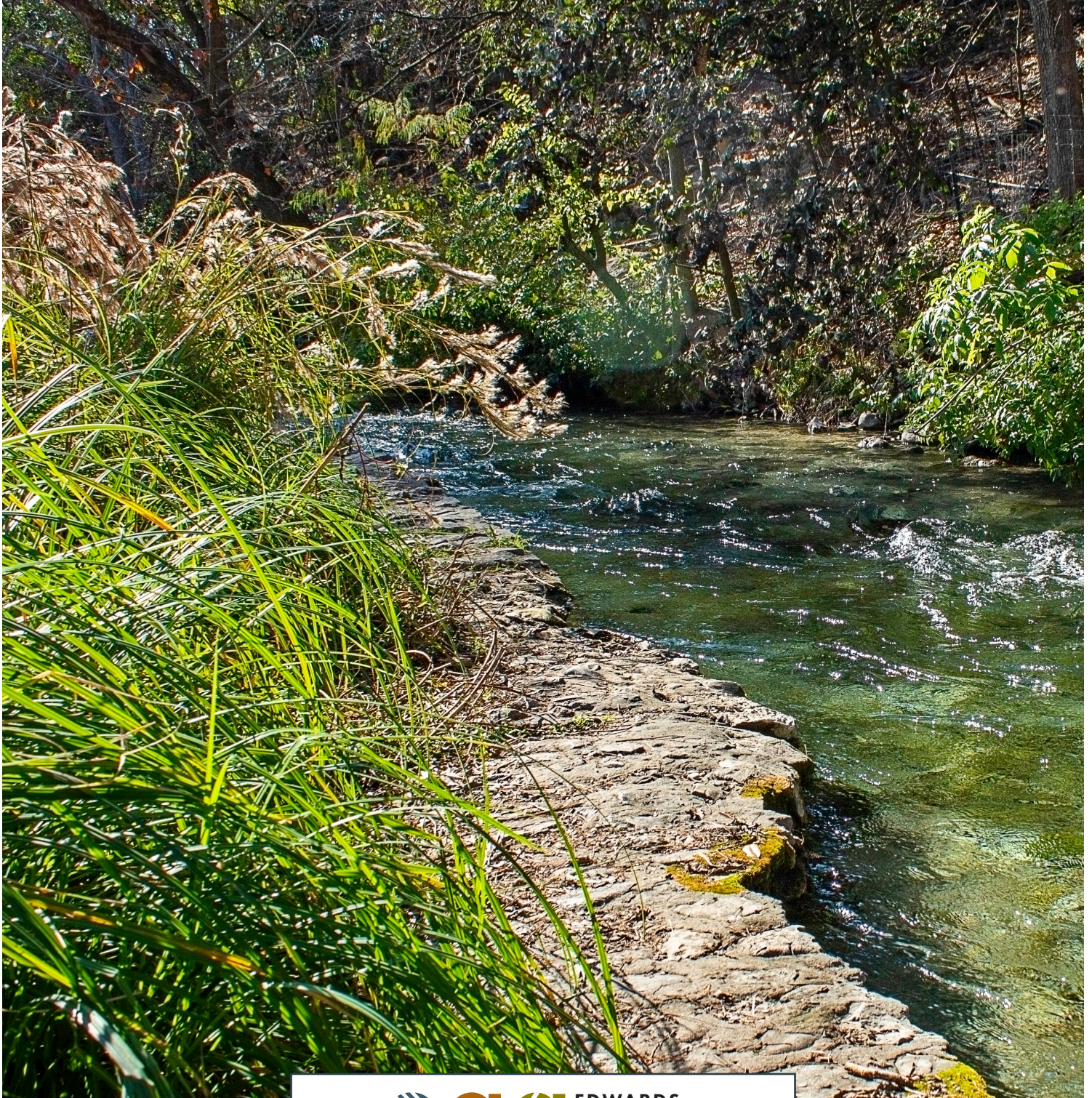


WATER QUALITY SUMMARY 2019



EDWARDS
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Background

The Edwards Aquifer Authority (EAA) monitors the quality of water in the Edwards Aquifer by sampling streams, wells, and springs across the region.

The Edwards Aquifer is a karst groundwater system formed by the dissolution of limestone bedrock. Dissolution occurs as rainwater or groundwater chemically reacts with limestone. This process significantly enhances the permeability of the Edwards Aquifer by creating caves, sinkholes, and other features through which water moves. The Aquifer can be divided into three main hydrologic zones, each with distinct characteristics: perennial and intermittent streams in the Contributing Zone, rapid recharge and fast groundwater velocities in the Recharge Zone, and highly productive wells and large spring systems in the Artesian Zone.

Water quality in the Contributing Zone is affected by both rainfall and evaporation and may change rapidly in response to storm events. Similarly, water quality in the Recharge Zone can change quickly and vary significantly due to stream infiltration from the Contributing Zone, direct rainfall, and rapid groundwater velocities. However, water quality in the deep Artesian Zone is generally more stable because of slower groundwater velocities and larger volumes of water available for dilution.

How We Monitor

The Edwards Aquifer is a unique and vulnerable asset. Therefore, the EAA established a comprehensive monitoring program to assess the quality of water throughout the Aquifer system. Water quality sampling consists of “grab” samples taken from streams, wells, and springs at specific times throughout the year. Grab samples are small discrete volumes of water that represent the composition of water present at a particular site and time.

Streams are generally sampled over the Recharge Zone. The resulting data is used to monitor the quality of water entering the Aquifer. Wells located throughout the Recharge and Artesian zones are sampled to assess the quality of groundwater within the Aquifer. Samples taken at springs provide composite data on water quality across the entire Aquifer system, reflecting contributions from recharge, groundwater, and surface water. Map 1 shows the locations of sampling sites and boundaries of each hydrologic zone.

Sampling in 2019

EAA staff collected grab samples from eight streams, 29 wells, and five spring groups between January and October 2019 (see Map 1). Water quality information for previous

years can be accessed online at www.edwardsaquifer.org/science-maps/research-scientific-reports/hydrologic-data-reports.

The results of laboratory analysis show that high quality water recharges and is produced by the Edwards Aquifer, making it suitable for a wide range of uses. Although most samples in 2019 contained no detectable contaminants, compounds of concern that were detected typically had concentrations less than their maximum contaminant levels (MCLs) established by the US Environmental Protection Agency (US EPA).

Understanding Results

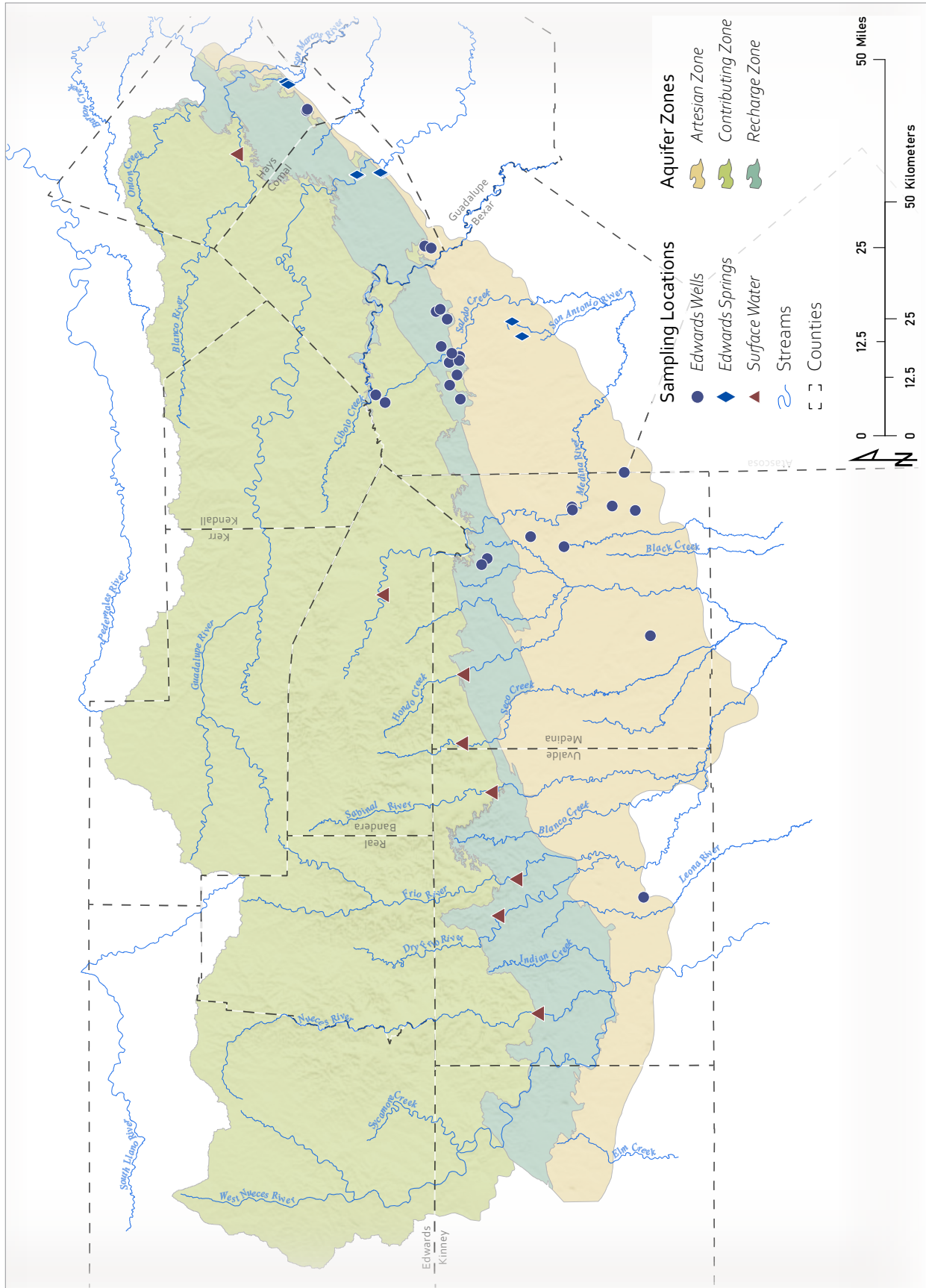
Water quality samples were analyzed for bacterial (E. coli), nutrient, dissolved metal, volatile organic compound (VOC), semivolatile organic compound (SVOC), pesticide, herbicide, and polychlorinated biphenyl compound (PCB) content.

Concentrations of individual chemical compounds (analytes) are reported in micrograms of chemical per liter of sampled water ($\mu\text{g/L}$). This unit is equivalent to parts per billion (ppb). Bacterial content is reported in units of most probable number per 100 milliliters of water (MPN/100 mL), a statistically informed value produced by laboratory analysis. This unit estimates the E. coli population per 100 mL of sampled water.



Above: Seco Creek, a major stream that recharges the Edwards Aquifer. Lower right: Preparation for well water quality sampling. Lower left: Restored channel of the springfed San Marcos River.

On the cover: Ongoing successful restoration at Comal Springs. Native trees stabilize the soil over Edwards Limestone rock outcrops, while replanted native grasses support birds, insects, and other organisms. These conservation efforts and others ensure the longterm quality and supply of Edwards Aquifer water.



Map 1. The map shows the locations for water quality samples collected by EAA staff in 2019. The samples represent 8 streams, 29 wells, and 5 spring groups. Samples were obtained from the Contributing, Recharge, and Artesian zones of the Edwards Aquifer.

Disclaimer: This map was created for demonstrative use by the Edwards Aquifer Authority (EAA) and not intended for other purposes. This map is to be used as an informational tool only.

Streams

Streams play an important role in the recharge of the Edwards Aquifer. Discharge from gravity-fed springs and runoff from precipitation accumulates as Hill Country streams in the Contributing Zone of the Aquifer. These streams flow south across the Recharge Zone, where the porous Edwards Limestone is exposed at the surface. As the streams cross this hydrologic zone, they lose all or most of their baseflow as recharge infiltrating through the base of the streams and into the Aquifer. To help assess the quality of this resource, the EAA samples stream water at eight sites within the Contributing and Recharge zones. The locations of sampling sites is shown below in Map 2. These data provide water quality insights for a major component of overall recharge to the Aquifer system.

The Nueces River is the westernmost stream that drains the Edwards Plateau, originating as two spring-fed forks in Real County and terminating at Corpus Christi Bay. Along its upper reach, baseflow from the Nueces descends into its abundant gravels and reappears as gravity fed springs. The Dry Frio and Frio Rivers also arise in Real County, flowing together near the town of Knippa. Garner State Park has provided access to the cool waters of Frio River for decades. Near the town of Three Rivers, the Frio River flows into the Nueces River.

The Sabinal River arises from springs near Lost Maples State Natural Area, in Bandera County, and joins with the Frio River. Seco Creek similarly arises from springs in Bandera County and flows into Hondo Creek. A portion of Seco Creek's high flow enters the Seco Creek Sinkhole, directly recharging the Edwards Aquifer. Hondo Creek arises from springs in Bandera County, near Seco Creek, and flows into the Frio River near the town of Pearsall. The Medina River arises from springs in Bandera County and flows into the

San Antonio River, south of San Antonio. Along its length, it is dammed to form Medina Lake. The Blanco River arises from headsprings in northeastern Kendall County, flowing eastward into the San Marcos River.

Streams sampling

Eight water quality samples were collected by EAA staff in 2019, one each from the Nueces River, Dry Frio and Frio Rivers, Sabinal River, Seco Creek, Hondo Creek, Medina River, and Blanco River. Samples were generally collected at or near USGS gauging stations located near the Recharge Zone. These samples were analyzed for bacterial (*E. coli*), dissolved metal, nutrient, semivolatile organic compound (SVOC), pesticide and herbicide, and polychlorinated biphenyl compound (PCB) concentrations.

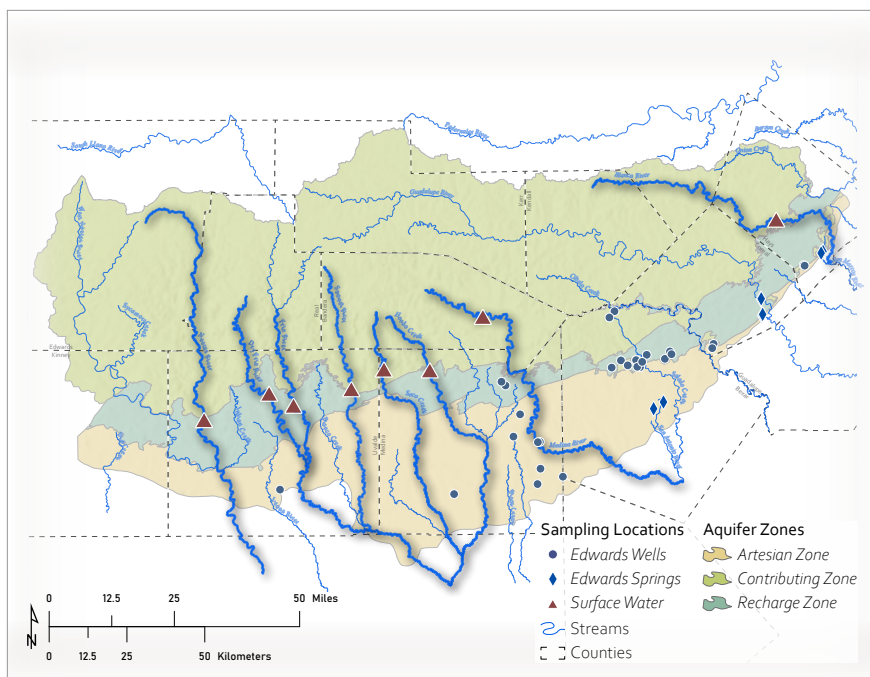
Results of streams sampling

Table 1 summarizes the analysis of eight stream water samples for concentrations of bacteria (*E. coli*), nutrient, dissolved metal, semivolatile organic compound (SVOC), herbicide and pesticide, and polychlorinated biphenyl (PCB) compounds. Since uses of stream water are generally limited to contact recreation, such as paddling and wading, bacterial content analyses are compared to TCEQ's Contact Recreation Standard (CRS). Five samples were found to exceed the CRS for bacteria.

Figure 1 provides additional detail for individual analytes that were detected in stream water samples. Bacteria, nutrient, and dissolved metals that were detected at trace and measurable concentrations have been included. *E. coli* was detected in five samples above the CRS of 126 MPN/100 mL. The presence of *E. coli* indicates that water may be

contaminated by human or animal wastes. Elevated bacterial levels in surface water can be caused by a variety of events, such as high rainfall and runoff. The dissolved metals aluminum, barium, boron, chromium, iron, manganese, strontium, vanadium, and zinc were detected at concentrations ranging from trace to measurable. Many dissolved metals occur naturally in Edwards Aquifer groundwater, originating from minerals that comprise the host rock. Nitrate was present at a measurable concentration in one sample and at trace concentrations in all others.

Map 2. Locations of eight sampling sites on major streams that cross the Contributing Zone and enter the Recharge Zone. The streams sampled in 2019 are, from west to east: the Nueces River, Dry Frio and Frio Rivers, Sabinal River, Seco Creek, Hondo Creek, Medina River, and Blanco River.



STREAM WATER QUALITY SUMMARY, CALENDAR YEAR 2019

Water Quality Parameter Group	Number of Samples Collected	Number of Detections Exceeding CRS
Bacteria (E. coli)	8	5
Metals	8	-
Nutrients	8	-
Semivolatile Organic Compounds (SVOCs)	8	-
Pesticide and Herbicide Compounds	8	-
Polychlorinated Biphenyl Compounds (PCBs)	8	-

Table 1. Summary of stream water sampling and concentrations of analytes in six water quality parameter groups. Bacterial samples are compared with contact recreation standards as published in Texas Surface Water Quality Standards (Title 30, Chapter 307 of the Texas Administrative Code), available online at www.tceq.texas.gov/waterquality/standards/2014standards.html. The complete set of water quality data used in the 2019 Water Quality Summary is available via an open records request through the EAA's Contact Us webpage www.edwardsaquifer.org/eea/contact-us.

DETECTED ANALYTE CONCENTRATIONS IN STREAMS

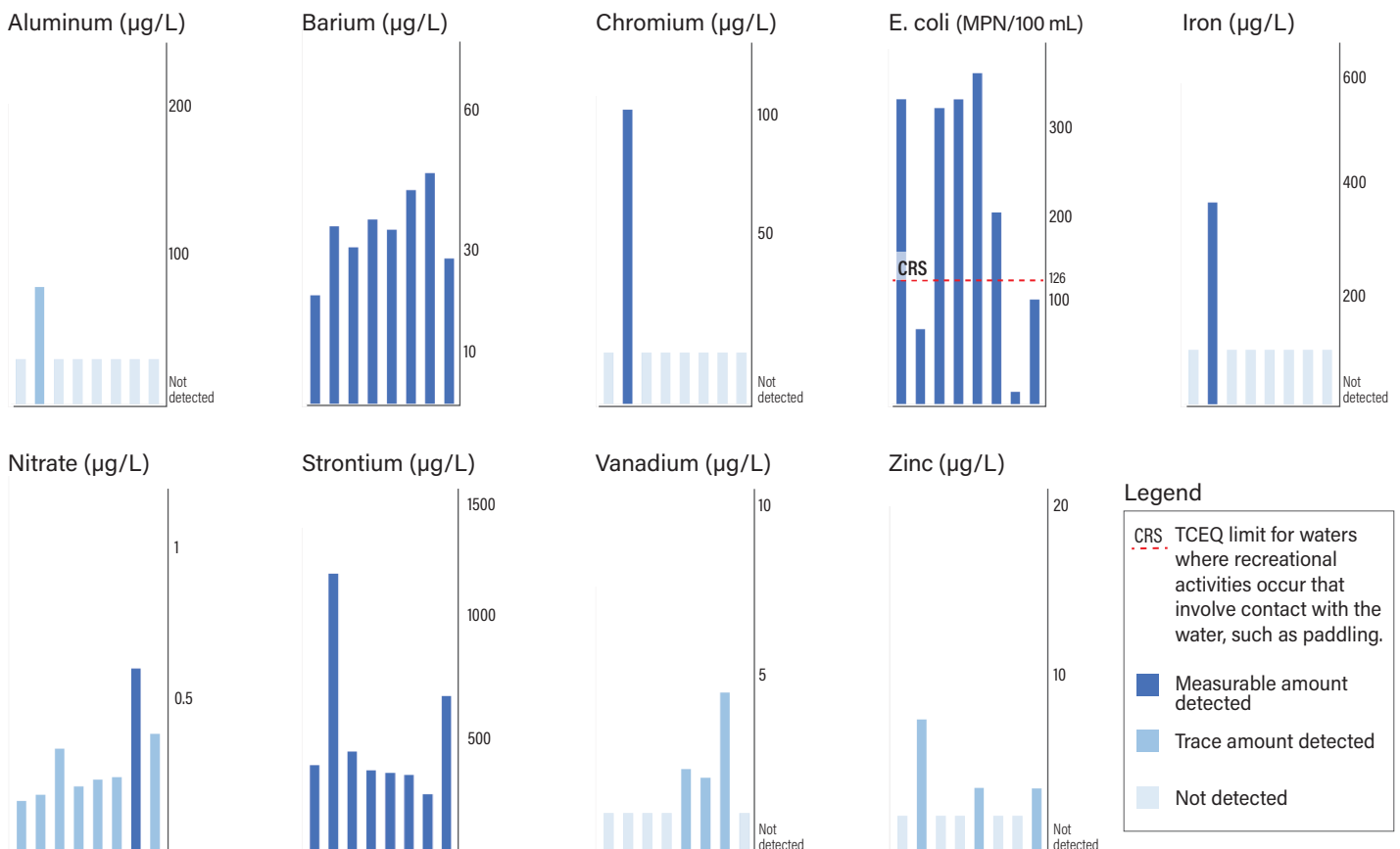


Figure 1. Barcharts of concentrations for individual analytes that had trace or measurable detections from one or more samples.

Wells

Thousands of wells throughout south central Texas pump water from the Edwards Aquifer to support municipal, agricultural, and livestock uses. The Aquifer is well known for yielding large volumes of high quality water. In order to monitor water quality trends within these wells and across the system, a selection of wells is sampled for laboratory analysis. In 2019, 29 wells were sampled across the Recharge, and Artesian Zones of the Aquifer.

Wells sampling

The EAA regularly participates in two interagency sampling efforts, in addition to providing sampling in support of locally focused projects. The National Water-Quality Assessment (NAWQA), a program of the United States Geological Survey (USGS), was established by the US Congress in 1991 to measure national water quality and track changes over time. In Bexar County, wells were constructed in the northwestern part of the county and regularly sampled by both the USGS and the EAA. In 2019, nine NAWQA wells were sampled by EAA staff. The EAA also participates in the Texas Water Development Board's (TWDB) groundwater quality sampling program. Like the NAWQA, TWDB's sampling program monitors the quality of water in Texas aquifers through time. In 2019, 15 wells in Bexar and Medina counties were sampled for the TWDB.

Additionally, the EAA collected water quality samples from wells throughout its jurisdiction that have been historically sampled. The overall selection of wells reflects a snapshot of the fresh Edwards Aquifer water used throughout the region. Sampled well locations are shown below in Map 3. Samples were analyzed for bacteria, dissolved metal, nutrient, volatile organic compound (VOC), semivolatile

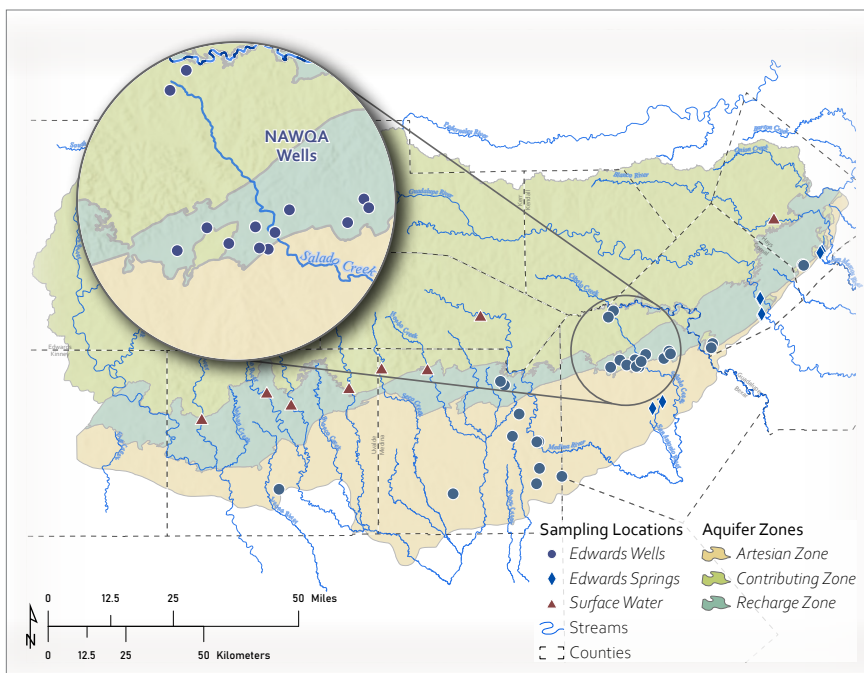
organic compound (SVOC), pesticide, herbicide, and polychlorinated biphenyl compound (PCB) concentrations.

Results of wells sampling

Since Edwards Aquifer well water is used for a variety of purposes, including household drinking water, sample results are compared to limits established in the Safe Drinking Water Act by the US EPA, which are incorporated into the Texas Administrative Code. Maximum contaminant levels (MCLs) are legal limits on the concentrations of specific chemical compounds and are intended to protect public health. The US EPA has also established secondary maximum concentration limits (SMCLs), which are intended as guidelines for aesthetic properties such as taste and smell. Unlike MCLs, SMCLs are not binding and do not indicate health risk.

Table 2 indicates the number of samples that were taken from wells and analyzed for levels of particular parameter groups. In the Edwards Aquifer wells sampled, most dissolved metals were not detected above their MCL; however, one sample contained an exceedance of its SMCL. Bacteria was detected in five samples. No chemicals in VOC, SVOC, herbicide and pesticide, or PCB groups were detected in concentrations exceeding their respective MCLs.

Figure 2 provides additional detail for individual analytes that were detected in well water samples. Bacteria, chemicals, nutrients, and dissolved metals that were detected at trace and measurable concentrations have been included. MCLs are indicated where applicable for comparison. The VOC acetone was detected in a single sample. The dissolved metals barium, boron, chromium, iron, manganese, strontium, vanadium, and zinc were detected at concentrations ranging from trace to measurable. The concentration of iron in a single sample exceeded its SMCL of 300 ug/mL. Many dissolved metals occur naturally in Edwards Aquifer groundwater, originating from minerals that comprise the host rock. Nitrate was detected in all samples at measurable concentrations below its MCL. E. coli was detected in five samples above the drinking water standard of zero MPN/100 mL. The presence of E. coli indicates water may be contaminated by human or animal wastes. Bacterial detections in groundwater can be caused by a variety of events, such as leaking septic tanks.



Map 3. Locations of 29 Edwards wells sampled in 2019 for water quality analysis. NAWQA wells are located in Bexar County, on the Recharge and Contributing zones. Wells sampled for the TWDB are located in Bexar and Medina counties.

WELL WATER QUALITY SUMMARY, CALENDAR YEAR 2019

Water Quality Parameter Group	Number of Samples Collected	Number of Detections Exceeding MCL
Bacteria (E. coli)	24	5
Metals	29	1
Nutrients	29	0
Volatile Organic Compounds (VOCs)	24	0
Semivolatile Organic Compounds (SVOCs)	27	0
Pesticide and Herbicide Compounds	29	0
Polychlorinated Biphenyl Compounds (PCBs)	12	0

Table 2. Summary of water sampling and concentrations of analytes in seven water quality parameter groups. Results are compared to primary and secondary drinking water standards established by the US EPA and adopted by the State of Texas in Title 30 of the Texas Administrative Code, Chapter 290, Subchapter F, available online at www.sos.state.tx.us/tac/index.shtml. The complete set of water quality data used in the 2019 Water Quality Summary is available via an open records request through the EAA's Contact Us webpage www.edwardsaquifer.org/eea/contact-us.

DETECTED ANALYTE CONCENTRATIONS IN WELLS

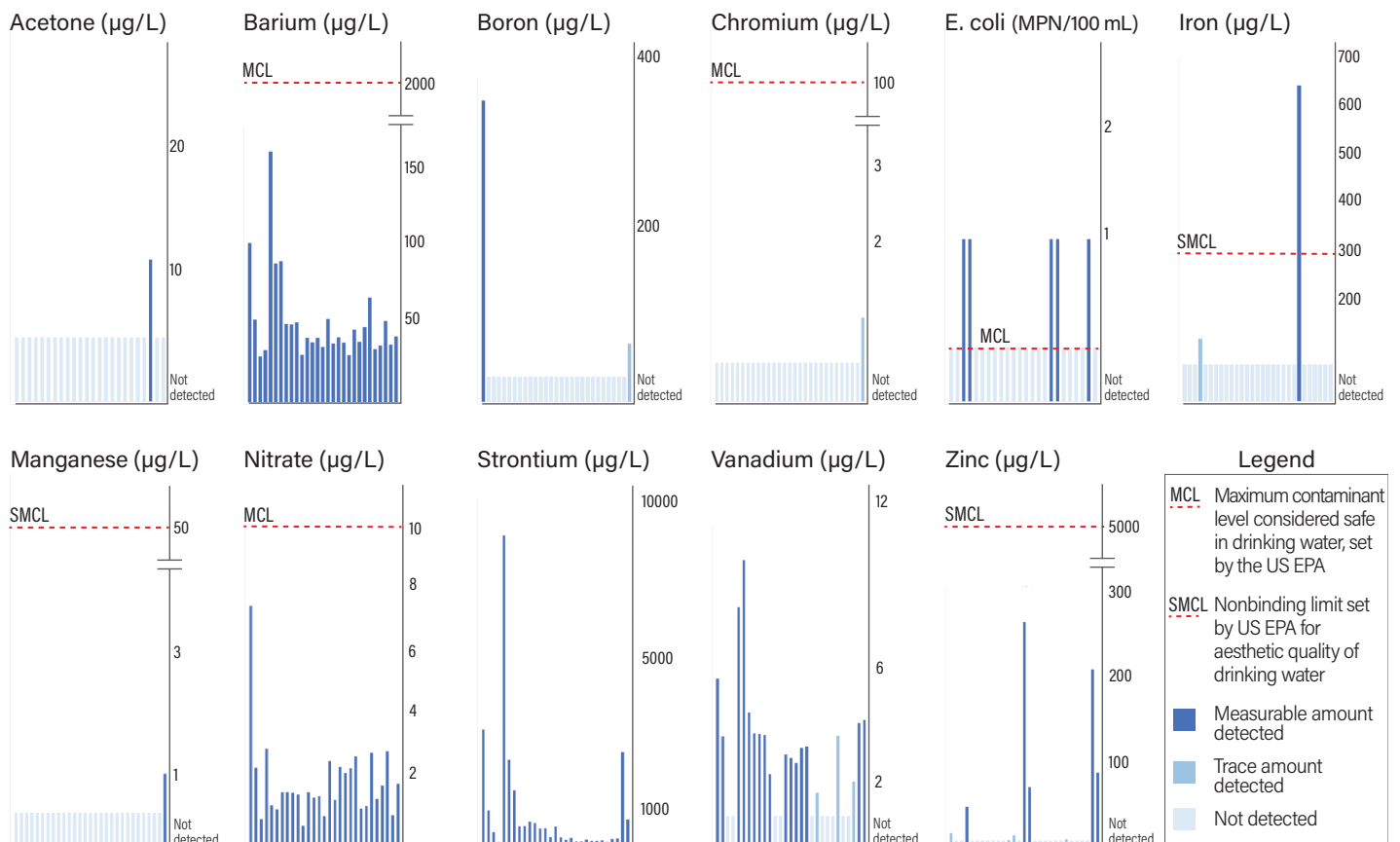


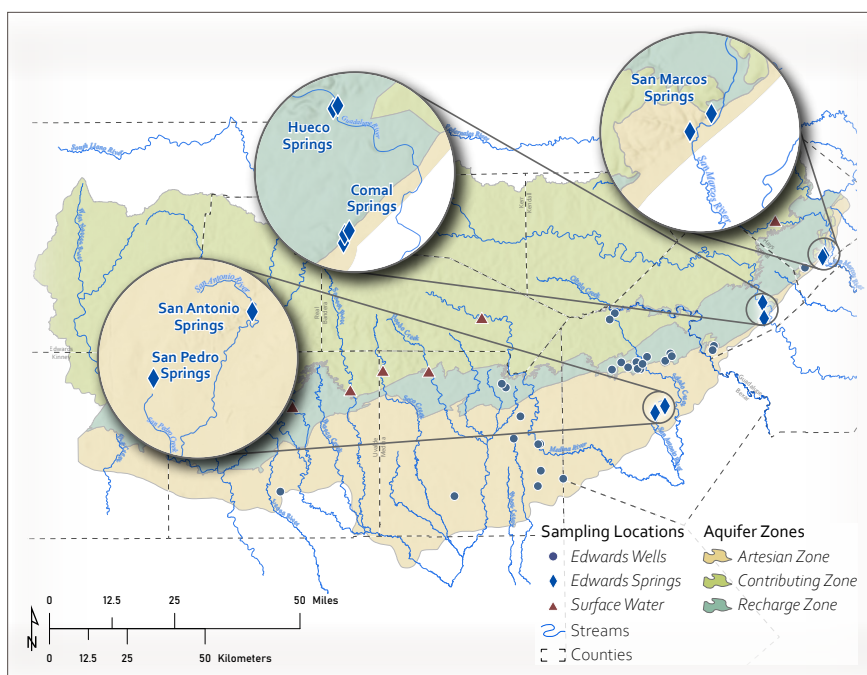
Figure 2. Barcharts of concentrations for individual analytes that had trace or measurable detections from one or more samples.

Springs

Water that flows overland via the streams and rivers of the Contributing Zone and enters the Edwards Aquifer in the Recharge Zone emerges aboveground as numerous springs. These springs host diverse, unusual plant and animal communities and have anchored human settlements for hundreds of years. Water that is discharged at these springs is a composite of the many contributions to the Edwards Aquifer. Five major spring groups are monitored by the EAA for water quality, shown below in Map 4.

Seven federally listed endangered and threatened species depend on the Comal Springs and San Marcos spring systems, including Texas wild rice (*Zizania texana*) and the San Marcos salamander (*Eurycea nana*). To protect these species, the Edwards Aquifer Habitat Conservation Plan (EAHCP) implements habitat protection, springflow protection, and supporting measures in partnership with local and federal stakeholders. More information on the EAHCP is available online at www.edwardsaquifer.org/habitat-conservation-plan. Hueco Springs is located on the banks of the Guadalupe River, near Comal Springs. All three spring systems emerge in outcrops of the Edwards Limestone.

The San Antonio River headwaters are formed by the San Antonio Springs, the best known of which is the Blue Hole, located on the University of the Incarnate Word campus. The Blue Hole spring only flows when the Aquifer level is sufficiently high; therefore, it is frequently dry during the summer and early fall. The nearby San Pedro Springs form the headwaters of San Pedro Creek, located on the grounds of San Pedro Park. Both the San Antonio and San Pedro spring systems emerge in outcrops of Austin Chalk in the Artesian Zone.



Springs sampling

These five spring systems throughout the EAA's jurisdiction were sampled twice in 2019, once each in March and September. This sampling interval captured information about the health of the Edwards Aquifer spring systems during high and low flow conditions. A total of 17 samples were analyzed for bacterial (*E. coli*), nutrient, dissolved metal, volatile organic compound (VOC), semivolatile organic compound (SVOC), pesticide and herbicide, and polychlorinated biphenyl compound (PCB) concentrations.

Results of springs sampling

Since uses of Edwards Aquifer spring water are limited to contact recreation, such as paddling and wading, bacterial content analyses are compared to TCEQ's Contact Recreation Standard (CRS).

Table 3 indicates the number of samples that were taken from springs and analyzed for levels of particular parameter groups. Bacterial detections did not exceed the CRS. No VOCs, SVOCs, pesticides, herbicides, or PCBs were detected in spring water samples.

Figure 3 provides additional detail for individual analytes that were detected in spring water samples. Bacteria, nutrient, and dissolved metals that were detected at trace and measurable concentrations have been included. While *E. coli* was detected in five samples, none exceeded the CRS of 126 MPN/100 mL. The presence of *E. coli* indicates water may be contaminated by human or animal wastes. Measurable but low concentrations of nitrate were found in all 17 samples. The dissolved metals barium, strontium, and vanadium were detected at concentrations ranging from trace to measurable. These metals frequently originate from minerals in the limestone host rock.

Map 4. San Antonio Spring is located at the headwaters of the San Antonio River, while San Pedro Springs provide flow for San Pedro Creek. Comal Springs feeds the Comal River, which winds through New Braunfels' Landa Park into the Guadalupe River. Nearby Hueco Springs also flow into the Comal River. The San Marcos Springs are the headwaters of the San Marcos River, which flows through Texas State University and San Marcos City Park.

SPRING WATER QUALITY SUMMARY, CALENDAR YEAR 2019

Water Quality Parameter Group	Number of Samples Collected	Number of Detections Exceeding CRS
Bacteria (E. coli)	17	0
Metals	17	-
Nutrients	17	-
Volatile Organic Compounds (VOCs)	17	-
Semivolatile Organic Compounds (SVOCs)	17	-
Pesticide and Herbicide Compounds	17	-
Polychlorinated Biphenyl Compounds (PCBs)	17	-

Table 3. Summary of springs sampling and concentrations of seven water quality parameter groups. Bacterial samples are compared with contact recreation standards (CRS) as published in Texas Surface Water Quality Standards (Title 30, Chapter 307 of the Texas Administrative Code), available online at www.tceq.texas.gov/waterquality/standards/2014standards.html. The complete set of water quality data used in the 2019 Water Quality Summary is available via an open records request through the EAA's Contact Us webpage www.edwardsaquifer.org/eea/contact-us.

DETECTED ANALYTE CONCENTRATIONS IN SPRINGS

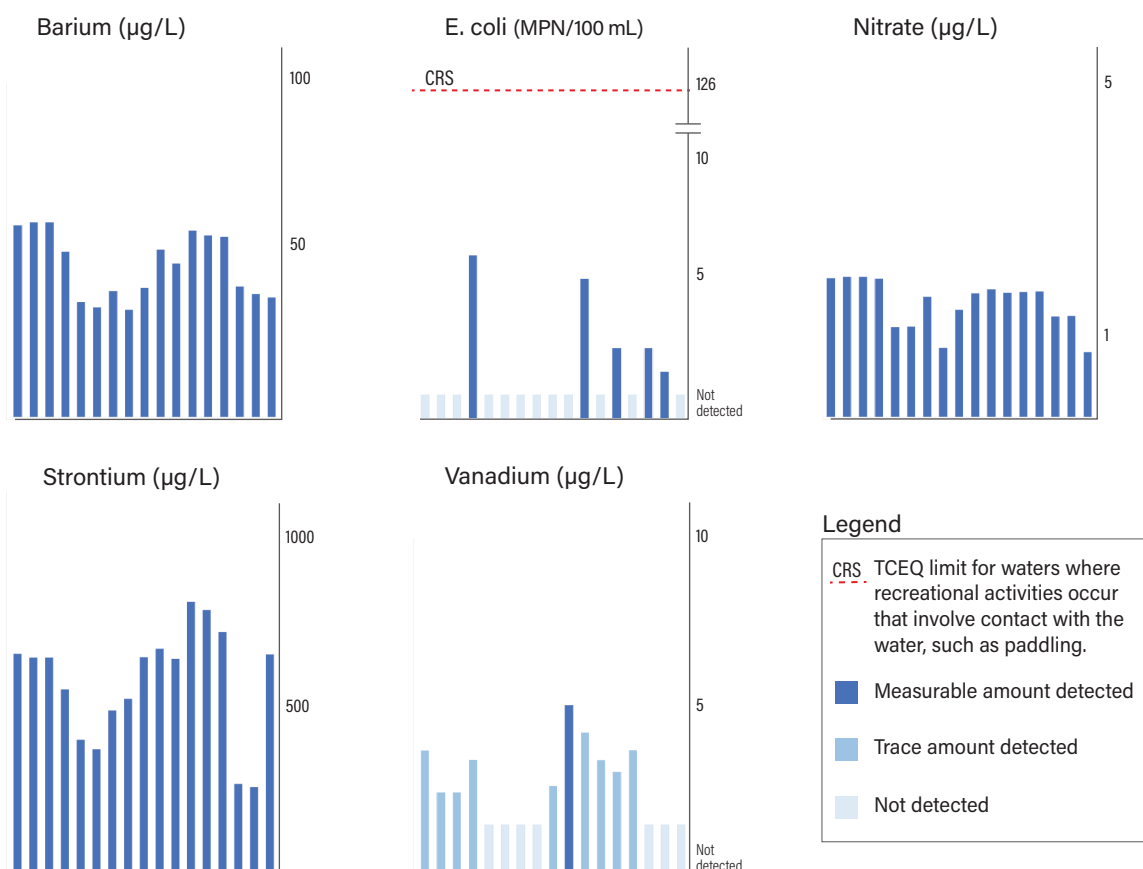


Figure 3. Barcharts of concentrations for individual analytes that had trace or measurable detections from one or more samples.

Summary

The EAA's sampling program provides data about the quality of water entering the Aquifer from surface streams, groundwater moving through the Aquifer, and the composite water that emerges at springs. The results of laboratory analysis for concentrations of bacteria, nutrient, dissolved metal, VOC, SVOC, pesticide, herbicide, and PCB compounds reveal that high quality water is present throughout the Edwards Aquifer system. Most water sampled from streams, wells, and springs did not have detectable levels of contaminants. Concentrations of dissolved metals were generally low and attributed to natural sources. In streams and springs, bacterial detections were likely caused by contamination from stormwater runoff and non-point sources.

Overall, the Edwards Aquifer produces some of the highest quality groundwater in the State of Texas. The EAA will continue to monitor water quality of the Contributing, Recharge, and Artesian Zones in its mission to manage, enhance, and protect the Edwards Aquifer.

Resources

Edwards Aquifer Habit Conservation Plan: <https://www.edwardsaquifer.org/habitat-conservation-plan/>

Edwards Aquifer Hydrologic Reports: <https://www.edwardsaquifer.org/science-maps/research-scientific-reports/hydrologic-data-reports/>

Edwards Aquifer Open Records Request: <https://www.edwardsaquifer.org/eea/contact-us/>

EPA Drinking Water Standards: <https://www.epa.gov/dwreginfo/drinking-water-regulations/>

National Water-Quality Assessment (USGS): <https://www.usgs.gov/mission-areas/water-resources/science/national-water-quality-assessment-nawqa/>

TCEQ Contact Recreation Standards: <https://www.tceq.texas.gov/waterquality/standards/2014standards.html/>

Texas Administrative Code: <https://www.sos.state.tx.us/tac/index.shtml/>

Texas Water Development Board groundwater quality sampling program: <http://www.twdb.texas.gov/groundwater/data/index.asp/>

Clockwise from top left: Pump used to sample water from wells. Amber glass sample bottles. WelIntel system used to remotely measure water levels. Array of sample containers. Deep pool in the Nueces River. Clear, cool water at Comal Springs. The Guadalupe River at Guadalupe River State Park. Honey Creek near its headwaters. View of the Hill Country near Seco Creek, in the Contributing Zone.

