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MONITORING RESULTS

FOR

LAKE HOUSTON WATERSHED BACTERIA IMPAIRMENTS

SAN JACINTO RIVER BASIN

SEGMENTS:

1002	**LAKE HOUSTON**
1003	**EAST FORK SAN JACINTO**
1004	**WEST FORK SAN JACINTO**
1004D	**CRYSTAL CREEK**
1004E	**STEWARTS CREEK**
1008	**SPRING CREEK**
1008B	**UPPER PANTHER BRANCH**
1008H	**WILLOW CREEK**
1009	**CYPRESS CREEK**
1009C	**FAULKEY GULLY**
1009D	**SPRING GULLY**
1009E	**LITTLE CYPRESS CREEK**
1010	**CANEY CREEK**
1011	**PEACH CREEK**

Prepared For:

Texas Commission on Environmental Quality (TCEQ)
Austin, Texas

Prepared By:

James Miertschin & Associates, Inc.

October 2008

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LAKE HOUSTON WATERSHED BACTERIA IMPAIRMENTS

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1.0 INTRODUCTION

1.1 BACKGROUND

Several stream segments of the San Jacinto River Basin above Lake Houston have been identified as impaired due to high bacteria levels (*E. coli*) that exceed the state criteria for contact recreation. The Texas Commission on Environmental Quality (TCEQ) has included these segments on the 303(d) List under Category 5a, meaning that a Total Maximum Daily Load (TMDL) can be scheduled immediately, and Category 5c, meaning that additional data will be collected before a TMDL is scheduled (TCEQ, 2008). A complete list of the impaired segments is provided in Table 1-1. In this table, the segments shown in bold are primary segments, and the segments with alphabetic suffixes are subsegments (tributaries of the primary segments). The locations of the primary segments are shown in Figure 1-1.

Table 1-1: Impaired Segments

Segment Number	Segment Name	303(d) Category
1002	**Lake Houston**	5a
1003	**East Fork San Jacinto**	5a
1004	**West Fork San Jacinto**	5a
1004D	Crystal Creek	5a
1004E	Stewarts Creek	5a
1008	**Spring Creek**	5a
1008B	Upper Panther Branch	5a
1008H	Willow Creek	5a
1009	**Cypress Creek**	5a
1009C	Faulkey Gully	5c
1009D	Spring Gully	5c
1009E	Little Cypress Creek	5a
1010	**Caney Creek**	5a
1011	**Peach Creek**	5a

The TCEQ, with assistance from James Miertschin & Associates, Inc. (JMA), is in the process of developing TMDLs for each of these impaired segments. As part of this effort, water quality monitoring activities have been performed to help identify potential sources of bacteria contamination and to provide additional data for determining TMDL allocations. The monitoring activities have included the collection of bacteria samples throughout each of the impaired segments (except Lake Houston).

The purpose of this report is to describe the monitoring work that has been performed and the data that have been collected. The remainder of Section 1.0 describes the scope and purpose of the monitoring activities. Sections 2.0 through 7.0 present the monitoring data collected for each of the impaired segments. Section 8.0 provides a summary of the monitoring results for the entire Lake Houston watershed.

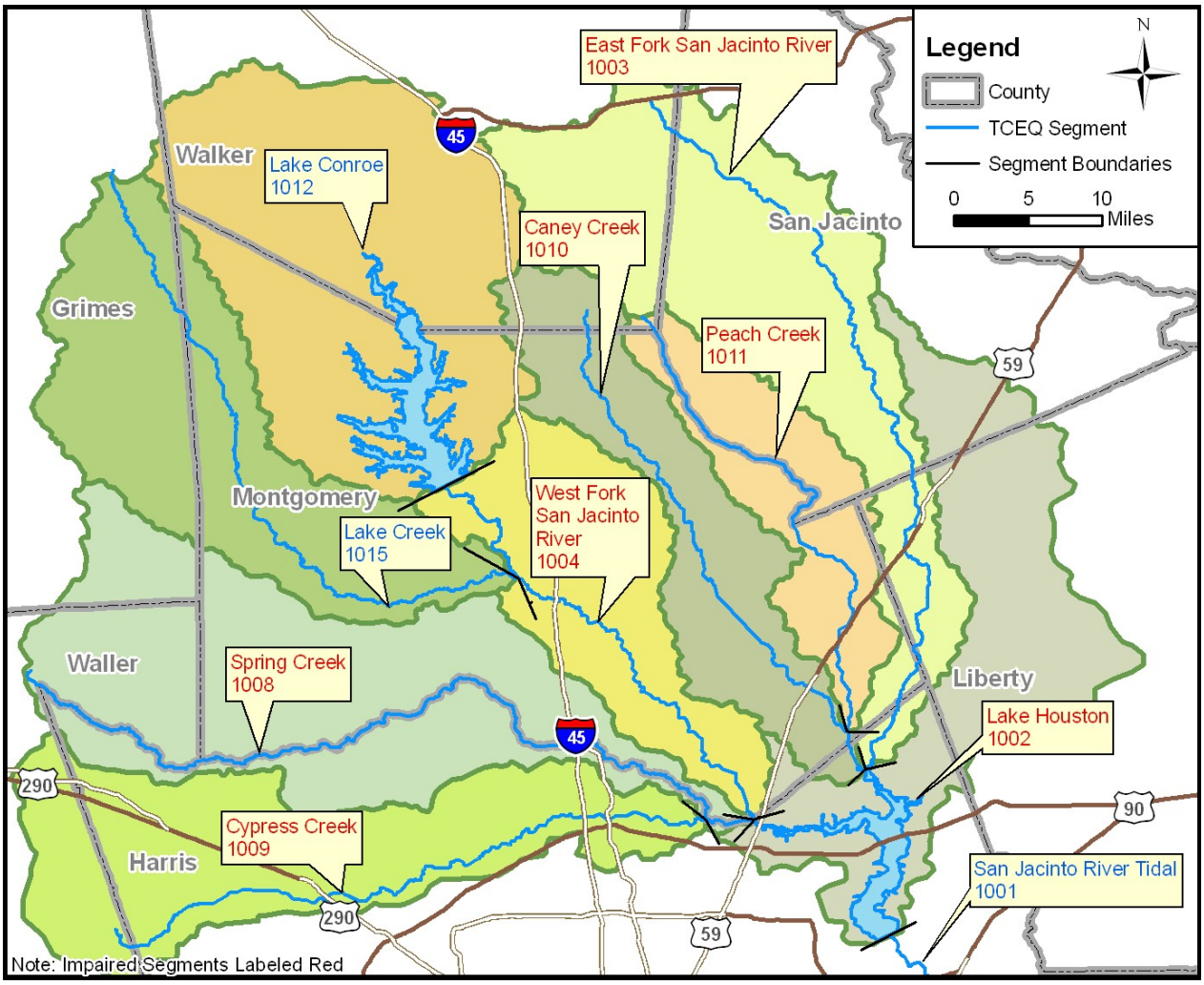

Figure 1-1: Segments of Project Study Area

1.2 MONITORING PLAN

The scope of the monitoring activities was developed in a TCEQ-approved Monitoring Plan (JMA 2007a). In general, the monitoring plan included activities to assess the extent of impairment, provide data to support the technical analysis of problems, identify potential sources of contamination, and support the determination of loadings essential to TMDL development.

The Monitoring Plan recognized that a significant amount of bacteria data already exists throughout the TMDL study area. A summary of the historic data can be found in the *Preliminary Data Review: Lake Houston Watershed Bacteria Impairments* (JMA 2007b). Most of the historic bacteria monitoring stations include a comprehensive dataset of bacteria sampling results. The stations generally provide good definition of bacteria levels under different hydrologic and seasonal conditions. However, the spatial coverage of the stations is somewhat limited. Therefore, the monitoring plan included numerous sampling surveys with spatially dense sampling.

1.2.1 Synoptic Sampling Surveys

The synoptic sampling surveys made up the largest portion of monitoring effort. Synoptic sampling involved the occupation of a comprehensive network of stations along the longitudinal extent of each segment. Major tributaries and selected point source contributors were also sampled. This type of monitoring was performed under baseflow conditions, which provided the most realistic opportunity to define specific reaches of the streams, tributaries, or point sources that are contributing bacteria. (It is a foregone conclusion that under runoff conditions, bacteria concentrations will be elevated across the entire survey area.) Two synoptic sampling surveys were conducted under baseflow conditions on each study segment (including subsegments).

1.2.2 Spatially Intensive Source Surveys

The spatially intensive studies were designed to cover relatively small watersheds with numerous sampling points to better define potential sources of bacteria. For these surveys, the sampling density was even greater than that of the synoptic sampling surveys. Furthermore, all flowing tributaries, point sources, and outfall pipes were sampled so long as they were accessible. As with the synoptic surveys, these surveys were performed under baseflow conditions. Because of the intensive nature of these surveys, it was not economically feasible to perform them on all segments. Instead, four watersheds were selected for spatially intensive studies:

- Upper East Fork San Jacinto River, Segment 1003, representing a largely rural area;
- Stewarts Creek, Segment 1004E, representing an urbanized area without permitted wastewater treatment facilities discharges;
- Willow Creek Segment 1008H, representing both a relatively rural area with septic systems and an urbanized area with numerous permitted wastewater treatment facilities; and
- Spring Gully Segment 1009D, representing a densely urbanized area with permitted wastewater treatment facilities.

The spatially intensive surveys included some additional monitoring activities:

Sediment Source Studies

Keen interest has been expressed in past studies regarding the role of sediment as a source of bacteria in impaired waterbodies. Therefore, a sediment source study was conducted in conjunction with each spatially intensive study (upper East Fork San Jacinto, Stewarts Creek, Willow Creek, and Spring Gully). The sediment source studies involved the collection of sediments within the stream bed and at radial distances from the edge of water along the stream bank. Samples were analyzed in the laboratory by mixing a measured weight of sediment with buffered water, mixing, then determining bacteria concentrations. The bacteria data were transformed to organism counts per unit weight of dry sediment.

Resuspension Studies

The resuspension of sediments from the stream channel bottom is another potential source of bacteria loadings in impaired segments. The objective of the resuspension study was to estimate the bacteria concentration that can be potentially released from the sediment upon disturbance, and then determine the gross fate of the resuspended bacteria. Two sites were selected for the experiment, in conjunction with spatially intensive studies: Willow Creek and Spring Gully. For these studies, a defined area of the streambed was vigorously disturbed by raking, in order to

resuspend the upper layer of deposited sediment. At the time of disturbance, dye was released as a hydrodynamic tracer, which could be tracked as it moved downstream. Bacteria samples were collected immediately after streambed disturbance and as the plume moved downstream.

Kinetics Studies

Bacteria regrowth in the stream environment has been hypothesized in previous bacteria studies. The existence/absence of regrowth of bacteria from municipal effluent discharges has received particular attention. Special studies were conducted at one location on Willow Creek and at one location on Spring Gully, in conjunction with spatially intensive studies, to provide additional information and data regarding this aspect of bacteria kinetics. Chambers of effluent, in combination with receiving water, were set up within the stream environment, maintained intact, and tested at regular intervals for bacteria concentrations.

1.2.3 Wet Weather Point Source Sampling

A wet weather point source survey was conducted on Willow Creek, Segment 1008H, to determine the actual discharge bacteria concentrations from wastewater treatment facilities (WWTFs) under wet weather conditions. Sampling of wastewater treatment facilities was conducted at the discharge points that were accessible outside of the fenced boundaries of the facilities (as was typical for synoptic and spatially intensive surveys). Sampling was also performed at a downstream monitoring station (Gosling Road) for comparison to the point source data.

1.3 MONITORING SCHEDULE

A Quality Assurance Project Plan (QAPP) for the monitoring activities was approved by TCEQ on 3 October 2007 (JMA, 2007c). Following QAPP approval, monitoring activities could commence. The first round of synoptic surveys was completed in November 2007. The spatially intensive and wet weather studies were completed from February through May 2008. The second round of synoptic surveys was completed in June 2008. Table 1-2 presents the dates of sampling for all synoptic, spatially intensive, and wet weather sampling.

Table 1-2: Sampling Schedule

Survey Type	Segments Surveyed	Sampling Dates
1st Round (Nov.) Synoptics	1003, 1010, 1011	1-2 Nov 2007
1st Round (Nov.) Synoptics	1004, 1004D, 1004E, 1008, 1008B, 1008H, 1009, 1009C, 1009D, 1009E	7-9 Nov 2007
Wet Weather Point Source	1008H (Willow Crk)	12 Feb 2008
Spatially Intensive	1003 (Upper East Fork)	27 Feb 2008
Spatially Intensive	1009D (Spring Gully)	25-27 Mar 2008
Spatially Intensive	1004E (Stewarts Crk)	24 Apr 2008
Spatially Intensive	1008H (Willow Crk)	13-14 May 2008
2nd Round Synoptics	1003, 1010, 1011, 1004D	4-5 Jun 2008
2nd Round (June) Synoptics	1004, 1004E, 1008B	13 Jun 2008
2nd Round (June) Synoptics	1008, 1008H, 1009, 1009C, 1009D, 1009E	18-19 Jun 2008

1.4 METHODS

The monitoring and analytical methods for this study are described, at length, in a QAPP approved by TCEQ on 3 October 2007 (JMA, 2007c). Key aspects of this plan are provided below.

Bacteria samples were analyzed by North Water District Laboratory Services, Inc. (NWDLS), located in The Woodlands, Texas. Samples were analyzed for *E. coli* bacteria using the Modified mTEC method (EPA Method 1603, Standard Method 9213D). Samples were collected in sealed, sterilized bottles containing sodium thiosulfate to neutralize any chlorine residual present in the water. Regular samples were collected in 120 mL bottles, and duplicate samples were typically collected in 275 mL bottles. At least one duplicate sample was collected for every nine regular samples, in accordance with TCEQ's *Surface Water Quality Monitoring Procedures* (2003).

The precision of the sample collection and analysis process was confirmed through the occasional collection of blind duplicate samples. These samples were collected from the same location but with separate 120 mL bottles. The bottles were filled directly from the stream, one immediately following the other. The second sample was arbitrarily named so that the laboratory would not know that it was a duplicate sample.

The results for duplicate samples (regular and blind) are presented in the Appendix.

Field parameters were collected at most sampling locations. Temperature and conductivity data were measured using Hanna handheld probes (model HI-98311). For conductivity, the probe was calibrated and validated on a daily basis using a standard solution of 1413 µS/cm. The temperature measurement function of the probe was checked against a National Institute of Standards and Technology (NIST) certified thermometer.

Chlorine samples were taken at almost all WWTF outfalls, and at many stream stations where chlorine residual was likely to be present. Total chlorine was measured in the field using a Hach test kit (model CN-70).

Optical brighteners were measured in the field using a Turner Aquafluor handheld fluorometer (model 8000-010). Optical brighteners were measured during the intensive surveys in areas upstream of WWTF discharges.

Flows were generally measured with a Pygmy (propeller-style) Meter. Where flows were too small to be metered, flow estimates were taken. Flow measurements were obtained at most pipe outfalls using timed deliveries (bucket and stopwatch). Approximate flows from WWTFs were determined by contacting the facility operator and requesting the daily flow for the date the sample was collected. At sampling sites with United States Geological Survey (USGS) stations, approximate flows were determined based on the provisional USGS stream gaging data.

2.0 EAST FORK SAN JACINTO RIVER, SEGMENT 1003

2.1 NOVEMBER 2007 SYNOPTIC SURVEY

A synoptic survey of the East Fork San Jacinto River was performed on 1 November 2007. As shown in Figure 2-1, several locations throughout the East Fork San Jacinto River Basin were sampled during this survey. Detailed sampling results for these stations are presented in Table 2-1. A longitudinal profile of bacteria concentrations can be found in Figure 2-2, and a similar plot of flow and conductivity data can be found in Figure 2-3.

Prior to the survey, the last significant rainfall occurred on 22 October. On this date, 0.48 inches of rainfall were recorded at the East Fork USGS Gage near Cleveland, and 0.83 inches at the Conroe Airport.

In the upper portions of the basin (State Highway 150 and above), very little flow was observed. At the most upstream station, EFSJ02, the East Fork appeared to be little more than a ditch, and little flow was present. Bacteria counts at these upper stations (EFSJ02, EFSJ01, 17431, and EFSJ04) were fairly high, and one sample exceeded the grab sample criterion of 394 cfu/100mL.

In the central portion of the basin (below SH 150 and above Cleveland), flows were significantly higher and conductivity levels were markedly lower in both the East Fork and Winters Bayou. These high flows and low conductivities suggest some natural source of baseflow (this flow source also appears to contribute to Peach Creek and Caney Creek at roughly the same latitude). However, bacteria counts were also higher, and all stations in this area (11237, 11238, and EFSJ03) exceeded the grab sample criterion.

Due to time constraints, the sample at the Cleveland WWTF (EFSJ05) was collected a day later than the rest of the stream samples; and it was collected at the end of the facility's chlorine contact tank, instead of at the end of the discharge pipe. Regardless, the low bacteria count at this location indicates that complete disinfection was achieved.

Below Cleveland, bacteria counts varied considerably, ranging from 16 to 1,227 cfu/100mL at sites 14242, 11236, and 11235.

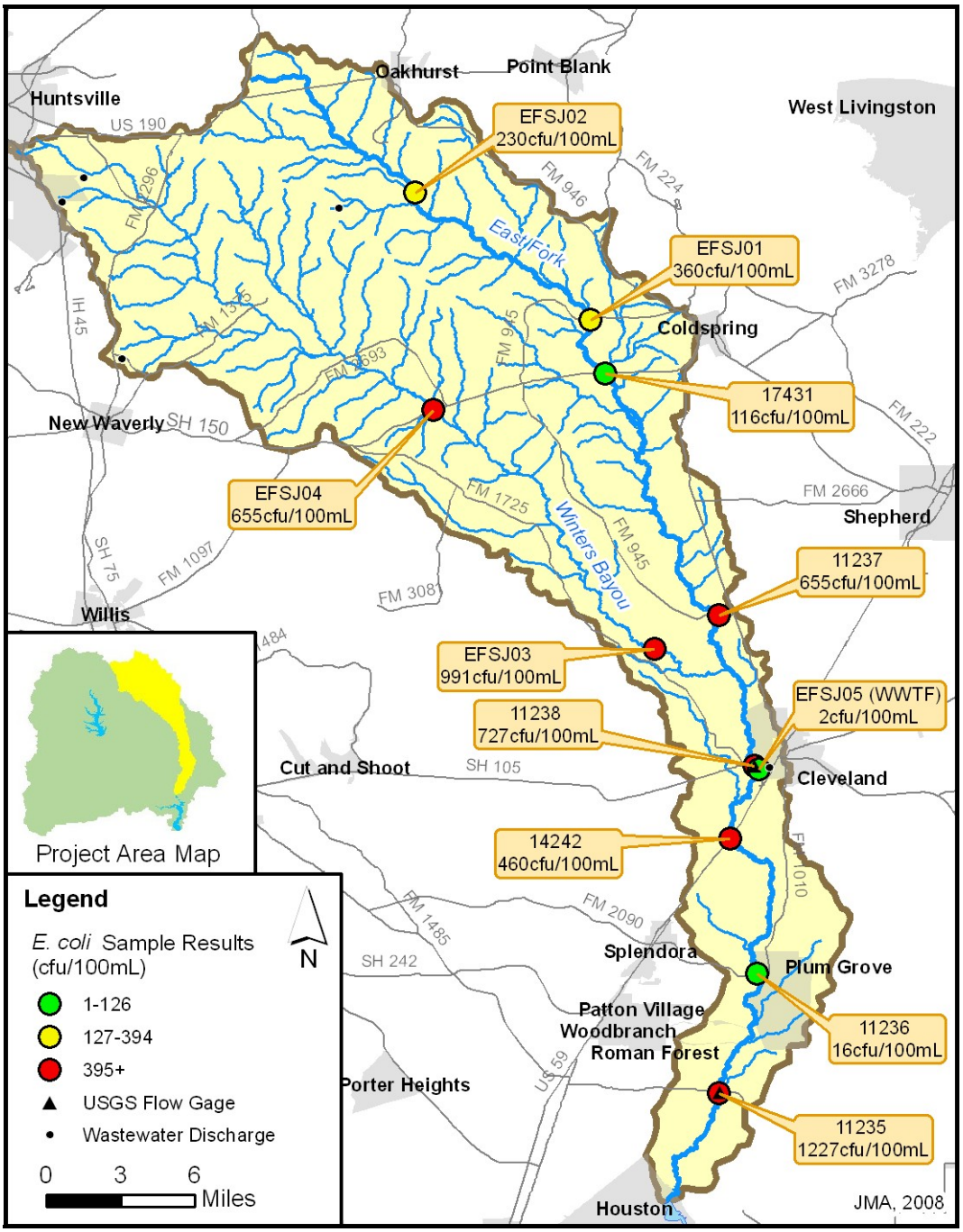

Figure 2-1: East Fork (Seg. 1003) Synoptic Survey Map, Nov. 2007

Table 2-1: East Fork (Seg. 1003) Synoptic Survey Results, Nov. 2007

Station	Station Type	Description	Station Mile	Sample Date	Sample Time	*E. coli* (cfu/100mL)	Flow Est. (cfs)*	Flow** Severity	Temp (C)	Cond (µS/cm)	Total Cl2 (mg/L)
EFSJ02	main stem	Jenkins Rd	64.1	1-Nov-07	16:40	230	< 0.1	2	17.6	275	-
EFSJ01	main stem	FM 945	53.6	1-Nov-07	15:44	360	-	3	17.0	348	-
17431	main stem	SH 150	50.1	1-Nov-07	17:14	116	0.07	2	18.5	329	-
11237	main stem	FM 945	33.9	1-Nov-07	17:38	655	*10*	3	17.7	131	-
EFSJ04	tributary	SH 150	30.3	1-Nov-07	14:55	655	< 1	3	17.6	265	-
EFSJ03	tributary	Shell Oil Rd	30.3	1-Nov-07	14:20	991	13	3	17.6	94	-
11238	main stem	SH 105	25.2	1-Nov-07	17:20	727	27	3	19.0	129	-
EFSJ05	WWTF	Cleveland	25.1	2-Nov-07	12:32	2	0.74	-	25.8	695	-
14242	main stem	US 59	21.5	1-Nov-07	16:55	460	-	3	19.2	144	-
11236	main stem	FM 2090	13.3	1-Nov-07	16:20	16	-	3	18.4	148	-
11235	main stem	FM 1485	6.5	1-Nov-07	15:40	1227	33	3	19.1	147	-

*Flow Estimates in *italics* were calculated based on nearby flow measurements

**1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

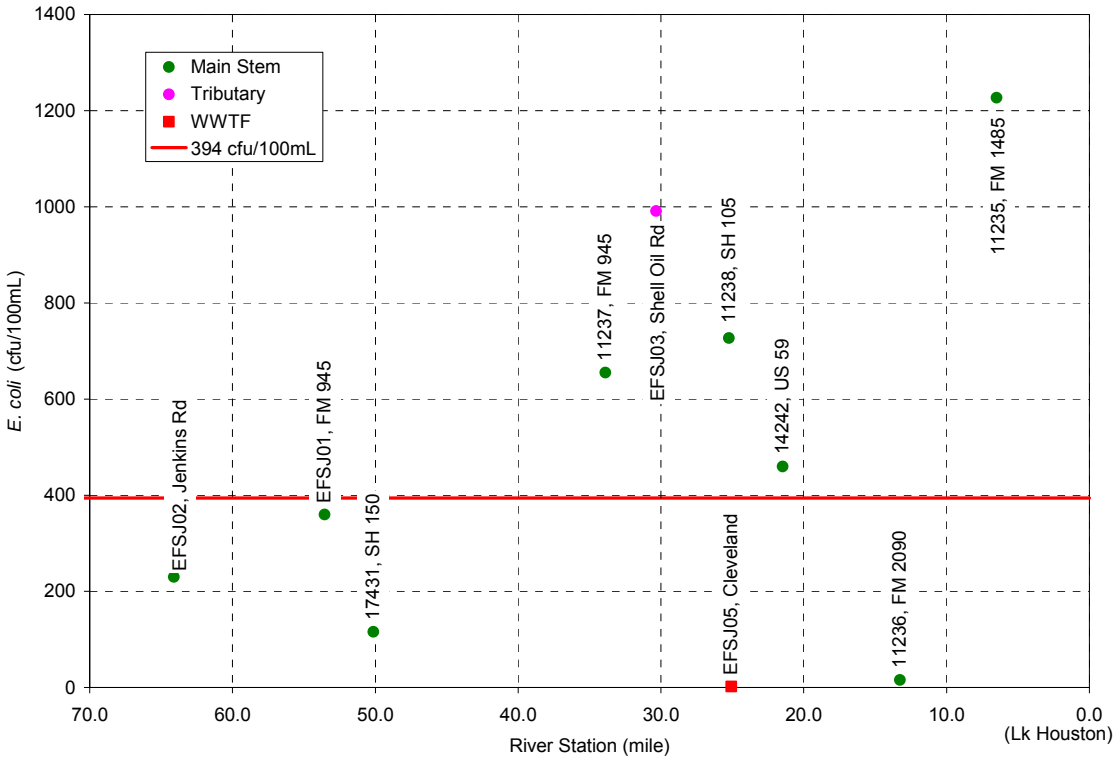

Figure 2-2: East Fork (Seg. 1003) Synoptic *E. coli* Profile, Nov. 2007

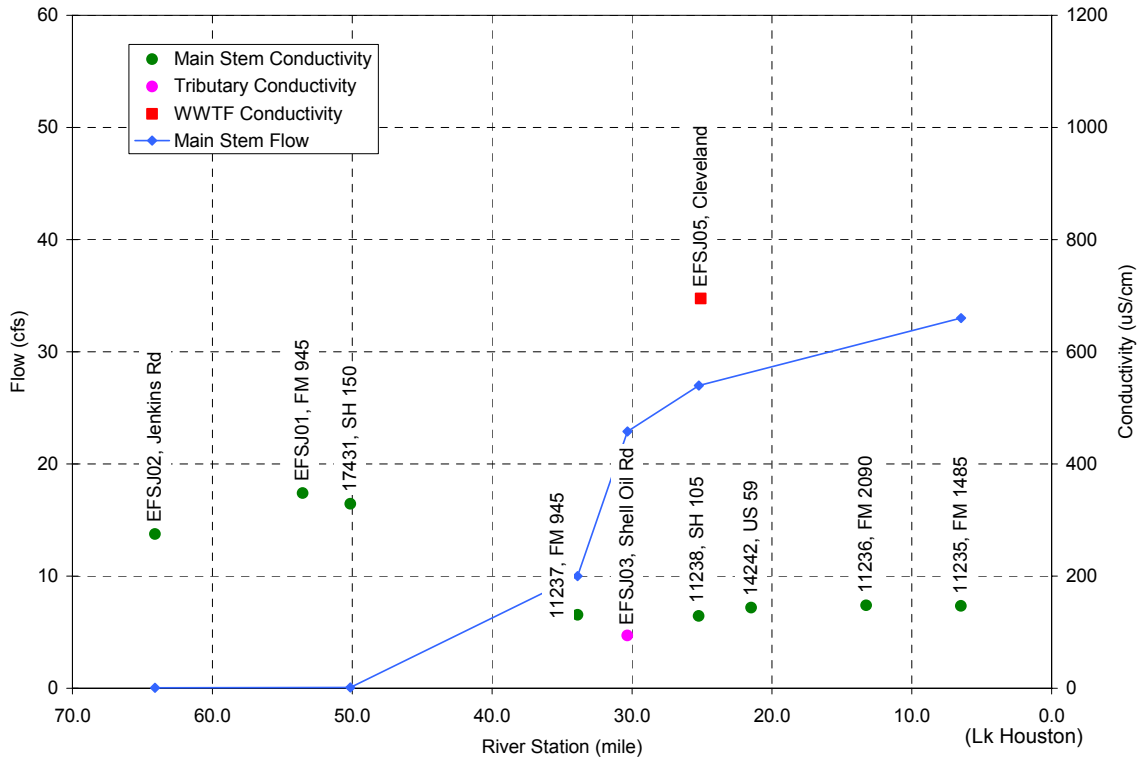

Figure 2-3: East Fork (Seg. 1003) Synoptic Cond. & Flow Profile, Nov. 2007

2.2 JUNE 2008 SYNOPTIC SURVEY

A second synoptic survey of the East Fork San Jacinto River was performed on 4 June 2008. As shown in Figure 2-4, several locations throughout the East Fork San Jacinto River Basin were sampled during this survey. Detailed sampling results for these stations are presented in Table 2-2. A longitudinal profile of bacteria concentrations can be found in Figure 2-5, and a similar plot of flow and conductivity data can be found in Figure 2-6.

Prior to the survey, the last significant rainfall occurred on 27-28 May. On 27 May, 0.38 inches of rainfall were recorded at the Conroe Airport; and on 28 May, 0.9 inches of rainfall were recorded at the East Fork USGS Gage near Cleveland.

In the upper portions of the basin (State Highway 150 and above), very little flow was observed, though more than in the November 2007 survey. Bacteria counts in these upper stations (EFSJ02, EFSJ01, 17431, and EFSJ04) were fairly high, and two samples exceeded the grab sample criterion of 394 cfu/100mL.

In the central portion of the basin (below SH 150 and above Cleveland), flows were significantly higher and conductivity levels were markedly lower in both the East Fork and Winters Bayou. However, bacteria counts were also higher, and all stations in this area (11237, 11238, and EFSJ03) exceeded the grab sample criterion, similar to the November 2007 survey.

Below Cleveland, all samples exceeded the grab sample criterion. A large number of birds were observed to be inhabiting the US 59 Bridge (Site 14242), and so samples were pulled both upstream and downstream of the bridge (instead of just upstream, which is standard protocol). The bacteria count downstream of the bridge was found to be three times higher than the upstream count.

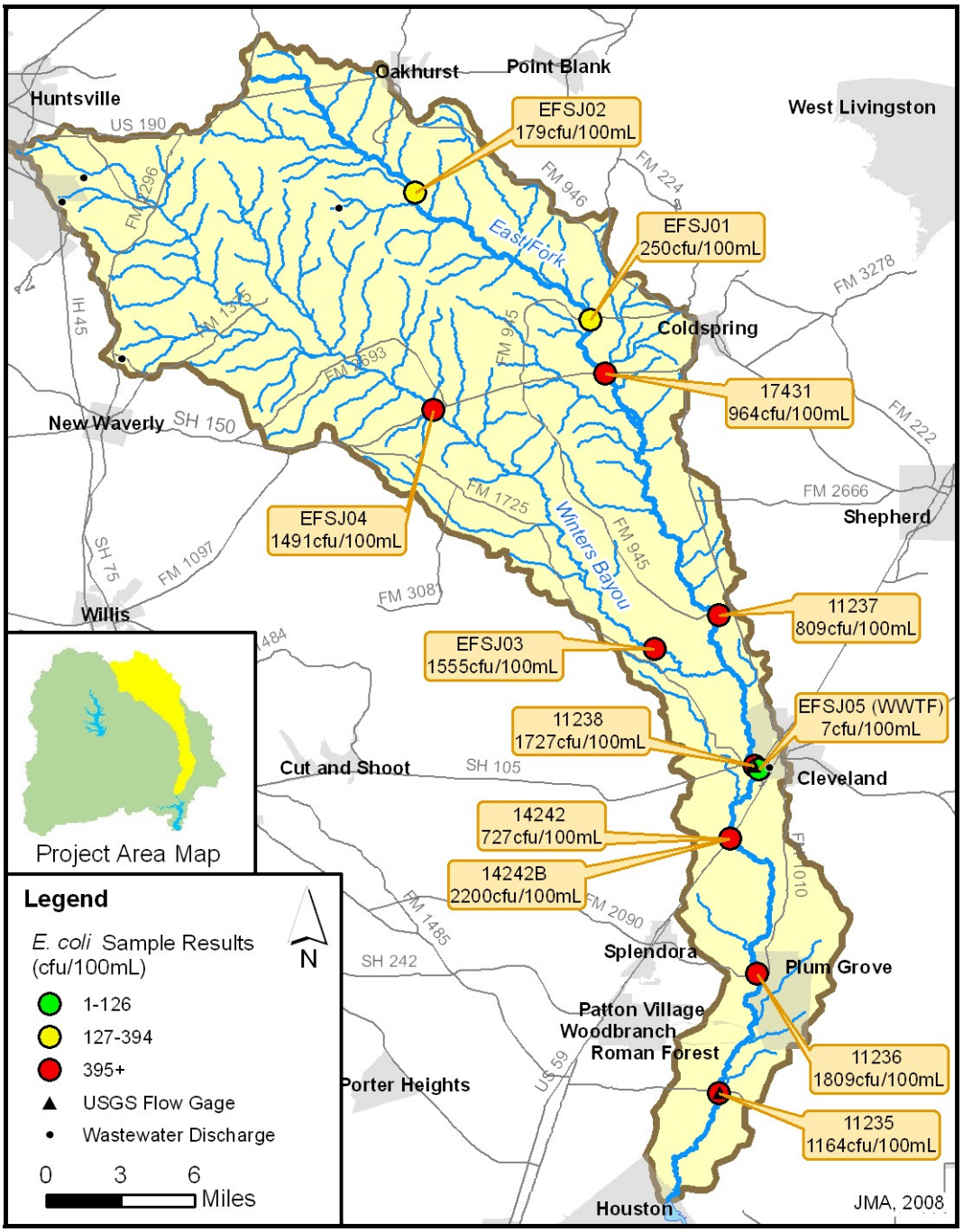

Figure 2-4: East Fork (Seg. 1003) Synoptic Survey Map, June 2008

Table 2-2: East Fork (Seg. 1003) Synoptic Survey Results, June 2008

Station	Station Type	Description	Station Mile	Sample Date	Sample Time	*E. coli* (cfu/100mL)	Flow Est. (cfs)*	Flow** Severity	Temp (C)	Cond*** (µS/cm)	Total Cl2. (mg/L)
EFSJ02	main stem	Jenkins Rd	64.1	4-Jun-08	10:25	179	0.45	3	25.7	465	-
EFSJ01	main stem	FM 945	53.6	4-Jun-08	10:55	250	-	3	25.9	386	< 0.05
17431	main stem	SH 150	50.1	4-Jun-08	11:50	964	0.74	3	26.1	389	< 0.05
11237	main stem	FM 945	33.9	4-Jun-08	9:54	809	*19*	3	25.5	211	< 0.05
EFSJ04	tributary	SH 150	30.3	4-Jun-08	12:25	1491	< 1	3	27.2	*348*	-
EFSJ03	tributary	Shell Oil Rd	30.3	4-Jun-08	9:10	1555	14	3	26.5	180	-
11238	main stem	SH 105	25.2	4-Jun-08	11:08	1727	38	3	27.6	*240*	-
EFSJ05	WWTF	Cleveland	25.1	4-Jun-08	10:51	7	0.47	-	28.4	*1023*	1.60
14242	main stem	US 59	21.5	4-Jun-08	11:35	727	-	3	28.0	*248*	< 0.05
14242B	main stem	d/s of US 59	21.5	4-Jun-08	11:46	2200	-	-	28.0	*248*	< 0.05
11236	main stem	FM 2090	13.3	4-Jun-08	12:15	1809	-	3	27.8	*231*	< 0.05
11235	main stem	FM 1485	6.5	4-Jun-08	12:46	1164	41	3	28.0	*232*	< 0.05

*Flow Estimates in *italics* were calculated based on flow measurements from nearby stations

**1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

***Conductivity values in italics are approximate. Probe did not pass post-calibration check.

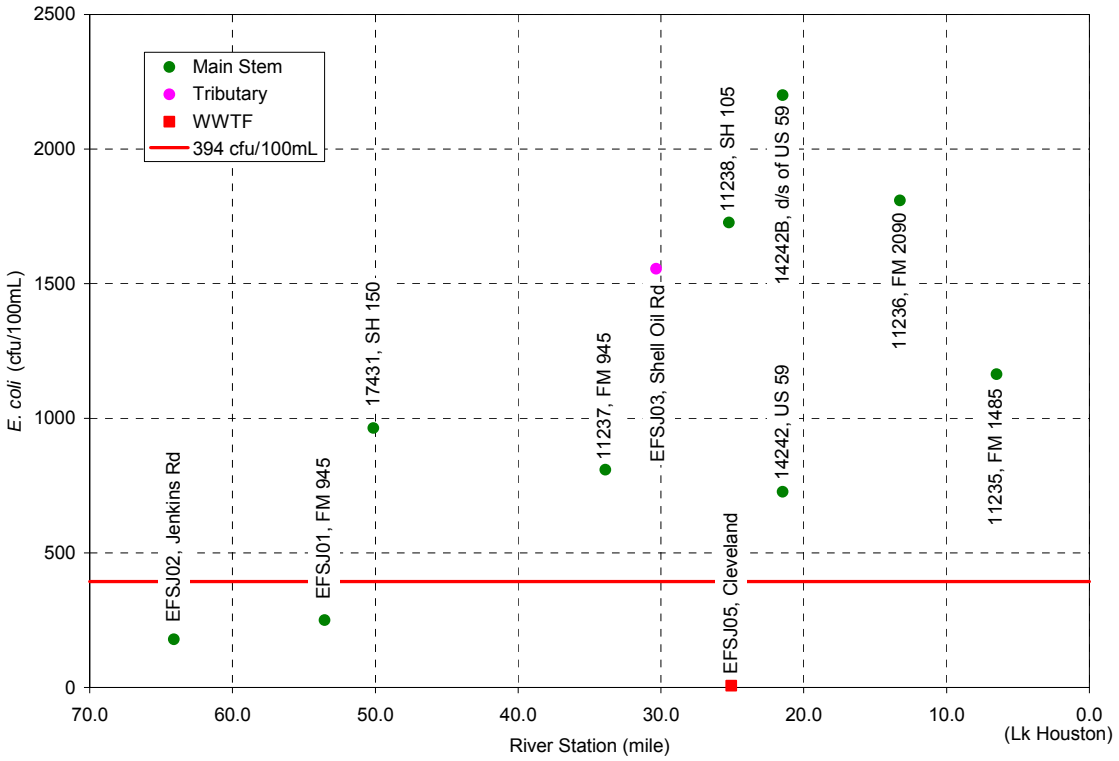

Figure 2-5: East Fork (Seg. 1003) Synoptic *E. coli* Profile, June 2008

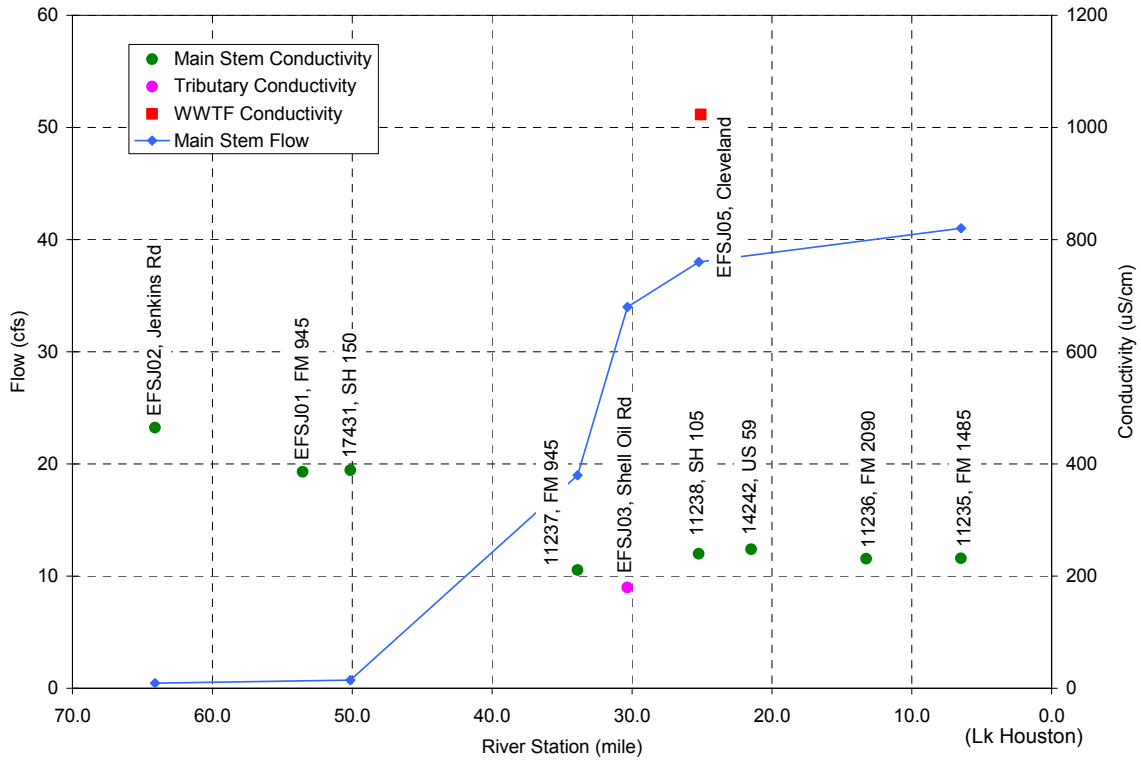

Figure 2-6: East Fork (Seg. 1003) Synoptic Cond. & Flow Profile, June 2008

2.3 SPATIALLY INTENSIVE SURVEY OF THE UPPER EAST FORK

A spatially intensive survey of the Upper East Fork of the San Jacinto River was performed on 27-28 February 2008. The survey extended from FM 945 North to FM 945 South. Twenty-five stations were sampled for *E. coli*. These locations included all points of access to the river and all major tributaries, as shown in Figure 2-7. Complete survey results are tabulated in Table 2-4.

Prior to the survey, the last significant rainfall occurred on 20 February. On this date, 0.4 inches of rainfall were recorded at the USGS Gage near Cleveland, and 0.91 inches at the Conroe airport. Despite the seven days of dry antecedent conditions, baseflows in the East Fork were elevated significantly when compared to the two synoptic surveys. The flow at SH 150, for example, was measured at 30 cfs during the spatially intensive survey, compared with less than one cfs during both of the synoptic surveys.

Bacteria concentrations measured during the spatially intensive survey were typically lower than the concentrations measured during the synoptic surveys. The highest *E. coli* count in the main stem of the river was 360 cfu/100mL, at Site E31, about 2 miles downstream of SH 150. Tributary *E. coli* concentrations varied more widely, and four sites exceeded the grab sample criterion of 394 cfu/100mL. No longitudinal trends in *E. coli* concentrations were apparent from the sampling results.

A sediment source survey was performed in conjunction with the spatially intensive survey. Sediment samples were collected from the east bank of the East Fork, immediately downstream of the FM 945 South. The sampling area was sandy and densely forested with considerable leaf litter covering the ground away from the bank. The samples were taken from the upper layer (approximately half inch) of soil below the leaf litter. The results of this sampling are presented in Table 2-3. The bacteria counts are reported per gram of sediment (dry weight).

Table 2-3: Upper East Fork Sediment Source Sampling Results

Location	*E. coli* (cfu/g)
stream bed	58
water's edge	490
1 ft from edge	630
3 ft from edge	573
10 ft from edge	457
50 ft from edge	273

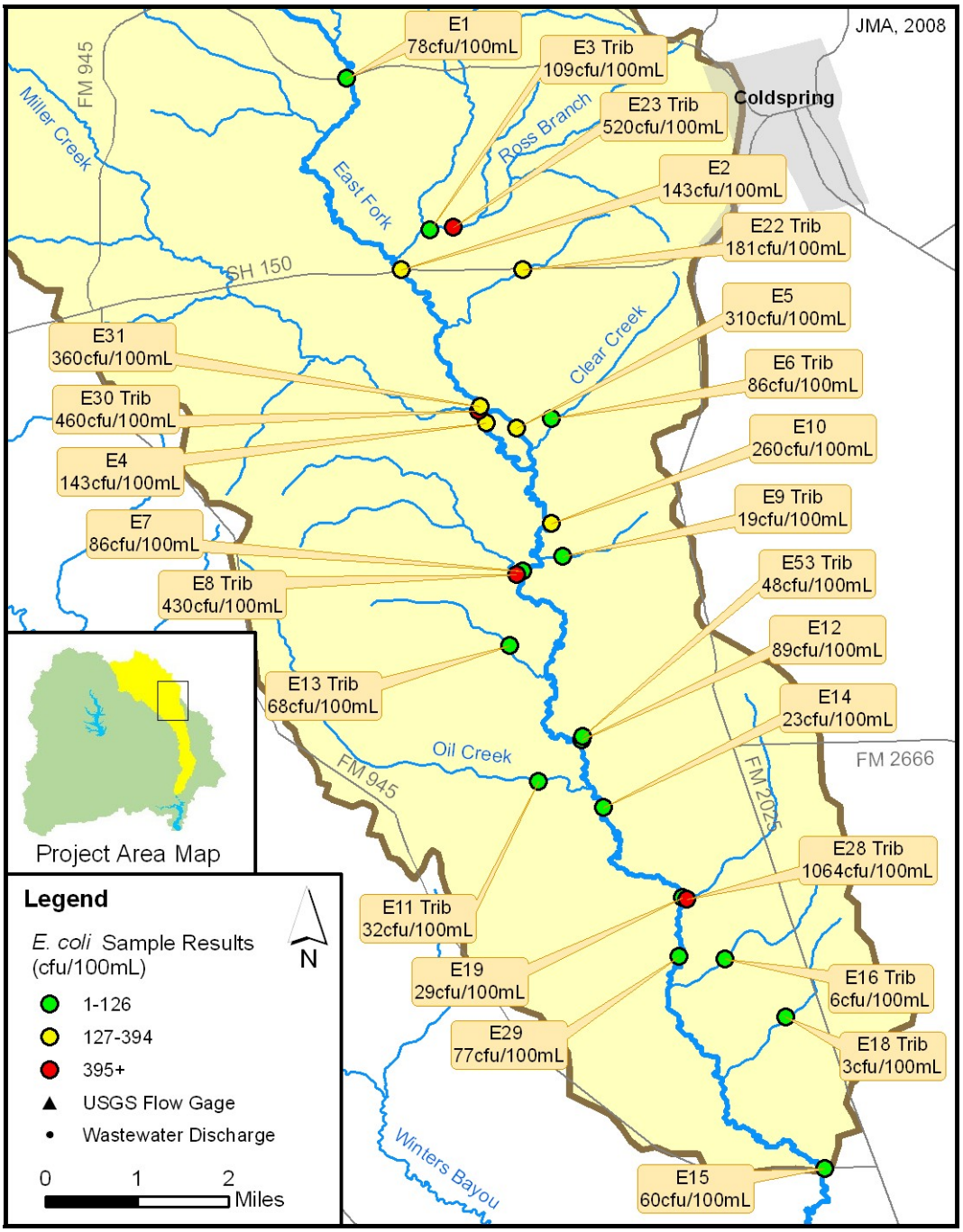

Figure 2-7: Upper East Fork Spatially Intensive Survey

Table 2-4: Upper East Fork Spatially Intensive Survey Results

Site ID	Site Description	Date	Time	*E. coli* (cfu/100mL)	Flow* Severity	Temp (C)	Cond** (µS/cm)	Optical Brightener	Flow (cfs)	Station Mile
E1	EFSJ at FM945 N	27-Feb-08	10:58	78	3	13.4	250	-	-	53.17
E23	Ross Branch at Western Ct	27-Feb-08	11:05	520	3	12.0	*410*	16	0.84	50.03
E3	Ross Branch near Sand Crk	27-Feb-08	10:25	109	3	8.9	343	18	0.92	50.03
E2	EFSJ at SH150	27-Feb-08	10:35	143	3	14.7	*301*	29	30	49.84
E22	Reese Branch at SH150	27-Feb-08	11:29	181	2	12.8	*491*	17	0.04	48.91
E31	EFSJ above Miller Crk	27-Feb-08	14:42	360	3	13.9	247	29	35	47.73
E30	Miller Crk nr Butch Auther Rd	27-Feb-08	13:57	460	3	13.5	206	22	2.1	47.69
E4	EFSJ at Butch Auther Rd W	27-Feb-08	9:00	143	3	10.8	*299*	30	-	47.69
E5	EFSJ at Butch Auther Rd E	27-Feb-08	8:45	310	2	10.5	*329*	50	-	47.23
E6	Clear Crk nr Butch Auther Rd	27-Feb-08	8:27	86	3	7.5	*80*	10	2.5	46.96
E10	EFSJ at FS280A	27-Feb-08	14:45	260	3	14.7	*288*	27	-	45.82
E9	Trib at Gas Field	27-Feb-08	14:30	19	3	16.8	*370*	9	1.3	45.08
E7	EFSJ at Gas Field	27-Feb-08	14:14	86	3	14.8	*286*	27	-	44.79
E8	Trib nr Gas Field	27-Feb-08	13:47	430	3	14.6	*177*	14	4.1	44.72
E13	Trib at FS256A	28-Feb-08	8:30	68	3	8.2	62	15	1.4	42.90
E53	Trib upstream of Vann Rd	27-Feb-08	17:10	48	3	14.5	*61*	7	0.07	41.38
E12	EFSJ at McAdams Vann Rd	27-Feb-08	15:50	89	3	13.8	*264*	27	36	41.35
E11	Oil Crk at River Crk Rd	27-Feb-08	15:25	32	3	13.9	*64*	11	1.8	40.73
E14	EFSJ at FS260	27-Feb-08	16:12	23	3	14.5	203	26	-	40.39
E19	EFSJ at River Crk Village	27-Feb-08	17:08	29	3	14.4	195	25	42	38.52
E28	Hickman Crk at River Crk Village	27-Feb-08	17:10	1064	3	13.7	*70*	7	0.73	38.48
E29	EFSJ at FS261	28-Feb-08	8:50	77	3	10.5	*189*	-	-	37.75
E16	Trib at FS261 N	28-Feb-08	9:07	6	3	10.6	*86*	9	0.1	37.26
E18	Trib at FS261 S	28-Feb-08	9:55	3	1	12.0	*189*	29	-	35.79
E15	EFSJ at FM945 S	28-Feb-08	10:19	60	3	12.2	181	24	61	33.89

*1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

**Conductivity values in italics are approxiamate. Probe did not pass post-calibration check.

3.0 WEST FORK SAN JACINTO RIVER, SEGMENT 1004

In this section, sampling results are presented for the main stem of the West Fork San Jacinto River (Section 3.1), followed by results for Crystal Creek (Segment 1004D) and Stewarts Creek (Segment 1004E) in Sections 3.2 and 3.3, respectively.

3.1 WEST FORK MAIN STEM, SEGMENT 1004

3.1.1 November 2007 Synoptic Survey

A synoptic survey of the West Fork San Jacinto River was performed on 7 November 2007. As shown in Figure 3-1, several locations along the West Fork San Jacinto River were sampled during this survey. Detailed sampling results for these stations are presented in Table 3-1. A longitudinal profile of bacteria concentrations can be found in Figure 3-2, and a similar plot of flow and conductivity data can be found in Figure 3-3.

Prior to the survey, the last significant rainfall occurred on 22 October. On this date, 0.87 inches of rainfall were recorded at the West Fork USGS Gage near Conroe, and 0.83 inches at the Conroe Airport.

Station 11250 on the Upper West Fork and Station WFSJ03 on Lake Creek represent the two most upstream sampling locations. Flows at each of these stations were roughly 5 cfs, and the relatively low conductivities observed at these stations indicate that the streams are not effluent dominated. Both of these stations had relatively high bacteria counts.

The Conroe WWTF, which was not sampled, is located near the confluence of Lake Creek and the West Fork. The discharge from this WWTF is around 10 cfs, and is therefore a significant flow source. Station 11245, which is located downstream of the Conroe WWTF, had a relatively high conductivity and a detectable chlorine residual. The bacteria count at this station was a relatively low 39 cfu/100mL.

Station 16624 is located at SH 242, downstream of Stewarts Creek, but immediately upstream of Crystal Creek. Several small WWTFs exist above this station. The bacteria count at this station was a relatively high 230 cfu/100mL.

Both Crystal Creek and Stewarts Creek exhibited relatively low bacteria concentrations at their most downstream stations. Bacteria levels at other stations on these creeks are presented in the following Sections 3.2.1 and 3.3.1. Together, these streams accounted for less than 10% of the total flow in the West Fork.

Two small tributaries below SH 242 were also sampled (WFSJ01 and WFSJ02). These tributaries had low to moderate bacteria counts. Flows in these tributaries were not measured, but were observed to be relatively small.

Station 13611 is the most downstream station that was sampled on the West Fork. This station is also the site of USGS Gage 08068090, which recorded a flow of 50 cfs on the day of sampling. The bacteria count at this station was a low 13 cfu/100mL.

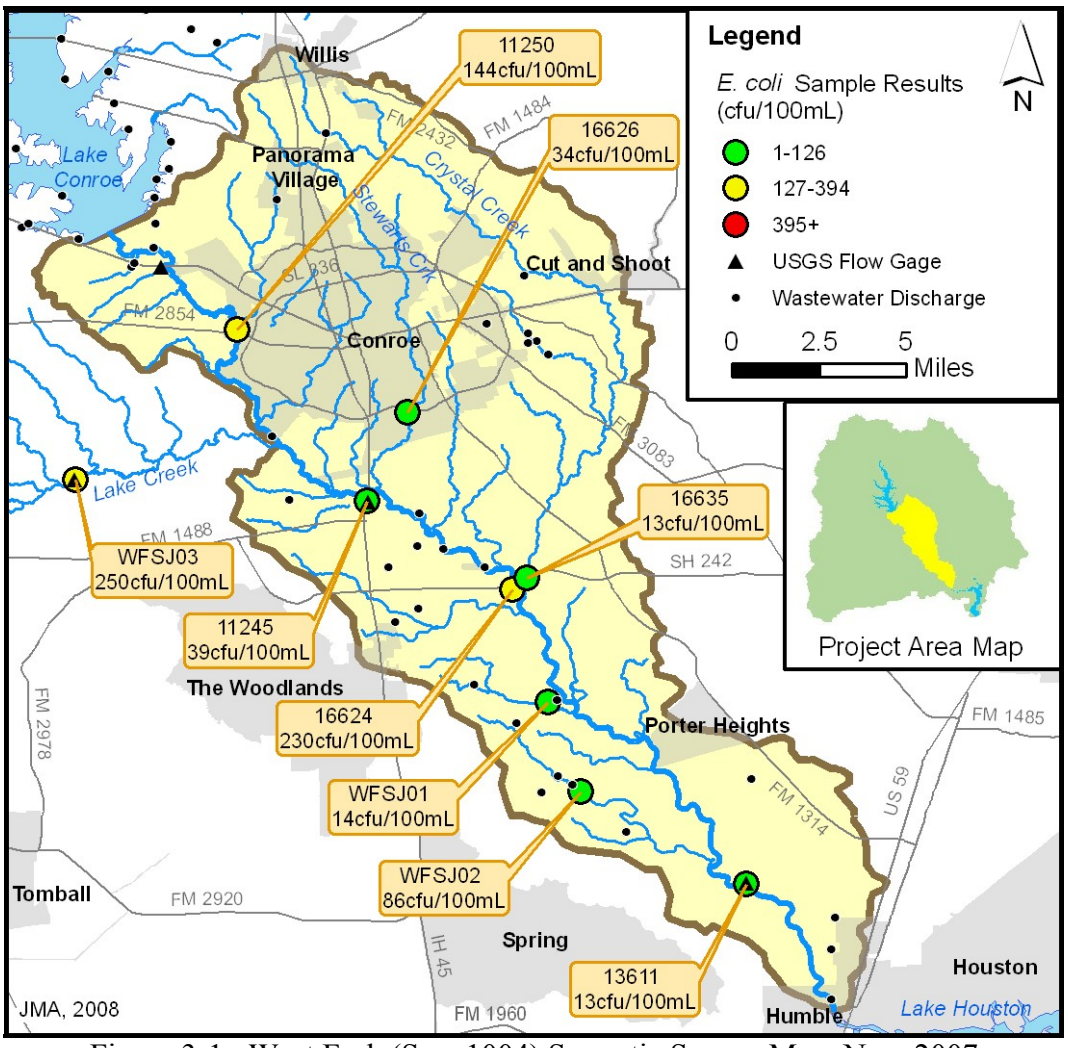

Figure 3-1: West Fork (Seg. 1004) Synoptic Survey Map, Nov. 2007

Table 3-1: West Fork (Seg. 1004) Synoptic Survey Results, Nov. 2007

Station Code	Station Type	Description	Station Mile	Sample Date	Sample Time	*E. coli* (cfu/100mL)	Flow Est. (cfs)	Flow* Severity	Temp (C)	Cond (µS/cm)	Total Cl2 (mg/L)
11250	main stem	FM 2854	33.1	7-Nov-07	10:48	144	4.7	2	16.0	255	< 0.05
WFSJ03	Lake Crk	Honea Egypt Rd	28.2	7-Nov-07	15:20	250	5.4	3	18.2	197	< 0.05
11245	main stem	IH 45	25.0	7-Nov-07	14:50	39	32	3	19.6	755	0.1
16626	Stewarts Crk	SH 75	24.5	7-Nov-07	11:40	34	0.8	2	15.4	277	< 0.05
16624	main stem	SH 242	18.6	7-Nov-07	10:32	230	-	3	18.5	646	< 0.05
16635	Crystal Crk	SH 242	18.2	7-Nov-07	10:50	13	2.6	3	18.0	655	< 0.05
WFSJ01	tributary	Sleepy Hollow	13.9	7-Nov-07	10:05	14	-	3	17.6	290	< 0.05
WFSJ02	tributary	Riley Fuzzel	6.4	7-Nov-07	9:15	86	-	2	17.5	990	< 0.05
13611	main stem	McCoy Lane	5.1	7-Nov-07	8:15	13	50	3	16.6	637	< 0.05

*1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

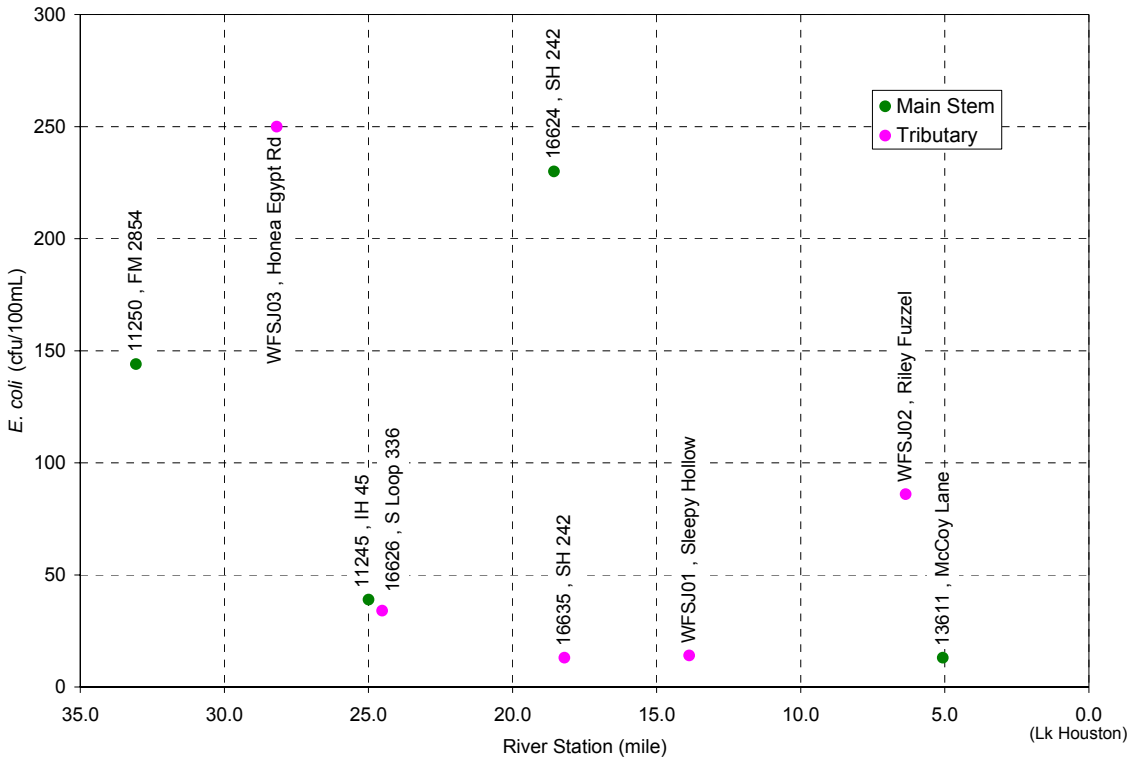

Figure 3-2: West Fork (Seg. 1004) Synoptic *E. coli* Profile, Nov. 2007

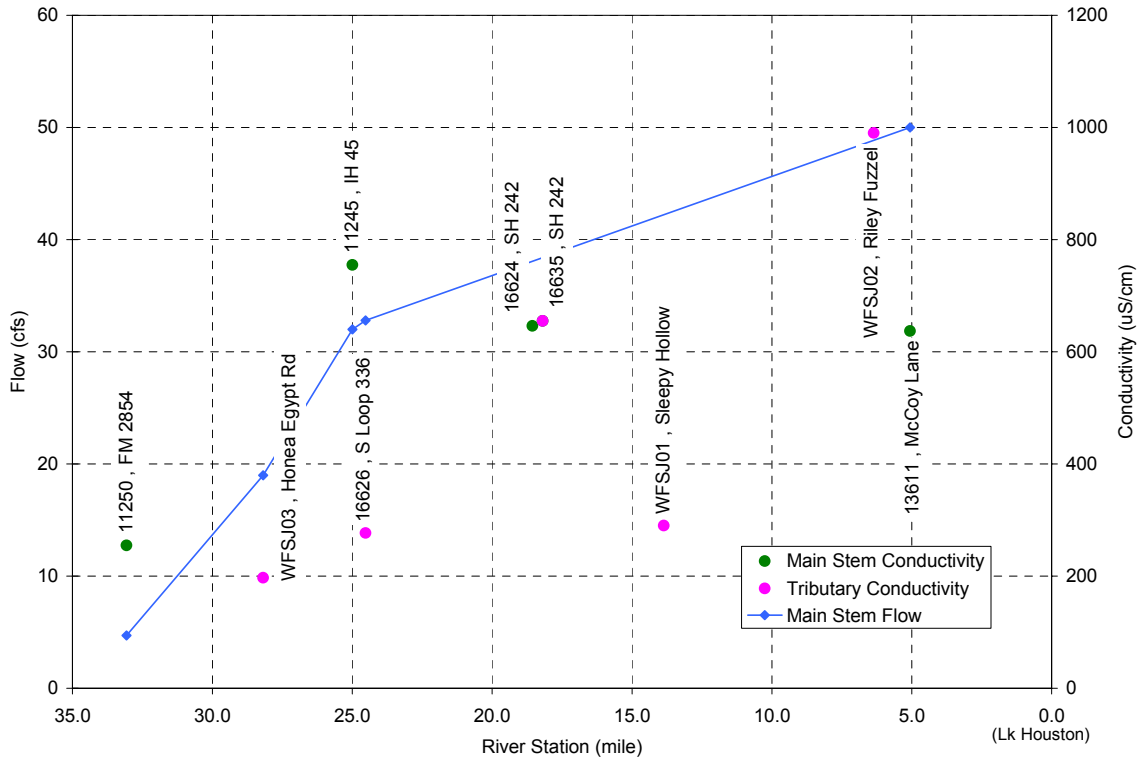

Figure 3-3: West Fork (Seg. 1004) Synoptic Cond. & Flow Profile, Nov. 2007

3.1.2 June 2008 Synoptic Survey

A second synoptic survey of the West Fork San Jacinto River was performed on 13 June 2008. As shown in Figure 3-4, several locations along the West Fork San Jacinto River were sampled during this survey. Detailed sampling results for these stations are presented in Table 3-2. A longitudinal profile of bacteria concentrations can be found in Figure 3-5, and a similar plot of flow and conductivity data can be found in Figure 3-6.

Prior to the survey, the last significant rainfall occurred on 10 June. On this date, 0.67 inches of rainfall were recorded at the West Fork USGS Gage near Conroe, and 0.35 inches at the Conroe Airport.

Station 11250, at FM 2854, is the most upstream station on the West Fork. The flow here, predominantly releases from Lake Conroe, was about 33 cfs, which was considerably higher than during the November survey. The station had a moderately high bacteria count and low conductivity.

Lake Creek is the largest tributary to the West Fork (except for Spring Creek, at the confluence with Lake Houston). The flow at this station was about 7.8 cfs, which was a little higher than during the November survey. The station had a low bacteria count and low conductivity.

The Conroe WWTF, which was not sampled, is located near the confluence of Lake Creek and the West Fork. The discharge from this WWTF is around 10 cfs, and is therefore a significant flow source. Station 11245, which is located downstream of the Conroe WWTF, had a relatively high conductivity, but no chlorine residual. The bacteria count at this station was a relatively low 56 cfu/100mL.

Station 16624 is located at SH 242, downstream of Stewarts Creek, but immediately upstream of Crystal Creek. The bacteria count at this station was a relatively low 68 cfu/100mL. Stewarts Creek exhibited relatively low bacteria concentrations, but Crystal Creek had a high bacteria count of 1,536 cfu/100mL. Bacteria levels at other stations on these creeks are presented in the following Sections 3.2.2 and 3.3.2. Together, these streams accounted for less than 10% of the total flow in the West Fork.

Two small tributaries below SH 242 were also sampled (WFSJ01 and WFSJ02). These tributaries had relatively low bacteria counts. Flows in these tributaries were found to be relatively small.

Station 13611 is the most downstream station that was sampled on the West Fork. This station is also the site of USGS Gage 08068090, which recorded a flow of 55 cfs on the day of sampling. The bacteria count at this station was a low 45 cfu/100mL.

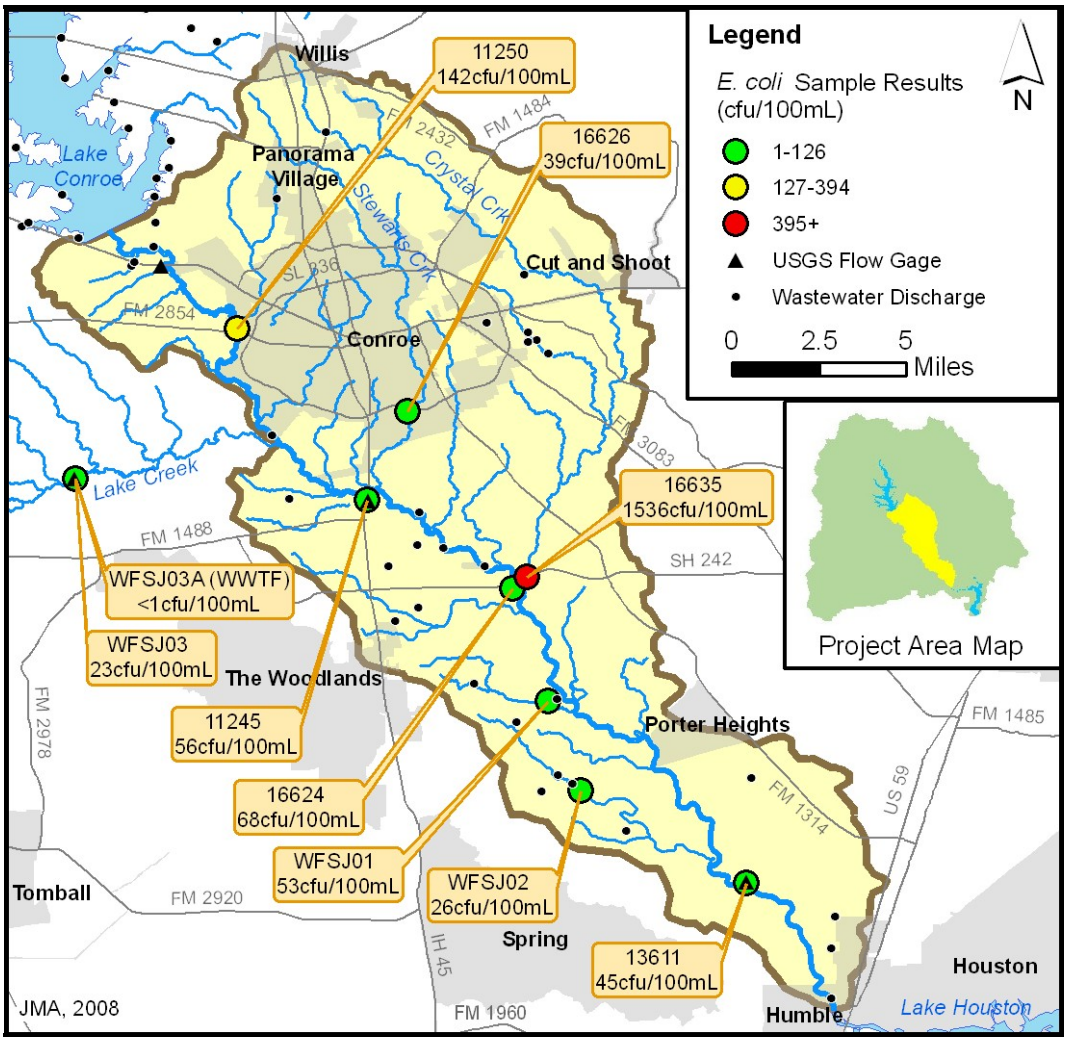

Figure 3-4: West Fork (Seg. 1004) Synoptic Survey Map, June 2008

Table 3-2: West Fork (Seg. 1004) Synoptic Survey Results, June 2008

Station Code	Station Type	Description	Station Mile	Sample Date	Sample Time	*E. coli* (cfu/100mL)	Flow Est. (cfs)	Flow* Severity	Temp (C)	Cond (µS/cm)	Total Cl2 (mg/L)
11250	main stem	FM 2854	33.1	13-Jun-08	7:12	142	-	3	24.8	246	< 0.05
WFSJ03	Lake Crk	Honea Egypt Rd	28.2	13-Jun-08	10:20	23	7.8	3	26.9	234	< 0.05
WFSJ03A	WWTF	Lake Ck WWTF	28.2	13-Jun-08	10:25	< 1	-	3	27.1	862	> 3.5
11245	main stem	IH 45	25.0	13-Jun-08	7:59	56	37	3	25.7	663	< 0.05
16626	Stewarts Crk	S Loop 336	24.5	13-Jun-08	9:20	39	1.7	3	26.7	204	-
16624	main stem	SH 242	18.6	13-Jun-08	8:34	68	-	3	26.5	496	< 0.05
16635	Crystal Crk	SH 242	18.2	5-Jun-08	9:40	1536	3.1	3	27.3	709	< 0.05
WFSJ01	tributary	Sleepy Hollow	13.9	13-Jun-08	11:18	53	0.4	3	27.4	440	< 0.05
WFSJ02	tributary	Riley Fuzzel	6.4	13-Jun-08	10:25	26	0.07	2	25.5	834	< 0.05
13611	main stem	Porter Heights	5.1	13-Jun-08	9:35	45	54	3	27.5	481	< 0.05

*1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

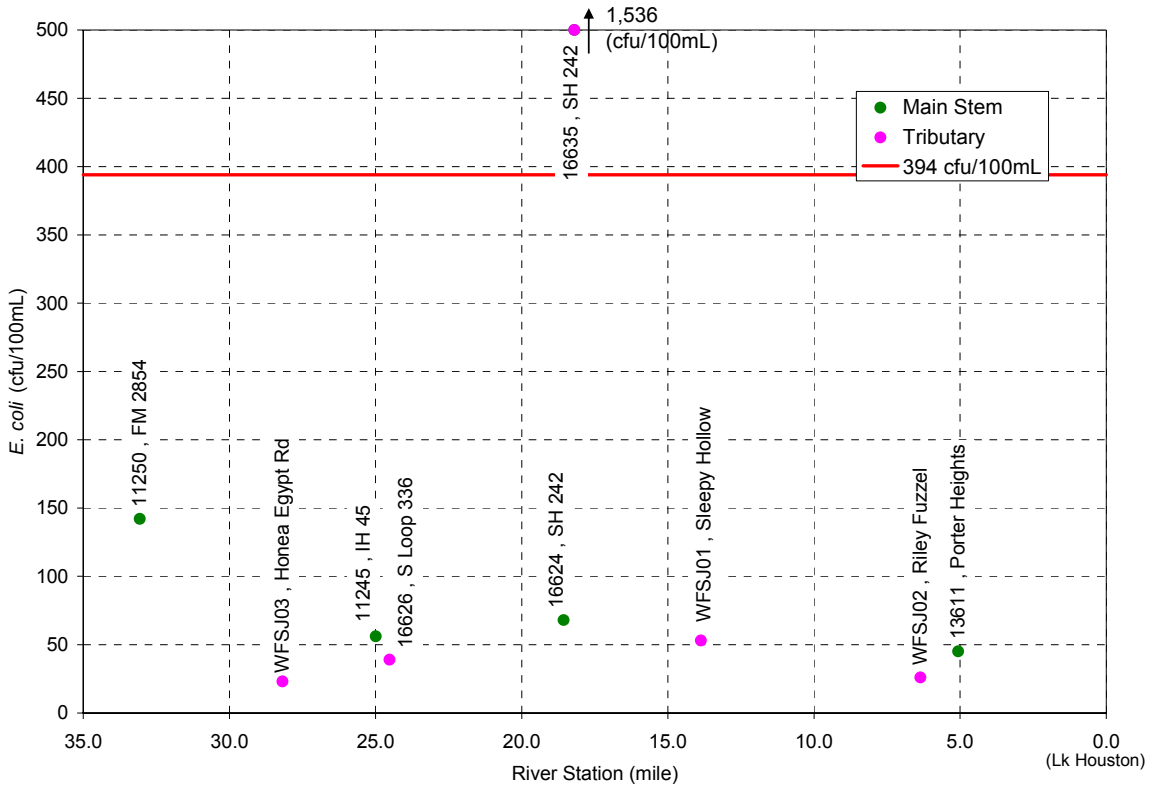

Figure 3-5: West Fork (Seg. 1004) Synoptic *E. coli* Profile, June 2008

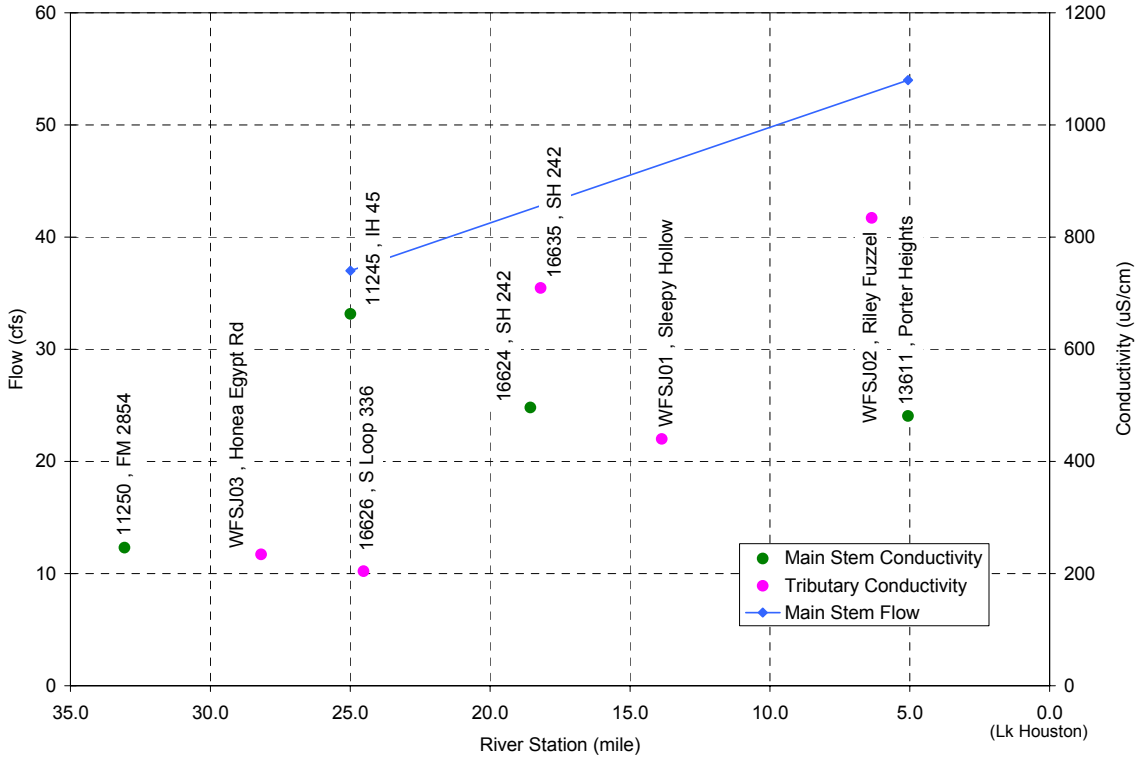

Figure 3-6: West Fork (Seg. 1004) Synoptic Cond. & Flow Profile, June 2008

3.2 CRYSTAL CREEK, SEGMENT 1004D

3.2.1 November 2007 Synoptic Survey

A synoptic survey of Crystal Creek was performed on 7 November 2007. As shown in Figure 3-7, several locations along Crystal Creek were sampled during this survey. Detailed sampling results for these stations are presented in Table 3-3. A longitudinal profile of bacteria concentrations can be found in Figure 3-8, and a similar plot of flow and conductivity data can be found in Figure 3-9.

Prior to the survey, the last significant rainfall occurred on 22 October. On this date, 0.87 inches of rainfall were recorded at the West Fork USGS Gage near Conroe, and 0.83 inches at the Conroe Airport.

Stations CRC03, CRC02, and 15804 are on the East Fork Crystal Creek (generally referred to as the main stem). The stations all have similar flow and conductivity values. The bacteria count at the first station (CRC03) was moderately high, but counts at the next two stations were lower.

Stations CRC01 and 15085 are on the West Fork of Crystal Creek. At Station CRC01, no flow was observed, and the bacteria concentration was relatively low. At Station 15805, there was significant flow, which originated primarily from upstream industrial dischargers. The conductivity at this station was 2,130 μS/cm, which is the highest value recorded anywhere in the Lake Houston watershed during the November surveys. A chlorine residual was also observed at this station.

Stations 11181 and 16635 are the two most downstream stations. These stations have similar flow and conductivity values. Bacteria levels at these stations were low to moderate.

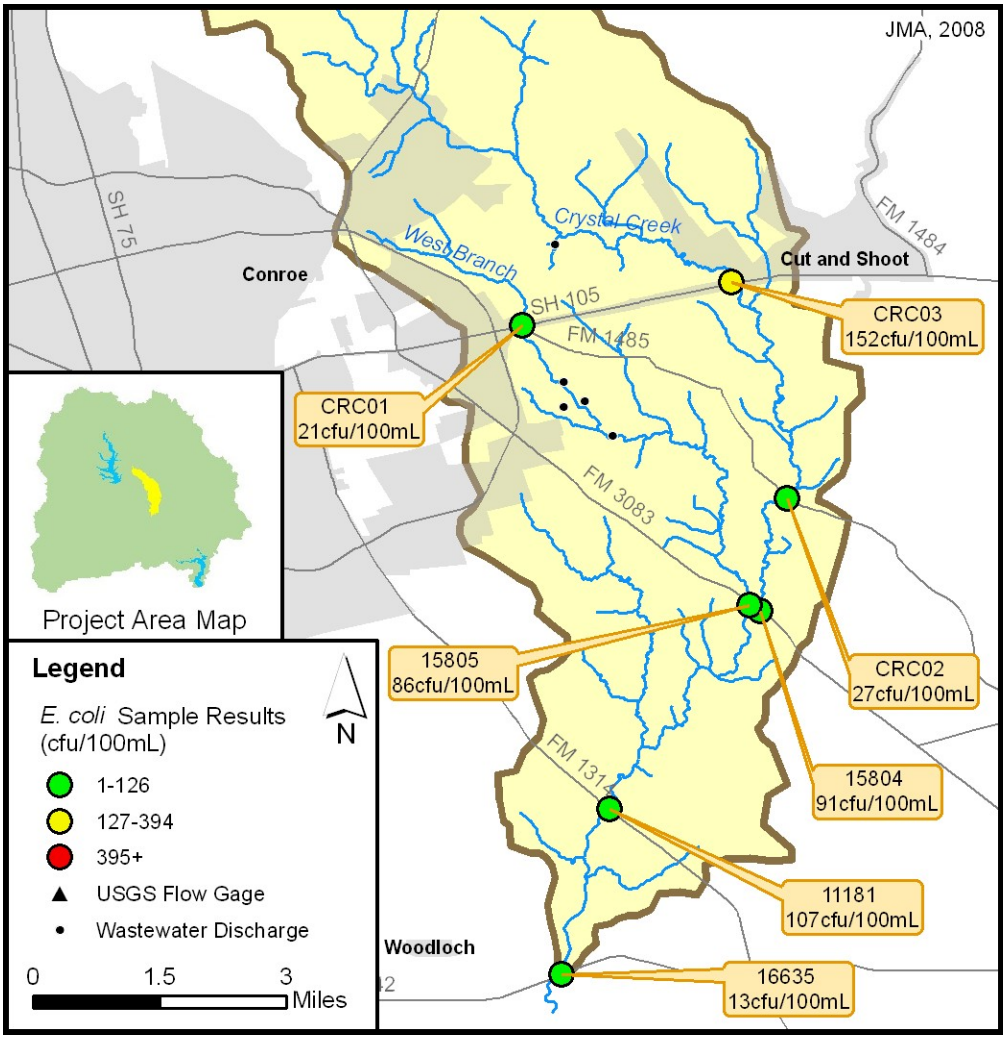

Figure 3-7: Crystal Creek (Seg. 1004D) Synoptic Survey Map, Nov. 2007

Table 3-3: Crystal Creek (Seg. 1004D) Synoptic Survey Results, Nov. 2007

Station Code	Station Type	Description	Station Mile	Sample Date	Sample Time	*E. coli* (cfu/100mL)	Flow Est. (cfs)	Flow* Severity	Temp (C)	Cond (µS/cm)	Total Cl2 (mg/L)
CRC03	main stem	SH 105	11.6	7-Nov-07	9:25	152	1.1	3	14.7	420	< 0.05
CRC02	main stem	FM 1484	8.2	7-Nov-07	12:20	27	-	2	15.2	383	< 0.05
15804	main stem	FM 3083	6.6	7-Nov-07	11:38	91	1.4	3	16.3	363	< 0.05
CRC01	tributary	SH 105	6.4	7-Nov-07	9:50	21	0	1	15.5	265	-
15805	tributary	FM 3083	6.4	7-Nov-07	11:50	86	0.9	3	15.0	2130	0.25
11181	main stem	FM 1314	2.9	7-Nov-07	11:12	107	_	3	16.5	660	< 0.05
16635	main stem	SH 242	0.7	7-Nov-07	10:50	13	2.6	3	18.0	655	< 0.05

*1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

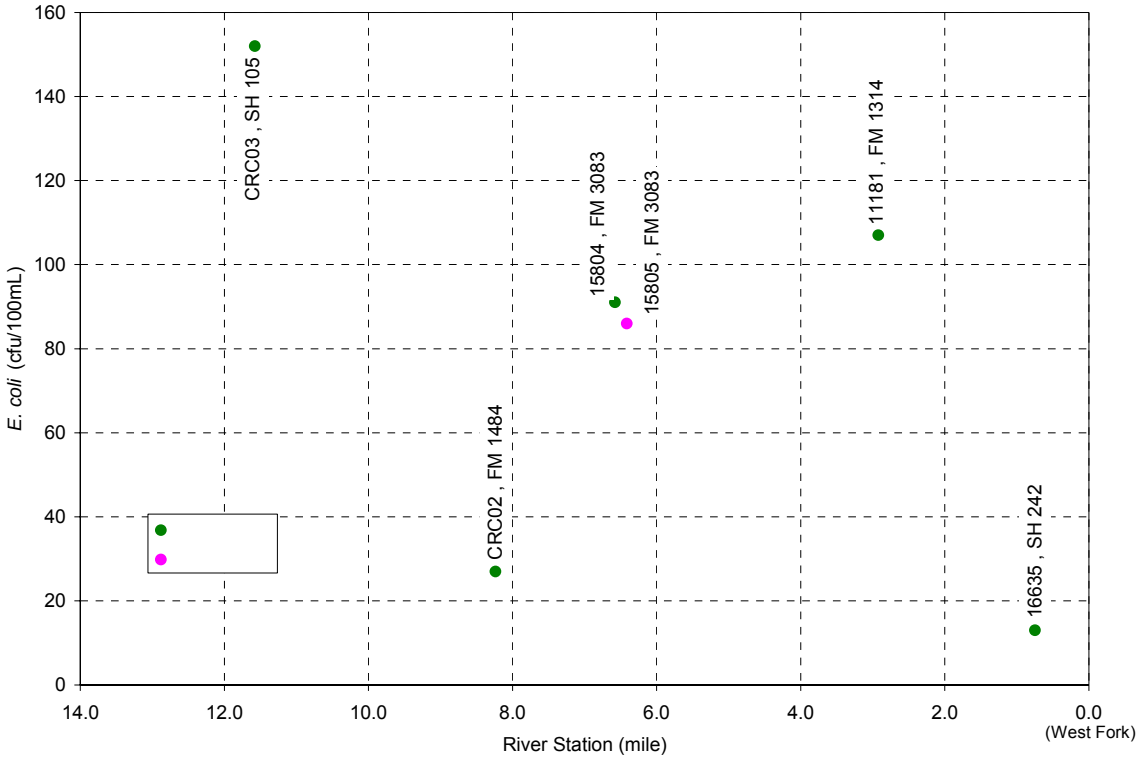

Figure 3-8: Crystal Creek (Seg. 1004D) Synoptic *E. coli* Profile, Nov. 2007

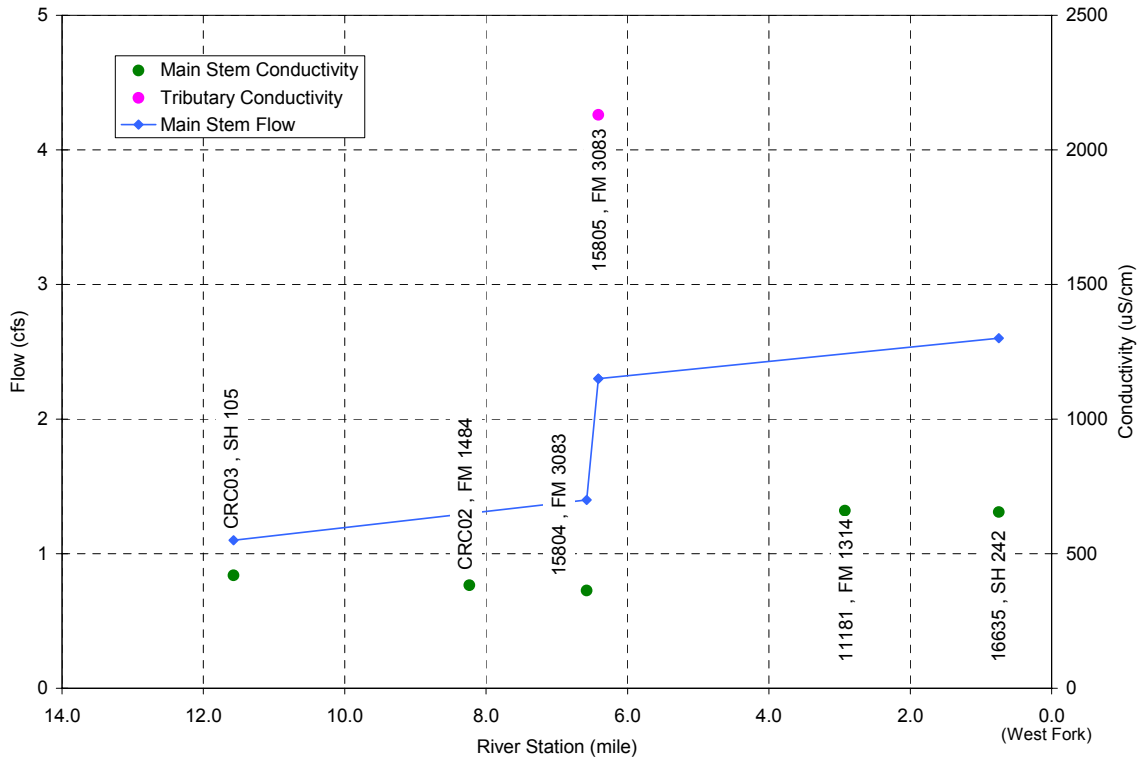

Figure 3-9: Crystal Creek (Seg. 1004D) Synoptic Cond. & Flow Profile, Nov. 2007

3.2.2 June 2008 Synoptic Survey

A second synoptic survey of Crystal Creek was performed on 5 June 2008. As shown in Figure 3-10, several locations along Crystal Creek were sampled during this survey. Detailed sampling results for these stations are presented in Table 3-4. A longitudinal profile of bacteria concentrations can be found in Figure 3-11, and a similar plot of flow and conductivity data can be found in Figure 3-12.

Prior to the survey, the last significant rainfall occurred on 27 May. On this date, 0.93 inches of rainfall were recorded at the West Fork USGS Gage near Conroe, and 0.38 inches at the Conroe Airport.

Stations CRC03, CRC02, and 15804 are on the East Fork Crystal Creek (generally referred to as the main stem). Bacteria counts at these stations were much higher than in the November survey. The two most upstream stations both exceeded the grab sample criterion of 394 cfu/100mL.

There was no flow and little standing water in the West Branch of Crystal Creek at SH 105 (CRC01), and no sample was collected. Station CRC04 is the outfall for the Huntsman chemical company. A sample was collected from the discharge of the company's treatment pond, and it yielded a relatively high bacteria count. At Station 15805, there was significant flow and a relatively high bacteria count. The conductivity at this station was 2,527 µS/cm, which was the highest value recorded anywhere in the Lake Houston watershed during the June surveys.

Stations 11181 and 16635 are the two most downstream stations. The two stations had similar conductivity values, but the bacteria count at 11181 was the lowest of the survey, while the bacteria count at 16635 was the highest.

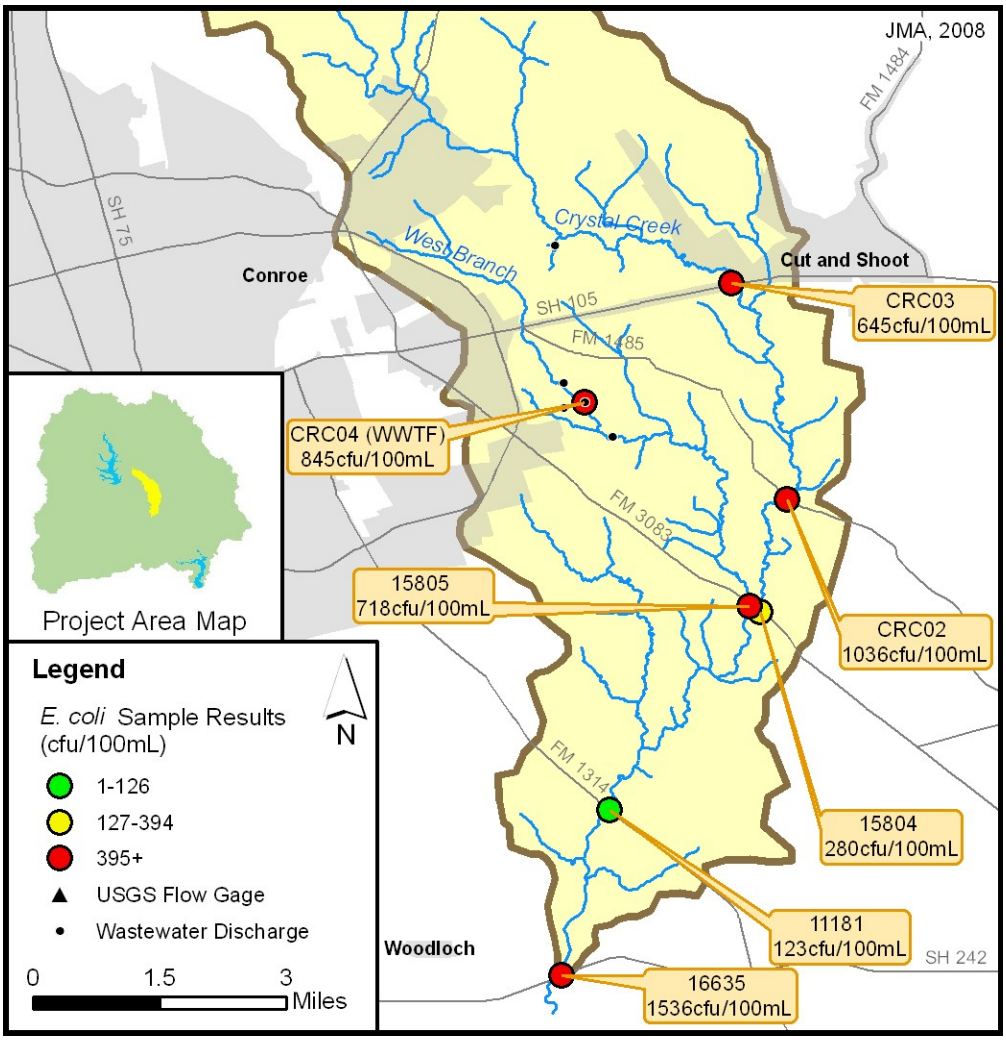

Figure 3-10: Crystal Creek (Seg. 1004D) Synoptic Survey Map, June 2008

Table 3-4: Crystal Creek (Seg. 1004D) Synoptic Survey Results, June 2008

Station Code	Station Type	Description	Station Mile	Sample Date	Sample Time	*E. coli* (cfu/100mL)	Flow Est. (cfs)	Flow* Severity	Temp (C)	Cond (µS/cm)	Total Cl2 (mg/L)
CRC03	main stem	SH 105	11.6	5-Jun-08	8:23	645	0.69	2	25.6	300	-
CRC02	main stem	FM 1484	8.2	5-Jun-08	11:40	1036	-	3	26.4	308	< 0.05
15804	main stem	FM 3083	6.6	5-Jun-08	11:20	280	1.3	3	25.8	336	< 0.05
CRC01	tributary	SH 105	6.4	5-Jun-08	8:04	-	0	1	-	-	-
CRC04	WWTF	Huntsman Corp.	6.4	5-Jun-08	11:48	845	0.18	-	30.4	835	< 0.05
15805	tributary	FM 3083	6.4	5-Jun-08	11:30	718	0.18	3	25.7	2527	< 0.05
11181	main stem	FM 1314	2.9	5-Jun-08	10:00	123	-	3	26.8	722	< 0.05
16635	main stem	SH 242	0.7	5-Jun-08	9:40	1536	3.1	3	27.3	709	< 0.05

*1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

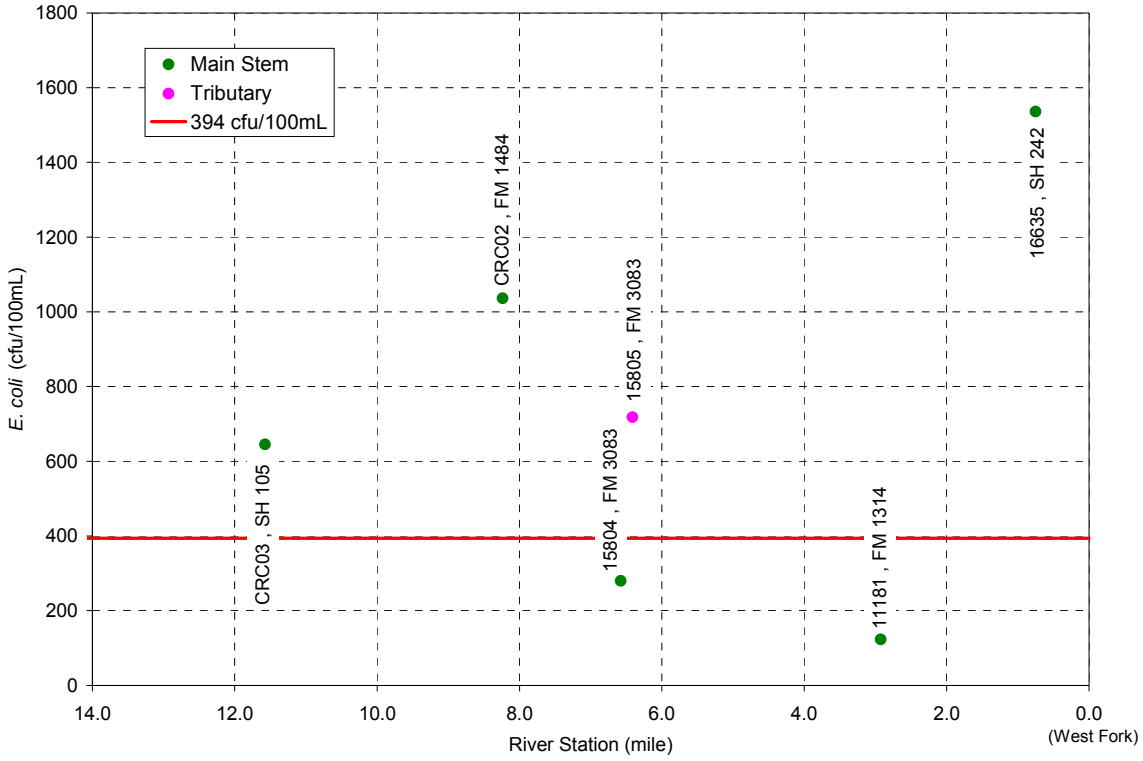

Figure 3-11: Crystal Creek (Seg. 1004D) Synoptic *E. coli* Profile, June 2008

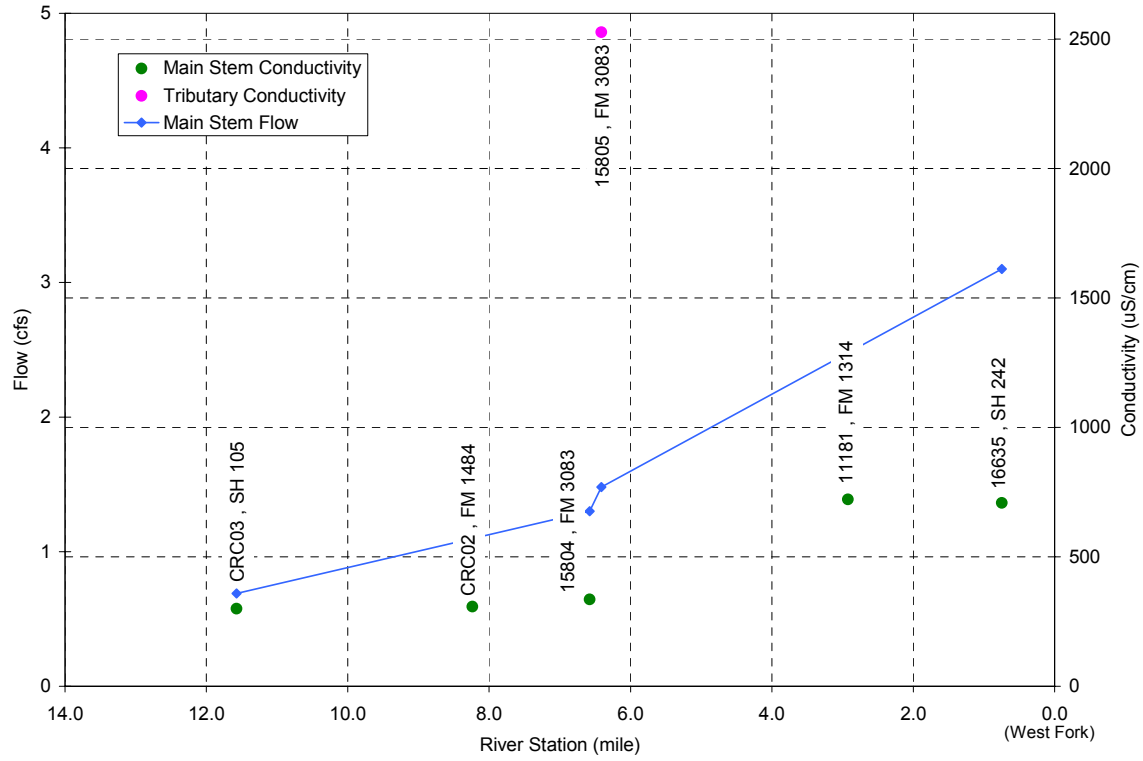

Figure 3-12: Crystal Creek (Seg. 1004D) Synoptic Cond. & Flow Profile, June 2008

3.3 STEWARTS CREEK, SEGMENT 1004E

3.3.1 November 2007 Synoptic Survey

A synoptic survey of Stewarts Creek was performed on 7 November 2007. As shown in Figure 3-13, several locations along Stewarts Creek were sampled during this survey. Detailed sampling results for these stations are presented in Table 3-5. A longitudinal profile of bacteria concentrations can be found in Figure 3-14, and a similar plot of flow and conductivity data can be found in Figure 3-15.

Prior to the survey, the last significant rainfall occurred on 22 October. On this date, 0.87 inches of rainfall were recorded at the West Fork USGS Gage near Conroe, and 0.83 inches at the Conroe Airport.

Stewarts Creek is a unique segment, because it exists in a highly urbanized environment, but receives no WWTF effluent. State Highway 75 (STC04) represents the most upstream sampling location. At this site there was only a trickle of flow, and the bacteria count was minimal. At the next downstream station (STC03) there was a bat colony under the FM 3083 bridge. Bat guano was observed in the stream and along the bank under this bridge. Therefore, a second sample was also pulled downstream of the bridge (STC03B). However, neither of the samples had particularly high bacteria counts.

The remaining four downstream stations (STC02, STC01, 11178, and 16626) were all found to have similar characteristics. The flow through this section of town was roughly 1 cfs and bacteria counts were relatively low. The conductivity levels were also relatively low, but increased gradually in the downstream direction.

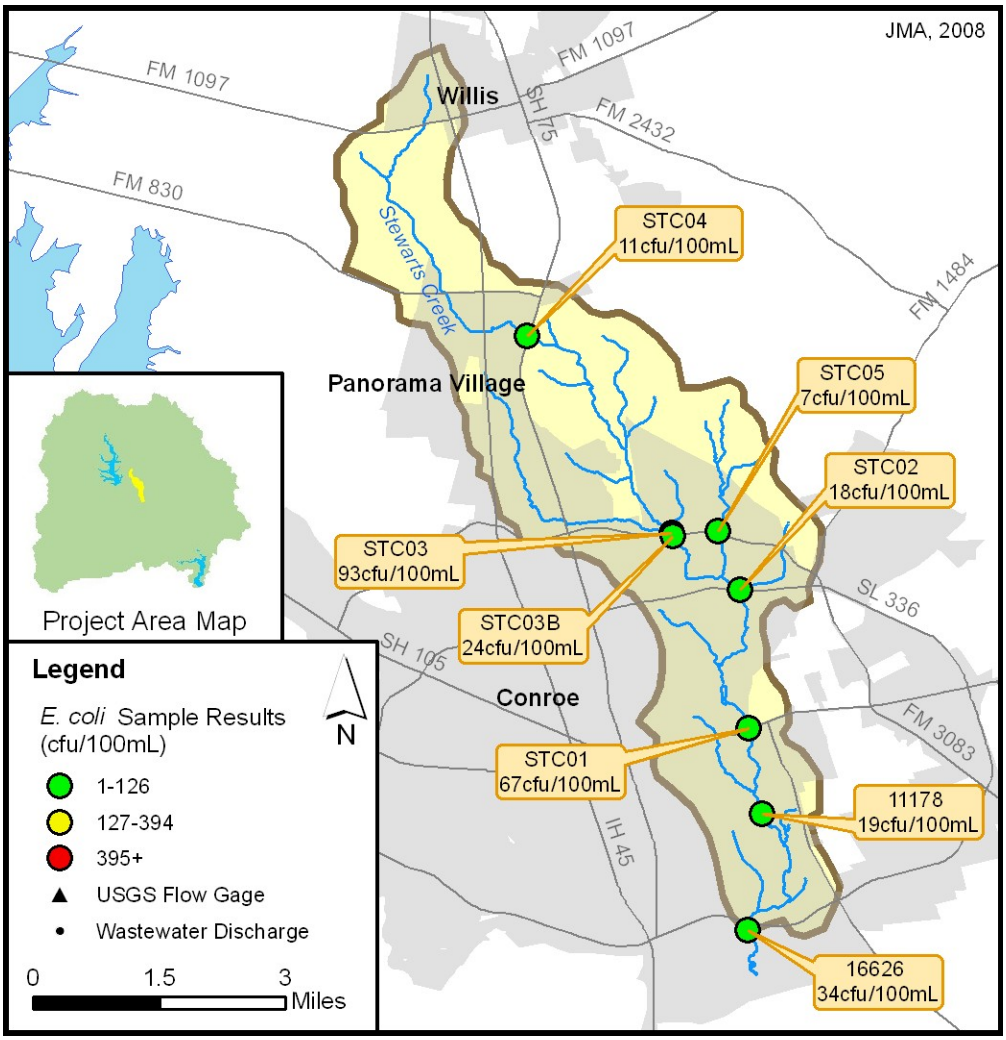

Figure 3-13: Stewarts Creek (Seg. 1004E) Synoptic Survey Map, Nov. 2007

Table 3-5: Stewarts Creek (Seg. 1004E) Synoptic Survey Results, Nov. 2007

Station Code	Station Type	Description	Station Mile	Sample Date	Sample Time	*E. coli* (cfu/100mL)	Flow Est. (cfs)	Flow* Severity	Temp (C)	Cond (µS/cm)	Total Cl2 (mg/L)
STC04	main stem	SH 75	12.7	7-Nov-07	7:50	11	< 0.1	3	16.6	118	-
STC03	main stem	FM 3083	9.5	7-Nov-07	8:15	93	0.21	3	14.2	148	< 0.05
STC03B	main stem	FM 3083	9.5	7-Nov-07	8:25	24	-	3	14.2	148	-
STC05	tributary	FM 3083	8.5	7-Nov-07	8:40	7	< 0.1	3	14.1	139	-
STC02	main stem	N Loop 336	8.3	7-Nov-07	8:55	18	-	3	14.7	173	< 0.05
STC01	main stem	SH 105	6.3	7-Nov-07	10:16	67	1.2	3	15.2	196	-
11178	main stem	Silverdale Dr	5.1	7-Nov-07	11:54	19	1.1	3	16.9	215	-
16626	main stem	S Loop 336	3.3	7-Nov-07	11:40	34	0.8	2	15.4	277	< 0.05

*1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

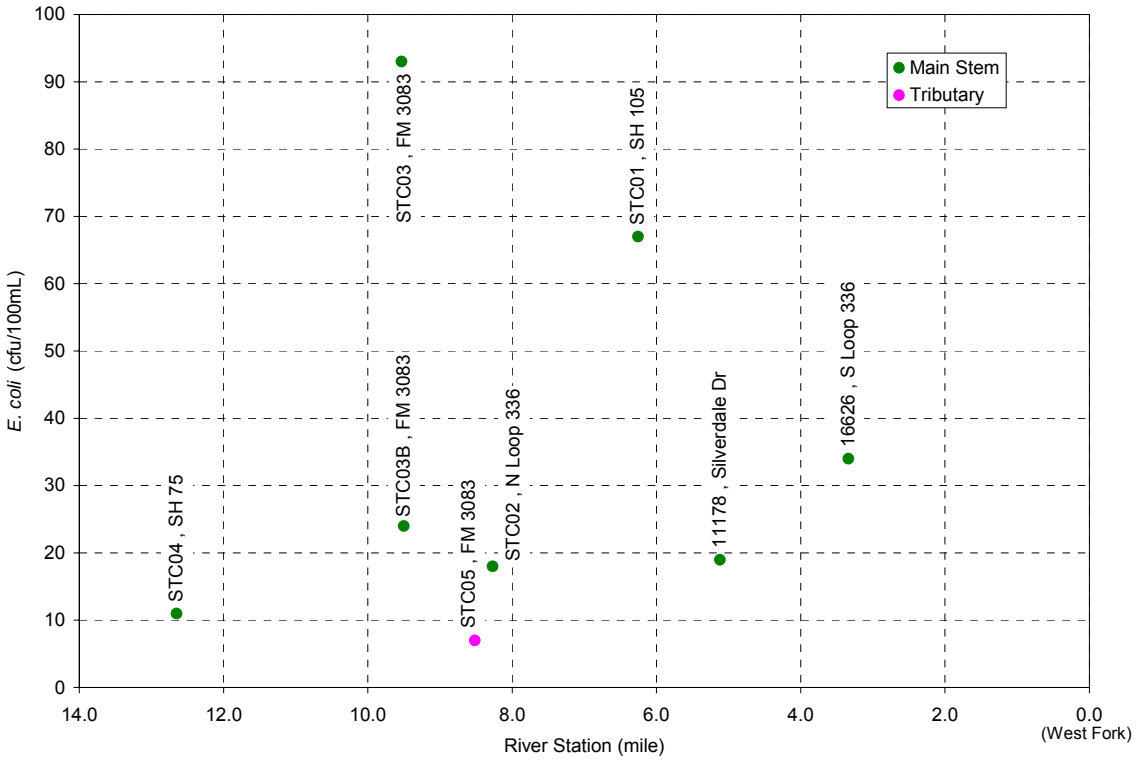

Figure 3-14: Stewarts Creek (Seg. 1004E) Synoptic *E. coli* Profile, Nov. 2007

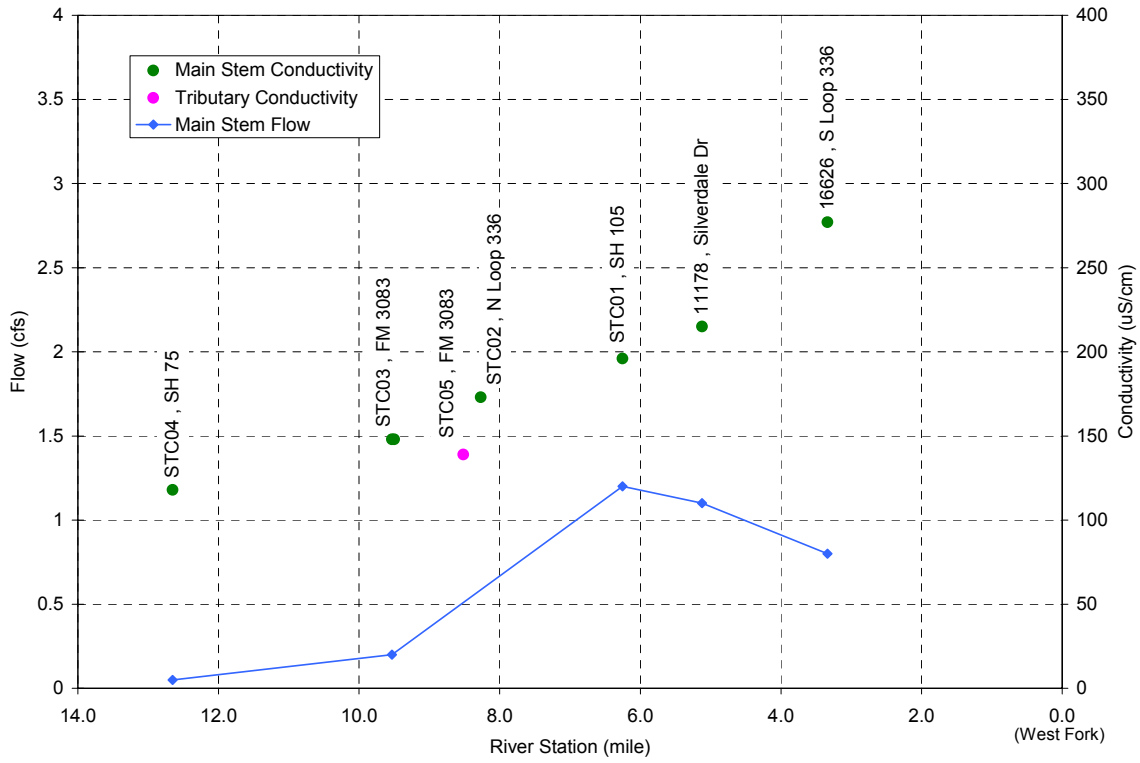

Figure 3-15: Stewarts Creek (Seg. 1004E) Synoptic Cond. & Flow Profile, Nov. 2007

3.3.2 June 2008 Synoptic Survey

A second synoptic survey of Stewarts Creek was performed on 13 June 2008. As shown in Figure 3-16, several locations along Stewarts Creek were sampled during this survey. Detailed sampling results for these stations are presented in Table 3-6. A longitudinal profile of bacteria concentrations can be found in Figure 3-17, and a similar plot of flow and conductivity data can be found in Figure 3-18.

Prior to the survey, the last significant rainfall occurred on 10 June. On this date, 0.67 inches of rainfall were recorded at the West Fork USGS Gage near Conroe, and 0.35 inches at the Conroe Airport.

State Highway 75 (STC04) represents the most upstream sampling location. At this site there was no flow, but the bacteria count was moderately high. At the next downstream station (STC03) there was a bat colony under the FM 3083 bridge. Bat guano was observed in the stream and along the bank under this bridge. Therefore, a second sample was also pulled downstream of the bridge (STC03B). However, neither of the samples had a particularly high bacteria count.

The remaining four downstream stations (STC02, STC01, 11178, and 16626) were all found to have similar characteristics. The bacteria counts were all relatively low. The conductivity levels were also relatively low, but increased gradually in the downstream direction.

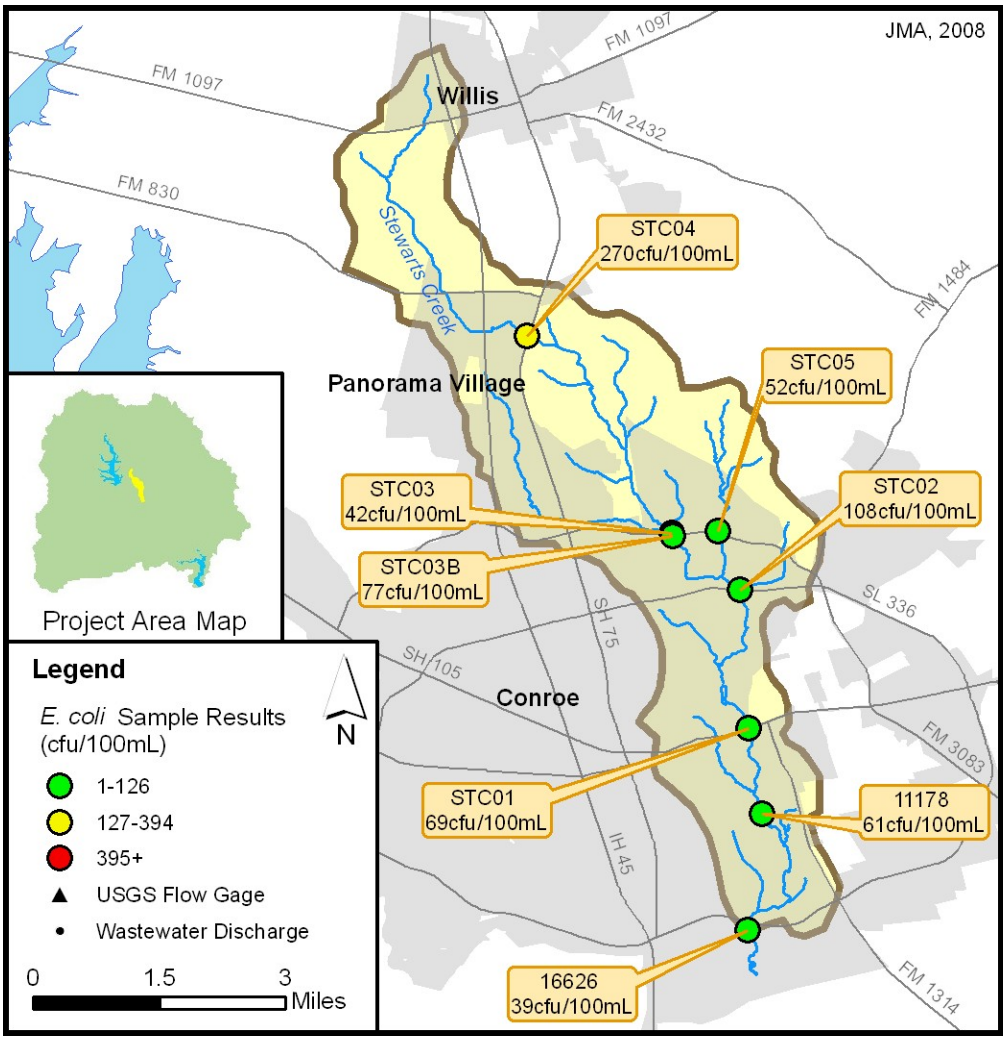

Figure 3-16: Stewarts Creek (Seg. 1004E) Synoptic Survey Map, June 2008

Table 3-6: Stewarts Creek (Seg. 1004E) Synoptic Survey Results, June 2008

Station Code	Station Type	Description	Station Mile	Sample Date	Sample Time	*E. coli* (cfu/100mL)	Flow Est. (cfs)	Flow* Severity	Temp (C)	Cond (µS/cm)	Total Cl2 (mg/L)
STC04	main stem	SH 75	12.7	13-Jun-08	7:30	270	0	1	26.7	123	-
STC03	main stem	FM 3083	9.5	13-Jun-08	8:00	42	0.59	3	24.4	135	-
STC03B	main stem	FM 3083	9.5	13-Jun-08	7:55	77	-	3	24.4	141	-
STC05	tributary	FM 3083	8.5	13-Jun-08	8:10	52	0.09	3	25.4	171	-
STC02	main stem	N Loop 336	8.3	13-Jun-08	8:20	108	-	3	25.0	162	-
STC01	main stem	SH 105	6.3	13-Jun-08	8:40	69	-	3	25.8	169	-
11178	main stem	Silverdale Dr	5.1	13-Jun-08	8:50	61	-	3	26.3	172	-
16626	main stem	S Loop 336	3.3	13-Jun-08	9:20	39	1.7	3	26.7	204	-

*1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

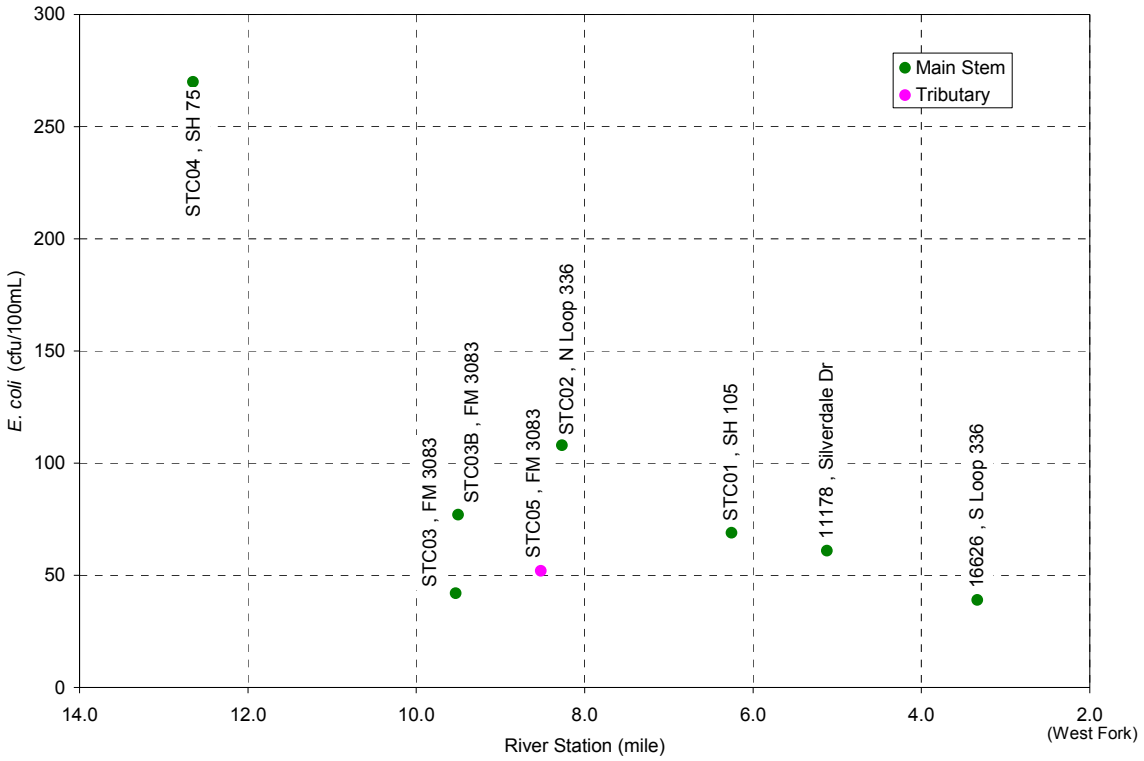

Figure 3-17: Stewarts Creek (Seg. 1004E) Synoptic *E. coli* Profile, June 2008

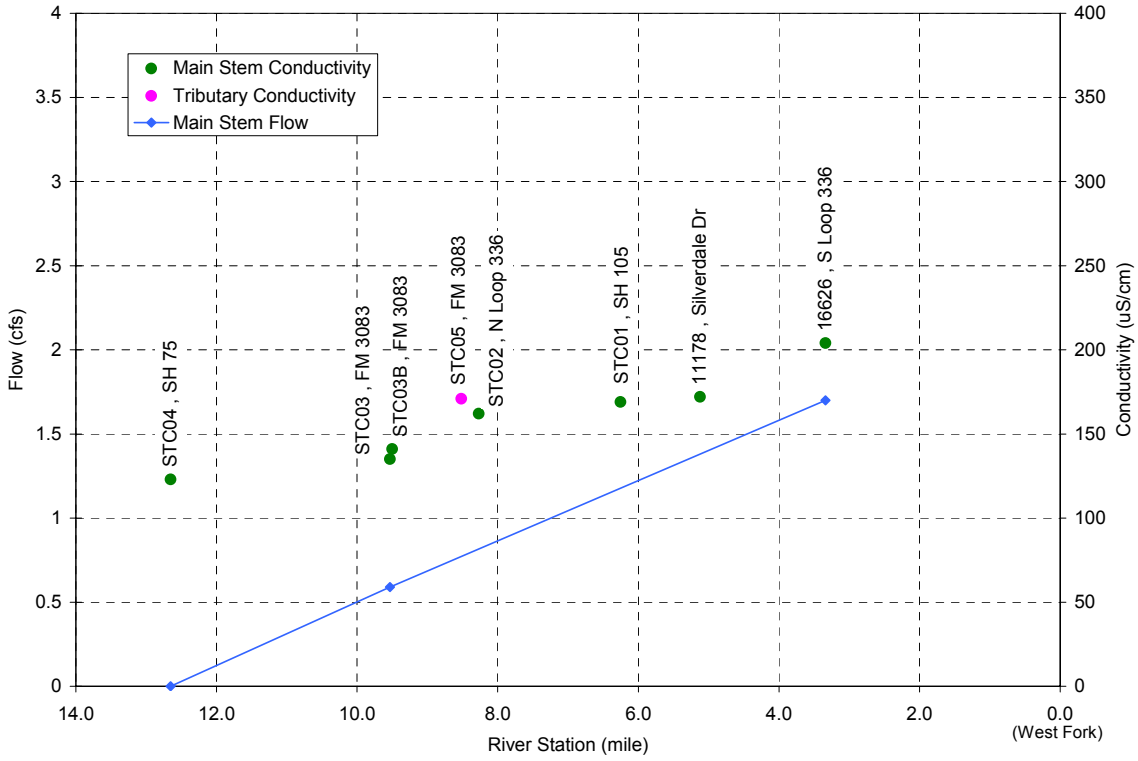

Figure 3-18: Stewarts Creek (Seg. 1004E) Synoptic Cond. & Flow Profile, June 2008

3.3.3 Spatially Intensive Survey of Stewarts Creek

An intensive survey of Stewarts Creek was performed on 24 April 2008. The survey covered virtually all of Stewarts Creek above the historical monitoring station at Loop 336 South. Forty-six sites were sampled for *E. coli*. These locations included all points of access to the creek and all major tributaries, as shown in Figures 3-19 and 3-20. Complete survey results are tabulated in Table 3-7.

Prior to the survey, the last significant rainfall occurred on 21 April. On this date, 0.21 inches of rainfall were recorded at the Conroe airport. (Prior to 21 April, the last significant rainfall was on 4 April.) Baseflows in Stewarts Creek during the intensive survey were comparable to the baseflows observed during the two synoptic surveys.

Bacteria concentrations in Stewarts Creek, upstream of I-45, were relatively high, and two sites exceed the grab sample criterion. At I-45 and US75, bacteria concentrations were much lower, possibly as the result of impoundments that exist in this area. At FM 3083, bacteria counts were much higher, possibly due to the bat colony that resides underneath this bridge.

Two tributaries confluence with Stewarts Creek a couple of miles below FM 3083. The first of these, Little Caney Branch, had relatively low bacteria counts. However, the second tributary (unnamed) had relatively high bacteria levels. In this tributary, conductivities and bacteria counts increased from upstream to downstream. Below these tributaries, bacteria counts in Stewarts Creek were moderately high in places.

An unnamed tributary, referred to as the "downtown tributary" confluences with Stewarts Creek below SH105. This tributary was sampled in numerous locations, and bacteria counts varied considerably. Many sites had moderately high bacteria counts, and two sites exceeded the grab sample criterion. The conductivities in this tributary were much higher than in Stewarts Creek proper.

Samples T39B and T39 were taken upstream and downstream of a roadway construction site, respectively. The downstream sample was observed to be more turbid, and had a higher bacteria count. Sample T40, at Loop 336 South, also had a moderately high bacteria count.

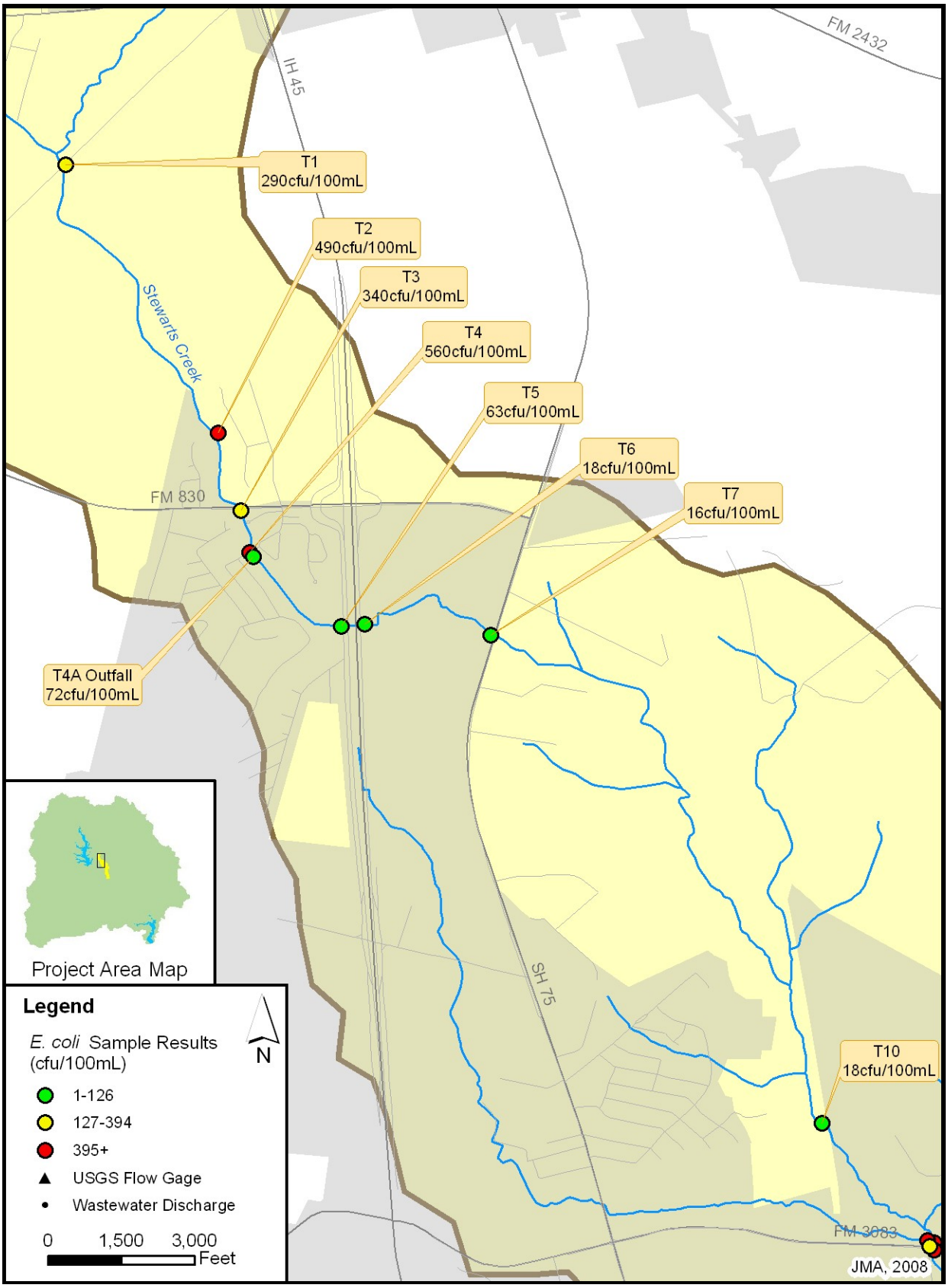

Figure 3-19: Stewarts Creek Spatially Intensive Survey above FM 3083

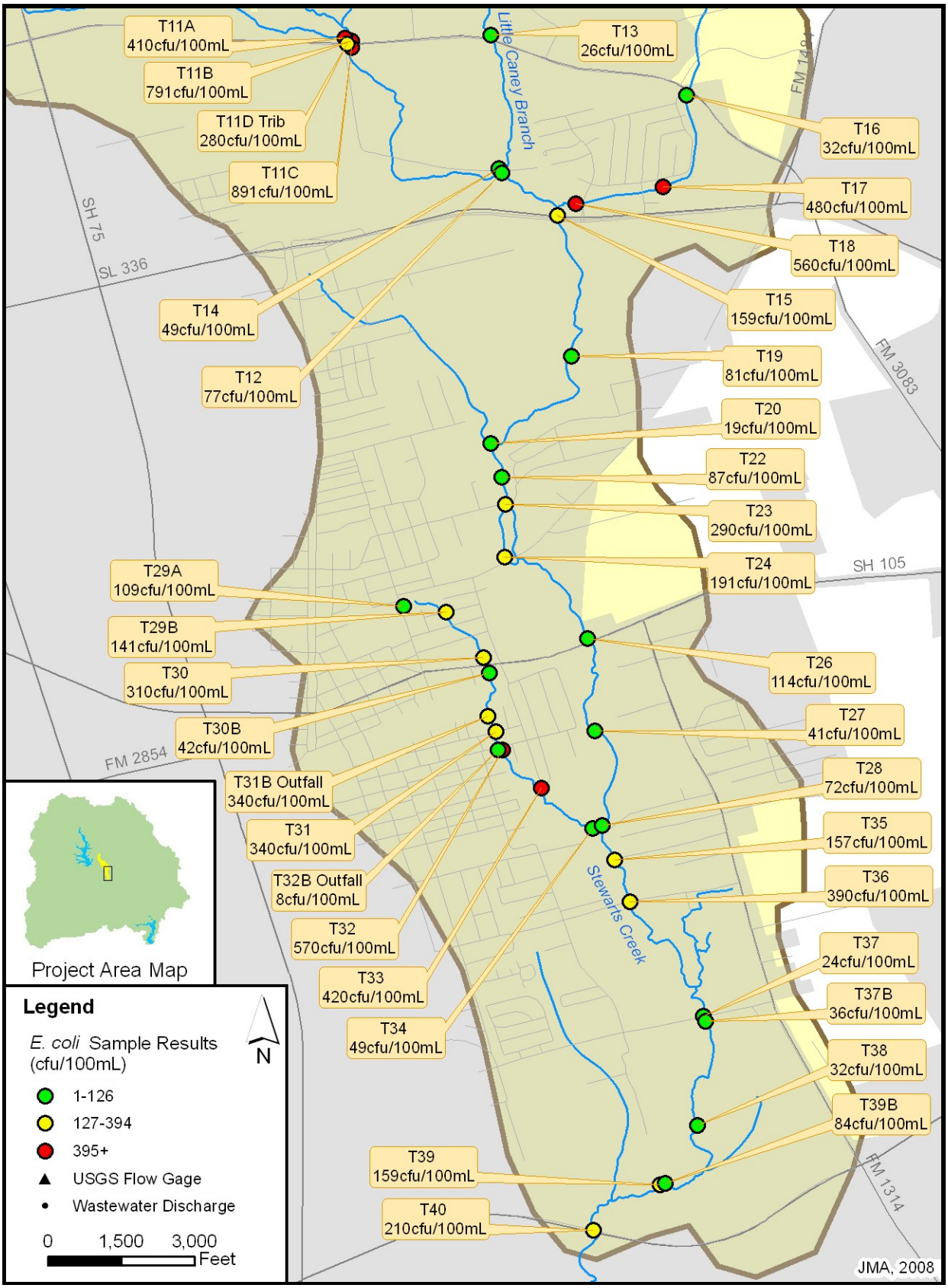

Figure 3-20: Stewarts Creek Spatially Intensive Survey below FM 3083

Table 3-7A: Stewarts Creek Spatially Intensive Survey Results

Site ID	Site Description	Date	Time	*E. coli* (cfu/100mL)	Flow* Severity	Temp (C°)	Cond (µS/cm)	Optical Brightener	Flow (cfs)	Station Mile
T1	Creek at Old Montgomery Rd.	24-Apr-08	15:30	290	-	28.0	275	-	-	15.43
T2	Creek 1,750 ft. u/s of FM 830	24-Apr-08	15:48	490	-	24.7	205	-	-	14.18
T3	Creek at FM 830	24-Apr-08	15:40	340	-	24.7	197	-	0.14	13.86
T4	Creek 910 ft. d/s of FM 830	24-Apr-08	16:00	560	-	25.3	187	-	-	13.69
T4A	Culvert 1,000 ft. d/s of FM 830	24-Apr-08	16:05	72	-	23.0	324	-	-	13.67
T5	Creek u/s at I-45	24-Apr-08	16:20	63	-	25.4	153	-	-	13.25
T6	Creek d/s at I-45	24-Apr-08	16:35	18	-	25.1	176	-	-	13.17
T7	Creek at SH 75	24-Apr-08	16:45	16	-	27.1	156	-	-	12.56
T10	Creek 3,450 ft. u/s of FM 3083	24-Apr-08	7:54	18	-	21.4	179	-	-	10.08
T11A	Creek u/s at FM 3083	24-Apr-08	13:11	410	-	24.2	171	-	0.37	9.56
T11B	Creek under FM 3083	24-Apr-08	13:15	791	-	23.9	182	-	-	9.54
T11D	Trib at FM 3083	24-Apr-08	13:30	280	-	22.0	262	-	-	9.53
T11C	Creek d/s at FM 3083	24-Apr-08	13:20	891	-	24.2	175	-	-	9.52
T12	Creek u/s of Little Caney	24-Apr-08	9:35	77	-	22.1	182	-	-	8.53
T13	Little Caney Branch at FM 3083	24-Apr-08	8:28	26	-	21.3	171	-	0.11	8.53
T14	Little Caney u/s of Creek	24-Apr-08	9:18	49	-	21.0	197	-	-	8.53
T15	Creek at Loop 336 North	24-Apr-08	9:47	159	-	22.0	193	-	0.88	8.28
T16	North Trib at FM 3083	24-Apr-08	8:39	32	-	23.1	166	-	0.02	8.23
T17	North Trib 1,900 ft. u/s of N. Loop 336	24-Apr-08	8:57	480	-	22.0	193	-	-	8.23
T18	North Trib at N. Loop 336	24-Apr-08	9:00	560	-	22.3	341	-	0.02	8.23
T19	Creek 3,000 ft d/s if N. Loop 336	24-Apr-08	10:55	81	-	23.9	222	-	-	7.69
T20	Creek 2.470 ft. u/s of FM 1484	24-Apr-08	11:25	19	-	23.5	193	-	-	7.17

*1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

Table 3-7B: Stewarts Creek Spatially Intensive Survey Results (continued)

Site ID	Site Description	Date	Time	*E. coli* (cfu/100mL)	Flow* Severity	Temp (C°)	Cond (µS/cm)	Optical Brightener	Flow (cfs)	Station Mile
T22	Creek 1,800 ft. u/s of FM 1484	24-Apr-08	11:50	87	-	24.0	195	-	-	7.07
T23	Creek 1,230 ft. u/s of FM 1484	24-Apr-08	12:23	290	-	24.1	196	-	-	6.94
T24	Creek at FM 1484	24-Apr-08	13:50	191	-	24.7	194	-	-	6.72
T26	Creek at SH 105	24-Apr-08	14:15	114	-	25.5	208	-	0.98	6.24
T27	Creek 2,000 ft. d/s of SH 105	24-Apr-08	14:35	41	-	25.2	211	-	-	5.86
T28	Creek u/s of Confluence w/ DT trib	24-Apr-08	11:43	72	3	23.1	213	13	-	5.46
T29A	Downtown Trib 2,080 ft. u/s of SH 105	24-Apr-08	7:49	109	2	20.5	588	19	0.004	5.43
T29B	Downtown Trib 1,380 ft. u/s of SH 105	24-Apr-08	8:25	141	2	21.8	356	25	0.003	5.43
T30	Downtown Trib 180 ft. u/s of SH 105	24-Apr-08	8:45	310	1	21.3	340	24	0.01	5.43
T30B	Downtown Trib 170 ft. d/s of SH 105	24-Apr-08	9:04	42	2	22.1	344	-	-	5.43
T31B	Ditch 1,000 ft. d/s of SH 105	24-Apr-08	10:15	340	1	21.4	534	25	-	5.43
T31	Downtown Trib 1,400 ft. d/s of SH 105	24-Apr-08	9:21	340	3	22.7	572	6	0.05	5.43
T32B	Outfall 1,780 ft. d/s of SH 105	24-Apr-08	10:50	8	3	25.0	577	4	0.004	5.43
T32	Downtown Trib 1,870 ft. d/s of SH 105	24-Apr-08	10:45	570	2	25.3	569	8	-	5.43
T33	Downtown Trib 2,950 ft d/s of SH 105	24-Apr-08	11:05	420	2	23.6	554	10	-	5.43
T34	Downtown Trib u/s of Creek	24-Apr-08	11:34	49	2	22.0	582	13	-	5.43
T35	Creek 960 ft. u/s of Silverdale Rd.	24-Apr-08	13:45	157	3	25.0	225	12	-	5.30
T36	Creek at Silverdale Rd.	24-Apr-08	14:06	390	3	25.5	226	12	1.2	5.13
T37	Creek u/s at Foster Rd.	24-Apr-08	14:25	24	3	28.7	240	11	-	4.58
T37B	Creek d/s at Foster Rd.	24-Apr-08	14:34	36	3	29.1	240	-	-	4.55
T38	Creek 3,500 ft. u/s of S. Loop 336	24-Apr-08	15:05	32	3	28.3	263	10	-	4.13
T39B	Creek 1,850 ft. u/s of S. Loop 336	24-Apr-08	16:03	84	3	29.4	265	12	-	3.82
T39	Creek 1,750 ft. u/s of S. Loop 336	24-Apr-08	16:08	159	3	29.3	265	13	-	3.80
T40	Creek at S. Loop 336	24-Apr-08	15:36	210	3	29.0	269	11	1.8	3.46

*1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

A sediment source survey was performed in conjunction with the spatially intensive survey. Sediment samples were collected from the west bank of Stewarts Creek, immediately downstream of the Loop 336 South bridge. The sampling area was similar to the East Fork site. It was sandy and densely forested with considerable leaf litter covering the ground away from the bank. The samples were taken from the upper layer (approximately half inch) of soil below the leaf litter. The results of this sampling are presented in Table 3-7. The bacteria counts are reported per gram of sediment (dry weight).

Table 3-8: Stewarts Creek Sediment Source Sampling Results

Location	*E. coli* (cfu/g)
stream bed	323
water's edge	50
1 ft from edge	327
3 ft from edge	25
10 ft from edge	10
50 ft from edge	9

Samples of bat guano were collected from beneath the FM 3083 bridge, north of Conroe. One sample was of wet (fresh) bat guano and a second sample was of dry (old) bat guano. The samples were analyzed with the same methodology used for the sediment source samples. The *E. coli* counts of the wet and dry bat guano were 36,000 cfu/g and 3,500 cfu/g, respectively.

4.0 SPRING CREEK, SEGMENT 1008

In this section, sampling results are presented for the main stem of Spring Creek (Section 4.1). Results for Upper Panther Branch (Segment 1008B) and Willow Creek (Segment 1008H) are presented in Sections 4.2 and 4.3, respectively.

4.1 SPRING CREEK MAIN STEM, SEGMENT 1008

4.1.1 November 2007 Synoptic Survey

A synoptic survey of Spring Creek's main stem was performed on 8 November 2007. As shown in Figure 4-1, several locations along Spring Creek were sampled during this survey. Detailed sampling results for these stations are presented in Table 4-1. A longitudinal profile of bacteria concentrations can be found in Figure 4-2, and a similar plot of flow and conductivity data can be found in Figure 4-3.

Prior to the survey, the last major rainfall occurred on 15 October. On this date, 1.54 inches of rainfall were recorded at the Houston Hooks Airport near Tomball. An additional 0.08 inches of rainfall occurred on 22 October.

The stations upstream of SH 249 were all characterized by low flows and low bacteria counts. At most stations, conductivity values were fairly low, suggesting natural flow sources. At station SC03, on Walnut Creek, the conductivity was significantly higher, suggesting the influence of upstream WWTF discharges.

At SH 249 (11314) the bacteria concentration was 2,800 cfu/100mL. This was the highest in-stream bacteria count reported from the November synoptic surveys.

Mill Creek confluences with Spring Creek downstream of SH 249. This creek is impounded immediately upstream of this confluence (Lake Neidigk), and the sample (SC02) was taken at the lake's spillway. Because lakes typically act as a sink for bacteria, it is not surprising that this site had a very low bacteria count.

At Kuykendahl Rd (17489), the conductivity level was still moderate, suggesting that the flow was a mixture of natural sources and WWTF discharges. The bacteria count at this station was fairly low. Downstream of this station, tributaries like Panther Branch and Willow Creek added considerable flow (mostly WWTF effluent) to Spring Creek. Sampling results for these two streams are presented in Sections 4.2.1 and 4.3.1.

The two most downstream stations on Spring Creek (11313 and 11312) had significantly higher bacteria counts than most upstream stations. These two stations were also characterized by higher flows and higher conductivity levels, resulting from numerous WWTF discharges.

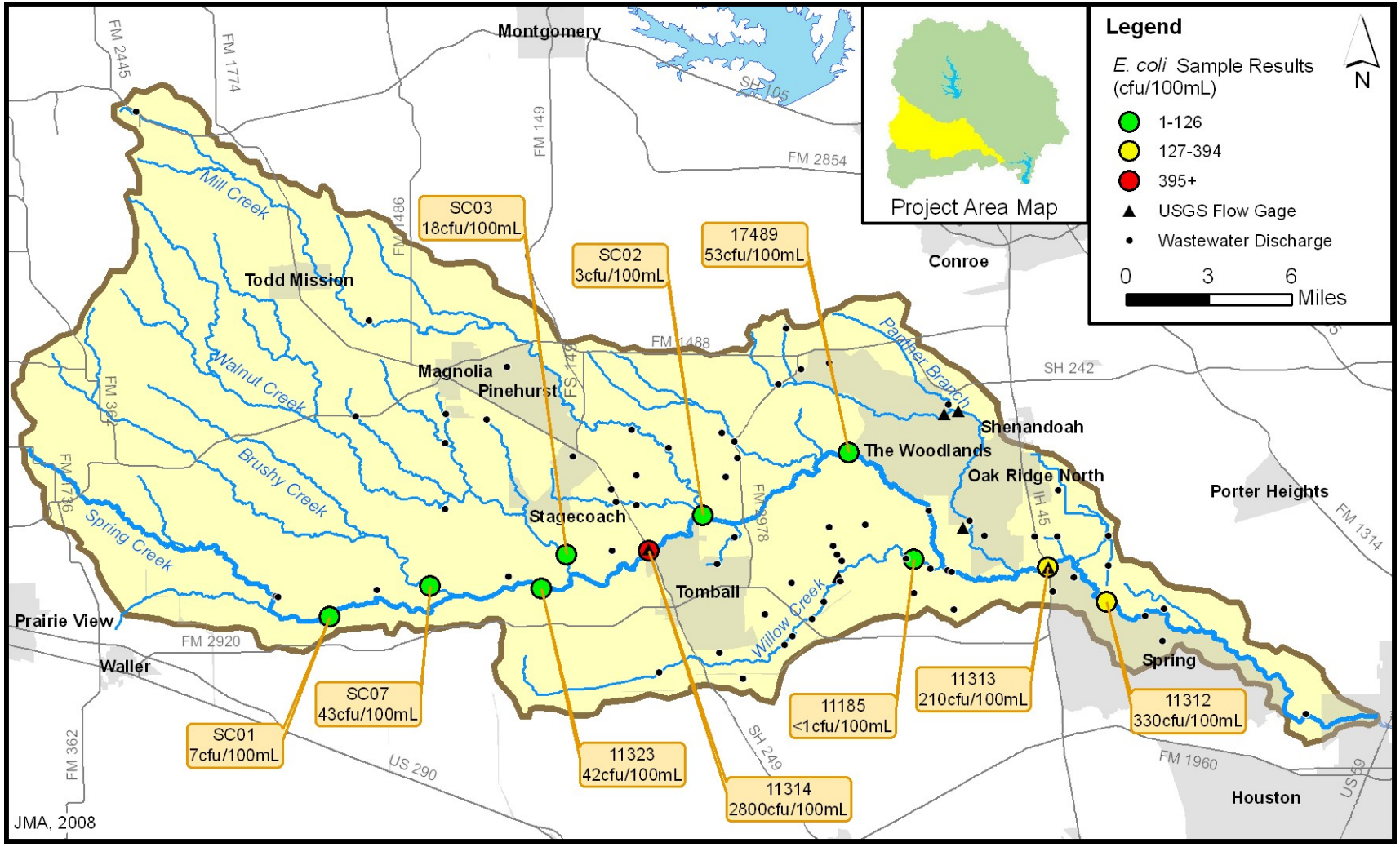

Figure 4-1: Spring Creek (Seg. 1008) Synoptic Survey Map, Nov. 2007

Table 4-1: Spring Creek (Seg. 1008) Synoptic Survey Results, Nov. 2007

Station Code	Station Type	Description	Station Mile	Sample Date	Sample Time	*E. coli* (cfu/100mL)	Flow Est. (cfs)	Flow* Severity	Temp (C)	Cond (µS/cm)	Total Cl2 (mg/L)
SC01	main stem	Murrell Rd	53.8	8-Nov-07	10:08	7	0.1	2	15.8	232	-
SC07	tributary	Glenmont Estates	48.6	8-Nov-07	9:34	43	0.48	3	14.8	295	-
11323	main stem	Decker Prairie Rd	45.1	8-Nov-07	9:05	42	-	3	15.3	240	< 0.05
SC03	tributary	Cypress Rosehill	43.6	8-Nov-07	8:45	18	0.3	2	14.4	607	< 0.05
11314	main stem	SH 249	39.6	8-Nov-07	12:46	2800	4.9	3	18.4	280	< 0.05
SC02	tributary	Neidigk Lake Outfall	36.6	8-Nov-07	13:05	3	-	3	20.0	262	< 0.05
17489	main stem	Kuykendahl Rd	28.8	8-Nov-07	10:33	53	-	3	16.8	360	-
11185	Willow Crk	Gosling Rd	21.6	8-Nov-07	9:00	< 1	5.7	3	16.6	860	0.8
11313	main stem	IH 45	16.8	8-Nov-07	8:25	210	27	3	15.7	545	-
11312	main stem	Riley Fuzzel Rd	13.1	8-Nov-07	7:55	330	-	3	16.5	575	-

*1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

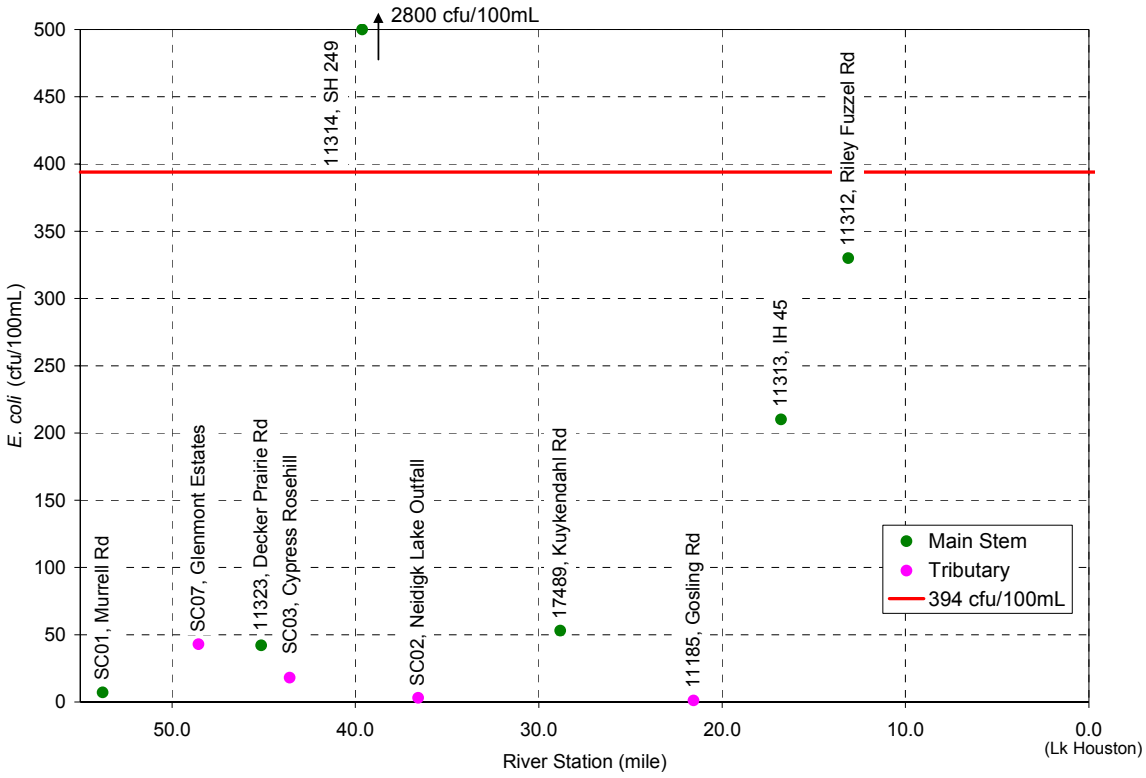

Figure 4-2: Spring Creek (Seg. 1008) Synoptic *E. coli* Profile, Nov. 2007

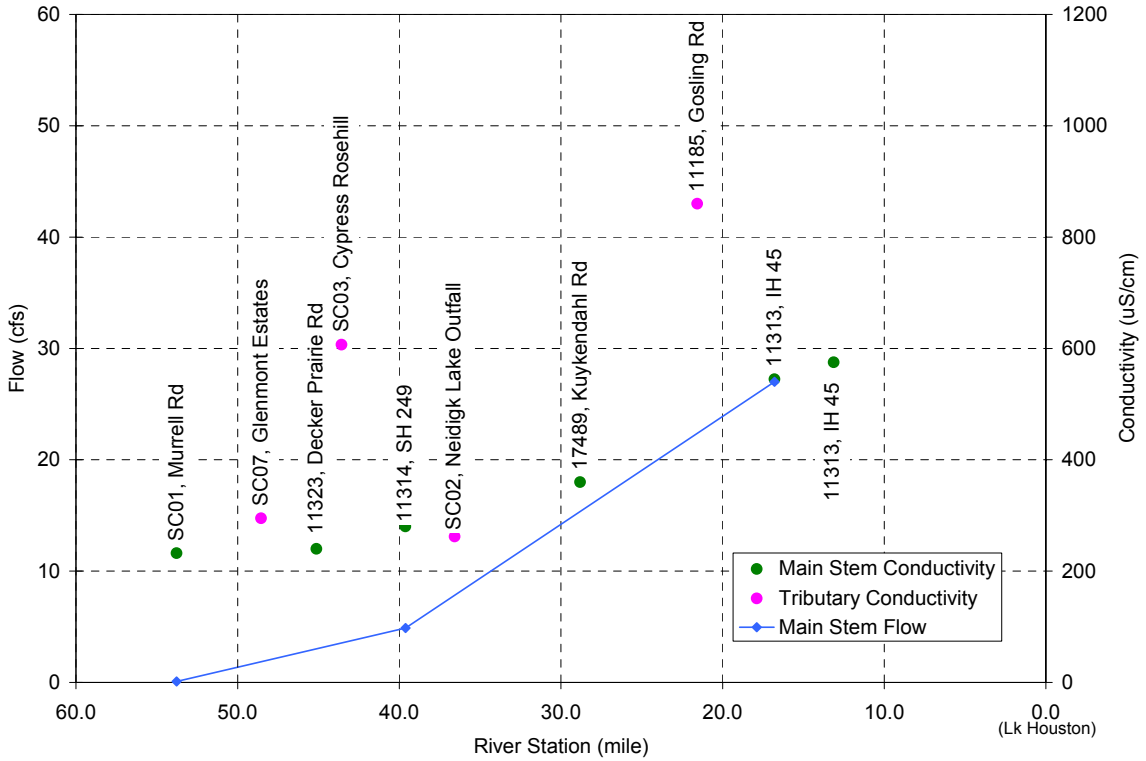

Figure 4-3: Spring Creek (Seg. 1008) Synoptic Cond. & Flow Profile, Nov. 2007

4.1.2 June 2008 Synoptic Survey

A second synoptic survey of Spring Creek's main stem was performed on 18 June 2008. As shown in Figure 4-4, several locations along Spring Creek were sampled during this survey. Detailed sampling results for these stations are presented in Table 4-2. A longitudinal profile of bacteria concentrations can be found in Figure 4-5, and a similar plot of flow and conductivity data can be found in Figure 4-6.

Prior to the survey, the last major rainfall occurred on 10 June. On this date, 0.87 inches of rainfall were recorded at the Houston Hooks Airport near Tomball. An additional 0.12 inches of rainfall occurred on 13 June.

The stations upstream of SH 249, were all characterized by low flows and fairly low bacteria counts. At most stations, conductivity values were fairly low, suggesting natural flow sources. At station SC03, on Walnut Creek, the conductivity was significantly higher, suggesting the influence of upstream WWTF discharges. At SH 249 (11314) the bacteria count was a moderately low 108 cfu/100mL, much lower than the level observed during the previous synoptic survey.

Mill Creek confluences with Spring Creek downstream of SH 249. This creek is impounded immediately upstream of this confluence (Lake Neidigk), and the sample (SC02) was taken at the lake's spillway. Because lakes typically act as a sink for bacteria, it is not surprising that this site had a very low bacteria count.

Panther Branch and Willow Creek added considerable flow (mostly WWTF effluent) to Spring Creek. The bacteria count at the downstream station on Willow Creek was moderately high, and higher than any of the counts observed in the main stem of Spring Creek. Additional sampling results for Panther Branch and Willow Creek are presented in Sections 4.2.2 and 4.3.2.

At the two most downstream stations (11313 and 11312), flows and conductivity levels were much higher than at the previous main stem stations. The bacteria counts at these stations were fairly low.

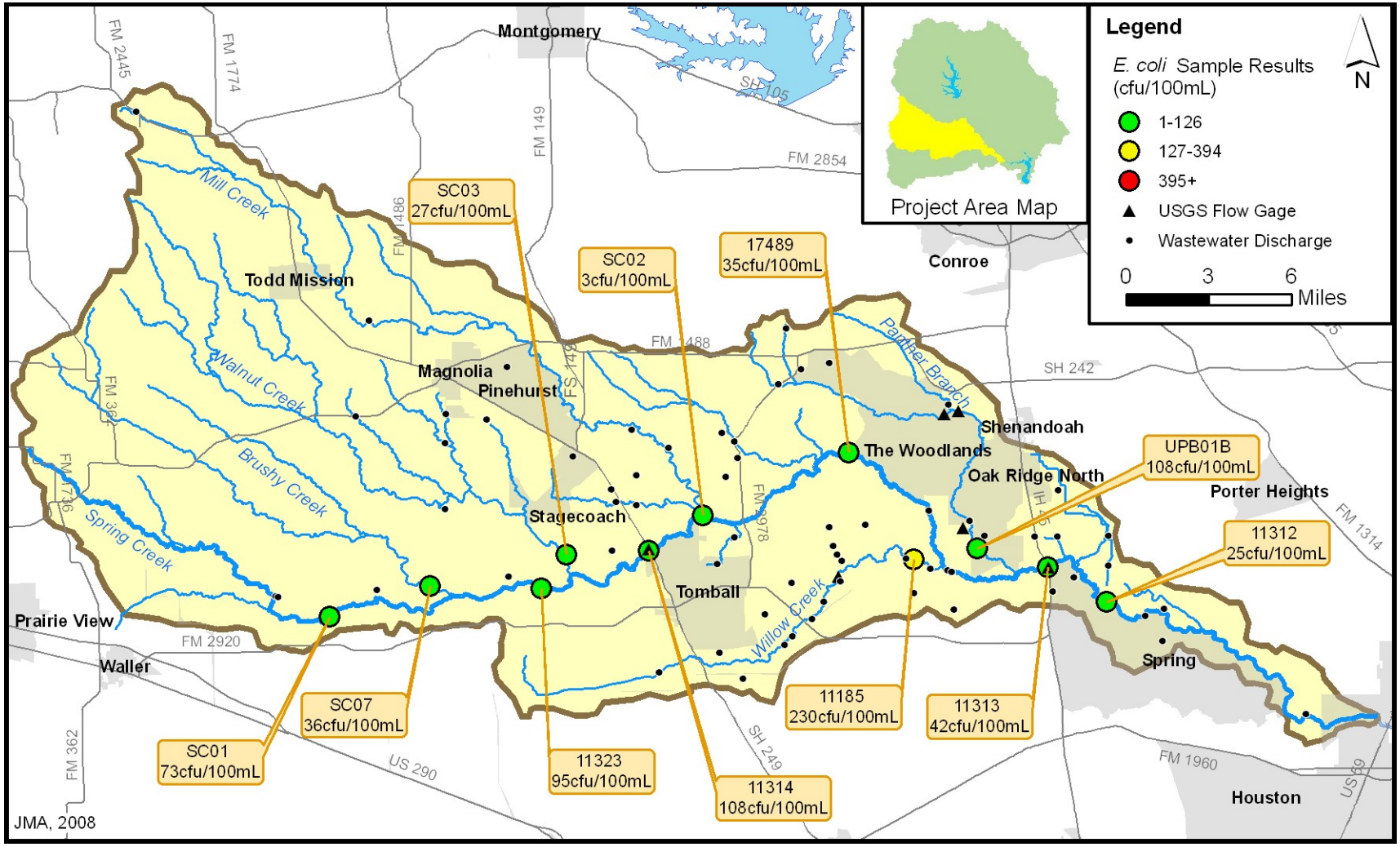

Figure 4-4: Spring Creek (Seg. 1008) Synoptic Survey Map, June 2008

Table 4-2: Spring Creek (Seg. 1008) Synoptic Survey Results, June 2008

Station Code	Station Type	Description	Station Mile	Sample Date	Sample Time	*E. coli* (cfu/100mL)	Flow Est. (cfs)	Flow* Severity	Temp (C)	Cond (µS/cm)	Total Cl2 (mg/L)
SC01	main stem	Murrell Rd	53.8	18-Jun-08	9:20	73	0.09	2	26.5	210	< 0.05
SC07	tributary	Glenmont Estates	48.6	18-Jun-08	9:56	36	0.31	2	25.7	293	< 0.05
11323	main stem	Decker Prairie Rd	45.1	18-Jun-08	11:18	95	-	2	27.7	243	0.08
SC03	tributary	Cypress Rosehill	43.6	18-Jun-08	10:56	27	0.7	3	25.9	457	< 0.05
11314	main stem	SH 249	39.6	18-Jun-08	9:10	108	4.1	3	26.9	329	< 0.05
SC02	tributary	Neidigk Lake Outfall	36.6	18-Jun-08	9:48	3	2.1	3	29.1	278	< 0.05
17489	main stem	Kuykendahl Rd	28.8	18-Jun-08	13:12	35	-	3	29.3	331	< 0.05
11185	Willow Crk	Gosling Rd	21.6	18-Jun-08	12:52	230	3.9	3	31.3	915	0.1
UPB01B	Panther Br	Grogan Point Rd.	18.1	18-Jun-08	16:40	108	-	3	33.7	750	< 0.05
11313	main stem	IH 45	16.8	18-Jun-08	13:25	42	14	3	30.8	530	< 0.05
11312	main stem	Riley Fuzzel Rd	13.1	18-Jun-08	13:50	25	-	3	32.2	576	< 0.05

*1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

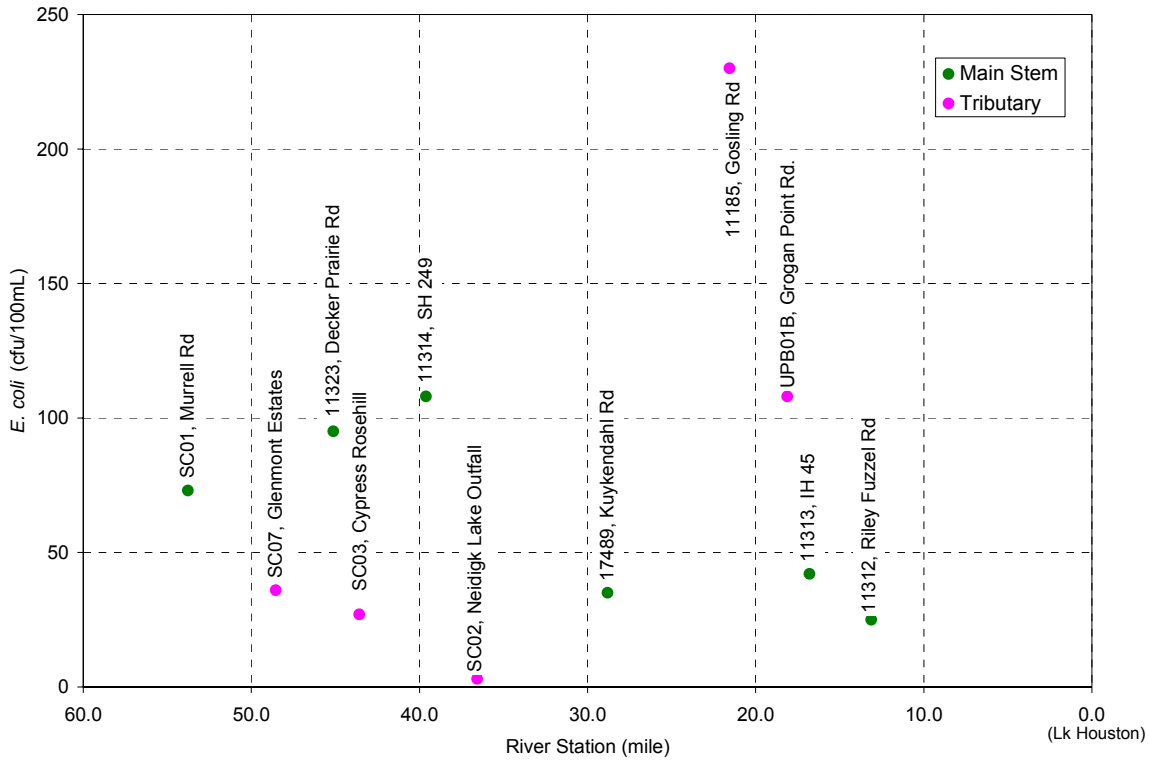

Figure 4-5: Spring Creek (Seg. 1008) Synoptic *E. coli* Profile, June 2008

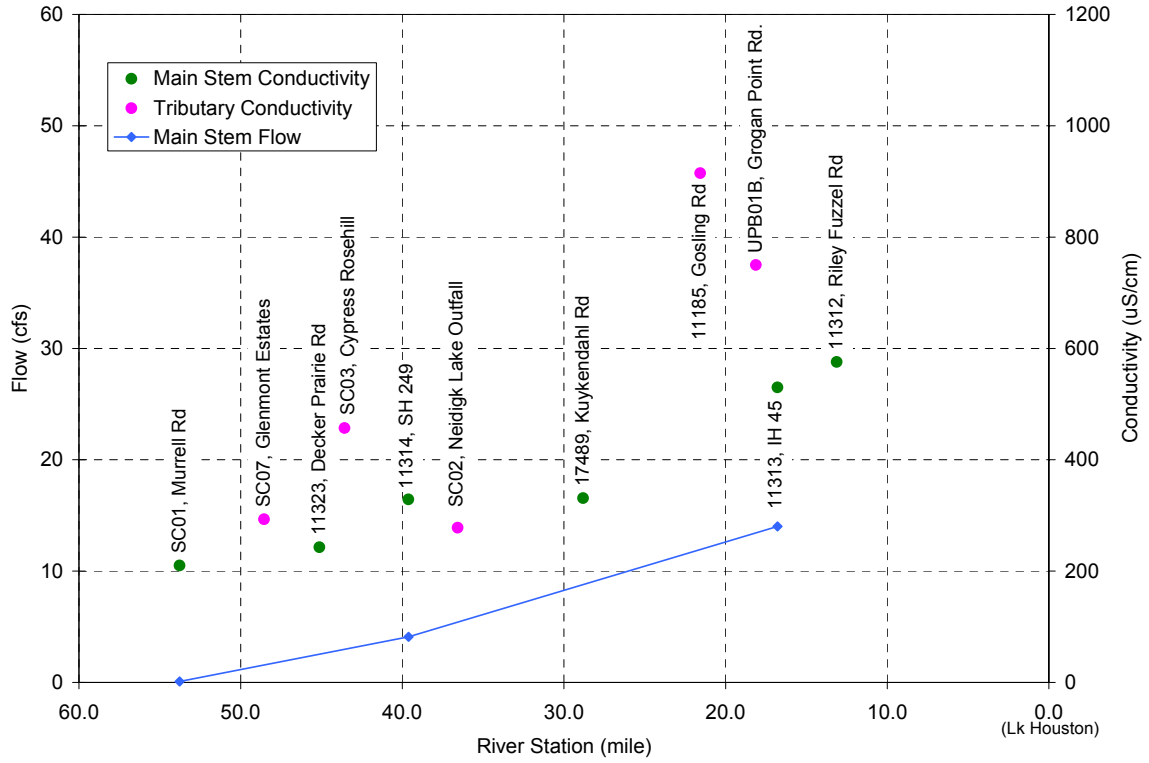

Figure 4-6: Spring Creek (Seg. 1008) Synoptic Cond. & Flow Profile, June 2008

4.2 UPPER PANTHER BRANCH, SEGMENT 1008B

4.2.1 November 2007 Synoptic Survey

A synoptic survey of Upper Panther Branch was performed on 7 November 2007. As shown in Figure 4-7, several locations along Upper Panther Branch were sampled during this survey. Detailed sampling results for these stations are presented in Table 4-3. A longitudinal profile of bacteria concentrations can be found in Figure 4-8, and a similar plot of flow and conductivity data can be found in Figure 4-9.

Prior to the survey, the last major rainfall occurred on 15 October. On this date, 1.54 inches of rainfall were recorded at the Houston Hooks Airport near Tomball. An additional 0.08 inches of rainfall occurred on 22 October.

The primary source of dry weather flow to Upper Panther Branch is the Woodlands WWTF (UPB04). Above this facility, flows in Panther Branch were only about 0.1 cfs, or less. Bacteria counts at upstream stations UPB02 and UPB03 were fairly low.

Station 16629 is located immediately above the Woodlands WWTF outfall, and station 16630 is located immediately downstream of the facility. The bacteria counts at these stations do not suggest that the WWTF is a major source of bacteria.

Bear Branch is a major tributary of Upper Panther Branch. Station UPB01 is located immediately downstream of an impoundment, and had a low bacteria count. Station 16631 is located closer to the confluence with Panther Branch and had a moderate bacteria count.

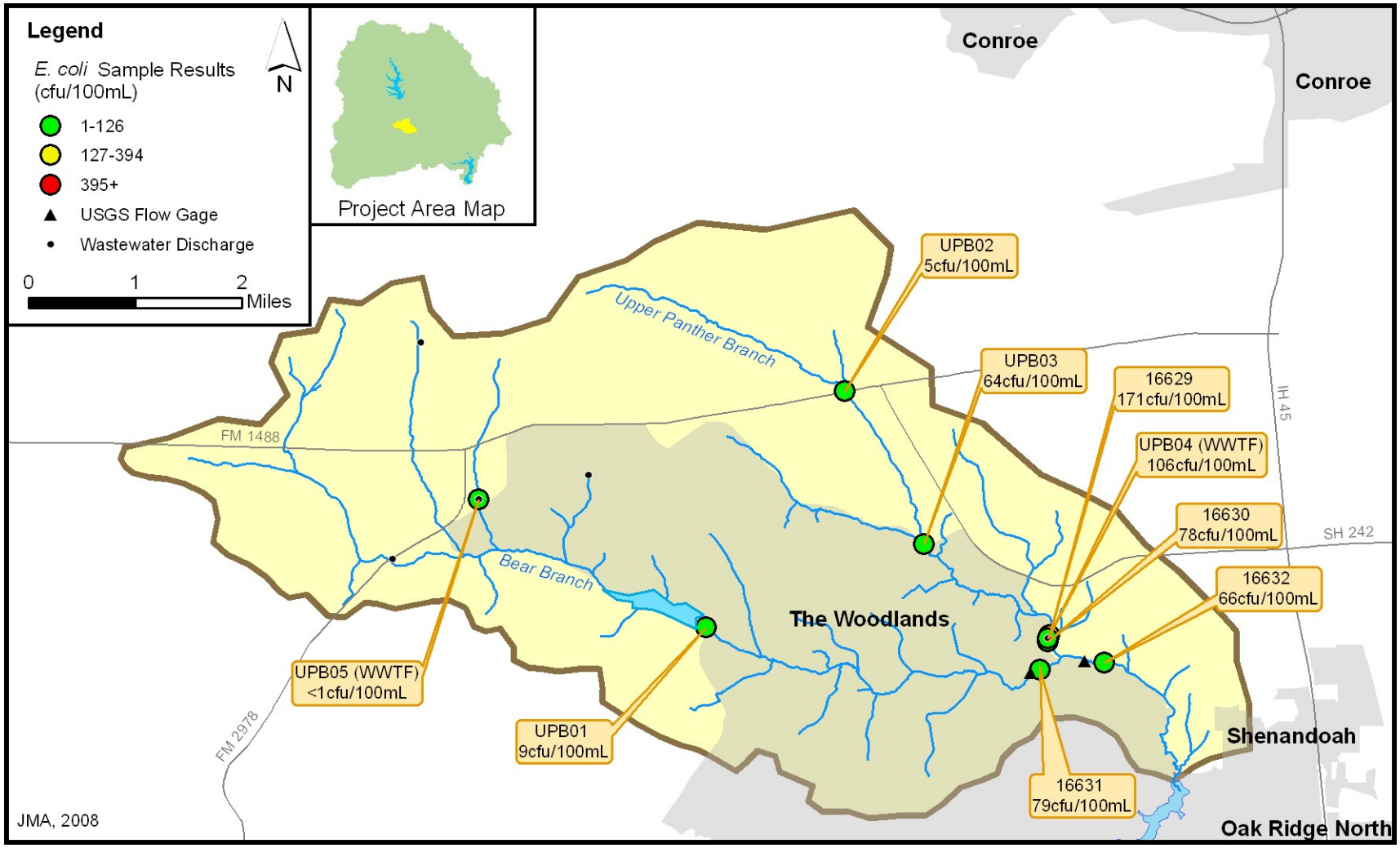

Figure 4-7: Upper Panther (Seg. 1008B) Synoptic Survey Map, Nov. 2007

Table 4-3: Upper Panther (Seg. 1008B) Synoptic Survey Results, Nov. 2007

Station Code	Station Type	Description	Station Mile	Sample Date	Sample Time	*E. coli* (cfu/100mL)	Flow Est. (cfs)*	Flow** Severity	Temp (C)	Cond (µS/cm)	Total Cl2 (mg/L)
UPB02	main stem	FM 1488	3.5	7-Nov-07	16:30	5	< 0.1	2	18.1	257	-
UPB03	main stem	Green Bridge Dr	1.9	7-Nov-07	16:15	64	0.13	2	16.9	280	-
16629	main stem	above WWTF	0.3	7-Nov-07	15:35	171	*0.4*	1	17.7	327	< 0.05
UPB04	WWTF	Woodlands	0.2	7-Nov-07	15:50	106	5.6	-	23.1	948	< 0.05
16630	main stem	below WWTF	0.2	7-Nov-07	16:00	78	*6*	3	23.6	912	-
UPB05	WWTF	Old Egypt Center	0.0	7-Nov-07	15:55	< 1	0.08	-	21.5	1545	> 3.5
UPB01	Bear Branch	Kuykendahl Rd	0.0	7-Nov-07	16:25	9	0.34	2	19.7	278	-
16631	Bear Branch	Research Forest	0.0	7-Nov-07	15:05	79	0.24	3	18.5	353	< 0.05
16632	main stem	Gosling Rd	-0.4	7-Nov-07	14:40	66	8.5	3	23.4	847	0.06

*Flow Estimates in *italics* were calculated based on flow measurements from nearby stations

**1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

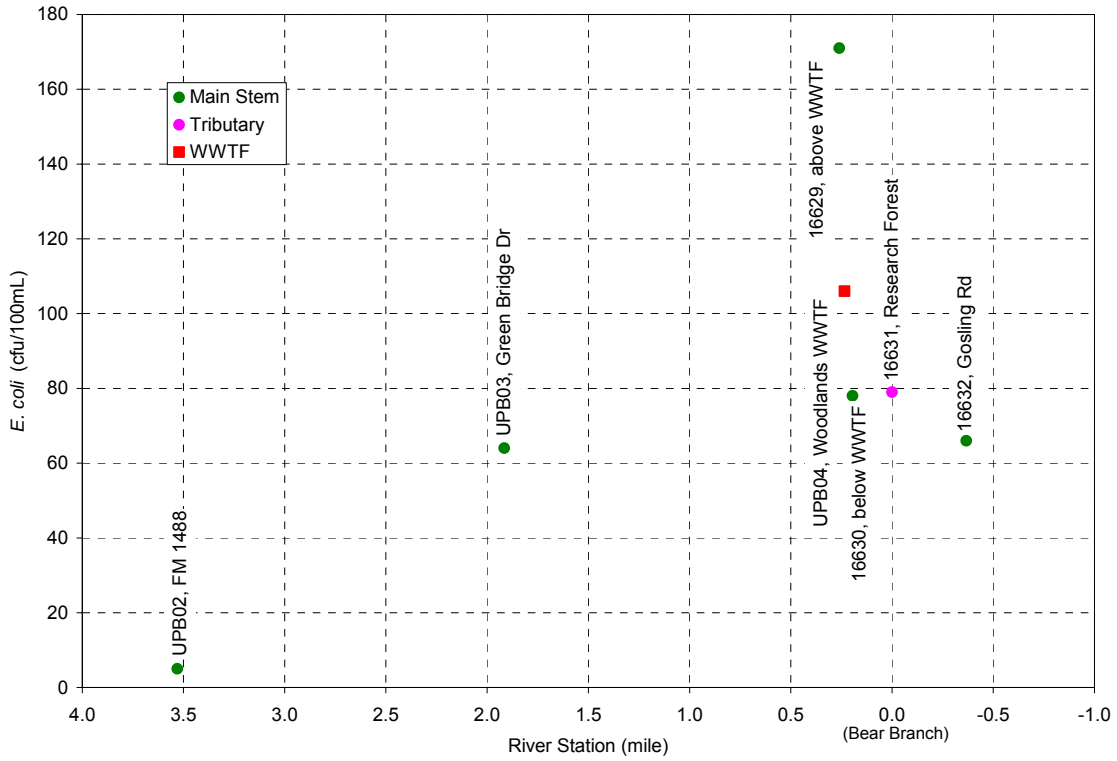

Figure 4-8: Upper Panther (Seg. 1008B) Synoptic *E. coli* Profile, Nov. 2007

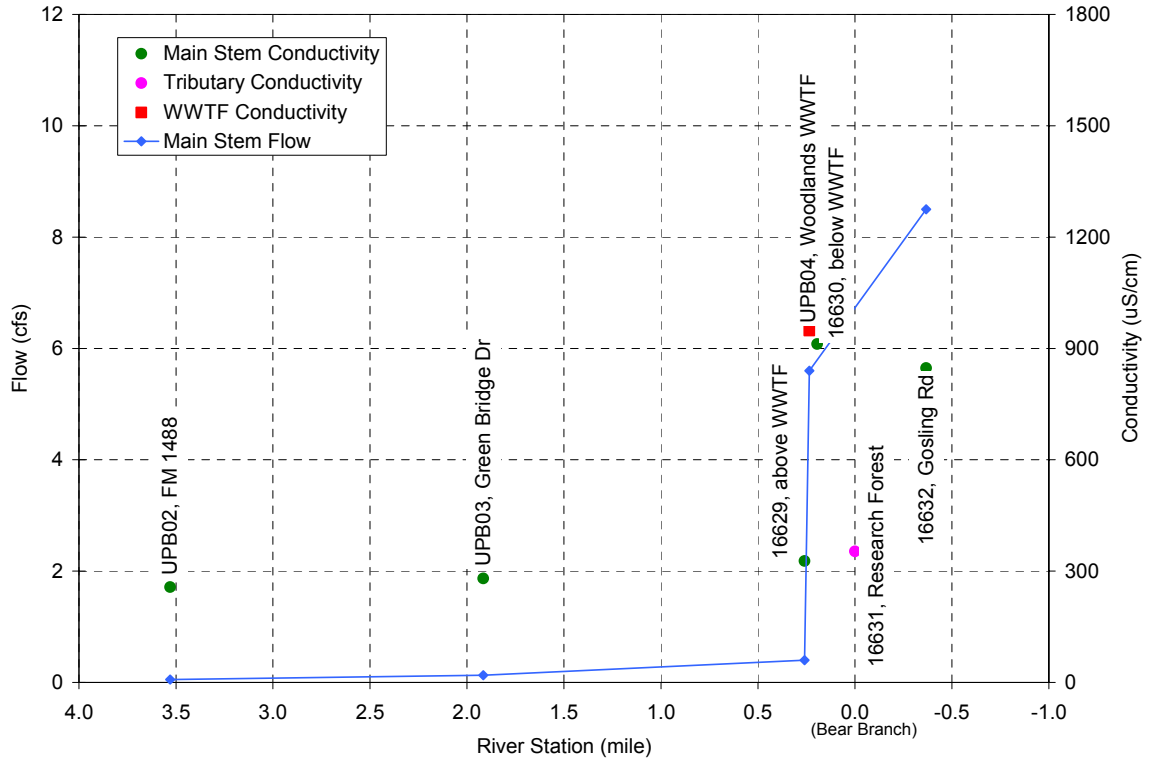

Figure 4-9: Upper Panther (Seg. 1008B) Synoptic Cond. & Flow Profile, Nov. 2007

4.2.2 June 2008 Synoptic Survey

A second synoptic survey of Upper Panther Branch was performed on 13 June 2008. As shown in Figure 4-10, several locations along Upper Panther Branch were sampled during this survey. Detailed sampling results for these stations are presented in Table 4-4. A longitudinal profile of bacteria concentrations can be found in Figure 4-11, and a similar plot of flow and conductivity data can be found in Figure 4-12.

Prior to the survey, the last major rainfall occurred on 10 June. On this date, 0.87 inches of rainfall were recorded at the Houston Hooks Airport near Tomball. An additional 0.12 inches of rainfall occurred on 13 June, though after the completion of sampling activities.

The primary source of dry weather flow to Upper Panther Branch is the Woodlands WWTF (UPB04). Above this facility, flows in Panther Branch were less than half of a cfs. While the bacteria count at UPB02 was relatively low, the bacteria count at UPB03 was relatively high.

Station 16629 is located immediately above the Woodlands WWTF outfall, and station 16630 is located immediately downstream of the facility. The bacteria counts at these stations do not suggest that the WWTF is a major source of bacteria.

Bear Branch is a major tributary of Upper Panther Branch. Station UPB01 is located immediately downstream of an impoundment and had a high bacteria count. Station 16631 is located closer to the confluence with Panther Branch and had a moderately low bacteria count.

At the most downstream station (16632), numerous birds were observed to be inhabiting the Gosling Road bridge. Therefore, a sample was pulled both upstream and downstream of the bridge. While both samples had moderately high bacteria counts, the samples did not indicate an increase in the bacteria load from upstream to downstream.

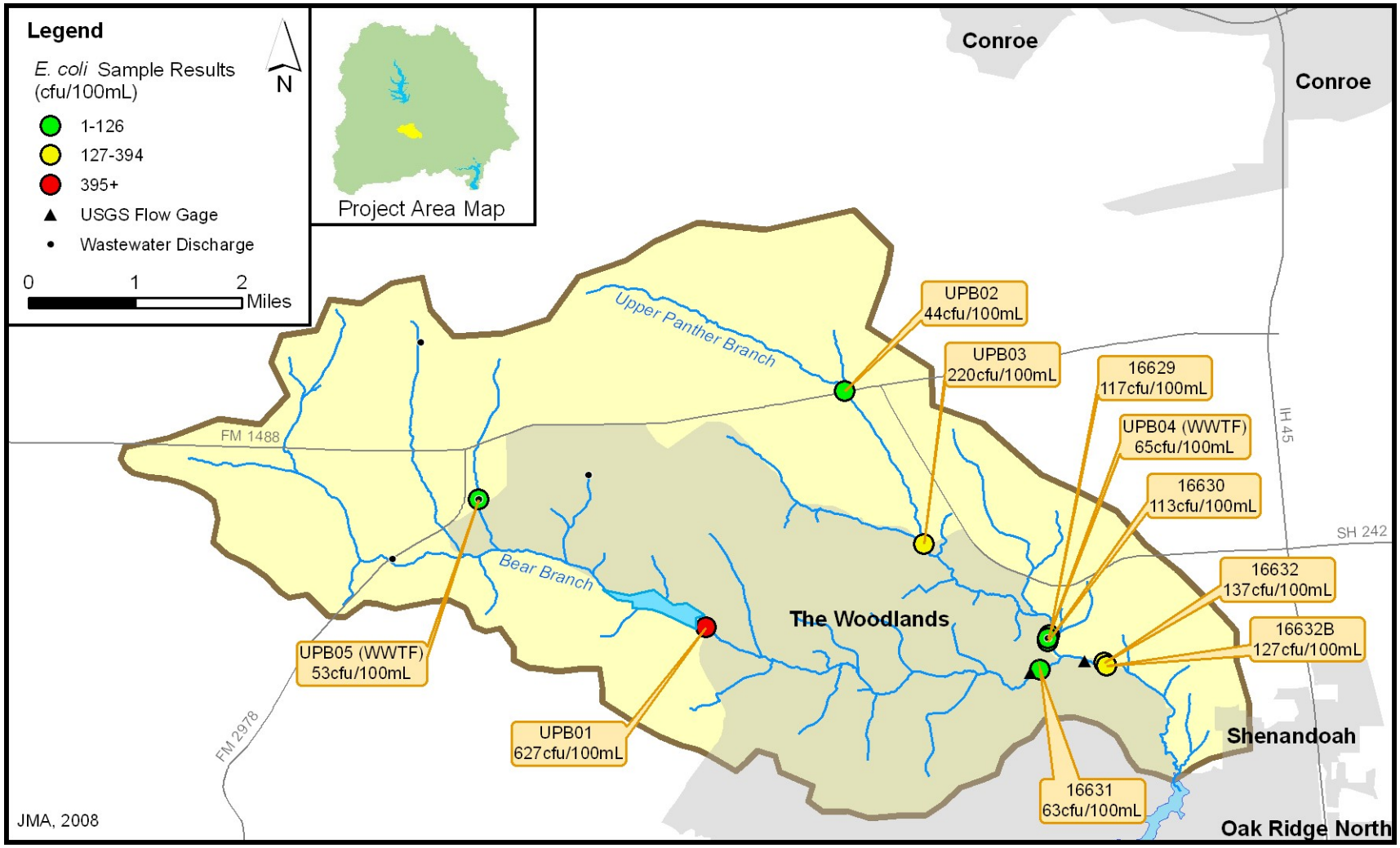

Figure 4-10: Upper Panther (Seg. 1008B) Synoptic Survey Map, June 2008

Table 4-4: Upper Panther (Seg. 1008B) Synoptic Survey Results, June 2008

Station Code	Station Type	Description	Station Mile	Sample Date	Sample Time	*E. coli* (cfu/100mL)	Flow Est. (cfs)*	Flow** Severity	Temp (C)	Cond (µS/cm)	Total Cl2 (mg/L)
UPB02	main stem	FM 1488	3.5	13-Jun-08	12:15	44	-	1	32.6	525	< 0.05
UPB03	main stem	Green Bridge Dr	1.9	13-Jun-08	12:00	220	0.35	3	27.2	359	< 0.05
16629	main stem	above WWTF	0.3	13-Jun-08	13:37	117	*0.35*	2	17.7	327	-
UPB04	WWTF	Woodlands	0.2	13-Jun-08	13:43	65	5.1	-	28.9	932	0.06
16630	main stem	below WWTF	0.2	13-Jun-08	13:55	113	*5.5*	3	29.7	915	< 0.05
UPB05	WWTF	Old Egypt Center	0.0	13-Jun-08	12:35	53	0.14	-	29.6	1284	0.9
UPB01	Bear Branch	Kuykendahl Rd	0.0	13-Jun-08	13:05	627	0.02	3	29.5	312	< 0.05
16631	Bear Branch	Research Forest	0.0	13-Jun-08	13:15	63	0.3	3	30.9	489	< 0.05
16632	main stem	Gosling Rd	-0.4	13-Jun-08	12:47	137	7.4	3	29.5	920	< 0.05
16632B	main stem	d/s of Gosling Rd.	-0.4	13-Jun-08	12:52	127	-	-	29.5	920	< 0.05

*Flow Estimates in *italics* were calculated based on flow measurements from nearby stations

**1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

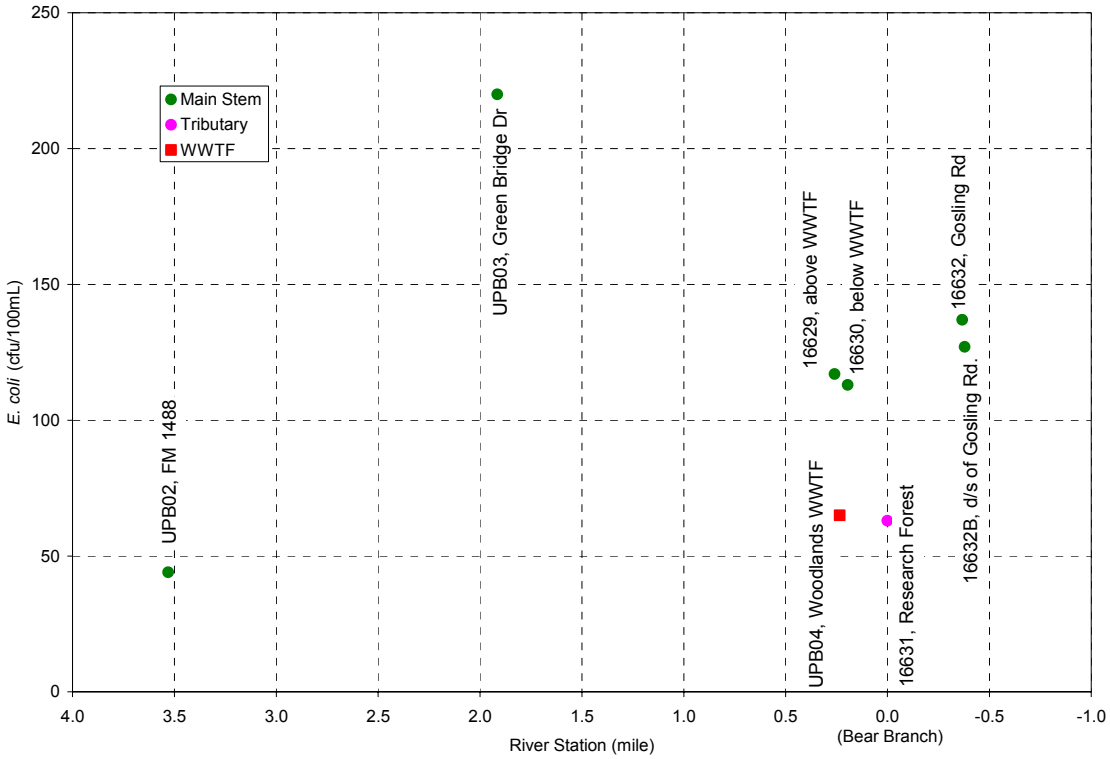

Figure 4-11: Upper Panther (Seg. 1008B) Synoptic *E. coli* Profile, June 2008

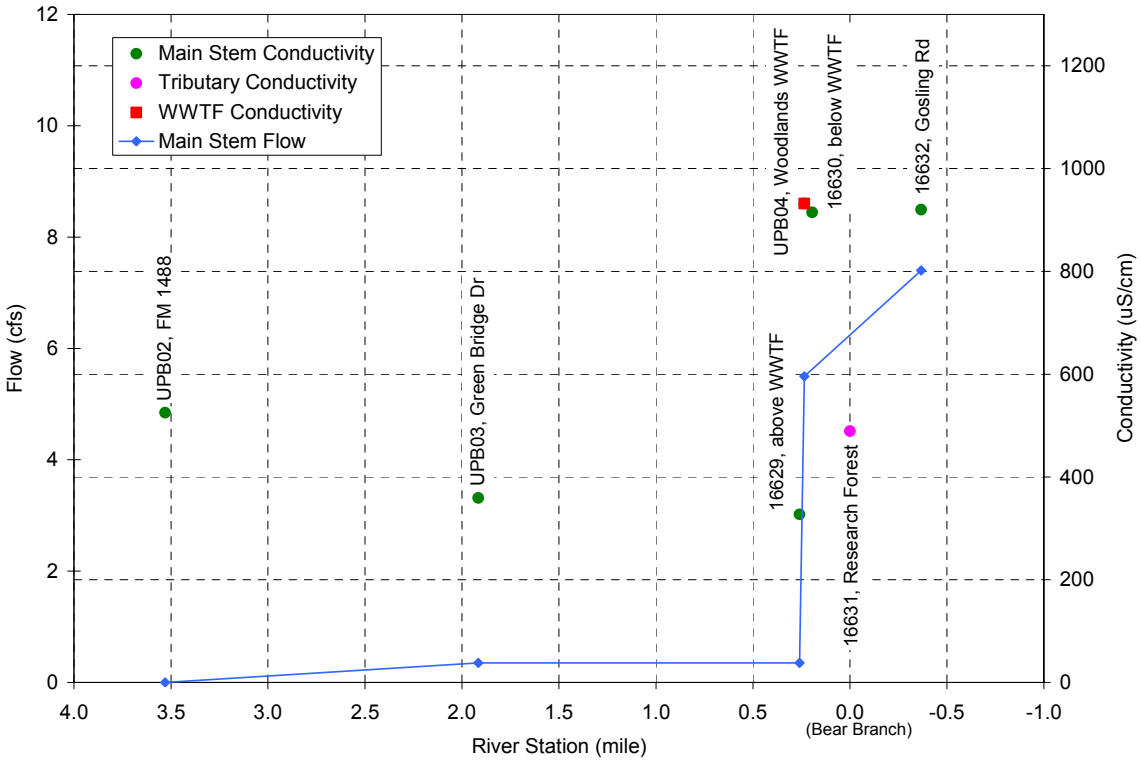

Figure 4-12: Upper Panther (Seg. 1008B) Synoptic Cond. & Flow Profile, June 2008

4.3 WILLOW CREEK, SEGMENT 1008H

4.3.1 November 2007 Synoptic Survey

A synoptic survey of Willow Creek was performed on 8 November 2007. As shown in Figure 4-13, several locations along Willow Creek were sampled during this survey. Detailed sampling results for these stations are presented in Table 4-5. A longitudinal profile of bacteria concentrations can be found in Figure 4-14, and a similar plot of flow and conductivity data can be found in Figure 4-15.

Prior to the survey, the last major rainfall occurred on 15 October. On this date, 1.54 inches of rainfall were recorded at the Houston Hooks Airport near Tomball. An additional 0.08 inches of rainfall occurred on 22 October.

The two most upstream stations on Willow Creek (WC05 and WC04) had zero flow, and very low bacteria counts. A trickle of flow existed at SH 249 (WC03), and the bacteria count here was also fairly low.

The Tomball WWTF (WC07) added significant flow, and from this point forward Willow Creek was effluent dominated. This WWTF and the other sampled WWTFs (WC09 and WC08), all had negligible bacteria counts.

Stations 16426 and WC02, downstream of Tomball, both had very low bacteria counts, even though little chlorine residual existed in the stream. Further downstream, station WC01, at Kuykendahl Rd, had the highest bacteria count in this segment, despite the presence of a chlorine residual.

Station WC06 is located on a tributary downstream of Kuykendahl Rd. The tributary receives discharges from multiple WWTFs, and the bacteria count at this station was fairly low.

The final main stem station was 11185. This station had a significant chlorine residual and a negligible bacteria count.

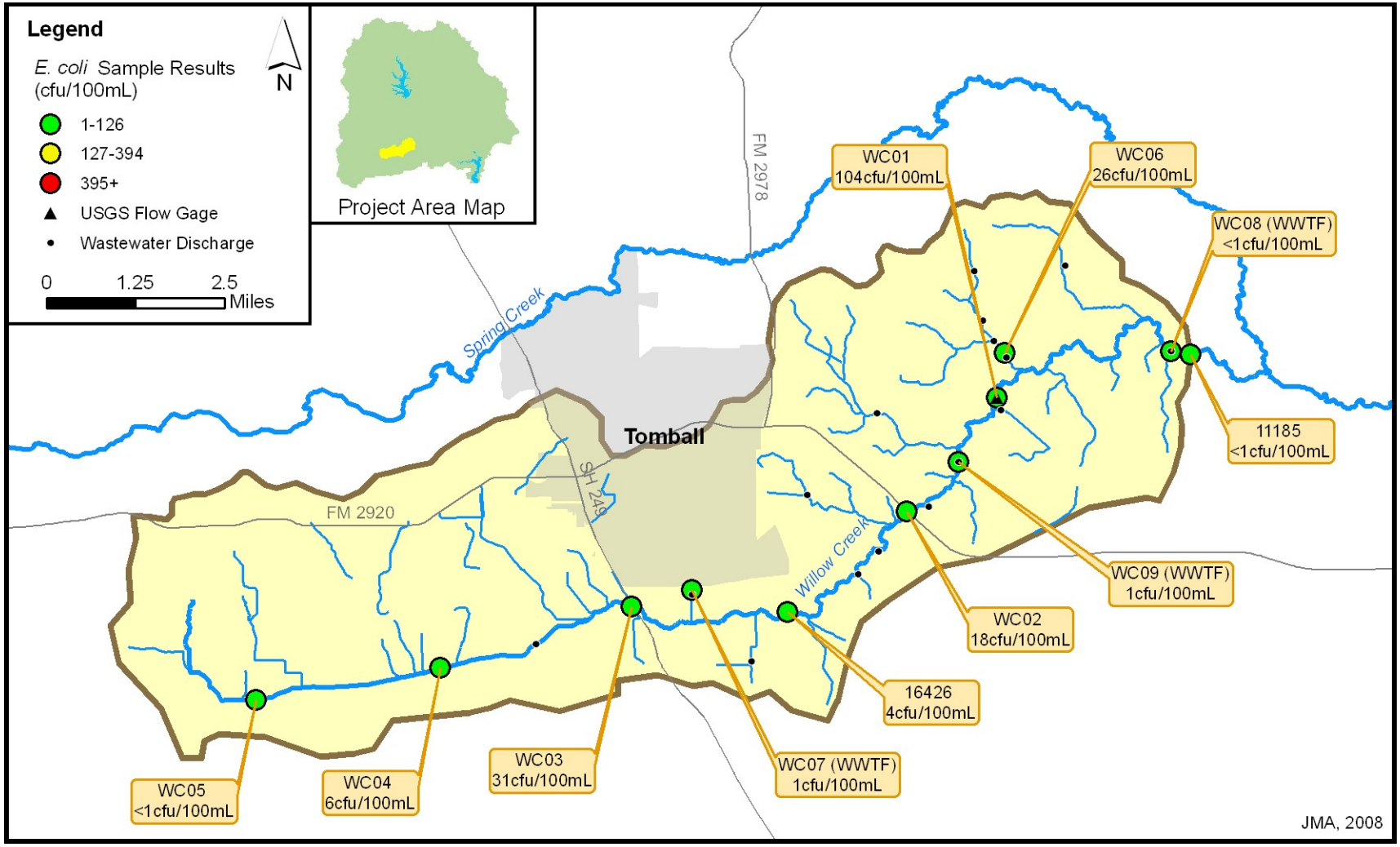

Figure 4-13: Willow Creek (Seg. 1008H) Synoptic Survey Map, Nov. 2007

Table 4-5: Willow Creek (Seg. 1008H) Synoptic Survey Results, Nov. 2007

Station Code	Station Type	Description	Station Mile	Sample Date	Sample Time	*E. coli* (cfu/100mL)	Flow Est. (cfs)	Flow* Severity	Temp (C)	Cond (µS/cm)	Total Cl2 (mg/L)
WC05	main stem	Cypress Rosehill	17.8	8-Nov-07	10:36	< 1	0	1	16.2	192	-
WC04	main stem	Telge Rd	15.4	8-Nov-07	10:56	6	0	1	18.8	199	-
WC03	main stem	SH 249	12.8	8-Nov-07	11:55	31	< 0.1	2	19.0	198	0.08
WC07	WWTF	Tomball	11.8	8-Nov-07	12:12	1	1.1	3	23.4	856	0.08
16426	main stem	Huffsmith Kohrville	10.5	8-Nov-07	13:34	4	2.5	3	20.1	810	< 0.05
WC02	main stem	FM 2920	7.8	8-Nov-07	11:50	18	1.6	3	17.5	840	< 0.05
WC09	WWTF	Dowdell	6.7	8-Nov-07	11:30	1	0.33	-	24.0	1310	2
WC01	main stem	Kuykendahl Rd	5.5	8-Nov-07	10:55	104	3.1	3	17.5	785	0.1
WC06	tributary	W Rayford Rd	5.4	8-Nov-07	10:05	26	-	3	19.1	1040	-
WC08	WWTF	Northhampton	1.7	8-Nov-07	9:27	< 1	0.65	3	22.8	964	> 3.5
11185	main stem	Gosling Rd	1.4	8-Nov-07	9:00	< 1	5.7	3	16.6	860	0.8

*1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

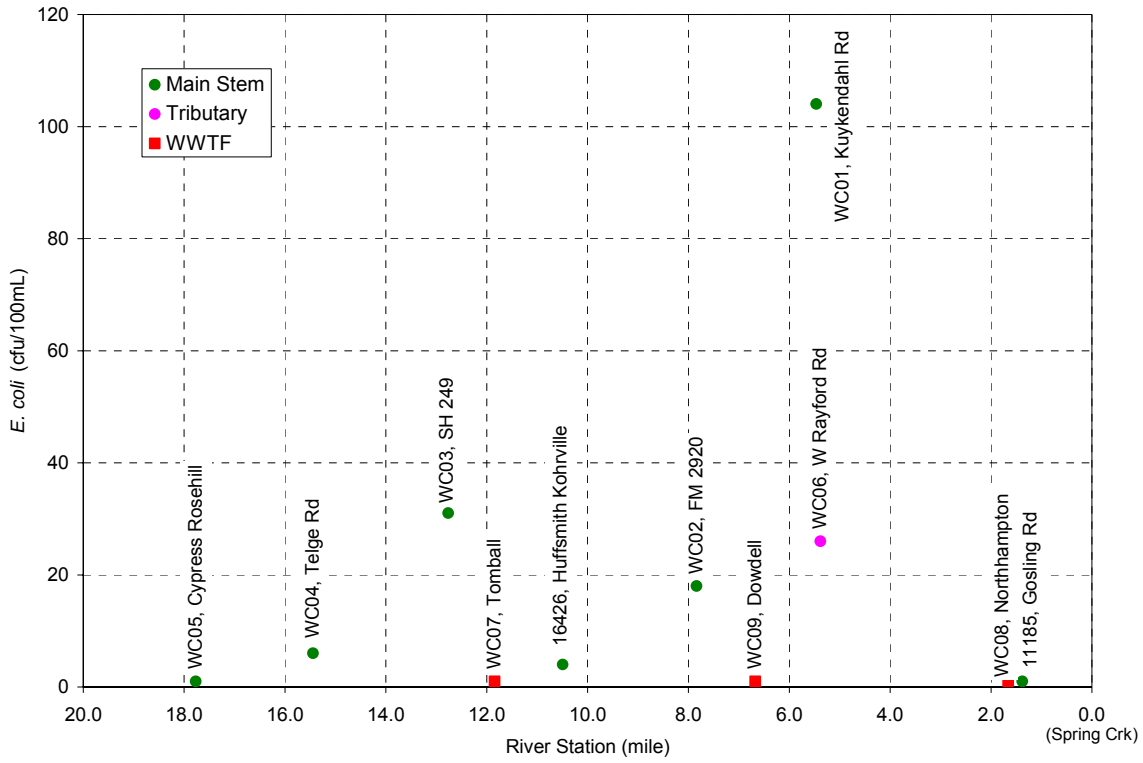

Figure 4-14: Willow Creek (Seg. 1008H) Synoptic *E. coli* Profile, Nov. 2007

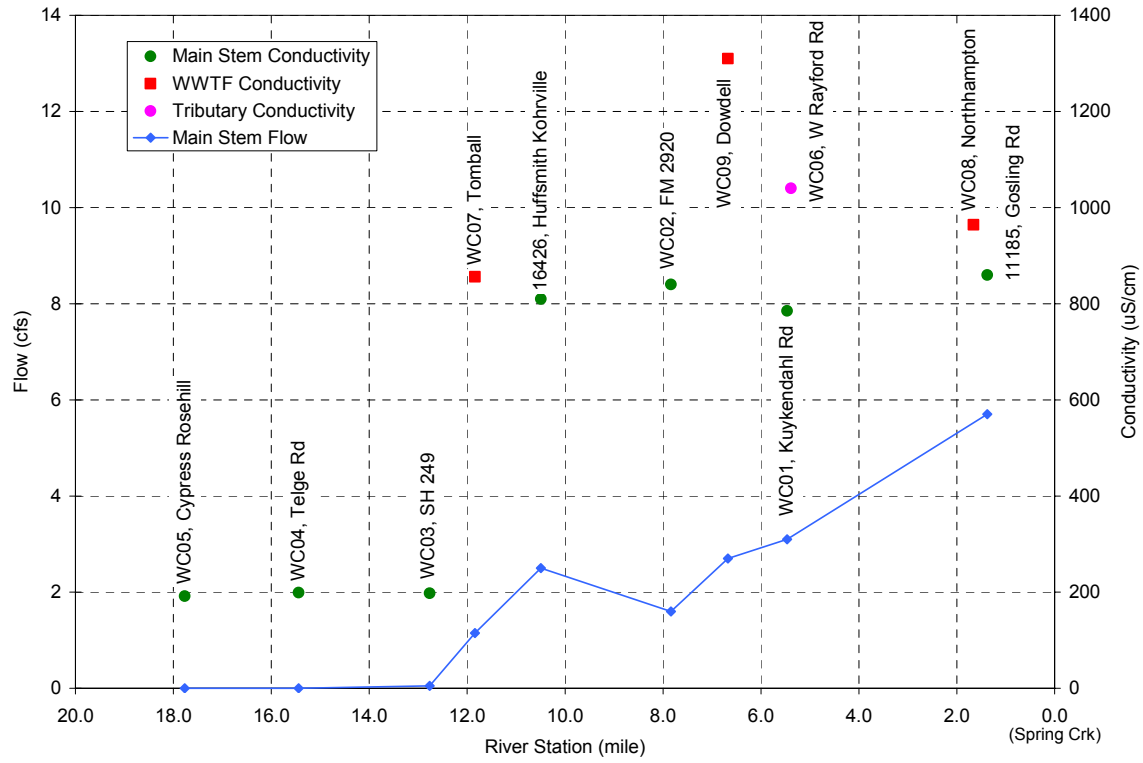

Figure 4-15: Willow Creek (Seg. 1008H) Synoptic Cond. & Flow Profile, Nov. 2007

4.3.2 June 2008 Synoptic Survey

A second synoptic survey of Willow Creek was performed on 18 June 2008. As shown in Figure 4-16, several locations along Spring Creek were sampled during this survey. Detailed sampling results for these stations are presented in Table 4-6. A longitudinal profile of bacteria concentrations can be found in Figure 4-17, and a similar plot of flow and conductivity data can be found in Figure 4-18.

Prior to the survey, the last major rainfall occurred on 10 June. On this date, 0.87 inches of rainfall were recorded at the Houston Hooks Airport near Tomball. An additional 0.12 inches of rainfall occurred on 13 June.

At the most upstream sampling site (WC04) there was zero flow and the bacteria count was very low. A trickle of flow existed at SH 249 (WC03), and the bacteria count here was also low.

Three WWTFs were sampled during the synoptic survey. The Tomball WWTF (WC07) was the most upstream WWTF, and from this point forward Willow Creek was effluent dominated. Because of its large size, the Tomball WWTF is required to dechlorinate before discharging. This resulted in a negligible chorine residual, but the bacteria count was still very low. The next downstream WWTF sample (WC09) had a very high chlorine residual and a negligible bacteria count. The third WWTF sample (WC08) resulted in a somewhat higher bacteria count despite the presence of a significant chlorine residual.

Downstream of the Tomball WWTF, most main stem samples had moderately low bacteria counts even though little chlorine residual existed in the stream. The final main stem station (11185) was an exception. This site had the combination of a chlorine residual and a moderately high bacteria count.

Station WC06 is located on a tributary downstream of Kuykendahl Rd. The tributary receives discharges from multiple WWTFs, and the bacteria count at this station was moderately low.

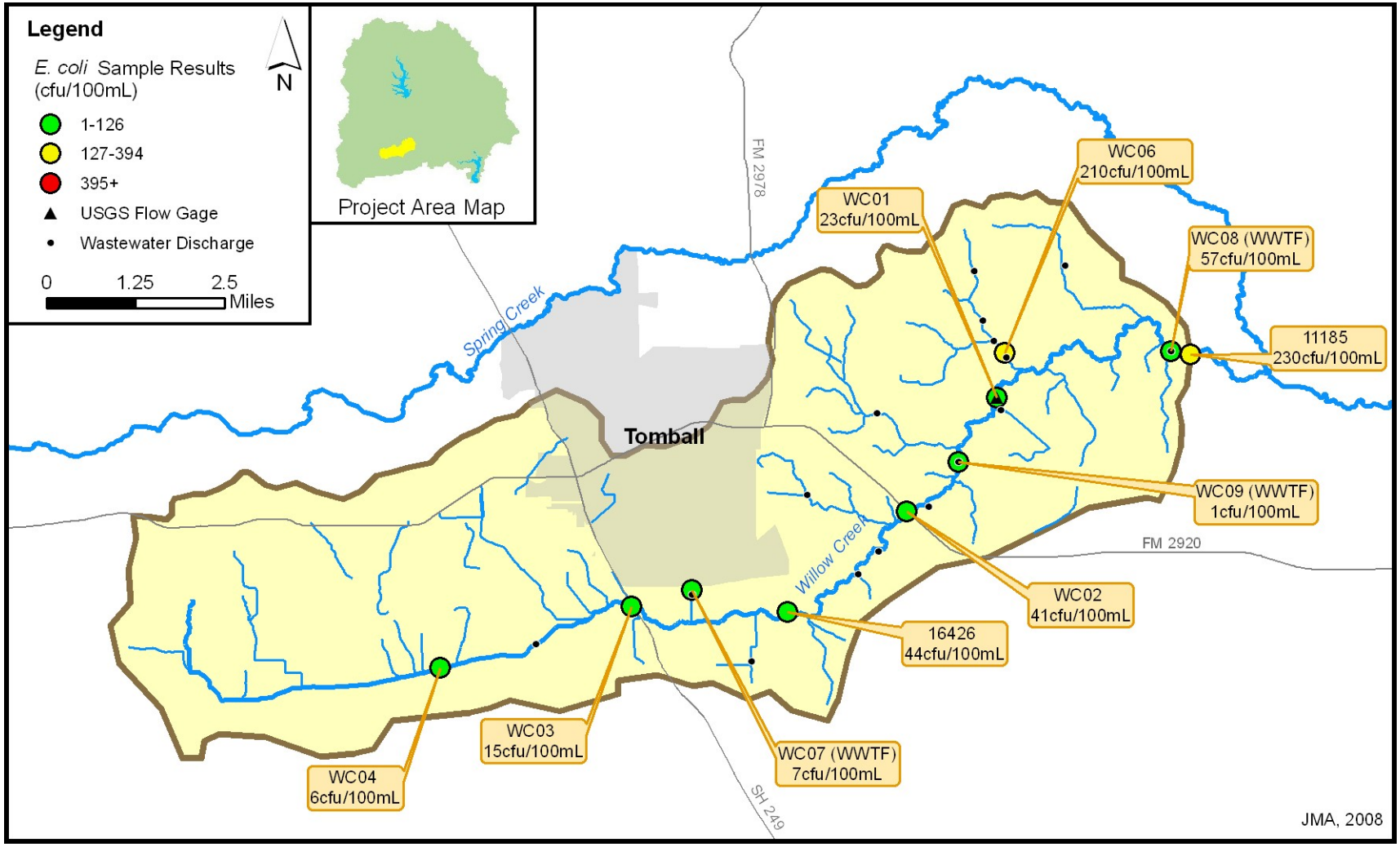

Figure 4-16: Willow Creek (Seg. 1008H) Synoptic Survey Map, June 2008

Table 4-6: Willow Creek (Seg. 1008H) Synoptic Survey Results, June 2008

Station Code	Station Type	Description	Station Mile	Sample Date	Sample Time	*E. coli* (cfu/100mL)	Flow Est. (cfs)	Flow* Severity	Temp (C)	Cond (µS/cm)	Total Cl2 (mg/L)
WC04	main stem	Telge Rd	15.4	18-Jun-08	11:30	6	0	1	31.2	188	< 0.05
WC03	main stem	SH 249	12.8	18-Jun-08	10:42	15	0.04	2	29.5	317	< 0.05
WC07	WWTF	Tomball WWTF	11.8	18-Jun-08	10:54	7	1.0	-	29.4	866	< 0.05
16426	main stem	Huffsmith Kohrville	10.5	18-Jun-08	10:20	44	-	3	28.2	964	< 0.05
WC02	main stem	FM 2920	7.8	18-Jun-08	11:20	41	-	3	28.7	930	< 0.05
WC09	WWTF	Dowdell	6.7	18-Jun-08	11:40	1	0.32	-	30.3	1235	> 3.5
WC01	main stem	Kuykendahl Rd	5.5	18-Jun-08	11:55	23	2.2	3	30.5	903	< 0.05
WC06	tributary	W Rayford Rd	5.4	18-Jun-08	12:10	210	0.69	3	29.4	1015	0.1
WC08	WWTF	Northhampton	1.7	18-Jun-08	12:35	57	0.54	-	29.5	975	0.9
11185	main stem	Gosling Rd	1.4	18-Jun-08	12:52	230	3.9	3	31.3	915	0.1

*1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

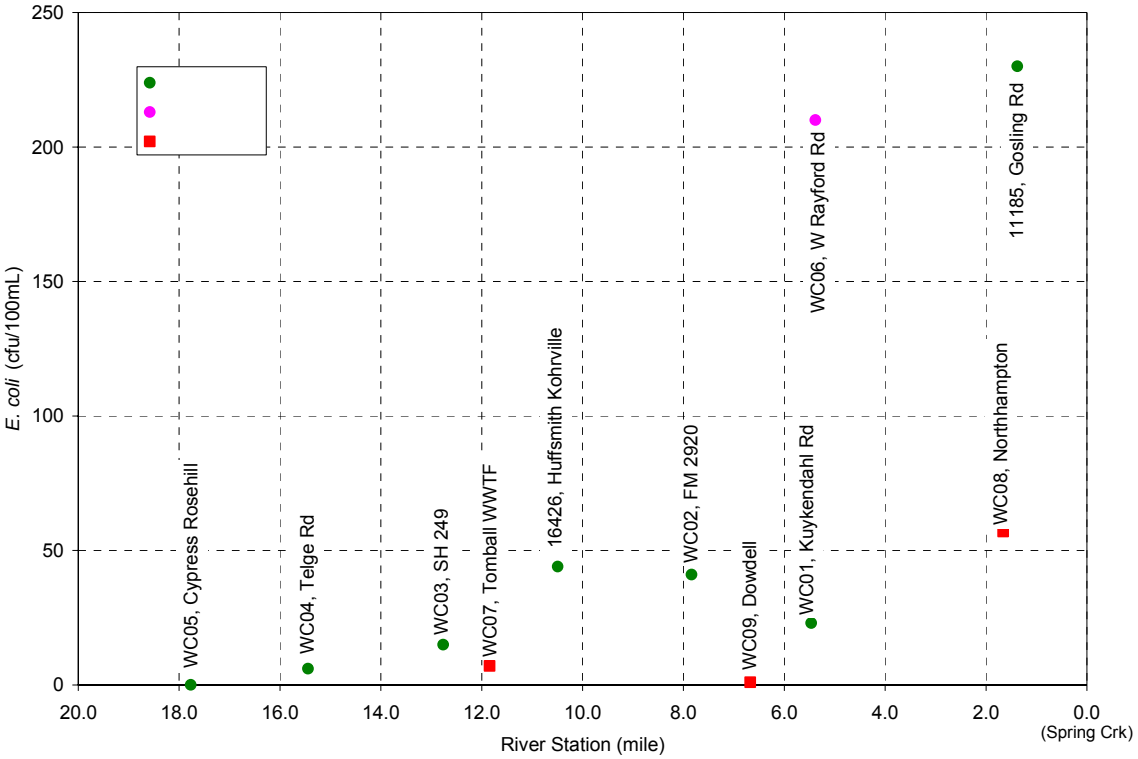

Figure 4-17: Willow Creek (Seg. 1008H) Synoptic *E. coli* Profile, June 2008

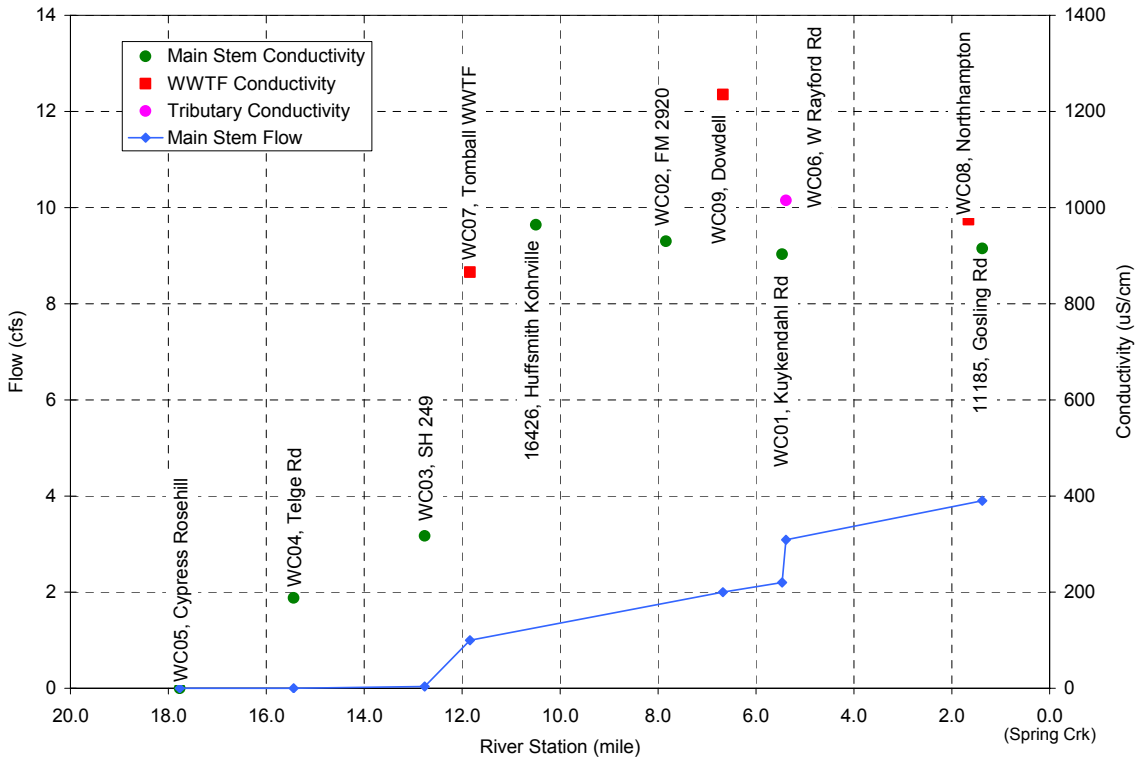

Figure 4-18: Willow Creek (Seg. 1008H) Synoptic Cond. & Flow Profile, June 2008

4.3.3 Spatially Intensive Survey of Willow Creek

A spatially intensive survey of Willow Creek was performed on 13-14 May 2008. The survey extended from SH 249 to Gosling Rd. Fifty-two sites were sampled for *E. coli*. These locations included all points of access to the creek and all major tributaries, as shown in Figures 4-19 and 4-20. Complete survey results are tabulated in Table 4-7.

Prior to the survey, the last significant rainfall occurred on 5 May. On this date, 3.45 inches of rainfall were recorded at the Houston Hooks Airport near Tomball. An additional 0.15 inches of rainfall occurred on 14 May following the completion of sampling activities.

At SH 249, four samples were collected. The two highway drainage outfalls (W10A and W10C) both had low bacteria counts. The two stream samples (W10 and W10B, above and below the bridge) had moderately low bacteria counts. The conductivities were relatively low, suggesting natural flow sources.

From SH 249 to FM 2920, all main-stem samples had fairly low bacteria counts. Flow in this section of Willow Creek increased from about 0.5 cfs to 2.9 cfs due to the contribution of several WWTFs. Conductivities in the main stem increased accordingly as the creek became effluent dominated. The WWTFs in this reach all had low bacteria counts. However, samples collected above and below the HC MUD 368 WWTF (W14) had significantly higher counts.

From FM 2920 to near Gosling Road, most main stem sites had relatively high bacteria counts. The highest main stem bacteria count (560 cfu/100mL) was observed just upstream of the confluence with Cannon Gully (W33). WWTFs in this section all had low bacteria counts. Bacteria counts in tributaries varied greatly.

At Gosling Road (W43), the main stem bacteria count was very low. This was most likely the result of the high chlorine residual originating from the Northampton MUD WWTF (W42).

Cannon Gully was the most intensely sampled tributary of this study. Four WWTFs discharge to Cannon Gully and its northern tributary, which cause the Gully to be effluent dominated. All four facilities had low bacteria counts. However, in-stream bacteria levels were high at a few locations along this tributary.

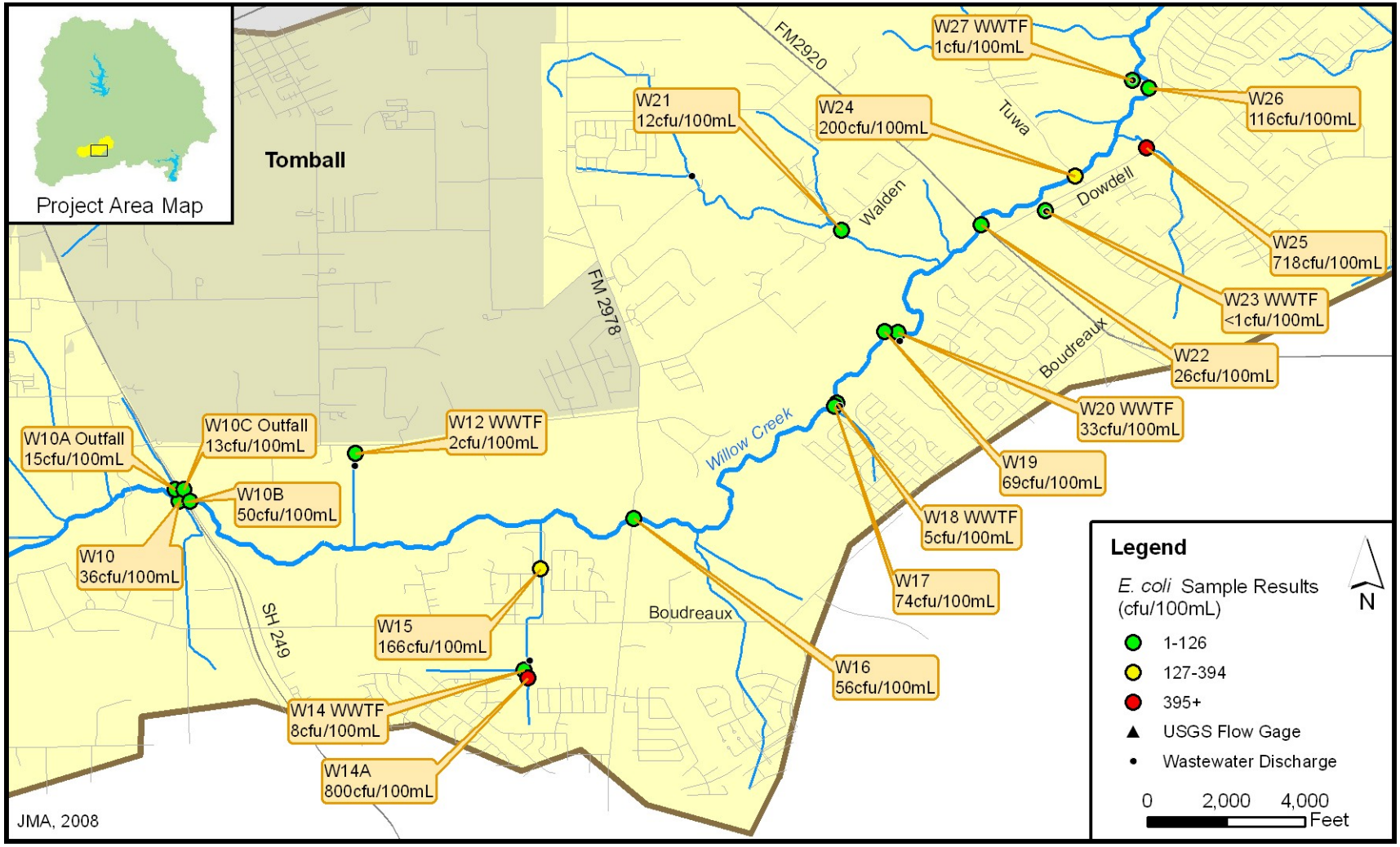

Figure 4-19: Willow Creek Spatially Intensive Survey above Kuykendahl Rd

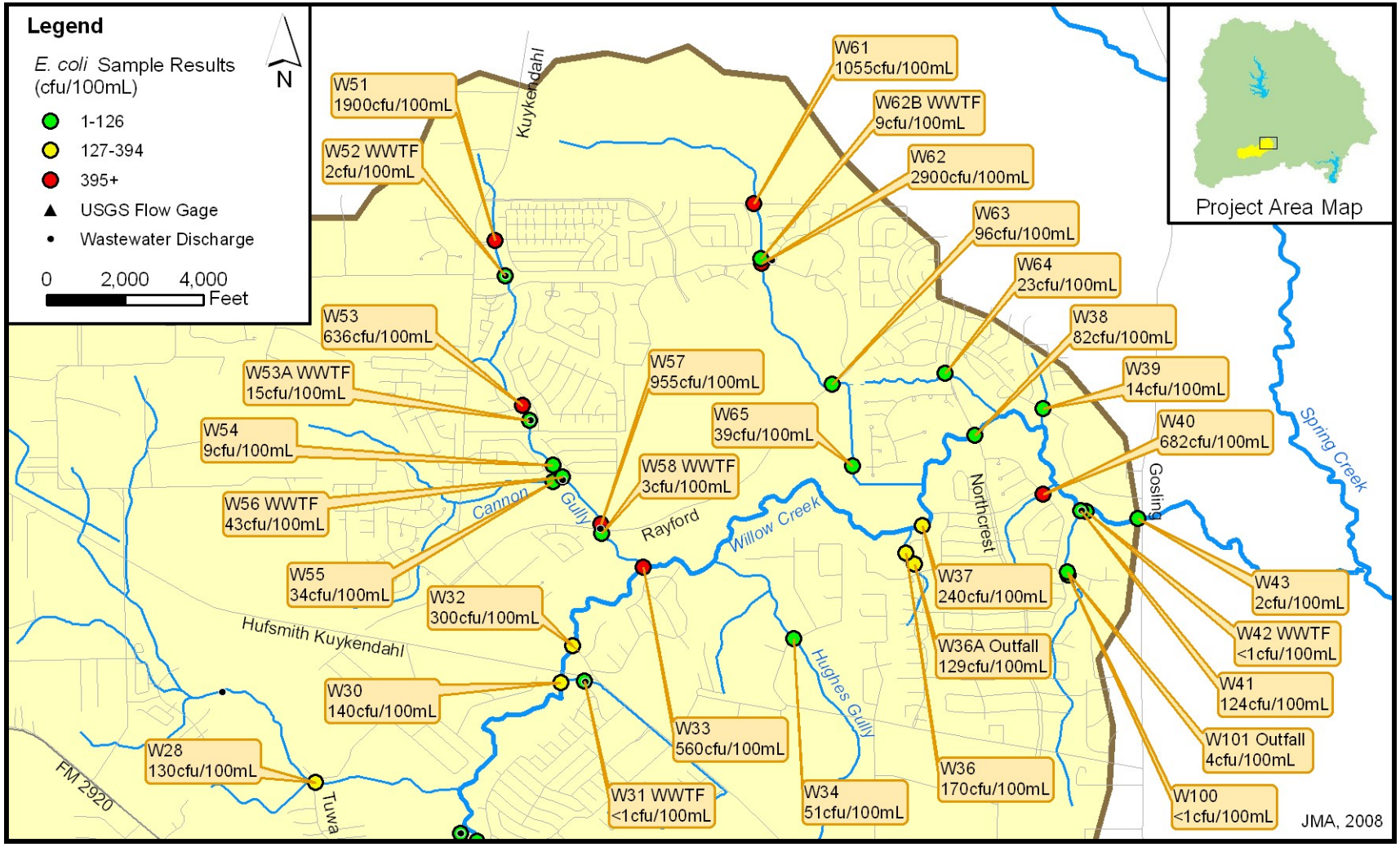

Figure 4-20: Willow Creek Spatially Intensive Survey below Kuykendahl Rd

Table 4-7A: Willow Creek Spatially Intensive Survey Results

Site ID	Site Description	Date	Time	*E. coli* (cfu/100mL)	Flow* Severity	Temp (C°)	Cond (µS/cm)	Cl2 (mg/L)	Flow (cfs)	Site Mile
W10A	Drainage Ditch u/s of SH 249	13-May-08	15:26	15	-	22.7	198	-	0.003	13.05
W10	Willow Crk u/s of SH 249	13-May-08	15:15	36	2	25.2	165	-	0.48	13.05
W10B	Willow Crk d/s of SH 249	13-May-08	15:37	50	2	25.0	175	-	-	13.00
W10C	Drainage Ditch d/s of SH 249	13-May-08	15:47	13	-	23.9	127	-	0.06	13.00
W12	City of Tomball WWTF	13-May-08	14:38	2	-	25.8	892	< 0.05	0.99	12.11
W14A	Trib. u/s of HC MUD 368	13-May-08	12:33	800	2	27.0	863	0.1	-	11.23
W14	HC MUD 368 WWTF	13-May-08	12:19	8	-	26.6	1034	1.4	0.81	11.23
W15	Trib. 2860 ft. d/s of HC MUD 368	13-May-08	11:48	166	3	25.3	969	0.12	-	11.23
W16	Willow Crk at FM 2978	13-May-08	11:05	56	3	24.6	667	< 0.05	1.9	10.74
W17	Willow Crk u/s of Inline Utilities WWTF	13-May-08	10:44	74	3	24.0	575	< 0.05	-	9.46
W18	Inline Utilities WWTF	13-May-08	10:25	5	-	25.0	640	0.3	0.16	9.44
W19	Willow Crk u/s of HC MUD 401	13-May-08	9:44	69	3	24.3	605	< 0.05	-	8.98
W20	HC MUD 401 WWTF	13-May-08	9:53	33	-	25.2	1481	0.7	0.1	8.93
W21	Trib. at Walden Rd.	13-May-08	16:33	12	2	24.6	154	-	0.004	8.36
W22	Willow Crk at FM 2920	13-May-08	9:01	26	3	23.4	563	< 0.05	2.9	8.10
W23	Pinewood Community WWTF	13-May-08	17:31	< 1	-	26.0	593	2.2	0.11	7.78
W24	Willow Crk at Tuwa Drive	13-May-08	17:56	200	3	25.1	565	< 0.05	-	7.55
W25	Trib. at Dowdell Rd.	13-May-08	17:57	718	3	25.8	132	< 0.05	0.19	7.27
W26	Willow Crk u/s of Dowdell PUD WWTF	13-May-08	17:45	116	3	25.2	514	< 0.05	-	6.99
W27	Dowdell PUD WWTF	13-May-08	17:39	1	-	26.7	1312	3.5	0.36	6.91
W28	Trib. at Tuwa Drive	13-May-08	17:44	130	2	26.4	151	-	0.002	6.70
W30	Willow Crk u/s of Willow Oaks WWTF	13-May-08	16:56	140	3	25.7	649	0.4	-	5.83
W31	Willow Oaks (Aqua Utilities) WWTF	13-May-08	17:14	< 1	-	25.0	645	3.5	0.02	5.79
W32	Willow Crk at Kuykendahl Rd.	13-May-08	16:21	300	3	24.8	534	< 0.05	7.1	5.65
W33	Willow Crk u/s of Cannon Gully	13-May-08	16:08	560	3	24.9	565	< 0.05	-	5.01
W51	Cannon Trib u/s of Timbercrest WWTF	14-May-08	8:39	1900	1	25.0	170	< 0.05	-	4.98

*1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

Table 4-7B: Willow Creek Spatially Intensive Survey Results (continued)

Site ID	Site Description	Date	Time	*E. coli* (cfu/100mL)	Flow* Severity	Temp (C°)	Cond (µS/cm)	Cl2 (mg/L)	Flow (cfs)	Site Mile
W52	Timbercrest Community WWTF	14-May-08	8:25	2	-	24.8	627	2.8	0.16	4.98
W53	Cannon Trib u/s of HC MUD 1 WWTF	14-May-08	8:45	636	2	25.0	916	< 0.05	-	4.98
W53A	HC MUD 1 WWTF	14-May-08	9:03	15	-	25.8	1077	0.9	0.36	4.98
W54	Cannon Trib u/s of Timberwilde WWTF	14-May-08	9:15	9	3	25.1	886	0.55	1.1	4.98
W56	Timberwilde (Aqua Utilities) WWTF	14-May-08	9:32	43	-	25.3	659	3	0.04	4.98
W55	Cannon Gully u/s of Cannon Trib	14-May-08	9:50	34	3	26.1	269	< 0.05	0.28	4.98
W57	Cannon Gully u/s of NWHC MUD 19	13-May-08	16:36	955	3	25.5	987	0.8	0.51	4.98
W58	NWHC MUD 19 WWTF	13-May-08	16:42	3	-	25.3	1107	0.4	0.2	4.98
W34	Hughes Gulley at Hampton Oaks Rd.	13-May-08	15:50	51	2	25.0	72	< 0.05	0.86	4.63
W36A	Outfall at Wellington Trib	13-May-08	15:15	129	-	23.1	1381	< 0.05	0.03	3.31
W36	Wellington Trib	13-May-08	15:20	170	2	23.4	484	< 0.05	< 0.01	3.31
W37	Willow Crk d/s of Welington Trib	13-May-08	14:51	240	3	25.3	538	< 0.05	-	3.26
W61	Trib u/s of NWHC MUD 19	13-May-08	11:36	1055	2	24.2	957	< 0.05	-	3.01
W62B	NWHC MUD 19 WWTF	14-May-08	10:25	9	-	27.0	1159	> 3.5	0.2	3.01
W62	Trib d/s of NWHC MUD 19 WWTF	13-May-08	11:10	2900	-	23.7	944	< 0.05	-	3.01
W63	3,380 ft. d/s of NWHC MUD 19 WWTF	13-May-08	12:00	96	2	24.6	263	< 0.05	-	3.01
W65	5,780 ft. d/s of NWHC MUD 19 WWTF	13-May-08	14:35	39	3	24.8	937	< 0.05	-	3.01
W38	Willow Crk at Northcrest Rd.	13-May-08	10:00	82	3	24.3	593	< 0.05	-	2.55
W64	6,180 ft. d/s of NWHC MUD 19 WWTF	13-May-08	10:18	23	1	25.5	191	< 0.05	-	2.40
W39	Haverford Trib	13-May-08	9:45	14	2	24.4	167	< 0.05	< 0.01	2.16
W40	Northway Trib	13-May-08	10:30	682	2	22.3	1143	< 0.05	0.01	1.84
W100	Inway Trib	14-May-08	11:01	< 1	3	23.7	977	< 0.05	0.09	1.67
W101	Outfall at Inway Trib	14-May-08	11:05	4	-	23.8	891	< 0.05	-	1.67
W41	Willow Crk u/s of Northhampton MUD	13-May-08	9:32	124	3	23.9	580	< 0.05	-	1.66
W42	Northhampton MUD WWTF	13-May-08	9:23	< 1	-	25.0	1145	> 3.5	0.71	1.66
W43	Willow Crk at Gosling Rd.	13-May-08	9:00	2	3	23.8	602	1.2	7.5	1.39

*1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

A sediment source survey was performed in conjunction with the spatially intensive survey on 14 May 2008. Sediment samples were collected from the south bank of Willow Creek near site W19. The sampling area was a small grassed clearing in the woods which lined most of the creek. The results of this sampling are presented in Table 4-8. The bacteria counts are reported per gram of sediment (dry weight).

Table 4-8: Willow Creek Sediment Source Sampling Results

Location	*E. coli* (cfu/g)
stream bed	1,769
water's edge	2,123
1 ft from edge	1,766
3 ft from edge	1,628
10 ft from edge	385
50 ft from edge	1

A resuspension study was performed in the northern tributary of Cannon Gully on 18 June 2008. Sediments were raked/disturbed over roughly a 10 foot long area immediately downstream of a closed bridge crossing. One sample was taken before sediment disturbance. Three additional samples were taken immediately following sediment disturbance. Dye was then added to the disturbed area, so that the resulting sediment plume could be tracked downstream. An additional three samples were collected 7 hours later at the location of the dye/sediment plume. The locations of sample collection are presented in Figure 4-21.

Table 4-9: Willow Creek Resuspension Study Sampling Results

Time	*E. coli* (cfu/100mL)	Station Feet	Sample Comments
10:04	14	0	Before Resuspension
10:05	1500	0	After Resuspension
10:05	56	0	After Resuspension
10:05	44	0	After Resuspension
16:51	177	1500	Dye Plume
16:58	141	1620	Dye Plume
17:00	250	1710	Dye Plume

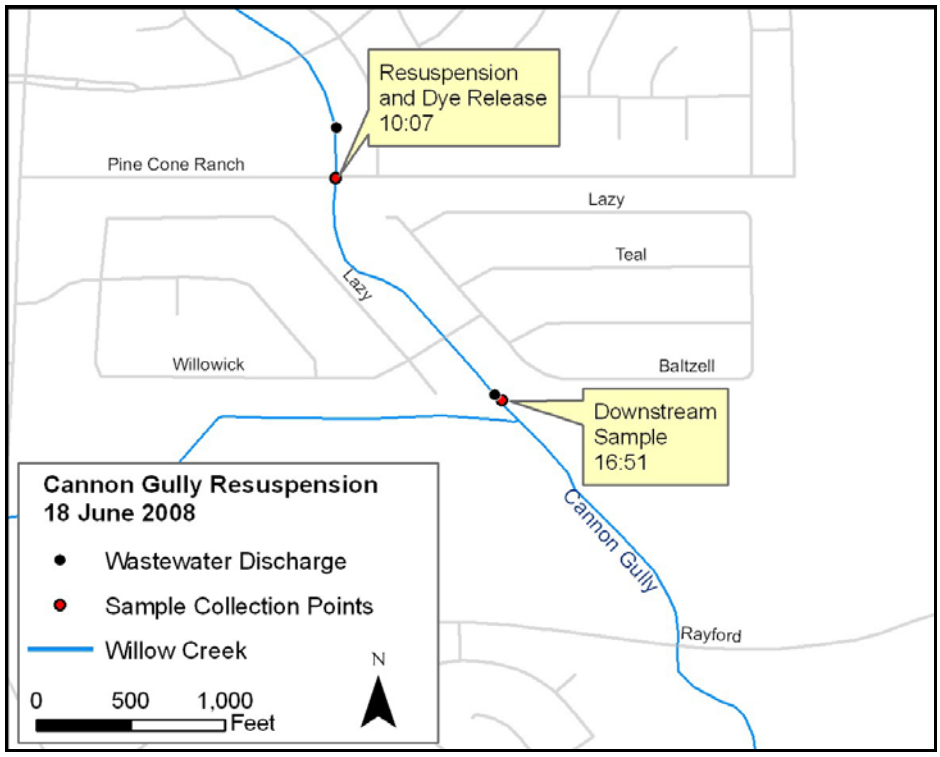

Figure 4-21: Willow Creek Resuspension Study Map

Two kinetics studies were performed on Willow Creek immediately upstream of the FM 2920 bridge. The first study took place on 13-14 May and the second study took place on 18-20 June. Results are presented in Tables 4-10 and 4-11 for the May and June studies, respectively. In both studies, the source water was taken directly from the creek at FM 2920, which was effluent dominated. The initial bacteria concentrations were fairly low.

For the May study, three different containers were used. All three were translucent plastic containers approximately 12 inches wide by 18 inches long by 12 inches high. Container A had an opaque plastic lid while Container B had a transparent plastic lid. Container C had a transparent plastic lid with an electronic stirring device. Samples from the containers were collected in duplicate.

Immediately after setting up the chambers, the first samples were collected at about 9:00 on 13 May. The next round of samples were collected at about 17:00 on 13 May, and as shown, little change in bacteria counts had occurred. A third round of sampling occurred at about 8:15 on 14 May, and the duplicate samples yielded significantly different bacteria counts. The fourth round of sampling occurred at about 16:45 on 14 May, and once again, the duplicate samples yielded significantly different results.

In general, it appears that the bacteria counts increased in all three containers throughout the course of the study. However, the variation in duplicate sample results is inexplicable and puts the results in question. It is possible that the wide variation is the result of laboratory error, but this is unlikely since the laboratory performed well when analyzing blind duplicates. It is also possible that contamination may have occurred when the samples were collected. This is

perhaps more likely, but it does not explain why the variation occurred only in samples taken on the second day, or why sometimes the second sample had a lower concentration than the first.

For the June study, just two containers were used. The containers were identical and were made of translucent plastic. They were approximately 8 inches wide, by 12 inches long, by 10 inches tall. The first container was un-stirred and the second container was manually stirred before samples were collected. Samples were always collected in duplicate.

Immediately after setting up the chambers, the first samples were collected at 10:45 on 18 June. A second and third round of sampling were performed on the mornings of 19 and 20 June. In general, the bacteria counts decreased substantially in both containers throughout the sampling period. Results from this round of testing were consistent and did not exhibit the variability that plagued the first dataset.

Table 4-10: May Willow Creek Kinetics Study

Date	Container A - Dark		Container B - Light		Container C - Continuously Mixed	
	Time	*E. coli* (cfu/100mL)	Time	*E. coli* (cfu/100mL)	Time	*E. coli* (cfu/100mL)
13-May-08	9:02	43	9:03	36	9:04	31
13-May-08	9:05	43	9:06	39	9:07	24
13-May-08	17:03	55	17:04	49	17:05	43
13-May-08	17:06	51	17:07	36	17:08	40
14-May-08	8:15	36	8:16	41	8:17	43
14-May-08	8:18	1064	8:19	973	8:20	6
14-May-08	16:42	520	16:43	1227	16:44	159
14-May-08	16:45	2600	16:46	360	16:47	755

Table 4-11: June Willow Creek Kinetics Study

Date	Container A - Unmixed		Container B - Mixed at time of sample	
	Time	*E. coli* (cfu/100mL)	Time	*E. coli* (cfu/100mL)
18-Jun-08	10:45	32	10:45	26
18-Jun-08	10:45	38	10:45	44
19-Jun-08	7:57	12	7:55	18
19-Jun-08	7:57	23	7:55	23
20-Jun-08	8:45	7	8:46	8
20-Jun-08	8:45	4	8:46	6

4.3.4 Wet Weather Point Source Survey of Willow Creek

A wet weather point source survey was performed on the afternoon of 12 February, 2008. All active WWTFs upstream of Gosling Road were sampled during this survey. In addition, two samples were collected from Willow Creek, at Gosling Road, near the time of peak stream flow.

Figure 4-22 presents the hydrologic conditions in Willow Creek before, during, and following the period of sampling. On the afternoon of 11 February, 0.38 inch of rainfall was recorded at Hooks airfield, near Tomball, followed by an additional 0.67 inches in the late morning of 12 February. The flow in Willow Creek peaked at about 17:30 on 12 February.

The discharges from thirteen WWTFs were sampled during this survey. Table 4-12 provides a more detailed account of sampling results (listed from upstream to downstream), including the results of samples pulled from the main stem of Willow Creek at Gosling Road. Table 4-13 provides average daily flows for the WWTFs (as reported by WWTF operators) and for the USGS gage at Kuykendahl Road.

Based on the tabulated flows and bacteria counts, estimated bacteria loads could be determined. At the time of the wet weather survey, the estimated load from WWTFs was 36 billion cfu/day, compared with an in-stream bacteria load of 20,000 billion cfu/day at Gosling Road. This suggests that the WWTF discharges accounted for only a small (and debatably negligible) portion of the total wet-weather, in-stream bacteria load. Additional discussion of the results is presented in Section 8.3.

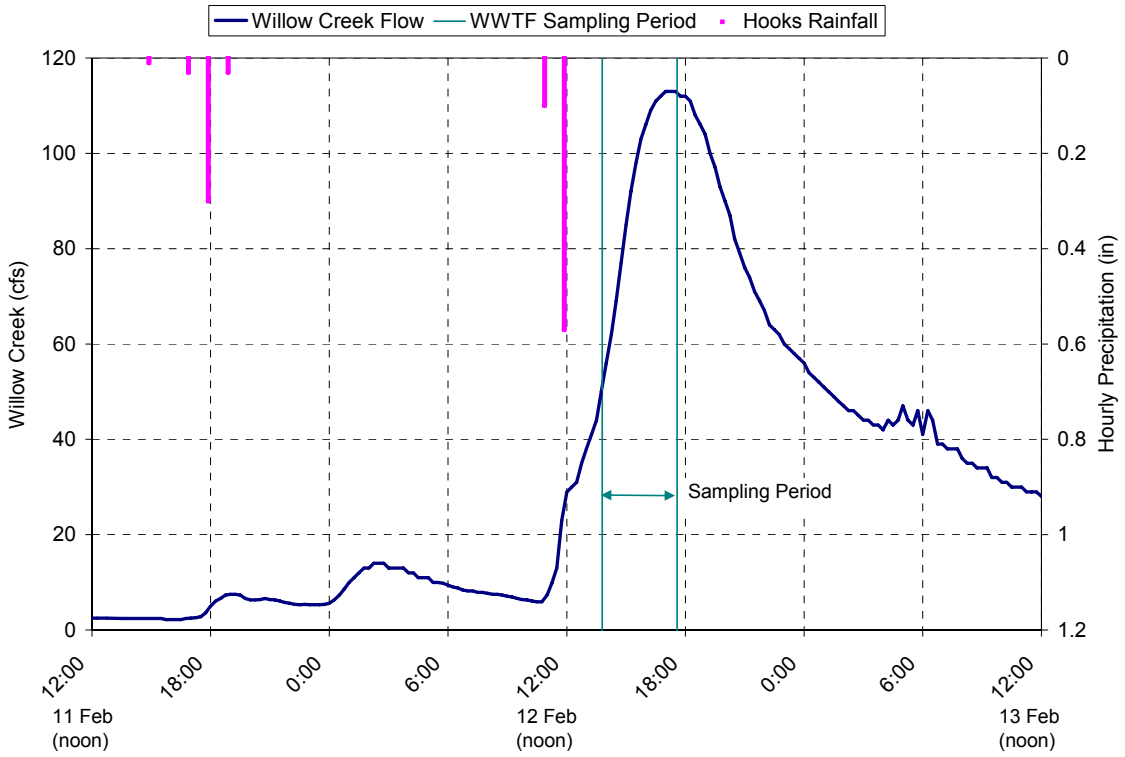

Figure 4-22: Willow Creek Wet Weather Survey Hydrograph

Table 4-13: Wet Weather Survey Average Daily Flows (cfs)

WWTF Permit #	9-Feb	10-Feb	11-Feb	12-Feb	13-Feb	14-Feb
10616-002	1.02	0.98	1.16	1.50	1.24	1.14
12044-001	0.78	0.71	0.73	0.83	0.66	0.69
13942-001	0.14	0.14	0.19	0.16	0.19	0.19
14421-001	0.06	0.06	0.06	0.08	0.05	0.08
12643-001	0.11	0.11	0.11	0.11	0.11	0.08
11404-001	0.43	0.38	0.47	0.41	0.46	0.25
13619-001	*0.03*	*0.03*	*0.03*	0.02	n/a	0.02
13487-001	0.11	0.11	0.11	0.16	0.11	0.11
11630-001	0.44	0.24	0.43	0.33	0.44	0.29
12519-001	*0.03*	*0.03*	*0.03*	0.04	0.04	0.04
14475-001	0.22	0.14	0.22	0.19	0.24	0.18
12153-001	0.08	0.08	0.08	0.15	0.20	0.09
10910-001	0.69	0.34	0.62	0.68	0.62	0.50
WWTF Total	4.1	3.3	4.2	4.7	4.3	3.7
USGS 08068325	4.2	1.8	2.8	44	33	12

Values in italics represent 3-day averages

Table 4-12: Willow Creek Wet Weather Survey Results

Sample ID	Station Description	Station Type	Permit #	Permitted Flows		Sample Date	Sample Time	*E. coli* (cfu/100mL)	Inst. Flows*		Temp (C)	Cond (µS/cm)	Total Cl2 (mg/L)
				(mgd)	(cfs)				(mgd)	(cfs)			
10616	City of Tomball	WWTF	10616-002	1.50	2.33	12-Feb-08	13:48	2	1.2	1.9	19.1	1010	< 0.05
12044	Harris Co. MUD #368	WWTF	12044-001	1.60	2.48	12-Feb-08	14:16	1	-	-	21.1	896	> 3.5
13942	Inline Utilities Inc.	WWTF	13942-001	0.25	0.39	12-Feb-08	14:43	8500	-	-	19.3	642	0.2
14421	Harris Co. MUD #401	WWTF	14421-001	0.60	0.93	12-Feb-08	15:48	73	0.012	0.018	20.1	1670	0.4
12643	Pinewood Community LP	WWTF	12643-001	0.10	0.16	12-Feb-08	16:15	< 1	0.054	0.084	20.7	682	3.0
11404	Dowdell PUD	WWTF	11404-001	0.95	1.47	12-Feb-08	16:38	74	0.142	0.22	22.1	1335	0.9
13619	Aqua Utilities Inc.	WWTF	13619-001	0.04	0.06	12-Feb-08	17:07	240	0.017	0.027	18.3	653	0.25
13487	Timbercrest Community LP	WWTF	13487-001	0.20	0.31	12-Feb-08	16:39	31	-	-	18.5	552	2.4
11630	Harris Co. MUD #1	WWTF	11630-001	1.50	2.33	12-Feb-08	16:16	230	-	-	19.6	973	0.8
12519	Aqua Utilities Inc.	WWTF	12519-001	0.10	0.16	12-Feb-08	16:00	220	-	-	18.5	740	0.5
14475	NW Harris Co. MUD #19	WWTF	14475-001	0.70	1.09	12-Feb-08	15:54	6	-	-	17	1154	0.3
12153	NW Harris Co. MUD #19	WWTF	12153-001	0.25	0.39	12-Feb-08	17:03	68	-	-	19.8	1151	> 3.5
10910	Northhampton MUD	WWTF	10910-001	0.75	1.16	12-Feb-08	17:35	4	-	-	19.6	988	1.3
11185	Willow Creek at Gosling Road	Stream	n/a	n/a	n/a	12-Feb-08	17:24	7800	72	112	15.9	250	< 0.05
92924	Blind Duplicate, Sta. 11185	Stream	n/a	n/a	n/a	12-Feb-08	17:29	6500	72	112	15.9	250	< 0.05

*Instantaneous flows, measured at time of sample collection

5.0 CYPRESS CREEK, SEGMENT 1009

In this section, bacteria data for the main stem of the Cypress Creek are presented (Section 5.1). Results for Faulkey Gully (Segment 1009C), Spring Gully (Segment 1009D), and Little Cypress Creek (Segment 1009E) are presented in Sections 5.2, 5.3, and 5.4, respectively.

5.1 CYPRESS CREEK MAIN STEM, SEGMENT 1009

5.1.1 November 2007 Synoptic Survey

A synoptic survey of Cypress Creek was performed on 9 November 2007. As shown in Figure 5-1, several locations along Cypress Creek were sampled during this survey. Detailed sampling results for these stations are presented in Table 5-1. A longitudinal profile of bacteria concentrations can be found in Figure 5-2, and a similar plot of flow and conductivity data can be found in Figure 5-3.

Prior to the survey, the last major rainfall occurred on 15 October. On this date, 1.54 inches of rainfall were recorded at the Houston Hooks Airport near Tomball. An additional 0.08 inches of rainfall occurred on 22 October.

Flows were very low in the upstream portion of the Cypress Creek watershed, and no significant flow was observed upstream of House Hahl Road (station 11333). These upstream stations all had low bacteria counts. Conductivity levels were low to moderate, suggesting flow mostly of natural origin. At House Hahl Road, the flow and conductivity were higher, suggesting the presence of WWTF effluent.

From House Hahl Road to SH 249 (station 11331) flows continued to rise due to WWTF discharges. Bacteria concentrations remained relatively low throughout this reach. Little Cypress Creek and Faulkey Gully were both effluent dominated, and also had relatively low bacteria counts. A chlorine residual was observed at the most downstream station in Little Cypress Creek. Additional data for Faulkey Gully and Little Cypress Creek can be found in Sections 5.2.1 and 5.3.1, respectively.

Below SH 249, bacteria counts in the main stem of Cypress Creek were higher than at the upstream stations. The highest main stem bacteria count (154 cfu/100mL) was found at Steubner-Airline Road (station 11330).

Two tributaries were sampled downstream of SH 249. Pilot Gully (CYC0A) enters Cypress Creek just downstream of SH 249. The flow of this Gully was not large, but the bacteria concentration exceeded the grab sample criterion. Spring Gully (17481) had a moderately high bacteria count. Additional data for Spring Gully can be found in Section 5.4.1.

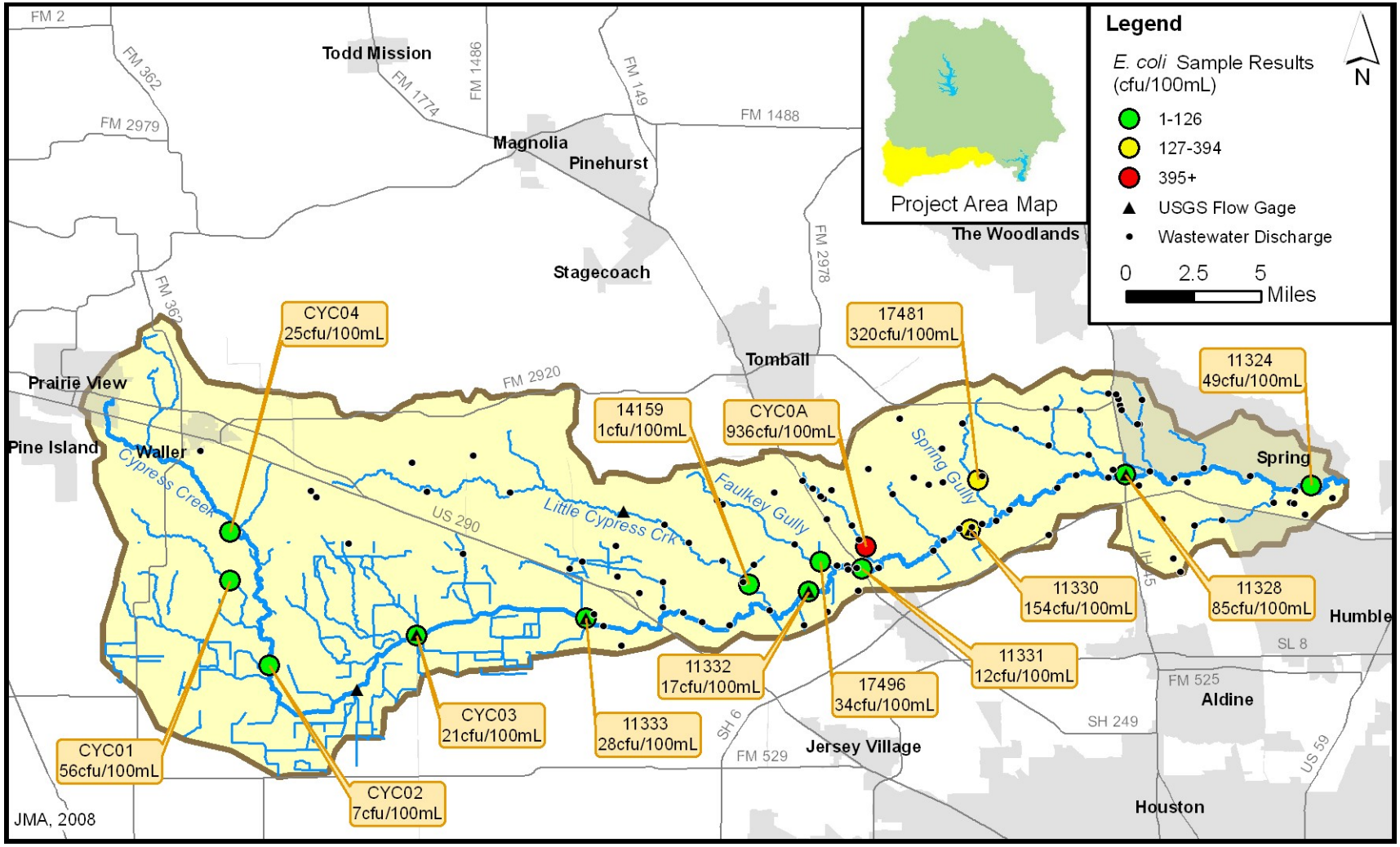

Figure 5-1: Cypress Creek (Seg. 1009) Synoptic Survey Map, Nov. 2007

Table 5-1: Cypress Creek (Seg. 1009) Synoptic Survey Results, Nov. 2007

Station Code	Station Type	Description	Station Mile	Sample Date	Sample Time	*E. coli* (cfu/100mL)	Flow Est. (cfs)*	Flow** Severity	Temp (C)	Cond (µS/cm)	Total Cl2 (mg/L)
CYC04	main stem	Mathis Rd	56.9	9-Nov-07	9:05	25	< 0.1	1	18.2	495	-
CYC01	tributary	Mathis Rd	51.4	9-Nov-07	9:15	56	< 0.1	1	19.1	144	-
CYC02	main stem	Hebet Rd	49.8	9-Nov-07	9:35	7	< 0.1	1	19.9	205	-
CYC03	main stem	Katy Hockley	41.4	9-Nov-07	9:55	21	< 0.1	1	19.9	283	-
11333	main stem	House Hahl Rd	35.5	9-Nov-07	10:30	28	1.5	3	20.4	940	-
14159	Little Cy Crk	Kluge Rd	27.8	9-Nov-07	14:45	1	3.2	3	23.8	830	0.35
11332	main stem	Grant Rd	25.7	9-Nov-07	10:46	17	6.4	3	19.0	751	-
17496	Faulkey G	Cypress Crk Dr	23.6	9-Nov-07	11:06	34	*1.7*	3	20.6	770	< 0.05
11331	main stem	SH 249	22.5	9-Nov-07	10:19	12	-	3	20.1	770	< 0.05
CYC0A	tributary	Louetta Rd	21.5	9-Nov-07	9:55	936	0.4	3	22.4	522	-
11330	main stem	Steubner-Airline	17.3	9-Nov-07	9:30	154	20	3	19.5	830	-
17481	Spring G	Spg Crk Oaks Dr	16.0	8-Nov-07	15:18	320	1.0	3	20.9	1060	-
11328	main stem	IH 45	9.9	9-Nov-07	8:08	85	35	3	19.3	841	< 0.05
11324	main stem	Cypresswood Dr	2.0	9-Nov-07	8:47	49	-	3	19.3	808	-

*Flow Estimates in *italics* were calculated based on flow measurements from nearby stations

**1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

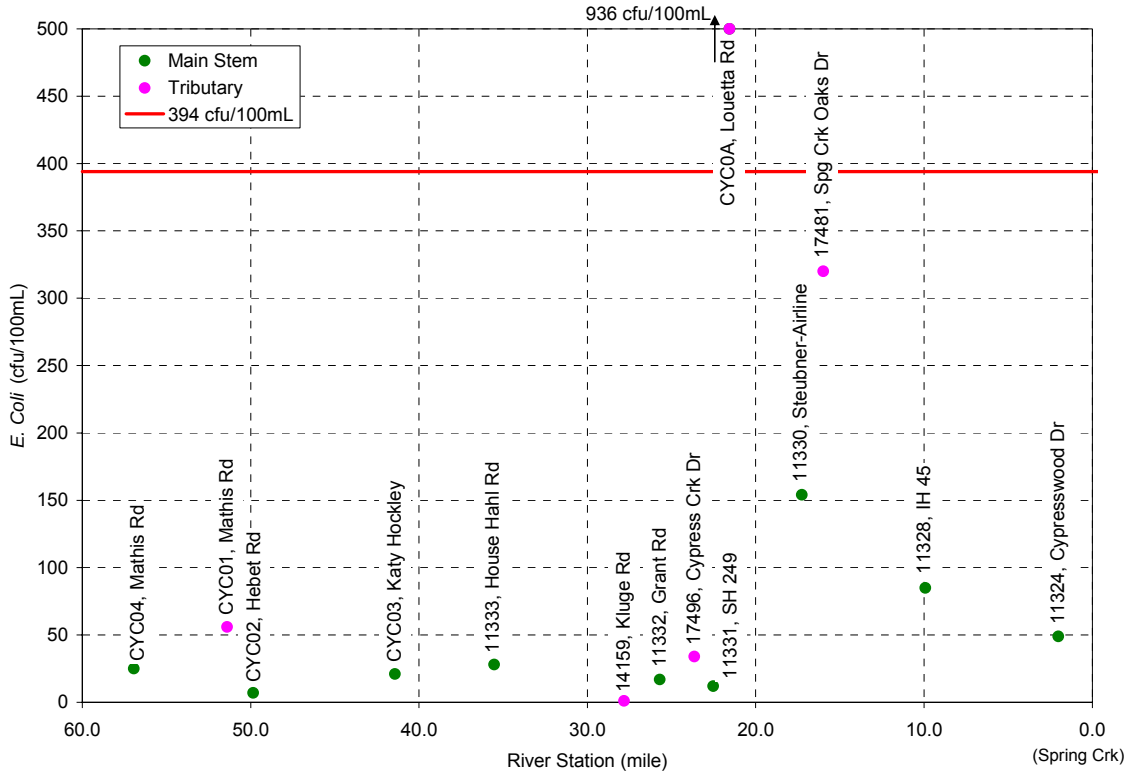

Figure 5-2: Cypress Creek (Seg. 1004) Synoptic *E. coli* Profile, Nov. 2007

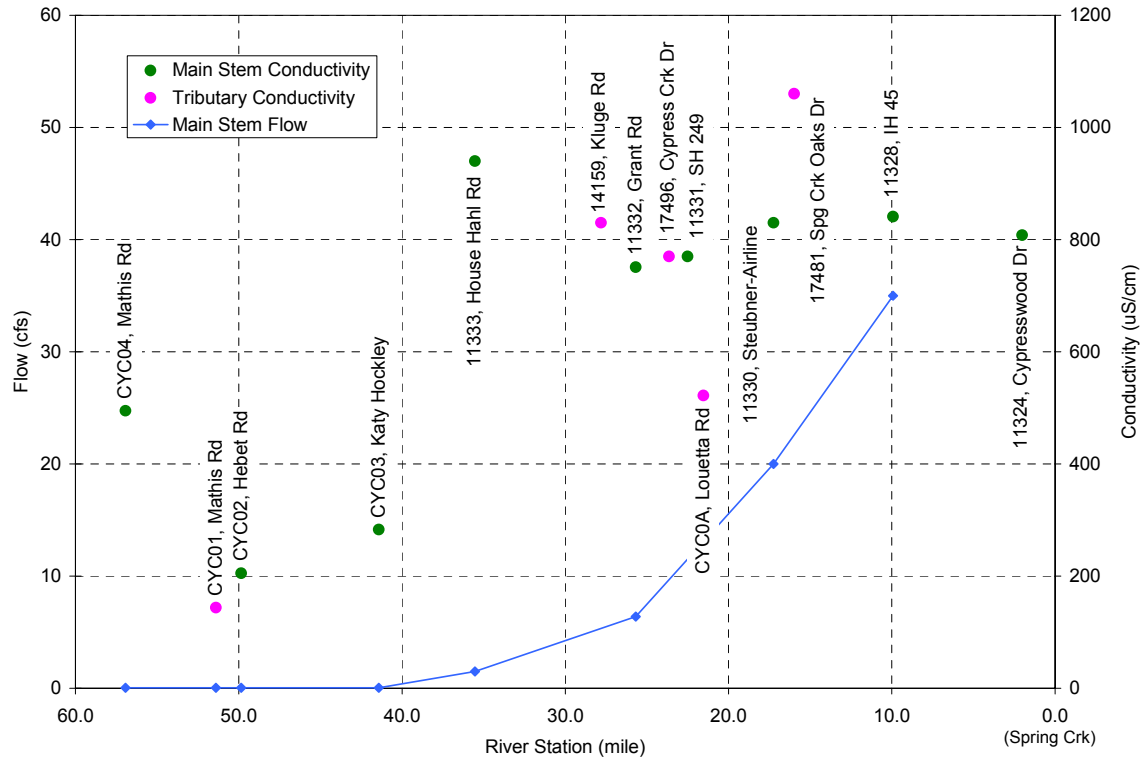

Figure 5-3: Cypress Creek (Seg. 1004) Synoptic Cond. & Flow Profile, Nov. 2007

5.1.2 June 2008 Synoptic Survey

A second synoptic survey of Cypress Creek was performed on 19 June 2008. As shown in Figure 5-4, several locations along Cypress Creek were sampled during this survey. Detailed sampling results for these stations are presented in Table 5-2. A longitudinal profile of bacteria concentrations can be found in Figure 5-5, and a similar plot of flow and conductivity data can be found in Figure 5-6.

Prior to the survey, the last major rainfall occurred on 10 June. On this date, 0.87 inches of rainfall were recorded at the Houston Hooks Airport near Tomball. An additional 0.12 inches of rainfall occurred on 13 June.

Flows were very low in the upstream portion of the Cypress Creek watershed, and no significant flow was observed upstream of House Hahl Road (station 11333). At the most upstream site (CYC04), which was a sluggish backwater, the bacteria count was moderately high. At House Hahl Road, the flow and conductivity were both substantially higher, suggesting the presence of WWTF effluent. The bacteria count at this site was fairly low.

Downstream of Grant Road, the main stem bacteria concentrations were moderately high. The highest main stem bacteria count (164 cfu/100mL) was found at Steubner-Airline Road (station 11330).

Three tributaries were sampled during this survey. Little Cypress Creek, Faulkey Gully, and Spring Gully had low to moderate bacteria counts. Additional data for these tributaries can be found in Sections 5.2.2, 5.3.2, and 5.4.2, respectively.

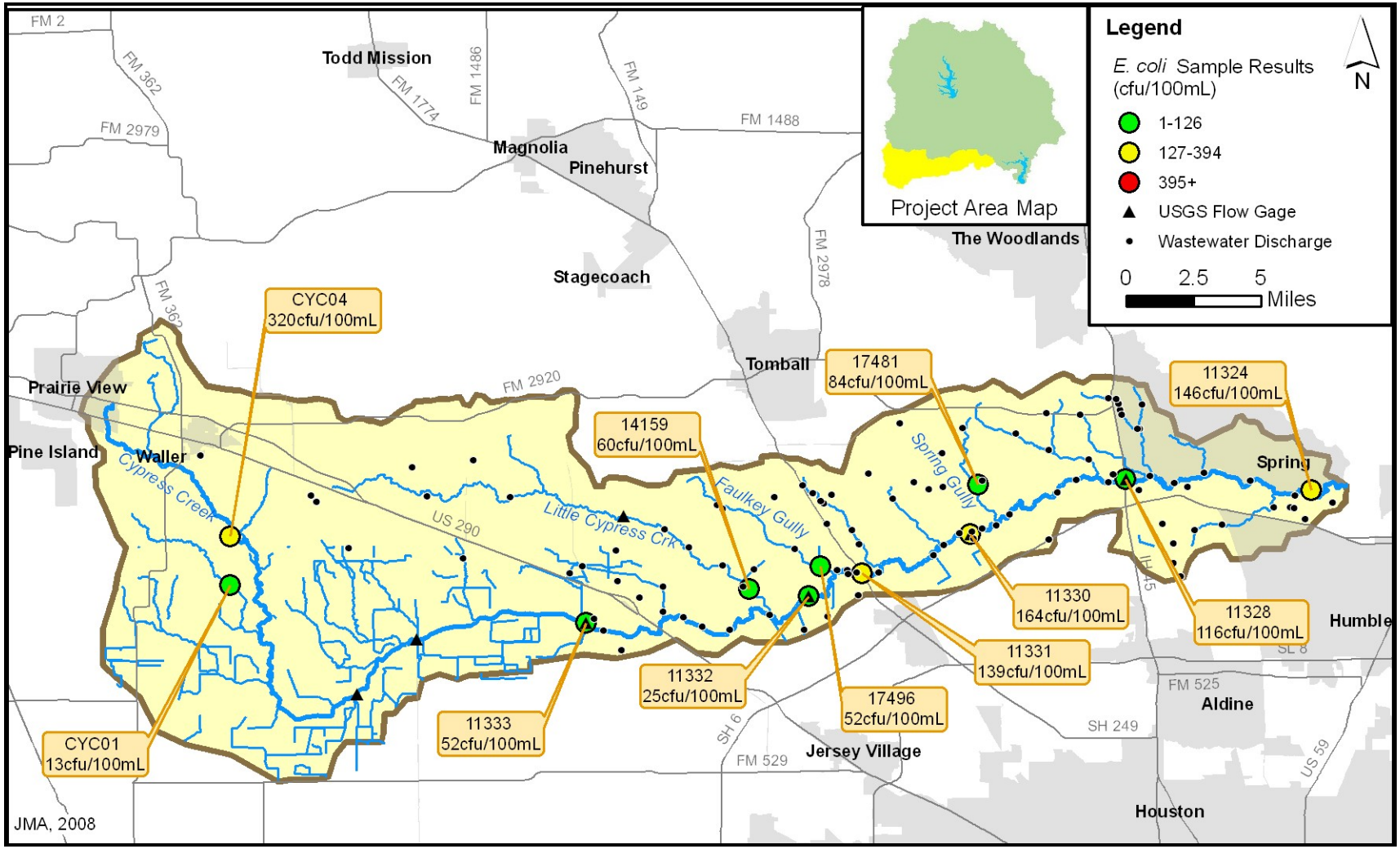

Figure 5-4: Cypress Creek (Seg. 1009) Synoptic Survey Map, June 2008

Table 5-2: Cypress Creek (Seg. 1009) Synoptic Survey Results, June 2008

Station Code	Station Type	Description	Station Mile	Sample Date	Sample Time	*E. coli* (cfu/100mL)	Flow Est. (cfs)	Flow* Severity	Temp (C)	Cond (µS/cm)	Total Cl2 (mg/L)
CYC04	main stem	Mathis Rd	56.9	19-Jun-08	8:34	320	0	-	27.1	500	0.08
CYC01	tributary	Mathis Rd	51.4	19-Jun-08	8:49	13	0	1	27.9	279	< 0.05
CYC02	main stem	Hebet Rd	49.8	19-Jun-08	9:06	-	0	1	-	-	-
CYC03	main stem	Katy Hockley	41.4	19-Jun-08	9:25	-	0	1	-	-	-
11333	main stem	House Hahl Rd	35.5	19-Jun-08	10:53	52	0.39	3	29.4	908	0.06
14159	Little Cy Crk	Kluge Rd	27.8	19-Jun-08	13:38	60	-	3	31.3	1003	0.3
11332	main stem	Grant Rd	25.7	19-Jun-08	12:40	25	22	3	30.9	833	< 0.05
17496	Faulkey G	Cypress Crk Dr	23.6	19-Jun-08	11:17	52	3.1	3	30.7	950	< 0.05
11331	main stem	SH 249	22.5	19-Jun-08	10:05	139	-	3	28.7	827	< 0.05
11330	main stem	Steubner-Airline	17.3	19-Jun-08	9:35	164	-	3	28.2	742	< 0.05
17481	Spring G	Spg Crk Oaks Dr	16.0	18-Jun-08	15:38	84	0.92	3	35.4	905	0.16
11328	main stem	IH 45	9.9	19-Jun-08	9:03	116	15	3	29.3	752	0.1
11324	main stem	Cypresswood Dr	2.0	19-Jun-08	8:40	146	-	3	28.3	794	< 0.05

*1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

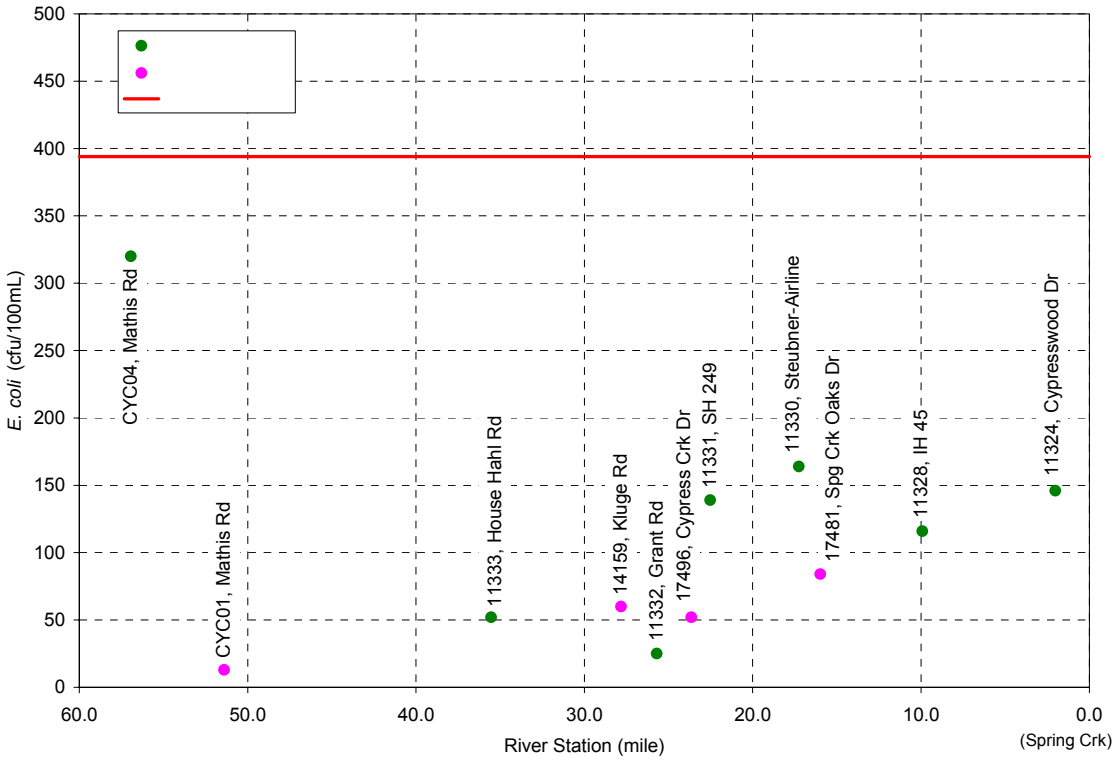

Figure 5-5: Cypress Creek (Seg. 1009) Synoptic *E. coli* Profile, June 2008

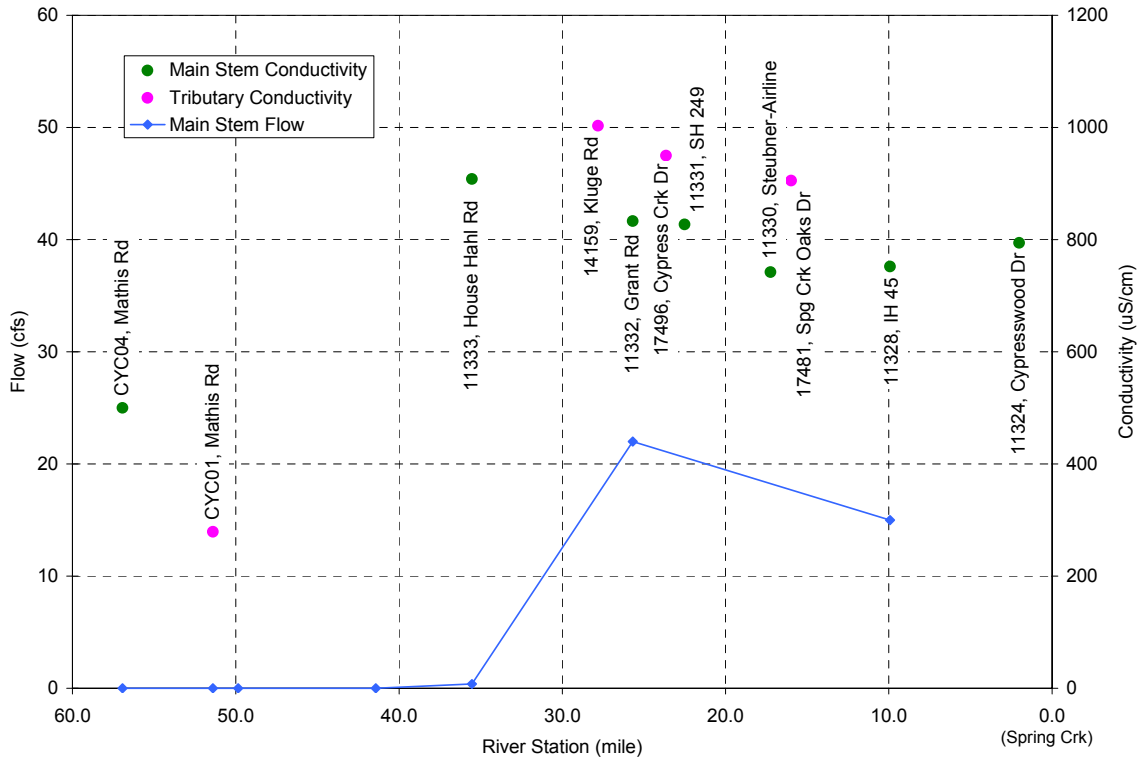

Figure 5-6: Cypress Creek (Seg. 1009) Synoptic Cond. & Flow Profile, June 2008

5.2 FAULKEY GULLY, SEGMENT 1009C

5.2.1 November 2007 Synoptic Survey

A synoptic survey of Faulkey Gully was performed on 9 November 2007. As shown in Figure 5-7, several locations along Faulkey Gully were sampled during this survey. Detailed sampling results for these stations are presented in Table 5-3. A longitudinal profile of bacteria concentrations can be found in Figure 5-8, and a similar plot of flow and conductivity data can be found in Figure 5-9.

Prior to the survey, the last major rainfall occurred on 15 October. On this date, 1.54 inches of rainfall were recorded at the Houston Hooks Airport near Tomball. An additional 0.08 inches of rainfall occurred on 22 October.

At the most upstream station (FG01) there was only a trickle of flow. The conductivity at this station was moderately high, and the bacteria count was relatively low.

The two sampled WWTFs (FG06 and FG05) provided a substantial portion of the flow to Faulkey Gully. Both of these WWTFs had moderately high bacteria counts, indicating that complete disinfection was not achieved.

Sample FG0A was collected at a large culvert draining to Faulkey Gully. This sample had a high conductivity suggesting a municipal source, and a relatively high bacteria count.

The bacteria counts of main-stem stations were generally low. Only site FG02, had a moderately high bacteria count (125 cfu/100mL).

Table 5-3: Faulkey Gully (Seg. 1009C) Synoptic Survey Results, Nov. 2007

Station Code	Station Type	Description	Station Mile	Sample Date	Sample Time	*E. coli* (cfu/100mL)	Flow Est. (cfs)*	Flow** Severity	Temp (C)	Cond (µS/cm)	Total Cl2 (mg/L)
FG01	main stem	Shaw Rd	4.8	9-Nov-07	15:49	24	0.03	2	23.0	571	-
FG06	WWTF	NWHC MUD 15	3.7	9-Nov-07	15:24	174	0.5	-	25.7	1199	< 0.05
FG02	main stem	Spring Cypress Rd	3.1	9-Nov-07	15:05	125	1.7	3	22.0	975	-
FG05	WWTF	Faulkey G. MUD	1.7	9-Nov-07	12:12	300	0.94	-	23.5	1002	0.1
FG03	main stem	Louetta Rd	1.5	9-Nov-07	11:38	8	1.7	3	22.5	740	< 0.05
FG0A	tributary	Lkwood Forest Dr	0.6	9-Nov-07	11:20	350	< 0.05	-	22.5	1049	0.1
17496	main stem	Lkwood Forest Dr	0.5	9-Nov-07	11:06	34	*1.7*	3	20.6	770	< 0.05

*Flow Estimates in *italics* were calculated based on flow measurements from nearby stations

**1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

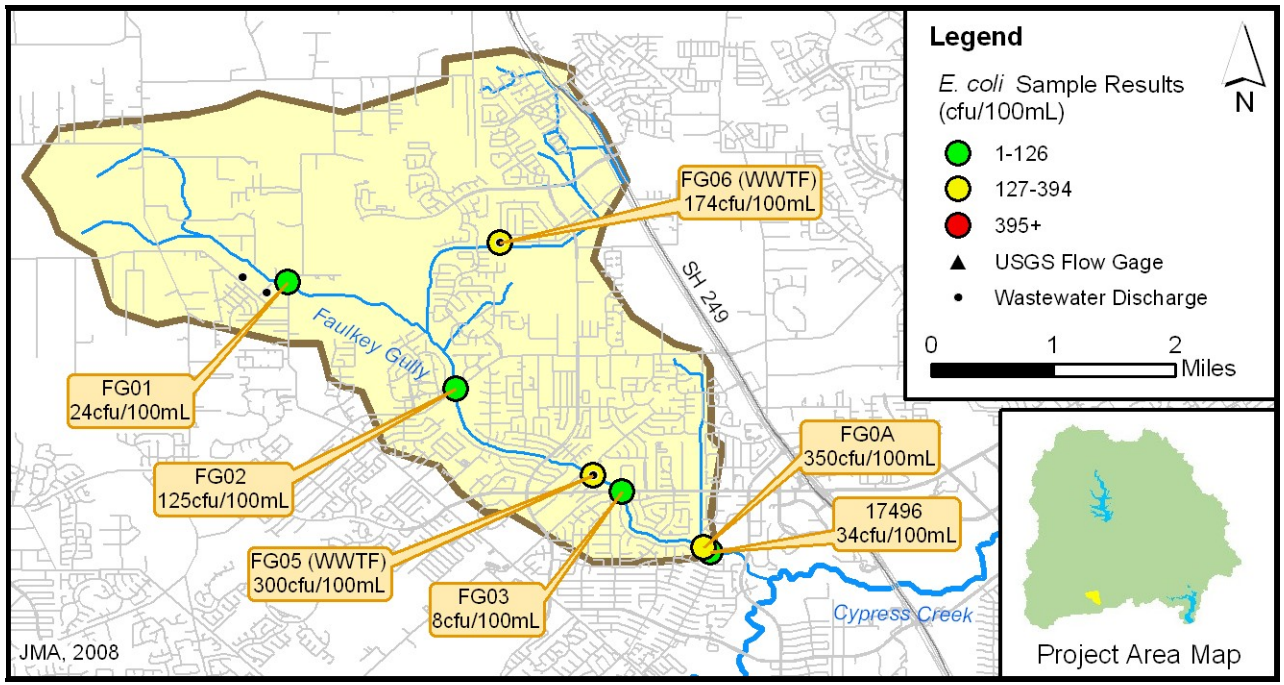

Figure 5-7: Faulkey Gully (Seg. 1009C) Synoptic Survey Map, Nov. 2007

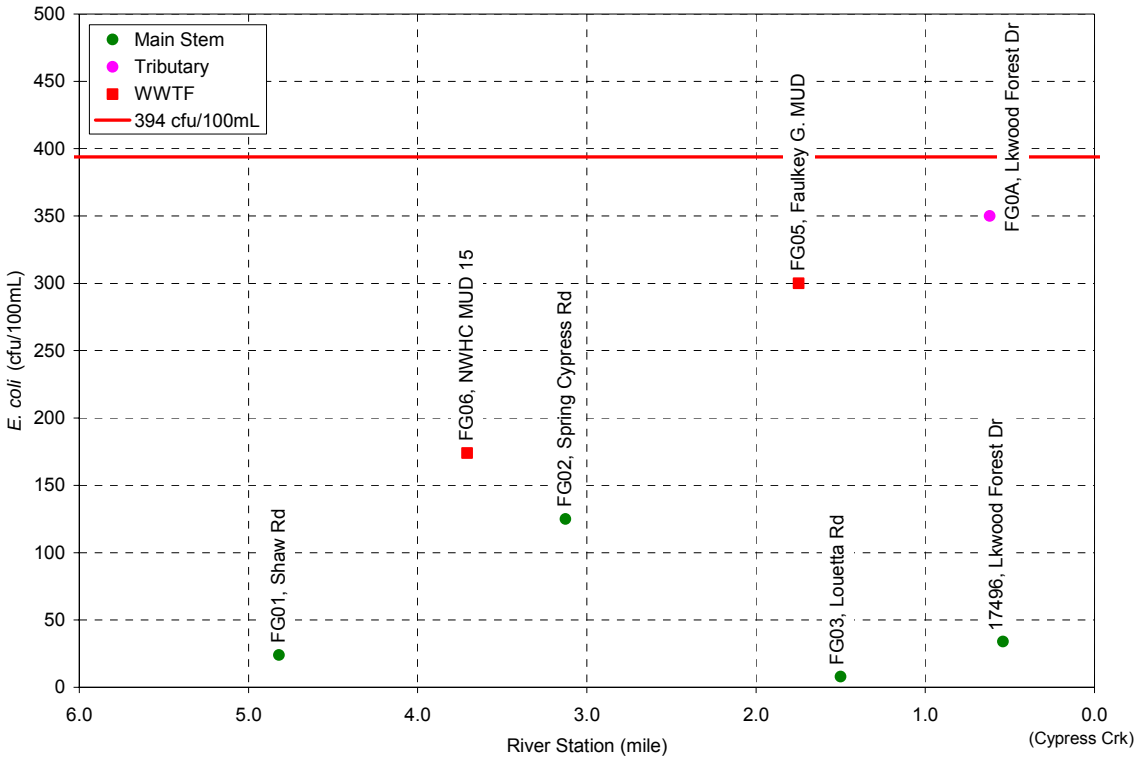

Figure 5-8: Faulkey Gully (Seg. 1009C) Synoptic *E. coli* Profile, Nov. 2007

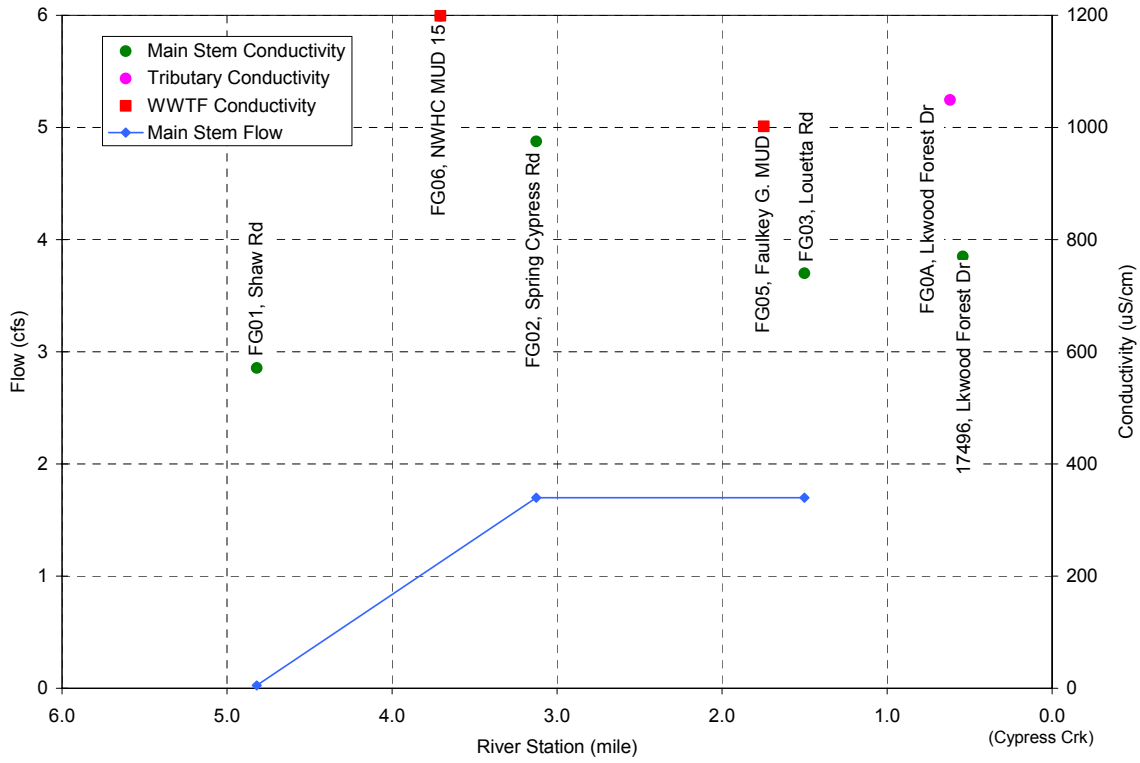

Figure 5-9: Faulkey Gully (Seg. 1009C) Synoptic Cond. & Flow Profile, Nov. 2007

5.2.2 June 2008 Synoptic Survey

A second synoptic survey of Faulkey Gully was performed on 19 June 2008. As shown in Figure 5-10, several locations along Faulkey Gully were sampled during this survey. Detailed sampling results for these stations are presented in Table 5-4. A longitudinal profile of bacteria concentrations can be found in Figure 5-11, and a similar plot of flow and conductivity data can be found in Figure 5-12.

Prior to the survey, the last major rainfall occurred on 10 June. On this date, 0.87 inches of rainfall were recorded at the Houston Hooks Airport near Tomball. An additional 0.12 inches of rainfall occurred on 13 June.

Four samples were pulled from the main stem of Faulkey Gully. At the most upstream main stem site (FG01) there was only a trickle of flow, but the conductivity and bacteria levels were moderately high. Downstream of this station, the conductivity and flow increased, due to contributions from WWTFs. The highest bacteria count on the main stem was 200 cfu/100mL, measured at Louetta Rd (FG03).

Three WWTFs were sampled for this survey. The first of these, FG04, served a small community, and the discharge rate was very low. The other two WWTFs (FG06 and FG05) provided a more substantial portion of the flow to Faulkey Gully. One of these WWTFs (FG06) had a moderately high bacteria count, indicating that complete disinfection was not achieved.

Table 5-4: Faulkey Gully (Seg. 1009C) Synoptic Survey Results, June 2008

Station Code	Station Type	Description	Station Mile	Sample Date	Sample Time	*E. coli* (cfu/100mL)	Flow Est. (cfs)	Flow* Severity	Temp (C)	Cond (µS/cm)	Total Cl2 (mg/L)
FG04	WWTF	Elite Computer WWTF	4.9	19-Jun-08	14:58	4	0.0003	-	27.7	566	2.3
FG01	main stem	Shaw Rd	4.8	19-Jun-08	14:38	123	0.01	2	28.8	549	0.06
FG06	WWTF	NWHC MUD 15	3.7	19-Jun-08	12:20	310	0.95	-	30.0	1135	< 0.05
FG02	main stem	Spring Cypress Rd	3.1	19-Jun-08	12:05	84	1.1	3	30.4	1094	< 0.05
FG05	WWTF	Faulkey G. MUD	1.7	19-Jun-08	11:45	52	0.97	-	29.5	819	< 0.05
FG03	main stem	Louetta Rd	1.5	19-Jun-08	10:40	200	2.8	3	28.5	978	< 0.05
17496	main stem	Lkwood Forest Dr	0.5	19-Jun-08	11:17	52	3.1	3	30.7	950	< 0.05

*1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

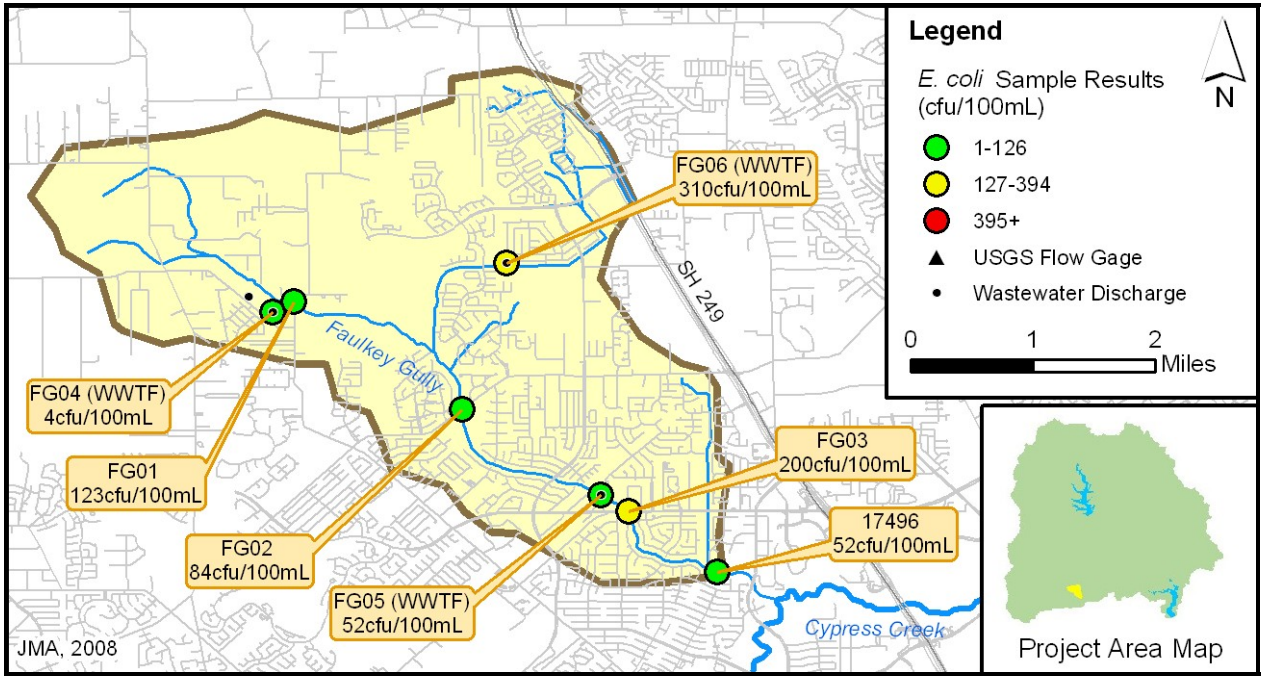

Figure 5-10: Faulkey Gully (Seg. 1009C) Synoptic Survey Map, June 2008

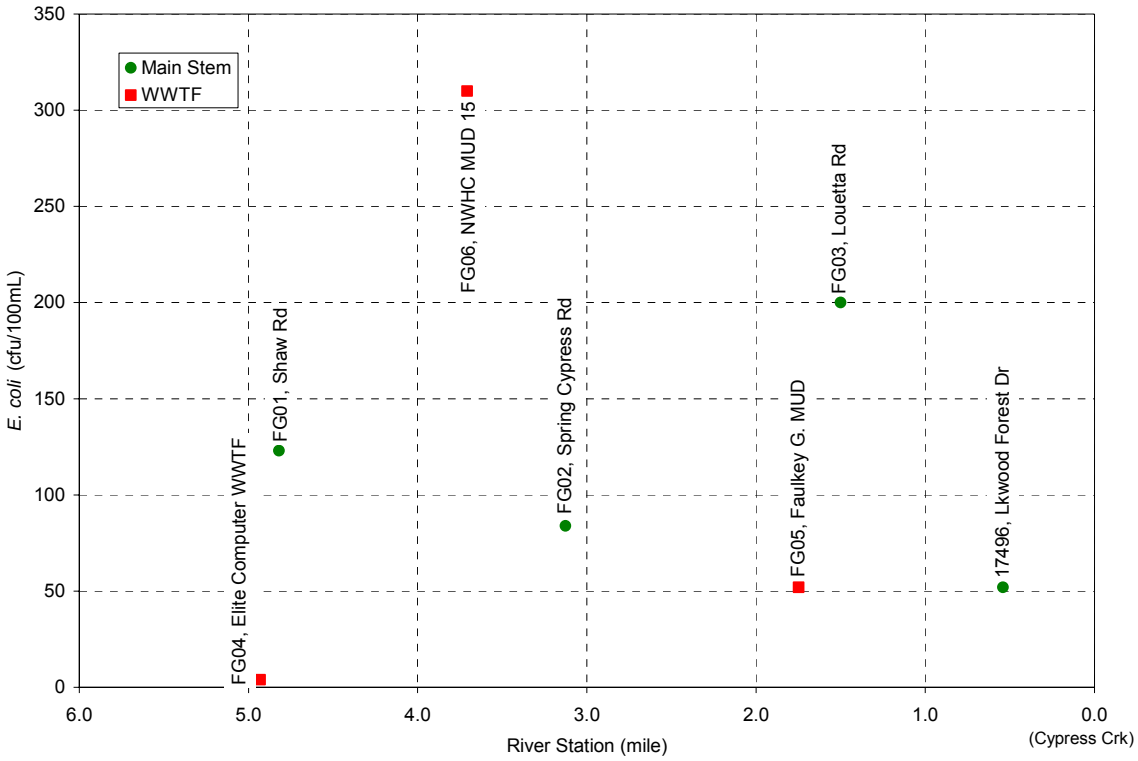

Figure 5-11: Faulkey Gully (Seg. 1009C) Synoptic *E. coli* Profile, June 2008

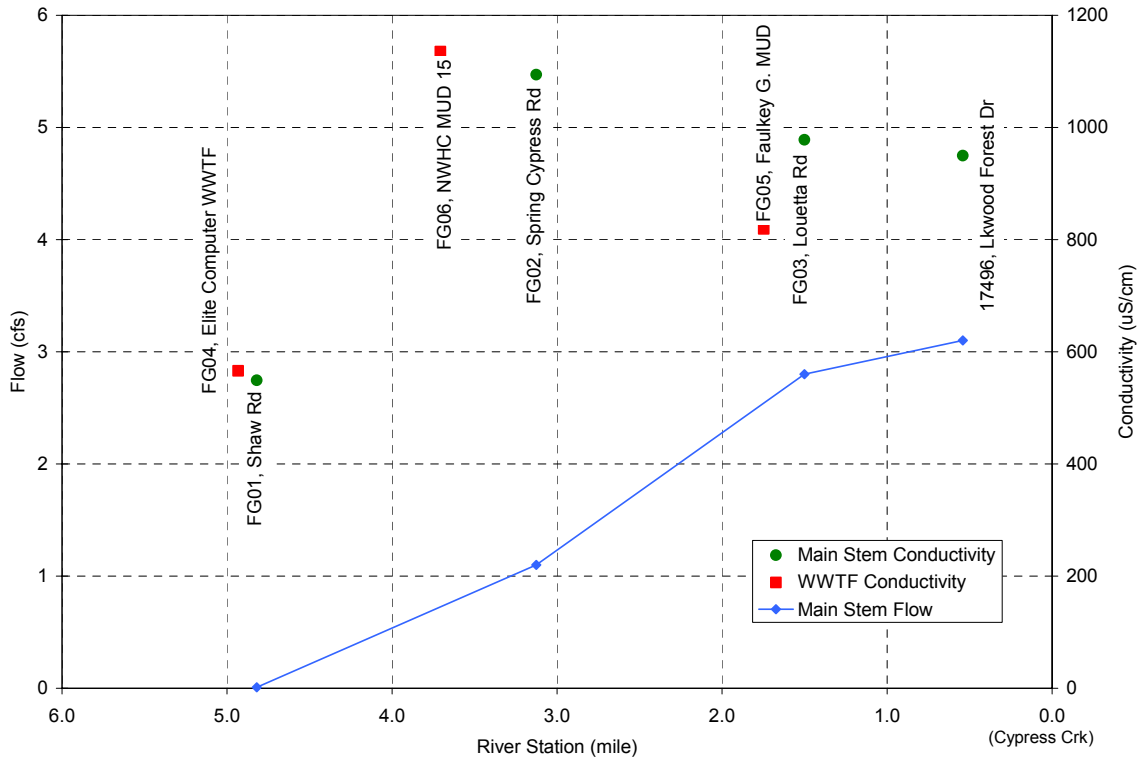

Figure 5-12: Faulkey Gully (Seg. 1009C) Synoptic Cond. & Flow Profile, June 2008

5.3 SPRING GULLY, SEGMENT 1009D

5.3.1 November 2007 Synoptic Survey

A synoptic survey of Spring Gully was performed on 8 November 2007. As shown in Figure 5-13, several locations along Spring Gully were sampled during this survey. Detailed sampling results for these stations are presented in Table 5-5. A longitudinal profile of bacteria concentrations can be found in Figure 5-14, and a similar plot of flow and conductivity data can be found in Figure 5-15.

Prior to the survey, the last major rainfall occurred on 15 October. On this date, 1.54 inches of rainfall were recorded at the Houston Hooks Airport near Tomball. An additional 0.08 inches of rainfall occurred on 22 October.

The most upstream sampling site on Spring Gully was the MUD 32 WWTF (SG09). Effluent from this treatment facility had a high bacteria count. The next two sampling sites (SG05 and SG04) had low bacteria counts, despite the fact that the flow at these sites originated primarily from the upstream WWTF.

The West Branch of Spring Gully (SG06) had a high bacteria count, exceeding the grab sample criterion. However, the flow in this segment was minimal, and so it had little impact on downstream segments. Below the confluence with the West Branch (SG03), the bacteria count in the main stem was low, similar to upstream concentrations along the main branch.

Two sites (SG01 and SG02) along the East Branch of Spring Gully were sampled. Both of these sites had low bacteria counts. A WWTF on the East Branch was also sampled, and it also had a low bacteria count.

The most downstream site (17481) had a fairly high bacteria count, despite the fact that upstream counts were generally quite low.

Table 5-5: Spring Gully (Seg. 1009D) Synoptic Survey Results, Nov. 2007

Station Code	Station Type	Description	Station Mile	Sample Date	Sample Time	*E. coli* (cfu/100mL)	Flow Est. (cfs)*	Flow** Severity	Temp (C)	Cond (µS/cm)	Total Cl2 (mg/L)
SG09	WWTF	NWHC MUD 32	4.6	8-Nov-07	15:55	718	0.64	-	20.8	990	< 0.05
SG05	main stem	Pine Lakes Blvd	4.5	8-Nov-07	16:10	7	0.64	2	24.4	1155	-
SG04	main stem	Spring Cypress Rd	3.5	8-Nov-07	14:36	26	0.6	3	21.5	1102	0.08
SG06	tributary	Klein Cemetery Rd	3.1	8-Nov-07	14:25	691	0.01	2	18.4	317	-
SG03	main stem	Fairway Oaks Dr	3.0	8-Nov-07	15:39	9	*0.6*	3	21.9	1050	-
SG02	tributary	Spring Cypress Rd	2.1	8-Nov-07	14:51	6	< 0.1	2	22.7	717	< 0.05
SG07	WWTF	Bilma WWTF	2.1	8-Nov-07	15:11	1	0.37	-	23.9	1037	1.8
SG01	tributary	Jester Rd	2.1	8-Nov-07	15:28	28	0.1	3	23.3	1027	0.7
17481	main stem	Spring Crk Oaks Dr	2.0	8-Nov-07	15:18	320	1.0	3	20.9	1060	-

*Flow Estimates in *italics* were calculated based on flow measurements from nearby stations

**1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

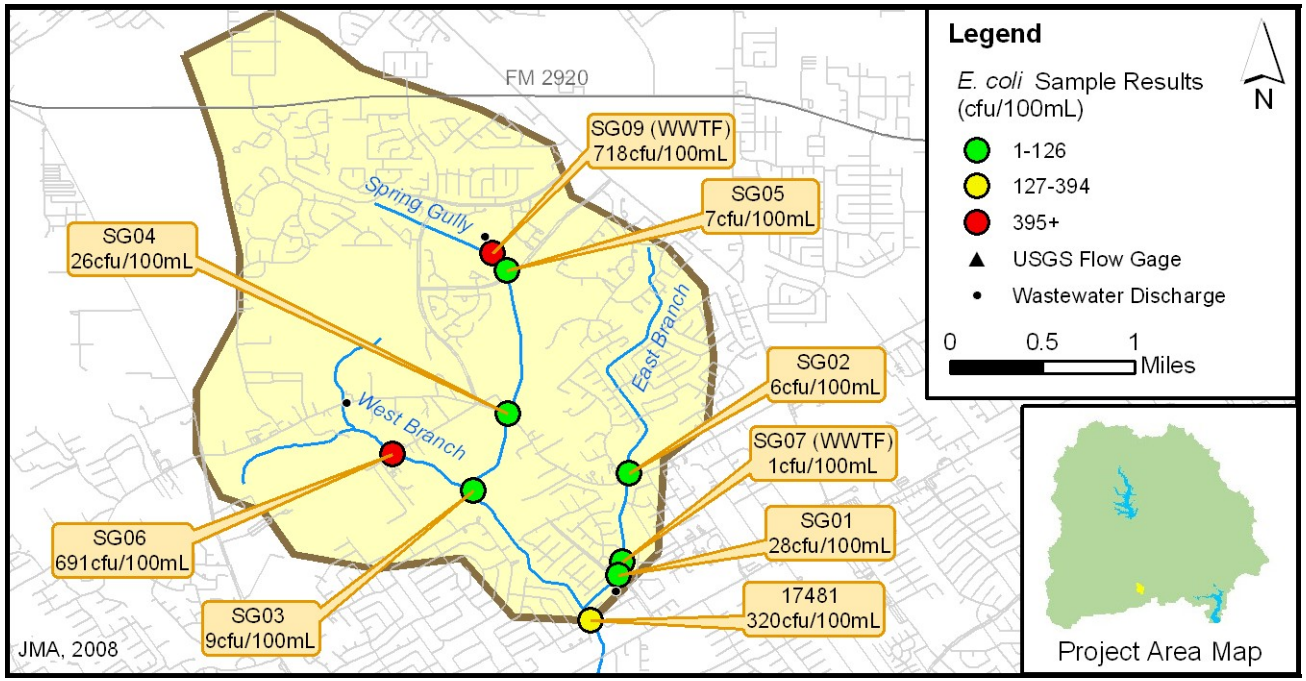

Figure 5-13: Spring Gully (Seg. 1009D) Synoptic Survey Map, Nov. 2007

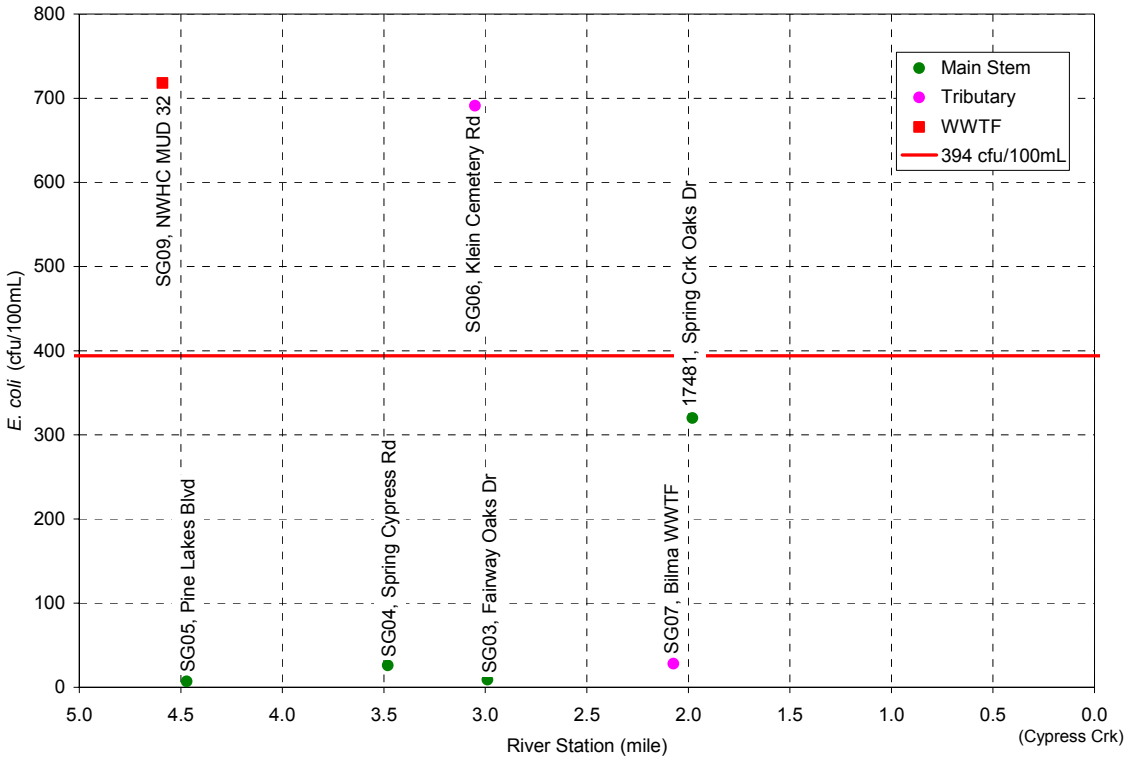

Figure 5-14: Spring Gully (Seg. 1009D) Synoptic *E. coli* Profile, Nov. 2007

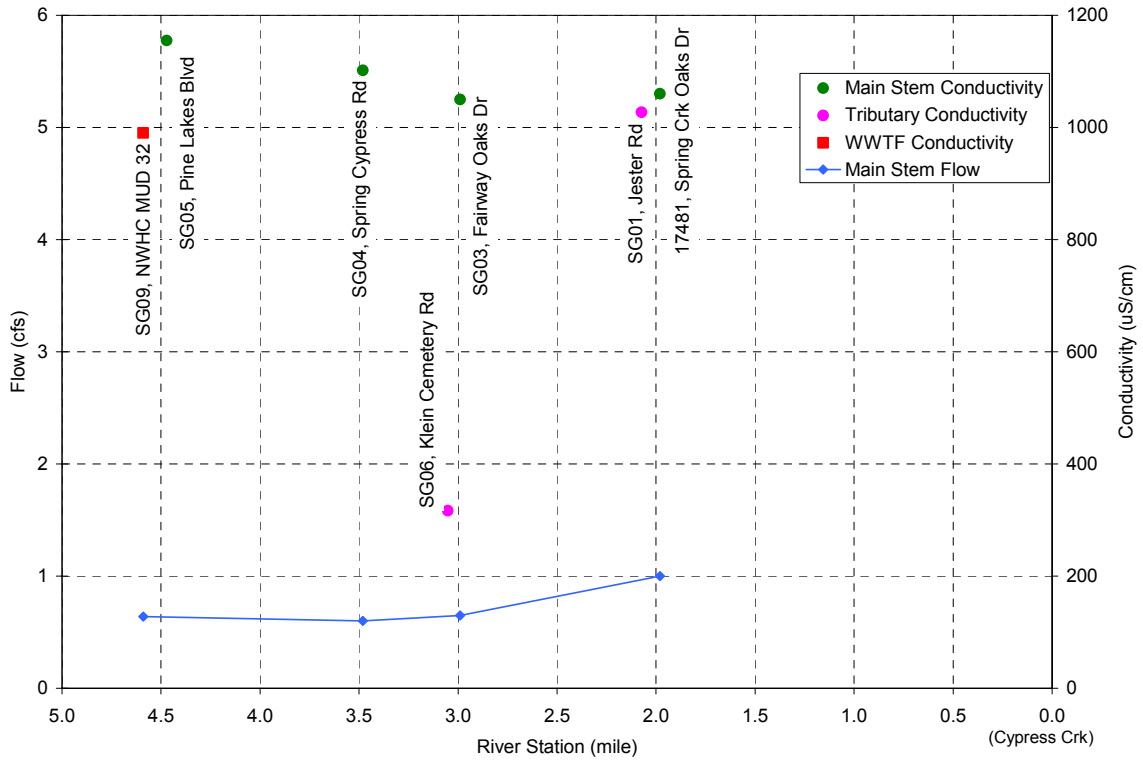

Figure 5-15: Spring Gully (Seg. 1009D) Synoptic Cond. & Flow Profile, Nov. 2007

5.3.2 June 2008 Synoptic Survey

A second synoptic survey of Spring Gully was performed on 18 June 2008. As shown in Figure 5-16, several locations along Spring Gully were sampled during this survey. Detailed sampling results for these stations are presented in Table 5-6. A longitudinal profile of bacteria concentrations can be found in Figure 5-17, and a similar plot of flow and conductivity data can be found in Figure 5-18.

Prior to the survey, the last major rainfall occurred on 10 June. On this date, 0.87 inches of rainfall were recorded at the Houston Hooks Airport near Tomball. An additional 0.12 inches of rainfall occurred on 13 June.

The most upstream sampling site on Spring Gully was the MUD 32 WWTF (SG09). This treatment facility had a moderately low bacteria count. At the next two downstream sampling sites (SG05 and SG04) the bacteria counts were somewhat higher.

Two stations (SG08 and SG06) were sampled on the West Branch of Spring Gully. These sites exhibited low to moderate bacteria levels, and the flow in this branch was minimal. Below the confluence with the West Branch, the bacteria count in the main stem (SG03) was also fairly low.

Two sites (SG01 and SG02) along the East Branch of Spring Gully were sampled. Both of these sites had low bacteria counts. A WWTF on the East Branch was sampled (SG07), and it also had a low bacteria count. Below the confluence with the East Branch, the bacteria count in the main stem (17481) was moderately low and a small chlorine residual was present.

Table 5-6: Spring Gully (Seg. 1009D) Synoptic Survey Results, June 2008

Station Code	Station Type	Description	Station Mile	Sample Date	Sample Time	*E. coli* (cfu/100mL)	Flow Est. (cfs)	Flow* Severity	Temp (C)	Cond (µS/cm)	Total Cl2 (mg/L)
SG09	WWTF	NWHC MUD 32	4.6	18-Jun-08	15:35	68	0.6	-	31.1	1070	1.4
SG05	main stem	Pine Lakes Blvd	4.5	18-Jun-08	15:25	126	-	3	32.4	1051	0.2
SG04	main stem	Spring Cypress Rd	3.5	18-Jun-08	14:34	132	1.1	3	33.7	1010	0.1
SG08	tributary	Spring Cypress Rd	3.1	18-Jun-08	14:20	12	-	2	34.6	283	0.16
SG06	tributary	Klein Cemetery Rd	3.1	18-Jun-08	14:45	92	0.03	2	29.1	404	< 0.05
SG03	main stem	Fairway Oaks Dr	3.0	18-Jun-08	16:20	65	-	3	35.1	956	0.1
SG02	tributary	Spring Cypress Rd	2.1	18-Jun-08	14:58	36	0.23	3	35.9	407	0.1
SG07	WWTF	Bilma WWTF	2.1	18-Jun-08	15:10	2	0.35	-	30.4	1034	1.9
SG01	tributary	Jester Rd	2.1	18-Jun-08	15:24	63	-	3	32.7	848	0.8
17481	main stem	Spring Crk Oaks Dr	2.0	18-Jun-08	15:38	84	0.92	3	35.4	905	0.16

*1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

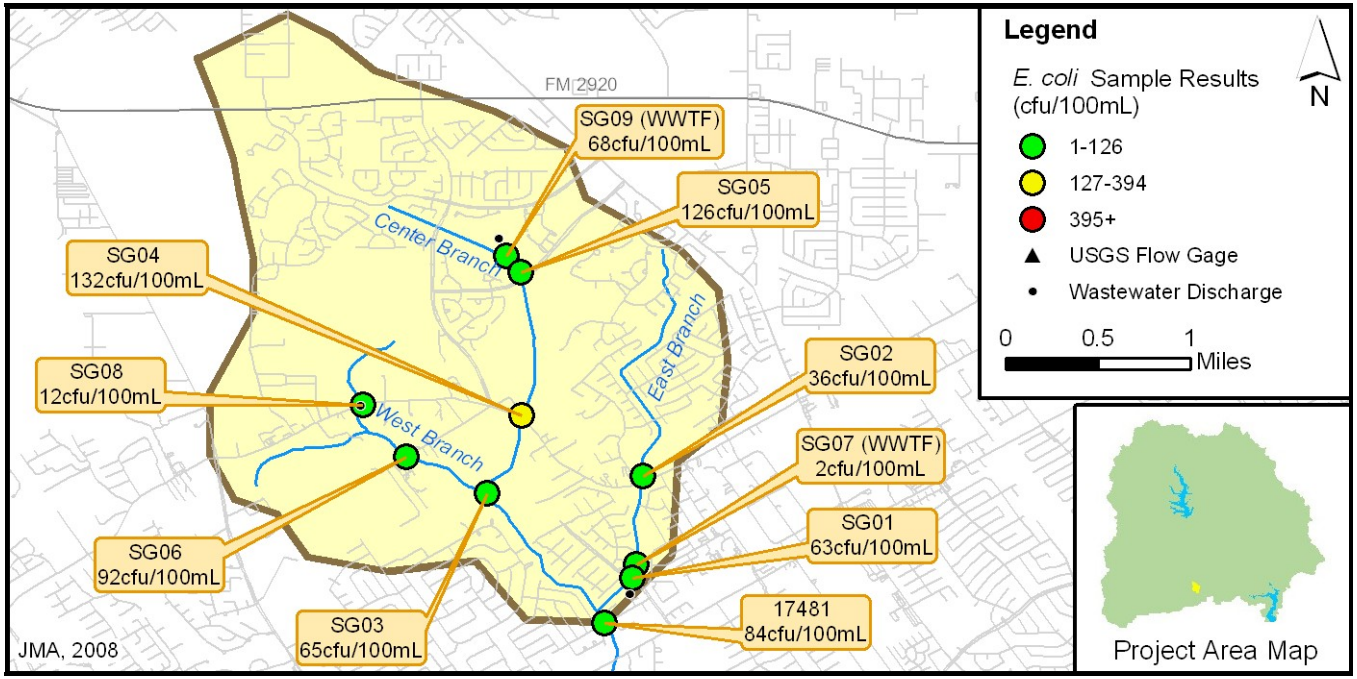

Figure 5-16: Spring Gully (Seg. 1009D) Synoptic Survey Map, June 2008

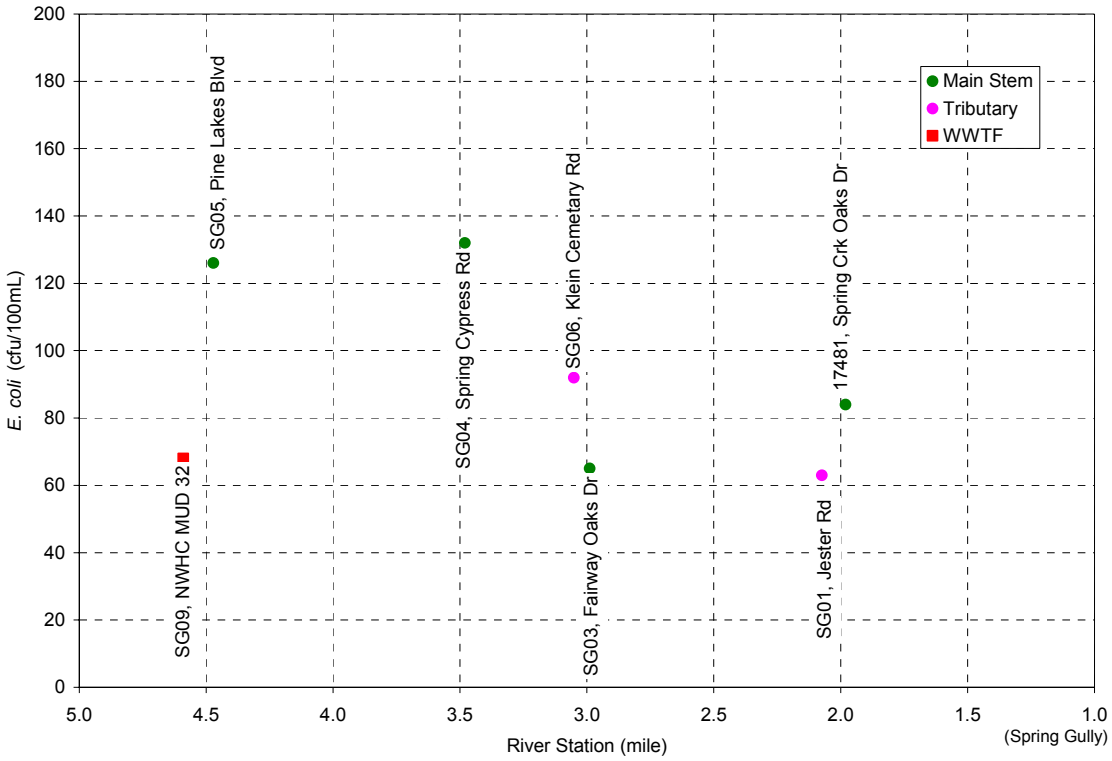

Figure 5-17: Spring Gully (Seg. 1009D) Synoptic *E. coli*. Profile, June 2008

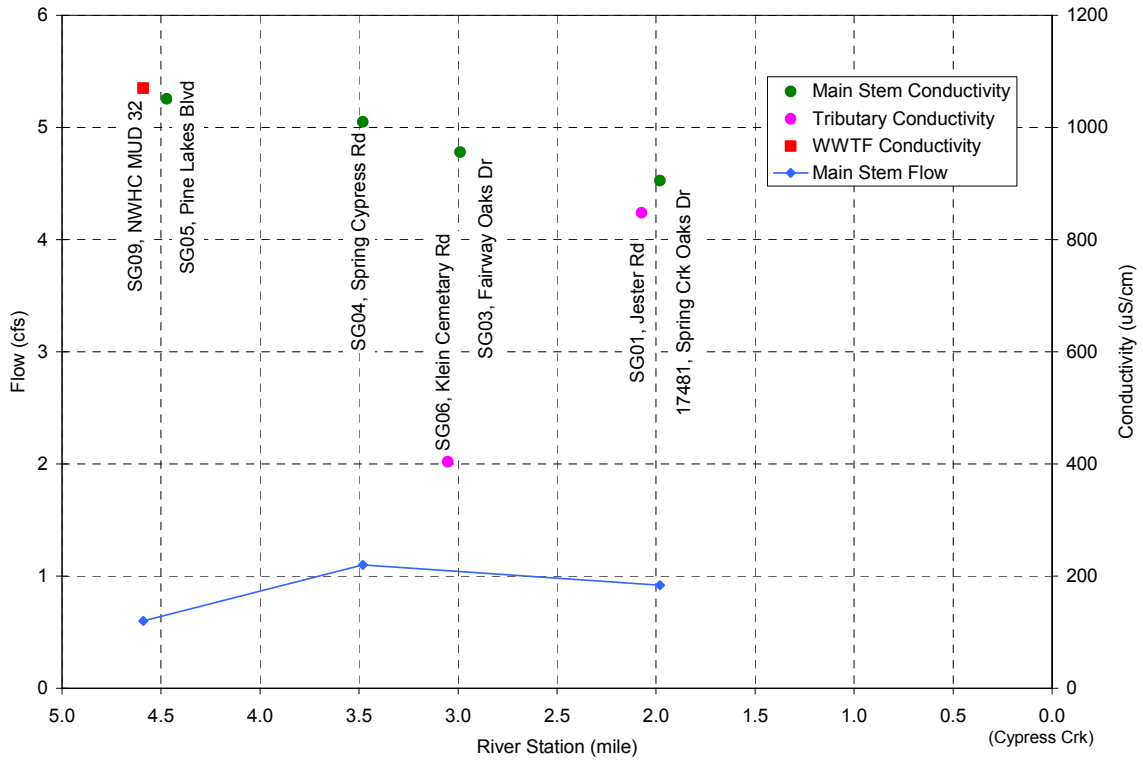

Figure 5-18: Spring Gully (Seg. 1009D) Synoptic Cond. & Flow Profile, June 2008

5.3.3 Spatially Intensive Survey of Spring Gully

A spatially intensive survey of Spring Gully was performed on 25-27 March 2008. The survey included the Center, East, and West Branches of Spring Gully above Spring Creek Oaks Drive. About sixty sites were sampled for *E. coli*. These locations included all points of access to the stream and all flowing outfalls, as shown in Figure 5-19. Complete survey results are tabulated in Tables 5-7, 5-8, and 5-9, for the Central Branch, West Branch, and East Branch respectively.

Prior to the survey, the last significant rainfall occurred on 17 March. On this date, 0.29 inches of rainfall were recorded at the Houston Hooks Airport near Tomball. An additional 0.03 inches of rainfall occurred on 18 March following the completion of sampling activities.

On the central branch of Spring Gully, the most upstream sample was collected from below Alvin Klein Rd (S17), where the Gully emerges from a large storm sewer culvert. At this location, the conductivity was high, suggesting a municipal source of flow. The bacteria count at this station was also moderately high. From Alvin Klein Rd to Pinelakes Blvd, the Gully flows through two large stormwater detention basins. Flows in the Gully were generally less than 0.1 cfs, and bacteria concentrations in the Gully were generally low. A couple of outfalls did have high bacteria counts, but they had small flows and they did not seem to have a major impact on bacteria levels in the Gully.

Just upstream of Pinelakes Blvd, NWHC MUD 32 WWTF discharges to the Gully (S3). On the primary sampling date (25 March), the bacteria count was just 6 cfu/100mL. However, on 27 March, the facility appeared to be malfunctioning (brown-colored effluent) and the concentration was 8,000 cfu/100mL. At Pinelakes Blvd, several storm sewer outfalls were sampled, and they all had elevated bacteria counts.

From Pinelakes Blvd to the confluence with the West Branch, Spring Gully flows through a golf course, stormwater detention basins, and farmland. Almost all sites had elevated bacteria levels. The only exception was site S23, immediately upstream of the confluence with the West Branch. Outfalls within this reach also had elevated bacteria levels. The outfall S19 had the highest bacteria level anywhere in the Spring Gully watershed. This outfall appears to drain from a nearby golf course (possibly from an amenity pond).

The West Branch of Spring Gully was notable for the blue-green color of its water. This coloring is probably the result of dyed amenity ponds which discharge to the Gully. At most locations throughout the length of the Gully bacteria levels were elevated. There is a point source on the West Branch operated by the Klein ISD. However, the outfall could not be located, and very little (or zero) flow was observed during this (or any other) survey of the Gully.

Below the West Branch confluence, bacteria levels in the Center Branch began to decline. At the confluence with the East Branch, bacteria levels were fairly low. Below the confluence, the most downstream site (S51) had a low bacteria count and a significant chlorine residual. The source of the chlorine was the Bilma WWTF, located on the East Branch (SI6).

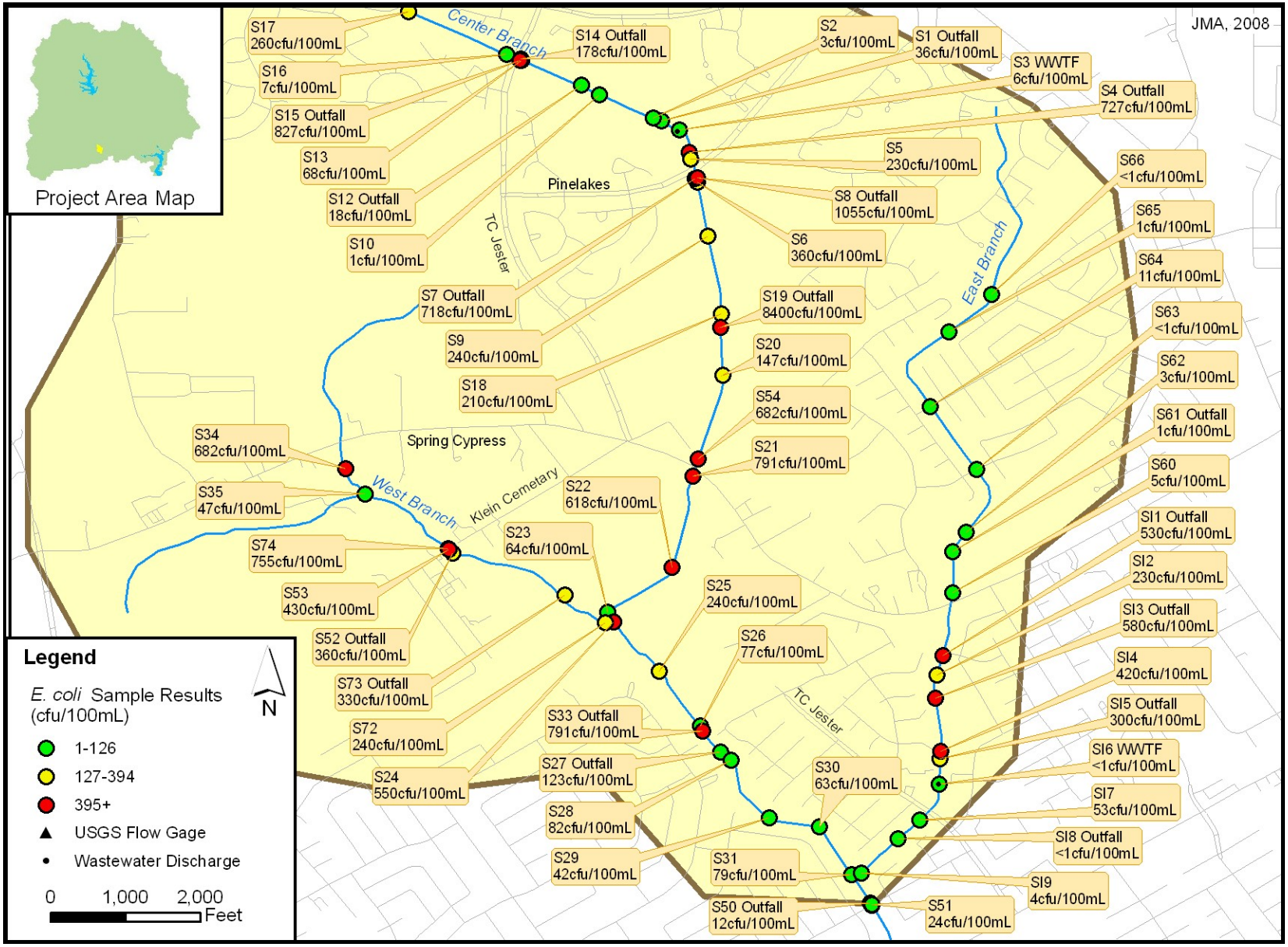

Figure 5-19: Spring Gully Spatially Intensive Survey

Table 5-7A: Spring Gully Center Br. Spatially Intensive Survey Results

Site ID	Site Description	Date	Time	*E. coli* (cfu/100mL)	Flow* Severity	Temp (C°)	Cond (µS/cm)	Cl2 (mg/L)	Optical Brightnr	Flow (cfs)	Station Feet
S17	d/s of Alvin Klein Rd.	25-Mar-08	16:50	260	3	19.8	858	-	-	0.01	15728
S16	u/s of TC Jester	25-Mar-08	16:40	7	3	20.2	851	-	-	0.06	14446
S15	Culvert at TC Jester (West)	25-Mar-08	16:15	827	-	16.5	715	-	-	0.002	14274
S14	Culvert at TC Jester (East)	25-Mar-08	16:09	178	-	18.0	729	-	25	0.007	14274
S13	d/s of TC Jester	25-Mar-08	16:05	68	3	19.8	791	< 0.05	20	-	14257
S12	Culvert 860 ft. d/s of TC Jester	25-Mar-08	15:45	18	-	17.9	622	< 0.05	29	0.003	13491
S10	1,100 ft. d/s of TC Jester	25-Mar-08	15:35	1	3	20.7	705	-	-	-	13239
S2	1,800 ft. d/s of TC Jester	25-Mar-08	9:46	3	3	15.2	652	0.06	20	-	12550
S70	Outfall 1,900 ft. d/s of TC Jester	27-Mar-08	10:38	7	3	23.5	505	1	-	-	12450
S1	Outfall 1,900 ft. d/s of TC Jester	25-Mar-08	9:45	36	-	15.7	906	-	30	0.02	12449
S3	NWHC MUD #32 WWTF	25-Mar-08	10:42	6	-	22.2	1149	1.7	51	-	12207
13152	NWHC MUD #32 WWTF	27-Mar-08	10:03	8000	-	24.4	1090	0.4	-	1.4	12207
S4	Culvert 240 ft. u/s of Pinelakes Blvd.	25-Mar-08	11:40	727	-	17.9	795	0.1	45	0.006	11871
S5	140 ft. u/s of Pinelakes Blvd.	25-Mar-08	11:50	230	3	22.5	1008	0.3	-	1.0	11771
S8	Culvert at Pine Lakes Blvd. (East)	25-Mar-08	12:15	1055	3	18.9	1000	< 0.05	23	0.008	11514
S7	Culvert at Pine Lakes Blvd. (West)	25-Mar-08	12:12	718	-	20.1	768	< 0.05	17	0.002	11513
S71	150 ft. d/s of Pinelakes Blvd.	27-Mar-08	11:09	2500	3	24.4	650	-	-	-	11487
S6	178 ft. d/s of Pinelakes Blvd.	25-Mar-08	12:10	360	-	22.7	1093	-	40	-	11459
S9	910 ft. d/s of Pinelakes Blvd.	25-Mar-08	12:50	240	-	21.8	989	0.12	-	-	10729
S18	1,930 ft. d/s of Pinelakes Blvd.	26-Mar-08	10:05	210	3	19.8	1039	< 0.05	-	-	9681
S19	Culvert 2,140 ft. d/s of Pinelakes Blvd.	26-Mar-08	10:15	8400	-	18.3	1373	< 0.05	-	0.02	9493
S20	1277 ft. u/s of Spring Cypress Rd.	26-Mar-08	10:35	147	3	19.8	1011	-	-	-	8855
S54	u/s of Spring Cypress Rd.	25-Mar-08	17:50	682	-	20.7	1056	< 0.05	-	0.51	7710
U55	d/s of Spring Cypress Rd.	25-Mar-08	17:55	618	-	20.7	1056	< 0.05	-	-	7468
S21	d/s of Spring Cypress Rd.	26-Mar-08	10:57	791	3	19.4	1020	-	-	-	7468
S22	1,370 ft. d/s of Spring Cypress Rd.	26-Mar-08	11:12	618	3	19.2	1034	< 0.05	-	-	6218
S23	u/s of confluence w/ West Branch	26-Mar-08	11:34	64	3	19.9	1000	-	-	0.01	5228
S25	1,080 ft. u/s of Center Court	26-Mar-08	12:05	240	3	19.8	969	-	-	-	4216
S26	200 ft. u/s of Center Court	26-Mar-08	12:20	77	3	20.0	968	-	-	-	3346
S33	Culvert 135 ft. u/s of Center Court	26-Mar-08	16:04	791	-	19.4	808	-	-	-	3278

*1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

Table 5-7B: Spring Gully Center Br. Spatially Intensive Survey Results (continued)

Site ID	Site Description	Date	Time	*E. coli* (cfu/100mL)	Flow* Severity	Temp (C°)	Cond (µS/cm)	Cl2 (mg/L)	Optical Brightnr	Flow (cfs)	Station Feet
S27	Culvert 200 ft. d/s of Center Court	26-Mar-08	14:40	123	-	18.6	603	0.06	-	0.004	2926
S28	364 ft. d/s of Center Court	26-Mar-08	14:50	82	3	20.9	969	-	-	-	2768
S29	1,420 ft. u/s of Confluence w/ East Br.	26-Mar-08	15:10	42	3	21.1	968	-	-	-	1816
S30	800 ft. u/s of Confluence w/ East Br.	26-Mar-08	15:19	63	3	20.7	960	-	-	-	1198
S31	u/s of Confluence w/ East Branch	26-Mar-08	15:30	79	3	20.4	943	0.06	-	-	466
S50	Culvert at Spring Creek Oaks	25-Mar-08	15:46	12	-	20.6	744	< 0.05	-	0.003	34
S11	u/s of Spring Creek Oaks	25-Mar-08	13:46	41	3	22.0	882	0.16	22	-	0
S51	u/s of Spring Creek Oaks	25-Mar-08	16:08	24	-	20.8	906	0.2	-	-	0
S32	u/s of Spring Creek Oaks	26-Mar-08	15:41	81	-	21.6	970	0.18	-	1.1	0

*1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

Table 5-8: Spring Gully West Branch Spatially Intensive Survey Results

Site ID	Site Description	Date	Time	*E. coli* (cfu/100mL)	Flow* Severity	Temp (C°)	Cond (µS/cm)	Cl2 (mg/L)	Optical Brightnr	Flow (cfs)	Station Feet
S34	380 ft. d/s of Spring Cypress Rd.	26-Mar-08	16:58	682	-	20.5	509	-	-	-	3991
S35	810 ft. d/s of Spring Cypress Rd.	26-Mar-08	17:07	47	-	21.0	264	-	-	-	3555
S74	u/s of Klein Cemetery Rd.	27-Mar-08	13:20	755	3	23.2	274	< 0.05	16	0.08	2274
S53	d/s of Klein Cemetery Rd.	25-Mar-08	17:12	430	-	18.3	284	< 0.05	-	-	2258
S52	Outfall d/s of Klein Cemetery Rd.	25-Mar-08	17:08	360	-	20.7	925	< 0.05	-	-	2198
S73	Trib. 728 ft. u/s of Center Br.	27-Mar-08	12:40	330	3	22.6	440	< 0.05	17	0.1	738
S72	100 ft. u/s of Center Br.	27-Mar-08	12:23	240	3	22.0	444	< 0.05	16	0.63	100
S24	at Confluence with Center Branch	26-Mar-08	11:38	550	-	18.4	351	< 0.05	-	0.63	5

*1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

Table 5-9: Spring Gully East Branch Spatially Intensive Survey Results

Site ID	Site Description	Date	Time	*E. coli* (cfu/100mL)	Flow* Severity	Temp (C°)	Cond (µS/cm)	Cl2 (mg/L)	Optical Brightnr	Flow (cfs)	Station Feet
S66	3,030 ft. u/s of Camellia Bend	26-Mar-08	15:50	< 1	3	23.9	255	< 0.05	9	-	9043
S65	2,290 ft. u/s of Camellia Bend	26-Mar-08	15:37	1	3	23.3	245	< 0.05	13	-	8326
S64	1,020 ft. u/s of Camellia Bend	26-Mar-08	15:27	11	3	22.7	228	< 0.05	16	0.01	7030
S63	Camellia Bend	26-Mar-08	15:15	< 1	3	22.3	221	< 0.05	19	-	6030
S62	990 ft. u/s of Spring Cypress Rd.	26-Mar-08	15:00	3	3	23.3	367	< 0.05	15	-	5078
S61	Culvert 730 ft. u/s of Spring Cypress Rd.	26-Mar-08	14:51	1	-	22.4	305	< 0.05	7	-	4778
S60	Spring Cypress Rd.	26-Mar-08	14:35	5	3	23.8	301	< 0.05	11	0.11	4222
SI1	Culvert 700 ft. d/s of Spring Cypress Rd.	26-Mar-08	10:32	530	-	20.6	986	< 0.05	28	-	3360
SI2	970 ft. d/s of Spring Cypress Rd.	26-Mar-08	10:44	230	3	19.9	499	< 0.05	14	-	3073
SI3	Culvert 1,310 ft. d/s of Spr. Cypress Rd.	26-Mar-08	11:13	580	-	20.2	1571	< 0.05	25	-	2761
SI4	830 ft. u/s of TC Jester	26-Mar-08	11:25	420	3	20.2	403	< 0.05	14	-	2064
SI5	Culvert 750 ft. u/s of TC Jester	26-Mar-08	11:35	300	-	20.5	1020	< 0.05	25	-	1978
SI6	Bilma WWTF	26-Mar-08	11:56	< 1	-	22.8	1001	1.3	52	0.41	1645
SI7	160 ft. d/s of TC Jester	26-Mar-08	12:10	53	3	22.7	905	0.5	40	0.29	1087
SI8	Culver 512 ft. d/s of TC Jester	26-Mar-08	12:35	< 1	-	22.3	726	0.6	2	0.002	736
SI9	u/s of Confluence with Center Br.	26-Mar-08	12:46	4	3	22.1	990	0.1	38	0.39	111

*1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

Above Spring Cypress Road, the East Branch of Spring Gully was characterized by low flows, low conductivities, and low bacteria counts. Below Spring Cypress Road, flows remained relatively low, but bacteria concentrations and conductivity levels increased significantly, probably as a result of trickling storm sewer outfalls with high bacteria counts. The Bilma WWTF introduced a significant chlorine residual to the Gully, which appears to have greatly reduced bacteria levels.

A sediment source survey was performed in conjunction with the spatially intensive survey on 26 March 2008. Sediment samples were collected from the East Branch of Spring Gully, immediately downstream of Spring Cypress Road. The sampling area was a maintained grass embankment with a recreational trail at the top. The results of this sampling are presented in Table 5-10. The bacteria counts are reported per gram of sediment (dry weight).

Table 5-10: Spring Gully Sediment Source Sampling Results

Location	*E. coli* (cfu/g)
stream bed	92
water's edge	154
1 ft from edge	1
3 ft from edge	2
10 ft from edge	1
36 ft from edge	1

A resuspension study was performed in the East Branch of Spring Gully on 26-27 March 2008. One sample was taken before sediment disturbance. Dye was then added to the disturbed area so that the resulting sediment plume could be tracked downstream. Additional samples were taken periodically, as shown in Table 5-11. The locations of the sediment/dye plume, at the times of sampling, are presented in Figure 5-20. These data indicate an increase in bacteria concentration as the sediment plume moved downstream. However, this increase in concentration may not be due to the sediment resuspension. As demonstrated in Figure 5-19, bacteria levels increased throughout this reach (below Spring Cypress Road) without the benefit of resuspension, probably as a result of loads from storm sewer outfalls.

Table 5-11: March Spring Gully Resuspension Study Sampling Results

Date	Time	*E. coli* (cfu/100mL)	Station Feet	Sample Comments
26-Mar-08	9:54	3	0	Before Resuspension
26-Mar-08	10:03	6	0	After Resuspension
26-Mar-08	10:08	9	200	
26-Mar-08	10:18	18	330	
26-Mar-08	10:38	430	480	
26-Mar-08	11:18	300	610	
26-Mar-08	12:18	310	730	
26-Mar-08	14:20	1164	950	
26-Mar-08	17:05	4300	1380	
27-Mar-08	12:00	21	1730	

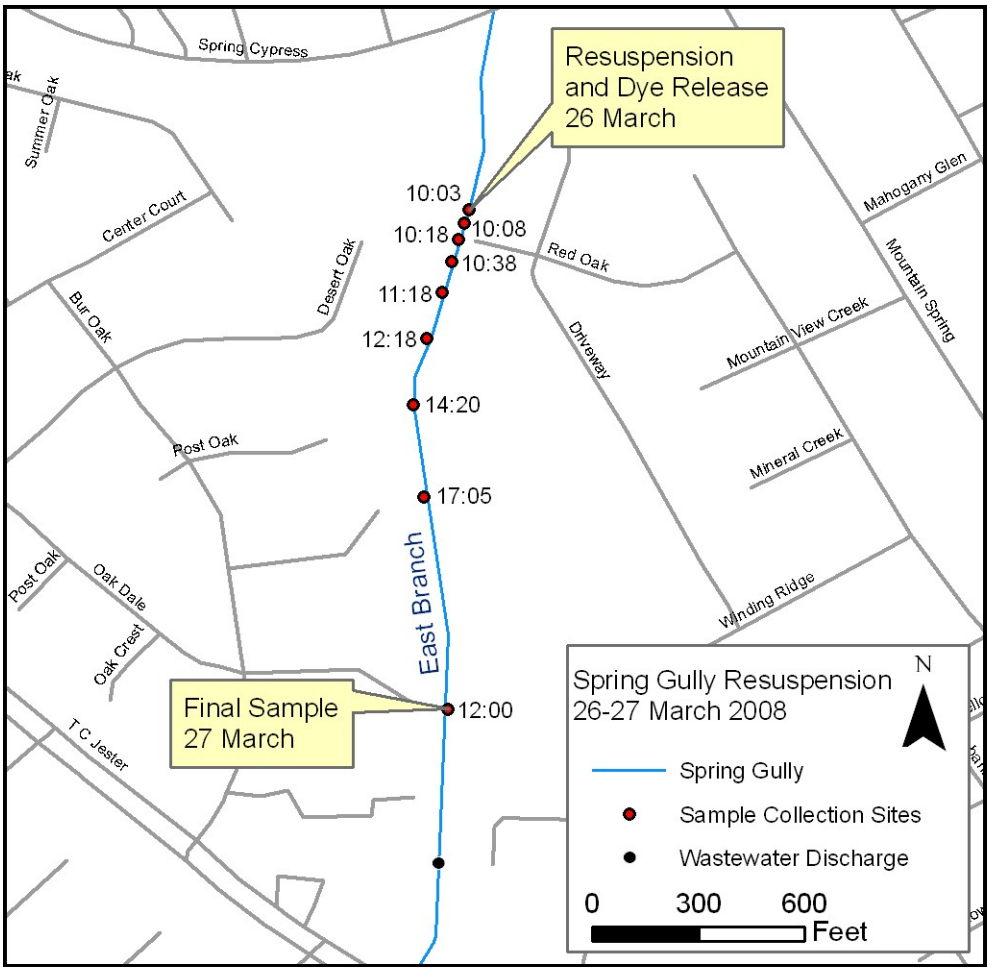

Figure 5-20: March Spring Gully Resuspension Study Map

A second resuspension study was performed in the Center Branch of Spring Gully on 18 June 2008. One sample was taken before sediment disturbance. Three additional samples were taken immediately following sediment disturbance, as shown in Table 5-12. Dye was then added to the disturbed area so that the resulting sediment plume could be tracked downstream. An additional three samples were collected eight hours later at the location of the dye/sediment plume. The locations of sample collection are presented in Figure 5-21.

Table 5-12: June Spring Gully Resuspension Study Sampling Results

Date	Time	*E. coli* (cfu/100mL)	Station Feet	Sample Comments
18-Jun-08	11:28	136	0	Before Resuspension
18-Jun-08	11:29	845	0	After Resuspension
18-Jun-08	11:29	736	0	After Resuspension
18-Jun-08	11:29	1036	0	After Resuspension
18-Jun-08	19:20	83	3160	50 ft upstream of peak
18-Jun-08	19:18	127	3210	at peak of dye plume
18-Jun-08	19:21	94	3260	50 ft downstream of peak

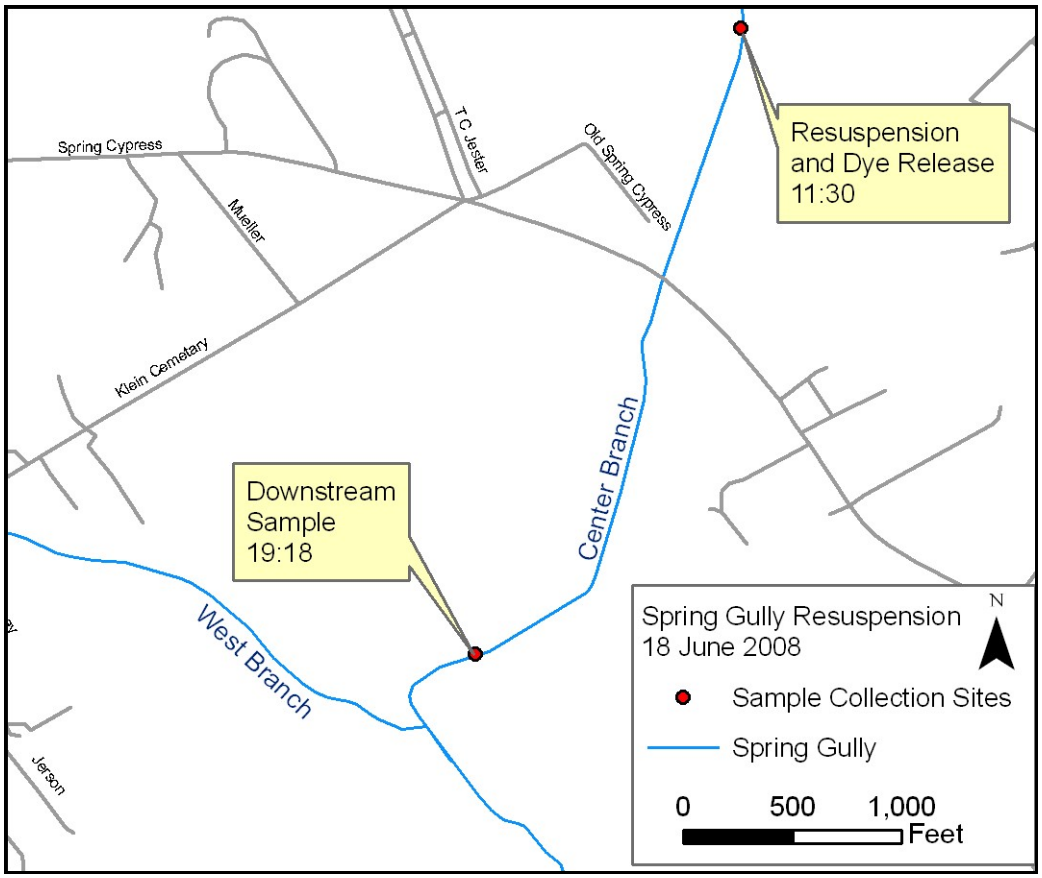

Figure 5-21: June Spring Gully Resuspension Study Map

Two kinetics studies were performed on Spring Gully. The first study took place on 25-26 March and the second study took place on 18-20 June. Results are presented in Tables 5-13 and 5-14 for the March and June studies, respectively.

The March study was performed on the Center Branch of Spring Gully, just upstream of the NWHC MUD 32 WWTF outfall. For this study, three different containers were used. Each container was filled with about 9.5 Liters of stream water, 1 L of WWTF effluent, and 1 L of discharge from a downstream culvert. All three containers were translucent plastic containers approximately 12 inches wide by 18 inches long by 12 inches high. Container A had an opaque plastic lid while Container B had a transparent plastic lid. Container C had a transparent plastic lid with an electronic stirring device.

Immediately after setting up the chambers, the first samples were collected at about 11:10 on 25 March. The next round of samples was collected at about 17:20 on 25 March, and as shown, little change in bacteria counts had occurred. A third round of sampling occurred at about 9:00 on 26 March, and again, little change had occurred. The fourth round of sampling occurred at about 17:30 on 26 March, and with the exception of Container C, little change had occurred. The unusually high count from Container C appears to be an outlier, and may represent contamination of the experiment, though this cannot be verified.

The June study was performed on the Center Branch of Spring Gully, just upstream of Spring Cypress Road. For this study, just two containers were used. Each container was filled with

water from the Gully (the NWHC MUD 32 WWTF was the predominant flow source in this portion of the Gully). The containers were identical and were made of translucent plastic. They were approximately 8 inches wide, by 12 inches long, by 10 inches tall. The first container was un-stirred and the second container was manually stirred before samples were collected. Samples were collected in duplicate.

Immediately after setting up the chambers, the first samples were collected at about 11:45 on 18 June. A second and third round of sampling were performed on the mornings of the 19 and 20 June. In general, the bacteria counts decreased substantially in both containers throughout the sampling period.

Table 5-13: March Spring Gully Kinetics Study

Date	Container A - Dark		Container B - Light		Container C - Continuously Mixed	
	Time	*E. coli* (cfu/100mL)	Time	*E. coli* (cfu/100mL)	Time	*E. coli* (cfu/100mL)
25-Mar-08	11:11	< 1	11:12	35	11:13	78
25-Mar-08	17:20	53	17:22	34	17:23	40
26-Mar-08	9:10	61	9:11	5	9:12	32
26-Mar-08	17:33	12	17:34	62	17:35	1164

Table 5-14: June Spring Gully Kinetics Study

Date	Container A - Unmixed		Container B - Mixed at time of Sample	
	Time	*E. coli* (cfu/100mL)	Time	*E. coli* (cfu/100mL)
18-Jun-08	11:45	220	11:45	38
18-Jun-08	11:45	29	11:45	330
19-Jun-08	8:22	44	8:20	39
19-Jun-08	8:22	56	8:20	17
20-Jun-08	9:16	< 1	9:15	1
20-Jun-08	9:16	< 1	9:15	1

5.4 LITTLE CYPRESS CREEK, SEGMENT 1009E

5.4.1 November 2007 Synoptic Survey

A synoptic survey of Little Cypress Creek was performed on 9 November 2007. As shown in Figure 5-22, several locations along Little Cypress Creek were sampled during this survey. Detailed sampling results for these stations are presented in Table 5-15. A longitudinal profile of bacteria concentrations can be found in Figure 5-23, and a similar plot of flow and conductivity data can be found in Figure 5-24.

Prior to the survey, the last major rainfall occurred on 15 October. On this date, 1.54 inches of rainfall were recorded at the Houston Hooks Airport near Tomball. An additional 0.08 inches of rainfall occurred on 22 October.

The most upstream site on Little Cypress Creek was at Bauer Road (LCC01). At this location, there was significant flow and high conductivity, suggesting that the flow originated from a WWTF discharge. The next downstream site (LCC02), however, had much lower conductivity and a significantly lower flow. LCC03 also had a low conductivity, but a higher flow. At all stations, the bacteria counts were low.

At Spring Cypress Road (LCC04) the conductivity level was moderate and the bacteria count was still low. Below Spring Cypress Road, three WWTFs were sampled. Each of these facilities had low bacteria counts, indicating complete disinfection. At the final station (14159), the bacteria count was negligible probably owing to the significant chlorine residual present in the stream.

Table 5-15: Little Cypress (Seg. 1009E) Synoptic Survey Results, Nov. 2007

Station Code	Station Type	Description	Station Mile	Sample Date	Sample Time	*E. coli* (cfu/100mL)	Flow Est. (cfs)	Flow* Severity	Temp (C)	Cond (µS/cm)	Total Cl2 (mg/L)
LCC01	main stem	Bauer Rd	14.4	9-Nov-07	11:10	27	0.31	2	20.0	741	< 0.05
LCC02	main stem	Mueschke Rd	9.6	9-Nov-07	11:35	25	< 0.1	2	20.4	185	< 0.05
LCC03	main stem	Rosehill Rd	7.3	9-Nov-07	12:00	14	0.5	2	20.2	147	-
LCC04	main stem	Spring Cypress Rd	3.5	9-Nov-07	12:15	32	-	3	21.5	431	-
LCC05	WWTF	NWHC MUD 5	2.9	9-Nov-07	12:35	8	0.66	-	26.2	1050	1.7
LCC06	WWTF	Grant Rd PUD	1.8	9-Nov-07	13:36	< 1	0.31	-	25.6	741	2
LCC07	WWTF	HC MUD 36	1.7	9-Nov-07	15:10	< 1	0.31	-	26.8	1275	> 3.5
14159	main stem	Kluge Rd	1.4	9-Nov-07	14:45	1	3.2	3	23.8	830	0.35

*1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

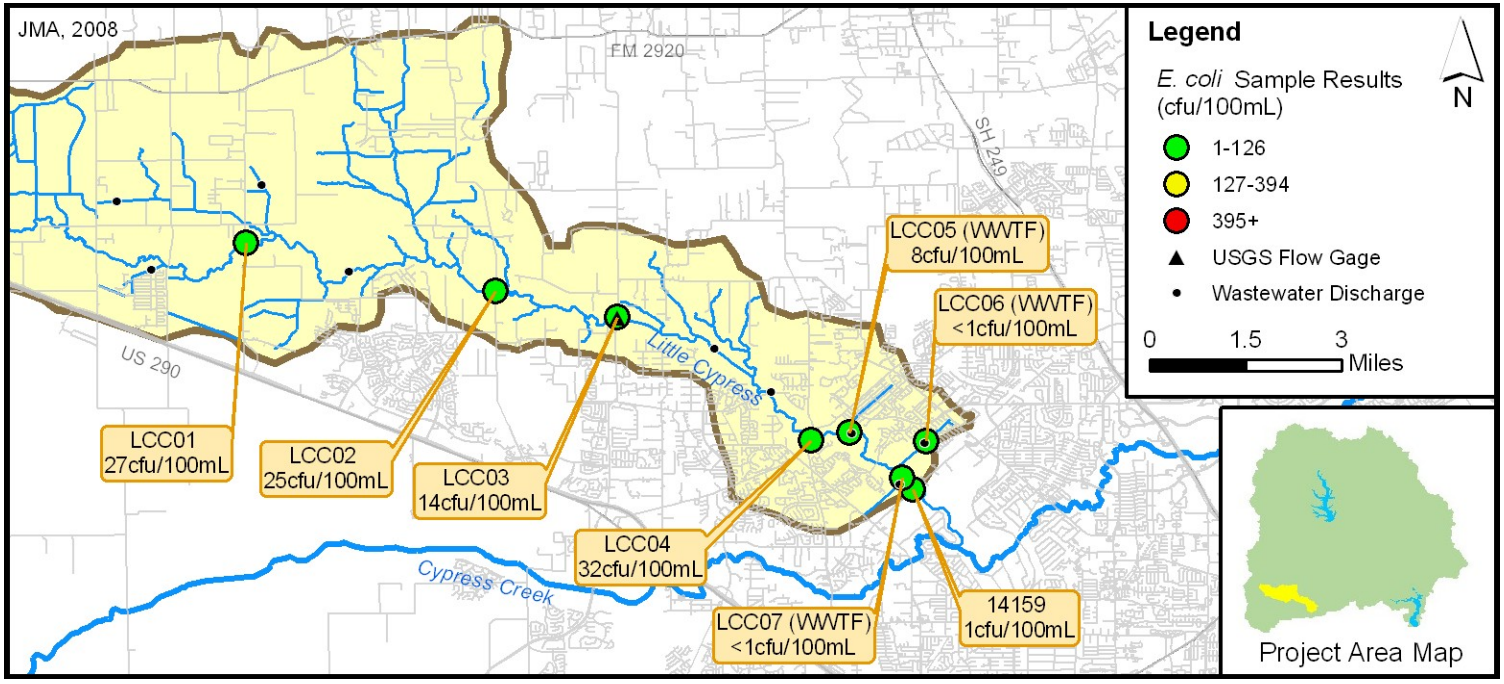

Figure 5-22: Little Cypress (Seg. 1009E) Synoptic Survey Map, Nov. 2007

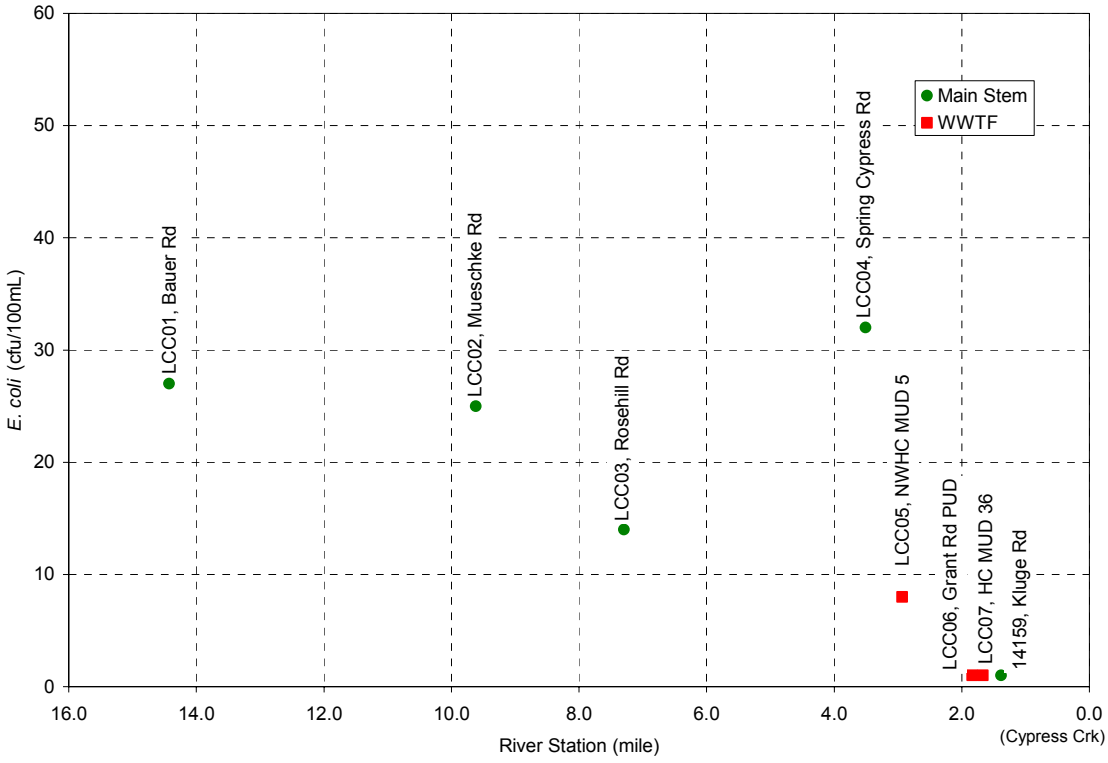

Figure 5-23: Little Cypress (Seg. 1009E) Synoptic *E. coli* Profile, Nov. 2007

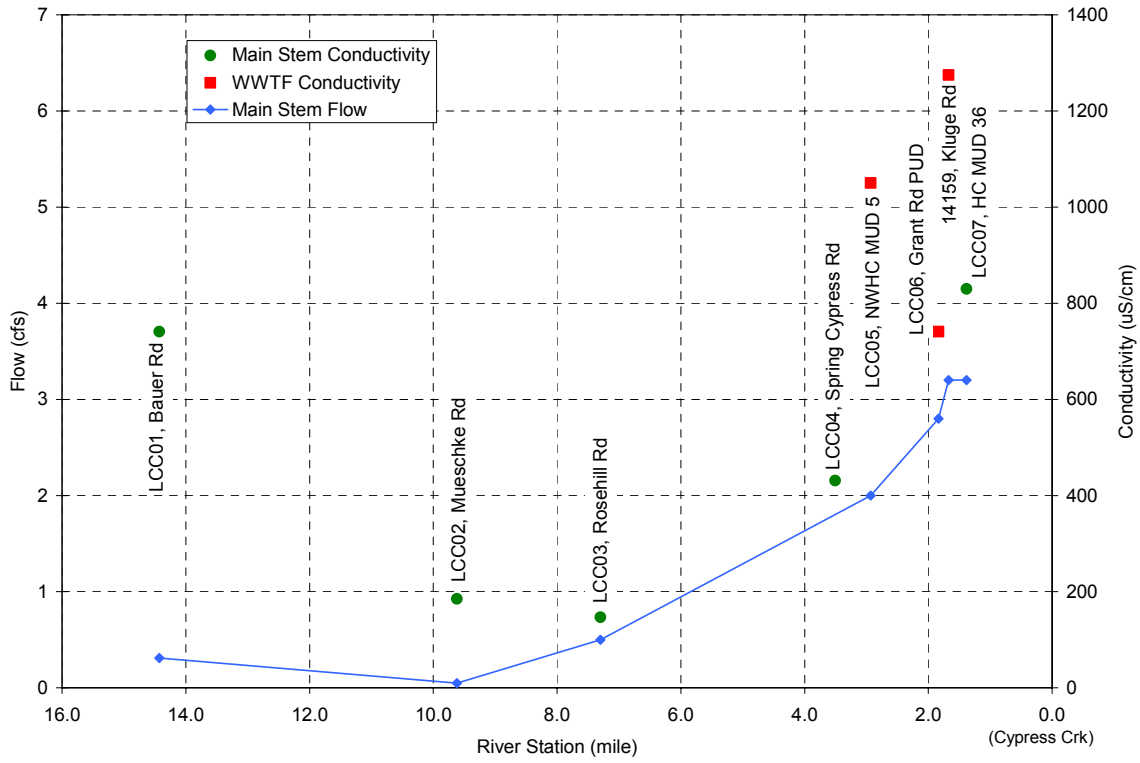

Figure 5-24: Little Cypress (Seg. 1009E) Synoptic Cond. & Flow Profile, Nov. 2007

5.4.2 June 2008 Synoptic Survey

A synoptic survey of Little Cypress Creek was performed on 9 November 2008. As shown in Figure 5-25, several locations along Little Cypress Creek were sampled during this survey. Detailed sampling results for these stations are presented in Table 5-16. A longitudinal profile of bacteria concentrations can be found in Figure 5-26, and a similar plot of flow and conductivity data can be found in Figure 5-27.

Prior to the survey, the last major rainfall occurred on 10 June. On this date, 0.87 inches of rainfall were recorded at the Houston Hooks Airport near Tomball. An additional 0.12 inches of rainfall occurred on 13 June.

The most upstream site on Little Cypress Creek was at Bauer Road (LCC01). At this location, there was significant flow and high conductivity, suggesting that the flow originated from a WWTF discharge. The next downstream site (LCC02), also had significant flow, but the conductivity was substantially lower. LCC03 had an even lower conductivity, but no flow was present. These stations had low to moderate bacteria counts.

At Spring Cypress Road (LCC04) the conductivity level was moderate and the bacteria count was still fairly low. Below Spring Cypress Road, three WWTFs were sampled. Two of these facilities had low bacteria counts, indicating complete disinfection. However, the Grant Road PUD (LCC06) had an elevated bacteria count. A community pond, next to the NWHC MUD 5 WWTF was also sampled, and the bacteria count was found to be fairly low. At the final station (14159) the bacteria count was 60 cfu/100mL despite the presence of a chlorine residual.

Table 5-16: Little Cypress (Seg. 1009E) Synoptic Survey Results, June 2008

Station Code	Station Type	Description	Station Mile	Sample Date	Sample Time	*E. coli* (cfu/100mL)	Flow Est. (cfs)	Flow* Severity	Temp (C)	Cond (µS/cm)	Total Cl2 (mg/L)
LCC01	main stem	Bauer Rd	14.4	19-Jun-08	9:45	103	-	3	26.3	804	< 0.05
LCC02	main stem	Mueschke Rd	9.6	19-Jun-08	10:13	47	0.07	3	27.0	584	0.16
LCC03	main stem	Rosehill Rd	7.3	19-Jun-08	10:29	< 1	0	1	26.5	375	< 0.05
LCC04	main stem	Spring Cypress Rd	3.5	19-Jun-08	11:20	67	0.18	3	29.8	698	0.06
LCC16	Pond	NWHC MUD 5 Pond	2.9	19-Jun-08	11:56	46	-	-	31.8	583	-
LCC05	WWTF	NWHC MUD 5	2.9	19-Jun-08	11:43	< 1	0.36	-	28.9	1101	> 3.5
LCC06	WWTF	Grant Rd PUD	1.8	19-Jun-08	12:37	420	0.31	-	29.5	730	0.2
LCC07	WWTF	HC MUD 36	1.7	19-Jun-08	14:12	2	0.37	-	30.5	1197	1.8
14159	main stem	Kluge Rd	1.4	19-Jun-08	13:38	60	2.2	3	31.3	1003	0.3

*1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

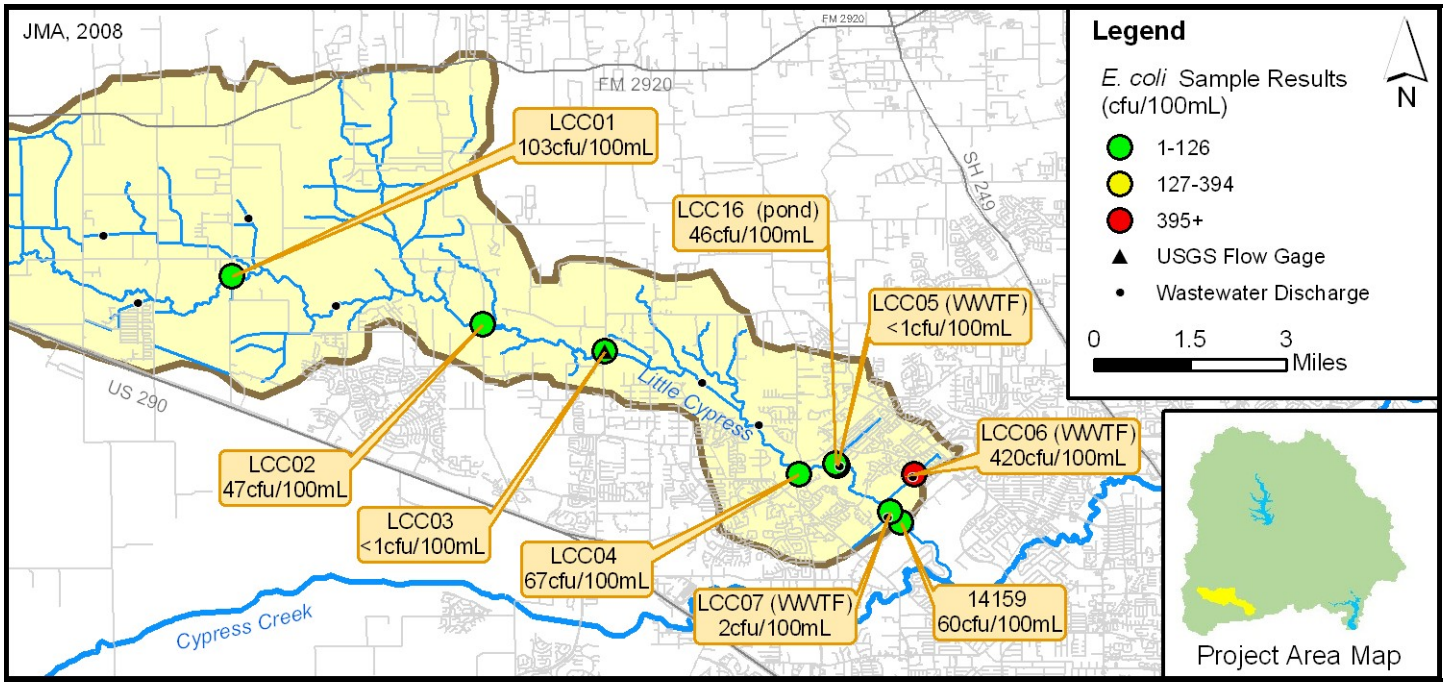

Figure 5-25: Little Cypress (Seg. 1009E) Synoptic Survey Map, June 2008

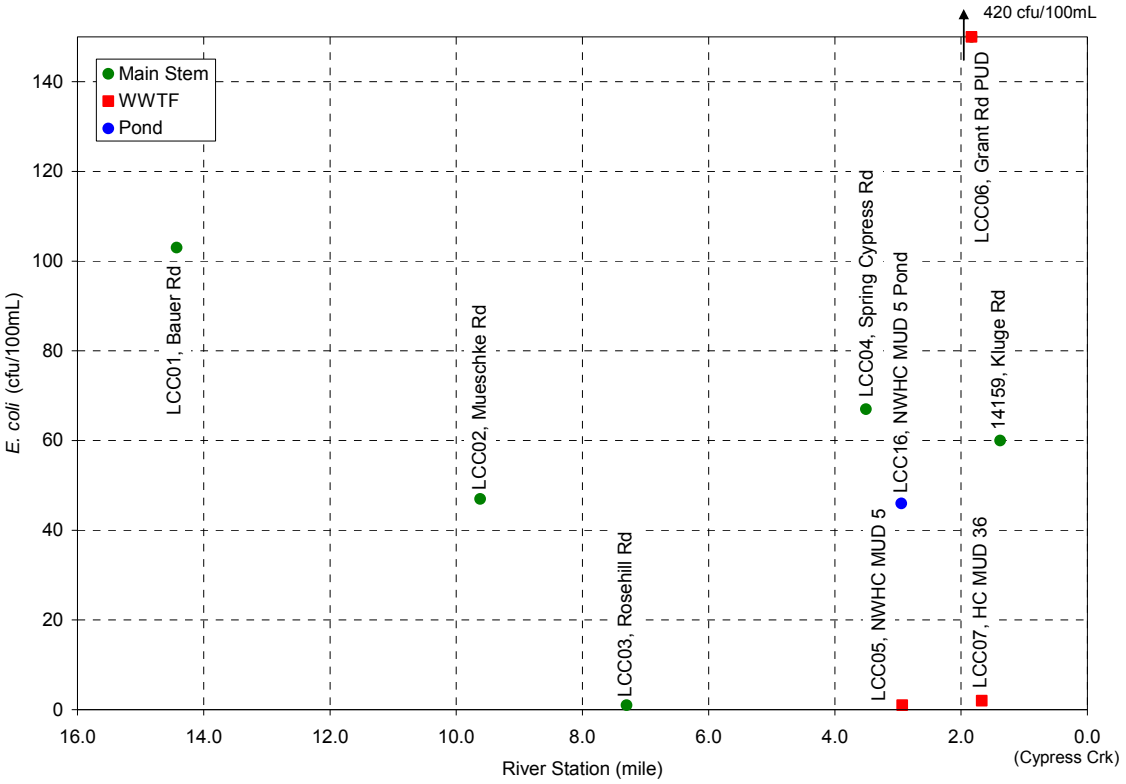

Figure 5-26: Little Cypress (Seg. 1009E) Synoptic *E. coli* Profile, June 2008

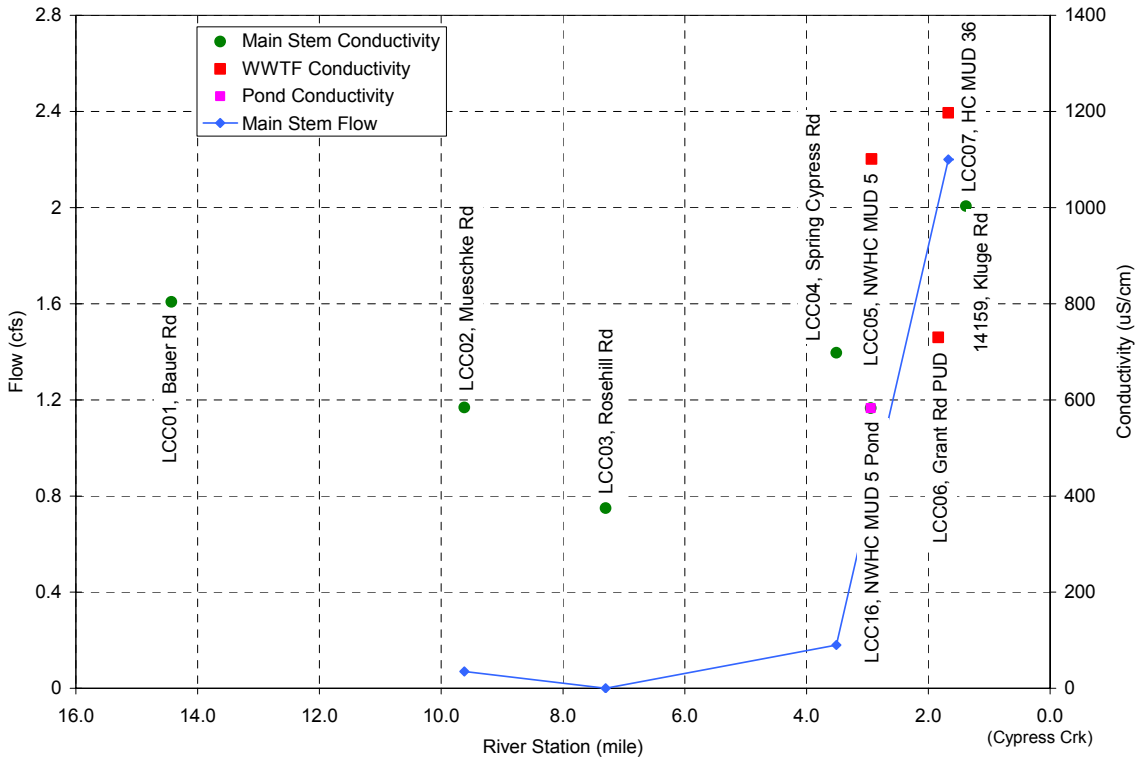

Figure 5-27: Little Cypress (Seg. 1009E) Synoptic Cond. & Flow Profile, June 2008

6.0 CANEY CREEK, SEGMENT 1010

6.1 NOVEMBER 2007 SYNOPTIC SURVEY

A synoptic survey of Caney Creek was performed on 2 November 2007. As shown in Figure 6-1, several locations along Caney Creek were sampled during this survey. Detailed sampling results for these stations are presented in Table 6-1. A longitudinal profile of bacteria concentrations can be found in Figure 6-2, and a similar plot of flow and conductivity data can be found in Figure 6-3.

Prior to the survey, the last significant rainfall occurred on 22 October. On this date, 0.83 inches of rainfall were recorded at the Conroe Airport.

The most upstream station on Caney Creek was at FM 1097 (CC02). At this station, the flow and the bacteria count were both relatively low, and conductivity was moderate. At the next downstream station, SH 105 (14241), the flow had increased substantially. Since the conductivity at this station was low, this flow appears to be of a natural source (this flow source also appears to contribute to Peach Creek and the East Fork San Jacinto River at roughly the same latitude).

At FM 2090 (11335) conditions were very similar to those at SH 105. Immediately below this site, effluent from the Conroe Independent School District WWTF (CC05) enters the stream. The bacteria count in this discharge was high, though the flow was not great.

Two tributaries were sampled below FM2090. At Spring Branch (CC03), the bacteria count was moderate and the conductivity was low. At Dry Creek (CC01), the bacteria count was high, and the conductivity was moderate. A WWTF (CC06) was also sampled on Dry Creek, and it was found to have a low bacteria count.

The most downstream main-stem station was at FM 1485 (11334). At this station, the bacteria count was moderate. The conductivity at this station was still relatively low, suggesting that most of the flow in this creek is natural in origin.

Two additional samples were collected downstream of FM 1485. A sample from the New Caney MUD WWTF (CC0A) had a low bacteria count. A sample from White Oak Creek (CC04) had a moderate bacteria count and fairly low conductivity.

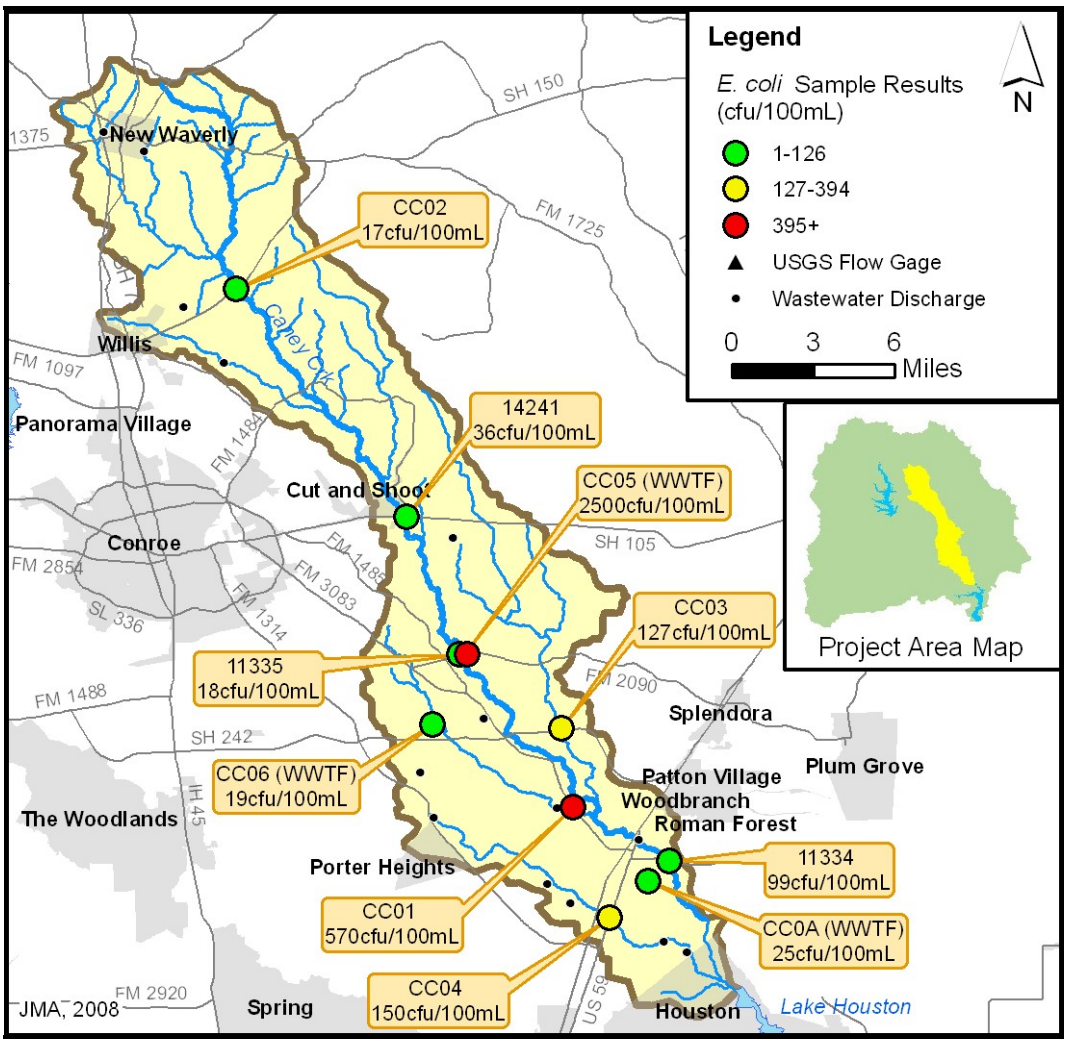

Figure 6-1: Caney Creek (Seg. 1010) Synoptic Survey Map, Nov. 2007

Table 6-1: Caney Creek (Seg. 1010) Synoptic Survey Results, Nov. 2007

Station Code	Station Type	Description	Station Mile	Sample Date	Sample Time	*E. coli* (cfu/100mL)	Flow Est. (cfs)*	Flow** Severity	Temp (C)	Cond (µS/cm)	Total Cl2 (mg/L)
CC02	main stem	FM 1097	41.0	2-Nov-07	9:38	17	0.47	2	16.4	392	-
14241	main stem	SH 105	27.6	2-Nov-07	10:45	36	*13.5*	3	17.5	96	-
11335	main stem	FM 2090	20.2	2-Nov-07	13:10	18	17	3	18.6	98	-
CC05	WWTF	Conroe ISD	20.2	2-Nov-07	13:20	2500	0.11	-	22.0	925	0.20
CC03	tributary	SH 242	10.5	2-Nov-07	9:25	127	< 1	1	16.2	168	< 0.05
CC06	WWTF	Lone Star Ranch	9.8	2-Nov-07	15:15	19	0.31	-	24.6	840	> 3.50
CC01	tributary	FM 1485	9.8	2-Nov-07	9:45	570	0.91	2	16.6	302	< 0.05
11334	main stem	FM 1485	6.2	2-Nov-07	10:30	99	*20*	3	17.2	123	0.15
CC0A	WWTF	New Caney MUD	4.9	2-Nov-07	16:10	25	0.62	-	23.2	640	0.08
CC04	tributary	SH 494	0.7	2-Nov-07	10:55	150	< 0.1	1	19.0	207	-

*Flow Estimates in *italics* were calculated based on flow measurements from nearby stations

**1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

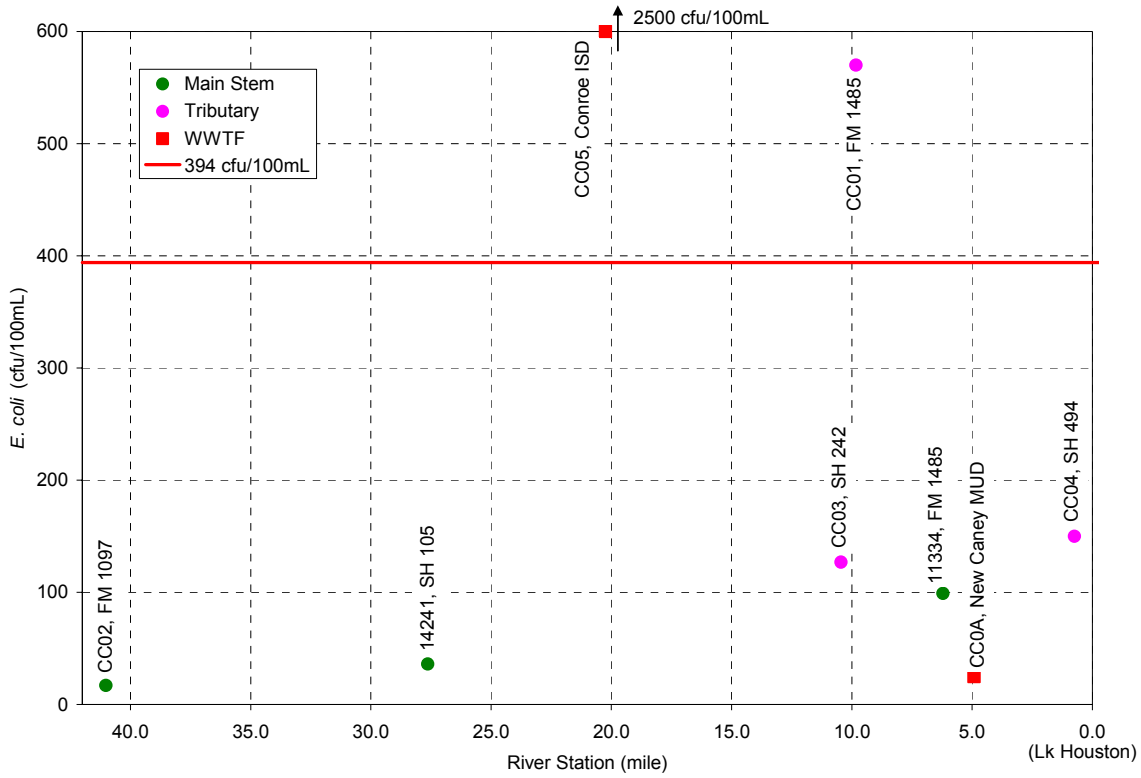

Figure 6-2: Caney Creek (Seg. 1010) Synoptic *E. coli* Profile, Nov. 2007

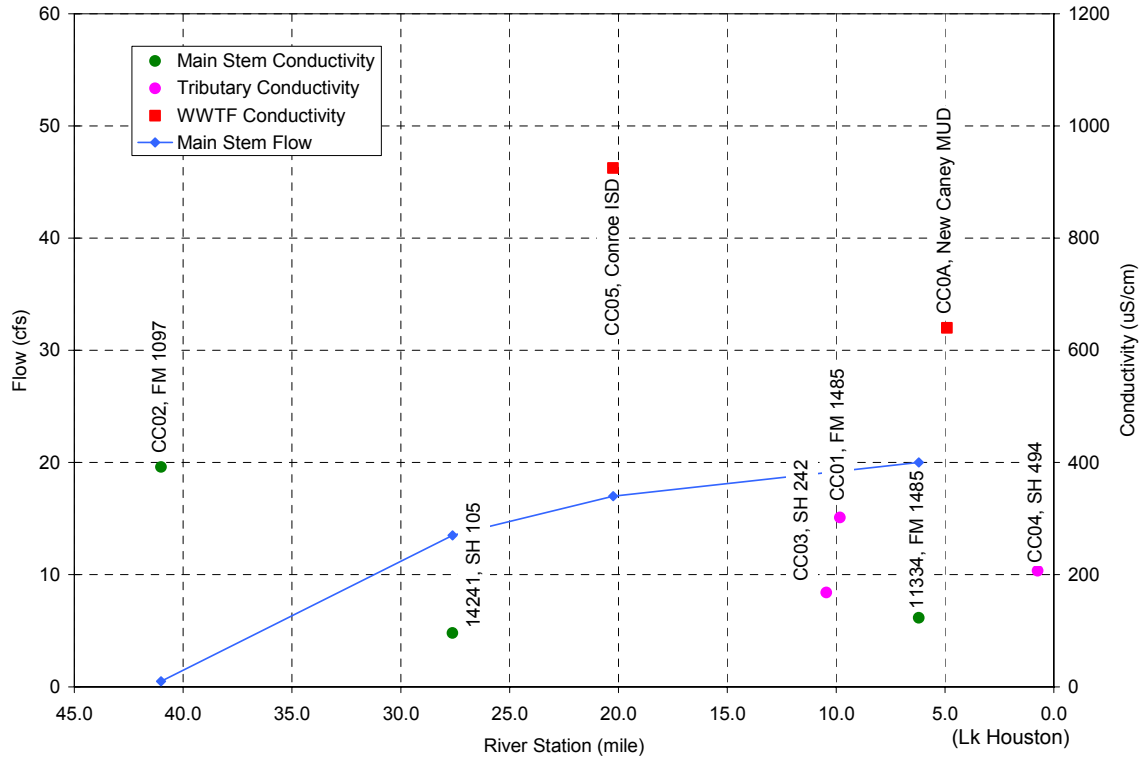

Figure 6-3: Caney Creek (Seg. 1010) Synoptic Cond. & Flow Profile, Nov. 2007

6.2 JUNE 2008 SYNOPTIC SURVEY

A second synoptic survey of Caney Creek was performed on 5 June 2008. As shown in Figure 6-4, several locations along Caney Creek were sampled during this survey. Detailed sampling results for these stations are presented in Table 6-2. A longitudinal profile of bacteria concentrations can be found in Figure 6-5, and a similar plot of flow and conductivity data can be found in Figure 6-6.

Prior to the survey, the last significant rainfall occurred on 27 May. On this date, 0.38 inches of rainfall were recorded at the Conroe Airport. An additional 0.03 inches of rainfall occurred on 5 June, but this was too small to produce runoff.

The most upstream station on Caney Creek was at FM 1097 (CC02). At this station, the flow was relatively low, and conductivity was moderate. At the next downstream station, SH 105 (14241), the flow had increased substantially and the conductivity was markedly lower. The bacteria counts at these stations were relatively high. An outfall at SH 105 was also sampled (14241B), and the bacteria count was fairly low.

At FM 2090 (11335) conditions were very similar to those at SH 105. Immediately below this site, effluent from the Conroe Independent School District WWTF (CC05) enters the stream. The bacteria count in this discharge was very low.

Three tributaries were sampled below FM 2090. At Spring Branch (CC03), the bacteria count was high and the conductivity was fairly low. At Dry Creek (CC01), the bacteria count was also high, and the conductivity was moderate. A WWTF (CC06) was also sampled on Dry Creek, and it was found to have a low bacteria count. A sample from White Oak Creek (CC04) had a high bacteria count and fairly low conductivity.

The last two main-stem stations were at US 59 (CC07) and FM 1485 (11334). Both of these sites exhibited high bacteria counts and low conductivities.

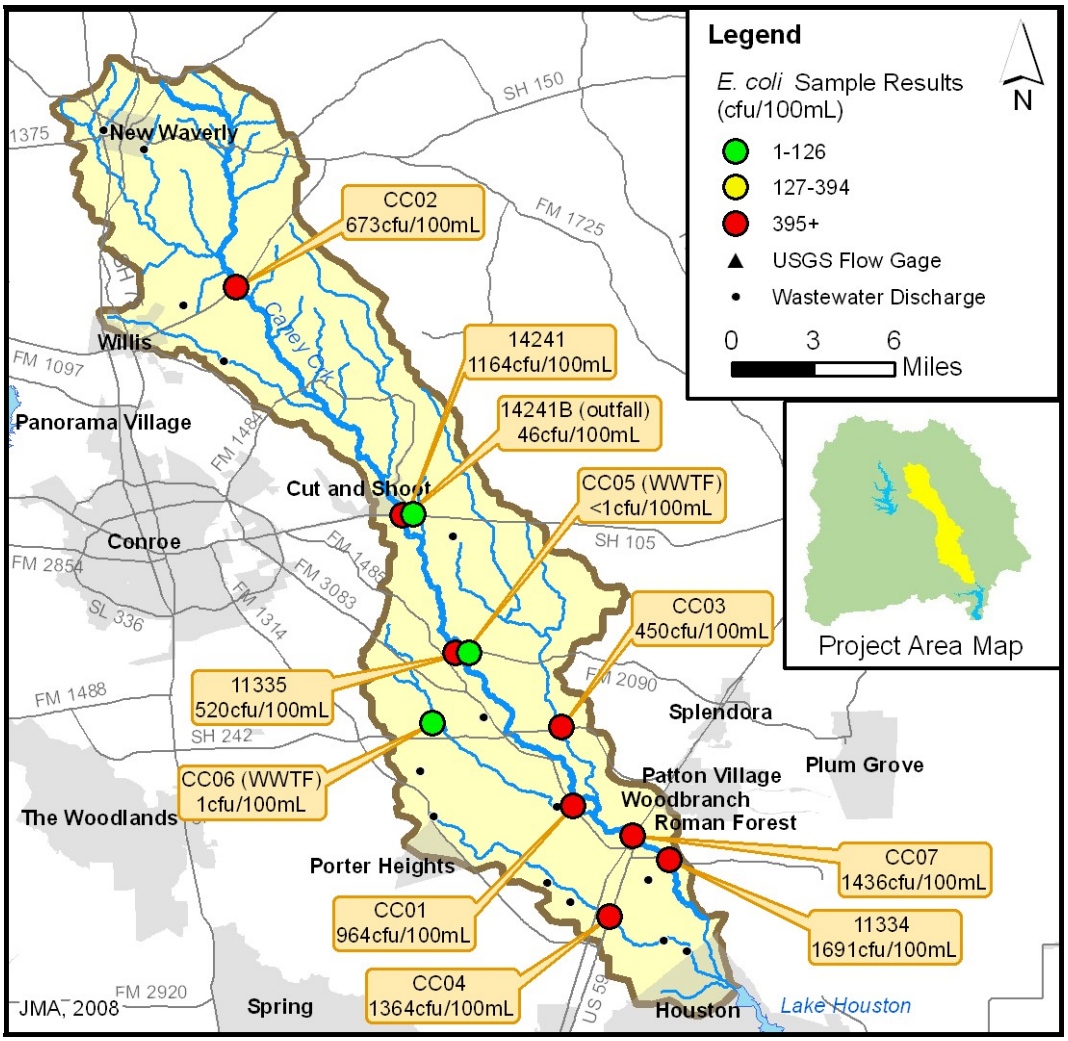

Figure 6-4: Caney Creek (Seg. 1010) Synoptic Survey Map, June 2008

Table 6-2: Caney Creek (Seg. 1010) Synoptic Survey Results, June 2008

Station Code	Station Type	Description	Station Mile	Sample Date	Sample Time	*E. coli* (cfu/100mL)	Flow Est. (cfs)	Flow* Severity	Temp (C)	Cond (µS/cm)	Total Cl2 (mg/L)
CC02	main stem	FM 1097	41.0	5-Jun-08	9:43	673	0.93	3	26.1	436	< 0.05
14241	main stem	SH 105	27.6	5-Jun-08	8:46	1164	21	3	25.1	119	< 0.05
14241B	pipe	SH 105	27.6	5-Jun-08	8:54	46	0.07	-	24.6	722	0.15
11335	main stem	FM 2090	20.2	5-Jun-08	10:30	520	19	3	26.8	129	< 0.05
CC05	WWTF	Conroe ISD	20.2	5-Jun-08	10:35	< 1	0.03	3	27.1	835	3.25
CC03	tributary	SH 242	10.5	5-Jun-08	8:20	450	0	1	26.0	206	< 0.05
CC06	WWTF	Lone Star Ranch	9.8	5-Jun-08	7:58	1	0.29	3	27.5	832	> 3.50
CC01	tributary	FM 1485	9.8	5-Jun-08	11:00	964	0.05	3	26.7	614	< 0.05
CC07	main stem	US59	7.9	5-Jun-08	8:40	1436	-	3	26.7	150	< 0.05
11334	main stem	FM 1485	6.2	5-Jun-08	8:55	1691	-	3	26.7	158	< 0.05
CC04	tributary	SH 494	0.7	5-Jun-08	9:10	1364	0.6	3	26.8	246	< 0.05

*1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

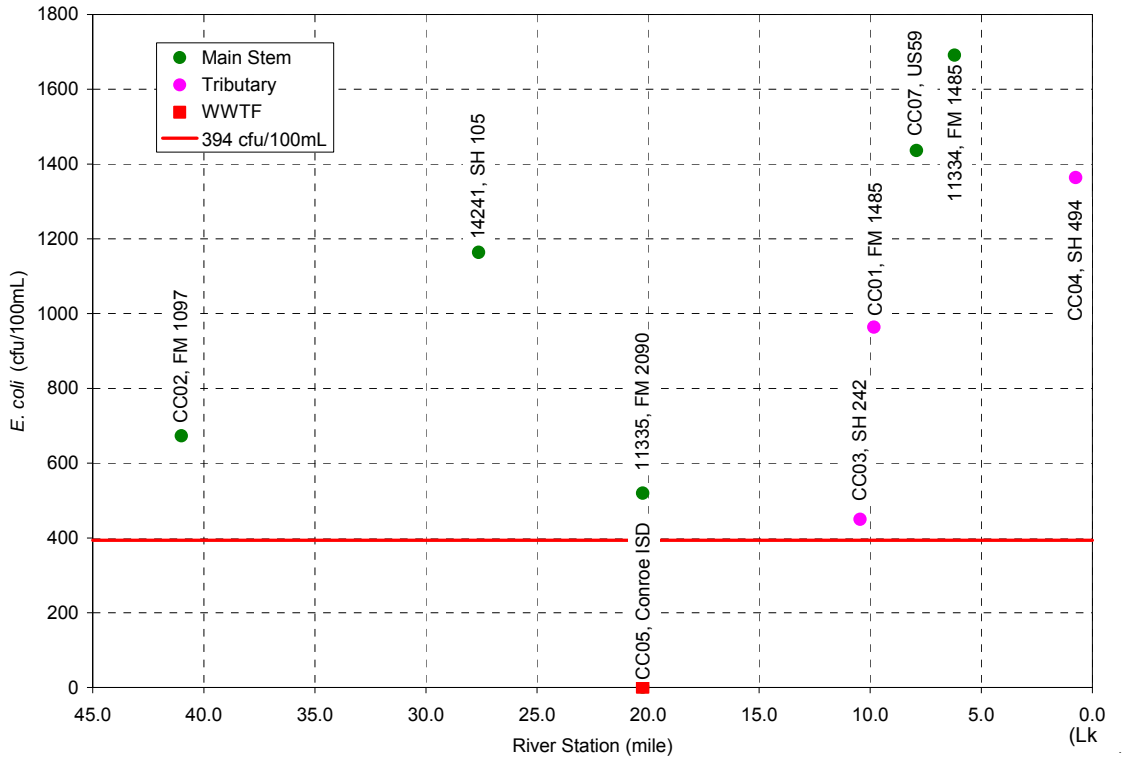

Figure 6-5: Caney Creek (Seg. 1010) Synoptic *E. coli* Profile, June 2008

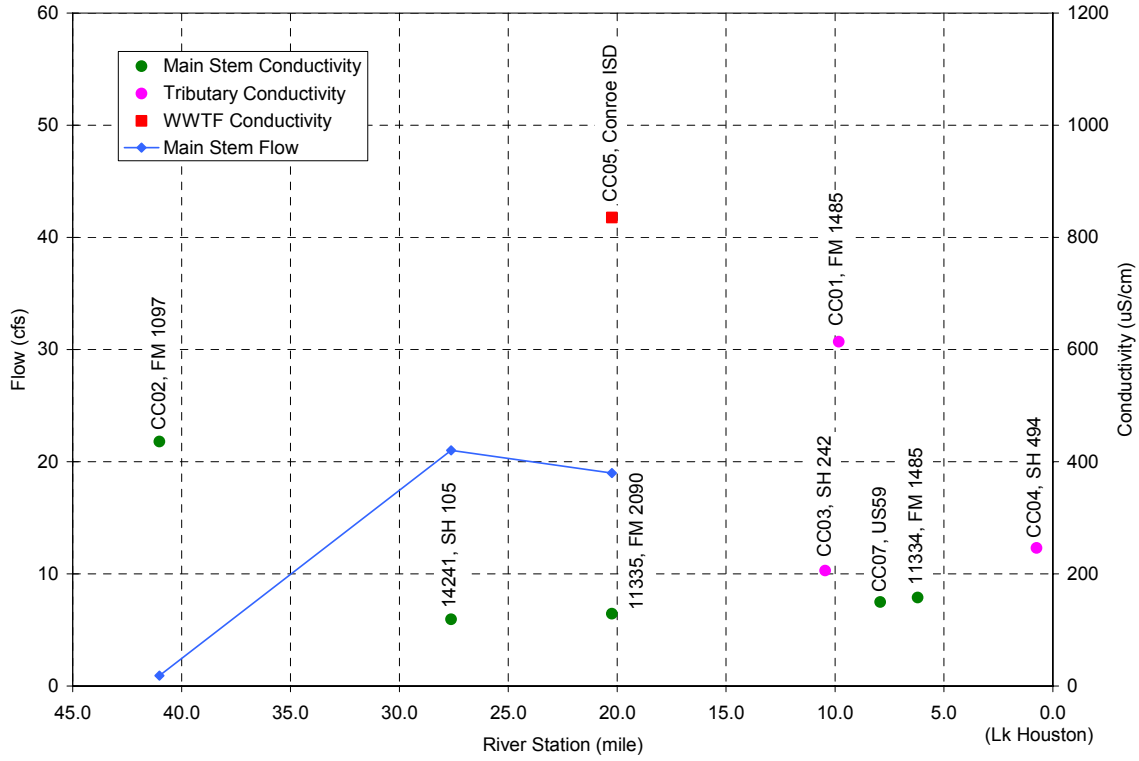

Figure 6-6: Caney Creek (Seg. 1010) Synoptic Cond. & Flow Profile, June 2008

7.0 PEACH CREEK, SEGMENT 1011

7.1 NOVEMBER 2007 SYNOPTIC SURVEY

A synoptic survey of Peach Creek was performed on 2 November 2007. As shown in Figure 7-1, several locations along Peach Creek were sampled during this survey. Detailed sampling results for these stations are presented in Table 7-1. A longitudinal profile of bacteria concentrations can be found in Figure 7-2, and a similar plot of flow and conductivity data can be found in Figure 7-3.

Prior to the survey, the last significant rainfall occurred on 22 October. On this date, 0.83 inches of rainfall were recorded at the Conroe Airport.

The most upstream station on Peach Creek was at FM 3081 (PC01). At this station, the conductivity was low and the flow was unusually high, considering the relatively small drainage area upstream of this station. The flow appears to be of a natural source (this flow source also appears to contribute to Caney Creek and the East Fork San Jacinto River at roughly the same latitude). The bacteria count at this station was moderately high.

The next two downstream stations were at SH 105 and Old Highway 105, sites 11338 and 16625, respectively. Conditions at the two sites were fairly similar. Conductivity was low, and bacteria counts were moderately high.

The next downstream station was at FM 2090 (11337). The bacteria level at this station was moderately high, and the conductivity was slightly higher than at the upstream stations. Below FM 2090, three WWTFs were sampled. Two of these facilities had negligible bacteria concentrations, but one had a bacteria count greater than 20,000 cfu/100mL. This was the highest bacteria count observed in the study area.

The final two downstream stations were at FM 1485 and Lake Houston State Park; sites 11336 and 17746, respectively. At both stations, bacteria counts were moderate. Conductivity levels were still low, though significantly higher than at the upstream stations.

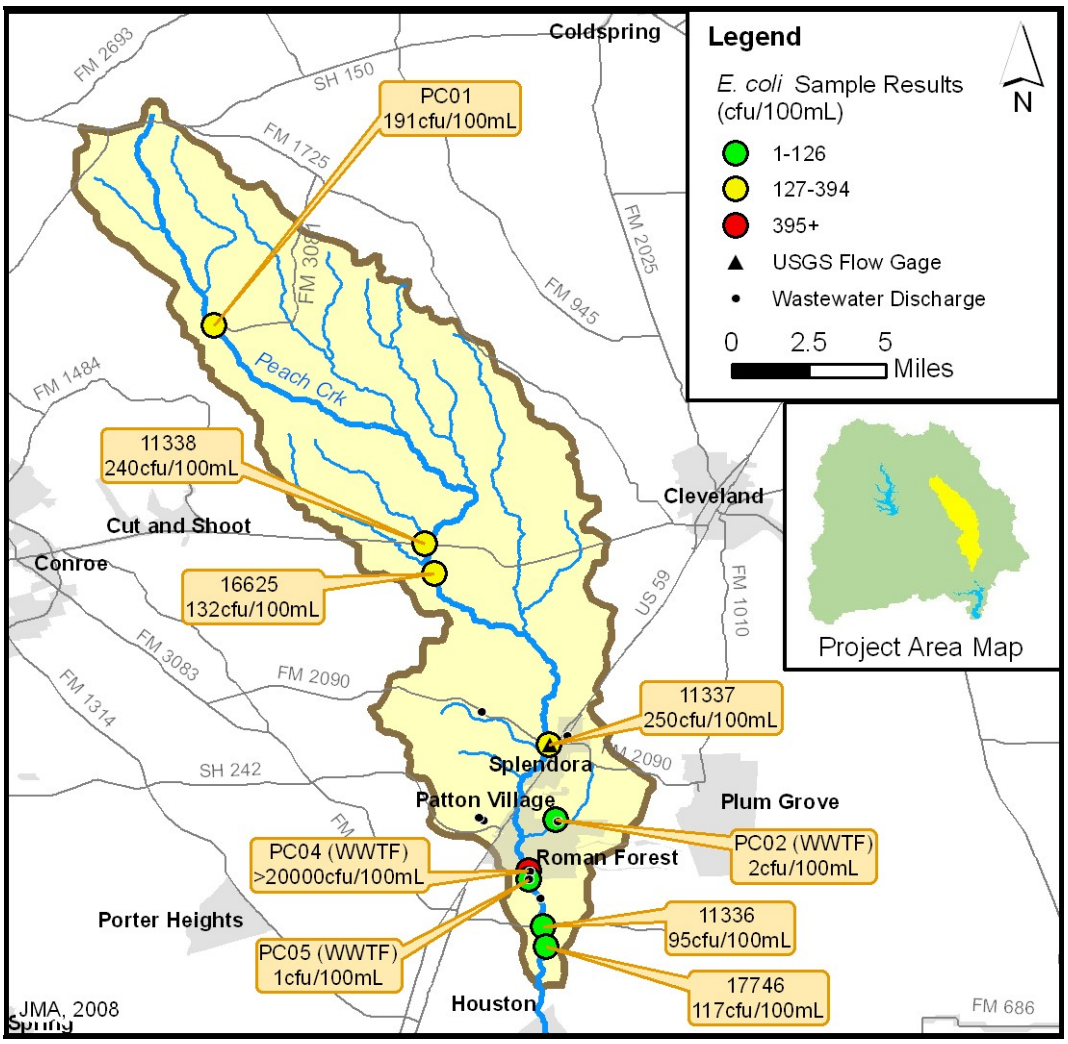

Figure 7-1: Peach Creek (Seg. 1011) Synoptic Survey Map, Nov. 2007

Table 7-1: Peach Creek (Seg. 1011) Synoptic Survey Results, Nov. 2007

Station Code	Station Type	Description	Station Mile	Sample Date	Sample Time	*E. coli* (cfu/100mL)	Flow Est. (cfs)	Flow* Severity	Temp (C)	Cond (µS/cm)	Total Cl2 (mg/L)
PC01	main stem	FM 3081	33.1	2-Nov-07	10:11	191	9.4	3	16.9	47	-
11338	main stem	SH 105	19.4	2-Nov-07	11:05	240	-	3	16.2	46	-
16625	main stem	Old Hwy 105	18.1	2-Nov-07	11:35	132	-	3	16.9	47	-
11337	main stem	FM 2090	9.4	2-Nov-07	12:50	250	18	3	17.5	66	-
PC02	WWTF	MC MUD #16	5.7	2-Nov-07	16:35	2	0.06	-	22.5	505	2.80
PC04	WWTF	Woodbranch	4.3	2-Nov-07	17:15	> 20000	0.03	-	23.1	765	< 0.05
PC05	WWTF	Roman Forest	4.0	2-Nov-07	17:20	1	0.23	-	24.0	786	2.50
11336	main stem	FM 1485	2.3	2-Nov-07	11:25	95	-	3	17.5	102	-
17746	main stem	Lk Houston Park	1.6	2-Nov-07	12:10	117	-	3	18.3	106	-

*1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

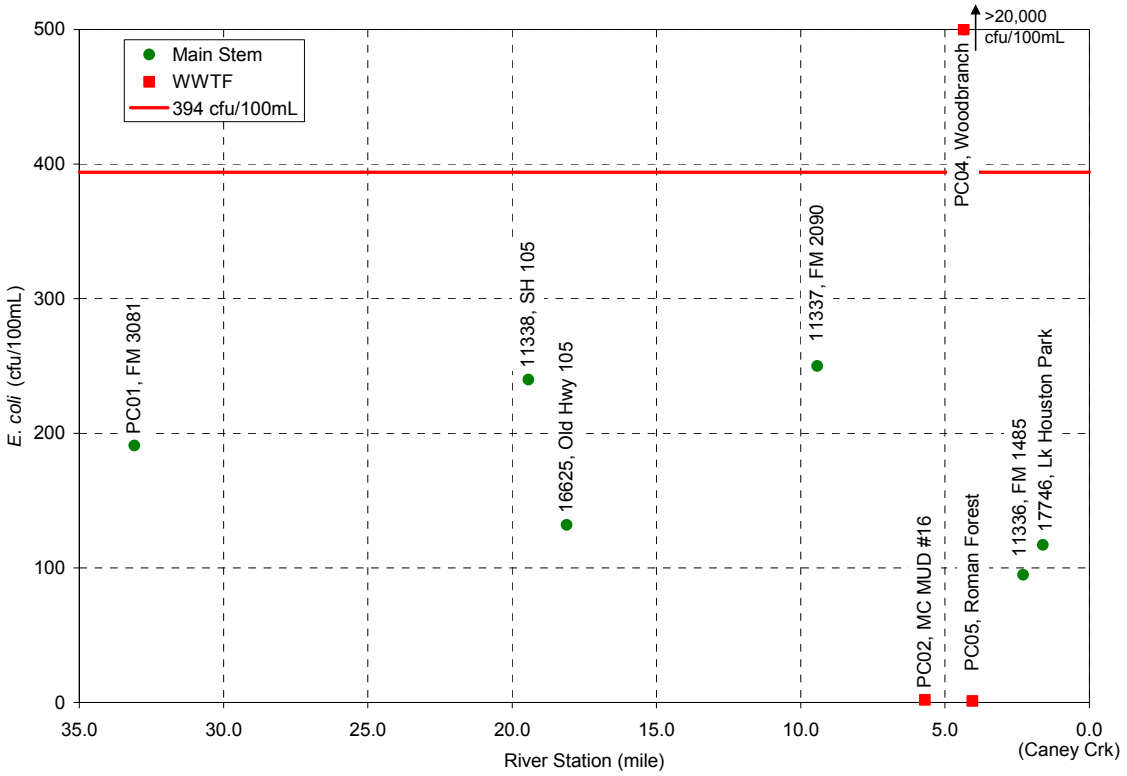

Figure 7-2: Peach Creek (Seg. 1011) Synoptic *E. coli* Profile, Nov. 2007

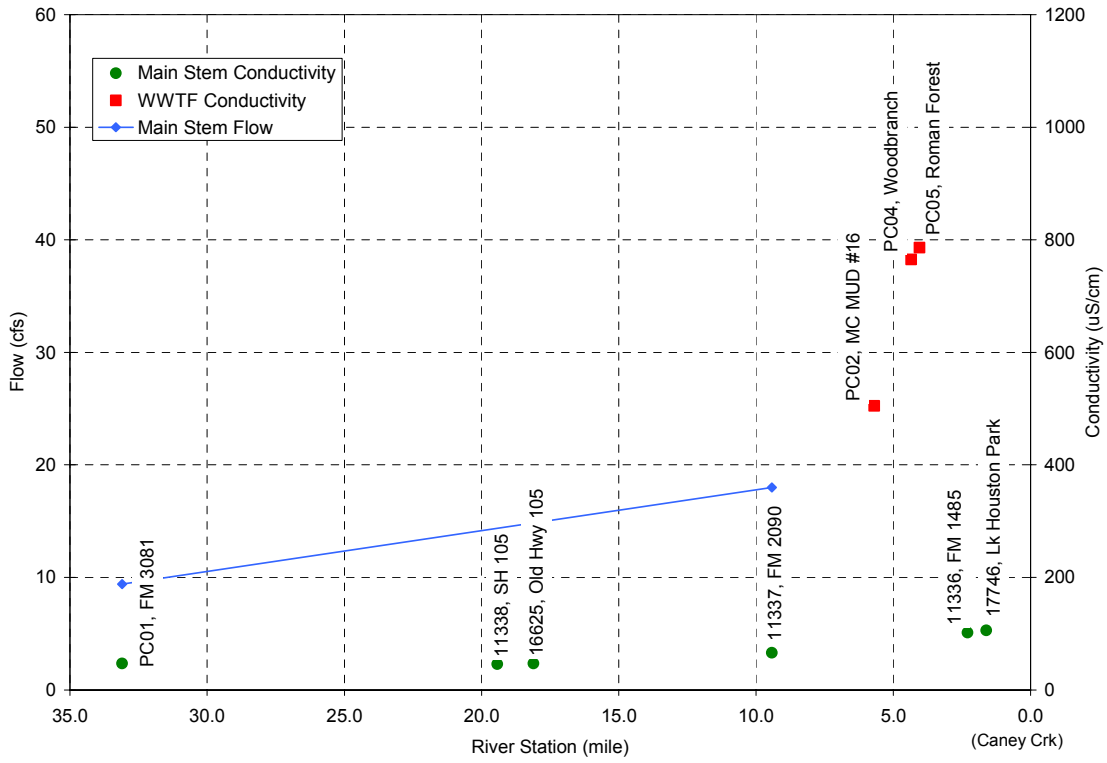

Figure 7-3: Peach Creek (Seg. 1011) Synoptic Cond. & Flow Profile, Nov. 2007

7.2 JUNE 2008 SYNOPTIC SURVEY

A second synoptic survey of Peach Creek was performed on 4 June 2008. As shown in Figure 7-4, several locations along Peach Creek were sampled during this survey. Detailed sampling results for these stations are presented in Table 7-2. A longitudinal profile of bacteria concentrations can be found in Figure 7-5, and a similar plot of flow and conductivity data can be found in Figure 7-6.

Prior to the survey, the last significant rainfall occurred on 27 May. On this date, 0.38 inches of rainfall were recorded at the Conroe Airport.

The most upstream station on Peach Creek was at FM 3081 (PC01). At this station, the conductivity was low and the flow was unusually high considering the relatively small drainage area upstream of this station. The bacteria count at this station was fairly low.

The next two downstream stations were at SH 105 and Old Highway 105, sites 11338 and 16625, respectively. The conductivities at both stations were low, but the bacteria count at Old Highway 105 was significantly higher than at SH 105.

The next downstream station was at FM 2090 (11337). The bacteria level at this station was moderately high, and the conductivity was still low, but notably higher than at the upstream stations. Below FM 2090, two WWTFs were sampled. (A third WWTF sample would have been taken at MC MUD 16, but it was not discharging.) Both of these facilities had very low bacteria counts.

The final two downstream stations were at FM 1485 and Lake Houston State Park; sites 11336 and 17746, respectively. At both stations, bacteria counts were moderate. Conductivity levels were still low, though significantly higher than at the upstream stations.

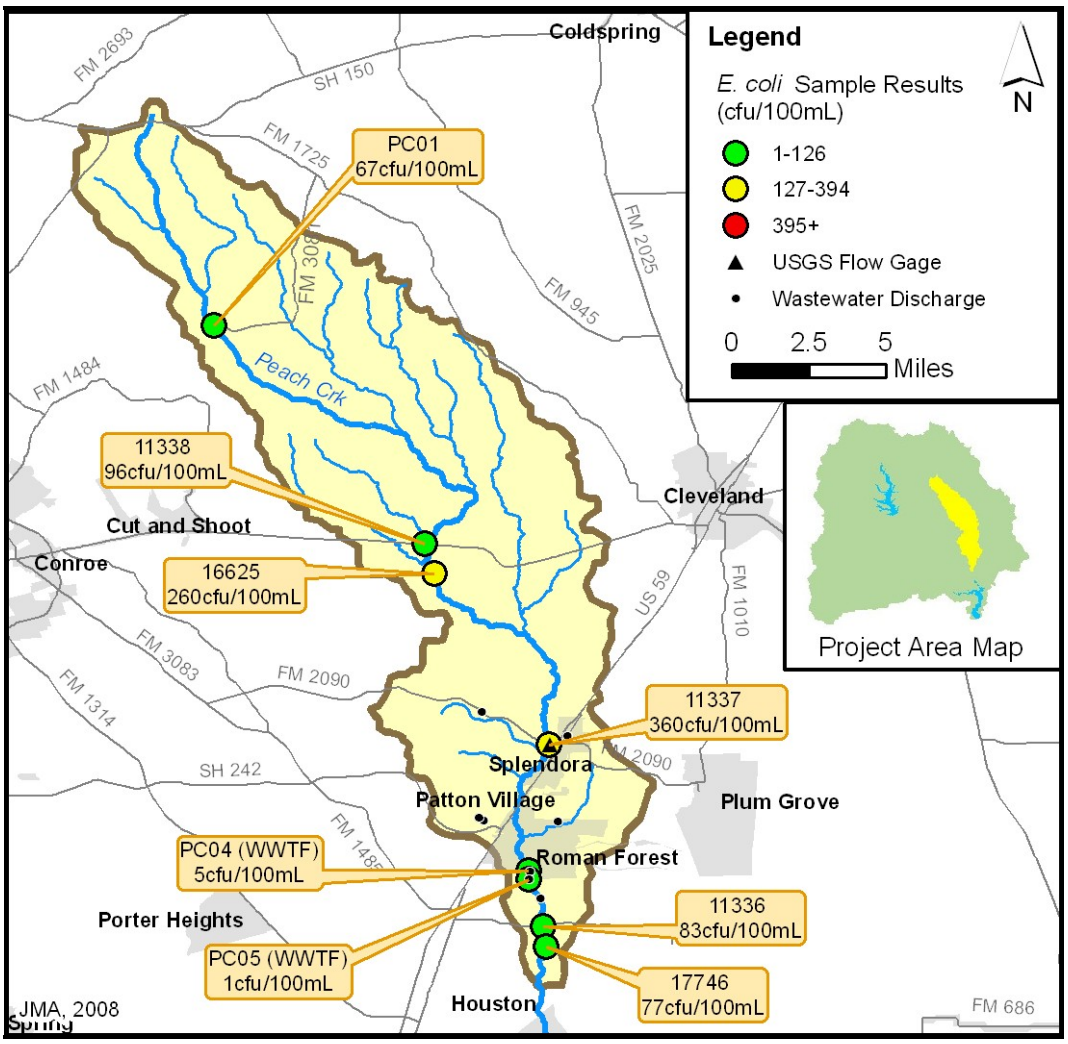

Figure 7-4: Peach Creek (Seg. 1011) Synoptic Survey Map, June 2008

Table 7-2: Peach Creek (Seg. 1011) Synoptic Survey Results, June 2008

Station Code	Station Type	Description	Station Mile	Sample Date	Sample Time	*E. coli* (cfu/100mL)	Flow Est. (cfs)	Flow* Severity	Temp (C)	Cond** (µS/cm)	Total Cl2 (mg/L)
PC01	main stem	FM 3081	33.1	4-Jun-08	15:15	67	7.7	3	26.2	55	-
11338	main stem	SH 105	19.4	4-Jun-08	15:50	96	-	3	28.0	55	< 0.05
16625	main stem	Old Hwy 105	18.1	4-Jun-08	16:10	260	-	3	27.6	57	< 0.05
11337	main stem	FM 2090	9.4	4-Jun-08	17:00	360	17	3	27.3	83	< 0.05
PC04	WWTF	Woodbranch	4.3	4-Jun-08	16:15	5	0.07	-	28.0	*877*	0.07
PC05	WWTF	Roman Forest	4.0	4-Jun-08	16:02	1	0.2	-	25.4	*909*	1.00
11336	main stem	FM 1485	2.3	4-Jun-08	15:37	83	-	3	28.2	*154*	< 0.05
17746	main stem	Lk Houston Park	1.6	4-Jun-08	15:03	77	-	3	28.5	*152*	< 0.05

*1=No Flow, 2=Low, 3=Normal, 4=Flood, 5=High, 6=Dry

**Conductivity values in italics are approximate. Probe did not pass post-calibration check.

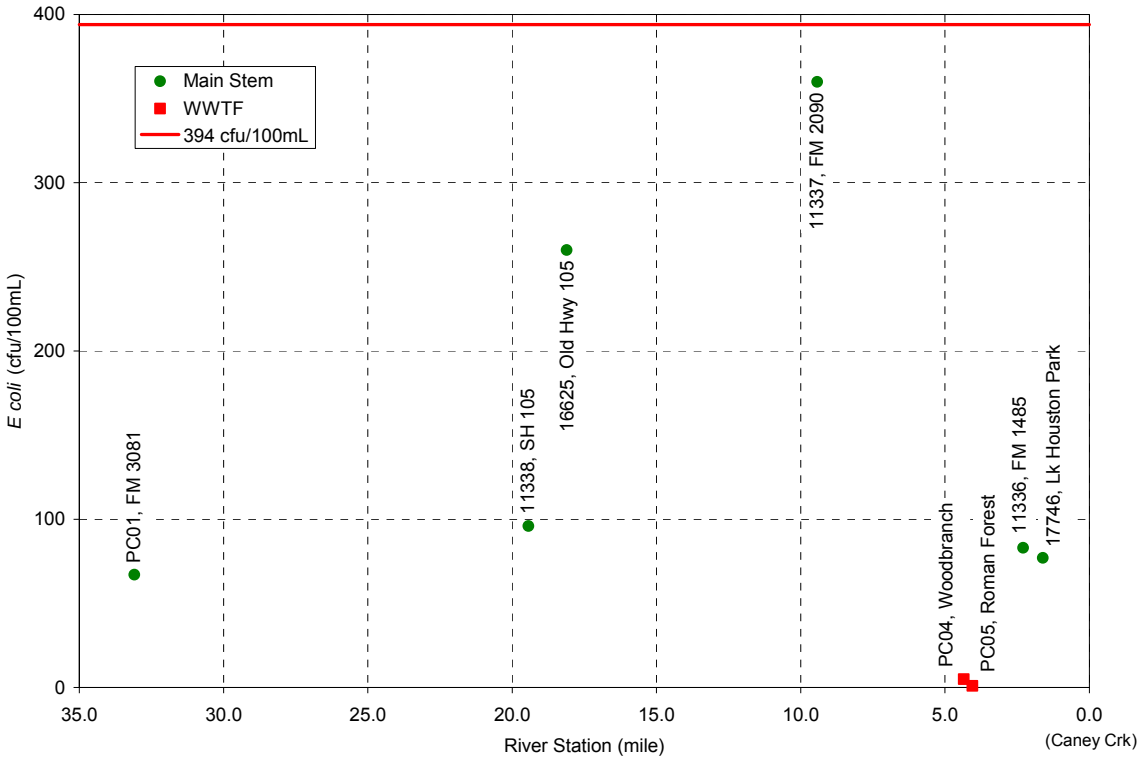

Figure 7-5: Peach Creek (Seg. 1011) Synoptic *E. coli* Profile, June 2008

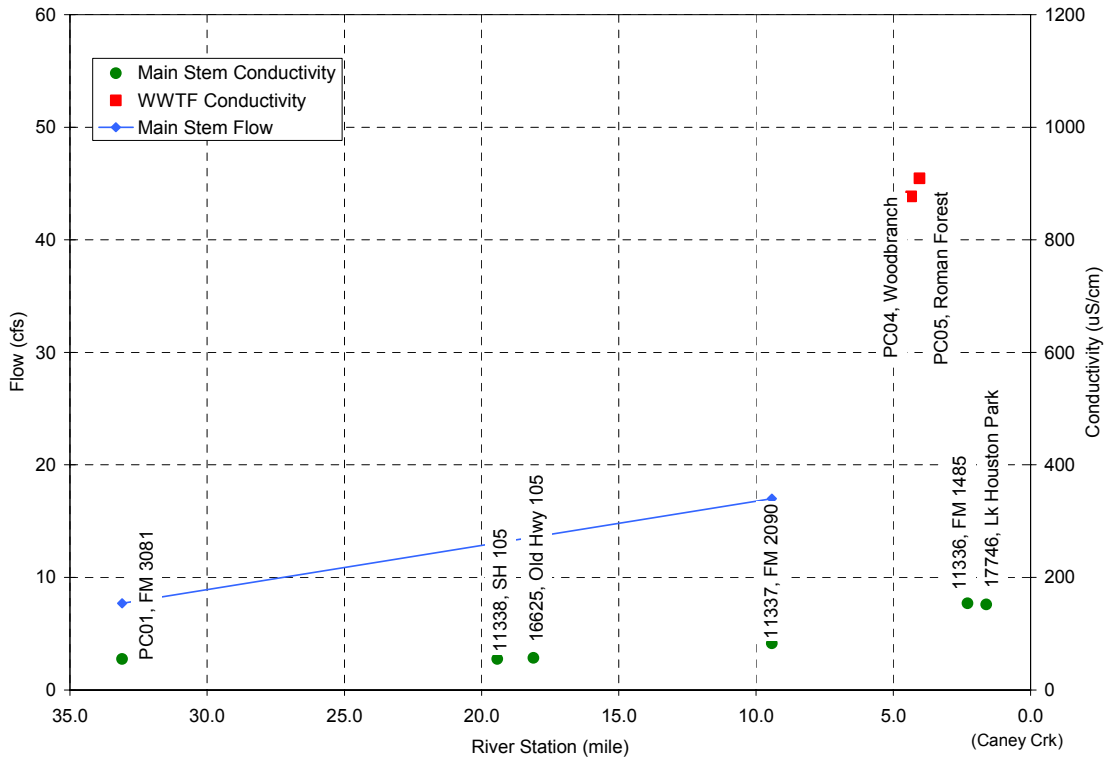

Figure 7-6: Peach Creek (Seg. 1011) Synoptic Cond. & Flow Profile, June 2008

8.0 SUMMARY AND DISCUSSION

This work represents a concentrated effort to obtain a spatially comprehensive assessment of bacteria levels throughout the Lake Houston watershed. The monitoring occurred over a period of eight months, and involved the collection of more than 500 *E. coli* samples. This section provides a comprehensive summary of the results in order to make comparisons between bacteria samples taken in different watersheds, under different conditions, and from different sources.

8.1 SYNOPTIC IN-STREAM MONITORING RESULTS SUMMARY

Bacteria levels were found to vary significantly by stream segment. Figures 8-1 and 8-2 present the bacteria monitoring results, by segment, for the November 2007 and June 2008 surveys. An observation from these figures is that bacteria levels were typically highest in the eastern portion of the Lake Houston watershed.

The highest bacteria concentrations were typically observed in the East Fork San Jacinto River. This was true in both the November and June surveys. The adjacent Peach Creek watershed had the second highest bacteria levels during the November survey. In the June survey, Peach Creek bacteria levels were somewhat lower, but still higher than in most other stream segments. In Caney Creek, bacteria levels were moderate during the November survey, but were very high in the June survey.

In the central and western portions of the Lake Houston watershed, bacteria counts were generally much lower. This side of the watershed is more developed and several streams are effluent dominated. At some of the sites, a significant chlorine residual was present.

In most segments, bacteria levels were similar during both surveys. However, in Crystal Creek, Caney Creek, and the East Fork San Jacinto River, bacteria levels were much greater during the June survey than during the November survey. The concentrations in Upper Panther Branch and Stewarts Creek also appear notably higher during the June survey.

Hydrologic conditions during the two surveys were generally similar, and both represent baseflow conditions. Table 8-1 provides a summary of the hydrologic conditions during the two surveys. It should be kept in mind that these are primarily USGS provisional flow values, which may be significantly adjusted in the future.

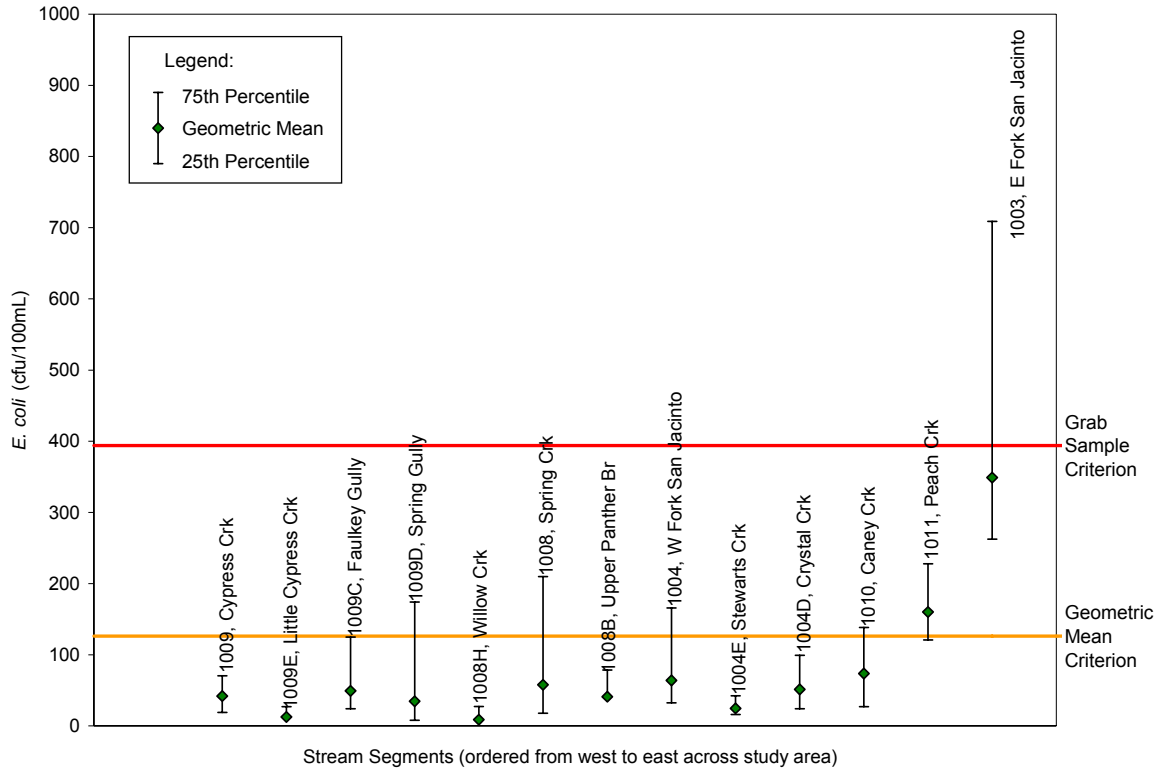

Figure 8-1: In-stream Synoptic Results by Segment, Nov. 2007

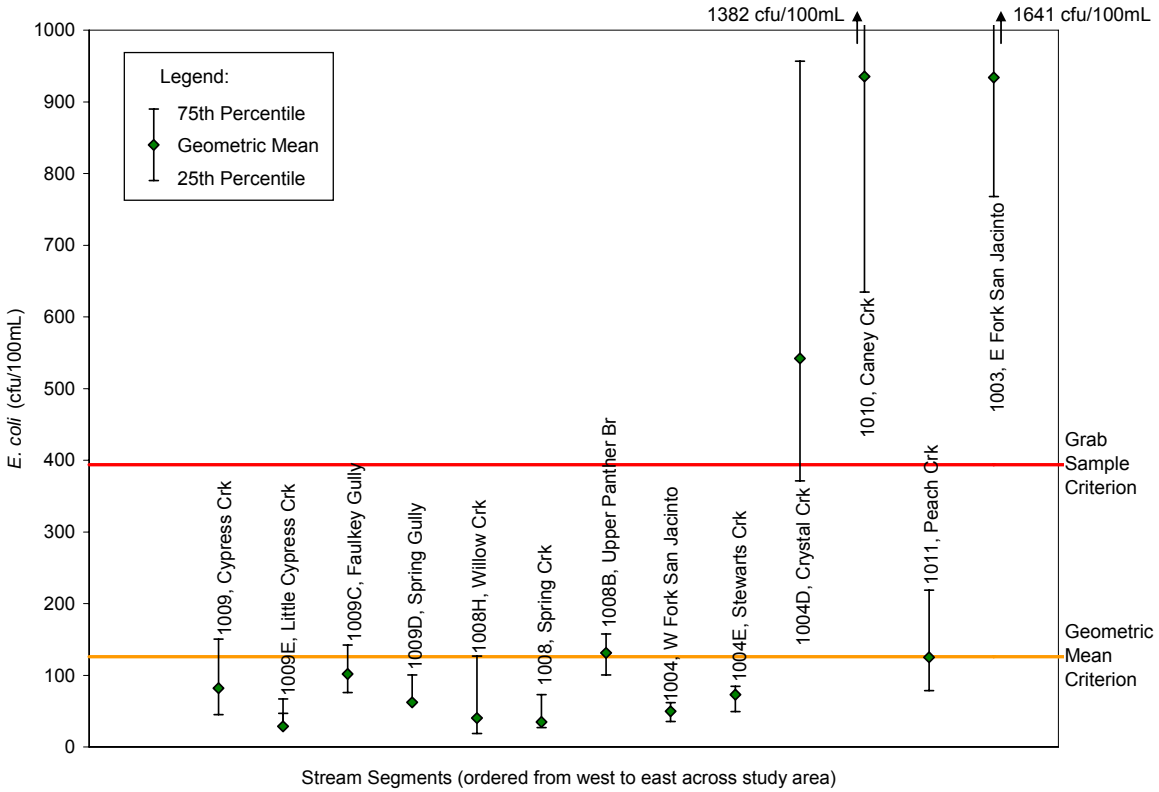

Figure 8-2: In-stream Synoptic Results by Segment, June 2008

Table 8-1: Comparison of Hydrologic Conditions for the Two Synoptic Surveys

USGS Station Number	Station Description		November 2007		June 2008	
	Stream	Location	(cfs)	Percentile	(cfs)	Percentile
8068000	West Fork	near Conroe	32	75	37	69
8068090	West Fork	above Lk Houston near Porter	50	72	54	70
8068275	Spring Creek	near Tomball	4.9	68	4.1	70
8068325	Willow Creek	near Tomball	3.1	N/A	2.2	N/A
8068390	Bear Branch	at Research Blvd, The Woodlands	0.24	92	0.3	90
8068400	Panther Branch	at Gosling Rd, The Woodlands	8.5	50	7.4	56
8068500	Spring Creek	near Spring	27	79	14	97
8068740	Cypress Creek	at House-Hahl Rd nr Cypress	1.5	72	0.2	93
8068780	Little Cypress Crk	near Cypress	0.5	63	0	94
8068800	Cypress Creek	at Grant Rd nr Cypress	6.4	75	22	41
8069000	Cypress Creek	near Westfield	35	69	15	100
8070000	East Fork	near Cleveland	27	77	38	64
8070200	East Fork	near New Caney	33	78	41	70
8070500	Caney Creek	near Splendora	17	86	19	81
8071000	Peach Creek	at Splendora	18	88	17	89

8.2 SYNOPTIC WWTF MONITORING RESULTS SUMMARY

Thirty-seven WWTF samples were collected during the two synoptic surveys. The results for these surveys are presented in Tables 8-2 and 8-3 and Figures 8-3 and 8-4. The two highest bacteria counts were from WWTFs in the Peach Creek and Caney Creek watersheds, during the November survey.

For facilities that were not required to dechlorinate, chlorine residuals ranged from <0.05 mg/L to >3.5 mg/L (the reporting limits of the test). High bacteria counts were not observed in any discharges with chlorine residuals of greater than 0.5 mg/L. In the November survey, six WWTFs had bacteria counts of greater than 100 cfu/100mL, while in the June survey, only two WWTFs had such high bacteria levels.

Table 8-2: WWTF Synoptic Sampling Results

Segment	TX Permit ID	Site ID	Note	November 2007		June 2008	
				E. coli (cfu/100mL)	Cl2 (mg/L)	*E. coli* (cfu/100mL)	Cl2 (mg/L)
1003	10766-001	EFSJ05		2	-	7	1.6
1010	12274-001	CC0A	*	25	0.08	-	-
1010	13690-001	CC05		2500	0.2	<1	3.25
1010	14029-001	CC06		19	>3.5	1	>3.5
1011	11386-001	PC02		2	2.8	-	-
1011	11993-001	PC04		>20000	<0.05	5	0.07
1011	13638-001	PC05		1	2.5	1	1
1008B	12597-001	UPB04	**	106	<0.05	65	0.06
1008B	14141-001	UPB05		<1	>3.5	53	0.9
1008H	10616-002	WC07	*	1	0.08	7	<0.05
1008H	10910-001	WC08		<1	>3.5	57	0.9
1008H	11404-001	WC09		1	2	1	>3.5
1009C	12600-001	FG04		-	-	4	2.3
1009C	11832-001	FG05	*	300	0.1	52	<0.05
1009C	11939-001	FG06	*	174	<0.05	310	<0.05
1009D	12025-002	SG07		1	1.8	2	1.9
1009D	13152-001	SG09		718	<0.05	68	1.4
1009E	11824-001	LCC05		8	1.7	<1	>3.5
1009E	11887-001	LCC06		<1	2	420	0.2
1009E	13753-001	LCC07		<1	>3.5	2	1.8

*Discharger must dechlorinate to <0.1 mg/L

**Discharger uses UV disinfection

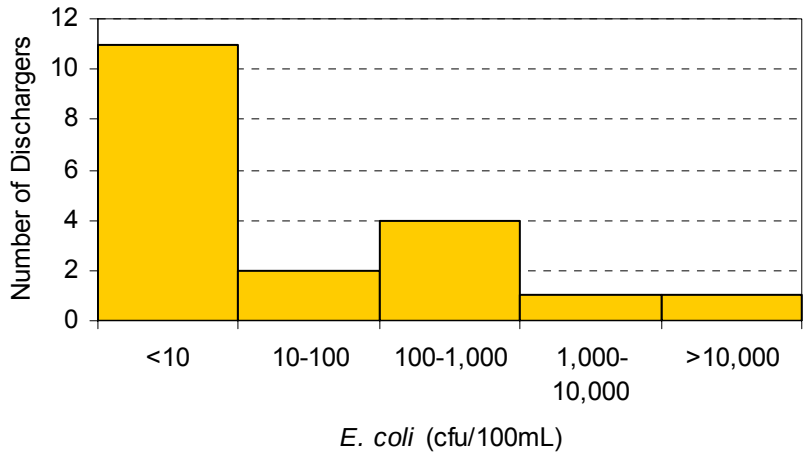

Figure 8-3: WWTF Synoptic Sampling Histogram, Nov. 2007

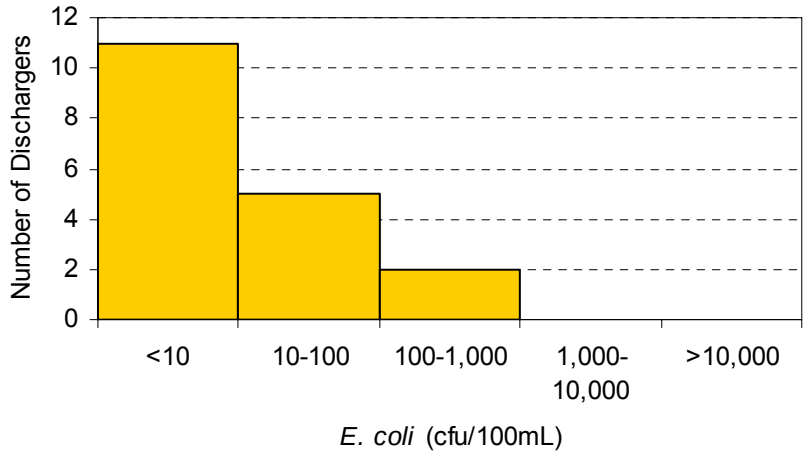

Figure 8-4: WWTF Synoptic Sampling Histogram, June 2008

8.3 SPATIALLY INTENSIVE SURVEY RESULTS SUMMARY

Spatially intensive surveys were conducted on the Upper East Fork San Jacinto River, Stewarts Creek, Willow Creek, and Spring Gully, as discussed in Sections 2.3, 3.3, 4.3, and 5.3, respectively. The surveys provided great detail on the spatial distribution of bacteria concentrations in the study watersheds. During these surveys, samples were collected along the stream channel, at all active WWTFs, and at all flowing tributaries and drainage outfalls that could be located. The data can be used to gage the response of in-stream bacteria levels to the variety of contributions over a short time period. The detailed results of these surveys were presented previously. This section attempts to summarize some of the important information gained from these surveys.

In-stream Bacteria Levels

Figure 8-5 presents summary statistics for the in-stream bacteria counts encountered during the intensive surveys. As shown, bacteria levels were similar in all four surveys. During the intensive surveys of the East Fork and Stewarts Creek, a large portion of the samples were collected from tributaries, and these results are included in the figure separate from the main stem results. As shown, bacteria counts in the tributaries exhibited more variability than in the main stem. This is not unexpected, since the main stem is where the tributaries mix and bacteria counts are averaged. Additional sampling would be required to determine whether the variation in concentrations is primarily temporal or spatial in nature.

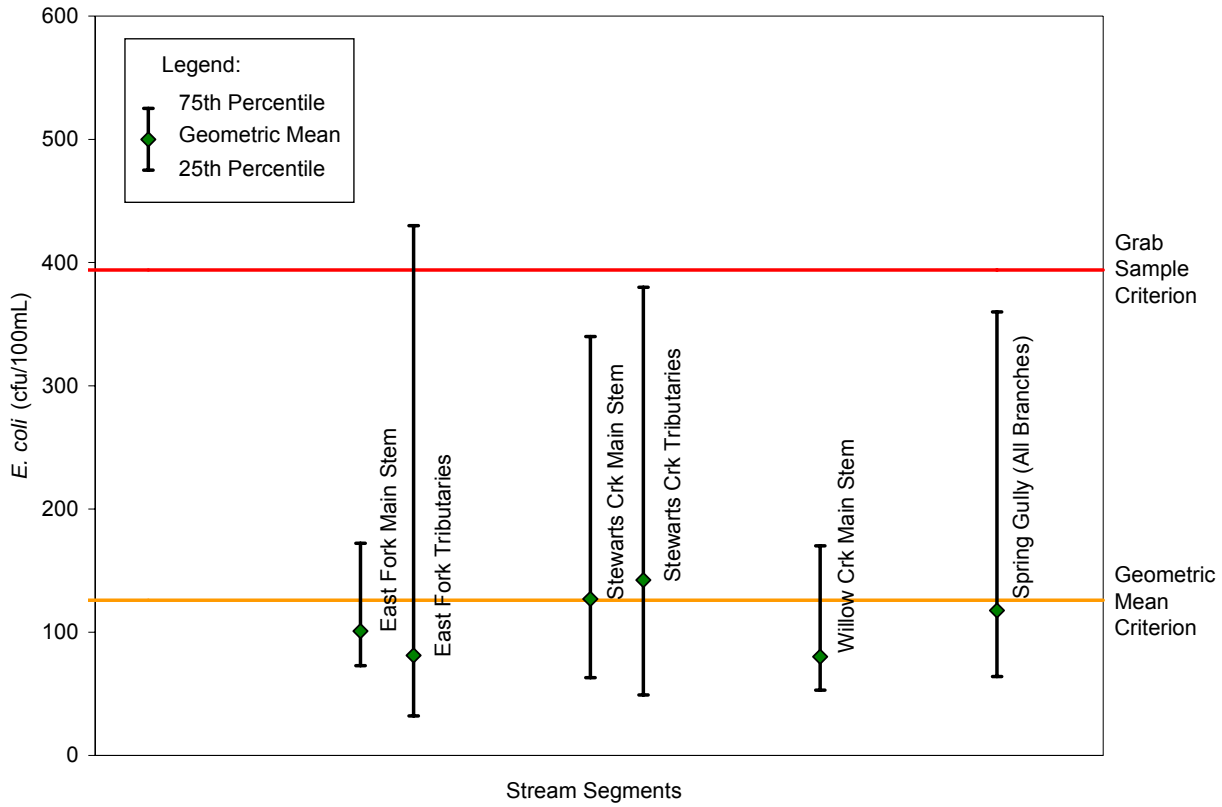

Figure 8-5: Intensive Survey In-stream Monitoring Results

Bacteria Levels in Drainage Outfalls

It was standard practice during the intensive surveys to sample any outfall observed to be discharging to the stream. About 25 outfalls, other than WWTFs, were sampled throughout the course of this project. It is presumed that the majority of these outfalls were storm sewers intended for urban and roadway drainage. Since the outfall samples were collected under dry weather conditions, the most probable sources of the observed flows would include lawn watering and irrigation systems, and leaking water or wastewater lines.

The vast majority of drainage outfall samples were collected during the Spring Gully Intensive Survey in March 2008. During this survey the median in-stream bacteria concentration was 80 cfu/100mL, while the median drainage outfall concentration was 360 cfu/100mL. Figure 8-6 presents a histogram of outfall sampling results. Flow rates from these outfalls were low, typically ranging from 0.002 to 0.02 cfs.

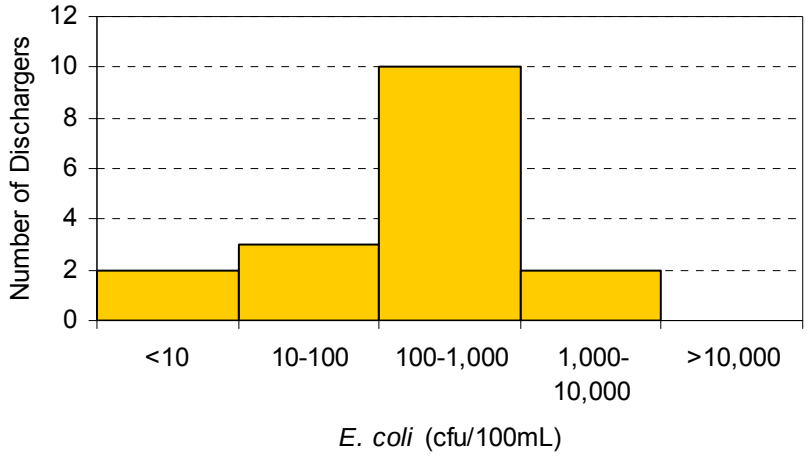

Figure 8-6: Drainage Outfall Sampling Histogram, Spring Gully, March 2008

Bacteria Levels in WWTFs under Wet and Dry Weather Conditions

During the intensive surveys, all contributing WWTFs were sampled. However, no WWTFs existed in the East Fork and Stewarts Creek survey areas, and there were just three in the Spring Gully watershed. The vast majority of WWTF samples were collected during the intensive survey of Willow Creek, when all thirteen active WWTFs upstream of Gosling Road were sampled. These thirteen WWTFs were also sampled during the wet weather point source survey of Willow Creek. The results of the intensive survey and wet weather survey were tabulated previously in Sections 4.3.3 and 4.3.4. Figures 8-7 and 8-8 provide histograms of the tabulated data. As evidenced by these figures, WWTF performance was considerably poorer during the wet weather event. However, as discussed in Section 4.3.4, the WWTF loads accounted for a very small portion of the total wet weather load in Willow Creek.

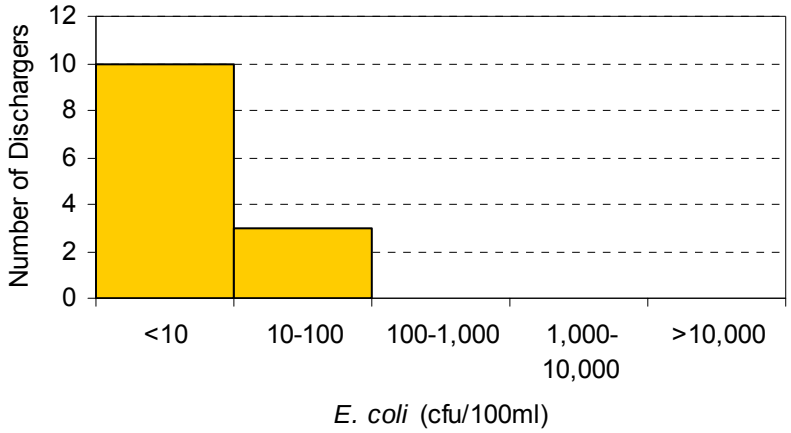

Figure 8-7: Intensive Survey WWTF Sampling Histogram, Willow Creek, May 2008

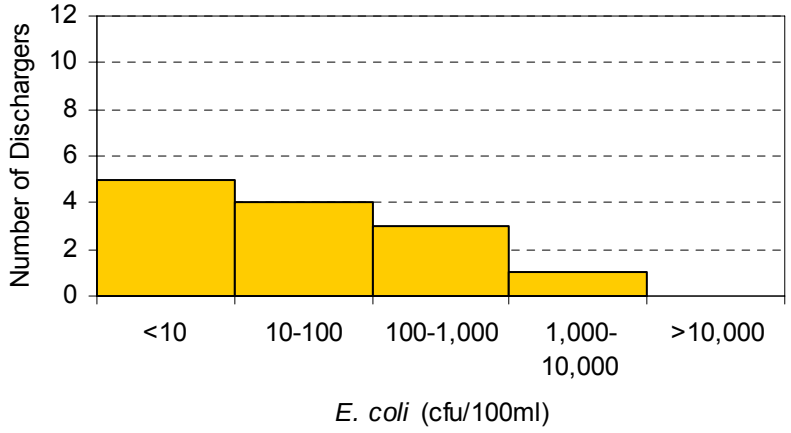

Figure 8-8: Wet Weather WWTF Sampling Histogram, Willow Creek, Feb. 2008

Sediment Source Study Results

Sediment source studies were conducted on the banks of the East Fork San Jacinto River, Stewarts Creek, Willow Creek, and Spring Gully, as discussed in Sections 2.3, 3.3, 4.3, and 5.3, respectively. The results of all sediment source studies are presented in Figure 8-9.

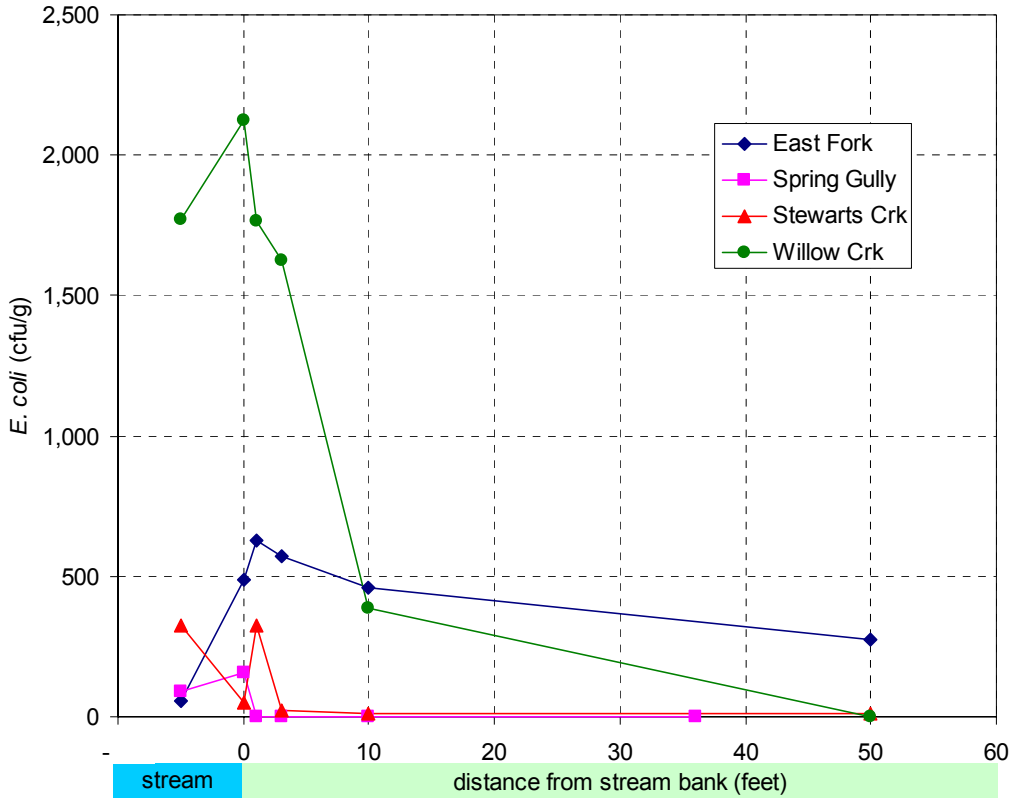

Figure 8-9: Sediment Source Results Summary

As shown, bacteria counts were generally highest near the stream bank. Moving away from the stream bank, bacteria counts generally decreased. Willow Creek had the highest bacteria counts near the stream bank. The East Fork had the highest bacteria counts at distances further from the bank.

The sediment data were collected to establish information regarding the typical bacteria content. Some studies have suggested that sediment scoured during runoff events could represent a significant source of bacteria to a stream. Of greatest concern has been the bacteria content of the sediments at the water's edge, since these are the most amenable to erosion or inundation.

An obvious question regards how these concentrations (in terms of cfu per gram of dry sediment) might relate to bacteria concentrations in the water column (in terms of cfu per 100 mL). To explore this, consider a water sample with 100 mg/L of total suspended solids (TSS). If the bacteria count for these solids is 1,000 cfu/g, then the bacteria count for this sample would be 10 cfu/100mL. Because in-stream TSS levels are typically under 100 mg/L, and rarely exceed 1,000 mg/L, these sediments would not be expected to be a major source of bacteria loading.

Resuspension Study Results

Resuspension studies were conducted on Willow Creek and Spring Gully, as discussed in Sections 4.3 and 5.3, respectively. In total, three studies were conducted: two on Spring Gully and one on Willow Creek.

The immediate effect of sediment resuspension on bacteria levels varied from study to study. One study suggested bacteria levels increased significantly (to around 1,000 cfu/100mL) following resuspension, another study suggested no increase, and the third study was inconclusive. A bacteria count of around 1,000 cfu/100mL is a relatively high value for baseflow conditions, but it is not unusually high under storm flow conditions when sediment resuspension would be most likely to occur.

Kinetics Study Results

Kinetics studies were conducted on Willow Creek and Spring Gully, as discussed in Sections 4.3 and 5.3, respectively. In total, four studies were conducted: two on Spring Gully and two on Willow Creek.

The first two kinetics studies (one on Willow Creek and one on Spring Gully) were not conclusive. In the first Willow Creek study, it appears that bacteria concentrations increased over the 32 hours in which the experiment was run. However, samples taken in duplicate did not match, which raised doubts about the validity of the results. In the first Spring Gully study, bacteria counts remained relatively constant, with the exception of one apparent outlier at the end of the experiment.

The second two studies both clearly exhibited decreasing bacteria concentrations throughout the course of sampling. Duplicate samples were relatively consistent compared to the earlier studies. The results of these experiments could be used to estimate bacteria decay rates. The first-order decay rates for Willow Creek and Spring Gully were estimated to be 0.9/day and 2.7/day, respectively. The variation in decay rates might be due to the fact that the Willow Creek site was shaded by heavy tree canopy while the Spring Gully site was exposed to sunlight.

9.0 REFERENCES

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TCEQ, 2003. *Surface Water Quality Monitoring Procedures, Volume 1: Physical and Chemical Monitoring Methods for Water, Sediment, and Tissue.* Document RG-415. Texas Commission on Environmental Quality (TCEQ). Austin, Texas. December 2003.

TCEQ, 2008. *Draft 2008 Texas 303(d) List*. Texas Commission on Environmental Quality (TCEQ). Austin, Texas. 26 September 2007. 19 March 2008.

APPENDIX

Regular *E. coli* QA/QC Duplicates

The testing of regular duplicates was performed by splitting the contents of a sampling bottle into two equal aliquots, and analyzing both independently. At least one duplicate sample was collected for every nine regular samples, in accordance with TCEQ's *Surface Water Quality Monitoring Procedures* (2003).

Sample ID	Date	Time	*E. coli* (cfu/100mL)	
			Original	Duplicate
CC02	2-Nov-07	13:34	17	23
CC06	2-Nov-07	16:10	19	21
CC0A	2-Nov-07	17:15	1	<1
StC01	7-Nov-07	10:16	67	62
15805	7-Nov-07	11:50	86	91
WFSJ03	7-Nov-07	15:20	250	230
16630	7-Nov-07	16:00	78	74
WC03	8-Nov-07	11:55	32	32
SC02	8-Nov-07	13:05	3	3
SG01	8-Nov-07	15:28	28	32
SG05	8-Nov-07	16:10	7	12
11330	9-Nov-07	9:30	154	186
11331	9-Nov-07	10:19	12	8
FG01	9-Nov-07	15:49	24	17
12643	12-Feb-08	16:15	<1	<1
11185	12-Feb-08	17:24	7,800	8,500
E7	27-Feb-08	14:14	86	86
E14	27-Feb-08	16:12	23	21
E15	28-Feb-08	10:19	60	59
S16	25-Mar-08	16:40	7	9
S64	26-Mar-08	15:27	11	11
S32	26-Mar-08	15:41	81	83
T31	24-Apr-08	9:21	340	290
T28	24-Apr-08	11:43	72	69
T23	24-Apr-08	12:23	290	270
T40	24-Apr-08	15:36	210	240
T3	24-Apr-08	15:40	340	310
T7	24-Apr-08	16:45	16	18
W18	13-May-08	10:25	5	7
W14	13-May-08	12:19	8	5
W10A	13-May-08	15:26	15	14
W30	13-May-08	16:56	140	122
WK2F	13-May-08	18:58	40	34
WK3F	14-May-08	8:20	6	8
W51	14-May-08	8:39	1,900	2,100
WK4D	14-May-08	16:45	2,600	3,100

Regular *E. coli* QA/QC Duplicates (continued)

Sample ID	Date	Time	*E. coli* (cfu/100mL)	
			Original	Duplicate
14242B	4-Jun-08	11:46	2,200	2,100
11338	4-Jun-08	15:50	96	105
CC03	5-Jun-08	8:20	450	410
CrC01	5-Jun-08	11:00	964	845
11250	13-Jun-08	7:12	142	151
StC04	13-Jun-08	7:30	270	310
UPB02	13-Jun-08	12:15	44	42
16631	13-Jun-08	14:43	63	68
LCC03	16-Jun-08	10:29	<1	1
SC02	18-Jun-08	9:48	3	2
SC03	18-Jun-08	10:56	27	25
11185	18-Jun-08	12:52	230	240
SG05	18-Jun-08	15:25	126	125
11324	19-Jun-08	8:40	146	140
LCC06	19-Jun-08	12:37	420	460
FG01	19-Jun-08	14:38	123	136

Blind *E. coli* QA/QC Duplicates

The precision of the sample collection and analysis process was confirmed through the occasional collection of blind duplicate samples. These samples were collected from the same location but with separate bottles. The bottles were filled directly from the stream, one immediately following the other. The second sample was arbitrarily named so that the laboratory would not know that it was a duplicate sample.

Sample ID	Date	Time	*E. coli* (cfu/100mL)	
			Original	Blind Dup.
PC04	2-Nov-07	17:15	>20,000	>20,000
11185	12-Feb-08	17:24	7800	6500
E1	27-Feb-08	10:58	78	66
E15	28-Feb-08	10:19	60	68
S54	25-Mar-08	17:50	682	618
T19	24-Apr-08	10:55	81	101
13611	13-Jun-08	9:41	46	45
SC09	18-Jun-08	13:16	35	43
SG15	18-Jun-08	16:22	65	43
LCC15	19-Jun-08	9:50	103	88