

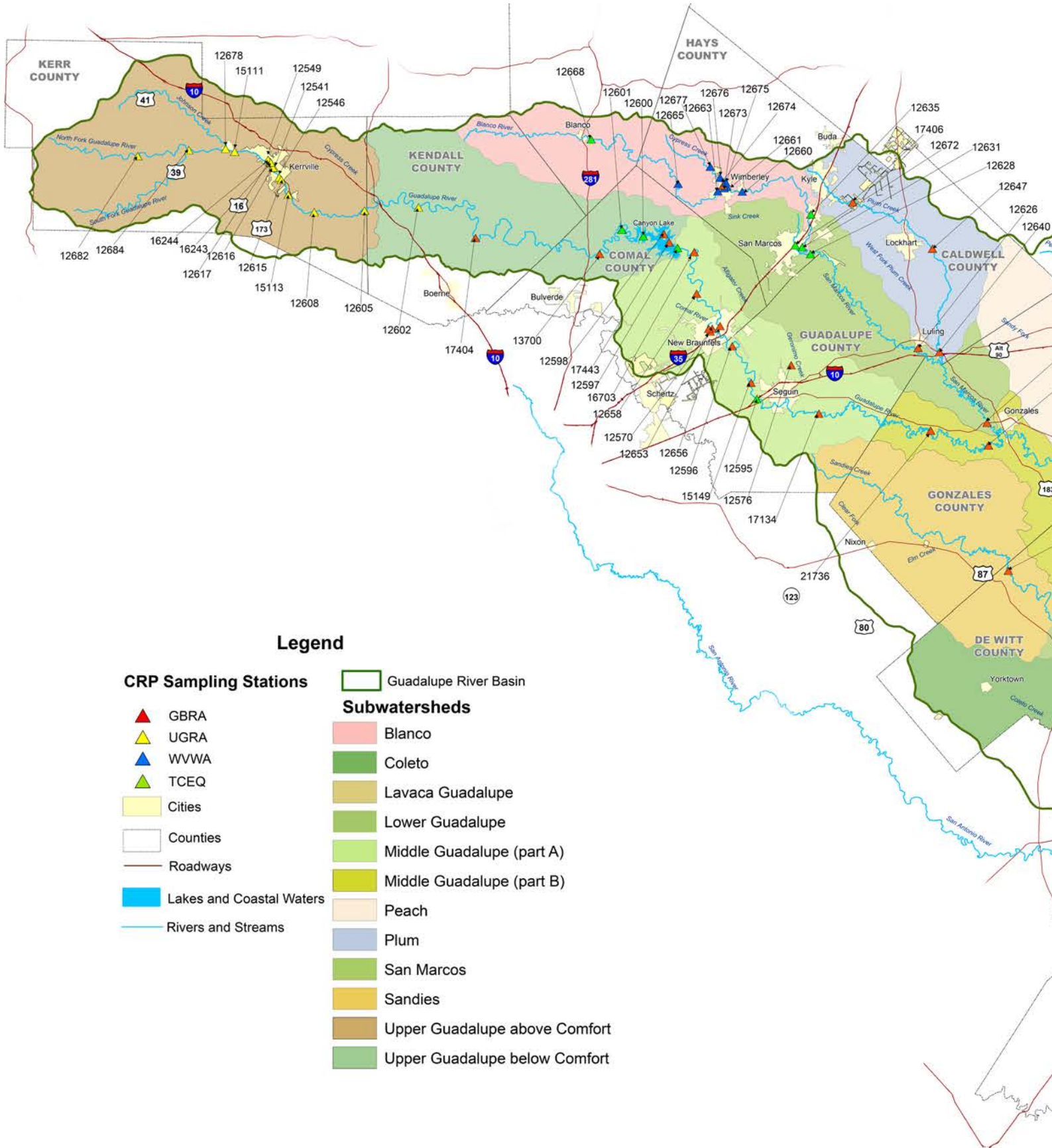


CLEAN RIVERS PROGRAM

2016

**GUADALUPE RIVER and
LAVACA-GUADALUPE COASTAL BASINS**

**BASIN
HIGHLIGHTS
REPORT**



Legend

CRP Sampling Stations

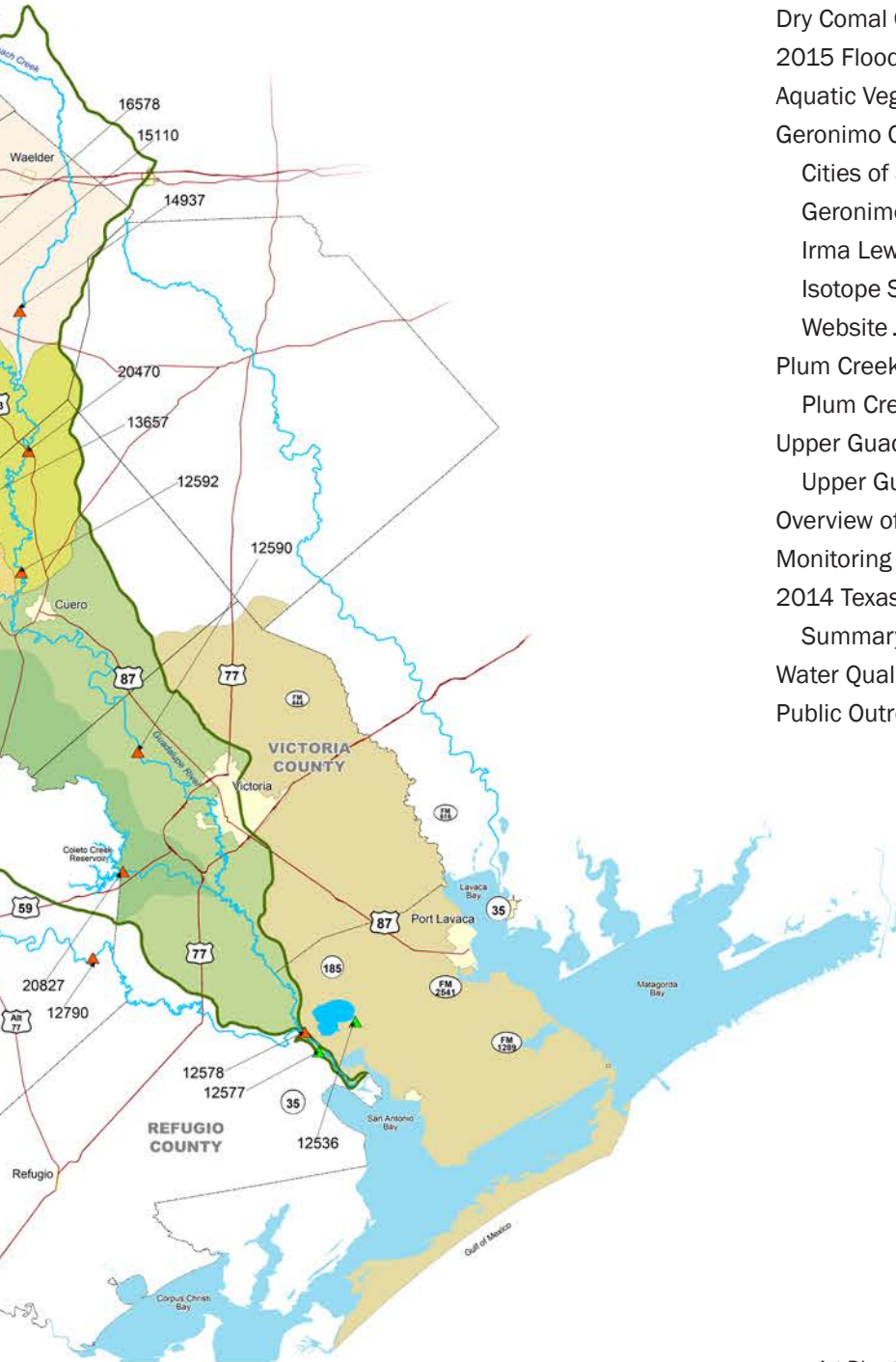
- ▲ GBRA
- ▲ UGRA
- ▲ WWVA
- ▲ TCEQ
- Cities
- Counties
- Roadways
- Lakes and Coastal Waters
- Rivers and Streams

Subwatersheds

- Blanco
- Coledo
- Lavaca Guadalupe
- Lower Guadalupe
- Middle Guadalupe (part A)
- Middle Guadalupe (part B)
- Peach
- Plum
- San Marcos
- Sandies
- Upper Guadalupe above Comfort
- Upper Guadalupe below Comfort

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CLEAN RIVERS PROGRAM

2016

BASIN HIGHLIGHTS REPORT

GUADALUPE RIVER and LAVACA-GUADALUPE COASTAL BASINS

This report highlights the 2015 activities of the Guadalupe River Basin and the Lavaca-Guadalupe Coastal Basin under the Clean Rivers Program (CRP) in 2015. The CRP is managed by the Texas Commission on Environmental Quality (TCEQ). The state-wide program is funded by the fees assessed to water rights and wastewater discharge permit holders. These fees are consolidated by the TCEQ and provided to the CRP partners for the administration of each river basin's program. 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 TCEQ. The activities described in this report include water quality monitoring, a review of the 2014 Texas Integrated Report of Surface Water Quality, public communication, watershed planning and stewardship activities. Information on other water quality studies, planning efforts and events that could affect water quality are also included in this years *Basin Highlights Report*.



The Year's Highlights

The year 2015 was a very wet year for the Guadalupe River Basin. The majority of the basin received several more inches of rainfall than normal in the first few months of the year. This was followed by an

extremely large rain event in the northern portion of the watershed on Memorial Day weekend. From May 23-25, 2015, parts of Kendall, Hays, Blanco and Comal counties received over 13 inches of rain.

Due to the saturated soil conditions from previous rain events, this historic rainfall caused extensive flash flooding throughout the upper portions of the watershed. The San Marcos River and Blanco River were especially hard hit. The Blanco River in Wimberley rose nearly 35 feet within a four-hour

By Lee Gudgell, GBRA Water Quality Technician

period and peaked at 44.90 feet on May 25, 2015. This volume of water resulted in an historic United States Geological Survey (USGS) estimated streamflow of 175,000 cubic feet per second on the Blanco River. The San Marcos River also rose to more than 40 feet at the USGS gaging station near Martindale. This extreme flooding resulted in devastating damage and loss of life and property. Flooding continued to influence water quality in the affected watersheds for months after the event due to large amounts of debris in the waterways. Information about the Memorial weekend flooding can be found on page 6.



GBRA has been working with the Texas Parks and Wildlife Department (TPWD), Gonzales County and local landowners to perform invasive plant treatment and removal activities on Lake Wood and Lake Gonzales in Gonzales County. Nuisance



macrophytes have impeded recreational uses and navigation on these water bodies and have been targeted for removal through a variety of means. Treatments primarily have been directed towards hydrilla and water hyacinth. More information about aquatic plant treatments can be found on page 7.

UGRA continues to provide CRP monitoring and public outreach services in Kerr County. The majority of UGRA activities in 2015 focused on the implementation of the Upper Guadalupe River bacteria reduction plan. Additional details about the UGRA and associated bacterial reduction activities can be found on page 14.

Several watershed protection projects (WPPs) were active in the Guadalupe River watershed in 2015. Watershed planning projects address all sources and causes of

impairments and threats to both surface and groundwater within a watershed. WPPs integrate activities and prioritize Best Management Practices (BMPs) that are based on their technical merit and load reductions along with their benefit to the community. These types of planning efforts voluntarily address complex water quality problems that cross multiple jurisdictions rather than follow political subdivisions, such as county lines or a cities' extraterritorial jurisdictions.

GBRA and the Geronimo and Alligator Creeks Stakeholder Committee continued monitoring and implementation activities identified by the WPP on Geronimo Creek and its tributary, Alligator Creek. This WPP continues to receive funding from the Texas State Soil and Water



Conservation Board (TSSWCB) and is facilitated by the Texas AgriLife Extension Service. This watershed extends from the headwaters of

Alligator Creek in a highly urbanized area of Comal County to the confluence of Geronimo Creek and the Guadalupe River near the city of Seguin. More information about the Geronimo and Alligator Creek WPP can be found on page 8.

GBRA continues to work with the Plum Creek Watershed Partnership to perform monitoring and implementation activities on



Plum Creek in Hays and Caldwell Counties. This WPP was written in 2008 to address a bacteria impairment identified in the 2004 TCEQ 303(d) list of impaired water bodies. Implementation and monitoring activities to address the bacteria impairment and associated nutrient concerns continue to occur in the watershed. Ongoing activities in 2015 included an illicit discharge monitoring survey in the city of Lockhart, a nitrate isotope identification monitoring project, feral hog removal and stream cleanup activities. More information regarding the Plum Creek WPP and ongoing management activities can be found on page 12.

The Highlights continued

The city of New Braunfels has begun work with the TCEQ and local stakeholders on the Comal River and Dry Comal Creek to develop a WPP for these areas to reduce bacteria concentrations. More information on watershed planning activities in these watersheds can be found on page 5.

The Meadows Center for Water and the Environment has been working on several WPP activities in the Guadalupe River Basin. The Cypress Creek has assessed aquatic life use concerns for depressed dissolved oxygen and impaired biological habitat. The Cypress Creek WPP was developed by the Meadows Center, the TCEQ and local stakeholders to address known and future concerns in this unique spring-fed watershed. The final draft of the plan was completed on October 12, 2015, and the plan was accepted by the United States Environmental Protection Agency (USEPA) on November 17, 2015. The Cypress Creek WPP is awaiting implementation funding to begin addressing remediation activities in the watershed.

The Meadows Center began development of a WPP with TCEQ on the Upper San Marcos River in 2012. This plan was developed to address 2010 impairment for total dissolved solids

(TDS) on the 303(d) list along with preventative concerns related to bacteria, nutrients, and suspended sediments. The impairment for TDS was removed from the 303(d) list in 2014 when the Texas Integrated Report of Surface Water Quality showed that TDS concentrations in this stream segment were meeting water quality standards. Despite the assessed improvement in water quality, planning activities have continued as a proactive measure to reduce the likelihood of future impairments in the face of rapid population growth.

In 2015, project staff completed water quality monitoring and created a draft BMP and load reduction report incorporating monitoring modeling and monitoring data.

The common thread of these community-based watershed planning activities is the CRP. Data that has been collected under the CRP has identified the segments in the Guadalupe River Basin that are impaired or have concerns. When BMPs are implemented in impaired water bodies, it will be the monitoring conducted by the CRP that will help to determine the effectiveness of the BMPs that are implemented.

The CRP water quality monitoring program provides quality-assured data that is used to characterize the watersheds, identify impairments or threats to water quality and provide a sound scientific basis for implementation and evaluation of BMPs.



Dry Comal Creek and Comal River Watershed Protection Plan

By Mark Enders, Watershed Coordinator with the City of New Braunfels

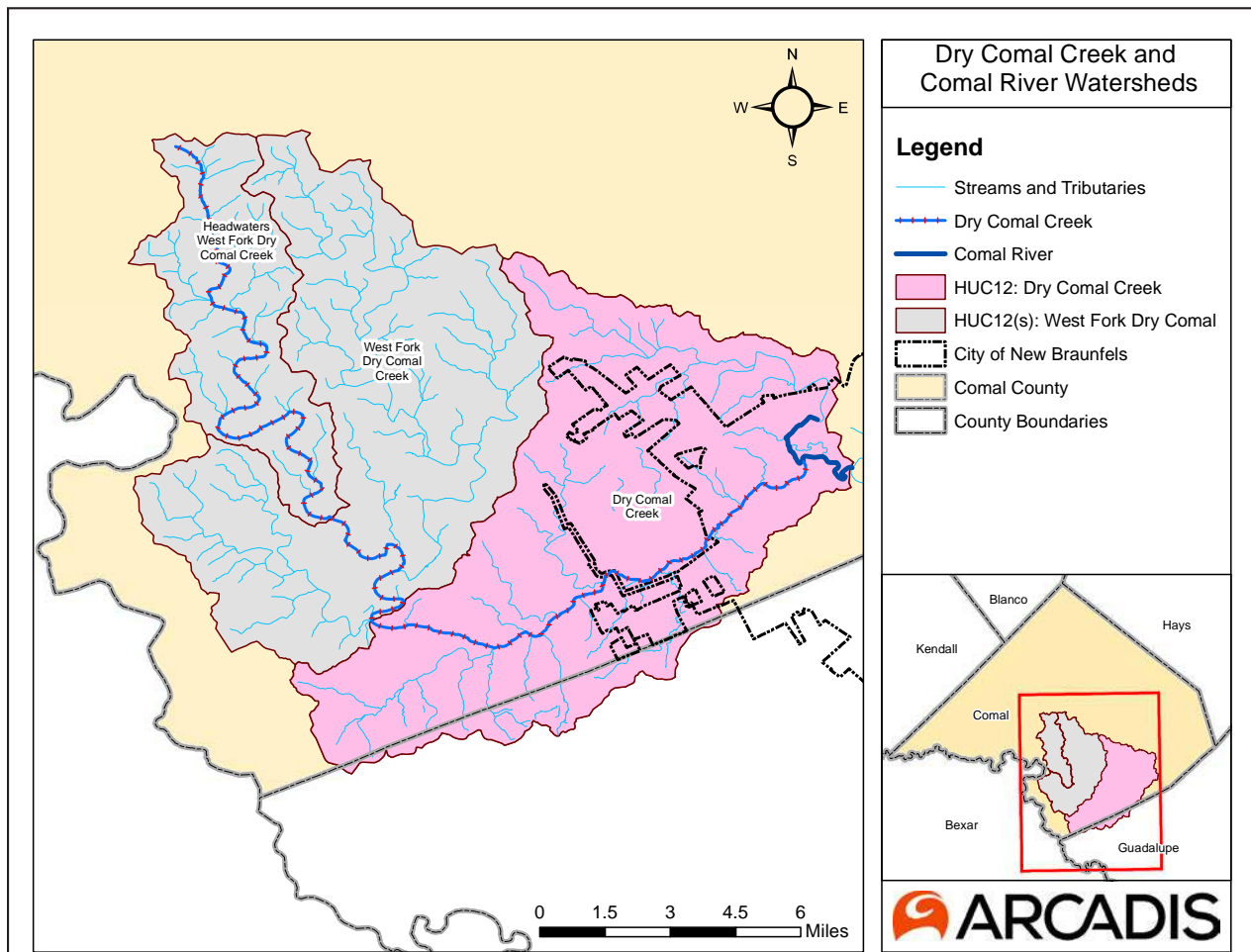
Segment 1811 & 1811A: (Comal River and Dry Comal Creek) The Dry Comal Creek is a 34-mile long tributary of the Comal River, with a large 110-square-mile drainage area, which begins in northern Comal County and extends to the center of New Braunfels. The Dry Comal is intermittent for the majority of its length, but accepts spring flows for the last mile of its journey before it merges with the Comal River.

The Comal River is the shortest navigable river in Texas with a total length of 2.5 miles. The entire river is contained within the City of New

Braunfels. The Comal River is fed by springs from the Edwards Aquifer and is home to several endangered species. The clear temperate waters of the Comal are widely used for recreational swimming and tubing activities before discharging into the Guadalupe River.

The city of New Braunfels is currently moving forward with the development of a Watershed Protection Plan (WPP) to address bacteria concerns in the Dry Comal Creek and Comal River watersheds. The development of the Dry Comal Creek-Comal River WPP has been

broken into two phases in order to best utilize available Clean Water Act Section 319 grant funds. Phase One of the Dry Comal Creek-Comal River WPP kicked off in August 2015 and includes efforts to characterize the watershed, assemble a working stakeholder group and define bacteria load reductions needed to meet applicable water quality standards for bacteria. Phase Two will involve continued stakeholder involvement, identification of bacteria management measures, and development of a WPP. Phase Two of the Dry Comal Creek-Comal



Dry Comal Creek and Comal River Watershed Protection Plan continued

River WPP will commence as Phase One is completed and grant funding is secured through the Texas Commission on Environmental Quality (TCEQ). The Dry Comal Creek-Comal River WPP project team includes staff from the city of New Braunfels, ARCADIS consultants and the Guadalupe-Blanco River Authority (GBRA).

Historical data collected by GBRA as part of ongoing Clean Rivers Program (CRP) sampling identified Dry Comal Creek (Segment 1811A) as impaired for bacteria. Segment 1811A was initially included on the 303(d) list in 2010. In 2011, the city of New Braunfels proactively initiated a bacteria monitoring program on Dry Comal

Creek to supplement data collected at Station 12570 (Dry Comal Creek at Seguin Street) as part of the CRP monitoring conducted by GBRA. The city of New Braunfels also initiated a supplemental bacteria monitoring program on the Comal River to address increasing bacteria levels in the Comal River watershed. A preliminary bacteria source tracking (BST) analysis was conducted in 2013 to help identify potential bacteria sources on the Dry Comal Creek and Comal River. The preliminary BST analysis indicated significant contributions from wildlife. In 2014, GBRA added a new monitoring location (Station 15082) on the Comal River in Landa Park, upstream of the confluence with

Dry Comal Creek, to help identify the impact of elevated Dry Comal Creek bacteria concentrations on the Comal River. The project team is using all existing water quality data from the Dry Comal Creek and Comal River to support water quality modeling efforts and to help identify bacteria loading trends.

The city of New Braunfels and the project team is looking forward to working with local stakeholders and partners to solidify the WPP and to ultimately improve water quality within the Dry Comal Creek and Comal River watersheds.



2015 Flooding

Following multiple years of drought conditions in the Guadalupe River watershed, the State Climatologist reported the month of May 2015 was the wettest May on record for state-wide precipitation in Texas. Intense rains on May 25 in the upper watershed caused the Blanco River to crest at record flood levels. The previous flood of record in Wimberley was exceeded by more than 11 feet in this event, causing severe damage to property, infrastructure, and riparian vegetation. The San Marcos and Guadalupe rivers crested at major flood levels in all downstream communities as these flood waters traveled downstream. Canyon Reservoir crested more than 18 feet

above its conservation pool elevation of 909 mean sea level (msl) during this event as a result of heavy rainfall in the Upper Guadalupe River watershed. Flood releases from Canyon Reservoir continued for several weeks until the July 4 holiday to bring the reservoir back down to its conservation pool.

Intense rains again fell in the Guadalupe River watershed on the morning of October 30, leading to flooding along the IH-35 corridor and in downstream communities. The city of New Braunfels had escaped flooding in the May event due to the flood control benefits of Canyon Reservoir. However, the October rainfall occurred in the watershed below Canyon Dam, leading to flooding along River Road and through New Braunfels. Floodwaters caused severe

damage along Cypress Creek in Wimberley, an area that also had not seen flooding in the May event. The city of Kyle experienced extensive flooding in this event as a result of approximately 10 inches of rain that fell in the Upper Plum Creek watershed over a period of 3 hours. Several homes in San Marcos and Martindale were flooded for the second time in 2015, with the October flood cresting just a few inches shy of May's record flood levels in these areas.





Aquatic Vegetation Control

The Guadalupe-Blanco River Authority (GBRA) has participated in aquatic vegetative control efforts since 1997. In 2015, Texas Parks and Wildlife Department (TPWD) performed several water hyacinth and hydrilla surveys along the Guadalupe River. After the surveys were conducted, TPWD developed survey maps that outlined the location and surface area in acres for the invasive aquatic vegetation species.

On April 14, 2015, TPWD staff performed a hydrilla survey on Lake Wood (H-5) and found approximately 65 acres of hydrilla. Hydrilla is a species native to Asia and was introduced to the United States in the 1950s through the aquarium trade. Hydrilla is undesirable because it can crowd out native species of aquatic plants and is capable of impeding irrigation and boating activities. However, flooding along the Guadalupe River in May

of 2015 created high sustained flow conditions, where the majority of the hydrilla population was removed from Lake Wood by the summer of 2015 without the need for herbicidal treatment. The absence of the hydrilla population in both lakes was confirmed by a follow-up survey by the TPWD in February of 2016.

On June 17, 2015, TPWD performed a water hyacinth survey on Lake Wood and Lake Gonzales (H-4) and found 52 acres of water hyacinth on Lake Wood and 44 acres of water hyacinth on Lake Gonzales. Water hyacinth is native to the Amazon River in South America and was introduced to the United States in the late 1800s through the aquarium trade. Water hyacinth affects fish communities by lowering light penetration and oxygen levels in the lake. Heavy infestations of water hyacinth can clog waterways and impede boat traffic as well. A follow-up survey was scheduled to

be conducted in February of 2016 to determine the effects of the treatment.

In the spring of 2015, GBRA met with several landowners along Lake Wood and Lake Gonzales and with TPWD personnel to discuss the future invasive aquatic vegetation surveys and plan for the treatment in both lakes. Through a grant funded by TPWD, GBRA contracted with a certified licensed applicator to spray water hyacinth on both lakes. A total of 13 days of spraying were conducted to help control the water hyacinth, which resulted in some of it being controlled. Future plans to control water hyacinth include conducting surveys in February and starting the control efforts in early spring instead of waiting until summer.

Geronimo Creek WPP Project Highlights

Facilitation and Implementation Activities

Segments 1804A & 1804C:

Geronimo Creek and Alligator Creek Watershed Protection Plan (GACWPP) Geronimo Creek is a spring-fed stream that arises west of SH 123, in northern Guadalupe County. The clear stream flows 17 miles through the dark clays of the Texas Blackland Prairie to its confluence with the Guadalupe River, 3 miles southeast of Seguin, Texas. Geronimo Creek is a perennial stream that receives base flow from numerous contributing springs and rainfall runoff inputs from Alligator Creek, Baer Creek, and several unnamed tributaries. Alligator Creek is a 13-mile intermittent stream that begins north of FM 1102 in Comal County. The typically dry creek bed cuts through a mixture of limestone and black clay in the Edwards Plateau and Texas Blackland Prairie transition zone before it merges with the Geronimo Creek in Guadalupe County.

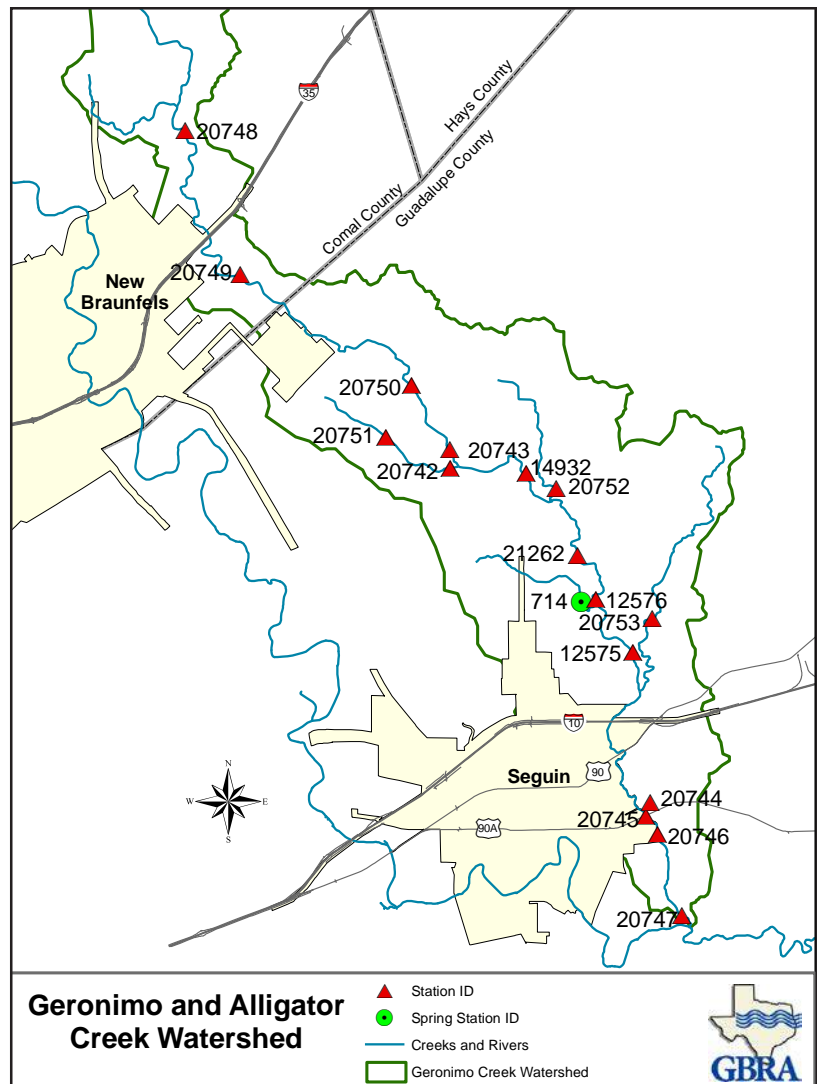
Texas AgriLife Extension was responsible for facilitation of the partnership and carrying out implementation of the GACWPP. Ward Ling serves as the watershed coordinator and has been involved with assisting entities to acquire grant funds, complete work plan deliverables, and follow-up reporting.

Nonpoint agricultural sources of pollutant loading may be addressed by implementing best management practices (BMPs) on agricultural operations. Agricultural producers, along with soil and water conservation districts (SWCDs), Texas State Soil and Water Conservation Board (TSSWCB), Natural Resource

Conservation Service (NRCS) and the Environmental Protection Agency (EPA) have been collaborating to protect the natural resources of Texas for decades. Through the TSSWCB's Water Quality Management Plan (WQMP) program, farmers and ranchers routinely implement BMPs on their land using financial and technical assistance programs of SWCDs that receive state and federal funds from TSSWCB, EPA, and NRCS. Expanding participation of agricultural

producers in implementation of the GACWPP is essential to achieve water quality improvement. As an established and well-known local entity, the Comal-Guadalupe SWCD is uniquely situated to engage and support agricultural producers in watershed restoration and protection efforts, including implementation of appropriate BMPs to address nonpoint source pollution.

A WQMP is a site-specific plan developed through, and approved by, SWCDs, which includes appropriate



Geronimo Creek WPP Project Highlights continued

land treatment practices, production practices, management measures, and technologies that prevent and abate agricultural and silvicultural nonpoint source pollution. SWCDs provide technical assistance to producers seeking to develop a WQMP. TSSWCB and NRCS have various financial assistance programs that help producers implement a WQMP. TSSWCB administers federal Clean Water Act (CWA) §319(h) funds through the Comal-Guadalupe SWCD #306 for support of one District Technician who will provide technical assistance to agricultural producers

in developing and implementing WQMPs and prescribed grazing plans in the Geronimo and Alligator creeks watershed. Upon certification of the WQMP, the district technician will work with landowners to implement the BMPs prescribed in the WQMP. The district technician will also assist landowners in applying for and obtaining financial assistance to aid in implementation of BMPs prescribed in WQMPs.

Texas A&M AgriLife Extension (AgriLife Extension) worked in partnership with Seguin Independent School District through a grant from the Seguin Education Foundation.

Extension provided educational training on local sources of nonpoint source pollution and feral hog biology and management measures. Students toured a local steel fabrication plant to gain “hands on” knowledge of the manufacturing process. This culminated in students designing and constructing feral hog traps in a high school welding class. One trap was auctioned off at a local charity event, while others were donated to local landowners to assist with reducing the feral hog population.

Cities of Seguin and New Braunfels

Upstream in the Alligator Creek watershed, New Braunfels is implementing components of its Phase II storm water permit, which will reduce bacteria and nutrient loading in storm water. The city of Seguin has just completed a Clean Water Act §319(h) grant, Best Management Practice Implementation Project to Reduce Bacteria and Nitrate-nitrogen Loading in the Geronimo Creek Watershed. The project provided

funding for the decommissioning of failing on-site sewage facilities (OSSFs) in the Oak Village North Subdivision after the homes were connected to the city’s newly installed wastewater collection system. The OSSFs are in the project area where a suspected source of *E. coli* is likely due to the high groundwater table, high failure rate, and the OSSF’s proximity to Geronimo Creek. The project was successful in that over 131

homes in the subdivision were taken off of septic systems and connected to the wastewater system. It is estimated that over 65 percent of the decommissioned septic systems were failing. Texas A&M AgriLife Extension staff assisted the city of Seguin with the grant application process, technical assistance, as well as final reporting to the Texas Commission on Environmental Quality.

Geronimo and Alligator Creeks Annual Cleanup

The Geronimo and Alligator creeks watershed protection plan partnership established an annual clean up on Geronimo and Alligator Creeks. The first event, held in the spring of 2013, was a huge success. More than 100 volunteers removed almost 3,000 pounds of trash and debris from the creeks and drainage system that drains into the creeks. Building upon the two previous years’ events, the 3rd Annual Geronimo and Alligator Creeks Clean Up event was held in April of 2015. One hundred and ninety-five volunteers cleaned up 22 locations where roadways cross the creeks and the large detention pond behind the Town Center at Creekside development. Volunteers collected 2,000 pounds of trash along 17 miles of roadway and creek banks. The city of New Braunfels and Progressive Waste Solutions donated disposal of all materials collected, and numerous other sponsors made donations of finances, as well as supplies, bottled water, and expertise.



Volunteers participate in the Geronimo and Alligator Creeks annual cleanup.

Irma Lewis Seguin Outdoor Learning Center

The Geronimo and Alligator Creek Watershed Protection Plan (GACWPP) states “an aggressive outreach and education program will be vital to successful engagement of watershed stakeholders.” To provide this type of outreach, in 2015, the Guadalupe-Blanco River Authority (GBRA) collaborated with Texas A&M AgriLife Extension and the Irma Lewis Seguin Outdoor Learning Center (ILSOLC) in the project titled, *Taking Charge of Water Quality in the Geronimo and Alligator Creeks Watershed through Outreach and Education.* The ILSOLC is an environmental and recreational learning center located in the heart of the Geronimo Creek watershed. Beginning with an initial donation of 23 acres from local resident Carla Blumberg in 1995, the ILSOLC has grown to more than 115 acres. With incredible support from the community, area school districts,

local businesses, public and private foundations, and a legion of volunteers, the ILSOLC has provided the citizens of south central Texas with a multitude of recreational and educational opportunities. ILSOLC offers many exciting, hands-on science and nature activities for explorers and naturalists of all ages.

Geronimo Creek flows through the facility and is used as part of an outdoor “classroom” for learning about nature and the environment. School children of all ages from the Seguin, New Braunfels, Comal and San Marcos Independent School Districts visit the facility annually. Classes rotate between stations to learn about fishing, kayaking, orienteering, and outdoor recreation. This project further expands that rotation by adding stations that focus on the environmental health of the creek and its riparian habitat.

The project combines technology with on-the-ground demonstrations and outdoor education to implement behavioral change in stakeholders living and working in the Geronimo and Alligator creeks watersheds. In 2015, a 5,000-gallon rainwater harvesting system was installed as part of the project, to provide one example of a low impact development structure. Other structures that will be installed as part of the project include pervious pavement, a rain garden, vegetated swale, and native landscape plots. Several of the project’s deliverables will highlight the Geronimo and Alligator creeks watershed, but will also be appropriate for use throughout the Guadalupe River Basin as well as across the state. The ILSOLC project is the first step taken towards implementation the GACWPP.



Rainwater harvesting located at the Seguin Outdoor Learning Center. Photo by Debbie Magin

Isotope Study

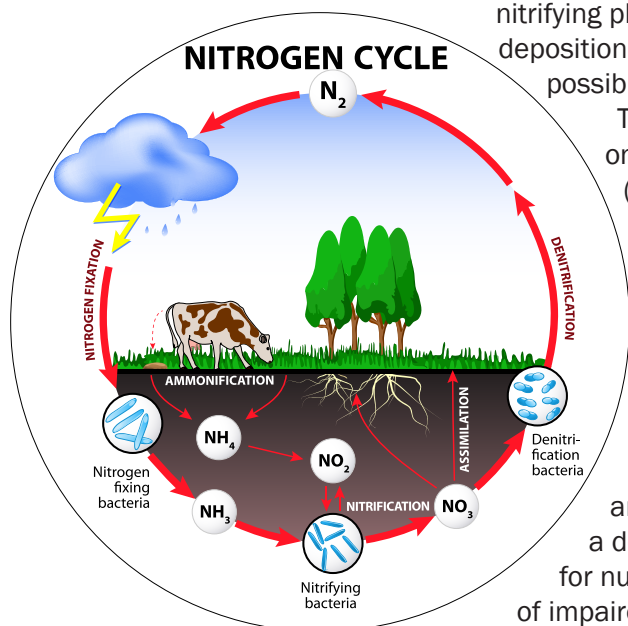
Beginning in the fall of 2013, the Guadalupe-Blanco River Authority (GBRA) and the U.S. Geologic Survey (USGS) began a project in both the Geronimo and Plum Creek watersheds. Since monitoring of Plum Creek and Geronimo Creek began in the late 1990s, these creeks have shown elevated concentrations of nitrate-nitrogen. Because the state stream water quality standards are not numeric for nutrients exceedances, 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 nitrate 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, while Geronimo Creek is also fed by springs from that same aquifer. Stakeholders in both watersheds have long suspected fertilizer use as a source of the nitrates in the Leona, but oddly enough, elevated concentrations of nitrates had been seen in water well testing long before commercial inorganic fertilizers came into use. Septic systems, animal wastes, organic fertilizers, nitrifying plants and atmospheric deposition round out the list of possible sources.

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).

Seven surface water sites in Plum Creek and Geronimo Creek watersheds have been sampled for major ions and for selected nutrient species, including nitrate-nitrogen and oxygen isotopes. GBRA and USGS have conducted targeted surface water quality monitoring over a range in hydrologic conditions (wet and dry conditions) as well as monitoring of rainwater, groundwater, wastewater effluent and springs in both watersheds.

The USGS is in the data analysis phase of the project and will produce a final report at the end of the three-year project.



The Texas Commission on Environmental Quality (TCEQ) has begun to develop water quality standards for nutrients. At the end of that process, the standards established by TCEQ and the Environmental Protection Agency (EPA) could move Plum Creek and Geronimo Creek from a designation of “concern for nutrients” to the 303(d) List of impaired waterbodies due to elevated nutrients. The Plum Creek

Website

The Guadalupe-Blanco River Authority (GBRA) continues to maintain the project website, with input from Texas A&M AgriLife Extension. In 2015, GBRA made the project webpage mobile device friendly. The original webpage was designed to

be viewed on a desktop computer format, but with a growing population of people accessing the website on

www.geronimocreek.org

mobile devices, GBRA made the decision to increase the readability, as well as the usefulness, of the site.

GBRA continues in its commitment to respond quickly and accurately to requested webpage updates and additions. The project page has received over

75,000 visits since its development in September 2009.

Plum Creek WPP

The Plum Creek Watershed Protection Plan Celebrates 10 Years!

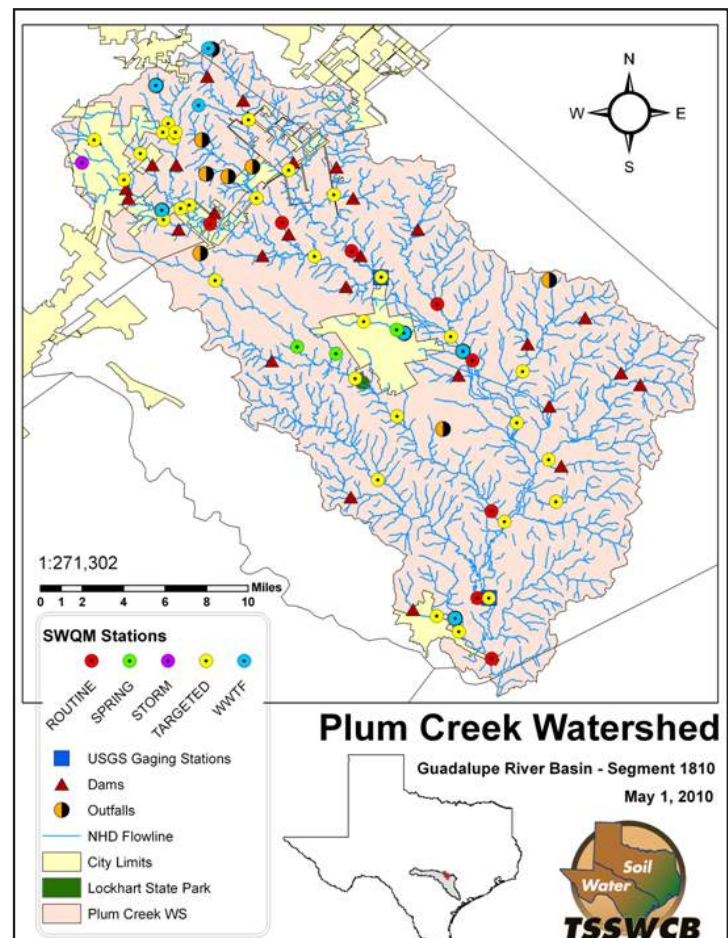
Segment 1810: (Plum Creek) Plum Creek begins near FM 2770 east of IH-35, in northeastern Hays County. The stream flows 52 miles to its confluence with the San Marcos River in Caldwell County south of Luling. At base flow, Plum Creek is best described as a shallow, slow moving, effluent dominated stream that flows from the Edwards Plateau Ecoregion through the gently rolling hills of the Texas Blackland Prairie. Two major floods in 2015, took Plum Creek well over its banks and resulted in substantial property loss throughout the watershed. The substrate of the creek is primarily made up of hard black clay while riparian vegetation consists of agricultural fields and scrub oak trees.

Segment Concerns: In 2004, Plum Creek was listed on the Texas 303(d) list for not meeting its designated contact recreation use due to elevated bacteria concentrations. In response, the Texas State Soil and Water Conservation Board (TSSWCB) and Texas A&M AgriLife Extension worked with local stakeholders to establish the Plum Creek Watershed Partnership (PCWP) in April 2006. The PCWP Steering Committee went to work and in February 2008 published the Plum Creek Watershed Protection Plan (WPP). The WPP detailed a non-regulatory, voluntary approach to reduce pollutant loading from a number of sources including 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. In 2009, the Plum Creek WPP became the first in Texas accepted by the U.S. Environmental Protection Agency (EPA). While stakeholder involvement and the pace of the WPP implementation has been strong, according to the 2014 Texas Integrated Report. Plum Creek continues to be impaired by elevated concentrations of *E. coli* bacteria and exhibits concerns for depressed dissolved oxygen and impaired habitat, as well as nutrient enrichment concerns for ammonia, nitrate, and total phosphorus. Because of the development and implementation of the Plum Creek WPP, the Texas Commission on Environmental Quality (TCEQ) categorizes Plum Creek as a Category 4b stream, meaning that regulatory action in the form of a Total Maximum Daily Loads (TMDL) for wastewater permit holders on Plum Creek is not scheduled as “other control requirements

are reasonably expected to result in attainment of all standards.”

It is important to note that watershed restoration of the size and scale undertaken by the PCWP cannot be realized overnight. Drought, floods, development, changing land use and the economy all play critical roles in this complex system of spring-fed streams, flood control structures, municipal storm sewers, agricultural runoff and permitted effluent discharges. While the achievement of water quality goals, i.e. the removal of the bacteria impairment and nutrient concerns, remain the focus of the PCWP, there is much more to the story of this remarkable group, now entering a defining tenth year.

From the time it was established in 2006, the PCWP has effectively increased water quality awareness in urban neighborhoods and rural communities throughout the Plum Creek watershed and beyond. The PCWP



Plum Creek WPP Celebrates 10 Years



has collaborated with dozens of organizations and industry specialists to provide workshops ranging from riparian habitat restoration to smart growth concepts for municipal officials. Guadalupe-Blanco River Authorities youth education program, emphasizing the importance of conserving and protecting water resources reaches every public school in the watershed. Community events like the Keep Lockhart Beautiful Annual Cleanup, now entering its ninth year, regularly draw volunteers by the hundreds. Thousands of acres of agricultural lands in the watershed are now covered by individual “Water Quality Management Plans.” People are truly taking ownership of their impacts to the watershed thanks to the efforts of the PCWP, and that energy is not fading. In recent years, the PCWP has remained actively engaged in Plum Creek WPP implementation, setting the standard for watershed protection in the State of Texas by hiring a local watershed coordinator (WC) and securing over \$2 million in local, state and national investment in watershed projects since 2012. TSSWCB Project #14-10, along with a renewed 12-party interlocal agreement will ensure a local Plum Creek WC into 2018.

Moving forward, the PCWP and Plum Creek WC will continue to work with local municipalities and groups like Keep Lockhart Beautiful, which was one of only 10 recipients of the 2015 Governor’s Community Achievement Award, and the Caldwell County Feral Hog Task Force (CCFHTF), which has received national and international attention for its unique approach to invasive species management. Formed by a group of concerned landowners brought together by the Plum Creek WC in 2013, the CCFHTF mission is “To monitor and reduce the impact of feral hogs to the land, water and wildlife species of Caldwell County.” Since its first coordinated management program began in September 2013, the CCFHTF has documented the removal of over 9,000 feral hogs in Caldwell County, an estimated economic benefit of well over \$3 million. The landowner cooperative and incentive programs championed by the CCFHTF are modeled on the successful design of the PCWP.

Noteworthy 2016 projects in which the PCWP will be actively engaged include: two TCEQ Clean Water Act (CWA) § 319(h) funded Low Impact Development projects for Caldwell County and the city

of Kyle totaling over \$500,000; a TSSWCB CWA § 319(h) funded bacterial source tracking study for the Plum Creek watershed; nine stream and/or community cleanup events; illicit dumping site cleanups, riparian workshops and youth education programs.

The PCWP remains strong for many reasons from local community support, to the efforts of a devoted local WC, to the unwavering support of state agencies like the TSSWCB and TCEQ. Perhaps there is no bigger reason for the strength and success of the PCWP than the steadfast dedication of the PCWP Steering Committee. This core group of individuals, described by one retired member as “guinea pigs” for watershed protection, has remained virtually unchanged over the project’s initial 10 years of existence. The commitment, knowledge, experience, integrity and evenhandedness of PCWP Steering Committee members are the foundation of the PCWP’s solid reputation and reason the PCWP has a seat at the table when decisions are made that will affect the future of water quality in the Plum Creek watershed.

Upper Guadalupe River Authority 2015 Highlights

Upper Guadalupe River Bacteria Reduction Plan

By Travis Linscomb, UGRA

In 2015, the Upper Guadalupe River Authority (UGRA) continued 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. Since that time, UGRA worked in partnership with the Texas Commission on Environmental Quality (TCEQ), the city of Kerrville, Kerr County, and the Texas Department of Transportation to address the impairment. The result of this partnership is the Bacteria Reduction Plan (Plan) for the Upper Guadalupe River that includes strategies to address the primary sources of bacteria pollution. Specifically, the Plan includes strategies focusing on birds nesting on bridges, large flocks of domestic waterfowl congregating in the lakes, septic systems, and pollution from general urban runoff. The ultimate goal of the Plan 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 (TSWQS).

Funding for the Plan through a Clean Water Act Section 319(h) grant from TCEQ officially ended in August 2014. Nevertheless, UGRA and the other local partners remained committed to continuing the management measures outlined in the Plan. UGRA coordinated with TCEQ and the Guadalupe-Blanco River Authority (GBRA) to incorporate the monitoring efforts initiated under the Plan into routine Clean Rivers Program monitoring. In doing so, disruption in the collection of water quality data was avoided and these sites continued to be sampled monthly throughout 2015. Additional strategies were also continued during the last year including the utilization of pet waste stations throughout the watershed, routine waterway clean up events, airing of public service announcements on local radio stations raising awareness of potential bacteria sources, and the development of signage discouraging waterfowl feeding.

Success from these efforts was realized in 2015 when both TCEQ and the Environmental Protection Agency (EPA) approved the most recent Texas Integrated Report that shows all sections of the Guadalupe River in Kerr County meeting bacteria standards!

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Overview of Water Quality Monitoring

One of the key roles of the Clean Rivers Program (CRP) is fostering coordination and cooperation in monitoring efforts. Coordinating 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 1 below outlines the types and amounts of water quality monitoring conducted in the Guadalupe River Basin and the Lavaca-Guadalupe Coastal Basin under a Texas Commission on Environmental Quality (TCEQ) approved Quality Assurance Project Plan for September 2014 through August 2015.



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. The UGRA has served as a long-time CRP partner with the Guadalupe-Blanco River Authority (GBRA), to ensure the programs objectives are met in Kerr County and throughout the entire Guadalupe River Basin. The goals of the CRP are to provide quality-assured data to the TCEQ for decision-making, identify and evaluate water quality issues, promote cooperative watershed planning, recommend management strategies, inform and engage stakeholders and maintain efficient use of public funds.

The Wimberley Valley Watershed Association (WVWA) is conducting the Blanco River- Cypress Creek Water Quality Monitoring Program. The goals of the program include establishing a baseline of water quality data; identifying potential pollution problems; documenting spatial and temporal changes; determining impacts of point and non-point source pollution; and assessing compliance with water quality standards. The program will also provide recommendations for local planning efforts to protect water quality. The GBRA is providing technical assistance and oversight of monitoring activities in addition to the laboratory analyses and quality assurance support.

The complete monitoring schedule is available at: <http://cms.lcra.org>.

Table 1. Monitoring parameter and frequencies conducted by monitoring partners in the Guadalupe River Basin in 2015.

Monitoring Parameters in FY 2015 (September 2014 through August 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	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				

2014 Texas Integrated Report of Surface Water Quality in the Guadalupe River Basin and Lavaca-Guadalupe Coastal Basin

The Environmental Protection Agency (EPA) conducted a complete review of the Texas Commission on Environmental Quality (TCEQ) 2014 Texas Integrated Report of Surface Water Quality in the Guadalupe River Basin. Based on its review, EPA has determined that Texas' 2014 list of water quality impaired segments still requiring total maximum daily loads (TMDLs) meets the requirements of Section 303(d) of the Clean Water Act (CWA) and EPA's implementing regulations. TCEQ produces a new report every two years on even numbered years as required by law. The Integrated Report lists all segments in Texas that were assessed and assigned a level of support. A healthy stream segment that meets the designated water quality assessment criteria is listed as fully supporting, (that data shows the stream standards are met), or no concern, (data shows the stream did not show excessive exceedances of screening criteria). Those stream segments that do not meet the applicable water quality criteria will receive a designation of nonsupport, screening level concern or use concern, based on the specific criteria being assessed. A segment can also receive a designation of not assessed if there is not enough data available. Each segment that is listed as impaired is assigned an assessment category to provide information about the water quality status or management activities being conducted on that water body. Category 4 contain those water bodies that have had a TMDL or

other pollution prevention or control activity associated with the segment and it is reasonable to expect future attainment of the water quality standards. Category 4 contains those impaired water bodies that are not supporting because of something other than a pollutant. Category 5 contains water bodies that do not meet the applicable water quality standards or is threatened for one or more designated uses by one or more pollutants. This category contains impaired water bodies that have a TMDL underway or scheduled or it is recommended that a review of the water quality standards be performed or additional data be collected.

The segments located in the Guadalupe River Basin that are reported on the 303(d) are listed on the table on page 17. Table 2 includes all assessed stream

segments in the Guadalupe River Basin and Lavaca-Guadalupe Coastal Basin, including segments that have water quality impairments reported on the 303(d) or concerns identified in the 2014 Integrated Report. There were no new stream segments listed as impaired in the 2014 report, but two stream segments are no longer listed. The Guadalupe River above Canyon Lake (Segment 1806) is no longer listed for contact recreation use impairment of bacteria concentrations as current data now shows the stream meets the assessment standard. The Upper San Marcos River (Segment 1814) is no longer listed for general use impairment of total dissolved solids concentrations because current data shows that it now meets the standard.



Table 2. 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	Impairment or Concern Removed 2014	Category (if assigned)	Year Listed
1701	Victoria Barge Canal	Nitrate-Nitrogen and Chlorophyll-a		Note 1	2000
1801	Guadalupe River Tidal	Nitrate-Nitrogen		Note 1	2002
1802	Guadalupe River below San Antonio	Nitrate-Nitrogen		Note 1	2002
1803	Guadalupe River below San Marcos River	Nitrate-Nitrogen	Bacteria	Note 1	2014
1803A	Elm Creek	Depressed Dissolved Oxygen; Chlorophyll-a		5b; Note 1	1999
1803B	Sandies Creek	Depressed Dissolved Oxygen; Impaired Fish and Macrobenthic Communities; Bacteria; Impaired Biological Habitat; Chlorophyll-a		5b	1999
1803C	Peach Creek	Depressed Dissolved Oxygen; Bacteria; Impaired Fish Community; Total Phosphorous and Chlorophyll-a		5b	2002
1803D	Salty Creek	Not Assessed			
1803E	Little Elm Creek	Not Assessed			
1803F	Denton Creek	Not Assessed	Bacteria		
1803G	Sandy Fork	Not Assessed	Bacteria		
1804	Guadalupe River below Comal River	No Impairments or Concerns			
1804A	Geronimo Creek	Bacteria; Nitrate-Nitrogen		5c; Note 1	2006
1804C	Alligator Creek	No Impairments or Concerns			
1804D	Bear Creek	Bacteria		Note 1	2014
1805	Canyon Lake	Mercury in Edible Fish Tissue; Ammonia-Nitrogen		5c; Note 1	2006
1806	Guadalupe River above Canyon Reservoir	Impaired Biological Habitat	Bacteria	Note 1	1999
1806A	Camp Meeting Creek	Depressed Dissolved Oxygen		Note 1	2004
1806D	Quinlan Creek	Bacteria; Depressed Dissolved Oxygen		5a; Note 1	2010
1806E	Town Creek	Bacteria; Depressed Dissolved Oxygen		5a; Note 1	2010
1807	Coletto Creek	No Impairments or Concerns			
1807A	Perdido Creek	No Impairments or Concerns			
1808	Lower San Marcos River	No Impairments or Concerns			
1809	Lower Blanco River	No Impairments or Concerns			
1810	Plum Creek	Bacteria; Depressed Dissolved Oxygen; Impaired Biological Habitat; Nitrate-Nitrogen; Total Phosphorus		4b; Note 1	2004
1810A	Town Branch	Bacteria; Depressed Dissolved Oxygen and Nitrate-Nitrogen		Note 1	2014
1811	Comal River	No Impairments or Concerns			
1811A	Dry Comal Creek	Bacteria		5c	2010
1812	Guadalupe River below Canyon Dam	No Impairments or Concerns			
1813	Upper Blanco River	No Impairments or Concerns	Depressed Dissolved Oxygen		
1814	Upper San Marcos River	No Impairments or Concerns	Total Dissolved Solids		
1815	Cypress Creek	Depressed Dissolved Oxygen and Impaired Biological Habitat		Note 1	2006
1816	Johnson Creek	No Impairments or Concerns			
1817	North Fork Guadalupe River	No Impairments or Concerns			
1818	South Fork Guadalupe River	Depressed Dissolved Oxygen		Note 1	2014

Note 1: No impairment assessment category is assigned to this segment. A water quality concern was identified rather than an impairment of a designated use. Concerns are identified for bodies of water near-nonattainment of water quality standards (CN) or not meeting numerical screening levels (CS).

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.

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

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 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, fine 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 groundwater 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.

Public Outreach and Education

A vital component of the Clean Rivers Program (CRP) is the participation of citizens, public and private institutions, private industries and others in determining the basin's activities as well as the CRP activities statewide. The public plays a crucial role in determining how to best protect the Guadalupe River Basin water resources for the future. These opportunities also provide for direct public participation to ensure that community concerns are addressed.

Each year the Guadalupe-Blanco River Authority (GBRA) and the Upper Guadalupe River Authority (UGRA) conduct one basin-wide Steering Committee meeting. The steering committee membership includes representation from municipalities, counties, industries, homeowner organizations, and state agencies. Meetings are scheduled to provide direction for the general CRP activities, as well as the development of work plans, monitoring plans, and major reports. These meetings are public meetings and their primary purpose is to review and approve achievable water quality objectives and priorities, give consideration to available technology, and guide work plans and the allocation of available resources. If you are interested in attending, notice of CRP Steering Committee meetings are made available on the GBRA website at <http://www.gbra.org/crp/> and associated meeting minutes are made available at <http://www.gbra.org/crp/participate.aspx>.

It has been over 10 years since Richard Louv's *Last Child in the Woods* hit the radar of Environmental Education. This award-winning landmark book coined the phrase nature deficit disorder, and called attention

to the lack of time that children spend outdoors. Citing research, the conclusion is that direct exposure to nature is essential for healthy childhood development and for the physical and emotional health of children. GBRA strongly supports the concept that children need to spend more time outdoors, and works actively throughout the basin to provide such opportunities for school-age children.

Education staff lends itself to a number of outdoor education facilities throughout the Guadalupe River Basin. Often times, GBRA has played the lead in offering outdoor classroom experiences to students. The Canyon Lake Gorge has been the site of such experiences for the last two years. Over 1,500 fifth-grade students from neighboring schools were given the opportunity to explore water related topics: the food web in aquatic environments, water quality, groundwater/surface water interactions, landforms, erosion, and nonpoint source pollution. This model will be used in outdoor classroom experiences at Jacob's Well State Natural Area and Coletto Creek Park and Reservoir in spring 2016. Students will rotate through stations, most of which will have a water theme. GBRA may be the lead on the development and planning of these field trips, but rely heavily on volunteers to assist with the stations. Master naturalists have been a tremendous help with both planning and implementation of these programs, especially at the Gorge and Jacob's Well.

A partnership with Texas Parks and Wildlife Department (TPWD) at Lockhart State Park also provides opportunities for students to explore water quality. In



Steering committee meeting held at the GBRA River Annex.

Public Outreach and Education continued

the fall, GBRA staff lead sessions for Lockhart ISD students on macroinvertebrates and water quality. In the springtime, these same students explore water quality monitoring by testing the dissolved oxygen level in Clear Fork Creek.

The Irma Lewis Seguin Outdoor Learning Center (ILSOLC) has a long partnership with GBRA. Geronimo Creek flows through the center's property. For more than a decade, hundreds of students annually from area school districts, including San Marcos, Seguin, New Braunfels, Navarro, Marion and Comal ISDs have participated in GBRA led sessions on macroinvertebrates and water quality, water quality testing, watersheds and nonpoint source pollution. Through a 319 NonPoint Source grant from the Texas Commission on Environmental



Volunteers work to build trails at the Environmental Learning Center Property adjacent to the Canyon Lake Gorge.

Quality, these efforts will be expanded in the future. Plans for a Riparian Walk, a geocaching activity, and a new interactive computer program, students will be introduced to the benefits of maintaining a healthy riparian system and how this affects water quality.

In the future, GBRA hopes to provide additional water quality sessions at its planned Environmental Learning Center in Comal County. The 20.5-acre property adjacent to the Canyon Lake Gorge will have classrooms and extensive programming to meet the outdoor experiential needs of area schools. TPWD has approved this and all other sites aforementioned as Certified Aquatic Science Field Sites. This effort has designated over 25 sites across the state of Texas, and of those nine are in the Guadalupe River Basin. Efforts by these sites and their partners continue to promote water quality education for students throughout the watershed – and working to eliminate nature deficit disorder in the process.



Elementary school students participate in environmental education field trips.

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