Lake Houston Segment 1002
Cypress Creek Segment 1009
Little Cypress Creek Segment 1009E
Faulkey Gully Segment 1009C
Spring Gully Segment 1009D

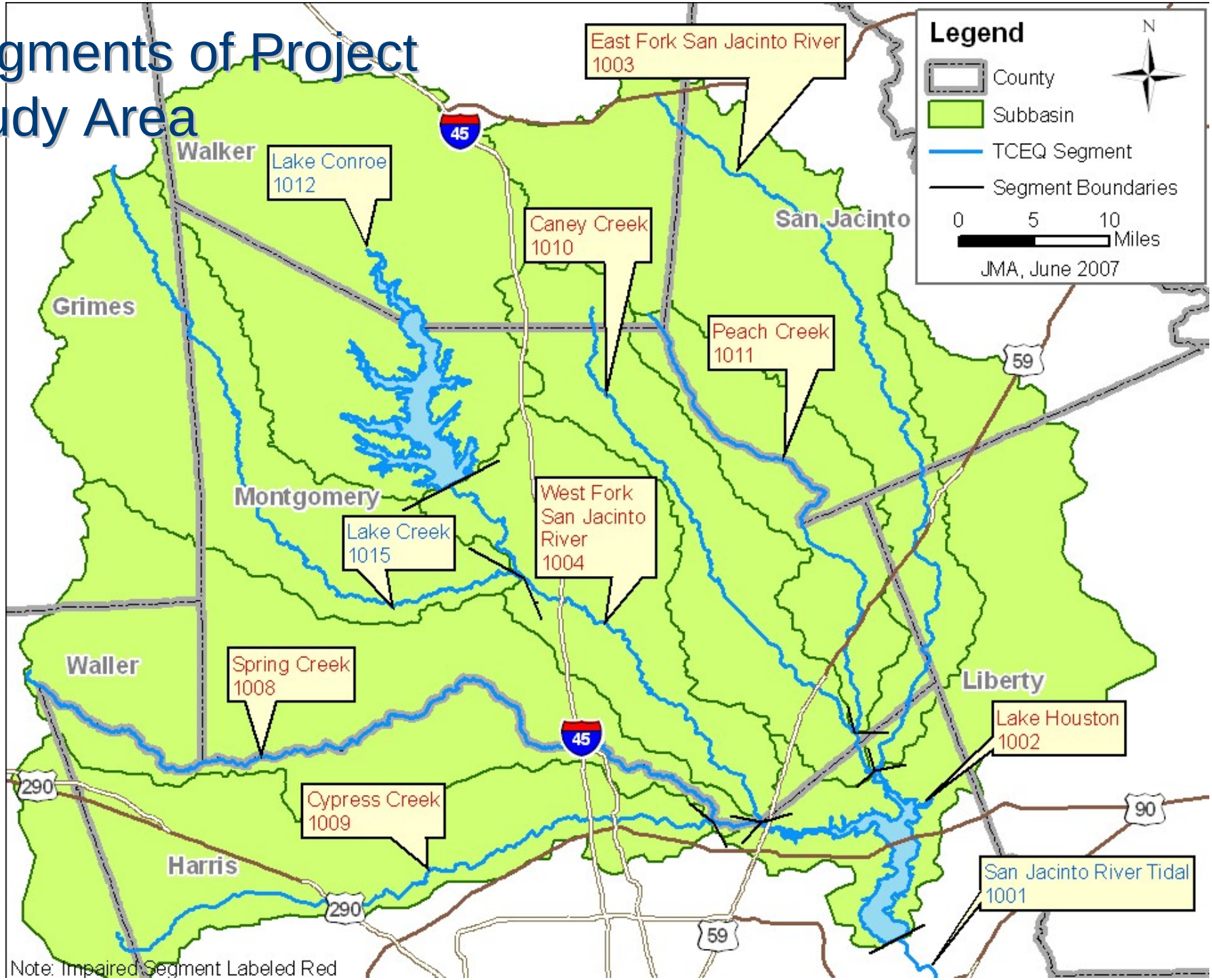
Preliminary Data Review & Monitoring Plan

James Miertschin, PhD,PE
James Miertschin & Associates
Environmental Engineering

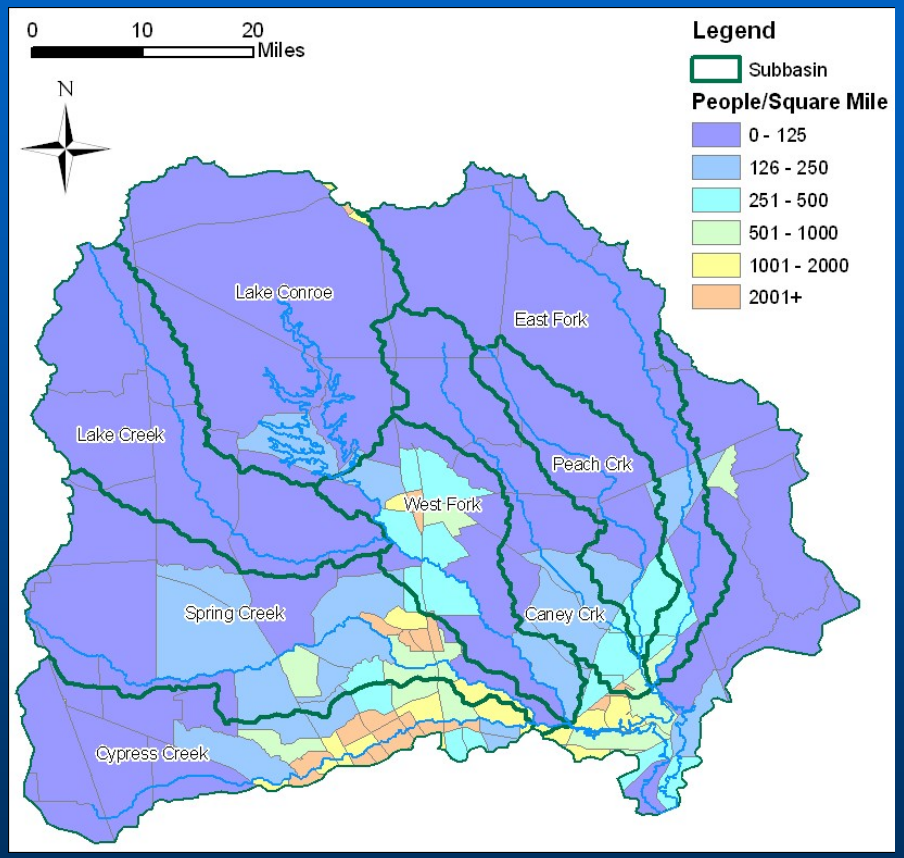
Introduction

- Several stream segments of San Jacinto River Basin above Lake Houston identified as impaired
- TCEQ divides segments into assessment units (AU) to refine spatial resolution
- Stream segment is considered impaired when geometric mean of *E. coli* exceeds criterion of 126 org/100mL

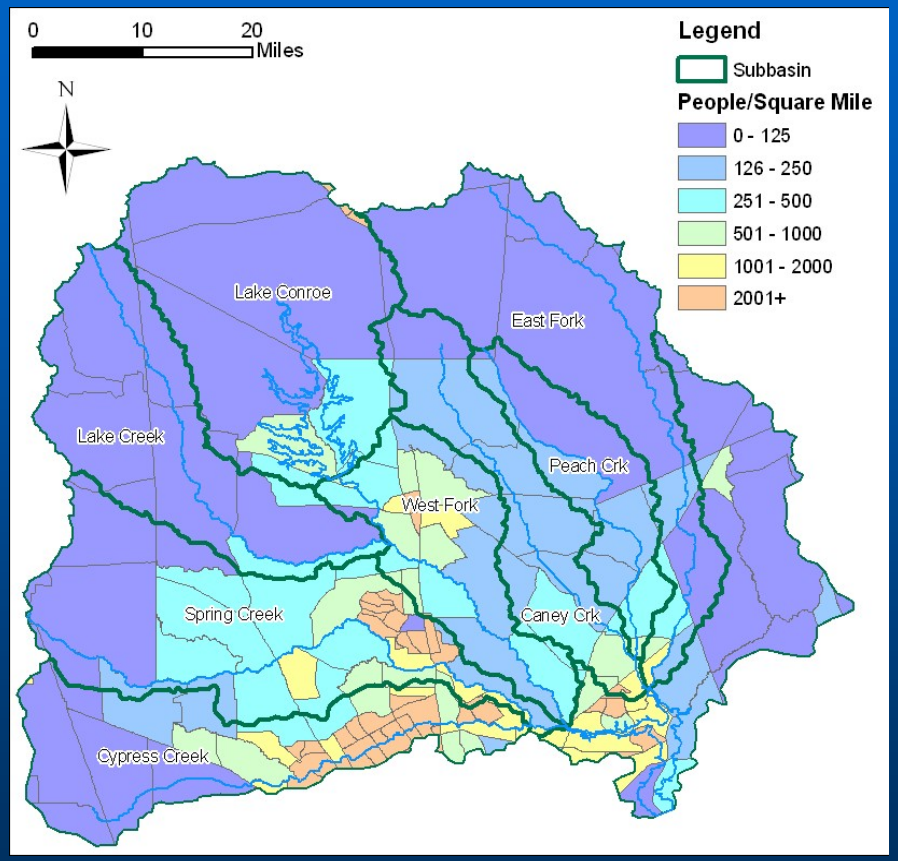
Segments of Project Study Area



Population Density



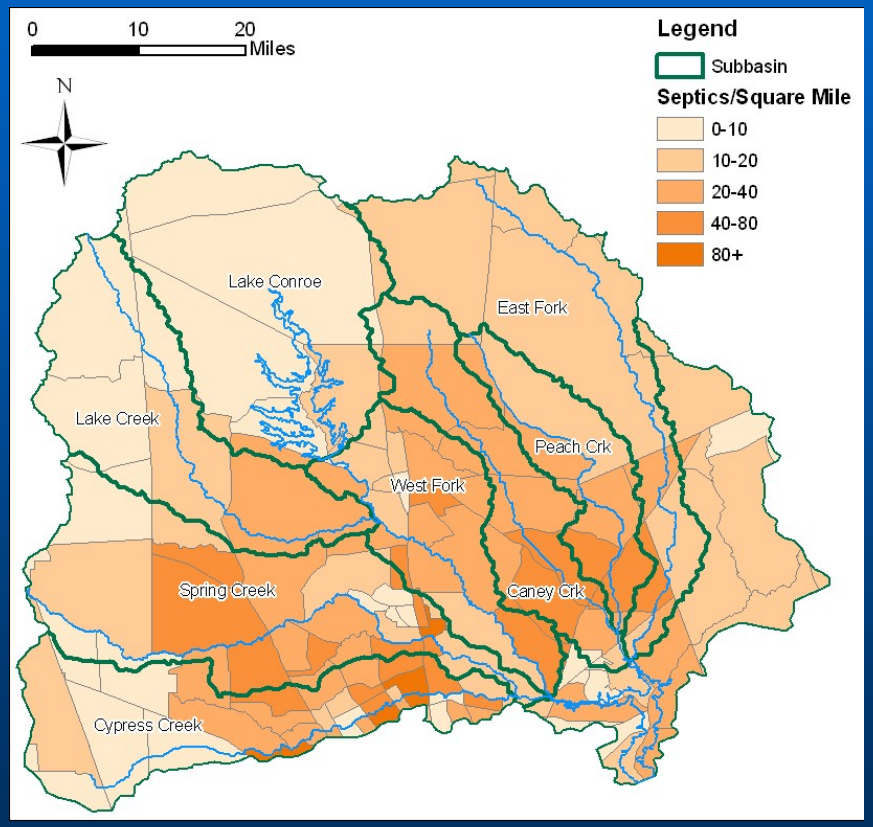
Project Area Population Density (1990)



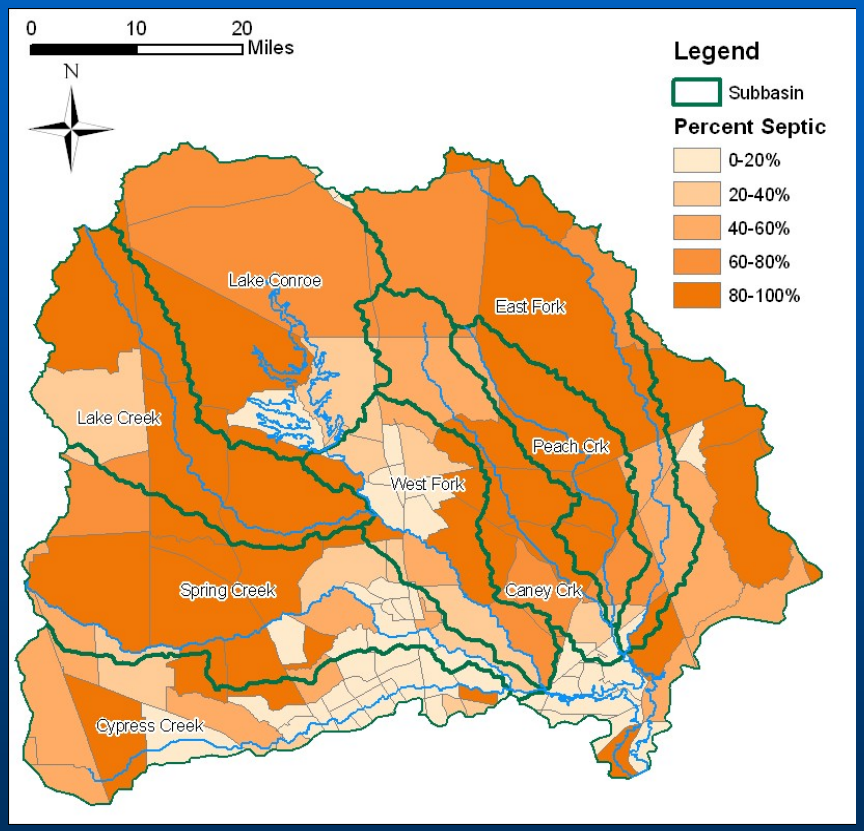
Project Area Population Density (2005)

US Census Bureau

Septic Systems



Septic System Density (1990)



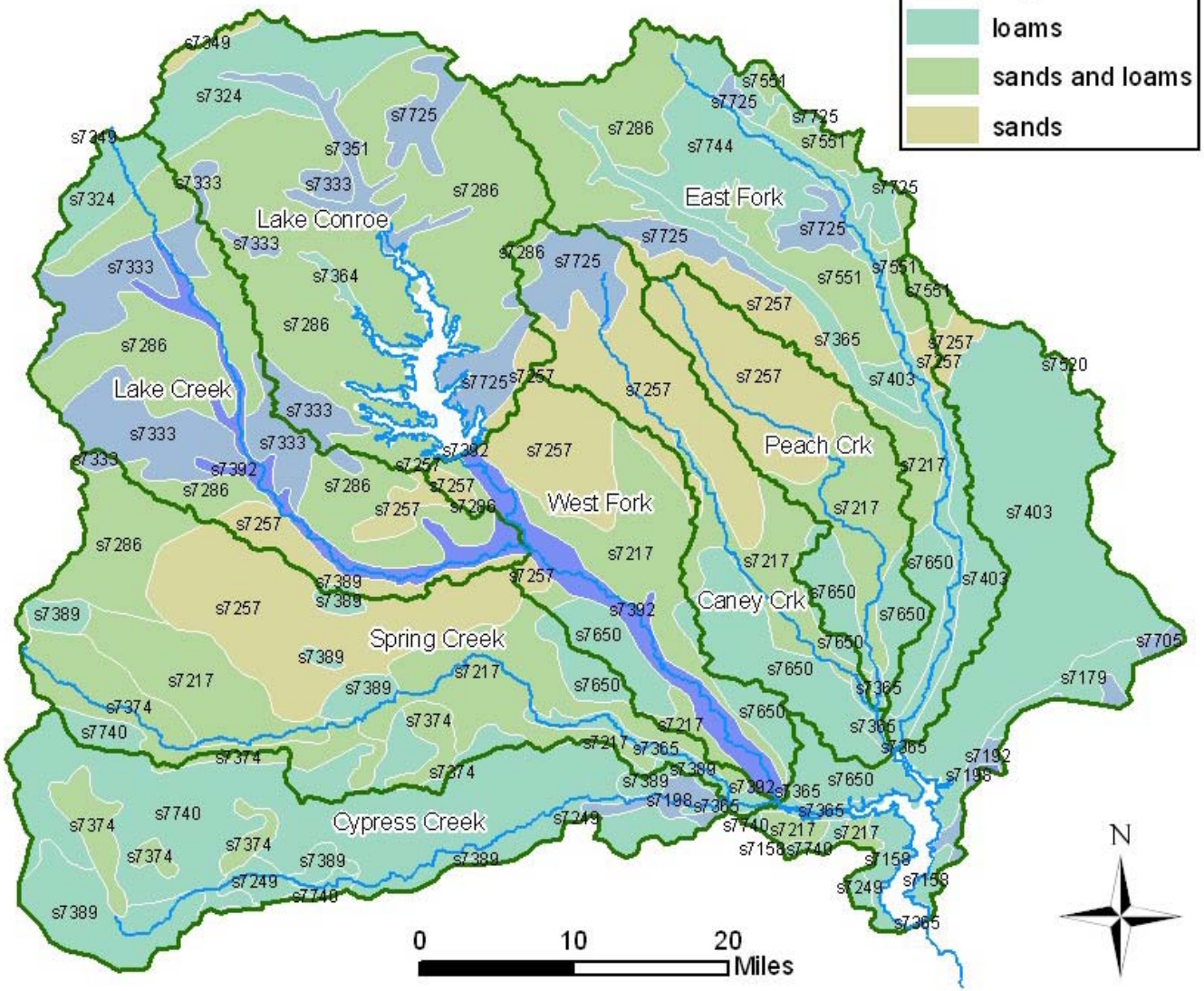
Percentage of Households Served by Septic Systems (1990)

US Census Bureau

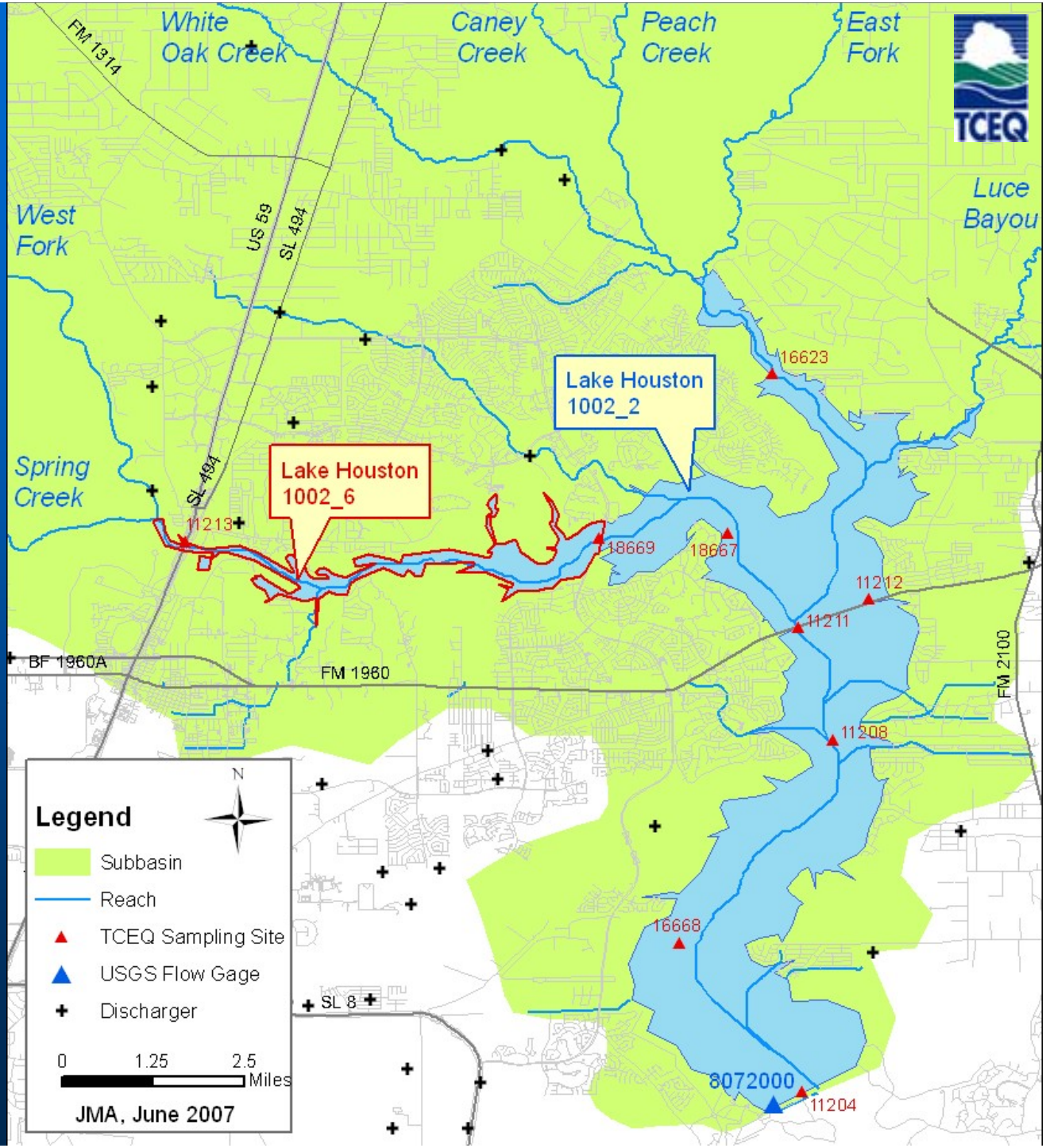
Soil Associations

Key	Soil Association
s7158	Ozan-Atasco-Aldine
s7179	Brackett-Bolar-Aledo
s7192	Lake charles-Beaumont
s7198	Morey-Mocarey-Bernard
s7217	Splendora-Segno-Landman-Boy
s7249	Gessner-Clodine-Addicks
s7257	Conroe
s7286	Huntsburg-Fetzer-Depcor-Boy-Annona
s7324	Greenvine-Falba-Burlewash-Arol
s7333	Latium-Frelsburg-Crockett-Carbengle-Brenham-Bosque-Bleiblerville
s7349	Tonkavar-Shiro-Gomery-Elmina
s7351	Nahatche-Kaufman-Gowker
s7364	Nahatche-Hatliff
s7365	Pluck-Kian-Hatliff
s7374	Wockley-Segno-Monaville-Hockley
s7389	Katy-Clodine-Aris
s7392	Tinn-Kaufman-Gladewater

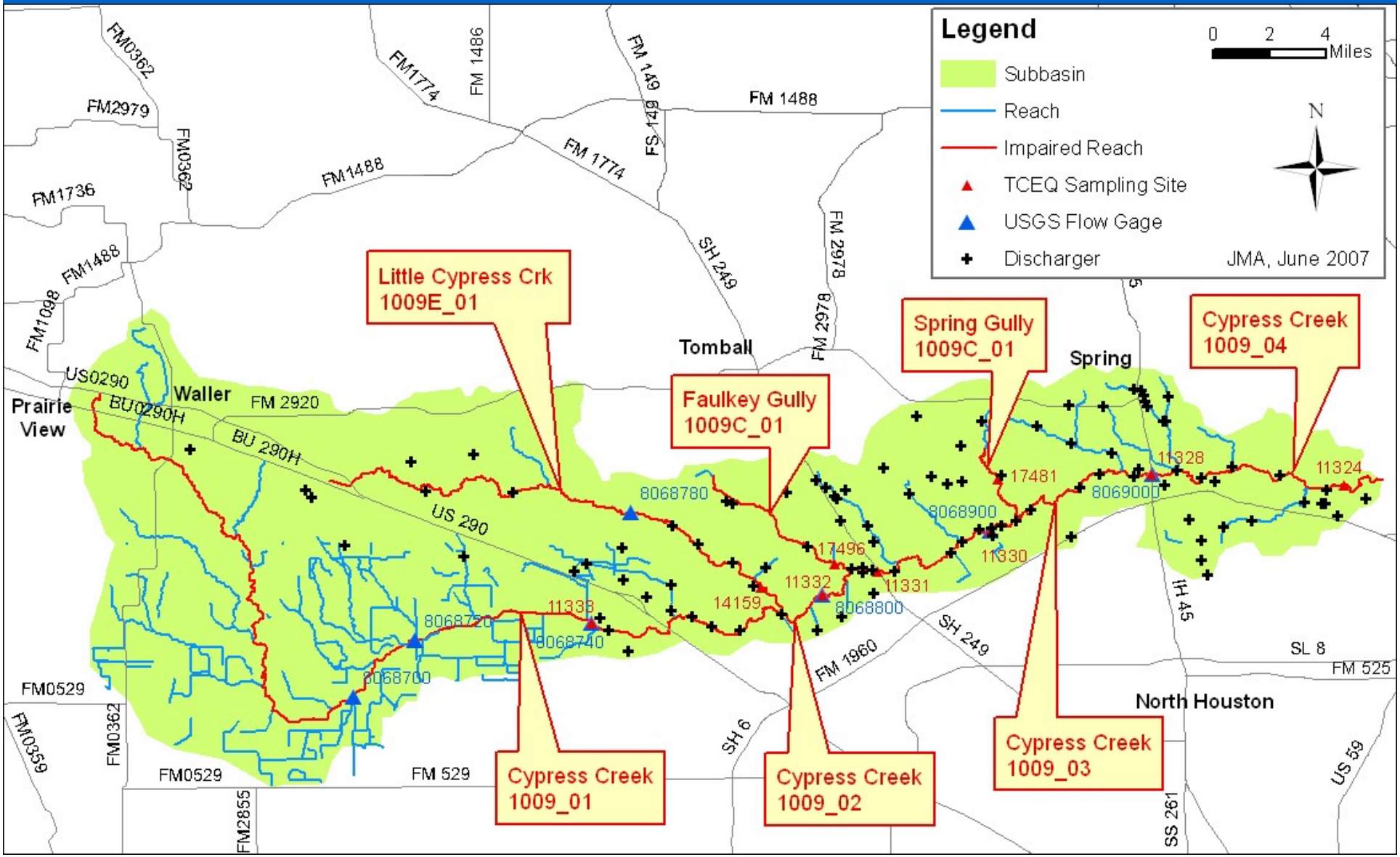
Key	Soil Association
s7398	Sealy-Kenney-Chazos
s7403	Waller-Sorter-Kirbyville
s7520	Waller-Otanya-Kirbyville-Dallardsville
s7551	Pinetucky-Doucette
s7650	Waller-Sorter
s7705	Woodville-Vamont
s7725	Woodville-Wiergate-Burkeville
s7740	Wockley-Hockley-Gessner
s7744	Woodville-Pinetucky



Lake Houston Study Area



Cypress Creek Study Area



Lake Houston Assessment Units and Results

Assessment Unit	Segment Name	Assessment Unit Description	# Samples	# Exceed	Geo. Mean	Impaired
1002_01	Lake Houston	Confluence with Red Gully to FM 1960 East Pass	372	41	41	No
1002_02	Lake Houston	West Lake Houston Parkway to FM 1960 West Pass	695	117	57	No
1002_03	Lake Houston	FM 1960 to Missouri Pacific Railroad	51	6	53	No
1002_04	Lake Houston	Missouri Pacific Railroad to Foley Road	51	13	72	No
1002_05	Lake Houston	From Foley Road to Dam	291	75	58	No
1002_06	Lake Houston	Confluence with Spring Creek to West Lake Houston Pkwy	173	55	182	Yes
1002_07	Lake Houston	Confluence with East Fork San Jacinto River to confluence with Red Gully	51	7	54	No

Cypress Creek Assessment Units and Results

Assessment Unit	Segment Name	Assessment Unit Description	# Samples	# Exceed	Geo. Mean	Impaired
1009_01	Cypress Creek	Upper portion of segment to downstream of US 290	35	14	304	Yes
1009_02	Cypress Creek	US 290 to SH 249	87	40	446	Yes
1009_03	Cypress Creek	SH 249 to IH 45	75	43	525	Yes
1009_04	Cypress Creek	IH 45 to confluence with Spring Creek	15	4	370	Yes
1009C_01	Faulkey Gully	From an unnamed lake 0.3 miles southeast of Telge Road to the confluence with Cypress Creek	36	15	550	Yes
1009D_01	Spring Gully	From immediately south of Spring Cypress Road to the confluence with Spring Creek	36	22	651	Yes
1009E_01	Little Cypress Creek	Entire Segment	35	20	612	Yes

Lake Houston, West Fork Arm Sampling Sites

TCEQ #	TCEQ Description
11213	LAKE HOUSTON WEST FORK SAN JACINTO ARM AT US 59 392 METERS SOUTH AND 71 METERS WEST OF INTERSECTION OF HAMBLEN ROAD AND US 59
18669	LAKE HOUSTON/WEST FORK SAN JACINTO RIVER AT NORTHBOUND/DOWNSTREAM W LAKE HOUSTON PKWY BRIDGE 380 M FROM INTERSECTION WITH KINGWOOD GREENS DR
18667	LAKE HOUSTON IN THE WEST FORK SAN JACINTO RIVER CHANNEL 270 M EAST AND 60 M NORTH OF MISTY COVE AT ATASCOCITA PLACE DR

Cypress Creek Sampling Sites

TCEQ #	TCEQ Description
11333	CYPRESS CREEK IMMEDIATELY DOWNSTREAM OF HOUSE HAHL ROAD NEAR CYPRESS
14159	LITTLE CYPRESS CREEK IMMEDIATELY DOWNSTREAM OF KLUGE ROAD IN HOUSTON
11332	CYPRESS CREEK IMMEDIATELY DOWNSTREAM OF GRANT ROAD NEAR CYPRESS
17496	FAULKEY GULLY OF CYPRESS CREEK 105 METERS DOWNSTREAM OF LAKEWOOD FOREST DRIVE NORTHWEST OF HOUSTON
11331	CYPRESS CREEK AT SH 249
11330	CYPRESS CREEK AT STEUBNER-AIRLINE ROAD IN HOUSTON
17481	SPRING GULLY AT SPRING CREEK OAKS DRIVE IN TOMBALL
11328	CYPRESS CREEK BRIDGE ON IH 45 15 MI NORTH OF HOUSTON
11324	CYPRESS CREEK IMEDIATELY DOWNSTREAM OF CYPRESSWOOD DRIVE/OLD TETTAR RD EXTENSION

Lake Houston, West Fork Arm
E. coli Data Summary

Station	11213	18669	18667
Location	US 59	West Lake Houston Pkwy	Atascocita Place Dr
Reach	WF Arm	WF Arm	WF Arm
Begin Date	Jun-00	Dec 01	Jun 00
End Date	Jun 06	May 05	May 05
Count	192	278	57
75th Percentile	**689**	385	**436**
Geometric mean	**211**	102	92
25th Percentile	40	27	20

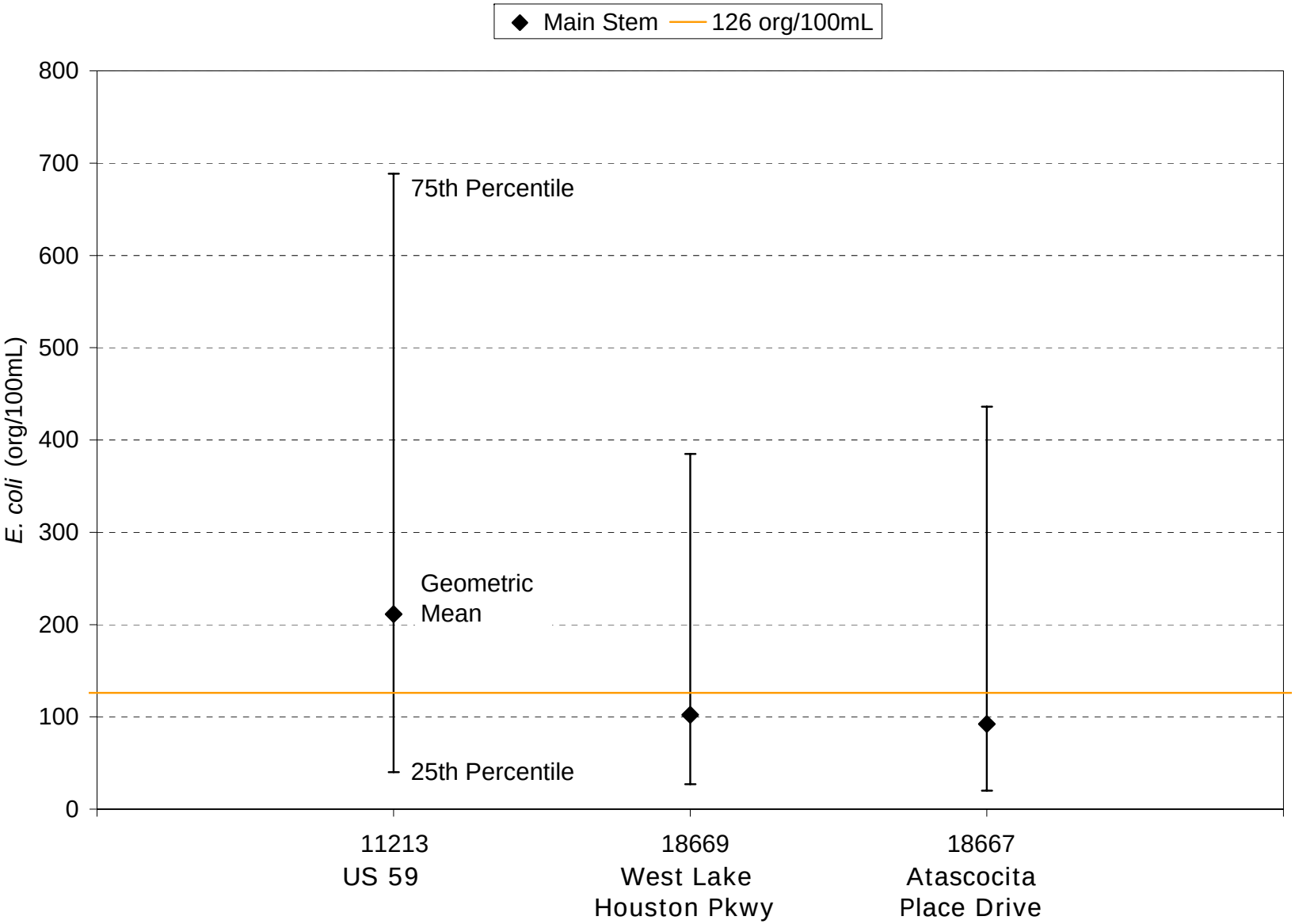
Cypress Creek *E. coli* Data Summary

Station	11333	14159	11332	17496	11331	11330	17481	11328	11324
Location	Hahl Rd	Kluge Rd	Grant Rd	Lake-wood Forest Dr	SH 249	Steubner -Airline Rd	Spring Crk Oaks Dr	IH 45	Cypress-wood Dr
Reach	Cypress	Little Cypress	Cypress	Faulkey	Cypress	Cypress	Spring	Cypress	Cypress
Begin Date	Jan 02	Jan 02	Jan 01	Jan 02	Jun 00	Jan 02	Jan 02	Jun 00	Jan 01
End Date	May 05	May 05	May 06	May 05	Apr 05	May 05	May 05	May 05	Jun 06
Count	41	41	61	42	41	42	42	100	22
75th Perc.	**580**	**1700**	**1200**	**1075**	**1112**	**1275**	**1325**	**1925**	**1659**
Geo. Mean	**291**	**589**	**405**	**555**	**573**	**642**	**597**	**533**	**470**
25th Perc.	110	210	110	175	242	228	233	130	182

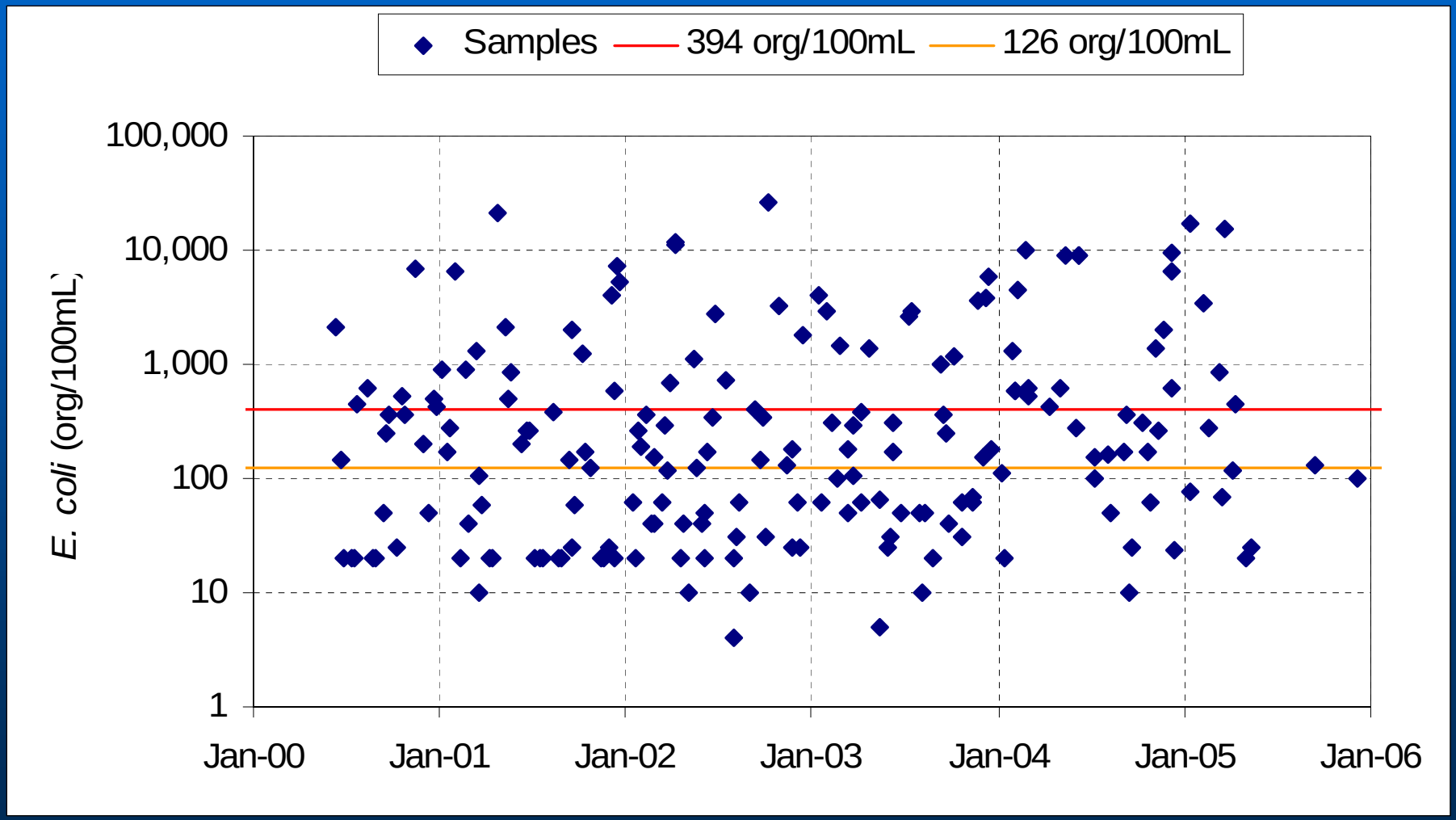
Spatial and Temporal Analysis

- Spatial analysis can be helpful when attempting to locate sources of bacteria
- Temporal analysis can be useful for determining changes in sources over time

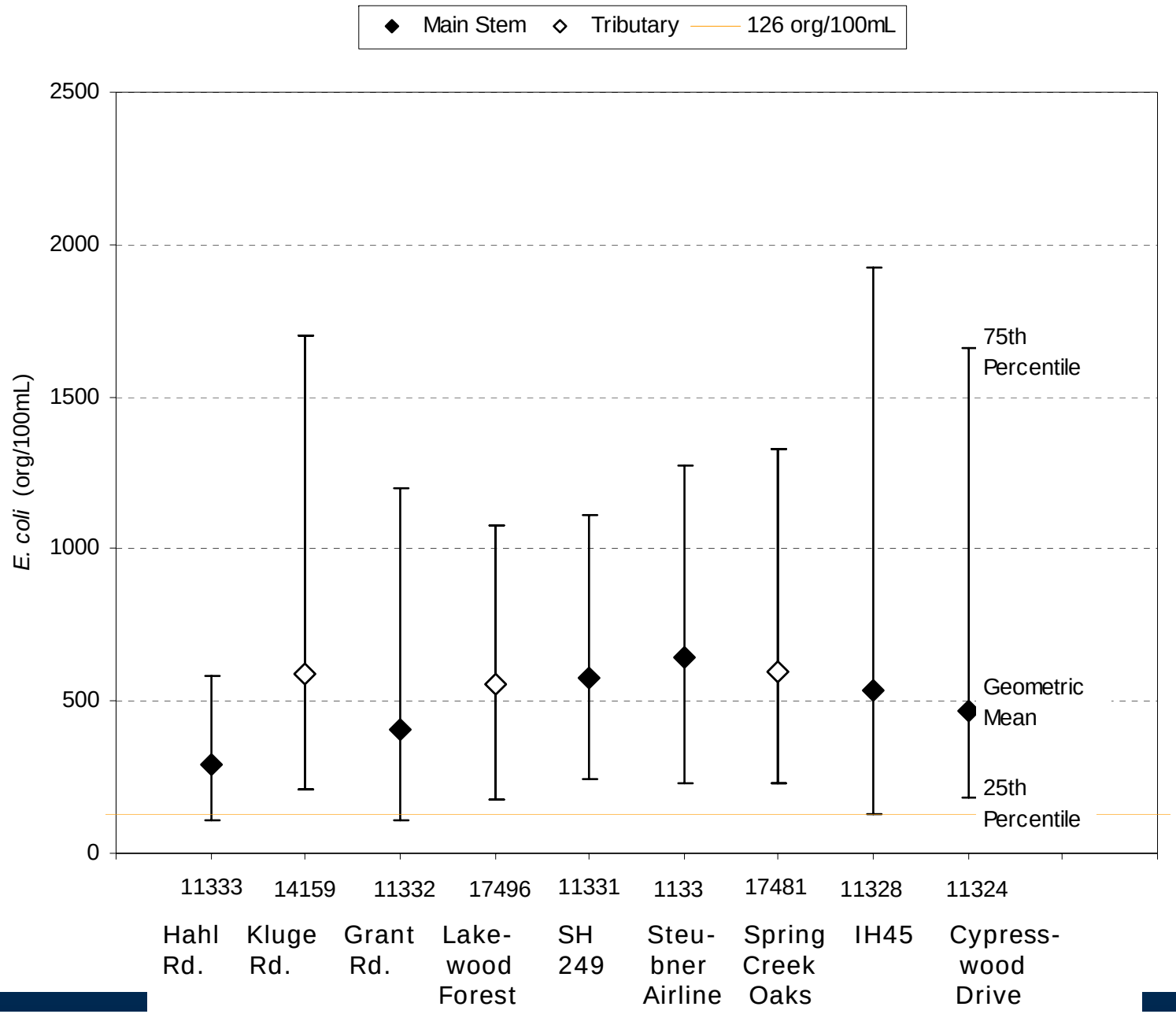
West Fork Arm Lake Houston Spatial Analysis



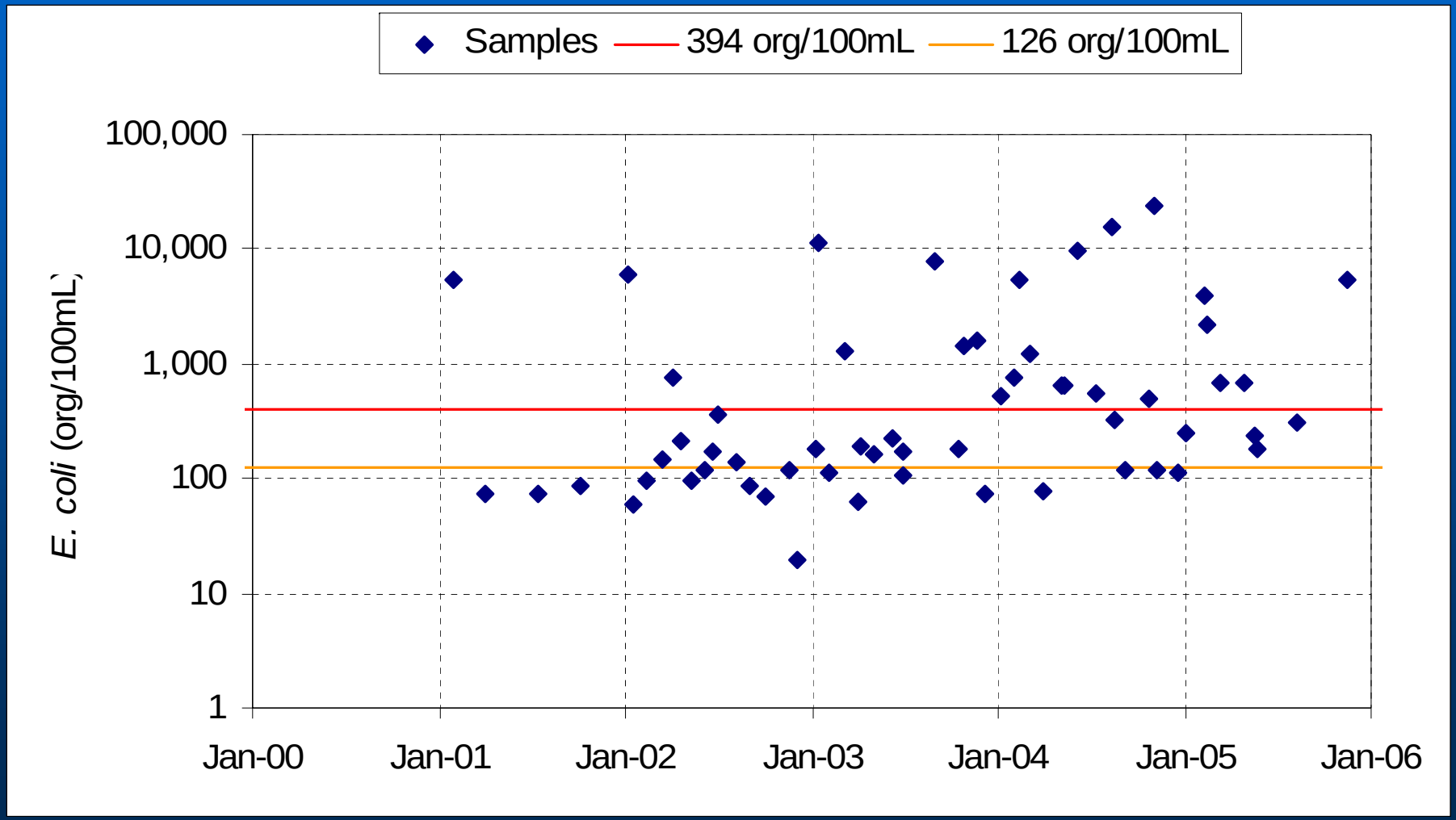
Temporal Analysis: Lake Houston at US 59 (#11213)



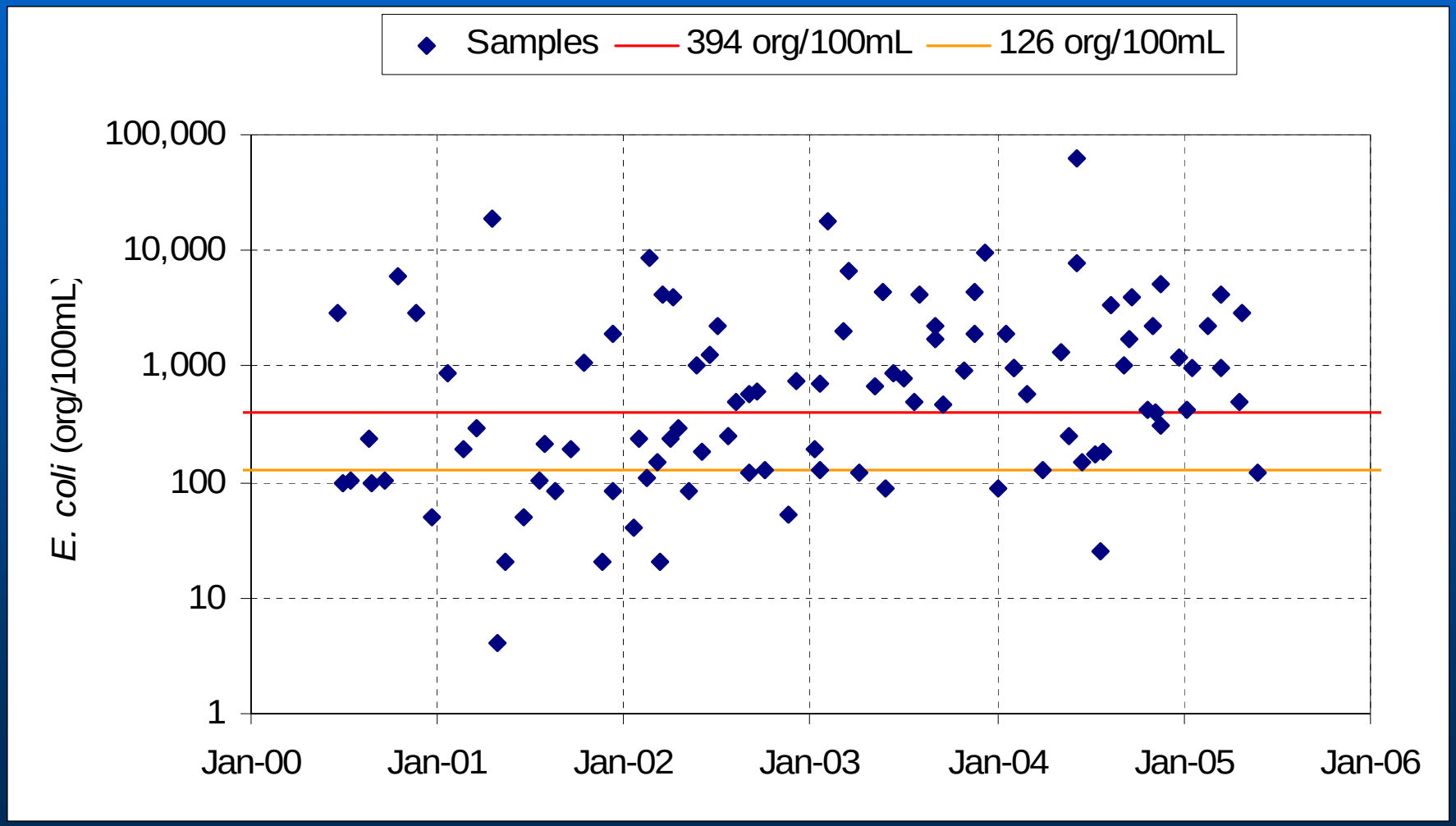
Cypress Creek Spatial Analysis



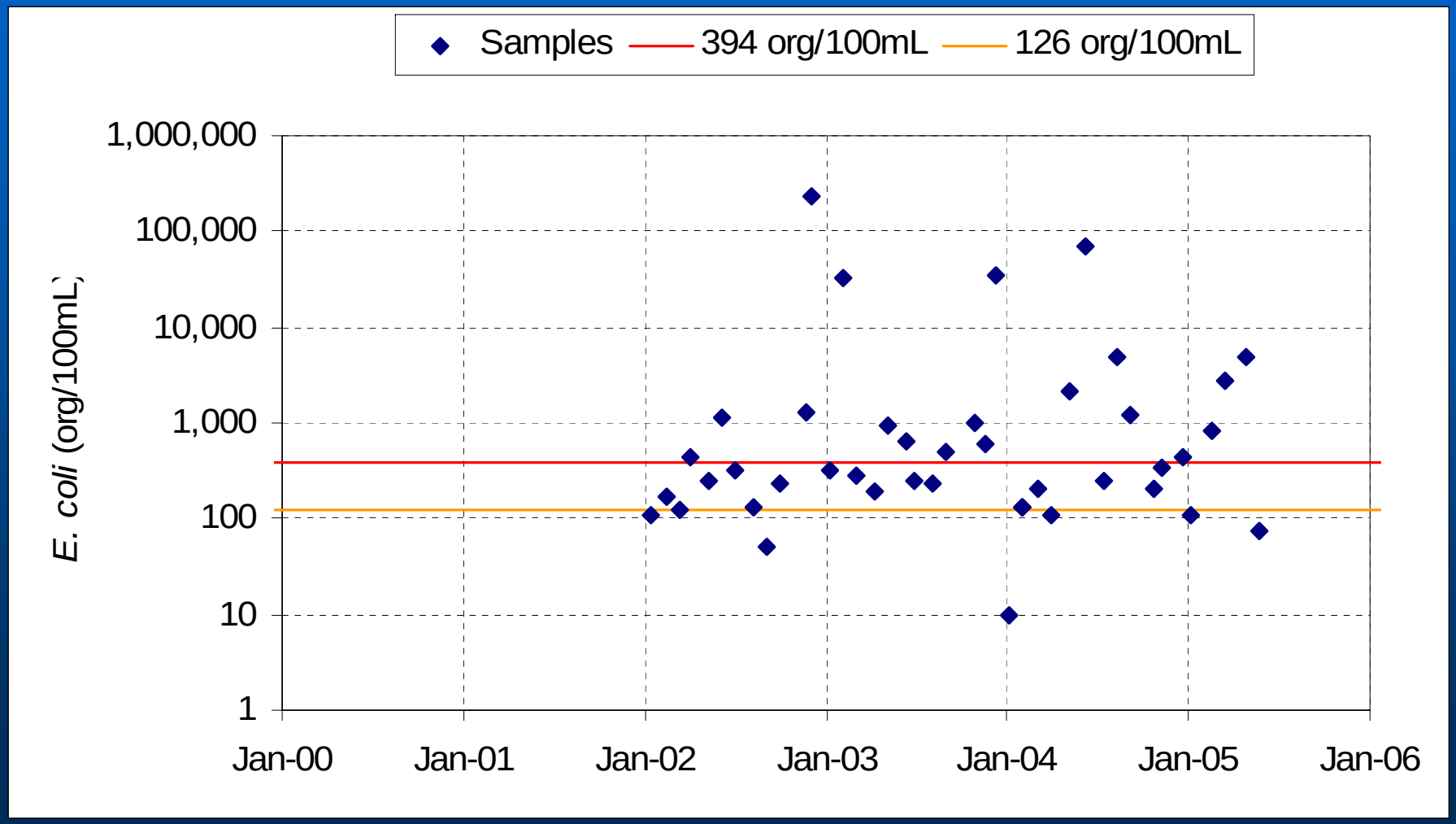
Temporal Analysis: Cypress Creek at Grant Road (#11332)



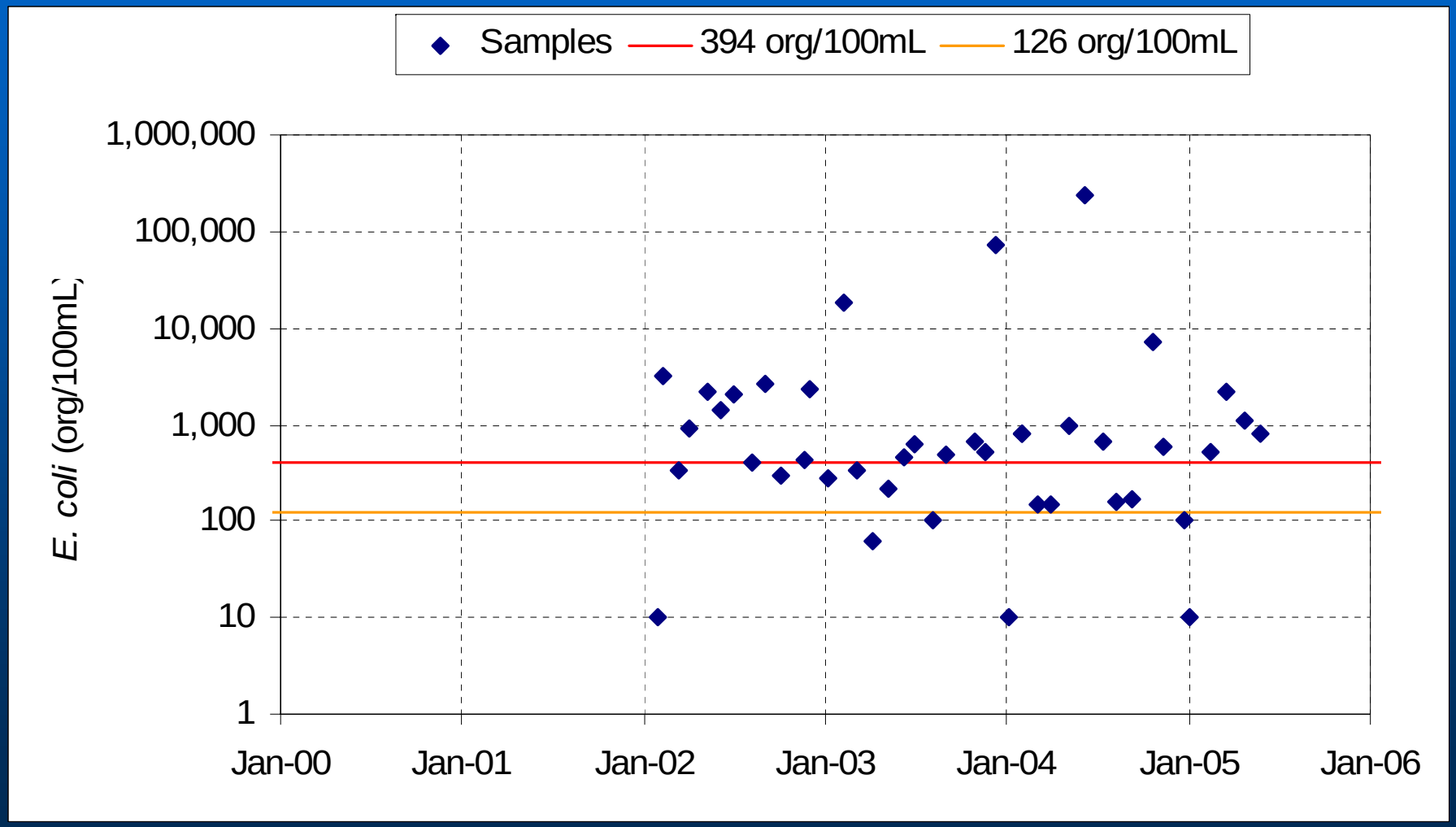
Temporal Analysis: Cypress Creek at IH 45 (#11328)



Temporal Analysis: Faulkey Gully at Lakewood Forest Drive (#17496)



Temporal Analysis: Spring Gully at Spring Crk Oaks Rd (#17481)



Flow Duration Curves

- A flow duration curve (FDC) is a graph of daily average streamflow versus the percent of days that the average streamflow value is exceeded
- FDCs are typically developed using daily flow data collected at USGS gaging stations

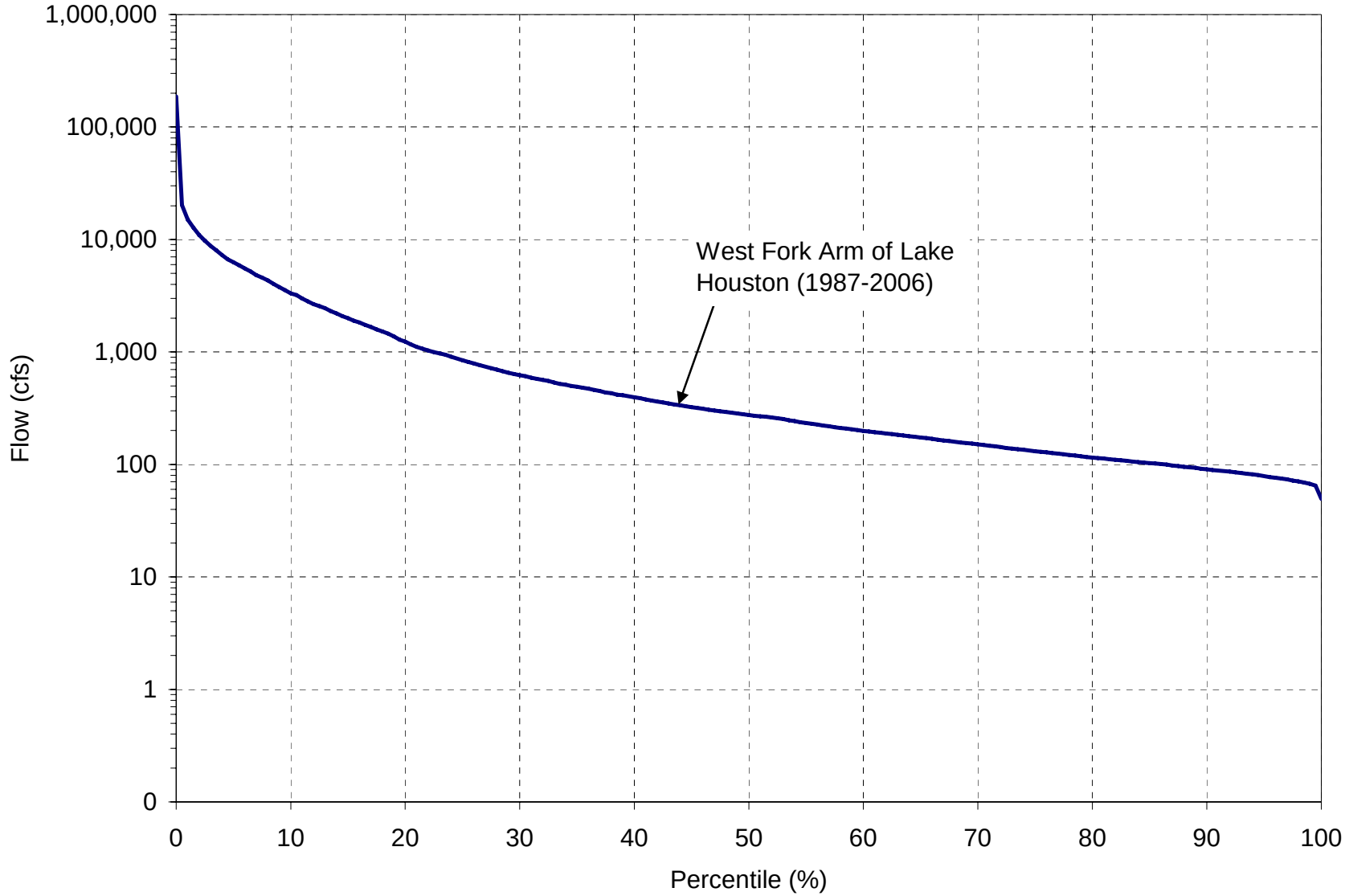
Flow Duration Curves Continued

- There are no flow gages in the West Fork Arm of Lake Houston
- Flow into the West Fork Arm was estimated by summing the flows from the West Fork San Jacinto River, Spring Creek, and Cypress Creek
- Since most sampling sites do not have a corresponding USGS gage, flow records were synthesized using nearby gages and drainage area adjustment factors

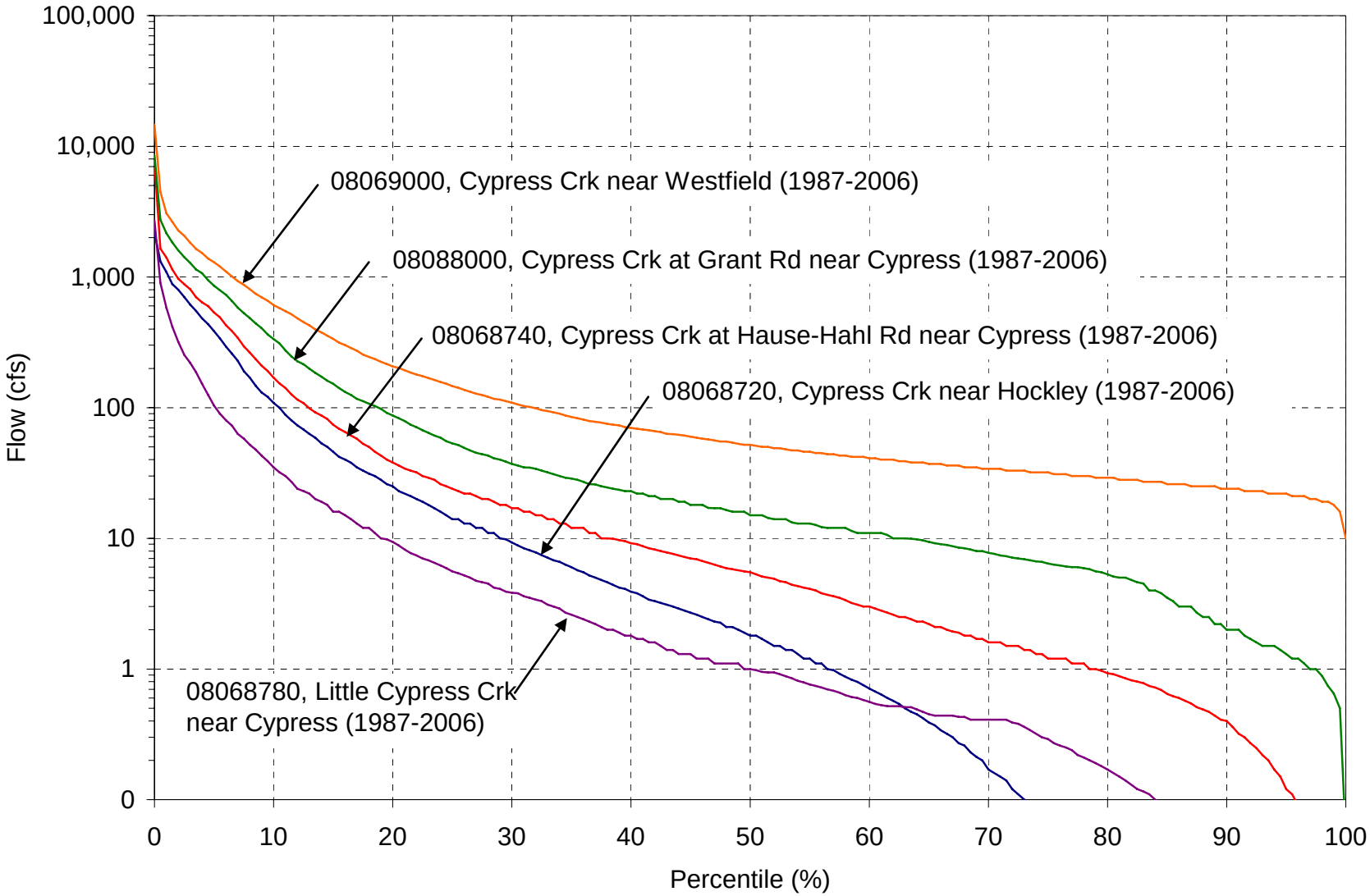
Cypress Creek USGS Flow Gages

Station	Stream	Location	Available FDC data
8068700	Cypress Creek	at Sharp Rd nr Hockley, TX	N/A
8068720	Cypress Creek	at Katy-Hockley Rd nr Hockley, TX	1987-2006
8068740	Cypress Creek	at House-Hahl Rd nr Cypress, TX	1987-2006
8068780	Little Cypress Creek	near Cypress, TX	1987-1992, 1997-2006
8068800	Cypress Creek	at Grant Rd nr Cypress, TX	1987-1992, 2001-2006
8068900	Cypress Creek	at Stuebner-Airline Rd nr Westfield, TX	N/A
8069000	Cypress Creek	near Westfield, TX	1987-2006

Lake Houston Flow Duration Curve



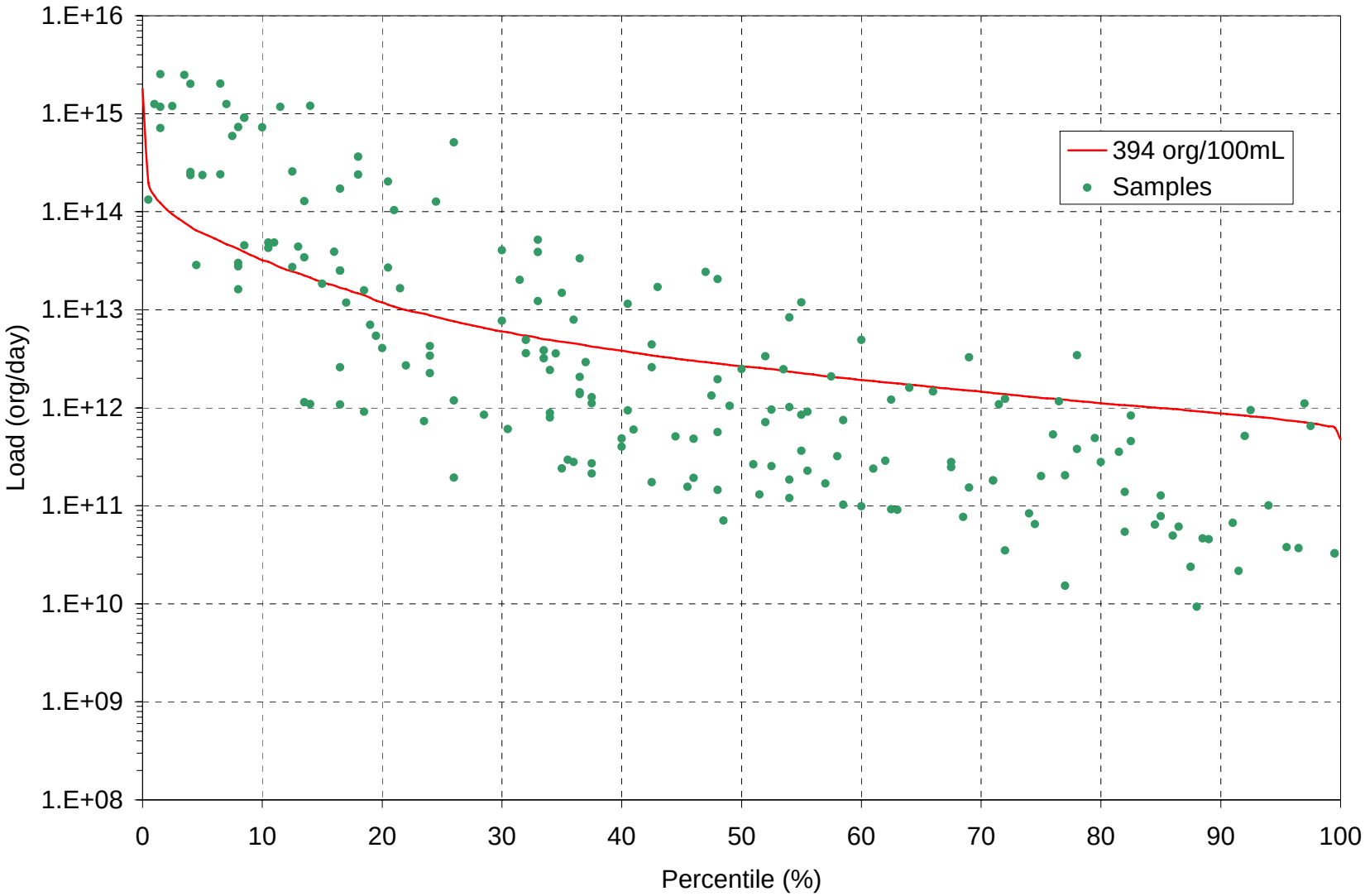
Cypress Creek Flow Duration Curves



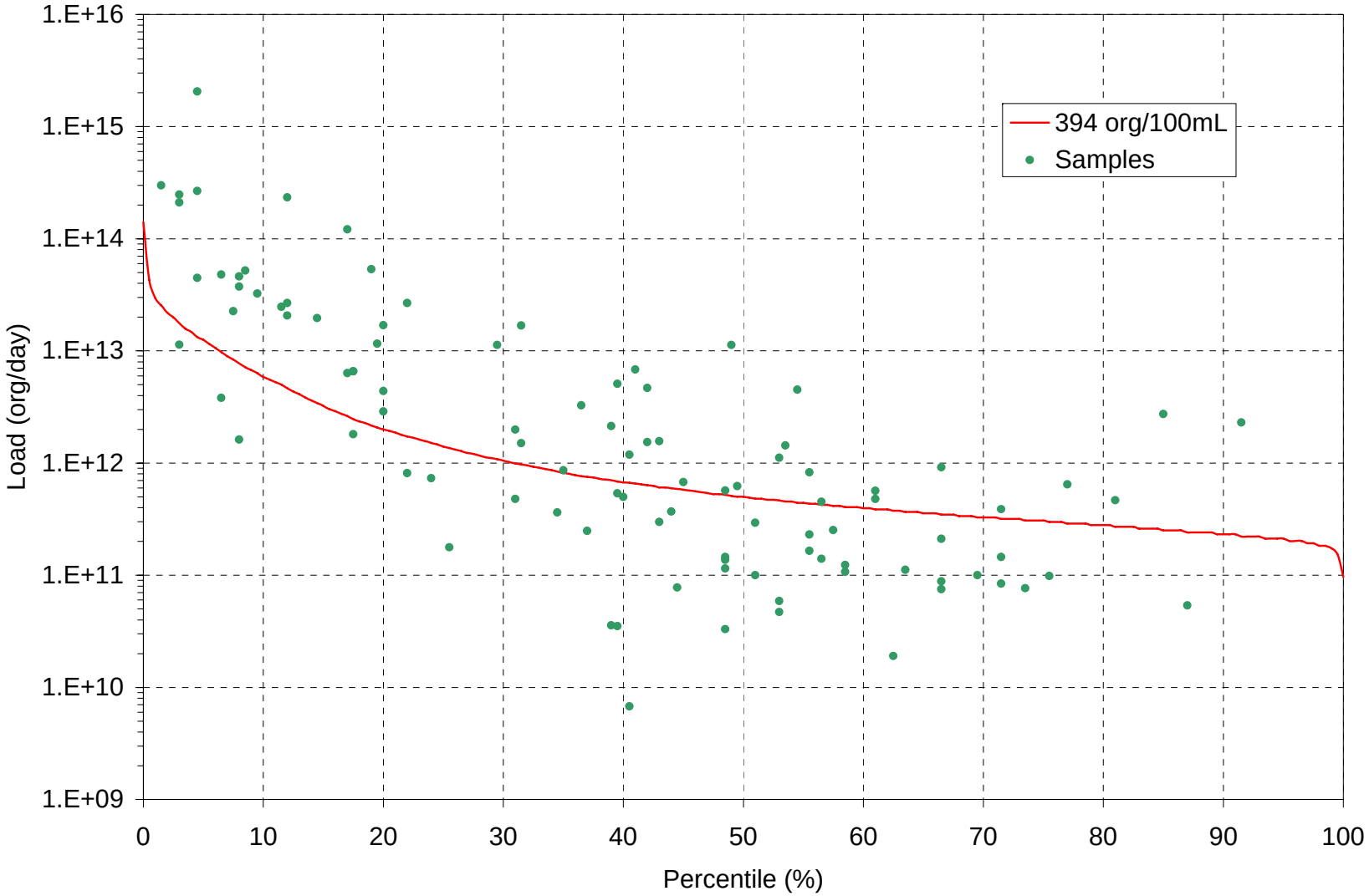
Load Duration Curves

- Load duration curves are presented from upstream to downstream
- Bacterial loads are the product of each grab sample bacteria concentration and the corresponding mean daily streamflow rate
- The greatest exceedances typically occur under high flow conditions

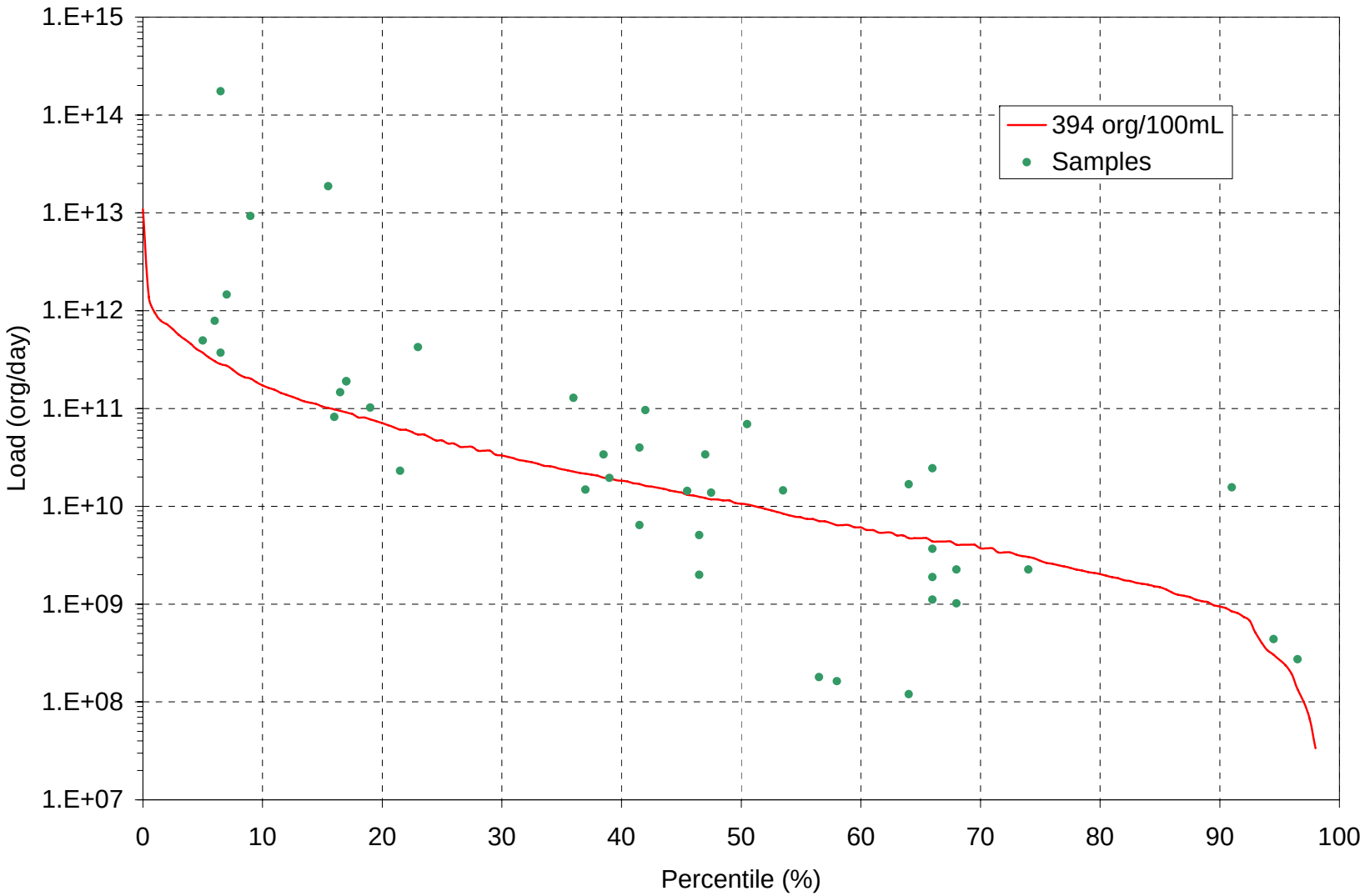
LDC for Lake Houston at US 59 (#11213)



LDC for Cypress Creek at IH 45 (#11328)



LDC for Spring Gully at Spring Creek Oaks Road (#17481)



Potential Sources

- Two primary source categories
  - Wasteloads (WL) - any source flowing into a waterway and covered by a permit
    - wastewater treatment plants
    - discharges of runoff from municipal areas covered under stormwater permits (MS4s)
  - Loads (L) - remaining diffuse sources of pollutants that are not covered by permit
    - runoff from rural or urban areas outside of permitting jurisdictions

Upstream Sources

- Water quality in the West Fork Arm of Lake Houston is dominated by inflows from the West Fork San Jacinto River and its tributaries (including Spring and Cypress Creeks).
- If bacteria levels in these upstream segments are reduced, then bacteria levels in the West Fork Arm of Lake Houston will also decline.

Runoff Sources

- Natural areas typically produce the smallest runoff source loads because they tend to produce the least runoff volume and tend to have the lowest density of fecal sources .
- Rural areas may also have smaller source loads due to lower runoff volumes and less impervious cover
- Urban areas may produce larger bacteria loads because of high impervious cover, which can increase the frequency and intensity of runoff events
- Monitoring plan will seek to characterize sources

Wastewater Treatment Facilities

- Potential to contribute significant bacteria loads if complete disinfection is not achieved
- Loads may be most noticeable under low flow conditions, during which some streams may be effluent dominated
- Also possible for treatment plants to contribute significant loads under wet weather conditions
- Increased loading due to stormwater inflow and infiltration may result in poorer plant performance

Lake Houston Wastewater Treatment Facility Summary

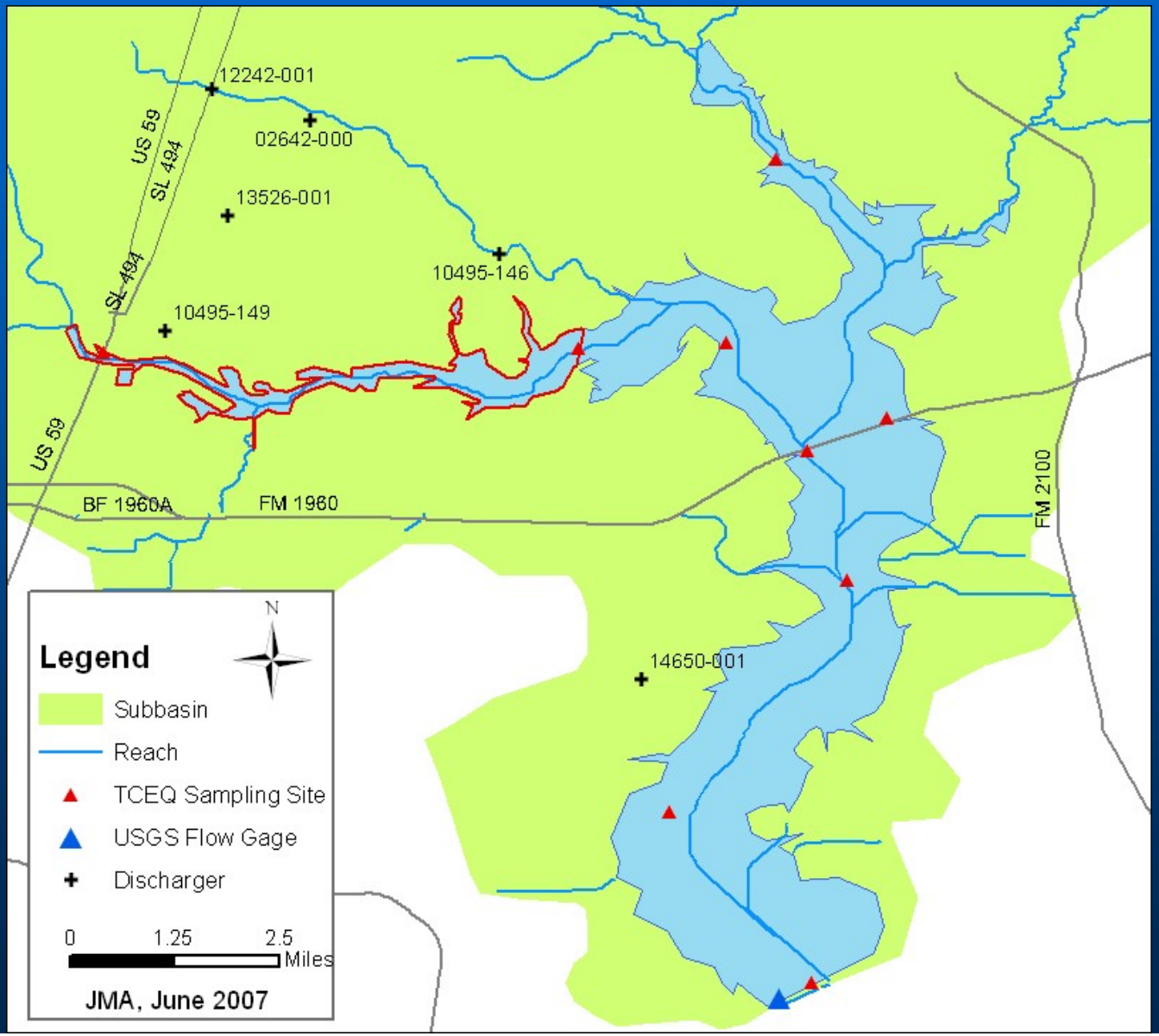
TCEQ Permit Number	EPA Permit Number	Name	County	Permitted Flow (MGD)	Current Flow (MGD)	Disinfection Monitoring
02642-000	TX0093483	PWT Enterprises, Inc.	Montgomery	0.003	0.0007	N
10495-146	TX0066583	City of Houston	Harris	6.6	5.1	F
10495-149	TX0115924	City of Houston	Harris	0.95	0.39	F
12242-001	TX0084042	Porter MUD	Montgomery	1.6	0.49	C
13526-001	TX0105996	Kings Manor MUD	Harris	0.4	0.22	C
14650-001	TX0128244	Pulte Homes of Texas LP	Harris	0.45	0	C

C=chlorine residual, F=fecal coliform, N=none, unk=unknown

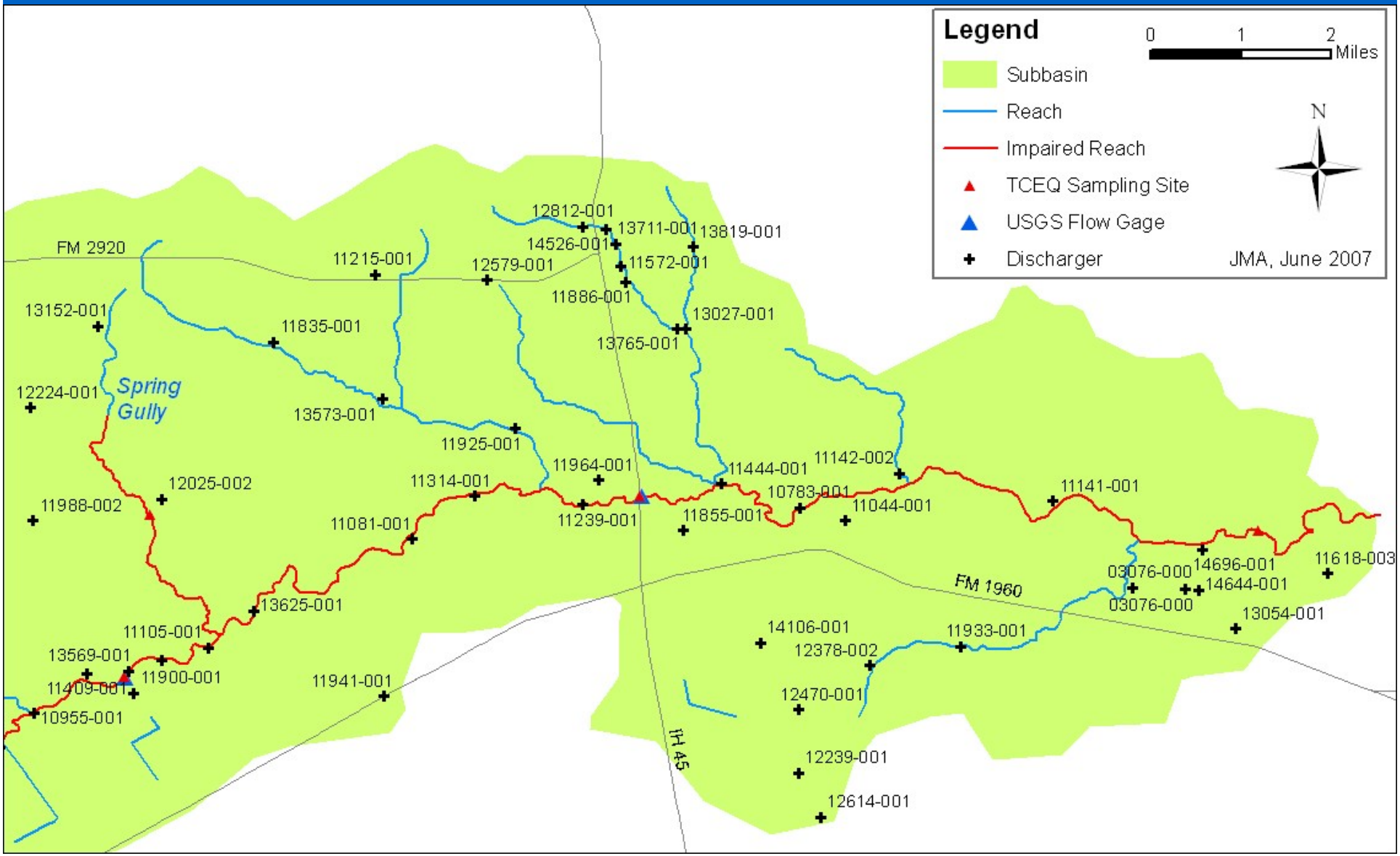
Cypress Creek Wastewater Treatment Facility Summary

- 101 permitted facilities
- Total current flow 29 MGD (45 cfs)
- Total Permitted flow 74 MGD (116 cfs)
- WWTP flows account for 100% of the stream flow at the 99th percentile regime (low flow), 76% of the flow at the 50th percentile

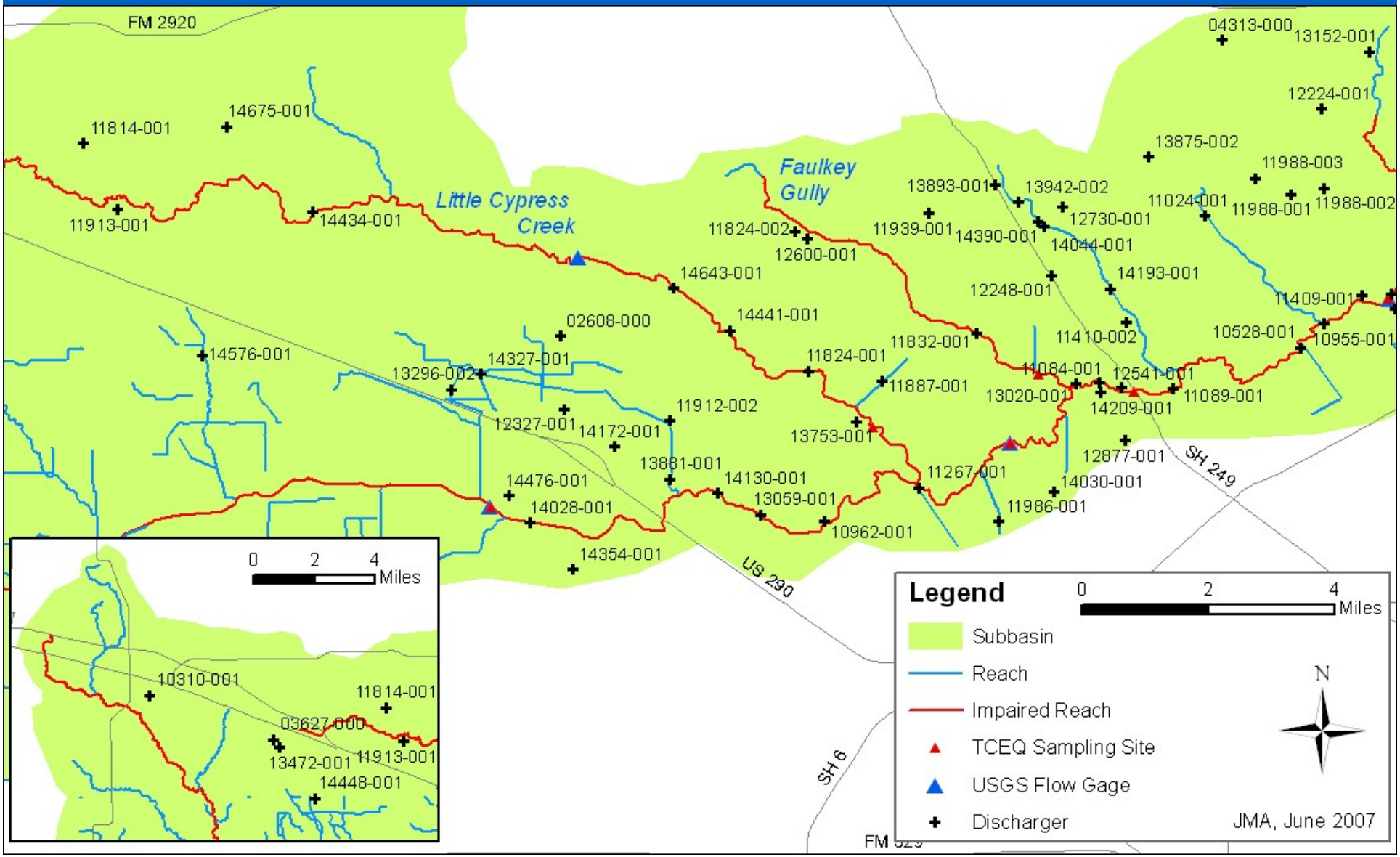
Lake Houston Treatment Facility Discharge Locations



Cypress Creek Treatment Facility Discharge Locations East



Cypress Creek Treatment Facility Discharge Locations West



Monitoring Plan

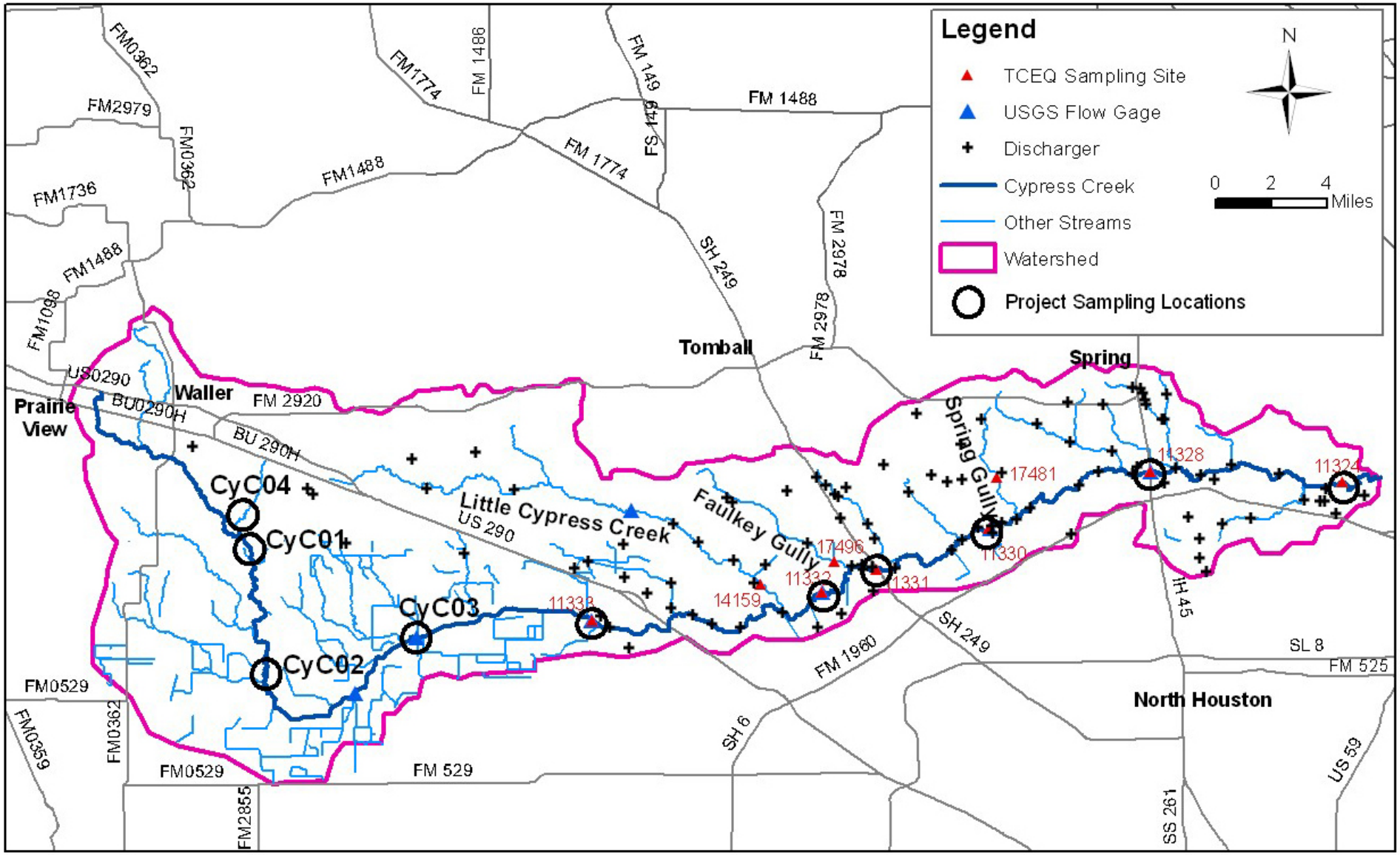
Monitoring Objectives

- Provide:
  - better definition of the water quality conditions on the study segments with respect to bacterial indicators,
  - definition of source areas or loading points that contribute to conditions in the segment,
  - data sufficient for estimation of loadings and support of allocation activities.

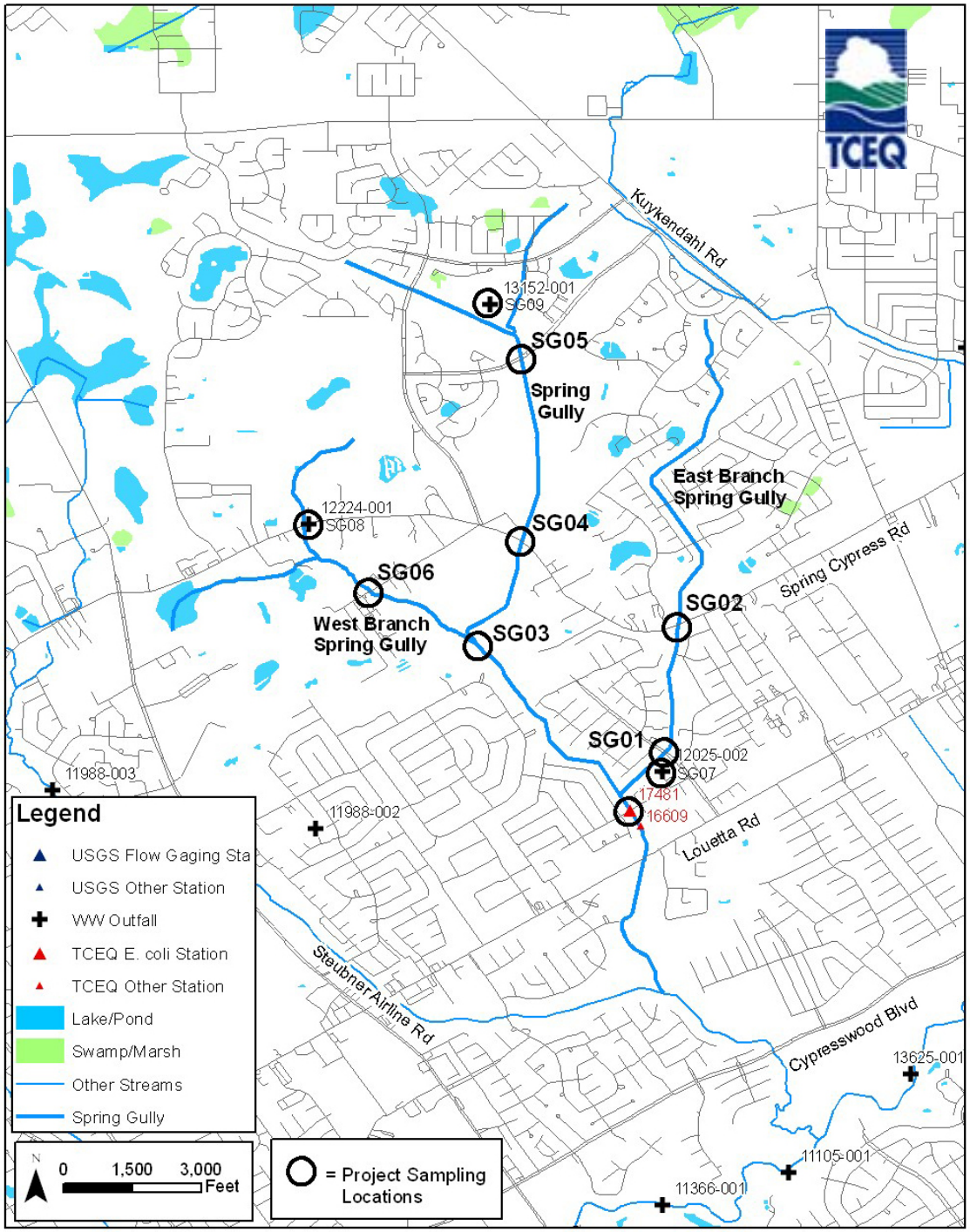
Synoptic Sampling Surveys

- Samples to be collected under baseflow conditions
- Ascertain source areas, longitudinal trends, extent of impairment
- Routine monitoring stations and additional sites
- Two synoptic sampling surveys on each study segment.
- General schedule for these events October 2007 to July 2008.
- Sampling commences after Quality Assurance Project Plan (QAPP) is approved by TCEQ.

Sampling Stations for Cypress Creek, Segment 1009



Sampling Stations for Spring Gully, 1009D



Spatially-Intensive Source Studies

- Upper East Fork San Jacinto River, Segment 1003; Stewarts Creek, Segment 1004E; Willow Creek Segment, 1008H; and Spring Gully, Segment 1009 D
- Evaluate specific source locations in detail
- Baseflow Conditions
- Selected segments: urban, rural
- Numerous sampling points, eg, 1000-ft intervals
- Sample pipes, outfalls, tributaries
- Test for bacteria, optical brighteners
- Extrapolate to similar areas in study area

Sediment Source Studies

- Upper East Fork San Jacinto River, Segment 1003; Stewarts Creek, Segment 1004E; Willow Creek Segment, 1008H; and Spring Gully, Segment 1009D
- Evaluate sediment as potential bacteria source
- Baseflow conditions
- Sediment sampling at varying distance from stream bed

Resuspension Study

- Willow Creek Segment, 1008H; and Spring Gully, Segment 1009D
- Evaluate resuspension of bed sediments as bacteria source
- Baseflow Conditions
- Track bacteria in water column over 1-2 days

Kinetics Study

- One location at each of the following: Willow Creek Segment, 1008H; and Spring Gully, Segment 1009D
- Evaluate regrowth of bacteria from point sources
- Baseflow Conditions
- In situ bacteria kinetic rates

Wet Weather Point Source Sampling Study

- Willow Creek Segment, 1008H
- Estimate WWTP loads under wet weather conditions
- Sample 10-30 WWTPs at outfall pipes
- Sample receiving stream at downstream monitoring station
- Estimate total event loading of bacteria from point sources
- Estimate proportion of total stream loading derived from point sources

Microbial Source Tracking

- Spring Gully, Segment 1009 D
- Conduct sampling and testing for qPCR
- Test for human presence/absence
- Test raw wastewater samples
- Rapid turn-around of results may guide additional testing
- One baseline survey
- Repeat if warranted

TCEQ Website for Project Information

http://www.tceq.state.tx.us/implementation/water/tmdl/82-lakehouston.html