WATER QUALITY SUMMARY 2021

EDWARDS AQUIFER AUTHORITY

Background

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

The Aquifer is a karst groundwater system formed by the dissolution of limestone bedrock. Dissolution occurs as rainwater or groundwater chemically reacts with limestone. The 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 because of 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 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 Contributing and Recharge zones. 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 collected at springs provide composite data on water quality across the entire Aquifer system, reflecting contributions from recharge, groundwater, and surface water. Map 1 shows sample locations and boundaries of each hydrologic zone.

Sampling in 2021

EAA staff collected grab samples from eight streams, 34 wells, and four spring groups between January and September 2021 (see Map 1). Water quality information for previous years can be accessed online at https://www.edwardsaquifer.org/science-maps/research-scientific-reports/hydrologic-data-reports/.

The results of laboratory analysis show that high-quality water enters and is produced by the Aquifer, making it suitable for a wide range of uses, such as municipal, agricultural, and livestock. Although most samples in 2021 contained no detectable contaminants, compounds of concerns that were detected typically had concentrations less than their maximum contaminant levels (MCLs) established by the US Environmental Protection Agency (US EPA).

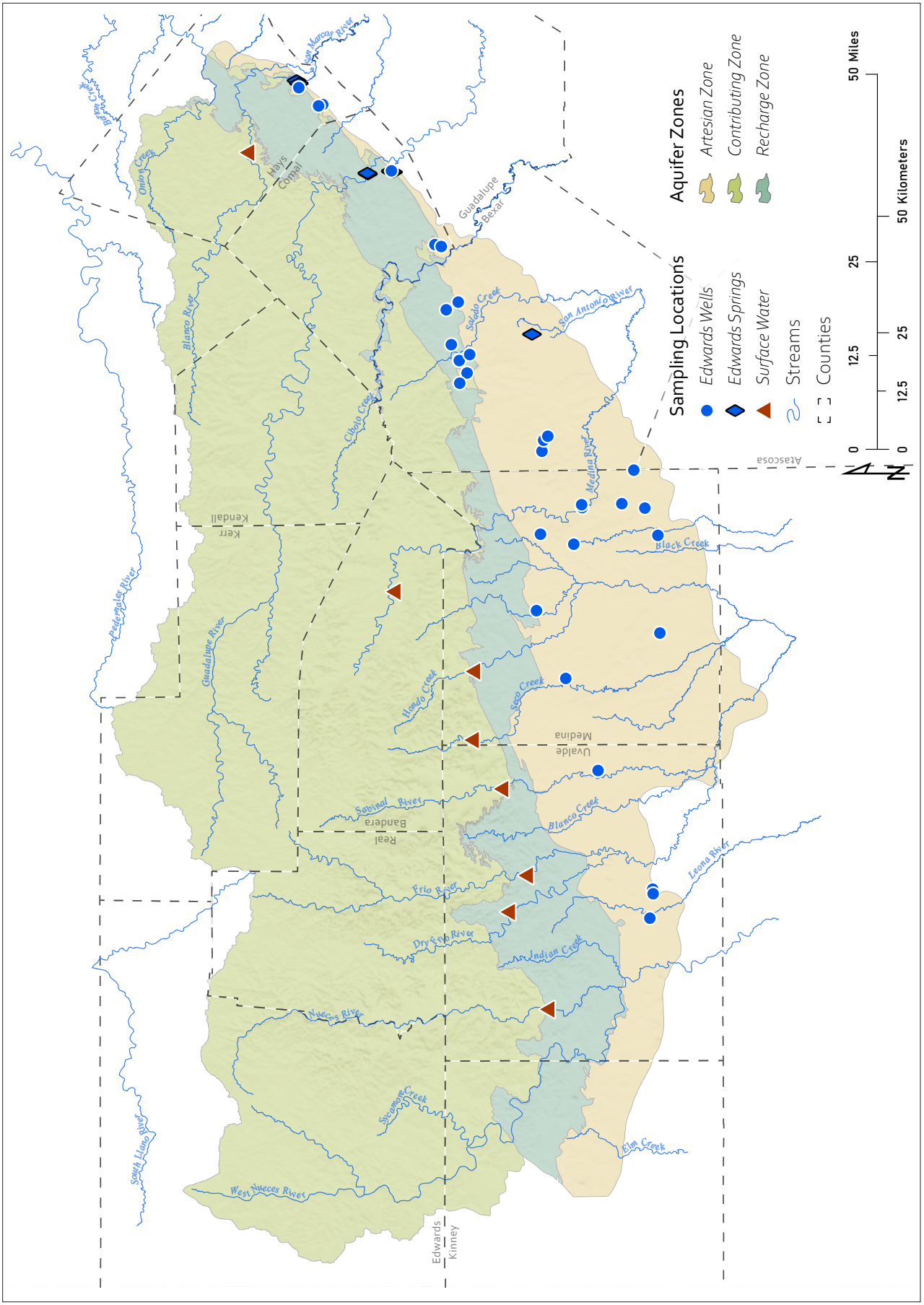
Understanding Results

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 per liter of sampled water (µg/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: Comal Springs, New Braunfels, TX. Lower left: Restored channel of the springfed San Marcos River.

On the cover: Texas wild rice (Zizania texana) thrives in the upper reaches of the San Marcos, River, TX. Continual conservation efforts provided by the Edwards Aquifer Habitat Conservation Plan and local citizens help keep this endgangered species protected.



Map 1. The map shows the locations for water quality samples collected by EAA staff in 2021. The samples represent eight streams, 34 wells, and four 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 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 though 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 sample locations are 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 (Nueces) is the westernmost stream that drains the Edwards Plateau, originating at 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 water of Frio River for decades. Near the town of Three Rivers, the Frio River flows into the Nueces.

The Sabinal River arises from springs near Lost Maples State Natural Area, 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 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 headwater springs in northeastern Kendall County, flowing eastward into the San Marcos River.

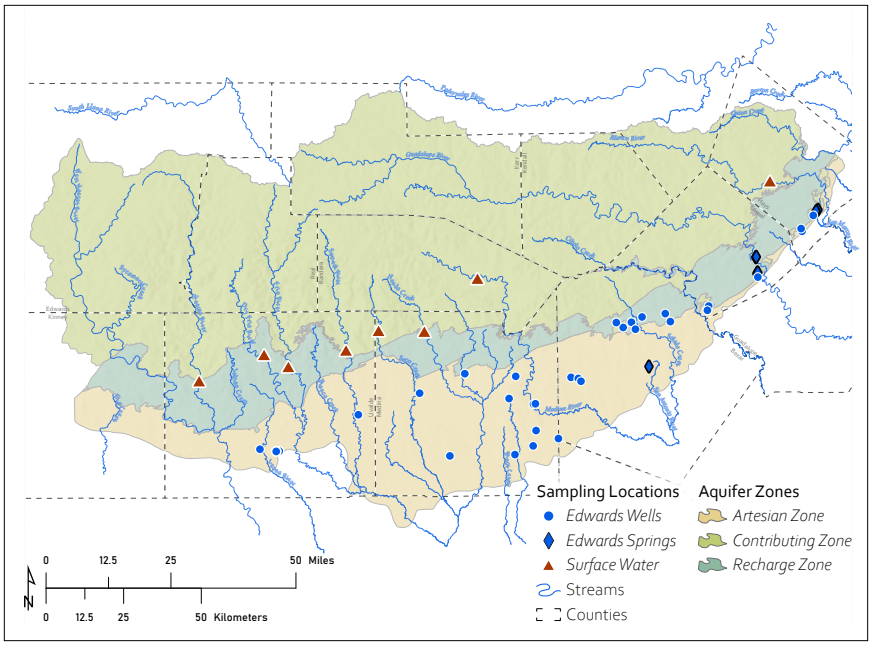
Streams sampling

Eight water quality samples were collected by EAA staff in 2021, one each from the Nueces, Dry Frio and Frio rivers, Sabinal River, Seco Creek, Hondo Creek, Medina River, and Blanco River. Samples were generally collected at or near US Geological Survey (USGS) gauging stations located near the Recharge Zone. These samples were analyzed for bacteria, dissolved metal, nutrient, SVOC, pesticide, herbicide, and PCB concentrations.

Results of streams sampling

Table 1 summarizes the analyses of eight stream water samples for concentrations of bacteria, nutrient, SVOC, pesticide, herbicide, and PCB compounds. Since uses of stream water are generally limited to contact recreation, such as paddling and wading, bacterial content analyses are compared to Texas Commission on Environmental Quality's (TCEQ) Contact Recreation Standard (CRS). One sample was 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 one sample above the CRS of 126 MPN/100mL. 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, iron, manganese, strontium, vanadium, and zinc were detected at concentrations ranging from trace to measurable. Many dissolved metals occur naturally in the Aquifer groundwater, originating from minerals that comprise the host rock. Nitrate was present at trace concentrations in all eight samples.



Map 2. Locations of eight sampling sites on major streams that cross the Contributing Zone and enter the Recharge Zone. The streams sampled in 2021 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 2021

Water Quality Parameter Group	Number of Samples Collected	Number of Detections Exceeding MCL
Bacteria (E. coli)	8	1
Metals	8	0
Nutrients	8	0
Volatile Organic Compounds (VOCs)	8	0
Semivolatile Organic Compounds (SVOCs)	8	0
Pesticide and Herbicide Compounds	8	0
Polychlorinated Biphenyl Compounds (PCBs)	8	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/eaa/contact-us.

DETECTED ANALYTE CONCENTRATIONS IN SURFACE WATER

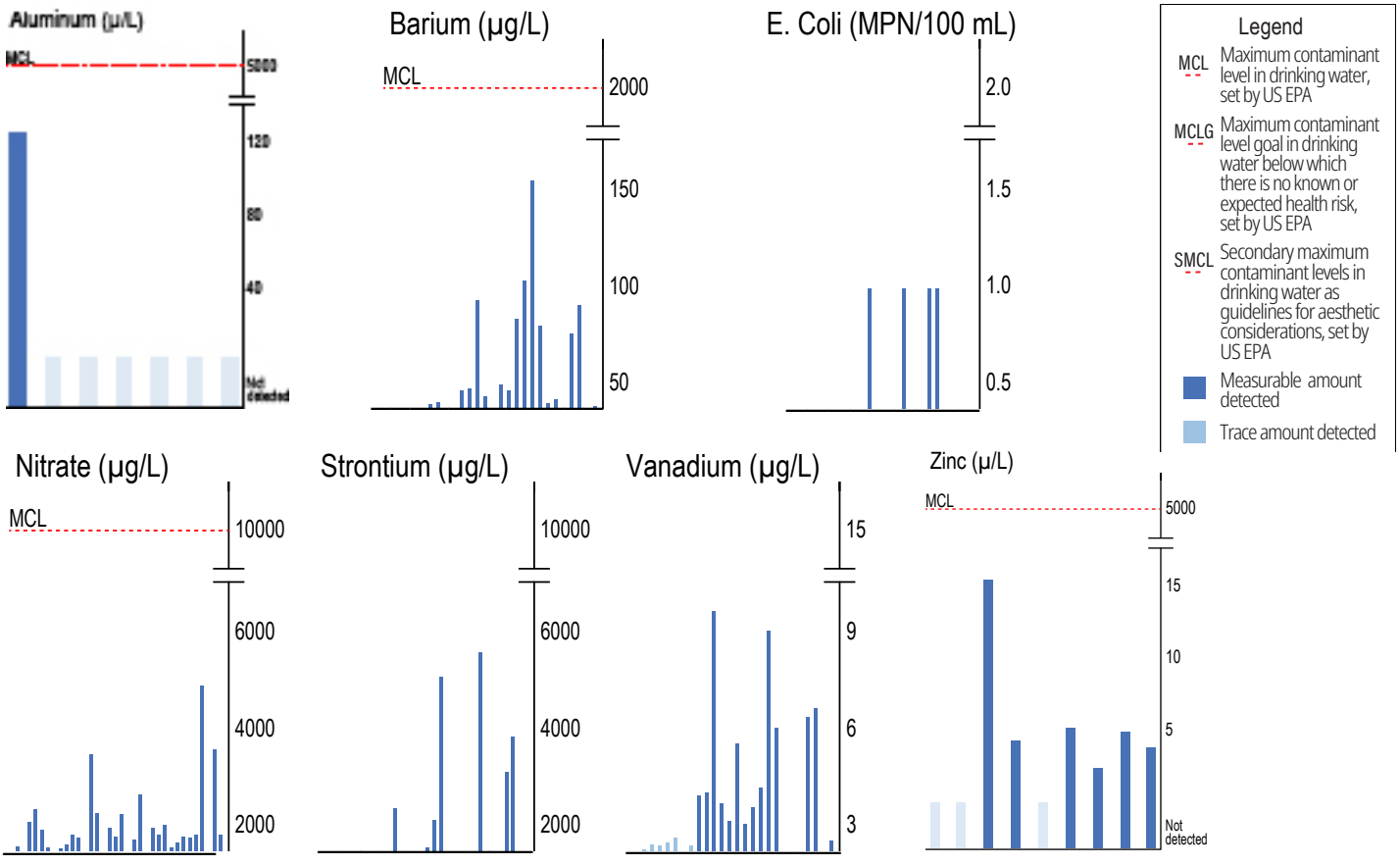


Figure 2. Barcharts of concentrations for individual analytes that had trace or measurable detections from one or more samples.

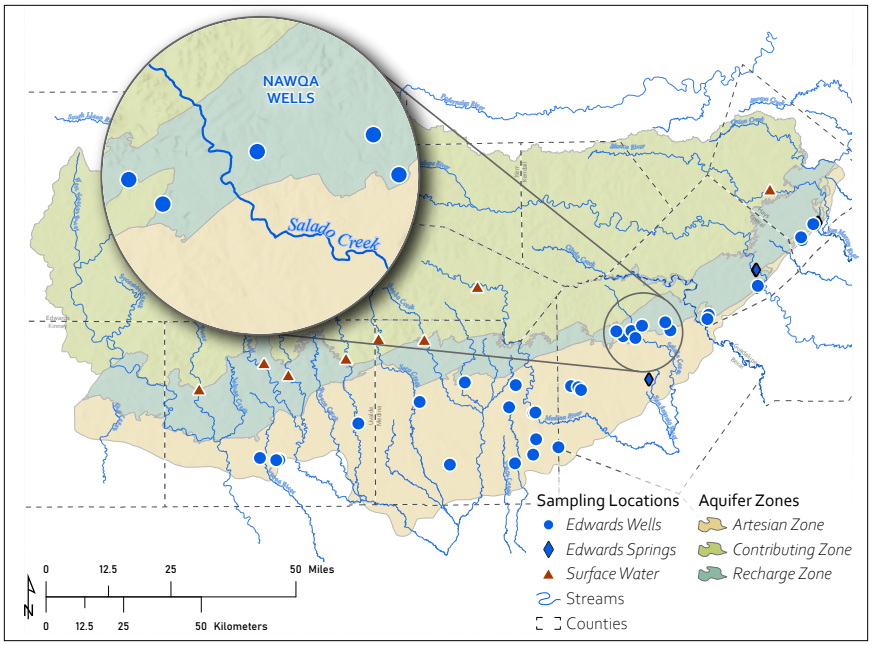
Wells

Thousands of wells throughout south central Texas pump water from the Aquifer to support municipal, agricultural, and livestock uses. The Aquifer is well known for yielding large volumes of high quality water. To monitor water quality trends within these wells and across the Aquifer's system, a selection of wells were sampled for laboratory analyses. In 2021, 34 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 USGS, was established by the US Congress in 1991 to measure national water quality and track changes over time. In Bexar County, 30 wells were constructed in the northwestern part of the county and are regularly sampled by both the USGS and EAA staff. The EAA also participates in the Texas Water Development Board's (TWDB) groundwater quality sampling program. Like NAWQA, TWDB's sampling program monitors the quality of water in Texas aquifers through time. In 2021, 15 wells in Bexar, Comal, Medina, and Uvalde counties were sampled for 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 Aquifer water used throughout the region. Sampled well locations are shown below in Map 3. Samples were analyzed for bacteria, dissolved metal, nutrient, VOC, SVOC, pesticide, herbicide, and PCB concentrations.



Map 3. Locations of 34 Edwards wells sampled in 2021 for water quality analysis. NAWQA wells are located in Bexar County, on the Recharge and Contributing zones. Wells sampled for TWDB are located in Bexar, Comal, Medina, and Uvalde counties.

Results of wells sampling

Since 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 are legal limits one the concentration of specific chemical compounds and are intended to protect public health. The US EPA also established secondary maximum concentration limits (SMCLs), that 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. The Aquifer wells that were sampled, most dissolved metals were not detected above their MCL. Bacteria was detected in four samples. No chemicals in VOC, SVOC, herbicide, 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, nutrient, and dissolved metals that were detected at trace and measurable concentrations have been included. MCLs are indicated where applicable for comparison. The VOC tetrachloroethene was detected in two samples and the VOC cyclohexene was detected in a single sample. The dissolved metals include aluminum, arsenic, barium, cadmium, chromium, iron, lead, lithium, manganese, mercury, molybdenum, nickel, strontium, thallium, vanadium, and zinc. Many dissolved metals occur naturally in Aquifer groundwater originating from minerals that comprise the host rock. Nitrate was detected in all sample at measurable concentrations below its MCL. E. coli was detected in four 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.

WELL WATER QUALITY SUMMARY, CALENDAR YEAR 2021

Water Quality Parameter Group	Number of Samples Collected	Number of Detections Exceeding CRS
Bacteria (E. coli)	25	4
Metals	34	0
Nutrients	34	0
Volatile Organic Compounds (VOCs)	25	0
Semivolatile Organic Compounds (SVOCs)	24	0
Pesticide and Herbicide Compounds	24	0
Polychlorinated Biphenyl Compounds (PCBs)	3	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 https://www.sos.state.tx.us/tac/index.shtml. The complete set of water quality data used in the 2021 Water Quality Summary is available via an open records request through the EAA's Contact Us webpage at http://www.edwardsaquifer.org/eaa/contact-us/.

DETECTED ANALYTE CONCENTRATIONS IN WELLS

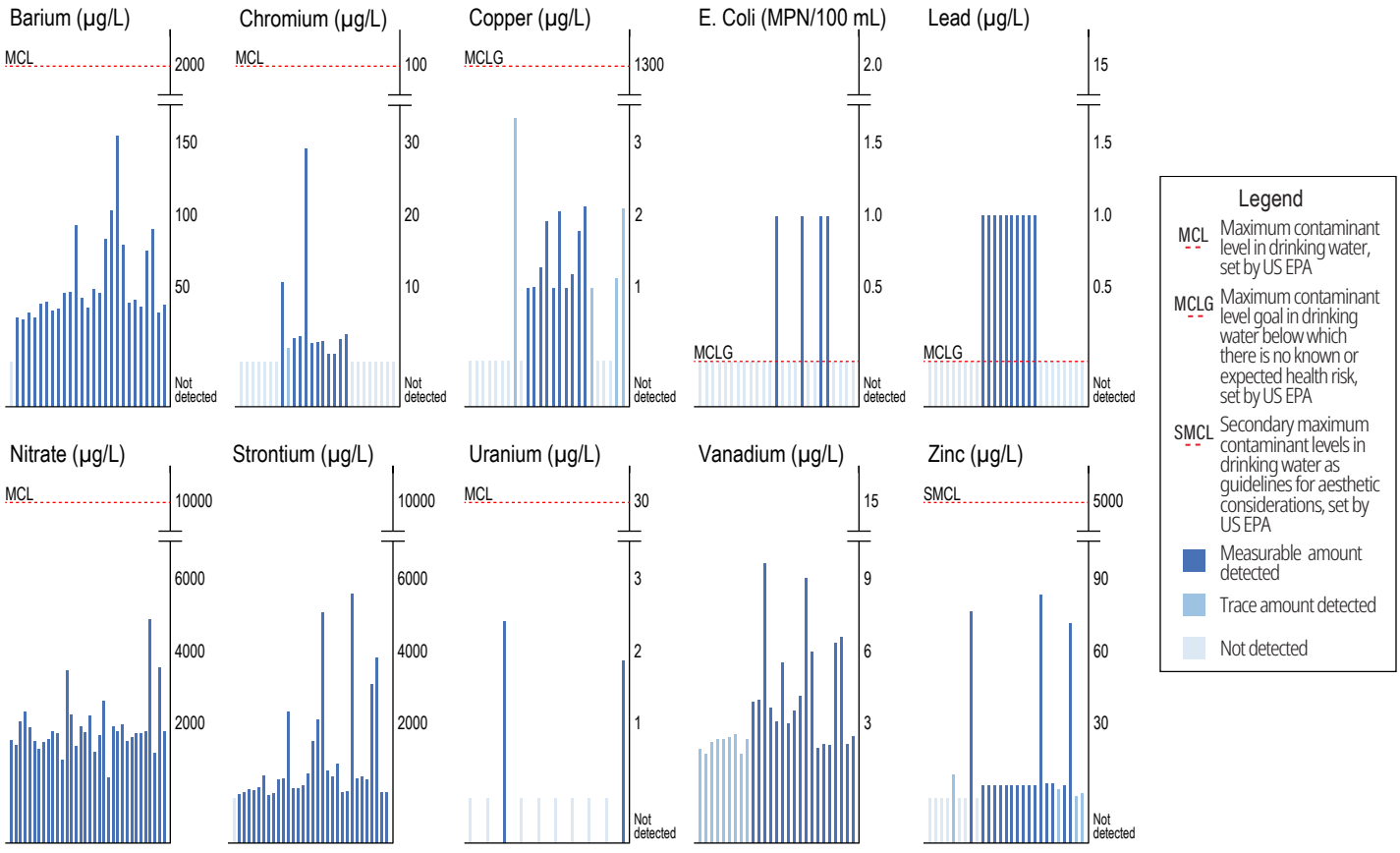


Figure 1. Barcharts of concentrations for individual analytes that had measurable detections from one or more samples.

Springs

Water that flows overland via the streams and rivers of the Contributing Zone and enters the 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 Aquifer. Four major spring groups that were monitored by the EAA for water quality in 2021 are shown below in Map 4.

Seven federally listed endangered species and threatened species depend on the Comal and San Marcos spring complexes, 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 on the EAHCP is available online at http://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 Bule Hole (San Antonio spring), located on the University of the Incarnate Word campus. The Blue Hole spring only flows when the Aquifer level is above 665 feet above sea level; therefore, it is frequently dry during the summer and early fall and was not sampled in 2021 due to Aquifer levels being below 665 feet above seal level. The nearby San Pedro springs form the headwaters of San Pedro Creek, located on the grounds of San Pedro Park. Both San Antonio and San Pedro spring systems emerge in outcrops of Austin Chalk in the Artesian Zone.

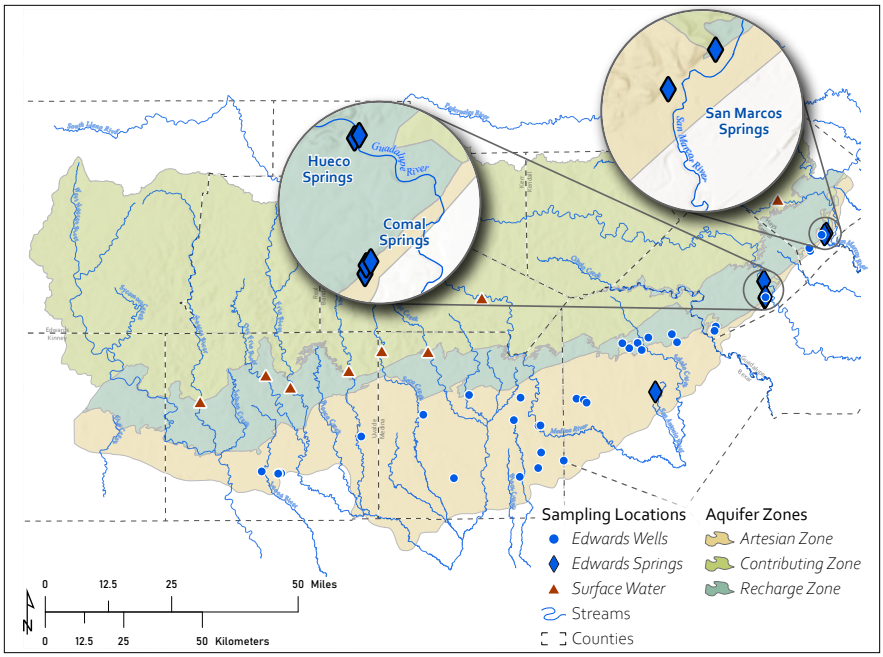
Springs sampling

These four spring systems twere sampled twice in 2021, once in April and September. A total of 11 samples were analyzed for bacteria, and 12 samples were analyzed for nutrient, dissolved metal, VOC, SVOC, herbicide, pesticide, and PCB concentrations.

Results of springs sampling

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, nor 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 in six samples, none exceeded the water 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 12 samples. The dissolved metals aluminum, barium, magnesium, nickel, strontium, vanadium, and zinc 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 (Blue Hole) is located at the headwaters of the San Antonio River, while San Pedro Spring provides flow for San Pedro Creek. Comal springs feed the Comal River, that winds through New Braunfels' Landa Park into the Guadalupe River. Nearby Hueco springs also flow into the Comal River. The San Marcos River flows through Texas State University and San Marcos City Park.

SPRING WATER QUALITY SUMMARY, CALENDAR YEAR 2021

Water Quality Parameter Group	Number of Samples Collected	Number of Detections Exceeding CRS
Bacteria (E. coli)	11	0
Metals	12	0
Nutrients	12	0
Volatile Organic Compounds (VOCs)	12	0
Semivolatile Organic Compounds (SVOCs)	12	0
Pesticide and Herbicide Compounds	12	0
Polychlorinated Biphenyl Compounds (PCBs)	12	0

Table 3. Summary of springs sampling and concentrations of analytes in seven 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 https://www.tceq.texas.gov/waterquality/standards/2014standards.html. The complete set of water quality data used in the 2021 Water Quality Summary is available via an open records request through the EAA's Contact Us webpage at http://www.edwardsaquifer.org/eaa/contact-us/.

DETECTED ANALYTE CONCENTRATIONS IN SPRINGS

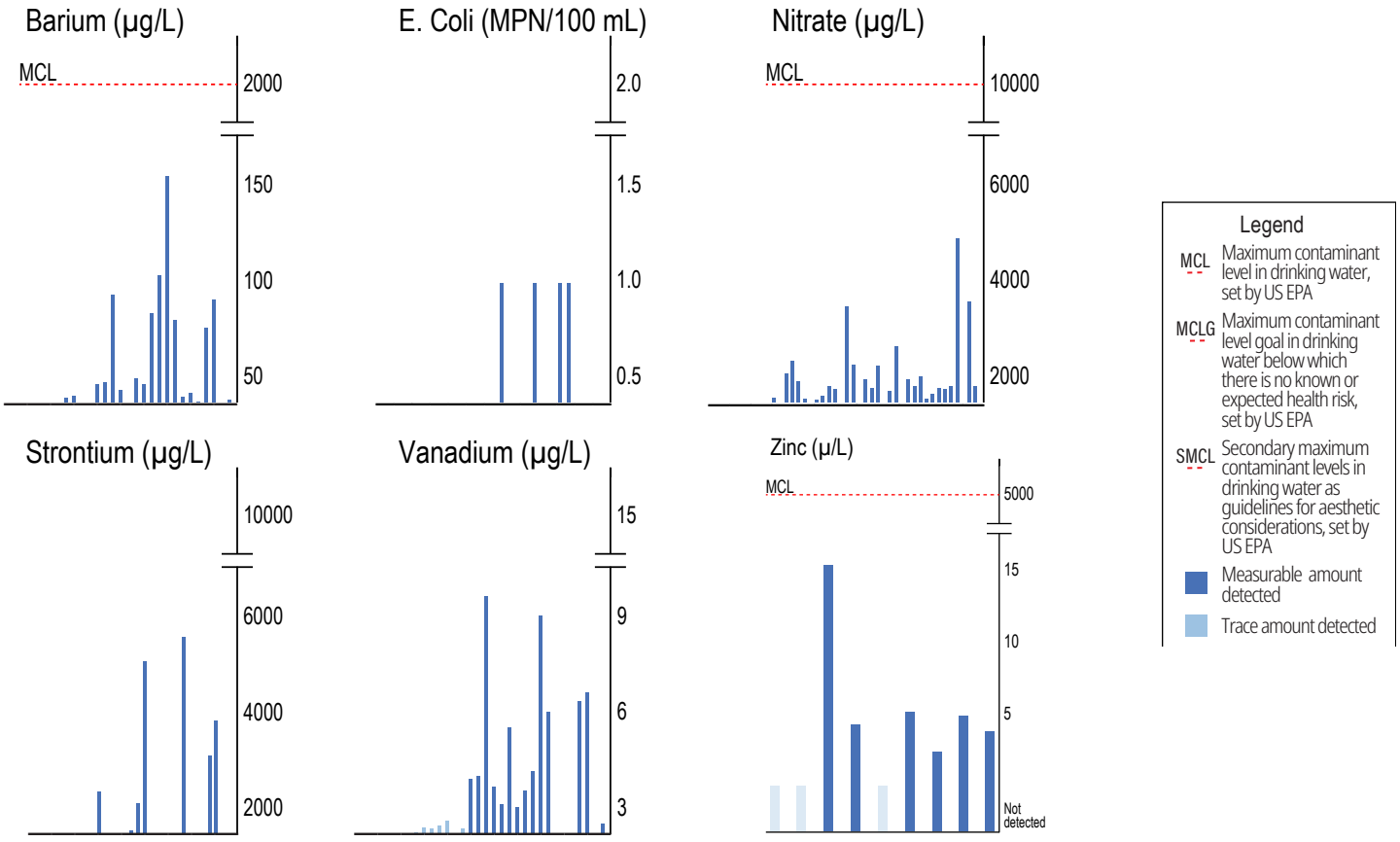


Figure 3. Barcharts of concentrations for individual analytes that had trace or measurable detections from one or more samples.

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 analyses 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 contaminates. 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/eaa/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. WellIntel 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.

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