

Clean Rivers Program **2015** **Basin Highlights Report**



Guadalupe River and Lavaca-Guadalupe Coastal Basins

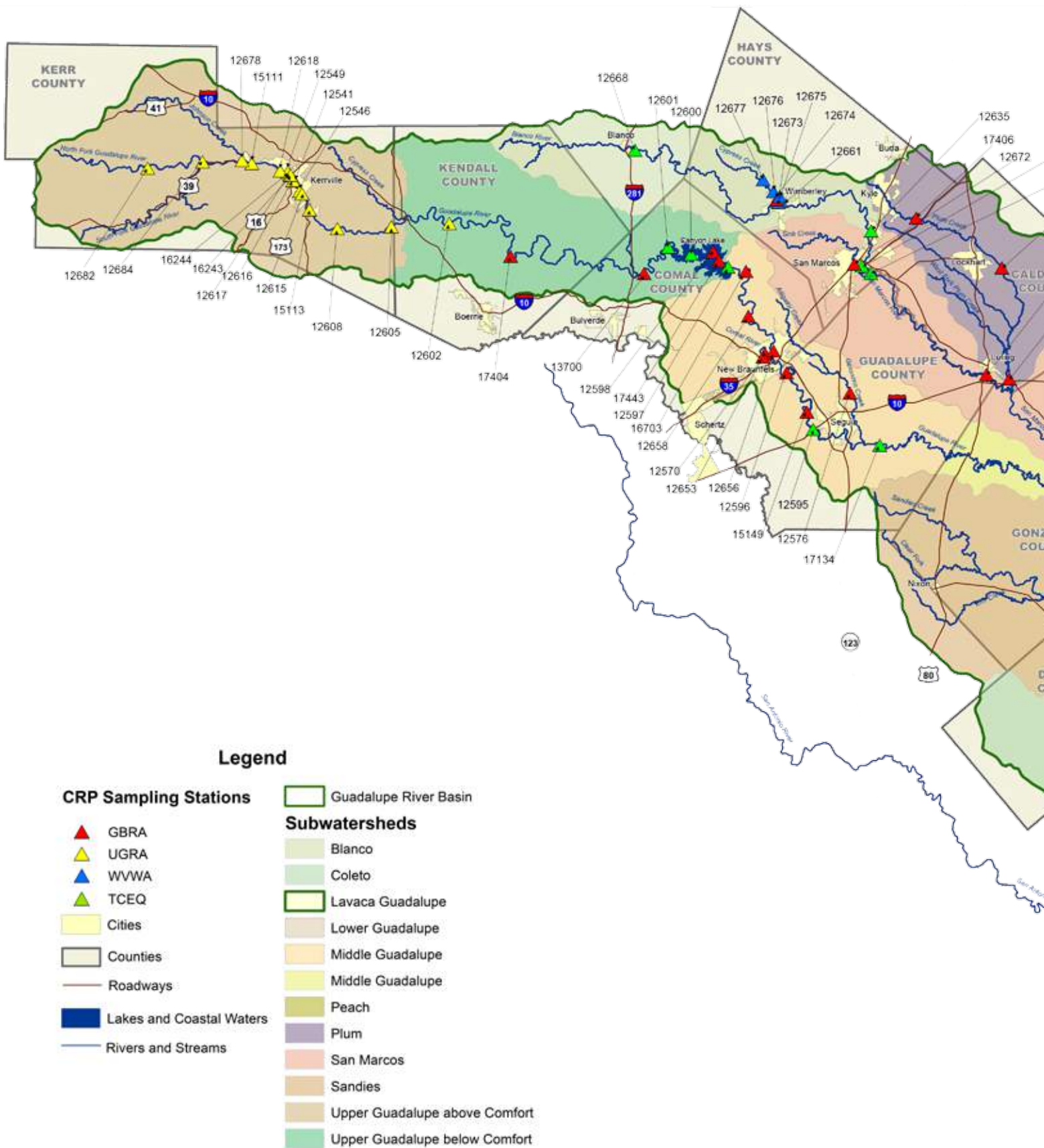
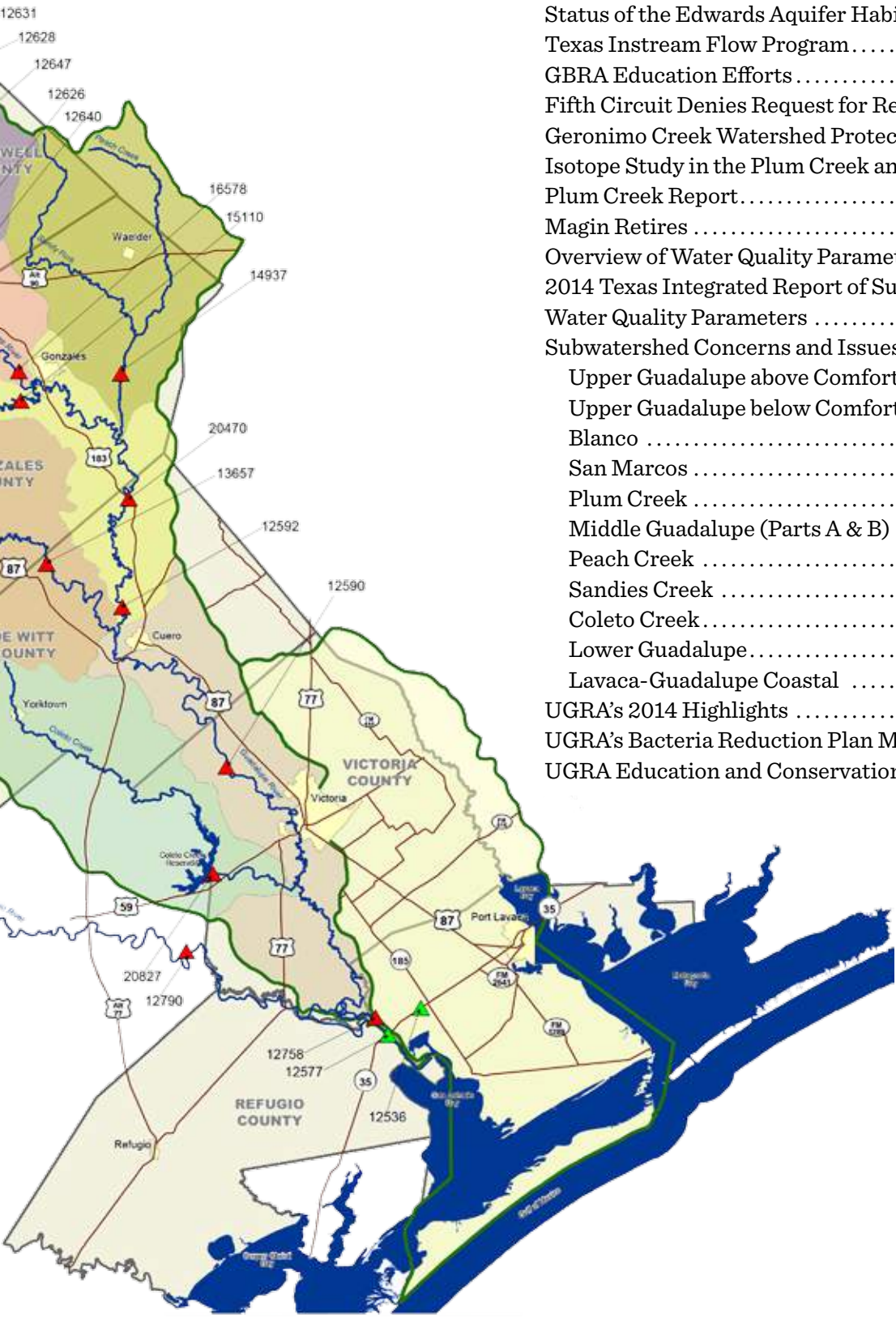


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Art Direction and Design by Janet Thome
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Introduction

This report highlights the activities within the Guadalupe River Basin and the Lavaca-Guadalupe Coastal Basin under the Clean Rivers Program (CRP) in 2014. The CRP is managed by the Texas Commission on Environmental Quality (TCEQ). The state-wide program is funded by fees assessed to water rights and wastewater discharge permit holders. The Guadalupe-Blanco River Authority (GBRA), together with the Upper Guadalupe River Authority (UGRA), carry out the water quality management efforts in the Guadalupe River Basin under contract with the TCEQ. The activities described in this report include water quality monitoring, a review of the draft 2014 Integrated Report, watershed planning, public communication, and watershed stewardship activities. This report also includes descriptions of each sub-watershed, including segment maps, specific concerns and special notes.

2014 Highlights

Prolonged drought conditions continued to impact the Guadalupe River Basin in 2014. The current period of reduced rainfall began in September of 2007 and continued throughout 2014. Intermittent rainfall was not distributed uniformly throughout the watershed, but the upper portion of the watershed received almost 5" less rain in 2014 than the annual average for the area and the lower basin received over 10" less than the annual average. The routine monitoring station 13700, on the Guadalupe River at Spring Branch above Canyon Reservoir, went dry in September 2014. Canyon Reservoir has slightly recovered from a historic low of 893 feet above mean sea level (AMSL) in 2009 and is currently stable at approximately 897 AMSL, which is still 12 feet below the conservation pool of 909 AMSL.

The Hays County Environmental Health team discontinued its monitoring activities for the Clean Rivers Program in the first quarter of the 2014 fiscal year due to financial constraints. The Wimberley Valley Watershed Association (WVWA) began monitoring three of the former Hays County routine monitoring stations on the Blanco River (Stations 12660, 12663, & 12665) in order to ensure the continuity of data available for review and assessment. The WVWA also adjusted its annual sampling schedule from targeted warm weather seasonal sampling to four evenly spaced quarterly monitoring events, so that collected data was representative of all watershed conditions for state assessments. The GBRA continues to provide technical support and training to WVWA staff to ensure that the data collected by this organization are of the highest quality.

In July 2014, the U.S. Fifth Circuit Court of Appeals held that the Texas Commission on Environmental Quality (TCEQ) reversed a district court ruling on the alleged deaths of 23 whooping cranes during the years of 2008 and 2009. The lawsuit filed by The Aransas Project (TAP) claimed that the TCEQ failed to provide adequate freshwater inflows from the Guadalupe River Basin into the bays and estuaries during times of drought. The lack of freshwater inflows was alleged to have reduced the blue crab populations available for consumption by the whooping cranes and thereby damaged the flock. Over the years, the whooping crane flock has increased approximately 4.6 percent per year. A U.S. Fish and Wildlife Service (USFWS) report in March 2015 indicated the population had increased to more than 300 based on the abundance survey. More information about the TAP lawsuit can be found on page 9.

A multiagency study of the flows of the lower Guadalupe River is currently underway. TCEQ, Texas Parks and Wildlife Department (TPWD), Texas Water Development Board (TPWD) and the GBRA are all working together



with stakeholder groups in the lower Guadalupe River sub-basin to determine the flows necessary to sustain a sound ecological environment. The Texas Instream Flows Program (TIFP) was enacted by the 77th Texas Legislature in 2001. This study will conduct scientific and engineering investigations of the physical habitat, water quality, and hydrological components of the riverine system to determine the flow regimes necessary to promote ecological integrity and maintain biodiversity. More information on the TIFP can be found on page 6.

There were no new water quality impairments listed in the Guadalupe River Basin

in the 2012 *Texas Integrated Report* and 303(d) list that was approved by the Environmental Protection Agency (EPA) in 2013, or the Draft 2014 *Texas Integrated Report* and 303(d) list. There were three water bodies and monitoring parameters that were removed from the 303(d) list in the 2012 *Texas Integrated Report* or the Draft 2014 Report. The Guadalupe River above Canyon Lake (Segment 1806) is no longer listed for impairment of contact recreation for bacteria, Camp Meeting Creek (1806A) is no longer listed for depressed dissolved oxygen; and the Upper San Marcos River (Segment 1814) is no longer listed for a General Use impairment of Total Dissolved Solids (TDS). The San Marcos River was listed for impaired TDS concentrations in the 2012 *Texas Integrated Report* with an average concentration of 402.64 mg/L, which was just 2.64 mg/L over the state standard of 400 mg/L. This parameter is not usually directly measured during routine monitoring, but is instead calculated for assessments by multiplying an in-situ specific

conductance value by a factor of 0.65. The GBRA began collecting additional monthly laboratory certified TDS values. This resulted in a new assessed TDS mean concentration of 364.79 mg/L, which was significantly lower than the state general use standard. The current impairments and concerns in the Guadalupe River Basin can be found on page 24.

Debbie Magin retired from the GBRA after 38 years of service and held the position of Director of Water Quality for the past 16 years. Debbie administered the Clean Rivers Program (CRP) activities as the GBRA project manager since GBRA began collecting water quality data as a cooperating partner with the TCEQ in 1996. More information can be found about Debbie Magin's career on page 22.

The Basin Highlights Report provides information on the status of projects directed toward water quality and environmental protection. Maps and specific information on the watersheds that make up the Guadalupe, Blanco and San Marcos River basins can be found in this report. Watershed information includes descriptions of waterway segments, and segment concerns.



Status of the Edwards Aquifer Habitat Conservation Plan Implementation

By Shaun Payne, EAA

The Edwards Aquifer Habitat Conservation Plan (EAHCP) protects the federally listed species in the Comal and San Marcos springs. The plan was developed through the Edwards Aquifer Recovery Implementation Program (EARIP), a consensus-based process involving a diverse body of stakeholders. This group included industries, agricultural users, municipalities, water purveyors, river authorities, environmental organizations, four state agencies, and groups with down-stream interests.

In early 2013, the U. S. Fish and Wildlife Service officially approved the EAHCP with five Permittees: Edwards Aquifer Authority, City of San Marcos, City of New Braunfels, Texas State University, and San Antonio Water System. An Incidental Take Permit (ITP) was awarded with EAHCP approval, which allows,



among other covered activities, authorized withdrawals from the Aquifer and recreational activities within the City of New Braunfels' and the City of San Marcos' jurisdictions.

The Implementing Committee, made up of the five permittees

of the ITP, plus GBRA, provides the leadership, and ultimately approval for the successful completion of the EAHCP. Assisting the Implementing Committee is the Science Committee, which acts as the technical advisory group, and the Stakeholder Committee, who represent the diverse interests in the Edwards Aquifer region and provides direction on critical policy decisions that must be made throughout the process. Decisions made are formed through consensus and made possible by the collaborative effort of all parties involved.

In 2014, our region experienced limited rainfall which negatively affected the Comal and San Marcos springs. Despite these environmental pressures, the implementation of the EAHCP continued to protect the habitat of the threatened and endangered species covered in the plan through both springflow protection efforts as well as habitat restoration.

Habitat restoration is an important aspect of the work outlined in the EAHCP. There are ten separate restoration efforts assigned to the Comal Springs and 16 in the San Marcos Springs. These measures are intended to improve the habitat for the covered species and minimize the effects of both development and recreation throughout the systems.



Photos Courtesy EAA

In the San Marcos Springs system, which has the most reliable springflow in Texas, water clarity and consistent, year-around water temperatures provide suitable conditions for the EAHCP's only covered plant species, the endangered Texas wild-rice. The City of San Marcos and Texas State University have made an incredible effort in protecting the habitat of all EAHCP covered species throughout 2014. In particular, the Texas wild-rice enhancement has proven to be specifically successful. This effort requires biologists to plant Texas wild-rice stands throughout the upper parts of the San Marcos River and remove excess sediment and non-native plants to allow continued growth. In addition to the Texas wild-rice enhancement, the City and the University, with help from Texas Parks and Wildlife, provide state scientific areas (SSA) in order to protect Texas wild-rice stands from the influx of recreational activity during the summer months. The city and the university have also established an extensive riparian restoration effort. This effort reestablished native plants along the banks of the San Marcos River and provides habitat protection from recreation and heavy rain events that often cause damage to the species' habitat.

In the Comal Springs system, the largest spring system in Texas, springflow variability requires specially-planned infrastructure and habitat restoration to ensure the longevity of the species' habitat. A significant milestone achieved in 2014 was the completion of

the flow-split management effort at Landa Lake. In this project, the City of New Braunfels restored aged culverts separating Landa Lake from the old channel of the Comal River to provide more reliable flows to newly restored habitat even in periods of decreased springflow. Prior to the culvert repairs, the old channel restoration effort had been successfully underway. This project focuses on the removal of non-native plants and excess sediment accumulation which helps provide ideal habitat for the species found in the Comal springs systems.

Springflow protection is ultimately what will determine the longevity of the species' survival. There are four separate measures that help reduce overall pumping of Edwards Aquifer water throughout the region to ensure adequate flows in both the San Marcos and Comal springs.

In order to maintain sufficient springflows, the Edwards Aquifer Authority (EAA) has initiated various programs to incentivize limited use of groundwater supplies. The Voluntary Irrigation Suspension Program Option, or VISPO, has been a particular success in 2014. VISPO is a voluntary program open to irrigators with groundwater withdrawal rights from the Edwards Aquifer. It encourages farmers to use less water in times of severe regional drought by financially compensating them when they suspend their groundwater pumping. This conservation program helps protect springflows by keeping much needed water in the aquifer. In 2014, the EAA successfully met their goal of 40,000 acre-feet of forbearance agreements and will expect to see that volume of water not pumped in 2015. This reduction of pumping will be an increased benefit to springflows.

Additionally, in collaboration with the San Antonio Water System's (SAWS) Aquifer Storage and Recovery facilities, or ASR, the EAA obtained over 6,000 acre-feet of leases to be used in times of severe drought. This measure

is designed to minimize the impacts of extended drought to the covered species through a three-step leasing program. The everyday operations and infrastructure required for ASR activities are managed by SAWS. Water allocated through these water leases is placed in separate aquifer storage to be used in times of extended drought.

Another key aspect of the EAHCP involves the collection and interpretation of the data about the springs. These supporting measures include biological monitoring and water quality monitoring. Both monitoring initiatives analyze the health of the systems throughout the year. In addition to monitoring, a major source of information comes from an applied Research program. Here, scientists conduct controlled experiments to better understand the species the EAHCP has committed to protect. These three important measures all provide the data necessary to complete the development of the ecological model.

This model will provide researchers and policy makers a more educated perspective on what the species, and their habitat, can withstand.

Since March 2013, when implementation of the EAHCP mitigation and minimization measures began, the habitat in the Comal and San Marcos springs systems have received valuable program benefits. These benefits were experienced despite the critical conditions both systems were under this summer.

Ultimately, throughout 2014, the partners have successfully implemented many critical aspects of the EAHCP through collaboration and consensus among the diverse group of stakeholders and decision makers. Due to this success, and years of planning involved through the EARIP, the program that preceded the implementation process, the process received the Department of Interior's Partners in Conservation Award in Washington, D.C. This award proves the program's effectiveness and collaborative nature. Without which, the many mitigation, and minimization efforts would not be as successful. The EAHCP can be viewed online at www.eahcp.org.



Texas Instream Flow Program

By Lee Gudgell

Senate Bill 2, enacted in 2001 by the 77th Texas Legislature, established the Texas Instream Flow Program (TIFP). The purpose of the TIFP is to perform scientific studies to determine flow conditions necessary to support a sound ecological environment in the rivers and streams of Texas. With passage of Senate Bill 3 in 2007, the Texas Legislature restated the importance of maintaining the health and vitality of the State's surface-water resources and further created a stakeholder process that would result in science and policy-based environmental flow regime recommendations to protect instream flows and freshwater inflows on a basin-by-basin basis. Stakeholder involvement has been a key component of the TIFP lower Guadalupe River sub-basin study. Through a series of TIFP sponsored meetings, stakeholders were briefed on the TIFP, informed about the available information and current conditions in the sub-basin, and provided a framework from which to define the study goals, objectives, and indicators.

The current focus of the TIFP study design is to provide an overview of available information. A document is currently being prepared by the TCEQ and TPWD to describe the results of preliminary analyses and reconnaissance surveys, including study site locations, data collection methods and analysis, and multidisciplinary coordination. This study design document will also include an assessment of current conditions, a conceptual model of the lower Guadalupe River basin and a description of proposed technical studies. The publication will also provide an overview of the stakeholder process and description of the study goals, objectives, and indicators developed with stakeholders, as well as a layout for continued stakeholder involvement and future activities.

In 2012, preliminary study design began for the Texas Instream Flow Program (TIFP) on the Lower Guadalupe River sub-basin. The Guadalupe River is approximately 450 river miles in length, has a drainage area of 5,979 square miles and houses a population of more than 500,000 people. The Guadalupe River basin covers 11 Texas counties, and passes through four different ecoregions before it ultimately empties



into the Guadalupe Estuary near the Gulf of Mexico. The flows of the upper reaches of the Guadalupe are fed by natural springs from the porous limestone of the Edwards plateau, which provide base flows during periods of drought. The Lower Guadalupe River sub-basin receives the flows of several major waterways,



including the Comal River, the San Marcos River, Peach Creek, Sandies Creek and the San Antonio River. The lower Guadalupe experiences significant changes as it travels to the estuary system. The clear waters and relatively steep gradients of the Edwards Plateau change to the darker waters and more moderate stream gradients of the Texas blackland prairies and Post Oak Savannah ecoregions, before reaching the nearly flat stream gradients of the Texas Gulf Coastal Plains and Guadalupe Delta.

The State of Texas and the Guadalupe River Basin have both experienced severe drought conditions since 2005. The stress induced by the recent reduction of rainfall in the Guadalupe River Basin has driven a renewed interest in the optimal usage of the finite surface water available. Based upon TCEQ records, an average of 8-10

percent of the river flows of the Guadalupe are currently utilized for agriculture, drinking water, recreation and industrial demands during average flows. The river basin is also home to a diverse ecological environment with endemic species that are not found anywhere else on the planet. The environmental flow conditions need to be

assessed to ensure that the future water demands of an expanding population can be balanced against the flow conditions needed to support a healthy environment. The scientific knowledge available for determining instream flow conditions has improved significantly within the last decade and it is now an optimal time for this research to occur. Beginning in 2012, the GBRA and local stakeholder groups partnered with state environmental agencies to study the freshwater ecological needs of the Lower Guadalupe River sub-basin.

Ultimately, the culmination of study efforts will be used to characterize the flow-habitat and flow-ecological relationships within the Lower Guadalupe River sub-basin and its riverine ecosystem. The results of these studies will provide a means of assessing the biological and physical impacts and benefits of varying flow regimes. A comprehensive tool will be generated from existing studies and field data that will provide the predictive capabilities necessary to evaluate the ecological significance of a full range of flows (from low, to moderate, to high throughout the annual hydrologic cycle) in the Lower Guadalupe River sub-basin.



GBRA Education Efforts

By Cinde Thomas-Jimenez

GBRA education staff continues to have a strong presence in both the Plum Creek and Geronimo Creek watersheds. Water quality education and monitoring are introduced to fourth and fifth grade students in these target watersheds. School year 2013-2014 was the eighth consecutive year GBRA staff-led efforts in 10 public elementary schools in the Plum Creek watershed. Working side-by-side with teachers and students, GBRA staff spent three weeks in classrooms presenting information (using a tabletop watershed model) to discuss watersheds, nonpoint source pollution and

Basin continues to maintain a strong presence in elementary schools throughout the river basin. Specific to the Guadalupe River Basin, this TEKS-correlated program uses an interdisciplinary approach to introduce the topic of water, placing an emphasis on watersheds and water quality. In addition, the curriculum touches on the water cycle, water uses in the basin, population growth, and water conservation. GBRA continues to offer teacher trainings for this program.

Waters to the Sea, Guadalupe River is GBRA's online multi-media middle school program, and teacher

trainings are ongoing. This new interactive learning program highlights relationships between human activities and water resources within the Guadalupe watershed from the river's headwaters to San Antonio Bay. The program addresses Texas science and social studies education standards (TEKS) through numerous short videos, animations, simulations, and multimedia interactives that draw from the region's rich history. Modules focus on themes ranging from: the impacts of urban growth on surface water runoff, to the importance of water for agriculture, to the importance of wetlands at the bay, to water conservation and to traditional Native American uses of natural resources. The program can be accessed by anyone at: <http://waterstothesea.com/guadalupe/>



Photo by Janet Thome

the Plum Creek project directly with the students. All needed supplies were donated to the schools including water monitoring test kits, watershed map posters and student workbooks. A total of 1,000 students and 38 teachers conducted one round of water quality testing in March 2014. Using the Texas Stream Team methods as a model for their monitoring, students have tested water from Plum Creek and tributaries for the following parameters: temperature, dissolved oxygen, pH, turbidity, nitrates, phosphates and bacteria. This same model has been introduced in Geronimo Creek schools at both the elementary and secondary levels. This extensive effort continues in 11 Plum Creek schools during 2014-15.

For 25 years straight, GBRA's award-winning fourth grade program, *Journey through the Guadalupe River*

GBRA staff is extremely active in schools throughout the river basin. In school year 2013-14, GBRA presented to 78 different school-age groups, totaling almost 11,000 students. Many of these presentations took place at partner sites, including the Cibolo Nature Center, the Big Red Barn, Canyon Lake Gorge, Aquarena Center, the Irma Lewis Seguin Outdoor Learning Center, and Lockhart State Park. GBRA and the Guadalupe River Foundation have acquired 20.5 acres in Comal County and are working on plans to build an Environmental Learning Center (ELC) at the site. Water quality activities will be offered at the new center once completed. Funding for the new ELC is ongoing. For more information on the ELC, contact Environmental Education Administrator Cinde Thomas-Jimenez at cthomas-jimenez@gbra.org.

Fifth Circuit Denies Request for Rehearing in Whooping Crane Case

The United States Court of Appeals for the Fifth Circuit on Dec. 15, 2014 denied a Petition for Rehearing En Banc in *The Aransas Project (TAP) vs. Shaw* in which a three-judge panel of the Fifth Circuit reversed a judgment of the U.S. District Court for the Southern District of Texas. In a June 30, 2014 decision, the Fifth Circuit panel agreed with defendants that the plaintiff failed to prove its case that diversions of water for use by Texans had led to multiple deaths of federally protected whooping cranes in the winter of 2008.

A lawsuit against the Texas Commission on Environmental Quality (TCEQ) initiated by a group wielding the federal Endangered Species Act (ESA) to bring a halt to water permitting on the Guadalupe and San Antonio rivers by alleging multiple deaths of the endangered whooping cranes that winter on the Texas coast led the Guadalupe-Blanco River Authority (GBRA) to intervene as a defendant. With only two whooping crane carcasses and two partial carcasses found during 2008-2009, no evidence supported the double-digit losses claimed by the plaintiffs.

Yet, on March 11, 2013, federal district court Judge Janis Graham Jack “adopted verbatim TAP’s proposed findings of fact” and held that the TCEQ caused the deaths of the whooping cranes by issuing water permits that resulted in diverting water from the cranes and ordered TCEQ to immediately stop issuing water permits on the Guadalupe and San Antonio rivers. The judge also ordered a costly federal planning process that is duplicative of current state programs.

In the decision released in December 2014, Judge Edith Jones, writing for the majority, indicated that 11 judges of the Fifth Circuit

had voted to deny TAP’s Petition for Rehearing En Banc, thus leaving in place the three-judge panel opinion (as modified), while four judges voted in favor of rehearing.

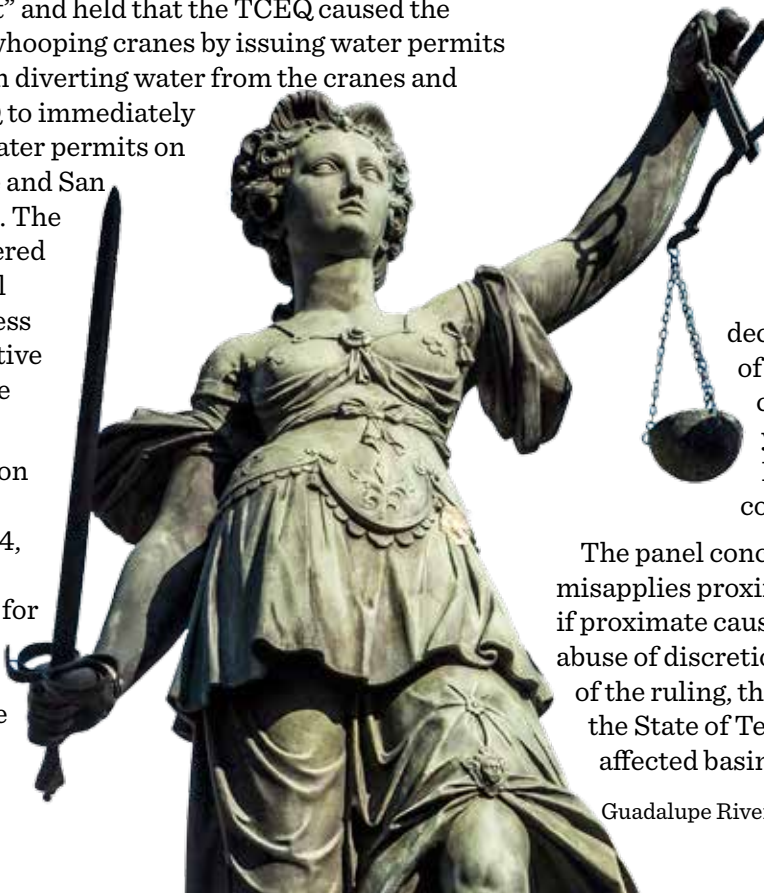
“After considerable thought on the issue of rehearing, the vast majority of the full Fifth Circuit decided to reaffirm the ruling of the original three-judge panel in this case,” Bill West, Jr., GBRA general manager said after hearing about the opinion.

Three of the four judges who favored a rehearing signed on to a dissenting opinion written by Judge Edward Prado. He opined that the panel’s decision independently weighed facts to render judgment in violation of principles of federal law and cautioned that the Supreme Court has reversed the Fifth Circuit before for improperly reweighing the factual findings of district courts. The plaintiffs in the case have 90 days from the issuance of the opinion to file an appeal with the U.S. Supreme Court.

In the Fifth Circuit hearing, GBRA’s appellate attorney Aaron Streett of the firm Baker Botts LLP argued that TAP failed to prove proximate cause as a matter of law because the chain of causation from permit holder to alleged harm to the cranes was too attenuated and

unforeseeable to constitute proximate cause. The Fifth Circuit panel that consisted of judges Jones, Jerry Smith and Emilio Garza agreed, finding “Nowhere does the court [District Court] explain why the remote connection between water licensing, decisions to draw river water by hundreds of users, whooping crane habitat, and crane deaths that occurred during a year of extraordinary drought compels ESA liability...the court’s ambiguous conclusion cannot be sustained.”

The panel concluded that “the district court’s opinion misapplies proximate cause analysis and further, even if proximate cause had been proven, the injunction is an abuse of discretion. The judgment is reversed.” Because of the ruling, the district court’s injunction stopping the State of Texas from issuing water permits for the affected basins is of no effect.



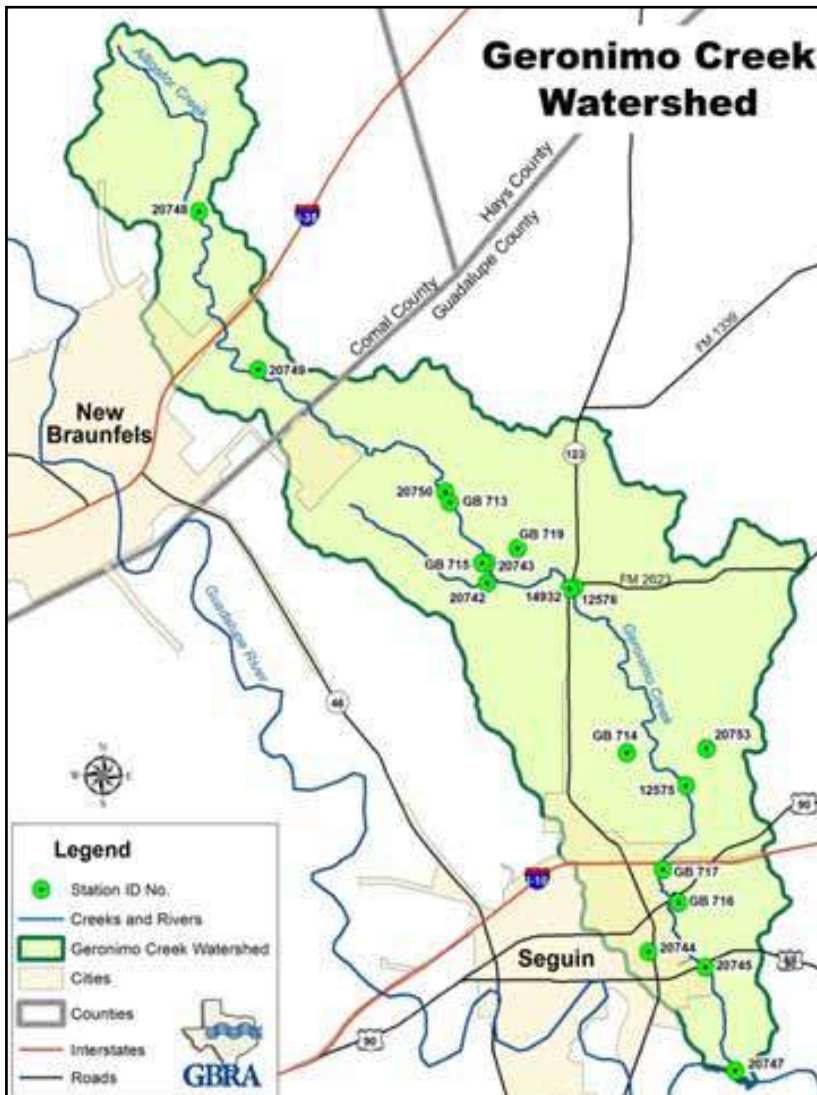
Geronimo Creek Watershed Protection Plan

By Debbie Magin/Ward Ling

In 2007, the Texas State Soil and Water Conservation Board (TSSWCB) Regional Watershed Coordination Steering Committee, using established criteria, ranked Geronimo Creek in the top three watersheds for selection of Watershed Protection Plan (WPP) development. The TSSWCB project 08-06 entitled, *Development of a Watershed Protection Plan for Geronimo Creek*, began in June 2008. The project included water quality monitoring, water quality modeling and WPP development. The development of the WPP for Geronimo and Alligator Creeks has been a stakeholder driven process lead by Texas AgriLife Extension (Extension) with support

from the Guadalupe-Blanco River Authority. The Geronimo and Alligator Creeks Watershed Partnership (the Partnership) Steering Committee includes local officials, land and business owners and citizens and is supported by state and federal agency partners. With technical assistance from project staff, the Steering Committee has identified issues that are of particular importance to the surrounding communities, and contributed information on land uses and activities that has been helpful in identifying the sources of nutrient and bacterial impairments, and in guiding the development of the WPP. The Geronimo Creek WPP was accepted by the US EPA in September 2012.

Figure 1. Map of watershed with sampling locations.



Historical data identified the impairment for bacteria and a concern for nutrients. The historical data was collected at one site (12576) by GBRA through the Clean Rivers Program (CRP). Through project 08-06, GBRA conducted an eighteen month water quality monitoring task that included an additional seven monthly routine ambient and six targeted stream sites on Geronimo Creek, Alligator Creek and three tributaries, and quarterly monitoring of two springs, three wells, and the single point source in the watershed. The TSSWCB project 11-06, *Water Quality Monitoring in the Geronimo Creek Watershed and Facilitation of the Geronimo and Alligator Creeks Watershed Partnership*, a two-year project, maintained an effective monitoring program providing critical water quality data that can be used to judge the effectiveness of WPP implementation efforts and can serve as a tool to quantitatively measure water quality restoration. The original water quality monitoring program attempted to fill gaps in the historical data but was hampered due to drought conditions in 2008-09. Collection samples verified there were periodic elevations of *E. coli* levels. GBRA has entered into a third monitoring project with the TSSWCB to collect data, under an approved quality assurance project plan, in order to evaluate the effectiveness of implementation projects scheduled for the watershed.

Agrilife and GBRA collaborate with TSSWCB to keep stakeholder engagement through semi-annual newsletters, maintaining the project website, and hosting Partnership Steering Committee meetings. Continuing these efforts is critical to effectively bridging the gap between projects that developed the Geronimo Creek WPP and beginning WPP implementation efforts.

In 2014, Extension facilitated and coordinated education and outreach activities in the watershed to promote public participation and implementation of the WPP. Extension included active use of local media outlets to communicate project planning efforts and activities, contributions to the project website, development and/or dissemination of factsheets and other educational resources, and coordination of local meetings and educational events. GBRA's Public Communication and Education Department provided additional education and outreach in the watershed.

The sampling program was continued in 2014 by retaining seven routine monthly sites and fourteen targeted sites. GBRA continued to monitor the routine ambient monitoring location monthly under the CRP. In 2013, two new sites on Geronimo Creek were added to replace two routine/targeted sites included in the WPP Development Project that were determined to be ineffective due to lack of flow or proximity to other sites. One of the new sites was located at Geronimo Creek at IH-10 in order to collect routine and targeted monitoring downstream of the Oak Village North Subdivision. The subdivision has been known for failing septic systems, and, because of this, the City of Seguin expanded the city's wastewater collection system to serve the subdivision. The second site was added on Highway 90 near the Irma Lewis Seguin Outdoor Learning Center (ILSOLC).

A comprehensive watershed approach was used to focus on the most significant potential sources of agricultural NPS pollution contributing to the current impairments, while at the same time looking ahead at potential future sources of pollution from urban and suburban growth. The outcomes of the 08-06 project included data in the form of load allocations and watershed models developed in partnership with local stakeholders and have benefited the local governmental entities as they formulate master plans and storm water management strategies. Recommended best management practices that were identified by the steering committee, work groups and partner agencies were prioritized for implementation. An important outcome of these projects was the identification of implementation strategies that get ahead of growth so that it can be directed in an environmentally-safe and community-accepted direction.



Geronimo Creek WPP Project Highlights

Website

GBRA and Extension maintain the project website. The website includes a photo gallery, monthly newsletters, meeting announcements and copies of meeting presentations. The Quality Assurance Project Plan (along with the current data tables) is posted on the Water Quality page and available for review by the

public. One of the most useful additions to the website was an online registration tab for the annual watershed cleanup. Other tabs on the webpage cover feral hogs, septic tank maintenance and the USGS Isotope Study (see *Plum Creek Watershed Partnership* update for more information on the USGS Isotope Study).

Geronimo Creek WPP Project Highlights

Facilitation and Implementation Activities

Texas AgriLife Extension was responsible for facilitation of the partnership and for coordination of implementation of the WPP. Ward Ling serves as the Extension's Watershed Coordinator. As part of his responsibilities, he assisted entities in the watershed with opportunities for implementation of best management practices identified in the WPP. He coordinated meetings between cities located in the watershed and TCEQ to discuss possible urban 319 implementation projects. These meetings generated several potential ideas, including upgrades to the storm water conveyance system in the Oak Village North subdivision and decommissioning of failing septic systems after they have connected to the city's newly installed wastewater collection system. The City of New Braunfels has developed a Stormwater Management Plan (SWMP) associated with their Phase II Municipal Separate Stormwater Sewer System (MS4) stormwater permit. Management measures included in the SWMP

address stormwater pollution within the City of New Braunfels city limits including upper portions of Alligator Creek. Specific minimum protection measures include an illicit discharge detection program, construction stormwater management program and stormwater management for new development.

Extension assisted GBRA with the preparation of a grant application to TCEQ that partnered with the ILSOLC. The ILSOLC is located in the watershed and its mission is to provide outdoor and environmental education opportunities to students as well as adults in the area. The objective of the ILSOLC project is to design and implement educational components of the WPP that will serve as tools that can be utilized with elementary school students through high school, with teachers, with civic leaders, with riparian landowners and with the general public to enhance understanding of the health of a riparian and creek ecosystem in the Geronimo and Alligator Creeks watershed.

Geronimo Creek WPP Project Highlights

Watershed Cleanup

The idea of a community cleanup was introduced to the partnership in the fall 2012 and was well received. The first cleanup was so successful it has become an annual event. Over 15 civic entities participated in the form of sponsorship or cleaning a designated site. In addition to financial contributions from sponsors, students from the art department of Texas Lutheran University submitted t-shirt designs. Area businesses and church groups sponsored cleanup areas and provided time for workers to participate. The cities of Seguin and New Braunfels provided roll-off containers for the collection, disposal, and recycling of collected materials. Middle school and high school National Honor Society and Interact groups volunteered. Parker

Lumber, the New Braunfels Municipal Airport, and Navarro High School allowed registration booths to be set up in their parking lots.

The list of project partners continues to grow. The number of volunteers in the second cleanup was over 230. More than twice the number that participated in the first event. The first cleanup resulted in the removal of 2,960 pounds of trash, 26 tires, and several large items such as a stove, air conditioner, car battery, and a toilet. In the second event, volunteers collected 7,020 pounds of trash along 17 miles of roadway and creek banks, removing 45 tires, 2 cubic yards of scrap metal, lumber and two toilets.



Photo by Louann Fisher



Photo by Liz Aquilar



Photo by Louann Fisher

Geronimo Creek WPP Project Highlights

Communication and Outreach

Public communications and outreach responsibilities were shared by Extension and GBRA. Outreach included newspaper articles produced and paid for by Extension. The articles were run in the two local papers, the *Seguin Gazette* and *New Braunfels Herald-Zeitung*. In addition to the news articles, Extension produced a quarterly electronic newsletter, aptly named by the partnership, *The Geronimo Flow*. Distribution of the newsletter has grown to over 400 email addresses.

Several workshops were held in the watershed including a feral hog workshop in May 2014, OSSF workshops in 2013 and 2014, the Lone Star Healthy Streams Workshop in the summer of 2014, a Smart Growth Workshop and a Rainwater Harvesting Workshop in 2014. Extension and GBRA assisted with a Texas Riparian and Stream Ecosystem Workshop in the fall of 2013. The Geronimo Creek watershed was the location for the first ever Texas Well Owner Network workshop in January 2013.

GBRA Communication and Education staff were very active in the watershed. For example, to educate and increase awareness of water quality issues in the watershed, GBRA began working with Seguin High School, assisting SHS teachers in conducting a project-based learning class in the summers of 2012 and 2013. Students in the summer program conducted studies on Geronimo Creek, such as benthic macroinvertebrate sampling and identification, water quality monitoring, and stream cleanup activities.

Cinde Thomas-Jimenez, with GBRA's environmental education administrator, worked with Seguin High School teachers to develop a two-week, intensive project-based learning class that also used Geronimo Creek as the focus. While earning two class credits (speech and technology), the students made a press kit and spoke to the public about issues pertaining

to the watershed. The students took a tour of the entire watershed, picked up trash along the creek and learned how water bugs can indicate the quality of water. The students made a presentation to the Seguin ISD School Board on the issues impacting the Geronimo Creek, including information on pet waste and feral hogs. GBRA staff helped with the production of Google fly-overs, maps and graphics. The class developed educational materials for the Geronimo Creek watershed. Students approached restaurants and businesses located in the watershed and secured agreements with them to distribute placemats and other educational items developed through the summer academy. GBRA took the student designs, made final edits, and with funding from Extension, produced 1,000 placemats, 500 brochures, and 500 magnets. The outreach materials were distributed to local restaurants and businesses for display and use on Water Monitoring Day.

Over the course of the project Thomas-Jimenez made presentations to classrooms in the Seguin ISD and Navarro ISD schools located in the watershed. Their presentations covered the water quality of Geronimo Creek, and included a water quality monitoring project using water collected from Geronimo Creek. GBRA Communication and Education staff prepared nonpoint source pollution activity kits for use with elementary classroom activities in the Geronimo and Alligator creeks watersheds. Kits support activities from the GBRA "Don't be Clueless about Water Quality" curriculum. Additionally, GBRA staff made presentations on nonpoint source pollution to hundreds of students in area classes visiting the ILSOLC and the Big Red Barn (Guadalupe County Agriculture Heritage Center), educational centers located in the Geronimo Creek watershed.



Photos by Liz Aquilar

Geronimo Creek WPP Project Highlights

Data Collection and Transmittal

Data collected through the monitoring tasks of the project is collected under an approved Quality Assurance Project Plan (QAPP) that is updated annually. The objective of the quality assurance task was to develop and implement data quality objectives and quality assurance/control activities in order to ensure data of known and acceptable quality are generated through this project. As part of the quality assurance task, GBRA Regional Laboratory staff worked on the standard operating procedure for EPA Method 1603 for the enumeration of *E. coli*, with the goal to become accredited for the method. Accreditation for EPA Method 1603 was granted in the second quarter of FY2013.

GBRA updates the TCEQ's Coordinated Monitoring Schedule each year to include the sites that are being sampled under this project. As part of this project, GBRA submitted requests and received station numbers for two new monitoring sites (Geronimo Creek at IH10 near Seguin and Geronimo Creek at Hwy 90 at the Seguin Outdoor Learning Center). Monthly data is uploaded to the TCEQ's Surface Water Quality Monitoring Information System.

GBRA conducted routine ambient monitoring at seven sites monthly, collecting field, conventional, flow and bacteria parameter groups. Routine ambient monitoring was conducted monthly at one station by GBRA (Site no. 14932, Geronimo Creek at Haberle Road) through the Clean Rivers Program (CRP). The objective of the routine monitoring was to provide water quality data to assess the effectiveness of implementing the Geronimo and Alligator Creeks WPP by enhancing current routine ambient monitoring regimes. The scheduling of routine water quality sampling was designed to complement existing routine ambient monitoring regimes such that routine water quality monitoring was

conducted monthly at eight sites in the watersheds. GBRA's Regional Laboratory conducted the sample analysis. Field parameters typically included in routine monitoring were pH, temperature, conductivity, and dissolved oxygen. Conventional parameters were total suspended solids, turbidity, sulfate, chloride, nitrate-nitrogen, ammonia-nitrogen, total kjeldahl nitrogen, chlorophyll *a*, pheophytin, total hardness, and total phosphorus. Flow parameters were collected by electric, mechanical or Doppler, including severity. The parameter for bacteria is *E. coli*.

Beginning in September 2012 through August 2014, 24 routine sampling events were conducted. The main

Table 1. Concentrations of *E. coli* under dry and wet conditions at the routine monitoring sites.

Site	No. of Samples	Median Flow-Dry (cfs)	E. coli Geomean - Dry	Range-Dry	No. of Samples (Wet)	Median Flow-Wet (cfs)	E. coli Geomean - Wet	Range-Wet	% Change btwn Dry and Wet *	E. coli Geomean 2008-2014**
Geronimo Creek at Haberle Road	60	4.3	138	51-520	12	5.6	661	140-16000	377.57	180
Geronimo Creek at SH123	42	2.3	339	130-1400	7	3.8	1366	280-11600	302.89	414
Geronimo Creek at HWY 90A	36	4.6	131	32-1200	13	6.15	235	35-5500	78.71	153
Geronimo Creek at IH10 near Seguin	21	4.2	162	55-63	4	5.75	612	140-8600	278.21	188
Geronimo Creek at SOLC	22	4.3	125	38-440	4	5.2	219	74-1500	74.40	137
Geronimo Creek at Hollub Lane	33	5.9	130	24-870	15	8.35	331	48-11000	154.31	174
Alligator Creek at Huber Road	39	0	68	1-2400	9	0.36	150	4-24000	121.00	79
Geronimo Creek at Huber Road	0	0	NA	NA	0	0	NA	NA	NA	NA

* Positive change indicates an increase in pollutant load with rainfall. Negative change indicates that rainfall is diluting the base flow pollutant concentration.

Stations highlighted have a base flow geometric mean greater than the water quality standard of 126 organisms/100 mL under dry conditions.

** Entire data set under all flow conditions through August 2014.

Table 2. Concentrations of total phosphorus under dry and wet conditions at the routine monitoring sites.

Site	No. of Samples	Median Flow-dry	Total P Mean - Dry	Range-Dry	No. of Samples (Wet)	Median Flow-wet	Total P Mean - Wet	Range-Wet	% Change btwn Dry and Wet *	Tot P Mean 2008-2014**
Geronimo Creek at Haberle Road	60	4.3	0.03	<0.01-0.22	12	5.6	0.13	<0.01-0.51	360.61	0.04
Geronimo Creek at SH123	43	2.3	0.06	<0.01-1.02	6	3.8	0.13	<0.05-0.34	138.39	0.06
Geronimo Creek at HWY 90A	36	4.6	0.03	<0.01-0.14	13	6.15	0.09	<0.01-0.24	209.73	0.05
Geronimo Creek at IH10 near Seguin	21	4.2	0.02	<0.01-0.06	3	5.75	0.03	<0.01-0.08	50.86	0.02
Geronimo Creek at SOLC	21	4.3	0.03	0.01-0.07	4	5.2	0.05	<0.01-0.09	108.02	0.03
Geronimo Creek at Hollub Lane	33	5.9	0.02	<0.01-0.08	15	8.35	0.09	<0.01-0.22	296.58	0.04
Alligator Creek at Huber Road	39	0	0.06	0.02-0.17	9	0.36	0.13	0.02-0.26	112.49	0.07
Geronimo Creek at Huber Road	0	0	NA	NA	0	0	NA	NA	NA	NA

* Positive change indicates an increase in pollutant load with rainfall. Negative change indicates that rainfall is diluting the base flow pollutant concentration.

Stations highlighted have a base flow mean concentration greater than the screening concentration of 0.69 mg/L Total Phosphorus, under dry conditions.

** Entire data set under all flow conditions through August 2014.

stem sites were flowing and were sampled. Of the routine sites monitored under this project (not on the main stem), one was routinely dry or dry with pools except during wet weather conditions (Geronimo Creek at Huber Road).

The following data tables compile the data collected to date at the routine sites. Because of the drought that dominated the weather patterns during the project there were significantly fewer monitoring events conducted under the influence of storm events.

Table 1 compares the geometric mean of the *E. coli* data collected at each routine site to the geometric mean

of the data collected under wet weather conditions. The data shows that storm water carries a significant load of bacteria into the stream. But even under dry conditions the geometric mean at five of the eight sites exceeded the stream standard for contact recreation (126 colony forming units per 100 milliliters).

Table 2 is the mean of the concentrations of total phosphorus at the routine sites. Although at no time, or under any flow conditions, did the mean exceed the screening concentration of 0.69 milligrams per liter there was an increase in total phosphorus during wet weather conditions.

Table 3. Concentrations of nitrate-nitrogen under dry and wet conditions at the routine monitoring sites.

Site	No. of Samples	Median Flow-Dry	NO3-N Mean - Dry	Range-Dry	No. of Samples (Wet)	Median Flow-Wet	NO3-N Mean - Wet	Range-Wet	% Change btwn Dry and Wet *	NO3-N Mean 2008-2014**
Geronimo Creek at Haberle Road	59	4.3	10.29	6.9-14	12	5.6	6.03	0.1-9.84	-41.38	9.57
Geronimo Creek at SH123	42	2.3	8.41	6.2-12	7	3.8	4.48	0.09-8.4	-46.75	7.84
Geronimo Creek at HWY 90A	36	4.6	9.22	3.2-14.1	13	6.15	6.05	0.02-11	-34.39	8.38
Geronimo Creek at IH10 near Seguin	21	4.2	10.25	7.8-13.0	4	5.75	8.15	3.8-11.4	-20.45	9.91
Geronimo Creek at SOLC	22	4.3	9.60	6.1-12.7	4	5.2	7.80	4.0-11.0	-18.71	9.32
Geronimo Creek at Hollub Lane	29	5.9	8.65	4.2-13.2	15	8.35	5.03	9.2-15	-41.81	7.41
Alligator Creek at Huber Road	39	0	1.80	10.6-39	9	0.36	1.21	5.8-9.0	-32.81	1.69
Geronimo Creek at Huber Road	0	0	NA	NA	0	0	NA	NA	NA	NA

* Positive change indicates an increase in pollutant load with rainfall. Negative change indicates that rainfall is diluting the base flow pollutant concentration. Stations highlighted have a base flow mean concentration greater than the screening concentration of 1.95 mg/L Nitrate Nitrogen, under dry conditions.

** Entire data set under all flow conditions through August 2014.

Table 4. Concentrations of ammonia-nitrogen under dry and wet conditions at the routine monitoring sites.

Site	No. of Samples	Median Flow-Dry	NH3-N Mean - Dry	Range-Dry	No. of Samples (Wet)	Median Flow-Wet	NH3-N Mean - Wet	Range-Wet	% Change btwn Dry and Wet *	NH3-N Mean 2008-2014**
Geronimo Creek at Haberle Road	35	4.3	0.13	<0.1-0.34	19	5.6	0.14	<0.1-0.32	15.66	0.13
Geronimo Creek at SH123	42	2.3	0.14	<0.1-0.36	7	3.8	0.16	<0.1-0.36	17.89	0.14
Geronimo Creek at HWY 90A	36	4.6	0.13	<0.1-0.37	13	6.15	0.12	<0.1-0.45	-10.56	0.13
Geronimo Creek at IH10 near Seguin	21	4.2	0.21	<0.1-1.26	4	5.75	0.18	<0.1-0.32	-15.81	0.21
Geronimo Creek at SOLC	22	4.3	0.18	<0.1-0.5	4	5.2	0.20	<0.1-0.36	13.40	0.18
Geronimo Creek at Hollub Lane	33	5.9	0.17	<0.1-0.77	15	8.35	0.12	<0.1-0.29	-29.60	0.15
Alligator Creek at Huber Road	38	0	0.17	<0.1-0.73	9	0.36	0.16	<0.1-0.46	-1.13	0.17
Geronimo Creek at Huber Road	0	0	NA	NA	0	0	NA	NA	NA	NA

* Positive change indicates an increase in pollutant load with rainfall. Negative change indicates that rainfall is diluting the base flow pollutant concentration. Stations highlighted have a base flow mean concentration greater than the screening concentration of 0.33 mg/L Ammonia-Nitrogen, under dry conditions.

** Entire data set under all flow conditions through August 2014.

Table 3 is a compilation of the nitrate-nitrogen data collected from 2008 through August 2014. The Leona Aquifer is the source of the springs contributing to the base flow of the Geronimo Creek. Historically, the concentration of the nitrate-nitrogen found in the Leona is very high, exceeding the drinking water standard of 10.0 milligrams per liter. The impact of the Leona on the base flow can be seen in the mean concentrations of nitrate-nitrogen at all six Geronimo Creek sites. All six sites exceed the TCEQ screening concentration of 1.95 milligrams per liter. Under wet weather conditions, storm water dilutes the base flow and lowers the mean concentrations at all sites.

Table 4 is a compilation of the data collected for ammonia-nitrogen. At no time, or under any flow conditions, did the mean exceed the screening concentration of 0.33 milligrams per liter.

Isotope Study in the Plum Creek and Geronimo Creek Watersheds

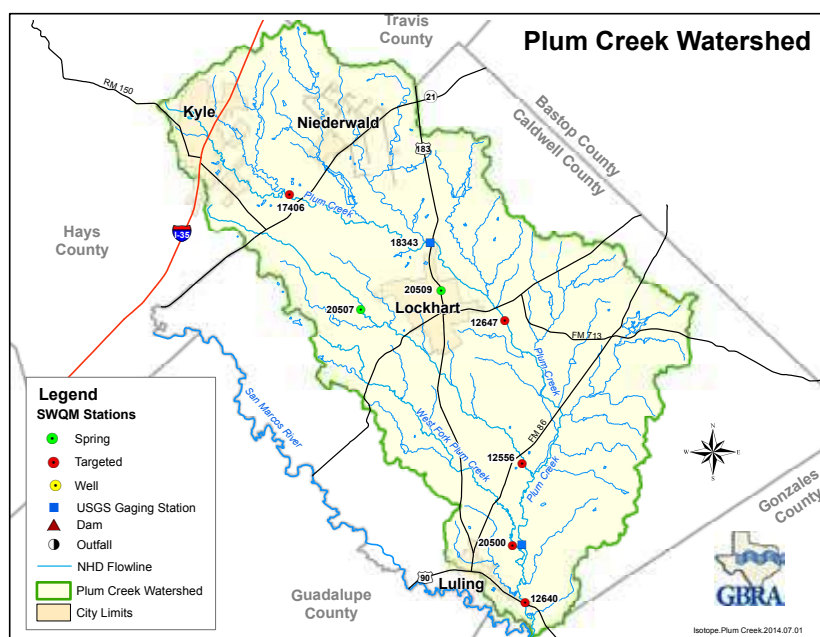
By Debbie Magin/Rebecca Lambert

Since monitoring of Plum Creek and Geronimo Creek began in the late 1990s, these creeks have shown elevated concentrations of nitrate-nitrogen. Currently, because the state stream water quality standards are not numeric for nutrients, exceedences of a screening concentration of 1.95 mg/L nitrate-nitrogen have been used to designate a stream as having a concern for nitrate-nitrogen. The possible sources of the nutrient concern are numerous. Plum Creek is effluent-dominated and is also fed by springs that come from the Leona Aquifer, known to have elevated concentrations of nitrate-nitrogen. Geronimo Creek is also fed by springs from that same aquifer. Stakeholders in both watersheds have long suspected fertilizer use as the source of the nitrates in the Leona, but oddly enough, elevated concentrations of nitrates had been seen in well testing long before commercial inorganic fertilizers came into use. Septic systems, organic fertilizers, nitrifying plants and atmospheric deposition round out the list of possible sources.

The TCEQ has begun to develop numeric water quality standards for nitrate-nitrogen. At the end of that process, the standards established by TCEQ and the EPA could move Plum Creek and Geronimo Creek from a designation of “concern” for nutrients on the 303(d) List of impaired waterbodies. The Plum Creek and Geronimo Creek Watershed Partnerships have not waited for “impaired waterbody” status to start working on best management practices that could reduce sources of nitrates. In order to help direct efforts and funding toward the most likely or most influential source(s) of nitrate, this project will look to isotopic signatures of nitrogen and oxygen in the nitrates. The ratios of the isotopes of nitrogen and oxygen in nitrate often are useful for determining sources of nitrates in groundwater and surface water. Isotopic ratios are expressed as the ratio of the heavier isotope to the lighter isotope relative to a standard in parts per thousand (USGS, 2011).

A total of 11 sites in the Plum Creek (7) and the Geronimo Creek (4) watersheds will be sampled for major ions, selected nutrient species including nitrate-nitrogen, and ($^{15}\text{N}/^{14}\text{N}$) and oxygen ($^{18}\text{O}/^{16}\text{O}$) isotopes four

times during the project period. Up to four wastewater effluents and one site for precipitation will be sampled for major ions, selected nutrient species including nitrate-nitrogen, and ($^{15}\text{N}/^{14}\text{N}$) and oxygen ($^{18}\text{O}/^{16}\text{O}$) isotopes four times during the project period. GBRA and USGS will conduct quarterly targeted surface water quality monitoring at five sites in the Plum Creek watershed and at two sites in the Geronimo Creek watershed over a range in hydrologic conditions (wet and dry conditions), collecting field, flow and conventional parameter groups. GBRA and USGS will conduct quarterly targeted groundwater quality monitoring at one well site in the Plum Creek watershed and one well site in the Geronimo Creek watershed, collecting field and conventional parameter groups. GBRA and USGS will also conduct quarterly targeted spring quality monitoring at one site in the Plum Creek watershed and one site in the Geronimo Creek watershed, collecting field, flow and conventional parameter groups. USGS will conduct targeted precipitation monitoring at one site in the Plum Creek watershed, collecting field and conventional parameter groups. GBRA and USGS will conduct wastewater quality monitoring at up to four wastewater facilities located in the Plum Creek watershed, collecting field, flow and conventional parameter groups.



Plum Creek Report

By Debbie Magin

Plum Creek rises in Hays County north of Kyle and runs south through Caldwell County, bypassing Lockhart and Luling, and eventually joins the San Marcos River at a confluence, just north of Gonzales County. Plum Creek is 52 miles in length and has a drainage area of 389 mi². In the *2008 Texas Water Quality Inventory and 303(d) List*, Plum Creek (Segment 1810) was listed as impaired because of elevated bacteria concentrations. The *Inventory* also noted that Plum Creek exhibited nutrient enrichment concerns for ammonia, nitrate+nitrite nitrogen and total phosphorus. Plum Creek has been listed as impaired on the 303(d) List since the 2004 due to bacterial contamination. In the *2012 Integrated Report*, Plum Creek was moved from *Category 5c*, the category that describes stream segments that need additional data and information to be collected before a Total Maximum Daily Load (TMDL) is scheduled, to *Category 4b*. Category 4b describes those stream segments where other pollution control requirements are reasonably expected to result in the attainment of the water quality standard in the near future, i.e. implementation of best management practices described in the watershed protection plan.

TSSWCB and AgriLife Extension established the Plum Creek Watershed Partnership (PCWP) in April 2006. The PCWP Steering Committee completed the “Plum Creek Watershed Protection Plan” in February 2008. Information about the PCWP is available at <http://plumcreek.tamu.edu/>. Sources of pollutants identified in the Plum Creek WPP include urban storm water runoff, pet waste, failing or inadequate on-site sewage facilities (septic systems), wastewater treatment

facilities, livestock, wildlife, invasive species (feral hogs), and oil and gas production.

Originally, the Plum Creek WPP was to be developed using only existing water quality data. However, discussions with stakeholders identified data gaps which would make source identification and establishment of water quality goals difficult. Accurate source identification is key to prioritizing implementation projects for funding. Through the TSSWCB project 03-19, *Surface Water Quality Monitoring to Support Plum Creek Watershed Protection Plan Development*, GBRA collected water quality data to fill the identified data gaps. During the project, sampling of water quality data was severely hampered by a prolonged drought that covered the watershed, causing the tributaries to run dry and the springs to slow to almost negligible flow. To avoid a suspension of data collection the TSSWCB funded a stop gap monitoring project, 10-54, *Surface Water Quality Monitoring to Support the Implementation of the Plum Creek WPP*, until a new project could begin.

Implementation of the Plum Creek WPP is currently underway. To demonstrate improvements in water quality, the Plum Creek WPP describes a water quality monitoring program designed to evaluate the effectiveness of Best Management Practices (BMPs) implemented across the watershed and their impacts on instream water quality. Water quality data will be used in the adaptive management of the WPP in order to evaluate progress in implementing the Plum Creek WPP and achieving water quality restoration.

Photos by Erich Schlegel



Plum Creek Report (cont.)

Project Overview

GBRA continues to collect surface water quality monitoring (SWQM) data to characterize the Plum Creek watershed, including the contributing wastewater effluents. Monitoring data is used to assess and evaluate the effectiveness of the BMPs that have been or will be implemented in the watershed as a result of the Plum Creek WPP. The sampling regime in the Plum Creek watershed includes diurnal, spring flow, storm event and targeted monitoring under more typical base flow conditions and attempts to provide a more complete and representative data set to characterize the Plum Creek watershed and document water quality improvements.

GBRA participated in the PCWP, Steering Committee, and Technical Advisory Group (TAG) in order to communicate project goals, activities and accomplishments to affected parties. Through funding

Routine ambient water quality data is collected monthly at three main stem stations by GBRA (17406, 12640 and 12647) through the Clean Rivers Program. GBRA conducts routine ambient monitoring at an additional five sites monthly, collecting field, conventional, flow and bacteria parameter groups.

GBRA staff attempt to collect targeted watershed monitoring at 35 sites twice per season, once under dry weather conditions and once under wet weather conditions, collecting field, conventional, flow and bacteria parameter groups. Spatial, seasonal and meteorological variation is captured in these snapshots of watershed water quality but has been severely hampered by the prolonged drought.

GBRA conducts 24-hour Dissolved Oxygen (DO) monitoring at eight sites monthly during the index period collecting field and flow parameter groups. These sites are the same as the sites for routine ambient monitoring. GBRA maintains a continuous water quality monitoring module that collects the flow and field parameters every 15 minutes.

GBRA conducts effluent monitoring at seven wastewater treatment facilities (WWTFs) once per month collecting field, conventional, flow, bacteria and effluent parameter groups. Monitoring of the wastewater effluent is used to characterize the WWTF contributions to flow regime and pollutant loadings.

GBRA conducts spring flow monitoring at three springs once per season collecting field, conventional, flow and bacteria parameter groups. Spatial and seasonal variation in spring flow is captured. This monitoring component is used to characterize spring contributions to flow regime and pollutant loadings. In 2014, 12 wells that are in the Leona Geologic formation were inventoried in order to provide water quality and meta data (water depth, installation method, date of installation, cased, sealed or open, use of water, land use in immediate area and proximity to Plum Creek or tributary) from shallow groundwater within the Plum Creek watershed, to determine if there is recharge of the Leona by the effluent-dominated Plum Creek or impacts of septic tanks to the shallow groundwater.



Photo by Janet Thome

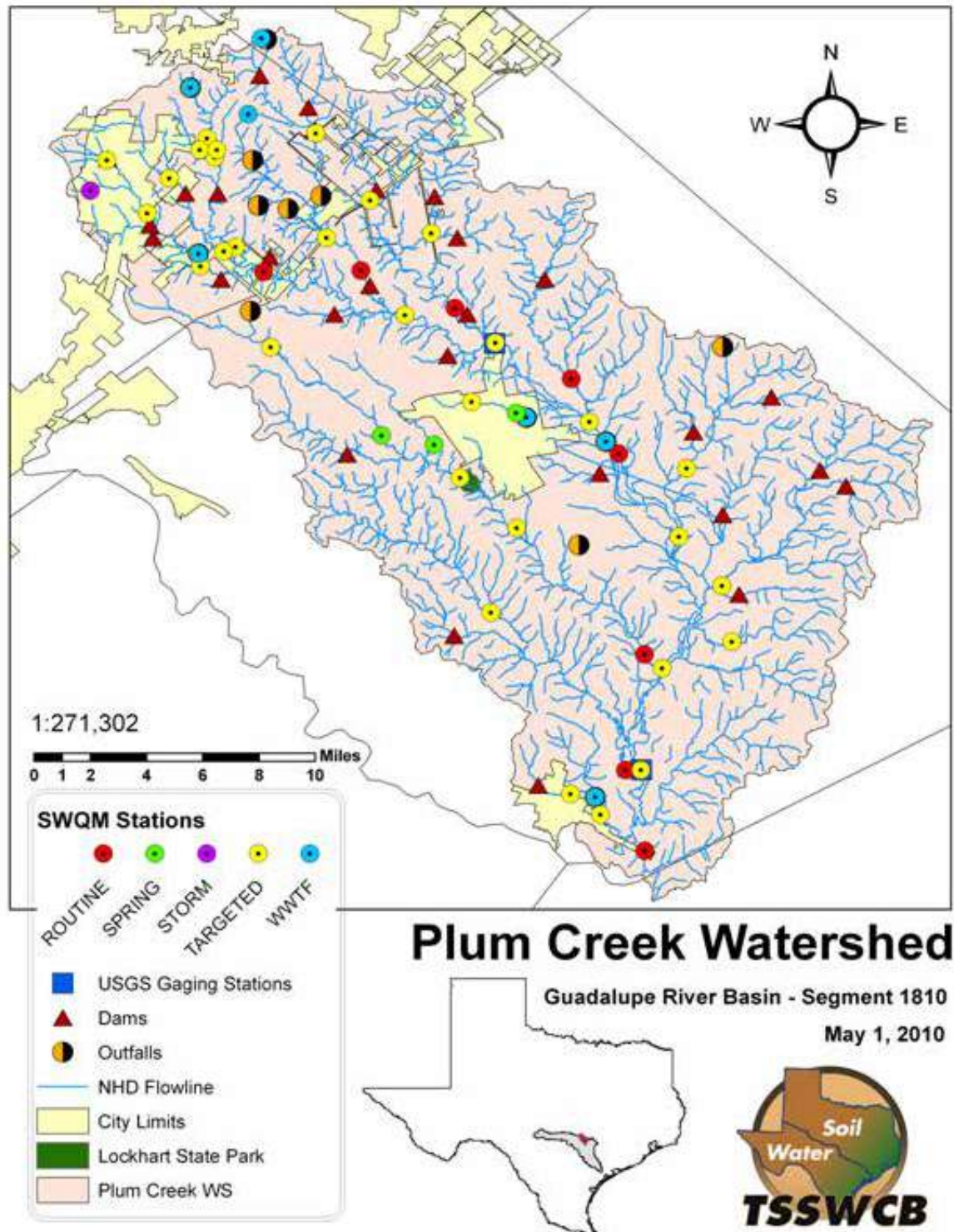
from an associated project (TSSWCB Project No. 11-07, *Coordinating Implementation of the Plum Creek Watershed Protection Plan*), Texas A&M University maintained the project's webpage at <http://www.gbra.org/plumcreek/> for the dissemination of information.

GBRA collects data under an approved QAPP to ensure data of known and acceptable quality was generated in this project. The QAPP is consistent with *EPA Requirements for Quality Assurance Project Plans (QA/R-5)*, the *TSSWCB Environmental Data Quality Management Plan*, and various Texas Commission on Environmental Quality (TCEQ) guidelines for monitoring procedures and methods. Figure 2 is a map of the routine monitoring locations, identified by task.

When the load duration curves for the WPP were being developed there was an observed loss of flow between the mid-and lower-index sites. As a result of this observation, the need for a gain/loss study was identified to better define the relationship between surface flows and groundwater recharge in the Plum Creek watershed.

USGS conducted a gain/loss survey on the Plum Creek watershed, based on five locations within the watershed. The study included two synoptic (manually-collected) surveys. USGS provided a tabulation of the data and GBRA attempted to draw limited conclusions from the data.

Figure 2. Map of the Plum Creek watershed with sampling locations.



Plum Creek Project Highlights

Stream Clean Ups

Annual stream clean-ups are held in Lockhart each fall. After each event, participants are invited to visit booths at the environmental fair, including the

watershed model that includes a scale model of the Plum Creek watershed. Additionally, the City of Kyle holds an annual stream clean-up each spring.



Photo by Nick Dornak

Plum Creek Project Highlights

Outreach and Education

GBRA education staff conducted outreach and education activities, including dissemination of information about the Plum Creek, the Partnership and related projects. Each fall, a tabletop watershed model, highlighting the Plum Creek watershed, is taken to

participating classrooms located in the watershed. Over 1,000 fourth and fifth graders and more than 50 teachers from the Hays Consolidated, Lockhart and Luling Independent School Districts learn about Plum Creek, its tributaries, and nonpoint source pollution. The

classroom presentation was expanded to include a week long water quality monitoring project. Water collected from the Plum Creek or one of its tributaries is brought to selected classrooms. Students performed water quality analyses in the spring semester. The water quality analyses include dissolved oxygen, pH, and nitrate-nitrogen, phosphates, and bacteria.

In order to continue to raise awareness of water quality and stewardship in the Plum Creek watershed and make water quality data available to the public, GBRA installed three kiosks in public locations in Kyle, Lockhart and Luling. These kiosks linked the public to the real-time monitoring site, the project web site, and other pertinent water quality information, and on-line training modules including the module on septic system operations (developed through TCEQ CWA §106 funds). The kiosks were available at three public libraries in the cities in the watershed.



Plum Creek Project Highlights

Interlocal Agreement for Funding of Local Watershed Coordinator

Since 2008 Agrilife Extension served as the watershed coordinator through the development and implementation of the WPP. Extension secured funding for implementation measures through grants, tracked the progress of implementation, and evaluated and reported water quality trends resulting in the implementation of management measures. As funding for facilitation by Extension was drawing to an end, GBRA, along with AgriLife and TSSWCB Staff, initiated discussions within the PCWP, looking for a means to sustain the progress on implementing the Plum Creek WPP. Twelve funding partners stepped up to participate in an interlocal agreement, drafted

by GBRA legal counsel, which provides matching funds to establish a local watershed coordinator. The WPP states, “In addition to technical and financial assistance required for implementation of management measures and outreach programs, it is recommended that a full-time [watershed] coordinator be employed to facilitate continued progress [throughout the 10-year implementation schedule].” The local watershed coordinator oversees project activities, seeks additional funding, organizes and coordinates regular updates for the Plum Creek Watershed Partnership, maintains the website, and coordinates outreach and education efforts in the watershed.

Plum Creek Project Highlights

Data Transmittal and Information Transfer

Originally, GBRA transferred monitoring data collected in the project to TSSWCB. Then beginning in June 2013, GBRA began transmitting the data to the TCEQ Data Management and Analysis Team using a tag number sequence assigned by TCEQ. The data collected in this project is uploaded to the TCEQ SWQMIS. Only those data which are supported by appropriate Quality Control (QC) and meet the measurement performance specifications defined for this project are considered acceptable, and are reported to TCEQ SWQMIS. A completed Data Summary was submitted with each data submittal. Corrective Action Reports are submitted by the GBRA field staff or the laboratory if there is a problem or deficiency encountered. Only three data sets were incomplete through August 2014 due to GBRA error, requiring a Corrective Action Report. If a problem occurs during a sampling event, every attempt is made to recollect the sample if the flow conditions

remain the same so there is no loss in data. A secondary lab was included in the QAPP in order to perform analyses when there is an instrument failure in the GBRA laboratory.



Debbie Magin Retires

By Mike Urrutia

Debbie Magin began her employment with the Guadalupe-Blanco River Authority on July 6, 1976, initially serving as laboratory analyst for the Regional Laboratory, and in 1982, was promoted to regional water quality laboratory director. In 1999 she was promoted to director of water quality Services where she continued to initiate, implement, manage and develop programs for meeting the GBRA charge to develop, conserve and protect the water resources of the Guadalupe River Basin.

Debbie Magin has developed unique and lasting relationships and partnerships with local entities, municipalities, districts, stakeholders, and representatives of state and federal agencies such as



Texas Commission on Environmental Quality, Texas State Soil and Water Conservation Board, Texas Water Development Board, Texas A&M AgriLife Extension, and the Environmental Protection Agency.

She is well known and respected for her expertise with laboratory services and water quality issues throughout the state.

Debbie received grant awards that total about \$5 million dollars; she was a finalist for the TCEQ 2013 Environmental Excellence Award, the 2010 Envision Central Texas Community Stewardship Awards – Taking Charge of Water Quality in the Plum Creek Watershed,

the Texas Water Utilities Association Distinguished Service Award, and Laboratory Analyst Award.

During her more than 15 years working with the Clean Rivers Program, Allison Woodall, the former program manager for the Clean Rivers Program, described Debbie Magin as an “incredibly remarkable person” to work with. “She brought energy, ideas, and a ‘can-do’ attitude to all her interactions and work. Bringing together stakeholders, significantly enhanced her program,



and met all the new challenges we would send her way with, ‘how can we make this work?’

Debbie supported GBRA’s objectives while finding a way to incorporate the various objectives of her stakeholders and the TCEQ,” explained Woodall.

“I can’t begin to list all the ways she helped the program and how much support she gave to those of us working in and around the program,” Woodall said, adding, “I can only say, ‘thank you.’”

Woodall said Magin made working in the program a “pleasant and often invigorating experience.”

“Debbie has been the driving force behind the development and implementation of many water quality improvement projects in the Guadalupe River Basin, such as the Plum Creek WPP and the Geronimo and Alligator Creeks WPP. The energy, enthusiasm, and spirit she put into her work just made you want to be a part of what she was doing. Also, the quality of her work is superior--the Plum Creek WPP has become the gold standard for how WPPs should be developed and managed in Texas. The contributions she has made to improve the waters in the basin will have long-reaching impact on the present generation of Texans, and to future generations, as well.” Ward Ling of Texas A&M AgriLife Extension, said.

Debbie, thank you for all your tireless work, your passion for our watershed and your sacrifice to protect the water quality of the Guadalupe River Basin. Your legacy will be long lasting; the Guadalupe River Basin will forever be grateful to you.

Overview of Water Quality Monitoring

One of the key roles of the Clean Rivers Program is fostering coordination and cooperation in monitoring efforts. Coordinated monitoring meetings are held annually and are attended by the entities collecting water quality data on the Guadalupe River and its tributaries. By coordinating these efforts and discussing the areas in need of additional monitoring, more data will be collected, maximizing the limited resources available to these entities. Table 5 outlines the types and amounts of water quality monitoring conducted in the Guadalupe River Basin and the Lavaca-Guadalupe Coastal Basin under a TCEQ-approved Quality Assurance Project Plan for September 2014 through August 2015.

In addition to the monitoring programs conducted by the Guadalupe-Blanco River Authority (GBRA), and the Upper Guadalupe River Authority (UGRA), the Wimberley Valley Watershed Association is conducting

water quality monitoring in the Lower Blanco and Cypress Creek watersheds. The goals of these programs include establishing baseline water quality data; identifying potential pollution problems; documenting spatial and temporal changes; determining impacts of point and nonpoint source pollution; and assessing compliance with water quality standards. These programs will also provide recommendations for local planning efforts to protect water quality. In addition to laboratory analyses, GBRA provides technical assistance and oversight of the quality assurance aspects of each program. The complete monitoring schedule is available at <http://cms.lcra.org>. The following sections of the *Basin Highlights Report* show, by watershed, the distribution of monitoring sites plus activities that may affect water quality, such as major communities and areas with a concentration of poultry production facilities, oil and gas and fracking activities.

Table 5. Monitoring parameter and frequencies conducted by monitoring partners in the Guadalupe River Basin in 2015.

Sampling Entity	Field Parameters	Conventional Parameters	Bacteria	Biological and Habitat	24 hr. Dissolved Oxygen	Metals in Water	Metals in Sediment	Organics in Water	Organics in Sediment
GBRA	19 sites monthly; 8 sites quarterly	19 sites monthly; 8 sites quarterly	19 sites monthly; 8 sites quarterly	1 site twice a year	1 site twice a year	1 site annually			1 site annually
UGRA	9 sites monthly; 11 sites quarterly	11 sites quarterly	9 sites monthly; 11 sites quarterly	1 site twice a year	1 site twice a year				
TCEQ	11 sites quarterly	11 sites quarterly	11 sites quarterly		1 site twice a year	1 site twice a year			
WVWA	9 sites quarterly	9 sites quarterly	9 sites quarterly		1 site annually				
TSSWCB Funded	36 sites 8 times a year; 13 sites 16 times a year; 10 sites quarterly; 7 sites monthly	36 sites 8 times a year; 13 sites 16 times a year; 10 sites quarterly; 7 sites monthly	36 sites 8 times a year; 13 sites 16 times a year; 10 sites quarterly; 7 sites monthly		8 sites 8 times a year				

2014 Texas Integrated Report of Surface Water Quality in the Guadalupe River Basin

The U.S. Environmental Protection Agency (EPA) conducted a complete review of TCEQ's 2012 Texas Integrated Report of Surface Water Quality in the Guadalupe River Basin. Based on its review, EPA has determined that Texas' 2012 list of water quality impaired segments still requiring TMDLs meets the requirements of Section 303(d) of the CWA and EPA's implementing regulations. TCEQ produces a new report every two years on even numbered years as required by law. The latest report completed by TCEQ in 2014 remains in draft form, because the 303(d) list must be

approved by the EPA before it is final. Segments located in the Guadalupe River Basin on the 303(d) are listed below. The list includes sites that have water quality concerns identified in the 2014 report. Plum Creek (Segment 1810) has been moved to Assessment Category 4b. Although this segment is still not meeting stream standards for one or more of its designated uses, the segment has ongoing implementation projects that should result in standards attainment in a reasonable length of time.

Summary of Findings from the 2014 Texas Integrated Report of Surface Water Quality in the Guadalupe River Basin. (Assessed using data inclusive of December 1, 2005 through November 30, 2012)

Segment Number	Water Body	Impairment or Concern	Category (if assigned)	Year First Identified
1801	Guadalupe River Tidal	Depressed Dissolved Oxygen; Nitrate-Nitrogen	Note 1	2002
1802	Guadalupe River Below San Antonio River	Nitrate-Nitrogen	Note 1	2002
1803	Guadalupe River Below San Marcos River	Nitrate-Nitrogen	Note 1	2014
1803A	Elm Creek	Depressed Dissolved Oxygen; Chlorophyll- <i>a</i>	5b	1999
1803B	Sandies Creek	Depressed Dissolved Oxygen; Impaired Biological Habitat and Impaired Fish and Macroinvertebrate Communities; Bacteria; Chlorophyll- <i>a</i>	5b and 5c	1999
1803C	Peach Creek	Depressed Dissolved Oxygen; Bacteria; Impaired Fish Community; Total Phosphorus and Chlorophyll- <i>a</i>	5b and 5c	2002
1803F	Denton Creek (tributary of Peach Creek)	Depressed Dissolved Oxygen; Bacteria	Note 2	2010
1803G	Sandy Fork (tributary of Peach Creek)	Bacteria	Note 2	2010
1804A	Geronimo Creek	Bacteria; Nitrate-Nitrogen	5c	2006
1805	Canyon Lake	Mercury in Edible Fish Tissue; Ammonia	5c	2006
1806	Guadalupe River Above Canyon Reservoir	Impaired Biological Habitat and Macroinvertebrate Community	Note 1	2012
1806A	Camp Meeting Creek	Depressed Dissolved Oxygen	Note 1	1999
1806D	Quinlan Creek	Bacteria; Depressed Dissolved Oxygen	5a	2010
1806E	Town Creek	Bacteria; Depressed Dissolved Oxygen	5a	2010
1810	Plum Creek	Bacteria; Nitrate-Nitrogen; Total Phosphorus; Depressed Dissolved Oxygen; Impaired Biological Habitat and Macroinvertebrate Community	4b	2004
1811A	Dry Comal Creek	Bacteria	5c	2010
1814	Upper San Marcos River	Total Dissolved Solids	Note 2	2010
1815	Cypress Creek	Depressed Dissolved Oxygen; Impaired Biological Habitat, Macroinvertebrate Community and Fish Community	Note 1	2010
1818	South Fork Guadalupe River	Depressed Dissolved Oxygen	Note 1	2014

Note 1: No category assigned identified for a concern rather than an impairment of a designated use. Concerns are identified for water bodies near-nonattainment of water quality standards (CN) or not meeting numerical or narrative screenings levels (CS).

Note 2: This impairment was removed from the 2014 draft 303(d), but this list has not yet been approved by the EPA.

Category 4: Standard is not attained or nonattainment is predicted in the near future due to one or more parameters, but no TMDLs are required.

4a - All TMDLs have been completed and approved by EPA.

4b - Other pollution control requirements are reasonably expected to result in the attainment of the water quality standard in the near future.

4c - Nonattainment of the standard for one or more parameters is shown to be caused by pollution, not by pollutants and that the water quality conditions cannot be changed by the allocation and control of pollutants through the TMDL process.

Category 5: Standard is not attained or nonattainment is predicted in the near future for one or more parameters.

5a - TMDLs are underway, scheduled, or may be scheduled for one or more parameters.

5b - review of the standards for one or more parameters will be conducted before a management strategy is selected, including a possible revision to the water quality standards.

5c - Additional data or information will be collected and/or evaluated for one or more parameters before a management strategy is selected.

Water Quality Parameters

Field Parameters are water quality constituents that can be obtained on-site and generally include: dissolved oxygen (DO), conductivity, pH, temperature, stream flow (not in reservoirs), and secchi disc depth (reservoirs only).

Dissolved Oxygen indicates the amount of oxygen available in the stream to support aquatic life. DO can be reduced by the decomposition of organic matter.

Conductivity is a measure of the water body's ability to conduct electricity and indicates the approximate levels of dissolved salts, such as chloride, sulfate and sodium. Elevated concentrations of dissolved salts can impact water as a drinking water source and aquatic habitat.

pH is a measure of the hydrogen ion concentration in an aqueous solution. It is a measure of the acidity or basic property of the water. Chemical and biological processes can be affected by the pH. The pH can be influenced by dissolved constituents, such as carbon dioxide and by point and nonpoint source contributions to the stream.

Temperature of the water affects the ability of the water to hold dissolved oxygen. It also has an impact on the biological functions of aquatic organisms.

Stream Flow is an important parameter affecting water quality. Low flow conditions common in the warm summer months create critical conditions for aquatic organisms. Under these conditions, the stream has a lower assimilative capacity for waste inputs from point and nonpoint sources.

Secchi Disc transparency is a measure of the depth to which light is transmitted through the water column, and thus the depth at which aquatic plants can grow.

Conventional Parameters are typical water quality constituents that require laboratory analysis and generally include: nutrients, chlorophyll *a*, total suspended solids, turbidity, hardness, chloride, and sulfate.

Nutrients include the various forms of nitrogen and phosphorus. Elevated nutrient concentrations may result in excessive aquatic plant growth and can make a water body unfit for its intended use(s).

Chlorophyll *a* is a plant pigment whose concentration is an indicator of the amount of algal biomass and growth in the water.

Turbidity is a measure of water clarity or light transmitting properties. Increases in turbidity are caused by suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter, plankton and other microscopic organisms.

Total Suspended Solids indicate the amount of particulate matter suspended in the water column.

Hardness is a composite measure of certain ions in water, primarily calcium and magnesium. The hardness of the water is critical due to its effect on the toxicity of certain metals. Typically, higher hardness concentrations in the receiving stream can result in reduced toxicity of heavy metals.

Chloride and Sulfate are major inorganic anions in water and wastewater. Numeric stream standards for chloride and sulfate have been set on all of the classified stream segments in the basin. Both of these inorganic constituents can impact the designated uses and can come from point and nonpoint sources, such as wastewater discharges, oil field activities, and abandoned flowing wells from ground-water with elevated concentrations of dissolved solids.

Other Parameters

Bacteria, specifically *E. coli*, is used as an indicator of the possible presence of disease-causing organisms.

Biological and Habitat assessment includes collection of fish community data, benthic macroinvertebrate (insects) data, and measurement of physical habitat parameters. This information is used to determine whether the stream adequately supports a diverse and desirable biological community. The physical, chemical and biological data are used together to provide an integrated assessment of aquatic life support.

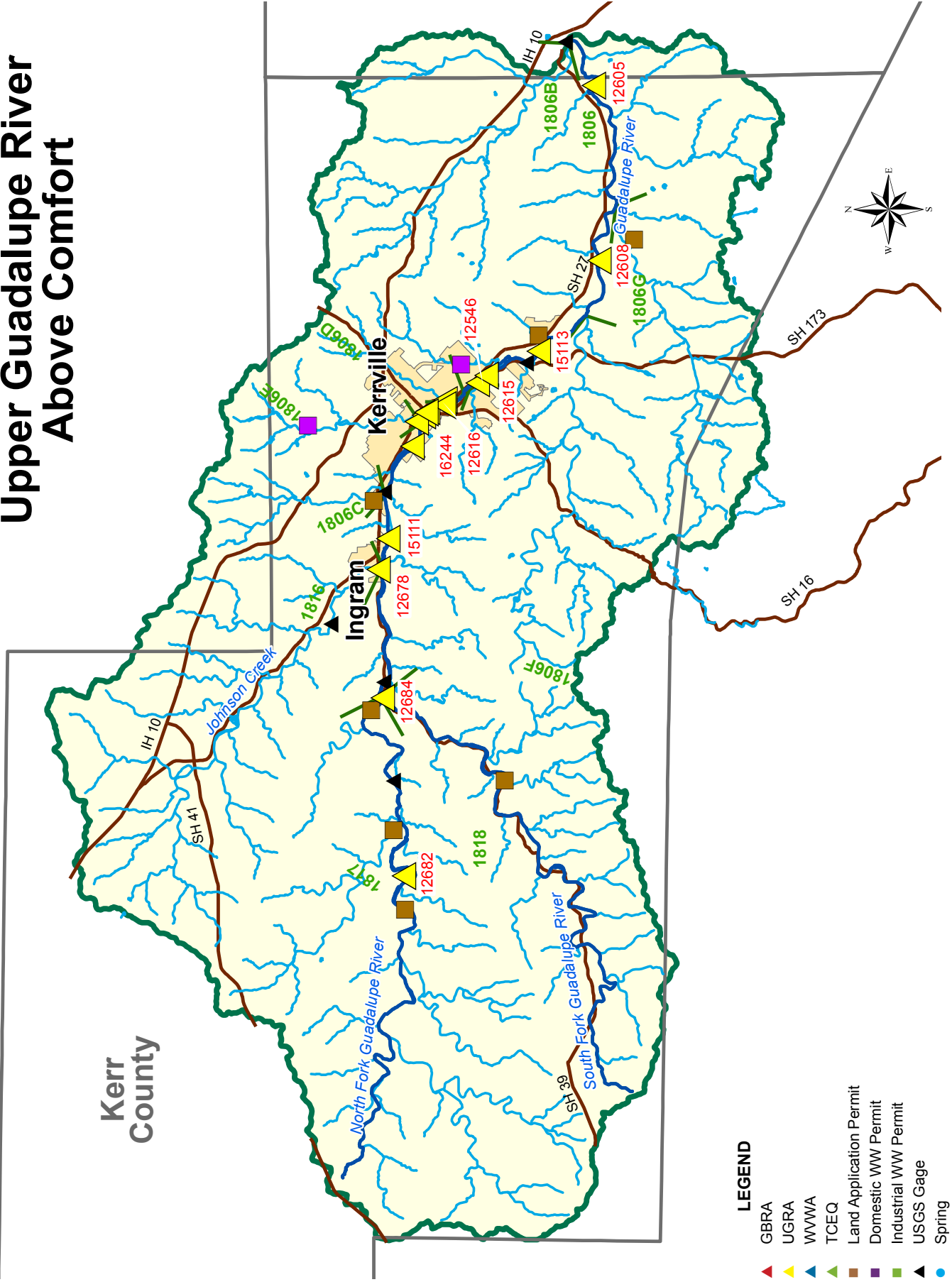
24-Hour DO studies perform measurements of DO in frequent intervals (e.g., one hour) in a 24-hour period. The average and minimum concentrations in the 24-hour period are compared to corresponding criteria. This type of monitoring takes into account the diurnal variation of DO and avoids the bias in samples taken only at certain times of the day.

Metals in Water, such as mercury or lead, typically exist in low concentrations, but can be toxic to aquatic life or human health when certain levels are exceeded. To obtain accurate data at low concentrations, the GBRA uses special clean methods that minimize the chance for sample contamination and provide high quality data.

Organics and Metals in Sediment could be a source of toxicants for the overlying water, though currently there are no numeric sediment standards.

Organics in Water, such as pesticides or fuels, can be toxic to aquatic life or human health when certain levels are exceeded.

Upper Guadalupe River Above Comfort





Upper Guadalupe River Watershed

River Segments, Descriptions and Concerns

Drainage Area: 850 square miles

Streams and Rivers: North Fork and South Fork of the Guadalupe River, Johnson Creek, Quinlan Creek, Camp Meeting Creek, Town Creek, Cypress Creek, Goat Creek, Turtle Creek, Verde Creek, Bear Creek

Aquifer: Trinity, Edwards Plateau

River Segments: 1816, 1817, 1818, 1806A-G

Cities: Center Point, Ingram, Kerrville, Comfort, Hunt

Counties: Kerr, Gillespie, Bandera, Kendall

EcoRegion: Edwards Plateau

Vegetation Cover: Evergreen Forest 46.9%, Grass/Herbaceous 14.4%, Shrublands 28.8%

Climate: Average annual rainfall 30 inches, Average annual temperature January 32°, July 94°

Land Uses: ranching, farming, tourism, light manufacturing

Water Body Uses: aquatic life, contact recreation, general use, fish consumption, and public water supply

Soils: Dark and loamy over limestone; to the south and east soils are variable with light colored brown to red soils in some areas and dark loamy or loamy soils over clay subsoils elsewhere

Permitted Wastewater Treatment Facilities: Domestic 2, Land Application 7, Industrial 0

Segment 1816: (Johnson Creek) This spring-fed 21 mile segment consisting of Johnson Creek to its confluence with the Guadalupe River in Kerr County has good water quality. Intermittent in stages, the stream crosses an area characterized by steep slopes, generally shallow, with stony soils that support grasses and open stands of live oak and Ashe Juniper.

Segment 1817: (North Fork Guadalupe River) The spring-fed 29 mile North Fork of the Guadalupe River is a perennial stream with exceptional aquatic life designation. River flow is swift but shallow. Typical riparian vegetation consists of bald cypress, live oak and Ashe Juniper.

Segment 1818: (South Fork Guadalupe River) The spring-fed 27 mile South Fork of the headwaters of the Guadalupe River is clear, with moderately flowing water and has excellent water quality. It is a narrow and shallow scenic river with bald cypress lined banks.

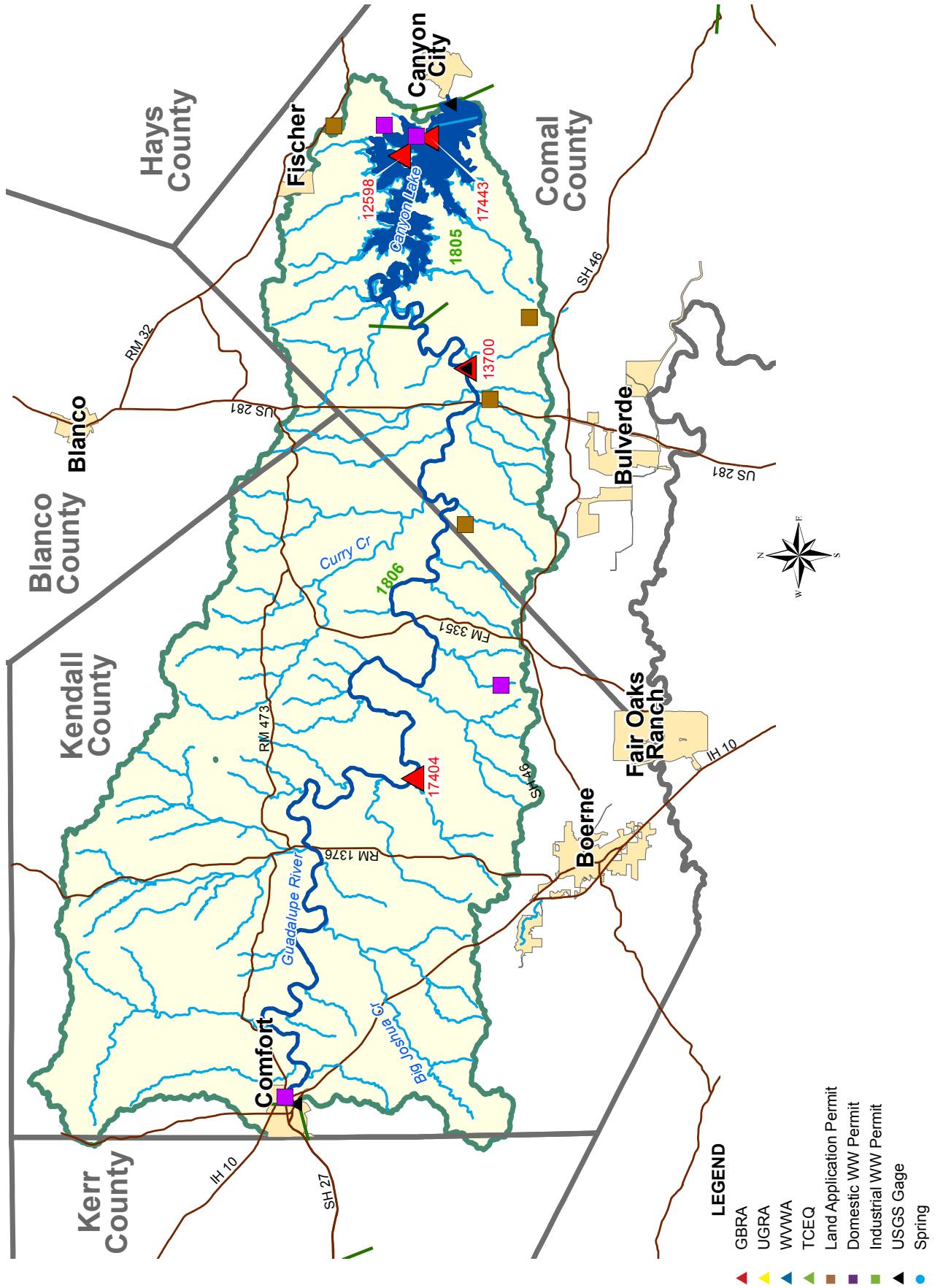
Segment Concerns: The Draft 2014 *Texas Integrated Report* identifies a concern for the dissolved oxygen grab samples at the screening level for the lower 1.5 miles of the South Fork of the Guadalupe River. However, the mean dissolved oxygen value is only 5.43 mg/L, which is only slightly below the aquatic life use criteria of 6.00 mg/L.

Segment 1806: (Guadalupe River above Canyon Lake) The Guadalupe River from the City of Comfort in Kendall County to the confluence with the North and South forks of the Guadalupe River in Kerr County is scenic with crystal clear water between bald cypress lined banks. The shallow riffle areas, punctuated with deep pools create an exceptional aquatic life ecosystem.

Segment Concerns 1806: Two portions of segment 1806 have aquatic life use concerns due to impaired habitat and impaired macrobenthic community.

Tributary Concerns: Two portions of segment 1806A, Camp Meeting Creek, have aquatic life use concerns for depressed dissolved oxygen levels. Segment 1806D, Quinlan Creek, has an aquatic life use concern for depressed dissolved oxygen and recreation use impairment for not supporting the *E. coli* bacteria geometric mean standard. Segment 1806E, Town Creek, also has an aquatic life use concern for depressed dissolved oxygen and a contact recreation use impairment for bacteria.

Guadalupe River Below Comfort



Guadalupe River Watershed Below Comfort

River Segments, Descriptions and Concerns



Photo by Tammy Beutnagel

Drainage Area: 596 square miles

Streams and Rivers: Guadalupe River from Comfort to Canyon Lake, Joshua Creek, Flat Rock Creek, Rebecca Creek, Block Creek, West Sister Creek

Lake: Canyon Lake

Aquifer: Trinity, Edwards Plateau

River Segments: 1805, 1806

Cities: Comfort, Kendalia, Bergheim, Bulverde, Canyon City, Spring Branch, Startzville, Sattler

Counties: Kerr, Comal, Kendall, Blanco

EcoRegion: Edwards Plateau

Vegetation Cover: Evergreen Forest 43.6%, Shrublands 11.0%, Grass/Herbaceous 31.3%

Climate: Average annual rainfall 32 inches, Average annual temperature January 38°, July 95°

Land Uses: urban, unincorporated suburban sprawl, cattle, goat and sheep production, light and heavy industry, and recreational

Water Body Uses: aquatic life, contact recreation, general use, fish consumption, and public water supply

Soils: Dark and loamy over limestone to loam with clay subsoils

Permitted Wastewater Treatment Facilities: Domestic 4, Land Application 4, Industrial 0

Segment 1806: This segment of the Guadalupe River extends from a point 1.7 miles downstream of Rebecca Creek Road in Comal County to the City of Comfort in Kendall County. This segment is characteristic of the Texas Hill Country with limestone streambeds and rolling terrain, which is commonly surrounded by Ashe juniper and bald cypress.

Segment Concerns: A sub-segment of this watershed, in Comal County, is no longer impaired for bacteria on the draft TCEQ 2014 303(d) list. Concentrations of *E. coli* have fallen to an assessed geometric mean of 109 organisms. The current assessment value falls below the state standard of 126 organisms. This change is most likely due to the reduced rainfall runoff caused by the prolonged drought, which is reducing the amount of bacteria being washed into the water body from animals living in the watershed. The diminished bacteria loading may reverse at some point in the future, when rainfall is more abundant in the watershed. Additional impervious cover from future population growth may also contribute to increased runoff and bacteria loading. The 2010 U.S. census population for Comal County was 108,472 and 2013 estimates show that the population has now increased to 118,480.

Segment 1805: Canyon Lake segment extends from Canyon Dam in Comal County to a point 1.7 miles downstream of Rebecca Creek Road in Comal County, and includes all of Canyon Reservoir. The reservoir has a maximum capacity of 740,900 acre feet, and a surface area of 8,230 acres.

Segment Concerns: The cove around Jacob's Creek Park has been listed as a concern in the Draft 2014 *Texas Integrated Report* and 303(d) List due to high ammonia nitrogen levels exceeding the screening criteria of 0.11 mg/L. Ammonia is of special concern in Canyon Reservoir, as high levels can cause fish mortalities. This concern was not assessed in any other parts of the reservoir.

Segment 1805 Special Notes: Canyon Reservoir remains on the 303(d) list of impaired water bodies because of the fish consumption advisory for longnose gar and striped bass that has been issued by the Texas State Department of Health Services (DSHS). Because concentrations of methylmercury in fish tissue of these species exceeds the criteria to protect human health, the DSHS advises that adults should limit consumption of longnose gar and striped bass to no more than two eight-ounce meals per month and children under 12 should limit consumption to no more than two four-ounce meals per month. Potential sources of mercury include emissions from coal-fired power plants, cement plants, volcanoes, industrial discharges, and improper disposal of batteries. Samples of water taken from Canyon Reservoir have shown no detectable concentrations of mercury. The DSHS has not speculated as to the source of the mercury. Canyon Reservoir will remain on the list until additional fish tissue studies are performed by DSHS and the concentrations of methylmercury are within the recommended criteria.

The U.S. Army Corps of Engineers manages releases of water from the reservoir when the elevation is above its conservation pool of 909 above mean sea level (AMSL). When the reservoir is at or below conservation pool, GBRA manages the stored water portion and reservoir releases. Canyon Reservoir fulfills its role as a storage reservoir and releases adequate amounts of water providing beneficial uses to cities, industry and individuals. Releases are determined based upon several factors including natural inflows, licensed flows for the project, senior water rights, contract releases from conservation pool for cities, industries and other downstream users and bays and estuary flow requirements.

Blanco River Watershed

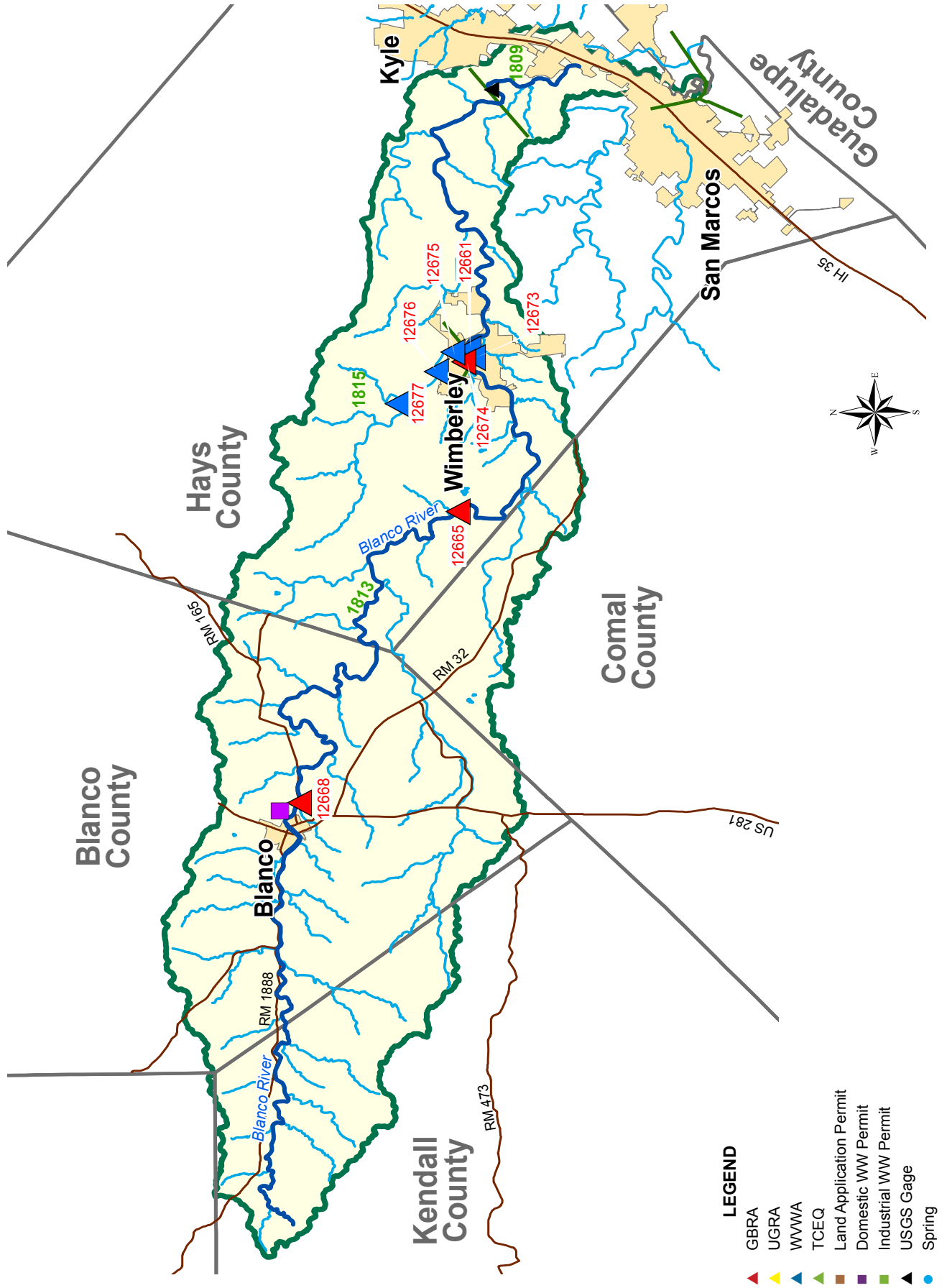




Photo by John Snyder

Blanco River Watershed

River Segments, Descriptions and Concerns

Drainage Area: 440 square miles

Streams and Rivers: Guadalupe River, Lower Blanco River, Upper Blanco River, Cypress Creek, Meier Creek, and Sycamore Creek

Aquifers: Edwards-Trinity, Trinity

River Segments: 1813, 1815, 1809

Cities: Blanco, Fisher, Wimberley, Kyle, San Marcos

Counties: Kendall, Comal, Blanco and Hays

EcoRegion: Edwards Plateau

Vegetation Cover: Evergreen Forest 42.9%, Shrublands 11.0%, Grass/Herbaceous 32.2%, Deciduous Forest 7.7%

Climate: Average annual rainfall 31 inches, Average annual temperature January 34°, July 94°

Land Uses: urban, agricultural crops (wheat, hay, oats, peaches and pecans), sheep, cattle, goats and turkey productions; light manufacturing and recreation

Water Body Uses: aquatic life, contact recreation, general use, fish consumption use, and public water supply use

Soils: Varies from thin limestone to black, waxy, chocolate, and grey loam, calcareous, stony, and clay loams

Permitted Wastewater Treatment Facilities: Domestic 1, Land Application 0, Industrial 0

Segment 1813: (Upper Blanco River) The Upper Blanco River flows for 71 miles from northern Kendall County to Limekiln Road in Hays County. This segment of the River is primarily spring-fed, but can experience extreme flash flood flows when influenced by rainfall runoff. Cypress Creek joins the Blanco River in the Village of Wimberley. The steep-sloped, intermittent, meandering stream is lined with bald cypress, oaks and Ashe juniper.

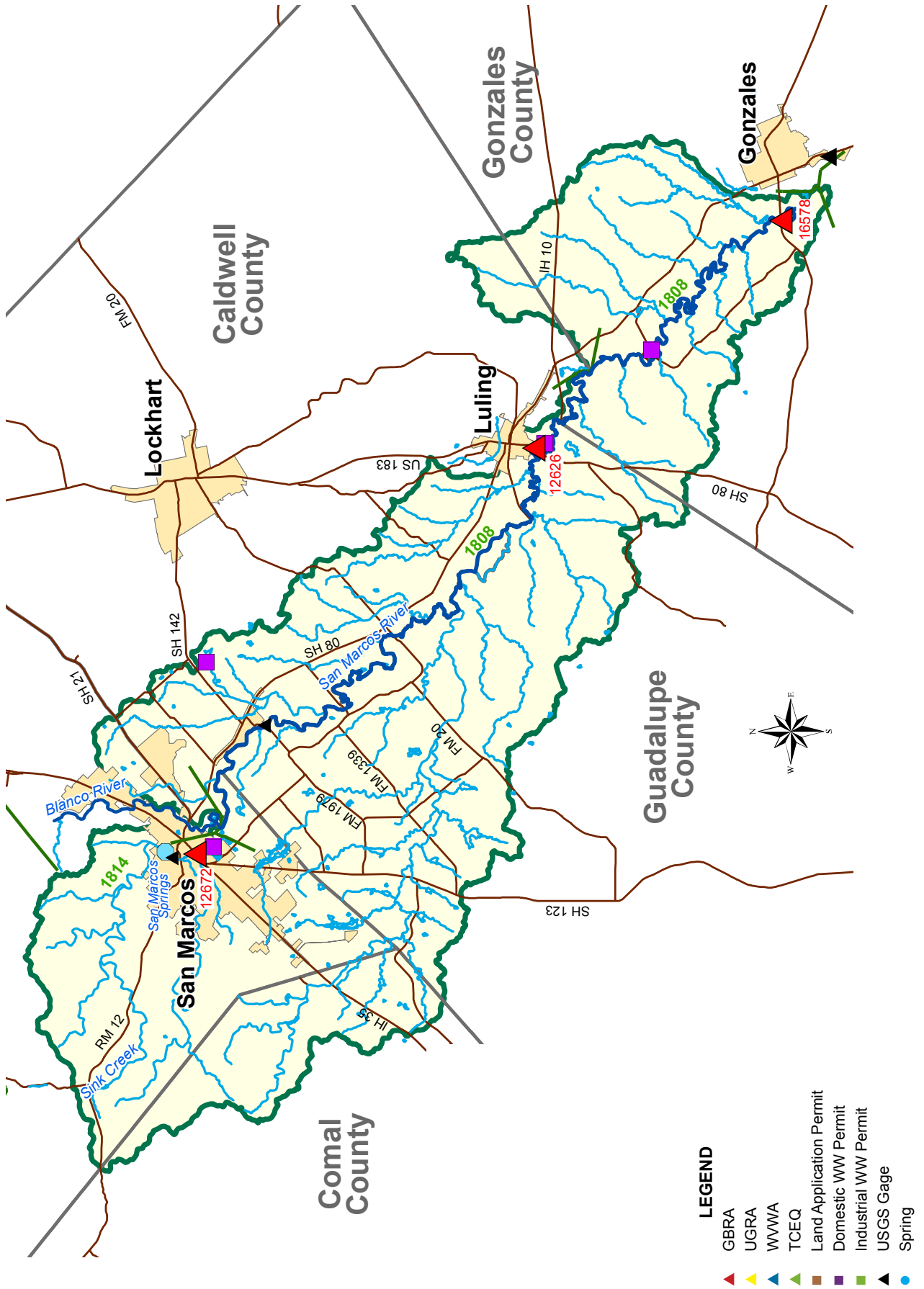
Segment Concerns: Urban and suburban growth (large lot housing developments) along the State Highway 281 corridor between San Antonio and Blanco is a growing concern because of the potential for nonpoint source pollution. Blanco County is a lightly populated county with an estimated 2013 U.S. census population of 10,723, but the population density increases considerably as the river flows into Hays County. Increased suburban growth may lead to additional flow volatility as nonpoint source cover expands and residential pumping increases. Additional stress on the shallow groundwater may reduce base spring flows.

Segment 1815: (Cypress Creek) Cypress is a spring-fed creek that flows for 14 miles upstream of the Village of Wimberley to the confluence with the Blanco River. Cypress Creek is picturesque, with clear water and bald cypress trees growing along the banks. The creek is a popular tourist destination for scenic views and contact recreation activities.

Segment Concerns: The segment is experiencing tremendous residential and commercial suburban growth. Residents are concerned that increased groundwater pumping may affect the discharge of the headwater springs. The current drought has caused Cypress Creek to go dry multiple times over the last few years. Diminished flows from the drought may have been a cause of the recent assessment concerns for depressed dissolved oxygen, impaired biological habitat, impaired fish community and impaired benthic macrobenthic community in the draft *2014 Texas Integrated Report*. Occasional spikes in *E. coli* bacteria concentrations are likely due to faulty septic tanks or urban nonpoint source pollution, such as pet waste. The Meadows Center for Water and the Environment has developed a watershed protection plan for Cypress Creek that has been accepted by the EPA. Modeling of data collected during the watershed characterization phase of the WPP, along with input from stakeholders, was used to determine a list of best management practices that could be utilized to help reduce the bacterial pollution loading in Cypress Creek as the WPP moves into the implementation phase in 2015.

Segment 1809: (Lower Blanco River) Located in the middle of the I-35 corridor from the northern boundary of the City of San Marcos and the southern boundary of the City of Kyle. Concerns include cumulative impacts of watersheds caused by construction and multiple subdivision development. Hays County is one of the fastest growing counties in the United States with a 2010 U.S. census population of 157,112 and an estimated 2013 population of 176,026.

San Marcos River Watershed



San Marcos River Watershed

River Segments, Descriptions and Concerns



Photo by Erich Schlegel

Drainage Area: 522 square miles

Streams and Rivers: Lower San Marcos River, Upper San Marcos River, Sink Creek, York Creek

Aquifers: Edwards-Balcones Fault Zone, Carrizo-Wilcox

River Segments: 1814, 1808

Cities: San Marcos, Maxwell, Martindale, Fentress, Prairie Lea, Luling, Ottine, Gonzales

Counties: Hays, Guadalupe, Caldwell, Gonzales

EcoRegion: Edwards Plateau, Post Oak Savannah, Texas Blackland Prairies

Vegetation Cover: Pasture/Hay 27.0%, Evergreen Forest 12.8%, Shrublands 12.2%, Grass/Herbaceous 16.3%, Deciduous Forest 19.0%, Row Crops 8.6%

Climate: Average annual rainfall 33 inches
Average annual temperature January 40°, July 96°

Land Uses: Urban, industry, agricultural crops (corn, sorghum, hay, cotton, wheat, pecans), cattle and hog production, poultry production, oil production, and recreation

Water Body Uses: aquatic life, contact recreation, general use, fish consumption, and public water supply

Soils: Varies from thin limestone to black, waxy, chocolate, and grey loam

Permitted Wastewater Treatment Facilities: Domestic 4, Land Application 0, Industrial 0

Segment 1814 (Upper San Marcos River) The entire Upper San Marcos River segment includes the flows of the San Marcos down to 0.6 miles upstream of the Blanco River Confluence in Hays County.

Segment Concerns: This spring-fed stream is home to a number of endangered species dependent upon the constancy of clean springflow. During drought conditions, springflow is a concern requiring additional effort to protect these species. The Edwards Aquifer Recovery Implementation Program developed a habitat conservation plan (HCP) to ensure that incidental take will not appreciably reduce the likelihood of the survival and recovery of covered species. Segment 184 is no longer listed for impaired concentrations of total dissolved solids (TDS). The GBRA perceived that the conductivity calculation method of measuring TDS may not have been adequately representing the true concentrations in the upper San Marcos River and began looking at methods to directly measure TDS. The GBRA determined that a laboratory certified filtration and evaporation method would be the best way to examine the true TDS on this waterbody. The GBRA began collecting and analyzing laboratory certified TDS concentrations monthly from October 2010 through August 2013 to test this hypothesis. Analyses of the data over this two year period revealed that the average laboratory TDS values on the Upper San Marcos River were 21% lower than values calculated from specific conductance measurements that were collected at the same time. The GBRA was unable to convince the TCEQ to apply a more representative 0.53 site specific calculation constant on the Upper San Marcos River, because a 0.65 constant is applied universally throughout the state. However, the monthly laboratory TDS values collected and reported by the GBRA for this study were averaged with calculated conductivity values during the TCEQ draft 2014 assessment, which resulted in the removal of the Upper San Marcos River from the list of state impairments. There are currently no other assessed water quality impairments or concerns on this segment.

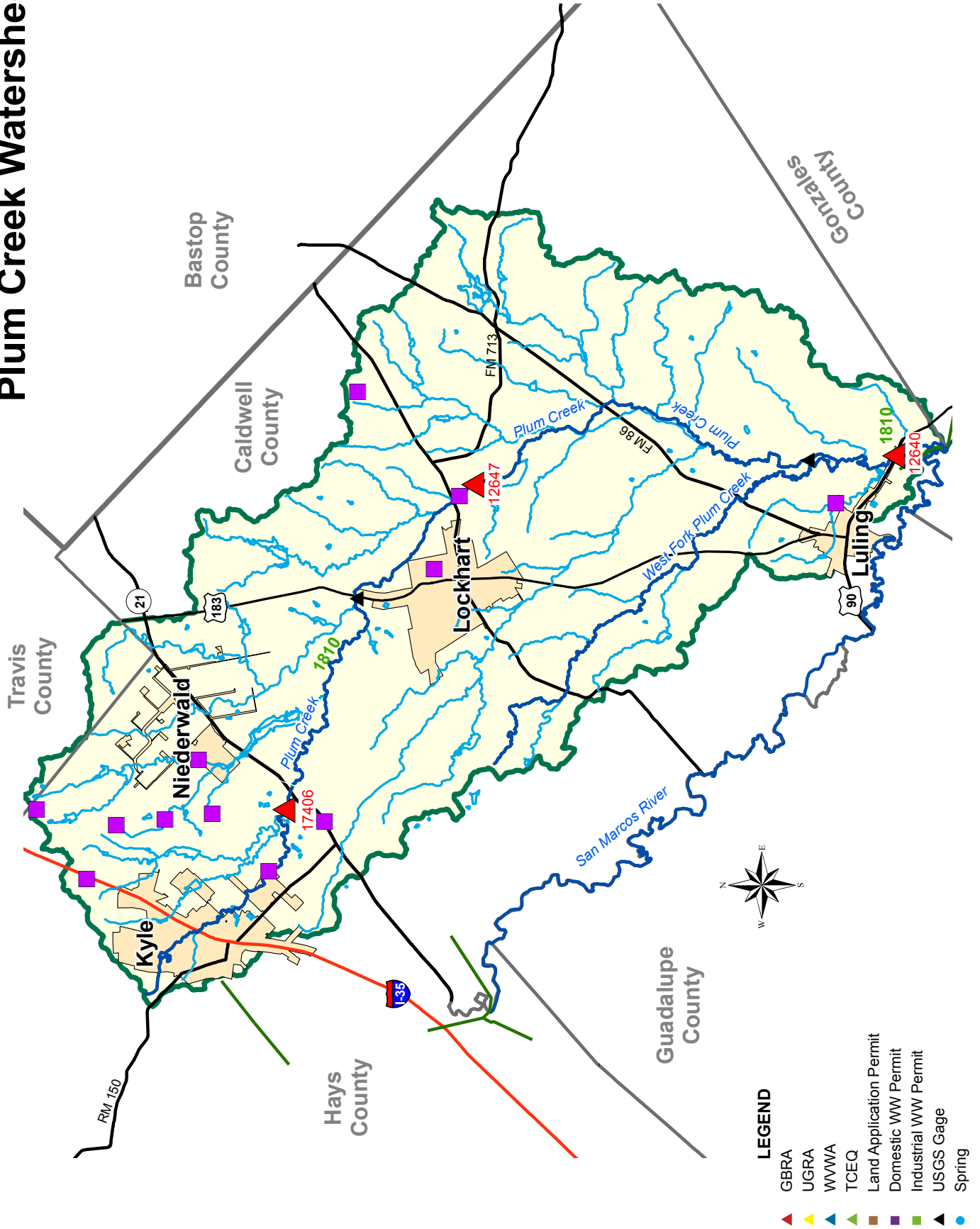
The Meadows Center for Water and the Environment (Texas State University) staff is developing a watershed protection plan for the Upper San Marcos River that should be submitted to the EPA in 2015.

The City of San Marcos is one of the fastest growing municipalities in the country with a 2010 U.S. census population of 44,894 and an estimated 2013 population estimate of 54,076. The City of San Marcos' population has reached the threshold that requires the city to develop a storm water pollution prevention plan (SWPP). San Marcos and Texas State University are developing the SWPP to comply with federal guidelines.

Segment 1808: (Lower San Marcos River) This segment of the San Marcos River with the Blanco River continuing about 75 miles until the point of confluence with the Guadalupe River outside the City of Gonzales. This segment receives flows from Plum Creek near the City of Luling. The lower San Marcos River is a low gradient, smooth flowing river during normal flow.

Segment Concerns: Protecting springflow is a concern during times of drought. Recreational use of the river is increasing as the population of this area expands and local residents have expressed concerns about how the increased traffic may be affecting the designated uses of the river. Residents are particularly concerned with the amount of solid waste litter that is finding its way into the river. Activities related to the production and transportation of petroleum may also pose potential threats to the watershed. There are no assessed water quality impairments or concerns in this segment.

Plum Creek Watershed



Plum Creek Watershed

River Segments, Descriptions and Concerns



Drainage Area: 397 square miles

Streams and Rivers: San Marcos River, Plum Creek, Clear Fork Creek, West Fork Plum Creek

Aquifers: Edwards-Balcones Fault Zone, Carrizo Wilcox

River Segments: 1810

Cities: Kyle, Buda, Uhland, Luling, Neiderwald, Lockhart

Counties: Hays, Travis, Caldwell

EcoRegion: Texas Blackland Prairies, Post Oak Savannah

Vegetation Cover: Deciduous Forest 23.6%, Pasture/Hay 22.9%, Shrublands 11.4%, Grass/Herbaceous 22.4%, Row Crops 14.4%

Climate: Average annual rainfall 33 inches, Average annual temperature January 40°, July 95°

Land Uses: Industry, urban, oil and gas production, cattle, hog and poultry productions, agriculture, crops (sorghum, hay, cotton, wheat and corn)

Water Body Uses: Aquatic life, contact recreation, general use and fish consumption

Soils: Black, waxy soil to sandy soil, limestone to black waxy chocolate and grey loam

Permitted Wastewater Treatment Facilities: Domestic 12, Land Application 0, Industrial 0

Segment 1810: (Plum Creek) Plum Creek begins near FM 2770 upstream of IH-35, in northeastern Hays County. The stream flows 52 miles to the confluence with the San Marcos River south of Luling, in Caldwell County. Plum Creek is usually a shallow, slow moving stream that flows from the Edwards Plateau Ecoregion through the gently rolling hills of the Texas Blackland Prairie. The substrate of the creek is typically made up of hard black clay, the riparian vegetation consists of agricultural fields and scrub oak trees.

Segment Concerns: In 2004, Plum Creek was listed on the state 303(d) list for not meeting its contact recreation use due to elevated bacteria concentrations. Plum Creek also has known general use concerns for having average total phosphorus and nitrate-nitrogen values above the state nutrient screening criteria. The Plum Creek Watershed Protection Plan was developed by the Texas State Soil and Water Conservation Board (TSSWCB) and accepted by the U.S. EPA in 2009 in order to address these impairments.

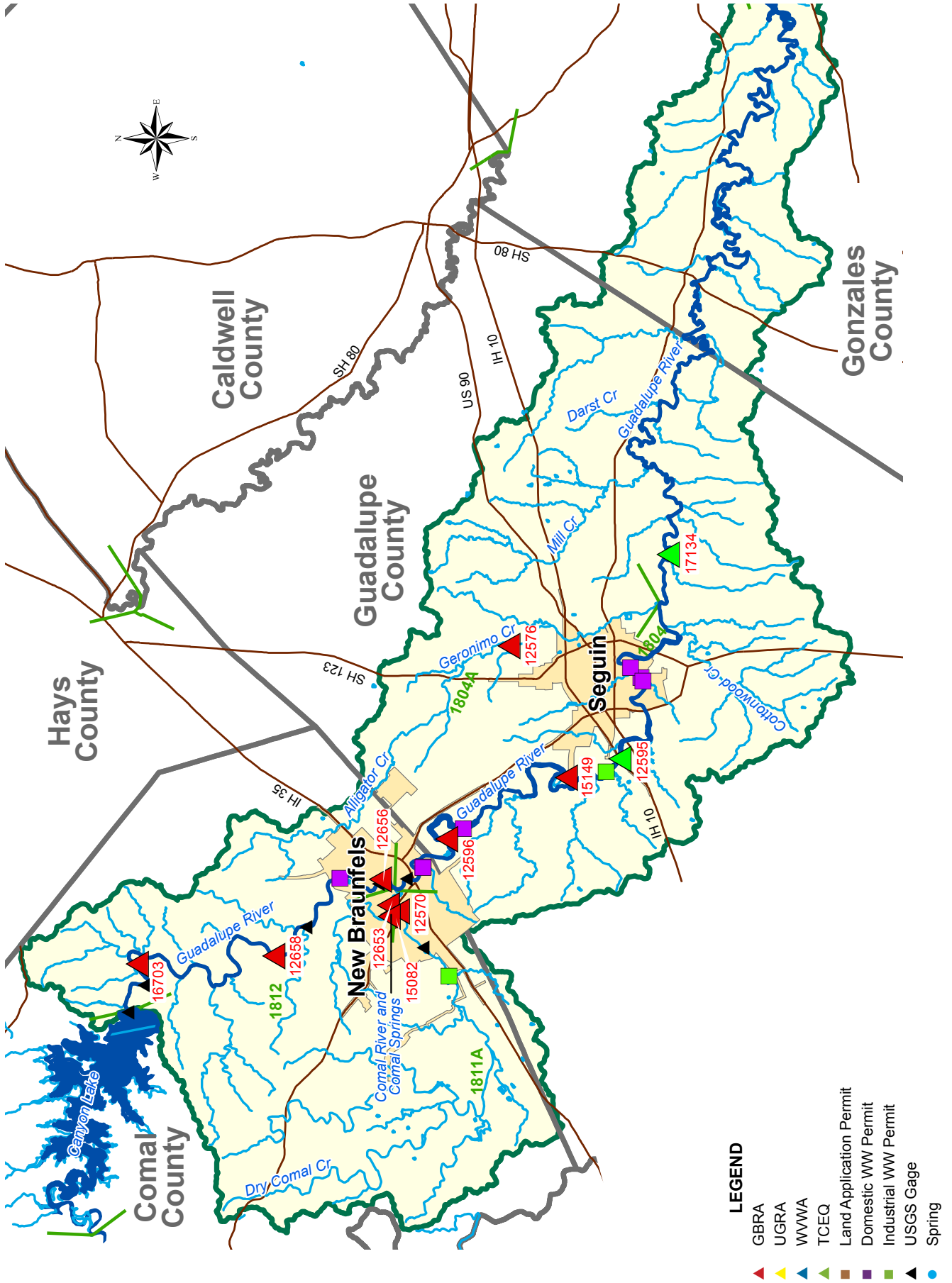
The project has now entered its third phase of implementation and currently includes projects that incorporate best management practices (BMPs) to help remove the pollution load and bring the stream into compliance with stream standards for contact recreation. The creek was originally assigned an assessment category of 5 on the 303(d) list of impairments, which means that the stream did not meet applicable water quality standards. The assessment category for this stream has since changed to 4 with the acceptance of the PC WPP by the EPA, which means that a TMDL will not be required in order to correct the impairments because of the ongoing implementation activities.

The current drought began in 2008 and has been particularly influential on the waters of Plum Creek. During times of drought, Plum Creek is effluent-dominated. These wastewater treatment plant discharges contribute nutrient loading to a stream with known nutrient concerns that are not being diluted by other sources of freshwater. However, during the summer of 2014, all of the tributaries above the City of Lockhart went dry. If it were not for the discharges from these facilities, the creek would have gone dry from the headwaters until it reached the springs near the City of Lockhart. The wastewater contributions to Plum Creek are a double-edged necessity in order to protect the current aquatic life uses of the stream.

The USGS will analyze the nitrate-nitrogen and associated isotopes of nitrogen and oxygen to determine the possible sources of nitrate-nitrogen concentrations in these watersheds (i.e. human, animal or fertilizer). The study is intended to develop a better understanding of the interactions between surface water and groundwater and evaluate strategies for reducing nitrate levels in these water bodies.



Middle Guadalupe River Watershed Part A



Middle Guadalupe Watershed, Part A and B

River Segments, Descriptions and Concerns



Middle Guadalupe Watershed A and B

Drainage Area: 939 square miles

Lakes, Streams and Rivers: Lake Gonzales (H-4), Lake Wood, Guadalupe River below Canyon Dam, Guadalupe River from confluence with the San Marcos River

Aquifers: Carrizo Wilcox, Edwards BFZ

River Segments: 1803, 1804, 1811, 1811(A), 1812

Cities: New Braunfels, Seguin, Gonzales, Cuero

Counties: Comal, Guadalupe, Gonzales, Lavaca, DeWitt

EcoRegions: Texas Blackland Prairies, Post Oak Savannah

Vegetation Cover: Pasture/Hay 25.5%, Grass/Herbaceous 15.1%, Evergreen Forest 18.0%, Shrublands 12.0%, Deciduous Forest 15.5%, Row Crops 8.1%

Climate: Average annual rainfall 29 inches, Average annual temperature January 35°, July 95°

Land Uses: urban, light manufacturing, heavy manufacturing, farming, cattle ranching, poultry, petroleum production, and gravel mining

Water Body Uses: aquatic life, contact recreation, fish consumption, general, public water supply, hydroelectricity, agricultural and industrial

Soils: Dark, calcareous clay, sandy loam, loam with clay subsoils, dark red sandstone, light tan and gray sandstone

Permitted Wastewater Treatment Facilities: Domestic 7, Land Application 1, Industrial 2

Segment 1812: (Guadalupe River below Canyon Reservoir) The Guadalupe River flows from Canyon Dam to the confluence with the Comal River and is considered one of the finest white-water stretches in the state. The rapids are attributed to the change in elevation as the river cuts through the Balcones Fault Zone. The river is scenic, with limestone bluffs, bald cypress, pecan and elm trees. Despite low flow, Trout Unlimited and Texas Parks and Wildlife Department continue to take advantage of cold-water releases from the bottom of Canyon Dam and sponsor the stocking of rainbow trout in the tailrace.

Segment Concerns: Water quality is good with no water quality concerns identified in the 2014 assessment. Releases from Canyon Reservoir can be anoxic in the late summer and early fall. The stilling basin and weirs aerate the water above the stream standard for aquatic life use. Stakeholders raised concerns about the impacts from heavy recreational use. The impacts mentioned are nonpoint source pollution loading (bacteria and trash) associated with the number of recreationists using the area during summer months.

Segment 1804A: (Geronimo Creek) The Geronimo Creek is a spring-fed stream that discharges into the Guadalupe River just downstream of the City of Seguin. Geronimo Creek is approximately 5.7 miles long and has a drainage basin of approximately 41mi².

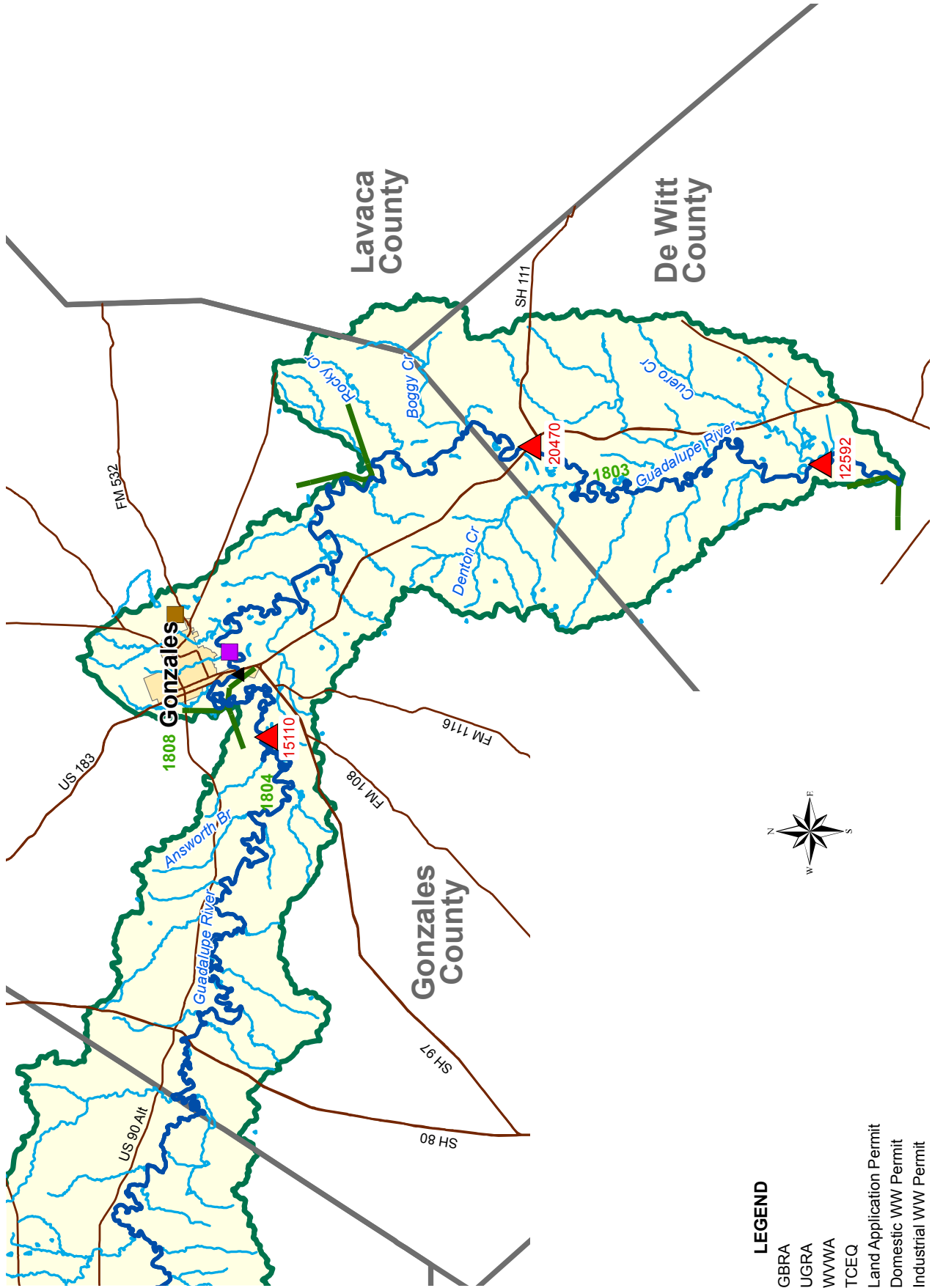
Segment Concerns: Beginning in 2009, and continuing through 2011, GBRA partnered with Texas AgriLife Extension on a Texas State Soil and Water Conservation Board CWA Section 319(h) grant to prepare a watershed protection plan for Geronimo Creek and its tributary, Alligator Creek. The creek was found to be impaired for bacteria and a concern for elevated nitrate-nitrogen. Modeling results have shown there needs to be a 42% reduction in the bacterial load at high flows and a 26% reduction at medium flows in the middle portion of Geronimo Creek to meet the state stream standard. Some management measures stakeholders will be recommending in the watershed protection plan include pet waste stations in urbanized areas and outreach and education focusing on the impacts of pet waste; outreach and education on septic systems; best management practices workshops, such as water quality management plans and riparian management for agricultural producers in rural portions of the county; workshops and distribution of information for landowners on management and control of feral hogs; and financial assistance to the cities to fund engineering for improvements to storm water collection systems.

In 2015 the United States Geological Survey (USGS) will begin collecting data for a Texas State Soil and Water Conservation Board (TSSWCB) contracted study of the groundwater of the Leona aquifer, surface water, precipitation and wastewater discharges in the Plum Creek and Geronimo Creek watersheds. To help direct efforts and funding toward the most likely or most influential source(s) of nitrate, the project will look to isotopic signatures of nitrogen and oxygen in the nitrates. Ratios of the isotopes of nitrogen and oxygen in nitrate are often useful for determining sources of nitrates in groundwater and surface water. The ratios can help determine sources of nitrates in groundwater and surface water. GBRA and TCEQ have established a continuous water quality monitoring station on this water body. Access to the hourly data can be found at www.texaswaterdata.org.

Segment 1811: (Comal River) The 2 ½ mile long Comal River is spring-fed from the Comal Springs (Edwards Aquifer) with no water quality issues. It is the shortest river in Texas and contained entirely within the City of New Braunfels.

Continued on p. 39

Middle Guadalupe River Watershed Part B



LEGEND

- GBRA
- UGRA
- WVWA
- TCEQ
- Land Application Permit
- Domestic WW Permit
- Industrial WW Permit
- USGS Gage
- Spring

Middle Guadalupe Watershed, Part A and B

River Segments, Descriptions and Concerns

Continued from p. 37

Referred to as an island ecosystem, the Comal River has a number of endangered species dependent upon the constancy of clean springflow for their survival. Springflow is a concern during drought conditions. The Edwards Aquifer Recovery Implementation Program began implementation of a scientifically-developed habitation conservation plan (HCP) designed to ensure that incidental take resulting from the covered activities are minimized and mitigated to the maximum extent practicable and will not appreciably reduce the likelihood of the survival and recovery of covered species associated with the aquifer, springs and river ecosystems. The City of New Braunfels is now unofficially the largest city in the Guadalupe watershed with an estimated 2013 population of 63,279. The population of the city has shown a substantial increase from the 2010 census of 57,744.

Segment Concerns: Although there are no water quality concerns identified in the river, GBRA has added a new monitoring location (15082) to this segment in Landa Park upstream of the Dry Comal Creek confluence to help identify the impact of elevated Dry Comal Creek bacteria concentrations on the Comal River.

The ongoing drought led to low springflow from the Edwards Aquifer during the summer of 2014. By late August, springflow levels were down to 65 cfs, which is very low compared to the median flow for the month (260 cfs). In the past, stakeholders have raised concerns regarding non-native invasive plant and fish species within the Comal River system. Non-native species control is currently being addressed through the Edwards Aquifer HCP. Specific HCP measures include the systematic removal of tilapia, armored catfish (and other member of the family Loricariidae), giant ramshorn snail, and Hygrophila (an invasive aquatic plant).

Segment 1811A: (Dry Comal Creek) The Dry Comal Creek is a large watershed that wraps around the City of New Braunfels and discharges into the Comal River. The creek is approximately 35 miles long and encompasses a drainage area of ~111 square miles. The majority of the watershed is dry during most of the year, but there is a small perennial portion of the creek that flows at all times inside of the New Braunfels City limits.

Segment Concerns: The Dry Comal Creek is listed as impaired for bacteria because concentrations exceeded the contact recreation standard in the draft 2014 Texas Integrated Report 303(d) list. The stream was originally listed for this impairment in 2010. This Comal River tributary potentially affects the water quality of the river. The City of New Braunfels has developed a SWMP associated with their Phase II MS4 stormwater permit. Management measures included in the SWMP address stormwater pollution within the City of New Braunfels city limits including the Dry Comal Creek.

Specific minimum protection measures include management of sanitary sewer systems, identification of potential animal sources of concern, an illicit discharge detection program, construction stormwater management program and stormwater management for new development. The City of New Braunfels has also applied for grant funding in order to understand and address bacteria concerns through a stakeholder-based watershed protection planning process.

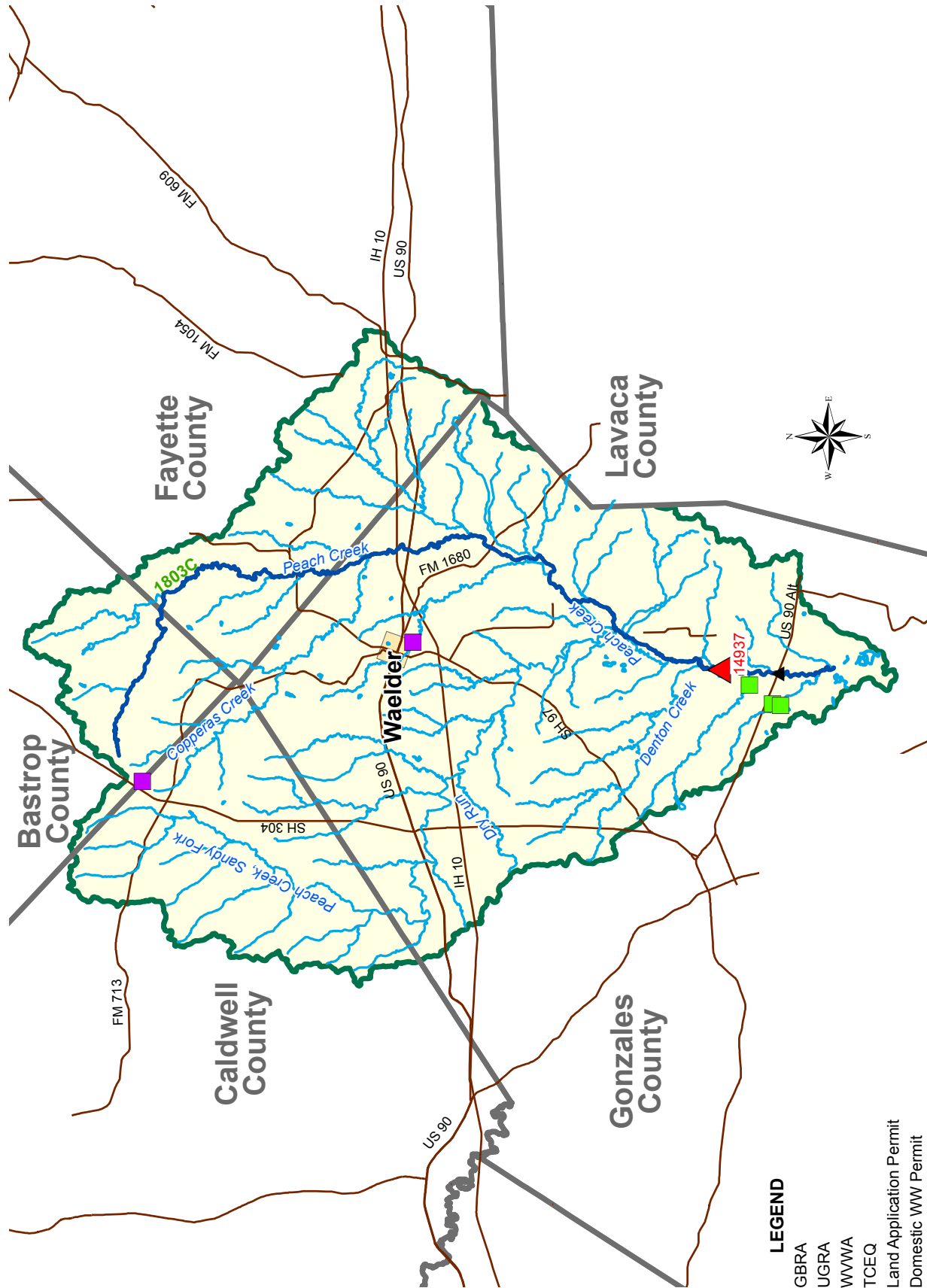
Segment 1804: (Guadalupe River below Comal River) This stretch of the Guadalupe River between the confluence with the Comal River in New Braunfels to the confluence of the San Marcos River in Gonzales is a beautiful flowing river. Seven GBRA hydroelectric facilities utilize elevation changes, creating small lakes widely used for recreation in Guadalupe County. From New Braunfels to below Seguin, the banks of the hydroelectric lakes are lined with private residences, primarily on septic tanks. Guadalupe River hydroelectric lakes have a history of problems created by non-native invasive aquatic macrophytes, such as hydrilla and water hyacinth.

Segment Concerns: In Guadalupe County, downstream of FM 1117, the Guadalupe River had problems with Hydrilla during the summer of 2014. This was likely due to the drought-driven low flows of the river and greatly reduced springflow. The aquatic herbicide Nautique was applied in a low flow section of the river below Seguin and triploid grass carp were released to eat the vegetation.

Segment 1803: (Guadalupe River below San Marcos River) From the point of the confluence of the San Marcos River, the Guadalupe becomes a much larger, slower moving stream as it flows toward the coast. Elevation changes are minimal.

Segment Concerns: A number of poultry farms and cattle ranches are located in the area. To date, there have been no problems in the main segment associated with these land uses, although subwatersheds have been listed as impaired (1803A Elm Creek, 1803B Sandies Creek, 1803C Peach Creek, 1803F Denton Creek and 1803G Sandy Fork). The Eagle Ford Shale Play, located in DeWitt and Gonzales counties, has become one of the richest oil and gas deposits in Texas because of the exploration technology called hydraulic fracturing or “fracking.” Fracking is the process to stimulate wells and recover natural gas and oil by creating fractures that extend from a well bore into formations and allow the product to travel more easily. The fracking solution can be made up of a proprietary mixture of organic chemicals, acids and bases. Concerns have been raised about the impacts that these activities will have on groundwater quality, surface water quality, the quantity of water needed in a water-short area and the potential for spills and loss of containment of chemicals.

Peach Creek Watershed



LEGEND

- GBRA
- UGRA
- WVWA
- TCEQ
- Land Application Permit
- Domestic WW Permit
- Industrial WW Permit
- USGS Gage
- Spring



Peach Creek Watershed

River Segments, Descriptions and Concerns

Drainage Area: 480 square miles

Streams and Rivers: Guadalupe River, Peach Creek, Copperas Creek

Aquifers: Carrizo-Wilcox

River Segments: 1803C

Cities: Waelder, Flatonia

Counties: Caldwell, Bastrop, Fayette, Gonzales

EcoRegion: Texas Blackland Prairies, Post Oak Savannah

Vegetation Cover: Shrublands 13.9%, Grass/Herbaceous 23.4%, Deciduous Forest 34.1%, Pasture/Hay 21.1%

Climate: Average annual rainfall 31 inches, Average annual temperature January 39°, July 94°

Land Uses: Recreation, extensive cattle and poultry productions, light industry and agricultural crops

Water Body Uses: Aquatic life, contact recreation, and fish consumption

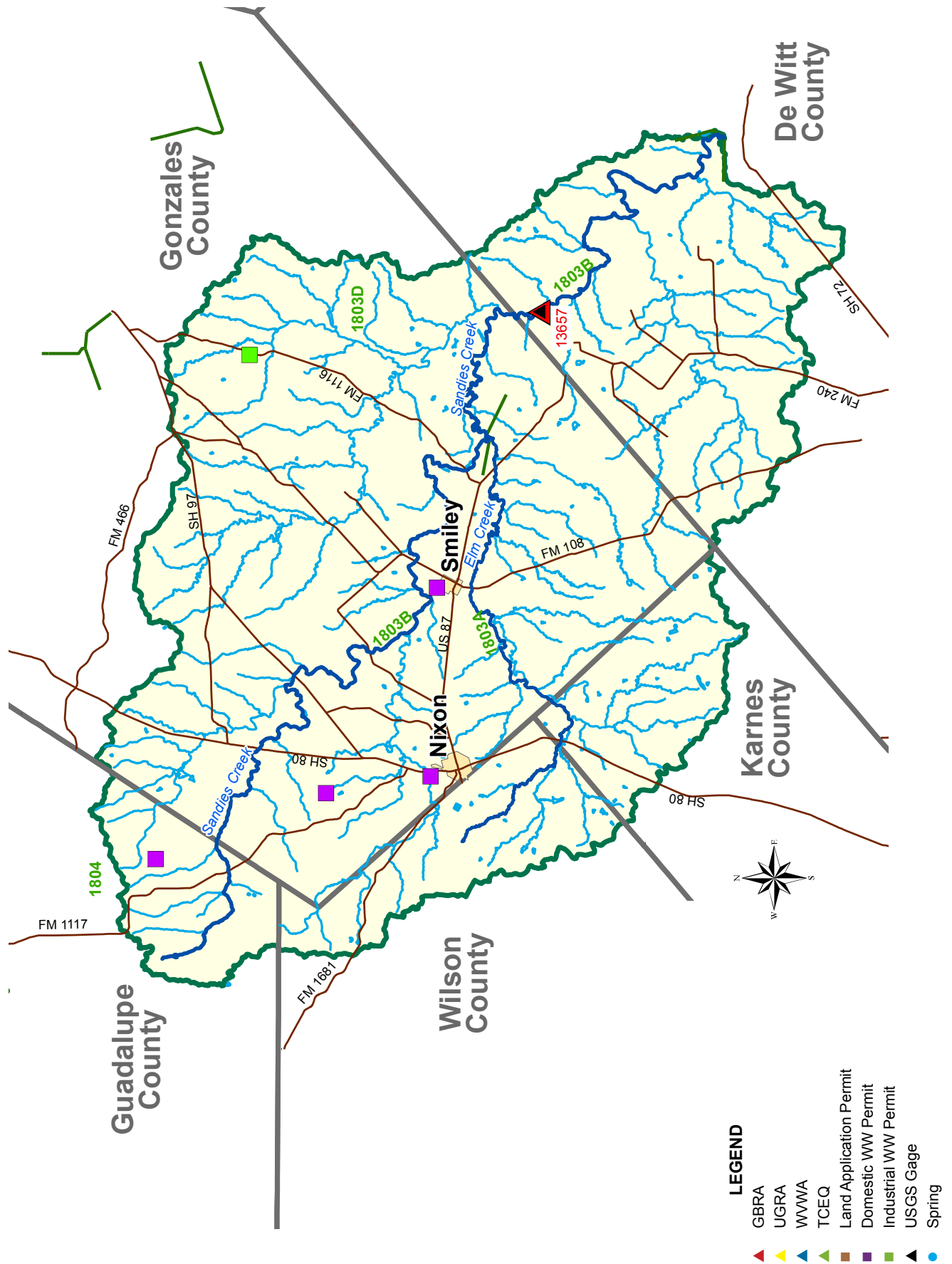
Soils: Dark red sandstone and tan and grey sandstone

Permitted Wastewater Treatment Facilities: Domestic 2, Land Application 0, Industrial 3

Segment 1803C: (Peach Creek, unclassified water body) Peach Creek is a tributary of the Guadalupe River that flows for 64 miles through the gently rolling hills of Bastrop and Fayette counties northeast of Waelder, before reaching the confluence with the Guadalupe River in eastern Gonzales County. The watershed largely consists of undeveloped ranch land and the sandy loam soils of the watershed are dominated by forests of Post Oak, Blackjack Oak, and other hardwoods.

Segment Concerns: Peach Creek was included on the *303(d) List of Impaired Water Bodies* in 2002 because of average bacteria concentrations that exceeded the contact recreation limit. Peach Creek was also found to have impaired dissolved oxygen levels for aquatic life use in 2006. Peach Creek was also found to have a general use nutrient screening criteria concern for elevated chlorophyll-*a* in 2010. A Total Maximum Daily Load (TMDL) has been adopted for Peach Creek, but to date no implementation of best management practices (BMPs) have been initiated to help remove the pollutant loads that were identified in the TMDL. Additional monitoring conducted under the TMDL study also found that the Denton Creek (1803F) and Sandy Fork (1803G) tributaries of Peach Creek had bacteria concentrations that exceeded the contact recreation standard. These tributaries were added to the 303(d) list of impaired water bodies in 2010. The tributaries were subsequently removed from the list in 2014.

Sandies Creek Watershed





Sandies Creek Watershed

River Segments, Descriptions and Concerns

Drainage Area: 711 square miles

Streams and Rivers: Guadalupe River, Elm Creek, Sandies Creek, Five Mile Creek, Salty Creek, Clear Creek, and O'Neil Creek

Aquifers: Carrizo-Wilcox, Gulf Coast

River Segments: 1803A, 1803B

Cities: Smiley, Nixon

Counties: Guadalupe, Karnes, Wilson, Gonzales, DeWitt

EcoRegion: Texas Blackland Prairies, Post Oak Savannah

Vegetation Cover: Pasture/Hay 24.9%, Deciduous Forest 19.6%, Row Crops 3.4%, Grass/Herbaceous 24.3%, Evergreen Forest 5.3%, Shrublands 21.1%

Climate: Average annual rainfall 31 inches, Average annual temperature January 39°, July 94°

Land Uses: Light manufacturing, extensive cattle and poultry production, agricultural crops (hay, sorghum, etc.)

Water Body Uses: Aquatic life, contact recreation and fish consumption

Soils: Dark red sandstone, light tan and gray sandstone

Permitted Wastewater Treatment Facilities: Domestic 4, Land Application 0, Industrial 1

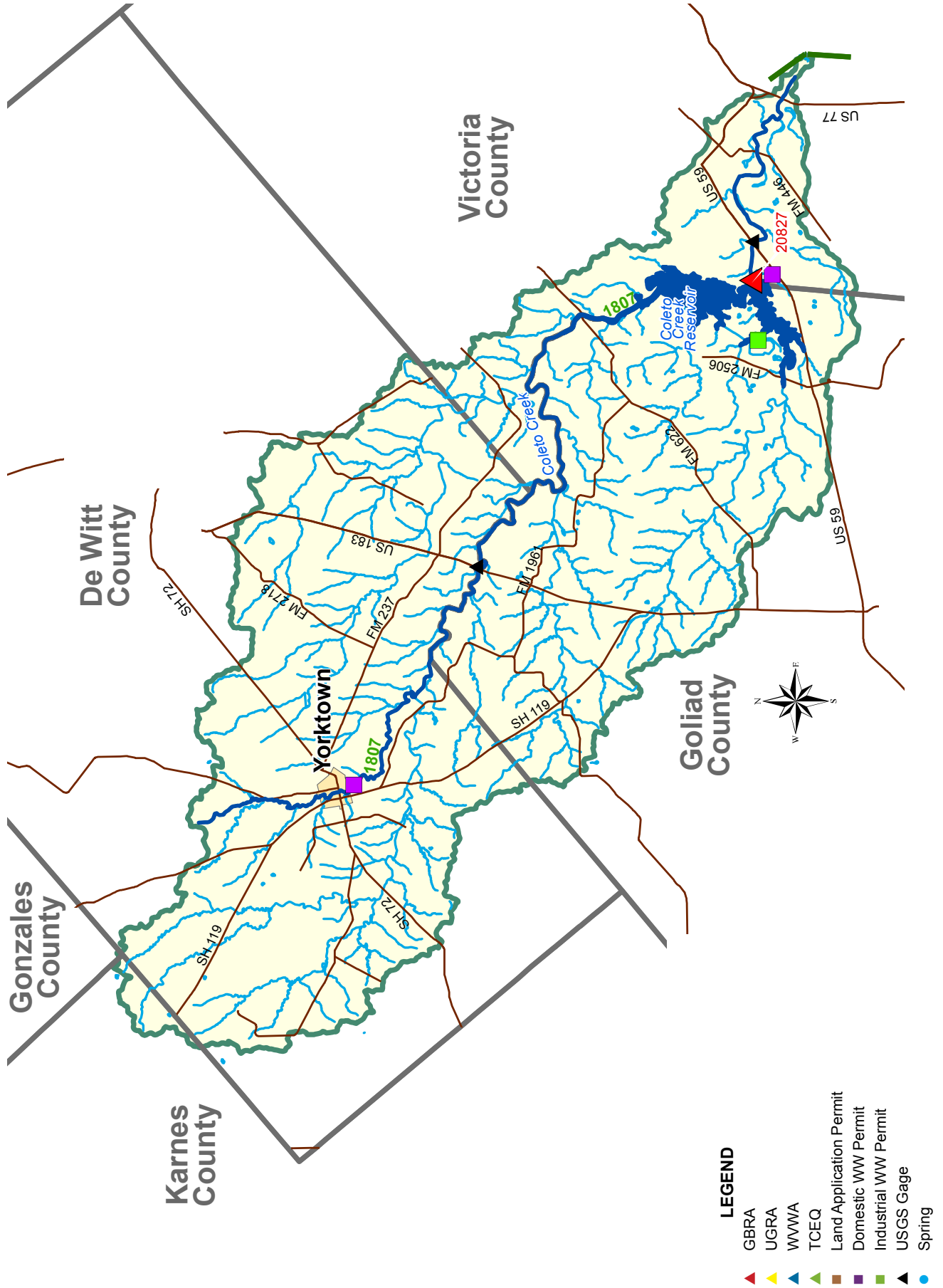
Segment 1803A: (Elm Creek, unclassified water body) Elm Creek flows 24.3 miles before it confluences with Sandies Creek, east of Smiley, in Gonzales County.

Segment Concerns: Elm Creek was listed on the 303(d) list of impaired water bodies in 1999 for impaired aquatic life use due to depressed dissolved oxygen and a concern for chlorophyll-*a*. Elm Creek was included in a Total Maximum Daily Load (TMDL) study, along with Sandies Creek, but as of 2015, the TMDL has not been adopted.

Segment 1803B: (Sandies Creek, unclassified water body) Sandies Creek originates in Guadalupe County northwest of Nixon, although the perennial portion of the creek begins in Gonzales County northwest of Smiley. The stream travels 65 miles to the confluence of the Guadalupe River west of Cuero, in DeWitt County. The name of this water body is aptly applied, as much of the stream bed consists of sandy substrate, which is largely typical of the surrounding Post Oak Savannah Ecoregion.

Segment Concerns: Sandies Creek has been listed on the 303(d) list of impaired water bodies for aquatic life since 1999 due to depressed dissolved oxygen. In 2002, the creek was also listed for impaired contact recreation use because of elevated bacteria concentrations. Additional aquatic life use impairments were assessed for impaired fish community and impaired macrobenthic community in 2010. These additional aquatic life use impairments were most likely a direct result of the depressed dissolved oxygen levels in the creek. Most recently, the draft *2014 Texas Integrated Report*, found that Sandies Creek has a nutrient screening concern for excessive concentrations of chlorophyll-*a*. Sandies Creek and Elm Creek were included in a TMDL study to address the known impairments, but as of 2015, the TMDL has not been adopted. The Eagle Ford Shale Play is one of the richest oil and gas deposits in Texas and uses the fracturing process that has raised concerns on potential impacts it may have on groundwater, surface water, and the quantity of water used in a water-short area and the potential for spills and loss of containment of chemicals.

Coledo Creek Watershed





Coledo Creek Watershed

River Segments, Descriptions and Concerns

Drainage Area: 558 square miles

Streams and Rivers: Guadalupe River, Coledo Creek, Perdido Creek, Twelve Mile Creek, Thomas Creek

Aquifer: Gulf Coast

River Segments: 1807

Cities: Yorktown

Counties: DeWitt, Goliad, Victoria

EcoRegion: Texas Blackland Prairies, Gulf Coastal Plains

Vegetation Cover: Pasture/Hay 15.3%, Shrublands 9.7%, Grass/Herbaceous 33.2%, Deciduous Forest 18.7%, Row Crops 5.0%

Climate: Average annual rainfall 30 inches, Average annual temperature January 41°, July 95°

Land Uses: Agricultural crops (sorghum, rice, cotton and corn), beef, hogs and poultry productions and oil and gas production

Water Body Uses: Aquatic life, contact recreation, fish consumption, public water supply and power plant cooling

Soils: Sandy, sandy loam and clay loam

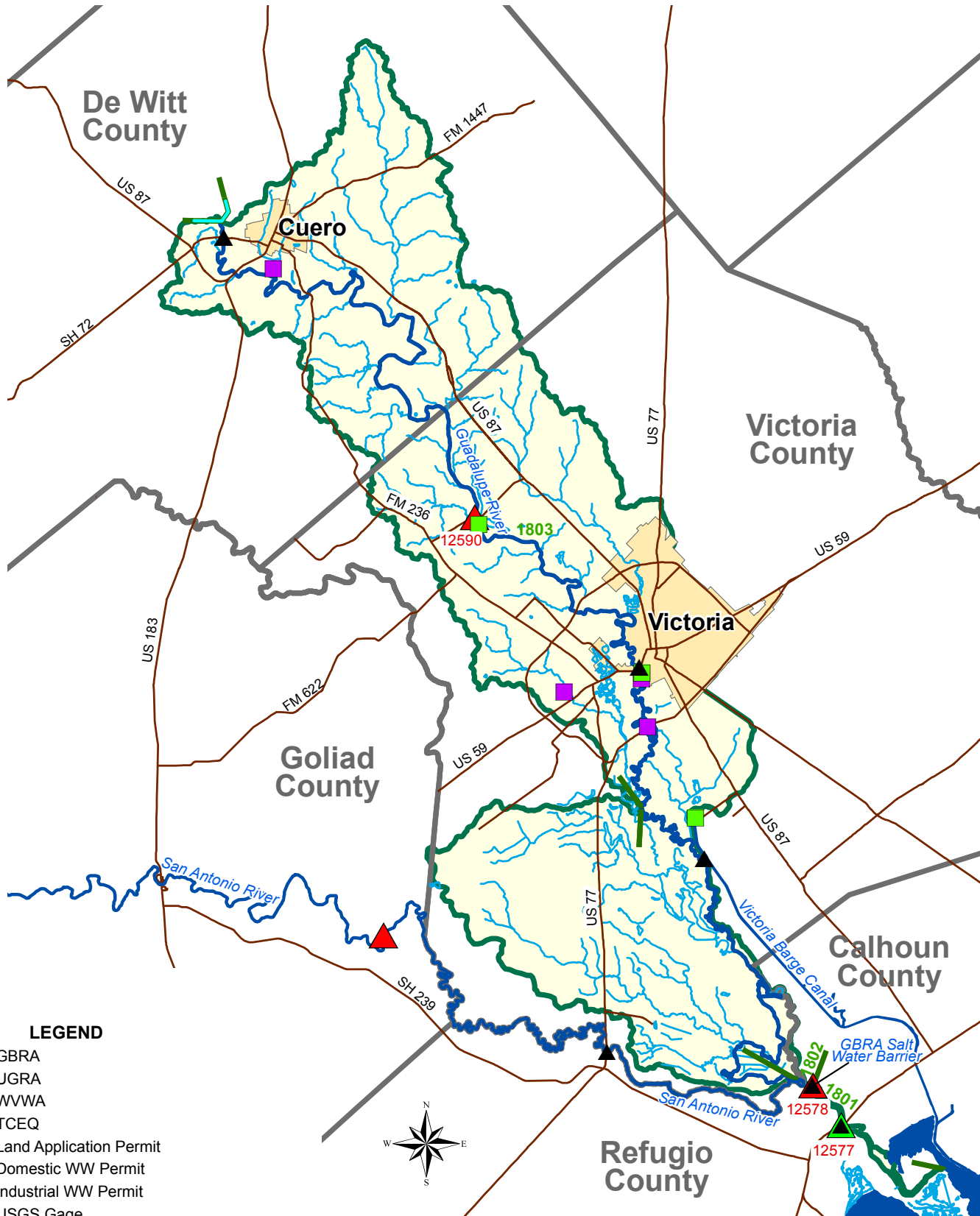
Permitted Wastewater Treatment Facilities: Domestic 2, Land Application 0, Industrial 1

Segment 1807: (Coledo Creek) Coledo Creek extends 27 miles beginning in Dewitt County, through Goliad and Victoria Counties, including the 3100-acre Coledo Creek Reservoir to the confluence with the Guadalupe River in Victoria County. The size of Coledo Creek's drainage basin can turn this normally slow moving creek into a fast flowing river during a typical South Texas rainstorm. Much of the creek bottom is sandy, with typical vegetation ranging from brush trees such as mesquite and huisache to large live oaks and anacua trees. The rural setting and limited development of this watershed you can still find a wide range of Texas wildlife along its shores ranging from turkey and deer, to red fox and bobcats. The completion of the Coledo Creek Reservoir provided habitat to support over 100 different species of birds, such as the Southern Bald Eagle, Osprey, and Roseate Spoonbills.

Segment Concerns: Coledo Creek Reservoir is used as for cooling water by a coal-fired power plant. This use may affect the aquatic life of the reservoir (temperature, dissolved oxygen, excessive aquatic macrophytes). The EPA issued a 2014 rule under section 316(b) of the Clean Water Act establishing a new limit to the number of fish that can be killed by impingement at a cooling water facility and allowing the facility to determine what technology to use to meet that standard. This new standard only applies to cooling water facilities that pull at least 2 million gallons per day (MGD) water and the Coledo Creek Power Station is currently evaluating its applicability to their operations.

Stakeholders remain concerned about the possible impacts of proposed in-situ groundwater uranium mining activities in the northwest portion of Goliad County. The area of concern is located in the recharge zone of the Evangeline component of the Gulf Coast Aquifer. Residents fear that the recent issuance of an EPA mining permit to Uranium Energy Corp. (UEC) will lead to contamination of surface water and underground drinking water supplies in the area. Other activities that may impact water quality in the area include increased oil field mining, new subdivision development and the introduction of invasive aquatic plants.

Lower Guadalupe River Watershed



Lower Guadalupe River Watershed

River Segments, Descriptions and Concerns



Drainage Area: 488 square miles

Streams and Rivers: Guadalupe River Tidal, Guadalupe River below San Antonio River, Guadalupe River below San Marcos River, Sandies Creek, Elm Creek, Coleta Creek, Spring Creek, McDonald Bayou

Aquifers: Carrizo-Wilcox, Gulf Coast

River Segments: part of 1803, 1802, 1801, 1701

Cities: Cuero, Victoria, Tivoli

Counties: Calhoun, Refugio, Victoria, DeWitt

EcoRegion: Gulf Coastal Plains, East Central Texas Plains

Vegetation Cover: Pasture/Hay 14.8%, Shrublands 21.1%, Row Crops 4.2%, Grass/Herbaceous 22.6%, Evergreen Forest 5.7%, Wetlands 10.2%, Deciduous Forest 14.8%

Climate: Average annual rainfall 37.4 inches, Average annual temperature January 53°, July 84°

Land Uses: Urban, agricultural crops (cotton, corn, wheat, rice, hay, grain sorghum), cattle and hog productions, industrial (plastics, chemicals, petrochemicals)

Water Body Uses: Aquatic life, contact recreation, general, fish consumption, heavy industrial and public water supply

Soils: Cracking clay subsoil, sandy, sandy and clay loam

Permitted Wastewater Treatment Facilities: Domestic 4, Land Application 0, Industrial 3

Segment 1803: (Guadalupe River below San Marcos River) From the point where the San Marcos River confluences with the Guadalupe River in Gonzales, Segment 1803 becomes a twisting, slow-moving coastal river, lined with pecan bottoms, with no rapids of any consequence. This portion of Segment 1803 begins to the west of the City of Cuero, flowing south to the west of the City of Victoria, to immediately upstream of the confluence with the San Antonio River. Minor tributaries that combine with the Guadalupe River in this portion of the watershed include Peach Creek, Sandies Creek and Coleta Creek.

Segment Concerns: In 2012, preliminary study design began on an in depth scientific study of the flows necessary to support a sound ecosystem on the Lower Guadalupe River. The Texas Instream Flow Program (TIFP) was enacted by the legislature under Texas Senate Bill 2. More information about this process can be found on page 22 of this report.

A general use nitrate-nitrogen concern was identified in the draft *2014 Texas Integrated Report* on the lower 25 miles of this segment. The average nitrate-nitrogen value was assessed at 8.47 mg/L, which was more than four times the nutrient screening level of 1.95 mg/L. The elevated nitrate concentrations were not identified in the additional 50 miles of this segment located upstream of the confluence with Coleta Creek.

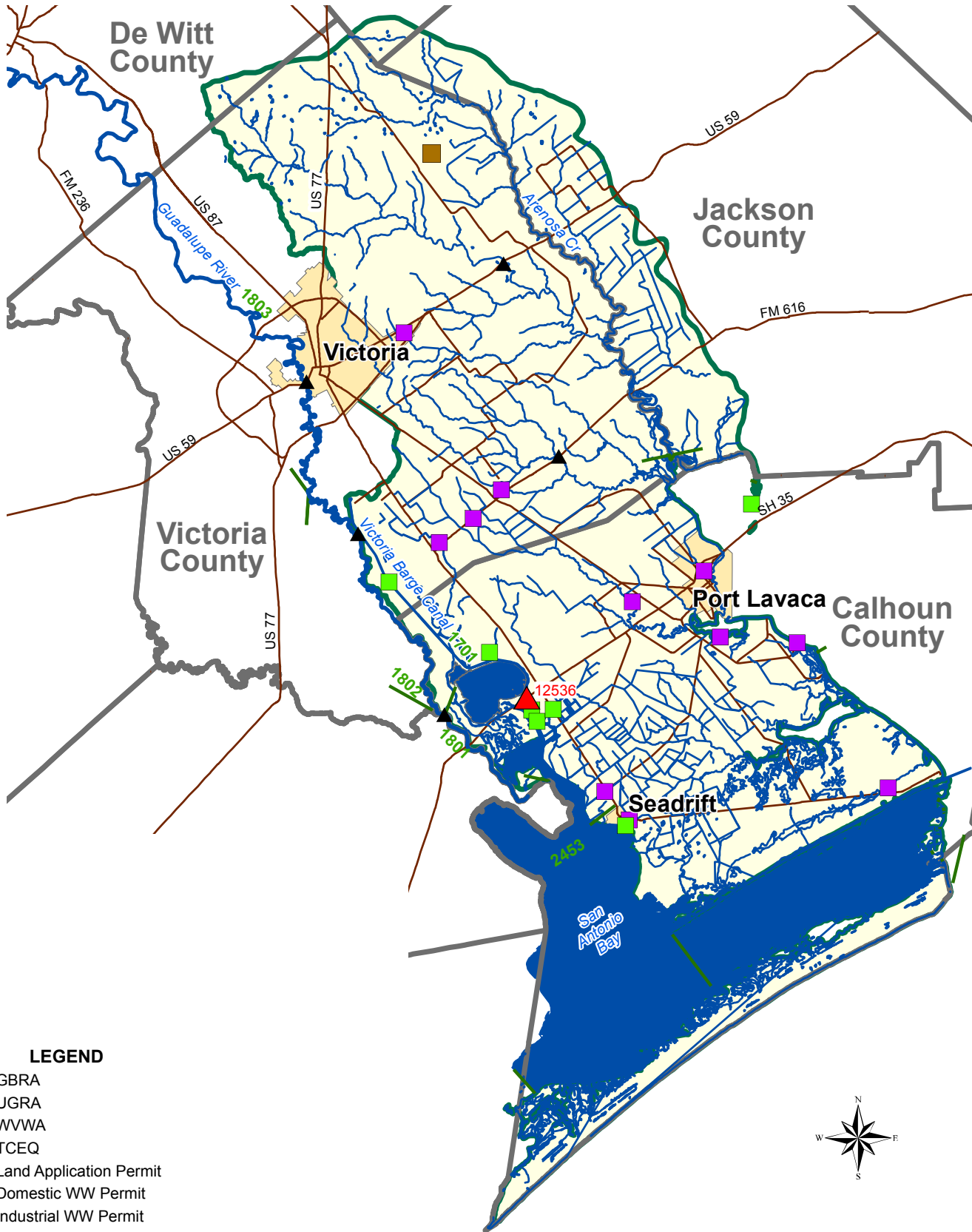
Segment 1802: (Guadalupe River below San Antonio River) This 0.4 mile long stretch between the confluence of the San Antonio and Guadalupe Rivers to the GBRA Salt Water Barrier is a typical slow moving coastal river. Following the confluence with the San Antonio River the watershed drainage expands from 5,979 square miles to 10,172 square miles and the average yearly flow of the Guadalupe River below this point increases by approximately 40%.

Segment Concerns: The draft *2014 Texas Integrated Report* assessed a mean concentration of 3.13 mg/L of nitrate-nitrogen for this segment, which exceeded the general use nutrient screening level criteria of 1.95 mg/L.

Segment 1801: (Guadalupe River Tidal) This tidally influenced portion of the Guadalupe River is prone to frequent log jams. The logs that travel downstream catch on bridges, railroad crossings and other obstructions creating restrictions to water flow, changes in the river channel, and producing new ecosystems. The floodplain can often extend several miles outside of the stream banks. The Senate Bill 3 stakeholder process has recommended instream flows for the Guadalupe and San Antonio rivers and inflows into the bays and estuaries in the lower basin. TCEQ has since established environmental flow requirements for the Guadalupe and San Antonio rivers using stakeholder recommendations. The ongoing Senate Bill 2 Texas Instream Flow Program (TIFP) will provide additional scientific data to the TCEQ in order to further refine the environmental flow requirements for the future and facilitate adaptive management strategies.

Segment Concerns: The draft *2014 Texas Integrated Report* assessed a mean concentration of 2.47 mg/L of nitrate-nitrogen for this segment, which exceeded the general use nutrient screening level criteria of 1.10 mg/L.

Guadalupe-Lavaca Coastal Basin



LEGEND

- ▲ GBRA
- ▲ UGRA
- ▲ WWWA
- ▲ TCEQ
- Land Application Permit
- Domestic WW Permit
- Industrial WW Permit
- ▲ USGS Gage
- Spring



Photo by John Snyder

Lavaca-Guadalupe Coastal Basin

River Segments, Descriptions and Concerns

Drainage Area: 998 square miles

Streams and Rivers: Guadalupe River, Garcitas Creek, Victoria Barge Canal, Mercado Creek, Arenosa Creek

Aquifer: Gulf Coast

River Segments: 1701

Cities: Victoria, Seadrift, Bloomington, Inez, Port O'Connor, Port Lavaca

Counties: Calhoun, Victoria, Jackson

EcoRegion: Gulf Coastal Plains

Vegetation Cover: Pasture/Hay 15.1%, Shrublands 16.9%, Row Crops 21.4%, Grass/Herbaceous 13.7%, Deciduous Forest 8.4%, Wetlands 17.2%

Climate: Average annual rainfall 42 inches, Average annual temperature January 44°, July 93°

Land Uses: Agriculture row crops (cotton, corn, rice and grain sorghum), urban, recreation, oil and gas production, cattle, hog and poultry production and industry (plastics, chemicals, petrochemicals)

Water Body Uses: Aquatic life, non-contact recreation, fish consumption and industrial cooling

Soils: Clay subsoils, deep black soil, sandy clay, dark clay loam, clay

Permitted Wastewater Treatment Facilities: Domestic 11, Land Application 1, Industrial 7

Segment 1701: (Victoria Barge Canal) The 35 mile long Victoria Barge Canal was completed in 1968. The barge canal was constructed to provide a navigable waterway from the Victoria Turning Basin in Victoria County to the Gulf Intracoastal Waterway (GIWW) at the confluence with the San Antonio Bay in Calhoun County. This waterway provides a route for barge traffic to reach the Port of Victoria without the need to deal with the frequent log jams and course changes in the Lower Guadalupe River. The canal was originally constructed 9 feet in depth and 100 feet in width, but was expanded from 1995 to 2002 to a depth of 12 feet and a width of 125 feet.

Segment Concerns: The draft *2014 Texas Integrated Report* identified general use concerns for chlorophyll-*a* and nitrate-nitrogen. Chlorophyll-*a* concentrations were assessed at a mean value of 39.34 mg/L, which exceeded the nutrient screening criteria of 11.60 mg/L by more than three times. Elevated chlorophyll-*a* values are usually linked to excessive algal growth in the water body. Algae biomass is dependent upon available nutrients and may be affected by the nitrate-nitrogen concern for this segment. The average nitrate-nitrogen concentration was assessed at 0.72 mg/L, which was four times greater than the nutrient screening criteria of 0.17 mg/L. Nutrient screening levels are more restrictive on the tidally influenced barge canal than in most freshwater waterways.

Upper Guadalupe River Authority 2014 Highlights



In 2014, the Upper Guadalupe River Authority (UGRA) continued working towards implementing measures to address the bacteria impairment in the Upper Guadalupe River. A portion of the Upper Guadalupe River was first listed as impaired for *E. coli* bacteria in 2002 and TCEQ adopted One Total Maximum Daily Load (TMDL) for Bacteria in Guadalupe River above Canyon Lake (Segment 1806) in 2007. In 2011, UGRA partnered with the City of Kerrville, Kerr County, and the Texas Department of Transportation to implement the Bacteria Reduction Plan for the Upper Guadalupe River through a Clean Water Act Section 319(h) grant from TCEQ. The ultimate goal of this project is to reduce bacteria concentrations in the Upper

Guadalupe River to levels that meet the contact recreation criteria defined in the Texas Surface Water Quality Standards. The Bacteria Reduction Plan includes strategies to address the primary sources of bacteria pollution that have been identified in this section of the Guadalupe River including birds nesting on bridges, large flocks of domestic waterfowl congregating in the lakes, septic systems, and pollution from general urban runoff. 2014 marked the third and final year that the Bacteria Reduction Plan received grant funding from TCEQ and much progress was made to implement the management measures outlined in the Plan. More information on the Bacteria Reduction Plan can be found on page 51.



UGRA's Bacteria Reduction Plan Measures Success

In August 2014, UGRA, in cooperation with the City of Kerrville, Kerr County, and TXDOT, completed a three year grant from TCEQ to implement measures to reduce bacteria concentrations in the Upper Guadalupe River. The following is a summary of milestones achieved throughout the course of the three year project:

- ✿ Bird deterrent netting installed on three sections of the SH16 bridge in Kerrville.
- ✿ 72 surveys conducted to monitor presence of waterfowl, other wildlife and recreation in the impaired reach.
- ✿ 42 water quality monitoring events conducted (438 bacteria samples collected).
- ✿ City of Kerrville invested over \$7 million in improvements to wastewater collection system.
- ✿ The installation of 22 pet waste stations throughout the watershed was funded. 4,247 pounds of pet waste collected in Flat Rock Park stations.
- ✿ Interactive kiosk with nonpoint source pollution education programs in use in community.
- ✿ Numerous presentations conducted highlighting nonpoint source pollution and watershed stewardship.

- ✿ Three UGRA Annual River Clean Ups conducted and a total of 919 participants removed 24,495 pounds of trash.
- ✿ UGRA River Crossing Clean Up Program removed 59,740 pounds of trash.
- ✿ Two local groups initiated citizen run routine clean ups.
- ✿ Four public service announcements developed and aired on local radio stations.
- ✿ Publications for homeowners with septic systems developed and distributed.
- ✿ Storm drain marking program initiated.
- ✿ Community-wide waterfowl management planning initiated.
- ✿ City of Kerrville conducted 1,243 hours of street sweeping.

The most notable achievement, however, came in December 2014 when TCEQ release the draft *2014 Texas Integrated Report*. For the first time in 12 years, the portion of the Guadalupe River flowing through the City of Kerrville was listed as fully supporting recreational use based on *E. coli* bacteria testing results! UGRA and other local entities remain committed to protecting and improving water quality and will continue to implement management measure identified in the Bacteria Reduction Plan. For more information visit <http://www.ugra.org/projects.html>

TAKE CARE OF YOUR SEPTIC SYSTEM AND IT WILL TAKE CARE OF YOU

Check for signs of system failure:

- Slowly draining sinks and toilets
- Gurgling sounds or backups in the plumbing
- Sewage odors
- Areas in the yard that remain wet during dry times
- Patches of excessive grass or plant growth

If you see signs of failure, schedule an inspection and repairs immediately.

For questions about your system or for a list of licensed professionals, contact the Kerr County Environmental Health Department (830) 896-9020.

Brought to you by the UGRA Bacteria Reduction Plan in partnership with Kerr County. Financed through grants from the Environmental Protection Agency through the Texas Commission on Environmental Quality.

THE DO's of Septic Systems

- ✓ DO learn the location of your septic system and drainfield. Keep a sketch of it with your maintenance records for service visits.
- ✓ DO keep a detailed record of repairs, pumpings, inspections, permits issued, and other maintenance activities.
- ✓ DO have your septic system inspected annually.
- ✓ DO have your septic tank pumped out regularly by a licensed professional.
- ✓ DO keep your septic tank cover accessible for inspections and pumpings. Install risers if necessary.
- ✓ DO call a professional whenever you experience problems with your system, or if there are any signs of system failure.
- ✓ DO conserve water to avoid overloading the system. Be sure to repair any leaky faucets or toilets.
- ✓ DO divert other sources of water, like roof drains and house footing drains, away from the septic system.
- ✓ DO contact the Kerr County Environmental Health Department (830-896-9020) with questions about your system or for a list of licensed professionals.

To learn how your aerobic or conventional septic system works visit: www.ugra.org/septic.html

Brought to you by the UGRA Bacteria Reduction Plan in partnership with Kerr County. Financed through grants from the Environmental Protection Agency through the Texas Commission on Environmental Quality.

THE DON'Ts of Septic Systems

- ✗ DON'T go down into a septic tank. Toxic gases are produced by the natural treatment processes in septic tanks and can kill in minutes. Extreme care should be taken when inspecting a septic tank, even when just looking in.
- ✗ DON'T allow anyone to drive or park over any part of the system.
- ✗ DON'T plant anything over or near the drainfield except grass. Roots from nearby trees or shrubs may clog and damage the drain lines.
- ✗ DON'T dig in your drainfield or build anything over it, and don't cover the drainfield with a hard surface such as concrete or asphalt. The area over the drainfield should have only a grass cover. The grass will not only prevent erosion, but will help remove excess water.
- ✗ DON'T use septic tank additives. These products usually do not help and some may even be harmful to your system.
- ✗ DON'T use your toilet as a trash can or pour harmful chemicals and cleansers down the drain. Harsh chemicals can kill the beneficial bacteria that treat your wastewater.
- ✗ DON'T use a garbage disposal excessively. Garbage disposals will increase the amount of solids in the septic system.

Take care of your septic system and it will take care of you.

UGRA EDUCATION CONSERVATION

As the lead water resource planning agency for the Upper Guadalupe River Basin, UGRA partners with municipal and county governments, communities, civic groups, and citizens to preserve and protect the water quality in all Kerr County surface waterbodies.



As an active partner in the Texas Clean Rivers Program, UGRA performs routine, quarterly sampling at ten sites in Kerr County and one site in Kendall County. UGRA also monitors tributaries to the Guadalupe River through the County Wide Goal Based Monitoring Program. This UGRA funded program monitors the same parameters as the Clean Rivers Program in order to increase the number of sites that are monitored routinely in the upper Guadalupe River so that water quality concerns can be addressed proactively.

UGRA's Summer Swimability Program provides information on current water quality conditions for local citizens. Samples for *E. coli* bacteria analysis are taken at 21 sites on a weekly basis from Memorial Day to Labor Day. The results are compared to state standards for contact recreation and are posted on the UGRA website.

UGRA provides opportunities for citizen stewardship and community involvement in protecting the water resources of Kerr County. A popular activity is the UGRA Volunteer Summer Study. This program is supported by interested members of the community who collect samples for *E. coli* bacteria analysis each summer. The information collected by the volunteers provides important data and helps identify areas in need of further investigation while including the community in water quality monitoring.

Central to these water monitoring programs is the nationally accredited UGRA Environmental Laboratory, a full service laboratory serving the entire Hill Country. The Laboratory's analytical services include bacteriological, chemical, and biological testing of drinking water, wastewater, and surface water. The Laboratory is accredited according to the National Environmental Laboratory Accreditation Program and is one of the largest microbiological laboratories in the region.

Conservation and Preservation Efforts

UGRA is committed to the elimination of trash from the river and actively solicits and promotes community involvement in its Trash-Free Initiative. UGRA arranges for and funds routine clean ups at fifteen low water crossings across the county. Over 27,600 pounds of trash was removed from these low water crossings in 2014.

Another cornerstone of the Trash-Free Initiative is UGRA's Annual River Clean Up, a county wide event to promote awareness of the importance of the Guadalupe River to the community and its proper stewardship. In 2014, more than 6,500 pounds of garbage was collected by 312 participants, working along the river from above Hunt, all the way to Center Point.

UGRA partners with other local entities for hazardous material spill containment and clean up. Absorbent hazmat socks and pillows are provided to area fire departments and the environmental health department to aid them in their efforts to contain and clean up oil



Photo by Lauren Young

and gas spills in and near the Guadalupe River.

UGRA promotes landowner practices that have the potential to enhance groundwater and surface water resources. UGRA currently offers financial incentives to eligible landowners to aid their brush management efforts. Additionally, UGRA has constructed four water and sediment control basins in the upper part of the watershed. These structures will improve

water quality and quantity by capturing flood flows which will reduce the amount of sediment that enters the river and also supplement spring flow by slowing releasing water over time. Please contact UGRA for more information on either of these programs.

UGRA also sponsors a rebate program to promote water conservation and watershed stewardship through rainwater harvesting. The Rainwater Catchment System Rebate Program is available to anyone with a Kerr County address and reimburses eligible applicants up to \$50 per calendar year.

Public Education to Raise Awareness of the Importance of the Guadalupe River

Part of UGRA's mission is to actively facilitate the understanding of water issues and engage the community in maintaining and promoting the health and enjoyment of the Upper Guadalupe River Basin.

UGRA has an active education program designed to give Kerr County residents a better understanding of the Upper Guadalupe River and its watershed. UGRA staff prepares presentations for area schools, clubs, organizations and summer camps to teach about water quality, conservation, the water cycle, and the importance of the Guadalupe River to the community. UGRA publishes a monthly column in local newspapers

about water quality, the aquatic environment and has an active public awareness campaign to keep the community informed on water issues. The Major Rivers water education program is distributed to 4th and 5th grade teachers in Kerr County to aid their lessons on the water cycle, conservation and Texas water resources through a joint effort by UGRA and Headwaters Groundwater Conservation District.

UGRA is a resource and advocate for the community on water quality, surface water, and the Guadalupe River. Please contact UGRA with comments, questions or concerns at (830) 896-5445 or visit www.ugra.org.

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