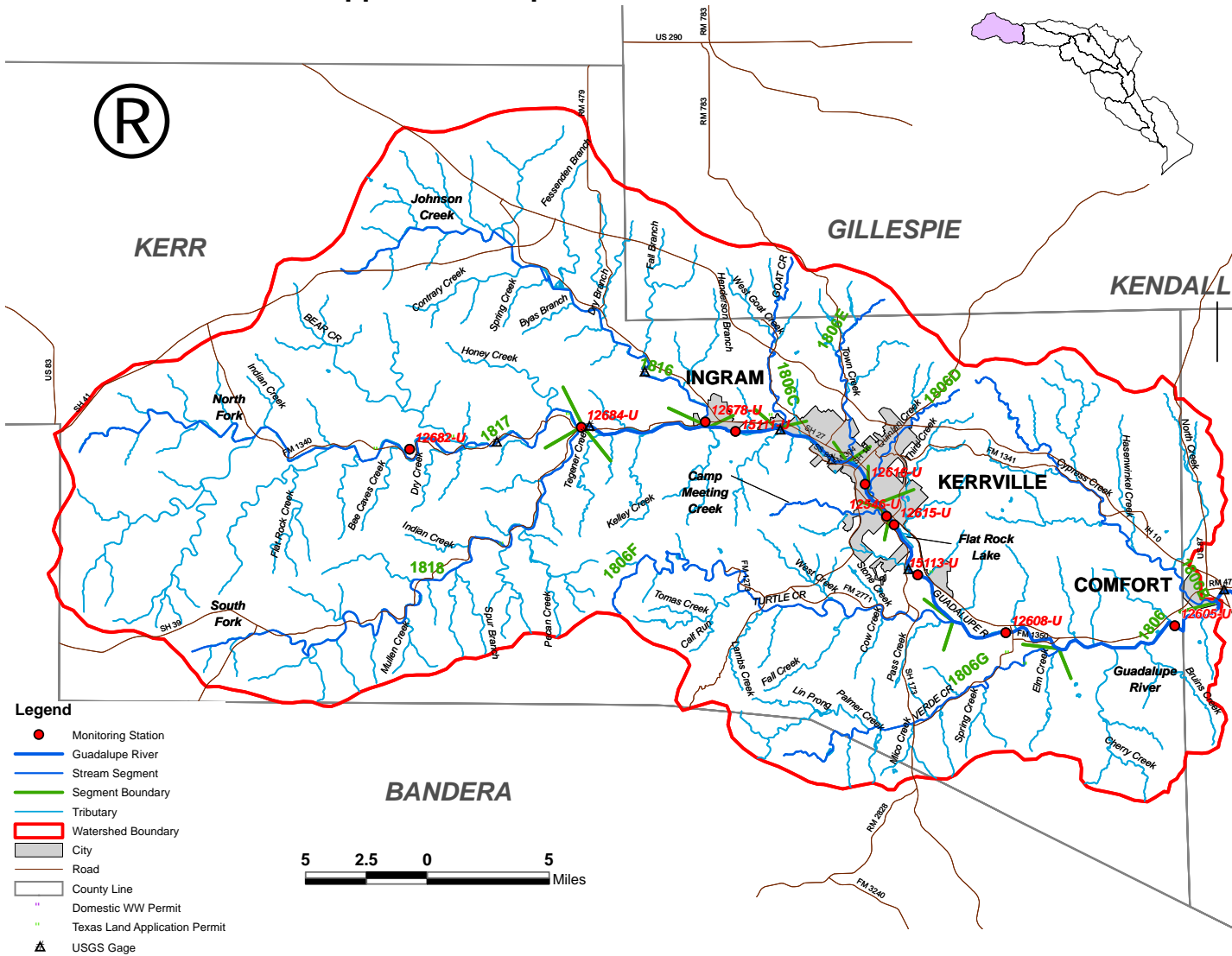
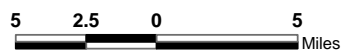


# Upper Guadalupe River Above Comfort



12682-U	North Fork Guadalupe River at Camp Waldemar
12684-U	South Fork Guadalupe River at Hunt Lions Park
12678-U	Johnson Creek at SH 39
15111-U	Guadalupe River at Riverview Road
12616-U	Guadalupe River at G Street
12546-U	Camp Meeting Creek
12615-U	Guadalupe River at Kerrville Schreiner Park
15113-U	Guadalupe River at Split Rock Road
12608-U	Guadalupe River at Center Point Lake
12605-U	Guadalupe River at Hermann Sons Road

- Legend**
- Monitoring Station
  - Guadalupe River
  - Stream Segment
  - Segment Boundary
  - Tributary
  - ▭ Watershed Boundary
  - ▭ City
  - Road
  - ▭ County Line
  - ⬭ Domestic WW Permit
  - ⬭ Texas Land Application Permit
  - ▲ USGS Gage



Sampling sites are labeled in red followed by the letter G (GBRA), T (TCEQ), U (UGRA) or W (Wimberly) indicating who is the monitoring entity.

## Upper Guadalupe above Comfort

**Drainage Area:** 850 square miles

**Streams and Rivers:** North Fork and South Fork of the Guadalupe River, Johnson Creek, Quinlin Creek, Flat Rock Lake, Camp Meeting Creek, Town Creek, Cypress Creek, Goat Creek, Turtle Creek, Verde Creek, Bear Creek

**Aquifer:** Trinity

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

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

**Counties:** Kerr, Gillespie, Bandera, Kendall

**EcoRegion:** Edwards Plateau

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

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

**Land Uses:** Ranching, Farming, Tourism, Light Manufacturing

**Water Body Uses:** Aquatic Life Use, Contact Recreation Use, General Use, Fish Consumption Use, Public Water Supply Use

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

**Permitted Wastewater Treatment Facilities:**  
 Domestic: 1    Land Application: 6    Industrial: 0

## Upper Guadalupe River above Comfort

The Upper Guadalupe River watershed above Comfort, Texas drains an area of 850 square miles. The majority of this drainage area is contained within Kerr County, although a small portion of the watershed includes areas in Gillespie, Bandera, and Kendall counties. Major streams and rivers within this drainage area include the North and South Fork of the Guadalupe River, Johnson Creek, Indian Creek, Quinlan Creek, Camp Meeting Creek, Town Creek, Third Creek, Cypress Creek, Goat Creek, Turtle Creek, Verde Creek, and Bear Creek. Cities include Hunt, Ingram, Kerrville, Center Point, and Comfort (Kerr and Kendall County).

Soils are generally dark and loamy over limestone, but are more variable in the southern and eastern portions of the watershed. Vegetation cover is primarily herbaceous and dominated by ash juniper with portions of shrub lands and grass or herbaceous land cover. Average rainfall is 30 inches and average annual temperature is 32 °F in January and 94 °F in July.

Land use in the Upper Guadalupe watershed is defined by ranching, farming, tourism, and light manufacturing. Water bodies are used for aquatic life, contact recreation, fish consumption, and as public water supplies. There is one permitted wastewater treatment facility and six land application facilities in the watershed. The City of Kerrville is permitted to release treated effluent into Third Creek from their wastewater treatment facility. Average annual discharge from this facility is 1.2 million gallons per day (MGD) into Third Creek and 0.91 MGD are reused primarily as irrigation. Quality limits for this facility are a daily average of 5 milligrams per liter (mg/L) carbonaceous biochemical oxygen demand and 5 mg/L total suspended solids.

### Stakeholder Concerns

Stakeholder concerns in this portion of the Guadalupe River basin are focused on preserving the nearly pristine water quality of the area and conserving the water resource of the Guadalupe River. Many are concerned about the predominance of ash juniper in the landscape.

Ash juniper is very efficient at intercepting rain and can capture over ½ inch of rain before it reaches the soil. In a normal year, most rain events produce ½ inch or less of rain. Therefore, rain falling over an area of dense cedar cannot be captured or stored by the watershed. Through brush management, ash juniper can be replaced with other native vegetation that will help enhance and maintain aquifer recharge and spring flow. Approximately 90% of all flow in the Guadalupe River at Kerrville is attributed to spring flow. Therefore, actions that enhance spring flow are crucial to conserving this precious water resource.

Portions of the Guadalupe River in Kerrville have experienced high *E. coli* bacteria levels in recent years. Many stakeholders are concerned that bacteria contamination will affect the recreational use of their favorite swimming holes and that the levels indicate degrading water quality (figure 1). Programs have been initiated to address this concern and are discussed later in the Segment

1806 section of this document. Some Kerr County residents are concerned about a proposed wastewater treatment facility. Recently, a permit application was submitted to the State for a proposed wastewater treatment facility that will discharge treated effluent into a tributary of the Guadalupe River. This proposed facility will not exceed a daily average flow of 25,000 gallons per day with quality limits of 10 mg/L biochemical oxygen demand and 15 mg/L total suspended solids. This permit is currently pending.

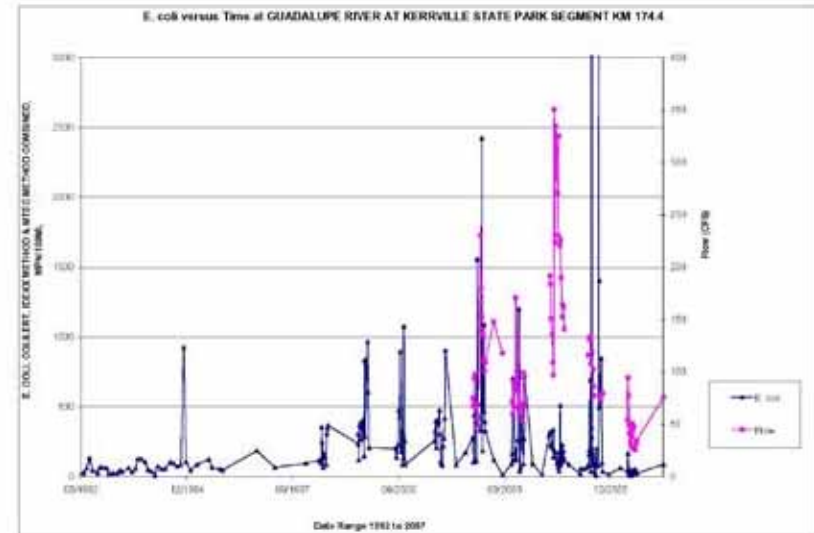


Figure 1. *E. coli* versus time at Kerrville Schreiner Park (12615). In assessment unit 1806\_04.

### Water Quality Monitoring

The designated river segments in The Upper Guadalupe River watershed above Comfort listed under the state of Texas Water Quality Management Plan are segment 1816 (Johnson Creek), segment 1817 (North Fork Guadalupe River), segment 1818 (South Fork Guadalupe River), and segment 1806 (Guadalupe River above Canyon Lake). River segment 1806 can be further divided into segments 1806A thru 1806G to describe specific streams that contribute flows directly to segment 1806.

The Guadalupe-Blanco River Authority (GBRA), together with the Upper Guadalupe River Authority (UGRA), carry out the water quality management efforts in this basin under contract with the Texas Commission on Environmental Quality (TCEQ). Ten sites in Kerr County are monitored on a quarterly basis as part of the Clean Rivers Program (CRP). During each sampling event, the following parameters are monitored: pH, dissolved oxygen, conductivity, temperature, flow, total suspended solids, volatile suspended solids, turbidity, sulfate, chloride, nitrate, total phosphorus, chlorophyll-a, and *E. coli*. In addition to these routine parameters, sampling is also conducted to analyze organics in sediment, metals in sediment, and to assess the biological community. In the past, sediment sampling could not be conducted annually because of unfavorable conditions due to the flash flood

flow regime of the Hill Country. Frequent scouring events and few depositional zones have made sediment collection impossible during some years. Sampling the biological community has also been impacted by flooding because of persistent high flow at the sample sites during some years. In general, the water quality of the Upper Guadalupe River watershed is highly impacted by highly variable flow.

Segment 1806, the Guadalupe River above Canyon Lake, has been identified by the TCEQ as not supporting designated uses due to elevated *E. coli* bacteria concentrations (figure 2). Due to this concern, a Total Maximum Daily Load (TMDL) study was conducted and subsequently adopted by TCEQ. This TMDL, titled *One Total Maximum Daily Load for Bacteria in the Guadalupe River Above Canyon Lake*, is now a part of the state's Water Quality Management Plan.

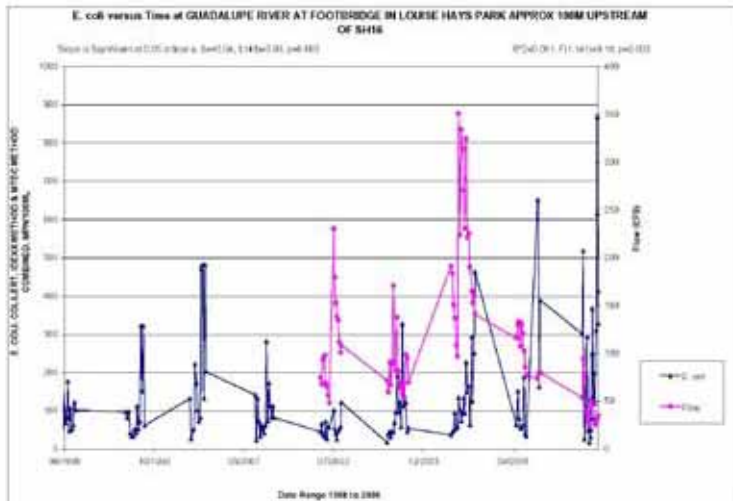


Figure 1. *E. coli* versus time at Louise Hays Park (16243) 100 meters upstream of SH 16, in assessment unit 1806\_06.

Another segment of concern is Camp Meeting Creek, segment 1806A. This stream has been listed as not supporting designated uses when screened against the dissolved oxygen 24-hour average. Additionally, the draft 2008 water quality assessment for the North Fork of the Guadalupe River (segment 1817) found some concern for dissolved oxygen samples at the screening level.

These water quality concerns, as well as the continued urbanization of areas adjoining the Guadalupe River in Kerr County, have focused the attention of the UGRA on a review of the current surface water quality monitoring programs in place in Kerr County. A decision was made to develop a Goal-Based Surface Water Quality Monitoring Plan for Kerr County for 2008.

The Goal-Based Monitoring Plan included a review of available data and recommendations for future water quality monitoring. Trend analyses were conducted by reviewing surface water quality data from the existing Surface Water

Quality Monitoring database (SWQM) maintained by TCEQ. The database covered the time periods from 1972 to 2007. The sites selected for review are located in segment 1806 of the Guadalupe River as well as tributaries of this segment. For the most part, the tributaries are not currently being monitored as part of a routine surface water quality monitoring program. The tributaries drain large areas of the Guadalupe River watershed and have the potential of carrying pollutant loads that could degrade water quality, especially in urbanized areas of Kerr County. As a result, the Goal-Based Monitoring Plan included recommendations to expand water quality monitoring activities on the tributaries of the Upper Guadalupe River.

The key parameters reviewed included specific conductivity, dissolved oxygen, nitrate nitrogen, total phosphorus, chlorides, sulfates, and *E. coli* and preference was given to the most recent data available whenever possible. An explanation of any trends noted at the monitoring sites was also included.

The document developed contains recommendations for a short term surface water quality monitoring program to be conducted by UGRA staff within the watersheds of the Guadalupe River in Kerr County. The primary goals of this monitoring program are to establish baselines of existing and desirable water quality and to identify areas needing more intensive monitoring. Following the initial round of monitoring, the results will be analyzed and used to establish action levels specific to each watershed. These action levels will trigger recommended voluntary Best Management Practices (BMPs) to address any noted downward trends in desirable water quality.

#### Johnson Creek, Segment 1816

Segment 1816, Johnson Creek, extends from the confluence with the Guadalupe River in Kerr County to a point 1.2 km (0.7 miles) upstream of the most upstream crossing of SH 41 in Kerr County. This segment consists of one assessment unit and one monitoring station. UGRA or GBRA has been monitoring Johnson Creek at SH 39 (site 12678) quarterly since 1998 as part of the CRP. This location is also a historical site and has data from the early 1980s to 1997. The Johnson Creek segment is spring fed and approximately 21 miles long. Median flow at site 12678 is 34 cubic feet per second. A USGS gauging station is located in this segment approximately 3.5 miles upstream from site 12678.

The 2008 draft Texas Water Quality Inventory has no impairments or concerns listed for segment 1816. The water quality at site 12678 is consistently good and the segment maintains an exceptional aquatic life use designation. The median concentration for dissolved oxygen is 7.9 milligrams per liter (mg/L), ranging from a minimum of 5.8 mg/L to a maximum of 10.7 mg/L. At no time during the period of 1998 to the present did the dissolved oxygen drop below the state standard (4 mg/L). The **specific conductance** ranged from 360 to 600 micromhos per centimeter ( $\mu\text{mho/cm}$ ), with a median conductivity of 471  $\mu\text{mho/cm}$ .

Water quality is very consistent from year to year. Nitrate values ranged from 0.2 to 3.3 mg/L with most below 3.0 mg/L. This indicates not much nutrient loading is occurring. Total phosphorus ranged from 0.003 to 0.05 mg/L with the bulk of

values being less than or equal to 0.01mg/L. This is a very clean body of water as far as nutrient loading is considered. Chlorides ranged from 1-33 mg/L with most values in the range of 15-30 mg/L. Again, this reinforces the relatively clean nature of this body of water. Sulfates ranged from 1-30 mg/L with most values in the 10-20 mg/L range. There was little variation exhibited annually or from year to year.

#### *Land Use*

The land use in the Johnson Creek watershed is rural with very low density residential development and some camps upstream of Ingram. The scenery and recreational opportunities attract many people to segment 1817. In fact, site 12678 is a very popular swimming hole for local residents. The stream standard for contact recreation is 394 colony forming units (cfu) of *E. coli* bacteria per 100 mL of water for a single grab sample or a geometric mean of 126 cfu. The geometric mean at site 12678 from 2001 to the present is 40 cfu of *E. coli*. During this time period, no sample exceeded the single sample standard of 394 cfu of *E. coli*, but there is an upsurge in the values from June thru September. More data is needed to establish if this trend is consistent with warmer temperatures and/or lower flow in the summer months.

#### North Fork Guadalupe River, Segment 1817

Segment 1817, North Fork Guadalupe River, extends from the confluence with the Guadalupe River in Kerr County to a point 18.2 km (11.3 miles) upstream of Boneyard Draw in Kerr County. This segment consists of one assessment unit and three monitoring stations. UGRA or GBRA has been monitoring the North Fork Guadalupe near Camp Waldemar (site 12682) site quarterly since 1998 as part of the CRP. This location is also a historical site and has data from 1976 to 1997. Two additional sites in this segment were monitored during the summer from 2002 - 2007 for *E. coli* and turbidity only. These sites are North Fork Guadalupe River at FM 1340 (site 12681) and North Fork Guadalupe River at Rock Bottom Road (site 16245). The North Fork Guadalupe River segment is spring fed and approximately 29 miles long. Median flow at site 12682 is 26.5 cubic feet per second. A USGS gauging station is located in this segment approximately 0.5 miles downstream from site 12682.

The 2008 draft Texas Water Quality Inventory lists no impairments for segment 1817, but did find a concern for depressed dissolved oxygen. Overall water quality at site 12682 is very good and the segment maintains an exceptional aquatic life use designation. The median concentration for dissolved oxygen is 7.4 milligrams per liter (mg/L), ranging from a minimum of 5.0 mg/L to a maximum of 9.7 mg/L. At no time during the period of 1998 to the present did the dissolved oxygen drop below the state standard (4 mg/L). The **specific conductance** ranged from 349 to 524 micromhos per centimeter ( $\mu\text{mho/cm}$ ), with a median conductivity of 395  $\mu\text{mho/cm}$ .

A review of the data available for the North Fork of the Guadalupe at this location indicates that consistently good water quality is maintained in this section of the river. Recent nitrate data was scarce but values ranged from <0.1 to 0.74 mg/L.

This indicates not much nutrient loading is occurring. Total phosphorus ranged from 0.002 to 0.022 mg/L with the bulk of values between 0.005 to 0.01 mg/L. This is another indication of very clean body of water as far as nutrient loading is considered. Chlorides ranged from 3-12 mg/L with most values in the range of 6-10 mg/L. Again, this reinforces the relatively clean nature of this body of water. Sulfates ranged from 2-16.5 mg/L. This is also a relatively low value for this parameter.

#### *Land Use*

The land use upstream in the North Fork Guadalupe River is rural with very low density residential development. Many Hill Country summer camps are located in segment 1817 due to the beautiful scenery and numerous recreational opportunities. The stream standard for contact recreation is 394 colony forming units (cfu) of *E. coli* bacteria per 100 mL of water for a single grab sample or a geometric mean of 126 cfu of *E. coli*. The geometric mean at site 12682 from 2001 to the present is 32 cfu of *E. coli*. During this time period, only one sample exceeded the single sample standard of 394 cfu of *E. coli*, but there was some indication of an upward trend in summer months. More data is needed to establish if this trend is consistent.

#### South Fork Guadalupe River, Segment 1818

Segment 1818, South Fork Guadalupe River, extends from the confluence with the Guadalupe River in Kerr County to a point 4.8 km (3.0 miles) upstream of FM 187 in Kerr County. This segment consists of five assessment units and each assessment unit contains one monitoring station. UGRA or GBRA has been monitoring the South Fork Guadalupe River adjacent to Hunt Lions Park (site 12684) quarterly since 1998 as part of the CRP. This site is located in the most downstream assessment unit of the segment. This location is also a historical site and has data from 1976 to 1997. The four additional sites in this segment were monitored during the summer from 2002 - 2007 for *E. coli* and turbidity only. These sites are South Fork Guadalupe Adjacent to Camp Arrowhead (site 12685), South Fork Guadalupe River at Seago Rd (site 16246), South Fork Guadalupe Adjacent to Camp Mystic (site 12686), South Fork Guadalupe Adjacent to Lynxhaven Lodge at SH 39 (site 12688). The South Fork Guadalupe River segment is spring fed and approximately 27 miles long. Median flow at site 12684 is 28 cubic feet per second.

The 2008 draft Texas Water Quality Inventory lists no impairments or concerns in segment 1818. Overall water quality at site 12684 is very good and the segment maintains an exceptional aquatic life use designation. The median concentration for dissolved oxygen is 8.4 milligrams per liter (mg/L), ranging from a minimum of 6.7 mg/L to a maximum of 10.5 mg/L. At no time during the period of 1998 to the present did the dissolved oxygen drop below the state standard for dissolved oxygen (4 mg/L). The **specific conductance** ranged from 360 to 475 micromhos per centimeter ( $\mu\text{mho/cm}$ ), with a median conductivity of 418 $\mu\text{mho/cm}$ .

A review of the data available for this South Fork Guadalupe River station

indicates that consistently good water quality is maintained in this section of the Guadalupe River. Nitrate values ranged from 0.06 to 1.1 mg/L with most below 0.7 mg/L. This indicates not much nutrient loading is occurring. Total phosphorus ranged from 0.003 to 0.067 mg/L with the bulk of values being less than or equal to 0.01 mg/L. Again, this indicates a very clean body of water as far as nutrient loading is considered. Chlorides ranged from 6-21 mg/L with most values in the range of 8-10 mg/L. Sulfates ranged from 0.5-22 mg/L with most values in the 5-15 mg/L range. There was little variation exhibited annually or from year to year.

#### Land Use

The land use in the South Fork Guadalupe River watershed is rural with very low density residential development. Much like the North Fork Guadalupe River, segment 1818 is home to numerous Hill Country summer camps promoting various recreational activities. The stream standard for contact recreation is 394 colony forming units (cfu) of *E. coli* bacteria per 100 mL of water for a single grab sample or a geometric mean of 126 cfu of *E. coli*. The geometric mean at site 12684 from 2001 to the present is 14 cfu of *E. coli*. No samples have ever exceeded the single sample standard of 394 cfu of *E. coli* at this location. The four other monitoring stations in segment 1818 also contain summertime *E. coli* data from 2002 - 2007. The majority of bacteria data during this time indicated *E. coli* levels well below the 394 cfu standard for a single grab sample and only twice did the *E. coli* level exceed the standard. There does appear to be an upsurge in the values from June thru September, but more data is needed to establish if this trend is consistent.

#### Guadalupe River above Canyon Lake, Segment 1806

Segment 1806, Guadalupe River above Canyon Lake, extends from a point (1.7 miles) downstream of Rebecca Creek Road in Comal County to the confluence of the North Fork Guadalupe River and the South Fork Guadalupe River in Kerr County. The segment is approximately 103 miles long. The segment is broken into eight assessment units, however only the following are within the Upper Guadalupe River watershed above Comfort: from confluence with Big Joshua Creek to Flat Rock Dam in Kerrville (1806\_02), from Flat Rock Dam in Kerrville to 1 mile upstream (1806\_03), from 1 mile upstream Flat Rock Dam to confluence with Camp Meeting Creek (1806\_04), from confluence with Camp Meeting Creek to 2 miles upstream (1806\_05), from RR 394 1 mile downstream (1806\_06), and the upper 10 miles of segment (1806\_07). There are five USGS gauging stations located in segment 1806. Median annual **flow** of the Guadalupe River at Hunt is 67 cubic feet per second (ft<sup>3</sup>/s) and median annual flow of the Guadalupe River at Comfort is 186 ft<sup>3</sup>/s.

The assessment units contain six sites which have been monitored by UGRA or GBRA quarterly since 1998 as part of the CRP. Guadalupe River at Hermann Sons Road (site 12605), Guadalupe River at Center Point Lake (site 12608), Guadalupe River at G Street (site 12616), and Guadalupe River at Kerrville Schreiner Park (site 12615) also contain historical data dating back to the mid 1970s and early 1980s. Guadalupe River at Split Rock Road (site 15113) and the Guadalupe River at Riverview Road (site 15111) have been monitored since the beginning of

the CRP only. Several additional sites in this segment were monitored during the summer from 2002 - 2007 for *E. coli* and turbidity only. These sites are Guadalupe River at IH 10 in Comfort (site 12603), Guadalupe River at Louise Hays Park dam (site 16243), Guadalupe River at SH 16 (site 12617), Guadalupe River at Louise Hays Park footbridge (site 16244), Guadalupe River at UGRA Lake (site 12618), Guadalupe River at Bear Creek Road (site 12619), Guadalupe River at Ingram Dam (site 12620), and Guadalupe River at Kelly Creek Road (site 16241).

The 2008 draft Texas Water Quality Inventory lists three impairments and no concerns in segment 1806. Assessment units 1806\_4 (refer to figure 1) and 1806\_6 (refer to figure 2) are impaired for bacteria with geometric mean values exceeding state standards for contact recreation. The TCEQ first identified the impairment to the contact recreation use of segment 1806 in the 2002 Texas Water Quality Inventory and 303(d) List. Due to this concern, a Total Maximum Daily Load (TMDL) study was conducted on the impaired portion of segment 1806 that flows through the City of Kerrville. The impaired reach is defined as the Guadalupe River from its confluence with Town Creek downstream to Flat Rock Lake. The TMDL was adopted by the TCEQ on July 25, 2007 and approved by the Environmental Protection Agency (EPA) on September 25, 2007. This TMDL, titled *One Total Maximum Daily Load for Bacteria in the Guadalupe River Above Canyon Lake*, is now a part of the state's Water Quality Management Plan.

UGRA received a grant from TCEQ for a three-year project aimed at reducing bacteria levels in the impaired reach of the Guadalupe River. The TMDL program also requires the development of an Implementation Plan that identifies pollution reduction strategies to achieve the desired load reductions and provides a detailed plan for implementation. The goal of the TMDL program is to restore and maintain the beneficial uses of the impaired water body.

Though TCEQ is tasked with developing the implementation plan, the state elected to allow UGRA and a local stakeholder group to develop a plan at the local level. UGRA will utilize the TCEQ grant to coordinate and develop an implementation plan for TCEQ's consideration. The grant project includes key assessment activities that are expected to provide better identification of the bacteria sources. Several sites in the impaired reach will be monitored on a routine basis for three years. During the summer, monitoring will increase to include intensive sampling of the impaired region and the tributaries that enter this reach. *E. coli*, temperature, pH, dissolved oxygen, conductivity, and flow data will be collected as well as qualitative information such as the number of swimmers and waterfowl present in the impaired region. Once the sources are identified, potential control measures will be evaluated and implemented over the three-year term of the project.

Despite bacteria concerns, overall water quality in segment 1806 is very good and all assessment units in the segment maintain an exceptional aquatic life use designation. The Guadalupe River at Riverview Road (Station 15111) is sampled quarterly by UGRA staff as part of the CRP. This site is located between the cities of Ingram and Kerrville. A review of the data available for the Guadalupe River at Riverview Road indicates a water body with slightly elevated values for nearly all parameters when compared to the upstream North Fork and South Fork stations.

However, the slight elevations still are not sufficient to lower the water quality below a good rating for this section of the river. **Specific conductivity** ranges from 378-511  $\mu\text{mho/cm}$  with the bulk of values within the 400-500  $\mu\text{mho/cm}$  range. The trends are very consistent year to year. Dissolved oxygen ranges from 5.97-10.5 mg/L with only one value out of 34 readings below 6.0 mg/L. No dissolved oxygen impacts were seen. Nitrate values ranged from 0.1 to 0.79 mg/L. This indicates not much nutrient loading is occurring. Total phosphorus ranged from 0.005 to 0.12 mg/L with the bulk of values being less than 0.02 mg/L. This is still a very clean body of water as far as nutrient loading is considered. Chlorides ranged from 10-24 mg/L with most values in the range of 10-17 mg/L. Again, this reinforces the relatively clean nature of this body of water. Sulfates ranged from 8.6-20 mg/L with most values in the 10-15 mg/L range. There was little variation exhibited annually or from year to year. *E. coli* testing did not result in any values which exceeded the single grab limit of 394 colonies/100 mL but there is an upsurge in the values from June thru September. More data is needed to establish if this is consistent.



Louise Hays Park

The land use in this area of the Guadalupe River is more affected by urbanization from the City of Ingram and the data indicates this increased influence on water quality. However, there does not seem to be any obvious degradation of water quality occurring at this time.

The Guadalupe River at Split Rock Road (Station 15113) is sampled quarterly by UGRA staff as part of the CRP. This site is located between the cities of Kerrville and Center Point. A review of the data

available indicates some effects on water quality by the increased urbanization in this section of the river. However, the available data indicate that the water quality still rates a designation of good. **Specific conductivity** ranges from 390-552  $\mu\text{mho/cm}$  with the bulk of values within the 400-500  $\mu\text{mho/cm}$  range. The trends are very consistent year to year. Dissolved oxygen ranges from 6.8-12.96 mg/L with no values going below 6.0 out of 36 readings. No dissolved oxygen impacts were seen in the data. Nitrate values ranged from 0.17 to 1.1 mg/L. This indicates not much nutrient loading is occurring. Total phosphorus ranged from 0.01 to 0.05 mg/L with the bulk of values being less than 0.025 mg/L. This indicates not much nutrient loading is occurring. Chlorides ranged from 15-32 mg/L, again reinforcing the conclusion that water quality is still relatively good. Sulfates ranged from 13-26 mg/L with not much variation exhibited annually or from year to year. *E. coli* testing did not result in any values which exceeded the single grab limit of 394 colonies/100 mL. This was surprising since this station is downstream of the impacted section of the Guadalupe River that flows through Kerrville. More data is needed to establish if this is consistent.

The land use just upstream of this section of the Guadalupe River is fairly dense residential and commercial urban development on both sides of the river.

## Camp Meeting Creek, Segment 1806A

Segment 1806A, Camp Meeting Creek, is an unclassified water body ranging from the confluence of Flat Rock Lake in southeastern Kerrville to the upstream perennial portion of the stream west of Kerrville. The segment contains two assessment units: the lower 9 miles of the segment (1806A\_02) and the upper 9 miles of the segment (1806A\_03). UGRA or GBRA has been monitoring the Camp Meeting Creek (site 12546) site quarterly since 1998 as part of the CRP. This site is located in the most downstream assessment unit of the segment. This location is also a historical site and has data from 1976 to 1997. The Camp Meeting Creek segment is approximately 27 miles long and median flow at site 12546 is 1.4 cubic feet per second (cfs).

The 2008 draft Texas Water Quality Inventory lists segment 1806A\_03 as impaired for dissolved oxygen because it has failed to meet the dissolved oxygen 24 hour standard. Overall water quality at site 12546 is fair and the segment only maintains a limited aquatic life use designation.

A review of the data available for station 12546 indicates that water quality in this stream is degraded. The median concentration for dissolved oxygen is 7.9 milligrams per liter (mg/L), ranging from a minimum of 2.8 mg/L to a maximum of 14.5 mg/L. On several occasions during the period of 1998 to the present, the dissolved oxygen values have dropped below the state standard for dissolved oxygen (4 mg/L) (figure 3). The **specific conductance** ranged from 435 to 825 micromhos per centimeter ( $\mu\text{mho/cm}$ ), with a median conductivity of 682

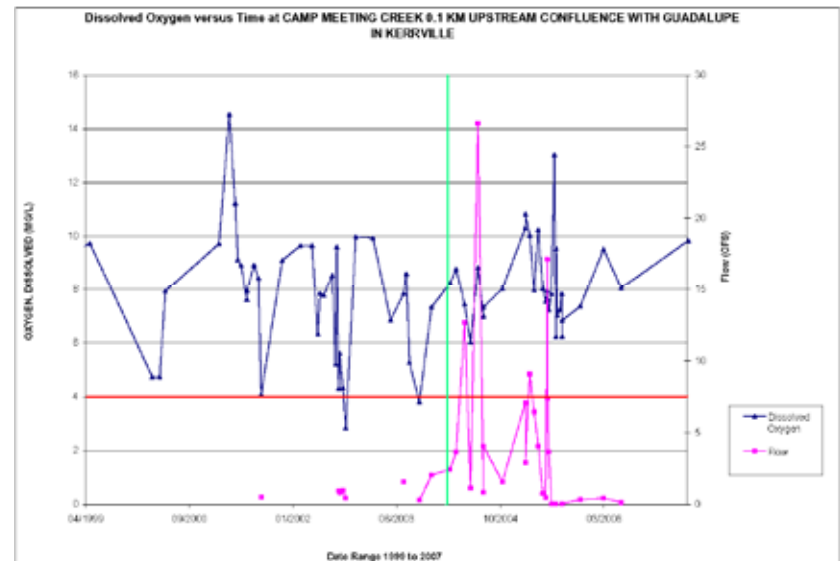


Figure 3. Graph of Dissolved Oxygen versus time at Camp Meeting Creek (12546), 0.1 miles above the confluence with the Guadalupe River. The red horizontal line on the graph represents the single sample standard of 4.0 mg/L of Dissolved Oxygen. The green vertical line on the graph indicates the transition to municipal sewer collection for several of the houses in the upper portion of the watershed.

µmho/cm. There was very little data on nitrates with a range of 0.1 to 17.7 mg/L and most values falling below 3.0 mg/L. More data is needed to see if nutrient enrichment is occurring. Total phosphorus ranged from 0.002 to 0.7 mg/L. When the one extreme value of 0.7 mg/L is removed, the remainder of the data falls within the 0.002 to 0.058 mg/L range. The total phosphorus value of 0.7 mg/L occurred at very low flow (0.4 cfs), but similar low flow events do not coincide with high total phosphorus results; this is an unusually high value that did not reoccur. This does not appear to be a nutrient enrichment issue but more data is needed. Chlorides ranged from 22-60 mg/L with the bulk of values within 30-50 mg/L. There is considerable fluctuation on an annual basis. Sulfates ranged from 9-195 mg/L but the bulk of values fell within 10 to 40 mg/L. Extreme fluctuations were evident but more data is needed to establish any patterns.

The stream standard for contact recreation is 394 colony forming units (cfu) of *E. coli* bacteria per 100 mL of water for a single grab sample or a geometric mean of 126 cfu of *E. coli*. The geometric mean at site 12546 from 2002 to the present is 74 cfu of *E. coli*. Two samples in 2002 and one sample in 2003 exceeded the single sample standard of 394 cfu of *E. coli* at this location.

Camp Meeting Creek travels through a densely populated area occupied by single family residences, a golf course, and mobile home parks. Numerous bridges also cross the creek creating opportunities for non-point source pollutants to enter the creek as runoff. Many residents in the upper section of Camp Meeting Creek rely on private septic systems. In 2004, Kerr County, the City of Kerrville and UGRA partnered to address potential water quality concerns and initiated municipal sewer collection for some homes in this area. Although there are still many more homes on septic systems, since the end of 2003, the single sample contact recreation standard of 394 cfu of *E. coli*, has only been exceeded two times and the dissolved oxygen level has not dropped below the state standard of 4.0 mg/L at this station. The data shown in figures 3 and 4 seems to indicate that the steps taken to address the septic problems in this area are helping to improve the water quality of the Camp Meeting Creek.

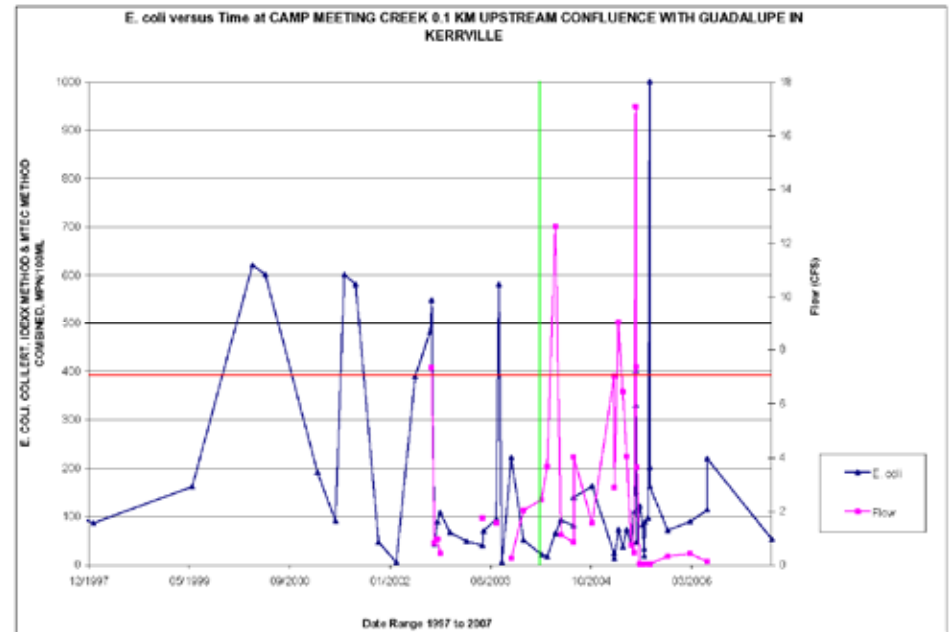


Figure 4. Graph of *E. coli* versus time at Camp Meeting Creek (12546), 0.1 miles above the confluence with the Guadalupe River. The red horizontal line on the graph represents the single sample contact recreation standard of 394 cfu *E. coli*. The green vertical line on the graph indicates the transition to municipal sewer collection for several of the houses in the upper portion of the watershed.