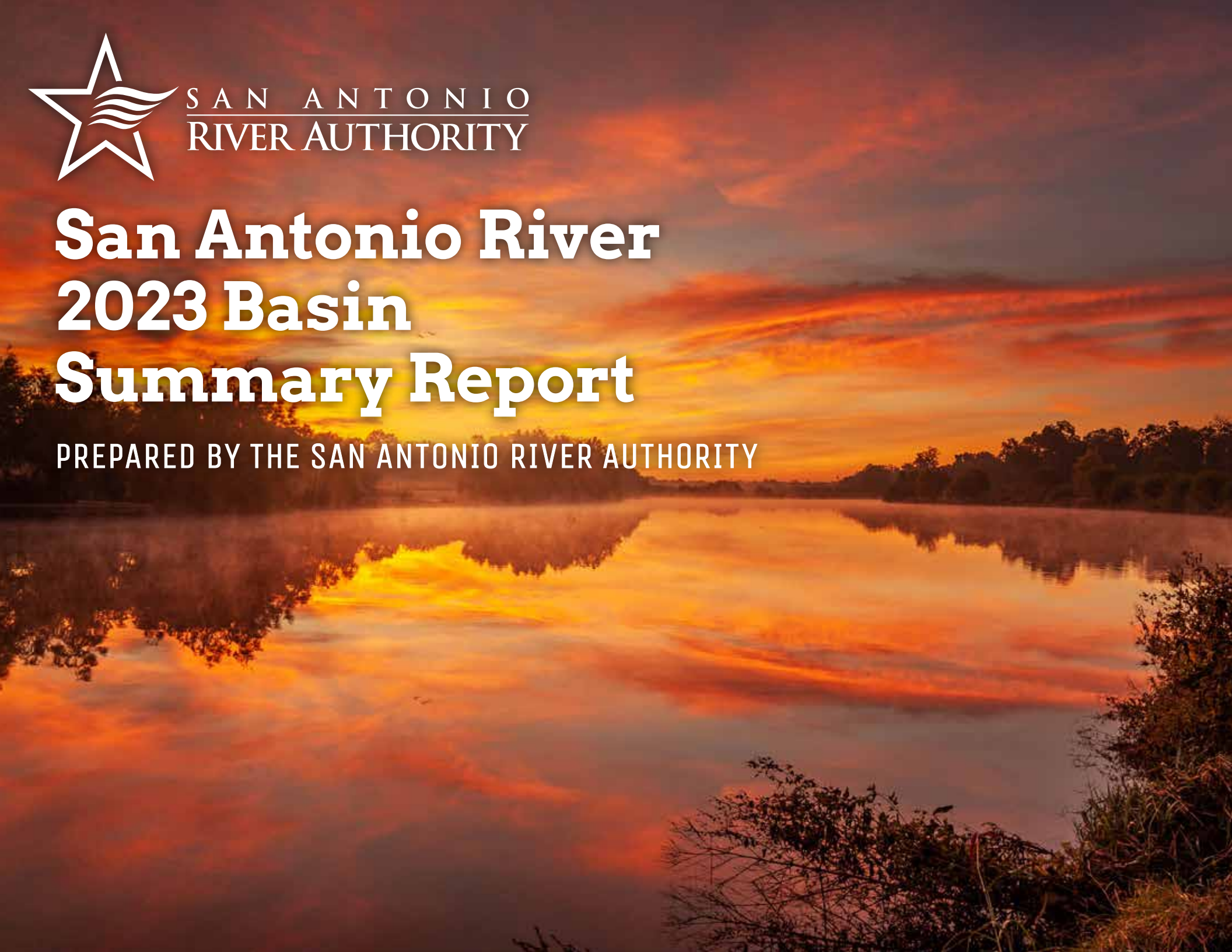


SAN ANTONIO
RIVER AUTHORITY

# San Antonio River 2023 Basin Summary Report

PREPARED BY THE SAN ANTONIO RIVER AUTHORITY

SAN ANTONIO RIVER AUTHORITY




*The preparation of this report was financed through grants from and in cooperation with the Texas Commission on Environmental Quality*


## Acknowledgements:


The San Antonio River Authority (River Authority) would like to acknowledge the time and effort the Environmental Advisory Committee (EAC) spent contributing, reviewing, and commenting on the 2023 Basin Summary Report.


## Environmental Advisory Committee:

| Name | County | Represents |
|---|---|---|
| Wilfred Korth | Goliad | Co-Chair |
| Janis Bush | Bexar | Co-Chair |
| Joe Baker | Karnes | Business & Industry |
| James Dodson | Victoria (Other) | Bay & Estuary |
| Heather Hansen | Wilson | Environment |
| Bree Jameson | Bexar | Environment |
| Jason Katcsmorak | Wilson | Environment |
| Stephen Lucke | Bexar | Environment |
| Annalisa Peace | Bexar | Environment |
| Glynis H. Strause | Karnes | Business & Industry |
| Connie Waters | Goliad | Agriculture |
| Joedy Yglesias | Bexar | Environment |
| John Hooker | Bexar | Academia |

*Cover Picture: San Antonio River at Acequa Park at Sunrise (ATT711)*

**Executive Summary:**

**Activities and Accomplishments:**

For the San Antonio River Authority (SARA) the Clean Rivers Program (CRP) is primarily a monitoring program. This program provides the basic monitoring needed both spatially and temporally to identify water quality issues and changes in the basin.

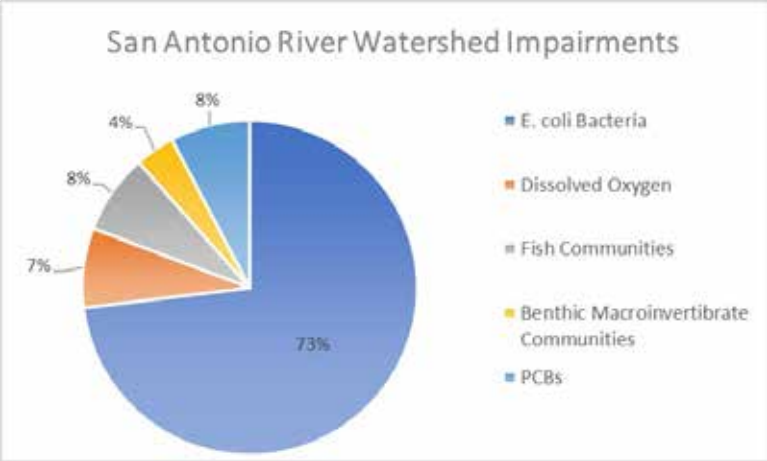
The data collected is collected with strict quality assurance. All samples are collected and analyzed in accordance with a quality assurance project plan tailored specifically for the San Antonio River Watershed and approved by the Texas Commission on Environmental Quality (TCEQ). Sample collection methods are followed as described by the TCEQ's Surface Water Quality Monitoring Procedures Volumes I and II (www.tceq.texas.gov/waterquality/monitoring). The samples are analyzed in the San Antonio River Authority's Laboratory. This is a TNI certified laboratory, with strict requirements to assure quality data. The data is managed and documented by our data management team that ensures that the data is accurately and timely provided to TCEQ.

The CRP emphasizes working with the public. Our data (and data of our partners Bandera County River Authority and Groundwater District (BCRAGD) and the City of Boerne) is readily available to the public in an easy to use form from the San Antonio River Authority's Website (www.sariverauthority.org). Once the analysis is completed, and the samples are reviewed by our quality assurance staff, the data is available to the public through the Water Quality Data Viewer.

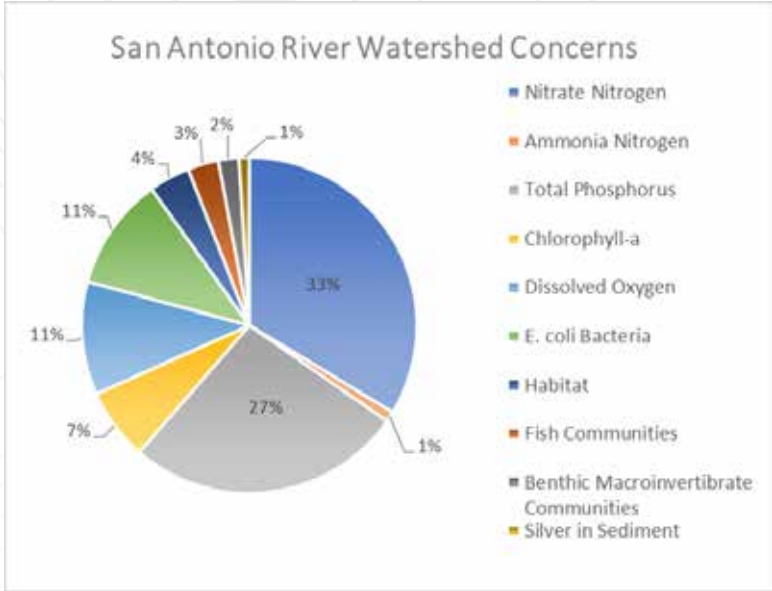
While the generation of the data and placing it on our website is part of the CRP, that data is the basis for other tools and projects in the watershed to protect and improve water quality, the ecology of the watershed and inform the public. Several tools have been developed (Water Quality Viewer and the Water Quality Bacteria Dashboard) to assist in reviewing and understanding the data that SARA and our partners generate. Continuous monitoring sites are paired with select CRP monitoring sites and stormwater sampling to assist in the development of water quality models that have been developed to assist in the placement of low impact development features to reduce stormwater pollution.

The Texas Clean Rivers Program is the cornerstone for monitoring in the San Antonio River Watershed, and the protection of water quality and ecology of our creeks and rivers.

**Significant Findings:**




*Graph showing that the most common impairment in the San Antonio River Watershed is E. coli bacteria based on the 2022 Integrated Report.*




*Graph showing that the most common concerns in the San Antonio River Watershed are nutrients based on the 2022 Integrated Report. .*

Recreational Use Designation: *E. coli* Bacteria.

In the San Antonio River Watershed all assessment units are designated for primary contact recreation 1. These include activities that are presumed to involve significant risk of ingestion of water. Activities that are considered primary contact recreation include: swimming, wading by children, skiing, diving, tubing, surfing, hand fishing (noodling), and whitewater kayaking, canoeing, or rafting. If the geometric mean of *E. coli* bacteria is greater than 126 MPN per 100mL in an area, that area is not meeting the primary contact recreation standard and you should avoid the activities listed above.

Clearly the most common impairment in the San Antonio River Watershed is *E. coli* bacteria. 73% of the impairments and 11% of the concerns identified in the 2022 IR for the San Antonio River Watershed are *E. coli* bacteria. Of the 51 stations

examined, 8 station showed a trend over time. 7 out of 8 sites showed an increasing trend over time. One station (18402) Escondido Creek showed a decreasing trend over time, however this site had an elevated geometric mean of 468.68 MPN per 100 mL, so this trend needs to continue for some time before this creek is meeting the standard. Typically, as flow increases, *E. coli* levels tend to increase greatly. 24 sites out of 51 showed an increasing trend as flow increased. This is typical, since during stormwater runoff events, water transports fecal matter and other pollutants to the streams. Also, bacteria tends to attach to sediment and settles to the bottom of a stream bed. High flows tend to re-suspend the sediment and the bacteria into the water column. However, two sites (21125 & 12824) on Medina River show a decreasing trend as flow increases. This may be due to point source pollution of fecal coliform. Both stations are currently meeting the surface water quality standard for *E. coli* bacteria.

I-plans and WPP:

The development of implementation plans (I-plan) is a stakeholder process that develops a plan with specific best management practices to reduce a specific pollutant so that a waterbody will meet its assigned standard. After the development and approval of the plan, the stakeholders meet annually for at least 5 years, to discuss the projects developed to reduce the pollutant and progress being made. I-Plans have been developed to address *E. coli* pollution for the upper San Antonio River, Apache Creek, Alazan Creek, San Pedro Creek, Six Mile Creek, Martinez Creek, Salado Creek, Menger Creek, Walzem Creek and the Lower San Antonio River. Watershed Protection Plans (WPP) are similar to an I-Plan, with the main difference being that a WPP can address multiple pollutants of concern, and a segment does not need to be impaired for a WPP to be developed. WPP have been developed for Upper Cibolo Creek, Upper San Antonio River, Mid and Lower Cibolo Creek.

Bacteria Source Tracking:

From September 2013 to the present the San Antonio River Authority has collected samples to determine the source of fecal matter in our creeks and rivers. River Authority staff have collected 110 events and shipped the samples to Texas A & M University for analysis.  Surprisingly, the most common source identified in all counties is wildlife.

The table below shows the percentage of each category found:

*Table ES-1: Shows that the sources for fecal matter in the watershed for all four counties in SARA's political district. Note that over half of the values are categorized as wildlife, while human ranges from 2% to 7%.*

| Category | District | Bexar | Wilson | Karnes | Goliad |
|---|---|---|---|---|---|
| Wildlife | 54% | 54% | 53% | 53% | 55% |
| Unidentified | 16% | 20% | 16% | 13% | 8% |
| Livestock | 21% | 18% | 18% | 26% | 22% |
| Human | 5% | 5% | 2% | 7% | 6% |
| Pets | 4% | 3% | 11% | 1% | 8% |

The information gained through bacteria source tracking allows us to focus our attention and funds in the area that has the best potential to reduce *E. coli* bacteria contamination in our creeks and rivers.

The San Antonio River Authority Regional Environmental Laboratory (SARA-REL) became the first river authority to implement bacterial source tracking (BST) capabilities using quantitative polymerase chain reaction (qPCR) analysis in 2015. Originally, the SARA-REL was able to detect the presence or absence of a human DNA marker in surface and ground waters. This technology and analytical technique aided in confirming the presence of human contamination in the event of a suspected sewage spill or pollution complaint.

Eventually, scientists at the SARA-REL would work to expand the BST program. In 2020, analysts successfully implemented quantitative BST capabilities that would provide the number of human DNA copies in these water samples.

Aquatic Life Use: Dissolved Oxygen, Toxic Substances in Water, Fish Communities, Benthic Macro-Invertebrate Communities, and Habitat.

Dissolved oxygen made up 7% of the impairments and 11% of the concerns in the San Antonio River Watershed identified in the 2022 IR. Creeks that were identified as impaired for dissolved oxygen typically have low flows and include Ecleto Creek, Clifton Branch, Picosa Creek, and the upper portion of Salado Creek. Low dissolved oxygen levels can cause stress for aquatic organisms and even death. The impaired streams all have relatively low flows and except for moving the reuse water discharge upstream, there is little that can be done. In the San Antonio River Watershed,

particularly in the urban portion of the watershed, we do occasionally see fish kills. These occur in areas that usually have good dissolved oxygen levels and are caused by small stormwater runoff events. These events have enough runoff to wash pollutants into the stream, but not enough to dilute the pollutants or increase flows.

Better management of stormwater events, especially the small or medium sized runoff event could reduce these occasional fish kills.

No impairments or concerns for toxic substances in water were found. However, a concern was found for silver in sediment at Lower Leon Creek, assessment unit 1906_06. A review of the sediment data for the two stations identified in that AU identified 4 results: <2.31, <1.74, <5.21, <1.82 mg/kg dry weight. The screening level for silver in sediment is 1.7 mg/kg dry weight. There is no way to know how far below the limit of quantitation that the true values are for these four samples. This may need to be re-assessed by TCEQ.

Fish Communities, Benthic Macro-Invertebrates and Habitat:

Salado Creek in assessment unit 1910_02 has an impairment for fish communities and benthic macro-invertebrates. Two stations are monitored for biologicals (12870 & 14929). The Integrated Report has no impairments or concerns for dissolved oxygen, but a review of the station data indicates that at station 12870, 29.8% grab dissolved oxygen levels were not meeting the dissolved oxygen average screening level, but no grab values were below the minimum standard. Station 14929 had 30.5% grab dissolved oxygen levels not meeting the dissolved oxygen average screening level, and 3.4% of the grab dissolved oxygen were not meeting the dissolved oxygen minimum standard. Both of these sites are downstream of the San Antonio Water Systems (SAWS) reuse water discharge, so flows should have been adequate. Additional monitoring will be needed to determine the cause. Habitat is not identified as a concern.

Two assessment units are currently identified as having impairments for fish on the San Antonio River: assessment unit 1911_09 (from the headwaters downstream to San Pedro Creek confluence) and 1911_08 (from San Pedro Creek Confluence with the San Antonio River downstream to Six Mile Creek). Assessment unit 1911_08 also has an impairment for benthic macro-invertebrates. These assessment units run through the center of San Antonio and are in a highly urbanized area. Much of 1911_09 is a concrete trapezoidal channel. Stormwater runoff occurs rapidly and disturbs instream habitat. Invasive species are common. A portion of 1911_09 and all of 1911_08 are part of the Mission Reach Restoration Project. The river has been given natural banks, sinuosity, and natural riparian area. Riffles and pools have been established and canoe shoots add oxygen to the river. Staff have also been conducting monitoring targeting the

different instream habitats to determine which fish inhabit each type of habitat and using that information to add instream habitat. Just this year, boulders were added to multiple places to provide cover for fish during high flow events. Staff are also involved in a project to re-introduce native mussels to the area.

Polychlorinated Biphenyls (PCBs) in Fish Tissue:

There is a fish advisory issued by the Texas Department of State Health Services (DSHS) (previously known as Texas Department of Health) recommending no consumption of any species from Leon Creek from the Old U.S. 90 bridge downstream to Loop 410 bridge due to PCBs is fish tissue.

In 2022, the DSHS published an addendum recommending continuing the consumption advisory for Leon Creek until contaminants such as PCBs, polychlorinated-p-dioxins (PCDDs)/ furans (PCDFs) and Per- and polyfluoroalkyl substances (PFAS) until levels decrease to a level that they are unlikely to pose a human health risk.

In 2016, a study by the US Geological Survey in cooperation with the San Antonio River Authority determined that PCBs congeners found at Loop 410 site (upstream of Joint Base San Antonio) were different from samples collected at Joint Base San Antonio and downstream. This indicated that there are multiple sources of PCBs in Leon Creek.

**Watershed Summaries:**

Upper San Antonio River (1911):

- The most common impairment is for *E. coli* bacteria. Trend analysis showed no strong trends for *E. coli* bacteria on the mainstem of the San Antonio River. *E. coli* bacteria showed an increasing trend as flow increased at the four most downstream sites. This indicates that *E. coli* bacteria is heavily influenced by stormwater runoff. Stormwater runoff transports pollutants like *E. coli* bacteria to the stream. It also re-suspends *E. coli* bacteria from the bed of the stream.
- Biological communities (fish and benthic macroinvertebrates) impairments are in the highly urbanized upper portion of the San Antonio River. This area is highly engineered to move stormwater runoff out of the area. Portions of the river are trapezoidal concrete channels with little instream habitat. The Mission Reach portion of this San Antonio River has been restored and steps taken to restore instream habitat to this area.

- The main concerns are related to nutrients (nitrate nitrogen, total phosphorus, and excessive chlorophyll-a). While nitrate nitrogen in the historic river loop area is increasing over time, none of the other stations are increasing. Six of the stations show a decreasing trend as flow increases for nitrate nitrogen. This indicates that the source of the elevated nitrate nitrogen is a point source. The main source is the re-use water that is discharged into the headwaters and in the river loop. This reuse water is needed to augment flow on the San Antonio River. Currently, there are only screening levels for nutrients in streams; science-based standards are needed. The main concern with nutrients is excessive nutrients can lead to low dissolved oxygen levels. Currently there are no impairments or concerns for dissolved oxygen on the San Antonio River.
- Two tributaries do have concerns for depressed dissolved oxygen (Picosa Creek, Unnamed Tributary). Both tributaries have low flows.

Lower San Antonio River (1901):

- The most common impairment is for *E. coli* bacteria. Trend analysis showed no strong trends over time for *E. coli* bacteria on the mainstem of the San Antonio River. Escondido Creek shows a decreasing trend over time for *E. coli* bacteria, however the geometric mean was 469 MPN per 100 mL well above the standard of 126 MPN per 100 mL. Limited bacteria source tracking indicated that 65% of the fecal matter was from wildlife at this station. The four lower stations (12794,17859,12791 and 12790) on the Lower San Antonio River and Ecleto Creek showed an increasing trend for *E. coli* bacteria as the flow increases. Escondido Creek showed no trend for *E. coli* bacteria associated with flow.
- A fish community is identified as impaired for the Southern Pacific Railroad bridge in Goliad County (12792). Conquista Crossing (16580) has a fish community concern.
- Chlorophyll-a is an impairment on two assessment units on the main stem of the San Antonio River and Eclecto Creek. Chlorophyll-a is an indication of planktonic algae. Excessive algae can lead to low dissolved oxygen levels, which can cause stress to aquatic organisms including fish kills. There are no dissolved oxygen impairments on the Lower San Antonio River, but Eclecto Creek has a concern for the average dissolved oxygen and an impairment for the minimum dissolved oxygen. SARA staff will continue to monitor Ecleto Creek for water chemistry and has two 24 hour dissolved oxygen deployments scheduled for next year.
- The most common concern on the Lower San Antonio River is for nutrients (nitrate nitrogen, total phosphorus), however there were no dissolved oxygen impairments or concerns on the main stem of the San Antonio River.

Eclecto does have a dissolved oxygen concern and impairment, but no concerns for nutrients. Nutrient levels are low at this site. Low dissolved oxygen levels are likely due to low flows and oxygen demand of algae.

Upper Cibolo Creek (1908):

- No trends were determined for the Upper Cibolo Creek.
- The only impairment for segment 1908 is *E. coli* bacteria. The sites in this assessment unit (1908_01) are in the City of Boerne or just downstream. The City of Boerne has experienced rapid expansion like most of the towns in the Texas Hill Country. Although the upper site is at the end of a park, it is best described as an urban environment, and the downstream site is influenced by urbanization upstream.
- Nutrients are a concern in this portion of the Upper Cibolo Creek. Site 15126 has the majority of elevated nutrients. This site is downstream of a wastewater treatment plant. There are no concerns or impairments for dissolved oxygen or chlorophyll-a.

Mid Cibolo Creek (1913):

- No impairments in the Mid Cibolo.
- In the assessment units downstream from a wastewater treatment plant, screening level concerns exist for total phosphorus and nitrate nitrogen. At the sampling location at Schaeffer Road, there is an increasing trend over time for nitrate plus nitrite nitrogen, but a decreasing trend for total phosphorus over time. Nitrate plus nitrogen showed a decreasing trend as flow increased, indicating that the source of the nitrate nitrogen is point source. There are no chlorophyll-a or dissolved oxygen concerns in the Mid Cibolo.

Lower Cibolo Creek (1902):

- *E. coli* bacteria is the only impairment on the Lower Cibolo Creek. None of the sample sites reviewed showed any trends over time for *E. coli* bacteria. Most of the stations showed increasing trend for *E. coli* bacteria as flow increased, indicating that much of the bacteria is from non-point source pollution.
- Tributaries of the Lower Cibolo Creek: Martinez Creek, Salitrillo Creek, and Clifton Branch have *E. coli* bacteria impairments. Clifton Branch also had an impairment for depressed dissolved oxygen. Both Martinez Creek and

Salitrillo Creek had increasing trends as flow increased for *E. coli* bacteria. Clifton branch had an increasing trend over time for *E. coli* bacteria indicating a worsening of *E. coli* bacteria levels, but it also had an increasing trend over time for dissolved oxygen indicating improvements for dissolved oxygen levels.

- Lower Cibolo Creek had concerns for nutrients (nitrate nitrogen and total phosphorus), habitat and benthic macroinvertebrates. Multiple sites had increasing trends over time for nutrients. At the sample site at FM 81, nitrate nitrogen showed an increasing trend as flow increased indicating that nitrate nitrogen is being transported to the creek during stormwater runoff events.
- Martinez Creek had concerns for *E. coli* bacteria and nutrients (nitrate nitrogen and total phosphorus). *E. coli* bacteria levels increased as flow increased, indicating non-point source pollution. Nitrate nitrogen levels decreased as flow increased indicating that the source is point source.
- Salitrillo Creek had concerns for nutrients (nitrate nitrogen and total phosphorus). Nitrate nitrogen showed a decreasing trend over time, indicating that levels are improving.
- Clifton Branch has concerns for ammonia nitrogen, total phosphorus, and depressed dissolved oxygen. Dissolved oxygen levels are improving over time.

<u>Medina River Above Medina Lake (1905):</u>

- *E. coli* bacteria is the only impairment on the Upper Medina River. This segment is divided into two assessment units. The upper assessment unit is fully meeting all standards. The upper most station in the upper assessment unit (at Patterson Ave.) has a geometric mean of 80.60 MPN per 100 mL, and an unusual trend for *E. coli* bacteria. *E. coli* bacteria is decreasing as flow increases. This could indicate that the source of the *E. coli* bacteria is point source, or it could simply mean that stormwater runoff is not transporting fecal matter from the surrounding area. The lower portion does not meet the standard for *E. coli* bacteria. According to the San Antonio River Authority's Bacteria Dashboard, the site upstream of the City of Bandera at the Mayan Ranch is meeting the *E. coli* standard, but the next station downstream (13638) at SH 173 is not meeting the *E. coli* standard with a geometric mean of 183.59 MPN per 100 ml. The sample site downstream of this site at Old English Crossing is also not meeting the *E. coli* standard with a geometric mean of 179.24 MPN per 100 mL. It is believed that people feeding wildlife may be the main cause of this impairment. Additional sampling between the Mayan Ranch site and SH 173 should be conducted to verify this assumption. Neither impaired site showed any trends for *E. coli* bacteria.

- There is a concern for the fish community in both assessment units and a concern for habitat on the lower assessment unit. Both of these may be due to habitat, lack of cover, flash floods due to natural topography of the area, and issues with drought.

Medina Lake (1904) and Medina Diversion Lake (1909):

- There were no impairments or concerns identified in the 2022 Integrated Report for Medina Lake or Medina Diversion Lake. However, zebra mussels have infected both lakes. Drought has also impacted both lakes.

  Zebra mussels are an invasive species that can out compete native species and can attach to infrastructure causing pipes to clog and mechanisms to jam. There is little that can be done other than educating the public on how to prevent the spread of zebra mussels into other waterbodies and monitoring uninfected waters for early detection.

Medina River Below Medina Diversion Lake (1903):

- *E. coli* bacteria is identified as an impairment on the Medina River from Medio Creek confluence downstream to the Medina River's confluence with the San Antonio River. Medio Creek which drains into Medina River has an impairment for *E. coli* bacteria. This portion of the Medina River is just south of the City of San Antonio. The San Antonio River Authority is currently conducting bacteria source tracking and stormwater sampling on the Lower Medina River in support of modeling to better understand this area.
- The upper portion of this segment (1903_05) had two stations 12824 and 14200 that had *E. coli* levels increasing over time. It is unclear why station 12824, Medina River at CR 2615 is increasing over time, since there is little urbanization in the area. The lower portion of the segment 1903_01, Station 12811 at FM 1937 showed an increasing trend for *E. coli* bacteria as flow increased. This area can be described as rural, with many small acreage homes in the area.
- Nitrates are a concern on the Lower Medina River from Polecat Creek to the confluence with the San Antonio River (1903_04 to 1903_01). Multiple wastewater treatment plants discharge into tributaries that drain into this portion of the Medina River. Nitrates show mixed trends over time, increasing over time at Applewhite Road (12814) and decreasing over time at Pleasanton Road (22225) and FM 1937 (12811). Stations 22225 and 12811 show a decreasing trend as flow increases indicating the nitrate nitrogen is due to point source(s), likely wastewater

treatment plant discharge. However there are no dissolved oxygen or chlorophyll-a concerns or impairments on the Lower Medina River.

Salado Creek (1910):

- *E. coli* bacteria is identified as an impairment on Salado Creek from Beitel Creek in north San Antonio downstream to Rosillo Creek south of San Antonio. As an urban creek, Salado Creek is impacted by stormwater runoff. In assessment unit 1910_02, Salado Creek at Gembler (12870) had an *E. coli* geometric mean below the TCEQ standard. This site is below the SAWS reuse water discharge, and the *E. coli* levels of the discharge are typically very low. No stations examined showed any trends over time for *E. coli* bacteria. Three out of four sites examined showed increased *E. coli* levels as flow increased indicating that stormwater runoff is a major factor in elevated *E. coli* bacteria levels.
- Depressed dissolved oxygen is identified as an impairment in the most upstream segment from the confluence with Beitel Creek downstream to Walzem Creek. This portion of the creek is upstream of the reuse water discharge, and often has very low flows. No trends were associated with dissolved oxygen on Salado Creek.
- Fish and benthic macroinvertebrates are identified as impaired in assessment unit 1910_02 (from Pershing Creek downstream to Rosillo Creek confluence). Recent sampling indicates that the quality of the fish community has improved. There was also a slight decrease in the average tolerant macroinvertebrate species, potentially indicating a decrease in physiochemical degradation.

Walzem Creek (1910A_01):

- *E. coli* bacteria is identified as an impairment. Nitrate nitrogen is identified as a concern. For the most part, Walzem Creek is a channelized concrete lined ditch that runs through neighborhoods and retail businesses. It is believed that the main source of E. coli and nutrients are due to wildlife, but additional work needs to be completed to verify this.

Menger Creek (1910D_01):

- *E. coli* bacteria is identified as an impairment for Menger Creek. Menger is an urban stream. There are no concerns associated with Menger Creek. Like Walzem Creek, much of Menger Creek is a channelized concrete lined ditch that runs through neighborhoods, retail businesses and industrial areas. Part of Menger Creek runs through the parking area of the AT&T Center. The source(s) are unknown. Additional work needs to be completed.

Salado Creek Tributary (1910C_01):

- *E. coli* bacteria is identified as a concern for the Salado Creek Tributary. This creek originates just south of Martin Luther King Dr. on the east side of San Antonio, and confluences with Salado Creek in J Street Park. This creek runs through mainly residential neighborhoods, undeveloped land, along IH 10 and into J Street Park. Much of the creek is channelized concrete lined ditch. The source(s) are unknown. Additional work needs to be completed.

Upper Salado Creek (1910F_01):

- Depressed dissolved oxygen and chlorophyll-a were identified as concerns for this assessment unit. This is Salado Creek upstream of Beitel Creek in northern San Antonio. Much of this assessment unit traverses across the contributing zone, recharge zone and the transition zone of the Edwards Aquifer. Due to recharge, the stream is intermittent or intermittent with pools. Portions of the creek are dry more often than they have flow. Low dissolved oxygen and excessive chlorophyll-a are likely due to low flows.

Upper Leon Creek (1907):

- There are no impairments or concerns identified by the TCEQ Integrated Report for segment 1907.
- Upper Leon Creek is identified as having a perennial flow type, but the creek originates in the Edward Aquifer Contributing Zone and then crosses the recharge zone and transition zone in northern Bexar County. Much of the Upper Leon Creek has intermittent flow. No trend analysis was evaluated.

Lower Leon Creek (1906):

- A portion of Lower Leon Creek is identified as impaired due to polychlorinated Biphenyls (PCBs) in fish tissue. The Texas Department of State Health Services (DSHS) advise that persons should not consume any species of fish from Leon Creek caught from the Old U.S. Highway 90 bridge downstream to the Loop 410 bridge. In addition, the DSHS conducted additional studies looking at polychlorinated-p-dioxins (PCDDs), furans (PCDFs) and per-and polyfluoroalkyl substances (PFAS). The DSHS published an addendum in 2022 recommending "the consumption advisory (ADV-42) presently in place for fish from Lower Leon Creek until contaminants, such as PCBs, PCDDs/PCDFs, and PFAS, are shown to have decreased to levels that are unlikely to pose a risk to human health."
- Assessment unit 1906_05 is identified as impaired for *E. coli* bacteria. In addition, assessment units 1906_02, 1906_04 and 1906_06 have concerns for *E. coli* bacteria. Lower Leon Creek is best described as an urban stream. Its watershed includes residential areas, retail and manufacturing businesses, and Lackland Air Force Base and the former Kelly Air Force Base which is now known as Joint Base San Antonio.
- There is a concern for depressed dissolved oxygen for assessment units from SH 16 in northwest San Antonio downstream to the confluence with Indian Creek in south San Antonio (1906_03 to 1906_06). The concern is for grab sample values evaluated against the average dissolved oxygen screening level. In 1910, SARA completed a study that examined several assessment units in the Lower Leon Creek, including 1906_04 and 1906_05. This study conducted 24-hr diurnal dissolved oxygen monitoring and concluded that based on the 24-hr sampling, the segment was meeting the high aquatic life use designation. SARA is currently conducting 24-hr monitoring for dissolved oxygen at station 14198 in assessment unit 1906_01, which is the most downstream assessment unit on the Lower Leon Creek, and it is meeting the high aquatic life use standard.
- Chlorophyll-a is identified as not meeting the screening level from SH 16 in Northwest Bexar County to a point southeast of Pearsall Park (1906_06 to 1906_05). This portion of the creek has low flow that may be contributing to the chlorophyll-a. It is also an urban area, so non-point source pollution is transported to the creek during storm water runoff events. This is an area that also has a concern for dissolved oxygen. The issues are likely related.

Medio Creek (1912):

- *E. coli* bacteria has been identified as an impairment for Medio Creek. Segment 1912 of Medio Creek is a mix of rural properties with increasing properties being used for business and industry along IH 35. However much of the

Upper Medio Creek (1912A) that feeds into segment 1912 has land use of residential, industrial and commercial properties on the southwest side of San Antonio. Impervious cover allows stormwater runoff to transport fecal matter to the creek. In addition, bacteria source tracking has identified that over half the fecal matter is from wildlife in Bexar County.

- Nutrients (nitrate nitrogen and total phosphorus) are identified as a concern. Both nutrients show an increasing trend over time. Total phosphorus did not show any significant trend as flow increased, but nitrate nitrogen showed an increasing trend as flow increased indicating that at least part of the source is non-point source runoff.

Medio Creek (1912A):

- *E. coli* bacteria has been identified as a concern for Upper Medio Creek. Much of Upper Medio Creek (1912A) land use is residential, industrial and commercial properties on the southwest side of San Antonio. Urbanization with its impervious cover allows stormwater runoff to transport fecal matter to the creek. In addition, bacteria source tracking has identified that over half the fecal matter is from wildlife in Bexar County.
- Nutrients (nitrate nitrogen and total phosphorus) are identified as a concern. A major nutrient source is commonly wastewater discharge, but currently there are no nutrient standards for streams, just a screening level. No data is available for trends.

**Recommendations:**

- Continue monitoring throughout the watershed through the Texas Clean Rivers Program.
- A study needs to be completed by the State to determine nutrient standards to protect the ecological health of our creeks, rivers, bays and estuary.
- An extensive study needs to be completed by the state or federal government to determine the steps needed remediate Leon Creek and implement those steps so the fish caught from Leon Creek from Old U.S. Highway 90 bridge downstream to the Loop 410 bridge can safely be consumed by the public.
- Elevated *E. coli* levels are usually associated with stormwater runoff events. To reduce *E. coli* bacteria levels stormwater runoff needs to be managed so that instead of transporting fecal matter to our streams, stormwater runoff slows down, spreads out, and soaks in. To accomplish this:

- SARA staff are developing and refining modeling to determine the best location to install needed best management practices to reduce *E. coli* bacteria to levels that will meet the standard.
- Staff is supporting the modeling effort by conducting stormwater sampling to be used to calibrate the model in our district.
- The San Antonio River Authority is providing outreach and training for green infrastructure, to help manage stormwater runoff.

- Samples have been collected to determine the source of the fecal contamination. Library dependent analyses were used to determine the sources. In each county tested, including Bexar County, greater than 50% of the isolates came from wildlife. This information can be used to target the source(s), by providing public outreach and education asking that the public not feed the wildlife near waterbodies. Two of the highest levels for *E. coli* bacteria are in Brackenridge Park and along the San Antonio River Walk. These are both areas with elevated wildlife populations because people are feeding the wildlife.
- Methods developed by our laboratory to determine if the fecal matter is human or non-human need to be employed in areas where it is not clear what the main source of fecal matter is.
- Continue to participate and support implementation plans and watershed protection plans.
- Joint studies and funding need to be made available for the detection of nontraditional pollutants within the basin.
- An extensive statewide outreach program about what can be done to stop the spread of invasive species needs to be established. Invasive species found in the Upper San Antonio River include armored catfish, tilapia and apple snails. Zebra mussels have infected Medina Lake and Medina Diversion Lake. We need to stop the spread of invasive species statewide. Every Texas resident and visitor needs to understand this.

# Table of Contents

# 1.0 Introduction

In 1991, the 72nd Texas Legislature passed legislation creating the Texas Clean Rivers Program (CRP). The program is administered by the Texas Commission on Environmental Quality (TCEQ). The TCEQ engages partners, mostly River Authorities, to manage water quality issues at a watershed level.

Goals and Objectives of the Program:

The goal of the program is to maintain and improve the quality of water within each river basin in Texas through an ongoing partnership involving the TCEQ, river authorities, other agencies, regional entities, local and state governments, industry, and citizens.

The Clean Rivers Program:

- Provides quality-assured data to the TCEQ for use in decision-making.
- Identifies and evaluates water quality issues.
- Promotes cooperative watershed planning.
- Recommends management strategies.
- Informs and engages stakeholders.
- Maintains efficient use of public funds.

The San Antonio River Authority's goal is to provide timely, relevant and defensible data to decision makers and the public to support actions that improve and protect the water quality and ecology of the riverine environment.

Goals of this Report:

This report provides a comprehensive review of water quality and ecology of the San Antonio River Watershed. The report provides a detailed understanding of water quality and ecological conditions, trends, and unique features of the San Antonio River Watershed for stakeholders and decision makers. This report attempts to provide an explanation for why current water quality conditions exist and identify current ecological conditions. By examining multiple sources and using multiple data analysis techniques along with professional knowledge of the watershed. Through examining the findings we can better describe the causes for problems and potentially determine future actions to protect and improve the water quality and ecology of our river system.

Coordination and Cooperation with Other Basin Entities:

Before the CRP, each entity collected its own data. To find where another agency was sampling, staff had to know someone who could explain what their agency was collecting in the San Antonio Watershed. Today, agency staff who sample in the San Antonio River Watershed meet together to discuss their sampling plans, exchange sites to reduce travel and the plan is posted on a website for anyone to review.

Because this data is analyzed using strict quality assurance protocols to protect the quality of the data, quality assurance staff are in contact with the Guadalupe Blanco River Authority (GBRA), so that should an instrument fail, or samples can't be run due to supply chain issues the samples can be sent to the GBRA laboratory, and the GBRA laboratory understands and has agreed to follow the San Antonio River Authority (SARA) Quality Assurance Project Plan (QAPP).

SARA works with our CRP partner the Bandera County River Authority and Groundwater District (BCRAGD), who monitors the Upper Medina River, Medina Lake and Medina Diversion Lake and our partner the City of Boerne, who monitors a site on Upper Cibolo Creek in the City of Boerne. We provide laboratory services, and data management on their samples and quality assurance support through the CRP. Our partner's data along with SARA data is available on the SARA website for their or anyone's use.

The Texas Commission on Environmental Quality (TCEQ) Region 13 and GBRA also monitor in the San Antonio River Watershed. Their work is conducted under a separate QAPP and laboratories. Their data along with all the data from the CRP Program is available on TCEQ's Surface Water Quality Web Reporting Tool.

The annual Surface Water Quality Monitoring Conference sponsored by TCEQ provides a platform where aquatic biologists and water quality professionals from across the state can meet, share ideas, resources, and get specific training for the Clean Rivers Program.

San Antonio River Watershed Overview:

There are six major perennial streams in the San Antonio River Watershed: San Antonio River, Cibolo Creek, Medina River, Medio Creek, Leon Creek, and Salado Creek. These streams are identified by TCEQ as classified streams and have criteria standards specific to them. The classified streams are then broken up into 13 segments and numerous unclassified waterbodies.

The San Antonio Watershed is located in south central Texas. The watershed begins in the northeast corner of Bandera County. Most streams flow in a southeasterly direction to Goliad County and then along the Refugio-Victoria County line where it joins the Guadalupe River. The Guadalupe River flows approximately 10 miles before entering Guadalupe Bay, which then flows into San Antonio Bay.

The northern and southern portions of the watershed are mostly rural, with livestock and wildlife common. Since the watershed lies in a semi-arid region wildlife tend to congregate near sources of water. Feral hogs, javelina, deer, rabbits, coyotes, raccoons, and opossums are common. However, like most of Texas, the population has grown. The Texas Hill Country is growing rapidly with large ranches being broken up into small hobby ranches, and often each small track of land has a water well and a septic system. Small towns like Bandera and Medina are also growing. This can put a strain on groundwater resources, and as the groundwater level drops, so does spring outputs that feed the hill country streams. In the southern portion of the basin the Eagle Ford shale oil and gas industry centered in Karnes County has brought people to the southern portion of the watershed. Numerous drilling pads can be seen on land that used to be farmed or ranched.

The center of the watershed is Bexar County and the City of San Antonio. In 2020, San Antonio was the 7$^{th}$ largest city in the US. The Census Bureau estimated the 2020 population at over 1.4 million people.

Like most large cities, impervious cover (streets, roofs, sidewalks, etc.) cause stormwater to rapidly runoff, and pick up pollutants and transport them to the nearest stream. Impervious cover does not allow stormwater runoff to slow down, spread out, soak into the soil, and slowly make its way to a stream.

The northeast portion of the basin is in an area known as the Texas Hill Country. The Texas Hill Country is at the southeast portion of the Edwards Plateau and consists of limestone that has been eroded to create hills. The hills are dominated by Ashe juniper and live oak trees. Soils are usually thin and grass is sparse. Rainfall runoff in this area drains into the creeks which then flow over the highly fractured Balcones Fault Zone, also known as the recharge zone of the Edwards Aquifer.

The center portion of the basin is located in the Texas Blackland Prairie. This portion is dominated by deep clay soils which expand with moisture and contract as they dry. The soils are gently sloping. The deep rich soils make the Blackland Prairie ideal for row crops but in this basin, the Blackland Prairie is dominated by urbanization.

The Texas Hill Country and the Blackland Prairie depend on the Edwards Aquifer for water for domestic, industrial and agricultural uses. The demand for water has put a strain on the Edwards Aquifer, causing water levels to drop. This has caused a reduction in spring flow into the creeks and rivers in the central portion of the watershed.

To combat the lack of flow in the San Antonio River, wells were drilled decades ago in and around Brackenridge Park to augment the flow with water from the Edwards Aquifer. In 2000, San Antonio Water System (SAWS) started discharging reuse water into the River and the Edward Wells were turned off to protect the drinking water supplies for the City of San Antonio.

Tourism is a major industry in San Antonio, and the number one tourist attraction in San Antonio is the River Walk. Tourists come from around the world to stroll along the River Walk, eat at world class restaurants along the river, and shop. To combat the drop in spring flow and to augment flow to the San Antonio River and Salado Creek, reuse water from San Antonio Water Systems supplements the flow. In addition, in the late 1990's two flood control tunnels were built, one next to the San Antonio River and the other next to San Pedro Creek. During stormwater events, water enters the tunnels upstream of downtown, flows under downtown and is discharged downstream of downtown. These tunnels along with a series of gates (dams) have been reworked to pump water from downstream up to upstream during non-flooding conditions. This allows water to continually flow in the urban portion of the San Antonio River.

South of the Texas Blackland Prairie is the East Central Texas Plains. This area is made up of gently sloping sandy loam and clay loam soils. The majority of this area is rural with towns interspersed. The economy of the region is dominated by the petroleum industry and ranching. Around 2010, oil and gas drilling increased dramatically in this area with horizontal drilling and hydraulic fracturing techniques being used in this area.  The Carrizo Aquifer is in the northern part of the region, while the Gulf Coast Aquifer is in the southern portion.

Located in southern Goliad County and along the Refugio-Victoria County line is the Western Gulf Coast Plain. The topography of this area is mostly flat with abundant grassy areas and fewer trees than the East Central Texas Plains. Row crops are more common than on the East Central Texas Plains. Farming, ranching and the petroleum industry make up the primary land use for this region.

Summary of Basin's Water Quality Characteristics:

Streams that originate in Bandera, Kendall and Northern Bexar County start out as clear hill country streams. The water is typically very hard due to the limestone in the area. However, once the streams cross the Edwards Aquifer Recharge Zone and the Transition Zone, much of the water is recharged into the Edwards Aquifer under normal conditions.

Most of the major rivers, San Antonio River, Medina River, Medio Creek, Leon Creek and Cibolo Creek become effluent dominated in Bexar County. Typically, wastewater discharges have elevated nutrient levels and low *E. coli* levels. However, stormwater runoff and excessive wildlife in parks along our waterways increase E. coli levels so that most of the urban streams are not meeting contact recreation standards. For this report, excessive wildlife is identified as wildlife, such as ducks and geese, with populations that create ecological damage and are sustained by food from humans. It does not include natural native populations that do not depend on humans for food.

Downstream from the City of San Antonio, there are portions of the river that are meeting the *E. coli* standard, and portions that are not meeting the standard.

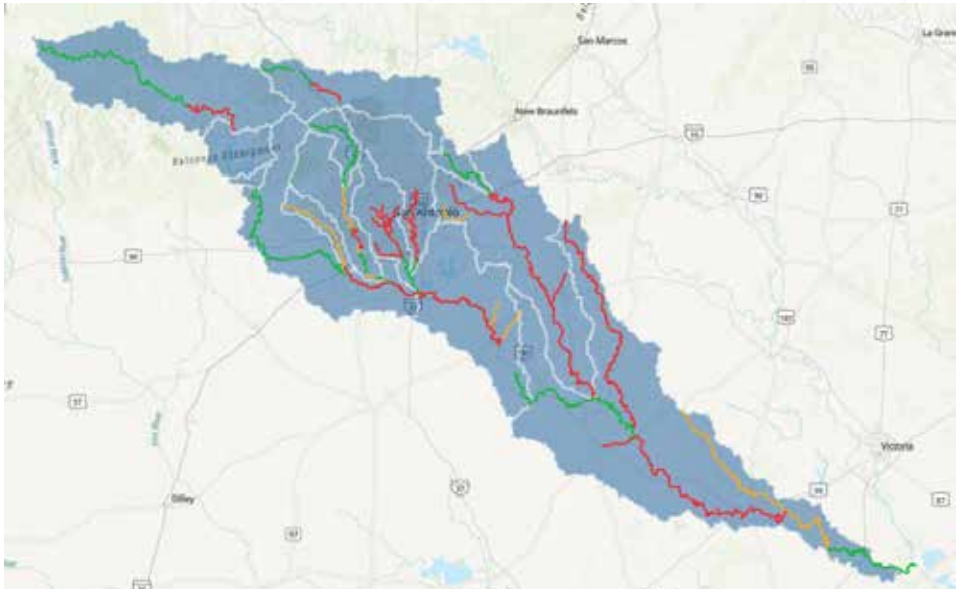



Image of San Antonio River Basin showing *E. coli* impairments (red), concerns (orange) and fully supporting the standard (green) from the Water Quality Viewer as reported by the TCEQ 2022 Integrated Report.

# 2.0 Public Involvement

San Antonio River Basin Environmental Advisory Committee (EAC):

The River Authority engages in numerous environmental studies and projects involving a public outreach component. Many of these studies and projects are identifying overlapping concerns and would benefit from cross sharing the knowledge acquired. In 2005, the River Authority Board of Directors approved the creation of an Environmental Advisory Committee (EAC) to serve as an umbrella committee dedicated to understanding, identifying, and addressing the environmental strengths and weaknesses within the San Antonio River Basin. The EAC began its work in April 2005. The advisory committee consists of up to 13 members, including two co-chairs, one representing Bexar County and the other representing a downstream county. Each member serves staggered, 3-year terms determined by the River Authority Board of Directors by lottery in August 2015. If deemed necessary by the River Authority staff to maintain a diverse and representative committee, an EAC member may serve beyond their term limit until an appropriate replacement can be approved and appointed by the River Authority Board of Directors. The table below lists the interest groups represented on the EAC. Some groups have more than one seat on the committee.

| General Stakeholder Categories for the Environmental Advisory Committee | |
|---|---|
| Co-Chairs | Business and Industry |
| Academia | Environmental |
| Agriculture | Recreational |
| Bay and Estuary | |

The EAC acts as the Clean Rivers Program (CRP) Steering Committee, providing guidance and feedback on the River Authority's annual monitoring schedule. While the EAC meets quarterly, the third quarter meeting is considered the CRP Steering Committee Meeting. At the Steering Committee Meeting, an overview of the program is discussed, including CRP goals, proposed work plan, allocation of resources, request for review of upcoming reports, and monitoring plans. The EAC is asked for feedback and additional comments and concerns for the basin. At the last meeting members identified concerns on per- and polyfluorinated substances (PFAS) and plastics. Staff discussed that we have been communicating with researchers at several universities on these subjects and that while the CRP had not addressed these pollutants, work was being conducted in our basin associated with PFAS and plastics.

Other recent discussions and presentations at the quarterly meetings include public outreach, education, the work our River Warriors are doing to protect the watershed, solar energy water impact, apple snail removal, avian study associated with the Mission Reach restoration and many more. EAC meeting agendas and presentations are available on the San Antonio River Authority's website on the EAC webpage.

River Reach Quarterly Newsletter:

Water quality information is regularly provided to the public through the River Authority's quarterly newsletter, River Reach. Created in 2003, the newsletter also features water quality-related community events that are hosted and/or sponsored by the River Authority. River Reach is distributed by regular mail and email to stakeholders throughout South Central Texas, including the River Authority's jurisdiction of Bexar, Wilson, Karnes, and Goliad counties. It is also distributed in person throughout the area at school functions, community events and public meetings. The River Reach Newsletter is a physical publication that started back in the Fall of 2022 after a year-long hiatus. Free subscriptions are made available through the agency's website at: https://www.sariverauthority.org/resources/river-reach

The River Authority Blog:

The River Authority Blog seeks to keep the community updated on River Authority water quality information, events, and projects in an informative, enjoyable way. The blog is published bi-weekly and is provided on the agency's website, subscription emails, and through multiple social media platforms as they are published. Features on staff members, such as water quality scientists, board member insights, native and invasive species of the San Antonio River Basin, parks and trails, and more provide a look at the myriad, diverse activities of the River Authority.

Education

*River Proud Field Trips*

River Authority education team offers free and original programming for 3rd grade through 12th grade students in Bexar, Wilson, Karnes, and Goliad Counties. Education programming is aligned to Texas Essential Knowledge and Skills (TEKS). It is the agency's mission to engage, educate and empower students to make informed decisions about the conservation and protection of the San Antonio River Watershed through thought-provoking, hands-on, and inquiry-driven explorations. Nature-based and place-based STEM programming are pillars in our field trip programming. The agency serves to augment what educators are teaching in the classroom, such as water quality issues and improvements, with real-world examples that are locally relevant to the students.

*Educator Professional Development Workshops*

Educator workshops are a free, professional development workshop for public school educators that serve kindergarten through 12th grade in Bexar, Wilson, Karnes, and Goliad Counties. The River Authority understands the critical importance of inspiring action for healthy creeks and rivers and knows that teachers are key in providing young citizens with the tools necessary to be innovative and take such action. Since 2015, teachers can earn State Board of Education Continuing Professional Education credits across a series of workshops that focus on watersheds, river ecology, water quality, STEM careers, aquatic science, and sustainability best practices.

River Warrior Volunteer Program

River Authority River Warrior volunteer program is in partnership with the San Antonio River Foundation and was implemented in 2020. The River Warriors dedicate thousands of volunteer hours to helping protect and preserve local waterways, including improvement of water quality.

*Apple Snail Removal Program:* The invasive and non-native giant apple snail (*Pomacea maculata*.) was first observed in the river in October 2019. This program trains volunteers, in agreement with Texas Parks and Wildlife Department, to remove the harmful organism safely and legally from the river. The volunteers are responsible for removing approximately 20% of the apple snails and their egg cases of the total removed by the agency. As of February 2023, the volunteers have removed 1,943 adult snails, and 9,043 egg cases from the San Antonio River since Summer 2020. Read more about apple snail removal efforts.

*"Beaver Dam" Pilot Program:* The River Authority leads stream restoration efforts to improve the physical, chemical, and biological functions of a stream system. The Beaver Dam Pilot Program is one of the most recent stream restoration efforts led by the River Authority to address the erosion issues at the Medina River Natural Area. The Medina River Natural Area has developed extensive erosion valleys contributing to sedimentation in the Medina River, affecting water quality and aquatic habitats. Volunteers, in collaboration with the River Authority's ecological engineering staff and the City of San Antonio Parks and Recreation Department, are helping to pilot test an alternative form of erosion control. The goal is to build a series of post-assisted log structures in the erosion valleys using local mesquite logs and brush materials and build mini dams to reduce the loss of sediment, allowing nature to rebuild and stabilize the erosion valleys. As of February 2023, 46 dams of the proposed 100 dams have been constructed and are showing positive results. Read more about the pilot beaver dam building project.

*Texas Stream Team Program* – The River Authority is involved with the Texas Stream Team citizen science data collection efforts through the Meadow Center for Water and the Environment. Approximately 15 volunteers are consistently monitoring between 12 and 25 monitoring sites across our introduction to the program in 2021.


*iNaturalist Citizen Science Program* – This program is designed to instruct volunteers on how to capture data across the watershed for scientific use regardless of experience level using the iNaturalist application. The volunteers participate in a once per year event with Texas Parks and Wildlife Department and partnering organizations for the City Nature Challenge.

*Litter Clean Up* – Litter pickups by volunteers are an ongoing effort and are held approximately once per month along the banks of the San Antonio River. Additional efforts by volunteers across the watershed are supported through a Litter Toolkit and training available on the website along with equipment loans for pickers and branded mesh litter bags. This program also attracts local businesses and corporations to engage with the agency's mission and vision on their volunteer workdays. In 2021-2022, the agency deployed the use of a digital citizen science application called Litterati, which engaged the volunteers with a citizen science data collection component. Approximately 200 to 500 pounds of litter are removed from the watershed per volunteer group effort.

*Paddling Crew Clean Up Program* – Volunteers in the paddling program are trained to safely pick up litter, engage in ecosystem restoration, and collect citizen science data through the iNaturalist app while they are paddling via kayak or canoe on the San Antonio River.

Basin Report Card:

The development of the San Antonio River Basin Report Card grew from the River Authority's drive to harmonize the needs of people and nature through our stewardship of rivers and land. The River Authority first researched the topic of

river basin report cards to learn from best management practices from around the world. *The Practitioner's Guide to Developing River Basin Report Cards* was also a valuable resource. For additional guidance in the development of this river basin report card, the River Authority also turned to our own mission statement, which states that we are committed to safe, clean, enjoyable creeks and rivers. The main purpose of the San Antonio River Basin Report Card is to shine a light on the healthy and the unhealthy aspects, including that of water quality, of the basin to educate the public and serve as a catalyst for community discussions that lead to individual choices and public policy decisions, actions, and investments that support a sustainable San Antonio River Basin. Ultimately, the intention of the basin report card is to inspire others to implement positive changes in their behavior that will result in improvements to the health of the San Antonio River Basin.

Don't Let Litter Trash Your River Initiative:

The River Authority's 'Don't Let Litter Trash Your River' (DLLTYR) initiative is a marketing and education initiative designed to increase awareness and educate watershed citizens of the litter problem facing the San Antonio River and its tributaries. The initiative is also designed to encourage individuals to take responsibility for this waterway pollutant. The initiative began in September 2021 in answer to the River Authority's poor 'F' grade on the Public Trash metric on the annually published Basin Report Card.

DDLTYR messages encourage educators, community members, corporations, and volunteers to take a pledge to put personal trash where it belongs and to pick up litter when they find it. Individuals that take the pledge receive periodic emails that encourage different modes of honoring their commitment to a safe, clean, and enjoyable river.

The DDLTYR initiative project produced marketing collateral, in English and Spanish, such as commercials, billboards, bus graphic wraps, and social media sponsored posts. The agency invested in paid media custom sponsorships and was also featured on local news outlets and television segments. The initiative was a major theme for the inaugural River Symposium in September 2021, as well.

The organization's Education and Engagement staff also crafted an award-winning multi-pronged programmatic approach to instill the DDLTYR pledge responsibilities of watershed stewardship to students, educators, and adult volunteers. These innovative, nature-based, scalable, and adaptive programs were: 1) DLLTYR Field Trips 2) DDLTYR Educator Professional Development, and 3) DLLTYR Service-Learning Campus Cleanup, and 4) River Warrior volunteer DDLTYR programs.




Coffee for Conservation:

In April 2022, the San Antonio River Authority and the San Antonio River Foundation partnered with local coffee shops to launch “Coffee & Conservation”, an awareness campaign encouraging sustainability practices in our community and keeping litter from entering waterways. For a month, customers received a discount on their beverage when ordering with a reusable beverage container.


River Symposium:

The River Symposium is designed to increase the community’s understanding of and appreciation for the San Antonio River Basin. The theme for the Inaugural River Symposium in September 2021 was Cleaning, Protecting, and Taking Pride in our Waterways.

The schedule of presentations and activities are designed to draw together area citizens, families, and professionals alike who share a common interest in the San Antonio River. This event also offers an opportunity for the public to interact with River Authority professionals, collaborating governmental agencies, non-profit organizations, other engaged citizens, and environmental and community advocates who are all working together to ensure area creeks and rivers remain healthy for generations to come.

Household Hazardous Waste Program:

The San Antonio River Authority, along with local partners, hosts six (6) free Household Hazardous Waste Collection Events within Wilson, Karnes, and Goliad counties. These semi-annual events are held in the spring and fall. County

residents may stop by to drop off unwanted household hazardous waste, tires, paint, used motor oil & filters, cleaning products, pesticides, computers, small electronics, and pharmaceuticals.

The River Authority hosts these household hazardous waste collection events with the hope that it will lead to a reduction in waste that enters local creeks and rivers. These are free events and are first come, first serve due to availability.

In the Fall of 2022, the River Authority held three household hazardous waste events in each of the downstream counties. These events received:

- Wilson County - 355 vehicles dropped off:  34,821 lbs. of household hazardous waste, 15,269 lbs. of e-waste, and 20.2 tons of tires.
- Karnes County - 144 vehicles dropped off: 11,309 lbs of household hazardous waste, 9,465 lbs of e-waste, and 31.11 tons of tires.
- Goliad County - 121 vehicles dropped off: 8,998 lbs of household hazardous waste, 5,366 lbs. of e-waste, and 7.4 tons of tires.

In the Spring of 2023, the River Authority held three household hazardous waste events in each of the downstream counties. We currently don't have information on the pounds of hazard waste yet, but the information we do have:

- Wilson County 430 vehicles dropped off: 24,393 lbs of e-waste, and 21.24 tons of tires.
- Karnes County: 82 vehicles dropped off:  3,919 lbs of e-waste, and approximately 15 tons of tires. (This event was impacted by severe weather where the River Authority had to delay opening due to lightning in the area).
- Goliad County: 126 vehicles dropped off:  6,059 lbs of e-waste, and 9.16 tons of tires.

Recreation:

The River Authority's recreation staff supports a public connection to local natural resources through a variety of programs. These programs include kayaking trips, fishing clinics, park tours, and other outdoor recreation opportunities throughout the San Antonio River Basin with the aim of introducing communities to the river, water quality issues and education, and instilling a sense of ownership among those who enjoy it. These free public opportunities allow for individuals to learn about the value of sustainable rivers and encourage stewardship of the San Antonio River and adjoining parks. These programs reach over 26,000 people annually, ranging in age from youth to adults.

Basura Bash:

In partnership with the San Antonio River Foundation, the Basura Bash Planning Organization, and a host of private businesses that sponsor staff, professional services and other resources, the River Authority supports the citizen led Basura Bash trash collection and recycle event. In addition to removing trash and recyclables from the banks of the San Antonio River and its 15 tributaries, the event serves to increase awareness of the need for river basin stewardship.

# 3.0 Water Quality Review

As part of the CRP, the San Antonio River Authority and their partners, Bandera County River Authority and Groundwater District and the City of Boerne collect samples throughout the watershed. Out of 83 routine sample sites visited in the watershed, 76 are visited by the San Antonio River Authority and our partners.

These samples are analyzed in the San Antonio River Authority Regional Environmental Laboratory (SARA-Lab). The SARA-Lab has been supporting the CRP since the early 1990s. It was first started in 1966 at the Salitrillo Wastewater Treatment Plant in Converse, Texas before it was relocated to downtown San Antonio, Texas. The SARA-Lab became the first river authority laboratory in the state of Texas to obtain accreditation through TCEQ under the National Environmental Laboratory Accreditation Program (NELAP) in 2008. Today, SARA-Lab analyzes water quality parameters for over 76 sites in coordination with SARA's CRP program and other partners.

Over the years, the SARA-Lab has striven to provide the CRP with essential water quality data through continued implementation of analytical instrumentation. This has been made possible through support of the CRP managers and SARA. Over the next year, the SARA-Lab will be implementing new instrumentation to support analyses such as non-distilled ammonia, total phosphorus, total Kjeldahl nitrogen (TKN) and inorganic anions including chloride, nitrate, nitrite, and sulfate. Implementation of newer instrumentation will allow SARA-Lab water quality scientists to improve existing testing procedures while using cutting edge technologies.

Data collected by SARA, BCRAGD, City of Boerne, TCEQ Regional Office and Guadalupe Blanco River Authority is used by TCEQ to develop the TCEQ's Integrated Report. This report is generated every two years and is submitted to EPA to satisfy the requirements of the federal Clean Water Act Sections 305(b) and 303(d). The TCEQ uses this report to determine where total maximum daily load studies (TMDL) need to be conducted, and where implementation plans and watershed protection plans need to be developed.

Tools have been developed by the SARA to allow the public to view and understand the data collected by SARA and our partners. For example, one very useful tool is the Water Quality Data Viewer. If you select a station in SARA's political district, and then select pathogens, information will pop up identifying the source of pollution found in that county and the percentages. For example, non-avian wildlife account for 39% of the fecal contamination in Wilson County.

Also on this webpage you can see a map of the basin identifying where there are impairments and concerns in the watershed according to the 2022 TCEQ Integrated Report (2022 IR), the 2020 IR and the 2018 IR for primary contact recreation use, general use (temperature, pH, chloride, sulfate, and total dissolved solids), aquatic life use (dissolved oxygen, toxic substances fish and benthic macroinvertebrates) and fish consumption use (advisories against eating fish caught in the identified area).

Another tool available to the public is the Water Quality Bacteria Dashboard. You can select the entire watershed, a county or draw a rectangle around an area you are interested in or select just one point and the dashboard will show you if the *E. coli* bacteria geometric mean is from:

- 1 – 126 MPN per 100 mL
- >126 – 206 MPN per 100 mL
- >206 – 630 MPN per 100 mL
- >630 MPN per 100 mL.

# 3.1 Water Quality Terminology

Priority Parameter Definition Descriptions

*Table 3-1: Priority Parameters*

| Parameter | Impact | Potential Causes |
|---|---|---|
| **Temperature** | Water temperature affects the oxygen content of the water, with warmer water unable to hold as much oxygen. When water temperature is too cold, cold-blooded organisms may either die or become weaker and more susceptible to other stresses, such as disease or parasites. | Colder water can be caused by reservoir releases. Warmer water can be caused by removing trees from the riparian zone, soil erosion, or use of water to cool manufacturing equipment. |
| **Conductivity** | Conductivity is a measure of the water body's ability to conduct electricity and indicates the approximate levels of dissolved salts, such as chloride, sulfate, and sodium in the stream. Elevated concentrations of dissolved salts can impact the water as a drinking water source and as suitable aquatic habitat. | Runoff from agricultural and mining operations, industrial and wastewater discharge, and the surrounding geology of the area can affect conductivity. |
| **pH** | Most aquatic life is adapted to live within a narrow pH range. Different organisms can live at and adjust to differing pH ranges. | Industrial and wastewater discharge, runoff from quarry operations and accidental spills. |
| **Dissolved Oxygen (DO)** | Organisms that live in the water need oxygen to live. In stream segments where DO is low, organisms may not have sufficient oxygen to survive. | Modifications to the riparian zone, human activity that causes water temperatures to increase, increases in organic matter, bacteria and over abundant algae may cause DO levels to decrease. |

| Parameter | Impact | Potential Causes |
|---|---|---|
| **Stream Flow** | Flow is an important parameter affecting water quality. Low flow conditions common in the warm summer months create critical conditions for aquatic organisms. At low flows, the stream has a lower assimilative capacity for waste inputs from point and nonpoint sources. | Stream flow may change as a result of natural factors (e.g., weather, groundwater discharge and recharge) or human factors (e.g., water withdrawals or discharges, land use changes). |
| **Secchi Disc Transparency** | Transparency is a measure of the depth to which light is transmitted through the water column and thus the depth at which aquatic plants can grow. | Low secchi disc depth is an estimate of turbidity. Low transparency can be caused by suspended sediment, organic matter, and algae. |
| **Turbidity** | Turbidity is a measure of the water clarity or light transmitting properties. Turbidity can impact primary productivity, habitat quality, and drinking water use. | Increases in turbidity are caused by suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter, plankton, and other microscopic organisms. |
| **Hardness** | The hardness of water is critical due to its effect on the toxicity of certain metals. Higher hardness concentrations in the receiving stream can result in reduced toxicity of heavy metals. | Hardness is a composite measure of certain ions in the water, primarily calcium and magnesium. |

| Parameter | Impact | Potential Causes |
|---|---|---|
| **Chloride** | Chloride is an essential element for maintaining normal physiological functions in all organisms. Elevated chloride concentrations can disrupt osmotic pressure, water balance and acid/base balances in aquatic organisms which can adversely affect survival, growth or reproduction. | Natural weathering and leaching of sedimentary rocks, soils and salt deposits can release chloride into the environment. Other sources can be attributed to oil exploration and storage, sewage, and industrial discharges, run off from dumps and landfills, and saltwater intrusion. |
| **Sulfate** | Effects of high sulfate levels in the environment have not been fully documented. However, sulfate contamination may contribute to the decline of native plants by altering chemical conditions in the sediment. | Due to abundance of elemental and organic sulfur and sulfide mineral, soluble sulfate occurs in almost all natural waters.<br>Other sources are the burning of sulfur containing fossil fuels, steel mills, and fertilizers. |
| **Total Dissolved Solids (TDS)** | High TDS may affect the aesthetic quality of the water, interfere with washing clothes, and corrode plumbing fixtures. High TDS in the environment can also affect the permeability of ions in aquatic organisms. | Mineral springs, carbonate deposits, salt deposits and sea water intrusion are sources for natural occurring high concentration TDS levels. Other sources can be attributed to oil exploration, drinking water treatment chemicals, storm water and agricultural runoff and point and nonpoint sources. |

| Parameter | Impact | Potential Causes |
|---|---|---|
| **Bacteria *Escherichia coli* (*E. coli*) or Enterococci** | Although fecal indicator bacteria may not themselves be harmful to human beings, their presence is an indicator of recent fecal matter contamination and that other pathogens dangerous to human beings may be present. | Present naturally in the digestive system of all warm-blooded animals, these indicator bacteria are in all surface waters. Poorly maintained or ineffective septic systems, overflow of domestic sewage or nonpoint sources and runoff from animal feedlots can elevate bacteria levels. |
| **Ammonia Nitrogen** | Elevated levels of ammonia in the environment can adversely affect fish and invertebrate reproductive capacity and reduce the growth of young. | Ammonia is excreted by animals and is produced during the decomposition of plants and animals. Ammonia is an ingredient in many fertilizers and is also present in sewage, storm water run-off, certain industrial wastewaters, and runoff from animal feedlots. |

| Parameter | Impact | Potential Causes |
|---|---|---|
| **Total Suspended Solids (TSS)** | Suspended solids increase turbidity which reduces light penetration and decreases the production of oxygen by plants. They can also clog fish gills.<br><br>Eventually, the suspended solids settle to the bottom of the stream or lake, creating sediment. Excessive sediment can cover instream habitat and smother benthic organisms and eggs. | Excessive TSS is the result of accelerated erosion and is often associated with high flows where riverbanks are cut or sediment is suspended. It can also be the result of sheet erosion, where over land flow of water causes a thin layer of soil to be carried by the water to the stream.<br><br>Disturbing vegetation without a proper barrier to slow down overland flow (such as construction sites or row cropping) increases TSS. |
| **Nutrients**<br><br>**Nitrogen**<br><br>**Nitrate**<br><br>**Total Phosphorus**<br><br>**Ortho- phosphate phosphorus** | Nutrients increase plant and algae growth. When plants and algae die, the bacteria that decompose them use oxygen. This reduces the dissolved oxygen in the water. High levels of nitrates and nitrites can produce nitrite toxicity, or “brown blood disease,” in fish. This disease reduces the ability of blood to transport oxygen throughout the body. | Nutrients are found in effluent released from wastewater treatment plants, fertilizers and agricultural runoff carrying animal waste from farms and ranches. Soil erosion and runoff from farms, lawns and gardens can add nutrients to the water. |
| **Chlorophyll -*a*** | High levels of chlorophyll -*a* can cause algae blooms, decrease water clarity, and cause swings in dissolved oxygen level due to photosynthesis. Most commonly measured as chlorophyll -*a.* | Algal blooms can result in elevated chlorophyll -*a* levels, indicating an increase in nutrients, such as nitrogen and phosphorus, that increase growth and reproduction in algal species. |

# 3.2 Data Review Methodology

**Review of the TCEQ 2022 Integrated Report (IR):**

Every two years, the TCEQ publishes the Texas Integrated Report of Surface Water Quality (IR). The IR identifies both the level of support for the period of record that the IR covers (usually 7 years) and the integrated level of support which is the overall level of support which can be due to carry forward information. The IR tables that follow in each segment show when a parameter is not supporting the standard (impaired) or if there is a concern for a parameter. A concern may be due to a parameter with a standard, nearing impairment, or it may be due to there only being a screening level, and standards have not been developed for that parameter.

Note that some parameters such as nutrients, habitat quality index, average grab dissolved oxygen and metals in sediment do not currently have water quality standards but do have screening levels.

The method TCEQ uses to determine impairments and concerns is described in the 2022 Guidance for Assessing and Reporting Surface Water Quality in Texas (https://www.tceq.texas.gov/downloads/water-quality/assessment/integrated-report-2022/2022-guidance.pdf).

In each watershed summary, the map of watershed impairments has icons that indicate impairments and concerns for the assessment units (AU). A red icon indicates that an impairment has been identified and a yellow icon indicates that a concern was identified according to the TCEQ's 2022 Integrated Report.

**San Antonio River Authority (River Authority) Evaluation of Data by Station:**

Datasets were reviewed by station using guidance associated with the TCEQ 2022 IR. There are a few major differences between the IR and the review of the data in this report.

- The IR evaluates data by assessment units which often causes the reviewer to combine multiple sites. This review was by sample site. If more than one site was used, due to gaps in data or changing stations within the same AU, it will be identified in the write up.

- The time period for the 2022 IR is from 12/1/2013 thru 11/30/2020. Additional years up to a total of ten years can be used if insufficient data is available. The time period used for trend analysis in this report is June 1, 2012 to May 31, 2022.

**River Authority Trend Analysis and Seasonality:**

Datasets for each site were analyzed for statistically significant trends in parameter values over time and flow. Data was retrieved from the TCEQ Surface Water Quality Monitoring Information System (SWQMIS) for at least one monitoring station in each classified segment and selected unclassified segments. Analytical methodology generally followed the guidelines indicated in the CRP guidance, Task 5, Exhibit 5E. Reported standards are taken from the 2022 Texas Surface Water Standards (TSWQS).

Statistical design for this report includes descriptive statistics and trend analyses, over both time and flow. Trend analyses required that the data included a minimum of 20 samples over a 10-year period, June 1, 2012 to May 31, 2022, had minimal continuity disruption, and was monitored over the majority of the specified date range.

Linear regression was used for trend analysis of parameter values vs. time and parameter values vs. flow. For linear regression, $r^2$ is a statistical measure of what percentage of the variation in the parameter values can be explained by the variation in flow. Values closer to 1 indicate that variation in parameter values is more dependent on flow, whereas values nearer to 0 indicate that the variation in parameter values is less dependent on flow. The slope value from the linear regression identifies both magnitude and direction of the trend. A negative slope indicates a decreasing (downward) trend and a positive slope indicates an increasing (upward) trend.

Significant trends ($p < 0.10$) were also identified as either decreasing or increasing. With the exception of flow and dissolved oxygen, decreasing parameter trends are generally beneficial and increasing trends are detrimental to water quality. The magnitude, timing, duration, and frequency of surface water flows all play a critical role in supporting the ecological integrity of streams and rivers. Depending on the time of the year, changing flows may be beneficial or detrimental to aquatic life cycles and riparian habitat. Trends were examined for the following water quality parameters:

- Flow
- Temperature
- Specific Conductance
- Total Dissolved Solids
- Dissolved Oxygen

- Dissolved Oxygen Deficit
- pH
- Total Suspended Solids
- Ammonia Nitrogen
- Nitrite Nitrogen
- Nitrate Nitrogen
- Nitrite + Nitrate Nitrogen (when nitrite and nitrate are analyzed together)
- Total Kjeldahl Nitrogen
- Total Phosphorous
- Chloride
- Sulfate
- *E. coli*
- Chlorophyll-a
- Secchi Depth

The Kruskal-Wallis test was used to check for a statistically significant ($p \leq 0.10$) seasonal component in the data. It should be noted that the Kruskal-Wallis test does not quantify which season is different or what the seasonality pattern is; it only detects the presence or absence of a significant difference between the defined seasons (i.e. seasonality). Seasons were defined as Non-Index (October 16 – March 14), Non-Critical (March 15 - June 30, October 1 – October 15), and Critical (July 1 – September 30), following the seasons defined in TCEQ Surface Water Quality Procedures Manual, 2012.

Variability in dissolved oxygen levels due to factors such as water chemistry or pollutants can be masked by the strong inverse relationship between dissolved oxygen (DO) and water temperature (as water temperature increases, DO usually decreases). In order to more accurately represent the variability in dissolved oxygen that may be caused by factors other than water temperature, a simple DO deficit is calculated as the difference between the potential and actual dissolved oxygen level at that temperature. DO deficit was calculated as

$$DO\ Deficit = [500/(Temperature + 35)] - DO.$$

Decreasing DO deficit values reflect an increase in dissolved oxygen relative to temperature, often due to changes in chemical (e.g. pollutants) or biological demands (e.g. aquatic plants or fish).

Due to variations in data collection methodology, timing, and reporting, the following qualifiers for trend analyses and descriptive statistics apply:

- Values exceeding 3 standard deviations from the mean (geomean for *E. coli* values) were identified as statistical outliers and excluded from analyses.
- For values less than the limit of quantitation (LOQ), the reported value was replaced with the LOQ in place at that time. Values greater than the maximum reportable values were replaced with the maximum reportable value. No further standardization of values due to changes in LOQ or maximum reportable value was conducted.
- When > 50% of reported values for a given parameter at a site were below the LOQ or above the maximum reportable value, no trend analyses were conducted due to the unreliability and inaccuracy of the statistical analyses for that type of dataset.
- In accordance with the TCEQ Surface Water Quality Procedures Manual, 2012, Total Dissolved Solids (TDS) was calculated as

$$TDS = Specific\ Conductance * 0.65$$

- For stations where SARA was not the primary sampling entity, nitrite+nitrate values were utilized for trending over time and flow. For sites where nitrite+nitrate was the primary value reported, nitrite+nitrate was calculated from available nitrite and nitrate data when necessary. The previously described method for handling values below the LOQ was applied before calculating nitrite+nitrate.
- Data for equivalent Chlorophyll-a methods were combined for trend analysis, including:
  - 32211 Chlorophyll-a, Spectrophotometric (Acidified)
  - 70953 Chlorophyll-a, Fluorometric Method
- Only data collected under routine monitoring (monitoring type = RT) were used for field and conventional water quality analysis.
- When more than one sample was collected during a given time period, generally bi-monthly, the sampling event with the most data was retained. In the event that multiple equally complete samples were collected in the same time period, the sample with a collection date and time most closely matching the dominant temporal pattern was retained (e.g. odd months, same day of week, same time of day). This selection was on a parameter-by-parameter basis, with each site being considered independently of other sites. It should be noted that some sites had different temporal patterns of collection for different parameters (e.g., *E. coli*).

- When necessary due to a high range of values, flow data was plotted on a log scale axis.
- *E. coli* graphs were produced with *E. coli* values plotted on a log scale axis.

In the watershed summaries in section 3.3, the focus was on parameters that were identified as impairments or concerns. Individual station data used for this report, is available on the San Antonio River Authority's website: (www.sariverauthority.org).

**River Authority Nektons (fish), Benthic Macroinvertebrates and Habitat Analysis:**

The collection and analysis of nektons, benthic macroinvertebrates and habitat analysis are based on guidance in the Surface Water Quality Monitoring Procedures Volume II (SWQM Vol. II). www.tceq.texas.gov/downloads/publications/rg/swqm-procedures-manual-volume-2-rg-416.pdf .

Changes in fish communities are compared by reviewing the index of biotic integrity which is based on drainage basin size, species richness and composition, trophic composition, and fish abundance and condition. In this report we also compare the change in tolerant and intolerant fish species found. Tolerant fish species are fish species that are tolerant to water quality pollution and/or habitat degradation. Intolerant fish species are found in waters that have low levels of pollutants and undamaged habitats instream and along the riparian zone.

**San Antonio River Watershed Summary**

The San Antonio River is broken up into two segments:

- Upper San Antonio River
- Lower San Antonio River

The headwaters of the San Antonio River originate on the campus of Incarnate Word University. There are many springs that feed the river, the largest being named the Blue Hole. Unfortunately demand for groundwater has caused the flow of springs to be sporadic at best. Wells were drilled to supplement the spring flows sometime prior to the 1930's. These wells used water from the Edwards Aquifer. In June of 2000, San Antonio Water System began discharging recycled water in Brackenridge Park. In 2008 the Hildebrand Well was plugged (Eckhardt, n.d.). Recycled water is also discharged near the River Walk on the extension near the convention center. The zoo well still discharges water in the zoo that then makes its way to the San Antonio River in Brackenridge Park. This water is essential for the ecology of the river and for the aesthetic beauty of the San Antonio River Walk.

Projects and Efforts of the Upper San Antonio River:

<u>Apple Snail Removal:</u>

Non-native species cause a threat to the Upper San Antonio River. The giant apple snail, *Pomacea maculata*, is native to humid tropical/subtropical regions of South America. Found in slow-moving, warm, freshwater systems, the downtown reaches of the Upper San Antonio River are well suited for these organisms to take hold (Florida FDOACS 2002). Giant apple snails pose a threat to overall river health due to their indiscriminate consumption of aquatic vegetation, lack of competition, and few predators. In addition, their robust reproductive cycles, with one snail able to produce up to 2,000 eggs every 14 days, lend to a rapid increase in population.

Giant apple snails were first observed in the Upper San Antonio in October 2019 in the Museum Reach of the San Antonio River. The River Authority and its partners have since worked to suppress the population via removal and monitoring. Removals are focused in the Museum, Downtown, King William, and Mission Reaches of the Upper San Antonio River. As of February 14, 2023, 9,716 giant apple snails and 45,215 egg cases have been removed across all four reaches. The River Authority and its partners will continue this effort and maintain engagement of the community and volunteers in these invasive species removals.

Mission Reach Intensive Nekton Survey:

An additional project to monitor the ecology of the river is the Mission Reach Intensive Nekton Survey. The Mission Reach Intensive Nekton Survey (MRINS) began as an effort to gauge the effectiveness of the ecological restoration within the Mission Reach of the San Antonio River. The first annual MRINS was conducted in 2019, several years after the initial restoration, to allow the new habitats to attract native fish back into the Mission Reach. The goal of the MRINS is to track new fish species that have returned to the Mission Reach and monitor a variety of trends in the nekton community. The data collected during MRINS ranges from fish occurrence and abundance to water quality and habitat availability. These data will allow for better management of our natural resources. For instance, data gathered through MRINS can show associations between fish and habitats which, in turn, can be used in introducing new habitat for fish with low abundance leading to a more diverse and healthier fish population. After three years, it appears that the ecological restoration of the Mission Reach is allowing for the revitalization of fish populations within the urban segments of the Upper San Antonio River. The surveys will continue biennially in the future with the next scheduled survey taking place in Fall 2023.

Freshwater Mussel Reintroduction Project:

Another project to restore the health of the Mission Reach is the Freshwater Mussel Reintroduction Project. Native freshwater mussels historically inhabited the Upper San Antonio River, however, due to urbanization over the past several decades, a near extirpation has occurred within the urban segments despite thriving populations downstream. Through the San Antonio River Improvements Project (SARIP), a collaboration with the United States Army Corps of Engineers, City of San Antonio, Bexar County, and San Antonio River Authority, the San Antonio River underwent a large-scale ecological restoration that was completed in 2013. The SARIP was responsible for restoring a previously channelized eight-mile portion of the Upper San Antonio River by increasing instream cover and improving resiliency, thus creating the Mission Reach segment of the San Antonio River. The San Antonio River Authority has begun assessing the feasibility of reintroducing freshwater mussels in the Mission Reach to increase connectivity with downstream populations and elevate ecosystem services in the urban reaches.

In 2014, the River Authority’s Holistic Mussel Project (HMP) began to determine what species of native mussels currently inhabit the San Antonio River and its major tributaries. Hundreds of miles of creeks and rivers have been surveyed throughout the San Antonio River Basin. These surveys have found thirteen native freshwater species; however, more species are likely to be identified with future surveys. The four most abundant species identified within the San Antonio River basin were chosen for reintroduction: Threeridge (*Amblema plicata*), Pimpleback (*Cylconaias pustulosa*), Yellow Sandshell (*Lampsilis teres*), and Pistolgrip (*Tritogonia verrucosa*).

To begin investigating the feasibility of introducing freshwater mussels into the urbanized Upper San Antonio River, the Mission Reach Mussel Survivability (MRMS) project began in 2017. In the MRMS project, adult mussels from the four target species were sourced from healthy populations in Lower San Antonio River and placed in cages at two experimental sites within the Mission Reach and one control site in Goliad County, Texas. Growth and survival were measured over the course of two years. Results from this study indicated that the observed mussel growth and survival within the Mission Reach were comparable to, and in some cases exceeded, that of the control site in the Lower San Antonio River. These encouraging results were a key component in deciding to reintroduce native mussels to the newly restored Mission Reach.

Freshwater mussel species have various habitat requirements that determine in which habitats each species are found. For example, one mussel species may utilize swift, shallow waters with large cobbles, and a different species could utilize slow moving pools with fine silt substrate. To identify the different habitat complexes within the Mission Reach, the River Authority partnered with several outside agencies and universities, chiefly Utah State University, Texas State University, and the U.S. Army Corps of Engineers to identify any potential habitat for the target mussel species. This habitat suitability model is currently in development and will likely be completed in 2023.

To propagate mussels, the River Authority has partnered with Inks Dam National Fish Hatchery. Inks Dam National Fish Hatchery is contracted to source wild gravid mussels and rear juvenile mussels until they are large enough to be stocked in the Mission Reach. This work is ongoing with the goal of introducing propagated mussels into the Mission Reach in the Spring of 2024.

The SARIP allowed for the restoration of instream habitat and riparian zones adjacent to the San Antonio River. Over the last decade, the River Authority has tracked the improved ecology via the Mission Reach Avian Study, monitoring and maintenance of native plant assemblages, and the Mission Reach Intensive Nekton Survey, and has improved fish communities through the reintroduction of Guadalupe Bass (*Micropterus treculii*). The reintroduction of native freshwater mussels is essential for a more holistic ecological restoration and reintroduction of the ecosystem services that native mussels provide.

Zebra Mussel Monitoring Effort:

Zebra mussels (*Dreissena polymorpha*) are an invasive mussel originating from Eurasia, and were inadvertently introduced into the U.S. in 1988, making their way to Texas in 2009. This species of mussel is problematic for both

infrastructure and riverine ecology. Zebra mussels can rapidly colonize a waterbody, as they reproduce quickly and have few natural predators in Texas waters. This population explosion can cause issues with infrastructure and can be detrimental to wildlife.

In 2019, the River Authority and multiple partners developed a proactive routine monitoring program to address zebra mussels as they began their spread towards the San Antonio River Basin. In February 2021, Medina Lake was designated as “positive” for zebra mussels by Texas Parks and Wildlife Department when members of the public reported sightings in the lake. After surveying several locations at Medina Lake, BCRAGD staff confirmed the presence of zebra mussels in June 2021 and Medina Lake was designated as “fully infested”. However, monitoring efforts are ongoing, and no zebra mussels have been identified within other areas of the San Antonio River Watershed.

SARA monitors Braunig and Calaveras Lakes, which are in the Upper San Antonio River Watershed for veliger (larval) zebra mussels. We have set out structure to determine if any zebra mussels are trying to establish themselves on hard surfaces at several locations. The San Antonio River Authority is currently developing a method to identify zebra mussel DNA in the streams. These steps are needed for early detection.

## Continuous Monitoring Data

*Staff performing maintenance on a continuous monitoring site, San Antonio River at San Juan Remnant.*

River Authority scientists maintain five stations measuring field parameters, including temperature, pH, specific conductance, and dissolved oxygen. Four of these are in the Upper San Antonio River watershed. These stations continuously record this data taken every 15 minutes and is transmitted every hour to a viewing platform online for remote access. Monitoring equipment is inspected and replaced for maintenance at least once a month. These stations have been active for eight years, save one newer station that was installed in late 2019 on San Pedro Creek but will be relocated to Calaveras Creek due to theft.

San Antonio River at Mitchell Street

San Antonio River at Lock & Dam

San Antonio River at San Juan

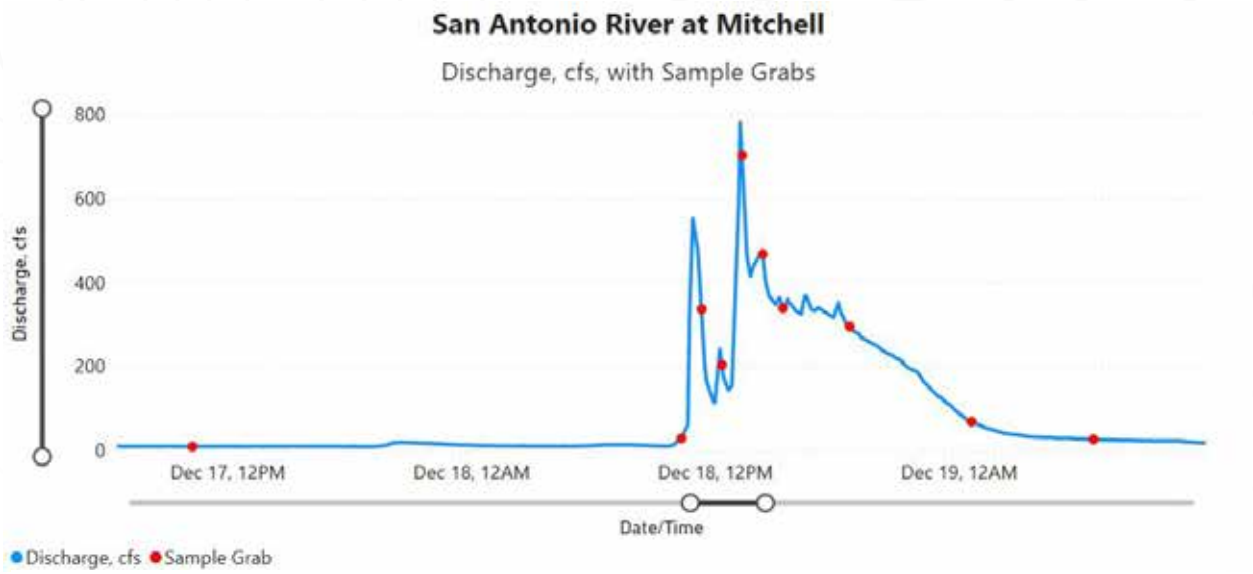
San Pedro Creek at Martin Street (relocating)

There were some changes to continuous monitoring stations in 2020 and 2021 to focus efforts and continue rotating monitoring in other sub-watersheds. Two stations were removed: San Pedro Creek at Furnish Street (station 12707) and San Antonio River at Tunnel Outlet. Two sampling stations that also collected continuous field parameters are currently not active, but infrastructure remains until sampling is needed to resume: San Antonio River at Woodlawn Avenue (station 12908) and Medio Creek at Hidden Valley (station 12916). Continuous monitoring stations are often paired with CRP sampling location so that water quality data collected as part of routine monitoring can be paired with the continuous monitoring data collected

Instream Continuous Monitoring Combined with Stormwater Sampling

Another project that incorporates CRP data include the modeling effort to determine the amount of best management practices (BMP) needed to meet the stream standard for *E. coli* bacteria by hydrologic unit code (HUC). This project uses CRP data to calibrate models for *E. coli* bacteria with the goal of placing BMP where it will do the best good. In addition to using CRP data to calibrate the models, stormwater samples are collected to better define the project.

For example, instream stormwater samples were collected from the San Antonio River at Mitchell Street in the Mission Reach Ecosystem Restoration Project in 2021. Staff collected two stormwater sample events to provide new data for engineering models. This type of sampling was done at this location in 2015 – 2018 as well. The infrastructure had remained in place to resume sampling again three years later, as field parameters have been measured at this station as part of continuous monitoring since 2015.




*Graph showing a storm event that was sampled at the San Antonio River at Mitchell Street*

Low Impact Development - BMP Stormwater Sampling

Staff have been conducting low impact development (LID) stormwater sampling at various locations, aiming to collect at least five viable storm events from each station. Stormwater sampling is underway at a San Antonio River Authority office, evaluating a High-Flow Media which was installed in December 2020, and at Elmendorf Lake Park, installed in February 2019. Heightened levels of bacteria in the west side creeks instigated the need for an integrated Implementation Plan (I-Plan) to decrease bacteria levels, which led to the stormwater sampling in Elmendorf Lake Park. Two past LID BMP sampling locations were on Ray Ellison Boulevard on the southwest side of San Antonio and on Hausman Road near University of Texas at San Antonio (UTSA). As of 2019, sampling is complete at both of these stations after five events were successfully collected. Two more sample events are needed from each of the two active BMP stations, Elmendorf Lake Park and High Flow Media.

*Structure designed to capture stormwater runoff from the street before it enters into the bioretention structure at Elmendorf Lake. Samples were collected prior to entering the BMP and after the BMP.*

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The CRP data, instream stormwater sampling, LID sampling and continuous monitoring are all designed to determine the best areas to install BMPs to reduce *E. coli* bacteria in the basin. This is a long-term project, and the model will need to be continuously fed data, because land use is continuously changing. It will take many years to re-develop areas with BMPs to reduce the *E. coli* levels, but if we don't start somewhere, it will never happen.

## Upper San Antonio TMDL/ Implementation Plan

An Implementation Plan (I-Plan) for three Total Maximum Daily Loads for bacteria in the Upper San Antonio River Watersheds (1911, 1910, and 1910A) was approved on April 6, 2016. This I-Plan was intended to complement an existing watershed protection plan that went into place in 2007 and was updated in 2014. The original Upper San Antonio TMDL/I-Plan included the Upper San Antonio River, Salado Creek and Walzem Creek. Management measures within this I-Plan included, among other items, justification for the San Antonio Zoo UV filtration system, public relations littering campaigns, and operation and maintenance plans for City of San Antonio staff.

Two additional addendums were added to the TMDL/I-Plan that include Menger Creek (1910D), Alazan Creek (1911C), San Pedro Creek, (1911D), Martinez Creek (1911I), and Six Mile Creek (1911E).

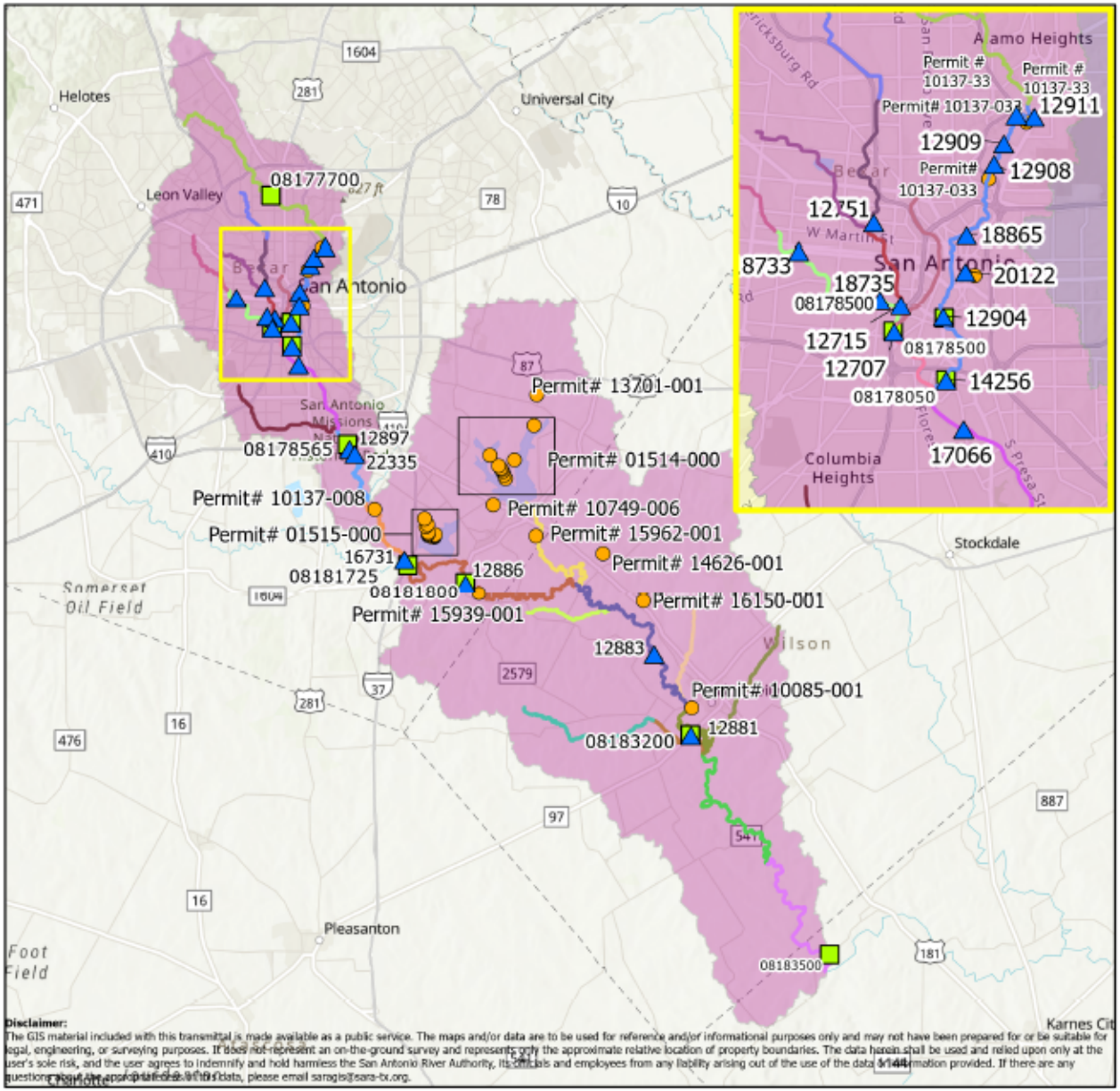
The stakeholder group continues to meet annually.

## Lower San Antonio River TMDL/Implementation Plan

An I-Plan for five TMDLs for Bacteria was adopted by TCEQ in 2018. This TMDL/I-Plan is for the Lower San Antonio River for AU 1901 thru 1905. The 2022 Integrated Report identifies as 1901_05 as fully supporting recreation use.

The stakeholder group continues to meet annually.

# Upper San Antonio River Watershed




- USGS Stations
- Wastewater Outfalls
- SARA Monitoring Stations

## Assessment Unit

- 1911A_01 - Olmos Creek
- 1911B_01 - Apache Creek
- 1911B_02 - Apache Creek
- 1911C_01 - Alazan Creek
- 1911C_02 - Alazan Creek
- 1911D_01 - San Pedro Creek
- 1911D_02 - San Pedro Creek
- 1911E_01 - Sixmile Creek
- 1911H_01 - Picosa Creek
- 1911H_02 - Picosa Creek
- 1911I_01 - Martinez Creek
- 1911I_02 - Martinez Creek
- 1911J_01 - Pajarito Creek
- 1911K_01 - Seguin Branch
- 1911L_01 - Unnamed Tributary
- 1911M_01 - Calaveras Creek
- 1911_01 - Upper San Antonio River
- 1911_02 - Upper San Antonio River
- 1911_03 - Upper San Antonio River
- 1911_04 - Upper San Antonio River
- 1911_05 - Upper San Antonio River
- 1911_06 - Upper San Antonio River
- 1911_07 - Upper San Antonio River
- 1911_08 - Upper San Antonio River
- 1911_09 - Upper San Antonio River

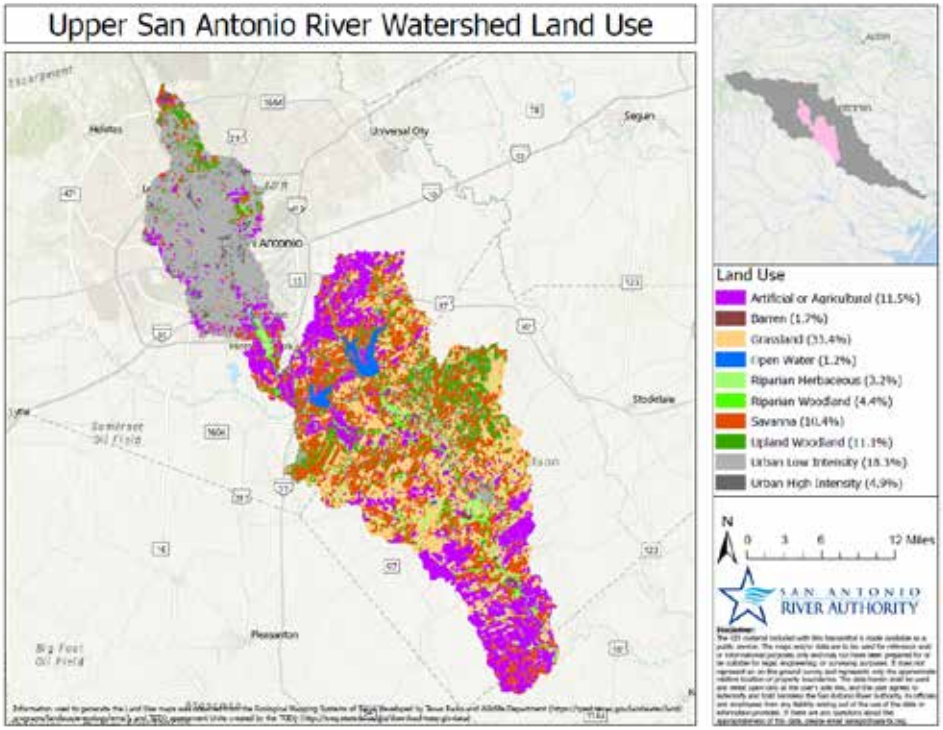
N

0 2.25 4.5 9 Miles

SAN ANTONIO RIVER AUTHORITY

## Upper San Antonio River Watershed Summary

The headwaters of the Upper San Antonio River originates approximately 100 meters upstream of Hildebrand Avenue inside the University of Incarnate Word Campus in San Antonio in Bexar County. The Upper San Antonio River generally flows southeastward about 88 miles until it becomes the Lower San Antonio River about 600 meters downstream of FM 791 at Mays Crossing near Falls City in Karnes County. The drainage area is approximately 544 square miles, which accounts for approximately 13.1% of the entire San Antonio River Basin. The Upper San Antonio River is a perennial freshwater stream that flows through the heavily urbanized areas of downtown San Antonio in Bexar County and continues to become wider and deeper as it flows south towards Falls City, Texas in Karnes County. Baseflows throughout the Upper San Antonio River are supplemented by wastewater outfalls from City Public Service of San Antonio, City of Floresville, the San Antonio Water System, the San Antonio River Authority, East Central ISD, Aqua Utilities Inc., EC Enterprises LLC., City of Elmendorf, and HK Real Estate Development LLC. This helps maintain flow in the Upper San Antonio River since the original springs are typically not flowing due to municipal use of the Edwards Aquifer.




The upper reaches of the Upper San Antonio River traverse through the urbanized areas of San Antonio, throughout Brackenridge Park and through downtown. It flows through several miles of the restored Mission Reach until it leaves San Antonio and continues through the geological formations of the Gulf Coastal Plains Province. Land use in the Upper San Antonio River Watershed is primarily grassland (33.4%), occurring largely throughout the portion of the watershed occurring outside of Loop 1604 within Bexar County and in the eastern/central portion of Wilson County. Throughout the same area, there are also upland woodlands (11.1%) within the watershed. Upland woodland habitat consists of mixed forests. The

northwest portion of the watershed, within the urban area of San Antonio, is characterized by urban low intensity land uses (18.3%). Urban low intensity is described as an area which contains urban development but is not entirely covered by impervious cover. The waterbodies that flow through the urban reaches have varying riparian vegetation, including trees like live oak (*Quercus fusiformis*), hackberry (*Celtis occidentalis*), cedar elm (*Ulmus crassifolia*), pecan (*Carya illinoinensis*), Texas oak (*Quercus buckleyi*), Texas persimmon (*Diospyros texana*), lantana (*Lantana* spp.), and cutgrass (*Leersia oryzoides*). Artificial or agricultural (11.5%), which can be defined as either row crops or grass farms, describe the land use in the watershed occurring between Loop 410 and Loop 1604 within San Antonio in Bexar County and in the southern portion of the watershed in Wilson County.

Information used to generate the land use maps was obtained from the SARA GIS Department and includes Ecological Mapping Systems of Texas developed by Texas Parks and Wildlife Department (https://tpwd.texas.gov/landwater/land/programs/landscape-ecology/ems/), and TCEQ Assessment Units data created by the TCEQ: https://gis-tceq.opendata.arcgis.com.

Upper San Antonio River has 11 wastewater treatment plant permits (Table 3-2). Three of the permits are considered major dischargers.

*Table 3-2: Wastewater treatment plants in the watershed.*

| Permittee Name | Permit Number | Discharge |
|---|---|---|
| San Antonio Water Systems (reuse water to augment the flow in the San Antonio River- Outfalls located at Brackenridge Park, Tunnel Inlet and Henry B Gonzales Convention Center) | 10137-033 | ≥ 1 million gallons per day |
| San Antonio Water System | 10137-008 | ≥ 1 million gallons per day |
| City Public Service of San Antonio | 01515-000 | stormwater, cooling water |
| EC Enterprises | 15939-001 | < 1 million gallons per day |

| Permittee Name | Permit Number | Discharge |
|---|---|---|
| East Central ISD | 13701-001 | < 1 million gallons per day |
| City Public Service of San Antonio | 01514-000 | ≥ 1 million gallons per day, stormwater |
| San Antonio River Authority | 10749-006 | < 1 million gallons per day |
| Aqua Utilities Inc | 14626-001 | < 1 million gallons per day |
| HK Real Estate Development LLC | 16150-001 | < 1 million gallons per day |
| City of Floresville | 10085-001 | < 1 million gallons per day |
| City of Elmendorf | 15962-001 | < 1 million gallons per day |

The San Antonio River Authority monitors all stations in this segment (Table 3-3).

*Table 3-3: Stations currently monitored by the CRP in the watershed.*

| Location Description | AU | ID |
|---|---|---|
| San Antonio River at FM 541 Near Poth | 1911_02 | 12880 |
| San Antonio River at SH 97 Near Floresville | 1911_03 | 12881 |
| San Antonio River at Dietzfield Road Cr 117 Northwest of Floresville | 1911_04 | 12883 |
| San Antonio River Mid Channel 30 M Downstream of Loop 1604 West of Elmendorf /Continuous Monitoring Site Cams 715 | 1911_05 | 12886 |
| San Antonio River Approx 835 Meters Upstream of The Medina River Confluence | 1911_06 | 16731 |
| San Antonio River at IH 410 Low Water Crossing Camino Coahuilatechan 0.25 Km Below the Bridge in San Antonio | 1911_07 | 12897 |
| San Antonio River 675 Meters Downstream of Camino Coahuilteca in San Antonio | 1911_07 | 22335 |
| San Antonio River at Mission Road Immediately Upstream of Riverside Municipal Golf Course 1.65 Km Downstream of San Antonio River/San Pedro Creek Confluence in San Antonio Tx | 1911_08 | 17066 |
| San Antonio River at Alamo St in San Antonio | 1911_09 | 12904 |
| San Antonio River at Woodlawn Ave in San Antonio | 1911_09 | 12908 |
| San Antonio River at Mulberry St in San Antonio | 1911_09 | 12909 |
| San Antonio River at Well No. 2 at Joske's Pavilion | 1911_09 | 12911 |

| Location Description | AU | ID |
|---|---|---|
| San Antonio River at W. Mitchell Street in Downtown San Antonio | 1911_09 | 14256 |
| San Antonio Zoo Outfall No 1 Discharge Channel 27 M Downstream of Discharge Culvert at Southeast Corner of Zoo Outside Zoo Property | Discharge into the River | 15722 |
| San Antonio River 57 m Upstream of Lexington Street Bridge and Approximately 1.3 Kilometers Downstream of IH 35 | 1911_09 | 18865 |
| San Antonio River Loop 111 M Downstream of Market Street at Little Rhein Steakhouse in San Antonio | 1911_09 | 20122 |
| Elmendorf Lake Near Northeast Bank 25 M Upstream of Dam Near 19th Street Bridge | 1911B_01 | 18733 |
| Apache Creek At Brazos Street Approximately 0.7 Km Upstream of The Confluence with Alazan Creek | 1911B_01 | 18735 |
| Alazan Creek at Tampico St in San Antonio | 1911C_01 | 12715 |
| San Pedro Creek at Furnish St in San Antonio Permit 0000968 Union Stock Yards | 1911D_01 | 12707 |
| Martinez Creek at Ruiz Street in San Antonio | 1911I_01 | 12751 |

The US Geological Survey (USGS) currently has nine real-time monitoring sites on the Upper San Antonio River and its tributaries. The USGS stream gages are maintained and operated by the USGS but rely on funding provided by state, regional, and local agencies or organizations that sponsor gage stations.

*Table 3-4: US Geological Survey continuous monitoring stations.*

| Location | ID | Real Time Available Parameters | Additional Sponsors |
|---|---|---|---|
| San Antonio River at San Antonio, TX (Downstream of S. Alamo St.) | 08178000 | Discharge, Gage Height, Precipitation | San Antonio River Authority |
| San Antonio River at Mitchell St, San Antonio, TX | 08178050 | Discharge, Gage Height, Precipitation | San Antonio River Authority |
| San Antonio River at Loop 410, San Antonio, TX | 08178565 | Discharge, Gage Height, Precipitation | San Antonio River Authority |
| San Antonio River near Braunig Lake near Elmendorf, TX | 08181725 | Discharge, Gage Height, Precipitation | CPS Energy |
| San Antonio River near Elmendorf, TX | 08181800 | Discharge, Gage Height, Precipitation, Dissolved Oxygen, Nitrate + Nitrite, pH, Specific Conductance, Temperature, Turbidity | CPS Energy, San Antonio Water System |
| San Antonio River near Floresville, TX | 08183200 | Discharge, Gage Height, Precipitation | San Antonio River Authority |
| San Antonio River near Falls City, TX | 08183500 | Discharge, Gage Height | Texas Water Development Board |
| Olmos Ck at Dresden Dr, San Antonio, TX | 08177700 | Discharge, Gage Height, Precipitation | San Antonio River Authority |
| San Pedro Ck at Furnish St, San Antonio, TX | 08178500 | Discharge, Gage Height, Precipitation | San Antonio River Authority |

**Texas Integrated Report on Surface Water Quality for the Clean Water Act:**

The TCEQ's 2022 Integrated Report (2022 IR) identified 27 assessment units (AU) for the Lower San Antonio River and its tributaries. Parameters that don't meet the TCEQ established standards are identified as impairments. Parameters with established standards are identified as having a concern when data indicate near nonattainment. Parameters with screening levels that are exceeded are identified as a screening level concern.

An AU often consists of a single representative station used to characterize standards attainment. The data from multiple stations in a single AU can also be used in the assessment. The 2022 IR results, including the 303(d) List of Impaired Waters, are reported at the AU level for each water body.

*Table 3-5: Impairments and concerns identified in the TCEQ 2022 Integrated Report*

| Segment | AU Description | AU ID | Station ID | Impairments | Concerns |
|---|---|---|---|---|---|
| San Antonio River | From the lower end of the segment up to just upstream of the confluence with Olmos Creek. | 1911_01 | 12879 | None | Total Phosphorus, Nitrate Nitrogen |
| | From the confluence with Olmos Creek up to just upstream of the confluence with Picosa Creek. | 1911_02 | 12880 | None | Total Phosphorus, Nitrate Nitrogen |
| | From just upstream of the confluence with Picosa Creek up to just upstream of the confluence with Lodi Branch in Floresville, Wilson County, Texas | 1911_03 | 12881 | *E. coli* bacteria | Total Phosphorus, Nitrate Nitrogen |
| | From just upstream of the confluence with Lodi Branch in Floresville, Wilson County, Texas up to just upstream of the confluence with Calaveras Creek. | 1911_04 | 12883 | *E. coli* bacteria | Total Phosphorus, Nitrate Nitrogen |

| Segment | AU Description | AU ID | Station ID | Impairments | Concerns |
|---|---|---|---|---|---|
| | From just upstream of the confluence with Calaveras Creek up to just upstream of the confluence with the Medina River. | 1911_05 | 12886, 12889 | *E. coli* bacteria | Total Phosphorus, Nitrate Nitrogen, Habitat |
| | From just upstream of the confluence with the Medina River up to just upstream of the confluence with Salado Creek. | 1911_06 | 12894, 16731 | None | Nitrate Nitrogen |
| | From just upstream of the confluence with Salado Creek up to just upstream of the confluence with Sixmile Creek. | 1911_07 | 12897, 20638 | None | Nitrate Nitrogen |
| | From just upstream of the confluence with Sixmile Creek to just upstream of the confluence with San Pedro Creek. | 1911_08 | 12899, 17066, 21547 | Fish Community, Macrobenthic Community, *E. coli* bacteria | Nitrate Nitrogen, Chlorophyll-a |
| | From just upstream of the confluence with San Pedro Creek up to the upper end of the segment. | 1911_09 | 12904, 12908, 12909, 12911, 14220, 14223, 14256, 15085, 18865, 20118, 20122 | Fish Community, *E. coli* bacteria | Total Phosphorus, Nitrate Nitrogen |

| Segment | AU Description | AU ID | Station ID | Impairments | Concerns |
|---|---|---|---|---|---|
| Olmos Creek | From the confluence with the Upper San Antonio River at a point 100 m upstream of Hildebrand Avenue upstream to the headwaters near Huebner Oaks and IH 10 in NW San Antonio. | 1911A_01 | No Stations | Not assessed | Not Assessed |
| Apache Creek | From the confluence with San Pedro Creek upstream to the confluence with Zarzamora Creek. | 1911B_01 | 18735 | *E. coli* bacteria | Nitrate Nitrogen |
| | From the confluence with Zarzamora Creek upstream to the headwaters at SH 421 (Bandera Rd) in San Antonio | 1911B_02 | No Stations | Not assessed | Not Assessed |
| Alazan Creek | From the confluence with Apache Creek up to the confluence with Martinez Creek | 1911C_01 | 12715 | *E. coli* bacteria | None |
| | From just upstream of the confluence with Martinez Creek to the upper end of the segment. | 1911C_02 | 20344 | *E. coli* bacteria | None |
| San Pedro Creek | From the confluence with segment 1911 up to the confluence with Apache Creek | 1911D_01 | 12707, 18736. 21105, 21599 | *E. coli* bacteria | Nitrate Nitrogen |
| | From the confluence with Apache Creek to the upper end of the segment. | 1911D_02 | 20119 | *E. coli* bacteria | Nitrate Nitrogen |
| Sixmile Creek | From the confluence with 1911 (approx. 225 yards South of Mission Rd) to the upper end of the water body | 1911E_01 | 21705 | *E. coli* bacteria | None |

| Segment | AU Description | AU ID | Station ID | Impairments | Concerns |
|---|---|---|---|---|---|
| Calaveras Reservoir | Calaveras Reservoir | 1911F_01 | No Stations | Not assessed | Not Assessed |
| Braunig Reservoir | Braunig Reservoir | 1911G_01 | No Stations | Not assessed | Not Assessed |
| Picosa Creek | From the confluence with 1911 up to the confluence with Mariana Creek | 1911H_01 | 20350 | Depressed DO (grab minimum) | Depressed DO (grab average) |
| | From the confluence with Mariana Creek up to the upper end of the water body. | 1911H_02 | No Stations | Not assessed | Not Assessed |
| Martinez Creek | Martinez Creek from the confluence of Alazan Creek in central San Antonio upstream to the concrete channel portion at San Francisco St in north San Antonio | 1911I_01 | 12751, 15723 | *E. coli* bacteria | None |
| | Martinez Creek from the concrete channel portion at San Francisco St upstream to the terminus at Vance Jackson Rd in north San Antonio | 1911I_02 | No Stations | Not assessed | Not Assessed |
| Pajarito Creek | From the confluence with the Upper San Antonio River upstream to the headwaters at Wilson CR 403 northwest of Floresville | 1911J_01 | No Stations | None | *E. coli* bacteria |

| Segment | AU Description | AU ID | Station ID | Impairments | Concerns |
|---|---|---|---|---|---|
| Seguin Branch | From the confluence with the Upper San Antonio River upstream to the headwaters approximately 2.2 km upstream of Wilson CR 331 north of Floresville | 1911K_01 | No Stations | None | *E. coli* bacteria |
| Unnamed Tributary of Upper San Antonio River | From the confluence with the Upper San Antonio River upstream to the confluence with an unnamed tributary 200 meters upstream of FM 1303 in Wilson County | 1911L_01 | No Stations | None | Depressed DO (grab average) |
| Calaveras Creek | From the confluence with the Upper San Antonio River upstream to the Calaveras Reservoir dam north of Elmendorf in Bexar County | 1911M_01 | No Stations | Not assessed | Not Assessed |

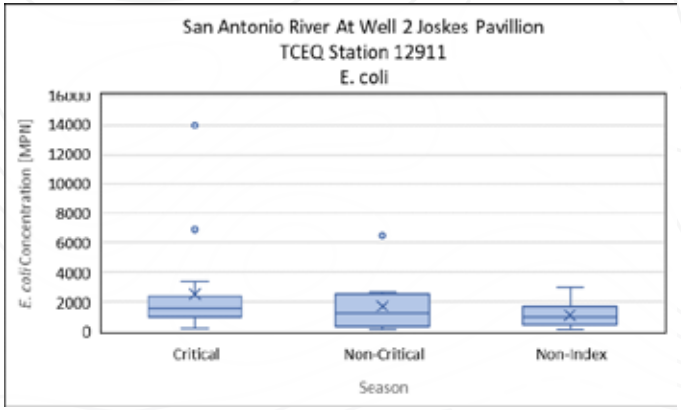
**Upper San Antonio River Watershed Routine Data Analysis:**

Only data with at least 10 years of data and no significant data gaps were used in the analysis. Nine stations (12911, 12908, 18865, 20122, 12904, 14256, 17066, 16731, and 12886) were evaluated. The TCEQ identified *E. coli* bacteria, as an impairment and nitrate nitrogen, total phosphorus, and chlorophyll-a as concerns.

Some of the parameters showed seasonality. For this report, the seasons were defined as: critical period (July 1$^{st}$ - September 30$^{th}$), non-critical period (March 15$^{th}$ - June 30$^{th}$ plus October 1$^{st}$ - October 15$^{th}$), and the non-index period (October 16$^{th}$ – March 14$^{th}$).

Upper San Antonio River:

*E. coli* geometric means ranged from 86.65 to 1038.71 MPN per 100 mL. Only the station upstream of the Medina River confluence met the TCEQ standard. The upper most sample station 12911 had the highest geometric mean followed closely by the location at the Little Rhein Steakhouse (Station 20122) which had a geometric mean of 1021.95 MPN per 100 mL. Station 12911 is located in Brackenridge Park which is a favorite place for people to feed the ducks and geese that inhabit the park. In addition, there are large rookeries that inhabit the park during the spring and summer. The Little Rhein Steakhouse station is located in the river loop, an area popular with tourists and locals. People enjoy eating outside at restaurants and throwing chips and bread to the ducks that inhabit the river loop.




*Graph showing seasonality at Brackenridge Park, the mean value is the highest during the critical season, and lowest during the non-index period.*

Five sites showed seasonality for *E. coli* bacteria. The two upper most sites (12911 and 12908) had the highest mean values during the critical period, due to the waste from the rookeries. As you move into the more natural Mission Reach Park, the lowest mean values were during the critical period.

None of the stations showed any trends over time associated with *E. coli* bacteria.

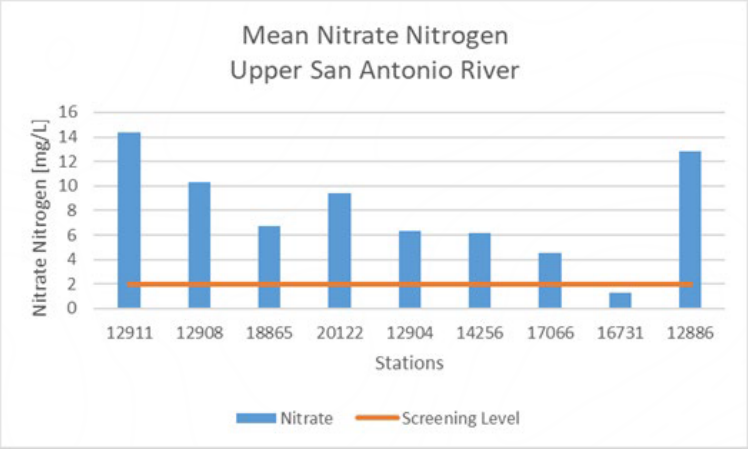
Only the four lower stations (17066, 16731,12886 and 12881) showed a significant trend associated with flow. These sites showed an increasing trend in *E. coli* as flow increased, indicating that stormwater runoff plays a major part in *E. coli* levels. Stormwater runoff transports the *E. coli* deposited on land into the river. Also high flows re-suspend sediments on the bottom of the river. *E. coli* tends to attach to sediment as it settles to the bottom of the river. During high flows the sediment along with the *E. coli* bacteria are re-suspended in the water column.

Nitrate nitrogen levels exceeded the screening levels from 100% (Station 20122) to 24.59% (Station 16731) percent of the time. Total phosphorus levels exceeded the screening levels from 77.97% (Station 12911) to 0% (Station 16731) of the time.

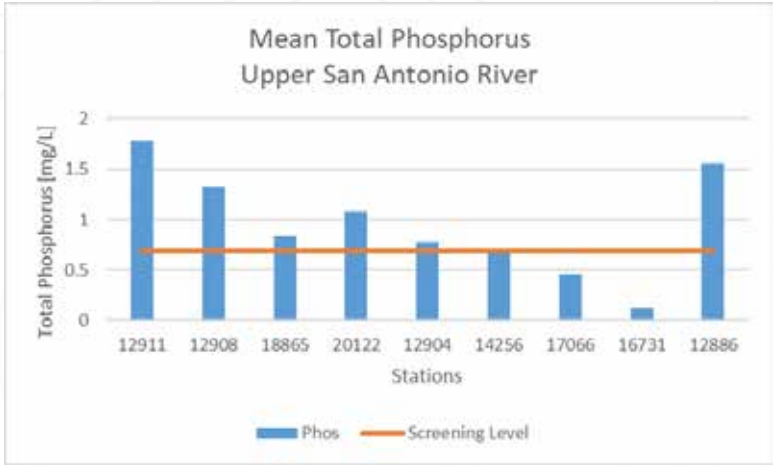
Three stations had significant seasonality (20122, 12904, and 16731) for both nitrate nitrogen and total phosphorus. The two more urban sites (20122 and 12904) had higher values during the critical period, while the more rural site had the lowest values during the critical period.

Two sites showed an increasing trend over time for nitrate nitrogen (20122 and 16731) and two sites showed a decreasing trend over time (17066 and 12886). No sites showed trends over time for total phosphorus.

Six sites (12911, 12908, 14256,17066, 12886,12881) had a decreasing trend as flow increased for nitrate nitrogen. This indicates that the source of the nitrate nitrogen is point source, not nonpoint source stormwater runoff.




*Graph showing nitrate nitrogen levels from upstream (left) to downstream (right). Note that station 12911 is just downstream from reuse water discharge to augment flow in the San Antonio River. Station 20122 is downstream of another reuse water discharge point. Station 12886 is just downstream from the Medina River confluence. Like the Upper San Antonio River, the Lower Medina River is an effluent dominated river.*



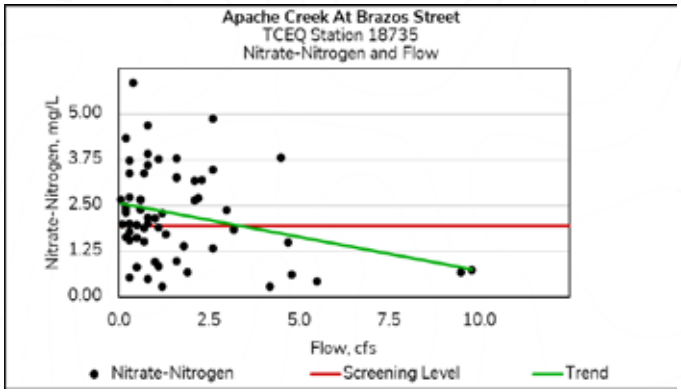

*Graph showing total phosphorus levels from upstream (left) to downstream (right). Note that station 12911 is just downstream from reuse water discharge to augment flow in the San Antonio River. Station 20122 is downstream of another reuse water discharge point. Station 12886 is just downstream from the Medina River confluence. Like the Upper San Antonio River, the Lower Medina River is an effluent dominated river.*

Westside Creeks:

Apache Creek, Alazan Creek, Martinez Creek, and San Pedro Creek are referred to as the Westside Creeks. The San Antonio River Authority is involved in a project on the Westside Creeks to restore the creeks to promote recreational use, cultural and historic awareness, improve water quality and the ecosystem while still maintaining the flood control components of the creeks to protect the neighborhoods from flooding.

Apache Creek:

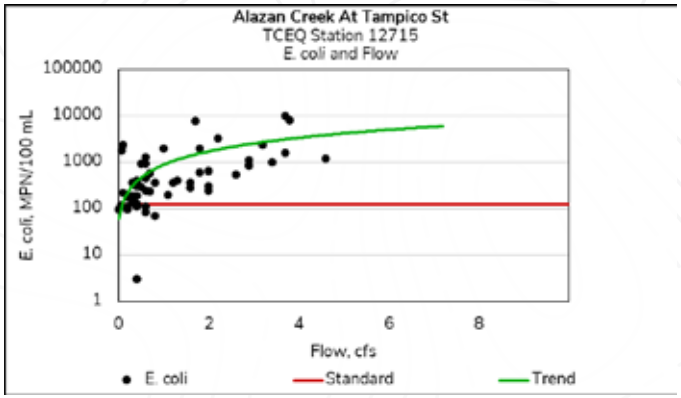
The TCEQ identified *E. coli* bacteria as an impairment and nitrate nitrogen as a concern. *E. coli* geometric mean was 404.44 MPN per 100 mL at this site. *E. coli* levels were seasonal with the higher levels during the critical period and the lower values during the non-index period. No trends were associated with *E. coli* bacteria levels.




*Graph showing decreasing trend for nitrate nitrogen as flow increases. Note that this dataset is heteroscedastic and therefore the p-value for this regression may be underestimated. We define "trends" herein as instances where the p-value of our model is less than 0.1 (see section 3.2 of this report).*

Nitrate nitrogen levels exceeded the screening levels 56.67 percent of the time; however, total phosphorus levels never exceeded the screening levels. Nitrate nitrogen showed no trends over time but did show a decreasing trend as flow increased. This may indicate point source pollution, or it may be due to water released from Elmendorf Lake. Elmendorf Lake used to be home to a large rookery and there are numerous ducks and geese that reside on the lake contributing fecal waste in and around the lake.

Alazan Creek:




*Graph showing E. coli levels increasing as flow increases.*

The TCEQ identified *E. coli* bacteria as an impairment for this creek. *E. coli* geometric mean was 427.55 MPN per 100 mL at this site. No trend was identified over time, but *E. coli* levels did increase as flow increased, indicating that stormwater runoff transports fecal waste to the creek.

Martinez Creek:

The TCEQ identified *E. coli* bacteria as an impairment for this creek. The *E. coli* geometric mean was 231.80 MPN per 100 mL at this site. No trend was identified over time, but *E. coli* levels did increase as flow increased, indicating that stormwater runoff transports fecal waste to the creek.

**Evaluation of Habitat, Nekton (fish) and Benthic Macroinvertebrate Communities:**

Habitat assessments are done during biological sampling events to holistically evaluate the health of a water body. Habitat quality can tell us how aquatic communities can be supported. The Habitat Quality Index (HQI) is a quantitative measurement used to assess aquatic habitat quality, as described in the Surface Water Quality Monitoring (SWQM) Procedures Manual. This is done by quantitatively and qualitatively assessing various features of the stream reach, including available instream cover, number of riffles, and the structure of riparian vegetation, among other things. These features have an intrinsic value for characteristics like bank stability, buffering capacity, and refugia for aquatic organisms. Based on the metrics measured, habitat quality is scored and then categorized as either limited, intermediate, high, or exceptional.

*Downstream view of TCEQ station 12909 during a habitat survey on August 18, 2022.*

Assessment of habitat in the Upper San Antonio River Watershed from 2019-2022 included TCEQ stations 12909, 16731, 12899, 12908 and 21547 (Table 3-6). According to San Antonio River Authority (River Authority) data, current habitat in the Upper San Antonio River Watershed is described as high quality according to the HQI.

*Table 3-6: Stations assessed for either biological surveys or 24 hour dissolved oxygen in the Upper San Antonio River Watershed.*

| Station Number | Station Name |
|---|---|
| 12909 | San Antonio River at Mulberry Street in San Antonio |
| 16731 | San Antonio River approximately 835 meters upstream of the Medina River Confluence |
| 12899 | San Antonio River at low water crossing for Padre Road near the end of Ashley Road |
| 12908 | San Antonio River at Woodlawn Avenue in San Antonio |
| 21547 | San Antonio River at VFW Boulevard |
| 12889 | San Antonio River at IH 37 southeast of San Antonio |
| 20118 | San Antonio River at Houston Street approximately 129 downstream of Travis Street |
| 18865 | San Antonio River 57 meters upstream of Lexington Street Bridge and approximately 1.3 kilometers downstream of IH 35 |
| 20122 | San Antonio River Loop 111 meters downstream of Market Street at Little Rhein Steakhouse in San Antonio |
| 18736 | San Pedro Creek at Probandt Street 195 meters upstream of the San Antonio River Confluence |

*Table 3-7: Species caught in the Upper San Antonio River Watershed and their native/non-native status and tolerances. Relative abundance for each species out of total individuals caught for the historical period assessed (2015-2018) and the current data period (2019-2022).*

| Common Name | Status | Tolerance | Relative Abundance | |
|---|---|---|---|---|
| | | | Historic (2015-2018) | Current (2019-2022) |
| Red Shiner | Native | Tolerant | 36.14% | 47.53% |
| Blue Tilapia* | Non-Native | Tolerant | 0.98% | 8.91% |
| Mimic Shiner | Native | Intolerant | 4.32% | 5.08% |
| Blacktail Shiner | Native | Intermediate | 1.94% | 4.84% |
| Central Stoneroller | Native | Intermediate | 24.94% | 4.60% |
| Bullhead Minnow | Native | Intermediate | 1.53% | 4.55% |
| Western Mosquitofish | Native | Tolerant | 4.27% | 3.50% |
| Longear Sunfish | Native | Intermediate | 4.94% | 3.37% |
| Rio Grande Cichlid | Native | Intermediate | 4.66% | 2.78% |
| Largemouth Bass | Native | Intermediate | 1.28% | 2.26% |
| Mexican Tetra | Native | Intermediate | 1.19% | 1.80% |
| Guadalupe Bass | Native | Intolerant | 1.55% | 1.79% |
| Sailfin Molly | Native | Tolerant | 2.01% | 1.74% |
| Redbreast Sunfish | Non-native | Intermediate | 1.17% | 1.46% |
| Texas Logperch | Native | Intolerant | 0.21% | 1.15% |
| Bluegill | Native | Tolerant | 1.58% | 0.92% |
| Channel Catfish | Native | Tolerant | 1.78% | 0.75% |
| Redspotted Sunfish | Native | Intermediate | 0.89% | 0.48% |
| Grey Redhorse | Native | Intermediate | 0.00% | 0.33% |
| Green Sunfish | Native | Tolerant | 1.58% | 0.30% |
| Yellow Bullhead | Native | Intermediate | 1.19% | 0.24% |
| Gizzard Shad | Native | Tolerant | 0.02% | 0.21% |
| Spotted Bass | Native | Intermediate | 0.37% | 0.21% |
| Burrhead Chub | Native | Intermediate | 0.05% | 0.19% |
| Suckermouth Catfish | Non-native | Tolerant | 0.37% | 0.18% |
| Orangespotted Sunfish | Native | Intermediate | 0.00% | 0.15% |
| Amazon Molly | Native | Intermediate | 0.00% | 0.15% |
| Common Carp | Non-native | Tolerant | 0.43% | 0.11% |
| Ghost Shiner | Native | Intermediate | 0.05% | 0.09% |
| Pterygoplichthys sp. | Non-native | Tolerant | 0.16% | 0.08% |
| Flathead Catfish | Native | Intermediate | 0.30% | 0.07% |
| Warmouth | Native | Tolerant | 0.05% | 0.05% |
| Spotted Gar | Native | Tolerant | 0.07% | 0.05% |
| Golden Shiner | Native | Tolerant | 0.00% | 0.04% |
| Tadpole Madtom | Native | Intolerant | 0.00% | 0.01% |
| Sand Shiner | Native | Intermediate | 0.00% | 0.01% |
| American Eel | Native | Intermediate | 0.02% | 0.01% |
| Blackstripe Topminnow | Native | Intermediate | 0.00% | 0.01% |
| Longnose Gar | Native | Tolerant | 0.00% | 0.01% |
| Inland Silverside | Native | Intermediate | 0.00% | 0.01% |

The Upper San Antonio River at these stations is characterized by overall moderate instream cover, pool size, flow and bank stability, channel sinuosity, and riparian buffer vegetation corridors. Higher quality features in this reach include stable bottom substrates and common riffle habitats. The average width of the riparian buffer across the five sites is about twelve meters wide and is dominated mainly by trees and grasses. Higher scores in these metrics indicates better instream and riparian habitat for aquatic organisms to inhabit, increasing species diversity and ecological integrity. The percent tree canopy coverage across the two sites is about 63%, providing ample shading to the river. Developed canopy and understory are present, however, an established mid-story is lacking. A more developed mid-story would allow for higher species abundance and diversity, leading to higher ecological function in the riparian zone.

Index of Biotic Integrity (IBI) is a measure of ecosystem health that uses a variety of metrics taken from survey data to estimate fish community health. These metrics include species composition, trophic composition, and percent intolerance. Based on current (2019-2022) River Authority data, average scores for the stations in

*Photo voucher of a Largemouth Bass (Micropterus salmoides) caught at station 21547 on June 28th, 2022.*

this watershed ranged from 35 (intermediate) at station 12909 to 45 (high) at station 16731. Overall, the average score for the Upper San Antonio River watershed is 39 (intermediate), indicating that the biotic integrity of the Upper San Antonio River Watershed is of moderate quality.

On average, the stations evaluated showed an increase of 8% in overall IBI when comparing historic (2015-2018) to current data. In recent years, there has been an elevated abundance of sensitive fish species. Guadalupe Bass increased from 1% to 2%, and Texas Logperch increased from 0.1% to 2%. Additionally, total relative abundance of non-native fish species decreased, due primarily to Blue Tilapia decreasing from 14% to 0.04%. The data also revealed that the increase of intolerant fish abundance was greater than that of other individuals. Intolerant individuals increased in abundance by about 3%, while the number of intermediate and tolerant individuals decreased by about 0.1% and 3%, respectively. This change in species assemblage highlights an increasingly diverse and ecologically resilient fish community within the Upper San Antonio River.

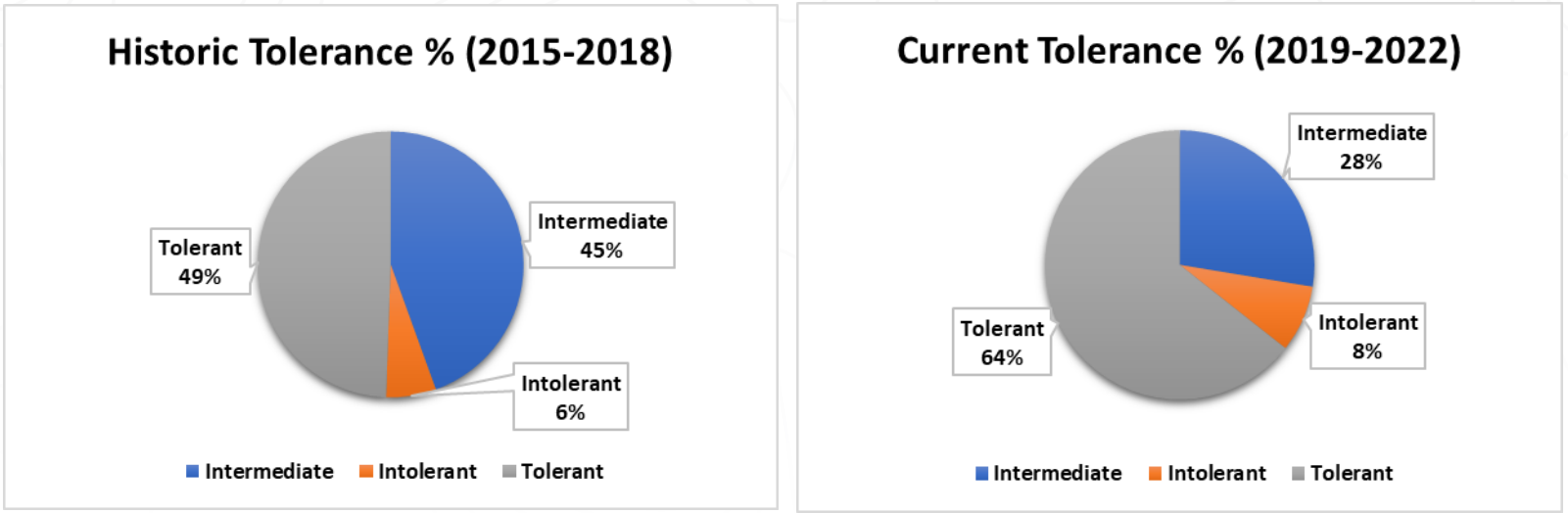
Segments 1911_08 (assessed at stations 12899 and 21547) and 1911_09 (assessed at stations 12908 and 12909) are considered to have an impaired fish community in water. Segment 1911_08 also has an impaired macrobenthic community in water. This could be for a myriad of reasons but may be due to depressed dissolved oxygen levels at these sites. Additional data and information will be collected or evaluated before a management strategy is selected.

Benthic macroinvertebrates are excellent biological indicators of water quality as they are the first organisms to respond to changes in water chemistry and habitat alterations. This data can be combined with the habitat and fish collection data to best understand stream health. The River Authority has conducted efforts to collect them at stations 12899 and 21547. The Benthic Index of Biotic Integrity (BIBI) is a quantitative measurement used by the TCEQ to assess macroinvertebrate assemblages and stream health, as described in SWQM. Data from 2019-2022 reveals the average score between the two stations has increased from a 28 (intermediate) to a 30 (high) in recent years. In addition, the Hilsenhoff Biotic Index (HBI), a quantitative score based on the abundance of tolerant taxa, for the benthic community of the Upper San Antonio

River watershed, scored 5 out of a scale of 0-10. Overall, data showed a 4% decrease in the average tolerant benthic macroinvertebrate species, potentially indicating a decrease in physiochemical degradation.

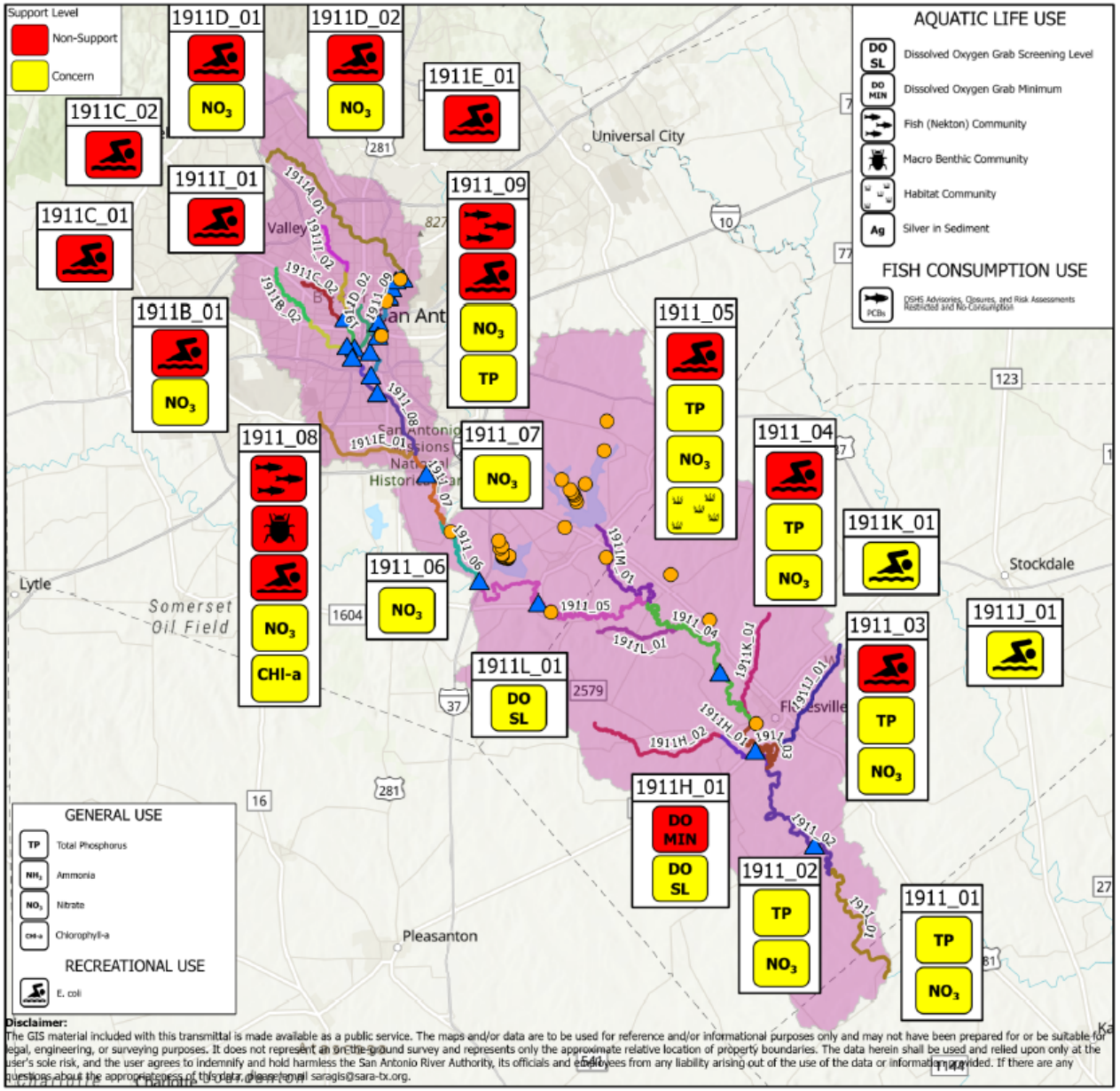
The 2022 Texas Surface Water Quality Standards (TSWQS) lists a 24-hour dissolved oxygen criteria of 5.0 mg/L average and a 3.0 mg/L minimum for the Upper San Antonio River. DO levels can decrease to dangerous levels for myriad of reasons. Oxygen levels below the demand of the aquatic organisms in the stream will cause high levels of stress and mortality.

In the last several years, 24-hour dissolved oxygen readings have been taken at ten different TCEQ stations, including 12889, 20118, 18865, 16731, 20122, 12909, 12899, 21457, 12908 and 18736. Dissolved oxygen levels at these stations averaged at 6.9 mg/L overall, ranging from 0.8 mg/L at station 18736 to 29 mg/L at the same station. For the last several years, these stations have met the minimum and average criteria for dissolved oxygen levels and meet the TSWQS.




*Distribution of tolerance values for all species caught in the Upper San Antonio River Watershed during both historic (2015-2018) and current (2019-2022) data periods.*

# Upper San Antonio River Watershed Impairments





Wastewater Outfalls

SARA Monitoring Station

## Assessment Unit

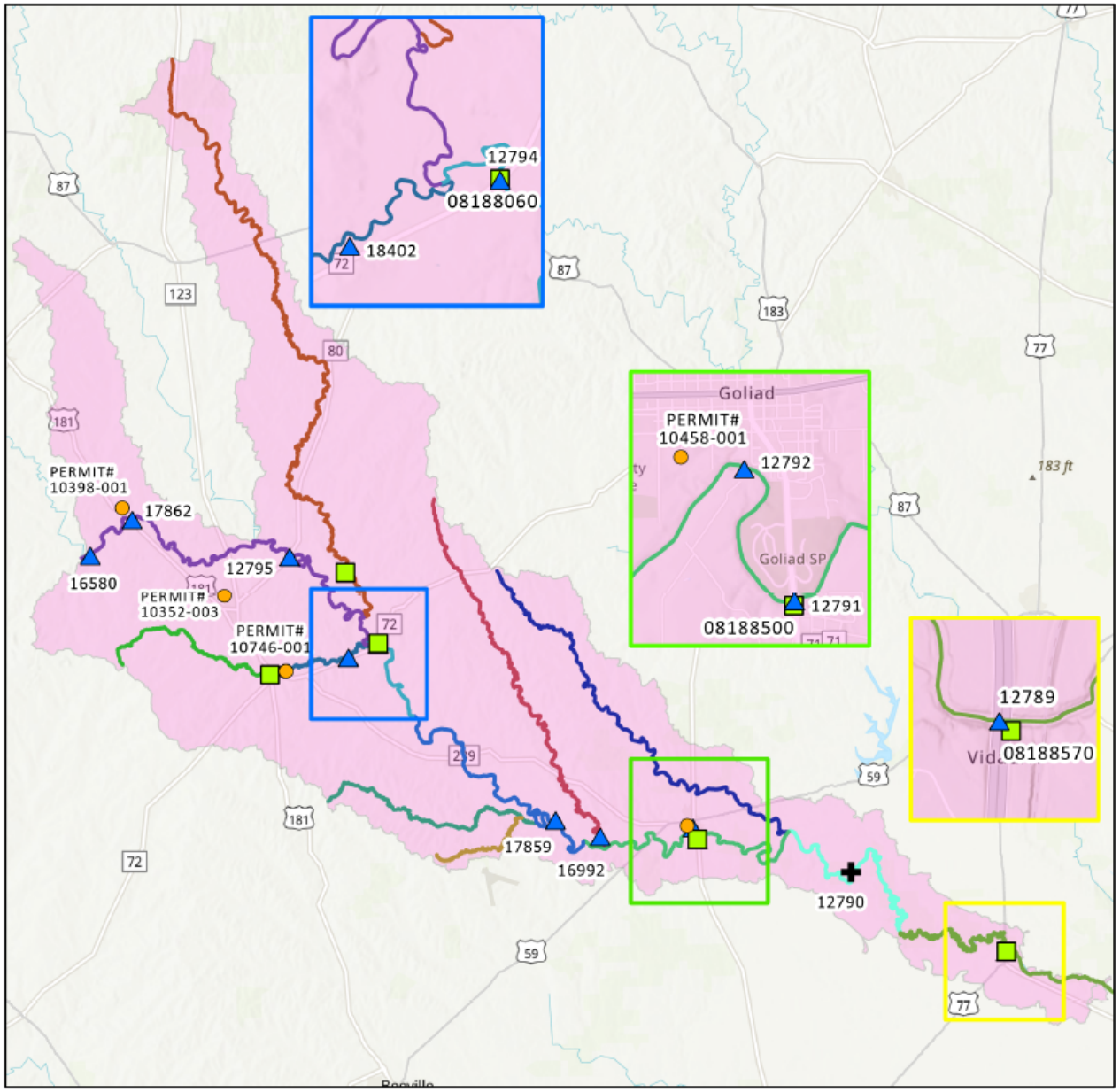
- 1911A_01 - Olmos Creek
- 1911B_01 - Apache Creek
- 1911B_02 - Apache Creek
- 1911C_01 - Alazan Creek
- 1911C_02 - Alazan Creek
- 1911D_01 - San Pedro Creek
- 1911D_02 - San Pedro Creek
- 1911E_01 - Sixmile Creek
- 1911H_01 - Picosa Creek
- 1911H_02 - Picosa Creek
- 1911I_01 - Martinez Creek
- 1911I_02 - Martinez Creek
- 1911J_01 - Pajarito Creek
- 1911K_01 - Seguin Branch
- 1911L_01 - Unnamed Tributary
- 1911M_01 - Calaveras Creek
- 1911_01 - Upper San Antonio River
- 1911_02 - Upper San Antonio River
- 1911_03 - Upper San Antonio River
- 1911_04 - Upper San Antonio River
- 1911_05 - Upper San Antonio River
- 1911_06 - Upper San Antonio River
- 1911_07 - Upper San Antonio River
- 1911_08 - Upper San Antonio River
- 1911_09 - Upper San Antonio River

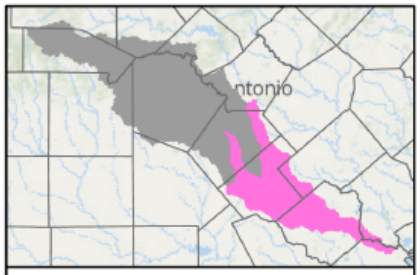
N

0 2.5 5 10 Miles

SAN ANTONIO RIVER AUTHORITY

# Lower San Antonio River Watershed




- USGS Stations
- Wastewater Outfalls
- GBRA Monitoring Station
- SARA Monitoring Station

## Assessment Unit

- 1901A_01 - Escondido Creek
- 1901A_02 - Escondido Creek
- 1901B_01 - Cabeza Creek
- 1901B_02 - Cabeza Creek
- 1901C_01 - Hord Creek
- 1901D_01 - Lost Creek
- 1901E_01 - Manahuilla Creek
- 1901F_01 - Ecleto Creek
- 1901_01 - Lower San Antonio River
- 1901_02 - Lower San Antonio River
- 1901_03 - Lower San Antonio River
- 1901_04 - Lower San Antonio River
- 1901_05 - Lower San Antonio River
- 1901_06 - Lower San Antonio River

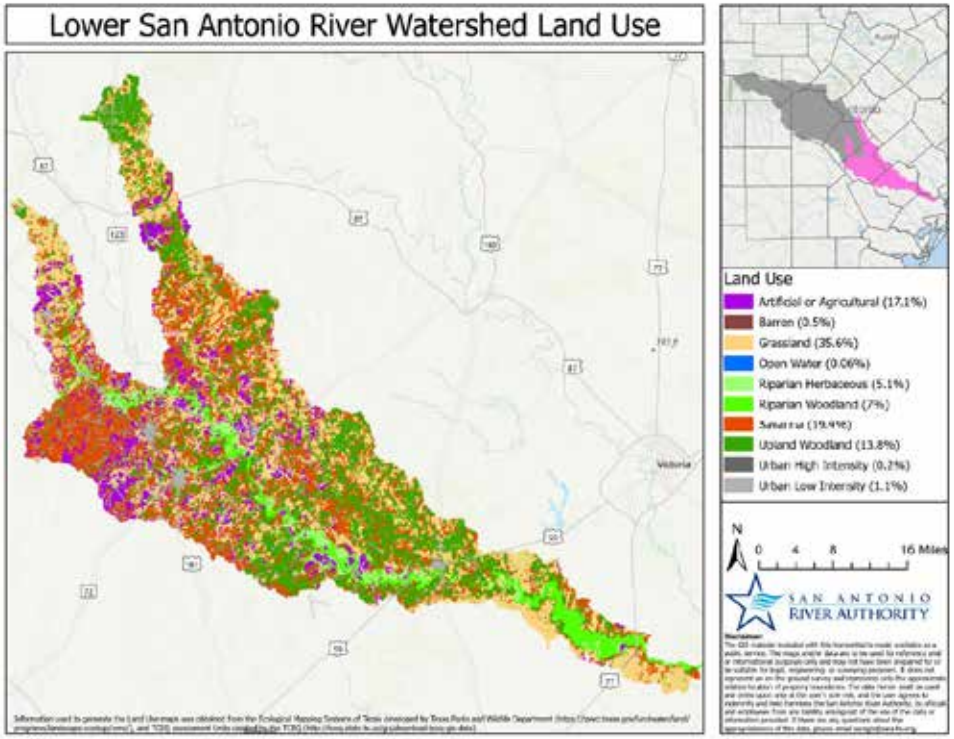
N

0 3.75 7.5 15 Miles

SAN ANTONIO RIVER AUTHORITY

## Lower San Antonio River Watershed Summary

The origin of the Lower San Antonio River is located approximately 700 meters south of the intersection of FM 791 and County Road 388 in Falls City, Texas in Karnes County at the transition from the Upper San Antonio River. The Lower San Antonio River flows generally toward the southeast about 155 miles until its confluence with the Guadalupe River in Refugio/Victoria County, approximately 3.5 miles north of the intersection of Texas Highway 35 and Austwell Road in Tivoli, Texas in Refugio County. The drainage area is approximately 1,192 square miles, which accounts for approximately 28.7% of the entire San Antonio River Basin. The Lower San Antonio River is a perennial river with wide channel beds with a variety of habitat, including deep pools, riffles, runs, and glides. Flow originates from the Upper San Antonio River (Segment 1911) and Lower Cibolo Creek (Segment 1902).




The majority of the Lower San Antonio River Watershed lies within the East Central Texas Plains, with gently sloping acidic clay and loam soils. Land use in the Lower San Antonio River Watershed primarily consists of grasslands (35.6%) and savannas (19.4%), with portions of the savanna mixed with artificial or agricultural land (17.1%). Grassland and savanna in this region are now largely used for livestock grazing and may consist of cordgrass marshes (*Sporobolus* spp.), tallgrass, and mid-grass prairies. Upland woodland habitat (13.8%), mixed through the lower/central portion of the watershed, primarily contains mesquite (*Prosopis glandulosa*), acacia (*Acacia farnesiana* or *A. smallii*), and prickly pear (*Opuntia engelmannii*), but can also contain blackjack oak (*Quercus marilandica*) and black hickory (*Carya texana*). Only 1.1% of land use in the Lower San Antonio River Watershed is considered urban low intensity and exist in the smaller population centers along Texas

Highway 239. Urban low intensity is characterized by human-derived impacts, typically involving high impervious cover such as buildings and other man-made structures.

Information used to generate the land use maps was obtained from the SARA GIS Department and includes Ecological Mapping Systems of Texas developed by Texas Parks and Wildlife Department (https://tpwd.texas.gov/landwater/land/programs/landscape-ecology/ems/), and TCEQ Assessment Units data created by the TCEQ https://gis-tceq.opendata.arcgis.com.

The Lower San Antonio River has five wastewater treatment plants.

*Table 3-8: Wastewater treatment plants in the watershed.*

| Permittee Name | Permit Number | Discharge |
|---|---|---|
| City of Falls City | 10398-001 | < 1 million gallons per day |
| City of Karnes City | 10352-003 | < 1 million gallons per day |
| City of Kenedy | 10746-001 | ≥ 1 million gallons per day |
| City of Kenedy | 03913-000 | ≥ 1 million gallons per day |
| City of Goliad | 10458-001 | < 1 million gallons per day |

The Guadalupe Blanco River Authority monitors one station (12790). SARA monitors the remaining stations.

*Table 3-9: Stations currently monitored by the CRP in the watershed.*

| Location Description | AU | ID |
|---|---|---|
| San Antonio River FM 2506 East of Fannin | 1901_01 | 12790 |
| San Antonio River Bridge on US 77-A and 183 Southeast of Goliad | 1901_02 | 12791 |
| San Antonio River at Southern Pacific RR Bridge in Goliad | 1901_02 | 12792 |
| San Antonio River at North Riverdale Rd 15 Km West of Goliad Texas | 1901_03 | 17859 |
| San Antonio River at SH 72 near Runge | 1901_04 | 12794 |
| San Antonio River at SH 80 SW of Helena | 1901_05 | 12795 |
| San Antonio River at Conquista Crossing 2.4 Km Downstream of FM 791 SW of Falls City | 1901_05 | 16580 |
| San Antonio River at US 77 on Refugio-Victoria County Line | 1901_06 | 12789 |
| San Antonio River Immediately Upstream of US 181 0.5 Km Southeast of Falls City Texas | 1901_05 | 17862 |
| Escondido Creek at Karnes CR 331 | 1901A_01 | 18402 |
| Cabeza Creek At FM 2043 1.6 Km Upstream of The San Antonio River Confluence 10.0 Km West of Goliad TX | 1901B_01 | 16992 |

The US Geological Survey (USGS) currently has five real-time monitoring sites on the Lower San Antonio River and its tributaries. The USGS stream gages are maintained and operated by the USGS but rely on funding provided by state regional and local agencies or organizations that sponsor gage stations.

*Table 3-10: US Geological Survey continuous monitoring stations.*

| Location | ID | Real Time Available Parameters | Additional Sponsors |
|---|---|---|---|
| San Antonio River at SH 72 near Runge, TX | 08188060 | Discharge, Dissolved, Gage Height, Oxygen, pH, Precipitation, Specific Conductance, Temperature, Turbidity | San Antonio River Authority |
| San Antonio River at Goliad, TX | 08188500 | Discharge, Gage Height, Dissolved Oxygen, Nitrate plus Nitrite, pH, Precipitation, Specific Conductance, Temperature, Turbidity | San Antonio River Authority, Texas Water Development Board, US Army Corps of Engineers |
| San Antonio River nr McFaddin, TX | 08188570 | Discharge, Dissolved, Gage Height, Precipitation | San Antonio River Authority |
| Ecleto Creek near Runge, TX | 08186500 | Discharge, Dissolved, Gage Height | - |
| Escondido Creek at Kenedy, TX | 08187500 | Discharge, Dissolved, Gage Height, Precipitation | - |

**Texas Integrated Report on Surface Water Quality for the Clean Water Act:**

The TCEQ's 2022 Integrated Report (2022 IR) identified ten assessment units (AU) for the Lower San Antonio River and its tributaries. Parameters that don't meet the TCEQ established standards are identified as impairment. Parameters with established standards are identified as having a concern when data indicate near nonattainment. Parameters with screening levels that are exceeded are identified as a screening level concern.

An AU often consists of a single representative station used to characterize standards attainment. The data from multiple stations in a single AU can also be used in the assessment. The 2022 IR results, including the 303(d) List of Impaired Waters, are reported at the AU level for each water body.

*Table 3-11: Impairments and concerns identified in the TCEQ 2022 Integrated Report*

| Segment | AU Description | AU ID | Station ID | Impairments | Concerns |
|---|---|---|---|---|---|
| Lower San Antonio River | 25 mi downstream of the confluence with Manahuilla Creek | 1901_01 | 12790 | None | Chlorophyll-a<br>Nitrate Nitrogen<br>Total Phosphorus<br>*E. coli* |
| | 25 mi upstream of Manahuilla Creek | 1901_02 | 12791<br>12792 | *E. coli*<br>Impaired Fish Community | Impaired Habitat<br>Nitrate Nitrogen<br>Total Phosphorus |
| | From 25 mi upstream of Manahuilla Cr to 9 mi downstream of Escondido Cr | 1901_03 | 12793<br>17859 | *E. coli* | Nitrate Nitrogen<br>Total Phosphorus |
| | 9 mi downstream of Escondido Creek | 1901_04 | 12794 | *E. coli* | Nitrate Nitrogen<br>Total Phosphorus |

| Segment | AU Description | AU ID | Station ID | Impairments | Concerns |
|---|---|---|---|---|---|
| | From upstream end of segment to Escondido Creek | 1901_05 | 12795<br>16580<br>17862 | None | Impaired Fish Community<br>Nitrate Nitrogen<br>Total Phosphorus |
| | Lower 31 mi of segment | 1901_06 | 12789 | None | Chlorophyll-a<br>Nitrate Nitrogen<br>Total Phosphorus |
| Escondido Creek | From the confluence with Lower San Antonio River upstream to the headwaters near Karnes CR 210 and FM 99 | 1901A_01 | 18402 | *E. coli* | Nitrate Nitrogen<br>Total Phosphorus |
| Cabeza Creek | From the confluence with the Lower San Antonio River west of Goliad, in Goliad County, to the upper end of the stream 9.3 km (5.7 mi) NW of Nordheim in DeWitt County | 1901B_01 | 16992<br>21991<br>21992 | *E. coli* | None |
| Manahuilla Creek | From the confluence with the Lower San Antonio River upstream to the headwaters southeast of Nordheim in DeWitt County | 1901E_01 | No Stations | None | *E. coli* |

| Segment | AU Description | AU ID | Station ID | Impairments | Concerns |
|---|---|---|---|---|---|
| Ecleto Creek | From the confluence with the Lower San Antonio River upstream to the headwaters adjacent to SH 123 south of Seguin in Guadalupe County | 1901F_01 | 20539 | *E. coli*<br>Depressed Dissolved Oxygen (min) | Chlorophyll-a<br>Depressed Dissolved Oxygen (avg) |

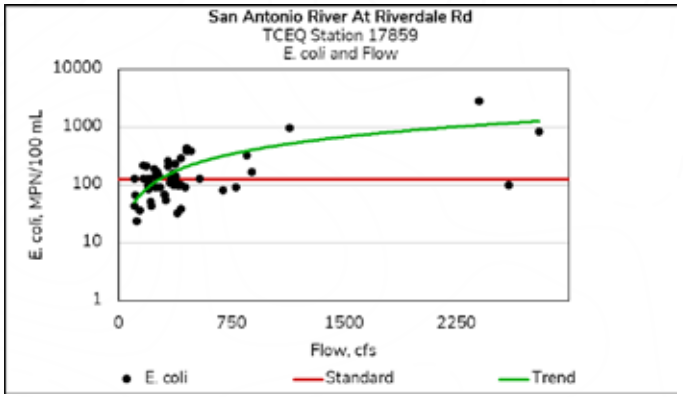
**Lower San Antonio River Watershed Routine Data Analysis:**

Only data with at least 10 years of data and no significant data gaps were used in the analysis. The TCEQ identified *E. coli* bacteria as an impairment and nitrate nitrogen, total phosphorus, and chlorophyll-a as concerns.

Some of the parameters showed seasonality. For this report, the seasons were defined as: critical period (July 1st - September 30th), non-critical period (March 15th - June 30th plus October 1st - October 15th), and the non-index period (October 16th – March 14th).

Lower San Antonio River:

*E. coli* geometric means ranged from 74.69 to 203.04 MPN per 100 mL. Only one station (12791) showed seasonality with the lowest values during the critical period. No stations showed any trending for *E. coli* over time. The four lower stations (12794, 17859,12791,12790) showed an increasing trend as flow increased. During stormwater runoff events, fecal matter and other pollutants are transported to the river. Also *E. coli* bacteria tend to attach to sediment and settle to the bottom of the river. As flow increases




*Graph showing E. coli levels increase as flow increases.*

under stormwater runoff conditions, the sediment along with the *E. coli* bacteria get resuspended into the water column.

Nitrate nitrogen levels exceeded the screening level from 94.44 (Station 12794) to 99.15 (Station 12790) percent of the time. The lowest station in the watershed (12790) had an increasing trend over time. The four lowest stations (12794, 17859, 12791, 12790) showed a decreasing trend as flow increased indicating that the source of the nitrate nitrogen is point source as opposed to non-point (stormwater runoff).

Total phosphorus levels exceeded the screening level from 72.88 (station 12790) to 88.33 (station 16580) percent of the time. Only the lowest station (12790) showed an increasing trend over time. The four lowest stations (12794, 17859, 12791, 12790) showed a decreasing trend as flow increased indicating that the source of the total phosphorus is point source as opposed to non-point (stormwater runoff).

Chlorophyll-a levels exceeded the screening level from 0.00 (Station 16580 & 12795) to 23.68 (Station 12790) percent of the time. The most downstream station in the watershed (12790) had an increasing trend over time. While chlorophyll-a showed no trending associated with flow.

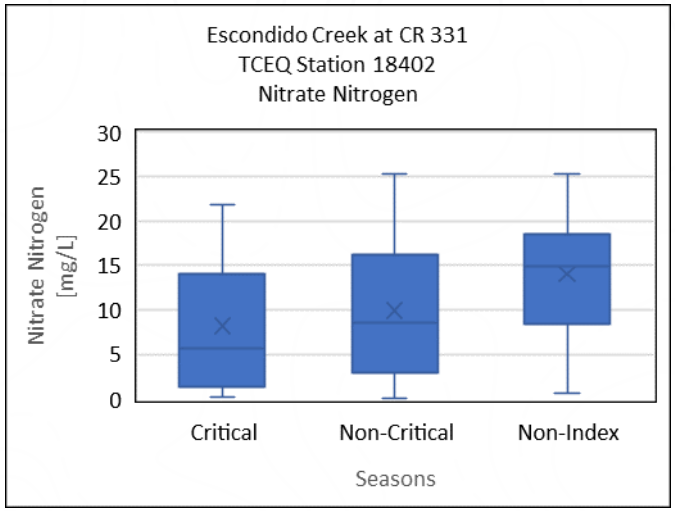
Note that station 12790, the most downstream station, had elevated nitrate nitrogen levels from 0.63 to 16.30 mg/L, with a mean value of 7.36 mg/L. Elevated total phosphorus levels from 0.23 to 1.97 mg/L with a mean value of 0.94 mg/L and elevated chlorophyll-a levels from < 1.00 to 103.00 µg/L with a mean value of 11.10 µg/L. This station only had one sampling event out of 117 events that did not meet the dissolved oxygen average screening level.

Escondido Creek:

The TCEQ 2022 IR identified *E. coli* bacteria as an impairment and nitrate nitrogen and total phosphorus as concerns for Escondido Creek.

*E. coli* geometric mean was 468.68 MPN per 100 mL at this site (18402). *E. coli* levels showed a decreasing trend over time, indicating that *E. coli* levels are improving. Limited bacteria source tracking indicated that 65% of the fecal matter was from wildlife at this station.

Nitrate nitrogen levels exceeded the screening level 84.48 percent of the




*Seasonality graph showing the nitrate levels are lower during the critical period and higher in the non-index period.*

time. Nitrate nitrogen showed seasonality with the lower levels during the critical period and higher levels in the non-index period. During the critical period, temperatures are hot with long intense hours of sunlight, which increases growth and reproduction of algae and aquatic plants. The algae and aquatic plants take up nutrients as they grow and reproduce. There were no trends associated with nitrate nitrogen at this station.

Total phosphorus levels exceeded the screening level 96.55 percent of the time. There were not seasonality or trends associated with total phosphorus at this location.

Ecleto Creek:

*E. coli* geometric mean was 135.32 MPN per 100 mL at this site. *E. coli* showed no seasonality, and there was no trend over time. This site did show *E. coli* increasing as flow increased. *E. coli* bacteria usually has elevated levels during stormwater runoff events and elevated flows.

No nitrate nitrogen or total phosphorus values exceeded TCEQ's screening levels, but 29.63 percent of chlorophyll-a results exceeded the screening level. Also, the dissolved oxygen screening level was not met 26.79 percent of the time and the minimum dissolved oxygen level criteria was not met 14.29 percent of the time. Ecleto Creek is identified as having a flow type of intermittent with pools. The flows during sampling ranged from 0.00 cfs to 11.0 cfs with an average flow of 1.20 cfs. This suggests that the main reason for algae and low dissolved oxygen is low flows and not pollution.

Cabeza and Manahuilla Creeks:

There was insufficient data to evaluate these creeks for trend analysis. The 2022 IR indicated there was an *E. coli* bacteria impairment on Cabeza Reek and an *E. coli* bacteria concern on Manahuilla Creek. Both were due to carry forward from previous assessments.

## Evaluation of Habitat, Nekton (fish) Communities and Diurnal Dissolved Oxygen:

*Table 3-12: Stations assessed for either biological surveys or 24 hour dissolved oxygen in the Lower San Antonio River Watershed.*

| Station Number | Station Name |
|---|---|
| 12792 | San Antonio River at Southern Pacific Railroad Bridge in Goliad |
| 16580 | San Antonio River at Conquista Crossing 2.4 kilometers downstream of FM 791 southwest of Falls City |
| 20539 | Ecleto Creek at FM 81 424 meters east and 103 meters north to the intersection of Karnes CR 334 and FM 81 |

*Downstream view of TCEQ station 16580 during a habitat survey on July 7, 2023.*

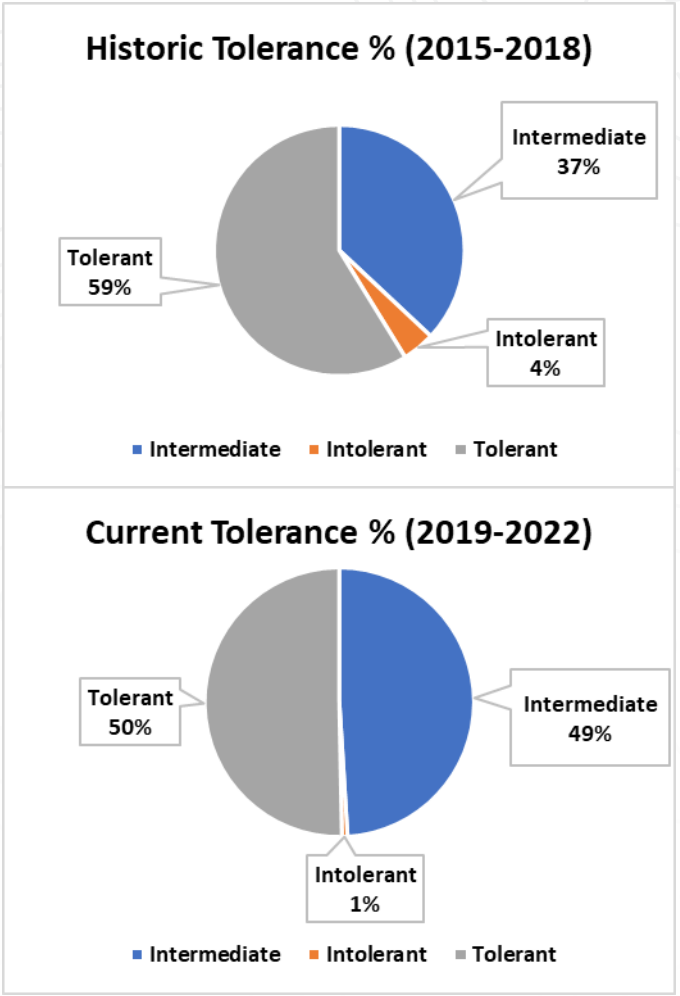
Habitat assessments are done during biological sampling events to holistically evaluate the health of a water body. Habitat quality can tell us how aquatic communities can be supported. The Habitat Quality Index (HQI) is a quantitative measurement used to assess aquatic habitat quality, as described in the Surface Water Quality Monitoring (SWQM) Procedures Manual. This is done by quantitatively and qualitatively assessing various features of the stream reach, including available instream cover, number of riffles, and the structure of riparian vegetation, among other things. These features have an intrinsic value for characteristics like bank stability, buffering capacity, and refugia for aquatic organisms. Based on the metrics measured, habitat quality is scored and then categorized as either limited, intermediate, high, or exceptional.

Assessment of habitat in the Lower San Antonio River Watershed from 2019-2022 included TCEQ stations 12792 and 16580 (Table 3-12). According to San Antonio River Authority (River Authority) data, current habitat in the Lower San Antonio River Watershed is described as intermediate quality according to the HQI.

The Lower San Antonio River at these stations is characterized as moderate quality due to rare instream cover, moderately unstable bottom substrate, moderate number of riffle habitats, a lack of pooled habitats, moderately stable flows and banks, moderate channel sinuosity, and wide riparian buffer vegetation corridors. The average width of the riparian buffer across the two sites is about sixteen meters wide and is dominated mainly by trees and grasses. The percent tree canopy coverage across the two sites is about 63%, providing ample shading to the river. Developed canopy and understory are present, however, and established mid-story is lacking. A more developed mid-story would allow for higher species abundance and diversity, leading to higher ecological function in the riparian zone. Segment 1901_02, assessed at station 12792, is considered to have impaired habitat in water. Station 16580 trends higher in habitat quality relative to station 12792 due mainly to higher quality of instream cover, bottom substrate stability, and number of riffles present. Higher scores in these habitat metrics would indicate better instream and riparian habitat for aquatic organisms to inhabit, increasing species diversity and ecological integrity.

*Table 3-13: Species caught in the Lower San Antonio River Watershed and their native/non-native status and tolerances. Relative abundance for each species out of total individuals caught for the historical period assessed (2015-2018) and the current data period (2019-2022)*

| Common Name | Status | Tolerance | Relative Abundance Historical (2015-2018) | Relative Abundance Current (2019-2022) |
|---|---|---|---|---|
| Red Shiner | Native | Tolerant | 46.48% | 36.58% |
| Bullhead Minnow | Native | Intermediate | 9.37% | 34.17% |
| Burrhead Chub | Native | Intermediate | 19.64% | 5.77% |
| Western Mosquitofish | Native | Tolerant | 2.67% | 5.55% |
| Channel Catfish | Native | Tolerant | 6.89% | 5.11% |
| Rio Grande Cichlid | Native | Intermediate | 0.42% | 2.24% |
| Longear Sunfish | Native | Intermediate | 1.58% | 2.18% |
| Ghost Shiner | Native | Intermediate | 0.57% | 1.32% |
| Sailfin Molly | Native | Tolerant | 1.25% | 1.17% |
| Green Sunfish | Native | Tolerant | 0.54% | 0.96% |
| Flathead Catfish | Native | Intermediate | 0.85% | 0.74% |
| Blacktail Shiner | Native | Intermediate | 0.05% | 0.57% |
| Bluegill | Native | Tolerant | 0.35% | 0.57% |
| Mexican Tetra | Native | Intermediate | 0.00% | 0.56% |
| Spotted Bass | Native | Intermediate | 0.57% | 0.44% |
| Guadalupe Bass | Native | Intolerant | 0.17% | 0.32% |
| Largemouth Bass | Native | Intermediate | 0.87% | 0.25% |
| Mimic Shiner | Native | Intolerant | 3.94% | 0.18% |
| Central Stone Roller | Native | Intermediate | 0.26% | 0.17% |
| Tadpole Madtom | Native | Intolerant | 0.07% | 0.13% |
| Orangespotted | Native | Intermediate | 0.33% | 0.13% |
| Amazon Molly | Native | Intermediate | 0.47% | 0.13% |
| Inland Silverside | Native | Intermediate | 0.09% | 0.12% |
| River Darter | Native | Intermediate | 0.00% | 0.10% |
| Gizzard Shad | Native | Tolerant | 0.31% | 0.09% |
| White Crappie | Native | Intermediate | 0.05% | 0.08% |
| Pterygoplichthys sp. | Non-native | Tolerant | 0.09% | 0.08% |
| Longnose Gar | Native | Tolerant | 0.00% | 0.06% |
| Spotted Gar | Native | Tolerant | 0.14% | 0.05% |
| Sheepshead Minnow | Native | Tolerant | 0.00% | 0.04% |
| Warmouth | Native | Tolerant | 0.02% | 0.04% |
| Texas Logperch | Native | Intolerant | 0.05% | 0.04% |
| Blue Catfish | Native | Intermediate | 0.00% | 0.01% |
| Smallmouth Buffalo | Native | Intermediate | 0.00% | 0.01% |
| Redspotted Sunfish | Native | Intermediate | 0.00% | 0.01% |
| Threadfin Shad | Native | Intermediate | 0.02% | 0.01% |
| American Eel | Native | Intermediate | 0.07% | 0.01% |
| Common Carp | Non-native | Tolerant | 0.02% | 0.00% |
| Suckermouth Catfish | Non-native | Tolerant | 0.02% | 0.00% |
| Ribbon Shiner | Native | Intermediate | 0.02% | 0.00% |
| White Mullet | Native | Intermediate | 0.07% | 0.00% |
| Grey Redhorse | Native | Intermediate | 0.12% | 0.00% |
| Sand Shiner | Native | Intermediate | 1.53% | 0.00% |




*Historical and current tolerance breakdown of fish occupying the Lower San Antonio River watershed.*

Index of Biotic Integrity (IBI) is a measure of ecosystem health that uses a variety of metrics taken from survey data to estimate fish community health. These metrics include species composition, trophic composition, and percent intolerance. Based on current (2019-2022) River Authority data, average scores for the two stations evaluated were 41 (intermediate) for station 12792 and 36 (intermediate) for station 16580. Overall, the average score for the Lower San Antonio River watershed is a 39 (intermediate) indicating that the biotic integrity of the Lower San Antonio River Watershed is of moderate quality.

On average, both stations showed a 4% increase in overall IBI when comparing historic and current data. In recent years, there has been a decrease in abundance of sensitive fish species. For example, the relative abundance of Mimic Shiner changed from 4% to 0.2%. However, the relative abundance of Guadalupe Bass and Tadpole Madtom did increase slightly (Table 3-13). Additionally, two of the non-native fish species found saw an overall decrease over recent years. Both Suckermouth Catfish and Common Carp decreased from 0.02% to 0%. The data also revealed that there has been an increase of intolerant and intermediate fish abundance in comparison to their historical abundance, resulting in a near even distribution as tolerant species in recent years.

*Photo voucher of a Tadpole Madtom (Noturus gyrinus) caught at TCEQ station 12792 on March 21st, 2022.*

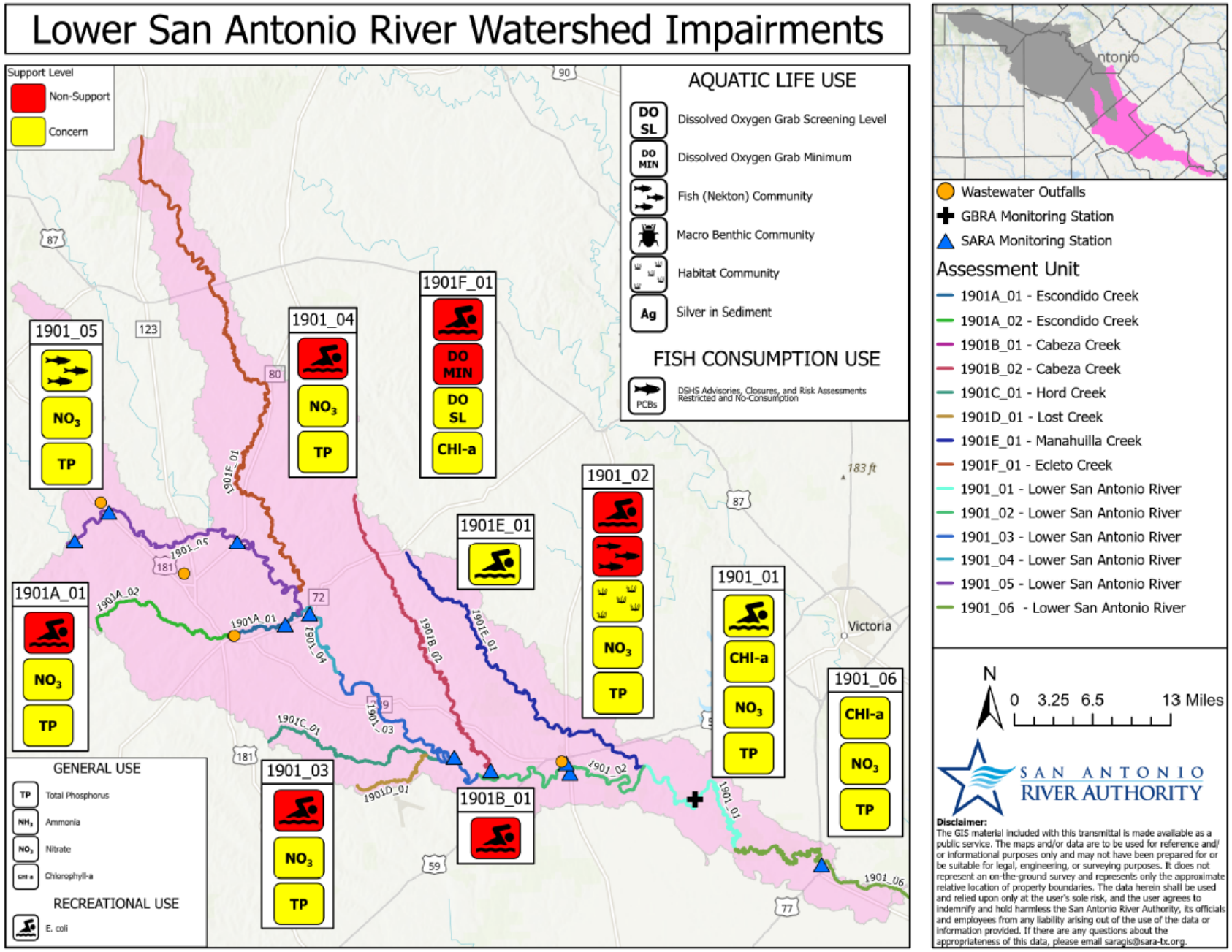
Both segment 1901_02 and 1901_05, assessed at station 16580, are considered to have an impaired fish community. Ecleto Creek, a contributing stream to the Lower San Antonio River, is considered to have depressed dissolved oxygen levels, which may contribute to this level of concern for fish communities.

The 2022 Texas Surface Water Quality Standards (TSWQS) lists a 24-hour dissolved oxygen criteria of 5.0 mg/L average and a 3.0 mg/L minimum for the Lower San Antonio River. DO levels can decrease to dangerous levels for a myriad of reasons. Oxygen levels below the demand of the aquatic organisms in the stream will cause high levels of stress and mortality.

In the last several years, 24-hour dissolved oxygen readings have been taken at three different TCEQ stations, including 12792, 16580 and 20539. Dissolved oxygen levels at these stations averaged at 5.8 mg/L overall, ranging from 0.1 mg/L at station 20539 to 11.9 mg/L at station 12792. Ecleto Creek is considered to have depressed dissolved oxygen levels;

additional data and information will be collected or evaluated before a management strategy is selected. The other two stations have met the minimum and average criteria for dissolved oxygen levels and meet the TSWQS.

# Lower San Antonio River Watershed Impairments







Wastewater Outfalls
GBRA Monitoring Station
SARA Monitoring Station

## Assessment Unit

- 1901A_01 - Escondido Creek
- 1901A_02 - Escondido Creek
- 1901B_01 - Cabeza Creek
- 1901B_02 - Cabeza Creek
- 1901C_01 - Hord Creek
- 1901D_01 - Lost Creek
- 1901E_01 - Manahuilla Creek
- 1901F_01 - Ecleto Creek
- 1901_01 - Lower San Antonio River
- 1901_02 - Lower San Antonio River
- 1901_03 - Lower San Antonio River
- 1901_04 - Lower San Antonio River
- 1901_05 - Lower San Antonio River
- 1901_06 - Lower San Antonio River

N

0 3.25 6.5 13 Miles

SAN ANTONIO RIVER AUTHORITY

**Disclaimer:**
The GIS material included with this transmittal is made available as a public service. The maps and/or data are to be used for reference and/or informational purposes only and may not have been prepared for or be suitable for legal, engineering, or surveying purposes. It does not represent an on-the-ground survey and represents only the approximate relative location of property boundaries. The data herein shall be used and relied upon only at the user's sole risk, and the user agrees to indemnify and hold harmless the San Antonio River Authority, its officials and employees from any liability arising out of the use of the data or information provided. If there are any questions about the appropriateness of this data, please email saragis@sara-tx.org.

*Table 3-14: Summary of Issues:*

| Water Quality Issue | Affected Area | Possible Influences | Possible Effects | Possible Solutions / Actions Taken |
|---|---|---|---|---|
| Fecal Contamination (*E. coli* Bacteria Impairment)<br><br>Identified on 2022 Integrated Report | • Upper San Antonio River-sporadic<br>• Apache Ck.<br>• Alazan Ck<br>• San Pedro Cr.<br>• Sixmile Ck.<br>• Martinez Ck.<br>• Pajarito Ck.<br>• Seguin Branch<br>• Lower San Antonio River -sporadic<br>• Escondido Ck.<br>• Cabeza Ck.<br>• Manahuilla Ck.<br>• Ecleto Ck. | • Rapid urbanization, impervious cover<br>• Construction stormwater controls failing<br>• Developments with septic tanks or small, privately-run wastewater treatment plants<br>• Small, slow-moving stream with little assimilative capacity<br>• Illegal dumping at creek crossings | • Increased quantity of stormwater scouring stream beds, creating additional sediment loading and urban-related pollutants<br>• Bacteria load from land use and effluent is not reduced by instream flow<br>• Significant primary contact recreation 1 (e.g., swimming) could lead to gastrointestinal illnesses | • Improve stormwater controls in new development<br>• Adequate construction oversight<br>• Wastewater regionalization to prevent multiple small package plants and reduce septic tanks |
| Depressed Dissolved Oxygen<br><br>Identified on 2022 Integrated Report | • Picosa Ck.<br>• Unnamed tributary of Upper San Antonio River in Wilson Co.<br>• Ecleto Ck. | • Organic matter and nutrients transported to the creek due to stormwater runoff<br>• Low flows | • Low dissolved oxygen levels in the creek can cause stress and death to aquatic organisms | • Encourage best management practices to reduce transportation of pollutants, especially nutrients and organic matter, to the river |

| Water Quality Issue | Affected Area | Possible Influences | Possible Effects | Possible Solutions / Actions Taken |
|---|---|---|---|---|
| Fish & Macrobenthic Communities<br><br>Identified on 2022 Integrated Report | • Upper San Antonio River – 1911_08 and 1911_09<br>• Lower San Antonio River -1901_02 and 1901_05 AU | • Urbanization has contributed to the flashiness of the creek which disturbs instream habitat<br>• Stormwater runoff contributes to sporadic water quality issues | • Diminished fisheries and biological communities | • Improve riparian zone and implement stormwater BMPs to reduce flashiness of the creek<br>• Improve instream habitat<br>• Continue promoting stormwater BMPs<br>• Continue monitoring |
| Nutrient enrichment (nitrate nitrogen, phosphorus, nitrogen)<br><br>Identified on 2022 Integrated Report | • Upper San Antonio River<br>• Apache Ck.<br>• Escondido Ck.<br>• San Pedro Ck.<br>• Lower San Antonio River | • Wastewater treatment plant effluent<br>• Row-crop agriculture<br>• Urban landscaping and maintenance | • Nutrients are necessary for algae, plants, and aquatic communities. Excessive nutrients can cause algae blooms which can cause significant swings in dissolved oxygen, causing stress and even death of aquatic communities<br>• Excessive nutrients can cause algae and cyanobacteria (blue -green algae) blooms that can release toxins into the water<br>• Excessive nutrients can cause algae blooms causing an aesthetic nuisance | • If dissolved oxygen swings are significant and biology shows a related effect, then some nutrient controls may be needed for wastewater treatment plants |

| Water Quality Issue | Affected Area | Possible Influences | Possible Effects | Possible Solutions / Actions Taken |
|---|---|---|---|---|
| Chlorophyll-a<br><br>Identified on 2022 Integrated Report | • Upper San Antonio River -1911_08<br>• Lower San Antonio River – 1901_01 and 1901_06<br>• Ecleto Ck. | • Elevated nutrient levels<br>• Improper use of fertilizers<br>• Organic matter and nutrients carried to creek due to stormwater runoff<br>• Low flow and pooling combined with warm temperature make a good habitat for growing algae | • Excessive algae in the water can increase the diurnal amplitude of dissolved oxygen in a creek. When the sun is out, photosynthesis occurs and dissolved oxygen levels are high, but when photosynthesis is not occurring at night, or the algae is decaying dissolved oxygen levels can get very low, causing stress and even death to aquatic organisms<br>• Elevated levels of chlorophyll-a can be an indication of toxic algae blooms | • Educate the public on the importance of using fertilizers according to manufacturer's directions<br>• Manage and dispose of pet and livestock waste properly, so it does not make its way to the creek<br>• Manage wildlife populations, by not feeding along waterways, and control invasive species such as feral hogs to reduce organic matter in the creek<br>• Manage stormwater runoff to reduce runoff in urban areas from picking up nutrients and waste and transporting them to the creek |

| Water Quality Issue | Affected Area | Possible Influences | Possible Effects | Possible Solutions / Actions Taken |
|---|---|---|---|---|
| Invasive Species<br><br>Staff Concern<br>Apple Snails, Tilapia, Armored Catfish,<br>Zebra Mussels | • Urban area of the Upper San Antonio River | • Due to spring flow and reuse water, the temperature of the water allows for non-native species<br>• This portion of the river is highly engineered to move floodwater out of the area. Habitat is poor | • Non-native species out competing native species and displacing native species | • Public Outreach discouraging people to not dump their aquariums in the river<br>• Removal of non-native species when that portion of the river is drained<br>• Physically removing the non-native species and their eggs during breeding season |

## Cibolo Creek Watershed Summary

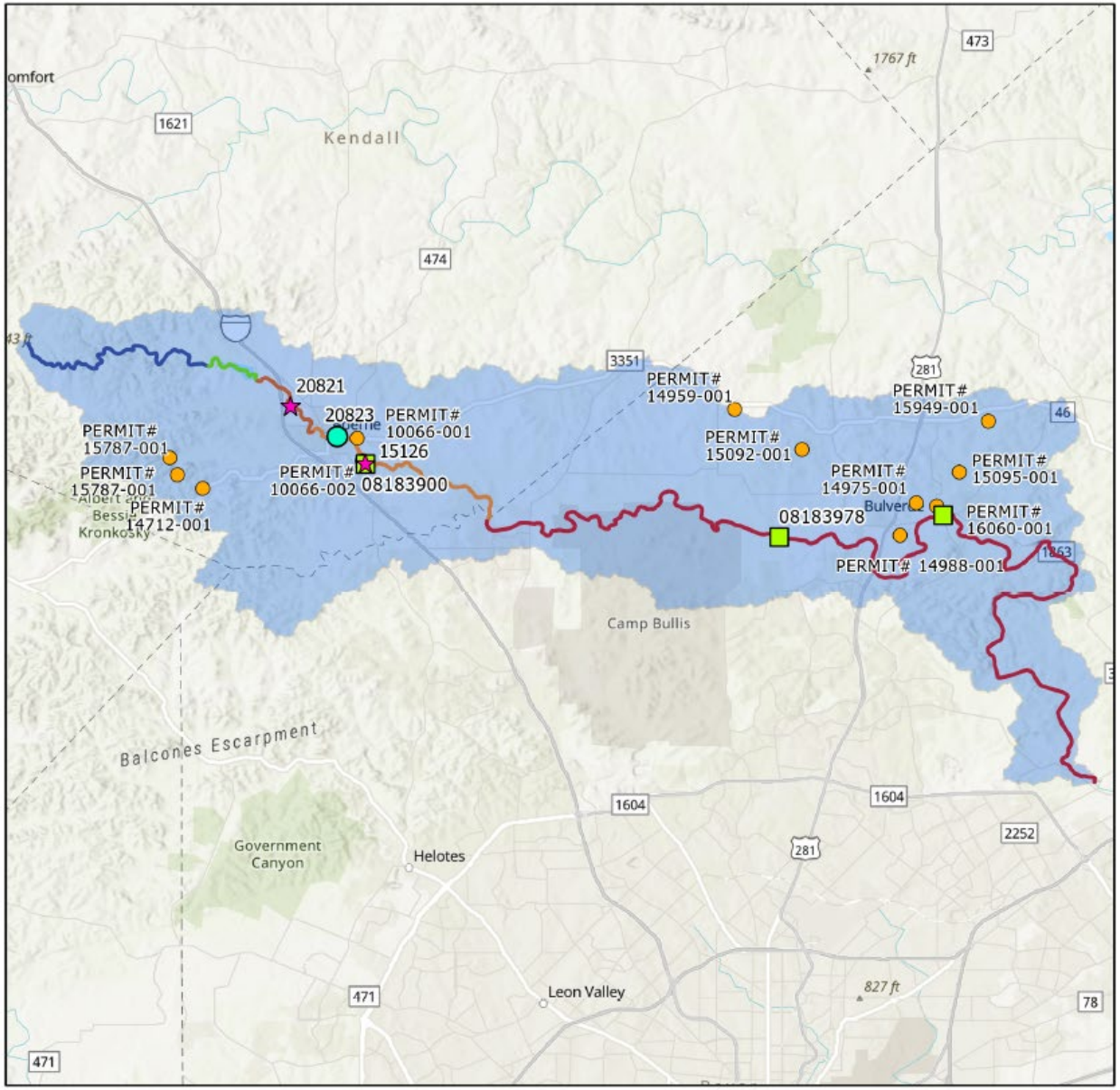
Cibolo Creek is broken up into three segments by the Texas Commission on Environmental Quality (TCEQ):

- Upper Cibolo Creek: Segment 1908
- Mid Cibolo Creek: Segment 1913
- Lower Cibolo Creek: Segment 1902

An Upper Cibolo Creek Watershed Protection Plan was developed with stakeholders' participation to protect the watershed for contact recreation and any other pollutant that might impair the watershed. The City of Boerne worked with TCEQ and Parsons to publish the watershed protection plan in 2013.

The Texas Water Resources Institute worked with the San Antonio River Authority to assist local stakeholders in developing and implementing best management practices to improve and protect water quality in the Mid and Lower Cibolo Creek watershed. The Watershed Protection Plan identifies best management practices that can specifically be used in the Mid and Lower Cibolo Watershed to reduce *E. coli* levels, improve dissolved oxygen values, and reduce nutrient (nitrate nitrogen, ammonia nitrogen, and total phosphorus) levels. The Watershed Protection Plan was completed in May 2019.

# Upper Cibolo Creek Watershed




- TCEQ Monitoring Station
- Boerne Monitoring Station
- USGS Stations
- Wastewater Outfalls

Assessment Unit

- 1908_01 - Upper Cibolo Creek
- 1908_02 - Upper Cibolo Creek
- 1908_03 - Upper Cibolo Creek
- 1908_04 - Upper Cibolo Creek
- 1908_05 - Upper Cibolo Creek

N

0 1.8 3.6 7.2 Miles

SAN ANTONIO RIVER AUTHORITY

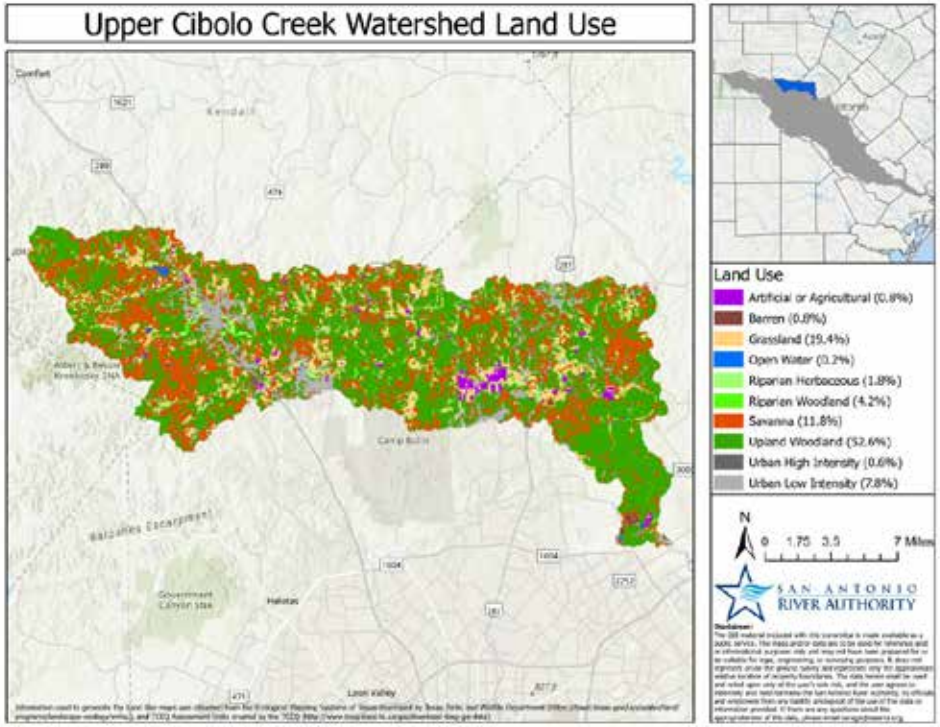
**Disclaimer:**
The GIS material included with this transmittal is made available as a public service. The maps and/or data are to be used for reference and/or informational purposes only and may not have been prepared for or be suitable for legal, engineering, or surveying purposes. It does not represent an on-the-ground survey and represents only the approximate relative location of property boundaries. The data herein shall be used and relied upon only at the user's sole risk, and the user agrees to indemnify and hold harmless the San Antonio River Authority, its officials and employees from any liability arising out of the use of the data or information provided. If there are any questions about the appropriateness of this data, please email saragis@sara-tx.org.

## Upper Cibolo Creek Watershed Summary

The headwaters of Upper Cibolo Creek originate at a point approximately 1.5 kilometers upstream of the confluence of Champee Springs in Kendall County, on private property on Turkey Knob Road in Boerne, Texas. Upper Cibolo Creek generally flows eastward, north of San Antonio, Texas, for approximately 93 miles until it becomes Mid Cibolo Creek at the Missouri-Pacific Railroad Bridge west of Bracken, Texas in Comal County. The drainage area is approximately 264 square miles, which accounts for approximately 6.3% of the entire San Antonio River Basin. Upper Cibolo Creek begins as clear, spring-fed stream with stable bedrock substrate and sparsely vegetated, rocky limestone banks. Though flow is designated as perennial from the headwaters near Champee Springs to the Union Pacific Railroad approximately 400m upstream of FM 2252, Upper Cibolo Creek has a propensity to lose water over the Edwards Aquifer Recharge Zone in segment 1908_03. Due to the intersection of the recharge zone, flow primarily occurs after major rainfall events, then quickly dissipates and the creek dries shortly after. Two major obstructions that occur in Upper Cibolo Creek are Boerne City Lake, in 1908_05, and a dam near downtown Boerne, TX along River Road in 1908_01.

The upper reaches of Upper Cibolo Creek flow through the higher elevations (from 1,900 to 1,400 feet) of the Champee Springs Ranches west of Boerne, Texas over karst landscapes and through private ranch properties. This area is characterized mainly by higher sloped Eckrant rock outcrops covered with cobble, stone, or boulder, and gently sloped silty clays. As the creek passes through Boerne, Texas in Kendall County, the soil composition shifts to mainly silty clay loams. Upper Cibolo Creek is prone to flash flooding within Boerne, Texas. As Upper Cibolo Creek continues east, soil compositions are mainly rocky limestone outcrops and silty clays. Upper Cibolo Creek flows through steep hill country terrain over limestone formations within the Edwards Plateau, where it intersects the contributing and recharge zones of the Edwards Aquifer.

Land use in Upper Cibolo Creek is primarily upland woodland (52.6%) throughout the region, with savanna (11.8%) and grasslands (19.4%) near evenly dispersed throughout. Throughout the developed areas of Boerne and Fair Oaks Ranch, Texas and along the I-10 corridor is urban low intensity with some level of impervious cover due to increasing urban development in the region. Upland woodland habitat consists of mixed forests with vegetation typical of the Texas Hill Country such as a variety of oak species (*Quercus* spp.), Ashe juniper (*Juniperus asheii*), and cedar elm (*Ulmus crassifolia*) dominating the canopies and Texas persimmon (*Diospyros texana*) and mountain laurel (*Sophora secundiflora*) mixed in the mid-story. The savanna portions contain various grasses interspersed with mesquite (*Prosopis glandulosa*), Ashe juniper, and oaks, while the grasslands are dominated by various grasses such as little bluestem (*Schizachyrium scoparium*) and purple threeawn (*Arisitida purpurea*).




Information used to generate the land use maps was obtained from the SARA GIS Department and includes Ecological Mapping Systems of Texas developed by Texas Parks and Wildlife Department (https://tpwd.texas.gov/landwater/land/programs/landscape-ecology/ems/ ), and TCEQ Assessment Units data created by the TCEQ https://gis-tceq.opendata.arcgis.com.

Upper Cibolo Creek has ten wastewater treatment plant permits with two sites, Kendall West Utilities and the City of Boerne, each having two outfalls. Only the City of Boerne is considered a major discharge.

*Table 3-15: Wastewater treatment plants in the watershed.*

| Permittee Name | Permit Number | Discharge |
|---|---|---|
| Kendall West Utility LLC | 15787-001 | ≤ 1 million gallons per day |
| Kendall West Utility LLC | 15787-001 | ≤ 1 million gallons per day |
| Miralomas MUD | 14712-001 | ≤ 1 million gallons per day |
| City of Boerne | 10066-001 | ≥ 1 million gallons per day |
| City of Boerne | 10066-002 | ≥1 million gallons per day |
| Two Seventy Seven Limited & GBRA | 14959-001 | ≤ 1 million gallons per day |
| DTB Investments LP | 15092-001 | ≤ 1 million gallons per day |
| DHJB Development LLC | 14975-001 | ≤ 1 million gallons per day |
| South Central Water Company | 14988-001 | ≤ 1 million gallons per day |
| South Central Water Company | 16060-001 | ≤ 1 million gallons per day |
| Ocean View Property Group LTD | 15949-001 | ≤ 1 million gallons per day |
| Lennar Homes of Texas Land and Construction LTD | 15095-001 | ≤ 1 million gallons per day |

The TCEQ monitors two stations (15126 and 20821), and the City of Boerne monitors one station (20823) on Upper Cibolo Creek.

*Table 3-16: Stations currently monitored by the CRP in the watershed.*

| Location Description | AU | ID |
|---|---|---|
| Cibolo Creek Immediately Downstream of Menger Creek Confluence SE of Boerne | 1908_01 | 15126 |
| Upper Cibolo Creek North Shore 30 Meters Upstream of Dam at River Road Park in Boerne | 1908_01 | 20823 |
| Upper Cibolo Creek at The Downstream End of City of Boerne's Northrup Park | 1908_04 | 20821 |

The US Geological Survey (USGS) currently has three real-time monitoring sites on Cibolo Creek. The USGS stream gages are maintained and operated by the USGS but rely on funding provided by state, regional and local agencies or organizations that sponsor gaging stations.

*Table 3-17: US Geological Survey continuous monitoring stations.*

| Location | ID | Real Time Available Parameters | Additional Sponsors |
|---|---|---|---|
| Cibolo Ck near Boerne, TX | 08183900 | Discharge, Gage Height | Cow Creek Groundwater Conservation District |
| Cibolo Ck at Specht Rd near Bulverde, TX | 08183978 | Discharge, Gage Height | Edwards Aquifer Authority |
| Cibolo Ck at Smithson Valley Rd near Bulverde, TX | 08184050 | Discharge, Gage Height | Edwards Aquifer Authority |

**Texas Integrated Report on Surface Water quality for the Clean Water Act:**

The TCEQ's 2022 Integrated Report (2022 IR) identified five assessment units (AU). The impairments and concerns are listed below.

*Table 3-18: Impairments and concerns identified in the TCEQ 2022 Integrated Report*

| Segment | AU Description | AU ID | Station ID | Impairments | Concerns |
|---|---|---|---|---|---|
| Upper Cibolo Creek | From the confluence of Balcones Creek upstream to N. School Street in Boerne | 1908_01 | 12853<br>12855<br>15126<br>16702<br>20649<br>20823 | *E. coli* | Nitrate Nitrogen<br>Total Phosphorus |
| | From the headwaters of Lake Boerne at low-water dam approximately 310 m (1017 ft) NNW of Lake Spur Drive in Boerne upstream to a point 1.5 km (0.9 mi) upstream of the confluence of Champee Springs in Kendall County | 1908_02 | 20830 | None | None |
| | From the Missouri-Pacific Railroad bridge west of Bracken in Comal County upstream to the confluence of Balcones Creek | 1908_03 | No Stations | None | None |
| | From N. School Street in Boerne upstream to the Lake Boerne Dam | 1908_04 | 12857<br>20821 | None | None |
| | From the Lake Boerne Dam upstream to the headwaters of Lake Boerne at low-water dam approximately 310 m (1017 ft) | 1908_05 | No Stations | None | None |

| Segment | AU Description | AU ID | Station ID | Impairments | Concerns |
|---|---|---|---|---|---|
| | NNW of Lake Spur Drive in Boerne | | | | |

**Upper Cibolo Creek Watershed Routine Data Analysis:**

No dataset had at least 10 years of data with no significant data gaps. Data analysis was not completed on this AU. The 2022 IR identifies *E.coli* bacteria as an impairment and nitrate nitrogen and total phosphorus as concerns in AU 1908_01. 1908_01 is from the Bexar County / Kendall County line upstream to the north side of the City of Boerne. Most of the Upper Cibolo Creek watershed is rural. AU 1908_01 is best described as urban. The sample sites are located in the City of Boerne. The remaining AU had no impairments or concerns.

**Evaluation of Habitat, Nekton (fish) and Benthic Macroinvertebrate Communities:**

*Left bank of station 20821 Upper Cibolo Creek at the downstream end of City of Boerne Northrup Park during a habitat assessment on May 4, 2020.*

Habitat assessments are done during biological sampling events to holistically evaluate the health of a water body. Habitat quality can tell us how aquatic communities can be supported. The Habitat Quality Index (HQI) is a quantitative measurement used to assess aquatic habitat quality, as described in the Surface Water Quality Monitoring (SWQM) Procedures Manual. This is done by quantitatively and qualitatively assessing various features of the stream reach, including available instream cover, number of riffles, and the structure of riparian vegetation, among other things. These features have an intrinsic value for characteristics like bank stability, buffering capacity, and refugia for aquatic organisms. Based on the metrics measured, habitat quality is scored and then categorized as either limited, intermediate, high, or exceptional.

Assessment of habitat in the Upper Cibolo Creek Watershed from 2019-2022 was completed at TCEQ station 20821 (Upper Cibolo Creek at the downstream end of City of Boerne Northrup Park). According to San

Antonio River Authority (River Authority) data, current habitat in the Upper Cibolo Creek Watershed is described as high quality according to the HQI.

Upper Cibolo Creek, at this station, is characterized by overall moderate to high quality features. Moderate quality features include instream cover, bank stability, channel sinuosity, while high quality features included bottom substrate stability, number of riffle habitat, available pool size, flow stability, and wide riparian buffer corridors. The average width of the riparian buffer across the site is about fifteen meters wide and is dominated mainly by trees and grasses. The percent tree canopy coverage across the site is about 51%, providing ample shading to the creek. Developed canopy and understory are present, however, and established midstory is lacking. A more developed mid-story would allow for higher species abundance and diversity, leading to higher ecological function in the riparian zone.

*Table 3-19: Species caught in the Upper Cibolo Creek Watershed and their native/non-native status and tolerances. Relative abundance for each species out of total individuals caught for the historical period assessed (2015-2018) and the current data period (2019-2022).*

| Common Name | Status | Tolerance | Relative Abundance Historical (2015-2018) | Relative Abundance Current (2019-2022) |
|---|---|---|---|---|
| Blacktail Shiner | Native | Intermediate | N/A | 36.69% |
| Longear Sunfish | Native | Intermediate | N/A | 16.73% |
| Largemouth Bass | Native | Intermediate | N/A | 7.19% |
| Central Stoneroller | Native | Intermediate | N/A | 6.65% |
| Orangethroat Darter | Native | Intermediate | N/A | 6.47% |
| Redbreast Sunfish | Non-Native | Intermediate | N/A | 6.47% |
| Western Mosquitofish | Native | Tolerant | N/A | 5.58% |
| Green Sunfish | Native | Tolerant | N/A | 4.14% |
| Rio Grande Cichlid | Native | Intermediate | N/A | 3.24% |
| Bluegill | Native | Tolerant | N/A | 2.88% |
| Yellow Bullhead | Native | Intermediate | N/A | 1.80% |
| Channel Catfish | Native | Tolerant | N/A | 1.44% |
| Flathead Catfish | Native | Intermediate | N/A | 0.54% |
| Warmouth | Native | Tolerant | N/A | 0.18% |

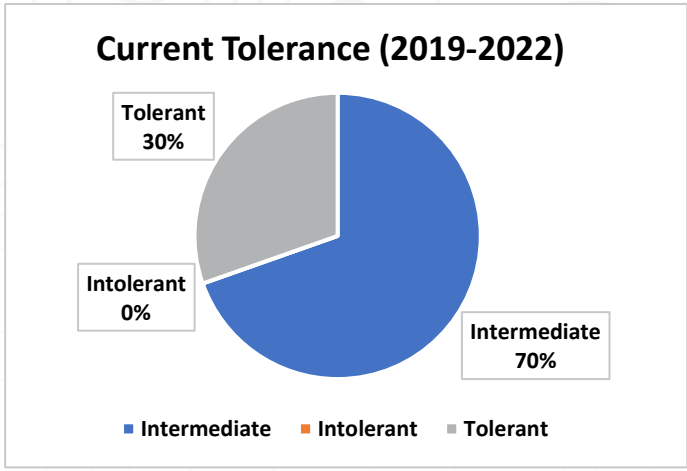
Index of Biotic Integrity (IBI) is a measure of ecosystem health that uses a variety of metrics taken from survey data to estimate fish community health. These metrics include species composition, trophic composition, and percent intolerance. Based on current (2019-2022) River Authority data, the score for station 20821 is 42 (high), indicating that the biotic integrity of the Upper Cibolo Creek Watershed is of high quality.

This Cibolo Creek station saw a total of 14 species with only one of them being a non-native species, giving it a 94% native species composition. In terms of tolerance, there was a higher percentage of intermediate individuals than tolerant individuals, and no intolerant species were observed. The collective relative abundance of those intermediate individuals was 86%, and 14% relative abundance of tolerant individuals. Of all individuals caught,

the highest abundances were seen in intermediate species such as Blacktail Shiner (37%), Longear Sunfish (17%), Largemouth Bass/Central Stoneroller (7%), and Redbreast Sunfish/Orangethroat Darter (6%).

*Photo voucher of a Blacktail Shiner (Cyprinella venusta) caught at TCEQ station 20821 Upper Cibolo Creek at the downstream end of City of Boerne Northrup Park on July 13th, 2020.*

The Upper Cibolo Creek Watershed shows no concerns for either aquatic life or habitat for segment 1908 based on current data for this site.

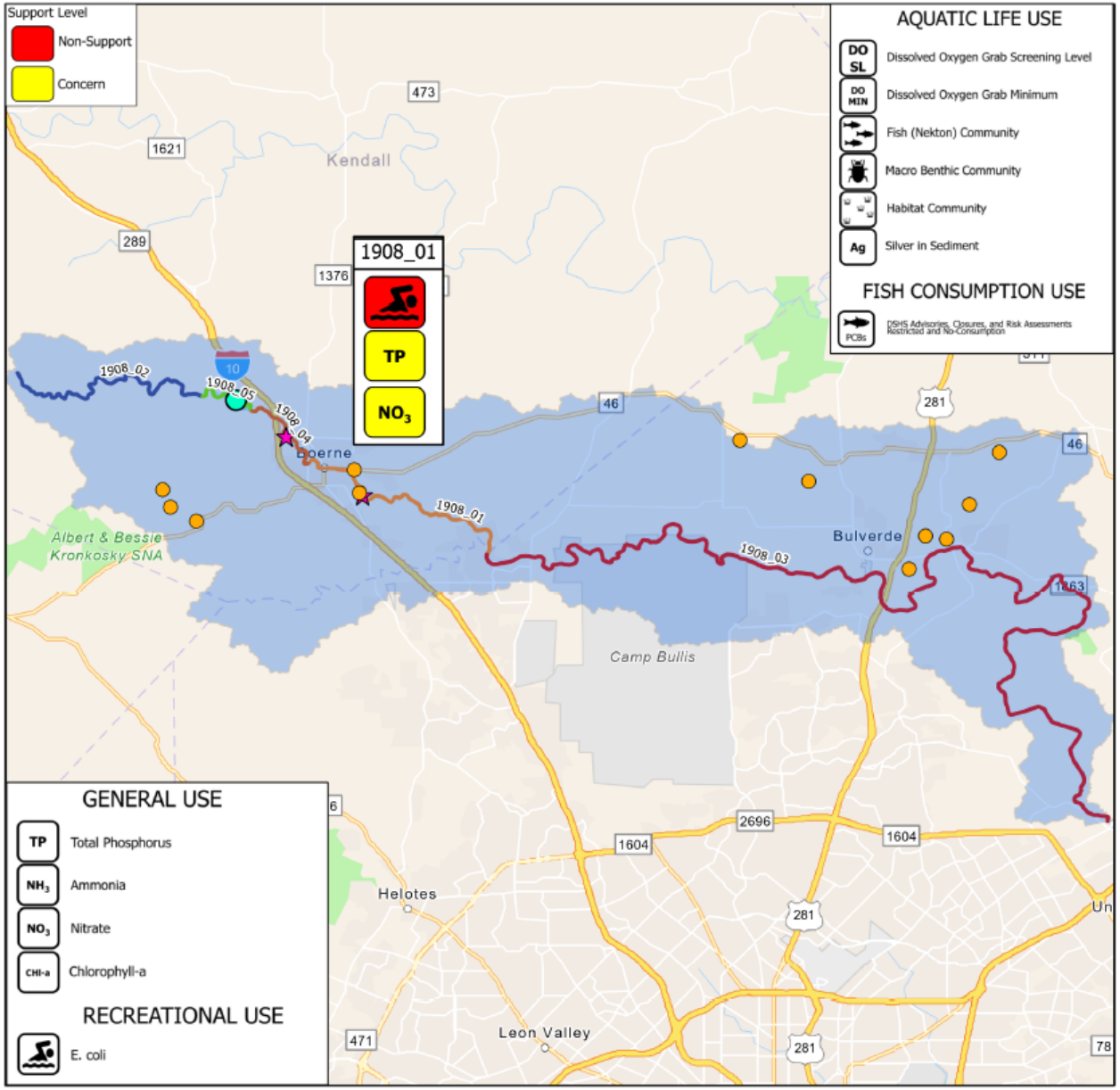


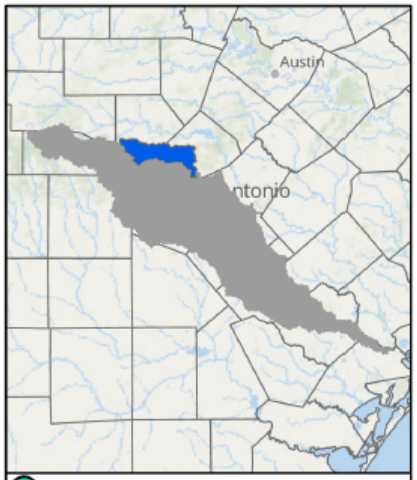

*Current tolerance breakdown of Upper Cibolo Creek watershed.*

The 2022 Texas Surface Water Quality Standards (TSWQS) lists a 24-hour dissolved oxygen criteria of 5.0 mg/L average and a 3.0 mg/L minimum for Upper Cibolo Creek. Dissolved oxygen levels can decrease to dangerous levels for a myriad of reasons. Oxygen levels below the demand of the aquatic organisms in the stream will cause high levels of stress and mortality.

In the last several years, 24-hour dissolved oxygen readings have been taken at station 20821. Dissolved oxygen levels at this station averaged at 6.2 mg/L overall, ranging from 3.9 mg/L in July 2020 to 9.1 mg/L in July 2020. For the last several years, this station has met the minimum or average criteria for dissolved oxygen levels and meets the TSWQS.

# Upper Cibolo Watershed Impairments




Boerne Monitoring Station
TCEQ Monitoring Station
Wastewater Outfalls

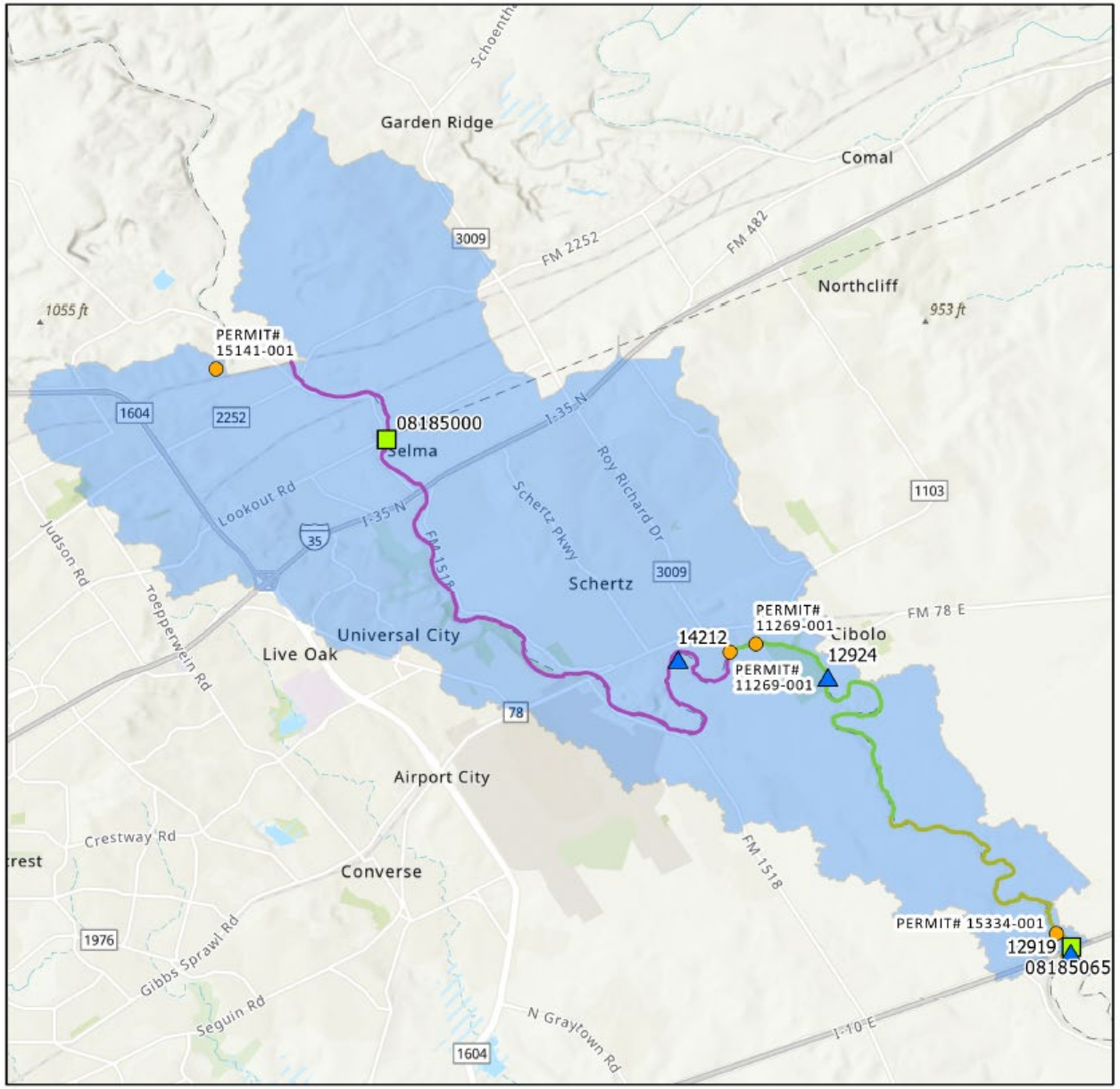
Assessment Unit
- 1908_01 - Upper Cibolo Creek
- 1908_02 - Upper Cibolo Creek
- 1908_03 - Upper Cibolo Creek
- 1908_04 - Upper Cibolo Creek
- 1908_05 - Upper Cibolo Creek

N

0 1.75 3.5 7 Miles

SAN ANTONIO RIVER AUTHORITY

# Mid Cibolo Creek Watershed





SARA Monitoring Station
USGS Stations
Wastewater Outfalls
Assessment Unit
1913_01 - Mid Cibolo Creek
1913_02 - Mid Cibolo Creek
1913_03 - Mid Cibolo Creek

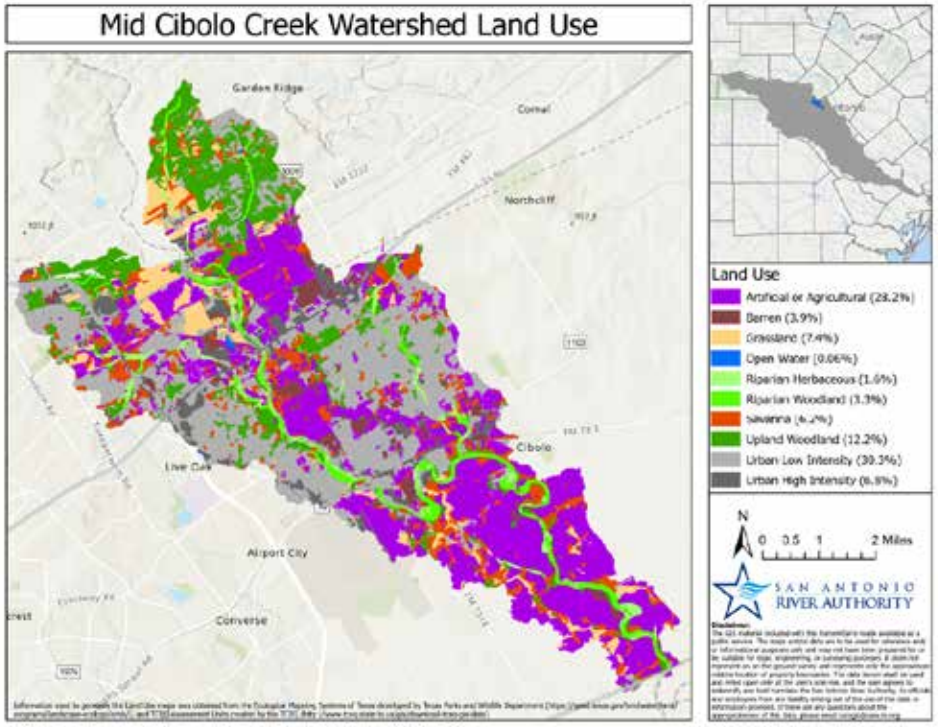
N
0 0.63 1.25 2.5 Miles

SAN ANTONIO RIVER AUTHORITY

Mid Cibolo Creek originates in Comal County at the Missouri-Pacific Railroad Bridge and flows southeast approximately 19 miles until it becomes Lower Cibolo Creek, 100 meters downstream of its intersection with IH-10, in far eastern Bexar County, Texas. The drainage area is approximately 43 square miles, which accounts for approximately 1.0% of the entire San Antonio River Basin. Flow is intermittent in the drier portions of the year from the upper end of the segment to approximately 100 meters north of the Cibolo Creek Municipal WWTP due to its location in the Edwards Aquifer Recharge Zone. Mid Cibolo Creek contains three assessment units.

The upper reaches of Mid Cibolo Creek begin at the transition of Upper Cibolo Creek to Mid Cibolo Creek where the elevation dips below 1,000 feet and slopes become gentler. The watershed exists primarily in the Texas Blackland Prairie, consisting of shrink-swell clays, but the majority of the creek flows through the urbanized areas of east San Antonio in Bexar County, Texas. The rich clays of the Texas Blackland Prairies are ideal for row crops, and areas not dominated by either urban high or urban low intensity are used for agriculture.

Land use in Mid Cibolo Creek is primarily urban low intensity (30.3%) and artificial or agricultural (28.2%), with some portions in the northern half of the watershed in urban high intensity (6.8%) areas, especially along the I-35 corridor. Urban low intensity is defined by human-derived impacts, typically involving impervious cover from buildings and other man-made structures, while urban high intensity is defined by high impervious cover from high levels of urban development and transportation corridors. Artificial and agricultural uses, occurring primarily in the southern portion of the watershed, consist of either row crops or grass farms. The northernmost portion of the watershed, in Comal County, consists of upland woodland (12.2%) with some grassland (7.4%) and savanna (6.2%) interspersed.




Information used to generate the land use maps was obtained from the SARA GIS Department and includes Ecological Mapping Systems of Texas developed by

Texas Parks and Wildlife Department (https://tpwd.texas.gov/landwater/land/programs/landscape-ecology/ems/ ), and TCEQ Assessment Units data created by the TCEQ https://gis-tceq.opendata.arcgis.com.

Mid Cibolo Creek has three wastewater treatment plant permits, with Cibolo Creek Municipal Authority (CCMA) having two discharge points. CCMA is the only major discharger.

*Table 3-12: Wastewater treatment plants in the watershed.*

| Permittee Name | Permit Number | Discharge |
|---|---|---|
| Judson ISD | 15141-001 | ≤ 1 million gallons per day |
| Cibolo Creek Municipal Authority | 11269-001 | ≥ 1 million gallons per day |
| Cibolo Creek Municipal Authority | 11269-001 | ≥ 1 million gallons per day |
| Cibolo Creek Municipal Authority | 15334-001 | ≤ 1 million gallons per day |

The San Antonio River Authority monitors three sample sites on Mid Cibolo Creek.

*Table 3-13: Stations currently monitored by the CRP in the watershed.*

| Location Description | AU | ID |
|---|---|---|
| Cibolo Creek 40 Meters Downstream from IH 10/US 90 on East Bank | 1913_01 | 12919 |
| Cibolo Creek at Schaeffer Rd 3 Mi East of Randolph Air Force Base | 1913_02 | 12924 |
| Cibolo Creek Upstream Cibolo Creek Municipal Authority's WWTP Permit 0011269-001 Off River Road | 1913_03 | 14212 |

The US Geological Survey (USGS) currently has two real-time monitoring sites on the Mid Cibolo segment. The USGS stream gages are maintained and operated by the USGS but rely on funding provided by state, regional and local agencies or organizations that sponsor gaging stations.

*Table 3-14: US Geological Survey continuous monitoring stations.*

| Location | ID | Real Time Available Parameters | Additional Sponsors |
|---|---|---|---|
| Cibolo Ck at Selma, TX | 08185000 | Discharge, Gage Height, Precipitation | Edwards Aquifer |
| Cibolo Ck near Saint Hedwig, TX | 08185065 | Discharge, Gage Height, Precipitation | San Antonio River Authority |

**Texas Integrated Report on Surface Water quality for the Clean Water Act:**

The TCEQ's 2022 Integrated Report (2022 IR) identified three assessment units (AU). The impairments and concerns are listed below.

*Table 3-15: Impairments and concerns identified in the TCEQ 2022 Integrated Report*

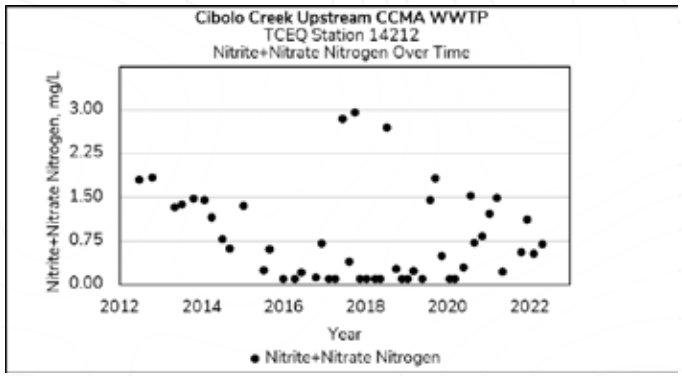
| Segment | AU Description | AU ID | Station ID | Impairments | Concerns |
|---|---|---|---|---|---|
| Mid Cibolo Creek | From 100 meters downstream of I10 up to unnamed tributary approximately 0.3 mi upstream of Weir Road, Bexar County, Texas. | 1913_01 | 12919<br>12921 | None | Nitrate Nitrogen<br>Total Phosphorus |
| | From the confluence with unnamed tributary approximately 0.3 mi upstream of Weir Road, Bexar County, Texas up to 100 meters upstream of the Cibolo Creek Municipal WWTP. | 1913_02 | 12924 | None | Nitrate Nitrogen<br>Total Phosphorus |
| | From 100 meters upstream of Cibolo Creek Municipal WWTP up to the upper end of the segment. | 1913_03 | 14212 | None | None |

**Mid Cibolo Creek Watershed Routine Data Analysis:**

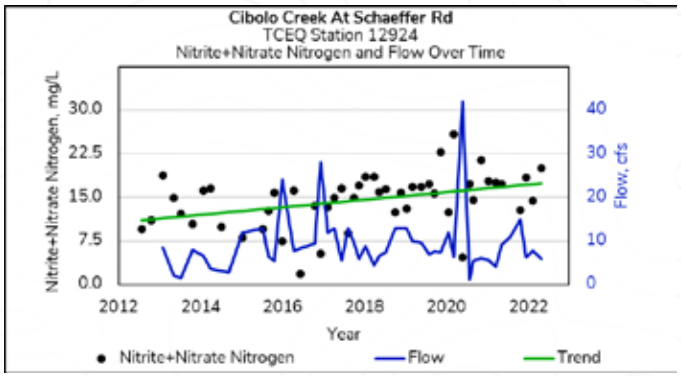
Only datasets with at least 10 years of data and no significant data gaps were used in the analysis. Two stations (14212 and 12924) had sufficient data to evaluate. The TCEQ Integrated Report identified no impairments for this watershed. The upper AU also had no concerns. The two lower AU had concerns for nitrate nitrogen and total phosphorus.

Nitrite plus nitrate nitrogen and total phosphorus showed no seasonality.

In the Mid Cibolo segment, Station 14212 is upstream of CCMA wastewater treatment plant. Station 12924 is downstream of the wastewater discharge. The majority of the flow feeding Cibolo Creek at station 12924 is from wastewater discharge. Both stations have been monitored by TCEQ in the past but are currently being monitored by SARA. The TCEQ laboratory analyzes nitrate nitrogen and nitrite nitrogen together. There is currently no screening level for nitrate plus nitrite nitrogen, but nitrite nitrogen levels are typically less than 0.5 mg/L at these stations according to SARA data. The mean value of nitrite nitrogen plus nitrate nitrogen at the upstream site (14212) is 0.81 mg/L while the downstream site (12924) has a mean of 14.51 mg/L, so nitrate nitrogen levels are elevated at the downstream site.

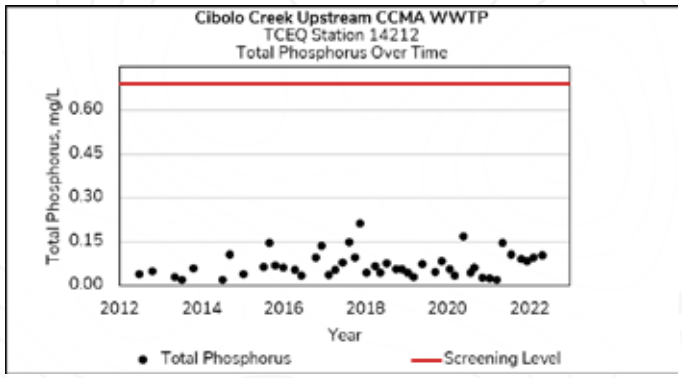



*Graph showing nitrite plus nitrate nitrogen at the upstream site.*

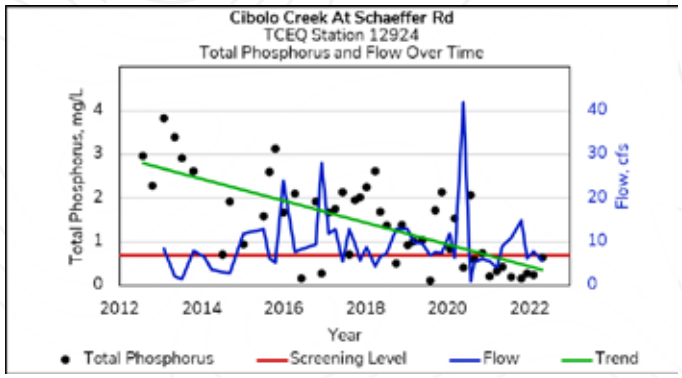



*Graph showing nitrite plus nitrate nitrogen at the downstream site. Values are greater at the downstream site. Note that there is an increasing trend over time.*

Nitrite plus nitrate nitrogen at site 12924 is increasing over time while nitrite plus nitrate nitrogen decreases as flow increases. This indicates that the source of the elevated nutrient is n ot from non-point source pollution, but rather a point source, Cibolo Creek Municipal Authority's Wastewater Treatment Plant.




*Graph showing total phosphorus at the upstream site. Values are lower at the upstream site. Note that at this site there is no trend over time.*




*Graph showing total phosphorus at the downstream site. Values are greater at the downstream site. Note that at this site there is a decreasing trend over time.*

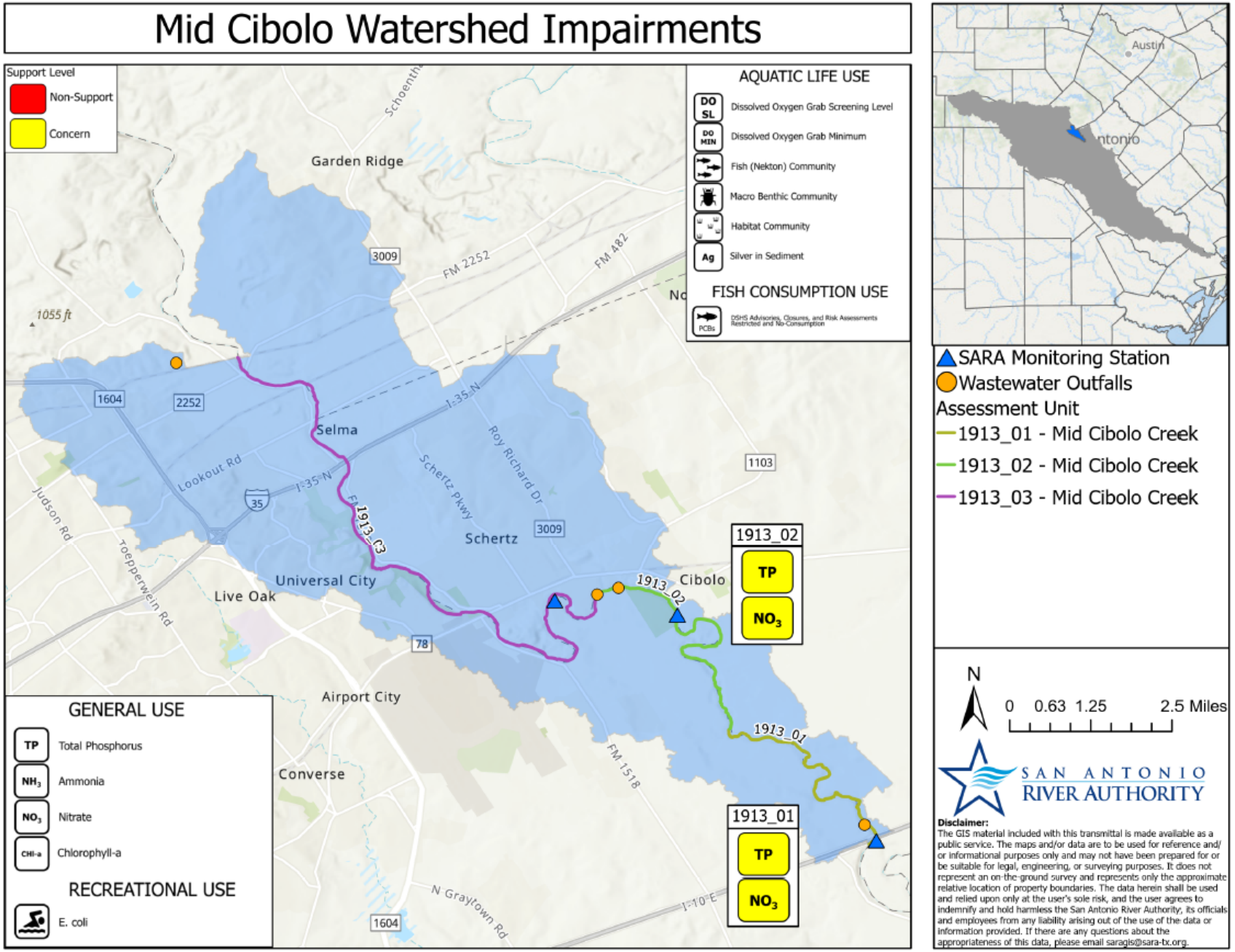
At the upstream site (14212) no total phosphorus levels exceeded the TCEQ screening level. At the downstream station (12924), 71.4% of the values exceed the total phosphorus screening level. However, phosphorus values are decreasing over time at this site.

**Evaluation of 24 Hour Dissolved Oxygen:**

The 2022 Texas Surface Water Quality Standards (TSWQS) lists a 24-hour dissolved oxygen criteria of 3.0 mg/L average and a 2.0 mg/L minimum for Mid Cibolo Creek. Dissolved oxygen levels can decrease to dangerous levels for a myriad of reasons. Oxygen levels below the demand of the aquatic organisms in the stream will cause high levels of stress and mortality.

In 2017, two 24-hour dissolved oxygen readings in Mid Cibolo Creek Watershed were taken at station 12924 Cibolo Creek at Schaeffer Road 3 miles east of Randolph Air Force Base. Dissolved oxygen levels at this station averaged at 6.0 mg/L overall, ranging from 1.2 mg/L in August 2017 to 12.2 mg/L in June 2017. The sample collected during the August (critical period) did not meet the minimum TSWQS but did meet the average TSWQS standard. The sample collected in June (non-critical period) met the TSWQS standard.

# Mid Cibolo Watershed Impairments







SARA Monitoring Station
Wastewater Outfalls
Assessment Unit
1913_01 - Mid Cibolo Creek
1913_02 - Mid Cibolo Creek
1913_03 - Mid Cibolo Creek

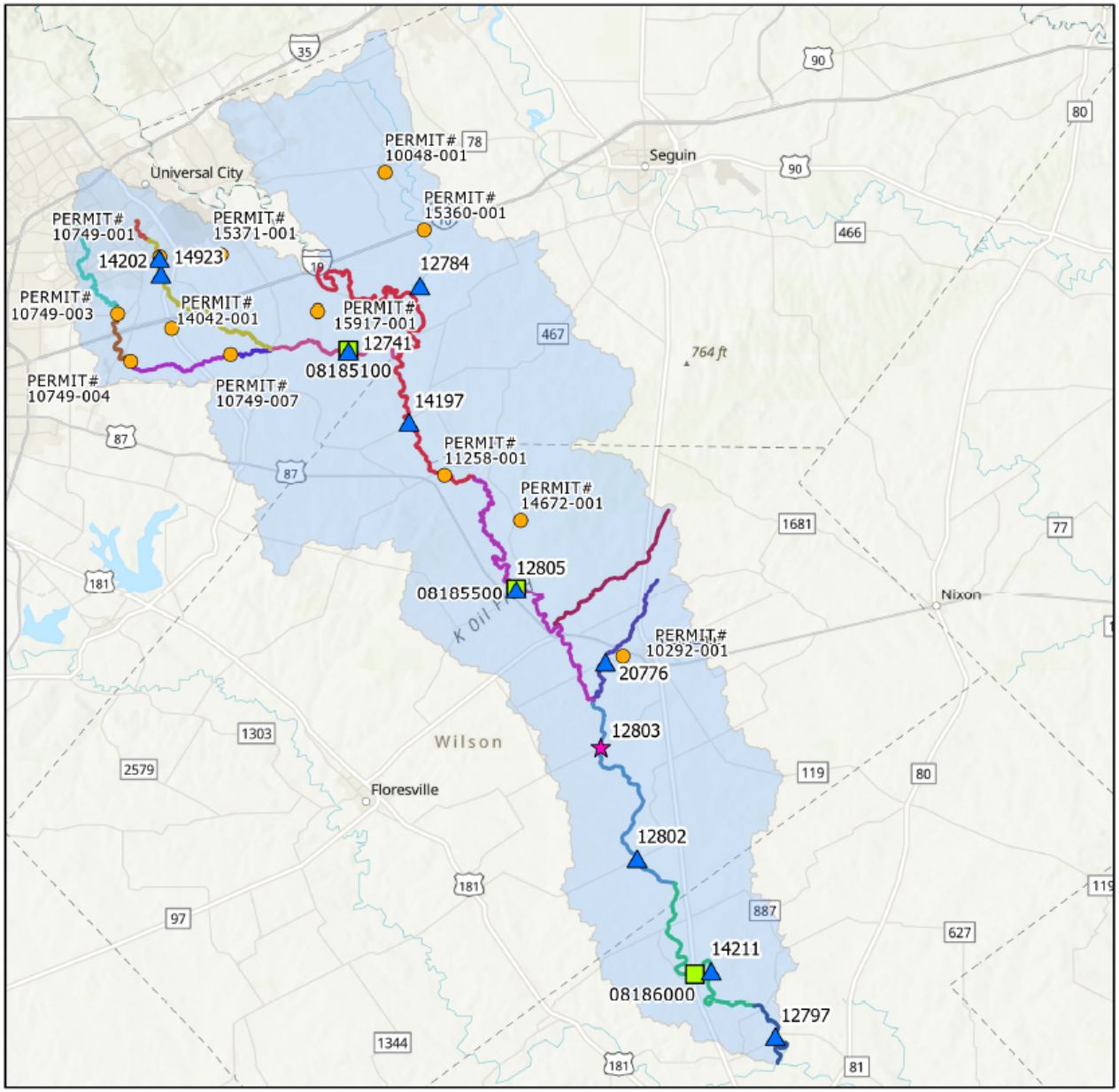
N

0 0.63 1.25 2.5 Miles

SAN ANTONIO RIVER AUTHORITY

**Disclaimer:**
The GIS material included with this transmittal is made available as a public service. The maps and/or data are to be used for reference and/or informational purposes only and may not have been prepared for or be suitable for legal, engineering, or surveying purposes. It does not represent an on-the-ground survey and represents only the approximate relative location of property boundaries. The data herein shall be used and relied upon only at the user's sole risk, and the user agrees to indemnify and hold harmless the San Antonio River Authority, its officials and employees from any liability arising out of the use of the data or information provided. If there are any questions about the appropriateness of this data, please email saragis@sara-tx.org.

# Lower Cibolo Creek Watershed




- SARA Monitoring Station
- TCEQ Monitoring Station
- USGS Stations
- Wastewater Outfalls

Assessment Unit

- 1902A_01 - Martinez Creek
- 1902A_02 - Martinez Creek
- 1902A_03 - Martinez Creek
- 1902A_04 - Martinez Creek
- 1902A_05 - Martinez Creek
- 1902B_01 - Salitrillo Creek
- 1902B_02 - Salitrillo Creek
- 1902C_01 - Clifton Branch
- 1902D_01 - Alum Creek
- 1902_01 - Lower Cibolo Creek
- 1902_02 - Lower Cibolo Creek
- 1902_03 - Lower Cibolo Creek
- 1902_04 - Lower Cibolo Creek
- 1902_05 - Lower Cibolo Creek

N

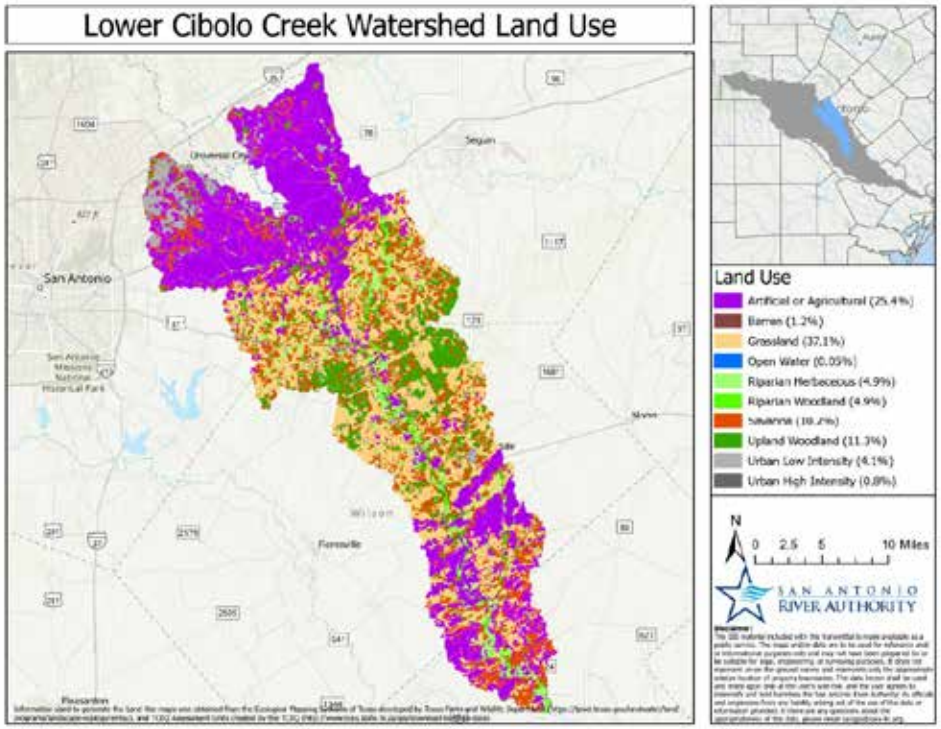
0 2.5 5 10 Miles

SAN ANTONIO RIVER AUTHORITY

## Lower Cibolo Creek Watershed Summary

Lower Cibolo Creek occurs from a point 100 meters downstream of IH 10 in Bexar/Guadalupe County and generally flows southward about 73 miles until its confluence with the San Antonio River approximately 3.5 kilometers east of the intersection between N FM 81 and SH 123 in Panna Maria, Texas in Karnes County. The drainage area is approximately 545 square miles, which accounts for approximately 13.1% of the entire San Antonio River Basin. Lower Cibolo Creek originates from spring flow southwest of the City of Schertz, Texas, and other springs along the reach maintain baseflows in the creek throughout the watershed. Flow transitions from intermittent with pools in Mid Cibolo Creek to perennial at Cibolo Creek @ IH 10 on the east side of Bexar County. Lower Cibolo Creek contains 5 assessment units on Cibolo Creek and numerous others on tributaries.

The upper reaches Lower Cibolo Creek originate in the developed portions of east San Antonio, Texas, and less developed areas in Schertz and Zuehl, Texas. Channel beds/banks along the creek are mostly deeply entrenched and composed of alluvial soils. As the stream moves southeastward it enters the East-Central Texas Plains Post Oak Savanna and Woodland ecoregion crossing through gentle slopes and flat grasslands. The vegetation that occurs within that watershed is dominated by plateau live oak (*Quercus fusiformis*), cedar elm (*Ulmus crassifolia*) and honey mesquite (*Prosopis glandulosa*) in the overstory and shrubs such as hog plum (*Colubrina texensis*), Texas kidneywood (*Eysenhardtia texana*), Texas persimmon (*Diospyros texana*) and Lindheimer prickleypear (*Opuntia engelmannii var. lindenheimer*) within the midstory. Soils within this creek include Lewisville silty clay within the upper portions and sandy loams, and sandy soils as the creek flows downstream.




Land use in Lower Cibolo Creek is primarily of artificial or agricultural (25.4%) land in east San Antonio and Schertz, Texas, which lie in the

northern portion of the watershed. This portion is characterized by either row crops or grass farms. The small portion of the watershed that lies in northeast San Antonio, Texas is characterized by small amounts of urban low intensity (4.1%) uses north of the agricultural land, wherein the area has some level of impervious cover, but is not completely dominated by urbanization. South of this portion, there is little to no urban impervious cover dominating the watershed. The central portion of the watershed, outside of San Antonio, Texas and into Wilson County, consists primarily of grassland habitat (37.1%), with some upland woodland (11.3%) habitat in the center of the grassland areas. There is also riparian herbaceous (4.9%) and riparian woodland (4.9%) habitats along the riparian corridor throughout the central and southern portion of the watershed.

Information used to generate the land use maps was obtained from the SARA GIS Department and includes Ecological Mapping Systems of Texas developed by Texas Parks and Wildlife Department (https://tpwd.texas.gov/landwater/land/programs/landscape-ecology/ems/ ), and TCEQ Assessment Units data created by the TCEQ https://gis-tceq.opendata.arcgis.com.

There are 12 wastewater treatment plants in the Lower Cibolo Creek. The treatment plants discharge into Escondido Creek, Salitrillo Creek, Woman Hollow Creek (A.K.A. Woman Hollering Creek), Martinez Creek, Santa Clara Creek and Cibolo Creek.

*Table 3-16: Wastewater treatment plants in the watershed.*

| Permittee Name | Permit Number | Discharge |
|---|---|---|
| San Antonio River Authority | 10749-001 | ≥ 1 million gallons per day |
| San Antonio River Authority | 10749-003 | ≥ 1 million gallons per day |
| San Antonio River Authority | 10749-004 | ≥ 1 million gallons per day |
| San Antonio River Authority | 14042-001 | ≤ 1 million gallons per day |
| City of Schertz and Cibolo Creek Municipal Authority | 15371-001 | ≤1 million gallons per day |
| San Antonio River Authority | 10749-007 | ≥ 1 million gallons per day |
| Green Valley Special Utility District (SUD) | 15917-001 | ≤ 1 million gallons per day |
| City of Marion | 10048-001 | ≤ 1 million gallons per day |
| Green Valley Special Utility District (SUD) | 15360-001 | ≤ 1 million gallons per day |
| City of La Vernia | 11258-001 | ≤ 1 million gallons per day |
| South Central Water Co. | 14672-001 | ≤ 1 million gallons per day |

| Permittee Name | Permit Number | Discharge |
|---|---|---|
| City of Stockdale | 10292-001 | ≤ 1 million gallons per day |

Twelve sample sites are monitored in the Lower Cibolo Creek Watershed. The TCEQ monitors one station (12803) south of the City of Stockdale and the SARA monitors the rest of the stations.

*Table 3-17: Stations currently monitored by the CRP in the watershed.*

| Location Description | AU | ID |
|---|---|---|
| Cibolo Creek At FM 81 East of Panna Maria | 1902 | 12797 |
| Cibolo Creek At Fm 541 West of Kosciusko | 1902 | 12802 |
| Cibolo Creek 28 Meters Downstream from Fm 537 On West Bank 4 Mi West of SH 123 South of Stockdale | 1902 | 12803 |
| Cibolo Creek At FM 539 | 1902 | 12805 |
| Cibolo Creek at Scull Crossing | 1902 | 14197 |
| Cibolo Creek at Scull Crossing | 1902 | 14197 |
| Cibolo Creek at Cr389 Near Cestohowa Texas | 1902 | 14211 |
| Martinez Creek on North Gable Road South of Zuehl | 1902A | 12741 |
| Salitrillo Creek at Autumn Run | 1902B | 14202 |
| San Antonio River Authority's Salitrillo WWTP 249 Meters DWSTRN from Schaefer Rd | 1902B | 14923 |

| Location Description | AU | ID |
|---|---|---|
| Clifton Branch at Old Floresville Road/Wilson County Road 401 2.7 Kilometers West of Stockdale | 1902C | 20776 |
| Santa Clara Creek on Cr 315 Santa Clara Rd Northwest of New Berlin 2.19 Km Upstream of the Confluence with Cibolo Creek | No AU Assigned | 12784 |

The US Geological Survey (USGS) currently has three real-time monitoring sites in the Lower Cibolo Creek Watershed. The USGS steam gages are maintained and operated by the USGS but rely on funding provided by state, regional and local agencies or organizations that sponsor the gage stations.

*Table 3-18: US Geological Survey continuous monitoring stations.*

| Location | ID | Real Time Available Parameters | Additional Sponsors |
|---|---|---|---|
| Cibolo Ck at Sutherland Springs, TX | 08185500 | Discharge, Gage Height, Precipitation | San Antonio River Authority |
| Cibolo Ck nr Falls City, TX | 08186000 | Discharge, Gage Height, Precipitation | San Antonio River Authority |
| Martinez Ck nr Saint Hedwig, TX | 08185100 | Discharge, Gage Height, Precipitation | San Antonio River Authority |

**Texas Integrated Report on Surface Water quality for the Clean Water Act:**

The TCEQ's 2022 Integrated Report (2022 IR) identified ten assessment units (AU) with either impairments and/or concerns for Cibolo Creek and its tributaries. An AU often consists of a single representative station used to characterize standards attainment. The data from multiple stations in a single AU can be used in the assessment. The 2022 IR results, including the 303(d) List of Impaired Waters, are reported at the AU level for each water body.

*Table3-19: Impairments and concerns identified in the TCEQ 2022 Integrated Report*

| Segment | AU Description | AU ID | Station ID | Impairments | Concerns |
|---|---|---|---|---|---|
| Lower Cibolo Creek | From the confluence with the Lower San Antonio River in Karnes County upstream to the confluence with Mulifest Creek | 1902_01 | 12797<br>20777 | *E. coli* | Nitrate Nitrogen |
| | From the confluence with Mulifest Creek upstream to the confluence with Pulaski Creek | 1902_02 | 23900<br>14211 | *E. coli* | Impaired macrobenthic community |
| | From the confluence with Pulaski Creek upstream to the confluence with Clifton Branch | 1902_03 | 12801<br>12802<br>12803<br>21755 | *E. coli* | Impaired Habitat<br>Nitrate Nitrogen |
| | From the confluence with Clifton Branch upstream to the confluence with Elm Creek | 1902_04 | 12804<br>12805<br>12806 | *E. coli* | Nitrate Nitrogen<br>Total Phosphorus |
| | From the confluence with Elm Creek upstream to a point 100 meters (110 yards) downstream of IH 10 in Bexar/Guadalupe County | 1902_05 | 14197 | *E. coli* | Nitrate Nitrogen<br>Total Phosphorus |
| Martinez Creek | From the confluence with Lower Cibolo Creek upstream to the confluence with Salitrillo Creek | 1902A_01 | 12741 | *E. coli* | Total Phosphorus |
| | From the confluence with Salitrillo Creek upstream to the confluence with Escondido Creek | 1902A_02 | No Station | Not Assessed | Not Assessed |

| Segment | AU Description | AU ID | Station ID | Impairments | Concerns |
|---|---|---|---|---|---|
| | From the confluence with Escondido Creek upstream to the Martinez II WWTP outfall approximately 1.1 km downstream of FM 1516 | 1902A_03 | No Station | None | *E. coli*<br>Nitrate Nitrogen<br>Total Phosphorus |
| | From the Martinez II WWTP outfall approximately 1.1 km downstream of FM 1516 upstream to Binz-Engleman Road | 1902A_04 | No Station | None | *E. coli*<br>Nitrate Nitrogen<br>Total Phosphorus |
| | From Binz-Engleman Road upstream to the headwaters near the intersection of O'Connor Road and New World Drive | 1902A_05 | No Station | Not Assessed | Not Assessed |
| Salitrillo Creek | From the confluence with Martinez Creek to FM 78 in Converse | 1902B_01 | 14202 | *E. coli* | Nitrate Nitrogen<br>Total Phosphorus |
| Clifton Branch | From the confluence of Lower Cibolo Creek upstream to the headwater 0.6 mi upstream of Wilson CR 424 north of Stockdale | 1902C_01 | 20775<br>20776 | *E. coli*<br>Depressed Dissolved Oxygen (min) | Ammonia Nitrogen<br>Total Phosphorus<br>Depressed Dissolved Oxygen (avg) |

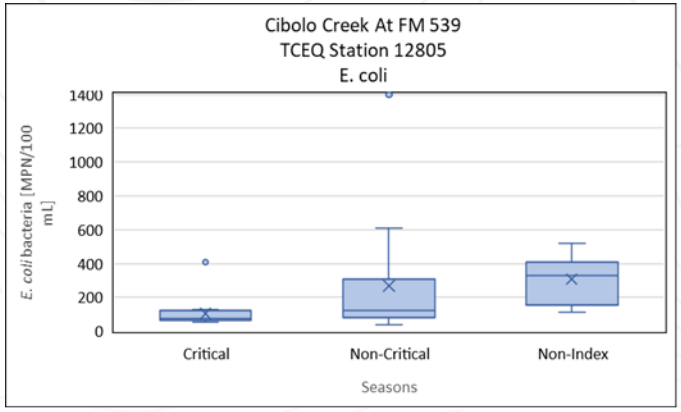
**Lower Cibolo Creek Watershed Routine Data Analysis:**

Only datasets with at least 10 years of data and no significant data gaps were used in the analysis.

Some of the parameters showed seasonality, their levels generally fluctuate predictively according to the seasons. For this report, the seasons were defined as: critical period (July 1st – September 30th), non-critical period (March 15th – June 30th plus October 1st – October 15th), and the non-index period (October 16th – March 14th).

Cibolo Creek:

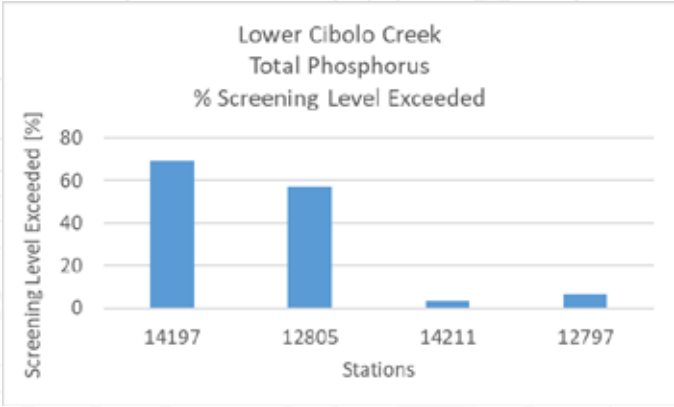
*E. coli* geometric means ranged from 135.15 to 226.97 MPN per 100 mL. None of the geometric mean values meet (greater than) the TCEQ standard. *E. coli* bacteria was identified as having seasonality at three out of the four sites. The values were lower during the critical period. This may be due to longer sunny days that provide natural UV radiation or due to low flows. None of the stations showed significant trends in *E. coli* over time. Three of the four stations showed significant increasing trends as flow increased. This is due to *E. coli* having a strong relationship with stormwater runoff. Typically, during a rainfall runoff event, *E. coli* levels in the creek increase exponentially.




*Graph showing seasonality for E. coli bacteria. Lowest values were during the critical period.*

Nitrate nitrogen levels exceeded the screening levels from 18.33 to 68.96 percent of the time. The higher values were in the upstream portion of Lower Cibolo Creek. Nitrate nitrogen and nitrite plus nitrate levels were lowest in the critical period. Plant and algae growth and reproduction are stimulated by sunlight and nutrients. With additional biomass during the critical period, nutrient uptake is greater. Three of the stations showed an increasing trend over time for nitrate nitrogen. The most downstream site showed an increasing trend as flow increased. This indicates that the source of the nitrate nitrogen is likely non-point source pollution due to stormwater runoff transporting nutrients to the creek.

Total phosphorus levels exceeded the screening levels from 3.33 to 69.49 percent of the time. The higher values were in the upstream portion of Lower Cibolo Creek. None of the stations showed significant seasonality. Three out of four sites showed an increasing trend over time for total phosphorus. None of the stations showed any trends associated with flow.




*Percent total phosphorus screening level was exceeded going from upstream (left) to downstream (right)*

Salitrillo Creek:

The 2022 IR indicated an impairment for *E. coli* bacteria. Concerns were identified for nitrate nitrogen and total phosphorus.

One station was examined for Salitrillo Creek. This station had an *E. coli* bacteria geometric mean of 249.53 MPN per 100 mL. This value exceeds the TCEQ standard for *E. coli* bacteria. Average *E. coli* bacteria values were lowest during the critical period. This may be due to longer sunny days that provide natural UV radiation. There was no significant trend over time. There was a significant increasing trend for *E. coli* bacteria as flow increased. This is due to *E. coli* having a strong relationship with stormwater runoff. Typically, during a rainfall runoff event, *E. coli* levels in the creek increase exponentially.

Nitrate nitrogen values exceeded the screening level 54.38% of the time. There was no significant seasonality associated with nitrate nitrogen, and no trend associated with flow. There was a decreasing trend over time for nitrate nitrogen.

Total phosphorus levels exceeded the TCEQ standard 100 % of the time. There were no seasonality or trends associated with total phosphorus.

The sample site at Salitrillo Creek and Autumn Run is approximately 1 mile downstream of the San Antonio River Authority's Salitrillo Wastewater Treatment Plant (WWTP). A review of nutrient levels collected from the Salitrillo WWTP discharge point indicate elevated levels of nutrients. However, the TCEQ has not developed nutrient standards for streams. The TCEQ screening level for ammonia nitrogen is 0.33 mg/L, but the wastewater treatment plant permit limit is 2 mg/L. There are no wastewater treatment plant limits for nitrate nitrogen and total phosphorus in this watershed. The elevated nutrient levels are due to the wastewater treatment plant discharge, but the *E. coli* levels are not from the wastewater treatment plant. Over the same period of record, sampling from the discharge point had a geometric mean of 12 MPN per 100 mL, while at the Autumn Run sample site the geometric mean is 249.53 MPN per 100 mL. This area is surrounded by subdivisions and likely causes for the elevated *E. coli* levels are wildlife and pet waste.

Martinez Creek:

Like Salitrillo Creek that feeds into Martinez Creek, Martinez Creek is dominated by wastewater discharges. The 2022 IR indicated an impairment for *E. coli* bacteria. Concerns were identified for nitrate nitrogen, total phosphorus, and *E. coli* bacteria. One station had sufficient data for analysis on Martinez Creek (12741).

Station 12741 had an *E. coli* bacteria geometric mean of 463.13 MPN per 100 mL. This value exceeds the TCEQ standard for *E. coli* bacteria. There was no significant seasonality or trend over time. There was a significant increasing trend for *E. coli* bacteria as flow increased.

While nitrate nitrogen is a concern on two AUs on Martinez Creek, they were not a concern for the AU (1902A_01) associated with this location. Only 15.25% of nitrate nitrogen exceeded the TCEQ screening level. Nitrate nitrogen also showed a decreasing trend as flow increased, indicating that the source is likely due to point source pollution and not the result of stormwater runoff.

The total phosphorus sample exceeded the TCEQ screening level 91.67% of the time. This is due to Martinez Creek being dominated by wastewater effluent. There were no significant trends associated with total phosphorus at this site. There was significant seasonality, with the average total phosphorus at its highest level during the critical period.

Clifton Branch:

The 2022 IR indicated impairments for *E. coli* bacteria and dissolved oxygen (minimum criteria). Concerns were identified for ammonia nitrogen and dissolved oxygen (average screening level). One station had sufficient data for analysis on Clifton Branch (20776).

Station 20776 had an *E. coli* bacteria geometric mean of 184.13 MPN per 100 mL. This value exceeds the TCEQ standard for *E. coli* bacteria. There was no significant seasonality or trend associated with flow. There was a significant increasing trend for *E. coli* bacteria over time at this site.

The TCEQ has both a minimum dissolved oxygen criteria and an average dissolved oxygen screening level. For the minimum dissolved oxygen criteria, thirteen values out of 59 values (22.03%) were below the minimum criteria at this site. Nineteen values out of 59 values (32.20%) were below the screening level at this site.

42.85% of the values at this site did not meet (greater than) the ammonia nitrogen screening level. There was no seasonality or trends associated with ammonia nitrogen at this site.

55.93% of the values at this site did not meet (greater than) the total phosphorus screening level.

A wastewater treatment plant discharges into an unnamed tributary of Clifton Branch upstream of sample site 20776. SARA has monitored a site upstream of the unnamed tributary Clifton Branch at SH97 (20775) in the past. Dissolved oxygen levels at the upstream site are very low with 89.4% of the dissolved oxygen levels below the TCEQ's minimum dissolved oxygen level standard, and 73.7% of the dissolved oxygen levels below the TCEQ average screening level. Nutrients (ammonia nitrogen, nitrate nitrogen, and total phosphorus), are also very low at this upstream site. *E. coli* levels are higher at this upstream site. The area around Clifton Branch is predominantly rural. The cause of the low dissolved oxygen levels on Clifton Branch is suspected to be naturally occurring due to extremely low flows and are not related to the wastewater treatment plant.

*E. coli* levels are higher at the upstream site, so the *E. coli* levels at station 20776 are likely not due to wastewater treatment plant. The nutrient levels are lower at the upstream site, so the nutrient concern may be due to the wastewater discharge or some unknown source downstream from station 20775.

**Evaluation of Habitat, Nekton (fish) and Benthic Macroinvertebrate Communities:**

*Lower Cibolo Creek approximately 2.25 km upstream of FM 537 southwest of Stockdale during a habitat survey on May 28, 2019.*

Habitat assessments are done during biological sampling events to holistically evaluate the health of a water body. Habitat quality can tell us how aquatic communities can be supported. The Habitat Quality Index (HQI) is a quantitative measurement used to assess aquatic habitat quality, as described in the Surface Water Quality Monitoring (SWQM) Procedures Manual. This is done by quantitatively and qualitatively assessing various features of the stream reach, including available instream cover, number of riffles, and the structure of riparian vegetation, among other things. These features have an intrinsic value for characteristics like bank stability, buffering capacity, and refugia for aquatic organisms. Based on the metrics measured, habitat quality is scored and then categorized as either limited, intermediate, high, or exceptional.

Assessment of habitat in the Lower Cibolo Creek Watershed from 2019-2022 included TCEQ stations 12802 Cibolo Creek at FM 541 West of Kosciusko, 14197 Cibolo Creek at Sculls Crossing, and 21755 Cibolo Creek approximately 2.25 km upstream of FM 537 southwest of Stockdale. According to San Antonio River Authority (River Authority) data, current habitat in the Lower Cibolo Creek Watershed is described

*Table 3-20: Stations assessed for either biological surveys or 24 hour dissolved oxygen in the Lower Cibolo Creek Watershed.*

| Station Number | Station Name |
|---|---|
| 12802 | Cibolo Creek at FM 541 West of Kosciusko |
| 14197 | Cibolo Creek at Scull Crossing |
| 21755 | Cibolo Creek approximately 2.25 kilometers upstream of FM 537 southwest of Stockdale |
| 20776 | Clifton Branch at Old Floresville Road/Wilson County Road 401 2.7 km west of Stockdale |
| 20775 | Clifton Branch at SH 97/US 87 1.9 km northwest of Stockdale |
| 12741 | Martinez Creek on North Gable Road south of Zuehl |

as high quality according to the HQI. Lower Cibolo Creek, at these stations, is characterized by features of varying qualities, including moderate in stream cover, bottom substrate stability, pool sizes, flow stability, and riparian buffer corridors. Lower quality features include bank stability and channel sinuosity.

*Table 3-21: Species caught in the Lower Cibolo Creek Watershed and their native/non-native status and tolerances. Relative abundance for each species out of total individuals caught for the historical period assessed (2015-2018) and the current data period (2019-2022).*

| Common Name | Status | Tolerance | Relative Abundance Historical (2015-2018) | Relative Abundance Current (2019-2022) |
|---|---|---|---|---|
| Red Shiner | Native | Tolerant | 44.38% | 37.61% |
| Mimic Shiner | Native | Intolerant | 13.93% | 17.06% |
| Longear Sunfish | Native | Intermediate | 13.93% | 12.05% |
| Bullhead Minnow | Native | Intermediate | 3.19% | 4.98% |
| Western Mosquitofish | Native | Tolerant | 8.18% | 4.76% |
| Spotted Bass | Native | Intermediate | 1.65% | 4.02% |
| Green Sunfish | Native | Tolerant | 1.46% | 2.92% |
| Rio Grande Cichlid | Native | Intermediate | 1.54% | 2.70% |
| Grey Redhorse | Native | Intermediate | 1.80% | 2.23% |
| Texas Logperch | Native | Intolerant | 0.77% | 2.04% |
| Central Stoneroller | Native | Intermediate | 0.04% | 1.68% |
| Bluegill | Native | Tolerant | 1.15% | 1.43% |
| Channel Catfish | Native | Tolerant | 1.84% | 1.43% |
| Ghost Shiner | Native | Intermediate | 0.00% | 1.07% |
| Flathead Catfish | Native | Intermediate | 0.38% | 0.99% |
| Largemouth Bass | Native | Intermediate | 0.15% | 0.88% |
| Sailfin Molly | Native | Tolerant | 1.92% | 0.58% |
| Spotted Gar | Native | Tolerant | 0.15% | 0.36% |
| River Darter | Native | Intermediate | 1.00% | 0.36% |
| Warmouth | Native | Tolerant | 0.12% | 0.17% |
| American Eel | Native | Intermediate | 0.00% | 0.14% |
| Redbreast Sunfish | Non-native | Intermediate | 0.08% | 0.14% |
| Blackstripe Topminnow | Native | Intermediate | 0.00% | 0.11% |
| Guadalupe Bass | Native | Intolerant | 0.00% | 0.11% |
| Sand Shiner | Native | Intermediate | 1.84% | 0.06% |
| Mexican Tetra | Native | Intermediate | 0.00% | 0.03% |
| Redear Sunfish | Native | Intermediate | 0.00% | 0.03% |
| Red Spotted Sunfish | Native | Intermediate | 0.00% | 0.03% |
| Gizzard Shad | Native | Tolerant | 0.12% | 0.03% |
| Tadpole Madtom | Native | Intolerant | 0.12% | 0.03% |
| Yellow Bullhead | Native | Intermediate | 0.15% | 0.03% |
| Common Carp | Non-native | Tolerant | 0.04% | 0.00% |
| Smallmouth Buffalo | Native | Intermediate | 0.04% | 0.00% |
| Orangespotted Sunfish | Native | Intermediate | 0.04% | 0.00% |

Higher scores in these metrics indicate better instream and riparian habitat for aquatic organisms to inhabit, increasing species diversity and ecological integrity.

The average width of the riparian buffer across the three sites is about eighteen meters wide and is dominated mainly by trees and grasses. The percent tree canopy coverage across the three sites is about 78%, providing ample shading to the creek. Developed canopy and understory are present, however, and established midstory is lacking. A more developed mid-story would allow for higher species abundance and diversity, leading to higher ecological function in the riparian zone. Station 14197 trends with the highest quality habitat of the three sites, with stable bottom substrate and large pool habitats setting it ahead of the other two sites.

Segment 1902_03 of the Lower Cibolo Creek, assessed at station 12802, is considered to have impaired habitat in water, likely due to poor instream cover and bank stability, small pools, and low channel sinuosity. However, habitat elsewhere in the watershed is not of concern and fish community quality is still considered to be high.

Index of Biotic Integrity (IBI) is a measure of ecosystem health that uses a variety of metrics taken from survey data to estimate fish community health. These metrics include species composition, trophic composition, and percent intolerance. Based on current data (2019-2022), scores ranged from 40 (intermediate) at station 12802 to 45 (high) at station 14197.

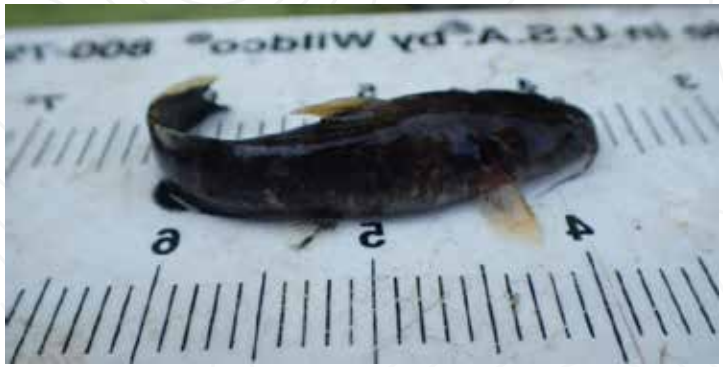
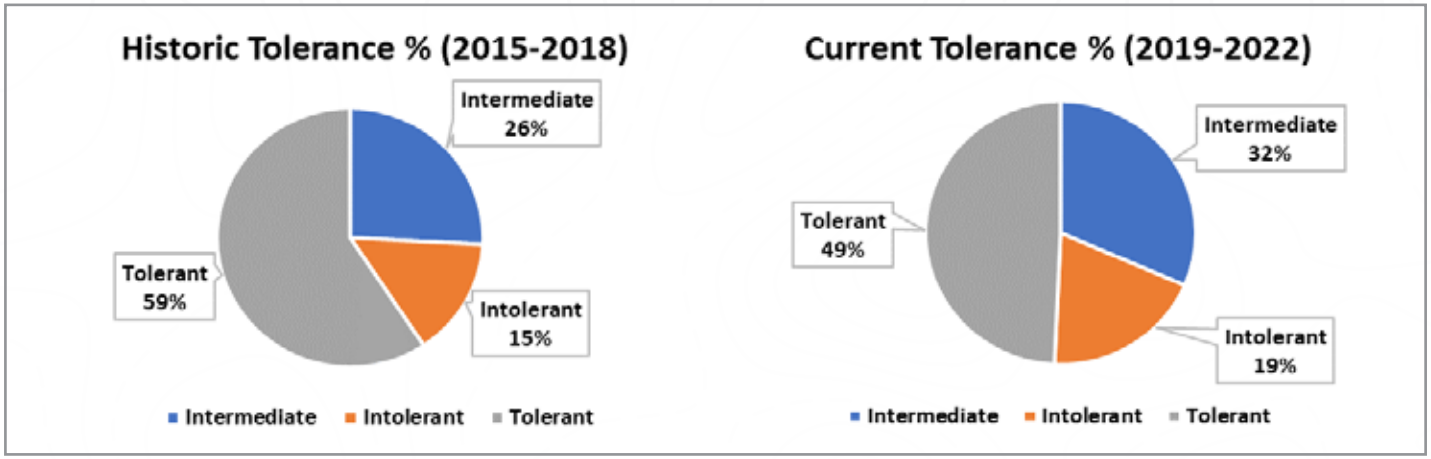


*Photo voucher of a Flathead catfish (Pylodictis olivaris) caught at TCEQ station 14197 on August 2, 2022*

Overall, the average score for the Lower Cibolo Creek Watershed is a 42 (high), indicating that the biotic integrity of the watershed is of high quality.




*Distribution of tolerance values across all fish species caught in the Lower Cibolo Creek Watershed in both the historic (2015-2018) and current (2019-2022) data periods.*

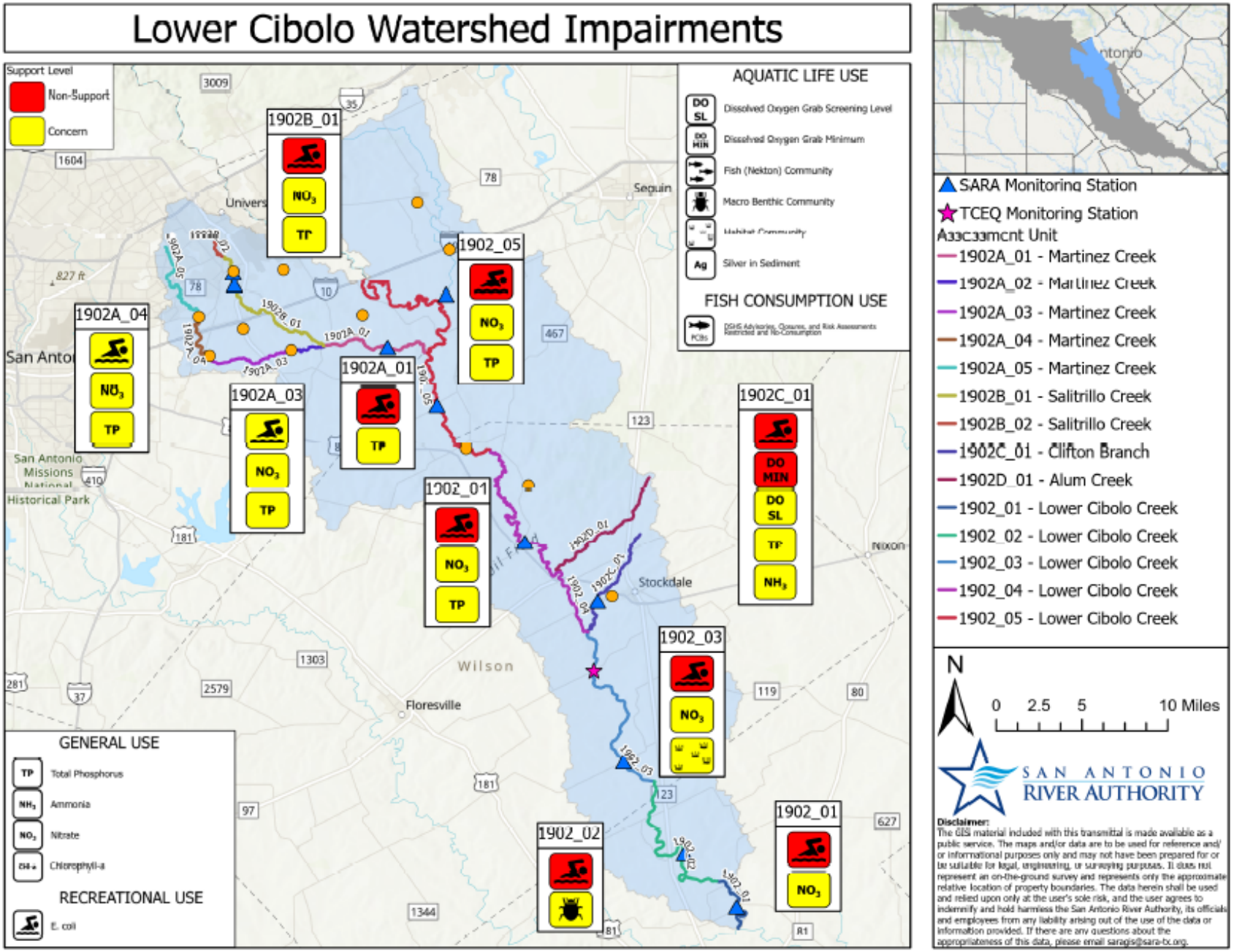
On average, both stations showed a 20% increase in overall IBI when comparing current (2019-2022) and historic (2015-2018) data. In recent years, there has been an elevated abundance of sensitive fish species. For example, relative abundance increased for Mimic Shiner, 14% to 17%, and Texas Logperch, 0.8% to 2% (Table 3-21). However, mixed results were observed regarding the two non-native fish species found, as Redbreast Sunfish increased in relative abundance, 0.08% to 0.14%, and Common Carp decrease in relative abundance, 0.04% to 0.00% (Table 3-21). The data also revealed that there was a general increase in the abundance of intolerant and intermediate fish species such as the Guadalupe Bass, Texas Logperch, Grey Redhorse, and Flathead Catfish over tolerant species like Red Shiner, Western Mosquitofish, and Gizzard Shad. This change in species assemblage highlights an increasingly diverse and ecologically resilient fish community within Lower Cibolo Creek.

Benthic macroinvertebrates are excellent biological indicators of water quality as they are the first organisms to respond to changes in water chemistry and habitat alterations. The River Authority has conducted efforts to collect them at TCEQ Station 14211 Cibolo Creek at CR 389. These data can be combined with the habitat and fish collection data to best understand stream health. The Benthic Index of Biotic Integrity (BIBI) is a quantitative measurement to assess macroinvertebrate assemblages and stream health, as described in SWQM Procedures. Data from 2021-2022 reveals that the average score of this station is 31 (high). In addition, the Hilsenhoff Biotic Index (HBI), a quantitative score based on the abundance of tolerant taxa, for the benthic community of the Lower Cibolo Creek watershed, was 5 out of a scale of 0-10. A score of 5 indicates a moderate number of tolerant taxa within those sampled in the watershed.

The 2022 Texas Surface Water Quality Standards (TSWQS) lists a 24-hour dissolved oxygen criteria of 5.0 mg/L average and a 3.0 mg/L minimum the Lower Cibolo Creek. Dissolved oxygen levels can decrease to dangerous levels for a myriad of reasons. Oxygen levels below the demand of the aquatic organisms in the stream will cause high levels of stress and mortality.

In the last several years, 24-hour dissolved oxygen readings have been taken at six different sites including 20776, 20775, 12741, 12802, 14197 and 21755. Dissolved oxygen levels at the six stations averaged at 5.3 mg/L overall, ranging from 0.0 mg/L at station 20776 to 11.5 mg/L at station 12802. For the last several years, both Clifton Branch stations (20775 and 20776) have not met either the minimum or average criteria for dissolved oxygen levels and are considered to have depressed dissolved oxygen levels. Basin-wide, average dissolved oxygen levels meet the TSWQS.

# Lower Cibolo Watershed Impairments






SARA Monitoring Station

TCEQ Monitoring Station

Assessment Unit

- 1902A_01 - Martinez Creek
- 1902A_02 - Martinez Creek
- 1902A_03 - Martinez Creek
- 1902A_04 - Martinez Creek
- 1902A_05 - Martinez Creek
- 1902B_01 - Salitrillo Creek
- 1902B_02 - Salitrillo Creek
- 1902C_01 - Clifton Branch
- 1902D_01 - Alum Creek
- 1902_01 - Lower Cibolo Creek
- 1902_02 - Lower Cibolo Creek
- 1902_03 - Lower Cibolo Creek
- 1902_04 - Lower Cibolo Creek
- 1902_05 - Lower Cibolo Creek

N

0 2.5 5 10 Miles

SAN ANTONIO RIVER AUTHORITY

**Disclaimer:**
The GIS material included with this transmittal is made available as a public service. The maps and/or data are to be used for reference and/or informational purposes only and may not have been prepared for or be suitable for legal, engineering, or surveying purposes. It does not represent an on-the-ground survey and represents only the approximate relative location of property boundaries. The data herein shall be used and relied upon only at the user's sole risk, and the user agrees to indemnify and hold harmless the San Antonio River Authority, its officials and employees from any liability arising out of the use of the data or information provided. If there are any questions about the appropriateness of this data, please email saragis@sara-tx.org.

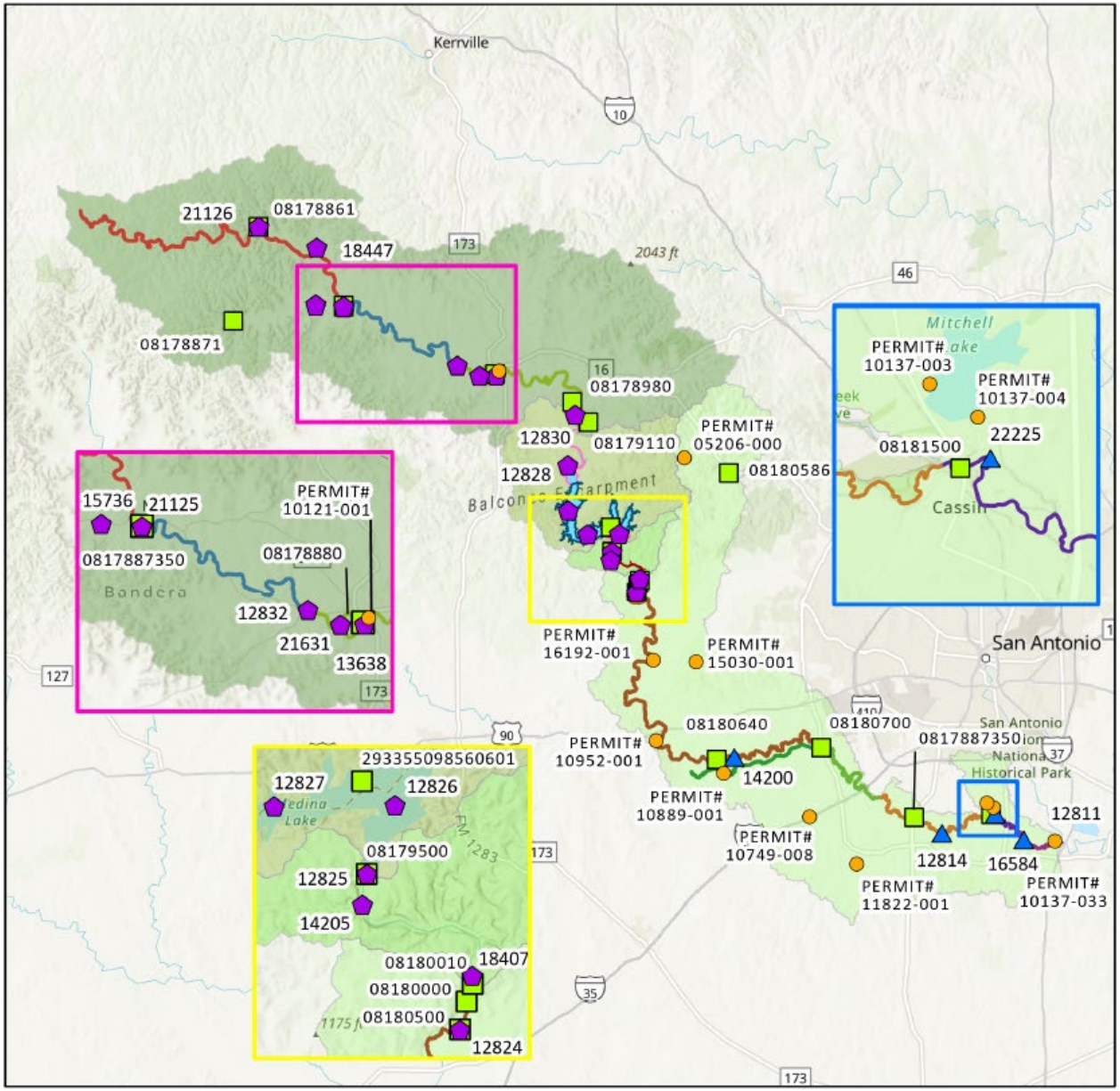
*Table 3-22: Summary of Issues:*

| Water Quality Issue | Affected Area | Possible Influences | Possible Effects | Possible Solutions / Actions Taken |
|---|---|---|---|---|
| Fecal Contamination (*E. coli* Bacteria Impairment).<br><br>Identified on 2022 Integrated Report | • Upper Cibolo<br>• Lower Cibolo<br>• Martinez Creek<br>• Salitrillo Creek<br>• Clifton Branch | • Rapid urbanization, impervious cover<br>• Construction stormwater controls failing<br>• Developments with septic tanks or small, privately-run wastewater treatment plants<br>• Small, slow-moving stream with little assimilative capacity<br>• Illegal dumping at creek crossings | • Increased quantity of stormwater scouring stream beds, creating additional sediment loading and urban-related pollutants<br>• Bacteria load from land use and effluent is not reduced by instream flow<br>• Significant primary contact recreation 1 (e.g., swimming) could lead to gastrointestinal illnesses | • Improve stormwater controls in new developments<br>• Adequate construction oversight<br>• Wastewater regionalization to prevent multiple small package plants and reduce septic tanks<br>• Discourage feeding of wildlife in and around creeks. |
| Depressed Dissolved Oxygen<br><br>Identified on 2022 Integrated Report | • Clifton Branch | • Low flows<br>• Organic matter and nutrients transported to the creek due to stormwater runoff | • Low dissolved oxygen levels in the creek can cause stress and death to aquatic organisms | • Encourage best management practices to reduce transportation of pollutants, especially nutrients and organic matter, to the river |

| Water Quality Issue | Affected Area | Possible Influences | Possible Effects | Possible Solutions / Actions Taken |
|---|---|---|---|---|
| Nutrient enrichment (nitrate nitrogen, phosphorus, ammonia nitrogen)<br><br>Identified on 2022 Integrated Report | • Upper Cibolo Creek<br>• Mid Cibolo Creek<br>• Lower Cibolo Creek<br>• Martinez Creek<br>• Salitrillo Creek<br>• Clifton Branch | • Wastewater treatment plant effluent<br>• Row-crop agriculture<br>• Urban landscaping and maintenance | • Nutrients are necessary for algae, plants, and aquatic communities. Excessive nutrients can cause algae blooms which can cause significant swings in dissolved oxygen, causing stress and even death of aquatic communities<br>• Excessive nutrients can cause algae and cyanobacteria (blue -green algae) blooms that can release toxins into the water<br>• Excessive nutrients can cause algae blooms causing an aesthetic nuisance | • If dissolved oxygen swings are significant and biology shows a related effect, then some nutrient controls may be needed for wastewater treatment plants |

| Water Quality Issue | Affected Area | Possible Influences | Possible Effects | Possible Solutions / Actions Taken |
|---|---|---|---|---|
| Macrobenthic Communities<br><br>Identified on 2022 Integrated Report | • Lower Cibolo Creek | • Urbanization in the upper portion of Lower Cibolo Creek has contributed to the flashiness of the creek which disturbs instream habitat<br>• Wastewater discharges and stormwater runoff contributes to sporadic water quality issues | • Diminished fisheries and biological communities | • Improve instream habitat<br>• Improve riparian zone and implement stormwater BMPs to reduce flashiness of the creek<br>• Continue promoting stormwater BMPs<br>• Continue monitoring |
| Habitat<br><br>Identified on 2022 Integrated Report | • Lower Cibolo Creek | • Rapid stormwater runoff from upstream cause bank erosion and incision<br>• Reduction of riparian buffer zones | • Diminished biological communities<br>• Erosion | • Stream restoration<br>• Public outreach of the importance of maintaining a riparian zone<br>• Reduce urban runoff.<br>• Continue to monitor |

# Medina River Watershed





- USGS Stations
- Wastewater Outfalls
- BCGDRA Monitoring Station
- SARA Monitoring Station

**Assessment Unit**

- 1903A_01 - Polecat Creek
- 1903_01 - Medina River Below Medina Diversion Lake
- 1903_02 - Medina River Below Medina Diversion Lake
- 1903_03 - Medina River Below Medina Diversion Lake
- 1903_04 - Medina River Below Medina Diversion Lake
- 1903_05 - Medina River Below Medina Diversion Lake
- 1905A_01 - North Prong Medina River
- 1905_01 - Medina River Above Medina Lake
- 1905_02 - Medina River Above Medina Lake
- 1904_01 - Medina Lake
- 1904_02 - Medina Lake
- 1904_03 - Medina Lake
- 1909_01 - Medina Diversion Lake

N

0 3.5 7 14 Miles

SAN ANTONIO RIVER AUTHORITY

## Medina River Watershed Summary

Medina River is broken up into four segments by the Texas Commission on Environmental Quality (TCEQ):

- Medina River Above Medina Lake: Segment 1905
- Medina Lake: Segment 1904
- Medina Diversion Lake: Segment 1909
- Medina River Below Medina Diversion Lake: Segment 1903

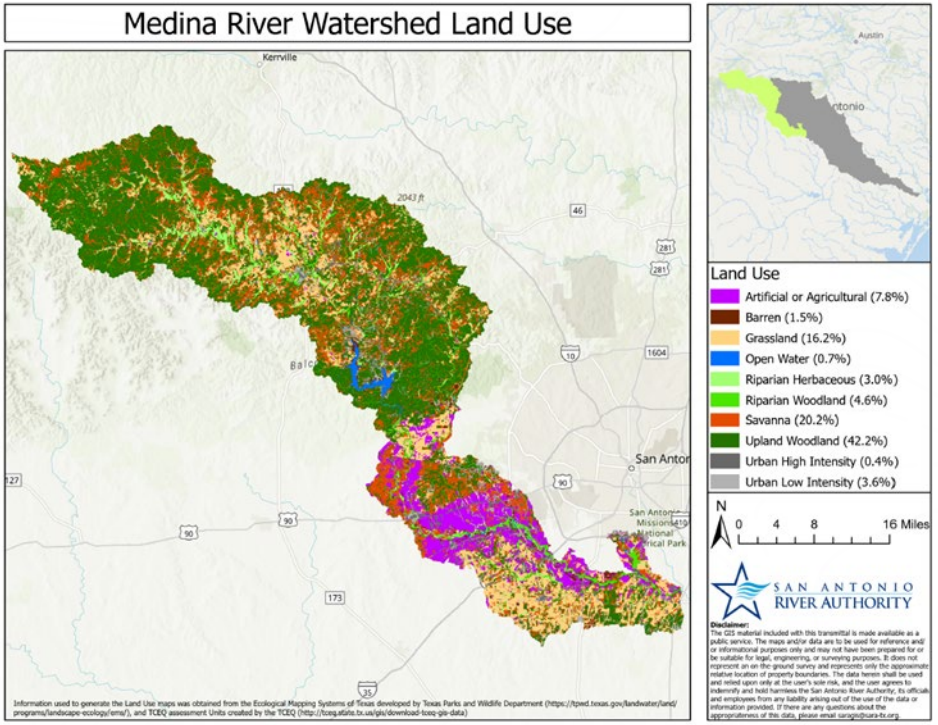
The origin of the Medina River above Medina Lake exists at the confluence of North Prong Medina River and West Prong Medina River, approximately 550 meters southwest of the intersection between State Highway 16 and FM 337 in Medina, Texas in Bandera County. The Medina River above Medina Lake generally flows towards the southeast for about 34 miles until it flows into Medina Lake. Medina Lake marks a portion of the boundary between Bandera and Medina Counties. The drainage area is approximately 534 square miles, which accounts for approximately 12.8% of the entire San Antonio River Basin. The Medina River begins narrower relative to downstream, fed from the North and West Prong Medina Rivers in the headwaters from the surrounding steep hills. Flow is intermittent especially during periods of long drought.

Medina Lake originates at the confluence of Medina River and Red Bluff Creek approximately 1.7 kilometers downstream of English Crossing Road in Medina County, Bandera Falls, Texas. Medina Lake is approximately 22.6 square kilometers and generally flows southward about until it discharges from the impoundment at Medina Dam and transitions into Medina River approximately 1.6 kilometers upstream of County Road 2615 in Medina County. The drainage area is approximately 99 square miles, which accounts for approximately 2.4% of the entire San Antonio River Basin. Medina Dam was constructed in 1912 and was originally constructed to irrigate farmland and has since become a local recreational area for area residents.

Segment 1909, Medina Diversion Lake, extends from Medina Diversion Dam upstream to Medina Lake Dam. The drainage area is approximately 15 square miles, which accounts for approximately 0.4% of the entire San Antonio River Basin. Impounded water in this stretch is primarily used for domestic and commercial irrigation needs. Land use in the 15 square mile catchment is made up primarily by forested land and population densities are relatively low. However, this area is majority private land with numerous lakefront properties lining the banks of the segment.

The headwaters of the Medina River below the Medina Diversion Lake begin at the southern end of the Diversion Lake, approximately 1.5 kilometers upstream of the Medina River's intersection with County Road 2615 in Medina, Texas in

Medina County. The Medina River Below Medina Diversion Lake flows southeastward about 78 miles until its confluence with the San Antonio River approximately 1.2 kilometers downstream of the San Antonio Water System's Steven M. Clouse Water Recycling Center discharge into the Medina River. The drainage area is approximately 410 square miles, which accounts for approximately 9.9% of the entire San Antonio River Basin. Flow is intermittent in the upper reaches during periods of heavy drought, but the discharges from the San Antonio Water System helps to otherwise maintain flows. Major tributaries to the Lower Medina River include Leon Creek, Geronimo Creek, and Medio Creek. Other contributors to the Medina River include effluent discharge from Steven M. Clouse Water Recycling Center and Medio Creek Recycling Center. The upper reach of this segment is characterized by exceptional water clarity, moderate to swift velocity, with gravel and limestone substrates. The banks are high and steep in some areas and this portion of the river has an array of well-defined, alternating riffle, run, glide, pool habitats. The lower reaches of this segment are characteristically deeper and more turbid due to the influence of the alluvial formations of the Gulf Coastal Plains. Habitat within this part of the river alternates between more runs and glides.




Medina River above Medina Lake lies entirely in the Edwards Plateau and is mainly rural. The banks of the Medina River above Medina Lake vary from gently sloping to steep limestone formations. The soil and rock composition of the area includes shallow clay soils with zero to two inches of material before either lithic bedrock or karst/limestone features. Steep hills surround the Medina River above Medina Lake, with increases in elevation of anywhere from 300 to 1,000 feet.

As the area surrounding the Medina River above Medina Lake is largely rural, most of the land is classified as upland woodland, with grassland bordering the riparian buffers around the river. The upland woodland habitat in this area of the Edwards Plateau region includes mixed forests with a variety of oak species (*Quercus* spp.), Ashe juniper (*Juniperus*

*asheii*), and cedar elm (*Ulmus crassifolia*) dominating the canopies and Texas persimmon (*Diospyros texana*) and mountain laurel (*Sophora secundiflora*) mixed in the mid-story. The riparian zone around the Medina River above Medina Lake are mainly riparian woodlands which include many large cypress trees (*Taxodium distichum*), willow (*Salix nigra*), and pecan (*Carya illinoinensis*). There is a small amount of urban low- and high intensity land cover inside the City of Bandera, and inside Lake Medina Shores, Texas, directly west of the transition between the Medina River and Medina Lake. Urban low intensity is defined by human-derived impacts, typically involving high impervious cover such as buildings and other man-made structures. Urban high intensity is characterized by areas that are dominated by high impervious cover due to high levels of development and transportation corridors.

Medina Lake lies entirely in the Edwards Plateau and is mainly rural. The banks Medina Lake vary from gently sloping to steep limestone formations. The soil and rock composition of the area includes shallow clay soils with zero to two inches of material before either lithic bedrock or karst/limestone features. Steep hills surround Medina Lake, with increases in elevation of anywhere from approximately 850 to 1,600 feet.

As the area surrounding the Medina Lake and the diversion lake is largely rural, most of the land is classified as upland woodland with a mixture of savanna and grasslands. The upland woodland habitat in this area of the Edwards Plateau region includes mixed forests with a variety of oak species (*Quercus* spp.), Ashe juniper (*Juniperus asheii*), and cedar elm (*Ulmus crassifolia*) dominating the canopies and Texas persimmon (*Diospyros texana*) and mountain laurel (*Sophora secundiflora*) mixed in the mid-story. The riparian zone around Medina Lake are mainly riparian woodlands which include cypress trees (*Taxodium distichum*), willow (*Salix nigra*), and pecan (*Carya illinoinensis*). There is a small amount of urban low intensity land use along the shores of Medina Lake, typically resulting from residential development. Urban low intensity is defined by human-derived impacts, typically involving high impervious cover such as buildings and other man-made structures. Urban high intensity is characterized by areas that are dominated by high impervious cover due to high levels of development and transportation corridors.

The upper reaches of the Medina River below Medina Diversion have a great variety of land uses and land cover types. The upper portion east and southeast of the Medina Diversion Lake is predominantly deciduous forests with pockets of herbaceous vegetation. Trees such as willows (*Salix nigra*), sycamore (*Platanus occidentalis*), bald cypress (*Taxodium distichum*), and pecan (*Carya illinoinensis*) dominate the riparian gallery forests. The river traverses over gently sloped, and generally flat land comprised of atco loam, divot clay loam, and knippa clay soils. The area immediately west and south of San Antonio has varying levels of development and open spaces. The lower part of the segment is mostly rural with cultivated crops and pasturelands with soils consisting primarily of loire clay loam, gullied land, and sunev clay loam.

Information used to generate the land use maps was obtained from the SARA GIS Department and includes Ecological Mapping Systems of Texas developed by Texas Parks and Wildlife Department (https://tpwd.texas.gov/landwater/land/programs/landscape-ecology/ems/ ), and TCEQ Assessment Units data created by the TCEQ https://gis-tceq.opendata.arcgis.com

The City of Bandera wastewater treatment plant is the only plant in the Upper Medina Watershed (1905). There are no wastewater treatment plants in the Medina Lake or the Medina Diversion Lake Watersheds. Homes in these areas have septic systems. The remainder of the permitted wastewater treatment plants are located in the Lower Medina River Watershed (1903).

*Table 3-23: Wastewater treatment plants in the watershed.*

| Permittee Name | Permit Number | Discharge |
|---|---|---|
| City of Bandera | 10121-001 | ≤ 1 million gallons per day |
| Aqua Utilities Inc. | 05206-000 | ≥ 1 million gallons per day |
| Forest Glen Utility Company | 15030-001 | ≤ 1 million gallons per day |
| Forest Glen Utility Company | 16192-001 | ≤ 1 million gallons per day |
| City of Castroville | 10952-001 | ≤ 1 million gallons per day |
| City of La Coste | 10889-001 | ≤ 1 million gallons per day |
| San Antonio River Authority | 10749-008 | ≤ 1 million gallons per day |
| City of Somerset | 11822-001 | ≤ 1 million gallons per day |

| Permittee Name | Permit Number | Discharge |
|---|---|---|
| San Antonio Water Systems | 10137-033 | ≥ 1 million gallons per day |
| San Antonio Water Systems | 10137-004 | ≤ 1 million gallons per day |
| San Antonio Water Systems | 10137-003 | ≥ 1 million gallons per day |

The San Antonio River Authority (SARA) monitors all stations in the Lower Medina River Watershed (1903), except for station 12824-below Medina Diversion Dam, which is monitored by the Bandera County River Authority and Groundwater District (BCRAGD). BCRAGD monitors all other stations. One station is monitored by both agencies, BCRAGD conducts routine monitoring at station 21631, and SARA and BCRAGD jointly conduct biological sampling at this station.

*Table 3-24: Stations currently monitored by the CRP in the watershed.*

| Location Description | AU | ID |
|---|---|---|
| Medina River at Old English Crossing Above Bandera Falls | 1905_01 | 12830 |
| Medina River At SH 173 1.9 Mi Upstream from Bandera Creek 5.6 Mi Downstream from Indian Creek | 1905_01 | 13638 |
| Medina River at North Side of Mayan Ranch, West of City of Bandera and 2.16 Kilometers Upstream of Schmidtke Road Crossing | 1905_01 | 21631 |
| Medina River At FM 470 West of Bandera | 1905_02 | 12832 |
| Medina River at Patterson Avenue in Moffett Park Medina, Texas | 1905_02 | 21125 |
| North Prong Medina River Aka Wallace Creek Immediately Upstream of SH 16 | 1905A_01 | 18447 |

| Location Description | AU | ID |
|---|---|---|
| North Prong Medina River at FM 2107 Approx 80 Meters Northeast of the Intersection of Brewington Creek Road and FM 2107 Northwest of Medina, Texas | 1905A_01 | 21126 |
| West Prong Medina River 11m Upstream from Coalkiln Rd 3 Km West of Medina and Immediately South of SH337 | AU not assigned | 15736 |
| Medina Lake at Medina Lake Dam West of San Antonio | 1904_01 | 12825 |
| Medina Lake Near Red Cove | 1904_01 | 12826 |
| Medina Lake Mid Lake Near Headwater | 1904_02 | 12829 |
| Medina Lake at Mormon Bluff | 1904_03 | 12827 |
| Medina Lake Between Cypress and Spettel Coves | 1904_03 | 12828 |
| Medina River Downstream Medina Reservoir in Mico, TX at Low Water Crossing | 1909_01 | 14205 |
| Medina Diversion Lake Near West Bank 40 M Upstream of Dam and Approximately 1 Mi Upstream of Medina River Crossing at Medina County Road 2615 | 1909_01 | 18407 |
| Medina River At FM 1937 Near Losoya | 1903_01 | 12811 |
| Medina River 500 Meters Downstream of Pleasanton Road in Bexar County | 1903_02 | 22225 |
| Medina River at Applewhite Road Approximately 1.16 Kilometers North of Neal Road at The Southern Boundary of The Toyota Property Cams Id 0769 USGS Site Id 08180850 | 1903_03 | 12814 |
| Medina River at CR 2615 Approx .5 Mi Downstream of Diversion Dam Near Rio Medina | 1903_05 | 12824 |

| Location Description | AU | ID |
|---|---|---|
| Medina River at CR 484 | 1903_05 | 14200 |
| City of San Antonio Dos Rios WWTP Discharge Into Medina River Permit WQ0010137-033 | WWTP Discharge No AU | 16584 |

The US Geological Survey (USGS) currently has 12 real-time monitoring sites on Medina River. The USGS stream gages are maintained and operated by the USGS but rely of funding provided by state, regional and local agencies or organizations that sponsor gaging stations.

*Table 3-25: US Geological Survey continuous monitoring stations.*

| Location | ID | Real Time Available Parameters | Additional Sponsors |
|---|---|---|---|
| N Prong Medina River at Brewington Ck near Medina, TX | 08178861 | Gage Height, Precipitation | Bandera County River Authority and Groundwater District |
| W Prong Medina River at Carpenter Ck Rd near Medina, TX | 08178871 | Gage Height, Precipitation | Bandera County River Authority and Groundwater District |
| Medina River at Patterson Rd at Medina, TX | 0817887350 | Discharge, Gage Height, Precipitation | Bandera County River Authority and Groundwater District |
| Medina River at Bandera, TX | 08178880 | Discharge, Gage Height | Edwards Aquifer Authority, Texas Water Development Board |
| Medina River above English Crossing near Pipe Creek, TX | 08178980 | Discharge, Gage Height, Precipitation | Edward Aquifer Authority |

| Location | ID | Real Time Available Parameters | Additional Sponsors |
|---|---|---|---|
| Red Bluff Ck at FM 1283 near Pipe Creek, TX | 08179110 | Discharge, Gage Height, Precipitation | San Antonio Water System |
| Medina Lake near San Antonio, TX | 08179500 | Water Elevation, Precipitation, Reservoir Storage, Surface Area | Bexar-Medina-Atascosa Counties, Texas, Water Control and Improvement District Counties, |
| Medina River Diversion Lake near Riomedina, TX | 08180010 | Surface Area, Reservoir Storage, Reservoir Elevation | None |
| Medina River near Riomedina, TX | 08180500 | Discharge, Gage Height | None |
| Medina River at La Coste, TX | 08180640 | Discharge, Gage Height | None |
| Median River near Macdona, TX | 08180700 | Discharge, Gage Height | San Antonio River Authority |
| Medina River near Somerset, TX | 08180800 | Discharge, Gage Height, Dissolved Oxygen, pH, Precipitation, Specific Conductance, Temperature, Turbidity | San Antonio River Authority, Texas Water Development Board |
| Medina River at San Antonio, TX | 08181500 | Discharge, Gage Height, Dissolved Oxygen, pH, Precipitation, Specific Conductance, Temperature, Turbidity | San Antonio River Authority, Texas Water Development Board |
| San Geronimo Creek near Helotes, TX | 08180586 | Discharge, Gage Height | Edwards Aquifer Authority |

**Texas Integrated Report on Surface Water Quality for the Clean Water Act:**

The TCEQ's 2022 Integrated Report (2022 IR) identified seven assessment units (AU) with either impairments and/or concerns for Medina River and its tributaries. An AU often consists of a single representative station used to characterize standards attainment. The data from multiple stations in a single AU can be used in the assessment. The 2022 IR results, including the 303(d) List of Impaired Waters, are reported at the AU level for each water body. The TCEQ's 2022 IR identifies four segments with a total of 12 assessment units (AU). The impairments and concerns are listed below.

*Table 3-26: Impairments and concerns identified in the TCEQ 2022 Integrated Report*

| Segment | AU Description | AU ID | Station ID | Impairments | Concerns |
|---|---|---|---|---|---|
| Medina River Above Medina Lake | From a point immediately upstream of the confluence of Red Bluff Creek upstream to RM 470 | 1905_01 | 12830<br>13638<br>21631 | *E. coli* | Impaired Fish Community<br>Impaired Habitat |
| | From RM 470 upstream to the confluence of the North Prong Medina River and the West Prong Medina River | 1905_02 | 12832<br>21125 | None | Impaired Fish Community |
| North Prong Medina River | From the confluence with the Medina River upstream to the headwaters approximately 3.5 km east of RM 187 in Bandera County | 1905A_01 | 18447<br>21126 | None | None |
| Medina Lake | Lower portion, from dam west to Masterson Point and east to Reuters Cove | 1904_01 | 12825<br>12826 | None | None |
| | Part of lake extending upstream from Brushy Creek to upper end of segment | 1904_02 | 12829 | None | None |

| Segment | AU Description | AU ID | Station ID | Impairments | Concerns |
|---|---|---|---|---|---|
| | Remainder of segment | 1904_03 | 12827<br>12828 | None | None |
| Medina Diversion Lake | From Medina Diversion Dam in Medina County to Medina Lake Dam in Medina County, up to the normal pool elevation of 926.5 feet (impounds Medina River) | 1909_01 | 14205<br>18407 | None | None |
| Medina River Below Medina Diversion Lake | From the confluence with the San Antonio River upstream to the confluence with Palo Blanco Creek approximately 2.0 km upstream of FM 1937 | 1903_01 | 12811 | *E. coli* | Nitrate Nitrogen<br>Total Phosphorus |
| | From the confluence with Palo Blanco Creek approximately 2.0 km upstream of FM 1937 upstream to the confluence with Lower Leon Creek | 1903_02 | 12812<br>12813 | *E. coli* | Nitrate Nitrogen<br>Total Phosphorus |
| | From the confluence with Lower Leon Creek upstream to the confluence with Medio Creek | 1903_03 | 12814 | *E. coli* | Nitrate Nitrogen |
| | From the confluence with Medio Creek upstream to the confluence with Polecat Creek approximately 125 m upstream of FM 1604 | 1903_04 | 12817<br>12819 | None | Nitrate Nitrogen |

| Segment | AU Description | AU ID | Station ID | Impairments | Concerns |
|---|---|---|---|---|---|
| | From the confluence with Polecat Creek approximately 125 m upstream of FM 1604 upstream to the Medina Diversion Dam | 1903_05 | 12821<br>12824<br>14200<br>22062<br>22063 | None | Impaired Macrobenthic Community |

Medina River Above Medina Lake Watershed Routine Data Analysis:

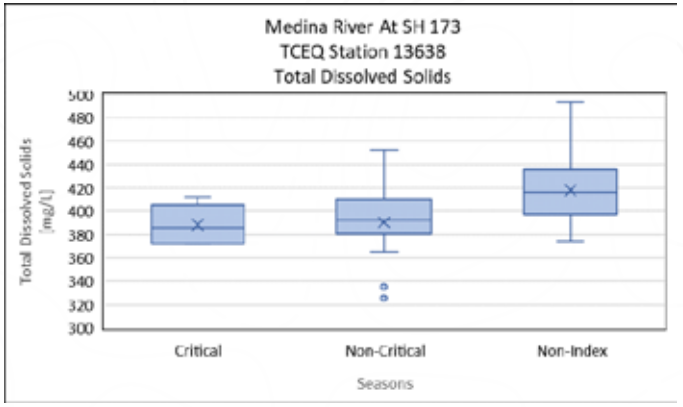
Only data with at least 10 years of data and no significant data gaps were used in the analysis.

Four stations were examined for routine water quality:

- Medina River at Patterson Ave: Station 21125
- Medina River at FM 470: Station 12832
- Medina River at SH 173: Station 13638
- Medina River at Old English Crossing: Station 12830

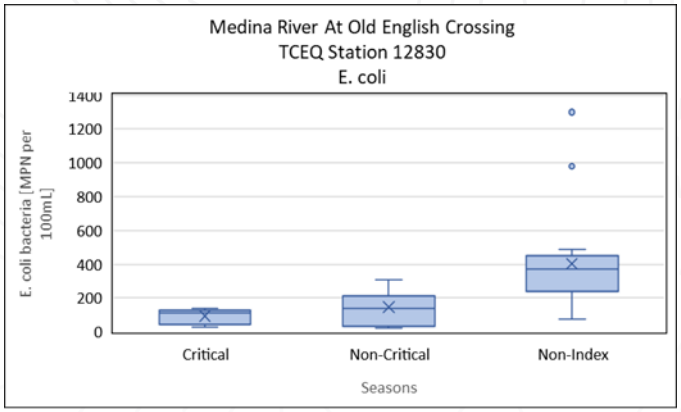
The 2022 IR identified an impairment for *E. coli* bacteria and concerns for fish communities and habitat in this segment.

A review of these stations identified that two stations (12832 and 13638) had the average total dissolved solids (TDS) greater than the TCEQ standard, however this standard is applied across the entire segment. Since the segment average is less than the standard, this segment is meeting the TCEQ standard for total dissolved solids. Neither of these sites showed any significant trend over time for TDS, but the TDS values decreased as flow increased, so this may be a symptom of droughts in this area.




*Seasonality plot showing that mean TDS values are higher during the non-index period for station 13638.*

Station 13638 did show significant seasonality. For this report, the seasons were defined as: critical period (July 1st – September 30th), non-critical period (March 15th – June 30th plus October 1st – October 15th), and the non-index period (October 16th – March 14th).

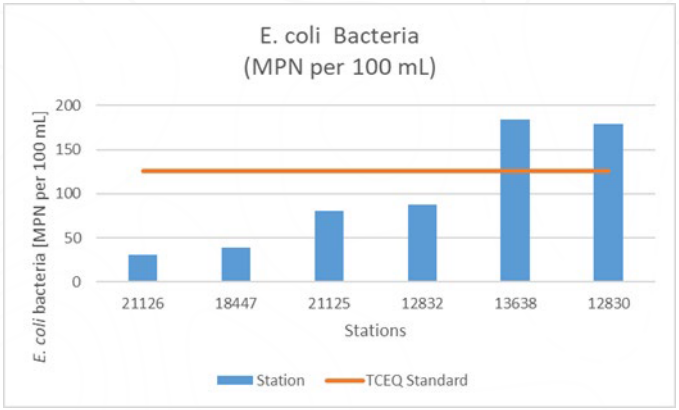



*Seasonality plot showing that E. coli levels lowest mean during the critical period and highest during the non-index period.*

The two most downstream stations (13638 and 12830) had *E. coli* levels with a geometric mean that does not meet (greater than) the TCEQ standard of 126 MPN per 100 mL. *E. coli* bacteria is an indication of recent fecal contamination.

*E. coli* bacteria at the upper most station (21125) on the main stem of the Upper Medina River is decreasing as flow increases. This could indicate that the source of the E. coli bacteria is point source, or it could simply mean that stormwater runoff is not transporting fecal matter from the surrounding area. The E. coli level at this station was 80.60 MPN per 100 mL.

As you move downstream on the Medina River there is more urbanization. However, limited bacteria source tracking indicates that the largest percentage of fecal matter is from wildlife, not humans or domestic animals. However, wildlife is often attracted to food provided by people and trash that they can feed on. Neither site showed trends for *E. coli* bacteria over time or flow. However, a plot of the geometric means for upstream to downstream show that the upper stations are meeting the TCEQ standard. Further investigation between station 12832 and 13638 may identify the source(s) of the elevated *E. coli* levels.




*Plot showing E. coli values from upstream (left) to downstream (right). Showing a jump in the E. coli geometric mean.*

North Prong of the Medina River:

The TCEQ Integrated Report (TCEQ IR) showed that there were no impairments or concerns.

Two stations were reviewed:

- North Prong Medina River at FM 2107: Station 21126
- North Prong Media River at SH 16: Station 18447

A review of these station identified no impairments or concerns.

**Evaluation of Habitat, Nekton (fish), and Diurnal Dissolved Oxygen:**

*Upstream view of TCEQ station 21631 Medina River at the north side of Mayan Ranch, west of City of Bandera and 2.16 kilometers upstream of the Schmidtke Road crossing during a habitat assessment on June 13, 2022.*

Habitat assessments are done during biological sampling events to holistically evaluate the health of a water body. Habitat quality can tell us how aquatic communities can be supported. The Habitat Quality Index (HQI) is a quantitative measurement used to assess aquatic habitat quality, as described in the Surface Water Quality Monitoring (SWQM) Procedures Manual. This is done by quantitatively and qualitatively assessing various features of the stream reach, including available instream cover, number of riffles, and the structure of riparian vegetation, among other things. These features have an intrinsic value for characteristics like bank stability, buffering capacity, and refugia for aquatic organisms. Based on the metrics measured, habitat quality is scored and then categorized as either limited, intermediate, high, or exceptional.3-27

Assessment of habitat in the Medina River above Medina Lake Watershed from 2019-2022 was completed at TCEQ station 21631 (Medina River at the north side of Mayan Ranch, west of City of Bandera and 2.16 kilometers upstream of the Schmidtke Road crossing). According to San Antonio River Authority (River Authority) data, current habitat in the Medina River above Medina Lake Watershed is described as intermediate quality according to the HQI.

*The left bank TCEQ station 21631 Medina River at the north side of Mayan Ranch, west of City of Bandera and 2.16 kilometers upstream of the Schmidtke Road crossing during a habitat assessment on June 13, 2022.*

The Medina River at station 21631 is characterized by overall moderate quality features, including instream cover, bottom substrate stability, number of riffle habitats, small pools, flow and bank stability, channel sinuosity, and riparian buffer vegetation corridors. Higher scores in these metrics indicate better instream and riparian habitat for aquatic organisms to inhabit, increasing species diversity and ecological integrity. The average width of the riparian buffer across the site is about ten meters wide and is dominated mainly by trees and grasses. The percent tree canopy coverage across the site is about 87%, providing ample shading to the river. Developed canopy and understory are present, however, and established midstory is lacking. A more developed mid-story would allow for higher species abundance and diversity, leading to higher ecological function in the riparian zone.

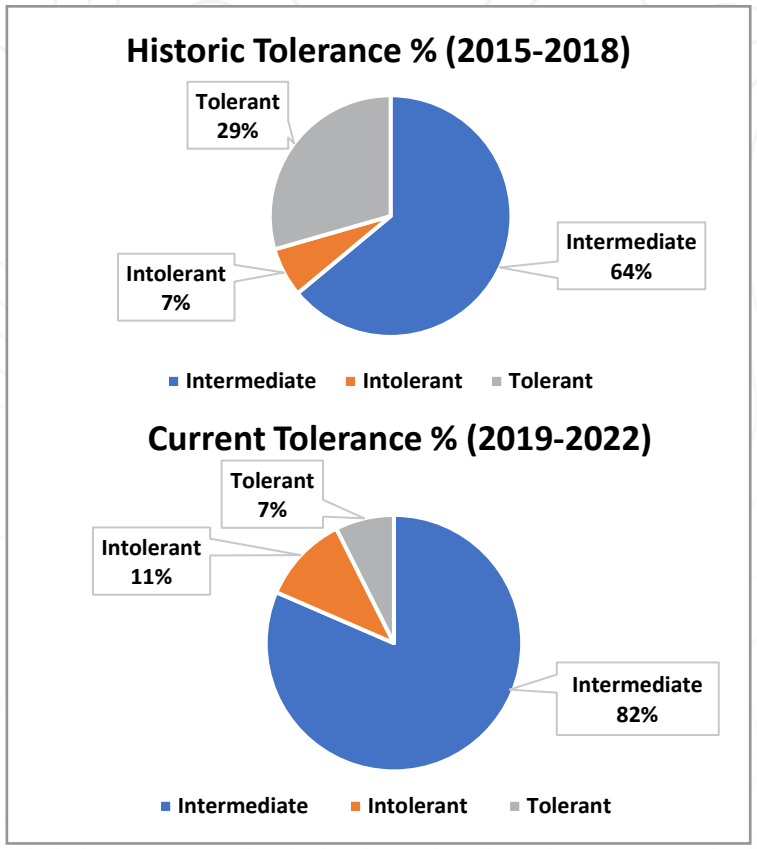
*Table 3-27: Species caught in the Medina River above Medina Lake Watershed and their native/non-native status and tolerances. Relative abundance for each species out of total individuals caught for the historical period assessed (2015-2018) and the current data period (2019-2022).*

| Common Name | Status | Tolerance | Relative Abundance Historical (2015-2018) | Relative Abundance Current (2019-2022) |
|---|---|---|---|---|
| Blacktail Shiner | Native | Intermediate | 35.43% | 25.75% |
| Texas Shiner | Native | Intermediate | 5.53% | 25.58% |
| Longear Sunfish | Native | Intermediate | 7.87% | 13.30% |
| Mimic Shiner | Native | Intolerant | 2.95% | 9.04% |
| Central Stoneroller | Native | Intermediate | 4.77% | 7.08% |
| Redbreast Sunfish* | Non-native | Intermediate | 2.65% | 5.20% |
| Western Mosquitofish | Native | Tolerant | 15.75% | 4.52% |
| Guadalupe Bass | Native | Intolerant | 2.57% | 1.79% |
| Rio Grande Cichlid | Native | Intermediate | 1.36% | 1.79% |
| Channel Catfish | Native | Tolerant | 2.57% | 1.19% |
| Green Sunfish | Native | Tolerant | 2.12% | 1.02% |
| Orangethroat Darter | Native | Intermediate | 0.45% | 0.94% |
| Flathead Catfish | Native | Intermediate | 0.76% | 0.60% |
| Bluegill | Native | Tolerant | 7.65% | 0.43% |
| Mexican Tetra | Native | Intermediate | 4.47% | 0.34% |
| Yellow Bullhead | Native | Intermediate | 0.00% | 0.34% |
| Greenthroat Darter | Native | Intolerant | 0.38% | 0.26% |
| Grey Redhorse | Native | Intermediate | 0.08% | 0.17% |
| Largemouth Bass | Native | Intermediate | 0.38% | 0.17% |
| Warmouth | Native | Tolerant | 0.23% | 0.17% |
| Ghost Shiner | Native | Intermediate | 0.00% | 0.09% |
| Redear Sunfish | Native | Intermediate | 0.00% | 0.09% |
| Spotted Bass | Native | Intermediate | 0.23% | 0.09% |
| Spotted Gar | Native | Tolerant | 0.00% | 0.09% |
| Red Shiner | Native | Tolerant | 0.83% | 0.00% |
| Texas Logperch | Native | Intolerant | 0.68% | 0.00% |
| Common Carp* | Non-native | Tolerant | 0.30% | 0.00% |

*Photo voucher of a Greenthroat Darter (Etheostoma lepidum) caught at TCEQ station 21631 Medina River at Mayan Ranch on June 13th, 2022.*

Index of Biotic Integrity (IBI) is a measure of ecosystem health that uses a variety of metrics taken from survey data to estimate fish community health. These metrics include species composition, trophic composition, and percent intolerance. Based on current (2019-2022) River Authority data, the score for station 21631 is 46 (high), indicating that the biotic integrity of the Medina River above Medina Lake Watershed is of high quality.

This Medina River station showed a 4% decrease in overall IBI when comparing current and historic (2015-2018). In recent years, there has been a decreased abundance in most sensitive fish species. For example, the relative abundance of Guadalupe Bass decreased by 1%, and Texas Logperch decreased from 0.7% to 0% (Table 3-27). The only sensitive species to show an increase in abundance was the Mimic Shiner, with an increase from 3% to 9% (Table 3-27). As for the non-native species found at this station, the Redbreast Sunfish saw an increase in relative abundance from 3% to 5%, while the Common Carp decreased, from 0.3% to 0%. Overall, data showed an increased abundance of intermediate fish species like the Central Stoneroller, Texas Shiner, and Orangethroat Darter; and a




*Historic and current breakdown of species tolerance within the Medina River above Medina Lake Watershed.*

decreased abundance of tolerant species like Western Mosquitofish and Bluegill. Based on these data and data from previous years, segment 1905_01, assessed at station 21631, is considered to have both an impaired fish community and impaired habitat in water.

The 2022 Texas Surface Water Quality Standards (TSWQS) lists a 24-hour dissolved oxygen criteria of 6.0 mg/L average and a 4.0 mg/L minimum for Medina River Above Medina Lake. Dissolved oxygen levels can decrease to dangerous levels for a myriad of reasons. Oxygen levels below the demand of the aquatic organisms in the stream will cause high levels of stress and mortality.

In the last six years, 24-hour dissolved oxygen readings have been taken at station 21631. The average dissolved oxygen values ranged from 7.0 mg/L to 8.2 mg/L. The minimum dissolved oxygen values ranged from 6.1 mg/L to 7.8 mg/L. For the last several years, this station has met the minimum and average criteria for dissolved oxygen levels.

Medina Lake:

Medina Lake has no impairments or concerns identified in the 2022 IR, however there are concerns not identified in the 2022 IR. Medina Lake is currently identified by Texas Parks and Wildlife as infested with zebra mussels. Zebra mussels are a destructive invasive species, they outcompete native species. The shells are sharp and can negatively impact contact recreation, the zebra mussels can clog pipes and jam mechanisms.

SARA has installed zebra mussel substrate samplers downstream of Medina Diversion Lake and in several locations in the Upper San Antonio River. In addition, the SARA laboratory has developed inhouse capabilities to detect zebra mussel DNA. These steps have been taken to provide early detection of zebra mussels as they expand their range. However the best solution is to prevent the spread of zebra mussels. SARA provides financial support for the Texas Parks and Wildlife zebra mussel awareness campaign. Texas Parks and Wildlife along with partners distribute information about the threat of zebra mussels at appropriate outreach events. SARA staff have placed stickers on the Mission Reach Paddling trail at enter and takeout locations asking people to “Clean, drain and dry our boat”. SARA staff is also monitoring Calaveras and Braunig Lakes for zebra mussel veliger (larval stage).

Another issue that is affecting Medina Lake is the low water level. As of March 2023, Medina Lake is 5.4% full. The drought has hurt the ecology of the lake and recreation opportunities. Most floating docks for recreation are on dry land and closed.

Medina Diversion Lake:

Medina Diversion Lake has no impairments or concerns identified in the 2022 IR. However it is also infested with Zebra Mussels. Medina Diversion Lake is surrounded by private land, and there are few recreational opportunities unless you are a landowner or know a landowner. The lake is used to irrigate farmland. It has also been impacted by the drought and has been unable to provide as much water as needed.

Medina River Below Medina Diversion Lake:

- Medina River at CR 2615: Station 12824
- Medina River at CR 484: Station 14200

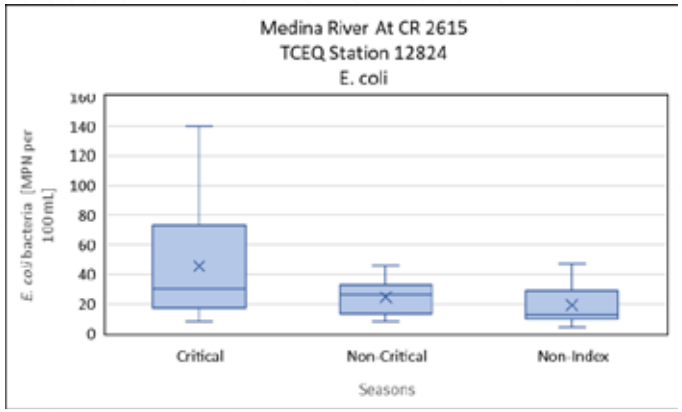
- Medina River at Applewhite Road: Station 12814
- Medina River near Pleasanton Road: Stations 12813 & 22225
- Medina River at FM 1937: Station 12811

The 2022 IR identified an impairment for *E. coli* bacteria and concerns for nutrients (nitrate nitrogen, total phosphorus), and macrobenthic community in this segment.

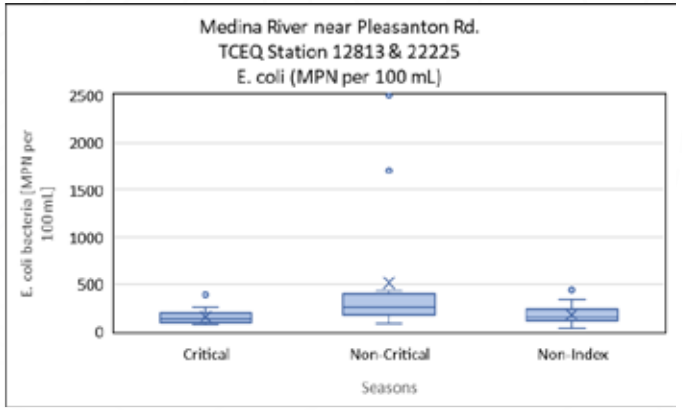
The most upstream station, just below the Diversion Lake Dam had a low *E. coli level*, however the remaining stations all had values greater than the TCEQ standard of 126 MPN per 100 mL.

Only two sites showed seasonality (combined station 12813 and 22225 and station 12824). For this report, the seasons were defined as: critical period (July 1st – September 30th), non-critical period (March 15th – June 30th plus October 1st – October 15th), and the non-index period (October 16th – March 14th).

Site 12824 is the most upstream site in this segment, in an area that is still rural, while combined stations 12813 and 22225 are in a more urban area. Note that station 12813 & 22225 are actually a combination of two sites that are very close. Station 12813 was abandoned due to safety concerns and station 22225 was selected to replace the station.



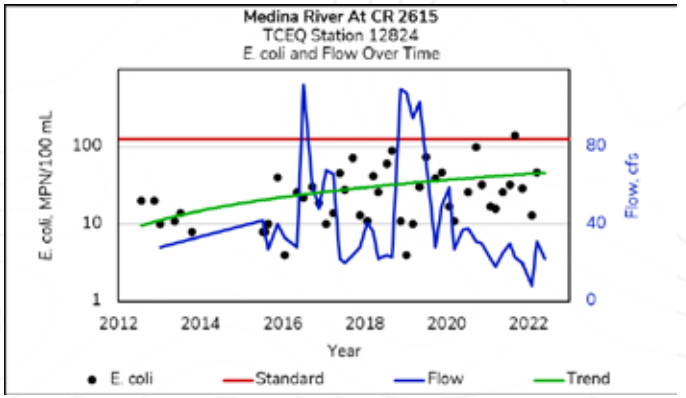

*Seasonality of E. coli bacteria showing the highest mean value is during the critical period.*




*Seasonality of E. coli bacteria showing the lowest mean value is during the critical period.*

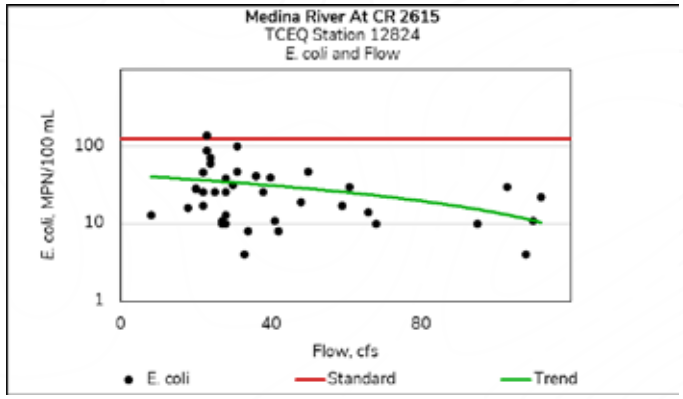
*E. coli* bacteria showed an increasing trend over time at the two uppermost stations evaluated for this segment, 12824 and 14200. This is particularly troublesome since station 12824 is currently meeting the TCEQ standard for *E. coli* bacteria.

Currently the Texas Water Resources Institute is looking into developing a watershed protection plan (WPP) for segments 1903_05, 1903_04, 1903_03 and Medio Creek. Work on the WPP will look into causes and develop a plan to protect and improve water quality in the Lower Medina River.




*Trend analysis over time. If this trend continues, eventually this station will not be meeting the standard.*

Typically *E. coli* levels increase exponentially as flow increases. Stormwater runoff picks up pollutants including fecal material and transports it into the river. Two stations showed a significant trend as flow increased. The upper most station 12824 shows a decreasing trend as flow increases which is unsusual. While this usually indicates that there is a point source contributing to the *E. coli* at that station, it is more likely that it is related to water releases from the Diversion Lake dam that have low *E. coli* values and not a point source bacteria issue. A review of the data indicates that this station has one of the lowest values (21.67 MPN per 100 mL) in the watershed.




*Decreasing trend of E. coli as flow increases at station 12824, just downstream from Medina Diversion Lake.*

The lower station (12811) showed an increasing trend for *E. coli* bacteria as flow increased indicating that stormwater runoff is increasing the *E. coli* levels in the river.

The nitrogen levels can not be compaired directly. The TCEQ analyzes nitrite plus nitrate nitrogen together, while SARA analyzes nitrite nitrogen and nitrate nitrogen separately. The screening level is applied to nitrate nitrogen only. However nitrogen levels apear to be increasing as you move downstream. This is likely due to discharges from wastewater treatment plants. One station showed seasonality for nitrate plus nitrate nitrogen (12824) and one station showed seasonality for nitrate nitrogen (12814). Both stations had the lowest average levels during the critical period and the highest levels in the non-index period. This is likely due to the nutrients being taken up by algae and plants during the warmer months, when algae and plants tend to grow and reproduce. The two most downstream sites (22225-12813 and 12811) showed a decreasing trend over time, while two of the upper stations showed an increasing trend over time for nitrogen. The two lower stations (22225-12813 and 12811) had elevated total phosphorus levels. Station (22225-12813) had 14 out of 60 samples above the TCEQ screening level.

*Medina River at Applewhite Road, Station 12814*

**Evaluation of Habitat, Nekton (fish), Benthic Macroinvertebrate Communities and Diurnal Dissolved Oxygen:**

*Downstream view of TCEQ station 14200 Medina River at CR 484 during a habitat assessment on July 7, 2022.*

Habitat assessments are done during biological sampling events to holistically evaluate the health of a water body. Habitat quality can tell us how aquatic communities can be supported. The Habitat Quality Index (HQI) is a quantitative measurement used to assess aquatic habitat quality, as described in the Surface Water Quality Monitoring (SWQM) Procedures Manual. This is done by quantitatively and qualitatively assessing various features of the stream reach, including available instream cover, number of riffles, and the structure of riparian vegetation, among other things. These features have an intrinsic value for characteristics like bank stability, buffering capacity, and refugia for aquatic organisms. Based on the metrics measured, habitat quality is scored and then categorized as either limited, intermediate, high, or exceptional.

Assessment of habitat in the Medina River below Medina Diversion Lake Watershed from 2019-2022 was completed at TCEQ station 14200 (Medina River at CR 484). According to San Antonio River Authority data, current habitat in the Medina River below Medina Diversion Lake Watershed is described as high quality according to the HQI.

The Medina River at this station is characterized by overall moderate to high quality features. Moderate quality features include instream cover, number of riffle habitats, bank stability, channel sinuosity, while high quality features include bottom substrate stability, pool size, flow stability, and wide riparian buffers. The average width of the riparian buffer across the site is about fifteen meters wide and is dominated mainly by trees and grasses. The percent tree canopy coverage across the site is about 88%, providing ample shading to the river. Developed canopy and understory are present, however, and established midstory is lacking. A more developed mid-story would allow for higher species abundance and diversity, leading to higher ecological function in the riparian zone.

*Table 3-28: Species caught in the Medina River below Medina Diversion Lake Watershed and their native/non-native status and tolerances. Relative abundance for each species out of total individuals caught for the historical period assessed (2015-2018) and the current data period (2019-2022).*

| Common Name | Status | Tolerance | Relative Abundance Historical (2015-2018) | Relative Abundance Current (2019-2022) |
|---|---|---|---|---|
| Blacktail Shiner | Native | Intermediate | 31.74% | 34.19% |
| Longear Sunfish | Native | Intermediate | 16.31% | 16.98% |
| Mimic Shiner | Native | Intolerant | 4.26% | 11.40% |
| Sailfin Molly | Native | Tolerant | 3.90% | 7.85% |
| Western Mosquitofish | Native | Tolerant | 3.55% | 5.28% |
| Central Stoneroller | Native | Intermediate | 2.30% | 4.83% |
| Ghost Shiner | Native | Intermediate | 0.00% | 2.19% |
| Channel Catfish | Native | Tolerant | 3.19% | 2.19% |
| Bluegill | Native | Tolerant | 9.93% | 2.11% |
| Rio Grande Cichlid | Native | Intermediate | 1.95% | 2.04% |
| Spotted Bass | Native | Intermediate | 1.77% | 2.04% |
| Redspotted Sunfish | Native | Intermediate | 7.09% | 1.66% |
| Orangethroat Darter | Native | Intermediate | 0.00% | 1.43% |
| Texas Logperch | Native | Intolerant | 1.24% | 2.34% |
| Redbreast Sunfish | Non-native | Intermediate | 0.35% | 1.21% |
| Flathead Catfish | Native | Intermediate | 3.19% | 0.98% |
| Warmouth | Native | Tolerant | 2.13% | 0.75% |
| Spotted Gar | Native | Tolerant | 0.18% | 0.15% |
| Largemouth Bass | Native | Intermediate | 1.77% | 0.15% |
| Blackstripe Topminnow | Native | Intermediate | 0.00% | 0.08% |
| Bullhead Minnow | Native | Intermediate | 1.02% | 0.08% |
| Guadalupe Bass | Native | Intolerant | 0.00% | 0.08% |
| Mexican Tetra | Native | Intermediate | 0.35% | 0.00% |
| Longnose Gar | Native | Tolerant | 0.18% | 0.00% |
| Red Shiner | Native | Tolerant | 1.06% | 0.00% |
| Green Sunfish | Native | Tolerant | 1.24% | 0.00% |
| Redear Sunfish | Native | Intermediate | 0.18% | 0.00% |
| Yellow Bullhead | Native | Intermediate | 0.18% | 0.00% |
| Grey Redhorse | Native | Intermediate | 0.89% | 0.00% |

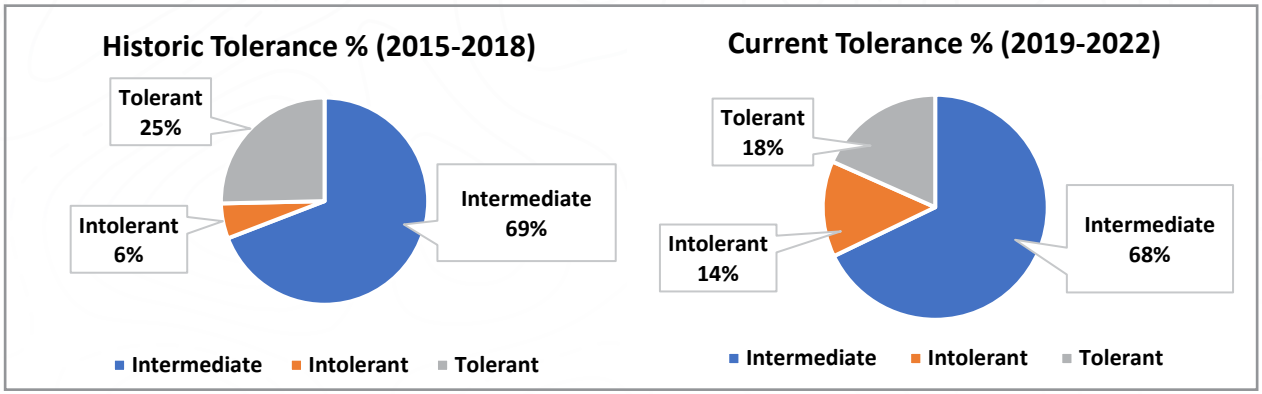
Index of Biotic Integrity (IBI) is a measure of ecosystem health that uses a variety of metrics taken from survey data to estimate fish community health. These metrics include species composition, trophic composition, and percent intolerance. Based on current (2019-2022) River Authority data, the overall score for station 14200 is 43 (high), indicating that the biotic integrity of the Medina River below Medina Diversion Lake Watershed is of high quality.

This Medina River station showed no change in overall IBI when comparing recent (2019-2022) and historic (2015-2018) data. Intermediate species account for the greatest relative abundance in recent years, most notably Blacktail Shiner at 34.19% and Longear Sunfish at 16.98% (Table 3-28). There was also increase of sensitive fish including Mimic Shiner, 4.26% to 11.40%, and Texas Logperch, 1.24% to 2.34% (Table 3-28). The presence of sensitive fish species is an indicator of high-quality habitat and positively influences the biotic integrity of the fish community. Even though the single non-native species found at this station had a slight increase of relative abundance (0.4% to 1.2%), 99% of individuals found were native to this region.


*Photo voucher of an Orangethroat Darter (Etheostoma spectabile) caught at TCEQ station 14200 Medina River at 484 on July 5,2022.*

Benthic macroinvertebrates are excellent biological indicators of water quality as they are the first organisms to respond to changes in water chemistry and habitat alterations. This data can be combined with the habitat and fish collection data to best understand stream health. The Benthic Index of Biotic Integrity (BIBI) is a quantitative measurement used by the TCEQ to assess macroinvertebrate assemblages and stream health, as described in SWQM. Data from station 14200 from 2021-2022 reveals that the average score of this station is 26 (intermediate). Segment 1903_05, assessed at station 14200, is considered to have an impaired macrobenthic community. In addition, the Hilsenhoff Biotic Index (HBI), a quantitative score based on the abundance of tolerant taxa, for the benthic community of the Lower Cibolo Creek watershed was 4.2 out of a scale of 0-10. A score of 4.2 indicates a moderate number of tolerant taxa within those sampled in the watershed.

The 2022 Texas Surface Water Quality Standards (TSWQS) lists a 24-hour dissolved oxygen criteria of 5.0 mg/L average and a 3.0 mg/L minimum for the Lower Medina River. Dissolved oxygen levels can decrease to dangerous levels for a myriad of reasons. Oxygen levels below the demand of the aquatic organisms in the stream will cause high levels of stress and mortality. In the last several years, 24-hour dissolved oxygen readings have been taken at station 14200. Dissolved oxygen levels at this station averaged at 8.1 mg/L overall, ranging from 5.5 mg/L in July 2022 to 9.3 mg/L in May 2021. For the last several years, this station has met the minimum or average criteria for dissolved oxygen levels and meets the TSWQS.




*Distribution of tolerance values for all species caught in the Medina River below Medina Diversion Lake Watershed during both the historic (2015-2018) and current (2019-2022) data periods.*

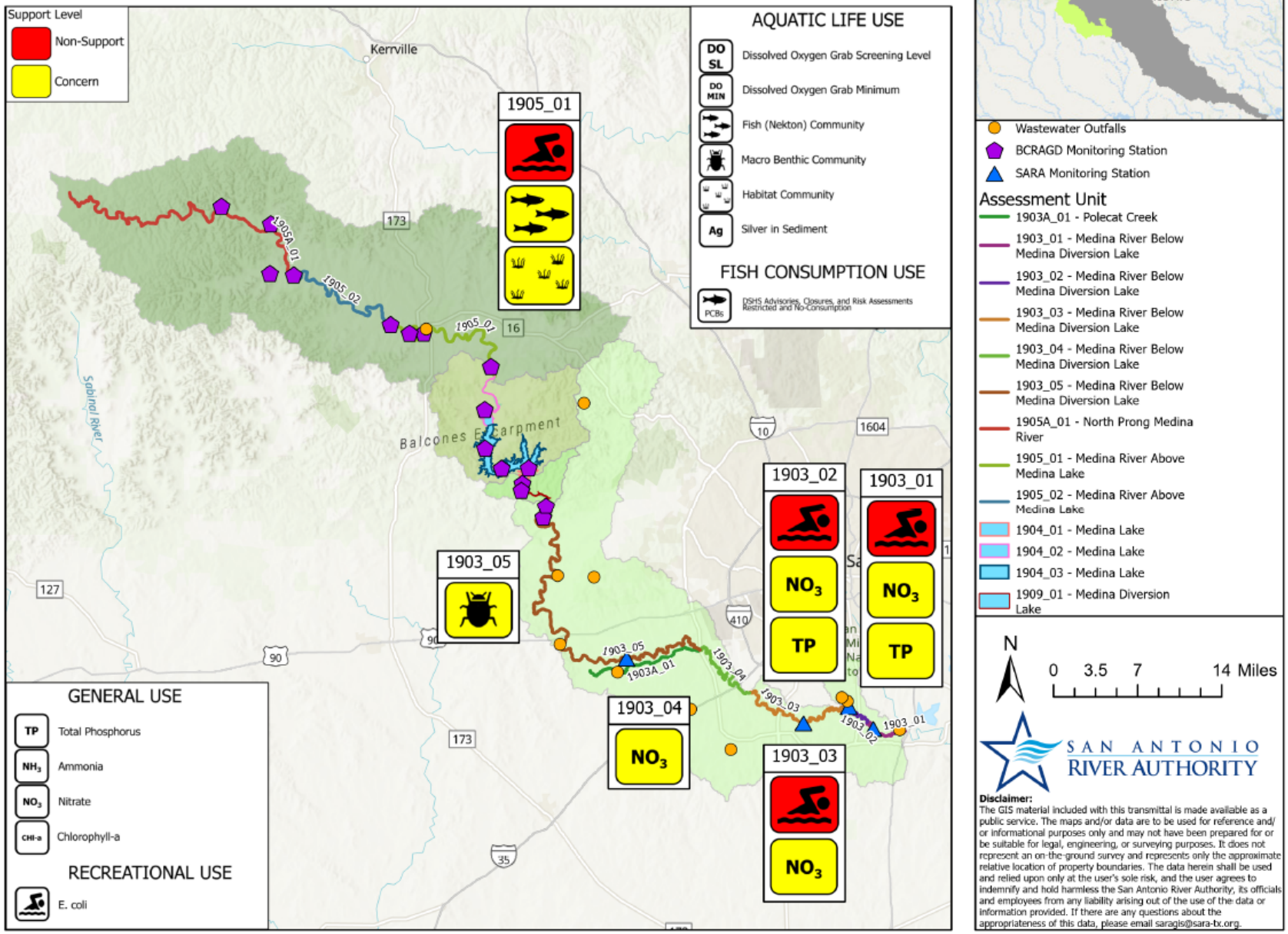
*Table 3-29: Summary of Issues:*

| Water Quality Issue | Affected Area | Possible Influences | Possible Effects | Possible Solutions / Actions Taken |
|---|---|---|---|---|
| Fecal Contamination (*E. coli* Bacteria Impairment)<br><br>Identified on 2022 Integrated Report | • Medina River Above Medina Lake (lower portion of segment)<br>• Medina River Below Medina Diversion Lake (lower portion of segment) | • Rapid urbanization, impervious cover<br>• Construction stormwater controls failing<br>• Developments with septic tanks or small, privately-run wastewater treatment plants<br>• Small, slow-moving stream with little assimilative capacity<br>• Illegal dumping at creek crossings | • Increased quantity of stormwater scouring stream beds, creating additional sediment loading and urban-related pollutants<br>• Bacteria load from land use and effluent is not reduced by instream flow.<br>• Significant primary contact recreation 1 (e.g., swimming) could lead to gastrointestinal illnesses | • Improve stormwater controls in new developments<br>• Adequate construction oversight<br>• Wastewater regionalization to prevent multiple small package plants and reduce septic tanks |
| Fish & Macrobenthic Communities<br><br>Identified on 2022 Integrated Report | • Medina River Above Medina Lake<br>• Medina River Below Medina Diversion Lake (upper portion of segment) | • Urbanization has contributed to the flashiness of the creek which disturbs instream habitat<br>• Stormwater runoff contributes to sporadic water quality issues | • Diminished fisheries and biological communities | • Improve riparian zone and implement stormwater BMPs to reduce flashiness of the creek<br>• Improve instream habitat<br>• Continue promoting stormwater BMPs<br>• Continue monitoring |

| Water Quality Issue | Affected Area | Possible Influences | Possible Effects | Possible Solutions / Actions Taken |
|---|---|---|---|---|
| Habitat in Water<br><br>Identified on 2022 Integrated Report | • Medina River Above Medina Lake (lower portion of segment) | • Topography- bedrock substrate and limited in stream habitat rather than to any specific pollutant(s) | Diminished fisheries and biological communities. | • Continue monitoring |
| Nutrient enrichment (nitrate nitrogen, phosphorus, ammonia nitrogen)<br><br>Identified on 2022 Integrated Report | • Medina River Below Medina Diversion Lake (lower portion of segment) | • Wastewater treatment plant effluent<br>• Urban landscaping and maintenance | • Nutrients are necessary for algae, plants, and aquatic communities. Excessive nutrients can cause algae blooms which can cause significant swings in dissolved oxygen, causing stress and even death of aquatic communities<br>• Excessive nutrients can cause algae and cyanobacteria (blue -green algae) blooms that can release toxins into the water<br>• Excessive nutrients can cause algae blooms causing an aesthetic nuisance | • If dissolved oxygen swings are significant and biology shows a related effect, then some nutrient controls may be needed for wastewater treatment plants<br>• Public outreach on proper use of fertilizers<br>• Public outreach and implement best management practices to reduce stormwater runoff |

| Water Quality Issue | Affected Area | Possible Influences | Possible Effects | Possible Solutions / Actions Taken |
|---|---|---|---|---|
| Invasive Species – Zebra Mussels<br><br>Stakeholders | • Medina Lake<br>• Medina Diversion Lake | • Infestation likely caused by either contaminated boats or using live bait from contaminated lake | • Out compete native species<br>• Reduce food supplies for recreational fish<br>• Clog pipes | • No real solutions available for infested lakes<br>• Monitor and early detection of waterbodies not contaminated |
| Drought<br><br>Stakeholders | • Entire Watershed | • Climate change<br>• Increased impervious cover | • Drying up of portions of river, low water level in lakes<br>• Lack of water available for irrigation | • BMP to allow stormwater runoff to soak in<br>• Reduce pressure on aquifers so springs flow more often<br>• Take action to reduce climate change |

# Medina River Watershed Impairments






Wastewater Outfalls
BCRAGD Monitoring Station
SARA Monitoring Station

Assessment Unit
- 1903A_01 - Polecat Creek
- 1903_01 - Medina River Below Medina Diversion Lake
- 1903_02 - Medina River Below Medina Diversion Lake
- 1903_03 - Medina River Below Medina Diversion Lake
- 1903_04 - Medina River Below Medina Diversion Lake
- 1903_05 - Medina River Below Medina Diversion Lake
- 1905A_01 - North Prong Medina River
- 1905_01 - Medina River Above Medina Lake
- 1905_02 - Medina River Above Medina Lake
- 1904_01 - Medina Lake
- 1904_02 - Medina Lake
- 1904_03 - Medina Lake
- 1909_01 - Medina Diversion Lake

N

0 3.5 7 14 Miles

SAN ANTONIO RIVER AUTHORITY

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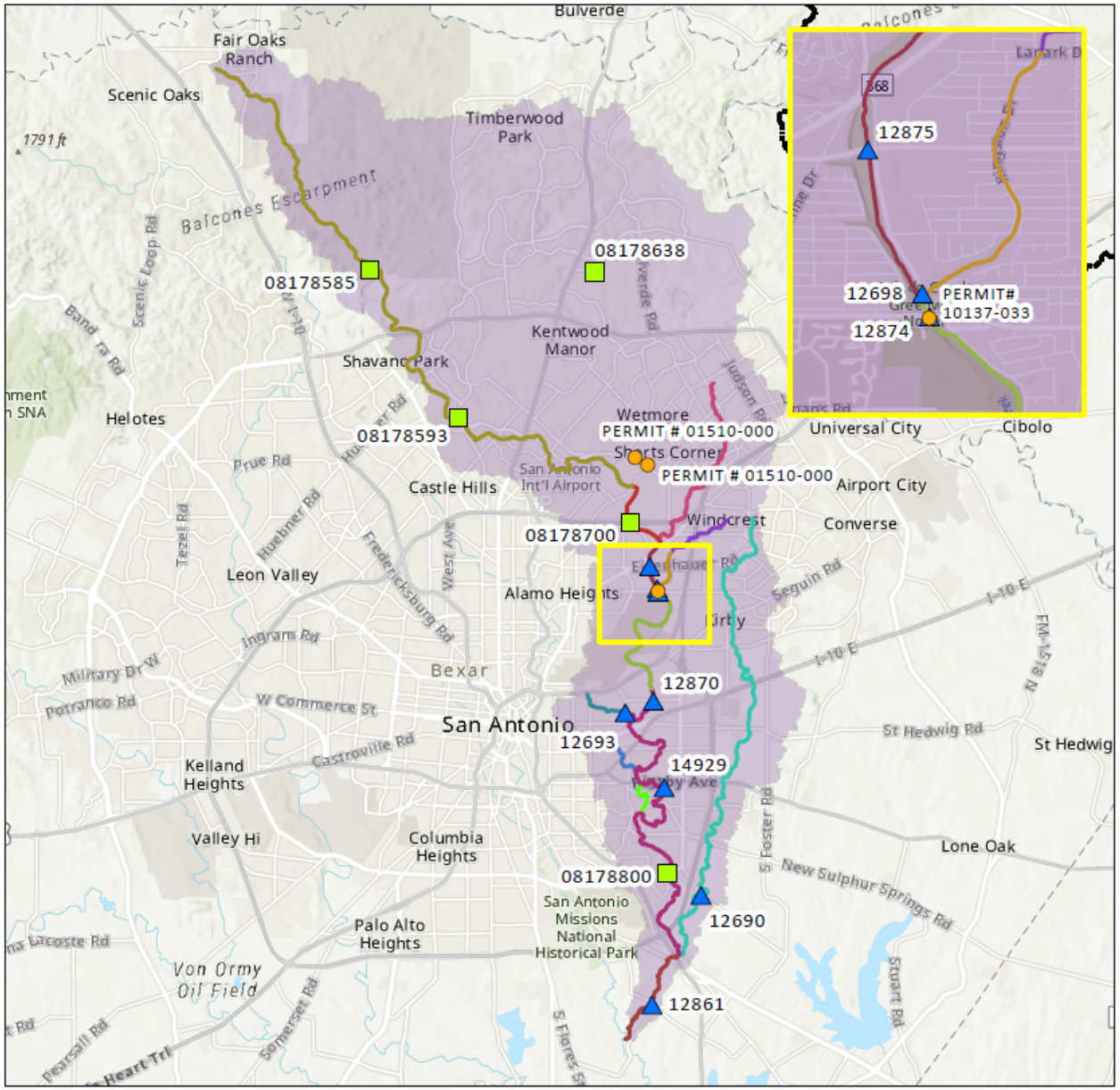
# Salado Creek Watershed




- USGS Stations
- Wastewater Outfalls
- SARA Monitoring Station

**Assessment Unit**

- 1910A_01 - Walzem Creek
- 1910A_02 - Walzem Creek
- 1910B_01 - Rosillo Creek
- 1910C_01 - Salado Creek Tributary
- 1910D_01 - Menger Creek
- 1910E_01 - Beitel Creek
- 1910F_01 - Upper Salado Creek
- 1910F_02 - Upper Salado Creek
- 1910G_01 - Salado Creek West Channel
- 1910_01 - Salado Creek
- 1910_02 - Salado Creek
- 1910_03 - Salado Creek
- 1910_04 - Salado Creek

N

0 1.5 3 6 Miles

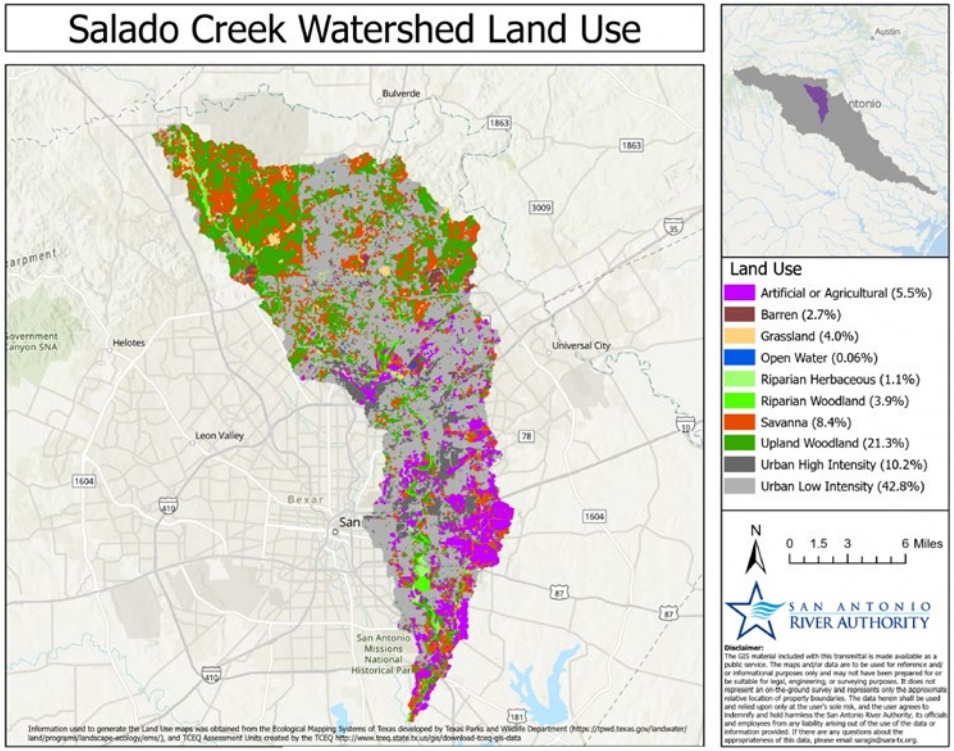
SAN ANTONIO RIVER AUTHORITY

## Salado Creek Watershed Summary

The headwaters of Upper Salado Creek originate near Rocking Horse Lane in Fair Oaks Ranch, Texas, in northern Bexar County. Salado Creek generally flows southward about 40 miles until its confluence with the San Antonio River near Blue Wing Road in southern Bexar County. The drainage area is approximately 222 square miles, which accounts for approximately 5.3% of the entire San Antonio River Basin. Salado Creek begins as a wide, shallow creek that transitions to a more narrow, deep creek as it flows downstream. Flow is intermittent from the headwaters of Upper Salado Creek throughout the Edwards Aquifer Recharge Zone to approximately one quarter mile upstream of North Loop 410. Due to the intersection of the recharge zone, flow primarily occurs after major rainfall events, then quickly dissipates and the creek dries shortly after. The intermittent to perennial boundary lies approximately 0.62 miles downstream of North Loop 410 at the confluence of Beitel Creek and Upper Salado Creek. This boundary is demarcated by the presence of seeps and springs contributing to the perennial flow which persists throughout Salado Creek until it's confluence with the San Antonio River. The San Antonio Water System's Salado Creek Water Recycling Center supplements base flow in Salado Creek upstream of James Park which supports much of the flow and habitat in Salado Creek.

The upper reaches of Salado Creek traverse steep hill country terrain over limestone formations within the Edwards Plateau, where it intersects the contributing, transition, and recharge zones of the Edwards Aquifer. As the Salado Creek flows downstream, the topography shifts to the gently rolling hills of the Texas Blackland Prairies. The creek becomes more entrenched as it flows toward its confluence with the San Antonio River. Lower portions of Salado Creek within the Blackland Prairies are characterized by alkaline clay soils which are typically utilized by the agricultural communities of Texas.

Land use in Salado Creek is primarily urban – low intensity (43%) occurring largely throughout the central portion of the watershed. Urban – low intensity is defined by human-derived impacts, typically involving high impervious cover such as buildings and other man-made structures. The northwest portion of the watershed, within the Edwards Plateau, is characterized by upland woodland habitat mixed with savanna and grassland. Upland woodland habitat (21%) consists of mixed forests with vegetation typical of the Texas Hill Country such as a variety of oak species (*Quercus* spp.), Ashe juniper (*Juniperus asheii*), and cedar elm (*Ulmus crassifolia*) dominating the canopies and Texas persimmon (*Diospyros texana*) and mountain laurel (*Sophora secundiflora*) mixed in the mid-story. The savanna portions (8%) contain various grasses interspersed with mesquite (*Prosopis glandulosa*), Ashe juniper, and oaks, while the grasslands (4%) are dominated by various grasses such as little bluestem (*Schizachyrium scoparium*) and purple threeawn (*Arisitida purpurea*). These land use types primarily occur throughout the extent of Camp Bullis and sporadically in other areas north of Loop 1604 in northern Bexar County.




Information used to generate the land use maps was obtained from the SARA GIS Department and includes Ecological Mapping Systems of Texas developed by Texas Parks and Wildlife Department (https://tpwd.texas.gov/landwater/land/programs/landscape-ecology/ems/ ), and TCEQ Assessment Units data created by the TCEQ https://gis-tceq.opendata.arcgis.com

Salado Creek has two wastewater treatment plant permits that currently discharge into the creek. Capitol Aggregates Inc. has two discharge points. San Antonio Water System discharges recycled water into Salado Creek at John James Park in San Antonio. This recycled water is needed for the health of the aquatic community in Salado Creek.

*Table 3-30: Wastewater treatment plants in the watershed.*

| Permittee Name | Permit Number | Permitted Discharge |
|---|---|---|
| Capitol Aggregates Inc. | 01510-000 | ≥ 1 million gallons per day |
| Capitol Aggregates Inc. | 01510-000 | ≥ 1 million gallons per day |
| San Antonio Water System | 10137-033 | ≥ 1 million gallons per day |

The San Antonio River Authority currently monitors 5 sites on Salado Creek and 3 tributaries of Salado Creek (see Table 3-31).

*Table 3-31: Stations currently monitored by the CRP in the watershed.*

| Location Description | AU | ID |
|---|---|---|
| Salado Creek at Southton Rd. in San Antonio | 1910_01 | 12861 |
| Salado Creek at Comanche Park | 1910_02 | 14929 |
| Salado Creek at Gembler Rd. in San Antonio | 1910_02 | 12870 |
| Salado Creek at Rittiman Rd. in San Antonio | 1910_03 | 12874 |
| Salado Creek at Eisenhauer Rd. in San Antonio | 1910_04 | 12875 |

| Location Description | AU | ID |
|---|---|---|
| Rosillo Creek at W.W. White Rd.in San Antonio | 1910B_01 | 12690 |
| Menger Creek immediately upstream of Coliseum Rd. | 1910D_01 | 12693 |
| Walzem Creek at Holbrook Rd. | 1910A_01 | 12698 |

The US Geological Survey (USGS) currently has 4 real-time monitoring sites on Salado Creek (see Table 3-32). The USGS stream gages are maintained and operated by the USGS but rely on funding provided by state, regional and local agencies or organizations that sponsor gaging stations.

*Table 3-32: US Geological Survey continuous monitoring stations.*

| Location | ID | Real Time Available Parameters | Additional Sponsors |
|---|---|---|---|
| Salado Creek at Wilderness Rd., San Antonio, TX | 08178585 | Precipitation, Gage Height | San Antonio Water System |
| Salado Creek at Blanco Rd, San Antonio, TX | 08178593 | Precipitation, Gage Height, Discharge | Edwards Aquifer Authority |
| Salado Creek at 410, San Antonio, TX | 08178700 | Precipitation, Gage Height, Discharge | San Antonio River Authority |
| Salado Creek at Loop 13, San Antonio, TX | 08178800 | Precipitation, Gage Height, Discharge | San Antonio River Authority |

**Texas Integrated Report of Surface Water Quality for the Clean Water Act.**

The TCEQ's 2022 Integrated Report (2022 IR) identified seven assessment units (AU) with either impairments and/or concerns for Salado Creek and its tributaries. An AU often consists of a single representative station used to characterize

standards attainment. The data from multiple stations in a single AU can be used in the assessment. The 2022 IR results, including the 303(d) List of Impaired Waters, are reported at the AU level for each water body.

*Table 3-33: Impairments and concerns identified in the TCEQ 2022 Integrated Report*

| Segment | AU Description | AU ID | Station ID | Impairments | Concerns |
|---|---|---|---|---|---|
| Salado Creek | From confluence with San Antonio River to confluence with Rosillo Creek | 1910_01 | 12861 | None | None |
| | From the confluence with Rosillo Creek up to the confluence with Pershing Creek | 1910_02 | 12864, 12870, 14929 | *E. coli,* Fish community, Macrobenthic community | None |
| | From the confluence with Pershing Creek up to the confluence with Walzem Creek. | 1910_03 | 12874 | *E. coli* | Depressed DO (grab average) |
| | From the confluence with Walzem Creek up to the confluence with Beitel Creek | 1910_04 | 12875 | *E. coli,* Depressed DO (grab minimum) | Depressed DO (grab average) |
| Walzem Creek | From the confluence with Salado Creek upstream to Lanark Dr in San Antonio | 1910A_01 | 12698 | *E. coli* | Nitrate Nitrogen |
| Salado Creek Tributary | From the confluence with segment 1910 to the upper end of the water body | 1910C_01 | No Station | None | *E. coli* |
| Menger Creek | From the confluence with segment 1910 to the upper end of the water body | 1910D_01 | 12693 | *E. coli* | None |
| Upper Salado | Upper Salado Creek from the confluence of Beitel Creek upstream to the headwaters in the city of Fair Oaks Ranch. | 1910F_01 | 17574 | None | Chlorophyll-a, Depressed DO (grab average) |

**Salado Creek Watershed Routine Data Analysis:**

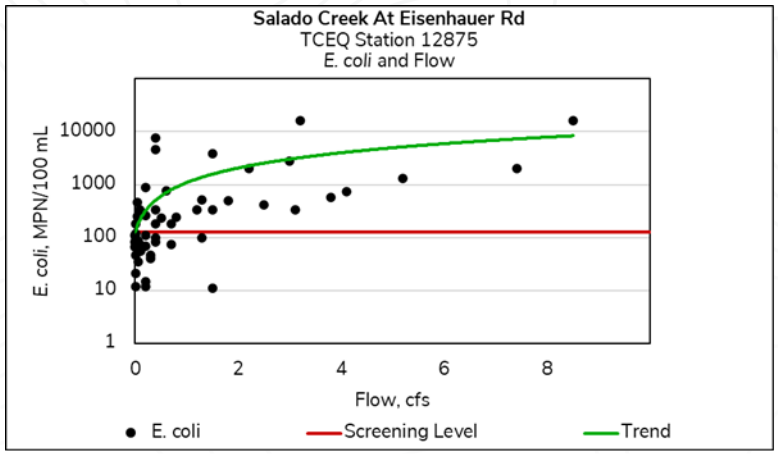
Four stations were examined for routine water quality on Salado Creek:

- Salado Creek at Eisenhauer Road (Station 12875)
- Salado Creek at Gembler Road (Station 12870)
- Salado Creek at Comanche Park (Station 14929)
- Salado Creek at Southton Road (Station 12861)

The 2022 IR identified an impairment for *E. coli* bacteria, fish and macrobenthic communities, dissolved oxygen, and concerns for the dissolved oxygen average screening criteria.

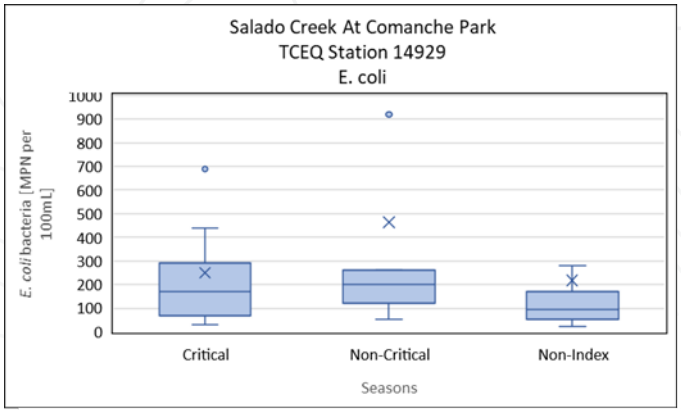
For *E. coli* bacteria none of the stations examined showed a significant trend over time. All of the stations except 14929 showed significant increasing trend as flow increased.

Station 14929 showed significant seasonality with elevated *E. coli* levels during the non-critical period. This is the period of time that includes May and June which are on average the months with the highest rainfall. It also includes the latter half of October which is the third highest rainfall month in this region.




*Plot showing increasing trend analysis as flow increases for E. coli bacteria at station 12875*

*E. coli* bacteria is an indication of recent fecal contamination. In this watershed, we typically see *E. coli* levels increase substantially due to stormwater runoff. As stormwater runoff flows over land, it picks up pollutants including fecal matter and transports them to the creek.




*Plot showing that the average and median values are highest during the Non-Critical Period season. This is a time rainfall is highest.*

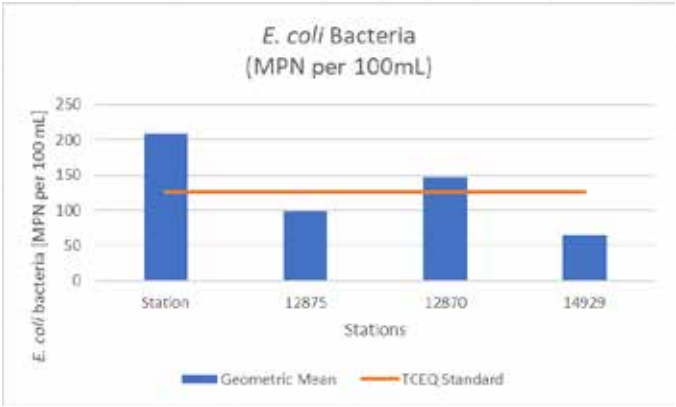
According to the 2022 IR, the three uppermost AUs had impairments for *E. coli* bacteria. The most downstream site meets the criteria for *E. coli* bacteria. This area is more rural, with less impervious cover.

The most upstream site (12875) has the highest geometric mean. This is an area that is just downstream from a highly urbanized area. The plot shows the geometric mean for the four sites evaluated. Two sites are meeting the TCEQ standard (12870 and 12861) the other two sites (12875 and 14929) are not.

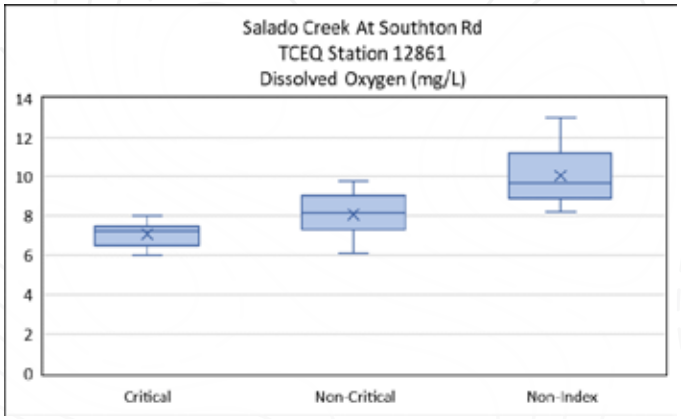
Evaluation of the four stations reviewed showed that one of the two stations in AU 1910_02 actually meets the TCEQ standard for *E. coli* bacteria. This station is the first station downstream from the SAWS re-use water. The re-use water typically has very low *E. coli* values. The geometric mean is less than 7 MPN per 100 mL for the re-use water.

SARA is currently sending samples to Texas A&M University to determine the source of the fecal matter at several stations on Salado Creek. In other watersheds that we have already used bacteria source tracking, at least half of the fecal matter is from wildlife. Data collected through the Clean Rivers Program and additional data collected specifically by SARA targeting stormwater events are being used to calibrate water quality models to determine where the best place is to implement best management practices (BMP) to reduce bacteria.

The Upper San Antonio River Implementation Plan (I-plan) includes Salado Creek, Walzem Creek, and Menger Creek to reduce *E. coli* bacteria in the basin. The I-plan was approved by TCEQ on April 6, 2016. Stakeholders continue to meet annually to discuss actions taken to reduce *E. coli* levels. The I-plan has 30 management measures to reduce E. coli bacteria, including reduce sanitary sewer overflows, advance low impact development, and expansion of the Pooper Scooper Program.




*Plot showing the geometric mean for E. coli bacteria at the four stations analyzed. Values are from upstream (left) to downstream (right) on Salado Creek.*




*Plot showing seasonality at station 12861. The highest dissolved oxygen levels are during the non-index period and the lowest values are during the critical period when temperatures are higher, and the flow is low.*

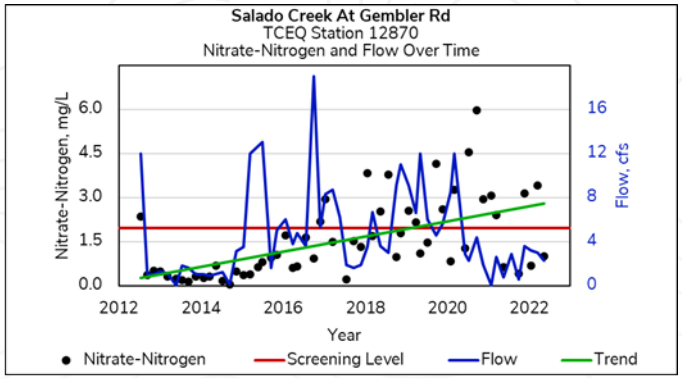
All four stations showed significant seasonality for dissolved oxygen with the mean value the lowest during the critical period. Dissolved oxygen levels are highest during the non-index period where temperatures are typically cooler. Dissolved oxygen levels are lowest during the critical period. During the critical period, temperatures are at their warmest, and flows are at their lowest, except immediately after a storm. As the temperature of the water increases during the critical period, the amount of dissolved oxygen that the water can hold decreases. Also, organic substances such as algae and plants die and decompose, this process consumes oxygen which lowers the dissolved oxygen levels particularly at night when photosynthesis is not occurring.

For dissolved oxygen, the 2022 IR identified the upper most assessment unit (1910_04) had an impairment for minimum grab dissolved oxygen criteria. The period of record for the integrated report was from 12/1/2013 thru 11/30/2020, seven years. The data reviewed for this report is from 6/1/2012 thru 5/31/2022, 10 years. A total of 56 samples were collected for dissolved oxygen at station 12875 (the only station in this AU) and only 4 values were below the minimum dissolved oxygen criteria for this segment. So, during the period of record that individual data sets were reviewed, station 12875 is meeting the minimum grab dissolved oxygen criteria. This station was also identified as having a concern for the dissolved oxygen average screening level in the 2022 IR. The data examined for this report agrees with this.

This AU is identified as perennial, but flows are often very low. Flow values were less than 0.01 cfs 21.4% of the time. Since this station has no concerns identified for nutrients, it is believed that the main reason for low dissolved oxygen level is due to the low flows. The AU downstream (1910_03) is also identified as having a concern for the dissolved oxygen screening level. It is believed that this concern is also due to low flows.

A TMDL was adopted in 2001, and it was determined that there was additional capacity in Salado Creek to assimilate oxygen -demanding materials, so an implementation plan was not needed. To preserve and protect the creek, stakeholders have introduced reuse water into the creek at John James Park (just below the station sampled for 1910_03), rehabilitated the sewage system that runs along the creek, and added a linear park along much of the creek.

The 2022 IR report does not identify any nutrient concerns. However, station 12870, has elevated nitrate nitrogen. This station also has an increasing trend over time for nitrate nitrogen. Station 12870 is the first station downstream from the SAWS re-use water. The re-use water typically has elevated nutrient values, with an average of 20.8 mg/L. The elevated nitrate nitrogen is likely due to the re-use water.




Plot showing nitrate nitrogen with an increasing trend over time at station 12870.

Unclassified Waters:

No data met the requirements of at least 10 years without significant gaps.

Walzem Creek:

The 2022 IR indicated that there was an impairment for *E. coli* bacteria and a concern for nitrate nitrogen. It is believed that the main source of *E. coli* and nutrients is due to wildlife. Most of the creek is dry, but as it nears the confluence with Salado Creek, it widens out and birds are often seen in the shallow water bathing.

Salado Creek Tributary:

The 2022 IR indicated that there was a concern for *E. coli* bacteria. The 2022 IR indicates that there was insufficient data and that this is a carry forward from previous IR. A review of SARA data indicates that twenty sample were collected from 9/18/2008 thru 8/11/2010. The geometric mean was 243 MPN per 100 mL which is greater than the TCEQ standard of 126 MPN per 100 mL. No additional sampling has been completed at this site.

Menger Creek:

The 2022 IR indicated that there was an impairment for *E. coli* bacteria. This was also a carry forward from previous integrated reports. The geometric mean for this site was 487.65 MPN per 100 mL.

Upper Salado Creek:

The 2022 IR indicated two concerns: depressed dissolved oxygen and chlorophyll-a. This sample site is an impoundment on Salado Creek. There is little flow unless a recent stormwater runoff event has occurred.

*Salado Creek Springs at Comanche Park*
*Station: 14929*

**Evaluation of Habitat, Nekton (fish), Benthic Macroinvertebrate Communities and Diurnal Dissolved Oxygen:**

Habitat assessments are done during biological sampling events to holistically evaluate the health of a water body. Habitat quality can tell us how aquatic communities can be supported. The Habitat Quality Index (HQI) is a quantitative measurement used to assess aquatic habitat quality, as described in the Surface Water Quality Monitoring (SWQM) Procedures Manual. This is done by quantitatively and qualitatively assessing various features of the stream reach, including available instream cover, number of riffles, and the structure of riparian vegetation, among other things. These features have an intrinsic value for characteristics like bank stability, buffering capacity, and refugia for aquatic organisms. Based on the metrics measured, habitat quality is scored and then categorized as either limited, intermediate, high, or exceptional.

Assessment of habitat in the Salado Watershed included TCEQ stations 12861, 12870 and 14929 (Table 3-34). According to San Antonio River Authority (River Authority) data, current habitat in the Salado Watershed is described as high quality according to the HQI.

*Downstream view of Salado Creek at station 12870 during the habitat assessment done on August 11, 2022. The right side of the creek is shown with concrete separating the creek from the adjacent campground.*

*Table 3-34: Biological stations assessed in the Salado Creek*

| Station Number | Station Name |
|---|---|
| 12861 | Salado Creek at Southton Road |
| 12870 | Salado Creek at Gembler Road |
| 14929 | Salado Creek at Comanche Park |

Salado Creek at these stations is characterized by adequate instream cover to support aquatic populations, bed stability and a moderate number of pools and riffles. Other characteristics of Salado Creek, such as channel sinuosity and riparian buffer widths, are impacted by human interaction with the creek, including concrete-lined banks in some portions of the reach. Higher scores in these metrics indicate better instream and riparian habitat for aquatic organisms to inhabit, increasing species diversity and ecological integrity. The average width of the riparian buffer across the three sites is about thirteen meters and is dominated mainly by trees and grasses, with an average tree canopy coverage of about 81%. Developed canopy and understory are present, however, an established midstory is lacking. A more developed mid-story would allow for higher species abundance and diversity, leading to higher ecological function in the riparian zone. Due to higher abundance of instream cover and riffles, larger pools, and better reach aesthetics, station12861 trends with the highest quality habitat of the three sites.

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*Table 3-35: Species caught in the Salado Watershed and their native/non-native status and tolerances. Relative abundance for each species out of total individuals caught for the historical period assessed (2015-2018) and the current data period (2019-2022).*

| Common Name | Status | Tolerance | Relative Abundance | |
|---|---|---|---|---|
| | | | Historic (2015-2018) | Current (2019-2022) |
| Red Shiner | Native | Tolerant | 33.50% | 25.89% |
| Mimic Shiner | Native | Intolerant | 8.55% | 19.24% |
| Longear Sunfish | Native | Intermediate | 20.89% | 16.52% |
| Central Stoneroller | Native | Intermediate | 4.35% | 15.21% |
| Redbreast Sunfish | Non-Native | Intermediate | 16.58% | 6.54% |
| Western Mosquitofish | Native | Tolerant | 2.40% | 2.28% |
| Bluegill | Native | Tolerant | 2.59% | 2.09% |
| Bullhead Minnow | Native | Intermediate | 0.90% | 1.54% |
| Warmouth | Native | Tolerant | 1.95% | 1.47% |
| Rio Grande Cichlid | Native | Intermediate | 0.79% | 1.30% |
| Guadalupe Bass | Native | Intolerant | 0.08% | 1.26% |
| Texas Logperch | Native | Intolerant | 0.11% | 0.98% |
| Spotted Bass | Native | Intermediate | 0.41% | 0.91% |
| Redspotted Sunfish | Native | Intermediate | 1.73% | 0.88% |
| Channel Catfish | Native | Tolerant | 0.90% | 0.86% |
| Sailfin Molly | Native | Tolerant | 0.71% | 0.60% |
| Grey Redhorse | Native | Intermediate | 0.00% | 0.44% |
| Largemouth Bass | Native | Intermediate | 1.20% | 0.44% |
| Yellow Bullhead | Native | Intermediate | 0.90% | 0.33% |
| Blackstripe Topminnow | Native | Intermediate | 0.04% | 0.26% |
| Ghost Shiner | Native | Intermediate | 0.04% | 0.26% |
| Green Sunfish | Native | Tolerant | 1.01% | 0.26% |
| Mexican Tetra | Native | Intermediate | 0.11% | 0.19% |
| Flathead Catfish | Native | Intermediate | 0.15% | 0.16% |
| Spotted Gar | Native | Tolerant | 0.04% | 0.07% |
| Inland Silverside | Native | Intermediate | 0.00% | 0.02% |
| Common Carp | Non-Native | Tolerant | 0.00% | 0.02% |
| Orangespotted Sunfish | Native | Intermediate | 0.04% | 0.00% |
| Black Bullhead | Native | Tolerant | 0.04% | 0.00% |

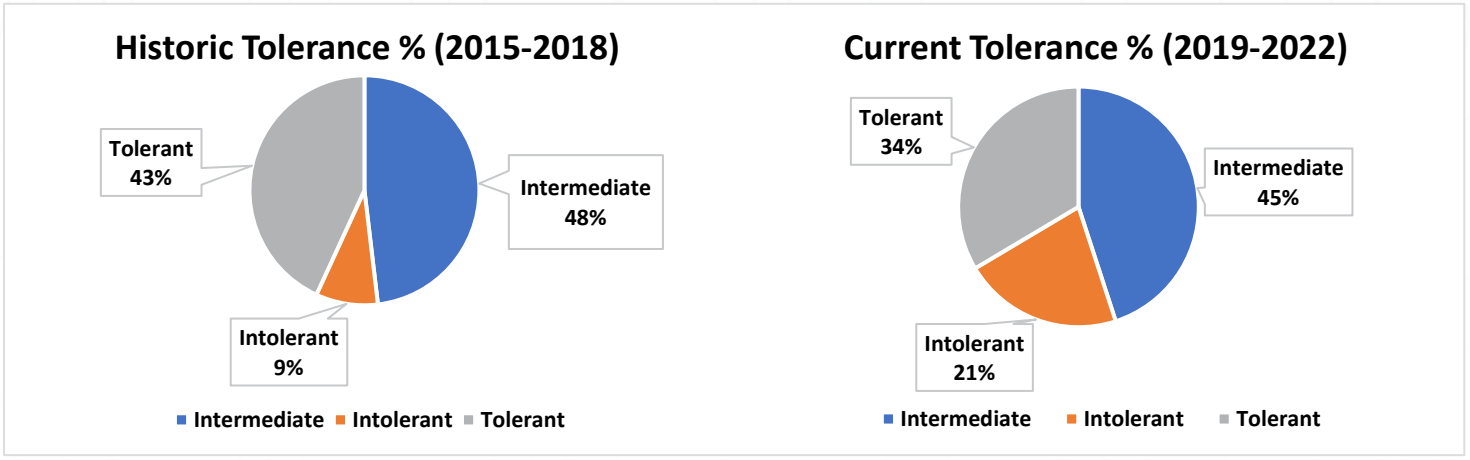
Index of Biotic Integrity (IBI) is a measure of ecosystem health that uses a variety of metrics taken from survey data to estimate fish community health. These metrics include species composition, trophic composition, and percent intolerance. Based on current (2019-2022) River Authority data, scores ranged from 39 (intermediate) at station 12870 to 43 (high) at station 12861. The overall average score for all three sites was 41, indicating that the biotic integrity of the Salado Creek Watershed is of high quality.

All three stations showed an increase in overall IBI, by 11% on average from the historic to current data period. Station 12861 had an average improvement rate of 14%, the most of the three sites. In recent years, there has been an elevated abundance of sensitive fish species. For example, relative abundance of both Guadalupe Bass and Texas Logperch increased from 0.1% to 1% (Table 3-35). Additionally, relative abundance for non-native fish decreased. For example, Redbreast Sunfish decreased from 17% to 7% (Table 3-35). Data also revealed there was a general decrease in the abundance of tolerant species like Red Shiner, Green Sunfish, and Warmouth in

*Texas Logperch voucher from a nekton sampling event at Station 12681 Salado Creek at Southton Road on August 11, 2020.*

favor of more intermediate and intolerant species like the Central Stoneroller and Mimic Shiner. This change in species assemblage highlights an increasingly diverse and ecologically resilient fish community in Salado Creek.

Despite habitat having a slight decline in quality over the last several years, the quality of the fish community has improved. This improvement can be primarily attributed to station 12861, perhaps due to this station's further distance from the city center relative to the other stations, higher dissolved oxygen values, and its proximity to the confluence of Salado Creek and the San Antonio River. Segment 1910_02, assessed at stations 12870 and 14929, is considered to have both impaired fish community in water as well as impaired macrobenthic community in water. This could be for a myriad of reasons but may be due to depressed dissolved oxygen levels at these sites. Additional data and information will be collected or evaluated before a management strategy is selected.

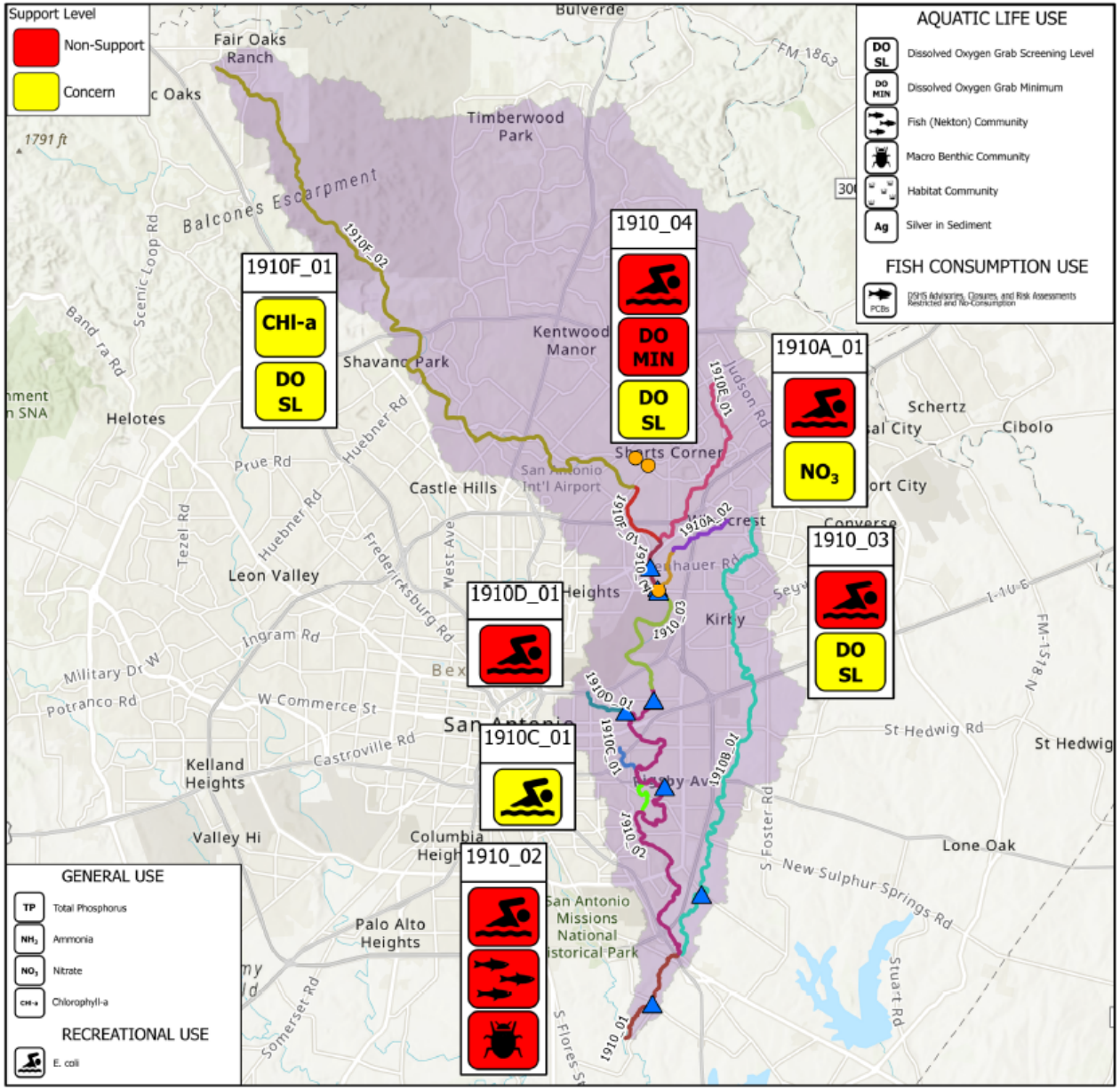



*Historic and current fish species tolerance percentage breakdowns for the Salado Creek Watershed.*

Benthic macroinvertebrates are excellent biological indicators of water quality as they are the first organisms to respond to changes in water chemistry and habitat alterations. The River Authority has continued efforts to collect benthic macroinvertebrates at stations 14929 and 12870. These data can be combined with the habitat and fish collection data to better understand stream health. The Benthic Index of Biotic Integrity (BIBI) is a quantitative measurement used by the TCEQ to assess macroinvertebrate assemblages and stream health, as described in Surface Water Quality Monitoring Procedures (SWQM). Data from 2019-2022 reveals the average score between the two stations was 27 (intermediate). In addition, the Hilsenhoff Biotic Index (HBI), a quantitative score based on the abundance of tolerant taxa, for the benthic community of the Salado Creek watershed was 5 out of a scale of 0-10. Recent data show a slight decrease in the average tolerant macroinvertebrate species, potentially indicating a decrease in physiochemical degradation.

The 2022 Texas Surface Water Quality Standards (TSWQS) lists a 24-hour dissolved oxygen criteria of 5.0 mg/L average and a 3.0 mg/L minimum for Salado Creek. DO levels can decrease to dangerous levels for myriad of reasons. Oxygen levels below the demand of the aquatic organisms in the stream will cause high levels of stress and mortality. Dissolved oxygen levels at the three biological stations averaged at 6.6 mg/L overall, ranging from 1.4 mg/L at station 12870 to 16.4 mg/L at station 14929. For the last several years, station 12870 has had lower dissolved oxygen values relative to the other stations. Basin-wide, minimum and average dissolved oxygen levels meet the TSWQ standards.

# Salado Creek Watershed Impairments




SARA Monitoring Station

Wastewater Outfalls

## Assessment Unit

- 1910A_01 - Walzem Creek
- 1910A_02 - Walzem Creek
- 1910B_01 - Rosillo Creek
- 1910C_01 - Salado Creek Tributary
- 1910D_01 - Menger Creek
- 1910E_01 - Beitel Creek
- 1910F_01 - Upper Salado Creek
- 1910F_02 - Upper Salado Creek
- 1910G_01 - Salado Creek West Channel
- 1910_01 - Salado Creek
- 1910_02 - Salado Creek
- 1910_03 - Salado Creek
- 1910_04 - Salado Creek

N

0 1.5 3 6 Miles

SAN ANTONIO RIVER AUTHORITY

*Table 3-36: Summary of Issues*

| Water Quality Issue | Affected Area | Possible Influences | Possible Effects | Possible Solutions / Actions Taken |
|---|---|---|---|---|
| Fecal Contamination (*E. coli* Bacteria Impairment).<br><br>Identified on 2022 Integrated Report | • Middle Salado Ck.<br>• Walzem Ck.<br>• Salado Tributary<br>• Menger Ck. | • Rapid urbanization impervious cover<br>• Construction stormwater controls failing<br>• Developments with septic tanks or small, privately-run wastewater treatment plants<br>• Small, slow-moving stream with little assimilative capacity<br>• Illegal dumping at creek crossings | • Increased quantity of stormwater scouring stream beds, creating additional sediment loading and urban-related pollutants<br>• Bacteria load from land use and effluent is not reduced by instream flow<br>• Significant primary contact recreation 1 (e.g., swimming) could lead to gastrointestinal illnesses | • Improve stormwater controls in new developments<br>• Adequate construction oversight<br>• Wastewater regionalization to prevent multiple small package plants and reduce septic tanks |
| Depressed Dissolved Oxygen<br><br>Identified on 2022 Integrated Report | • Salado Ck.<br>• Upper Salado Ck. | • Organic matter and nutrients transported to the creek due to stormwater runoff<br>• Low flows | • Low dissolved oxygen levels in the creek can cause stress and death to aquatic organisms | • Implement reuse water just below the Edwards Aquifer recharge zone on Salado Creek<br>• Encourage best management practices to reduce transportation of pollutants, especially nutrients and organic matter, to the river |

| Water Quality Issue | Affected Area | Possible Influences | Possible Effects | Possible Solutions / Actions Taken |
|---|---|---|---|---|
| Fish & Macrobenthic Communities<br><br>Identified on 2022 Integrated Report | • Salado Ck. Lower Middle | • Urbanization has contributed to the flashiness of the creek which disturbs instream habitat<br>• Stormwater runoff contributes to sporadic water quality issues | • Diminished fisheries and biological communities | • Improve riparian zone and implement stormwater BMPs to reduce flashiness of the creek<br>• Improve instream habitat<br>• Continue promoting stormwater BMPs<br>• Continue monitoring |
| Nutrient enrichment (Nitrate Nitrogen)<br><br>Identified on 2022 Integrated Report | • Salado Ck. Station 12870 (not identified in 2022 IR)<br>• Walzem Ck. | • Wastewater treatment plant effluent<br>• Spring water high in nitrates from geology of aquifer formation<br>• Row-crop agriculture | • Can increase production of algae causing an aesthetic nuisance<br>• Can cause significant swings in dissolved oxygen, affecting viability of aquatic life<br>• In moderate amounts, can actually enhance the fish population | • Watering golf courses and other open areas with effluent may actually reduce water quality due to reduced flows instream |

| Water Quality Issue | Affected Area | Possible Influences | Possible Effects | Possible Solutions / Actions Taken |
|---|---|---|---|---|
| Chlorophyll-a<br><br>Identified on 2022 Integrated Report | • Upper Salado Ck. (unclassified portion) | • Improper use of fertilizers<br>• Organic matter and nutrients carried to creek due to stormwater runoff.<br>• Low flow and pooling combined with warm temperature make a good habitat for growing algae | • Excessive algae in the water can increase the diurnal amplitude of dissolved oxygen in a creek. When the sun is out, photosynthesis occurs and dissolved oxygen levels are high, but when photosynthesis is not occurring at night, or the algae is decaying dissolved oxygen levels can get very low, causing stress and even death to aquatic organisms<br>• Elevated levels of chlorophyll-a can be an indication of toxic algae blooms | • Educate the public on the importance of using fertilizers according to manufacturer's directions<br>• Manage and dispose of pet and livestock waste properly, so it does not make its way to the creek<br>• Manage wildlife populations, by not feeding along waterways, and control invasive species such as feral hogs to reduce organic matter in the creek<br>• Manage stormwater runoff to reduce runoff in urban areas from picking up nutrients and waste and transporting them to the creek |

## Leon Creek Watershed Summary

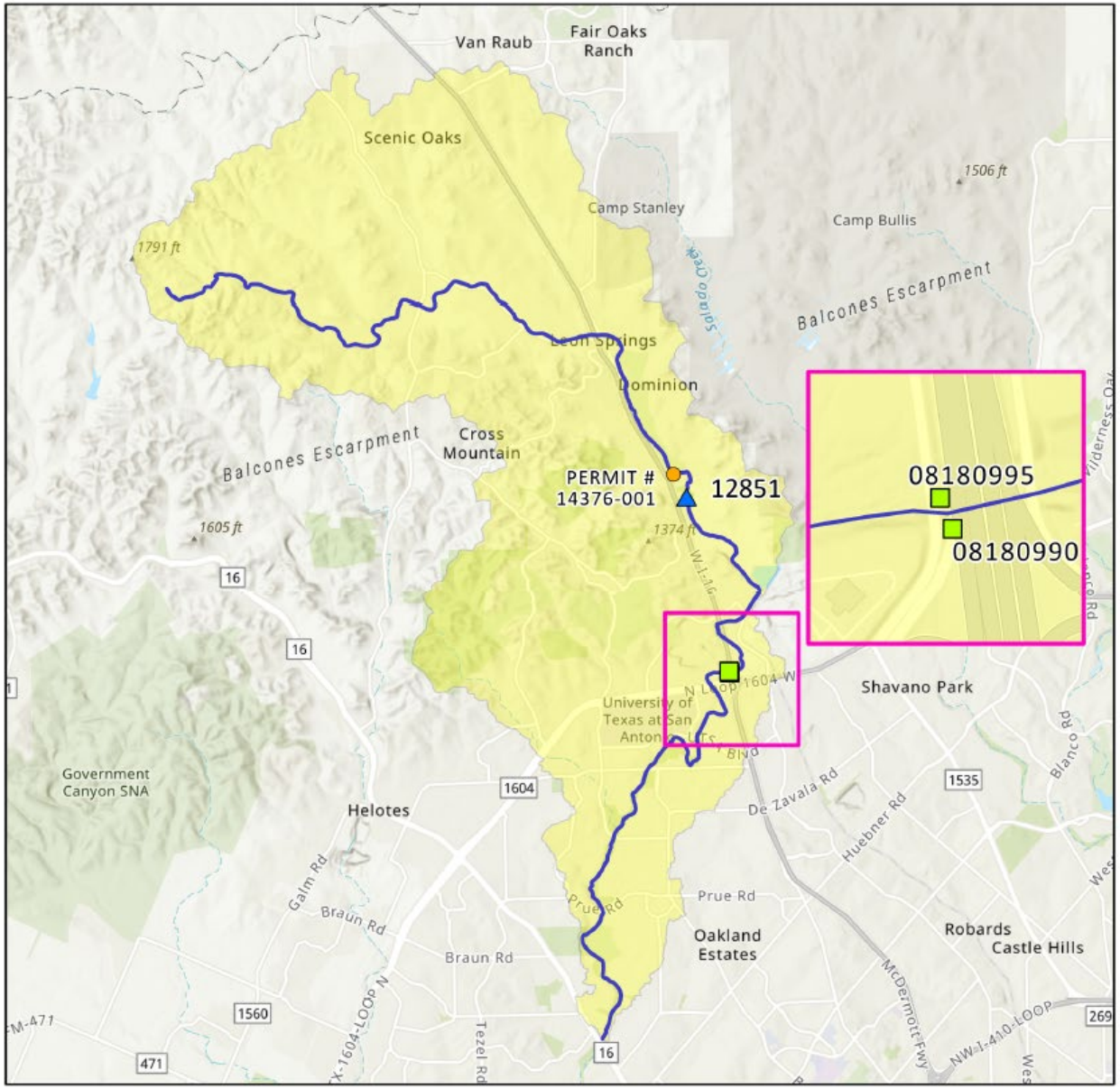
Leon Creek is broken up into two segments by the Texas Commission on Environmental Quality (TCEQ).

- Upper Leon Creek
- Lower Leon Creek

Most of the Upper Leon Creek is in the Edwards Aquifer contributing, recharge or transition zone. Due to this, low flows or no flows are common. There is little monitoring in the Upper Leon Creek because there is so little water except after stormwater events.

Lower Leon Creek is in a highly urbanized portion of San Antonio. In addition, Lower Leon Creek runs along the former Kelly Airforce Base (now referred to as Joint Base San Antonio). Since the 1980's the Air Force has been involved in remediation of contaminated soil and shallow groundwater.

# Upper Leon Creek Watershed





USGS Stations

Wastewater Outfalls

SARA Monitoring Station

## Assessment Unit

1907_01 - Upper Leon Creek

N

0 0.75 1.5 3 Miles

SAN ANTONIO RIVER AUTHORITY

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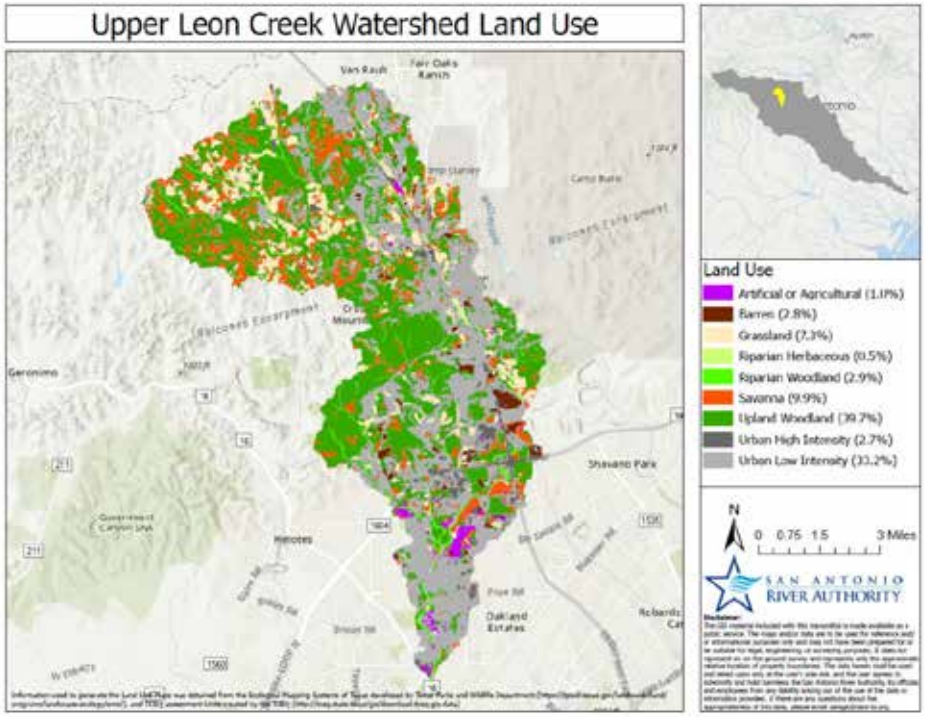
## Upper Leon Creek Watershed Summary

The headwaters of Upper Leon Creek originate approximately 2.4 kilometers south of Crow Ranch in Bexar County, north of Helotes, Texas. Upper Leon Creek generally flows southward west of and along the IH-10 corridor for about 24 miles until it becomes Lower Leon Creek 100 meters upstream of SH 16 in west San Antonio, Texas in Bexar County. The drainage area is approximately 60 square miles, which accounts for approximately 1.4% of the entire San Antonio River Basin. The majority of the Upper Leon Creek is a wide channel with ephemeral to intermittent flow with sparse large pools. Flow primarily occurs following heavy rainfall events. Upper Leon Creek contains one assessment unit.

Upper Leon Creek passes through the Texas Hill Country region in the Edwards Plateau ecoregion. Because of the karst topography, soils here are shallow above large limestone deposits. Topography in this region includes rolling hills created from the erosion of limestone deposits. Many of the larger private properties in the northwest portion of the watershed are used for hobby ranching. As the creek flows downstream towards Lower Leon Creek, the land shifts to gentle slopes into the Texas Blackland Prairies where it becomes Lower Leon Creek and is characterized by mainly rich clay soils.

Land use in Upper Leon Creek is primarily upland woodland (39.7%) and urban low intensity (33.2%). Upland woodland in the Edwards Plateau, where this western portion of the watershed occurs, is characterized mainly by mixed forests with vegetation typical of the Texas Hill Country such as a variety of oak species (*Quercus* spp.), Ashe juniper (*Juniperus asheii*), and cedar elm (*Ulmus crassifolia*) dominating the canopies and Texas persimmon (*Diospyros texana*) and mountain laurel (*Sophora secundiflora*) mixed in the mid-story. Urban low density, occurring along the IH-10 corridor and in the southern portion of the watershed inside Loop 1605 in San Antonio, can be described as urban



development that is built up but is not completely dominated by impervious cover. The grassland portions (7.3%) are dominated by various grasses such as little bluestem (*Schizachyrium scoparium*) and purple threeawn (*Arisitida purpurea*). Grassland areas typically occur near the riparian corridors throughout the upland woodland habitat.

Information used to generate the land use maps was obtained from the SARA GIS Department and includes Ecological Mapping Systems of Texas developed by Texas Parks and Wildlife Department (https://tpwd.texas.gov/landwater/land/programs/landscape-ecology/ems/ ), and TCEQ Assessment Units data created by the TCEQ https://gis-tceq.opendata.arcgis.com

Upper Leon Creek has one wastewater treatment plant.

*Table 3-37: Wastewater treatment plants in the watershed.*

| Permittee Name | Permit Number | Discharge |
|---|---|---|
| Leon Springs Utility Company | 14376-001 | ≤ 1 million gallons per day |

The San Antonio River Authority only monitors one site in the Upper Leon Creek watershed:

*Table 3-38: Stations currently monitored by the CRP in the watershed.*

| Location Description | AU | ID |
|---|---|---|
| Leon Creek in Raymond Russell Park at Low Water Bridge | 1907_01 | 12851 |

The US Geological Survey (USGS) currently has one real-time monitoring site in the Upper Leon Creek watershed. The USGS stream gages are maintained and operated by the USGS but rely on funding provided by state, regional and local agencies or organizations that sponsor the gaging stations.

*Table 3-39: US Geological Survey continuous monitoring stations.*

| Location | ID | Real Time Available Parameters | Additional Sponsors |
|---|---|---|---|
| Leon Ck at IH 10 and Loop 1604 near San Antonio, TX | 08180990 | Gage Height | San Antonio Water System, Texas Department of Transportation |

**Texas Integrated Report of Surface Water Quality for the Clean Water Act:**

The TCEQ's 2022 Integrated Report (2022 IR) identifies one assessment unit (AU) for Upper Leon Creek watershed and it has no impariments or concerns identified.

*Table 3-40: Impairments and concerns identified in the TCEQ 2022 Integrated Report*

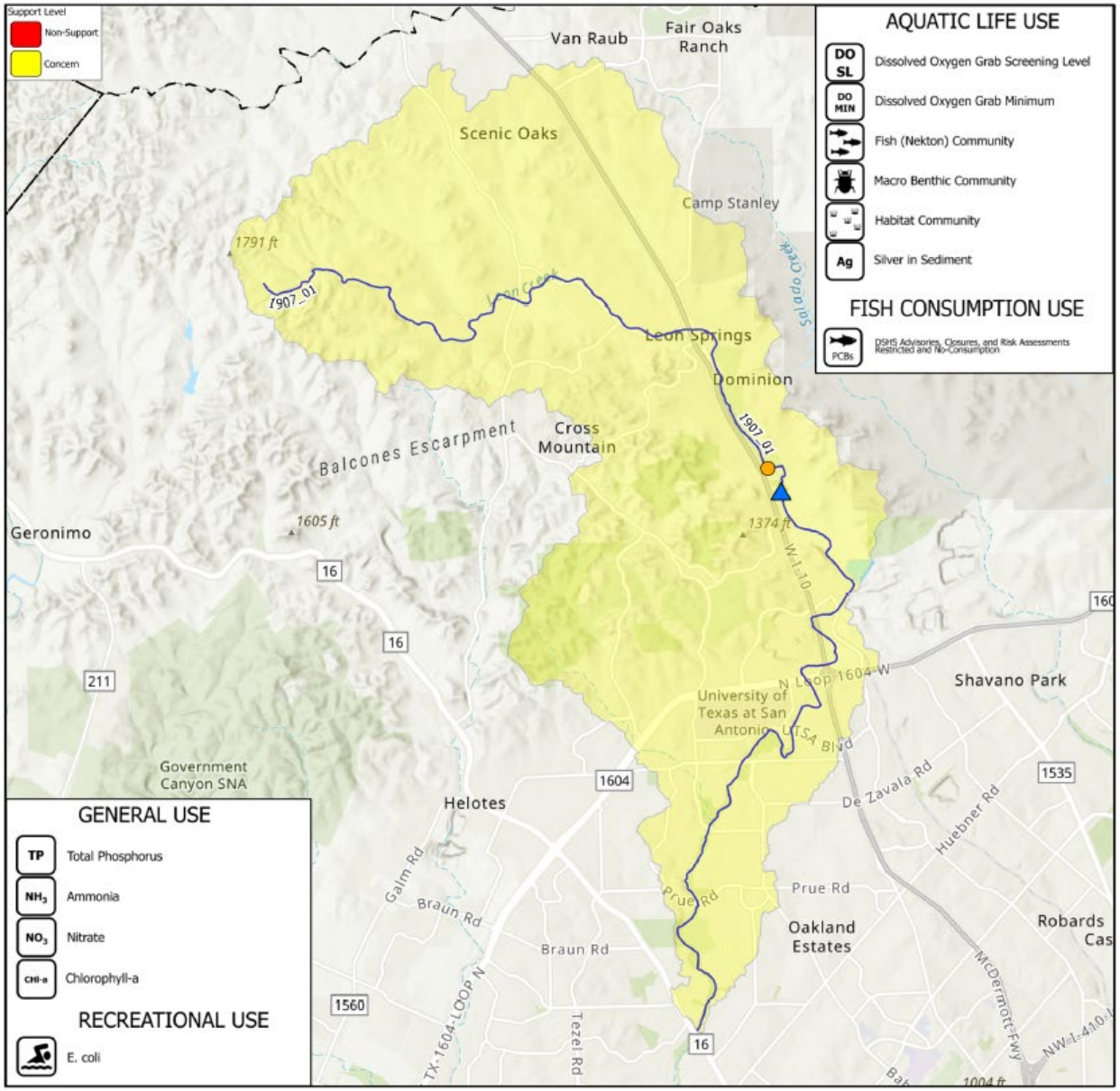
| Segment | AU Description | AU ID | Station ID | Impairments | Concerns |
|---|---|---|---|---|---|
| Upper Leon Creek | From a point 100 meters (110 yards) upstream of SH 16 northwest of San Antonio in Bexar County to a point 9.0 km (5.6 mi) upstream of Scenic Loop Road north of Helotes in Bexar County | 1907_01 | 12851<br>14252<br>20612 | None | None |

While the 2022 IR identifies the Upper Leon Creek as perennial, most of it is intermittent with pools due to the creek traversing the Edwards Aquifer Recharge and Transition Zones. The sample site (12851) is often pooled and identified as having no flow.

There were no sites that had a long-term record of sampling, so no seasonality or trend analysis was possible. This area watershed is highly urbanized, so using best management practices to manage stormwater runoff would be ideal. The City of San Antonio is currently developing the Howard W. Peak greenway trail systems along several urban creeks and rivers in urban areas. These trails are a great way to get the public in nature areas, but it is also a great way to protect riparian areas around the creek. Riparian areas help remove pollutants from stormwater runoff, by slowing down the flow and allowing the runoff to soak into the soil. Much of the Leon Creek greenway is in the Upper Leon Creek watershed. The Leon Creek Greenway offers approximately 20 miles of trails.


*Map of the Howard W. Peak Greenway Trail on Leon Creek, Salado Creek, Medina River, Upper San Antonio River, and Westside Creeks (Apache Creek, Alazan Creek, Martinez Creek, and San Pedro Creek). Map courtesy of the City of San Antonio.*

# Upper Leon Creek Watershed Impairments





Wastewater Outfalls

SARA Monitoring Station

## Assessment Unit

1907_01 - Upper Leon Creek

N

0 0.75 1.5 3 Miles

SAN ANTONIO RIVER AUTHORITY

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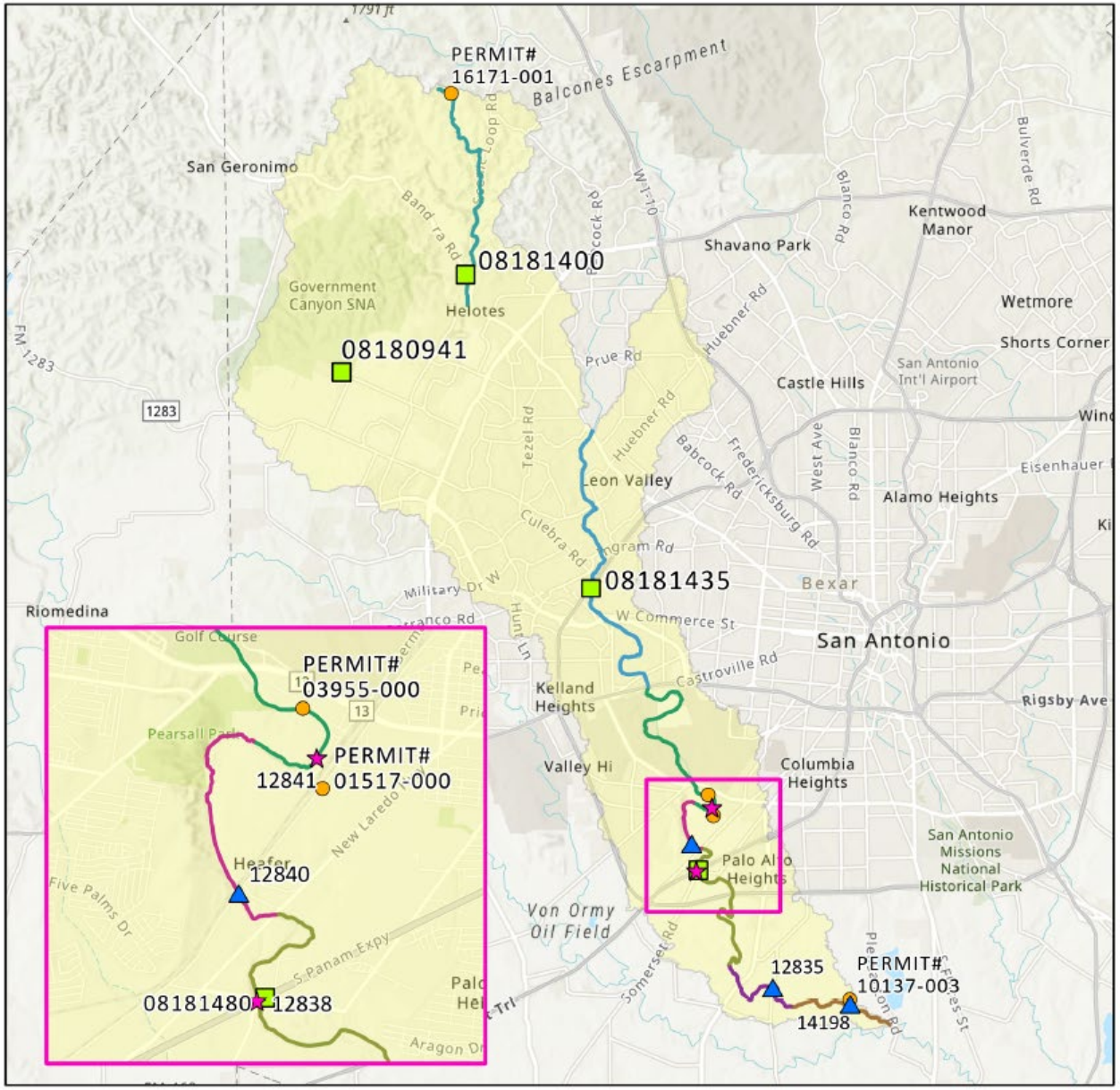
# Lower Leon Creek Watershed





- USGS Stations
- Wastewater Outfalls
- SARA Monitoring Station
- TCEQ Monitoring Station

**Assessment Unit**

- 1906A_01 - Helotes Creek
- 1906_01 - Lower Leon Creek
- 1906_02 - Lower Leon Creek
- 1906_03 - Lower Leon Creek
- 1906_04 - Lower Leon Creek
- 1906_05 - Lower Leon Creek
- 1906_06 - Lower Leon Creek

N

0 1.25 2.5 5 Miles

SAN ANTONIO RIVER AUTHORITY

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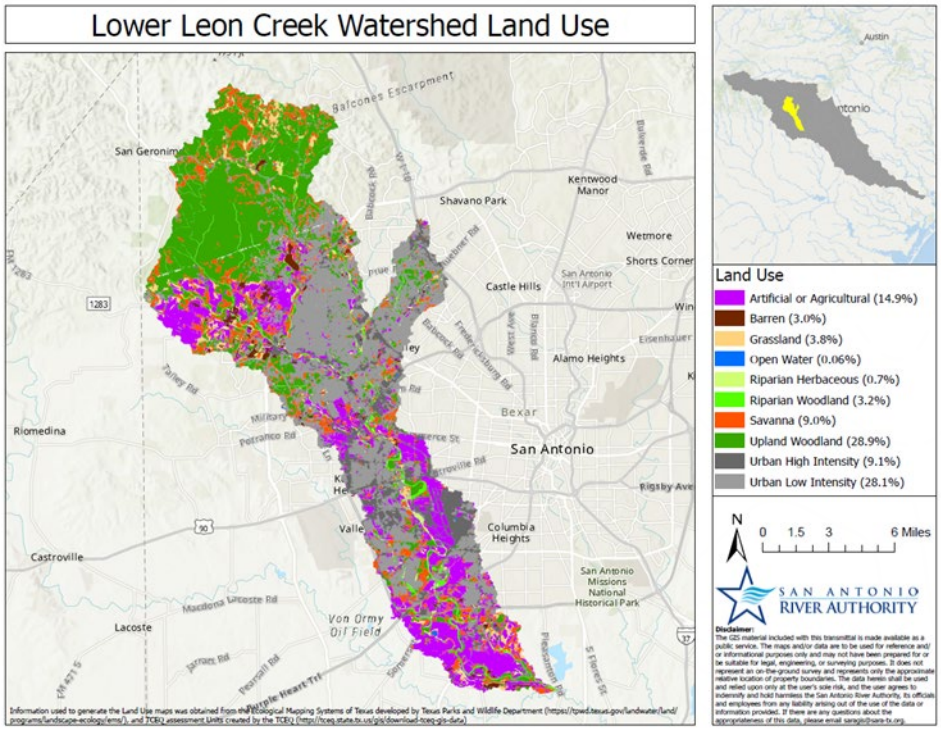
## Lower Leon Creek Watershed Summary

Lower Leon Creek originates 100 meters upstream of SH 16 in west San Antonio, Texas in Bexar County, downstream of Upper Leon Creek. Lower Leon Creek generally flows due south for about 32 miles until the confluence with the Medina River in Bexar County. The drainage area is approximately 177 square miles, which accounts for approximately 4.2% of the entire San Antonio River Basin. During years of below average precipitation, Lower Leon Creek begins as a wide, ephemeral creek bed that transitions to perennial flow just upstream of US 90 on the west side of San Antonio. Wastewater outfalls along Lower Leon Creek include permits from the San Antonio Water System, City Public Service of San Antonio, and the U.S. Department of the Air Force. Lower Leon Creek contains six assessment units.

The upper reaches of Lower Leon Creek flow through primarily urban areas in northwest and west San Antonio after flowing through the hill country areas of Helotes. Lower Leon Creek between Highway 16 and Highway 151 in San Antonio, Texas in Bexar County lies within the Edwards Aquifer Recharge Zone and primarily flows following heavy rain events. As the creek continues south, the channels become deeper and narrower and are surrounded by alluvial soil.

Land use in Lower Leon Creek is primarily upland woodland (28.9%) in the northernmost portion of the watershed, outside of Loop 1604 in San Antonio and from Helotes, Texas in Bexar County continuing north. The upland woodland habitat in this hill country is composed of mixed canopy forests which include a variety of oak species (*Quercus* spp.), Ashe juniper (*Juniperus asheii*), and cedar elm (*Ulms crassifolia*) dominating the canopies and Texas persimmon (*Diospyros texana*) and mountain laurel (*Sophora secundiflora*) mixed in the mid-story. The rest of the watershed south of Helotes, Texas in Bexar County is dominated by urban low intensity (28.1%) uses and then by artificial or agricultural



(14.9%) uses. Urban low intensity is defined by human-derived impacts, typically involving high impervious cover such as buildings and other man-made structures. Artificial or agricultural areas in the watershed are characterized mainly by row crops or grass farms. Smaller portions of the watershed, as the area moves closer to the downtown area of San Antonio, are classified as urban high intensity (9.1%), wherein large transportation corridors and other urban development cause the area to be dominated by impervious cover, thereby increasing stormwater runoff. The savanna portions (9.0%) contain various grasses interspersed with mesquite (*Prosopis glandulosa*), Ashe juniper, and oaks, while the grasslands (3.8%) are dominated by various bunch grasses including little bluestem (*Schizachyrium scoparium*) and inland sea oats (*Chasmanthium latifolium*).

Information used to generate the land use maps was obtained from the SARA GIS Department and includes Ecological Mapping Systems of Texas developed by Texas Parks and Wildlife Department (https://tpwd.texas.gov/landwater/land/programs/landscape-ecology/ems/ ), and TCEQ Assessment Units data created by the TCEQ https://gis-tceq.opendata.arcgis.com

There are four wastewater treatment plants in the Lower Leon Creek Watershed, three on Leon Creek and one on Helotes Creek.

*Table 3-41: Wastewater treatment plants in the watershed.*

| **Permittee Name** | **Permit Number** | **Discharge** |
|---|---|---|
| Municipal Operations LLC | 16171-001 | ≥ 1 million gallons per day |
| US Department of the Air Force | 03955-000 | groundwater |
| City Public Service of San Antonio | 01517-000 | ≥ 1 million gallons per day |
| San Antonio Water System | 10137-003 | ≥ 1 million gallons per day |

Currently five sites on the Lower Leon Creek are monitored.

*Table 3-42: Stations currently monitored by the CRP in the watershed.*

| Location Description | AU | ID |
|---|---|---|
| Leon Creek Upstream from Leon Creek WWTP and Approx 980 Meters Upstream of The Confluence with Comanche Creek | 1906_01 | 14198 |
| Leon Creek 24 Meters Downstream from Applewhite Road in San Antonio | 1906_02 | 12835 |
| Leon Creek At IH 35 South of San Antonio | 1906_03 | 12838 |
| Leon Creek at Quintana Road in San Antonio | 1906_04 | 12840 |
| Leon Creek At Low Water Crossing at Ruiz Ranch 1.73 Km Downstream of Loop 13 South of San Antonio | 1906_05 | 12841 |

The US Geological Survey (USGS) currently has 2 real-time monitoring sites on Lower Leon Creek and one site each on Helotes Creek and Culebra Creek. The USGS stream gages are maintained and operated by the USGS but rely on funding provided by state, regional and local agencies or organizations that sponsor gage stations.

*Table 3-43: US Geological Survey continuous monitoring stations.*

| Location | ID | Real Time Available Parameters | Additional Sponsors |
|---|---|---|---|
| Leon Creek at Loop 410 at San Antonio, TX | 08181435 | Gage Height, Precipitation | San Antonio River Authority |
| Leon Creek at IH 35, San Antonio, TX | 08181480 | Discharge, Gage Height | San Antonio River Authority |
| Helotes Creek at Helotes, TX | 08181400 | Discharge, Gage Height | Edwards Aquifer Authority |

| Location | ID | Real Time Available Parameters | Additional Sponsors |
|---|---|---|---|
| Culebra Ck in Government Canyon State Natural Area near Helotes, TX | 08180941 | Gage Height, Precipitation | San Antonio Water System |

**Texas Integrated Report of Surface Water Quality for the Clean Water Act:**

The TCEQ's 2022 Integrated Report (2022 IR) identified six assessment units (AU) with five AUs having either impairments and/ or concerns for Lower Leon Creek.

*Table 3-44: Impairments and concerns identified in the TCEQ 2022 Integrated Report*

| Segment | AU Description | AU ID | Station ID | Impairments | Concerns |
|---|---|---|---|---|---|
| Lower Leon Creek | From the confluence of the Medina River upstream approximate 3.5 mi to the northside of Toyota plant | 1906_01 | 14198 | None | None |
| | From the northside of the Toyota plant upstream to the confluence of Indian Creek | 1906_02 | 12836 | None | *E. coli* |
| | From confluence with Indian Creek to Hwy 353 (New Laredo Hwy) | 1906_03 | 12838 | PCBs in Edible Tissue | Depressed Dissolved Oxygen (avg) |
| | 4 From Hwy 353 (New Laredo Hwy) upstream approximately 2 mi to a point southeast of Pearsall Park | 1906_04 | 12840 | PCBs in Edible Tissue | *E. coli*<br>Depressed Dissolved Oxygen (avg) |
| | From a point southeast of Pearsall Park upstream to US 90 on the westside of San Antonio | 1906_05 | 12841<br>12843<br>12844 | *E. coli*<br>PCBs in Edible Tissue | Chlorophyll-a<br>Depressed Dissolved Oxygen (avg) |

| Segment | AU Description | AU ID | Station ID | Impairments | Concerns |
|---|---|---|---|---|---|
| | From US 90 on the westside of San Antonio upstream to a point 100 meters upstream of SH 16 northwest of San Antonio | 1906_06 | 12845<br>14209 | PCBs in Edible Tissue | *E. coli*<br>Chlorophyll-a<br>Silver in Sediment<br>Depressed Dissolved Oxygen (avg) |

**Lower Leon Creek Watershed Routine Data Analysis:**

Only datasets with at least 10 years of data and no significant data gaps were used in the analysis. Only one station met the criteria for analysis, Leon Creek Upstream Leon Creek WWTP (14198). All parameters examined were meeting either the TCEQ standard or screening criteria. Some concerning trends that are increasing over time include specific conductance, total dissolved solids (calculated from conductivity) and dissolved oxygen deficit. These parameters indicate deterioration in water quality; however, all are within TCEQ standards. Total dissolved solids are often caused by the natural leaching of minerals into the stream, but urbanization and stormwater runoff may also increase total dissolved solids. Dissolved oxygen deficit is increasing over time. This may be due to increased urbanization, and reduction in vegetation that often comes with urbanization.

Parameters that increase as flow increases are usually a result of pollutants being picked up from the land and transported to the creek. *E. coli* bacteria, ammonia nitrogen and nitrate nitrogen, while below the TCEQ's standard and screening levels, increase as flow increases. To protect the creek, protect riparian areas and increase green infrastructure such as the Howard Peak Greenway to allow the stormwater runoff slow down, soak in and allow the soil to filter the water as it makes it way to the creek.

Secchi depth decreased as flow increased. Secchi depth measures clarity. As flow increases, mainly due to stormwater runoff, pollutants are transported to the creek. Increased flows in the creek cause erosion and re-suspension of sediment which reduces the clarity of the water. Increasing green infrastructure and reducing impervious cover can protect and improve water quality.

**Leon Creek Watershed Issues:**

While the data set evaluated (Station 14198) had no impairments, this does not characterize the watershed.

In 2003, the Texas Department of Health issued a fish advisory recommending no consumption of any species from Leon Creek from the Texas State Highway 90 bridge downstream to Military Drive in San Antonio due to polychlorinated biphenyls (PCBs) in fish tissue.

In 2010, the Texas Department of State Health Services (DSHS) (previously known as Texas Department of Health) expanded the fish advisory recommending no consumption of any species from Leon Creek from the Old U.S. 90 bridge downstream to Loop 410 bridge due to PCBs in fish tissue.

In 2022, the DSHS published an addendum recommending continuing the consumption advisory for Leon Creek until contaminants such as PCBs, polychlorinated-p-dioxins (PCDDs)/ furans (PCDFs) and per- and polyfluoroalkyl substances (PFAS) decrease to a level that they are unlikely to pose a human health risk.

In 2016, a study by the US Geological Survey in cooperation with the San Antonio River Authority determined that PCB congeners found at Loop 410 site (upstream of Joint Base San Antonio) were different from samples collected at Joint Base San Antonio and downstream. The study indicated that there are multiple sources of PCBs in Leon Creek.

The upper portion of the Lower Leon Creek Segment has impairments and concerns with *E. coli* bacteria. There are also concerns for dissolved oxygen and chlorophyll-a. These are likely due to low flows in this portion of Leon Creek.

There is also a concern for silver in sediment. The source of this is unknown.

**Evaluation of Habitat, Nekton (fish) and 24 Hour Dissolved Oxygen:**

*TCEQ station 14198 during a habitat assessment on August 9, 2022.*

Habitat assessments are done during biological sampling events to holistically evaluate the health of a water body. Habitat quality can tell us how aquatic communities can be supported. The Habitat Quality Index (HQI) is a quantitative measurement used to assess aquatic habitat quality, as described in the Surface Water Quality Monitoring (SWQM) Procedures Manual. This is done by quantitatively and qualitatively assessing various features of the stream reach, including available instream cover, number of riffles, and the structure of riparian vegetation, among other things. These features have an intrinsic value for characteristics like bank stability, buffering capacity, and refugia for aquatic organisms. Based on the metrics measured, habitat quality is scored and then categorized as either limited, intermediate, high, or exceptional.

Assessment of habitat in the Lower Leon Creek Watershed from 2019-2022 included TCEQ station 14198 (Leon Creek upstream from Leon Creek Wastewater Treatment Plant). According to San Antonio River Authority (River Authority) data, current habitat in the Lower Leon Creek Watershed is described as high quality according to the HQI.

Lower Leon Creek at this station is characterized by overall high-quality features, including bottom substrate stability, large available pools, and an extensive riparian buffer zone. Some moderate features present include flow stability, bank stability, number of riffles, instream cover, and channel sinuosity. Higher scores in these metrics indicate better instream and riparian habitat for aquatic organisms to inhabit, increasing species diversity and ecological integrity. The average width of the riparian buffer across station 14198 is wider than twenty meters throughout the site and is dominated mainly by trees and grasses. The percent tree canopy coverage across the site is about 57%, providing ample shading to the creek. Developed canopy and understory are present, however, an established midstory is lacking. A more developed mid-story would allow for higher species abundance and diversity, leading to higher ecological function in the riparian zone.

*Table 3-45: Species caught in the Lower Leon Creek Watershed and their native/non-native status and tolerances. Relative abundance for each species out of total individuals caught for the historical period assessed (2015-2018) and the current data period (2019-2022).*

| Common Name | Status | Tolerance | Relative Abundance Historical (2015-2018) | Relative Abundance Current (2019-2022) |
|---|---|---|---|---|
| Blacktail Shiner | Native | Intermediate | 20.67% | 48.98% |
| Red Shiner | Native | Tolerant | 29.35% | 6.77% |
| Grey Redhorse | Native | Intermediate | 0.18% | 6.44% |
| Longear Sunfish | Native | Intermediate | 10.72% | 5.92% |
| Rio Grande Cichlid | Native | Intermediate | 1.10% | 5.78% |
| Texas Logperch | Native | Intolerant | 1.86% | 4.08% |
| Central Stoneroller | Native | Intermediate | 5.97% | 3.93% |
| Mimic Shiner | Native | Intolerant | 11.26% | 3.56% |
| Spotted Bass | Native | Intermediate | 2.83% | 3.31% |
| Bullhead Minnow | Native | Intermediate | 2.02% | 2.44% |
| Mexican Tetra | Native | Intermediate | 1.71% | 1.82% |
| Western Mosquitofish | Native | Tolerant | 3.65% | 1.70% |
| Channel Catfish | Native | Tolerant | 2.86% | 1.47% |
| Largemouth Bass | Native | Intermediate | 1.00% | 0.77% |
| Bluegill | Native | Tolerant | 1.97% | 0.77% |
| Guadalupe Bass | Native | Intolerant | 0.00% | 0.50% |
| Suckermouth Catfish | Non-native | Tolerant | 0.15% | 0.39% |
| Warmouth | Native | Tolerant | 0.18% | 0.31% |
| Redbreast Sunfish | Non-native | Intermediate | 0.20% | 0.21% |
| Gizzard Shad | Native | Tolerant | 0.05% | 0.17% |
| Flathead Catfish | Native | Intermediate | 0.69% | 0.14% |
| Sailfin Molly | Native | Tolerant | 1.02% | 0.14% |
| Spotted Gar | Native | Tolerant | 0.08% | 0.12% |
| American Eel | Native | Intermediate | 0.03% | 0.08% |
| Ghost Shiner | Native | Intermediate | 0.05% | 0.08% |
| Green Sunfish | Native | Tolerant | 0.31% | 0.06% |
| Longnose Gar | Native | Tolerant | 0.00% | 0.02% |
| Amazon Molly | Native | Intermediate | 0.05% | 0.02% |
| Redspotted Sunfish | Native | Intermediate | 0.03% | 0.02% |
| Common Carp | Non-Native | Tolerant | 0.03% | 0.00% |

Index of Biotic Integrity (IBI) is a measure of ecosystem health that uses a variety of metrics taken from survey data to estimate fish community health. These metrics include species composition, trophic composition, and percent intolerance. Based on current (2019-2022) River Authority data, the average score for station 14198 is a 49 (high), indicating that the biotic integrity of the Salado Watershed is of high quality.

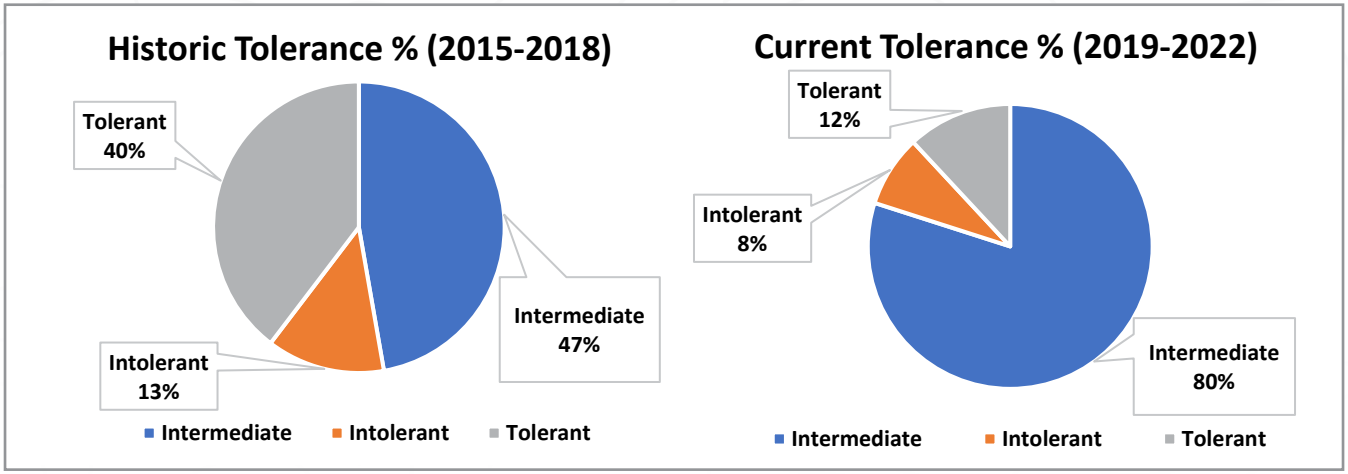
This Leon Creek station showed an increase in overall IBI, by 10% on average, when comparing current (2019-2022) and historic (2015-2018) data. In recent years, there has been an elevated abundance of sensitive and intermediate fish species. For example, relative abundance increased for Guadalupe Bass, 0% to 0.5%, and for Texas Logperch, 2% to 4% (Table 3-45). The most notable change is shown in Blacktail Shiner, having increased in relative abundance from 21% to 49%. In general, there was a larger increase of intolerant and intermediate individuals, like Guadalupe Bass, Texas Logperch, and Blacktail Shiner, than in tolerant individuals.

*Photo voucher of a Red Shiner (Cyprinella lutrensis) caught at TCEQ station 14198 Leon Creek upstream from Leon Creek WWTP on April 18th, 2022.*

The Lower Leon Creek watershed shows no concerns for either aquatic life or habitat for segment 1906 based on data gathered from this site in recent years (2019-2022).

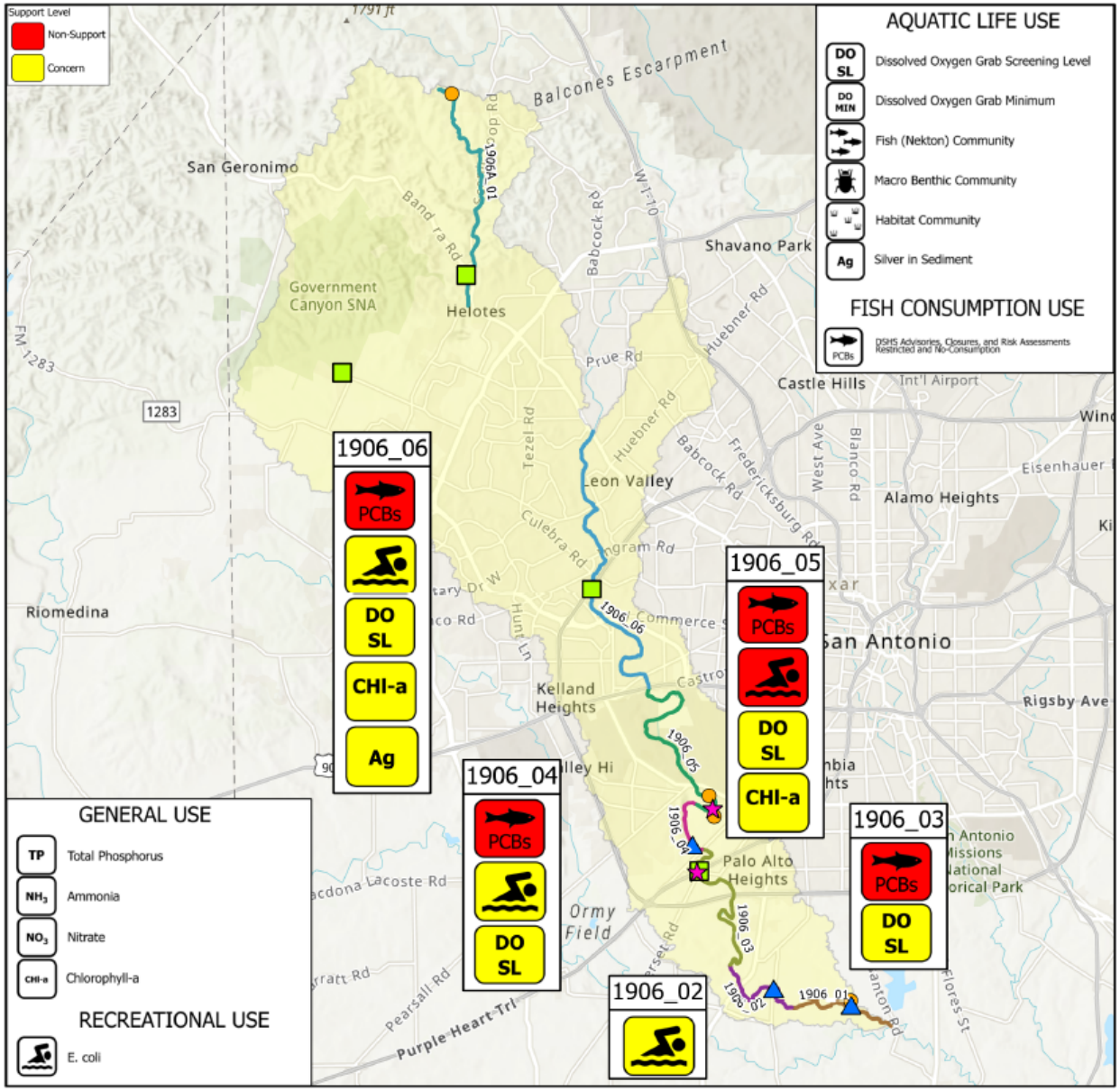
The 2022 Texas Surface Water Quality Standards (TSWQS) lists a 24-hour dissolved oxygen criteria of 5.0 mg/L average and a 3.0 mg/L minimum for Lower Leon Creek. Dissolved oxygen levels can decrease to dangerous levels for a myriad of reasons. Oxygen levels below the demand of the aquatic organisms in the stream will cause high levels of stress and mortality.

In the last several years, 24-hour dissolved oxygen readings have been taken at station 14198. Dissolved oxygen levels at this station from March 2015 to August 2022, ranged from 2.6 mg/L in August 2022 to 10.3 mg/L in August 2020. This assessment unit (1906_01) currently meets the TSWQS.




*Distribution of tolerance values for all species caught in the Lower Leon Creek Watershed during both the historic (2015-2018) and current (2019-2022) data periods.*

# Lower Leon Creek Watershed Impairments





- Wastewater Outfalls
- USGS Stations
- SARA Monitoring Station
- TCEQ Monitoring Station

## Assessment Unit

- 1906A_01 - Helotes Creek
- 1906_01 - Lower Leon Creek
- 1906_02 - Lower Leon Creek
- 1906_03 - Lower Leon Creek
- 1906_04 - Lower Leon Creek
- 1906_05 - Lower Leon Creek
- 1906_06 - Lower Leon Creek

N

0 1.25 2.5 5 Miles

SAN ANTONIO RIVER AUTHORITY

*Table 3-46: Summary of Issues*

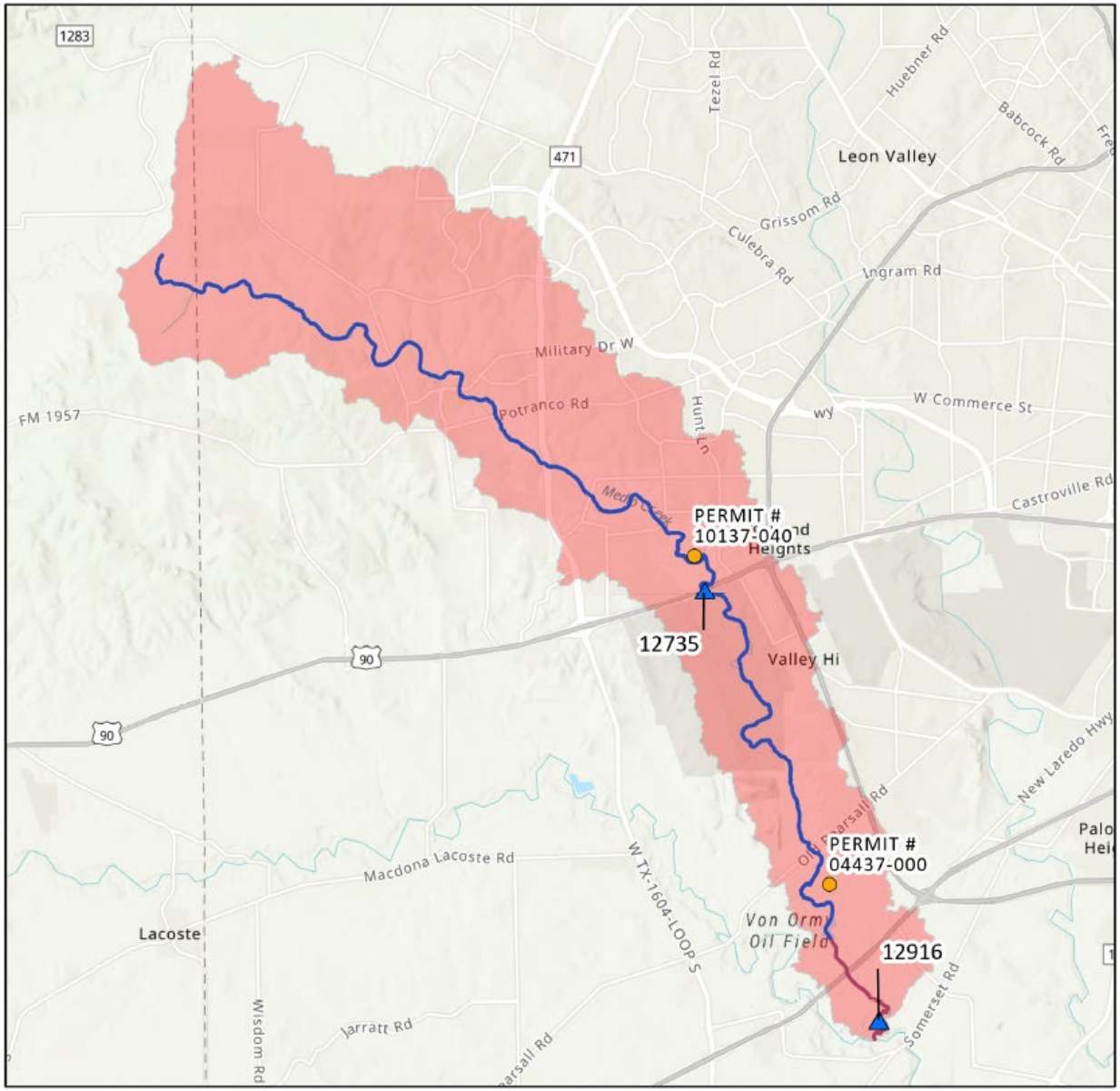
| Water Quality Issue | Affected Area | Possible Influences | Possible Effects | Possible Solutions / Actions Taken |
|---|---|---|---|---|
| Fecal Contamination (*E. coli* Bacteria Impairment).<br><br>Identified on 2022 Integrated Report | • Sporadic: Lower Leon Creek | • Rapid urbanization, impervious cover<br>• Construction stormwater controls failing<br>• Developments with septic tanks or small, privately-run wastewater treatment plants<br>• Small, slow-moving stream with little assimilative capacity<br>• Illegal dumping at creek crossings | • Increased quantity of stormwater scouring stream beds, creating additional sediment loading and urban-related pollutants<br>• Bacteria load from land use and effluent is not reduced by instream flow.<br>• Significant primary contact recreation 1 (e.g., swimming) could lead to gastrointestinal illnesses | • Improve stormwater controls in new developments.<br>• Adequate construction oversight<br>• Wastewater regionalization to prevent multiple small package plants and reduce septic tanks. |
| Depressed Dissolved Oxygen<br><br>Identified on 2022 Integrated Report | • Upper Portion: Lower Leon Creek | • Organic matter and nutrients transported to the creek due to stormwater runoff.<br>• Low flows | • Low dissolved oxygen levels in the creek can cause stress and death to aquatic organisms. | • Encourage best management practices to reduce transportation of pollutants, especially nutrients and organic matter, to the river. |

| Water Quality Issue | Affected Area | Possible Influences | Possible Effects | Possible Solutions / Actions Taken |
|---|---|---|---|---|
| Impairments for polychlorinated biphenyls (PCBs)<br><br>Identified on 2022 Integrated Report | • Leon Creek from Old US Highway 90 bridge downstream to the Loop 410 bridge. Upper portion of Lower Leon Creek. | • Illegal disposal of transformers, capacitors, hydraulic flids, lubricants containing PCBs.<br>• Accidental spills of fluids containing PCBs. | • Texas Department of State Health Services issued a fish advisory stating that persons should not consume any species of fish from these waters. | • San Antonio Metropolitan Health Districts have put up signs warning the public about the fish advisory.<br>• Multiple studies have been completed looking at this issue. PCBs are in fish tissue and sediment. |
| PFAS<br><br>Stakeholder Concern<br><br>Texas Department of State Health Services (DSHS) Addendum 01 | • Leon Creek from Old US Highway 90 bridge downstream to the Loop 410 bridge. Upper portion of Lower Leon Creek. | • Foam for fighting fires.<br>• Flame resistant materials.<br>• Landfills<br>• Too numerous to identify | • Serious human health effects from exposure | • Unknown what actions can be taken, other than testing to determine areas where PFAS is found and avoid ingestion of contaminated water, soil and tissue. |

| Water Quality Issue | Affected Area | Possible Influences | Possible Effects | Possible Solutions / Actions Taken |
|---|---|---|---|---|
| Silver in Sediment | • Upper Portion: Lower Leon Creek | • Industrial discharge<br>• Stormwater runoff over industrial areas. | • Impairments to aquatic organisms, particularly those with a larval stage. | • The River Authority analyzed silver in sediment in this AU. Four samples were analyzed in this AU and the values were less than the limit of quantitation. Unfortunately the limit of quantitation was greater than the TCEQ screening level. |

| Water Quality Issue | Affected Area | Possible Influences | Possible Effects | Possible Solutions / Actions Taken |
|---|---|---|---|---|
| Chlorophyll-a<br><br>Identified on 2022 Integrated Report | Upper Portion: Lower Leon Creek | • Improper use of fertilizers<br>• Organic matter and nutrients carried to creek due to stormwater runoff.<br>• Low flow and pooling combined with warm temperature make a good habitat for growing algae. | • Excessive algae in the water can increase the diurnal amplitude of dissolved oxygen in a creek. When the sun is out, photosynthesis occurs and dissolved oxygen levels are high, but when photosynthesis is not occurring at night, or the algae is decaying dissolved oxygen levels can get very low, causing stress and even death to aquatic organisms.<br>• Elevated levels of chlorophyll-a can be an indication of toxic algae blooms | • Educate the public on the importance of using fertilizers according to manufacturer's directions.<br>• Manage and dispose of pet and livestock waste properly, so it does not make its way to the creek.<br>• Manage wildlife populations, by not feeding along waterways, and control invasive species such as feral hogs to reduce organic matter in the creek.<br>• Manage stormwater runoff to reduce runoff in urban areas from picking up nutrients and waste and transporting them to the creek. |

# Medio Creek Watershed





Wastewater Outfalls

SARA Monitoring Station

## Assessment Unit

1912A_01 - Upper Medio Creek

1912_01 - Medio Creek

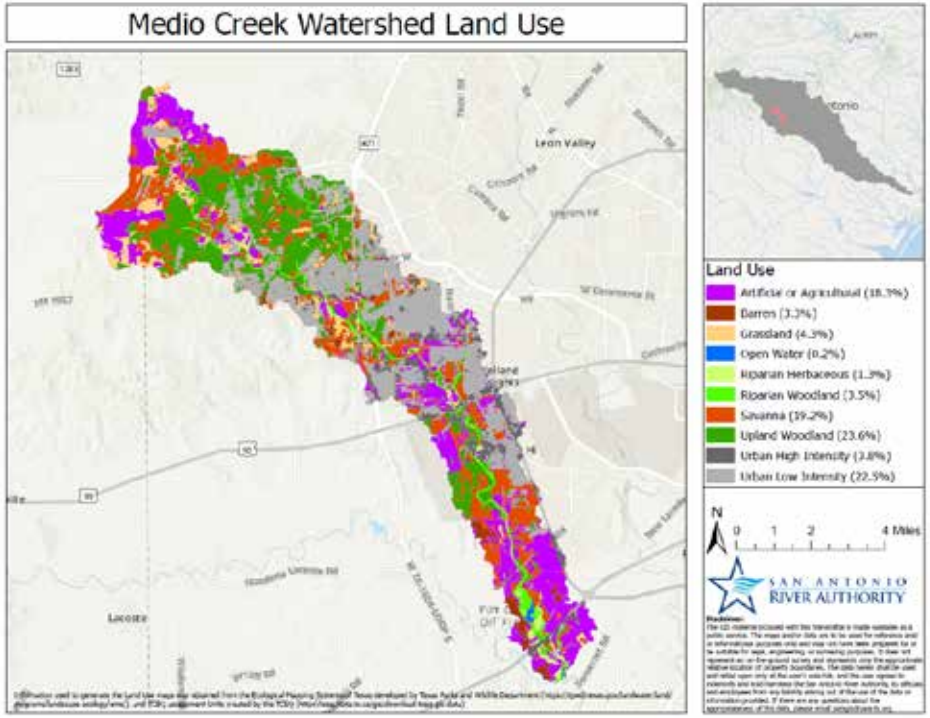
N

0 0.75 1.5 3 Miles

SAN ANTONIO RIVER AUTHORITY

**Disclaimer:**
The GIS material included with this transmittal is made available as a public service. The maps and/or data are to be used for reference and/or informational purposes only and may not have been prepared for or be suitable for legal, engineering, or surveying purposes. It does not represent an on-the-ground survey and represents only the approximate relative location of property boundaries. The data herein shall be used and relied upon only at the user's sole risk, and the user agrees to indemnify and hold harmless the San Antonio River Authority, its officials and employees from any liability arising out of the use of the data or information provided. If there are any questions about the appropriateness of this data, please email saragis@sara-tx.org.

**Medio Creek Watershed Summary:**




The headwaters of Upper Medio Creek originate approximately one mile upstream of the Bandera/Medina County line, approximately 1.5 kilometers southeast of the intersection of County Roads 381 and 471. Medio Creek generally flows southeastward for about 26 miles until it reaches its confluence with the Medina River below Medina Lake, approximately 580 meters northwest of the intersection of Von Ormy Road and Somerset Road in Von Ormy, Texas in Bexar County. The drainage area is approximately 54 square miles, which accounts for approximately 1.3% of the entire San Antonio River Basin. Upper Medio Creek is dry or intermittent from the headwaters for approximately 12 miles until it reaches the San Antonio Water System's Medio Creek Water Recycling Center located north of U.S. Highway 90 West.

The Medio Creek watershed is characterized by a mixture of land use and cover. The upper reaches of Medio Creek flow over a moderately sloped mixture of agricultural lands, forest shrub lands, and suburban neighborhoods consisting primarily of cobbly clay, silty clay, and Patrick soils. The middle portion of this creek continues to see higher levels of urban development near its confluence with Caracol Creek, near Loop 1604 S, and through the City of Von Ormy. Lower portions of Medio Creek are characterized by larger areas of forest, shrub, herbaceous and agricultural lands. The soils of the lower portions of the creek flow through level land comprised mainly of gullied lands with moderate to strong slopes at a closer proximity to the creek.

The undeveloped portions of this land are characterized as Blackland Prairie landscape. Forest vegetation consists of a variety of oak species (*Quercus* spp.), Cedar Elm (*Ulmus crassifolia*) and Netleaf Hackberry (*Celtis reticulata*) that dominate the canopies. The midstory consists of shurbs such as American Beautyberry (*Callicarpa americana*), Fragrant sumac (*Rhus aromatica*), and several species of *Yucca*. Grasses in the area are comprised of Big Bluestem (*Andropogpn gerardi*), Little Bluestem (*Schizachyrium scoparium)* and Indiangrass (*Sorghastrum nutans*).

Information used to generate the land use maps was obtained from the SARA GIS Department and includes Ecological Mapping Systems of Texas developed by Texas Parks and Wildlife Department (https://tpwd.texas.gov/landwater/land/programs/landscape-ecology/ems/ ), and TCEQ Assessment Units data created by the TCEQ https://gis-tceq.opendata.arcgis.com

Medio Creek has two wastewater treatment plants that currently discharge into the creek.

*Table 3-47: Wastewater treatment plants in the watershed.*

| Permittee Name(S) | Permit Number | Discharge |
|---|---|---|
| San Antonio Water System | 137040-040 | ≥ 1 million gallons per day |
| San Antonio Water System | 04437-000 | ≥ 1 million gallons per day |

The San Antonio River Authority currently monitors one site on Medio Creek and one site on a contributing segment of Medio Creek.

*Table 3-48: Stations currently monitored by the CRP in the watershed.*

| Location Description | AU | ID |
|---|---|---|
| Medio Creek at Hidden Valley Campground | 1912_01 | 12916 |
| Medio Creek at US 90 West | 1912A_01 | 12735 |

The US Geological Survey currently has no real-time monitoring sites on Medio Creek.

**Texas Integrated Report on Surface Water quality for the Clean Water Act:**

The TCEQ's 2022 Integrated Report (2022 IR) identified two assessment units (AU). The impairments and concerns are listed below.

*Table 3-49: Impairments and concerns identified in the TCEQ 2022 Integrated Report*

| Segment | AU Description | AU ID | Station ID | Impairments | Concerns |
|---|---|---|---|---|---|
| Medio Creek | From the confluence with the Medina River in Bexar County to a point 1.0 km upstream of IH 35 at San Antonio in Bexar County | 1912_01 | 12916 | *E. coli* | Total Phosphorus<br>Nitrate Nitrogen |
| Upper Medio Creek | From approximately 1.0 km (0.6 mi) upstream of IH 35 at San Antonio to approximately 1.0 mi. upstream of the Bexar/Medina County Line. | 1912A_01 | 12735 | None | Total Phosphorus<br>Nitrate Nitrogen<br>*E. coli* |

**Medio Creek Routine Data Analysis:**

Medio Creek:

Only datasets with at least 10 years of data and no significant data gaps were used in the analysis. Only one station met the criteria for analysis, Medio Creek at Hidden Valley Campground.

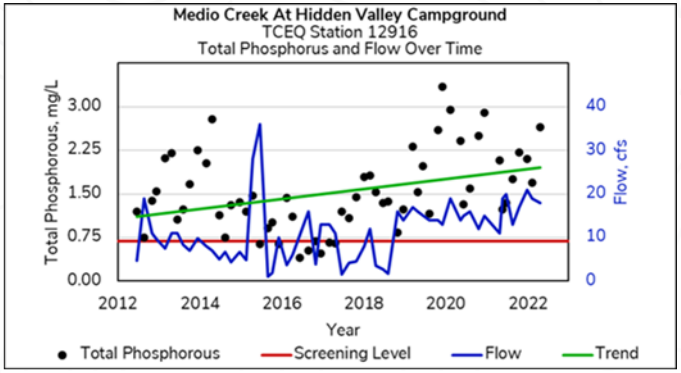
At this station the geometric mean for *E. coli* was 129.78 MPN per 100 mL, which is greater than the standard of 126 MPN per 100 ml. *E. coli* bacteria showed no seasonality or trending at this station.

70.0% of the nitrate nitrogen values did not meet the state screening level for nitrate nitrogen in freshwater streams.

88.3% of the total phosphorus values did not meet the state screening level for total phosphorus in freshwater streams.

Nutrients showed seasonality, their levels generally fluctuate predictively according to the seasons. For this report, the seasons were defined as: critical period (July 1st -September 30th), non-critical period (March 15th - June 30th plus October 1st - October 15th), and the non-index period (October 16th – March 14th).

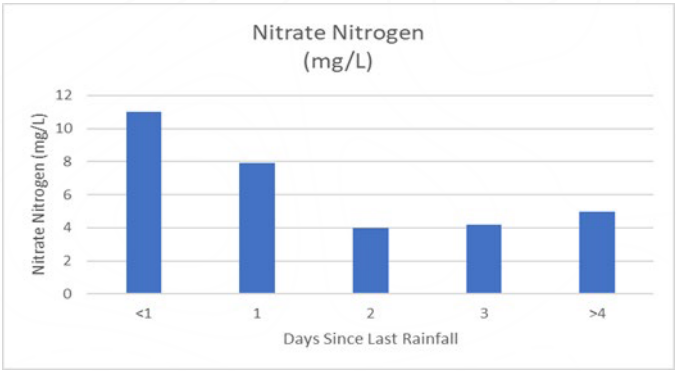
Nutrient (nitrate nitrogen and total phosphorus) levels are at their lowest levels during the critical period. This may be due the nutrients in the creek being taken up and stored by plants and algae. Also, nutrients levels were at their highest levels during the non-index period, this is the cooler part of the year when algae and aquatic plants are not as abundant.




*Graph showing trend of total phosphorus increasing over time.*

Nutrients (nitrate nitrogen and total phosphorus) both showed an increasing trend over time. This is likely due to the continued urbanization in the area, which also causes increased discharge to the wastewater treatment plants that discharge to Medio Creek. Nitrate nitrogen also showed an increase trend as flow increased.

A review of the data showed that nitrate values were highest on the days that it rained indicating that stormwater runoff contributed to the increasing trend.




*Graph showing that nitrate levels are highest on days that it rained for station 12916, indicating that elevated nitrate nitrogen levels are also due to stormwater runoff.*

Upper Medio Creek:

There is only one station in the unclassified protion of Medio Creek, and it had insufficient data for analysis. 2022 Integrated Report indicated that there were concerns for *E.coli* bacteria, nitrate nitrogen and total phosphorus. Less than a mile upstream of station 12735 is Medio Creek Wastewater Treatment Plant. Often elevated nutrient levels are associated with wastewater treatment plants. From station 12735 upstream to west Military Drive the area landuse is mainly subdivisions and light retail with substantial impervious cover from streets and homes which can increase stormwater runoff which can transport pollutants such as *E. coli* to the creek.

**Evaluation of Habitat, Nekton (fish), Benthic Macroinvertebrate Communities and Diurnal Dissolved Oxygen:**

*Downstream view of TCEQ station 12916 Medio Creek at Hidden Valley Campground during a habitat assessment on April 7, 2022.*

Habitat assessments are done during biological sampling events to holistically evaluate the health of a water body. Habitat quality can tell us how aquatic communities can be supported. The Habitat Quality Index (HQI) is a quantitative measurement used to assess aquatic habitat quality, as described in the Surface Water Quality Monitoring (SWQM) Procedures Manual. This is done by quantitatively and qualitatively assessing various features of the stream reach, including available instream cover, number of riffles, and the structure of riparian vegetation, among other things. These features have an intrinsic value for characteristics like bank stability, buffering capacity, and refugia for aquatic organisms. Based on the metrics measured, habitat quality is scored and then categorized as either limited, intermediate, high, or exceptional.

Assessment of habitat in the Medio Creek Watershed from 2019-2022 was completed at TCEQ station 12916 (Medio Creek at Hidden Valley Campground). According to San Antonio River Authority (River Authority) data, current habitat in the Medio Creek Watershed is described as high quality according to the HQI used by TCEQ.

High quality features in Medio Creek at this station include bottom substrate stability, flow consistency, and wide riparian buffer vegetation corridors. Moderate features include instream cover, pool size, and bank stability.  Higher scores in these metrics indicate better instream and riparian habitat for aquatic organisms to inhabit, increasing species diversity and ecological integrity. The average width of the riparian buffer across the site is about nineteen meters wide and is dominated mainly by trees and grasses. The percent tree canopy coverage across the site is about 83%, providing ample shading to the creek. Developed canopy and understory are present, however, an established midstory is lacking. This location is at a campground, A more developed mid-story would allow for higher species abundance and diversity, leading to higher ecological function in the riparian zone. This site is a private park. Lack of a midstory may be due to clearing of the area, browsing of wildlife and lack of sunlight from established trees.

*Table 3-50: Species caught in the Medio Creek Watershed and their native/non-native status and tolerances. Relative abundance for each species out of total individuals caught for the historical period assessed (2015-2018) and the current data period (2019-2022).*

| Common Name | Status | Tolerance | Relative Abundance Historical (2015-2018) | Relative Abundance Current (2019-2022) |
|---|---|---|---|---|
| Western Mosquitofish | Native | Tolerant | 2.89% | 28.03% |
| Blacktail Shiner | Native | Intermediate | 28.14% | 22.19% |
| Longear Sunfish | Native | Intermediate | 14.43% | 7.33% |
| Mexican Tetra | Native | Intermediate | 3.61% | 6.17% |
| Channel Catfish | Native | Tolerant | 2.16% | 4.97% |
| Red Shiner | Native | Tolerant | 10.62% | 4.73% |
| Threadfin Shad | Native | Intermediate | 0.10% | 4.00% |
| Bullhead Minnow | Native | Intermediate | 5.36% | 3.38% |
| Green Sunfish | Native | Tolerant | 7.01% | 2.85% |
| Mimic Shiner | Native | Intolerant | 4.23% | 2.85% |
| Rio Grande Cichlid | Native | Intermediate | 0.52% | 2.80% |
| Sailfin Molly | Native | Tolerant | 0.72% | 2.51% |
| Spotted Bass | Native | Intermediate | 3.61% | 1.64% |
| Bluegill | Native | Tolerant | 3.30% | 1.40% |
| Inland Silverside | Native | Intermediate | 2.78% | 0.82% |
| Flathead Catfish | Native | Intermediate | 0.52% | 0.72% |
| Central Stoneroller | Native | Intermediate | 5.57% | 0.53% |
| Texas Logperch | Native | Intolerant | 0.10% | 0.53% |
| Grey Redhorse | Native | Intermediate | 0.10% | 0.43% |
| Guadalupe Bass | Native | Intolerant | 0.00% | 0.43% |
| Largemouth Bass | Native | Intermediate | 2.37% | 0.39% |
| Gizzard Shad | Native | Tolerant | 0.00% | 0.29% |
| Orangespotted Sunfish | Native | Intermediate | 0.72% | 0.14% |
| Pterygoplicthys sp. | Non-Native | Tolerant | 0.00% | 0.14% |
| Red Spotted Sunfish | Native | Intermediate | 0.41% | 0.14% |
| Tadpole Madtom | Native | Intolerant | 0.00% | 0.14% |
| Spotted Gar | Native | Tolerant | 0.31% | 0.10% |
| Warmouth | Native | Tolerant | 0.21% | 0.10% |
| Amazon Molly | Native | Intermediate | 0.00% | 0.05% |
| Blackstripe Topminnow | Native | Intermediate | 0.00% | 0.05% |
| Blue Tilapia | Native | Tolerant | 0.00% | 0.05% |
| White Crappie | Native | Intermediate | 0.00% | 0.05% |
| Yellow Bullhead | Native | Intermediate | 0.00% | 0.05% |
| Burrhead Chub | Native | Intermediate | 0.21% | 0.00% |

Index of Biotic Integrity (IBI) is a measure of ecosystem health that uses a variety of metrics taken from survey data to estimate fish community health. These metrics include species composition, trophic composition, and percent intolerance. Based on current (2019-2022) data, the score for station 12916 is 45 (high), indicating that the biotic integrity of the Medio Creek Watershed is of high quality.

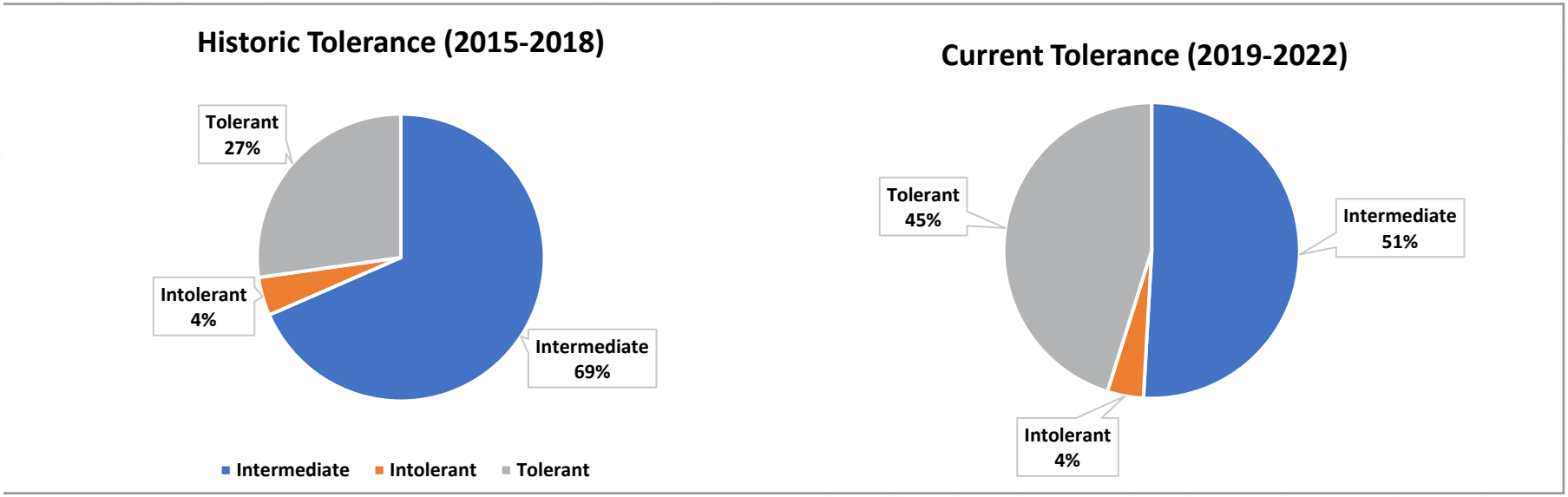
This Medio Creek station showed a 5% decrease in overall IBI when comparing current data to historic (2015–2018) data. In recent years, majority of the sensitive species have shown an increase in abundance. For example, relative abundance for Texas Logperch, Guadalupe Bass and Tadpole Madtom all increased. The Mimic Shiner, however, showed a decrease from 4% to 3% (Table 3-50). Overall, data revealed there was a general increase in the abundance of tolerant fish species like Channel Catfish, Western Mosquitofish, and Gizzard Shad. The non-native Pterygoplicthys sp., increased from not present to a relative abundance of 0.1%.

The Medio Creek Watershed shows no concerns for either aquatic life or habitat for segment 1912 based on current data.

*Photo voucher of a Sailfin Molly (Poecilia latipinna) caught at TCEQ station 12916 Medio Creek at Hidden Valley on July 25th, 2022.*

The 2022 Texas Surface Water Quality Standards (TSWQS) lists a 24-hour dissolved oxygen criteria of 4.0 mg/L average and a 3.0 mg/L minimum for Medio Creek. Dissolved oxygen levels can decrease to dangerous levels for a myriad of reasons. Oxygen levels below the demand of the aquatic organisms in the stream will cause high levels of stress and mortality.

In the last several years, 24-hour dissolved oxygen readings have been taken at station 12916. Dissolved oxygen levels at this station averaged at 6.2 mg/L overall, ranging from 4.5 mg/L in July 2019 to 9.0 mg/L in April 2019. Currently, Medio Creek is meeting both the minimum and average dissolved oxygen TSWQS.

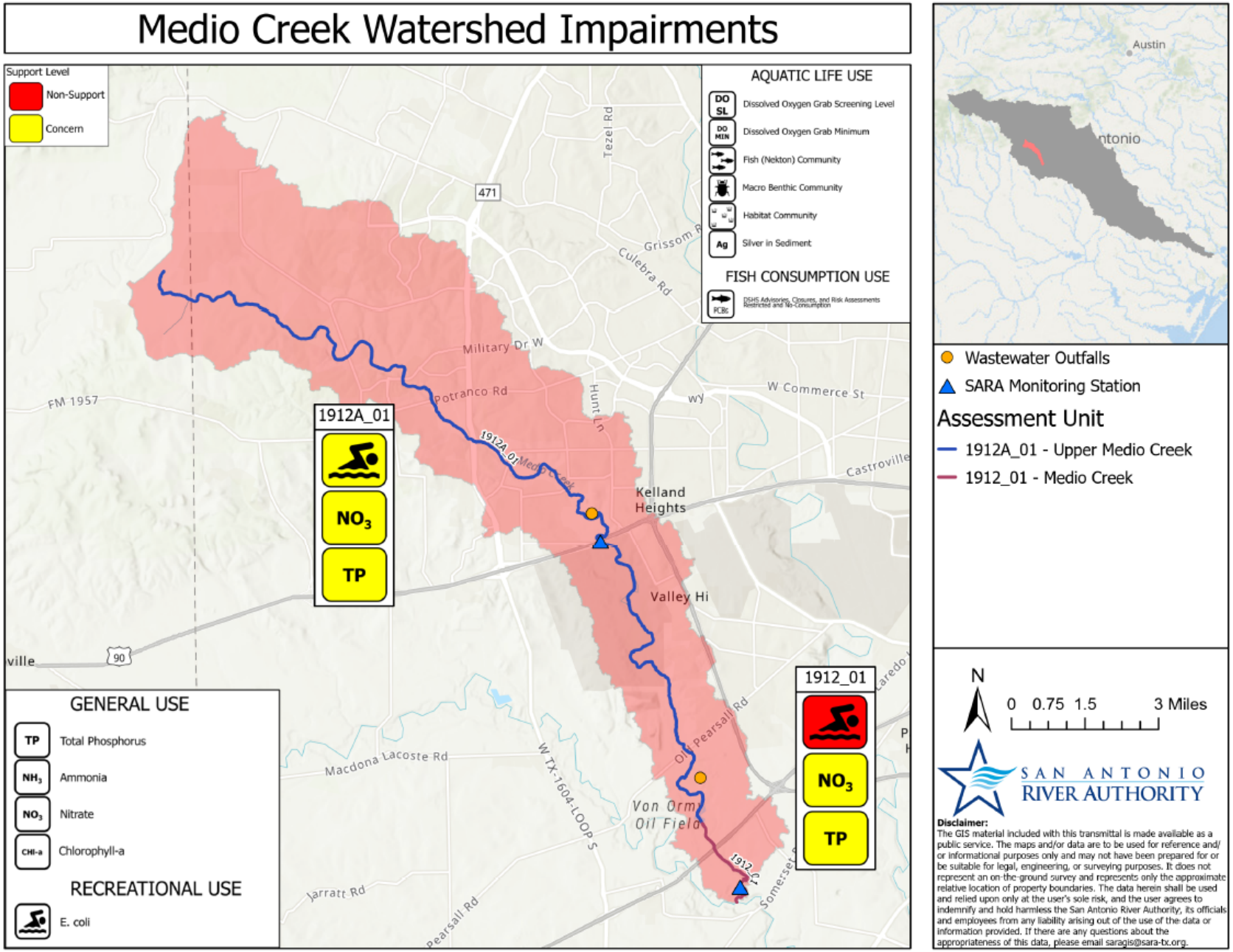



*stribution of tolerance values for all fish species caught in the Medio Creek Watershed during both the historic (2015-2018) and current (2019-2022) data periods.*

*Table 3-51: Summary of Issues*

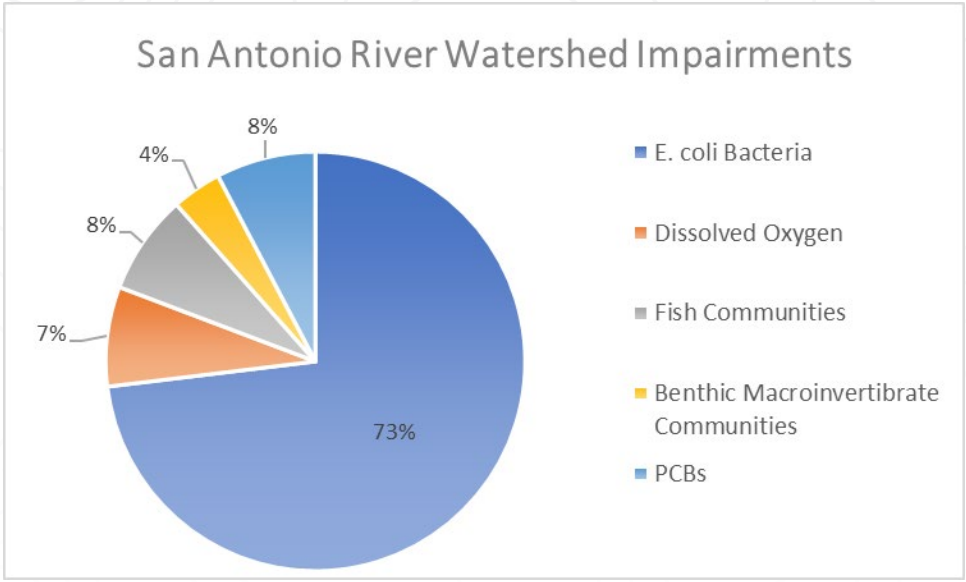
| Water Quality Issue | Affected Area | Possible Influences | Possible Effects | Possible Solutions / Actions Taken |
|---|---|---|---|---|
| Fecal Contamination (*E. coli* Bacteria).<br><br>Identified on 2022 Integrated Report | • Medio Creek entire watershed<br>• Upper Medio Creek entire watershed | • Rapid urbanization, impervious cover<br>• Construction stormwater controls failing<br>• Developments with septic tanks or small, privately-run wastewater treatment plants<br>• Small, slow-moving stream with little assimilative capacity illegal dumping at creek crossings | • Increased quantity of stormwater scouring stream beds, creating additional sediment loading and urban-related pollutants<br>• Bacteria load from land use and effluent is not reduced by instream flow.<br>• Significant primary contact recreation 1 (e.g., swimming) could lead to gastrointestinal illnesses | • Improve stormwater controls in new developments.<br>• Adequate construction oversight<br>• Wastewater regionalization to prevent multiple small package plants and reduce septic tanks. |
| Nutrient enrichment (nitrates and phosphorus)<br><br>Identified on 2022 Integrated Report | • Medio Creek entire watershed<br>• Upper Medio Creek entire watershed | • Wastewater treatment plant effluent<br>• Spring water high in nitrates from geology of aquifer formation<br>• Row-crop agriculture | • Can increase production of algae causing an aesthetic nuisance.<br>• Can cause significant swings in dissolved oxygen, affecting viability of aquatic life.<br>• In moderate amounts, can actually enhance the fish population | • If dissolved oxygen swings are significant and biology shows a related effect, then some phosphorus controls may be needed for wastewater treatment plants.<br>• Watering golf courses and other open areas with effluent may actually reduce water quality due to reduced flows instream |

# Medio Creek Watershed Impairments



# 4.0 Watershed Summary Recommendations & Conclusions

The TCEQ's Integrated Report (2022 IR) identifies impairments. An impairment is identified when a standard identified in Title 30, Chapter 307 of the Texas Administrative Code is not supported, evaluating the data according to the Guidance for Assessing and Reporting Surface Water Quality in Texas.




According to the 2022 Integrated Report the most common impairment in the San Antonio Watershed is *E. coli* bacteria. *E. coli* bacteria is an indicator of recent fecal contamination, and it is used to determine if the state's primary contact recreation standard is being met. *E. coli* bacteria impairments make of 73% of the impaired AUs in the San Antonio Watershed.

Samples have been collected to determine the source of the fecal contamination. Library dependent analyses were used to determine the sources. In each county tested, including Bexar County, greater than 50% of the isolates came from wildlife. This information can be used to target the source(s), by providing public outreach and education asking that the public not feed the wildlife near waterbodies. Two of the highest levels for *E. coli* bacteria are in Brackenridge Park and along the San Antonio River Walk. These are both areas with excessive wildlife because people are feeding the wildlife.

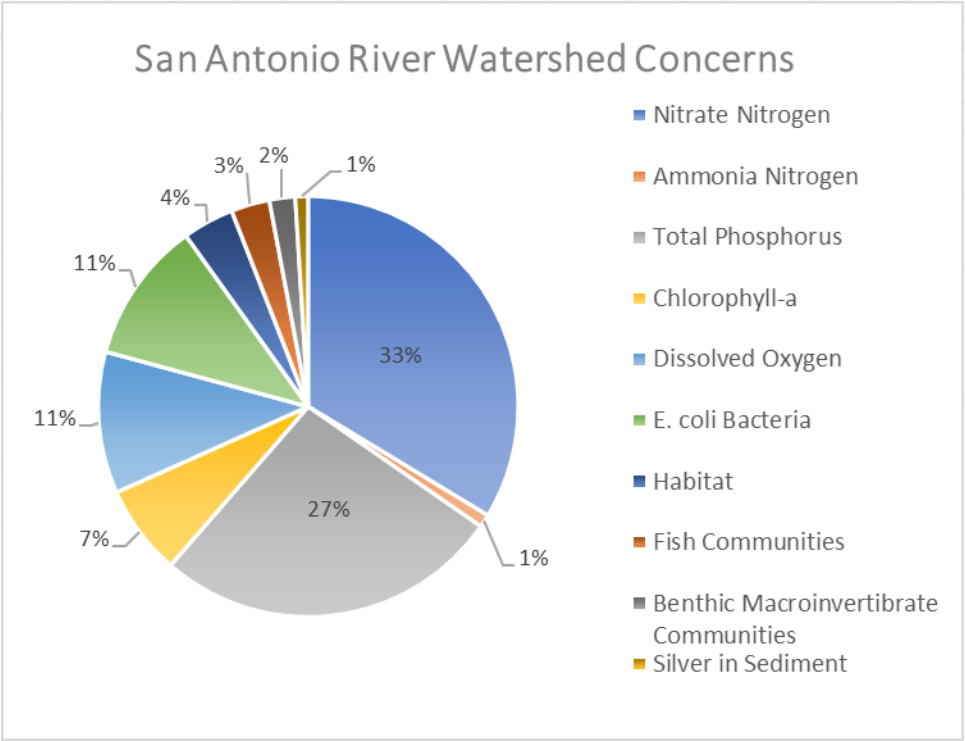
Fish communities are identified as impaired in 8% of the impaired assessment units and benthic macroinvertebrates are identified as impaired in 4% of the impaired assessment units. It is unclear the cause of these impairments. They may be due to water quality and / or habitat.

Dissolved oxygen is identified as an impairment in 7% of the impaired assessment units. Three out of four assessment units with dissolved oxygen impairments were streams with flows identified as intermittent with pools. The fourth station (Salado Creek) is identified as perennial but often had very low flows. The assessment unit with the impairment for

dissolved oxygen is upstream of the re-use water discharge to augment flow in the creek. The dissolved oxygen impairments may be due more to low flows than water quality.

PCBs in fish tissues are an impairment on a portion of Leon Creek only. This is believed to be a legacy pollutant released into the environment in and around the Lackland Air Force Base. A fish advisory has been issued advising the public not to eat any fish from a point 100 meters upstream of State Highway 16 northwest of San Antonio in Bexar County to its confluence with the Medina River due to PCB concentrations in fish tissue. Recently, Per-and polyfluoroalkyl substances (PFAS) have also been identified in fish tissue in the same area by the Texas Department of State Health Services.

The 2022 IR also identifies concerns. A concern for near non-attainment is identified when there is not sufficient data to identify an impairment for a standard identified in Title 30, Chapter 307 of the Texas Administrative Code or when there is not a standard, but TCEQ has identified screening levels in the Guidance for Assessing and Reporting Surface Water Quality in Texas. In this report we did not distinguish between the two types of concerns.




The most common concerns in this basin are for nutrients (nitrate nitrogen 33%, total phosphorus-27%, and ammonia nitrogen 1%). The TCEQ determined each nutrient screening level by determining the 85$^{th}$ percentile from their surface water quality monitoring database. Nutrient standards are needed that are specific for each river and creek to protect the aquatic ecosystem of rivers, creeks, bays and estuaries. Nutrients are needed for the development of aquatic plants and algae. These are the bases for the food web that support the aquatic ecosystems. Elevated levels of nutrients can cause algae blooms and overgrowth of aquatic plants. As algae and aquatic plants die and decompose, they consume oxygen and can cause fish kills, and dead zones. Determining the appropriate nutrient

level is a delicate balancing act. If the values are too high, you can create fish kills and dead zones in our rivers, creeks, bays and estuaries. If the nutrient level is too low, you can starve the aquatic ecosystem and harm fisheries in our rivers, creeks, bays and estuaries.

Chlorophyll-a is a pigment found in algae, and plants. Excessive nutrient levels can cause rapid growth, which in turn can cause low dissolved oxygen.

Silver in sediment was found only in one assessment unit on Leon Creek. The origin of this is unknown.

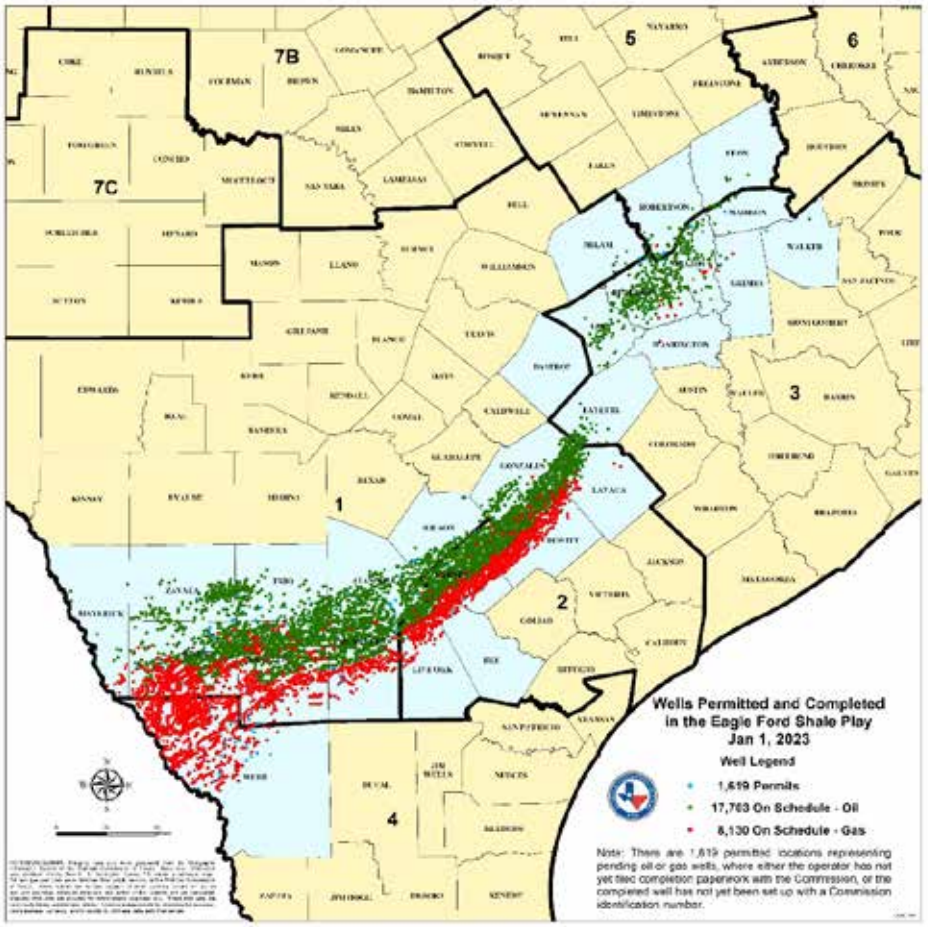
# 4.1 Recommendations & Comments

Stakeholder Concerns:

Stakeholders have expressed the following concerns either at the March 2023 CRP stakeholder meeting or at other meetings of the Environmental Advisory Committee (EAC).

- There is a concern about solar farms that are becoming popular in this basin. Possible concerns about pollutants generated and also erosion concerns. While this is outside of the Clean Rivers Program, staff investigated and provided a presentation at a follow up Environmental Advisory Committee meeting about solar farms.
- A stakeholder expressed concern about plastics in the basin. SARA staff informed the stakeholder that we were not testing for plastics in the basin as part of the CRP, but that we are in contact and assisting staff at University of Texas at San Antonio (UTSA) that are studying plastics locally.
- A stakeholder expressed concern about perfluoroalkyl and polyfluoroalkyl (PFAS). SARA staff informed the stakeholder that we were not testing for PFAS in the basin as part of the CRP and our laboratory does not have the capability to test for them. SARA did send some water samples to Texas A&M University researchers, and they analyzed for PFAS chemicals, and the values were low. SARA staff has also been in touch with Texas Department of State Health Services staff who did fish tissue analyses for PFAS, and we are following developments from EPA waiting for a PFAS stream standard.

- A stakeholder expressed concern about fracking which is a process that injects liquid at high pressure into a well to force open existing fissures to extract oil or gas. Most of the fracking is associated with the Eagle Ford Shale which is a hydrocarbon producing geologic formation. The Eagle Ford Shale oil production in the San Antonio River Basin is centered around the lower portion of Wilson County and Karnes County. This area includes portions of the Lower San Antonio River, Lower Cibolo Creek and Ecleto Creek. The USGS produced a scientific Investigations Report in 2018 with funding from the San Antonio River Authority. This study (Land-Cover Changes Associated With Oil and Natural-Gas Production and Concentrations of Selected Constituents in Surface-Water and Streambed-Sediment Samples Collected Upstream From and Within an Area of Oil and Natural-Gas Production, South Texas, 2008–17) looked at change in land use due hydrocarbon production and streambed sediment sample for potential pollutant concentrations.




*Map showing location of Eagle Ford Shale Play in Texas published by the Railroad Commission of Texas.*

- A stakeholder asked that weights be added to the hazardous waste disposal writeup in the public outreach in the report. Information from the last two hazardous waste disposal collections in each county has been added to the report.

Recommendations To Protect and Improve Water Quality:

- Continue monitoring throughout the watershed through the Texas Clean Rivers Program.
- An extensive study needs to be completed by the State or Federal Government to determine the steps needed to remediate the PCBs and PFAS pollutants and implement those steps so the fish from Leon Creek can safely be consumed by the public.
- A study needs to be completed by the State to determine nutrient standards to protect the ecological health of our creeks, rivers, bays and estuary. The results of the study need to be implemented by the state.
- Elevated *E. coli* levels are usually associated with stormwater runoff events. In an effort to reduce *E. coli* levels, SARA staff are developing and refining modeling to determine the best locations to install needed best management practices to reduce *E. coli* bacteria to levels that will meet the standard.
- Staff is supporting the modeling effort by conducting stormwater sampling to be used to calibrate the model in our district.
- The San Antonio River Authority is providing outreach and training for green infrastructure to help manage stormwater runoff.
- Samples have been collected to determine the source of the fecal contamination. Library dependent analyses were used to determine the sources. In each county tested, including Bexar County, greater than 50% of the isolates came from wildlife. This information can be used to target the source(s), by providing public outreach and education asking that the public not feed the wildlife near waterbodies. Two of the highest levels for *E. coli* bacteria are in Brackenridge Park and along the San Antonio River Walk. These are both areas with elevated wildlife populations because people are feeding the wildlife.
- Continue to participate and support implementation plans and watershed protection plans.
- Joint studies and funding need to be made available for the detection of nontraditional pollutants within the basin.
- Statewide outreach program to discourage people from feeding wildlife.
- Statewide outreach program about what can be done to stop the spread of invasive species.

# 4.2 Conclusions

The San Antonio River Authority, Bandera County River Authority and Groundwater District and the City of Boerne provide most of the data for the Integrated Report that TCEQ publishes every two years. Because of the CRP, our staff are out in the basin collecting samples, but also identifying issues such as fish kills, encroachment on the river, and illegal dumping, and resolving the issue or passing this information to other entities that can resolve the issue. Knowledge gained through the CRP and building relationships with landowners and local governments has allowed SARA to assist researchers at universities and get access to research in our watershed. Without the CRP, there would be considerably less known about the water quality, aquatic ecology and riparian areas in the San Antonio River Watershed.

Dr. H. James Harrington said: ""Measurement is the first step that leads to control and eventually to improvement. If you can't measure something, you can't understand it. If you can't understand it, you can't control it. If you can't control it, you can't improve it."

In the next biennium the San Antonio River Authority and our partners plan to continue to collect, submit and analyze scientifically defensible water quality data, and information about biological communities in and around our creeks, rivers and lakes. Make this data accessible to students, researchers, public and other agencies so it may be used to improve water quality and biological communities. The data that the CRP gathers are the building blocks for other programs designed to improve water quality and the ecology of our watershed. Programs and agencies use this data to develop implementation plans, watershed protection plans and permitting discharges into our creeks and rivers. The San Antonio River Authority uses the data to develop water quality models that can be used to determine the best areas to implement best management practices to reduce pollutants. Staff use the information gathered to make informed decisions on improving biological communities and stream restoration. While staff is out sampling, they report any concerns they find to SARA's Environmental Investigator, or other agencies who have enforcement powers.

Since our information is available in an easy-to-use format, we will never fully know the extent that the data collected by the CRP is used to protect and improve water quality and the ecology of our riverine systems, but we do know that it is used by others.

# Appendix A - List of Acronyms

| | |
|---|---|
| AU | Assessment Unit |
| Ave | Average |
| BCRAGD | Bandera River Authority and Ground Water District |
| BMP | Best Management Practice |
| BST | Bacteria Source Tracking |
| cfs | Cubic Feet Per Second |
| CMM | Coordinated Monitoring Meeting |
| CMS | Coordinated Monitoring Schedule |
| CN | Concern for Designated Use |
| CRP | Clean Rivers Program |
| CS | Concern for Screening |
| CWA | Clean Water Act |
| DNA | Deoxyribonucleic Acid |
| DO | Dissolved Oxygen |
| DSHS | Department of State Health Services |
| EAC | Environmental Advisory Committee |
| EPA | U.S. Environmental Protection Agency |
| F | Fahrenheit |

| | |
|---|---|
| GIS | Geographical Information System |
| GBRA | Guadalupe-Blanco River Authority |
| HQI | Habitat Quality Index |
| IBI | Index of Biotic Integrity |
| I-Plan | Implementation Plan |
| IR | Texas Integrated Report of Surface Water Quality |
| LID | Low Impact Development |
| mg/L | Milligrams Per Liter |
| MPN | Most Probable Number |
| NLCD | National Land Cover Database |
| OSSF | On-Site Sewage Facilities |
| QAPP | Quality Assurance Project Plan |
| qPCR | Quantitative Polymerase Chain Reaction |
| SARA-REL | San Antonio River Authority Regional Environmental Laboratory |
| SAWS | San Antonio Water Systems |
| SSO | Sanitary Sewer Overflows |
| S.U. | Standard Units |
| SWQM | Surface Water Quality Monitoring |
| SWQMIS | Surface Water Quality Monitoring Information System |
| TAMU | Texas A & M University |

| | |
|---|---|
| TCEQ | Texas Commission on Environmental Quality |
| TDS | Total Dissolved Solid |
| TKN | Total Kjeldahl Nitrogen |
| TMDL | Total Maximum Daily Load |
| TPWD | Texas Parks and Wildlife Department |
| TSS | Total Suspended Solids |
| TSSWCB | Texas State Soil and Water Conservation Board |
| TSWQS | Texas Surface Water Quality Standards |
| TWDB | Texas Water Development Board |
| USFWS | United States Fish and Wildlife Service |
| USGS | United States Geological Survey |
| UTSA | University of Texas at San Antonio |
| WPP | Watershed Protection Plan |
| WWTP | Wastewater Treatment Plant |

# Appendix B - References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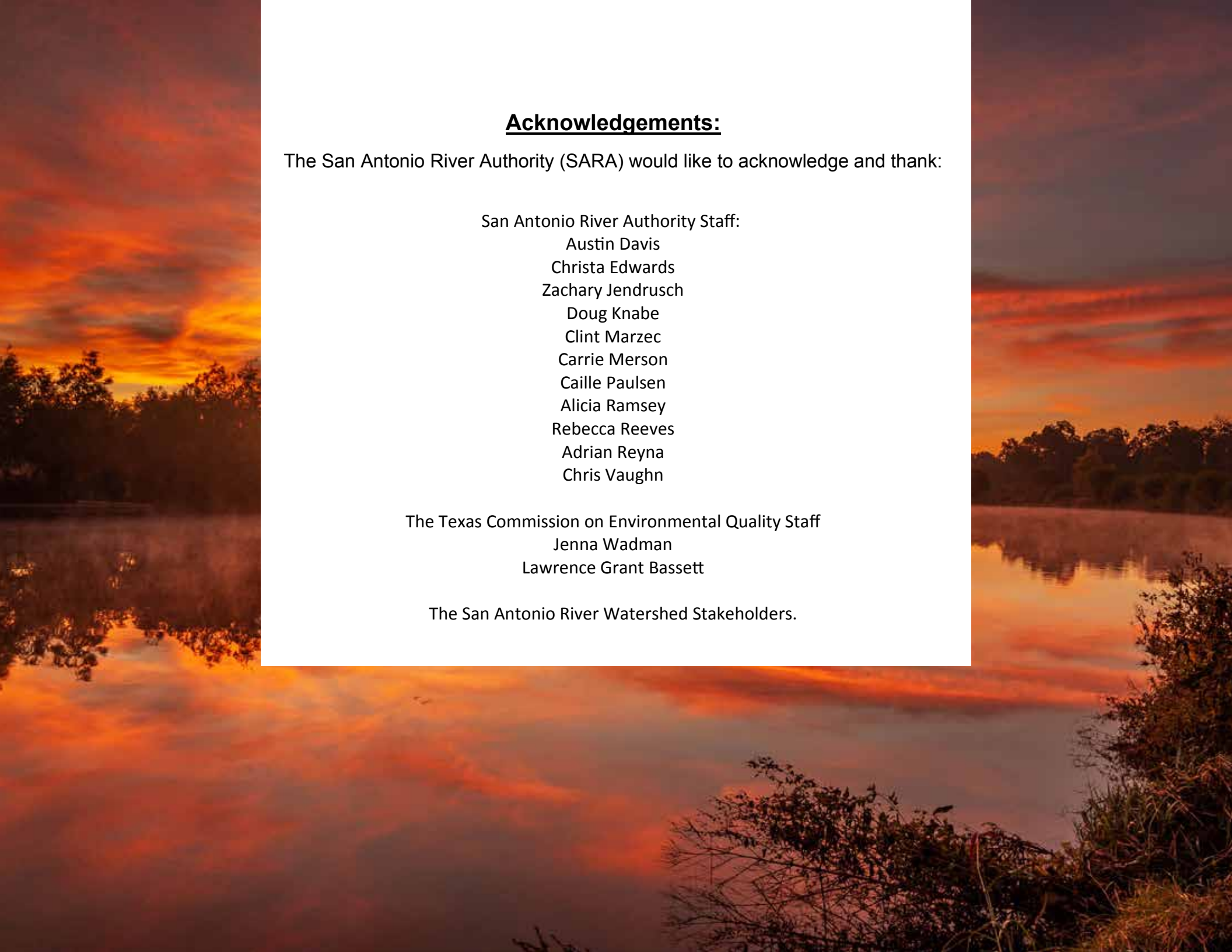


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