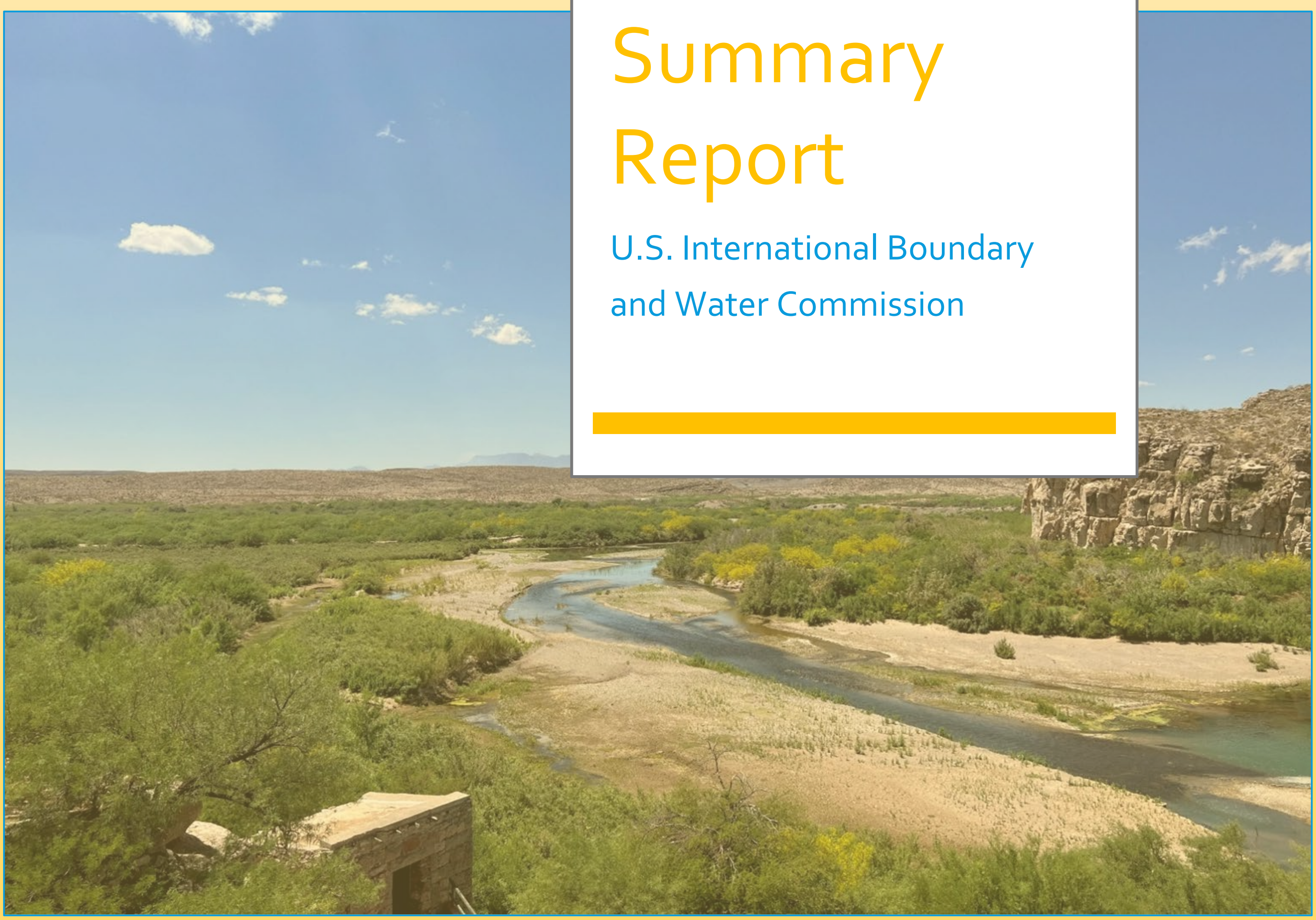
Rio Grande Basin Summary Report

U.S. International Boundary and Water Commission



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Executive Summary

The purpose of this report is to inform the public, the stakeholders, and other agencies as to the condition of the Rio Grande basin, improvements and potential problems within the watershed, the efforts of the Texas Clean Rivers Program (CRP) and its partners to monitor and assess the waters of the basin, and potential resolutions to any negative trends within the basin.

The Texas Clean Rivers Program was created by the state of Texas in 1991 in response to growing concerns that water resource issues were not being pursued in an integrated, systematic manner. The Rio Grande Basin did not have a river agency at that time. Matters were further complicated by the fact that two countries share the river. To address the international nature of the watershed, the state of Texas through the Texas Commission on Environmental Quality (TCEQ), contracted with the United States section, International Boundary and Water Commission (USIBWC) in October 1998 to administer the CRP for the Rio Grande Basin.

The legislation creating the CRP requires that ongoing water quality assessments be conducted using an approach that integrates water quality and water quantity issues within a river basin, or watershed. Another aspect of the CRP is that it provides a forum that allows for the exchange of information and ideas between the CRP and the public. Stakeholders within the basin are given the opportunity to comment and ensure that local issues are addressed within the program.

Since the Rio Grande Basin is so large and encompasses a variety of areas consisting of differing climates, vegetation, geology, flow regimes, and environmental issues, the basin it can be difficult to tackle all its needs. The basin has been divided into four sub-basins to better address the needs of each watershed: the Lower Rio Grande Sub-Basin, the Middle Rio Grande Sub-Basin, and the Upper Rio Grande Sub-Basin and the Pecos River Basin. Data collected from these sub-basins is entered by IBWC into a database administered by the TCEQ. The CRP and TCEQ use the database to assess concerns about the basin and produce reports on the basin as mandated by federal law.

For this report USIBWC analyzed water quality data from January 1, 2012, to December 31, 2022. The data was statistically examined to determine if water quality at each station meets minimum standards, which are set by the state. The water quality data was also analyzed for trends to assess for future problems or to evaluate positive improvements to previous issues. If problems were noted, possible causes of those problems were explored, and recommendations were made to address the issue.

The Lower Rio Grande Sub-Basin extends from Falcon Reservoir to the mouth of the Rio Grande. The Sub-Basin is divided into three segments. Problems in this Sub-Basin include bacteria and nutrients with the probable cause of these contaminants coming from municipal discharges. This Sub-Basin has also experienced problems with excessive growth of invasive aquatic weeds. In the tidal area (close to the Gulf of Mexico), low flow can also create saltwater intrusion causing salinity levels to increase. Parameters of concern in this portion of the basin include chlorophyll, ammonia, nitrate, pH, and fish kill.

The Middle Rio Grande Sub-Basin extends from Amistad Reservoir to Falcon Reservoir and includes three segments. While salinity concerns are not as great for this area as upper reaches of the river, bacteria and nutrient levels remain a concern. Because these contaminants are typically highest below areas of higher population densities, it is probable that the high levels of bacteria and nutrients are caused by wastewater discharges. Corrective actions such as installation of new wastewater treatment plants (WWTP), upgraded WWTPs, and more stringent discharge regulations will help alleviate the problem.

The Upper Rio Grande Sub-Basin extends from the Texas/New Mexico state line to Amistad Reservoir and consists of six segments. Primary concerns of this Sub-Basin include high bacterial levels, salinity (chloride, sulfate, TDS), and nutrients (ammonia and phosphorus). Wastewater from communities along the river and agricultural runoff contribute to the high levels of bacteria, salts, and nutrients. Corrective actions such as the installation of new WWTPs, upgraded WWTPs, and more stringent discharge regulations could help alleviate the problem.

The Pecos River Sub-Basin extends from the Texas/New Mexico state line to the Rio Grande and contains three segments. The Pecos Sub-Basin data evaluation revealed concerns about salt concentrations. The Pecos River enters Texas with high dissolved solids and salt concentrations. The high salinity levels are aggravated by low flows and the prevalence of salt cedar.

Potential solutions to the problems noted in the basin lead to the following recommendations for future studies for the CRP. The current level of monitoring effort should remain the same or increase. An increased number of strategically placed monitoring stations will only increase our ability to understand current problems. The CRP should also facilitate efforts by partners to perform special studies on water quality issues in the Rio Grande Basin as well as support their efforts to gain funding for these projects. Evaluation of aging WWTP infrastructure would let policy makers and city officials know where to focus for improvements. Additionally, continued communication with stakeholders and counterparts in Mexico and New Mexico will help find common ground and potential solutions to water quality issues.

Introduction

Rio Grande Watershed

The Rio Grande Basin drains an area of over 330,000 square miles (800,000 square km) in Colorado, New Mexico, and Texas in the United States and Chihuahua, Durango, Coahuila, Nuevo Leon, and Tamaulipas in Mexico (Figure 1). It forms the international boundary between the United States and Mexico along the last 1,254 miles (2,018 km) of its journey from the Colorado Rockies to the Gulf of Mexico. The Texas Clean Rivers Program (CRP) monitors and assesses the portion of the Rio Grande Basin from the point it enters Texas to its end at the Gulf of Mexico. The Rio Grande Basin in Texas drains an area of 86,720 square miles (224,600 square km). The Texas portion of the Rio Grande forms the border between the United States and Mexico for 1,254 miles (2,018 km). The Pecos River enters Texas from New Mexico and runs 409 miles (660 km) through Texas to the Rio Grande. Because of the large distances and the varying ecosystems, the basin is divided into four sub-basins (Figure 2). The Lower Rio Grande Sub-Basin runs from a point just below International Falcon Dam to the confluence with the Gulf of Mexico; the middle Rio Grande Sub-Basin runs from a point just below International Amistad Dam to International Falcon Dam in Starr County; the upper Rio Grande Sub-Basin runs from the point the river enters Texas at the Texas-New Mexico border to International Amistad dam in Val Verde County; and lastly the Pecos River Sub-Basin runs from Red Bluff Reservoir at the Texas-New Mexico border to its confluence with the Rio Grande in Val Verde County.

Figure 1. Map of the entire Rio Grande Basin

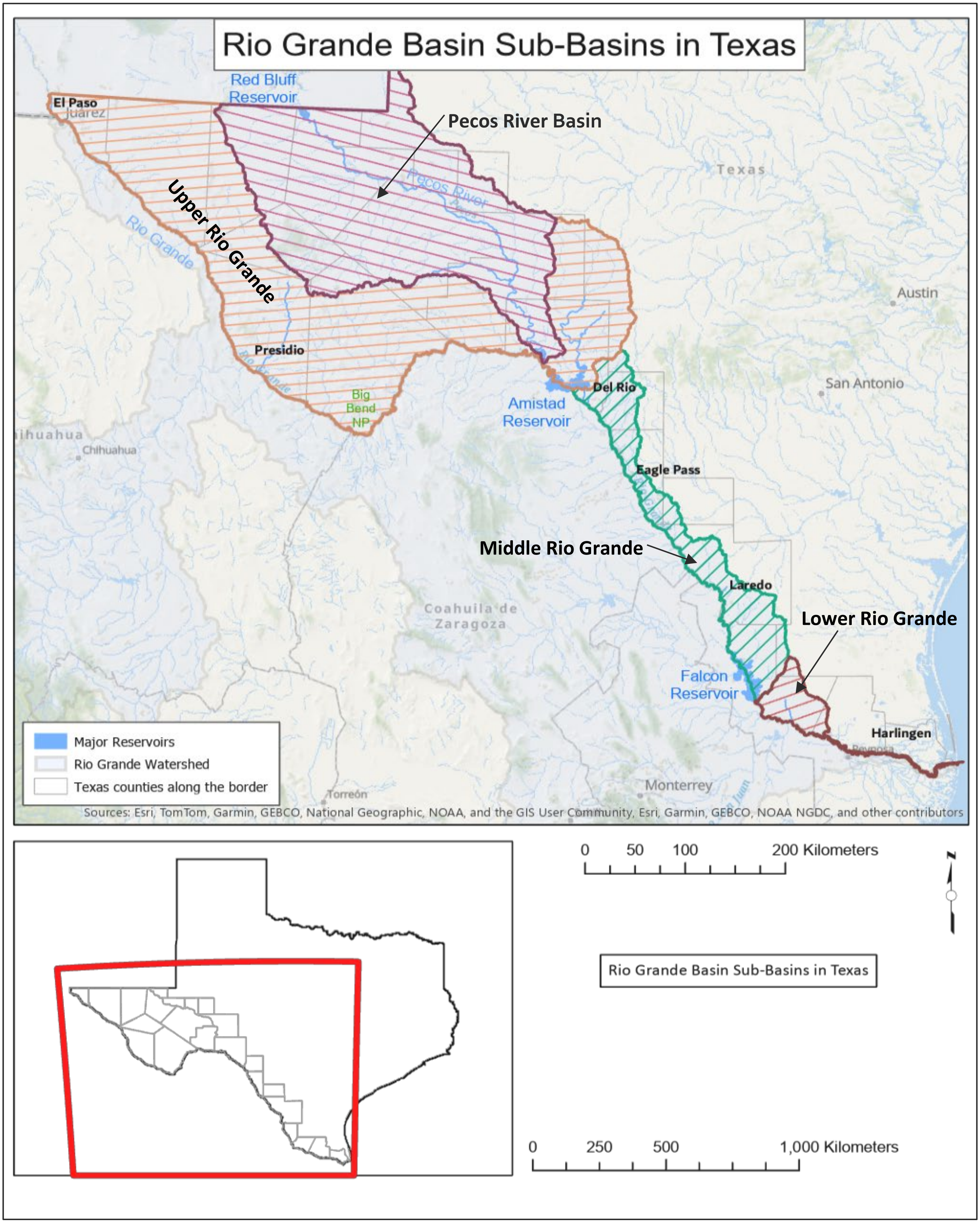


Figure 2. Map of the Sub-Basin in the Rio Grande Basin

The Lower Rio Grande Sub-Basin

The lower Rio Grande Sub-Basin extends from below Falcon Reservoir downstream to where it empties into the Gulf of Mexico. It runs for approximately 280 river miles (451 kilometers). The climate here is arid to semiarid. Major cities in the area include McAllen, Harlingen, and Brownsville, all with a combined population of more than 420,000 people. In Mexico the cities of Reynosa and Matamoros have a combined population of more than a million people. The communities along the border here depend 100% on the river's water for drinking water. These communities also depend on the water for agriculture irrigation, same as the other Sub-Basins. Water quality issues faced in this area include high bacteria levels, high salinity, and low dissolved oxygen. The lower portion of the river includes segments 2301, 2302, 2302A.

Aerial photograph of Rio Grande entering the Gulf of Mexico

Amistad Reservoir

The Middle Rio Grande Sub-Basin

The middle Rio Grande Sub-Basin extends from Amistad Reservoir downstream to Falcon Reservoir. It is approximately 303 river miles (488 kilometers). As with the upper Sub-Basins the primary use for its water is agriculture and domestic along with industrial use. Segments in this Sub-Basin are 2303, 2304, and 2313. The climate here is arid characterized by high temperatures. High levels of bacteria are one of the most common water quality issues in the area. Major metropolitan areas in this Sub-Basin include the neighboring cities of Laredo, TX and Nuevo Laredo, MX with a combined population of approximately 636,516 people, and the neighboring cities of Eagle Pass, TX and Piedras Negras, MX with a combined population of 267,000 people. The reservoir in this area serves a crucial role in providing flood control, water supply, and hydropower generation.

The Upper Rio Grande Sub-Basin

The upper Rio Grande Sub-Basin begins at the New Mexico - Texas boundary and continues downstream to the International Amistad Reservoir. The total length is approximately 650 river miles (1,045 km). The main uses for water in this Sub-Basin are agriculture and drinking water. Due to the heavy use of water for agriculture irrigation, this Sub-Basin faces many water quality issues. The Sub-Basin is characterized as semi-arid, with hot summers, limited precipitation, and an abundant amount of sunshine. This Sub-Basin includes the metropolitan area of El Paso and Ciudád Juarez, which have a combined population of 3.4 million people. Additionally, the Sub-Basin also includes the sister cities of Presidio and Ojinaga and Big Bend National Park. The segments contained in this Sub-Basin are 2314, 2308, 2307, 2306, 2309, 2309A and 2305.

Boquillas Del Carmen, Big Bend National Park

Pecos River at Coyanosa

The Pecos River Basin

The Pecos River is approximately 926 river miles (1,490 kilometers) and originates in the Sangre de Cristo Mountains in New Mexico. It flows through New Mexico and Texas before joining the Rio Grande by Amistad International Reservoir, making it one of the major tributaries of the Rio Grande. Water from the Pecos is also mainly utilized for agriculture irrigation and municipal use. Like much of the land around the Rio Grande, the Pecos basin primarily experiences an arid to semiarid climate. Some of the water quality issues in the area include low dissolved oxygen and high salinity. River segments in the Pecos River include 2310, 2310A, 2311, and 2312. Major cities in this basin include Pecos, Fort Stockton and Monahans among others.

Watershed Characteristics

The Rio Grande basin passes through several ecoregions, seeing many different climates, soils, vegetation, and geology. The Pecos River sub-basin lies in the Trans-Pecos ecoregion with a small portion of the eastern edge lying in the Edwards Plateau ecoregion. The Upper Rio Grande Sub-Basin lies entirely in the Trans-Pecos ecoregion. The topmost portion of the Middle Rio Grande Sub-Basin lies in the Edwards Plateau ecoregion with the remainder of the sub-basin lying in the south Texas Brush Country. The Lower Rio Grande Sub-Basin occupies the southeastern portion of the south Texas Brush Country ecoregion. Topography in the Pecos River sub-basin is generally plains as the river runs along the Permian Basin and empties into the Rio Grande downstream of Big Bend National Park, forming an arm of International Amistad Reservoir. In the upper Rio Grande Sub-Basin, the river rounds mountains of the Chihuahuan Desert and flows through arid mountains, high hills, and rock outcrops until it passes Big Bend National Park. Upon leaving the International Amistad Reservoir and entering the Middle Rio Grande Sub-Basin, the topography begins to form rolling, irregular plains and continues this pattern until turning into coastal plains as the river approaches the Gulf of Mexico in the Lower Rio Grande Sub-Basin. Major tributaries to the main rivers include:

- Independence Creek in the Pecos River Sub-Basin
- The Rio Conchos, in the Upper Rio Grande Sub-Basin near Presidio, Texas
- The Devils River, also in the Upper Rio Grande Sub-Basin
- San Felipe Creek in the Middle Rio Grande Sub-Basin
- The Rio Salado below Laredo, Texas
- The Rio Sand Juan above McAllen, Texas

There are many other smaller tributaries and springs that also contribute to the Rio Grande Basin from the United States and Mexico. In the lower Rio Grande Sub-Basin, soils are primarily silts and clays laid down by past estuarine conditions and coastal processes. The extreme lower Rio Grande region is composed of deltaic deposits laid down when the region was a large river delta, much like what is visible at the confluence of the Mississippi with the Gulf of Mexico. In the Middle Rio Grande Sub-Basin, the soils are primarily clay and loam mixed with gravels. In the Upper Rio Grande Sub-Basin, the soils are sands underlain by clay and loam away from the river. These soils are interrupted by weathered and un-weathered bedrock along the river. Soils in the Pecos River Sub-Basin are primarily silts mixed with clay and loam underlain by caliche and clays, which prevent much of the rainfall in the region from percolating into the ground and, instead, aid in the evaporation of rainfall.

Vegetation in the lower Rio Grande sub-basin below Falcon Reservoir is mesquite and blackgrass, but the remainder of the basin is cropland all the way to the Gulf of Mexico where there are some wetland environments. The middle Rio Grande Sub-Basin vegetation is primarily cropland near the river and blackgrass and mesquite away from the river. In the Upper Rio Grande Sub-Basin, the vegetation consists of tobosa shrubs, tarbrush, creosote, and blackgrass in the plains areas, and mesquite, creosote, and Lechuguilla in the mountain regions. Saltcedar, an invasive shrub, is also creating monocultures in many parts of the Upper Rio Grande. Lastly, the Pecos River Sub-Basin consists of desert grasses, mesquite, sage, and creosote. Along the banks of the Pecos River, saltcedar bushes have taken over as the dominant species.

The Rio Grande Basin receives very little rainfall compared to other basins in Texas. The Rio Grande relies on snowpack from the southern Rocky Mountains in Colorado and in New Mexico to drain into the upper reservoirs for delivery to the lower part of the Rio Grande in Texas. Drought conditions (below average rainfall and snowpack) have affected water storage in the reservoirs upstream of Texas. The Pecos River and the Upper Rio Grande Sub-Basins are primarily arid, desert environments that receive very little rainfall and have high evaporation rates. Normal annual rainfall ranges from 9 inches (23 cm) in the upper portion of the two sub-basins to 15 inches (38 cm) near Amistad Dam. The Middle Rio Grande Sub-Basin averages 25 inches (63 cm) of rain, as does the western portion of the Lower Rio Grande Sub-Basin. The remainder of the Lower Rio Grande Sub-Basin receives over 25 inches (63 cm) of rainfall. The Lower Rio Grande region is experiencing the effects of the drought conditions throughout the basin even though it has such a relatively high annual rainfall. Some of the heavy rainfall that occurs from ocean source storms drives far enough upstream to be captured by Falcon Dam, but most of the rainfall flows out into the Gulf of Mexico.

Clean Rivers Program History

In the early 1990s there was a growing concern about the degradation of water quality in Texas' rivers and streams due to industrial, agricultural, and urban activities. In response to these concerns, the Texas Legislature passed the Texas Clean Rivers Act and established The Texas Clean Rivers Program (CRP) to provide a comprehensive approach to water quality management, focusing on data collection, analysis, and public awareness. Officially established in 1991, the program represents a collaborative effort between various governmental agencies, nonprofit organizations, academic institutions, and local communities to monitor, assess, and protect the state's water resources. The Texas Clean Rivers Program operates under the Texas Commission on Environmental Quality (TCEQ) and is part of the Clean Water Act's vision for clean and safe water. The primary objective of the program is to provide credible and up-to-date information on the state of Texas' water bodies, ensuring that stakeholders can make informed decisions and take actions to preserve and improve water quality.

Clean Rivers Program at USIBWC

Since the Rio Grande in Texas serves as the border between the United States and Mexico, and the watershed is divided between the two countries, a bi-national approach to this watershed is needed. The International Boundary and Water Commission (IBWC) is a s a bi-national government agency established to apply boundary and water treaties and settle disputes between the United States and Mexico. The Treaty of February 3, 1944, for the "Utilization of waters of the Colorado and Tijuana Rivers and of the Rio Grande" distributed the waters in the international stretch of the Rio Grande and authorized the IBWC to give preferential attention to the solution of border sanitation problems. The "Joint Memorandum of Engineers Recommendation of an Initial International Program for Observation of the Quality of International Waters of the United States and Mexico," dated July 5, 1977, established an IBWC surface water quality monitoring program. In 1998, TCEQ partnered with the U.S. Section of the IBWC (USIBWC) to administer the Clean Rivers Program for the Rio Grande Basin. The USIBWC has been administering the CRP by partnering with various entities along the river throughout the years. Work performed by the USIBWC includes coordinating and conducting water quality monitoring, facilitating stakeholder outreach, and providing assessments of water quality data and water resources in the region.

Today USIBWC works with 13 partners, who collectively monitor 119 stations throughout the basin (Figure 3). Each partner participates in water quality monitoring, provides advice and suggestions to improve the program, and helps improve the overall water quality of the basin. Additionally, partners aid in developing and conducting special studies and working with the public to increase awareness on water quality issues.

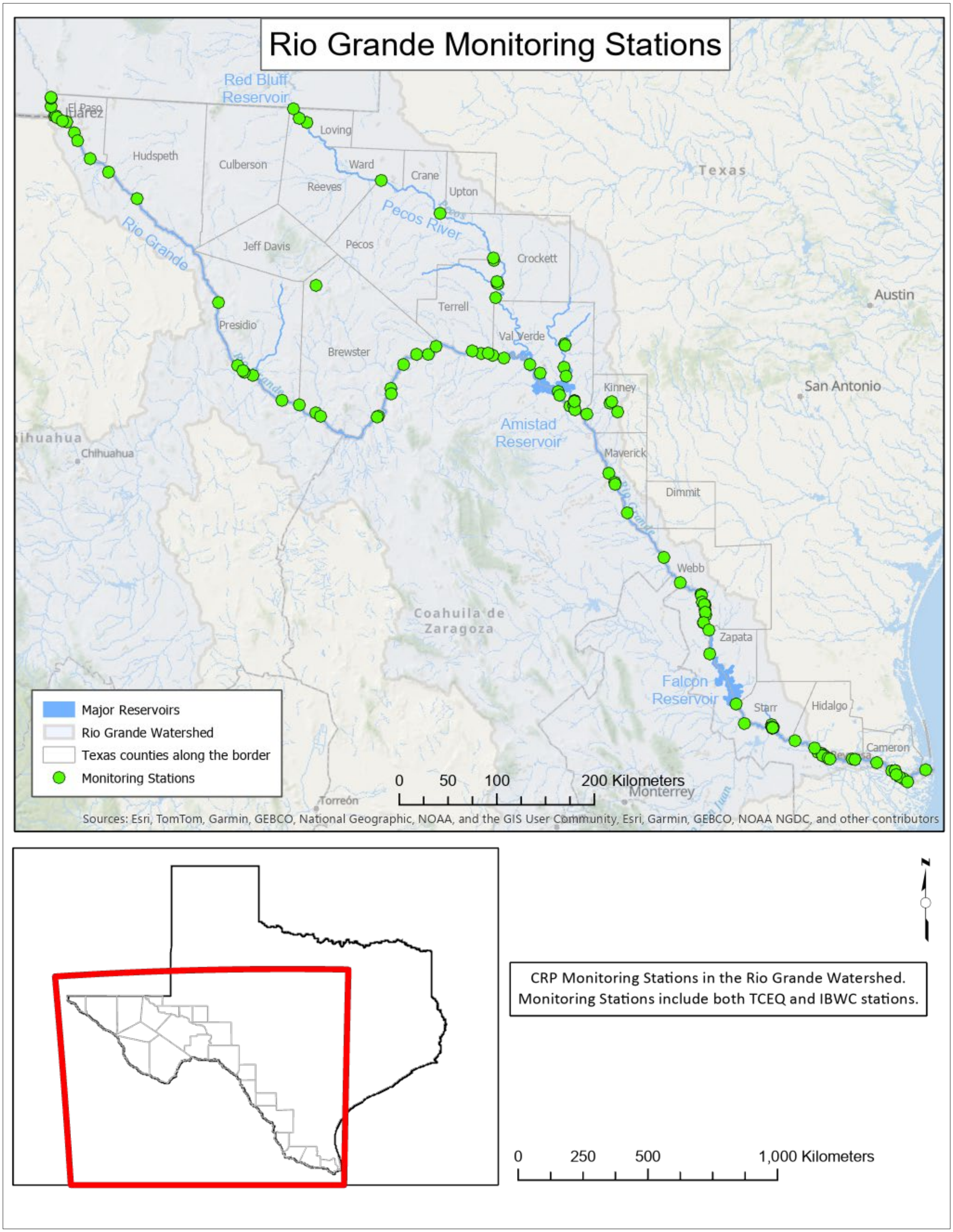


Figure 3. Surface Water Monitoring stations on the Rio Grande Basin.

Public Involvement and Outreach

Public involvement is imperative for CRP and comes in many forms. Staff at CRP attend several meetings organized by various interest groups to discuss issues with water quality. Presentations at these meetings serve to inform these groups of the goals and efforts in the basin, learn what others are doing in the basin, and to eliminate duplication of efforts. Support is also provided to academia research studies within the basin. Some of these studies include chemical and bacteriological studies around major metropolitan areas and possible adverse impacts on the wildlife due to domestic wastewater. One of the many goals within the CRP is to maximize the level of effort within the basin by leveraging grant funds with CRP dollars. CRP has also assisted other agencies who have received grants to do research in the Rio Grande, by either providing additional field personnel, lab support or project coordination with Mexico.

Basin Advisory Committee

The Basin Advisory Committee (BAC) is one of the many ways that CRP communicates with stakeholders. Members of this committee include public and special interest groups within the sub-basins that are concerned with the protection of water resources. BAC meetings are held three times in the biennium and discuss water quality issues, areas of concern in the basin, and mitigation efforts. These meetings give the committee a chance to provide input and voice their concerns about the quality of the water in the Rio Grande Basin. The meetings also serve a forum to present research projects conducted by CRP and its partners.

Rio Grande Citizens' Forum

The purpose of the Rio Grande Citizens' forum is to facilitate the exchange of information between the USIBWC and the public about projects. Volunteer board members from the community assist the USIBWC in this outreach effort. Forum boards have been established in the lower and upper Rio Grande. Public meetings of the Citizens' forum are held quarterly in the applicable border communities and provide a useful venue for the USIBWC to provide information to stakeholders while also learning about the community's interests and concerns regarding the work at USIBWC.

IBWC staff educating the public at an Earth week event at UTEP, October 2023

Outreach

Outreach efforts are essential for raising awareness about water conservation, pollution prevention, and the importance of maintaining healthy river ecosystems.

Presentations at the University of Texas at El Paso (UTEP) serve as valuable educational opportunities for students and faculty to learn about Texas CRP's initiatives, research findings, and the significance of their work in preserving Texas rivers. These presentations not only inform but also engage the academic community in discussions about environmental stewardship and sustainability.

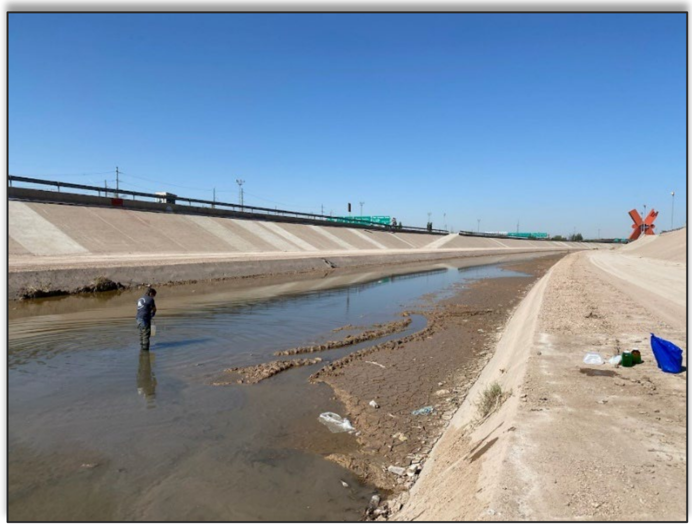
Participation in career days at elementary schools offers a unique chance to educate young minds about environmental issues early on. By showcasing the work of the Texas CRP and careers in environmental science, students are inspired to pursue interests in STEM fields and possibly consider future involvement in water conservation efforts. One of the events USIBWC CRP staff has participated in for the last two years in a row is Earth Week at UTEP. Earth Week provides a platform to amplify the message of environmental awareness and conservation to a broader audience. Through events, workshops, and activities during Earth Week, CRP staff can reach students, faculty, and the local community, encouraging them to take action to protect their natural resources.

Career day Keystone Christian School, Feb 2023

Overall, these outreach efforts not only raise awareness about Texas CRP's mission and objectives but also foster a sense of responsibility and ownership among individuals and communities towards protecting Texas rivers for future generations. By engaging with diverse audiences through presentations, school visits, and community events, the Texas Clean Rivers Program can continue to build support and momentum for its vital conservation efforts.

Water Quality Monitoring Overview

Water quality monitoring is an essential process to assess the physical, chemical, and biological characteristics of water bodies. These characteristics help TCEQ determine at what capacity the water can be used for and the overall health of the river. To continue to provide valuable water quality data the USIBWC CRP has maintained its large network of water quality stations through the years. By performing routine monitoring of these stations at regular intervals throughout the year, the health of the water system can be determined. Water quality standards for the Rio Grande set forth by TCEQ are shown in Table 1. Designated uses and water quality parameters are found in Tables 2 and 3.



Station 14665 located in the channelized portion of the Rio Grande.

Routine monitoring in the Rio Grande Basin helps us understand its unique characteristics, which can in turn help us to:

- Assess environmental health.
- Protect human health.
- Manage resources.

Partners collect water quality samples at approximately 119 (54 belong to USIBWC and the rest to TCEQ) routine monitoring stations throughout the basin. That number, however changed in 2023 when eight stations became unavailable due to border security issues. Sediment samples are also collected at some stations. In addition to collecting samples for laboratory analysis, personnel also make field observations to record conditions at the time the sample were taken. Field observations include things such as weather conditions, recent rain events in the area, water color, and other general notes pertinent to water quality and stream uses. Quantitative field measurements are made using specialized equipment. The parameters taken include water and air temperature, water depth, water clarity, stream flow and how that flow compares to the normal flow for that water body. Table 3 describes field parameters in more detail.

The routine collection of field parameters, together with laboratory parameters, allows us to determine the health of the river ecosystem and can aid in the identification of potential issues. Data is compared against the TSWQS criteria and screening levels, which are outlined in Table 1. Indicators that are directly tied to support of designated uses and criteria adopted in the TSWQS include:

- Water temperature (general use)
- pH (general use)
- Dissolved Oxygen (DO) (aquatic life)
- Chloride (general use)

- Sulfate (general use)
- Total Dissolved Solids (TDS) (general use)
- *E. coli* (contact recreation)

Further, more intensive monitoring can be conducted when routine monitoring shows a trend in a water quality issue. By focusing on the trend, a more comprehensive approach can be taken to mitigate such issue.

Table 1. Primary Surface Water Quality Standards for the Rio Grande Basin

2022 Texas Surface Water Quality Standards for the Rio Grande Basin												
Segments		**Uses**				**Criteria**						
Segment No.	**Segment Description**	**Recreation**	**Aquatic Life**	**Domestic Water Supply**	**Other**	**Cl-1 (mg/L)**	**SO4-2 (mg/L)**	**TDS (mg/L)**	**Dissolved Oxygen (mg/L)**	**pH Range (SU)**	**Indicator Bacteria* (#/100ml)**	**Temp (°F)**
2301	Rio Grande Tidal	PCR	E						5.0	6.5-9.0	35	95
2302	Rio Grande below Falcon Reservoir	PCR	H	PS		270	350	880	5.0	6.5-9.0	126	90
2303	International Falcon Reservoir	PCR	H	PS		200	300	1,000	5.0	6.5-9.0	126	93
2304	Rio Grande Below Amistad Reservoir	PCR	H	PS		200	300	1,000	5.0	6.5-9.0	126	95
2305	International Amistad Reservoir	PCR	H	PS		150	270	800	5.0	6.5-9.0	126	88
2306	Rio Grande above Amistad Reservoir	PCR	H	PS		200**	450**	1,400**	5.0	6.5-9.0	126	93
2307	Rio Grande below Riverside Diversion Dam	PCR	H	PS		300	550	1,500	5.0	6.5-9.0	126	93
2308	Rio Grande below International Dam	NCR	L			250	450	1,400	3.0	6.5-9.0	605	95
2309	Devils River	PCR	E	PS		50	50	300	6.0	6.5-9.0	126	90
2310	Lower Pecos River	PCR	H	PS		1,700	1,000	4,000	5.0	6.5-9.0	126	92
2311	Upper Pecos River	PCR	L**			7,000	3,500	15,000	5.0	6.5-9.0	33	92
2312	Red Bluff Reservoir	PCR	H			3,200	2,200	9,400	5.0	6.5-9.0	33	90
2313	San Felipe Creek	PCR	H	PS		50	50	400	5.0	6.5-9.0	126	90
2314	Rio Grande above International Dam	PCR	H	PS		340	600	1,800	5.0	6.5-9.0	126	92

PCR - Primary Contact Recreation　NCR - Noncontact Recreation　PS - Public Water Supply
E - Exceptional Aquatic Life　L - Limited Aquatic Life　H - High Aquatic Life　TDS - Total Dissolved Solids
Cl- - chloride　SO42- - sulfate　DO - Dissolved Oxygen

*Indicator Bacteria is *E. coli* for freshwater and *enterococci* for saltwater (2301, 2311, 2312)

** Revisions are currently under EPA review

The critical low flow for Segments 2309 and 2313 is calculated according to §307.8(a)(2)(A) of the TSWQS.

Designated Uses

The State of Texas assigns designated uses for water bodies and determines the Texas Surface Water Quality Standards (TSWQS). Standards are set to not only maintain the quality of the water but also improve it. Designated uses for the Texas surface waters are described in Table 2. Further information on standards and decision-making can be found at the TCEQ website.

Contact recreation (CR) –Is defined as fishing, swimming, wading, boating, and direct water contact. *Escherichia coli* (*E. coli*) and enterococci bacteria are used as indicators for bacterial contamination. The 2010 revisions to the TSWQS created subcategories of Primary (PCR) and Secondary Contact Recreation (SCR). PCR refers to activities such as swimming, and SCR refers to non-immersing recreation activities such as canoeing and fishing.

Public water supply (PS) – This use is designated for drinking water sources. The primary concern is total dissolved solids (TDS). The TSWQS includes a list of parameters that are screened to ensure safe domestic water supply use. Table 3 provides more information on these parameters and their effects on a water body.

Aquatic life use (ALU) – Designed to protect aquatic species including fish and benthic macroinvertebrates (aquatic insects). This designation has five levels depending on the ability of a water body to support aquatic life (exceptional, high,

Table 2. Designated Uses for Surface Water

Designated Uses			
Designated use	Description	Primary parameter	Criteria
Contact Recreation (CR)	Three levels depending on the use: Fishing, swimming, wading, boating, etc. *Note: Secondary contact recreation criteria is not applied in any of the segments in the Rio Grande Basin*	Freshwater: *E. coli* Tidal and saline: *Enterococcus (Entero)*	Primary contact recreation (significant possibility of water ingestion, i.e., swimming)
			Secondary contact recreation (limited body contact that possess a less significant risk of ingestion of water, i.e., fishing, boating)
			Non-contact recreation: Unsuitable for contact recreation
Public Water Supply (PS)	Drinking water source	See full list of Human Health Criteria in Table 2 of the TSWQS	
Aquatic Life Use (ALU)	4 levels depending on the ability of water body to support aquatic life	Dissolved Oxygen-average values* *The listed DO criteria apply to freshwater streams and reservoirs	(E) Exceptional 6.0 mg/L
			(H) High 5.0 mg/L
			(I) Intermediate 4.0 mg/L
			(L) Limited 3.0 mg/L
			(M) Minimal 2.0 mg/L
	Toxics in Water	See full list of Aquatic Life Criteria in Table 1 of the TSWQS	
Fish Consumption (FC)	Prevent contamination to protect human health	See full list of Human Health Criteria in Table 2 of the TSWQS Example: Mercury - 0.0122 ug/L in water & fish	
General Use (GU)	General water quality	Water Temperature, High pH, Low pH, Dissolved Solids, Nutrients, and Chlorophyll-a. See Table 3.	

intermediate, limited, and minimal). The primary parameter used to determine the ALU of a waterbody is dissolved oxygen (DO).

Fish consumption (FC) – This designation applies to all water bodies where citizens may collect and consume fish. The TSWQS includes a list of parameters that are used to screen waters and ensure the fish consumption use is met.

General use – To safeguard general water quality.

Table 3. Water Quality Parameters

Field Parameters		
Parameter	**Description**	**Effects to water body**
pH	Measure of how acidic or basic the water is. The values range from 0 to 14, with 7 being neutral. pH values less than 7 indicate acidity, whereas a pH greater than 7 indicates a base.	Values greater than 9.0 and less than 5.0 can have detrimental effects on the health of aquatic life, wildlife, and humans.
Specific Conductance	Indicator of how well the water conducts electricity. Pure water does not conduct electricity; impurities such as salts and metals in water are what allow electricity to pass through the water. Since total and dissolved metal values should be very low, conductivity primarily measures how much salt is in the water. Most naturally occurring waters have some level of conductivity.	High conductivity can cause physiological effects in animals and plants. It also could be a result of high TDS. Indirect effects of excess dissolved solids are primarily the elimination of desirable food plants and habitat-forming plant species. Agricultural uses of water for livestock watering are limited by excessive dissolved solids and high dissolved solids can be a problem in water used for irrigation.
Dissolved Oxygen (DO)	The oxygen freely available in water.	Low DO values can lead to a reduced abundance and diversity in aquatic communities. Very low levels (<2 mg/L) can be indicative of higher levels of oxygen-demanding plants that use up DO during the decay process.
Secchi Depth	A measure of the transparency of water - the maximum depth at which a black and white disk is visible.	Higher transparency leads to a more robust aquatic plant life (particles in water block sunlight for photosynthesis). High transparency coupled with high nutrients can lead to negative impacts on DO and aquatic life.
Stream Flow	Volume of water moving over a location over a period. 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.
Conventional Laboratory Parameters		
Solids	Total and dissolved materials of any kind (calcium, magnesium, potassium, sodium, bicarbonates, chlorides, and sulfates).	High total dissolved solids indicate higher amounts of dissolved salts which can reduce the diversity of aquatic life and can render the water unusable for human consumption, industry, and agriculture.
Nutrients	Nutrients include nitrogen compounds, ammonia, and phosphorus.	High levels can cause excessive plant growth, which can lead to reduced dissolved oxygen and fish kills, reduced stream flow and reduced navigability of the waters. Elevated ammonia can also be toxic to aquatic life.
Chlorophyll-a	Chlorophyll-a is used as an indicator of algal growth in water.	High levels for long periods may indicate low water quality and are indicative of excess nutrient levels.
Bacteria	Bacteria found in the intestinal tracts of warm-blooded animals.	These organisms are used as indicators of bacterial pollution and possible presence of waterborne pathogens. Sources of high bacteria are wastewater that has not been treated for bacteria, concentrations of animals, and application of animal-based fertilizers.
Non-conventional Laboratory Parameters		

Metals	Aluminum, arsenic, barium, chromium, copper, lead, mercury, nickel, silver, and zinc. Metals can be tested as total or dissolved metals in water or metals in sediment to determine long-term accumulation.	High concentrations can result in long- and short-term effects on aquatic life and human health.
Organics	Chemicals containing carbon and hydrogen. Organic compounds analyzed are herbicides, pesticides, and industrial compounds both in water and in sediment.	Organics can result in long- and short-term effects on aquatic life and human health.
Biological Parameters		
Nekton	Fish captured in the river during biological surveys using both electrofishing and seining methods	Using the Index of Biotic Integrity (IBI) can indicate biodiversity and overall health of river.
Benthics	Freshwater macroinvertebrates collected during a five-minute kicknet method	Using IBI, this biological aquatic assemblage analysis indicates biodiversity and overall health of river. Healthy macroinvertebrate communities can be excellent indicators of high-water quality.

How does data get collected?

The Clean Rivers Program at the USIBWC relies on the collaboration of dedicated partners who voluntarily contribute to water quality data collection alongside their primary projects and work objectives. This collective effort enables the CRP to achieve extensive spatial monitoring coverage across the expansive and intricate watershed it oversees. The program is proud to have affiliations with a diverse group of partners, encompassing federal and state agencies, universities, and municipalities, as well as non-profit organizations.

The partners involved in the USIBWC Clean Rivers program include:

El Paso Water International Laboratory	City of Laredo Environmental Services
Brownsville Public Utilities Board Laboratory	USIBWC American Dam Field Office
Big Bend National Park (BBNP)	USIBWC Amistad Dam Field Office
Texas Parks and Wildlife Department (TPWD)	USIBWC Falcon Dam Field Office
Rio Grande International Study Center (RGISC)	USIBWC Mercedes Field Office
Midland College	USIBWC Presidio Field Office
University of Texas Rio Grande Valley - Edinburg	

All partners within the USIBWC CRP undergo training lead by CRP staff. They adhere to standardized sampling methods outlined in the TCEQ's Surface Water Quality Monitoring Procedures Manual, Volume 1. Agreement on the monitored stations is reached through collaborative discussions between TCEQ, CRP, and partners at annual meetings.

Coordinated Monitoring Schedule

Partners that monitor the Rio Grande in Texas gather annually to discuss and coordinate monitoring activities. Information on the monitoring station locations, who is collecting water quality data, and how often within the Rio Grande watershed can be found on the Coordinated Monitoring Schedule https://cms.lcra.org/

Field sheets and chain of custody records are diligently maintained by both the partners and USIBWC CRP staff, ensuring data traceability and integrity. All partners utilize identical monitoring equipment for collection of field data. All water samples collected are sent to laboratories accredited by the State of Texas under the National Environmental Laboratory Accreditation Program (NELAP). A NELAP accreditation is a prerequisite for data acceptance by TCEQ, which is crucial for its inclusion in the Integrated Report.

The USIBWC CRP consolidates field data received from partners along with laboratory analysis data. The staff rigorously assesses the data against quality assurance criteria, compiles into comprehensive reports, and submits the data to the TCEQ for thorough review. Following TCEQ approval, the data is uploaded into the state's Surface Water Quality Monitoring Information System (SWQMIS) database. All data collected by CRP partners is made accessible to the public through the USIBWC website.

Technical Summary: What are Impaired Waters?

The Texas Integrated Report of Surface Water Quality (IR), previously known as the Texas Water Quality Inventory and 303(d) List, plays a pivotal role in evaluating the quality of surface waters within the state. This comprehensive assessment is integral for water resources. It provides critical insights to inform decision-making processes, particularly for programs like the Clean River Program. The report is mandated by Sections 305(b) and 303(d) of the federal Clean Water Act (CWA).

Assessment Process:
The Texas Integrated Report evaluates data from the state's water quality database over a 7-year period, with a new 7-year dataset assessed every two years. A minimum of 20 samples is typically required for the assessment. Assessments are conducted in delineated portions of water bodies termed assessments units (AUs). This facilitates precise and site-specific evaluations of the water body's condition.

Texas Surface Water Quality Standards
The state utilizes the Texas Surface Water Quality Standards (TSWQS) for each river basin and identifies water bodies that do not meet uses and criteria in the Texas Integrated Report. These standards are crucial for classifying water bodies and setting benchmarks for water quality management.

Clean Water Act Requirements
In compliance with the Clean Water Act's Sections 303(d) and 305(b), Texas is obligated to submit reports documenting water quality across the state. These reports identify water bodies that either meet or fail to meet their assigned designated uses, such as contact recreation, aquatic life, or drinking water. The assessment includes comparing data against established water quality indicators outlined in the Texas State Water Quality Standards.

Numeric and Narrative Criteria
Water quality parameters are evaluated based on numeric and narrative criteria. Numeric criteria are specific to each segment and are set to ensure compliance with designated uses. Failure to meet these criteria results in classification as impaired, leading to inclusion in the 303(d) List of Impaired Waters.

Narrative Criteria and Screening Levels
Narrative criteria assessed using state-developed screening levels help identify potential water quality concerns that do not necessarily indicate an impairment. These screening levels are particularly useful for parameters historically linked to environmental issues in specific areas. Figure 4 shows the segments in the Rio Grande that are impaired for bacteria and salinity.

The 2022 TSWQS for the Rio Grande Basin became effective as state rule on September 29, 2022, and the 2022 Integrated Report was approved by the Environmental Protection Agency (EPA) on July 7, 2022. The standards revisions have been submitted to the EPA and some portions of the TSWQS are still under review.

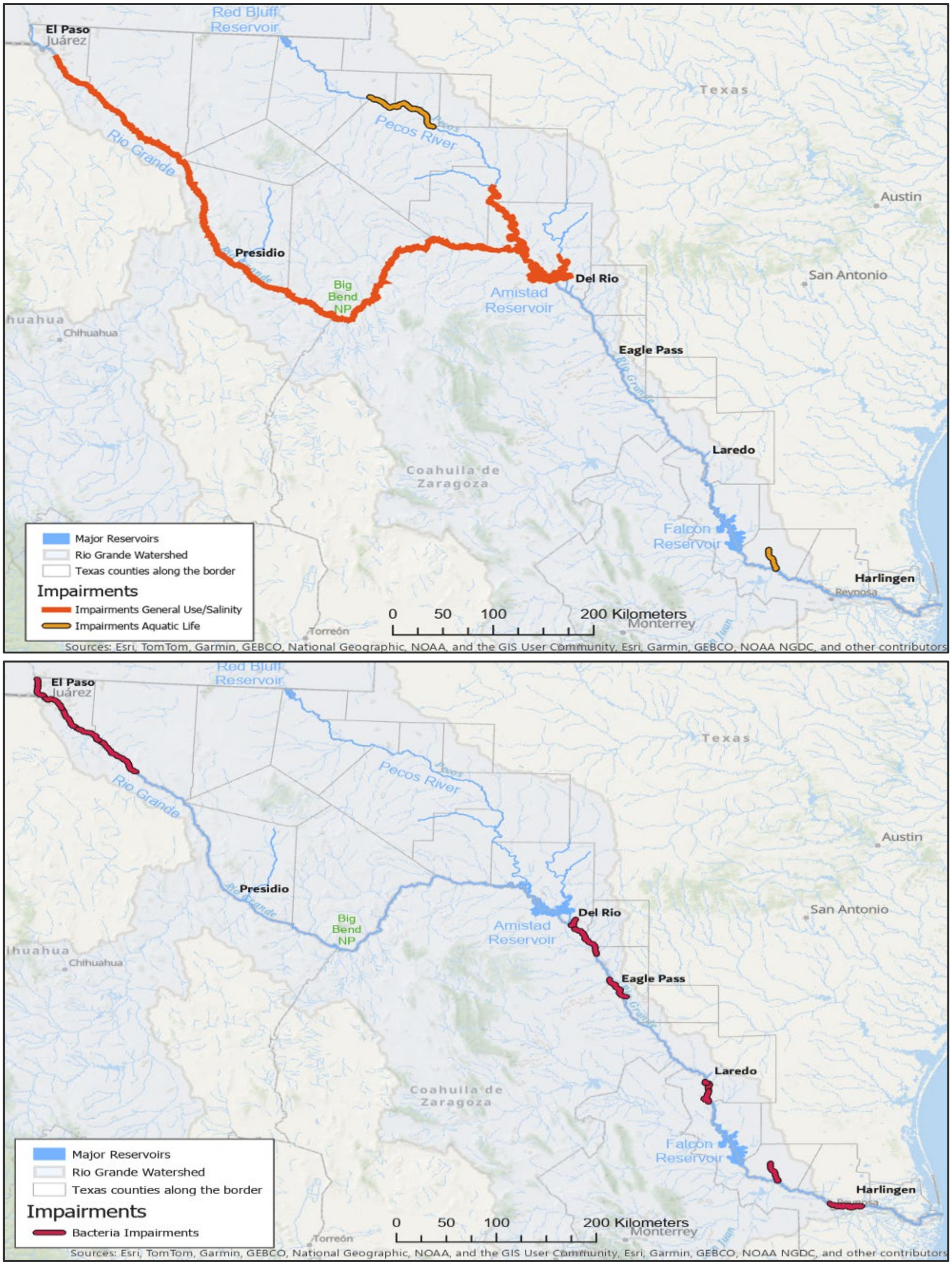


Figure 4. Impaired river segments in the Rio Grande

Table 4. Summary of Water Quality Impairments and Concerns in the Rio Grande Basin

Segment	Segment Name	Impairment(s)	Year Listed	Concern(s)	Type
2301	Rio Grande Tidal	No impairment		Bacteria Chlorophyll-a Depressed DO Nitrate	CN CS CS CS
2302	Rio Grande Below Falcon Reservoir	Bacteria	1996	Ammonia Chlorophyll-a Depressed DO pH	CS CS CS CN
2302A	Arroyo Los Olmos	Bacteria Depressed dissolved oxygen	2004 2022	Chlorophyll-a Depressed DO	CS CS
2303	International Falcon Reservoir	No Impairment		Ambient toxicity Fish kill	CS CN
2304	Rio Grande Below Amistad International Reservoir	Bacteria	1996	Ambient toxicity Ammonia	CS CS
2304B	Manadas Creek	No Impairment		Antimony in sediment Bacteria Nitrate Total phosphorus	CS CN CS CS
2305	International Amistad Reservoir	Chloride	2014	Fish kill	CN
2306	Rio Grande Above Amistad International Reservoir	Sulfate	2010	Chlorophyll-a	CS
2306A	Alamito Creek	No Impairment		No Concern	
2307	Rio Grande Below Riverside Diversion Dam	Chloride Total dissolved solids Bacteria	1996 19962002	Ammonia Chlorophyll-a Depressed DO Nitrate Total phosphorus	CS CN CS CS CS CS
2308	Rio Grande Below International Dam	Bacteria	2014	Ammonia Chlorophyll-a Total phosphorus	CS CS CS
2309	Devils River	No Impairment		No Concern	
2310	Lower Pecos River	Sulfate Total dissolved solids	2022 2020	No Concern	
2310A	Independence Creek	No Impairment		No Concern	
2311	Upper Pecos River	Depressed DO	2006	Bacteria Chlorophyll-a	CN CS
2312	Red Bluff Reservoir	No Impairment		No Concern	
2313	San Felipe Creek	Bacteria	2014	No Concern	
2314	Rio Grande Above International Dam	Bacteria	2002	Chlorophyll-a Total phosphorus	CS CS

CN - Concern for near-nonattainment of the Water Quality Standards

CS - Concern for water quality based on screening levels.

Note: Each segment is further subdivided into assessment units (AU). The entire segment may not be impaired. The complete list of impairments and AUs can be found at the TCEQ 303(d) website

Data Selection and Methodology

The water quality data utilized in this analysis was sourced from the TCEQ's Surface Water Quality Monitoring Information System (SWQMIS) database. SWQMIS serves as the repository for surface water quality data across the State of Texas. The data collection adhered to a TCEQ-approved Quality Assurance Project Plan (QAPP). Instances where data exhibited quality concerns, as indicated by a qualifier code in SWQMIS, was excluded from the analysis.

The analysis focuses on data from monitoring stations in the Rio Grande Basin spanning the period January 1, 2012, to December 31, 2022. Trend analysis was used of across water quality parameters to discern areas experiencing improvement, degradation, or those necessitating additional monitoring. Additionally, the analyses aimed to determine the impact of water quality improvement projects or management changes.
To ensure a robust analysis, the USIBWC CRP opted to conduct trend analysis on stations with a minimum of 20 sampling events.

Water quality parameters subjected to analysis included pH, dissolved oxygen, ammonia, chlorophyll-a, total phosphorus, bacteria (*E. coli* or *Enterococcus*), sulfate, chloride, nitrate + nitrite, and total dissolved solids. For each parameter, data analysis encompassed minimums, maximus, means, and regression trends. Trend analysis allows for the identification of temporal changes in water quality parameters.

Regression analyses was not conducted for stations with fewer than twenty data points over the specified period. Instead means, minimums and maximus were provided for informational purposes. The significance of regression analyses was determined with a p-value of less than 0.05. A p-value is a measure of the likelihood that the observed difference between groups occurred by chance. The results are considered statistically significant if the p-value is less than the significance level (0.05).

The datasets often included variables reported at the limit of quantification (LOQ). Standardizing LOQ was applied to handle such instances; for example, a value reported as < 3 was analyzed using a value of 3. Considering technological advancements in evaluating nutrient concentrations at lower levels, datasets were examined and adjusted to prevent skewing. Results suggesting trends due to changing quantitation limits were flagged and not reported as significant, ensuring the integrity of the analysis.

Lower Rio Grande Sub-Basin

The Lower Rio Grande Sub-Basin stretches from below International Falcon Dam to its confluence with the Gulf of Mexico. Figure 5 shows the monitoring stations in the lower portion of the Rio Grande Basin. This 280-mile (451-km) stretch of the Rio Grande runs through Starr, Hidalgo, and Cameron counties of Texas and forms the border between those counties and the Mexican state of Tamaulipas. Population centers along the Lower Rio Grande have grown tremendously in the past ten years. Agriculture, trade, services, and manufacturing are the primary economic activities in this region. Major cities in the Sub-Basin include McAllen, Harlingen, and Brownsville, Texas on the U.S. side of the river, and Matamoros and Reynosa, Tamaulipas on the Mexican side.

The Lower Rio Grande Sub-Basin depends entirely on the Rio Grande as its source of drinking water. Anticipated increases in municipal and industrial demands resulting from rapid population growth will only further the strain on a limited resource already taxed by previous drought conditions and high agricultural use. The Lower Rio Grande Sub-Basin occupies the southeastern portion of the South Texas Brush Country region. Two significant aquifers lie beneath a central part of this region— the Carrizo-Wilcox and Gulf Coast Aquifers. Groundwater in the area is brackish, requiring the construction of a desalinization plant and the possible construction of additional plants. Studies such as the Lower Rio Grande Basin Study by the Rio Grande Regional Water Authority (RGRWA) and the U.S. Bureau of Reclamation are being conducted on the desalinization of groundwater and ocean water to supplement drinking water supplies in the Lower Rio Grande Valley due, in part, to the high salinity in the water in this region. Most agricultural and urban discharges do not enter the Rio Grande in this reach, as they are diverted to canals that ultimately empty into the Gulf of Mexico; however, excessive flows that exceed the capacity of the channels can be routed to the Rio Grande. This has been done during severe inclement weather, such as hurricanes and tropical storms.

The USIBWC has two dams along this stretch of the river: Anzalduas Dam, and Retamal Dam. Anzalduas and Retamal dams are diversion dams for water accounting purposes, but either one can be used for emergency flooding situations. The Lower Rio Grande Valley also has an emergency floodway meant to divert flood waters from the Rio Grande to the Gulf of Mexico during extreme flood events, which was last used in 2010 during Hurricane Alex.

The USIBWC CRP has three partners in the Lower Rio Grande, the USIBWC Mercedes field office, Brownsville Public Utilities Board, and the University of Texas Rio Grande Valley- Edinburg.

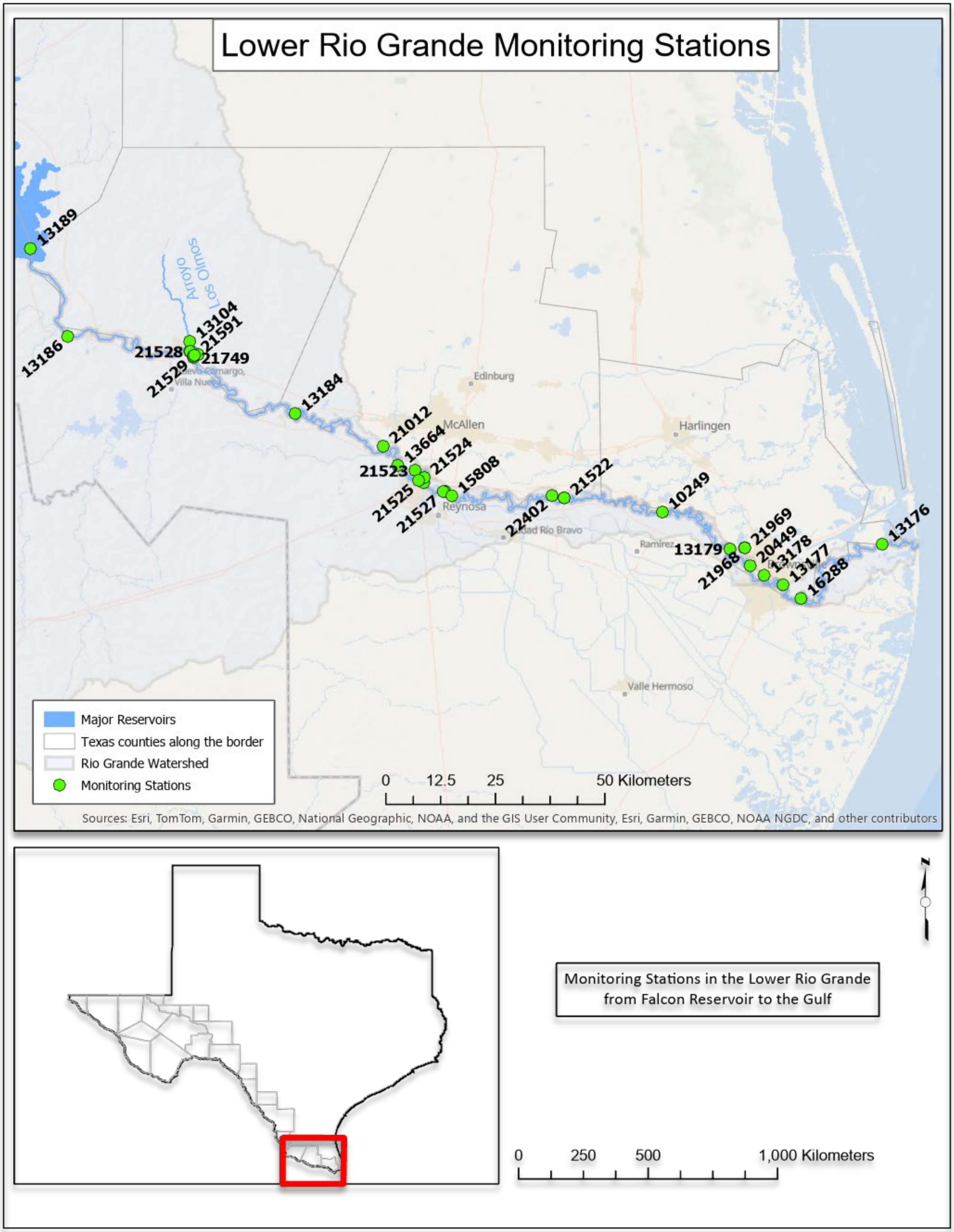


Figure 5. Map of monitoring stations at the lower section of the Rio Grande Basin in Texas

Lower Rio Grande Water Quality Update

The lower section of the Rio Grande includes river segments 2302, 2302A 2301. Figure 6 shows the segments located in this reach. Table 5 identifies the river segment along with the corresponding stations.

Table 5. Lower Rio Grande Sub-Basin River Segments and Active and Historic Stations.

River Segment	Segment description	Assessment Units (AU)	Stations	Station Description
2301	Rio Grande Tidal	2301_01	13176	Rio Grande Tidal
		2301_02	16288	Rio Grande at Zacata Creek
2302	Rio Grande below Falcon Reservoir	2302_01	13177	Rio Grande at El Jardin pump station
			13178	Rio Grande at Brownsville International Bridge
			13179	Rio Grande at River Bend
			20449	Brownsville PUB intake
		2302_02	10249	Downstream San Benito Pumping Station
		2302_03	15808	Rio Grande at Pharr International Bridge
			17247	Rio Grande at Progresso
		2302_04	13181	Rio Grande at Hidalgo
			13664	Rio Grande at Anzalduas Dam
		2302_05	21012	Rio Grande off Shuerbach Road
		2302_06	13184	Rio Grande at Los Ebanos
			21749	Rio Grande at Los Olmos Creek
		2302_07	13185	Rio Grande at Fort Ringgold
			13186	Rio Grande at Rio Alamo
2302A	Arroyo Los Olmos	2302A_01	13103	Los Olmos Creek at Rio Grande City
			13104	Arroyo Los Olmos NW of Rio Grande City
			21591	Arroyo Los Olmos at Rio Grande

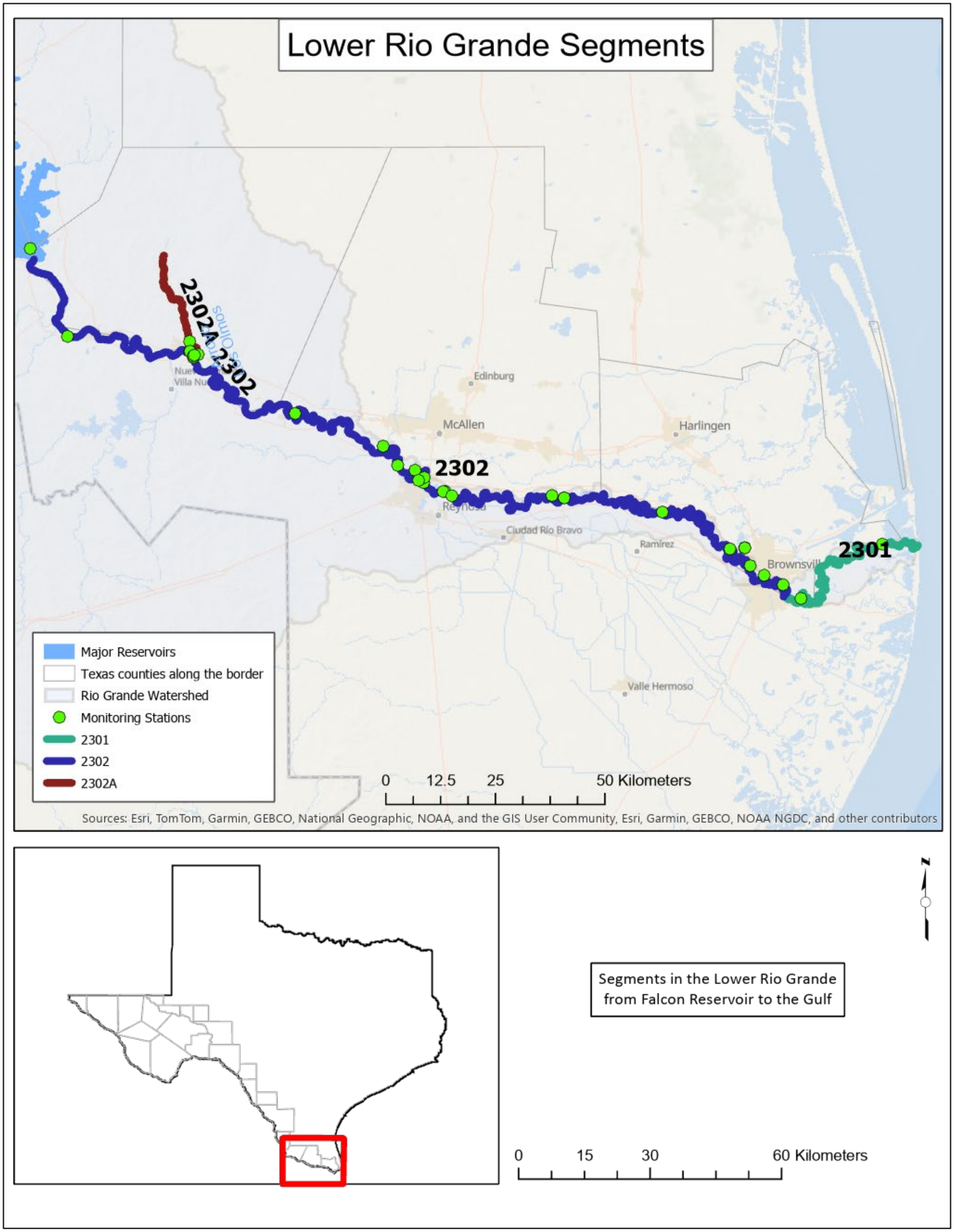


Figure 6. Map of segments at the lower section of the Rio Grande Basin in Texas

Segment 2301 – Rio Grande Tidal

Segment 2301 stretches from the confluence with the Gulf of Mexico in Cameron County to a point 10.8 km (6.7 mi) downstream of the International Bridge in Cameron County. The segment is classified as a tidal stream and has two assessment units: AU 2301_01 which runs from the confluence with the Gulf of Mexico in Cameron County to a point 71.7 km (44.6 mi) upstream and AU 2301_02, which runs from a point 71.7 km (44.6 mi) upstream of the mouth the Rio Grande to a point 10.8 km (6.7 mi) downstream of the International Bridge in Cameron County. Station 13176 monitors AU 2301_01 and station 16288 historically monitored AU 2301_02. These are the only these two stations that monitor the tidal segment. The segment does not have any impairments, however there is a concern for bacteria, chlorophyll, nitrate, and depressed oxygen in the water.

Due to the saltwater influence in this portion of the river *Enterococcus* rather than *E. coli* is collected. Over the ten-year period of 2012-2022, the stations only collected a total of 10 samples. Station 13176 began sampling for enterococci in fiscal year 2024 again after training was conducted on new personnel. Station 13176 was also the station that had the most samples analyzed for chlorophyll. As shown in Figure 7, levels for chlorophyll exceeded the 21 ug/L screening level, indicating a concern. Values for nitrate exhibit fluctuations with no consistent upward or downward trend at station 13176. There was insufficient data for nitrate at station 16288 to conduct analysis.

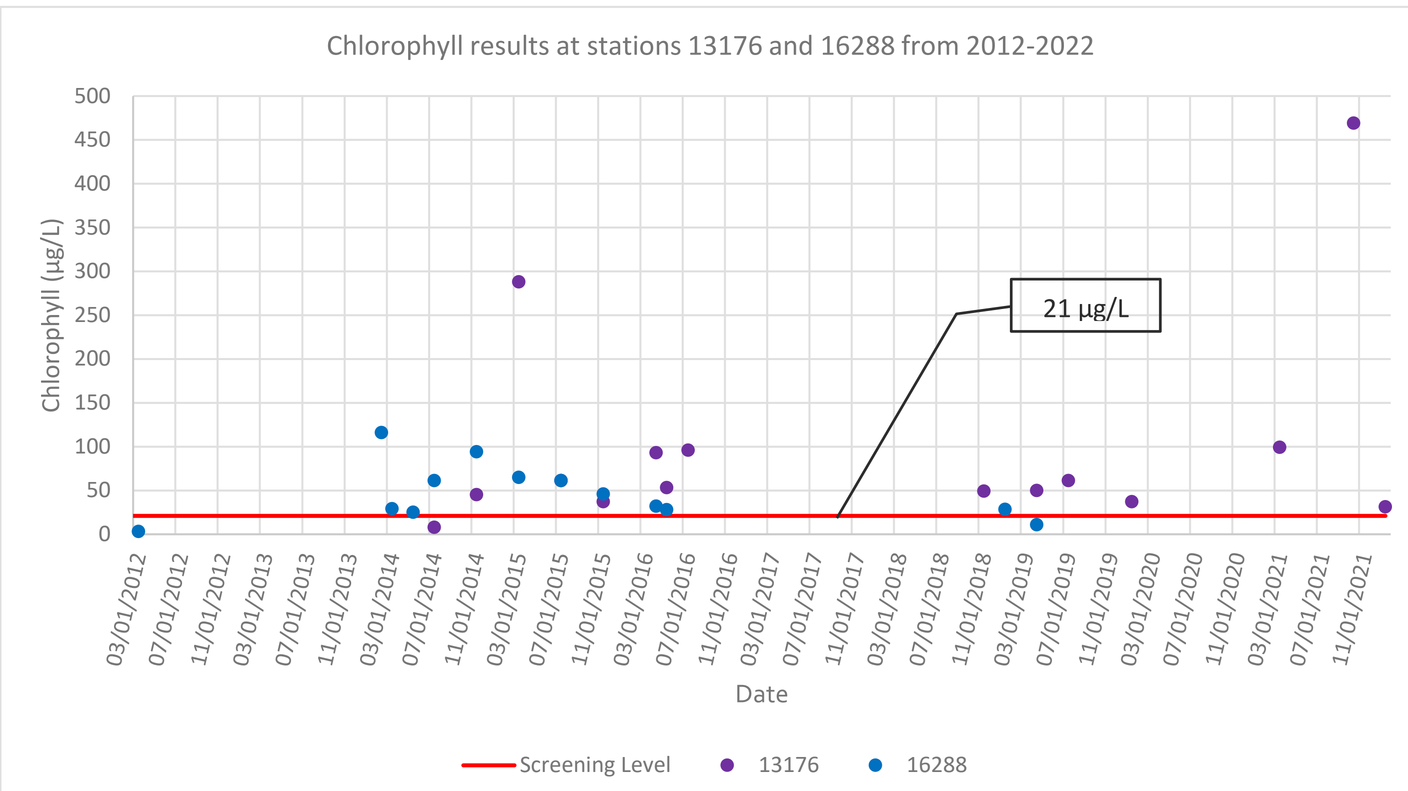


Figure 7. Chlorophyll results for stations 13176 and 16288 from the years 2012-2022.

Segment 2302 – Rio Grande below Falcon Reservoir

Segment 2302 runs from a point 10.8 km (6.7 mi) downstream of the International Bridge in Cameron County to Falcon Dam in Starr County. The segment is classified as a freshwater stream and has seven assessment units.

- 2302_01, International Bridge near El Jardin Pump to Rancho Viejo Floodway
- 2302_02, Rancho Viejo Floodway upstream to Progresso International Bridge
- 2302_03, Progresso International Bridge to McAllen International Bridge
- 2302_04, McAllen International Bridge upstream to Anzalduas Dam
- 2302_05, Anzalduas Dam upstream to Los Ebanos Ferry Crossing
- 2302_06, Los Ebanos Ferry Crossing upstream to Arroyo Los Olmos
- 2302_07, Arroyo Los Olmos upstream to Falcon Reservoir Dam

There is a total of 14 stations on this segment that were used for analysis. The stations are as follows:

- 13177 – Rio Grande Tidal
- 13178 – Rio Grande at Brownsville International Bridge
- 13179 – Rio Grande at River Bend
- 20449 – Brownsville PUB intake
- 10249 – Downstream of San Benito Pumping Station
- 15808 – Rio Grande at Pharr International Bridge
- 17247 – Rio Grande at Progresso
- 13181 – Rio Grande at Hidalgo
- 13664 – Rio Grande at Anzalduas
- 21012 – Rio Grande off Shuerbach Road
- 13184 – Rio Grande at Los Ebanos
- 21749 – Rio Grande at Los Olmos Creek
- 13185 – Rio Grande at Fort Ringgold
- 13186 – Rio Grande at Rio Alamo

Segment 2302 is listed as impaired for bacteria and there are concerns for chlorophyll, ammonia, pH, and dissolved oxygen in water. Stations 15808, 13177, and 13181 were the three stations with the highest geometric means of *E. coli* from 2012-2022. However, no significant trends were identified. Figure 8 shows the bacteria results for these stations.

In contrast, stations 10249, 20449, and 21012 had the lowest geometric means, at 21.5 MPN/100 mL, 24 MPN/100 mL, and 25.8 MPN/100 mL respectively. A trend analysis of these stations did not identify any significant trends.

Additionally, a broader trend analysis by year across the multiple stations did not reveal any statistically significant increases or decreases. Overall, the data suggests that bacteria levels have remained somewhat stable across the stations in this segment, with no significant long-term trends detected. High levels in some of the stations still require further investigation and continued monitoring. Table 6 shows these top three stations with the highest geomeans and the top three stations with the lowest geomeans, along with the geometric mean, count, slope, and p-value for each of the stations. The sources of high bacteria levels can be traced to municipal impacts. Lack of substantial infrastructure to handle high growth rates and increased amounts of municipal waste are a contributing factor. Cameron and Hidalgo counties in the lower portion of the basin are home to many colonias, low-income communities, that lack proper wastewater infrastructure. Although efforts have been underway to establish infrastructure for these underserved communities, there are still some population clusters needing basic water and wastewater services. More background information on colonias, population growth, and funding can be found on an analysis paper written in 2021.

Table 6. Geometric means for *E. coli,* counts, slopes, and p-values.

	Station	Geometric mean (MPN/100mL)	Count (n)	Slope	p-value
Highest geomean	15808	348	58	0.15	0.60
	13177	187.2	61	0.34	0.76
	13181	123.2	69	0.06	0.12
Lowest geomean	10249	21.5	31	-0.019	0.45
	20449	24	104	-0.018	0.40
	21012	25.8	26	-0.013	0.73

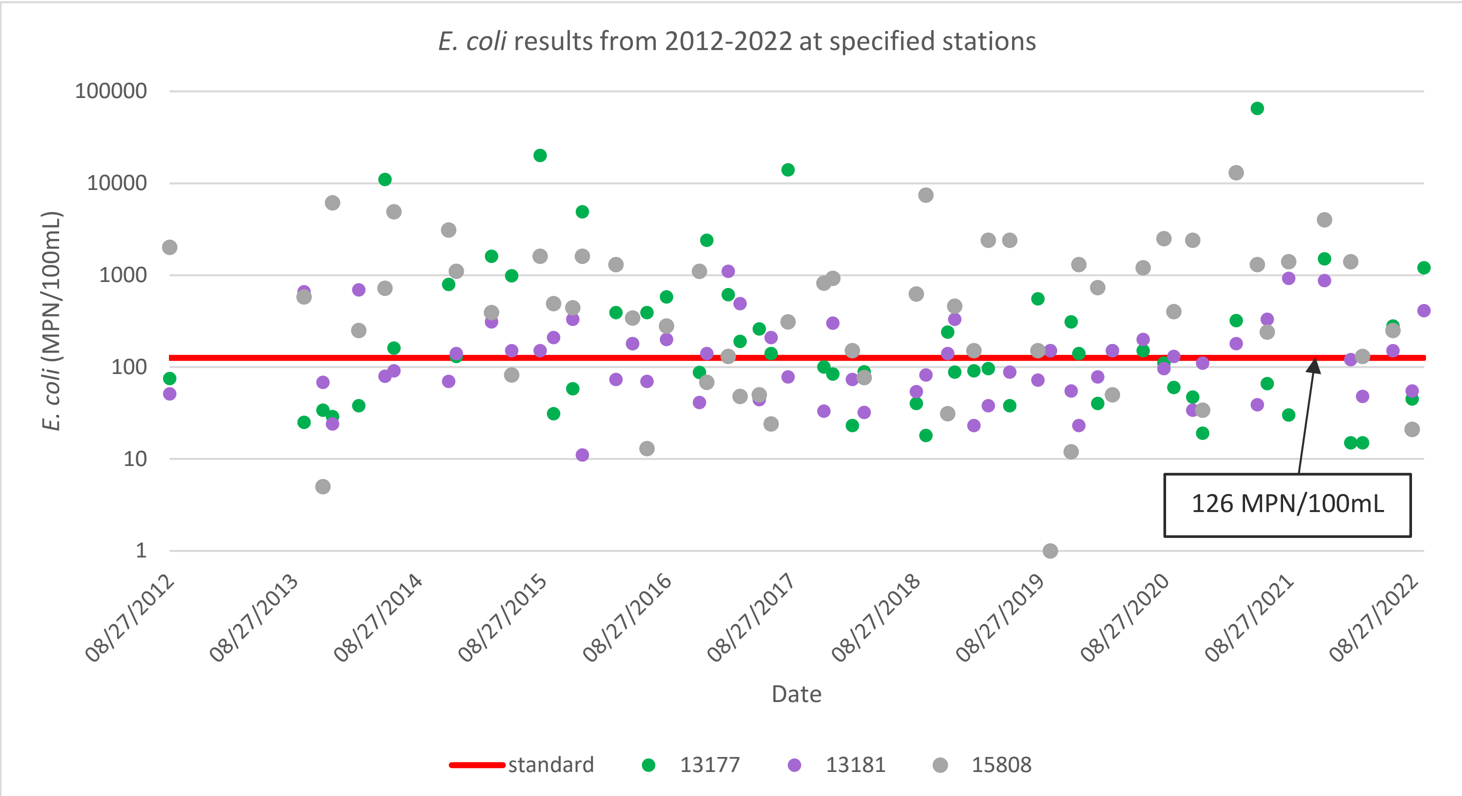


Figure 8. *E. coli* results for stations 13177, 13181 and 15808 from the years 2012-2022.

Chlorophyll, dissolved oxygen (DO), and pH, the parameters of concern in this segment, help detect changes in water quality over time, indicating shifts in natural processes or human activities. For example, pH can influence the solubility of certain chemicals, like ammonia, making it more toxic. Changes in chlorophyll or DO are also indicators of stressors in the ecosystem. High chlorophyll levels can indicate changes in algal populations, while DO is essential for fish and other aquatic organisms. In segment 2302 stations 13177, 13664, 15808, and 13181 had the highest average levels of chlorophyll. Fertilizers, septic systems, and sewage can contribute to high levels of chlorophyll. Figure 9 shows the results for these stations.

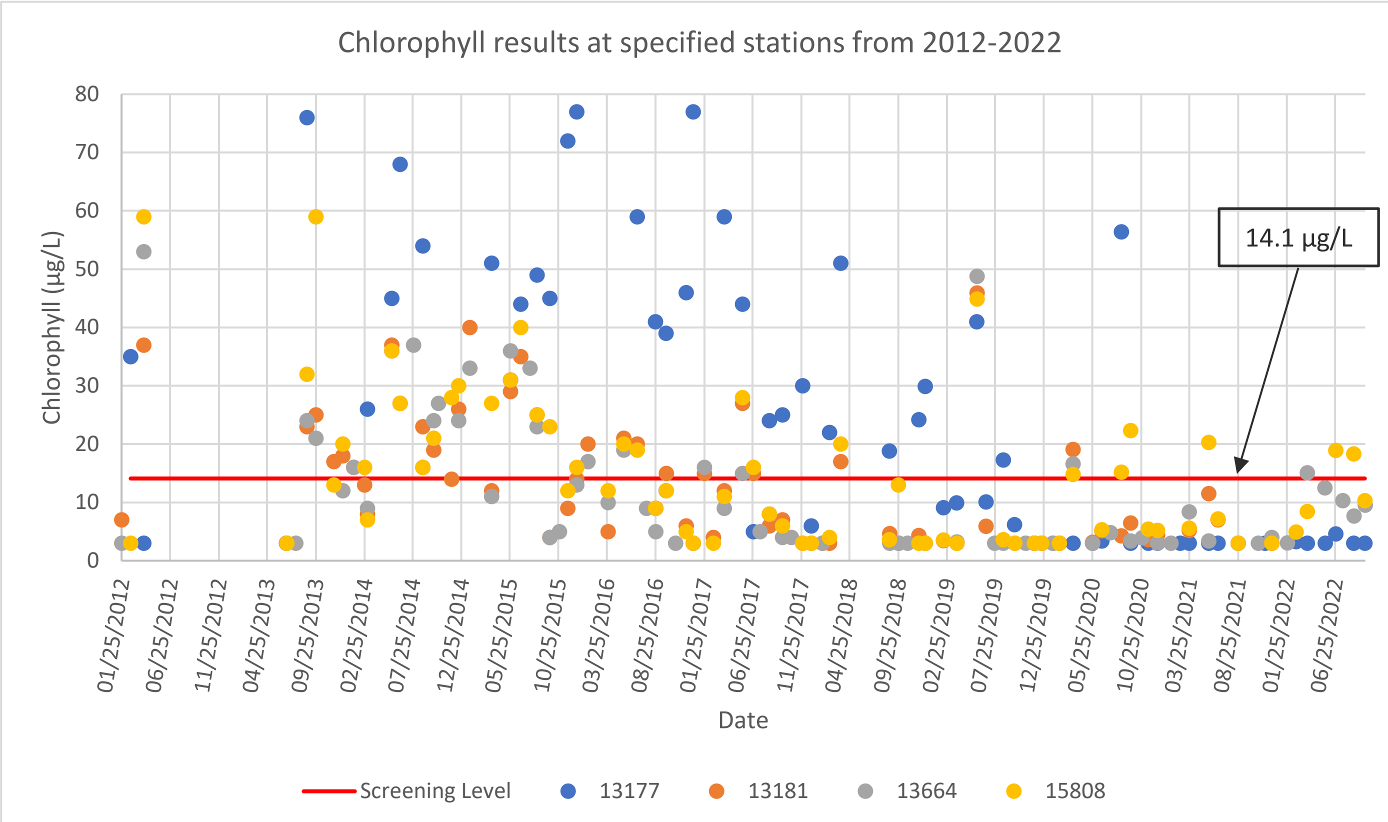


Figure 9. Chlorophyll yearly average results for specified stations from the years 2012-2022.

For DO, values that are lower than the standard indicate that the waterbody may not be meeting its designated use. Again stations 13177, 15808, 13184, and 13181 have the lowest DO averages for the ten-year period, although averages were above the 5 mg/L screening level. Table 7 shows the ten-year average of these stations along with the count of each and Figure 10 shows the results for each sampling event. In the early years of the ten-year period from 2012-2015, DO values were below the screening level of 5.0 mg/L. Continued monitoring of these stations is imperative due to the data suggesting several water quality issues within the same stations.

Table 7. Stations with the lowest average of DO from 2012-2022

Station	Average (mg/L)	Count (n)
13177	6.3	60
15808	6.7	55
13184	6.9	48
13181	7.0	65

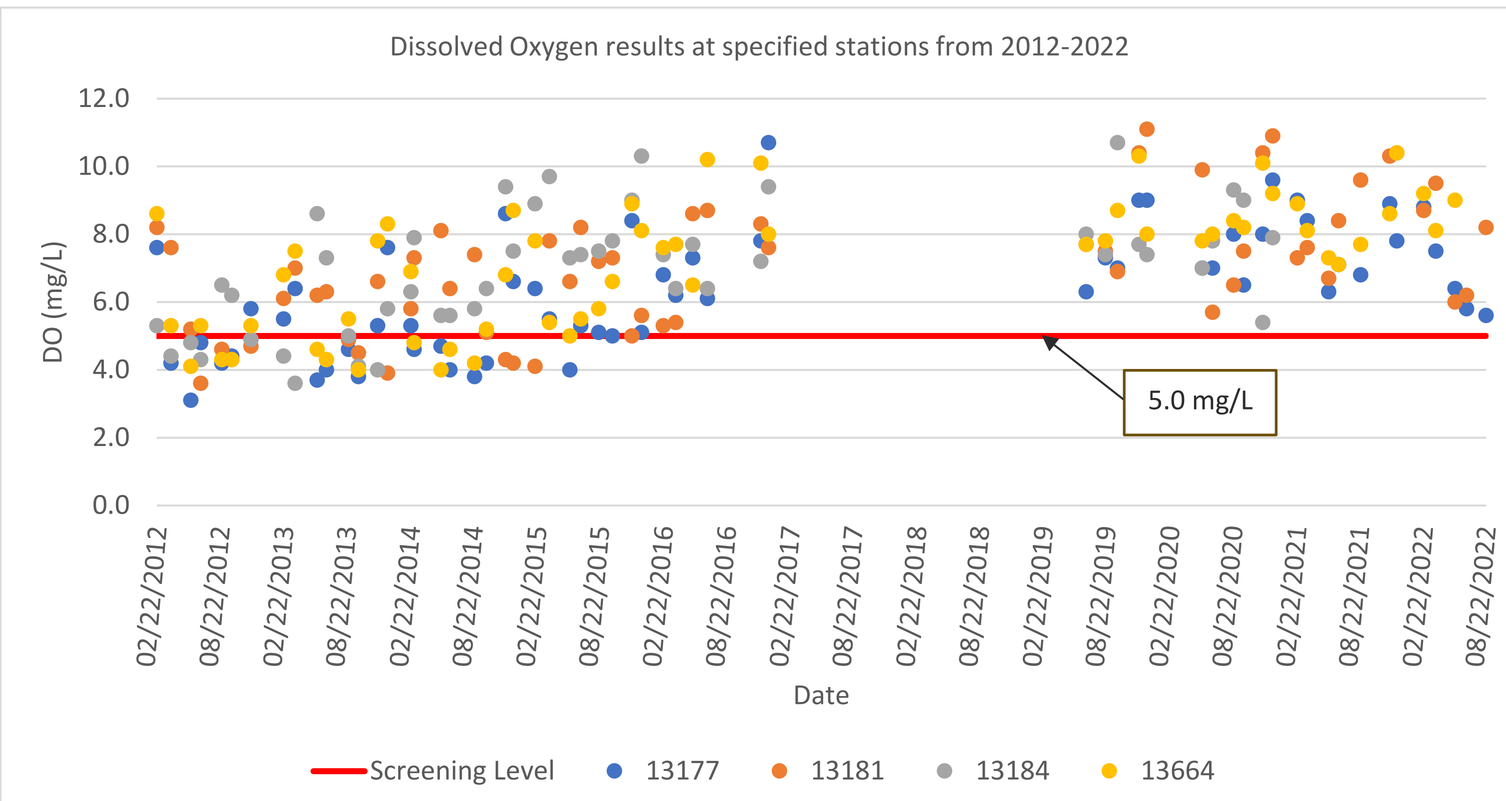


Figure 10. Dissolved Oxygen results for specified stations from the years 2012-2022.

Segment 2302A – Arroyo Los Olmos

Segment 2302A stretches from Rio Grande confluence at Rio Grande City to El Sauz in Starr County. This segment includes only assessment unit 2302A_01 and is monitored by stations 13103, 13104, and 21591. Arroyo Los Olmos is impaired for bacteria and dissolved oxygen and has a concern for chlorophyll-*a*. Out of the three stations, only station 13103 had sufficient data to conduct a statistical analysis. Station 13103 is located at Los Olmos Creek at US 83 East of 2nd Street South of Rio Grande City. Levels of bacteria are above the standard at this station. For the ten-year period, the geomean for *E. coli* was 877 MPN/100 mL. This value is well above the standard of 126 MPN/100 mL. Figure 11 shows the results for bacteria at station 13103. Station 13103 has low flow, which can contribute to accumulation of contaminants. This coupled with urban run-off create unsuitable conditions. As plants photosynthesize (using chlorophyll) they produce oxygen, which in turn can create a saturation of DO. In the case of this segment low flow, accompanied by the decay of plants can be a contributing factor to the low DO.

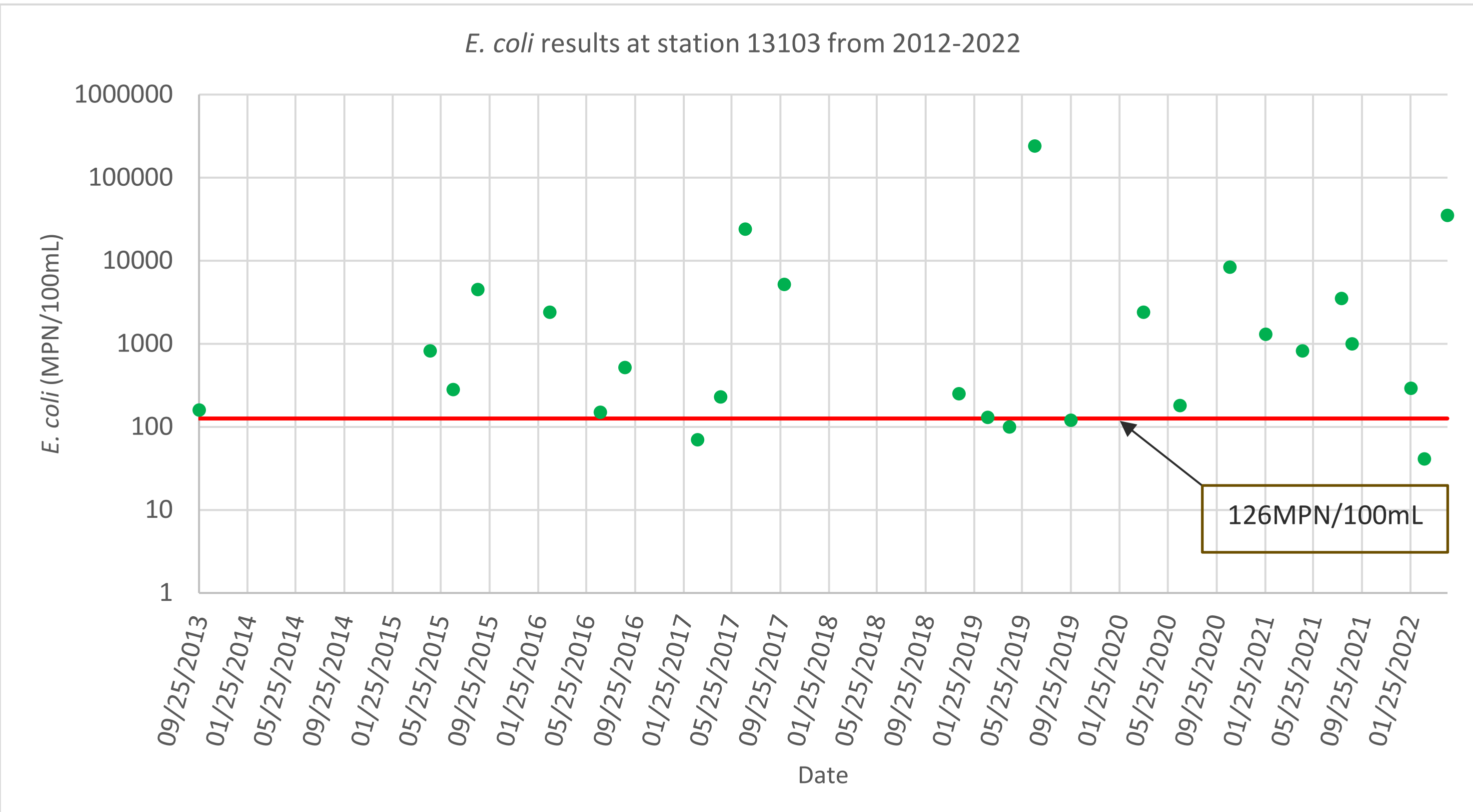


Figure 11. *E. coli* results at station 13103 from the years 2012-2022.

Lower Rio Grande Land Use

Most of the urban areas in this segment are closer to the Gulf of Mexico. The beginning of the segment is mostly undeveloped but proceeding downstream there are small and large urban developments on both sides of the border. Figure 12 shows the areas of highest urban concentration in the lower portion of the Rio Grande Basin. There are very small developments dotting the land that follow the river throughout the entire segment on both sides of the border, and may presumably be colonias, or very poor communities with access to little or no wastewater infrastructure and poor sanitary conditions. The Lower Rio Grande Valley is heavily influenced by agriculture, and a large part of the lands near the river is agricultural crop lands. There are several large industrial buildings on the Mexican side of the border. This area has ports of entry as well which see heavy traffic, commercial and private, daily. Figure 13 shows the land use for the lower Rio Grande Portion of the basin.

Impacts on Water Quality

Agricultural: This segment is heavily impacted by the agricultural industry, and most of the land is cropland. There are some private ranchlands in the surrounding areas that have livestock. Agricultural return flows may contribute to high salinity in the water being returned to the river and may also have a negative impact on the bacteria counts. It is important to note that return flows are received from both the U.S. and Mexico, and both may be contributing to the problem. Agricultural return flows are also high in nutrients, which can contribute to algal blooms. Livestock that graze near the river can also be a contributing source of bacteria.

Wildlife: The area is a popular stop for migratory birds, which may also contribute to the bacteria issues in this area. There is also livestock grazing around the river due to private ranches. Other small wildlife is also common and could be small contributors to bacteria problems.

Urban Runoff: There are multiple communities along the river in this span of the basin. Roma, Rio Grande City, Mercedes, McAllen, Weslaco, La Joya, Harlingen, and many other cities border the river until it reaches the Gulf on the U.S. side, while numerous towns and cities border the river on the Mexican side as well.

Drought: Texas has been experiencing severe drought for the past decade. A drought event is characterized by a prolonged period of abnormally low rainfall, which affect water levels. Low flow in the Rio Grande leads to a concentration of pollutants, such as bacteria, nutrients, and TDS. In the tidal section (segment 2301) low flow rates lead to saltwater intrusion which can create high salinity levels.

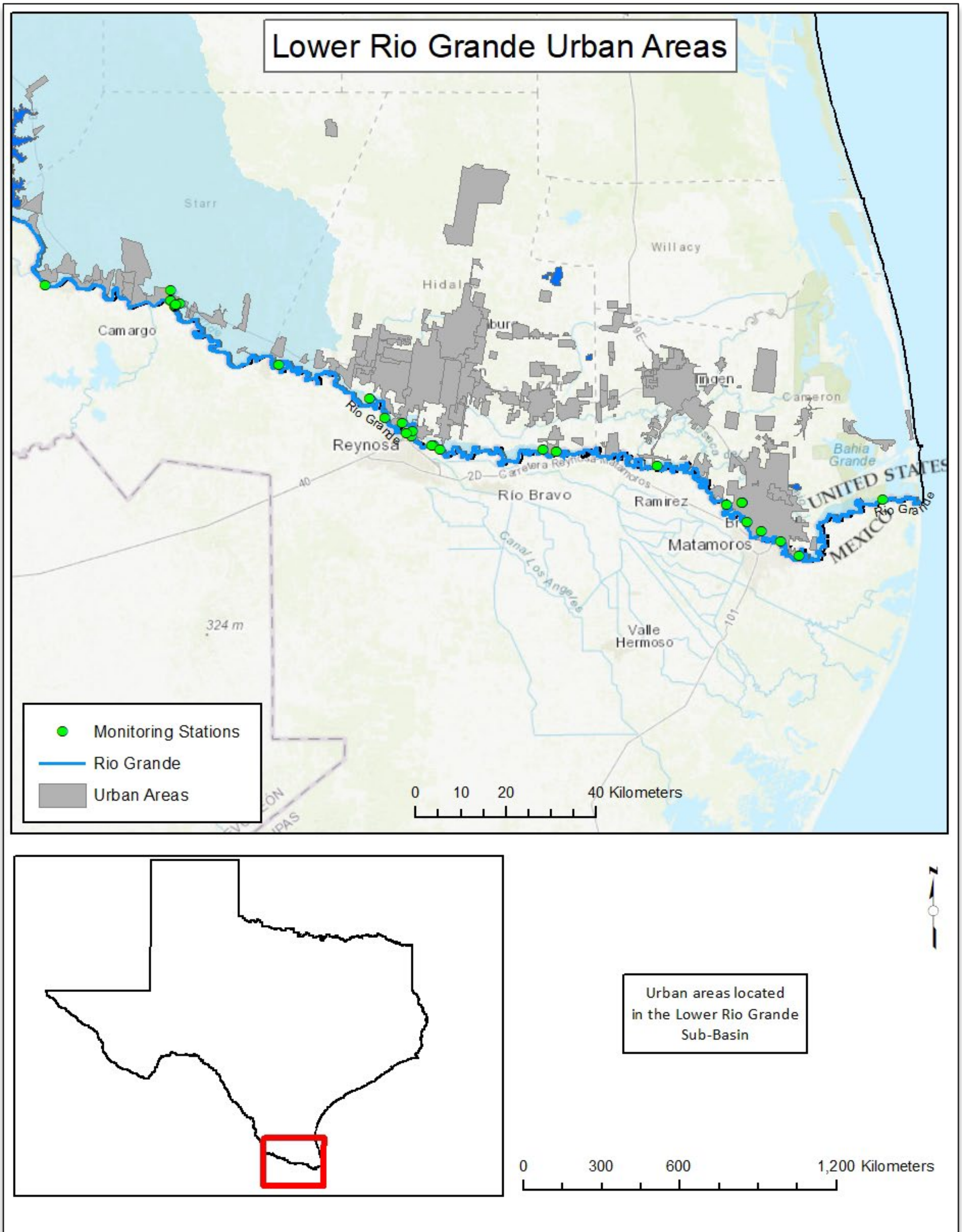


Figure 12. Map of the urban areas in the Lower Rio Grande Sub-Basin

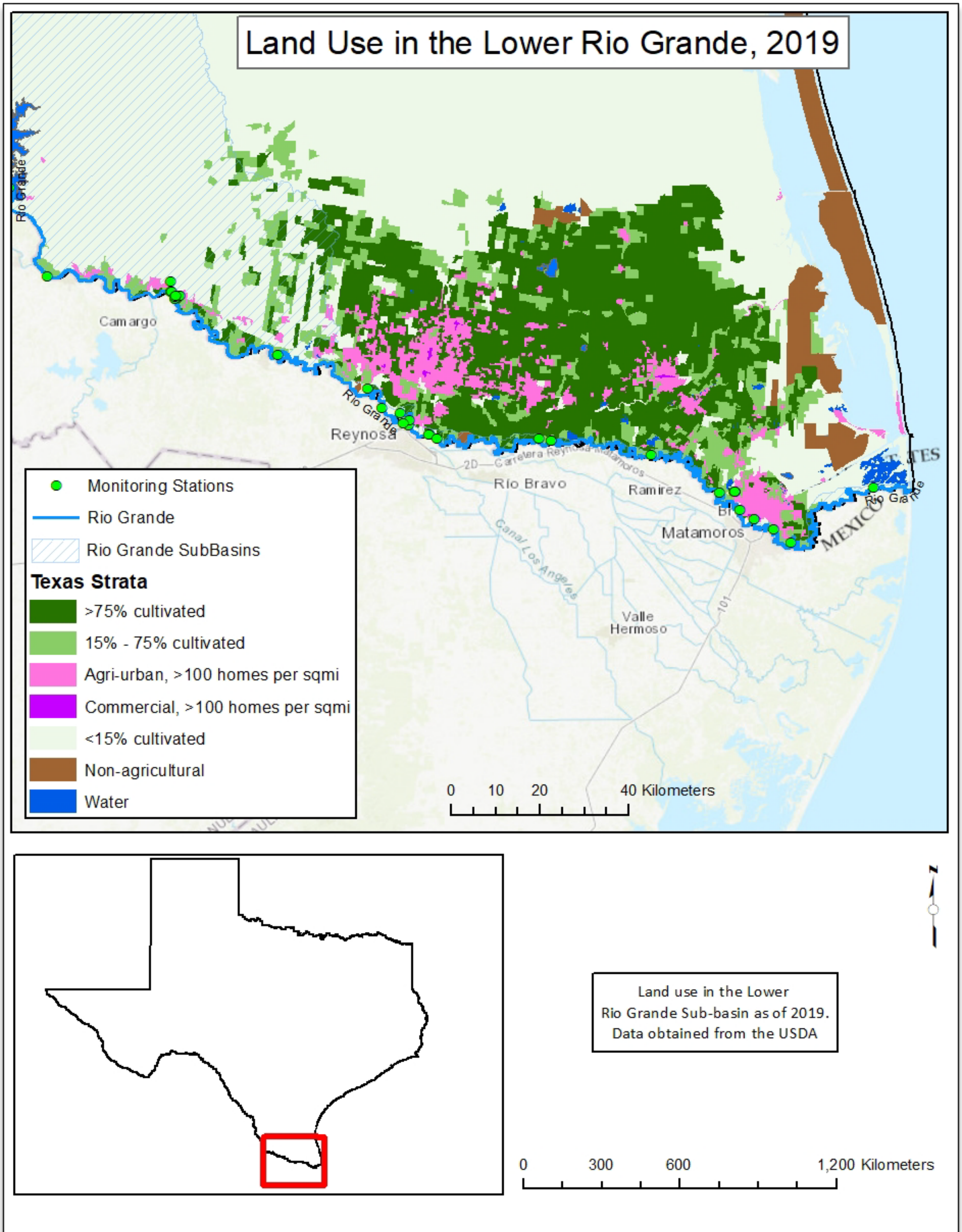


Figure 13. Map of the land use at the lower section of the Rio Grande Basin in Texas

Lower Rio Grande Significant Findings

The lower portion of the Rio Grande Basin is characterized by high bacteria levels, hence the bacteria impairments in segments 2302 and 2302A as listed in the IR. Figure 14 shows the segments that are impaired for bacteria on the lower Rio Grande Basin. Bacteria levels are impacted by municipal sources. This is also exacerbated by aging wastewater treatment infrastructure and a growing population. Unfortunately, bacteria levels continue to remain above the standard and do not indicate a significant decrease in the ten-year period. Segment 2302A, Arroyo Los Olmos, is also impaired for dissolved oxygen. Figure 15 shows the location of this impairment in the Lower Rio Grande Basin. As discussed before low dissolved oxygen levels can affect the ability of aquatic life to thrive and can lead to fish kills. Levels of DO are affected by multiple sources, such as discharges either from agriculture or industrial sources, temperature of the water (warmer water can decrease the solubility of oxygen in the water), and low flow. This area of the basin has been experiencing high temperatures due to drought conditions, which have degraded water quality.

There are also several parameters of growing concern in these segments. These parameters include chlorophyll, ammonia, nitrate, and pH. Figures 16 and 17 show the segments with a chlorophyll concern and an ammonia and nitrate concern, respectively. Agriculture runoff contributes to excess nutrients and salts commonly present in fertilizers used in agricultural practices.

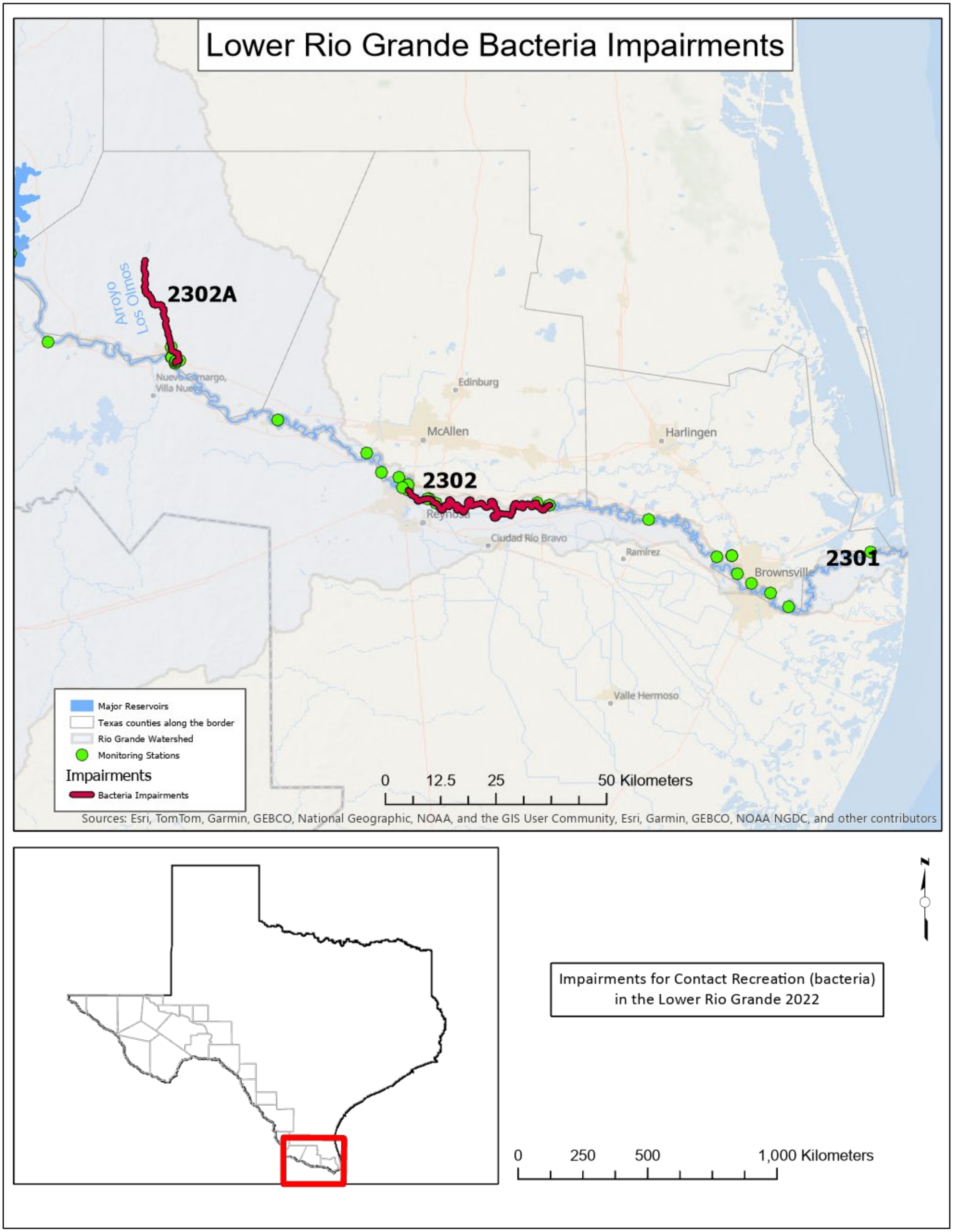


Figure 14. Map of the bacteria impaired river segments in the lower section of the Rio Grande Basin in Texas

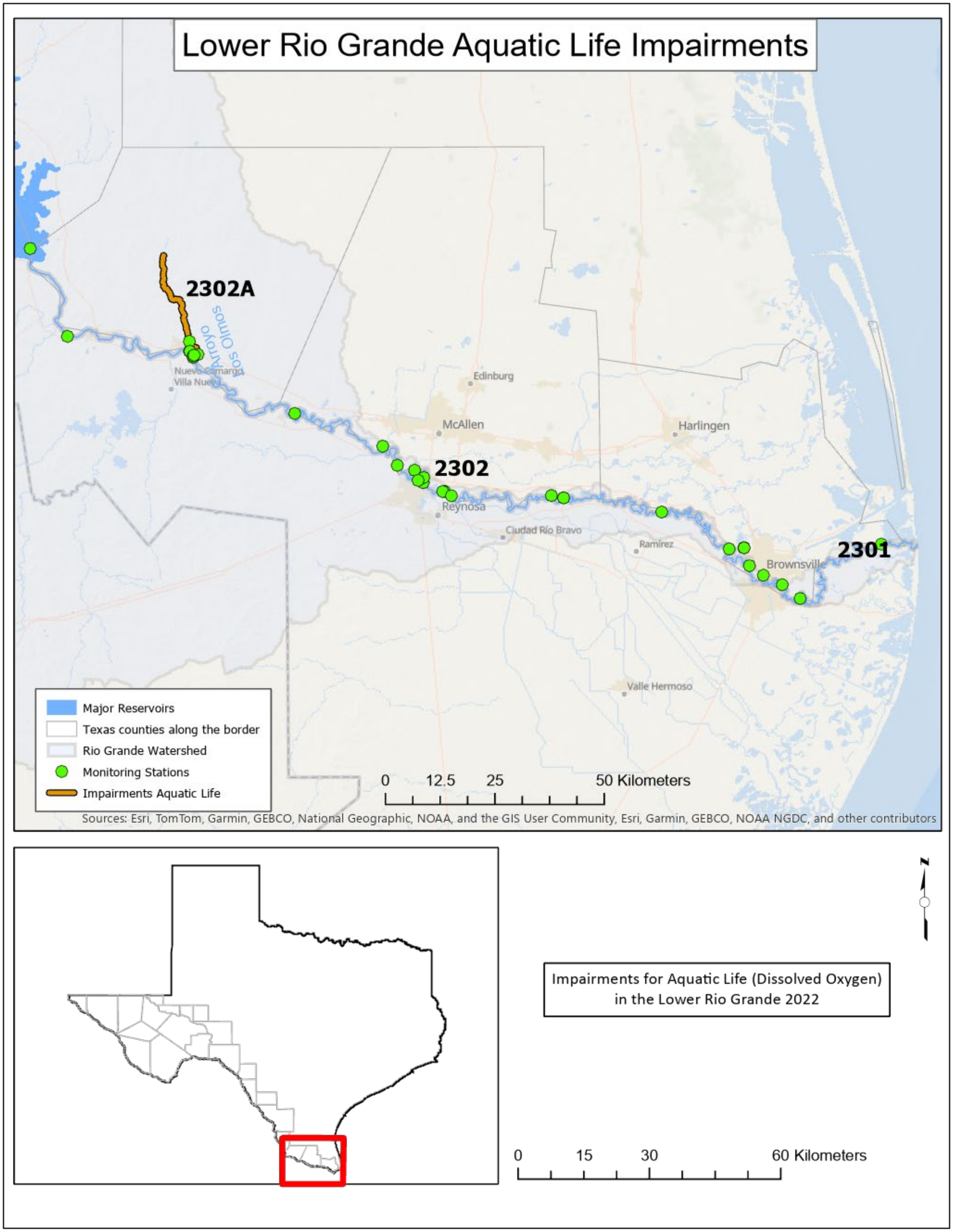


Figure 15. Map of the dissolved oxygen impaired river segments in the lower section of the Rio Grande Basin

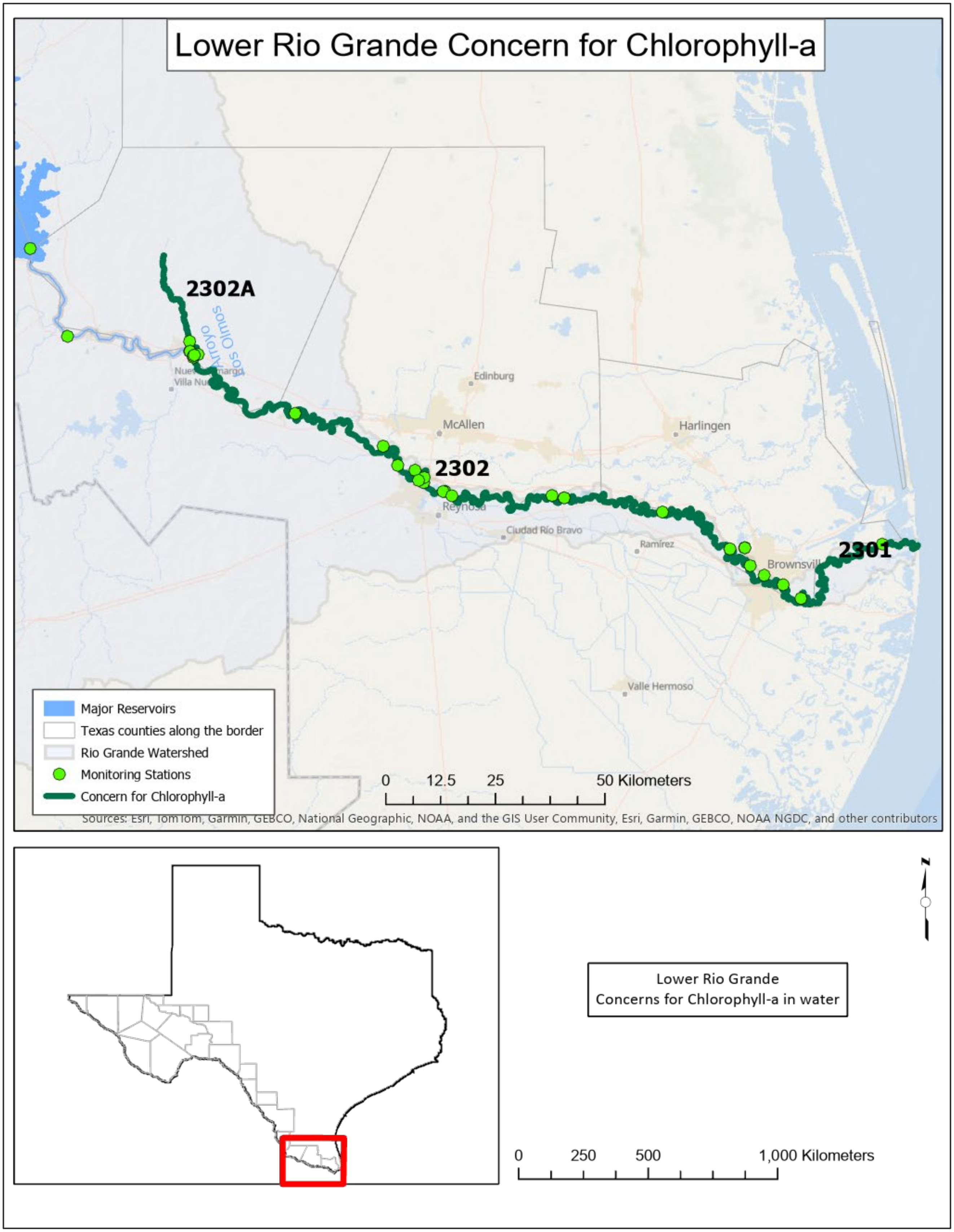


Figure 16. Map of the river segments in the lower section of the Rio Grande Basin with concerns for chlorophyll.

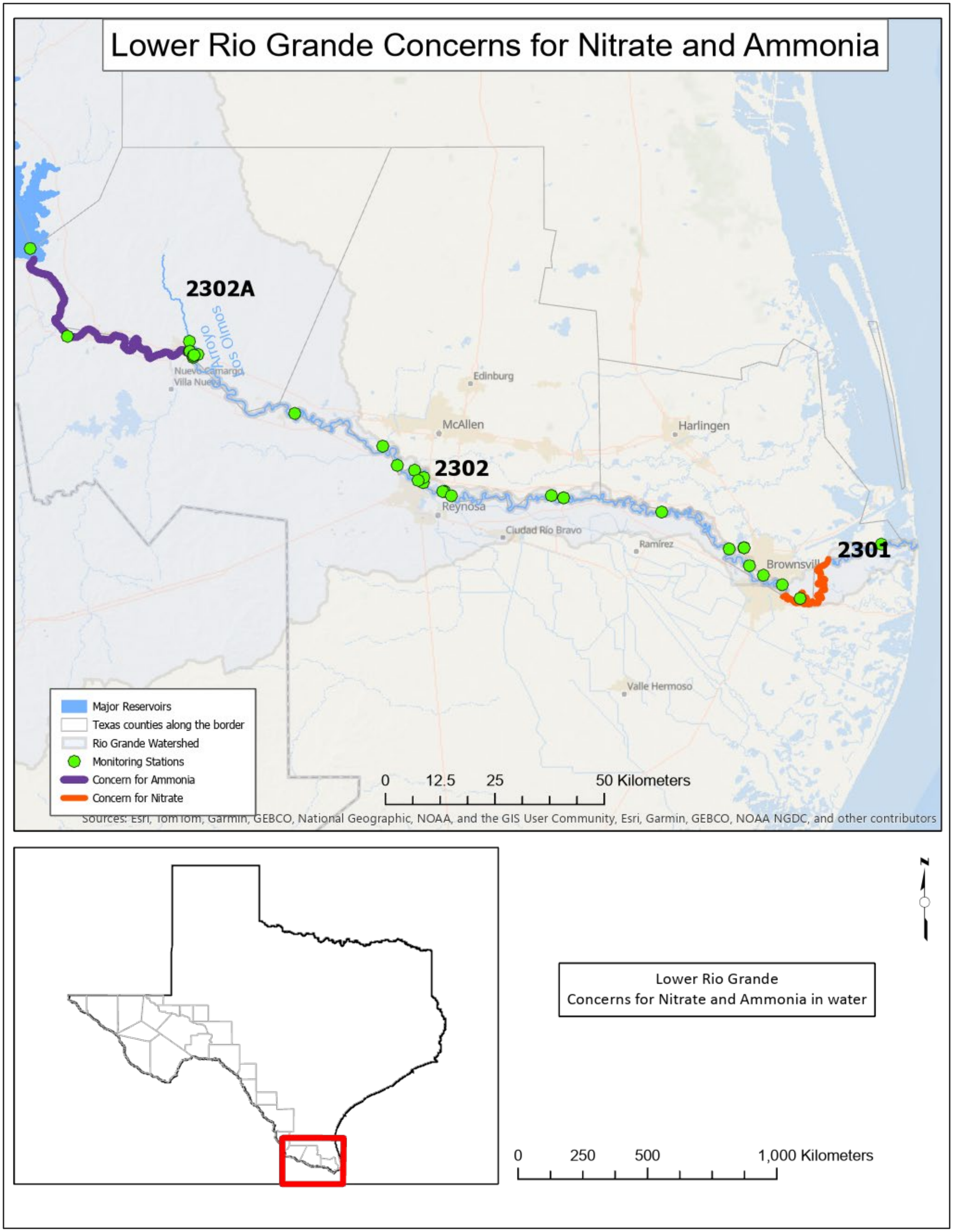


Figure 17. Map of the concerns for nitrate and ammonia in the lower section of the Rio Grande Basin in Texas

Middle Rio Grande Sub-Basin

The Middle Rio Grande Sub-Basin extends from just below the International Amistad Reservoir to International Falcon Reservoir. Covering a 303-mile (487 km) stretch across five counties in Texas and the Mexican States of Coahuila, Nuevo Leon, and Tamaulipas, this region includes major cities such as Del Rio, Eagle Pass, and Laredo, Texas, along with sister cities Ciudad Acuna, Coahuila, and Nuevo Laredo, Tamaulipas. The northernmost and easternmost parts of the Sub-Basin lie in the Edwards Plateau region, while the remainder is situated in the South Texas Brush County. Downstream of the International Amistad Reservoir, the terrain transitions to rolling plains, continuing until it becomes coastal plains near the Gulf of Mexico in the Lower Rio Grande Sub-Basin.

The area has experienced significant population growth, particularly in Laredo, which is one of the fastest-growing cities in Texas. Contributing factors include increased trade with Mexico, manufacturing expansion, and a rise in tourism. The region's largest economic sectors include tourism, hunting, ranching, and government with the Laughlin Air Force Base in Del Rio playing a significant role.

Most of the communities along this portion of the Rio Grande depend on surface water for domestic, agriculture, and industrial use, except for Del Rio, TX, which relies on groundwater from the Edwards-Trinity Aquifer. San Felipe Creek, a major spring-fed tributary within Del Rio, contributes pristine spring waters directly into the Rio Grande downstream of the International Amistad Dam.

The USIBWC manages Falcon International Dam in this area. The Falcon reservoir is utilized for conservation purposes, releasing water during scheduled intervals and severe weather events to prevent flooding downstream.

In this area USIBWC CRP partners with USIBWC Falcon Dam, The City of Laredo Environmental Services, and Rio Grande International Study (RGISC). Figure 18 shows the area covered along with the sampling stations located at the Middle Rio Grande Sub-Basin.

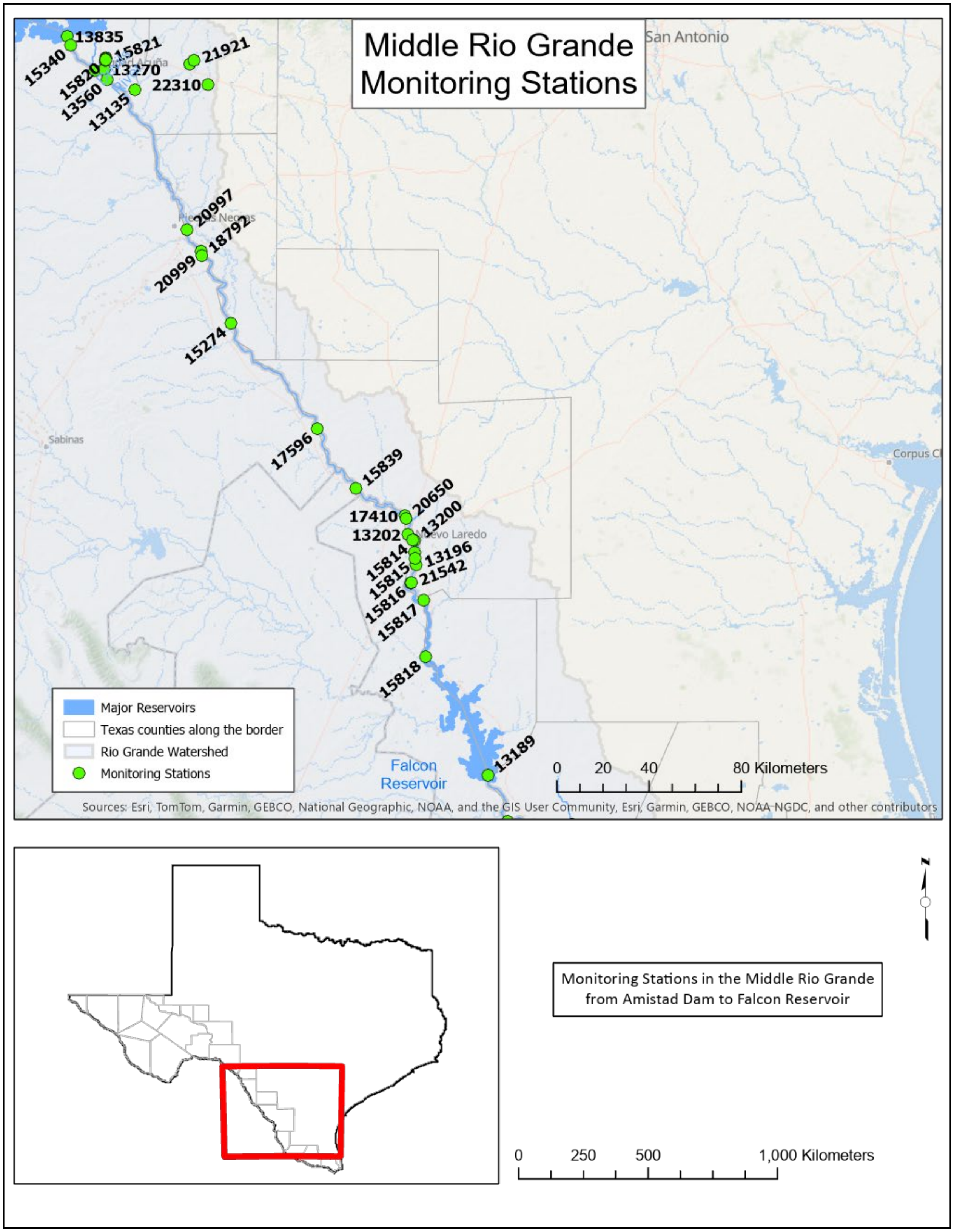


Figure 18. Map of Middle section of the Rio Grande Basin in Texas

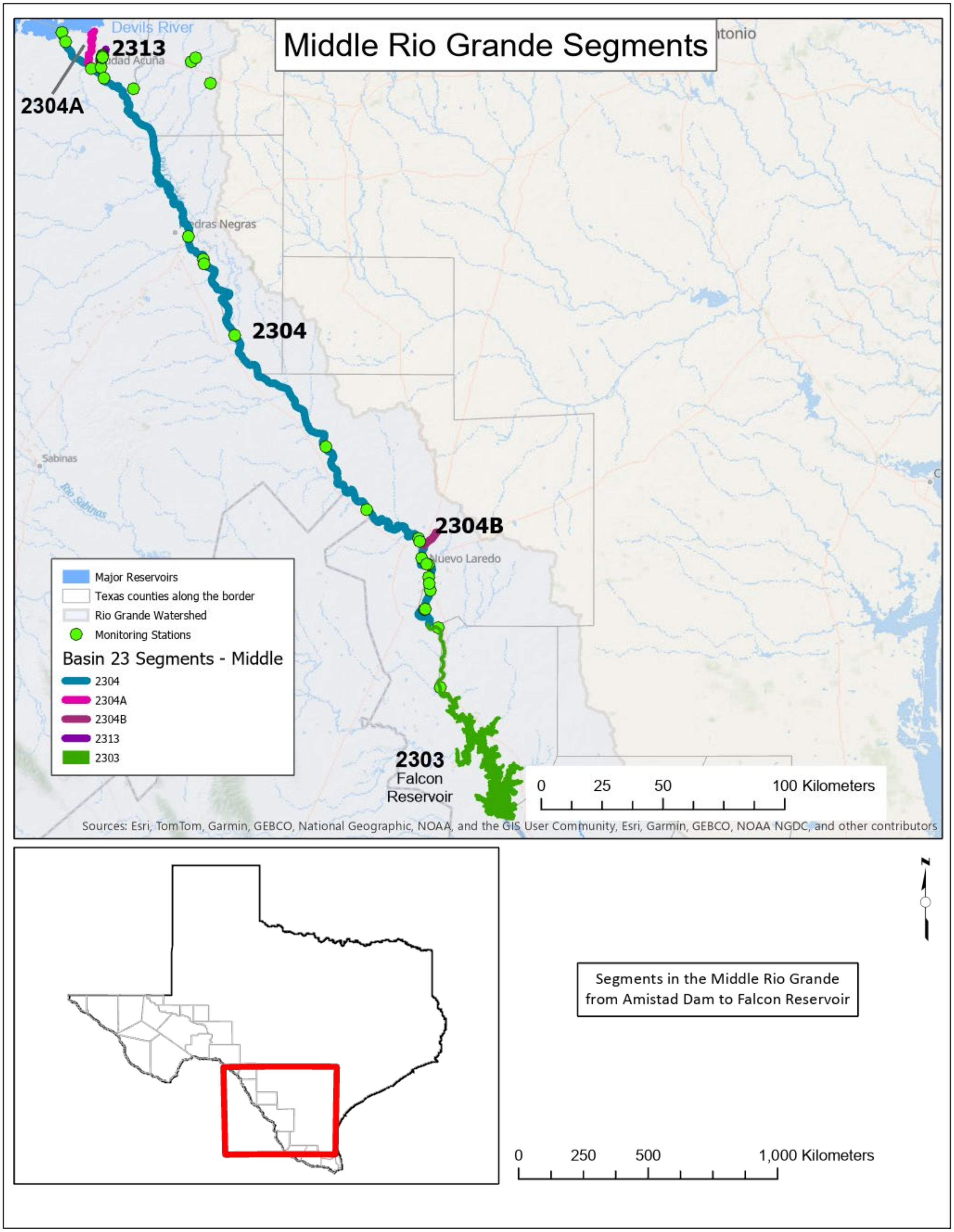


Figure 19. Map of Middle section segments of the Rio Grande Basin in Texas

Table 8. Middle Rio Grande Sub-Basin River Segments and FY 2024 Stations.

River Segment	Segment description	Assessment Units (AU)	Stations	Station Description
2303	International Falcon Reservoir	2303_01	--	No Stations
		2303_02	--	No Stations
		2303_03	13189	Falcon Lake at IBWC monument
		2303_04	--	No Stations
		2303_05	15817	Rio Grande at Webb/Zapata County line
			15818	Falcon at San Ygnacio WTP intake
2304	Rio Grande Below Amistad Dam	2304_01	13196	Rio Grande at Pipeline Crossing
			15816	Rio Grande at El Cenizo
			21542	Rio Grande al Cenizo Park
		2304_02	13200	Rio Grande at Zacata Creek
			15815	Rio Grande at Masterson
		2304_03	15814	Rio Grande at Juarez-Lincoln Bridge
		2304_04	13202	Laredo water treatment pump intake
			17410	Rio Grande at World Trade Bridge
			20650	Rio Grande at Father McNaboe Park
		2304_05	--	There are no stations at this AU
		2304_06	15274	Rio Grande downstream of Cuervo Creek
			15839	Rio Grande at Colombia Bridge
			17596	Rio Grande at Apache Ranch
		2304_07	18792	Rio Grande at Riverside Drive
			20999	Rio Grande at Kickapoo Boat Ramp
		2304_08	20997	Rio Grande at Main Street Boat Ramp
		2304_09	13560	Rio Grande at Moody Ranch
		2304_10	13208	Rio Grande downstream Amistad Dam near gage 340
			15340	Rio Grande downstream of Amistad Dam upstream IBWC gage 08-4509
2304B	Manadas Creek	2304B_01	13116	Manadas Creek
2313	San Felipe Creek	2313_01	13270	San Felipe Creek at Guyler
			15820	San Felipe Creek at West Springs
			15821	San Felipe Creek at Blue Hole Flood

Middle Rio Grande Water Quality Update

The Middle section of the Rio Grande includes river segments 2303, 2304, 2309, 2309A, and 2313. Figure 18 shows the area covered by the Middle Rio Grande Sub-Basin and Figure 19 shows the segments located in this reach. Table 8 identifies the river segment along with the corresponding stations. Each segment will be discussed in further detail below.

Segment 2303 – International Falcon Reservoir

Photo taken at Falcon International Dam.

Segment 2303, International Falcon Reservoir, runs from Falcon Dam in Starr County to the confluence of the Rio Salado (Mexico) in Zapata County, which runs for 68 miles (110 km). There are five assessment units in the segment. Three stations monitor this segment: station 13189, 15817, and 15818 in assessment units 3 and 5. Assessment units 1, 2 and 4 do not have monitoring stations. The reservoir does not have any impairments, however there is a concern for ambient toxicity in water at assessment unit 5 and a concern for fish kill in water at assessment unit 4. The stations did not have enough data for analysis or to establish a trend.

The land around Falcon Reservoir has been historically used for grazing by local ranchers. Run-off from these activities can impact the quality of the water. Availability of water is also an issue. Drought throughout the basin has put a strain in the water availability of the reservoir. For the past two decades the Rio Grande Basin has experienced below average precipitation, with some areas experiencing severe drought conditions. In the years 2020 and 2021 this area experienced extreme drought. The latest data on water availability can be found here.

Segment 2304 – Rio Grande Below Amistad Dam

Segment 2304 stretches from a point 0.66 km (0.41 mi) upstream of the confluence of the Arroyo El Lobo (Mexico) in Webb County to Amistad Dam in Val Verde County. This area houses the major sister cities of Del Rio, Eagle Pass, and Laredo, TX; Ciudad Acuña, Coahuila and Piedras Negras, Coahuila; Coahuila and Nuevo Laredo, Tamaulipas. The segment is further divided into the following assessments units (AU):

Photo taken atop Amistad Dam facing North.

- 2304_01, Arroyo El Lobo (Mexico) in Webb County upstream to the San Idelfonso Creek
- 2304_02, San Idelfonso Creek confluence upstream to International Bridge #2
- 2304_03, International Bridge #2 upstream to the City of Laredo water treatment plant intake
- 2304_04, City of Laredo water treatment plant intake upstream to the World Trade Center Bridge
- 2304_05, World Trade Center Bridge upstream to the Columbia Bridge
- 2304_06, Columbia Bridge upstream to El Indio
- 2304_07, El Indio upstream to downstream of US Hwy 277 (Eagle Pass)
- 2304_08, Downstream Hwy 277 upstream to the Las Moras Creek confluence
- 2304_09, Las Moras Creek confluence upstream to the San Felipe Creek Confluence
- 2304_10, San Felipe Creek confluence upstream to Amistad Dam

Assigned designated uses for this segment include contact recreation with high aquatic life, general uses, fish consumption, and public water supply use. Contact recreation, however, is limited in some AUs since there has been an impairment for bacteria since 1996. There is a total of 18 monitoring stations in this segment. Those stations are as follows:

- Station 17410 – Rio Grande at World Trade Bridge
- Station 17596 – Rio Grande at Apache Ranch
- Station 22310 – Las Moras Creek downstream from Fort Clark Springs
- Station 20997 – Rio Grande at Main Street boat ramp upstream from Eagle Pass International Bridge
- Station 21542 – Rio Grande at El Cenizo Park
- Station 20650 – Rio Grande at Father McNaboe City Park in Laredo
- Station 18792 – Rio Grande at Kickapoo Casino
- Station 13196 – Rio Grande at Pipeline crossing downstream of Laredo
- Station 13200 – Rio Grande upstream of confluence of Zapata Creek
- Station 13202 – Rio Grande Laredo water treatment plant pump intake
- Station 13560 – Rio Grande downstream of Del Rio at Moody Ranch
- Station 15340 – Rio Grande downstream of Amistad Dam

- Station 15839 – Rio Grande at Colombia Bridge
- Station 15814 – Rio Grande at Juarez-Lincoln international bridge 2
- Station 15815 – Rio Grande at Masterson Rd downstream of international bridge 1
- Station 15816 – Rio Grande at Rio Bravo downstream of El Cenizo
- Station 15274 – Rio Grande east bank at IBWC Weir Dam 6
- Station 13208 – Rio Grande upstream of US 277 Bridge in Del Rio

Segment 2304 is impaired for bacteria, according to the 2022 Integrated Report and has concerns for ammonia and water toxicity. A majority of the stations in this area exhibit bacteria counts higher than the standard of 126 MPN/100mL. There is considerable variability in *E. coli* concentrations among the stations in this segment. Some stations show relatively stable concentrations over the years, while others exhibit more significant fluctuations.

An analysis of the *E. coli* data indicates that the highest concentration recorded was 240,000 MPN/100 mL. This elevated level of *E. coli* concentration is significantly above the set standard. This highest concentration was observed at stations 13196 and 15816. Both stations are located around the Laredo, TX area. The statistical trend analysis for the specified stations over the years 2012-2022 identified one station with a significant trend in bacteria concentrations, where the significance is determined by a p-value less than 0.05. From the analysis, station 13560 showed a significant trend with a positive slope and a p-value of 0.0259. This indicates a statistically significant increase in *E. coli* concentrations at this station over the specified period. This result suggests that, among the stations in this segment, station 13560 has experienced a notable upward trend in *E. coli* concentrations. Figure 20 shows the trend at station 13560 over the period between 2012-2022.

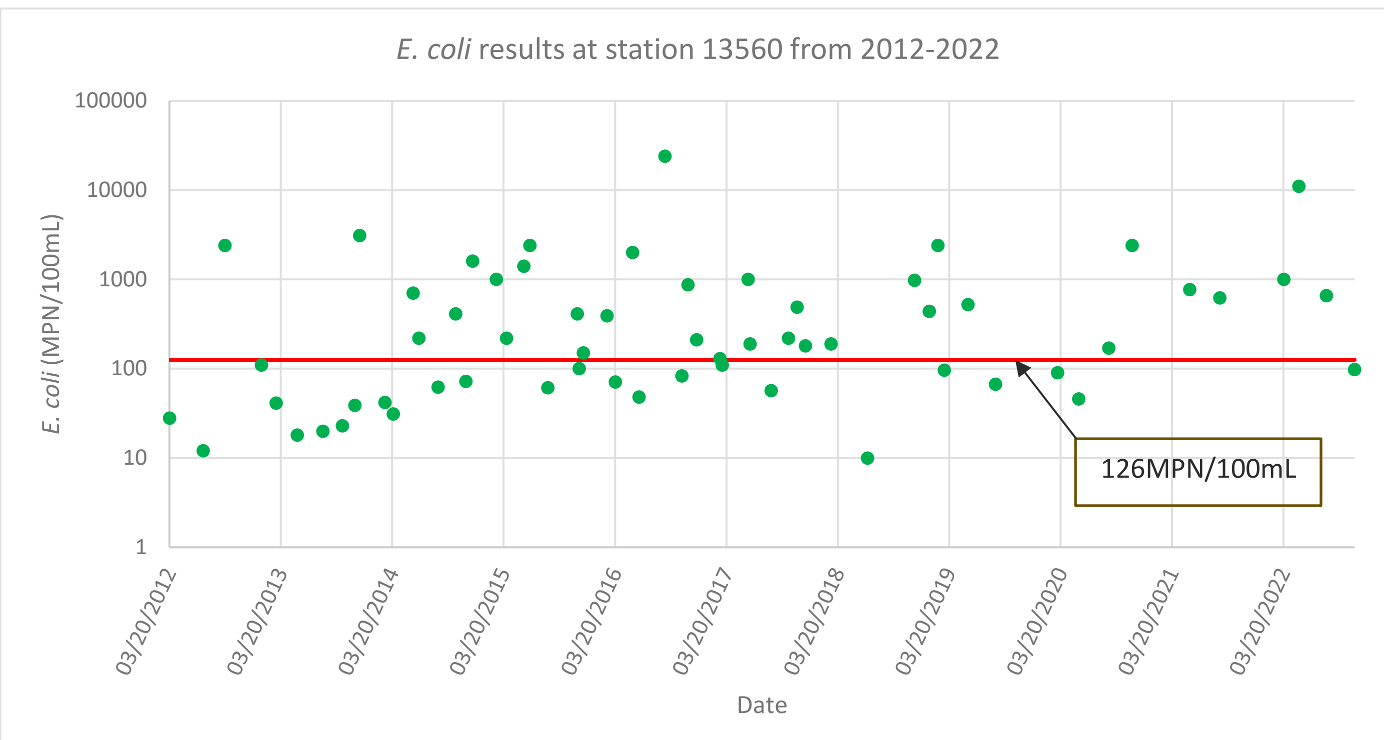


Figure 20. *E. coli* results for station 13560 from the years 2012-2022.

Such high concentrations pose serious health risks, indicating that the water at these locations is highly polluted and unsuitable for recreational activities or water consumption without treatment. Bacterial pollution can originate from various sources, including sewage overflows, agricultural runoff, or waste from wildlife and domestic animals. In the Laredo area, aging wastewater infrastructure coupled with a growing population contributes to the bacteria levels.

The concern for ammonia is in AU 2304_01, which is covered by stations 13196, 15816 and 21542. Station 13196 did not have enough data points. Stations 15816 and 21542 did have enough data points but not for the entire 10-year period. Figure 21 shows the results of ammonia levels at these stations over the period from 2014 to 2022. Levels remained near the screening level of 0.33 mg/L, until an increase in ammonia in 2021. Since there was not a complete ten-year period worth of data, trend analysis was not conducted. As seen in Figure 21 levels decreased after the peak in 2021. The high levels in 2021 could have been due to unintentional discharge. A trend analysis after 2024 will reveal if levels remained stable after the peak.

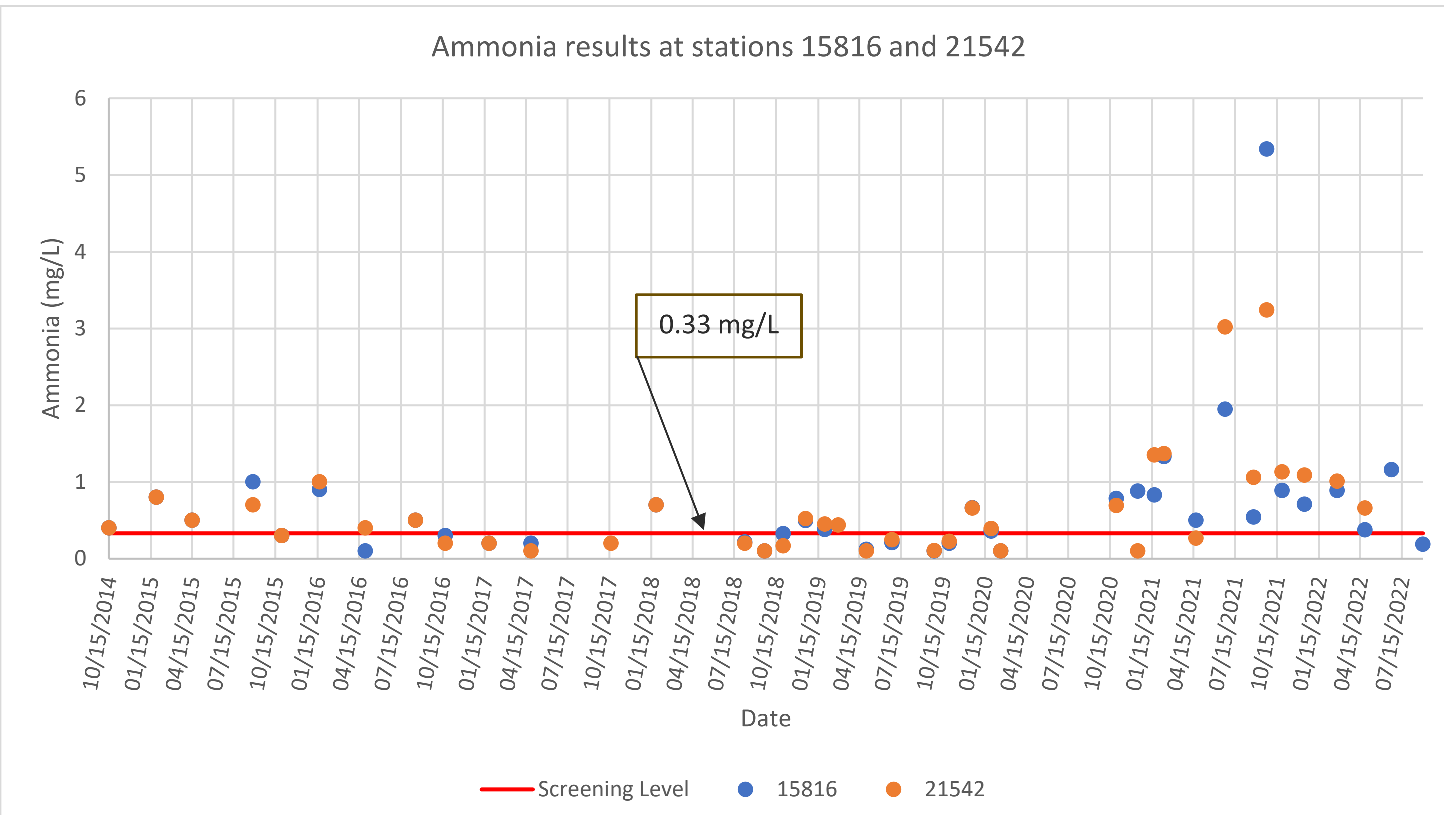


Figure 21. *Ammonia* results for stations 15816 and 21542 from the years 2014-2022.

Segment 2304B – Manadas Creek

Segment 2304B encompasses Manadas Creek and it runs from the Rio Grande confluence in Laredo to a point 1.3 km (0.81 mi) upstream of Bob Bullock Loop. This segment is a freshwater stream that contains only one assessment unit, 2304B_01 and it is monitored by station 13116 – Manadas Creek at FM 1472 North of Laredo. Figure 22 shows an aerial image of the area of Manadas Creek and station 13116. Data gathered from this station indicates the segment has concerns for bacteria, nitrate, and total phosphorus. There is also a concern for antimony in sediment.

Figure 22. Image from Google Earth of Manadas Creek and station 13116

Bacteria results for this station were not enough for analysis, and while nitrate+nitrite and total phosphorus did have enough instances, the data did not exhibit a significant trend. The results do indicate levels above the screening levels for both parameters. Figure 23 shows the results for nitrate+nitrite, while Figure 24 shows the results for total phosphorus with the respective screening level. While nitrates are important plant nutrients, excess amounts can cause issues. High nitrates along with high amounts of phosphorus can cause eutrophication in a water system. Dissolved oxygen (DO), and temperature of water can affect this as well, causing hypoxia (low DO). As seen from Figure 22, the monitoring station is located around an industrial park. Industrial discharges are a potential source, along with wastewater treatment plants and runoff from cropland.

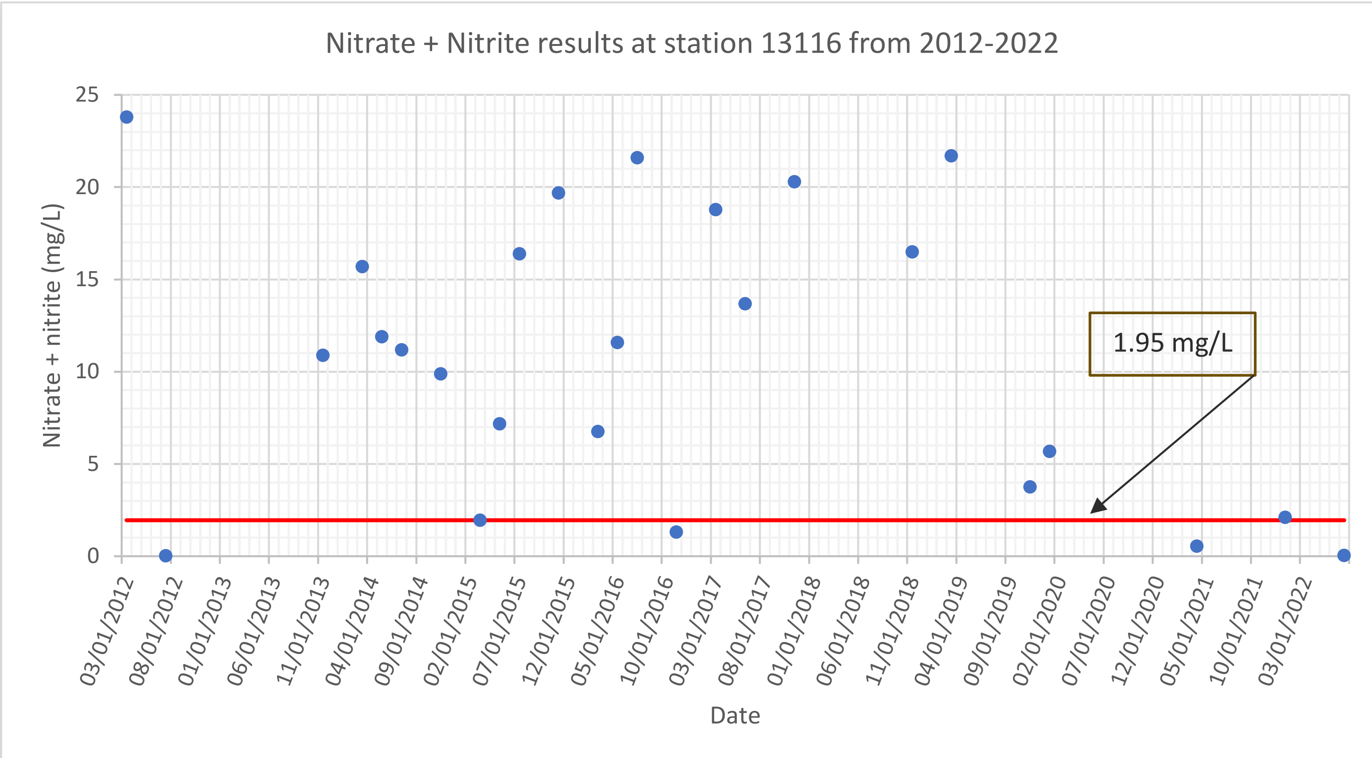


Figure 23. Nitrate+Nitrite results for station 13116 from the years 2012-2022.

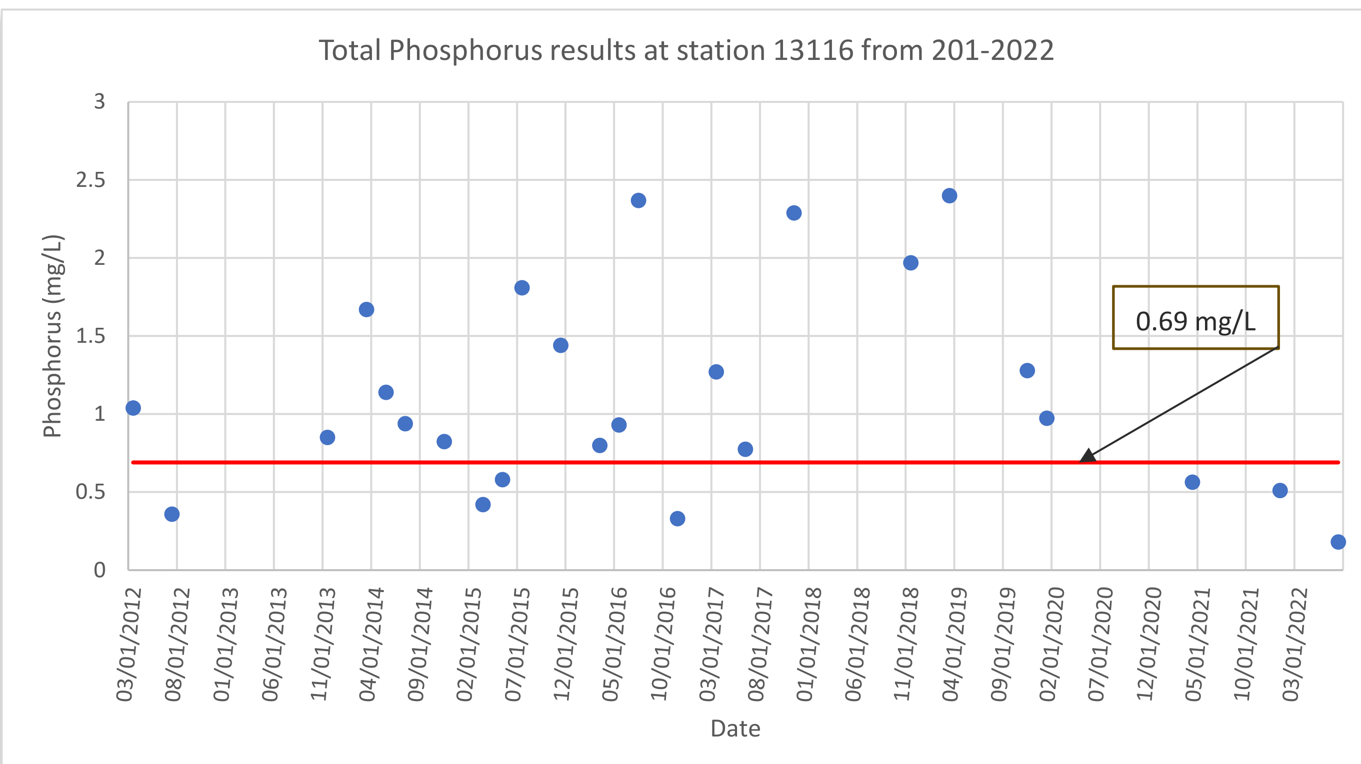


Figure 24. Total Phosphorus results for station 13116 from the years 2012-2022.

Segment 2313 – San Felipe Creek

Segment 2313 stretches from the confluence with the Rio Grande in Val Verde County to a point 4.0 km (2.5 mi) upstream of US 90 in Val Verde County. The creek is a pristine water source that originates in the Del Rio area in Val Verde County. A series of 10 springs, collectively known as the San Felipe Springs, arise to form the headwaters of San Felipe Creek. This spring-fed stream flows through parts of Del Rio and serves as a drinking water source. San Felipe Creek, San Felipe Spring #3, and Spring #2 are the only water source for the city of Del Rio and Laughlin Air Force Base. It is also a popular recreational area. Segment 2313 has only one assessment unit, 2313_01, which runs from the Rio Grande confluence to the San Felipe Springs upstream of US Hwy 90. This segment is monitored by three stations:

- 13270 – San Felipe Creek at Guyler Confluence with the Rio Grande
- 15820 – San Felipe Creek at West Springs near West Wells in Del Rio/in West Channel of Creek 0.5 km Upstream from US90 Bridge.
- 15821 – San Felipe Creek at Blue Hole Flood Gates in Park between US90 Bridge and Southern Pacific RR Bridge in Del Rio/50 m downstream of US90.

The 2022 TCEQ Integrated report lists this segment as impaired for bacteria. Analysis for this segment will focus on stations 13270 and 15821. Station 15820 only had data from 2012-2017, which was not enough for a trend analysis.

Analysis of bacteria from stations 13270 and 15821 indicated high levels of bacteria throughout the ten-year period from 2012-2022. Figure 25 and Figure 26 show the results of bacteria levels at stations 13270 and 15821 respectively. The values were mostly over the standard of 126 MPN/100mL. Station 13270 exhibited an increase in 2017, indicating an unusual increase compared to the other years which showed more moderate fluctuations. Station 15821 had a more consistent pattern with a notable peak in 2018, but generally lower concentrations compared to station 13270. Neither station, however, showed a statistically significant trend in *E. coli* concentrations over the past decade. The area of Del Rio experienced an abnormal wet period from January to May of 2017, which could have created more run-off going into the water ways causing a peak in results.

The other parameters tested for at these sites remained constant. This suggests stable conditions over the period. Table 9 shows the average for each parameter, the count, and the slope and p-value from trend analysis. As shown in the table most parameters had a slope of zero (or very small) meaning the results did not have a change during the ten-year period. Nitrite+nitrate had a p-value less than 0.05 indicating significance, however, with a slope of nearly zero the increase has been small. Ranchland around the area can be slowly contributing to the increase of nitrite+nitrate.

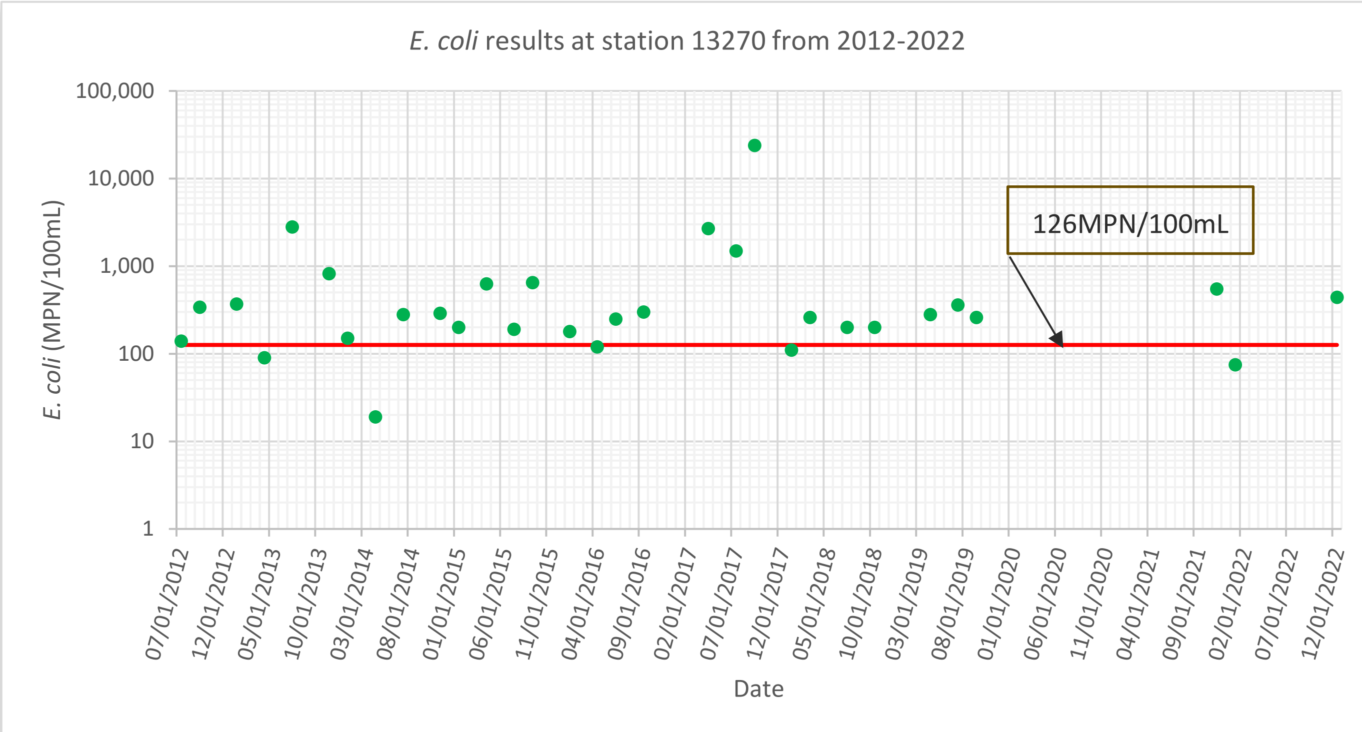


Figure 25. *E. coli* results for station 13270 from the years 2012-2022.

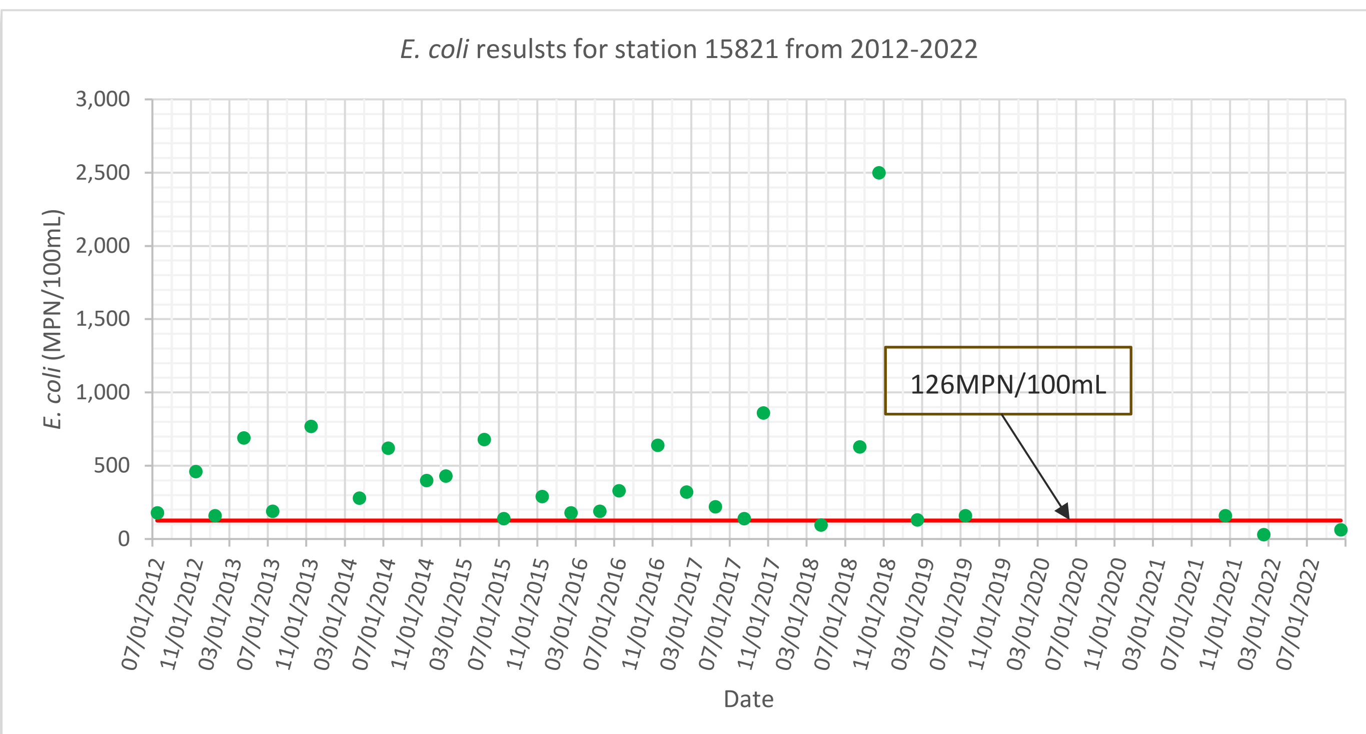


Figure 26. *E. coli* results for station 15821 from the years 2012-2022.

Table 9. Average, slope, and p-values for specified parameters at stations 13270 and 15821 from 2012-2022.

Station	Parameter	Average (mg/L)	Count (n)	Slope	P-value
13270	Total Phosphorus	0.03	29	0.00	0.60
	Nitrite+Nitrate	1.43	34	0.00	0.04
	Ammonia	0.05	32	0.00	0.93
	Chloride	21.80	34	0.00	0.48
	Sulfate	26.79	34	-0.01	0.14
	E. coli	317.38*	32	0.14	0.84
	Chlorophyll	0.53**	28	-0.0001	0.07
15821	Total Phosphorus	0.05	31	0.00	0.62
	Nitrite+Nitrate	1.57	33	0.00	0.57
	Ammonia	0.05	32	0.00	0.58
	Chloride	13.61	34	0.00	0.55
	Sulfate	12.66	34	0.00	0.17
	E. coli	249.83*	31	-0.04	0.58
	Chlorophyll	0.53**	30	-0.002	0.22

**A geomean is used for E. coli rather than an average and the unit is MPN/100mL*

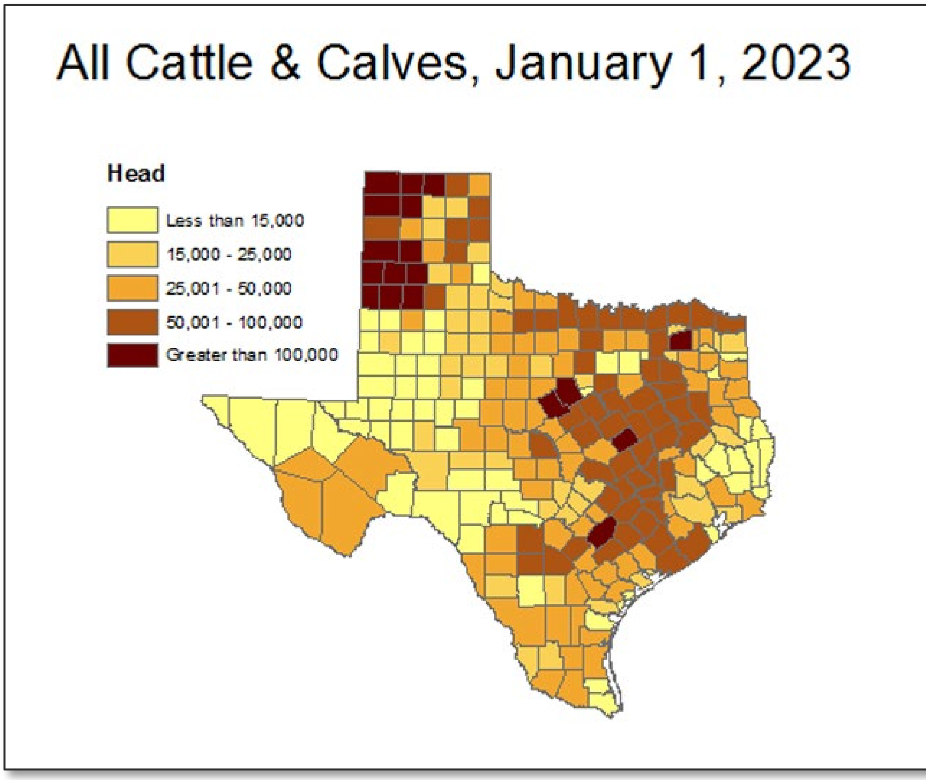
***Unit for chlorophyll is µg/L*

A negative slope indicates a decrease in trend. A p-value <0.05 indicates a statistically significant trend.

Middle Rio Grande Land Use

The area in this section of the Rio Grande is located within the Southern Texas Plains ecological region. It is composed of several major cities, small towns, and settlements. Figure 27 shows all the urban areas in this section of the Rio Grande. Some of the larger urban areas include the cities of Del Rio, Eagle Pass and Laredo. Across the border, the sister cities of Ciudad Acuña, Piedras Negras, and Nuevo Laredo add to the population of the area.

These communities have access to the river or its tributaries on both sides of the border throughout the segment. Much of the land along the Rio Grande in this segment, on both sides of the border, is privately owned and is kept in its natural condition. Figure 28 shows the percentage of agricultural land use in the Middle Rio Grande Sub-Basin in 2019 (data obtained from the United States Department of Agriculture). There are cattle ranches as shown in the map obtained from the USDA. Cattle operations affect water quality by adding excess nutrients (nitrogen or phosphorus) and create erosion which increases sedimentation.



Map obtained from the 2023 Agriculture Statistics conducted by the USDA showing cattle and calves head count in Texas per county.

Industrial businesses, such as manufacturing factories are also a major component of the area along the river, especially along the larger urban areas, particularly in downtown Nuevo Laredo. There are also several permitted wastewater discharge points along the Rio Grande as shown in Figure 29. These discharges are permitted through the Texas Commission on Environmental Quality.

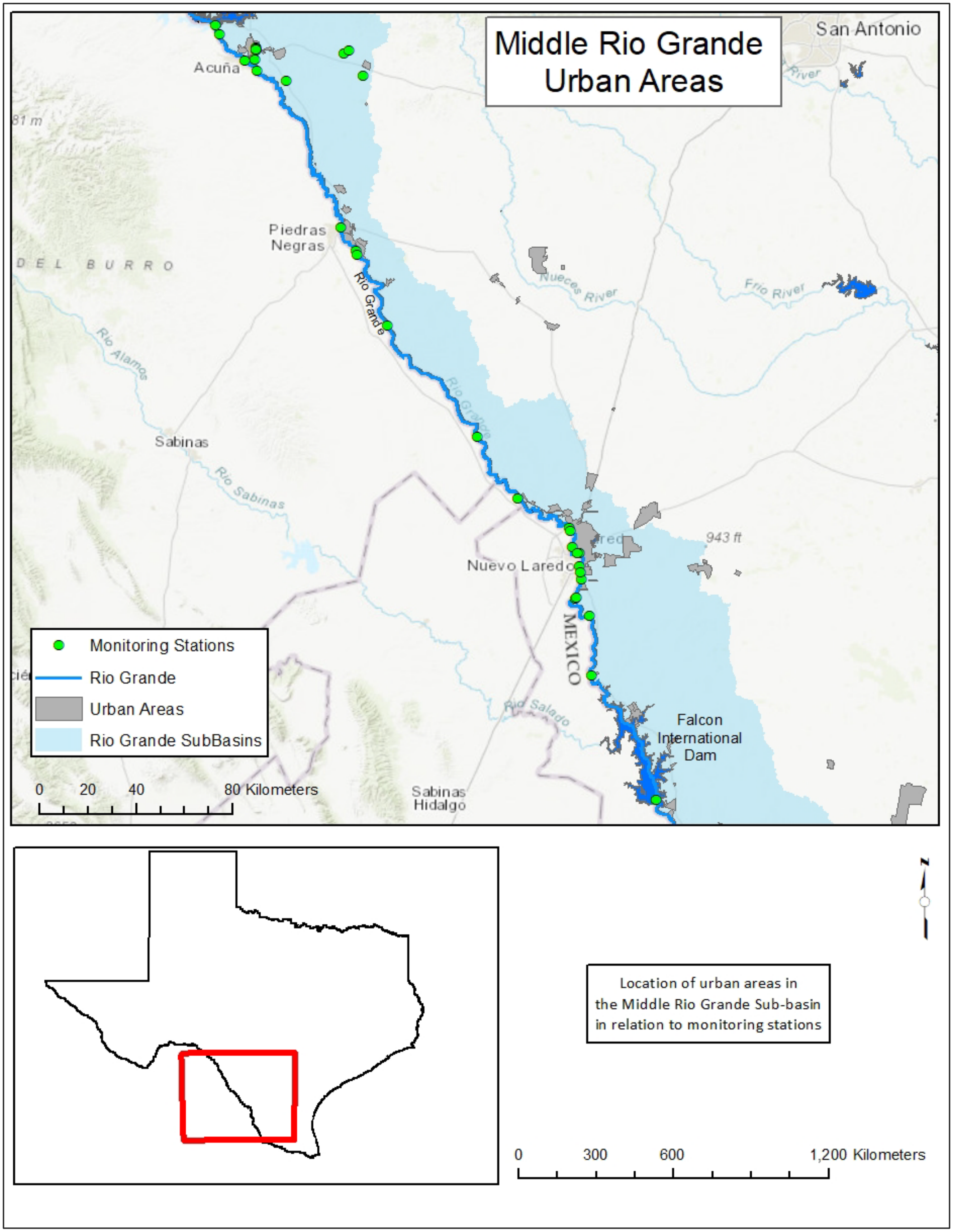


Figure 27. Map of urban areas located in the Middle section of the Rio Grande Basin in Texas.

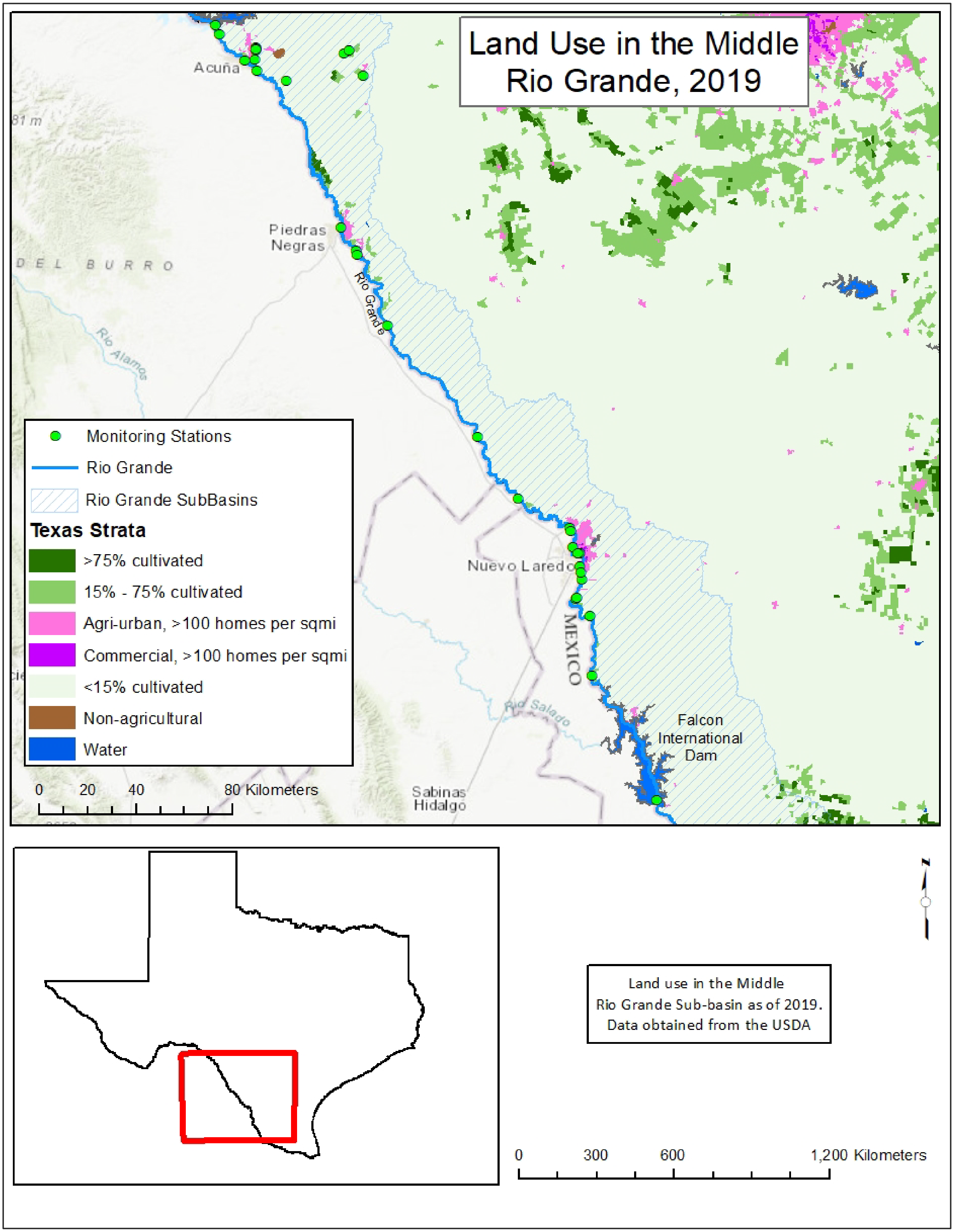


Figure 28. Map land use in the Middle section of the Rio Grande Basin in Texas.

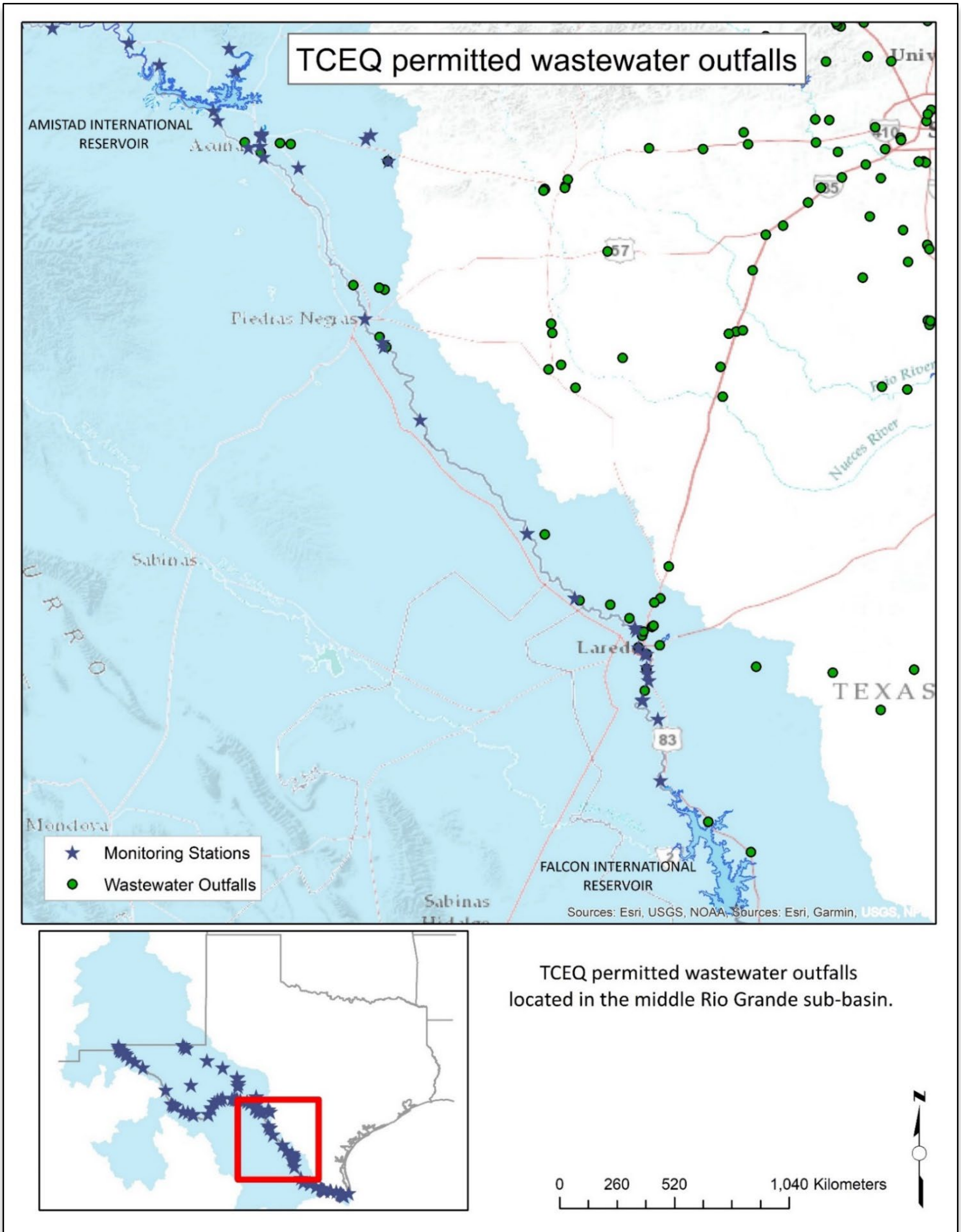


Figure 29. Map of wastewater outfalls located in the Middle section of the Rio Grande Basin in Texas

Impacts on Water Quality

- Agricultural: The use of water from the Rio Grande to irrigate agriculture lands causes return flows high in nutrients, like phosphorus or nitrogen. High concentrations of these nutrients in water can cause algal growth which can lead to high turbidity and decreased dissolved oxygen levels. In Del Rio, for example, irrigation systems and canals supply water to agricultural fields along the creek. Approximately 3,000 acre-feet of water per year (978,000,000 gallons) is diverted from the San Felipe creek for agriculture. The use of fertilizers and pesticides also influences the water quality in this reach.

- Wildlife: The several species of wildlife that call the Rio Grande home may also contribute to the negative impacts on water quality. Bacteria and nutrients from feces make its way into the waters of the river. High levels of bacteria make the waters unusable for contact recreation and exposes humans to various health risks. Water quality may also be impacted by animals coming to graze at local watering holes. Closer to urban developments, domesticated animals may contribute to the bacterial concerns in the river.

- Urban Runoff: Rapid urban growth in the areas along this reach of the Rio Grande also impacts the water in a negative manner. Where there is urban sprawl there is also the increased use of vehicles and the need for parking spaces. Rainfall runoff from parking lots can introduce pollutants, such as oil, metals, and trash and debris, into streams. This area is also home to ten international bridge crossings, which add to pedestrian and vehicle traffic. According to the Department of Transportation, between 2008 and 2018 pedestrian crossings increased by 17%, bus crossings increased by 1.7%, truck crossings increased almost 70%, and railcars increased by 33%. Given that the Rio Grande is the international border in Texas, these bridges are adjacent to it, therefore it is heavily impacted by commercial traffic on the ports of entry and roadways. On top of these increased crossings, the area also faces the new influx of migrants crossing through the river. Several discarded items and trash can be found along the river, where migrants cross.

Photo taken by monitoring station 13560 Rio Grande at Moody Ranch by Del Rio, TX

- Nonpoint sources: Nonpoint sources refer to the contamination of water bodies from widespread sources, rather than from a single, well-defined point of discharge. Pollution from nonpoint sources in this reach are associated with runoff from various land use uses and activities such as the ones described above.

Middle Rio Grande Significant Findings

Data gathered from the middle section stations suggest bacteria is high. TCEQ's Integrated Report lists segment 2304 and segment 2313 as impaired for bacteria (see Figure 30). In segment 2313 all stations show a geomean higher than the standard. Station 13560 in segment 2304 exhibited a statistically significant increase in bacteria levels. A closer analysis of this station would be beneficial to pinpoint contamination sources. However, as with the lower portion of the basin, high bacteria levels are attributed to wastewater discharges. Despite the upgrade to collection systems and new wastewater treatment facilities, this area has seen an increase in population, which adds to the load. According to the 2021 Texas Infrastructure Report Card sanitary sewer overflows (SSO) in the state increased from 2,500 in 2019. To address these sewer overflows some major municipalities are working with the EPA. Although these SSOs numbers are for the entire state, the Rio Grande Basin is not immune and is also affected.

Additionally, there is a concern for ammonia in segment 2304. Ammonia can be a contributing factor to elevated levels of bacteria in the river since it can provide favorable conditions for bacteria to thrive. Most of the sources are listed as non-point, therefore a more focused approach is needed in this this area to pinpoint discharge points or source of pollutant and determine specific solutions. This could perhaps include a special study to evaluate the source of pollution and implement solutions.

The Middle Rio Grande also has concern for fish kill in water as shown in Figure 31, and concern for ambient toxicity in water as shown in Figure 32. Drought conditions and high-water temperatures can be a contributing factor to fish kills.

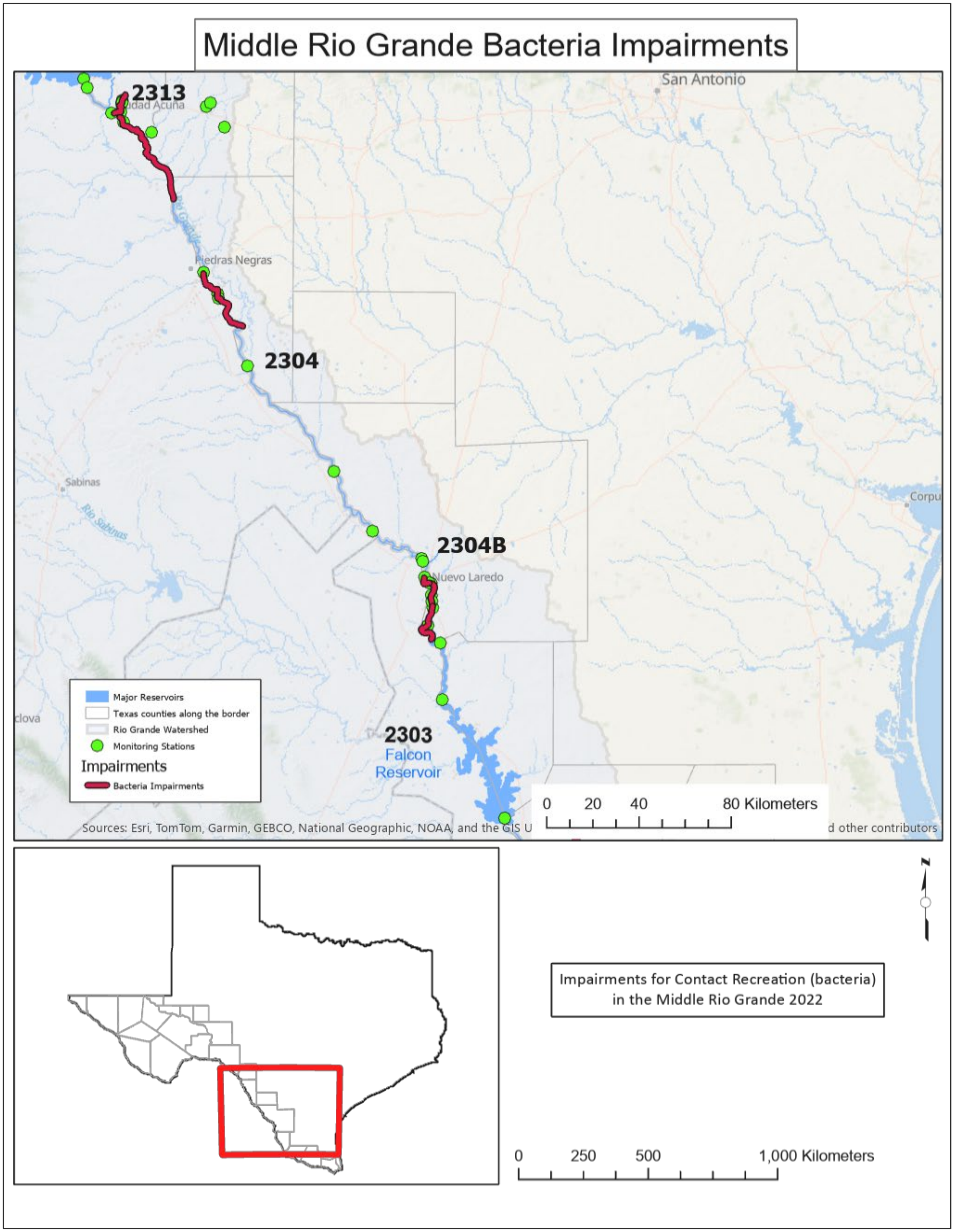


Figure 30. Map of Middle section segments of the Rio Grande Basin in Texas impaired for bacteria.

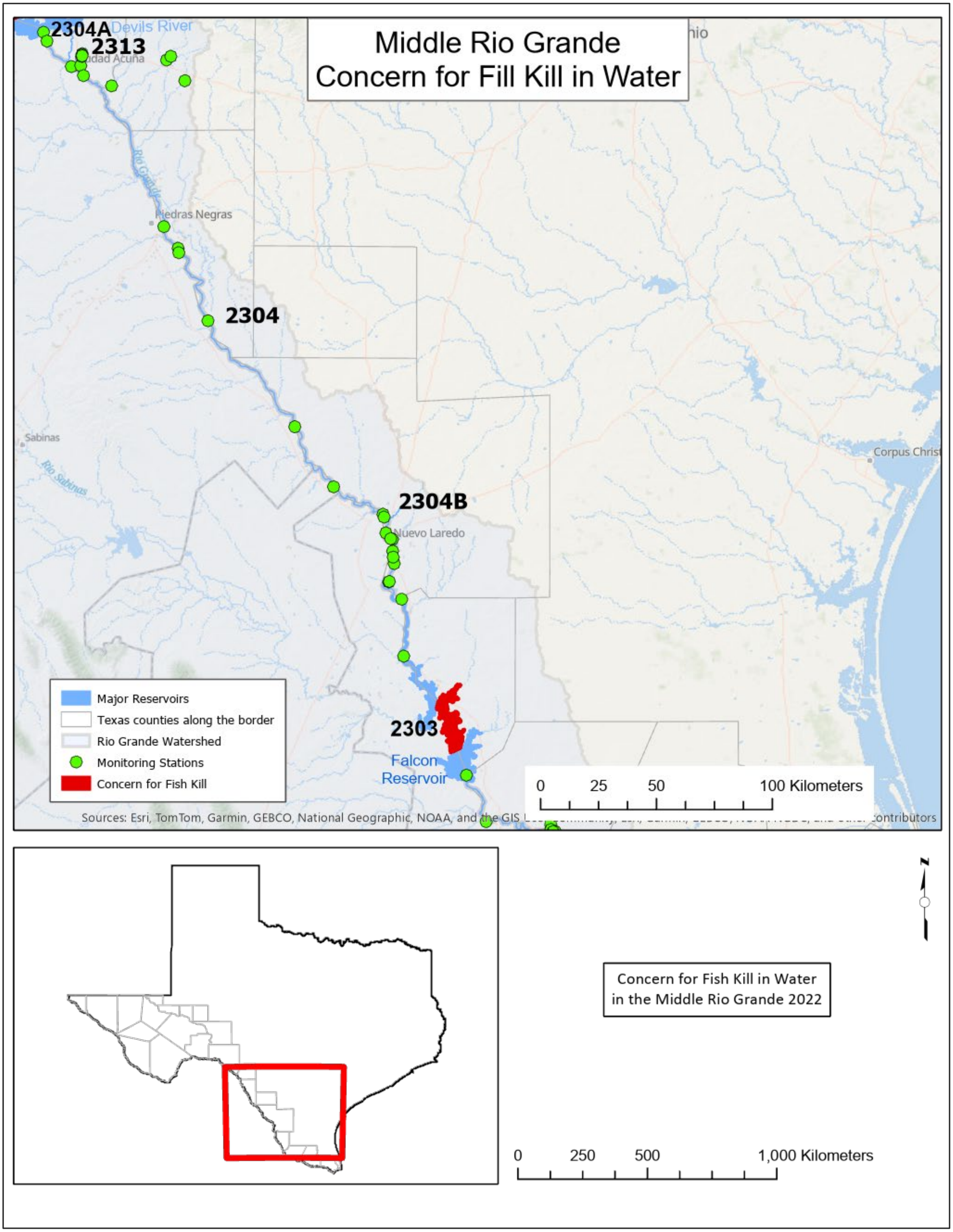


Figure 31. Map of Middle section segments of the Rio Grande Basin in Texas with a concern for Fish Kill in water.

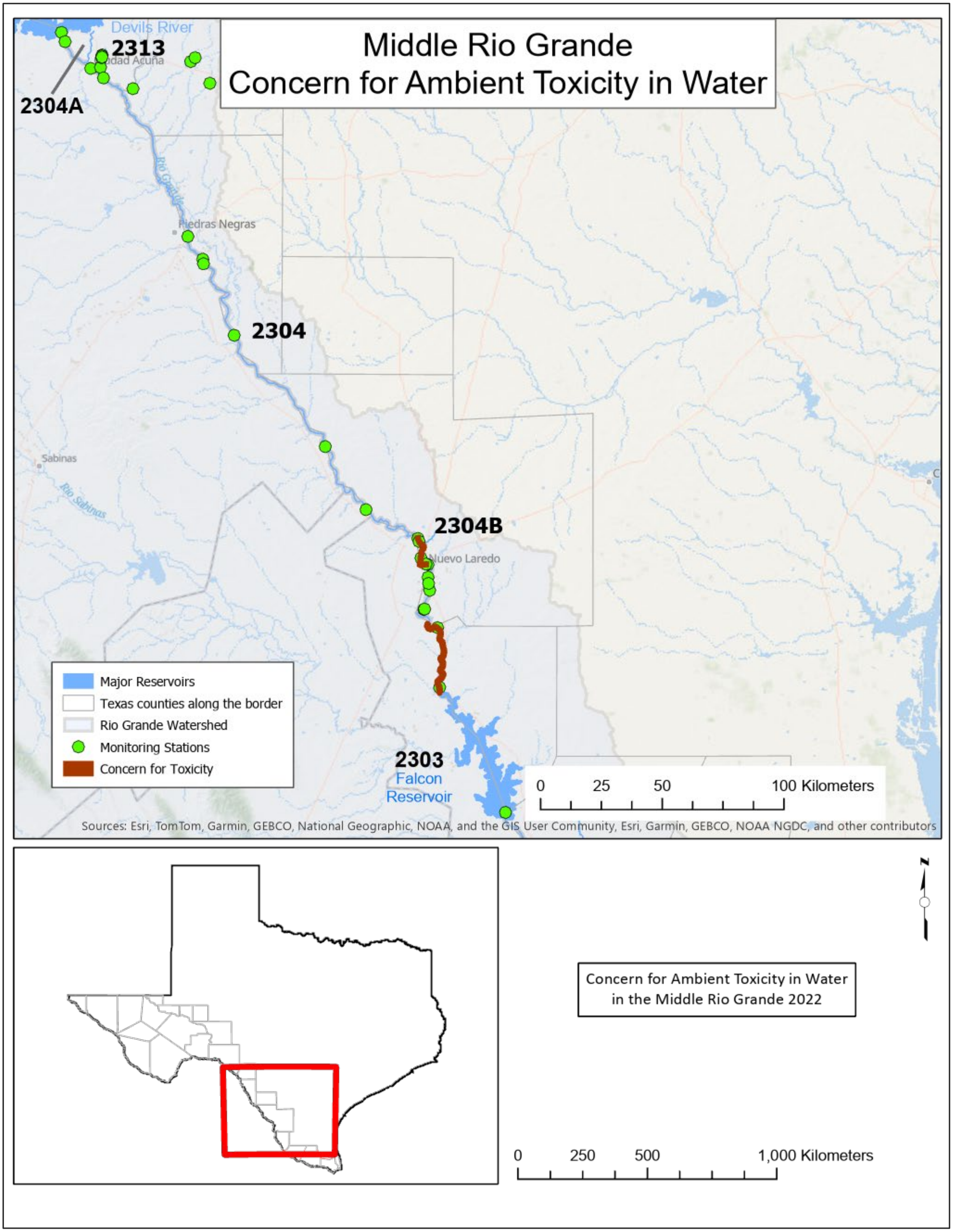


Figure 32. Map of Middle section segments of the Rio Grande Basin in Texas with a concern for ambient toxicity.

Upper Rio Grande Sub-Basin and Pecos River Basin

The Upper Rio Grande Sub-Basin extends from the New Mexico-Texas state line downstream to the International Amistad Reservoir, for a total of 650 miles. Due to historical changes in the channel, the Rio Grande meanders in and out of Texas and New Mexico with some sections forming the boundary between the two states. Proceeding downstream, the Rio Grande forms the international boundary between the U.S. and Mexico. The economy of this region is based on agriculture, manufacturing, tourism, wholesale and retail trade, and government, including the Fort Bliss Army installation in El Paso, Texas.

The Upper Rio Grande Sub-Basin lies entirely in the Trans-Pecos region. The upper portion of the river traverses the mountains of the Chihuahuan desert, flowing through arid mountains, high hills, and rock outcrops as it passes through Big Bend National Park. This region depends largely on groundwater sources for its water supply. Two aquifers, the Edwards-Trinity (Plateau) and Hueco-Mesilla Bolsons, combined with six minor aquifers contribute to most of the region's water supply. During irrigation season, the water in the Rio Grande is used for agriculture by New Mexico, Texas, and Mexico. The City of El Paso also uses the river to provide half of its drinking water supply. The sister cities of El Paso, Texas, and Ciudad Juárez, Chihuahua, have a combined population of more than 2 million people, and lands surrounding the cities are used primarily for agriculture. The agricultural return flows drastically reduce water quality and quantity by introducing highly saline water into the river, as well as high levels of nutrients such as nitrates and phosphates.

In addition, water downstream of these cities contains wastewater effluent, and raw or partially treated sewage; as a result, the upper Rio Grande downstream of El Paso and Ciudad Juárez contains very high levels and bacteria. As the river traverses the sister cities of Presidio, Texas and Ojinaga, Chihuahua, the Rio Conchos joins with the Rio Grande, improving water quality and significantly increasing water quantity. The blended water from both rivers then flows through Big Bend Ranch State Park, Big Bend National Park, and the Rio Grande Wild and Scenic Area, where tourism and wildlife depend on water quality and quantity.

The waters of the Rio Grande flow through the Upper Rio Grande Sub-Basin until they reach International Amistad Reservoir. Benefits created by the reservoir include flood prevention for downstream communities, improved water quality, water supply, and steady, continuous flow in the river below the dam. The reservoir is also a popular area for fishing and recreation, and the dam contains two hydroelectric plants that produce electricity for communities on both sides of the border.

In the upper section, the Pecos River Basin also contributes to the Rio Grande water quality. The headwaters of the Pecos River originate in the Sangre de Cristo Mountains of north-central New Mexico. The Pecos River Sub-Basin consists of the portion of the Pecos River from the point it enters Texas at Red Bluff Reservoir in Loving County to its confluence with the Rio Grande in Val Verde County. Population centers along the river are relatively few and the region has experienced a general decline in population.

Water in the Pecos River is naturally high in dissolved solids and salt concentrations. The high salinity levels are aggravated by low flows and the prevalence of salt cedar, an invasive species that is an enormous water consumer. The introduction of high-quality fresh water from natural springs feeding Independence Creek creates significant changes to the aquatic community in the Pecos River. The Pecos River is one of the saltiest rivers in the western U.S. and contributes almost 10 percent of the stream inflow into International Amistad Reservoir and 26 percent of the total salt loading. As the major contributor of salt to the reservoir, lake salinity can get very high (in 1988 the lake salinity exceeded 1,000 parts per million [ppm] for one month) and can fluctuate with the changing flow and salt content of the Pecos River. Watershed data evaluations have revealed issues relating to water quality and quantity.

Upper Rio Grande and Pecos River Basin Water Quality Update

In the upper section of the Rio Grande, USIBWC field offices, American Dam Field Office, Presidio Field Office, and Amistad Dam Field Office, collect data for CRP. The El Paso Water Laboratory, Big Bend National Park, and the Texas Park and Wildlife Department also collect data for this portion. In the Pecos River USIBWC CRP partners with Midland College for data collection in the lower sections of the Pecos River. Segments 2314, 2308, 2307, 2306, 2309, and 2305 make up the upper section of the Rio Grande Sub-Basin, while river segments 2310, 2311, and 2312 make up the Pecos River Basin. Table 10 shows the segments, assessment units (AU) and stations at each AU for the upper portion of the Rio Grande Basin. Table 11 shows the segments, AUs and stations located at the Pecos River. Figure 33 shows the monitoring stations located in the Pecos River Basin and Upper Rio Grande Sub-Basin and Figure 34 shows the river segments in that region.

Rio Grande at American Dam in El Paso, TX

Table 10. Upper Rio Grande Sub-Basin River Segments and Stations

River Segment	Segment description	Assessment Units (AU)	Stations	Station Description
2305	Amistad International Dam	2305_01	15892	Amistad Reservoir at buoy 28
			16379	Pecos River downstream from US90W
		2305_02	13237	Devils River
			15893	Amistad Reservoir at Devils River arm
		2305_03	13835	Amistad Reservoir at buoy 1
		2305_04	--	No stations
2306	Rio Grande above Amistad Reservoir	2306_01	13223	Rio Grande at Foster Ranch
		2306_02	--	No stations
		2306_03	13225	Rio Grande at Gerstacker Bridge
		2306_04	16730	Rio Grande at Rio Grande Village
		2306_05	--	No stations
		2306_06	13228	Rio Grande at Santa Elena Canyon
		2306_07	13229	Rio Grande below Conchos
			16862	Rio Grande at Colorado Canyon
			18441	Rio Grande at Lajitas boat ramp
		2306_08	17000	Rio Grande at Presidio Railroad Bridge
			17001	Rio Grande at Presidio/Ojinaga Bridge
2306A	Alamito Creek	2306A_01	--	No stations
		2306A_02	--	No stations
2307	Rio Grande below Riverside Diversion Dam	2307_01	13230	Rio Grande at above Conchos
		2307_02	17407	Rio Grande at Candelaria
		2307_03	--	No stations
		2307_04	15704	Rio Grande at Guadalupe International Bridge
			15795	Rio Grande at Alamos Control structure
		2307_05	14465	Rio Grande at Riverside Canal
2308	Rio Grande below International Dam	2308_01	15528	Rio Grande downstream from Haskell WWTP
			15529	Rio Grande upstream from Haskell WWTP
2309	Devils River	2309_01	--	No stations
		2309_02	13239	Devils River Natural Area
		2309_03	--	
2309A	Dolan Creek	2309A_01	14942	Dolan Springs
2314	Rio Grande above International Dam	2314_01	13272	Rio Grande at Courchesne Bridge
			13274	Rio Grande at Borderland Road
			13275	Rio Grande at Vinton Bridge
			13276	Rio Grande Upstream of Anthony Drain
			15089	Rio Grande at American Dam
			17040	Rio Grande at Anapra Bridge
		2314_02	--	No stations

Table 11. Pecos River Basin Segments and Stations

River Segment	Segment description	Assessment Units (AU)	Stations	Station Description
2310	Lower Pecos River	2310_01	--	No stations
		2310_02	14163	Pecos River at Independence Creek
			18801	Lower Pecos River at Brotherton Ranch
2310A	Independence Creek	2310A_01	13109	Independence Creek at John Chandler Ranch
		2310A_02	--	No stations
2311	Upper Pecos River	2311_01	14164	Pecos River Upstream of Independence Creek
		2311_02	--	No stations
		2311_03	13257	Pecos River at Girvin
			13260	Pecos River at Monahans
		2311_04	--	No stations
		2311_05	--	No stations
		2311_06	--	No stations
		2311_07	--	No stations
		2311_08	13265	Pecos River at Orla
2312	Red Bluff Reservoir	2312_01	13267	Red Bluff Reservoir
		2312_02	13269	Red Bluff Reservoir at Texas-NM border

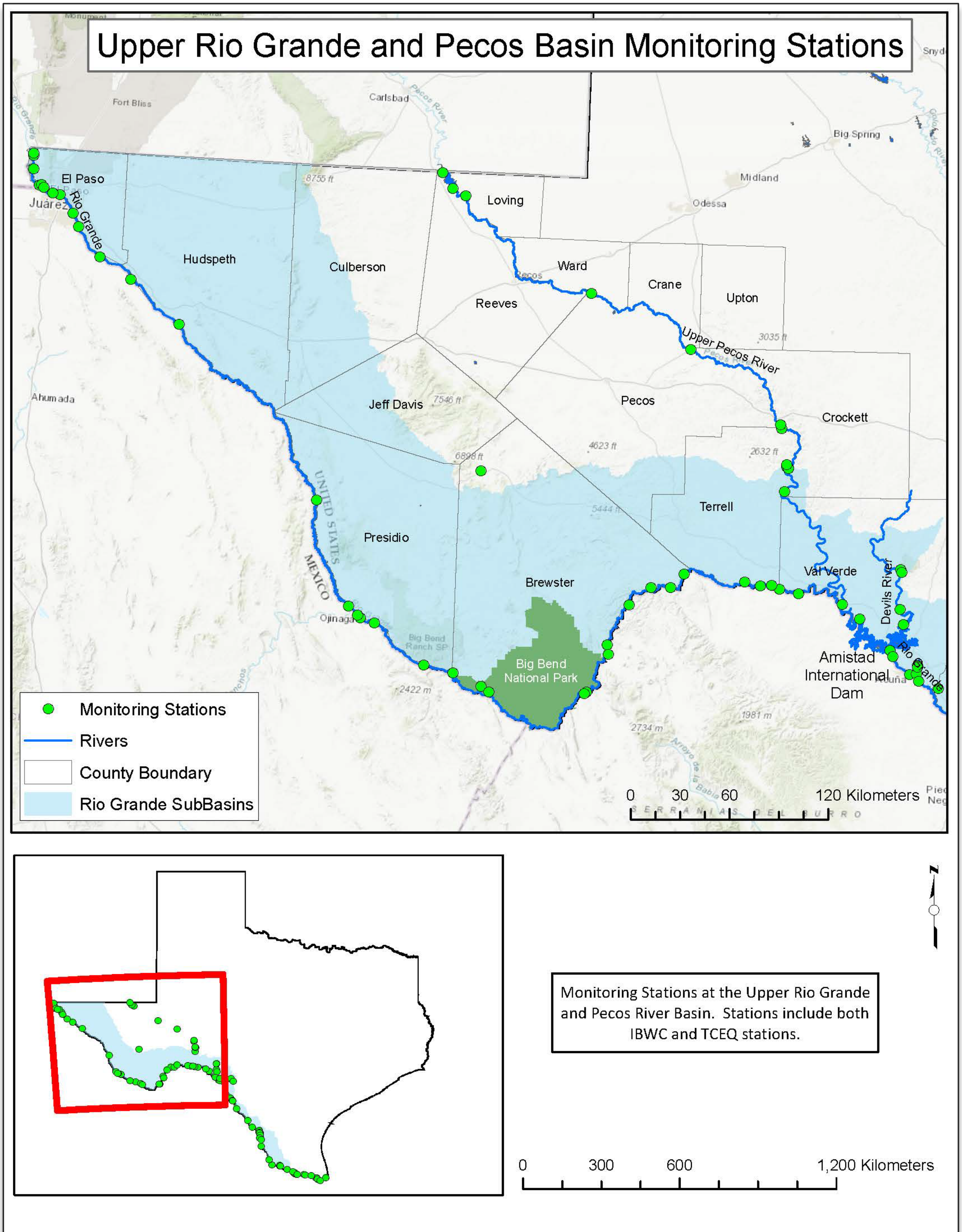


Figure 33. Map of the monitoring stations in the Upper Rio Grande Basin and Pecos River Basin

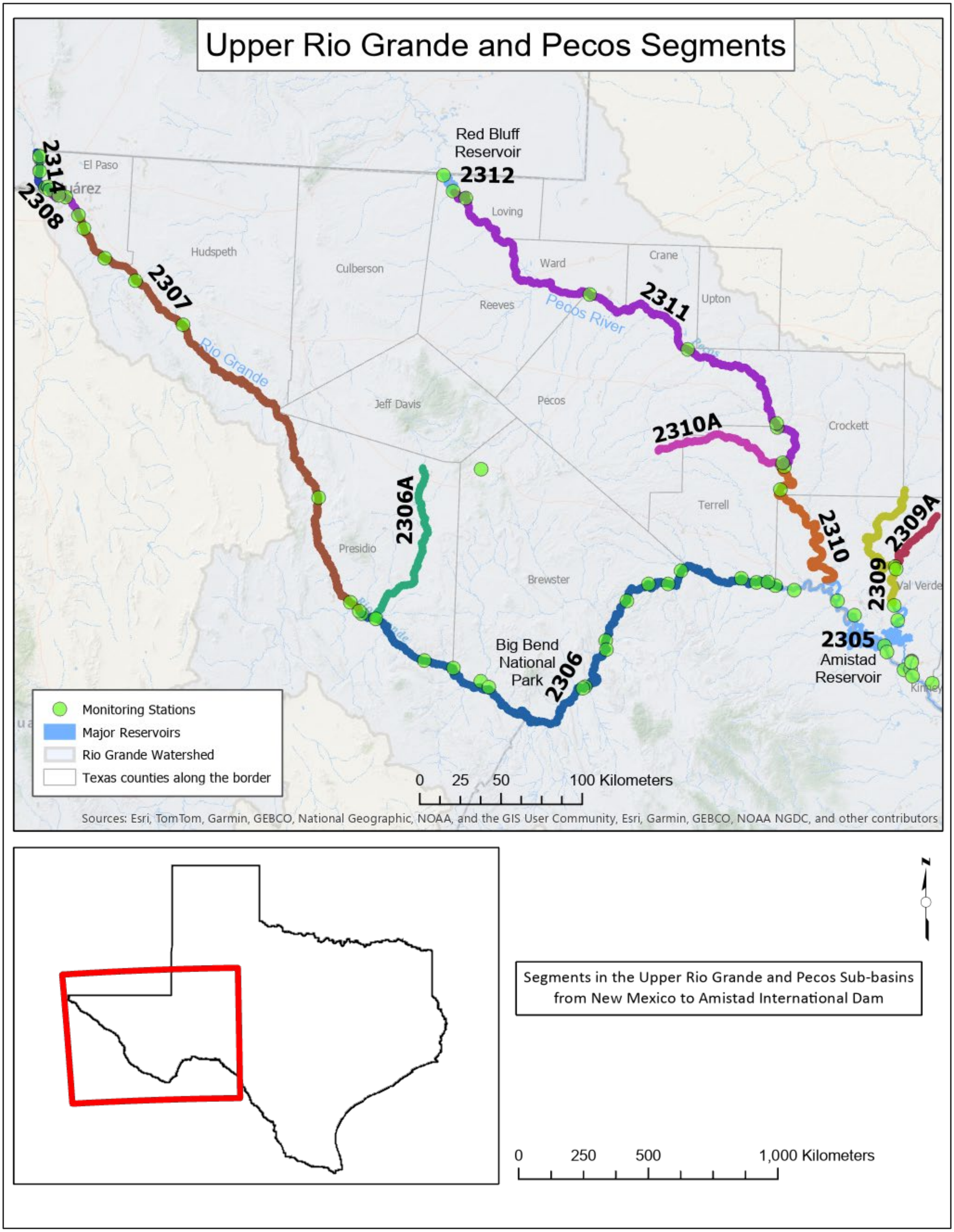


Figure 34. Map of the river segments in the Upper Rio Grande Basin and Pecos River Basin

Segment 2305 – Amistad International Reservoir

Segment 2305, Amistad Reservoir, is in the upper portion of the Rio Grande in Texas. It stretches from Amistad Dam to a point 1.8 km (1.1 mi) downstream of the confluence of Ramsey Canyon on the Rio Grande and to a point 0.7 km (0.4 mi) downstream of the confluence of Painted Canyon on the Pecos River. There are four assessment units monitored by six stations. Assessment units are as follows:

- Assessment unit 2305_01 – Rio Grande Arm
- Assessment unit 2305_02 – Devils River Arm
- Assessment unit 2305_03 – Area around International Boundary Buoy 1
- Assessment unit 2305_04 – Remainder of reservoir

Monitoring stations in this segment are:

- 15892 Amistad Reservoir at buoy 28
- 16379 Pecos River downstream from US90W
- 13237 Devils River
- 15893 Amistad Reservoir at Devils River arm
- 13835 Amistad Reservoir at buoy 1

Amistad Dam at the border with Mexico

The International Amistad Reservoir is impaired for chloride in water and there is a concern for fish kill. The chloride impairments were added again in the 2022 Integrated Report after being removed in 2016. The impairment was originally listed in the 2014 Integrated Report. The standard for chloride in this segment is 150 mg/L. Analysis was done on Stations 13237, 13835, 15892 and 15893 where there was enough data (more than 20 data points) to conduct analysis. The averages and counts are listed in Table 12. Though the chloride averages in these stations do not exceed the standard, stations 13835 and 15892 are close to 150 mg/L. Figure 35 shows the results for these stations (minus 13237 since it had low values). The results are mainly under the standard aside from results at stations 15892 and 13835 between 2014 and 2018 which exceeded the 150 mg/L standard. Table 12 also shows the slope and p-value for the trend at these stations. The statistical analysis indicates that stations 13835 and 15892 have statistically significant increasing trends. A statistically significant trend indicates that the upward trend is unlikely to be random. An increasing chloride levels can be caused by agricultural runoff. Data from station 13237 suggests a slight increase, though this station had the lowest levels of chloride. According to the data gathered from this segment, sulfate has exceeded the standard of 270 mg/L as well. Figure 36 shows the results for sulfate at the stations with more than 20 instances. Stations 15892 and 13835 had some results over the standard for the segment. Chloride and sulfate are important parameters to measure because they are an indication of high salinity in the water. Fresh water organisms cannot tolerate high salinity levels. The years from 2014 to 2017 were high precipitation years. According to the National Park Service, the yearly average rainfall at Amistad is approximately 19 inches. The years 2014, 2015, 2016, and 2017 saw and average of 26.43, 22.25, 31.69, and 21.35 inches respectively. During rain events the area is prone to flash floods, which can contribute to the high levels of dissolved solids to enter the waterways. Additionally, inflows from its tributaries increase salinity especially from the Pecos River and the Rio Grande above the Rio Conchos. This can increase during growing season due to the return flow from irrigation practices.

Table 12. Average and count for chloride at stations in segment 2305 from 2012-2022.

Station	Average (mg/L)	Count (n)	Slope	p-value
13237	14.67	35	0.42	0.085
13835	119.29	28	1.2	0.037
15892	134.12	25	2.8	0.012
15893	70.81	29	-1.9	0.4

A negative slope indicates a decrease in trend. A p-value <0.05 indicates a statistically significant trend.

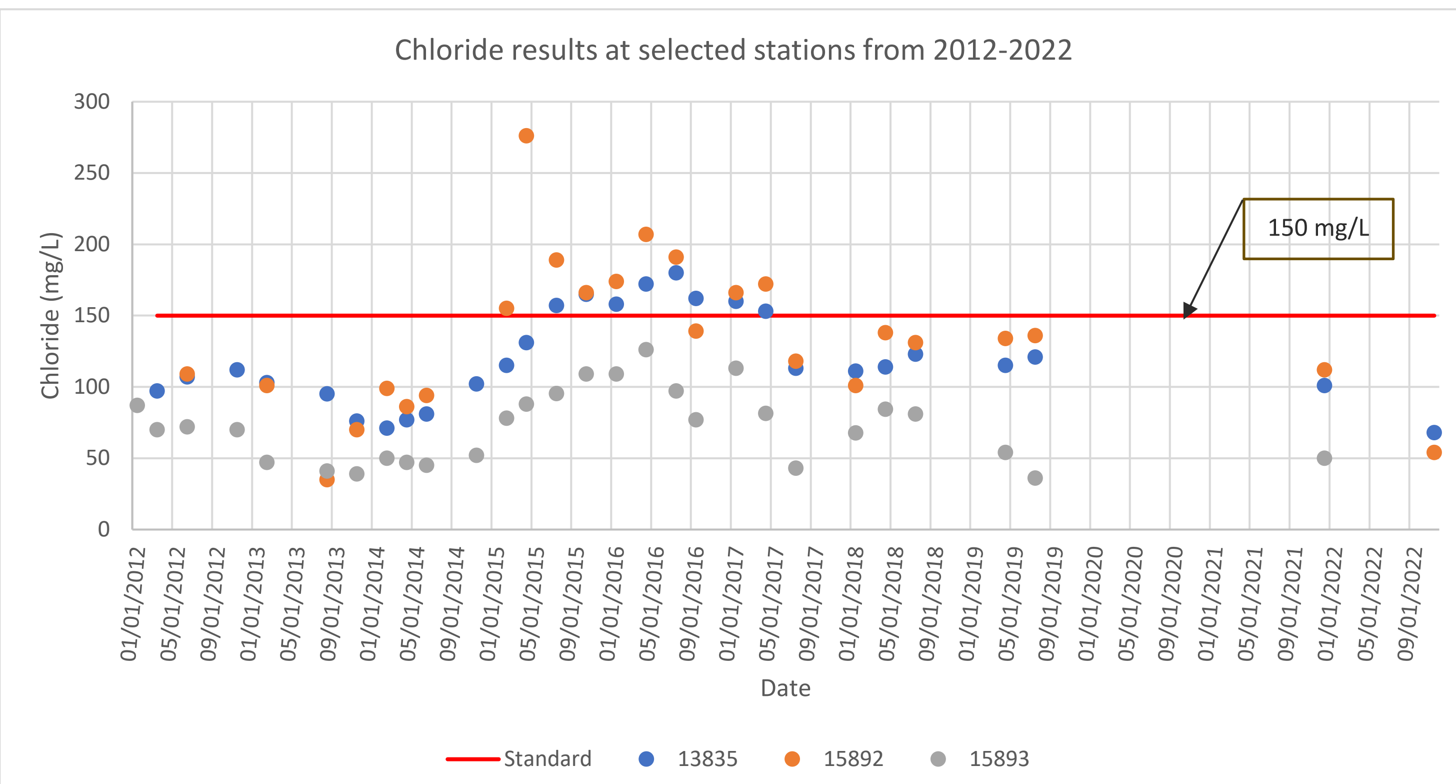


Figure 35. Chloride results at station selected stations in segment 2305 from the years 2012-2022.

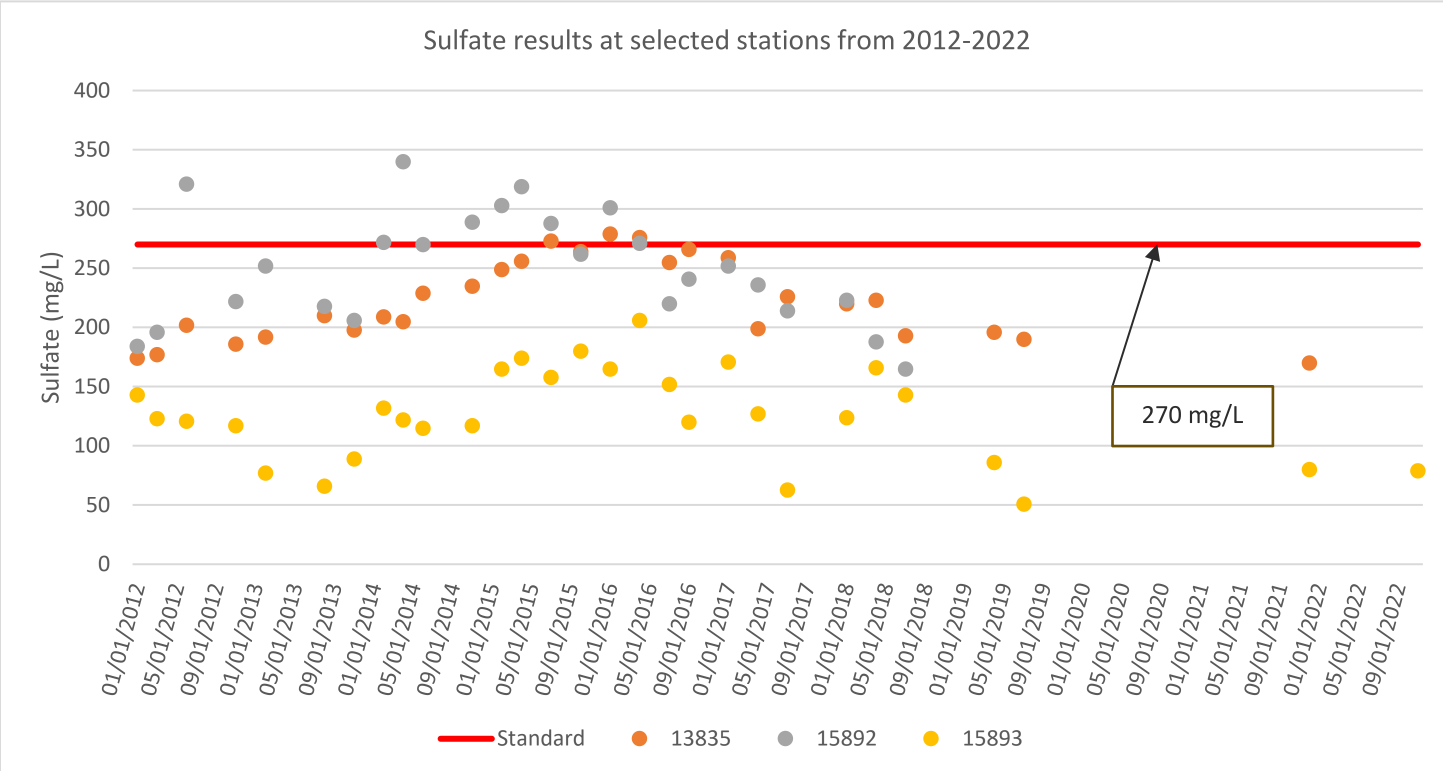


Figure 36. Sulfate results at station selected stations in segment 2305 from the years 2012-2022.

Segment 2306 – Rio Grande Above Amistad Reservoir

Segment 2306 stretches from a point 1.8 km (1.1 mi) downstream of the confluence of Ramsey Canyon in Val Verde County to the confluence of the Rio Conchos (Mexico) in Presidio County. There are eight assessment units, which are monitored by nine stations. This segment is listed as impaired for sulfate and has a concern for chlorophyll in water.

For the analysis of this segment, stations 13229, 13228, 16730 and 13225 had a count of more than 20 samples. This provided more data points to conduct a proper analysis. In this segment, the standard for sulfate in the 2022 Standards is 450 mg/L, which is higher than the previous segment. It should be noted that the sulfate standard of 450 mg/L has not been approved by the EPA yet, so the previous standard of 570 mg/L is used for assessment in the Integrated Report. Although there is a higher threshold than segment 2305, values for each of the stations were still higher than the standard as seen in Figure 37. As the figure shows, most of the analyzed samples for all stations were above the standard. Table 13 shows the average and count for each of the stations. Aside from station 13225 the ten-year average for sulfate was above 450 mg/L. There are several fluctuations in the results with several peaks followed by decrease in values, however, the data does not indicate a clear long-term trend in any of the specified stations. Extensive use of water for agriculture irrigation contributes to high sulfate levels. The Rio Conchos coming from Chihuahua, Mexico provides input to samples from these stations. Agriculture from both sides of the border contributes to water quality.

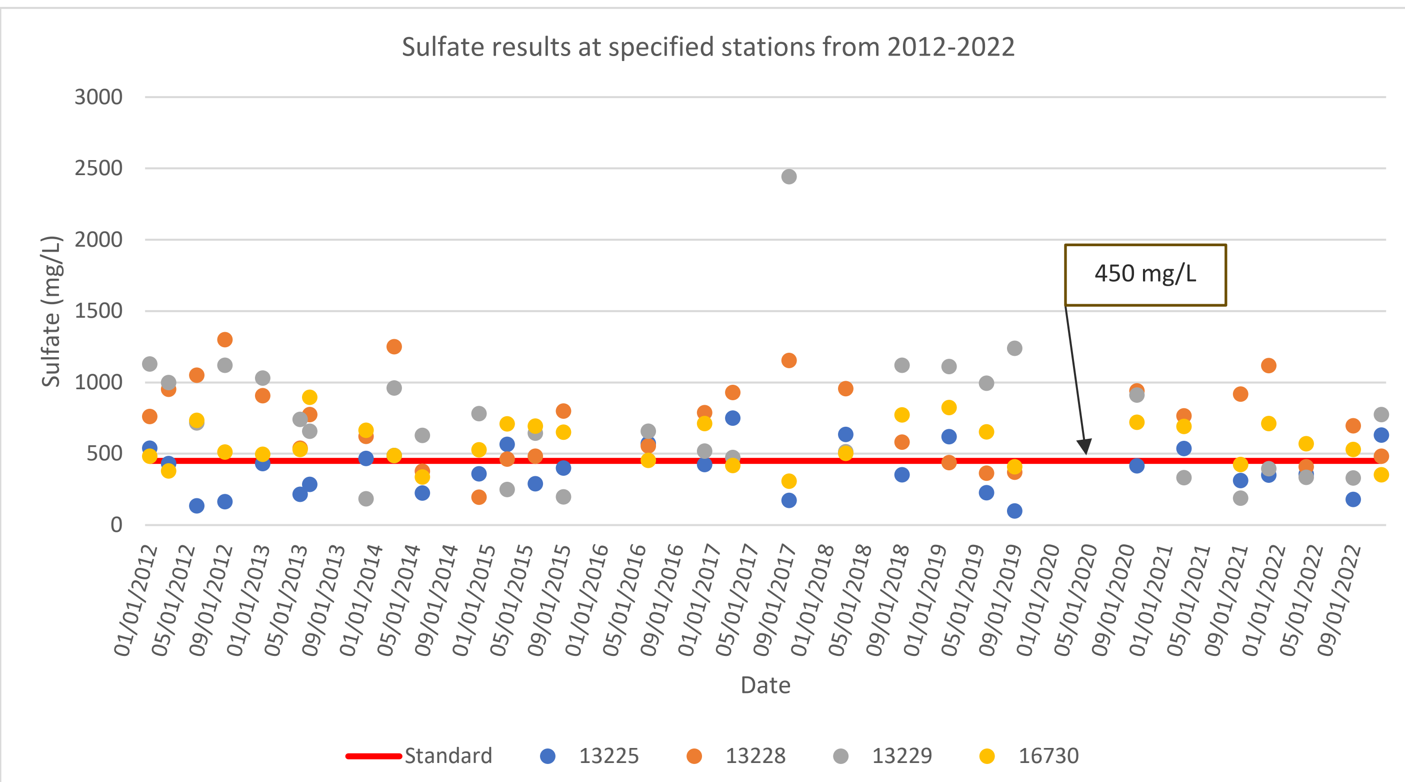


Figure 37. Sulfate results at selected stations in segment 2306 from the years 2012-2022.

Table 13. Average and count for sulfate at stations in segment 2306 from 2012-2022.

Station	Average (mg/L)	Count (n)
13225	387.83	30
13228	682.58	69
13229	707.68	97
16730	556.68	36

Another parameter that shows exceedances at this segment is *E. coli* bacteria. Stations 13225, 13228, 13229, 17000, and 17001 had sufficient data for trend analysis. Figure 38 shows the bacteria values from 2012-2022 at stations 13225, 13228, and 13229. Results from these stations exceeded the standard of 126 MPN/100mL throughout the years. The figure also shows all the fluctuations in results over the ten-year period. Figure 39 shows the results for the remaining stations. Stations 17000 and 17001 only monitor for bacteria. The results are for the most part evenly distributed above or below the standard. The geomean was below the standard for all stations except at station 17001 as shown in Table 14. As stated above the area around these stations receives waters from the Rio Conchos, which originates in Chihuahua, Mexico. Growing use for municipal and agricultural practices in Mexico has also deteriorated the quality of the Rio Conchos. Both the Rio Grande and Rio Conchos have experienced low flows due to a persistent drought.

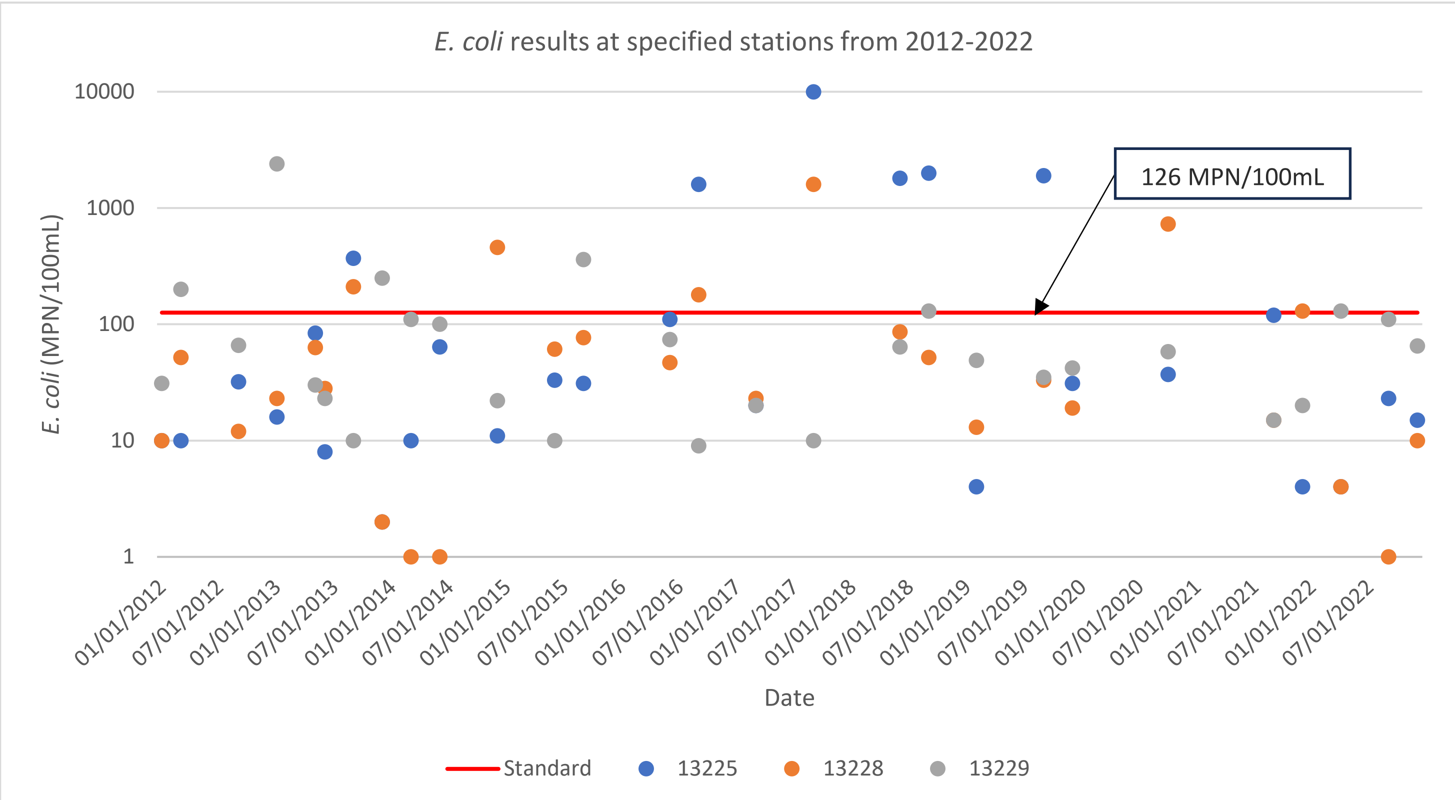


Figure 38. *E. coli* results at selected stations in segment 2306 from the years 2012-2022.

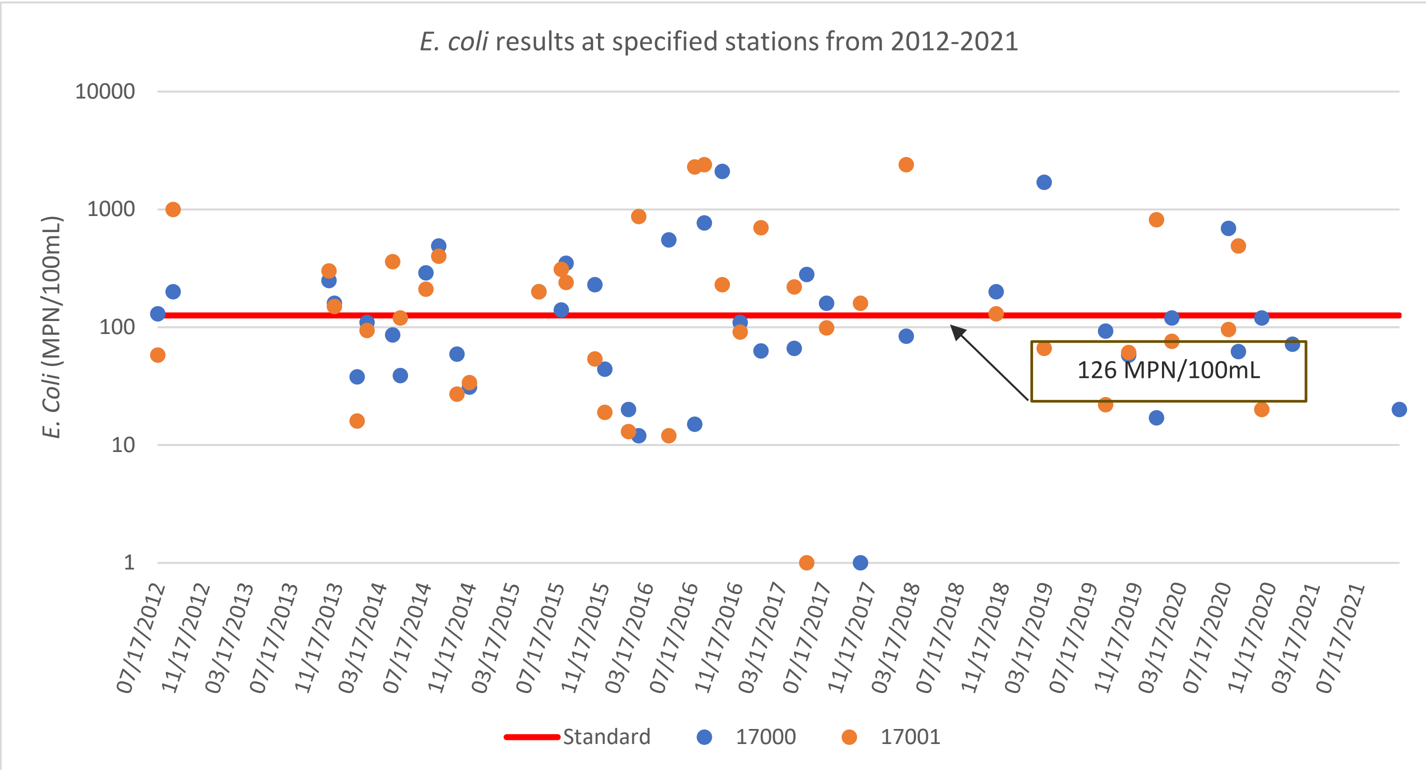


Figure 39. *E. coli* results at selected stations in segment 2306 from the years 2012-2021.

Table 14. Geomean and count for specified stations at segment 2306 from 2012-2022

Station	Geomean (MPN/100mL)	Count (n)
13225	48.21	28
13228	28.62	46
13229	61.41	72
17000	104.35	41
17001	127.33	39

Lastly, for chlorophyll, the parameter of concern in this segment, only station 13229 had an average above the screening level of 14.1 µg/L. The average for chlorophyll at this station for the ten-year period was 25.8 µg/L. Individual results at station 13229 and the other two stations (13228 and 16730) that had more than 20 samples did exceed the screening level on some instances during the period between 2012 and 2022, as seen in Figure 40, which visualizes the results for each of these stations. Data suggests that concentrations, although above the screening level on some instances, have remained relatively stable, without significant increases or decreasing during the specified timeframe.

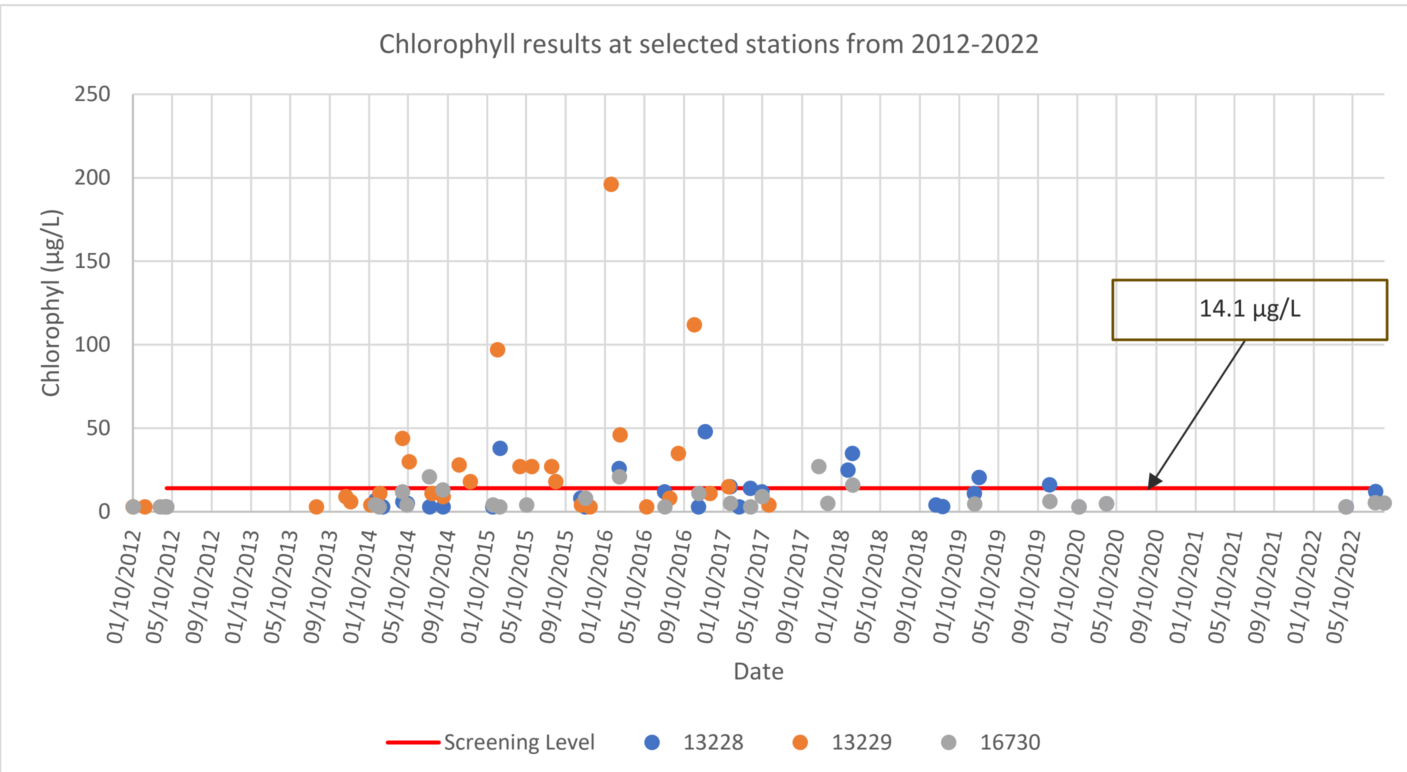


Figure 40. Chlorophyll results at selected stations in segment 2306 from the years 2012-2022.

Segment 2307 – Rio Grande below Riverside Diversion Dam

Segment 2307 stretches from the confluence of the Rio Conchos (Mexico) in Presidio County to Riverside Diversion Dam in El Paso County. There are five assessment units, monitored by six station stations. This segment is listed as impaired for chloride, total dissolved solids, and bacteria. There are also concerns for ammonia, chlorophyll, depressed dissolved oxygen, nitrate, and total phosphorus in the water. Flow in this segment is from none to low creating stagnant water at times. Return flow from agricultural practices upstream contributes to the salts and nutrients.

Stations in this segment with sufficient data points for bacteria trend analysis were 13230, 14465 and 15704. For chloride, stations with sufficient data points in the ten-year period were 13230 and 15704 and lastly for total dissolved solids only stations 13230 and 15795 had sufficient data points for analysis.

The analysis for bacteria indicated that data points often exceeded the standard of 126 MPN/100mL in all three stations as shown in Figure 41.

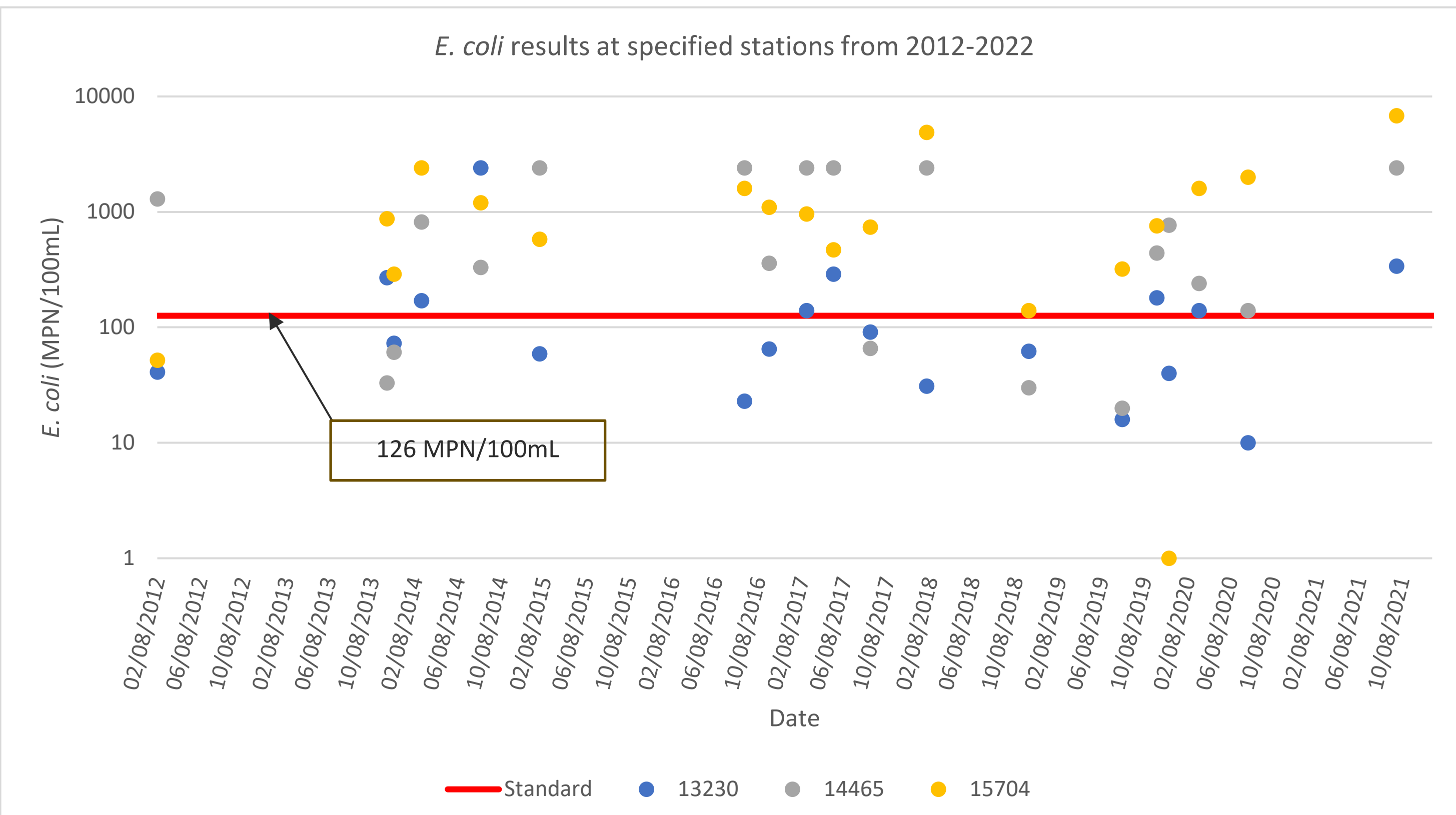


Figure 41. *E. coli* results at selected stations in segment 2307 from the years 2012-2022.

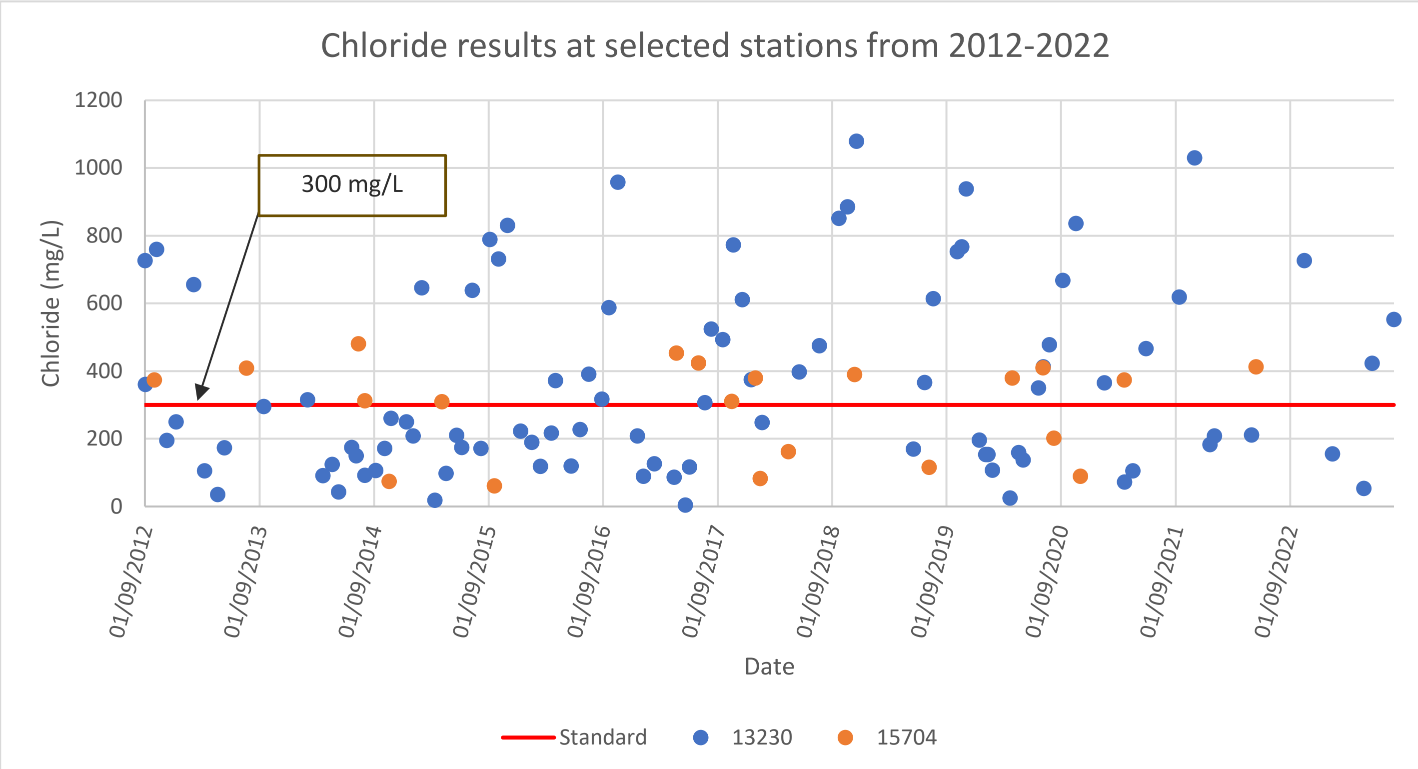


Figure 42. Chloride results at selected stations in segment 2307 from the years 2012-2022.

Like bacteria, chloride levels at stations 13230, 15704, and 15795 exceeded the standard of 300 mg/L. Station 15795 had the highest levels of chloride, however it did not have enough data within the ten-year period to do a trend analysis. The high chloride results from station 15795 in comparison to the other stations could be the discharge coming from Mexico. Often foam is evident at the site along with low flow, creating stagnant water. Analysis on stations 13230 and 15704 did not identify any significant trends. Figure 42 shows the results for chloride at stations 13230 and 15704.

The last parameter for which the segment is impaired is TDS. Only station 13230 had enough data points for analysis. As shown in Figure 43, station 13230 had most of the results above the 1,500 mg/L standard for segment 2307. However, no significant TDS trends were identified. Table 15 summarizes the averages for each parameter at each station along with the number of instances. As mentioned above, returned flow from irrigation is a contributing factor, however the area around station 13230 has seen reduced flow brought on by drought.

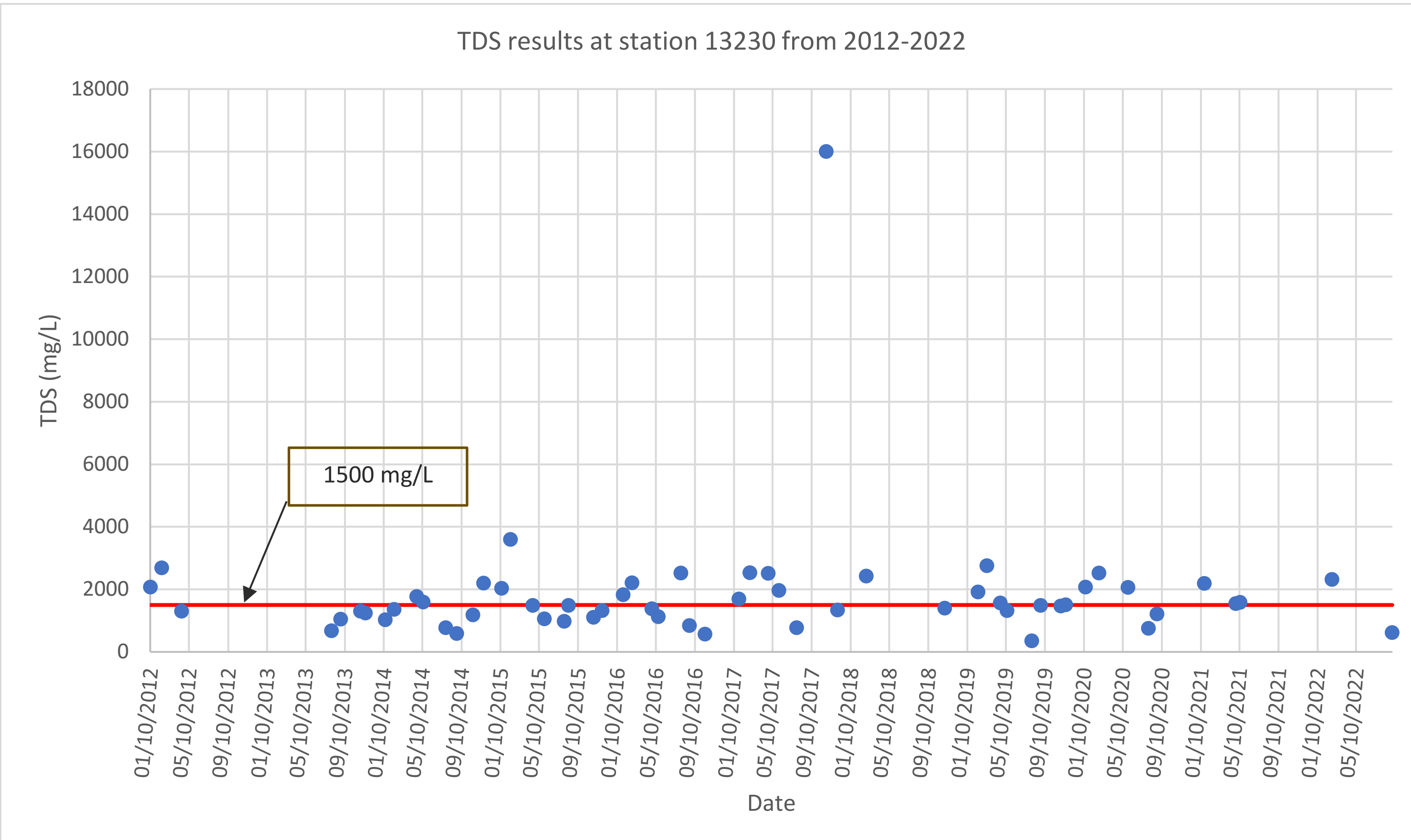


Figure 43. TDS results at selected stations in segment 2307 from the years 2012-2022.

Table 15. Average and count for stations in segment 2307 from 2012-2022.

Station	Parameter	Average (mg/L)	Count (n)
13230	Chloride	363	93
	E. coli	147.71*	67
	TDS	1,825	57
14465	*E. Coli*	489.77*	28
15704	Chloride	295	22
	E. coli	548.51*	20
15795	Chloride	1,190	22
	TDS	3,122	24

*For *E. coli* the geomean rather than the average is used.

Segment 2308 – Rio Grande below International Dam

Segment 2308 stretches from the Riverside Diversion Dam in El Paso County to International Dam in El Paso County. There is only one assessment unit, monitored by two station stations. This segment is listed as impaired for bacteria and has concerns for ammonia, chlorophyll, and total phosphorus. The two stations that currently monitored are stations 15528 and 15529. Out of these two stations, only station 15528 had sufficient data points for analysis.

There was a total of 29 data points for bacteria with a geomean of 1997.01 MPN/100 mL. This value is well above the standard of 605 MPN/100 mL. Single values also remained well above the standard as shown in Figure 44. Station 15528 is downstream of a wastewater treatment plant outfall which might explain the high bacteria levels. There have also been instances of discharge from the Mexican side that can contribute to the bacteria count.

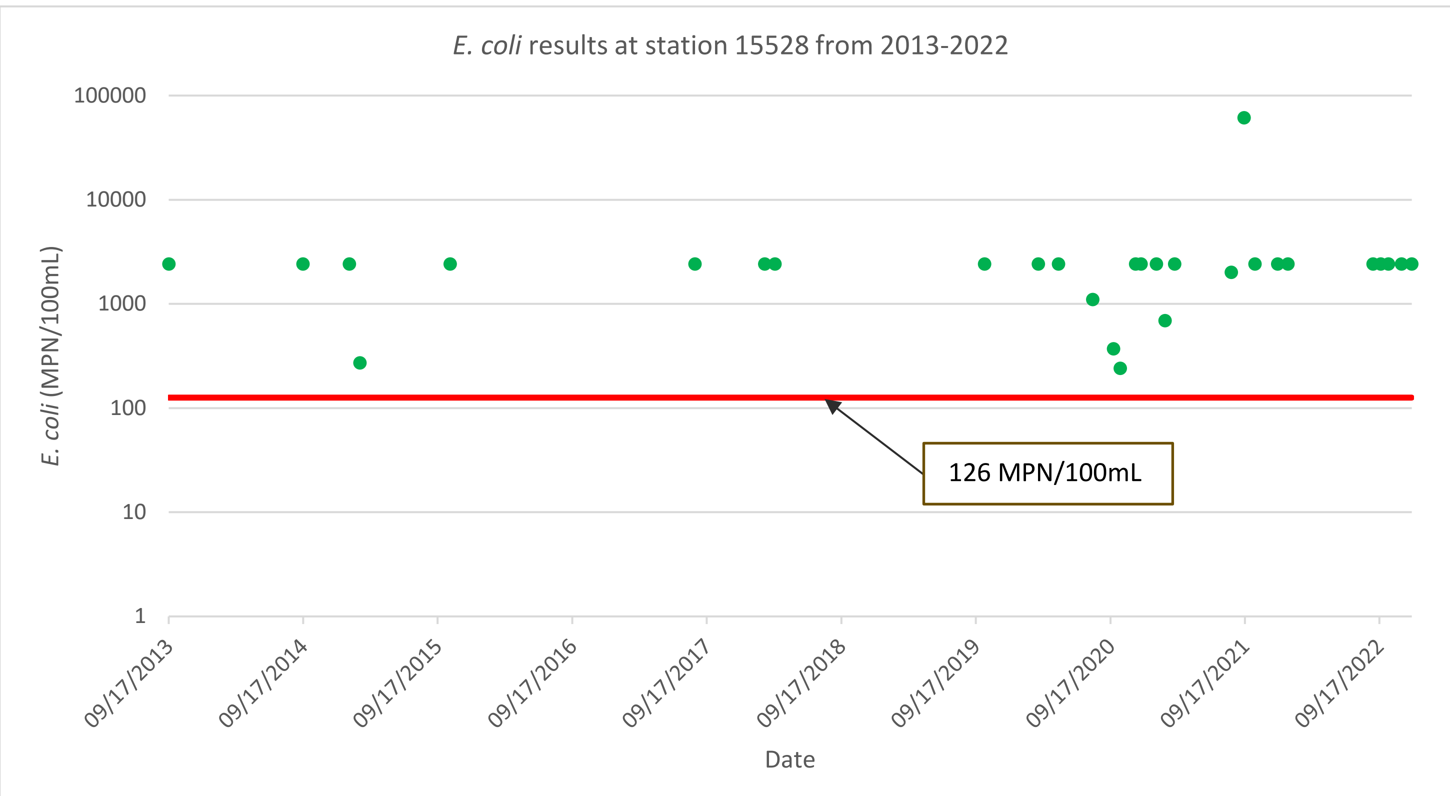


Figure 44. *E. coli* results at station 15528 from the years 2013-2022.

For chlorophyll, again only station 15528 had enough data points for analysis. There was a total of 29 data points for chlorophyll for an average of 60.96 µg/L, which is well above the screening level of 14.1 µg/L. Like the results for bacteria, chlorophyll results remained consistently over the screening level as shown in Figure 45. This site is downstream of a WWTP outfall, and it is part of the channelized portion of the river. This portion receives discharge from the plant and stormwater runoff. Additionally, the site maintains minimal flow. Minimal flow allows for sediment to accumulate. This can also explain the concern for total phosphorus and ammonia.

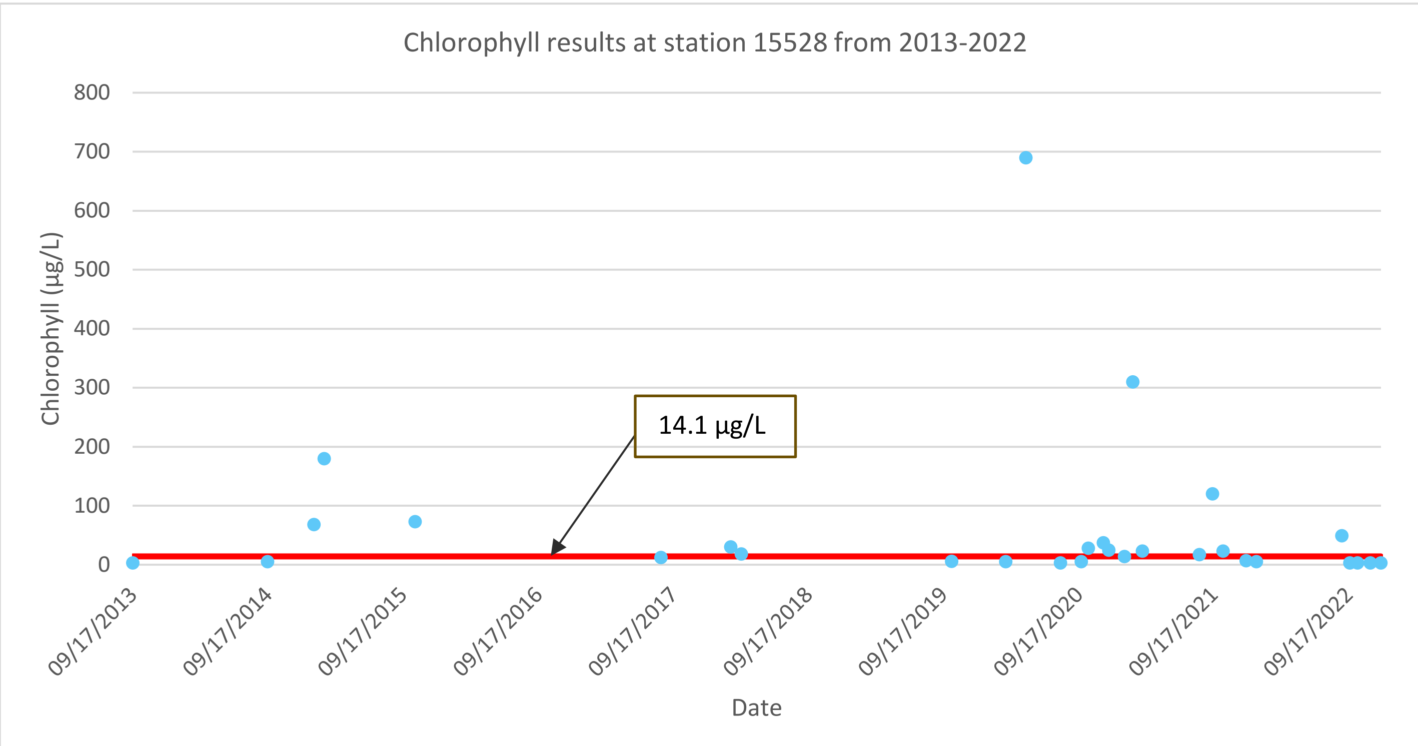


Figure 45. Chlorophyll results at station 15528 from the years 2013-2022.

Segment 2309 – Devils River

Segment 2309 is a freshwater stream that stretches from a point 0.6 km (0.4 mi) downstream of the confluence of Little Satan Creek in Val Verde County to the confluence of Dry Devils River in Sutton County. This segment includes:

- AU 2309_01 – Devils River Arm of Amistad Reservoir upstream to Falls Canyon just below the Dolan Creek confluence.
- 2309_02 – Falls Canyon just below the Dolan Creek confluence upstream to Wallace Canyon
- 2309_03 – Wallace Canyon to the upper segment boundary at the Dry Devils River confluence

Devils River facing Dolan Falls at station 13239.

Station 13239 - Devils River on Devils River State Natural Area 1.7 KM Upstream of Dolan Creek, is the only station in this segment. Data collected from station 13239 indicates that this segment does not have impairments or concerns at this time. However, bacteria analysis shows an increase in bacteria over the 10-year period from 2012-2022. Figure 46 shows *E. coli* results from 2012-2022. Though levels remained under the standard of 126 MPN/100mL, the upward trend is statistically significant, with a p-value of 0.03. This emphasizes the significance of continuing to monitor this area. The area around the Devils River is rural and it is used for ranching. Ranching practices can be a contributing factor to the increase in bacteria in the water.

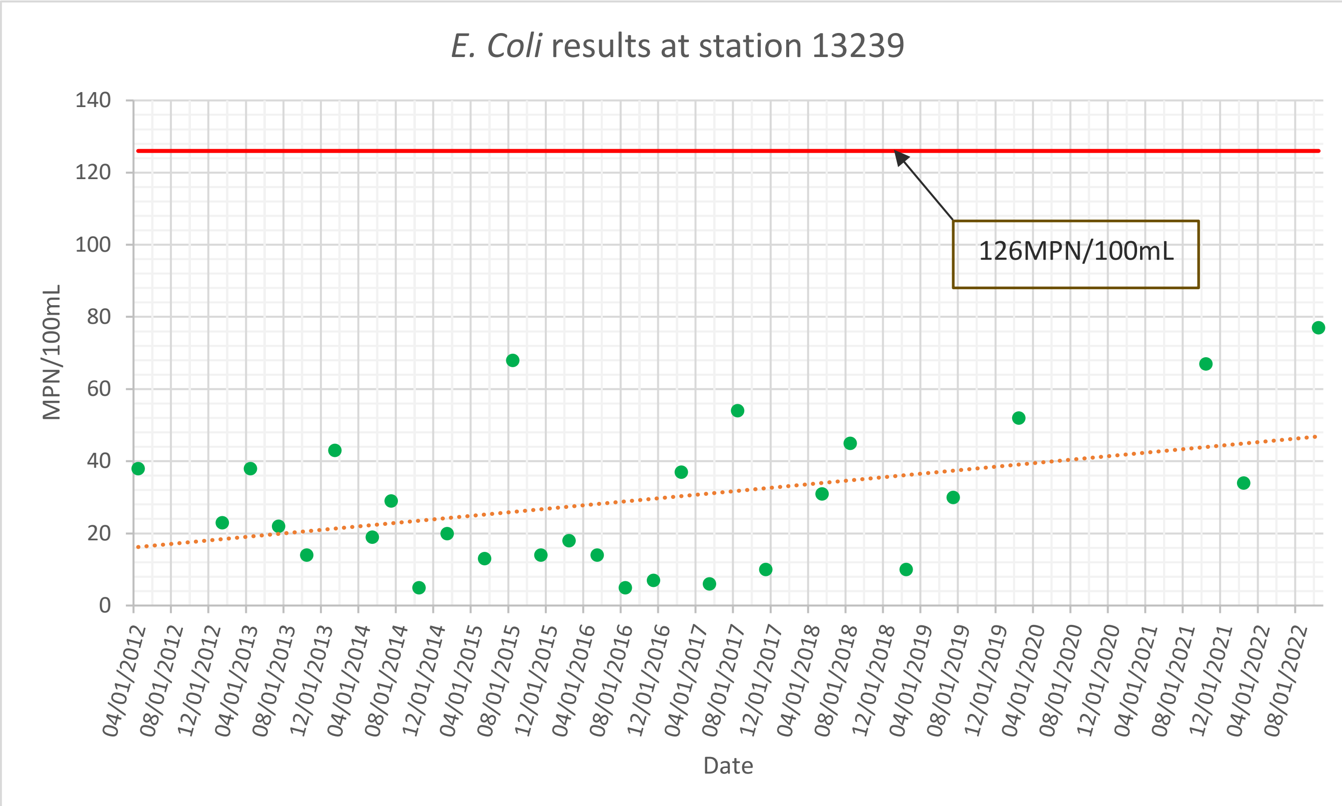


Figure 46. *E. coli* results for station 13239 from the years 2012-2022.

All other parameters remained under the standard or screening level. Table 16 shows the ten-year average for the specified parameters at station 13239. Figure 47 shows the results for TDS from 2012-2022 (only missing year 2021). Elevated levels of TDS can impact aquatic life by altering the water chemistry, increasing salinity levels, disrupting nutrient balance, and introducing toxic contaminants. This can have cascading negative impacts on water quality.

Table 16. Average for specified parameters at station 13239 from 2012-2022.

Parameter	Average (mg/L)	Count (n)	Standard (mg/L)	Screening Level (mg/L)
Ammonia	0.048	32		0.33
Nitrate+Nitrite	1.24	33		1.95**
Total Phosphorus	0.042	32		0.69
Chloride	16.0	33	50	
Sulfate	8.82	33	50	
Total Dissolved Solids	269.5	23	300	
Chlorophyll	1.42*	28		14.1*

**Units for Chlorophyll are µg/L*

*** Screening level is for nitrate*

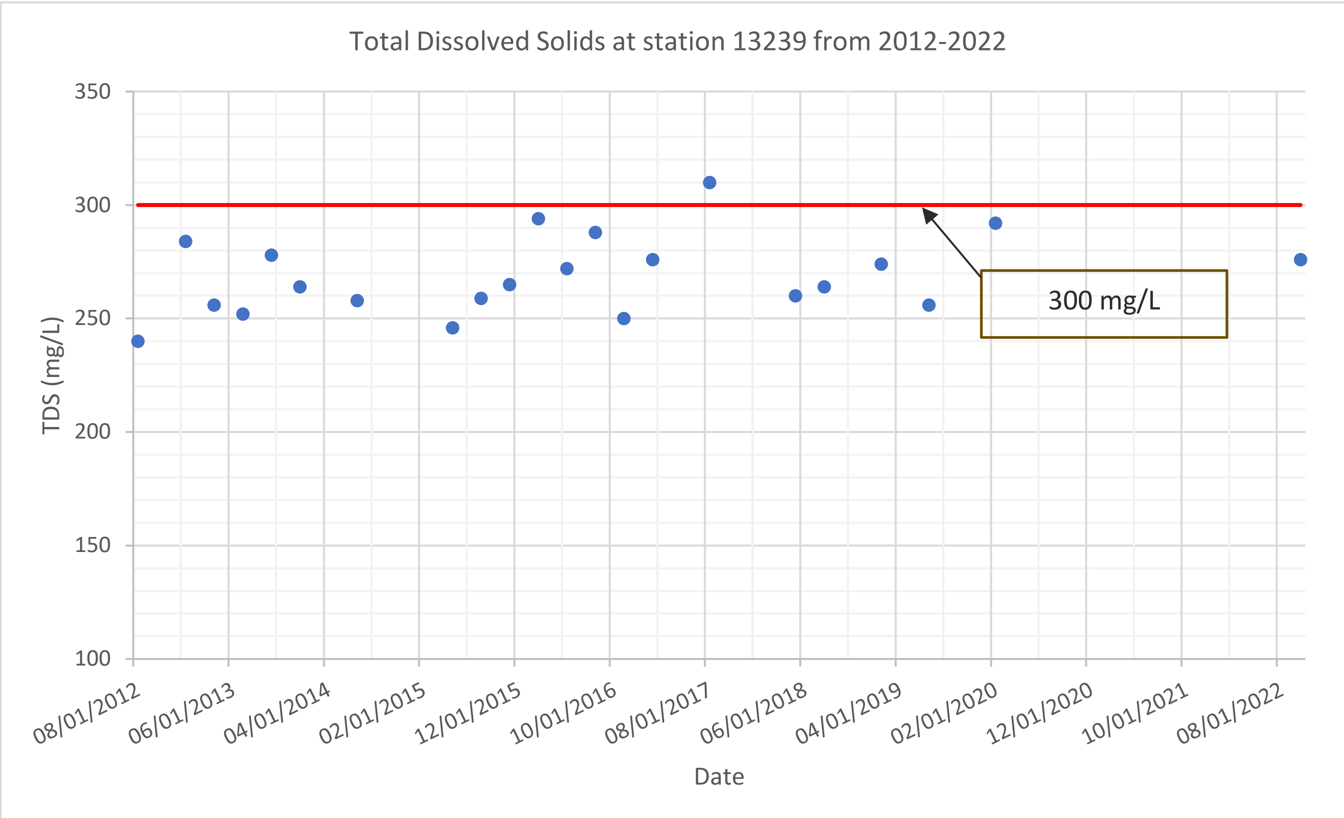


Figure 47. Total dissolved solids results for station 13239 from the years 2012-2022.

Segment 2309A – Dolan Springs

Segment 2309A is a freshwater stream that stretches from Devils River confluence to 46.7 km (29 mi) south of Sonora and 4.8 km (3 mi) west of US 277 in Val Verde County. This segment includes assessment units 2309A_01 and 2309A_02. Station 14942 - Dolan Springs 100 yds Upstream of Confluence with Devils River Immediately Upstream of Road Crossing is the only station in this segment. There are currently no impairments or concerns in this reach.

Dolan Creek at station 14942

As with the previous station, values at station 14942 were all under the standard or screening levels. Figure 48 shows *E. coli* levels over the ten-year period. Results for each sampling event remained under the 126 MPN standard. Figure 49 shows the values of TDS over the ten-year period. Further analysis suggests that TDS remained relatively stable with one higher value in 2016. From these parameters, bacteria exhibited a statistically significant upward trend with a p-value of 0.0008. In contrast the changes in TDS were relatively minor and not statistically significant.

The other parameters remained under standards and screening levels. Table 17 breaks down the ten-year average for each of the parameters along with number of sampling events (count), slope, and p-values from trend analysis.

This area sees a lot of human activity due to its nature trails and water activities. The area is also home to a state natural area. Heightened human activity can contribute to decreased water quality.

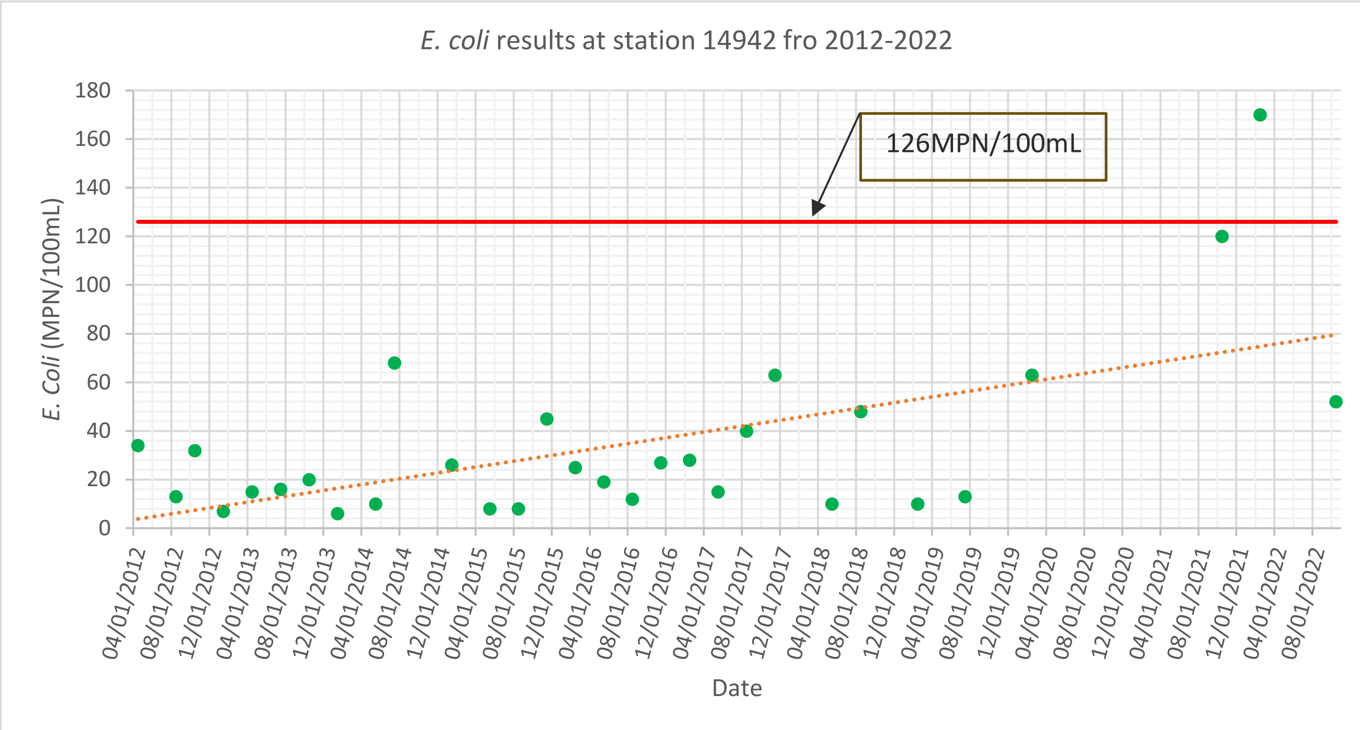


Figure 48. *E. coli* results for station 14942 from the years 2012-2022.

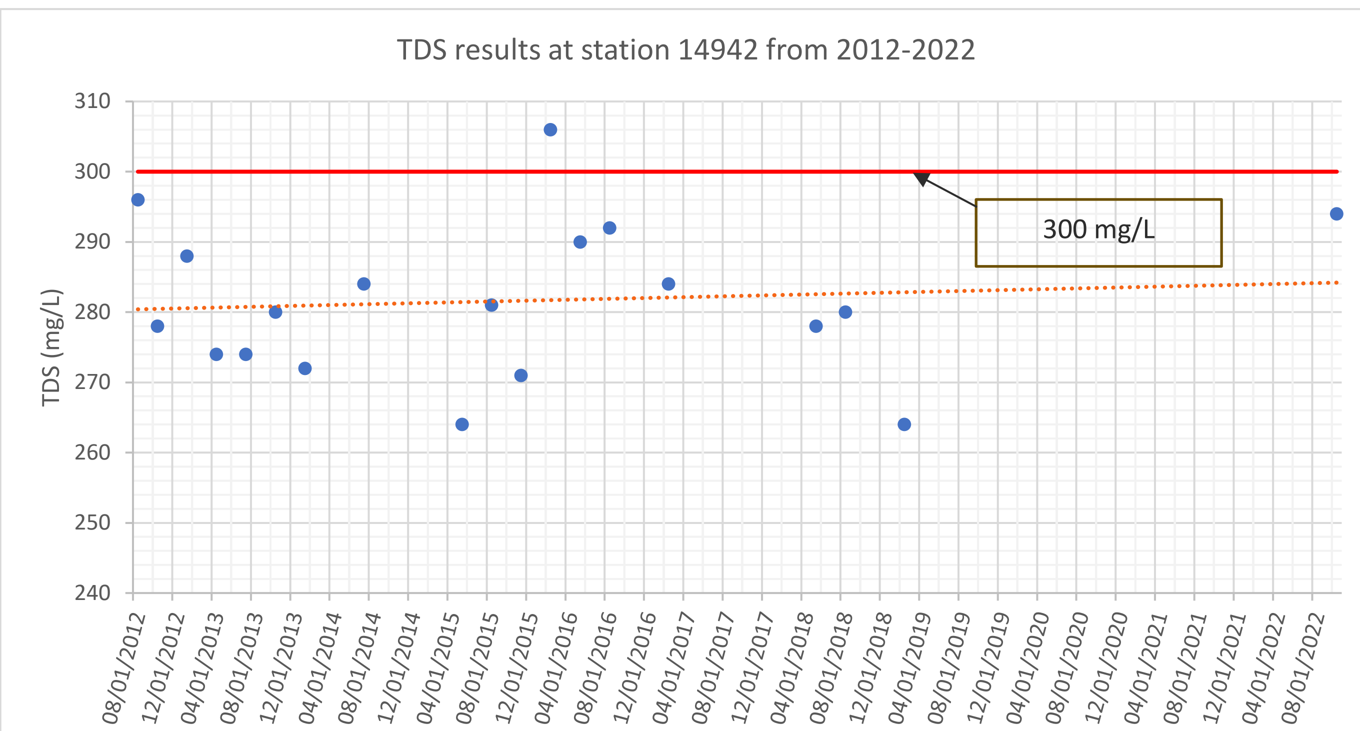


Figure 49. Total dissolved solids results for station 14942 from the years 2012-2022.

Table 17. Average, slope, and p-values for specified parameters at station 14942 from 2012-2022.

Parameter	Average (mg/L)	Count (n)	Standard (mg/L)	Screening Level (mg/L)	Slope	P-Value
Ammonia	0.05	33		0.33	0.033	0.77
Nitrite+Nitrate	1.53	34		1.95†	-0.013	0.372
Total Phosphorus	0.02	33		0.69	0.0085	0.42
Chloride	15.54	34	50		-3.56	0.730
Sulfate	7.53	34	50		0.224	0.967
E. coli	21.52*	32	126		7.14	0.0008
TDS	281.58	19**	300		0.36	0.726
Chlorophyll	1.42 µg/L	29		14.1 µg/L	-0.267	0.227

**A geomean is used for E. coli rather than an average.*

**** Station had a sample size for that parameter less than the sample size required for trend analysis (n ≥ 20).

A negative slope indicates a decrease in trend. A p-value <0.05 indicates a statistically significant trend.

† Screening level is for nitrate (mg/L).

Segment 2314 – Rio Grande above International Dam

Segment 2314 stretches from International Dam in El Paso County to the New Mexico State Line in El Paso County. There are two assessment units (2314_01 and 2314_02) in this segment. All the stations that monitor this reach, however, are only within AU 2314_01. This segment is listed as impaired for bacteria and has concerns for chlorophyll and total phosphorus. This area has seen a lot of industrial discharges. The water is sometimes foamy and of a white color. Collaboration with IBWC's Mexican counterpart is underway to mitigate the discharge.

International Dam walkway with Cd. Juarez, Chihuahua, MX in the background.

Stations with sufficient data points in this segment are stations 13272, 13276, 15089 and 17040. Station 17040 exhibited the highest levels of

E. coli, while station 13276 exhibited the lowest levels. All stations exceeded the standard consistently throughout the ten-year period as shown in Figure 50. Analysis indicates that at station 13272 levels remain steady and the data does not show an increase or decrease. Chlorophyll also exceeded the screening level of 14.1 µg/L at these stations as shown in Figure 51. High chlorophyll levels indicate high concentrations of algae. This usually occurs when there is an excess in nutrients entering the waterways from fertilizers, sewage or urban runoff.

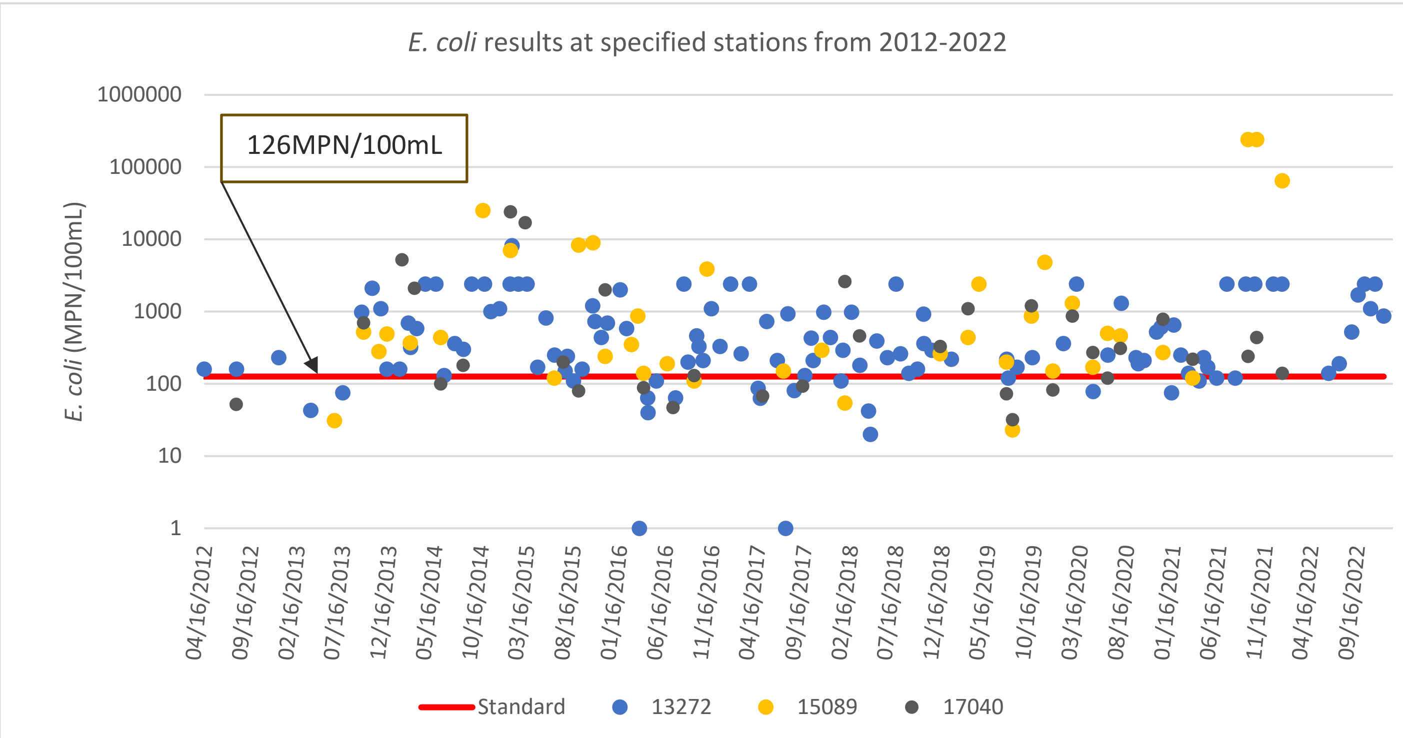


Figure 50. *E. coli* results at specified stations in segment 2314 from the years 2012-2022.

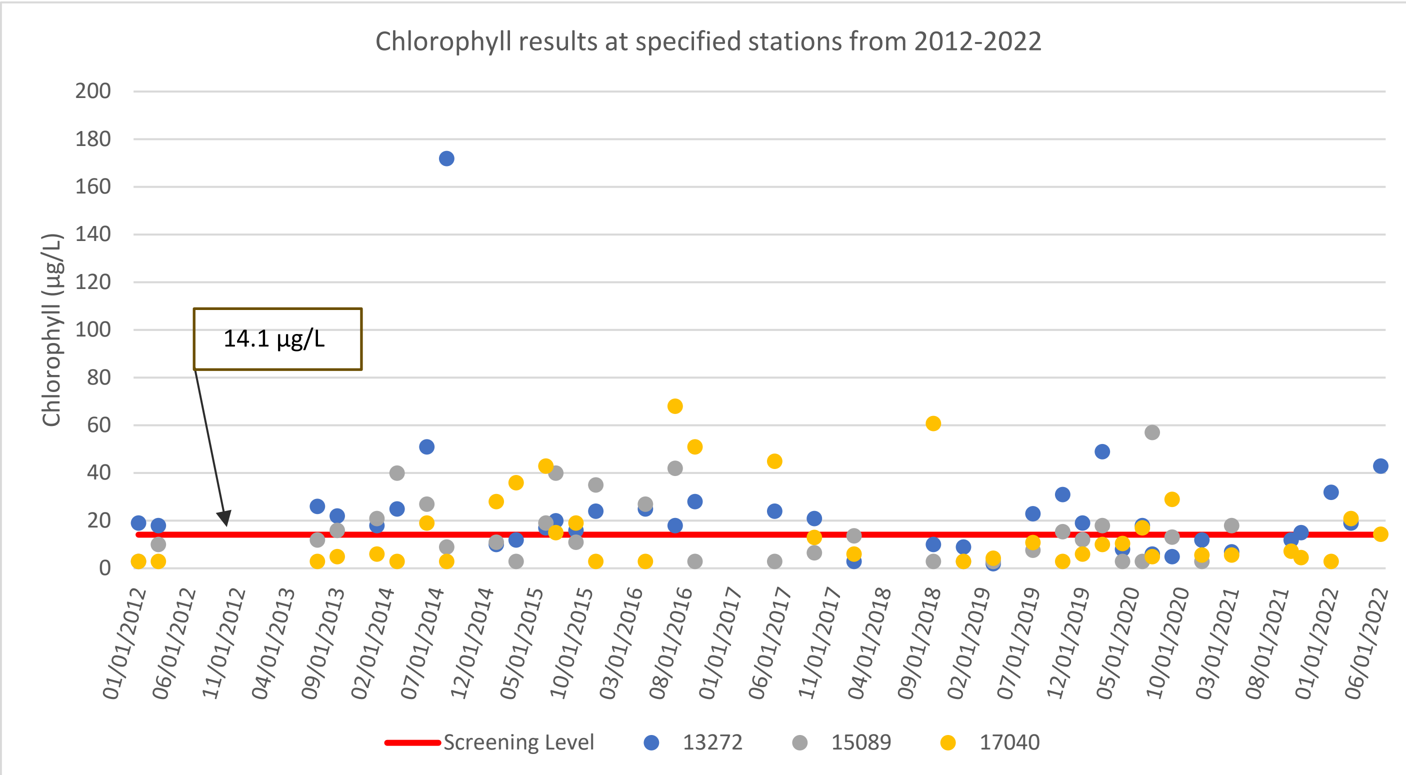


Figure 51. Chlorophyll results at specified stations from the years 2012-2022.

Segment 2310 – Lower Pecos River

Segment 2310 runs from a point 0.7 km (0.4 mi) downstream of the confluence of Painted Canyon in Val Verde County to a point immediately upstream of the confluence of Independence Creek in Crockett/Terrell County. It has two assessment units monitored by two stations, which are both located on the second AU. This river segment is impaired for sulfate and total dissolved solids. A combination of run-off from agriculture and low flows brought about by drought contribute to the high sulfate and TDS levels. Additionally, the area of the Pecos River has natural rock formations that contribute to salinity levels. In contrast, segment 2310A, Independence Creek, does not have any impairments or concerns.

For the sulfate analysis, station 18801 provided the data points. As shown in Figure 52 sulfate levels at this station exceeded the 1000 mg/L standard for segment 2310 in some instances. High levels of sulfate can derive from sewage or industrial runoff and create high salinity levels that can have an adverse effect on aquatic life.

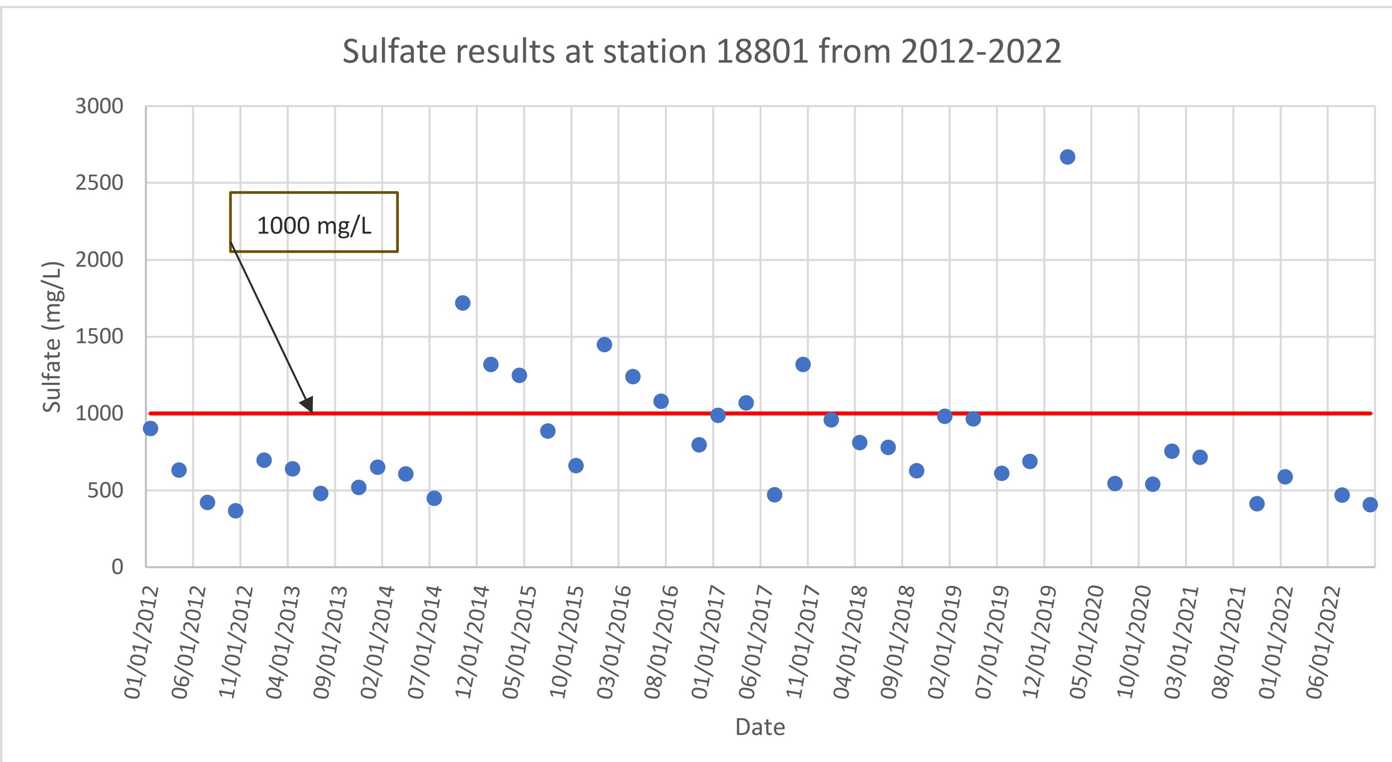


Figure 52. Sulfate results at station 18801 from the years 2012-2022.

Total dissolved solids also contribute to salinity in the water. For this parameter, neither of the stations in this segment had enough data points for trend analysis (less than 20 data points or less than 10 years). However, Figure 53 shows the results at station 14163 from 2014 to 2022. TDS levels were often above the standard of 4,000 mg/L.

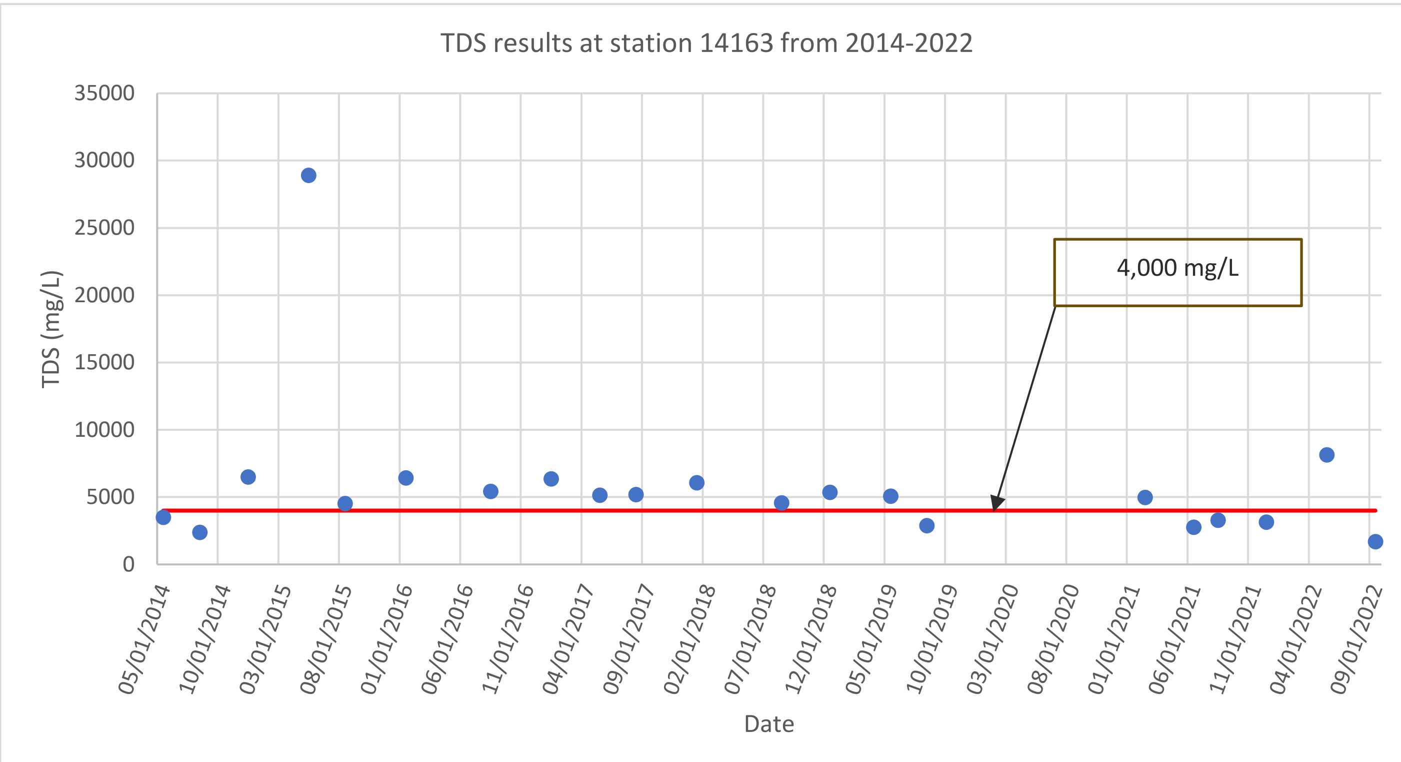


Figure 53. TDS results at station 14163 from the years 2014-2022.

Segment 2311 – Upper Pecos River

Segment 2311 runs from a point immediately upstream of the confluence of Independence Creek in Crockett and Terrell County to Red Bluff Dam in Loving and Reeves County. There are eight assessment units in this segment with six stations used for analysis in this report. The segment is listed as impaired for depressed dissolved oxygen (DO) and has chlorophyll and bacteria as parameters of concern.

The DO impairment on 2311_03 is based on 24-hour data using the 24-hour minimum standard of 3 mg/L. However, instantaneous DO data was assessed for this report. Stations 13249, 13257, 13260, and 13265 were the stations in this segment that had a count of more than 20 DO results. Table 18 has the average for DO at the stations. As discussed before, results for DO may indicate a water quality issue if they go below the screening level of 5.0 mg/L. Levels of DO below this screening level indicate a lack of oxygen in the water which aquatic life need to survive. At the specified stations, however, DO results remained above the screening level (see Figure 54) throughout the ten-year period from 2012-2022 except for some values at stations 13257 and 13260 between 2012-2014. Evidence of potential sites with low DO are stagnant or turbid water or sites with high abundance of plants. Rain events can create the flow needed to maintain DO levels. Areas in the upper Pecos River have been experiencing moderate to severe drought according to the National Integrated Drought Information System (NIDIS) developed by the National Oceanic and Atmospheric Administration (NOAA), which could explain low flows.

Stations in this segment did not have enough data points to conduct an analysis for bacteria. However, the few data points that were collected do show bacteria counts at higher levels than the standard of 126 MPN/100mL. Collection of more samples will indicate if bacteria levels are persistently high in this segment.

Chlorophyll results did have enough data points for analysis. Results for chlorophyll at stations 13249, 13257, 13260, and 13265 are plotted in Figure 55. These results show fluctuations in values but there are several results over the 14.1 µg/L screening level. The highest values belong to station 13265.

Table 18. DO average and count for stations in segment 2311 from 2012-2022

Station	DO Average (mg/L)	Count (n)
13249	7.8	42
13257	7.6	39
13260	7.8	44
13265	8.2	26

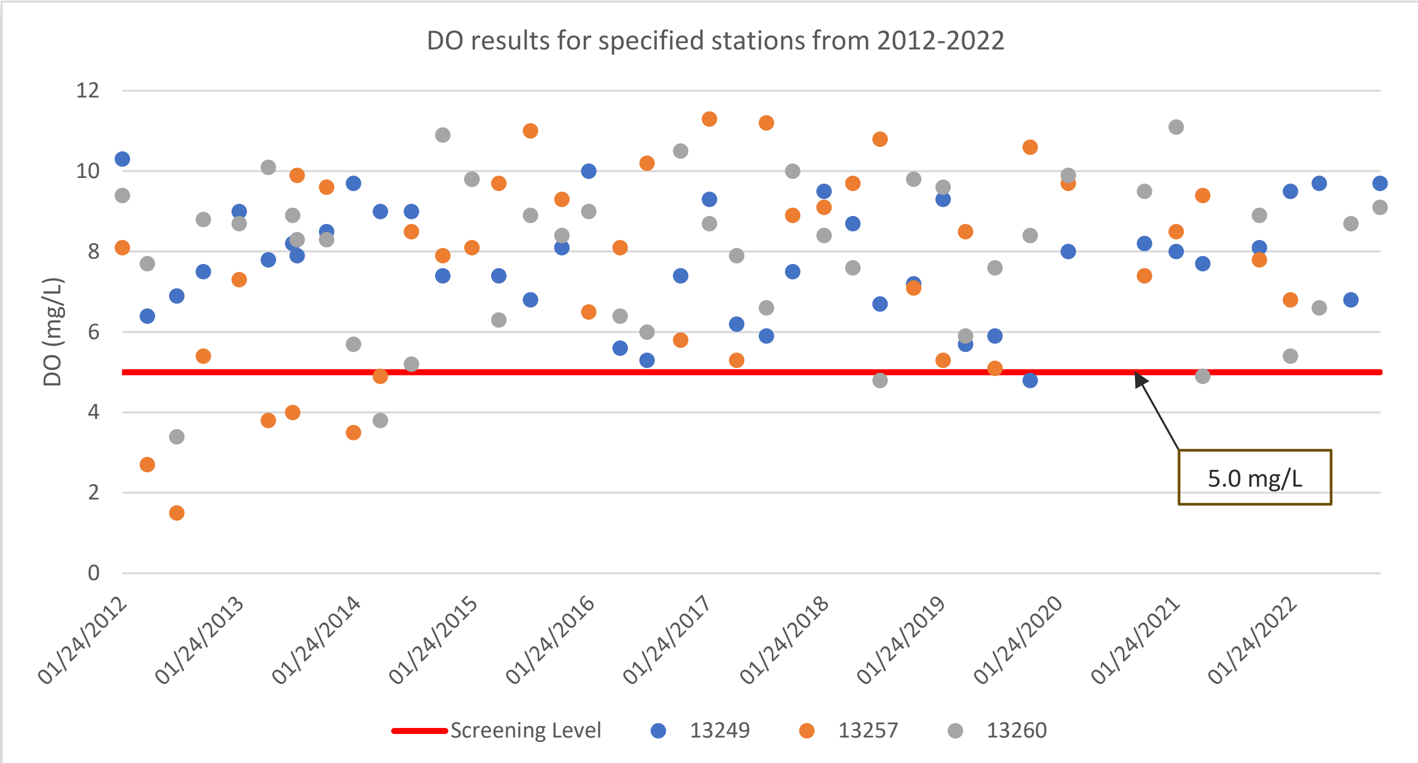


Figure 54. DO results at specified stations at segment 2311 from the years 2012-2022.

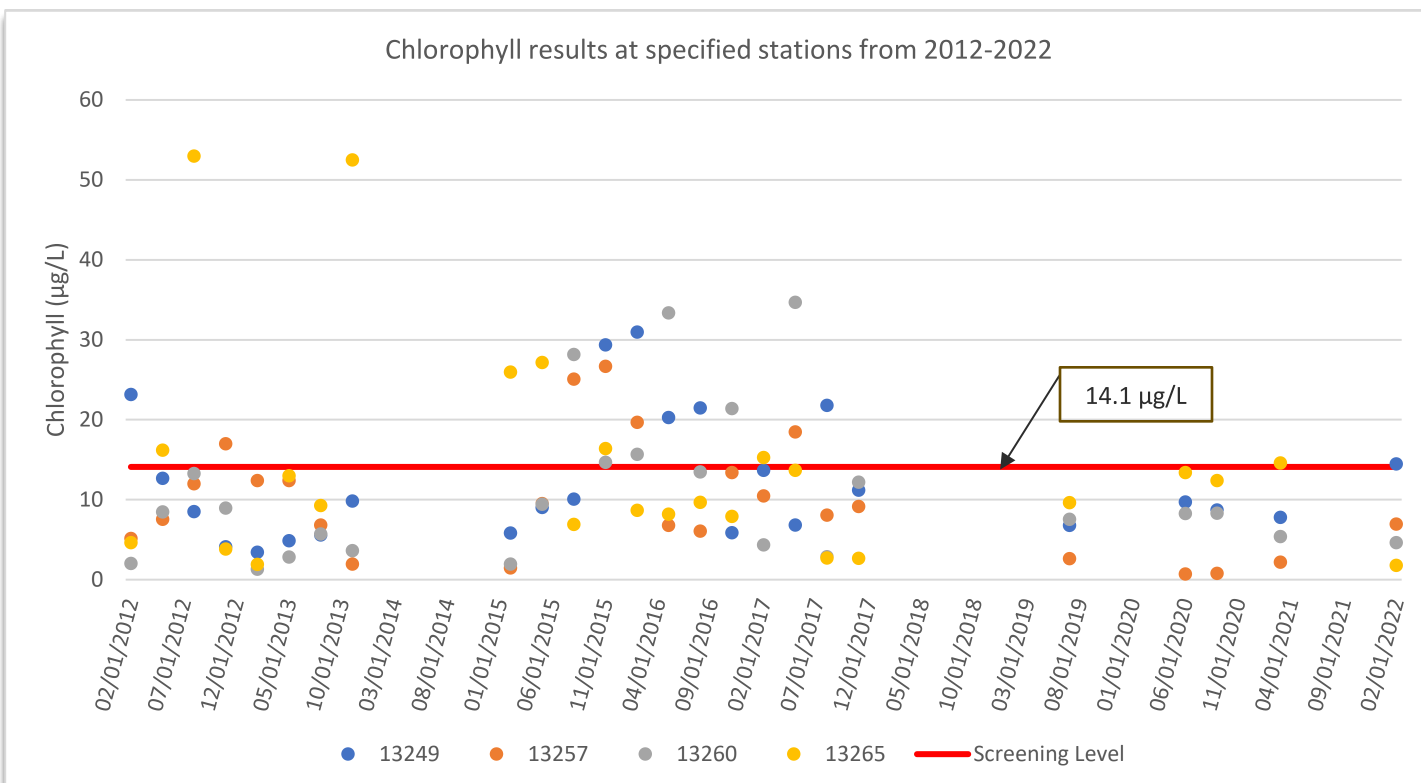
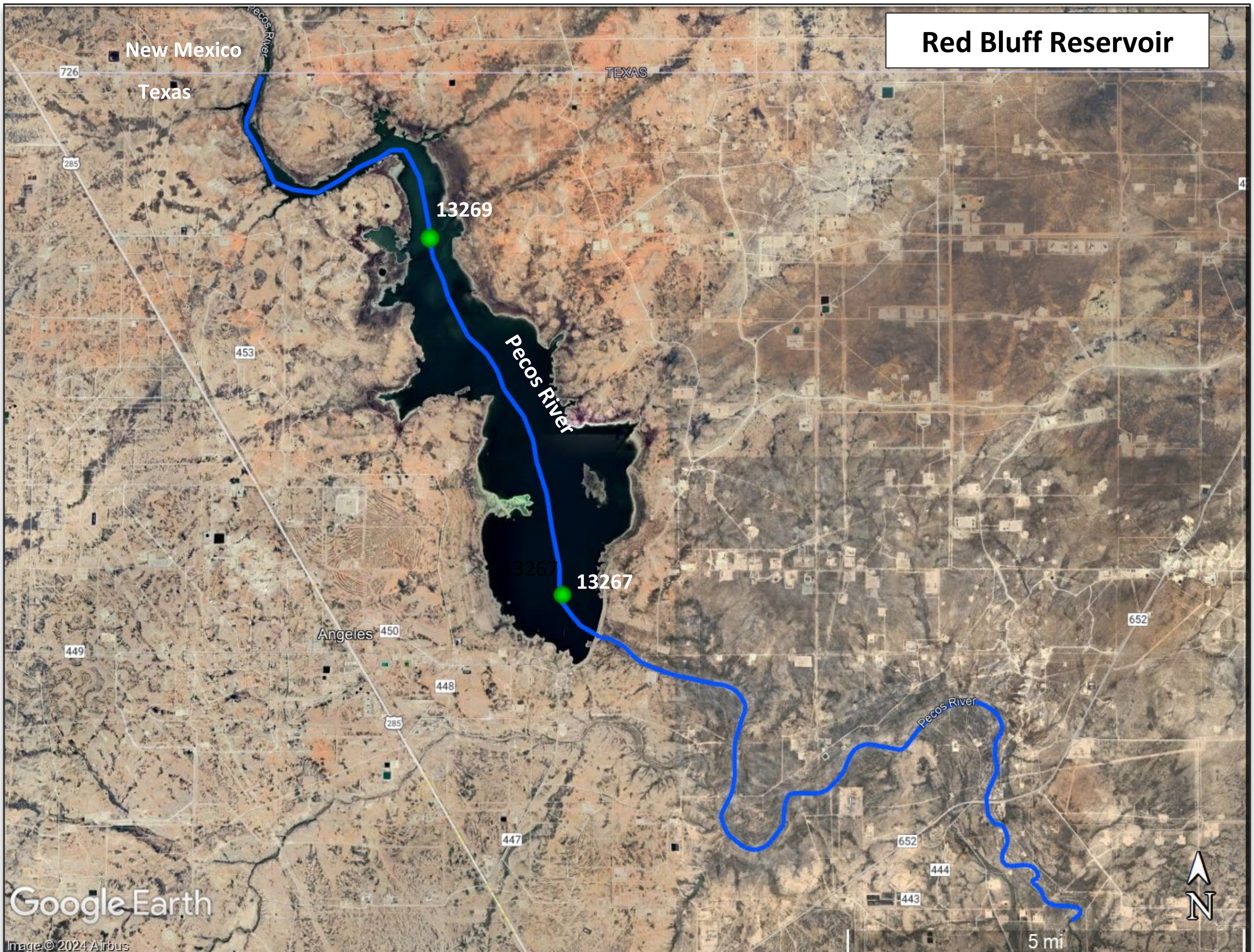


Figure 55. Chlorophyll results at specified stations at segment 2311 from the years 2012-2022.

Segment 2312 – Red Bluff Reservoir

Segment 2312 runs from Red Bluff Dam in the Loving/Reeves County line to the New Mexico state line in Loving/Reeves County, up to the normal pool elevation of 2842 feet (866 m) (impounds the Pecos River), which runs for 11 miles (18 km). This reservoir is used to impound the waters of the Pecos River entering Texas from New Mexico. Water is then released at the request of irrigation districts or municipalities. There are two assessment units in this segment, with one monitoring station each. Assessment unit 2312_01 runs from the Red Bluff Dam to mid-lake and has monitoring station 13267 (Red Bluff Reservoir). Assessment unit 2312_02 runs from mid-lake to the Texas/New Mexico state line and is monitored by station 13269 (Red Bluff Reservoir at TX/NM state line). This segment does not have any impairments or concerns and no significant trends were identified.



Red Bluff Reservoir along the Pecos River in the Texas/New Mexico border

Upper Rio Grande and Pecos River Basin Land Use

The Upper Rio Grande watershed is surrounded by highly urbanized areas and agricultural fields. Figure 56 shows the urban areas in these sections and Figure 57 shows the land use. Communities are mainly concentrated in the New Mexico/Texas state line, including the communities of Anthony, Vinton, and Canutillo, down through major cities such as El Paso and Ciudad Juárez, downstream to the smaller outlying communities of Horizon, San Elizario, Clint, Fabens, and Ft. Hancock. In the past five years, this metropolitan area has grown substantially, putting a heavier burden on both drinking and wastewater treatment plants to treat water for the communities. A large part of the land surrounding the river in these smaller communities are agricultural fields. El Paso and Ciudad Juárez are also home to several ports of entry, which see heavy traffic, both commercial and private, going back and forth across the border.

On the west side of El Paso, across from the University of Texas at El Paso, is an area in Ciudad Juárez named Anapra. This area is one of the more poverty-stricken areas of Ciudad Juárez, a colonia, and many of these communities have little to no access to municipal services and are exposed to poor sanitary conditions. The area of Sunland Park, New Mexico, which is immediately upstream of El Paso, is also a lower socio-economic area. Many of these homes still have septic systems or are in the area serviced by the Sunland Park Wastewater Treatment Plant, which is constantly operating over capacity. The areas adjacent to the Rio Grande in many parts of Ciudad Juárez are also heavily populated by industrial plants, which also have an impact on the river since the discharge goes into the river.

The Pecos River Basin is less urbanized. Waters of the Pecos River may be used for salt-tolerant crops; however, overviews in Google Earth do not indicate many farmlands around the river. There are more farms visible near the Sheffield area, but the lower portions of the Pecos are dotted by what look to be private residences right along the banks of the river, which may or may not be farms or ranches. This area of the basin also has significant oil and refining industries, and these industries own large portions of land.

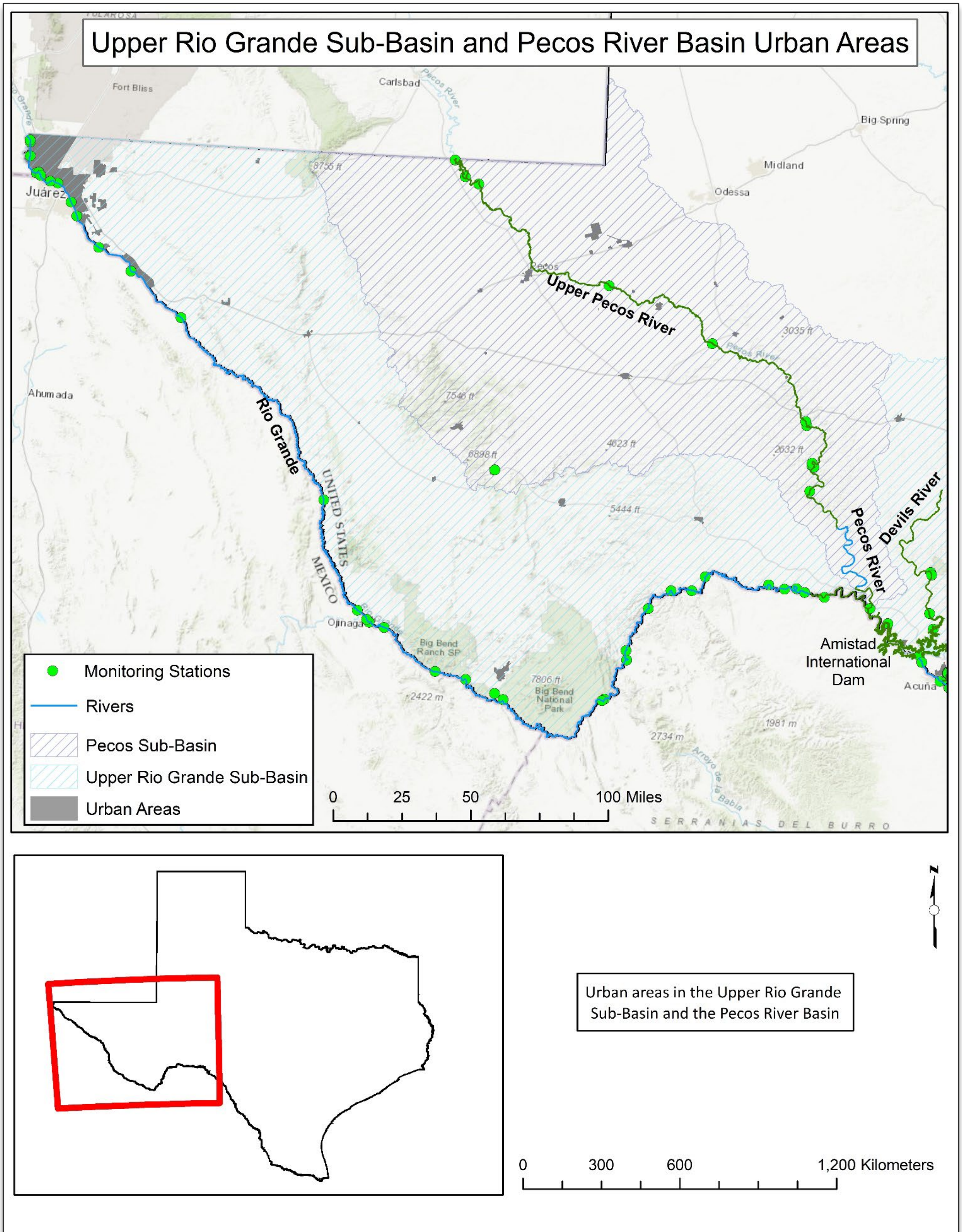


Figure 56. Map of the urban areas in the Upper Rio Grande Sub-Basin and the Pecos River Basin

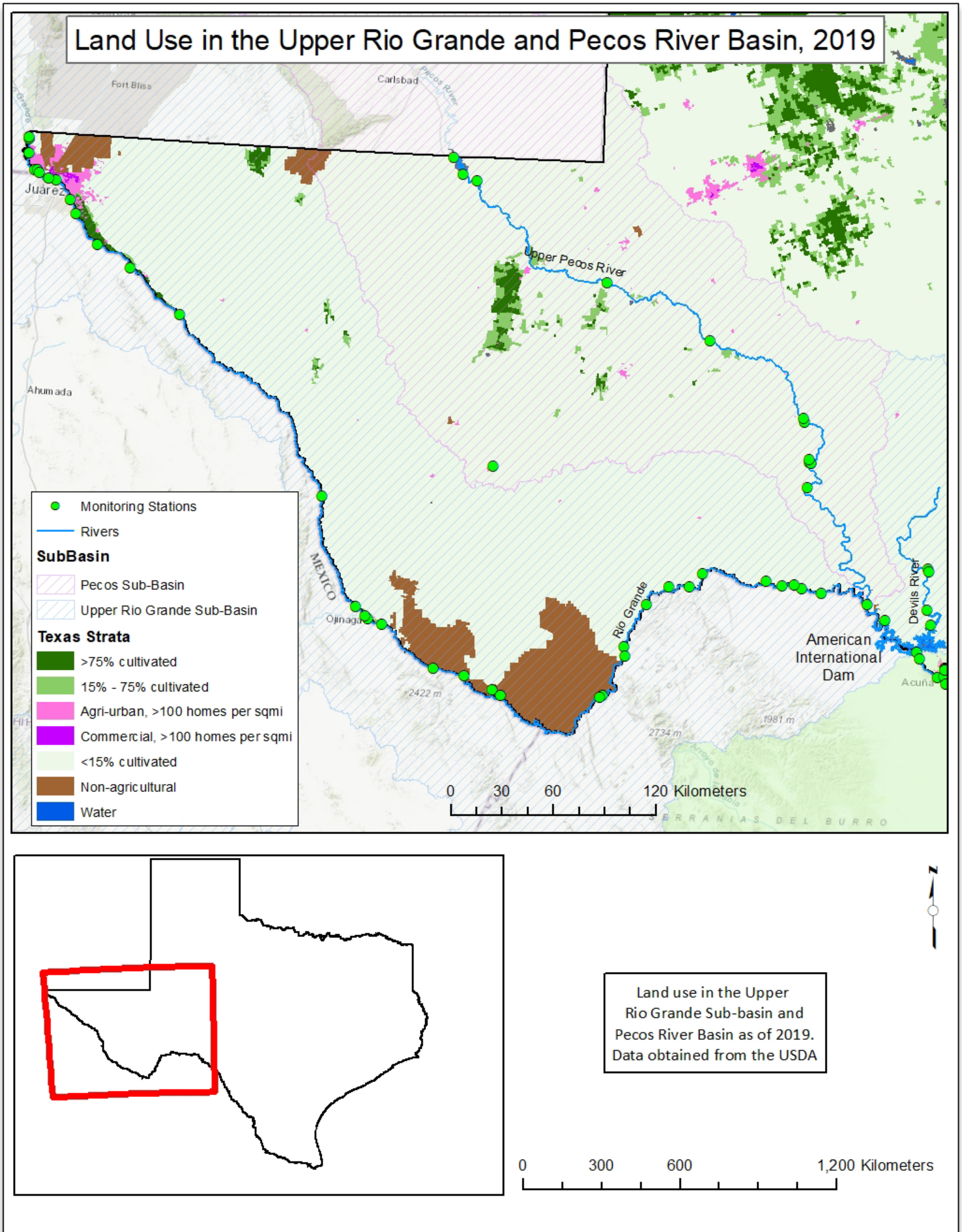


Figure 57. Map of the land use in the Upper Rio Grande Sub-Basin and the Pecos River Basin

Upper Rio Grande and Pecos River Basin Significant Findings

Data gathered from the upper Rio Grande area suggest that bacteria, chloride, and total dissolved solids (TDS) remain an issue for this Sub-Basin. The 2022 Integrated Report supports the data and listed segment 2305 as impaired for chloride, segment 2306 for sulfate, and 2307 is listed as impaired for chloride, bacteria, and TDS. Lastly, segment 2308 has a bacteria impairment. For stations in segment 2307 and 2308, geomean values for bacteria are all over the standard. There are also parameters of concern for the upper Rio Grande. These parameters include chlorophyll, ammonia, nitrate, and phosphorous. Chlorophyll is the main parameter that the data shows to be over the screening level. Figure 58 shows the segments impaired for bacteria and Figure 59 shows the segments impaired for dissolved solids, which includes levels of chloride, sulfate and/or dissolved solids, all of which indicate high salinity. Several areas along the river in this area remain unmonitored. It would be advantageous to have additional sample stations to gather data in these areas.

Data for the Pecos River Basin indicate impairments for sulfate, dissolved solids, and dissolved oxygen. Stations in segment 2311 all have an average higher than the standard for the Pecos River for those parameters. The area also presents some concerns for chlorophyll and bacteria. High values for these parameters relate to agriculture runoff as with all Sub-Basins. A focused study on salinity levels will prove helpful to the Pecos River to develop a specific watershed protection plan.

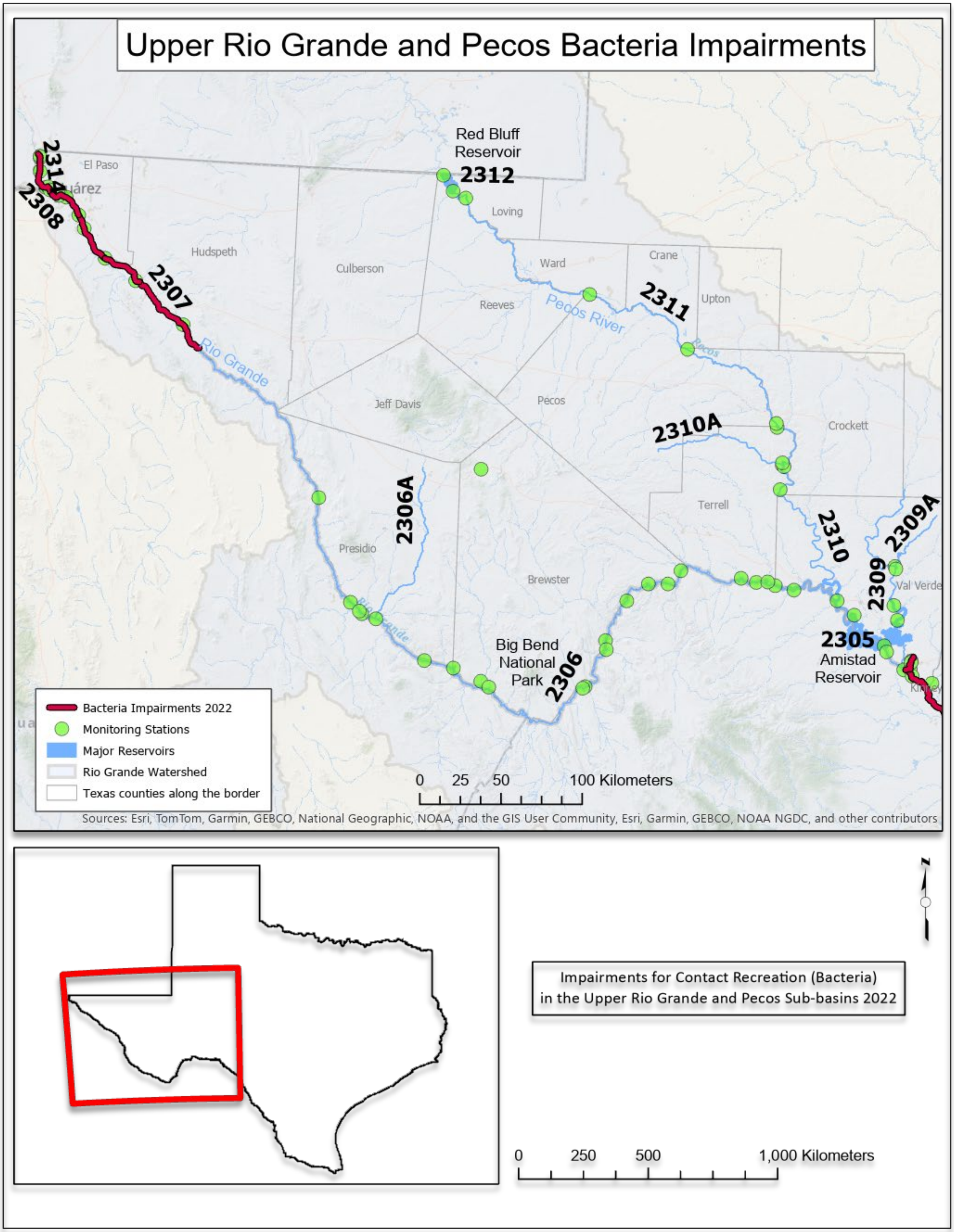


Figure 58. Map of the river segments in the Upper Rio Grande Basin and Pecos River impaired for bacteria.

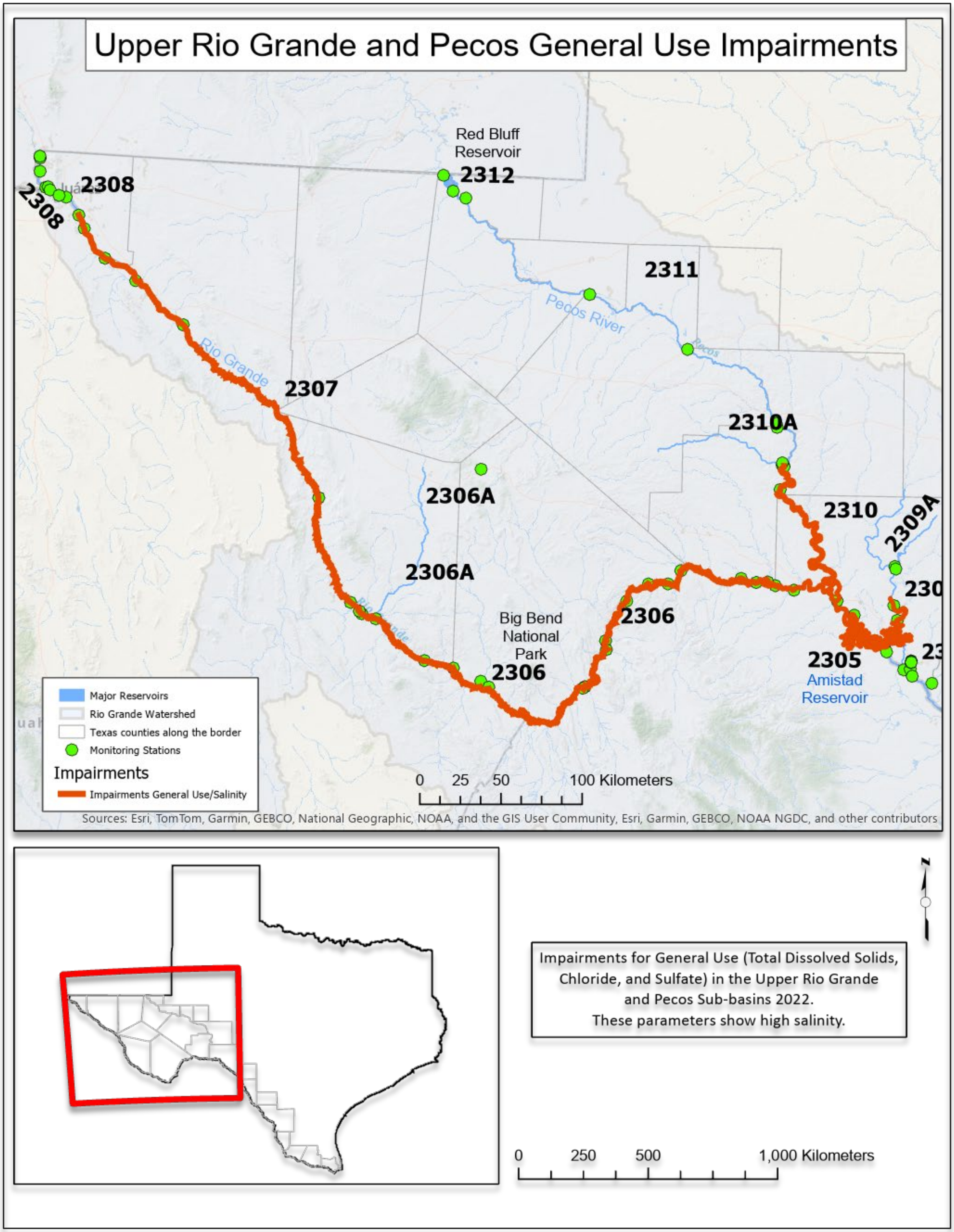
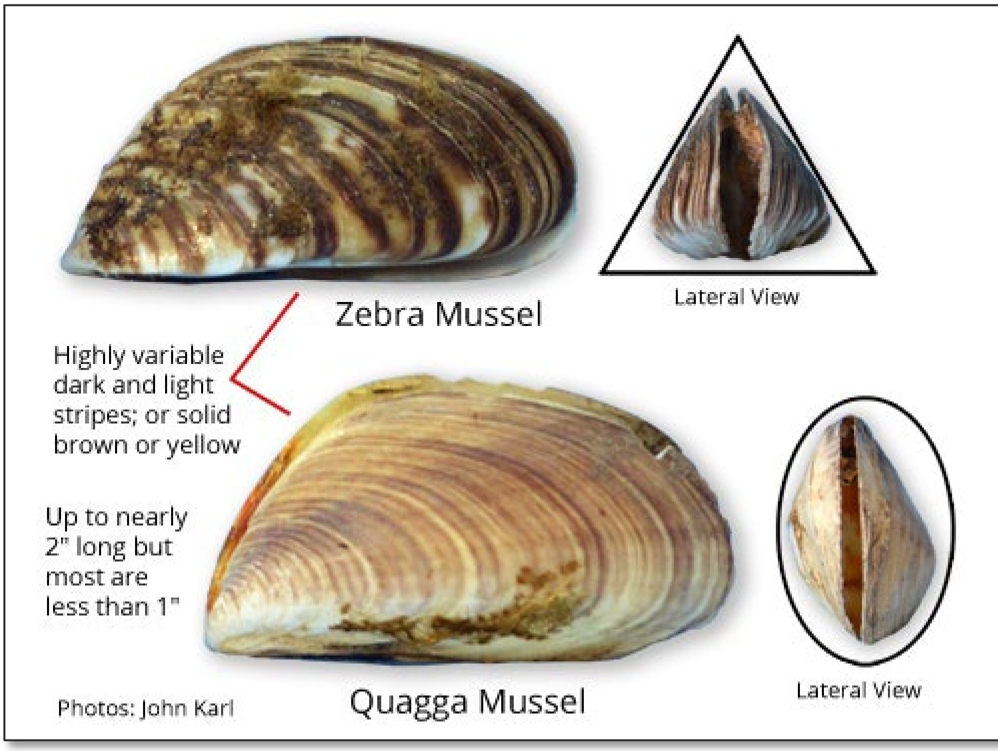


Figure 59. Map of the river segments in the Upper Rio Grande Basin and Pecos River impaired for dissolved solids.

Invasive Species

Invasive species pose a significant threat to ecosystems, disrupting the natural balances of the native species. Unfortunately, the Rio Grande is not immune to these threats. The Rio Grande in Texas faces multiple invasive species challenges, ranging from plants to aquatic animals. These species often outcompete native species for resources and alter the habitat of the native species. Some prominent invasive species in the Rio Grande include water hyacinth *(Eichhornia crassipes)*, hydrilla *(Hydrilla verticillate),* giant reed *(Arundo donax)*, and salt cedars *(Tamarix spp.)*.



https://www.nidwater.com/quagga-and-zebra-mussel-prevention-and-monitoring-program

More recently, in 2021 and 2022, the Texas Park and Wildlife Department (TPWD) reported the detection of invasive quagga mussel *(Dreissena bugensis)* larvae at Amistad Lake. This is the first time this species of mussels was detected in Texas and the first finding of any invasive mussel in the Rio Grande Basin. Though no juvenile or adult quagga mussels were detected, and the larvae detected was in low numbers, the TPWD classified Amistad Lake as positive for quagga mussels. Sightings of zebra mussels *(Dreissena polymorpha)* have also reported on more than one occasion in the area by both members of the IBWC Mexican section and the National Park Service (NPS) staff in late February of this year. In contrast to the quagga mussels, zebra mussels have been detected in multiple sizes and at multiple sites at Amistad Lake. The lake has been designated as infested with zebra mussels as well. The TPWD provided a news release on March 20, 2024 with more information on these species of mussels and what the department is doing moving forward. Both species are highly invasive freshwater mollusks and are known for their prolific reproduction rates and ability to quickly colonize new environments.

Though invasive species are not a direct source of pollution, they can indirectly impact water quality. One of these impacts is the disruption of the nutrient cycle. For example, invasive plants like the giant reed and hyacinth take up excessive amounts of nitrogen and phosphorus from the water, depleting nutrient resources for native species. In the case of mussels, since they are filter feeders, meaning they can consume large amounts of organisms, such as phytoplankton, they reduce the availability of food for other aquatic species. Their feeding activities also increase water clarity. Although this might seem like a positive effect by filtering suspended solids, it allows for light to penetrate further into the water column, which can potentially alter the distribution of the aquatic vegetation and algae. Changes in light availability can also affect the temperature and oxygen levels in the water.

Summary of Findings

Though in some areas bacteria has decreased during the last 10 years, it continues to be above the state's standard throughout the Rio Grande Basin and many segments remained impaired for this parameter. The Pecos River Basin is not impaired, but levels are high enough to be of concern. Various sources of urban and agriculture runoff are the contributors for the high bacteria levels. Agriculture runoff does not only contribute to increased bacteria levels but also nutrient loads such as nitrogen and phosphorous. Excess nutrients can lead to algal blooms which can cause dissolved oxygen levels to drop resulting in fish kills. Population growth is also a factor. Communities among the border continue to be one of the fastest growing in the state, especially in the middle portion of the basin. As these populations increase there is a larger demand for water resources and more pressure put on local municipalities to process waste. This coupled with aging wastewater infrastructure can be a contributing factor the high bacteria levels in the Rio Grande.

Excess Water hyacinth (Eichhornia crassipes) at Rio Grande at Riverbend, Brownsville, TX.

Total dissolved solids (TDS) also continue to be an issue, specifically in the upper Rio Grande Sub-Basin and the Pecos River basin. TDS measures the combination of inorganic substances such as minerals, salts, and other ions and is often used to measure the salinity of the water. Again, this can be mainly attributed to agriculture runoff from the surrounding areas and parts of New Mexico.

Another growing parameter of concern is chlorophyll. The concern is across all the Sub-Basins. As mentioned above, agriculture runoff contributes to excess nutrients. This, coupled with record high temperatures that have been experienced in the basin for the past 5-10 years, make it perfect for algae growth. Additionally, there are concerns for dissolved oxygen. Portions of the Middle Rio Grande Sub-Basin and the Lower Sub-Basin face high populations of invasive aquatic plants. These plants, along with low flow in several segments, can be contributing factors. Low dissolved oxygen indicates oxygen depletion in the water, which can cause fish kills (among other factors). Fish kills have been reported as a concern in segments 2303 and 2305.

Recommendations

Continued routine monitoring is imperative for the health of the Rio Grande Basin. However, impaired areas necessitate a more focused approach. Many impairments and areas of concern are due to non-point source pollution, according to the TCEQ 2022 Integrated Report. In order to improve water quality in the Rio Grande Basin, the source of these nutrients and bacteria must be identified. By identifying sources of pollution, the targeted management plans can be made, and remediation done. Furthermore, collaboration between cities, towns, and municipalities to improve wastewater treatment and infrastructure will prove beneficial. Collaboration with local communities, industries, and environmental organizations to develop and implement water quality improvement plans will also be beneficial. These plans include:

- Implementing best management practices (BMPs) to reduce agriculture runoff.
- Watershed protection plans.
- Stormwater runoff management.
- More stringent environmental laws for oil and gas industries

Stakeholder participation as well as public awareness and education are also important factors. Stakeholders include ranchers and farmers, municipalities, irrigation districts, public water utilities, and non-government agencies or non-profit organizations. Educating the public and stakeholders about the importance of water quality and the impact of their activities can go a long way. Communities can also participate in restoration projects that can help to naturally improve water quality.

Overall, collaboration between every level of government, communities, and industries will be a way to move forward and address the water quality issues facing the Rio Grande Basin, not only here in the United States but in Mexico as well. Coordinated efforts to address transboundary water quality issues and promote joint initiatives for the improvement of water quality are essential. CRP will continue to gather and analyze water quality data to identify parameters with high concentrations or those that frequently exceed acceptable standards to prioritize them.

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Websites:
International Boundary and Water Commission – U.S. Section, Texas Clean Rivers Program
https://www.ibwc.gov/crp/

Texas Commission on Environmental Quality – Texas Clean Rivers Program
https://www.tceq.texas.gov/waterquality/clean-rivers

2022 Texas Integrated Report of Surface Water Quality for Clean Water Act Sections 305(b) and 303(d)
https://www.tceq.texas.gov/waterquality/assessment/22twqi/22txir