2003 Regional Assessment of Water Quality in the Rio Grande Basin

United States Section, International
Boundary and Water Commission
Texas Clean Rivers Program

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By

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and Water Commission

Authority

This study and report were undertaken by the United States Section of the International Boundary and Water Commission pursuant to the agreement with the Texas Commission on Environmental Quality under Contract Number 582-2-44870/IBM-01-27 to administer the Texas Clean Rivers Program in the Rio Grande basin.

Participating Agencies

Federal

United States Geological Survey

Big Bend National Park Service

Natural Resource Conservation Service

State

Texas Commission on Environmental Quality

Upper Pecos Soil and Water Conservation District #213

Local

The City of El Paso, Public Service Board

The City of Laredo Environmental Services Division

The City of Laredo Health Department

The City of Brownsville

The Rio Grande International Study Center

Texas A&M Experiment Station, El Paso

Texas Cooperative Extension, Fort Stockton

The University of Texas at El Paso

New Mexico State University

El Paso Community College

International

United States Section, International Boundary and Water Commission

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List of Acronyms

AWRL	Ambient Water Reporting Limit
BEAT	Border Environmental Assessment Team
BOD	Biochemical Oxygen Demand
BMP	Best Management Practice
CAFO	Concentrated Animal Feeding Operation
COC	Chain of Custody
CRP	Texas Clean Rivers Program
DO	Dissolved Oxygen
EPA	Environmental Protection Agency
EPCC	El Paso Community College
EPWU	El Paso Water Utilities
GIS	Geographic Information Systems
IBC	International Boundary Commission
IBWC	International Boundary and Water Commission, United States and Mexico
MAL	Minimum Analytical Limit
MCLs	Maximum Contaminant Levels
MSA	Monitoring Systems Audit
MxIBWC	Mexican Section, International Boundary and Water Commission
NMSU	New Mexico State University
NASQAN	National Stream Quality Accounting Network
NLIWTP	Nuevo Laredo International Wastewater Treatment Plant
NPS	National Park Service
PdNWC	Paso del Norte Watershed Council
PdR	Project del Rio
PREP	Pecos River Ecosystem Project
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RGACE	Rio Grande American Canal Extension
RGISC	Rio Grande International Studies Center
7Q2	Seven day, two year low flow
TCEQ	Texas Commission on Environmental Quality
TDH	Texas Department of Health
TDS	Total Dissolved Solids
TDWS	Texas Drinking Water Standards
TNRCC	Texas Natural Resource Conservation Commission
TMDL	Total Maximum Daily Load
TPWD	Texas Parks and Wildlife Department
TRACS	TCEQ Regulatory Activities and Compliance System
TSS	Total Suspended Solids
TSWQS	Texas Surface Water Quality Standards
USGS	United States Geological Survey
USIBWC	United States Section, International Boundary and Water Commission
UTEP	University of Texas at El Paso
WWTP	Wastewater Treatment Plant

Executive Summary

Border communities of Texas and Mexico use the Rio Grande as a source of drinking water, an irrigation tool, and for recreational use. Water from the river is used and reused by a diverse group of people that differ in needs and management strategies. Understanding of river dynamics and water quality issues is essential to those entities charged with management and preservation of the Rio Grande Basin. 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 initiated 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. At that time, no river agency existed for the Rio Grande Basin. Matters were further complicated by the fact that two countries share the river. In order to address the international nature of the watershed, the state of Texas through the Texas Commission on Environmental Quality, 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. The citizens of the basin are offered the opportunity to comment and ensure that local issues are addressed within the program.

The collection of water quality data is outlined in the Rio Grande Basin Monitoring Plan-Quality Assurance Project Plan (QAPP). This document outlines the monitoring program, how data is collected and analyzed, quality assurance and quality control criteria, and reporting requirements. The IBWC and ten partners (various federal, state and local entities) collect various field and laboratory water quality parameters at 68 stations on the Rio Grande and 12 stations on the Pecos River. Because the Rio Grande Basin is so large and encompasses a large variety of areas having differing climates, plant communities, geology, flow regimes, and environmental pressures, the basin has been divided into four sub-basins. Data collected from these sub-basins are entered 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. The database is also made available to outside interested parties for use in other projects.

The CRP has introduced many new stations and, through the USIBWC, expanded partnerships to assist in the collection of data and water quality samples throughout the basin. The CRP created a website that allows access to water quality data and monitoring station locations for anyone needing the data. Public outreach by the CRP has expanded public knowledge about the program and taken water quality and quantity preservation into the classrooms of elementary, high school, and even, college students. Research projects in the basin receive support from the CRP through advice, equipment, data, and assistance leading to important information on the effects and conditions in the basin.

For this report the CRP analyzed water quality data from the previous five years. The data was statistically examined for evidence of rising or falling trends as well as determining if water quality at each station meets minimum standards. If problems were noted, possible causes of those problems were explored and recommendations made to address the issue.

The Pecos River sub-basin extends from the Texas/New Mexico state line to the Rio Grande and contains 3 segments with a total of 12 monitoring stations. The Pecos Sub-basin data evaluation revealed concerns about salt concentrations and water quantity. 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. A project is now being implemented by Texas A&M University to eradicate salt cedar from the Pecos using herbicides. Effects of salt cedar removal on water flow and salt are currently being evaluated by various agencies involved in the project including the CRP.

The Upper Rio Grande sub-basin extends from the Texas/New Mexico state line to Amistad Reservoir and contains six segments with a total of 26 monitoring stations. Primary concerns of the 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 fecal coliform and nutrients found in some portions of this segment. Corrective actions such as installation of new WWTPs, upgraded WWTPs, and more stringent discharge regulations will help alleviate the problem. Additionally, the CRP is assisting EPCC in a project that proposes to identify specific non-point sources such as agricultural runoff that contribute to the problem. High salinity is attributed primarily to current irrigation practices. The CRP is assisting in a project head by Texas A&M University Agricultural Research Center to quantify and identify the mechanisms contributing to increased salinities.

The Middle Rio Grande sub-basin extends from Amistad Reservoir to Falcon Reservoir and includes 3 segments with a total of 23 monitoring stations. 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. Again, corrective actions such as installation of new WWTPs, upgraded WWTPs, and more stringent discharge regulations will help alleviate the problem. The CRP is participating in several special studies in conjunction with other U.S. and Mexican agencies to determine sources of contaminants and possible solutions to current problems.

The Lower Rio Grande sub-basin extends from Falcon Reservoir to the mouth of the Rio Grande. The sub-basin contains two segments with a total of 13 monitoring stations. Problems in this sub-basin also include bacteria and nutrients with the probable cause of these high contaminant loads being municipal discharges. Other problems in this sub-basin include excessive growth of aquatic weeds and low flows. Low flows have caused the mouth of the Rio Grande to become blocked with sediment at times. Texas Parks and Wildlife have been experimenting with different methods of aquatic weed control and researchers from UTEP have initiated studies to determine the cause of the blockage of the mouth of the Rio Grande.

The problems noted in the previous paragraphs lead to the following recommendations for future study. 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. In order to better understand the concerns of various stakeholders in the Basin, CRP staff has looked into "incorporating" the annual meetings with other groups in the basin in an effort to receive greater input into the program and to inform more members of the public about our efforts in the basin. CRP will continue to hold meetings within each sub-basin and strive to improve communication with basin stakeholders as well as improving communication with stakeholders outside the CRP monitoring area such as Mexico and New Mexico. In order to better track basin wide issues, the CRP should acquire water quality data from Mexico and New Mexico for assessment of the entire basin and for improved source tracking.

1.0 INTRODUCTION

The Rio Grande, like most western rivers, is at the heart of communities it supplies with water for drinking, irrigating, and fishing. It generates great emotion at all levels of thought, from the spiritualist who sees it as the Earth's mother, to the realist who only sees a conveyance channel for delivering water for the benefit of people. Somewhere in-between is the majority of the people who have come to rely on it as a drinking water supply. In no other period of history has the river been used to fulfill the needs of a population that is so diverse and populous using and re-using the water as it flows from one community to the next. Being able to understand this dynamic is at the top of everyone's list - state legislators, community leaders, federal and state agencies, environmentalists, farmers, and a growing number of people who simply want to be sure there will be water when the tap is opened.

Underlying the need for water is the quality of the water itself. Although water quality predominantly meets State of Texas water quality standards, pollution of the river continues to occur and affects all aspects of use. The Rio Grande as it flows into Texas from New Mexico exceeds the criterion established for salinity, bacteria, and secondary screening levels for nutrients.

Salinity

High salt levels in the Rio Grande limit its use for agriculture and municipal use. Increases in salinity occur as return flows with elevated dissolved salt levels from Texas and Mexico enter the Rio Grande in west Texas. Additional salt loadings are observed at the confluence with the Rio Conchos just upstream of Presidio, Texas and Ojinaga, Chihuahua. In the Pecos River, the main concern is the lack of water for agriculture. This coupled with high salt content from geologic formations limit its use. Tributaries in the Lower Pecos River and below Big Bend National Park dilute and improve the quality of the water as it enters International Amistad Reservoir. The salinity in the Middle and Lower Rio Grande currently meet the applicable surface water quality standards.

Bacteria/Nutrients

The trend of high bacterial and nutrient levels is seen throughout the border around the larger populated sister cites that continue to grow at a rapid pace. Different requirements for wastewater treatment between states and countries, nonpoint source influences such as cattle and aquatic fowl, and in some cases, untreated wastewater discharges result in high bacterial concentrations. Additionally, nutrient levels appear to increase in the same area where bacterial levels are high. The source of contamination containing both types of constituents may indicate the originating source to be a point source (wastewater). Wastewater infrastructure projects are still being developed along the border to meet the needs of communities. Additional monitoring around the infrastructure projects will produce data that can help determine the benefit to water quality from the new WWTP's.

The continuing challenge for the people and communities in this basin is finding a balance that promotes a healthier river while continuing to provide a sustainable water supply. The purpose of this report is to inform the public, the stakeholders, and other agencies on:

- the condition of the Rio Grande,
- improvements and potential water quality problems within the watershed,
- the efforts of the CRP and its partners to monitor and assess the waters of the basin, and
- potential resolutions to any negative trends within the basin.

This document is the fourth in a series of reports on water quality in the Rio Grande since the inception of the CRP. The Texas Natural Resource Conservation Commission (TNRCC) prepared the first three reports under the Border Environment Assessment Team (BEAT) in the Office of Water Resource Management. In the fall of 2002, as part of the latest legislative review of the agency, the TNRCC changed its name to the Texas Commission on Environmental Quality (TCEQ) to better represent the agency's role.

The Rio Grande in Texas serves as the border between the United States and Mexico, and divides the watershed of the Rio Grande in half. In order to address the international nature of the watershed, the state of Texas through the 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. This partnership has resulted in better coverage within the basin and additional information to better address issues along the border. The USIBWC has expanded the program to include additional partners in water quality monitoring. Specific items of concern are addressed by supporting special projects in the basin both in the United States and Mexico.

<u>History of the International Boundary and Water Commission</u>

As established by Treaties in 1848 and 1853, the international boundary between the United States and Mexico along Texas follows the center of the Rio Grande from its mouth on the Gulf of Mexico, a distance of 1,254 miles (2,019 km), to a point just upstream of El Paso, Texas and Ciudad Juárez, Chihuahua.

Although sparsely settled at the time of the 1848 and 1853 Treaties, the region rapidly developed, beginning with the coming of the railroads in the 1880s and the development of irrigated agriculture after the turn of the century. The Treaty of Guadalupe Hidalgo, February 2, 1848, established the international boundary. Temporary commissions were formed by these boundary treaties to perform the first joint mission of the Governments of the United States and Mexico, which was to survey and demarcate the boundary on the ground in accordance with the treaties. As the settlements grew along the boundary rivers and the adjoining lands began to be developed for agriculture in the late nineteenth century. Questions arose as to the location of the boundary when the rivers changed their course and transferred tracts of land from one side of the river to the other. The two Governments by the Convention of November 12, 1884 adopted certain rules designed to deal with such questions.

1889
By the Convention of March 1, 1889, the Governments of the United States and Mexico created the International Boundary Commission (IBC), to consist of a United States Section and a Mexican Section. The IBC was charged with the application of the rules of the 1884 Convention, for the settlement of questions arising as to the location of the boundary when the rivers changed their course. That Convention was modified by the Banco Convention of March 20, 1905 to retain the Rio Grande as the boundary.

1906
The Convention of May 21, 1906 provided for the distribution, between the United States and Mexico, Rio Grande water above Fort Quitman, Texas for the 89-mile (143 km) international boundary reach of the Rio Grande through the El Paso-Juárez Valley. This Convention allotted to Mexico 60,000 acre-feet annually Rio Grande water to be delivered in accordance with a monthly schedule at the head gate to Mexico's Acequia Madre just above Ciudad Juárez, Chihuahua. To facilitate such deliveries, the United States constructed, at no expense to Mexico, the Elephant Butte Dam in its territory. The Convention includes the proviso that in case of extraordinary drought or serious accident to the irrigation system in the United States, the amount of water delivered to the Mexican canal shall be diminished in the same proportion as the water delivered to lands under the irrigation system in the United States downstream of Elephant Butte Dam.

1933
In the Convention of February 1, 1933, the two Governments agreed to jointly construct, operate and maintain, through the IBC, the Rio Grande Rectification Project, which straightened and stabilized the 155-mile (249 km) river boundary through the highly developed El Paso-Juárez Valley. The project further provided for the control of the river's floods through this Valley.

1944
The Treaty of February 3, 1944 for "Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande" distributed between the two countries Rio Grande water from Fort Quitman to the Gulf of Mexico. Of the Rio Grande water, the Treaty allocates to Mexico:

- (1) All of the waters reaching the main channel of the Rio Grande from the San Juan and Alamo Rivers, including the return flows from the lands irrigated from those two rivers;
- (2) Two-thirds of the flow in the main channel of the Rio Grande from the measured Conchos, San Diego, San Rodrigo, Escondido and Salado Rivers, and the Arroyo Las Vacas, subject to certain provisions; and
- (3) One-half of all other flows occurring in the main channel of the Rio Grande downstream from Fort Quitman.

The Treaty allots to the United States:

- (1) All of the waters reaching the main channel of the Rio Grande from the Pecos and Devils Rivers, Good Enough Spring and Alamito, Terlingua, San Felipe and Pinto Creeks;

(2) One-third of the flow reaching the main channel of the river from the six named measured tributaries from Mexico and provides that this third shall not be less, as an average amount in cycles of five consecutive years, than 350,000 acre-feet annually; and

(3) One-half of all other flows occurring in the main channel of the Rio Grande downstream from Fort Quitman.

The 1944 Treaty further provided for the two Governments to jointly construct, operate and maintain on the main channel of the Rio Grande the dams required for the conservation, storage and regulation of the greatest quantity of the annual flow of the river to enable each country to make optimum use of its allotted waters.
In the 1944 Treaty, the two Governments agreed to give preferential attention to the solution of all border sanitation problems.

It changed the name of the International Boundary Commission (IBC) to the International Boundary and Water Commission (IBWC). This Treaty entrusts the IBWC with the application of its terms, the regulation and exercise of the rights and obligations which the two Governments assumed there under, and the settlement of all disputes to which its observance and execution may give rise. The Treaty also provides that the IBWC study, investigate and report to the Governments on hydroelectric facilities that should be built at the international storage dams and flood control works, other than those specified in the Treaty. These studies also estimate the cost and the parts to be built, operated, and maintained by each Government through its Section of the IBWC.

1970

The Treaty of November 23, 1970 resolved all pending boundary differences and provided for maintaining the Rio Grande as the international boundary. The Rio Grande was reestablished as the boundary throughout its 1,254-mile (2,019 km) section. The Treaty includes provisions for restoring and preserving the character of the Rio Grande as the international boundary. Provisions include restoration of lost character, to minimize channel changes, and to resolve problems of sovereignty that may arise due to future changes in the Rio Grande channel. It contains procedures designed to avoid territory loss by either country related to future changes in the river's course. This Treaty, too, charged the IBWC with carrying out its provisions.

Current IBWC Mission

The mission of the IBWC is to apply the rights and obligations, which the Governments of the United States and Mexico assume under the numerous boundary and water treaties and related agreements. The mission is carried out in a way that benefits the social and economic welfare of the peoples on both sides of the boundary and improves relations between the two countries.

As provided for in the treaties and agreements, those rights and obligations include:

- Distribution between the two countries of the waters of the Rio Grande;
- Regulation and conservation of the waters of the Rio Grande for their use by the two countries by joint construction, operation and maintenance of international

storage dams, reservoirs, and plants for generating hydroelectric energy at the dams;

- Protection of lands along the river from floods by levee and floodway projects;
- Solution of border sanitation and other border water quality problems;
- Preservation of the Rio Grande as the international boundary; and
- Demarcation of the land boundary.

History of the Clean Rivers Program

In 1991, the Texas Legislature passed the Texas Clean Rivers Act (Senate Bill 818) in response to growing concerns that water resource issues were not being pursued in an integrated, systematic manner. The TCEQ, then TNRCC, had partnered with river agencies throughout Texas to Administer the CRP in each river basin in Texas. Because there was no river authority in the Rio Grande basin, the USIBWC was approached because it was the most logical choice. The USIBWC has field offices along the border with Mexico and can coordinate projects through its counterpart in Mexico - Mexican Section, International Boundary and Water Commission (MxIBWC).

The act requires that ongoing water quality assessments be conducted for each river basin in Texas. This approach that integrates water quality and water quantity issues within a river basin, or watershed, using the watershed management approach. The Clean Rivers Program (CRP) legislation mandates that "each river authority (or local governing entity) shall submit quality-assured data collected in the river basin to the Commission (TCEQ)." "Quality assured data" in the context of the legislation, means "data that complies with the Commission rules for water quality monitoring programs, including rules governing the methods under which water samples are collected and analyzed and data from those samples are assessed and maintained."

A watershed is a geographic area in which water, sediments, and dissolved materials drain into a common outlet. The watershed management approach looks at the entire watershed for water quality issues. Using this approach, problems can be tracked at any point upstream to a source(s). This helps identify and fix water quality problems within the basin in the most efficient way. It also gives us insight into the complexity of the watershed and to see how solutions or problems in one area can affect the watershed far from the source. The state of Texas is divided into 23 river basins. The Rio Grande Basin is designated as Basin 23.

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. The citizens of the basin are offered the opportunity to comment and ensure that local issues are addressed within the program. Every year, public meetings are held to update stakeholders on the progress of current projects and to present results of water quality monitoring. Maintaining local support is critical to the CRP and its' success in addressing water quality issues.

Prior to this year, water rights and wastewater permit fees that are collected in Texas would fund the CRP. A portion of the fees collected would be returned to the basin where they originated as funding for programs like the CRP. This past year, water rights and wastewater permits, along with drinking water fees and regulatory assessment fees were consolidated into one fund within the TCEQ's Water Resource Management Account.

Data collection and analysis

Since the Rio Grande Basin is so large, the basin is divided into four sub-basins; Upper, Middle, Lower, and Pecos. Each sub-basin contains segments created by TCEQ. The CRP monitors the basin at 68 stations along the Rio Grande and 12 stations along the Pecos River. Since the basin is so long, we receive help in the collection of samples throughout the basin by partnering agencies. Sample collectors record field observations/measurements (weather, flow, pH, temperature, conductivity, and dissolved oxygen) and collect water chemistry samples. The water samples are then sent to a contract lab for chemical analysis, while sample collectors perform bacteriological analysis.

After the sample collectors and the contract lab do the analyses/measurements, all of the data is sent to the CRP for entry into the IBWC/CRP database. The database information is used by the CRP in assessment of the water quality at Rio Grande monitoring stations. Data is also posted on the webpage for public access.

The collection of water quality data is outlined in the Rio Grande Basin Monitoring Plan-Quality Assurance Project Plan (QAPP). This document outlines the monitoring program, how data is collected and analyzed, quality assurance/quality control (QA/QC), and reporting requirements. Prior to collecting any samples, the USIBWC, TCEQ, and its CRP partners must agree to follow the protocols established in the QAPP. CRP partners are provided the equipment and training to perform the fieldwork. From the time samples are collected to the actual reporting, the samples and data must meet specific criteria in order to be considered valid, quality assured data. Once the data has been verified, the data is included in the database that will be used by the CRP and TCEQ to report on water quality.

Parameters

The parameters in this report were selected to present information on constituents that can affect water quality, limit the intended uses of the water, or harm the aquatic life. A brief explanation of the parameters analyzed include:

- **Acute Toxicity** - The ability of a substance to cause poisonous effects to test organisms resulting in biological harm or death after a single exposure or dose.
- **Alkalinity** - A measure of the acid-neutralizing capacity of water. Bicarbonate, carbonate and hydroxide are the primary forms of alkalinity in natural waters. The presence of borates, phosphates, and silicates may increase the concentration of alkalinity.
- **Ammonia Nitrogen** - Naturally occurring in surface and wastewaters, it is produced by the breakdown of compounds containing organic nitrogen. High levels can be lethal to certain fish species.
- **Biochemical Oxygen Demand (BOD)-** A measure of the amount of oxygen consumed in the biological processes that break down organic matter in water.

High BOD levels are an indicator of increased pollution in the water, which may result in decreased oxygen levels in the receiving stream.

- **Chloride** - One of the major inorganic ions in water and wastewater. Industrial and agricultural processes can increase concentrations. High levels can affect plant growth and the use of the water for agricultural or municipal purposes.
- **Chlorophyll-*a*** - Photosynthetic pigment that is found in all green plants. The concentration of chlorophyll-*a* is used to estimate phytoplankton biomass in surface water.
- **Conductivity** - Dissolved substances in water dissociate into ions with the ability to conduct electrical current. Conductivity is a measure of how salty the water is; salty water has high conductivity.
- **Dissolved Oxygen (DO)** - The oxygen freely available in water. Dissolved oxygen is vital to fish and other aquatic life and for the prevention of odors.
- **Fecal coliform/*Escherichia coli (E. coli)*** - Bacteria found in the intestinal tracts of warm-blooded animals. These organisms are used as indicators of pollution and possible presence of waterborne pathogens.
- **Nitrate-Nitrogen** - A compound containing nitrogen that can exist as a dissolved solid in water. Excessive amounts can have harmful effects on humans and animals.
- **Organic Compounds (Volatile and Semi-volatile)** - Compounds used in industry (commercial or agricultural). When present in water they could potentially affect aquatic life and human health.
- **Orthophosphate as Phosphorus** - Nearly all phosphorus exists in water in the phosphate form. Orthophosphate can be directly utilized by plants and organisms, is usually the least abundant nutrient, and is commonly the limiting factor. Excessive amounts of phosphorus can contribute to the eutrophication (growth of aquatic vegetation because of excess nutrients resulting in depressed DO levels) of lakes and rivers.
- **pH** - The hydrogen ion activity of water caused by the breakdown of water molecules and presence of dissolved acids and bases.
- **Sulfate**- Sulfate is derived from rocks and soils containing gypsum, iron sulfides and other sulfur compounds. Industrial discharges may contain high levels of sulfate and can affect conveyance systems, under anaerobic conditions, due to bacterial activity that converts sulfate to hydrogen sulfide, subsequently forming sulfuric acid.
- **Total Dissolved Solids** - The amount of material (inorganic salts and small amounts of organic material) dissolved in water. High TDS concentrations can limit the use of water for agriculture, drinking water, and industrial use.
- **Total Hardness** - The sum of the calcium and magnesium concentrations, expressed as calcium carbonate in mg/L.
- **Total Organic Carbon** - Method used to determine the amount of organic carbon present in water and wastewater.
- **Total Phosphorus** - Phosphorus is found in surface water and waste streams almost exclusively in the form of phosphates ($T\text{-}PO_4$). It is found in solution, particulates, detritus, or in living aquatic organisms. Other sources of phosphates include decomposition of organic material and erosion of rock.

- **Total Suspended Solids** - A measure of the total suspended particles in water, both organic and inorganic.
- **Trace Elements (Metals)** - Metals occur naturally in the watershed and may increase when used for anthropogenic processes. High levels can result in bioaccumulation within aquatic species causing short or long-term effects and may pose health concern issues with regards to fish consumption, agriculture, or public water supply.
- **7Q2** - The 7Q2 (low flow) is defined as the seven-day, two-year low flow. The lowest average stream flow for seven consecutive days with a recurrence interval of two years, as statistically determined from historical data. For perennial freshwater streams, the only parameters that are applicable below 7Q2 are chloride, sulfate, TDS, acute toxics, and toxicity.

Validating Water Quality Data

The QAPP is an integrated, comprehensive surface water quality monitoring program for the international reach of the Rio Grande that achieves multiple water quality monitoring objectives. The overall goal is to provide valid water quality data that can be used to assess water quality in the Rio Grande. Each monitoring station consists of routine monitoring and special studies in the Rio Grande basin and is a coordinated effort by several entities participating in the CRP.

Samples are collected according to the procedures outlined in the TCEQ Surface Water Quality Monitoring (SWQM) Procedures. Personnel participating in the Rio Grande are trained using this guidance. Proper sample collection requires knowledge of proper sampling and preservation techniques, container specifications, and documentation. Each CRP partner is evaluated annually on field sampling techniques, known as a Monitoring Systems Audit (MSA) to ensure that proper sampling technique and instrument use are being applied.

Field personnel submit field data sheets that contain site information and water quality data that were collected in the field. The field data form is sent to the CRP staff to be included in the water quality database. Samples are shipped to the laboratory for analysis accompanied by a chain of custody form (COC). The COC is used to document sample handling during transfer from the field to the laboratory and among contractors.

Samples that are submitted to the laboratory are analyzed according to the methods specified in the QAPP. The QA/QC requirements in Tables 1-3 list the criteria that must be met in order for data to be considered valid. Each method describes how the sample will be handled prior to and during the analysis. Samples must also be analyzed within a specified time to be considered valid. The method must be sensitive enough to be reported at the Ambient Water Reporting Limit (AWRL) established by the TCEQ that replaced the Minimum Analytical Limit (MAL) during this past year. Changes were made to the reporting limits because of improved laboratory methods available and improved accuracy at lower levels. The laboratory QA/QC program must meet or exceed the criteria and must adhere to the requirements specified in the QAPP prior to analyzing samples in the Rio Grande Basin.

CRP staff review field data sheets, COCs, and laboratory reports to verify that all criteria from the time of sample collection up to the report generation have been completed and meet the requirements specified in the QAPP. Data that does not meet these criteria will not be reported in the dataset but will be archived with an explanation as to why the data did not meet QA/QC requirements. Data that has been verified will be entered into the Rio Grande CRP database and undergo a final check for errors in the dataset. The database checks the data for values below the AWRL, incorrect station numbers, incorrect parameter codes, and for data that is outside the normal range for a given parameter. TCEQ field offices in the Rio Grande basin submit the data collected directly to TCEQ in Austin and fall under the reporting requirements of the TCEQ statewide SWQM QAPP. All data collected by the CRP and TCEQ field offices is stored in the TCEQ Regulatory Activities and Compliance System (TRACS). This is a statewide database. TCEQ then analyzes the data for all of the above stated requirements prior to inclusion of the data into their database. When all data have passed the many checks, it is used in producing the many assessments done on the basin.

Partners

Monitoring efforts in such a large basin would not be possible by a single entity. The Rio Grande Basin CRP receives huge support from many other agencies, offices, and institutions in its efforts to monitor the Rio Grande Basin. This support comes in the form of sample collection, visual inspection of sites, recommendations about problems or special areas of concern, recommendations for new sites, and assistance with special studies. Below is a list of our partners and the support they provide.

Big Bend National Park National Park Service – Collect samples at two sites along the Rio Grande in the Big Bend National Park area. This part of the river is a popular area for rafting and wading. Park personnel collect water quality samples to insure this information is available for people who plan on being in the water.

Upper Pecos Soil and Water Conservation District (UPSWCD) #213 – Through the Natural Resources Conservation Service (NRCS), samples are collected at two sites along the upper portion of the Pecos River. The UPSWCD, through Mr. Larry Fernandes, has supported the CRP for the past four years providing personnel to collect samples and collect field data.

City of Brownsville – The Environmental Services division of the City of Brownsville participates in the CRP. Mr. Joe Hinojosa has been a CRP committee member for over four years.

City of Laredo– The City of Laredo’s Environmental Services Division (ESD) provides support in the Laredo/Nuevo Laredo reach of the Rio Grande. Collects water samples at two sites in the Middle Rio Grande in Laredo. The ESD provides support to the CRP by

- Collecting water quality samples,
- Hosting public meetings,
- Hosting CRP partner meetings, and

- Providing local expertise in addressing water quality issues.

City of Laredo Health Department – Collect bacteria data at eight sites around the City of Laredo. The health department provides field and laboratory support to the CRP on a monthly basis.

Texas Cooperative Extension (Fort Stockton) – The CRP has provided support for special studies and receives recommendations and information about conditions along the Pecos River

Rio Grande International Study Center - Collect water samples in the Middle Rio Grande around Laredo at seven sites.

University of Texas at El Paso - Collect water samples at two sites in the Upper Rio Grande below El Paso.

El Paso Community College – Assists in water sample collection at four sites in the Upper Rio Grande in El Paso. The CRP has provided the EPCC assistance in the collection of water samples for special studies and research in the El Paso area.

El Paso Water Utilities – Analysis of water samples collected in the Upper Rio Grande in the El Paso area.

USIBWC American Dam Office – Collect water samples at five sites in the Upper Rio Grande around El Paso.

USIBWC Amistad Office – Collect water samples at four sites along the Upper Rio Grande near Del Rio.

USIBWC Falcon Dam Office – Collect water samples at three sites along the Middle Rio Grande.

USIBWC Mercedes Field Office – Collect water samples at five sites in the Lower Rio Grande around Anzalduas Dam and at one site in a Mexican drain.

USIBWC Presidio Field Office – Collect water samples at four sites in the Upper Rio Grande around Presidio.

<u>USGS NASQAN</u>

United States Geological Survey (USGS)- National Stream Quality Accounting Network (NASQAN)

The USGS has monitored the water quality in the Rio Grande Basin as part of the redesigned NASQAN since 1995. The NASQAN program was designed to characterize the concentrations and transport of sediment and selected chemical constituents found in the nation's large rivers- including the Mississippi, Colorado, and Columbia in addition to the Rio Grande. In these four basins, the USGS operates a network of 40 NASQAN sites, with an emphasis on quantifying the mass flux for each constituent (the amount of material moving past the site, expressed in tons per day).

By applying a consistent flux-based approach in the Rio Grande Basin, the NASQAN program is generating the information needed to identify regional sources for a variety of constituents, including agricultural chemicals and trace elements, in the basin. The effect of the large reservoirs on the Rio Grande can be observed as constituent fluxes are routed downstream. The analysis of constituent fluxes on a basin-wide scale will provide the means to assess the influence of human activity on water-quality conditions in the Rio Grande.

Eight NASQAN sampling sites were selected in the basin to monitor the fluxes from sub basins. Sites were located specifically to measure inflow and outflow of material from the two main-stem reservoirs (Amistad International and Falcon International) that strongly affect the flux of chemical constituents and sediment in the Rio Grande. Land use in the sub basins is dominated by rangeland, with forest, agricultural, and urban areas constituting the remainder. Each of these sites is located within the Texas portion of the Rio Grande.

- **Rio Grande at El Paso**- reflects drainage of the entire Rio Grande main stem in Colorado and New Mexico. The site at El Paso is 125 river miles downstream of Elephant Butte Reservoir in New Mexico and 1.7 miles upstream of the American Dam at El Paso. This site is administered under the USGS National Water Quality Assessment (NAWQA) program, which involves intensive water-quality studies focusing on the effect of land use on water quality. The Upper Rio Grande NAWQA, with its study of cause and effect relations between land use and water quality within a part of the larger regional NASQAN setting, exemplifies the complementary nature of the NASQAN and NAWQA programs.
- **Rio Grande at Foster Ranch near Langtry**- is approximately 600 miles downstream of El Paso and 300 miles downstream of the confluence of the Rio Grande and Rio Conchos. Because much of the water reaching El Paso is diverted, stream flow at Foster Ranch is largely from tributaries below the Rio Conchos and this, along with the Pecos River station, provides data to describe the flux of constituents and sediment into Amistad International Reservoir.
- **Pecos River near Langtry**- is on the Pecos River approximately 15 miles upstream of its confluence with the Rio Grande. The Pecos River is the major tributary to the Rio Grande within the United States.
- **Rio Grande below Amistad Dam near Del Rio**- has a mean residence time of about 1.6 years, which allows for numerous chemical, physical, and biological processes to alter the quality of the inflowing water. These processes include deposition of sediment, evaporative concentration of solutes, and biological removal of nutrients. This site provides data on the outflow from the reservoir, which can be compared to data on the inflow to assess the effect of retention and transformation of material within the reservoir.
- **Rio Grande below Laredo**- about 37 percent of the water that discharges from the Rio Grande basin enters the river between the Amistad International Reservoir and Laredo. This reach also has large centers of population and industry that

could affect water quality. This site provides data to account for the inflow of chemical constituents and sediment from this major sub-basin to the Rio Grande and to describe the quality of inflow to Falcon International Reservoir.

- **Rio Grande below Falcon Dam-** is 2.5 miles downstream of Falcon Dam. The Rio Salado in Mexico, which joins the Rio Grande at the upstream end of Falcon international Reservoir, is the major tributary to this reach. This site provides data on the retention and transformation of materials transported into Falcon International Reservoir.
- **Arroyo Colorado at Harlingen and Rio Grande near Brownsville-** reflect the total outflow of the Rio Grande to the Laguna Madre and the Gulf of Mexico. These sites reflect runoff from the principal agricultural area in the Rio Grande Basin.

Constituents measured as a part of the NASQAN program include major nutrients and carbon, suspended and dissolved trace elements such as copper, lead, and zinc, many common water-soluble pesticides such as atrazine and metalochlor, and suspended sediment. Frequency of sampling ranges from 6 to 10 times per year depending on local site characteristics. The sampling strategy is to assess water-quality conditions throughout the range of flows, with an emphasis on high flows. The strategy will be adjusted as the program progresses in an iterative process as more is learned about patterns of concentrations and fluxes throughout the basin.

For the past four years, the USGS NASQAN program has collaborated with the Texas Clean Rivers Program. Through Ms. Rebecca Lambert, USGS NASQAN staff has participated in coordinated monitoring meetings (to reduce duplication in sampling plans) and provides water quality data to the TCEQ. Additional projects have been contemplated to address water quality issues in the Rio Grande basin. The concentration of metals in the Big Bend area from historic mining is being addressed through a cooperative effort being led by the USGS in cooperation with the CRP and the TCEQ.

Data from the Rio Grande NASQAN are published annually in the USGS water resources data for Texas reports. Additionally, data can be obtained electronically via the Internet at:

http://water.usgs.gov/public/nasqan

2.0 PUBLIC INVOLVEMENT

Public involvement comes in many different forms for the CRP. CRP staff attends various meetings organized by interest groups in the Rio Grande Basin to hear what issues they think need attention. Presentations at these meetings serve to inform these groups of the goals and efforts in the basin. It is important for CRP staff to "network" with other groups to ensure that water quality data is readily available for the Rio Grande in Texas and to eliminate duplication of efforts. We hope to provide additional data with the help of agencies located in New Mexico to cover more of the river. A more comprehensive assessment will not be possible until the program is expanded to include Mexican agencies as part of the working group.

Support is also provided to academia and other agency 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 goal within the CRP is to maximize the level of effort within the basin by leveraging grant funds with CRP dollars. CRP has assisted other agencies and groups who have received grants to do research in the Rio Grande by providing support either through additional field personnel, lab support, or project coordination with Mexico.

Basin Advisory Committee

One of the ways that we communicate with our stakeholders is through the Basin Advisory Committees. Members of this committee include public and special interest groups within the sub-basins concerned with the protection of the water resources. Basin Advisory Committee meetings are held once a year to discuss what issues the CRP has been involved in and areas of concern within the basin. The meeting gives the committee a chance to inform us about areas of concern that they would like to see the CRP address. Also at the meeting, we provide a forum for the presentation of research progress and findings within the basin conducted by the CRP and our partners.

Adopt A River Campaign

The USIBWC began a program three years ago in the greater El Paso area to encourage citizens to adopt a section of the river to periodically beautify by removing trash and debris from the banks. To date, this program has brought in ten adoptions from community organizations and businesses.

Binational Water Festival

For the past three years, the CRP has participated in the Binational Water Festival organized by WERC. This program brings together many agencies in the water and environmental conservation fields to educate school age children in Las Cruces, New Mexico, El Paso, Texas, and Ciudad Juarez, Chihuahua, Mexico about the importance of preserving our environment and our water.

Mission Possible

Mission Possible is an annual conference that brings together individuals, organizations, and businesses to recognize the importance of environmental action in the Upper Rio

Grande. Through a series of talks and panel discussions, participants have the opportunity to discuss pressing issues that face the community. The CRP participates by giving a presentation on current efforts and issues in the sub-basin and by participating in a question and answer panel to address concerns from the community and to receive input as well.

The Mission Possible conference is organized by Environmental Defense, The League of Woman Voters and other organizations in the El Paso area. In 2001, the CRP received an award at the Mission Possible conference for its efforts in environmental protection and awareness in the Rio Grande basin.

<u>Paso del Norte Watershed Council</u>
The Paso del Norte Watershed Council (PdNWC) is a diverse, multi-agency, group comprised of individuals who represent federal, state, and local interests in the southern New Mexico - West Texas region. The PdNWC is a sub-group of the New Mexico-Texas (NM-TX) Water Commission. The NM-TX Water Commission consists of representatives from both states with the goal of achieving sustainable water supplies through regional water planning. The NM-TX Commission saw the need for a committee that could address environmental concerns with regard to water related projects in the region. The PdNWC will explore and develop ways that the river and habitat can be improved during future projects. For any project that is proposed in the region under the El Paso – Las Cruces Sustainable Water Project through the NM - TX Water Commission, 2% of the project funds are set aside for environmental enhancements. The PdNWC is envisioning leveraging those funds with grant monies to maximize the environmental effort and restore some of the lost ecosystem in the Rio Grande. The CRP has been participating in the PdNWC since its formation and will provide water quality data in support of this group.

Another aspect of the PdNWC that the CRP will assist in involves using Geographic Information Systems (GIS) software to map land use in the region. Maps that identify land use, hydrology, and other "layers" provide invaluable information that can be used by various groups for their own research.

<u>Volunteer Monitoring- Project Del Rio (PdR)</u>
Project del Rio is a bilingual environmental education program working with secondary students and teachers in the Rio Grande watershed. Project del Rio's goal is to develop in students the skill and motivation to become effective citizens in their communities. PdR uses the analysis of water quality and involvement in community projects in the Rio Grande as a springboard for students to develop these lifelong skills.

PdR has developed a variety of resources including field manuals, quality assurance guidelines, cross-cultural activities, interdisciplinary guidelines, action taking and community problem-solving handbooks, and a sustainable development curriculum for the border. Each year, for the past eleven years, PdR has worked with over 2,000 students in over 60 schools in the United States and Mexico along 1,900 miles (3,000km) of the Rio Grande (Figure 1). Twenty-six schools are located in Mexico, twenty-four in Texas and the balance in New Mexico and Colorado. PdR has hosted over 30 teacher workshops and Student Congresses, coordinated 16 watershed-wide monitoring days, and reached over 20,000 students.

Figure 1. Project del Rio in Action.

PdR has a commitment to the citizens in the Rio Grande watershed. Their approaches are pragmatic, long-term and community-based. Culturally, they want to nurture a sensitivity and openness about the way people live, the choices they make, and the opportunities for sharing, learning and working together. And socially, they want to instill in students that they are both valued by society and have a responsibility to society.

CRP staff assists PdR, through project directors Ms. Lisa LaRoque (United States) and Ms. Alma Galvan (Mexico), by providing information collected through the CRP to help the students analyze and interpret the information they collect on their projects.

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 USIBWC 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 USIBWC work.

El Paso Community College (EPCC)

The CRP has been working with EPCC for the last three years, assisting them in conducting research in the Rio Grande. Through Dr. Maria Alvarez, the CRP, and EPCC have helped each other attain prospective goals, mainly addressing water quality issues in the El Paso/Ciudad Juárez region. One goal of EPCC has been to develop and test more effective methods to conduct water quality studies. A second goal is to use these methods in a pilot study to examine the toxicity and pathogen distribution in surface and groundwater in the border region.

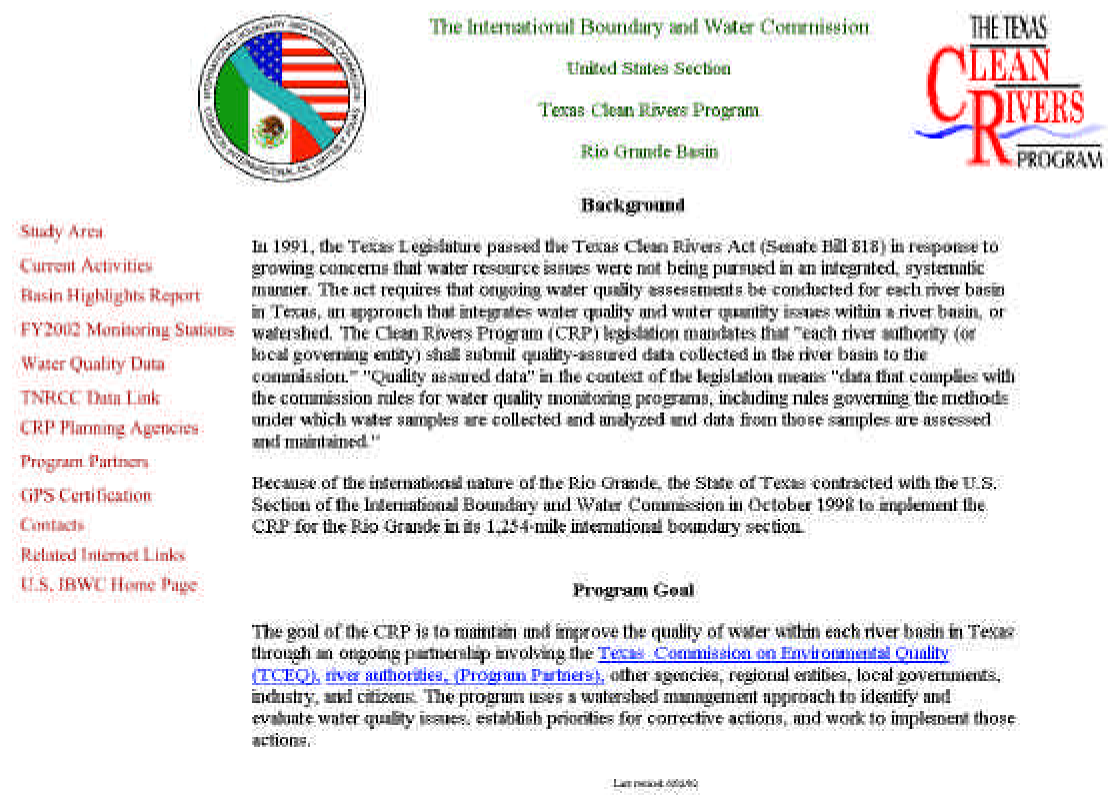
During the first funding period, baseline data was collected for total and fecal coliform, presence or absence of *H. pylori* using two assays, and chemical toxicity using a novel assay developed by New Mexico State University (NMSU). During the second funding period, the study was expanded to include testing for enteroviruses and *Cryptosporidium* to have representative organisms from all major pathogen groups. In addition, chemical parameters that may contribute to chemical toxicity of the water were also determined. Results of the work conducted by the EPCC and its partners are described under special studies in the Upper Rio Grande section.

Rio Grande Basin Clean Rivers Program Website

The CRP website makes available information on our water quality data (Figure 2). The address for our website is:
www.ibwc.state.gov/CRP/Welcome.htm

The study area page presents a graphic illustration of the region of the state monitored, locations of monitoring sites, major cities, roads and major water bodies.
The water quality data page contains a list of monitoring sites within the basin (Figure 3). A Microsoft Excel file containing available water quality data for that site can be obtained by clicking on a Station ID. At the top of this page is a link to the monitoring frequency and parameters for the current year.

The CRP Planning Agencies page and the Program Partners page contain links to other agencies collecting water quality data in the state and to agencies assisting in Rio Grande water quality monitoring efforts. Many of these web sites also contain water quality data.


The International Boundary and Water Commission

United States Section

Texas Clean Rivers Program

Rio Grande Basin

THE TEXAS CLEAN RIVERS PROGRAM

Study Area
Current Activities
Basin Highlights Report
FY2002 Monitoring Stations
Water Quality Data
TNRCC Data Link
CRP Planning Agencies
Program Partners
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Contacts
Related Internet Links
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Background

In 1991, the Texas Legislature passed the Texas Clean Rivers Act (Senate Bill 818) in response to growing concerns that water resource issues were not being pursued in an integrated, systematic manner. The act requires that ongoing water quality assessments be conducted for each river basin in Texas, an approach that integrates water quality and water quantity issues within a river basin, or watershed. The Clean Rivers Program (CRP) legislation mandates that "each river authority (or local governing entity) shall submit quality-assured data collected in the river basin to the commission." "Quality assured data" in the context of the legislation means "data that complies with the commission rules for water quality monitoring programs, including rules governing the methods under which water samples are collected and analyzed and data from those samples are assessed and maintained."

Because of the international nature of the Rio Grande, the State of Texas contracted with the U.S. Section of the International Boundary and Water Commission in October 1998 to implement the CRP for the Rio Grande in its 1,254-mile international boundary section.

Program Goal

The goal of the CRP is to maintain and improve the quality of water within each river basin in Texas through an ongoing partnership involving the Texas Commission on Environmental Quality (TCEQ), river authorities, (Program Partners), other agencies, regional entities, local governments, industry, and citizens. The program uses a watershed management approach to identify and evaluate water quality issues, establish priorities for corrective actions, and work to implement those actions.

Figure 2. Rio Grande Basin Clean Rivers Program Website.

Monitoring Stations for the Rio Grande Basin

Below is a list by segment of the FY2003 monitoring stations. For a more detailed list of the monitoring stations and a schedule of parameters tested and frequency click HERE

For a PDF file describing the monitoring parameters, click here

Click on station ID number to download an Excel format file that contains all of the available water quality data for that station from 1995 to present.

Segment 2301 - Rio Grande Tidal

Station ID	Station Description
13176	Rio Grande Tidal at State Highway 2 near Boca Chica

Segment 2302 - Rio Grande below Falcon Reservoir

Station ID	Station Description
10249	Rio Grande 6.3 km downstream from San Benito pumping plant
13103	Arroyo Los Olmos Bridge on US 83 south of Rio Grande City
13177	Rio Grande below El Jardin at Brownsville
13179	Rio Grande near River Bend boat ramp, west of Brownsville
13181	Rio Grande at International Bridge
13184	Rio Grande at SH 886 near Los Ebanos
13185	Rio Grande at Fort Ringhold, 1 mi downstream of Rio Grande City
13186	Rio Grande below Rio Alamo near Fronton
13187	Rio Grande 2.5 mi below Falcon Dam at diversion structure

Figure 3. Monitoring Stations Webpage.

Table 1 Rio Grande Basin Clean Rivers Staff

Staff – Title	Phone Number	E-mail address
Sylvia Waggoner - Division Engineer	(915) 832-4740	sylviawaggoner@ibwc.state.gov
Gilbert Anaya - Environmental Protection Specialist	(915) 832-4702	gilbertanaya@ibwc.state.gov
Wayne Belzer - Environmental Protection Specialist	(915) 832-4703	waynebelzer@ibwc.state.gov
Ryan Nelson - Environmental Protection Assistant	(915) 832-4771	renelson@ibwc.state.gov
Christy Castillo - Administrative Assistant	(915) 832-4168	christycastillo@ibwc.state.gov

3.0 Basin Overview

The Rio Grande Basin drains an area of over 330,000 square miles (800,000square km) in Colorado, New Mexico, and Texas in the United States and Chihuahua, Durango, Coahuila, Nuevo Leon, and Tamaulipas in Mexico. It forms the international boundary between the United States and Mexico along the last 1,254 miles (2,018km) of its journey from the Colorado Rockies to the Gulf of Mexico. The Pecos and Devils River, as well as many minor tributaries, in the United States are also contained within the watershed as they drain into the Rio Grande. In Mexico, the Rio Conchos and numerous other tributaries drain into the Rio Grande. The Texas CRP monitors and assesses the portion of the Rio Grande Basin from the point it enters Texas at El Paso to its end at the Gulf of Mexico.

The climate in the region is arid in the west to semi-arid near the coast. Annual rainfalls range from 9 inches (22.8 cm) per year in El Paso to 27 inches (68.6 cm) in Brownsville. Humidity in the western part of the basin is very low resulting in high evaporation rates.

Population in the basin has doubled in the last 20 years with the majority of the population along the Rio Grande situated in sister cities lying adjacent to each other. The El Paso – Ciudad Juárez area boasts the largest population with over 600,000 in El Paso and about 1.2 million in Juárez. Projections on population in this area for the year 2025 are over three million people. Other sister cities along the Rio Grande border are listed in Table 2.

Table 2. U.S. and Mexico Sister Cities.

U.S. City	Population	Mexico City	Population	Total Population
Presidio	5,000	Ojinaga	23,000	28,000
Del Rio	34,000	Ciudad Acuña	82,000	116,000
Eagle Pass	22,400	Piedras Negras	117,000	139,400
Laredo	177,000	Nuevo Laredo	275,000	452,000
McAllen	106,000	Reynosa	337,000	443,000
Brownsville	140,000	Matamoros	364,000	504,000

Many other smaller communities also share resources along the Rio Grande border.

Drinking water supplies in the basin are a combination of groundwater resources and Rio Grande water from El Paso to Del Rio. Below that point, groundwater becomes too brackish to use for drinking water forcing communities along the border to depend entirely on surface water. However, groundwater resources in far west Texas are being depleted at a rapid rate. Current projections by the USGS and the El Paso Water Utilities (EPWU) show that potable groundwater resources from the Hueco Bolson will be depleted by 2025.

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 (2,020 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 in divided into four sub-basins. 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; 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; the Middle Rio Grande sub-basin runs from a point just below International Amistad Dam to International Falcon Dam in Starr County; the Lower Rio Grande sub-basin runs from a point just below International Falcon Dam to the confluence with the Gulf of Mexico.

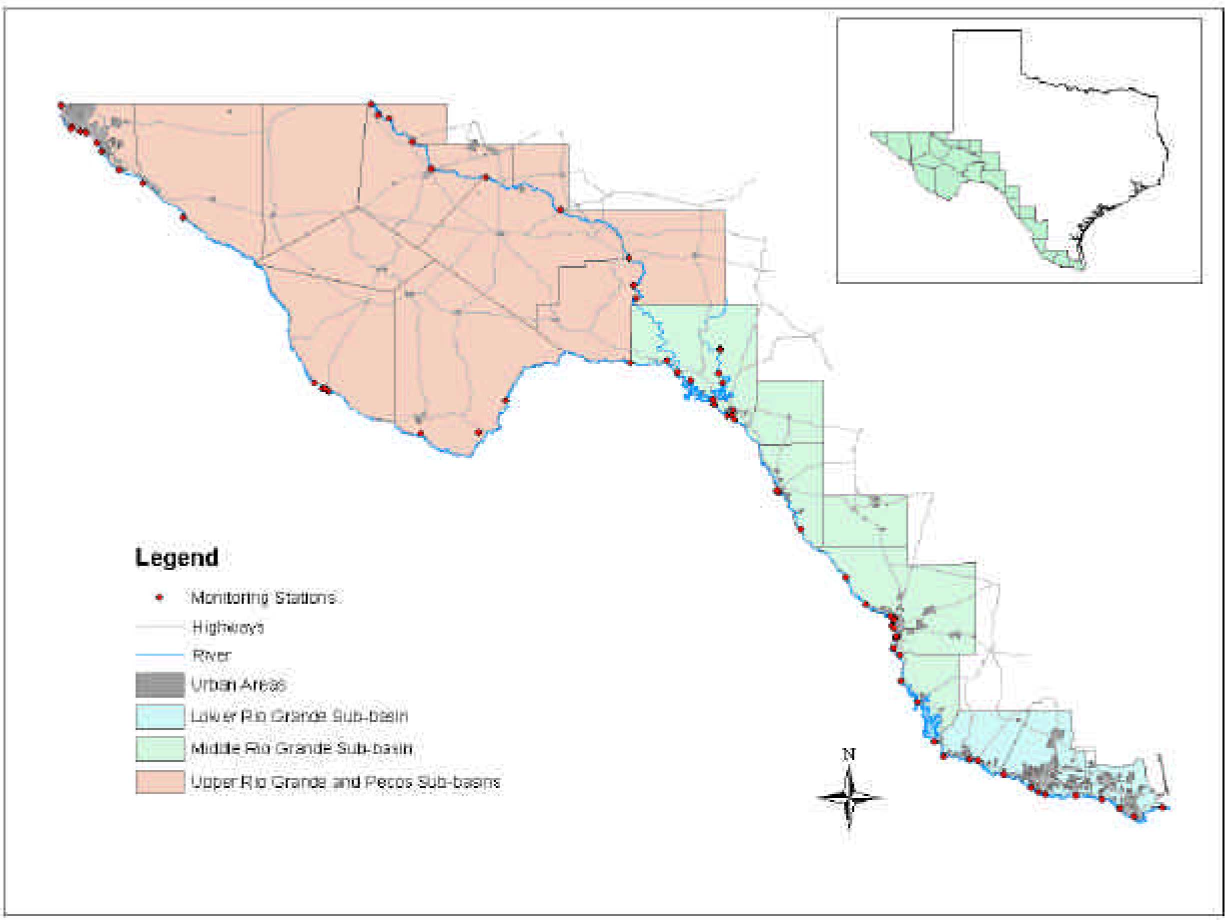

Figure 4. Rio Grande Basin.

<u>Watershed Characteristics</u>
The ecoregions listed below are based on the TPWD classifications from their website (Figure 5). 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 top most portion of the Middle Rio Grande sub-basin lies in the Edwards plateau eco-region 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.

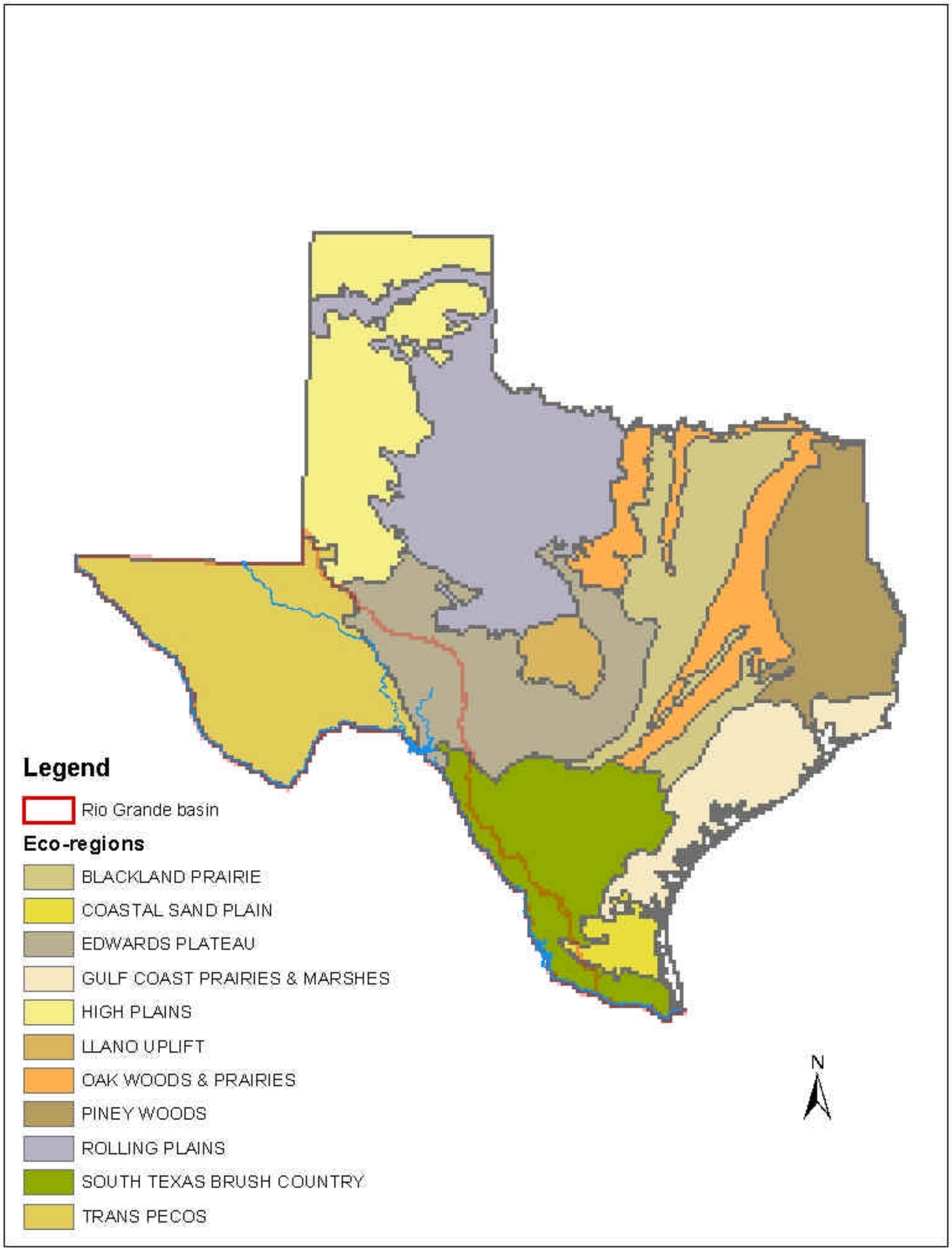

Figure 5. Texas Ecoregions.

Topography

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 the 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 tuning 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 Lower 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, forms an arm of International Amistad Reservoir,
- San Felipe Creek in the Middle Rio Grande sub-basin in Del Rio, Texas,
- the Rio Salado below Laredo, Texas, and,
- the Rio San Juan above McAllen, Texas.

There are many other smaller tributaries that also contribute to the Rio Grande Basin from the United States and Mexico.

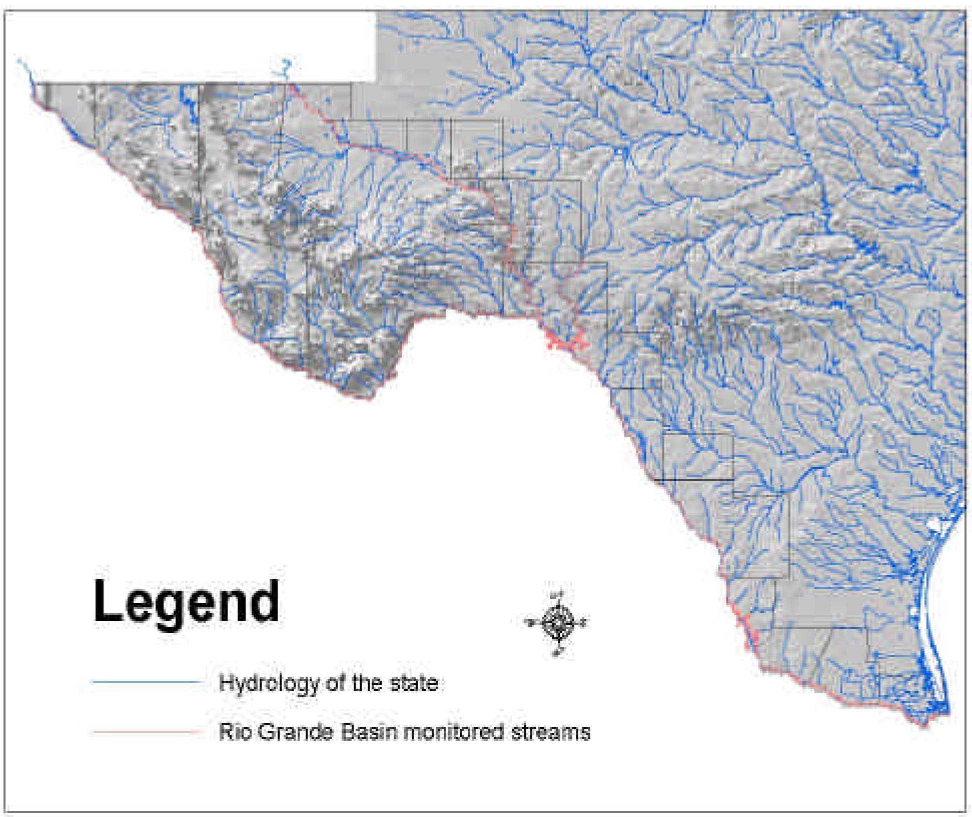

Figure 6. Rio Grande Hydrology.

Soils

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. 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. In the Middle Rio Grande sub-basin, the soils are primarily clay and loam mixed with gravels. In the Lower Rio Grande sub-basin, soils are primarily silts and clays laid down by 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.

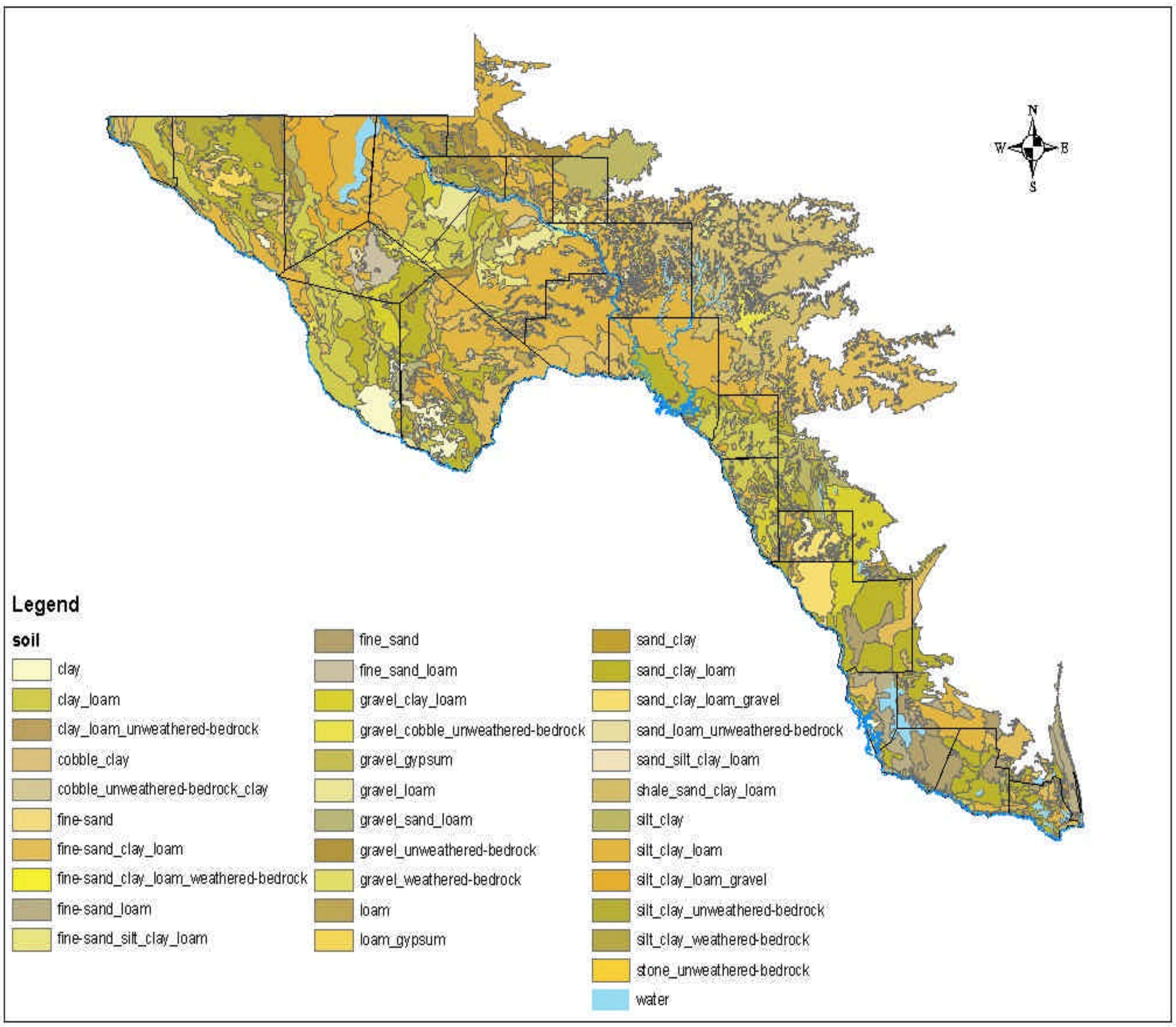

Figure 7. Rio Grande Basin Soils.

Vegetation

Vegetation in the Pecos River sub-basin consists of desert grasses, mesquite, sage, and creosote. Along the banks of the Pecos River, invasive saltcedar bushes have taken over as the dominant species. 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. The Middle Rio Grande sub-basin vegetation is primarily cropland near the river and blackgrass and mesquite away from the river. The Lower Rio Grande sub-basin vegetation below Falcon Reservoir is also 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.

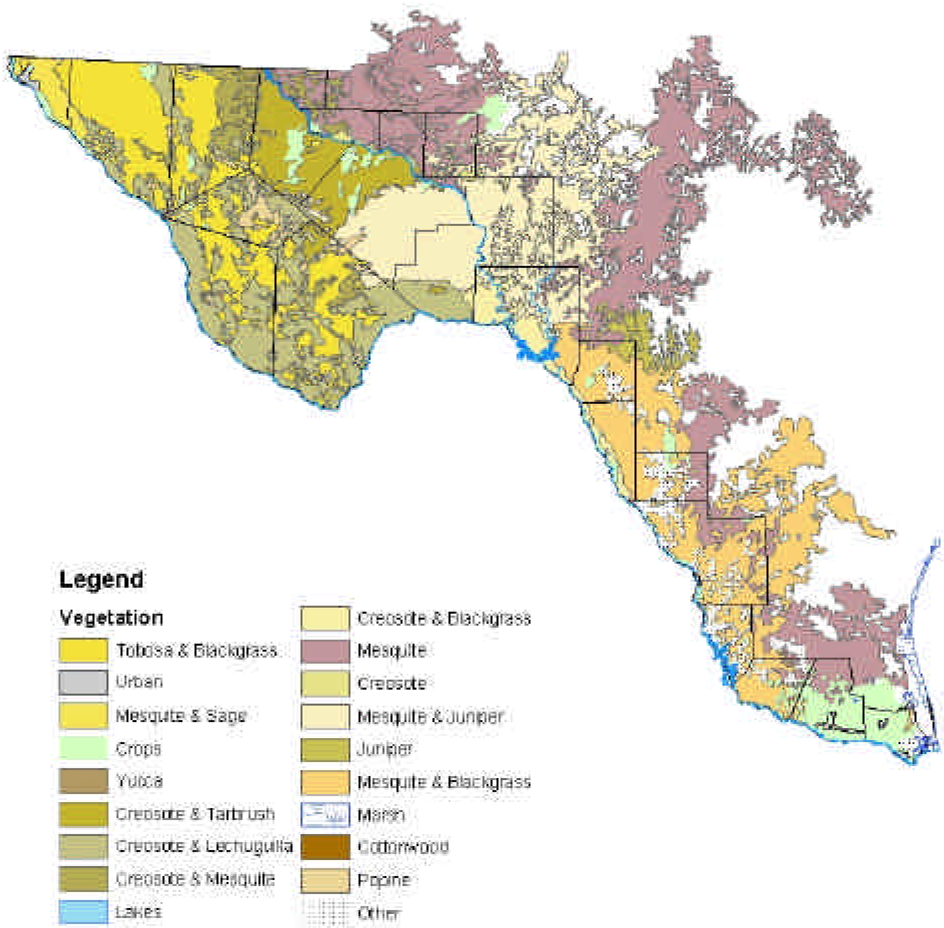

Figure 8. Rio Grande Basin Vegetation.

Rainfall

The Rio Grande Basin receives very little rainfall compared to other basins in Texas. The Rio Grande relies on snow pack 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. Over the past ten years, drought conditions (below average rainfall and snow pack) have affected the Rio Grande Basin. The Pecos River and the Upper Rio Grande sub-basins are primarily arid, desert environments with very little rainfall and 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 the majority of the rainfall flows out into the Gulf of Mexico.

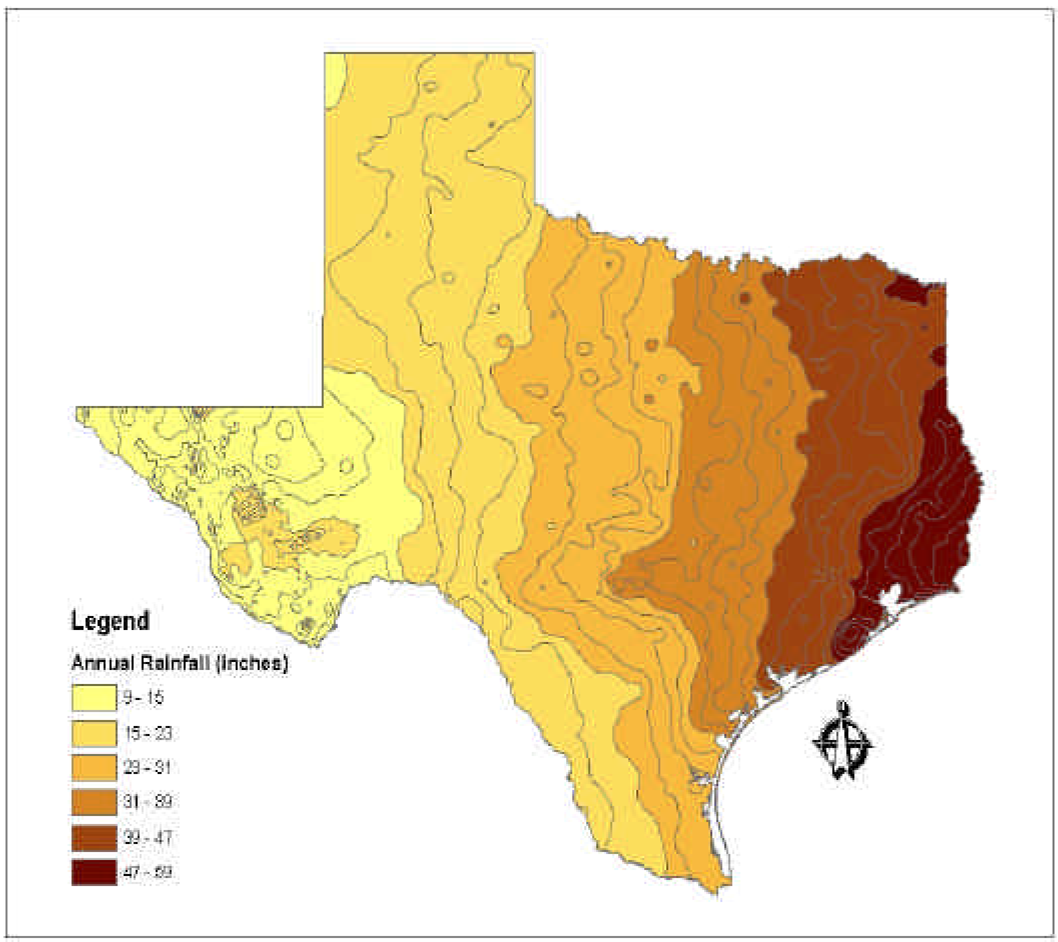

Figure 9. Texas Annual Rainfall.

Groundwater

Groundwater in the Pecos River sub-basin comes from the Rustler and Dockum minor aquifers and the Cenozoic major aquifer in the Upper Pecos and from the western edge of the Edwards-Trinity Aquifer in the middle and lower parts of the sub-basin. In the Upper Rio Grande sub-basin, groundwater comes from the Hueco Bolson major aquifer for the El Paso–Ciudad Juárez area. The Edwards-Trinity can be found in the eastern part of the sub-basin, as can a few minor aquifers like the West Texas and Capitan Reef. In the Middle Rio Grande sub-basin, there are the Edwards-Trinity and Carrizo major aquifers. The Lower Rio Grande sub-basin has the Gulf Coast major aquifer and no minor aquifers.

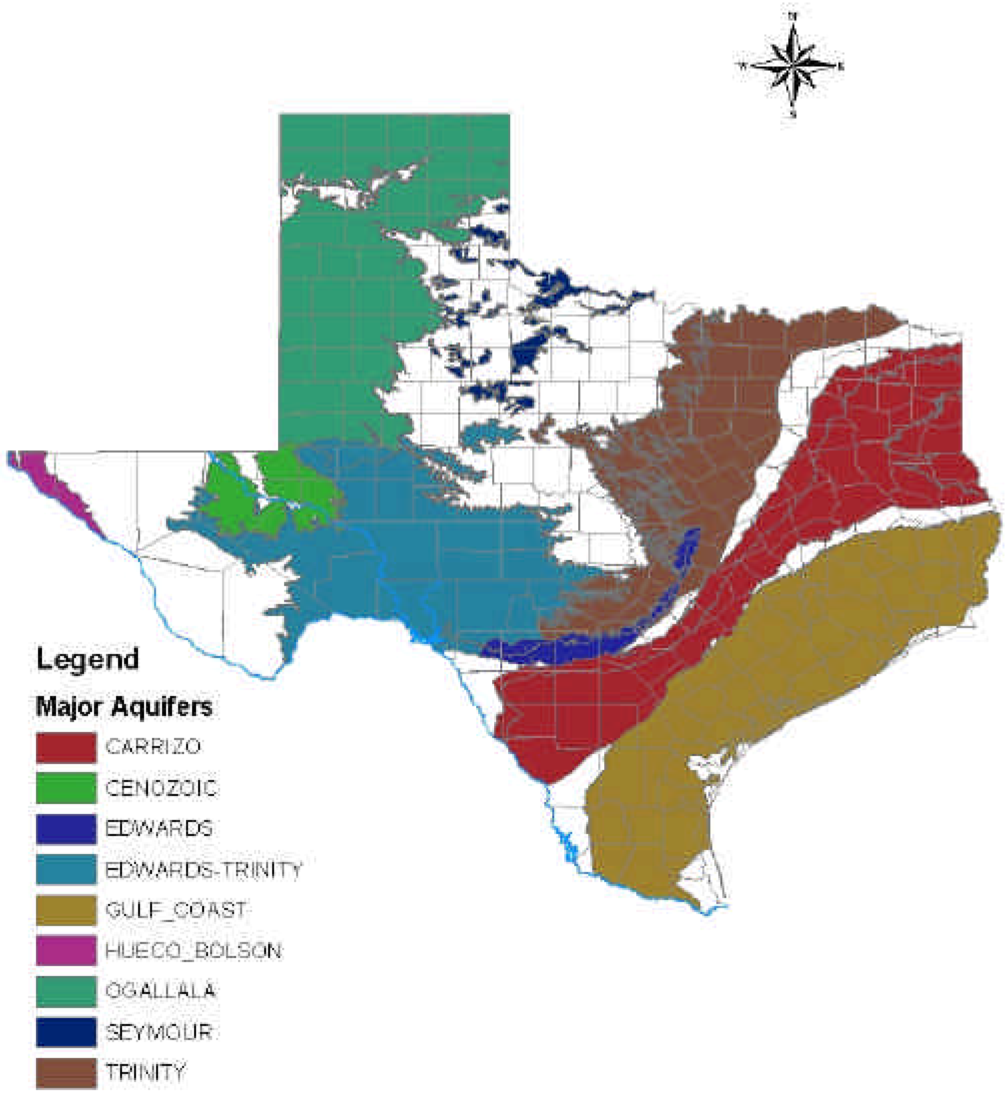

Figure 10. Texas Major Aquifers.

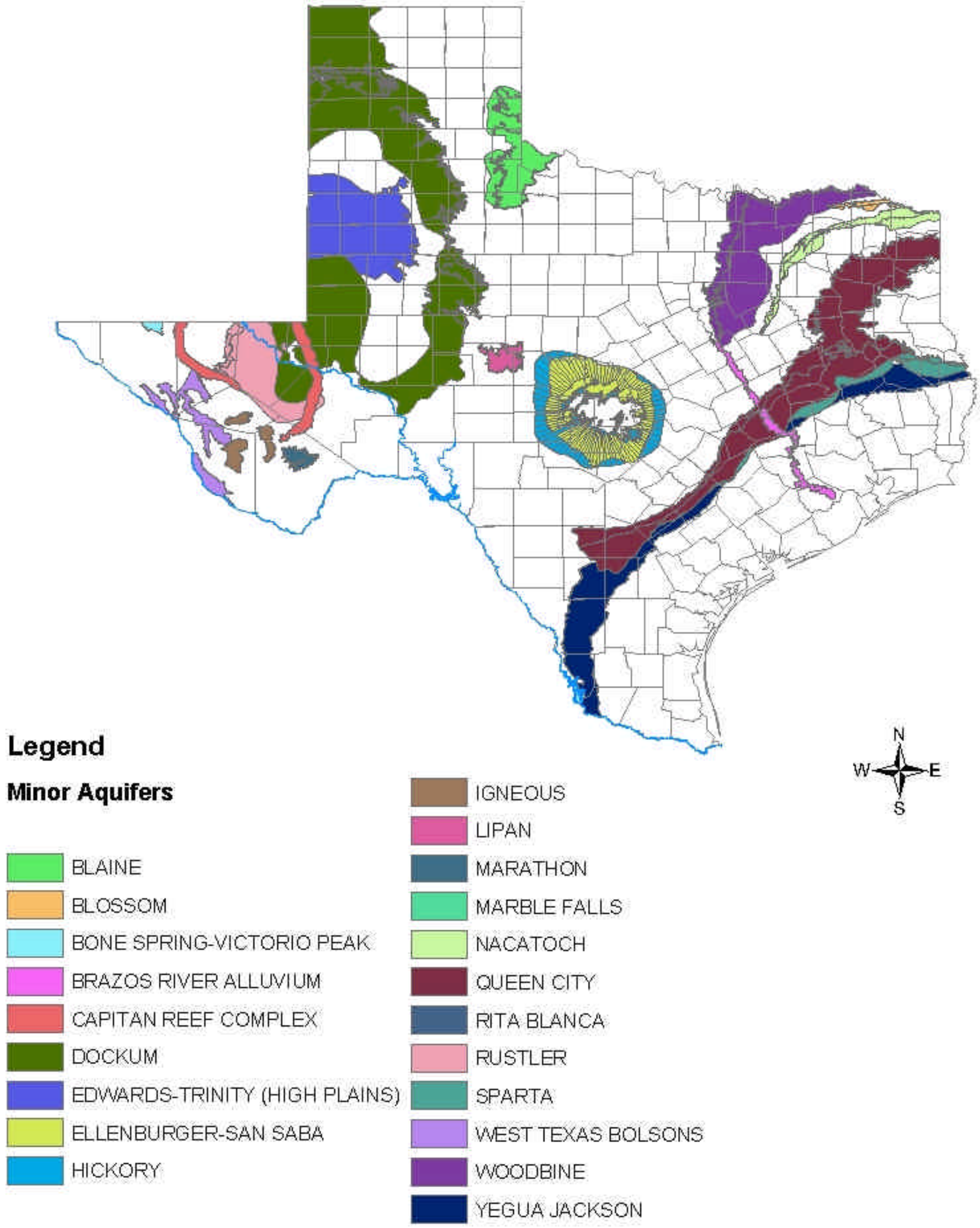

Figure 11. Texas Minor Aquifers.

4.0 Technical Summary

Texas Water Quality Inventory- 305(b) and 303(d) Report

Under the Clean Water Act (CWA), each state is required to submit to the Environmental Protection Agency (EPA) a report on water quality known as the 305(b) report. This report identifies which bodies of water are meeting, and which are not, the designated uses assigned to each river segment by analyzing the data against established indicators of water quality. This assessment is conducted with data collected by various agencies working in the Rio Grande Basin.

Primary Concerns

Primary indicators of water quality (such as dissolved salts, dissolved oxygen, etc.) are directly linked to a designated use and have been adopted as Texas Surface Water Quality Standards (TSWQS) for water bodies in Texas. Secondary indicators are not tied to support of a specific designated use and generally have not been adopted as a standard (usually referred to as screening levels), for example nutrients like nitrate-nitrogen or phosphorus.

Indicators that are directly tied to support of designated uses and criteria adopted in the TSWQS include:

- Water temperature (general use)
- PH (general use)
- Chloride (general use)
- Sulfate (general use)
- TDS (general use)
- Fecal coliform, *E. coli* (contact recreation)
- DO (aquatic life)

(See Appendix I for criteria for each parameter by river segment).

Specific criteria for each of the parameters are assigned to each classified segment in the TSWQS based on the characteristics of the segment. Chloride, sulfate, and TDS criteria represent annual averages of all values that were collected for each segment. The nonsupport of a designated use can only be identified with 10 or samples. Tier 1 primary concerns are identified for sites where only four to nine samples are available. Tier 2 primary concerns are identified when there are ten or more samples with at least two exceedances (applies to grab DO samples only).

Secondary Concerns

Secondary concerns are indicators that are not specifically tied directly to support of designated uses and may or may not be adopted in the TSWQS. Segments with concerns regarding the secondary indicators, such as nutrients, will be included in the 305(b) report but will not be reported as a concern in the 303(d) section of the report. A secondary concern is identified if the screening level is exceeded greater that 25 percent of the time, based on the number of exceedances for a given sample size. Some of the parameters assessed include:

- Nutrients in freshwater streams and reservoirs- Ammonia nitrogen, nitrite plus nitrate, ortho-phosphate, total phosphate, and chlorophyll-*a*.
- Public water supply- Chloride, sulfate, and TDS based on TDWS secondary standards.
- Metals and organics in sediment and tissue.

<u>Designated Uses</u>
Rivers in Texas are divided into segments based on factors such as stream characteristics, land use, habitat, and water quality. Evaluation of the stream segment further identifies the quality of the water and habitat in the segment and is assigned the appropriate designated use.

Aquatic Life Use
Segments in Texas are designated as exceptional, high, intermediate, or limited categories for aquatic life use. Support of the aquatic life use is based on assessment of dissolved oxygen, toxic substances in water criteria, ambient water and sediment toxicity test results, and biological screening levels for habitat, macrobenthos, and fish (TCEQ, Guidance, p 19).

Each set of criteria is generally evaluated independently of each other and the segment is considered impaired when any of the individual criteria are not met. Support of this use is based on the assessment of the following parameters:

- Dissolved oxygen,
- Ambient water and sediment toxicity,
- Biological screening levels for habitat, macrobenthos, and fish.

Dissolved Oxygen (DO)
Each classified water body in the TSWQS is assigned one of the following aquatic life uses, based on physical, chemical, and biological characteristics: *exceptional*, *high*, *intermediate*, *limited*, or *no significant aquatic life use*. DO criteria (24-hr averages) to protect this aquatic life use for freshwater are 6.0, 5.0, 4.0, 3.0 and 2.0 mg/L, respectively. Unclassified perennial water bodies are presumed to have a high aquatic life use and corresponding DO criteria. As with other parameters, a Tier 1 concern is identified if only four to nine samples are available, a Tier 2 concern if ten or more DO grab samples were collected over a 5-year period.

Most of the DO data collected at fixed monitoring stations are instantaneous measurements collected during daylight hours. A comparison between 24-hour and instantaneous DO is conducted to determine compliance, which may result in a concern. Water bodies with Tier 2 aquatic life primary concerns are candidates for 24-hour sampling. The water body will be placed on the 303(d) list if impairment of the aquatic life use is indicated by sufficient 24-hour DO data or if the average DO minimum is exceeded with 10 or more grab samples.

Toxic Substances in Water Criteria
Support of the aquatic life use, based on toxic chemicals in water, includes evaluation of those metals and organic substances for which criteria have been developed. The TCEQ has developed water quality criteria in the TSWQS for 12 metals and 26 organic substances. Acute criteria apply to all waters of the state except in small zones of initial dilution near wastewater discharge points. Chronic criteria apply wherever there are aquatic life uses outside of mixing zones, in intermittent streams that maintain large perennial pools, and in flowing streams when the stream flow is greater than the 7Q2.

Ambient Water and Sediment Toxicity Tests
Aquatic life use support is also evaluated based on ambient water and sediment toxicity testing. The TCEQ, in cooperation with EPA Region 6 and the CRP, routinely collect water and sediment samples for ambient toxicity testing to assess potential toxicity in water bodies, and to evaluate the effectiveness of implemented toxicity control measures. Laboratories conduct standard 24- to 48-hour acute and 7-day chronic toxicity tests on ambient water and sediment samples using *Ceriodaphnia dubia* (water flea) and *Pimephales promelas* (fathead minnow) in freshwater. Support of the aquatic life use using ambient toxicity data when ten or more samples are available is based on the occurrence of toxicity in water and/or sediment.

Biological and Habitat Assessment
Biological characteristics are assessed, based on fish and/or macrobenthos data using multi-metric indices of biological integrity, which integrate structural and functional attributes. An overall score is assigned to the water body and compared to the designated aquatic life use category. Unlike other parameters that are evaluated separately, the indices combine a number of parameters to determine compliance. In the Rio Grande Basin, biological and habitat assessment were not assessed as resources were limited and current priorities existed in other watersheds.

Contact Recreation
This designation applies to all waters of the state with the exception of a portion of the Houston Ship Channel and Segment 2308 in the Rio Grande. All other segments in Texas are considered primary contact because of the use of the rivers for fishing, wading, and swimming. The indicators used to assess this use are *Escherichia coli* (*E. coli)*, fecal coliform, and enteroccoci (for saltwater). These indicators measure the amount of bacteria that are present in the water that could be associated with pathogens. During the latest standards update, Texas adopted *E. coli* as the primary indicator (replacing fecal coliform) because it is more indicative of contamination by disease causing bacteria than fecal coliform.

The contact recreation use is assigned to all water bodies, except for special cases such as Segment 2308 in the Rio Grande Basin. Full support of the contact recreation use is not a guarantee that the water is completely safe of disease-causing organisms. Three organisms analyzed in water samples to determine support of the contact recreation use are fecal coliform and *E. coli* in freshwater and Enterococci in tidal water.

The preferred indicators are *E. coli* for freshwater and Enterococci (for tidal waters). Most of the bacteriological data are routinely monitored at fixed stations at quarterly or monthly frequencies. Support of the contact recreation use is based on a 10-sample minimum. For bacteria data, the following long-term geometric averages established as criteria include; fecal coliform- 200-colonies/100 ml, *E. coli*- 126 colonies/100 ml, and Enterococci- 35 colonies/100 ml. A fecal coliform criterion of 400-colonies/100 ml, an *E. coli* criterion of 394-colonies/100 ml, and an Enterococci criterion of 89-colonies/100 ml also apply to individual grab samples. The contact recreation use is not supported if the geometric average of the samples collected exceeds the mean criterion or if the criteria for individual samples are exceeded greater than 25 percent of the time.

The equation for the geometric mean is: $GM = {}^{n} v(y_1 y_2 y_3 \ldots y_n)$.

Non-Contact Recreation
Bacteria densities are elevated and recurrent in Segment 2308 of the Rio Grande near El Paso. Elevated bacterial densities are caused by pollution that cannot be reasonably controlled under Texas law. A fecal coliform geometric average of 2,000 colonies/100 ml or an *E. coli* geometric average of 605 colonies/100 ml are assigned to protect the non-contact recreation use in this segment. A fecal coliform criterion of 4,000 colonies/100 ml applies to individual grab samples.

A non-contact recreation use is assigned to water bodies where ship and barge traffic makes contact recreation unsafe (Segments 1005, 1701, 2437, 2438, 2484, and 2494), and to Rita Blanca Lake (0105), which is a waterfowl refuge. The non-contact recreation use for these water bodies is protected by the same criteria assigned to contact recreation water- fecal coliform, *E. coli*, and Enterococci. Some water bodies such as segments 1006 and 1007 of the Houston Ship Channel are not assigned either contact or non-contact recreation uses due to local statutes that preclude recreational uses for safety reasons.

Public Water Supply Use
Many communities rely on surface water for their drinking water supply. Standards are in place to insure water quality meets not only TSWQS but secondary drinking water standards also.

Finished Drinking Water
In the TSWQS, 219 segments are designated for the public water supply use. That use for these water bodies is protected by both the TSWQS and the TDWS. The criteria apply to finished (after treatment) drinking water that is sampled at the point of entry to distribution systems. Public water supply use support is based on exceedances of maximum contaminant levels (MCLs) for organic and inorganic drinking water standards. A running annual average of samples (minimum of four) is computed and compared to the TDWS.

Surface Water

The public water supply use is also assessed for surface water by evaluation of the same organic and inorganic chemical MCLs developed for finished drinking water. These assessments are restricted to water bodies designated in the TSWQS for public water supply use. For each parameter at each site, the average of all concentrations (10-sample minimum) collected during a five-year period and the running annual average (of at least four quarterly samples) are compared against the drinking water MCLs to determine public water supply use support. A primary concern is identified if the average concentration exceeds the MCL and is based on only four to nine samples.

Fish Consumption

Whether commercial or recreational, the consumption of fish is monitored because of the ability of certain chemicals to accumulate in the tissue of the fish. Support of the fish consumption use is determined by two assessment methods. The first is by the designation of the human health criteria in the TSWQS. For each toxicant parameter at each site, the average of all values for water samples collected during a five-year period is computed. The averages are compared to human health criteria. The second is assessed by TDH for fish consumption advisories and aquatic life closures. The TDH has a website, (www.tdh.state.tx.us/bfds/ssd/survey.html), that contains information concerning fish consumption advisories and aquatic life closures. The fish consumption use is supported in water bodies where the TDH has collected tissue data and a subsequent risk assessment indicates no appreciable risk of deleterious effects due to consumption over a person's lifetime. The use is partially supported when a restricted-consumption advisory has been issued for the general population, or a sub-population that could be at greater risk (children or women of child bearing age). The fish consumption use is not supported when a no-consumption advisory has been issued for the general population, sub-population, or when an aquatic life closure has been issued that prohibits the taking of aquatic life from the affected water body.

General Use Criteria

TDS, chloride, sulfate, pH, and water temperature are used to assess multiple designated uses.

Preparation of Water Quality Inventory Report

If data meet the criteria in this section, the data are evaluated against TSWQS criteria and attainment/non attainment is determined. An inventory of each segment is created using current monitoring station information. The report summarizes water quality and identifies use support by station and segment. This data in turn is used to generate the 303(d) that lists only segments that are not meeting water quality standards. Both reports are required to fulfill federal CWA requirements and update water quality inventories that were previously conducted. The process maintains an ongoing water quality database that outlines water quality over the years to determine if the waterways in Texas are being protected and if not, to develop a plan to correct the problem.

The Texas Water Quality Inventory report summarizes the data by segment for each river basin in Texas. The information is used to create another report known as the 303(d) list. This list identifies river segments that are not protecting a designated use as identified by the water quality indicators that exceed the state standard(s). Segments on the 303(d) list must have a corrective action plan developed to achieve the water quality standard(s) not being attained. This is called the Total Maximum Daily Load (TMDL) process. In 2002, the TCEQ Water Quality Inventory report now contains the 305(b) and 303(d) reports in the same document.

The analyses were done using approved TCEQ and USIBWC guidance documents and were a joint effort by USIBWC, CRP partners, and TCEQ staff. This section explains in greater detail the steps taken for the:

- Preparation and review of the Texas Water Quality Inventory, 305(b)/303(d) report, and
- Screening water quality data for Trends.

Data that has undergone review and is submitted to the TCEQ is entered into the TRACS database. Every two years, TCEQ staff take the most recent five years of data and assesses the data against the TSWQS and drinking water (Texas Drinking Water Standards-TDWS). The data must meet the criteria specified in the most recent version of TCEQ's "Guidance for Assessing Texas Surface and Finished Drinking Water Quality Data" (http://www.tnrcc.state.tx.us/water/quality/02_twqmar/02_305guide_final.pdf). The TSWQS most recently adopted by the TCEQ and approved by the EPA are used for the assessment. Numerical criteria established in the TDWS for finished water (after treatment) provide a quantitative basis for evaluating support of the public water supply use.

The data must undergo a series of checks before it is used for evaluation. The following areas represent some of the criteria that must be met:

A. **Sources of data**- Information that may be considered includes SWQM and CRP data found in the TRACS system. Data from the TCEQ's Water Permits and Resource Management databases (for secondary drinking water standards), volunteer monitoring programs, and/or other quality assured data. Other data from state or federal agencies, such as data from Texas Department of Health (TDH), Texas Parks and Wildlife Department (TPWD), and the USGS found in the TRACS database may be included. All data must be collected under QAPPs that ensure data are of known and appropriate quality.

B. **Period of record**- Data from the most recent 5-year period are considered for assessment. Most monitoring groups collect data at fixed sites on a monthly or quarterly basis. Data outside the 5-year period may be used for some assessment purposes at the discretion of TCEQ SWQM staff. Such uses may include the determination of trends or the identification of concerns of sediment and tissue contamination.

C. **Frequency and duration of sampling-** The assessment must use a sample set that is spatially and temporally representative of conditions in the water body. At a minimum, samples distributed over at least two seasons and over two years must be utilized, with some made during an index period (March 15-October 15). The data set should not be biased toward unusual conditions, such as flow, runoff, or season. Biological sampling and 24-hour dissolved oxygen measurements must be conducted during the index period to be considered in the assessment. Sediment and fish samples generally do not vary greatly over time and are considered useful integrators of water quality over time and space. Samples for fish and sediment can be collected as part of a one-time special monitoring event.

D. **Minimum number of samples-** At least ten samples over the 5-year period of record are required at each site for use assessment.

- All field measurements (DO, pH, and temperature);
- Water quality constituents (nutrients, bacteria, chlorophyll-a, dissolved solids, and ions); and
- Toxicants in water, sediment, and fish tissue collected routinely in the water body, and ambient water and sediment toxicity.

If there are less than ten samples, the use can only be assessed as a primary concern, for example sample sets of three measurements, where all three measurements exceed the criterion or screening level. In this instance, the water body will be identified as a primary concern.

In finished drinking water, an average calculated from at least four samples is required for comparison to the primary and secondary drinking water standards.

E. **Use of the binomial method for establishing required number of exceedances for partial and nonsupport of designated uses -** This method was selected by TCEQ to eliminate potential sources of error (Type I and Type II error). An example of Type I error is classifying a water body as partially or not supporting, when that water body is actually fully supporting. Type II error is classifying a water body as fully supporting when that water body is actually partially or not supporting. Previous methods for determining support/non-support did not thoroughly take into account Type I & II error. The binomial method is a useful tool for estimating the probability of committing Type I and/or Type II error. By setting an acceptable rate of exceedances for committing either type of error with respect to sample size, the minimum number of samples exceeding the use support becomes more valid and thus more valuable when assessing water quality.

F. **Flow conditions-** Streams are routinely monitored under highly variable flow conditions from extreme low flows that typically occur in late summer months, to high flows that follow seasonal storm events. Water quality criteria and screening levels generally apply to flowing streams as long as flow exceeds the seven-day, two-year low flow (7Q2). Small, unclassified streams in Texas develop intermittent stream flow in summer months and eventually become completely dry, while others maintain perennial pools when flow is interrupted. Additional guidance was developed by TCEQ to apply to streams under these different flow conditions.

G. **Values below limit of detection-** For values reported as less that the AWRL, there is no generalized way to determine the true value of the data between zero and the AWRL. For assessments, 50 percent of an analytical reporting limit is computed for these nondetects. This is done to include as many individual data points in the analysis as possible and to indicate the level of monitoring effort. These occurrences are particularly noteworthy, because they may indicate concentrations that are below those of concern.

H. **Spatial coverage-** A single monitoring station is considered to be representative of no more than 25 miles (40 km) in freshwater, tidal stream, and ocean shoreline. In reservoirs and estuaries, one station can represent 25 percent of the total square miles, but not to exceed more than 5,120 acres or eight square miles (20.7 square km). Other factors such as the confluence of a major tributary or an instream dam may also limit the spatial extent of the assessment based on only one station. The remaining area not covered by a single site will be reported as not assessed.

Screening Water Quality for Trends

Analyzing data for trends is another important aspect of understanding water quality data. It helps the CRP determine areas that are improving, or getting worse, as well as providing information on areas that may need additional monitoring. It helps to demonstrate if water quality improvement projects and other changes are making a difference. This information can be presented to steering committees to provide input and help to prioritize issues that are of importance to the community.

One way to determine if a trend exists is by running a statistical analysis on the water quality data. The method chosen by the TCEQ and CRP is called a linear regression. This method uses a formula that draws a line through the data that indicates the "best fit" based on the data presented. You can estimate how a dependent variable, such as dissolved oxygen, is affected by one or more independent variables, such as season or the amount of flow in the river. By applying certain criteria to the data to improve confidence in the results, it provides for a quick yes/no response as to whether a trend exists in the data. For example, in certain parts of the Rio Grande Basin, flow in the river is dependent on the allocation of water for irrigation and municipal/industrial use, and it has been noticed by looking at historical trends that the conductivity levels increase (the water gets saltier) when the flow in the river is lowest during the non-irrigation season. In order to better understand the water quality issues in the Rio Grande, a statistical analysis was done for the most recent five years of data. The analyses will help identify trends in data by providing more information to identify areas where potential problems exist, highlight areas that are improving, and determine if water quality improvement projects and other changes are making a difference in water quality.

The trend analysis of water quality data involves a series of steps to identify those sites and parameters that exhibit a potential trend and determine if that trend still exists after accounting for stream flow and season. The data was prepared by selecting the data sets that met the minimum required number of samples and period of record. If additional data was needed outside of the most current five-year period, an additional year was added to the data set to meet the minimum number of samples.

Transformations

After the data has been reviewed using the plots created to test the assumptions, some of the data may have to be transformed to decrease the variability in the data. Data is transformed by taking the log of the value. Using the log reduces the variability due to high or low values in the dataset, creating a "smoother" graph.

Accounting for Flow and Season

The steps taken to identify trends with the linear regression analysis and testing the assumptions may verify that a trend does exist in the data. Two influences also can affect the trend besides time, flow and season. In order to account for the two, additional regression analyses are done to determine if a trend still exists after accounting for flow and season using the same criteria for the initial linear regression.

Simple Linear Regression

The method selected by the TCEQ to identify trends is known as a linear regression. A specific set of statistics was used to determine whether a potential trend exists. By using current spreadsheet software available, the criteria were entered and a summary report was created for each analysis. The following statistical criteria were used:

- *R-squared*- The higher the value (greater than 0.2 or 20 percent), the more likely that there is a significant relationship between the two variables and a trend exists.
- *T-ratio*- If the ratio is > or = |1| (absolute value), then the slope is different from 0 (a straight horizontal line when plotted on a graph) and a trend may exist. The greater the value than |1| indicates an increase in the trend and is more pronounced (either going up or down with respect to time).
- *P-value*- (attained significance level) <0.1 (10 percent) gives significance to the statistics. The smaller the value from 0.1, the greater the effect of the trend.

Plot The Data

Along with the information from the linear regression, graphs are created to view the data to help CRP staff determine if the assumptions about the data are valid. The graphs used to test for assumptions were:

- Plot the data versus time
    - Does the relationship look linear or is there some sort of curve to the data?
    - Is there a shift in the trend (does the slope of the line follow and upward or downward direction with respect to time)?
    - Is the variability around the regression line constant or do the measurements exhibit much higher or lower values during a specific period in the graph such as during summer or winter months?
    - If either of these situations occur, then the parameter data need to be transformed

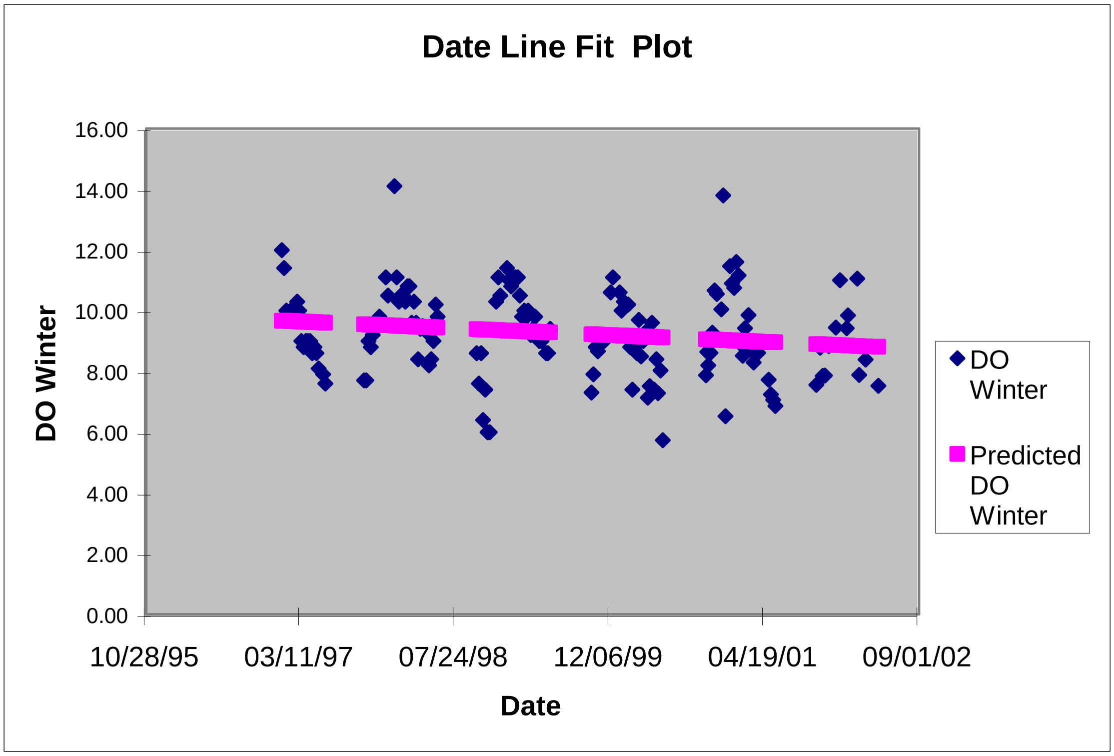

Figure 12. Example of Plot of Data versus Time.

- Plot the residuals versus time
    - Is there any curvature or direction to the data?
    - If there is curvature or direction to the data, then the assumptions are invalid

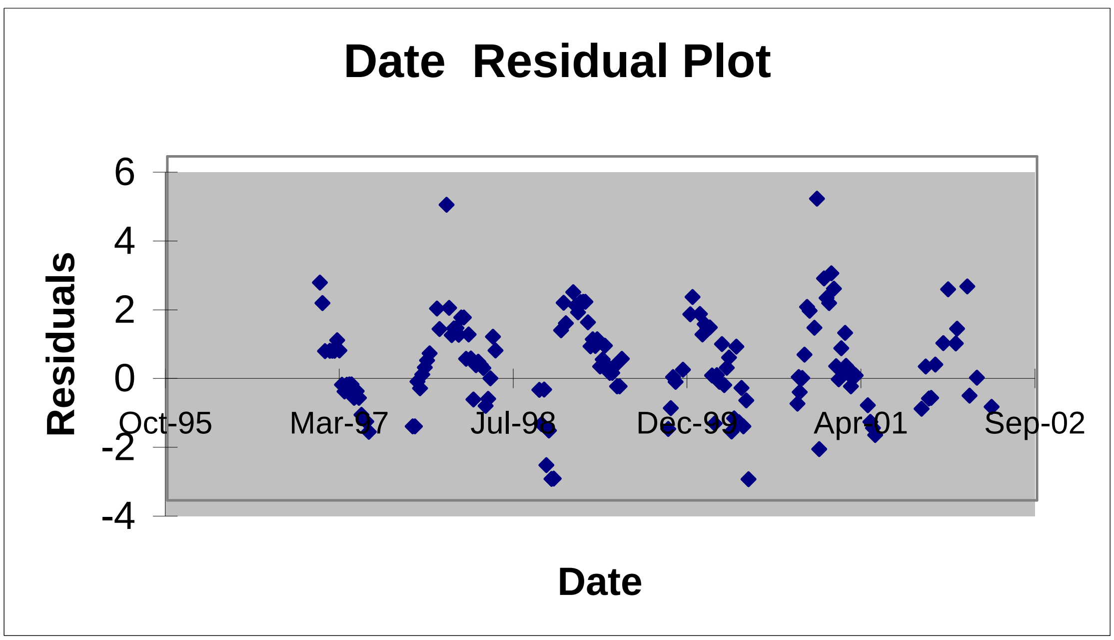

Figure 13. Example of Plot of Residuals versus Time.

- Normal probability plot
    - Does the data follow a straight, sloped line?
    - If the plot is significantly curved or has a number of measurements that do not follow the pattern, then the data may need to be transformed

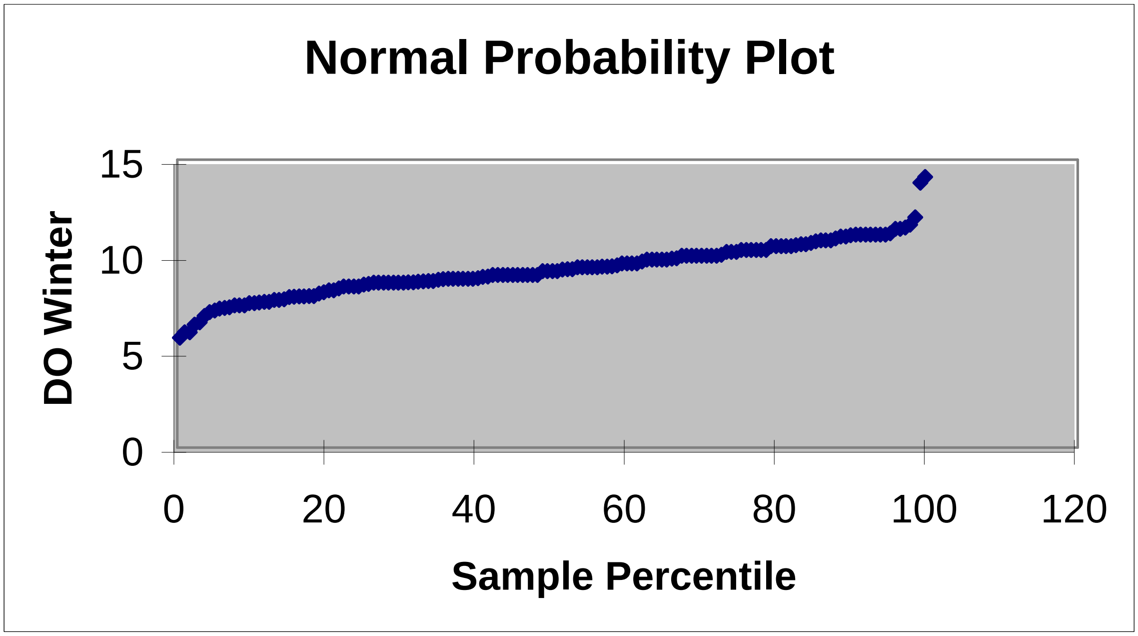

Figure 14. Example of Normal Probability Plot.

Watershed Summaries

The analysis of water quality data is one of the most important aspects of the CRP. The CRP staff has attempted to take technical analyses and reports and present them in a user-friendly format. Each level of analysis performed on the water quality data provides information that by itself explains one or more aspects of either water quality or the overall health of the river. When put together with other analyses, it provides a better understanding of the data and can be presented to planning agencies or interested individuals in various forms depending on the desired format, such as a graph, report, table or map. It is still important to explain the technical aspect of the creation of the reports because it is an important part of the data quality and may be important to end users of the data as a point of reference. The following section provides the information from the analyses of the data by station within each respective sub-basin.

Pecos River Sub-Basin

Watershed Overview

Population centers along the Pecos are relatively few and the entire area has seen a decline in the population within the last ten years.

Figure 15. The Pecos River at the USIBWC Langtry gage site.

Table 3 Pecos River Sub-basin Populations

City	Population
Pecos	10,757
Fort Stockton	8,301
Monahans	6,851
Barstow	507

Other less populated cities in the area are Langtry, Sheffield, Girvin, Mentone, and Orla.

There are 23 permitted dischargers in the sub-basin including five Concentrated Animal Feeding Operations (CAFOs), 10 industrial, and eight municipal (Figure 13).

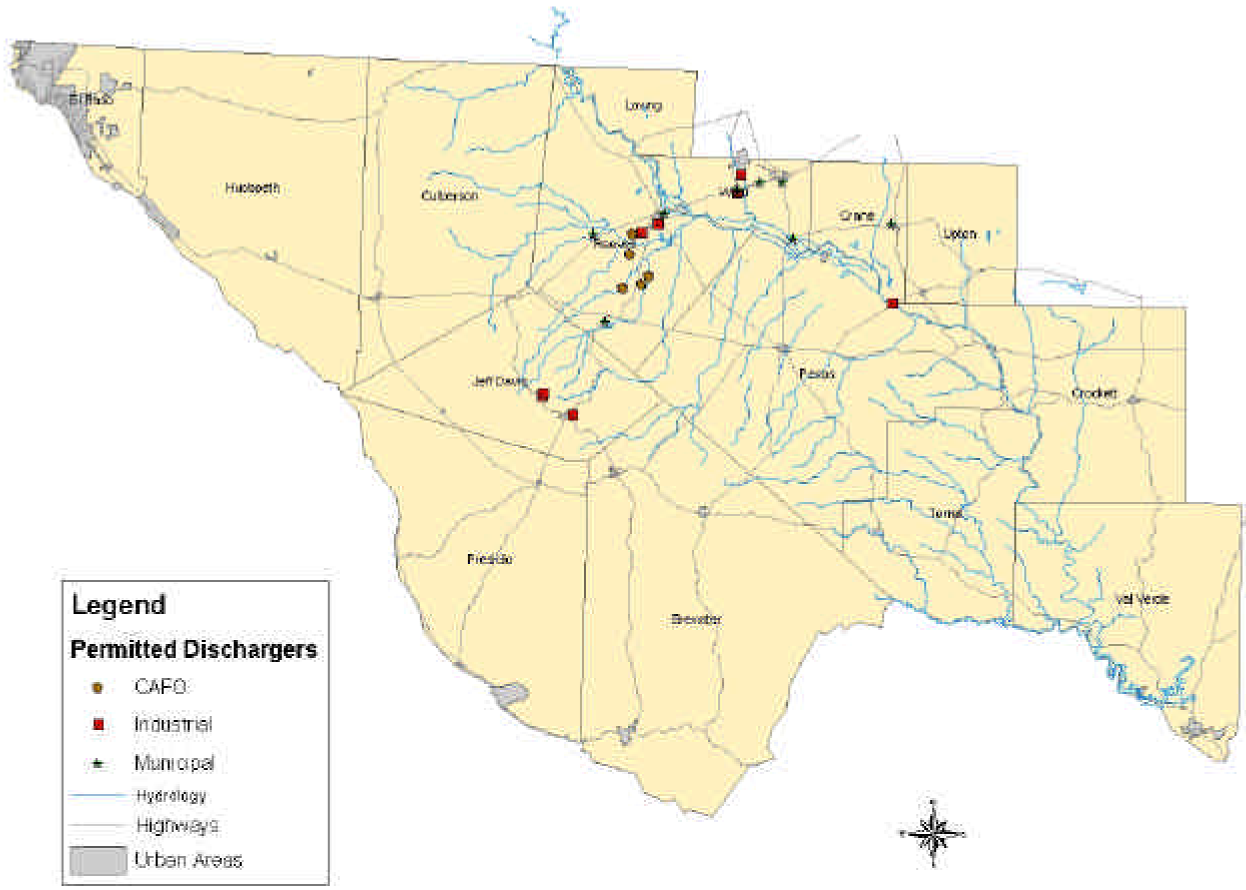

Figure 16. Pecos River Sub-basin Permitted Dischargers.

The Pecos River sub-basin is the portion of the Pecos River from the point it enters Texas at Red Bluff Reservoir to its confluence with the Rio Grande. The sub-basin contains three segments:

- Red Bluff Reservoir (2312) – from Red Bluff Dam in Loving/Reeves County 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).
- Upper Pecos River (2311) – From a point immediately upstream of the confluence of Independence Creek in Crockett/Terrell County to Red Bluff Dam in Loving/Reeves County, which runs for 349 miles (561 km).

- Lower Pecos River (2310) – From a point 0.4 miles (0.7 km) 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, which runs for 49 miles (79 km).

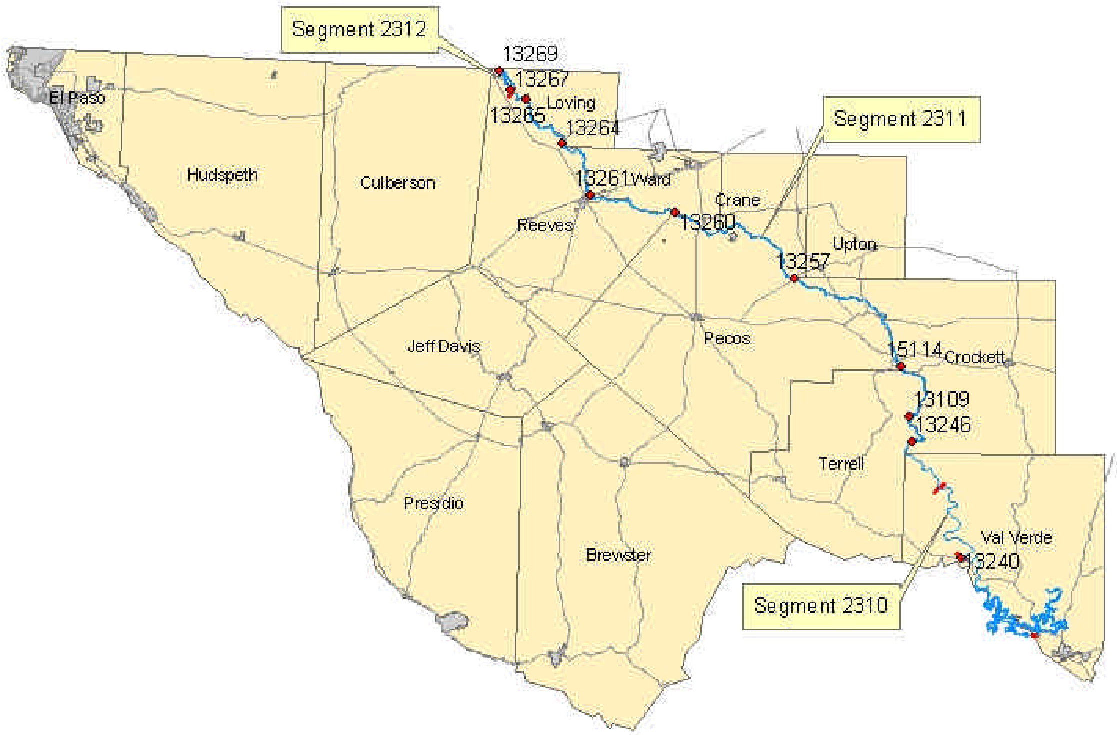

Figure 17. Pecos River Sub-basin Monitoring Stations.

Red Bluff Reservoir-Segment 2312

Segment 2312 is the Texas portion of Red Bluff Reservoir encompassing 11,700 acres. Listed uses include high aquatic life use, contact recreation, general use, and fish consumption. All uses are fully supported except fish consumption, which has not been assessed.

Segment 2312 contains two monitoring stations: 13267 – Red Bluff Reservoir above dam, north of Orla, and 13269 – Red Bluff Reservoir ½ mile (0.8 km) south of the Texas – New Mexico border.

Figure 18. Pecos River Leaving Red Bluff Reservoir.

Station 13267 shows no concerns or impairments. This station shows a decreasing trend in pH, which indicates an improvement in this parameter. Conductivity, sulfate, and total dissolved solids (TDS) show an increasing trend. Although this trend has not resulted in impairment, the trend indicates increasing salinity.

Station 13269 contains a nutrient enrichment concern for elevated levels of nitrate-nitrite. This station also contains a decreasing trend in pH towards a more desirable level but does not show the increasing trends in the salt concentrations as Station 13267.

Upper Pecos River-Segment 2311
Segment 2311 is classified as a freshwater stream stretching for 349 miles (562 km). Its listed uses are high aquatic life use, contact recreation, general use, and fish consumption. All uses are fully supported except for fish consumption, which has not been assessed.

This segment contains six monitoring stations, four of which were used for the assessment and two recent stations evaluated for trends. These stations include 13257 – Pecos River at US 67 NE of Girvin; 13260 – Pecos River at FM 1776 SW of Monahans; 13261 – Pecos River near Pecos, Texas; 13264 – Pecos River near Mentone, Texas; 13265 – Pecos River at FM 652 bridge NE of Orla; and 15114 – Pecos River 1.6 miles (2.6 km) upstream of US 290, SE of Sheffield.

Station 13257 shows an aquatic life use concern for depressed dissolved oxygen. Trend analyses show that conductivity and TDS trends decline with increased flow, as would be expected. This also shows that a large contributor to the high salinity problem in the Pecos River is the lack of significant flow. Trend analyses also show an increasing trend in orthophosphate.

Station 13260 showed no concerns or impairments. Trend analyses show a slight increase in fecal coliform contamination. Conductivity shows very little trend but when compared to flow, there is a decline in overall salt concentrations. TDS shows an increasing trend that is close to the standard. Orthophosphate also shows an increasing trend, but is still well below the screening level.

Station 13261 and 13264 are new stations, therefore there is insufficient data collected to assess for concerns or impairments or to perform a trend analysis.

Figure 19. Pecos River Near Pecos, Texas.

Station 13265 shows an aquatic life use concern for impaired fish habitat, impaired fish community, and impaired macrobenthos community, however, the data is limited. The trend analysis on pH shows a beneficial decline towards 7.4 but a slightly inclined trend in organic nitrogen concentrations.

Station 15114 did not have any concerns or impairments. This site shows a slight incline in pH values. Trends at this site show declines in conductivity concentrations and in nitrate and nitrite.

Lower Pecos River-Segment 2310
Segment 2310 is classified as a freshwater stream with a length of 89 miles (143 km). Its designated uses are high aquatic life use, contact recreation, general use, fish consumption, and public water supply.

This segment contains four monitoring stations: 13109 – Independence Creek 0.5 miles (0.8 km) downstream of John Chandler Ranch headquarters; 13240 – Pecos River at gaging station 7.4 miles (11.9 km) east of Langtry, 15 miles (24.1 km) upstream of confluence with Rio Grande; 13246 – Pecos River 4.67 miles (7.52 km) upstream of the Val Verde/Crockett/Terrell county line, and 16379 – Pecos River 0.7 miles (1.1 km) downstream from US 90 W in Val Verde county.

Station 13109 was not assessed for concerns or impairments. Trend analysis on pH shows a rapidly improving pH trend as it has gone from a relatively high pH of 8.2 in 1995 to a pH of 7.7 in 2002 as well as a subsequent decrease in conductivity, TDS, fecal coliform contamination, and nitrate.

Station 13240 contains a concern for public water supply due to higher than standard concentrations in chloride, sulfate, and TDS. There is a slight declining trend in dissolved oxygen levels during the summer months. There is also a declining trend in salt concentrations with increased flow, as would be expected. This demonstrates that the degradation in water quality is related to the declining quantities of water in the river.

Figure 20. Pecos River Near The Rio Grande.

Station 13246 also has the same concern for public water supply due to high concentrations of chloride, sulfate, and TDS. This site also has a slight decline in dissolved oxygen (DO) levels but also shows a decline in pH from over 8 to 7.7. Other parameters showing trends that are moving towards exceeding standards are salt concentrations and fecal contamination. These trends are directly influenced by the decline in water quantity in this segment.

Station 16379 does not contain enough data for a determination of trends but the station is listed by the state as having the same concerns as the previous stations in this segment.

Basin Concerns

The largest concern within the sub-basin is the quantity of water for irrigation. Water quality is too salty to be used for potable drinking water. The primary source for drinking water in the communities along the Pecos River comes from near brackish groundwater sources. Residents in this region use water purification in their homes and businesses.

Because the water in the Pecos River enters Texas with a TDS that exceeds drinking water standards and gets progressively higher in the Upper Pecos, the water is only used for irrigation of crops. The primary concern then for the water is to prevent continued salt concentrations and to increase water quantity.

Figure 21. Saltcedar Bush.

Drought conditions throughout the southwest have resulted in decreased water deliveries in the Pecos River from New Mexico to Texas. It is also believed that an introduced plant species, Saltcedar, is also contributing to the decline in water quantity as well as reducing water quality. Saltcedar is an invasive plant that was originally brought to this country as an ornamental plant in the late 1800's and was introduced in 1925 along the Pecos River for erosion control. Since that time, saltcedar has dominated the banks of the river and caused significant damage to the ecosystem by out competing the indigenous species, increasing salinity in the river and causing excessive water loss.
Saltcedar eradication through the use of herbicides began in New Mexico in 1995, when the invasion of saltcedar caused a small lake to dry up. Wells drilled in the area of the lake showed that the groundwater level in that area was greater than 15 feet (4.6 m) below the surface. Arsenal brand herbicide was used to eradicate the saltcedar in that area. Approximately two to three years later, water levels not only climbed higher but the small lake contained water once again.

In Texas, saltcedar eradication efforts were brought into light for two reasons. First, the Red Bluff Water and Power Control District noticed that a large amount of water that was released was not reaching the Girvin, Texas gage station. Second, water losses in and saltcedar intrusions along a tributary of the Pecos River called Salt Creek, were threatening the life of the Pecos Pupfish. This creek houses the only genetically pure population of this fish in the world. Saltcedar eradication projects in Texas began along this creek.

Dr. Charles Hart of Texas Cooperative Extension (TCE), under the Pecos River Ecosystem Project (PREP), began to experiment with herbicidal eradication of saltcedar in Salt Creek so that the irrigation district would not have to divert the local farmers irrigation water into Salt Creek. The herbicidal eradication of saltcedar led to an increased amount of water in the creek and prevented the Pecos pupfish from being placed on the endangered species list.

The TCE started the project in September 2000 by using different application techniques and different herbicides. They found that rotary wing aircraft was more effective and cost efficient than fixed wing aircraft because a helicopter can rapidly land and refuel and a plane had to make multiple passes to obtain full coverage of the saltcedar with the herbicide where a helicopter could accomplish this in one pass. Experimentation with different droplet sizes to obtain the most effective application of herbicide showed that 1000 microns prevented drift of the droplets in the air and provided the greatest coverage. They also experimented with three different herbicides in different mixtures. The brands of herbicides used were Arsenal, Rodeo and Induce. Each plot was evaluated after one year and again after two years. They discovered that the most effective treatment was to use Arsenal only at a rate of 15 gallons per acre (14 liters per square meter).

Figure 22. Saltcedar After Arsenal Application.

Water quantity data are being collected 24 hours a day, seven days a week to determine if there is any effect by saltcedar removal. The water quantity is being monitored through the use of ground water monitoring wells that contain water level sensors (some of which were provided by the USIBWC CRP) and by the USGS gaging station in Girvin, Texas.

Water quality data is also being monitored to determine if salt concentrations are reduced through the eradication of saltcedar. The CRP is doing this monitoring with water sample collection being done by the Upper Pecos Soil and Water Conservation District, the Natural Resources Conservation Service, TCEQ, and the USGS.

Application of Arsenal along the Pecos is possible because EPA granted the TCE a special Section 24(c) label. Since that time EPA is going to re-label Arsenal for use around any waters allowing the TCE to spray along the entire length of the Pecos and also to not limit the width of the spraying area.

The active ingredient in Arsenal is Imazapyr. According to a BASF representative, Imazapyr destroys certain enzymes used by woody plants for protein synthesis. These enzymes are not found in any animals, including humans. Arsenal cannot affect any plant located in any depth of water because the half-life of Imazapyr in water is four hours. The organic by-products of Imazapyr then break down in four days into naturally occurring carbon compounds that have no adverse effect on any kind of life. Arsenal also has a rapid dispersion rate that renders it harmless almost instantly in moving waters. The BASF representative stated that Imazapyr does not concentrate in impounded waters and does not collect in the soil.

The TCE went before the state legislature to prevent the commercial sale of saltcedar, but were unsuccessful. They did, however, receive a $1 million grant to continue its efforts throughout the Pecos River Basin. To date, the project has been applied along the Salt Creek and along the Pecos River from Red Bluff to Grandfalls, Texas. Monitoring of the past two years of the applied areas has shown a 94 % kill rate.

Future projects are to continue monitoring the water quality and quantity, to apply Arsenal along the Pecos River to the Rio Grande, prevention of re-invasion of saltcedar by re-application of Arsenal and mechanical removal of unaffected saltcedar in applied areas, and indigenous species re-introduction.

Upper Rio Grande Sub-Basin

Watershed Overview

The Upper Rio Grande basin extends from the New Mexico-Texas state line downstream to the International Amistad Reservoir. The Rio Grande forms the international border between Texas in the United States and four states (Chihuahua and Coahuila) in Mexico. In west Texas, the Rio Grande begins to flow through communities known as "sister cities", where one community is located in the United States and the other in Mexico. The first of these communities, the cities of El Paso and Ciudad Juárez, form the largest population along the border in Texas with an estimated population of over two million people.

Figure 23. The Rio Grande as it enters El Paso/Ciudad Juárez.

The Rio Grande is used as a drinking water supply as well as for irrigated agriculture. Downstream of El Paso/Ciudad Juárez, return flows make their way through a part of the river known as the "forgotten river" because of the lack of instream flows and the policies in place that allocate the waters of the Rio Grande. The river flows for about 150 miles (241 km) with only minimal use of the river for ranching and limited agriculture. Large stands of salt-cedar have taken hold in this area upstream of Presidio, Texas. The Rio Conchos flows into the Rio Grande above Presidio, Texas and Ojinaga, Chihuahua. Currently, the Rio Conchos provides approximately half of the flow in the Rio Grande around Presidio/Ojinaga. Additional flow is picked up around Big Bend National Park as additional tributary and spring flow make their way into the river. The Big Bend area once flourished as an area mined for primarily mercury in Texas and silver in Mexico. This industry has been replaced by eco-tourism such as rafting, hiking, and backpacking. Small-scale farms dot the landscape further downstream of the national park. Upstream of Del Rio, Texas and Ciudad Acuña, the Pecos River meets the Rio Grande providing additional flows prior to entering International Amistad Reservoir.

Intrastate compacts and international treaties govern the distribution and allocation of water in the upper Rio Grande from the headwaters in Colorado downstream to the area just below Fort Hancock, Texas at the IBWC gaging station known as the Fort Quitman gage. The region has been in an extended drought, which has depleted water supplies in most of the major and minor reservoirs in the Rio Grande Basin.

The **Convention of May 21, 1906** provides for the distribution between the United States and Mexico of the waters of the Rio Grande in the international reach of the river between the El Paso-Juárez Valley and Fort Quitman, Texas. Article 1 provided for a storage dam near Engle, New Mexico, and the auxiliary distribution system for the purpose of delivering (from the United States) 60,000 acre-feet of water annually to Mexico.

The **Rio Grande Project** allocates the waters of the Rio Grande between New Mexico and Texas. The agricultural community receives the majority of the water through the Elephant Butte Irrigation District in New Mexico and the El Paso County Water Improvement District #1 in Texas. The City of El Paso also receives a portion of the project water for municipal use.

Table 4 Upper Rio Grande Sub-basin Populations

City	Population
El Paso	563,662
Fort Stockton	7,846
Presidio	4,167
Van Horn	2,435

There are 65 permitted dischargers in the sub-basin including nine CAFOs, 48 industrial, and eight municipal.

Figure 24. Upper Rio Grande Sub-basin Permitted Dischargers.

The Upper Rio Grande sub-basin is the portion of the Rio Grande from the point it enters Texas to Amistad Reservoir. The sub-basin contains six segments:

- Rio Grande above International Dam (2314)– From International Dam in El Paso County to the New Mexico state line in El Paso County, which runs for 21 miles (33 km).
- Rio Grande Below International Dam (2308)– From the Riverside Diversion Dam in El Paso County to the International Dam in El Paso County, which runs for 15 miles (24 km).
- Rio Grande Below Riverside Diversion Dam (2307)– From the confluence of the Rio Conchos (Mexico) in Presidio County to Riverside Diversion Dam in El Paso County, which runs for 222 miles (357 km).
- Rio Grande Above Amistad Dam (2306)– From a point 1.1 miles (1.8 km) downstream of the confluence of Ramsey Canyon in Val Verde County to the confluence of the Rio Conchos (Mexico) in Presidio County, which runs for 313 miles (503 km).

- International Amistad Reservoir (2305)– From Amistad Dam in Val Verde County to a point 1.1 miles (1.8 km) downstream of the confluence of Ramsey Canyon in Val Verde County, which runs for 75 miles (120 km).
- Devils River (2309)– From a point 0.4 miles (0.6 km) downstream of the confluence of Little Satan Creek in Val Verde County to the confluence of the Dry Devils River in Sutton County, which runs for 67 miles (108 km).

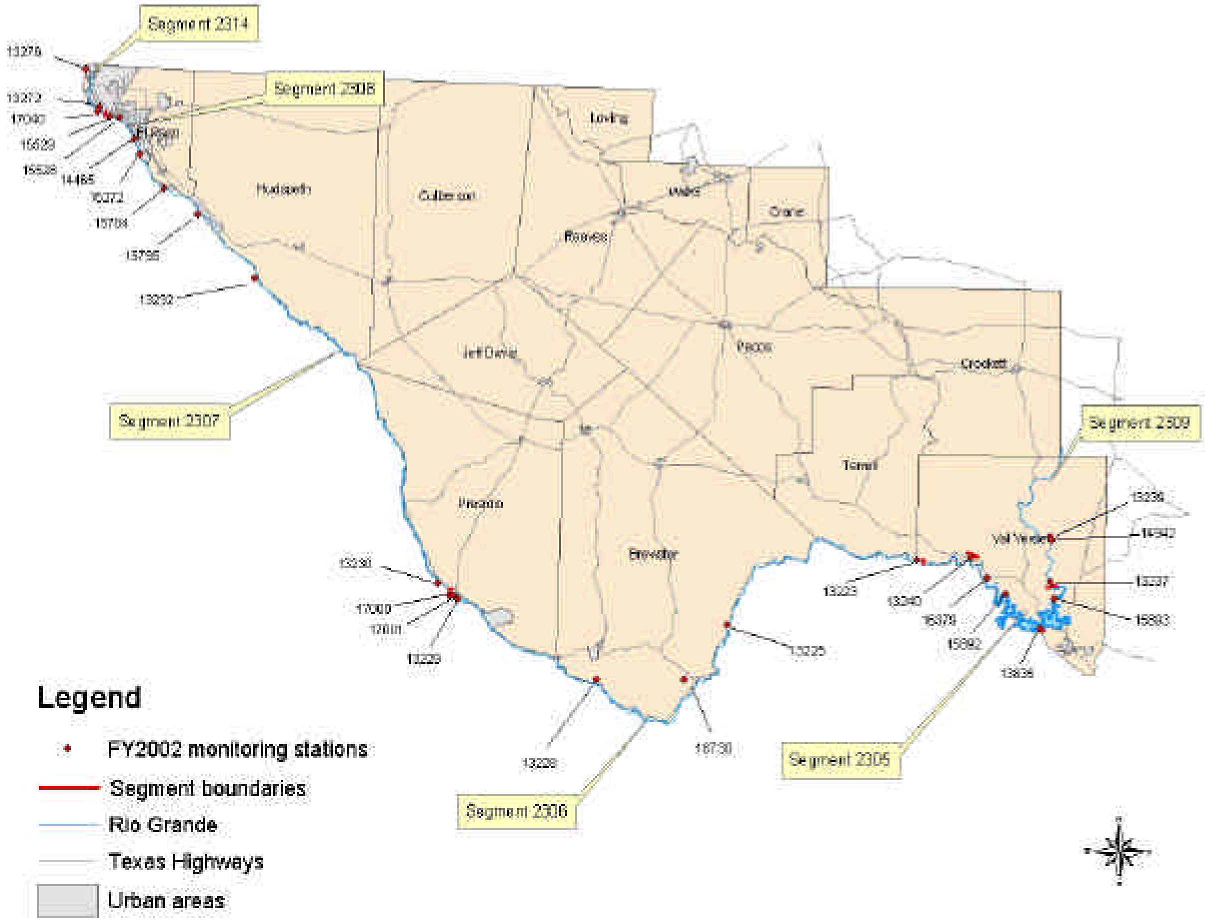

Figure 25. Upper Rio Grande Sub-basin Monitoring Stations.

Rio Grande above International Dam- Segment 2314

Segment 2314 extends for 21 river miles (33.8 km) from the New Mexico-Texas state line downstream to International Dam in El Paso County. It is a classified water body with designated uses that include high aquatic life use, public water supply, fish consumption, and contact recreation. Irrigated agriculture, industry, and municipal wastewater treatment effluents impact this area. The amount of water in the river depends largely on the needs of water rights holders with the majority of the flow delivered between March and October. The water is diverted for use by the United States at the American Dam that flows in the Rio Grande American Canal Extension (RGACE). About two miles (3.2 km) downstream, water is delivered to Mexico at the International Diversion Dam for agricultural use. There are two stations monitored on

Segment 2314, Station 13276- Rio Grande upstream of east drain near Anthony, Texas, and Station 13272- Rio Grande at Courchesne Bridge.

Station 13276- Rio Grande upstream of east drain near Anthony, Texas. Water quality parameters meet TSWQS at this station. There is a concern for chlorophyll-*a* at this site. Excessive algae can lead to depressed dissolved oxygen levels and eutrophication but currently does not show any signs of this condition.

Station 13272- Rio Grande at Courchesne Bridge. This station has shown increased bacterial levels occurring throughout the year. The station is impacted by return flows from agriculture and wastewater treatment plant effluents. CRP and its partners will continue to analyze for fecal coliform and *E. coli* to determine the source of the impairment.

Rio Grande below International Dam-Segment 2308

Segment 2308 begins at International Dam and flows through El Paso and Ciudad Juarez. Because of water diversions upstream in segment 2314, this segment becomes intermittent in nature just downstream of the downtown areas. Once an effluent dominated segment, the Haskell R. Street Wastewater Treatment Plant (WWTP) no longer discharges into the river. Instead, the effluent is discharged into the RGACE to be credited for water used by the City of El Paso from the Rio Grande for part of its drinking water supply. This has lead to diminished flows resulting in a losing stream (water goes back into the water table) just downstream of the concrete lined portion of the segment below Station 15528.

Figure 26. Channelized Section in Segment 2308.

The designated uses of limited aquatic life use, noncontact recreation, and general use standards were fully supported. The fish consumption and public water supply uses were not assessed. With the completion of the RGACE, water is no longer diverted from this segment for use as a public water supply. The designated use of this segment for public water supply should be re-evaluated.

Three stations monitored in this segment include Station 15529- Rio Grande 1.5 miles (2.4 km) upstream from Haskell WWTP outfall, south of Bowie High School football stadium in El Paso, Station 15528- Rio Grande 0.8 miles (1.3 km) downstream from Haskell Street WWTP outfall, and Station 14465- Rio Grande at Riverside Canal 1.1 miles (1.8km) downstream of Zaragosa International Bridge.

Station 15529 is located within the concrete lined portion of the river upstream of the Haskell R. Street WWTP. There are no return flows into this area of the river and the flow is very low throughout the year. The majority of the flow is seepage from the International Dam and occasional releases from the RGACE diversion structure located upstream of the station. Water samples collected at this site show that water quality is being met with only minor and infrequent exceedances above the standard.

Station 15528 is very similar to 15529. It is also located in the concrete lined portion of the segment and throughout the year only receives minimal flow. Historically, the Haskell R. Street WWTP discharged just upstream of this station, however, the treatment plant now discharges into the RGACE and only in time of maintenance (no more than three days per month) are flows diverted to the river. Recent upgrades to the treatment process also improved the Haskell WWTP effluent. The upgraded aeration basin now allows for denitrification to occur resulting in lower concentrations of ammonia, which can be toxic to certain species of aquatic life. Recent data from samples collected at this site showed a decreasing trend in the river when the upgrade was completed. Bacterial levels increased because the effluent was no longer being discharged into the river. The chlorine residual in the effluent and dilution helped to keep levels low in the river.

Samples collected at Station 14465 indicate that ammonia has been a concern in recent years. Analyses of the trend data show the concentration of ammonia dropping with respect to time. The source of ammonia has not been determined at this time. Other parameters show that the standards are being met with little or no change being seen in the trend analysis for other water quality indicators. Flow has decreased significantly around this station with the completion of the RGACE. The majority of the flow in this area continues to be diverted by both countries for municipal and agricultural use.

Rio Grande below Riverside Diversion Dam-Segment 2307

Segment 2307 extends from below Riverside Diversion Dam in El Paso County and flows over 220 river miles (354 km) downstream to the confluence with the Rio Conchos in Presidio County. This segment is designated for contact recreation, public water supply, high aquatic life use, and fish consumption. The aquatic life and public water supply uses are fully supported. The general uses and contact recreation were not fully supported.

This segment is often referred to as the “forgotten river” stretch because of minimal instream flow that is composed of primarily return flows from the United States and Mexico consisting of agricultural and municipal returns. There are five monitoring stations on this segment monitored by the University of Texas at El Paso (UTEP), the TCEQ El Paso field office, the El Paso Community

Figure 27. The "Forgotten River" stretch of the Rio Grande.

College (EPCC), and the USIBWC El Paso Headquarters office.

Station 16272- Rio Grande at San Elizario, 1,640 feet (500 m) upstream of Capomo Road and 6.3 miles (10.2 km) downstream of Zaragosa International Bridge. This station has not been assessed because it lacks enough data points for comparison against water quality standards.

Figure 28. Rio Grande at Alamo Grade.

Station 15704- Rio Grande at Guadalupe port of entry bridge at FM 1109 west of Tornillo, Texas. This station is also on the current monitoring schedule but lacks enough data for assessment.

Station 15795- Rio Grande at Alamo Grade Control Structure, 6 miles (9.7 km) upstream of the Fort Hancock port of entry. Data from this site show that comparison against surface water quality standards exceed the limits set for chloride and fecal coliform. Ammonia levels are above screening levels, which may be a result of either a point or nonpoint source pollution. Additional monitoring is needed to determine the source. Trend analysis shows that the concentrations at this site have been staying at current levels (no change). The Rio Grande at this point begins to be more heavily influenced by return flows from both the United States and Mexico.

Station 13232- Rio Grande at Neely Canyon, south of Fort Quitman. This station receives all return flows from both countries. The result is increasing in concentrations of various water quality constituents. The chloride concentrations nearly double and sulfate also exceeds the state criterion. Because of increasing salinity, the TDS criterion is also exceeded. Bacteria levels appear to decrease slightly compared to the upstream station at Alamo Grade Control Structure. Trend analysis does not show any significant changes in the data.

Station 13230- Rio Grande 2.4 miles (3.9 km) upstream from the Rio Conchos confluence. The samples collected here show that water quality improves slightly when compared to the upstream station. Small communities in this region may divert some water for small scale ranching but for the most part, this part of the river is used minimally. The parameters to assess public water supply (chloride, sulfate, and TDS) continue to exceed the standard. Secondary concerns such as ammonia and phosphorus exceed secondary screening levels. Because phosphorus increase compares to the upstream station, another source is probably contributing to the increase. Ammonia has dropped significantly but still exceeds the screening levels. Trend analysis show that phosphorus has been declining with respect to time, which may indicate that water quality with regards to phosphorus, is getting better. Conductivity on the other hand has been increasing. The increase in conductivity may be a result of reduced flows in the river or accumulated salts along the banks or in the water table are making their way into the main channel.

Rio Grande above Amistad Dam-Segment 2306

Segment 2306 begins just downstream of the confluence with the Rio Conchos and flows through the Big Bend Ranch State Park and National Park and is impounded at the International Amistad Reservoir. This segment is approximately 313 river miles (504 km) long. The largest communities in this segment are Presidio, Texas and Ojinaga, Chihuahua. The cities along with the smaller communities utilize the river for farming and ranching. The town of Lajitas, Texas and Nuevo Lajitas, Chihuahua have lured tourism back into this area between the State and National parks by offering rafting, horseback riding, and by providing a newly renovated resort area.

Figure 29. Rio Grande at Candelaria upstream of Presidio.

The designated uses assigned to this segment are high aquatic life, contact recreation, fish consumption, and public water supply use. The fish consumption use is fully supported. This segment was identified previously as only partially supporting the aquatic life use due to toxicity in water. Results from a statewide toxicity study still showed toxicity in this reach, but a source could not be identified. There are additional concerns for public water supply, contact recreation and general use standards as they continue to exceed the surface water quality standards.

There are seven monitoring stations in Segment 2306. The USIBWC Presidio Field office, TCEQ El Paso office, USGS, and the National Park Service (NPS) provide support and sample at these stations.

Figure 30. Rio Grande upstream of Lajitas.

Station 13229- Rio Grande below Rio Conchos confluence near Presidio. This station captures the flows of the Rio Grande and Rio Conchos upstream of the cities of Presidio, Texas and Ojinaga, Chihuahua. The USIBWC Presidio field office, the TCEQ El Paso office, and the USGS collect samples at this site. The general use constituents analyzed chloride, sulfate, and TDS exceed the surface water quality criteria as well as the standards set for a drinking water supply. Average fecal coliform concentrations exceed the criteria indicating there is a potential source entering the river in this area. The potential for illness due to ingestion of water is higher because of the bacterial concentrations that could cause gastrointestinal disease. The concentration of total phosphorus continues to exceed secondary screening levels at this site. Ammonia is above the screening level but is not increasing in concentration.

Current trend analyses indicate that chloride, sulfate, and TDS have been increasing during the assessment period. This may be due in part to reduced flows in this reach. The data for conductivity helps to support this inference as the trend during this period shows it as increasing for this time period. Conductivity correlates well with the increase in dissolved salts. The Rio Conchos Basin has been in an extended drought and the reservoir system storage has been low, resulting in below average releases into the Rio Grande.

Station 17001- Rio Grande at Presidio/Ojinaga Vehicle Bridge. The IBWC Presidio field office monitors this station for field parameters and fecal coliform. This station is located within both communities and the concentration of fecal coliform begins to exhibit the same trends that are observed throughout the basin for bacteria. The concentration of fecal coliform goes up as the river flows through the city. This is most likely due to untreated wastes entering the river or from wastewater that has been treated using primary treatment technology that generally only reduces the bacterial concentration to 1000 cfu/100 mls, compared to the standard for surface water being 400 colonies/100 ml for an instantaneous grab or 200 colonies/100 ml for the geometric average.

Figure 31. Rio Grande at Santa Elena Canyon.

Station 17000- Rio Grande at Presidio Railroad Bridge. This station is still within the city limits of both communities and the bacterial concentrations continue to increase as compared to station 17001. Trend analysis shows that the concentration has remained steady throughout the assessment period.

Station 13228- Rio Grande at the mouth of Santa Elena Canyon. The USIBWC Presidio office and the Big Bend NPS provide support at this site. After the river has passed through the Presidio/Ojinaga area, it flows through smaller communities, picking up additional flow from tributaries such as Terlingua Creek and San Carlos Creek. Bacteria levels drop and are below the surface water standards. This is important because this part of the river is used extensively for rafting and wading. The concentration of dissolved salts continues to exceed the standards for public water supply. The trend analysis for conductivity has shown a steady increase during the assessment period. As more stations exhibit this trend, it helps to support the reasoning that reduced flow is the primary reason for increased dissolved salts in the river. Total phosphorus continues to exceed the screening criteria at this site. Ammonia has dropped below the screening level at this station.

Station 16730- Rio Grande at Rio Grande Village in Big Bend National Park. As the river flows through the Big Bend National Park in Texas and the Canyon de Santa Elena and Maderas del Carmen in Mexico (states of Chihuahua and Coahuila), additional tributary flow and natural springs help to decrease the concentration of chloride, sulfate, and TDS to levels that meet surface water quality standards. The levels are still above the level for public water supply and would need additional treatment prior to use for drinking water. Total phosphorus levels have decreased and are below secondary screening criteria. Trend analysis indicate the concentration of parameters analyzed have not changed significantly during the assessment period.

Station 13225- Rio Grande at FM 2627 (Gerstacker Bridge) below Big Bend. The TCEQ El Paso office monitors this station. Samples collected have shown that the general use standards are being met. Bacterial levels are low and support contact recreation. The level of dissolved salts for finished drinking water are still being exceeded and are a concern for the public water supply use.

Station 13223- Rio Grande at Foster Ranch west of Langtry off HWY 90 W. The water quality has continued to improve as evidenced at this station monitored by the TCEQ El Paso office and the USGS. TDS levels in the Rio Grande have dropped and now meet both surface water and finished drinking water standards. There is still a secondary concern for the level of total phosphorus found in the river that exceeds the secondary screening level. Comparing the total phosphorus data, there appears to be no trend in the data, meaning the level of phosphorus in the water appears to be remaining constant.

<u>International Amistad Reservoir-Segment 2305</u>

This is the part of the Rio Grande impounded by International Amistad Reservoir in Val Verde County. Flows from the Pecos River enter the Rio Grande just upstream of Amistad Reservoir and also include the flow from the Devils River. The area of the reservoir encompasses 64,900 acres (263 square km) with a normal pool elevation of 1117 feet 340.5 (m). Levels at Amistad Reservoir have been below average during the assessment period. This is primarily from reduced flows originating from

Figure 32. International Amistad Dam.

Luis Leon Reservoir on the Rio Conchos that has averaged approximately 35 percent of the average flow during the assessment period (1998-present).

Amistad Reservoir is a popular place for boating, fishing, and picnicking. Hydroelectric power is generated at the dam by both the United States and Mexico. The dam also serves as a sink for sediment, resulting in clearer water released from the dam compared to the heavy sediment load the river carries above the reservoir. Water stored at the reservoir belongs to both the United States and Mexico based on the allocation of waters outlined in the 1994 Water Treaty. Water is released from Amistad Reservoir to downstream water rights holders in the United States and Mexico as well as to provide water for storage at Falcon Reservoir for use further downstream.

The designated uses for the reservoir include high aquatic life use, contact recreation, general uses, fish consumption and public water supply. Currently, all uses are being met except for fish consumption, which has not been assessed. There are three monitoring stations on the reservoir monitored by personnel from the USIBWC Amistad field office and the TCEQ San Antonio office.

Station 15892- Amistad Reservoir Rio Grande Arm at Buoy 28. Personnel from the TCEQ San Antonio office collect water quality samples at this site on a quarterly basis. The parameters of concern upstream of the reservoir such as chloride, sulfate, TDS, and nutrients are all being attained, even at higher standards. This is important for the downstream users who rely on this supply for drinking water. Tracking the concentration of nutrients becomes more important because of the effects these nutrients can have allowing for algal growth. Trend analysis at this station does not show any evidence of increasing or decreasing concentrations over time.

Station 15893- Amistad Reservoir Devils River Arm at Buoy DRP. Personnel from the TCEQ San Antonio Office monitor this station. Limited data is available at this site but the parameters assessed attained surface water quality standards.

Station 13835- Amistad Reservoir at Buoy #1. Concentrations of total phosphorus exceed the secondary screening criteria established for reservoirs which is lower than the level proposed for a stream, 0.18 compared to 0.8 mg/L. This is due to the reservoir being more sensitive to nutrients compared to the freer flowing river. Trend analysis shows that most parameters exhibit no change with respect to time. The trend for total phosphorus does show a decreasing trend versus time that could indicate improving water quality concerning the phosphorus levels in the reservoir.

Devils River-Segment 2309

Segment 2309 is defined from a point 0.4 miles (0.6 km) downstream of the confluence of Little Satan Creek in Val Verde County to the confluence of Dry Devils River in Sutton County. It is 67 river miles (107.8 km) in length and empties into the Amistad Reservoir. Designated uses include exceptional aquatic life use, contact recreation, public water supply, fish consumption and general uses. All uses are fully supporting except for fish consumption, which was not assessed.

Personnel from the TCEQ San Antonio office monitor station 13239- Devils River on Devils River State Natural Area 1.1 miles (1.7 km) upstream of Dolan Creek and Station 13237- Devils River at Pafford Crossing near Comstock. Additionally, Dolan Creek, Segment 2309A, is also monitored by the TCEQ at Station 14942- Dolan Springs 100 yards (91.4 m) upstream of confluence with Devils River immediately upstream of road crossing.

Water quality in this creek is very similar to San Felipe Creek. It is a high quality stream with an average TDS of 380 mg/L compared to the 700 mg/L that is found in the Rio Grande in the same area. All parameters are below surface water quality standards. No trends have been identified in the data as well as no concerns.

Basin Concerns
The primary concerns in the upper Rio Grande can be grouped into three categories:

- Elevated levels of bacteria,
- Salinity (chloride, sulfate, TDS), and
- Nutrients (ammonia and phosphorus)

Bacteria
Regarding bacteria, one of the primary concerns in this area is the lack of wastewater infrastructure to meet the needs of communities within the upper basin such as in Ciudad Juárez in Chihuahua, Mexico. Two wastewater treatment plant projects were developed and went into operation in 2001. Prior to the treatment plants, untreated wastewater was discharged into an open canal system where it was mixed with Rio Grande water delivered to Mexico under the 1906 convention, and used for irrigation. Eventually, the canal would empty into the Rio Grande downstream of El Paso near Fort Hancock, Texas. The discharges of untreated wastewater into the canal created a potential health hazard for citizens living in the vicinity.

Figure 33. Swimming in the Rio Grande Around El Paso.

Additional concerns were identified upstream of El Paso, Texas where bacterial levels exceed the standard in an area where canals from irrigated agriculture and WWTP outfalls, which are designed for primary treatment only, discharge into the Rio Grande, causing exceedances compared to the surface water quality standard in Texas. Segment 2314 in Texas overlapped with a segment in New Mexico, Segment 2101 for about 16 miles (25.7km). The standard for fecal coliform in Segment 2101, with the designated use of secondary contact, was 1000 colonies/100 ml compared to the Texas standard of 200 cfu/100 mls and designated for contact recreation. In 2002, the New Mexico Water Quality Control Board adopted a new standard of 200 colonies/100 ml to better protect this segment. New permits issued in this region will now have to comply with a more stringent discharge permit that hopefully will result in lower bacterial concentrations in the river.

Other communities are upgrading their existing WWTPs to meet the demands from increased population and to protect public health. Smaller communities will face increasing demand on their WWTPs and have to begin plans to look at upgrade or develop a broader, regional facility to meet future needs. Providing the infrastructure and treatment facilities is the first step in controlling the concentration of fecal coliform in the river. The CRP will continue to monitor the river for fecal coliform and *E. coli* at all of its routine monitoring stations to determine the benefits of upgraded and new wastewater treatment projects.

The communities located around the Big Bend Ranch State Park and Big Bend National Park such as Lajitas, Terlingua, Study Butte, and Rio Grande Village, that rely on tourism, expect the Rio Grande to meet the standards for contact recreation for rafting and wading. Upgrades being planned in Ojinaga, Chihuahua have an added benefit to the downstream users around Big Bend. This type of planning and development must continue to occur in order to get a handle on reducing bacterial concentrations in the upper portion of the Rio Grande in Texas.

Another source that the CRP is trying to identify is nonpoint source pollution that may also be a potential source of impairment for bacteria from either natural sources or runoff from concentrated animal feeding operations. The ability to differentiate between species to identify the source of contamination is now possible and being tested in the upper basin. CRP will be an active participant in using this new technology to help provide more information to assess bacterial levels and their sources in the basin.

An Assessment of Microbial Contamination and Chemical Toxicity of the Rio Grande Water Including Bacterial, Viral and Cryptosporidium Assays (Maria E. Alvarez, Ph. D., El Paso Community College, and Kevin Oshima, Ph. D., New Mexico State University, Principal Investigators)

The CRP and its partners have assisted El Paso Community College (EPCC) and New Mexico State University (NMSU) with this project for the past three years. CRP provided training on field techniques, sample collection, and equipment. CRP staff and EPCC students coordinate and sample on a monthly basis. The EPCC analyze the samples for microbial contaminants while the El Paso Water Utilities analyze for chemical constituents.

Abstract- The United States-Mexico border has unique problems related to water resources. The potential of surface and groundwater contamination with infectious organisms and toxic chemicals as a result of agricultural, domestic and maquiladora activities is very large. For this reason, continuous and accurate assessment of the quality of our water supplies is of paramount importance. The objectives of this study were to monitor water quality of the Rio Grande and selected groundwater sites and to

use the data to determine if a correlation exists between water quality indicators, toxicity, pathogen detection and environmental attributes. Other goals include determining if traditional water monitoring techniques, based on the detection of indicator organisms such as fecal coliform, can be correlated with the presence of *Helicobacter pylori* and to provide additional data on the utility of an ultrafiltration approach to concentrating and detecting pathogens from water.

Total coliform, fecal coliform, *E. coli*, *H. pylori* and chemical toxicity samples were collected at seven sites along the Rio Grande. Enterovirus, *Cryptosporidium*, and *Giardia* assays were conducted for two of the seven sites. The results show that there is a great variability in the number of Total coliform, fecal coliform, and *E. coli* on a month-to-month basis. All seven sites exceeded the standard for contact recreation waters the majority of the time. *H. pylori* as detected by an ELISA antigen test showed positive results for all the sites the majority of the time. Toxicity as determined by Botsford's Toxicity Assay ranged between 0 to 94 percent. Values above 50 percent are considered toxic. Most of the sites displayed significant chemical toxicity the majority of the time. To analyze any between data from all parameters that were measured in the study, the Pearson-Moment correlation procedure was used. As expected, there was a highly significant correlation between fecal coliform, total coliform, and *E. Coli*. Chemical toxicity shows significant positive correlations with total coliforms and specific conductivity and a negative correlation with temperature of sample. This can be due to nonpoint contamination events and the decreased river flow in the winter months. Since no significant correlation was observed between the presence of *H. pylori* antigen and the three indicators of fecal contamination including total and fecal coliform, and *E. coli*, this indicates the latter cannot be used as indicators of the presence of *H. pylori* in surface water.

Recovery of *Cryptosporidium* oocysts from the Rio Grande sites was determined from November 2001-December 2002. The highest recovery of oocysts occurred in the spring and summer months. Lower concentration of *Giardia* cysts was detected during the same period. The second objective of this part of the study was to determine the ability of the two-step ultrafiltration system to concentrate and recover naturally occurring enteric viruses from surface water from the Rio Grande.

Although there is a lot of variation on a month-to-month basis, the results show evidence of elevated concentrations of coliforms, protozoa, and enteroviruses in the Rio Grande as well as a high degree of toxicity. Indications of the impact of anthropogenic activity and the drought and river flow restrictions on microbial contamination and chemical toxicity were observed in this study. Additional studies are needed to determine the exact source(s) of fecal contamination and the significance of fecal contamination to public health.

The major goal of this project has been to examine the chemical toxicity and pathogen distribution of the Rio Grande basin using and evaluating a variety of techniques. The CRP has made significant progress toward this goal since there is now a database that includes information on the traditional and novel biological and chemical water quality indicators for a three-year period. This project has also succeeded in promoting collaboration among researchers from a variety of institutions including EPCC, NMSU, Texas A&M, Arizona State University Water Quality Center, U.T. Houston School of Public Health and the USIBWC. This work has been presented at national and regional meetings of the American Society for Microbiology, the Annual Conference of Quality of Life on the Border, the Annual Biomedical Research Conference for Minority Students and the TCEQ/USIBWC Clean Rivers Program meetings. Three papers have been submitted for publication and one has been submitted to an international journal. At least two additional papers will result from the data generated by this project.

Salinity

Salinity has been a concern for many years in the upper basin primarily due to extensive water use for agriculture and as a drinking water supply. Water from the Rio Grande picks up salt from the soil after it has been used for irrigation from one community to the other, increasing the dissolved salt content to a point where it does not meet the standards for a public water supply. Municipalities, such as the City of El Paso's Water Utility (Public Service Board), that use conventional treatment may have to use additional treatment technologies to meet drinking water standards, which will result in increased customer cost. The salinity concentration in the river below El Paso almost doubles making it difficult for farmers to use for growing crops in both the United States and Mexico. Currently, the only known user of surface water for drinking water purposes is the town of Lajitas, Texas. Because of the water quality concerns, Lajitas has added reverse osmosis as another treatment process to insure good quality water for its community.

The impact of saltcedar in relation to increasing salinity is currently being evaluated. It has been determined that saltcedar uses more water than native plants but the increase in salinity to the soil and water has not been quantified.

Farmers in the Presidio, Texas and Ojinaga, Chihuahua area utilize ground water primarily to grow crops while a few continue to use the Rio Grande and Rio Conchos. "Burning" of the soil, which is a result of too much salt (sodium in particular), binds the soil to a point that water cannot penetrate and percolate into it, no matter how much water is applied. Land has been taken out of production because of this, prompting the farmer to find an alternate use for the land, for example creating a tree farm instead of planting crops. Other land is just left to recover naturally.

Evaluating salt accumulation and release processes in riparian zones of a semi-arid river system (S. Miyamoto, Ph. D., and Fares Howari, Ph. D., Texas A&M Agricultural Research Center, El Paso, Texas). CRP staff has been assisting the Texas A&M Experiment Station located in El Paso to collect salinity data under a joint project between the USIBWC and Texas A&M University. Dr. Seiichi Miyamoto has been involved in numerous projects and studies to assist the agricultural and urban communities understand the impact of salinity to the uses of soil and water.

Abstract- Salts are the most frequent contaminant, which limits full utilization of water resources in Texas. In the case of the Rio Grande along the U.S.-Mexico border in Texas, high salinity has been a concern, and became increasingly so in recent years, due to the steady increase at the Amistad Reservoir. Salinity at the reservoir was 560 ppm when constructed in 1968, and began to climb after 1983. Salinity is now fluctuating between 750 and 900 ppm, and could exceed the federal drinking water standard of 1000 ppm, if not managed properly. High salt in the Rio Grande around and below El Paso, Texas and in the Pecos River needed additional information to determine if salts were accumulating in the riparian zones and flood plains.

The reason for this increase in salinity is unknown at present. The data available from the USIBWC indicate that the increase in salinity at the Amistad Reservoir coincided with the increase in river flow during the high precipitation period, better known as a period of "El Niño". This may indicate that the increase in salinity is probably associated with salt flushing into stream-flow during flood or bank overflow events. Such incidences are documented frequently in semi-arid regions of Australia, but seldom reported in the Western United States. The goal of this project is to initiate investigation into salt storage and release processes in an attempt to better understand their contribution to in-stream salinity fluctuation.

Objectives

1. Obtain salinity distribution data in selected riparian banks of the middle Rio Grande.
2. Establish an automated system for monitoring river flow and salinity on a continuous basis.
3. Explore a spectral method of delineating the distribution of riverbanks with high salt storage.

Progress and Accomplishments

Objective 1. The analysis of the data has yet to be completed. It is becoming apparent that salinity readings are highly variable. The high water table at some of the sites, for example, seems to have soil surface salinity ranging from 100 to 300 dS m^{-1} (salinity of sea water is 57 dS m^{-1}). However, soil salinity a few centimeters below the surface decreased to a range of 30 to 60 dS m^{-1}, then eventually to an order of 10 to 20 dS m^{-1} at the deepest sampling depth of 47.2 inches (120 cm). The salinity of the soil appears to be increasing from upstream sites in New Mexico compared to the downstream sites in and below the El Paso and Hudspeth counties. This preliminary data will undergo additional analyses to verify extreme readings for accuracy.

Objective 2. Continuous flow data is available from gaging stations along the Rio Grande, however; salinity data is only collected one to two times per month. For analyzing flow and salinity relationships as well as salt release from riparian zones, it is imperative that we have a greater data collection capability. Continuous salinity measuring devices have been installed at four sites to collect salinity readings on an hourly basis. Three of the sites, Rio Grande at Fort Quitman, Rio Grande at Candelaria, and the Pecos River at Langtry, are monitored by the USIBWC and the fourth, Pecos

River at Girvin, is monitored by the Texas Cooperative Extension, Fort Stockton and the USGS Water Monitoring Unit at San Angelo. All of the sensors have been calibrated, and reliable, continuous data is being collected.

Objective 3. The use of remote sensing data (satellite imagery) for identification of salt-affected soils on a large-scale landscape is relatively new. Typically, this was accomplished first by analyzing remotely sensed images, which may show unique spectral characteristics. Secondly, the corresponding ground areas are studied for salt contents or some other properties using traditional methods. This type of approach has some value for identifying salt-affected areas in a large barren landscape, but not for riverbanks with a limited dimension or size.

Traditional method. A portable spectro-radiometer was used to measure the reflectance from salt-crusted and non-crusted soils at three locations in the Rio Grande in February 2002 when salt crusts were most visible. Results show a constant relationship between reflectivity and soil salinity. It is probable that soils can be delineated into at least two groups based on reflectance measurement, a group having salt crust and another group without.

Remote Sensing method. Dr. Howari has developed an extensive spectral library for various salt crystals to identify the type of evaporite minerals, which make up the salt crust. The salt crust that appears on riverbank surfaces is usually made of various evaporite minerals, such as gypsum, halite and thenardite. This heterogeneous nature of salt crusts may make it difficult to identify spectral patterns when compared against the library spectra made for “pure” salts. Originally, it was thought that spectral patterns could be used to determine if salts accumulated on the ground surface are being washed into the stream or staying on the ground. Because of equipment limitations, these questions cannot be answered at this time.

Current and Future Plans

The overall goal is to continue working on the work identified in the three objectives. 1) Soil salinity is very high in certain parts of the riparian zone (at or above what is found near the seacoast). A model, HYDORUS-2D, developed by U.S. Salinity Laboratory will be used to analyze salt accumulation and distribution in selected riparian zones in the Rio Grande. 2) Continuous monitoring of the Rio Grande will be ongoing with the USIBWC at the three sites currently being used. An effort will be made to sustain this monitoring program. 3) The analyses of spectral data hold good potential, if the effort is linked with an organization with remote sensing capabilities.

Nutrients
Although still considered secondary indicators and have not been adopted as water quality standards, these parameters still provide valuable information for assessing the water quality. Elevated levels of phosphorus and ammonia concentrations usually lead back to a discharge from municipal/industrial or agricultural source in general. It can be the result of a WWTP that is not operating properly, not converting ammonia to nitrate, or a system that is not capable of converting at all, as most primary systems for example. Phosphorus travels unchanged through the treatment process and is used in many types of fertilizer. Ammonia can be toxic to certain aquatic species and, as stated, could be an indicator that other pollutants may be present in the water associated with the source. Phosphorus can lead to algal blooms, which may lead to eutrophication (depressed dissolved oxygen levels). The Rio Grande is a fast moving river and has not exhibited these conditions to any great extent. Identifying the source to minimize the impact is still important and the CRP will continue to collect data on nutrients to protect the overall health of the river.

Additional Studies in the Upper Rio Grande

Assessment of Arsenic and Heavy Metals Concentrations in Water and Sediments of the Rio Grande at El Paso – Juárez Metroplex Region. (J.V. Rios-Arana, E.J Walsh, and J.L. Gardea-Torresday. University of Texas at El Paso.)
The study was conducted to determine if runoff and wind deposition of smelting residues has contributed to the pollution of the Rio Grande in the El Paso – Ciudad Juárez area. Researchers analyzed arsenic and heavy metals (Cr, Cu, Cd, Ni, Pb, and Zn) concentrations in water and sediment samples collected at seven sites in the El Paso –Juárez region. Physical and chemical parameters were also measured at each site because of the potential influences they have on metal content in water. Arsenic and heavy metal concentrations were determined using Inductively Coupled Plasma (ICP) emission spectroscopy using EPA approved methods and guidelines. The sites are located around and in El Paso with three sites located near a smelter plant. The data from these sites confirmed the presence of heavy metals in the water and sediment. Values for Zn and Pb exceeded the freshwater chronic limits set by the EPA. These elevated metals concentrations may cause an impact on health and reproduction for organisms living in this region of the Rio Grande. UTEP plans to continue their research to obtain more information, to determine changes in metals concentrations due to seasonal variations in flow, and to assess the impact of these metals on the population of organisms in this region.

Fish Community Surveys and Related Stream Habitat Assessments in the Rio Grande from below Presidio, Texas to near Cajoncitos, Mexico, J.B. Moring, Ph. D., USGS, In Press.
The Rio Grande represents the Chihuahuan Desert's most extensive aquatic and associated riparian environments. Aquatic life inventories in the Rio Grande through the Big Bend region indicate that 4 of 36 native fish species known from the river and its tributaries in the Big Bend region have been extirpated, including the endangered Rio Grande silvery minnow (Platania 1990). Of the remaining native species, the Big

Bend gambusia is federally endangered, and the Rio Grande chub, blue sucker, blotched gambusia, Chihuahua shiner, Mexican stoneroller, Proserpine shiner, Rio Grande darter, and the Rio Grande shiner have been identified by the U.S. Fish and Wildlife Service (USFWS) as species of concern. The majority of the species with reduced ranges and populations occur only in the Rio Grande between El Paso and Falcon Reservoir. Thirty-two native fish species persist, but compete with 11 exotic fish species, a number that has steadily grown in recent years.

The Research and Investigations section of the USGS in Austin, Texas conducted fish community surveys and assessed related in-stream habitat conditions in the Rio Grande from just below Presidio, Texas to near Cajoncitos, Mexico between April 1st and 5th, 2002. The data from this effort will provide updated baseline information regarding the occurrence and distribution of fishes in this reach of the Rio Grande.

Middle Rio Grande Sub-Basin

Watershed Characteristics

The Middle Rio Grande sub-basin represents the portion of the river below Amistad Dam downstream to include International Falcon Reservoir. As the river flows through the scenic vistas of the Seminole Canyons and is impounded in the International Amistad Reservoir, the solids carried by the river settle making the downstream releases much clearer. Water quality improves mostly due to the addition of high quality water from the Devils River. Downstream of Amistad Dam the river continues to flow through sister cities that utilize the river for irrigation and as their drinking water supply. The City of Del Rio, Texas is the only large city along the river in this part of the basin that utilizes groundwater, as it's principal water supply. The other communities such as Eagle Pass, Texas and Laredo, Texas rely on the river as their primary drinking water supply. Because of drought conditions, some communities are exploring alternate sources to supplement the river supply to insure an adequate supply for its community. The release of water from Amistad Dam is based on allocation of water rights in the United States and Mexico and to provide flow to International Falcon Dam for further distribution. As is the case along the United States-Mexico border throughout Texas, sister cities located in this reach struggle to stay ahead of development and to provide the infrastructure to minimize the pollution going into the Rio Grande. CRP and its partners continue to collect water quality data to assist community leaders monitor above and below the major populated areas in order to determine what impacts are occurring and what can be done to minimize their effects.

Table 5 Middle Rio Grande Sub-basin Populations

City	Population
Del Rio	33,867
Eagle Pass	22,413
Laredo	176,576
Zapata	4,856

There are 65 permitted dischargers in the sub-basin include three CAFOs, 39 industrial, and 23 municipal.

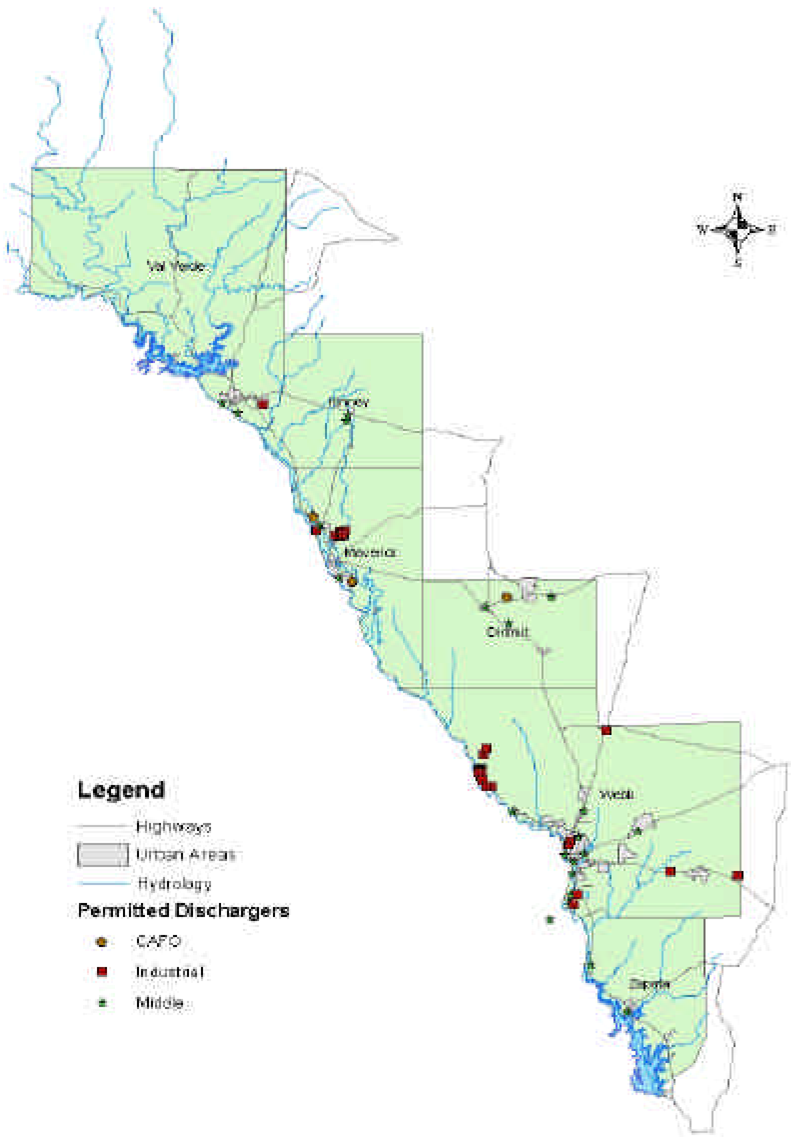

Figure 34. Middle Rio Grande Sub-basin Permitted Dischargers.

The Middle Rio Grande sub-basin is the portion of the Rio Grande from below International Amistad Dam to International Falcon Reservoir. The sub-basin contains three segments:

- Rio Grande Below Amistad Reservoir (2304)– From the confluence of the Rio Salado (Mexico) in Zapata County to Amistad Dam in Val Verde County, which runs for 226 miles (364 km).
- International Falcon Reservoir (2303)– From Falcon Dam in Starr County to the confluence of the Rio Salado (Mexico) in Zapata County, which runs for 68 miles (110 km).

- San Felipe Creek (2313)– From the confluence of the Rio Grande in Val Verde County to a point 2.5 miles (4.0 km) upstream of US 90 in Val Verde County, which runs for 9 miles (14 km).

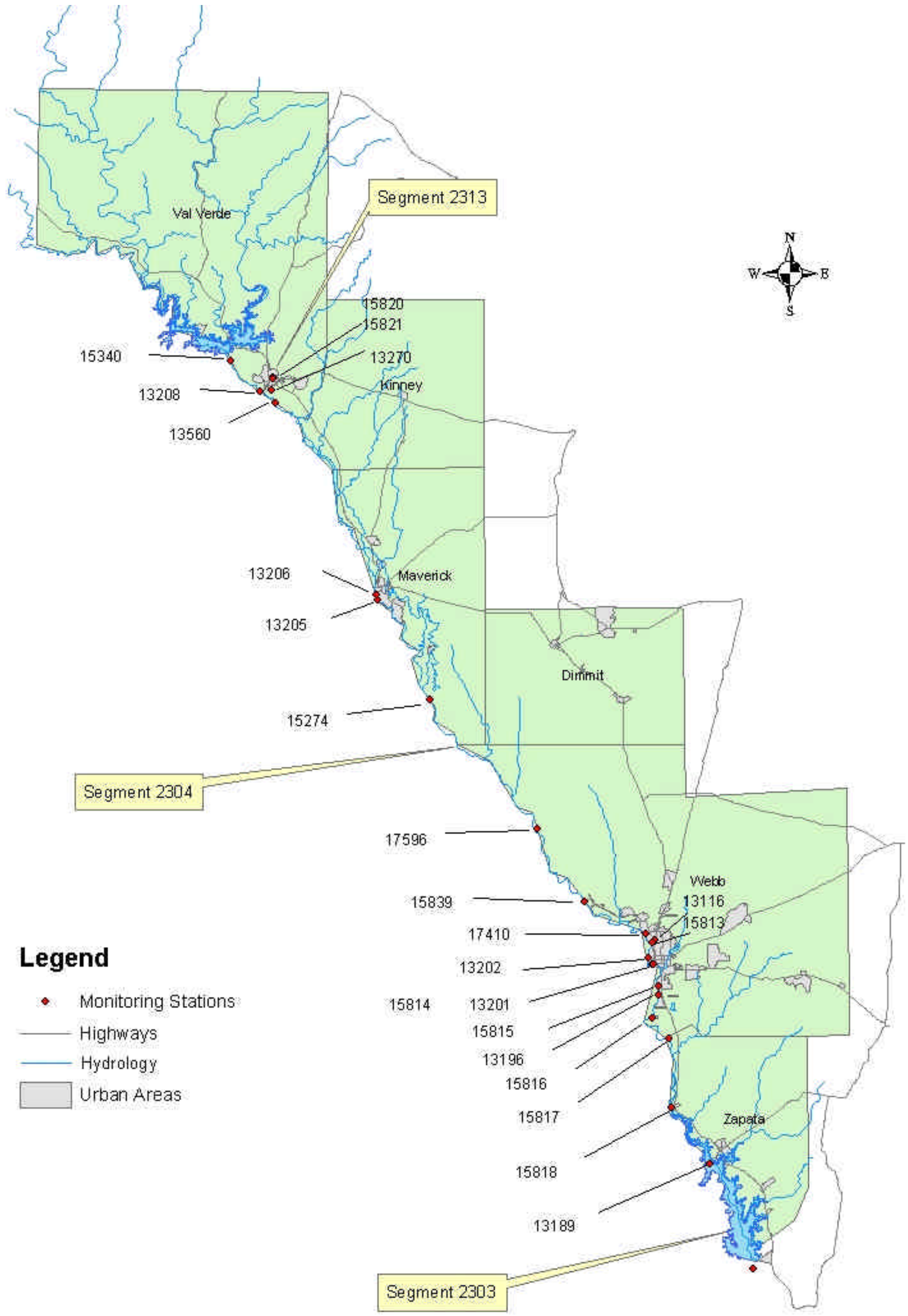

Figure 35. Middle Rio Grande Sub-basin Monitoring Stations.

San Felipe Creek-Segment 2313

Segment 2313 is a high quality stream that originates in the Del Rio area. Two springs, located within the city limits, make up the San Felipe springs, which becomes the San Felipe Creek. It flows through a portion of the city until providing it with a high quality water supply for drinking, fishing, and swimming. Recently, the City of Del Rio, Texas constructed a water treatment facility to provide the city with a means of treatment, reverse osmosis, if needed.

The segment is designated for high aquatic life, contact recreation, general use, fish consumption, and for public water supply use. All uses were fully supported except for fish consumption, which was not assessed. This creek has a positive effect on the Rio Grande. Water quality is very high and helps to reduce some of the loading in the Rio Grande as it travels downstream to other communities.

Figure 36. Sampling at San Felipe Creek in Del Rio.

Station 15820- San Felipe Creek at West Springs, near west wells in Del Rio. Personnel from the TCEQ San Antonio office monitor this station. No trends or concerns were identified at this site.

Station 15821- San Felipe Creek at Blue Hole flood gates, in park between U.S. 90 Bridge and Southern Pacific Railroad Bridge in Del Rio, Texas. Not enough data has been collected to assess this site.

Station 13270- San Felipe Creek at Guyler Confluence with the Rio Grande. All parameters analyzed for met the surface water quality standards for this segment. Trend analysis showed no change in the concentration(s) over the assessment period.

Rio Grande below Amistad Reservoir-Segment 2304

Segment 2304 is defined as the Rio Grande just downstream of Amistad Reservoir to the confluence of the Arroyo Salado in Zapata County. The segment is 226 river miles (364 km) in length. The sister cities of Del Rio, Texas and Ciudad Acuña, Coahuila, Eagle Pass, Texas and Piedras Negras, Coahuila, Laredo, Texas and Nuevo Laredo, Tamaulipas are located in this part of the Rio Grande Basin. The water body uses for this segment are high aquatic life use, contact recreation, general uses, fish consumption, and public water supply use. The public water supply, fish consumption, and general uses are fully supported.

The standard for fecal coliform was not met in different parts of the segment indicating a concern for contact recreation. As stated previously, *E coli* will replace fecal coliform as the primary indicator of fecal contamination. Until enough data is collected, fecal coliform will still be collected and used to assess this segment. Ambient toxicity was not met in previous years downstream of Del Rio, Texas. This part of the river will continue be identified as not meeting aquatic life due to ambient toxicity until additional data can be collected to demonstrate use support.

There are 18 monitoring stations in this segment primarily located within the populated areas along the river.

Station 15340- Rio Grande 2.1 miiles (3.4 km) downstream of Amistad Dam above weir dam (IBWC gage #08-4509.00). This site is collected by the USGS under the NASQAN program and the TCEQ San Antonio office. Analysis at this site indicates total phosphorus is a concern. All other indicators of water quality are being met at this site.

Station 13208- Rio Grande 12.8 miles (20.6 km) below Amistad Dam, 1,115 feet (340 m) upstream of U.S. 277 Bridge in Del Rio. The TCEQ San Antonio and Amistad Dam field offices provide support for this site. There is a concern for total phosphorus at this site. Trend analysis shows that total phosphorus levels are staying constant during the assessment period.

Stations 13560- Rio Grande, 4.5 miles (7.2 km) downstream of Del Rio, Texas at Moody Ranch. The concentration of fecal coliform bacteria compared to the upstream site has increased and is above the surface water quality standard. Total phosphorus continues to exceed the screening criteria but appears to be declining over time based on the trend analysis.

Figure 37. USIBWC Personnel Sampling at Moody Ranch in Del Rio.

Station 13206- Rio Grande at U.S. 277 in Eagle Pass, Texas. The TCEQ San Antonio Office and the USIBWC Amistad Dam field offices collect samples at this site. Water quality is being met with the concentration of parameters below surface water quality standards. Fecal coliform and total phosphorus are within acceptable limits at this site as compared to the upstream station.

Station 13205- Rio Grande near Irrigation canal Lateral 50 at U.S. 277 in Eagle Pass, Texas. This station and 13206 represent the trend that is seen throughout the Rio Grande. Water quality parameters are being met at station 13206 after recovering from exceedances that occurred downstream of Del Rio, Texas. As the river flows through Eagle Pass, Texas, the concentration of bacteria goes up above the surface water standard. Total phosphorus and ammonia both increase above secondary screening levels. This is a pattern seen when discharges from communities is returned to the river. Addressing and identifying these returns is one of the goals in the CRP.

Station 15274- Rio Grande at USIBWC Weir Dam six miles south of El Indio, 0.6 miles (1 km) downstream of Cuervo Creek. Limited data at this site prevents assessment of many of the uses, although the bacterial levels are below surface water standards at this station.

Station 17596- Rio Grande at Apache Ranch. This station was recently added to the monitoring program and is monitored by the USIBWC Laredo field office. There is not enough data to adequately assess this station at the current time.

Figure 38. Rio Grande at Colombia International Bridge Upstream of Laredo.

Station 15839- Rio Grande at the Colombia Bridge. The Rio Grande International Studies Center (RGISC) and the City of Laredo Health Department collect data at this site. This station is located upstream of the Laredo, Texas and Nuevo Laredo, Tamaulipas, upstream of the populated areas. Assessment of the data indicates water quality is being met.

Station 17410- Rio Grande below World Trade Bridge. This station has only been sampled for the past two years and not enough data points have been collected properly assess the site. The RGISC collects the samples at this site on a quarterly basis.

Station 13116- Manadas Creek at FM 1472 North of Laredo. The City of Laredo's Environmental Services Division helps to monitor this site under the CRP. Additional data is needed to assess this site.

Station 15813- Rio Grande at CP&L Power Plant Intake. The City of Laredo Environmental Health Department collects bacterial samples at this site. Samples are collected on a monthly basis. The assessment shows that fecal coliform levels are meeting surface water quality standards at this site.

Station 13202- Rio Grande at Laredo Water Treatment Plant pump intake. Surface water quality standards are being met at this station. Trend analysis shows no changes in water quality with respect to time.

Station 13201- Rio Grande 98 feet (30 m) upstream of U.S. 81 Bridge (Convent Avenue) in Laredo. The City of Laredo Environmental Health Department collects bacteria samples on a monthly basis while Dr. Tom Vaughan of the RGISC collects water quality data to include bacteria and physicochemical parameters. Analysis of the data shows that bacteria starts to increase at this site exceeding surface water quality standards set for contact recreation. All other parameters meet standards and criteria.

Station 15814- Rio Grande at International Bridge #2 (East Bridge) in Laredo. Compared with the upstream station, bacterial densities increase from a geometric average of 239 colonies/100 ml to 316 colonies/100 ml. Trend analysis shows that the concentration during the assessment period was increasing.

Station 15815- Rio Grande at Masterson Road in Laredo, 6.2 miles (9.9 km) downstream of International Bridge #1. The City of Laredo Environmental Health Department collects bacterial data on a monthly basis. Fecal coliform concentrations continue to rise, compared to the upstream station, with an average concentration of 371 colonies/100 ml. Trend analysis shows no change with respect to time.

Station 15816- Rio Grande at Rio Bravo, 0.3 miles (0.5 km) downstream of the community of El Cenizo. The City of Laredo Environmental Health Department collects samples for fecal coliform and *E. Coli* analysis. The current assessment indicates that samples for fecal coliform exceed the surface water quality standard, 224 colonies/100 ml compared to the 15815, which is 371 colonies/100 ml.

Station 13196- Rio Grande at Pipeline Crossing, 8.6 miles (13.9 km) below Laredo. The USGS collects under the NASQAN program and the RGISC and the City of Laredo Health Department monitor this station for routine parameters. This station, much like most of the upstream station within the Cities of Laredo and Nuevo Laredo (Dos Laredos), shows an increase in bacteria. The concentration of ammonia, a secondary concern, also increases. The concentration of fecal coliform compared to the next upstream site increases from 224 colonies/100 ml to an average of 851 colonies/100 ml. Although both exceed the surface water standard and screening criteria, the trend analysis indicates a decreasing trend meaning, although still high, the water quality is improving. All other water quality parameters are meeting surface water quality standards.

Figure 39. Collecting Field Data in Laredo at Masterson Road.

Station 15817- Rio Grande at Webb/Zapata County line. The RGISC collects water quality samples at this site. The concentration of fecal coliform continues to exceed the standard at this site (288 colonies/100 ml), although not as high as station 13196. The levels of ammonia have dropped below screening levels and overall water quality is good. Trend analysis shows that dissolved oxygen is increasing during the summer months, fecal coliform is showing a decreasing trend, as well as ammonia, which leads us to believe water quality is getting better instead of worse.

International Falcon Reservoir-Segment 2303

Segment 2303 is defined as that part of the Rio Grande that is impounded by the International Falcon Dam at a normal pool elevation of 301 feet (91.7 m). The reservoir, like Amistad, is used for recreation, water supply, and hydroelectric power generation. The extended drought along with below average flow from tributaries has resulted in less water in the reservoir and reduced allocations for downstream users, primary irrigated agriculture.

The designated uses for the reservoir include contact recreation, high aquatic life, fish consumption, and for public water supply use. The public water supply and general uses are fully supported. The high aquatic life use, contact recreation and fish consumption uses were not assessed. Previously listed as exceeding the surface water quality standards for chloride and TDS, these parameters were removed from the 303(d) list in 2000 as recent data showed the segment was attaining the standards.

Station 13189- Falcon Lake at International Boundary Monument #1. During this past year, the station was re-activated to increase the amount of water quality data in the reservoir and is currently being monitored by the USIBWC Falcon Field Office. There are not enough data points at this time to assess the site.

Station 15818- Falcon Reservoir at San Ygnacio Water Treatment Plant intake, 984.2 feet (300 m) downstream from U.S. B83 Bridge. Dr. Tom Vaughan of the RGISC monitors the station for general water quality parameters, toxicity, and metals on a semi-annual basis. Additional data needs to be collected to assess all designated uses.

Basin Concerns

Overall, the water quality in the Middle Rio Grande Basin from below Amistad to Falcon Reservoir has remained the same or is improving. The concerns for salts in the Upper portion of the Rio Grande are not found in this reach. From reviewing the water quality data though, it becomes apparent that the concerns for bacteria and nutrients continue to occur and remain a concern within and below communities that border the Rio Grande. The increases typically occur below return drains and tributaries, which leads CRP staff to believe that the main source of contamination is still due to wastewater discharges. Cities in both the United States and Mexico are working to address this problem by constructing new WWTP plant facilities and upgrading collection systems. This is the first step in controlling the concentration of bacteria and associated pollutants found in wastewater.

The nutrient loadings occur in the same frequency, mostly, as high bacteria levels. High total phosphorus and in some cases ammonia-nitrogen also indicate that return discharges from populated areas are the main source of these constituents. This is important for communities to know especially for those concerned about using the Rio Grande as a drinking water supply as well as for eating the fish and coming into contact with the water. It is important for people to understand that the overall water quality is good, but more must be done to minimize the impacts of return flows into the river for the health of the system and for the benefit of the downstream users, of which we are all a part.

Community Involvement. Another source of concern within city limits is illegal discharges and dumping. More and more communities are providing support to control the impacts from these events. The TCEQ used to provide the majority of the enforcement in this area. As communities get larger, it became apparent that cities and counties had to play a more active role in this area. For example, the City of Laredo, Texas has been leading the way in this part of the basin by taking a proactive approach in this area. The city consolidated the Environmental Engineering Division of the Laredo Engineering Department and the Hazardous Materials Division of the Laredo Fire Department now known as the Environmental Services Division directed by Riazul I. Mia. Bringing these divisions together into one department provides a single point of contact so a person who has a concern does not have to search for someone to address an environmental issue. The division monitors storm water discharges as required under the National Pollutant Discharge Elimination System (NPDES) to know what is going into the tributaries and ultimately the river, along with providing education materials, managing the household hazardous waste program, inspecting warehouses and issuing permits where hazardous materials are stored (cityoflaredo.mainnewsarchives/073001/s2.htm).

<u>*Special Studies*</u>

Binational Study Regarding the Intensive Monitoring of the Rio Grande Waters in the Vicinity of Laredo, Texas and Nuevo Laredo, Tamaulipas between the United States and Mexico, November 6-16, 2000, IBWC- United States and Mexico.

Figure 40.   Sampling Team Poses in Between Sample Collections.

The Rio Grande is an important water supply for the United States-Mexico border region. Communities such as the sister Cities of Laredo, Texas and Nuevo Laredo, Tamaulipas rely heavily on the river for agriculture and as a drinking water supply. Within the last thirty years, the two cities have been experiencing rapid population growth and expansion due to the increasing trade between the United States and Mexico. The Rio Grande is influenced in this area by treated wastewater effluents, untreated wastewater, and tributary flows. In order to address water quality issues, current information must be available to determine the condition of the river.

In November 2000, the International Boundary and Water Commission, United States and Mexico (IBWC), along with other federal and state agencies, collected seven sets of water quality samples in the Rio Grande along the Laredo/Nuevo Laredo reach to determine the ambient water quality during low flow conditions. The river samples were also compared to current TSWQS as a point of reference on current water quality conditions. Additionally, samples were collected at the Nuevo Laredo International Wastewater Treatment Plant (NLIWTP) to compare the effluent discharges with the standards established under IBWC Minute No. 279. The information collected from this study would also assist agencies that monitor the Rio Grande identify areas that need additional or increased monitoring.

Results of the study show that overall water quality compared to TSWQS is comparable and the majority of the parameters fall within acceptable limits. Contact recreation (swimming and wading) is not being attained because fecal coliform and *E. Coli* levels increase as the river flows through both communities. The increase in concentration of bacteria in the mainstem of the river as it flows through the two communities should be addressed in current monitoring programs and extended to a binational level. This effort should include the Rio Grande to include the tributaries in this reach to identify the sources of bacterial contamination that continue to affect this portion of the river. Also, provide the means for the creation of a binational network for the timely exchange of water quality data between water quality monitoring entities in the Laredo/Nuevo Laredo area.

The results obtained by Mexico in this study indicate that the organic compounds detected in the main stem of the Rio Grande, such as hexachloro 1-3 butadiene, hexachloroethane and 1-4 dichlorobenzene are coming probably from agricultural, municipal and industrial activities, and are the constituents of major concern according to the criteria employed. The NLIWTP is producing a very good quality effluent. Samples collected for the facility show a very good efficiency removal of solids and with the exception of two samples exceeding the fecal coliform limit; the standards established under IBWC Minute No. 279 were being met. The presence of organic compounds was detected in the NLIWTP effluent by both countries. Currently, applicable legislation does not consider the presence of organic compounds, such as hexachloro 1-3 butadiene, hexachloroethane and 1-4 dichlorobenzene which were detected in the NLIWTP effluent; however, and given the origin, persistence and behavior of these organic compounds, it is considered that these should be included in future monitoring studies.

The monitoring program should be continued at the NLIWTP Influent contemplated under IBWC Minute No. 297 to identify all those companies that discharge wastewater into the sewerage system with the objective of regulating these discharges and thus protect the proper functioning of the Nuevo Laredo wastewater treatment process; while for the Rio Grande, we suggest a systematic monitoring to determine the sources of contamination for the purposes of regulating them and thus preclude the deterioration of the system to be able to use the water whenever required. Future monitoring programs should be designed to efficiently collect the data, which will permit an evaluation of the effects of these applications on receiving bodies of water and their ecosystems.

Health Consultation, Rio Grande at Laredo, Laredo, Webb County, Texas, December 20, 2001, Texas Department of Health.
Subsistence and recreational fishing from the Rio Grande are well-documented activities in the United States and Mexico. As suggested by population statistics, the public health impacts of consuming contaminated fish from the Rio Grande may be substantial. Prompted by previous studies done in the Rio Grande, this study (funded by the TCEQ) was developed to evaluate potential adverse health effects from consumption of fish from the Rio Grande. The first phase of this assessment, reported in this health consultation, targeted two sites near Laredo, Texas. One site was directly upstream of Laredo; the other was downstream of the city.

The Texas Department of Health (TDH) found the presence of Aroclor 1254 (a polychlorinated biphenyl- PCB) and DDE (a degradation product of DDT- dichloro-diphenyl-trichloro-ethane) downstream of Laredo and DDE upstream of Laredo. The TDH concluded that regular consumption of fish from the Rio Grande in the near vicinity of Laredo, Texas (upstream and downstream) should not result in exposure to doses of PCBs or DDE or combinations of the two chemicals that would exceed risk management guidelines. Therefore, eating fish from the Rio Grande near Laredo poses no apparent public health risk.

Lower Rio Grande Sub-Basin

Watershed Characteristics

Population centers along the Lower Rio Grande have grown tremendously in the last ten years.

Table 6 Lower Rio Grande Sub-basin Populations.

Cities	Population
Brownsville	137883
Harlingen	58210
La Joya	3157
McAllen	106822
Mercedes	14531
Pharr	42318
Progresso	4833
Rio Grande City	14886
Weslaco	27630

There are 109 permitted dischargers in the sub-basin include six CAFOs, 62 industrial, and 41 municipal dischargers.

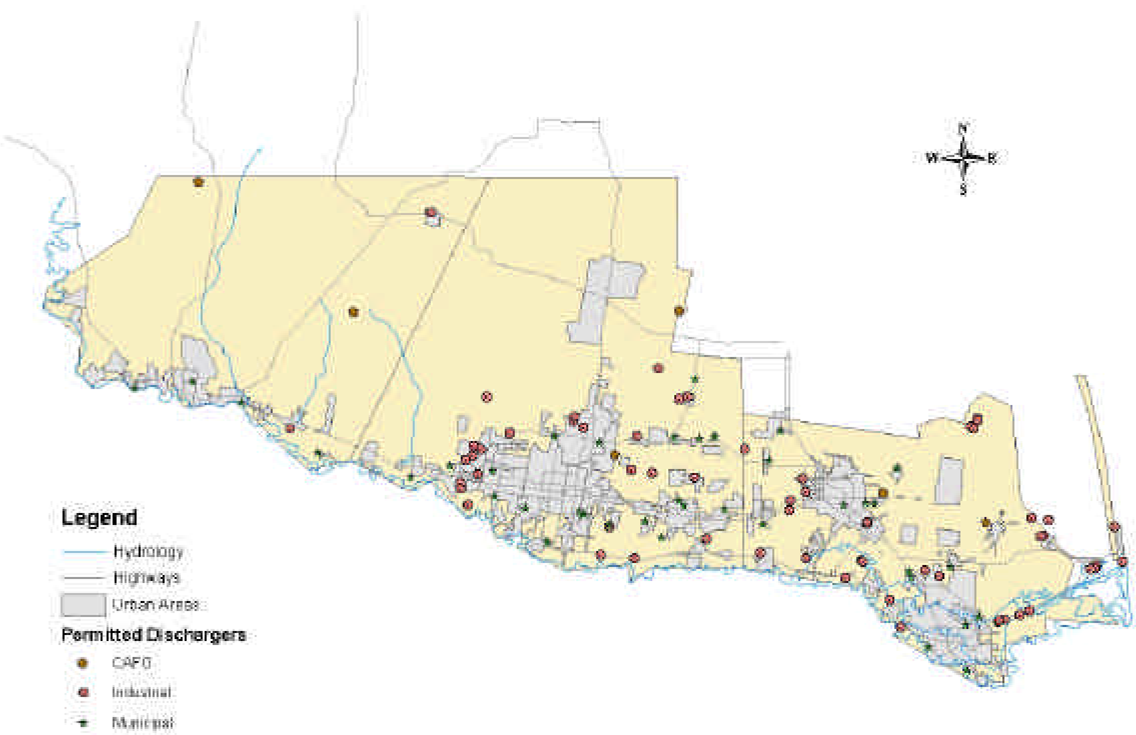

Figure 41. Lower Rio Grande Sub-basin Permitted Dischargers.

The Lower Rio Grande is the section of the Rio Grande from a point just below Falcon Reservoir to the mouth of the Rio Grande at the Gulf of Mexico. The sub-basin contains two segments:

- Rio Grande below Falcon Reservoir (2302)– From a point 6.7 miles (10.8 km) downstream of the International Bridge in Cameron County to Falcon Dam in Starr County, which runs 231 miles (371 km).
- Rio Grande Tidal (2301)– From the confluence with the Gulf of Mexico in Cameron County to a point 6.7 miles (10.8 km) downstream of the International Bridge in Cameron /county, which runs 49 miles (79 km)

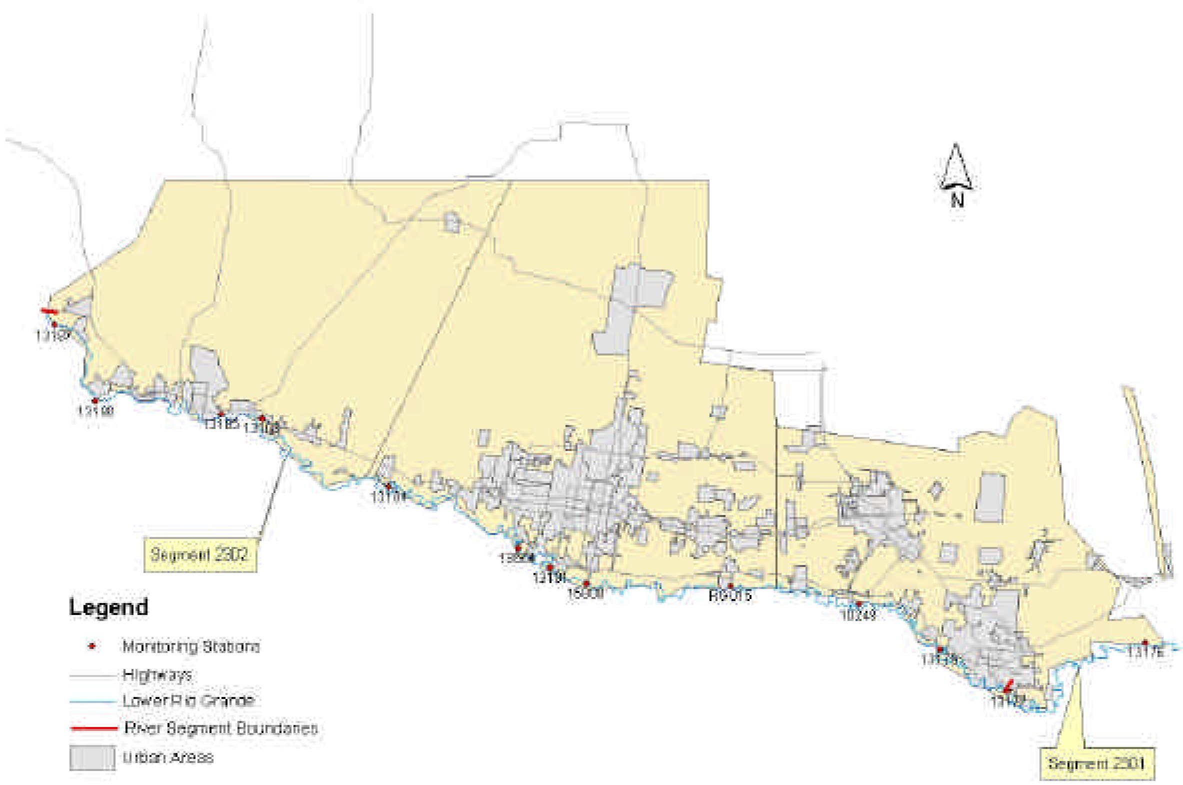

Figure 42. Lower Rio Grande Sub-basin Monitoring Stations.

Rio Grande below Falcon Reservoir-Segment 2302

Segment 2302 is classified as a freshwater stream with a length of 231 miles (371.8 km) and contains 12 monitoring stations. Its designated uses are high aquatic life use, contact recreation, general use, fish consumption, and public water supply. This segment contains an impairment for contact recreation use due to high bacteria levels in the portion of the segment from Pharr International Bridge to downstream of Santa Ana Wildlife Refuge.

Station 13186 - Rio Grande below Rio Alamo near Fronton. This site has a nutrient enrichment concern for exceeding the total phosphorous standard. Trend analyses show a very slight decline in pH and dissolved oxygen. This site also has shown an improvement in TDS, conductivity, chlorides, sulfates, ammonia, and total phosphorous over the past five years.

Station 13103 - Arroyo Los Olmos Bridge on US 83 south of Rio Grande City. This site shows a significant decline in overall salt concentrations.

Station 13184 - Rio Grande at SH 886 near Los Ebanos. This site has a slight declining trend in chloride, sulfate, and conductivity.

Station 13664 - Rio Grande 0.5 mi (0.8 km) below Anzalduas dam, 12.2 mi (19.6 km) from Hidalgo. There is limited data at present for this site except for conductance which shows periods of high and low concentration, but shows no trend otherwise.

Station 13181 - Rio Grande International Bridge at US 281 at Hidalgo. Dissolved oxygen displays a very slight declining trend. On the positive side, all remaining primary and secondary concerns exhibit a declining trend. PH is also declining towards an ideal pH of 7.4.

Station 15808 - Rio Grande 656 feet (200 m) upstream of Pharr International Bridge. Salt concentrations, ammonia, and total phosphorous levels at this site show a declining trend.

Station 13180 – Rio Grande below El Anhelo drain south of Las Milpas. This site is listed on the 303(d) list as having a contact recreation use impairment due to high bacteria levels. This site has limited data and has not had any data collected at this site for several years. Station 15808 upstream of this site and station RG015 downstream of this site contain recent data and do not exhibit this same impairment. This does not mean that the impairment does not still exist. Resuming sample collection at this site could confirm or deny that this condition presently exists.

Station RG015 - Rio Grande 238 feet (100 m) upstream from the FM 1015 Bridge at Progresso. This is a recent site that has limited data and cannot be analyzed for concerns or trends.

Station 10249 - Rio Grande 3.9 miles (6.3 km) downstream from San Benito pumping plant, 9.5 miles (15.3 km) SW of San Benito. This site has limited data and cannot be analyzed for concerns or trends at this time.

Station 13179 - Rio Grande near River Bend boat ramp, approximately five miles west of Brownsville on US 281. This is another site with too few data collections to confidently analyze for trends.

Station 13177 - Rio Grande El Jardin pump station 300 feet (91 m) below intake. All primary and secondary concerns at this site show a declining trend, except for ortho-phosphorous, which exhibit a rapidly climbing trend.

Rio Grande Tidal-Segment 2301

Segment 2301 is classified as a tidal stream with a length of 49 miles (79 km). Its designated uses are exceptional aquatic life use, contact recreation, general use, and fish consumption. All uses are supported, except fish consumption, which has not been assessed.

This segment contains only one monitoring station: 13176 – Rio Grande Tidal at SH 4 near Boca Chica. This site contains an algal growth concern for excessive algae as determined by high chlorophyll-*a* levels. Trend analyses show an increasing trend in dissolved oxygen and a decreasing trend in bacterial contamination. Orthophosphate has shown a slow increase in its trend.

Basin concerns

Water quality in the region has seen many improvements with slight problems with bacterial and phosphorous contamination. The sources for these water quality issues can be traced to municipal impacts. They can also be associated with the main concern in the sub-basin, the lack of water quantity.

Water quantity has steadily declined in the sub-basin due to several factors. Drought conditions in the entire basin, including this region, are having a cumulative effect on water quantity in this sub-basin. Increased population in the Lower Rio Grande Valley has lead to increased water usage by municipalities. Groundwater in this region is too brackish to use for public consumption, so municipalities rely solely on surface water as their drinking water source. The final factor decreasing water quantity in this sub-basin is the rapid invasion of non-native aquatic plants, specifically hydrilla and water hyacinth.

Figure 43. Water Hyacinth in the Lower Rio Grande Sub-basin.

Figure 44. Hydrilla in the Lower Rio Grande Sub-basin.

Texas Parks and Wildlife Department (TPWD), with assistance from several state, federal, and international agencies, have been reasonably successful in removing water hyacinth blockages from key areas on the river over the last few years. Removal efforts generally take place in the fall. Part of the effort is to use mechanical removal, but the TPWD is working on a Memorandum of Understanding with Mexico to use herbicides to assist in the removal of water hyacinth.

Projects to remove or control hydrilla include the release of grass carp that feed on the hydrilla. Initially, TPWD released a small community of grass carp fitted with radio transmitters to track the carp's movements. No tagged fish have moved upstream of the Anzalduas Dam since the fish were introduced. TPWD plans to release a larger number of fish for hydrilla control soon. Recommendations will probably range from 16,000 to 42,000 triploid grass carp to control vegetation (hydrilla) downstream of Anzalduas Dam to the coast.

All of the above water quantity issues have led to a decreased velocity in the flow of water in the Lower Rio Grande resulting in the closure of the mouth of the river at it's confluence with the Gulf of Mexico. Several attempts to reopen the mouth by government agencies and by local citizens have been unsuccessful. Recent studies by hydrologists at the University of Texas at El Paso in a study for the USIBWC have shown that the reduced flows in the river are not sufficient to prevent sediment build up from accumulating. Increased rains from the Gulf of Mexico bring enough water into the river on occasion to allow the river to reopen its connection with the Gulf. During these times, the mouth of the river is open, but without increased flows in the river, the condition will re-occur.

Figure 45. Mouth of the Rio Grande when Closed.

5.0 Conclusions and Recommendations

Conclusions

During the past five years that the USIBWC has been administering CRP in the Rio Grande Basin, it has tried to build upon the program developed by the TCEQ. The USIBWC expanded the range of the CRP by adding additional monitoring stations, recruited more partners, and supported ongoing research in the basin. These efforts have resulted in:

- Increased data under an approved QAPP. More data is being provided to the TCEQ in the Rio Grande under a qualified plan than has been in the past. CRP staff have stressed the importance of collecting quality assured data and will continue to provide support and training to insure that all individuals involved in water quality monitoring are aware of these requirements.
- CRP's website serves as a clearinghouse of water quality data that can be easily downloaded by any user via the Internet. Current information on the CRP's activities is available along with reports and interactive basin maps.
- Concerns for bacteria occur throughout the basin along the border. CRP and its partners have collected additional fecal coliform and *E. coli* data to determine use attainment status and are now poised to focus on specific areas to isolate and identify the sources of pollution. Intensive surveys such as the study conducted by the IBWC to assess the affects of the NLIWTP show the benefits of providing communities with this type of facility. Bacterial, biological and chemical waste loadings have been reduced, effectively removing a vector of disease in the Dos Laredos community.
- The work done by the EPCC, NMSU, and ASU to identify contaminants in the upper Rio Grande has provided valuable information regarding bacterial, viral, and chemical concentrations that can be found in an area affected by municipal, industrial, and agricultural discharges.
- Getting a better handle on salinity.
    - The Texas A&M Extension Service in El Paso has collected additional information that can be used to evaluate the accumulation and transport of salts within the basin. This ongoing program will result in a better understanding of the flow-salinity relationship and may provide the basis for real-time monitoring in the Upper Rio Grande. CRP staff will continue to work with Dr. S. Miyamoto in support of this project as well as others that are being done through the Extension Service.
    - The TCE Fort Stockton, continues to oversee PREP. This project is using a new approach to eradicating and controlling the spread of saltcedar in the Pecos River in Texas. Additional information is being collected that will quantify the savings in water that was being lost through evapotranspiration to the saltcedar. As the work in the Pecos River is completed, the TCE, through Dr. Charlie Hart, has met with the Binational Rio Grande/Rio Bravo Ecosystem Workgroup (BREW) to present the PREP as a way to control saltcedar in the Rio Grande.

Pecos River Sub-basin

There are no impairments for this basin on the 303(d) list, but there are listed concerns for high salt levels in the upper segments of the river. Chloride, sulfate, and TDS levels in the Pecos River enter the state of Texas at high levels and get increasingly higher in its travels towards the Rio Grande. Saltcedar invasion, natural salt intrusions, and decreased flows have all contributed to this increase. The upper portion of the river is not used for public drinking water supply, so the high salt levels meet the designated uses. The salt levels in the lower segment of the river are reduced because of freshwater tributaries and springs such as Independence Creek. Because this segment of the river is listed as a public drinking water supply, the high levels of salt in the upper segment create a concern in the lower segment. Ever increasing salt levels are not being diluted enough by the freshwater tributaries to maintain drinking water levels in the lower segment of the river.

Upper Rio Grande Basin Sub-basin

Water quality concerns in the Rio Grande consists of elevated levels of bacteria, dissolved salts, and nutrients. Exceedances in bacteria occur in Segment 2314, 2307, and 2306. The main cause of high bacteria is due to point and nonpoint source discharges around populated areas above and below El Paso/Ciudad Juárez and the Presidio/Ojinaga area. The high levels of salts are due to return flows that carry dissolved salts from irrigated agriculture and runoff from soil that is high in salinity. Salinity only decreases when additional flow from tributaries and springs help dilute the level of salts in the water prior to reaching International Amistad Reservoir. Nutrient concerns appear to occur in areas that are of concern for fecal coliform, which may indicate that the sources affecting both parameters, is related. Decreased flows in this area are primarily due to lower than average releases from Luis Leon Reservoir in the Rio Conchos sub-basin.

Middle Rio Grande Sub-basin

The water quality found in the Rio Grande has shown improvement during the assessment period. Trend analysis either showed no change or improved conditions for the majority of the parameters. The main concerns in this sub-basin are exceedances in fecal coliform and nutrients. Toxicity has been identified as a concern and must be addressed through additional monitoring to verify if the non-attainment status is warranted. As in the upper sub-basin, bacterial levels increase around sister cities because of municipal discharges into the river of partially treated and untreated wastewater. As stated above, it is believed nutrients are found to exceed the secondary screening criteria because of the same discharges that cause high bacterial counts.

Lower Rio Grande Sub-basin

The primary concern in this region is decreased water quantity due to drought conditions and invasive plant species (hydrilla and water hyacinth) in the water. Water quality is generally good throughout the sub-basin with the exception of bacteria and TDS data from station 13180, which has not been monitored in several years.

Recommendations

Water Quality Monitoring

The level of effort should remain the same or increase in this area. Routine, baseline data is the primary source of data used in the assessment process. New monitoring stations have been added in the Rio Grande Basin and plans to introduce more monitoring stations are underway in an effort to create a complete picture of the changes in water quality throughout the basin. The concerns identified in the basin are part of the regular suite of parameters analyzed under the CRP. CRP will assess and introduce additional parameters as needed into the monitoring schedule.

Current projects are underway in communities that will either upgrade wastewater treatment capabilities or construct new ones. These improvements along with Best Management Practices (BMP) being established for farming should result in an improvement to water quality in the Rio Grande. These efforts should continue until the infrastructure is available to all people who live in the United States-Mexico border. This will be an ongoing process and CRP will continue to monitor the success of these projects, such as the NLIWTP, through its routine monitoring program.

Intensive Studies

CRP partners provide a means for the program to expand on the routine monitoring program. There is a lot of enthusiasm to pursue separate studies by Rio Grande partners and the CRP fully supports these efforts. Additional information is being gathered on pathogens, salinity, saltcedar, and future efforts are going to focus on real-time monitoring, metals studies, fish surveys, and biological monitoring.

Funding Sources

CRP has been able to leverage dollars by joining other studies and funding a portion of the work being done. Partners within the basin continually submit grant proposals to secure funds outside of the scope of CRP. CRP will continue to support these efforts and will assist water quality related projects as much as possible. CRP staff will continue to provide field training to personnel collecting data in the basin.

Steering Committee Development

CRP has continued to solicit the input of steering committee members to help guide the CRP during the year. In order to reach more individuals, CRP staff has looked into "incorporating" the annual meetings with other groups in the basin in an effort to receive greater input into the program and to inform more members of the public about our efforts in the basin. CRP will continue to hold meetings within each sub-basin and strive to improve communication with basin stakeholders.

Because of the international nature of the border region and identification of water quality concerns, it is becoming apparent that any long-term program established to improve water quality will need to include the participation of communities where the watershed is located. Part of the Rio Grande watershed lies in New Mexico and Mexico. Areas of concern to water quality affect the entire region and any plan to address these concerns will require intrastate, binational support. The CRP staff intend on developing a binational, intrastate steering committee in the hope of developing a stakeholder group that will be able to address issues such as TMDL development when the time comes.

Basin Action Summary

WATER BODY	IMPAIRED USE	PARAMETER OF CONCERN	POSSIBLE SOURCE	ACTIONS TAKEN	RECOMMENDED ACTIONS	RANK	POSSIBLE FUNDING SOURCE	ACTIVE PARTICIPANTS
RIO GRANDE BELOW FALCON RESERVOIR								
Segment 2302	Contact Recreation	Fecal Coliform	Point and Nonpoint Sources	Developing and rehabilitating infrastructure for wastewater collection and treatment	Source tracking	Low	NADBANK and BECC	BECC NADBANK USIBWC MXIBWC
Segment 2302	Contact Recreation	Fecal Coliform	Point and Nonpoint Sources	Water quality monitoring	Continue water quality monitoring	Low	CRP	USIBWC TCEQ
RIO GRANDE BELOW AMISTAD RESERVOIR								
Segment 2304	Contact Recreation	Fecal Coliform	Point Sources	Developing and rehabilitating infrastructure for wastewater collection and treatment	Source tracking	Medium	NADBANK and BECC	BECC NADBANK USIBWC MXIBWC
Segment 2304	Contact Recreation	Fecal Coliform	Point Sources	Water quality monitoring	Continue water quality monitoring	Low	CRP	USIBWC TCEQ RGISC City of Laredo Health Dept.
Segment 2304	Aquatic Life Use	Ambient toxicity	Point Sources	Continue water quality monitoring	Re-assess use with additional data collected	Low	CRP	USIBWC TCEQ RGISC
RIO GRANDE ABOVE AMISTAD RESERVOIR								
Segment 2306	Contact Recreation	Fecal Coliform	Point Sources and urban runoff	Developing and rehabilitating	Source tracking	Medium	NADBANK and BECC	BECC NADBANK

WATER BODY	IMPAIRED USE	PARAMETER OF CONCERN	POSSIBLE SOURCE	ACTIONS TAKEN	RECOMMENDED ACTIONS	RANK	POSSIBLE FUNDING SOURCE	ACTIVE PARTICIPANTS
				infrastructure for wastewater collection and treatment				USIBWC MXIBWC
Segment 2306	Contact Recreation	Fecal Coliform	Point Sources and urban runoff	Water quality monitoring	Continue water quality monitoring	Low	CRP	USIBWC TCEQ Big Bend NPS
Segment 2306	Aquatic Life Use	Ambient toxicity	Point Sources	Continue water quality monitoring	Re-assess use with additional data collected	Low	CRP	TCEQ
Segment 2306	General Water Quality Uses	Elevated levels of TDS, chloride, and sulfate	Point and Nonpoint Sources	Water quality monitoring	Continue water quality monitoring	Low	CRP	USIBWC TCEQ USGS Big Bend NPS
RIO GRANDE BELOW RIVERSIDE DIVERSION DAM								
Segment 2307	General Water Quality Uses	Elevated levels of TDS, chloride, and sulfate	Point (municipal, and industrial) and Nonpoint Sources, flow regime, hydro modification	Water quality monitoring	Continue water quality monitoring	Low	CRP	USIBWC TCEQ UTEP EPCC
Segment 2307	General Water Quality Uses	Elevated levels of TDS, chloride, and sulfate	Point (municipal, and industrial) and Nonpoint Sources, flow regime, hydro modification	Ongoing study evaluating salinity	Saltcedar control, BMP's in agricultural areas	Low	319(h) funding	
Segment 2307	Contact Recreation	Fecal Coliform	Point and Unknown Nonpoint Sources		Develop and improve wastewater treatment facilities in the upper portions of the segment	Low	NADBANK and BECC	BECC NADBANK USIBWC MXIBWC
RIO GRANDE ABOVE INTERNATIONAL DAM								
Segment 2314	Contact Recreation	Fecal Coliform	Point and Nonpoint Sources, CAFO's	Water quality monitoring	Develop and improve wastewater treatment facilities discharging into Rio Grande, and	Low	BECC and NADBANK, 319(h) funding,	

WATER BODY	IMPAIRED USE	PARAMETER OF CONCERN	POSSIBLE SOURCE	ACTIONS TAKEN	RECOMMENDED ACTIONS	RANK	POSSIBLE FUNDING SOURCE	ACTIVE PARTICIPANTS
					BMP's to prevent runoff			
Segment 2314	Contact Recreation	Fecal Coliform	Point and Nonpoint Sources, CAFO's	Water quality monitoring	Source tracking	Low	CRP	

APPENDIX I. Standards Tables.

PECOS SUB-BASIN	Mean	N	Standard	# ex	%ex	Support designated uses or secondary concerns
Segment 2310						
Station 13109						
DO (mg/L)	8.5	28	5	0	0	meets designated uses
Chloride (mg/L)	119	27	1700	0	0	meets designated uses
Sulfate (mg/L)	169	27	1000	0	0	meets designated uses
TDS (mg/L)	688	27	4000	0	0	meets designated uses
pH (SU)	8.05	27	6.5-9.0	0	0	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	13	26	400	0	0	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	11		200			meets designated uses
Total Phosphate (mg/L)	0.062	19	0.8	0	0	no concern
Ortho-Phosphate (mg/L)	0.044	18	0.5	0	0	no concern
Ammonia (mg/L)	0.04	19	0.17	0	0	no concern
Nitrate/Nitrite (mg/L)	0.609	25	2.76	0	0	no concern
Chlorophyll *a* (mg/L)	8.63	19	11.6	0	0	no concern
Station 13240						
DO (mg/L)	8.66	27	5	0	0	meets designated uses
Chloride (mg/L)	671	24	1700	0	0	meets designated uses
Sulfate (mg/L)	399	24	1000	0	0	meets designated uses
TDS (mg/L)	1989	24	4000	1	4.17	meets designated uses
pH (SU)	8.03	24	6.5-9.0	0	0	meets designated uses
Total Phosphate (mg/L)	0.014	23	0.8	0	0	no concern
Ortho-Phosphate (mg/L)	0.006	24	0.5	0	0	no concern
Nitrate/Nitrite (mg/L)	0.533	24	2.76	0	0	no concern
Station 13246						

PECOS SUB-BASIN	Mean	N	Standard	# ex	%ex	Support designated uses or secondary concerns
DO (mg/L)	8.19	30	5	0	0	meets designated uses
Chloride (mg/L)	1241	20	1700	1	5	meets designated uses
Sulfate (mg/L)	761	20	1000	1	5	meets designated uses
TDS (mg/L)	3219	20	4000	4	20	meets designated uses
pH (SU)	7.97	23	6.5-9.0	0	0	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	27	22	400	0	0	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	22		200			meets designated uses
Total Phosphate (mg/L)	0.037	20	0.8	0	0	no concern
Ortho-Phosphate (mg/L)	0.035	17	0.5	0	0	no concern
Ammonia (mg/L)	0.04	19	0.17	0	0	no concern
Nitrate/Nitrite (mg/L)	0.424	19	2.76	0	0	no concern
Chlorophyll *a* (mg/L)	3.11	20	11.6	0	0	no concern
Segment 2311						
Station 13257						
DO (mg/L)	6.69	29	5	8	27.59	does not meet designated uses
Chloride (mg/L)	5473	21	7000	3	14.29	meets designated uses
Sulfate (mg/L)	3551	21	3500	10	47.62	does not meet designated uses
TDS (mg/L)	13476	21	15000	6	28.57	does not meet designated uses
pH (SU)	7.89	24	6.5-9.0	0	0	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	16	22	400	0	0	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	7		200			meets designated uses
Total Phosphate (mg/L)	0.079	21	0.8	0	0	no concern
Ortho-Phosphate (mg/L)	0.135	21	0.5	0	0	no concern
Ammonia (mg/L)	0.078	21	0.17	2	9.52	no concern
Nitrate/Nitrite (mg/L)	0.931	19	2.76	0	0	no concern
Chlorophyll *a* (mg/L)	4.21	21	11.6	1	4.76	no concern

PECOS SUB-BASIN	Mean	N	Standard	# ex	%ex	Support designated uses or secondary concerns
Station 13260						
DO (mg/L)	8.81	14	5	0	0	meets designated uses
Chloride (mg/L)	4549	18	7000	2	11.11	meets designated uses
Sulfate (mg/L)	2743	18	3500	1	5.56	meets designated uses
TDS (mg/L)	10893	18	15000	1	5.56	meets designated uses
pH (SU)	7.75	20	6.5-9.0	1	5	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	96	19	400	1	5.26	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	20		200			meets designated uses
Total Phosphate (mg/L)	0.041	18	0.8	0	0	no concern
Ortho-Phosphate (mg/L)	0.086	18	0.5	0	0	no concern
Ammonia (mg/L)	0.052	18	0.17	0	0	no concern
Nitrate/Nitrite (mg/L)	0.07	16	2.76	0	0	no concern
Chlorophyll *a* (mg/L)	5.8	18	11.6	1	5.56	no concern
Station 13265						
DO (mg/L)	8.22	23	5	1	4.35	meets designated uses
Chloride (mg/L)	2758	21	7000	0	0	meets designated uses
Sulfate (mg/L)	2267	21	3500	0	0	meets designated uses
TDS (mg/L)	7488	21	15000	0	0	meets designated uses
pH (SU)	7.76	23	6.5-9.0	0	0	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	28	23	400	0	0	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	15		200			meets designated uses
Total Phosphate (mg/L)	0.056	21	0.8	0	0	no concern
Ortho-Phosphate (mg/L)	0.046	20	0.5	0	0	no concern
Ammonia (mg/L)	0.109	21	0.17	0	0	no concern
Nitrate/Nitrite (mg/L)	0.183	20	2.76	0	0	no concern
Chlorophyll *a* (mg/L)	8.77	21	11.6	1	4.76	no concern

PECOS SUB-BASIN	Mean	N	Standard	# ex	%ex	Support designated uses or secondary concerns
Station 15114						
DO (mg/L)	8.58	25	5	1	4	meets designated uses
Chloride (mg/L)	3451	21	7000	0	0	meets designated uses
Sulfate (mg/L)	2005	21	3500	0	0	meets designated uses
TDS (mg/L)	8467	21	15000	0	0	meets designated uses
pH (SU)	7.86	24	6.5-9.0	0	0	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	30	23	400	0	0	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	26		200			meets designated uses
Total Phosphate (mg/L)	0.067	21	0.8	0	0	no concern
Ortho-Phosphate (mg/L)	0.083	20	0.5	0	0	no concern
Ammonia (mg/L)	0.04	20	0.17	0	0	no concern
Nitrate/Nitrite (mg/L)	0.346	20	2.76	0	0	no concern
Chlorophyll *a* (mg/L)	6.89	21	11.6	1	4.76	no concern
Segment 2312						
Station 13267						
DO (mg/L)	7.7	17	5	2	11.6	meets designated uses
Chloride (mg/L)	1852	11	3200	0	0	meets designated uses
Sulfate (mg/L)	1979	11	2200	3	27.27	does not meet designated uses
TDS (mg/L)	6171	11	9400	0	0	meets designated uses
pH (SU)	8.03	13	6.5-9.0	0	0	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	2	11	400	0	0	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	1		200			meets designated uses
Total Phosphate (mg/L)	0.025	11	0.18	0	0	no concern
Ammonia (mg/L)	0.165	11	0.106	6	54.55	concern
Chlorophyll *a* (mg/L)	9	11	21.4	1	9.09	no concern
Station 13269						

PECOS SUB-BASIN	Mean	N	Standard	# ex	%ex	Support designated uses or secondary concerns
DO (mg/L)	8.375	12	5	0	0	meets designated uses
Chloride (mg/L)	1605	10	3200	0	0	meets designated uses
Sulfate (mg/L)	1510	10	2200	1	10	meets designated uses
TDS (mg/L)	4805	10	9400	0	0	meets designated uses
pH (SU)	7.98	12	6.5-9.0	0	0	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	3	10	400	0	0	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	2		200			meets designated uses
Total Phosphate (mg/L)	0.059	10	0.18	0	0	no concern
Ammonia (mg/L)	0.054	10	0.106	1	10	no concern
Chlorophyll *a* (mg/L)	8.9	10	21.4	1	10	no concern

UPPER RIO GRANDE SUB-BASIN	Mean	N	Standard	# ex	%ex	Support designated uses or secondary concerns
Segment 2305						
Station 13835						
DO (mg/L)	7.8	25	5	0	0	meets designated uses
Chloride (mg/L)	159	17	150	12	70.59	does not meet designated uses
Sulfate (mg/L)	216	17	270	1	5.8	meets designated uses
TDS (mg/L)	708.8	17	800	1	5.88	meets designated uses
pH (SU)	8.14	25	6.5-9.5	1	4	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	2	21	400	0	0	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	1		200			meets designated uses
Total Phosphate (mg/L)	1.45	12	0.18	7	58.37	concern
Ammonia (mg/L)	0.189	10	0.106	6	60	concern

UPPER RIO GRANDE SUB-BASIN	Mean	N	Standard	# ex	%ex	Support designated uses or secondary concerns
Station 15892						
DO (mg/L)	8.56	14	5	0	0	meets designated uses
Chloride (mg/L)	142	12	150	3	25	meets designated uses
Sulfate (mg/L)	216	12	270	0	0	meets designated uses
TDS (mg/L)	795	12	800	3	25	meets designated uses
pH (SU)	8.09	14	6.5-9.5	0	0	meets designated uses
Total Phosphate (mg/L)	0.038	12	0.18	0	0	no concern
Ortho-Phosphate (mg/L)	0.036	12	0.05	7	58.33	concern
Ammonia (mg/L)	0.04	12	0.106	0	0	no concern
Nitrate/Nitrite (mg/L)	0.313	12	0.32	5	41.67	concern
Chlorophyll *a* (mg/L)	2.1	11	21.4	0	0	no concern
Segment 2306						
Station 13223						
DO (mg/L)	8.26	56	5	2	3.57	meets designated uses
Chloride (mg/L)	140	32	300	0	0	meets designated uses
Sulfate (mg/L)	300	30	570	0	0	meets designated uses
TDS (mg/L)	844	29	1550	0	0	meets designated uses
pH (SU)	7.92	30	6.5-9.0	0	0	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	60	12	400	0	0	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	40		200			meets designated uses
Total Phosphate (mg/L)	0.932	30	0.8	5	16.7	no concern
Ortho-Phosphate (mg/L)	0.0141	30	0.5	0	0	no concern
Ammonia (mg/L)	0.016	31	0.17	0	0	no concern
Nitrate/Nitrite (mg/L)	0.692	39	2.76	0	0	no concern
Station 13228						
DO (mg/L)	8.88	47	5	0	0	meets designated uses

UPPER RIO GRANDE SUB-BASIN	Mean	N	Standard	# ex	%ex	Support designated uses or secondary concerns
Chloride (mg/L)	415	35	300	27	77.14	does not meet designated uses
Sulfate (mg/L)	663	35	570	25	71.43	does not meet designated uses
TDS (mg/L)	1857	35	1550	27	77.14	does not meet designated uses
pH (SU)	7.96	39	6.5-9.0	1	2.56	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	797	30	400	4	13.33	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	68		200			meets designated uses
Total Phosphate (mg/L)	1.08	36	0.8	6	16.67	no concern
Ortho-Phosphate (mg/L)	0.312	31	0.5	3	9.68	no concern
Ammonia (mg/L)	0.1	36	0.17	5	13.89	no concern
Nitrate/Nitrite (mg/L)	0.39	32	2.76	0	0	no concern
Chlorophyll *a* (mg/L)			11.6	13	54.29	concern
Station 13229						
DO (mg/L)	7.69	62	5	2	3.23	meets designated uses
Chloride (mg/L)	406	60	300	45	75	does not meet designated uses
Sulfate (mg/L)	637	60	570	39	65	does not meet designated uses
TDS (mg/L)	1827	60	1550	48	80	does not meet designated uses
pH (SU)	7.84	62	6.5-9.0	0	0	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	1028	60	400	29	48.33	does not meet designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	476		200			does not meet designated uses
Total Phosphate (mg/L)	2.52	55	0.8	15	27.27	concern
Ortho-Phosphate (mg/L)	0.247	34	0.5	5	14.71	no concern
Ammonia (mg/L)	0.192	59	0.17	21	35.59	concern
Nitrate/Nitrite (mg/L)	0.51	34	2.76	0	0	no concern
Chlorophyll *a* (mg/L)	17.8	38	11.6	18	47.37	concern
Station 16730						
DO (mg/L)	8.18	20	5	0	0	meets designated uses

UPPER RIO GRANDE SUB-BASIN	Mean	N	Standard	# ex	%ex	Support designated uses or secondary concerns
Chloride (mg/L)	304	18	300	11	61.11	does not meet designated uses
Sulfate (mg/L)	539	18	570	10	55.56	does not meet designated uses
TDS (mg/L)	1519	18	1550	11	61.11	does not meet designated uses
pH (SU)	7.74	21	6.5-9.0	0	0	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	105	13	400	1	7.69	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	27		200			meets designated uses
Total Phosphate (mg/L)	0.397	18	0.8	2	11.11	no concern
Ortho-Phosphate (mg/L)	0.133	16	0.5	1	6.25	no concern
Ammonia (mg/L)	0.153	18	0.17	4	22.22	concern
Nitrate/Nitrite (mg/L)	0.163	15	2.76	0	0	no concern
Chlorophyll *a* (mg/L)	12.33	17	11.6	7	41.18	concern
Station 17000						
DO (mg/L)	7.94	17	5	0	0	meets designated uses
pH (SU)	7.49	17	6.5-9.0	0	0	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	1513	17	400	16	94.2	does not meet designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	1208		200			does not meet designated uses
Station 17001						
DO (mg/L)	7.84	17	5	0	0	meets designated uses
pH (SU)	7.47	17	6.5-9.0	1	5.88	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	123	17	400	0	0	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	105		200			meets designated uses
Segment 2307						
Station 13225						
DO (mg/L)	8.91	22	5*	0	0	meets designated uses
Chloride (mg/L)	231	24	300	6	25	meets designated uses

UPPER RIO GRANDE SUB-BASIN	Mean	N	Standard	# ex	%ex	Support designated uses or secondary concerns
Sulfate (mg/L)	446	24	550	5	20.83	meets designated uses
TDS (mg/L)	1343	23	1500	10	43.48	does not meet designated uses
pH (SU)	8.072	20	6.5-9.0	0	0	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	69	21	400	0	0	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	34		200			meets designated uses
Total Phosphate (mg/L)	0.932	24	0.8	3	12.5	no concern
Ortho-Phosphate (mg/L)	0.067	23	0.5	0	0	no concern
Ammonia (mg/L)	0.027	24	0.17	0	0	no concern
Nitrate/Nitrite (mg/L)	0.183	24	2.76	0	0	no concern
Chlorophyll *a* (mg/L)	7.31	20	11.6	2	10	no concern
Station 13230						
DO (mg/L)	8	34	5	0	0	meets designated uses
Chloride (mg/L)	545.6	55	300	46	83.64	does not meet designated uses
Sulfate (mg/L)	607	55	550	32	58.18	does not meet designated uses
TDS (mg/L)	2025	55	1500	46	83.64	does not meet designated uses
pH (SU)	7.77	60	6.5-9.0	1	1.67	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	197	58	400	5	8.62	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	82		200			meets designated uses
Total Phosphate (mg/L)	1.27	43	0.8	16	37.21	concern
Ortho-Phosphate (mg/L)	0.294	28	0.5	4	14.29	no concern
Ammonia (mg/L)	0.197	50	0.17	22	44	concern
Nitrate/Nitrite (mg/L)	0.805	28	2.76	2	7.14	no concern
Chlorophyll *a* (mg/L)	22.27	26	11.6	15	57.69	concern
Station 13232						
DO (mg/L)	8.53	39	5	0	0	meets designated uses
Chloride (mg/L)	729.9	33	300	31	93.94	does not meet designated uses

UPPER RIO GRANDE SUB-BASIN	Mean	N	Standard	# ex	%ex	Support designated uses or secondary concerns
Sulfate (mg/L)	612.6	33	550	22	66.67	does not meet designated uses
TDS (mg/L)	2452	33	1500	30	90.91	does not meet designated uses
pH (SU)	7.84	33	6.5-9.0	0	0	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	378	31	400	5	16.13	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	116		200			meets designated uses
Total Phosphate (mg/L)	0.793	33	0.8	11	33.33	concern
Ortho-Phosphate (mg/L)	0.451	30	0.5	10	33.33	concern
Ammonia (mg/L)	1.11	32	0.17	13	40.63	concern
Nitrate/Nitrite (mg/L)	1.02	28	2.76	1	3.57	no concern
Chlorophyll *a* (mg/L)	16.92	19	11.6	10	52.63	concern
Station 15795						
DO (mg/L)	8.31	54	5	6	11.11	meets designated uses
Chloride (mg/L)	324.9	32	300	15	46.88	does not meet designated uses
Sulfate (mg/L)	388.7	32	550	4	12.5	meets designated uses
TDS (mg/L)	1310	32	1500	7	21.88	meets designated uses
pH (SU)	8.03	54	6.5-9.0	0	0	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	3516	33	400	13	39.39	does not meet designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	266		200			does not meet designated uses
Total Phosphate (mg/L)	0.812	23	0.8	7	30.43	concern
Ortho-Phosphate (mg/L)	0.495	21	0.5	8	38.1	concern
Ammonia (mg/L)	1.563	34	0.17	17	50	concern
Nitrate/Nitrite (mg/L)	1.315	21	2.76	5	23.81	no concern
Chlorophyll *a* (mg/L)	17.7	23	11.6	7	30.43	concern
Segment 2308						
Station 14465						
DO (mg/L)	8.99	222	3	3	1.35	meets designated uses

UPPER RIO GRANDE SUB-BASIN	Mean	N	Standard	# ex	%ex	Support designated uses or secondary concerns
Chloride (mg/L)	148	168	250	14	8.33	meets designated uses
Sulfate (mg/L)	271	171	450	7	4.09	meets designated uses
TDS (mg/L)	771	165	1400	1	0.61	meets designated uses
pH (SU)	7.97	226	6.5-9.0	3	1.33	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	636	217	400	47	21.66	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	58		2000			meets designated uses
Total Phosphate (mg/L)	0.582	18	0.8	4	22.22	no concern
Ortho-Phosphate (mg/L)	0.268	10	0.5	2	20	no concern
Ammonia (mg/L)	1.18	170	0.17	99	58.24	concern
Chlorophyll *a* (mg/L)	10.2	18	11.6	5	27.78	concern
Station 15528						
DO (mg/L)	9.9	209	3	0	0	meets designated uses
Chloride (mg/L)	165	198	250	14	8.33	meets designated uses
Sulfate (mg/L)	264	202	450	7	4.09	meets designated uses
TDS (mg/L)	820	198	1400	1	0.61	meets designated uses
pH (SU)	7.95	214	6.5-9.0	5	2.34	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	1338	197	400	63	31.98	does not meet designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	84.9		2000			meets designated uses
Total Phosphate (mg/L)	0.629	29	0.8	9	31.03	concern
Ortho-Phosphate (mg/L)	0.121	12	0.5	0	0	no concern
Ammonia (mg/L)	2	203	0.17	115	56.65	concern
Chlorophyll *a* (mg/L)			11.6	4	16	no concern
Station 15529						
DO (mg/L)	9.72	186	3	0	0	meets designated uses
Chloride (mg/L)	145	174	250	20	11.49	meets designated uses
Sulfate (mg/L)	274	177	450	21	11.86	meets designated uses
TDS (mg/L)	7.97	173	1400	4	2.31	meets designated uses

UPPER RIO GRANDE SUB-BASIN	Mean	N	Standard	# ex	%ex	Support designated uses or secondary concerns
pH (SU)	8.11	190	6.5-9.0	0	0	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	2077	176	400	100	56.82	does not meet designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	511		2000			does not meet designated uses
Ammonia (mg/L)	0.172	178	0.17	54	30.34	concern
Segment 2309						
Station 13237						
DO (mg/L)	10.07	13	6	0	0	meets designated uses
Chloride (mg/L)	14.13	14	50	0	0	meets designated uses
Sulfate (mg/L)	8.31	14	50	0	0	meets designated uses
TDS (mg/L)	380	14	300	2	14.29	meets designated uses
pH (SU)	8.19	13	6.5-9.0	0	0	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	5.9	10	400	0	0	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	3		200			meets designated uses
Total Phosphate (mg/L)	0.02	14	0.8	0	0	no concern
Ortho-Phosphate (mg/L)	0.033	13	0.5	0	0	no concern
Ammonia (mg/L)	0.045	14	0.17	0	0	no concern
Nitrate/Nitrite (mg/L)	1.12	13	2.76	0	0	no concern
Chlorophyll *a* (mg/L)	1	14	11.6	0	0	no concern
Segment 2314						
Station 13276						
temp						
DO (mg/L)	8.55	22	5	1	4.55	meets designated uses
Chloride (mg/L)	102	18	340	0	0	meets designated uses
Sulfate (mg/L)	219	17	600	0	0	meets designated uses
TDS (mg/L)	824	18	1800	1	5.56	meets designated uses
pH (SU)	8.05	22	6.5-9.0	0	0	meets designated uses

UPPER RIO GRANDE SUB-BASIN	Mean	N	Standard	# ex	%ex	Support designated uses or secondary concerns
Fecal Coliform (Single Grab) (cfu/100ml)	202	22	400	3	13.64	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	121		200			meets designated uses
Total Phosphate (mg/L)	0.474	14	0.8	1	7.14	no concern
Ortho-Phosphate (mg/L)	0.03	14	0.5	0	0	no concern
Ammonia (mg/L)	0.069	15	0.17	1	6.67	no concern
Nitrate/Nitrite (mg/L)	0.693	14	2.76	0	0	no concern
Station 13272						
DO (mg/L)	8.89	231	5	1	0.43	meets designated uses
Chloride (mg/L)	140.36	200	340	0	0	meets designated uses
Sulfate (mg/L)	268.54	202	600	0	0	meets designated uses
TDS (mg/L)	791.67	199	1800	0	0	meets designated uses
pH (SU)	8	244	6.5-9.0	0	0	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml) (cfu/100ml)	1507	220	400	127	57.73	does not meet designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	567		200			does not meet designated uses
Total Phosphate (mg/L)	0.3647	10	0.8	1	10	no concern
Ortho-Phosphate (mg/L)	0.0659	29	0.5	0	0	no concern
Ammonia (mg/L)	0.206	180	0.17	70	38.89	concern
Station 17040						
DO (mg/L)	8.92	17	5	0	0	meets designated uses
pH (SU)	8.2	17	6.5-9.0	0	0	meets designated uses

MIDDLE RIO GRANDE SUB-BASIN	Mean	N	Standard	# ex	%ex	Support designated uses
Segment 2303						
Station 15839						
DO (mg/L)	9.14	20	5	0	0	meets designated uses
Chloride (mg/L)	115	16	200	0	0	meets designated uses
Sulfate (mg/L)	178	16	300	0	0	meets designated uses
TDS (mg/L)	604	16	1000	0	0	meets designated uses
pH (SU)	8.16	20	6.5-9.0	0	0	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	1.41	46	400	4	8.7	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	29		200			meets designated uses
Total Phosphate (mg/L)	0.234	16	0.18	8	50	concern
Ortho-Phosphate (mg/L)	0.028	15	0.05	3	20	no concern
Ammonia (mg/L)	0.023	16	0.106	0	0	no concern
Nitrate/Nitrite (mg/L)	0.458	15	0.32	8	53.33	concern
Chlorophyll *a* (mg/L)	1.86	16	21.4	0	0	no concern
Segment 2304						
Station 13194						
DO (mg/L)	7.75	23	5	0	0	meets designated uses
Chloride (mg/L)	152.5	16	200	1	6.25	meets designated uses
Sulfate (mg/L)	217	16	300	1	6.25	meets designated uses
TDS (mg/L)	761	16	1000	1	6.25	meets designated uses
pH (SU)	7.76	26	6.5-9.0	7	31.82	does not meet designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	5203	22	400	20	90.91	does not meet designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	1371		200			does not meet designated uses
Total Phosphate (mg/L)	3.11	15	0.8	6	42.86	concern
Ammonia (mg/L)	0.231	15	0.17	11	73.33	concern
Station 13196						

MIDDLE RIO GRANDE SUB-BASIN	Mean	N	Standard	# ex	%ex	Support designated uses
DO (mg/L)	8.28	26	5	0	0	meets designated uses
Chloride (mg/L)	130	20	200	0	0	meets designated uses
Sulfate (mg/L)	194	20	300	0	0	meets designated uses
TDS (mg/L)	619	20	1000	0	0	meets designated uses
pH (SU)	8.05	27	6.5-9.0	0	0	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	3417	54	400	33	61.11	does not meet designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	830		200			does not meet designated uses
Total Phosphate (mg/L)	0.48	20	0.8	2	10	no concern
Ammonia (mg/L)	0.209	20	0.17	12	60	concern
Station 13202						
DO (mg/L)	8.64	24	5	0	0	meets designated uses
Chloride (mg/L)	131	20	200	0	0	meets designated uses
Sulfate (mg/L)	193	20	300	0	0	meets designated uses
TDS (mg/L)	656	20	1000	0	0	meets designated uses
pH (SU)	8.06	24	6.5-9.0	0	0	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	158	52	400	5	9.62	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	42		200			meets designated uses
Total Phosphate (mg/L)	0.374	20	0.8	2	10	no concern
Ortho-Phosphate (mg/L)	0.042	10	0.5	0	0	no concern
Ammonia (mg/L)	0.91	20	0.17	5	25	no concern
Nitrate/Nitrite (mg/L)	0.273	10	2.76	0	0	no concern
Chlorophyll *a* (mg/L)	2.78	11	11.6	0	0	no concern
Station 13205						
DO (mg/L)	8.03	63	5	2	3.17	meets designated uses
Chloride (mg/L)	145	56	200	1	1.79	meets designated uses
Sulfate (mg/L)	182	56	300	0	0	meets designated uses

MIDDLE RIO GRANDE SUB-BASIN	Mean	N	Standard	# ex	%ex	Support designated uses
TDS (mg/L)	646	56	1000	0	0	meets designated uses
pH (SU)	7.84	63	6.5-9.0	0	0	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	965	53	400	21	39.62	does not meet designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	252		200			does not meet designated uses
Total Phosphate (mg/L)	1.22	53	0.8	13	24.53	no concern
Ortho-Phosphate (mg/L)	0.095	35	0.5	1	2.86	no concern
Ammonia (mg/L)	0.226	53	0.17	30	56.6	concern
Nitrate/Nitrite (mg/L)	0.411	33	2.76	0	0	no concern
Chlorophyll *a* (mg/L)	3.56	30	11.6	2	6.67	no concern
Station 13206						
DO (mg/L)	9.15	28	5	0	0	meets designated uses
Chloride (mg/L)	125	25	200	0	0	meets designated uses
Sulfate (mg/L)	178	25	300	0	0	meets designated uses
TDS (mg/L)	624	25	1000	0	0	meets designated uses
pH (SU)	8.06	28	6.5-9.0	0	0	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	196	24	400	2	8.33	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	43.49		200			meets designated uses
Total Phosphate (mg/L)	0.47	22	0.8	4	18.18	no concern
Ortho-Phosphate (mg/L)	0.235	17	0.5	2	11.6	no concern
Ammonia (mg/L)	0.15	16	0.17	7	43.75	concern
Nitrate/Nitrite (mg/L)	0.388	10	2.76	0	0	no concern
Chlorophyll *a* (mg/L)	2.15	17	11.6	1	5.88	no concern
Station 13208						
DO (mg/L)	8.43	40	5	2	5	meets designated uses
Chloride (mg/L)	136	30	200	0	0	meets designated uses
Sulfate (mg/L)	196	30	300	0	0	meets designated uses

MIDDLE RIO GRANDE SUB-BASIN	Mean	N	Standard	# ex	%ex	Support designated uses
TDS (mg/L)	660	30	1000	1	3.33	meets designated uses
pH (SU)	7.89	40	6.5-9.0	1	2.5	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	69.4	39	400	1	2.56	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	42		200			meets designated uses
Total Phosphate (mg/L)	0.975	28	0.8	9	32.4	concern
Ortho-Phosphate (mg/L)	0.077	17	0.5	1	5.88	no concern
Ammonia (mg/L)	0.133	29	0.17	11	37.93	concern
Nitrate/Nitrite (mg/L)	0.353	18	2.76	0	0	no concern
Chlorophyll *a* (mg/L)	1.68	16	11.6	0	0	no concern
Station 13209						
DO (mg/L)	6.14	18	5	8	44.44	does not meet designated uses
Chloride (mg/L)	187	33	200	18	54.55	does not meet designated uses
Sulfate (mg/L)	179	33	300	0	0	meets designated uses
TDS (mg/L)	736	18	1000	1	5.56	meets designated uses
pH (SU)	7.77	33	6.5-9.0	0	0	meets designated uses
Total Phosphate (mg/L)	0.014	18	0.8	0	0	no concern
Ortho-Phosphate (mg/L)	0.005	18	0.5	0	0	no concern
Nitrate/Nitrite (mg/L)	0.288	14	2.76	0	0	no concern
Station 13560						
DO (mg/L)	9.19	63	5	0	0	meets designated uses
Chloride (mg/L)	127	58	200	1	1.72	meets designated uses
Sulfate (mg/L)	177	58	300	0	0	meets designated uses
TDS (mg/L)	627	57	1000	0	0	meets designated uses
pH (SU)	7.94	63	6.5-9.0	3	4.76	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	386	59	400	17	28.81	does not meet designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	156		200			meets designated uses

MIDDLE RIO GRANDE SUB-BASIN	Mean	N	Standard	# ex	%ex	Support designated uses
Total Phosphate (mg/L)	0.909	51	0.8	12	23.53	no concern
Ortho-Phosphate (mg/L)	0.067	37	0.5	1	2.7	no concern
Ammonia (mg/L)	0.137	51	0.17	17	33.33	concern
Nitrate/Nitrite (mg/L)	0.415	40	2.76	0	0	no concern
Chlorophyll *a* (mg/L)	1.98	35	11.6	0	0	no concern
Station 13698						
Chloride (mg/L)	139	31	200	0	0	meets designated uses
Sulfate (mg/L)	199	31	300	0	0	meets designated uses
pH (SU)	7.96	34	6.5-9.0	0	0	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	287	10	400	1	10	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	75		200			meets designated uses
Station 15813						
Fecal Coliform (Single Grab)	1191	29	400	3	10.34	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	43		200			meets designated uses
Station 15814						
DO (mg/L)	9.33	12	5	0	0	meets designated uses
pH (SU)	8.16	11	6.5-9.0	0	0	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	619	39	400	17	43.59	does not meet designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	317		200			does not meet designated uses
Total Phosphate (mg/L)	0.07	10	0.8	0	0	no concern
Chlorophyll *a* (mg/L)	2.7	10	11.6	0	0	no concern
Station 15815						
Fecal Coliform (Single Grab) (cfu/100ml)	624	36	400	16	44.44	does not meet designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	373		200			does not meet designated uses

MIDDLE RIO GRANDE SUB-BASIN	Mean	N	Standard	# ex	%ex	Support designated uses
Station 15816						
Fecal Coliform (Single Grab) (cfu/100ml)	356	31	400	7	22.58	does not meet designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	225.6		200			does not meet designated uses
Station 15817						
DO (mg/L)	8.51	53	5	0	0	meets designated uses
Chloride (mg/L)	130	43	200	0	0	meets designated uses
Sulfate (mg/L)	196	43	300	0	0	meets designated uses
TDS (mg/L)	642	42	1000	0	0	meets designated uses
pH (SU)	8.09	33	6.5-9.0	3	5.66	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	2533	50	400	26	52	does not meet designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	289		200			does not meet designated uses
Total Phosphate (mg/L)	0.666	42	0.8	3	7.14	no concern
Ortho-Phosphate (mg/L)	0.157	27	0.5	0	0	no concern
Ammonia (mg/L)	0.125	42	0.17	17	40.48	concern
Nitrate/Nitrite (mg/L)	0.791	30	2.76	0	0	no concern
Chlorophyll *a* (mg/L)	3.83	32	11.6	2	6.25	no concern
Segment 2313						
Station 13270						
Sulfate (mg/L)	35	10	50	1	10	meets designated uses
TDS (mg/L)	275	10	400	0	0	meets designated uses
Total Phosphate (mg/L)	0.02	10	0.8	0	0	no concern
Ortho-Phosphate (mg/L)	0.07	10	0.5	0	0	no concern
Ammonia (mg/L)	0.035	10	0.17	0	0	no concern
Nitrate/Nitrite (mg/L)	1.54	10	2.76	0	0	no concern

LOWER RIO GRANDE SUB-BASIN	Mean	N	Standard	# ex	%ex	Support designated uses or secondary concerns
Segment 2301						
Station 13176						
DO (mg/L)	7.95	44	5	2	4.55	meets designated uses
pH (SU)	8.14	44	6.5-9.0	0	0	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	537	40	400	12	30	does not meet designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	101		200			meets designated uses
Total Phosphate (mg/L)	7.34	29	0.71	13	44.83	concern
Ortho-Phosphate (mg/L)	0.183	13	0.55	0	0	no concern
Ammonia (mg/L)	0.214	32	0.58	1	3.13	no concern
Nitrate/Nitrite (mg/L)	0.221	13	1.83	0	0	no concern
Chlorophyll *a* (mg/L)	18.49	14	19.2	5	35.71	concern
Segment 2302						
Station 13103						
DO (mg/L)	8.81	11	5	2	18.18	partially meets designated uses
pH (SU)	8.15	10	6.5-9.0	1	10	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	522	10	400	5	50	does not meet designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	316		200			does not meet designated uses
Station 13177						
DO (mg/L)	8.06	71	5	4	5.63	meets designated uses
Chloride (mg/L)	212	76	270	15	19.74	meets designated uses
Sulfate (mg/L)	258	76	350	11	14.47	meets designated uses
TDS (mg/L)	869	77	880	27	35.06	does not meet designated uses
pH (SU)	8.01	78	6.5-9.0	2	2.56	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	319	61	400	13	21.31	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	113		200			meets designated uses

LOWER RIO GRANDE SUB-BASIN	Mean	N	Standard	# ex	%ex	Support designated uses or secondary concerns
Total Phosphate (mg/L)	1.58	64	0.8	10	15.63	no concern
Ortho-Phosphate (mg/L)	0.181	42	0.5	2	4.76	no concern
Ammonia (mg/L)	0.198	63	0.17	32	50.79	concern
Nitrate/Nitrite (mg/L)	0.367	47	2.76	0	0	no concern
Chlorophyll *a* (mg/L)	11.9	44	11.6	8	18.18	no concern
Station 13181						
DO (mg/L)	8.23	71	5	0	0	meets designated uses
Chloride (mg/L)	149	60	270	0	0	meets designated uses
Sulfate (mg/L)	208	60	350	0	0	meets designated uses
TDS (mg/L)	703	62	880	4	6.45	meets designated uses
pH (SU)	7.99	77	6.5-9.0	0	0	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	185	71	400	9	12.68	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	115		200			meets designated uses
Total Phosphate (mg/L)	0.82	63	0.8	12	19.05	no concern
Ortho-Phosphate (mg/L)	0.093	40	0.5	1	2.5	no concern
Ammonia (mg/L)	0.139	62	0.17	20	32.26	concern
Nitrate/Nitrite (mg/L)	0.167	36	2.76	0	0	no concern
Chlorophyll *a* (mg/L)	3.38	37	11.6	0	0	no concern
Station 13184						
Chloride (mg/L)	159	21	270	0	0	meets designated uses
Sulfate (mg/L)	216	21	350	0	0	meets designated uses
pH (SU)	7.94	21	6.5-9.0	0	0	meets designated uses
Station 13185						
Chloride (mg/L)	142	41	270	0	0	meets designated uses
Sulfate (mg/L)	193	41	350	0	0	meets designated uses

LOWER RIO GRANDE SUB-BASIN	Mean	N	Standard	# ex	%ex	Support designated uses or secondary concerns
TDS (mg/L)	623	17	880	0	0	meets designated uses
pH (SU)	7.63	41	6.5-9.0	0	0	meets designated uses
Station 13186						
DO (mg/L)	7.17	66	5	1	1.52	meets designated uses
Chloride (mg/L)	129	57	270	1	1.75	meets designated uses
Sulfate (mg/L)	193	59	350	2	3.39	meets designated uses
TDS (mg/L)	626	59	880	3	5.08	meets designated uses
pH (SU)	7.77	65	6.5-9.0	4	6.15	meets designated uses
Fecal Coliform (Single Grab) (cfu/100ml)	52	62	400	0	0	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	38		200			meets designated uses
Total Phosphate (mg/L)	3.17	57	0.8	15	26.32	concern
Ortho-Phosphate (mg/L)	0.142	35	0.5	2	5.71	no concern
Ammonia (mg/L)	0.157	56	0.17	20	35.71	concern
Nitrate/Nitrite (mg/L)	0.248	33	2.76	0	0	no concern
Chlorophyll *a* (mg/L)	4.4	33	11.6	3	9.09	no concern
Station 13664						
Chloride (mg/L)	158	23	270	0	0	meets designated uses
Sulfate (mg/L)	216	23	350	0	0	meets designated uses
pH (SU)	8.02	24	6.5-9.0	0	0	meets designated uses
Station 15808						
DO (mg/L)	8.43	56	5	1	1.79	meets designated uses
Chloride (mg/L)	155	51	270	0	0	meets designated uses
Sulfate (mg/L)	210	51	350	0	0	meets designated uses
TDS (mg/L)	702	51	880	4	7.84	meets designated uses
pH (SU)	7.94	55	6.5-9.0	0	0	meets designated uses

LOWER RIO GRANDE SUB-BASIN	Mean	N	Standard	# ex	%ex	Support designated uses or secondary concerns
Fecal Coliform (Single Grab) (cfu/100ml)	488	47	400	10	21.28	meets designated uses
Fecal Coliform (Geometric Mean) (cfu/100ml)	138		200			meets designated uses
Total Phosphate (mg/L)	0.701	49	0.8	7	14.29	no concern
Ortho-Phosphate (mg/L)	0.075	37	0.5	0	0	no concern
Ammonia (mg/L)	0.136	49	0.17	13	26.53	concern
Nitrate/Nitrite (mg/L)	0.162	35	2.76	0	0	no concern
Chlorophyll *a* (mg/L)	7.5	38	11.6	4	10.53	no concern

APPENDIX II. Trend Tables

PECOS SUB- BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
Segment 2310									
Station 13109									
DO summer (mg/L)	8.06	7.3	8.7	0.014	0.291	0.781	8		No trend
DO winter (mg/L)	8.68	7.7	10	0.0051	0.305	0.764	20		No trend
Chloride (mg/L)	119	95	131	0.445	**3.68**	**0.002**	19	Up	Predicted values increased from 109 mg/L to 129 mg/L
Sulfate (mg/L)	170	132	189	0.282	**2.58**	**0.019**	19	Up	Predicted values increased from 158 mg/L to 181 mg/L
TDS (mg/L)	688	550	925	0.02	0.71	0.484	27		No trend
pH (SU)	8.05	7.8	87	0.344	**-3.69**	**0.001**	28	Down	Predicted values decreased from 8.25 mg/L to 7.8 mg/L
log Fecal Coliform (cfu/100ml)	1.03	0.301	1.43	0.125	**-1.85**	**0.076**	26	Down	Predicted values decreased from 1.2 cfu/100ml to 0.849 cfu/100ml
Conductivity (uS/cm)	1130	1000	1230	0.354	**-3.7**	**0.001**	27	Down	Predicted values decreased from 1185 uS/cm to 1076 uS/cm
Total Phosphate (mg/L)	0.062	0.01	0.66	0.244	**-1.04**	0.313	19		No trend
Ortho-Phosphate (mg/L)	0.044	0.01	0.06	0.28	**-2.49**	**0.024**	18		Trend is artifact of change in reporting limits
Ammonia (mg/L)	0.04	0.025	0.05	0.623	**-5.29**	**0.00006**	19		Trend is artifact of change in reporting limits
Nitrate/Nitrite (mg/L)	0.609	0.33	1.34	0.0435	**-1.02**	0.317	25		No trend
Station 13240									
DO summer (mg/L)	7.75	6.6	9.2	0.091	-0.343	0.502	11		No trend
DO winter (mg/L)	9.3	7.2	10.9	0.0083	-0.947	0.368	16		No trend
Chloride (mg/L)	671	102	1018	0.0107	0.488	0.629	24		No trend
Sulfate (mg/L)	399	68	618	0.016	0.607	0.549	24		No trend
TDS (mg/L)	1989	381	5940	0.0032	-0.267	0.792	24		No trend
pH (SU)	8.03	7.6	8.3	0.004	-0.312	0.758	24		No trend
log Fecal Coliform (cfu/100ml)									<10 Data Points
Conductivity (uS/cm)	3030	716	4420	0.013	0.548	0.589	24		No trend

PECOS SUB- BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
Total Phosphate (mg/L)	0.014	0.005	0.07	0.042	-0.961	0.347	23		No trend
Ortho-Phosphate (mg/L)	0.006	0.001	0.06	0.0002	0.076	0.94	24		No trend
Ammonia (mg/L)									<10 Data Points
Nitrate/Nitrite (mg/L)	0.533	0.05	1.91	6E-05	-0.039	0.969	24		No trend
Station 13246									
DO summer (mg/L)	7.67	6.7	9.5	0.227	**1.43**	0.195	9		No trend
DO winter (mg/L)	8.41	5.6	10.4	0.241	**-2.45**	**0.024**	21	Down	Predicted values decreased from 9.3 mg/L to 7.5 mg/L
Chloride (mg/L)	1241	813	1830	0.023	-0.649	0.525	20		No trend
Sulfate (mg/L)	761	494	1130	0.028	-0.723	0.479	20		No trend
TDS (mg/L)	3219	870	4610	0.004	-0.269	0.791	20		No trend
pH (SU)	7.97	7.8	8.1	0.294	**-2.96**	**0.007**	23	Down	Predicted values decreased from 8.06 mg/L to 7.89 mg/L
log Fecal Coliform (cfu/100ml)	1.34	0.778	1.79	0.147	**1.85**	**0.078**	22	Up	Predicted values increased from 1.17 cfu/100ml to 1.51 mg/100ml
Conductivity (uS/cm)	5245	3429	8070	0.091	**-1.44**	0.163	23		No trend
Total Phosphate (mg/L)	0.037	0.02	0.12	0.012	-0.464	0.648	20		No trend
Ortho-Phosphate (mg/L)	0.035	0.01	0.06	0.063	**1**	0.332	17		No trend
Ammonia (mg/L)	0.04	0.01	0.05	0.126	**-1.57**	0.136	19		No trend
Nitrate/Nitrite (mg/L)	0.424	0.1	0.96	0.13	**-1.59**	0.129	19		No trend
Segment 2311									
Station 13257									
DO summer (mg/L)	5.12	2.6	8.1	0.027	0.559	0.589	13		No Trend
DO winter (mg/L)	7.97	2.3	11.3	0.019	0.522	0.61	16		No Trend
Chloride (mg/L)	5473	2880	7280	0.0001	-0.051	0.96	21		No Trend
Sulfate (mg/L)	3551	2680	4360	0.228	**2.37**	**0.028**	21	Up	Predicted values increased from 3221 mg/L to 3888 mg/L
TDS (mg/L)	13476	7340	18300	0.161	**1.91**	**0.071**	21	Up	Predicted values increased from 11723 mg/L to 15263 mg/L

PECOS SUB- BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
pH (SU)	7.89	6.9	8.7	0.0037	0.284	0.779	24		No Trend
log Fecal Coliform (cfu/100ml)	0.856	0	1.94	0.0032	0.252	0.803	22		No Trend
Conductivity (uS/cm)	19964	14000	25800	0.0358	0.883	0.387	23		No Trend
Total Phosphate (mg/L)	0.079	0.01	0.46	0.05	**-1**	0.329	21		No Trend
Ortho-Phosphate (mg/L)	0.135	0.01	0.3	0.241	**2.45**	**0.024**	21	Up	Predicted values increased from 0.058 mg/L to 0.213 mg/L
Ammonia (mg/L)	0.078	0.01	0.7	0.07	**-1.19**	0.247	21		No Trend
Nitrate/Nitrite (mg/L)	0.931	0.42	2.17	0.0034	0.241	0.812	19		No Trend
Station 13260									
DO summer (mg/L)	5.95	2.1	10.6	0.0869	0.925	0.379	11		No Trend
DO winter (mg/L)	8.81	5.6	10.4	0.025	-0.551	0.592	14		No Trend
Chloride (mg/L)	4549	113	8340	0.021	0.59	0.564	18		No Trend
Sulfate (mg/L)	2743	159	4510	0.065	**1.05**	0.309	18		No Trend
TDS (mg/L)	10893	530	21100	0.117	**1.45**	0.164	18		No Trend
pH (SU)	7.75	7.4	9.2	7E-06	-0.011	0.991	20		No Trend
log Fecal Coliform (cfu/100ml)	1.3	0.301	3.08	0.113	**1.47**	0.159	19		No Trend
Conductivity (uS/cm)	15159	891	26700	0.022	0.629	0.536	20		No Trend
Total Phosphate (mg/L)	0.041	0.01	0.07	0.021	0.589	0.564	18		No Trend
Ortho-Phosphate (mg/L)	0.086	0.01	0.3	0.408	**3.32**	**0.004**	18	Up	Predicted values increased from 0.014 mg/L to 0.156 mg/L
Ammonia (mg/L)	0.052	0.01	0.15	0.067	**-1.07**	0.3	18		No Trend
Nitrate/Nitrite (mg/L)	0.07	0.01	0.44	0.024	-0.592	0.563	16		No Trend
Station 13265									
DO summer (mg/L)	6.54	3.5	7.9	0.004	-0.155	0.882	8		No Trend
DO winter (mg/L)	8.83	7	12	0.0241	0.685	0.501	21		No Trend
Chloride (mg/L)	2758	1630	5410	2E-05	-0.02	0.984	21		No Trend
Sulfate (mg/L)	2267	1660	2920	0.057	**1.07**	0.299	21		No Trend

PECOS SUB- BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
TDS (mg/L)	7488	4840	11600	0.065	**1.15**	0.265	21		No Trend
pH (SU)	7.76	7	8.1	0.0937	**-1.47**	0.155	23		No Trend
log Fecal Coliform (cfu/100ml)	1.21	0	2.06	0.051	**1.06**	0.3	23		No Trend
Conductivity (uS/cm)	10860	7390	20900	0.0083	-0.418	0.68	23		No Trend
Total Phosphate (mg/L)	0.056	0.01	0.15	0.006	0.324	0.749	21		No Trend
Ortho-Phosphate (mg/L)	0.046	0.01	0.3	0.036	0.819	0.423	20		No Trend
Ammonia (mg/L)	0.109	0.01	0.93	0.004	-0.269	0.791	21		No Trend
Nitrate/Nitrite (mg/L)	0.183	0.01	0.5	0.003	-0.228	0.822	20		No Trend
Station 15114									
DO summer (mg/L)	7.83	5.6	10	0.061	0.689	0.712	7		No Trend
DO winter (mg/L)	8.87	4.4	12.3	0.0288	-0.286	0.786	18		No Trend
Chloride (mg/L)	3451	1400	5230	0.047	-0.971	0.344	21		No Trend
Sulfate (mg/L)	2005	856	2750	0.026	-0.706	0.488	21		No Trend
TDS (mg/L)	8467	3720	12100	0.019	-0.607	0.551	21		No Trend
pH (SU)	7.86	7.6	8.1	0.0614	**1.2**	0.243	24		No Trend
log Fecal Coliform (cfu/100ml)	1.42	1	1.93	0.0202	0.658	0.517	23		No Trend
Conductivity (uS/cm)	12400	5830	18400	0.105	**-1.61**	0.123	24		No Trend
Total Phosphate (mg/L)	0.067	0.03	0.24	0.007	-0.369	0.716	21		No Trend
Ortho-Phosphate (mg/L)	0.083	0.01	0.3	0.181	**1.99**	**0.062**	20	Up	Predicted values increased from 0.035 mg/L to 0.131 mg/L
Ammonia (mg/L)	0.04	0.01	0.07	0.169	**-1.92**	**0.071**	20		Trend is artifact of change in reporting limits
Nitrate/Nitrite (mg/L)	0.346	0.13	0.6	0.048	-0.956	0.352	20		No Trend
Segment 2312									
Station 13267									
DO combined (mg/L)	7.78	3.7	10.9	0.009	-0.315	0.758	13		No Trend
Chloride (mg/L)	1852	834	3160	0.133	1.17	0.269	11		No Trend

PECOS SUB- BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
Sulfate (mg/L)	1979	1550	2460	0.447	**2.69**	**0.025**	11	Up	Predicted values increased from 1736 mg/L to 2303 mg/L
TDS (mg/L)	6171	4060	9140	0.59	**3.6**	**0.006**	11	Up	Predicted values increased from 4893 mg/L to 7874 mg/L
pH (SU)	8.03	7.8	8.2	0.471	**-3.12**	**0.009**	13	Down	Predicted values decreased from 8.16 SU to 7.86 SU
log Fecal Coliform (cfu/100ml)	0.132	0	0.845	0.0427	0.634	0.542	11		No Trend
Conductivity (uS/cm)	8972	6130	12700	0.269	**2.01**	**0.069**	13		Predicted values increased from 7784 mg/L to 10414 mg/L
Total Phosphate (mg/L)	0.025	0.01	0.06	0.224	**1.61**	0.141	11		No Trend
Ortho-Phosphate (mg/L)									<10 Data Points
Ammonia (mg/L)	0.165	0.025	0.75	0.011	-0.319	0.757	11		No Trend
Nitrate/Nitrite (mg/L)	0.173	0.01	0.46	0.021	0.387	0.71	9		No Trend
Station 13269									
Do Combined (mg/L)	8.375	6.6	11	0.006	0.247	0.809	12		No Trend
Chloride (mg/L)	1605	476	2740	0.09	0.89	0.4	10		No Trend
Sulfate (mg/L)	1510	374	2210	0.017	0.368	0.722	10		No Trend
TDS (mg/L)	4805	1520	7600	0.0693	0.772	0.462	10		No Trend
pH (SU)	7.98	7.7	8.2	0.217	**-1.66**	0.127	12		No Trend
log Fecal Coliform (cfu/100ml)	0.205	0	1.15	0.026	0.459	0.658	10		No Trend
Conductivity (uS/cm)	7788	4660	10700	0.084	0.96	0.359	12		No Trend
Total Phosphate (mg/L)	0.059	0.01	0.1	0.001	0.096	0.926	10		No Trend
Ortho-Phosphate (mg/L)									<10 Values
Ammonia (mg/L)	0.054	0.025	0.11	0.053	0.667	0.523	10		No Trend
Nitrate/Nitrite (mg/L)									<10 Data Points

UPPER RIO GRANDE SUB-BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
Segment 2305									
Station 13835									
DO Combined (mg/L)	7.85	5.8	10.7	0.007	0.401	0.692	25		No trend
Chloride (mg/L)	159	116	206	0.584	**-4.59**	**0.0004**	17	Down	Predicted values decreased from 173 mg/l to 124 mg/ L
Sulfate (mg/L)	216	176	283	0.328	**-2.71**	**0.016**	17	Down	Predicted values decreased from 228 mg/l to 186 mg/ L
TDS (mg/L)	708.8	584	1000	0.331	**-2.73**	**0.015**	17	Down	Predicted values decreased from 758 mg/L to 592 mg/L
pH (SU)	8.14	7.3	9.4	0.003	-0.262	0.795	25		No trend
log Fecal Coliform (cfu/100ml)	0.067	-0.301	1	0.029	-0.748	0.463	21		No trend
Conductivity (uS/cm)	1100	965	1221	0.346	**-3.49**	**0.002**	25	Down	Predicted values decreased from 1143 S/cm to 1012 S/cm
Total Phosphate (mg/L)	1.45	0.05	4.42	0.368	**-2.41**	**0.033**	12	Down	Predicted values decreased from 2.42 mg/L to -0.186 mg/L
Ortho-Phosphate (mg/L)									<10 Data Points
Ammonia (mg/L)	0.189	0.02	0.589	0.547	**-3.11**	**0.014**	10	Down	Trend is artifact of change in reporting limits
Nitrate/Nitrite (mg/L)									<10 Data Points
Station 15892									
DO Combined (mg/L)	8.56	6.8	10.8	0.0009	0.102	0.182	14		No trend
Chloride (mg/L)	142	121	164	0.168	**-1.42**	0.186	12		No trend
Sulfate (mg/L)	216	180	259	0.029	-0.549	0.595	12		No trend
TDS (mg/L)	795	609	1940	0.058	-0.785	0.451	12		No trend
pH (SU)	8.09	7.7	8.4	0.553	**3.85**	**0.002**	14	Up	Predicted values increased from 7.88 SU to 8.31 SU
log Fecal Coliform (cfu/100ml)									<10 Data Points
Conductivity (uS/cm)	1145	1013	1322	0.045	**-0.754**	0.465	14		No trend
Total Phosphate (mg/L)	0.038	0.01	0.05	0.619	**4.03**	**0.002**	12	Up	Trend is artifact of change in reporting limits
Ortho-Phosphate (mg/L)	0.036	0.03	0.04	0.71	**4.94**	**0.0006**	12	Up	Trend is artifact of change in reporting limits
Ammonia (mg/L)	0.04	0.025	0.05	0.71	**4.94**	**0.0005**	12	Up	Trend is artifact of change in reporting limits
Nitrate/Nitrite (mg/L)	0.313	0.06	0.52	0.164	**-1.4**	0.192	12		No trend

UPPER RIO GRANDE SUB-BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
Segment 2306									
Station 13223									
DO summer (mg/L)	6.75	4.1	8	0.017	-0.575	0.572	21		No Trend
DO winter (mg/L)	9.17	5.4	12.1	0.0002	0.088	0.931	35		No Trend
Chloride (mg/L)	132	28	266	0.0002	0.076	0.94	30		No Trend
Sulfate (mg/L)	300	123	521	0.098	**1.73**	**0.093**	30		Predicted values increased from 270 mg/L to 367 mg/L
TDS (mg/L)	844	404	1370	0.099	**1.72**	**0.096**	29		Predicted values increased from 767 mg/L to 1028 mg/L
pH (SU)	7.92	7.4	8.5	0.041	**1.09**	0.283	30		No Trend
log Fecal Coliform (cfu/100ml)	1.61	0.903	2.22	0.331	**-2.23**	**0.05**	12	Down	Predicted values decrease from 1.87 cfu/100 ml to 1.21 cfu/100 ml
Conductivity (uS/cm)	1251	506	2200	0.0026	0.376	0.709	56		No Trend
Total Phosphate (mg/L)	0.932	0.01	8.25	0.0123	0.591	0.559	30		No Trend
Ortho-Phosphate (mg/L)	0.014	0.001	0.06	0.344	**3.82**	**0.0006**	30	Up	Trend is artifact of change in reporting limits
Ammonia (mg/L)	0.016	0.002	0.1	0.268	**3.26**	**0.003**	31	Up	Predicted values increased from 0.0037 mg/L to 0.0432 mg/L
Nitrate/Nitrite (mg/L)	0.692	0.05	1.66	0.0204	0.879	0.384	39		No Trend
Station 13228									
DO summer (mg/L)	7.12	5.4	9.82	0.0449	0.752	0.466	14		No Trend
DO winter (mg/L)	9.62	6.11	14.52	0.0084	0.511	0.612	33		No Trend
Chloride (mg/L)	415	9	680	0.07	**1.57**	0.125	35		No Trend
Sulfate (mg/L)	663	125	1021	0.07	**1.57**	0.124	35		No Trend
TDS (mg/L)	1857	348	2720	0.0723	**1.6**	0.118	35		No Trend
pH (SU)	7.96	7.21	9.1	0.0281	**-1.03**	0.307	39		No Trend
log Fecal Coliform (cfu/100ml)	1.83	0	3.9	0.039	**1.07**	0.295	30		No Trend
Conductivity (uS/cm)	2654	458	3910	0.072	**1.72**	**0.094**	40		Predicted values increased from 2138 uS/cm to 2967 uS/cm
Total Phosphate (mg/L)	1.08	0.01	15.5	0.013	0.669	0.508	36		No Trend

UPPER RIO GRANDE SUB-BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
Ortho-Phosphate (mg/L)	0.312	0.03	4.1	0.021	0.781	0.441	31		No Trend
Ammonia (mg/L)	0.1	0.01	1.3	0.0566	**1.42**	0.162	36		No Trend
Nitrate/Nitrite (mg/L)	0.39	0.01	2.13	0.0034	-0.319	0.751	32		No Trend
Station 13229									
DO summer (mg/L)	6.42	3.9	8.95	0.326	**3.03**	**0.007**	21	Up	Predicted values increased from 5.4 mg/L to 7.53 mg/L
DO winter (mg/L)	8.33	6.1	11.24	0.013	-0.716	0.479	41		No Trend
Chloride (mg/L)	406	38	802	0.066	**2.03**	**0.047**	60	Up	Predicted values increased from 335 mg/L to 484 mg/L
Sulfate (mg/L)	637	230	1000	0.049	**1.73**	**0.089**	60		Predicted values increased from 577 mg/L to 705 mg/L
TDS (mg/L)	1827	680	3280	0.0989	**2.52**	**0.014**	60	Up	Predicted values increased from 1588 mg/L to 2091mg/L
pH (SU)	7.84	7.1	9	0.41	**-6.45**	**2.00E-08**	62	Down	Predicted values decreased from 8.25 SU to 7.40 SU
log Fecal Coliform (cfu/100ml)	2.68	1.46	3.9	0.0031	0.424	0.673	60		No Trend
Conductivity (uS/cm)	2679	1010	4420	0.0924	**2.92**	**0.004**	86	Up	Predicted values increased from 2348 S/cm to 3161 S/cm
Total Phosphate (mg/L)	2.52	0.03	40.8	0.0402	**-1.48**	0.142	55		No Trend
Ortho-Phosphate (mg/L)	0.247	0.01	1.5	0.0031	0.315	0.755	34		No Trend
Ammonia (mg/L)	0.192	0.005	2.7	0.0006	-0.188	0.852	59		No Trend
Nitrate/Nitrite (mg/L)	0.51	0.005	2.58	0.015	0.697	0.491	34		No Trend
Station 16730									
DO Combined (mg/L)	8.18	5.65	11.6	0.0046	0.288	0.776	20		No Trend
Chloride (mg/L)	304	40	465	0.113	**-1.42**	0.173	18		No Trend
Sulfate (mg/L)	539	122	775	0.114	**-1.44**	0.17	18		No Trend
TDS (mg/L)	1519	204	2100	0.121	**-1.48**	0.158	18		No Trend
pH (SU)	7.74	7.4	8.1	0.152	**-1.85**	**0.08**	21	Down	Predicted values decreased from 7.85 SU to 7.63 SU
log Fecal Coliform (cfu/100ml)	1.43	0	2.65	0.085	**1.01**	0.333	13		No Trend
Conductivity (uS/cm)	2279	749	2780	0.024	-0.68	0.505	21		No Trend

UPPER RIO GRANDE SUB-BASIN	**Mean**	**Min**	**Max**	**R^2**	**T ratio**	**P value**	**N**	**Trend**	**Comments**
Total Phosphate (mg/L)	0.397	0.05	2.74	0.081	**1.18**	0.252	18		No Trend
Ortho-Phosphate (mg/L)	0.133	0.01	0.8	0.027	-0.624	0.543	16		No Trend
Ammonia (mg/L)	0.153	0.01	0.76	0.0403	-0.82	0.424	18		No Trend
Nitrate/Nitrite (mg/L)	0.163	0.02	0.87	0.0971	**-1.18**	0.258	15		No Trend
Station 17000									
DO Combined (mg/L)	7.94	6.8	9.6	0.0626	-0.78	0.44	17		No Trend
Chloride (mg/L)									<10 Data Points
Sulfate (mg/L)									<10 Data Points
TDS (mg/L)									<10 Data Points
pH (SU)	7.49	7	8	0.253	-1.94	0.07	17	Down	Predicted values decrease from 7.74 SU to 7.29 SU
log Fecal Coliform (cfu/100ml)	3.08	2.43	3.57	0.059	-1.43	0.171	17		No Trend
Conductivity (uS/cm)	3019	2390	3830	0.0001	0.583	0.568	17		No Trend
Total Phosphate (mg/L)									<10 Data Points
Ortho-Phosphate (mg/L)									<10 Data Points
Ammonia (mg/L)									<10 Data Points
Nitrate/Nitrite (mg/L)									<10 Data Points
Station 17001									
DO Combined (mg/L)	7.84	6.8	9.4	0.039	-0.78	0.447	17		No Trend
Chloride (mg/L)									<10 Data Points
Sulfate (mg/L)									<10 Data Points
TDS (mg/L)									<10 Data Points
pH (SU)	7.47	6.1	8.2	0.201	**-1.95**	**0.07**	17	Down	Predicted values decrease from 7.80 SU to 7.19 SU
log Fecal Coliform (cfu/100ml)	2.01	1.6	2.51	0.121	**-1.44**	0.171	17		No Trend
Conductivity (uS/cm)	3020	2395	3820	0.022	0.583	0.568	17		No Trend

UPPER RIO GRANDE SUB-BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
Total Phosphate (mg/L)									<10 Data Points
Ortho-Phosphate (mg/L)									<10 Data Points
Ammonia (mg/L)									<10 Data Points
Nitrate/Nitrite (mg/L)									<10 Data Points
Segment 2307									
Station 13225									
DO Combined (mg/L)	8.91	5.2	12.08	1E-06	0.004	0.997	22		No Trend
Chloride (mg/L)	231	89	465	0.19	**-2.27**	**0.033**	24	Down	Predicted values decreased from 299 mg/L to 123 mg/L
Sulfate (mg/L)	446	60	658	0.072	**-1.3**	0.206	24		No Trend
TDS (mg/L)	1343	605	2060	0.089	**1.74**	**0.096**	23	Down	Predicted values decreased from 1516 mg/l to 1113 mg/L
pH (SU)	8.072	7.51	8.6	0.35	**-3.11**	**0.006**	20	Down	Predicted values decreased from 8.2 mg/L to 7.8 mg/L
log Fecal Coliform (cfu/100ml)	1.53	8.45	2.52	0.0073	0.374	0.712	21		No Trend
Conductivity (uS/cm)	2014	1160	2870	0.0083	-0.387	0.703	20		No Trend
Total Phosphate (mg/L)	0.932	0.02	9.09	0.0094	0.457	0.652	24		No Trend
Ortho-Phosphate (mg/L)	0.067	0.01	0.4	0.103	**-1.56**	0.134	23		No Trend
Ammonia (mg/L)	0.027	0.01	0.06	0.289	**2.99**	**0.006**	24	Up	Trend is artifact of change in reporting limits
Nitrate/Nitrite (mg/L)	0.183	0.01	1.48	0.071	**1.29**	0.207	24		No Trend
Station 13230									
DO summer (mg/L)	6.39	4	7.7	0.531	**3.84**	**0.002**	15	Up	Predicted values increased from 5.34 mg/L to 7.61mg/L
DO winter (mg/L)	8.01	5.68	10.83	0.0032	-0.318	0.752	34		No Trend
Chloride (mg/L)	545.6	85	991	0.0025	-0.363	0.718	55		No Trend
Sulfate (mg/L)	607	255	1100	0.003	-0.4	0.69	55		No Trend
TDS (mg/L)	2025	850	3057	0.0026	0.372	0.711	55		No Trend
pH (SU)	7.77	6.7	9.2	0.0003	-0.129	0.897	60		No Trend

UPPER RIO GRANDE SUB-BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
log Fecal Coliform (cfu/100ml)	1.91	1.11	3.48	0.0043	0.488	0.627	58		No Trend
Conductivity (uS/cm)	3160	1150	4750	0.0408	**1.67**	**0.098**	68	Up	Predicted values increased from 2995 uS/cm to 3476 uS/cm
Total Phosphate (mg/L)	1.27	0.025	7.47	0.124	**-2.41**	**0.02**	43	Down	Predicted values decreased from 2.39 mg/L to 0.388 mg/L
Ortho-Phosphate (mg/L)	0.294	0.01	1.9	0.21	**-2.63**	**0.014**	28	Down	Predicted values decreased from 0.61mg/L to 0.039 mg/L
Ammonia (mg/L)	0.197	0.01	1.56	0.0539	**-1.65**	0.104	50		No Trend
Nitrate/Nitrite (mg/L)	0.805	0.02	3.3	0.0154	-0.638	0.53	28		No Trend
Station 13232									
DO summer (mg/L)	8.12	5.5	14.6	0.0615	-0.886	0.392	14		No Trend
DO winter (mg/L)	8.76	5.38	12.5	0.0184	-0.659	0.517	25		No Trend
Chloride (mg/L)	729.9	246	1410	0.01	-0.56	0.579	33		No Trend
Sulfate (mg/L)	612.6	250	1150	0.004	0.353	0.727	33		No Trend
TDS (mg/L)	2452	892	4410	0.0323	**-1.02**	0.317	33		No Trend
pH (SU)	7.84	7.3	8.7	0.0258	-0.906	0.371	33		No Trend
log Fecal Coliform (cfu/100ml)	2.06	0.845	3.78	0.0032	0.304	0.763	31		No Trend
Conductivity (uS/cm)	3430	540	6230	0.136	**2.21**	**0.035**	33	Up	Predicted values increased from 2850 uS/cm to 3992 uS/cm
Total Phosphate (mg/L)	0.793	0.01	2.5	0.0134	0.648	0.522	33		No Trend
Ortho-Phosphate (mg/L)	0.451	0.03	2.32	0.0062	0.417	0.68	30		No Trend
Ammonia (mg/L)	1.11	0.02	6.79	0.0046	0.37	0.714	32		No Trend
Nitrate/Nitrite (mg/L)	1.02	0.05	3.02	0.0003	0.086	0.932	28		No Trend
Station 15795									
DO summer (mg/L)	6.6	3.74	10.3	0.0091	0.318	0.756	13		No Trend
DO winter (mg/L)	8.85	2.15	16.9	0.0056	-0.468	0.643	41		No Trend
Chloride (mg/L)	324.9	96	809	0.0498	**1.25**	0.219	32		No Trend
Sulfate (mg/L)	388.7	181	708	0.0214	0.809	0.425	32		No Trend

UPPER RIO GRANDE SUB-BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
TDS (mg/L)	1310	594	2670	0.0465	**1.21**	0.236	32		No Trend
pH (SU)	8.03	6.64	8.61	0.0009	0.211	0.833	54		No Trend
log Fecal Coliform (cfu/100ml)	2.43	0	4.9	0.0105	0.574	0.57	33		No Trend
Conductivity (uS/cm)	2123	1007	5290	0.0364	**1.4**	0.167	54		No Trend
Total Phosphate (mg/L)	0.812	0.09	2.23	0.252	**2.66**	**0.015**	23	Up	Predicted values increased from 0.32 mg/L to 1.4 mg/L
Ortho-Phosphate (mg/L)	0.495	0.06	1.87	0.136	**1.73**	**0.099**	21	Up	Predicted values increased from 0.21 mg/L to 0.85 mg/L
Ammonia (mg/L)	1.563	0.03	8.21	0.137	**2.25**	**0.031**	34	Up	Predicted values increased from 0.21mg/L to 1.4 mg/L
Nitrate/Nitrite (mg/L)	1.315	0.05	4.1	0.0775	**-1.26**	0.222	21		No Trend
Segment 2308									
Station 14465									
DO summer (mg/L)	8.46	2	12.6	0.107	**-2.88**	**0.005**	71	Down	Predicted values decrease from 9.5 mg/L to 6.7 mg/L
DO winter (mg/L)	9.24	1.9	13.8	0.0007	0.325	0.745	151		No Trend
Chloride (mg/L)	148	46	300	0.028	**-2.18**	**0.03**	168	Down	Predicted values decrease from 164 mg/L to 123 mg/L
Sulfate (mg/L)	271	113	1836	0.014	**-1.54**	0.124	171		No Trend
TDS (mg/L)	771	298	1460	0.004	-0.763	0.446	165		No Trend
pH (SU)	7.97	6.9	9.59	0.325	**10.38**	**7.00E-21**	226	Up	Predicted values increase from 7.6 mg/L to 8.4 mg/L
log Fecal Coliform (cfu/100ml)	1.82	0	4.65	0.034	**2.73**	**0.007**	217	Up	Predicted values increase from 1.5 cfu/100 ml to 2.25 cfu/100 ml
Conductivity (uS/cm)	1290	560	2310	9E-06	0.039	0.968	177		No Trend
Total Phosphate (mg/L)	0.582	0.02	1.7	0.001	-0.154	0.879	18		No Trend
Ortho-Phosphate (mg/L)									<10 Data Points
Ammonia (mg/L)	1.18	0.003	8.89	0.234	**-7.16**	**2E-11**	170	Down	Predicted values decreased from 2.44 mg/L to 0.9 mg/L
Nitrate/Nitrite (mg/L)									
Station 15528									
DO summer (mg/L)	9.8	5.74	13.4	0.217	**-4.43**	**0.00003**	73	Down	Predicted values decreased from 11.2 mg/L to 7.7mg/L
DO winter (mg/L)	9.92	6.9	15.6	0.086	**3.54**	**0.0005**	136	Up	Predicted values increased from 9.2 mg/L to 10.7 mg/L

UPPER RIO GRANDE SUB-BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
Chloride (mg/L)	165	57	383	0.042	**-2.93**	**0.004**	198	Down	Predicted values decreased from 188 mg/L to 131 mg/L
Sulfate (mg/L)	264	114	762	0.0007	0.382	0.703	202		No Trend
TDS (mg/L)	820	88	1594	6E-06	-0.035	0.971	198		No Trend
pH (SU)	7.95	6.48	9.72	0.562	**16.5**	**7.00E-40**	214	Up	Predicted values increased from 7.16 mg/L to 8.93 mg/L
log Fecal Coliform (cfu/100ml)	1.92	0	5	0.385	**11.06**	**2.00E-22**	197	Up	Predicted values increased from 0.65 cfu/100 ml to 3.6cfu/100 ml
Conductivity (uS/cm)	13.88	323	2780	0.002	0.625	0.533	212		No Trend
Total Phosphate (mg/L)	0.629	0.05	2.3	0.09	**-1.64**	0.113	29		No Trend
Ortho-Phosphate (mg/L)	0.121	0.04	0.41	0.189	**-1.52**	0.157	12		No Trend
Ammonia (mg/L)	2	0.01	12.3	0.413	**11.89**	**5.00E-25**	203	Down	Predicted values decreased from 5.2 mg/L to 2.55 mg/L,
Nitrate/Nitrite (mg/L)									
Station 15529									
DO summer (mg/L)	9.57	5.47	12.5	0.158	**-3.42**	**0.0002**	64	Down	Predicted values decreased from 10.54 mg/L to 8.15 mg/L
DO winter (mg/L)	9.8	6.2	13.43	0.0667	**2.92**	**0.004**	122	Up	Predicted values increased from 9.26 mg/L to 10.49 mg/L
Chloride (mg/L)	145	10	380	0.0003	0.233	0.816	174		No Trend
Sulfate (mg/L)	274	118	750	0.0008	-0.373	0.709	177		No Trend
TDS (mg/L)	7.97	206	1820	0.0045	0.881	0.379	173		No Trend
pH (SU)	8.11	7.2	8.8	0.282	**8.59**	**3E-15**	190	Up	Predicted values increased from 7.8 mg/L to 8.4 mg/L
log Fecal Coliform (cfu/100ml)	2.69	0	5	0.015	**1.63**	0.104	176		No Trend
Conductivity (uS/cm)	1331	610	2820	0.036	**2.66**	**0.008**	190	Up	Predicted values increased from 1185 uS/cm to 1520 uS/cm
Total Phosphate (mg/L)									
Ortho-Phosphate (mg/L)									
Ammonia (mg/L)	0.172	0.02	1.4	0.0337	**2.48**	**0.014**	178	Up	Predicted value increased from 0.116 mg/L to 0.252 mg/L
Nitrate/Nitrite (mg/L)									
Segment 2309									
Station 13237									

UPPER RIO GRANDE SUB-BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
DO Combined (mg/L)	9.9	8	12.8	0.0003	-0.056	0.956	13		No Trend
Chloride (mg/L)	14.13	7	19	0.161	**-1.52**	0.155	14		No Trend
Sulfate (mg/L)	8.31	1	15	0.004	0.209	0.838	14		No Trend
TDS (mg/L)	380	198	3660	0.065	-0.915	0.378	14		No Trend
pH (SU)	8.19	8	8.4	0.257	**1.95**	**0.077**	13	Up	Predicted values increased from 8.09 SU to 8.24 SU
log Fecal Coliform (cfu/100ml)	0.451	0	1.3	0.052	0.661	0.527	10		No Trend
Conductivity (uS/cm)	384	347	427	0.024	-0.627	0.539	18		No Trend
Total Phosphate (mg/L)	0.02	0.01	0.07	0.479	**-3.22**	**0.006**	14		Trend is artifact of change in reporting limits
Ortho-Phosphate (mg/L)	0.033	0.03	0.04	0.818	**7.05**	**0.04**	13		Trend is artifact of change in reporting limits
Ammonia (mg/L)	0.045	0.01	0.06	0.201	**1.73**	0.107	14		No Trend
Nitrate/Nitrite (mg/L)	1.12	0.01	1.58	0.137	**1.31**	0.214	13		No Trend
Segment 2314									
Station 13276									
DO summer (mg/L)	7.14	3.08	9.2	0.279	**-1.97**	**0.077**	12	Down	Predicted values decrease from 10.07 mg/L to 6.17 mg/L
DO winter (mg/L)	9.79	8.1	12.3	0.082	**1.19**	0.25	18		No Trend
Chloride (mg/L)	96.15	34.7	196	0.097	**1.73**	**0.093**	30	Up	Predicted values decrease from 79 mg/L to 122 mg/L
Sulfate (mg/L)	208.1	90	369	0.06	0.978	0.343	29		No Trend
TDS (mg/L)	759.8	456	3130	0.002	-0.239	0.813	30		No Trend
pH (SU)	8.11	7.45	9.7	0.117	**-1.93**	**0.064**	30	Up	Predicted values increase from 7.9 mg/L to 8.11 mg/L
log Fecal Coliform (cfu/100ml)	2.03	0.77	3.08	0.176	**2.45**	**0.021**	30	Up	Predicted values increase from 2.47 mg/L to 3.09 mg/L
Conductivity (uS/cm)	980	240	1640	0.029	0.907	0.372	30		No Trend
Total Phosphate (mg/L)	0.354	0.07	4.14	0.002	-0.222	0.826	26		No Trend
Ortho-Phosphate (mg/L)	0.038	0.025	0.06	0.717	**5.52**	**0.0001**	14	Up	Trend is artifact of change in reporting limits
Ammonia (mg/L)	0.074	0.005	0.51	0.009	-0.479	0.636	27		No Trend
Nitrate/Nitrite (mg/L)	0.57	0.16	2.13	0.062	**1.2**	0.242	24		No Trend

UPPER RIO GRANDE SUB-BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
Station 13272									
DO summer (mg/L)	8.41	4.6	25	0.193	**-4.31**	**0.00005**	81	Down	Predicted values decrease from 9.5 mg/L to 6.4 mg/L
DO winter (mg/L)	9.27	5.73	14.1	0.03	**-2.16**	**0.032**	151	Down	Predicted values decrease from 9.67 mg/L to 8.83 mg/L
Chloride (mg/L)	140.4	35	334	0.0002	0.212	0.832	200		No Trend
Sulfate (mg/L)	268.5	127	565	0.0001	-0.156	0.876	202		No Trend
TDS (mg/L)	791.7	178	1560	0.008	**1.23**	0.219	199		No Trend
pH (SU)	8	6.9	8.8	0.039	**3.13**	**0.002**	244	Up	Predicted values increase from 7.91mg/L to 8.11 mg/L
log Fecal Coliform (cfu/100ml)	2.74	0	4.84	0.073	**4.15**	**0.00005**	220	Up	Predicted values increase from 1.68 mg/L to 2.57 mg/L
Conductivity (uS/cm)	1326	553	3160	0.002	0.989	0.323	472		No Trend
Total Phosphate (mg/L)	0.365	0.2	1.02	0.14	**1.14**	0.285	10		No Trend
Ortho-Phosphate (mg/L)	0.066	0.01	0.32	0.095	**1.68**	0.104	29		No Trend
Ammonia (mg/L)	0.206	0.02	1.91	0.026	**2.19**	**0.03**	180	Down	Predicted values decrease from 0.087 mg/L to 0.052 mg/L
Nitrate/Nitrite (mg/L)									<10 Data Points
Station 17040									
DO Combined (mg/L)	8.92	6.21	11.9	0.0314	-0.697	0.496	17		No Trend
Chloride (mg/L)									<10 Data Points
Sulfate (mg/L)									<10 Data Points
TDS (mg/L)									<10 Data Points
pH (SU)	8.2	7.62	8.64	0.118	**-1.42**	0.176	17		No Trend
log Fecal Coliform (cfu/100ml)									<10 Data Points
Conductivity (uS/cm)	1122	768	1820	0.084	**-1.17**	0.259	17		No Trend
Total Phosphate (mg/L)									<10 Data Points
Ortho-Phosphate (mg/L)									<10 Data Points
Ammonia (mg/L)									<10 Data Points
Nitrate/Nitrite (mg/L)									<10 Data Points

MIDDLE RIO GRANDE SUB-BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
Segment 2303									
Station 15839									
DO summer (mg/L)									<10 Data Points
DO winter (mg/L)	9.16	8.06	10.96	0.006	-0.298	0.769	17		No Trend
Chloride (mg/L)	115	77	145	0.053	0.889	0.389	16		No Trend
Sulfate (mg/L)	178	119	214	0.001	-0.142	0.889	16		No Trend
TDS (mg/L)	604	458	912	0.015	-0.466	0.648	16		No Trend
pH (SU)	8.16	7.79	8.45	0.019	0.59	0.562	20		No Trend
log Fecal Coliform (cfu/100ml)	1.41	0	2.81	0.01	0.681	0.499	46		No Trend
Conductivity (uS/cm)	955	740	1210	0.334	**-2.92**	**0.009**	19	Down	Predicted values decreased from 1125 uS/cm to 838 uS/cm
Total Phosphate (mg/L)	0.234	0.03	1.22	0.003	-0.199	0.845	16		No Trend
Ortho-Phosphate (mg/L)	0.028	0.005	0.07	0.006	-0.273	0.789	15		No Trend
Ammonia (mg/L)	0.023	0.01	0.06	0.161	**1.64**	0.124	16		No Trend
Nitrate/Nitrite (mg/L)	0.458	0.05	0.86	0.004	0.225	0.826	15		No Trend
Segment 2304									
Station 13194									
DO summer (mg/L)	7.47	6.1	8.3	0.395	**-2.28**	**0.051**	10	Down	Predicted values decreased from 8.31mg/L to 6.89 mg/L
DO winter (mg/L)	7.93	5.4	9.5	0.0002	-0.057	0.955	16		No Trend
Chloride (mg/L)	152.5	65	267	0.129	**1.44**	0.171	16		No Trend
Sulfate (mg/L)	217	95	351	0.051	0.87	0.399	16		No Trend
TDS (mg/L)	761	520	1186	0.06	0.947	0.36	16		No Trend
pH (SU)	7.76	5.4	9.5	0.008	0.436	0.666	26		No Trend
log Fecal Coliform (cfu/100ml)	3.13	1.56	4.88	0.002	-0.176	0.862	22		No Trend
Conductivity (uS/cm)	1181	594	2193	0.008	-0.444	0.661	27		No Trend

MIDDLE RIO GRANDE SUB-BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
Total Phosphate (mg/L)	3.11	0.04	21.6	0.072	**1.01**	0.333	15		No Trend
Ortho-Phosphate (mg/L)									<10 Data Points
Ammonia (mg/L)	0.231	0.04	0.54	0.143	**1.47**	0.164	15		No Trend
Nitrate/Nitrite (mg/L)									
Station 13196									
DO summer (mg/L)									<10 Data Points
DO winter (mg/L)	8.77	6.1	14.4	0.011	-0.469	0.644	22		No Trend
Chloride (mg/L)	142	87.4	181	0.011	0.344	0.737	13		No Trend
Sulfate (mg/L)	203	124	249	0.074	-0.844	0.42	11		No Trend
TDS (mg/L)	651	516	780	0.029	-0.514	0.619	11		No Trend
pH (SU)	7.95	6.8	8.4	0.007	-0.336	0.741	17		No Trend
log Fecal Coliform (cfu/100ml)	2.93	1.51	4.57	0.161	**-3.1**	**0.003**	52	Down	Predicted values decreased from 3.37 cfu/100 ml to 2.42 cfu/100 ml
Conductivity (uS/cm)	1176	775	2244	0.092	**-1.24**	0.235	17		No Trend
Total Phosphate (mg/L)	0.6	0.05	2.55	0.317	**-2.04**	**0.071**	11	Down	Trend due to unusually high values in 1997
Ortho-Phosphate (mg/L)									<10 Data Points
Ammonia (mg/L)	0.209	0.08	0.5	0.326	**-2.96**	**0.008**	20	Down	Predicted values decreased from 0.27 mg/L to 0.121 mg/L
Nitrate/Nitrite (mg/L)									<10 Data Points
Station 13202									
DO summer (mg/L)									<10 Data Points
DO winter (mg/L)	9.08	6.8	13.7	0.047	-0.858	0.404	17		No Trend
Chloride (mg/L)	140	100	173	0.0003	0.055	0.957	12		No Trend
Sulfate (mg/L)	203	143	244	0.036	-0.615	0.552	12		No Trend
TDS (mg/L)	688	582	780	0.035	-0.569	0.583	11		No Trend
pH (SU)	8.08	7.8	8.4	0.031	0.59	0.567	13		No Trend

MIDDLE RIO GRANDE SUB-BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
log Fecal Coliform (cfu/100ml)	1.62	0.54	303	0.001	0.257	0.798	52		No Trend
Conductivity (uS/cm)	1184	830	2232	0.128	**-1.27**	0.23	13		No Trend
Total Phosphate (mg/L)	0.6	0.005	3.18	0.035	-0.569	0.583	11		No Trend
Ortho-Phosphate (mg/L)	0.042	0.005	0.09	0.073	-0.793	0.45	10		No Trend
Ammonia (mg/L)	0.14	0.01	0.244	0.005	-0.233	0.82	12		No Trend
Nitrate/Nitrite (mg/L)	0.273	0.09	0.47	0.385	**-1.18**	0.272	10		No Trend
Station 13205									
DO summer (mg/L)	27.7	24.8	30	0.049	**-1.02**	0.32	22		No Trend
DO winter (mg/L)	18.4	11.5	27.9	0.0007	-0.127	0.9	26		No Trend
Chloride (mg/L)	145	12	1220	0.013	0.847	0.4	56		No Trend
Sulfate (mg/L)	182	22	255	0.102	**-2.48**	**0.016**	56	Down	Predicted values decreased from 197 mg/L to 164 mg/L
TDS (mg/L)	689	571	832	0.102	**-1.61**	0.119	25		No Trend
pH (SU)	7.84	6.8	8.5	0.204	**-2.58**	**0.016**	28	Down	Predicted values decreased from 8.1 SU to 7.6 SU
log Fecal Coliform (cfu/100ml)	2.43	0.602	4.13	0.026	**-1.16**	0.249	53		No Trend
Conductivity (uS/cm)	1000	104	1230	0.036	0.904	0.375	24		No Trend
Total Phosphate (mg/L)	1.73	0.005	10.45	0.053	0.972	0.345	19		No Trend
Ortho-Phosphate (mg/L)	0.096	0.04	0.7	0.055	**-1.37**	0.18	34		No Trend
Ammonia (mg/L)	0.259	0.025	0.078	0.022	**1.19**	0.247	20		No Trend
Nitrate/Nitrite (mg/L)	0.411	0.1	1.3	0.194	**-2.73**	**0.01**	33	Down	Predicted values decreased from 0.62 mg/L to 0.29 mg/L
Station 13206									
DO summer (mg/L)	8.02	6.6	10.2	0.007	0.249	0.809	11		No Trend
DO winter (mg/L)	9.88	5.9	14.3	0.085	**1.18**	0.255	17		No Trend
Chloride (mg/L)	125	85	155	0.164	**-2.12**	**0.044**	25	Down	Predicted values decreased from 132 mg/L to 112 mg/L
Sulfate (mg/L)	178	127	212	0.399	**-3.91**	**0.0006**	25	Down	Predicted values decreased from 193 mg/L to 153 mg/L

MIDDLE RIO GRANDE SUB-BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
TDS (mg/L)	643	508	780	0.636	**-4.75**	**0.0003**	16	Down	Predicted values decreased from 715 mg/L to 506 mg/L
pH (SU)	8.06	7.3	8.5	0.068	**-1.35**	0.188	27		No Trend
log Fecal Coliform (cfu/100ml)	1.64	0.778	3.48	0.053	**1.11**	0.278	24		No Trend
Conductivity (uS/cm)	991	807	1135	0.052	**-1.17**	0.254	27		No Trend
Total Phosphate (mg/L)	0.704	0.01	5	3E-05	-0.02	0.984	14		No Trend
Ortho-Phosphate (mg/L)	0.244	0.03	1.79	0.079	**-1.14**	0.274	17		No Trend
Ammonia (mg/L)	0.127	0.01	0.449	0.186	**-2.08**	**0.051**	21	Down	Predicted values decreased from 0.18 mg/L to 0.04 mg/L
Nitrate/Nitrite (mg/L)	0.388	0.09	0.96	0.617	**-3.59**	**0.007**	10	Down	Predicted values decreased from 0.75 mg/L to 0.26 mg/L
Station 13208									
DO summer (mg/L)	7.05	3.7	12.2	0.019	0.467	0.649	13		No Trend
DO winter (mg/L)	9.1	5.5	13.2	0.153	**2.12**	**0.044**	27	Up	Predicted values increased from 7.89 mg/L to 10.6 mg/L
Chloride (mg/L)	138	90	170	0.333	**-3.67**	**0.001**	29	Down	Predicted values decreased from 156 mg/L to 117 mg/L
Sulfate (mg/L)	187	44	243	0.152	**-2.28**	**0.03**	31	Down	Predicted values decreased from 209 mg/L to 156 mg/L
TDS (mg/L)	660	144	1010	0.181	**-2.49**	**0.019**	30	Down	Predicted values decreased from 733 mg/L to 566 mg/L
pH (SU)	7.89	7.3	9.3	0.041	**1.13**	0.266	32		No Trend
log Fecal Coliform (cfu/100ml)	1.64	0.301	2.91	0.03	**1.08**	0.283	40		No Trend
Conductivity (uS/cm)	1.9	899	1248	0.457	**-5.03**	**0.00002**	32	Down	Predicted values decreased from 1174 uS/cm to 987 uS/cm
Total Phosphate (mg/L)	0.982	0.005	5.83	0.089	**-1.59**	0.123	28		No Trend
Ortho-Phosphate (mg/L)	0.132	0.01	0.7	0.284	**-2.43**	**0.027**	17	Down	Predicted values decreased from 0.31 mg/L to 0.019 mg/L
Ammonia (mg/L)	0.131	0.003	0.599	0.31	**-3.48**	**0.002**	29	Down	Predicted values decreased from 0.22 mg/L to 0.011 mg/L
Nitrate/Nitrite (mg/L)	0.347	0.08	0.79	0.368	**-2.87**	**0.013**	16	Down	Predicted values decreased from 0.56 mg/L to 0.25 mg/L
Station 13209									
DO summer (mg/L)									<10 Data Points
DO winter (mg/L)	8.02	3.5	10.1	0.067	-0.802	0.443	11		No Trend

MIDDLE RIO GRANDE SUB-BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
Chloride (mg/L)	187	61	240	0.58	**-6.55**	**3E-07**	33	Down	Predicted values decreased from 222 mg/L to 116 mg/L
Sulfate (mg/L)	179	93	228	0.263	**3.33**	**0.002**	33	Up	Predicted values increased from 161 mg/L to 214 mg/L
TDS (mg/L)	736	385	1500	0.159	**-1.74**	0.101	18		No Trend
pH (SU)	7.77	7.2	8.3	0.064	**-1.45**	0.157	33		No Trend
log Fecal Coliform (cfu/100ml)									<10 Data Points
Conductivity (uS/cm)	1144	645	1240	0.284	**-3.5**	**0.001**	33	Down	Predicted values decreased from 1215 uS/cm to 998 uS/cm
Total Phosphate (mg/L)	0.014	0.004	0.075	0.028	-0.679	0.507	18		No Trend
Ortho-Phosphate (mg/L)									All Values < AWRL
Ammonia (mg/L)									<10 Data Points
Nitrate/Nitrite (mg/L)	0.288	0.133	1.01	0.092	**1.1**	0.291	14		No Trend
Station 13560									
DO summer (mg/L)	8.04	5.5	13.1	0.025	-0.69	0.499	20		No Trend
DO winter (mg/L)	9.7	5.5	19.9	0.002	**-2.56**	0.8	31		No Trend
Chloride (mg/L)	127	64	220	0.128	**-2.36**	**0.024**	40	Down	Predicted values decreased from 145 mg/L to 115 mg/L
Sulfate (mg/L)	177	103	219	0.097	**-2.06**	**0.035**	41	Down	Predicted values decreased from 197 mg/L to 171 mg/L
TDS (mg/L)	675	431	812	0.084	**-1.25**	0.228	19		No Trend
pH (SU)	7.97	5	10	0.026	0.984	0.331	39		No Trend
log Fecal Coliform (cfu/100ml)	2.19	0.477	3.51	0.001	0.293	0.77	59		No Trend
Conductivity (uS/cm)	993	505	1237	0.14	**-2.25**	**0.032**	33	Down	Predicted values decreased from 1085 uS/cm to 909 uS/cm
Total Phosphate (mg/L)	0.909	0.01	5.7	0.131	**-2.72**	**0.009**	51	Down	Predicted values decreased from 1.91 mg/L to 0.07 mg/L
Ortho-Phosphate (mg/L)	0.074	0.01	0.7	0.147	**-2.45**	**0.019**	37	Down	Predicted values decreased from 1.6 mg/L to 0.02 mg/L
Ammonia (mg/L)	0.137	0.02	0.564	0.137	**-2.79**	**0.007**	51	Down	Predicted values decreased from 0.21 mg/L to 0.06 mg/L
Nitrate/Nitrite (mg/L)	0.415	0.2	1.24	0.085	**-1.88**	**0.067**	40	Down	Predicted values decreased from 0.54 mg/L to 0.34 mg/L
Station 13698									

MIDDLE RIO GRANDE SUB-BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
DO summer (mg/L)									<10 Data Points
DO winter (mg/L)									<10 Data Points
Chloride (mg/L)	139	6	173	0.002	0.219	0.828	31		No Trend
Sulfate (mg/L)	199	16	240	0.015	-0.657	0.516	31		No Trend
TDS (mg/L)									<10 Data Points
pH (SU)	7.96	7.3	8.4	0.236	**3.14**	**0.004**	34	Up	Predicted values increased from 7.7 SU to 8.1 SU
log Fecal Coliform (cfu/100ml)	1.87	0.544	3.3	0.05	-0.651	0.533	10		No Trend
Conductivity (uS/cm)	1063	122	1280	0.037	**1.11**	0.273	34		No Trend
Total Phosphate (mg/L)									<10 Data Points
Ortho-Phosphate (mg/L)									<10 Data Points
Ammonia (mg/L)									<10 Data Points
Nitrate/Nitrite (mg/L)									<10 Data Points
Station 15813									
DO summer (mg/L)									<10 Data Points
DO winter (mg/L)									<10 Data Points
Chloride (mg/L)									<10 Data Points
Sulfate (mg/L)									<10 Data Points
TDS (mg/L)									<10 Data Points
pH (SU)									<10 Data Points
log Fecal Coliform (cfu/100ml)	1.63	0	4.38	0.011	0.557	0.582	29		No Trend
Conductivity (uS/cm)									<10 Data Points
Total Phosphate (mg/L)									<10 Data Points
Ortho-Phosphate (mg/L)									<10 Data Points
Ammonia (mg/L)									<10 Data Points
Nitrate/Nitrite (mg/L)									<10 Data Points

MIDDLE RIO GRANDE SUB-BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
Station 15814									
DO Combined (mg/L)	9.3	8.01	11.41	0.055	0.762	0.463	12		No Trend
Chloride (mg/L)									<10 Data Points
Sulfate (mg/L)									<10 Data Points
TDS (mg/L)									<10 Data Points
pH (SU)	8.16	7.73	8.4	0.008	-0.267	0.795	11		No Trend
log Fecal Coliform (cfu/100ml)	2.5	1.3	3.56	0.297	**3.95**	**0.0003**	39	Up	Predicted values increased from 2.07cfu/100ml to 2.94 cfu/100ml
Conductivity (uS/cm)	909	618	1220	0.002	-0.139	0.893	11		No Trend
Total Phosphate (mg/L)									<10 Data Points
Ortho-Phosphate (mg/L)									<10 Data Points
Ammonia (mg/L)									<10 Data Points
Nitrate/Nitrite (mg/L)									<10 Data Points
Station 15815									
DO summer (mg/L)									<10 Data Points
DO winter (mg/L)									<10 Data Points
Chloride (mg/L)									<10 Data Points
Sulfate (mg/L)									<10 Data Points
TDS (mg/L)									<10 Data Points
pH (SU)									<10 Data Points
log Fecal Coliform (cfu/100ml)	2.57	1.3	3.43	0.025	0.97	0.338	36		No Trend
Conductivity (uS/cm)									<10 Data Points
Total Phosphate (mg/L)									<10 Data Points
Ortho-Phosphate (mg/L)									<10 Data Points
Ammonia (mg/L)									<10 Data Points

MIDDLE RIO GRANDE SUB-BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
Nitrate/Nitrite (mg/L)									<10 Data Points
Station 15816									
DO summer (mg/L)									<10 Data Points
DO winter (mg/L)									<10 Data Points
Chloride (mg/L)									<10 Data Points
Sulfate (mg/L)									<10 Data Points
TDS (mg/L)									<10 Data Points
pH (SU)									<10 Data Points
log Fecal Coliform (cfu/100ml)	2.35	1.47	3.46	0.0002	0.084	0.933	31		No Trend
Conductivity (uS/cm)									<10 Data Points
Total Phosphate (mg/L)									<10 Data Points
Ortho-Phosphate (mg/L)									<10 Data Points
Ammonia (mg/L)									<10 Data Points
Nitrate/Nitrite (mg/L)									<10 Data Points
Station 15817									
DO summer (mg/L)	7.93	5.6	13.24	0.53	**3.82**	**0.002**	15	Up	Predicted values increased from 5.7 mg/L to 9.9 mg/L
DO winter (mg/L)	8.74	5.4	12.9	0.05	**1.07**	0.295	24		No Trend
Chloride (mg/L)	131	127	39	0.009	-0.525	0.603	34		No Trend
Sulfate (mg/L)	200	75	253	0.003	0.281	0.78	33		No Trend
TDS (mg/L)	642	466	874	0.07	**-1.55**	0.132	34		No Trend
pH (SU)	8.09	7.44	9.1	0.093	**1.77**	**0.085**	33	Up	Predicted values increased from 7.9 SU to 8.3 SU
log Fecal Coliform (cfu/100ml)	2.46	0.7	4.88	0.445	**-6.21**	**1E-07**	50	Down	Predicted values decreased from 3.45 cfu/100ml to 1.58 cfu/100ml
Conductivity (uS/cm)	1117	594	2193	0.123	**-1.71**	0.1	23		No Trend
Total Phosphate (mg/L)	0.666	0.005	8.41	0.04	**-1.29**	0.205	42		No Trend

MIDDLE RIO GRANDE SUB-BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
Ortho-Phosphate (mg/L)	0.164	0.04	0.32	0.038	0.988	0.332	27		No Trend
Ammonia (mg/L)	0.131	0.02	0.28	0.264	**-3.39**	**0.001**	34	Down	Predicted values decreased from 0.2 mg/L to 0.1 mg/L
Nitrate/Nitrite (mg/L)	0.791	0.3	1.35	0.095	**-1.71**	**0.098**	30	Down	Predicted values decreased from 1.05 mg/L to 0.66 mg/L
Segment 2313									
Station 13270									
DO summer (mg/L)									<10 Data Points
DO winter (mg/L)	8.69	8.1	9.3	0.109	0.993	0.349	10		No Trend
Chloride (mg/L)	22	5	111	0.001	0.128	0.899	17		No Trend
Sulfate (mg/L)	29.3	7	181	0.0009	0.119	0.906	17		No Trend
TDS (mg/L)	283	228	378	0.236	**-2.15**	**0.047**	17	Down	Predicted values decreased from 304 mg/L to 248 mg/L
pH (SU)	7.84	7.7	8	0.215	**1.89**	**0.081**	15	Up	Predicted values increased from 7.79 SU to 7.90 SU
log Fecal Coliform (cfu/100ml)									<10 Data Points
Conductivity (uS/cm)	478	443	506	0.091	**-1.19**	0.255	16		No Trend
Total Phosphate (mg/L)	0.03	0.005	0.06	0.848	**6.69**	**0.0002**	10	Up	Trend is artifact of change in reporting limits
Ortho-Phosphate (mg/L)	0.075	0.03	0.35	0.216	**-1.49**	0.175	10		No Trend
Ammonia (mg/L)	0.034	0.01	0.07	0.006	0.222	0.83	10		No Trend
Nitrate/Nitrite (mg/L)	1.6	0.24	2.02	0.007	-0.326	0.749	17		No Trend

LOWER RIO GRANDE SUB-BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
Segment 2301									
Station 13176									
DO summer (mg/L)	6.22	3.9	8.3	0.375	**2.79**	**0.029**	15	Up	Predicted values increased from 5.4 mg/L to 7.7 mg/L
DO winter (mg/L)	8.84	6.62	13.1	0.0006	-0.124	0.902	29		No Trend
Chloride (mg/L)	1869	38	13600	0.027	-0.914	0.367	32		No Trend
Sulfate (mg/L)	680	237	1820	0.194	**-2.68**	**0.012**	32	Down	Predicted values decreased from 891 mg/L to 300 mg/L
TDS (mg/L)	4035	703	25500	0.035	**-1.03**	0.308	32		No Trend
pH (SU)	8.14	7.64	9	0.007	-0.527	0.601	44		No Trend
log Fecal Coliform (cfu/100ml)	2.01	-0.301	3.64	0.134	**-2.42**	**0.02**	40	Down	Predicted values decreased from 2.57 cfu/100ml to 1.04 cfu/100ml
Conductivity (uS/cm)	3879	1010	26100	0.011	**1.02**	0.308	94		No Trend
Total Phosphate (mg/L)	7.34	0.005	46.1	0.017	-0.611	0.546	29		No Trend
Ortho-Phosphate (mg/L)	0.183	0.005	0.49	0.752	**5.77**	**0.0001**	13	Up	Predicted values increased from 0.0 mg/L to 0.346 mg/L
Ammonia (mg/L)	0.214	0.025	1.56	0.026	-0.901	0.375	13		No Trend
Nitrate/Nitrite (mg/L)	0.221	0.005	1.4	0.053	-0.785	0.499	32		No Trend
Segment 2302									
Station 13103									
DO Combined (mg/L)	8.81	4	15.1	0.594	-1.62	0.137	11		No Trend
Chloride (mg/L)									<10 Data Points
Sulfate (mg/L)									<10 Data Points
TDS (mg/L)									<10 Data Points
pH (SU)	8.15	7.4	9.42	0.466	**2.64**	**0.029**	10	Up	Predicted values increased from 7.6 SU to 8.7 SU
log Fecal Coliform (cfu/100ml)	2.49	1.45	3	0.0003	0.048	0.962	10		No Trend

LOWER RIO GRANDE SUB-BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
Conductivity (uS/cm)	9415	24597	613	0.511	**-3.07**	**0.013**	11	Down	Predicted values decreased from 17790 uS/cm to 1753 uS/cm
Total Phosphate (mg/L)									<10 Data Points
Ortho-Phosphate (mg/L)									<10 Data Points
Ammonia (mg/L)									<10 Data Points
Nitrate/Nitrite (mg/L)									<10 Data Points
Station 13177									
DO summer (mg/L)	6.65	0.68	11	0.137	**-1.99**	**0.058**	27	Down	Predicted values decreased from 7.64 mg/L to 5.23 mg/L
DO winter (mg/L)	8.91	2.3	14.97	0.076	**-1.85**	**0.071**	44	Down	Predicted values decreased from 10.0 mg/L to 8.5 mg/L
Chloride (mg/L)	212	95	515	0.131	**-3.34**	**0.001**	76	Down	Predicted values decreased from 257 mg/L to 150 mg/L
Sulfate (mg/L)	258	116	564	0.193	**-4.21**	**0.00007**	76	Down	Predicted values decreased from 309 mg/L to 187 mg/L
TDS (mg/L)	869	0.05	1980	0.101	**-2.9**	**0.005**	77	Down	Predicted values decreased from 1019 mg/L to 655 mg/L
pH (SU)	8.01	4.95	9.1	0.099	**-2.89**	**0.005**	78	Down	Predicted values decreased from 8.2 SU to 7.6 SU
log Fecal Coliform (cfu/100ml)	2.05	-0.301	3.46	0.025	**-1.24**	0.219	61		No Trend
Conductivity (uS/cm)	1447	2163	787	0.149	**-3.65**	**0.0004**	78	Down	Predicted values decreased from 1679 uS/cm to 1112 uS/cm
Total Phosphate (mg/L)	1.58	0.02	21.3	0.037	**-1.54**	0.126	64		No Trend
Ortho-Phosphate (mg/L)	0.181	0.03	0.6	0.341	**4.54**	**0.00005**	42	Up	Predicted values increased from 0.01 mg/L to 0.303 mg/L
Ammonia (mg/L)	0.198	0.02	1.56	0.084	**-2.36**	**0.022**	63	Down	Predicted values decreased from 0.3 mg/L to 0.167 mg/L
Nitrate/Nitrite (mg/L)	0.367	0.02	1.42	0.077	**-1.94**	**0.059**	47	Down	Predicted values decreased from 0.53 mg/L to 0.2 mg/L
Station 13181									
DO summer (mg/L)	7.18	5.1	9.5	0.036	**-1.01**	0.318	30		No Trend
DO winter (mg/L)	9.01	6	14.9	0.027	**-1.04**	0.303	41		No Trend
Chloride (mg/L)	149	22	257	0.075	**-2.17**	**0.034**	60	Down	Predicted values decreased from 165 mg/L to 128 mg/L
Sulfate (mg/L)	208	76	329	0.228	**-4.14**	**0.0001**	60	Down	Predicted values decreased from 241 mg/L to 166 mg/L
TDS (mg/L)	703	392	935	0.195	**-3.81**	**0.0003**	62	Down	Predicted values decreased from 783 mg/L to 609 mg/L

LOWER RIO GRANDE SUB-BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
pH (SU)	7.99	6.53	9	0.111	**-3.06**	**0.003**	77	Down	Predicted values decreased from 8.2 SU to 7.7 SU
log Fecal Coliform (cfu/100ml)	2.06	1	3.14	0.001	0.295	0.768	71		No Trend
Conductivity (uS/cm)	1188	537	1976	0.209	**-4.45**	**0.00003**	77	Down	Predicted values decreased from 1344 uS/cm to 987 uS/cm
Total Phosphate (mg/L)	0.82	0.005	7.73	0.068	**-2.11**	**0.039**	63	Down	Predicted values decreased from 1.52 mg/L to 0.01 mg/L
Ortho-Phosphate (mg/L)	0.093	0.01	0.7	0.085	**-1.87**	**0.069**	40	Down	Predicted values decreased from 0.159 mg/L to 0.01 mg/L
Ammonia (mg/L)	0.139	0.01	0.78	0.175	**-3.57**	**0.0007**	62	Down	Predicted values decreased from 0.22 mg/L to 0.04 mg/L
Nitrate/Nitrite (mg/L)	0.167	0.02	0.5	0.019	-0.812	0.422	36		No Trend
Station 13184									
DO summer (mg/L)									<10 Values
DO winter (mg/L)									<10 Values
Chloride (mg/L)	159	95	241	0.131	**-1.69**	0.107	21		No Trend
Sulfate (mg/L)	216	138	312	0.151	**-1.84**	**0.082**	21	Down	Predicted values decreased from 239 mg/L to 187 mg/L
TDS (mg/L)									<10 Values
pH (SU)	7.94	7.3	8.4	0.056	**1.06**	0.302	21		No Trend
log Fecal Coliform (cfu/100ml)									<10 Values
Conductivity (uS/cm)	1162	835	1650	0.291	**-2.79**	**0.011**	21	Down	Predicted values decreased from 1312 uS/cm to 980 uS/cm
Total Phosphate (mg/L)									<10 Values
Ortho-Phosphate (mg/L)									<10 Values
Ammonia (mg/L)									<10 Values
Nitrate/Nitrite (mg/L)									<10 Values
Station 13185									
DO summer (mg/L)									<10 Values
DO winter (mg/L)									<10 Values
Chloride (mg/L)	142	44	229	0.199	**-3.12**	**0.003**	41	Down	Predicted values decreased from 163 mg/L to 113 mg/L

LOWER RIO GRANDE SUB-BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
Sulfate (mg/L)	193	60	280	0.199	**-3.11**	**0.05**	41	Down	Predicted values decreased from 220 mg/L to 158 mg/L
TDS (mg/L)	623	438	803	0.624	**-4.99**	**0.001**	17	Down	Predicted values decreased from 710 mg/L to 535 mg/L
pH (SU)	7.63	7	8.4	0.0007	-0.173	0.863	41		No Trend
log Fecal Coliform (cfu/100ml)									<10 Values
Conductivity (uS/cm)	1092	480	1500	0.222	**-3.33**	**0.002**	41	Down	Predicted values decreased from 1215 uS/cm to 925 uS/cm
Total Phosphate (mg/L)									<10 Values
Ortho-Phosphate (mg/L)									<10 Values
Ammonia (mg/L)									<10 Values
Nitrate/Nitrite (mg/L)									<10 Values
Station 13186									
DO summer (mg/L)	6.75	5.5	10.8	0.003	-0.276	0.785	24		No Trend
DO winter (mg/L)	8.27	3.5	15.5	0.016	-0.8	0.429	42		No Trend
Chloride (mg/L)	129	26	300	0.166	**-3.32**	**0.001**	57	Down	Predicted values decreased from 159 mg/L to 97 mg/L
Sulfate (mg/L)	193	57	425	0.191	**-3.67**	**0.068**	59	Down	Predicted values decreased from 235 mg/L to 146 mg/L
TDS (mg/L)	626	194	1870	0.12	**-2.79**	**0.007**	59	Down	Predicted values decreased from 749 mg/ L to 486 mg/L
pH (SU)	7.77	5.9	9.1	0.002	-0.382	0.703	65		No Trend
log Fecal Coliform (cfu/100ml)	1.58	-0.301	2.37	0.009	0.752	0.455	62		No Trend
Conductivity (uS/cm)	1046	730	2110	0.191	**-3.88**	**0.0002**	66	Down	Predicted values decreased from 1208 uS/cm to 848 uS/cm
Total Phosphate (mg/L)	3.17	0.005	59.4	0.05	**-1.7**	**0.094**	57	Down	Predicted values decreased from 6.5 mg/L to 0.22 mg/L
Ortho-Phosphate (mg/L)	0.142	0.01	2.2	0.002	-0.248	0.806	35		No Trend
Ammonia (mg/L)	0.157	0.01	0.78	0.093	**-2.36**	**0.022**	56	Down	Predicted values decreased from 1.22 mg/L to 0.08 mg/L
Nitrate/Nitrite (mg/L)	0.248	0.02	2.51	0.029	0.965	0.342	33		No Trend
Station 13664									
DO summer (mg/L)									<10 Values

LOWER RIO GRANDE SUB-BASIN	Mean	Min	Max	R^2	T ratio	P value	N	Trend	Comments
DO winter (mg/L)									<10 Values
Chloride (mg/L)	158	89	219	0.162	**-2.01**	**0.057**	23	Down	Predicted values decreased from 177 mg/L to 134 mg/L
Sulfate (mg/L)	216	118	291	0.194	**-2.25**	**0.035**	23	Down	Predicted values decreased from 243 mg/L to 184 mg/L
TDS (mg/L)									<10 Values
pH (SU)	8.02	7.5	8.74	0.016	-0.592	0.56	24		No Trend
log Fecal Coliform (cfu/100ml)									<10 Values
Conductivity (uS/cm)	1335	590	2670	0.0001	-0.214	0.83	372		No Trend
Total Phosphate (mg/L)									<10 Values
Ortho-Phosphate (mg/L)									<10 Values
Ammonia (mg/L)									<10 Values
Nitrate/Nitrite (mg/L)									<10 Values
Station 15808									
DO summer (mg/L)	7.21	5.4	9.31	0.016	-0.516	0.344	18		
DO winter (mg/L)	9.02	2.83	13.3	0.03	**-1.05**	0.296	38		
Chloride (mg/L)	155	76	240	0.258	**-4.12**	**0.001**	51	Down	Predicted values decreased from 185 mg/L to 123 mg/L
Sulfate (mg/L)	210	117	304	0.273	**-4.29**	**0.00008**	51	Down	Predicted values decreased from 246 mg/L to 172 mg/L
TDS (mg/L)	702	318	999	0.109	**-2.44**	**0.018**	51	Down	Predicted values decreased from 776 mg/L to 623 mg/L
pH (SU)	7.94	7	8.3	0.003	-0.431	0.669	55	Down	Predicted values decreased from 7.97 SU to 7.92 SU
log Fecal Coliform (cfu/100ml)	2.14	0	4	0.018	0.916	0.364	47		
Conductivity (uS/cm)	1177	692	1570	0.129	**-2.79**	**0.007**	55	Down	Predicted values decreased from 1288 uS/cm to 1043 uS/cm
Total Phosphate (mg/L)	0.701	0.04	10.6	0.112	**-2.44**	**0.018**	49	Down	Predicted values decreased from 1.67 mg/L to 0.02mg/L
Ortho-Phosphate (mg/L)	0.075	0.01	0.2	0.009	-0.553	0.583	37		
Ammonia (mg/L)	0.136	0.02	0.78	0.159	**-2.98**	**0.004**	49	Down	Predicted values decreased from 0.21 mg/L to 0.051 mg/L
Nitrate/Nitrite (mg/L)	0.162	0.01	0.52	0.008	0.499	0.621	35		