Brazos River Authority

Clean Rivers Program
FY2005/2006

Comprehensive Study of Sulphur Creek
Segment 1217b

Special Study Final Report
September 2006

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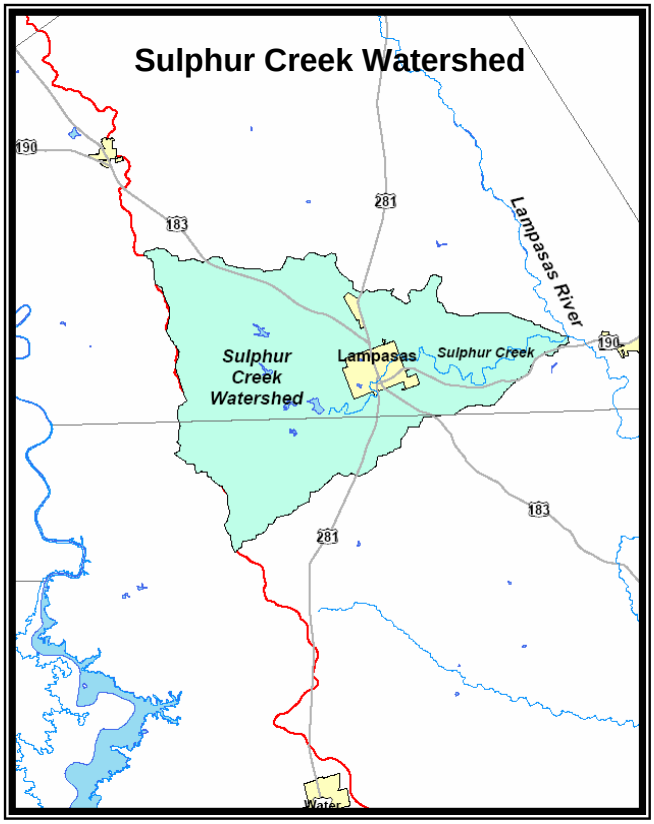
EXECUTIVE SUMMARY

The Sulphur Creek micro-watershed is located entirely inside Lampasas and Burnet Counties. Sulphur Creek flows for approximately twenty miles through Lampasas County and the City of Lampasas before entering the Lampasas River upstream of Stillhouse Hollow Lake. Sulphur Creek is a spring fed system characterized by high concentrations of dissolved solids that are a result of chloride and sulfate bearing geologic features in the watershed. Routine water quality data collected by the Brazos River Authority through the Clean Rivers Program between 1998 and 2005 has historically indicated acceptable water quality conditions supporting the stream's designated use standards and criteria as set by the Texas Commission on Environmental Quality. Members of a local volunteer group, Friends of Sulphur Creek (FOSC), have been monitoring the stream since 1998 and have witnessed changes over time and periods when water quality conditions appeared to be polluted.



Over the past several years, members of FOSC have raised concerns regarding increased bacteria concentrations, nutrients and sedimentation in Sulphur Creek. The local citizens have also reported visual changes over the years, such as an increase in turbidity and foam on the water surface. Foaming events have been noted on or after "heavy wash days" downstream of OMI, Inc. WWTP and it is suspected that the cause of the foam was from detergents containing phosphates. Potential sources of bacteria and elevated orthophosphate are the local wastewater outfall and/or leakage from aging septic systems. In addition, the local stakeholder group has expressed concern that increased development in the area may be causing an increase in sedimentation.

The Brazos River Authority developed a special study under its Clean Rivers Program to collect comprehensive and thorough documentation of water quality conditions in Sulphur Creek during a 12-month period. The Brazos River Authority, members of the FOSC, and OMI, Inc. (operators of the Lampasas WWTP) entered into an agreement to coordinate efforts in monthly monitoring of eight stream and two spring sites on Sulphur Creek for one year.

The results of this CRP Special Study indicate that, overall, Sulphur Creek provides supporting water quality conditions as defined by TCEQ. Monitoring stations 18783 and 18760 both exhibit a concern for elevated levels of *E. coli* bacteria. A potential bacteria

contributor in this area is the resident domestic waterfowl population. Dissolved oxygen levels were intermittently low at stations 15780, 18782 and 18783. During the study, 7% of grab samples collected at station 15780 fell below the TCEQ minimum dissolved oxygen standard criteria of 3.0 mg/l. Greater than 25% of grab samples fell below the TCEQ dissolved oxygen criteria of 5.0 mg/l at stations 15780 and 18782. In addition, 13% of samples fell below the TCEQ absolute minimum DO criteria and station 18783. Dissolved oxygen data was assessed for a stream with a high aquatic life use designation. Both chloride and TDS standard criteria were in exceedence at several of the special study monitoring stations. The chloride and TDS exceedances are likely attributable to concentration during chronic drought conditions in a spring driven creek system. All components of the biological assessments met or exceeded TCEQ standard criteria.

INTRODUCTION

Background

Several studies have been conducted on Sulphur Creek and while only a few isolated water quality impacts were identified over the years, the citizens continued to be concerned with the stream's water quality conditions. On December 16, 2004, representatives from BRA, TCEQ, TPWD, Texas Watch and members of FOSC reviewed available water quality data and watershed information to assess the need for further monitoring and data collection. Based on the consensus of the group, the Brazos River Authority developed a special study under its Clean Rivers Program to collect comprehensive and thorough documentation of water quality conditions in Sulphur Creek during a 12-month period. The Brazos River Authority, members of the FOSC, and OMI, Inc. (operators of the Lampasas WWTP) entered into an agreement to coordinate efforts in monthly monitoring of eight stream and two spring sites on Sulphur Creek for one year.

Friends of Sulphur Creek Group Training Session - 2005

The objectives of this study were to

to determine if field observations (i.e., turbidity, flow, algae, presence of foam) correlate with fluctuations of water quality constituents and the presence of non-point source pollutants during targeted monitoring events;

to characterize spatial and temporal fluctuations of water quality constituents; and

to compare concentrations of water quality constituents to TCEQ assessment criteria to determine if concentrations of water quality constituents are elevated.

HISTORICAL STUDIES

Texas Parks and Wildlife Department, Fish Kill Events

Information regarding several pollution and fish kill incidents has been provided by Texas Parks and Wildlife Department (TPWD). In July and September of 1973, pollution events occurred below the City of Lampasas WWTP characterized by low dissolved oxygen and high specific conductance, ammonia, and biological oxygen demand (BOD) levels.

In 1988, a significant fish kill occurred in the first two miles upstream of Sulphur Creek's confluence with the Lampasas River. Rotenone, a chemical used for fish eradication, was found in a Sulphur Creek pool. TPWD personnel counted more than 4,000 non-game and game fish killed in this single event. This was an isolated incident attributed to the intentional misuse of chemicals by individuals.

In 1992, a manhole overflowed into Sulphur Creek two miles upstream of Gunderland Park. This spill was characterized by a red fluid made up of raw sewage, blood, turkey feathers and viscera. In some cases, the spills described above resulted in large blooms of filamentous algae in Sulphur Creek.

TCEQ Water Quality Intensive Survey

In 1997, the Brazos River Authority in cooperation with TCEQ conducted an intensive survey of Sulphur Creek from Naruna Road to the confluence with the Lampasas River. The intensive survey goals were to, 1) identify and document the current water quality conditions within the Sulphur Creek watershed, 2) provide a comparative database for evaluation with prior water quality studies, and 3) collect data which can assist in defining the realistic, reasonable, and attainable aquatic use standard for Sulphur Creek.

Table 1. Station location and description from 1997 TCEQ Intensive Survey

Site	Description
Sulphur Creek at Naruna Road	Downstream from FM 1478 bridge and former low water crossing on Sulphur Creek
Sulphur Creek at the Randall Fry Ranch	Downstream from a spring, the Randall Fry Ranch is used for livestock
Sulphur Creek at Green # 2	The low water dam at the Lampasas Municipal Golf Course at Green Two
Sulphur Creek at the city park	Site located immediately downstream from the "main" spring at the city park (Hancock Park)
Spring outflow into city pool	Site at the artesian overflow into the city pool
City pool discharge	Site at pool overflow into Sulphur Creek
Sulphur Creek at CR 7	Site located downstream from bridge; first road crossing downstream from WWTP discharge
Sulphur Creek at CR8 (now CR 3050)	Site located downstream from bridge
Lampasas River at FM 2313	Site located at first bridge upstream from confluence of Sulphur Creek and Lampasas River
Lampasas River at US HWY 190	Site located at first bridge downstream from confluence of Sulphur Creek and Lampasas River

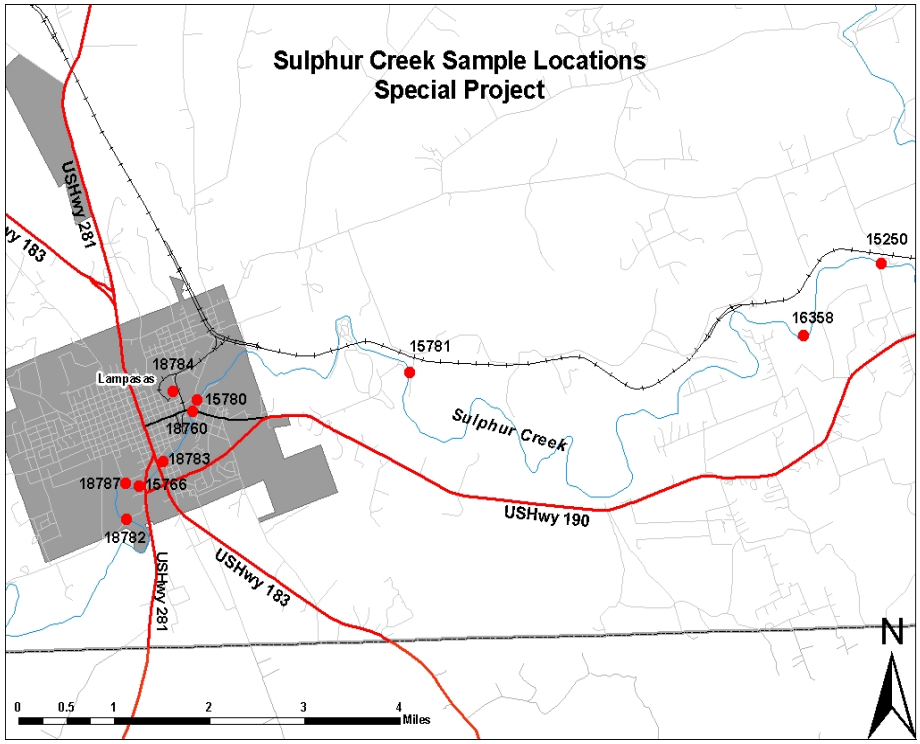
The survey included water quality sampling at ten locations on Sulphur Creek (Table 1.) every four hours for one 24 hour period. Additionally, a survey of the fish communities was made at the Naruna Road and County Road 7 stream sites and benthic collections were conducted at Green Number Two and County Road 7 stream sites. Both chemical and biological data results from this survey indicated supporting water quality conditions for the stream segment. Fecal coliform data results showed elevated levels at the Randall Fry Ranch and County Road 8 (now CR 3050) locations; the ranch site was most likely impacted by livestock operations and no potential source was identified for the County Road 8 location.

TPWD Biological Assessments

Texas Parks and Wildlife Department (TPWD) has conducted several biological assessments of Sulphur Creek in the last decade. The majority of this work has concentrated on macro-benthic community surveys. All assessments that have been conducted to date indicate High Aquatic Life Use with many "clean-water species" present in the creek.

Current Study Area

The study area includes the Sulphur Creek Segment 1217B of the Lampasas River between Sulphur Creek crossing at Naruna Road eastward to the confluence of Sulphur Creek with the Lampasas River (See Map).



WATER QUALITY STANDARDS AND CRITERIA

Table 2. indicates the current standards for Sulphur Creek segment 1217B. These standards and criteria are approved by the Environmental Protection Agency (EPA) and used by the Texas Commission on Environmental Quality (TCEQ) to assess water quality conditions in the segment. Methodologies and guidelines for data analysis and use of standards and criteria are published in the TCEQ Chapter 307 Texas Surface Water Quality Standards and the Guidance for Assessing Texas Surface and Finished Drinking Water Quality Data (August 15, 2003).

Table 2. Surface water quality standards/criteria for Segment 1217B

Parameter	Criteria or Screening Level
Water Temperature	32.8 C
Dissolved Oxygen	absolute minimum - 3.0mg/l 24hr minimum 5.0mg/l
pH	6.5 – 9.0
E. coli	≥ 394 MPN in ≥ 25% of samples and/or geometric mean ≥126 MPN/10ml
Chloride	500 mg/l
Sulfate	100 mg/l
Total Dissolved Solids	1200 mg/l
Nitrite + Nitrate Nitrogen*	2.76 mg/l
Orthophosphate phosphorus*	0.5 mg/l

WORK PLAN

The Friends of Sulphur Creek (FOSC), a volunteer citizen monitoring (VCM) group, has documented changing conditions over several years in Sulphur Creek, Segment 1217B of the Lampasas River. The Brazos River Authority has also routinely monitored Sulphur Creek for many years and has cooperated with FOSC in investigations of water quality. Despite Sulphur Creek not being listed on the State of Texas 303(d) list of impaired waterways, questions on the water quality of Sulphur Creek persist. On December 16, 2004, a group of water quality professionals reviewed available water quality data and watershed information to assess the need for further monitoring and data collection. There was inconsistency between volunteer collected data and data collected by the Clean Rivers Program. The BRA and FOSC decided that a more thorough documentation of water quality conditions would be undertaken on Sulphur Creek as part of CRP. The Brazos River Authority, FOSC, and OMI, Inc. (operators of the Lampasas WWTP) entered into an agreement to conduct monthly monitoring of eight stream and two spring sites on Sulphur Creek (Table 3.) for one year. In addition, targeted monitoring and biological assessments are included in this study.

Routine Monitoring

The Authority, in cooperation with FOSC and OMI, Inc., began routine monitoring of eight stream and two spring sites on Sulphur Creek (Table 3.) during June of 2005. Monitoring was conducted on a monthly basis. These sites are monitored for basic field parameters, dissolved oxygen, pH, specific conductance, TDS, TSS, nutrients, and *E. coli* levels. Members of FOSC and volunteers with OMI, Inc. were trained on the traditional methods used by volunteers to collect data on dissolved oxygen, pH, specific

conductance, and observational data. Remaining analyses were conducted by BRA laboratory personnel. Water samples and data sheets collected by FOSC, were delivered to OMI, Inc. in Lampasas, TX. River authority personnel picked up samples and delivered them to the BRA central office laboratory. Routine monitoring was conducted in accordance with the *Surface Water Quality Monitoring Procedures, Vol. 1: Physical and Chemical Monitoring Methods for Water, Sediment, and Tissue* (TCEQ 2003).

Table 3. Station locations and descriptions for 2005 Special Study

Station ID	Site Description
18782 [a]	Sulphur Creek at Naruna Road
15766	Sulphur Creek at Hancock Golf Cart Crossing in Hancock Park
18783 [a]	Sulphur Creek 105m downstream of US183 (Brook Park)
15780 [a]	Sulphur Creek 1000 ft downstream of Lampasas WWTP
18760	Sulphur Creek upstream of Lampasas WWTP
15781 [a]	Sulphur Creek at CR 7 Sparks Crossing
15250 [b]	Sulphur Creek at CR 3050
16358 [a]	Sulphur Creek at Deadman's Cut
18787 [a]	Sulphur Creek at Hancock Springs discharge
18784	Hannah Springs in tank adjacent to Burleson Creek

[a] Sites for routine and targeted monitoring. Targeted monitoring for foaming or heavy run-off events that can include up to four events per year.
[b] Site designated for biological sampling

Targeted Monitoring

In recent years, volunteers' data and observations continued to indicate potential problems with elevated phosphorus, increased sedimentation, unusual foaming events and possible aquatic life degradation. Routine monitoring data results collected by the Authority did not indicate poor water quality conditions described by these observations. However, these problems and the potential sources may be sporadic in nature and may be difficult to document with routine water quality monitoring. Therefore, up to four targeted monitoring events were recommended for this study. Targeted monitoring was to be conducted when FOSC members observed foaming conditions or significant runoff similar to the conditions observed by FOSC members in the past. The same information and samples are collected as routine monitoring sampling events with the addition of Volatile Organic Compound (VOCs) samples. The VOC analyses were to be conducted to investigate if priority pollutants were present during unusual conditions as observed by the FOSC members. No targeted monitoring events were conducted during this study (see discussion).

Biological Monitoring

Biological assessments are conducted in accordance with *Aquatic Life Monitoring* procedures for the purpose of providing baseline data on environmental conditions and to determine if the aquatic life use is being attained. The locations are selected and assessment procedures follow guidelines set forth by the *Draft Surface Water Quality Monitoring Procedures, Vol. 2: Methods for Collecting and Analyzing Biological Community and Habitat Data* (TCEQ 2005). An Index of Biotic Integrity (IBI) is calculated for the fish and benthic community. The resulting score places the biotic community into one of the four following Aquatic Life Use (ALU) categories: limited, intermediate, high, or exceptional. In addition, chemical and physical assessments are conducted that further aid in defining the ALU of the stream.

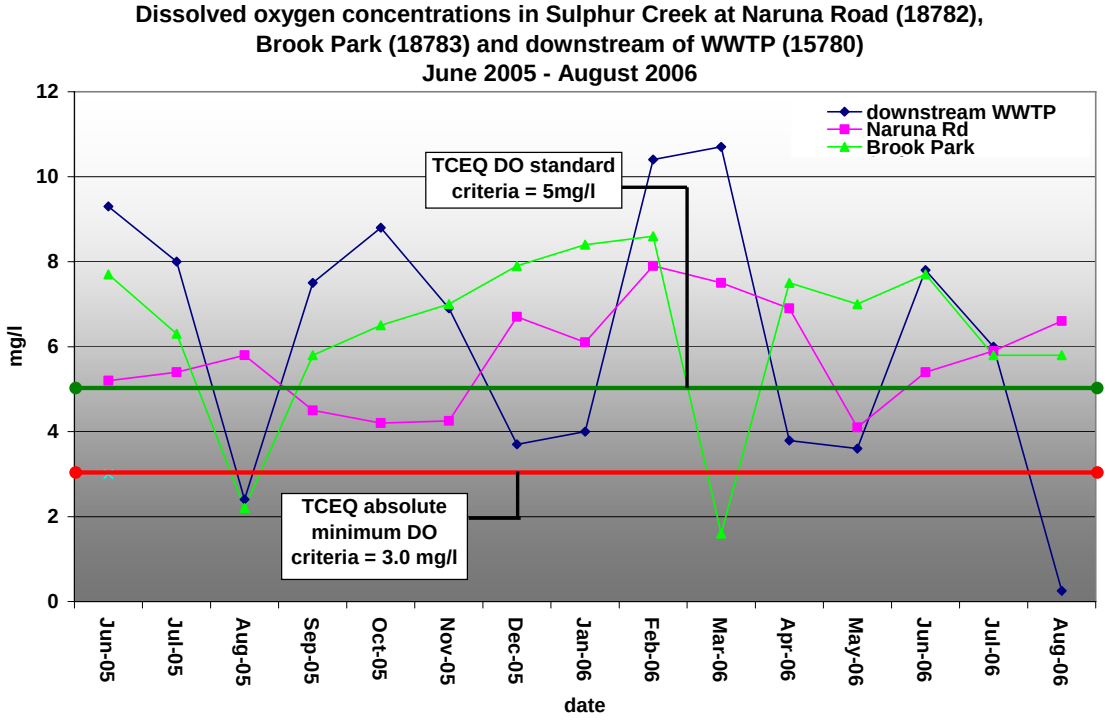
CONCLUSIONS AND DISCUSSION

Data sets are limited to 12 – 19 observations, except for station 15250 which has routine long-term data going back many years. See Appendix A for a summary of data.

Routine Monitoring Data Results

Naturally occurring geologic mineral deposits that contain chloride and sulfate underlie much of the Sulphur Creek watershed. These minerals are introduced to the stream through the many springs located along this stream segment. Data results indicate that several station locations are in exceedence of the state chloride standard criteria of 500 mg/l (see Appendix A). Chronic drought conditions may be the cause of this exceedence during the study period. Dissolved solids also exceed the state criteria for segment 1217b at three of the study station locations (15780, 15781, and 16358) and may also be elevated due to drought conditions.

Figure 1



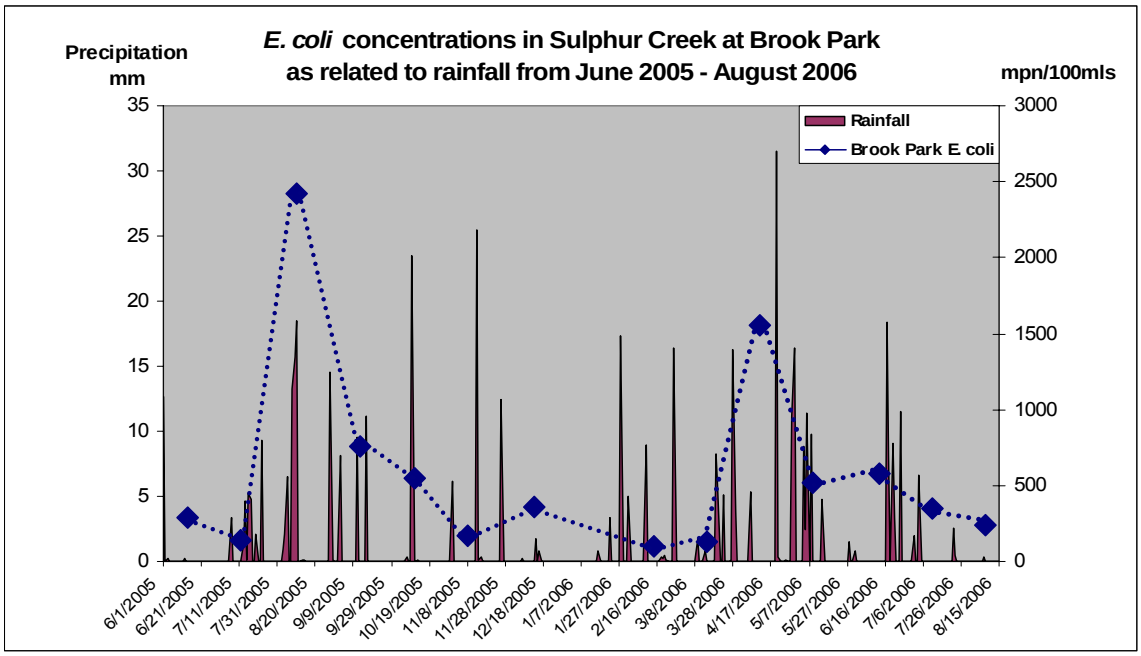
Dissolved oxygen criteria were achieved based on the results of the 24 hour DO study conducted at station 15250. Grab samples analyzed for DO concentrations were evaluated against the TCEQ standard criteria of 5.0 mg/l and the TCEQ absolute minimum criteria of 3.0 mg/l. Sulphur Creek is assigned a high Aquatic Life Use designation by TCEQ. This designation is also supported by the results of the biological assessment conducted as a part of this study. Grab sample analyses for dissolved oxygen exhibited intermittently low levels of dissolved oxygen at stations 18782, 18783

and 15780 respectively (see Figure 1). The means and median values at stations 18782 and 15780 were both above the DO criteria of 5.0 mg/l; however, greater than 25% of samples were below the 5.0 mg/l standard (see Appendix A). The mean and median value of station 18783 was also above the TCEQ DO criteria of 5.0 mg/l; however, 13% of samples fell below the TCEQ absolute minimum DO criteria of 3.0 mg/l. Data results from station 15766 were rejected because of concerns about data quality. As expected, samples taken from the springs' inflow contained very low levels of oxygen.

The *E. coli* standard criterion for a single sample is 394 mpn/100ml.

Based on limited data results (Appendix B), elevated levels of *E. coli* exist at stations 18783 and 18760. *E. coli* concentrations at both sites appear to be influenced by one wet weather event that occurred in August of 2005 (see Appendix B and Figures 2 and 3). Rainfall totals from the 8th of August through the 10nth of August measured 1.9 inches and correspond with E. coli concentrations greater than 2420 MPN/100ml.

Figure 2



When considering all sites located along Sulphur Creek (excluding 18784 located off channel), *E. coli* results ranged from 770 mpn/100ml to 2420 mpn/100ml for the 8th of August 2005. Throughout the study, bacteria levels were found to be consistently higher at sites 18783 and 18760 than other monitoring stations. Other wet weather events in October 2005 and May 2006 also correspond to elevated levels of *E. coli* at stations 18783 and 18760. However, the results of many sample events at stations 18783 and 18760 indicate elevated *E. coli* concentrations that cannot be attributed to runoff conditions (see Table 4). Non-point contributions from animal waste may be the cause of the elevated levels of bacteria documented between the US 183 bridge and the Lampasas WWTP. It is possible that the resident population of domesticated waterfowl

residing in and around Brook Park is one of the significant sources of *E. coli* contamination. In addition, colonies of Cliff swallows often nest in large numbers under highway overpasses and prefer to be near water. Swallow colonies under the US Highway 183 bridge could be a source of *E. coli* contamination, particularly at the Brook Park station located immediately downstream of the bridge. Fecal waste left behind by pets that visit Brook Park also may contribute to the elevated levels of *E. coli*. Septic infiltration along Sulphur Creek in downtown Lampasas is not a likely contributor to elevated *E. coli* as sewage treatment is provided for the city by the operators of the Lampasas WWTP.

Figure 3

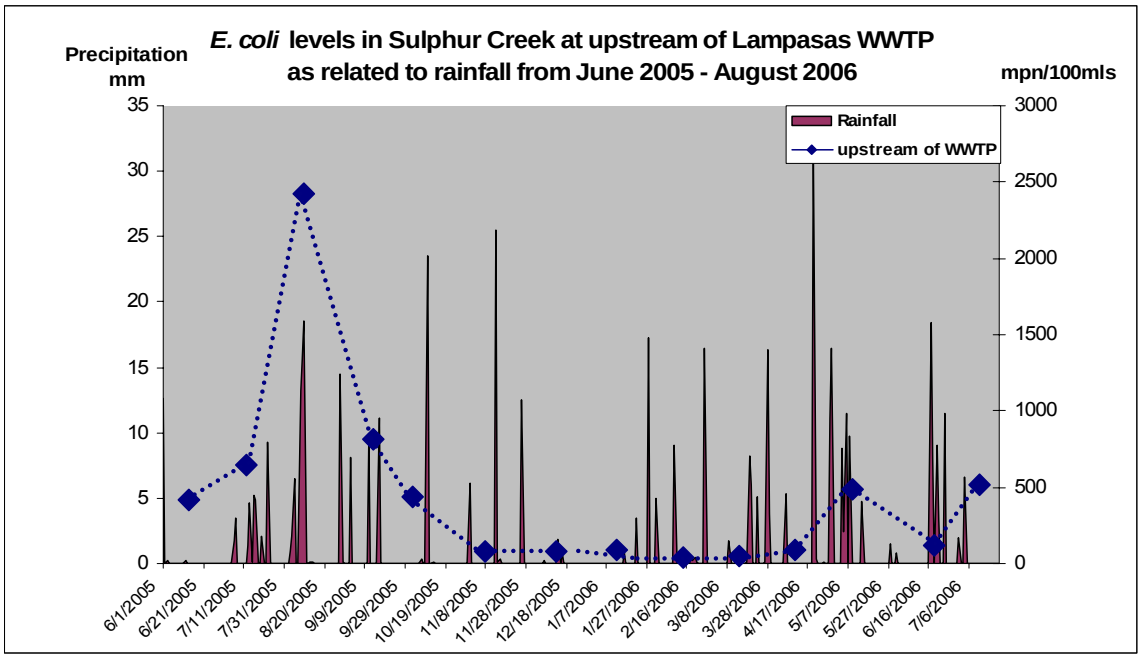


Table 4. Elevated *E. coli* levels measured after significant rainfall events in Sulphur Creek at Brook Park and upstream of Lampasas WWTP

Rainfall event duration	Rainfall (in)[a]	Date of sample event	Station 18783 *E. coli* MPN/100ml	Station 18760 *E. coli* MPN/100ml
-	0	14 June 2005	285	416
-	0	12 July 2005	137	649
8 – 10 August 2005	1.87	10 August 2005	>2420	>2420
-	0	13 Sept. 2005	756	816
-	0	3 Oct. 2005		435
10th August	0.92	11 Oct 2005	548	
-	0	11 April 2006	1553	91
4 – 8 May	1.27	9 May 2006	517	488
-	0	13 June 2006	579	
17 June – 18 June[b]	1.04	19 June 2006		116
-	0	11 July 2006	344	517

[a] Precipitation data provided by Texas A&M Texas Weather Connection website at http://webgis.tamu.edu

[b] Rainfall of one inch with no corresponding elevation of *E. coli*

The chloride/dissolved solids issues that were documented during the study are the likely result of a concentration effect in a spring driven system during a chronic drought. The bacteria levels at the station in Brooks Park (18783) and upstream of the Lampasas WWTP (18760) are likely related to general non-point contributions and possibly the domestic waterfowl located in Brook Park. Bacteria concentrations were typically below the TCEQ's criteria throughout this study; however, when significant runoff occurs with a storm event, bacteria concentrations can be elevated as is observed in streams under similar conditions throughout the state. As discussed above, oxygen levels were intermittently low downstream of the Naruna Road, Brook Park, and downstream of the Lampasas WWTP. The occasional low dissolved oxygen concentrations are likely attributable to low flow conditions during the Texas summer as well as influence from ground water.

Concentrations of nitrate and orthophosphate were below secondary screening level as currently defined by TCEQ.

Targeted Monitoring Events

No targeted monitoring sampling was conducted during the study period. Initiation of targeted monitoring was at the discretion of FOSC members based on prior observations. According to the members, foaming events like those that were described by volunteers in years past did not occur during the study period or were not deemed representative of "typical" foaming events in the past.

Biological Assessment Results

Biological assessments were conducted on Sulphur Creek at Lampasas County Road 3050 (station 15250) on May 31st and September 29th in 2005. The May survey was conducted during the TCEQ defined Index Period and the September survey was conducted in the TCEQ defined Critical Period. Biotic indices were calculated that measured the quality of the stream's biotic communities at the time of data collection.

Fish collections were performed using electro-fishing and seining methods. This study utilized the regionalized IBI format which is based on data collected from specific ecoregions in Texas.

Table 5. 2005 Sulphur Creek Biological Assessment Results – Station 15250

Study Period	Habitat	Benthic	Fish	DO mean	DO min
Index (May)	Intermediate	High	Exceptional	Exceptional	Exceptional
Critical (Sept)	High	Exceptional	Exceptional	Exceptional	Exceptional

During the index period assessment conducted in May, 22 species of fish were collected. Fish collections were typical and consisted, in part, of three species of sunfish, Spotted bass, Guadalupe bass, Channel catfish, and Flathead catfish. Four intolerant species were collected, including the Dusky darter, Texas logperch, Mimic shiner, and Guadalupe bass. The index period collection resulted in a regional IBI score of 58 which indicates Exceptional Aquatic Life Use as defined by the State of Texas (*Draft Surface Water Quality Monitoring Procedures, Vol. 2: Methods for Collecting and Analyzing Biological Community and Habitat Data* (TCEQ 2005).

During the critical period assessment conducted during September, 21 species of fish were collected. Again, fish collections were typical and consisted, in part, of three species of sunfish, Spotted bass, Channel catfish, and Flathead catfish. Two intolerant species were collected including the Dusky darter and the Mimic shiner. The regional IBI score was calculated as 54 which is consistent with Exceptional Aquatic Life Use as defined by the State of Texas.

Station 15250 - Sulphur Creek at CR 3050, September 2005

Dissolved oxygen criteria were achieved and rated as exceptional for both study periods. The benthic macroinvertebrate community rated in the high aquatic life use category during the index period and as exceptional during the critical period. Aquatic life use was attained by the benthic macroinvertebrate community during both events, despite the fact that physical habitat rated only intermediate during the May index period. All results reflected healthy environmental conditions and there were no discernible impacts from the domestic wastewater discharge located upstream of the site location.

Recommendations

The routine water quality and biological monitoring data collected under this special study are consistent with prior data results collected since 1998. Due to the lack of targeted monitoring as planned for in this special study, it is not possible to determine if observations such as turbidity, flow, algae, or presence of foam correlates with water quality constituents and/or the presence of pollutants.

Based on the study results, two additional monitoring stations on Sulphur Creek (18783 and 18760) are recommended to better define water quality conditions relative to elevated chlorides, TDS, and a possible concern for *E. coli*.

The Clean Rivers Program will continue to be a forum for the local stakeholders to exchange information with agencies involved in environmental protection. To the extent the FOSC members choose to continue volunteer monitoring, this information may be presented to the CRP Steering Committee, along with routine water quality data collected by BRA staff, in identifying areas of concern and priorities for future studies.

Insert Appendix A:

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Appendix B. *E. Coli* Data for Sulphur Creek Study *E.coli* units in MPN/100ml

E. coli	Sulphur Creek Naruna Rd – Station 18782	Hancock Springs – Station 18787	Sulphur Creek at Golf Cart X - Station 15766	Sulphur Creek at Brook Park – Station 18783	Sulphur Creek Upstrm WWTP Station 18760	Sulphur Creek Dwnstrm of WWTP - Station 15780	Sulphur Creek at CR 7 Sparks X - Station 15781	Sulphur Creek at Deadmans Cut - Station 16358	Sulphur Creek @ CR 3050 – Station 15250	Hannah Springs – Station 18784
Collect Date										
8-Jul-2002									344	
5-Aug-2002									96	
19-Sep-2002									194	
25-Nov-2002									1733	
10-Dec-2002									326	
15-Jan-2003									98	
4-Feb-2003									119	
5-Mar-2003									153	
31-Mar-2003									40	
5-May-2003									32	
5-Aug-2003									15	
14-Oct-2003									13	
19-Apr-2004									36	
8-Jul-2004									12	
7-Oct-2004									30	
7-Oct-2004									206	
25-Jan-2005					104				108	
8-Mar-2005					387				291	
11-Apr-2005					344				727	
10-May-2005					240				86	
14-Jun-2005	20	37	28	285	416	108	54		32	36
12-Jul-2005	2	816	129	137	649	93	155	25	33	1
10-Aug-2005	1986	1553	770	>2420	>2420	2420	1046	2420	>2420	15
13-Sep-2005	5	6	8	756	816	130	76	75	88	<1
3-Oct-2005					435				35	
11-Oct-2005	24	23	25	548		124	166			<1

8-Nov-2005	8	4	20	172	79	<1	66	49	34	
13-Dec-2005	47	<1	15	361	78	112	64	66	50	<1
12-Jan-2006	11		16		89		152	91	74	
14-Feb-2006	49	<1	78	96	36	82	142	138	192	<1
14-Mar-2006	22	<1	24	133	47	125	111	166	61	<1
11-Apr-2006	16	<1	249	1553	91	157	49	125	37	<1
9-May-2006	649	<1	31	517	488	249	345	182	134	<1
19-Jun-2006	11	<1	18	579	116	579	29	44	11	<1
11-Jul-2006	14	2	42	344	14	195	32	31	12	<1
16-Aug-2006	18	4	15	240	18	74	11	19		<1