Appendix B: Preliminary Action Report

BACTERIA IMPLEMENTATION GROUP'S TOP FIVE MOST AND TOP FIVE LEAST IMPAIRED WATER BODIES

PRELIMINARY ACTION REPORT

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1.0 Introduction

1.1 Background

The Bacteria Implementation Group (BIG), a partnership of government, business, and community leaders, was formed in 2008 following the completed Total Maximum Daily Load (TMDL) study. The BIG developed an implementation plan (I-Plan) that addresses elevated levels of bacteria in 72 bacteria-impaired segments in the Houston-Galveston region. The *BIG's Top Five Most and Top Five Least Impaired Water Bodies* project was developed as a result of the BIG's tracking of bacteria levels and development of the Top 10 Most/ Top 10 Least Impaired Water Bodies lists. The Top 10 Most Impaired Water Bodies are impaired assessment units (AUs) with the highest geometric means relative to the state standards for bacteria; and the Top 10 Least Impaired Water Bodies are impaired AUs with the lowest geometric means relative to the state standards for bacteria. See Figure 1. The purpose of *BIG's Top Five Most and Top Five Least Impaired Water Bodies* project is to investigate potential bacteria discharges in selected AUs from the Top 10/Least 10 lists to eliminate them by working with local jurisdictions in an effort to assist with Illicit Discharge Detection and Elimination (IDDE) in the BIG area. The ultimate goal of the project is to improve conditions enough to meet state water quality standards and remove listed stream segments from the state's list of bacteria-impaired waterways.

The BIG project area drains to Galveston Bay, where a sizeable area of the Bay's oyster producing waters are restricted to recreational harvest by the Texas Department of State Health Services due to elevated bacteria levels. However, contact recreation is the primary impairment or concern identified in the BIG region and will be the focus of this project. The contact recreation standard uses indicator bacteria (*E. coli* and Enterococcus) as surrogates for the potential presence of human pathogens. Bacteria is known to come from a variety of sources (anthropogenic and wildlife) and is associated with land cover/land uses which include but are not limited to agriculture and urban development run-off, wastewater conveyance and treatment, and illicit discharges.

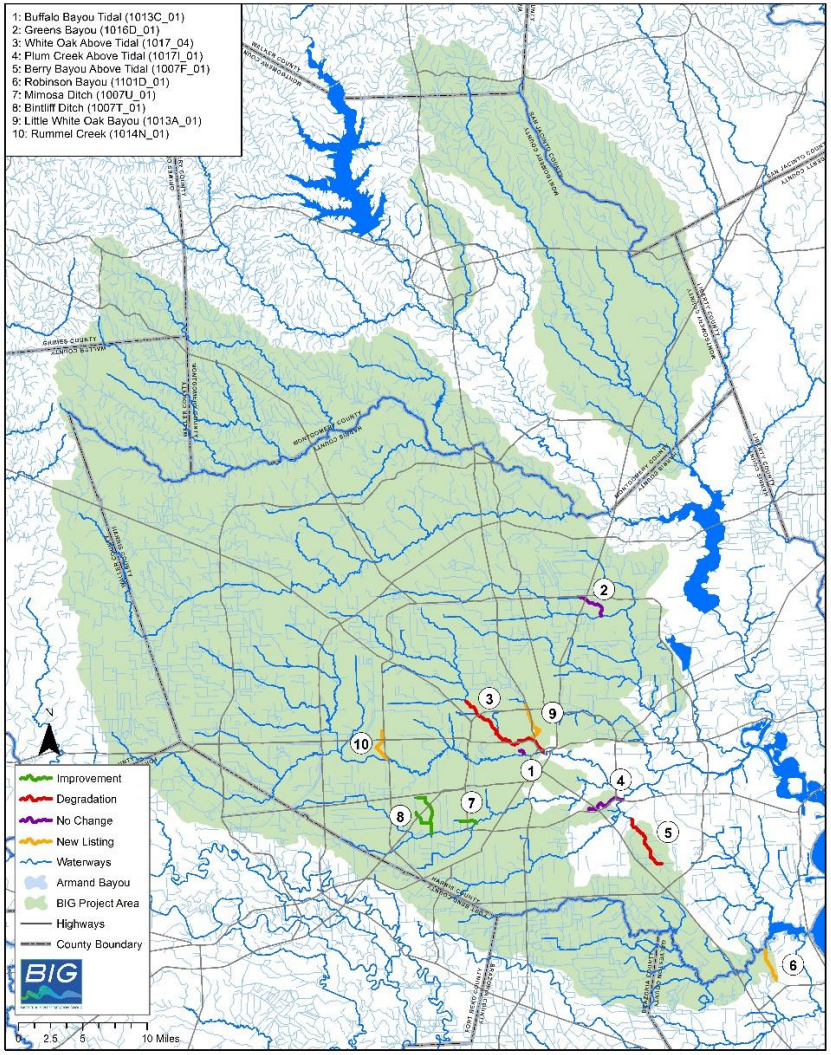
The Houston-Galveston Area Council (H-GAC) is the Regional Council of Governments for the Gulf Coast State Planning Region and has been actively involved in regional water quality planning and public outreach activities since the 1970s. H-GAC is designated as the lead agency responsible for administration of the *BIG's Top Five Most and Top Five Least Impaired Water Bodies* project. The project is funded through grants from the U.S. Environmental Protection Agency through the Texas Commission on Environmental Quality's (TCEQ) Galveston Bay Estuary Program (GBEP).

1.2 Project Description

H-GAC staff will address 10 targeted watersheds (five each from the Top 10/Least 10 lists) by prioritizing the watersheds through desk reviews, ground truthing, identifying elevated sources of bacteria in the field through sample collection and analysis, and reporting those elevated bacteria sources to appropriate local jurisdictions. H-GAC will not correct the sources but will work with those jurisdictions to remove and/or eliminate the sources.

Local project partners are participating in a technical workgroup to share their extensive knowledge of subject AUs during regular progress meetings held throughout the project period. The project has been split into three phases for simplicity. Figure 2 delineates the three phases through a project flow chart and describes the tasks contained within. This Preliminary Action Report summarizes results for Phase I tasks completed between April and July 2016.

BIG'S TOP TEN MOST IMPAIRED ASSESSMENT UNITS



BIG'S TOP TEN LEAST IMPAIRED ASSESSMENT UNITS

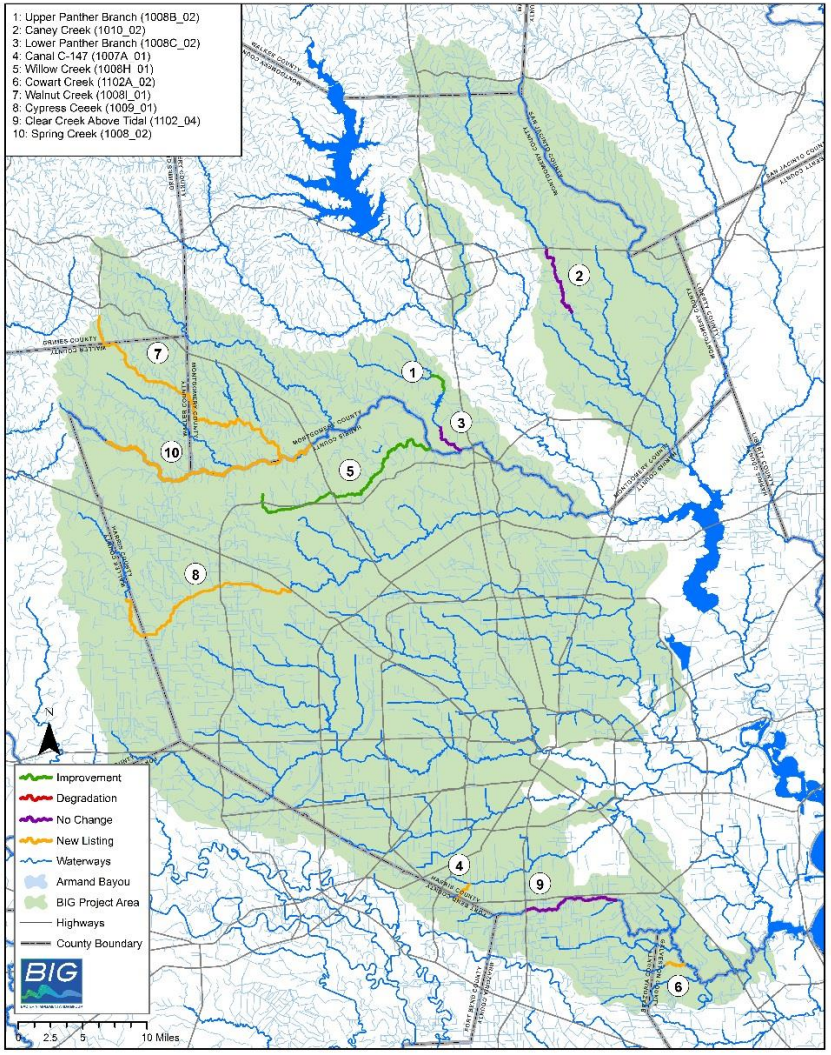


Figure 7. Bacteria Implementation Group's (BIG's) 2015 Top 10/Least 10 AU maps

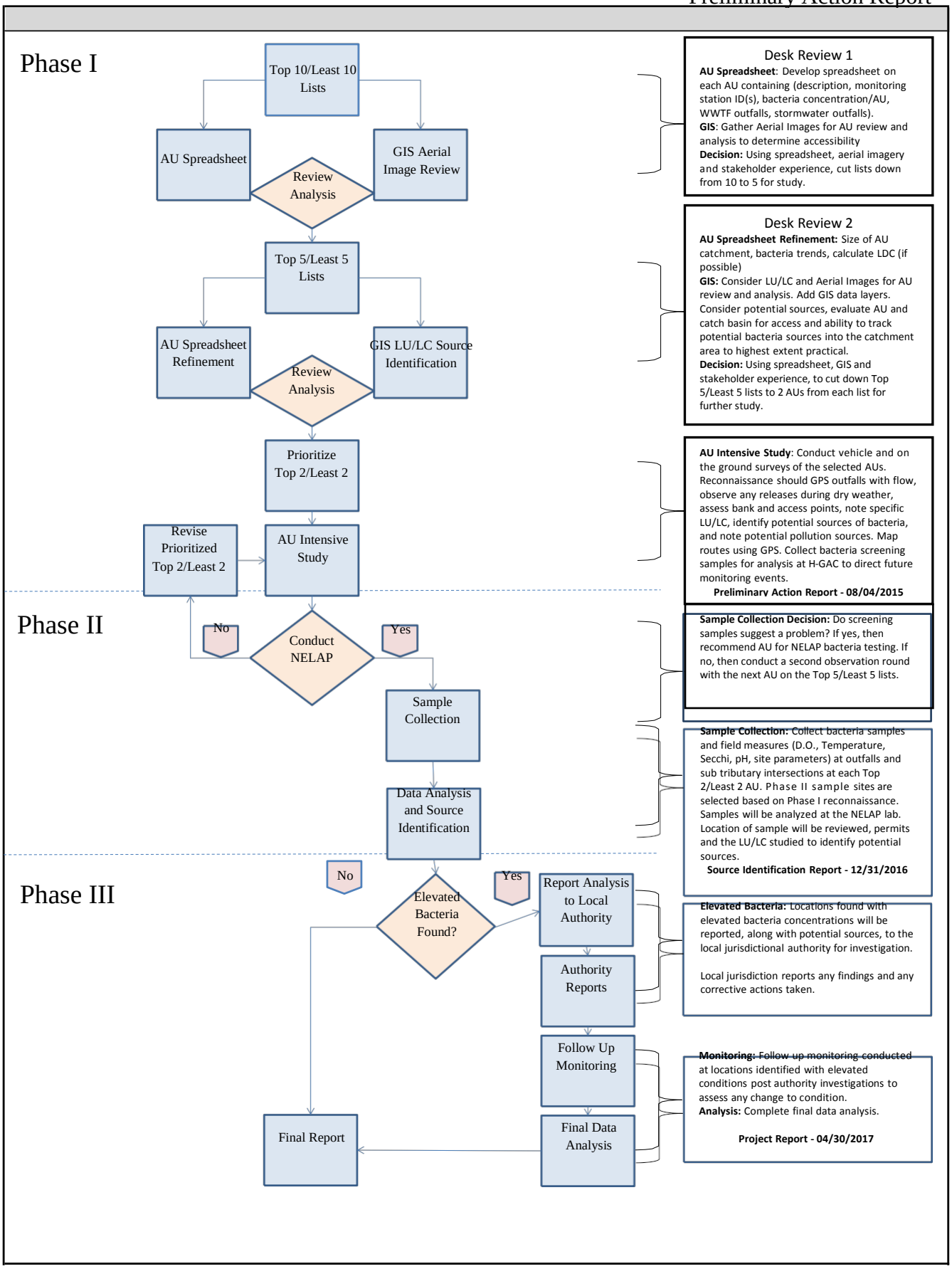


Figure 2. Project flow chart and timeline

2.0 Desk Review 1

During Desk Review 1, initial information about each AU on the BIG's Top 10/Least 10 lists were gathered through GIS map development and data analysis using SAS 9.3 statistical software. Desk Review 1 maps included information about the catchment area for each Top 10/Least 10 AU, as well as AU length, active monitoring stations, wastewater treatment facility (WWTF) outfalls, stormwater outfalls, and on-site sewage facilities (OSSFs). Desk Review 1 maps can be found in Appendix A.

An AU spreadsheet supplements the Top 10/Least 10 lists Desk Review 1 maps. The AU spreadsheet includes a description of each AU on the Top 10/Least 10 lists, along with designated uses, bacteria geometric mean concentrations, number of bacteria measurements used in analysis, as well as a description of active monitoring stations for each AU. Information from the Desk Review 1 AU spreadsheet can be found in the technical workgroup meeting presentation included in Appendix A.

Historical Clean Rivers Program (CRP) monitoring data ranging from January 2005 to present were used to develop moving seven-year bacteria geometric mean plots for each AU on the Top 10/Least 10 lists. The moving seven-year geometric mean plots for bacteria provide a visual interpretation of bacteria fluctuations over time for each AU being analyzed. Desk Review 1 moving-seven year bacteria geometric mean plots can be found in Appendix A.

All materials gathered during Desk Review 1 were presented at the technical workgroup meeting on April 20, 2016. Local partners and interested stakeholders participated and provided feedback about findings and shared additional knowledge and expertise about the Top 10AUs discussed. Based on Desk Review 1 results and discussions with the technical workgroup, the BIG's Top 10 AUs were cut down to the Top 5/Least 5 AUs with bacteria concentration, designated uses, accessibility, and level of interest being the primary criteria by which the lists were prioritized. Table 1 lists the final Top 5/Least 5 AUs that were selected. All materials presented at the meeting, as well as meeting summary notes, can be found in Appendix A.

Table 7. Top 5/Least 5 AU list after Phase I: Desk Review 1

Top Five Most Impaired AUs	Top Five Least Impaired AUs
Berry Bayou Above Tidal (Segment 1007F_01)	*Upper Panther Branch (Segment 1008B_02)*
Mimosa Ditch (Segment 1007U_01)	Lower Panther Branch (Segment 1008C_02)
Bintliff Ditch (Segment 1007T_01)	Canal C-147 (Segment 1007A_01)
Little White Oak Bayou (1013A_01)	Cowart Creek (Segment 1102A_02)
Rummel Creek (1014N_01)	Clear Creek Above Tidal (Segment 1102_04)

3.0 Desk Review 2

During Desk Review 2, the existing GIS maps from Desk Review 1 were further refined to include additional information about the prioritized Top 5/Least 5 AUs. In addition to the map layers included in Desk Review 1, a land use/land cover (LU/LC) layer was added to the Desk Review 2 maps to better identify potential bacteria sources within each AU on the Top 5/Least 5 lists. Potential bacteria sources were also identified on the Desk Review 2 maps with GPS coordinates included for each. Desk Review 2 maps can be found in Appendix B.

Further statistical analysis of historical CRP data was conducted for each AU on the Top 5/Least 5 lists during Desk Review 2. In addition to the moving seven-year bacteria geometric mean plots, a trend

analysis was conducted for each AU to evaluate if bacteria conditions have been improving or getting worse over time. LDCs were also developed for AUs with available U.S. Geological Survey (USGS) flow data. A LDC is a graphical illustration that shows the corresponding relationship between contaminant loadings and stream flow conditions in a given area. Only two AUs on the Top 5/Least 5 lists had enough flow data available to generate LDCs, including Little White Oak Bayou and Cowart Creek. To better evaluate which stream segments tend to have high bacteria concentrations during dry weather conditions, bacteria versus days since last rain graphs were generated for the remaining AUs on the Top 5/Least 5 lists where LDCs were not feasible. Trend graphs, LDCs, and rain graphs generated during Desk Review 2 can be found in Appendix B.

All materials gathered during Desk Review 2 were presented at the technical workgroup meeting on May 26, 2016. The established workgroup participated and provided feedback on findings to assist in prioritizing the Top 5/Least 5 list down to a Top 2/Least 2 list for further assessment and ground truthing during the AU Intensive Study portion of Phase I. Based on Desk Review 2 results and discussions with the technical workgroup, the BIG's Top 5/Least 5 AUs were cut down to the Top 2/Least 2 AUs with bacteria conditions, designated uses, accessibility, and level of interest being the primary criteria by which the lists were prioritized. Table 2 lists the final Top 2/Least 2 AUs that were selected. All materials presented at the meeting, as well as meeting summary notes, can be found in Appendix B.

Table 2. Top 2/Least 2 AU list that was decided on after Phase I: Desk Review 2

Top Two Most Impaired AUs	Top Two Least Impaired AUs
Little White Oak Bayou (1013A_01)	*Upper Panther Branch (Segment 1008B_02)*
Rummel Creek (1014N_01)	Canal C-147 (Segment 1007A_01)

4.0 AU Intensive Study: Top 2 Most Impaired

4.1 Little White Oak Bayou

Little White Oak Bayou, Segment 1013A_01, is one of the most impaired water bodies within the BIG geographic area, with an *E.coli* geometric mean concentration of 1975 MPN/100mL compared to the state water quality standard of 126 MPN/100mL. Desk Review 1 and 2 findings show the primary LU/LC within the 7.9 square mile catchment area is residential. The total length of the waterway is approximately 3.9 miles with two active CRP monitoring stations: station 11148 at Little White Oak Bayou and Trimble Street; and station 16648 at Little White Oak Bayou and White Oak Drive. Designated uses for this segment include Aquatic Life Use, General Use, and Contact Recreation Use. Refer to Figure 3 for the watershed map of Little White Oak Bayou developed during Desk Review 2.

Statistical analysis of Little White Oak Bayou data revealed a gradual decrease in bacteria geometric mean concentrations since 2005 (Figure 4). However, *E.coli* concentrations remain significantly higher than the 126 MPN/100mL standard for the majority of samples collected during the assessment period (Figure 5). The LDC curve generated for station 11148 on Little White Oak Bayou revealed the majority of data points exceeding the state standard for *E.coli* during dry conditions, implying that dry weather discharges high in bacteria seem to be a common occurrence for this stream segment (Figure 6).

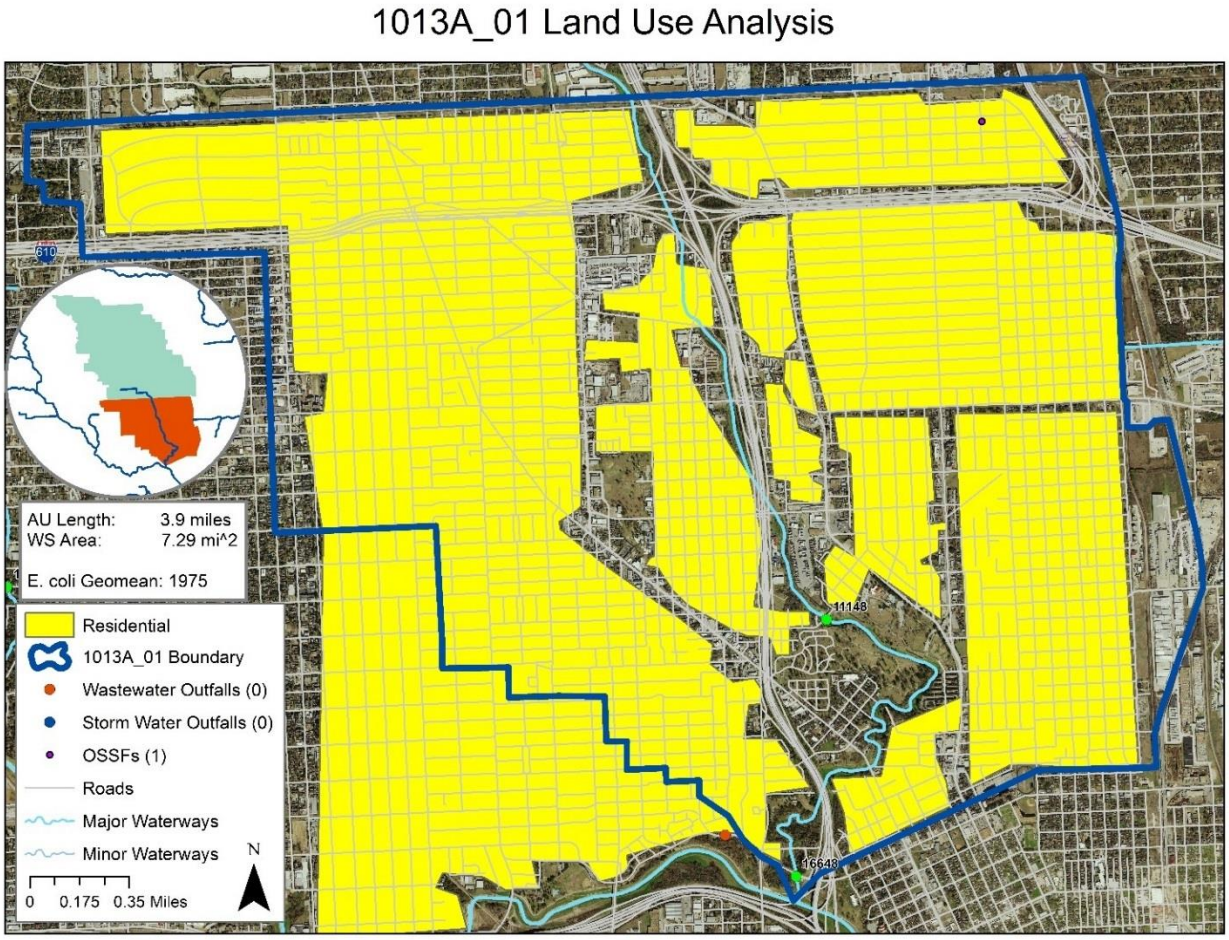


Figure 3. Desk Review 2 map for Little White Oak Bayou Segment 1013A_01

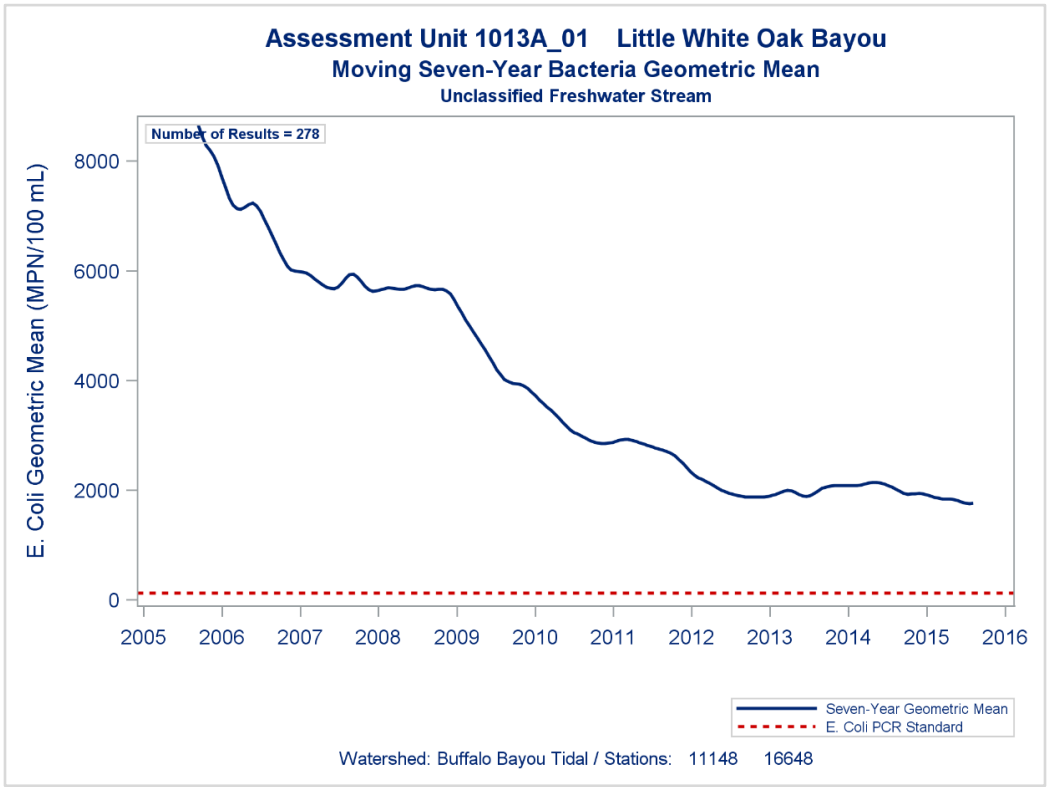


Figure 4. Moving seven-year E.coli geometric mean plot for Little White Oak Bayou

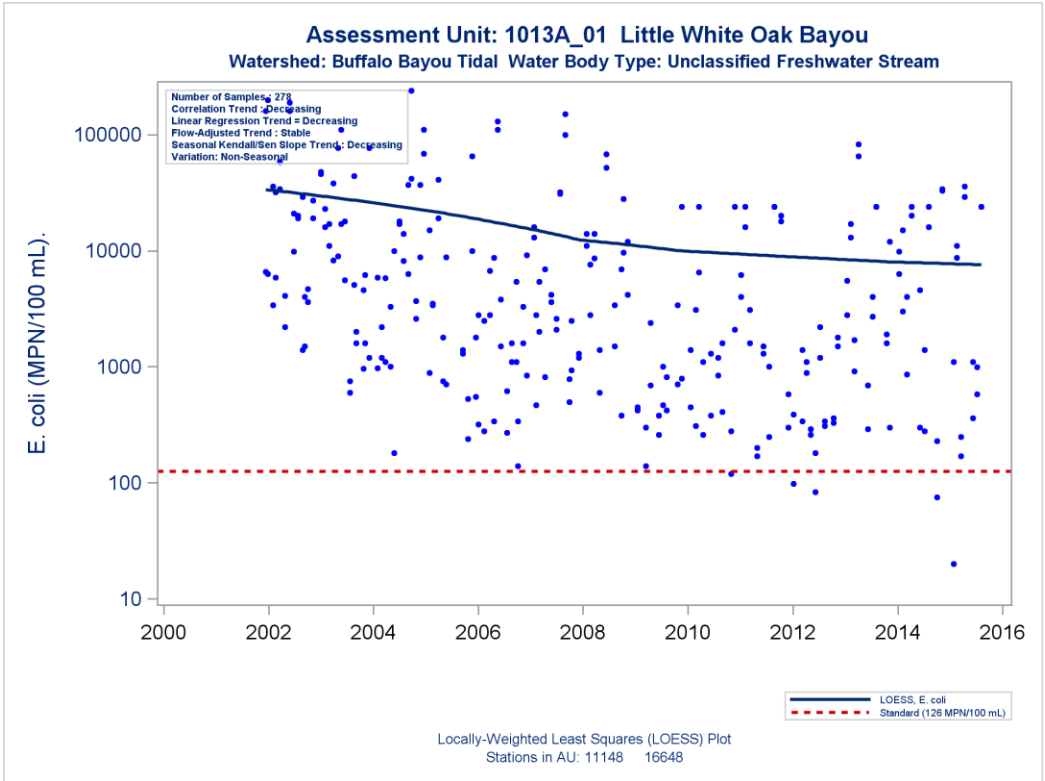


Figure 5. E.coli trend analysis for Little White Oak Bayou

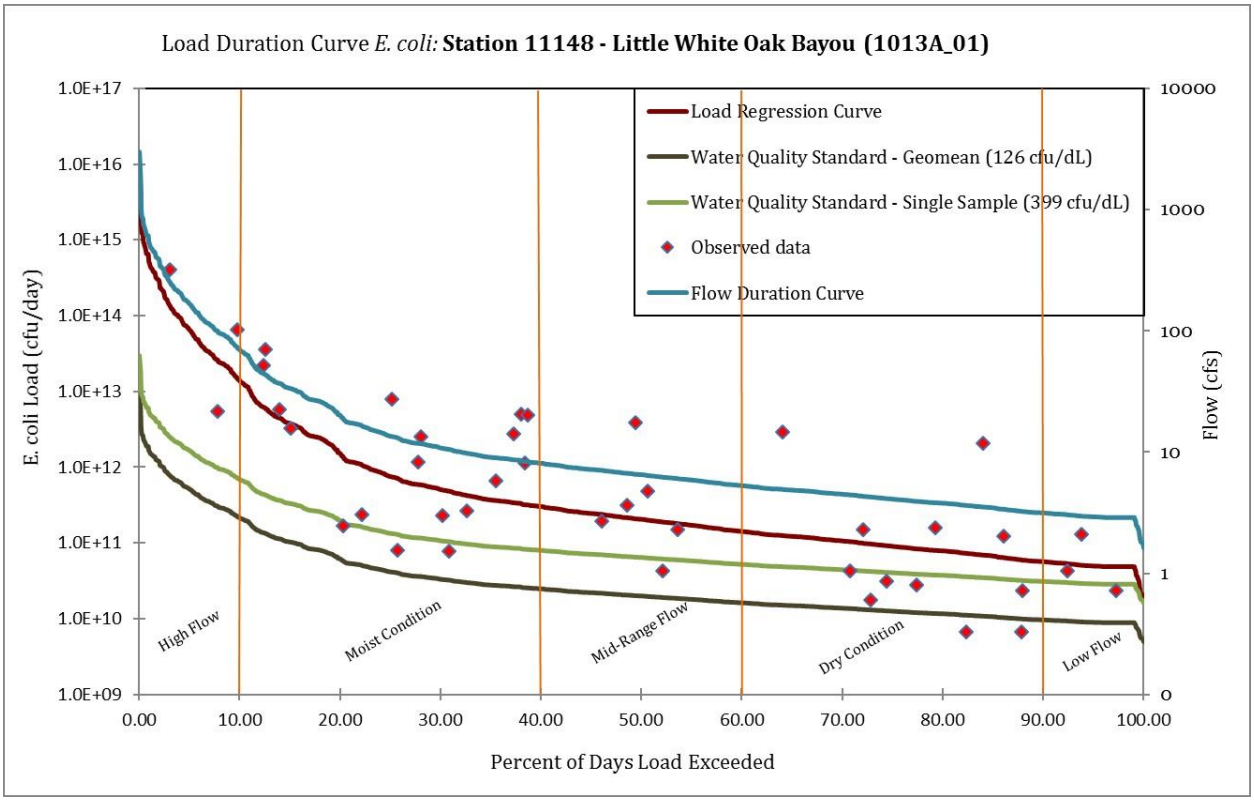


Figure 6. LDC for Little White Oak Bayou at station 11148

4.1.1 Windshield Survey

The windshield survey for Little White Oak Bayou was conducted on June 22, 2016. The waterway was investigated by vehicle, and points of access and potential bacteria sources were noted during the survey. Primary land use is residential throughout the catchment area with light commercial land uses present along the primary thoroughfares of Fulton Street, Main Street, and the I-45 and I-610 corridors. Although no potential bacteria sources were observed during the windshield survey, a significant amount of accumulated trash and litter was seen at bridge crossings and access points throughout the waterway. Refer to Figure C1 in Appendix C for a map of the windshield survey route.

4.1.2 Bacteria Screening

A total of 25 bacteria screening samples were collected along Little White Oak Bayou during the on-the -round surveys July 13, 18, and 20, 2016. Samples were collected at eight discharging outfalls (Figure 7) and one tributary, while the rest of the samples were surface water samples collected in an effort to better identify hot spots and trace bacteria sources back to their origin. It should be noted that a significant rain event occurred on July 19, 2016, making the samples collected on July 20, 2016, wet weather samples. Sample sites from July 20, 2016, will be re-visited during Phase II to collect dry weather samples for comparison.

Figure 7. Collecting sample from discharging outfall

Samples were analyzed using the Coliscan Easygel method to test for *E.coli* concentrations. The prepared water samples were plated on a treated petri dish and incubated at a temperature of 33°C for 28 hours. Upon incubation, *E.coli* within the samples produce enzymes that react with color reagents in the media to create dark blue colonies. The number of colonies present on each petri dish reflect the *E.coli* concentration for that sample (Figure 8). Samples with greater than 200 blue colonies are labeled as Too Numerous To Count (TNTC). Two dilutions were measured for each sample and the average concentration is reported in Table 3. Refer to Figure 9 for a station map illustrating the location and sample type for each sample collected during the Little White Oak Bayou survey, and to Figure 10 for a map illustrating the bacteria results for each sample collected. Additional information about sample locations and descriptions can be found in Table C1 in Appendix C.

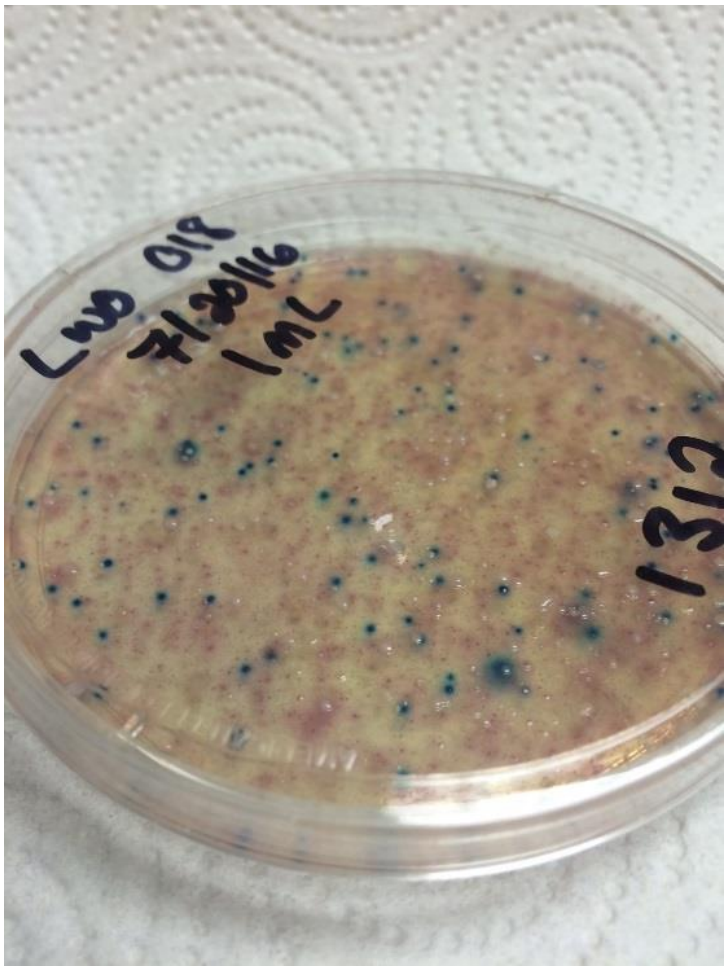


Figure 8. Coliscan Easygel E.coli colony count for Little White Oak Bayou sample 018

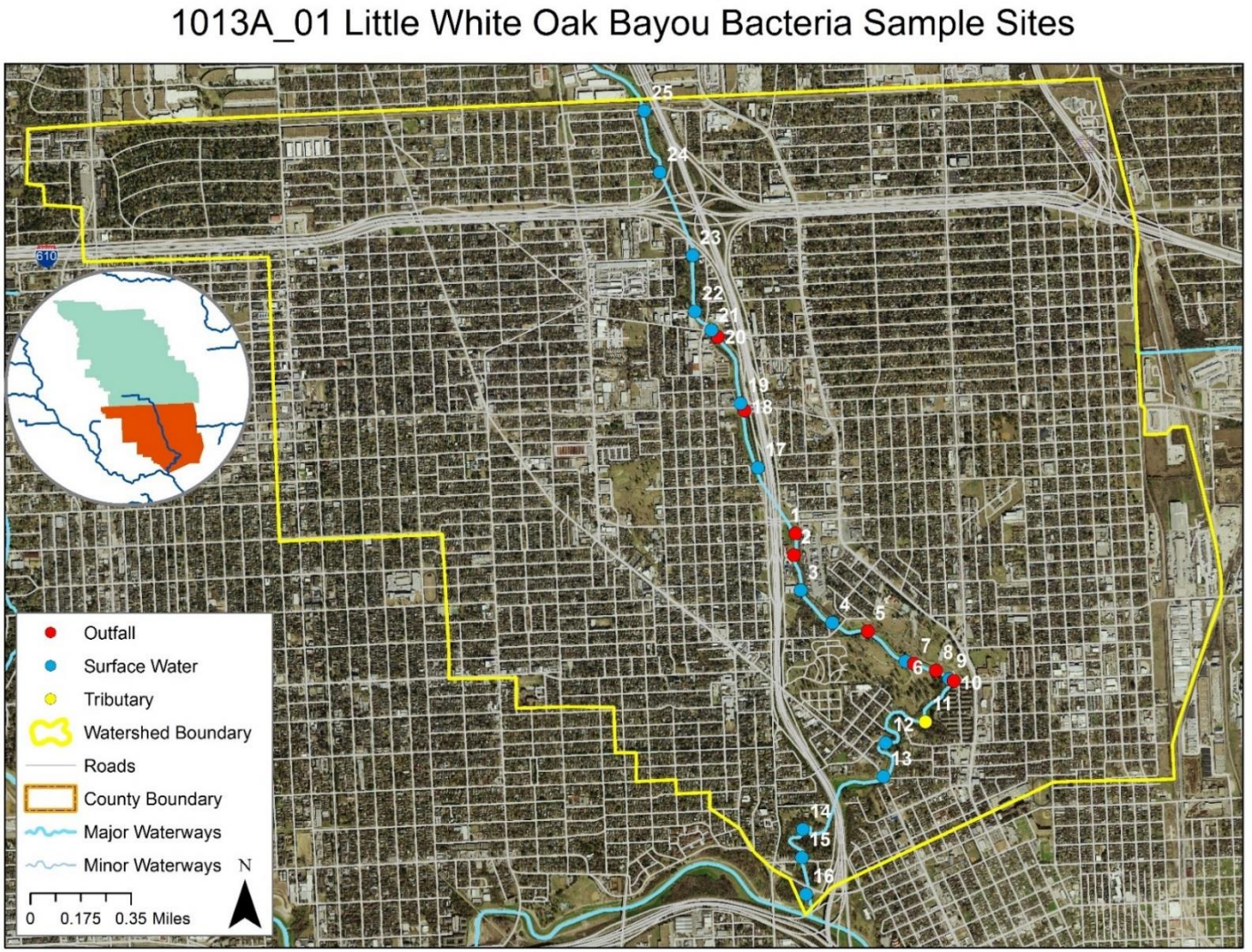


Figure 9. Station map for Little White Oak Bayou survey on July 13, 18, and 20, 2016

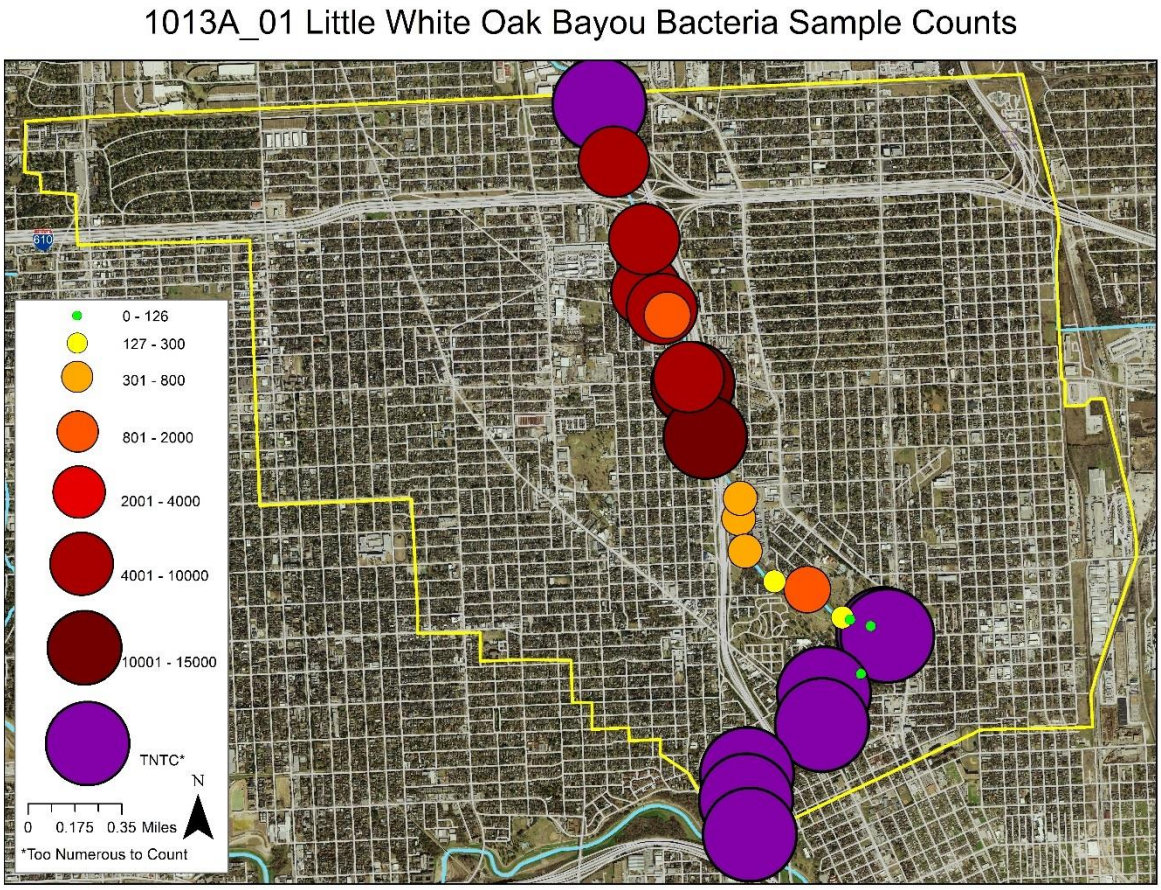


Figure 10. Bacteria screening results for Little White Oak Bayou surveys

4.1.3 Significant Findings

The most significant observation recorded during the Little White Oak Bayou survey was the litter and trash problem along the entire waterway. Portions of Little White Oak's banks were completely covered in trash and debris ranging from tires, shopping carts, plastics, Styrofoam, aluminum, and clothing. Trees along the lower portion of the waterway were covered in trash, likely from high flow conditions washing significant amounts of litter downstream that become trapped in branches and wrapped around tree trunks (Figures 11-14). However, even with the accumulated trash, there were abundant amounts of wildlife and aquatic organisms observed during the field surveys. Turtles and various bird species were common, many of which have made homes in the littered trees, shopping carts and tires. Alligator gar were also observed, primarily at the mouth of storm drains and outfall locations.

Table 3 lists all significant findings that require further investigation and follow-up sampling. The average *E.coli* count for the Little White Oak Bayou bacteria screening was approximately 3,974 cfu/100mL, which is likely a gross underestimation considering 32 percent of the samples were TNTC. Due to the extremely high concentrations found within this segment, samples collected with *E.coli* counts greater than 9,000 cfu/100mL were flagged as problem areas where further investigation is recommended. Three of the 25 samples collected had no bacteria colony forming units--two outfalls and one tributary. Further investigation is recommended for the non-detect sample locations to identify potential chlorine leaks or illicit discharges with high anti-bacterial agents.

Table 3. Summary of bacteria results and significant findings for Little White Oak Bayou

No.	Tier II ID	Tier II Type	Outfall Flow	Sample ID	Sample Type	*E. coli (cfu/100ml)*	Issue	Date Identified	Further Investigation	Latitude	Longitude
1	023	Outfall	Present	001	Outfall	575	N/A	7/13/2016	No	29.79758	-95.37048
2	025	Outfall	Present	002	Outfall	700	N/A	7/13/2016	No	29.79642	-95.37062
3	N/A	N/A	N/A	003	Surface Water	450	N/A	7/13/2016	No	29.79464	-95.37029
4	N/A	N/A	N/A	004	Surface Water	250	N/A	7/13/2016	No	29.79296	-95.36852
5	034	Outfall	Present	005	Outfall	1025	N/A	7/13/2016	No	29.79088	-95.36414
6	N/A	N/A	N/A	006	Surface Water	150	N/A	7/13/2016	No	29.79090	-95.36438
7	036	Outfall	Present	007	Outfall	0	No Bacteria	7/13/2016	Yes	29.79083	-95.36405
8	041	Outfall	Present	008	Outfall	0	No Bacteria	7/18/2016	Yes	29.79039	-95.36263
9	N/A	N/A	N/A	009	Surface Water	TNTC	High Bacteria	7/18/2016	Yes	29.78994	-95.36188
10	044	Outfall	Present	010	Outfall	TNTC	High Bacteria	7/18/2016	Yes	29.78984	-95.36163
11	048	Tributary	N/A	011	Surface Water	0	No Bacteria	7/18/2016	Yes	29.78782	-95.36334
12	N/A	N/A	N/A	012	Surface Water	TNTC	High Bacteria	7/18/2016	Yes	29.78683	-95.36567
13	N/A	N/A	N/A	013	Surface Water	TNTC	High Bacteria	7/18/2016	Yes	29.78513	-95.36585
14	N/A	N/A	N/A	014	Surface Water	TNTC	High Bacteria	7/18/2016	Yes	29.78260	-95.37060
15	050	Outfall	Present	015	Surface Water	TNTC	High Bacteria	7/18/2016	Yes	29.78119	-95.37070
16	N/A	N/A	N/A	016	Surface Water	TNTC	High Bacteria	7/18/2016	Yes	29.77933	-95.37054
17	N/A	N/A	N/A	017	Surface Water	10900	High Bacteria	7/20/2016	Yes	29.80087	-95.37254
18	053	Outfall	Present	018	Outfall	13300	High Bacteria	7/20/2016	Yes	29.80372	-95.37321
19	N/A	N/A	N/A	019	Surface Water	7300	N/A	7/20/2016	No	29.80414	-95.37343
20	055	Outfall	Present	020	Outfall	1350	N/A	7/20/2016	No	29.80751	-95.37463
21	N/A	Outfall	Absent	021	Surface Water	6650	N/A	7/20/2016	No	29.80787	-95.37498
22	N/A	Outfall	Absent	021	Surface Water	6650	N/A	7/20/2016	No	29.80787	-95.37498
23	N/A	Outfall	Absent	021	Surface Water	6650	N/A	7/20/2016	No	29.80787	-95.37498
24	056	Outfall	Absent	022	Surface Water	9450	High Bacteria	7/20/2016	Yes	29.80884	-95.37589
25	N/A	N/A	N/A	023	Surface Water	4300	N/A	7/20/2016	No	29.81165	-95.37593
26	058	Outfall	Absent	024	Surface Water	5800	N/A	7/20/2016	No	29.81596	-95.37775
27	N/A	N/A	N/A	025	Surface Water	TNTC	High Bacteria	7/20/2016	Yes	29.81901	-95.37845
28	035	Outfall	Absent	N/A	N/A	N/A	Screen Cover	7/13/2016	Yes	29.79082	-95.36403
29	040	Outfall	Absent	N/A	N/A	N/A	Screen Cover	7/18/2016	Yes	29.79043	-95.36283
30	052	Sewer Manhole	Absent	N/A	N/A	N/A	Damaged	7/20/2016	Yes	29.80126	-95.37309
31	N/A	Outfall	Absent	N/A	N/A	N/A	Suspicious Pipe	7/20/2016	Yes	29.80425	-95.37350
32	033	Outfall	Present	N/A	N/A	N/A	Screen Cover	7/13/2016	Yes	29.79246	-95.36655
33	047	Sewer Manhole	N/A	N/A	N/A	N/A	Open	7/18/2016	Yes	29.78791	-95.36320

Figure 11. Shopping cart and litter on water bank

Figure 12. Trash wrapped around tree trunks in lower portion of Little White Oak

Figure 13. Trash accumulated on water banks near I-45 bridge

Figure 14. Washed up trash trapped by tree branches

Other than the in-stream and outfall samples collected, additional findings that require further investigation include the following:

1) Three suspicious outfall pipes adjacent to the Moody Park area had metal screened covers attached to the ends. One of the three pipes had a small amount of discharge dripping from the outfall, but not enough for sample collection and bacteria screening. Locations for the screened outfalls can be found in Table 3 (Tier II ID 033, 035, and 040). Refer to Figures 15-17 for images of the three suspicious outfall pipes.

Figure 15. Outfall Tier II ID 035

Figure 16. Outfall Tier II ID 035

Figure 17. Outfall Tier II ID 040

2) Two sewer manholes require follow-up investigation. One manhole (Tier II ID 047) was found along the Bayou with an open lid likely from a recent sewer overflow. The smell of sewage inside the manhole could be detected from the bank. A second damaged manhole was found along the Bayou (Tier II ID 052). This manhole was about six feet tall with a large hole in the cement casing. Another hole was found in the ground by the sewer manhole. It was unclear if this was an active or abandoned manhole, but further investigation is recommended to ensure raw sewage does not discharge at the location. Refer to Table 3 for locations of each manhole, and to Figures 18-20 for images of each.

Figure 18. Outfall Tier II ID 047

Figure 19. Outfall Tier II ID 052

Figure 20. Outfall Tier II ID 052

3) A suspicious drain line from the Astro Inn's parking lot leads directly into Little White Oak Bayou on the right bank upstream of the West Cavalcade Street bridge. There was no discharge at the outfall at the time of sampling, but a surface water sample (019) was collected directly downstream of the pipe line resulting in an *E.coli* concentration of 7,300 cfu/100mL. Additional investigation is recommended to ensure this is not an illicit discharge. Refer to Table 3 (No. 31) for GPS coordinates and to Figure 21-23 for images of the drain line and parking lot.

Figure 21. Astro Inn Parking lot (No. 31)

Figure 22. Outfall No. 31

Figure 23. Outfall Tier No. 31

4.2 Rummel Creek

Rummel Creek, Segment 1014N_01, is one of the most impaired water bodies within the BIG geographic area, with an *E.coli* geometric mean concentration of 1960 MPN/100mL compared to the state water quality standard of 126 MPN/100mL. The stream length is approximately 3.04 miles with a catchment area of 4.62 square miles. There is one active CRP monitoring station located at Rummel Creek and Memorial Drive (station ID 11188). Primary LU/LC in the area is residential with some light commercial and industrial land uses present north of Beltway 8. Designated uses for this segment include Aquatic Life Use, General Use, and Contact Recreation Use. Potential bacteria sources identified during Desk Review 2 include dirt yards and a nursery located at the intersection of I-10 and Beltway 8(Figure 24).

Statistical analysis of Rummel Creek data revealed a gradual decrease in bacteria geometric mean concentrations since 2005 (Figure 25). However, *E.coli* concentrations remain significantly higher than the 126 MPN/100mL standard for the majority of samples collected during the assessment period (Figure 26). No LDC graphs were generated for Rummel Creek because flow data from USGS was unavailable for this segment. To assess the occurrence of high *E.coli* concentrations during dry weather conditions, an *E.coli* versus days since last rain graph was developed and showed data points exceeding the state water quality standard for bacteria more than 20 days after the last rain event (Figure 27).

4.2.1 Windshield Survey

The windshield survey for Rummel Creek was June 22, 2016. The waterway was investigated by vehicle, and points of access and potential pollution sources were noted. Primary land use is residential throughout the catchment area with commercial and industrial land uses present primarily north of Beltway 8 and at the intersection of I-10 and Beltway 8. Several industrial stormwater outfalls are adjacent to the I-10 corridor north of Beltway 8 before the stream goes underground. Nearby facilities include a hospital and various flooring distribution and furniture warehouses. A large plant nursery is on the southwest corner of the I-10 and Beltway 8 intersection adjacent to where Rummel Creek emerges from underground. A large discharging outfall appeared to be coming from the stormwater detention area adjacent to the nursery. A significant amount of vegetation was growing through the cement-lined channel adjacent to the nursery and stormwater detention outfall (Figure 28). Refer to Figure D1 in Appendix D for a map of the windshield survey route.

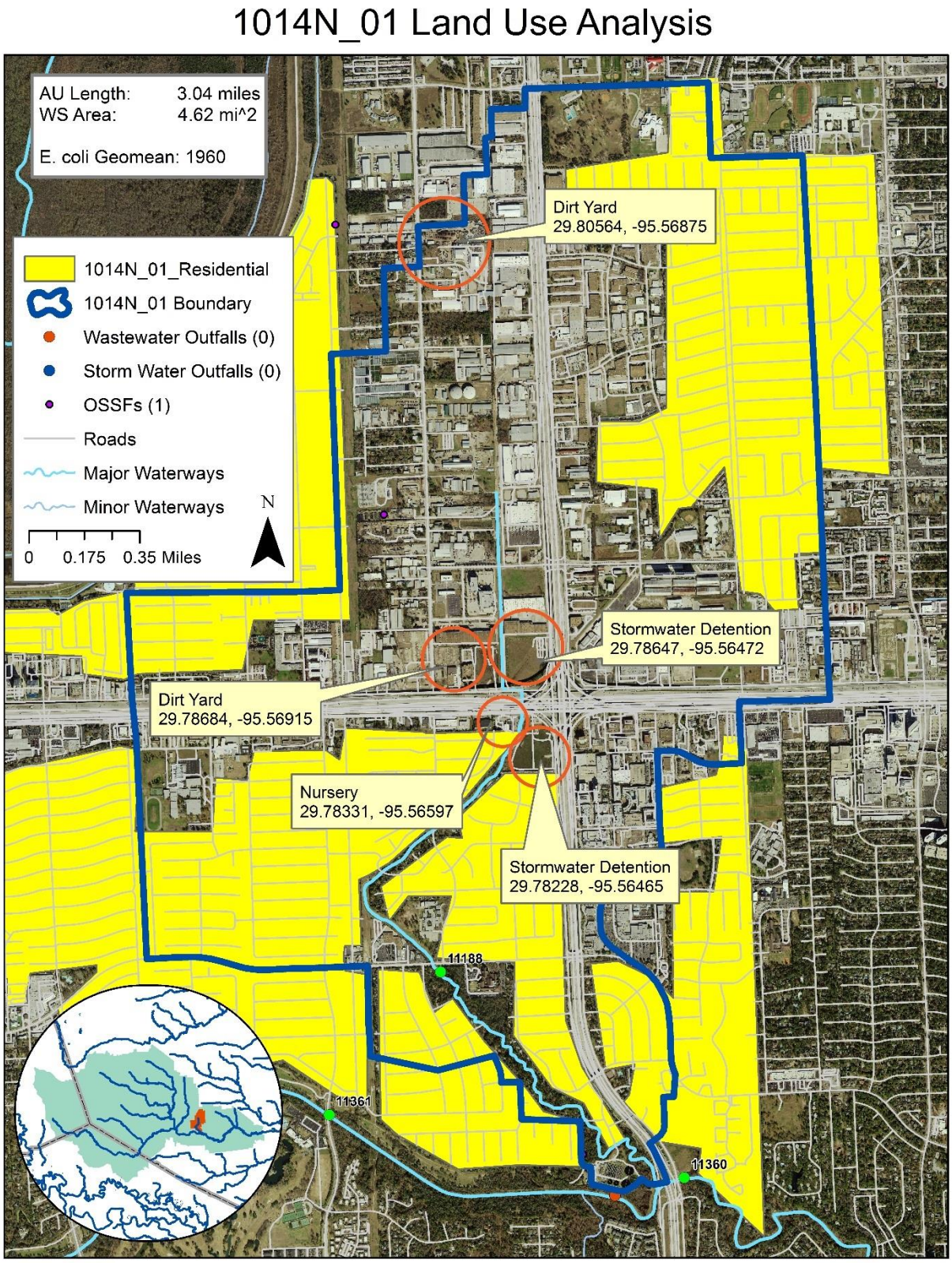


Figure 24. Desk Review 2 map for Rummel Creek, Segment 1014N_01

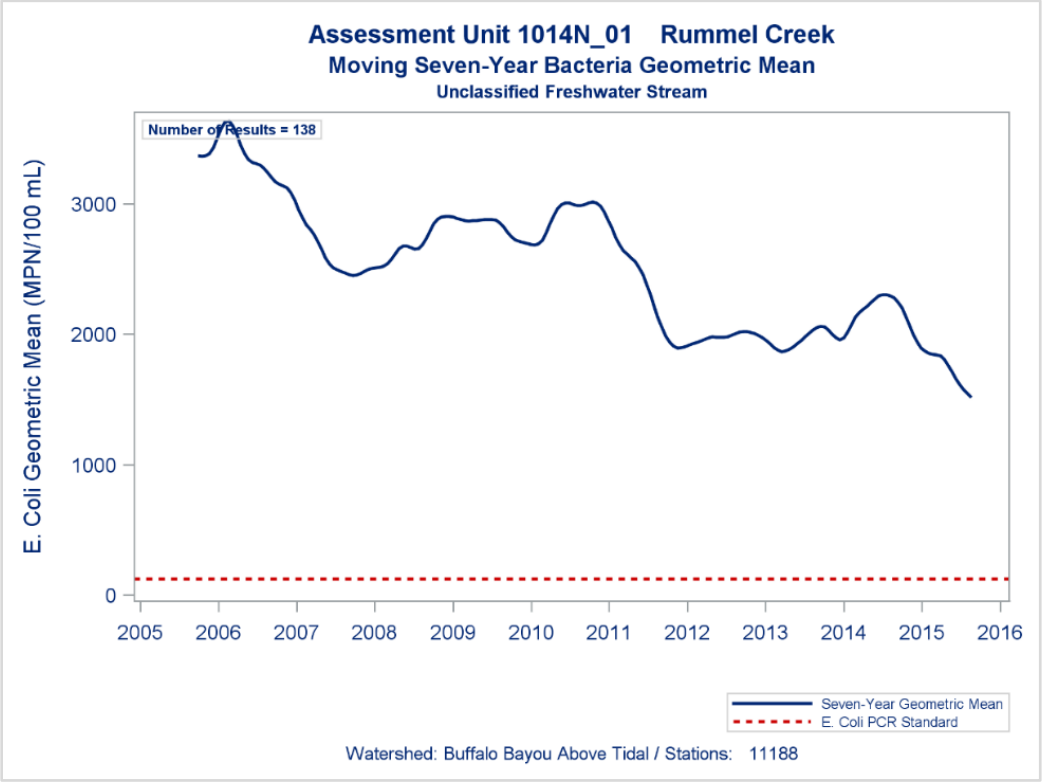


Figure 25. Moving seven-year E.coli geometric mean plot for Rummel Creek

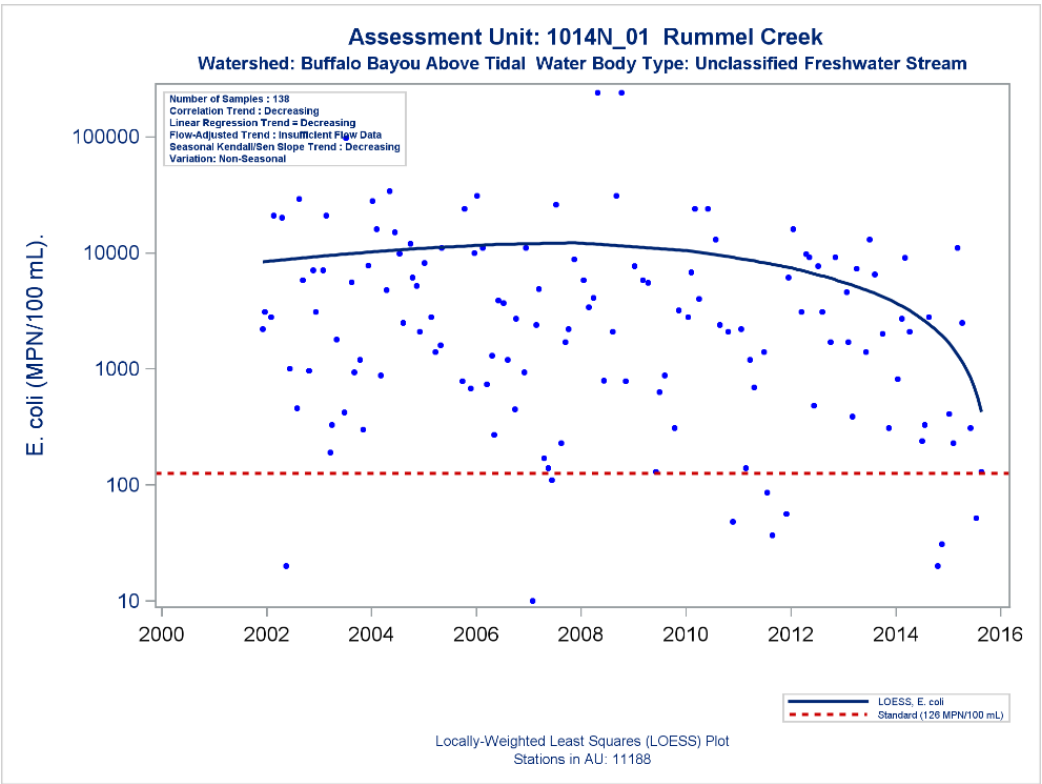


Figure 26. E.coli trend analysis for Rummel Creek

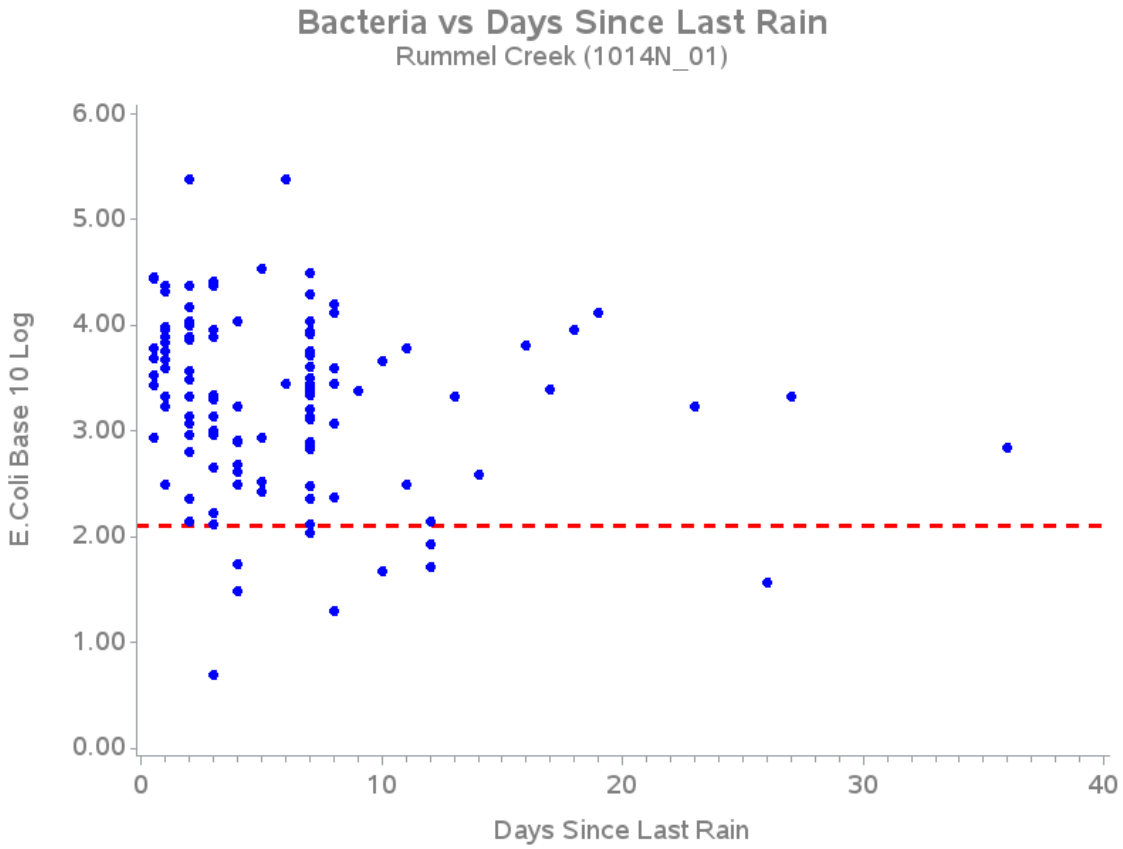


Figure 27. Bacteria versus days since last rain graph for Rummel Creek. Red dotted line represents the water quality standard for E.coli.

Figure 28. Stormwater detention outfall adjacent to plant nursery at southwest corner of I-10 and Beltway 8 intersection

4.2.2 Bacteria Screening

A total of 13 bacteria screening samples were collected along Rummel Creek during the on-the-ground survey July 11, 2016. Samples were collected at four discharging outfalls and two tributaries, while the rest of the samples were surface water samples collected in an effort to better identify hot spots and trace bacteria sources back to their origin.

Samples were analyzed using the Coliscan Easygel method to test for *E.coli* concentrations. Two dilutions were measured for each sample and the average concentration is reported in Table 4. Refer to Figure 29 for a station map illustrating the location and sample type for each sample collected during the Rummel Creek survey, and to Figure 30 for a map illustrating the bacteria results for each sample collected. Additional information about sample locations and descriptions can be found in Table D1 in Appendix D.

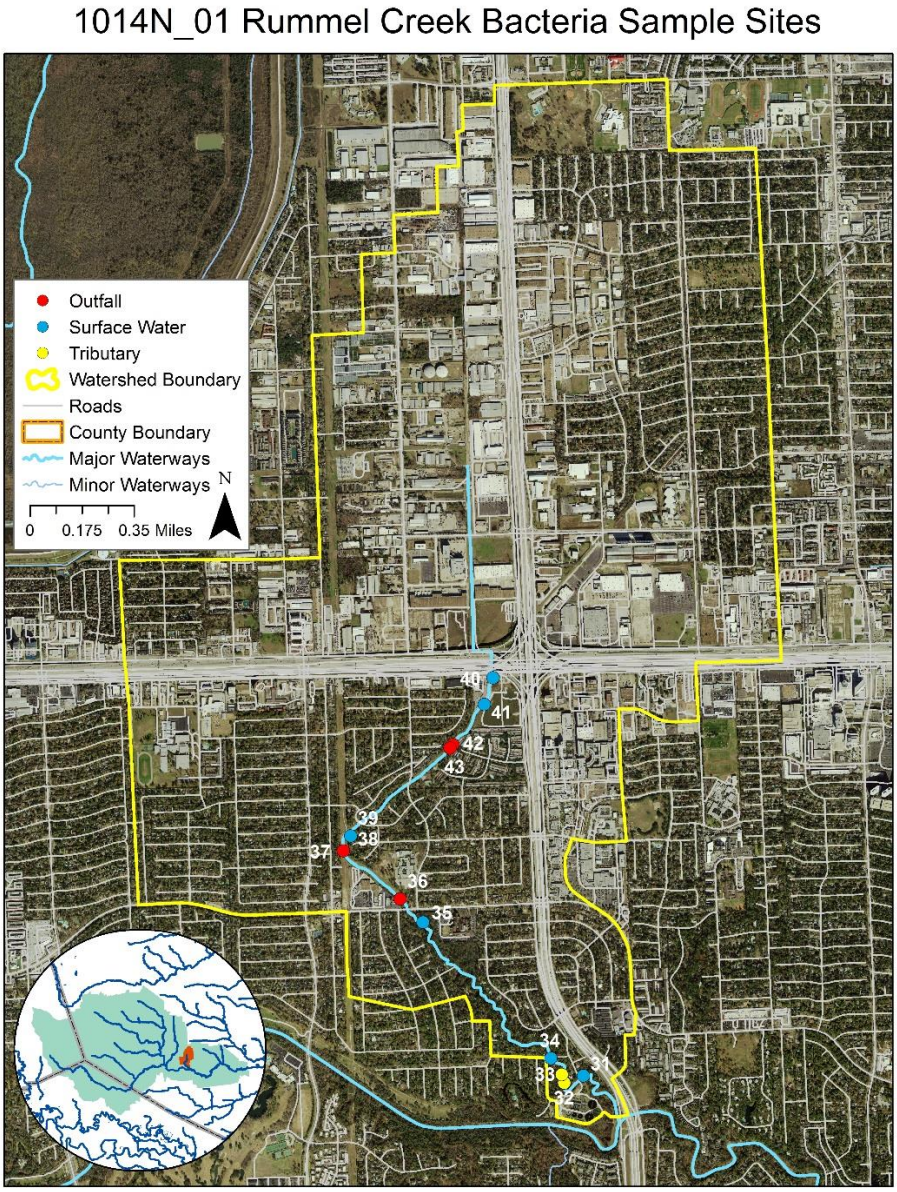


Figure 29. Station map for Rummel Creek survey July 11, 2016

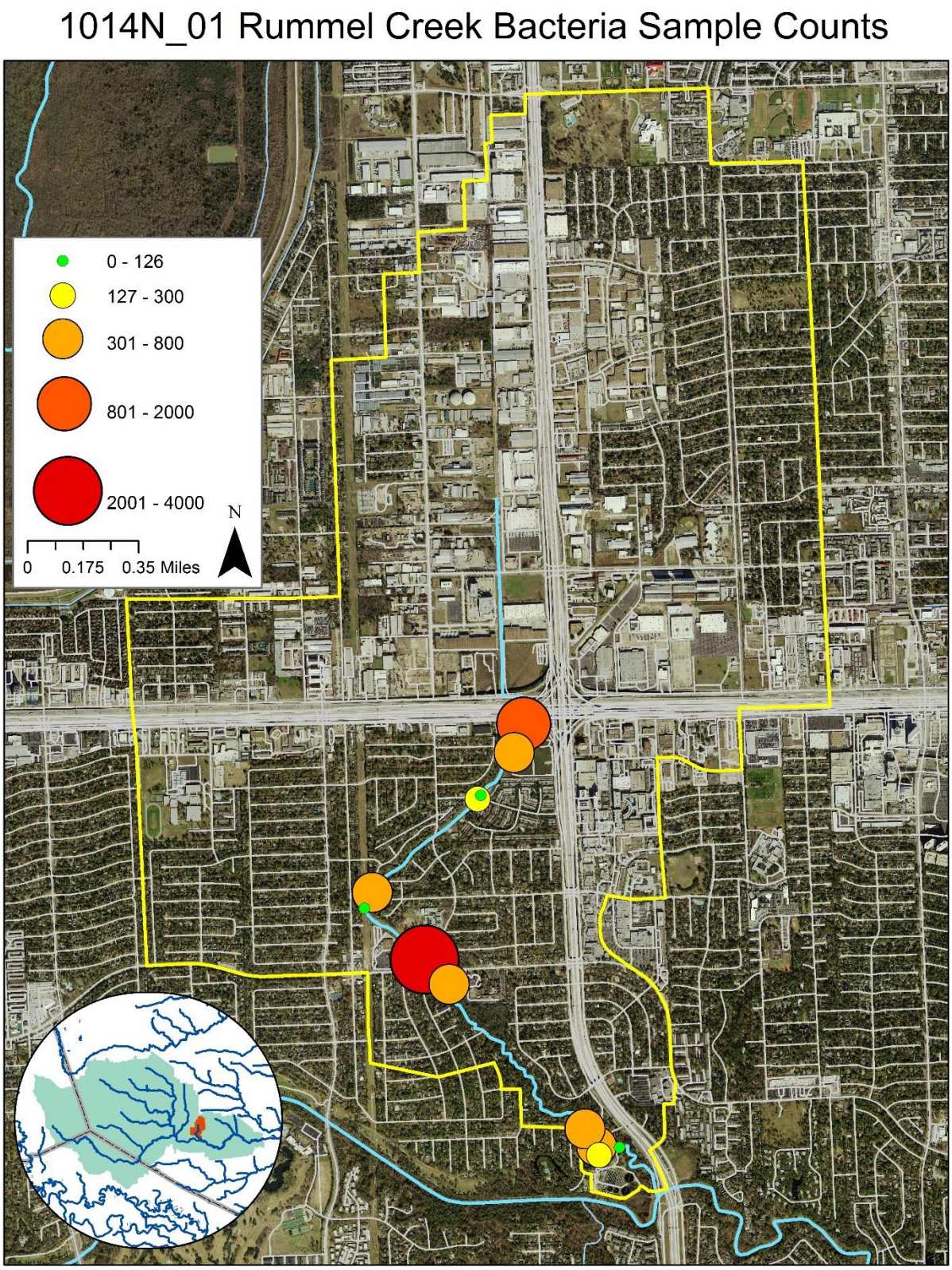


Figure 30. Bacteria screening results for Rummel Creek survey

Table 4. Summary of bacteria results and significant findings for Rummel Creek

No.	Tier II ID	Tier II Type	Outfall Flow	Sample ID	Sample Type	*E. coli (cfu/100ml)*	Issue	Date Identified	Further Investigation	Latitude	Longitude
1	N/A	N/A	N/A	031	Surface Water	125	N/A	7/11/2016	No	29.76429	-95.56070
2	002	Tributary	Absent	032	Surface Water	225	N/A	7/11/2016	No	29.76397	-95.56178
3	003	Tributary	Absent	033	Surface Water	775	High Bacteria	7/11/2016	Yes	29.76438	-95.56191
4	N/A	N/A	N/A	034	Surface Water	525	High Bacteria	7/11/2016	Yes	29.76519	-95.56248
5	N/A	N/A	N/A	035	Surface Water	425	N/A	7/11/2016	No	29.77200	-95.56940
6	006	Outfall	Present	036	Outfall	2275	High Bacteria	7/11/2016	Yes	29.77316	-95.57065
7	010	Outfall	Present	037	Outfall	100	N/A	7/11/2016	No	29.77559	-95.57374
8	N/A	N/A	N/A	038	Surface Water	400	N/A	7/11/2016	No	29.77630	-95.57330
9	N/A	N/A	N/A	039	Surface Water	700	High Bacteria	7/11/2016	Yes	29.77630	-95.57330
10	N/A	N/A	N/A	040	Surface Water	925	High Bacteria	7/11/2016	Yes	29.78381	-95.56509
11	N/A	N/A	N/A	041	Surface Water	350	N/A	7/11/2016	No	29.78252	-95.56563
12	021	Outfall	Present	042	Outfall	125	N/A	7/11/2016	No	29.78060	-95.56744
13	023	Outfall	Present	043	Outfall	225	N/A	7/11/2016	No	29.78044	-95.56762

4.2.3 Significant Findings

Table 4 lists all significant findings that require further investigation and follow-up sampling. The average *E.coli* count for the Rummel Creek bacteria screening was approximately 552 cfu/100mL. Samples collected with *E.coli* counts greater than 500 cfu/100mL were flagged as problem areas where further investigation is recommended.

Noteworthy findings include sample 033 collected at a bend in the stream segment where trash accumulation was observed and apparent groundwater discharge was present. A slight sheen was visible on the water surface at the same location disturbed by the groundwater movement in the otherwise stagnant water (Figure 31). Two dilapidated pipes were observed at sample location 034 where high bacteria levels were detected. One pipe was bored under the waterway (Figure 32) while the other crossed above the water at street level. A concrete slab was found on the floor of Rummel Creek just downstream of the Rummel Creek Road bridge (Figure 33). The concrete was impeding water flow and creating high algae accumulation on the upstream side of the slab. Samples were taken upstream and downstream of the concrete slab, and bacteria levels were higher upstream where water flow was slower (sample 039). Algae was common throughout the waterway but appeared particularly dense north of Memorial Drive near Rummel Creek Elementary School (Figures 34-35). The sample collected at this location (sample 036) had the highest bacteria concentration collected during the Rummel Creek survey.

Figure 31. Groundwater discharge and surface sheen at sample 033

Figure 32. Pipe and outfall near sample 034

Figure 33. Concrete slab downstream of Rummel Creek Road

Figure 34. Dense algal blooms near Rummel Creek Elementary School (sample 036)

Figure 35. Dense algal blooms near Rummel Creek Elementary School (sample 036)

5.0 AU Intensive Study: Top 2 Least Impaired

5.1 Canal C-147

Canal C-147, Segment 1007A_01, is one of the least impaired water bodies within the BIG geographic area. It is close to meeting state water quality standards for bacteria, with an *E.coli* geometric mean concentration of 157 MPN/100mL compared to the 126 MPN/100mL standard. The segment length is approximately 2.08 miles with a catchment area of 2.63 square miles. There is one active CRP monitoring station at the downstream end of Canal C-147 at Tiffany Drive (station ID 16656). Primary LU/LC identified during Desk Review 2 is residential. Designated uses for this segment include Aquatic Life Use, General Use, and Recreation Use. Potential bacteria sources identified during Desk Review 2 include the WWTF located south of Beltway 8, and Pine Island Sand and Gravel northwest of the WWTF (Figure 36).

Statistical analysis of Canal C-147 data revealed a gradual decrease in bacteria geometric mean concentrations since 2005 (Figure 37). However, *E.coli* concentrations remain higher than the 126 MPN/100mL standard for nearly half of the samples collected during the assessment period (Figure 38). No LDC graphs were generated for Canal C-147 because flow data from USGS was unavailable for this segment. Bacteria versus days since last rain graphs for Canal C-147 show few instances where data points exceed the state water quality standard for bacteria after 10 or more days of no rain, with the majority of high bacteria concentrations following significant rain events (Figure 39).

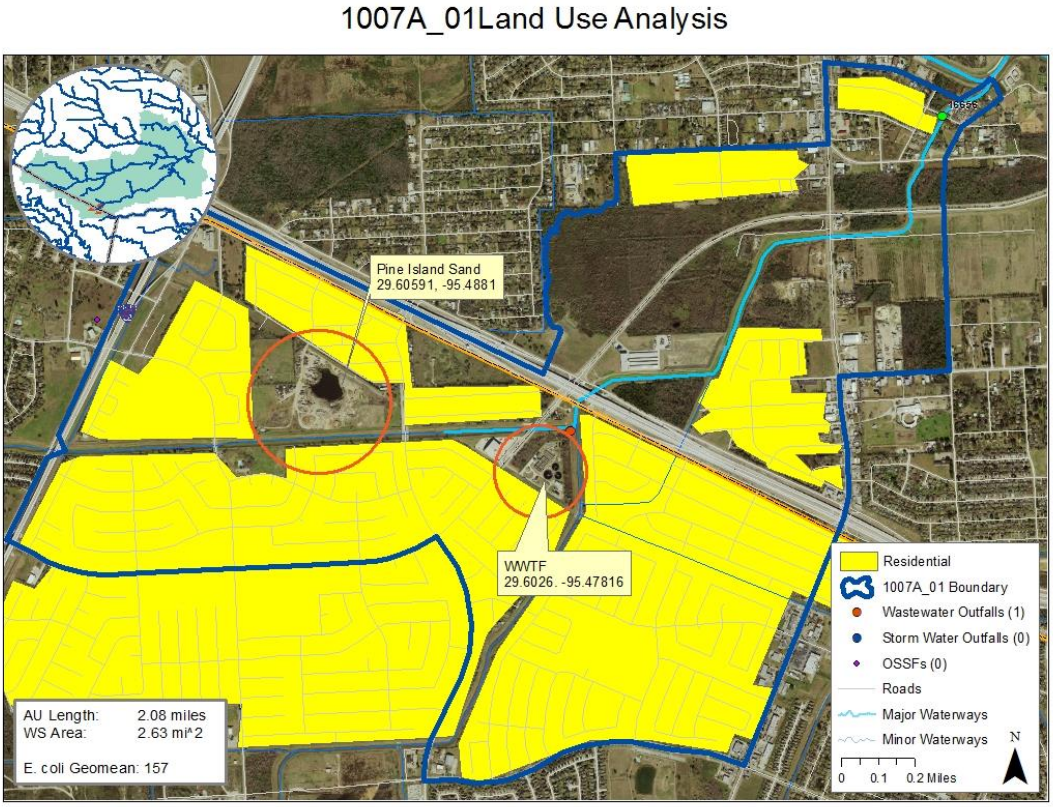


Figure 36. Desk Review 2 map for Canal C-147, Segment 1007A_01

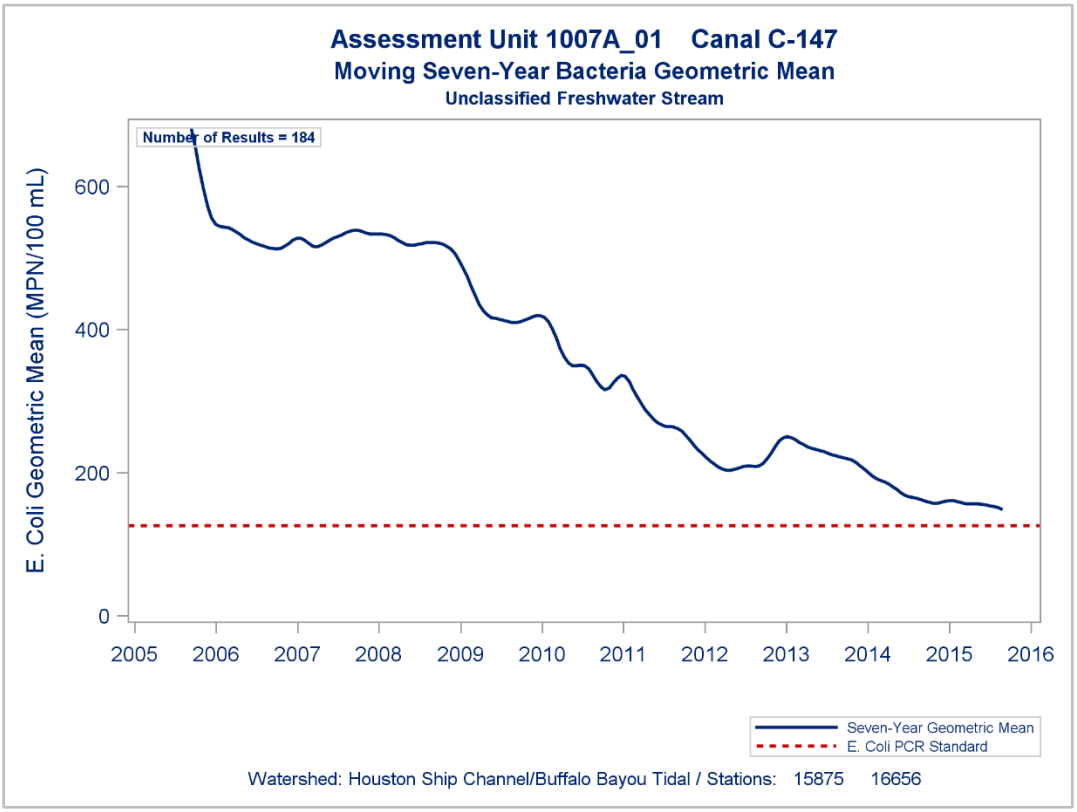


Figure 37. Moving seven-year E.coli geometric mean plot for Canal C-147

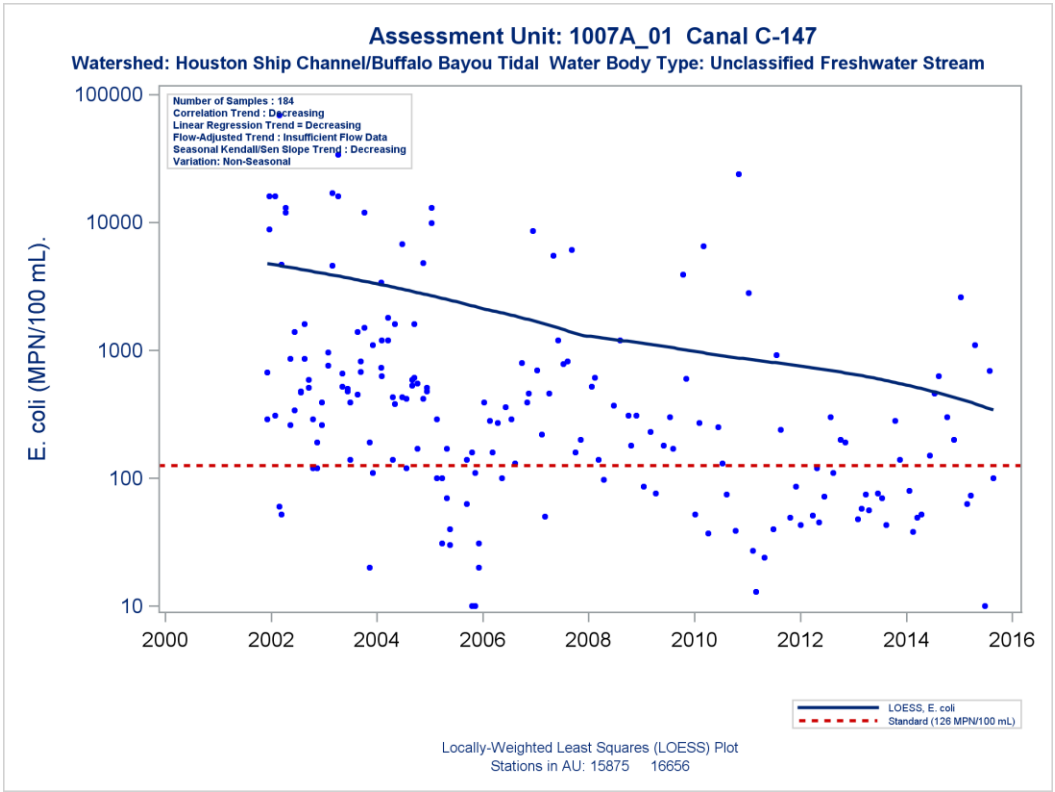


Figure 38. E.coli trend analysis for Canal C-147

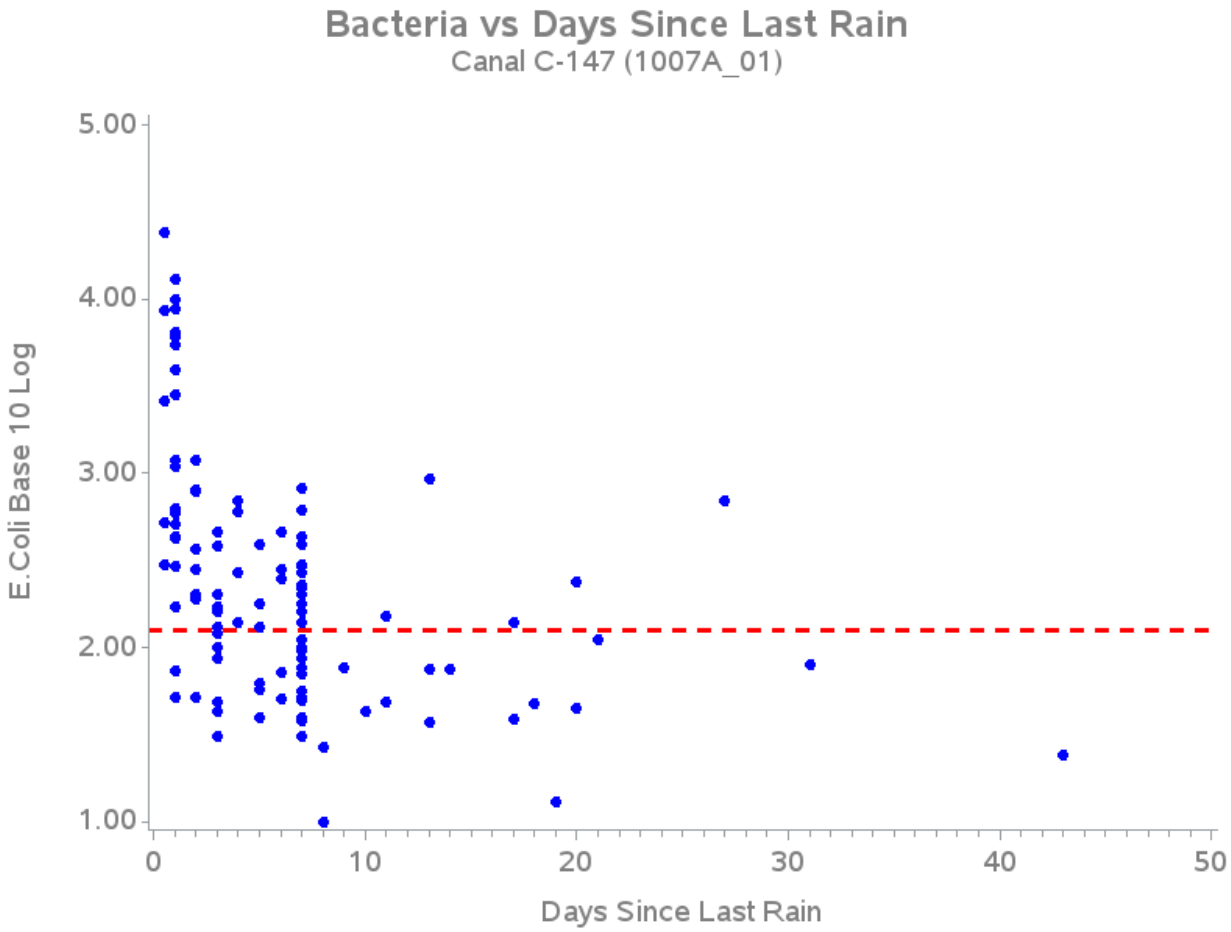


Figure 39. Bacteria versus days since last rain graph for Canal C-147. Red dotted line represents the water quality standard for E.coli.

5.1.1 Windshield Survey

The windshield survey for Canal C-147 was conducted on June 22, 2016. The waterway was investigated by vehicle, and points of access and potential pollution sources were noted. Primary land use is residential throughout the catchment area, with light commercial land uses present along the primary thoroughfares of West Fuqua Street and the Beltway 8 corridor. Illegal dumping of trash was common in the neighborhood at the downstream end of the canal adjacent to the CRP monitoring station. A significant amount of household trash, including mattresses, fencing, and furniture, was found in alleyways and ditches near the stream (Figures 40-42). Refer to Figure E1 in Appendix E for a map of the windshield survey route.

Figure 40. Illegal dumping

Figure 41. Illegal dumping

Figure 42. Illegal dumping

5.1.2 Bacteria Screening

A total of 21 bacteria screening samples were collected along Canal C-147 during the on the ground survey June 30, 2016. Samples were collected at eight discharging outfalls and three tributaries while the rest of the samples were surface water samples collected in an effort to track bacteria sources back to their origin.

Samples were analyzed using the Coliscan Easygel method to test for *E.coli* concentrations (Figure 43). Two dilutions were measured for each sample and the average concentration is reported in Table 5. Refer to Figure 44 for a station map illustrating the location and sample type for each sample collected during the Canal C-147 survey, and to Figure 45 for a map illustrating the bacteria results for each sample collected. Additional information about sample locations and descriptions can be found in Table E1 in Appendix E.

Figure 43. Plating Canal C-147 samples using Coliscan Easygel methodology

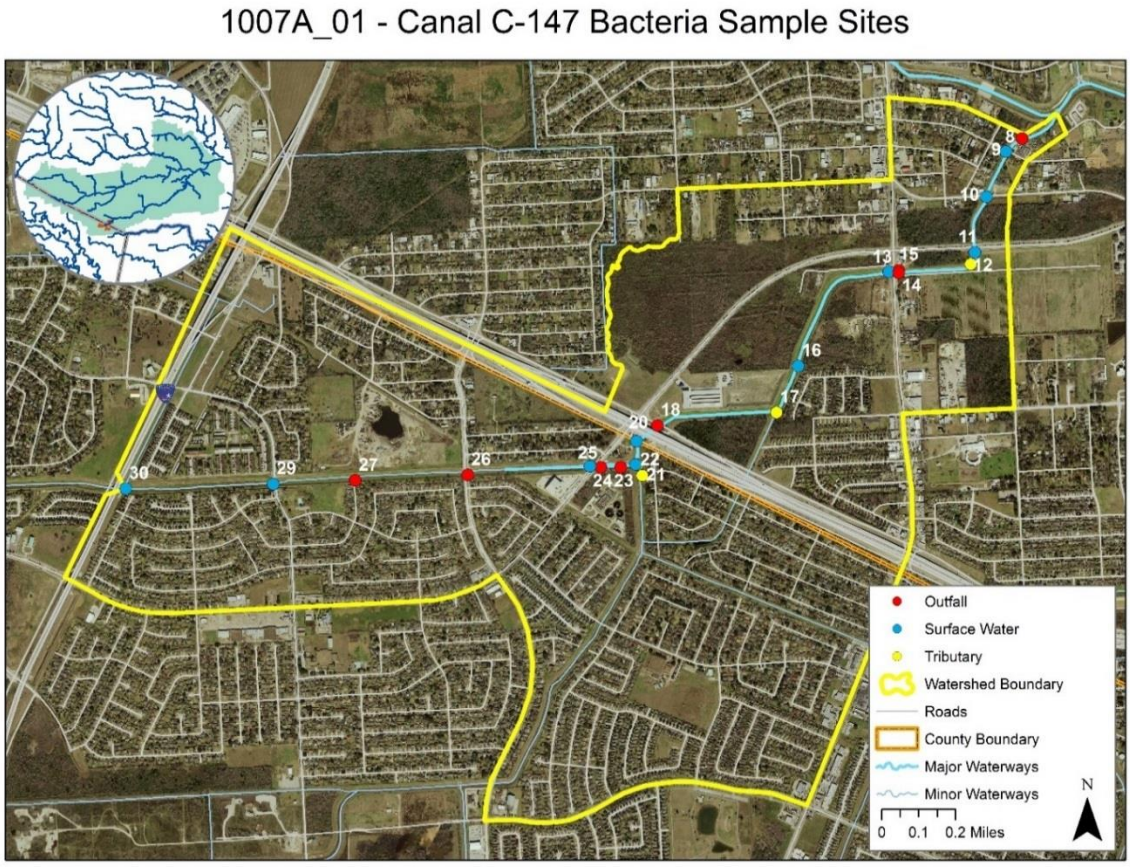


Figure 44. Station map for Canal C-147 survey June 30, 2016

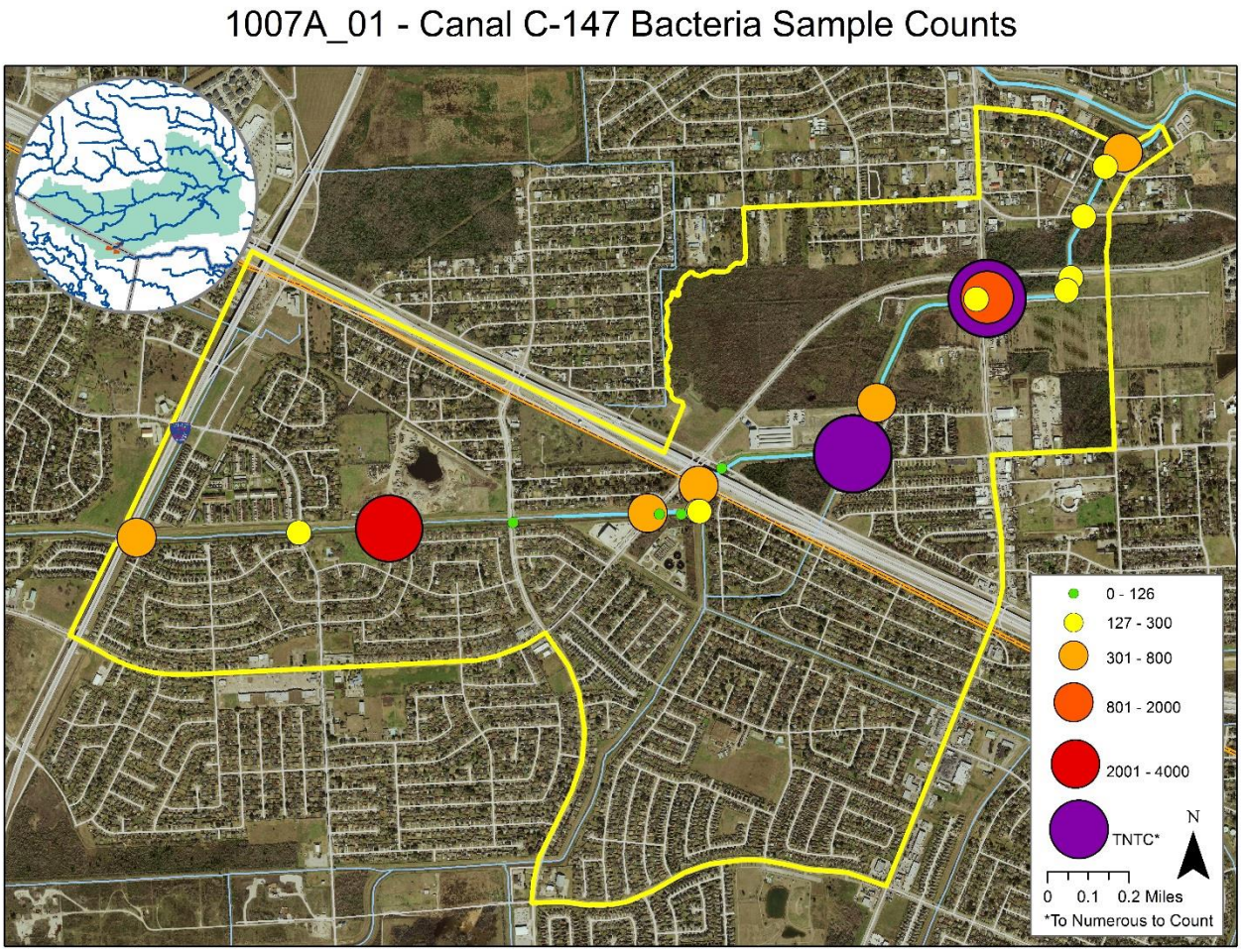


Figure 45. Bacteria screening results for Canal C-147 survey

5.1.3 Significant Finding

Table 5 lists all significant findings that require further investigation and follow up sampling. The average *E.coli* count for Canal C-147 bacteria screening was approximately 443 cfu/100mL which is likely a slight underestimation because about 10 percent of the samples were TNTC and were not incorporated into the overall average for the waterway. Samples collected with *E.coli* counts greater than 500 cfu/100mL were flagged as problem areas where further investigation is recommended. One outfall sample collected had no bacteria colony forming units detected during analysis. Further investigation is recommended for the non-detect sample to identify potential chlorine leaks or illicit discharges with high anti-bacterial agents.

Noteworthy findings include the high bacteria loading from an outfall (sample 008) directly downstream of the CRP monitoring station off Tiffany Drive (Figure 46). Discharges from this outfall would not be captured in routine CRP monitoring due to its location. Two large concrete storm drains directly downstream of the South Post Oak Road bridge (Figure 47-48) had high *E.coli* concentrations (samples 013 and 014). Another high bacteria source discharging into the canal was a small tributary north of Beltway 8, sample 021 (Figure 49).

Table 5. Summary of bacteria results and significant findings for Canal C-147

No.	Tier II ID	Tier II Type	Outfall Flow	Sample ID	Sample Type	*E. coli (cfu/100ml)*	Issue	Date Identified	Further Investigation	Latitude	Longitude
1	N/A	Outfall	Present	008	Outfall	800	High Bacteria	6/30/2016	Yes	29.61648	-95.45901
2	N/A	N/A	N/A	009	Surface Water	230	N/A	6/30/2016	No	29.61599	-95.45975
3	N/A	N/A	N/A	010	Surface Water	290	N/A	6/30/2016	No	29.61424	-95.46069
4	N/A	N/A	N/A	011	Surface Water	200	N/A	6/30/2016	No	29.61206	-95.46129
5	N/A	Tributary	Present	012	Surface Water	180	N/A	6/30/2016	No	29.61161	-95.46149
6	N/A	Outfall	Present	013	Outfall	TNTC	High Bacteria	6/30/2016	Yes	29.61142	-95.46475
7	N/A	Outfall	Present	014	Outfall	1770	High Bacteria	6/30/2016	Yes	29.61145	-95.46475
8	N/A	N/A	N/A	015	Surface Water	190	N/A	6/30/2016	No	29.61140	-95.46519
9	N/A	N/A	N/A	016	Surface Water	510	High Bacteria	6/30/2016	Yes	29.60781	-95.46939
10	N/A	Tributary	Present	017	Surface Water	TNTC	High Bacteria	6/30/2016	Yes	29.60601	-95.47043
11	N/A	Outfall	Present	018	Outfall	40	N/A	6/30/2016	No	29.60564	-95.47581
12	N/A	N/A	N/A	020	Surface Water	320	N/A	6/30/2016	No	29.60504	-95.47677
13	N/A	Tributary	Present	021	Surface Water	190	N/A	6/30/2016	No	29.60412	-95.47678
14	N/A	N/A	N/A	022	Surface Water	230	N/A	6/30/2016	No	29.60413	-95.47684
15	N/A	Outfall	Present	023	Outfall	50	N/A	6/30/2016	No	29.60404	-95.47752
16	N/A	Outfall	Present	024	Outfall	10	N/A	6/30/2016	No	29.60406	-95.47842
17	N/A	N/A	N/A	025	Surface Water	530	High Bacteria	6/30/2016	Yes	29.60412	-95.47890
18	N/A	Outfall	Present	026	Outfall	0	No Bacteria	6/30/2016	Yes	29.60392	-95.48441
19	N/A	Outfall	Present	027	Outfall	2130	High Bacteria	6/30/2016	Yes	29.60384	-95.48948
20	N/A	N/A	N/A	029	Surface Water	230	N/A	6/30/2016	No	29.60379	-95.49318
21	N/A	N/A	N/A	030	Surface Water	520	High Bacteria	6/30/2016	Yes	29.60378	-95.49982

Figure 46. Outfall with dry weather discharge downstream of CRP monitoring station (sample 008)

Figures 45 and 46. Storm drains downstream of the S. Post Oak Road bridge (samples 013 and 014)

Figure 47. Tributary north of Beltway 8 with high bacteria concentration (sample 021)

5.2 Upper Panther Branch

Upper Panther Branch, Segment 1008B_02, is one of the least impaired water bodies within the BIG geographic area. It is close to meeting state water quality standards for bacteria, with an *E.coli* geometric mean concentration of 133 MPN/100mL compared to the 126 MPN/100mL standard. The segment length is approximately 2.21 miles with a catchment area of 2.01 square miles. There are two active CRP monitoring stations: station 16632on Upper Panther Branch at Gosling Road; and station 16630 directly downstream of the WWTF. Primary LU/LC identified during Desk Review 2 is residential. Designated uses for this segment include Aquatic Life Use, Fish Consumption Use, General Use, and Recreation Use. Potential bacteria sources identified during Desk Review 2 include the WWTF off Research Forest Drive north of Gosling Road and a residential neighborhood east of Gosling with a concentration of OSSFs (Figure 48).

Statistical analysis of Upper Panther Branch data revealed a significant decrease in bacteria geometric mean concentrations in recent years (Figure 49). However, *E.coli* concentrations exceeding the 126 MPN/100mL standard are still frequent (Figure 50). No LDC graphs were generated for Upper Panther Branch because flow data from USGS was unavailable for this segment. Bacteria versus days since last rain graphs for this segment show few instances where data points exceed the state water quality standard for bacteria after 10 or more days of no rain, with the majority of high bacteria concentrations occurring immediately after significant rain events (Figure 51).

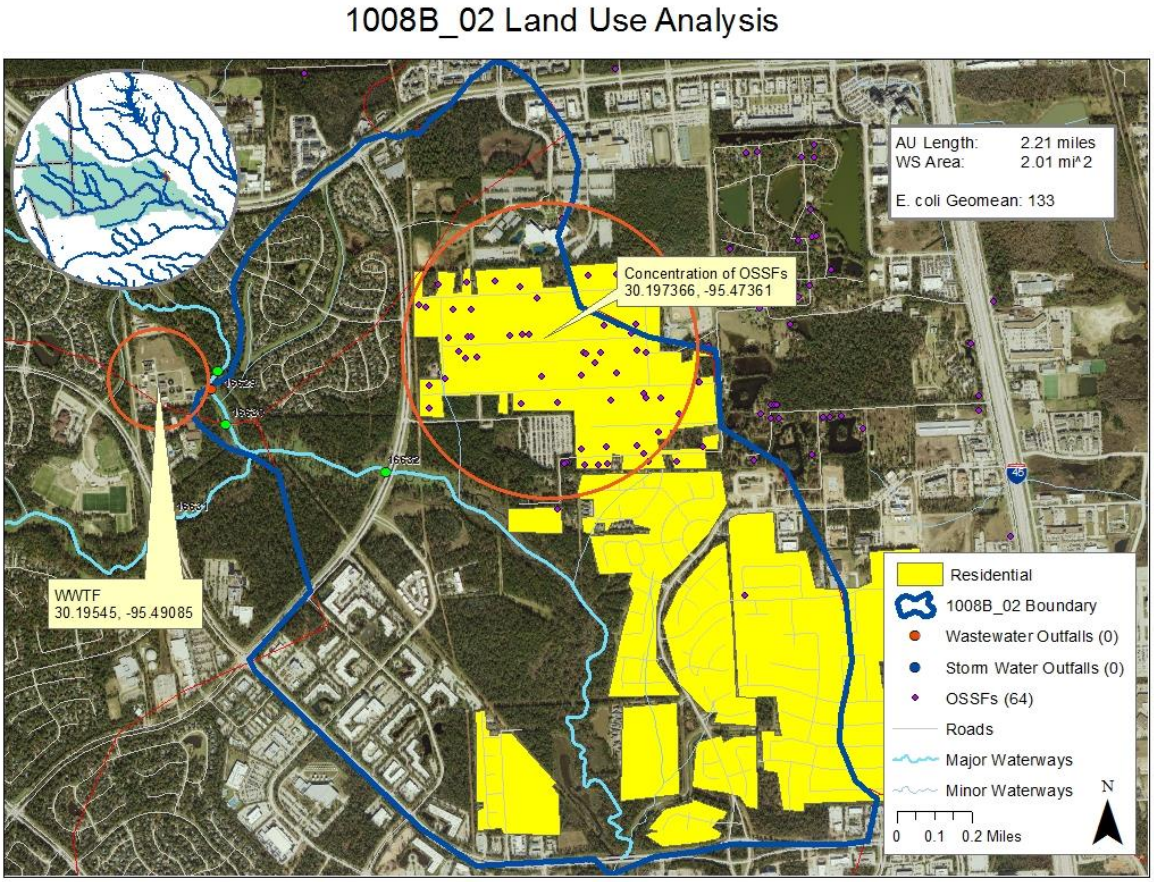


Figure 48. Desk Review 2 map for Upper Panther Branch, Segment 1008B_02

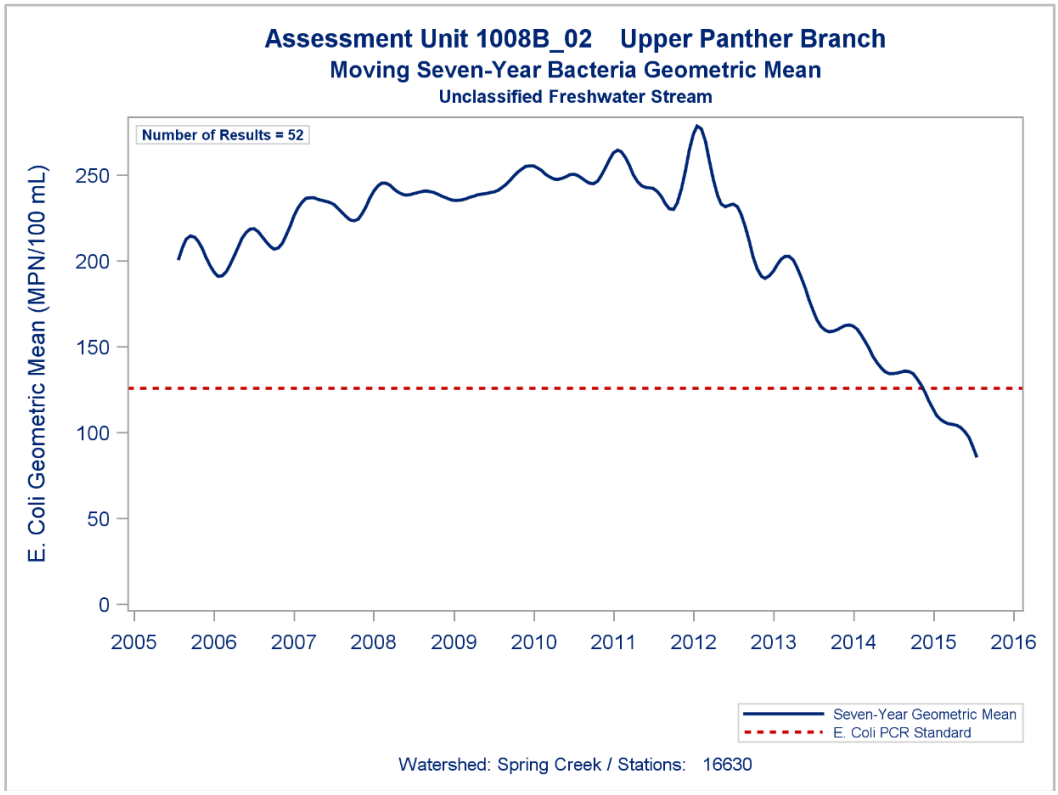


Figure 49. Moving seven-year E.coli geometric mean plot for Upper Panther Branch

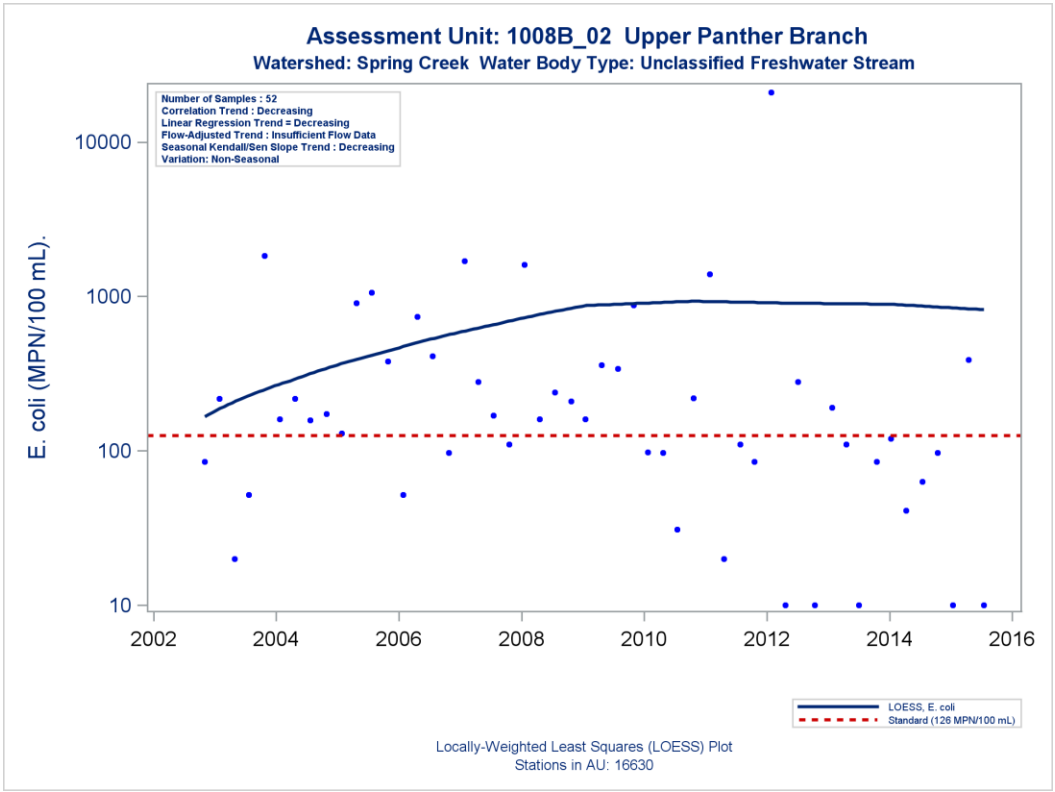


Figure 50. E.coli trend analysis for Upper Panther Branch

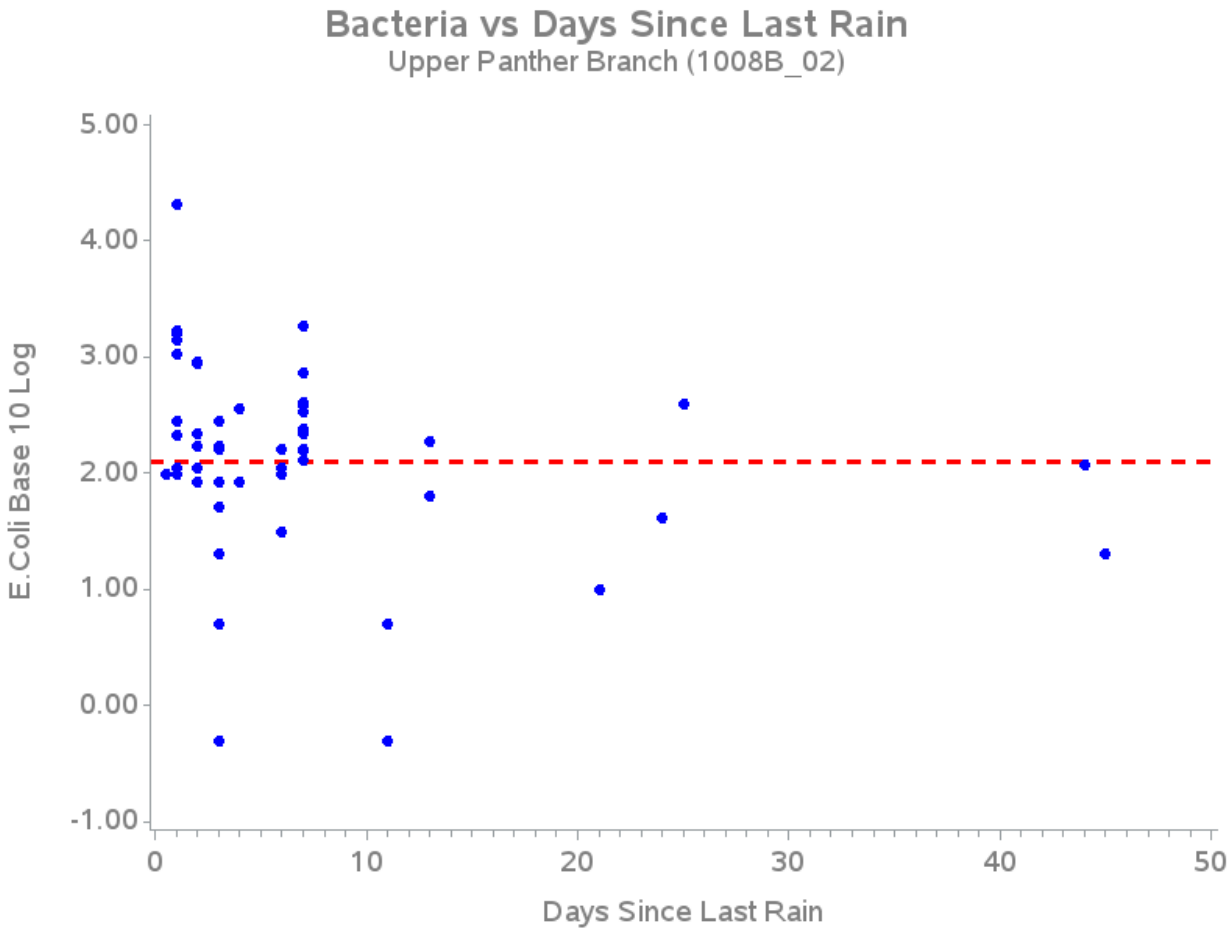


Figure 51. Bacteria versus days since last rain graph for Canal C-147. Red dotted line represents the water quality standard for E.coli

5.2.1 Windshield Survey

The windshield survey for Upper Panther Branch was on June 21, 2016. The waterway was investigated by vehicle, and points of access and potential pollution sources were noted. Primary land use is residential throughout the catchment area, with light commercial land uses present mainly along Research Forest Drive. Access points were difficult to locate by vehicle and would require a short trek through neighborhoods or hiking trails to reach the waterway (Figure 52). There were no potential bacteria sources observed during the windshield survey. Refer to Figure F1 in Appendix F for a map of the windshield survey route.

Figure 52. Hiking trail leading to Upper Panther Branch

5.2.2 Bacteria Screening

A total of 15 bacteria screening samples were collected along Upper Panther Branch during the on-the-ground survey on July 26 and 27, 2016. Samples were collected at nine discharging stormwater drainage tributaries and one discharging outfall, while the rest of the samples were surface water samples collected in an effort to track bacteria sources back to their origin.

Samples were analyzed using the Coliscan Easygel method to test for *E.coli* concentrations. Two dilutions were measured for each sample, and the average concentration is reported in Table 6. Refer to Figure 53 for a station map illustrating the location and sample type for each sample collected during the Upper Panther Branch survey, and to Figure 54 for a map illustrating the bacteria results for each sample collected. Additional information about sample locations and descriptions can be found in Table F1 in Appendix F.

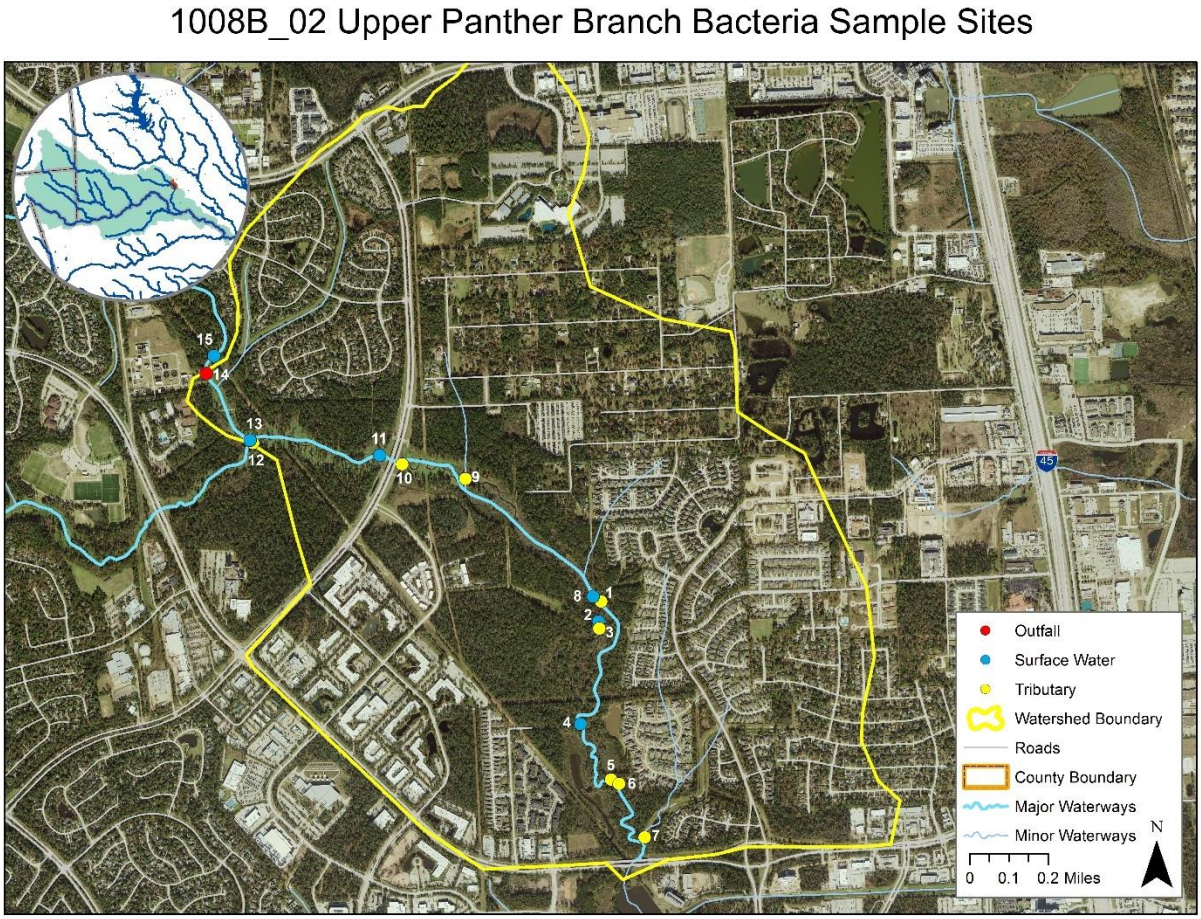


Figure 53. Station map for Upper Panther Branch survey July 26 and 27, 2016

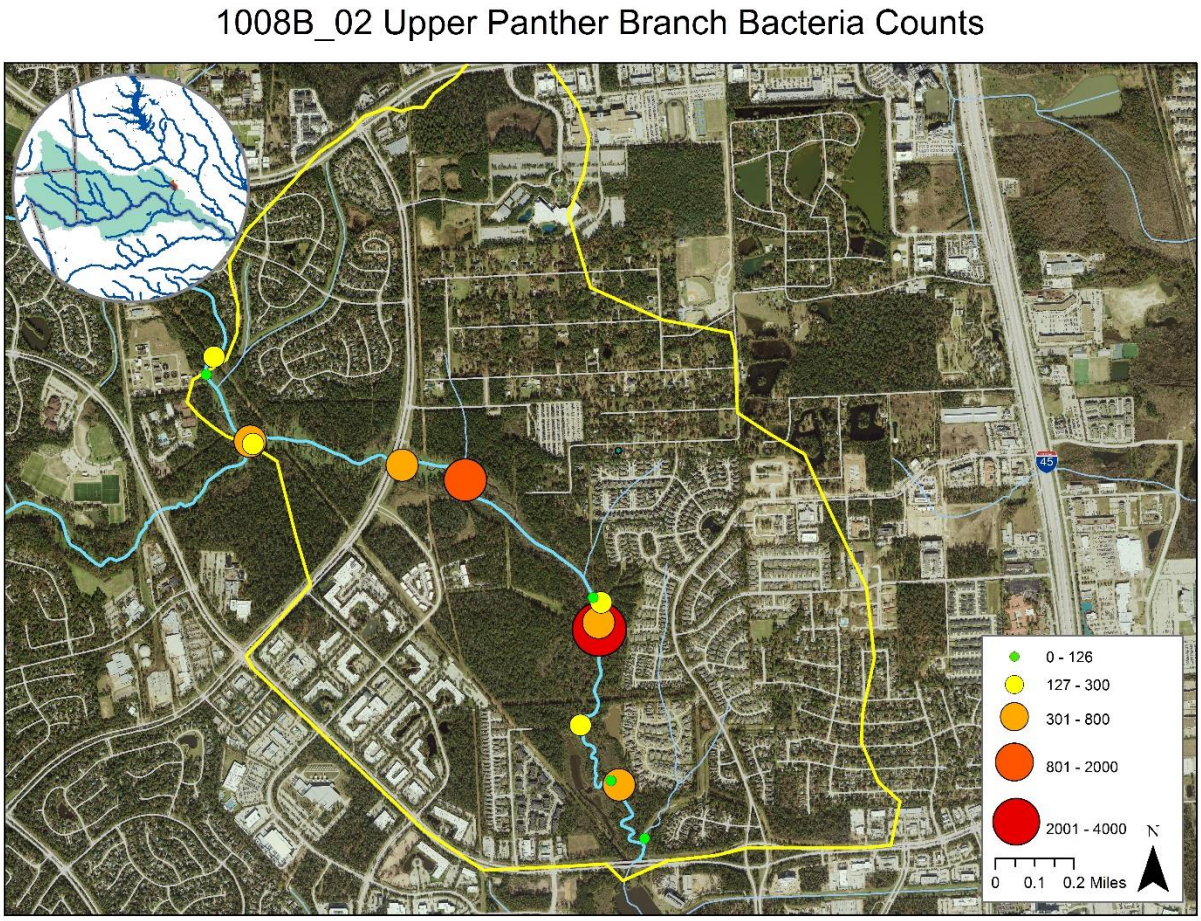


Figure 54. Bacteria screening results for Upper Panther Branch surveys

5.1.3 Significant Findings

The most significant observation recorded during the Upper Panther Branch surveys was the strong odor and presence of chlorine throughout the waterway. Chlorine test strips were used at the majority of sample locations to detect estimated chlorine levels. All chlorine test strips tested positive for chlorine with *at least* 1.0 mg/L present for every sample tested (Figure 55). Many of the stormwater drainage tributaries had lower levels of chlorine and higher bacteria concentrations compared to the main stem of Upper Panther Branch. Further investigation is recommended in order to identify where the chlorine was originating.

Figure 55. Chlorine test strip result for Upper Panther Branch sample 004

Table 6 lists all significant findings that require further investigation and follow-up sampling. The average *E.coli* count for Upper Panther Branch bacteria screening was approximately 496 cfu/100mL. Samples collected with *E.coli* counts greater than 500 cfu/100mL were flagged as problem areas where further investigation is recommended.

Noteworthy findings include the high bacteria loading from a stormwater drainage tributary (Tier II ID 065) originating from the subdivision off Grogans Mill Road (Figure 56). Homeowners were seen walking their dogs along the drainage tributaries in this area, making pet waste a potential contributor of bacteria at this location. Another stormwater drainage tributary (Tier II ID 072, sample 009) coming from the sporting facility on Marisco Place had high *E.coli* concentrations, l with the water sample having a strong petrochemical smell likely from surface runoff from the adjacent parking lot (Figure 57). Several of the tributaries feeding into Upper Panther Branch had a very distinct reddish tint (Figures 58-60). It was unclear if this was a result of impacts from different soil types or if there were other factors. However, there did not seem to be a correlation between bacteria concentration and red water at these sample locations.

Figure 56. Stormwater drainage tributary with high bacteria concentration (Tier II ID 065, sample 003)

Figure 57. Stormwater drainage tributary with high bacteria concentration (Tier II ID 072, sample 009)

Figures 58-60. Red tinted waters in the tributaries of Upper Panther Branch

Table 6. Summary of bacteria results and significant findings for Upper Panther Branch

No.	Tier II ID	Tier II Type	Outfall Flow	Sample ID	Sample Type	*E. coli (cfu/100ml)*	Issue	Date Identified	Further Investigation	Latitude	Longitude
1	062	Tributary	Present	001	Surface Water	170	N/A	7/26/2016	No	30.18642	-95.47234
2	063	Tributary	Present	002	Surface Water	310	N/A	7/26/2016	No	30.18568	-95.47247
3	065	Tributary	Present	003	Surface Water	3420	High Bacteria	7/26/2016	Yes	30.18542	-95.47245
4	067	N/A	N/A	004	Surface Water	140	N/A	7/26/2016	No	30.18191	-95.47338
5	068	Tributary	Present	005	Surface Water	100	N/A	7/26/2016	No	30.17983	-95.47214
6	069	Tributary	Present	006	Surface Water	580	High Bacteria	7/26/2016	Yes	30.17966	-95.47181
7	070	Tributary	Present	007	Surface Water	60	N/A	7/26/2016	No	30.17765	-95.47079
8	071	N/A	N/A	008	Surface Water	50	N/A	7/26/2016	No	30.18661	-95.47267
9	072	Tributary	Present	009	Surface Water	1040	High Bacteria	7/27/2016	Yes	30.19110	-95.47796
10	073	Tributary	Present	010	Surface Water	390	N/A	7/27/2016	No	30.19172	-95.48064
11	N/A	N/A	N/A	011	Surface Water	230	N/A	7/27/2016	No	30.19200	-95.48200
12	074	Tributary	Present	012	Surface Water	270	N/A	7/27/2016	No	30.19266	-95.48696
13	N/A	N/A	N/A	013	Surface Water	400	N/A	7/27/2016	No	30.19277	-95.48708
14	075	Outfall	Present	014	Outfall	20	N/A	7/27/2016	No	30.19528	-95.48886
15	N/A	N/A	N/A	015	Surface Water	260	N/A	7/27/2016	No	30.19593	-95.48851

6.0 Conclusion

The *BIG's Top Five Most and Top Five Least Impaired Water Bodies* project was developed in an effort to demonstrate the value of a prioritized watershed approach for correcting bacteria sources in impaired water bodies within the BIG geographic area. The project began with a Top 10/Least 10 list of bacteria impaired water bodies developed by the BIG that was then prioritized and pared down to the Top 2/Least 2 lists through desk reviews and input from a technical workgroup. The resulting list of four AUs were then subject to further assessment and field investigation in order to identify potential bacteria sources. This Preliminary Action Report summarizes tasks completed during the first phase of the project, including Desk Review 1, Desk Review 2, windshield surveys, and field investigations for bacteria screening.

6.1. Next Steps

Phase II of the project will include professional water quality monitoring at the locations found to have high bacteria concentrations during the screening in Phase I. This report will help prioritize problem areas so Phase II investigations can be more focused to areas that present significant concerns. H-GAC staff will meet with the technical workgroup and local jurisdictions to discuss Phase I findings and plan where to focus efforts for the next phase of the project. Phase II sample results will then be reported to the appropriate jurisdictions for further investigation and implementation of corrective actions to reduce bacteria loadings into the surveyed AUs. Phase III of the project will include follow-up monitoring at locations where corrective actions were implemented to investigate the effectiveness of bacteria reduction practices.

Appendix A: Desk Review 1 Materials



TOP FIVE MOST AND TOP FIVE LEAST IMPAIRED WATER BODIES

Workgroup Meeting
April 20, 2016

Project Overview

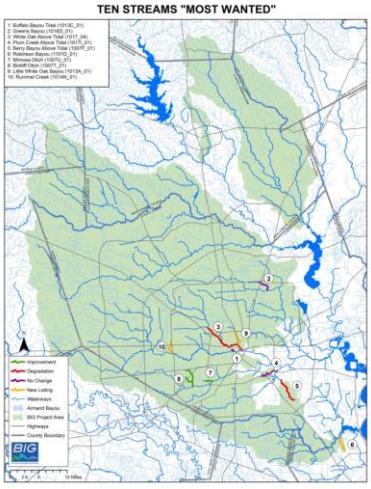
- Phase I
  - Desk Review 1
  - Desk Review 2
  - AU Intensive Study
- Phase II
  - Sample Collection Decision
  - Sample Collection
- Phase III
  - Elevated Bacteria
  - Agency Action Report
  - Follow-up Monitoring
  - Analysis

Phase I: Desk Review 1

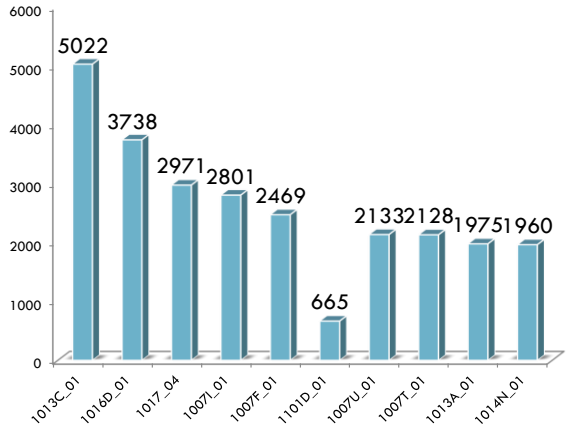
- Review and analyze top 10 most wanted list
  - AU Spreadsheet
  - GIS Aerial Image Review
- Top 10 lists pared down to create preferential Top 5/Least 5 lists
  - BIG I-Plan Geographic Priority Framework:
    - Bacteria Level
    - Accessibility
    - Use Level
    - Implementation Opportunities
    - Future Land Use Changes

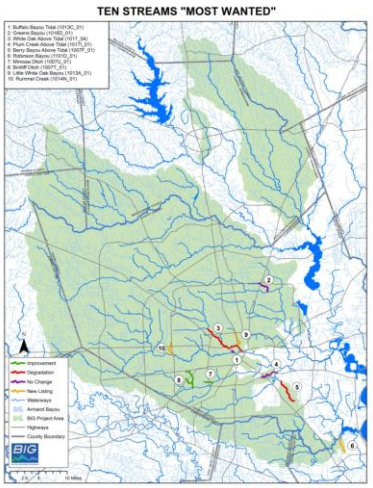
Top 10 Most Wanted

Rank	Assessment Unit	Use Level
1	Buffalo Bayou Tidal (1013C_01)	ALU; GU; RU
2	Greens Bayou (1016D_01)	ALU; GU; RU
3	White Oak Above Tidal (1017_04)	ALU; GU; RU
4	Plum Creek Above Tidal (1007I_01)	ALU; GU; RU
5	Berry Bayou Above Tidal (1007F_01)	ALU; GU; RU
6	Robinson Bayou (1101D_01)	ALU; GU; RU
7	Mimosa Ditch (1007U_01)	ALU; GU; RU
8	Bintliff Ditch (1007T_01)	ALU; GU; RU
9	Little White Oak Bayou (1013A_01)	ALU; GU; RU
10	Rummel Creek (1014N_01)	ALU; GU; RU

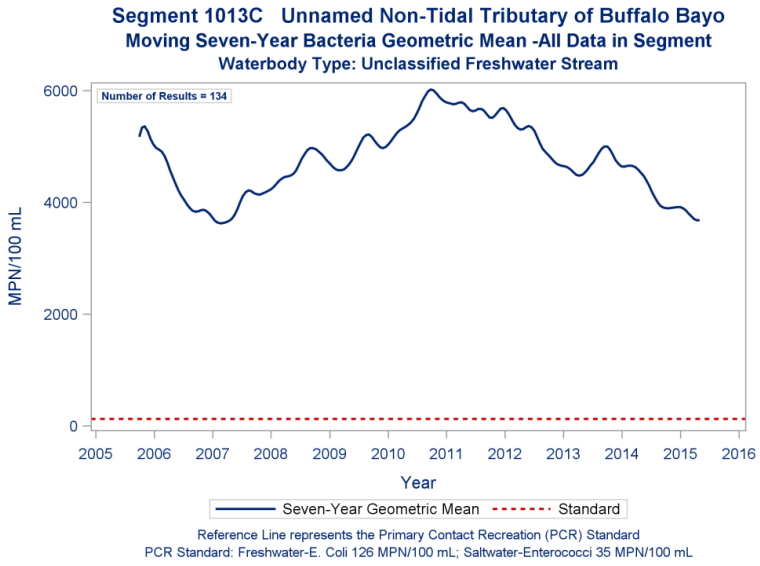


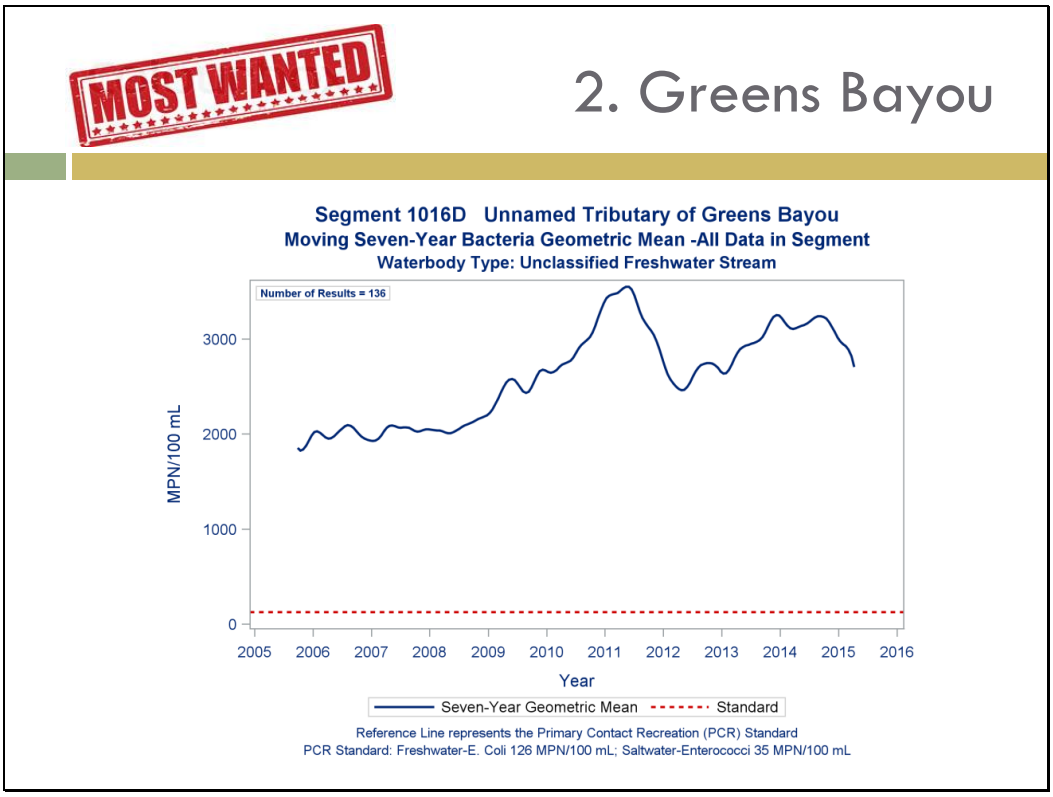
Top 10 Most Wanted

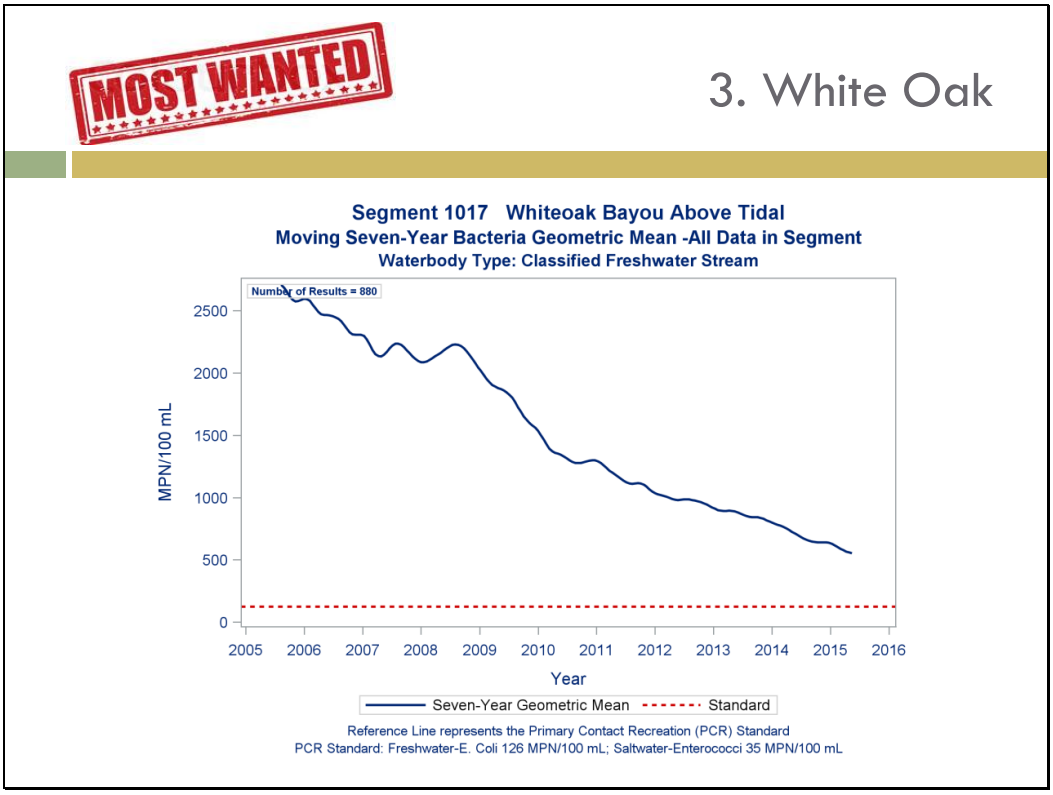


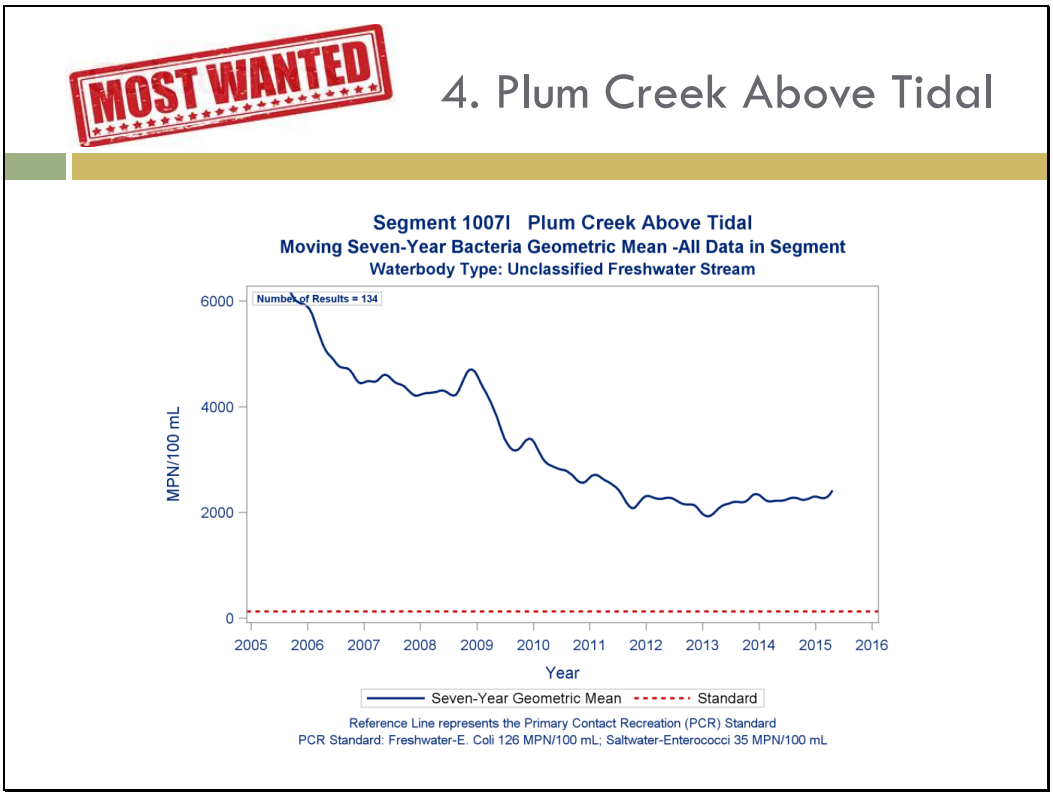


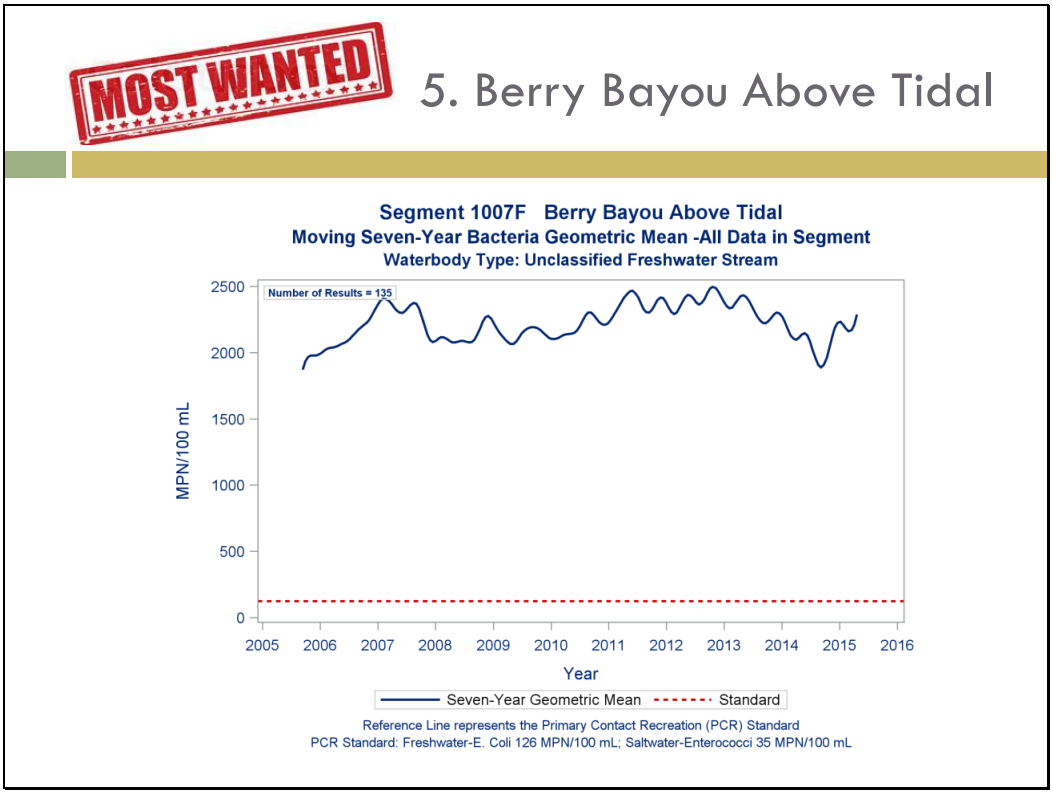
1. Buffalo Bayou Tidal

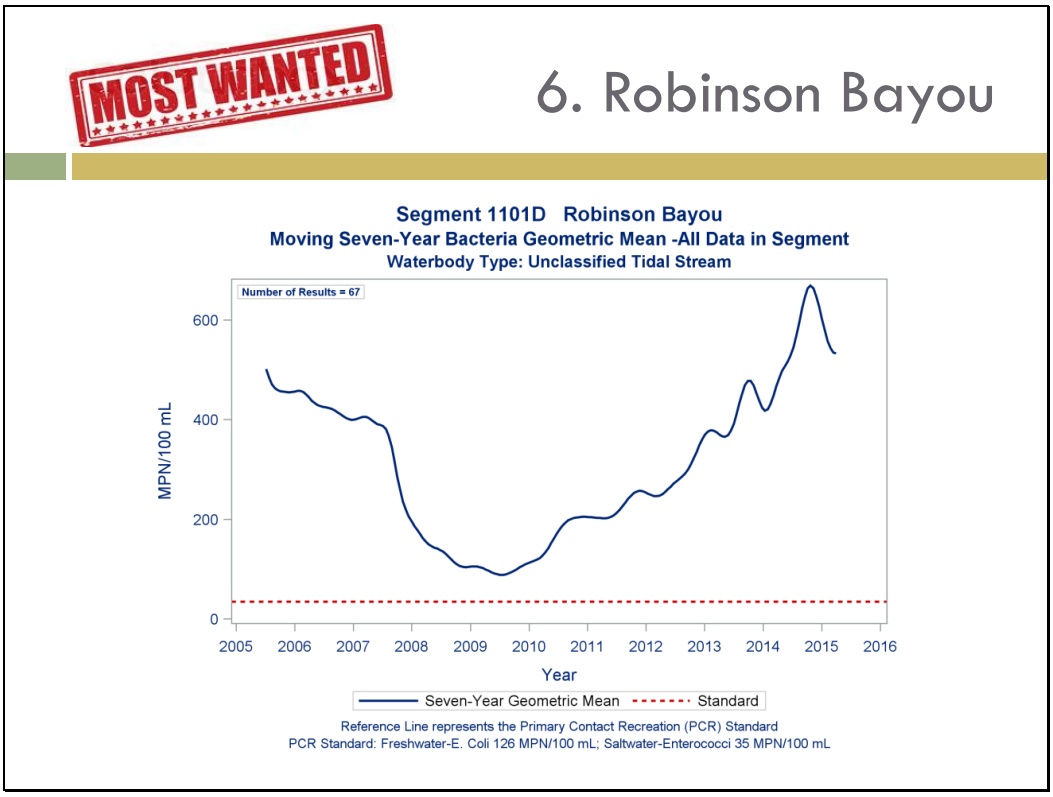


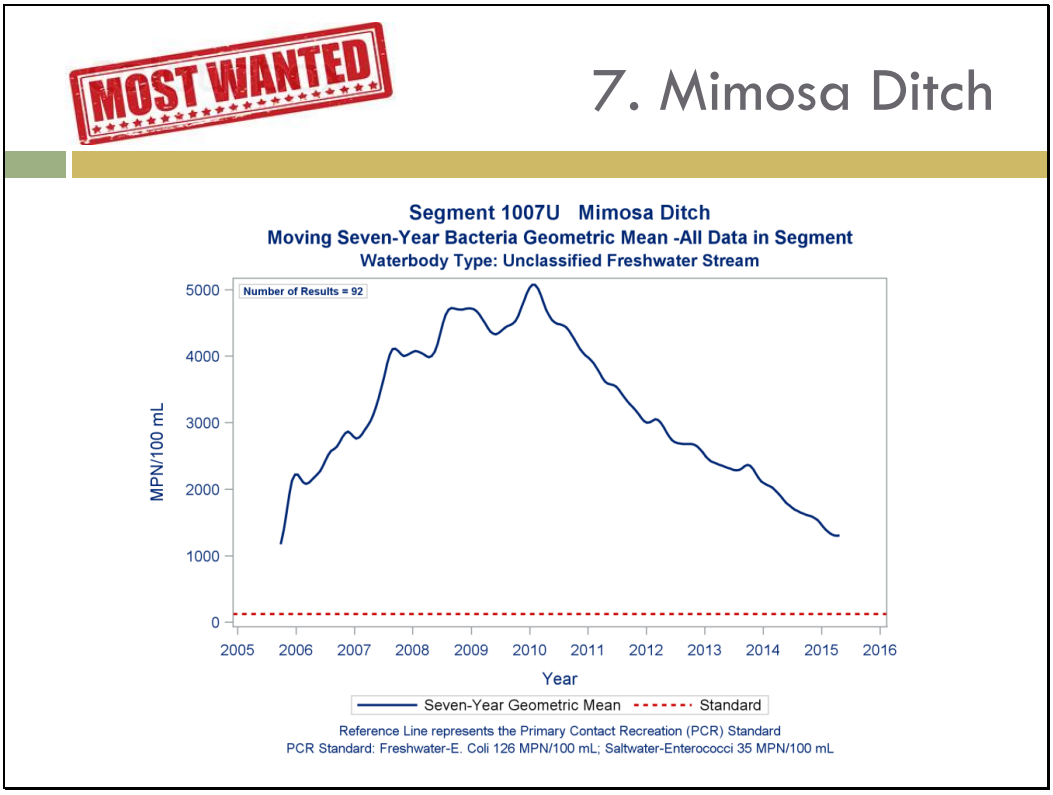

MOST WANTED
2. Greens Bayou
Segment 1016D Unnamed Tributary of Greens Bayou
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Unclassified Freshwater Stream
Number of Results = 136
MPN/100 mL
3000
2000
1000
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year
Seven-Year Geometric Mean
Standard
Reference Line represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL

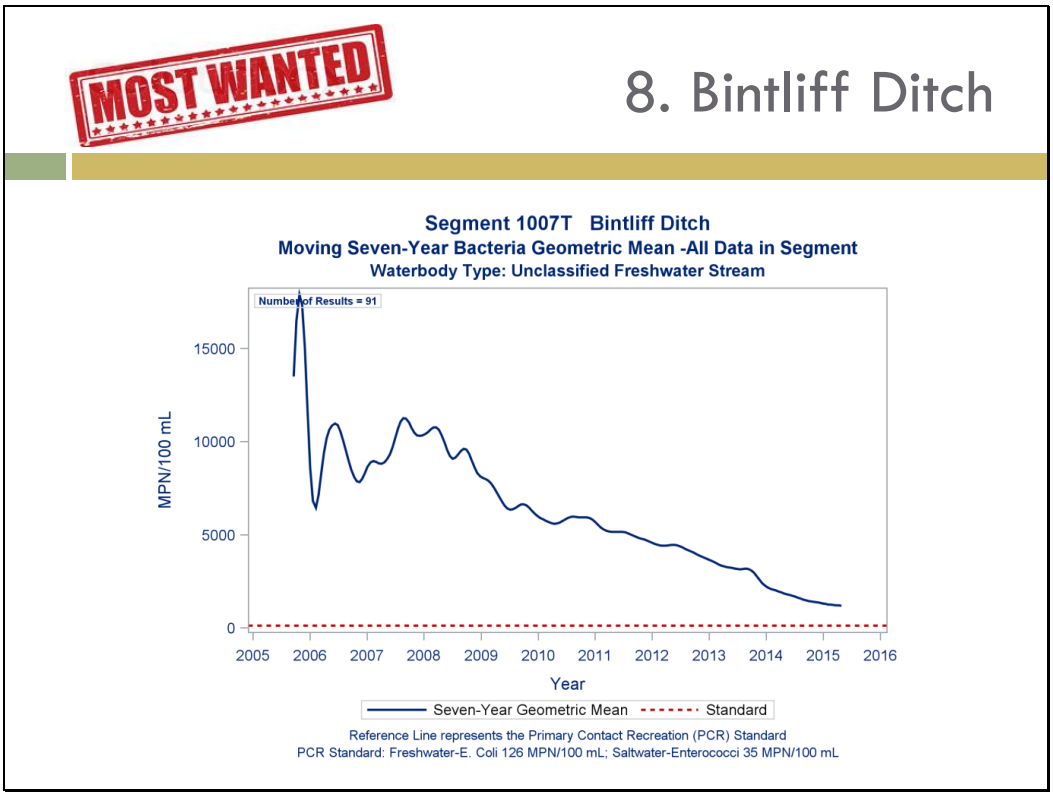

MOST WANTED
3. White Oak
Segment 1017 Whiteoak Bayou Above Tidal
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Classified Freshwater Stream
Number of Results = 880
MPN/100 mL
2500
2000
1500
1000
500
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year
Seven-Year Geometric Mean
Standard
Reference Line represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL

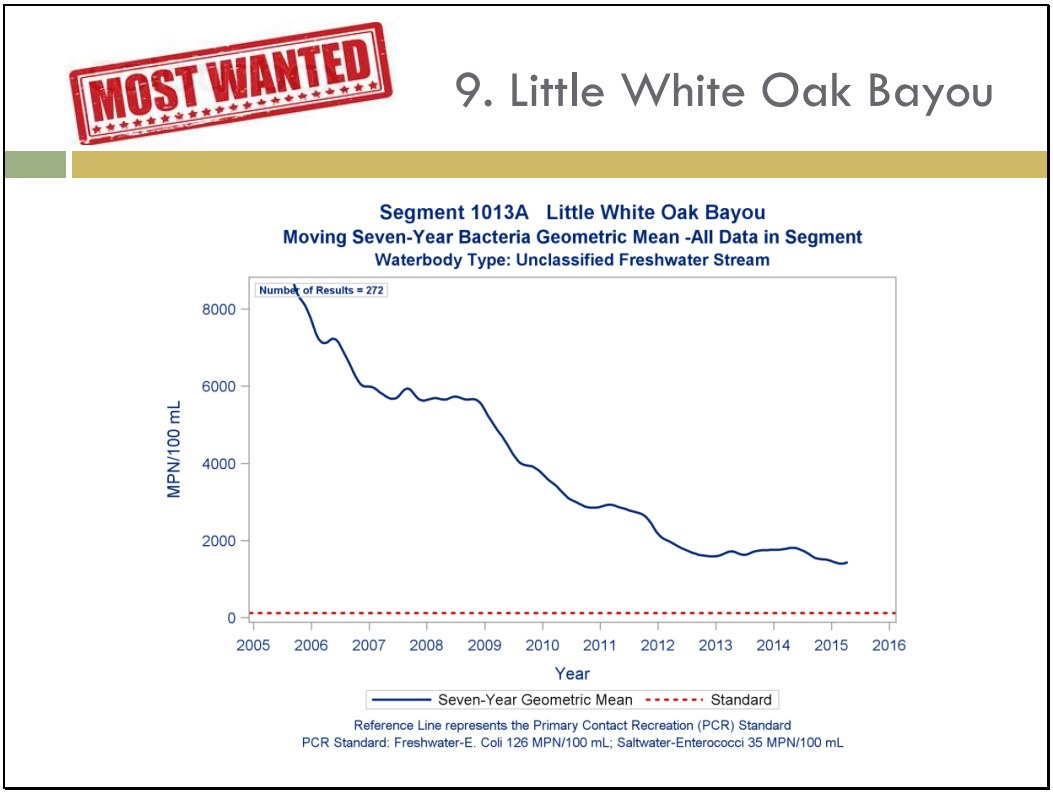

MOST WANTED
4. Plum Creek Above Tidal
Segment 1007I Plum Creek Above Tidal
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Unclassified Freshwater Stream
Number of Results = 134
MPN/100 mL
6000
4000
2000
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year
Seven-Year Geometric Mean
Standard
Reference Line represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL


MOST WANTED
5. Berry Bayou Above Tidal
Segment 1007F Berry Bayou Above Tidal
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Unclassified Freshwater Stream
Number of Results = 135
MPN/100 mL
2500
2000
1500
1000
500
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year
Seven-Year Geometric Mean
Standard
Reference Line represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL

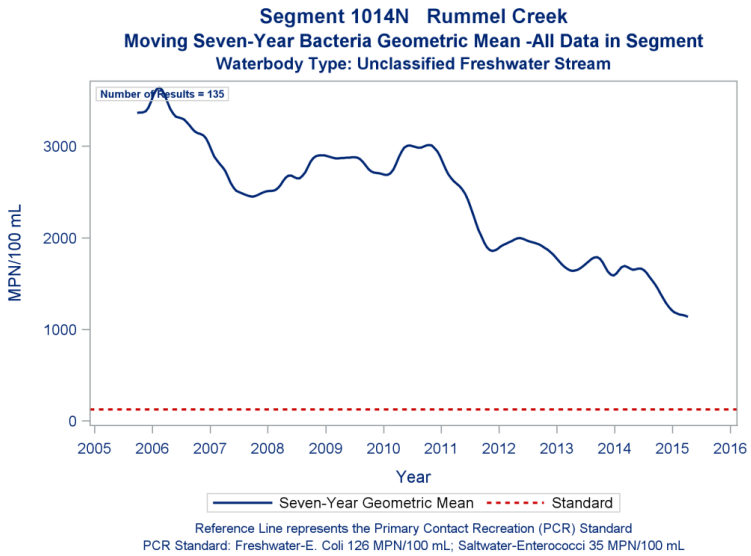

MOST WANTED
6. Robinson Bayou
Segment 1101D Robinson Bayou
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Unclassified Tidal Stream
Number of Results = 67
MPN/100 mL
600
400
200
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year
Seven-Year Geometric Mean
Standard
Reference Line represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL


MOST WANTED
7. Mimosa Ditch
Segment 1007U Mimosa Ditch
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Unclassified Freshwater Stream
Number of Results = 92
MPN/100 mL
5000
4000
3000
2000
1000
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year
Seven-Year Geometric Mean
Standard
Reference Line represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL


MOST WANTED
8. Bintliff Ditch
Segment 1007T Bintliff Ditch
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Unclassified Freshwater Stream
Number of Results = 91
MPN/100 mL
15000
10000
5000
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year
Seven-Year Geometric Mean
Standard
Reference Line represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL

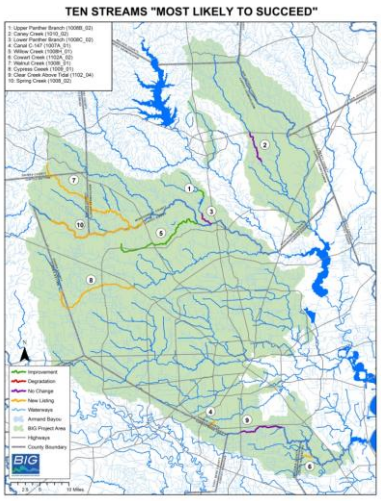

MOST WANTED
9. Little White Oak Bayou
Segment 1013A Little White Oak Bayou
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Unclassified Freshwater Stream
Number of Results = 272
MPN/100 mL
8000
6000
4000
2000
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year
Seven-Year Geometric Mean
Standard
Reference Line represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL

10. Rummel Creek

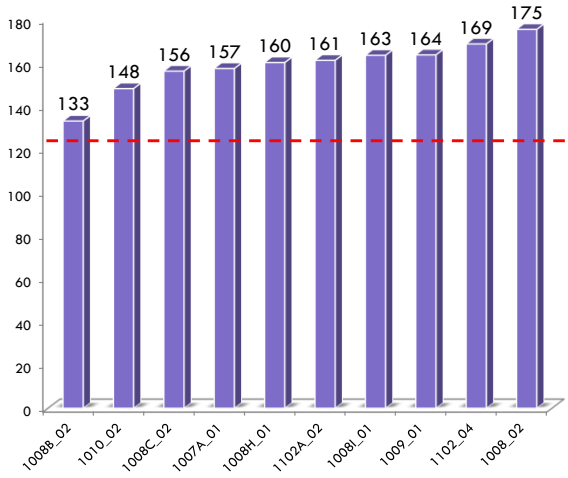


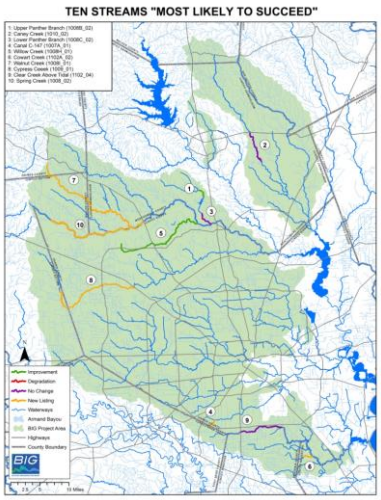
Top 10 Most Likely to Succeed

Rank	Assessment Unit	Use Level
1	Upper Panther Branch (1008B_02)	ALU; FCU; GU; RU
2	Caney Creek (1010_02)	ALU; GU; PWSU; RU
3	Lower Panther Branch (1008C_02)	ALU; FCU; GU; RU
4	Canal C-147 (1007A_01)	ALU; GU; RU
5	Willow Creek (1008H_01)	ALU; GU; RU
6	Cowart Creek (1102A_02)	ALU; GU; RU
7	Walnut Creek (1108I_01)	ALU; GU; RU
8	Cypress Creek (1009_01)	ALU; GU; PWSU; RU
9	Clear Creek Above Tidal (1102_04)	ALU; FCU; GU; RU
10	Spring Creek (1008_02)	ALU; GU; PWSU; RU

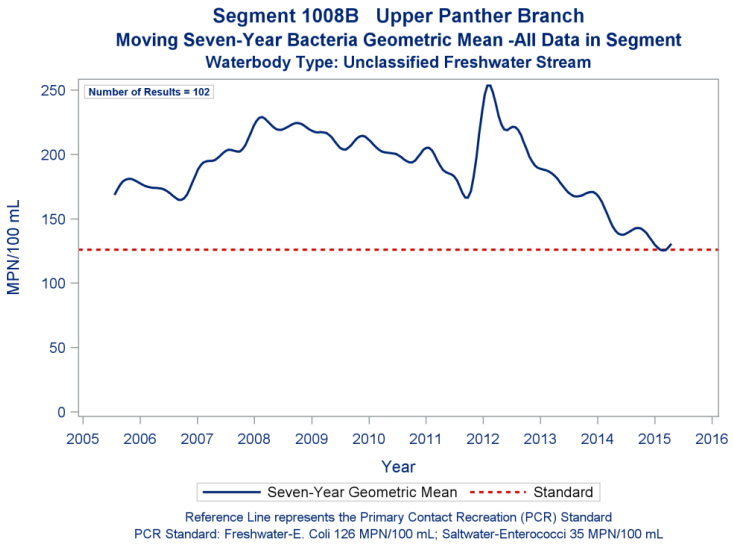


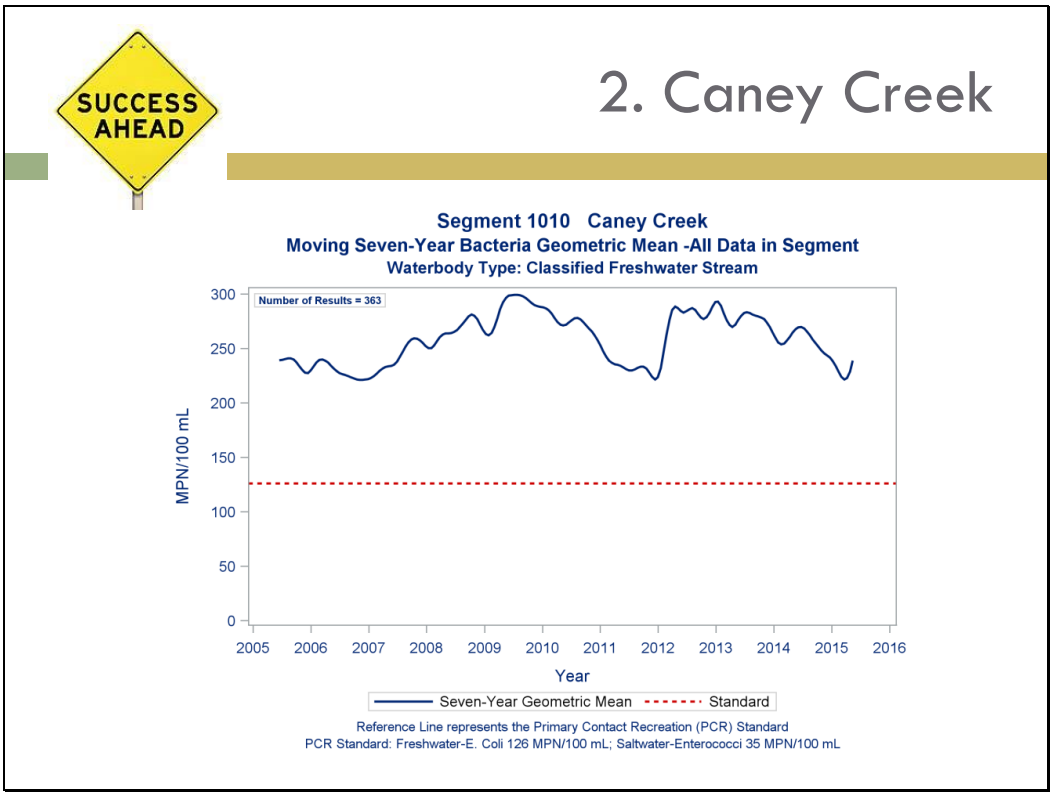
Top 10 Most Likely to Succeed

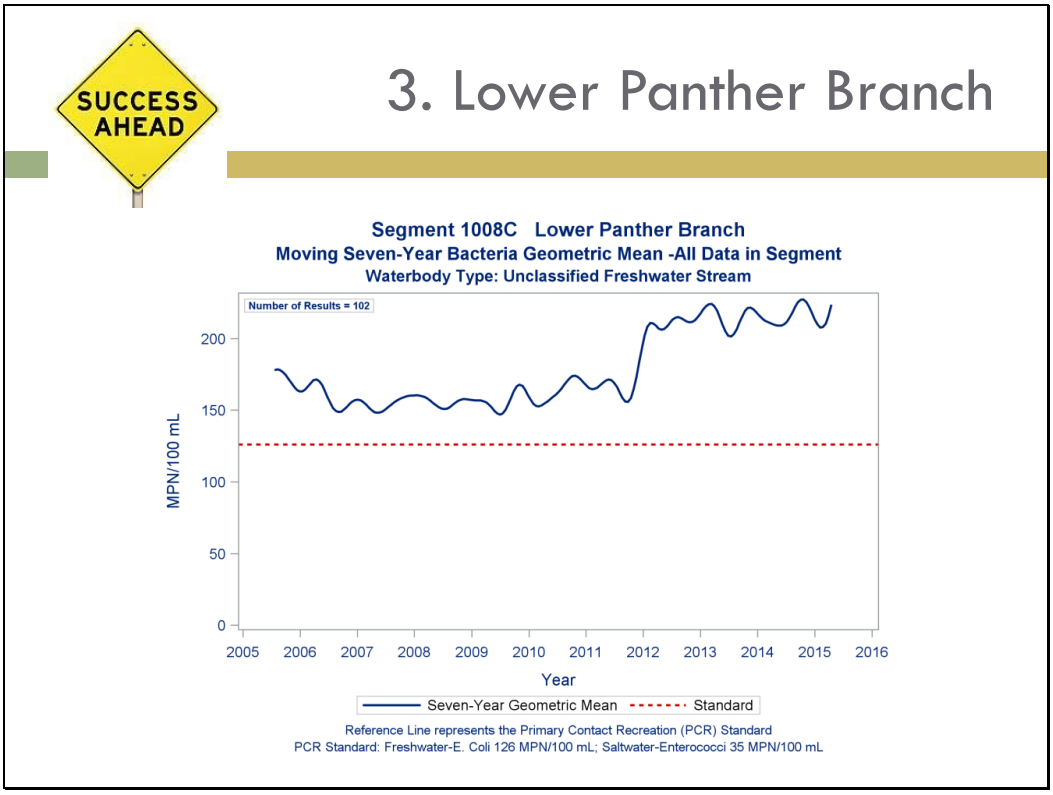


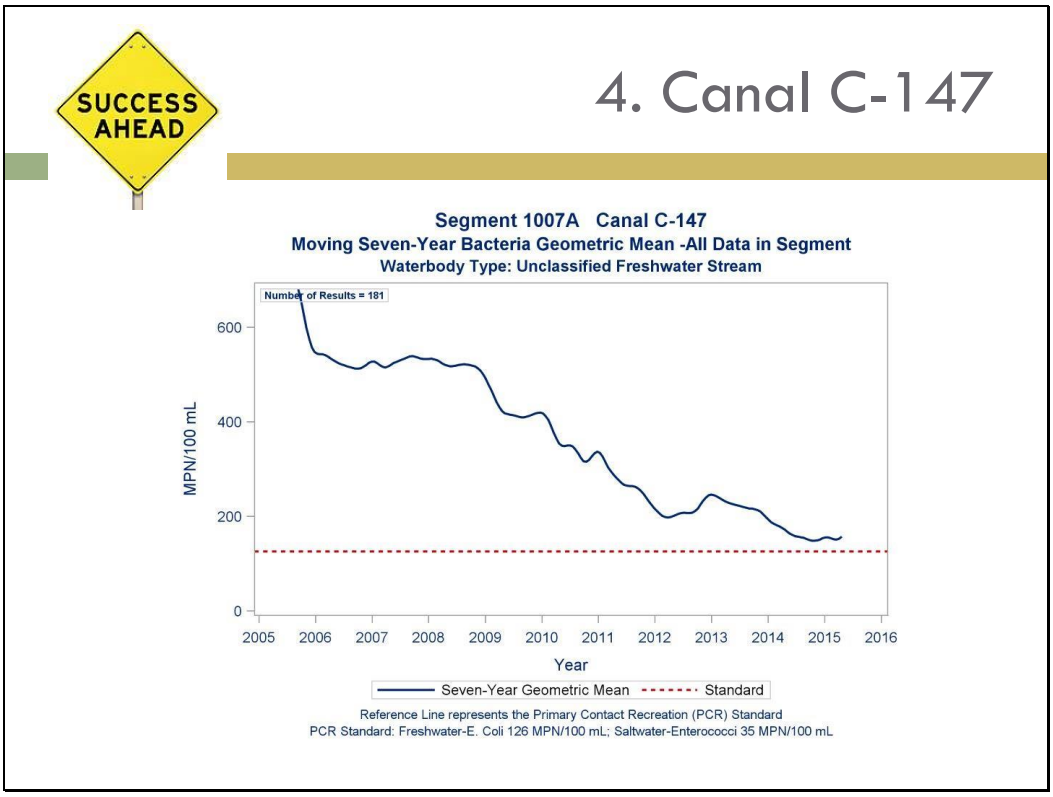


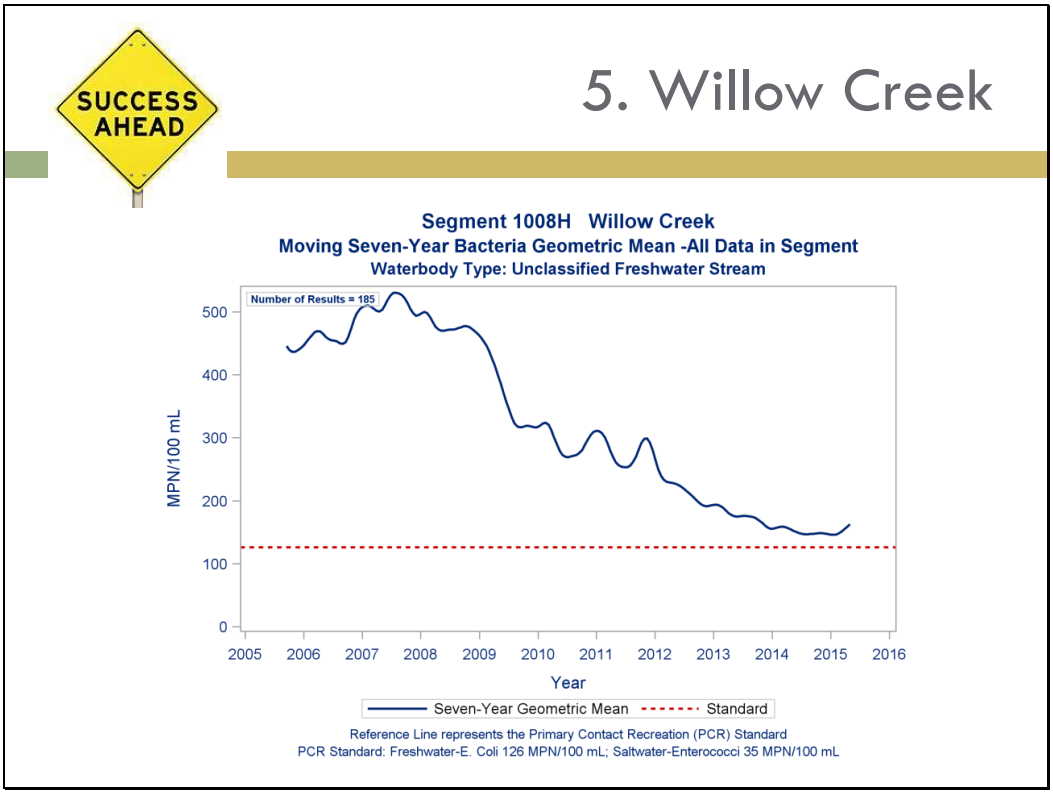
1. Upper Panther Branch

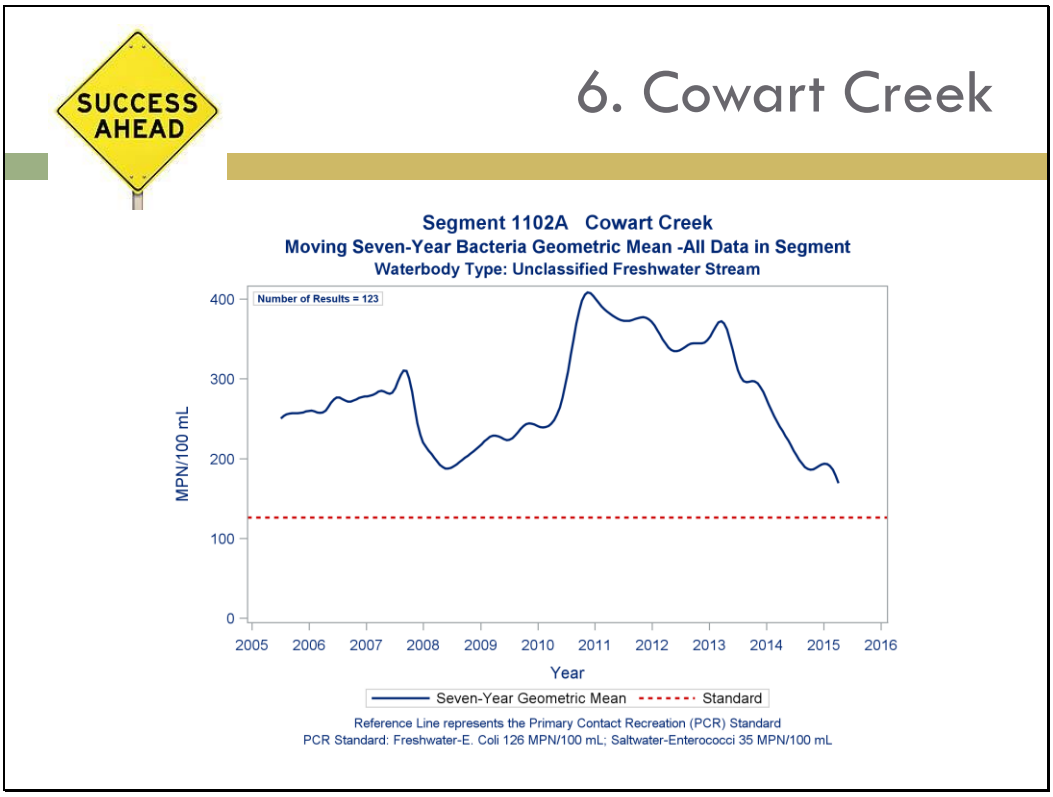


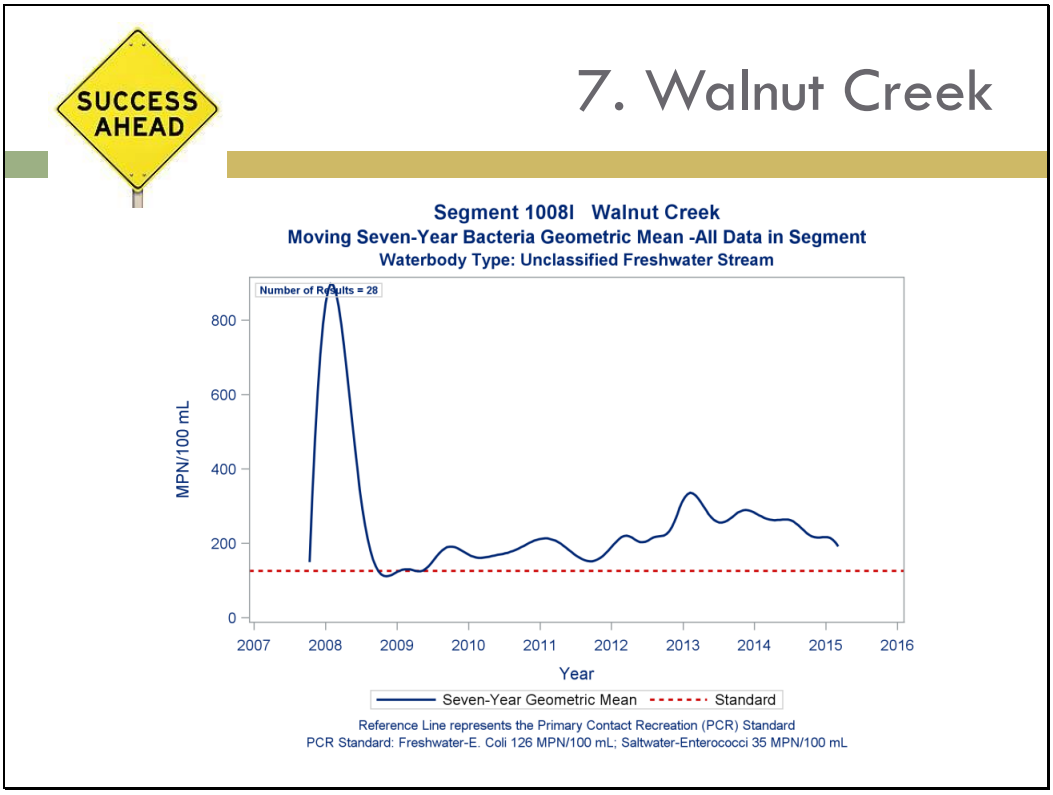

SUCCESS AHEAD
2. Caney Creek
Segment 1010 Caney Creek
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Classified Freshwater Stream
Number of Results = 363
MPN/100 mL
300
250
200
150
100
50
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year
Seven-Year Geometric Mean
Standard
Reference Line represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL

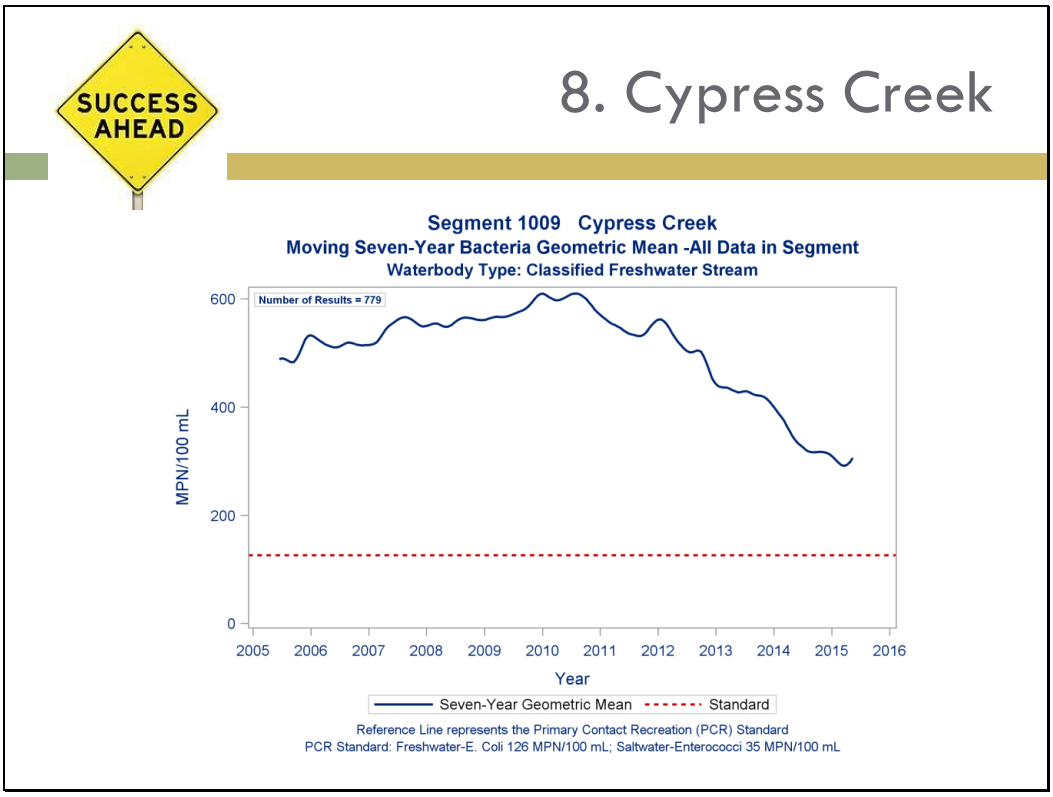

SUCCESS AHEAD
3. Lower Panther Branch
Segment 1008C Lower Panther Branch
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Unclassified Freshwater Stream
Number of Results = 102
MPN/100 mL
200
150
100
50
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year
Seven-Year Geometric Mean
Standard
Reference Line represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL

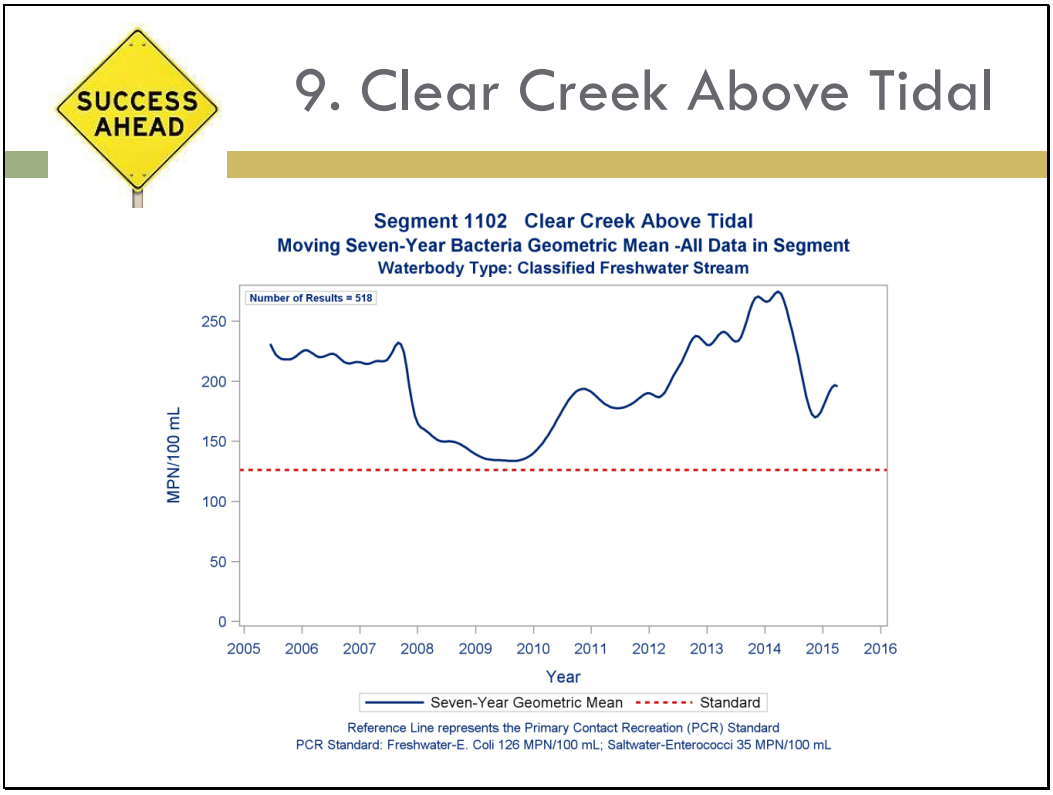

SUCCESS AHEAD
4. Canal C-147
Segment 1007A Canal C-147
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Unclassified Freshwater Stream
Number of Results = 181
MPN/100 mL
600
400
200
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year
Seven-Year Geometric Mean
Standard
Reference Line represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL


SUCCESS AHEAD
5. Willow Creek
Segment 1008H Willow Creek
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Unclassified Freshwater Stream
Number of Results = 185
MPN/100 mL
500
400
300
200
100
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year
Seven-Year Geometric Mean
Standard
Reference Line represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL

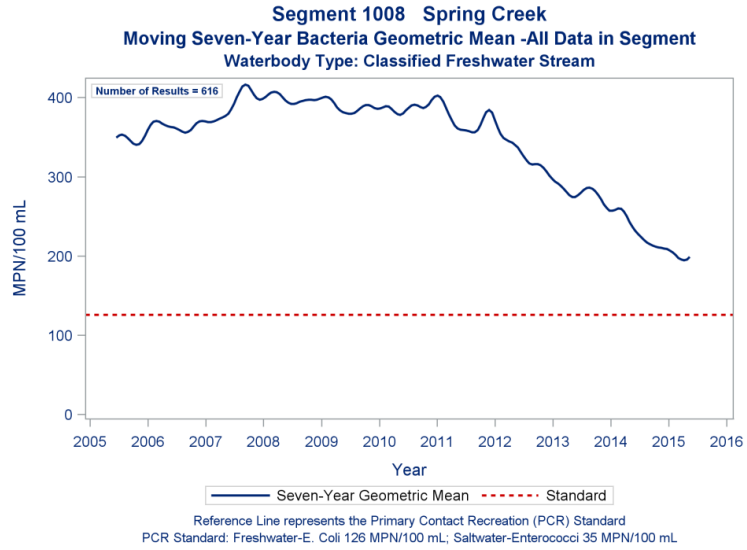

SUCCESS AHEAD
6. Cowart Creek
Segment 1102A Cowart Creek
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Unclassified Freshwater Stream
Number of Results = 123
MPN/100 mL
400
300
200
100
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year
Seven-Year Geometric Mean
Standard
Reference Line represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL


SUCCESS AHEAD
7. Walnut Creek
Segment 1008I Walnut Creek
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Unclassified Freshwater Stream
Number of Results = 28
MPN/100 mL
800
600
400
200
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year
Seven-Year Geometric Mean
Standard
Reference Line represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL


SUCCESS AHEAD
8. Cypress Creek
Segment 1009 Cypress Creek
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Classified Freshwater Stream
Number of Results = 779
MPN/100 mL
600
400
200
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year
Seven-Year Geometric Mean
Standard
Reference Line represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL


SUCCESS AHEAD
9. Clear Creek Above Tidal
Segment 1102 Clear Creek Above Tidal
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Classified Freshwater Stream
Number of Results = 518
MPN/100 mL
250
200
150
100
50
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Year
Seven-Year Geometric Mean
Standard
Reference Line represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL

10. Spring Creek



Next Steps

- **Phase I completion by June 30th, 2016**
  - Review 1 ~ April, 2016
  - Review 2 ~ May, 2016
  - AU Intensive Study ~ June, 2016
- **Phase II completion by October 31st, 2016**
  - Sample Collection & NELAP Testing ~ July - Aug, 2016
  - Data Analysis & Source ID ~ Sep - Oct, 2016
- **Phase III completion by April 30th, 2017**
  - Reporting to Local Authorities ~ Nov 2016 – Jan, 2017
  - Follow up monitoring ~ Feb – March, 2017
  - Final data analysis ~ April, 2017

Top 5 / Least 5 Workgroup Meeting Notes

Wednesday, April 20, 2016

1:00 PM to 3:00 PM
H-GAC Conference Room D
3555 Timmons Lane, 2nd Floor

1. Introductions

Paniz began the meeting at approximately 1:05 PM. Paniz welcomed and thanked everyone for coming and initiated self-introductions.
Persons in Attendance:
Paniz Miesen – H-GAC
William Merrell – H-GAC
Becki Begley – H-GAC
Rachel Fields – H-GAC
Steven Johnston – H-GAC
Lisa Marshall – GBEP
Robert Snoza – HCFCD
Steve Hupp – Bayou Preservation
Lisa Groves – City of Houston

Persons on Conference Line:
Denis Hall – Harris County Pollution Control

2. Project Overview

Paniz briefly reviewed the project flow chart with the group. Project is split into three phases.

- Phase I includes two desktop reviews and initial groundtruthing of chosen assessment units (AUs).
- Phase II includes sample collection, NELAP testing, and analysis of data.
- Phase III includes working with local jurisdictions to implement bacteria reduction measures and conduct follow-up sampling.

This meeting was held to satisfy Review 1 tasks associated with Phase I of the project: *Reduce the Top 10 Most Wanted and Top 10 Most Likely to Succeed AU list to Top 5 Most Wanted and Top 5 Most Likely To Succeed.*

3. Review of Top 10 Most Wanted AUs

The workgroup reviewed subwatershed maps and moving bacteria geometric mean plots for each AU on the Top 10 Most Wanted list and discussed important considerations and information pertinent to each AU.

1-Buffalo Bayou Tidal:

- Portions of this AU go underground creating some accessibility issues.
- This AU has been subject to assessment and special studies by the City of Houston and the Bayou Preservation Association.
- Area still seems to have many problems that are worth analyzing.
- Potential sources of pollution include leaking OSSFs.

2-Greens Bayou:

- Steve Hupp mentioned an unknown outfall location west of Hwy 59. Outfall permit exists, but actual outfall itself is hard to find.
- Apartment complexes in the area have been known to have wastewater problems.
- Lots of poison ivy.
- Possible OSSF issues north of the Beltway.
- Area known to have suspect dry weather flows.
- Slight sewage odor noticeable near sample locations.

3-White Oak:

- Noticeable sewage odor present in area around TC Jester and 11th.
- Larger homeless population in area.
- Something is going on in and around the underground portions of the AU, especially near the hospital, around Hwy 290, and near station 16596.
- City of Houston has assessed the area but hasn't found any significant bacteria point sources.
- Ammonia levels have been high but were linked to leaking A/C unit.
- Lots of new infrastructure around station 16595 may have improved bacteria conditions in recent years.
- Safety and accessibility issues were mentioned.

4-Plum Creek:

- High bacteria hits have been found in the ditch near the stadium south of the 610 Loop.
- Lift station upstream of sampling location may be faulty and a potential source of bacteria.
- Areas upstream and downstream of the YMCA have had high bacteria levels. SSOs have been common in this area.
- Shallow concrete channels are common.
- May run into accessibility issues on private properties.

5-Berry Bayou:

- Station 16661 has had higher bacteria hits compared to the other sampling stations in this AU – assessment should focus upstream of this station.
- There is a network of open ditches in this AU which may make accessibility a potential issue.
- Not much work has been done in this AU, making it a good candidate for further assessment.
- Old and rusty infrastructure/collection systems are common in area.
- Based on samples collected, upstream portion seems to have higher bacteria levels. No hits in southern portions.
- Concrete lining is common in most areas upstream, many of which are newly constructed or are currently under construction.
- Steve Hupp suggested reviewing the most recent data to see if rehab in the area has made any impact on the water quality.
- Good option for further assessment.

6-Robinson Bayou:

- Enterococcus is the indicator bacteria for this AU. Top 5 / Least 5 project will be focusing only on AUs where *E.coli* is the indicator bacteria.

7-Mimosa Ditch:

- City of Bellaire mentioned dog shelter upstream of the sample location as possible bacteria source. Further discussion revealed that the shelter is too small and far from the waterway to be a significant source.
- High dry weather flows at Rice are suspect.
- A lot of construction and infrastructure rehab in the area.
- City of Bellaire jurisdiction.
- Good option for further assessment.

8-Bintliff Ditch:

- City of Houston did a special study in this area a few years ago.
- Accessibility is an issue; chain link fences/gates and high vegetation on private property block access in many areas. Robert Snoza of HCFCD followed up with information regarding property rights and Fee ownerships. He does not believe HCFCD maintains this waterway and COH has had Fee ownership since 1960.
- Potential OSSF problems.
- Previous assessments by Bayou Preservation have found the area south of Hwy 59 and North of Bellaire are problem areas.
- Steve Hupp of Bayou Preservation has assessed the western branch and Carol LaBreche of COH has assessed the eastern branch – both are having bacteria problems.
- Good option for further assessment.

9-Little White Oak:

- City of Houston samples show station 11148 with highest bacteria levels compared to other stations in this AU.
- Fish kills have occurred upstream of station 11148.
- Lisa Groves mentioned the COH did a characterization 5-6 years ago and did not get significant bacteria hits.
- Steve Hupp has assessed the upstream portion and got no bacteria hits but did find high chlorine levels in surface water. Lisa Groves said they found leaking potable water in that area when they did their characterization which may have been the chlorine source.
- Lisa Groves also mentioned a lift station upstream of station 16648 with foul odor (Woodland Park area).
- Accessibility issues in some areas.
- Would be a very time intensive assessment due to the density of development and mixed use.
- Good option for further assessment.

10-Rummel Creek:

- Clean Rivers Program (CRP) partners mentioned wanting an additional monitoring station added on this AU during the CMM meeting on 4/12/16 due to concerns about potential pollution sources in areas where contact recreation is common.
- Area directly south of I-10 has seen issues including a fish kill last summer. Mulch yard and nursery nearby may be source of nutrients and bacteria to the waterway causing fish kills.
- Robert Snoza mentioned there are two pumped TXDOT detention basins in this area.
- Good option for further assessment.

4. Review of Top 10 Most Likely to Succeed AUs

The workgroup reviewed subwatershed maps and moving bacteria geometric mean plots for each AU on the Top 10 Most Likely to Succeed list and discussed important considerations and information pertinent to each AU.

1-Upper Panther Branch:

- San Jacinto River Authority does the monitoring for this AU.
- Wildlife is a likely contributor of bacteria in this AU.
- Steve Hupp mentioned this may be a good AU for source tracking.
- No one at the meeting has done much work in this area.
- Good option for further assessment.

2-Caney Creek:

- Rural watershed.
- Cattle grazing is common.
- Failing OSSFs may be a potential bacteria contributor.
- Drain field issues related to lot size present in the area.
- There is currently a WPP underway for this area. That may be a more fitting means of characterizing this AU.

3-Lower Panther Branch:

- San Jacinto River Authority does the monitoring for this AU.
- Increasing bacteria trends are likely related to increased development in the area.
- Feral hogs may be a potential source here.
- No one at the meeting has done much work in this area.
- Good option for further assessment.

4-Canal C-147:

- Flood control did work on detention basin improvements.
- Flea market and bull fighting in eastern portion of the watershed.
- Recently constructed wastewater treatment facility in the area. Would be interesting to compare before and after samples to see the impact.
- Not much work done in this AU by meeting attendees.
- Good option for further assessment.

5-Willow Creek:

- Lisa Groves of COH samples at station 11185.
- Wastewater treatment facility (WWTF) installed 10-11 years ago upstream of sample location.
- There are a lot of wastewater outfalls in this AU.
- May be a good area for regionalization of WWTFs.
- Good option for further assessment.

6-Cowart Creek:

- Environmental Institute of Houston (EIH) does the monitoring in this AU.
- May run into some accessibility issues (private properties).
- No one at meeting has done much work in this area.
- Good option for further assessment.

7-Walnut Creek:

- H-GAC staff has encountered an angry homeowner concerned about trespassing in the area when monitoring.
- There is currently a WPP underway for this area. That may be a more fitting means of characterizing this AU.

8-Cypress Creek:

- Upcoming development planned for the area.
- There has been some research done on overflow conditions in this AU.
- South of sample location is a large wetland mitigation area.
- Livestock is a likely bacteria contributor in this AU.
- Private properties may cause accessibility issues.
- Good option for further assessment.

9-Clear Creek Above Tidal:

- Environmental Institute of Houston (EIH) does the monitoring for this AU.
- There is a high variety of pollution sources in this area.
- Good option for further assessment.

10-Spring Creek:

- Covers a very large geographic area.
- Rural residential watershed.
- Bacteria geomeans have been gradually improving since 2012.

5. Next Steps:

Paniz reviewed the project timeline with the workgroup.

- Phase I completion by June 30th, 2016
- Phase II completion by October 31st, 2016
- Phase III completion by April 30th, 2017

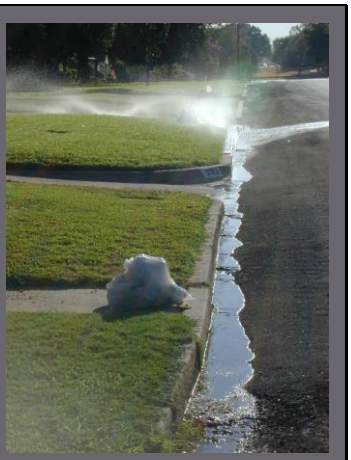
There will be another workgroup meeting scheduled in May to discuss Phase I, Review 2 tasks: *Reducing the Top 5 / Least 5 list to the final Top 2 / Least 2 AUs.*

6. Adjourn

Paniz thanked the group again for attending. Meeting adjourned at 3:15 PM.

Appendix B: Desk Review 2 Materials





BIG'S TOP FIVE MOST & TOP FIVE LEAST IMPAIRED WATER BODIES

May 26, 2016 | Workgroup Meeting

Project Overview

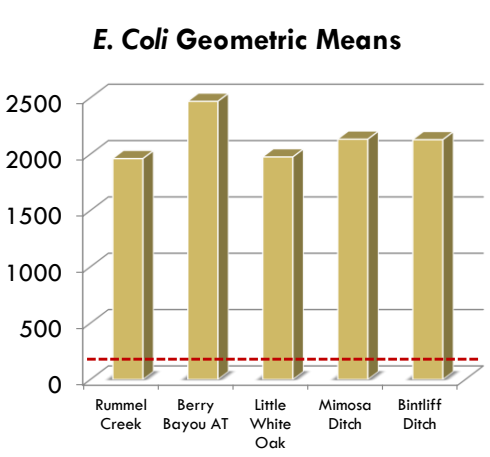
- **Phase I completion by June 30th, 2016**
  - Pare down Top 10 / Least 10 to Top 2 / Least 2
  - AU intensive study of Top 2 / Least 2
- **Phase II completion by October 31st, 2016**
  - Sample collection & NELAP testing
  - Data analysis and source identification
- **Phase III completion by April 30th, 2017**
  - Report to local authorities and work with local jurisdictions to implement bacteria reduction measures
  - Follow up monitoring and data analysis

Phase I: Review 2

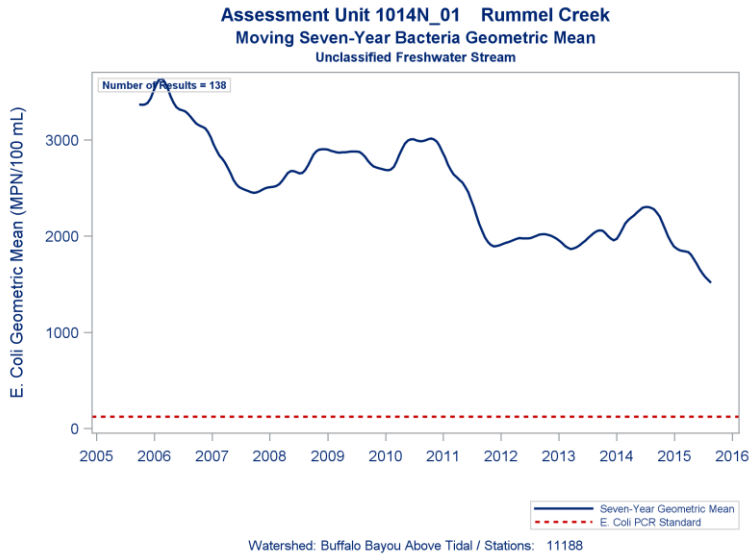
- Review Top 5 Most Wanted AUs
  - Moving seven-year bacteria geomeans
  - Trend analysis
  - LDCs or bacteria vs days since last rain
  - GIS maps
- Review Top 5 Most Likely to Succeed AUs
  - Moving seven-year bacteria geomeans
  - Trend analysis
  - LDCs or bacteria vs days since last rain
  - GIS maps
- Rank Top 5 / Least 5 in order of priority

Top 5 Most Wanted

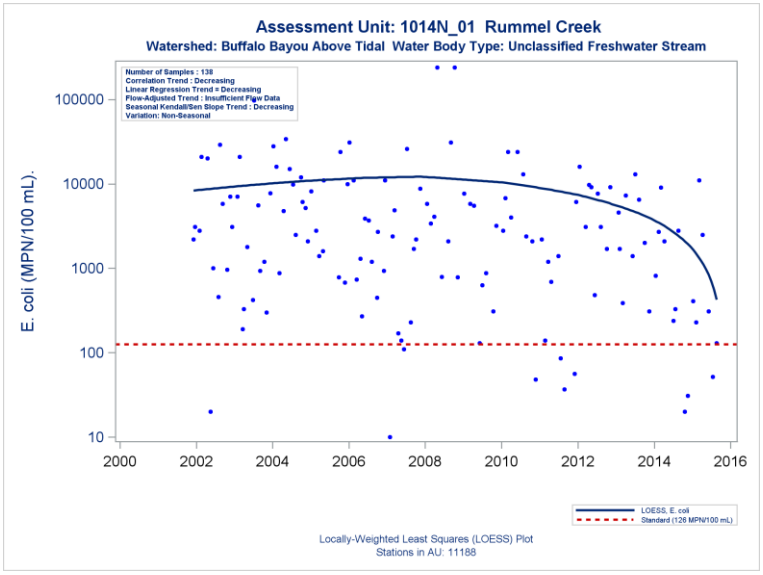
Top 5 Most Wanted
1) Rummel Creek (1014N_01)
2/3) Berry Bayou Above Tidal (1007F_01)
2/3) Little White Oak Bayou (1013A_01)
4) Mimosa Ditch (1007U_01)
5) Bintliff Ditch (1007T_01)



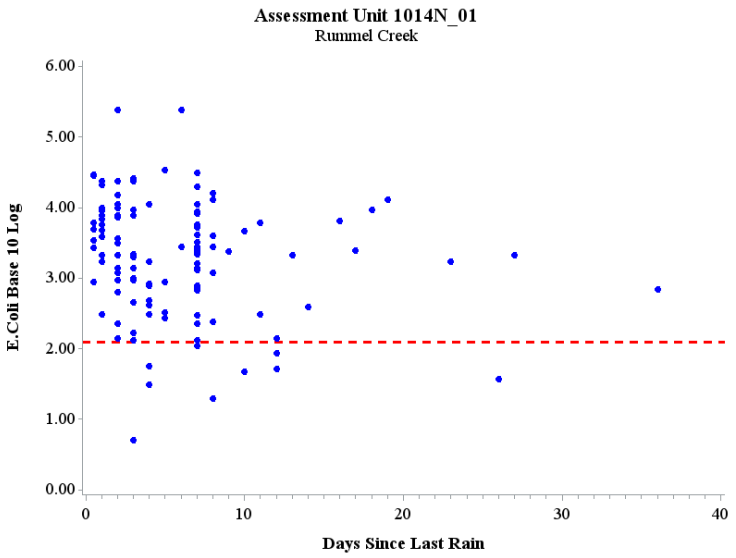
Rummel Creek (1014N_01)



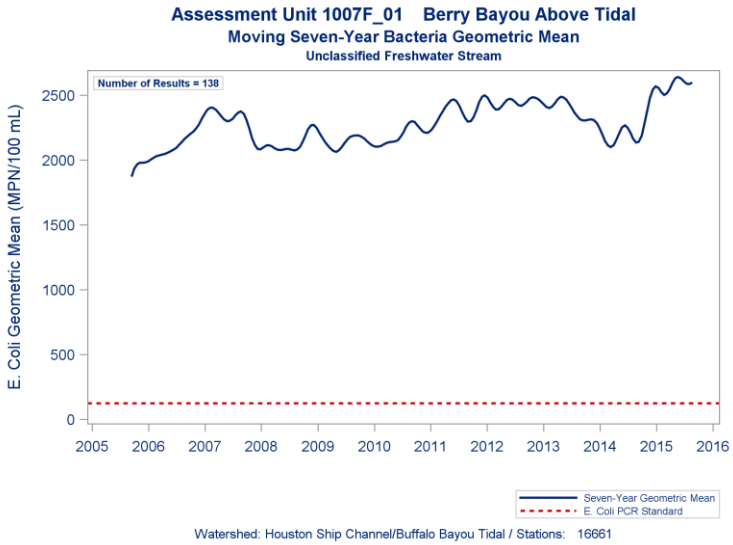
Rummel Creek (1014N_01)



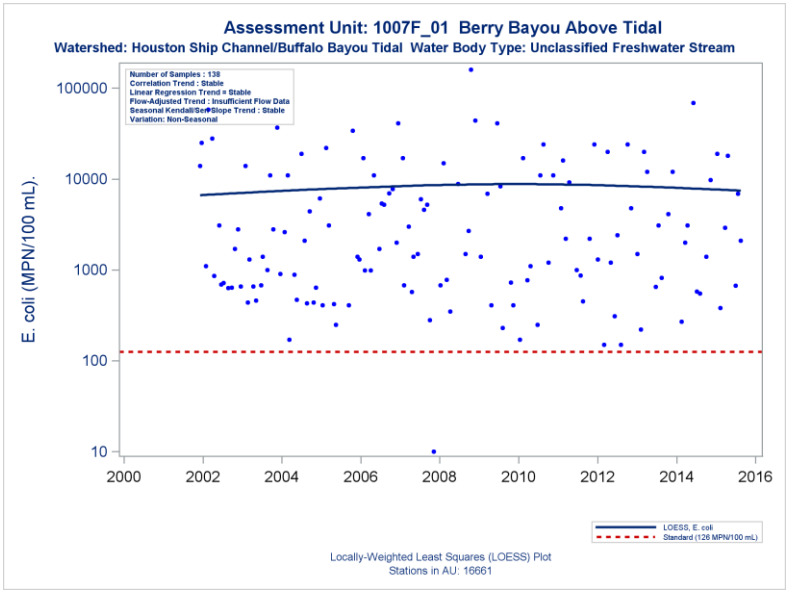
Rummel Creek (1014N_01)



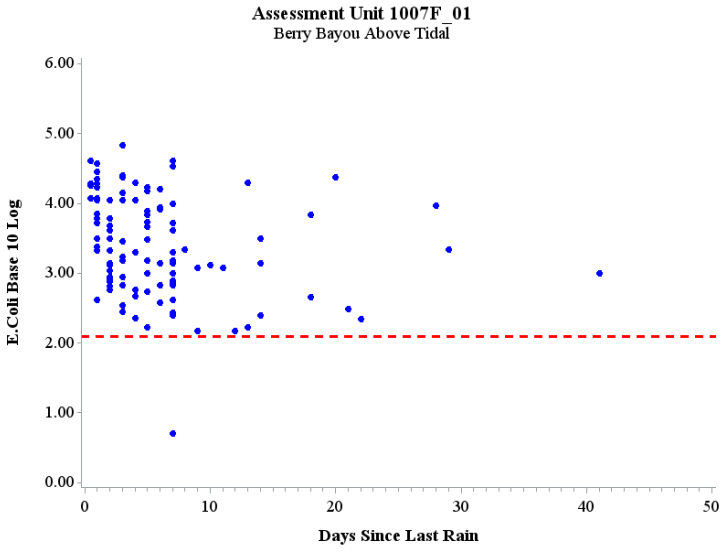
Berry Bayou (1007F_01)



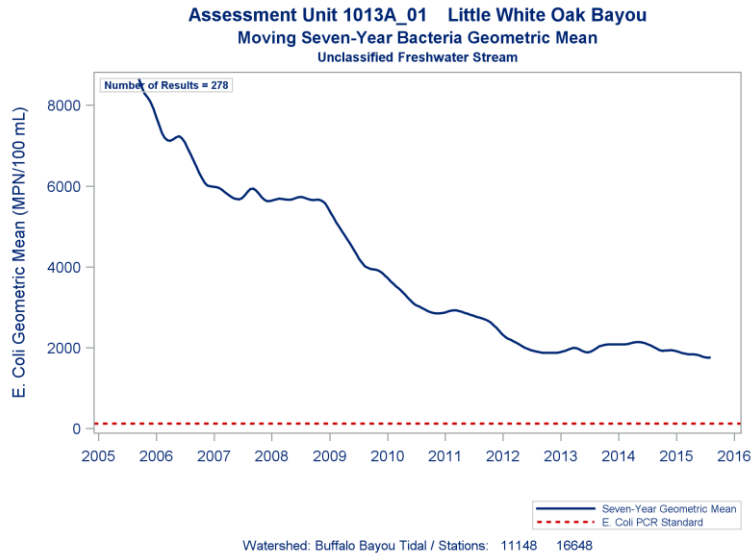
Berry Bayou (1007F_01)



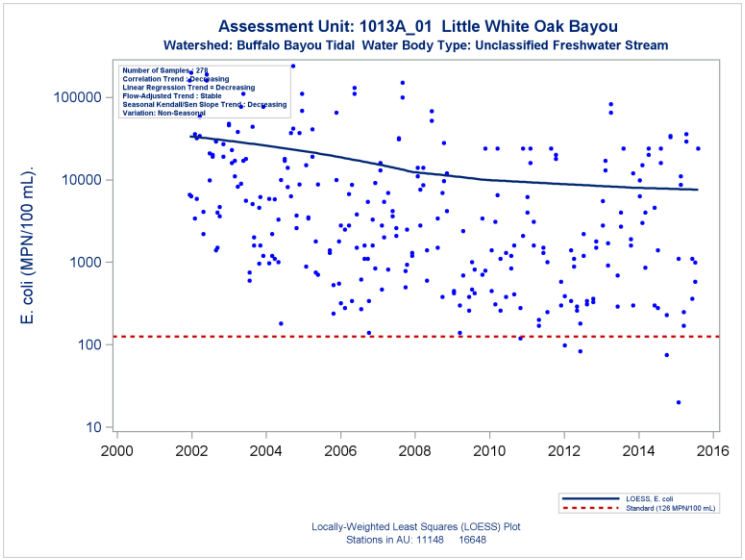
Berry Bayou (1007F_01)



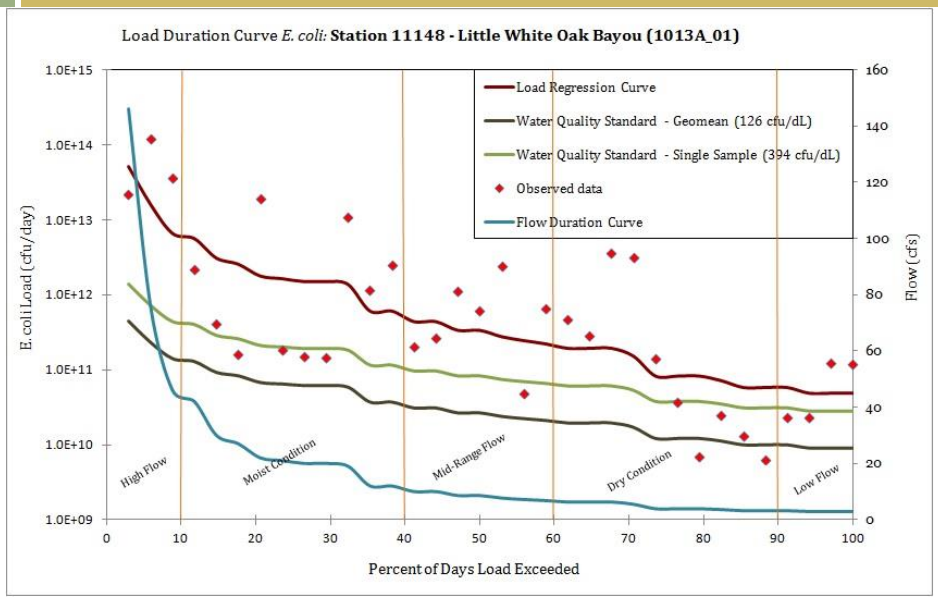
Little White Oak (1013A_01)



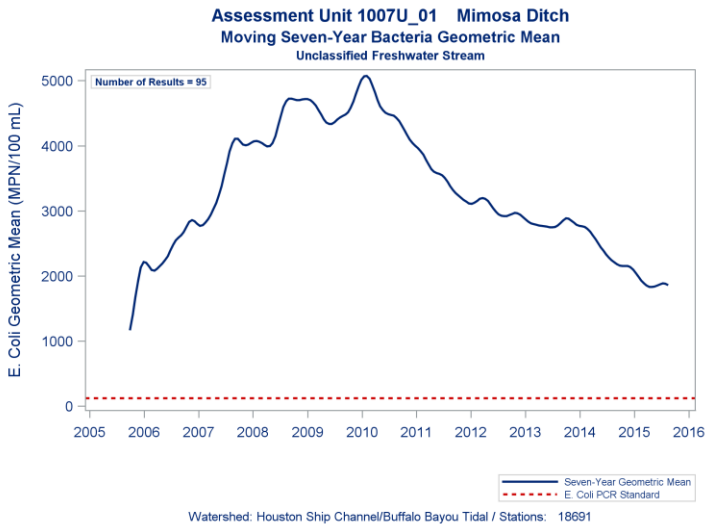
Little White Oak (1013A_01)



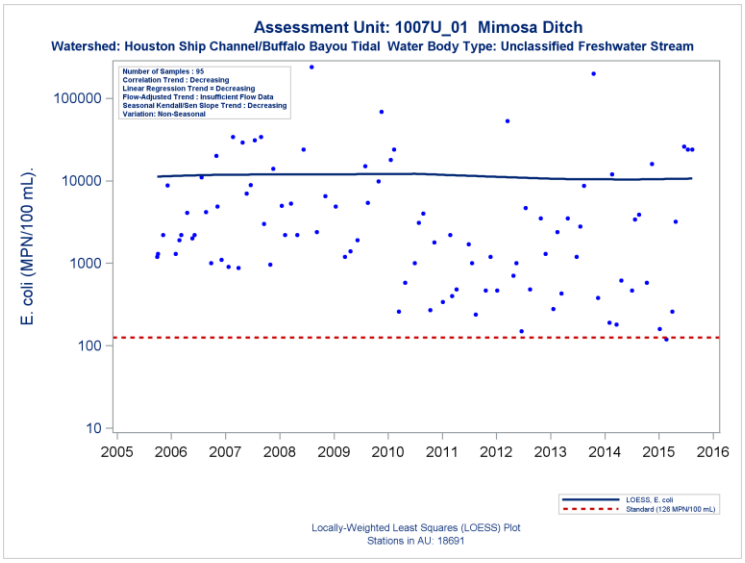
Little White Oak (1013A_01)



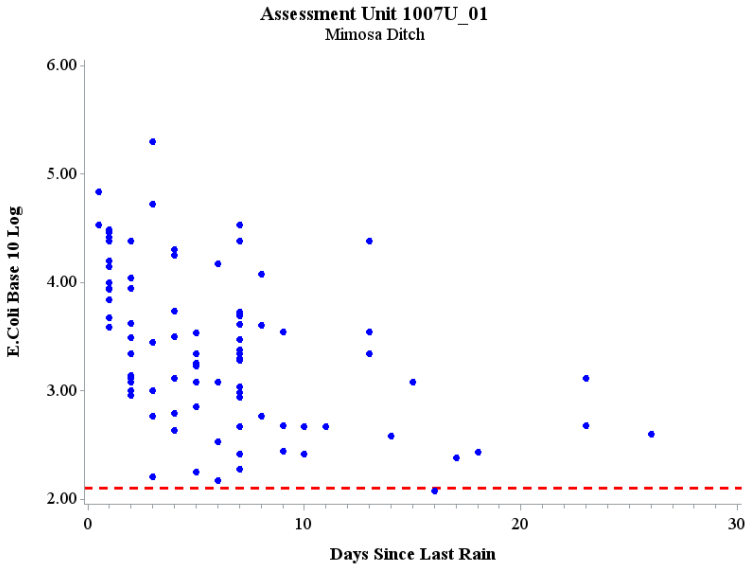
Mimosa Ditch (1007U_01)



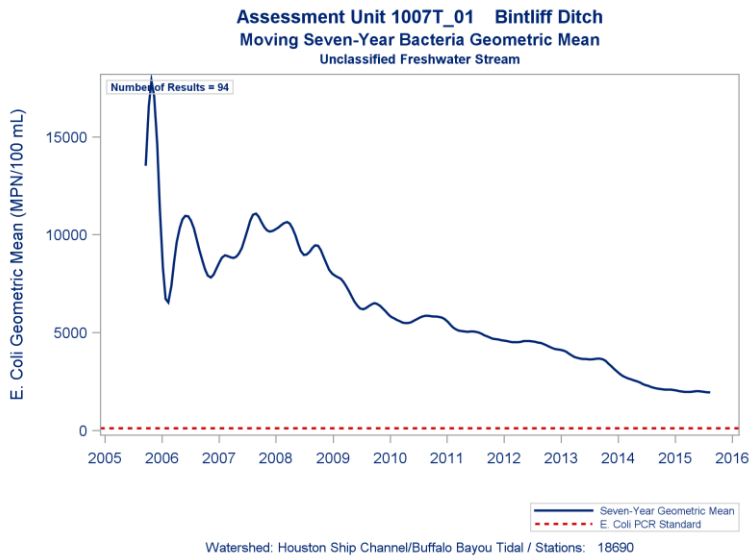
Mimosa Ditch (1007U_01)



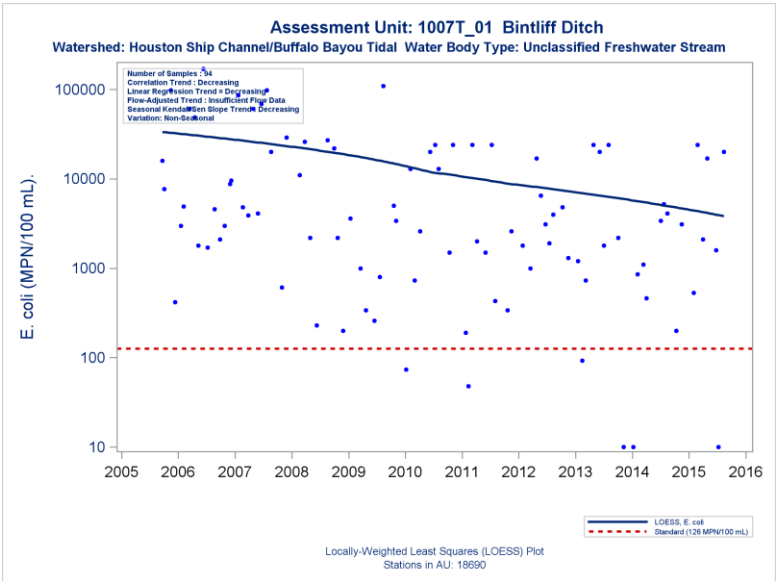
Mimosa Ditch (1007U_01)



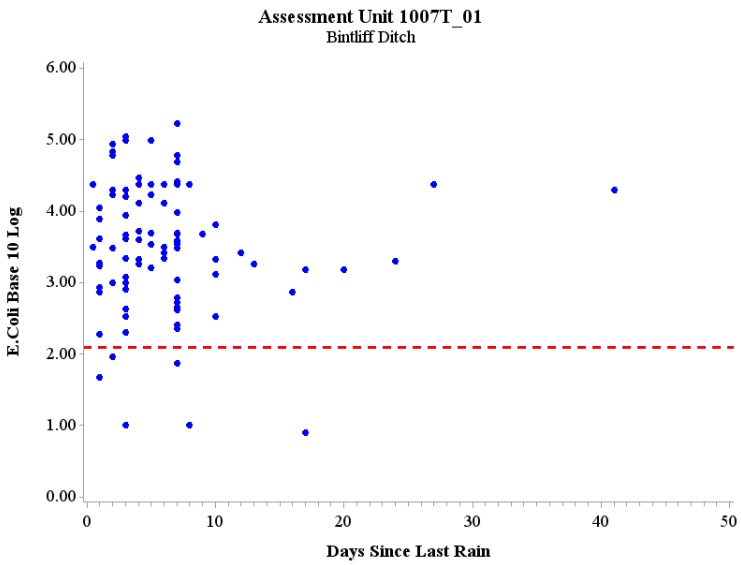
Bintliff Ditch (1007T_01)



Bintliff Ditch (1007T_01)

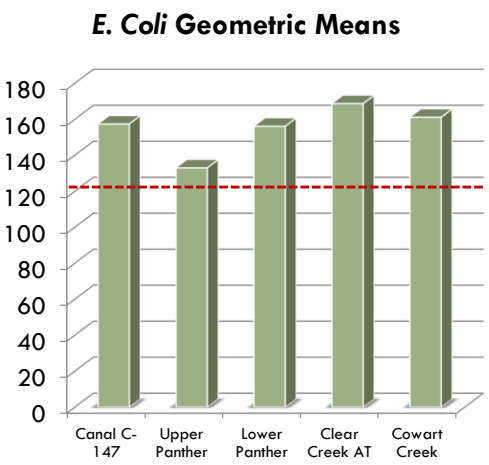


Bintliff Ditch (1007T_01)

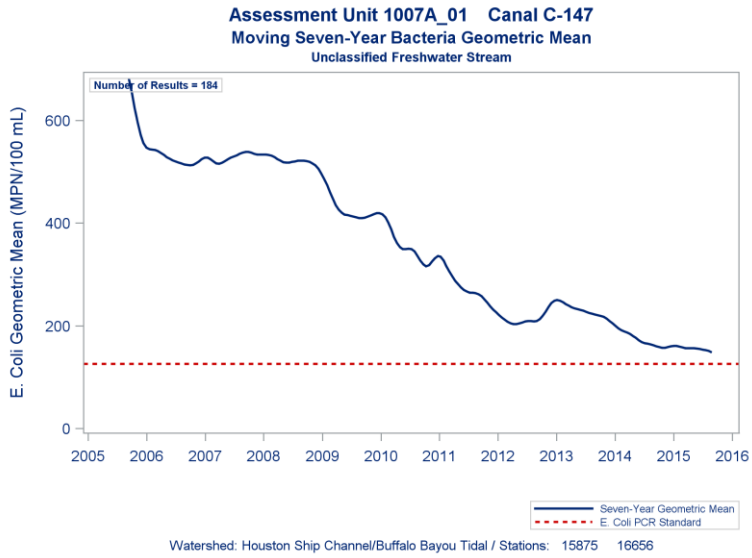


Top 5 Most Likely to Succeed

Top 5 Most Likely to Succeed
1) Canal C-147 (1007A_01)
2/3) Upper Panther Branch (1008B_02)
2/3) Lower Panther Branch (1008C_02)
4) Clear Creek Above Tidal (1102_04)
5) Cowart Creek (1102A_02)



Canal C-147 (1007A_01)



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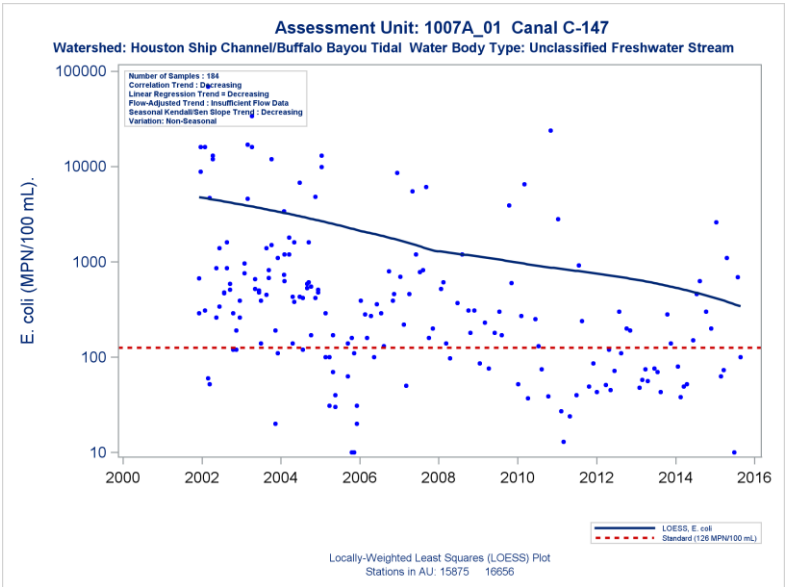
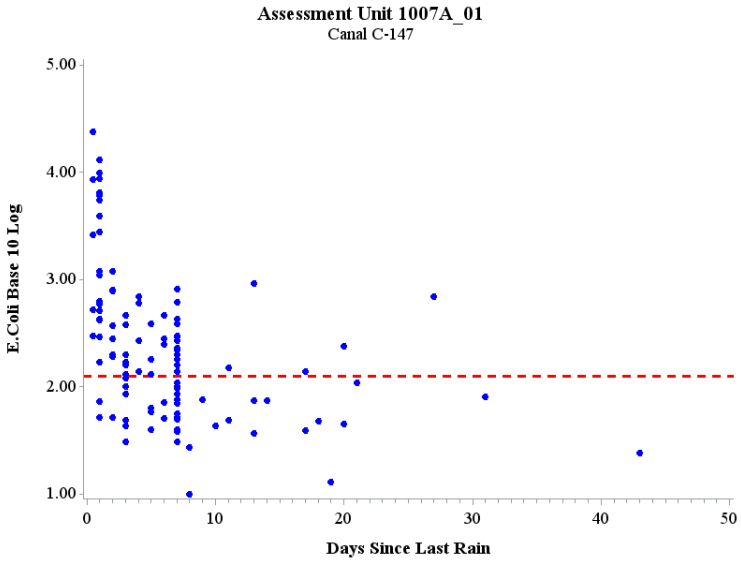
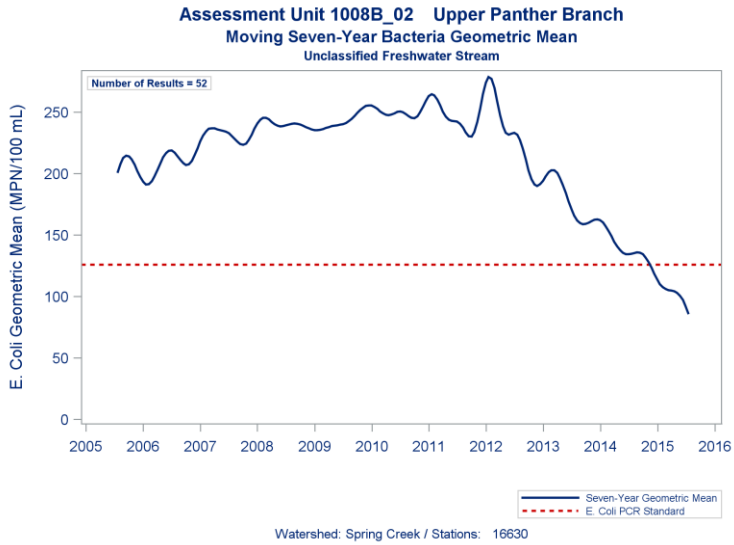


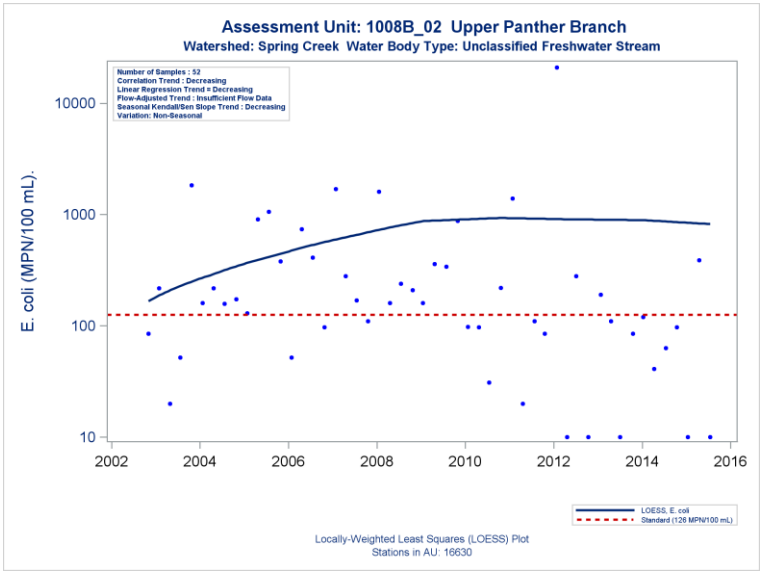
Canal C-147 (1007A_01)



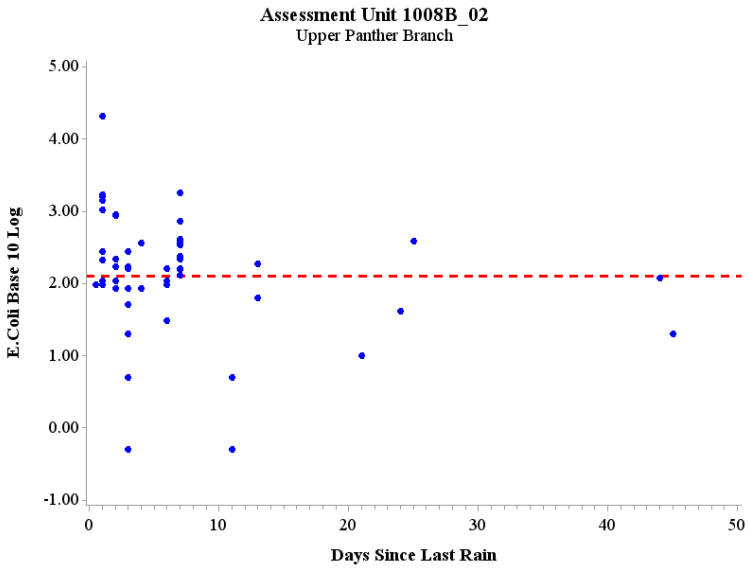
Upper Panther Branch (1008B_02)



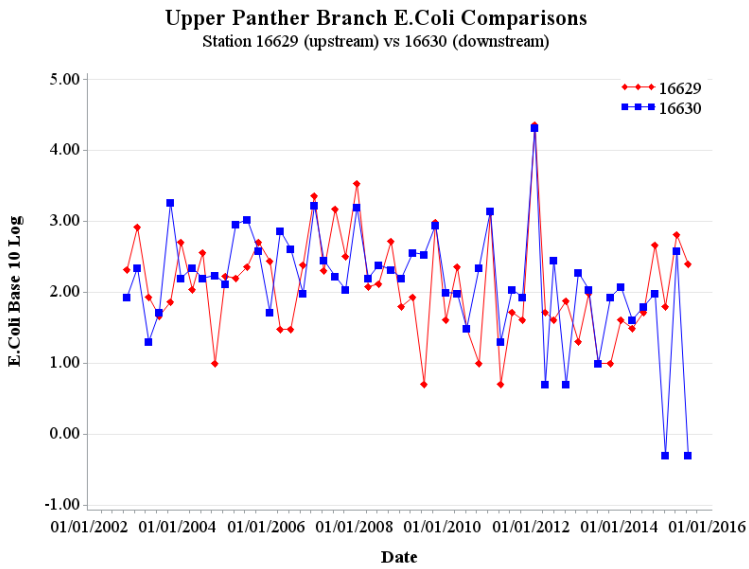
Upper Panther Branch (1008B_02)



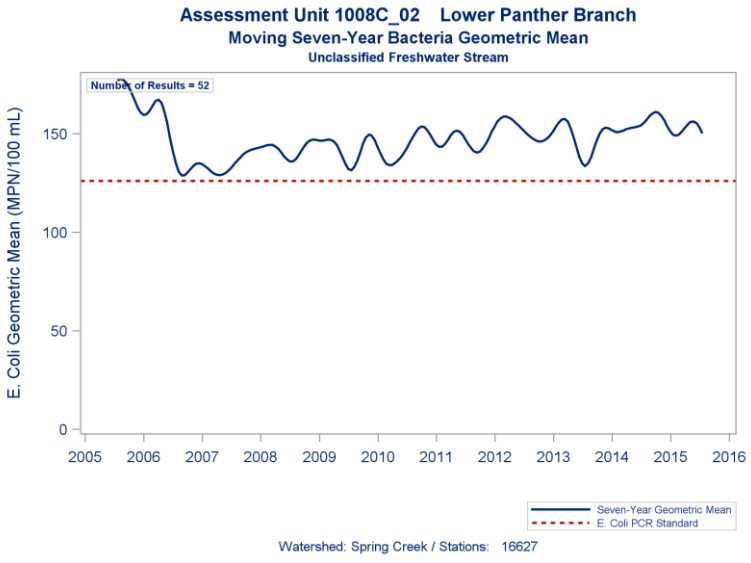
Upper Panther Branch (1008B_02)



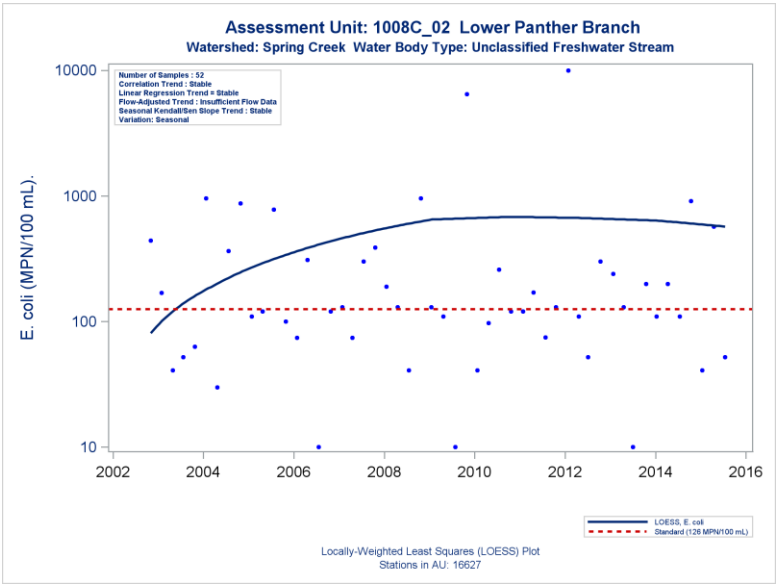
Upper Panther Branch (1008B_02)



Lower Panther Branch (1008C_02)



Lower Panther Branch (1008C_02)



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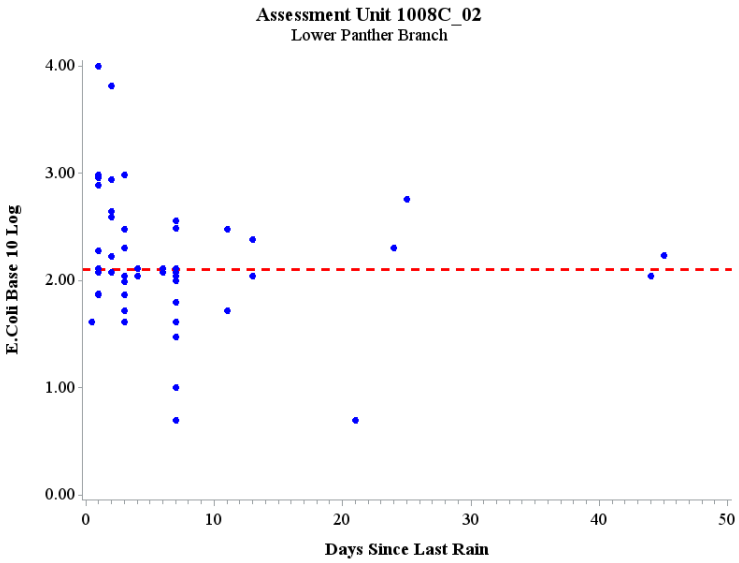
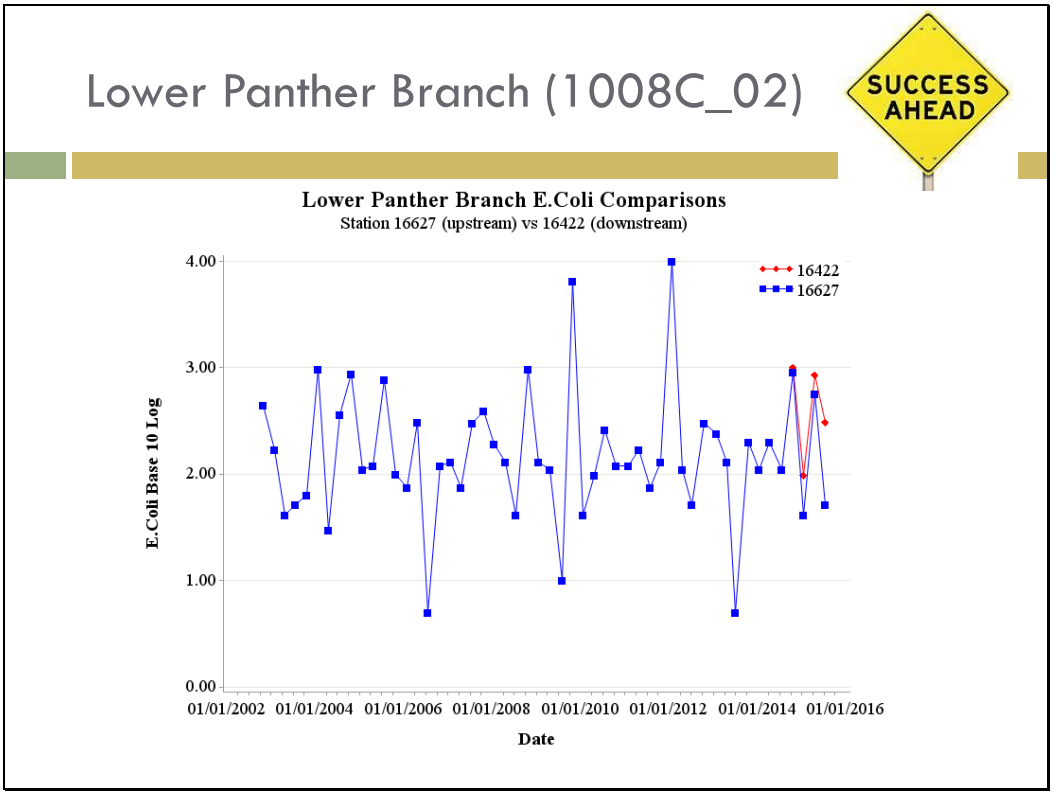
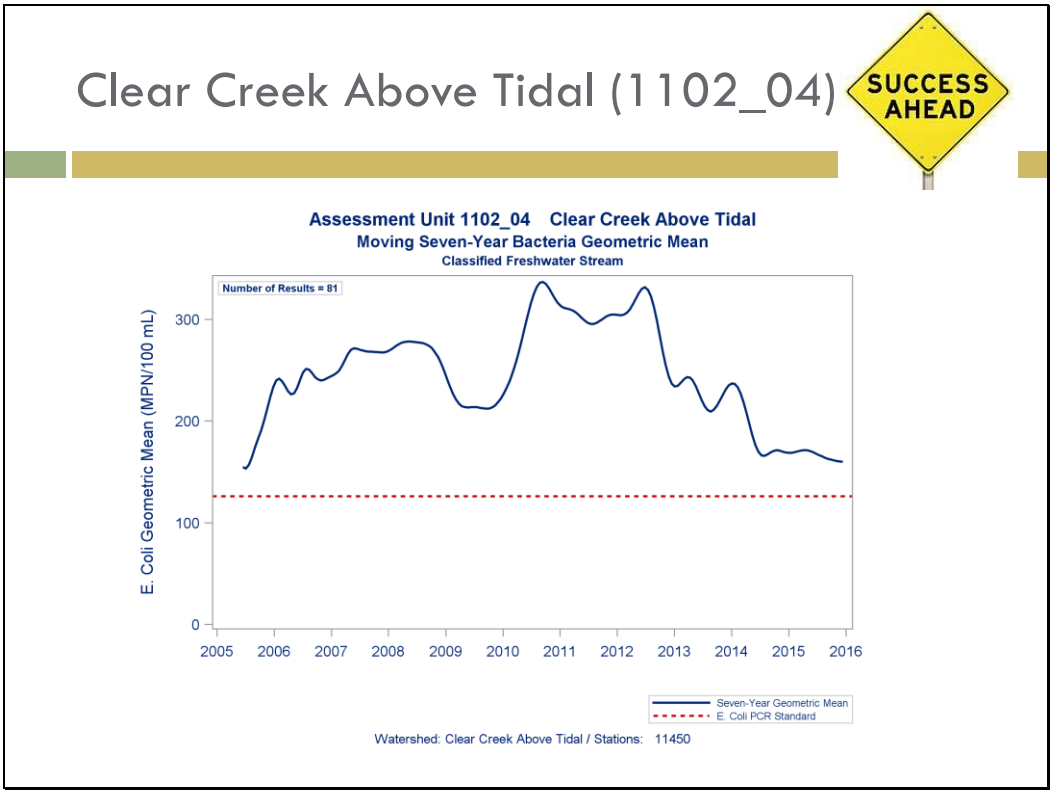


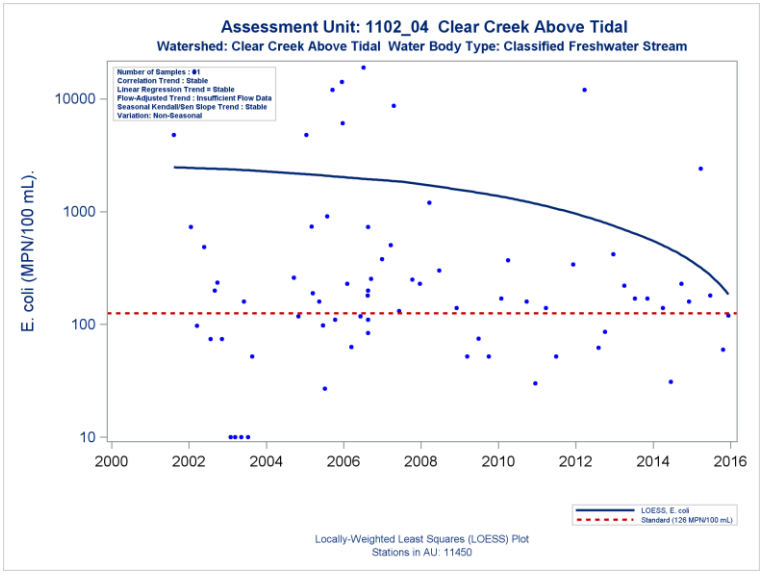
Lower Panther Branch (1008C_02)



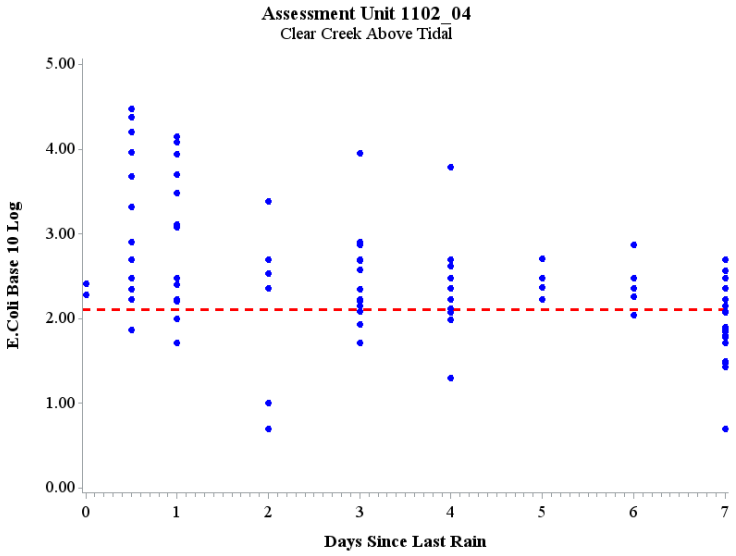
Clear Creek Above Tidal (1102_04)



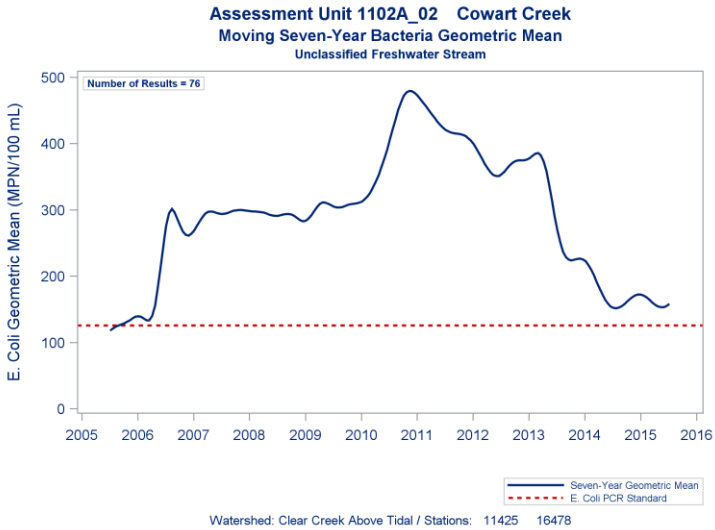
Clear Creek Above Tidal (1102_04)



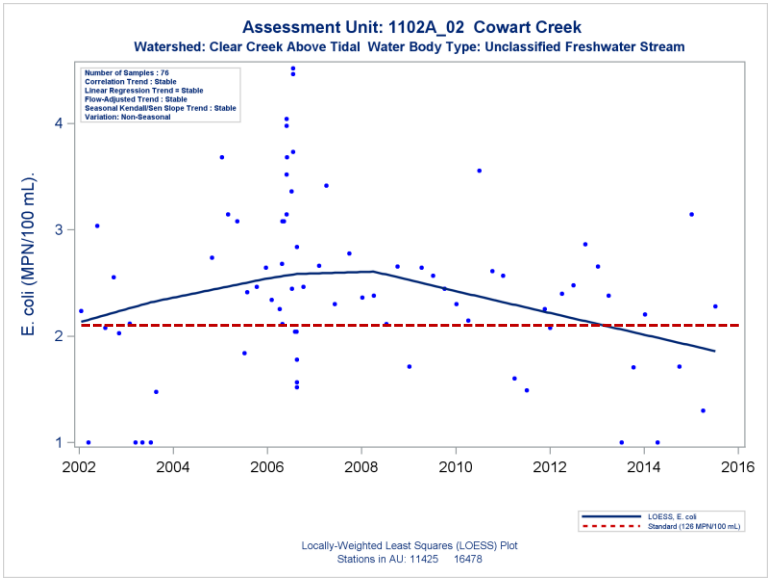
Clear Creek Above Tidal (1102_04)



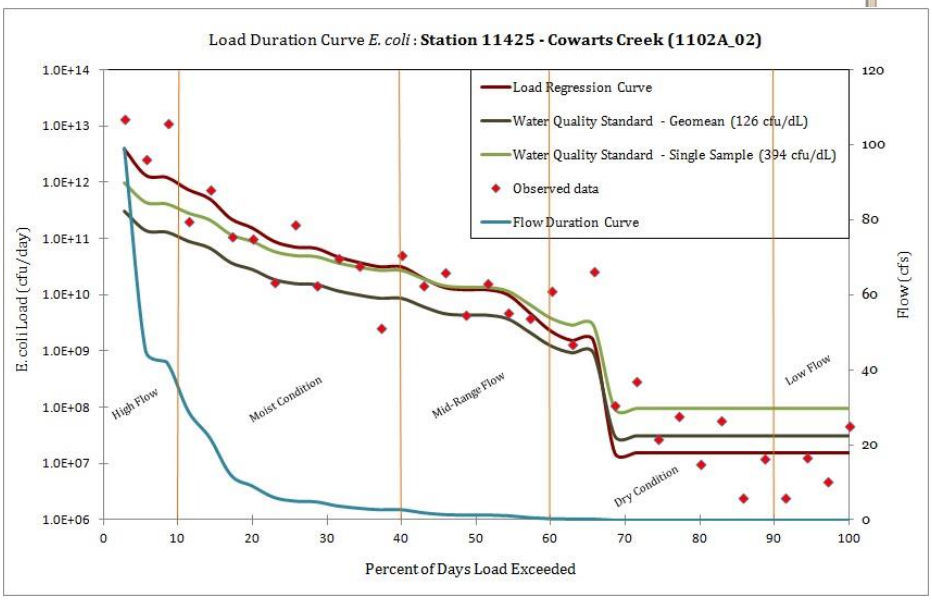
Cowart Creek (1102A_02)



Cowart Creek (1102A_02)



Cowart Creek (1102A_02)



Top 5/ Least 5 in Order of Priority

Top 5 Most Wanted	Top 5 Most Likely to Succeed
1) Rummel Creek (1014N_01)	**1) Canal C-147 (1007A_01)**
2) Little White Oak Bayou (1013A_01)	**2) Upper Panther Branch (1008B_02)**
3) Mimosa Ditch (1007U_01)	3) Lower Panther Branch (1008C_02)
4) Berry Bayou Above Tidal (1007F_01)	4) Cowart Creek (1102A_02)
5) Bintliff Ditch (1007T_01)	5) Clear Creek Above Tidal (1102_04)

Top 5 / Least 5 Workgroup Meeting Notes
Thursday, May 26, 2016
1:00 PM to 3:00 PM
H-GAC Conference Room D
3555 Timmons Lane, 2nd Floor

7. Introductions

Persons in Attendance:
Paniz Miesen – H-GAC
Steven Johnston – H-GAC
Denise Hall – Harris County Pollution Control
Steve Hupp – Bayou Preservation
Danielle Cioce – Harris County Watershed Protection
Robert Snoza – Harris County Flood Control
Carol LaBreche – City of Houston
Lisa Leja – City of Houston
Ambrose Okpokpo – City of Houston

Persons on Conference Line:
Lisa Groves – City of Houston

8. Project Overview

- This meeting was held to satisfy Review 2 tasks associated with Phase I of the project: *Prioritize the Top 2 Most Wanted and Top 2 Most Likely to Succeed AUs that will be subject to characterization and identification of bacteria sources.*

9. Review of Top 5 Most Wanted AUs

The workgroup reviewed statistical graphs and subwatershed maps for each AU on the Top 5 Most Wanted list. Graphical analysis included moving seven-year bacteria geomeans, *E. coli* trend analysis, LDCs, and *E. coli* vs days since last rain plots. Maps included outfall locations, OSSFs, land use information, and potential bacteria sources. The following are important notes and considerations pertinent to each AU based on the analysis provided.

1-Rummel Creek:

- Analysis of *E. coli* data revealed a slight decreasing trend in bacteria concentrations, but the geometric mean of 1960 MPN/100 mL is still well above the 126 MPN/100 mL standard.
- High *E. coli* concentrations during dry periods are common.

- Potential bacteria sources include dirt yards using manure based products and the plant nursery adjacent to I-10 at the Belteway.
- There are two stormwater detention basins adjacent to 1-10 and the Beltway.
- Clean Rivers Program (CRP) partners have expressed concern about Rummel Creek and the need for additional monitoring/characterization to find and eliminate bacteria sources due to known contact recreation.
- Accessibility is favorable.
- City of Houston offered access to GIS layer with lift station locations.
- City of Houston's Gims would also be a useful tool for finding information about current or planned rehab projects in the greater Houston area.

2-Berry Bayou:

- *E. coli* concentrations have remained well above the 126 MPN/100 mL standard with more than 90% of the data exceeding the state water quality standard.
- Current *E. coli* geometric mean is 2469 MPN/100 mL.
- Heavy residential and industrial land uses in the watershed.
- It was mentioned that there may be old grandfathered in OSSFs in this watershed than are not shown on the map.
- Berry Bayou watershed is one of the larger AUs on the Most Wanted list measuring at 12.69 square miles.
- Concrete lining is common in most areas, many of which are newly constructed or are currently under construction, making accessibility an issue in some areas.

3-Little White Oak:

- A slight decreasing trend in *E. coli* concentrations detected.
- Geomean is still well above the 126 MPN/100 mL standard at 1975 MPN/100 mL.
- LDC curve shows dry weather bacteria exceedances are common.
- Highly mixed use area with potential for illicit discharges.
- No wastewater outfalls are located along this AU.
- Lift station upstream of station 16648.
- City of Houston conducted a characterization in 2009 and found homes discharging gray water into Little White Oak.
- A fish kill occurred last summer from unknown causes.
- Bayou Preservation characterizations found high chlorine levels and low *E. coli*. City of Houston found leaking potable water in that area which may have been the chlorine source.
- A lot of interest in this AU due to the lack of information and knowledge about bacteria point sources. Workgroup curious about what the cause of

high *E. coli* concentrations are in a highly urbanized and residential area with no WWTF outfalls.

4-Mimosa Ditch:

- Slight decreasing trend detected for *E. coli* in this AU.
- Geometric mean is 2133 MPN/ 100 mL compared to the 126 MPN/100 mL standard.
- *E. coli* concentrations have been significantly higher than the standard even during dry periods.
- Mimosa Ditch watershed borders City of Houston and City of Bellaire but is in the City of Houston jurisdiction.
- Bellaire WWTF outfall located on the downstream end of the AU.
- High dry weather flows at Rice are suspect.
- Likely that bacteria sources are originating from the northern portions of the watershed with the majority of inputs coming from underground.
- Underground systems may make it difficult to identify bacteria sources.

5-Bintliff Ditch:

- Trend analysis detected slight decreasing trend in *E. coli* concentrations in Bintliff Ditch.
- Bacteria geomean is 2133 MPN/100 mL
- High *E. coli* concentrations during dry periods are common.
- Accessibility is an issue; chain link fences/gates and high vegetation on private property block access in many areas.
- Samples collected from bridges due to difficult accessibility.
- Underground system north of Bellaire.
- City of Houston found leaking storm drain last year, problem has been fixed.
- Bayou Preservation and City of Houston assessments found areas adjacent to Hwy 59 as problem areas for both stems.

10. Review of Top 5 Most Likely to Succeed AUs

The workgroup reviewed statistical graphs and subwatershed maps for each AU on the Top 5 Most Likely to Succeed list. Graphical analysis included moving seven-year bacteria geomeans, *E. coli* trend analysis, LDCs, *E. coli* vs days since last rain, and station comparison plots. Maps included outfall locations, OSSFs, land use information, and potential bacteria sources. The following are important notes and considerations pertinent to each AU based on the analysis provided.

1-Canal C-147:

- *E. coli* trend analysis and moving geomeans have been decreasing.
- Nearly half the data points collected still exceed the 126 MPN/100 mL geomean.

- *E. coli* geomean is 157 MPN/100 mL.
- *E. coli* exceedances during dry weather periods occur on an infrequent basis.
- Canal located in unincorporated Fort Bend County in the City of Missouri City.
- Flea market and bull fighting in eastern portion of the watershed.
- Recently constructed wastewater treatment facility in the area. Would be interesting to compare before and after samples to see the impact.
- No previous characterizations or assessments we are aware of have taken place in this area.
- Good option for further assessment.

2-Upper Panther Branch:

- Moving seven-year geometric means have been decreasing to near compliance, but current *E. coli* geomean is still slightly above the 126 MPN/100 mL standard at 133 MPN/100 mL.
- *E. coli* exceedances during dry periods are rare.
- Comparison of monitoring stations upstream and downstream of the WWTF outfall revealed similar fluctuations in bacteria concentrations for both stations.
- San Jacinto River Authority does the monitoring for this AU.
- Wildlife is a likely contributor of bacteria in this AU.
- Concentrated area of OSSFs NE of the AU with a small tributary running through that area. No monitoring stations are located immediately downstream of these OSSFs so any potential bacteria loadings from OSSFs would go undetected.
- No previous characterizations or assessments we are aware of have taken place in this area.
- Good option for further assessment.

3-Lower Panther Branch:

- Moving seven-year bacteria geomeans have been fluctuating slightly above the standard since 2006.
- Nearly half the samples collected have exceeded the state bacteria standard with concentrations reaching as high as 10,000 MPN/100 mL between 2011-2013.
- Current *E. coli* geomean is 156 MPN/100 mL.
- *E. coli* exceedances during dry weather occurs on an infrequent basis.
- San Jacinto River Authority does the monitoring for this AU.
- Increasing bacteria trends are likely related to increased development in the area.
- Feral hogs may be a potential source here.
- No previous characterizations or assessments we are aware of have taken place in this area.

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4-Clear Creek Above Tidal:

- Moving seven-year bacteria geomeans have been fluctuating above the standard since late 2005.
- Trend analysis detected stable *E.coli* trends with more than half the samples collected still exceeding the state standard.
- *E. coli* geomean for this AU is 169 MPN/100 mL.
- New development in the area.
- No WWTF outfalls located in this AU.
- AU supports wildlife; alligator gars are commonly seen in this AU.
- Environmental Institute of Houston (EIH) does the monitoring for this AU.
- There would be value in comparing historical data from upstream stations to downstream stations to help identify problem areas.
- Very high flows at times would make it difficult to find bacteria sources.

5-Cowart Creek:

- Moving seven-year bacteria geomeans have been fluctuating above the standard since late 2005.
- *Stable E. coli* trend detected for this AU with more than half the samples collected exceeding the state standard.
- *E. coli* geomean is currently 161 MPN/100 mL.
- Frequent and extreme exceedances were common around 2006-2007 but have since improved.
- Relatively easy access along the AU, but may run into accessibility issues on private properties.
- There are possibly more grandfathered in OSSFs present in this watershed that are not on the current maps.
- Horses and other animals living on small ranchettes may be a potential contributor of bacteria.
- Environmental Institute of Houston (EIH) does the monitoring in this AU.
- No previous characterizations or assessments we are aware of have taken place in this area.

11. Top 5 / Least 5 Prioritizations

- Based on the available information, the workgroup discussed how to prioritize the Top 5 / Least 5 list based on where we should focus our characterizations moving forward.

Top 5 Most Wanted	Top 5 Most Likely to Succeed
1) Rummel Creek (1014N_01)	**1) Canal C-147 (1007A_01)**
2) Little White Oak Bayou (1013A_01)	**2) Upper Panther Branch (1008B_02)**
3) Mimosa Ditch (1007U_01)	3) Lower Panther Branch (1008C_02)
4) Betty Bayou Above Tidal (1007F_01)	4) Cowart Creek (1102A_02)
5) Bintliff Ditch (1007T_01)	5) Clear Creek Above Tidal (1102_04)

12. Next Steps:

- H-GAC staff will begin conducting field surveys and collecting baseline data for the Top 2 AUs on each list in June, 2016.
- If no bacteria hits are detected during any of the Top 2 / Least 2 assessments, H-GAC staff will move down the prioritization list and assess the next AU listed.
- Workgroup will convene again in late summer/early fall to review baseline data and discuss findings.

13. Adjourn

Appendix C: AU Intensive Study:

Little White Oak Bayou

Figure C1. Windshield survey route for Little White Oak Bayou

Table C1. Bacteria screening results for Little White Oak Bayou

Sample No	Date	Time	Sample Type	Outfall Characteristics			Latitude	Longitude	*E. coli* (cfu/100ml)	Comments/Description
				Material	Pipe Diameter	Water Depth				
001	7/13/2016	8:57	Outfall	Metal pipe	24"	0.5"	29.7975	-95.37048	575	Waypoint No. 040. Foam and algae present. Small fish in water.
002	7/13/2016	9:09	Outfall	Metal pipe	24"	3"	29.79642	-95.37062	700	Waypoint No. 041. Partially submerged outfall.
003	7/13/2016	9:28	SW	Natural channel			29.79464	-95.37029	450	Waypoint No. 042. Lots of trash. Large birds nearby.
004	7/13/2016	9:48	SW	Natural channel			29.79296	-95.36852	250	Waypoint No. 043. Sampled downstream of two outfalls. Dead mammal smell.
005	7/13/2016	10:27	Outfall	Concrete storm drain	48"	4"	29.79247	-95.36649	1025	Waypoint No. 044. Water from outfall cooler with a chlorine smell. Three people observed on bank.
006	7/13/2016	10:47	SW	Natural channel			29.7909	-95.36438	150	Waypoint No. 045. Lots of trash.
007	7/13/2016	10:56	Outfall	Metal pipe	24"	0.5"	29.79076	-95.3639	0	Waypoint No. 046. Sweet smell. Soil discoloration below outfall opening.
008	7/18/2016	8:31	Outfall	Concrete storm drain	120"	30"	29.79039	-95.36263	0	Waypoint No. 047. Fish. Large waterfall sound.
009	7/18/2016	8:45	SW	Natural channel			29.78994	-95.36188	TNTC	Waypoint No. 048. Upstream of bend/large storm drain.
010	7/18/2016	8:54	Outfall	Concrete storm drain	108"	3"	29.78984	-95.36163	TNTC	Waypoint No. 049. Large storm drain. Strange smell - acid?
011	7/18/2016	9:20	Tributary	Natural channel			29.78782	-95.36334	0	Waypoint No. 050. Natural tributary. Turtle.
012	7/18/2016	9:57	SW	Natural channel			29.78683	-95.36567	TNTC	Waypoint No. 051. Lots of trash. Downstream of construction site.
013	7/18/2016	10:22	SW	Natural channel			29.78513	-95.36585	TNTC	Waypoint No. 052. Upstream of Main St. bridge. Lots of rocks and ripples.
014	7/18/2016	11:18	SW	Natural channel			29.7826	-95.3706	TNTC	Waypoint No. 049 (yellow gps). Downstream of 45. Adjacent to stormwater wetlands.
015	7/18/2016	11:39	SW	Natural channel			29.78119	-95.3707	TNTC	Waypoint No. 050 (yellow gps). Lots of gar.
016	7/18/2016	11:53	SW	Natural channel			29.77933	-95.37054	TNTC	Waypoint No. 051 (yellow gps). Near hike and bike trail. Lots of trash.
017	7/20/2016	8:44	SW	Natural channel			29.80087	-95.37254	10900	Waypoint No. 053.
018	7/20/2016	9:10	Outfall	Concrete storm drain	72"	Unkown	29.80378	-95.37322	13300	Waypoint No. 054. Fish jumping. Downstream of Calvalcade bridge. Sampled at mouth of storm drain.
019	7/20/2016	9:20	SW	Natural channel			29.80414	-95.37343	7300	Waypoint No. 055. Upstream of Calvalcade bridge. Downstream of outfall and drain line on right bank
020	7/20/2016	9:40	Outfall	Metal pipe	48"	2"	29.80751	-95.37463	1350	Waypoint No. 056. Clear discharge.
021	7/20/2016	9:50	SW	Natural channel			29.80787	-95.37498	6650	Waypoint No. 057. Downstream of metal outfall pipe. Upstream of bridge at Link.
022	7/20/2016	10:25	SW	Natural channel			29.80884	-95.37589	9450	Waypoint No. 058. Surface water adjacent to outfall No. 056. Redish tint to sediment.
023	7/20/2016	10:44	SW	Natural channel			29.81165	-95.37593	4300	Waypoint No. 059. Downstream of underground 610.
024	7/20/2016	11:00	SW	Natural channel			29.81589	-95.37767	5800	Waypoint No. 060. Upstream of 610 underground.
025	7/20/2016	11:20	SW	Natural channel			29.81901	-95.37845	TNTC	Waypoint No. 061. Surface water sample downstream of Stokes bridge.

Appendix D: AU Intensive Study:

Rummel Creek

Figure D1. Windshield survey route for Rummel Creek

Table D1. Bacteria screening results for Rummel Creek

Sample No	Date	Time	Sample Type	Outfall Characteristics			Latitude	Longitude	*E. coli (cfu/100ml)*	Comments/Description
				Material	Pipe Diameter	Depth of Water				
031	7/11/2016	9:00	SW	Natural channel			29.76429	-95.5607	125	Low flow. Algae present
032	7/11/2016	9:20	Tributary	Natural channel		18"	29.76397	-95.56178	225	H_2S/rotten egg smell present. Slimy/mucky soil.
033	7/11/2016	9:36	Tributary	Natural channel		6"	29.76438	-95.56191	775	Sheen on water. Trash on bank. Groundwater from soil on bank slowly flowing into creek.
034	7/11/2016	10:03	SW	Natural channel			29.76519	-95.56248	525	Old and rusty water pipe nearby.
035	7/11/2016	10:40	SW	Natural channel			29.772	-95.5694	425	Waypoint No. 032. Small fish present. Sample taken from inside the Edith L. Moore Nature Sanctuary
036	7/11/2016	11:00	Outfall	Metal pipe	48"	2"	29.77316	-95.57065	2275	Waypoint No. 033. Water snake nearby. Heavy algae in water.
037	7/11/2016	11:18	Outfall	Concrete storm drain	48"	1"	29.77559	-95.57374	100	Waypoint No. 034. Heavy algae inside outfall and in water.
038	7/11/2016	11:30	SW	Natural channel			29.7763	-95.5733	400	Waypoint No. 035. Downstream of concrete slab (erosion control?). Small fish present.
039	7/11/2016	11:31	SW	Natural channel			29.7763	-95.5733	700	Upstream of concrete slab (erosion control?). Heavy algae.
040	7/11/2016	12:30	SW	Concrete channel			29.78381	-95.56509	925	Houston Garden Center and 10. Very steep concrete bank. Heavy plant accumulation and growth.
041	7/11/2016	12:39	SW	Concrete channel			29.78252	-95.56563	350	Waypoint No. 037. Very steep concrete bank. Heavy plant accumulation and growth.
042	7/11/2016	12:50	Outfall	Metal pipe	36"	1"	29.7806	-95.56744	125	Waypoint No. 038. Snake skin nearby. Heavy algae.
043	7/11/2016	12:58	Outfall	Metal pipe	48"	1"	29.78044	-95.56762	225	Waypoint No. 039. Heavy algae. Stagnant water.

Appendix E: AU Intensive Study:

Canal C-147

Figure E1. Windshield survey route for Canal C-147

Table E1. Bacteria screening results for Canal C-147

Sample No	Date	Time	Sample Type	Outfall Characteristics			Latitude	Longitude	*E. coli (cfu/100ml)*	Comments/Description
				Material	Pipe Diameter	Depth of Water				
008	6/30/2016	9:00	Outfall	Metal pipe lined with rubber	24"	1.5"	29.61648	-95.45901	800	Outfall upstream of CRP monitoring station. Some algae present
009	6/30/2016	9:10	SW	Concrete channel			29.61599	-95.45975	230	
010	6/30/2016	9:21	SW	Concrete channel			29.61424	-95.46069	290	Manhole on either side of bridge crossing. Slight yellow tint to water
011	6/30/2016	9:32	SW	Concrete channel			29.61206	-95.46129	200	Cliff swallows and ducks present. Some algae present
012	6/30/2016	9:38	Tributary	Concrete lined at discharge point; natural channel upstream		2"	29.61161	-95.46149	180	Snail. Some algae present
013	6/30/2016	9:51	Outfall	Concrete storm drain (left)	114"	6"	29.61142	-95.46475	TNTC	Algae common
014	6/30/2016	9:52	Outfall	Concrete storm drain (right)	108"	3"	29.61145	-95.46475	1770	Algae common
015	6/30/2016	10:02	SW	Concrete channel; natural channel upstream			29.61140	-95.46519	190	Concrete lining ends here; natural channel upstream of bridge
016	6/30/2016	10:17	SW	2 metal outfall pipes directly upstream; natural channel	30"	0"	29.60781	-95.46939	510	Downstream of 2 outfalls (not flowing). Lots of fish at mouth of outfalls
017	6/30/2016	10:26	Tributary	Natural channel		7"	29.60601	-95.47043	TNTC	
018	6/30/2016	10:48	Outfall	Metal pipe with concrete lining at discharge point			29.60564	-95.47581	40	Algae common
020	6/30/2016	11:51	SW	Natural channel			29.60504	-95.47677	320	Upstream of Beltway 8 bridge. Lots of fish, big and small. Some algae present
021	6/30/2016	11:58	Tributary	Natural channel			29.60412	-95.47678	190	Trib adjacent to WWTF outfall; 2 different color waters at mixing point
022	6/30/2016	12:01	SW	Natural channel			29.60413	-95.47684	230	SW downstream of WWTF outfall & upstream of tributary; 2 different color waters at mixing point
023	6/30/2016	12:10	Outfall	Metal pipe	48"	9"	29.60404	-95.47752	50	WWTF outfall; high flow
024	6/30/2016	12:16	Outfall	Metal pipe with concrete lining at discharge point	30"	1"	29.60406	-95.47842	10	Lots of vegetation growing out of outfall
025	6/30/2016	12:22	SW	Natural channel			29.60412	-95.47890	530	
026	6/30/2016	12:37	Outfall	Metal pipe lined with rubber; concrete at discharge	48"	2"	29.60392	-95.48441	0	Water had a sweet smelling odor similar to detergent or soap; thick algal growth at discharge
027	6/30/2016	12:50	Outfall	Metal pipe	48"	0.5"	29.60384	-95.48948	2130	Yellow tinted water; lots of fish
029	6/30/2016	13:00	SW	Natural channel			29.60379	-95.49318	230	
030	6/30/2016	13:14	SW	2 concrete lined storm drains directly upstream; natural channel			29.60378	-95.49982	520	

Appendix F: AU Intensive Study:

Upper Panther Branch

Figure F1. Windshield survey route for Upper Panther Branch

Table F1. Bacteria screening results for Upper Panther Branch

Sample No	Date	Time	Sample Type	Outfall Characteristics			Latitude	Longitude	*E. coli (cfu/100m*	Comments/Description
				Material	Pipe Diameter	Depth of Water				
001	7/26/2016	9:17	Tributary	Natural channel			30.18642	-95.47234	170	Waypoint No. 062. Drainage/tributary conveyance point. Fish/snake/mushrooms present.
002	7/26/2016	9:30	SW	Natural channel			30.18568	-95.47247	310	Waypoint No. 063. Chlorine smell. Brownish cloudy water.
003	7/26/2016	9:37	Tributary	Natural channel			30.18542	-95.47245	3420	Waypoint No. 064. Tributary from stormwater outfall near chlorine smell. Small fish.
004	7/26/2016	10:11	SW	Natural channel			30.18191	-95.47338	140	Waypoint No. 065. Wide channel. Sweet smell. Chlorine test strip >1.0ppm, <4.0ppm
005	7/26/2016	10:35	Tributary	Natural channel			30.17983	-95.47214	100	Waypoint No. 067. Tributary No. 068. Chlorine smell. Chlorine test strip ~4.0ppm
006	7/26/2016	10:44	Tributary	Natural channel			30.17966	-95.47181	580	Waypoint No. 068. Tributary No. 069. Red color. Chlorine test strip ~0.8ppm
007	7/26/2016	11:07	Tributary	Natural channel			30.17765	-95.47079	60	Waypoint No. 069. Tributary No. 070. Chlorine smell. Chlorine test strip ~4.0ppm
008	7/26/2016	11:54	SW	Natural channel			30.18661	-95.47267	50	Waypoint No. 072. Downstream of tributary 071. Chlorine smell. Chlorine test strip ~10.0ppm
009	7/27/2016	9:45	Tributary	Natural channel			30.1911	-95.47796	1040	Waypoint No. 073. Tributary No. 072. Petrol smell.
010	7/27/2016	10:02	Tributary	Natural channel			30.19172	-95.48064	390	Waypoint No. 074. Tributary No. 073.
011	7/27/2016	10:12	SW	Natural channel			30.19201	-95.48141	230	SW sample upstream of Gosling bridge. Chlorine smell.
012	7/27/2016	10:39	Tributary	Natural channel			30.19266	-95.48696	270	Waypoint No. 075. Cloudy water. Bear Branch Tributary.
013	7/27/2016	10:32	SW	Natural channel			30.19277	-95.48708	400	Waypoint No. 076. SW sample upstream of Bear Branch. Chlorine smell/wetland H_2S smell.
014	7/27/2016	10:57	Outfall	Natural channel			30.19528	-95.48886	20	Waypoint No. 077. SW sample at wastewater treatment outfall. Chlorine smell.
015	7/27/2016	11:10	SW	Natural channel			30.195927	-95.48851	260	SW sample upstream of wastewater treatment outfall.