Project Area 2
River Basin Groups D and E
Bacteria Impairments
TMDL

Texas Commission on Environmental Quality
James Miertschin & Associates, Inc.

Introduction

- Section 303 (d) of the Clean Water Act requires states to identify water bodies that do not meet applicable water quality standards. This is known as the 303 (d) list.

- Pursuant to the Clean Water Act, and development of the 303 (d) list, the TCEQ is responsible for development of TMDL's.

- Due to elevated bacteria indicators, specifically fecal coliform or E. coli., Peach Creek was selected for assessment in an area known as Project Area 2 – Basin Groups D and E.

What is a TMDL (Total Maximum Daily Load)?

- Establishes the maximum amount of an impairing substance, or stressor, that a waterbody can assimilate and still meet Water Quality Standards
- allocate that load among pollutant contributors
- are a tool for implementing State water quality standards and are based on the relationship between pollution sources and in-stream water quality conditions

Which Waterbodies Require TMDLs?

- Waterbodies require TMDLs when the pollution control requirements are not stringent enough to meet applicable Water Quality Standards.

What are Water Quality Standards?

- Serve two (2) purposes:
  - they establish water quality goals for a waterbody
  - they provide a regulatory basis for controls beyond technologically based limits

What are Criteria?

- Criteria are water quality conditions which are to be met in order to support and protect designated uses.
- Criteria are expressed as the number of "colony forming units" of bacteria per 100 milliliters (ml) of water.
- Indicator bacteria, although not generally pathogenic, are indicative of potential contamination by feces of warm blooded animals.

Segment 1803C – Peach Creek

- Placed on the 2000 §303(d) list because bacteria exceeded the segment specific criteria of 126 colonies per 100 ml (geometric mean) and 394 colonies per 100 ml (single grab).

- Designated Uses
  - Aquatic Life
  - Contact Recreation
  - Fish Consumption

TMDL Development

- Segment is listed on the federal Clean Water Act Section 303 (d) list
- Selection of Pollutant for TMDL
- Initiate TMDL Project
- Data Collection – Compile data about current water quality conditions, collect additional data
- Data Assessment – Quantify impacts and sources (point, non-point, natural background, atmospheric deposition)

TMDL Development, continued

- TMDL Allocation – Identify a quantifiable water quality target for each constituent
- Implementation Plan – Comprehensive strategy for restoring the beneficial uses of the water body
- Draft TMDL Report
- TCEQ Review / Public Comment
- TCEQ Approval / EPA Approval
- Implementation

Stakeholder Involvement

- Improve the quality and quantity of contributions to TMDL projects
- Ensure that state government considers the local perspective in its decisions
- Lead to consensus-based solutions
- Encourage open dialogue on water quality issues

What is E. coli?

- abbreviated name of the bacterium in the Family Enterobacteriacae named Escherichia (Genus) coli (Species).
- E. coli and other kinds of bacteria within our intestines are necessary for us to develop, operate properly, and remain healthy.
- E. coli along with other species of bacteria, provide our bodies with many necessary vitamins, for example K and B-complex vitamins. These vitamins are absorbed through our intestines, where the bacteria reside.

E. coli 0157:H7

- Is a member of the EHEC – enterohemorrhagic E. coli group and produces a toxin, called Shiga-like toxin (SLT), or Vero toxin.

- This toxin is a protein that causes severe damage, specifically:
  - hemorrhaging
  - hemolytic syndrome (HUS),
  - kidney failure
  - loss of red Blood cells

How does E. coli spread?

- E. coli bacteria can be spread by many sources, such as:
  - undercooked ground beef,
  - un-pasteurized milk,
  - raw vegetables,
  - and contaminated water.
- E. coli can be passed from person-to-person.

How does E. coli get in the water?

- E. coli comes from human and animal wastes. During precipitation, E. coli may be washed into creeks, rivers, streams, lakes, or groundwater and ultimately may end up in drinking water.

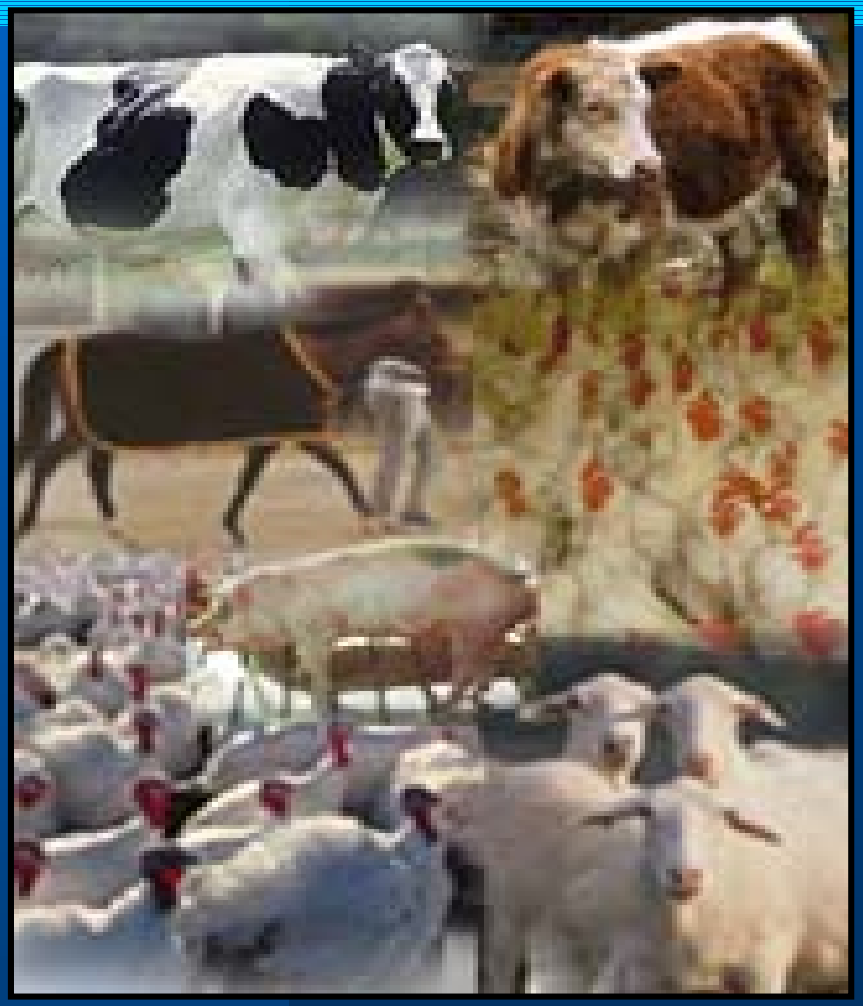
Point Source Pollution

- Point Source - "Point Source" means any discernible, confined, and discrete conveyance from which pollutants are or may be discharged.
- Examples include:
  - pipe
  - ditch
  - channel
  - tunnel
  - conduit
  - well
  - landfill
  - concentrated animal feeding operation, etc.

Non-point Source Pollution

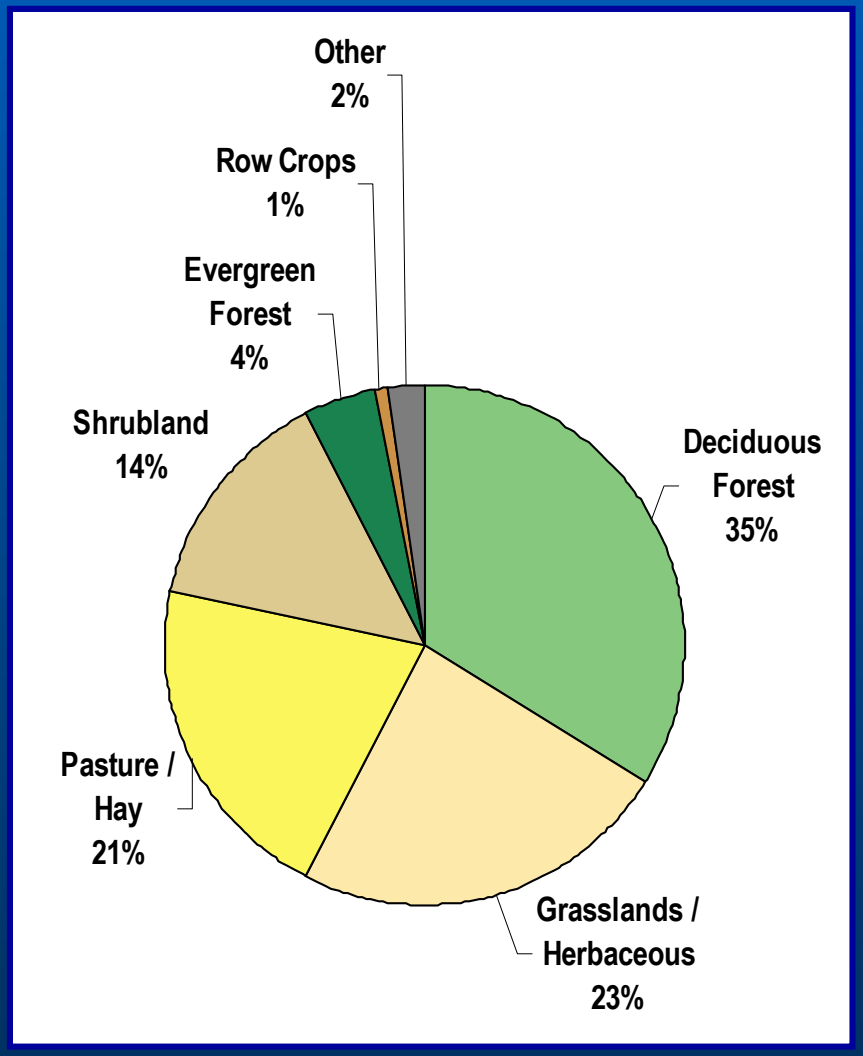
- Non-point Source – "Non-Point Source" pollution occurs when rainfall or sprinkler runoff gathers manure, oil, grease, litter, fertilizer and other toxic substances and washes them into storm drains, creeks and rivers.

Suspect Pollutant Sources



- Wastewater Treatment Plants
- Confined Animal Feedlot Operations (CAFO's)
- On-Site Sewage Facilities (OSSF's)
- Domestic Animal Feces
- Wild Animal Feces
- Storm Water Runoff
- Agriculture Practices

Segment 1803C Peach Creek Landuse



Purpose of Today's Meeting

- Review *E. coli* Data (historical and current) for Peach Creek
- Bacteria Source Tracking (BST) Results
- Discuss next phase

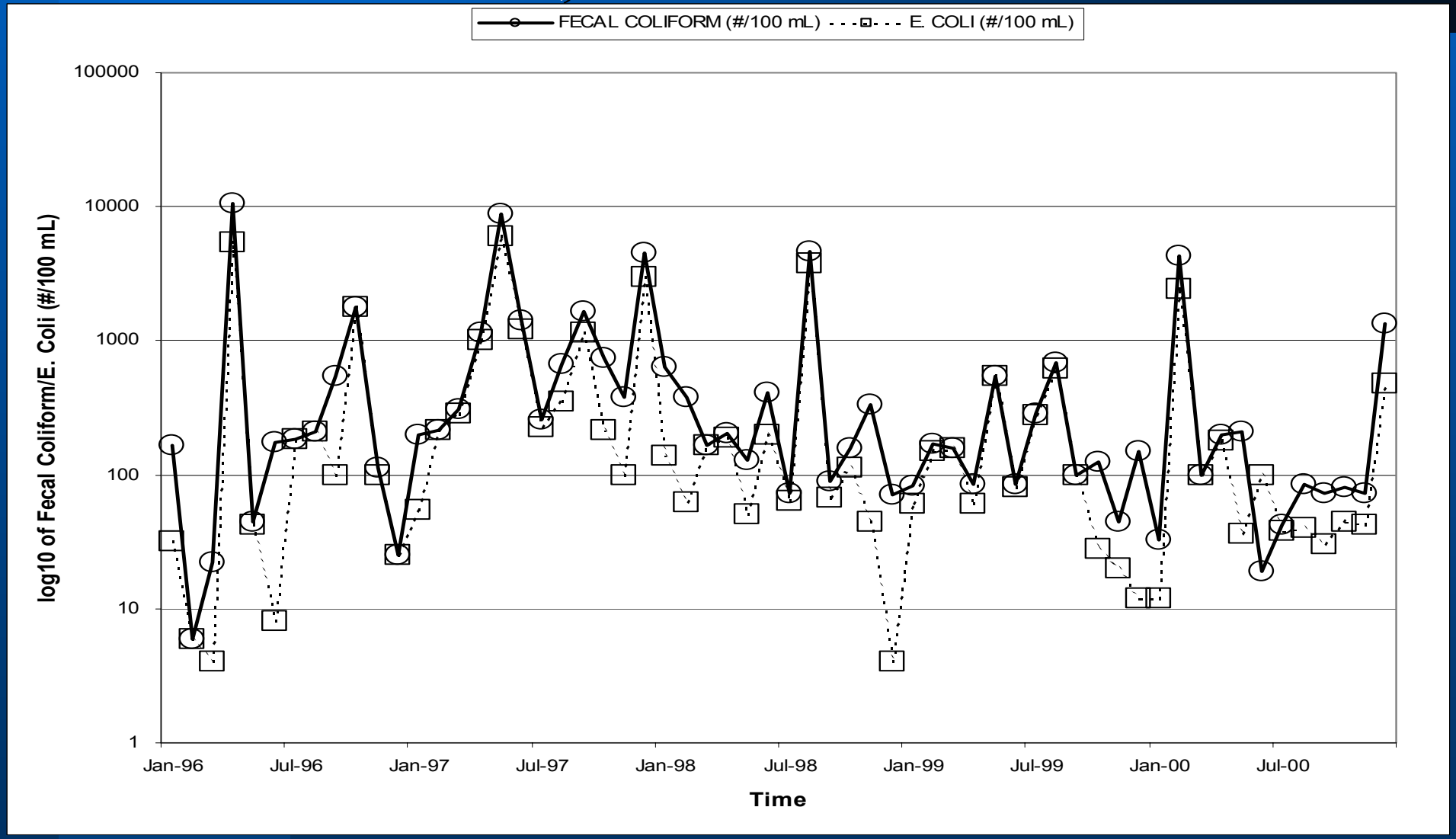
Peach Creek *E. coli* Data (1996-2001)

STATION	LOCATION	NO. OF SAMPLES	NO. OF EXCEED	GEO MEAN COL/100 ML	STATUS	COVERAGE
14937	CR 353	60	12	121	fully supporting	lower 25 mi

Peach Creek Fecal Coliform Data (1996-2001)

STATION	LOCATION	NO. OF SAMPLES	NO. OF EXCEED	GEO MEAN COL/100 ML	STATUS	COVERAGE
14937	CR 353	60	17	226	not supporting	lower 25 mi

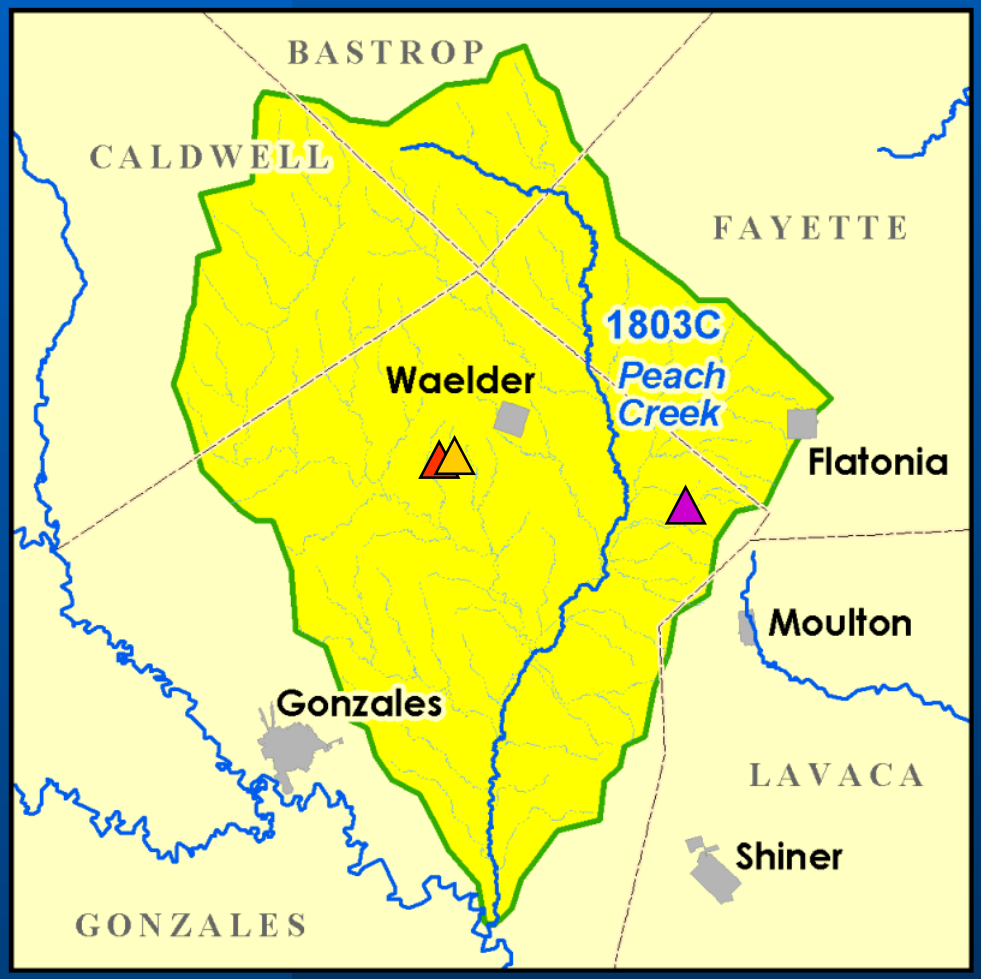
Peach Creek E. Coli/Fecal Coliform vs. Time, Station 14937, Peach Creek at CR 353



Previous Phase Monitoring for *E. coli*

- Agricultural Watershed
  - 25 mile reach
- 4 monitoring stations
- 10 sampling surveys

Segment 1803C Peach Creek
Confined Animal Feedlot Operations

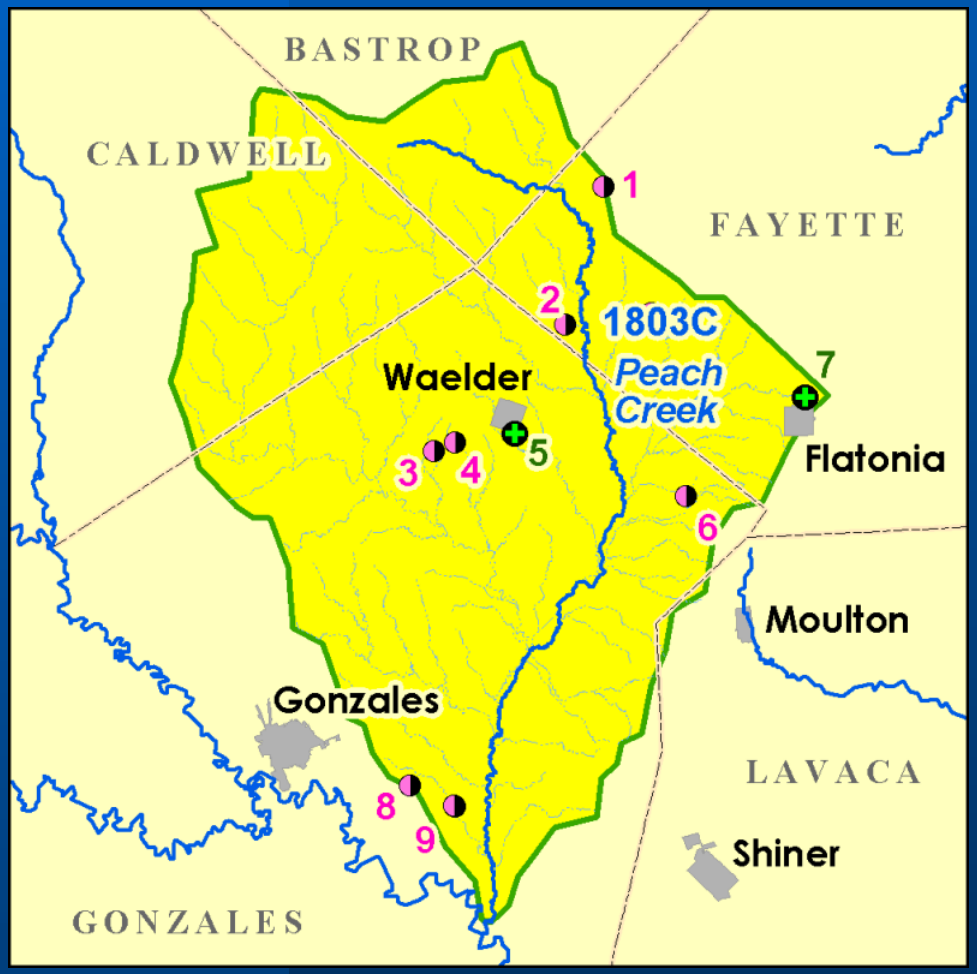


Cal-Maine Foods
3 Poultry Facilities

Number of Chickens

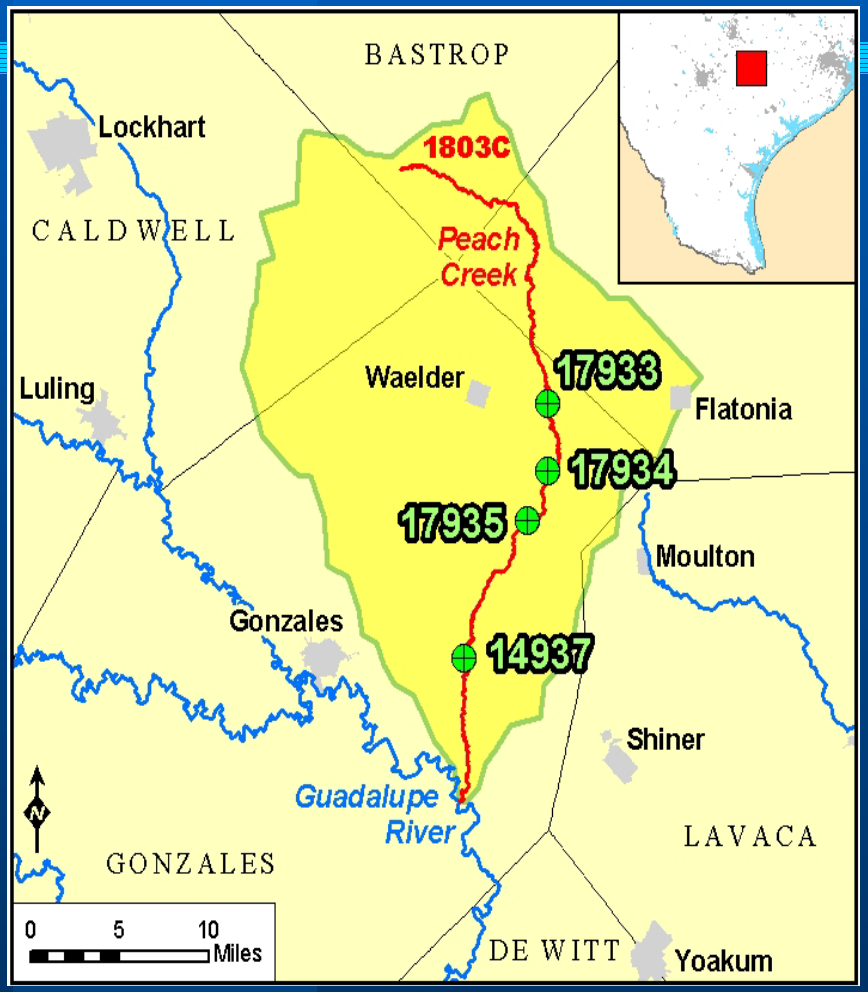
CAFO 1	1,680,192
CAFO 2	1,297,416
CAFO 3	+ 2,394,000
TOTAL	5,371,608

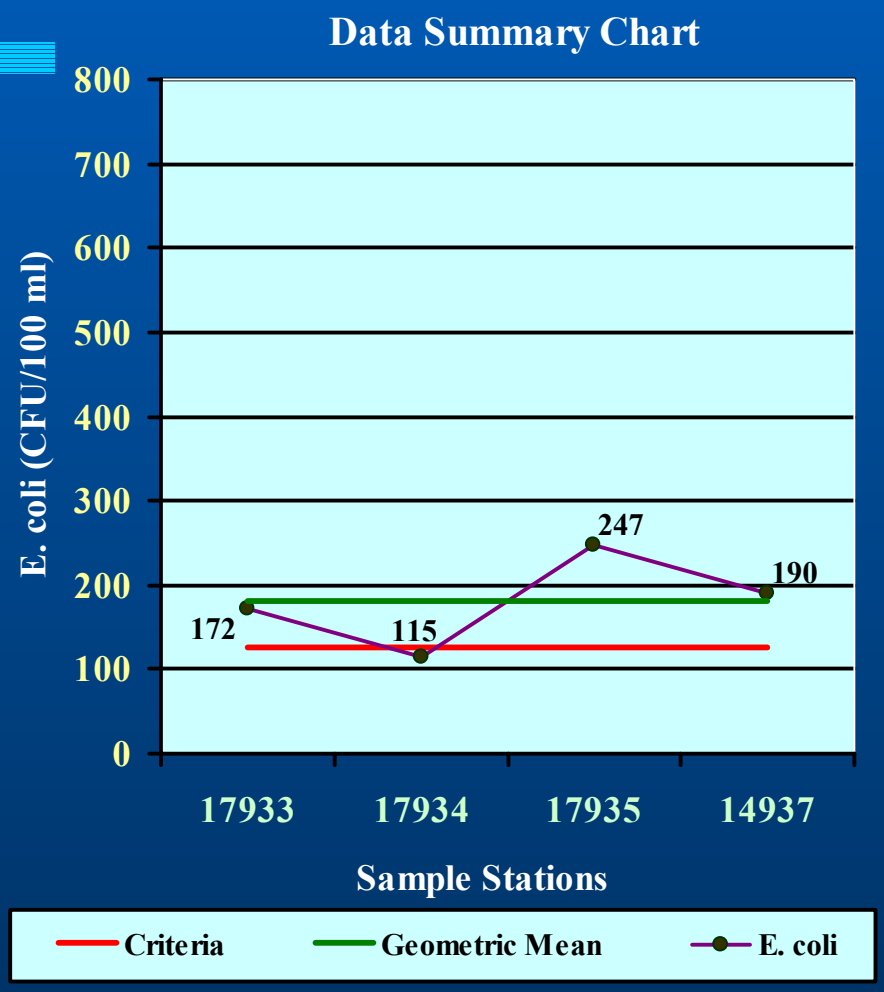
Segment 1803C Peach Creek Wastewater Treatment Plants



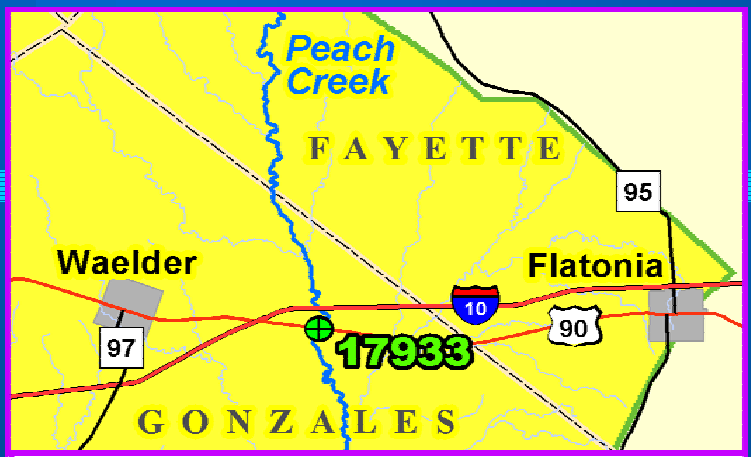
1 McCarty Road Landfill
2 Laughlin Environmental
3 Cal-Maine
4 Cal-Maine
5 **City of Waelder**
6 Cal-Maine
7 **City of Flatonia**
8 Southern Clay Products
9 Southern Clay Products

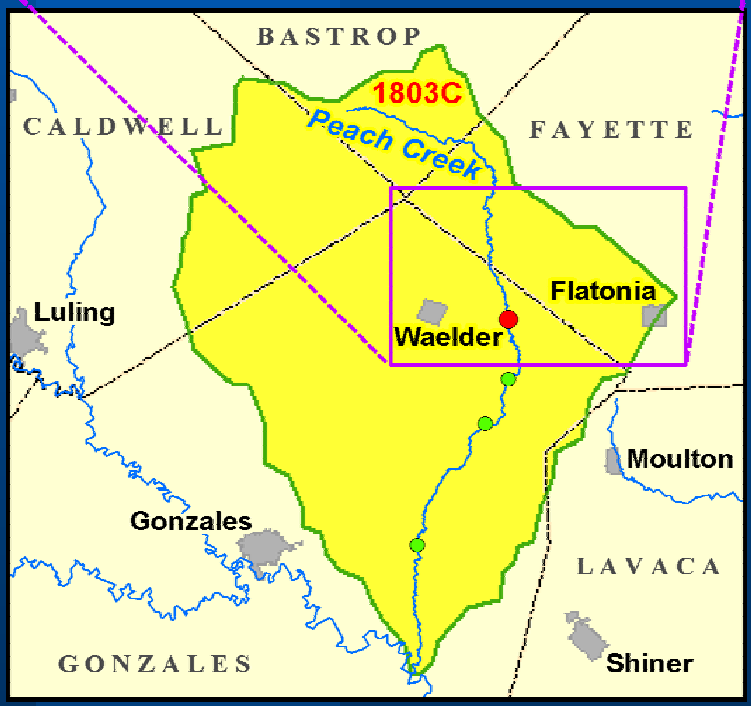
Project Sample Results

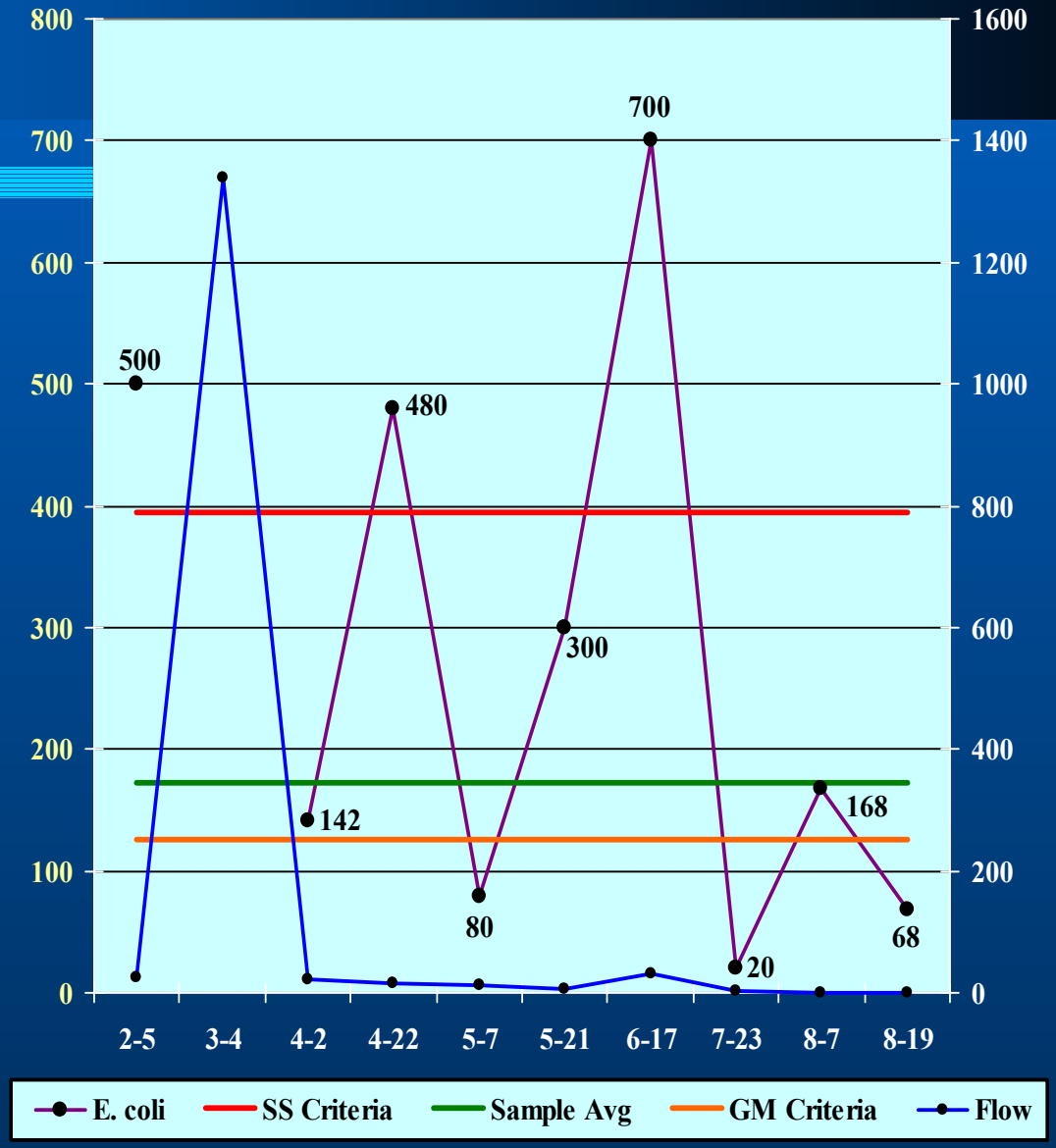




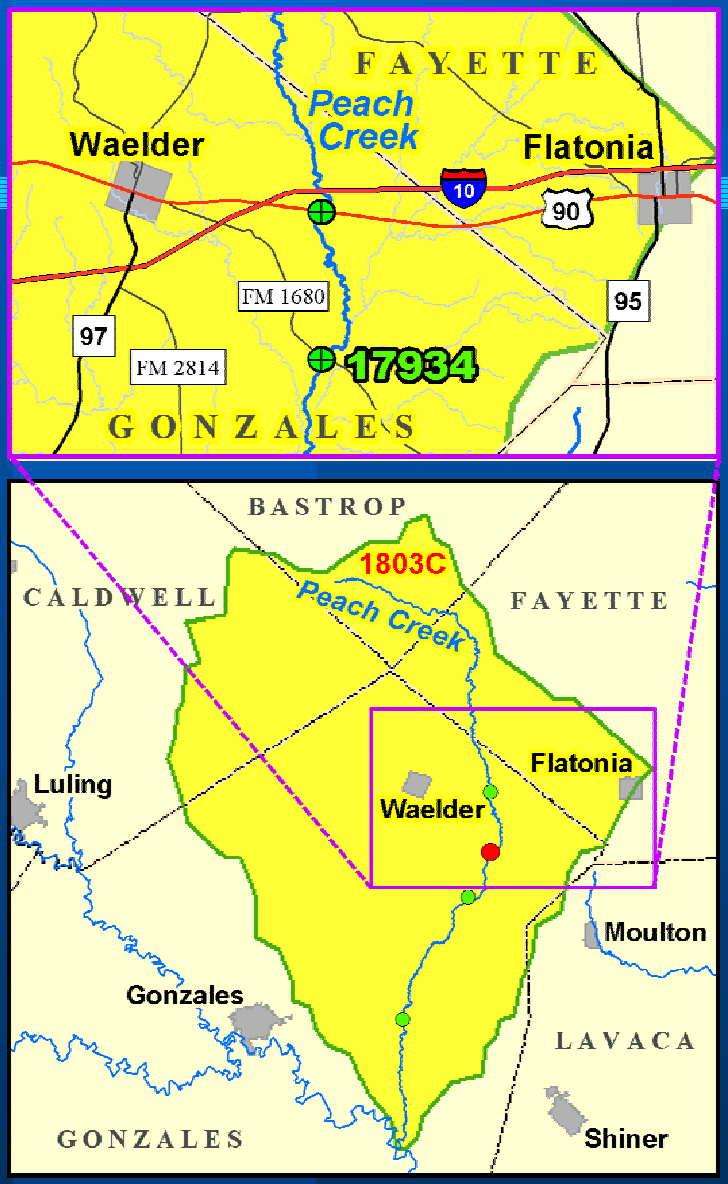
Station ID 17933 – Peach Creek at US 90

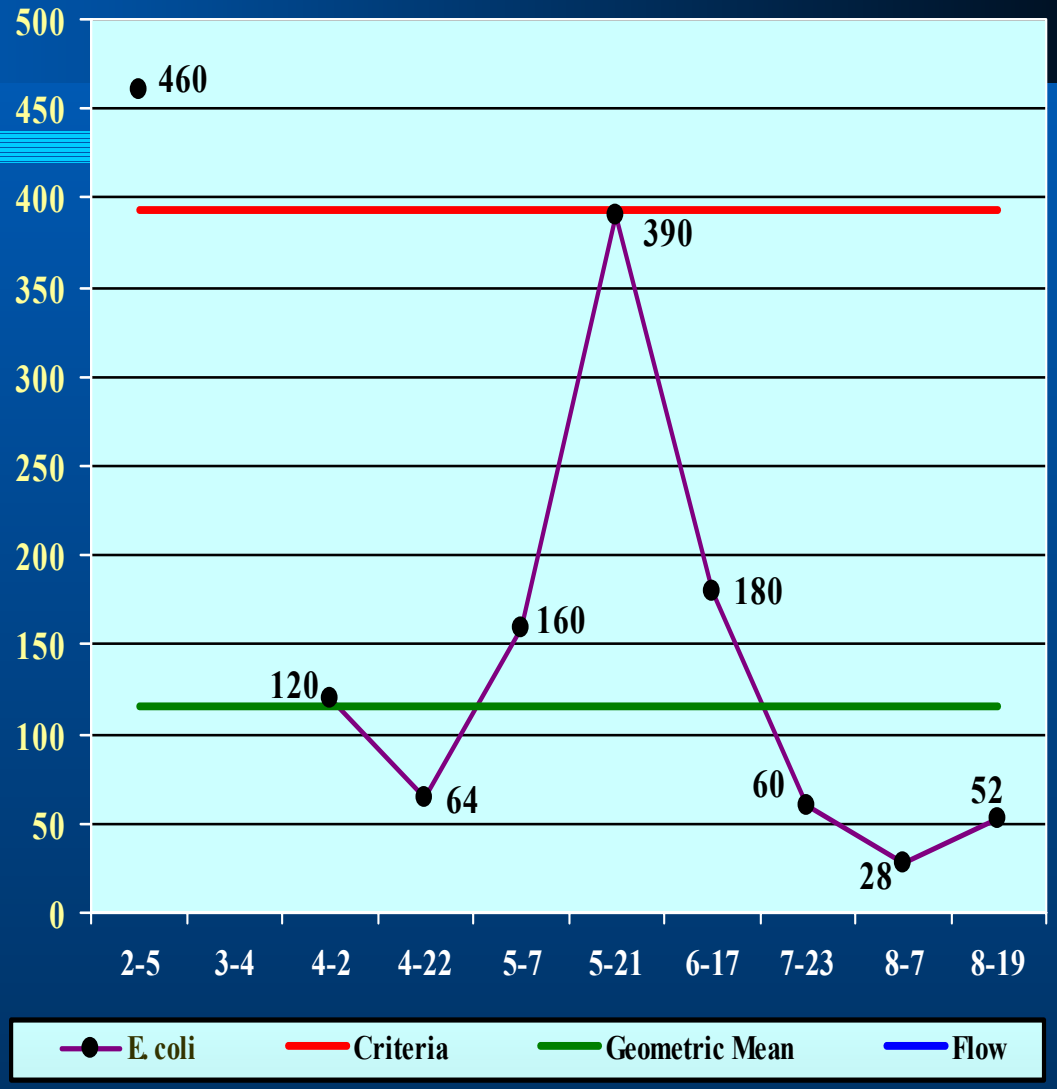




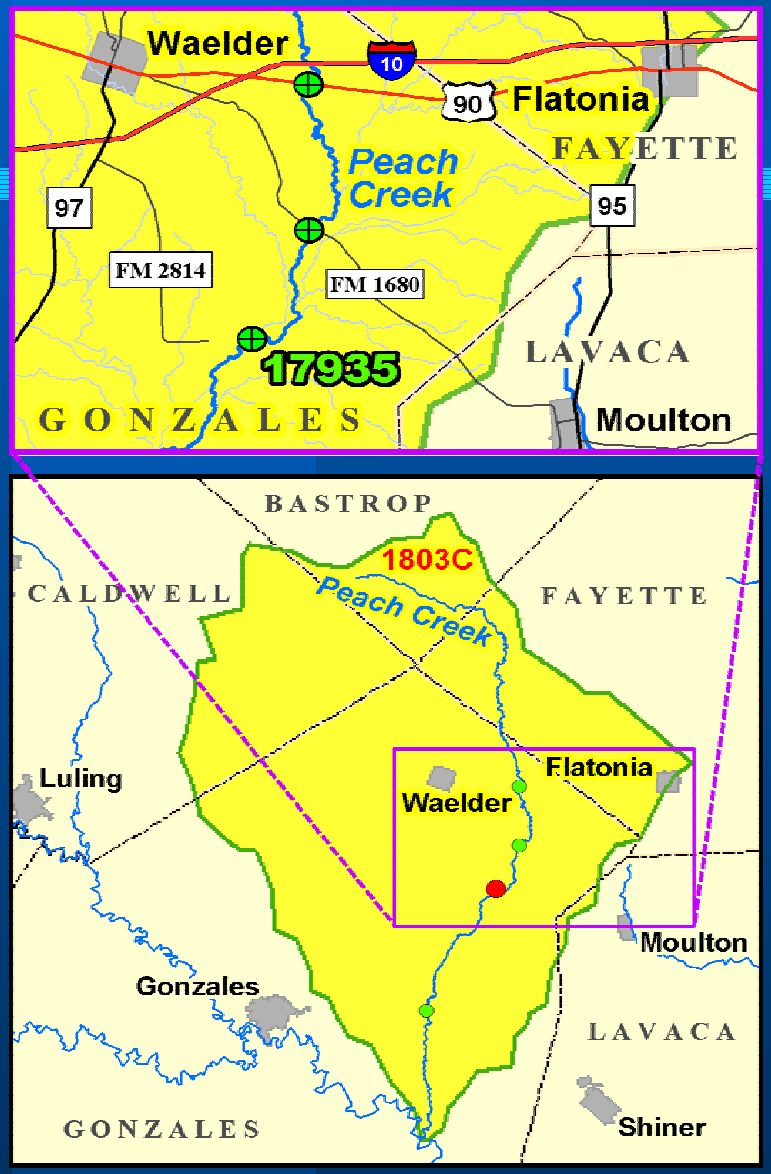


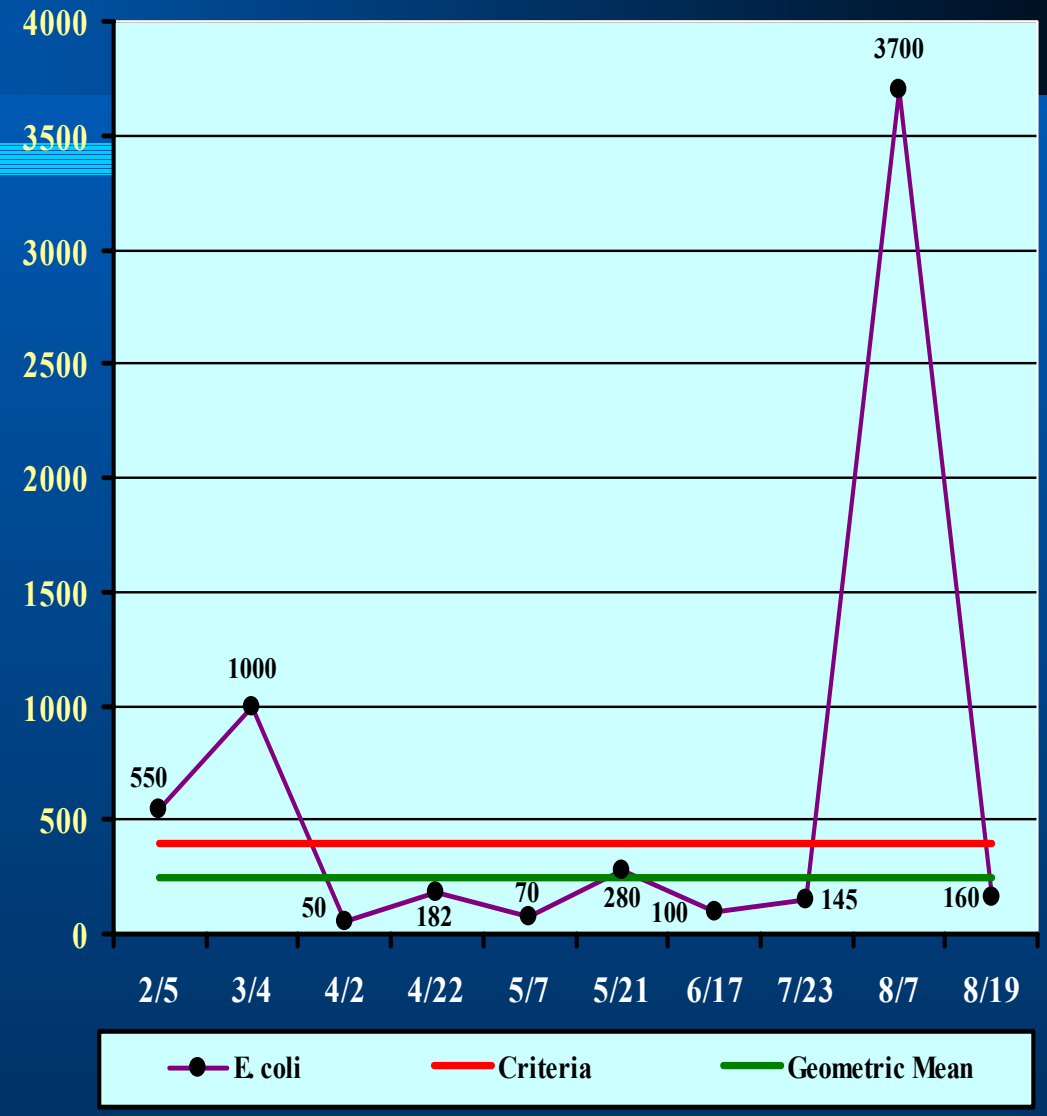
Station ID 17934 – Peach Creek at FM 1680



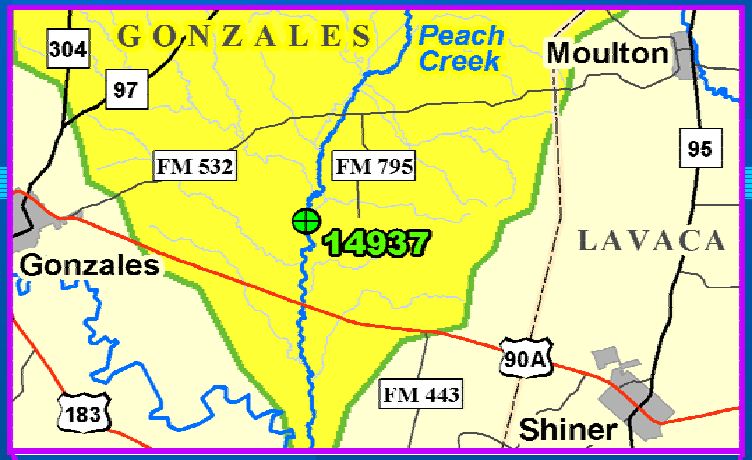


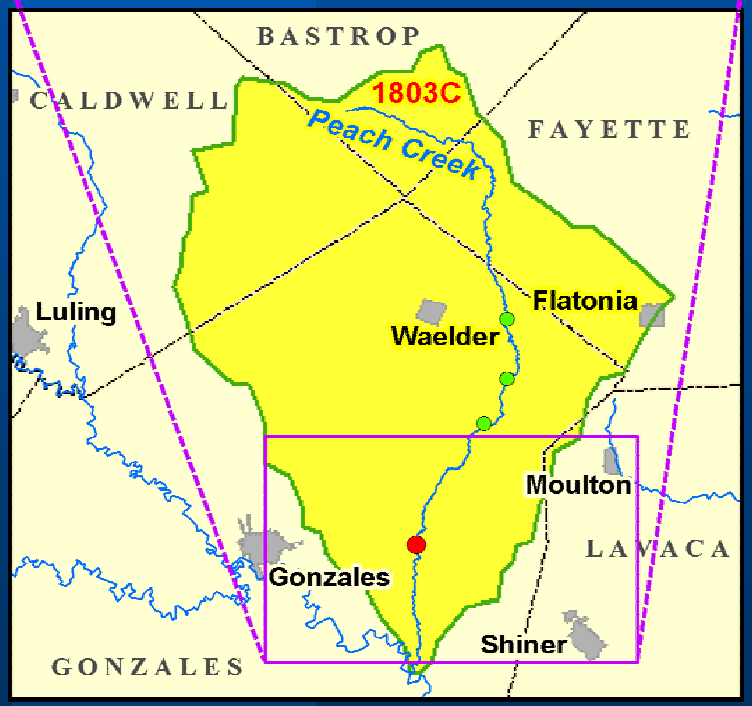
Station ID 17935 – Peach Creek at CR 397

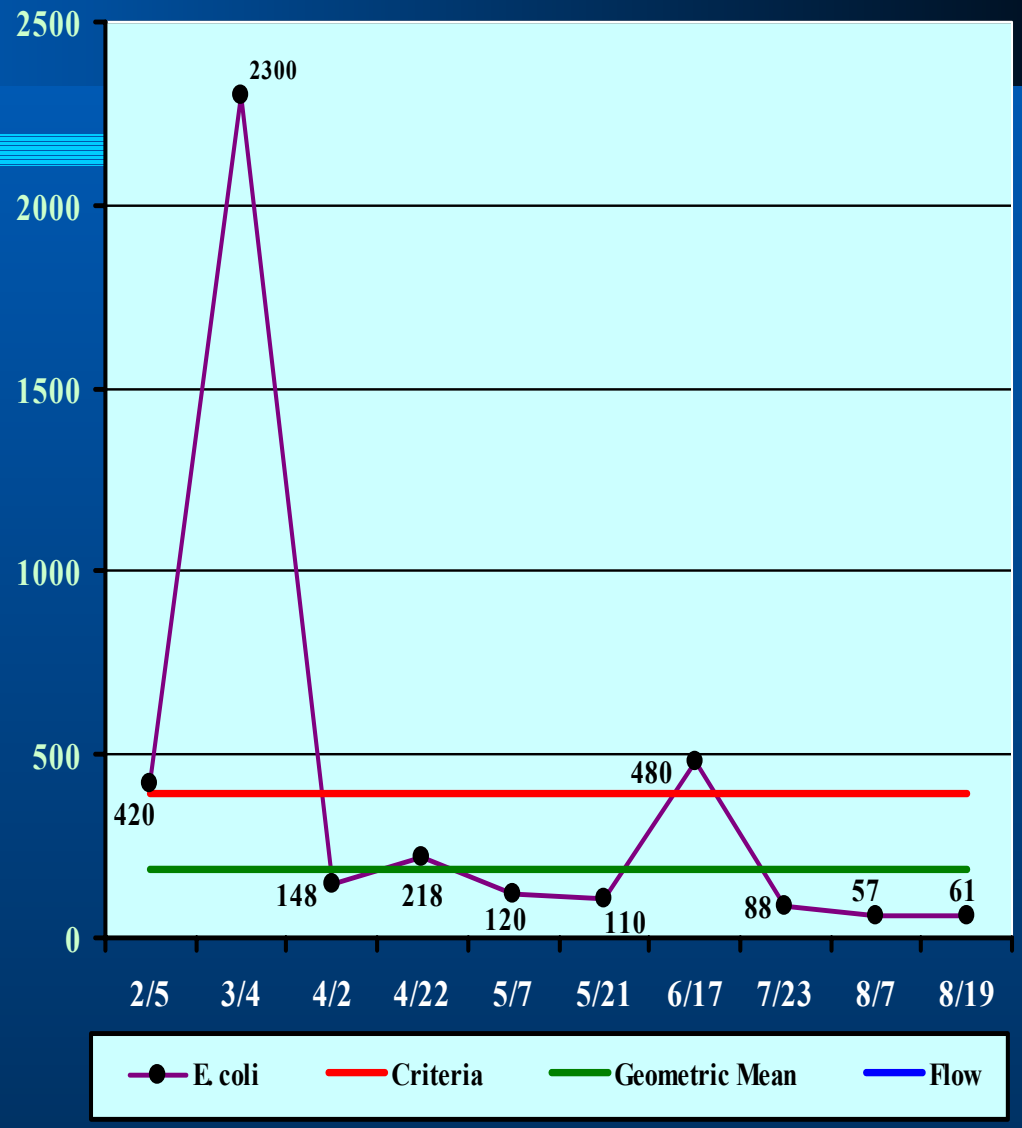




Station ID 14937 – Peach Creek at CR 353





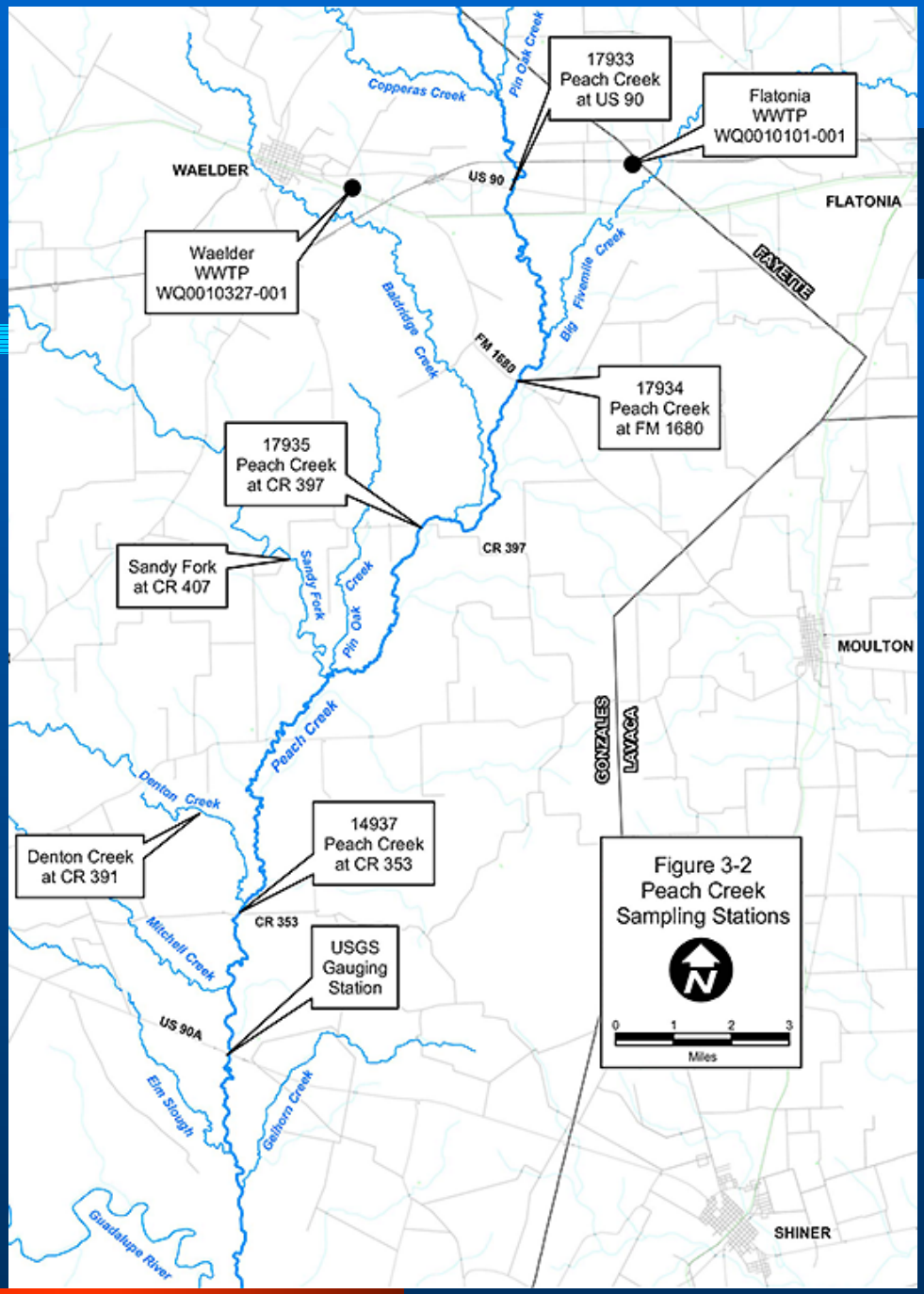


Recent Phase

- Segment 1803C Peach Creek
  - Baseflow Sampling
  - Runoff Sampling
  - 4 Mainstem stations
  - 2 Tributary stations
  - 2 Point sources

Monitoring Plan Details

		Modeling Support				
		Baseflow Sampling (TN) 1 Event			Runoff Sampling (TN) 2 Events	
Description	Station ID	E. Coli	Field Parameters (T, DO, pH, Cond., Cl_2-Res., Flow Quan., Flow Severity)	E. coli in Sediment	E. Coli	Field Parameters (T, DO, pH, Cond., Cl_2-Res., Flow Quan., Flow Severity)
Main Stem						
PEACH CREEK AT US 90	17933	3	3	1	10	10
PEACH CREEK AT FM 1680	17934	3	3	1	10	10
PEACH CREEK NEAR HICKSTON	17935	3	3	1	10	10
PEACH CREEK AT GONZALES CR 353, 14.0KM EAST OF GONZALES	14937	3	3	1	10	10
Tributaries						
SANDY FORK AT CR 407 WEST OF HICKSTON, TX	TBD	3	3	1	10	10
DENTON CREEK AT CR 391	TBD	3	3	1	10	10
Wastewater Discharges						
FLATONIA WWTP DISCHARGE (PERMIT WQ0010101-001)	N/A	3	3	0	10	10
WAELDER WWTP DISCHARGE (PERMIT WQ0010327-001)	N/A	3	3	0	10	10

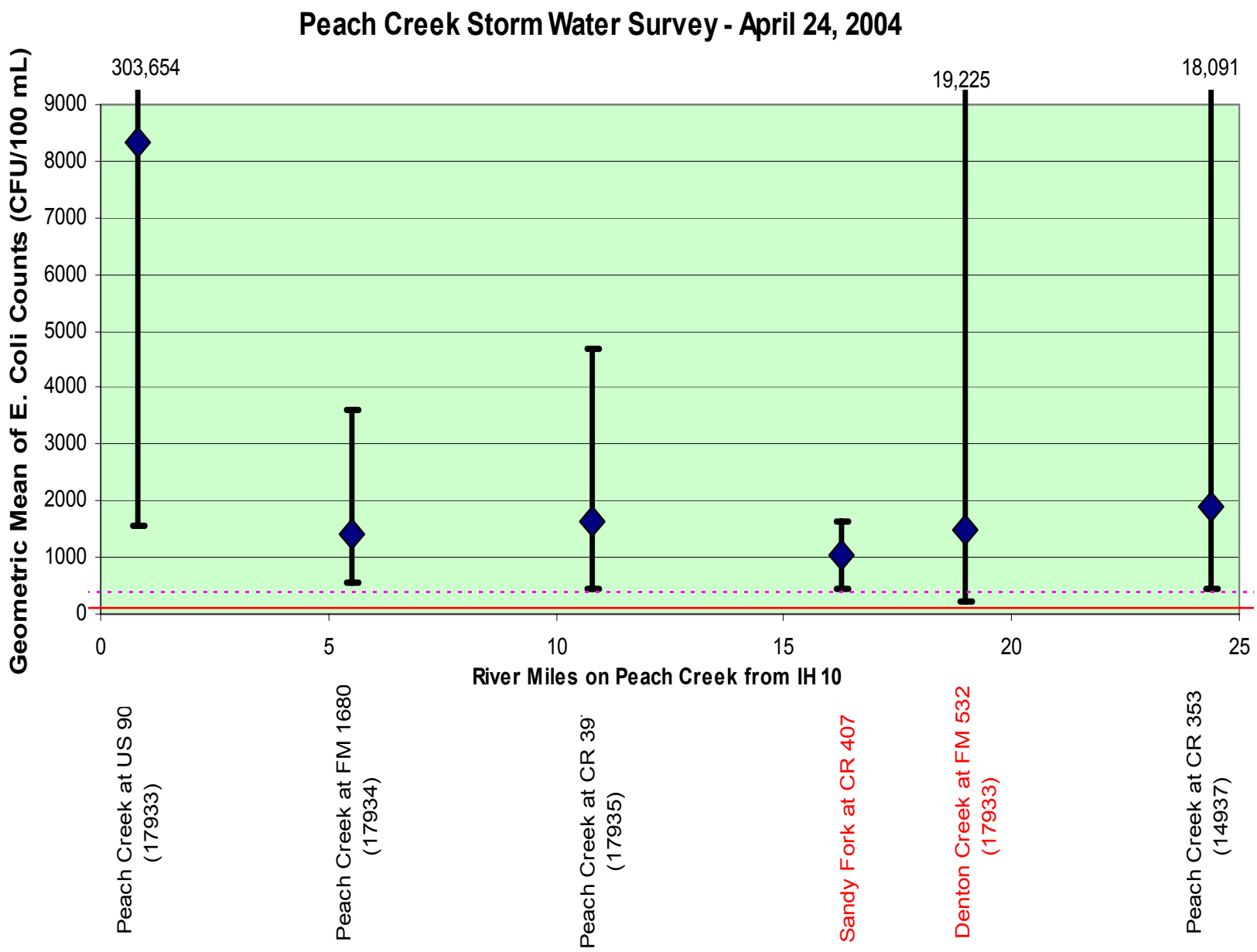

17933
Peach Creek
at US 90
Flatonia
WWTP
WQ0010101-001
Copperas Creek
Pin Oak Creek
WAELDER
US 90
FLATONIA
Waelder
WWTP
WQ0010327-001
Baldridge Creek
Fivemile Creek
Big
FAYETTE
FM 1680
17934
Peach Creek
at FM 1680
17935
Peach Creek
at CR 397
CR 397
Sandy Fork
at CR 407
Sandy Fork
Pin Oak Creek
MOULTON
GONZALES
LAVACA
Peach Creek
Denton Creek
14937
Peach Creek
at CR 353
Denton Creek
at CR 391
CR 353
Mitchell Creek
USGS
Gauging
Station
US 90A
Elm Slough
Gellhorn Creek
Guadalupe River
SHINER
Figure 3-2
Peach Creek
Sampling Stations
N
0
1
2
3
Miles

Field Measurements

Time of Travel

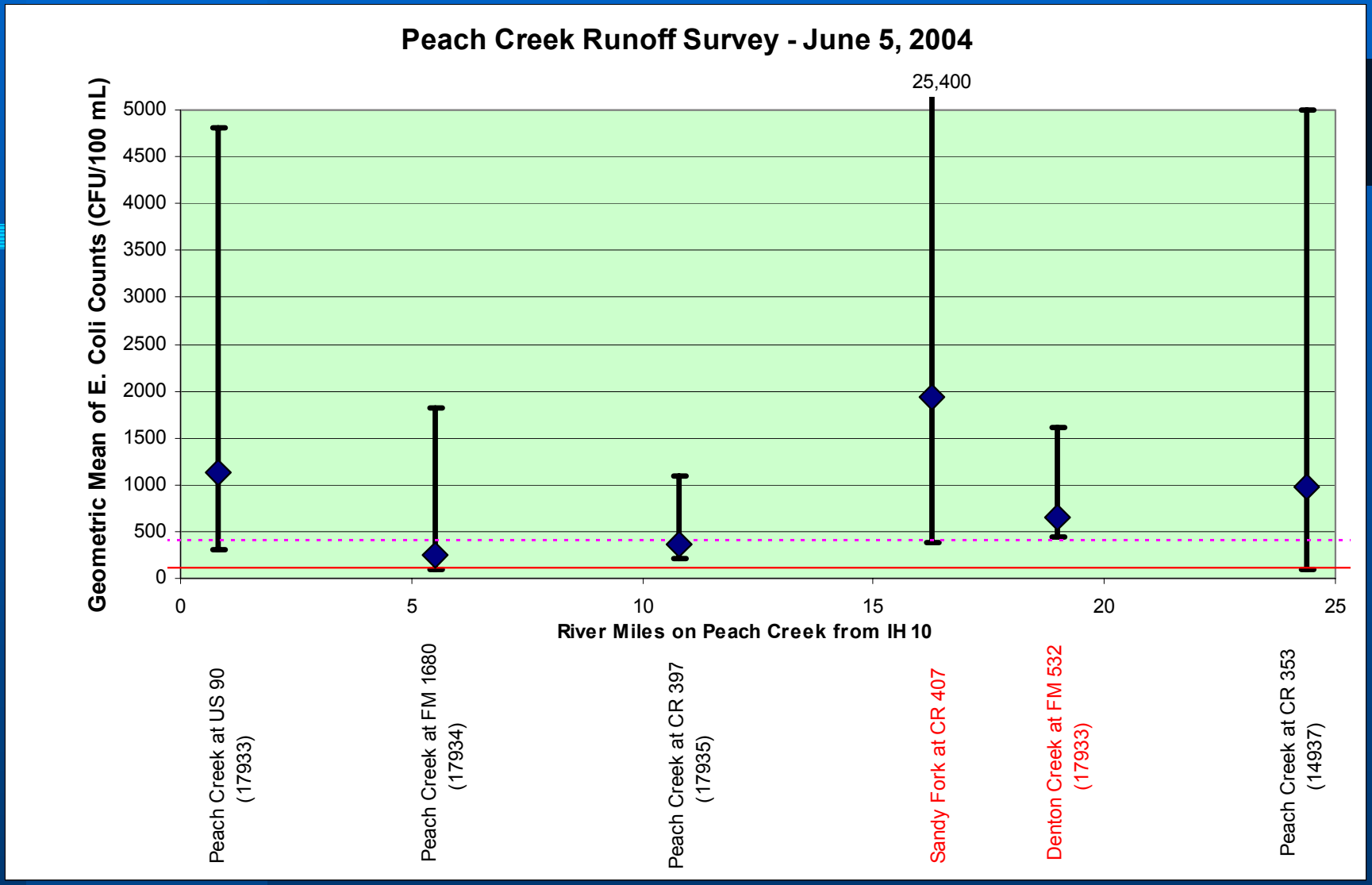
Time of Travel

Bacteria Kinetics


Peach Creek Storm Water Survey - April 24, 2004
Geometric Mean of E. Coli Counts (CFU/100 mL)
303,654
19,225
18,091
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
5
10
15
20
25
River Miles on Peach Creek from IH 10
Peach Creek at US 90 (17933)
Peach Creek at FM 1680 (17934)
Peach Creek at CR 39' (17935)
Sandy Fork at CR 407
Denton Creek at FM 532 (17933)
Peach Creek at CR 353 (14937)

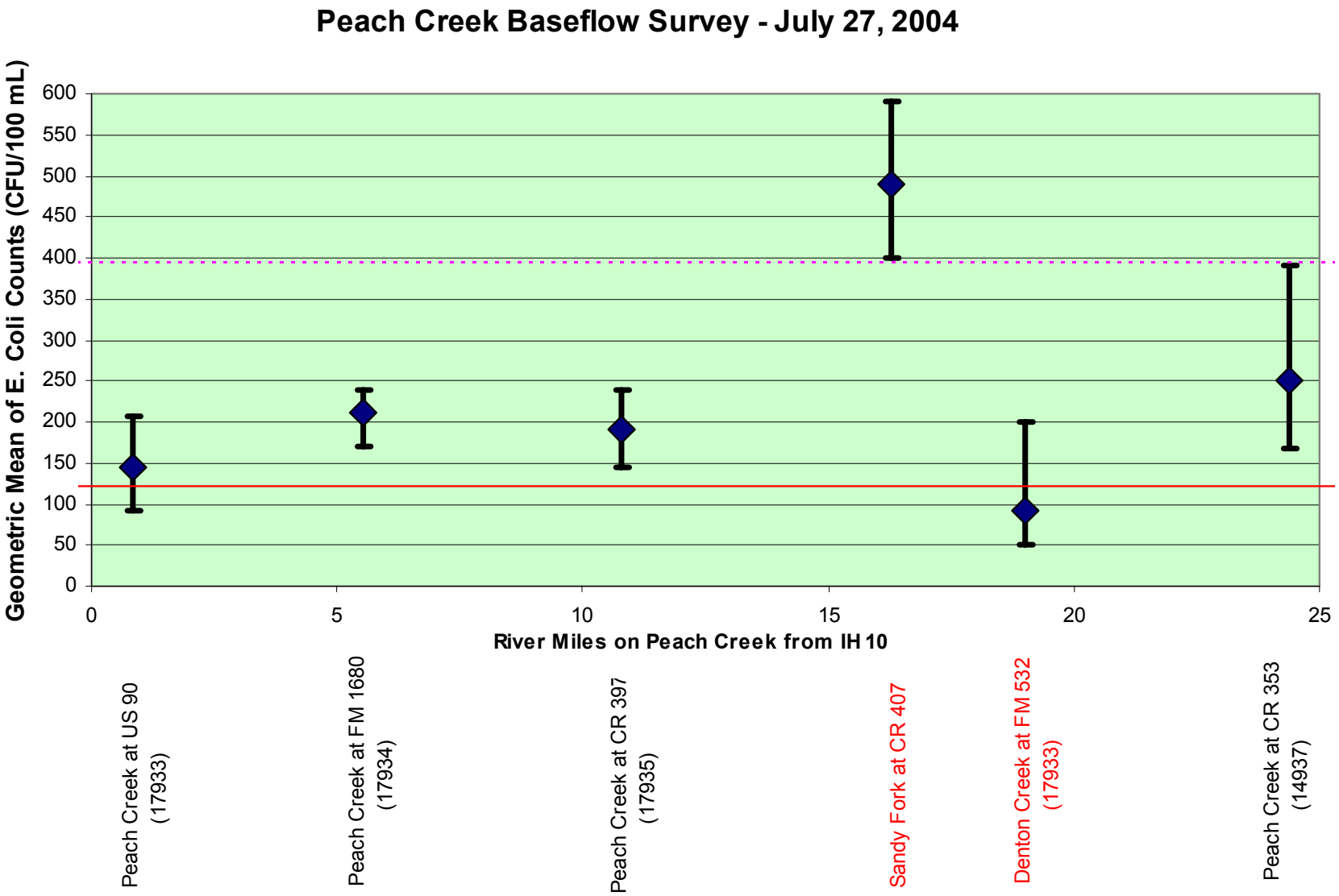
Peach Creek Storm Water Runoff Survey – April 24, 2004

- Main Stem
  - 4 Stations Sampled
  - 4 Stations with geometric means > 126 CFU/100 ml
  - 4 Stations with maximums > 394 CFU/100 ml
- Tributaries
  - 2 Stations Sampled
  - 2 Stations geometric means > 126 CFU/100 ml
  - 2 Stations with maximums > 394 CFU/100 ml
- WWTPs
  - 2 WWTPs sampled
  - 0 WWTPs with geometric means > 126 CFU/100 ml
  - 0 WWTPs with maximums > 394 CFU/100 ml


Peach Creek Runoff Survey - June 5, 2004
Geometric Mean of E. Coli Counts (CFU/100 mL)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
25,400
0
5
10
15
20
25
River Miles on Peach Creek from IH 10
Peach Creek at US 90 (17933)
Peach Creek at FM 1680 (17934)
Peach Creek at CR 397 (17935)
Sandy Fork at CR 407
Denton Creek at FM 532 (17933)
Peach Creek at CR 353 (14937)

Peach Creek Runoff Survey – June 5, 2004

- Main Stem
  - 4 Stations Sampled
  - 4 Stations with geometric means > 126 CFU/100 ml
  - 4 Stations with maximums > 394 CFU/100 ml
- Tributaries
  - 2 Stations Sampled
  - 2 Stations geometric means > 126 CFU/100 ml
  - 2 Stations with maximums > 394 CFU/100 ml
- WWTPs
  - 2 WWTPs sampled
  - 0 WWTPs with geometric means > 126 CFU/100 ml
  - 0 WWTPs with maximums > 394 CFU/100 ml


Peach Creek Baseflow Survey - July 27, 2004
Geometric Mean of E. Coli Counts (CFU/100 mL)
600
550
500
450
400
350
300
250
200
150
100
50
0
0
5
10
15
20
25
River Miles on Peach Creek from IH 10
Peach Creek at US 90 (17933)
Peach Creek at FM 1680 (17934)
Peach Creek at CR 397 (17935)
Sandy Fork at CR 407
Denton Creek at FM 532 (17933)
Peach Creek at CR 353 (14937)

Peach Creek Baseflow Survey – July 27, 2004

Main Stem

- 4 Stations Sampled
- 4 Stations with geometric means > 126 CFU/100 ml
- 0 Stations with maximums > 394 CFU/100 ml

Tributaries

- 2 Stations Sampled
- 1 Stations geometric means > 126 CFU/100 ml
- 1 Stations with maximums > 394 CFU/100 ml

WWTPs

- 2 WWTPs sampled
- 0 WWTPs with geometric means > 126 CFU/100 ml
- 0 WWTPs with maximums > 394 CFU/100 ml

Bacterial Source Tracking (BST)

- Method: Ribotyping
  - Genetic fingerprints of E. coli strains
  - Genes that code for ribosome RNA
  - Distinguish between different bacterial strains
  - Agricultural Research and Extension Center (AREC) in El Paso

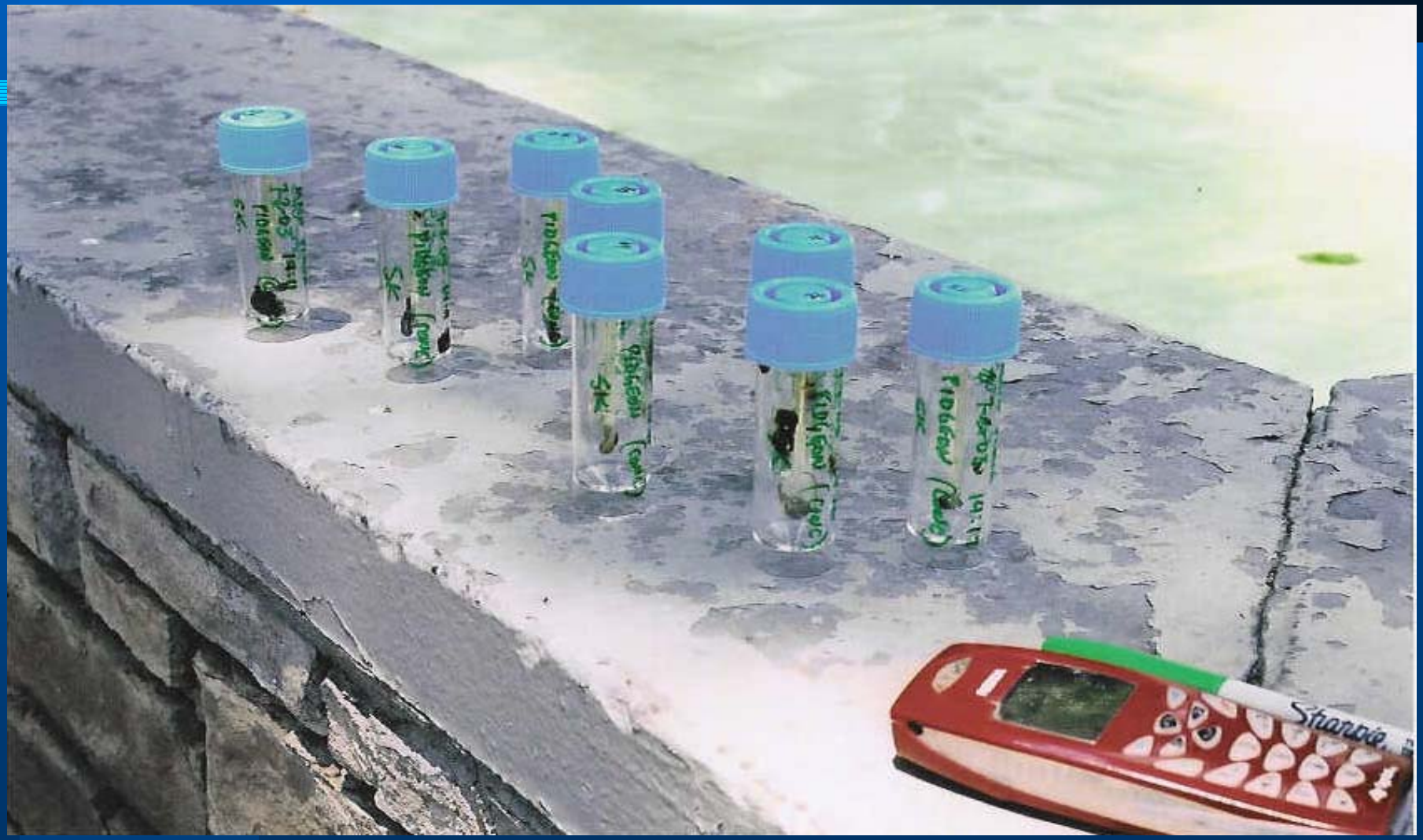
Bacterial Source Tracking (BST)

- Library of Known Bacteria Types (knowns)
- Salado Creek/Upper San Antonio River: 500 samples
- Lower San Antonio River: 200 Samples
- Peach Creek: 300 samples

BST

BST

BST



BST Water Samples (Unknowns)

- Peach Creek
  - Station 14937 – CR 353 – 80 samples

Bacteria Source Tracking (BST) Results

Dr. George D. Di Giovanni
Associate Professor, Environmental Microbiology
El Paso Agricultural Research and Extension Center
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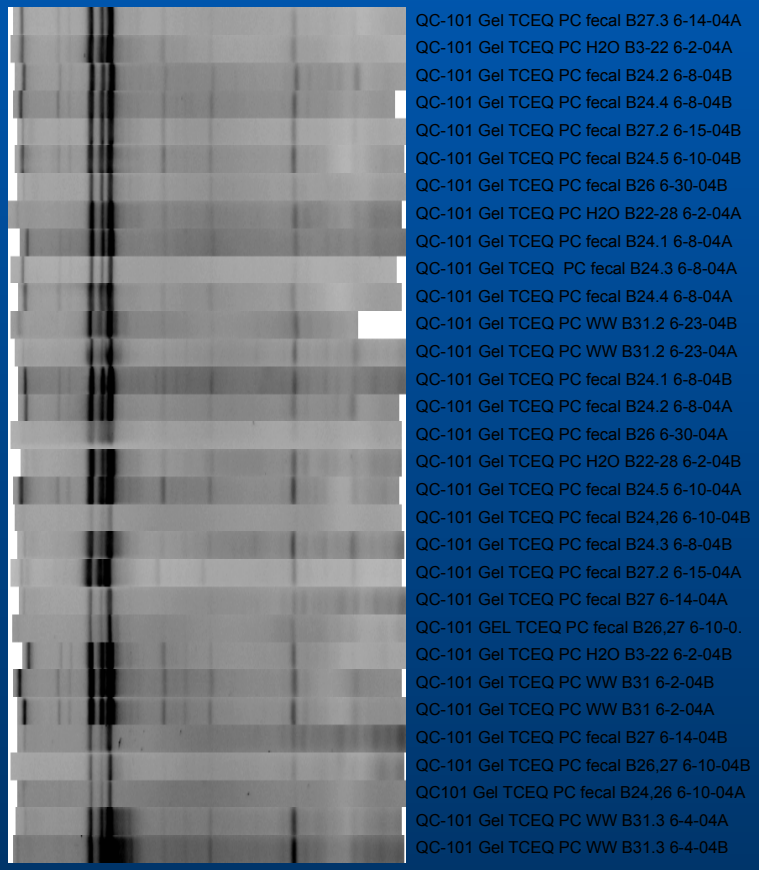
El Paso, Texas 79927-5020
(915) 859-9111 ext. 231
gdigiovanni@ag.tamu.edu

Reproducibility of ERIC-PCR DNA Fingerprints for Peach Creek

31 ERIC-PCR replicates of *E. coli* QC-101



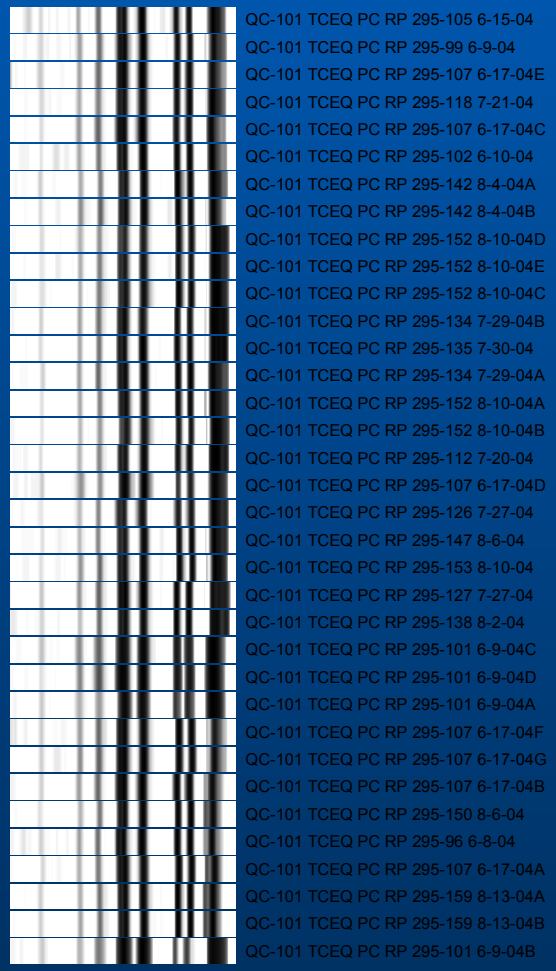
Average similarity and SD of replicates: 92.1% ± 5.3%

Range: 97.6% - 72.3%

85% Similarity Cutoff used to indicate significant match between water isolates and source library

Reproducibility of RiboPrint DNA Fingerprints for Peach Creek

35 RiboPrint replicates of *E. coli* QC-101



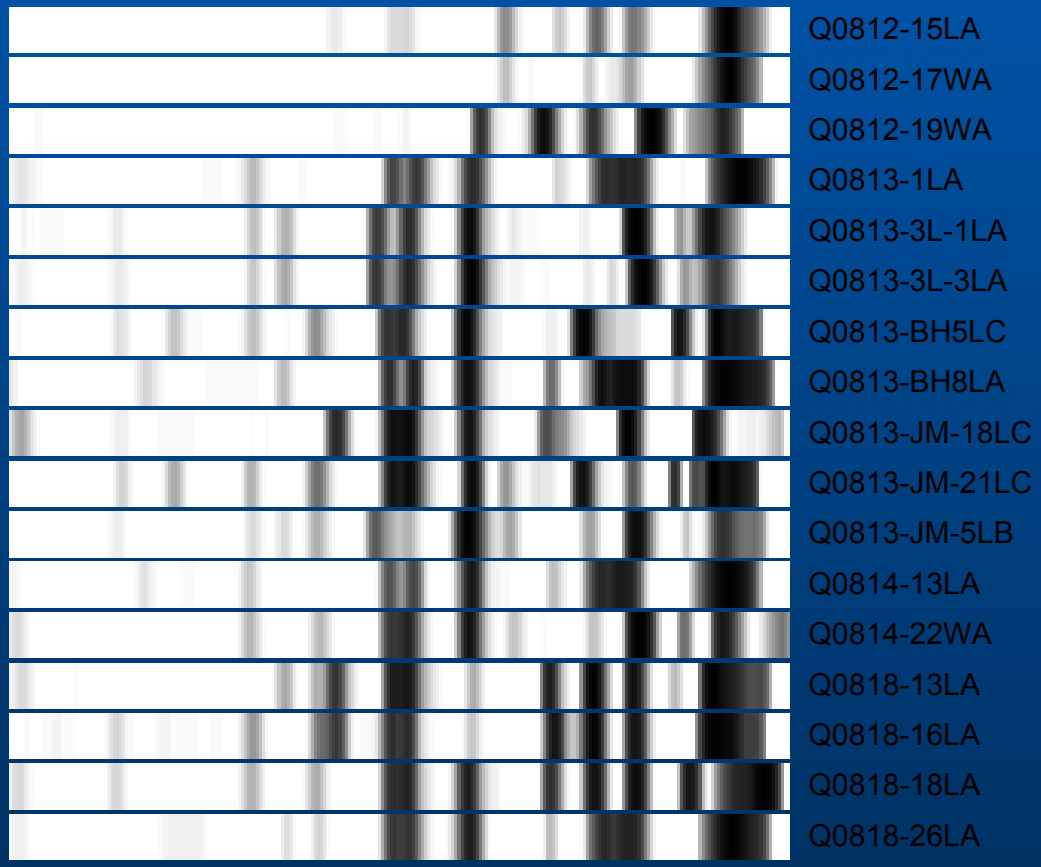
Average similarity and SD of replicates: 89.8% ± 6.2%

Range: 97.9% - 71.4%

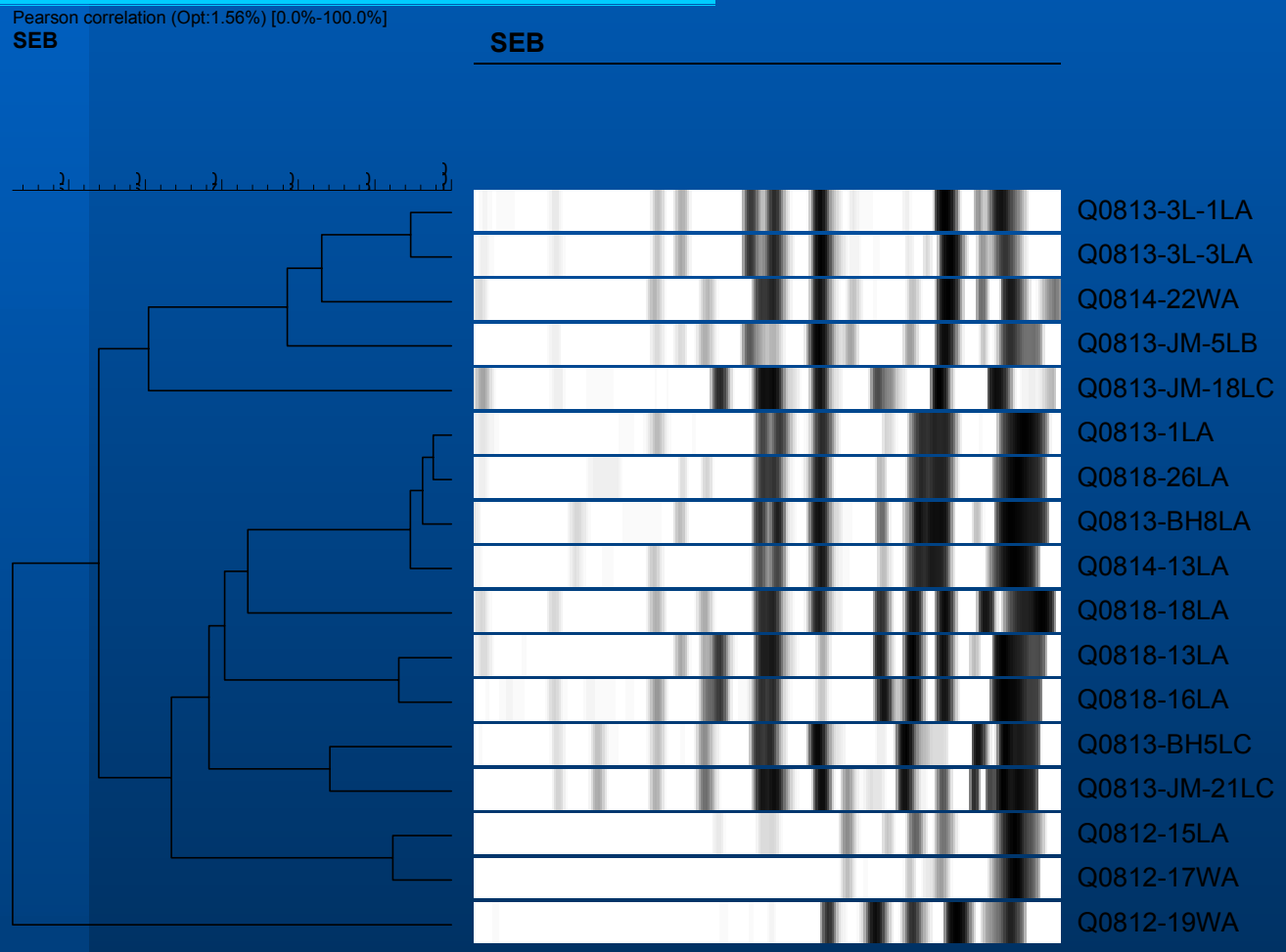
85% Similarity Cutoff used to indicate significant match between water isolates and source library

RAW DATA

SEB

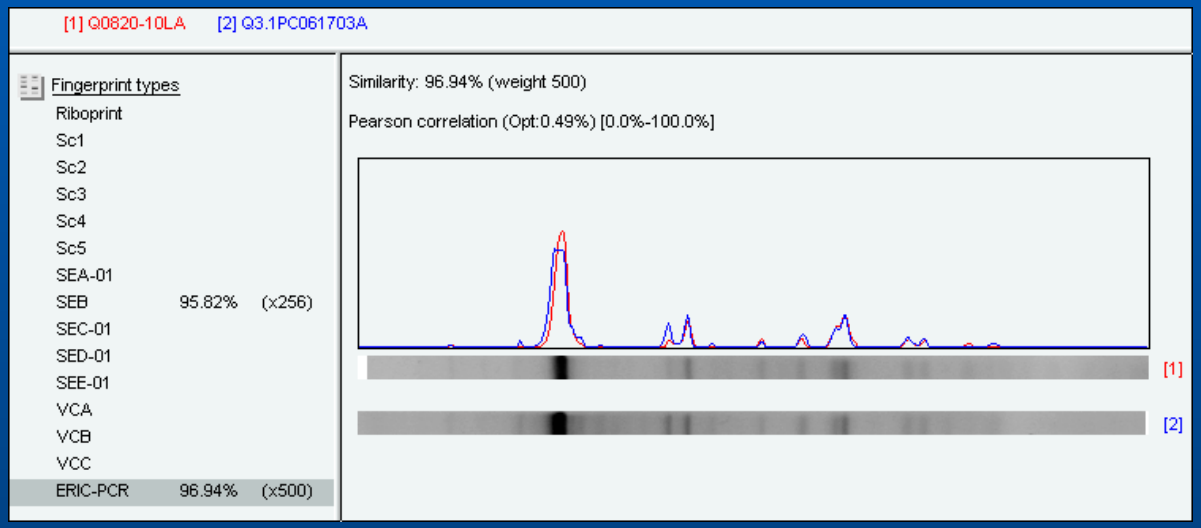

Q0812-15LA
Q0812-17WA
Q0812-19WA
Q0813-1LA
Q0813-3L-1LA
Q0813-3L-3LA
Q0813-BH5LC
Q0813-BH8LA
Q0813-JM-18LC
Q0813-JM-21LC
Q0813-JM-5LB
Q0814-13LA
Q0814-22WA
Q0818-13LA
Q0818-16LA
Q0818-18LA
Q0818-26LA

ANALYZED DATA

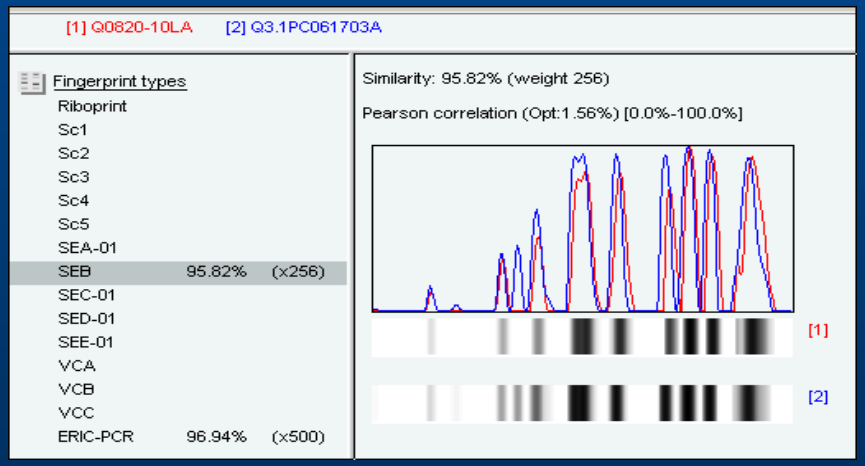


Source Identification

Best ERIC-PCR Match (96.9% Similarity) of Water Isolate to Known Source (Pig) Isolate in Library

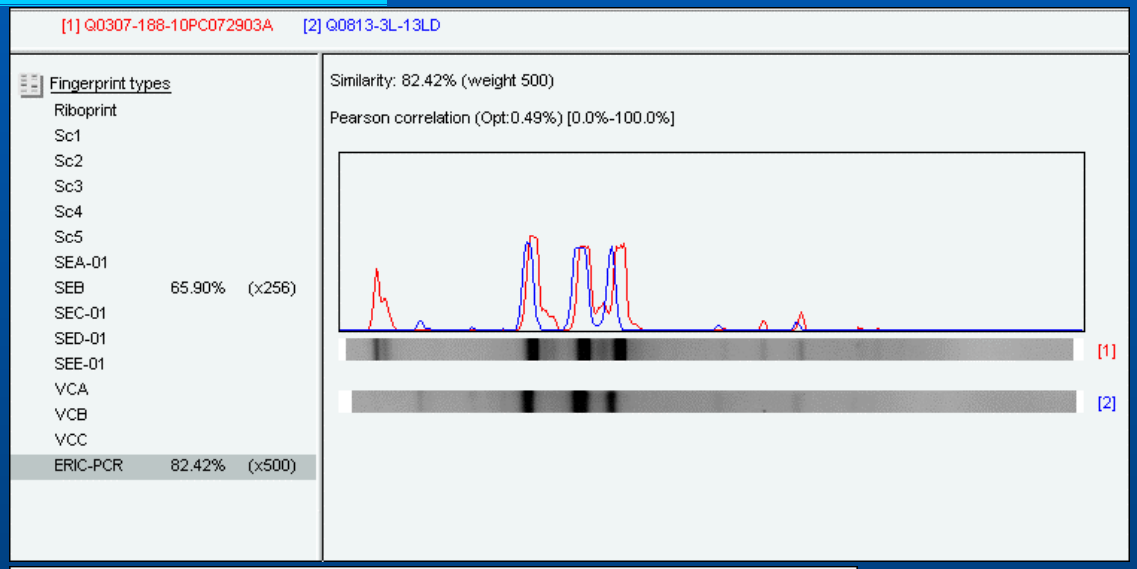


Best RiboPrint Match (95.8% Similarity) of Water Isolate to Known Source (Pig) Isolate in Library

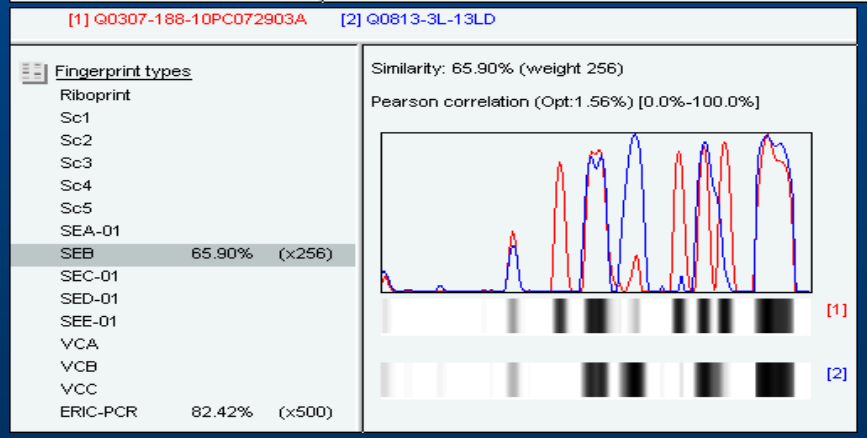


Source Identification

No Match (Unidentified) Water Isolate, Best ERIC-PCR Match of only 82.4% Similarity to Known Source Isolate in Library



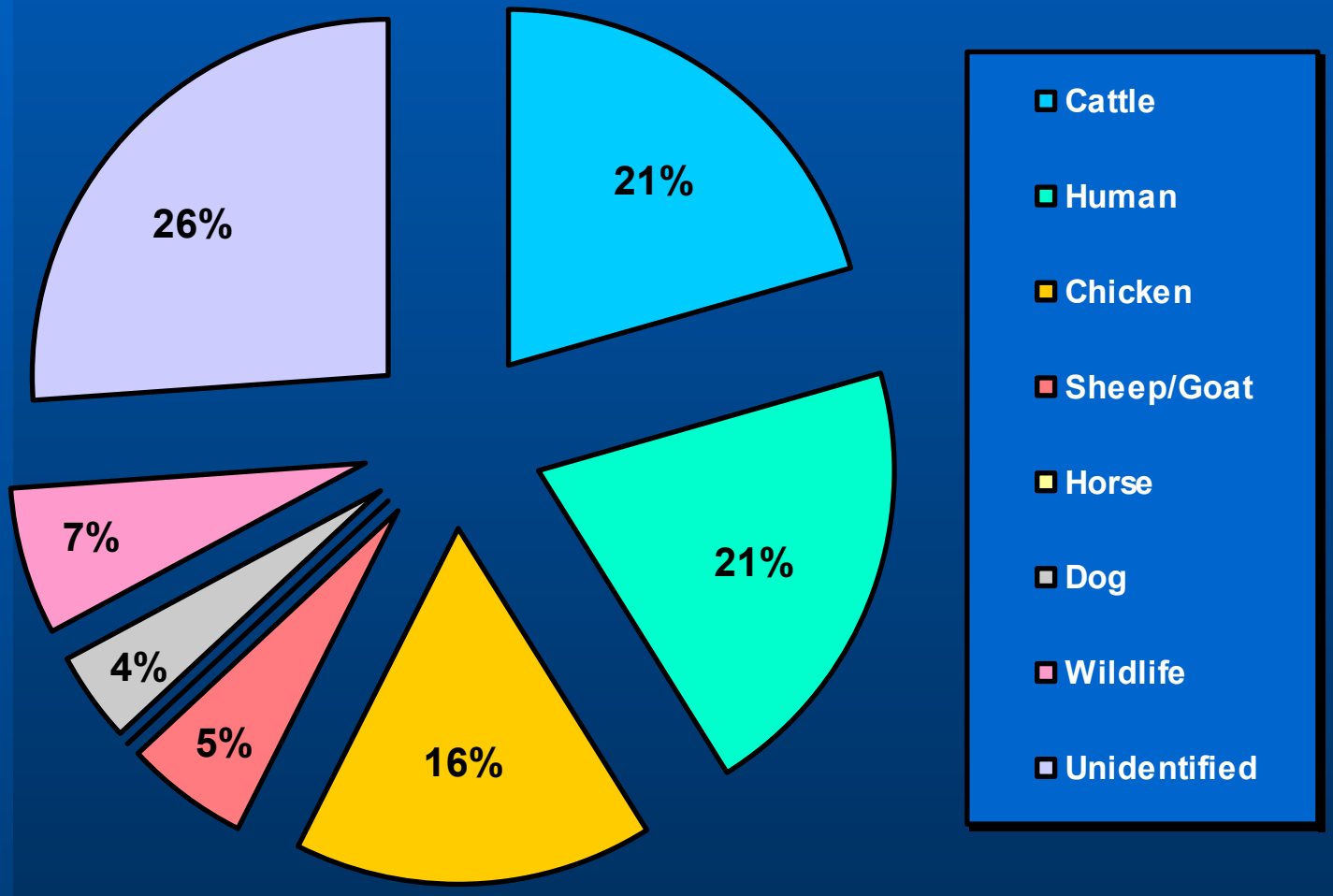
No Match (Unidentified) Water Isolate, Best RiboPrint Match of only 65.9% Similarity to Known Source Isolate in Library



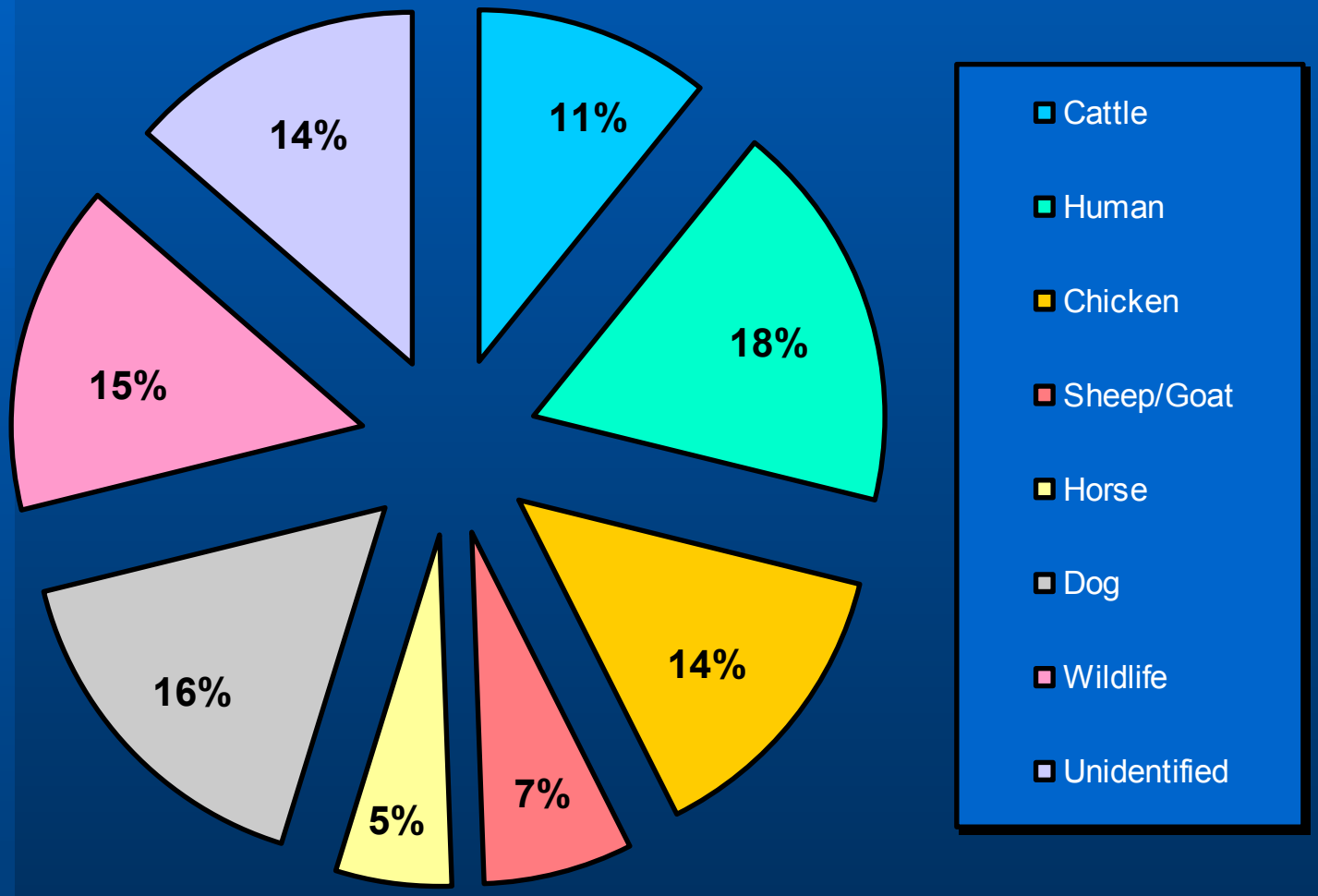
Preliminary Source Identification of Ambient Water Samples from Peach Creek (n=73)

Source	Number Isolates ERIC-PCR (≥85% sim) ID	% of Total Sources	Number Isolates RiboPrinting (≥85% sim) ID	% of Total Sources
Cattle	15	20.5	8	11.0
Domestic Sewage	15	20.5	13	17.8
Chicken	12	16.4	10	13.7
Sheep	3	4.1	5	6.8
Dog	3	4.1	12	16.4
Racoon	2	2.7	5	6.8
Coyote	2	2.7	0	0.0
Goat	1	1.4	0	0.0
Horse	0	0.0	4	5.5
Skunk	0	0.0	3	4.1
Pig	1	1.4	1	1.4
Duck	0	0.0	1	1.4
Deer	0	0.0	1	1.4
Unidentified	19	26.0	10	13.7

ERIC-PCR DATA RESULTS



RIBOTYPING DATA RESULTS



TPDES General Permit No. TXG920000

- Part II Permit Applicability and Coverage
  - Section B. Limitations on Coverage
  - 1. Limitations Based on Facility Location
    - Discharges from the following CAFOs are not eligible for coverage under this general permit and must be authorized under an individual permit:
    - (d) Any CAFO where any part of a production area or land management unit is located in a watershed of a segment listed on the current EPA approved 303(d) list of impaired waters as required by 33 USC §1313(d) where a Total Maximum Daily Load (TMDL) implementation plan has been adopted by the Commission that established additional water quality protection measures for CAFOs which are not required by the CAFO general permit.

Questions / Comments ?