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Bacterial Source Tracking to Support the Development and Implementation of Watershed Protection Plans for the Lampasas and Leon Rivers

Leon River Watershed Final Report

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Texas Water Resources Institute
make every drop count

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Acronyms

ADCM	Acoustic Doppler Current Meter
ARCC	Average Rate of Correct Classification
AgriLife-TP	Blackland Research and Extension Center in Temple
BST	Bacterial Source Tracking
CAFO	Concentrated Animal Feeding Operation
CFS	Cubic Feet per Second
CFU	Colony Forming Units
DNA	Deoxyribonucleic Acid
DO	Dissolved Oxygen
E. coli	*Escherichia coli*
EPA	Environmental Protection Agency
ERIC-PCR	Enterobacterial Repetitive Intergenic Consensus Sequence Polymerase Chain Reaction
ERIC-RP	ERIC-PCR and RiboPrinting Composite DNA Fingerprints
LRW	Leon River Watershed
MGD	Million Gallons per Day
n	Number of Samples (or *E. coli* isolates)
NA-MUG	Nutrient Agar with 4-methylumbelliferyl- β-D-glucuronide (MUG)
mTEC	Membrane Thermotolerant *E. coli*
OSSF	Onsite Sewage Facility
QAPP	Quality Assurance Protection Plan
RARCC	Random Average Rate of Correct Classification
RCC	Rate of Correct Classification
RiboPrinting	Automated Ribosomal Ribonucleic Acid Genetic Fingerprinting
TCEQ	Texas Commission on Environmental Quality
TMDL	Total Maximum Daily Load
TNTC	Too Numerous To Count
TSSWCB	Texas State Soil and Water Conservation Board
USDA	United States Department of Agriculture
UTSPH-EP	University of Texas Health Science Center at Houston School of Public Health, El Paso Regional Campus
WPP	Watershed Protection Plan

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Executive Summary

The *Bacterial Source Tracking to Support the Development and Implementation of Watershed Protection Plans for the Lampasas and Leon Rivers* project was developed to provide supplemental information to stakeholders engaged in the development and implementation of watershed protection plans for each watershed. The Leon River is listed as an impaired water body for elevated levels of *E. coli* and does not support its designated contact recreation use. The Lampasas River was also considered impaired for elevated *E. coli* levels until 2010 when it was determined that the data listing the segment no longer met the State's criteria for assessment. Through the watershed protection planning process, stakeholders in each watershed will use adaptive management to refine management strategies that will mitigate bacteria loading from potential sources of pollution within the watershed.

Pairing intensive water quality monitoring and bacterial source tracking (BST), this project was designed to produce useful information that will improve local knowledge of pollutant sources contributing bacteria to the watershed. Typically, water quality data is collected in a watershed on a quarterly basis at a limited number of sampling locations. The intensive water quality monitoring implemented through this project collected monthly samples at 15 monitoring stations over the course of a year. This provided a much clearer look at seasonal and spatial trends in water quality. Additionally, this expansive set of water quality samples was used for BST and allowed estimates of bacteria source contributions to be made at each sampling station. Collectively, these data and associated analysis provided an enhanced look at water quality and pollutant source contributions that will aid watershed stakeholders in their implementation efforts.

Historic drought conditions negatively affected this sampling effort as the Leon River and many of its tributaries were diminished to mere pools or were completely dry for a portion of the monitoring period. When these conditions existed, water samples were not collected or analyzed. These unfavorable drought conditions did not appear to adversely impact water quality as *E. coli* levels recorded were typically well within the state's water quality standard. The diminished number of samples did reduce the effectiveness of the BST by potentially masking some of the temporal variations in *E.*

coli that might have otherwise been observed. Collectively though, the BST results shed light on the sources of *E. coli* in present in the watershed that actually do impact in-stream water quality.

Water quality data collected revealed that *E. coli* levels were periodically elevated across the watershed and were likely a result of nonpoint sources of pollution entering the waterways during or shortly after runoff producing rain events. Collectively, the geometric mean of data from all sites was 60.6 cfu/100 mL, or approximately half of the state's current primary contact recreation standard of 126 cfu/100 mL. Of the 15 sampling stations, only 2 exhibited *E. coli* concentration geometric means above this level. These data will be submitted to TCEQ for consideration in the next bi-annual water quality assessment.

BST results from the watershed returned somewhat anticipated results. In looking at all sampling stations combined, wildlife (avian and non-avian) combined to garner 60% of the *E. coli* identified while cattle made up 14%, human sources accounted for 8%, pets and other non-avian livestock both accounted for 7%, and avian livestock was identified 2% of the time. The remaining 9% of the samples analyzed were not able to be identified. Similar results were also produced by conducting BST on each sampling station individually; however, these results should be considered cautiously as the number of samples available for analysis at some stations due to the drought conditions reduces the utility of these findings.

Collectively, the water quality data collected and BST analysis conducted provide useful information to watershed stakeholders and will enable local decision making to be refined as needed.

Introduction

Fecal pollution of water originates from a wide variety of sources, including storm water runoff, wastewater treatment facility discharges, septic tanks, domestic pets, livestock, wildlife and illegal dumping. The majority of microorganisms found in fecal pollution generally do not pose a risk to human health; however, fecal pollution may also contain pathogenic microorganisms capable of causing diseases (pathogens). Testing water for specific pathogens is not feasible due to the high cost, difficulty in performing the tests and the highly variable occurrence of specific pathogens. As a result, the presence of fecal pollution, and consequently the potential presence of pathogens, is typically based upon the detection of fecal indicator bacteria.

Fecal indicator bacteria, such as *Escherichia coli* (*E. coli*), are found in the guts and feces of all mammals and birds. Fecal indicator bacteria typically occur at high levels in fecal pollution sources, are thought to have limited survival in the environment, and are easy and inexpensive test for. Numerous studies have linked the levels of fecal indicator bacteria (and pathogens by association) in water with levels of gastrointestinal disease (e.g. diarrhea, vomiting, and stomach cramps) observed in swimmers. Water quality standards based on levels of fecal indicator bacteria (e.g. *E. coli*) were subsequently developed to help quantify the risk of illness due to recreational contact with water at varying levels of fecal contamination.

In an effort to accurately identify sources contributing to bacterial loading, specifically *E. coli* in the Leon River Watershed (LRW), targeted water quality monitoring paired with bacterial source tracking (BST) was employed. Texas A&M AgriLife Research's - Water Science Laboratory located at the Blackland Research and Extension Center in Temple (AgriLife-TP) cooperated with the University of Texas Health Science Center at Houston School of Public Health, El Paso Regional Campus (UTSPH-EP) to measure LRW stream flow and collect, enumerate, and genetically type *E. coli* from LRW sources. LRW known fecal source *E. coli* were collected and genetically typed to supplement the Texas *E. coli* BST Library for identifying the sources of *E. coli* isolated from LRW water samples. Water samples were filtered and *E. coli* present were selectively cultured and enumerated by AgriLife-TP. Following enumeration, cultures were shipped to El Paso for genetic typing by UTSPH-EP. Using BST, the human and animal sources of *E. coli* isolated from water can be determined (Casarez et al., 2007). Advances in BST

technologies and techniques helped produce high certainty results which may be used to support the implementation of the watershed protection plan (WPP) for the LRW.

Project Goals

The overall goals for this project included:

- Monitor water quality and quantity at 15 locations within the LRW, monthly, for 1 year
- Collect and analyze LRW water samples for *E. coli* concentration
- Concurrently measure stream water quantity (flow) and quality (physical, chemical)
- Collect known fecal samples for the isolation of *E. coli* and supplementation of the Texas *E. coli* BST Library
- Conduct BST analysis to assess and identify different sources contributing to the bacterial loading of the LRW
- Deliver BST results to stakeholders through the on-going WPP process

Investigative Approach

AgriLife-TP carried out the field monitoring portion of the project which included: 1) cooperating with state agencies and stakeholders to determine monitoring locations, 2) physically scouting and identifying suitable monitoring locations, 3) collecting monthly water samples in conjunction with water quantity (flow) and water quality measurements, 4) enumerating *E. coli* present in collected samples using U. S. Environmental Protection Agency (EPA) method 1603 modified mTEC (USEPA 2006), and 5) collecting at least 50 known source fecal samples for the isolation of *E. coli* and augmentation of the Texas *E. coli* BST Library. Building on previous work conducted in the LRW (TSSWCB project 06-12, Leon River Watershed Protection Plan Project), this project used portions of the Texas Commission on Environmental Quality (TCEQ) and TSSWCB approved 3-Tier Approach for Developing Bacteria TMDLs, as recommended by the joint Bacteria TMDL Task Force.

Leon River Watershed and Study Area

The LRW, located in the Brazos River Basin, is bound by Proctor Lake upstream and Belton Lake downstream. The Leon River (Segment 1221) is 190 miles long and the watershed is approximately 1,375 square miles covering portions of Comanche, Erath, Hamilton, and Coryell

Counties before it reaches Belton Lake (Segment 1220). A small portion of the watershed lies within Mills County. LRW is predominantly rural supporting rangeland and row crop agriculture. Forests cover a sizable area and dairy production exists in the northern portion of the watershed. In 1996, the Leon River below Lake Proctor (Segment 1221) was placed on the *303(d) List* as being impaired for bacteria levels because it did not support its designated contact recreation use. The *2010 303(d) List* identified all but 2 of the segment's assessment units as impaired or having a concern for near non-attainment resulting from elevated *E. coli* levels. Additionally, 4 tributaries of the Leon River have been listed as impaired for bacteria (1221A – Resley Creek, 1221B – South Leon River, 1221D – Indian Creek, 1221F – Walnut Creek).

LEO 09, Leon River at CR431 near Jonesboro, Hamilton County

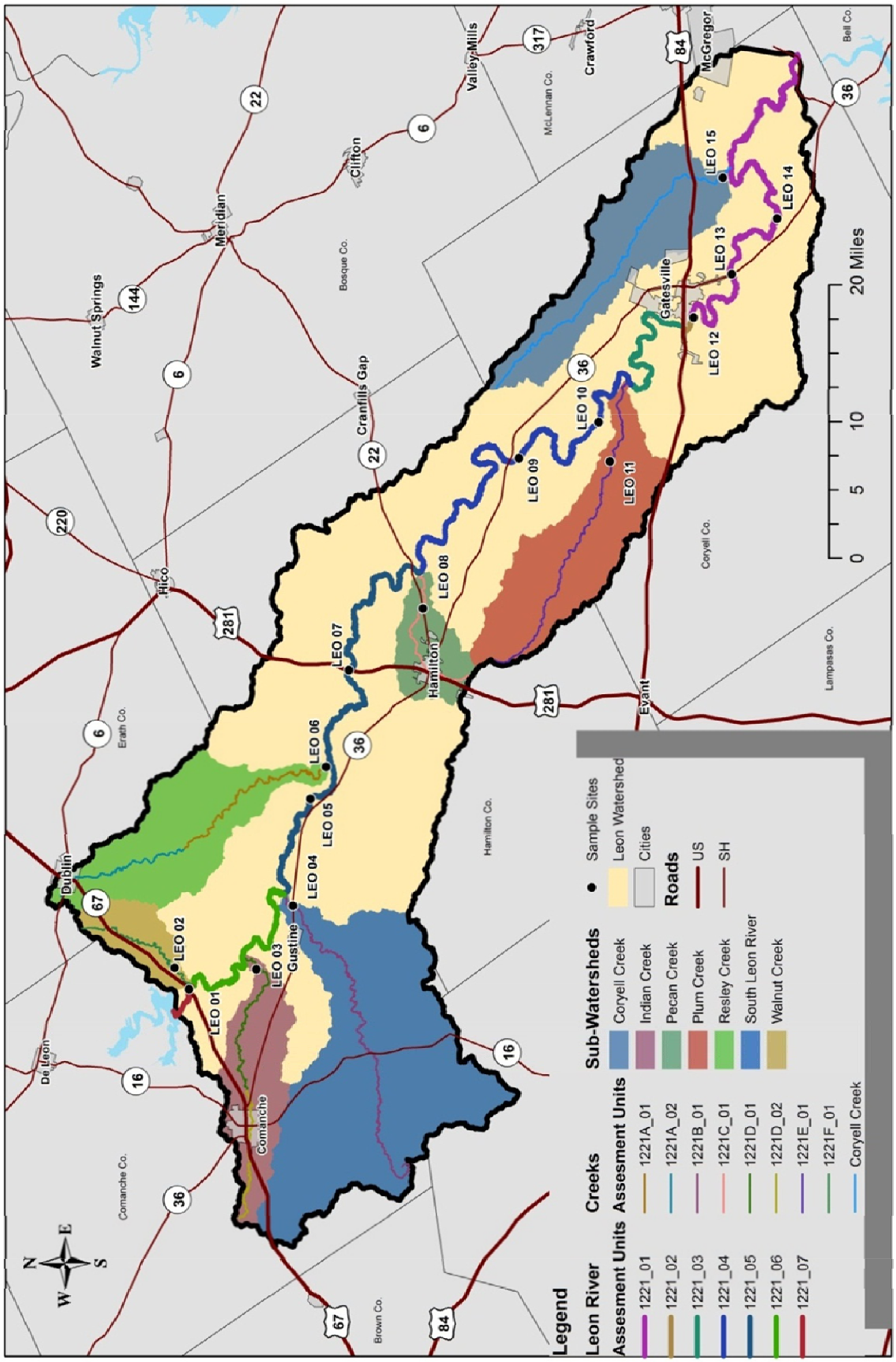


Figure 1. Leon River watershed and water quality monitoring sites

Hydrological Characteristics

Base Flow

The Trinity and several small, local aquifers underlie most of the LRW and contribute to the base flow of area streams. There are no notable springs in the monitored portion of the watershed.

Runoff

The Leon River watershed is located within the Lampasas Cut Plains, the northern most extension of the Edwards Plateau, and the Western Cross Timbers. This area is prone to flash flooding due to the topography, soil, and vegetation, which causes rapid runoff during intense rainstorms. For example, during the course of the study 1 runoff event occurred between October 8 and 9, 2011 when area-wide rainfall totals of 2-5 inches were recorded. Runoff recorded at the USGS gauge on the Leon River at Highway 281 increased from 1.9 cubic feet per second (CFS) to 1820 CFS in 1 hour, and increased to a maximum of 3000 CFS over 7 hours.

Drought

As monitoring commenced in February 2011, Comanche, Coryell, Erath, Hamilton, and Mills Counties where experiencing moderate to severe drought conditions; Bell and Coryell Counties were rated as abnormally dry. By August 2011, all counties in the study area exhibited extreme to exceptional drought conditions, as reported by the National Drought Mitigation Center located at the University of Nebraska (web site: http://droughtmonitor.unl.edu). Figure 2 depicts drought progress during the monitoring period from February 2011 to January 2012. This project documented water quality and quantity conditions observed in the Leon River under exceptional drought conditions that meteorologists characterized as the worst 1-year drought documented in Texas since record keeping began in 1895. During 2011, 100 percent of the state experienced drought conditions and 86 percent recorded “exceptional drought”, the most severe category.

Precipitation amounts were obtained from the Comanche, Hamilton, Gatesville, Fort Hood, and Lampasas airport records between January 1, 2011 and January 24, 2012. Normal average annual rainfall for the area is approximately 30 inches. Average precipitation recorded by area airports during the monitoring period was 13.44 inches. The longest period without significant daily rainfall was 125 days (note: “significant daily rainfall” is defined in this report as 0.5

inches, or more, per day). Precipitation between February 1 and September 30, 2011 averaged 4.33 inches. Precipitation between October 1, 2011 and January 24, 2012 averaged 7.34 inches.

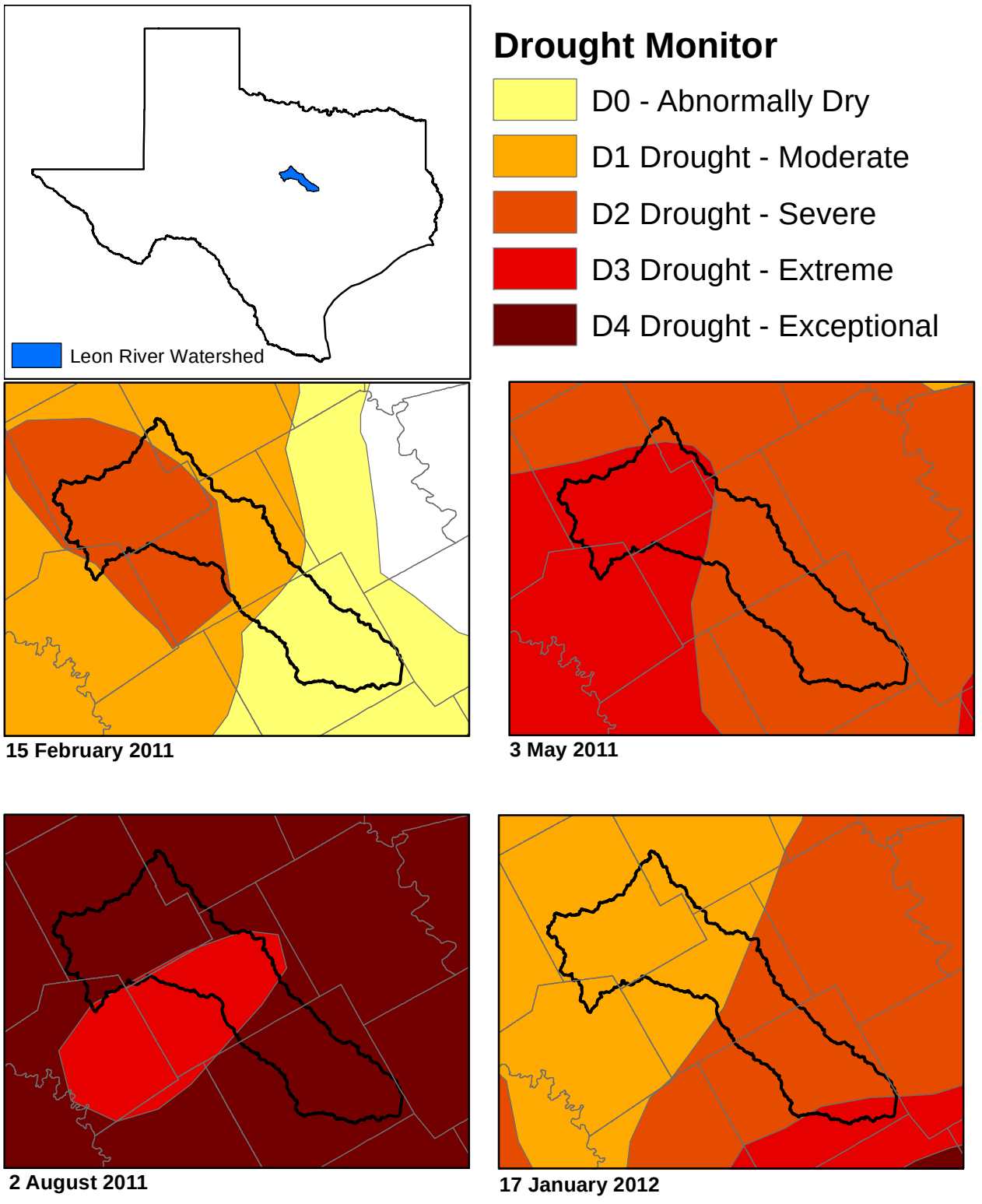


Figure 2. 2011Texas drought monitor maps. Source: http://droughtmonitor.unl.edu

Six sites within the LRW had no flowing water 25% - 50% the time. These included: Indian Creek (LEO 3), South Leon River (LEO 04), Resely Creek (LEO 6), Pecan Creek (LEO 8), Plum Creek (LEO 11), and Coryell Creek (LEO 15). Of these 6, Indian Creek (LEO 03), South Leon River (LEO 04), and Plum Creek (LEO 11) were flowing 4 or fewer times during the study.

No flow condition in South Leon River (LEO 4), Comanche County

Surface Water Quality and Quantity Monitoring

Monitoring Location Selection

Monitoring stations were selected based on recommended sampling locations described in the Leon WPP, previous history, location in the watershed, and accessibility. Proposed watershed sampling locations were scouted between July and November of 2010 to determine monitoring suitability. Suitability factors utilized included: representativeness of specific portion of the

watershed, safe accessibility, and streambed characteristics. Fifteen sites were selected (Figure 1 and Table 1), 8 on the Leon River and 7 on tributaries. Monitoring began in February of 2011. Sampling locations were generally located at the intersection of the stream channel and a public road, mainly for accessibility. Most had either a bridge or low water crossing present. Bridges are inherently focal points for birds, wildlife, cattle, and humans. Birds roost and nest on bridges; wildlife and livestock may cross roadways underneath bridges when accessible or loaf in the shade; people fish, socialize, and dump trash near bridges. The remains of many animals including processed deer, hogs, dogs, cats, and goats were observed dumped near bridges on the banks and in the river. Some reaches of the Leon River and its tributaries are suitable for, and sometimes used for recreational activity. The Leon River at FM 1829 and Coryell Creek at FM 107, both in Coryell County, were observed to have the heaviest recreational use during this study.

General Sampling Procedures and Frequency

Fifteen locations in the Leon River Watershed (Figure 1 and Table 1) were sampled monthly for 1 year during the study (180 scheduled measurement events). Grab samples were taken upstream of the bridge when possible and stream flow was measured within 50 meters of the sampling site depending on channel conditions. The presence of human activity, nesting birds, or other wildlife, was noted in the Field Log. Water samples for *E. coli* enumeration and BST were collected directly from the stream (channel midpoint or deepest accessible portion). Care was taken to avoid the surface and bottom micro-layers which may be enriched with bacteria and not representative of the water column. Immediately after collection the sample was stored on ice for transport and delivered to the lab within 6 hours of collection.

Table 1. Water quality monitoring sites

Site	TCEQ ID	Location	County	Latitude	Longitude	USGS Gage
LEO 01	11934	Leon River at Hwy 67/377	Comanche	31.95778	-98.4593	Yes
LEO 02	17379	Walnut Creek at FM 1476	Comanche	31.97312	-98.4367	No
LEO 03	11818	Indian Creek at CR 304	Comanche	31.88658	-98.4381	No
LEO 04	11817	South Leon River at Hwy 36	Comanche	31.84813	-98.3708	No
LEO 05	11933	Leon River at CR 382	Comanche	31.82971	-98.2575	No
LEO 06	11808	Resely Creek at CR 394	Comanche	31.81303	-98.2240	No
LEO 07	11932	Leon River at Hwy 281	Hamilton	31.78746	-98.1211	Yes
LEO 08	17547	Pecan Creek at Hwy 22	Hamilton	31.71031	-98.0563	No
LEO 09	11930	Leon River at CR 431	Hamilton	31.60882	-97.8968	No
LEO 10	11929	Leon River at CR 190	Coryell	31.52514	-97.8601	No
LEO 11	18405	Plum Creek at CR 106	Coryell	31.5126	-97.9001	No
LEO 12	17501	Leon River at Faunt Leroy Park	Coryell	31.46250	-97.7492	No
LEO 13	11926	Leon River at Hwy 36	Coryell	31.38369	-97.7017	No
LEO 14	11925	Leon River at FM 1829	Coryell	31.33584	-97.6425	No
LEO 15	11804	Coryell Creek at FM 10+7	Coryell	31.39278	-97.5994	No

Water quality and quantity parameters recorded at each sampling location are listed in (Table 2). Water temperature, pH, specific conductivity, and dissolved oxygen were measured with a Quanta multi-probe simultaneously with the collection of grab samples. Water depth was measured at the point where the grab sample was taken. Stream flow volume or discharge was measured using an acoustic digital current meter (OTT Acoustic Doppler Current Meter (ADCM), Hach Hydromet, Loveland CO). Monitoring location, LEO 01 and LEO 07, coincided with United States Geological Survey (USGS) stream flow monitoring gauges and stream flow was reported using USGS stream flow volume data.

Table 2. Water quality and quantity parameters

Parameter	Status	Reporting Units
Laboratory		
Escherichia coli	Critical	Colony Forming Units (CFU) per 100 mL
Field		
Dissolved Oxygen	Non-Critical	mg/L
pH	Non-Critical	Dimensionless (standard pH scale)
Specific Conductance	Non-Critical	µS/cm
Temperature	Non-Critical	°C
Flow Volume	Critical	CFS

Monthly routine sampling was conducted between the 14th and 24th days of the month. Field sampling was scheduled for Monday and Tuesday to allow for sample laboratory enumeration by AgriLife-TP and shipping to UTSPH-EP for BST processing later in the week.

Special Conditions

Surface water sampling during a drought of record presented several challenges. The flow profile at monitored sites was often very shallow and/or narrow making it difficult to conduct measurements with the Quanta Multi-parameter probe and the ADCM. During the very dry portion of the study, several locations exhibited surface flow with areas of subsurface flow above and below sampling sites. Flow conditions were noted in the field data sheet (i.e., flow, sub-surface, pooled, dry, etc.). Over the course of the study, 6% of measurements exhibited normal flow, 3% high flow, 57% low flow, 17% no flow, and 17% were completely dry. Due to drought conditions, water was flowing during measurement events 66% of the time.

Physical and chemical water parameters

Dissolved oxygen, temperature, pH, and specific conductance were measured and recorded *in situ* using a hand-held multiparameter sonde (HACH, Loveland CO, Model: Quanta). The probe was calibrated in the lab prior to each sampling event.

Table 3. Averages of physical and chemical parameters

Site	TCEQ Station ID	Water Temp (°C)	DO (mg/L)	pH	Conductance (µS/cm)	Flow (CFS)
LEO 1	11934	19.26	6.53	7.28	974	11.42
LEO 2	17379	15.09	6.01	7.51	1106	0.28
LEO 3	11818	15.04	7.62	7.85	1419	0.20
LEO 4	11817	18.50	8.66	7.94	1002	0.31
LEO 5	11933	18.60	8.28	7.63	1006	2.59
LEO 6	11808	16.84	9.12	7.63	1289	0.11
LEO 7	11932	17.19	9.51	7.96	791	1.90
LEO 8	17547	16.00	8.91	7.97	862	0.17
LEO 9	11930	16.70	8.19	7.95	641	7.34
LEO 10	11929	19.92	4.28	7.37	679	5.72
LEO 11	18405	19.32	7.66	7.18	416	0.53
LEO 12	17501	20.96	7.90	7.68	609	15.24
LEO 13	11926	21.09	6.72	7.62	635	17.09
LEO 14	11925	23.25	7.31	7.73	643	12.06
LEO 15	11804	21.01	9.75	7.66	498	2.86

Temperature

Water temperatures displayed typical seasonal differences. The lowest temperatures occurred in the February, ranging from 7.6 – 14.1°C and the warmest in July and August, ranging between 27.0 – 31.1 °C.

Dissolved Oxygen

Dissolved oxygen (DO) concentration ranged from 7.6 to 15.0 mg/L in February and 2.2 to 6.8 mg/L in July.

pH

The pH ranged from 6.57 to 8.91 among all sites. The lowest pH recorded was 6.57 in the Leon River at Highway 67/377 (LEO 01) on August 22, 2011and the highest of 8.91 in Pecan Creek at Highway 22 (LEO 08) on January 20, 2012.

Specific Conductance

Measurements for the specific conductance of the Leon River, above LEO 07, and its tributaries ranged from 474 to 1600 µS/cm with an average of 1036 µS/cm. Sites below LEO 07 ranged from 249 to 1116 µS/cm and averaged 637 µS/cm.

Measuring stream flow at Resely Creek (LEO 06) with Acoustic Doppler Current meter

Flow Volume

Stream flow volume or discharge was measured using an ADCM. Measurements were conducted in reaches free from obstructions (large rocks, vegetation, etc.) with good laminar flow (i.e., minimal turbulence). The ADCM concurrently measured vertical depth and integrated flow velocity across the channel to calculate the flow volume. Measuring stream flow under drought conditions presented several challenges. Stream flow at monitored sites was often very low. Under these conditions stream cross-section profiles were too shallow or narrow to

accommodate a measurement with the ADCM. In some cases, the timed float method was utilized to measure flow volumes. The main channel discharge, beginning at LEO 01 was influenced by releases from Proctor Dam. Water is withdrawn from the river for agricultural irrigation purposes downstream. This was frequently observed. For example, on June 20, 2011, the USGS gage near LEO 01 reported a flow of 34 CFS at 9:55am; at 10:55am, 35 river miles downstream, 0.22 CFS was measured at LEO 05 by AgriLife-TP. The flow from Proctor Dam had been at or above 34 CFS for at least 6 days prior to the LEO 05 measurement. The Leon River from LEO 09 in Hamilton County, and all downstream river locations, had flow present during scheduled sampling events. In contrast, all Leon River tributaries exhibited intermittent flow during the study. The 7 tributaries had 84 sampling scheduled events during which water was not flowing 55% of the time.

Table 4. Summary of sampling events (note: samples collected under flowing conditions only)

Station	TCEQ Station ID	Scheduled Sampling Events	Waterbody Status		
			Flowing	Ponded	Dry
LEO 1	11934	12	12	0	0
LEO 2	17379	12	7	2	3
LEO 3	11818	12	4	3	5
LEO 4	11817	12	4	4	4
LEO 5	11933	12	10	2	0
LEO 6	11808	12	5	4	3
LEO 7	11932	12	7	5	0
LEO 8	17547	12	6	2	4
LEO 9	11930	12	7	5	0
LEO 10	11929	12	12	0	0
LEO 11	18405	12	3	5	4
LEO 12	17501	12	12	0	0
LEO 13	11926	12	12	0	0
LEO 14	11925	12	12	0	0
LEO 15	11804	12	4	2	6

Bacteria Enumeration

Laboratory Procedures

Water samples were collected and enumerated for *E. coli* from all monitoring locations, when flow was present. Samples were collected and processed by AgriLife-TP within 8 hours using the EPA Method 1603 modified mTEC procedure. Aliquots of the collected sample were filtered to yield *E. coli* counts for that sample. Aliquot volumes were determined by visually assessing the sample's turbidity and knowledge of previous *E. coli* counts from that site. Following required processing and incubations periods, *E. coli* colonies were counted.

Samples testing negative for *E. coli* were recorded as 0.5 CFU/100 mL for calculation purposes (NOTE: when calculating geometric mean, a zero value calculation causes a "divide by zero" error. TCEQ guidance requires using 0.5 in place of a zero as this does not increase the geometric mean average or negatively influence the total CFU). If bacterial growth was too numerous to count (TNTC), the minimum estimated value assumed a count of >200 CFU multiplied by smallest volume filtered. Table 5 summarizes *E. coli* enumeration as the geometric mean of all flowing samples by monitoring location. All data can be found in Appendix B. Following enumeration, plates exhibiting good CFU growth and separation were shipped to the UTSPH-EP. Up to 8 representative colonies were then isolated on Nutrient Agar with MUG (NA-MUG), confirmed as *E. coli*, and archived. Up to 5 isolates per water sample were subjected to BST analysis.

Results

Enumeration yielded a wide range of *E. coli* CFU present in the streams at different times, locations and under varying conditions. The lowest CFU observed was one and occurred at LEO 04 on January 23, 2012. The highest CFU observed was 840 and occurred at LEO 02 on December 12, 2011.

Five of the 15 monitored sites had flowing water during all 12 visits. The geometric mean of *E. coli* enumerations at these sites ranged between 2 and 780 CFU/100 mL. There were 61 scheduled sampling events in which no samples were taken due to lack of stream flow.

Table 5. Summary of *E. coli* enumerations, expressed as colony forming units (CFU) per 100 mL, sampled from flowing water in the Leon River watershed

Station	TCEQ Station ID	# of Samples	Geometric Mean (CFU/100 mL)
LEO 1	11934	12	40
LEO 2	17379	8	163
LEO 3	11818	4	225
LEO 4	11817	4	32
LEO 5	11933	10	118
LEO 6	11808	5	71
LEO 7	11932	7	54
LEO 8	17547	6	16
LEO 9	11930	7	36
LEO 10	11929	12	76
LEO 11	18405	3	20
LEO 12	17501	12	75
LEO 13	11926	12	54
LEO 14	11925	12	66
LEO 15	11804	4	42

* Geometric means reported in this column were calculated using data collected from flowing water at each respective sampling site.
*** BOLD** geometric means exceed the state's contact recreation standard of 126 CFU/100 mL

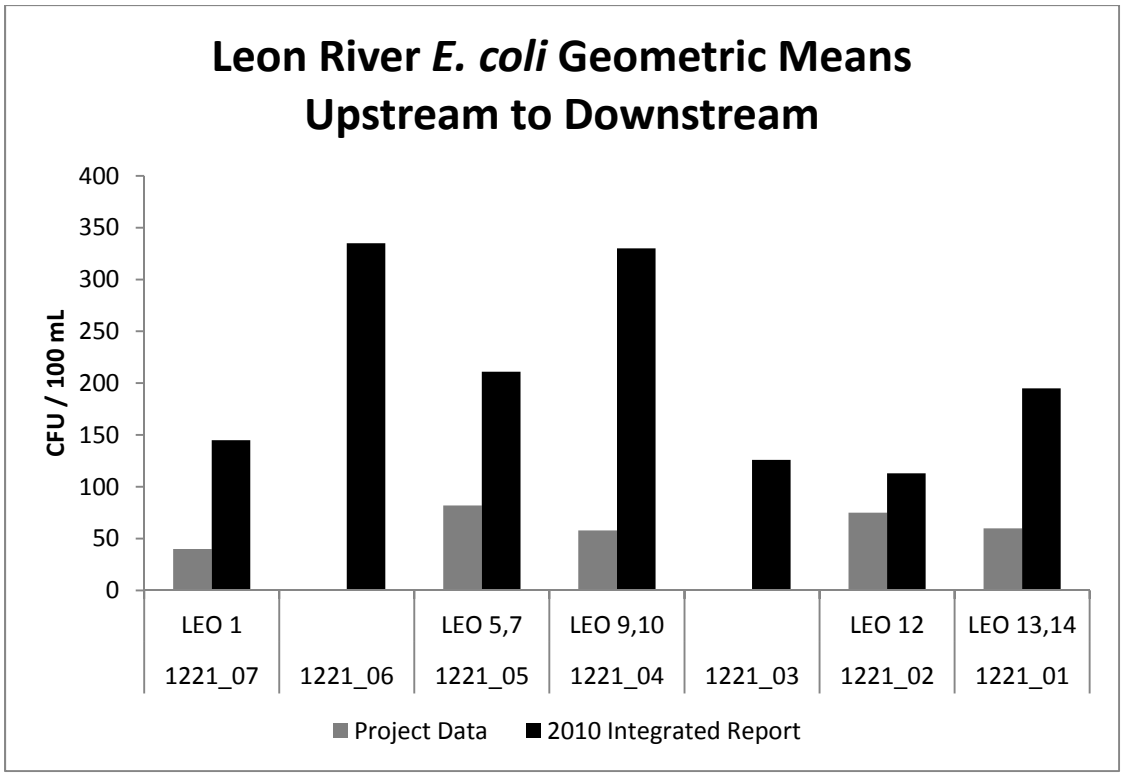


Figure 3. *E. coli* geometric means of project data along Leon River TCEQ segments

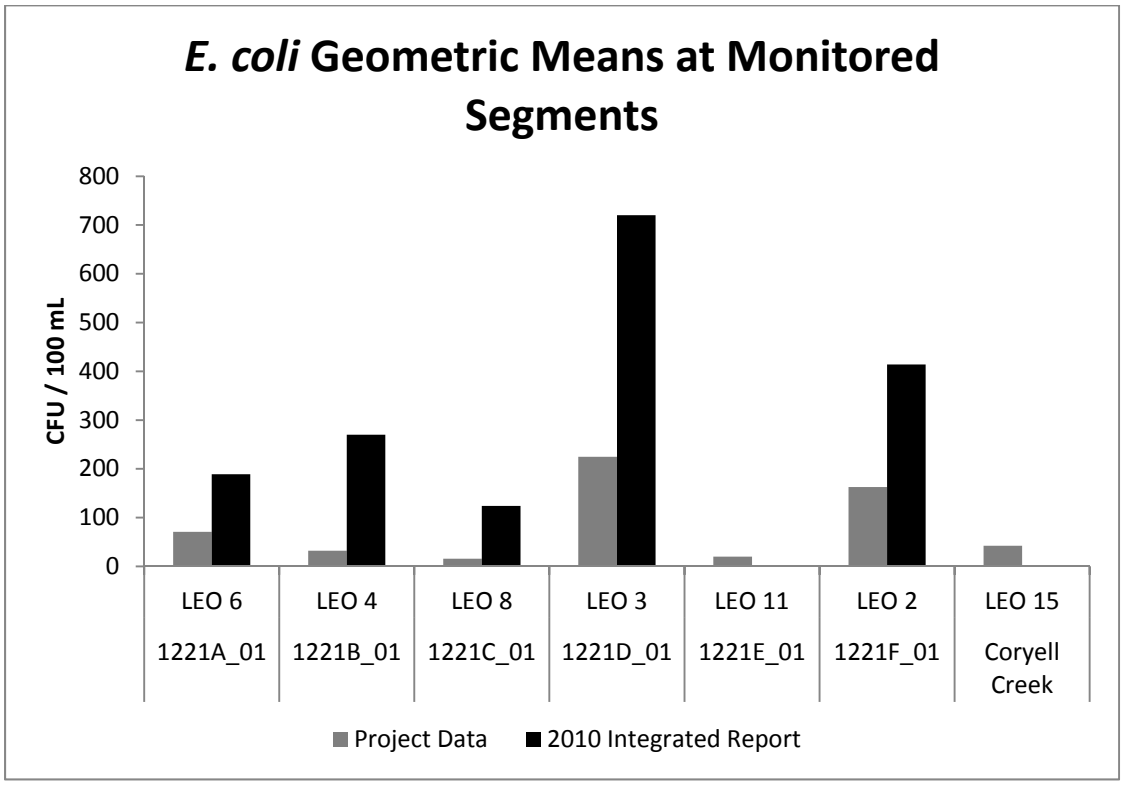


Figure 4. *E. coli* geometric means of project data along LRW creeks, TCEQ segments

Known Source Fecal Sampling

Findings from BST work conducted across Texas suggest that incorporating self-validated local watershed isolates, or known source samples, into the statewide library may have a beneficial effect on identification rates and accuracy. Therefore, a total of 95 known source fecal samples were collected from the LRW for the isolation of *E. coli*.

Collecting known source sample at Hamilton Wastewater Treatment Facility

General Procedures

Known source sampling took place between January 19, 2011 and April 4, 2012. Samples were collected during known source collection trips and scheduled monitoring trips with help from cooperating landowners, wastewater treatment facility operators, septic pumping service operators, USDA Wildlife Services Wildlife Damage Management Technicians, and Fort Hood Directorate of Public Works-Environmental Hog Trapping Program. Host sources were selected based on stakeholder concern and supplementation of the Texas *E. coli* BST library. A total of 95

fresh, known source fecal samples were collected in the watershed including: human and 13 species of domestic and wild animals (Table 6).

Table 6. Known source fecal samples collected in the Leon River watershed

Known Source	Quantity	Quantity by County			
		Comanche	Hamilton	Coryell	Bell
Wastewater	21	5	8	8	-
Septic Tank	1	-	-	1	-
Beef Cow	17	4	7	6	-
Dairy Cow	10	10	-	-	-
Horse	1	-	1	-	-
Goat	1	-	-	1	-
Cat	1	1	-	-	-
Feral Hog	31	3	2	10	16
Deer	3	-	3	-	-
Raccoon	1	-	1	-	-
Fox	1	-	1	-	-
Coyote	1	-	-	1	-
Cottontail	1	-	-	1	-
Skunk	1	-	-	1	-
Opossum	1	-	1	-	-
Swallow	3	-	-	3	-
Total	95	23	24	32	16

Human Sources

Domestic Sewage

Municipal wastewater samples were collected at the Comanche, Hamilton, and Gatesville (2) wastewater treatment facilities. Multiple samples were taken at each facility. Ten permitted facilities are present in the study area (Table 7). Individual samples were analyzed and positive plates where shipped to UTSPH-EP for genetic typing and inclusion in the Texas *E. coli* BST Library.

Table 7. City, volume, and discharge location for permitted Leon River point source discharges.

Location	Permit Volume (MGD)	Facility Type	Discharge to:
Upper Leon River Municipal Water Dist.	0.065	Domestic Sewage Treatment	Unnamed Tributary
City of Comanche	0.595	Domestic Sewage Treatment	Indian Creek
City of Gustine	0.082	Domestic Sewage Treatment	South Leon River
Circle T Promotions Ltd	0.018	Domestic Sewage Treatment	Bear Creek
City of Hamilton	0.88	Domestic Sewage Treatment	Pecan Creek
City of Dublin	0.45	Domestic Sewage Treatment	Resely Creek
City of Gatesville (Leon)	1.00	Domestic Sewage Treatment	Leon River
City of Gatesville (Stillhouse)	2.20	Domestic Sewage Treatment	Stillhouse Branch
City of Oglesby	0.05	Domestic Sewage Treatment	Station Creek
US Dept. of the Navy	n/a	Groundwater	Station Creek

Septic Systems

The Leon River watershed is predominantly rural with Gatesville being the largest city found entirely within the watershed boundaries. On-site sewage facilities (OSSFs) are the dominant type of waste water disposal system used in the watershed. One OSSF sample was collected from a commercial pump truck and was thus a composite of several OSSFs. The sample was collected and processed in the same manner as wastewater samples.

Collecting known source septic tank sample directly from pump truck

Grazing Livestock Sources

Ranching

Free ranging livestock in the watershed include cattle, horses, goats, sheep, and exotics. In total, 19 known source livestock samples were collected and submitted from the LRW. These included horse, goat, and beef-cow samples.

Concentrated Animal Feeding Operations

Within the Leon River watershed, there are 31 permitted concentrated animal feeding operations (CAFO) (Draft Leon WPP, 2010). These are concentrated in 6 tributaries of the Leon River: Below Proctor Dam, Walnut Creek, Indian Creek, South Leon River, Resely Creek, and Leon River (Lamkin area). A total of 10 known source CAFO samples were submitted from the LRW.

Wildlife Sources

The Leon River Watershed has a variety of habitats supporting numerous wildlife species. The watershed contains areas of cropland, improved pastures, rangeland, cedar/oak covered hills with steep canyons and bluffs, and riparian corridors that provide cover and forage for rabbits,

whitetail deer, wild turkey, coyotes, grey fox, squirrel, bobcats, skunks, opossums, raccoons, songbirds, waterfowl, game birds, and raptors.

Mammalian

Most known source mammalian samples were collected from droppings on the ground and identified by the close proximity of animals as well as fresh road-kill specimens.

Known source collected from fresh road kill

Avian

Avian sampling focused on species actively nesting on bridges at monitoring sites. Cliff Swallow samples were collected by placing plastic sheeting under bridge-nesting birds and checking the surface after birds had returned to normal activities. A total of 3 known source avian samples (i.e., Cliff Swallow) were submitted from the LRW.

Feral Hogs

Feral hog samples were collected with help from local trappers and the Fort Hood trapping program. In total, 31 known source feral hog samples from LRW were submitted for processing.

Hog trap near station LEO 06 on Resely Creek in Comanche County

Bacterial Source Tracking

In water bodies that exceed fecal indicator bacteria standards, a common approach to reducing monitored bacteria levels is to study the watershed and identify sources of fecal pollution and develop watershed protection plans. Laboratory tests are used by researchers to identify sources of fecal pollution, a process referred to as bacterial source tracking (BST). This process can identify different strains of *E. coli* that have adapted to conditions in the guts of their specific animal hosts, resulting in strains that are specifically associated with that species or class of animals (e.g. avian and non-avian wildlife, cattle, humans, etc.). As a result, BST laboratory tests allow the identification of likely human and animal sources of *E. coli* fecal pollution impacting a waterbody.

Two BST tests commonly used on *E. coli* are automated ribosomal ribonucleic acid genetic fingerprinting (RiboPrinting) and enterobacterial repetitive intergenic consensus sequence polymerase chain reaction (ERIC-PCR). These tests generate DNA fingerprints that resemble bar codes. The RiboPrinting and ERIC-PCR techniques are known as 'library-dependent' methods

that require reference libraries of DNA fingerprints for *E. coli* isolated from known human, livestock, and wildlife fecal samples. The fingerprints of *E. coli* isolated from water samples are matched with the fingerprints in the identification library to identify the likely sources of fecal pollution.

Technical Approach

To identify the human and animal sources of fecal pollution impacting the Leon River, ERIC-PCR and RiboPrinting composite DNA fingerprints (ERIC-RP) were generated for *E. coli* isolated from river water samples. These were compared to the Texas *E. coli* BST Library, which was also supplemented with known source fecal *E. coli* isolates from the local Leon River watershed.

Water Sample Processing

Water samples were processed by AgriLife-TP for *E. coli* enumeration using USEPA Method 1603 with modified mTEC medium (USEPA 2006). After *E. coli* enumeration, plates were shipped to UTSPH-EP. Up to 8 representative colonies were then isolated on Nutrient Agar with MUG (NA-MUG), confirmed as *E. coli*, and archived. Up to 5 isolates per water sample were then subjected to BST analysis for identification.

Known Source Fecal Samples

Between January 2011 and April 2012, a total of 95 known source fecal samples were collected from the Leon River watershed by AgriLife-TP for the isolation of *E. coli*. Collected samples were shipped to UTSPH-EP where samples were streaked onto modified mTEC medium. Up to 5 positive colonies were then reconfirmed to be *E. coli* by streaking onto NA-MUG medium. *E. coli* were successfully isolated from 71 fecal samples, and 323 isolates (up to 5 confirmed *E. coli* isolates per sample) were archived. Up to 3 isolates per sample were then screened for clones (identical isolates) using ERIC-PCR fingerprinting and non-clonal isolates for each sample were selected for RiboPrinting and inclusion into the local watershed library.

ERIC-PCR and RiboPrinting of *E. coli*

E. coli isolates from water samples and known source fecal samples were DNA fingerprinted using a repetitive sequence polymerase chain reaction (rep-PCR) method known as enterobacterial repetitive intergenic consensus sequence PCR (ERIC-PCR) (Versalovic,

Schneider et al. 1994). Following ERIC-PCR analysis, *E. coli* water isolates and selected source isolates were RiboPrinted using the automated DuPont Qualicon RiboPrinter and the restriction enzyme *Hin*dIII. For RiboPrinting, all bacterial isolate sample processing was automated using standardized reagents and a robotic workstation, providing a high level of reproducibility. ERIC-PCR and RiboPrinting was performed as previously described (Casarez, Pillai et al. 2007).

Analysis of composite ERIC-RP DNA fingerprints was performed using Applied Maths BioNumerics software. Genetic fingerprints of *E. coli* from ambient water samples were compared to fingerprints of known source *E. coli* isolates in the Texas *E. coli* BST library (ver. 10-12) and the likely human and animal sources were identified. ERIC-RP composite patterns of water isolates were compared to the library using a best match approach and an 80% similarity cutoff (Casarez, Pillai et al. 2007). If a water isolate was not at least 80% similar to a library isolate it was considered unidentified. Although fingerprint profiles were considered a match to a single entry, identification was to the source class, and not to the individual animal species represented by the best match. When analyzing data for the entire watershed, source classes were divided into 7 groups, 1) human; 2) pets; 3) cattle; 4) avian livestock; 5) other non-avian livestock; 6) avian wildlife; and 7) non-avian wildlife, including feral hogs. When analyzing subset data (e.g. individual stations), source classes were divided into 4 groups: 1) human; 2) cattle (which was of special concern for this watershed); 3) other domestic animals (including avian and other non-avian livestock and pets); and 4) wildlife (avian and non-avian). It should be noted that the wildlife source class in this study included feral hogs. The DNA fingerprints from *E. coli* isolated from known feral hog samples are shared more with wildlife than other domesticated livestock.

Library Description

The process for selecting known source isolates for inclusion into the state BST library has recently been refined and was applied to this project. All de-cloned isolates from individual source samples (up to 3) were included in the local watershed library, independent of their similarity to other library isolates. Jackknife analysis of the local watershed library ERIC-RP fingerprints was used to identify the isolates that were correctly classified using a 7-way split of source classes (i.e. human, pets, cattle, other non-avian livestock, avian livestock, avian wildlife,

and non-avian wildlife). Isolates with unique fingerprints (left unidentified using an 80% similarity cutoff) were also included to create the local self-validated library.

The local self-validated source isolates were then added to the current Texas *E. coli* BST Library (along with similarly selected isolates from Lampasas) (ver. 10-12 PRE). Jackknife analysis on the Texas *E. coli* BST library was then used to screen out any previously "unidentified" source isolates (those with unique fingerprints) that were incorrectly matching using a 3-way split of source classes (human, domestic animals, wildlife). Isolates that were still unique (left unidentified using an 80% similarity cutoff) were left in the library in order to reflect the diversity of patterns potentially seen in unknown water samples.

Of the 95 known fecal samples collected from the Leon River watershed, *E. coli* were successfully isolated from 71 samples, and 323 isolates (up to 5 confirmed *E. coli* isolates per sample) were archived. Of these, 202 isolates from the 71 positive source samples (up to 3 per sample) were screened using ERIC-PCR, with 132 isolates from those samples RiboPrinted and included in the local watershed library. After self-validation screening, 85 isolates from 60 samples were included in the initial (ver. 10-12 PRE) Texas *E. coli* BST Library. After Jackknife analysis, 82 isolates from 58 Leon source samples (82% of the local library samples) were left in the Texas *E. coli* BST Library (ver. 10-12). This version of the statewide library was used to identify the source classes for water isolates from the Leon River watershed.

The Texas *E. coli* BST Library (ver. 10-12) contains 1632 isolates from 1423 samples and represents 12 watershed projects across Texas and thousands of archived and screened samples. The results of Jackknife analysis using a 7-way split of source classes is included in Table 8 and the results using a 4-way split is included in Table 9.

Table 8. Texas *E. coli* BST Library (ver. 10-12) composition and rates of correct classification (RCCs) by Jackknife analysis of ERIC-RP composite data sets using an 80% similarity cutoff and 7-way split

Source Class	Number of Isolates	Number of Samples	Library Composition and Expected Random Rate of Correct Classification	Calculated Rate of Correct Classification (RCC)	RCC to Random Ratio***	Left Unidentified (unique patterns)
Human	413	353	25%	90%	3.6	19%
Pets	103	92	6%	67%	11.2	33%
Cattle	251	207	15%	83%	5.5	11%
Avian Livestock	102	86	6%	76%	12.7	23%
Other Non-Avian Livestock	120	114	7%	76%	10.9	13%
Avian Wildlife	246	227	15%	82%	5.5	20%
Non-Avian Wildlife	397	344	24%	82%	3.4	16%
Total	**1632**	**1423**	**RARCC* = 14%**	**ARCC** = 83%**		**18%**

*RARCC, expected random average rate of correct classification

**ARCC = average rate of correct classification: the proportion of all identification attempts which were correctly identified to source class for the entire library, which is similar to the mean of the RCCs for all source classes when the number of isolates in each source class is similar

***An RCC/Random Ratio greater than 1.0 indicates that the rate of correct classification is better than random. For example, the rate of correct classification for human is 3.6-fold greater than random chance.

Table 9: Texas *E. coli* BST Library (ver. 10-12) composition and rates of correct classification (RCCs) by Jackknife analysis of ERIC-RP composite data sets using an 80% similarity cutoff and 4-way split

Source Class	Number of Isolates	Number of Samples	Library Composition and Expected Random Rate of Correct Classification	Calculated Rate of Correct Classification (RCC)	RCC to Random Ratio***	Left Unidentified (unique patterns)
Human	413	353	25%	90%	3.6	19%
Cattle	251	207	15%	83%	5.5	11%
Other Domestic Animals	325	292	20%	79%	4.0	22%
Wildlife	643	571	39%	92%	2.4	18%
Total	**1632**	**1423**	**RARCC* = 25%**	**ARCC** = 89%**		**18%**

*RARCC, expected random average rate of correct classification

**ARCC = average rate of correct classification: the proportion of all identification attempts which were correctly identified to source class for the entire library, which is similar to the mean of the RCCs for all source classes when the number of isolates in each source class is similar

***An RCC/Random Ratio greater than 1.0 indicates that the rate of correct classification is better than random. For example, the rate of correct classification for human is 3.6-fold greater than random chance.

BST Results

UTSPH-EP received 116 water samples from flowing water from the 15 sampling stations between February 2011 and January 2012. UTSPH-EP successfully isolated *E. coli* from 114 samples and a total of 877 isolates (up to 8 per sample) were archived. Up to 5 isolates per sample, for a total of 566 isolates from the 114 water samples, were analyzed with ERIC-PCR and RiboPrint composite (ERIC-RP) fingerprinting and identified using the Texas *E. coli* BST Library (ver. 10-12).

BST results for all 566 watershed isolates are presented in Figure 6. Given the rural nature of the watershed it was not surprising that wildlife (both non-avian and avian) was the major contributor of *E. coli* in the Leon River. For other contributing sources of pollution, 14% of

isolates were identified as cattle-derived, while 8% of the isolates were identified as human-derived. Note that over 90% of the water isolates were identifiable using the Texas *E. coli* BST Library (ver. 10-12).

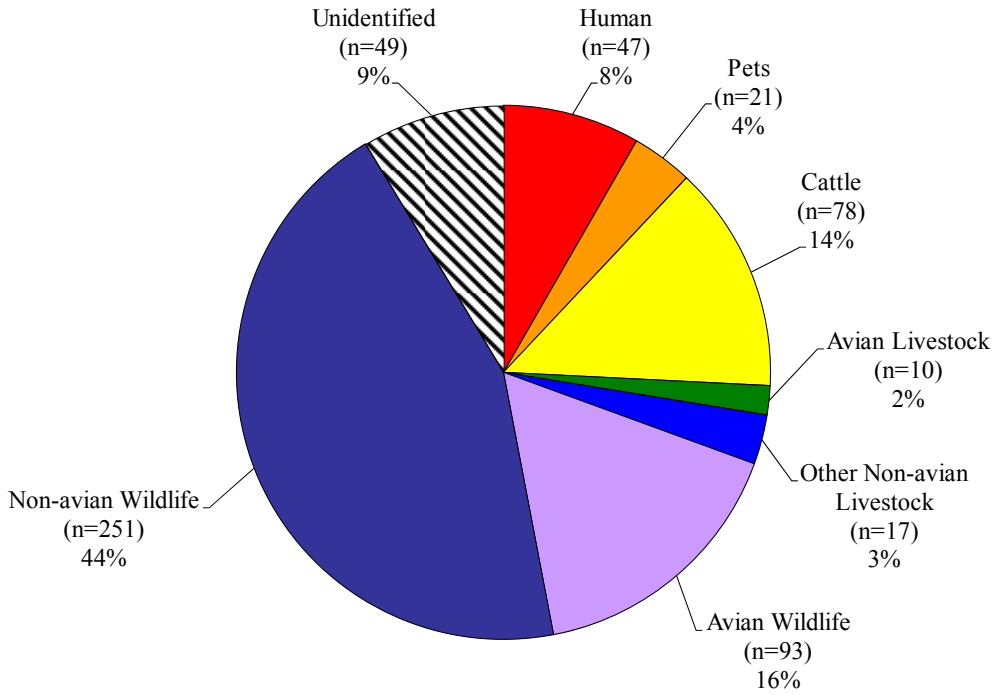


Figure 5: Identification of *E. coli* water isolates from the Leon River watershed using a 7-way split of source classes and an 80% similarity cutoff (n = 647 isolates from 131 water samples)

A breakdown of the watershed by sampling station is given in Appendix A using a 4-way split of source classes, but generally all follow a similar pattern. Figure 7 presents BST results for each site scaled to the *E. coli* geometric means. Wildlife was the major contributor at all sites, with cattle and human as less significant contributors. Thirteen of the fifteen sites were below the regulatory *E. coli* geometric mean standard of 126 CFU/100 mL for the 12 months of the study, and therefore were in compliance with recreation standards. It should be noted that the study period included drought conditions which left some sampling locations (sites LEO 3, 4, 6, 8, 11, and 15) dry or with no flowing water, especially during the summer sampling. These sites are therefore represented by less than half of the potential water samples (2-5 samples; 10-25 isolates). Interpretation of results must be carefully considered since percentages of source identification can easily be skewed by such small numbers.

LEO 2 (17379) and LEO 3 (11818) did exceed the geometric mean standard, but like the other locations, appear mostly to be impacted by wildlife. LEO 3 (11818) had the highest *E. coli* geometric mean at 225 CFU/100 mL, with 65% of the isolates identified as wildlife and also a relatively large portion of unidentified isolates (25%). This was most likely due to underrepresented wildlife or perhaps non-specific cosmopolitan strains that have been screened from the library. Interpretation must be carefully considered, however, since dry and no-flow conditions meant that LEO 3 is represented by only 20 isolates from 4 samples (collected Feb., Mar., May, and Dec.).

LEO 2 (17379) is represented by a more statistically robust 8 samples and 40 isolates, and had an *E. coli* geometric mean of 163 CFU/100 mL. Again, the major contributor was wildlife (65% of isolates). The second leading contributor was cattle, representing the identified source for 20% of the isolates. There is a dairy and pastures upstream of this site, and cattle do have access to the creek around this area.

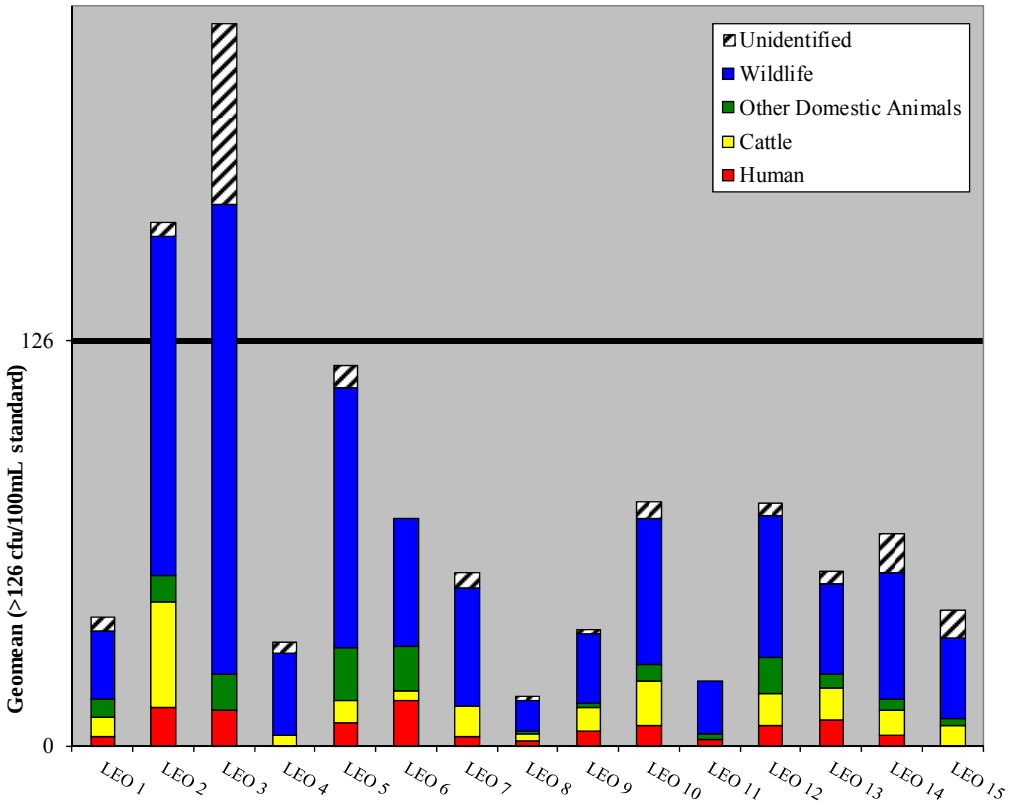


Figure 6: 4-way split BST results for each site scaled to the *E. coli* 12-month geometric means.

Over the course of the study there were 10 single sampling events that exceeded the individual sample limit of 394 CFU/100 mL. Source identifications for the isolates collected from samples in compliance were compared to those from exceedance samples (Figures 8 and 9, respectively). In both cases, wildlife was the major contributor, although an increase in avian wildlife was associated with the exceedance samples. It is important to note that human, cattle, and other livestock do not appear to be dominant contributors during exceedance events.

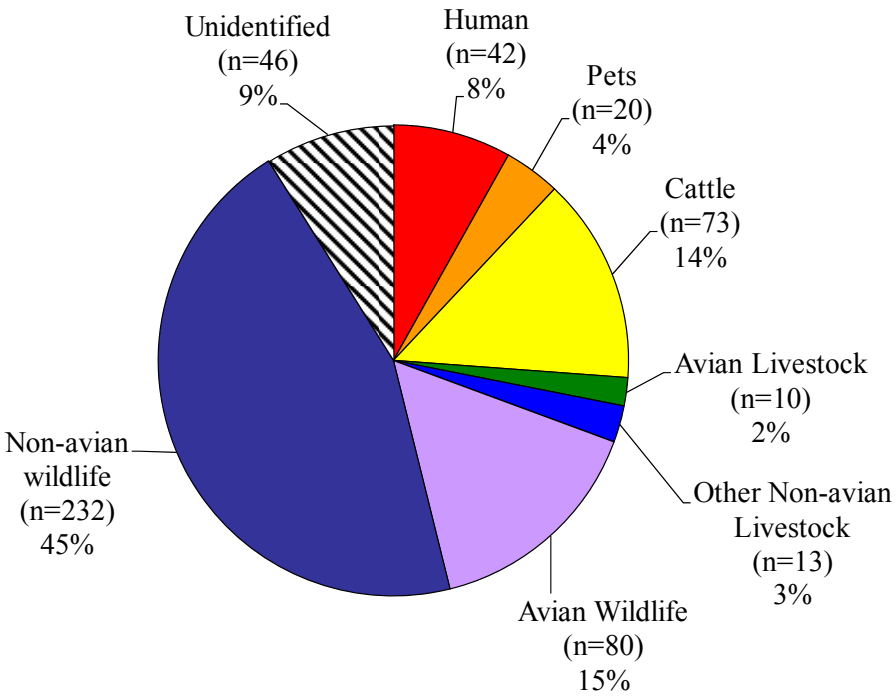


Figure 7: Identification of *E. coli* isolates from samples which were in compliance with the single sample maximum of <394 CFU/100 mL (516 isolates from 104 sampling events –all eligible sampling sites and dates included)

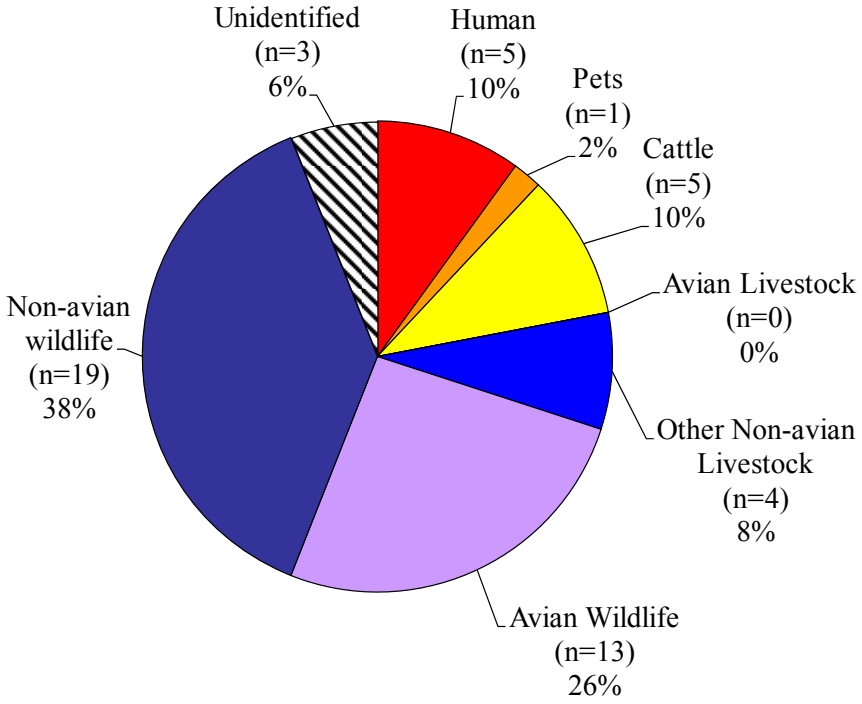


Figure 8: Identification of *E. coli* isolates from samples which were in exceedance of the single sample maximum of <394 CFU/100 mL (50 isolates from 10 sampling events, all eligible sampling sites and dates included)

UTSPH-EP also evaluated how source distributions changed over the study (Figure 10), although it should be noted that with only one year of data strong conclusions cannot be drawn. The months of May and October had the highest average *E. coli* counts (152 CFU/100 mL and 167 CFU/100 mL, respectively). Again, wildlife accounted for about half of the identified isolates, with approximately 70% of the isolates identified as wildlife for May samples (14 samples, 70 isolates). October showed the highest contribution from other domestic animals, its second leading contributor, with 24% of the 45 isolates (9 samples) identified to this source. While August had about equal wildlife and cattle contributions (33% each) and a relatively high human contribution (25%), the overall bacterial counts were low (25 CFU/100 mL) and there were a low number of samples collected due to drought conditions (5 samples; 24 isolates).

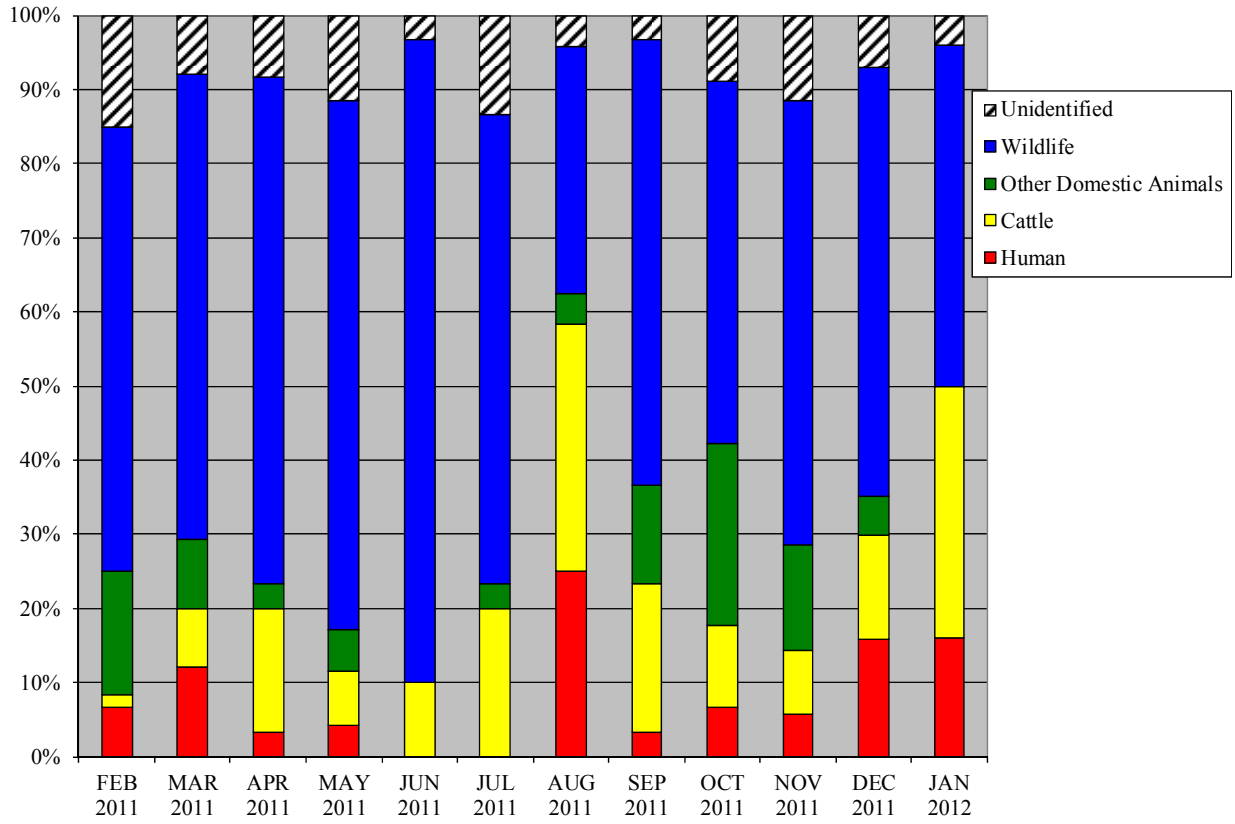


Figure 9: 4-way split of source classes by month (stacked pie chart) all sites combined

SUMMARY AND DISCUSSION

Most sites were in compliance with the *E. coli* geometric mean standard of 126 CFU/100 mL. The BST results indicated that wildlife was the major pollution source impacting the Leon River when there were significant impacts (high *E. coli* geometric means) as well as under compliance

conditions. Potential wildlife sources include coyotes, deer, wild birds, and feral hogs (as defined in this study). The relative contributions from humans and cattle did not increase for exceedance samples.

It should be noted that this study was conducted in a time of record-breaking drought which resulted in nearly one third of the sampling events being null due to dry or no-flow conditions. Note that when isolates from 17 ponded water samples were included in the analyses, the BST results were not significantly different from the flowing water samples discussed here. Drought conditions may have resulted in lower bacterial counts and perhaps different source contribution patterns than during more normal conditions. The results of this more in depth study of the Leon River still confirms the earlier less-extensive BST studies of the Leon River watershed which reported wildlife as the major contributor, followed by cattle and human.

The individual sampling sites mirror the results for the overall watershed. Emphasis should be placed on the sites with consistently higher bacterial counts. LEO 3 (11818) with an *E. coli* geometric mean of 225 CFU/100 mL may require further monitoring to determine whether its exceedances and level of unidentified isolates are significant. However, since wildlife was a major contributor at this site, fecal pollution may be difficult to control. Wildlife was also the major pollution source impacting LEO 2 (17379). Controlling the impact of cattle, the second leading contributor accounting for 20% of the identified isolates, may improve the water quality for this section of the Leon River watershed. Therefore, additional investigation (e.g., targeted *E. coli* monitoring) may be needed to determine if there are controllable cattle pollution sources. A watershed protection plan for the Leon River is already being implemented to improve water quality. The results of this study can be integrated into the plan through adaptive management.

REFERENCES

Casarez, E.A., S.D. Pillai, et al. (2007). "Direct comparison of four bacterial source tracking methods and a novel use of composite data sets." J Appl Microbiol **103**(2): 350–364.

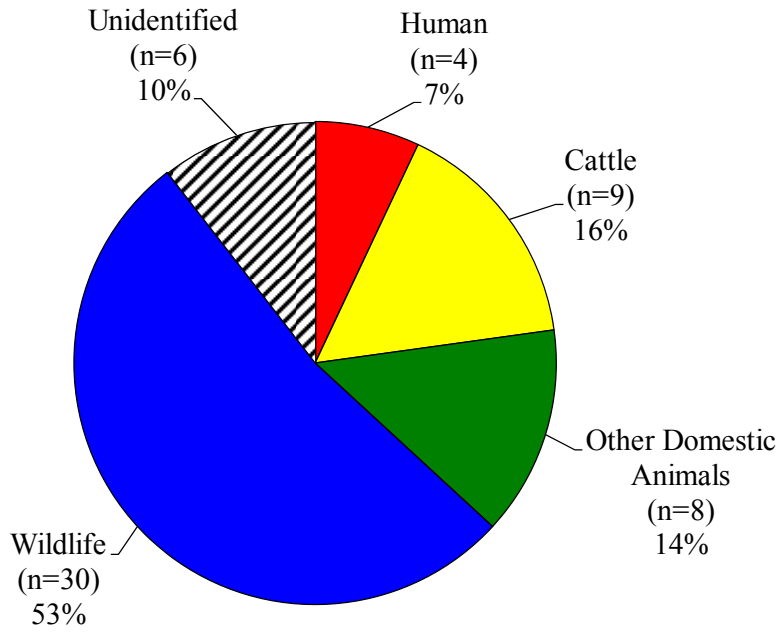
Parsons Water & Infrastructure Inc., Brazos River Authority. 2010. "Draft Watershed Protection Plan for the Leon River Below Proctor Lake and Above Bottom Lake." Available online at: http://brazos.org/LeonRiverWPP.asp

Timmons, J.B., B. Higginbotham, R. Lopez, J.C. Cathey, J. Mellish, J. Griffin, A. Sumrall, K. Skow. (2012). "Feral hog population, growth, density and harvest in Texas." Texas A&M AgriLife Extension Service. SP-472.

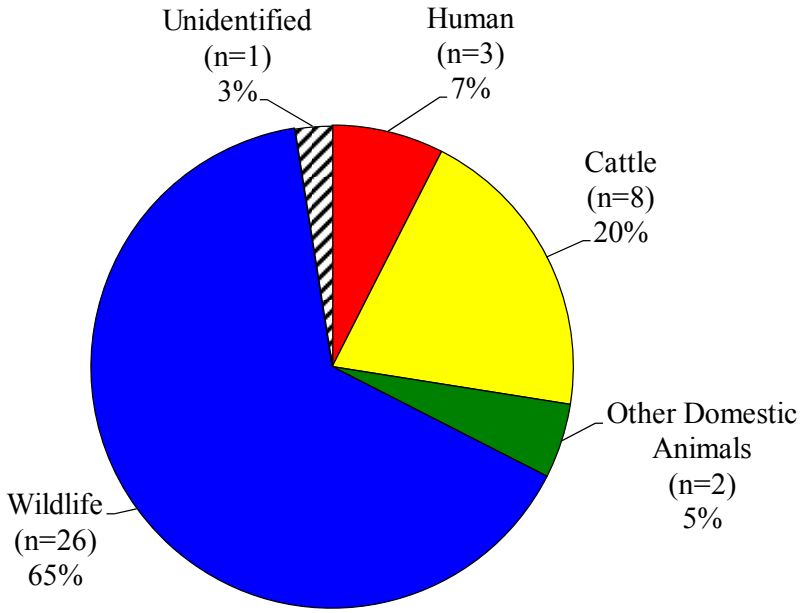
USEPA (2006). Method 1603: *Escherichia coli* (*E. coli*) in water by membrane filtration using modified membrane-thermotolerant *Escherichia coli* agar (Modified mTEC). Washington, DC, Office of Research and Development, Government Printing Office.

Versalovic, J., M. Schneider, et al. (1994). "Genomic fingerprinting of bacteria using repetitive sequence-based polymerase chain reaction." Meth. Mol. Cell. Biol. **5**: 25-40.

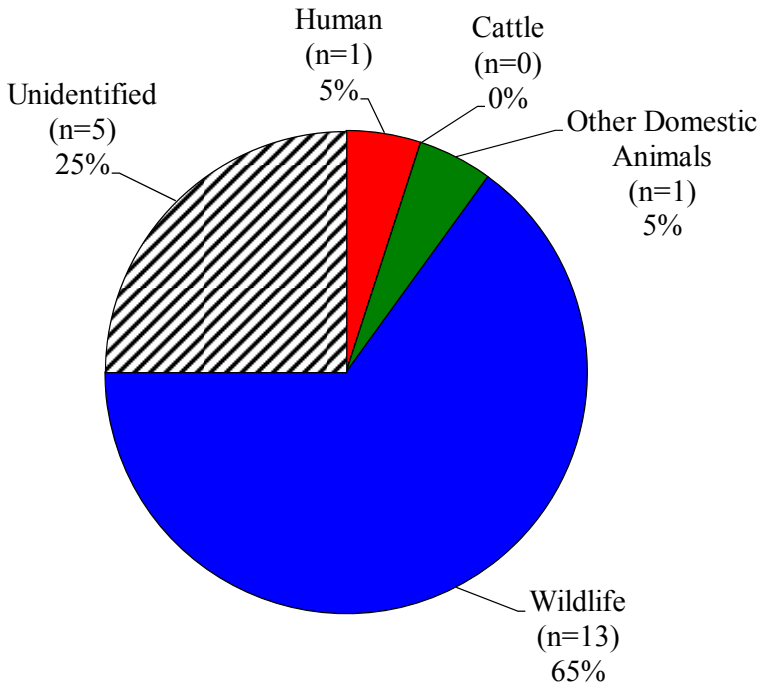
Appendix A: Source Identifications by Sampling Station



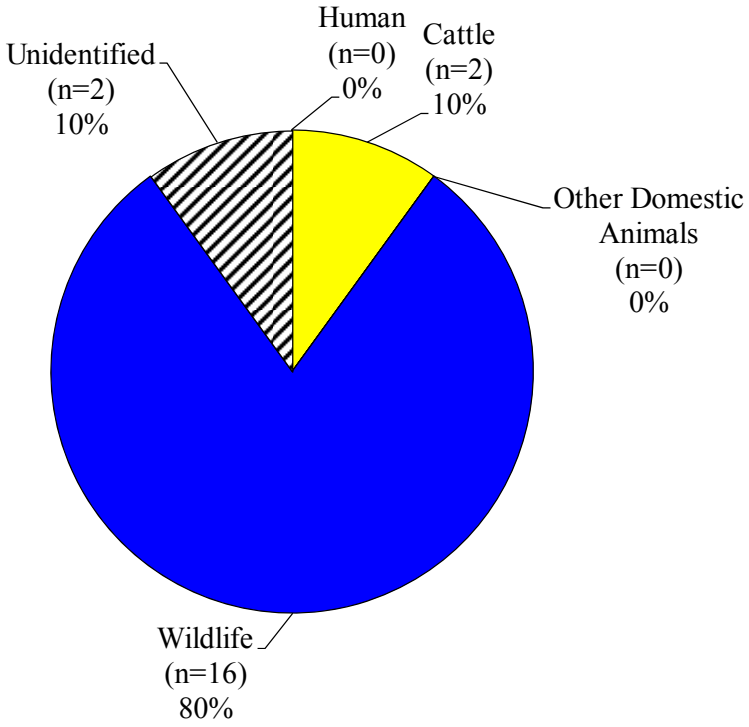
LEO 1 (11934) geometric mean = 40 CFU/100 mL (n=57 isolates; 12 samples)



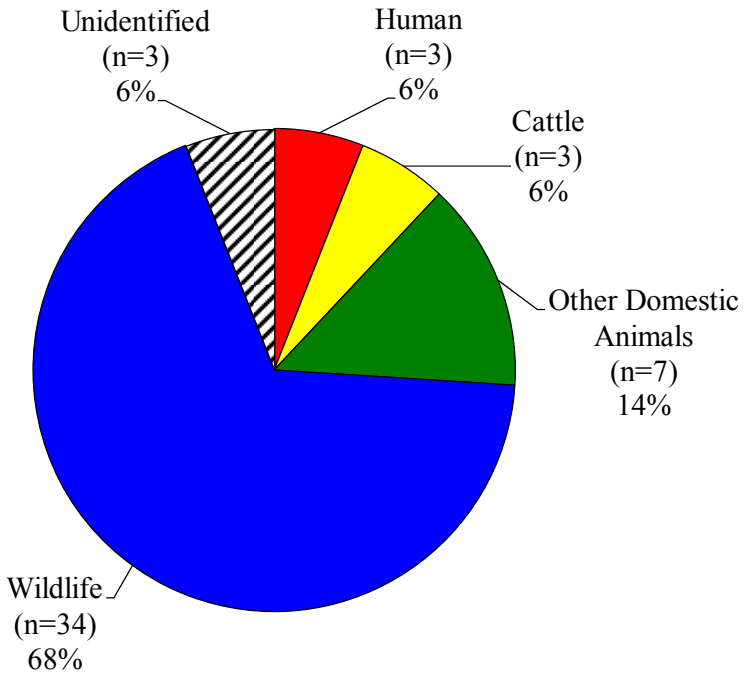
LEO 2 (17379) geometric mean = 163 CFU/100 mL (n = 40 isolates; 8 samples)



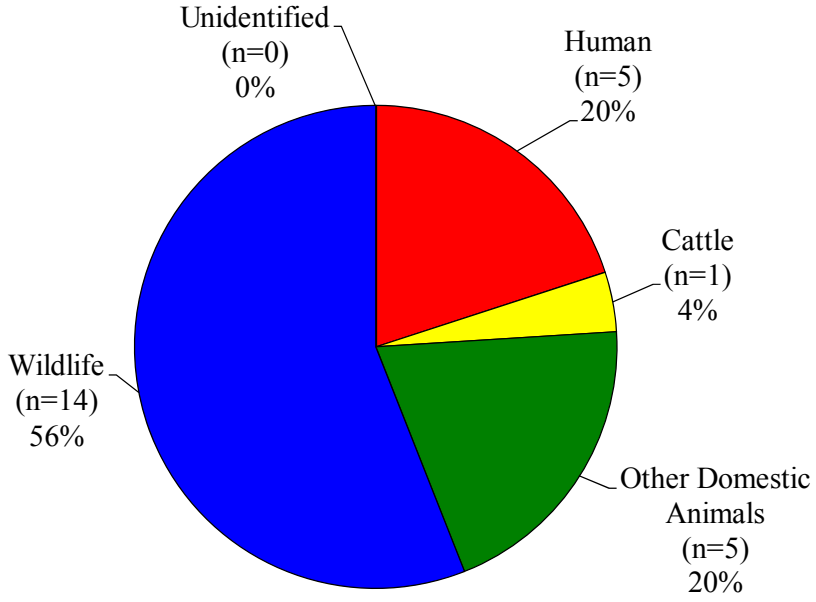
LEO 3 (11818) geometric mean = 225 CFU/100 mL (n = 20 isolates; 4 samples)



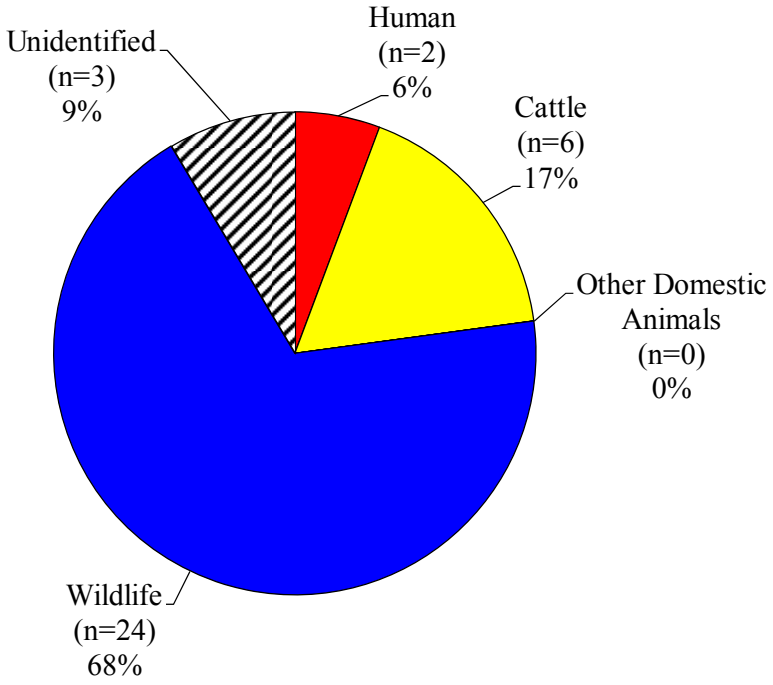
LEO 4 (11817) geometric mean= 32 CFU/100 mL (n = 20 isolates; 4 samples)



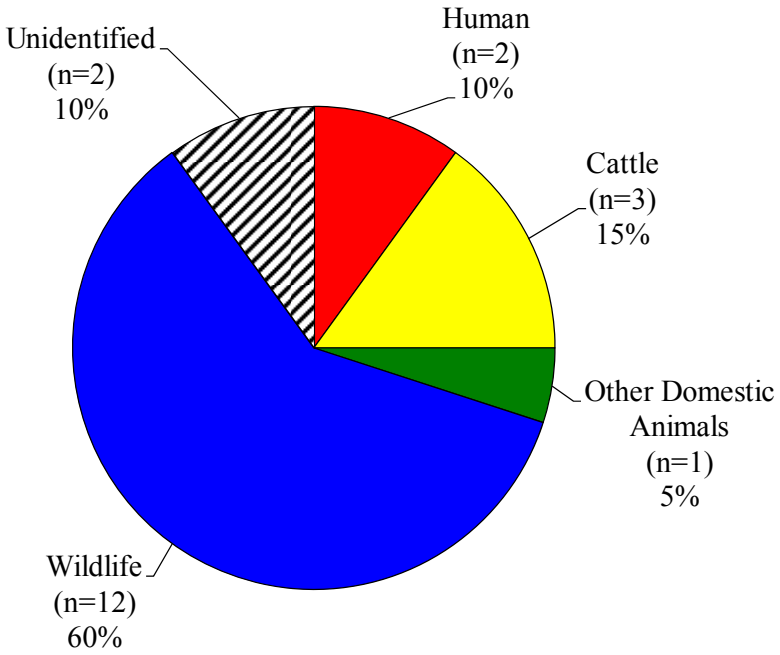
LEO 5 (11933) geometric mean= 118 CFU/100 mL (n = 50 isolates; 10 samples)



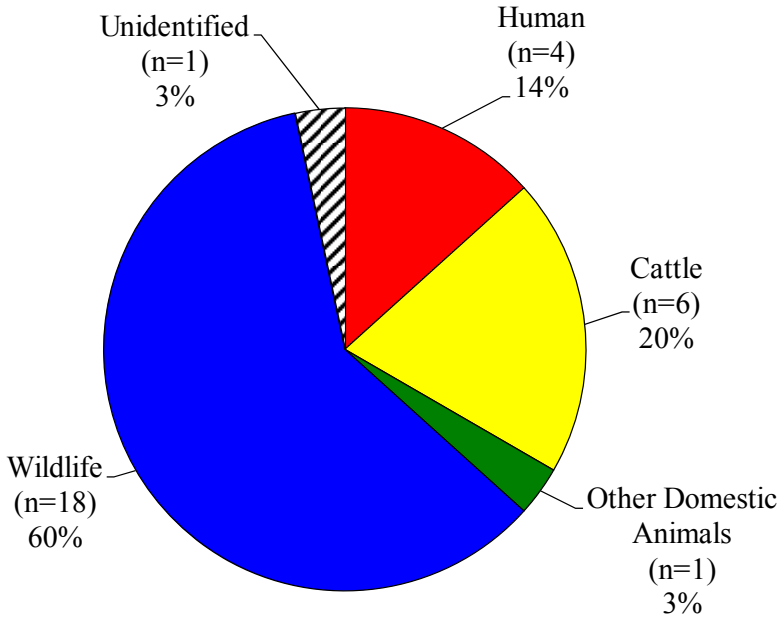
LEO 6 (11808) geometric mean= 71 CFU/100 mL (n = 25 isolates; 5 samples)



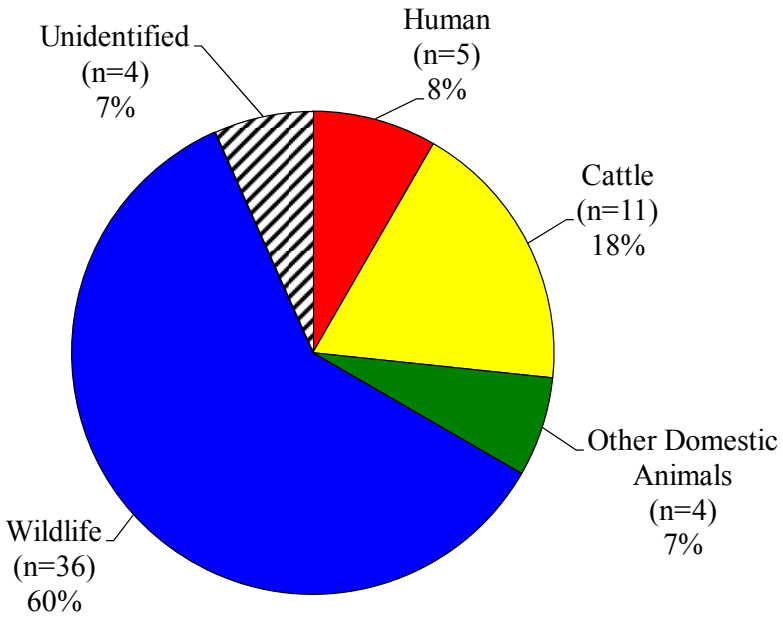
LEO 7 (11932) geometric mean= 54 CFU/100 mL (n = 35 isolates; 7 samples)



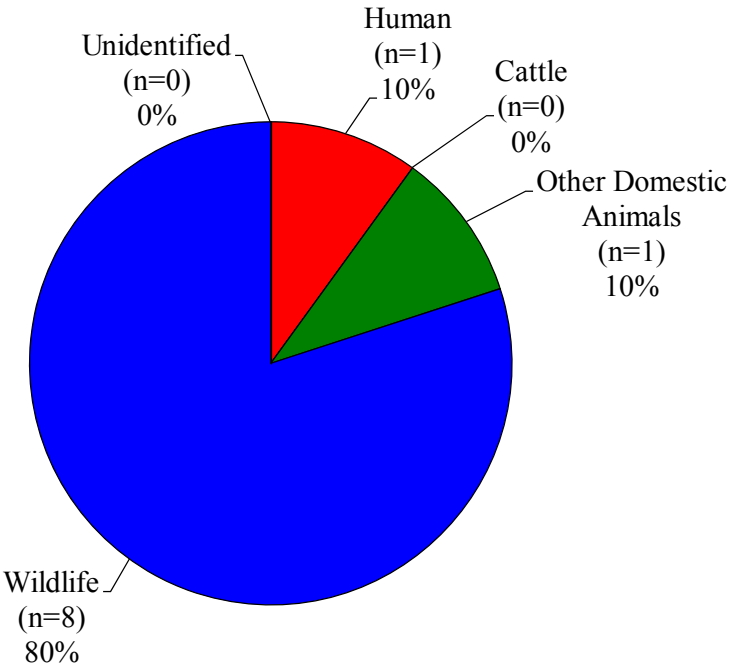
LEO 8 (17547) geometric mean = 16 CFU/100 mL (n = 20 isolates; 4 samples)



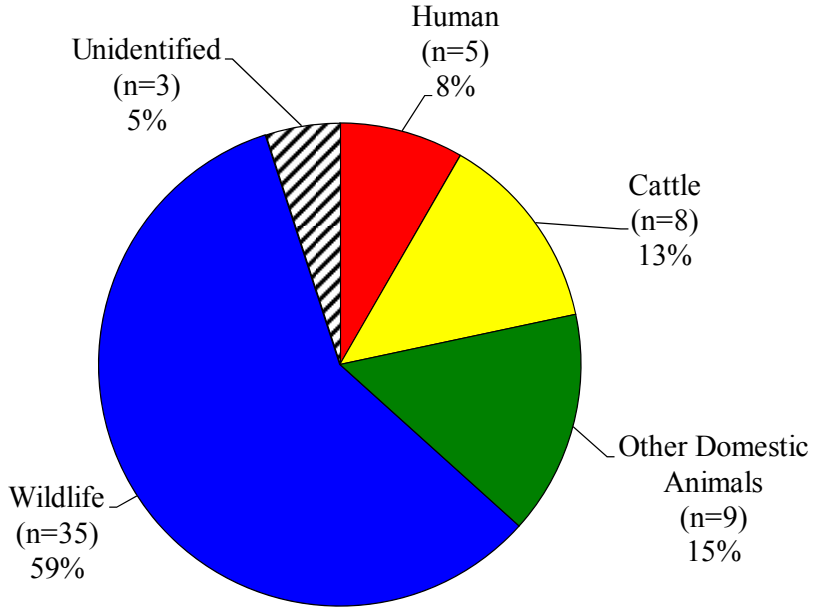
LEO 9 (11930) geometric mean= 36 CFU/100 mL (n = 30 isolates; 6 samples)



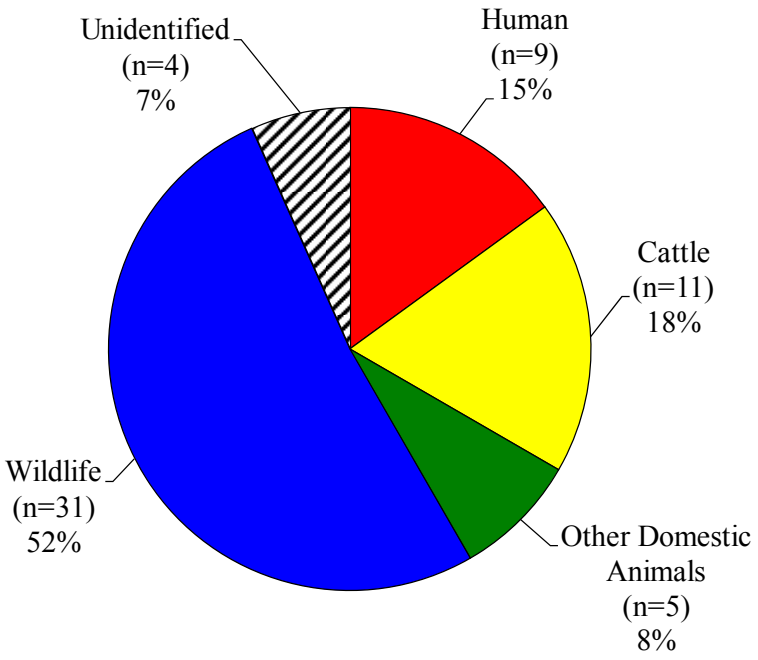
LEO 10 (11929) geometric mean= 76 CFU/100 mL (n = 60 isolates; 12 samples)



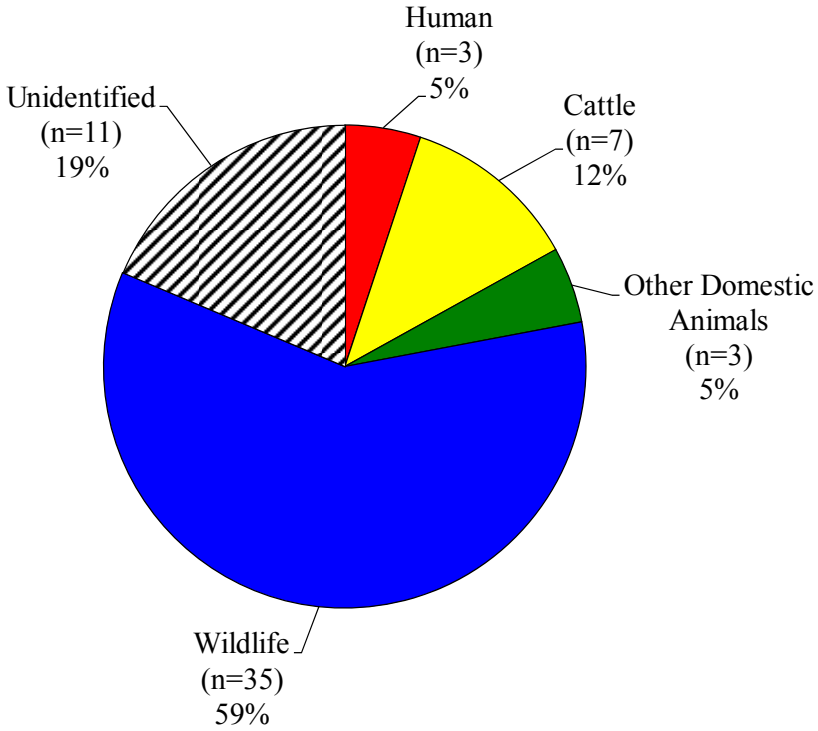
**LEO 11 (18405) geometric mean = 20 CFU/100 mL (n = 10 isolates; 2 samples)
(Please note that this graphic represents bacteria isolates obtained from only two water samples. While the isolates represented are real, the lack of other isolates potentially hides the influence of other contributing sources of *E. coli* to this site).



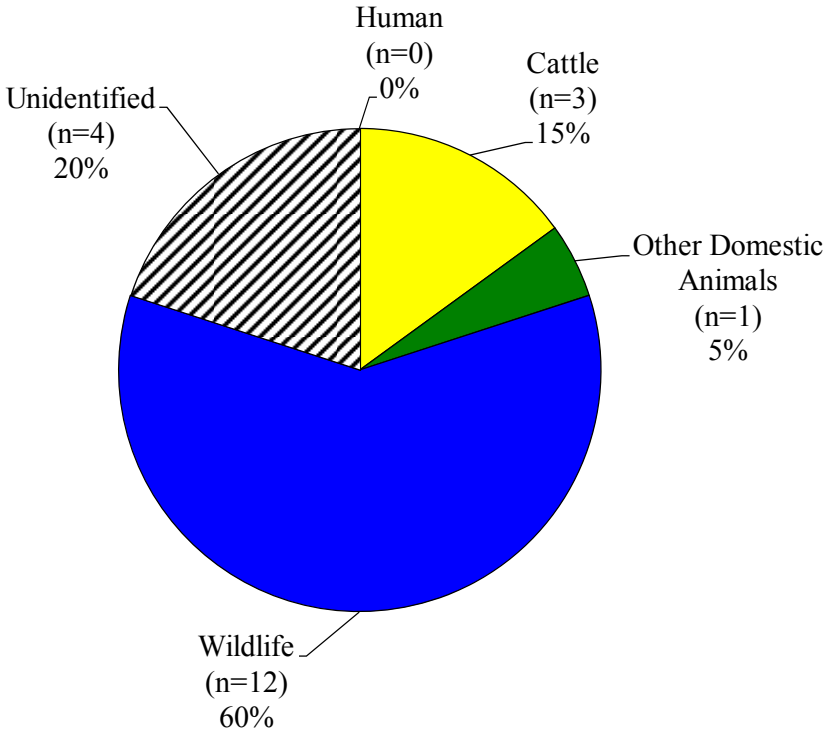
LEO 12 (17501) geometric mean = 75 CFU/100 mL (n = 60 isolates; 12 samples)



LEO 13 (11926) geometric mean = 54 CFU/100 mL (n = 60 isolates; 12 samples)



LEO 14 (11925) geometric mean = 66 CFU/100 mL (n = 59 isolates; 12 samples)



LEO 15 (11804) geometric mean = 42 CFU/100 mL (n = 20 isolates; 4 samples)

Appendix B: All Sampling Data

Data Notes:

Present Weather 1=Clear 2=Partly Cloudy 3=Cloudy 4=Rain, 5=Other

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

ID	Date	Time	Location	TCEQ Station	Sample Type	Air Temp (C)	Weather	Last Rain (days)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/cm)	Water Temp (C)	Stream Depth (cm)	Flow Severity	Instaneous Stream Flow (cfs)	Ecoli/100 mL	Split
47	2/14/2011	9:45	LEO 1	11934	Water	17	1	36	11.49	7.17	1258	8.07	0.1	2	3.08	38	40
48	2/14/2011	10:15	LEO 2	11896	Water	19.5	1	36	9.77	7.64	1087	8.07	0.1	2	0.29	105	
49	2/14/2011	10:40	LEO 3	11934	Water	21	1	36	11.55	8.03	1364	7.82	0.22	3	0.37	610	
50	2/14/2011	11:15	LEO 4	11817	Water	22	1	36	>15	8.22	1083	7.88	0.1	2	0.42	24	
51	2/14/2011	11:45	LEO 5	11933	Water	20.5	1	36	13.06	7.85	1318	7.79	0.17	2	3.44	48	
52	2/14/2011	12:10	LEO 6	11808	Water	21	1	36	13.47	7.41	1600	12.8	0.1	2	0.07	74	
53	2/14/2011	12:45	LEO 7	11932	Water	20.8	1	36	11.9	8.02	1140	8.5	0.35	2	4.1	22	
54	2/14/2011	13:15	LEO 8	17547	Water	19.8	1	36	13.43	8.29	973	7.59	0.1	2	0.42	4	
55	2/14/2011	13:50	LEO 9	11930	Water	24.5	1	36	12.21	8.15	743	7.78	0.23	2	13.39	7	
56	2/15/2011	9:45	LEO 10	11929	Water	20	1	36	7.92	7.09	737	10.53	0.43	2	8.26	46	44
57	2/15/2011	10:20	LEO 11	18405	Water	20.8	1	37	7.64	7.07	491	13.51	<0.1	2	0.11	2	
58	2/15/2011	11:05	LEO 12	17501	Water	24	1	37	11.01	7.74	663	11.58	0.31	2	15.8	32	
59	2/15/2011	11:55	LEO 13	11926	Water	22	1	37	12.04	7.85	651	10.78	0.4	2	22.99	48	
60	2/15/2011	12:04	LEO 14	11925	Water	26	1	37	13.09	7.97	652	11.7	0.74	2	23.33	36	
61	2/15/2011	12:55	LEO 15	11804	Water	28	1	37	11.06	7.63	481	14.13	0.15	2	6.44	12	
93	3/21/2011	10:20	LEO 1	11934	Water	21.5	1	80	4.82	6.87	864	19.16	80	3	12	151	119
94	3/21/2011	10:45	LEO 2	17379	Water	22	1	80	4.93	7.3	1031	18.69	0.24	2	0.48	243	
95	3/21/2011	11:20	LEO 3	11934	Water	22	1	80	1.19	7.54	1600	18.84	0.29	2	0.21	160	
96	3/21/2011	11:50	LEO 4	11817	Water	22	1	80	4.14	7.68	1149	20.03	0.24	2	0.5	25	
97	3/21/2011	12:30	LEO 5	11933	Water	23.5	2	80	4.86	7.22	1286	20.34	0.21	2	1.46	29	
98	3/21/2011	13:15	LEO 6	11808	Water	26	2	77	6.68	7.59	1391	19.76	0.14	2	0.19	106	
99	3/21/2011	14:05	LEO 7	11932	Water	28.5	2	77	7.94	7.77	1097	20.4	0.58	2	4.4	20	
100	3/21/2011	14:55	LEO 8	17547	Water	29	2	77	3.91	7.39	961	20.35	0.18	2	0.18	25	
101	3/22/2011	9:40	LEO 9	11930	Water	21.2	1	78	6.61	7.5	791	20.47	0.32	2	1.34	21	23
102	3/22/2011	10:15	LEO 10	11929	Water	22.9	2	78	6.37	7.29	753	20.14	0.34	2	6.25	102	
103	3/22/2011	10:46	LEO 11	18405	Water	24.6	1	78	8.42	7.56	500	18.32	0.18	2	0.1	40	
104	3/22/2011	11:45	LEO 12	17501	Water	26.5	3	78	9.13	7.59	673	20.87	0.33	2	11.77	73	
105	3/22/2011	12:15	LEO 13	11926	Water	26	1	78	8.39	7.59	674	21.02	0.44	2		81	
106	3/22/2011	12:55	LEO 14	11925	Water	27	2	78	9.07	7.75	678	21.02	0.17	2		65	
107	3/22/2011	13:25	LEO 15	11804	Water	27.2	2	78	7.84	7.38	479	19.93	0.19	2	5.81	68	
141	4/18/2011	10:25	LEO 1	11934	Water	25	2	8	6.85	7.03	895	20.23	0.49	3	4.9	44	39
142	4/18/2011	10:50	LEO 2	17379	Water	31	2	8	5.97	7.13	1010	19.35	0.31	2	0.19	60	
143	4/18/2011	11:10	LEO 3	11818	Water	26	2	8						1			
144	4/18/2011	11:50	LEO 4	11817	Water	28.5	2	8	4.34	7.53	1109	20.77	0.13	2	<0.01	24	
145	4/18/2011	12:30	LEO 5	11933	Water	30	2	8	4.14	7.12	1091	22.64	<0.1	2	0.13	45	
146	4/18/2011	12:55	LEO 6	11808	Water	30	2	8						1			
147	4/18/2011	14:00	LEO 7	11932	Water	28.1	2	8	7.85	7.69	1184	23.01	0.48	2	0.45	9	

ID	Field Comments
47	Flow value USGS gage.
48	Sample taken above bridge.
49	Water somewhat turbid, some attached algae.
50	Sample taken 100 ft above bridge. Dead raccoon under bridge.
51	4 deer remains in/on river bank. Small log jam dam under bridge, impounding water above bridge. No birds.
52	Sample taken above bridge.
53	Sample taken above bridge. Long deep pool with observable flow.
54	Sample taken above bridge. Attached and floating algae.
55	Sample taken above bridge. 2 foot log jam upstream of bridge. Remains of 4 hogs in river. Some attached algae.
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57	Sample taken above bridge.
58	Sample taken above bridge.
59	Sample taken above bridge.
60	Sample taken above bridge.
61	Sample taken above bridge.
93	No birds seen. Sample taken 100 ft above bridge.
94	Floating and attached algae. Hydrogen sulfide odor.
95	Floating and attached algae. Water brown - had odor.
96	Attached algae, some floating. Water clear. Cricket frogs. Small fish in riffles. Some cliff swallow nests, no birds.
97	Sample taken above bridge.
98	Floating and attached algae. Soft bottom.
99	
100	No floating algae - some attached. Water has "sewer odor". Water clear. Some small fish.
101	Several fresh hog carcasses decomposing in water. Sample taken a few feet above bridge - log jam. Numerous small fish, some algae.
102	Some algae, many small fish.
103	Many small fish. Some floating and attached algae.
104	Some attached algae.
105	Sampled above bridge. Flow meter reading 0.0 cfs in strong current. Flow value est from previous data and flow at LEO12/LEO1 4.
106	Sample taken above bridge.
107	Sample collected above bridge. Some attached algae. Water clear.
141	Swallows on nest. Turbid-brown. Sample taken 120 ft above bridge.
142	Sample taken above bridge. Water clear. A lot of floating and attached algae. Cricket frogs.
143	Water clear, soft bottom. Swallows on nest. Sample taken 50 ft above bridge. No algae, cow patties in water. Turtle, tadpoles, minnows.
144	Sampled above bridge, floating/attached algae. Small fish & tadpoles. Pond above bridge with trickle through rocks below bridge.
145	Sampled above bridge. Attached and floating algae. Fresh beaver sticks in dam under bridge.
146	No swallows seen, some algae, surface scum. Water turbid. Red eared slider. Ponding under bridge near dam.
147	Sampled 50 ft above bridge. Attached algae. Numerous swallows and small fish.

ID	Lab Comments
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57	No colonies, plate not shipped to El Paso
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ID	Date	Time	Location	TCEQ Station	Sample Type	Air Temp (C)	Weather	Last Rain (days)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/cm)	Water Temp (C)	Stream Depth (cm)	Flow Severity	Instaneous Stream Flow (cfs)	Ecoli/100 mL	Split
148	4/18/2011	13:25	LEO 8	17547	Water	30.5	2	8	3.86	7.1	1116	23.5	0.18	2	<0.01	116	
149	4/19/2011	10:55	LEO 9	11930	Water	31	2	8	6.48	8	782	23.11	0.4	2	8.89	13	11
150	4/19/2011	11:40	LEO 10	11929	Water	32	2	8	5.76	7.83	761	23.34	0.46	2	9.87	440	
151	4/19/2011	12:25	LEO 11	18405	Water	31.5	2	8						1			
152	4/19/2011	12:55	LEO 12	17501	Water	29.5	2	8	8.87	8.06	680	23.96	0.34	3	15.55	205	
153	4/19/2011	13:30	LEO 13	11926	Water	29	2	8	7.79	8	690	23.97	0.4	2	10.32	34	
154	4/19/2011	13:55	LEO 14	11925	Water	29.5	3	8	8.85	8.07	707	24.02	0.45	2	9.99	43	
155	4/19/2011	14:25	LEO 15	11804	Water	31.5	3	8	7.02	7.72	519	22.96	0.16	2	1.91	88	
213	5/23/2011	10:45	LEO 1	11934	Water	28	2	42	7.03	7.19	808	23.85	0.1	3	13	540	
214	5/23/2011	11:30	LEO 2	17379	Water	28	2	42	6.17	7.64	1050	22.77	0.11	2		124	
215	5/23/2011	12:25	LEO 3	11818	Water	29	2	42	3.72	7.53	1221	25.08	<0.1	2	0.06	330	
216	5/23/2011	13:15	LEO 4	11817	Water	29.2	2	42	11.14	8.33	668	25.31	<0.1	2		74	61
217	5/23/2011	14:10	LEO 5	11933	Water	31.8	3	42	7.24	7.46	752	27.5	0.15	2		40	
218	5/23/2011	14:40	LEO 6	11808	Water	33	2	42	5.78	7.59	1257	27.67	0.12	2		106	
219	5/23/2011	15:05	LEO 7	11932	Water	35	2	2	5.06	7.53	223	25.85	0.35	2		>2400	
220	5/23/2011	15:25	LEO 8	17547	Water	31	2	2	3.77	7.49	385	25.63	<0.1	2		112	
221	5/24/2011	10:50	LEO 9	11930	Water	30	2	2	5.63	7.69	549	26.16	0.4	3	23.16	116	
222	5/24/2011	11:25	LEO 10	11929	Water	30	2	13	5.53	7.69	753	25.79	0.52	5	38.52	770	
223	5/24/2011	11:55	LEO 11	18405	Water	31.7	3	11	6.92	6.92	258	26.14	0.24	3	1.38	200	
224	5/24/2011	12:45	LEO 12	17501	Water	31	2	11	5.63	7.6	302	25.86	0.52	5	100.67	780	
225	5/24/2011	13:40	LEO 13	11926	Water	32	2	11	7.81	7.96	693	26.34	0.62	5	125.1	82	
226	5/24/2011	14:15	LEO 14	11925	Water	34	2	11	9.82	8.25	991	27.07	0.48	5	71.72	94	
227	5/24/2011	15:00	LEO 15	11804	Water	37.5	2	11	13.09	7.89	513	27.54	0.15	2	0.22	44	44
265	6/20/2011	9:55	LEO 1	11934	Water	28	2	70	6.6	7.59	816	25.25	0.38	5	34	40	46
266	6/20/2011	10:15	LEO 2	17379	Water	27	2	70						1		6	
267	6/20/2011	10:30	LEO 3	11818	Water		2	70						6			
268	6/20/2011	10:40	LEO 4	11817	Water		2	70						6			
269	6/20/2011	10:55	LEO 5	11933	Water		2	70	4.59	7.1	952	26.95	0.12	2	0.22	124	
270	6/20/2011	11:15	LEO 6	11808	Water	29.25	2	70						1			
271	6/20/2011	11:50	LEO 7	11932	Water	32	2	32	3.66	7.55	468	27.16	0.42	1		46	
272	6/20/2011	12:15	LEO 8	17547	Water		2	32						6			
273	6/20/2011	12:45	LEO 9	11930	Water	35	2	32						1			
274	6/21/2011	9:45	LEO 10	11929	Water	28.5	3	41	3.92	7.19	668	27.04	0.22	2	0.12	450	582
275	6/21/2011	8:55	LEO 11	18405	Water	30	3	40						1			
276	6/21/2011	10:00	LEO 12	17501	Water	31	3	40	6.42	7.88	633	28.22	0.28	2	2.6	22	
277	6/21/2011	10:30	LEO 13	11926	Water	30	3	40	2.55	7.32	585	28.87	0.45	2	2.57	14	

ID	Field Comments
148	Flow noticeably lower than previous visits. Attached algae, small fish. Water clear. Sampled above bridge. No birds noted.
149	No swallows noted. Cricket frog, soft shelled turtles, numerous small fish. Some attached algae. No dead animals seen.
150	Swallows nesting. Samples taken above bridge. Numerous small fish, a little attached algae.
151	Trickle of water to pool downstream no surface flow from pool. Possible subsurface flow. Sample from pool. Water clear. Many small fish
152	Numerous small fish, cricket frogs. Duckweed along bank, floating algae in duckweed. Attached algae.
153	A few swallows seen, sample taken above bridge. Some attached algae.
154	No swallows. Small fish, cricket frogs. Some attached algae and floating algae near bank. Duckweed along bank.
155	Swallows present. Sampled above bridge. Some attached algae. Water clear. Numerous small fish, cricket frogs.
213	Water is brown, turbid. Swallows present.
214	Water is clear, no algae. Numerous small fish. Evidence that creek has been up since last visit. No swallows.
215	Water is brown in pools. Trickle of flow. Evidence that creek has been up since last visit.
216	No swallows. Water brown and turbid. Trickle of flow. Numerous small fish. No algae.
217	Water brown and turbid. Trickle of flow. Many small fish. Site cleaner - debris dam gone.
218	Water brown and turbid. Trickle of flow. Cattle tracks abundant in and around creek.
219	Water is muddy. USGS gage reads 0, not visually apparent due to pooling. Many swallows on bridge. Sampled short distance upstream.
220	Water is clear. A few swallows. Small fish.
221	No swallows seen, No algae. Water turbid. Wood debris dam gone.
222	Swallows present. Water turbid.
223	Water brownish, semi-clear. Has been over low water bridge. Small fish in pools. No algae.
224	
225	Water turbid. Swallows present. Small fish.
226	Water less turbid than upstream sites, not brownish. Swallows on bridge.
227	Water clear. Floating and attached algae. Numerous small fish. Swallows present.
265	Few swallow on bridge. Water turbid- brown. Highest flow we have seen. Sample taken downstream of bridge.
266	No flow, pool sampled under bridge. Dry above and below bridge. Water clear. Numerous small fish.
267	Creek dry except for one small puddle
268	river is dry with a few small pools too small to sample
269	Very low flow. Numerous small fish. Yellow catfish, 20 lb., remains on bank.
270	No flow. Long pool upstream from bridge. Water turbid. Rooted macrophysics.
271	No flow observed. No dry areas in river bed seen. Water turbid, not brown. Few swallows on bridge.
272	creek totally dry
273	No flow, pools above, under, and below bridge. Sample taken under bridge. Water clear in pool, attached algae. Many mussel shells.
274	Water turbid in eddies, much clearer in current. Attached and floating algae. Small fish.
275	No flow, water is clear. Shallow pools above and below bridge, rock bottom. Numerous small cricket frogs and small fish.
276	Water clear, abundant attached and floating algae. Numerous small fish and Cricket frogs.
277	Water turbid, some attached algae. Few swallows on bridge. Small fish and Cricket frogs.

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267	No sample collected.
268	No sample collected.
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272	No sample collected.
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ID	Date	Time	Location	TCEQ Station	Sample Type	Air Temp (C)	Weather	Last Rain (days)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/cm)	Water Temp (C)	Stream Depth (cm)	Flow Severity	Instaneous Stream Flow (cfs)	Ecoli/100 mL	Split
278	6/21/2011	10:55	LEO 14	11925	Water	31	2	40	3.92	7.5	615	27.54	0.3	2	3.94	40	
279	6/21/2012	11:15	LEO 15	11804	Water	30	3	40						1			
313	7/18/2011	10:10	LEO 1	11934	Water	31.6	2	>100	2.17	7.31	845	28.6	0.3	3	11	56	84
314	7/18/2011	10:20	LEO 2	17379	Water		2	>100						6			
315	7/18/2011	10:35	LEO 3	11818	Water		2	>100						6			
316	7/18/2011	10:45	LEO 4	11817	Water		2	>100						6			
317	7/18/2011	11:00	LEO 5	11933	Water	31.1	2	>100						1			
318	7/18/2011	11:15	LEO 6	11808	Water		2	>100						6			
319	7/18/2011	11:30	LEO 7	11932	Water	35.3	2	69	6.79	8.27	486	28.45	0.2	2	0.16	220	
320	7/18/2011	12:10	LEO 8	17547	Water		2	69						6			
321	7/18/2011	12:20	LEO 9	11930	Water	35.4	2	69						1			
322	7/19/2011	9:00	LEO 10	11929	Water	28.5	2	78	4.1	7.25	620	27.64	0.28	2	0.16	8	
323	7/19/2011	9:24	LEO 11	18405	Water		2	77						6			
324	7/19/2011	9:50	LEO 12	17501	Water	32.2	2	77	6.06	7.94	604	29.33	0.3	2	2.43	28	36
325	7/19/2011	10:30	LEO 13	11926	Water	33	2	77	2.98	7.42	648	30.12	0.48	2	1.29	32	
326	7/19/2011	10:55	LEO 14	11925	Water	35.4	2	77	4.11	7.53	628	29.35	0.2	2	0.53	82	
326	7/19/2011	11:10	LEO 15	11804	Water		2	77						6			
327	7/19/2011	11:10	LEO 15	11804	Water		2	77						6			
344	8/22/2011	10:31	LEO 1	11934	Water	32.8	2	9	4.11	6.57	899	28.13	0.15	3	4.6	72	56
345	8/22/2011	10:45	LEO 2	17379	Water		2	9						6			
346	8/22/2011	11:00	LEO 3	11818	Water		2	9						6			
347	8/22/2011	11:20	LEO 4	11817	Water		2	9						6			
348	8/22/2011	12:00	LEO 5	11933	Water		2	9						6			
349	8/22/2011	12:20	LEO 6	11808	Water		2	>100						6			
350	8/22/2011	13:08	LEO 7	11932	Water	33.8	2	>100						1			
351	8/22/2011	13:25	LEO 8	17547	Water		2	>100						6			
352	8/22/2011	13:40	LEO 9	11930	Water		2	>100						6			
353	8/23/2011	9:40	LEO 10	11929	Water	30.7	2	>100	2.55	7	627	26.97	0.12	2	<0.01	24	31
354	8/23/2011	10:05	LEO 11	18405	Water		2	>100						6			
355	8/22/2011	10:38	LEO 12	17501	Water	35.4	2	>100	5.9	7.33	644	29	0.1	2		40	
356	8/23/2011	11:23	LEO 13	11926	Water	29.78	2	>100	3.35	7.3	697	29.78	0.15	2	0.29	12	
357	8/23/2011	11:47	LEO 14	11925	Water	36.1	2	>100	5.25	7.39	581	29.08	0.12	2	0.66	12	
358	8/23/2011	12:05	LEO 15	11804	Water		2	>100						6			
393	9/19/2011	10:30	LEO 1	11934	Water	24.1	2	50	5.69	7.11	868	24.04	0.12	5	39	42	35
394	9/19/2011	10:45	LEO 2	17379	Water		2	50						6			
395	9/19/2011	11:00	LEO 3	11818	Water		2	50						6			
396	9/19/2011	11:10	LEO 4	11817	Water		2	50						6			
397	9/19/2011	11:35	LEO 5	11933	Water	26.8	2	50	5.94	7.73	973	25.28	0.26	3	13.44	715	

ID	Field Comments
278	Water somewhat turbid. Numerous small fish, Cricket frogs. Few swallows on bridge.
279	Sample taken from small pool under bridge. Water clear. Some attached algae. Numerous small fish.
313	Water turbid. Swallows on bridge.
314	creek completely dry
315	dry except for one small puddle
316	one shallow puddle seen from bridge
317	No flow, series of pools. No birds or nests. Sample taken beneath bridge. Numerous small fish. Water turbid. Attached/floating algae.
318	shallow pool upstream of bridge
319	No flow seen. Water turbid. No swallows seen, nest on bridge. Many small fish, cricket frogs, some algae. Sampled upstream.
320	no pools visible from bridge
321	Long pools above and below bridge. Sampled above bridge. Small fish and cricket frogs.
322	Water clear. Abundant dust/scum on surface. Numerous small fish and water striders. Long pool up/down stream. Some algae.
323	one small pool about 200ft downstream of bridge
324	Water clear, floating and attached algae, some Duckweed. Numerous small fish, Sunfish, 12'' Black Bass, Cricket Frogs, Texas Slider.
325	Water clear, slightly turbid. Swallows on bridge. Sampled upstream of bridge.
326	Water clear. Swallows on bridge. Sampled upstream. Small fish. Some attached algae.
326	creek bed is damp, no pools visible from road
327	Sunny - haze. Dry - no pools one damp spot.
344	No birds. Water turbid-brown.
345	damp under the bridge, otherwise dry
346	totally dry
347	totally dry
348	stagnant pools, creek dry otherwise
349	one pool upstream, otherwise dry
350	Long pools above and below bridge, no flow between them. No birds, numerous small fish.
351	Clear - sunny - few cumulus. Dry - one small pool seen. No sample taken.
352	small puddle upstream; completely dry downstream
353	Water turbid in pools, clearer in flow areas. Numerous small fish. Overhanging vegetation.
354	one puddle 100 yds upstream
355	Water clear. Animal tracks, cricket frogs. Problem with flow meter, flow estimate with USGS gage upstream.
356	Water clear in flows, somewhat turbid in pools. Attached algae. Turtles, Sunfish, numerous small fish.
357	Water clear in flow, somewhat turbid in pools. Attached algae, numerous small fish. Algae on gravel.
358	few damp spots
393	Water turbid.
394	completely dry
395	completely dry
396	completely dry
397	Good flow, water turbid. Some rain over the weekend.

ID	Lab Comments
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ID	Date	Time	Location	TCEQ Station	Sample Type	Air Temp (C)	Weather	Last Rain (days)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/cm)	Water Temp (C)	Stream Depth (cm)	Flow Severity	Instaneous Stream Flow (cfs)	Ecoli/100 mL	Split
398	9/19/2011	11:55	LEO 6	11808	Water		2	50						6			
399	9/19/2011	12:15	LEO 7	11932	Water		2	4						1			
400	9/19/2011	12:50	LEO 8	17547	Water		2	4						6			
401	9/19/2011	13:25	LEO 9	11930	Water		2	4						6			
402	9/20/2011	9:30	LEO 10	11929	Water	20.2	2	>100	2.33	7.25	629	20.81	0.1	2	0.13	13	11
403	9/20/2011	9:50	LEO 11	18405	Water		2	>100						6			
404	9/20/2011	10:20	LEO 12	17501	Water	24.5	2	>100	6.04	7.42	632	22.86	0.15	2	2.31	19	
405	9/20/2011	10:50	LEO 13	11926	Water	27.9	2	>100	3.37	7.52	689	23.66	0.2	2	2.7	140	
406	9/20/2011	11:20	LEO 14	11925	Water	29	2	>100	2.62	7.61	709	23.11	0.2	2	1.04	36	
407	9/20/2011	11:35	LEO 15	11804	Water		2	>100						6			
424	10/24/2011	10:40	LEO 1	11934	Water	28	2	15	3.88	6.87	684	19.03	0.28	2	0.71	45	15
425	10/24/2011	11:20	LEO 2	17379	Water	21.6	2	15	2.83	7.03	1221	16.74	<0.1	2	0.15	440	
426	10/24/2011	11:40	LEO 3	11818	Water		2	15						6			
427	10/24/2011	11:55	LEO 4	11817	Water		2	15						1			
428	10/24/2011	12:20	LEO 5	11933	Water	23.4	2	15	8.7	7.42	831	18.51	0.12	2	0.32	165	
429	10/24/2011	12:40	LEO 6	11808	Water		2	15						6			
430	10/24/2011	13:10	LEO 7	11932	Water	23.5	2	15	7.05	7.15	474	19.16	0.24	2	1.1	80	
431	10/24/2011	13:35	LEO 8	17547	Water		2	15						6			
432	10/24/2011	14:20	LEO 9	11930	Water	28.4	2	15	9.66	8.27	337	19.95	0.15	2	1.08	375	
433	10/25/2011	9:35	LEO 10	11929	Water	22.8	2	16	2.12	7.07	432	18.14	0.12	2	1.59	285	331
434	10/25/2011	10:00	LEO 11	18405	Water		2	16						6			
435	10/25/2011	10:35	LEO 12	17501	Water	23.8	2	16	7.08	7.43	461	19.29	0.31	2	4.32	100	
436	10/25/2011	11:05	LEO 13	11926	Water	24.1	2	16	5.99	7.31	390	19	0.25	2	6.25	175	
437	10/25/2011	11:35	LEO 14	11925	Water	23.4	2	16	6.12	7.37	385	19.39	0.2	2	5.79	205	
438	10/25/2011	11:50	LEO 15	11804	Water		2	16						6			
465	11/14/2011	10:25	LEO 1	11934	Water	24.3	2	36	4.12	7.53	1172	16.36	0.25	2	2.8	60	49
466	11/14/2011	10:50	LEO 2	17379	Water	24.6	2	36	3.05	7.51	1192	16.34	0.12	2	0.15	78	
467	11/14/2011	11:15	LEO 3	11818	Water		2	36						6			
468	11/14/2011	11:25	LEO 4	11817	Water		2	36						6			
469	11/14/2011	11:45	LEO 5	11933	Water	28	2	36	9.55	7.75	1137	17.67	0.13	2	0.34	380	
470	11/14/2011	12:00	LEO 6	11808	Water		2	36						6			
471	11/14/2011	12:50	LEO 7	11932	Water	26.3	2	36						1			
472	11/14/2011	13:20	LEO 8	17547	Water		2	36						6			
473	11/14/2011	13:40	LEO 9	11930	Water		2	36						1			
474	11/14/2011	14:05	LEO 10	11929	Water	27.8	2	36	1.77	7.39	612	18.74	0.16	2	0.01	118	
475	11/14/2011	14:25	LEO 11	18405	Water		2	36						1			
476	11/15/2011	9:40	LEO 12	17501	Water	20.9	2	37	8.35	7.27	627	18.45	0.21	2	2.02	160	118

ID	Field Comments
398	completely dry
399	small pools; too small to sample; dry in between
400	one small pool
401	small pools, no flow
402	Water clear above bridge, turbid under bridge. Numerous small fish, some Duckweed, and a little algae.
403	two shallow puddles
404	Water clear. Duckweed and attached algae. Numerous small fish and cricket frogs. Squirrel swimming in river.
405	Water clear, slight turbidity. Numerous small fish and cricket frogs. Some Duckweed and attached algae.
406	Water clear, slight turbidity. Numerous small fish and cricket frogs. A little Duckweed and attached algae.
407	very small puddles
424	Water brown and turbid.
425	Dry under bridge, H2S odor.
426	one small pool downstream of bridge
427	No flow, dry under bridge with few pools upstream.
428	Water clear with brown tint. Numerous small fish.
429	small, brown pools downstream of bridge
430	Water turbid, numerous small fish.
431	one pool above bridge
432	Water clear with some turbidity. Small fish.
433	Water clear with brown tint. Numerous cricket frogs and small fish.
434	small pool upstream, puddles downstream
435	Water somewhat turbid, numerous fish.
436	Water brown and turbid. Cricket frogs.
437	Clear with some turbidity.
438	dry creek
465	Water clear, slight turbidity.
466	Water clear. Lots of leaves on surface. Fresh cow tracks on creek bed.
467	creek dry
468	one small pool visible
469	Water clear with brown tint. 3 fresh deer carcasses in water under bridge, 2 bucks, 1 doe. Cows coming down bank to water.
470	one small puddle
471	Water clear with brown tint. Numerous small fish and cricket frogs. Cannot tell if there is flow.
472	few pools, no flow
473	large pool upstream, small pool downstream, no flow
474	Water clear with brown tint. Numerous small fish.
475	no flow, few pools
476	Water clear. Numerous small fish and cricket frogs.

ID	Lab Comments
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ID	Date	Time	Location	TCEQ Station	Sample Type	Air Temp (C)	Weather	Last Rain (days)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/cm)	Water Temp (C)	Stream Depth (cm)	Flow Severity	Instaneous Stream Flow (cfs)	Ecoli/100 mL	Split
477	11/15/2011	10:15	LEO 13	11926	Water	21	2	37	7.5	7.45	495	17.71	0.28	2	3.12	61	
478	11/15/2011	10:40	LEO 14	11925	Water	21.6	2	37	7.95	7.68	463	19	0.39	2	2.03	140	
479	11/15/2011	11:00	LEO 15	11804	Water		2	37						6			
496	12/12/2011	10:40	LEO 1	11934	Water	8.6	2	8	12.97	8.68	1021	7.9	0.28	2		2	0
497	12/12/2011	11:00	LEO 2	17379	Water	8.8	2	8	7.33	8.12	1023	9.07	0.21	2	0.29	840	
498	12/12/2011	11:30	LEO 3	11818	Water	9.1	2	8	7.58	8.28	1490	8.4	<0.1	2	0.01	79	
499	12/12/2011	12:00	LEO 4	11817	Water	9.8	2	8						1			
500	12/12/2011	12:35	LEO 5	11933	Water	10.2	2	8	9.7	8	1006	7.89	0.2	2	2	90	
501	12/12/2011	13:10	LEO 6	11808	Water	10.3	2	8	6.98	7.85	1079	9.18	<0.1	2	<0.1	54	
502	12/12/2011	13:40	LEO 7	11932	Water	10	2	8	10	8.27	530	8.09	0.42	2	2.3	160	
503	12/12/2011	14:05	LEO 8	17547	Water	10.5	2	8	13.49	8.62	731	8.03	0.11	2	0.07	22	
504	12/12/2011	14:50	LEO 9	11930	Water	10.7	2	8	6.34	7.97	380	7.52	0.12	2	0.27	76	
505	12/13/2011	10:00	LEO 10	11929	Water	12.4	2	9	1.92	7.81	811	9.85	0.16	2	0.31	4	
506	12/13/2011	10:35	LEO 11	18405	Water	13	2	9						1			
507	12/13/2011	11:10	LEO 12	18405	Water	13.5	2	9	9.69	7.97	746	10.87	0.35	2	2.65	57	52
508	12/13/2011	11:40	LEO 13	11926	Water	13.5	2	9	8.81	7.83	725	9.63	0.38	2	3.67	80	
509	12/13/2011	12:10	LEO 14	11925	Water	14.4	2	9	7.85	7.84	659	9.69	0.48	2	4.94	210	
510	12/13/2011	12:40	LEO 15	11804	Water		2	9						6			
538	1/23/2012	10:55	LEO 1	11934	Water	10.8	2	14	8.62	7.41	1560	10.47	0.21	2		4	4
539	1/23/2012	11:55	LEO 2	17379	Water	14.5	2	14	10.66	7.6	1234	9.65	0.12	2	0.37	78	
540	1/23/2012	11:50	LEO 3	11818	Water	15.5	2	14						1			
541	1/23/2012	12:30	LEO 4	11817	Water	16	2	14	10.26	7.43	902	12.95	0.25	6		1	
542	1/23/2012	12:55	LEO 5	11933	Water	18.5	2	50	>15	8.63	716	11.43	0.28	2	1.93	430	
543	1/23/2012	13:20	LEO 6	11808	Water	18	2	50	12.7	7.73	1120	14.78	0.14	2	0.05	40	
544	1/23/2012	13:50	LEO 7	11932	Water	16	2	50	>15	8.57	625	12.71	0.15	2	1	120	
545	1/23/2012	14:15	LEO 8	17547	Water	17.3	2	50	>15	8.91	1007	10.87	0.18	2	0.15	1	
546	1/23/2012	15:00	LEO 9	11930	Water	16.3	2	50	10.41	8.04	903	11.91	0.42	2	3.25	13	
547	1/24/2012	9:45	LEO 10	11929	Water	12.2	4	51	7.11	7.6	743	10.65	0.23	2	3.4	150	93
548	1/24/2012	10:15	LEO 11	18405	Water	11.7	4	51						1			
549	1/24/2012	10:50	LEO 12	17501	Water	10.7	4	51	10.61	7.93	654	11.48	0.21	2	7.53	210	
550	1/24/2012	11:30	LEO 13	11926	Water	11.1	2	51	>15	7.87	686	11.2	0.18	2	9.7	91	
551	1/24/2012	12:00	LEO 14	11925	Water	13.4	2	51	9.04	7.75	648	11.69	40	2	8.62	85	
552	1/24/2012	12:30	LEO 15	11804	Water	14.2	2	51						1		0	

ID	Field Comments
477	Water clear with brown tint. Small fish and Cricket frogs.
478	Water clear. Numerous small fish and cricket frogs. Lot of leaves on bottom.
479	totally dry
496	Water somewhat turbid. USGS gage reads zero, we observed flow, visual estimate.
497	Water clear.
498	Water clear.
499	One pool downstream opf bridge. Water clear with brown tint. Flock of mallards in ditch 1/2 mile S of river.
500	Water clear. At least 6 deer carcasses in water under bridge. Deer hair floating in water.
501	Water clear with brown tint. Numerous cattle tracks in creek, soft mud bottom.
502	Water brown.
503	Water clear.
504	Water a little turbid.
505	Water clear, H2S odor with oily sheen on top and black/brown scum on bottom.
506	Water clear, unmeasurable flow under bridge. Subsurface flow through gravel bar downstream. Numerous Black wigglers.
507	Water clear.
508	Water turbid with some clarity.
509	Water clear, slight turbidity.
510	creek dry
538	Water is flowing. Water brown and turbid.
539	Water is clear. Brown attached algae.
540	Water clear with brown tint.
541	One pool. Water clear. A few small fish.
542	Sample taken downstream of bridge in flowing water. Water is clear - turbid.
543	Water clear. Deep mud bottom.
544	Water is turbid, brown.
545	Water clear. Some floating and attached algae. Small fish.
546	Water somewhat turbid, Cricket frog.
547	Water clear with slight tint. Ducks in river. Seeps and a spring on left bank.
548	No flow - pools. Water is clear.
549	Water is turbid. Some attached algae.
550	Water turbid and brown.
551	Water turbid.
552	One pool. Water is clear. Bottom covered with leaves. Numerous insect wigglers

ID	Lab Comments
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ID	Date	Time	Type	Lab Comments
15	1/25/2011	11:30	Sewage Wastewater	Water sample shipped to El Paso
16	1/25/2011	11:30	Sewage Wastewater	Water sample shipped to El Paso
17	1/25/2011	11:30	Sewage Wastewater	Water sample shipped to El Paso
18	1/25/2011	11:30	Sewage Wastewater	Water sample shipped to El Paso
19	1/25/2011	11:30	Sewage Wastewater	Water sample shipped to El Paso
20	1/25/2011	13:25	Sewage Wastewater	Water sample shipped to El Paso
21	1/25/2011	13:25	Sewage Wastewater	Water sample shipped to El Paso
22	1/25/2011	13:25	Sewage Wastewater	Water sample shipped to El Paso
23	1/25/2011	13:25	Sewage Wastewater	Water sample shipped to El Paso
24	1/25/2011	13:25	Sewage Wastewater	Water sample shipped to El Paso
25	1/25/2011	13:30	Fecal	
26	1/25/2011	13:30	Fecal	
27	1/25/2011	14:30	Sewage Wastewater	Water sample shipped to El Paso
28	1/25/2011	14:30	Sewage Wastewater	Water sample shipped to El Paso
29	1/25/2011	14:30	Sewage Wastewater	Water sample shipped to El Paso
30	1/25/2011	14:30	Sewage Wastewater	Water sample shipped to El Paso
31	1/25/2011	14:30	Sewage Wastewater	Water sample shipped to El Paso
108	3/21/2011	11:15	Fecal	
109	3/21/2011	11:15	Fecal	
110	3/21/2011	13:40	Fecal	
111	3/21/2011	13:40	Fecal	
112	3/21/2011	13:45	Fecal	
113	3/21/2011	13:45	Fecal	
114	3/21/2011	13:45	Fecal	
115	3/21/2011	14:40	Sewage Wastewater	25 microliters on mTec plate
116	3/21/2011	14:40	Sewage Wastewater	25 microliters on mTec plate
117	3/21/2011	0:00	Sewage Wastewater	25 microliters on mTec plate
118	3/21/2011	15:00	Fecal	
119	3/22/2011	10:30	Fecal	
120	3/22/2011	13:48	Fecal	
121	3/22/2011	13:47	Fecal	
159	4/26/2011	13:05	Sewage Wastewater	25 µl of sample plated on mTec agar.
160	4/26/2011	13:05	Sewage Wastewater	25 µl of sample plated on mTec agar.
161	4/26/2011	13:05	Sewage Wastewater	25 µl of sample plated on mTec agar.
162	4/26/2011	13:15	Fecal	
163	4/26/2011	13:15	Fecal	

ID	Field Comments
477	Water clear with brown tint. Small fish and Cricket frogs.
15	Comanche wastewater treatment facility. Sample taken from clarifier in running water. Discharged into Indian Creek. Lat. 31.89356 Lon. -98.59379
16	Comanche wastewater treatment facility. Sample taken from clarifier in running water. Discharged into Indian Creek. Lat. 31.89356 Lon. -98.59379
17	Comanche wastewater treatment facility. Sample taken from clarifier in running water. Discharged into Indian Creek. Lat. 31.89356 Lon. -98.59379
18	Comanche wastewater treatment facility. Sample taken from clarifier in running water. Discharged into Indian Creek. Lat. 31.89356 Lon. -98.59379
19	Comanche wastewater treatment facility. Sample taken from clarifier in running water. Discharged into Indian Creek. Lat. 31.89356 Lon. -98.59379
20	City of Hamilton wastewater treatment facility. Sample taken prior to UV treatment in running water. Discharged into Pecan Creek. Lat. 31.70903 Lon. -98.11539
21	City of Hamilton wastewater treatment facility. Sample taken prior to UV treatment in running water. Discharged into Pecan Creek. Lat. 31.70903 Lon. -98.11539
22	City of Hamilton wastewater treatment facility. Sample taken prior to UV treatment in running water. Discharged into Pecan Creek. Lat. 31.70903 Lon. -98.11539
23	City of Hamilton wastewater treatment facility. Sample taken prior to UV treatment in running water. Discharged into Pecan Creek. Lat. 31.70903 Lon. -98.11539
24	City of Hamilton wastewater treatment facility. Sample taken prior to UV treatment in running water. Discharged into Pecan Creek. Lat. 31.70903 Lon. -98.11539
25	Cow sample from ground in a feedlot next to the City of Hamilton wastewater treatment facility. Near Pecan Creek. Lat. 31.70819 Lon. -98.11549 Beef Cattle.
26	Cow sample from ground in a feedlot next to the City of Hamilton wastewater treatment facility. Near Pecan Creek. Lat. 31.70819 Lon. -98.11549 Beef Cattle
27	City of Gatesville wastewater treatment facility. Samples taken from clarifier prior to chlorine treatment in running water. Discharged into the Leon River. Lat. 31.42782 Lon. -97.74443
28	City of Gatesville wastewater treatment facility. Samples taken front clarifier prior to chlorine treatment in running water. Discharged into the Leon River. Lat. 31.42782 Lon. -97.74443
29	City of Gatesville wastewater treatment facility. Samples taken front clarifier prior to chlorine treatment in running water. Discharged into the Leon River. Lat. 31.42782 Lon. -97.74443
30	City of Gatesville wastewater treatment facility. Samples taken front clarifier prior to chlorine treatment in running water. Discharged into the Leon River. Lat. 31.42782 Lon. -97.74443
31	City of Gatesville wastewater treatment facility. Samples taken front clarifier prior to chlorine treatment in running water. Discharged into the Leon River. Lat. 31.42782 Lon. -97.74443
108	Beef cow. Sample taken 100 yards East of LEO 03 (Indian Creek). Sample several days old - moist in center. Lat. 31.886379 Lon. -98.437513
109	Beef cow. Sample taken 100 yards East of LEO 03 (Indian Creek). Sample several days old - moist in center. Lat. 31.886379 Lon. -98.437513
110	Beef Cow. Near LEO 06 - 300 yards from Resely Creek. Lat. 31.12906 Lon. -98.226033
111	Beef Cow. Near LEO 06 - 300 yards from Resely Creek. Lat. 31.12906 Lon. -98.226033
112	Feral Hog. Near LEO 06 - 400 yards from Resely Creek. Samples in hog trap. Trap had 6 hogs in it 2 days go. Lat. 31.812637 Lon. -98.227638
113	Feral Hog. Near LEO 06 - 400 yards from Resely Creek. Samples in hog trap. Trap had 6 hogs in it 2 days go. Lat. 31.812637 Lon. -98.227638
114	Feral Hog. Near LEO 06 - 400 yards from Resely Creek. Samples in hog trap. Trap had 6 hogs in it 2 days go. Lat. 31.812637 Lon. -98.227638
115	City of Hamilton wastewater treatment facility. Samples taken from separate dips after screening. Lat. 31.709285 Lon. -98.114842
116	City of Hamilton wastewater treatment facility. Samples taken from separate dips after screening. Lat. 31.709285 Lon. -98.114842
117	City of Hamilton wastewater treatment facility. Samples taken from separate dips after screening. Lat. 31.709285 Lon. -98.114842
118	Beef Cow. Sample taken 8 feet from Pecan Creek at LEO 08. Lat. 31.710119 Lon. -98.056010
119	Beef Cow. Sample taken about 1 mile east of Levita on FM 2412 - Near CR 107. Lat. 31.508665 Lon. -97.875901
120	Beef Cow - calf. Sample taken within 1/2 mile of CR 322 bridge over Leon River - two river miles below the confluence of Coryell Creek and Leon River.
121	Beef Cow - calf. Sample taken within 1/2 mile of CR 322 bridge over Leon River - two river miles below the confluence of Coryell Creek and Leon River.
159	Gatesville Stillhouse WWP. 402 Stillhouse Rd. Lat. 31444987 Lon. -97.749712 Discharge into Stillhouse Branch. Sample taken before treatment. Each sample a separate dip.
160	Gatesville Stillhouse WWP. 402 Stillhouse Rd. Lat. 31444987 Lon. -97.749712 Discharge into Stillhouse Branch. Sample taken before treatment. Each sample a separate dip.
161	Gatesville Stillhouse WWP. 402 Stillhouse Rd. Lat. 31444987 Lon. -97.749712 Discharge into Stillhouse Branch. Sample taken before treatment. Each sample a separate dip.
162	Field next to Gatesville Stillhouse WWP. Mixed breed - beef cow.
163	Field next to Gatesville Stillhouse WWP. Mixed breed - beef cow.

ID	Date	Time	Type	Lab Comments
164	4/26/2011	13:15	Fecal	
203	5/17/2011	12:05	Fecal	
204	5/17/2011	12:05	Fecal	
205	5/17/2011	12:05	Fecal	
206	5/17/2011	12:05	Fecal	
207	5/17/2011	12:05	Fecal	
208	5/17/2011	12:05	Fecal	
262	6/14/2011	10:30	Fecal	
263	6/14/2011	10:30	Fecal	
264	6/14/2011	12:15	Fecal	
292	6/28/2011	14:00	Fecal	
293	6/28/2011	14:00	Fecal	
294	6/28/2011	14:00	Fecal	
295	6/28/2011	14:00	Fecal	
296	6/28/2011	14:00	Fecal	
328	7/25/2011	10:30	Sewage Septic Tank	Four plates from this sample.
384	9/14/2011	10:55	Fecal	
385	9/14/2011	11:10	Fecal	
386	9/14/2011	11:30	Fecal	
387	9/14/2011	11:55	Fecal	
388	9/14/2011	12:45	Fecal	
389	9/14/2011	12:45	Fecal	
390	9/14/2011	12:45	Fecal	
391	9/14/2011	12:45	Fecal	
392	9/14/2011	12:55	Fecal	
439	10/24/2011	11:00	Fecal	
440	10/24/2011	11:00	Fecal	
441	10/24/2011	11:00	Fecal	
442	10/24/2011	11:00	Fecal	
443	10/24/2011	11:00	Fecal	
444	10/24/2011	11:00	Fecal	
445	10/24/2011	11:00	Fecal	
446	10/24/2011	11:00	Fecal	
447	10/24/2011	11:00	Fecal	
448	10/24/2011	11:00	Fecal	
449	10/24/2011	13:50	Fecal	

ID	Field Comments
164	Field next to Gatesville Stillhouse WWP. Mixed breed - beef cow.
203	Feral Hog - trapped on Fort Hood in Area 23 near Bear Creek. Lat. 31.211384 Lon. -97.530653
204	Feral Hog - trapped on Fort Hood in Area 23 near Bear Creek. Lat. 31.211384 Lon. -97.530653
205	Feral Hog - trapped on Fort Hood in Area 23 near Bear Creek. Lat. 31.211384 Lon. -97.530653
206	Feral Hog - trapped on Fort Hood in Area 23 near Bear Creek. Lat. 31.211384 Lon. -97.530653
207	Feral Hog - trapped on Fort Hood in Area 23 near Bear Creek. Lat. 31.211384 Lon. -97.530653
208	Feral Hog - trapped on Fort Hood in Area 23 near Bear Creek. Lat. 31.211384 Lon. -97.530653
262	Cliff Swallow LEO 13 - Hwy 36 Leon River Bridge. Samples collected from plastic sheets under bridge where birds were nesting. The samples are less than 20 min. old when collected. Coryell County.
263	Cliff Swallow LEO 13 - Hwy 36 Leon River Bridge. Samples collected from plastic sheets under bridge where birds were nesting. The samples are less than 20 min. old when collected. Coryell County.
264	Cliff Swallow LEO 14 - FM 1829 Leon River Bridge. Samples collected from plastic sheets under bridge where birds were nesting. The samples are less than 20 min. old when collected. Coryell County.
292	Feral Hog. Fort Hood - Hogs trapped in the Leon River Watershed above Belton Reservoir - specific location not known. Samples collected from pen where hogs are kept for disposal. There were five hogs in pen. Bell/Coryell County.
293	Feral Hog. Fort Hood - Hogs trapped in the Leon River Watershed above Belton Reservoir - specific location not known. Samples collected from pen where hogs are kept for disposal. There were five hogs in pen. Bell/Coryell County.
294	Feral Hog. Fort Hood - Hogs trapped in the Leon River Watershed above Belton Reservoir - specific location not known. Samples collected from pen where hogs are kept for disposal. There were five hogs in pen. Bell/Coryell County.
295	Feral Hog. Fort Hood - Hogs trapped in the Leon River Watershed above Belton Reservoir - specific location not known. Samples collected from pen where hogs are kept for disposal. There were five hogs in pen. Bell/Coryell County.
296	Feral Hog. Fort Hood - Hogs trapped in the Leon River Watershed above Belton Reservoir - specific location not known. Samples collected from pen where hogs are kept for disposal. There were five hogs in pen. Bell/Coryell County.
328	Coryell County - Southwest of Turnersville on CR 232. Maybe in Bosque Watershed. Septic tank from a residence being pumped by Sonny Goodwin - he collect sample in a plastic bottle he had rinsed with Clorox solution.
384	Northeast of Hamilton on Jim Kenton property near Egg Creek. 31.75525 -97.99187 Deer. Sample found near deer feeder.
385	Northeast of Hamilton on Jim Kenton property near Egg Creek. 31.75720 -97.99356 Deer. Sample found near deer feeder.
386	Northeast of Hamilton on Jim Kenton property near Egg Creek. 31.75734 -97.99727 Deer. Sample found near deer feeder.
387	Northeast of Hamilton on Jim Kenton property near Egg Creek. 31.75294 -97.99659 Raccoon. Sample found near deer feeder.
388	Northeast of Hamilton on Jim Kenton property near Egg Creek. 31.75459 -97.98644 Beef Cow. Sample in pasture near house.
389	Northeast of Hamilton on Jim Kenton property near Egg Creek. 31.75459 -97.98644 Beef Cow. Sample in pasture near house.
390	Northeast of Hamilton on Jim Kenton property near Egg Creek. 31.75459 -97.98644 Beef Cow. Sample in pasture near house.
391	Northeast of Hamilton on Jim Kenton property near Egg Creek. 31.75459 -97.98644 Beef Cow. Sample in pasture near house.
392	Northeast of Hamilton on Jim Kenton property near Egg Creek. 31.75220 -97.98608 Horse. Sample in pasture near house.
439	Holstein heifer. Samples taken in feedlot with about 40 head of cattle. Sample very fresh. Overcrest Dairy on FM 1476 - about 1/3 mile NE of Hwy 67 - near Proctor in Comanche County. Lat. 31.4205 Lon. -97.5439
440	Holstein heifer. Samples taken in feedlot with about 40 head of cattle. Sample very fresh. Overcrest Dairy on FM 1476 - about 1/3 mile NE of Hwy 67 - near Proctor in Comanche County. Lat. 31.4205 Lon. -97.5439
441	Holstein heifer. Samples taken in feedlot with about 40 head of cattle. Sample very fresh. Overcrest Dairy on FM 1476 - about 1/3 mile NE of Hwy 67 - near Proctor in Comanche County. Lat. 31.4205 Lon. -97.5439
442	Holstein heifer. Samples taken in feedlot with about 40 head of cattle. Sample very fresh. Overcrest Dairy on FM 1476 - about 1/3 mile NE of Hwy 67 - near Proctor in Comanche County. Lat. 31.4205 Lon. -97.5439
443	Holstein heifer. Samples taken in feedlot with about 40 head of cattle. Sample very fresh. Overcrest Dairy on FM 1476 - about 1/3 mile NE of Hwy 67 - near Proctor in Comanche County. Lat. 31.4205 Lon. -97.5439
444	Holstein heifer. Samples taken in feedlot with about 40 head of cattle. Sample very fresh. Overcrest Dairy on FM 1476 - about 1/3 mile NE of Hwy 67 - near Proctor in Comanche County. Lat. 31.4205 Lon. -97.5439
445	Holstein heifer. Samples taken in feedlot with about 40 head of cattle. Sample very fresh. Overcrest Dairy on FM 1476 - about 1/3 mile NE of Hwy 67 - near Proctor in Comanche County. Lat. 31.4205 Lon. -97.5439
446	Holstein heifer. Samples taken in feedlot with about 40 head of cattle. Sample very fresh. Overcrest Dairy on FM 1476 - about 1/3 mile NE of Hwy 67 - near Proctor in Comanche County. Lat. 31.4205 Lon. -97.5439
447	Holstein heifer. Samples taken in feedlot with about 40 head of cattle. Sample very fresh. Overcrest Dairy on FM 1476 - about 1/3 mile NE of Hwy 67 - near Proctor in Comanche County. Lat. 31.4205 Lon. -97.5439
448	Holstein heifer. Samples taken in feedlot with about 40 head of cattle. Sample very fresh. Overcrest Dairy on FM 1476 - about 1/3 mile NE of Hwy 67 - near Proctor in Comanche County. Lat. 31.4205 Lon. -97.5439

449 Grey Fox. Sample taken from fresh road kill (blood had not dried on road) on FM 1602 near the intersection with CR 313 in Hamilton County. Lat. 31.4205 Lon. -97.5439

ID	Date	Time	Type	Lab Comments
449	10/24/2011	13:50	Fecal	
511	12/13/2011	9:45	Fecal	
512	12/13/2011	10:50	Fecal	
513	12/13/2011	0:00	Fecal	
536	1/17/2012	10:00	Fecal	
537	1/17/2012	10:00	Fecal	
553	1/23/2012	11:35	Fecal	
569	2/8/2012	12:45	Fecal	
574	2/22/2012	14:15	Fecal	
575	2/22/2012	14:15	Fecal	
576	2/22/2012	14:45	Fecal	
577	2/22/2012	14:15	Fecal	
578	2/22/2012	14:15	Fecal	
579	2/29/2012	11:20	Fecal	
580	2/29/2012	11:20	Fecal	
581	2/29/2012	11:20	Fecal	
585	3/19/2012	11:30	Fecal	
586	4/1/2012	9:30	Fecal	
587	4/3/2012	17:00	Fecal	
588	4/4/2012	0:00	Fecal	
589	4/4/2012	14:00	Fecal	
590	4/4/2012	14:00	Fecal	
591	4/4/2012	14:00	Fecal	
592	4/4/2012	14:00	Fecal	

ID	Field Comments
449	Grey Fox. Sample taken from fresh road kill (blood had not dried on road) on FM 1602 near the intersection with CR 313 in Hamilton County. Lat. 31.4205 Lon. -97.5439
511	Opossum (Didelphis virginiana). Fresh road kill on Coryell Co. 196 near LEO 10. Lat. 31.531435 Lon. -97.853074
512	Cottontail Rabbit (Sylvilagus floridanus). Fresh road kill in Coryell County on FM 2412, about one mile NW of Co 174. Lat. 31.480508 Lon. -97.842058
513	Skunk (Mephitis mephitis). Fresh road kill on bridge at LEO 14. Lat. 31.335602 Lon. -97.642991
536	Feral Hog caught in Trap by USDS Wildlife Service Trapper. Ten miles Northwest of Hamilton in Hamilton County. Lat. 31.83186 Lon. -98.19685 (May be in Comanche County)
537	Feral Hog caught in Trap by USDS Wildlife Service Trapper. Ten miles Northwest of Hamilton in Hamilton County. Lat. 31.83186 Lon. -98.19685 (May be in Comanche County)
553	Domestic Cat. Fresh road kill on FM 1476 in Comanche County southeast of LEO 02. Lat. 31.960680 Lon. -98.421304
569	Feral Hog trapped in Area 47 of Fort Hood. South of Pidcoke in Cowhouse area. Sample taken from concrete floor of holding pen - hog alive and eating corn. 31.250087 -98.892946 (in center of Area 47)
574	Feral Hog from Ft. Hood Trapping program. Exact location not known - Trapped in area 47 or area 35. Sample collected from concrete floor of holding pen on Base. Five hogs in pen.
575	Feral Hog from Ft. Hood Trapping program. Exact location not known - Trapped in area 47 or area 35. Sample collected from concrete floor of holding pen on Base. Five hogs in pen.
576	Feral Hog from Ft. Hood Trapping program. Exact location not known - Trapped in area 47 or area 35. Sample collected from concrete floor of holding pen on Base. Five hogs in pen.
577	Feral Hog from Ft. Hood Trapping program. Exact location not known - Trapped in area 47 or area 35. Sample collected from concrete floor of holding pen on Base. Five hogs in pen.
578	Feral Hog from Ft. Hood Trapping program. Exact location not known - Trapped in area 47 or area 35. Sample collected from concrete floor of holding pen on Base. Five hogs in pen.
579	Feral Hog from Ft. Hood Trapping program. Trapped in area 20 - Bear Creek Valley -Owl Creek Mountain. Sample collected from concrete floor of holding pen on Base. Six hogs in pen. Lat. 31.213740 Lon. -97.536232
580	Feral Hog from Ft. Hood Trapping program. Trapped in area 20 - Bear Creek Valley -Owl Creek Mountain. Sample collected from concrete floor of holding pen on Base. Six hogs in pen. Lat. 31.213740 Lon. -97.536232
581	Feral Hog from Ft. Hood Trapping program. Trapped in area 20 - Bear Creek Valley -Owl Creek Mountain. Sample collected from concrete floor of holding pen on Base. Six hogs in pen. Lat. 31.213740 Lon. -97.536232
585	Feral Hog caught in Trap by USDS Wildlife Service Trapper. Six miles east of Jonesboro near Coryell Creek.
586	Fresh Feral Hog fecal sample collected from oat feeder by USDS Wildlife Service Trapper. Two miles west of Ater in Coryell County in Leon River area.
587	Fresh goat fecal sample collected by USDS Wildlife Service Trapper. Two miles west of Ater in Coryell County in Leon River area.
588	Coyote caught in Trap by USDS Wildlife Service Trapper. Eight miles east of Gatesville in Coryell County, Coryell Creek area.
589	Feral Hog from Ft. Hood Trapping program. Trapped in area 300, 33, or 47. - Sample collected from concrete floor of holding pen on Base. Four hogs in pen. Lat. 31.213740 Lon. -97.536232
590	Feral Hog from Ft. Hood Trapping program. Trapped in area 300, 33, or 47. - Sample collected from concrete floor of holding pen on Base. Four hogs in pen. Lat. 31.213740 Lon. -97.536232
591	Feral Hog from Ft. Hood Trapping program. Trapped in area 300, 33, or 47. - Sample collected from concrete floor of holding pen on Base. Four hogs in pen. Lat. 31.213740 Lon. -97.536232
592	Feral Hog from Ft. Hood Trapping program. Trapped in area 300, 33, or 47. - Sample collected from concrete floor of holding pen on Base. Four hogs in pen. Lat. 31.213740 Lon. -97.536232