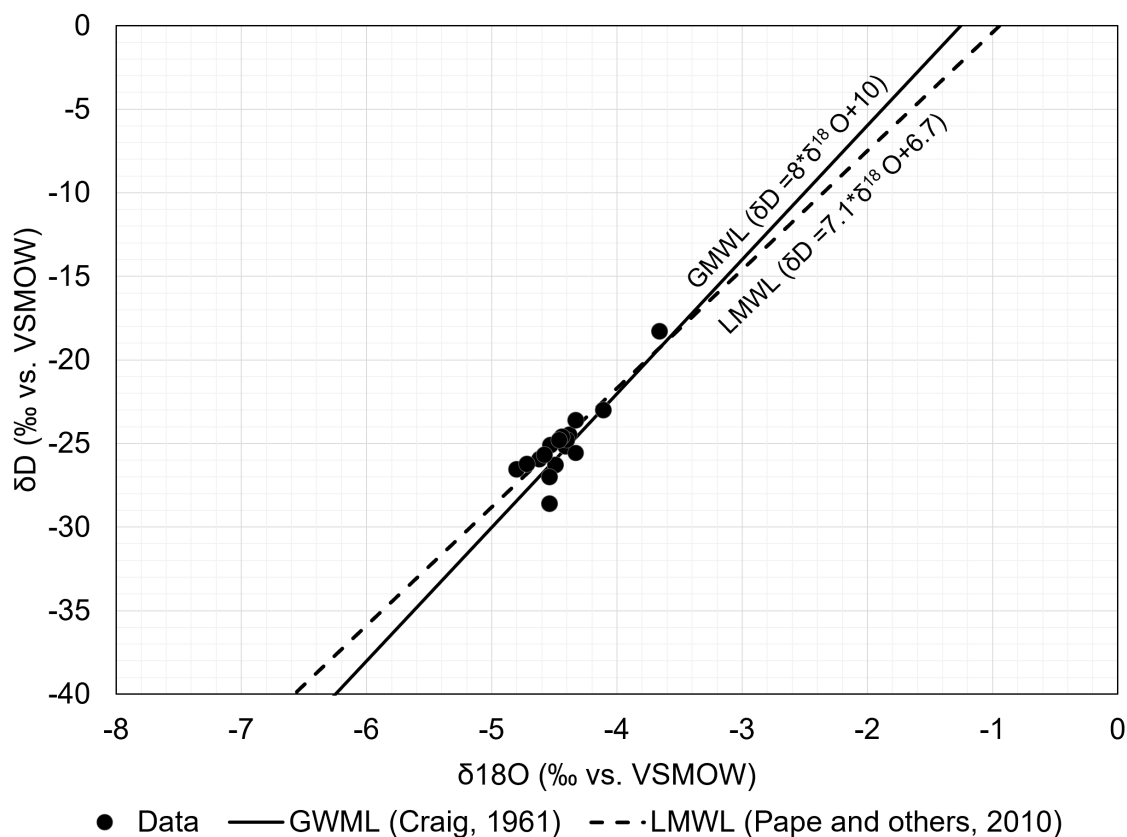


Figure 3.15 Stable isotope ratios of oxygen and hydrogen ($\delta^{18}\text{O}$ and δD).

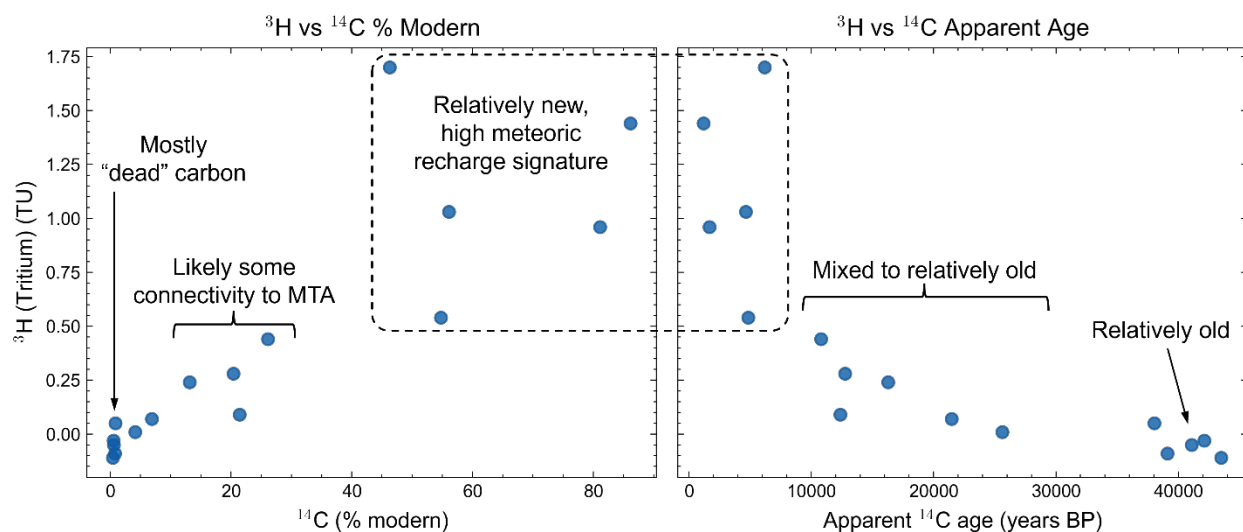


Figure 3.16 Pair of bivariate plots of Tritium values vs Carbon-14 % modern and Apparent Carbon-14 age.

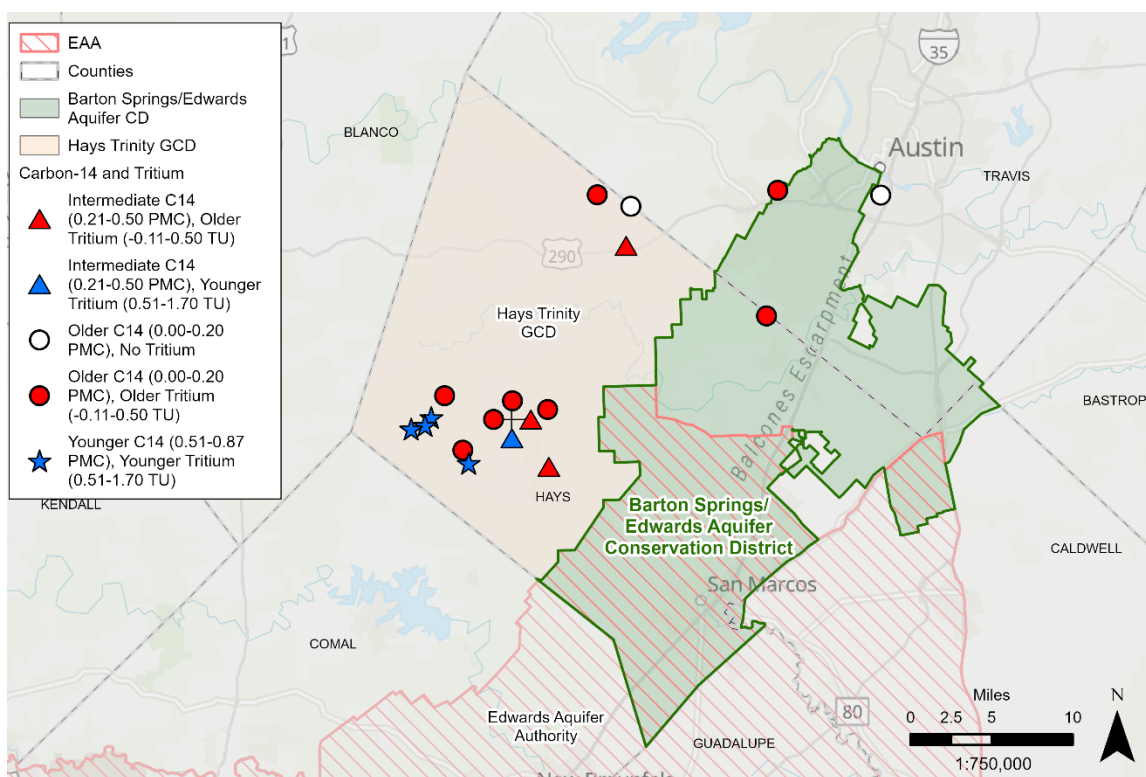


Figure 3.17 Map of Carbon-14 and Tritium concentrations in the study area.

SECTION 4: STRATIGRAPHY AND STRUCTURAL EVALUATION

4.1 METHODOLOGY

The stratigraphic model of the LTA was refined within the study area by incorporating the data compiled in Section 2 to the stratigraphic model created by Hunt and others (2020). Geophysical logs were targeted throughout the District to establish the top (Sligo top) and bottom (Hosston base/Paleozoic top) of the LTA at discrete points throughout the study area (Figure 4.1). Special attention was focused on acquiring geophysical logs within the eastern region where historical data is sparse.

Databases inspected for this effort included the TWDB BRACS database (TWDB, 2025a), BSEACD logs, the proprietary TGS R360 well log database, and RRC DICE. Additionally, well reports from the TWDB GWDB were included within this study where LTA units were apparent (TWDB, 2025b). In addition to the 102 stratigraphic points and 159 calculated stratigraphic points within the Hunt and others (2020) database, an additional 35 geophysical logs and 5 TWDB GDB well reports were incorporated in this study to update the stratigraphic model of the LTA (Figure 4.2 and Figure 4.3). The structural top of the LTA was considered the top of the Sligo Formation when present in the section and, when absent, the top of the Hosston Formation was considered the top. The bottom of the LTA was selected at the unconformable boundary between the Hosston Formation and the underlying Paleozoic rocks. Stratigraphic picks made for this study are shown in (Appendix C). The contour maps were produced by incorporating the datasets from Hunt and others (2020) into ArcGIS Pro (Esri Inc., Version 3.5.2, 2025) and manually revising contour lines where additional stratigraphic picks were incorporated from this study.

Gridded structure surfaces were generated for the LTA top and bottom by converting the contour lines to a raster grid using the “Topo to Raster” 3-D Analyst ArcGIS Pro tool. The tool interpolates a raster surface using a specific input point dataset. Once the raster grids were generated, a thickness surface of the LTA was calculated by using the “Minus” 3-D Analyst tool that subtracts raster values of one dataset from another.

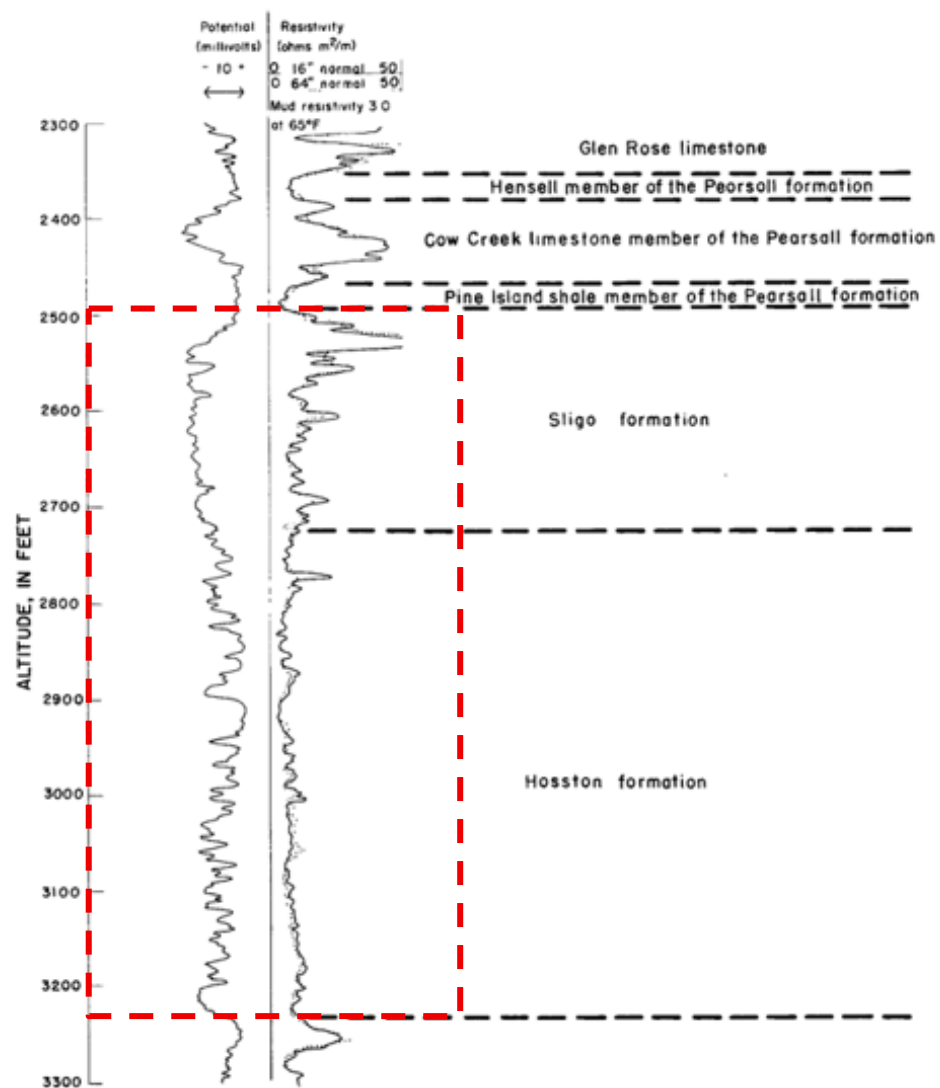


Figure 4.1 Partial section from a geophysical log in eastern Hays County showing the Sligo and Hosston formations of the LTA (modified from DeCook, 1963).

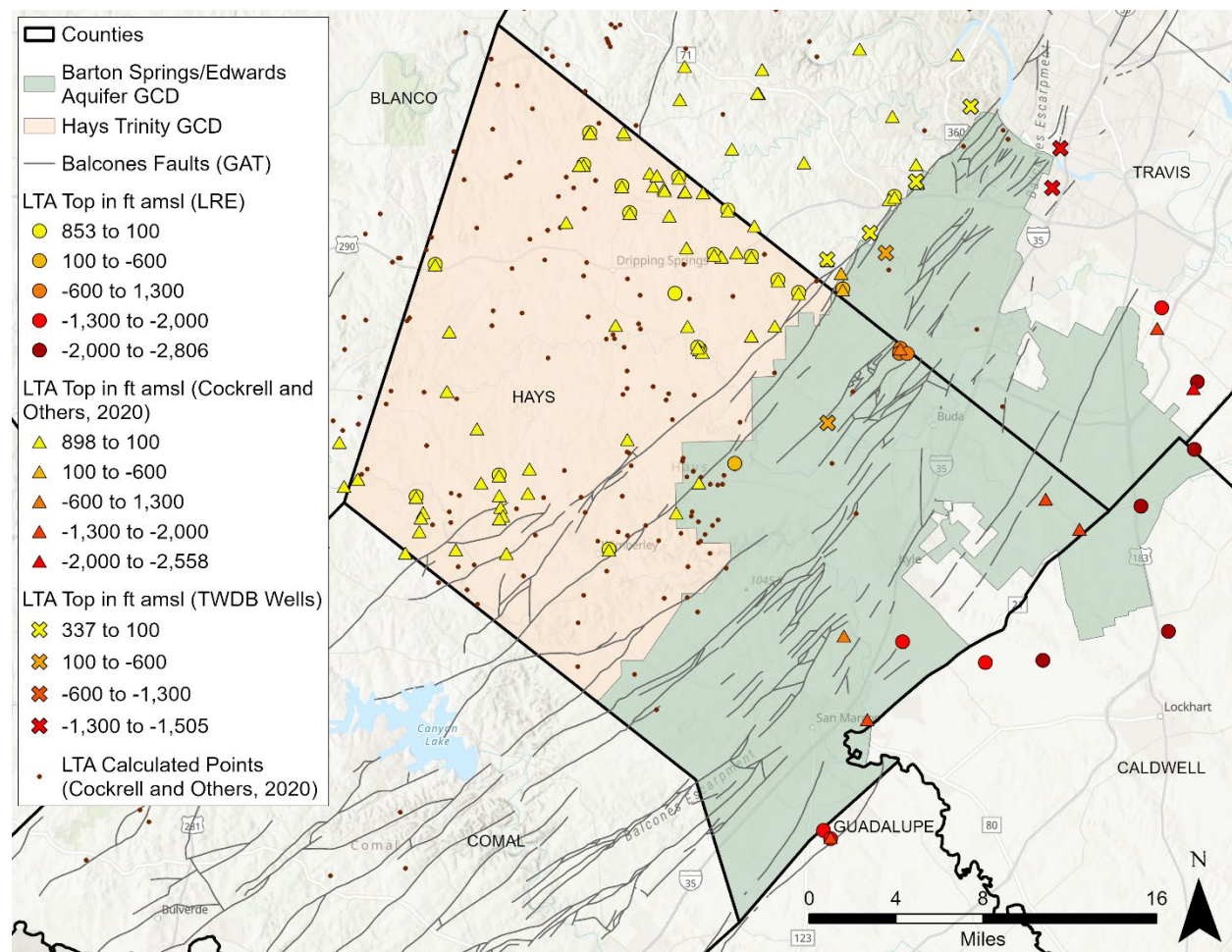


Figure 4.2 Control points for the LTA top structural contour map.

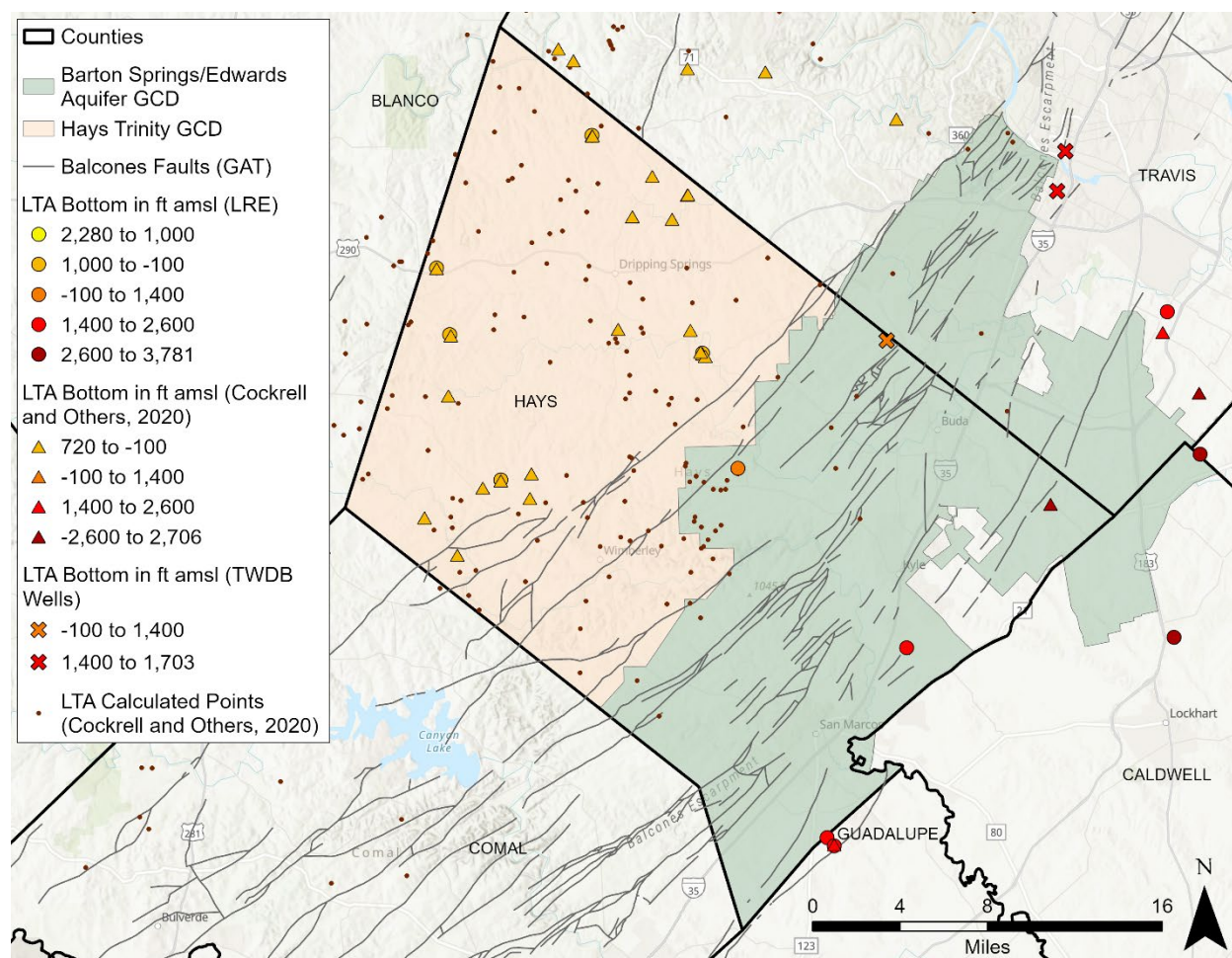


Figure 4.3 Control points for the LTA bottom structural contour map.

4.2 RESULTS

Structural contour maps showing the depth of the top and bottom of the LTA are shown in Figure 4.4 and Figure 4.5. The maps represent formation tops in depth above mean sea level (ft amsl) to provide a more accurate depiction of the subsurface structure. Each formation map highlights control points for formation picks with a black circle and calculated points from Cockrell and others (2020) are shown with a gray circle. The contour maps show the greatest variance from the Hunt and others (2020) contour maps in the southeastern area, where multiple logs were added within this study (Figure 4.6 and Figure 4.7).

Gridded surfaces of the LTA top and bottom are shown in Figure 4.8 and Figure 4.9, and a map presenting the thickness of the LTA is shown in Figure 4.10. Aquifer thickness ranges from 384 to 1,104 ft thick with a spatially-averaged thickness of 667 feet. The thickest portion of the aquifer is in the eastern portion of the District in Caldwell County.

This area also represents a portion of the aquifer that gets deeper (in an eastern direction) more rapidly than the Cockrell and others (2020) data suggest.

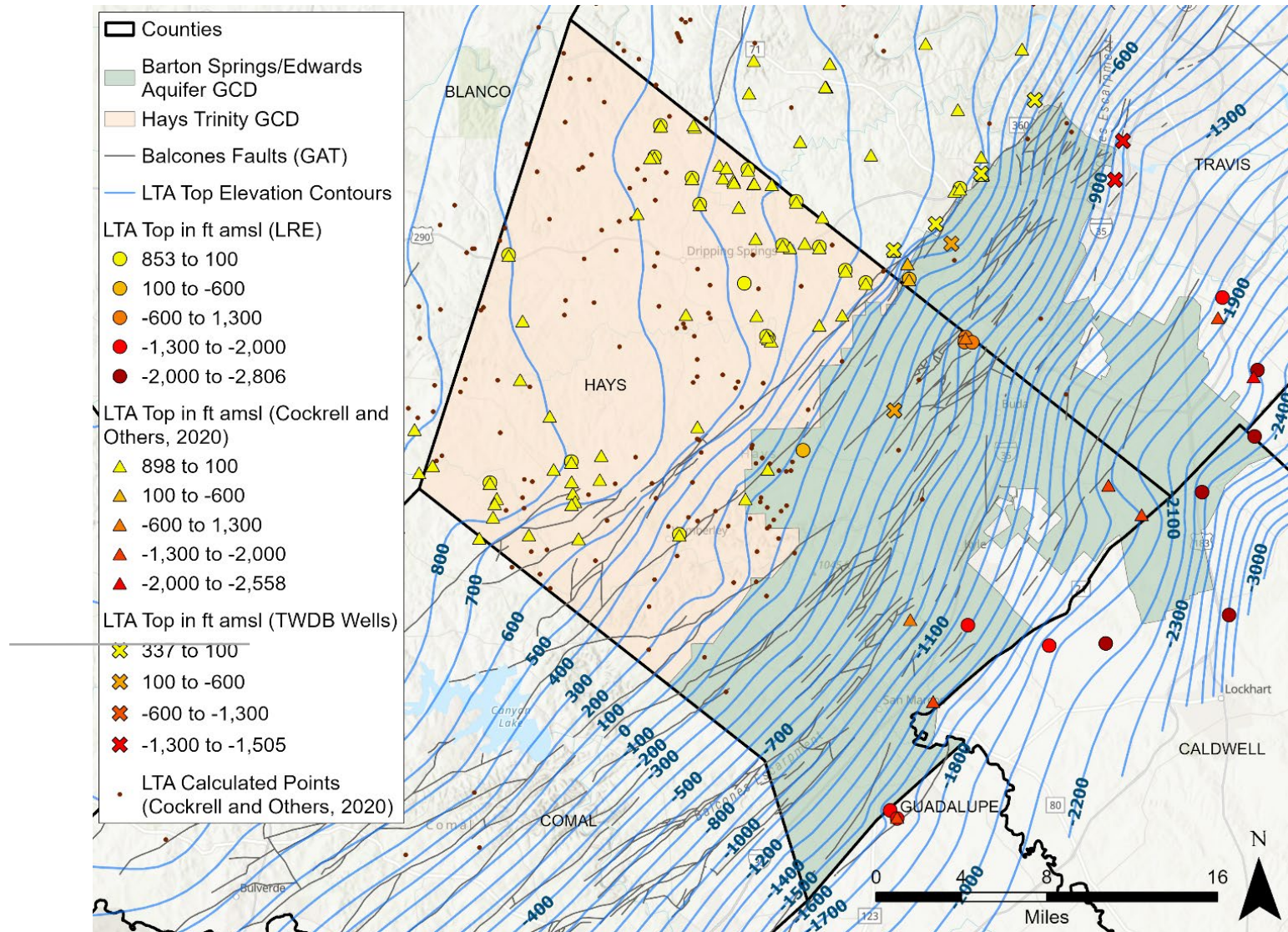


Figure 4.4 Structural contour map of the LTA top and the associated control points.

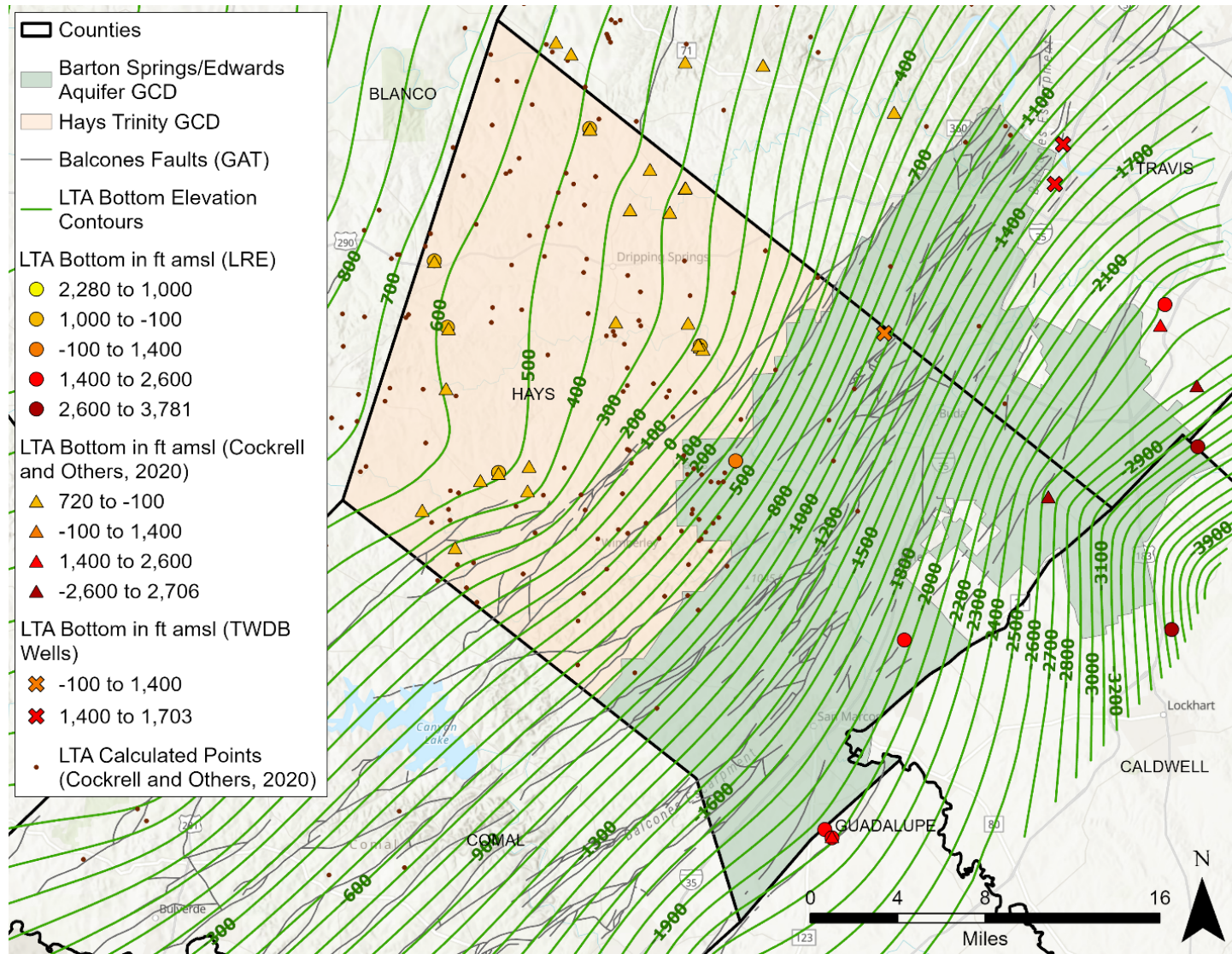


Figure 4.5 Structural contour map of the LTA bottom and the associated control points.

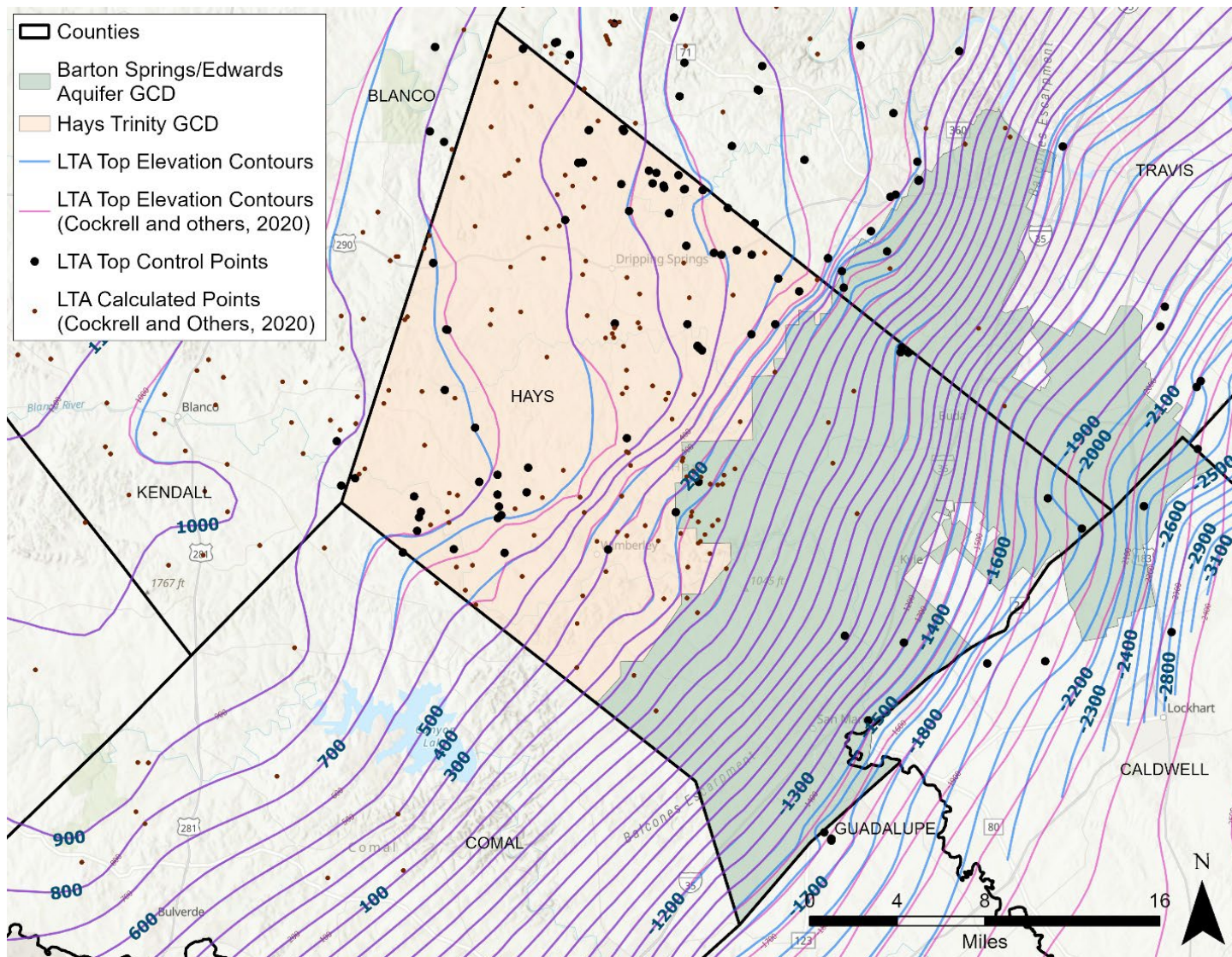


Figure 4.6 LTA top elevation contours generated in this study and by Hunt and others (2020). Purple contour lines indicate where the contour lines from the two studies overlap and are therefore unchanged in this study.

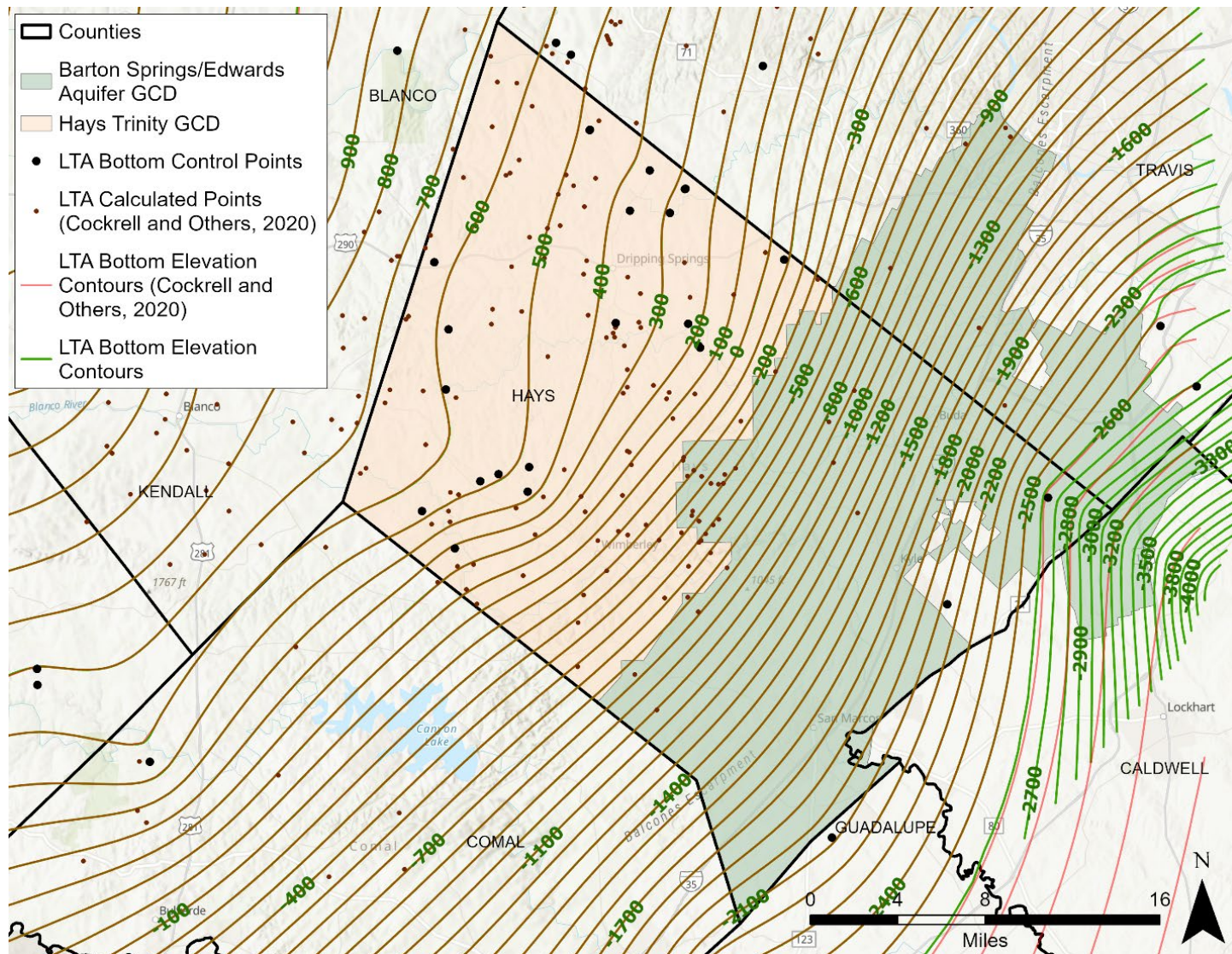


Figure 4.7 LTA bottom elevation contours generated in this study and by Hunt and others (2020). Orange-brown contour lines indicate where the contour lines from the two studies overlap and are therefore unchanged in this study.

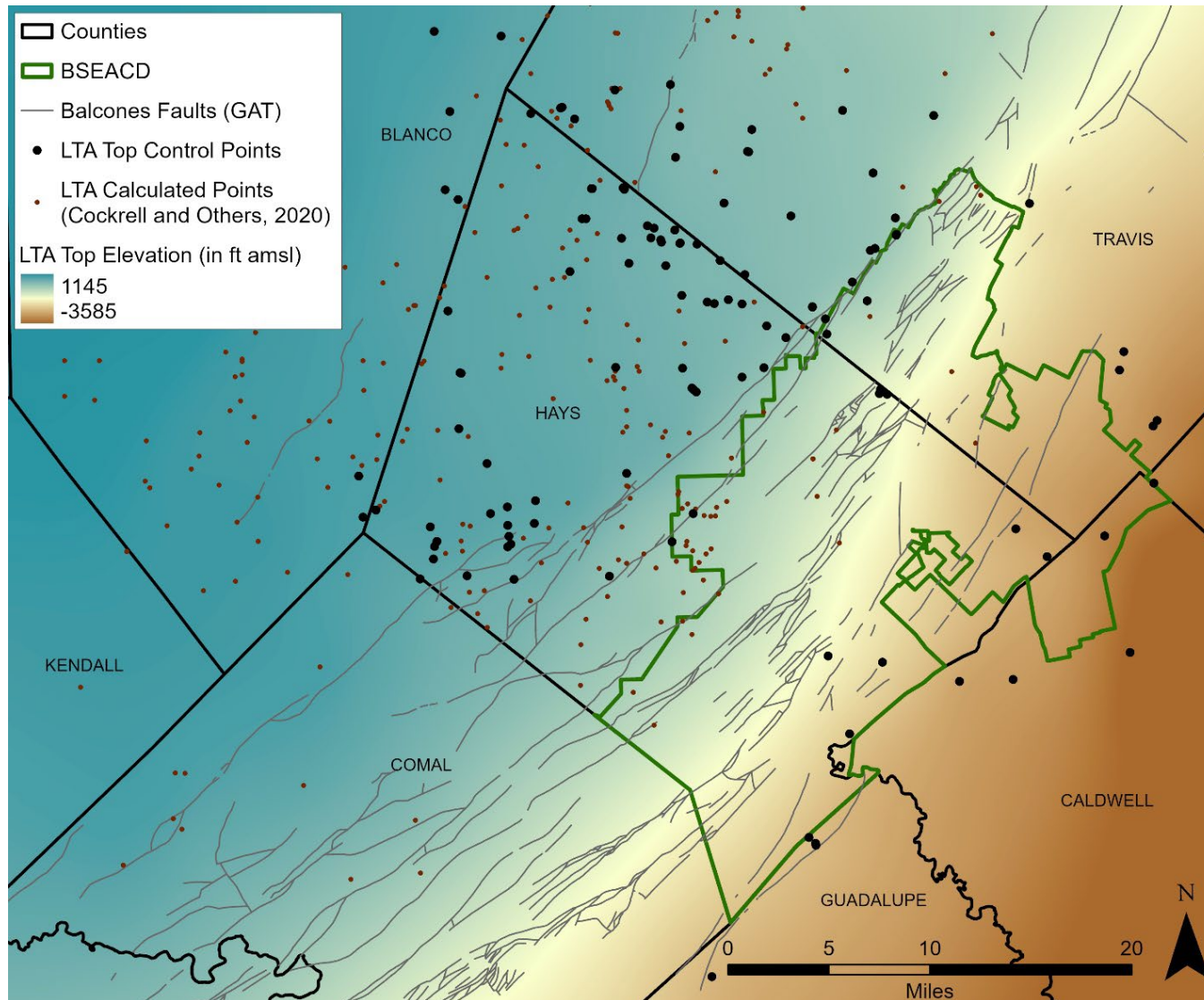


Figure 4.8 Gridded elevation surface of the LTA top generated from the structural contours.

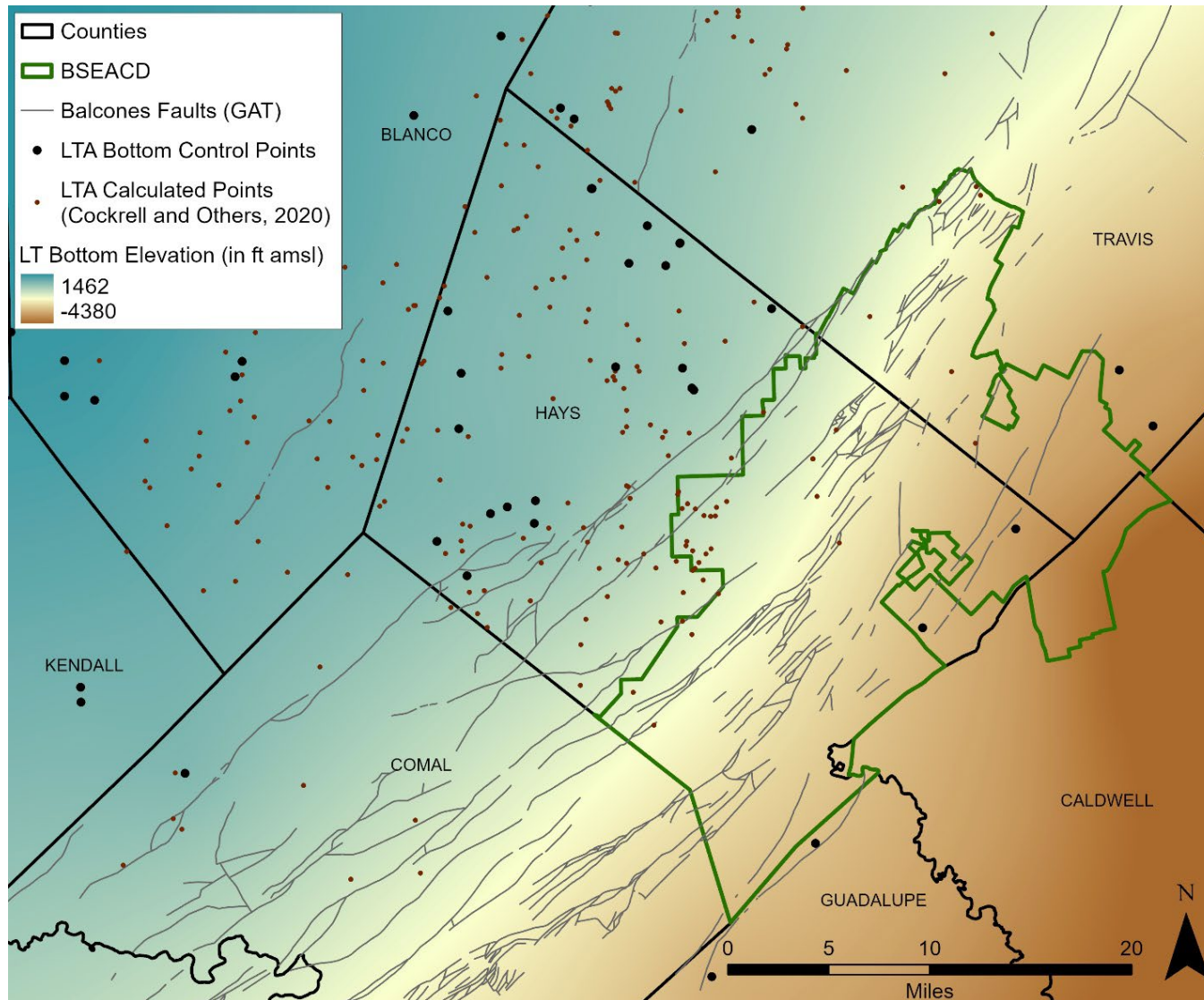


Figure 4.9 Gridded elevation surface of the LTA bottom generated from the structural contours.

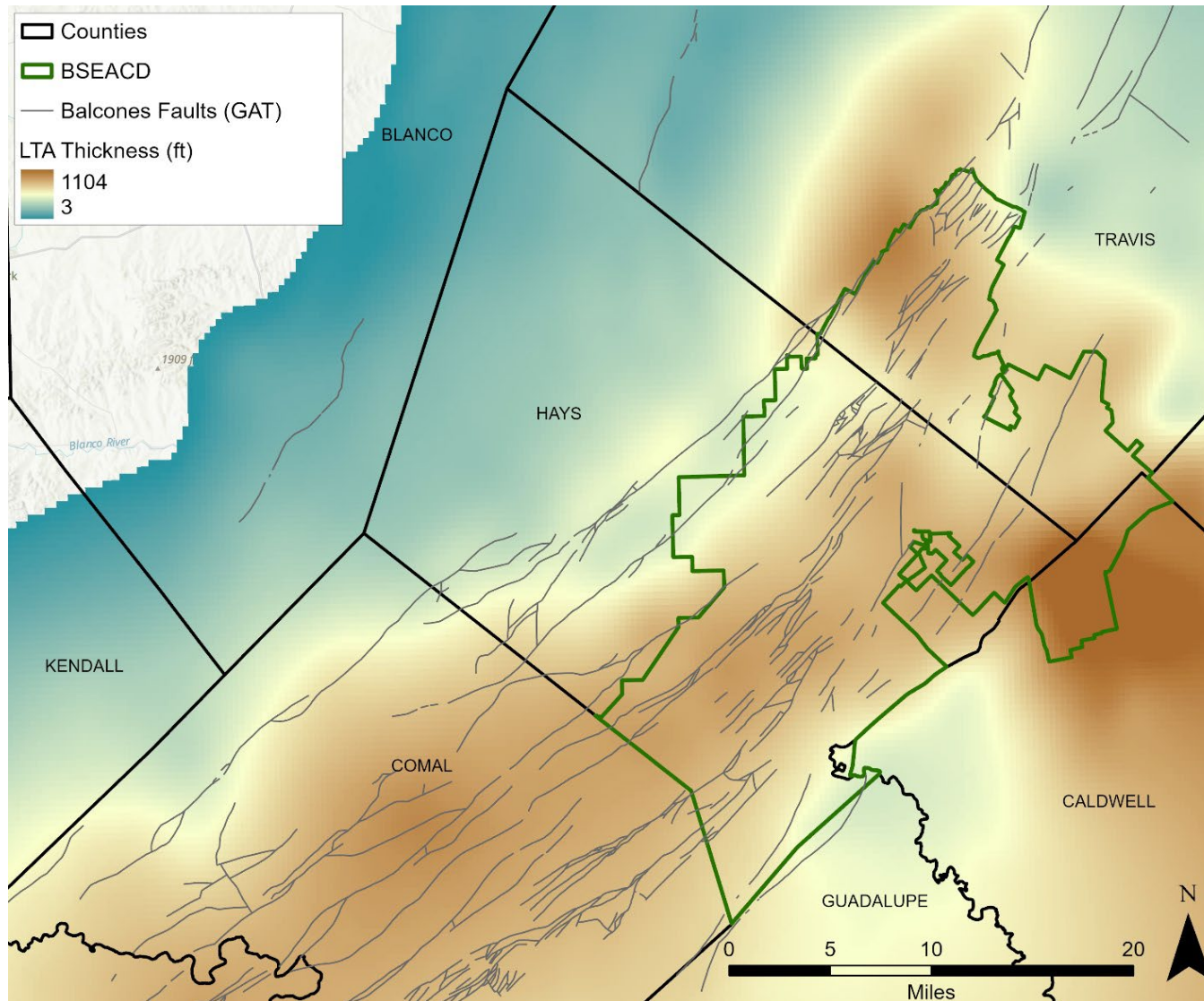


Figure 4.10 Thickness of the LTA within and around the study area. Thickness of the LTA within BSEACD ranges from 384 to 1,104 ft.

SECTION 5: GROUNDWATER AVAILABILITY AND RECHARGE ASSESSMENT

5.1 HYDROGRAPHS

Water level measurements can provide insight into aquifer response to pumping and seasonality, regional groundwater decline over time, and spatial variation of water levels within the aquifer. Hydrographs for BSEACD were created from water level measurements within the TWDB database for wells completed in the LTA. Historical water level records were available for two wells within the District (Figure 5.1). The hydrograph for well SWN 5050757 indicates a decrease in water level at a rate of 8.4 ft/yr since 2021. In contrast, the hydrograph for well SWN 5850121 located towards the north of the District indicates an increase in water level at a rate of 0.5 ft/yr since 1991.

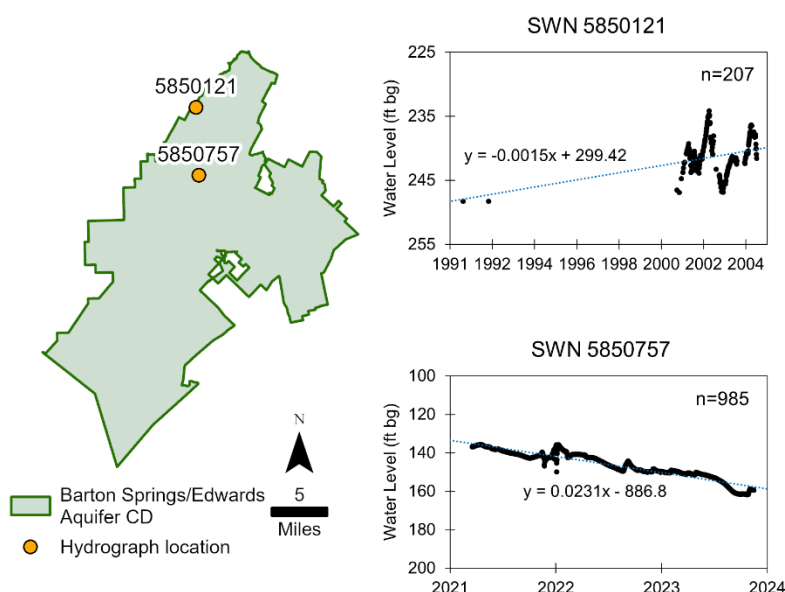


Figure 5.1 Hydrographs for Lower Trinity Aquifer wells in the District with multiple water level measurements.

It is important to note that while these hydrograph datasets are foundational for understanding LTA water level fluctuations and trends in the District over time, the represented time periods are relatively short and do not extend through important hydrologic events such as the historic drought in 2011. Furthermore, these data points are concentrated in the northwestern part of the District and may not be fully representative of the eastern and southern, downdip areas. These hydrographs highlight the need for, 1) continued monitoring to capture realistic temporal water level change in the LTA; and 2) additional monitoring locations, particularly in the eastern and southern areas of the District, to better represent those areas and better understand possible compartmentalization of the LTA across the Balcones Fault Zone.

5.2 POTENTIOMETRIC SURFACE

The potentiometric surface for the LTA (Figure 5.2) was developed by compiling water-level elevations from 259 wells in the final LTA dataset, including Fall 2018 potentiometric control points reported by Hunt and others (2020). The combined dataset was spatially interpolated in ArcGIS Pro using the “Topo to Raster” tool, which was then contoured at 50-ft intervals. As monitoring well coverage is uneven, with most data points concentrated in Hays and Travis counties, the generated potentiometric surface map provides a general representation of the regional hydraulic head. Contours located farther from the water-level control points are shown as dashed lines to indicate areas where the interpolated potentiometric surface is less constrained by measured data and subject to greater uncertainty.

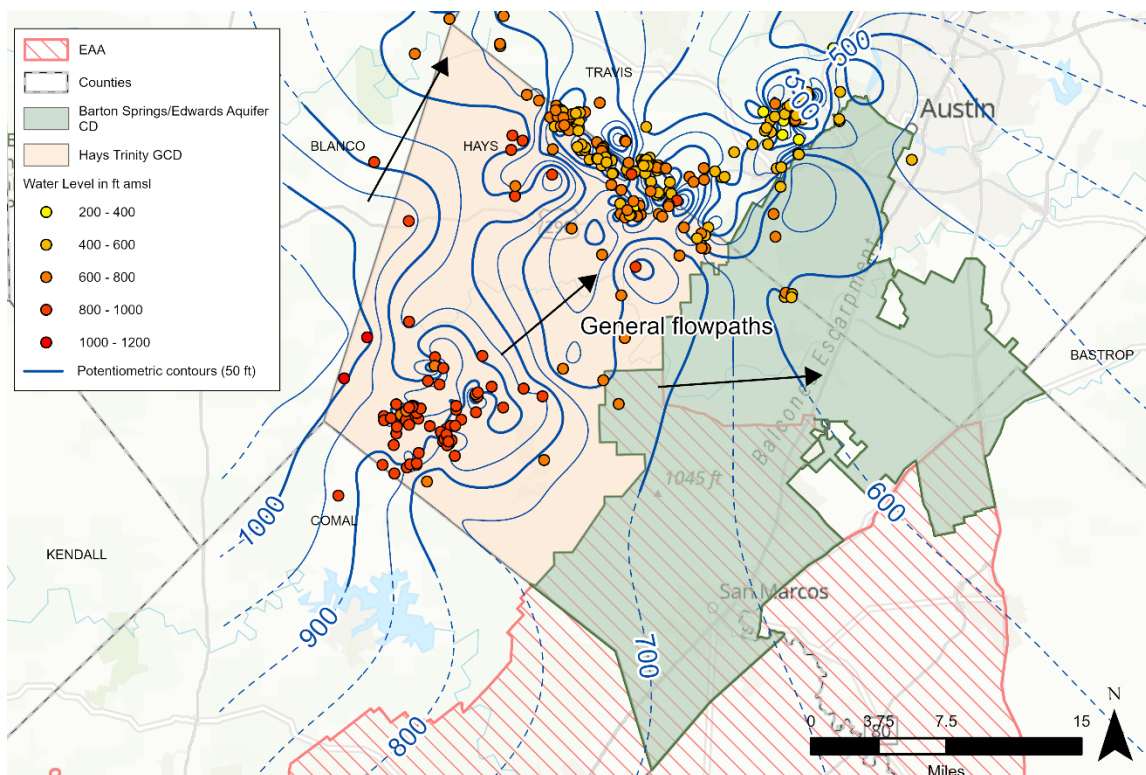


Figure 5.2 Potentiometric surface of the LTA.

Overall, the mapped heads in the conservation district span roughly 450-800 ft amsl, with higher potentiometric elevations to the southwest and lower elevations towards the northeast. This produced a hydraulic gradient that indicated predominantly groundwater flow trending northeast, which is consistent with the inferred east-northeast trending flow directions of the LTA in the nearby study area detailed in Hunt and others (2020). It is important to re-emphasize that there is a data gap in reported water levels in the southern

and eastern region of the District. Additional data collection efforts in these areas will help constrain more representative potentiometric surfaces for the LTA in the District.

5.3 RECHARGE

Regional recharge from precipitation is limited because the Lower Trinity Aquifer has minimal surface outcrop within the study area. Recharge to the aquifer is interpreted to occur primarily through vertical leakage from adjacent aquifers, particularly the overlying Middle Trinity Aquifer, where groundwater can migrate through fractures and faults in the Hammett Shale or in areas where the Hammett thins or is absent (Ashworth, 1983; Ashworth and others, 2001; BSEACD, 2020; Hunt and others, 2020). Ashworth (1983) identified updip areas north and west of the study area, where the Hammett Shale is thin or absent, as the principal recharge zones for the Lower Trinity Aquifer. Additional leakage may occur where the Hammett is faulted. Localized recharge to, or discharge from, the aquifer may also occur in northern Hays County and western Blanco County where incision of the Pedernales River exposes Lower Trinity strata. The magnitude of annual recharge to the Lower Trinity Aquifer remains uncertain because of the limited extent of aquifer outcrop, insufficient groundwater-surface water interaction data, and the poorly constrained distribution and connectivity of fractures within the Hammett Shale.

Groundwater-surface water interactions studied west of the Bee Creek Fault Zone adjacent to the Colorado River suggest the LTA is hydrologically connected to the Colorado River and Lake Travis (Hunt and others, 2020). State Well 57-40-304 indicates a direct correlation to Lake Travis water levels as the river has incised into the Lower Trinity Aquifer (Hunt and others, 2020). Through hydrologic connectivity may exist, the quantification of recharge rates from the surface water to the LTA at this location or along the outcrop region has not yet been investigated.

The Hill Country Trinity Aquifer Conceptual Model Report attempts to quantify recharge rates and found that the percentage of precipitation that ultimately infiltrates and recharges the Trinity Aquifer can be as much as 30% in their study area (Toll and others, 2018). However, this estimate applies to the Trinity Aquifer as a whole and is not specific to the Lower Trinity Aquifer. Recharge rates are also highly variable and are influenced by factors including precipitation amount and intensity, antecedent moisture conditions, vegetation, soil and rock characteristics, temperature, and seasonal conditions. Modeling efforts of Toll and others (2018) estimated recharge amounts through precipitation were 1.8 to 1.85 inches per month in November of 2004, which was the wettest month from 1980 through 2015. Because exposures of the Lower Trinity Aquifer at the land surface are limited, only a small proportion of this recharge is expected to directly affect the Lower Trinity Aquifer.

5.4 HYDRAULIC PROPERTIES

The ability of an aquifer to transmit and store groundwater varies depending on its lithology, structure, depositional environment, and the presence of fractures and faults (Robinson and others, 2022). Such factors influence an aquifer's hydraulic properties including hydraulic conductivity, transmissivity, storativity, specific yield, and specific storage. An aquifer's hydraulic properties are primarily determined from aquifer test data.

Hydraulic conductivity (K) is a measure of the rate of flow of water through a cross section of porous media under a given hydraulic gradient and is expressed in units of gallons per day per square foot (gpd/ft²) or feet per day (ft/day) (Driscoll, 1986). Transmissivity (T), a function of hydraulic conductivity and aquifer thickness, is a measure of groundwater flow through the entire thickness of an aquifer (or across a well screen) and is expressed in units of gallons per day per foot (gpd/ft) or feet squared per day (ft²/d) (Miller and others, 2025). Storativity (S), also referred to as the coefficient of storage, describes the volume of water a confined aquifer will release when water level is lowered by a unit of length over a unit area (Robinson and others, 2022; Miller and others, 2025). For unconfined aquifers, storativity is referred to as the specific yield (S_y) and is the volume of water than an unconfined aquifer releases from storage per unit surface area of aquifer per unit decline in the water table (Freeze and Cherry, 1979). Storativity and specific yield are dimensionless. Specific storage (S_s) represents an aquifer's capacity to release water from or take water into storage when water level changes, and is defined as the volume of water that a unit volume of saturated aquifer releases from storage per unit decline of hydraulic head and is expressed as per unit length ($[L]^{-1}$) (Freeze and Cherry, 1979; Kuang and others, 2020).

5.4.1 Transmissivity from Constant Rate Pumping Tests

In the BSEACD and HTGCD area, 19 LTA wells had transmissivities calculated from constant rate pumping tests. Sources for pumping test data included a production permit application (Wet Rock Groundwater Services, LLC, 2021), published reports by BSEACD (Camp and others, 2020; Hunt and others, 2010), and personal communications with HTGCD. Transmissivities determined from constant rate pumping tests are summarized in Table 5.1 and Table 5.2, their spatial distribution is shown in Figure 5.3, and additional information for each constant rate pumping test is included in Appendix D. Transmissivities were reported for five wells within the District. Their median transmissivity value is 1,240 gpd/ft.

5.4.2 Transmissivity from Specific Capacity Tests

Specific capacity (SC) is the rate of discharge per unit of drawdown; it is a measure of a well's productivity and is expressed as gallons per minute per foot (gpm/ft) (Driscoll, 1986;

Robinson and others, 2022). Driscoll (1986) describes an empirical method for estimating transmissivity based on specific capacity data. While transmissivities estimated from specific capacity tests are not as robust as those determined through constant rate pumping tests, specific capacity data is often more available and can provide a general idea of transmissivity in an area lacking other data. Specific capacity is calculated by dividing the discharge rate in gallons per minute (gpm) by the amount of drawdown in feet. In the BSEACD and HTGCD area, 15 wells had the discharge and drawdown data needed to calculate specific capacity. Four of the wells (MapIDs 12, 13, 14, and 15) are located outside of the 3-mile buffer in Southwestern Travis County Groundwater Conservation District but are included as extra data points; these data were provided by HTGCD. Only one of well (MapID 11), with an estimated transmissivity of 867 gpd/ft, is within the BSEACD. Table 5.1 and Table 5.2 summarize the transmissivities estimated from specific capacity values after applying Driscoll's empirical method (Equation 5.1). The spatial distribution of these transmissivities is shown in Figure 5.4 and additional information for each specific capacity test is included in Appendix E. Driscoll's empirical method for computing transmissivity is:

$$\frac{Q}{s} = \frac{T}{2000} \quad \text{(Equation 5.1)}$$

Where:

Q = discharge rate, in gallons per minute

s = drawdown, in feet

T = Transmissivity, in gallons per day per foot

Table 5.1 Transmissivity values (gpd/ft) estimated from aquifer tests.

	Count	Min	Max	Range	Median	Mean
Constant Rate Pumping Tests	19	100	10,000	9,900	956	1,863
Specific Capacity Tests	15	167	15,200	15,033	1,400	2,511

Table 5.2 Transmissivity values (gpd/ft) estimated from aquifer tests within BSEACD.

		Transmissivity (gpd/ft)				
	Count	Min	Max	Range	Median	Mean
Constant Rate Pumping Tests	5	500	3,646	3,146	1,240	1,741
Specific Capacity Tests	1*	867				

* Only wells without a constant rate pumping test were included in count.

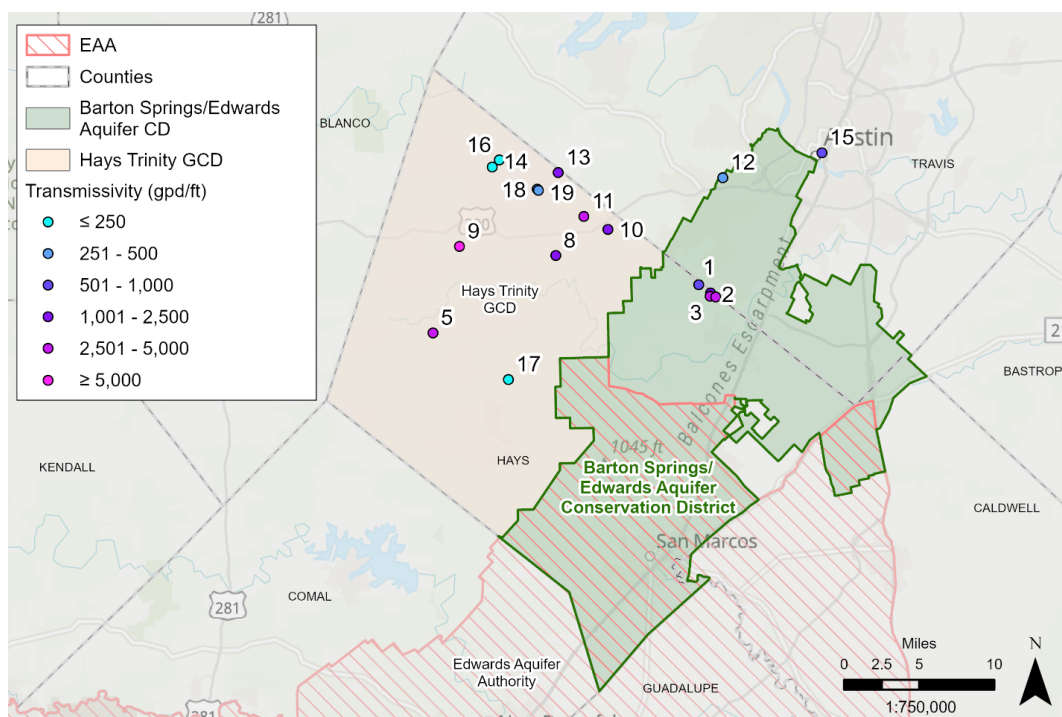


Figure 5.3 Location of constant rate pumping tests and distribution of transmissivity values (gpd/ft). Well labels correspond to Map IDs in Appendix D.

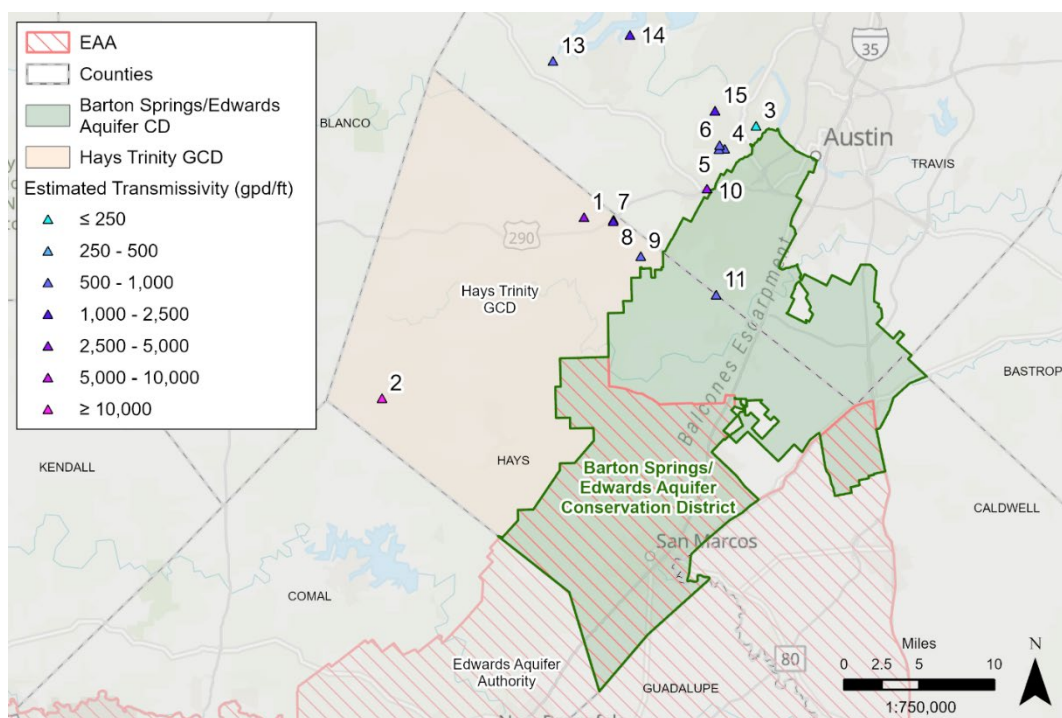


Figure 5.4 Location distribution of transmissivity values (gpd/ft) derived from specific capacity tests. Well labels correspond to Map IDs in Appendix E.

5.4.3 Storativity and Specific Yield Values

The most representative storativity values are determined through analysis of observation well data from aquifer pumping tests. Of the 14 wells with storativity values calculated from observation well data (Appendix D), five of the wells are located within BSEACD. Storativity within the District ranges from 3.25×10^{-5} to 1.00×10^{-3} with a median storativity of 1.61×10^{-4} .

Table 5.3 summarizes specific yield values for the LTA applied in several regional studies. Specific yield values for the north and north-central portion of the Lower Trinity Aquifer range from 0.1 to 0.21 (Kelley and others, 2014; Miller and others, 2025). Specific yield values for the south and south-central portion of the Lower Trinity Aquifer are two to three orders of magnitude less, ranging from 0.0008 to 0.060 (Jones and others, 2011; Robinson and others, 2022). As Hays and Travis counties are located in the south-central portion of the LTA, we used the specific yield values from both the Southern Trinity Aquifer GAM and the Hill Country Trinity Aquifer BRACS report to compute an estimated range of groundwater volume in the LTA (Section 5.5).

Table 5.3 Summary of published specific yield values for the Lower Trinity Aquifer.

Specific Yield (unitless)	Source
0.1	Northern Trinity and Woodbine Aquifers GAM (Kelley and others, 2014)
0.11 – 0.21	Williamson County Hydrogeology Numerical Model (Miller and others, 2025)
0.0008	Southern Trinity Aquifer GAM (Jones and others, 2011)
0.060	Hill Country Trinity Aquifer BRACS report (Robinson and others, 2022)

5.5 CONNECTIVITY AND GROUNDWATER MOVEMENT

The potentiometric surface map indicates that regional groundwater movement in the LTA in the study area is predominantly toward the northeast. This lateral flow interpretation was supported by the accompanying geochemical evolution observed along the inferred flow path. Piper-diagram trends showed that increasing TDS was primarily associated with increases in Ca, Mg, and SO_4 , consistent with progressive water-rock interactions along the flowpath. Additionally, the saturation index patterns further suggested that gypsum SI remains undersaturated but trends positive downgradient, which was consistent with continued gypsum dissolution gradually driving the solution toward equilibrium as Ca and SO_4 ions dissolve.

Furthermore, the isotopic analyses provided additional support for a slow, laterally connected flow with long residence times. The radiocarbon and tritium results indicated that groundwater in the study area was predominantly old (10,000-40,000 years), which

is consistent with the degree of water-rock interactions implied by the TDS and Ca–Mg–SO₄ enrichment in the Stiff diagram map. In contrast, there were no clear spatial patterns in anthropogenic indicators (e.g., nitrate) that suggested dominant modern recharge or contamination pathways across the study area. Overall, the combined evidence of old apparent radiocarbon ages and lack of anthropogenic signatures is most consistent with limited vertical exchange with the overlying Trinity units. This interpretation aligns with the regional hydrostratigraphic framework in which the Hammett Shale unit acts as a laterally extensive confining layer separating the Middle and Lower Trinity aquifers, reducing vertical connectivity (Watson and others, 2023).

SECTION 6: SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The body of work described in this report was undertaken to increase knowledge of the hydrogeology and geochemistry of the Lower Trinity Aquifer within the Barton Springs-Edwards Aquifer Conservation District using currently available data. The data collection and analysis completed by LRE were aimed at answering questions related to the quantity and quality of groundwater in the LTA.

Lower Trinity Aquifer dataset: The main limitation of current work on the LTA is a lack of data, especially towards the eastern and southern areas of the BSEACD. LRE refined the existing stratigraphic surfaces for the LTA and extended these surfaces towards the east by incorporating BRACS geophysical logs. Improved data coverage is still needed for the southern part of the District. Elemental composition data for the Sligo and Hosston formations were collected by sampling available core and cuttings, and performing XRD and XRF analysis.

Compartmentalization and hydraulic connection: The water chemistry results indicated limited vertical mixing of the LTA with the Middle Trinity Aquifer, likely due to the Hammett Shale. The geochemical makeup is a mix of Ca-Mg-HCO₃ waters upgradient, and predominantly Ca-Mg-SO₄ waters downgradient, although substantial local variability in TDS and major ion composition occurs within the broader regional trend. Based on the available data, the primary geochemical controls on the system are most likely carbonate buffering and gypsum dissolution.

Given the flow paths trending northeast in the study area (based on the potentiometric surface) and the overall regional tendency toward increasing TDS and sulfate enrichment along the interpreted flow direction, there is evidence for general lateral connectivity in the LTA upgradient from the BFZ. Radioactive isotope data provide additional support for this interpretation, with younger apparent groundwater ages occurring primarily in the southwestern portion of the study area and generally older apparent groundwater ages occurring farther northeast. However, both the isotope and major ion data indicate that this regional trend is superimposed on these local variability observations.

In the western part of the HTGCD, solute concentrations and TDS vary between the endmembers of the dataset over relatively short distances, suggesting possible compartmentalization within the LTA corresponding to the BFZ. Relatively fresh groundwater occurs near high-TDS, sulfate-rich groundwater, while younger, intermediate, and older radioactive isotope signatures also occur close together in this particular region. The co-occurrence of the major ion and isotope endmembers in this southwestern portion of the study area is consistent with contributions from multiple flow

paths, groundwater mixing with meteoric water in hotspots, and localized differences in hydraulic connectivity to the MTA.

Compartmentalization within the LTA is supported by the combined geochemical and isotope data, but remains difficult to relate to individual structural features based on available geologic and structural data. The offset of individual faults within the BFZ could not be determined using the data currently available. Higher data density is required within the BFZ to define individual offsets and to provide greater detail of the LTA structure within the BFZ. Additional collection of water isotopic and major ion data across structural features would support stronger spatial characterization of flow paths and hydraulic connectivity in the LTA throughout the District. LRE recommends drilling additional monitor wells within the BFZ, particularly near known faults, to investigate the effects BFZ faults have on the LTA within the District.

Sources and rates of recharge: Isotopic analyses indicated predominantly old groundwater, implying recharge reaching the LTA in the study area was limited. Infiltration may occur along located pathways, such as the instance of the outlier intermediate age groundwater signatures in southern Hays County. Rainfall does not provide any quantifiable recharge to the LTA, at least not on an aquifer-wide or regional basis. To better determine recharge potential to the LTA, more work is needed to characterize the hydrologic communications between the Colorado River, the Pedernales River, and Lake Travis with underlying aquifers.

Groundwater mining: Water level data, low recharge rates, and data from Hunt and others (2020) indicate that the LTA is currently being mined in portions of the study area. Though water levels in the LTA may be locally stable, such as north of the District around well 5850121, records in other parts of the District indicate a steady decline in water level over recent years. Overall, the availability of long-term groundwater level data is sparse and aquifer conditions are not known in the eastern and southern areas of the District. More groundwater monitoring locations across the District, especially in the eastern and southern parts of the BSEACD, and long-term monitoring are needed to fully characterize temporal and spatial trends.

Groundwater volume: Based on available data, an estimation of LTA storage volume at this time would not provide defensible information to the District. Additional information on hydraulic properties and water levels in the LTA, particularly in the eastern and southern portions of the BSEACD, are critical for estimating storage volume in the LTA. Review of LTA stratigraphy and available water level data suggest that with continued water level declines, confined conditions in the LTA may transition to unconfined conditions starting from the west and moving towards the eastern part of the District.

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APPENDIX A

Signed Copy of LTA Study Change Order Request No. 1

LTA Study Change Order Request No. 1

To: Charlie Flatten, General Manager
Cc: Jeff Watson, PG, Senior Hydrogeologist
From: Stephanie Wong, PhD, PG
Reviewed By: Gretchen Miller, PhD, PE, PG
Jordan Furnans, PhD, PE, PG
Date: November 10, 2025
Project: Lower Trinity Aquifer Study
Subject: Change Order Request No. 1

LRE Water, LLC (“LRE”) provides herein our proposed Change Order Request No. 1 for licensed professional hydrogeologic services to support the ongoing Lower Trinity Aquifer Study undertaken on behalf of Barton Springs-Edwards Aquifer Conservation District (“BSEACD” or “District”) located in Hays and Travis counties, Texas. This change order alters the scope of the project, authorizes allocation of project funds to alternative subtasks, and does **NOT** change the total project budget.

Based on the original Request for Proposal dated July 19, 2024, LRE understands that BSEACD aims to better understand the geochemical makeup of LTA groundwater, potential sources of recharge, and potential vertical mixing between the LTA and the Middle Trinity Aquifer. To develop a geochemical model that can evaluate these aquifer characteristics, elemental composition data from the Sligo and Hosston formations are required. However, a thorough survey of available literature and datasets revealed that these data do not currently exist within or near the study area. As such, generating elemental composition data for the LTA through XRF and XRD analysis would be a valuable addition to the scope of the LTA Study. The estimated cost for this additional data collection and analysis effort is \$5,844. Per telephone discussions with BSEACD on September 17, 2025, LRE received approval to proceed with this added scope for no added cost to the original contract total. If needed, BSEACD approves LRE to move funds between tasks to cover costs. Additionally, to help cover the cost of the added scope, BSEACD directed LRE to focus study efforts to the LTA within the District rather than the aquifer underlying the BSEACD and Hays Trinity Groundwater Conservation District as written in the original scope.

Since receiving approval from BSEACD, LRE has collected samples of LTA core and cuttings, and submitted the samples to laboratories at The University of Texas at Austin to be prepared for analysis.

We appreciate the opportunity to undertake this work on behalf of BSEACD. If you have any questions or feedback about the services discussed in this change order, please call our assigned Project Manager for this effort, Dr. Stephanie Wong, PG. Stephanie is reachable at 254-350-0930 and at Stephanie.Wong@lrewater.com.

Sincerely,

LRE WATER



Stephanie S. Wong, PhD, PG
Staff Hydrogeologist III



Jordan Furnans, PhD, PE, PG
Regional Director

Change Order Authorization:

Barton Springs/Edwards Aquifer Conservation District
Contracting Agency

charlie flatten
Authorized By (Signature)

11/13/2025

Date

Charlie Flatten

Authorized By (Print)

APPENDIX B

Lithologic Descriptions of BEG CRC Core and Drill Cutting Samples

LITHOLOGIC DESCRIPTIONS OF BEG CRC CORE AND DRILL CUTTING SAMPLES

Well Name	Sample (ft)	Sample Box/Bag No.	Formation	Sample Description	Sample Weight (g)	Sample Date
BSEACD Reimers MW#3	118.5	7	Hosston	Gray moderately sorted, subangular, fine-grained sandstone. Calcium carbonate cement, subangular quartz grains.	20.5	9/23/2025
	137.5	8	Hosston	Gray conglomerate. Friable, subangular, poorly sorted calcareous-cemented silty sandstone.	23	9/23/2025
	145	9	Hosston	Weathered conglomerate with silty calcareous red matrix.	28.2	9/23/2025
	166	11	Hosston	Red and white calcareous siltstone, friable.	23.4	9/23/2025
	199	14	Hosston	White lime/mudstone with red mottles, poorly cemented.	20.1	9/23/2025
	217	16	Hosston	Conglomerate with red, gray, tan, pebbles with haloing/discoloration. Red, white, and gray calcareous matrix. Angular clasts (fine sand to cobbles).	37.2	9/23/2025
	239.5	18	Hosston	Weathered conglomerate with white clasts and red calcareous matrix. Orange/brown/oxidized in areas.	30.9	9/23/2025
	254	19	Hosston	Gray conglomerate with red, brown, black angular to subrounded clasts. Pebble to cobble size clasts. Gray calcareous sandy matrix.	26	9/23/2025
Spillar Well	915	910-920	Sligo	Gray silty lime/dolostone with abundant coated and skeletal grains.	27.3	9/23/2025
	1095	1090-1100	Hosston	Dark reddish brown siltstone with medium-coarse subangular quartz grains.	24.0	9/23/2025

APPENDIX C

Stratigraphic Picks from Geophysical Logs Used for Structure Mapping

STRATIGRAPHIC PICKS FROM GEOPHYSICAL LOGS USED FOR STRUCTURE MAPPING

Log Name	BRACS No.	API No.	SWN	Q Number	Latitude	Longitude	County	TD (ft)	Elevation (ft amsl)	Hammett Top (ft bgs)	Sligo Top (ft bgs)	Hosston Top (ft bgs)	Paleozoic Top (ft bgs)	LTA Top (ft amsl)	Hammett Thickness (ft)	LTA Thickness (ft)
4202100586	50276	4202100586	5859602	Q-98	30.0630	-97.6420	Bastrop	3930	577	2885	2915	3140	3710	-2338	30	795
4205503024	20860	4205503024			29.9416	-97.6648	Caldwell	4239	449	3235	3255	3600	4230	-2806	23	969
4205531299	86605	4205531299			30.0258	-97.6839	Caldwell	3388	591	2952	2978	3140		-2387	26	
4218732148	35601	4218732148			29.8129	-97.9331	Guadalupe	3833	607	2215	2240	2495	2885	-1633	25	645
4220900030	6468	4220900030	5755701	Q-1	30.1519	-98.2150	Hays	4661	1371	563		600	845	771		845
4245300323	19218	4245300323			30.1082	-97.6384	Travis	3770	548	2830	2860	3105	3690	-2312	30	
42031_Flat Creek Crossing No 3	55532				30.2840	-98.2251	Blanco	523	1099	245		310		789		
42031_Flat Creek Crossing No 4	55533				30.2768	-98.2144	Blanco	380	981	185		230		785		
42055_Dietz_BlanksNo2	85578	4205505032			29.9239	-97.7618	Caldwell	3013	627	2680	2700	2825		-2073	20	
4218732149 IndDN	67791	4218732149			29.8073	-97.9276	Guadalupe	3835	632	2228	2250	2525	2912	1618	22	662
42209_5850755	88017		5850755		30.1347	-97.8669	Hays	1620	728	1312	1352	1476		-624	40	
42209 Beltera	55468		5849413		30.1981	-97.9803	Hays	903	1096	576	616	708		480	40	
42209 Farmer No 1	55531				30.2468	-98.0793	Hays	645	1099	458	483	515		616	25	
42209 Gragg02	88221				30.1315	-97.8678	Hays	1505	718	1285	1335	1438		-617	50	
42209 Gragg03	88222				30.1311	-97.8616	Hays	1700	702	1308	1350	1475		-648	42	
42209 Graner	55543		5748912		30.2520	-98.0352	Hays	770	1099	594	617	648		509	23	
42209_Heather Hills_a	55550		5748702		30.2615	-98.1085	Hays	650	1218	526	553	590		665	27	
42209 HEIDENREICH_1	86618				29.9381	-97.8695	Hays	2767	692	2335	2376	2438	2677	-1684	41	301
42209_Kemp Hills No 2_a	55564				30.1731	-97.9444	Hays	700	951	555	593	686		358	38	
42209 Nells_a	55593		5763706		30.0412	-98.2418	Hays	430	1096	209	243	350		853	34	
42209 Pond 2_a	55600				30.2288	-98.0735	Hays	800	1135	530	555	583		580	25	
42209_River Oaks 2_b	42873		5748705		30.2829	-98.1034	Hays	800	1282	538	590	618	773	692	52	183
42209 Sabino Ranch_b	55617		5764717		30.0037	-98.0941	Hays	755	871	531	569	687		302	38	
42209_Salt Lick 3	100965				30.1380	-98.0230	Hays	780	951	394	441	530	774	510	47	
42209_Salt Lick TH 2	55618				30.1367	-98.0216	Hays	780	1005	396	443	548	747	562	47	304
42209_Signal Hill Rd	55624				30.1819	-97.9601	Hays	905	1050	609	646	739		404	37	
42209_Skipton1	86800				30.1964	-98.2242	Hays	762	1322	510	552	580	735	803	42	183
42209_Whirl Away 1_a	55648		5756604		30.1999	-98.0091	Hays	905	1237	711	757	854		480	46	
42209 Willis	55651				30.0546	-98.1777	Hays	582	1076	245	288	400	570	788	43	282
42453_Oak Hill	55594		5850130		30.2363	-97.8691	Hays	840	843	592	630	699		213	38	
42453_Spillar well_1	55629		5849615		30.1751	-97.9104	Travis	1210	899	862	900	1000		-1	38	
Q10_209	42973		5756301	Q-10	30.2294	-97.9978	Hays	847	1120	645	660			460	15	
Q150_055	15283	4205503075	6702508	Q-150	29.9230	-97.8062	Caldwell	2860	614	2570	2600	2820		-1986	30	
Q35_453	58925	4245300224	5851801	Q-35	30.1581	-97.6648	Travis	3312	525	2325	2355	2520	3080	-1830	30	725

APPENDIX D

Constant Rate Pumping Test Summary Table

CONSTANT RATE PUMPING TEST SUMMARY TABLE

Map ID	Well ID	ID Type	Well Name	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Static Water Level (ft bg)	Pumping Duration (hours)	Pumping Rate (gpm)	Maximum Drawdown (ft)	Specific Capacity (gpm/ft)	Transmissivity (gpd/ft)	Storativity	Source
1	575596	SDR	Copper Hills Well No. 5	30.14282	-97.8802	154.62	36	95.3	426.82	0.22	671.5993	3.25E-05	BSEACD ¹
2	473734	SDR	Gragg Tract #1	30.13473	-97.8669	138	5.5	115	431	0.27	1239.519	ND	BSEACD ²
3	527500	SDR	Gragg Tract #2	30.13151	-97.8678	136	96	168	437	0.38	2650.341	4.50E-05	BSEACD ²
4	527505	SDR	Gragg Tract #3	30.13095	-97.8614	141	93	175	320	0.54	3645.996	2.76E-04	BSEACD ²
5	ND	ND	Mt. Sharp	30.10111	-98.1775	300	24.6	34	5.6	6.1	4000	7.00E-05	BSEACD ³
6	ND	ND	Brushy Top 2005 No. 3	30.16272	-98.4157	ND	2	13.6	91.98	0.15	108	ND	BSEACD ³
7	ND	ND	Brushy Top 2006 (RBT 3A)	30.16272	-98.4157	293.39	24	12	88.7	0.14	180	4.00E-06	BSEACD ³
8	ND	ND	Chama Trace Pumping Well	30.17361	-98.0391	210.51	24	30	34.2	0.88	1900	5.00E-05	BSEACD ³
9	5756480	TWDB GWDB	Roger Hanks	30.18417	-98.1461	ND	24	150	9.28	16.16	10000	5.00E-03	BSEACD ³
10	5849413	TWDB GWDB	Foster Ranch/Belterra	30.19806	-97.9803	408	120	95	143	0.75	1500	ND	BSEACD ³
11	ND	ND	Polo Club	30.211	-98.0068	384.1	48	108	86	1.26	3500	1.00E-04	BSEACD ³
12	5850126	TWDB GWDB	St. Andrews No. 2	30.24594	-97.851	257.9	24	36	260	0.14	500	1.00E-03	BSEACD ³
13	ND	ND	Fronterra	30.25364	-98.0346	509.98	24.15	11	20.2	0.54	2000	1.00E-03	BSEACD ³

Map ID	Well ID	ID Type	Well Name	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Static Water Level (ft bg)	Pumping Duration (hours)	Pumping Rate (gpm)	Maximum Drawdown (ft)	Specific Capacity (gpm/ft)	Transmissivity (gpd/ft)	Storativity	Source
14	ND	ND	Heather Hills	30.26017	-98.1079	317.01	24	7.3	176.09	0.04	100	3.00E-04	BSEACD ³
15	5843703	TWDB GWDB	Driskill Hotel Well	30.26805	-97.74	70 ft above LSD	31.47	19.6	53.2	0.37	569	ND	BSEACD ³
16	585591	SDR	Horseshoe Ridge No. 1	30.2667	-98.1001	211	17 32	40	314 330	0.13 0.12	175	3.20E-05	HTGCD ⁴
17	592655	SDR	Horseshoe Ridge No. 2	30.0550	-98.0942	264	12.6	33	446	0.073991			HTGCD ⁴
18	626220	SDR	Silver Creek PWS-2 (pumping well)	30.2379	-98.0582	531.37	49	11.9	195.25	0.06	350	ND	HTGCD ⁵
19	640867	SDR	Silver Creek PWS-1 (obs. well)	30.2369	-98.0571	557.12	ND	ND	11.1	ND	450	5.00E-05	HTGCD ⁵

"ND" indicates no data.

SOURCES:

- ¹ Wet Rock Groundwater Services, LLC, 2021, Copper Hills Water System Well No. 5: Production Permit Application for Aqua Texas, Inc. 135 p.
- ² Camp, J., Hunt, B.B., Smith, B.A., 2020, Evaluating the Potential Groundwater Availability within a Lower Trinity Aquifer Well Field, Balcones Fault Zone, Hays County, Central Texas: BSEACD Technical Memo 2020-0630, June 30, 2020. 70 p.
- ³ Hunt, B.B., Smith, B.A., Kromann, J., Wierman, D.A., Mikels, J.K., 2010, Compilation of Pumping Tests in Travis and Hays Counties, Central Texas: BSEACD Data Series Report 2010-0701, July 2010. 86 p.
- ⁴ Personal communications with Hays Trinity Groundwater Conservation District, Horseshoe Ridge aquifer test.
- ⁵ Personal communications with Hays Trinity Groundwater Conservation District, Silver Creek aquifer test.

APPENDIX E

Specific Capacity Test Summary Table

SPECIFIC CAPACITY TEST SUMMARY TABLE

Map ID	Well ID	ID Type	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)	Static Water Level (ft bg)	Pumping rate (gpm)	Maximum Drawdown (ft)	Duration (hours)	Specific Capacity (gpm/ft)	Estimated Transmissivity (gpd/ft)
1	5756308	GWDB	30.2108	-98.0067	384	108	86	48	1.2558	2,512
2	5763702	GWDB	30.0394	-98.2353	210	38	5	6	7.6	15,200
3	5842507	GWDB	30.2958	-97.8128	320	15	180	12	0.0833	167
4	5842702	GWDB	30.2742	-97.8483	55	100	200	3	0.5	1,000
5	5842705	GWDB	30.2739	-97.8547	46	50	195	2	0.2564	513
6	5842706	GWDB	30.2778	-97.8539	55	25	60	2	0.4167	833
7	5849408	GWDB	30.2078	-97.9739	478	102	73	36	1.3973	2,795
8	5849409	GWDB	30.2064	-97.9742	547	21	22	0	0.9545	1,909
9	5849509	GWDB	30.1722	-97.9442	313	150	567	48	0.2646	529
10	5850130	GWDB	30.2361	-97.8689	342	92	63	39	1.4603	2,921
11	596155	SDR	30.1336	-97.861	153	130	300	36	0.4333	867
12	5740304	GWDB	30.47242	-98.0223	88.24	23	11	3	2.0909	4,182
13	5748307	GWDB	30.36199	-98.0383	208.25	20	69.1	0.75	0.2894	579
14	5833815	GWDB	30.38573	-97.9517	354.85	40	57.15	0.3	0.6999	1,400
15	5842416	GWDB	30.31109	-97.8583	630.2	20	17.7	0.33	1.1299	2,260