2014 Update to the Plum Creek Watershed Protection Plan

DEVELOPED BY

THE PLUM CREEK WATERSHED PARTNERSHIP

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Plum Creek Watershed Partnership

2014 Update to the Plum Creek Watershed Protection Plan

Prepared for the
Plum Creek Watershed Partnership
by

Nick Dornak,
Plum Creek Watershed Coordinator

Plum Creek Watershed Partnership
1403 Blackjack Street, Suite B
Lockhart, TX 78644

http://plumcreek.tamu.edu

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Forward

In 2006, the Texas State Soil and Water Conservation Board and the Texas A&M AgriLife Extension Service introduced a new concept to a group of citizen stakeholders from the Plum Creek Watershed. The concept was a voluntary program with the goal to restore water quality to the small creek that had its headwaters in one of the fastest growing regions in Texas. The development of a watershed protection plan was an alternative to a Total Maximum Daily Load, a process that develops a "budget" for pollutant loading but could only enforce that budget on permittees. Little did the stakeholders know that the Plum Creek Watershed Partnership would eventually serve as an example, and often times, the guinea pig, for watershed protection activities throughout the State. The Partnership was the first to get their watershed protection plan accepted by EPA and it was the first to put together local funding to match federal dollars to hire a local watershed coordinator. Now as we move into our seventh year of implementation, water quality has not been restored, but we are still working toward improvement. The development of a watershed protection plan and its implementation are exercises in *adaptive management*. Nonpoint source pollution is very difficult to identify and manage because it comes from the everyday activities of many different sources. There is no pipe that we can find and turn off. The sources of pollution we took on are much more elusive, and we need to keep in mind that this process requires patience and resolve. In the watershed protection plan process the stakeholders identified pollutant sources and those sources haven't changed. But the location and extensiveness of those sources may have changed. Land use changes, rural lands becoming urban, urban flight to our rural counties and explosive population growth along the IH 35 corridor will cause us to redirect our management strategies, if not in concept, then in location and focus. Local residents are recognizing that they are not just living in Hays County, Caldwell County, Kyle, Buda, Lockhart or Luling; they live in the Plum Creek Watershed. Landowners have been introduced to the idea that their land is not isolated and activities on that land, no matter how small, can have an impact on water quality. We are affecting changes in our small part of the world, developing habits that will become second nature, like picking up after our pets. Our stakeholders understand that the dumping of tires and batteries will harm the creek. The Plum Creek Watershed Protection Plan, while it hasn't reached its goal, has become a shining example of how we must first affect a change in ourselves before we can effectively change the conditions that we have created. We have faith that we will get to our goal but more importantly when we do, we will be proud of the process and what we learned along the way. We will stay the course and continue to work with stakeholders to improve the quality of water in the Plum Creek Watershed.

Debbie Magin,
Director of Water Quality Services
Guadalupe-Blanco River Authority

Overview

In an effort to address nonpoint source pollution in Plum Creek, the 'Plum Creek Watershed Partnership' (Partnership) began implementation of the Plum Creek 'Watershed Protection Plan' (WPP) in February 2008. The WPP serves as a stream restoration guidebook that relies on voluntary adoption of best management practices (BMPs) determined by watershed stakeholders to be most effective for achieving the water quality goals established for Plum Creek. Including the reduction of both bacteria and nutrient concentrations throughout the entire 397 square mile (1028 km^2) Plum Creek watershed, the goals identified in the WPP are admittedly challenging and will require a long-term commitment from local watershed stakeholders to be realized. While the work continues, as of the date of this publication, Plum Creek continues to be recognized by the State of Texas as impaired for Primary Contact Recreation. Nutrient levels remain a concern and *E. coli* levels in excess of 126 colony forming units per 100 milliliters (126cfu/100mL) persist throughout the creek.

Since implementation of the WPP began in 2008, the Plum Creek watershed has experienced some significant changes. The watershed has endured the most severe drought on record, at times resulting in all but those areas immediately below springs or effluent discharges running dry. Large swaths of the watershed have been transformed by the construction of State Highway 130 and rapid residential and commercial growth along the Interstate 35 Corridor. Rural landuse characteristics have changed as well with a considerable increase in the number of small farms in both Hays and Caldwell County. The precipitous increase of reported feral hog activity throughout the watershed has further served to alter the landscape and pollutant loading characteristics. Understanding the new challenges posed by these transformative developments is essential for determining the proper adaptive management strategies to be implemented. Water quality restoration in a watershed as large and diverse as Plum Creek's will only be achieved through a coordinated, dynamic and sustained effort on the part of many watershed municipalities and citizen stakeholders.

The decision of the Partnership to transition primary WPP coordination from AgriLife Extension to an independent watershed coordinator in 2012 placed a greater emphasis on local control and may represent a paradigm shift in future WPP planning. In 2011, an Interlocal Agreement was signed by 12 project partners and provided matching funds for a CWA §319(h) grant to support a Plum Creek Watershed Coordinator (WC). The presence of a local WC was desired by the Partnership as a way to enhance stakeholder participation in watershed projects, as well as to better understand and respond to the evolving needs and interests of local communities. Funding has been requested for the continuation of this position through 2017.

Effective watershed management is neither a simple, predetermined series of steps or a "quick fix" that guarantees watershed improvement. Rather, it is a long-term commitment to stewardship of the natural resources that characterize a watershed coupled with the adoption of BMPs that fit within the socioeconomic dynamics of the local communities. It is the people, not the plan that will ultimately determine the success or failure of watershed goals. Systematic re-evaluation of prescribed management measures throughout the watershed is imperative. To maintain the greatest likelihood of success, the development, implementation and revision of BMPs must consider both historic and newly acquired data along with observed social and ecological trends in the watershed.

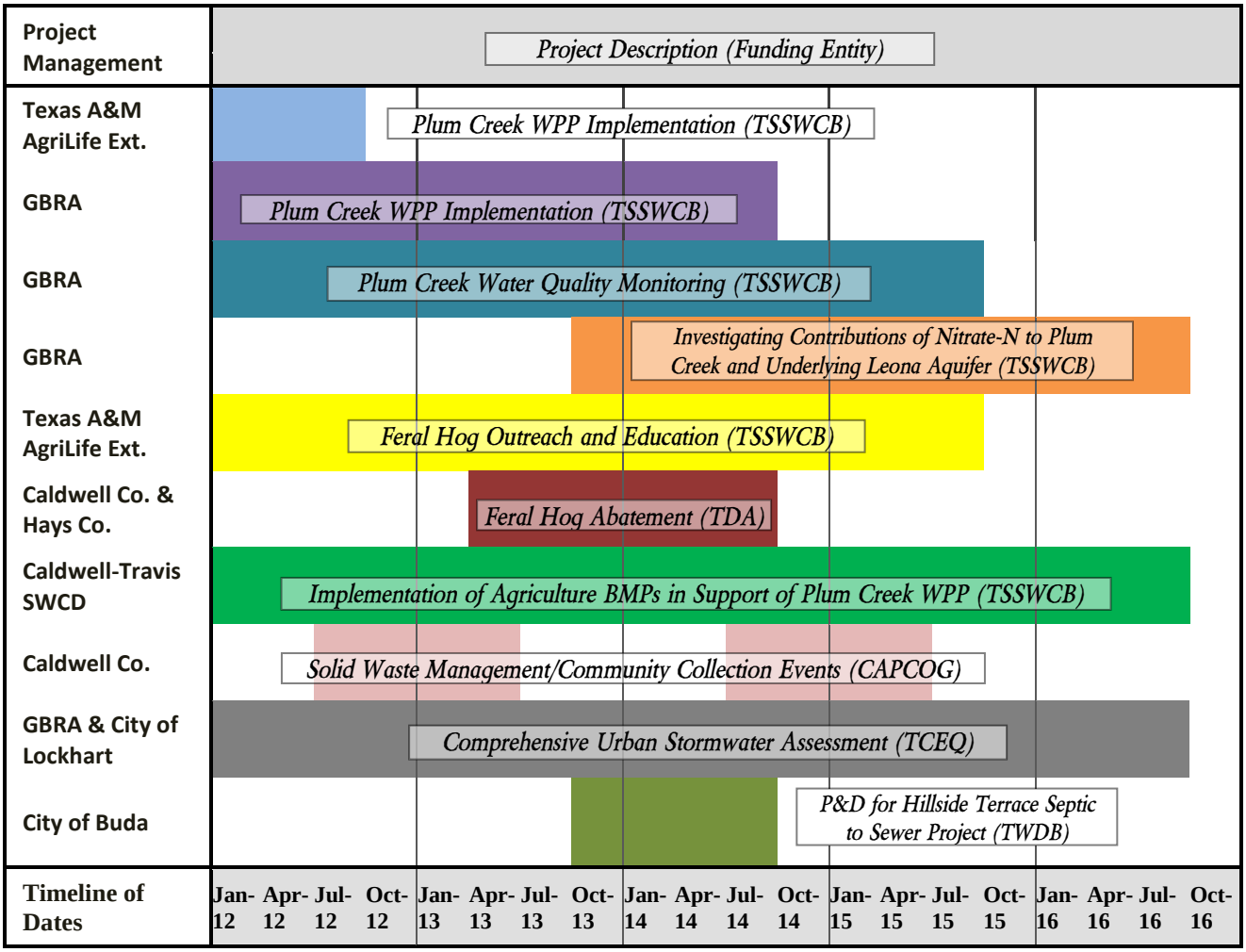
This document functions as:

- a progress report on efforts to implement the Plum Creek WPP since its initial release with a primary focus on activities and updates from December 2011 through March 2014
- a modification to the goals and strategies identified in the WPP
- an analysis of collected water quality data to ascertain interim progress in achieving water quality restoration goals

Progress Toward Implementation Milestones

The Plum Creek WPP was designed by a local steering committee and partnership of watershed stakeholders to identify strategies, management measures, outreach and educational efforts to reduce pollutants and improve water quality throughout the Plum Creek Watershed. Since the completion of the WPP, the Partnership has accomplished many of these measures, which are outlined in this Update. Table 1 shows the timeline of grants received and/or managed during the reporting period for this Update. An analysis of water quality data is also included later in this document. Figure 1 identifies subwatersheds within each monitoring region as established in the WPP. These subwatersheds were used to prioritize areas for implementation[1].

Table 1. Timeline of funding for implementation grants received and/or managed since December 1, 2011



[1] Two-letter abbreviation corresponds to the stream segment and associated Clean Rivers Program (CRP) monitoring location receiving runoff from each subwatershed. UH = Uhland [17406]; LO = Lockhart [12647]; LU = Luling [12640]. See Table 13 for a detailed list of all monitoring locations in the watershed.

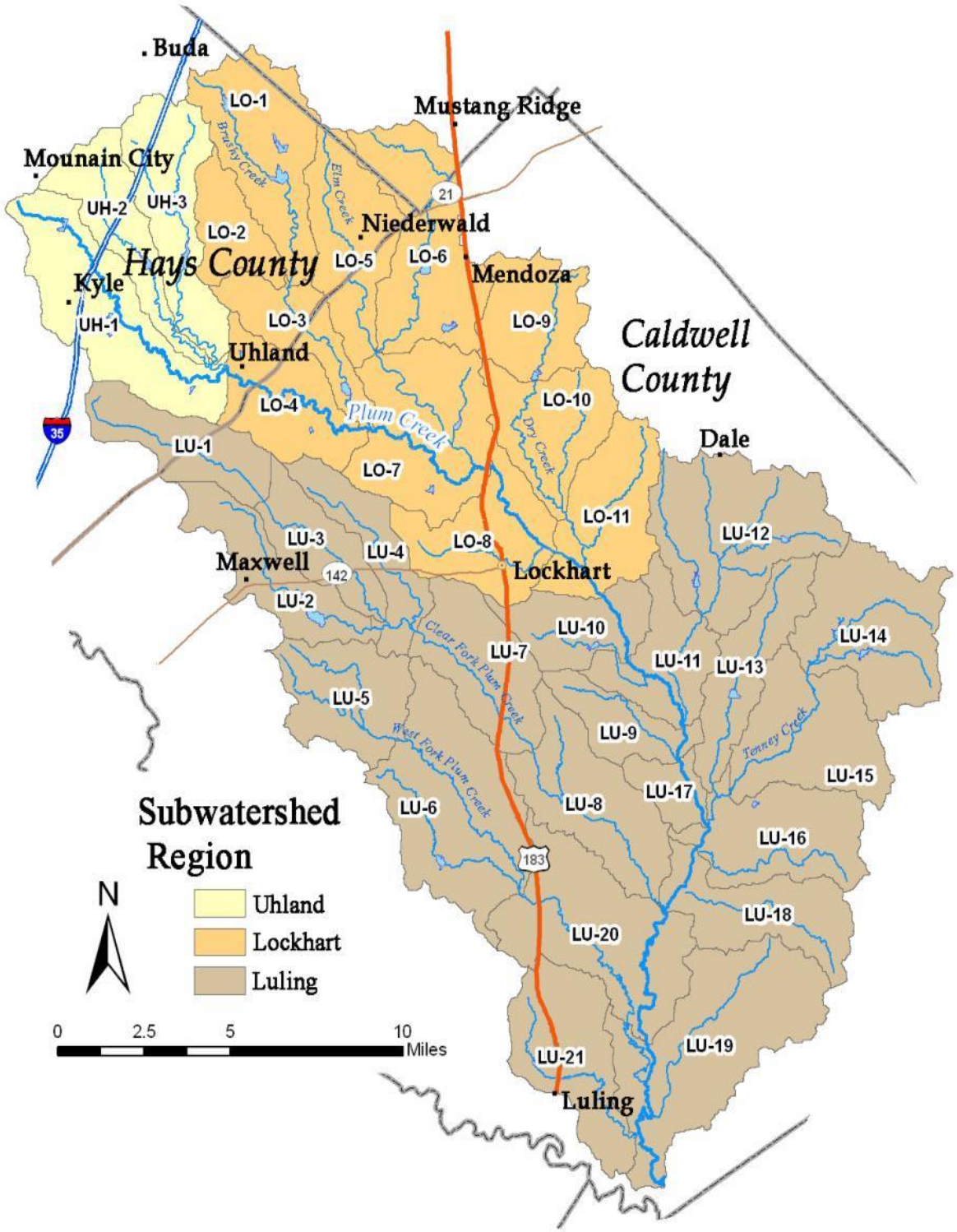


Figure 1. Subwatersheds identified for Plum Creek.

Urban Stormwater Management

Urban development continues to be an increasingly critical issue in the watershed, and implementation of management measures in these areas will be extremely important. The Partnership has engaged the cities of Kyle, Lockhart, Luling, and Buda to implement strategies in the WPP and identify additional management measures that satisfy city needs and supplement water quality improvement efforts.

Large swaths of the watershed have been transformed by the construction of State Highway 130, which opened October 24, 2012. Further, rapid residential and commercial growth along the Interstate 35 Corridor between Austin and San Antonio continues to pose substantial challenges for managing urban stormwater and municipal wastewater throughout the uppermost segments of Plum Creek. The City of Kyle, in particular, experienced exponential population growth (427%) from 2000 to 2010 as defined by the U.S. Census Bureau (Tables 2 and 3). As small towns struggle with becoming urbanized centers, the impacts to existing stormwater and wastewater systems can be profound, greatly increasing the risk of significant water quality degradation. In an effort to minimize these risks to the watershed, the Partnership strongly recommends the implementation of low-impact development (LID) projects. BMPs for LID projects, including rain gardens, permeable pavement and other "green infrastructure", can significantly reduce stormwater intensity and pollutant loading by limiting the amount of impervious cover for new construction and replacing existing impervious surfaces with strategic retrofits. The Partnership will work with developers and local municipalities to achieve funding for LID projects in the watershed.

As defined by the 2010 Census, the cities of Buda and Kyle are both included as part of the Urbanized Area of the City of Austin (Figure 2). Each of these cities now falls under Phase II MS4 requirements. The Texas Commission on Environmental Quality (TCEQ) issued the new Phase II MS4 General Permit, TPDES Permit No. TXR040000, on December 13, 2013. All regulated entities (new and existing) will have 180 days to apply for coverage or a waiver under the general permit. Each entity must submit a Notice of Intent (NOI) and a new or revised Stormwater Management Program or a waiver, if applicable. The City of Kyle received notice in early 2014 that they would be included as a regulated entity under this permit and has initiated a planning effort to comply with the new provisions.

As an integral part of the urban stormwater management effort in Plum Creek, the Partnership worked to assist the cities of Lockhart and Luling with development of project proposals which were submitted to TCEQ for CWA §319(h) funding. The City of Luling determined it was unable to accept the urban implementation grant due to changes in local economic conditions. The City of Lockhart accepted and signed their grant, which was executed in August 2010. The grant, originally schedule to be completed by August 2012 was extended an additional year to allow Lockhart more time to complete a stormwater mapping project. While many of the implementation components of the grant were completed successfully and on time, complications meeting grant demands, notably problems with a QAPP that required subsequent corrective action, led to Lockhart's decision not to complete an illicit discharge survey. The survey was a critical element of Lockhart's grant and a prescribed management measure

identified in the Plum Creek WPP that would serve to detect and eliminate illicit discharge sources throughout the City's stormwater system. The Guadalupe-Blanco River Authority (GBRA) has obtained additional grant funding from TCEQ to complete the illicit discharge survey for the City with a report scheduled to be completed by August 2016.

Grant programs are important for nonpoint source management efforts in the urban sector; however, consideration must be given to the fiscal and staff limitations of small cities. Grant projects that require significant matching funds and frequent reporting present a significant challenge for smaller municipalities that, in many cases, have the greatest need for this type of financial support. Further, unanticipated communication difficulties among grantors and grantees, such as the one that preceded Lockhart's withdrawal prior to completion of their implementation grant, must be addressed to ensure future participation in similar programs. The Partnership will continue to work with the cities and TCEQ to improve communication and develop new strategies for achieving urban stormwater management milestones identified in the WPP. To this end, several meetings between watershed cities and TCEQ staff, facilitated by the Partnership, will take place in the summer of 2014.

Table 2. Population of incorporated cities completely or partially within the Plum Creek watershed[2].

City	2000 Census Population	2010 Census Population	Percent Change
Buda	2,404	7,295	203%
Kyle	5,314	28,016	427%
Lockhart	11,615	12,698	9%
Luling	5,080	5,411	7%
Martindale	953	1,116	17%
Mountain City	671	648	-3%
Mustang Ridge	785	861	9%
Niederwald	584	565	-3%
Uhland	386	1,014	163%

Table 3. Population of counties partially within the Plum Creek Watershed[2].

County	2000 Census Population	2010 Census Population	Percent Change
Caldwell	32,194	38,066	18%
Hays	97,589	157,107	61%
Travis	812,280	1,024,266	26.1%

[2] Source: Texas State Data Center and Office of the State Demographer.

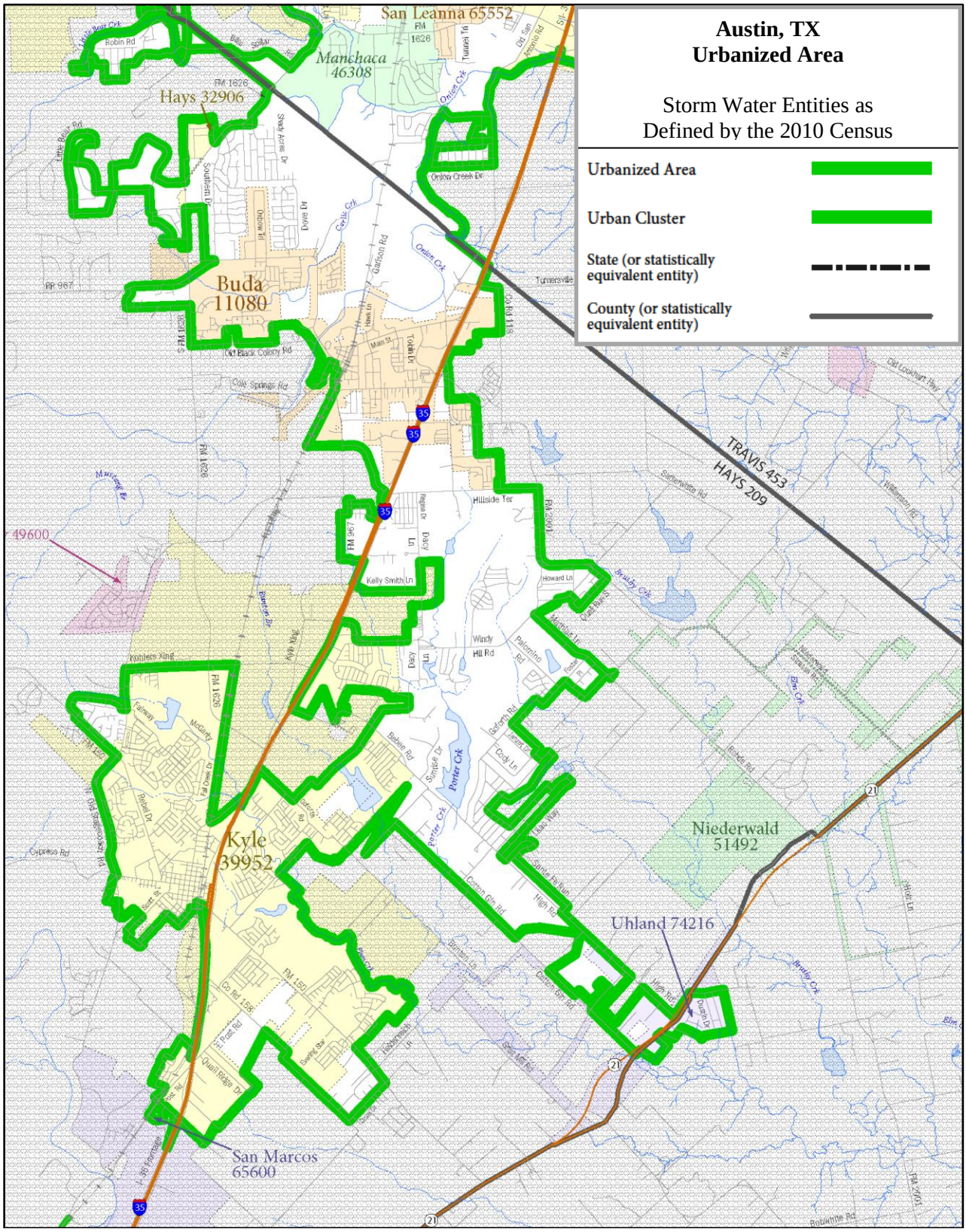


Figure 2. Lower Portion of Austin Urbanized Area Map of Stormwater Entities as Defined by the 2010 Census includes the cities of Buda and Kyle.

URBAN STORMWATER MANAGEMENT

Urban Stormwater Assessments, Mapping and Illicit Discharge Survey
To identify the most effective locations for the installation of structural stormwater controls, the Cities of Kyle and Lockhart incorporated comprehensive urban stormwater assessments into their TCEQ CWA §319(h) grants. The City of Kyle regularly updates a map of their entire system, which now includes 2,058 storm drain inlets, 291 storm drain outlets, and 825 stormwater manholes. These analyses have enabled evaluation of current stormwater flows and conveyance systems, identified needs, and supported optimal placement for additional controls.

In 2013, Lockhart completed mapping of their stormwater system, including 288 inlets. A "Storm Water and Drainage Management Plan" to improve water quality in Plum Creek and determine improvements to the City's drainage system was completed in July 2013. Several complications arose during the CWA §319(h) grant process precluding Lockhart from completing an illicit discharge survey incorporated into the grant as a key element. In response to a request from TCEQ, the GBRA has been awarded a 2-year grant set to begin in 2014 that will allow for completion of the illicit discharge survey and final report. GBRA will be evaluating 100% of mapped sites to identify and sample potential illicit discharges. City of Lockhart staff will be notified if any illicit discharges are located during the survey, and has agreed to enforce the City's drainage ordinance upon notification.

Urban Stormwater Markers, Inlet Protection Filter Devices, and No Dumping Campaigns
The cities of Buda, Kyle and Lockhart have installed "no dumping" markers on the majority of storm drain inlets throughout the city limits (Figure 3). In addition to stormwater inlet tiles, the City of Lockhart's TCEQ CWA §319(h) project included funds to purchase and install storm inlet protection filter devices including 80 locations in downtown. These devices, intended to reduce NPS pollution in the form of grass clippings, leaves and debris, regularly became clogged with debris during rain events, prohibiting proper drainage of the City's stormwater. A decision was made by the City in 2012 to remove the filters due to potentially unsafe conditions arising from clogged inlets (Figure 4).

Figure 3. No dumping markers on storm drains in Lockhart, Kyle and Buda.

Figure 4. Lockhart storm drain inlet protection and storm drain marker.

Street Sweeping Programs

Street sweeping programs have continued in cities throughout the Plum Creek watershed. The Cities of Lockhart and Luling already had implemented street sweeping programs with city funds prior to WPP implementation. The Cities of Buda and Kyle each purchased street sweepers with city funds and initiated sweeping programs in priority areas starting at the end of 2008. Kyle swept 4,099 miles (164 miles per month during normal operation) of roadways from June 2011 through March 2014; however, the City's sweeper was inoperable from September 2011 through May 2012 due to damage sustained from a vehicle accident. Lockhart continues sweeping an average of 50-60 miles per month or about 660 miles/year. Buda has 55.9 miles of streets that are swept multiple times annually. Luling city maintenance crews plan to maintain an existing program in which all city streets are swept at least monthly. Sweeping efforts will continue to be adjusted to account for new development with expansion of coverage and frequency as necessary and possible.

Ordinance to Include the Use of Mulch Tubes

The City of Kyle developed and approved (November 1, 2011) an ordinance to require the use of mulch tubing in areas of high runoff or environmental sensitivity. Consistent with the new ordinance, the City installed approximately 500 linear feet of mulch tubing along a retrofit project completed in 2012 at Steeplechase Park. According to City Staff, this has been the only project where directives in the ordinance have been applied as silt fencing continues to be used for most new construction projects.

Urban Waterfowl Management

The City of Lockhart identified a large domestic waterfowl population in City Park as a potential bacteria source. In 2008, 60% of the resident ducks at the City Park pond were relocated to a private property outside of the City. The other 40% of the duck population remained at the park. The City noted that under normal conditions the pond does not discharge to Town Branch or Plum Creek, and based on comments received from local citizens in 2011 regarding the aesthetic value of the ducks in the park, the City made the decision to no longer manage the duck population. According to City officials, however, the number of ducks and other waterfowl in the City Park pond has grown significantly throughout the reporting period for this Update leading to a recent decision by the City to remove 50% of the existing duck population in 2014.

Dog Waste Management

As the local human population continues to grow, it is likely that the pet population will keep pace. To address this component of the Plum Creek WPP urban stormwater component, the Cities of Kyle, Buda and Lockhart each have enacted pet waste ordinances requiring proper disposal in parks and public areas. According to City of Luling officials, a pet ordinance, adopted in 1966, includes a requirement for the removal of pet waste from public and private property[3]. Pet waste stations with bag dispensers, waste receptacles and signage encouraging their use have been purchased and installed throughout the watershed utilizing CWA §319(h) grant funding from the Texas State Soil and Water Conservation Board (TSSWCB) (Figure 5). Some municipalities have also taken the initiative to install additional waste stations with city funds. Currently 50 pet waste stations are known to be in use throughout the watershed, including: Kyle (16), Buda (18), Lockhart (10), and Luling (6).

Each spring an annual Plum Creek cleanup is held in Kyle. In 2012, the event moved from Steeplechase Park to Lake Kyle, which does not allow pets on the premises. Despite the lack of recent data, significant decreases in dog droppings marked at the Steeplechase Park event in 2010 and 2011 coupled with the continued utilization of pet waste stations in Kyle parks bodes well for the urban stormwater management goals for pet waste outlined in the Plum Creek WPP.

Figure 5. Pet waste stations installed in City Parks in Lockhart and in Kyle.

Enforcement of existing ordinances and education of pet owners remain priorities. Public education campaigns in Kyle, Lockhart, Luling and Buda promote proper pet waste management. Further, the City of Luling has expressed a desire to attain additional CWA §319(h) grant funding to enhance their current pet waste management and education program.

[3] Correction to 2012 Plum Creek WPP Update

Hays County Development Regulations

In July 2011, Hays County adopted regulations to provide a framework for the orderly and efficient development of rural and suburban areas outside of incorporated cities. The purpose of these regulations was to implement the powers and duties of the County authorized under the Texas Water Code, the Texas Health and Safety Code, the Texas Local Government Code and other laws, to establish the policies of the Commissioners Court and to set forth procedures to be followed in County proceedings in regulating certain activities associated with development in Hays County. According to Hays County Development Services, these regulations have served to simplify procedures, avoid delays, save expense, and facilitate the administration and enforcement of laws and regulations by the County. The regulations are consistent with the WPP goals of improving water quality from stormwater, construction sites, and wastewater from new development and are supported by the Partnership.

Caldwell County Development Regulations

In January 2011, Caldwell County adopted an ordinance for the purpose of providing a framework for, "the safe, orderly, and healthful development of the unincorporated areas, these issues being hereby declared to be worthwhile public purposes and in the public interest."[4] The regulations are consistent with the WPP goals of improving water quality from stormwater, construction sites, and wastewater from new development and are supported by the Partnership. The ordinance includes:

- On Site Sewage Facility (OSSF) requirements including certification by an engineer or licensed sanitarian and maintenance agreements for new and existing aerobic systems
- Drainage design requirements and criteria to manage stormwater conveyance
- Erosion and sediment control requirements to manage erosion and requires the development of a permanent erosion control plan
- Stream setback requirements protecting riparian vegetation and water quality

[4] From *Caldwell County Development Ordinance,* adopted January 18, 2011

Wastewater Management

Efforts to enhance wastewater management for private septic systems have seen some noteworthy progress since 2011. While improved management of septic systems, particularly older conventional systems, continues to be hampered by limited inspection and enforcement capabilities, state agencies and local municipalities in the Plum Creek watershed have taken significant steps to provide much needed funding and incentives for the purpose of reducing the potential for pollutant loading from OSSFs. Substantial funding has been obtained through the Texas Water Development Board (TWDB) Clean Water State Revolving Fund loan program and an Interlocal Agreement between Hays County and the City of Buda to complete planning and design for a project that would serve to connect a 264-home subdivision (Hillside Terrace), located in Plum Creek subwatershed UH-3, to central sewer service.

While funding for the continued voluntary monitoring of WWTFs has been secured, significant progress toward treatment improvements for centralized systems in the watershed has not yet been realized. The Partnership strongly recommends that WWTFs discharging into Plum Creek and its tributaries strive to achieve 5-5-2-1 treatment levels [5 mg/L $CBOD_5$, 5 mg/L TSS, 2 mg/L NH_3-N, 1 mg/L P]; however, operators have little financial incentive to invest additional capital in the infrastructure enhancements that would be required to meet these standards. Furthermore, a series of illicit discharges and other major permit violations from 2010 through 2014 at the City of Kyle WWTF and Goforth WWTF, both of which are located in the upper reaches of the watershed, have made progress toward achieving nonpoint source water quality goals identified in the WPP extremely difficult to ascertain. Despite a history of TCEQ enforcement actions and fines levied against the two Aqua Texas, Inc. subsidiaries that operate these facilities, operational failings at these plants have continued to persist.[5,6]

Downstream impacts from the illicit discharge of improperly treated WWTF effluent in the watershed are assumed to be significant, but the extent to which the effects are being realized is difficult to quantify. The Plum Creek Watershed Steering Committee (Steering Committee) has clarified that zero discharge, land application of wastewater effluent would result in greater pollutant loading reductions while also serving to enhance water conservation efforts on behalf of watershed stakeholders. The Partnership recommends that new wastewater treatment facilities consider Texas Land Application Permits (TLAP) as an alternative to dispose of treated effluent. Serious knowledge gaps remain with regard to regrowth of *E. coli* in the environment relative to the completeness of disinfection. In most cases, effluent sampling conducted by GBRA indicates very low levels, often < 10cfu/100mL. However, downstream concentrations are often much higher, with no known inflows or significant concentrations of potential sources nearby. Understanding the dynamics of regrowth and reactivation of bacteria after the disinfection process of WWTFs is of vital importance to improving wastewater management.

Despite some setbacks, accomplishments since the implementation of the Plum Creek WPP in 2008 have provided some water quality benefits and will help guide future progress. Currently, three permitted WWTFs in the watershed require 5-5-2-1 treatment of wastewater. The most

[5] Aqua Operations, Inc. and the City of Kyle are listed as co-permittees at the Kyle WWTF
[6] Aqua Operations,Inc. and Aqua Utilities,Inc. are subsidiaries of Aqua Texas, Inc., a division of Aqua America, Inc.

recent of these was permitted in February 2013. The permittee for this facility has further indicated that they are willing to work with the Partnership to explore additional options that will help protect riparian integrity and water quality in the receiving stream, including rain gardens, constructed wetlands and/or other stormwater treatment. It is the desire of the Partnership that future developments will look at this as an example of how to protect waterways as urbanization continues and will demonstrate that, with collaborative efforts, voluntary improvements to wastewater treatment can be made in the Plum Creek watershed.

The Partnership suggests that efforts to achieve WPP goals for wastewater management may require additional financial or other incentives to encourage voluntary adoption of higher treatment levels for WWTFs in the Plum Creek watershed. While the implementation of WPP recommendations for WWTFs in the watershed is completely voluntary, TPDES permit limitations and requirements are enforceable under State law. The operation of WWTFs can be lucrative, and in some cases, companies may consider the penalties assessed by regulatory agencies for permit violations minimal compared to making the necessary infrastructure and system improvements to ensure sustained permit compliance. TCEQ and other regulatory agencies could consider stricter regulatory policies, including more substantial fines and additional monitoring requirements, to deter repeated violations from poorly performing facilities, particularly those discharging into threatened and impaired waterways such as Plum Creek. The anticipated adoption of new statewide water quality standards for nutrients for freshwater streams will serve to further protect water quality in the Plum Creek watershed.

WASTEWATER MANAGEMENT

Major permit violations and water quality concerns at two watershed WWTFs

While the utilization of a robust outreach and education strategy along with providing funding and incentives for the voluntary enhancement of WWTFs has been the primary focus of the Partnership's approach to managing point source discharges in the watershed, serious permit violations, including a series of illicit discharges totaling well over 1 million gallons of untreated and partially treated wastewater due to operational failings at the City of Kyle WWTF (WQ0011041002) in 2010, 2012 and 2014, have led to revised strategies for addressing the management of WWTFs in the Plum Creek watershed (Figure 6). Data reveal that significant levels of bacteria and other pollutants have been regularly discharged into the upper segments of the watershed in effluent from the Kyle WWTF, operated by Aqua Operations, Inc., since voluntary monitoring was initiated in April 2011 (see Table 18)[7]. Further, a series of permit violations including "failure to maintain proper safeguards to prevent illicit discharge during power outage" and the discovery of extremely elevated concentrations of *E. coli* and total suspended solids (TSS) in the facility's effluent resulted in enforcement orders issued to Aqua Utilities, Inc. in 2010[8] and in 2014[9] for operational failings at the Goforth WWTF (WQ0013293001). The aforementioned violations are of utmost importance to the Partnership as the downstream impacts from these illicit discharges are assumed to be significant; however,

[7] Operational duties of the City of Kyle WWTF have been designated to Aqua Operations, Inc., through a binding contract between the City of Kyle and Aqua Operations, Inc.

[8] Agreed Order, Docket No. 2009-1962-MWD-E - "Failure to maintain adequate safeguards to prevent illicit discharge during power outage"

[9] Agreed Order, Docket No. 2013-0901-MWD-E - *E. coli* single grab, TSS daily average conc., TSS single grab conc., TSS daily average loading

the extent to which the effects are being realized is difficult to quantify. Heightened dialogue among the Partnership, WWTF permittees and TCEQ staff has been facilitated by the Steering Committee to address concerns and evaluate solutions.

In addition to reported permit violations, a voluntary monitoring program funded by CWA §319(h) grant funds, has revealed *E. coli* concentrations in the Kyle WWTF effluent exceeding the water quality standard for contact recreation of 126 most probable number per 100 milliliters (MPN/100mL) in 48.6% of samples taken from April 2011 through December 2013[10]. Five sampling events at the Kyle WWTF revealed *E. coli* concentrations in excess of 1,000 MPN/100mL. The monitoring program, which collects water quality data from six additional WWTFs in the watershed, revealed *E. coli* concentrations exceeding 126 MPN/100mL in only 2.2% of the total samples (5 of 218) collected from these sites over the same period. It is important to note that the monitoring program implemented at the selected 7 WWTFs is part of a voluntary program for the purpose of data collection only and evaluates a broad set of parameters to determine overall potential impacts to receiving waters from the discharge of effluent from WWTFs. The data collected through this program is not reported to TCEQ and cannot be used for consideration of permit violations. The TPDES permit for the City of Kyle WWTF does not currently include *E. coli* limits; however, this parameter will be included in any permit authorized for the facility subsequent to the expiration of its existing permit in February 2015. For a review of recent permit violations by the Kyle WWTF and Partnership response, see *Appendix B.*

Figure 6. Sludge filling Plum Creek downstream from Kyle WWTF looking west from Heidenreich Road (left), Tankers pump sludge from Plum Creek near Kyle WWTF outfall (right), November 21, 2012. Note damage to riparian vegetation. Photos by Nick Dornak, WC

[10] *E. coli* concentrations in 18 of 37 samples collected monthly during the monitoring period exceeded 126 MPN/100mL

Kyle Water Reuse Feasibility Study

The City of Kyle recently completed a study in November 2012 to determine the feasibility of implementing the Region L water supply strategy of using reclaimed water from WWTF effluent by identifying potential users and costs of expanding an existing single user system. The one year study was 100% grant funded by the TWDB (50%) and the Bureau of Reclamation (50%). The Partnership was represented on the Technical Advisory Group. The study's objectives included: identifying viable means of implementing the regional objective of conserving the Barton Springs/Edwards Aquifer groundwater resources and Guadalupe River surface water resources through water recycling and reuse; reduce the annual discharge of nutrients to Plum Creek; provide sustainable water sources for the continued growth of Kyle; meet the increasing recreation service expectations of a growing community.

The assessment by the staff of the Barton Springs/Edwards Aquifer Conservation District (BSEACD) indicates that, as currently conceived and proposed, the water re-use project by the City of Kyle should not encounter or be accompanied by adverse impacts on the local or regional groundwater resources. Conversely, there exist both the likely benefits of a desired overall reduction in the waste contaminant loadings to Plum Creek downstream of the project area, and the potential benefit of reducing the demand on the Barton Springs segment of the Edwards Aquifer during extreme drought conditions by substituting reclaimed water for some part of the demand for irrigation water. The assessment did not attempt to quantify those positive impacts. The conclusions drawn by BSEACD are largely based on the location of all the project elements on the much less sensitive transition zone and the absence of certain pathways to affect important regional and local aquifer systems. BSEACD staff believes that the project would benefit from the following recommendations and suggestions:

1) Future modifications to the reclaimed-water distribution and irrigation systems should not extend into the contributing transition zone without a more complete assessment of risks, and must not extend into the recharge zone, regardless of its status regarding compliance with the Edwards Rules.
2) The City should work with the BSEACD to implement an arrangement to achieve additional extreme drought pumping curtailments of its Historical Use Production Permit in order to increase and assure the project's propounded potential benefit of reducing pumping on the Barton Springs aquifer and thereby preserving of the Desired Future Condition (DFC) established for the freshwater Barton Springs segment of the Edwards Aquifer, in exchange for some valuable policy consideration.
3) The City should ensure the reuse project is included in the next revision of the Region L Water Plan to account for its benefits in regional and state water planning and to make the project eligible for additional attractive funding by the Texas Water Development Board.
4) Before the project is implemented, the City should make a thorough compilation of existing data, walking surveys, and analysis of areal imagery to identify any potential abandoned wells, and ensure that abandoned wells are properly plugged (and newly discovered existing wells are avoided.)

5) After the project details are finalized and before the project is approved, the City should continue to engage the various regulatory entities in identifying and assessing their potential regulatory issues with the project.
6) As part of the process in finalizing the project, the City should highlight the project's shared benefits between the City and both BSEACD and the Partnership, and identify those benefits as key objectives of the project; the City should then consider entering into interlocal agreements or MOU's with one or both of those entities for the purpose of achieving those benefits with more certainty.
7) The City should conduct a field reconnaissance prior to construction of the reclaimed-water distribution system to assess wells in the vicinity of the distribution lines and irrigation areas that obtain water from the Austin Chalk, and to inspect and repair any such wells for openings that could allow entry of reclaimed water into the well bore.
8) The City should also inspect the EAA public water supply wells and the well that provides water to the Plum Creek Golf Course, which are relatively close to the project's major distribution lines, for any openings at the well heads that could allow for movement of contaminants in to the wells, and/or also consider providing a larger buffer in the routing of the effluent lines around those wells.

Buda Water Reuse Project

The City of Buda has completed its Wastewater Treatment Plant (WWTP) Expansion from 0.95 MGD to 1.5 MGD. As part of this expansion project, the City has installed reuse pipe from the WWTP to the City Park property on the south side of the WWTP. The City has received a Chapter 210 permit modification from TCEQ to allow the distribution of reuse water to additional locations that were not included in the original permit authorization. A bulk reuse station is in operation for construction use immediately south of the Public Works Department that will allow contractors to utilize reuse water instead of potable water for construction projects.

Previously, the City of Buda installed purple pipe along most of Main Street from Old San Antonio Road through Stagecoach Park to Public Works, and along Cabela's Drive from Main Street to Old San Antonio Road. These lines are being used to provide reuse water to customers along Main Street and Cabela's Drive. These lines will provide irrigation to the main street medians, City Park, and the Sportsplex. In addition, there is potential for use of this water for irrigation by Cabela's, the new Microtel Hotel, the new Noah's Ark Self Storage, the proposed multi-family development at the southwest corner of the Cabela's tract, Creekside Villas, Texas Lehigh Cement, and by Nighthawk Foods for reuse water to replenish their cooling towers.

Sewer Pipe Replacement and New Sewer Service

The cities of Buda, Kyle, Lockhart, and Luling have budgeted city funds to replace aging wastewater conveyance infrastructure. In some areas, sewer lines consist of outdated clay pipes that are easily damaged and typically are beyond their original design life. These cities continue to move forward with replacement of critical areas within city limits. The Cities have made varied progress in replacing sanitary sewer pipes since the WPP was published (Table 4).

Table 4. Sewer line repaired, replaced and/or extended by Plum Creek watershed cities since WPP implementation.

City	2008 – 2011 Sewer Line Repaired/ Replaced (linear feet)	2012 – 2013 Sewer Line Repaired/ Replaced (linear feet)	Notes
Buda	1,500	*8,523*	*$1.4M projected cost for replacing 8,523 ft. of pipe 2012-14.* WPP Goal, Yrs. 1-6 = 8,523
Kyle	4,660	None reported	$432,000 spent 2008 through 2011 on repairs and extensions to 50 new homes. No large scale sewer line replacement since 2011 due to budgetary constraints. Funding will continue to be requested in 14-15. WPP Goal Yrs. 1-6 = 4,800 ft.
Lockhart	4,000	1,470	$39,500 spent 2012 through 2013. WPP Goal, Yrs. 1-6 = 3,600 ft.
Luling	*None reported in the watershed	*None reported in the watershed	*$1.7M spent extending new service to 50 homes and businesses in the *San Marcos River watershed.* WPP Goal Yrs. 1-6 = 4,800 ft.
Totals	**10,160**	**9,993**	**20,153**

New E. coli Effluent Limits and Monitoring Requirements for Permitted WWTFs

As of December 31, 2009, TCEQ, through the Texas Pollutant Discharge Elimination System (TPDES), requires bacteria effluent limits and monitoring requirements in all WWTF permits. These requirements will be a part of permit language for all TPDES permits for which a Notice of Application and Preliminary Decision is published on or after January 1, 2010 and will include *E. coli* monitoring of all facilities and new *E. coli* limits consistent with ensuring that WWTF effluent water quality meets or exceeds *E. coli* standards for contact recreation.

Most facilities in the watershed renewed their permits during 2008-2010, but six of the twelve permits were renewed without the *E. coli* limits and one permit expired. The new monitoring requirements for *E. coli* limits for the remaining WWTFs will be considered by March 2015. Table 5 identifies permit details for all permitted WWTFs in the watershed, including current *E. coli* limits, if any, and those to which TCEQ has applied the new *E. coli* effluent limits and monitoring requirements. More stringent limits to improve effluent remains a high priority in the watershed, despite facing significant financial hurdles associated with improved treatment process costs.

Table 5. TPDES wastewater discharge permits in the Plum Creek watershed.

FACILITY NAME	Type of Disinfection	MAX PERMITTED FLOW (MGD)	PERMIT NUMBER	EFFECTIVE DATE	EXPIRATION DATE	*E. coli* effluent limits	*E. coli* effluent monitoring requirements
KYLE	Chlorine	3/4.5	WQ0011041-002	02/04/2010	02/01/2015	no limit in either phase[1]	no monitoring requirement in either phase[1]
LOCKHART NO. 2 (FM 20 Plant)	UV	1.5	WQ0010210-002	02/04/2010	02/01/2015	126 cfu/100mL daily avg[2]; 394 cfu/100mL daily max	once per day
BUDA	Chlorine	0.6/0.95/1.5	WQ0011060-001	02/16/2010	02/01/2015	no limit in either phase[1]	no monitoring requirement in either phase[1]
LOCKHART NO. 1 (Larremore Street Plant)	Chlorine	1.1	WQ0010210-001	03/04/2010	02/01/2015	126 cfu/100mL daily avg[2]; 394 cfu/100mL daily max	once per week
LULING-NORTH	Chlorine	0.9	WQ0010582-002	4/11/2014	02/01/2017	126 cfu/100mL daily avg[2]; 399 cfu/100mL daily max	twice per month
RANCH AT CLEAR FORK	Chlorine	0.33/0.7	WQ0014439-001	10/30/2013	02/01/2016	126 cfu/100mL daily avg[2]; 399 cfu/100mL daily max	once per month
NIEDERWALD (Brushy Creek WWTP)	Chlorine	0.075/0.122/0.25	WQ0014762-001	09/21/2010	03/01/2015	n/a – permit expired	n/a – permit expired
RAILYARDS-PARKLAND	UV	0.35	WQ0014165-001	07/28/2005	02/01/2010	n/a – permit expired	n/a – permit expired
RAILYARDS-VILLAGE HOMES	Chlorine	0.075/0.12375	WQ0014060-001	05/11/2010	02/01/2015	126 cfu/100mL daily avg[2]; 394 cfu/100mL daily max	once per quarter
GOFORTH	Chlorine	0.0424	WQ0013293-001	04/13/2010	02/01/2015	126 cfu/100mL daily avg[2]; 394 cfu/100mL daily max	once per week
SUNFIELD	Chlorine	0.25/0.5/0.99	WQ0014377-001	01/29/2014	02/01/2017	126 cfu/100mL daily avg[2]; 399 cfu/100mL daily max	once per month
SHADOW CREEK (formerly CASTLETOP)	Chlorine	0.162/0.486	WQ0014431-001	02/22/2010	02/01/2015	no limit in either phase[1]	no monitoring requirement in either phase[1]
CROSSWINDS	Chlorine	.20/0.481	WQ0015011001	02/20/2013	02/01/2015	126 cfu/100mL daily avg[2]; 394 cfu/100mL single grab	once per month

[1] Language in "Other Requirements" – The permittee is hereby placed on notice that the Executive Director of the TCEQ will be initiating rulemaking and/or changes to procedural documents that may result in bacteria effluent limits and monitoring requirements for this facility.

[2] Language in "Definitions" defines *daily avg* as the arithmetic average of all effluent samples as required by the permit within a period of one calendar month consisting of at least four separate measurements.

New 5-5-2-1 Discharge Permit in the Plum Creek Watershed

In February 2013, a permit to discharge was granted to EB Windy Hill, L.P. for the Crosswinds WWTF (WQ0015011001). The permit authorizes the discharge of treated domestic wastewater at a daily average flow not to exceed 0.20 million gallons per day in the interim phase and a daily average flow not to exceed 0.40 million gallons per day in the final phase. The plant will be located on the south end of Mockingbird Lane, approximately 2 miles east of the intersection of Interstate Highway 35 and County Road 122 (Bebee Road) in Hays County. The treated effluent will be discharged to Porter Creek which flows into Soil Conservation Service (SCS) Site 6 Reservoir, to Porter Creek, to Bunton Branch and finally into Plum Creek. The unclassified receiving water has a high aquatic life designated use for the Porter Creek and SCS Site 6 Reservoir portions.

A settlement agreement between watershed landowners and the developers was finalized in 2012. In addition to meeting 5-5-2-1 permit limits encouraged by the Partnership, the developers have indicated that they are willing to explore options including rain gardens, constructed wetlands and/or other stormwater treatment that will help protect riparian integrity and water quality in the receiving stream. It is the desire of the Partnership that future developments will look at this as an example of how to protect waterways as urbanization continues, and will demonstrate that with collaborative efforts, voluntary improvements to wastewater treatment can be made in the Plum Creek watershed. The settlement highlights are as follows:

- Stringent effluent limits of 5-5-2-1, with voluntary inclusion of biological denitrification treatment.
- Reporting of effluent monitoring data to the Partnership
- Land application of effluent under a 210 Reclaimed Water Re-use Authorization, including irrigation on undeveloped property phases in an effort to delay the discharge of effluent to the creek.
- Mitigation of potential nuisance conditions by inclusion of an enclosed headworks with charcoal air filtration system, noise-proof enclosed blower system and backup generation, as well as observation of "Dark Skies" recommendations to limit nighttime lighting

Numerous discussions and an official meeting of Steering Committee members and executives with Walton Development and Management regarding TPDES Permit No. WQ0014439-001 for the proposed Ranch at Clear Fork WWTF were unable secure the inclusion of voluntary 5-5-2-1 permit limits prior to permit renewal for the unconstructed facility in 2013. The permit allows for the discharge of 0.0424 MGD of treated wastewater into Clear Fork Plum Creek from a proposed new development near Uhland, TX. Conversations with Walton regarding the Plum Creek WPP and Steering Committee recommendations including stormwater management, options for water reuse, TLAPs, LID and water conservation measures will continue in 2014.

Voluntary Effluent Monitoring by WWTFs

The Buda, Lockhart, Shadow Creek, and Sunfield wastewater treatment facilities in the Plum Creek watershed voluntarily initiated monthly *E. coli* and even some phosphorus monitoring with their own financial resources. The monitoring of parameters not included in a WWTF's permit is considered voluntary and the resulting data are not required to be sent to TCEQ. This monitoring is conducted by each WWTF and is separate from the TSSWCB CWA §319(h) grant for targeted sampling in the Plum Creek watershed that includes monitoring of WWTF effluent.

The Lockhart facilities have voluntarily collected phosphorus data both upstream and downstream from their facilities on a periodic basis using their own financial resources. Results of the targeted water quality monitoring program indicate this should be a priority at all facilities to improve understanding of the role of point sources in nutrient enrichment, which appears to be significant. Removing phosphorus remains a high priority in the watershed, despite facing significant financial hurdles associated with improved effluent treatment.

The Partnership also participated in numerous discussions with TCEQ in pursuit of unannounced inspections to provide additional information on loading from point sources; however, no unannounced inspection program has been implemented by TCEQ in the watershed.

Phosphorus Removal

Many WWTFs in the Plum Creek watershed currently do not have phosphorus limits. As a result, phosphorus concentrations in effluent frequently are significantly greater than the screening criteria, particularly in the effluent and downstream of those facilities without phosphorus limits. The Partnership believes it is imperative that point sources be worked with more closely by the regulatory authorities to reduce these substantial and clearly defined nutrient contributions. It is expected that TCEQ will adopt new statewide water quality standards for nutrients for freshwater streams in the future. The incorporation of nutrient limits into TPDES permits serves as an excellent and highly anticipated next step in this process. Load Duration Curves (LDCs) for nutrients using the State's screening criteria's as the target water quality load were developed at each of the three routine stations. Load reductions for total phosphorus based on the LDCs in the WPP resulted in a need for a 27% reduction at the Uhland Station 17406, 5.4% reduction at the Lockhart Station 12647, and no reduction at the Luling Station 12640.

Recommended Facility Upgrades

Efforts to obtain funding for the installation of Supervisory Control and Data Acquisitions (SCADA) systems for all lift stations and WWTFs in the Plum Creek watershed have been strongly encouraged but largely have not been undertaken due to the need for increased financial investment. After the 2010 wastewater spill from the Kyle WWTF of over a million gallons into the Plum Creek and subsequent fish kill, Kyle and Aqua Source, Inc. installed a SCADA system at the Kyle plant in November 2011. The City receives data that indicate effluent depth at the wastewater lift station, helps monitor the WWTF for a possible overflow, and allows the City to contact the operators of the plant if there are any concerns. While SCADA systems are designed to identify potential overflows, the systems do not indicate water quality concerns in a plant's effluent nor was the SCADA system installed at the Kyle WWTF able to predict or prevent the disruptions that took place at the Kyle WWTF in November and December 2012.

Plum Creek Community Wet Well at the Kyle WWTF Experiences Difficulties

Construction of a new wet well with bar screens began in November 2011 to reduce suspended solids in effluent from the Kyle WWTF to be used for irrigation at the Plum Creek Community Golf Course. The bar screens were designed to collect suspended solids, algae, and plastics that have caused pump clogging in the past so they can be sent to a grinder and then pumped back to the front of the WWTF System for retreating. In the weeks leading up to the major disruption and the Kyle WWTF and subsequent notification of the spill to TCEQ on November 20, 2012,

the manager of the golf course contacted the Partnership, as the wet well was collecting sludge and other materials from post-treatment WWTF effluent. The materials caused the bar screens to clog significantly and the grinder pumps were no longer working. Figures 7 and 8 reveal evidence of the clogged bar screens and sludge in the wet well as early as November 3, 2012.

Figure 7. Clogged bar screens, Plum Creek Community Golf Course, Nov. 3, 2012.

Figure 8. Sludge in wet well, Plum Creek Community Golf Course, Nov. 3, 2012.

Septic System Connection to Sewer

The Partnership continues to work with Hays County and the City of Buda on a project to connect a 264-home subdivision (Hillside Terrace) located in Plum Creek subwatershed UH-3 to central sewer service. This project is located in Hays County and is in the Buda Extraterritorial Jurisdiction (ETJ). This subdivision has been identified by local citizens and city and county staff as a site of chronically failing septic systems on small lots and is located in a critical subwatershed identified in the watershed planning process as having a high likelihood of impacting water quality. An unnamed tributary of Andrews Branch passes through and drains much of this neighborhood before it flows into Andrews Branch and Porter Creek that meets with Bunton Branch just before entering Plum Creek upstream of the Uhland water quality monitoring site. Pre-application meetings were held with the TWDB Economically Distressed Areas Program. This program provides funding for water and wastewater projects in economically distressed and disadvantaged areas. However, the program requires adoption and use of model subdivision regulations by both the City and County. Through an extended assessment process, it was determined that Hays County had several areas where recently approved and adopted revisions to county development regulations were not sufficient to meet TWDB program requirements. As a consequence, no funding could be obtained through this program.

Subsequently, AgriLife Extension worked with Hays County and the City of Buda to conduct a socioeconomic survey of Hillside Terrace residents and develop an application for the TWDB Clean Water State Revolving Fund (CWSRF) Intended Use Plan for 2012. The survey indicated an annual median household income of $25,500, and qualified the project area as a disadvantaged community with potential to receive up to 70% loan forgiveness. The project is categorized as a nonpoint source project which also places it in a separate ranking category of NPS projects. The Hillside Terrace project for $5,600,000 ranked third in the NPS projects

category with a score of a 71, but the small amount of loan forgiveness money was all utilized by the first project.

The Partnership continued to work diligently with Hays County and City of Buda officials throughout 2012 and 2013 to refine and submit a new CWSRF application to secure planning and design funding for the Hillside Terrace project, this time meeting with success. In 2013, the City was notified that it had been selected to receive a loan from the TWDB to prepare design drawings for the construction of a wastewater collection system for the Hillside Terrace Subdivision at a cost of just over $400,000. The TWDB is providing 70% loan forgiveness for the project which will be completed in 2014. With exceptional support for this project from Hays County, the City of Buda entered into an Interlocal Agreement with the County to cover the additional 30% ($120,000) of project cost not covered by loan forgiveness. The City intends to submit an application for construction funding once the design plans have been approved. Construction of the wastewater improvements will result in removing approximately 264 failing on-site wastewater systems from operation.

The $5,600,000 total cost and infrastructure installation for the Hillside Terrace project will require a substantial commitment of time and resources from the City of Buda and Hays County to be completed successfully. The Partnership will continue to work with the City and County to achieve additional funding for this project. The TCEQ has designated grants funds for the decommissioning of failing OSSFs, which could help to offset a significant portion of the Hillside Terrace construction costs. Another potential future funding option for wastewater and water issues in the watershed that will be explored is Texas Department of Agriculture (TDA) Community Development Block Grant funds.

Wastewater in the Counties

Both Hays and Caldwell Counties adopted new policies and regulations in 2011 to ensure proper maintenance for new and existing aerobic septic systems. In Caldwell County and the City of Uhland, owners of both new and existing aerobic systems are required to have a quarterly maintenance contract with an approved list of contractors developed by the TCEQ. Hays County does allow homeowners to maintain their own aerobic systems; however, they are required to complete an extensive training course.

Conventional septic systems in the Plum Creek watershed do not have the same requirements as aerobic systems. As a result, maintenance of such systems is frequently neglected, and problematic systems often are reported only when a complaint is filed by a neighbor or other individual due to standing water and smell. If problems are severe enough to cause surfacing of wastewater, it is very likely that system failure has been occurring underground for an extended period of time. These situations can only be prevented if all systems are required to undergo regular inspection and maintenance. The general lack of septic system maintenance and inspection requirements for conventional systems has created a significant obstacle to addressing septic system contributions to the water quality impairment in Plum Creek.

Hays County has been tracking their complaints and violations regarding septic systems in a database. From December 2011 through January 2014, 245 systems were inspected with 163 found to be in violation. A total of 151 of the systems in violation have since completed the

necessary measures to be back in compliance, by repairs, pumping, disconnecting additional structures or installing new systems. Since 2008, 359 total systems in Hays County have been found in violation *and* completed the necessary steps to be in compliance[11]. From December 2011 through January 2014, the Caldwell County Sanitarian and Caldwell County Constables inspected 30 OSSFs on suspected septic system violations. Twenty-two cases were reported to have been resolved while 8 remain in either the Caldwell County District Attorney's Office or with a Caldwell County Justice of the Peace. According to the Caldwell County Sanitarian, a total of 303 new septic permits have been issued in the County since January 2011 with 220 issued over the December 2011 through January 2014 reporting period for this Update.

Education and outreach efforts to improve homeowner awareness of the importance of proper septic system use and maintenance have been identified as a critical element for achieving WPP pollutant reduction goals and have been ongoing in the watershed since 2008. Three additional workshops have been planned for watershed homeowners in 2014, including one conventional OSSF maintenance workshop to be held in Caldwell County and two aerobic system operation workshops set for Hays County.

[11] Plum Creek WPP goal for septic systems in Hays and Caldwell Counties, Years 1-6 = 600 repaired / 300 replaced.

Agricultural Nonpoint Source Management

The Caldwell-Travis SWCD in cooperation with the Hays County SWCD have received more than $360,000 from TSSWCB CWA §319(h) nonpoint source grants in FY08, FY12 and FY13 to provide technical assistance for development of TSSWCB-certified Water Quality Management Plans (WQMPs). The grants also provide financial incentives to implement certain BMPs prescribed in the WQMPs. The Caldwell-Travis SWCD hired a technician in May 2009 to provide the technical assistance and implement the program in the Plum Creek watershed within Caldwell and Hays Counties. Due to extreme drought and difficult economic times initial landowner interest in the program was very low; a lot of producers have not been in a position to assume new financial obligations. Overall, livestock numbers and crop production activities in the watershed have been much lower than in previous years.

These recent weather patterns have substantially affected pollutant loading characteristics in the primary agricultural subwatersheds. Decreased plant cover likely resulted in greater loss of soil and associated nutrients in many areas when rainfall occurred. Although fewer numbers of livestock may have reduced overall bacteria loading during this period, remaining animals may have concentrated near riparian areas with perennial water sources that often provided the only source of forage. Producers are keenly aware of the need to replace lost vegetative cover and continue to seek options for rehabilitating their properties.

Texas A&M AgriLife Extension and the SWCD Technician have promoted interaction between the Steering Committee and the U.S. Department of Agriculture – Natural Resources Conservation Service (USDA-NRCS) Local Work Groups to blend the goals of the Plum Creek WPP with the resource concerns and conservation priorities for the Environmental Quality Incentives Program (EQIP). Recommendations from the Local Work Groups assist USDA-NRCS in allocating EQIP county base funds and with resource concerns for other USDA Farm Bill programs.

The Caldwell-Travis SWCD and TSSWCB continue to investigate and adjust the suite of approved management practices for the program as requests from landowners are received and evaluated. While the maximum reimbursement rate for financial incentives (funded through the 319(h) grant) are set at 60%, the Caldwell-Travis SWCD will annually adjust the average price of practices to remain competitive with current market rates.

At times efforts to adjust approaches and tailor programs to local needs can be challenging. For example, an ongoing study at Texas A&M University, funded by the TSSWCB, indicates that shade structures may reduce the percent of time cattle spend in riparian areas by 11-31% and thus are expected to result in similar reductions in direct deposition of manure and associated bacteria and nutrients into these areas. At this time, NRCS does not have a Practice Standard for alternative shade structures approved for use in Texas; therefore, even though the use of alternative shade structures may be encouraged within the watershed, without a practice standard, financial incentives for this practice cannot be provided through either TSSWCB or NRCS. The TSSWCB and Texas A&M University are working to provide the NRCS with the necessary scientific basis to develop a practice standard for shade structures in Texas. NRCS will

continue to work with individuals, groups, federal agencies and state agencies to include new and/or innovative technologies as they are developed and proven through scientific research.

Adjustments to the program have included an increase from $10,000 to $15,000 maximum per farm for financial incentives. Additional practices with BMP codes for the field office technical guide have been added to the approved list including the well pumping plant (533) and critical area planting (342). The current list of approved practices for funding through the 319(h) grant includes:

- Riparian Herbaceous Buffers (390): Establishes an area of grasses, grass-like plants, and forbs along water courses to improve and protect water quality by reducing the amount of sediment and other pollutants in runoff as well as nutrients and chemicals in shallow groundwater.
- Grassed Waterways (412): Natural or constructed channel shaped or graded and established with suitable vegetation to protect and improve water quality.
- Riparian Forest Buffers(391): Established an area predominated by trees and shrubs located adjacent to and up-gradient from watercourses to reduce excess amounts of sediment, organic material, nutrients, and pesticides in surface runoff and excess nutrients and other chemicals in shallow groundwater flow.
- Watering Facilities (614): Places a device (tank, trough, or other watertight container) for providing animal access to water and protects streams, ponds, and water supplies from contamination by providing alternative access to water.
- Field Borders (386): Establishes a strip of permanent vegetation at the edge or around the perimeter of a field to protect soil and water quality.
- Filter Strips (393): Establishes a strip or area of herbaceous vegetation between agricultural lands and environmentally sensitive areas to reduce pollutant loading in runoff.
- Nutrient Management (590): Manages the amount, source, placement, form, and timing of the application of plant nutrients and soil amendments to minimize agricultural nonpoint source pollution of surface and groundwater resources.
- Cross-Fencing (382): Facilitates the implementation of a rotational grazing system by creating multiple fields for forage utilization by livestock. This practices improves forage and stream health by excluding livestock from areas for a given period of time.
- Pipelines (516): Facilitates the transportation of water source to a watering facility for livestock.
- Water Well (642): Provides groundwater that will be transported and used by livestock.
- Pasture and Hayland Planting (512): Establishes a permanent vegetative cover of improved grasses, either seeded or vegetative, to be utilized by livestock for forage.
- Rangeland Planting (550): Establishes a permanent vegetative cover of native grasses to be utilized by livestock for forage.

Through dedicated efforts of the local SWCD Technician, participation from watershed landowners continues to improve, with 16 plans certified or in development, to date. The

current listing of certified plans and plans in development for each subwatershed may be found in Table 6 (livestock operations) and Table 7 (cropland operations).

The WQMP goals for the Plum Creek WPP have been more difficult to attain than first anticipated due to difficult economic situation, drought cycles, and the loss of time in the hiring and training of the technician. Changes in WQMP goal totals may need to be adjusted for the remaining years to reflect the current status of the program. The current SWCD Technician workplan is designed for the certification of 15 new WQMPs over a span of 3 years. Noting that the 2018 goal of the Plum Creek WPP is to have 235 WQMPs on livestock operations and 24 WQPMs on cropland operations, the District Technician shall strive to develop additional WQMPs beyond the minimum of 15. Continued emphasis will be placed on outreach to the agricultural community to increase program participation. The SWCD Technician will work closely with the WC

Table 6. Recommended number of management plans for livestock operations by subwatershed.

Region	Subwatershed	Animal Units	Farms	Conservation Plans Needed	Certified Plans	Plans in Development
Uhland	UH-1	493	10	6	0	0
	UH-2	403	8	5	0	0
	UH-3	731	15	10	0	0
	Region Total	1628	33	21	0	0
Lockhart	LO-1	1024	20	3	0	0
	LO-2	327	7	1	0	0
	LO-3	717	14	2	0	0
	LO-4	852	17	3	0	0
	LO-5	882	18	3	0	0
	LO-6	1751	35	5	0	0
	LO-7	2019	40	6	0	0
	LO-8	506	10	2	0	0
	LO-9	828	17	2	0	0
	LO-10	1117	22	3	0	0
	LO-11	1308	26	4	0	0
	Region Total	11329	227	34	0	0
Luling	LU-1	168	3	1	0	0
	LU-2	748	15	6	1	0
	LU-3	498	10	4	0	0
	LU-4	322	6	3	0	0
	LU-5	1257	25	10	1	0
	LU-6	1879	38	15	2	0
	LU-7	694	14	6	0	0
	LU-8	1027	21	8	0	1
	LU-9	542	11	4	0	0
	LU-10	600	12	5	1	0
	LU-11	1020	20	8	0	0
	LU-12	1787	36	15	0	1
	LU-13	999	20	8	0	0
	LU-14	1662	33	14	1	0
	LU-15	1173	23	10	2	0
	LU-16	1124	22	9	1	0
	LU-17	344	7	3	0	0
	LU-18	986	20	8	2	0
	LU-19	2348	47	19	1	0
	LU-20	1981	40	16	1	1
	LU-21	989	20	8	0	0
	Region Total	22147	443	182	13	3
Total		35101	702	237	13	3

Table 7. Recommended number of management plans for cropland operations by subwatershed.

Region	Subwatershed	Cropland Acres	Farms	Conservation Plans Needed	Certified Plans	Plans in Development
Uhland	UH-1	1374	6	2	0	0
	UH-2	930	4	1	0	0
	UH-3	569	2	1	0	0
	Region Total	2873	12	4	0	0
Lockhart	LO-1	1138	5	2	0	0
	LO-2	149	1	0	0	0
	LO-3	433	2	1	0	0
	LO-4	1163	5	2	0	0
	LO-5	1374	6	3	0	0
	LO-6	742	3	2	0	0
	LO-7	1117	5	2	0	0
	LO-8	1890	8	4	0	0
	LO-9	742	3	2	0	0
	LO-10	222	1	0	0	0
	LO-11	1117	5	2	0	0
	Region Total	10087	44	20	0	0
Luling	LU-1	4059	18	0	0	0
	LU-2	2171	9	0	0	0
	LU-3	2623	11	0	0	0
	LU-4	3143	14	0	0	0
	LU-5	148	1	0	0	0
	LU-6	72	1	0	0	0
	LU-7	1106	5	0	0	0
	LU-8	1890	8	0	0	0
	LU-9	742	3	0	0	0
	LU-10	88	1	0	0	0
	LU-11	500	2	0	0	0
	LU-12	240	1	0	0	0
	LU-13	289	1	0	0	0
	LU-14	88	1	0	0	0
	LU-15	506	2	0	0	0
	LU-16	24	1	0	0	0
	LU-17	70	1	0	0	0
	LU-18	351	2	0	0	0
	LU-19	72	1	0	0	0
	LU-20	30	1	0	0	0
	LU-21	351	2	0	0	0
	Region Total	18563	86	0	0	0
Total		31523	142	24	0	0

Invasive Species Management and Landowner Engagement

In Texas, feral hogs cause a variety of problems including crop, pasture and rangeland damage, predation of livestock, pets, and wildlife, transmission of disease and parasites, and plant communities and other environmental damage. Effects of their activities on water resources include increased sediment, bacteria and nutrient loading, algae blooms, oxygen depletion, and bank erosion. In areas where high numbers of hogs are present or where animals spend a significant portion of their time in and near streams, they can be a major contributor of bacteria and nutrients. This invasive exotic species caused such concern at the national level that they received specific attention from the Office of the President. Executive Order 13112 was issued in 1999 to all federal agencies. This Presidential Document calls upon agencies "whose actions may affect the status of invasive species" to detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner" through "eradicating, suppressing, reducing, or managing invasive species populations, preventing spread of invasive species from areas where they are present."

Overall damage from feral hogs varies widely depending on landuse, population density and a host of other factors. A Texas A&M study conducted in 2004 estimated $51.7M in annual statewide damages to agriculture alone as a result of feral hog activity. Since 2004, wild pig populations have increased along with estimated financial losses. According to a 2011 study conducted by the Texas A&M Institute of Renewable Resources and reported in a Texas A&M AgriLife Extension publication with funding support through a TSSWCB CWA §319(h) grant, the feral swine population in Texas, then estimated at 2.6 million with a margin of error of just over 30%, is estimated to grow at a rate of between 12% and 22% per year (Timmons et al., 2011).

Because of the agricultural and environmental problems posed by feral hogs, it was proposed as a component of a TSSWCB CWA §319(h) to hire a Texas Wildlife Services (TWS) position for direct feral hog control in the Plum Creek watershed. Due to concerns over feasibility and public perception, this component of the grant was not funded by the EPA. However, in light of the importance of managing feral hogs for environmental benefits, the grant was reconfigured to support an AgriLife Extension Assistant to provide one-on-one feral hog management education and offer technical assistance to watershed landowners as they sought to control feral hog damage on their properties. In 2013, the position was reconfigured to extend feral hog education efforts outside of the watershed to a multi-county region. More information on these outreach efforts as they apply to the Plum Creek watershed can be found in the outreach and education Chapter below. The Partnership will continue to work with state agencies that have responsibilities associated with feral hogs in order to advance the discussion with the United States Environmental Protection Agency (EPA) regarding the alignment of established federal priorities for invasive species control (Executive Order 13112 and EPA OWOW Action Plan) with available grant programs (i.e., 319(h)).

Feral Hog Control through November 2011

In addition to the feral hog education component supported through TSSWCB CWA §319(h) funds, the Partnership was able to secure cooperation from TWS with financial support from the TDA to conduct aerial control of feral hogs in 2010. Through flights conducted in January, February, and March 2010, a total of 372 hogs were removed from approximately 40,000 acres in 22 subwatersheds. This project was popular among participating landowners and served to strengthen interest in cooperative management. Additionally, an online self-reporting tool was developed for landowners in the watershed to document harvest numbers. As of November 2011, the removal of 270 feral hogs had been communicated through this tool for a total of 642 feral hogs reported to be harvested in the watershed.

Adaptive Management Strategies for Feral Hog Control

The 2012 Plum Creek WPP Update stated that innovative strategies were urgently needed to promote progress and success in spite of traditional program limitations. The 2012 Update determined that future efforts should be directed toward achieving "participation of a high percentage of area landowners to increase controlled acreage and manage contiguous properties." The Update went on to state that "assistance from state and federal agencies will be necessary to address this challenge".

As the statewide Texas feral hog population continues to skyrocket, landowners in Caldwell and Hays County, with guidance and support from the Partnership, have come together with local government officials, professional trappers and recreational hunters, agricultural organizations, environmental groups, wildlife management associations, outdoor enthusiasts, multiple state agencies, a private helicopter company, a toll road operator and river authority to implement an innovative program that seeks to take this part of Central Texas back from the feral hogs.

Hog Out 2012

While the Partnership was unable to secure funding for dedicated feral hog removal efforts through a TWS staff position, it was determined that significant water quality benefits to Plum Creek could be realized through local initiatives in Caldwell County and Hays County to reduce economic and ecological damage from feral hogs. Funds from the statewide "Hog Out" competition and grant program funded by the TDA, offered Texas counties as much as $20,000 for feral hog abatement efforts based on the success of a 3-month education and eradication program from October through December 2012. After a number of planning meetings with AgriLife Extension, county officials and local landowners, the Partnership was able to facilitate and manage *Hog Out* programs in both Caldwell and Hays County.

As biological evidence was required to verify harvest totals in each county, it was determined that a small bounty program offering $2 per hog would provide some initiative for local hunters and trappers to "turn in their tails" while minimizing potential abuses of the system intended to reward local feral hog removal efforts. In September 2012, County Commissioners in both counties agreed unanimously to provide up to $1,000 toward the bounty effort[12]. The Partnership enlisted the services of local feed stores, Texas Master Naturalists and citizen volunteers to implement the bounty program in each of their respective communities. Small

[12] Caldwell County Commissioners voted to supplement the program with an additional $1,000 in November 2012.

businesses in each county also contributed more than $1,000 in prizes to further incentivize the effort. The Partnership developed a data logging system and produced detailed maps of each county. Bounty participants were required to use these maps to clarify actual harvest location (Figure 9). Twenty-four volunteers who agreed to oversee 6 bounty stations (3 in each county) received one hour of feral hog education from the WC that also included safe handling of biologicals and data entry training. A press release was issued by the Partnership detailing the *Hog Out* program for each county. The news was picked up by local media and word of mouth. Finally, the first feral hog bounty program to include the Plum Creek watershed was launched October 1, 2012.

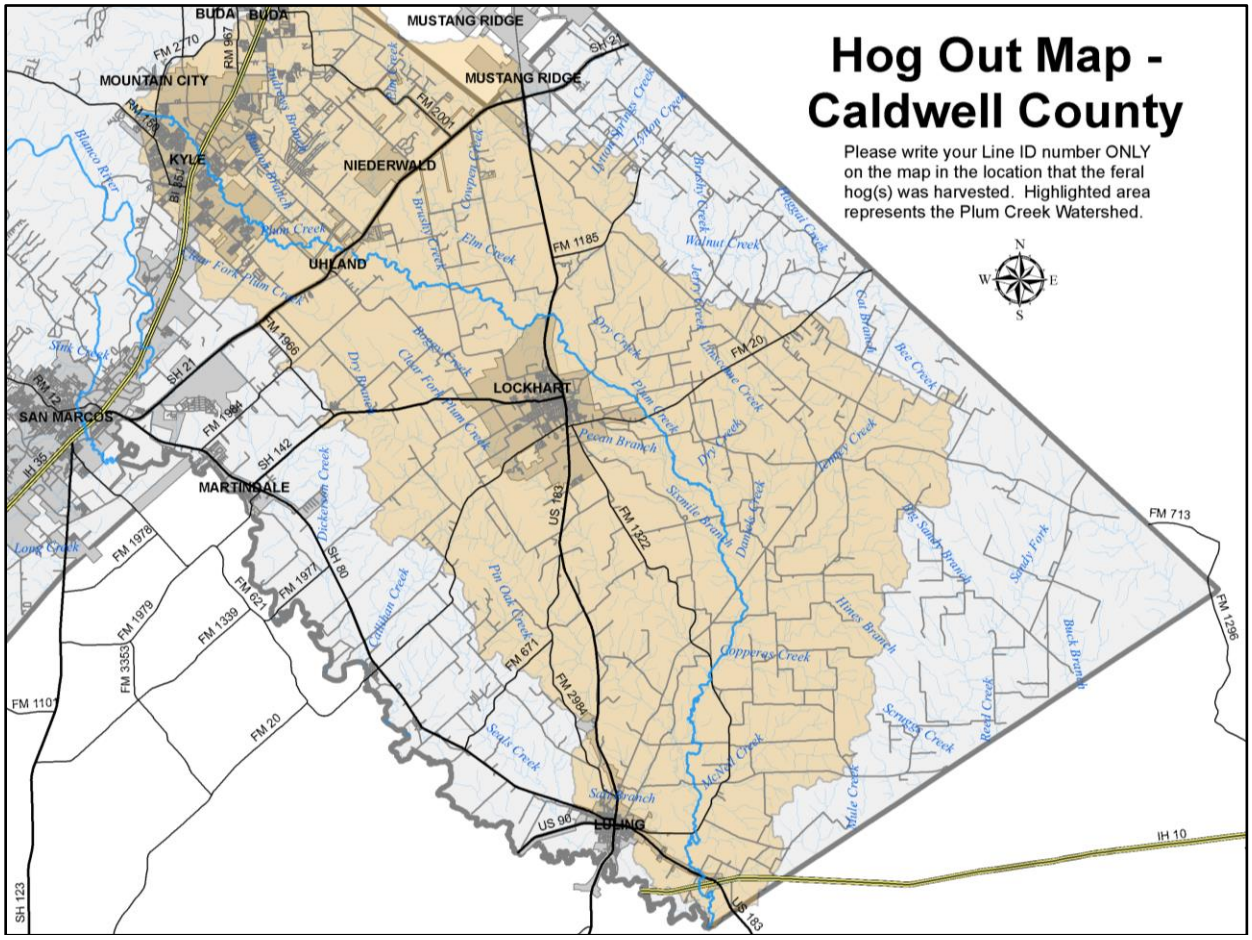


Figure 9. 2012 Caldwell County Hog Out Map.

The second component of the Hog Out competition and grant program was feral hog education. The competition's scoring system was actually weighted toward education, granting 1 point for each individual receiving at least one hour of feral hog education and ½ point for each harvested feral hog. The Partnership worked with AgriLife Extension, a Hays County Commissioner and Cabela's to conduct several workshops in each county. A one-hour feral hog education component was also included in the November 2012 Steering Committee quarterly meeting, which saw attendance more than double from the two-year average. In total 45 individuals attended workshops held in Hays County and 68 individuals were trained in Caldwell County.

In October and November 2012, the presence of feral hogs and reported feral hog-vehicle collisions on the newly opened 130 Toll Road led to nationwide media coverage of the feral hog problem in the watershed and the $2 feral hog bounty program in Hays and Caldwell. The story was featured in countless television and radio news programs as well as newspapers from San Francisco and New York. The WC was interviewed about the program by *The Economist,* the *Austin-American Statesman,* and *Lonestar Outdoor News* among others. A widely syndicated radio show for hunters and outdoor enthusiasts from the Midwest to Canada discussed the program with the WC and inquired as to how their communities should prepare for the inevitable population increase of feral hogs. The popularity of the program eventually led to Animal Planet featuring the WC and several watershed landowners on a documentary program in 2013.

While advertised widely, the bounty program in Hays County documented only 110 feral hogs harvested from October through December 2012. The $2/hog bounty and associated prizes were not enough to motivate participation from Hays County hunters, trappers and landowners. Landowners and County officials acknowledge, however, that feral hogs are a serious concern and continue to cause significant damage to Hays County natural resources. The Hays County program's total score of 100 was not sufficient to earn a TDA grant award in 2012.

In Caldwell County, volunteers verified 902 harvested feral hogs from participants during the 3-month program. The removal of an additional 123 Caldwell County feral hogs was documented by a local helicopter company that had conducted aerial hunting during the reporting period. Caldwell County's total score was 580.5 and ranked 5th in the State. For their efforts, Caldwell County was awarded a $5,000 grant in 2013. These funds were utilized to fund outreach efforts and purchase feral hog population management equipment, including game cameras and a "Smart Trap" system that utilizes a motion sensor and cellular technology to monitor the trap, notify users when hogs are present and allow users to make real-time feral hog management decisions 24-hours per day. Subsequently, a 30' corral designed to work with the Smart Trap system was purchased with funds from a separate grant. This system is part of a cooperative trap sharing program for Caldwell County landowners.

While participation and success was greater than expected in Caldwell County, ultimately, the bounty investment was small in comparison to the exposure that the Partnership received locally for its part in the program. Bringing more national attention to the damaging effects feral hogs have on agriculture and the environment was an unforeseen, but noteworthy, benefit. One of the most critical takeaways from the program was the motivation of Caldwell County landowners and public officials to take an active role in feral hog management efforts. This interest in the feral hog component of the Plum Creek WPP has provided numerous opportunities to engage previously inactive landowners in the Partnership's efforts to implement a multifaceted, balanced approach to water quality restoration in the watershed. In an effort to harness the momentum of the 2012 Hog Out program, the WC met with an enthusiastic group of approximately 20 landowners and concerned stakeholders in January 2013. This group would eventually become the founding members of the Caldwell County Feral Hog Task Force (CCFHTF).

The Caldwell County Feral Hog Task Force

To support AgriLife Extension efforts, and to increase local participation, landowners in Caldwell County, with guidance from the Partnership and WC, established the CCFHTF in 2013.

The first "Feral Hog Planning Meeting" was organized by the WC in January 2013 and was attended by approximately 20 landowners and watershed stakeholders. Additional meetings were held in February, March and May 2013. In March 2013, the group drafted a preliminary action plan for Caldwell County feral hog control efforts. By May 2013, the group transitioned from an ad hoc collection of a few concerned individuals to a recognized task force supported by Caldwell County. Caldwell County Commissioner's Court, *Resolution 16-2013*, established technical and financial support for the CCFHTF for up to 5 years. Now partnering with concerned individuals in Hays County, as well, the CCFHTF is directed by an eight-member Leadership Committee facilitated by the WC and made up of local landowners, representatives for Caldwell and Hays County and technical experts.

Caldwell County – Hays County Feral Hog Action Plan

The developing partnership between the CCFHTF and Hays County eventually led to a final draft of the *Caldwell County - Hays County Feral Hog Action Plan* (*Action Plan*), which was approved by the CCFHTF Leadership Committee in July 2013. The Partnership between the two counties and approved *Action Plan* served as the platform for an application to TDA on behalf of the two counties for grant funding to implement the plan designed to begin in September 2013. The grant, which was to provide 100% matching funds up to $30,000, required significant coordination and involvement of a coalition of local landowners, businesses, agricultural groups, environmental organizations, and county officials to meet local fundraising goals to qualify for the full amount of matching funds. The WC facilitated meetings among Leadership Committee members and potential funding entities, eventually securing $31,000 in matching cash donations along with in-kind matching funds from volunteers, vendors and Caldwell County staff exceeding $24,000. In August 2013, Caldwell County and Hays County officials were notified that they received the first TDA County Hog Abatement Matching Program (CHAMP) grant awarded in the State of Texas. The grant is being managed by the CCFHTF and supports the implementation of year-1 of the *Action Plan.*

The *Action Plan* establishes a short duration, high intensity, feral hog management program for Caldwell and Hays County designed to reduce feral hog populations and related damages in both counties. The CCFHTF used multiple metrics, including the "Feral Hog Population Growth, Density and Harvest in Texas" publication and conference calls with industry experts to provide a basis for determining project goals, objectives and results analyses. Key management components of the project include a $5/hog bounty program, aerial control, three wireless corral traps, a 40' drop net, and a professional trapping company that also operates certified a feral swine holding facility working to coordinate food bank donations through USDA inspected processors. Adaptive management strategies will likely be required as the Leadership Committee assesses quarterly progress and budget reporting. It will take several more years of landowner participation and data collection to determine the true effectiveness of the *Action Plan* to achieve identified feral hog management goals for Hays and Caldwell counties.

The size of feral hog populations in Hays and Caldwell counties is not known. Current estimation methods used in wildlife management are not easily applied to feral hogs, particularly in a project area of this scale. Based on available data, however, a total harvest goal of 5,835 feral hogs in year-one of the *Action Plan* is anticipated to have a marked effect on current feral swine numbers and to serve as a critical first step in achieving flat to negative long-term population growth of the Caldwell and Hays County feral hog population. Additional analyses

will be conducted to determine trends in feral swine economic impacts to landowners. It also anticipated that the goal of removing a large number of feral hogs in one year would have some effect on reducing bacteria loading in Plum Creek and other streams throughout Caldwell and Hays County. The CCFHTF is taking feral hog management to a new level by providing financial incentives, building coalitions and investing in the latest technologies for feral hog control. All programs and equipment are available to any landowner in Hays or Caldwell County at no cost. To facilitate this, the WC worked with the CCFHTF to develop a "Landowner Cooperative Sharing Program."

Implementation of the Action Plan began September 1, 2013. As of March 31, 2014, the documented feral hog harvest total for Caldwell and Hays County was 3,324 (Figure 10) with more than 90% taken in Caldwell County. Through seven months 2,605 feral hogs were removed through the bounty program, 487 were removed during aerial operations from a hired contractor and three flights provided by TWS, and 232 were removed over four months by a professional trapping program (Figure 11). To boost involvement and better track the feral hog harvest in Hays County, a "Log Your Hogs" campaign will be implemented in April 2014 along with a "Hog Hunters Brunch, Awards and Raffle" event in to be held in Kyle.

It is worthwhile to note a substantial drop in the number of feral hogs taken during a March 2014 aerial gunning operation conducted by TWS on approximately 40,000 acres in the Plum Creek watershed when compared to a January through March 2010 operation covering roughly the same treatment area. The 220 feral hogs taken in 2014 represent a 40% drop compared to the 372 taken in 2010, and while the WC recognized the difference could be due to natural variation, it may also reflect the benefits of CCFHTF population and damage reduction efforts. Ultimately, this effort establishes the need for continued evaluation and sustained management utilizing an integrated approach to removing feral hogs from Hays and Caldwell counties.

Reporting by the CCFHTF has exceeded previous attempts to quantify feral hog damage and harvest rates in the Plum Creek watershed, and on a larger scale, Caldwell and Hays County. The Partnership encourages stakeholders to continue feral swine management practices that will serve to improve water quality in the watershed. Further, the Partnership and WC will continue to work with the CCFHTF to develop a sustainable, long-term funding mechanism to continue their efforts in the Plum Creek watershed. To provide more information on CCFHTF programs, a website, www.feralhogtaskforce.com, has been developed and will be launched in 2014.

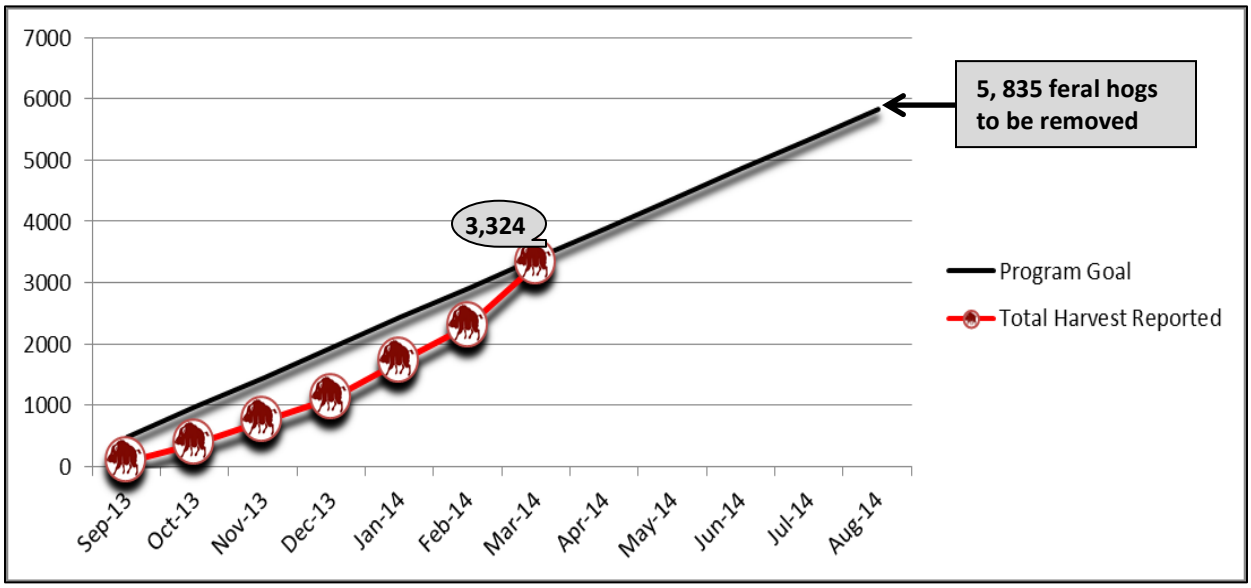


Figure 10. Caldwell – Hays County Feral Hog Action Plan progress September 2013 to March 2014.

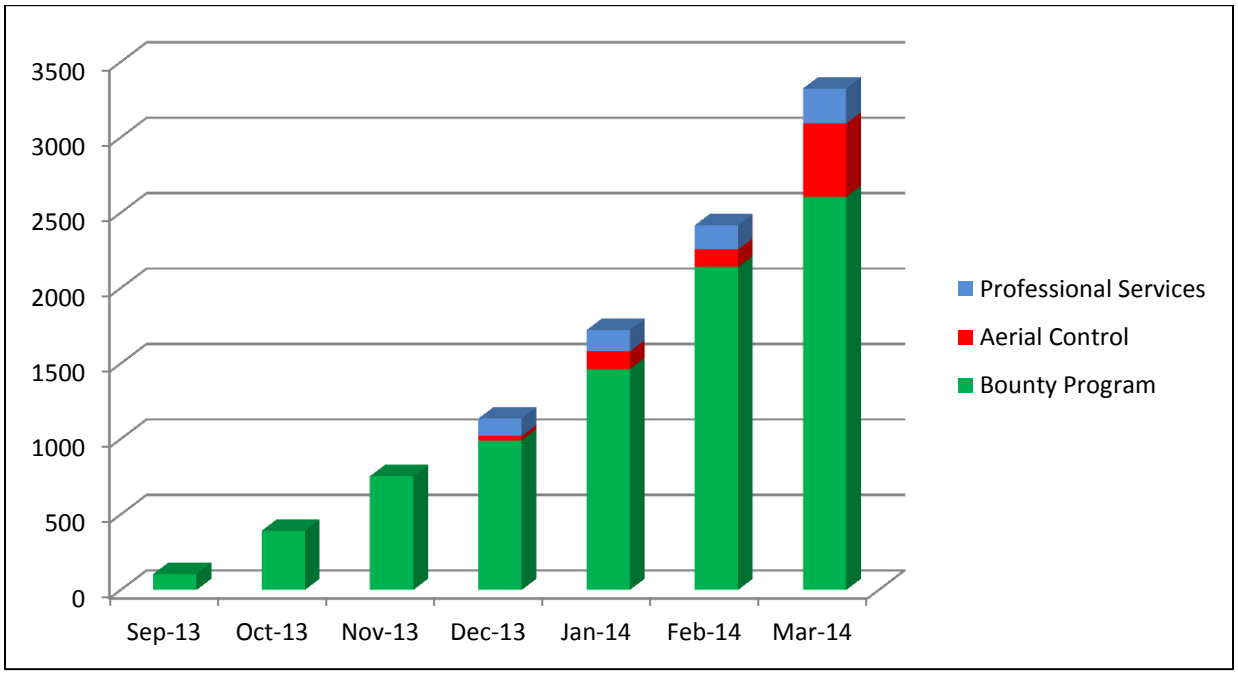


Figure 11. Caldwell – Hays County Feral Hog Action Plan accumulated progress by harvest method September 2013 through March 2014.

Outreach and Education Strategy

PUBLIC OUTREACH

Education of citizens in the watershed to increase awareness and facilitate involvement in the Plum Creek WPP process continues to be of tremendous significance in the push to reduce nonpoint source pollution. Outreach and education will continue to be a key focus of the Partnership's efforts throughout implementation. A major success for the Partnership was the acquisition of TCEQ CWA §106 funds to support the *Taking Charge of Water Quality in the Plum Creek Watershed* project to conduct a significant portion of the educational activities outlined in the WPP. Many of the resources developed through this project have been adapted and utilized in other watersheds across the state, and the effort has received multiple awards for its creativity and effectiveness. In coordination with this project and other Partnership efforts, AgriLife Extension, GBRA, and TSSWCB have produced numerous publications, press releases, and newsletters directed toward watershed stakeholders. Additionally, multiple websites and educational modules have been developed as information and education resources for the public in Plum Creek and across the state.

The WC regularly makes site visits to assist or consult watershed landowners and municipal officials with project planning. At times, the WC has also served as a liaison between landowners and regulatory agencies when questions or concerns arise about possible violations and impacts to water quality. Informal one-on-one or small groups meetings facilitated by the WC have also provided many opportunities for new partnerships, enhanced cooperatives and innovative solutions for water quality concerns in the watershed.

Plum Creek Watershed Protection Plan

The Plum Creek WPP is a 176-page color document that can be found electronically at the Plum Creek Website at http://plumcreek.tamu.edu/WPP. Over 750 copies have been printed and distributed throughout the watershed at Partnership Meetings, city council and county commissioner court meetings, field days, workshops, and other events. Five hundred (500) copies of the 2012 Plum Creek WPP Update have been printed and continue to be distributed at local and statewide meetings, workshops and events. A PDF of the Update may also be downloaded from the website.

Plum Creek Contact List and Targeted Outreach

The Partnership has made great strides to engage stakeholders through enhanced electronic communication protocols defined by a targeted outreach approach focusing on the delivery of user-specific content. Sign-up sheets have been made available at numerous state and local events attended by the WC from 2012 through 2014. In addition to general contact information, individuals are asked to identify any related professional or volunteer organizations with which they are affiliated, as well as to prioritize specific Plum Creek WPP components for which they would like to receive additional information including:

- Feral hog programs
- Water Quality Management Plans
- Volunteer opportunities
- General information

A database organizing Plum Creek contacts into unique categories of interest is managed by the WC. As of March 2014, the Partnership's stakeholder contact list has grown to well over 500 individuals and groups. Emails providing general information about Partnership activities and WPP development are now distributed directly to 423 stakeholders and media outlets. Further, the delivery of project-specific materials and updates can now be directed toward designated audiences and critical stakeholders.

The targeted approach to outreach has also been applied to selected Partnership meetings and other watershed programs. A key objective for the WC was to ascertain and strive to understand local concerns and attitudes toward issues with the potential to impact the watershed. In an effort to harness local energy, enhance stakeholder participation and address community concerns, unique themes focusing on current events in the watershed have been incorporated into press releases and meeting agendas. As a result, quarterly Steering Committee meetings have seen increased public participation.

News Releases

In 2012, responsibility for the development and distribution of news releases transitioned from AgriLife Extension to the Partnership. The WC works with the TSSWCB to develop regional press releases describing important events and key developments in the watershed to further encourage involvement in the implementation process. As of March 2014, fifty-two press releases have directly detailed Plum Creek efforts. Available press releases may be downloaded from the Partnership website library page http://plumcreek.tamu.edu/library/. Articles are publicized through TSSWCB Conservation News, directly distributed to the Partnership through email and Facebook, and publicized through TSSWCB Conservation News and other print media and electronic outlets as appropriate.

Partnership Website and Facebook Page

The Partnership website (http://plumcreek.tamu.edu) is now maintained by the Partnership and hosted by the Texas Water Resources Institute (TWRI) Spatial Sciences Laboratory. The site includes information about the Plum Creek watershed, background on the WPP and the Partnership, links to updated water quality data, information on feral hog control and other management programs, descriptions of outreach efforts, a list of upcoming events, a library of resources developed for the Partnership, and links to project partners and related sites. With an average of 12.5 new viewers every day from December 2011 through March 2014, the number of unique visitors to the Partnership website has doubled over the 27-month reporting period for this Update, bringing the total number of unique visitors to 20,633 since the site's initial launch in 2006. GBRA hosts a separate website with the water quality monitoring data and four online training modules; since this site was initiated in February 2009 it has had a total of 100,624 page views. Table 8 provides a breakdown of feature utilization for GBRA's Plum Creek web page since 2009. The number of page views and rate of new visitors to these websites are valuable metrics for determining the popularity of new projects and sustained interest in existing watershed programs. Maintaining public interest and expanding the reach of WPP programs to new audiences are critical to Partnership sustainability and WPP success. Social media platforms, such as the Partnership's Facebook page, have been created to engage local stakeholders with photos and commentary on Partnership events, announce watershed activities, highlight media coverage and provide links to additional resources. Since December 2011 the number of Facebook "Likes" has grown from 49 to 163. While these are modest

numbers, the ability to expeditiously generate additional local interest in watershed events has been realized with popular posts occasionally reaching 1,000 or more users.

Table 8. GBRA website page view breakdown since 2009.

Website component	Unique visitors Jan '12 to Mar '14	Total unique visitors since 2009
GBRA Plum Creek web page (includes water quality data)	11,574	22,789
Wastewater Treatment Module	33,565	48,793
Aerobic and Septic Systems Module (includes Spanish version)	16,912	22,688
Fats, Oils and Grease Module	4,258	4,768
Stormwater Module	243	1,586
Total Page Views	**66,552**	**100,624**

Watershed Protection Campaign Brochure

AgriLife Extension developed a brochure entitled *The Plum Creek Watershed: Your Water, Your Home*, which summarizes Partnership efforts through 2008 and provides basic management practice recommendations. This tri-fold brochure has been an extremely popular resource with more than 7,500 copies distributed to counties, cities, schools, and other organizations to engage a broader audience in the local watershed effort. The Partnership feels that a revised edition of this brochure would be a valuable resource for future outreach and education efforts.

Real-time Water Quality Monitoring Station Installed near Lockhart

Through a Clean Water Act §319 grant, GBRA installed a real-time water quality monitoring station in Plum Creek, near the City of Lockhart. The station is part of the TCEQ's Statewide Continuous Water Quality Monitoring Network (CWQMN). The station collects flow, dissolved oxygen, specific conductance, temperature, pH and turbidity every 15 minutes. The data can be accessed from any personal computer with internet capabilities. To visit any site in the TCEQ CWQMNs visit:
http://www.tceq.state.tx.us/cgi-bin/compliance/monops/water_site_photo.pl?cams=763.

Volunteer Monitoring

Texas Stream Team (Stream team) is an environmental education and monitoring program administered by Texas State University-San Marcos funded through a Clean Water Act §319 grant from TCEQ. Stream team is a network of trained volunteers collecting water quality data on lakes, rivers, streams, wetlands, and estuaries across the state. Stream team has a strong presence in the Plum Creek watershed with volunteers monitoring 18 locations in the watershed (Figure 12).

In addition to their trainings regularly held in San Marcos, Stream team has provided numerous educational opportunities for watershed stakeholders since December 2011:

- 1/27/2012: - Provided an NPS Environmental Presentation at Plum Creek Elementary to 17 students and 1 teacher.
- 2/10/2012 – Provided an NPS Environmental Presentation using the watershed model to Science Hall Elementary in Kyle to 117 students and 4 teachers.
- 9/22/2012 – Attended the Keep Lockhart Beautiful Plum Creek Cleanup and Science Fair. Operated a booth where TST gave an NPS Environmental Presentation using the watershed model, and gave a water quality monitoring demonstration to 200 people.
- 10/18/2012 – Provided an NPS Environmental Presentation using the watershed model and conducted invertebrate sampling at Lockhart State Park for 88 students.
- 5/2/2013 – Attended the Plum Creek Partnership Stakeholder Meeting and gave a presentation on Texas Stream Team data collected in the Plum Creek Watershed.
- 8/29/2013 – Submitted a Plum Creek Watershed Data Summary Report to TCEQ.

  7/20/2013 – Provided an NPS Environmental Presentation using the watershed model to an unknown number of people at Lockhart State Park.

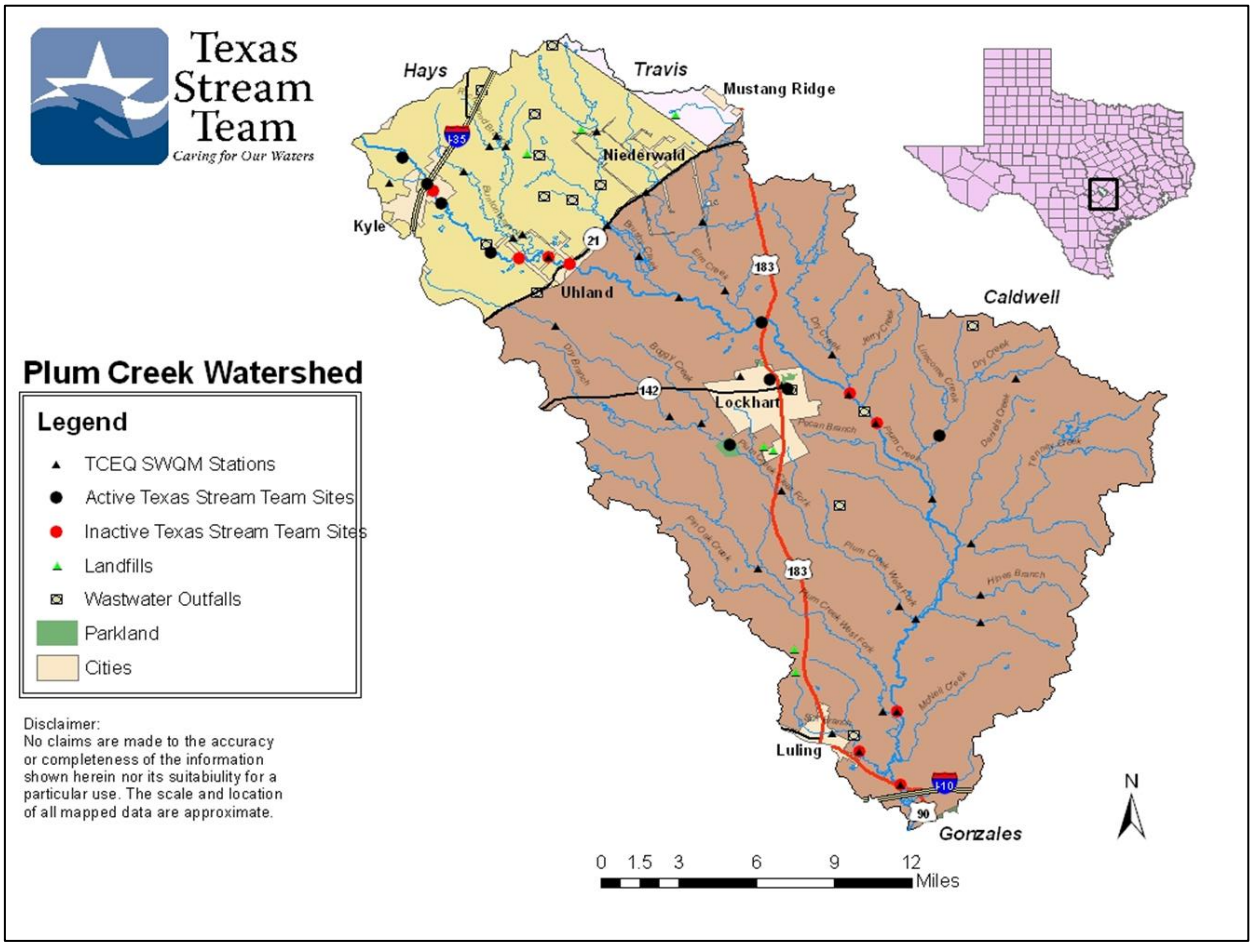


Figure 12. Map of volunteer monitoring locations in the Plum Creek watershed.

GBRA Youth Education and Plum Creek School Water Quality Project

To promote youth education and involvement in the Partnership, a water quality monitoring program was initiated in the 2006-2007 school year and is being conducted annually. Over 6,600 students and teachers from thirteen Hays ISD, Lockhart ISD, and Luling ISD schools have participated in classroom instruction and hands-on investigation of water quality in Plum Creek since 2006. GBRA's effort has continued through the 2013-14 school year with a total of almost 1,000 fourth and fifth grade students and over 30 teachers conducting a round of water quality testing in the classrooms (Tables 9 and 10). Students are currently using a modification of the Stream Team model for their monitoring and are testing water from Plum Creek and some of its tributaries for temperature, dissolved oxygen, pH, turbidity, nitrates, phosphates and bacteria.

Each year, the project begins with outreach to elementary schools in the watershed. After receiving approval from the campuses, dates are planned for classroom outreach and for the week of monitoring. GBRA education staff visits each individual campus and each class is engaged in a 45 minute lesson, using a table-top watershed model to illustrate and discuss watersheds, nonpoint source pollution and the Plum Creek project directly with the students. Water monitoring test kits, all needed supplies, watershed map posters and student workbooks are donated to the schools by GBRA.

Table 9. Results for the GBRA Plum Creek School water quality project, School Year 2013-14.

School	Negley	Kyle	Fuentes	Pfluger	Camino Real	Hemphill	Bluebonnet	Navarro	Plum Creek	Luling Shanklin
Sample location	Plum Creek at Burleson Rd.	Plum Creek at Burleson Rd.	Plum Creek at Steeple-chase Park	Richmond Branch off Windy Hill Rd.	Brushy Creek at SH 21 crossing	Plum Creek a Plum Creek Rd., Uhland	Plum Creek at 183, Lockhart	Clear Fork Creek at Old Fentress Rd	Town Branch at Lockhart City Park	Plum Creek at CR 135
Turbidity	0 JTU Good	0 JTU Good	20 JTU Good	40 JTU Good	40 JTU Good	40 JTU Good	40 JTU Good	0 JTU Excellent	0 JTU Excel.	40 Good
Temp	10ºC	12ºC	14ºC	14ºC	9ºC	10ºC	11ºC	18ºC	24ºC	14ºC
Dissolved Oxygen	35% Poor	46% Poor	20% Poor	38% Poor	90% Good	35% Poor	76% Good	42% Poor	38% Poor	78% Good
Phos-phates	1 ppm Excel.	1 ppm Excel.	1 ppm Excel.	1 ppm Excel.	1 ppm Excel.	2 ppm Good	2 ppm Good	1 ppm Excellent	2 ppm Good	2 ppm Good
Nitrates	5 ppm Fair	5 ppm Fair	3 ppm Fair	40 ppm Poor	5 ppm Fair	40 ppm Poor	5 ppm Fair	N/A	20 ppm Poor	5 ppm Fair
pH	7 Excel.	7 Excel.	7 Excel.	7 Excel.	7 Excel.	7 Excellent	6 Good	8 Good	7 Good	7 Good
Bacteria	Pos.	Neg.	Positive	Positive	n/a	Positive	Positive	Positive	Positive	Positive

Table 10. Highlights of the GBRA youth education program, December 2011 through March 2014.

Spring 2012	Lockhart State Park Spring presentations to Lockhart fifth graders (400 students) Composition Challenge (2 Plum Creek schools, 200 fourth grade students)
Fall 2012	Lockhart State Park Fall presentations to Lockhart fifth graders (400 students) Big Red Barn Ag Fair (4 Plum Creek schools, 400 fourth grade students)
Spring 2013	Lockhart State Park Spring presentations to Lockhart fifth graders (400 students) Composition Challenge (3 Plum Creek schools, 300 fourth grade students)
Fall 2013	Lockhart State Park Fall presentations to Lockhart fifth graders – 4 schools, 400 students Big Red Barn Ag Fair (6 Plum Creek schools, 630 fourth grade students)
Spring 2014	Lockhart State Park Spring presentations to Lockhart fifth graders (300 students) Composition Challenge (6 Plum Creek schools, 650 fourth grade students

After all of the school presentations have taken place, GBRA Education staff goes to creeks nearby the schools and gathers buckets of water to take to the campuses. While at the creek, the DO samples are 'fixed'. When the water arrives at the schools, it is quickly taken to the classrooms, where the lab has been set up by the teachers with students eagerly waiting to conduct the monitoring. Students are rotated through stations, and all students have the opportunity to conduct all of the tests. Data is recorded in their booklets, and the teachers submit data to GBRA.

The GBRA Ag Fair held each year at the Big Red Barn near Seguin, TX, has provided hands-on educational opportunities for thousands of area elementary students. Fourth graders throughout the Guadalupe-Blanco River Watershed, including 6 Plum Creek Elementary Schools, attended the 2013 GBRA Ag Fair (Figure 13). The WC demonstrated potential runoff and erosion effects for a variety of land uses and land cover types using a rainfall simulator. One particular highlight of this effort was the consistent identification of bacteria as a potential surface water pollutant by students from the Plum Creek schools.

Figure 13. Fourth graders attend the 2013 GBRA Ag Fair, Seguin, TX. Photo by Nick Dornak, WC

Plum Creek Watershed Kiosks in Kyle, Lockhart and Luling

Three new Plum Creek Watershed kiosks were set up in Kyle, Lockhart, and Luling during 2011 for the public to learn more about the watershed, wastewater treatment and watersheds in general. These interactive kiosks display educational modules by touch screen enabling the user to participate in mini-lessons on water subjects including watersheds and nonpoint source pollution, the wastewater treatment process, and the operation and maintenance of aerobic and conventional septic systems. At a touch of a finger, they can access general information on water quality and watershed protection, put together an electronic puzzle of the Guadalupe River Basin and take a fly-over of the Plum Creek watershed, using Google Earth. The kiosks also include links to real-time data for Plum Creek, which means that users are able to look at the current temperature, pH, dissolved oxygen, conductivity, turbidity, and flow at sites along the stream. Additional links are available for historical data including the TCEQ Clean Rivers Program, GBRA, the Partnership, and the City's website. The kiosks were designed by GBRA, and funded by the TSSWCB through an EPA Clean Water Act Section 319 (h) Nonpoint Point Source Pollution Grant Program. Exactly 13,830 total kiosk "hits" were logged for 2012 and 2013 with subtotals for each of the kiosks including Kyle (8,350), Lockhart (4,087) and Luling (1,393) [13]

Tributary and Watershed Roadway Signage

In 2013, the Partnership again contacted the Texas Department of Transportation (TxDOT) to inquire as to the potential for permission to be granted to install roadway signage marking Plum Creek tributaries and entrance points to the watershed. Despite sign installation in other watersheds across the state, the local TxDOT office policy remains to deny any nonessential signage that does not provide directions to motorists. As this outreach strategy is a highly visible means of boosting awareness of the Plum Creek watershed among local stakeholders and watershed users, the Partnership will continue to pursue this WPP directive.

Outreach at Local Meetings and Events

The Partnership participates actively in several local annual events that have a strong environmental stewardship component. These include: the City of Kyle, Plum Creek Watershed Clean-Up; the Keep Lockhart Beautiful, *Plum Creek/Town Branch/Lockhart Springs* Clean-Up and Environmental Fair; the Luling Foundation Field Day; Chisholm Trail Roundup, *Natural Resources Fair*; and the Annual Bastrop-Caldwell County Wildlife Management Association Wildlife Extravaganza and others[14]. Since 2006, approximately 5,147 individuals have been reached with information on Partnership efforts in the watershed through these events (1,240 since December 2011).

In addition, to presentations and annual project updates given to Partnership businesses, organizations and municipalities, the WC regularly engages the public at quarterly meetings of the Steering Committee. As public interest in Partnership activities has grown, the WC has been invited to serve as the keynote speaker or featured presenter for a number of local and regional organizations representing a diverse array of watershed stakeholders. These include:

- 2012 Caldwell County Farm Bureau Annual Convention
- Hays County Master Naturalist Chapter meeting

[13] Luling kiosk was offline for the majority of 2013.
[14] Natural Resources Fair and BCCWMA Wildlife Extravaganza added in 2012.

- Texas Water Utility Association
- Clear Fork Wildlife Management Association
- Independent Cattlemen's Association of Texas, Mid-Tex Chapter meeting
- Tri-Community Wildlife Management Association
- Meeting of Caldwell County realtors
- Lockhart Kiwanis
- Luling Lion's Club
- Thousands more have been reached through educational programming and meetings with various entities within the watershed.

Local, State and National Media

The Plum Creek watershed has been a focus of much media attention throughout the region, state, nation and beyond. Based on stakeholder participation rates and media coverage, the Plum Creek feral hog component and CCFHTF programs in Caldwell and Hays County have been, by far, the most popular media stories of 2012, '13 and '14. Local and regional media outlets, which provide more stakeholder-specific information, have also shown a spotlight on Plum Creek watershed workshops, trainings and other projects, including the Hillside Terrace Wastewater Project, Watershed Cleanup Events and Keep Lockhart Beautiful activities. Other stories of public interest and/or concern affecting the Plum Creek watershed have also been featured in local, state and national media outlets. Those with the greatest potential to impact WPP implementation have included the opening of the 85 mph SH130 Tollway, the 2012 illicit discharges from the Kyle WWTF, the proposed Ranch at Clear Fork WWTF and associated housing and commercial development to be located near Uhland, TX, and the proposed SH130 Environmental Park, a landfill and transfer station to be located just north of Lockhart.

Figure 14. *Pork, chopped* from The Economist, May 4, 2013.

Notable media coverage has included:

- May 2013 issue of The Economist magazine, *Pork, chopped* (Figure 14)
- 2013 Animal Planet documentary, *Invasion of the Mutant Pigs*, was filmed on location in the Plum Creek watershed and featured interviews with the WC and local landowners
- Bloomberg TV: *Texas Feral Hog Wrecks Mark Losing Battle with Animals*
- At least twelve separate television interviews with the WC have been featured from 2012-14 on daily news programs in the Dallas, Austin, San Antonio and Houston television markets

- A feature story and extended interview with the WC on "the *Big Wild*", an outdoor radio program heard on 23 stations across the Midwest and Canada
- Multiple radio interviews with KLBJ News in Austin and the Texas Farm Bureau Report
- *Here a Pig, There a Pig*, featured in the April 2014 issue of Texas Co-op Power magazine
- *Counties stepping up feral hog eradication efforts*, Lone Star Outdoor News
- Front page and/or feature length articles discussing the Partnership and/or Plum Creek activities published in the San Francisco Chronicle, Austin-American Statesman, Hays Free Press, San Marcos Daily Record, San Marcos Mercury, The University Star – Texas State University, Luling Newsboy, Lockhart Free Press, the GBRA River Run and numerous others

Texas Watershed Steward Workshops

Texas Watershed Steward is a science-based watershed training program that helps citizens identify and take action to address local water quality impairments. The Texas Watershed Steward Program is funded through Clean Water Act §319(h) nonpoint source grants from the TSSWCB and the EPA. A total of 128 participants attended the two workshops in 2007 and 2008. Six-month follow-up evaluations indicated that as a result of the training events, 95% of participants were better equipped to be stewards of their watershed. A third full-day workshop was planned for September 2012; however, due to low RSVP returns, the workshop was cancelled. As the Partnership's reach has expanded and interest in watershed programs continues to grow, another TWS workshop may be realistic in the future; however, no additional TWS workshops have been planned for 2014.

Texas Well Owner Network Workshop

In May 2013, the Texas Well Owner Network program offered a free, one-day educational training for Plum Creek watershed stakeholders wanting to become more familiar with groundwater resources, septic system maintenance, well maintenance, water quality and water treatment. Private well owners are independently responsible for operating their wells and monitoring the quality of their water. The training, which included a presentation from the WC, focused primarily on water quality issues in the Plum Creek watershed as well as efforts by the Partnership, TWRI and the TSSWCB to improve water resources in the area. Well owners were allowed to bring water samples to the training to be screened for nitrate nitrogen (NO_3-N), total dissolved solids and arsenic. The GBRA Regional Laboratory also provided testing for *E. coli* bacteria for $10 per sample. Thirty-seven people attended the workshop with the reported value of this program to attendees estimated at $647.97 per participant with some individuals estimating up to $2,500. Total savings for all participants was an estimated $23,975.

URBAN OUTREACH

NEMO workshops

TCEQ CWA §106 funds were used in 2008 to conduct two Nonpoint Education for Municipal Officials (NEMO) workshops entitled *Managing Urban Growth: Quality of Life and Environmental Issues*. These workshops targeted city and county employees and elected officials. One additional NEMO workshop funded by a TSSWCB, Clean Water Act §319(h) grant is scheduled to take place in Lockhart in June 2014. The "smart growth" workshop will be

coordinated by the Partnership, AgriLife Extension and GBRA. Topics will include LID, stormwater management and reducing impervious surfaces.

Online Stormwater Management Module

TCEQ CWA §106 funds enabled GBRA to develop an online educational module for municipal operations employees outlining the processes and best practices for urban stormwater management. The module has been promoted among watershed cities and is available on the Partnership and GBRA websites at http://www.gbra.org/stormwater/default.aspx. Since it was developed in September 2009, a total of 1,586 unique visitors have utilized the module.

Stormwater Management and Nonpoint Source Pollution Education and Outreach

No additional stormwater management demonstrations have taken place in the watershed since the events in June and July 2007, prior to the release of the WPP; however, additional demonstrations may be warranted as cities formulate decisions for the selection and placement of additional controls. The Cities of Kyle and Lockhart incorporated comprehensive urban stormwater assessments into TCEQ CWA §319(h) grants enabling evaluation of current stormwater flows and conveyance systems, identifying needs, and supporting optimal placement for additional controls. The final phase of Lockhart's assessment, an illicit discharge survey, will be completed by GBRA with a final report expected in 2016. The Partnership will continue to work with the City of Luling to pursue funds for a comprehensive assessment of their stormwater system.

Stormwater management and nonpoint source pollution prevention campaigns have been enacted or continue in cities throughout the watershed. The City of Lockhart has developed and distributed "What can I do?" flyers and reusable tote bags at numerous local events. The flyers, which include information on household hazardous waste (HHW) and pet waste, were mailed to 5,300 Lockhart utility customers. Lockhart has also utilized local media and newsletters to address nonpoint source pollution and continues to work with a web designer to incorporate all flyers into the City website and to develop an interactive page for nonpoint source pollution.

Low-impact Development

Local municipalities continue to struggle with balancing increased development demands with the costs and responsibilities to maintain adequate infrastructure for the proper management of stormwater runoff. The Partnership has determined that this presents a potential risk to water quality in Plum Creek. To address this challenge, the Partnership will actively engage municipalities in the watershed to adopt LID as an integral adaptive management strategy for future planning and development.

LID is a water quality BMP that can serve to reduce pollutant loading from urban runoff while providing relatively low-cost water saving solutions for cities coping with increasing demands for potable water. In addition to mitigating peak flows and reducing stormwater runoff volume, as demonstrated in Table 12, bioretention, green roofs and retention basins (wet ponds), in particular, have been shown to be effective at reducing bacteria concentrations (Leisenring et al. 2012). Planting trees and incorporating native plants into new and existing landscaping are low cost, low maintenance LID practices that also serve to mitigate stormwater runoff and improve water quality by capturing and storing water and nutrients for extended periods of plant uptake.

Other benefits have been established for several varieties of permeable pavements. The Partnership will further encourage the incorporation of rainwater harvesting systems into LID projects to provide additional long-term cost savings through water conservation and to provide another tool for stormwater runoff reduction and peak flow mitigation.

Table 11. Influent/Effluent Summary Statistics for *E. coli* (cfu/100mL) from International Stormwater Best Magement Practices Database Pollution Category Summary Statistical Addendum: TSS, Bacteria, Nutrients, and Metals (Leisenring et al. 2012)

BMP Type	Count of Studies and EMCs		25th Percentile		Median (95% Conf. Interval*)		75th Percentile	
	In	Out	In	Out	In	Out	In	Out
Grass Strip	NA	NA	NA	NA	NA	NA	NA	NA
Bioretention	3, 54	3, 54	42	5	150 (50, 210)	44 (6, 137)	1820	965
Bioswale	5, 39	5, 39	295	1200	3990 (200, 5600)	4190 (1200, 5900)	11000	10000
Composite	NA	NA	NA	NA	NA	NA	NA	NA
Detention Basin	3, 32	3, 32	398	60	1300 (460, 1990)	429 (82, 720)**	12600	1880
Green Roof	1, 6	3, 39	8	5	232 (1, 550)	16 (5, 48)	5.0	61
Manufactured Device-D	NA	NA	NA	NA	NA	NA	NA	NA
Manufactured Device-F	NA	NA	NA	NA	NA	NA	NA	NA
Manufactured Device-P	NA	NA	NA	NA	NA	NA	NA	NA
Media Filter	NA	NA	NA	NA	NA	NA	NA	NA
Retention Pond	4, 68	4, 69	607	10	2800 (1350, 4300)	**150 (31, 387)****	17500	800
Wetland Basin	3, 42	3, 42	257	65	785 (363, 1350)	632 (199, 1160)	2510	3580

The Partnership will work with local municipalities, developers and businesses to incorporate LID into new projects and to retrofit existing structures with LID components. Such projects, ideally installed at locations accessed by the public and decision-makers, can be used as an outreach and education tool for demonstrating the social, environmental, and economic benefits to the surrounding community. Studies have shown that implementing more natural stormwater management practices with less reliance on conventional, conveyance focused designs can actually reduce overall project costs (USEPA 2007). The Partnership will encourage watershed stakeholders to continue to set the example for other communities outside of the watershed facing similar challenges to find cost-effective solutions for responsible and sustainable growth. With committed efforts on the part of the Partnership, the consistent adoption of LID practices and principles is not only possible, but should be viewed as an essential adaptive management strategy and a vital step toward achieving the long-term water quality goals identified by watershed stakeholders in the WPP.

Urban Sector Turf and Landscape Management

The Partnership worked with AgriLife Extension's Sports and Athletic Field Education (SAFE) program to conduct a 6-hour training event in March 2009 for 49 personnel from area parks departments and school athletics departments. The workshop provided education tailored to management of golf courses and other sports and athletic fields, with topics including fertilizer and pesticide selection and use, irrigation management, aerification of soils, and cultural practices such as mowing height and frequency. While they remain a valid component of the WPP, no additional SAFE trainings have been completed since 2009 due to time and scheduling constraints.

Household Hazardous Waste and Recycling Programs

The City of Lockhart has taken an aggressive approach to attaining grant funding and budgeting local funds to enhance HHW management and recycling. A TCEQ CWA §319(h) grant awarded to the City included provisions for hosting annual hazardous and electronic waste collection days in 2010 and 2011. The City has utilized additional funds to continue this program in 2012 and 2013. The results of these events, which have included the collection of 16,538 lbs. of HHW and 35,400 lbs. of hazardous paint, are provided in Table 12. A Capital Area Council of Governments (CAPCOG) FY 2014-2015 Solid Waste Grant recently awarded to Lockhart will provide continued funding for an HHW event to be held in the fall of 2014. The cities of Kyle, Buda and Lockhart each provide information on their websites regarding HHW and recycling. Kyle residents participated in a City of San Marcos HHW collection event held in late 2013. A private company provides hazardous waste disposal for Luling businesses but does not service residential customers.

Table 12. City of Lockhart household hazardous waste collection event results, 2010 thru 2013.

Year	Total # Households	HHW collected in lbs	Hazardous Paint in lbs	Lead Acid Batteries in lbs	Cost of Hazardous Materials contractor Services
2010	250	5,661	13,287	225	$13,428
2011	288	3,651	11,561	20	$11,366
2012[15]	175	4,173	6,172	0	$15,267
2013	107	3,053	4,380	0	$8,681
Total	820	16,538	35,400	245	$48,742

Lockhart's TCEQ CWA §319(h) grant project also provided for expansion of services at the city recycling center to include disposal of kitchen fats, oils, and grease (FOG) in addition to existing oil, oil filter, and antifreeze disposal services. A collection tank for grease and cooking oils was placed at the Lockhart Recycling Center, so the material can be removed and recycled into products such as animal feeds and ingredients used in consumer and industrial products like soaps, cosmetics, rubber and plastics. An additional CAPCOG Solid Waste Grant awarded to the City for FY 2013 provided $18,000 toward the purchase of a forklift for the Lockhart Recycling Center. To support these projects, the City has handed out 1,505 FOG jugs at numerous local events, distributed multiple informative flyers to 5,300 Lockhart utility customers and produced "What can I do?" biodegradable litter bags and reusable tote bags (Figures 15 and 16). The tote bags and 1-gallon FOG jugs included stickers and other items to encourage youth participation.

[15] Two events HHW collection events held in 2012.

Figure 15. City of Lockhart, "What can I do?" campaign materials. Photos courtesy of the City of Lockhart.

Figure 16. Children decorate reusable tote bags and FOG jugs at the Lockhart Public Library.

SEPTIC SYSTEM OUTREACH

Online Septic System Module

TCEQ CWA §106 funding also supported GBRA and AgriLife Extension efforts to develop an online module to address the proper function and maintenance of septic systems. Illustrating both conventional and aerobic systems, the module was developed for OSSF owners, professional installers, maintenance providers, and inspectors. The module is available in both English (http://www.gbra.org/septic.swf) and Spanish (http://www.gbra.org/septic-spanish.swf) and can be found on both the Partnership and GBRA websites. Since its launch in 2009, the module has been utilized by 22,688 unique visitors. While initial efforts focused on local municipal officials, school teachers, and residents in the Plum Creek watershed, this module has been promoted across the state and has been utilized in several other watershed efforts.

Septic System Workshops

AgriLife Extension conducted a total of seven OSSF operation and maintenance workshops in Caldwell and Hays Counties with support through TCEQ CWA §106 funds during 2008-2009. Four events were tailored to homeowners (two each addressing conventional and aerobic systems) and two events targeted practitioners. An additional "train-the-trainer" course was aimed at developing capacity for local designated representatives to deliver maintenance courses to homeowners. Overall, 118 practitioners and 74 homeowners participated in the workshops. In addition, AgriLife Extension provided watershed maps and technical assistance to designated representatives in the watershed to aid in addressing local septic system issues. To complement septic system outreach efforts, over 50,000 copies of 15 different septic system management factsheets were delivered to cities and counties for distribution throughout the watershed. Three additional OSSF workshops are planned for the watershed in 2014.

MUNICIPAL WASTEWATER OUTREACH

Online Wastewater Treatment Facility Module

TCEQ CWA §106 funds were used by GBRA to develop an online informational wastewater treatment module that addresses treatment methods and processes and explains the importance of proper wastewater management to protect the quality of receiving waters. In addition to being distributed to public officials and watershed residents by email and over 760 post cards, this module was sent to wastewater facility operators for use in educating the public. The module is available on both the Partnership and GBRA (http://www.gbra.org/wastewater-treatment.swf) websites and has received 48,793 unique visitors since its launch in 2009. The educational module was selected by the Water Environment Association of Texas for the 2008 Presidential Award for "Outstanding Effort toward Public Outreach and Communication".

Online Fats, Oils, and Grease Module

TCEQ CWA §106 funds supported the development of an online training module to outline management practices for handling FOG. The module also addresses proper use and disposal of household hazardous chemicals and is geared toward both businesses and homeowners. The module is available on the GBRA and Partnership websites (http://www.gbra.org/fog.swf) and has been used by 4,768 unique visitors since its release 2009.

Fats, Oils, and Grease Workshops

TCEQ CWA §106 funds designated for conducting outreach in the watershed expired before TCEQ could host workshops for restaurants and apartments on proper management and disposal of FOG. Further, the TCEQ Small Business Assistance Program no longer conducts these workshops. Nevertheless, the GBRA online FOG module will continue to be promoted, and as mentioned previously, the City of Lockhart has recently implemented a robust FOG educational program and continues to improve their recycling system through capital investments, education and outreach.

AGRICULTURAL OUTREACH

Soil and Water Testing Campaigns

Annual county-based soil and water testing campaigns have been conducted annually by AgriLife Extension in Hays and Caldwell Counties from 2009 through 2013; however, no programs were conducted in 2011. Landowners submitted 148 samples for the 2009 campaign and 164 samples for the 2010 campaign. Agricultural operations were represented by 280 of the 312 samples for 10,298 acres. Projected fertilizer savings based on soil tests for agricultural operations were an estimated 202,075 pounds of nitrogen and 320,250 pounds of phosphate compared to rates proposed before testing. Over 80% of lawn and landscape samples received a recommendation for no application of phosphorus fertilizer due to high soil test levels. The 2012 and 2013 campaigns yielded a total of 83 samples representing 2,455 acres. A number of these soil test results also recommended no application of phosphorus due to extremely high levels already present in the soil.

This management practice has not only provided environmental benefits by reducing nutrient loading to the soil and potentially to water resources, but also created the opportunity for an economic impact estimated at $302,948 in cost savings for the 2009 and 2010 campaigns alone.

These programs are supported by TSSWCB §319(h) funds that help defray costs for watershed residents.

Nutrient, Crop, and Livestock Grazing Management Education

Agricultural and Natural Resource education programs have been provided frequently for Caldwell County and Hays County residents and producers. During 2012 and 2013 a number of programs have emphasized nutrient, crop, and livestock grazing management and practices. From December 2011 to December 2013 the following relevant programs have been conducted:

- 2012 Luling Foundation Annual Field Day - 275 Attendees
- 2012 Rebuilding the Beef Herd Seminar - 45 Attendees
- 2012 Luling Forage Field Day - 12 Attendees
- 2012 Stock Pond Management Workshop - 32 Attendees
- 2012 Rangeland Management Workshop - 11 Attendees
- 2013 Beef Cattle Field Day - 39 Attendees
- 2013 Horticulture and Soil Workshop - 10 Attendees
- 2013 Producer's Series I - 33 Attendees
- 2013 Luling Foundation Annual Field Day - 282 Attendees
- 2013 Rainwater Management Class - 2 Attendees
- 2013 Brush and Weed Management - 11 Attendees
- 2013 Producer's Series II - 15 Attendees
- 2013 Private Applicator Training - 5 Attendees
- 2013 Small Acreage Livestock Class - 8 Attendees
- 2013 Small Acreage Land Management Series - 5 Workshops (Hays County)

The Lone Star Healthy Streams Program

The Lone Star Healthy Streams (LSHS) Program provides rural landowners with education on reducing the amount of bacteria entering Texas water bodies. The program is providing a coordinated and comprehensive education program designed to increase awareness of the bacteria issues associated with grazing and dairy cattle, poultry, horses and feral hogs; and encourage voluntary implementation of BMPs to reduce bacteria runoff, which will ultimately lead to improved water quality. Development of this program was initiated in 2007 by the Texas A&M AgriLife Extension Service and TWRI with funding through CWA §319(h) grants from TSSWCB and United States EPA. LSHS has now expanded into a new project, "*Development of a Synergistic, Comprehensive Statewide Lone Star Healthy Streams Program"*. More information on the Lone Star Healthy Streams Program is available at http://lshs.tamu.edu/.

To date, the following LSHS programs have been delivered in the watershed:

- October 2010 – Luling Foundation Water Field Day – 162 individuals
- March 2011 – Caldwell County – 31 individuals
- August 2011 – Caldwell County Expo presentation – 85 individuals
- February 2012 – Luling Feral Hog Workshop – 310 individuals
- February 2013 – Luling Feral Hog Workshop – 125 individuals
- February 2014 – Luling Feral Hog Workshop – 103 individuals

FERAL HOG MANAGEMENT OUTREACH

Feral Hog Management Workshops

To improve direct landowner management and increase public knowledge on the issue, AgriLife Extension has coordinated a series of four-hour watershed-based feral hog management workshops in multiple watersheds, including Plum Creek. Attendance at the annual workshop held in Luling has been 260, 310, 125 and 103 respectively for 2011 through 2014. One-hour watershed-based feral hog presentations were also conducted in support of County Extension Agent programming and in response to program requests from members of the community. Between December 2011 and March 2014 a total of 29 one-hour presentations were conducted. These one-hour programs were attended by 1825 individuals with an estimated adult education economic impact of $130,653.43. Attendees are not limited to residents of Plum Creek watershed, and some travel considerable distances to attend. Significant focus is placed on the potential for hogs to harm the environment and degrade water quality, and attendees receive presentations on a variety of management options from various agencies including Texas A&M AgriLife Extension Service, TPWD, TDA, TWS, and the Texas Animal Health Commission (TAHC). Attendees were not limited to residents of Plum Creek watershed, and some travel considerable distances to attend. These events are a key avenue for relaying information to landowners in the Plum Creek watershed and beyond. TSSWCB CWA §319(h) funds have been used to cover workshop expenses so that the events are available at no cost to attendees[16].

Technical Assistance

From December 2011 through March 2014, the Extension Associate stationed in the watershed has provided technical assistance to landowners on feral hog management through 15 site visits. Theses site visits allow for landowners to receive property specific information relating to feral hog management. A research-based management recommendation is provided that accounts for site specific variations in habitat, while also addressing landowner concerns. A total of 2,766 individuals have obtained direct assistance with approximately 623 contact hours recorded. Totals since WPP implementation include: 135 site visits; 54 community presentations; 6,073 individuals obtaining direct assistance; and 3,113 contact hours.

Feral Hog Reporting System

AgriLife Extension developed an online feral hog reporting system to track sightings and damage caused by the animals. The system has been used by project personnel to target areas for focused management assistance, and the system has been somewhat useful in validating the SELECT analysis performed during plan development. A total of 195 public reports have been made, with some from areas not in the watershed. One hundred sixty landowners have reported a total of 1892 feral hogs removed from the watershed through the reporting system as of January 2014. The system has now been relocated to a standalone website but is still accessible through the feral hog section of the Partnership website. The reporting website has been a beneficial tool in tracking the removal of feral hogs from the watershed.

[16] TSSWCB CWA §319(h) funds do not cover food costs for attendees.

Feral Hog Management Fact Sheets

A significant project accomplishment has been the production of a series of factsheets addressing feral hog management (Figure 17). Developed by AgriLife Extension with TSSWCB CWA §319(h) funds, the following publications are available in the AgriLife Bookstore, on the Partnership website and at scribd.com, seven are also in Spanish:

- *Feral Hog Population Growth, Density and Harvest in Texas*
- *Feral Hogs Negatively Affect Native Plant Communities*
- *Feral Hog Approved Holding Facility Guidelines in Texas*
- *Feral Hogs, Plum Creek, and You*
- *Recognizing Feral Hog Sign* (Spanish)
- *Box Traps for Capturing Feral Hogs* (Spanish)
- *Corral Traps for Capturing Feral Hogs* (Spanish)
- *Snaring Feral Hogs* (Spanish)
- *Building a Feral Hog Snare* (Spanish)
- *Placing and Baiting Feral Hog Traps* (Spanish)
- *Door Modifications for Feral Hog Traps* (Spanish)
- *Feral Hogs Impact Ground-nesting Birds*
- *Feral Hog Laws and Regulations in Texas*
- *Feral Hogs and Disease Concerns*
- *Feral Hogs and Water Quality in Plum Creek*
- *Feral Hog Transportation Regulations*
- *Using Fences to Exclude Feral Hogs from Wildlife Feeding Stations*

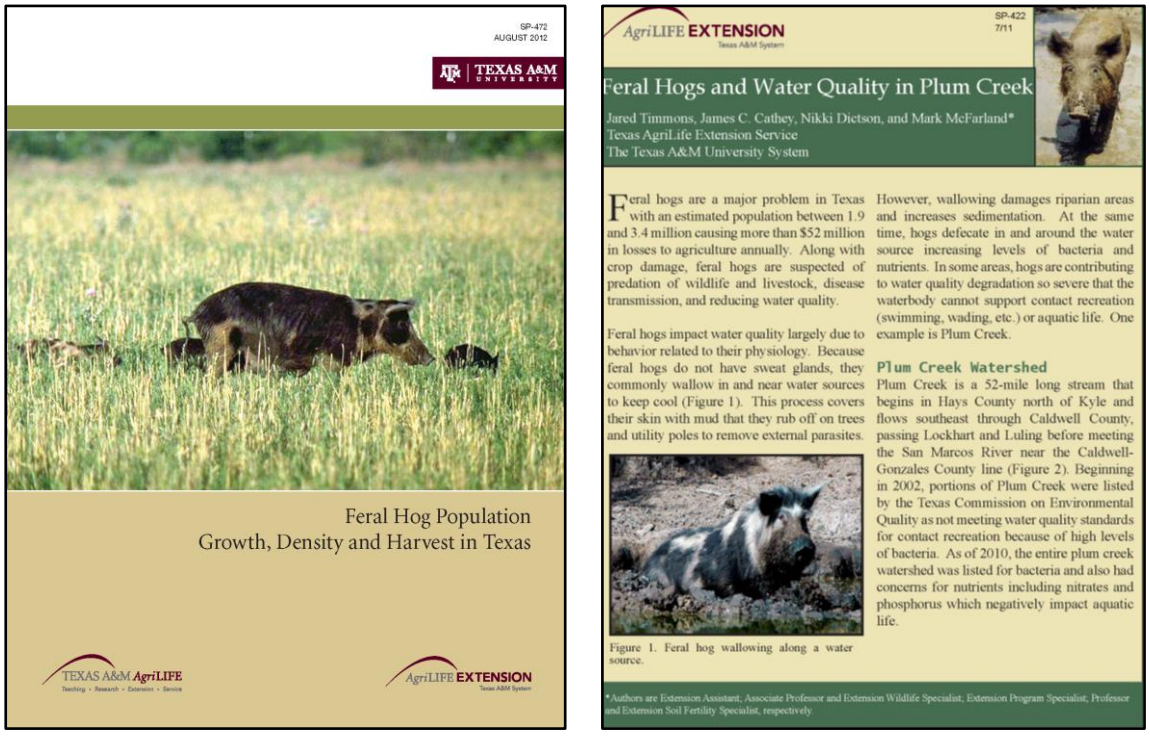


Figure 17. Two Examples of feral hog management fact sheets developed for the watershed.

Over 7,500 copies of the publications have been distributed throughout the watershed and are available on the project website. These publications have been very popular, and a review of website traffic indicates they have been downloaded over 22,130 times from www.scribd.com, 2,477 times from the Texas A&M AgriLife bookstore. The feral hog fact sheets page on the Partnership website received 673 views from visitors residing in 48 states plus the District of Columbia. Feral hog management has become a significant issue across the nation, and efforts in the Plum Creek watershed have provided resources that will have a far-reaching impact.

Social Media Outreach

Between December 2011 and March 2014, ninety-nine feral hog related blog posts to the Wild Wonderings Blog received 75,723 views[17]. AgriLife Extension Associates also worked in connection with the eXtension.org Feral Hogs Community of Practice (CoP) Social Media team to administer the Feral Hog CoP Facebook and Twitter accounts. The Feral hog CoP Facebook account reached 186,722 individuals and the Twitter page reached over 66,524 individuals during this time period. There are 18 feral hog videos on the Wildlife and Fisheries Department YouTube website that have been viewed over 126,620 times. To further broadcast these resources, the Texas A&M AgriLife Extension Service partnered with AgSmart TV and Roku. This partnership resulted in an additional 69,278 views of the feral hog videos. The Feral Hog CoP website builds on local efforts by providing a national platform for feral hog educational resources facilitated by over 65 members from across the United States. The Feral Hog CoP website contains 76 articles, 101 FAQs and 4 webinars relating to feral hogs and their management. On the Partnership website, two voice-over power-point presentations are available for viewing. These social media outlets allow Texas A&M AgriLife Extension personnel to expand the reach of their information and reach audiences that may not attend traditional face-to-face programs.

STREAM AND RIPARIAN WORKSHOPS

"I walked in knowing little, and now I understand wetlands, upland plants and how to look at my land differently," --workshop attendee

Riparian workshops held in the watershed have targeted owners and managers of property adjacent to Plum Creek and its tributaries with a focus on management practices to restore and maintain riparian health in these critical areas. Riparian areas, not only serve to retain soil moisture and provide critical wildlife habitat, they are often nature's last defense for reducing pollutant loading in streams. While it is no easy task to determine where nonpoint source pollution originates, it is clear as to what it must go through to reach a stream. Through outreach and education, along with dedicated land managers, many riparian areas throughout the Plum Creek watershed are improving; however, drought, feral hog activity, overgrazing and continued development along the creek are just a few of the major risk factors to riparian health in the watershed. The Partnership has placed a high value on protecting and restoring riparian areas within the watershed. If properly implemented, most of the best practices identified in the WPP will serve to "remove the hindrances" to riparian ecosystem health and allow natural restoration

[17] http://wild-wonderings.blogspot.com/.

of these sensitive but resilient areas to take place. To augment stakeholder knowledge and facilitate the adoption of management practices most effective for protecting riparian areas, a significant investment of time and resources has been paid to riparian outreach and education.

The Partnership has coordinated with the TPWD, USDA Natural Resources Conservation Service - State Riparian Service Team, and the Nueces River Authority to conduct two stream and riparian workshops in 2010 and 2011 for a total of 184 participants. The first workshop for the newly established Texas Riparian and Stream Ecosystem Education Program was held June 2013 in Lockhart (Figures 18 and 19). The program, funded through a TSSWCB and EPA CWA §319(h) grant, provides no-cost education on how streams function and the role of vegetation in stream systems. The workshop included indoor classroom presentations by representatives from AgriLife Extension, TPWD, Texas A&M Forest Service, USDA Natural Resources Conservation Service and Guadalupe-Blanco River Land Trust coupled with an afternoon field visit to stream sites to see Plum Creek in action. A total of 65 landowners and Plum Creek watershed stakeholders attended the workshop.

Sixty-five Plum Creek watershed stakeholders attended the Texas Riparian and Stream Ecosystem Education Program held June 2013 in Lockhart, TX. The riparian workshop included classroom instruction, Figure 18 (left) and in-field demonstrations, Figure 19 (below). Photos by Leslie Lee, TWRI

Recognizing the risk to riparian areas and water quality as a function of the rapid increase in small farm ownership in both Caldwell and Hays County, in 2013 the Partnership attempted to acquire funding to establish the Plum Creek Riparian Cooperative (PCRC) and associated Leadership Team through an additional TSSWCB CWA §319(h) grant. The intent of this program was to utilize the knowledge, influence and networking power of trained local landowners to communicate the importance of proper riparian ecosystem stewardship to neighbors and friends in the Plum Creek watershed. This would be facilitated and enhanced through a professionally designed marketing and outreach strategy as well as a series of small "living room" workshops focusing on the implementation of both rural and urban BMPs to mitigate nonpoint source pollution in the Plum Creek watershed through effective riparian management. This program did not receive CWA §319 funding; however, the Partnership continues to place a high value on the incredible potential for this program and will continue to seek funding for a "scaled-down" version of the PCRC.

ILLEGAL DUMPING/LITTER PREVENTION CAMPAIGN

Using TCEQ CWA §106 funds, GBRA partnered with Caldwell and Hays Counties to remove trash and debris and discourage littering of streams throughout the Plum Creek watershed in 2008 and 2009. The Partnership further cooperated with Caldwell County to secure funding from CAPCOG to support personnel and purchase trash removal equipment. Through the combined efforts of GBRA and Caldwell County, 144 tires, 22,820 pounds of refuse, 9 batteries and numerous appliances were removed from the Plum Creek watershed and properly disposed in 2008 and 2009.

In 2011, Caldwell County made the decision to create a full-time position for an Environmental Investigator to administer fines and develop outreach and management programs to deter illegal dumping. From December 2011 through December 2013, the Caldwell County Environmental Investigator issued 10 citations resulting in $2,000 in fines. Five other citations were dismissed as a result of corrective action being taken. The Environmental Investigator periodically holds Community Collection Events (CCEs) for Caldwell County citizens to dispose of nonhazardous solid waste at no charge.

In 2012, the WC worked with Caldwell County to apply for CAPCOG Regional Solid Waste grant funds to hold CCEs in each of the four Caldwell County Precincts from 2012 through 2013. Despite significant budget cuts for this grant program, the Caldwell County CCE's were awarded a grant in the amount of $18,349 to conduct the events. Local match exceeded $40,000 in cash and in-kind contributions. Two key aspects of this proposal were the inclusion of tire disposal to be provided at no cost to local citizens, and the involvement of Pegasus School volunteers, based in Caldwell County, to provide assistance with the removal and hauling of nonhazardous solid waste from handicapped and elderly individuals (Figure 20). Due to the anticipated expense and unknown public interest in the tire collection program, tires were capped at 200 per event; however, after seeing truckloads of tires turned away one hour into the first event, the Partnership worked with the County to identify less expensive disposal options that included tire recycling. In response to a Partnership proposal, in December 2012, the Caldwell County Commissioner's Court voted to supplement the tire program with $3,000 in additional

funds. The new approach received much support from watershed stakeholders and excellent participation rates by county citizens. The four event totals include:

- 65 tons of solid waste collected (includes tires @ 20 pounds each)
- 2,459 tires removed/recycled
- 267 participants
- 72 volunteer hours donated

Figure 20. Pegasus school student volunteers participate in the Caldwell County Community Collection Event held April 2013, Dale, TX. Photo by Nick Dornak, WC

Five additional CCEs were held in Caldwell County from September 2013 through March 2014. Total participation for these events included 152 participants and 40 tons of refuse. Total solid waste safely removed from the Plum Creek watershed and surrounding area through Caldwell County CCEs from December 2011 through March 2014 has surpassed 100 tons. The Partnership applauds the Caldwell County leaders, staff, volunteers and citizens for taking a proactive role in solid waste management.

Note: Caldwell County has been awarded an additional $8,460 from CAPCOG to hold four scrap tire collection/recycling events during FY2015. The Partnership would like to offer a note of thanks to the CAPCOG Solid Waste Program staff for their dedication and support of solid waste projects in Caldwell County and the Plum Creek watershed. CAPCOG has become an active partner in implementation and outreach for the Plum Creek WPP and is represented regularly at public meetings, collection events and educational programs throughout the watershed.

COMMUNITY CLEANUP EVENTS IN LOCKHART AND KYLE

TCEQ CWA §106 funds were used to initiate an annual stream cleanup event for Town Branch in the City of Lockhart and to expand ongoing efforts for the Plum Creek Watershed Clean-Up in the City of Kyle. Citizen volunteers work together to remove trash and debris from tributaries in these urban areas of the watershed. In Lockhart, volunteer cleanup days have 200 to 300 participants. These events are used to provide education and increase awareness of broader issues and efforts throughout the watershed (Figure 21). The events are supported by Keep Texas Beautiful, local sponsors and the Cities.

Figure 21. Community Stream Cleanup Events, Lockhart 2013 (top) and Kyle 2010 (bottom).

In 2012 and 2013 the Partnership worked with GBRA and the City of Lockhart to continue the annual Keep Lockhart Beautiful, *Plum Creek/Town Branch/Lockhart Springs* Cleanup Event, as it is now named. The event also boasts a well-attended Environmental Fair (Figure 22). Local business, organizations and individual sponsors contributed just over $2,000 to the effort in 2012 with fundraising success doubling to over $4,000 from 40 sponsors in 2013. As the Partnership

has assumed primary coordination of the Lockhart event as of 2013, we have been fortunate to retain a core group of cleanup leaders and volunteers that return year after year. These dedicated and enthusiastic individuals provide knowledge, experience and consistency to the event, which is now entering its seventh year. In addition to these wonderful sponsors and volunteers, the Partnership would also like to thank the GBRA staff that participates every year in a coordinated cleanup both upstream and downstream of the Lockhart WWTFs.

Figure 22. 5th Annual, Keep Lockhart Beautiful Cleanup and Environmental Fair, September 2012. Photos by Nick Dornak, WC

The 6th Annual Keep Lockhart Beautiful *Plum Creek/Town Branch/Lockhart Springs* Cleanup Event held in September 2013 resulted in the removal of 1,580 lbs. of refuse and 840 lbs. of recyclable materials from 4.5 stream miles of Plum Creek and its tributaries. Volunteers also planted wildflowers at City Park (Figure 23). The 2012 event yielded 2,130 lbs. of refuse and 310 lbs. of recyclables from 4.5 stream miles. GBRA provided "Environmental Passports" encouraging volunteers to attend the accompanying Environmental Fair, which featured demonstrations on litter prevention, illegal dumping, watershed function and aquatic invertebrates. "Stamped Passports" were entered into a drawing for numerous prizes donated by local businesses and individuals.

With the City of Lockhart's renewed commitment to becoming an official Keep Texas Beautiful Affiliate, the decision was made by the City and the Partnership in 2013 that developing a KLB Cleanup Subcommittee under the auspices of the City's "Keep Lockhart Beautiful" program would be a mutually beneficial merger serving bolster the City's new program and provide oversight and accounting for Cleanup Event funds and services. The WC currently sits on the Keep Lockhart Beautiful Board of Directors and serves as the co-chair of the KLB Cleanup Subcommittee with another nominated cleanup volunteer.

In 2012, the Plum Creek Watershed Clean-Up in Kyle moved from Steeplechase Park to Lake Kyle. The City of Kyle Parks and Recreation Department coordinates the annual event. Results of the Kyle Clean-Up events include:

- 2012 – 200 volunteers (2,000 lbs. of refuse)
- 2013 – 75 volunteers (740 lbs. of refuse)

- 2014 – 175 volunteers (1,800 lbs. of refuse)

Figure 23. 6th Annual Keep Lockhart Beautiful Cleanup volunteers plant wildflowers at City Park, September 2013. Photo by Nick Dornak, WC

Measures of Success

ROUTINE WATER QUALITY MONITORING DATA

The 2012 Update to the Plum Creek WPP reported impairments and concerns for the three Plum Creek segments monitored through the CRP and evaluated in the 2010 Texas Integrated Report. With the release of the 2012 Texas Integrated Report, additional concerns have been added to the middle and lower segments of Plum Creek. The TCEQ used data collected during the seven-year reporting period from December 1, 2003 through November 30, 2010 in their assessment which resulted in depressed dissolved oxygen added to the lower segment (1810_01) and impaired habitat added as a concern for the middle segment (1810_02). In review of the Draft 2012 Texas Integrated Report which proposed to identify impaired habitat as a concern for both 1810_02 and the upper segment (1810_03), both the GBRA and the Partnership submitted comments to dispute the analyses used by the TCEQ in this determination. In response, the TCEQ did not include impaired habitat concern for 1810_03 in the final report. Table 13 identifies the current impairments and concerns in Plum Creek as described in the 2012 Texas Integrated Report.

Table 13. Impairments and concerns for Plum Creek, 2012 Texas Integrated Report.

Assessment Unit	Parameter	Status
1810_01: Confluence with San Marcos River to approximately 2.5 miles upstream of the confluence with Clear Fork Plum Creek	*E. coli* geometric mean	Nonsupport (4b)
	Dissolved Oxygen grab screening level	Concern
	Nitrate screening level	Concern
1810_02: From approximately 2.5 miles upstream of confluence with Clear Fork Plum Creek to approximately 0.5 miles upstream of SH 21	*E. coli* geometric mean	Nonsupport (4b)
	Impaired Habitat (24-hr minimum Dissolved Oxygen)	Concern
	Nitrate screening level	Concern
	Orthophosphorus screening level	Concern
	Total Phosphorus screening level	Concern
1810_03: From approximately 0.5 miles upstream of SH 21 to upper end of segment	*E. coli* geometric mean	Nonsupport (4b)
	Dissolved Oxygen grab screening level	Concern
	Nitrate screening level	Concern
	Total Phosphorus screening level	Concern

In 2008, a CWA §319(h) grant was awarded to GBRA to collect water quality data under routine and targeted hydrologic conditions. The monitoring program increased the number of routine (monthly) monitoring sites from the original three CRP monitored sites to eight. It also includes targeted sites that are monitored once under dry weather conditions and once under wet weather conditions each season, collecting field, conventional, flow and bacteria parameter groups. The current monitoring program includes the 8 routine sites, 26 targeted sites spread throughout the watershed, 7 WWTP sites, 3 spring sites and a stormwater site. These data will be utilized to target "hot spots" in the watershed.

The following map (Figure 24) and table (Table 14) identify monitoring station locations and type. Only parameters discussed in the WPP are included here. Additional parameters for these locations and results from GBRA targeted monitoring can be found at http://plumcreek.tamu.edu.

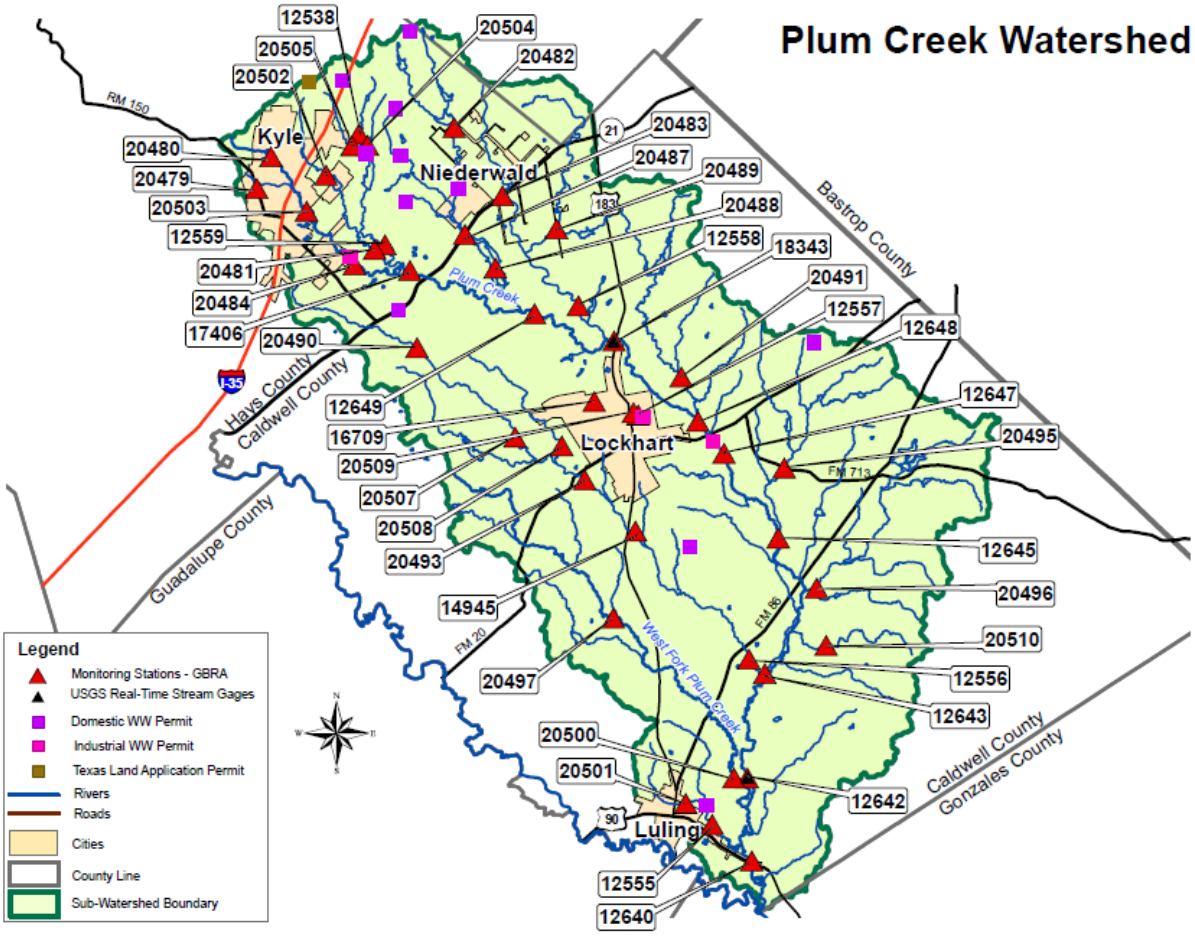


Figure 24. Water quality monitoring locations in the Plum Creek watershed.

Table 14. Plum Creek monitoring locations and sampling type.

Site No.	Site Name	Latitude	Longitude	Sample Type
12538	Andrews Branch at CR 131	30.03	97.827	Targeted
12555	Salt Branch at FM 1322	29.676	97.625	Targeted/Stormwater
12556	Clear Fork Plum Creek at Salt Flat Rd. (CR 128)	29.76	97.602	Routine/Targeted/Diurnal
12557	Town Branch at E. Market St. (upstream of Lockhart WWTP #1)	29.885	97.665	Targeted
12558	Elm Creek at CR 233	29.96	97.798	Routine/Targeted/Diurnal
12559	Porter Creek at Dairy Road	29.974	97.812	Targeted
12640	Plum Creek at CR 135	29.657	97.602	Routine/Targeted/Diurnal
12642	Plum Creek at Biggs Road (CR131)	29.7	97.604	Targeted
12643	Plum Creek at FM 1322	29.753	97.593	Targeted
12645	Plum Creek at Youngs Lane (CR 197)	29.822	97.584	Targeted
12647	Plum Creek at Old McMahan Rd (CR202)	29.865	97.615	Routine/Targeted/Diurnal/ Stormwater
12648	Plum Creek at Old Kelly Road (CR 186)	29.882	97.63	Targeted
12649	Plum Creek at CR 233	29.938	97.725	Targeted
14945	Clear Fork Plum Creek at Old Luling Rd (CR 213)	29.826	97.668	Targeted
16709	Town Branch west of Lockhart	29.826	97.668	Targeted
17406	Plum Creek at Plum Creek Road	29.96	97.798	Routine/Targeted/Diurnal
18343	Plum Creek upstream of US 183	29.923	97.679	Targeted
20479	Unnamed Tributary FM 150 near Hawthorn Dr.	30.003	97.887	Targeted
20480	Plum Creek downstream of NRCS 1 spillway	30.019	97.879	Targeted
20481	Bunton Branch at Heidenreich Lane	29.971	97.819	Targeted
20482	Brushy Creek at FM 2001 (dwnstrm of NRCS 12)	30.033	97.771	Targeted
20483	Elm Creek at SH 21 (downstream of NRCS 16)	29.998	97.743	Targeted
20484	Plum Creek at Heidenreich Lane (downstream of Kyle WWTP)	29.963	97.831	Targeted/Stormwater
20486	11041-002 City of Kyle and Aquasource WWTP	29.97	97.832	WW Effluent
20487	Brushy Creek at SH 21	29.978	97.766	Targeted
20488	Brushy Creek at Rocky Road (Upstream NRCS 14)	29.961	97.748	Routine/Targeted/Diurnal
20489	Cowpen Creek at Schuelke Road	29.981	97.712	Targeted
20490	Clear Fork Plum Creek at Farmers Road	29.921	97.794	Targeted
20491	Dry Creek at FM 672	29.904	97.64	Routine/Targeted/Diurnal
20492	10210-001 City of Lockhart WWTP #1	29.884	97.663	WW Effluent
20493	Clear Fork Plum Creek at PR 10 (State Park)	29.853	97.697	Targeted
20494	10210-002 City of Lockhart WWTP #2	29.872	97.622	WW Effluent
20495	Dry Creek at FM 713	29.858	97.58	Targeted
20496	Tenney Creek at Tenney Creek Road	29.796	97.562	Targeted
20497	West Fork Plum Creek at FM 671	29.782	97.681	Targeted
20498	Copperas Creek at Tenney Creek Road (downstream of Cal-Maine)	29.751	97.557	Targeted
20499	10582-002 City of Luling WWTP	29.685	97.627	WW Effluent

Table 14. continued

Site No.	Site Name	Latitude	Longitude	Sample Type
20500	West Fork Plum Creek at Biggs Road (CR131)	29.7	97.612	Routine/Targeted/Diurnal
20501	Salt Branch at Salt Flat Road (Upstream of Luling WWTP)	29.687	97.64	Targeted
20502	Bunton Branch at Dacy Lane (upstream of NRCS 5)	30.009	97.847	Targeted
20503	Plum Creek at Lehman Road	29.991	97.858	Targeted
20504	Porter Creek at Quail Cove Road	30.024	97.822	Targeted
20505	Richmond Branch at Dacy Lane	30.024	97.831	Targeted
20507	Clear Fork Springs at Borchert Loop (CR 108)	29.869	97.731	Spring
20508	Boggy Creek Springs at Boggy Creek Road (CR 218)	29.865	97.713	Spring
20509	Lockhart Springs	29.887	97.668	Spring
20510	Hines Branch at Tenney Creek (CR 141, downstream of Cal-Maine)	29.767	97.557	Targeted
99923	11060-001 City of Buda and GBRA WWTP	30.057	97.836	WW Effluent
99936	14431-001 GBRA Shadow Creek WWTP	30.043	97.811	WW Effluent
99937	14377-001 GBRA Sunfield WWTP	30.083	97.799	WW Effluent

GBRA Routine Monitoring Results

The water quality data collected at eight routine sites on Plum Creek, including five tributaries, is compiled in the following tables. The data was collected as part of the CWA §319 grants, a TSSWCB state grant and the Clean Rivers Program. Only parameters discussed in the WPP are listed. The data has been separated based on the hydrologic conditions of each sampling event. Rainfall data, additional parameters for these locations and results from targeted monitoring can be found on the GBRA website at http://www.gbra.org/plumcreek/data.aspx and http://pcwp.tamu.edu.

The region has experienced moderate to exceptional drought conditions throughout much of the time period since implementation of the Plum Creek WPP. While drought conditions have lessened in the watershed over the reporting period for this Update, December 2011 through March 2014, variable weather patterns have continued to impact hydrologic function and sampling opportunities.

Plum Creek was first listed on the 303(d) list in 2004 due to high *E. coli* concentrations. All segments of the creek were removed from the 303(d) list with the issuance of the 2010 Texas Integrated Report which reclassified the entirety of Plum Creek as a *Category 4b* stream. While Plum Creek continues to exceed the water quality contact recreation standard of 126 organisms per 100 mL throughout its upper, middle and lower reaches, a TMDL is not currently being considered for implementation by the TCEQ as "other control requirements are reasonably expected to result in the attainment of all standards."

Water quality data collected at 8 routine monitoring stations in the Plum Creek watershed are presented in Tables 15 through 18. The two columns on the far right compare the entire data set under all flow conditions for the full 6-year WPP implementation period (January 2008 through December 2013) to the data collected over the most recent 3-year period of implementation (January 2011 to December 2013).

Water quality data evaluated for *E. coli* concentrations measured during routine monitoring of the Plum Creek watershed are presented in Table 15. A number of clear observations should be noted from the flow and *E. coli* monitoring results presented in this Update. An average of 20 sampling events have been added to the data assessed at the three CRP monitoring locations (top three rows) since the previous assessment conducted for the 2012 Update to the Plum Creek WPP. The data show a 24% increase in median baseflow measured at Plum Creek at CR 202 (Lockhart CRP) coupled with a 23% increase in the baseflow *E. coli* geomean. When evaluating the *E. coli* geomean under all flow conditions from January 2011 to December 2013 at the Lockhart CRP, data show that *E. coli* concentrations over this period were 31% higher than concentrations measured over the entire 6-year reporting period since 2008. Water quality conditions at the Lockhart CRP are influenced by the uppermost areas of the watershed including Kyle, Buda, Uhland and the City of Lockhart to a lesser extent. Due to the rapid growth and urbanization in this area as well as multiple major permit violations by WWTFs located near the headwaters of Plum Creek, there has been an increase in baseflow and *E. coli* concentrations over the past three years at Lockhart CRP site. While it is demonstrated that rainfall events contribute significant *E. coli* loads, it is important to note that the bacterial contamination is still present and highly variable under baseflow conditions.

Table 15. Water quality monitoring results for *E. coli* at routine stations in Plum Creek categorized by meteorological conditions during sampling (dry weather or wet weather).

Site	No. of Samples	Median Flow-Dry (cfs)	E. coli Geomean - Dry	Range-Dry	No. of Samples	Median Flow-Wet (cfs)	E. coli Geomean - Wet	Range-Wet	% Change btwn Dry and Wet *	E. coli Geomean 2008-2013**	E. coli Geomean 2011-2013**
Plum Creek at Plum Creek Road	52	1.8	380	36-4840	28	8.6	650	64-24000	71.05	460	430
Plum Creek at CR 202	46	4.2	190	16-3740	31	14.69	450	36->24200	136.84	260	340
Plum Creek at CR 135	50	5	110	9-1200	36	36	450	26-13000	309.09	190	150
Clear Fork Plum Creek at Salt Flat Road	38	0.8	80	3-3150	27	5	590	41-12030	637.50	180	250
West Fork Plum Creek at Biggs Road	25	dry w pools	30	1-240	22	0.01	250	10-2500	733.33	80	120
Elm Creek at CR 233	17	0	42	4-690	19	0.01	206	5-17330	390.48	110	110
Dry Creek at CR 672	6	0.1	160	48-610	12	0.35	870	140-4400	443.75	480	430
Brushy Creek at Rocky Road	25	<0.01	80	5-1900	22	1.7	510	19-5480	537.50	190	250

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

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

** Last two columns compare entire data set under all flow conditions for the entire WPP implementation period to the data set collected over the last two years of implementation.

Despite the successful implementation of numerous BMPs throughout the watershed, no significant improvements in *E. coli* concentration can be derived from the available data; however, it is important to note that the *E. coli* geomean under baseflow conditions in Plum Creek at CR 135 (Luling CRP) has remained below 126 despite increasing *E. coli* concentrations upstream. Further, data show a decreasing trend in overall *E. coli* concentrations (both wet and dry conditions) measured at the Luling CRP site over the most recent 3-year period with a 21% decrease in the *E. coli* geomean compared to the larger 6-year dataset. Located just upstream of Plum Creek's confluence with the San Marcos River, the Luling CRP site is one of the best indicators for overall water quality conditions in the Plum Creek watershed.

Water quality data evaluated for total phosphorus concentrations measured during routine monitoring of the Plum Creek watershed are presented in Table 16. Total phosphorus concentrations are assessed for concerns using a screening concentration of 0.69 mg/L. The data collected under dry conditions at the CRP sites located along the main stem exceed this screening concentration consistently due to the high contributions of wastewater effluents to the baseflow. Comparing the phosphorus concentrations measured under dry conditions to the concentrations measured under wet conditions at these sites, the data show a consistent reduction in the phosphorus load as a result of dilution from runoff. This trend is reversed for routinely monitored Plum Creek tributaries. While the tributary monitoring locations presented below (last 5 rows) typically do not exceed the screening concentration, data show that phosphorus concentrations typically increase at these sites during runoff events. Phosphorus concentrations at each routine monitoring site remain relatively unchanged when comparing the 2011 through 2013 dataset to the entire 6-year dataset.

Table 16. Water quality monitoring results for phosphorus at routine stations in Plum Creek categorized by meteorological conditions during sampling (dry weather or wet weather).

Site	No. of Samples	Median Flow	Total P Mean - Dry	Range-Dry	No. of Samples	Median Flow	Total P Mean - Wet	Range-Wet	% Change btwn Dry and Wet *	Tot P Mean 2008-2013**	Tot P Mean 2011-2013**
Plum Creek at Plum Creek Road	50	1.8	3.12	0.04-5.26	27	8.6	1.26	0.27-4.56	-59.62	2.46	2.36
Plum Creek at CR 202	46	4.2	1.42	0.5-2.69	31	14.69	0.96	0.19-2.26	-32.39	1.24	1.31
Plum Creek at CR 135	50	5	0.99	0.22-2.69	29	36	0.79	0.20-2.12	-20.20	0.91	0.94
Clear Fork Plum Creek at Salt Flat Road	38	0.8	0.07	<0.05-0.31	27	5	0.18	<0.05-0.9	157.14	0.12	0.1
West Fork Plum Creek at Biggs Road	24	dry w pools	0.57	0.06-2.14	22	0.01	0.36	0.07-0.85	-36.84	0.47	0.35
Elm Creek at CR 233	17	0	0.14	0.06-0.27	21	0.01	0.17	0.06-0.45	21.43	0.17	0.16
Dry Creek at CR 672	6	0.1	0.35	0.23-0.47	12	0.35	0.37	0.17-0.69	5.71	0.35	0.37
Brushy Creek at Rocky Road	25	<0.01	0.11	<0.05-0.3	22	1.7	0.13	<0.05-0.37	18.18	0.12	0.12

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

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

** Last two columns compare entire data set under all flow conditions for the entire WPP implementation period to the data set collected over the last two years of implementation.

According to the TCEQ assessment protocol, a stream will have a concern for NO_3-N if the mean concentration exceeds 1.95 mg/L. Table 17 shows that the upper two main stem sites on Plum Creek exceed the screening concentration under dry flow conditions due to the contribution of wastewater effluents. As the water flows down Plum Creek, the mean NO_3-N concentration drops below the screening concentration. This reduction could be due to the long residence time between the Lockhart CRP site and Luling CRP site during low flow conditions, which allows biological uptake of nitrate by macrophytes and algae. It is important to reiterate that drought impacts the stream by reducing baseflow which increases the percent of wastewater effluent under baseflow conditions and by reducing the contributions of tributaries which have been dry for a significant amount of time during the monitoring period. As with phosphorus, NO_3-N concentrations at each routine monitoring site remain relatively unchanged when comparing the 2011 through 2013 dataset to the entire 6-year dataset.

Table 17. Water quality monitoring results for nitrate nitrogen at routine stations in Plum Creek categorized by meteorological conditions during sampling (dry weather or wet weather).

Site	No. of Samples	Median Flow	NO3-N Mean - Dry	Range-Dry	No. of Samples	Median Flow	NO3-N Mean - Wet	Range-Wet	% Change btwn Dry and Wet *	NO3-N Mean 2008-2013**	NO3-N Mean 2011-2013**
Plum Creek at Plum Creek Road	50	1.8	15.94	2.68-34.8	27	8.6	7.68	0.37-29.3	-51.82	12.95	13.96
Plum Creek at CR 202	46	4.2	7.02	2.53-16.3	31	14.69	4.06	0.51-11.6	-42.17	5.82	5.82
Plum Creek at CR 135	50	5	1.67	<0.05-6.24	29	36	2.66	0.07-7.96	59.28	1.91	1.93
Clear Fork Plum Creek at Salt Flat Road	38	0.8	0.58	<0.05-3.02	27	5	0.74	<0.05-2.08	27.59	0.64	0.54
West Fork Plum Creek at Biggs Road	24	dry w pools	0.33	<0.05-1.06	22	0.01	0.23	<0.05-1.36	-30.30	0.3	0.35
Elm Creek at CR 233	17	0	0.1	<0.05-0.35	21	0.01	0.28	<0.05-1.39	180.00	0.2	0.17
Dry Creek at CR 672	6	0.1	0.22	<0.05-0.8	12	0.35	0.63	<0.05-3.78	186.36	0.49	0.33
Brushy Creek at Rocky Road	25	<0.01	0.15	<0.05-0.69	22	1.7	0.25	<0.05-1.44	66.67	0.2	0.17

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

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

** Last two columns compare entire data set under all flow conditions for the entire WPP implementation period to the data set collected over the last two years of implementation.

Water quality data evaluated for ammonia nitrogen (NH_3-N) concentrations measured during routine monitoring of the Plum Creek watershed are presented in Table 18. Sources of NH_3-N include decomposition of organic material present in the stream, agricultural contributions and wastewater discharges. Comparing water quality data collected under both dry and wet conditions for the entire 6-year dataset, the mean concentration of NH_3-N only exceeded the screening concentration of 0.33 mg/L in Plum Creek at Plum Creek Road (Uhland CRP). While NH_3-N levels remain close to the screening concentration at several routine monitoring locations, the data show an encouraging trend with all sites at or below the screening concentration under both dry and wet conditions over the 2011 through 2013 sampling period.

Table 18. Water quality monitoring results for ammonia-nitrogen at routine stations in Plum Creek categorized by meteorological conditions during sampling (dry weather or wet weather).

Site	No. of Samples	Median Flow	NH3-N Mean - Dry	Range-Dry	No. of Samples	Median Flow	NH3-N Mean - Wet	Range-Wet	% Change btwn Dry and Wet *	NH3-N Mean 2008-2013**	NH3-N Mean 2011-2013**
Plum Creek at Plum Creek Road	48	1.8	0.46	<0.1-5.62	28	8.6	0.35	<0.1-3.16	-23.91	0.42	0.32
Plum Creek at CR 202	45	4.2	0.17	<0.1-0.9	31	14.69	0.17	<0.1-0.71	0.00	0.17	0.22
Plum Creek at CR 135	49	5	0.17	<0.1-0.38	29	29	0.21	<0.1-0.66	23.53	0.18	0.2
Clear Fork Plum Creek at Salt Flat Road	38	0.8	0.19	<0.1-0.45	27	5	0.16	<0.1-0.36	-15.79	0.18	0.2
West Fork Plum Creek at Biggs Road	25	dry w pools	0.21	<0.1-0.98	22	0.01	0.21	<0.1-1.91	0.00	0.21	0.25
Elm Creek at CR 233	17	0	0.31	<0.1-1.24	21	0.6	0.24	<0.1-1.04	-22.58	0.27	0.28
Dry Creek at CR 672	6	0.1	0.23	<0.10-0.46	12	0.35	0.31	<0.1-0.0.76	34.78	0.28	0.33
Brushy Creek at Rocky Road	25	<0.01	0.22	<0.1-1.08	22	1.7	0.28	<0.1-0.35	27.27	0.26	0.2

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

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

** Last two columns compare entire data set under all flow conditions for the entire WPP implementation period to the data set collected over the last two years of implementation.

Data collected at the wastewater treatment facilities are tabulated in Table 19. During baseflow conditions, many sites along Plum Creek are dominated by wastewater effluent. During the drought, the Uhland CRP site would have been dry if not for the wastewater effluents discharged upstream. In November 2010, monitoring site 20484 (Plum Creek at Heidenreich Lane) experienced a fish kill caused by high levels of ammonia and low dissolved oxygen due to the discharge of poorly treated wastewater from the Kyle WWTF, operated by Aqua Operations, Inc. Plant disruptions that lead to a major overflow of partially treated wastewater in November and December of 2012 left a ¼ mile to ½ mile stretch of Plum Creek downstream of the Kyle WWTF filled with sludge and other contaminants for several weeks. Additional operational failings have been identified during routine monitoring of the facility revealing numerous spikes in *E. coli* concentrations and NH_3-N concentrations well above permitted limits.

When comparing water quality data collected from this facility's effluent since routine sampling began in 2011 with data collected over the same period at downstream CRP monitoring sites (Uhland and Lockhart), there appears to be a reasonable correlation between *E. coli* spikes identified at the WWTF and elevated *E. coli* levels downstream. Figure 25 presents *E. coli* concentrations measured in the effluent from the Kyle WWTF from April 2011 through January 2014 along with corresponding *E. coli* concentrations measured downstream at CRP sites near Uhland and Lockhart. Sampling is typically conducted at these sites only once per month. As noted previously, however, concentrations in the Kyle WWTF effluent exceeded the water quality standard for contact recreation of 126 MPN/100mL in 48.6% of samples taken from April 2011 through December 2013[18]. Five sampling events at the Kyle WWTF revealed *E. coli* concentrations in excess of 1,000 MPN/100mL.

[18] *E. coli* concentrations in 18 of 37 samples collected monthly during the monitoring period exceeded 126 MPN/100mL

Table 19. Wastewater treatment plant water quality monitoring results in the Plum Creek Watershed, April 2008 through December 2013.

Site	Effluent Requirements E.coli/TotP/NH3-N	No. of Samples	Median Flow	*E. coli* Geo-Mean	Range	Total P Mean, mg/L	Range	NO3-N Mean, mg/L	Range	NH3-N Mean, mg/L	Range
Kyle and Aqua Texas	NA/NA/3	40	2.4	93	<1->4840	3.88	0.78-8.94	21.1	0.27-35.5	1.46	<0.2-22.2
Buda and GBRA	NA/1.2/2	38	1.2	2	<1-25	0.40	0.21-0.84	20.77	10.4-29.5	0.22	<0.2-2.79
Shadow Creek and GBRA	NA/1/2	38	0.2	3	<1->2420	0.51	0.1-2.36	8.78	0.52-15.8	0.86	<0.2-6.01
Sunfield and GBRA	NA/1/2	34	0.075	1	<1-4	0.48	0.21-0.96	45.2	22.5-63.5	<0.2	0.24
Lockhart #1 and GBRA	126/NA/3	38	0.80	3	<1-820	3.38	1.91-17.3	15.7	6.2-26.3	0.66	<0.2-7.2
GBRA Lockhart #2	126/NA/3	38	1.4	11	<1-980	2.57	0.31-7.36	6.62	0.08-26.0	0.45	<0.2-7.85
Luling	NA/NA/3	38	0.31	2	<1->4840	3.8	1.84-5.89	20.2	0.19-44.2	0.49	<0.2-2.84

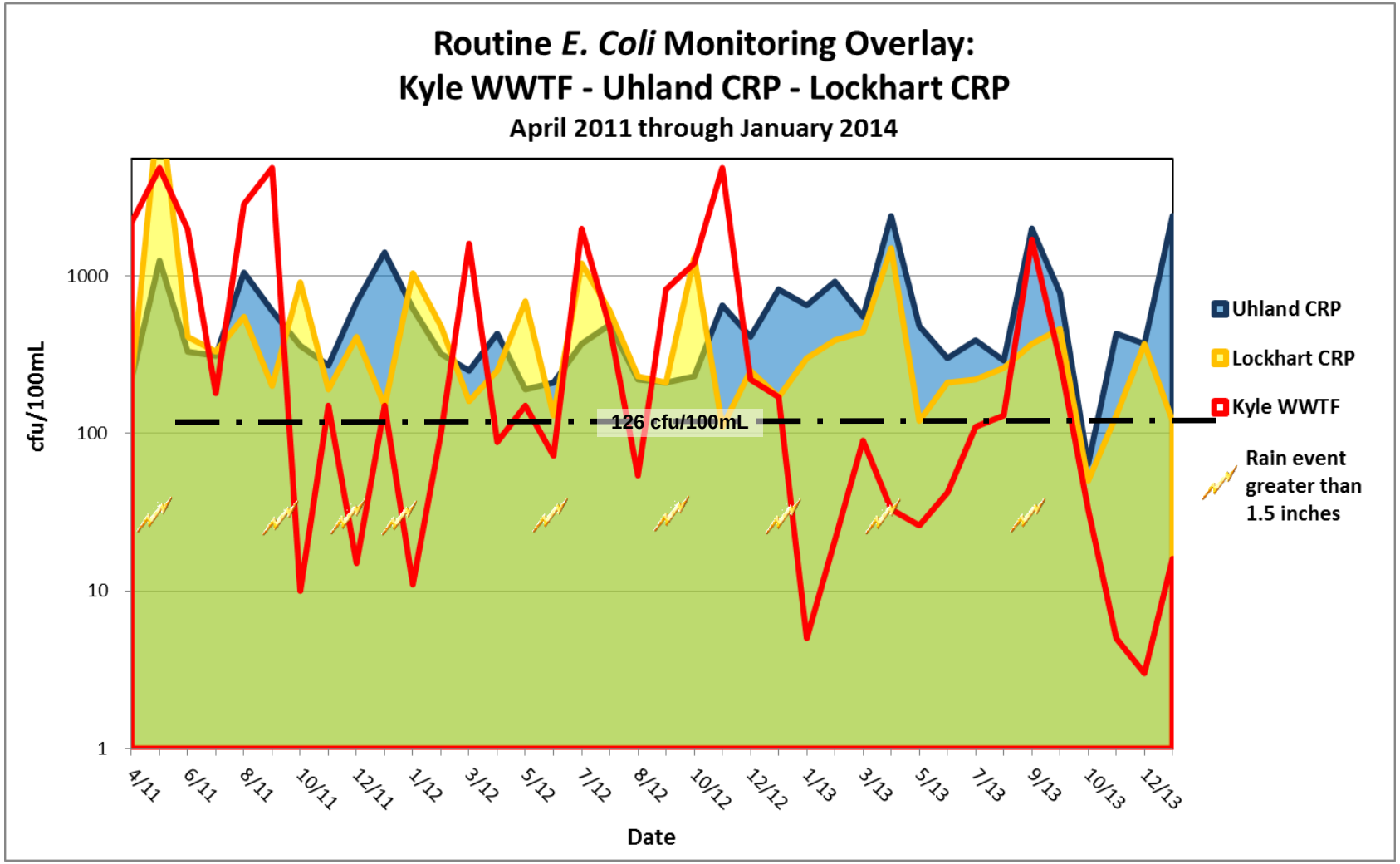


Figure 25. Routine *E. coli* monitoring overlay: Kyle WWTF – Uhland CRP Site – Lockhart CRP Site, April 2011 through January 2014.

Data collected from Boggy Springs, Lockhart Springs, and Clear Fork Springs can be found in Table 20. The samples were collected quarterly but the hydrologic conditions were noted. The mean *E. coli* concentrations are at or above the water quality standard for contact recreation under both hydrologic conditions. These results could be impacted by the difficulty of collecting a representative sample of the springs, one that would not be impacted by either low flow conditions or after a rainfall event that contributes pollutant loads via surface runoff to the channel at the outlet of the springs.

Table 20. Water quality monitoring results for three springs sites in the Plum Creek Watershed.

Site	No. of Samples	Median Flow	*E. coli* Geomean[1]	*E. coli* Range	*E. coli* Geomean Post-impl[2]	Tot P Mean[1]	Tot P Range	Tot P Mean Post-impl[2]	NO3-N Mean[1]	NO3-N Range	NO3-N Mean Post-impl[2]	NH3-N Mean[1]	NH3-N Range	NH3-N Mean Post-impl[2]
Boggy Springs	16	0.20	170	52-9800	171	<0.05	<0.05-0.06	<0.05	6.40	2.36-8.28	6.17	0.17	<0.1-0.31	0.18
Lockhart Springs	16	0.73	266	70-770	271	<0.05	<0.05-0.06	<0.05	10.11	7.35-11.9	10.4	0.16	<0.1-0.36	0.18
Clear Fork Springs	15	0.6	234	50-2420	169	<0.05-0.07	<0.05	<0.05	6.08	4.68-7.36	5.98	0. 16	<0.1-0.29	0.18

[1] entire data set [2] Post implementation - most recent 36 months only, for a total of 12 samples

Analysis of Water Quality Trends at CRP Stations

A trend analysis was calculated at the three CRP stations that are monitored monthly and located in Uhland (Figure 26), Lockhart (Figure 27) and Luling (Figure 28) using a running 3-year geometric mean or median calculated for each 6-month period in March and September over the sampling period. These data are influenced by the extreme drought experienced in this area which has, at times, greatly reduced flows at the sites. The red line on the graphs indicates the water quality standard for *E. coli* and the state's screening criteria level for NO_3-N and total phosphorus. To meet water quality standards or screening criteria levels the blue area should be below the red line.

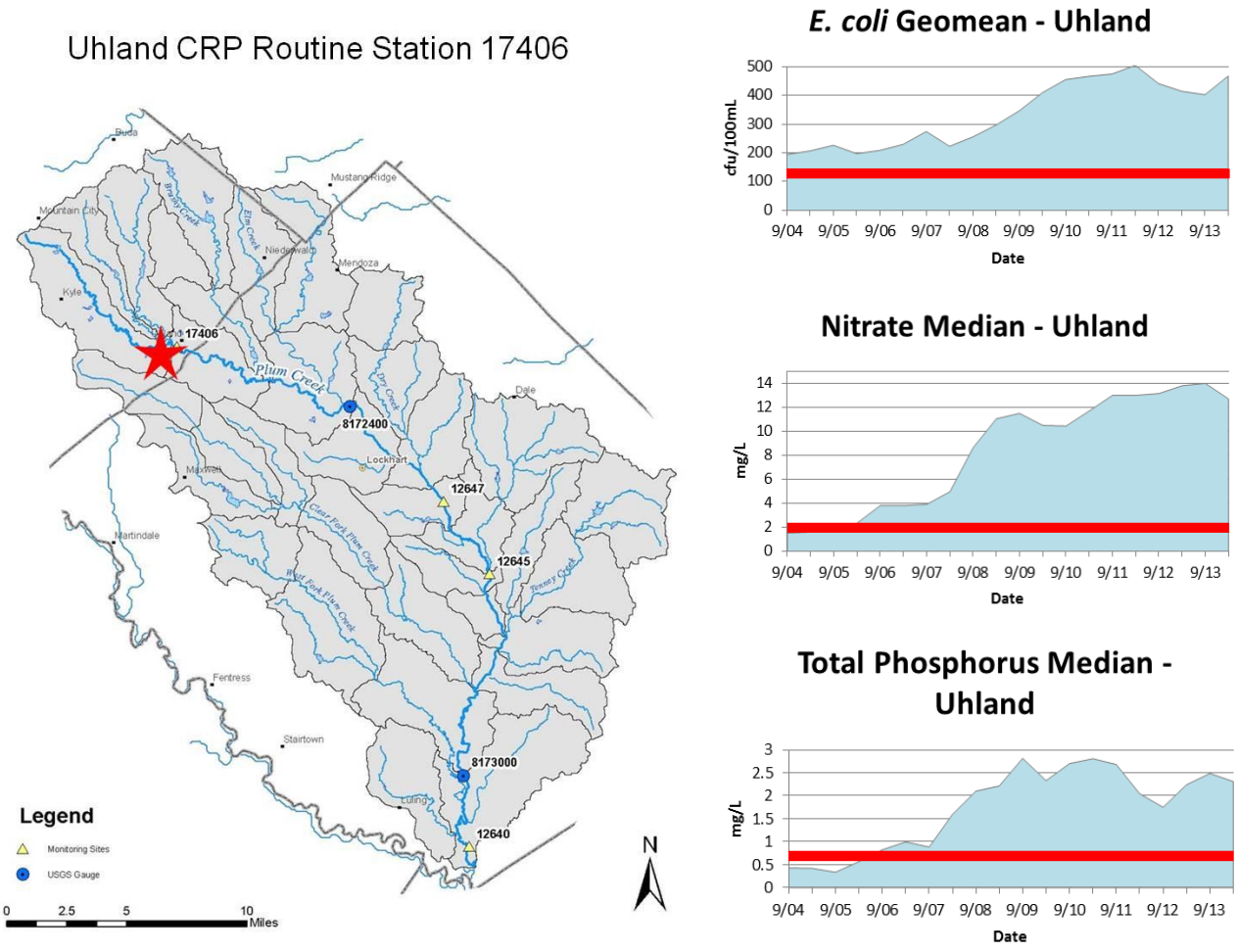


Figure 26. Uhland CRP routine monitoring station and water quality trend analysis for *E. coli*, nitrate nitrogen, and total phosphorus

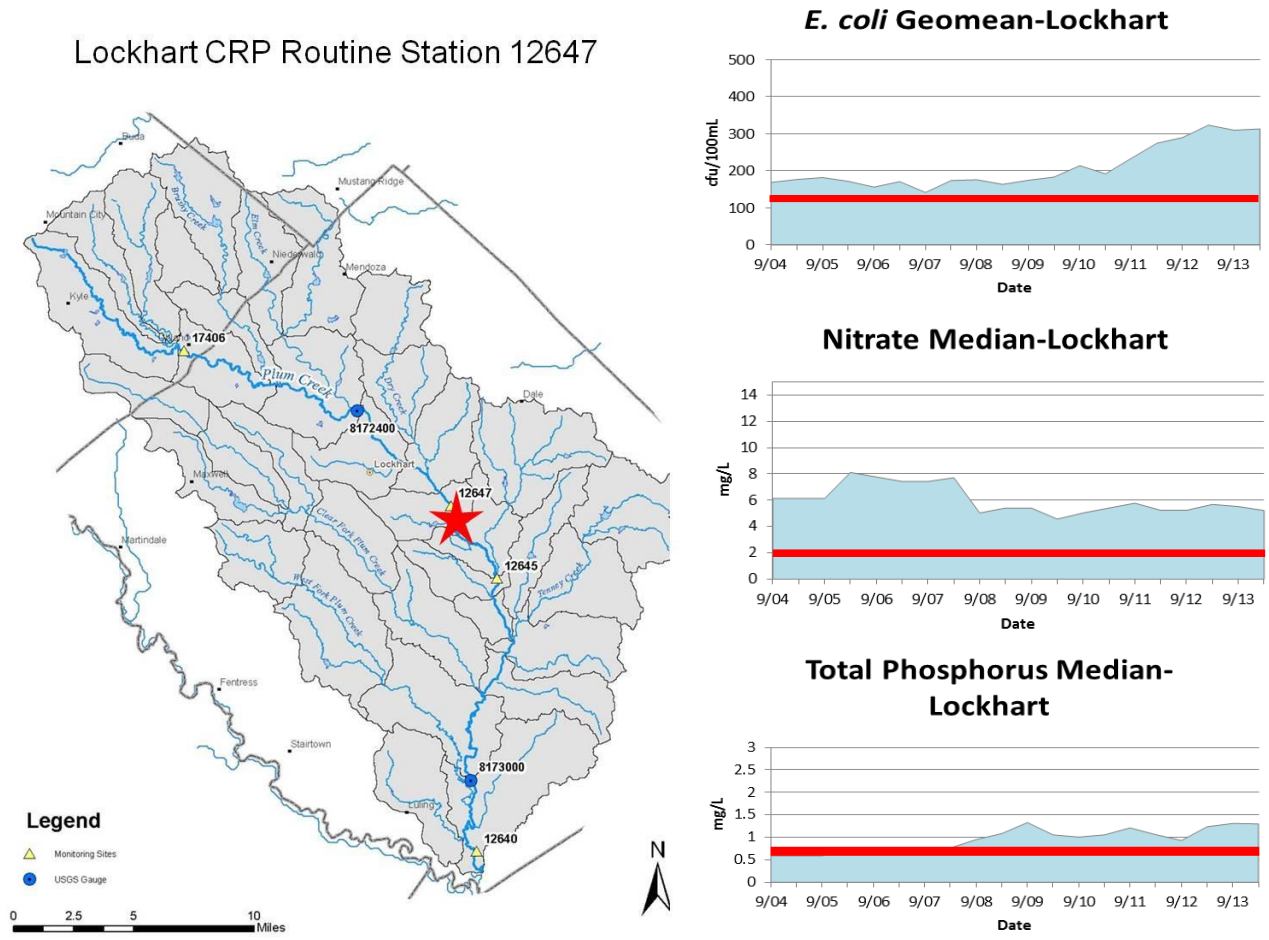


Figure 27. Lockhart CRP routine monitoring station and water quality trend analysis for *E. coli*, nitrate nitrogen, and total phosphorus.

The Partnership is encouraged to see that while *E. coli*, NO_3-N and total phosphorus concentrations have continued to increase rapidly in the upper section of Plum Creek, the trend analyses suggest that as additional flows are added to the mainstem; water quality conditions appear to be improving significantly before reaching the Luling CRP station. Addressing water quality degradation in the headwaters of Plum Creek, most likely a result of increasing urban development, erratic pulses of failing OSSF wastewater and the discharge of improperly treated WWTF effluent, will continue to be a top priority for the Partnership through the next phase of implementation.

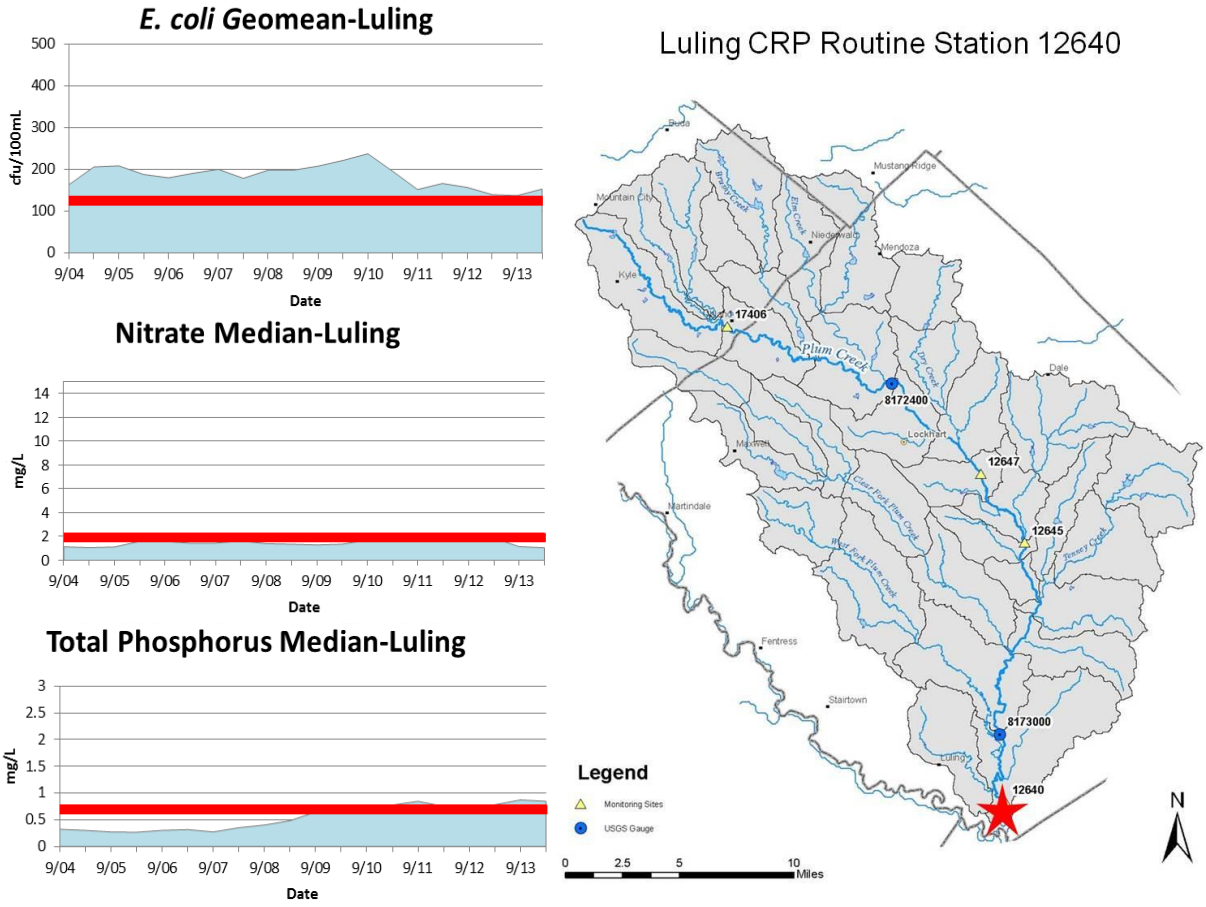


Figure 28. Luling CRP routine monitoring station and water quality trend analysis for *E. coli*, nitrate nitrogen, and total phosphorus.

GBRA Targeted Monitoring Results

TSSWCB provided CWA §319(h) funding for the GBRA to conduct an intensive targeted monitoring project to supplement data collected for TCEQ assessment purposes. In addition to expanding the number of routine monthly monitoring stations from three to eight sites monthly (as discussed in the previous section), 35 sites are now sampled twice per season during both dry and wet weather conditions; six WWTFs are sampled once per season, three springs are sampled seasonally; and automated stormflow sampling of selected rainfall events was conducted at an urban site in the City of Kyle. After the initial period of funding (May 2007 through March 2010), TSSWCB utilized state funds to continue the mainstem and tributary portions of this monitoring regime through December 2010. GBRA will continue this comprehensive monitoring regime through 2014 with additional CWA §319(h) grant funds from the TSSWCB. This increased monitoring strategy provides a higher level of understanding of the spatial and temporal trends of pollutant loading, serves to refine the focus of management efforts, and helps track the performance of ongoing implementation activities. Because this is a critical part of adaptive management in the Plum Creek watershed, the targeted monitoring will play a key role in future watershed efforts and should continue. Table 21 summarizes data collected thus far. There is a considerable variation between and within sites, depending on the water quality parameter.

Table 21. Routine and targeted monitoring data in the Plum Creek Watershed categorized by meteorological conditions during sampling (dry weather or wet weather). Special instructions for shaded cells are located below the last row of the table.

Site	No. of Samples - Dry	Median Flow - Dry	*E. coli* Geomean - Dry	*E. coli* Range-Dry	No. of Samples - Wet	Median Flow - Wet	*E. coli* Geomean - Wet	*E. coli* Range-Wet	Tot P Mean - Dry	Tot P Range-Dry	Tot P Mean - Wet	Tot P Range-Wet	NO3-N Mean - Dry	NO3-N Range-Dry	NO3-N Mean - Wet	NO3-N Range-Wet	NH3-N Mean - Dry	NH3-N Range-Dry	NH3-N Mean - Wet	NH3-N Range-Wet
Andrews Branch at CR 131	16	0.9	176	36-1400	13	1.8	540	41-10460	0.31	0.18-0.55	0.21	0.13-0.44	15.25	2.49-22.6	8.29	1.14-20.6	0.19	0.1-0.35	0.23	0.05-0.44
Brushy Creek at FM2001	2	0	3	2-4	10	19	190	<1-6800	0.07	0.03-0.1	0.16	0.05-0.46	<0.05	<0.05-0.1	0.77	<0.05-5.7	0.24	0.05-0.42	0.26	0.05-0.47
Brushy Creek at SH21	11	0	29	1-160	12	1.75	798	72-7270	0.07	0.05-0.16	0.16	0.06-0.33	0.14	<0.05-0.65	0.54	<0.05-2.83	0.33	0.05-1.0	0.19	0.05-0.45
Bunton Branch at Dacy Lane (CR205)	12	0.01	45	15-220	10	0.55	524	50-3550	0.06	<0.05-0.25	0.07	0.02-0.22	0.12	<0.05-0.23	0.53	<0.05-1.63	0.19	0.1-0.57	0.2	0.05-0.42
Bunton Branch at Heidenreich Lane (CR152)	5	dry	71	12-210	10	1.1	637	190-2360	0.06	0.02-0.08	0.1	<0.05-0.22	0.43	0.09-0.86	0.69	0.14-1.82	0.27	<0.1-0.65	0.22	<0.1-0.51
Clear Fork Plum Creek at Old Luling Road (CR213)	17	0.7	57	10-270	15	1	239	20-2000	0.06	<0.05-0.16	0.15	<0.05-0.39	1.51	<0.05-7.12	1.33	0.06-5.4	0.21	<0.1-0.65	0.2	0.1-0.59
Clear Fork Plum Creek at CR 228	3	dry	59	10-750	3	0	210	10-3080	0.14	0.13-0.15	0.14	0.06-0.24	0.03	<0.05	0.48	0.15-1.04	0.17	<0.1-0.29	0.14	<0.1-0.35
Clear Fork Plum Creek at PR 10	16	0.69	52	19-140	15	1.2	292	31-3870	0.03	<0.05-0.07	0.1	<0.05-0.39	2.63	0.12-5.3	2.52	0.12-5.44	0.26	<0.1-1.03	0.15	<0.1-0.33
Copperas Creek at Tenney Creek Rd (CR141)	2	<0.01	342	180-650	5	0.04	747	10-17000	0.10	0.08-0.12	0.46	0.14-0.93	0.12	<0.05-0.22	0.4	<0.05-1.2	0.39	0.31-0.46	0.24	0.02-0.37

Table 21. continued

Site	No. of Samples - Dry	Median Flow - Dry	*E. coli* Geomean - Dry	*E. coli* Range-Dry	No. of Samples - Wet	Median Flow - Wet	*E. coli* Geomean - Wet	*E. coli* Range-Wet	Tot P Mean - Dry	Tot P Range-Dry	Tot P Mean - Wet	Tot P Range-Wet	NO3-N Mean - Dry	NO3-N Range-Dry	NO3-N Mean - Wet	NO3-N Range-Wet	NH3-N Mean - Dry	NH3-N Range-Dry	NH3-N Mean - Wet	NH3-N Range-Wet
Cowpen Creek at Schuelke Rd (CR222)	0	dry	NA	NA	6	0.56	1572	160-46100	NA	NA	0.21	0.06-0.39	dry	NA	0.79	<0.05-2.32	dry	NA	0.36	<0.1-0.59
Dry Creek at FM713	2	0	228	10-2700	6	0.14	1328	420-16000	0.19	0.13-0.27	0.35	0.15-0.88	0.99	<0.05-2.79	0.47	0.1-1.24	0.36	0.14-0.78	0.25	<0.1-0.34
Elm Creek at SH 21	0	dry	NA	NA	6	2.15	346	160-630	NA	NA	0.1	0.04-0.19	dry	NA	0.43	<0.05-1.4	NA	NA	0.25	<0.1-0.42
Hines Branch at Tenney Creek Rd (CR141)	2	0	121	70-210	7	0	640	30-24200	0.18	NA	0.24	0.06-0.44	<0.05	<0.05	0.73	<0.05-1.55	0.22	<0.1-0.35	0.26	0.13-0.49
Plum Creek at Biggs Rd (CR131)	17	5.9	178	79-490	15	34	1061	170-15000	0.91	0.38-1.64	1	0.27-1.76	1.88	0.09-4.26	2.35	0.22-7.5	0.21	<0.1-0.57	0.25	0.12-0.77
Plum Creek at CR 186	17	3.2	208	70-540	15	10.6	686	150-24200	1.22	0.67-2.19	1.03	0.3-2.04	7.65	1.08-13	3.47	0.74-10.2	0.14	<0.1-0.25	0.19	<0.1-0.46
Plum Creek at CR 233	17	1.5	107	45-450	7	6.1	711	120-10460	2.41	0.68-4.27	1.44	0.22-3.96	10.04	2.0-21.3	5.41	0.38-22.8	0.17	<0.1-0.33	0.23	<0.1-0.4
Plum Creek at FM 1322	17	4.8	167	53-650	15	27	1039	73-16000	1.03	0.46-1.64	0.97	0.29-2.14	3.38	0.07-8.74	2.41	0.85-7.08	0.19	<0.1-0.34	0.18	<0.1-0.45
Plum Creek at Heidenreich Lane (CR152)	21	1.75	1352	460-4840	13	3.3	2505	280->24200	3.86	2.71-5.02	1.81	0.33-4.36	18	6.07-26.5	10.5	0.65-28.7	1.3	<0.10-10.4	0.47	<0.1-1.96
Plum Creek at Lehman Rd	14	0.01	80	5-1300	15	1.2	684	85-19860	0.03	<0.02-0.08	0.07	<0.05-0.17	0.51	<0.05-3.28	0.81	<0.05-4.38	0.14	<0.1-0.34	0.18	<0.1-0.75
Plum Creek at Youngs Lane (CR197)	16	3.8	160	76-490	14	13.8	1320	520-17330	1.32	0.47-2.14	1.02	0.28-2.8	4.33	0.17-10.7	3.61	0.73-10.7	0.18	<0.1-0.3	0.17	<0.1-0.36

Table 21. continued

Site	No. of Samples - Dry	Median Flow - Dry	*E. coli* Geomean - Dry	*E. coli* Range- Dry	No. of Samples - Wet	Median Flow - Wet	*E. coli* Geomean - Wet	*E. coli* Range- Wet	Tot P Mean - Dry	Tot P Range- Dry	Tot P Mean - Wet	Tot P Range- Wet	NO3-N Mean - Dry	NO3-N Range- Dry	NO3-N Mean - Wet	NO3-N Range- Wet	NH3-N Mean - Dry	NH3-N Range- Dry	NH3-N Mean - Wet	NH3-N Range- Wet
Plum Creek downstrm of NRCS 1	13	0	18	1-1120	15	0	79	10-4800	0.35	0.04-0.98	0.31	0.04-0.87	1.13	<0.05-7.84	0.7	<0.05-6.52	0.59	<0.1-2.81	0.18	<0.1-0.46
Plum Creek upstrm of Hwy 183	17	1	67	12-220	13	19	596	50->24200	1.91	0.64-3.42	1.26	0.23-3.18	4.87	0.13-10.3	3.15	0.63-9.67	0.17	<0.1-0.3	0.2	<0.1-0.65
Porter Creek at Dairy Rd (CR151)	11	0.12	148	8-580	12	2.3	769	120-24200	0.07	<0.05-0.16	0.11	<0.05-0.22	0.23	<0.05-1.22	0.61	<0.05-2.78	0.33	<0.1-0.9	0.23	<0.1-0.52
Porter Creek Trib at Quail Cove Rd	0	dry	NA	NA	7	<0.01	541	40-4800	NA	NA	0.19	0.07-0.38	NA	NA	0.86	<0.05-3.14	NA	NA	0.21	<0.10-0.51
Richmond Branch at Dacy Lane (CR205)	14	0	202	44-2420	12	0.23	657	120-18600	0.12	<0.05-0.82	0.1	0.03-0.43	0.19	<0.05-0.72	1.05	0.06-3.89	0.61	<0.1-6.36	0.21	<0.1-0.76
Salt Branch at Salt Flat Road	13	0	625	65-4840	15	0.06	1823	170->24200	0.61	0.03-4.13	0.28	<0.02-0.7	0.29	<0.05-1.94	0.28	<0.05-1.33	0.51	<0.1-1.76	0.27	0.11-0.71
Salt Branch at FM 1322	16	0.19	192	17-2150	15	0.4	600	10-13000	3.38	1.93-4.22	1.55	0.24-3.69	9.34	0.08-29.5	2.98	0.23-11.6	0.46	0.17-2.59	0.38	0.15-0.82
Tenney Creek at Tenney Creek Rd (CR141)	0	dry	NA	NA	5	0	511	5-10000	NA	NA	0.41	0.32-0.65	NA	NA	0.29	0.16-0.47	NA	NA	0.19	<0.1-0.30
Town Creek at E. Market St	17	0.74	225	57-730	15	1.3	575	70-16000	0.05	<0.05-0.07	0.1	0.04-0.23	10	0.69-12.4	8.3	3.9-11.4	0.23	<0.1-0.86	0.15	<0.1-0.43

Table 21. continued

Site	No. of Samples - Dry	Median Flow - Dry	*E. coli* Geomean - Dry	*E. coli* Range- Dry	No. of Samples - Wet	Median Flow - Wet	*E. coli* Geomean - Wet	*E. coli* Range- Wet	Tot P Mean - Dry	Tot P Range- Dry	Tot P Mean - Wet	Tot P Range- Wet	NO3-N Mean - Dry	NO3-N Range- Dry	NO3-N Mean - Wet	NO3-N Range- Wet	NH3-N Mean - Dry	NH3-N Range- Dry	NH3-N Mean - Wet	NH3-N Range- Wet
Town Creek W of Lockhart (Stueve Lane)	0	dry	NA	NA	5	0	270	5->24200	NA	NA	0.72	0.15-1.71	NA	NA	0.81	<0.05-3.14	NA	NA	0.44	<0.1-1.54
West Fork Plum Creek at FM671	1	dry	37	NA	7	0.06	493	10-8160	0.12	NA	0.15	<0.05-0.29	<0.05	NA	0.29	<0.05-0.75	0.84	NA	0.19	<0.1-0.41

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

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

Stations highlighted have a base flow mean concentration greater than the screening level of 1.95 mg/L under dry conditions.

Stations highlighted have a base flow mean concentration greater than the screening level of 0.33 mg/L under dry conditions.

Rainfall Patterns from January 2008 – March 2014

This region of Texas has seen historic drought levels that have led to crop failures, livestock sell off, and wildfires. Dry conditions in the Plum Creek watershed in 2007-2009 dramatically affected the landscape. Rainfall returned in fall and winter of 2009; however, dry conditions returned by the end of 2010 and continued with unprecedented intensity throughout 2011. Moderate drought conditions have been predominant throughout most of 2012 and 2013. The average monthly rainfall is plotted along with the historic average monthly amounts for the period of 1943-2013 (Figure 29). These recent weather patterns have substantially affected pollutant loading characteristics throughout the watershed. Decreased plant cover likely resulted in greater loss of soil and associated nutrients in many areas as rains returned.

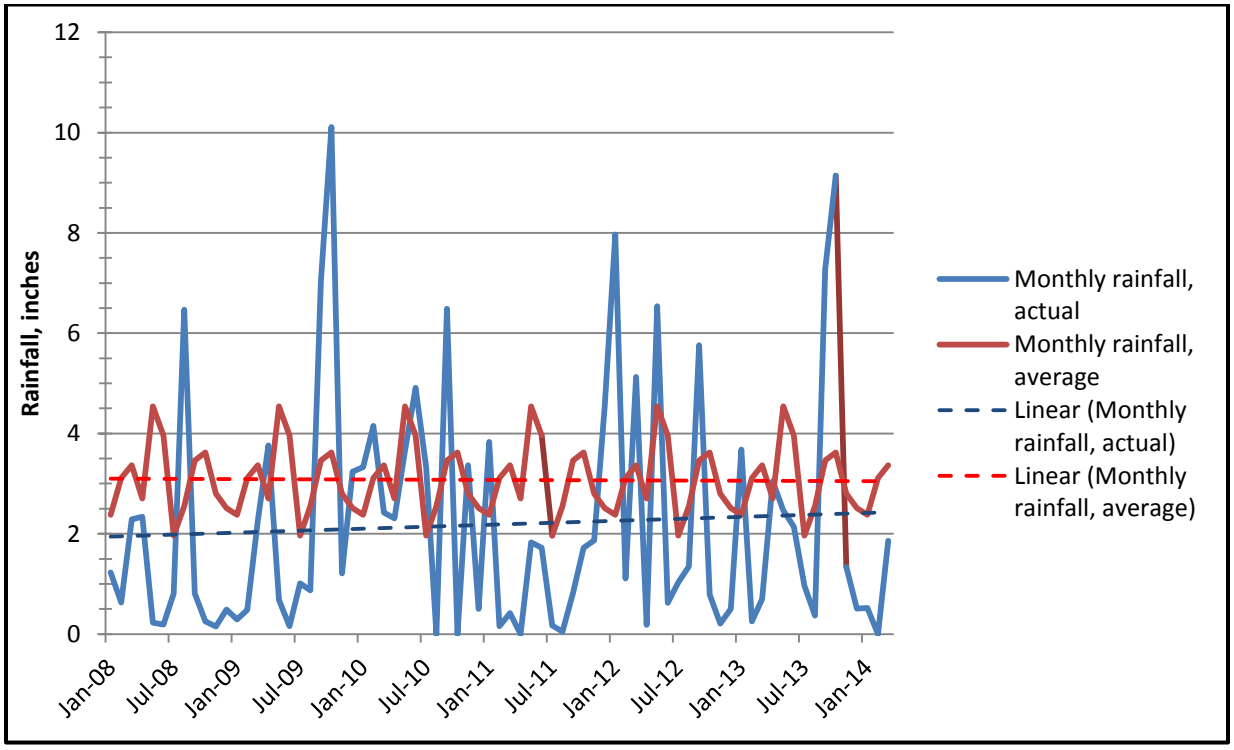


Figure 29. Rainfall data from 2008-2014 of actual rainfall and historic average rainfall amounts. Trendlines have been added to compare mean monthly precipitation over the reporting period to historic mean.

Stream Biological Assessments

In addition to water quality analyses, GBRA conducts annual biological and habitat assessments at two sites in the Plum Creek watershed under the Clean Rivers Program: Plum Creek at CR 202 near Lockhart (12647) and Plum Creek at Plum Creek Road near Uhland (17406). Surveys of the fish and macroinvertebrate communities in the stream as well as the plant communities and physical characteristics of the environment adjacent to the stream serve as indicators of positive or negative responses to changes in stream conditions. The type and the number of fish and macroinvertebrate species collected are used to calculate the Index of Biotic Integrity (IBI). Table 22 presents the IBI scores and the classifications based on those scores for each site evaluated since 2006. Bioassessments were not performed at either site in 2007 and at the Plum Creek at Plum Creek Road site in 2009 due to high flow events that scoured the stream.

Table 22. Stream biological assessments at two sites on Plum Creek.

Stream Biological Assessment - IBI Score (Classification)												
Location	2006		2008		2009		2010		2011		2012	
	Nekton	Benthic	Nekton	Benthic	Nekton	Benthic	Nekton	Benthic	Nekton	Benthic	Nekton	Benthic
Plum Creek at Plum Creek Road near Uhland	33 (Limited)	20 (Limited)	42 (High)	29 (High)	Flooding	Flooding	41 (High)	24 (Interm)	*Removed from Monitoring Schedule*			
Plum Creek at CR 202 downstream of Lockhart	24 (Limited)	17 (Limited)	42 (High)	22 (Interm)	40 (Interm)	25 (Interm)	35 (Interm)	24 (Interm)	43 (High)	26 (Interm)	34 (Limited)	33 (High)

During the March 2009 Guadalupe River Basin coordinated monitoring meeting, the CRP stakeholders agreed to remove the biological monitoring event at station 17406 after fiscal year 2010 in order to re-distribute the funding into new monitoring projects elsewhere in the basin. The decision to discontinue the biological assessment at this station was largely due to the results from the last available assessment event in September of 2008 using the newly published SWQM Procedures Manual: Volume 2 aquatic life monitoring (ALM) protocols. This event showed that all three calculated biological monitoring criteria were meeting the designated "High" aquatic life use for the stream segment. The removal of biological monitoring at station 17406 was also possible because aquatic life use monitoring had been added to another station (12647) on Plum Creek at Old McMahan Road, downstream of the City of Lockhart, which represented a larger portion of the Plum Creek watershed.

The IBI classification system for nekton species developed by the TPWD is specific to each ecoregion. The IBI classification system for the benthic community developed by the TCEQ is applied to all ecoregions across the state. The following are the stream classifications assigned based on IBI scores (Table 23).

Table 23. Stream classifications assigned based on IBI scores for the site.

Classification	Nekton	Benthic
Exceptional	≥49	>36
High	41-48	29-36
Intermediate	35-40	22-28
Limited	<35	<22

GBRA has observed that the majority of macroinvertebrate species collected at both locations are tolerant species. Additionally, there are very few nekton species collected per unit effort and those fish species caught included very few benthic invertivores (fish that feed on invertebrates). The lower species diversity and number of individuals collected have negatively impacted the IBI scores at the Plum Creek sites. There are more tolerant species found at these sites than intolerant species.

The TCEQ assesses the biological integrity of streams by comparing the classification given a site based on the IBI score to the water quality standard for flowing streams. The presumed use for flowing streams is High Aquatic Life Use. Aquatic Life Monitoring (ALM) protocol used by

TCEQ requires that two assessments be conducted each year for two years, with one of the annual assessments done in the critical period (July-September) and one done outside the critical period (March-October). The biological assessments conducted by GBRA on the Plum Creek sites were done only in the critical period of each year. ALM performed by GBRA on the Plum Creek sites was to provide baseline data on environmental conditions.

BACTERIAL SOURCE TRACKING

Bacterial source tracking (BST) is a valuable tool for identifying human and animal sources of fecal pollution. BST has not yet been utilized to determine in-stream source loading in the watershed. The Partnership has been evaluating opportunities to employ BST strategies throughout the reporting period for this Update. Investments by the state in building BST analytical laboratory infrastructure and the use of the Texas *E. coli* BST library now provide substantial cost and time savings for the identification of nonpoint source pollution in watersheds across the state. A renewed interest in BST has led to some very encouraging results. As of the date of this publication, discussions among the TSSWCB, GBRA and the Partnership are underway to develop a state-funded BST monitoring project for Plum Creek. With dramatic landuse changes in the watershed since the development of the Plum Creek WPP, the Partnership is encouraged that a BST project would provide valuable insight for determining proper adaptive management strategies to address current sources and conditions contributing to significant *E. coli* loading.

NITRATE NITROGEN ISOTOPE STUDY

Since monitoring of Plum Creek and Geronimo Creek began in the late 1990's, 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" to 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 BMPs 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). Figure 30 describes graphically the relationship of nitrogen and oxygen isotopes, and the nitrogen cycle.

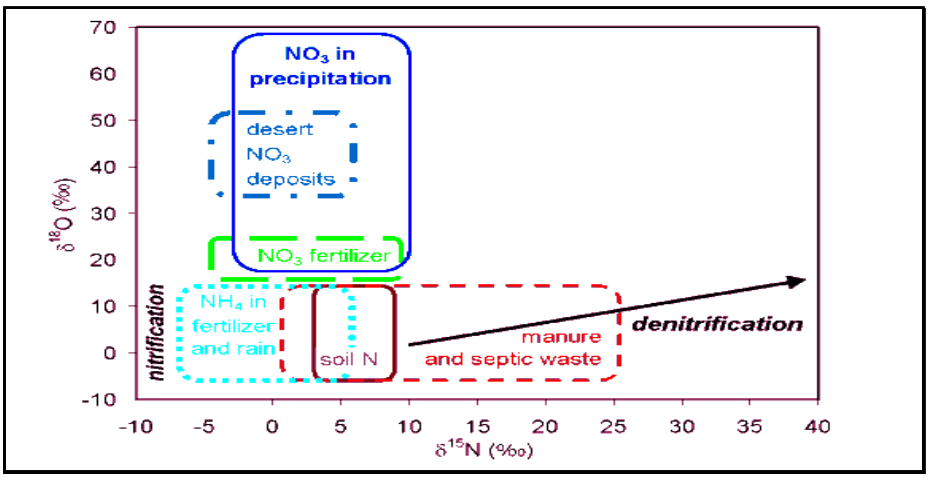


Figure 30. Relationships of nitrogen and oxygen isotopes and the nitrogen cycle.

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 ($^{15}N/^{14}N$) and oxygen ($^{18}O/^{16}O$) isotopes four times during the project period. GBRA and USGS will conduct quarterly targeted surface water quality monitoring at 5 sites in the Plum Creek watershed and at 2 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 1 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 conduct quarterly targeted spring quality monitoring at 1 site in the Plum Creek watershed and one site in the Geronimo Creek watershed, collecting field, flow and conventional parameter groups. A total of 44 environmental samples and six (6) quality-assurance samples will be collected. The quality-assurance samples will consist of 2 field blanks and 4 replicate samples. Sample collection will occur approximately every quarter and if possible, sampling will occur over a range in hydrologic conditions. Field parameters and flow will be collected at the same time as the water-quality samples.

BACTERIA REDUCTIONS

Tables 24 and 25 evaluate *E. coli* load characteristics and anticipated reductions upon full implementation of the Plum Creek WPP.

Table 24. Annual load characteristics and *E. coli* reductions for each station (in billions of cfu).

Monitoring Station	Average Annual *E. coli* Load (cfu/year)	Lower 95% CI	Upper 95% CI	Load Reduction (cfu/year)	Target Load (cfu/year)
Uhland (17406)	1.12E+05	8.74E+04	1.36E+05	7.28E+04	3.92E+04
Lockhart (12647)	4.26E+05	2.46E+05	6.06E+05	6.39E+04	3.62E+05
Luling (12640)	3.02E+07	1.04E+07	5.01E+07	1.24E+07	1.78E+07

Table 25. Estimated regional pollutant load reductions expected upon full implementation of the Plum Creek WPP.

Management Measure	Expected Load Reduction								
	Uhland			Lockhart			Luling		
	Ec[1]	N[2]	P[3]	Ec	N	P	Ec	N	P
Urban Stormwater Management Measures									
Pet Waste Collection Stations	7.2E+12	70.6	8.2	7.3E+12	158.5	17.9	6.0E+14	1.4	N/A
Comprehensive Urban Stormwater Assessment	4.3E+13	531.7	19.1	1.9E+13	929.6	32.5	**1.8E+15**	7.8	N/A
Retrofit Stormwater Detention Basins									
Initiate Street Sweeping Program									
Manage Urban Waterfowl Populations									
Rehabilitate Stormwater Retention Pond									
Wastewater Management Measures									
Wastewater Upgrade (TSS Reduction)	3.5E+10	N/A	N/A	2.1E+10	N/A	N/A	**3.2E+12**	N/A	N/A
Wastewater Upgrade (Phosphorus Removal)									
Voluntary Monthly *E. coli* Monitoring									
Voluntary Monthly Phosphorus Monitoring									
Sanitary Sewer Pipe Replacement									
Lift Station SCADA Installation									
Initiate Sanitary Sewer Inspection Program									
Septic System Inspection/Enforcement (New Position)	6.1E+12	22.7	13.3	5.0E+12	42.2	24.2	**3.8E+14**	0.4	N/A
Septic System Repair									
Septic System Replacement									
Septic System Connection to Sewer									

Table 25. continued

Management Measure	Expected Load Reduction								
	Uhland			Lockhart			Luling		
	Ec[1]	N[2]	P[3]	Ec	N	P	Ec	N	P
Agricultural Management Measures									
WQMP Technician (New Position)	9.6E+12	5,472	827	2.1E+13	30,427	4,772	**5.6E+15**	542	N/A
Livestock Water Quality Management Plans									
Cropland Water Quality Management Plans									
Non-Domestic Animal and Wildlife Management Measures									
Feral Hog Control (New Position)	7.3E+12	1,615	327	1.2E+13	5,902	1,163	**4.0E+15**	105	N/A
Feral Hog Control (Equipment)									

[1] Ec: *E. coli* reduction indicated in cfu/year.
[2] N: Nitrogen reduction in kg/year.
[3] P: Phosphorus reduction in kg/year.

ADAPTIVE MANAGEMENT

Adaptive management is a type of natural resource management in which decisions are made as part of an ongoing science-based process. Adaptive management involves testing, monitoring, and evaluating applied strategies and incorporating new knowledge into management approaches that are based on scientific findings and the needs of society. Results are used to modify management policy, strategies, and practices [65 Fed. Reg. 62566-62572 (October 18, 2000)].

The Partnership is committed to incorporating adaptive management strategies into the Plum Creek WPP as new information on pollutant sources and public concerns are identified in the watershed. The Plum Creek watershed is extremely diverse in terms of landuse, land cover and socioeconomic characteristics with rapid development in the headwaters and a predominantly rural setting for the lower reaches of the watershed. Over the course of project implementation, instream monitoring data provided by GBRA will be compared with interim milestones and water quality criteria to determine progress in achieving water quality standards. If water quality improvement is not being demonstrated within the proposed timeframes, efforts will be made to increase adoption of BMPs and adjust strategies or focus areas if and when necessary.

Since the publication of the 2012 Update to the Plum Creek WPP, the Partnership has worked diligently to continue to engage new stakeholders and to communicate with existing partners in an effort to build greater support for management measures identified in the Plum Creek WPP. The early success of the CCFHTF is just one example of adaptive management as a direct result of efforts on behalf of the Partnership and its project partners to cooperate in new and innovative ways to improve water quality while also reducing the extreme economic and ecological damage resulting from feral hog activity in the watershed. The involvement of so many people

throughout the watershed in feral hog programs during the reporting period for this Update has led to much local, state and national media attention on the risks posed to water quality by expanding feral hog populations. This is an important point that is clearly taking hold in the watershed as Partnership meeting attendance and new visitors to the Plum Creek website continue to increase.

Further, it has become unmistakably apparent that the Partnership must develop new strategies to actively inform the public and policy makers of the significant impact rapid urban development is having on water quality in the Plum Creek watershed. To address degrading water quality in the middle and upper reaches of the creek and achieve the urban stormwater management load reductions shown in Table 25, the Partnership recommends investment in LID and other urban nonpoint source pollution mitigation practices, such as septic-to-sewer projects, that will serve to reduce the introduction of bacteria and nutrient loads to Plum Creek. When coupled with effective outreach, these projects can provide quick returns on investment in terms of water conservation and improved water quality. Further, these projects will lead to a greater probability of achieving long-term sustainability for a healthy, functioning Plum Creek watershed. The Partnership will actively pursue funding for these and other wastewater management projects in partner cities throughout the watershed. The Partnership will continue educational efforts for developers, landowners and communities throughout the watershed to raise awareness and encourage participation in the Plum Creek WPP's voluntary programs.

The Partnership will continue to work with regulatory agencies such as the TCEQ and Railroad Commission to communicate the need for adequate oversight of wastewater management and energy development in the watershed. Huge inflows of inadequately treated WWTF effluent in the upper segments of Plum Creek during the reporting period have very likely led to major spikes in *E. coli* concentrations and nutrient levels measured at downstream CRP monitoring sites. While WWTFs provide a necessary service and can contribute beneficial flows to downstream stakeholders, poorly operated facilities have the potential to singlehandedly negate the steady progress that has been made as a result of significant time and resources invested in nonpoint source pollution prevention efforts. The Partnership will continue to encourage water reuse options and voluntary adoption of 5-5-2-1 effluent treatment levels by WWTF operators in the watershed and will continue to provide critical information to our stakeholders and state agencies as they work together to adopt the policies needed to support responsible growth and the restoration of Plum Creek.

The Plum Creek WPP Update is a document that will be developed, approved by the Steering Committee and published every two years. This report will include an analysis of water quality data to determine progress toward achieving pollutant load reductions, provide updates on the implementation of prescribed management measures, and characterize the critical watershed issues that will determine the proper adaptive management decisions necessary to realize the water quality goals identified in the WPP.

IMPLEMENTATION SCHEDULE AND MILESTONES

The WPP was developed based on a 10-year implementation schedule with implementation proceeding through the end of calendar year 2018. Table 26 provides the projected timeline for achievement of pollutant load reductions and bacteria concentration targets for the Plum Creek

WPP. While it is not expected that the interim target concentrations will be precisely met in any given year, this table serves as a blueprint for gauging water quality progress as a result of implementation. The water quality goals are for each site to be under the water quality standard for *E. coli* with a 7-year geometric mean below 126 cfu/100 ml.

The 3-year geometric mean for *E. coli* bacteria was computed every 6 months through August 2013 to examine trends in Plum Creek (Table 27). While progress toward water quality goals is moving forward for the Luling segment, both the Uhland and Lockhart segments of Plum Creek have seen sustained increases in *E. coli* concentrations over the past 4 to 6 years. The effects of drought, urban development and illicit point source discharges are all suspected to have significant effects on water quality at these stations. Table 26 also corrects miscalculated data from Table 24 of the *2012 Plum Creek WPP Update* and presents an additional two years of water quality data. The 2014 Integrated Report, published by TCEQ, will be a key juncture for assessing interim progress in achieving restoration with full implementation of the WPP measured in the 2020 Integrated Report.

Table 26. *E. coli* interim targets over 10-year implementation period.

Date	*E. coli* Concentration (cfu/100mL)		
	Uhland (17406)	Lockhart (12647)	Luling (12640)
Feb-08	**240**	**121**	**195**
Aug-09	**217**	**118**	**183**
Feb-11	**193**	**116**	**171**
Aug-12	**170**	**113**	**159**
Feb-14	146	110	147
Feb-16	115	107	131
Feb-18	84	103	115

Table 27. Computed actual rolling 3-year geometric means for *E. coli* [19]

Date	*E. coli* Concentration (cfu/100mL)		
	Uhland (17406)	Lockhart (12647)	Luling (12640)
Feb-08	**221**	**121**	**180**
Aug-08	217	155	191
Feb-09	290	161	203
Aug-09	**341**	**182**	**204**
Feb-10	418	184	222
Aug-10	429	185	223
Feb-11	**480**	**204**	**219**
Aug-11	472	233	164
Feb-12	506	277	167
Aug-12	**458**	**289**	**162**
Feb-13	405	315	142
Aug-13	426	309	144

[19] Corrects miscalculated *E. coli* concentrations identified on Table 24 of the 2012 Plum Creek Watershed Protection Plan Update

Tables 28.1 and 28.2 serve as a progress update to the implementation schedule outlined in the Plum Creek WPP. The tables indicate work completed mid-way through the sixth year of implementation and can be compared with water quality trends to determine the need for adaptive management. While implementation of some measures began almost immediately, work toward others has required significant additional effort to secure participation and funding. For certain strategies, major work is not expected until later stages of the overall effort. It is anticipated that changes in water quality will experience a lag period following the implementation of management measures, and substantive changes may require several years to be discernible.

Table 28.1. Progress toward implementation of management measures identified in Table 10.1 of the Plum Creek WPP.

Management Measure	Responsible Party	Year			
		1-3	4-6	**Status thru Mar 30, 2014**	7-10
Urban Stormwater Management Measures					
Pet Waste Collection Stations	City of Kyle	13	4	**16**	4
Pet Waste Collection Stations	City of Lockhart	10	4	**10**	4
Pet Waste Collection Stations	City of Luling	6	2	**6**	2
Pet Waste Collection Stations	City of Buda	10	4	**18**	4
Comprehensive Urban Stormwater Assessment	City of Kyle	1	---	**Completed**	---
Retrofit Stormwater Detention Basins	City of Kyle	2	---	**Completed**	---
Initiate Street Sweeping Program	City of Kyle	---	---	**Initiated and continuing**	---
Comprehensive Urban Stormwater Assessment and Illicit Discharge Survey	City of Lockhart	1	---	**In progress**	---
Manage Urban Waterfowl Populations	City of Lockhart	---	---	**Ongoing**	---
Comprehensive Urban Stormwater Assessment	City of Luling	1	---	**0**	---
Rehabilitate Stormwater Retention Pond	City of Luling	1	---	**0**	---
Initiate Street Sweeping Program	City of Buda	1	---	**Initiated and continuing**	---

Table 28.1. continued

Management Measure	Responsible Party	Year			
		1-3	4-6	**Status thru Mar 30, 2014**	7-10
Wastewater Management Measure					
Wastewater Upgrade (TSS Reduction)	WWTF Operators	---	3	**3**	7
Wastewater Upgrade (Phosphorus Removal)	WWTF Operators	---	3	**3**	7
Voluntary Monthly *E. coli* Monitoring	WWTF Operators	---	---	**5**	---
Voluntary Monthly Phosphorus Monitoring	WWTF Operators	---	---	**2**	---
Sanitary Sewer Pipe Replacement	City of Kyle	2,400 ft	2,400 ft	**4,660 ft**	3,200 ft
Lift Station SCADA Installation	City of Kyle	3	4	**1**	---
Sanitary Sewer Pipe Replacement	City of Lockhart	1,800 ft	1,800 ft	**5,470 ft**	2,400 ft
Initiate Sanitary Sewer Inspection Program	City of Luling	1	---	**1**	---
Sanitary Sewer Pipe Replacement	City of Luling	2,400 ft	2,400 ft	**0***	3,200 ft
Lift Station SCADA Installation	City of Luling	4	1	**0**	
Sanitary Sewer Pipe Replacement	City of Buda	--	8,523 ft	**10,023 ft**	--
Septic System Inspection/Enforcement (New Position)	Caldwell County	2		**0**	
Septic System Repair/Replacement	Hays County	300	300	**359**	400
Septic System Repair/Replacement	Caldwell County.	150	150	**34****	200
Septic System Connection to Sewer	City of Uhland	100	100	**0**	150

*16,672 ft. of new sewer pipe was installed to connect 50 homes in the San Marcos River watershed.
**No change since November 2011. Caldwell County did not provide additional information requested for this Update.

Table 28.1. continued

Management Measure	Responsible Party	Year			
		1-3	4-6	**Status thru Mar 30, 2014**	7-10
Agricultural Management Measures					
WQMP Technician (New Position)	SWCD	---	---	**Funded through FY 2016**	---
Livestock Water Quality Management Plans	SWCD	65	70	**13 certified 3 in progress**	102
Cropland Water Quality Management Plans	SWCD	6	9	**1**	9
Non-Domestic Animal and Wildlife Management Measures					
Feral Hog Education (New Position)	AgriLife Extension	---	---	**Funded through FY 2015**	---
Feral Hog (Demonstration Equipment)	AgriLife Extension	---	---	**$10,000 of Equip.**	---
Monitoring Component					
Targeted Water Quality Monitoring	GBRA	---	---	**Funded through FY 2015**	---
Comprehensive Stream Assessment	GBRA	12	12	**10**	16
Bacterial Source Tracking	TAMU	1	---	**0**	---

Table 28.2. Progress toward implementation of management measures identified in Table 10.2 of the Plum Creek WPP.

Outreach Activity	Responsible Party	Year			
		1-3	4-6	**Status thru Mar 30, 2014**	7-10
Broad-Based Programs					
Texas Watershed Steward Training Sessions	AgriLife Extension	3	2	**2**	1
Elementary School Water Quality Project	GBRA	---	---	**over 1,000 kids/yr funded through 2015**	---
Plum Creek Watershed Protection Brochure	GBRA/ AgriLife Extension	---	---	**7,200 distributed of 12,000**	---
Tributary and Watershed Roadway Signage	AgriLife Extension	60	---	**TxDOT denied**	---
Displays at Local Events	AgriLife Extension/TSSWCB	9	9	**42***	9
Watershed Billboards	AgriLife Extension	Partnership decided against moving forward with this option			
Urban Programs					
Pet Waste Programs	Cities/TCEQ/ AgriLife Extension	2	---	**4**	---
NEMO Workshops	GBRA/TCEQ/ AgriLife Extension	2	---	**3**	---
Fats, Oils, and Grease Workshop		2	---	**0**	---
Municipal Site Assessment Visits		4	---	**9**	---
Urban Sector Nutrient Education	AgriLife Extension	3	3	**4**	3
Sports and Athletic Field Education (SAFE)	AgriLife Extension	3	3	**1**	3

Table 28.2. continued

Outreach Activity	Responsible Party	Year			
		1-3	4-6	**Status thru Mar 30, 2014**	7-10
Wastewater Programs					
Develop Online Training Modules	GBRA	4	---	**4**	---
Septic System Workshops and Assistance	AgriLife Extension/GBRA	4	3	**7 Completed 3 Scheduled**	3
Agricultural Programs					
Soil and Water Testing Campaigns	AgriLife Extension	3	3	**5**	3
Agriculture Nutrient Management Education	AgriLife Extension	3	3	**8**	3
Crop Management Seminars	AgriLife Extension	3	3	**3**	3
Agricultural Waste Pesticide Collection Days	TCEQ	1	No longer funded by TCEQ	**1**	No longer funded by TCEQ
Lone Star Healthy Streams – Grazing Cattle Education	AgriLife Extension	3	3	**3**	3
Non-Domestic Animal and Wildlife Programs					
Lone Star Healthy Streams - Feral Hog Management Workshop	AgriLife Extension	2	1	**6**	2
Additional Programs					
Stream and Riparian Workshops	AgriLife Extension	2	1	**3**	2
Illegal Dumping Site Targeted Cleanup	GBRA, AgriLife Extension, Keep Texas Beautiful, Cities, Counties	3	3	**12**	3
Community Stream Cleanup Events		2	3	**12**	3
Rainwater Harvesting Education/ Demonstration	AgriLife Extension	2	1	**3**	2

PROGRAM COORDINATION AND PARTNERSHIP SUSTAINABILITY

The Partnership recognized early in the process that the fundamental issues associated with long-term project sustainability are extremely complex. These included concerns about how and by whom the implementation strategy would be facilitated and how funding would be obtained and managed to support active project management and achieve project goals. To address these critical questions, the Partnership created a sustainability subcommittee to research strategies and provide information and options. Experience, input, and recommendations regarding potential approaches were obtained from numerous agencies, entities, groups, and existing watershed efforts both in Texas and across the nation.

AgriLife Extension in collaboration with the GBRA and Steering Committee members engaged personnel and officials with each of the municipalities and counties within the watershed to build strong cooperative partnerships. This effort led to the development and signing (July 2011) of an interlocal agreement (available on the Partnership website) with local partner entities that provided the 40% match required for a new TSSWCB CWA §319(h) implementation grant to fund a locally-housed watershed coordinator. Numerous meetings and presentations were conducted with city councils, county commissioner's courts and organization boards to provide project updates and information on the interlocal agreement and match structure for the new project. The 12 participating entities included Caldwell and Hays Counties, the cities of Lockhart, Luling, Kyle, Uhland, and Buda, GBRA, Plum Creek Conservation District, Polonia Water Supply Corporation, Hays County Soil and Water Conservation District and the Caldwell Travis Soil and Water Conservation District. The project has established a local WC position managed by GBRA and housed by Caldwell County in Lockhart.

The WC has actively promoted Plum Creek WPP implementation, coordinated the Partnership, continued to build and strengthen local partnerships and has sought external grants to facilitate implementation activities and provide the balance of funds needed to sustain the position. At meetings held during the summer of 2013, the 12 original participating entities in the Interlocal Agreement, decided to again provide the 40% local match required for a TSSWCB CWA §319(h) implementation grant that, if approved, would support local facilitation of the Partnership and the Plum Creek WPP through August 2017. These efforts have been guided by the understanding that watershed management programs should strive to transition dependency on federal support to local sponsorship. Plum Creek is the first watershed in Texas to solidify, through an interlocal agreement, local governmental entities' commitment to jointly fund a WC for the mutual benefit of all the entities involved.

Other Developments

In addition to the strategies outlined in the WPP, a number of other efforts and events in the watershed are expected to have significant impacts on watershed stewardship into the future. While some of these only indirectly address water quality, all have implications with regard to education, planning, and regulatory activities in the watershed.

SMALL FARMS TRENDING UP

Severe drought, urban sprawl and demographic changes in the region have been accompanied by several notable shifts in land use throughout the suburban and rural areas of Caldwell and Hays County. While the number of new housing starts in Caldwell County has been negligible, from January 2010 through March 2014 there have been 1,513 new homes built in Hays County[20]. It is interesting to note that despite the rapid population increase in the region, the total land in farms has actually remained steady, with a small, but somewhat surprising, increase in both Hays and Caldwell County from 2007 to 2012[21]. While total agricultural acreage has been relatively stable, the number of farms, particularly those under 50 acres, has risen significantly from 2007 to 2012[22]. Table 29 provides selected agricultural data for Caldwell County and Hays County.

Table 29. Selected data from USDA Census of Agriculture for Caldwell County and Hays County.

County	Number of Farms		Land in Farms (Acres)		Average Size of Farm (Acres)		Total Cropland (Acres)		Number of Small Farms (<50 acres)		Land in Small Farms (<50 acres)	
	2007	2012	2007	2012	2007	2012	2007	2012	2007	2012	2007	2012
Caldwell	1,421	1,623	304,737	310,433	214	191	71,459	55,928	587	693	12,649	14,832
Hays	1,136	1,439	235,568	245,006	207	170	39,265	30,315	532	750	11,089	14,056
Note: 2012 Land in Farms as a percent of Total Land Area – Caldwell County (88.7%), Hays County (56.3%)												

Recognizing the trend toward smaller farms and noting the changing demographics of rural land ownership in Caldwell County away from legacy landowners and toward those with limited experience and/or knowledge of sustainable agricultural management practices, in 2012 the Caldwell County AgriLife Extension, Leadership Advisory Board, identified small acreage farms as a primary area of concern. AgriLife Extension in Hays County has also taken steps to address the increasing number of smaller farms with a "Small Acreage Landowner, Land Management Series" that offer five separate workshops in July and August of 2013.

The Partnership feels it is critical that new landowners are educated on proper livestock stocking rates, nutrient management and riparian ecosystem function. Additional agricultural and water quality outreach to this particular demographic could yield significant improvements in water

[20] According to Austin Board of Realtors, MLS query
[21] USDA, National Agricultural Statistics Service, 2007 and 2012 Census of Agriculture – County Data
[22] Increase in number of farms under 50 acres from 2007 to 2012: Caldwell County(+18.1%), Hays County (+41.0%)

quality throughout the Plum Creek watershed. At a meeting facilitated by a Steering Committee member in January 2013, the WC presented information on the Plum Creek WPP to a group of Caldwell County realtors. A key result of this meeting was an agreement that packets containing information on the Plum Creek WPP would be distributed to new and prospective homeowners and landowners in Caldwell County and surrounding areas.

SH130 Environmental Park

While permit applications filed with the TCEQ in 2013 and 2014 by GreenGroup Holdings, LLC, for the construction and operation of a new 2.5 million ton landfill have been applauded by supporters, the proposed development has also been met with staunch opposition by a significant number of Caldwell County landowners and citizens. The transfer station and landfill, as proposed, would be located just north of Lockhart, about one mile east of SH183. The facility would provide some benefits and services to local citizens in the form of "free waste collection days" and other projects seeking to encourage proper disposal of nonhazardous waste. The facility would not be permitted to handle hazardous waste or sewage sludge. As would be expected, however, general concerns from the community of stakeholders include risk to groundwater, stormwater management, odor, traffic, aesthetics and real estate values among others. The Partnership has been involved in numerous meetings with GreenGroup Holdings, LLC, executive staff and planners as well as meetings of the primary opposition group, EPICC, in an attempt to better understand the issues and to communicate the goals of the Plum Creek WPP with decision makers. The Partnership will continue to seek information on this project including any potential risks and/or benefits to watershed stakeholders as this proposal is evaluated by local communities and regulatory entities.

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Central Texas Greenprint for Growth

The Trust for Public Land, Envision Central Texas, and the Capital Area Council of Governments completed the Central Texas Greenprint for Growth to help area communities make informed land use decisions and guide where growth and development ideally should occur in relation to the protection of important natural, cultural, and recreational resources. The project identified high priority areas for conservation in Hays, Caldwell, and Bastrop Counties that meet ecosystem protection goals, provide open space and park needs, and support the overarching vision of sustainable growth for the Central Texas area. In both Hays and Caldwell Counties, protecting water quality and quantity were selected as the highest priority goal. Efforts in these areas will benefit watershed stewardship as the region undergoes significant development in the future. The goal of the planning effort is for cities and counties to incorporate the Greenprint into their planning/zoning and master plan processes to identify opportunities for conservation and protection of the high priority areas. A copy of the plan may be downloaded from http://cloud.tpl.org/pubs/convis_tx_centexreport.pdf.

Appendix A: List of Acronyms

7Q2 Minimum	7-Day, 2-Year Discharge
AVMA	American Veterinary Medical Association
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
BSEACD	Barton Springs/Edwards Aquifer Conservation District
CAFO	Concentrated Animal Feeding Operation
cfu	Colony Forming Units
CI	Confidence Interval
CRP	Clean Rivers Program
CWA	Clean Water Act
EDAP	Economically Distressed Area Program
EPA	United States Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
ESRI	Environmental Systems Research Institute
ETJ	Extraterritorial Jurisdiction
GBRA	Guadalupe-Blanco River Authority
GIS	Geographic Information System
LDC	Load Duration Curve
LID	Low Impact Development
LO	Lockhart Region Subwatershed Designation
LU	Luling Region Subwatershed Designation
MGD	Million Gallons per Day
MPN	Most Probable Number
MS4	Municipal Separate Storm Sewer System
NAIP	National Agriculture Imagery Program
NEMO	Nonpoint Source Education for Municipal Officials
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPS	Nonpoint Source Pollution
NRCS	National Resources Conservation Service

OSSF	On-Site Sewage Facility
RRC	Railroad Commission of Texas
SAFE	Sports Athletic Field Education
SCADA	Supervisory Control and Data Acquisition
SELECT	Spatially Explicit Load Enrichment Calculation Tool
SEP	Supplemental Environmental Project
SRF	State Revolving Fund
SWAT	Soil and Water Assessment Tool
SWCD	Soil and Water Conservation District
TACAA	Texas Association of Community Action Agencies
TAG	Technical Advisory Group
TAMU	Texas A&M University
TCEQ	Texas Commission on Environmental Quality
TDA	Texas Department of Agriculture
TFB	Texas Farm Bureau
TMDL	Total Maximum Daily Load
TPDES	Texas Pollutant Discharge Elimination System
TPWD	Texas Parks and Wildlife Department
TSS	Total Suspended Solids
TSSWCB	Texas State Soil and Water Conservation Board
TWDB	Texas Water Development Board
TWDMS	Texas Wildlife Damage Management Service
TxDOT	Texas Department of Transportation
UGRA	Upper Guadalupe River Authority
UH	Uhland Region Subwatershed Designation
USDA	United States Department of Agriculture
USGS	Unites States Geological Survey
UV	Ultraviolet
WC	Plum Creek Watershed Coordinator
WPP	Watershed Protection Plan
WQMP	Water Quality Management Plan
WWTF	Wastewater Treatment Facility

Appendix B: Brief History of City of Kyle WWTF Permit Violations since 2010

Following a spill of over 1 million gallons of untreated effluent from the Kyle WWTF and resulting fish kill in 2010, TCEQ issued a violation order and fine in the amount of $20,000. When the voluntary monitoring program, initiated in April 2011, revealed consistently high *E. coli* concentrations in the facility's effluent, numerous discussions with City of Kyle officials and Aqua Texas, Inc. management were initiated by the Partnership to discuss water quality concerns and suggested mitigation. Of particular concern was the lack of plant oversight including a limited warning system for potential plant malfunctions and minimal staffing compared to other facilities in the watershed. The facility was typically staffed by one B–level operator present for 1 to 2 hours per day. A Supervisory Control and Data Acquisition (SCADA) system was installed in 2011 allowing the City to receive data that indicate effluent depth at the wastewater lift station, help monitor the WWTF for possible overflows; however, elevated levels *E. coli* continued to be discharged from the facility.

Currently, the Kyle WWTF permit does not have *E. coli* limits included in its permit. Rather, the permit requires a chlorine residual of at least 1.0 mg/L after a detention time of 20 minutes to ensure bacteria disinfection. No permit violations have ever been reported to the TCEQ with regard to chlorine residual at the facility leading to initial objections from Aqua Texas, Inc. to the validity of *E. coli* data collected from the WWTF through the voluntary monitoring program. Additional concerns over the volume and quality of wastewater entering the plant from the City of Kyle sewer system. Upon further investigation, it was presented, and generally accepted by City of Kyle officials, that it was the chlorine treatment process and permittee reporting protocol utilized at the plant which enabled the operator to achieve permit requirements while also allowing for the high levels of *E. coli* revealed during routine voluntary monitoring. Current TCEQ policy allows operators to calibrate chlorine treatment to successfully disinfect bacteria from a facility's effluent based on average flow rather than continuous recalibration that adjusts to variabilities in daily flow through the plant. It is the understanding of the Partnership that a recalibration of chlorine treatment process regularly took place immediately preceding the water quality sampling by the operator satisfying permit requirements. This was not the case prior to the sampling done during the routine voluntary monitoring which showed extremely high variability in effluent *E. coli* concentrations (Table 18).

Two additional meetings to discuss water quality concerns, including the chlorine treatment process, took place between the Partnership and City of Kyle officials in the summer and fall of 2012, and a report on water quality was delivered to the Steering Committee on November 8, 2012. A chronology of significant events leading up to and immediately following the November 2012 illicit discharge of "over 100,000 gallons" of partially treated effluent to Plum Creek from the Kyle WWTF is presented below. Based on the documented downstream effects to Plum Creek and the extended period of time from the first evidence of sludge entering the creek, the volume of the illicit discharge likely exceeded several million gallons.

Chronology of notable events surrounding the 2012 illicit discharge from the City of Kyle WWTF:

- From November 8 through November 15 – Conversations and emails between the Partnership, the City of Kyle and the City's legal team regarding bacteria concerns continued as well as a discussion on the City's plan to address the issue.
- November 13 – Plum Creek Development, LLC, which holds permit for use of reclaimed water from the Kyle WWTF under Title 30 Texas Administrative Code, Chapter 210, notified the Partnership and Aqua Texas, Inc. of solids in the facility's effluent. Personal hygiene products and other solids discharged in the effluent were clogging the screens and grinder pumps installed post-treatment, but above the facility's outfall, to remove such objects prior to reuse water being applied to the Development's golf course. Aqua Texas, Inc. was not responsive to the concerns and the City of Kyle had no solutions for mitigation. Photos of clogged screens were taken as early as November 2.
- November 14 – During routine sampling of Plum Creek at Heidenreich Lane, pictures of black sludge covering Plum Creek were taken immediately downstream of the WWTF.
- November 19 – As sludge continued to build in the creek up to ½ mile downstream of the WWTF, the City of Kyle's legal team requests WWTF effluent water quality data from the Partnership and any pictures taken of the sludge. The City was prepared to put Aqua Texas, Inc. on written notice.
- November 20 – Aqua Texas, Inc. issued a press release regarding the disruption.
- November 21 – TCEQ inspects plant and illicit discharge. Pictures and video were taken of a thick layer of sludge solidifying the creek from the outfall to approximately ¼ mile downstream of the WWTF. Vacuum trucks were brought in to begin sludge removal.
- December 3 – Second disruption at the WWTF results in additional illicit discharge of sludge into Plum Creek.
- February 2013 – Well over two months after the first spill and over one month after TCEQ's request, a dewatering and sludge removal project was initiated by Aqua Texas, Inc. Significant damage to riparian vegetation resulted from this operation.
- Spring 2013 – TCEQ issues a violation order and a proposed $80,000 fine. The final details on this enforcement action are scheduled for a hearing to take place October 2014.

Throughout the spring and summer of 2013, the Partnership engaged the City of Kyle, Aqua Texas, Inc., and legal representation for both permittees in a series of discussions to inform them about the opportunity to fund a *Supplemental Environmental Project* (SEP), a program available through TCEQ, that would have benefitted downstream users and offset a portion of the $80,000 fine imposed by TCEQ. This opportunity was also made clear to the permittees following the 2010 spill; however, the decision was once again made not to pursue this option due to the fear of liability and pending and ongoing litigation between the co-permittees. Aqua Texas, Inc. abruptly cut off communication with the Partnership once the decision was reached. Limited discussion between the City and Aqua Texas, Inc. continues and a hearing to settle the violation and associated penalties is scheduled for October 2014. The Partnership believes that a valuable opportunity to benefit watershed stakeholders and improve downstream water quality was missed as a result.

Despite the lack of an SEP, two critical management decisions were implemented by Aqua Texas, Inc. in 2013 to address partnership concerns regarding the operation of the Kyle WWTF. According to City of Kyle staff, Aqua Texas, Inc. now staffs the facility with an onsite B-operator for 4 to 6 hours per day and has installed a flow-paced chlorination system that enables for the automatic recalibration of chlorine treatment to account for flow variability. While monthly voluntary monitoring data suggest some water quality improvements with regard to bacteria have been realized during normal operations, NH_3-N levels exceeding permit limits for the Kyle WWTF were reported to TCEQ by Aqua Operations, Inc. in 2013 and high *E. coli* concentrations were revealed during routine, voluntary monitoring in August and September 2013. Further, a power outage at the plant in January 2014 causing wastewater to overflow from a City of Kyle manhole led to another illicit discharge of at least 10,000 gallons into Plum Creek. The Partnership feels that it is relevant to point out that in 2010, TCEQ assessed and administrative penalty in the amount of $4,775 on the Aqua Texas, Inc. subsidiary, Aqua Utilities, Inc., for "failure to maintain adequate safeguards to prevent the discharge of untreated or inadequately treated wastes during electrical power failures" at the Goforth WWTF in violation of TEX. ADMIN. CODE § 305.125(5).

Although data show that the geometric mean for *E. coli* samples taken since April 2011 from the Kyle WWTF (91 MPN/100mL) is below the contact recreation standard, it is critical to note that the geometric mean for *E. coli* samples taken with the same frequency and over the same period from the six other WWTFs in the watershed ranges from <1 to 12 MPN/100mL. The high variability of *E. coli* concentrations in the Kyle WWTF effluent and three major illicit discharges since 2010 as a result of operational failings underscore the potentially significant overall degradation to water quality in the Plum Creek watershed for which this particular facility is responsible.

Permit No. WQ0011041002, City of Kyle WWTF, will expire February 1, 2015. An application for permit renewal is expected to be submitted by the City and Aqua Texas, Inc. prior to August 2014. A meeting between the Partnership and TCEQ staff is scheduled for April 2014 to discuss WWTF operational concerns and the permit renewal process. This meeting is significant in that representatives from multiple TCEQ divisions will be sharing information with the Partnership. It is the hope of the Partnership that the new *E. coli* limits and monitoring requirements will result in improved effluent water quality and overall stream health for Plum Creek. The Partnership also believes that the value of cross-divisional meetings, such as this, will encourage more collaboration among TCEQ staff and watershed stakeholders in future permitting and enforcement decisions.

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