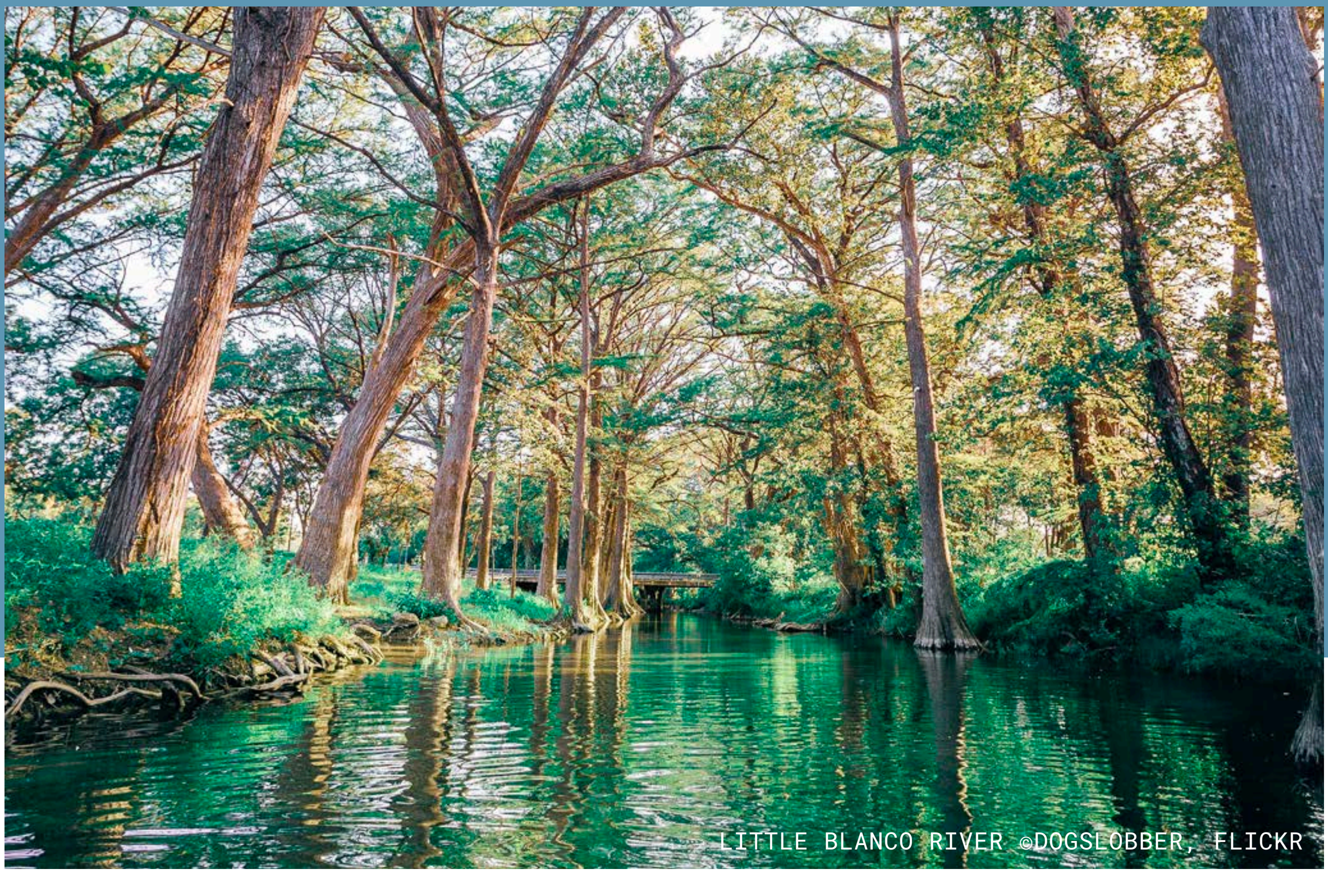
Contract Report 23-002

# Little Blanco River Occurrence of Flowing Water Central Texas Hill Country, USA





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February 2023


THE MEADOWS CENTER FOR WATER AND THE ENVIRONMENT

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We especially thank the landowners that allowed us to enter their property. Without the cooperation of private landowners, opportunities for us to expand our knowledge of the river and joining aquifers would not be possible.


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# Little Blanco River Occurrence of Flowing Water

# Central Texas Hill Country, USA


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**February 2023**


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CROSSING ON CHICK RANCH RIVER IN THE 1950s ©CONNIE CHICK

# CONTENTS

# LIST OF FIGURES

# LIST OF TABLES



# ACRONYMS

**CFS** Cubic feet per second

**EARDC** Edwards Aquifer Research Data Center

**ESRI** Environmental Systems Research Institute

**GPM** Gallons per minute

**GIS** Geographic Information Systems

**MRLC** Multi Resolution Land Characteristics

**NHD** National Hydrological Database

**NLCD** National Land Cover Database

**RM** Ranch to Market

**RR** Ranch Road

**SWR** State Well Report

**TWDB** Texas Water Development Board

LITTLE BLANCO RIVER ON ELO KRUEGER SCENIC LOOP IN BLANCO COUNTY, TEXAS ©JANA, STOCK.ADOBE.COM

# INTRODUCTION

The Little Blanco River in Blanco County, Texas is a picture-perfect example of a classic Texas Hill Country stream in certain sections where clear waters flow over limestone riverbeds along towering Cypress tree-lined, shady banks. Some sections of the river, however, more often resemble a dry creekbed. The Texas Hill Country is chock-full of contrasts such as this, due to the complex system of karst aquifer systems which are common in this region.

Over the past several years, the Meadows Center has teamed up with many partners throughout Central Texas to study the complex interconnectedness of groundwater and surface water of river and spring systems within the Colorado, Guadalupe, and Pedernales river basins. A group of visionary landowners, known as the Friends of the Little Blanco River Valley, and the Hill Country Alliance approached the Meadows Center in 2019 to assist them in gaining a better understanding of this small yet significant river system. The overarching goal of the study is to keep the Little Blanco River clean, clear, and flowing for generations to come. Crossing through four of the fastest growing counties within the state, now is the time to gain insight into the local hydrogeology and how the Little Blanco River can best be conserved and protected.


**FIGURE 1.** LITTLE BLANCO RIVER CROSSING AT HIGHWAY 32

# SCOPE OF STUDY

The Little Blanco River, a tributary of the Blanco River, is situated in the southern portion of the Upper Blanco River watershed and spans 68.5 square miles (43,870 acres). US Highway 281 bisects the central portion of the Little Blanco River watershed in a north-south orientation. Ranch to Market (RM) 32 traverses much of the watershed in a northwest-southeast orientation. The river traverses four counties: Kendall, Blanco, Hays, and Comal. The Little Blanco River flows eastward towards its confluence with the Blanco River. The main stem of the Little Blanco River is approximately 23 miles in length. The gradient of the river is from west to east at approximately 24 feet/mile (Figure 2).

Named tributaries to the river include Schuelz Creek, Rochou Creek, Cypress Branch, and Kentucky Branch (Figure 3). Historically, development in the watershed has been sparse, though in recent years there has been an uptick in rural/suburban type development and that is expected to continue. According to the State of the Hill Country Report, the population in unincorporated areas of Blanco County has grown by 104 percent since 1990 (Texas Hill Country Conservation Network, 2022).

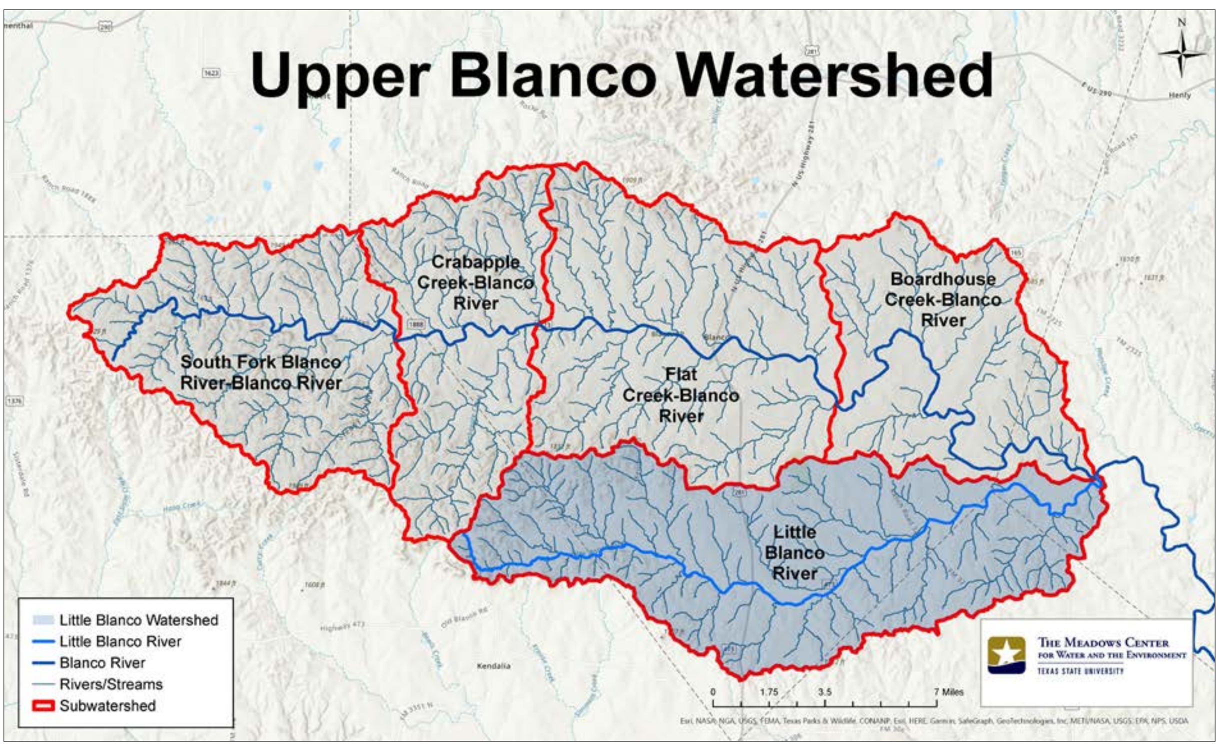



**FIGURE 2.** UPPER BLANCO RIVER WATERSHED


**FIGURE 3.** LITTLE BLANCO WATERSHED

**FIGURE 4.** LITTLE BLANCO RIVER AT GREENS HOLLOW NEAR RM 32 (PHOTO CREDIT: STEPHEN SAKS)

## Methods and Data

### GIS MAPPING

Geographic Information Systems (GIS) is a versatile tool that can be used for a variety of functions, including mapping physical and hydrological features of a certain area, housing and centralizing multiple forms of environmental data, and performing spatial and data analysis using various tools offered within the program. The study used the Environmental Systems Research Institute (ESRI) suite of GIS products, specifically ArcGIS Pro. Land cover data was collected and analyzed for patterns using National Land Cover Database (NLCD) raster files, along with shapefiles of watershed and subwatershed boundaries, tributaries, and flowlines from the National Hydrological Database (NHD). A composite geologic map of the watershed created from Geologic Atlas of Texas Bureau of Economic Geology at the University of Texas at Austin (Barnes, 1981) was added for analysis of geology.

### SUBSURFACE DATA

Drillers' logs were retrieved from the Texas Water Development Board (TWDB) website (https://www.twdb.texas.gov/groundwater) to gain insight into area-specific subsurface hydrogeology and well construction. In some cases, location coordinates on the logs were corrected. The TWDB database extends back to 2002, therefore no wells drilled before 2002 are included. None of the wells utilized in this study for direct water level measurements and water quality sampling were contained in the TWDB database.

### WATER CHEMISTRY MAPPING AND ANALYSIS

Chemical analysis of surface water and groundwater is used to evaluate water quality, examine human impacts, and understand water pathways of groundwater to the surface and vice versa. Major ion chemistry is a standard tool used to decipher hydrogeochemical patterns as well as impacts of human activity. Spatial patterns in water chemistry were evaluated as related to natural sources by utilizing spatial analysis in ArcGIS. The field sampling data points provide spatial locations for the water samples. Surface and groundwater samples were collected by the Meadows Center team and were analyzed for naturally occurring cations and anions by the Edwards Aquifer Research Data Center (EARDC) Laboratory at Texas State University. Groundwater quality data was extracted from the Texas Water Development Board online database (https://www.twdb.texas.gov/groundwater) in addition to the water quality samples collected and analyzed by Meadows Center staff and partner laboratory.

### DISCHARGE MEASUREMENTS

To determine losing and gaining reaches of the river, a synoptic discharge measurement event was performed. Based on available landowner access, measurements were made at semi-regular intervals along the length of the river with "live" water. Sites were generally near dams or access road bridges. Flow measurements were made using a SonTek FlowTracker2 (FT2) handheld Acoustic Doppler Velocimeter generally following United States Geological Survey (USGS) protocols.

### LAND COVER ANALYSIS

Land cover, particularly developed land use, can play a role in determining water quality, and both storm flow and base flow. Increased impervious cover, septic systems, organized sewage treatment, and non-point source pollution can impact water quality. GIS files of basin land cover data from 2001 and 2019 were obtained from the National Land Cover Database (NLCD) provided by the Multi-Resolution Land Characteristics (MRLC) Consortium (https://www.mrlc.gov/).

# STUDY RESULTS

## Land Cover

The land cover data sets from 2001 and 2019 were compared to determine land cover changes over the period. Figures 5 and 6 indicate 2001 and 2019 land cover of the Little Blanco River watershed. Although the data sets contained a detailed breakdown of many land cover types, many similar land uses were combined for the purpose of this report and consolidated into eight categories to analyze land use changes. The watershed was primarily shrub, forest, and grasslands in 2001. Approximately 2.5 percent of the watershed was developed. Table 1 includes a listing of land cover types with a description of each type contained in Appendix A – Land Cover Descriptions.

Shrub and forestland cover types still dominated the watershed in 2019 (Figure 7 and Table 2). There was a significant decline in grasslands, totaling approximately 4,000 acres since 2001. Shrub land increased by approximately 4,500 acres. Developed land increased from 2.5 percent to 3.5 percent of the watershed. Based on Figures 5 and 6, the change from grassland to shrubs appears most pronounced in the western area of the watershed, west of Hwy 281 and north of the creek in the eastern areas of the watershed.

While there were minor changes in land cover in the eighteen-year observation period, some changes resulting in loss or gains in the existing coverage types are noteworthy (Table 3). The lack of an increase in development (clearing of native vegetation, paved roads, other instances of impervious coverage such as homes, commercial buildings, and sidewalks) over the observation period within the watershed is a good sign. Pathways for recharge to the aquifer, as well as a lack of nonpoint source pollutants from impervious cover that is often associated with developed spaces, allow for healthy groundwater levels and excellent surface water quality. According to Naismith Engineering (2005), "most of the studies evaluated indicated that measurable water quality impacts began to occur in the range of ten to fifteen percent (10 to 15 percent) gross impervious cover."

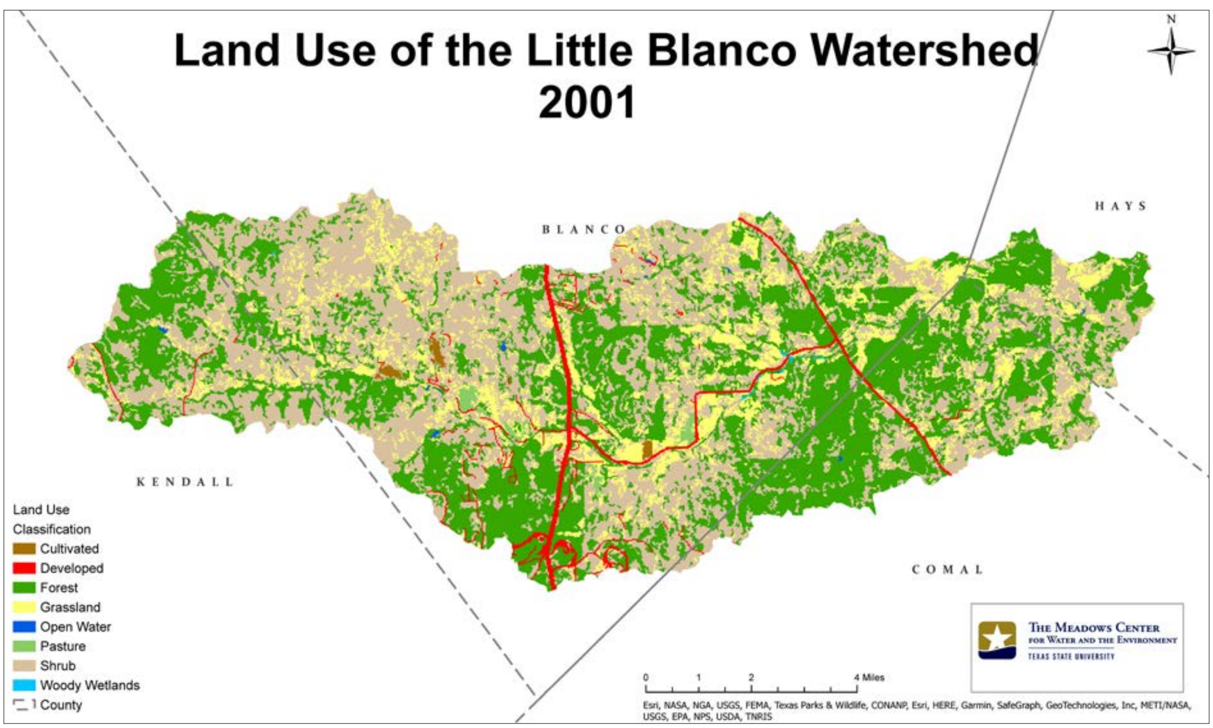



**FIGURE 5.** LAND USE 2001 (TNRIS DATA HUB, 2022)

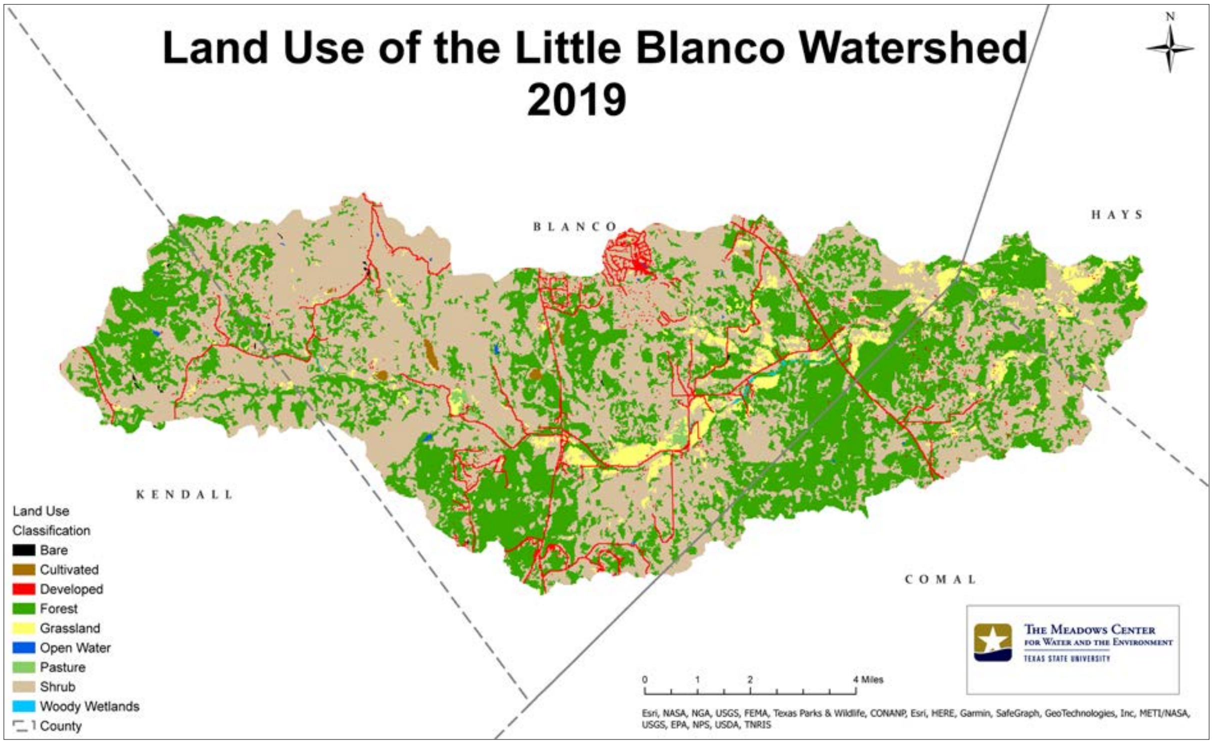



**FIGURE 6.** LAND USE 2019 (TNRIS DATA HUB, 2022)

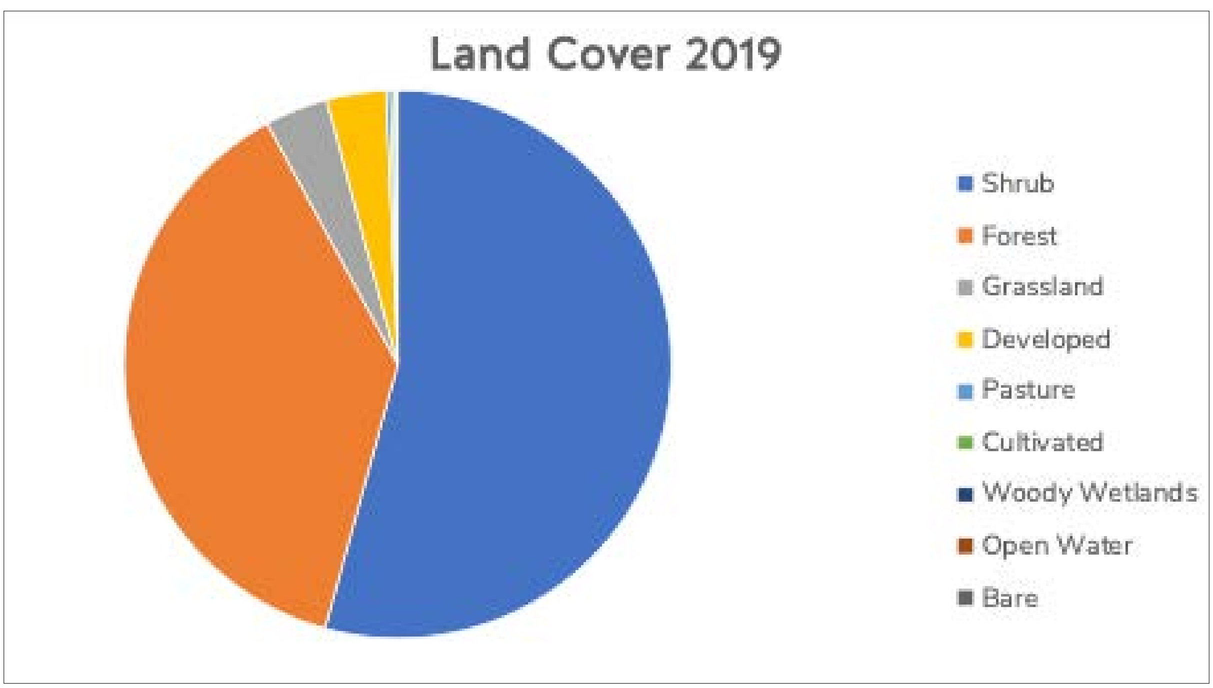



**FIGURE 7.** LAND COVER 2019

**TABLE 1.** LAND USE 2001

| LAND USE 2001 | TOTAL ACREAGE | TOTAL HECTARAGE | PERCENTAGE |
|---|---|---|---|
| Shrub | 19,393.60 | 7,848.31 | 44.2% |
| Forest | 17,394.85 | 7,039.45 | 39.65% |
| Grassland | 5,676.30 | 2,297.12 | 12.94% |
| Developed | 1,065.36 | 431.14 | 2.43% |
| Pasture | 182.86 | 74 | 0.42% |
| Cultivated | 108.65 | 43.97 | 0.25% |
| Open Water | 30.88 | 12.5 | 0.07% |
| Woody Wetlands | 22.44 | 9.08 | 0.05% |
| **Total** | **43,874.93** | **17,755.57** | **100.00%** |

**TABLE 2.** LAND USE 2019

| LAND USE 2019 | TOTAL ACREAGE | TOTAL HECTARAGE | PERCENTAGE |
|---|---|---|---|
| Shrub | 23,817.47 | 9,638.59 | 54.28% |
| Forest | 16,585.67 | 6,711.98 | 37.8% |
| Grassland | 1,632.59 | 660.69 | 3.72% |
| Developed | 1,540.61 | 623.46 | 3.51% |
| Pasture | 118.87 | 48.1 | 0.27% |
| Cultivated | 101.32 | 41 | 0.23% |
| Woody Wetlands | 30.66 | 12.41 | 0.07% |
| Open Water | 28.88 | 11.69 | 0.07% |
| Bare | 18.89 | 7.64 | 0.04% |
| **Total** | **43,874.95** | **17,755.56** | **100.00%** |

**TABLE 3.** LAND USE CHANGE 2001-2019

| LAND USE TYPE | 2001 LAND COVER (ACRES) | 2019 LAND COVER (ACRES) | CHANGE IN LAND COVER (ACRES) |
|---|---|---|---|
| Shrub | 19,393.60 | 23,817.47 | 4,423.87 |
| Forest | 17,394.85 | 16,585.67 | -809.18 |
| Grassland | 5,676.30 | 1,632.59 | -4,043.71 |
| Developed | 1,065.36 | 1,540.61 | 475.25 |
| Pasture | 182.86 | 118.87 | -63.99 |
| Cultivated | 108.65 | 101.32 | -7.33 |
| Open Water | 30.88 | 28.88 | -2.00 |
| Woody Wetlands | 22.44 | 30.66 | 8.22 |

## Geology of the Little Blanco River Basin

The Little Blanco River watershed is underlain by gently east to southeast dipping Cretaceous age carbonate rock units (Figure 8). The upper most surficial rock unit is the Edwards Limestone and is present on hilltops on the far western edge of the watershed. Underlying the Edwards Limestone is the Glen Rose formation. Except where remnants of the Edwards are present on hilltops, the Glen Rose formation is the surficial rock unit present throughout the watershed. The Glen Rose formation consists of two members: the Upper and Lower Glen Rose formations. The Upper Glen Rose is present in the higher elevations in the western half of the watershed, generally west of Highway 281. The Upper Glen Rose consists of thin to medium-bedded limestone and dolomite. In the eastern part of the watershed, the Upper Glen Rose has been eroded to expose the Lower Glen Rose member. The Lower Glen Rose can exhibit extensive karst development. The Hensel and Cow Creek formations underlie the Glen Rose Formation (Figure 9). The Hammett Shale separates the Cow Creek from the underlying Sligo and Hosston Formations (Wierman, 2010).

Alluvium and terrace deposits occupy the river valley throughout most of its length. These deposits consist of varying amounts of gravel, sand, and silt.

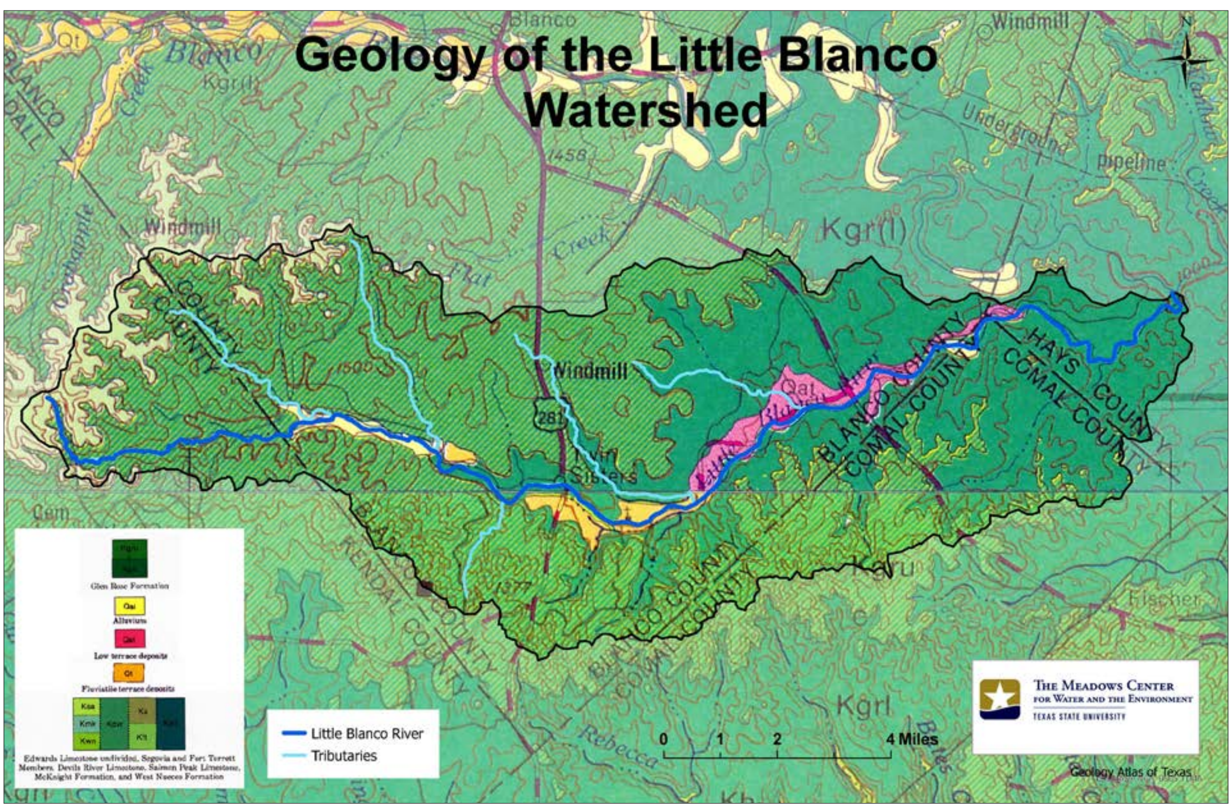



**FIGURE 8.** GEOLOGY OF THE LITTLE BLANCO SUBWATERSHED

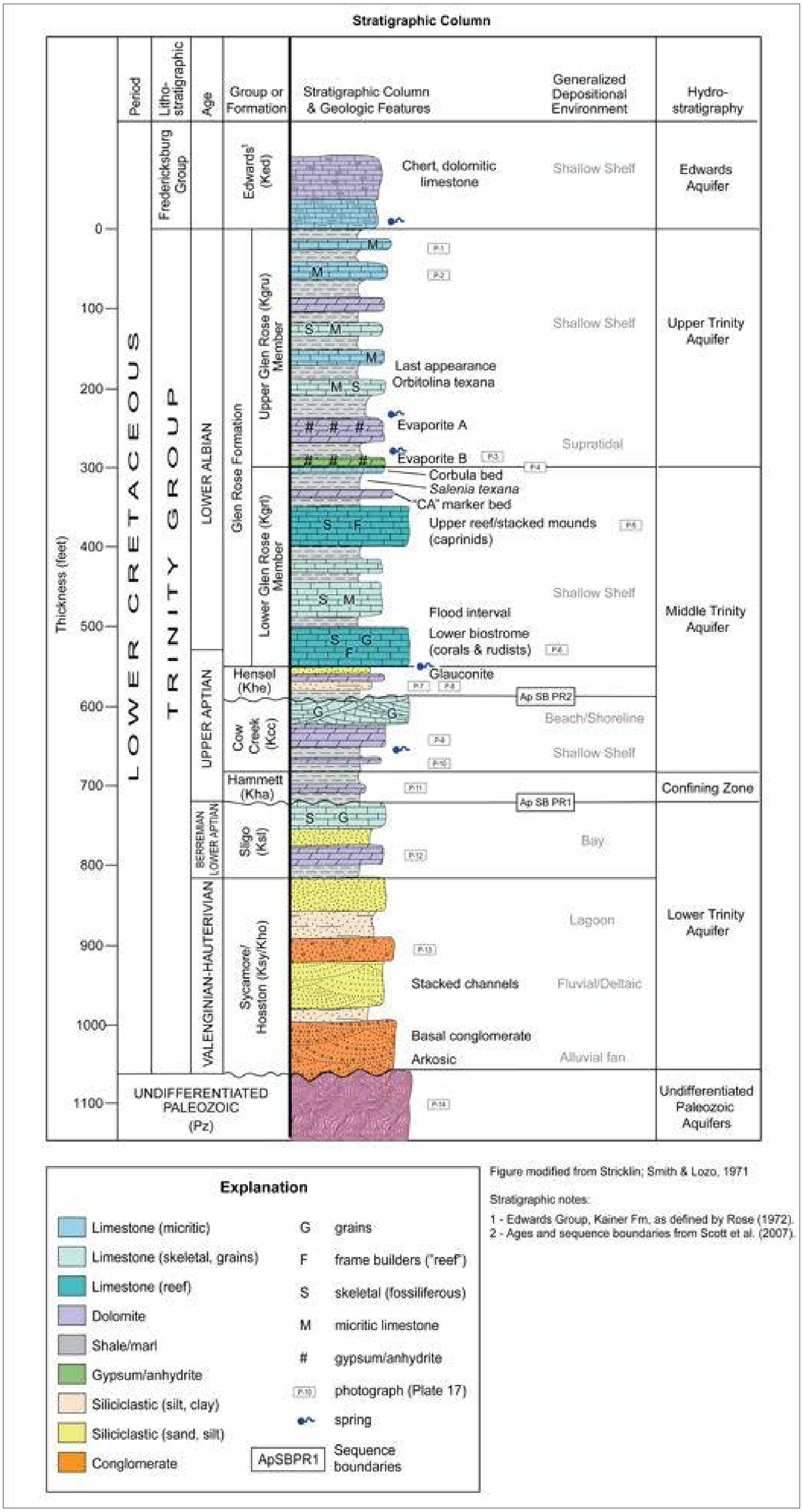



**FIGURE 9.** STRATIGRAPHIC AND HYDROSTRATIGRAPHIC COLUMN (FROM WIERMAN, 2010)

**FIGURE 10.** ALLUVIAL DEPOSITS OVERLYING LOWER GLEN ROSE, WEST OF HWY 281 ON LITTLE BLANCO ROAD

**FIGURE 11.** LOWER GLEN ROSE FORMING FLAT RIVER BOTTOM, WEST OF HWY 281 ON LITTLE BLANCO ROAD

The Edwards Limestone is relatively thin in the area and not considered a significant source of groundwater, though there are occasional seeps and springs that emanate from the contact with the underlying Upper Glen Rose. The Upper Trinity Aquifer consists of the Upper Glen Rose limestone. Shallow, perched water table aquifers, with their associated seeps and springs commonly present within the Upper Trinity aquifer, contribute water to the headwater tributaries. A review of the TWDB groundwater database indicates the Upper Trinity is not a significant source of water to wells in the area.

Review of TWDB data indicates the Middle Trinity aquifer is the primary source of groundwater to wells in the watershed. The Middle Trinity consists of the Lower Glen Rose, Hensel, and Cow Creek Formations. Several evaporate beds (gypsum and anhydrite) are present at the base of the Upper Glen Rose near the contact with the Lower Glen Rose.

The local alluvial and terrace deposits in the river bottoms likely contain water where underlain by impermeable carbonate layers. While not a significant source of water to wells, shallow groundwater contained within the unconsolidated alluvial/terrace deposits may be a significant contributor of water to base flow in the river.

Due to the limited number of wells available for measurements included in this study, watershed wide groundwater flow directions were not determined. Several regional studies, as summarized in Hunt (2019), indicate groundwater flow direction in the Middle Trinity to be to the east-southeast (Figure 12).

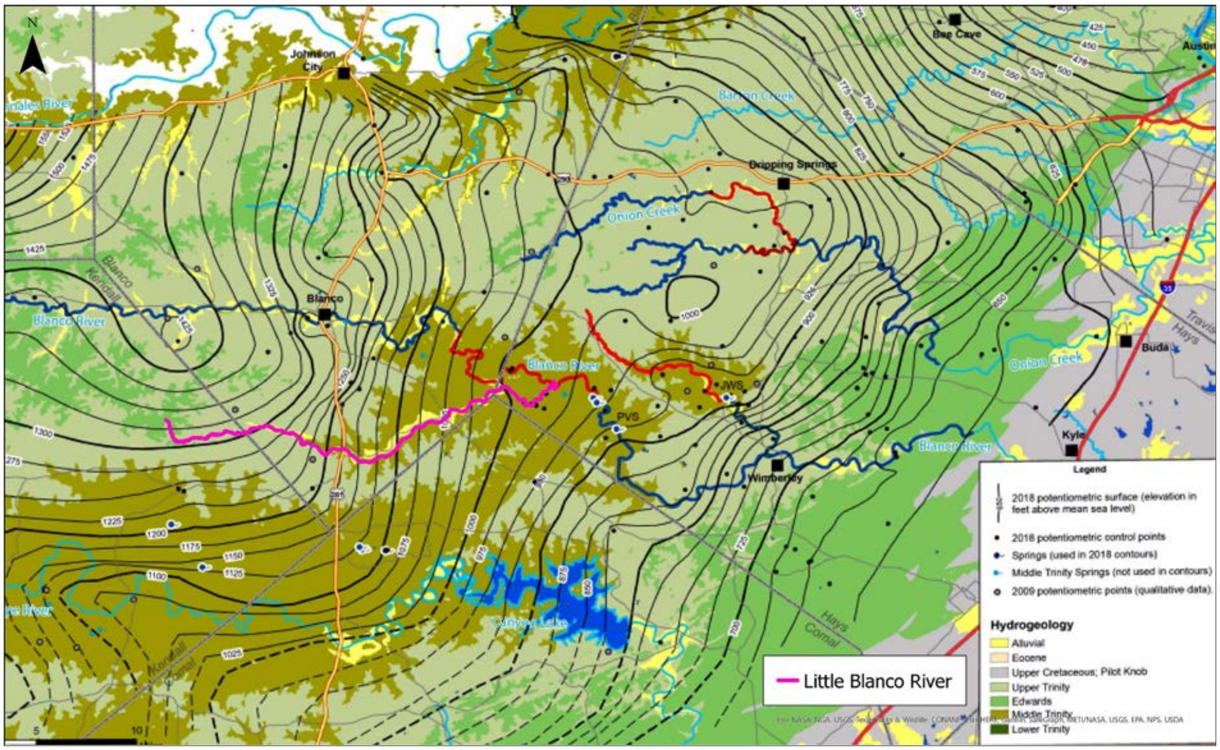



**FIGURE 12.** POTENTIOMETRIC SURFACE MAP OF THE MIDDLE TRINITY AQUIFER (AFTER HUNT, 2019)

Depth to water from the ground surface measured at wells monitored during this study (Figure 14) generally ranged from 50 to 100 feet (Figure 15). The wells were selected for monitoring based on accessibility and close proximity to the river. Well logs were not available for any of the wells but based on regional information, it is believed that all the wells were completed in the Middle Trinity aquifer, either in the Lower Glen Rose or Hensel/Cow Creek. Groundwater elevations were below the base of the river in all locations during the study. Groundwater levels near the river that are above the base of the river would be indicative of groundwater discharge to the river, or a gaining river condition. If groundwater levels are below the base of the river, this would indicate a river losing condition. Though it appears that all groundwater river levels were below the base of the river during this study, drought conditions developed causing water levels to drop below the river whereas in wetter conditions, the levels would be higher.

An extensive survey of wells and springs was performed by the Texas Board of Water Engineers (Barnes and Cumley, 1942) (Figure 16). No major springs were noted along the river. The lack of well-defined springs indicates gains to the river from the subsurface are diffuse and shallow in origin.

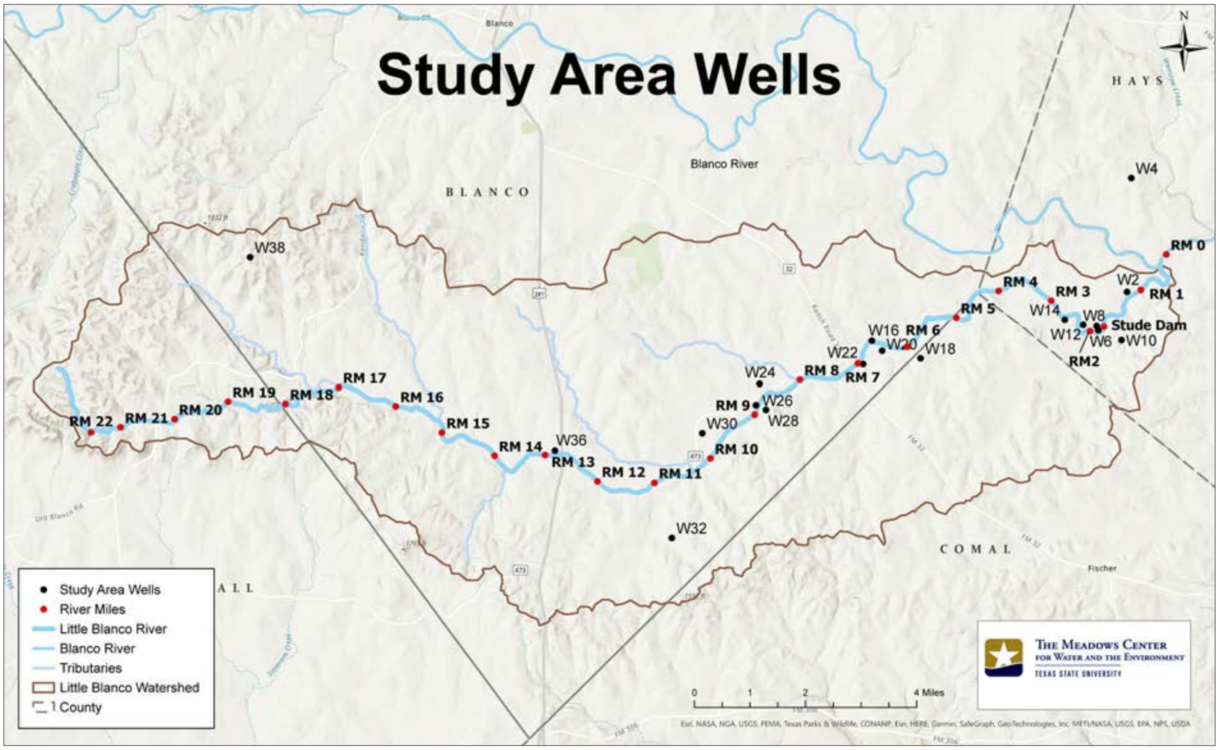



**FIGURE 13.** STUDY AREA WELLS

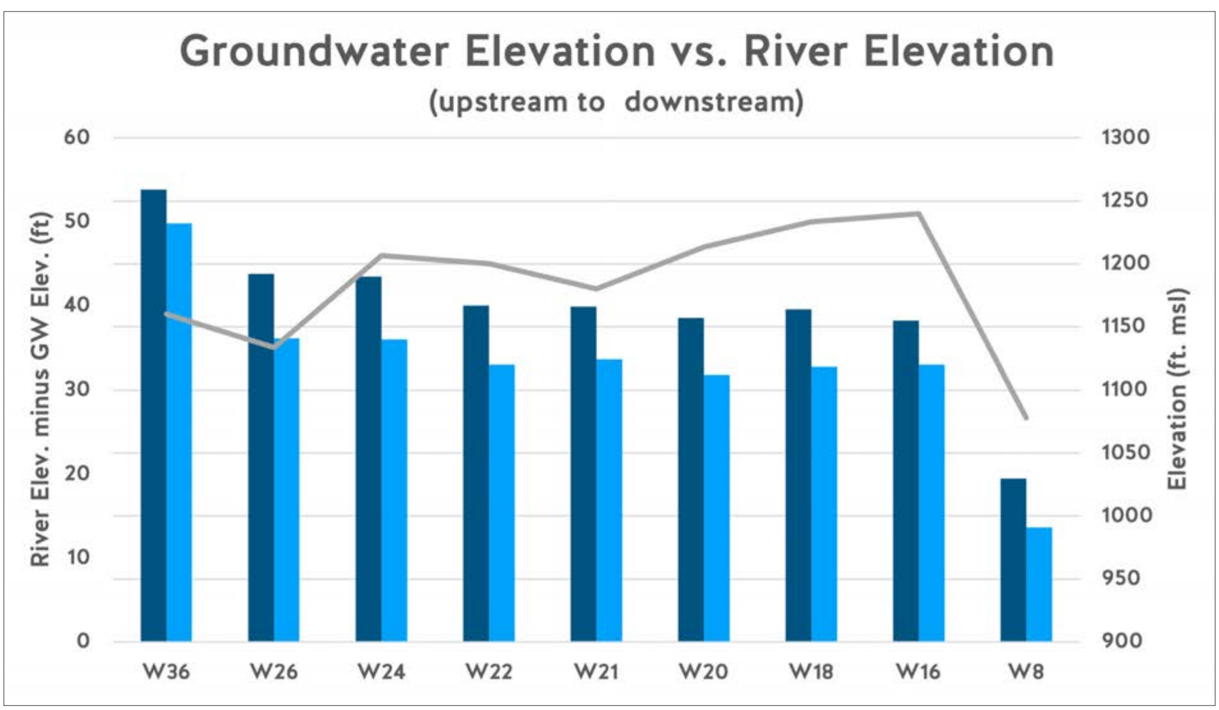



**FIGURE 14.** GROUNDWATER ELEVATION VS. RIVER ELEVATION

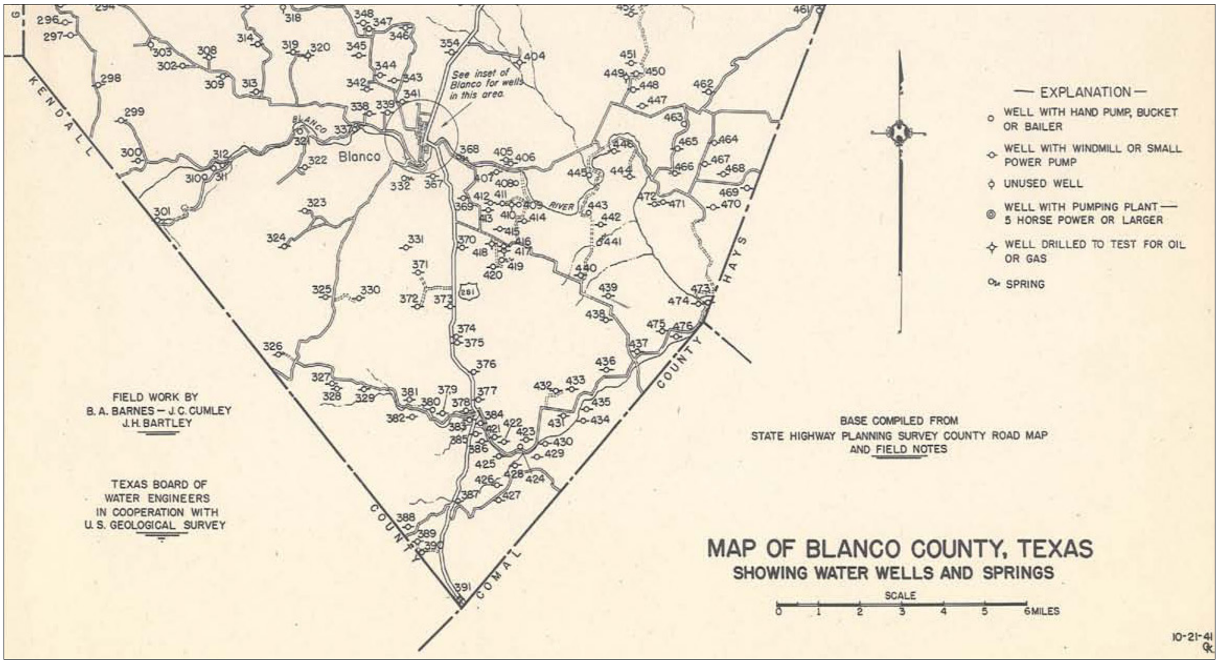



**FIGURE 15.** MAP OF BLANCO COUNTY, TEXAS (CREDIT: BARNES AND CUMLEY, 1942)


| River Mile | Elevation (feet) |
|---|---|
| RM 0 | 1002 |
| RM 1 | 1018 |
| Stude Dam | 1031 |
| RM 2 | 1034 |
| RM 3 | 1063 |
| RM 4 | 1103 |
| RM 5 | 1121 |
| RM 6 | 1143 |
| RM 7 | 1167 |
| RM 8 | 1178 |
| RM 9 | 1193 |
| RM 10 | 1212 |
| RM 11 | 1225 |
| RM 12 | 1238 |
| RM 13 | 1255 |
| RM 14 | 1284 |
| RM 15 | 1306 |
| RM 16 | 1356 |
| RM 17 | 1392 |
| RM 18 | 1426 |
| RM 19 | 1463 |
| RM 20 | 1561 |
| RM 21 | 1622 |
| RM 22 | 1689 |

**FIGURE 16.** LITTLE BLANCO RIVER MILES

## Visual Flow Discharge Observations

On the ground observations and air photo research made during the study indicate there are several distinct flow reaches. The upper reaches of the river in and near Kendall County were dry. These reaches only flow during storm events. A slight, but persistent trickle of water was observed in Schuetz Creek where it crosses Little Blanco Road near River Mile 15 (Figure 16). Due to access issues, it is not clear if that flow continued to the main stem of the Little Blanco River. In Blanco County, east of Hwy 281, relative low flow was present at the three Little Blanco Road crossings. No springs were noted in this area with flow likely originating from the alluvial and terrace deposits in the valley.

Flow from this area increases to approximately River Mile 7, where the river becomes a losing reach, losing all flow to the subsurface except during storm events. The losing reach is over the Lower Glen Rose. The remainder of the river is dry from approximately 0.6 miles downstream of Ranch Road (RR) 32 and only flows during major storm events.

There is a major spring and pools in the river at SW1 (Figure 17). The spring originates from a cliff of the Lower Glen Rose. The river flows a short distance (0.3 mile) where it is lost to the subsurface. The river has a few isolated downstream pools towards the confluence with the Blanco River.

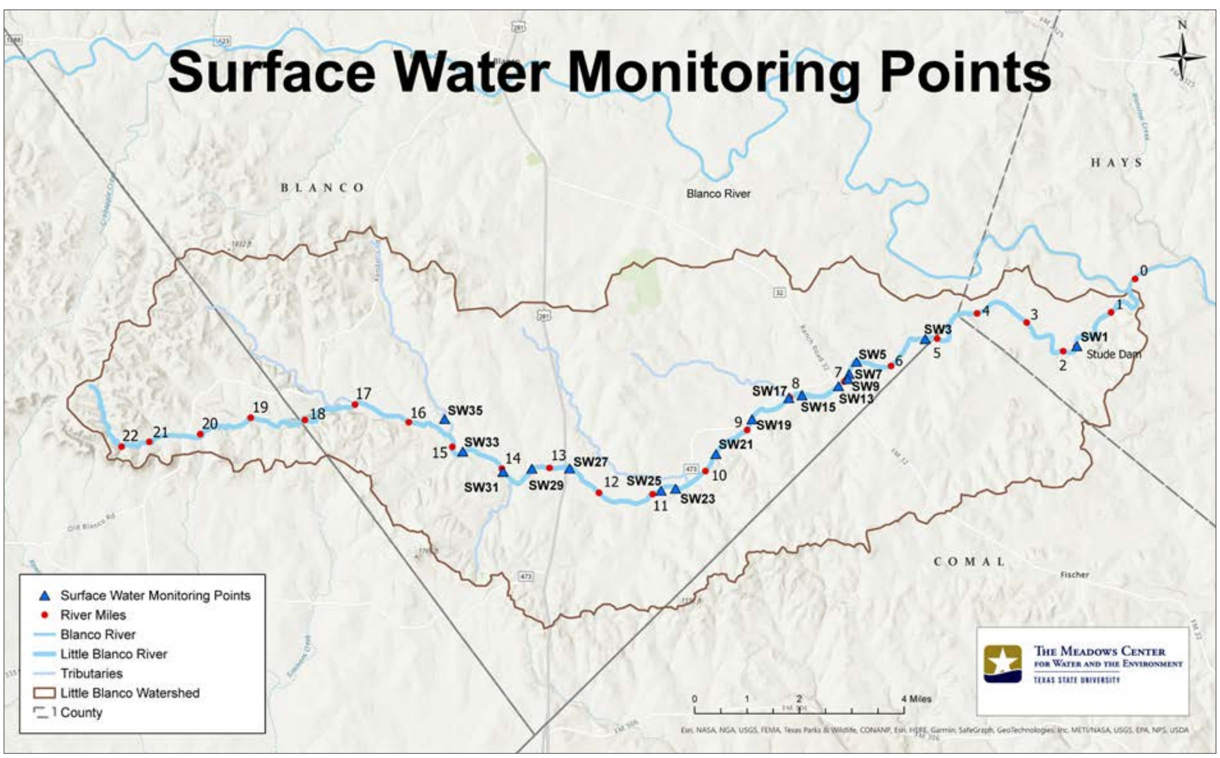



FIGURE 17. RIVER MILES AND SURFACE WATER MONITORING POINTS

**FIGURE 18.** SITE 1: POOL BENEATH LOWER GLEN ROSE IN HAYS COUNTY

## USGS Discharge Measurements

The USGS maintains a surface water flow gauging station (USGS Gauge 08170890) in the Little Blanco River at RR 32. The gauge measures the stream stage from which discharge can be determined. The gauge was installed in 2016 primarily for flood warning purposes after the Memorial Day flood of 2015. The period of record is from 2016 to present.

There were periods of no flow at the gauge site in 2017, 2018, and 2022. Low flows of less than 0.5 cfs were measured in 2019 and 2021. A linear trend line is shown in Figure 19. The overall discharge trend is downward but, due to the short period record and "flashy" nature of flow, it is not clear if this represents a short-term cycle or a longer trend.

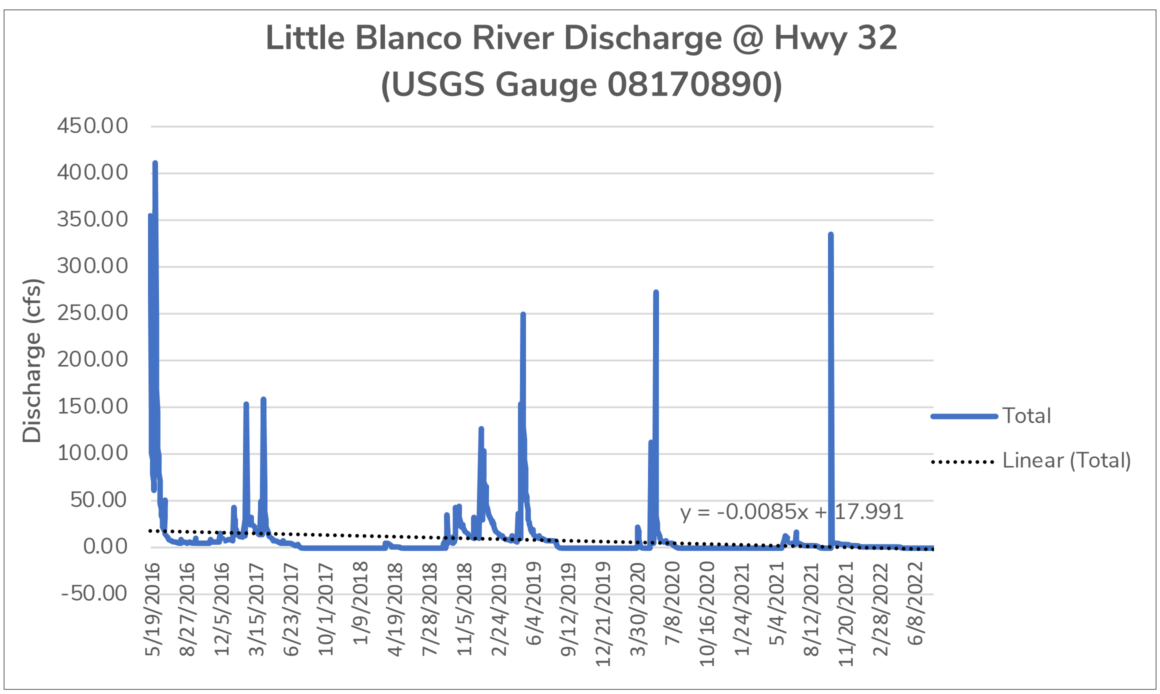



**FIGURE 19.** LITTLE BLANCO RIVER DISCHARGE AT HIGHWAY 32

The mean daily discharge for the period of record is 8.2 cubic feet per second (cfs) with a median discharge of 1.2 cfs. The linear trend of the discharge data is downward from 2006 – 2019. Flow percentiles from the discharge data were calculated and shown in Figure 20.

Based on actual flow measurements made by Meadows during the study, the river is near peak baseflow at the USGS gauge making the gauge a good measure of total discharge. As the major losing reach of the river starts above the gauge location, the gauge is a good measure of how much water is recharging the Lower Glen Rose Aquifer.

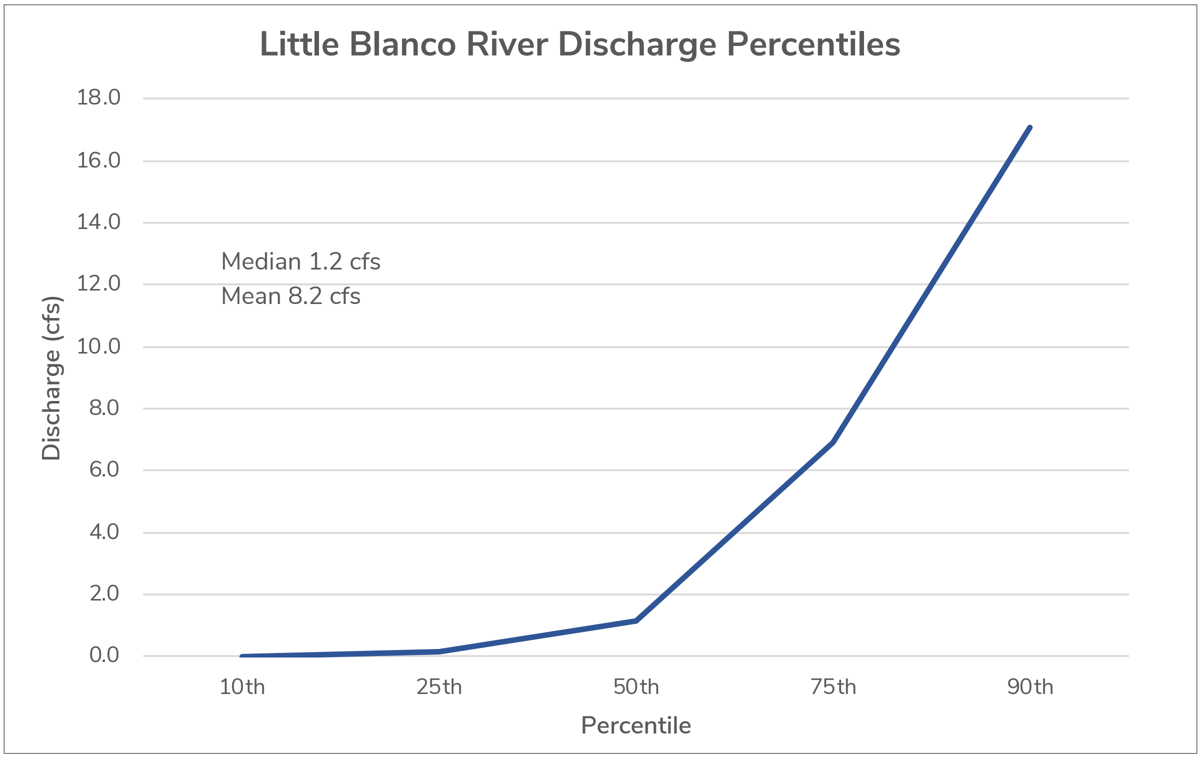



**FIGURE 20.** LITTLE BLANCO RIVER DISCHARGE PERCENTILES

## Synoptic Discharge Event

A synoptic surface water gauging event took place on December 14-15, 2021 to measure base flow in the Little Blanco River (Table 4 and Figure 23). Base flow is key to maintaining flow in the stream to maintain its ecologic health and value to local landowners. Flow measurements were made using a SonTek FlowTracker2 handheld Acoustic Doppler Velocimeter® generally following USGS protocols. River miles from the confluence of the Little Blanco River and the Blanco River were determined using GIS techniques (Figure 16).

Baseflow has many definitions, including the following:

> *"Baseflow is the sustained flow of water in a river including contributions from both interflow and groundwater discharge, independent of dry or wet weather conditions (Groundwater Dictionary, 2019).*
>
> *"Baseflow is the portion of streamflow that comes from "the sum of deep subsurface flow and delayed shallow subsurface flow ([www.definitions.net](www.definitions.net))."*
>
> *The USGS defines baseflow as groundwater discharge (Barlow, 2015).*

**TABLE 4.** LITTLE BLANCO DISCHARGE - DECEMBER 14-15, 2021

| SITE ID | LATITUDE | LONGITUDE | RIVER MILE | DISCHARGE (CFS) | DISCHARGE (GPM) |
|---|---|---|---|---|---|
| SW1 | 30.03065 | -98.264437 | 1.3 | 0 | 0 |
| SW3 | 30.03234 | -98.306274 | 5 | 0 | 0 |
| SW5 | 30.02687 | -98.325224 | 6.4 | 0 | 0 |
| SW9 | 30.02275 | -98.327625 | 6.6 | 1.5 | 674 |
| SW11 | 30.02106 | -98.330221 | 6.8 | 2.9 | 1302 |
| SW13 | 30.01899 | -98.340313 | 7 | 2.7 | 1212 |
| SW15 | 30.01835 | -98.34391 | 7.8 | 3.3 | 1468 |
| SW17 | 30.01327 | -98.35408 | 8 | 2.3 | 1046 |
| SW19 | 29.99667 | -98.375174 | 9 | 2.1 | 920 |
| SW23 | 29.99618 | -98.379185 | 9.5 | 1.7 | 750 |
| SW25 | 30.00151 | -98.40443 | 10.9 | 1.3 | 584 |
| SW29 | 30.00147 | -98.414845 | 13.3 | 1.4 | 629 |
| SW31 | 30.00072 | -98.422807 | 13.9 | 1.5 | 674 |
| SW33 | 30.00556 | -98.433903 | 14.8 | 0.78 | 350 |
| SW35 | 30.01335 | -98.438921 | 15.2 | trickle | trickle |

**FIGURE 21.** CHICK FAMILY IN THE LITTLE BLANCO RIVER AT THE CHICK RANCH IN 1936
PHOTO CREDIT: CONNIE CHICK

**FIGURE 22.** MEADOWS CENTER STAFF RECORDS FLOW WITH THE FLOWTRACKER (PHOTO CREDIT: ANDREW SHIREY)

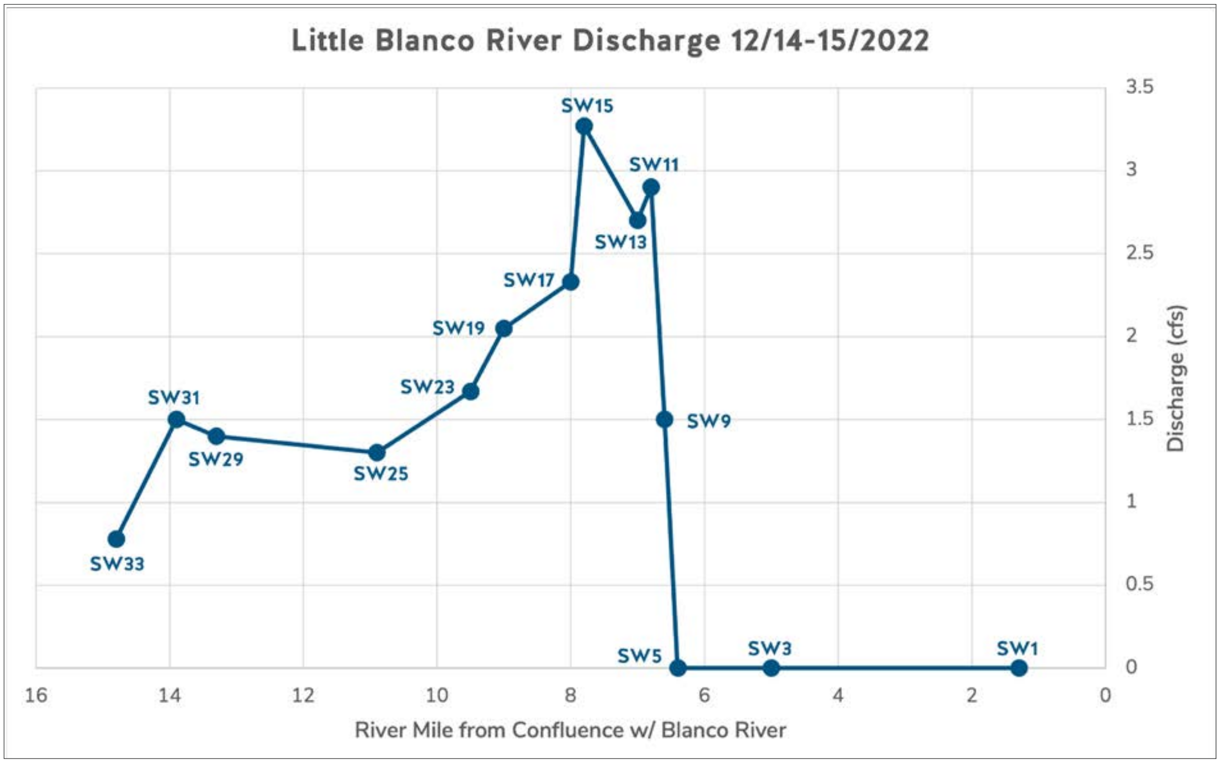



**FIGURE 23.** LITTLE BLANCO RIVER DISCHARGE, DECEMBER 2022

**FIGURE 24.** LITTLE BLANCO RIVER INTERSECTING COMAL, HAYS, AND BLANCO COUNTIES (PHOTO CREDITS: DOUG WEIRMAN (2023) AND BRIAN HUNT (2013))

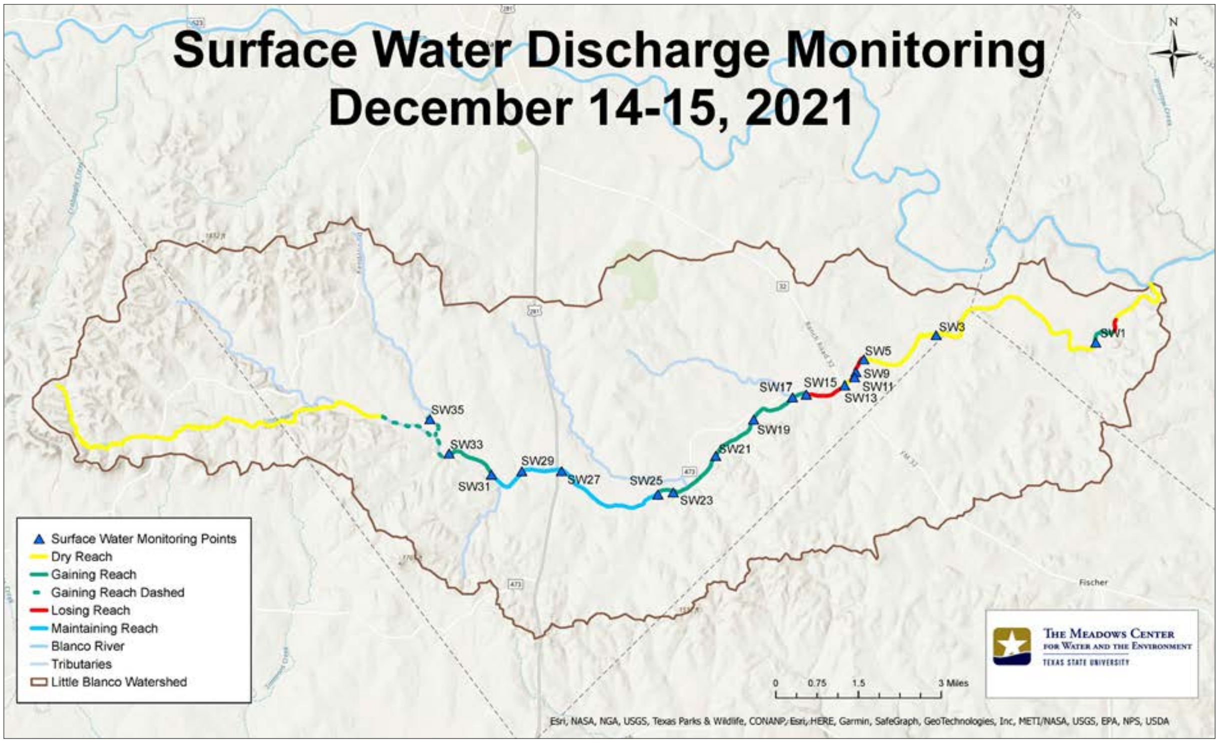



**FIGURE 25.** SURFACE WATER DISCHARGE MONITORING, DECEMBER 2021

The key to understanding base flow is to understand interactions with the aquifers that contribute to base flow. Aquifer health is key to creek health. Storm flow from precipitation events can be important to creek health, but it has a short duration in nature. Storm flow was not evaluated in this study. Losses from evapotranspiration were not accounted for and were believed to be minimal.

Flow measurements were made at thirteen sites and estimated at another site (Schuetz Creek). Other sites of no flow were observed and noted. The results of the event are shown on Table 4, Figure 23, and Figure 25. As previously mentioned, access to the river was not available so the actual headwaters were not determined, but air photo research indicates the headwaters are near the confluence with Schuetz Creek.

From SW33 to SW31, flow increased by roughly 50 percent. For the next several miles, there was little change in discharge. There may have been a slight loss of water into the alluvial deposits, or simple measurement differences. Discharge increases from SW25 to SW 15, a little less than a mile from RR 32. From SW15 to SW5, the river loses all its flow, with the largest losses beginning near the USGS gauge and continuing to SW5. Several observations at road crossings further downstream indicate no flow.

An intent of the study was to conduct an additional synoptic event during higher discharge, but the lack of precipitation meant only declining flow. The losing reach between SW9 and SW5 completely dried up, allowing observations of the dry riverbed in this major losing reach (see Figures 26-27).

**FIGURE 26.** LOSING REACH LOOKING UPSTREAM TOWARD SW9.

**FIGURE 27.** LOSING REACH NEAR SW5 NOTE: LOWER GLEN ROSE STREAM BOTTOM AND UNCONSOLIDATED TERRACE DEPOSITS ON BANKS

## Little Blanco River Water Quality

### TEXAS COMMISSION ON ENVIRONMENTAL QUALITY (TCEQ) – SURFACE WATER QUALITY MONITORING INFORMATION SYSTEM DATA (SWQMIS)

TCEQ monitored the Little Blanco River (Segment 1813) intermittently at three sites from 1988 to 1999 (Table 5). Parameters measured included bacteria, nutrients, flow, field, 24-hour measurements, and metals. Available data for each site are summarized by parameter in Table 6. Two 24-hour monitoring events took place on the Little Blanco River at Chick Ranch Road and those data are summarized in Table 7. The streamflow measurements collected between 1988 and 1993 are plotted in Figure 28. These data provide some historical perspective regarding water quality at several locations but are of limited value in determining watershed water quality.

**TABLE 5.** TEXAS COMMISSION ON ENVIRONMENTAL QUALITY SURFACE WATER QUALITY MONITORING DATA FROM THE LITTLE BLANCO RIVER (SEGMENT 1813) IN HAYS COUNTY, TEXAS

| STATION ID | STATION DESCRIPTION | PERIOD OF RECORD | NUMBER OF EVENTS | PARAMETER(S) |
|---|---|---|---|---|
| 12560 | Little Blanco River at Chick Ranch Road | 1988-1993 | 8 | E. coli bacteria<br>Nutrients (ammonia, nitrite, nitrate, TKN, nitrite+nitrate, total phosphorus, chlorophyll a, orthophosphate)<br>Flow (instantaneous streamflow, flow severity) |
| | | 1991-1993 | 6 | Field (temperature, dissolved oxy-gen, pH, specific conductance, transparency) |
| | | 1988-1989 | 2 | 24-hour measurements (Temperature, specific conductance, dissolved oxygen, pH) |
| | | 1991 | 1 | Metals (Dissolved calcium, potassi-um, magnesium, and sodium) |
| 12561 | Little Blanco River off Little Blanco Road | 1983 | 1 | Nutrients (ammonia, nitrite, ni-trate, TKN, nitrite+nitrate, total phosphorus, chlorophyll a, ortho-phosphate) |
| 12567 | Little Blanco River at Ranch Road 32 | 1999 | 1 | Nutrients (ammonia, TKN, ni-trite+nitrate, total phosphorus, or-thophosphate) |

**TABLE 6.** SUMMARY OF SURFACE WATER QUALITY MONITORING DATA COLLECTED BY THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY FROM THE LITTLE BLANCO RIVER (SEGMENT 1813) IN HAYS COUNTY, TEXAS

| PARAMETER | 12560 – CHICK RANCH RD. | 12561-LITTLE BLANCO RIVER RD. | 12567 – RANCH ROAD 32 |
|---|---|---|---|
| Field | (n=8) | | |
| Temperature (°C) | 20.1 | NM | NM |
| Dissolved oxygen (mg/L) | 8.5 | NM | NM |
| pH (s.u.) | 7.7 | NM | NM |
| Specific conductance (µS/cm) | 416 | NM | NM |
| Transparency (m) | 1.1 | NM | NM |
| Nutrients | (n=8) | (n=1) | (n=1) |
| Ammonia (mg/L) | 0.04 | < 0.02 | < 0.20 |
| Nitrite (mg/L) | 0.02 | < 0.01 | NM |
| Nitrate (mg/L) | 0.03 | 0.12 | NM |
| TKN (mg/L) | 0.21 | 0.20 | < 0.20 |
| Nitrite+Nitrate (mg/L) | 0.27 | 0.13 | < 0.05 |
| Total Phosphorus (mg/L) | 0.03 | 0.02 | <0.01 |
| Orthophosphate (mg/L) | 0.03 | 0.02 | <0.02 |
| Chlorophyll a (µg/L) | 1.9 | 2 | NM |
| *E. coli | 53 | NM | NM |
| Dissolved Metals | (n=1) | (n=1) | (n=1) |
| Calcium (mg/L) | 62 | NM | NM |
| Potassium (mg/L) | 1 | NM | NM |
| Magnesium (mg/L) | 12 | NM | NM |
| Sodium (mg/L) | 7 | NM | NM |
| Alkalinity (mg/L as CaCO3) | 183 (n=8) | 203 | 225 |
| Flow | (n=8) | | |
| Instantaneous streamflow (cfs) | 12.3 | NM | NM |
| Flow severity | 2 – low flow<br>2 – normal flow<br>2 – high flow | NM | NM |

*Geometric mean was calculated for E. coli; NM =Not Measured.

**TABLE 7.** SUMMARY OF 24-HOUR SURFACE WATER QUALITY MONITORING DATA COLLECTED BY THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY FROM THE LITTLE BLANCO RIVER (SEGMENT 1813) IN HAYS COUNTY, TEXAS

| PARAMETER | 12560 - CHICK RANCH RD. | |
|---|---|---|
| Event date | 6/29-30/1988 | 3/20-21/1989 |
| 24-hour measurements | Average (Range) | Average (Range) |
| Number of measurements | 19 | 24 |
| Temperature (°C) | 28.9 (26.2-33.6) | 19.0 (14.9-22.4 |
| Dissolved oxygen (mg/L) | 7.1 (6.2 – 8.9) | 7.7 (6.2-8.5) |
| pH (s.u.) | 7.8 (7.7-7.9) | 7.9 (7.8-8.0) |
| Specific conductance (µS/cm) | 347 (330-357) | 373 (370-377) |

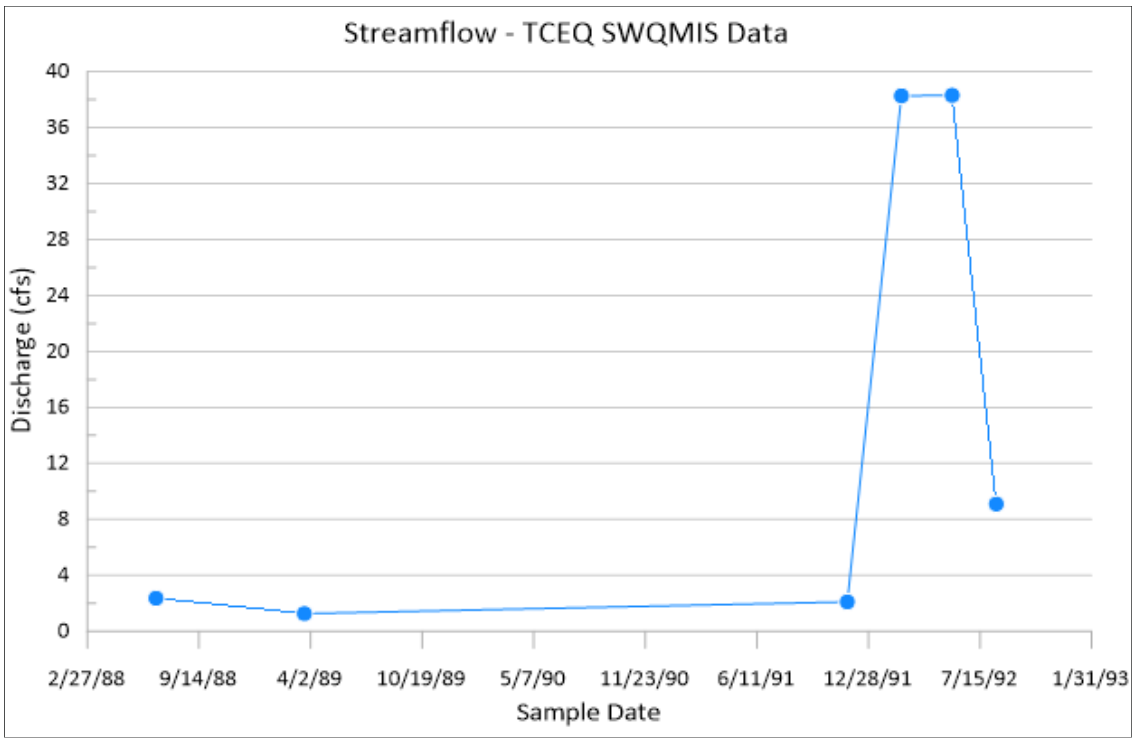



**FIGURE 28.** TEXAS COMMISSION ON ENVIRONMENTAL QUALITY STREAMFLOW DATA FROM THE LITTLE BLANCO RIVER (SEGMENT 1813) AT CHICK RANCH ROAD IN HAYS COUNTY, TEXAS

## TEXAS WATER DEVELOPMENT BOARD DATA

The TWDB database (TWDB, 2022) contains water quality data from water wells in the Little Blanco River Watershed dating back to the late 1930s (Figure 29). Wells are sampled by the TWDB or others sporadically. There are typically one or two data points for a given location. These data are useful in general to characterize aquifer water quality, but not particularly useful for determining long term trends at a given location. There was an extensive water quality survey performed in Blanco County in 1938 -1941. The survey was performed by the Texas State Board of Water Engineers in cooperation with the United States Geological Survey (Barnes and Cumley, 1942).

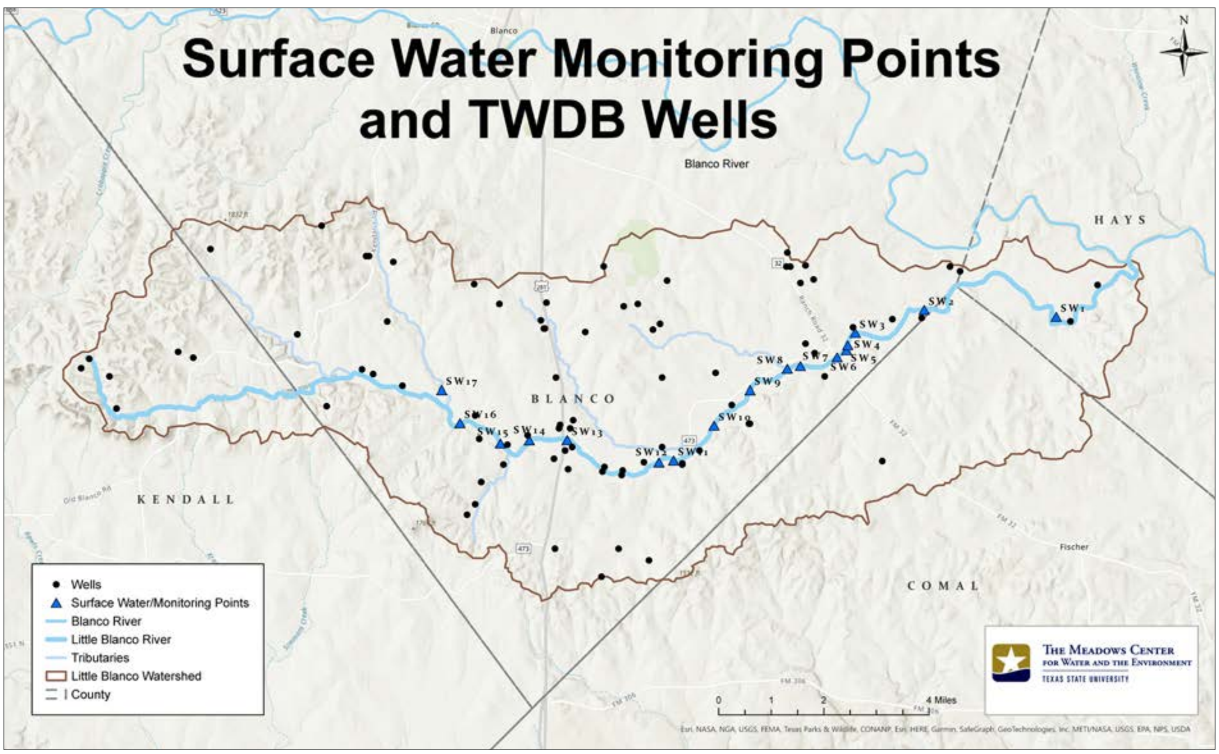



FIGURE 29. SURFACE WATER MONITORING POINTS AND TWDB WELLS

## MEADOWS CENTER SYNOPTIC WATER QUALITY DATA

As part of this study, the Meadows Center collected water samples at eight of the flow gauging stations and nine groundwater wells on February 22-23, 2021. These samples represent a snapshot in time of base flow conditions. A series of common, naturally occurring anions and cations were analyzed by the Edwards Aquifer Research Data Center (EARDC) Laboratory at Texas State University. Anions were analyzed using the Environmental Protection Agency (EPA) Method 300.1A and cations were analyzed using Standards Methods 2320B. These data along with laboratory QA/QC data are included in Appendix C.

## SUMMARY OF WATER QUALITY RESULTS

Several widely accepted methods of graphically representing water quality data are presented below: piper plots and stiff plots. Both methods are used to visualize the abundance of common, natural ions in water. The piper plot is a trilinear diagram comprised of a ternary diagram showing cations (lower left), a ternary diagram representing anions (lower right) and a rhombic plot in the middle (Figure 30). On a stiff diagram, the left side of the diagram shows cation concentrations and the right side shows anion concentrations. The further a point is from the center of the graph, the larger the ionic concentration. Both types of plots can be used to identify waters of similar origin.

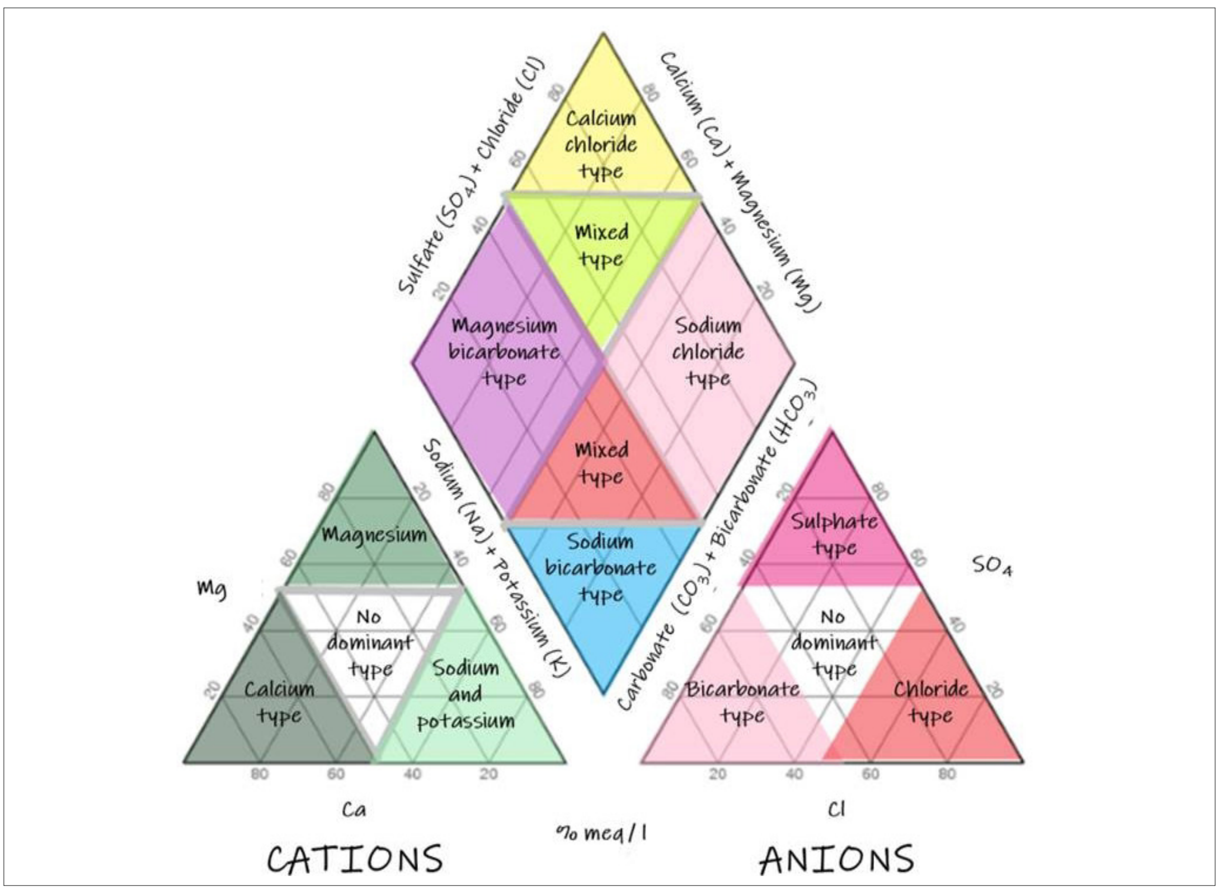



**FIGURE 30.** PIPER PLOT SAMPLE SHOWING CLASSIFICATION OF WATERS BASED ON COMMON CATIONS AND ANIONS (HTTPS://HATARILABS.COM/)

Figures 31-33 are piper plots developed from data in the Little Blanco River watershed. Figures 31 and 32 were developed using historic TWBD groundwater quality data. Figure 30 used data from the 1938 survey and is missing potassium data. Figure 32 shows data from after 1938 contained in the TWDB database. Figure 33 displays the Meadows groundwater and surface data collected during this study. The data indicates all waters to be of similar calcium magnesium bicarbonate type water. The aquifers in the watershed are carbonate in nature (limestone and dolomite). Calcium is the dominant cation in limestone with magnesium becoming more abundant in dolomite, so the classification is consistent with the aquifer type.

Major anions and cations measured from samples collected by Meadows staff are included in Appendix C. In general range concentrations are in narrow ranges. The exceptions are calcium and sulfate, and to a lesser extent magnesium, which is quite variable in both surface water and groundwater. As mentioned in the Geology Section, there are evaporate deposits of gypsum and anhydrite commonly found near the base of the Upper Glen Rose and top of the Lower Glen Rose. These deposits are soluble, and if not isolated by well casings in water wells, can contribute dissolved constituents to groundwater. These layers are the major source of high sulfates (sulfur odor) in local groundwater. As well logs are not available for the wells sampled, interpretation is limited.

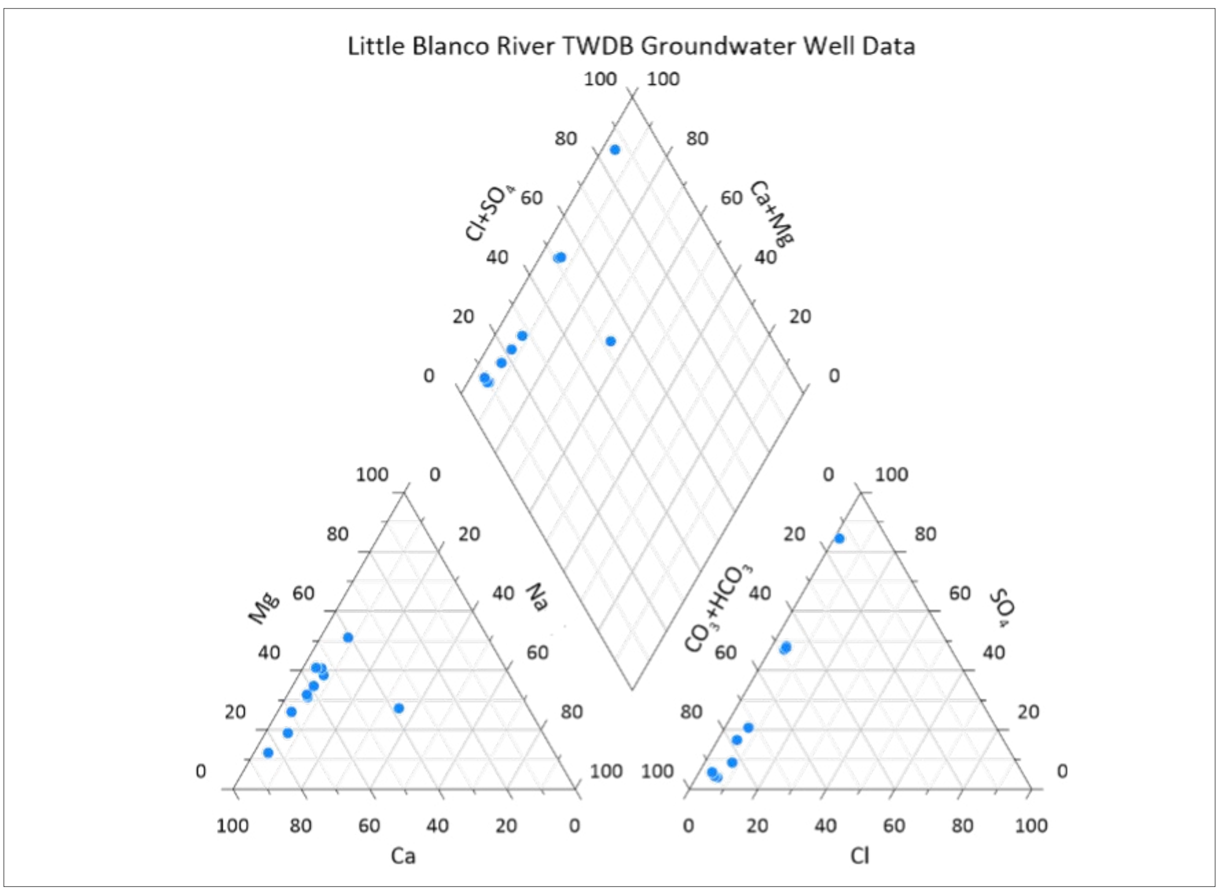



**FIGURE 31.** BLANCO RIVER TWDB 1938 GROUNDWATER WELL DATA

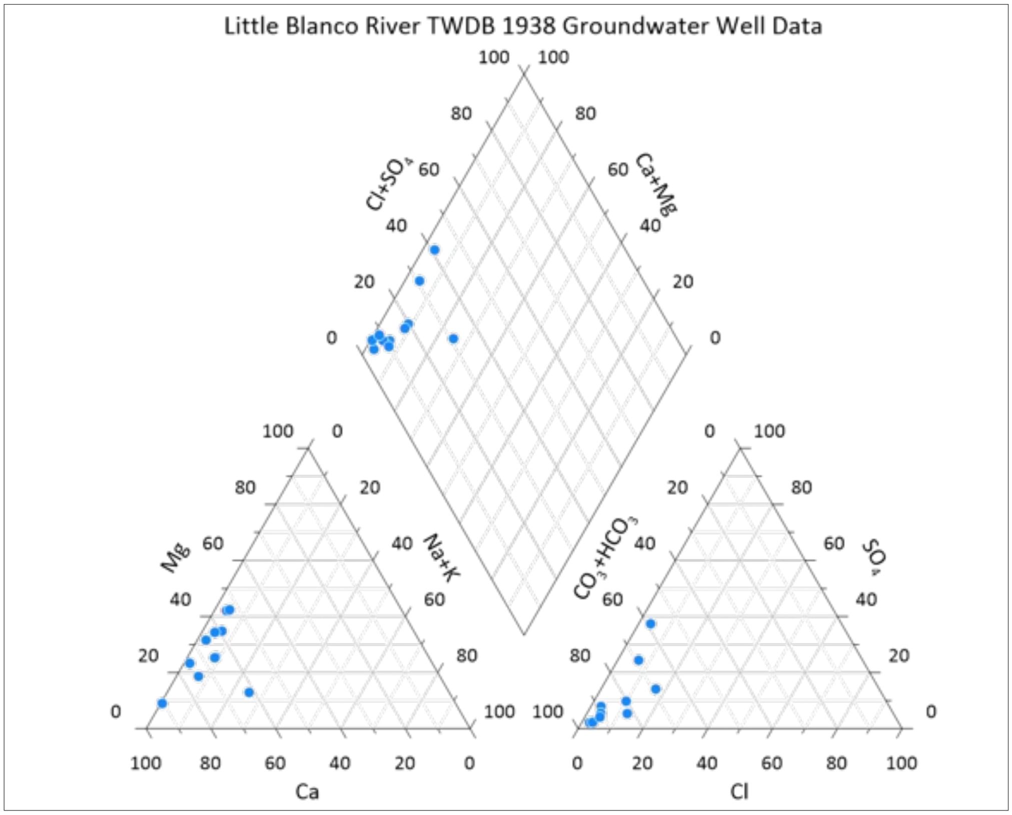



**FIGURE 32.** LITTLE BLANCO RIVER TWDB POST 1938 GROUNDWATER WELL DATA

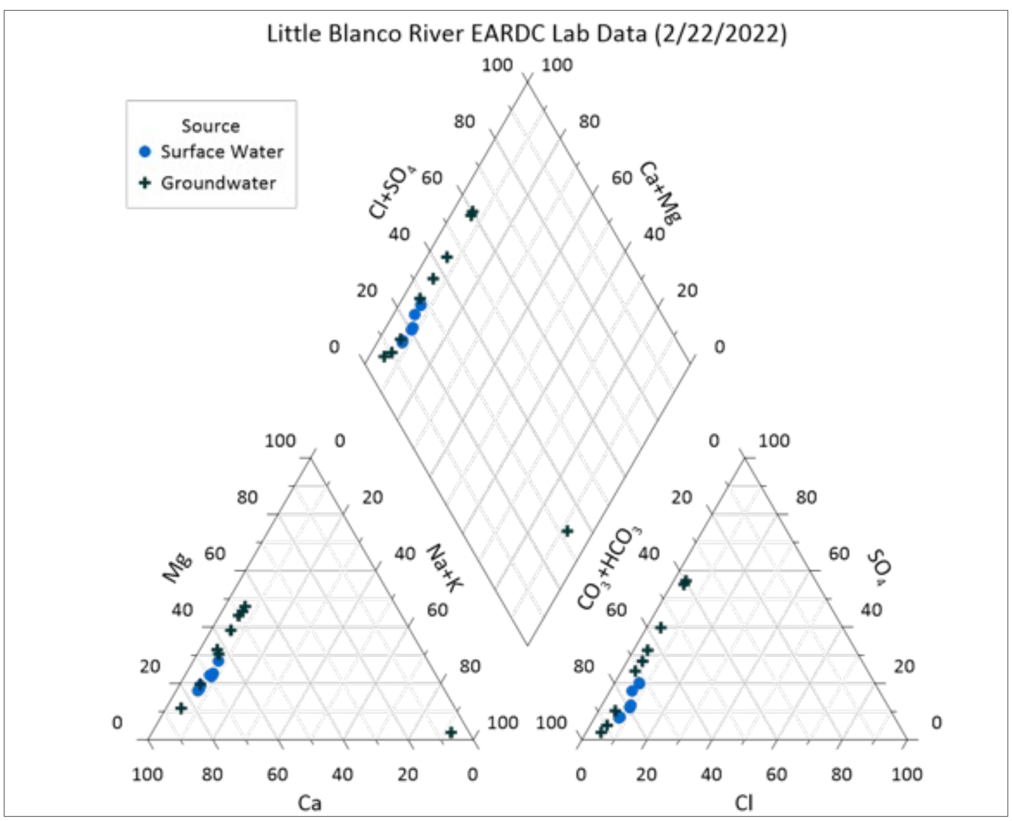



**FIGURE 33.** LITTLE BLANCO RIVER EARDC LAB DATA (2/22-23/2022)

Calcium and sulfate show a trend of increasing downstream. Figure 34 is a graph of sulfate and calcium versus river mile. Both parameters show a significant increase in concentration near River Mile 9. The source of the increased calcium and sulfate is likely dissolution of the gypsum beds near the base of the Upper Glen Rose. This is the same reach of the river that had significant gains in flow discharge (Figure 25).

Figure 35 is a stiff diagram of the surface water sites samples during the study. The diagrams are of similar shape indicating a similar source of water.

Though the data was limited, a series of shallow wells were identified in the TWDB database in reach of increasing flow and sulfate/calcium increases. Depths ranged from 42 feet to 150 feet. These were typically older wells, many sampled in 1938. The wells were located along the gaining reach and likely drilled through the alluvial/terrace deposits and completed in the Lower Glen Rose. The water quality was generally similar to the surface water samples and plot in a similar fashion on the stiff diagrams indicating a shallow source of groundwater discharging to the river (Figure 36).

Stiff diagrams of groundwater samples collected during the study reflect more variable water quality as compared to surface water and the TWDB wells (Figure 37). Wells GW 21, GW 22 and GW 26 have higher magnesium and sulfate than other wells and surface water and are along the gaining reach of the river. The depths and completion aquifer(s) of these wells is not known, so it is difficult to interpret the data. The higher magnesium may indicate the wells are completed in the Cow Creek which is typically more dolomitic than the Hensel or Lower Glen Rose. Well GW 16 is located at the end of the losing reach and water quality tends to reflect surface water quality.

Strontium is a commonly occurring cation in carbonate rocks in Texas (Muskgrove, 2021). Strontium was detected at relatively elevated background in most of the groundwater samples, except two of the downstream wells. Strontium was not detected in any of the surface water samples. If the underlying carbonate rocks were contributing significant amounts of water to the river, one would expect strontium to be present in base flow. Strontium typically increases in concentration in groundwater with longer residency time in the aquifer. Short residency time in the shallow carbonates may result in no strontium being detected in surface water.

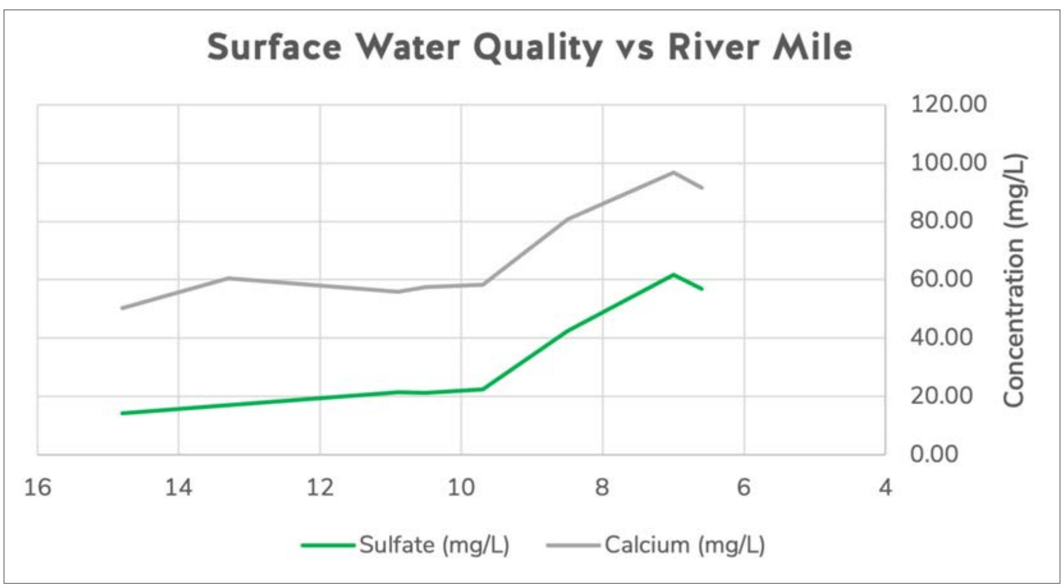



**FIGURE 34.** SULFATE AND CALCIUM VS RIVER MILE

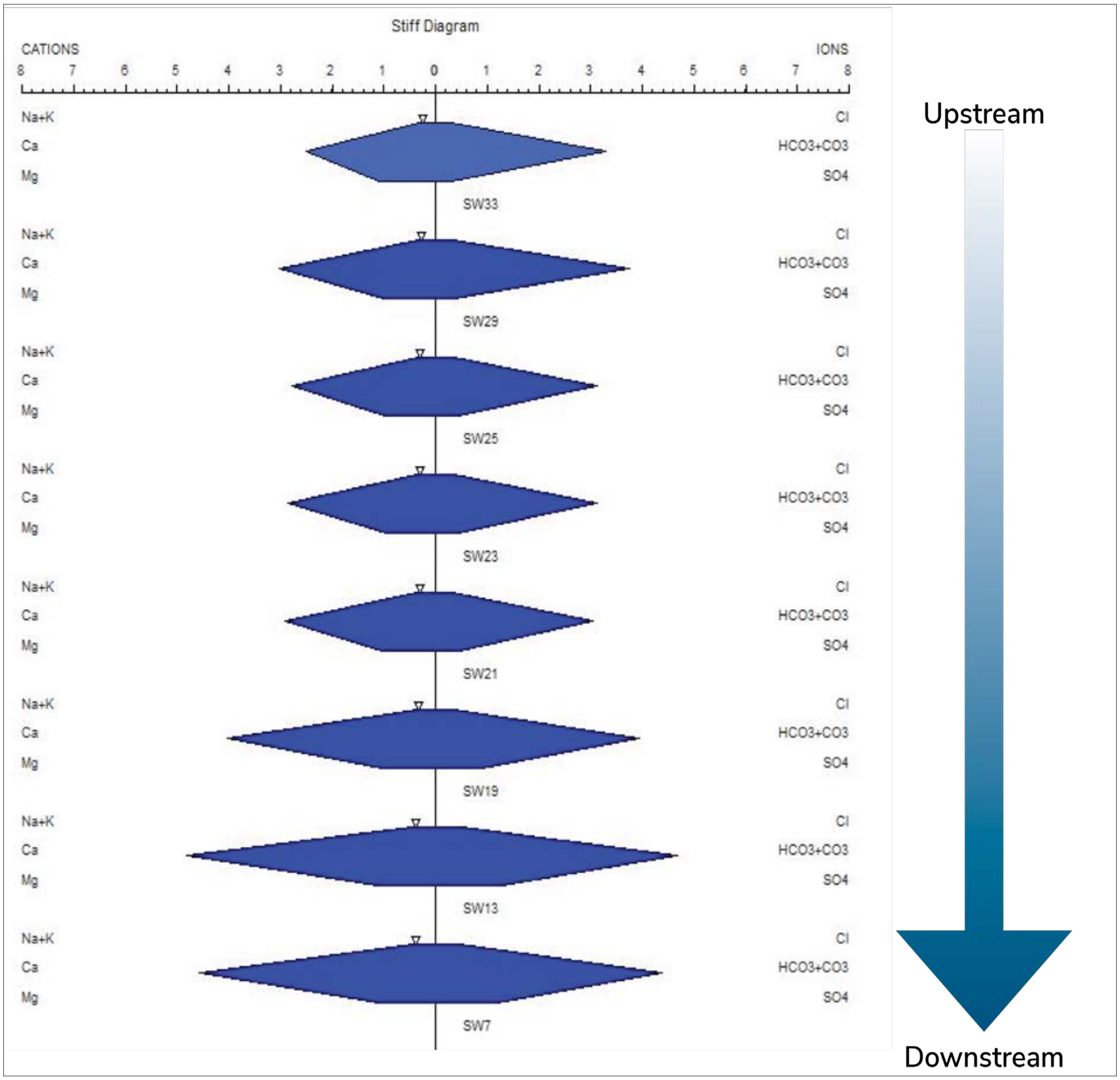



**FIGURE 35.** STIFF DIAGRAMS OF SURFACE SAMPLES OBTAINED 12/22-23/2021 (RESULTS ARE SHOWN WITH UPSTREAM DATA AT THE TOP AND DOWNSTREAM RESULTS AT THE BOTTOM)

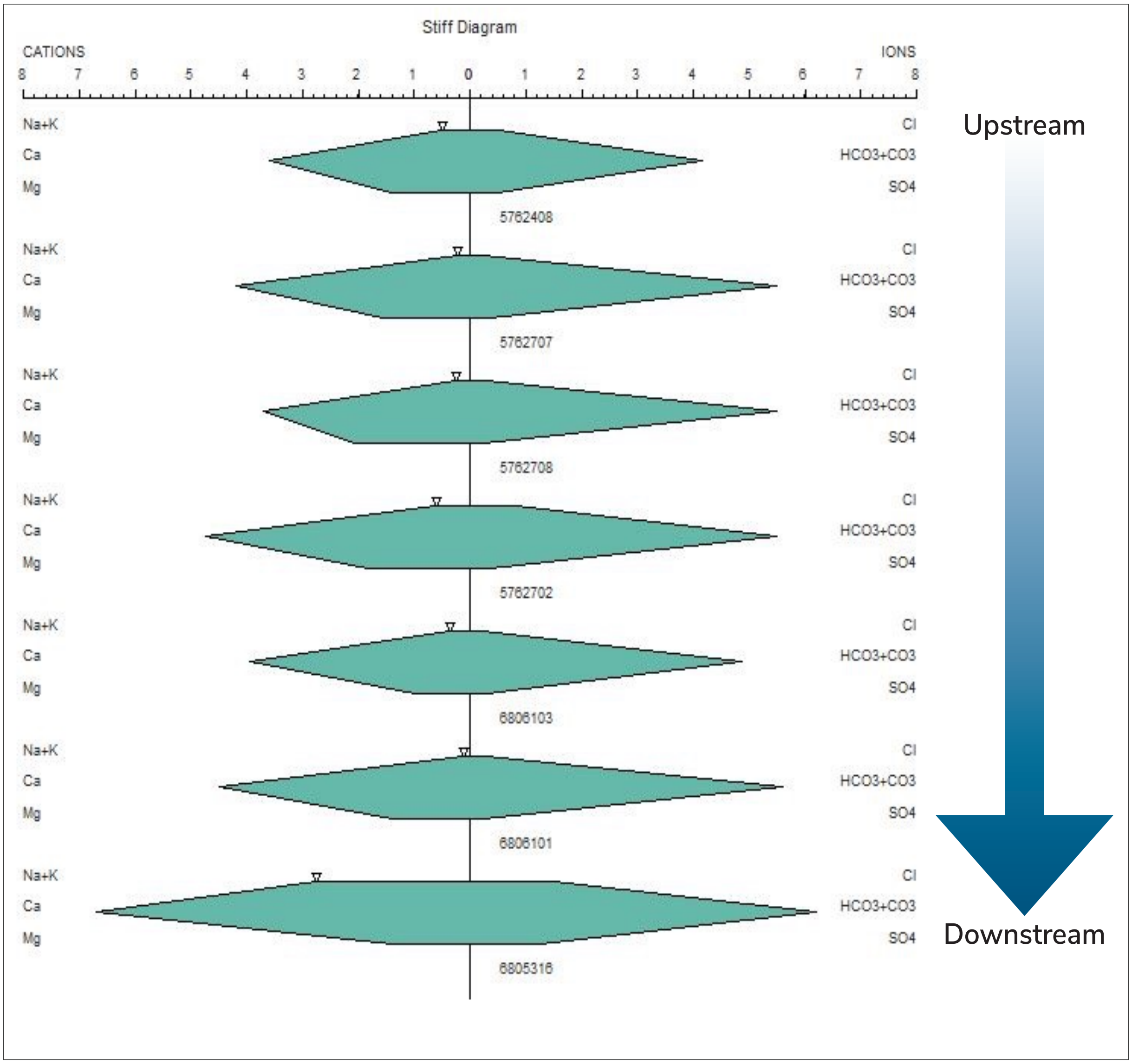



**FIGURE 36.** STIFF DIAGRAMS OF TWDB WELLS (RESULTS ARE SHOWN WITH UPSTREAM DATA AT THE TOP AND DOWNSTREAM RESULTS AT THE BOTTOM)

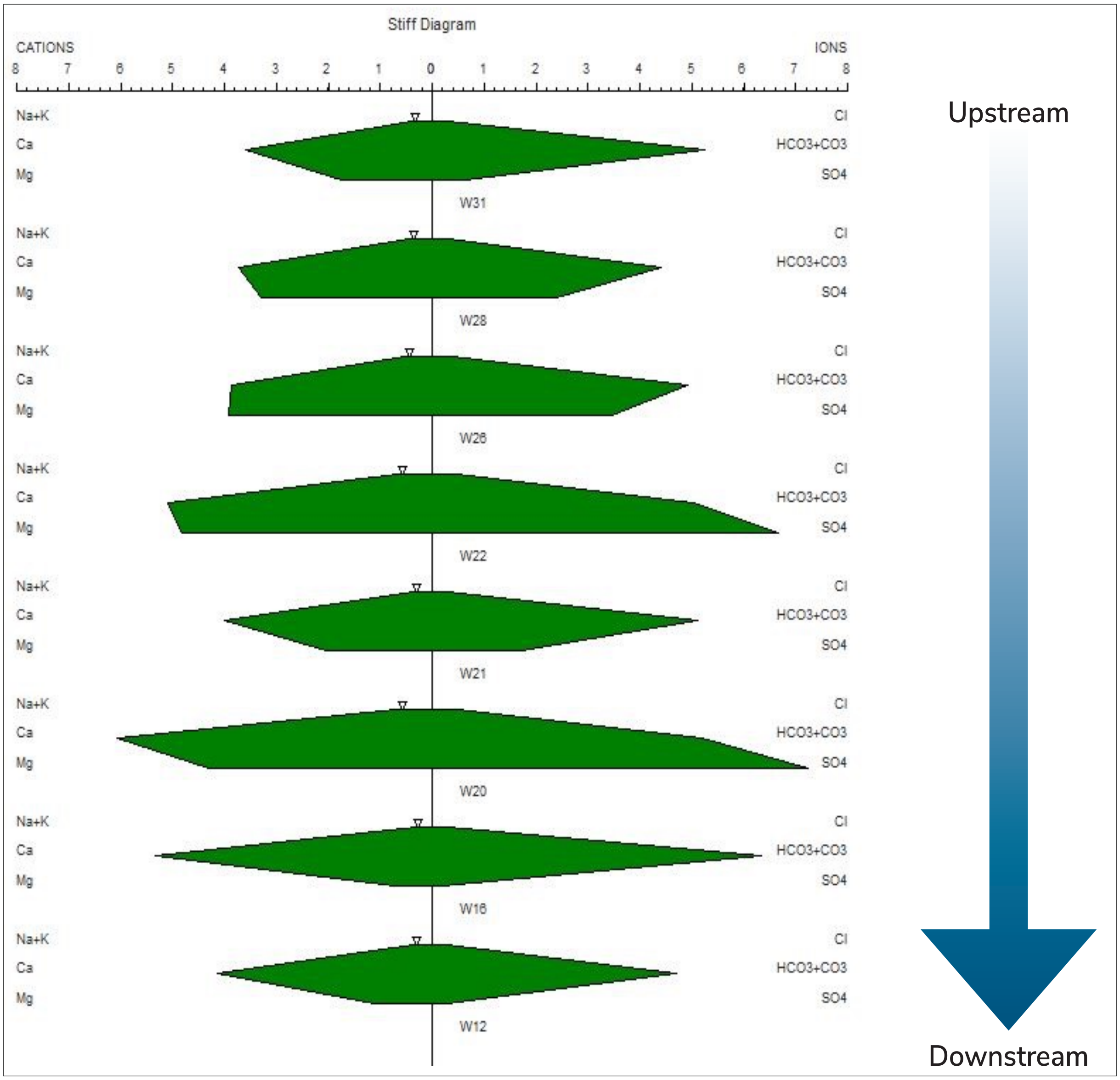



**FIGURE 37.** STIFF DIAGRAMS OF GROUNDWATER FROM MEADOWS STUDY WELLS (RESULTS ARE SHOWN WITH UPSTREAM DATA AT THE TOP AND DOWNSTREAM RESULTS AT THE BOTTOM)

# SUMMARY OF RESULTS

Hydrologic data on the Little Blanco River is sparse as the river has not been the subject of comprehensive evaluation or long-term monitoring. Therefore, the results of this study are based on sparse historical data and the data collected during this study, which should be viewed as a snapshot in time. The study was hampered by a severe drought, to the point where the river ceased flowing. Also, land access was limited in the headwaters area of the river west of Highway 281. Though the study was limited, valuable insight was gained into the hydrology and surface water/groundwater interactions of the river.

The geology of the watershed is characterized by carbonate rocks of the Cretaceous Age. The upper part of the watershed is incised through Upper Glen Rose limestone with a limited amount of Edwards caprock. Near Highway 281, the Upper Glen Rose has been totally eroded and the underlying Lower Glen Rose is the surficial bedrock unit throughout the rest of the downstream watershed. In more recent times, terrace and alluvial deposits have developed in the river bottoms.

The Upper Trinity Aquifer, consisting of the Upper Glen Rose, may have areas of perched water that can discharge into tributaries via seeps and small springs, particularly during wet weather. The Middle Trinity Aquifer is the primary potable water source in the area. The Middle Trinity Aquifer consists of the Lower Glen Rose, Hensel, and Cow Creek members. During early development of the region, shallow wells were completed in the Lower Glen Rose. Over time, wells have been drilled deeper and often are completed in the Cow Creek.

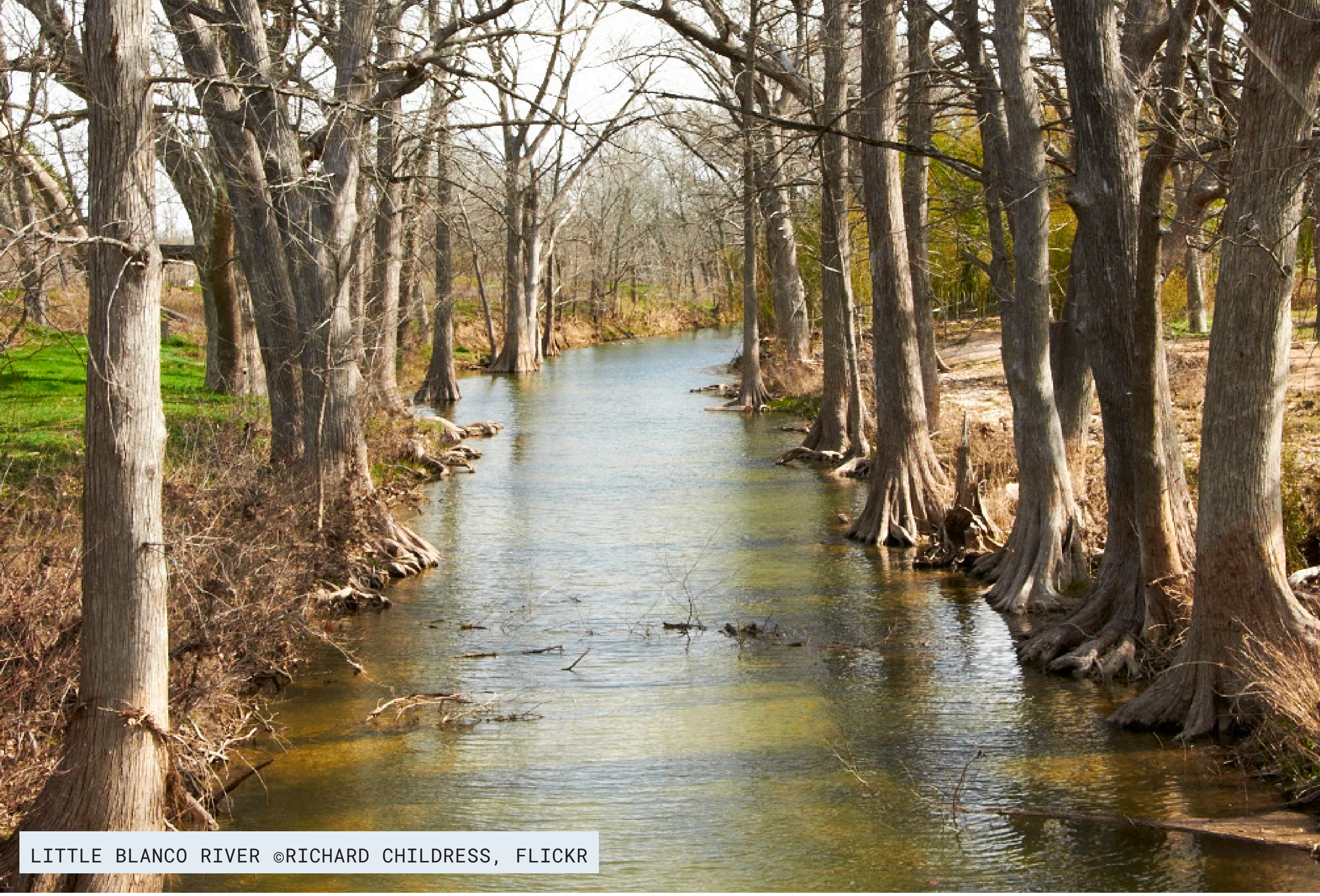
Hydrogeologically, the watershed can be described by several distinct areas. The upper watershed contained in the Upper Glen Rose is typically dry, though occasional seeps and springs may be present. Seepage from the alluvial deposits may contribute to base flow. Though not directly observed in this study, the headwaters seeps/springs of the river occur in this area. The central river area is considered the gaining reach of the river. It begins upstream of Highway 281 and extends past RR 32. There is a significant gaining area as the river approaches RR 32 where the USGS gauge (#08170890) is located.

There is increasing sulfate and calcium in the river in this gaining reach, which may indicate increasing groundwater contributions or perhaps concentrations of calcium and sulfate due to evaporation. Strontium, a commonly occurring cation in carbonate environments, was measured in groundwater samples, but not surface water samples indicating there is not a large, deep groundwater contribution. Groundwater elevations in wells along the river are lower than the elevation of the river indicating deeper groundwater is not the source of water to the river.

Based on the current study, maximum base flow is reached near RR 32. A little less than a mile downstream of RR 32, all flow ceases, infiltrating into the exposed Lower Glen Rose during baseflow conditions. The discharge measured at the USGS gauge can be considered a good estimate of the amount of water lost to the aquifer in the downstream losing reach. Due to drought/low flow conditions during the study, the losing capacity of this reach was not observed (i.e., the discharge necessary to flow over the dam).

The remainder of the river is often referred to as the "Dry Little Blanco" with no base flow occurring. One exception is a Lower Glen Rose spring occurring downstream of the Hays County line. The spring discharges into the river and forms several pools before the losing reach.

The Little Blanco River is a very "flashy river," rising quickly with precipitation events and losing flow and going dry during droughts. Since the USGS gauge was installed in 2016, there have been four low flow or no flow events measured. The low/no flow events were broken by significant rain events, with instantaneous flow exceeding over 1000 cfs and in one case exceeding 5000 cfs. The major flood events recharge shallow groundwater and provide bank storage which slowly discharge as base flow during drier periods.



LITTLE BLANCO RIVER ©RICHARD CHILDRESS, FLICKR

# CONCLUSION

The results of this base flow study indicate the Little Blanco River has not been seriously degraded and is in good condition, but flow is very dependent on climate. At present, there is little intense development and land use from 2001 to present does not indicate any significant changes that would impact the river. The Little Blanco River is a "flashy" river, dependent on relatively frequent large precipitation events to maintain base flow. Limited development in the watershed and good care of riparian areas has maintained good water quality. Potential increases in impervious cover have the potential to degrade water quality.

The current study was impacted by increasingly severe drought conditions and therefore limited in the number of flow measurements that could be obtained. The USGS gauge is in a suitable location to enable future monitoring of flow conditions and allow for the tracking of long-term trends.

# REFERENCES

Barnes, B.A. and Cumley, J.C. (1942). Blanco County, Texas: Records of wells and springs, drillers' logs, water analyses, and map showing locations of wells and springs. Texas Board of Water Engineers.

Barnes, V.E. Project Director (1981 version), Geologic Atlas of Texas (GAT)-Llano Sheet, Bureau of Economic Geology at the University of Texas-Austin.

Hunt, B. B., Smith, B. A., Gary, R. and Camp, J. (2019). March 2018 Potentiometric Map of the Middle Trinity Aquifer, Central Texas. Barton Springs/Edwards Aquifer Conservation District Report of Investigations 2019-0109.

Muskgrove, M. (2021). The Occurrence and Distribution of Strontium in U.S. Groundwater. Applied Geochemistry Volume 126, March 2021

Naismith Engineering (2005). Regional Water Quality Protection Plan for the Barton Springs Segment of the Edwards Aquifer and Its Contributing Zone.

Texas Hill Country Conservation Network (2022), The State of the Hill Country Report.

Texas Natural Resource Information System (2022). Website: https://data.tnris.org/

Watson, J., (2019).

Wierman, D. A., Broun, A. S., Hunt, B. B., (2010), Hydrogeologic Atlas of the Hill Country Trinity Aquifer, Blanco, Hays, and Travis Counties, Central Texas. Hays-Trinity Groundwater Conservation District, United States.

# APPENDIX A. LAND COVER TYPES

## National Land Cover Database Class Legend and Description

| Class\ Value | Classification Description |
|---|---|
| **Water** | |
| 11 | **Open Water**- areas of open water, generally with less than 25% cover of vegetation or soil. |
| 12 | **Perennial Ice/Snow**- areas characterized by a perennial cover of ice and/or snow, generally greater than 25% of total cover. |
| **Developed** | |
| 21 | **Developed, Open Space**- areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes. |
| 22 | **Developed, Low Intensity**- areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20% to 49% percent of total cover. These areas most commonly include single-family housing units. |
| 23 | **Developed, Medium Intensity** -areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50% to 79% of the total cover. These areas most commonly include single-family housing units. |
| 24 | **Developed High Intensity**-highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80% to 100% of the total cover. |
| **Barren** | |
| 31 | **Barren Land (Rock/Sand/Clay)** - areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover. |
| **Forest** | |
| 41 | **Deciduous Forest**- areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change. |
| 42 | **Evergreen Forest**- areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage. |

| | |
|---|---|
| 43 | **Mixed Forest**- areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75% of total tree cover. |
| **Shrubland** | |
| 51 | **Dwarf Scrub**- Alaska only areas dominated by shrubs less than 20 centimeters tall with shrub canopy typically greater than 20% of total vegetation. This type is often co-associated with grasses, sedges, herbs, and non-vascular vegetation. |
| 52 | **Shrub/Scrub**- areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions. |
| **Herbaceous** | |
| 71 | **Grassland/Herbaceous**- areas dominated by gramanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing. |
| 72 | **Sedge/Herbaceous**- Alaska only areas dominated by sedges and forbs, generally greater than 80% of total vegetation. This type can occur with significant other grasses or other grass like plants, and includes sedge tundra, and sedge tussock tundra. |
| 73 | **Lichens**- Alaska only areas dominated by fruticose or foliose lichens generally greater than 80% of total vegetation. |
| 74 | **Moss**- Alaska only areas dominated by mosses, generally greater than 80% of total vegetation. |
| **Planted/Cultivated** | |
| 81 | **Pasture/Hay**-areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation. |
| 82 | **Cultivated Crops** -areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled. |
| **Wetlands** | |
| 90 | **Woody Wetlands**- areas where forest or shrubland vegetation accounts for greater than 20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water. |
| 95 | **Emergent Herbaceous Wetlands**- Areas where perennial herbaceous vegetation accounts for greater than 80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water. |

# APPENDIX B. GROUNDWATER ELEVATIONS

| WELLS | | LAT | LONG | GRND ELEV | MP | DTW 12_14_21 | WL ELEV | DTW 2_2_22 | WL ELEV | DTW 4_26_22 | WL ELEV | DTW 6_30_22 | WL ELEV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| W2 | Still #1* | 30.038 | -98.259 | 1079 | nm | 83 | 996.1 | 84.6 | 994.4 | 84.7 | 994.4 | 83.2 | 996 |
| W6 | Stude Guest House | 30.030 | -98.266 | 1077 | 1.2 | 85.5 | 992.7 | nm | nm | nm | nm | nm | nm |
| W8 | Stude #4 River Well | 30.029 | -98.266 | 1071 | 1.7 | 78.9 | 993.8 | 79.5 | 991.5 | 80.7 | 990.3 | nm | nm |
| W12 | Stude Wind Mill #1 | 30.031 | -98.270 | 1083 | 0 | 89.6 | 993.4 | nm | nm | nm | nm | nm | nm |
| W16 | Erickson | 30.027 | -98.325 | 1182 | 1.3 | 59.8 | 1123.5 | 59.9 | 1122.1 | 63.8 | 1118.2 | 66.9 | 1115.1 |
| W18 | LBRR Well #2 | 30.023 | -98.312 | 1252 | 1.5 | 133.6 | 1119.9 | 133.6 | 1118.4 | 135.4 | 1116.6 | nm | nm |
| W20 | LBRR Well #1 Pasture | 30.025 | -98.322 | 1159 | 1.8 | 45.6 | 1115.2 | 47.8 | 1111.2 | 49.3 | 1109.7 | 51.9 | 1107.1 |
| W21 | LBRR Well #2 Field Edge | 30.017 | -98.324 | 1178 | 1.9 | 50.5 | 1129.4 | 50.4 | 1127.6 | 58.1 | 1119.9 | 59.9 | 1118.1 |
| W22 | LBRR Well #1 | 30.022 | -98.327 | 1180 | 1 | 60.7 | 1120.3 | 61.2 | 1118.8 | 61.5 | 1118.5 | 61.6 | 1118.4 |
| W24 | Cross Creek House Well | 30.017 | -98.354 | 1209 | 1.7 | 61.2 | 1149.5 | 69.4 | 1139.6 | 87.1 | 1121.9 | 97.1 | 1112.0 |
| W26 | Wallace Well #2 (river) | 30.013 | -98.355 | 1201 | 0.7 | 47.2 | 1154.5 | 60.2 | 1140.8 | 79 | 1122 | nm | nm |
| W28 | Wallace Well #1 | 30.012 | -98.353 | 1230 | 0 | 68.2 | 1161.8 | nm | nm | 62.9 | 1167.1 | 85.5 | 1144.6 |
| W32 | Collie Ranch - High point well | 29.983 | -98.377 | 1356 | 1.2 | 214.6 | 1142.6 | nm | nm | nm | nm | nm | nm |
| W36 | Abdenour Well | 30.002 | -98.407 | 1291 | 1.7 | 50.8 | 1241.9 | 52 | 1239 | 59.1 | 1231.9 | nm | nm |
| W38 | Kevin & Julie Zincke | 30.046 | -98.487 | 1813 | 2 | 286.1 | 1528.9 | nm | nm | nm | nm | nm | nm |

*Data from HTGCD
nm = not measured
DTW = Depth to Water
Elev expressed in mean sea level

# APPENDIX C. WATER QUALITY RESULTS

TEXAS STATE UNIVERSITY

*The rising STAR of Texas*

**Date of Final Report:** 3/22/22

**Water Analysis Report**

Sample #: 164881-90; 164909-17

The Meadows Center
Jenna Walker
601 University Dr.
San Marcos, TX 78666
512-245-9201

Dear Jenna Walker,

EARDC laboratory received 19 sample on 2/23/22 for the analysis presented in the following report.

This final report provides results only to the sample(s) as received for the above referenced lab sample numbers. The EARDC laboratory certifies that the results are NELAP compliant, unless otherwise noted, and in accordance with the referenced methods. This document contains (21) pages.

The Case narrative provides explanations for any deviations from, additions to or exclusions from the methods and defines any abbreviations. The EARDC Laboratory will not reproduce this report without written authorization from the client.

Thank you for selecting the EARDC laboratory for your analytical needs. If you have any questions regarding these results, please contact us at (512)245-2329. We look forward to assisting you again.

Sincerely,

Technical Director (or Deputy)

TEXAS STATE UNIVERSITY
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The Meadows Center
Jenna Walker
601 University Dr.
San Marcos, TX 78666
512-245-9201

**Lab Sample #:** 164881

**Date Sampled:** 2/22/22
**Date Received (by lab):** 2/23/22
**Date Reported:** 3/22/22

**Time Sampled:** 10:45
**Time Received:** 11:55a
**Sample Description:** potable

**Sample ID:** W12
**Sample Type: Grab**

| Parameter | Results | MDL | LOQ | Units | Date Analyzed | Time Analyzed | Analyst | Method | Qualifier |
|---|---|---|---|---|---|---|---|---|---|
| Total Kjeldahl Nitrogen | **<0.79** | ---- | 0.79 | mg/L | 3/16/22 | 4:53p | ma | E351.2 | s |
| Total Phosphorus | **0.042** | ---- | 0.024 | mg/L | 3/10/22 | 9:30a | ma/tw | M4500PE-2011 | |
| Total Alkalinity | **232** | 20 | ---- | mg/L | 02/24/22 | 2:40p | nr | M2320B-2011 | |
| Total Hardness | **260** | ---- | 17 | mg/L | 03/01/22 | 10:12a | ma/tw | M2340C-2011 | |

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**Lab Sample #:** 164882

**Date Sampled:** 2/22/22
**Date Received (by lab):** 2/23/22
**Date Reported:** 3/22/22

**Time Sampled:** 11:15
**Time Received:** 11:55a
**Sample Description:** potable

**Sample ID:** W16
**Sample Type:** Grab

| Parameter | Results | MDL | LOQ | Units | Date Analyzed | Time Analyzed | Analyst | Method | Qualifier |
|---|---|---|---|---|---|---|---|---|---|
| Total Kjeldahl Nitrogen | **<0.79** | ---- | 0.79 | mg/L | 3/16/22 | 4:53p | ma | E351.2 | s |
| Total Phosphorus | **<0.024** | ---- | 0.024 | mg/L | 3/10/22 | 9:30a | ma/tw | M4500PE-2011 | |
| Total Alkalinity | **312** | 20 | ---- | mg/L | 02/24/22 | 2:40p | nr | M2320B-2011 | |
| Total Hardness | **248** | ---- | 17 | mg/L | 03/01/22 | 10:12a | ma/tw | M2340C-2011 | |



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**Lab Sample #:** 164883

**Date Sampled:** 2/22/22
**Date Received (by lab):** 2/23/22
**Date Reported:** 3/22/22

**Time Sampled:** 12:00
**Time Received:** 11:55a
**Sample Description:** potable

**Sample ID:** W20
**Sample Type:** Grab

| Parameter | Results | MDL | LOQ | Units | Date Analyzed | Time Analyzed | Analyst | Method | Qualifier |
|---|---|---|---|---|---|---|---|---|---|
| Total Kjeldahl Nitrogen | **<0.79** | ---- | 0.79 | mg/L | 3/16/22 | 4:53p | ma | E351.2 | s |
| Total Phosphorus | **<0.024** | ---- | 0.024 | mg/L | 3/10/22 | 9:30a | ma/tw | M4500PE-2011 | |
| Total Alkalinity | **256** | 20 | ---- | mg/L | 02/24/22 | 2:40p | nr | M2320B-2011 | |
| Total Hardness | **650** | ---- | 85 | mg/L | 03/01/22 | 10:12a | ma/tw | M2340C-2011 | L |

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**Lab Sample #:** 164884

**Date Sampled:** 2/22/22
**Date Received (by lab):** 2/23/22
**Date Reported:** 3/22/22

**Time Sampled:** 12:50
**Time Received:** 11:55a
**Sample Description:** potable

**Sample ID:** W21
**Sample Type: Grab**

| Parameter | Results | MDL | LOQ | Units | Date Analyzed | Time Analyzed | Analyst | Method | Qualifier |
|---|---|---|---|---|---|---|---|---|---|
| Total Kjeldahl Nitrogen | **<0.79** | ---- | 0.79 | mg/L | 3/16/22 | 4:53p | ma | E351.2 | s |
| Total Phosphorus | **0.073** | ---- | 0.024 | mg/L | 3/10/22 | 9:30a | ma/tw | M4500PE-2011 | |
| Total Alkalinity | **252** | 20 | ---- | mg/L | 02/24/22 | 2:40p | nr | M2320B-2011 | |
| Total Hardness | **330** | ---- | 85 | mg/L | 03/01/22 | 10:12a | ma/tw | M2340C-2011 | L |

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**Lab Sample #:** 164885

**Date Sampled:** 2/22/22
**Date Received (by lab):** 2/23/22
**Date Reported:** 3/22/22

**Time Sampled:** 12:30
**Time Received:** 11:55a
**Sample Description:** potable

**Sample ID:** W22
**Sample Type: Grab**

| Parameter | Results | MDL | LOQ | Units | Date Analyzed | Time Analyzed | Analyst | Method | Qualifier |
|---|---|---|---|---|---|---|---|---|---|
| Total Kjeldahl Nitrogen | **<0.79** | ---- | 0.79 | mg/L | 3/16/22 | 4:53p | ma | E351.2 | s |
| Total Phosphorus | **0.064** | ---- | 0.024 | mg/L | 3/10/22 | 9:30a | ma/tw | M4500PE-2011 | |
| Total Alkalinity | **248** | 20 | ---- | mg/L | 02/24/22 | 2:40p | nr | M2320B-2011 | |
| Total Hardness | **630** | ---- | 85 | mg/L | 03/01/22 | 10:12a | ma/tw | M2340C-2011 | L |

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**Lab Sample #:** 164887

**Date Sampled:** 2/23/22
**Date Received (by lab):** 2/23/22
**Date Reported:** 3/22/22

**Time Sampled:** 10:15
**Time Received:** 11:55a
**Sample Description:** potable

**Sample ID:** W28
**Sample Type: Grab**

| Parameter | Results | MDL | LOQ | Units | Date Analyzed | Time Analyzed | Analyst | Method | Qualifier |
|---|---|---|---|---|---|---|---|---|---|
| Total Kjeldahl Nitrogen | **<0.79** | ---- | 0.79 | mg/L | 3/16/22 | 4:53p | ma | E351.2 | s |
| Total Phosphorus | **<0.024** | ---- | 0.024 | mg/L | 3/10/22 | 9:30a | ma/tw | M4500PE-2011 | |
| Total Alkalinity | **242** | 20 | ---- | mg/L | 02/24/22 | 2:40p | nr | M2320B-2011 | |
| Total Hardness | **400** | ---- | 85 | mg/L | 03/01/22 | 10:12a | ma/tw | M2340C-2011 | L |

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**Lab Sample #:** 164886

**Date Sampled:** 2/22/22
**Date Received (by lab):** 2/23/22
**Date Reported:** 3/22/22

**Time Sampled:** 16:00
**Time Received:** 11:55a
**Sample Description:** potable

**Sample ID:** W26
**Sample Type: Grab**

| Parameter | Results | MDL | LOQ | Units | Date Analyzed | Time Analyzed | Analyst | Method | Qualifier |
|---|---|---|---|---|---|---|---|---|---|
| Total Kjeldahl Nitrogen | **<0.79** | ---- | 0.79 | mg/L | 3/16/22 | 4:53p | ma | E351.2 | s |
| Total Phosphorus | **<0.024** | ---- | 0.024 | mg/L | 3/10/22 | 9:30a | ma/tw | M4500PE-2011 | |
| Total Alkalinity | **242** | 20 | ---- | mg/L | 02/24/22 | 2:40p | nr | M2320B-2011 | |
| Total Hardness | **400** | ---- | 34 | mg/L | 03/01/22 | 10:12a | ma/tw | M2340C-2011 | L |

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**Lab Sample #:** 164888

**Date Sampled:** 2/22/22
**Date Received (by lab):** 2/23/22
**Date Reported:** 3/22/22

**Time Sampled:** 10:15
**Time Received:** 11:55a
**Sample Description:** potable

**Sample ID:** W28 DUP
**Sample Type: Grab**

| Parameter | Results | MDL | LOQ | Units | Date Analyzed | Time Analyzed | Analyst | Method | Qualifier |
|---|---|---|---|---|---|---|---|---|---|
| Total Kjeldahl Nitrogen | **<0.79** | ---- | 0.79 | mg/L | 3/16/22 | 4:53p | ma | E351.2 | s |
| Total Phosphorus | **<0.024** | ---- | 0.024 | mg/L | 3/10/22 | 9:30a | ma/tw | M4500PE-2011 | |
| Total Alkalinity | **264** | 20 | ---- | mg/L | 02/24/22 | 2:40p | nr | M2320B-2011 | |
| Total Hardness | **390** | ---- | 85 | mg/L | 03/01/22 | 10:12a | ma/tw | M2340C-2011 | L |

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**Lab Sample #:** 164889

**Date Sampled:** 2/22/22
**Date Received (by lab):** 2/23/22
**Date Reported:** 3/22/22

**Time Sampled:** 15:00
**Time Received:** 11:55a
**Sample Description:** potable

**Sample ID:** W31
**Sample Type: Grab**

| Parameter | Results | MDL | LOQ | Units | Date Analyzed | Time Analyzed | Analyst | Method | Qualifier |
|---|---|---|---|---|---|---|---|---|---|
| Total Kjeldahl Nitrogen | **<0.79** | ---- | 0.79 | mg/L | 3/16/22 | 4:53p | ma | E351.2 | s |
| Total Phosphorus | **0.029** | ---- | 0.024 | mg/L | 3/10/22 | 9:30a | ma/tw | M4500PE-2011 | |
| Total Alkalinity | **258** | 20 | ---- | mg/L | 02/24/22 | 2:40p | nr | M2320B-2011 | |
| Total Hardness | **290** | ---- | 85 | mg/L | 03/01/22 | 10:12a | ma/tw | M2340C-2011 | L |

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**Lab Sample #:** 164890

**Date Sampled:** 2/22/22
**Date Received (by lab):** 2/23/22
**Date Reported:** 3/22/22

**Time Sampled:** 14:00
**Time Received:** 11:55a
**Sample Description:** potable

**Sample ID:** W35
**Sample Type: Grab**

| Parameter | Results | MDL | LOQ | Units | Date Analyzed | Time Analyzed | Analyst | Method | Qualifier |
|---|---|---|---|---|---|---|---|---|---|
| Total Kjeldahl Nitrogen | **<0.79** | --- | 0.79 | mg/L | 3/16/22 | 4:53p | ma | E351.2 | s |
| Total Phosphorus | **<0.024** | ---- | 0.024 | mg/L | 3/10/22 | 9:30a | ma/tw | M4500PE-2011 | |
| Total Alkalinity | **244** | 20 | ---- | mg/L | 02/24/22 | 2:40p | nr | M2320B-2011 | |
| Total Hardness | **<17** | ---- | 17 | mg/L | 03/01/22 | 10:12a | ma/tw | M2340C-2011 | |

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**Lab Sample #:** 164909

**Date Sampled:** 2/22/22
**Date Received (by lab):** 2/23/22
**Date Reported:** 3/22/22

**Time Sampled:** 14:05
**Time Received:** 11:55a
**Sample Description:** potable

**Sample ID:** SW 33
**Sample Type: Grab**

| Parameter | Results | MDL | LOQ | Units | Date Analyzed | Time Analyzed | Analyst | Method | Qualifier |
|---|---|---|---|---|---|---|---|---|---|
| Total Kjeldahl Nitrogen | **<0.79** | ---- | 0.79 | mg/L | 3/16/22 | 4:53p | ma | E351.2 | s |
| Total Phosphorus | **<0.024** | ---- | 0.024 | mg/L | 3/10/22 | 9:30a | ma/tw | M4500PE-2011 | |
| Total Alkalinity | **162** | 20 | ---- | mg/L | 02/24/22 | 2:40p | nr | M2320B-2011 | |
| Total Hardness | **186** | ---- | 17 | mg/L | 03/01/22 | 10:12a | ma/tw | M2340C-2011 | |

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**Lab Sample #:** 164910

**Date Sampled:** 2/22/22
**Date Received (by lab):** 2/23/22
**Date Reported:** 3/22/22

**Time Sampled:** 12:10
**Time Received:** 11:55a
**Sample Description:** potable

**Sample ID:** SW7
**Sample Type:** Grab

| Parameter | Results | MDL | LOQ | Units | Date Analyzed | Time Analyzed | Analyst | Method | Qualifier |
|---|---|---|---|---|---|---|---|---|---|
| Total Kjeldahl Nitrogen | **<0.79** | ---- | 0.79 | mg/L | 3/16/22 | 4:53p | ma | E351.2 | s |
| Total Phosphorus | **<0.024** | ---- | 0.024 | mg/L | 3/10/22 | 9:30a | ma/tw | M4500PE-2011 | |
| Total Alkalinity | **216** | 20 | ---- | mg/L | 02/24/22 | 2:40p | nr | M2320B-2011 | |
| Total Hardness | **330** | ---- | 34 | mg/L | 03/01/22 | 10:12a | ma/tw | M2340C-2011 | L |

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**Lab Sample #:** 164911

| | | | | | |
|---|---|---|---|---|---|
| **Date Sampled:** | 2/22/22 | **Time Sampled:** | 12:50 | **Sample ID:** SW13 | |
| **Date Received (by lab):** | 2/23/22 | **Time Received:** | 11:55a | | |
| **Date Reported:** | 3/22/22 | **Sample Description:** | potable | **Sample Type: Grab** | |

| Parameter | Results | MDL | LOQ | Units | Date Analyzed | Time Analyzed | Analyst | Method | Qualifier |
|---|---|---|---|---|---|---|---|---|---|
| Total Kjeldahl Nitrogen | **<0.79** | ---- | 0.79 | mg/L | 3/16/22 | 4:53p | ma | E351.2 | s |
| Total Phosphorus | **0.082** | ---- | 0.024 | mg/L | 3/10/22 | 9:30a | ma/tw | M4500PE-2011 | |
| Total Alkalinity | **230** | 20 | ---- | mg/L | 02/24/22 | 2:40p | nr | M2320B-2011 | |
| Total Hardness | **308** | ---- | 34 | mg/L | 03/01/22 | 10:12a | ma/tw | M2340C-2011 | L |

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**Lab Sample #:** 164912

**Date Sampled:** 2/23/22 **Time Sampled:** 9:45 **Sample ID:** SW19 DUP
**Date Received (by lab):** 2/23/22 **Time Received:** 11:55a
**Date Reported:** 3/22/22 **Sample Description:** potable **Sample Type: Grab**

| Parameter | Results | MDL | LOQ | Units | Date Analyzed | Time Analyzed | Analyst | Method | Qualifier |
|---|---|---|---|---|---|---|---|---|---|
| Total Kjeldahl Nitrogen | **<0.79** | ---- | 0.79 | mg/L | 3/16/22 | 6:20P | ma | E351.2 | s |
| Total Phosphorus | **<0.024** | ---- | 0.024 | mg/L | 3/10/22 | 9:30a | ma/tw | M4500PE-2011 | |
| Total Alkalinity | **190** | 20 | ---- | mg/L | 02/24/22 | 2:40p | nr | M2320B-2011 | |
| Total Hardness | **268** | ---- | 34 | mg/L | 03/01/22 | 10:12a | ma/tw | M2340C-2011 | I |

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**Lab Sample #:** 164913

| | | | | | |
|---|---|---|---|---|---|
| **Date Sampled:** | 2/23/22 | **Time Sampled:** | 9:45 | **Sample ID:** | SW19 |
| **Date Received (by lab):** | 2/23/22 | **Time Received:** | 11:55a | | |
| **Date Reported:** | 3/22/22 | **Sample Description:** | potable | **Sample Type:** | **Grab** |

| Parameter | Results | MDL | LOQ | Units | Date Analyzed | Time Analyzed | Analyst | Method | Qualifier |
|---|---|---|---|---|---|---|---|---|---|
| Total Kjeldahl Nitrogen | **<0.79** | ---- | 0.79 | mg/L | 3/16/22 | 6:20P | ma | E351.2 | s |
| Total Phosphorus | **<0.024** | ---- | 0.024 | mg/L | 3/10/22 | 9:30a | ma/tw | M4500PE-2011 | |
| Total Alkalinity | **194** | 20 | ---- | mg/L | 02/24/22 | 2:40p | nr | M2320B-2011 | |
| Total Hardness | **266** | ---- | 17 | mg/L | 03/01/22 | 10:12a | ma/tw | M2340C-2011 | |

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**Lab Sample #:** 164914

| | | | | | |
|---|---|---|---|---|---|
| **Date Sampled:** | 2/22/22 | **Time Sampled:** | 15:00 | **Sample ID:** SW21 | |
| **Date Received (by lab):** | 2/23/22 | **Time Received:** | 11:55a | | |
| **Date Reported:** | 3/22/22 | **Sample Description:** potable | | **Sample Type: Grab** | |

| Parameter | Results | MDL | LOQ | Units | Date Analyzed | Time Analyzed | Analyst | Method | Qualifier |
|---|---|---|---|---|---|---|---|---|---|
| Total Kjeldahl Nitrogen | **<0.79** | ---- | 0.79 | mg/L | 3/16/22 | 6:20P | ma | E351.2 | s |
| Total Phosphorus | **<0.024** | ---- | 0.024 | mg/L | 3/10/22 | 9:30a | ma/tw | M4500PE-2011 | |
| Total Alkalinity | **150** | 20 | ---- | mg/L | 02/24/22 | 2:40p | nr | M2320B-2011 | |
| Total Hardness | **192** | ---- | 17 | mg/L | 03/01/22 | 10:12a | ma/tw | M2340C-2011 | |

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**Lab Sample #:** 164915

**Date Sampled:** 2/22/22
**Date Received (by lab):** 2/23/22
**Date Reported:** 3/22/22

**Time Sampled:** 14:45
**Time Received:** 11:55a
**Sample Description:** potable

**Sample ID:** SW23
**Sample Type: Grab**

| Parameter | Results | MDL | LOQ | Units | Date Analyzed | Time Analyzed | Analyst | Method | Qualifier |
|---|---|---|---|---|---|---|---|---|---|
| Total Kjeldahl Nitrogen | **<0.79** | ---- | 0.79 | mg/L | 3/16/22 | 6:20P | ma | E351.2 | s |
| Total Phosphorus | **<0.024** | ---- | 0.024 | mg/L | 3/10/22 | 9:30a | ma/tw | M4500PE-2011 | |
| Total Alkalinity | **154** | 20 | ---- | mg/L | 02/24/22 | 2:40p | nr | M2320B-2011 | |
| Total Hardness | **198** | ---- | 17 | mg/L | 03/01/22 | 10:12a | ma/tw | M2340C-2011 | |

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**Lab Sample #:** 164916

**Date Sampled:** 2/22/22
**Date Received (by lab):** 2/23/22
**Date Reported:** 3/22/22

**Time Sampled:** 13:30
**Time Received:** 11:55a
**Sample Description:** potable

**Sample ID:** SW25
**Sample Type: Grab**

| Parameter | Results | MDL | LOQ | Units | Date Analyzed | Time Analyzed | Analyst | Method | Qualifier |
|---|---|---|---|---|---|---|---|---|---|
| Total Kjeldahl Nitrogen | **<0.79** | ---- | 0.79 | mg/L | 3/16/22 | 6:20P | ma | E351.2 | s |
| Total Phosphorus | **<0.024** | ---- | 0.024 | mg/L | 3/10/22 | 9:30a | ma/tw | M4500PE-2011 | |
| Total Alkalinity | **154** | 20 | ---- | mg/L | 02/24/22 | 2:40p | nr | M2320B-2011 | |
| Total Hardness | **194** | ---- | 17 | mg/L | 03/01/22 | 10:12a | ma/tw | M2340C-2011 | |

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**Lab Sample #:** 164917

**Date Sampled:** 2/22/22
**Date Received (by lab):** 2/23/22
**Date Reported:** 3/22/22

**Time Sampled:** 14:15
**Time Received:** 11:55a
**Sample Description:** potable

**Sample ID:** SW29
**Sample Type: Grab**

| Parameter | Results | MDL | LOQ | Units | Date Analyzed | Time Analyzed | Analyst | Method | Qualifier |
|---|---|---|---|---|---|---|---|---|---|
| Total Kjeldahl Nitrogen | **<0.79** | ---- | 0.79 | mg/L | 3/16/22 | 6:20P | ma | E351.2 | s |
| Total Phosphorus | **<0.024** | ---- | 0.024 | mg/L | 3/10/22 | 9:30a | ma/tw | M4500PE-2011 | |
| Total Alkalinity | **184** | 20 | ---- | mg/L | 02/24/22 | 2:40p | nr | M2320B-2011 | |
| Total Hardness | **208** | ---- | 17 | mg/L | 03/01/22 | 10:12a | ma/tw | M2340C-2011 | |

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## Case Narrative

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San Marcos, TX 78666
512-245-9201

Sample #: 164881-90; 164909-17

**MDL**= Method Detection Limit
**LOQ** = Limit of Quanitaion
**mg/L** = milligrams per liter
**M**= Standard Methods for the Examination of Water and Wastewater
**E** = Environmental Protection Agency

**N** - EARDC not NELAP accredited for this analysis
**A**- Not available for accreditation
**B**- Analyte detected in blank (negative control) but concentration is not greater than 1/10 sample concentration
**F**- QC parameter failed
**S** -Spike Recovery or Spike RPD failed. All other QC passed, so recovery problem judged to be either matrix or solution related not system related. Results reported and QC Flagged.
**I** - Results invalidated due Quality Control (QC) failure
**H** - Holding time exceeded
**V** - Value above Quantitative Range
**L** - LOQ is multiplied by dilution Factor

**SC** - subcontracted



Edwards Aquifer Research and Data Center
220 Sessom Dr./Rm. 248 Freeman Bldg./ San Marcos TX 78666 phone: 512-245-2329/ fax: 512-245-2669
Texas State University, founded in 1899, is a member of the Texas State University System

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EDWARDS AQUIFER RESEARCH AND DATA CENTER LABORATORY
601 University Drive
San Marcos, Texas 78666-4684

Telephone: 512/245-2329
FAX: 512/245-2669
E-mail: jg13@txstate.edu

# CHAIN-OF-CUSTODY & ANALYSIS REQUEST

Client/Project Name: The Meadows Center

Sampler: (signature) Jenna Walker

| Field Sample ID | Start Date/Time | End Date/Time | Sample Type (Grab/ Comp.) | Sample Description (Drinking Water or Non-Potable) | Analysis, Containers and Sample Preservation | Sample Temp. (°C) CF= -0.1 °C | Lab ID# |
|---|---|---|---|---|---|---|---|
| Stude W12 | 2/22/22 10:42 | | | well | ions, ~~alkalinity, Total P, N, hardness~~ | 11.6/11.5 | 164880 |
| ~~Erickson W12~~ | ~~11:00~~ 15:42 | ~~10:42~~ | | ~~well~~ | ~~ions,~~ " | | |
| W12 | 2/22/22 10:42 | 10:45 | | well | Total P, N, alkalinity, hardness | | 164881 |
| W16 | 2/22/22 1100 | 1115 | | " | " | | 164882 |
| W20 | 1150 | 1200 | | " | " | | 164883 |
| W21 | 1240 | 1250 | | " | " | | 164884 |
| W22 | 12:22 | 1230 | | " | " | | 164885 |
| W26 | 15:45 | 1600 | | " | " | | 164886 |

| Relinquished by: (print & sign) | Date | Received by: (print & sign) | Date | Time |
|---|---|---|---|---|
| Jenna Walker Jenna Walker | 2/22/22 | | | |
| | | | | |
| | | | | |
| | | Received for EARDC Laboratory: (print & sign) [signature] | 2-23-22 | 11:55 |

Sample Disposal Method:

Disposed of by: (signature) | Date | Time

**CODES**
P-Plastic
L-Liter
G-Glass
mL-Milliliters
$H_2SO_4$-Sulfuric Acid
$HNO_3$-Nitric Acid
HCl-Hydrochloric Acid

Client Address and Phone #: *(Required)*
601 University Dr
San Marcos, TX
78666 512-245-9201

Temp. taken with Vincnt
Cooling process has begun Y (Y/N)
pH strips CIN ____

General Comments: 164881-164886 → EARDC
Joint project w/ Ashley C. (Biology lab). They are doing cations & billing for these samples. EARDC's is just for ... post

Sample to be subcontracted ☐ Yes ☐ No

FORM: 003COC REV. 2013    CIN = Chemical Inventory Number    CF = correction factor °C = degrees centigrade Y = Yes N = No

1

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# CHAIN-OF-CUSTODY & ANALYSIS REQUEST

Client//Project Name: The Meadows Center

Sampler: (signature) Jenna Walker

| Field Sample ID | Start Date/Time | End Date/Time | Sample Type (Grab/ Comp.) | Sample Description (Drinking Water or Non-Potable) | Analysis, Containers and Sample Preservation | Sample Temp. (°C) CF= -0.1 °C | Lab ID# |
|---|---|---|---|---|---|---|---|
| W28 | 2/23/22 10:00 | 10:15 | | Well | Total P, N, alkalinity, hardness | 11.6/11.5 | 164887 |
| W28-DUP | " | " | | " | " | | 164888 |
| W31 | 2/22/22 1445 | 1500 | | " | " | | 164889 |
| W35 | " 1340 | 1400 | | " | " | | 164890 |
| SW7 | " 1210 | 1220 | | river | anions, cations | | 164891 |
| S13 | " 12:50 | " 13:00 | | " | " | | 164892 |
| SW19 | 2/23/22 9:45 | 10:00 | | " | " | | 164893 |

| Relinquished by: (print & sign) | Date | Received by: (print & sign) | Date | Time |
|---|---|---|---|---|
| Jenna Walker / Jenna Walker | 2/23/22 | | | |
| | | | | |
| | | | | |
| | | Received for EARDC Laboratory: (print & sign) [signature] | 2-23-22 | 11:55 |

Sample Disposal Method:

Disposed of by: (signature) | Date | Time

| CODES | Client Address and Phone #: (Required) | | General Comments: |
|---|---|---|---|
| P-Plastic<br>L-Liter<br>G-Glass<br>mL-Milliliters<br>$H_2SO_4$-Sulfuric Acid<br>$HNO_3$-Nitric Acid<br>HCl-Hydrochloric Acid | 601 Univ Dr<br>SM, TX 78666<br>512-245-9201 | Temp. taken with Vincent<br>Cooling process has begun Y (Y/N)<br>pH strips CIN — | See note on COC pg 1<br>Sample to be subcontracted ☐ Yes ☐ No |

FORM: 003COC REV. 2013 CIN = Chemical Inventory Number CF = correction factor °C = degrees centigrade Y = Yes N = No

(2)

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# CHAIN-OF-CUSTODY & ANALYSIS REQUEST

Client/Project Name: The Meadows Center

Sampler: (signature) Jenna Walker

| Field Sample ID | Start Date/Time | End Date/Time | Sample Type (Grab/ Comp.) | Sample Description (Drinking Water or Non-Potable) | Analysis, Containers and Sample Preservation | Sample Temp. (°C) CF= -0.1 °C | Lab ID# |
|---|---|---|---|---|---|---|---|
| SW19 DUP | 2/23/22 ~~9:45~~ | 1000 | | river | anions, cations | 11.5 | 164894 |
| SW21 | ~~2/23/22~~ 1500 | 1515 | | " | " | ↓ | 164895 |
| SW29 | " 1415 | 1430 | | " | " | | 164896 |
| SW23 | " 1425 | " 1428 | | " | " | | 164897 |
| SW25 | " 1330 | 1335 | | " | " | | 164898 |
| SW33 | " 1405 | " 1420 | | " | " | | 164899 |
| W16 | " 1100 | 1105 | | well | " | | 164900 |
| W20 | " 1150 | 1155 | | " | " | | 164901 |

| Relinquished by: (print & sign) | Date | Received by: (print & sign) | Date | Time |
|---|---|---|---|---|
| Jenna Walker Jenna Walker | 2/23/22 | | | |
| | | | | |
| | | | | |
| | | Received for EARDC Laboratory: (print & sign) [signature] | 2-23-22 | 11:55 |

| Sample Disposal Method: | Disposed of by: (signature) | Date | Time |
|---|---|---|---|
| | | | |

**CODES**
P-Plastic
L-Liter
G-Glass
mL-Milliliters
$H_2SO_4$-Sulfuric Acid
$HNO_3$-Nitric Acid
HCl-Hydrochloric Acid

Client Address and Phone #: *(Required)*
601 Univ Dr
SM, TX 78666
512-245-9201

Temp. taken with Vincent
Cooling process has begun Y (Y/N)
pH strips CIN ——

General Comments: see note on COC pg 1

Sample to be subcontracted ☐ Yes ☐ No

FORM: 003COC REV. 2013 — CIN = Chemical Inventory Number — CF = correction factor °C = degrees centigrade Y = Yes N = No

(3)

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# CHAIN-OF-CUSTODY & ANALYSIS REQUEST

Client//Project Name: The Meadows Center

Sampler: (signature) Jenna Walker

| Field Sample ID | Start Date/Time | End Date/Time | Sample Type (Grab/ Comp.) | Sample Description (Drinking Water or Non-Potable) | Analysis, Containers and Sample Preservation | Sample Temp. (°C) CF= -0.1 °C | Lab ID# |
|---|---|---|---|---|---|---|---|
| W21 | 2/22/22 12:40 | 12:45 | | well | anions, cations | 11.6/11.5 | 164902 |
| W22 | " 1220 | 1225 | | " | " | | 164903 |
| W26 | " 1545 | 1550 | | " | " | | 164904 |
| W28 DUP | " 1000 | 1005 | | " | " | | 164905 |
| W28 | " | " | | " | " | | 164906 |
| W31 | " 1445 | 1450 | | " | " | | 164907 |
| W35 | " 1340 | 1345 | | " | " | | 164908 |
| SW 33 | " 1405 | 1405 | | river | Total P, N, alkalinity, hardness | | 164909 |

| Relinquished by: (print & sign) | Date | Received by: (print & sign) | Date | Time |
|---|---|---|---|---|
| Jenna Walker Jenna Walker | 2/23/22 | | | |
| | | | | |
| | | | | |
| | | Received for EARDC Laboratory: (print & sign) [signature] | 2-23-22 | 11:55 |
| Sample Disposal Method: | Disposed of by: (signature) | | | |

**CODES**
P-Plastic
L-Liter
G-Glass
mL-Milliliters
$H_2SO_4$-Sulfuric Acid
$HNO_3$-Nitric Acid
HCl-Hydrochloric Acid

Client Address and Phone #: *(Required)*
601 Univ Dr
San Marcos, TX
78666
512-245-9201

Temp. taken with Vincent
Cooling process has begun Y (Y/N)
pH strips CIN ——

General Comments:
see note coc pg 1

Sample to be subcontracted ☐ Yes ☐ No

FORM: 003COC REV. 2013 CIN = Chemical Inventory Number CF = correction factor °C = degrees centigrade Y = Yes N = No

(2)

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# CHAIN-OF-CUSTODY & ANALYSIS REQUEST

Client//Project Name: The Meadows Center

Sampler: (signature) Jenna Walker

| Field Sample ID | Start Date/Time | End Date/Time | Sample Type (Grab/ Comp.) | Sample Description (Drinking Water or Non-Potable) | Analysis, Containers and Sample Preservation | Sample Temp. (°C) CF= -0.1 °C | Lab ID# |
|---|---|---|---|---|---|---|---|
| SW7 | 2/22/22 12:10 | " | | River | Total P, N, alkalinity, hardness | 11.6/11.5 | 164910 |
| SW13 | " 12:50 | " | | " | " | | 164911 |
| SW19 DUP | 2/23/22 9:45 | " | | " | " | | 164912 |
| SW19 | " | " | | " | " | | 164913 |
| SW21 | 2/22/22 1500 | " | | " | " | | 164914 |
| SW23 | " 1445 | 1500 | | " | " | | 164915 |
| SW25 | " 1330 | 1330 | | " | " | | 164916 |
| SW29 | " 1415 | 1415 | | " | " | | 164917 |

| Relinquished by: (print & sign) | Date | Received by: (print & sign) | Date | Time |
|---|---|---|---|---|
| Jenna Walker / Jenna Walker | 2/23/22 | | | |
| | | | | |
| | | | | |
| | | Received for EARDC Laboratory: (print & sign) [signature] | 2-23-22 | 11:55 |

Sample Disposal Method: | Disposed of by: (signature) | Date | Time

**CODES**
P-Plastic
L-Liter
G-Glass
mL-Milliliters
$H_2SO_4$-Sulfuric Acid
$HNO_3$-Nitric Acid
HCl-Hydrochloric Acid

Client Address and Phone #: *(Required)*
601 Univ Dr
SM, TX
78666
512-245-9201

Temp. taken with Vincent

Cooling process has begun Y (Y/N)

pH strips CIN ✓

General Comments: see date note COC pg 1

Sample to be subcontracted ❑ Yes ❑ No

FORM: 003COC REV. 2013 CIN = Chemical Inventory Number CF = correction factor °C = degrees centigrade Y = Yes N = No

(3)

# Subcontracted Analysis

Date: 2/23/22 Sample # ______________

Client Name Meadows Center

Analyses to be subcontracted:

EARDC Run Sample#
164881-90 &
164909-17

not subcontracted but work divided between EARDC & Ashley's lab (biology)

Subcontracting Lab:

____ San Antonio Testing Lab

____ LCRA Environmental Lab

____ GBRA Laboratory

____ Other Lab ______________________________

Client acknowledges that the analyses listed above will be subcontracted to the lab above.

Jenna Walker ______________________ 2/23/22 ______________

Client Signature Date

EARDC-SUBANALYSES-R0
Effective Date: 9/30/2019 (supersedes all previous versions)

**Water Analysis Report**

| Parameter | Results | MDL | Coefficient of Determination ($r^2$) | Date Analyzed | Analyst | Method |
|---|---|---|---|---|---|---|
| **Anions** | | | | | | |
| Fluoride | 1.0035 | 1 | 99.0564 | 2/28/22 | AC | EPA 300.1 A |
| Chloride | 1.0316 | 1 | 99.7994 | 2/28/22 | AC | |
| Nitrite ($NO_2$-N)* | 1.0906 | 1 | 99.3508 | 2/28/22 | AC | |
| Bromide | 1.0889 | 1 | 99.11 | 2/28/22 | AC | |
| Nitrate ($NO_3$-N)** | 1.0212 | 1 | 99.0157 | 2/28/22 | AC | |
| Phosphate ($PO_4$-P)*** | 1.0603 | 1 | 99.7019 | 2/28/22 | AC | |
| Sulfate | 1.0376 | 1 | 99.1843 | 2/28/22 | AC | |

| | Results (mg/L) | Expected (mg/L) | | %Recovery | Acceptable Range |
|---|---|---|---|---|---|
| Lab Blank | 0 | 0 | | 0 | <20 |
| LCS | 4.9306 | 5 | | 98.612 | 90-110% |
| Matrix Spike_1 | 0.9735 | 1 | | 97.35 | 90-110% |
| Matrix Spike_2 | 49.8887 | 50 | | 99.7774 | 90-110% |
| Sample Dup_1 | 2.5874 | | **Avg.** | 2.4839 | |
| Sample Dup_2 | 2.3804 | | **%RPD=** | 8.333668827 | 0-20% |

| Parameter | Results | MDL | Coefficient of Determination ($r^2$) | Date Analyzed | Analyst | Method |
|---|---|---|---|---|---|---|
| **Cations** | | | | | | |
| Lithium | 0.1055 | 0.1 | 99.4963 | 2/28/22 | AC | Standard Methods 2320B |
| Sodium | 0.1174 | 0.1 | 99.9784 | 2/28/22 | AC | |
| Ammonium [b] | 0.0968 | 0.1 | 99.7304 | 2/28/22 | AC | |
| Potassium | 0.1088 | 0.1 | 99.9744 | 2/28/22 | AC | |
| Magnesium | 0.0946 | 0.1 | 99.9908 | 2/28/22 | AC | |
| Manganese | 0.9843 | 0.1 | 99.3038 | 2/28/22 | AC | |
| Calcium | 0.9921 | 0.1 | 99.9857 | 2/28/22 | AC | |
| Strontium | 0.9981 | 0.1 | 99.8458 | 2/28/22 | AC | |
| Barium | 0.983 | 0.1 | 99.9659 | 2/28/22 | AC | |

[b]Quadratic fit

| | Results (mg/L) | Expected (mg/L) | | %Recovery | Acceptable Range |
|---|---|---|---|---|---|
| Lab Blank | 0 | 0 | | 0 | <20 |
| LCS | 24.9917 | 25 | | 99.9668 | 90-110% |
| Matrix Spike_1 | 1.1043 | 1 | | 110.43 | 90-110% |
| Matrix Spike_2 | 79.8644 | 80 | | 99.8305 | 90-110% |
| Sample Dup_1 | 11.665 | | **Avg.** | 11.5318 | |
| Sample Dup_2 | 11.3986 | | **%RPD=** | 2.310133717 | 0-20% |

| | | ANIONS | | | | | | | CATIONS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLE ID# | SAMPLE NAME | FLUORIDE (MG/L) | CHLORIDE (MG/L) | NITRITE (MG/L) | BROMIDE (MG/L) | NITRATE (MG/L) | PHOSPHATE (MG/L) | SULFATE (MG/L) | LITHIUM (MG/L) | SODIUM (MG/L) | AMMONIUM (MG/L) | POTASSIUM (MG/L) | MAGNESIUM (MG/L) | MANGANESE (MG/L) | CALCIUM (MG/L) | STRONTIUM (MG/L) | BARIUM (MG/L) |
| 164891 | SW7 LBR | 2.19 | 16.40 | 0.00 | 0.00 | 1.77 | 0.00 | 56.96 | 0.00 | 8.79 | 0.00 | 1.28 | 13.28 | 0.00 | 91.55 | 0.00 | 0.00 |
| 164892 | SW13 LBR | 2.47 | 16.97 | 0.00 | 0.00 | 1.74 | 0.00 | 61.78 | 0.00 | 9.03 | 0.00 | 1.24 | 13.46 | 0.00 | 96.85 | 0.00 | 0.00 |
| 164893 | SW19 LBR | 2.00 | 12.27 | 0.00 | 0.00 | 1.74 | 0.00 | 42.48 | 0.00 | 7.34 | 0.00 | 1.48 | 12.65 | 0.00 | 80.71 | 0.00 | 0.00 |
| 164894 | SW19 LBR DUP | 2.60 | 11.84 | 0.00 | 0.00 | 1.72 | 0.00 | 40.50 | 0.00 | 7.21 | 0.00 | 1.51 | 12.60 | 0.00 | 80.73 | 0.00 | 0.00 |
| 164895 | SW21 LBR | 1.72 | 12.03 | 0.00 | 0.00 | 1.54 | 0.00 | 22.49 | 0.00 | 6.85 | 0.00 | 1.95 | 11.43 | 0.00 | 58.20 | 0.00 | 0.00 |
| 164896 | SW29 LBR | 1.74 | 12.00 | 0.00 | 0.00 | 1.59 | 0.00 | 16.92 | 0.00 | 6.54 | 0.00 | 1.70 | 12.09 | 0.00 | 60.45 | 0.00 | 0.00 |
| 164897 | SW23 LBR | 1.88 | 12.46 | 0.00 | 0.00 | 1.53 | 0.00 | 21.15 | 0.00 | 6.98 | 0.00 | 1.82 | 11.78 | 0.00 | 57.56 | 0.00 | 0.00 |
| 164898 | SW25 LBR | 1.68 | 12.28 | 0.00 | 0.00 | 1.51 | 0.00 | 21.39 | 0.00 | 6.73 | 0.00 | 1.85 | 11.73 | 0.00 | 55.88 | 0.00 | 0.00 |
| 164899 | SW33 LBR | 1.76 | 10.24 | 0.00 | 0.00 | 1.50 | 0.00 | 14.24 | 0.00 | 5.91 | 0.00 | 1.74 | 13.22 | 0.00 | 50.20 | 0.00 | 0.00 |
| 164880 | W12 LBR | 2.41 | 9.50 | 0.00 | 0.00 | 3.34 | 0.00 | 12.76 | 0.00 | 6.79 | 0.00 | 2.11 | 13.40 | 0.00 | 82.84 | 0.00 | 0.00 |
| 164900 | W16 LBR | 2.23 | 11.08 | 0.00 | 0.00 | 6.73 | 0.00 | 8.56 | 0.00 | 6.07 | 0.00 | 1.27 | 8.61 | 0.00 | 106.98 | 0.00 | 0.00 |
| 164901 | W20 LBR | 3.79 | 17.32 | 0.00 | 0.00 | 1.52 | 0.00 | 347.69 | 0.00 | 13.36 | 0.00 | 3.54 | 52.14 | 0.00 | 121.75 | 16.78 | 0.00 |
| 164902 | W21 LBR | 3.72 | 10.50 | 0.00 | 0.00 | 4.09 | 0.00 | 82.63 | 0.00 | 6.81 | 0.00 | 1.83 | 24.80 | 0.00 | 80.28 | 12.06 | 0.00 |
| 164903 | W22 LBR | 4.65 | 16.65 | 0.00 | 0.00 | 1.70 | 0.00 | 320.33 | 0.00 | 13.04 | 0.00 | 3.86 | 58.45 | 0.00 | 101.77 | 19.56 | 0.00 |
| 164904 | W26 LBR | 5.11 | 13.57 | 0.00 | 0.00 | 1.87 | 0.00 | 165.59 | 0.00 | 10.16 | 0.00 | 3.09 | 47.73 | 0.00 | 77.34 | 17.61 | 0.00 |
| 164905 | W28 LBR DUP | 6.23 | 11.51 | 0.00 | 0.00 | 3.11 | 0.00 | 111.48 | 0.00 | 8.49 | 0.00 | 3.29 | 40.76 | 0.00 | 76.67 | 14.30 | 0.00 |
| 164906 | W28 LBR | 7.32 | 11.68 | 0.00 | 0.00 | 3.21 | 0.00 | 115.54 | 0.00 | 8.19 | 0.00 | 3.24 | 40.06 | 0.00 | 74.93 | 13.22 | 0.00 |
| 164907 | W31 LBR | 4.12 | 11.07 | 0.00 | 0.00 | 4.78 | 0.00 | 30.15 | 0.00 | 7.58 | 0.00 | 1.88 | 21.03 | 0.00 | 71.88 | 12.28 | 0.00 |
| 164908 | W35 LBR | 6.02 | 12.13 | 0.00 | 0.00 | 1.73 | 0.00 | 96.88 | 0.00 | 156.12 | 0.00 | 2.55 | 2.39 | 0.00 | 8.23 | 4.50 | 0.00 |

| DATE | TIME | SITE ID | DISCHARGE (CFS) | TEMPERATURE (°C) | PH (SU) | DO (MG/L) | CONDUCTIVITY (µS/CM) | DEPTH (FT) | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|
| 12/14/21 | | SW1 | 0 | | | | | | some flow from upper spring |
| 12/14/21 | | SW3 | 0 | | | | | | |
| 12/14/21 | | SW5 | 0 | | | | | | pooled water behind dam |
| 12/14/21 | 10:04 AM | SW9 | 1.5 | 15.5 | 7.8 | 8.6 | 587 | 1.8 | |
| 12/14/21 | 11:35 AM | SW11 | 2.9 | 16.3 | 7.7 | 7.8 | 590 | 2 | |
| 12/14/21 | 1:17 PM | SW13 | 2.7 | 16.6 | 7.7 | 7.9 | 587 | 1 | |
| 12/14/21 | 2:47 PM | SW15 | 3.27 | 16.5 | 7.5 | 7.6 | 575 | 0.3 | |
| 12/14/21 | 2:30 PM | SW17 | 2.33 | | | | | | NM? - I think flow was measured by Marcus, do you remember if wq was measured? Was it by me? |
| 12/14/21 | 3:00 PM | SW19 | 2.05 | | | | | | NM? - I think flow was measured by Marcus, do you remember if wq was measured? Was it by me? |
| 12/14/21 | 3:52 PM | SW21 | 0.49 | 17.1 | 7.8 | 9.1 | 430 | 2.2 | |
| 12/14/21 | 3:55 PM | SW23 | 1.67 | 17.5 | 8.1 | 9.9 | 433 | 0.9 | |
| 12/14/21 | 2:04 PM | SW25 | 1.3 | 16.9 | 8.2 | 9.9 | 427 | 0.9 | |
| 12/15/21 | 1:20 PM | SW27 | NM | 16.5 | 7.4 | 9.3 | 440 | 2.8 | Closer to W36 |
| 12/15/21 | 10:20 AM | SW29 | 1.4 | 18.1 | 8 | 9.8 | 459 | 0.3 | |
| 12/15/21 | 10:23 AM | SW31 | 1.5 | 18.3 | 8.3 | 11.3 | 729 | 1.5 | |
| 12/15/21 | 11:15 AM | SW33 | 0.78 | 19.9 | 8.2 | 10 | 411 | 0.15 | |
| 12/15/21 | 1:00 PM | SW35 | 0.0045 | 22.6 | 8.1 | 10.2 | 482 | 0.3 | Flow estimate in gpm. |
| 2/1/22 | 11:00 AM | SW13 | 3.6 | 13.1 | 7.8 | 8.7 | 577 | 1 | |
| 2/1/22 | 12:43 PM | SW9 | 1.97 | 13.3 | 7.8 | 9.1 | 585 | 1.3 | |

| DATE | TIME | SITE ID | WELL LEVEL | TEMPERATURE (°C) | PH (SU) | DO (MG/L) | CONDUCTIVITY (µS/CM) | COMMENTS |
|---|---|---|---|---|---|---|---|---|
| 4/26/22 | 12:45 PM | W12 | 80.7 | 19.7 | 6.88 | 9.1 | 430 | |
| 4/26/22 | 1:00 PM | W16 | 63.76 | 21.54 | 6.65 | 3.95 | 621 | |
| 4/26/22 | 1:45 PM | W18 | 135.4 | nm | nm | nm | nm | |
| 4/26/22 | 2:00 PM | W20 | nm | 21.54 | 7.09 | 6.4 | 1083 | |
| 4/26/22 | 2:30 PM | W21 | 58.1 | 20.83 | 6.79 | 4.5 | 581 | |
| 4/26/22 | 2:45 PM | W22 | 61.5 | 21.01 | 6.89 | 4.9 | 1081 | |
| 4/26/22 | 3:00 PM | W24 | 87.1 | nm | nm | nm | nm | |
| 4/26/22 | 3:15 PM | W26 | 79 | 20.56 | 6.84 | 0.13 | 972 | |
| 4/26/22 | 3:30 PM | W28 | 62.9 | 21.8 | 6.91 | 1.21 | 683 | |
| 4/26/22 | 4:00 PM | W36 | 59.1 | nm | nm | nm | nm | |
| 6/29/22 | 9:50 AM | W6 | | 21.7 | 6.88 | 4.92 | 486.5 | workshop, need to clarify which wells are which |
| 6/29/22 | 10:35 AM | W8 | N/A | 23.2 | 6.86 | 5.21 | 621 | tape hung at 95 ft |
| 6/29/22 | 11:00 AM | W12 | 139.12 | N/A | N/A | N/A | N/A | |
| 6/29/22 | 11:15 AM | W16 | 66.92 | 26.1 | 6.68 | 1.77 | 629.9 | |
| 6/29/22 | 11:45 AM | LBRR | N/A | N/A | N/A | N/A | N/A | Dry |
| 6/29/22 | 11:52 AM | W20 | 51.91 | 22.6 | 6.95 | 4.1 | 1079 | |
| 6/29/22 | 12:05 PM | W21 | 59.9 | 21.9 | 7.04 | 6.43 | 586.8 | |
| 6/29/22 | 12:20 PM | W22 | 62.23 | 22.48 | 7.18 | 7.76 | 649.3 | pumping, 61.62 not pumping |
| 6/29/22 | 1:00 PM | W24 | 97.05 | N/A | N/A | N/A | N/A | |
| 6/29/22 | 1:05 PM | W26 | 94.66 | 25.6 | 7.15 | 5.44 | 965.5 | by creek, pump on |
| 6/29/22 | 1:20 PM | W28 | 85.45 | 22.7 | 6.83 | 0 | 667.8 | |
| 6/29/22 | 2:15 PM | W34 | N/A | 24.2 | 6.72 | 1.44 | 1906 | |
| 6/29/22 | 2:50 PM | W36 | nm | 25.1 | 7.28 | 6.89 | 740.3 | |
| 6/29/22 | 3:30 PM | W31 | n/a | 21.4 | 6.9 | 1.57 | 539.3 | |
| 6/29/22 | | SW1 | | | | | | some flow from upper spring |
| 6/29/22 | | SW3 | | | | | | dry |
| 6/29/22 | | SW5 | | | | | | dry |

| DATE | TIME | SITE ID | WELL LEVEL | TEMPERATURE (°C) | PH (SU) | DO (MG/L) | CONDUCTIVITY (μS/CM) | COMMENTS |
|---|---|---|---|---|---|---|---|---|
| 6/29/22 | | SW9 | | | | | | dry |
| 6/29/22 | | SW11 | | | | | | dry |
| 6/29/22 | | SW13 | | | | | | dry |
| 6/29/22 | | SW15 | | | | | | dry |
| 6/29/22 | 1:34 PM | SW17 | 0.2 | 31.3 | 8.19 | 11.66 | 414.6 | |
| 6/29/22 | 1:53 PM | SW19 | 0.2 | 28.2 | 7.26 | 8.04 | 592.8 | |
| 6/29/22 | 3:40 PM | SW21 | 0.1 | 32.35 | 7.79 | 9.55 | 429.7 | pooled |
| 6/29/22 | 3:30 PM | SW23 | 0.2 | 32.1 | 8.17 | 11.11 | 392.7 | |
| 6/29/22 | 2:25 PM | SW25 | 0.2 | 34.1 | 7.99 | 10.9 | 402.3 | |
| 6/29/22 | 2:40 PM | SW27 | 0.3 | 30.94 | 8.12 | 10.51 | 322 | |
| 6/29/22 | 3:15 PM | SW29 | 0.1 | 33.7 | 8.58 | 12.2 | 340.7 | pooled |
| 6/29/22 | 3:10 PM | SW31 | 0.1 | 32.1 | 8.27 | 10.04 | nm | pooled |
| 6/29/22 | 3:00 PM | SW33 | 0.1 | 37.1 | 7.5 | 0 | 1380 | pooled |


THE MEADOWS CENTER
FOR WATER AND THE ENVIRONMENT
TEXAS STATE UNIVERSITY

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