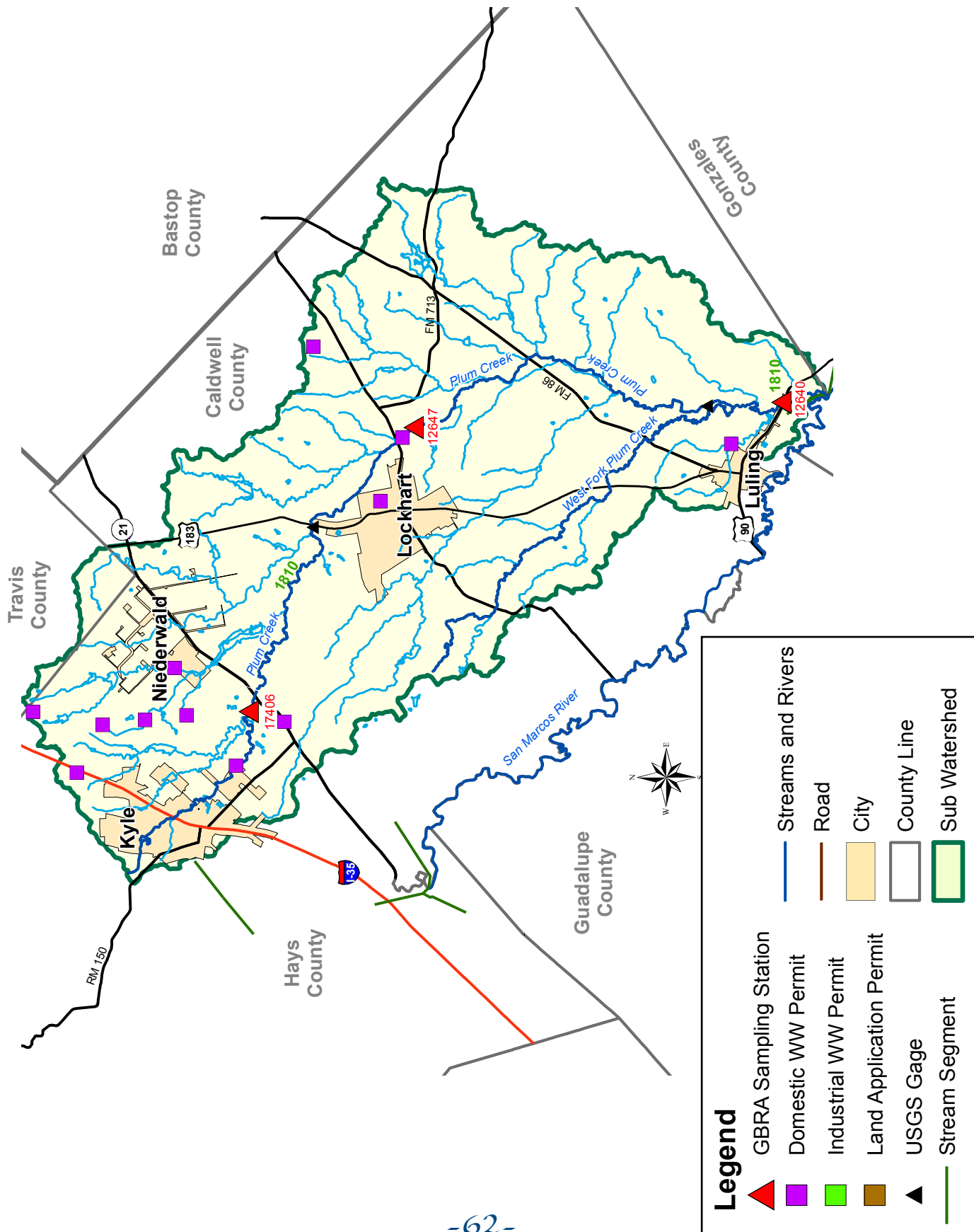


Plum Creek Watershed



Plum Creek Watershed

River Segments, Descriptions and Concerns

Segment 1810 (Plum Creek): Plum Creek begins in northeastern Hays County at about FM 2770 and continues 52 miles to the confluence with the San Marcos River south of Luling in Caldwell County. Plum Creek is typically a shallow, slow moving stream flowing through gently rolling hills lined with agricultural fields and scrub oak trees.

Drainage Area: 397 square miles

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

Aquifers: Edwards-Balcones Fault Zone, Carrizo Wilcox

River Segments: 1810

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

Counties: Hays, Travis, Caldwell

EcoRegions: Texas Blackland Prairies, Post Oak Savannah

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

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

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

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

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

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



Photo by Lee Gudgell

Plum Creek Watershed

River Segments, Descriptions and Concerns

Plum Creek Watershed

Plum Creek, Segment 1810, has its headwaters in Hays County near the City of Kyle. The creek travels through Hays and Caldwell Counties and confluences with the San Marcos River near the City of Luling. The stream has been assessed by TCEQ and is listed on the 2012 Texas Water Quality Inventory as impaired for bacteria, with concerns for nutrients, including nitrate nitrogen, ammonia nitrogen, orthophosphate and total phosphorus. Additionally, it is listed with a concern for dissolved oxygen at the minimum grab concentration of 3.0 milligram per liter (mg/L) and impaired habitats. This segment was listed as impaired in 2004 for exceedences of *E. coli* bacteria. The creek still appears on the list of impaired water bodies but as a category 4b waterbody. This designation means that there are activities being implemented in the watershed that “are reasonably expected” to result in the attainment of the water quality standards.

Plum Creek was selected by the Texas State Soil and Water Conservation Board (TSSWCB) for a voluntary effort to improve water quality. The Plum Creek Watershed Partnership, made up of local stakeholders, was formed to guide the process and address the bacteria and nutrient concerns. The Partnership developed the **Plum Creek Watershed Protection Plan (PCWPP)** to serve as guidance for restoring and protecting local water quality. The Partnership spent a significant amount of time identifying potential sources of the bacteria and nutrient loads. Those sources included pet waste from urban areas, failing septic systems, wastewater treatment plants, livestock, feral hogs, and other agricultural activities. In 2008 the PCWPP was accepted by the US EPA. The efforts of the Partnership moved to voluntary implementation of the best management practices recommended in the plan.

Led by a steering committee, the Partnership worked with citizens, businesses, public officials and state and federal agencies in the watershed to develop a plan that recommended implementation practices that could restore the health of Plum Creek. The PC WPP recognized that success in improving and protecting water resources



depends on the people who live and work in the watershed. After first determining the potential sources and locations of the pollutant loads, the Partnership determined to what degree bacteria and nutrient concentrations should be reduced to meet the water quality standards.

To better determine the sources of pollutant loads and related implementation recommendations, the Partnership divided

Plum Creek into three regions. The Uhland region is the upper portion of the watershed and contains the City of Kyle and parts of the City of Buda. This region has dense urban development and the stream is effluent-dominated. The middle watershed is referred to as the Lockhart region and is a mix of land uses including urban development in the City of Lockhart and along the SH 130 corridor, and agricultural operations including both cropland and livestock. The lower portion of the watershed is referred to as the Luling area. This portion of the creek receives flow from two tributaries, Clear Fork and West Fork. The creek confluences with the San Marcos River near the City of Luling. These creeks flow primarily through rural areas that support livestock, farming and pastureland. Bacteria reductions needed to restore water quality to stream standards range from a 15% reduction in the Lockhart area to a 65% reduction in the Uhland portion. Nitrate nitrogen would need to be reduced by 43% in the Uhland portion to 80% in the Lockhart portion. Phosphorus loading would need to be reduced by 27% in the Uhland reach to 49% in the Lockhart portion.

In addition to identification of potential sources and load reductions, the WPP recommends management measures that, if implemented, would go a long way in reducing those pollutant loads. Topical work groups looked at key land uses, activities and related pollutant sources. Those areas include agricultural sources, urban sources and wastewater, including septic systems. Management measures that could reduce bacteria and nutrient loading from urban sources include management of pet waste by collection stations and pet waste ordinances, as well as urban storm water assessments and conveyance modifications. Management measures that could reduce the loading from agricultural-related activities include planning and financial assistance to farmers and ranchers for development of

Plum Creek Watershed

River Segments, Descriptions and Concerns

management plans that reduce bacteria and nutrient losses, including grassed waterways, nutrient management and conservation easements. The plan also suggested outreach and education activities and feral hog controls.

The efforts of the Partnership are focused now on voluntary implementation of the best management practices recommended in the plan. Since 2008 significant changes have taken place in the Plum Creek watershed. The region has endured the most severe drought since the 1950's, resulting in all but those areas immediately below the springs or effluent discharges running dry. In addition, large areas of the watershed have been transformed by the construction of State Highway 130. New commercial and residential development has exploded along the highway as well as along the IH 35 corridor between Austin and San Antonio.

Acknowledging and understanding the changing land use and activities in the watershed are key to adaptive management. Combined with continued intensive water quality monitoring of the watershed, necessary adjustments can be made in response to these changes that will enable continued progress toward the water quality goals established in the plan (TSSWCB, 2012). The TSSWCB has funded water quality monitoring to support the data being collected by the Clean Rivers Program in order to assess implementation practices that have been or will be implemented as a result of the Plum Creek Watershed Protection Plan.

The stream is broken into three assessment units: from the confluence with the San Marcos River to 2.5 miles upstream of the confluence with Clear Fork Plum Creek; from that point to 0.5 mile upstream of the crossing with SH 21; and, from that point to the upper end of the segment.

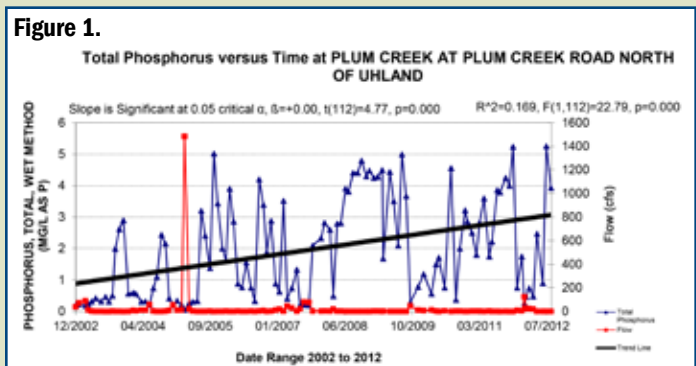
The Upper Plum Creek Watershed

The stream begins in an area of rapid development along the IH 35 corridor, between the cities of Kyle and Buda. The stream is made up of flow from several tributaries such as Andrews Branch, Porters Creek and Bunton's Branch. These streams receive wastewater discharges from the City of Kyle's wastewater plant (WWTP), the City of Buda's wastewater plant and several smaller plants that serve new subdivisions just beginning to develop. In the upper portion of the watershed, there are eight wastewater plants that

are constructed and currently discharge to tributaries of Plum Creek. The largest facility of which is the City of Kyle's WWTP at 4.5 million gallons per day (MGD). Most of these facilities are permitted with future phases that when all the plants reach their final capacity will be permitted for over 10 MGD. The permit limits for the majority of the facilities in the upper portion of the watershed are 5 mg/L biochemical oxygen demand; 10 mg/L total suspended solids and 2 mg/L ammonia-nitrogen. The effluents of the WWTP serving of Buda, Sunfield and Shadow Creek have limits for total phosphorus of 0.8 mg/L, 1.0 mg/L and 1.0 mg/L respectively. These facilities all utilize chlorine for disinfection.

In addition to urban areas, this portion of the watershed includes agricultural land and areas that have been known to have old, failing or inappropriately built septic tanks, according to the Hays County Environmental Health Office. In addition to these sources of nonpoint source loading of bacteria, pet waste is considered a source of *E. coli* as well.

GBRA maintains a routine monitoring location in the upper assessment unit located at the crossing of the creek at Plum Creek Road near the community of Uhland. Uhland is not served by a municipal wastewater system at this time. A review of the historical data from the Plum Creek at Plum Creek Road station (station no. 17406) shows trends of diminishing water quality. The most prominent water quality concerns are for nutrient and bacteria concentrations. The increased nutrient levels in the creek are due in large part because the stream is effluent-dominated. Additional wastewater effluent and nutrient loading has been added to the creek in recent years as the Kyle and Buda WWTPs have increased in capacity. Figure 1 shows the increasing trend in total phosphorus concentrations over time.

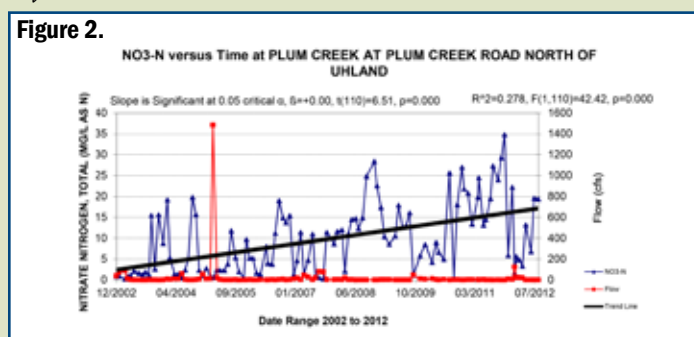


Plum Creek Watershed

River Segments, Descriptions and Concerns

The median concentration of **total phosphorus** was 1.73 mg/L, ranging from 0.05 mg/L to 5.26 mg/L. For 67.5% of the monitoring events from 2003 to 2012 the data for total phosphorus was above the screening concentration of 0.69 mg/L.

Nitrate nitrogen also shows an increasing trend over time (Figure 2). The median concentration for nitrate nitrogen was 8.24 mg/L, ranging from 0.22 mg/L to 34.8 mg/L, exceeding the screening concentration of 1.95 mg/L 75.9% of the time. Spikes in nitrate concentrations appear to be linked to low flow periods when the stream is effluent-dominated. Total phosphorus and nitrate nitrogen are of concern because of the potential for promoting nuisance algal blooms that can deplete oxygen in the stream, especially in the early morning hours, degrading the habitat for fish and aquatic invertebrates.



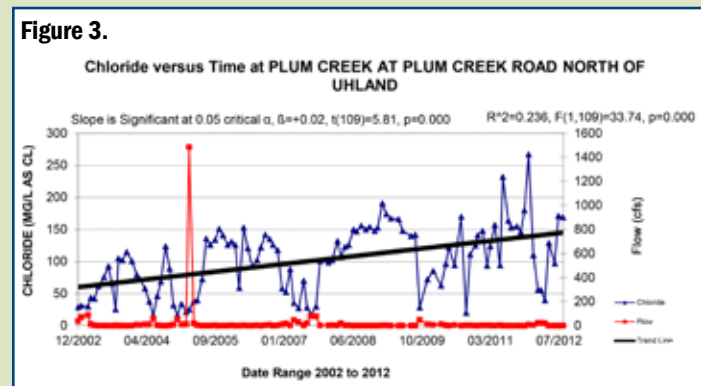
Ammonia nitrogen exceeded the screening concentration 14.8% of the time but of more concern was the magnitude of the exceedences. Three of the 12 sampling events that exceeded the 0.33 mg/L screening concentration for ammonia nitrogen were greater than 10 mg/L. Ammonia nitrogen is a concern because of its toxicity to fish. Because of the effluent dominance of the stream, the most logical source of these nutrients is wastewater discharge but other sources of nutrients should be considered such as runoff carrying fertilizers from agricultural fields and lawns and organic wastes from animals such as livestock, pets and wildlife.

This portion of the stream is impaired by fecal bacteria, including *E. coli*. The geometric mean of the *E. coli* concentrations was 282 MPN/100 mL, which exceeds the stream standard for contact recreation of 126 colonies/100 mL. The concern for the exceedence of the stream standard for contact recreation has become increasingly elevated as the

areas surrounding this portion of Plum Creek have become increasingly urbanized, with more chance for interaction between the creek and people living in the watershed.

The **temperature** ranged from 6.0°C to 28.4°C at the Plum Creek Road station, with a median temperature of 21.4°C. The **pH** ranged from 7.0 to 8.2, with a median value of 7.8. The median **dissolved oxygen** concentration was 7.3 mg/L, ranging from 2.2 mg/L to 14.1 mg/L. The stream standard for dissolved oxygen for this segment is 5.0 mg/L and the minimum dissolved oxygen standard is 3.0 mg/L. The stream was at or below 5.0 mg/L eight times out of 118 sampling events and below 3.0 mg/L four times.

Total suspended solids (TSS) have ranged between 0.8 mg/L and 177 mg/L with a median value of 21.1 mg/L between 2003 and 2012. TSS can consist of suspended materials including algal cells, organic material and sediment brought in by rainfall runoff from fields and construction stations. The median **conductivity** during this period was 1065 micromhos per (umhos/cm) ranging from 330 umhos/cm to 1600 umhos/cm. Conductivity levels along with dissolved salts are significantly increasing over time (Figure 3). The increase in dissolved solids during low flows can be attributed to contributions from groundwater sources that have elevated dissolved solids or from wastewater effluent.



The Middle Plum Creek Watershed

The water quality of the middle portion of Segment 1810, is represented by the data collected by the GBRA at the monthly monitoring site at CR 202 (station no. 12657), southeast of the City of Lockhart. The middle portion of the creek flows through agricultural cropland, pastureland and the urbanized areas in and around the City of Lockhart. There is some ground water recharge by the stream near

Plum Creek Watershed

River Segments, Descriptions and Concerns

Hwy 183 north of Lockhart. Additionally, it is near this area that oil and gas production begins to become a dominant land use.

The City of Lockhart, as well as Caldwell County, are primed for growth over the next few years as construction of the SH 130 tollway and its spur, SH 45, bring traffic into the area. The Texas Department of Transportation has constructed a mitigation wetland near the creek and Hwy 183. The area includes walking and bike trails, kiosks and birding trails. The area is strictly to mitigate lost wetlands during construction of SH 130. Water quality was not considered in the design though it will capture flood



Photo by Debbie Magin

waters that would normally inundate Plum Creek, and slow water down as it travels through weirs. There is no way to pump water from Plum Creek to supplement the wetlands in times of drought. The site took a big hit during the droughts of 2009 and 2011.

The creek receives wastewater effluent discharged from the City of Lockhart's two WWTPs, whose combined permitted volume is 2.6 MGD. Neither plant have effluent limits for phosphorus but do have an effluent limit for ammonia nitrogen of 3.0 mg/L. The effluents must meet a carbonaceous biochemical oxygen demand of 10 mg/L and total suspended solids of 15 mg/L. The Lockhart Larremore facility, located in the city, uses chlorine to disinfect the effluent. The Lockhart FM 20 facility, located outside the city and upstream of the GBRA monitoring location at CR 202, uses ultraviolet light to disinfect the effluent and must analyze the effluent for fecal coliform bacteria daily.

The median **flow** at the GBRA station at CR 202 (3.9 cubic feet per second or cfs) is approximately two times the flow at the upstream Plum Creek at Plum Creek Road station (2.2 cfs) that is monitored by GBRA. Even though there is loss of flow to recharge upstream of Lockhart, the additional flow from groundwater springs and the two wastewater treatment plants that are located in and near the city are sufficient and consistent enough to double the flow at this monitoring station. These springs, according to local citizens, are not known to go dry, even in driest periods. The springs are thought to originate from the Leona formation that is known for elevated nitrate nitrogen.

The median **conductivity** at the Plum Creek at CR 202 station is 921 umhos/cm, ranging from 223 umhos/cm to 1140 umhos/cm, which are slightly lower levels than are seen upstream. The median **dissolved oxygen** concentration was 7.7 mg/L, ranging from 4.4 mg/L to 13.6 mg/L. The median **temperature** at the TCEQ station was 22.9°C, ranging from 8.1°C to 28.8°C. The median **pH** was 7.9, ranging from 7.4 to 8.4, not falling outside the range of the pH stream standard. The highest recorded temperature and lowest recorded flow at this station occurred in July of 2009 during a period of drought conditions and extremely low flows.

The median concentration for **total suspended solids** was 13.8 mg/L, ranging from 1 mg/L to 414 mg/L. Comparing the TSS to flow data at this station suggests that the TSS increases with high flows which are often associated with storm events. The inorganic constituents, **chloride** and **sulfate**, had median concentrations of 89.4 mg/L and 78.6 mg/L respectively, never exceeding the stream standard for these constituents of 350 mg/L and 150 mg/L.

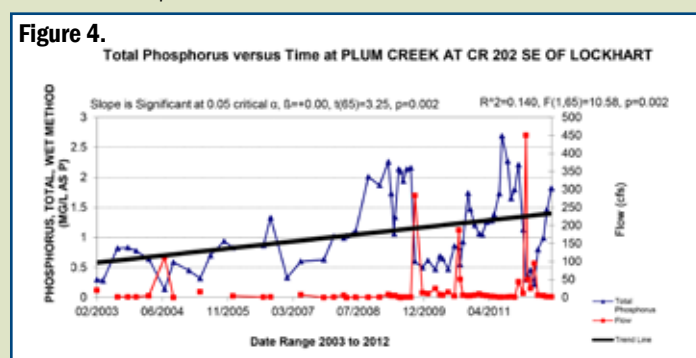
Nitrate nitrogen, ammonia nitrogen, and total phosphorus were measured at the TCEQ station at CR202. The **nitrate nitrogen** median concentration was 5.8 mg/L, ranging from 0.65 mg/L to 51.6 mg/L and exceeding the stream stream screening criteria of 1.95 mg/L 63 out of 67 measurements (94.0%). The maximum value (51.6 mg/L) was collected by the TCEQ regional office in October of 2008 during a period of extremely low stream flow. Sources of the nitrates at this location are most likely the springs that originate from the Leona formation as well as wastewater effluent. **Ammonia** nitrogen ranged

Plum Creek Watershed

River Segments, Descriptions and Concerns

from the Limit of Quantification (LOQ) to 0.1 mg/L, with a median concentration that was less than the LOQ. The concentrations that were measured exceeded the stream screening criteria of 0.33 mg/L a total of two times.

Figure 4 shows that **total phosphorus** concentrations are increasing over time at this monitoring station. Sources of total phosphorus include wastewater effluent, storm water that carries in fertilizers and organic material and failing septic tanks.

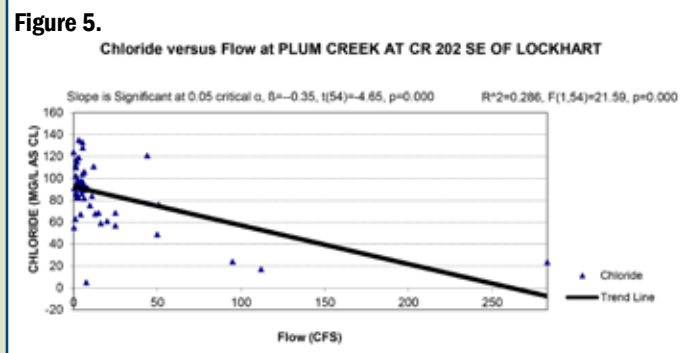


Confirming the bacterial impairment identified in the 2008 Texas Water Quality Inventory, the geometric mean for *E. coli* at the CR202 station was 227 MPN/100mL, exceeding the contact recreation standard for *E. coli* of 126 colonies/100mL. No sampling events measured **chlorophyll a** greater than the LOQ used by the laboratory.

The Lower Plum Creek Watershed

Land use in the lower Plum Creek watershed is primarily agricultural crop and pastureland and forests with a heavy concentration of oil and gas production activities. The only urbanized area is the City of Luling where the creek confluences with the San Marcos River. GBRA has had a monthly monitoring station in this portion of the watershed located at CR 135 since 1998. TCEQ has monitored this station and their data was included in the historical review. The 2012 Texas Water Quality Inventory listed the lowest assessment unit of the Plum Creek as impaired for bacteria, with a concern for nitrate nitrogen.

The base flow in the lower portion of the watershed is impacted by saline groundwater. As the stream flow is increased with storm water and runoff, the concentration of dissolved salts goes down. For example, Figure 5 shows the inverse relationship of chloride and flow, with a decreasing



trend over time. Another source of dissolved solids occurs when there are spills or leaks associated with oil field activities.

Median flow (11 cfs) in the lower portion of the creek is nearly three times the flow at the TCEQ station in the middle Plum Creek (3.9 cfs), due to the contribution of flow from the West Fork and Clear Fork tributaries that confluence with the Plum Creek in the lower portion of the watershed.

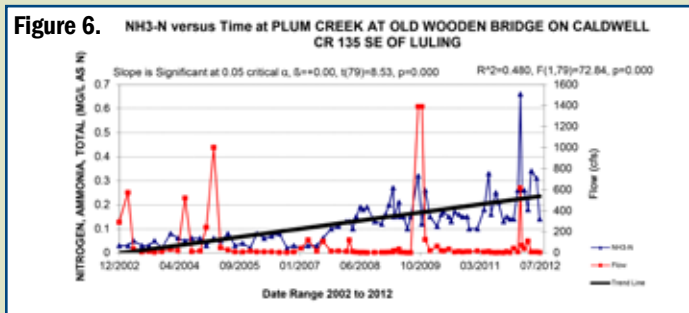
The median **temperature** at the GBRA CR135 station is 22.0°C, ranging from 6.2°C to 29.3°C. The **conductivity** ranged from 239 umhos/cm to 2660 umhos/cm, with a median conductivity of 1244 umhos/cm, 10% higher than the lower two monitoring stations. The **pH** ranged from 7.0 to 8.3, with a median pH of 7.9. The **dissolved oxygen** ranged from 3.4 mg/L to 14.6 mg/L, with a median concentration of 7.4 mg/L. The dissolved oxygen fell below the stream standard of 5.0 mg/L 14 times out of 117 measurements from 2003 to 2012. The stream had sustained oxygen levels below 5.0 mg/L during much of the dry summers of 2008 and 2009.

Total suspended solids ranged from 2 mg/L to 527 mg/L, with a median concentration of 21.3 mg/L. The highest concentrations of solids are associated with high flows, following storm events as the runoff carries in sediments. **Chloride** and **sulfate** concentrations were higher at this station than the other two monitoring stations. The median chloride concentration was 155 mg/L, ranging from 124 mg/L to 495 mg/L, exceeding the stream standard of 350 mg/L for chloride 3 times. Sulfate ranged from 14.9 mg/L to 163 mg/L, with a median concentration of 83.5 mg/L, exceeding the stream standard for sulfate of 150 mg/L one time.

Plum Creek Watershed

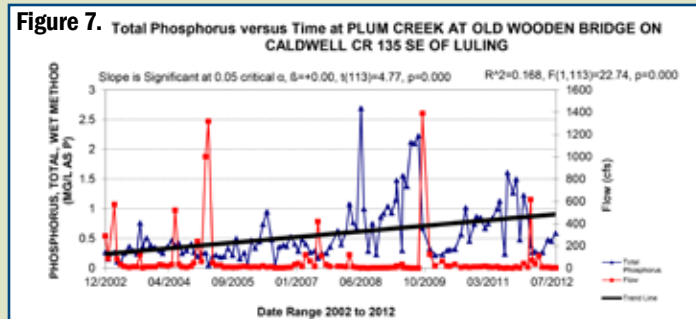
River Segments, Descriptions and Concerns

Nitrate nitrogen, ammonia nitrogen and total phosphorus were analyzed at the GBRA station in the lower Plum Creek. The median concentration for **nitrate nitrogen** was 1.40 mg/L, ranging from 0.05 mg/L to 7.52 mg/L, and exceeding the screening concentration of 1.95 mg/L 37 times out of 112 measurements, or 33% of the time. The **ammonia nitrogen** concentration ranged from the LOQ to 0.66 mg/L, with a median concentration of 0.13 mg/L, only exceeding the screening concentration of 0.33 mg/L one time. Looking at the concentration of ammonia nitrogen over time, we see a significant drop in concentration in 2001. Ammonia nitrogen appears to be significantly increasing with time (Figure 6). This is possibly due to reduction in flow due to drought conditions, which are causing the stream to be more heavily influenced by wastewater and groundwater.



Total phosphorus concentrations showed a significant increasing trend over time (Figure 7). The median concentration of total phosphorus was 0.39 mg/L, ranging from 0.05 mg/L to 2.69 mg/L. Ten of the 133 measurements were higher than the screening concentration of 0.69 mg/L, or 7.5% of the time. A possible explanation for the trend could be the increased frequency of analysis in the later years of the historical record.

From 2003 to 2010 the geometric mean for *E. coli* at the Plum Creek at CR 135 was 180 MPN/100mL. As



expected there is a rise in *E. coli* concentrations as storm flows bring in more sediment and associated bacteria.

The stakeholders that have attended the annual meetings for the Clean Rivers Program Steering Committee as well as those that have commented at other Plum Creek watershed meetings are concerned about several issues. The issues include the impacts from wastewater effluents, the potential for contamination and spills from unattended oil and gas production facilities, excessive illegal trash dumping in the creek and poorly functioning or failing septic tanks. Two major wastewater plant upsets occurred at the City of Kyle's WWTP near the headwaters of the stream during this assessment period. TCEQ has been working with the city to ensure that such events do not happen again. The Plum Creek Watershed Partnership completed the development of a watershed protection plan that was adopted by the US EPA as a means to repair the water quality impairments in the Plum Creek watershed. As part of the plan, the members recommended that a compact be entered into by governmental entities and interested parties in the watershed, promoting regionalization of wastewater facilities rather than package plants, the utilization of wastewater for reuse and the increased level of wastewater treatment that includes reduction of nutrient concentrations. 🐾

Plum Creek Issues and Concerns			
Water Quality Issue	Affected Area	Possible Influences/Concerns	Possible Actions Taken/to be Taken
Bacteria	Plum Creek	Urban storm water; pet waste; failing septic systems; poorly treated wastewater; livestock and agricultural runoff; feral hogs; wildlife	Implementation of the watershed protection plan adopted in 2008
Nutrients	Plum Creek	Wastewater effluent; urban runoff; pet waste; failing septic systems; livestock and agricultural runoff; Feral hogs; wildlife	
Impaired Habitat	Plum Creek	Illegal dumping	