Water Quality Data Collection and Trends Analysis Report

for the West Fork San Jacinto River and Lake Creek Watershed Protection Plan and Characterization of Spring Creek and Cypress Creek

February 14, 2019

This document was prepared by the Houston-Galveston Area Council (H-GAC) for the stakeholders of the West Fork Watersheds Partnership, the Texas Commission on Environmental Quality (TCEQ), and the Galveston Bay Estuary Program (GBEP) of the TCEQ. This project is funded by a Clean Water Act Section 319(h) grant from the TCEQ and additional funding from GBEP.

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1.0 Introduction

To serve the development of a watershed protection plan (WPP) for the West Fork San Jacinto River and Lake Creek, and as part of an effort to characterize the Spring and Cypress Creek watersheds, the H-GAC conducted a series of water quality analyses. The purpose of this effort was to better understand water quality trends and variability that impact the ability of these waterways to meet state water quality standards and the water quality goals of local stakeholders.

This document will discuss the:

- Analysis design and purpose for these analyses;
- Data sources evaluated, including:
    - current and historical ambient water quality sampling data;
    - discharge monitoring reports (DMR) from wastewater treatment facilities (WWTFs)
    - sanitary sewer overflow (SSO) reports; and
- The outcome and implications of the analyses.

2.0 Analysis Purpose and Design

Purpose

The primary impetus for the WPP and characterization efforts (project) in the West Fork San Jacinto River (Segment 1004), Lake Creek (1015) and the characterization studies in Spring (1008) and Cypress (1009) Creeks, are the water quality impairments and/or concerns listed for these segments[1]. The primary water quality issues identified as being of interest to this project are fecal waste and pathogens (as evidenced by elevated levels of fecal indicator bacteria) and depressed DO (in part evidenced by elevated levels of nutrients – nitrogen and phosphorus compounds – and other precursors). Additional concerns raised by project stakeholders include introduction of sediment from mining operations and

[1] The source for impairment or concern status is the 2014 Texas Integrated Report of Surface Water Quality, which describes the assessment process and results for these segments. The State of Texas assesses its waterways every two years, based on seven years of data. These assessments form the basis by which segments (defined portions of waterways) and their tributaries are classified as having impairments (inability to meet a state water quality standard for which a numerical or other specific limit exists) or concerns (levels of constituents which exceed screening levels or other criteria, but for which numerical or specific limits do not exist). The existence of an impairment is usually the primary driver for developing watershed-based plans for affected segments. More information on the assessments can be accessed at https://www.tceq.texas.gov/waterquality/assessment/305_303.html . A Draft 2016 Integrated Report was approved by TCEQ on 10/17/18, subsequent to the original version of this report, but is currently awaiting EPA approval.

other sources in the watershed. The indicators for these challenges are the constituents of concern for this analysis effort.

Analysis Project Design

Identifying the desired answers and uses of the data evaluations is the first step in developing an analysis project design. The following answers and uses were identified as being necessary for informing stakeholders and their subsequent project decisions:

- General understanding
  - Is there sufficient data to describe water quality conditions in the watershed?
  - What is the extent of the problem?
  - Is the problem spatially variable (i.e. do some areas have worse water quality than others?)
  - Are the issues seasonally variable?
- Specific Sources
  - Are permitted dischargers[2] meeting their permit limits?
  - Are there significant SSOs in the watershed?
    - If so, where are they located, and what is causing them?
- Model inputs[3]
  - Flow and bacteria data for Load Duration Curves (LDCs)
  - Nutrient data and flow data for nutrient modeling (GLAM)

H-GAC and TCEQ developed the water quality data acquisition and evaluation approach reflected in this document to satisfy these information and modeling input needs. Additional information about the data quality objectives, concerns, and methodologies used in these analyses can be found in the West Fork San Jacinto River and Lake Creek Modeling Quality Assurance Project Plan (QAPP)[4]. The general design for this evaluation project is:

1) Acquisition:
   a. Acquire 5 years[5] of quality-assured ambient water quality data[6] from the state's Surface Water Quality Monitoring Information System (SWQMIS) database for all monitoring stations active in the project watersheds.
   b. Acquire 5 years of DMRs from all WWTFs in the watershed.

[2] For the purpose of this document, the permitted dischargers referred to are WWTFs operating under TPDES water quality permits, whose discharges are evaluated through DMRs, and whose unintended releases are evaluated via SSO reports.
[3] The focus of this document is the general understanding and specific sources. Model inputs are discussed in greater depth in the modeling methodology and modeling report documents available at www.westforkwpp.com/project-documents.html.
[4] This document is available for review at www.westforkwpp.com/uploads/9/6/6/3/9663419/modeling_qapp_amendment_1.pdf
[5] Updated during year two of the project to include all available data from the project period itself.
[6] The constituents for these acquisition tasks are summarized in Table 1.

c. Acquire 5 years of SSO reports from all WWTFs in the watershed.
d. Acquire the most current data collected and/or reported for the aforementioned sources in the three-year additional period during which the WPP was developed. This data was only considered for this revised report.

2) Evaluation
    a. Ambient data
        i. Determine if sufficient data exists for each station
        ii. Identify the historical trends for constituents of concern, by each station
        iii. Identify any seasonal trends, by constituent
        iv. Evaluate the relative character of water quality between stations
        v. Update evaluations subsequent to the development of the WPP.
    b. DMRs
        i. Evaluate the constituents of concern for compliance with WWTF permit limits
        ii. Evaluate the general level of compliance for WWTFs
        iii. Evaluate the seasonality of exceedances
        iv. Evaluate the relationship between plant size and exceedance
        v. Update evaluations subsequent to the development of the WPP.
    c. SSOs
        i. Evaluate the number of SSOs by segment
        ii. Evaluate the volume of SSOs by segment
        iii. Evaluate the causes of SSOs by segment
        iv. Update evaluations subsequent to the development of the WPP.

Table 1 - Constituents of concern by evaluation task

Constituent of concern	Ambient	DMR	SSO
E. coli (bacteria)	x	x	
DO (grab)	x	x	
DO (24-hr)	x		
Temperature	X		
pH	X		
Chlorophyll-a	X		
Nitrate+Nitrite	x		
Flow (grab)	x		
Ammonia Nitrogen (NH3-N)	x	x	
Total Phosphorus	x		
TSS	x	x	
CBOD5		x	
Cause (SSO)			x
Volume (SSO)			x

3.0 Evaluations

Overview

The initial evaluations were completed in April 2017 using the data available in SWQMIS (ambient) and the latest revisions to TCEQ databases (DMR and SSO) at that time. The updated evaluations were completed in January and February 2019, after the development and approval of the WPP. Statistical analyses were conducted in Statistical Analysis Software (SAS), and spatial evaluations were evaluated using Geographical Information Systems (GIS, specifically ArcGIS 10.x). The outcomes of the evaluations were evaluated by project staff to translate the outputs into actionable implications for the WPP and characterization efforts. The full data and evaluation worksheets for these efforts are available on request but are not included in this report for sake of brevity. The information presented below is a summary of outcomes that have relevance for the project.

Ambient Data

Ambient water quality data are collected at over 400 sites in the 13-county Houston-Galveston region by H-GAC, local partners, and the TCEQ as part of the Clean Rivers Program (CRP)[7]. In general, most monitoring stations are sampled by CRP partners on a quarterly frequency for a suite of field, bacteriological, and conventional parameters[8]. Waterways are inherently dynamic systems, and water quality at any given time can vary greatly dependent on conditions at the time[9]. However, a history of samples provides a more representative view of the range of conditions that may be present in that waterway. Ambient data is important for characterizing waterways because it represents a range of conditions and has a historical aspect that allows for the identification of trends over time. The final determination of the regulatory status of each segment is based primarily on these ambient data. The goals and decisions for the WPP(s) are established in part due to the regulatory status, and therefore ambient data is an important source of information for informing stakeholder decisions. The current monitoring stations, by collecting entity, are shown in Figure 1 and described in Table 2. Additional detail about the range of data and number of sampling events reviewed for each monitoring station can be found in Appendix A.

[7] More information about this state-wide water quality monitoring program can be found at https://www.tceq.texas.gov/waterquality/clean-rivers.
[8] More information about the specific monitoring and programmatic details of the local CRP can be found at http://www.h-gac.com/community/water/rivers/.
[9] For this report, 24-hour DO data is discussed in this section. In terms of technical terminology under CRP, 24-hour DO sampling is not considered "ambient" data, but rather, "biased sampling" because it is often collected during certain seasonal timeframes. Due to the nature of the 24-hour data for this project, and the basic categorization of this report, it is discussed as ambient data.

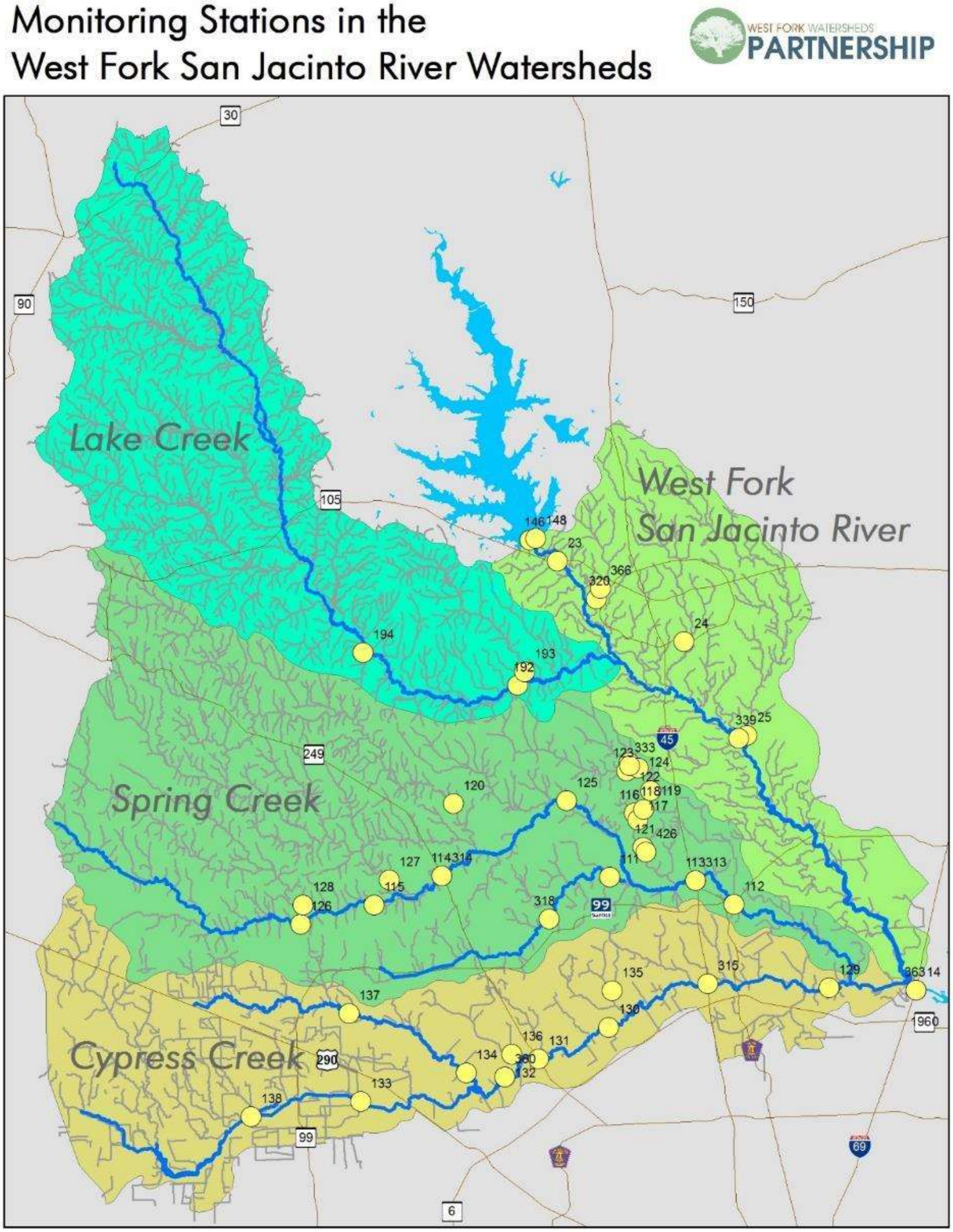


Figure 1 - West Fork Watersheds monitoring stations

Table 2 - Monitoring station locations

Map ID	Station ID	Site Location
1	11211	Lake Houston at FM 1960
2	11212	Lake Houston at FM 1960
3	11213	Lake Houston
4	18667	Lake Houston in the West Fork San Jacinto River Channel
5	18670	Lake Houston/Luce Bayou 123 at Lakewater Drive
6	20782	Lake Houston West Fork San Jacinto River Arm
7	11251	West Fork San Jacinto River at SH 105
8	16626	Stewarts Creek at Loop 336 SE of Conroe
9	16635	Crystal Creek at SH 242
10	11185	Willow Creek at Gosling Road
11	11312	Spring Creek at Riley Fussel Road
12	11313	Spring Creek Bridge at IH 45
13	11314	Spring Creek at SH249
14	11323	Spring Creek at Rosehill-Decker Road
15	16481	Lake Woodlands at Western Reach in The Woodlands
16	16482	Lake Woodlands at South End in The Woodlands
17	16483	Lake Woodlands at Mid Point in The Woodlands
18	16484	Lake Woodlands at North End in The Woodlands
19	20461	Mill Creek 2km Upstm of Hardin Store Road
20	16627	Lower Panther Branch at Sawdust Road
21	16629	Upper Panther Branch at Research Forest Drive
22	16631	Bear Branch Bridge at Shadow Bend
23	16632	Upper Panther Branch at Gosling Road Bridge
24	17489	Spring Creek at Kuykendahl Road Northeast of Houston
25	18868	Spring Creek at Roberts Cemetery Road West-Northwest of Tomball
26	20462	Walnut Creek at Decker Prairie Rosehl Road Northwest of Tomball
27	20463	Brushy Creek at Glenmont Estates Boulevard
28	11324	Cypress Creek at Cypresswood Drive Bridge
29	11330	Cypress Creek at Steubner-Airline Road in Houston
30	11331	Cypress Creek at SH249
31	11332	Cypress Creek at Grant Road Near Cypress
32	11333	Cypress Creek at House-Hahl Road Near Cypress
33	14159	Little Cypress Creek at Kluge Road in Houston
34	17481	Spring Gully at Spring Creek Oaks Drive in Tomball
35	17496	Faulkey Gully of Cypress Creek at Lakewood Forest Drive
36	20456	Little Cypress Creek at Mueschke Road
37	20457	Cypress Creek at Katy Hockley Road
38	11342	Lake Conroe at Dam
39	13915	Lake Conroe Usgs Site Al
40	11367	Lake Creek at County Road
41	17937	Mound Creek at Mulligan Road
42	18191	Lake Creek at FM 149
43	11313	Spring Creek Bridge at IH 45
44	11314	Spring Creek at SH249
45	11328	Cypress Creek Bridge on IH 45
46	20730	Willow Creek at Tuwa Road
47	11250	West Fork San Jacinto River at FM 2854
48	16630	Upper Panther Branch at Research Forest Drive
49	11243	West Fork San Jacinto River at SH 242
50	11332	Cypress Creek at Grant Road
51	11213	Lake Houston
52	20731	White Oak Creek at Memorial Drive
53	16422	Panther Branch at Sawdust Road

Constituents of concern

Routine ambient water quality monitoring under the CRP includes sampling for a suite of conventional, bacteriological, and field parameters. For this evaluation, a subset of those parameters most closely related to the goals of the WPP and characterization studies has been selected for in-depth analysis. The constituents reviewed are:

- *E. coli* – a bacterial indicator of the presence of fecal wastes, and an indicator of the safety of waterways for human recreation.
- *DO, grab* – an indicator of the ability of the waterway to support aquatic life
- *24-Hour DO* – an indicator of the change in DO over a daily cycle, and part of the criteria for determining compliance with the aquatic life use water quality standard.
- *Temperature* – an indicator of a waterway's ability to hold oxygen, and a means for correlating other indicators to conditions in the waterways.
- *pH* – an indicator of the acidity or basicness of water, which may affect aquatic life and other uses.
- *Chlorophyll-a* – an indicator of aquatic plant productivity and action, which can indicate areas in which algal blooms or elevated nutrient levels are present, and thus potentially depressed DO.
- *Nitrate+Nitrite* – a measure of nitrogenous compounds and indicator of nutrient levels (and thus potential DO impacts).
- *NH3-N* – a measure of specific nitrogenous compound that can impact aquatic life and is an indicator of nutrient levels and potentially of improperly treated sewage effluent.
- *Flow (grab)* – a measure of water volume over time
- *Total Phosphorus* – an indicator of nutrient levels, especially in relation to potential for algal blooms and depressed DO in elevated levels.
- *TSS* - a measure of the amount of suspended particles in water that indicates the potential of light infiltration in the water column and the presence of particulate matter on which bacteria may seek shelter.

The original period the assessed data cover is 2012-2017, with the majority of data falling between the 2012-2016 time frame. The additional period covered in this updated report includes data collected between 2015-2018. The original period is intended to show a broader historic data review, while the updated analyses focus on short-term trends at the start of implementation.The primary questions these evaluations sought to answer relate to: 1) the sufficiency of the data to characterize conditions; 2) the spatial component of variations in water quality conditions; 3) the extent of water quality issues; and 4) trends in water quality conditions, including any observable seasonal patterns[10]. The assessment was completed on the segment level, with attention to any unclassified tributaries which may be

[10] Throughout this ambient water evaluation, statistically significance is defined as a p-value of 0.05 or less. Any significance not based on this statistical review (e.g. seasonal trends, qualitative comments) will be specifically described as not being related to this significance threshold. The quantitative analysis for the ambient conditions was conducted using SAS.

experiencing issues not common in the entire segment watershed. Full analysis of all the constituents for all stations is included as graphs in Appendix B[11].

West Fork San Jacinto River (Segment 1004)

The West Fork of the San Jacinto River (West Fork) evaluated in this project includes the stretch of the waterway between Lake Conroe to the north (being the hydrologic starting point for the watershed, for all intents and purposes) and Lake Houston to the south. This segment is the primary waterway of the project area; Lake Creek (1015), Spring Creek (1008), and Cypress Creek (segment 1009) are tributaries to the West Fork, even though Cypress and Spring enter the system almost at the juncture with Lake Houston. Inflow from Lake Conroe is generally of good quality, but the headwaters of many of the West Fork's unclassified tributaries begin in, or flow through, the denser urban area of the City of Conroe and its environs. The waterway includes the burgeoning Highway 45 growth corridor, and aspects of The Woodlands and similar developments. Additional growth is expected to push into this watershed in the coming decades. The waterway is a popular recreation area and contains large stretches of undeveloped area in its lower extent.

There are six stations in the waterway (Table 3 and Figure 2), three on the main body, and one each on Crystal, Stewarts, and White Oak Creek. The data for all stations is representative of several years' worth of sampling and is sufficient to describe the conditions during the study period. Based on the 2014 integrated Report of Surface Water Quality (covering seven years of data, where available, through 2012), this segment is impaired for fecal indicator bacteria (1004, 1004D, 1004E)[12], and a concern for nitrate (1004).

Table 3 - Monitoring stations of the West Fork San Jacinto River

Station	Segment	Segment Name	Sampling Events[13]
11243	1004	West Fork San Jacinto River	32
11250	1004	West Fork San Jacinto River	32
11251	1004	West Fork San Jacinto River	34
16635	1004D	Crystal Creek	32
16626	1004E	Stewarts Creek	33
20731	1004J	White Oak Creek	14

[11] Statistical analysis in the graphs of Appendix B are based on a LOESS curve rather than a straight regression curve to better indicate change in trend over time for disparate stations.
[12] It should be noted that 1004J is not included in the 2014 assessment because insufficient data was available for this station at that time.
[13] The number in parentheses indicates the sampling events considered as part of the post-WPP update. Some of these samples may overlap with samples in the original assessment and should not be considered cumulatively.

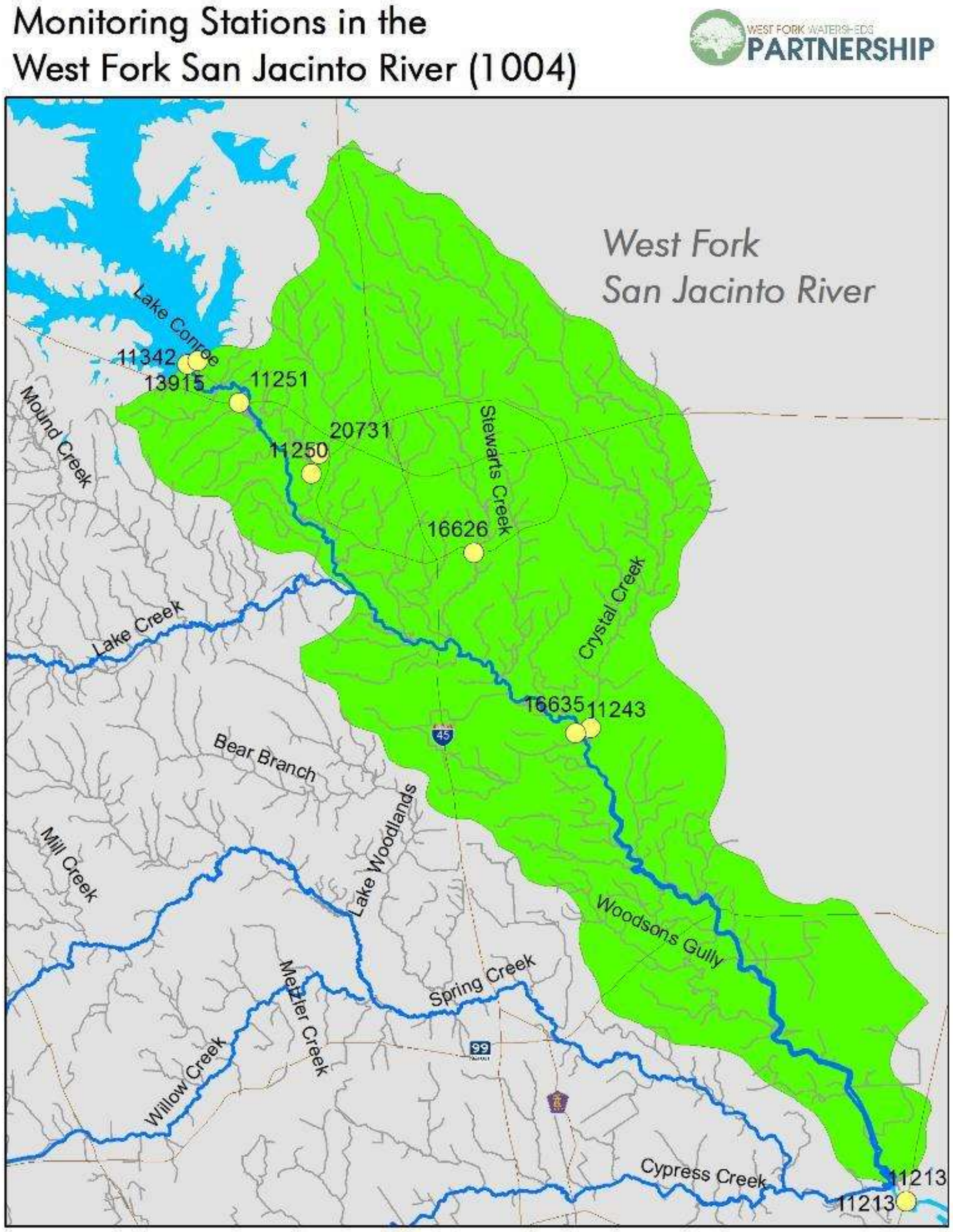


Figure 2 - Monitoring stations in the West Fork (Segment 1004)

Table 4 indicates the constituents in Segment 1004 and its unclassified tributaries for which there are statistically significant trends. The lack of an increase in *E. coli* during this time frame is notable, and the decrease in phosphorus is also a good sign. The increasing chlorophyll-a does not seem to correlate to a decreasing DO trend. Table 5 indicates any changes or new trends in the updated analyses.

Table 4 - Trending constituents, West Fork (2012-2017)

Segment	Parameter	Trend	P-value	Number of Samples
1004	Chlorophyll a	Increasing	0.0007	22
1004	Total Phosphorus	Decreasing	0.0053	95
1004E	E. Coli	Decreasing	0.0369	33

Table 5 - Trending Constituents, West Fork (2015-2018)

Segment	Parameter	Trend	Number of Samples
1004	Chlorophyll a	Stable, limited data	9
1004	Total Phosphorus	Increasing	45
1004E	E. Coli	Stable. limited data	17
1004D	Nitrate	Increasing, limited data	17
1004J	Dissolved Oxygen (Grab)	Increasing, limited data	11
1004J	E. Coli	Decreasing, limited data	11

Notable findings in review of the monitoring results include:

- *E. coli* samples[14] covered a wide range of values, but in most of the waterways[15] there are ample exceedances of the contact recreation standard, with some of the unclassified tributaries (1004J, especially) seeing many samples orders of magnitude above the standard. In segment

[14] It should be noted, when viewing the graphs for *E. coli* results in Appendix B, that the scale for the y axis is logarithmic.

[15] Assessment units (AUs) within a segment are delineated by TCEQ as portions of a segment or unclassified tributary on which assessments are based and are typically designated as segment_0X (e.g., 1004_01, 1004_02, etc.). An AU may be an entire waterway, or a portion thereof. For this report, data is not broken down to the AU level unless specific reason exists to explain spatial difference in results.

1004 specifically, the moving 7-year geomean[16] indicates a continued degradation (which is not reflected in the tributaries, even though they are in excess of the standard.)

- Nutrients (NH3-N, Nitrate, Total Phosphorus, chlorophyll-a) were generally under screening levels, except for station 11243 which had appreciable number of exceedances for nitrate and total phosphorus levels. Station 11250 has an increasing trend for chlorophyll-a, but the majority of results are still under screening levels.
- DO (grab) levels show no appreciable issues with DO screen levels[17].
- Other parameters (temperature, flow, TSS, pH) did not show any patterns of note or water quality issues, although TSS levels were elevated at times.
- Overall, elevated levels of fecal bacteria remain the primary issue for this waterway.
- The update to the original analyses indicated the following:
  - The E. coli levels in 1004 which had been decreasing in the previous analyses has stabilized in the limited data of the updated analyses.
  - Total Phosphorus which had been decreasing in the original analyses, has shown an increase in the main stem.
  - The limited data available for 1004D indicates increasing levels of Nitrate.
  - The limited data available for E. coli and DO grab samples in 1004J shows improvement.

Lake Creek (Segment 1015)

Lake Creek is the northernmost segment in the watershed, draining rural areas to the west of Lake Conroe in its headwaters, and rapidly growing areas west of the City of Conroe near its junction with the West Fork. Historically its water quality reflected its less-developed character. Additional growth is expected to push into this watershed in the coming decades as it moves north and west from the Houston area. The waterway is a popular recreation area and contains large stretches of undeveloped area in its upper extent.

There are three stations in the Lake Creek system (Table 6 and Figure 3), two on the main body, and one on Mound Creek. The data for all stations is representative of several years' worth of sampling and is sufficient to describe the conditions in the southeastern half of the watershed during the study period. Additional data would be helpful in fully characterizing the upper half of the watershed, which does not have current monitoring stations. Based on the 2014 integrated Report of Surface Water Quality elements of this segment are impaired for fecal indicator bacteria (1015A) and have concerns for depressed DO and impaired macrobenthic community (1015).

[16] Graphs of moving seven-year geomeans are included as Appendix C.
[17] 24-hour DO data for this segment is currently unavailable pending TCEQ review. This section will be updated as it becomes available.

Table 6 - Monitoring stations of Lake Creek

Station	Segment	Segment Name	Sampling Events
11367	1015	Lake Creek	25
18191	1015	Lake Creek	22
17937	1015A	Mound Creek	20

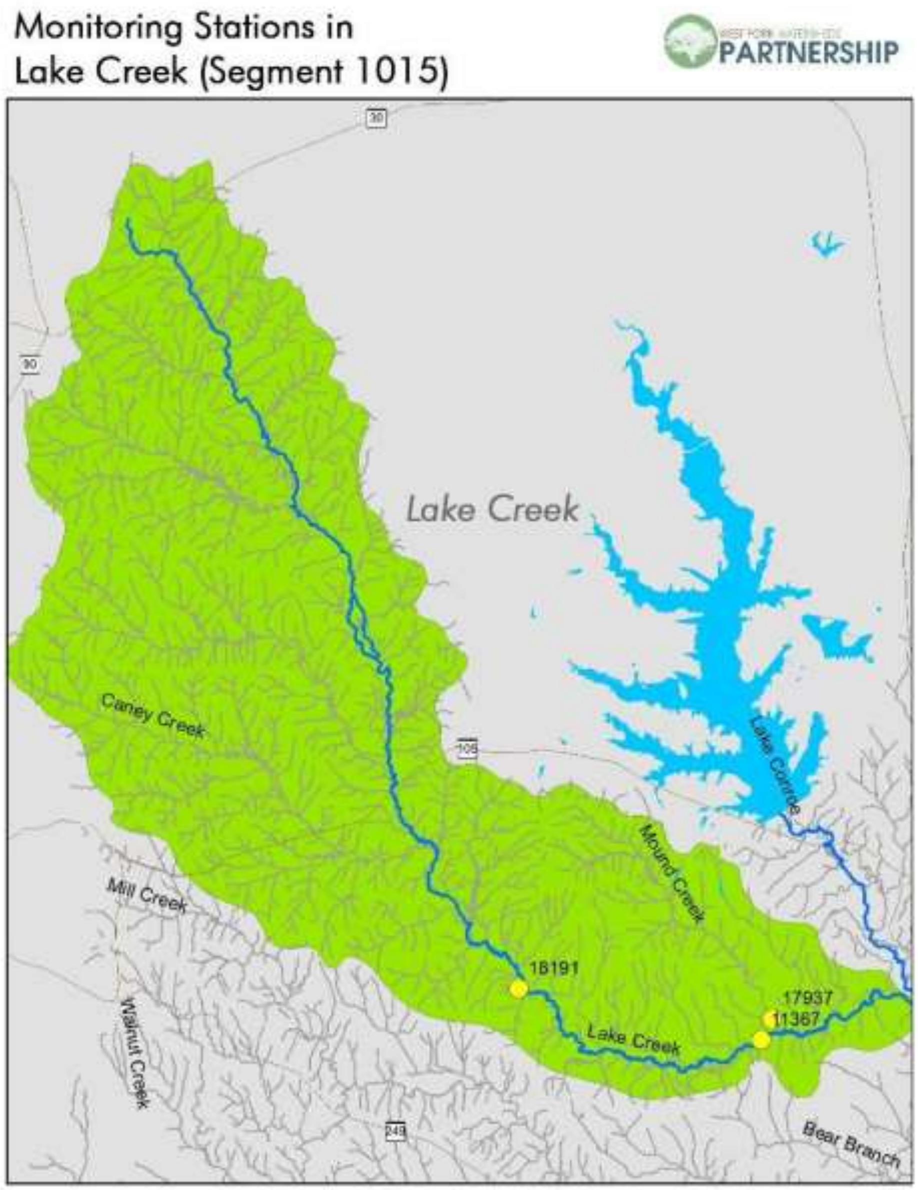


Figure 3 - Monitoring stations in Lake Creek (Segment 1015)

Table 7 indicates the constituents in Segment 1015 and its unclassified tributaries for which there are statistically significant trends. There were no trends for primary constituents of concern other than pH, which has no direct implication for water quality concerns under this project without a correlation with other issues. Table 8 indicates any changes or additional trends noted in the updated analyses.

Table 7 - Trending Constituents, Lake Creek (2012-2017)

Segment	Parameter	Trend	P-value	Number of Samples
1015	pH	Increasing	0.0151	44

Table 8 - Trending Constituents, Lake Creek (2015-2018)

Segment	Parameter	Trend	Number of Samples
1015	pH	Stable	22
1015	DO (grab)	Increasing	22
1015	Total Phosphorus	Increasing	22

Notable findings in review of the monitoring results include:

- *E. coli* samples showed a range of conditions, but for both the main channel and Mound Creek stations, there were numerous samples in excess of the water quality standard. An analysis of the moving 7-year geomeans indicates no appreciable increase but continues above the standard for both 1015 and 1015A[18].
- Nutrients (NH3-N, Nitrate, Total Phosphorus) were generally under screening levels, with few exceptions for any parameter or station.
- DO levels (grab) were often below the screening level for the main channel, but without issue in Mound Creek.
- 24-hour DO data[19] indicated that the main channel had varied results, with 75% of events meeting the standard for both minimum and averages. However, the event for both parameters

[18] See Appendix C.
[19] There were a limited number of samples for station 11367 on 1004 and 1015A.

that comprises the 25% was during 2011 and may be explained by dry conditions during a drought of record. The event recorded in Mound Creek indicated compliance.

- Other parameters (temperature, flow, TSS, pH) did not have any results of note, although TSS results were mixed on the main channel (though much lower on Mound Creek).
- Overall, *E. coli* levels are the continuing primary challenge for this segment, with current data indicating that it may be listed for bacterial impairment in the future assessments.
- The update to the original analyses indicated the following:
    - pH levels in 1015 which had been increasing in the original analyses, have stabilized in the updated analyses.
    - DO grab samples in 1015 show improvement.
    - Total Phosphorus in 2015 is increasing.

Spring Creek (Segment 1008)

Spring Creek is the middle of the three primary tributary segments in the watershed, draining some rural areas in its western extent, and a mix of developed and developing areas along most of its central reach, through the more densely developing areas of The Woodlands before its junction with the West Fork just upstream of the confluence of the system with Lake Houston. Additional growth is expected to push north and west into this watershed in the coming decades. The waterway is a popular recreation area, and a great deal of community focus has been placed on its riparian corridor.

The segment is heavily monitored, with 20 monitoring stations (Table 9 and Figure 4); six on the main body, one on Mill Creek (1008A), two on Upper Panther Branch (1008B), two on Panther Branch (1008C), one on Bear Branch (1008E), four on Lake Woodlands (1008F), two on Willow Creek (1008H), and one on Brushy Creek (1008J). The data for all stations is representative of several years' worth of sampling and is sufficient to describe the conditions during the study period. Based on the 2014 integrated Report of Surface Water Quality elements of this segment are impaired for fecal indicator bacteria (1008, 1008A, 1008B, 1008C, 1008E, 1008H) and depressed DO (1008, 1008A, 1008J) The segment also has concerns for depressed DO (1008,) impaired fish community (1008), total phosphorus (1008, 1008B, 1008C, 1008F, 1008H), nitrate (1008, 1008B, 1008C, 1008F, 1008H), ammonia (1008F), DO (grab)(1008A, 1008C, 1008F), indicator bacteria (1008F, 1008I, 1008J), and chlorophyll-a (1008F).

Table 9 - Monitoring stations of Spring Creek

Station	Segment	Segment Name	Sampling Events
11312	1008	Spring Creek	52
11313	1008	Spring Creek	33
11314	1008	Spring Creek	48
11323	1008	Spring Creek	52
17489	1008	Spring Creek	52
18868	1008	Spring Creek	22
20461	1008A	Mill Creek	35
16629	1008B	Upper Panther Branch	66
16630	1008B	Upper Panther Branch	68
16422	1008C	Panther Branch	23
16627	1008C	Panther Branch	68
16631	1008E	Bear Branch	68
16481	1008F	Lake Woodlands	63
16482	1008F	Lake Woodlands	63
16483	1008F	Lake Woodlands	64
16484	1008F	Lake Woodlands	63
11185	1008H	Willow Creek	52
20730	1008H	Willow Creek	52
20462	1008I	Walnut Creek	21
20463	1008J	Brushy Creek	24

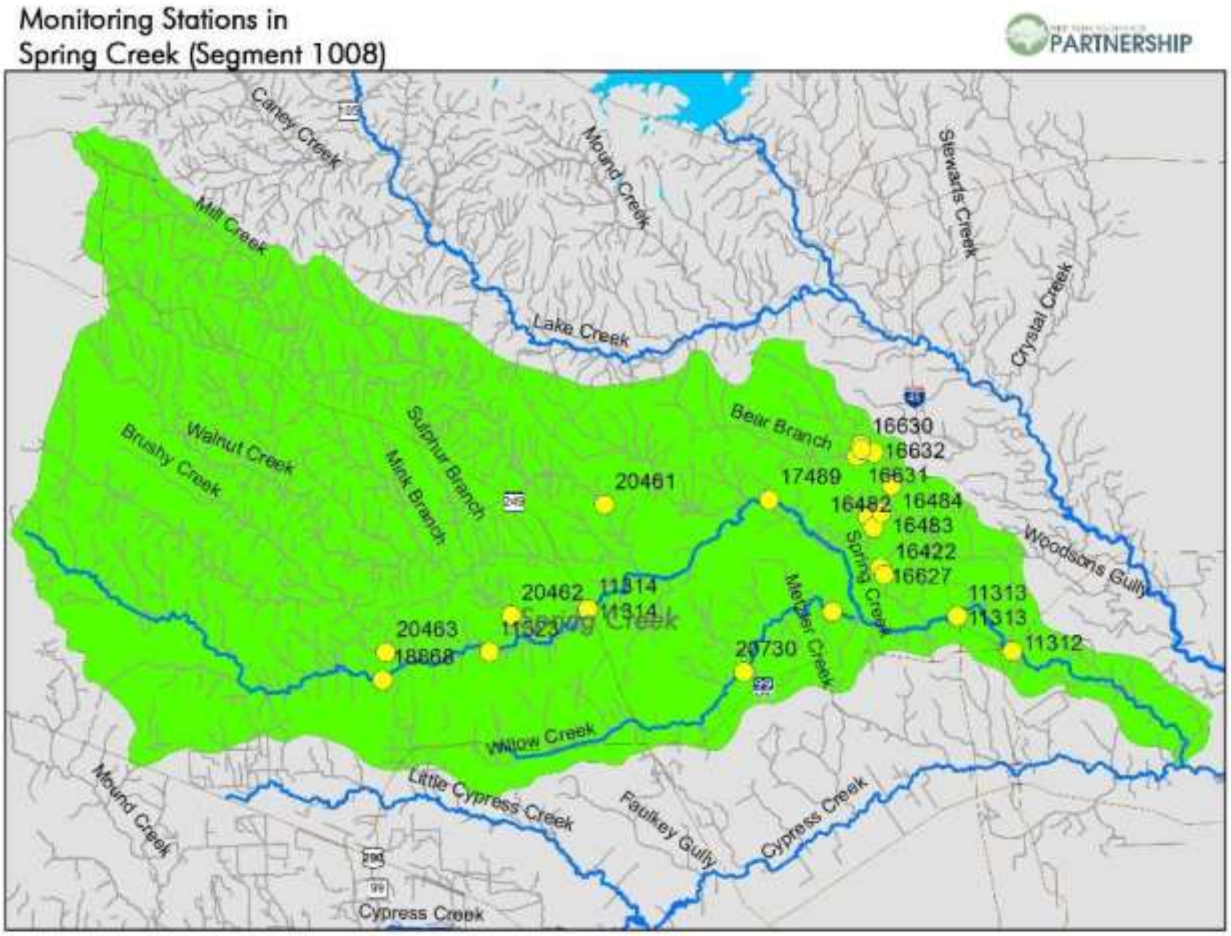


Figure 4 - Monitoring stations in Spring Creek (Segment 1008)

Table 10 indicates the constituents in Segment 1008 and its unclassified tributaries for which there are statistically significant trends. While Spring Creek and its tributaries have a long list of water quality issues, the majority of trends are positive. *E. coli* levels are on the increase in many areas, which is a primary water quality issue for the project watershed. TSS levels increasing in the main channel and 1008h is possibly an exacerbating factor for bacteria but the compliance with screening levels must be considered and not just the trend. DO and nutrient levels are getting better in many of the unclassified segment tributaries, which is a positive sign, though absolute issues remain. Table 11 indicates any changes or additional trends noted in the updated analyses.

Table 10 - Constituent trends, Spring Creek (2012-2017)

Segment	Parameter	Trend	P-value	Number of Samples
1008	E. Coli	Increasing	0.008	254
1008	Instantaneous Flow	Increasing	0.0027	96
1008	Nitrate-N	Decreasing	0.0292	257
1008	Total Phosphorus	Decreasing	0.0019	257
1008	TSS	Increasing	0.0036	257
1008B	DO	Increasing	<.0001	134
1008C	DO	Increasing	0.0201	90
1008E	DO	Increasing	0.0003	67
1008E	Nitrate-N	Decreasing	0.0305	46
1008F	DO	Increasing	0.0504	251
1008F	E. Coli	Decreasing	0.0499	86
1008F	TSS	Decreasing	0.0002	86
1008H	E. Coli	Increasing	0.0003	102
1008H	Nitrate-N	Decreasing	0.0007	104
1008H	Total Phosphorus	Decreasing	<.0001	104
1008H	Total Suspended Solids	Increasing	<.0001	104
1008J	pH	Increasing	0.0265	20
1008J	TSS	Decreasing	0.0294	20

Table 11 - Trending Constituents, Spring Creek (2015-2018)

Segment	Parameter	Trend	Number of Samples
1008	E. coli	Decreasing	136
1008	Instanteous Flow	Stable	66
1008	Nitrate +Nitrite	Increasing	22
1008	Nitrite	Increasing	125
1008	Total Phosphorus	Stable	147
1008	TSS	Stable	147
1008A	Nitrate +Nitrite	Decreasing, limited data	11
1008B	pH	Decreasing	44
1008B	DO	Stable	44
1008C	DO	Stable	44
1008C	Total Phosphorus	Decreasing, limited data	14
1008E	DO	Stable	22
1008E	Nitrate-N	(insufficient data)	7
1008F	E. Coli	Stable	28
1008F	TSS	Stable	28
1008F	Chlorophyll-a	Increasing, limited data	14
1008F	Total Phosphorus	Decreasing, limited data	14
1008H	E. Coli	Stable	54
1008H	Nitrate-N	Stable	54
1008H	Ammonia-N	Increasing	54
1008H	Total Phosphorus	Increasing	54
1008H	TSS	Decreasing	54

Segment	Parameter	Trend	Number of Samples
1008J	Total Phosphorus	Increasing, limited data	11
1008J	pH	Stable, limited data	11
1008J	TSS	Stable, limited data	11

Notable findings in review of the monitoring results include:

- *E. coli* samples vary widely throughout the watershed, but all waterways exhibit numerous exceedances of the standard, although some (especially Lake Woodlands, 1008F) have rarer levels of exceedance, while others (Willow Creek, 1008H) have a majority of samples in excess. Individual stations were generally mixed. A moving 7-year geomean indicates appreciable improvement since 2011, although geomeans still remain above the standard[20]. Similar analysis of geomeans for the tributaries are mixed.
- Nutrients (NH3-N, Nitrate, Total Phosphorus) were generally elevated, despite trends toward improved water quality:
  - Nitrate levels were elevated in 1008 (11312 and 11313), 1008B (16630), 1008C (16422), 1008F (all stations), and 1008H (all stations).
  - Total phosphorus levels were elevated in 1008 (11312, 11313), 1008B (16630), 1008C (16422), 1008F (all stations), and 1008H (all stations).
  - Ammonia levels were better, being elevated only in 1008F (all stations).
- DO levels (grab) were generally good, except for 1008 which had many samples below the screening level, and 1008A which had an appreciable number of its samples below the screening level.
- 24-hour DO data was available for 1008A (which did not meet the standard on many occasions for both average and minimum parameters), 1008I (which did not meet the standard on some occasions for minimums), and 1008J (which was fully in compliance).
- Other parameters (temperature, flow, TSS, pH)
- The update to the original analyses indicated the following:
  - E. coli levels in 1008 which had been increasing, showed a decrease.
  - Nitrate and Nitrite in 1008 which had been decreasing originally, now show an increasing trend.
  - pH in 1008B and Total Phosphorus in 1008C show improvement.
  - Ammonia in 1008H, and Total Phosphorus in 1008H and 1008J are increasing.
  - TSS in 1008H had been increasing, but now show a decreasing trend.

[20] See Appendix C.

Cypress Creek (Segment 1009)

Cypress Creek is the most southerly of the three primary tributary segments in the watershed, draining some rural (but rapidly developing) areas of the Katy Prairie in its western extent, and developed areas along most of its central reach before its junction with the West Fork just upstream of the confluence of the system with Lake Houston. Additional growth is expected to push west into this watershed in the coming decades. The waterway is a popular recreation area, and a great deal of community focus has been placed on its riparian corridor, including an active greenway.

The segment is heavily monitored, with 11 monitoring stations (Table 12 and Figure 5); seven on the main body, one on Faulkey Gully (1009C), one on Spring Gully (1009D), and two on Little Cypress Creek (1009E). The data for all stations is representative of several years' worth of sampling and is sufficient to describe the conditions during the study period. Based on the 2014 integrated Report of Surface Water Quality elements of this segment are impaired for fecal indicator bacteria (1009, 1009C, 1009D, 1009E). The segment also has concerns for depressed DO (1009, 1009E), nitrate (1009, 1009C, 1009D, 1009E), total phosphorus (1009, 1009C, 1009D, 1009E), impaired macrobenthic communities (1009), and ammonia (1009D).

Table 12 - Monitoring stations of Cypress Creek

Station	Segment	Segment Name	Sampling Events
11324	1009	Cypress Creek	25
11328	1009	Cypress Creek	33
11330	1009	Cypress Creek	52
11331	1009	Cypress Creek	52
11332	1009	Cypress Creek	54
11333	1009	Cypress Creek	52
20457	1009	Cypress Creek	19
17496	1009C	Faulkey Gully	52
17481	1009D	Spring Gully	51
14159	1009E	Little Cypress Creek	51
20456	1009E	Little Cypress Creek	22

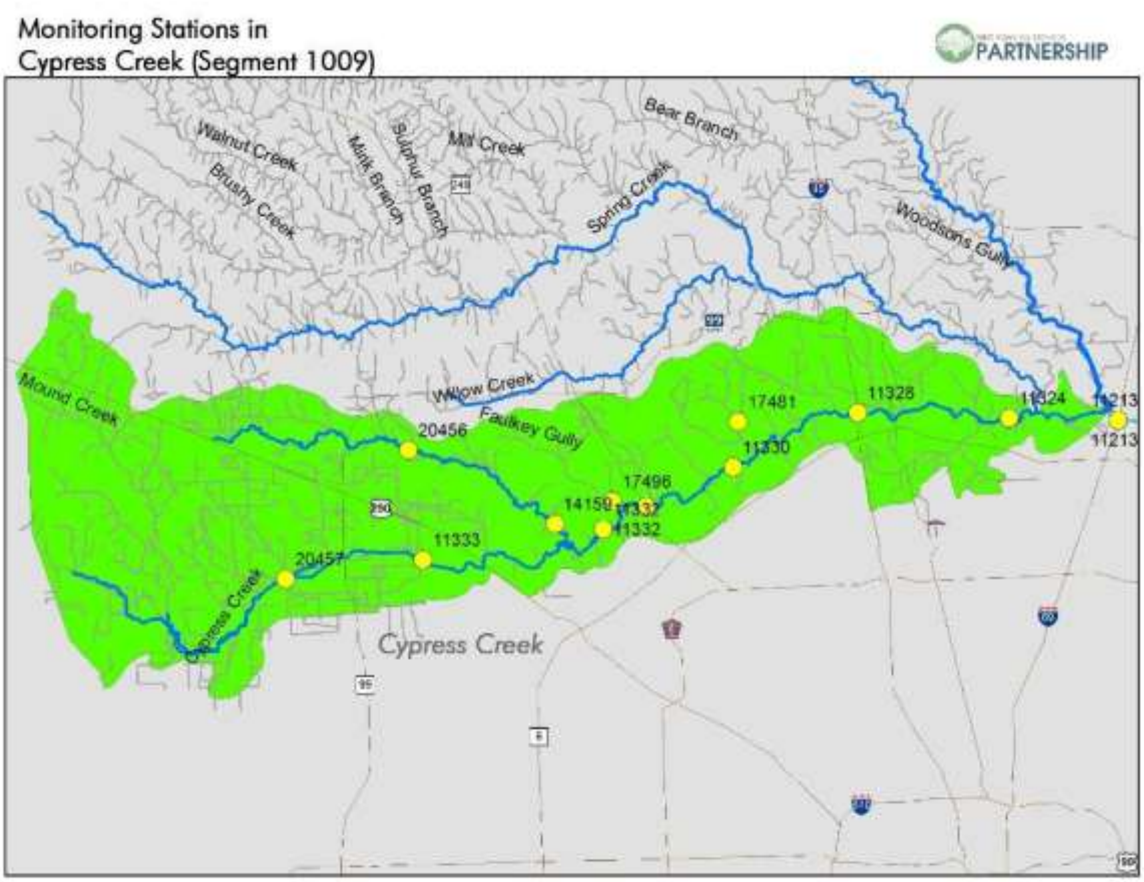


Figure 5 - Monitoring stations in Cypress Creek (Segment 1009)

Table 13 indicates the constituents in Segment 1009 and its unclassified tributaries for which there are statistically significant trends. While there are numerous water quality issues for Cypress and its tributaries, the main channel and many of the unclassified tributaries show improvement on nutrients and/or DO. As with Spring Creek, worsening trends include primary water quality issue *E. coli* and TSS. Further development in the headwaters may exacerbate these issues. Table 14 indicates any changes or additional trends noted in the updated analyses.

Table 13 - Constituent trends, Cypress Creek (2012-2017))

Segment	Parameter	Trend	P-value	Number of Samples
1009	E. Coli	Increasing	0.0018	292
1009	Instantaneous Flow	Increasing	<.0001	167
1009	Nitrate-N	Decreasing	<.0001	284
1009	pH	Decreasing	0.0038	291
1009	Total Phosphorus	Decreasing	<.0001	281
1009	TSS	Increasing	<.0001	284
1009C	Total Phosphorus	Decreasing	0.0277	52
1009D	Ammonia-N	Decreasing	0.0016	51
1009D	DO	Increasing	0.026	49
1009E	Nitrate-N	Decreasing	0.0085	73
1009E	Total Phosphorus	Decreasing	0.0038	73
1009E	TSS	Increasing	0.0004	73

Table 14 - Trending Constituents, Cypress Creek (2015-2018)

Segment	Parameter	Trend	Number of Samples
1009	E. Coli	Stable	145
1009	Instantaneous Flow	Stable	84
1009	Nitrate-N	Stable	125
1009	pH	Stable	146
1009	Total Phosphorus	Stable	144
1009	TSS	Stable	146
1009C	E. Coli	Decreasing	27
1009C	Nitrate-N	Decreasing	27
1009C	Total Phosphorus	Stable	27
1009D	E. coli	Decreasing	26
1009D	Ammonia-N	Stable	26
1009D	DO	Stable	26
1009E	Nitrate-N	Stable	39
1009E	Total Phosphorus	Stable	39
1009E	TSS	Stable	39

Notable findings in review of the monitoring results include:

- *E. coli* samples for all waterways in this segment indicate that conditions are consistently (though not solely) above the standard. While levels remain consistently in excess of the standard, examination of moving seven-year geomeans indicates a longer-term progression toward better quality even though levels remain above the standard in current trends[21].
- Nutrients (NH3-N, Nitrate, Total Phosphorus) were mixed in this segment group. Ammonia levels were consistently high in the main channel, generally meeting the standard in 1009C, but mixed in 1009D and 1009E. Nitrate levels in most of the stations of the main channel were

[21] See Appendix C.

consistently elevated, except for station 20457. 1009C and 1009D had consistently elevated levels, while 1009E was split between consistently low levels in station 20456 and elevated levels in 14159. Similarly, total phosphorus levels were elevated for the main channel, 1009C and 1009D, and to a lesser extent, the stations of 1009E.

- DO levels (grab) were generally positive, with the main channel, 1009C, 1009D, and station 14159 of 1009E being consistently above the screening level. Station 20456 of 1009E was the outlier, with consistently low DO levels.
- Other parameters (temperature, flow, TSS, pH) did not show many notable patterns, other than higher than average TSS levels (as also noted in the trends) in the tributaries (less so in the main channel, but present).
- The update to the original analyses indicated that:
    - Many constituents which had previously been worsening in the original analyses have stabilized or improved.
    - E. coli and Nitrate in 1009C showed new trends toward improvement.

Relationship to Flow

As part of the ambient data analyses, staff considered the relationship of constituent levels to flow conditions. Further work on flow and bacteria was completed as part of LDC model development. However, these ambient analyses pointed out several statistically significant relationships worth noting in characterizing these watersheds. Of specific interest was the relationship between flow and bacteria concentrations. The West Fork and Spring Creek saw less obvious relationships between flow and bacteria concentrations, indicating a potential mix of bacteria sources affecting different flow conditions (i.e. point and nonpoint source). Cypress Creek and Lake Creek saw fairly consistent nonpoint source indications, as bacteria concentrations increased with flow fairly regularly throughout the stations of the waterway. Detailed graphs of these relationships can be seen in Appendix D.

Ambient Analysis Summary

The watersheds of the project area exhibit water quality challenges reflective of their developmental status. The more heavily developed watersheds (1008, 1009) have greater numbers of concerns and impaired AUs than the least developed (1015). This pattern generally holds true for a comparison of individual stations within the segments as well.

Bacteria remains an issue through most of the area, except for some areas of Lake Creek. However, lack of monitoring data from northerly reaches should not be taken as an absence of impairment, but rather, insufficiency of data. It is likely that bacteria levels, absent intervention, will continue to increase in Lake Creek as development advances.

Despite trends toward generally better water quality, nutrients remain a challenge for DO in 1008 and 1009, with suburban and exurban development being likely prominent sources.

Elevated TSS levels do not seem directly related to effluent flows (see DMR data analysis in the following pages), though wastewater is likely a component. Additional review may be needed to understand the potential sources of TSS. Anecdotal reports from stakeholders indicate that heavy (and relatively poorly regulated) activity by sand and gravel operations in the riparian corridors may be an appreciable part of this issue.

While water quality issues persist in these waterways since the 2014 assessment, they are not extraordinary in extent such that voluntary intervention through watershed-based plans would be fruitless. Targeted assessment and application of best management practices could be expected to reduce or remove impairments and concerns in these watersheds.

The updated analyses showed a mix of trends, but the same general relationships in terms of primacy of individual pollutants by waterway. The improvement of E. coli levels in Spring and Cypress Creek waterways, despite varying trends in nutrients and other parameters, was a positive sign for the aims of the watershed protection efforts focused on fecal bacteria. The lack of statistically significant worsening of fecal bacteria levels in the West Fork and Lake Creek, in the face of rapidly increasing populations, while not wholly a positive, is still worth noting.

DMR Data

Discharges from wastewater treatment plants are regulated by water quality permits from the TCEQ which require stringent limits for effluent quality. In general, wastewater treatment plants in the region are able to meet their permits with few excursions. However, because human waste has an appreciable pathogenic potential[22], identifying trends in permit exceedances for indicator bacteria by WWTFs is important in understanding overall impacts to waterways. Additionally, effluent (especially if improperly treated) can be a source of nutrient precursors to depressed DO. Discharges from WWTFs are monitored on a regular basis (with a frequency dependent on plant size and other factors). The data from these required sampling events is submitted to (and compiled by) the TCEQ as DMRs. As with any self-reported data, there is an expectation that some degree of uncertainty or variation from conditions may occur, but these DMRs are the most comprehensive data available for evaluating WWTFs in the watershed.

For this project, staff evaluated five parameters common to most WWTF permits, as reported in the last five years (2012-2017) of DMRs available from TCEQ, and then again as part of updated analyses (2016-

[22] While the project considers many sources of fecal bacteria, recent research has indicated that human waste has a significantly higher risk of causing sickness in humans as compared to animal sources. Additional information about this research can be reviewed at http://oaktrust.library.tamu.edu/handle/1969.1/158640?show=full. (Gitter, 2017).

2018[23].) Some parameters are themselves constituents of concern, while the others are indicators of the presence or potential presence of untreated/improperly treated waste[24]:

- Indicator bacteria (*E. coli)* – this common gut bacteria indicates the presence of untreated fecal waste and related pathogens which can impact human health.
- TSS – this measure of the amount of suspended particles in water indicates the efficiency of the WWTF process, and the potential of effluent to impact sedimentation and light transmission in the waterway. Excessive particles in the water quality can foster bacteria survival, among other impacts.
- NH3-N – this nitrogenous compound is specifically harmful to aquatic systems, can impact human health in high concentrations, contributes to algal blooms and low DO, and can indicate the efficiency of wastewater treatment processes.
- DO, grab samples – this indicator directly characterizes the ability of the effluent to support aquatic life, and indicates the potential presence of nutrients and other oxygen-demanding substances (and thus the efficiency of treatment processes).
- CBOD5 – This indicator, which measures the depletion of oxygen over time by biological processes, indicates the efficiency of treatment.

The parameter evaluations were based on the regulatory permit limits specific to each plant, and consider the number of exceedances by each plant, in each year, in each segment, and as a percentage of the total samples.

Indicator Bacteria (E. coli)

E. coli is an indicator bacterium widely common to the guts of warm-blooded animals. While many strains of *E. coli* are not themselves problematic, they are closely related to the presence of fecal waste, and therefore, to the host of pathogens present in wastes. The water quality standard for ambient conditions is 126 colony-forming units per 100ml of water (for the geomean of samples) and 399 cfu/100ml (for single grab samples), and these standards are generally applied as a permit condition for wastewater as well[25]. Evaluations for compliance with the permit limits were compared between segments, between plants, between years, between category (average or maximum values), and by

[23] The updated analyses focused on the conformance of the results with permit limits. Investigations done under the original analyses to characterize the watershed (seasonality, plant size impacts, etc.) were not repeated.

[24] In consideration of the nutrient loading capacity of the plants, it should be noted that many nutrient parameters are not standard permit limits, and thus may not be tested. Based on review of correlations between nutrient parameters and flow for many stations the analyses did show a likelihood of plants as nutrient loading sources for non-permit limit parameters, particularly in effluent-dominated streams.

[25] Select plants have more stringent limits depending on site-specific conditions, or participation in TMDL projects like the Houston-area Bacteria Implementation Group (BIG). For all analyses, the actual limit for each plant was used in comparison with its plant-specific results. The range of limits applied to the average and maximum conditions ranges from 63 to 399 cfu/100ml.

season. 171 plants reported bacteria results for these segments during the original analysis period. The outcomes are summarized in Tables 15 through 19.

Table 15 - Reporting and E. coli exceedances, total project area (2012-2017)

Parameter	Number	%	Number AVG	%	Number MAX	%
Plants in DMR	179	100%	179	100	179	100
Plants report bacteria	171	96%	171	96	171	96
Greater than 1% violations	68	40%	32	19	80	47
Greater than 5% violations	21	12%	14	8	28	16
Greater than 10% violations	3	2%	3	2	12	7
Greater than 25% violation	0	0	0	0	2	1

Table 16 - E. coli statistics (2015-2018)

Parameter	Number	% of samples
Parameter	Number	% of samples
Plants in DMR dataset	177	100%
Plants report bacteria	175	99%
Total Exceedances	26	0.5%
1004	*4*	*0.6%*
1008	*16*	*0.9%*
1009	*6*	*0.2%*

Table 17 - E. coli exceedances by season and segment (2012-2017)

Exceedance by Season by segment				
	Spring (Months 3-5)	Summer (6-8)	Fall (9-11)	Winter (12-2)
1004	6	7	**13**	9
1008	22	**39**	22	17
1009	25	**32**	17	11
1015	0	**2**	0	1

Table 18 - Summary of E. coli exceedances by segment, year, and category (2012-2017)

Exceedances by year, total						
	2012	2013	2014	2015	2016	2017
Total Exceedances	31	60	48	42	40	2
Exceedances of Average	8	12	16	6	7	0
Exceedances of Maximum	23	48	32	36	33	2
Exceedances by segment by year, total						
	2012	2013	2014	2015	2016	2017
1004	1	8	12	11	3	0
1008	10	26	19	20	23	2
1009	20	23	17	11	14	0
1015	0	3	0	0	0	0
Exceedances by segment by year, average limit condition						
	2012	2013	2014	2015	2016	2017
1004	0	2	4	3	0	0
1008	3	7	6	2	5	0
1009	5	2	6	1	2	0
1015	0	1	0	0	0	0
Exceedances by segment by year, maximum limit condition						
	2012	2013	2014	2015	2016	2017
1004	1	6	8	8	3	0
1008	7	19	13	18	18	2
1009	15	21	11	10	12	0
1015	0	2	0	0	0	0

Table 19 - E. coli exceedances by plant size (2012-2017)

Exceedance by plant size by segment					
Size	total	1004	1008	1009	1015
0>0.5 MGD	125	27	65	30	3
0.5-1 MGD	29	1	12	16	0
1-5MGD	60	4	17	39	0
5-10 MGD	9	3	6	0	0
> 10 MGD	0	0	0	0	0
Distribution of plants by size					
Size	total	1004	1008	1009	1015
0>0.5 MGD	114	19	39	50	6
0.5-1 MGD	35	4	10	21	0
1-5MGD	27	2	6	19	0
5-10 MGD	2	1	1	0	0
> 10 MGD	0	0	0	0	0
Comparison of size distribution with exceedances					
Plant Size	% of plants	% of exceeds			
0>0.5 MGD	64	56			
0.5-1 MGD	20	13			
1-5MGD	15	27			
5-10 MGD	1	4			
>10 MGD	0	0			

In general, the results indicated that a very small number of exceedances were noted (223 out of 14,317 records), and only three plants had greater than 10% of their samples show up as violations. Maximum values were more commonly exceeded than average/geomean limits, indicating there is likely some variability in conditions, as would be expected. Exceedances were greater in the Spring and Cypress Creek segments, but this generally reflects the far larger number of WWTFs in these watersheds. Except for segment 1004, summer was the season with the greatest number of exceedances throughout the project areas. Plant size was not a statistically significant indicator of potential to exceed limits[26] on the whole and varied from segment to segment in importance. While WWTFs may be appreciable contributions under certain conditions, in localized areas, the DMR analysis indicates that they are not likely a significant driver of segment bacteria impairments due to the comparatively few exceedances and the relatively small volumes of effluent. The updated analyses indicated that, for the shorter period

[26] As indicated previously, self-reported data obscures underlying uncertainties about variability in conditions. This is exacerbated when comparing manned, larger facilities who are more likely to sample more frequently, and smaller facilities who sample less frequently and are generally unmanned. These results should not be taken to have statistical significance.

of time represented, compliance remained high. No single plant had excessive violations, as there were 26 exceedance events spread out over 16 plants. All but one of the exceedances were for plants with the lower 63 MPN/100mL limit specific to the Bacteria Implementation Group TMDL area plants. Average exceedance was 720 MPN/100mL, but 10 of the events at the 63 MPN/100mL plants were well under the 126 MPN/100mL ambient standard.

Dissolved Oxygen

DO levels in WWTF effluent help indicate the efficiency of treatment processes. DO is generally more stable in effluent than it can be in ambient conditions because it is less subject to natural processes and variation in insolation. DO is measured in mg/L, and the permit limits with which results are compared vary based on the receiving water body and other factors. Unlike other contaminants, DO limits are based on a minimum, rather than maximum level. Generally, permit limits for the data reviewed ranged between 4-6 mg/l. Evaluations for compliance with the permit limits were compared between segments, between plants, between years, between category (average or maximum values), and by season. 171 plants reported DO results for these segments during this period. The outcomes are summarized in Tables 20-22.

Table 20 - DO limit violations by year and segment (2012-2017)

Violations by segment by year

	2012	2013	2014	2015	2016	2017	total
1004	5	0	2	8	10	0	25
1008	12	19	15	17	20	1	84
1009	27	14	22	32	33	2	130
1015	0	0	0	0	0	0	0
Total	44	33	39	57	63	3	239

Table 21 - DO limit violations by segment by year (2012-2017)

Violations by season by segment

	Spring (Months 3-5)	Summer (6-8)	Fall (9-11)	Winter (12-2)	Total
1004	10	9	3	3	25
1008	24	17	12	31	84
1009	32	29	33	36	130
1015	0	0	0	0	0
Total	66	55	48	70	239

Table 22 - DO sample summary (2015-2018)

Parameter	Number	% of samples
Plants in DMR dataset	177	100%
Plants report DO	175	99%
Total Records	7117	100%
Total Exceedances	87	1.2%
1004	24	2.5%
1008	14	0.6%
1009	48	1.4%
1015	1	0.4%

As with the *E. coli* data, there were very few violations of DO limits (239 total violations for 10403 records in the original (2012-2017) analyses, and 87 violations of 7117 records in the updated analyses.) There were no statistically significant seasonal components for the whole area or individual segments. The greater number of violations in the Spring and Cypress watersheds were again proportional to the greater number of records from those segments. Based on these data and analyses, it is unlikely WWTFs are having any appreciable impact from DO levels in effluent, even before the dilution of these small volumes (relative to the larger volumes of the waterways) is considered. In the updated analyses there was a lower overall rate of exceedance. The 87 violations represented 32 plants, with an average of 2.7 violations each. Only four facilities had more than five violations, and only two had more than ten.

Total Suspended Solids

TSS is generally an indication of wastewater treatment efficiency in removing solids. Substantial TSS levels in effluent can contribute to fostering bacterial regrowth as bacteria uses suspended particles as a protected growth medium. It can also decrease insolation in the water column and lead to deposition of particles on the substrate, etc. However, it can also be useful as indicator that inefficient treatment may have led to other waste products (nutrients, etc.) being elevated in effluent.

Permit limits for TSS include a concentration based (average) limit (in mg/l) and a total weight-based limit (in weight/day). For this evaluation, only the measured concentration records were considered. Both average and maximum permit limit values exist for most plants. Evaluations for compliance with the permit limits were compared between segments, between plants, between years, and between category (average or maximum values). 177 plants reported TSS results for these segments during this period. In the updated analyses, 177 plants reported concentration based average results, which were the focus of the evaluation. The outcomes are summarized in Tables 23 -25.

Table 23 - Total TSS samples and violations by segment (2012-2017)

Total Samples						
Segment	Total	Average	Maximum	% Exceed (total)	% Exceed (average)	% Exceed (maximum)
1004	3165	1490	1675	0.9	1.8	0.7
1008	6872	3522	3350	0.8	1.6	0.3
1009	10620	5310	5310	0.7	1.3	0.4
1015	626	313	313	1.0	1.9	0.6
Total	21283	10635	10648	0.8	1.5	0.4

Table 24 - TSS Violations by segment, year, and limit type (2012-2017)

Exceedances by segment by year, total

	2012	2013	2014	2015	2016	2017	Total
1004	5	2	7	2	10	1	27
1008	6	8	18	12	13	1	58
1009	15	9	19	12	15	1	71
1015	0	1	4	0	0	1	6
Total	26	20	48	26	38	4	162

Exceedances by segment by year, AVG

	2012	2013	2014	2015	2016	2017	Total
1004	5	2	7	2	10	1	27
1008	6	8	18	12	13	1	58
1009	15	9	19	12	15	1	71
1015	0	1	4	0	0	1	6
Total	26	20	48	26	38	4	162

Exceedances by segment by year, MAX

	2012	2013	2014	2015	2016	2017	Total
1004	2	1	2	1	6	0	12
1008	2	0	4	4	1	0	11
1009	3	2	7	3	7	0	22
1015	0	0	2	0	0	0	2
Total	7	3	15	8	14	0	47

Table 25 - TSS results summary (2015-2018)

Parameter	Number	% of samples
Plants in DMR dataset	177	100%
Plants report DO	177	100%
Total Records	7240	100%
Total Exceedances	79	1.1%
1004	12	1.3%
1008	42	1.7%
1009	22	0.6%
1015	3	1.2%

Corresponding to other parameters, TSS violations were rare, making up less than one percent of the total sample records. There were no clear differences by segment (when proportional ratio of samples to violations was considered) or by year. The majority of the violations were for the average limit, but the small subset of violations in general makes any implication drawn from this somewhat meaningless. In general, TSS results indicate WWTFs are operating within their permit limits with little issue and that TSS inputs from WWTFs are not likely a chronic issue of importance for the waterways. In the updated analyses, 177 plants reported 7240 results. The 79 violations were produced by 32 plants. Only three plants had more than 5 violations, and only 1 had more than 10. The rate of exceedance was roughly the same as the expanded original time period. The updated analyses indicate that the results of the original analyses are still characteristic of TSS contributions from plants.

Ammonia Nitrogen

NH3-N is a nitrogenous compound that can be toxic in concentration to people and aquatic wildlife, and can also contribute to the deleterious impacts of elevated nutrient loadings. Additionally, excessive NH3-N levels in effluent indicate inefficient wastewater treatment, and may correlate to the presence of improperly treated sewage.

Like TSS, permit limits for NH3-N include a concentration based (average) limit (in mg/l) and a total weight-based limit (in weight/day). For this evaluation, only the measured concentration records were considered. Both average and maximum permit limit values exist for most plants. Evaluations for compliance with the permit limits were compared between segments, between plants, between years, and between category (average or maximum values). 172 plants reported NH3-N results for these segments during the original analysis period, and 174 plants in the updated analyses period, in which the focus was placed on the concentration based average limit. The outcomes are summarized in Tables 26 through 28.

Table 26 - Total NH3-N samples and violation percentages by segment (2012-2017)

Total Samples						
Segment	total	Average	Maximum	% Exceed (Total)	% Exceed (Average)	% Exceed (Maximum)
1004	2856	1428	1428	2.2	2.7	1.7
1008	6872	3522	3350	2.5	2.8	2.3
1009	10248	5124	5124	1.1	1.3	1.0
1015	626	313	313	2.2	2.6	1.9
Total	20602	10387	10215	1.8	2.0	1.5

Table 27 - NH3-N Violations by segment, year, and limit category (2012-2017)

Exceedances by segment by year, total							
	2012	2013	2014	2015	2016	2017	Total
1004	14	13	17	14	4	0	62
1008	33	26	40	27	45	4	175
1009	27	16	16	22	29	4	114
1015	2	4	3	3	2	0	14
Total	76	59	76	66	80	8	365
Exceedances by segment by year, AVG							
	2012	2013	2014	2015	2016	2017	Total
1004	9	7	10	9	3	0	38
1008	18	15	23	15	26	2	99
1009	13	9	5	14	21	3	65
1015	2	2	2	1	1	0	8
Total	42	33	40	39	51	5	210
Exceedances by segment by year, MAX							
	2012	2013	2014	2015	2016	2017	Total
1004	5	6	7	5	1	0	24
1008	15	11	17	12	19	2	76
1009	14	7	11	8	8	1	49
1015	0	2	1	2	1	0	6
Total	34	26	36	27	29	3	155

Table 28 - Summary of NH3-N results (2015-2018)

Parameter	Number	% of samples
Plants in DMR dataset	177	100%
Plants report DO	174	98%
Total Records	7119	100%
Total Exceedances	160	2.2%
1004	20	2.1%
1008	80	3.3%
1009	57	1.6%
1015	3	1.4%

Corresponding to other parameters, NH3-N violations were relatively rare, making up two percent of the total sample records, and two to 2.5 percent of the individual segment records in the original analyses. There were no clear differences by segment (when proportional ratio of samples to violations was considered) other than an appreciably lower rate of exceedance in segment 1009. Distribution by year was fairly even as well[27]. The majority of the violations were for the average limit, but the small subset of violations in general makes any implication drawn from this somewhat meaningless. In general, NH3-N results indicate WWTFs are operating within their permit limits with little issue and that NH3-N inputs from WWTFs are not likely a chronic issue of importance for the waterways. The updated analyses indicated that the original characterization holds steady, although there was a slightly higher rate of exceedance in general, especially so for segment 1008, but slightly lower for other individual segments.

CBOD5

CBOD5 is not a pollutant itself, but is an indicator of biological oxygen demand, and thus potentially the presence of improperly treated effluent in a sample.

Like TSS and NH3-N, permit limits for CBOD5 include a concentration based (average) limit (in mg/l) and a total weight-based limit (in weight/day). For this evaluation, records for both were considered because of the nature of the test. Both average and maximum permit limit values exist for concentration limits for most plants. Evaluations for compliance with the permit limits were compared between segments, between plants, between years, and between category (average or maximum values) for concentration limits. For the updated analyses, the focus was specifically on the average concentration values. 172 plants reported CBOD5 results for these segments during the original analysis period, and 173 reported in the updated analyses. The outcomes are summarized in Tables 29-31.

[27] Apart from 2017, for which full data is not yet available.

Table 29- CBOD5 samples by number, segment and percent exceedance (2012-2017)

Total Samples						
Segment	Total samples	Average	Maximum	% exceed, total	% exceed, AVG	% exceed, MAX
1004	4287	2796	1491	1.1	1.6	0.3
1008	10350	6964	3386	0.6	0.7	0.3
1009	15369	10246	5123	0.5	0.7	0.2
1015	939	626	313	1.0	1.3	0.3
Total	30945	20632	10313	0.6	0.8	0.3

Table 30- CBOD5 exceedances by year, segment, and category (2012-2017)

Exceedances by segment by year, total							
	2012	2013	2014	2015	2016	2017	Total
1004	13	6	10	12	8	0	49
1008	3	8	16	16	13	5	61
1009	6	9	18	18	22	5	78
1015	1	2	2	1	3	0	9
Total	23	25	46	47	46	10	197

Exceedances by segment by year, AVG							
	2012	2013	2014	2015	2016	2017	Total
1004	12	4	8	12	8	0	44
1008	3	4	15	12	13	5	52
1009	4	8	13	17	21	4	67
1015	1	2	1	1	3	0	8
Total	20	18	37	42	45	9	171

Exceedances by segment by year, MAX							
	2012	2013	2014	2015	2016	2017	Total
1004	1	2	2	0	0	0	5
1008	0	4	1	4	0	0	9
1009	2	1	5	1	1	1	11
1015	0	0	1	0	0	0	1
Total	3	7	9	5	1	1	26

Table 31 - Summary of CBOD sample results (2015-2018)

Parameter	Number	% of samples
Plants in DMR dataset	177	100%
Plants report DO	173	98%
Total Records	7020	100%
Total Exceedances	22	0.3%
1004	1	0.1%
1008	8	0.3%
1009	13	0.4%
1015	0	0.0%

In both the original and updated analyses, compliance with CBOD limits was very high, with less than 1% of all samples, and samples for each waterway respectively, being in violation of permit limits. The samples in the updated analyses showed a lower rate of exceedance in general. However, neither the rate or degree of exceedance indicated in either set of analyses indicates a problem with compliance in the watershed overall, with only one plant have greater than two violations.

Overview of results

While there were exceedances for the evaluated constituents, the majority of plants met their permit limits the majority of the time without significant issue in both the original and updated analyses. Even allowing for variability in effluent conditions not reflected in the DMR results, it is unlikely that WWTFs are an appreciable source of contamination in the watershed. Bacteria source modeling support this evaluation, indicating that for *E. coli* specifically, WWTFs are projected to account for a fairly minor amount of overall load.

However, in interpreting these results, it should be noted that while WWTFs may not be the largest source of bacteria, they are likely one of the human fecal waste sources, and therefore have an inherently higher pathogenic potential than other sources. Additionally, unlike other source of natural and diffuse fecal waste in the watersheds, WWTF effluent has both regulatory controls and voluntary measures by which improperly treated wastewater may be addressed. Given the nature of WWTF effluent as a human pollutant, and our direct ability to influence its character, WWTF bacteria should be considered as a potential focus for some best management practices. While other constituents (e.g. nutrients) are not necessarily any more harmful than other sources in the watershed, the principle of direct control of effluent applies to their consideration as well. This is exacerbated for nutrients given the lack of permit limits for many nutrient parameters, and the likelihood that WWTFs may be appreciable nutrient loading sources in effluent dominated streams.

Sanitary Sewer Overflows

Unlike treated WWTF effluent, SSOs represent a high, if episodic risk, because they can have concentrations of bacteria several orders of magnitude higher than treated effluent. Untreated sewage can contain large volumes of raw fecal matter, making its significant health risk where SSOs are sizeable and/or chronic issues. The causes of SSOs vary from human error to infiltration of rainwater into sewer pipes.

This study considered five years of TCEQ SSO violation data for 2011/2012 through 2016 (2017 data was not yet available). 466 records from 94 plants were considered for the watershed area. The updated analyses looked at a three-year period of data between 2016-2018, which includes 184 records representing 67 plants. Table 32 indicates the number of SSOs in each year for each segment.

Table 32 - SSOs by segment and year (2012-2018)

Number	Total	2011	2012	2013	2014	2015	2016[28]	2017	2018
1004	78	8	6	14	20	20	27	10	5
1008	118	30	14	14	21	28	23	18	9
1009	240	48	39	31	22	38	38	35	12
1015	30	3	4	7	4	4	6	1	0
Total	466	89	63	66	67	90	94	64	26

Number of SSOs overall for the project areas was fairly constant, with a slight increase at the end of the period. SSOs by segment were also generally constant over the period, except for segment 1004 which showed a marked increase through 2016, but then a significant decrease in 2017 and 2018. 2018 data generally represented a decrease in number, although records only reflect those received through November by the TCEQ.

Comparing the number of SSOs by segment requires a consideration of the proportional number of plants in each segment (i.e. all things being equal, segments with more plants should have proportionally more SSOs) Table 33 indicates the number of plants reporting SSO by segment to the proportion of both plants in that segment, and the total number of SSOs reported.

[28] The numbers for 2016, present in the original analyses, have been updated to reflect the full 2016 year of data in the updated analyses.

Table 33 - Proportional relationship of total plants, reporting plants, and total SSOs (2012-2017)

Segment	% of total WWTFs	% plants reporting SSOs	% of total SSOs
1004	15%	15%	30%
1008	31%	23%	20%
1009	51%	58%	45%
1015	3%	4%	4%

In general, the number of plants reporting SSOs by segment was proportional to the number of plants in the segment overall. Segment 1008 was slightly underrepresented, and segment 1009 was slightly overrepresented. However, the number of total SSOs by segment was far less proportional to the number of plants per segment or the number of plants reporting SSOs. In this case, segments 1008, 1009 were underrepresented in the SSO count, and segment 1004 had almost double the number of SSOs proportionate to its plant count. This suggests that segment 1004 has a greater number of SSOs per plant, while segment 1008 has a relatively smaller number of plants reporting relatively fewer SSOs. Segment 1009 had a disproportionately higher number of plants which reported a less disproportionately fewer number of SSOs.

While the number of SSOs indicates the frequency with which sewage systems have events, and thus the chronicity of the load from those plants, the volume of SSOs indicates the extent of the impact they have (i.e. a small plant with 100 small SSOs may produce a more chronic, but smaller discharge than a large plant with a single SSO of a much larger volume). Table 34 indicates the volume of SSOs by segment, by year.

Table 34 - SSO volume by segment and year, in gallons

Volume	Total	2011	2012	2013	2014	2015	2016[29]	2017	2018
1004	1,463,528	17,994	68,024	23,355	208,315	915,725	247,095	67,093	64,921
1008	287,129	15,375	17,500	46,613	54,305	36,070	117,743	77,493	7,764
1009	1,042,241	247,430	83,280	203,251	92,349	127,587	213,452	184,458	7,911
1015	195,950	11,000	55,00	1,050	0	16,500	160,090	850	0
Total	2,988,848	291,799	174,304	274,269	354,969	1,095,882	799,190	329,894	80,597

The total volume by year varied greatly, representing the often-episodic nature of SSOs. Volume by year for each segment also varied greatly, and not always in relationship to other segments (e.g. in 2012 SSOs in segment 1008 went up sharply, and down sharply in segment 1009). This suggests that commonly experienced causes (precipitation levels, etc.) may not be a primary driver for SSOs.

As with number of SSOs, it is important to consider the proportional relationship between the relative size of plants (indicated by proportion of average flow[30]) in each segment to the volume of SSOs being reported, as shown in Table 35.

Table 35 - Comparison of plants, effluent volume, and SSO volume by segment (2012-2017)

Segment	% of total WWTFs	% of total effluent Volume	% of total SSO Volume
1004	15%	20%	49%
1008	31%	29%	10%
1009	51%	50%	35%
1015	3%	1%	6%

Segment 1004's WWTFs have a slightly higher volume per plant on average, but a significantly higher proportion of the SSO volume in both absolute ad relative terms. Conversely, Segments 1008 and 1009 have shares of the total effluent volume roughly proportion to their share of WWTFs, but their SSO volumes are appreciably smaller. Segment 1015 have a proportionally overrepresented share of SSO volume, but this comparison is not very meaningful given the relatively small number of plants and small

[29] The numbers for 2016, present in the original analyses, have been updated to reflect the full 2016 year of data in the updated analyses.

[30] For this analysis, the average of reported DMR flows was taken for each plant, and then summed by segment. Outliers were minor (less than 1%) and discarded if no clear explanation existed in their permit or data as to why their DMR data might be erroneous (e.g. a plant reporting 1000 MGD average without corresponding permit limit or other corroborating data). Outliers were primarily industrial, and not likely to have bacteria-heavy SSOs, so no appreciable skewing of the data is expected by this method.

average flows in this segment. In comparison of both numbers and volumes of SSOs, segment 1004 stands out as having numbers and volumes disproportionate to its WWTF compliment. While preliminary modeling indicates SSOs in general are not likely an appreciable chronic source of bacteria (and other products from the waste stream) but may be impactful on a local, episodic basis.

Cause is another important factor in characterizing SSOs. Steps to remediate problem areas are typically designed to meet the originating causes. Much of the watershed has relatively new infrastructure, outside of the Conroe area and some other selected older communities. SSO causes were broken into 10 categories to reflect the breakdown in the SSO database. It should be noted, however, that this categorization depends on the accuracy of the data reported by the utilities. Additionally, while a single cause is typically listed on the SSO report, many SSOs are caused by a combination of factors[31]. Table 36 shows the breakdown of cause by type, number, and segment.

Table 36 - SSO Cause by segment (2012-2017)

Cause by number and segment						
% of Total SSOs	Total SSOs	1004	1008	1009	1015	Causes
16.5	77	29	13	34	1	Blockage in Collection System Due to Fats/Grease
4.9	23	5	6	11	1	Unknown Cause
3.9	18	3	7	8	0	Power Failure
7.7	36	11	7	14	4	Collection System Structural Failure
20.2	94	31	20	41	2	Lift Station Failure
4.1	19	4	4	10	1	Human Error
16.7	78	22	19	31	6	Blockage in Collection System-Other Cause
11.4	53	7	12	33	1	WWTP Operation or Equipment Malfunction
3.9	18	7	3	7	1	Blockage Due to Roots/Rags/Debris
10.7	50	23	10	16	1	Rain / Inflow / Infiltration
100	**466**	**142**	**101**	**205**	**18**	**Total**

By number, there is no heavy focus on a specific cause overall. Blockages in general make up about a third of all the SSOs, but stem from different issues. Lift station failures make up about a fifth of all SSOs, but also likely involve multiple causative factors. As noted previously, however, volume of SSOs is as important a consideration as number. Table 37 shows the breakdown for volume, type, and segment.

[31] e.g., fats, oils, and grease collecting in lift station motors can cause overflows in high rain events when excess water is in a system. The event may be listed as lift station failure, but FOG and inflow and infiltration of rainwater were also causative elements.

Table 37 - SSO cause by volume and segment

Cause by volume and segment (in gallons)						
Causes	Total	% total	1004	1008	1009	1015
Blockage in Collection System Due to Fats/Grease	256,465	8.6	165,508	30,725	59,232	1,000
Unknown Cause	186,581	6.2	110	79,030	27,441	80,000
Power Failure	169,684	5.7	2,020	8,400	159,264	0
Collection System Structural Failure	173,935	5.8	77,240	18,375	77,320	1,000
Lift Station Failure	356,847	11.9	111,973	160,330	84,044	500
Human Error	65,473	2.2	22,500	31,198	8,775	3,000
Blockage in Collection System-Other Cause	209,656	7.0	33,811	129,225	44,270	2,350
WWTP Operation or Equipment Malfunction	275,541	9.2	13,135	87,550	174,706	150
Blockage Due to Roots/Rags/Debris	29,223	1.0	15,953	2,800	9,920	550
Rain / Inflow / Infiltration	1,265,523	42.3	1,066,861	65,650	53,012	80,000
Total	2,988,928	100.0	1,509,111	613,283	697,984	168,550

While the causes by volume comparison shows a mix of causes, inflow and infiltration (I&I) stands out as a primary share of the total volume. However, cause categories within each segment vary widely. 1004 is driven strongly by I&I, while the other segments are a greater mix of causes than the totals suggest.

Tables 38 and 39 reflects the breakdown of causes by number and volume within the updated analyses period.

Table 38 - Cause by number and segment (2015-2018)

Cause by number and segment						
Causes	Total	% total	1004	1008	1009	1015
Blockage in Collection System-Other Cause	13	7.1%	5	4	3	1
Unknown Cause	29	15.8%	4	8	16	1
Rain / Inflow / Infiltration	40	21.7%	15	10	14	1
Collection System Structural Failure	16	8.7%	2	2	10	2
Lift Station Failure	22	12.0%	10	6	6	0
Blockage in Collection System Due to Fats/Grease	14	7.6%	2	2	9	1
Blockage Due to Roots/Rags/Debris	6	3.3%	2	0	3	1
WWTP Operation or Equipment Malfunction	19	10.3%	0	6	13	0
Hurricane	14	7.6%	1	7	6	0
Power Failure	9	4.9%	1	4	4	0
Human Error	2	1.1%	0	1	1	0
Total	184	100.0%	42	50	85	7

Table 39 - Cause by volume and segment (2015-2018)

Cause by volume and segment (in gallons)						
Causes	Total	% total	1004	1008	1009	1015
Blockage in Collection System-Other Cause	12,469	1.0%	2,719	5,895	3,705	150
Unknown Cause	252,149	20.8%	54,710	85,050	32,389	80,000
Rain / Inflow / Infiltration	434,410	35.9%	232,097	10,501	111,812	80,000
Collection System Structural Failure	77,835	6.4%	8,920	1,100	67,615	200
Lift Station Failure	148,007	12.2%	77,183	65,250	5,574	0
Blockage in Collection System Fats/Grease	20,955	1.7%	2,030	215	17,860	850
Blockage Due to Roots/Rags/Debris	6,625	0.5%	900	0	5,175	550
WWTP Operation or Equipment Malfunction	24,340	2.0%	0	1,164	23,176	0
Hurricane	60,258	5.0%	400	58,428	1,430	0
Power Failure	151,736	12.5%	150	15,000	136,586	0
Human Error	20,898	1.7%	0	20,398	500	0
Total	1,209,682	100%	379,109	263,001	405,822	161,750

SSO Summary

SSOs are always a concern in watersheds with bacterial impairment and vulnerability to nutrient loading. Their concentrations of untreated human waste pose a disproportionately high risk to human health during recreation, and their episodic nature can make them an acute risk while they are ongoing. In terms of chronic loading, SSOs volumes in the project area are generally too small on an average basis to move conditions in the waterways in general. For comparison, a single plant of small to moderate size may have a discharge of 3 million gallons a day (MGD), while the sum total of all SSOs in the project area for a year is less than 3 million gallons. The SSOs are far greater in concentration, but their relatively minor volumes negate them to some degree as a primary source in average conditions.

However, given their pathogenic potential, inherently close proximity to urban populations, and the principle of focusing on those sources within our control, SSOs should remain as a consideration for BMPs in the watersheds. Segment 1004 is a particularly good candidate for focus on this issue given its relatively high rate and volume of SSOs. The relative relationship between number and volume of cause by segment remained similar in the updated analyses, with a mix of causes by number of SSOs, and rainwater infiltration showing up as the most common cause (though still representing only a third of the total) by volume.

4.0 Outcomes and Implications

The review of water quality data for the watersheds of the West Fork San Jacinto River provided a better understanding of the character of water quality issues in these systems and will inform subsequent stakeholder decisions. The primary questions answered were in regard to the sufficiency of the data, the extent and severity of water quality trends, seasonality of water quality issues, and the potential impact of wastewater effluent and SSOs.

In general, the review concluded that data was sufficient for all analyses, although additional 24-hour DO data would be valuable in future efforts.

As discussed in the individual analyses, the water quality issues facing these waterways are widespread in extent. Areas not currently impaired show some trends toward concerns and impairments in ambient data. Positive trends in some areas (nutrients, etc.) are balanced to some degree by negative trends in *E. coli.*

The updated analyses do not change the water quality picture a great deal, with mixed changes in trending parameters. While *E. coli* levels were moving positively in Spring and Cypress Creeks, their lack of improvement in the West Fork and Lake Creek was a step backwards from the previous analyses.

Permitted wastewater effluent was generally of good quality and unlikely to be a water quality issue except in limited scales and timeframes. The exception to this is the likelihood that nutrients without permit limits are source loads from plants, especially in effluent-dominated streams. While some segments (i.e. 1004) have disproportionately higher incidence of SSOs, they were present in all segments (though of a relatively small expected impact to average daily loadings.) There were few statistically significant relationships between exceedance of water quality standards and WWTF permit limits, or incidences of SSOs, and seasonal change other than expected relationships evident in DO levels in ambient conditions. In the updated analyses, there were fewer SSOs in the latter years (although 2018 data may not be complete), but they remain an issue, and the relative relationship between segments and rates of SSO occurrence remains similar.

Overall, water quality in these watersheds faces many challenges, but is within the range which may be successfully addressed through best management practices under a watershed-based plan. With continued growth of the Houston region pushing north and west into these watersheds, the implication for future water quality is likely negative without intervention. Subsequent efforts should be made to identify causes and sources of the primary constituent of concern (indicator bacteria), and to characterize nutrient sources further to identify areas within the project watersheds most vulnerable to pollutant loadings and/or best suited for BMP siting.

Appendix A – Monitoring Site Data Summary

Table A1 indicates the segment/tributary name, number of monitoring events, rang of monitoring data in the 2012-2017 period for the ambient monitoring stations reviewed for this data evaluation. Table A2 represents the 2016-2018 updated analyses period.

Table A1 - Monitoring site data summary (2012-2017)

Station	Segment	Segment Name	Sampling Events	Earliest Event	Latest Event
11243	1004	West Fork San Jacinto River	32	3/16/2011	7/20/2016
11250	1004	West Fork San Jacinto River	32	1/12/2011	1/11/2017
11251	1004	West Fork San Jacinto River	34	1/20/2011	7/20/2016
16635	1004D	Crystal Creek	32	1/20/2011	7/20/2016
16626	1004E	Stewarts Creek	33	1/20/2011	7/20/2016
20731	1004J	White Oak Creek	14	2/7/2013	5/18/2016
11312	1008	Spring Creek	52	1/13/2011	8/24/2016
11313	1008	Spring Creek	33	1/20/2011	7/20/2016
11314	1008	Spring Creek	48	1/13/2011	8/24/2016
11323	1008	Spring Creek	52	1/13/2011	8/24/2016
17489	1008	Spring Creek	52	1/13/2011	8/24/2016
18868	1008	Spring Creek	22	3/30/2011	5/17/2016
20461	1008A	Mill Creek	35	3/30/2011	5/17/2016
16629	1008B	Upper Panther Branch	66	1/25/2011	8/10/2016
16630	1008B	Upper Panther Branch	68	1/25/2011	8/10/2016
16422	1008C	Panther Branch	23	10/15/2014	8/10/2016
16627	1008C	Panther Branch	68	1/25/2011	8/10/2016
16631	1008E	Bear Branch	68	1/25/2011	8/10/2016
16481	1008F	Lake Woodlands	63	1/25/2011	8/10/2016
16482	1008F	Lake Woodlands	63	1/25/2011	8/10/2016
16483	1008F	Lake Woodlands	64	1/25/2011	8/10/2016
16484	1008F	Lake Woodlands	63	1/25/2011	8/10/2016
11185	1008H	Willow Creek	52	1/13/2011	8/24/2016
20730	1008H	Willow Creek	52	1/13/2011	8/24/2016
20462	1008I	Walnut Creek	21	3/30/2011	5/17/2016
20463	1008J	Brushy Creek	24	3/30/2011	6/22/2016
11324	1009	Cypress Creek	25	3/10/2011	3/14/2017

Station	Segment	Segment Name	Sampling Events	Earliest Event	Latest Event
11328	1009	Cypress Creek	33	1/20/2011	7/20/2016
11330	1009	Cypress Creek	52	1/13/2011	8/22/2016
11331	1009	Cypress Creek	52	1/13/2011	8/22/2016
11332	1009	Cypress Creek	54	1/13/2011	8/22/2016
11333	1009	Cypress Creek	52	1/13/2011	8/22/2016
20457	1009	Cypress Creek	19	3/24/2011	5/16/2016
17496	1009C	Faulkey Gully	52	1/13/2011	8/22/2016
17481	1009D	Spring Gully	51	1/13/2011	8/22/2016
14159	1009E	Little Cypress Creek	51	1/13/2011	8/22/2016
20456	1009E	Little Cypress Creek	22	3/30/2011	5/16/2016
11367	1015	Lake Creek	25	3/31/2011	5/18/2016
18191	1015	Lake Creek	22	3/31/2011	5/17/2016
17937	1015A	Mound Creek	20	3/31/2011	5/18/2016

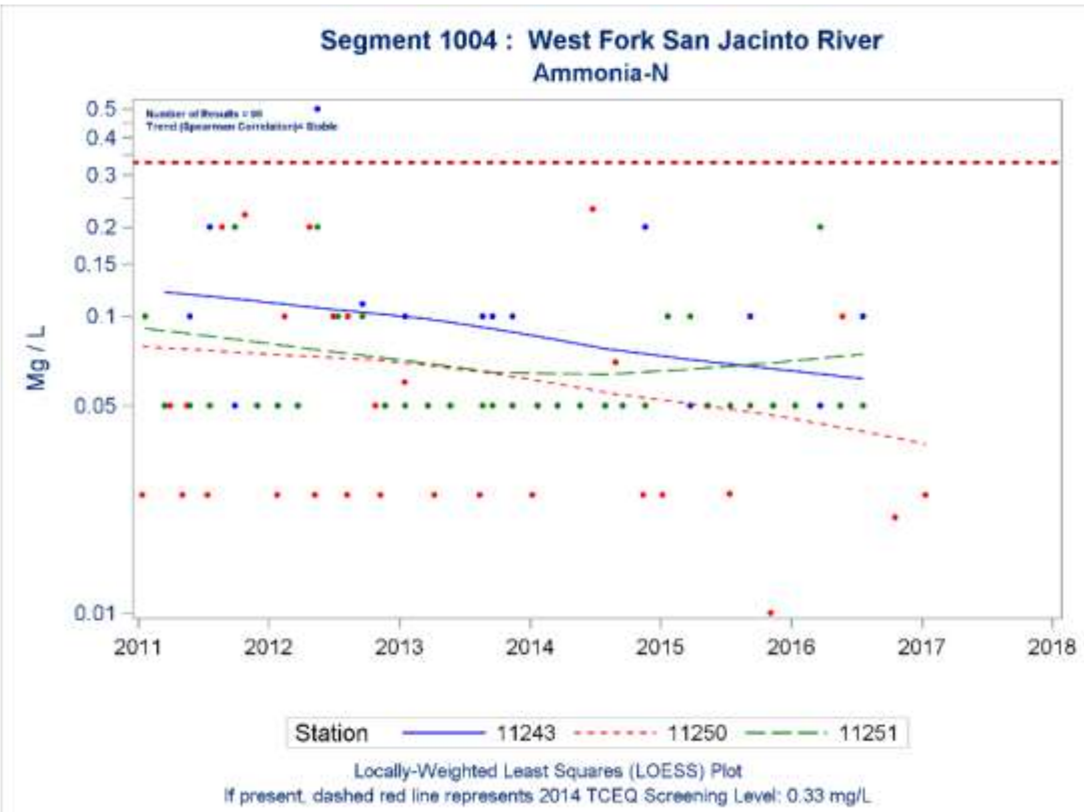
Table A2 - Monitoring site data summary (2015-2018)

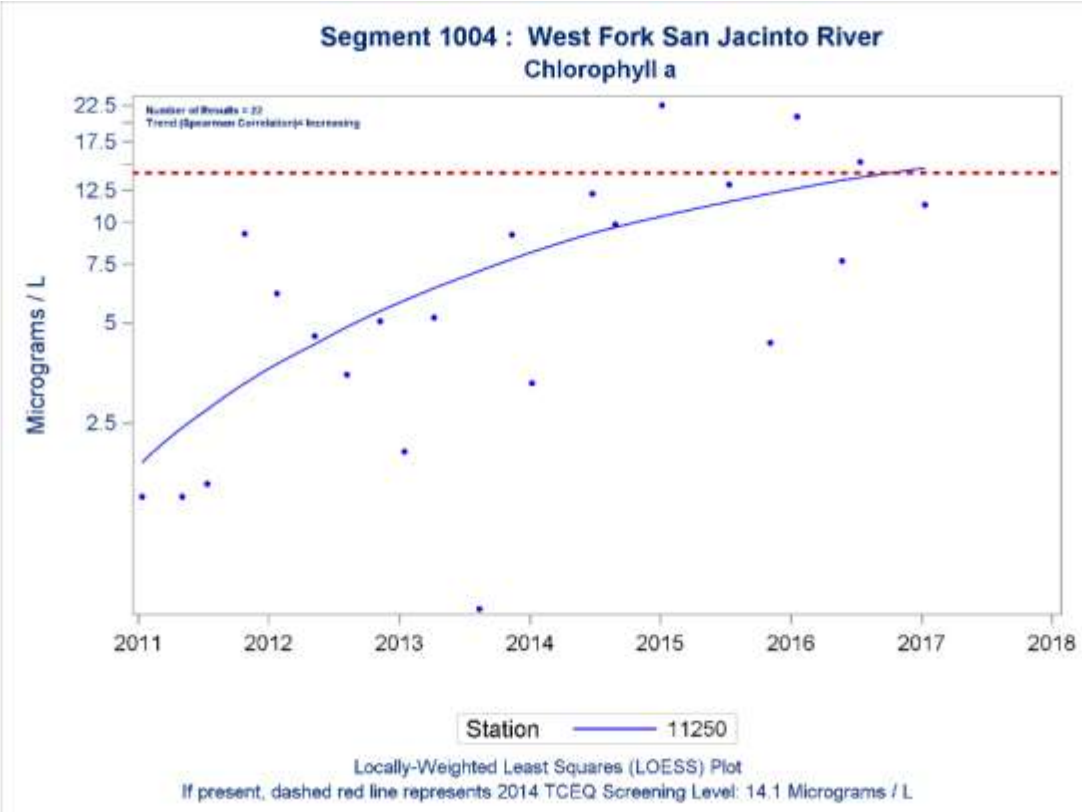
Segment	Station	Sampling Events	Earliest Event	Latest Event
1004	11243	17	07/15/2015	05/16/2018
1004	11250	11	07/13/2015	05/03/2018
1004	11251	17	07/15/2015	05/16/2018
1004D	11181	4	12/20/2017	05/16/2018
1004D	16635	13	07/15/2015	07/12/2017
1004E	16626	17	07/15/2015	05/16/2018
1004J	20731	11	08/05/2015	03/13/2018
1008	11312	27	06/29/2015	04/16/2018
1008	11313	16	07/15/2015	05/16/2018
1008	11314	27	06/29/2015	04/16/2018
1008	11315	18	08/18/2015	06/09/2017
1008	11323	30	06/29/2015	04/16/2018
1008	17489	27	06/29/2015	04/16/2018
1008	18868	16	08/12/2015	05/22/2018
1008A	20461	9	08/11/2015	10/04/2016

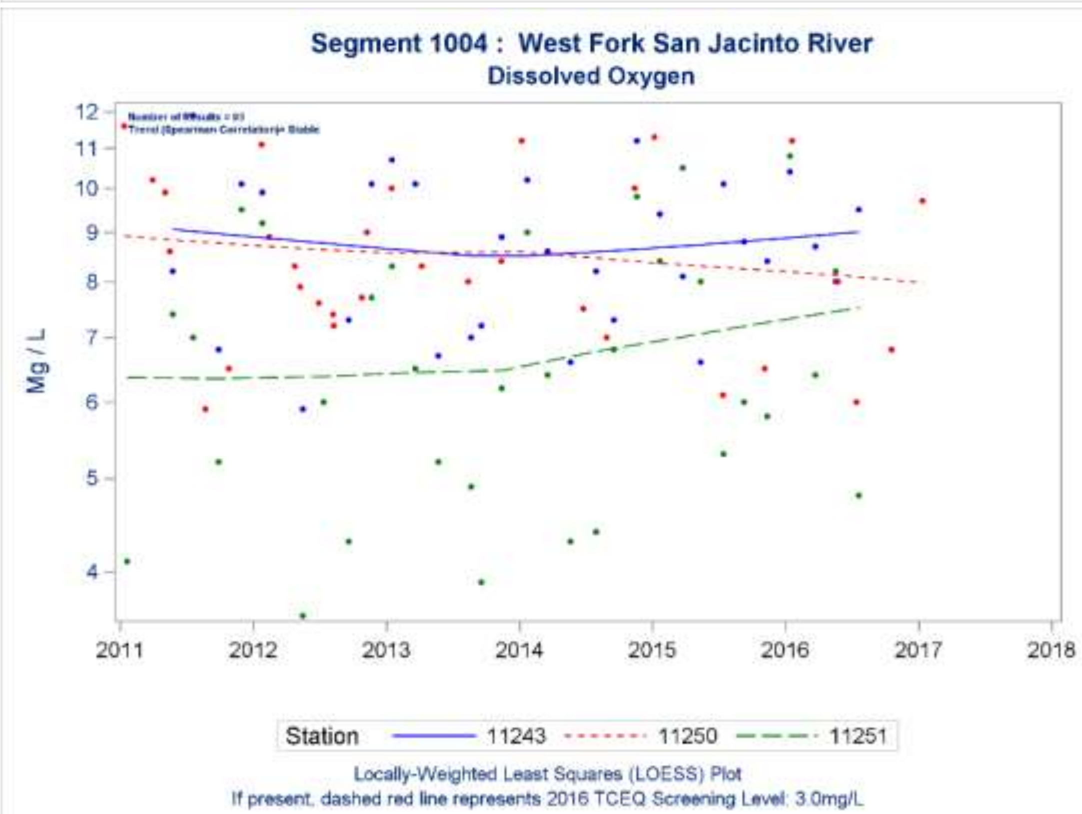
Segment	Station	Sampling Events	Earliest Event	Latest Event
1008A	21957	7	03/14/2017	03/15/2018
1008B	16629	22	06/10/2015	09/13/2017
1008B	16630	22	06/10/2015	09/13/2017
1008C	16422	22	06/10/2015	09/13/2017
1008C	16627	22	06/10/2015	09/13/2017
1008E	16631	22	06/10/2015	09/13/2017
1008F	16481	22	06/10/2015	09/13/2017
1008F	16482	22	06/10/2015	09/13/2017
1008F	16483	22	06/10/2015	09/13/2017
1008F	16484	22	06/10/2015	09/13/2017
1008H	11185	27	06/29/2015	04/16/2018
1008H	20730	27	06/29/2015	04/16/2018
1008I	20462	17	08/11/2015	03/15/2018
1008J	20463	18	08/12/2015	03/14/2018
1009	11324	11	06/09/2015	04/05/2018
1009	11328	16	07/15/2015	05/16/2018
1009	11330	27	06/23/2015	04/26/2018
1009	11331	27	06/23/2015	04/26/2018
1009	11332	27	06/23/2015	04/26/2018
1009	11333	27	06/23/2015	04/26/2018
1009	20457	11	10/06/2015	05/24/2018
1009C	17496	27	06/23/2015	04/26/2018
1009D	17481	26	06/23/2015	04/26/2018
1009E	14159	27	06/23/2015	04/26/2018
1009E	20456	12	08/12/2015	05/22/2018
1015	11367	18	08/11/2015	03/13/2018
1015	18191	17	08/11/2015	03/15/2018
1015A	17936	1	09/30/2015	09/30/2015
1015A	17937	11	09/29/2015	03/07/2018

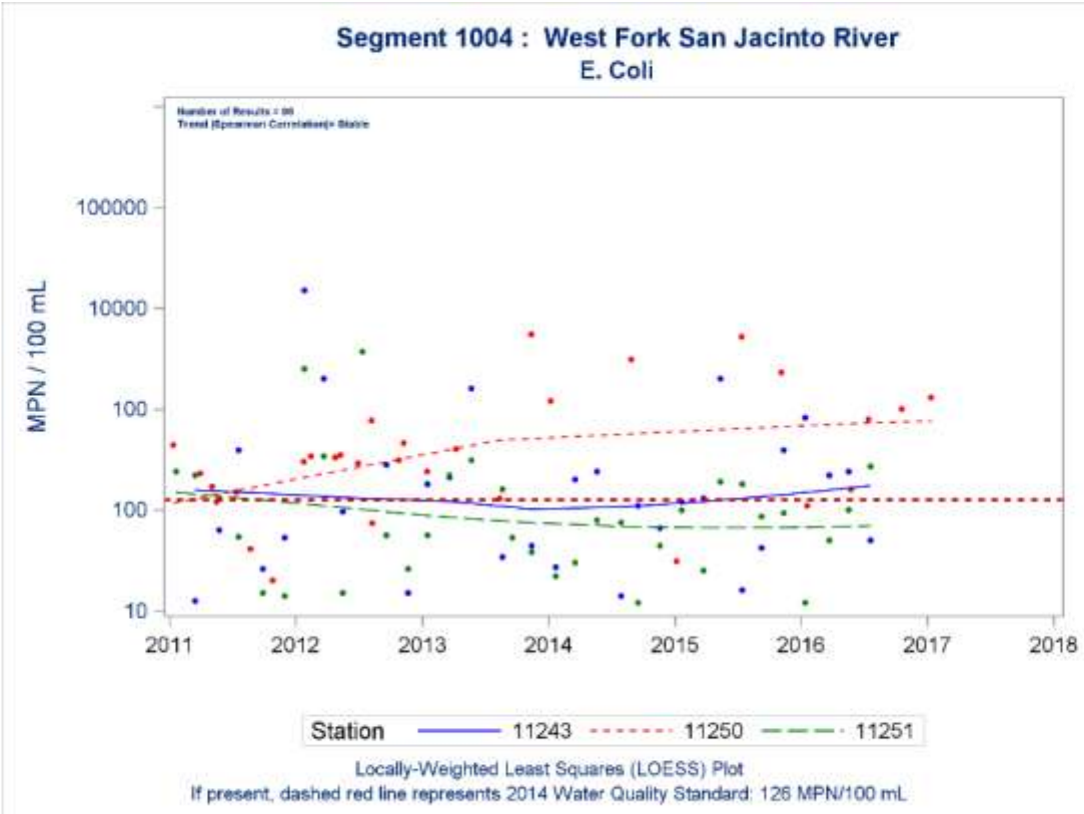
Appendix B – Water Quality Graphs (original analyses, 2012-2017)

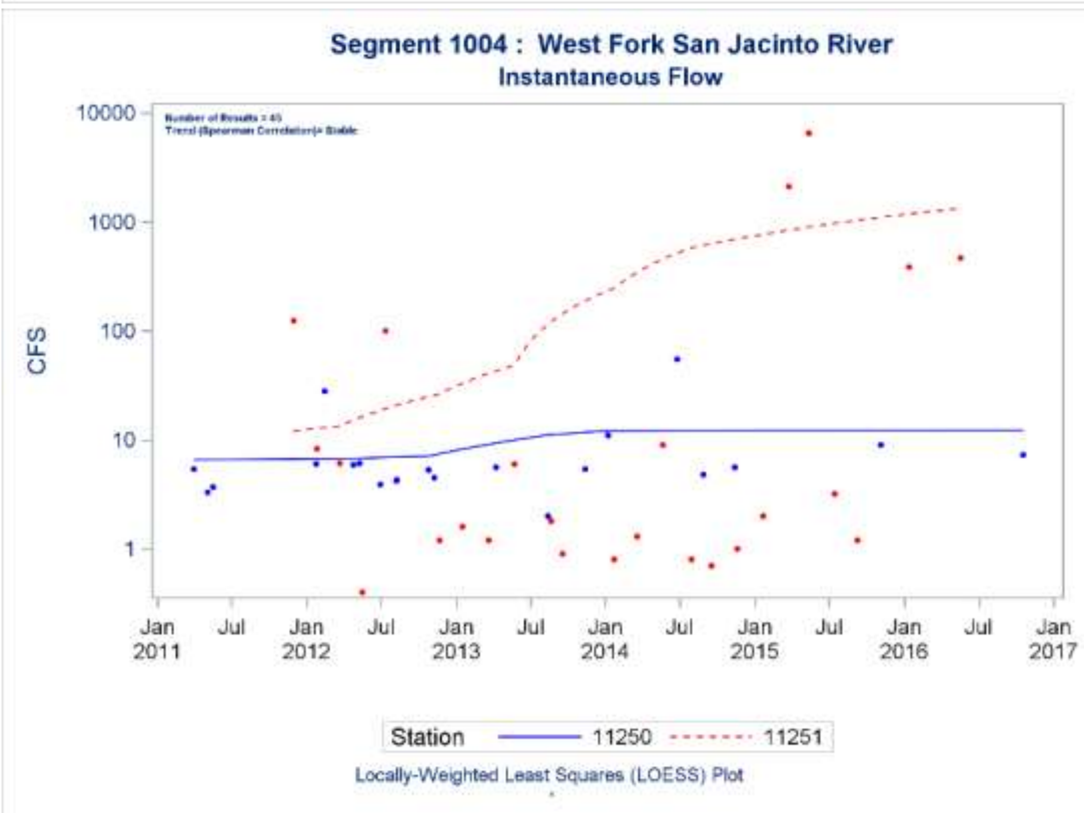
The graphs in this Appendix represent the detailed analysis of water quality by contituent for each segment and unclassified tributary. Graphs of data from the updated analyses do not cover a period of time significant enough to show long term trends in graph form, but are a available in digital form on request.

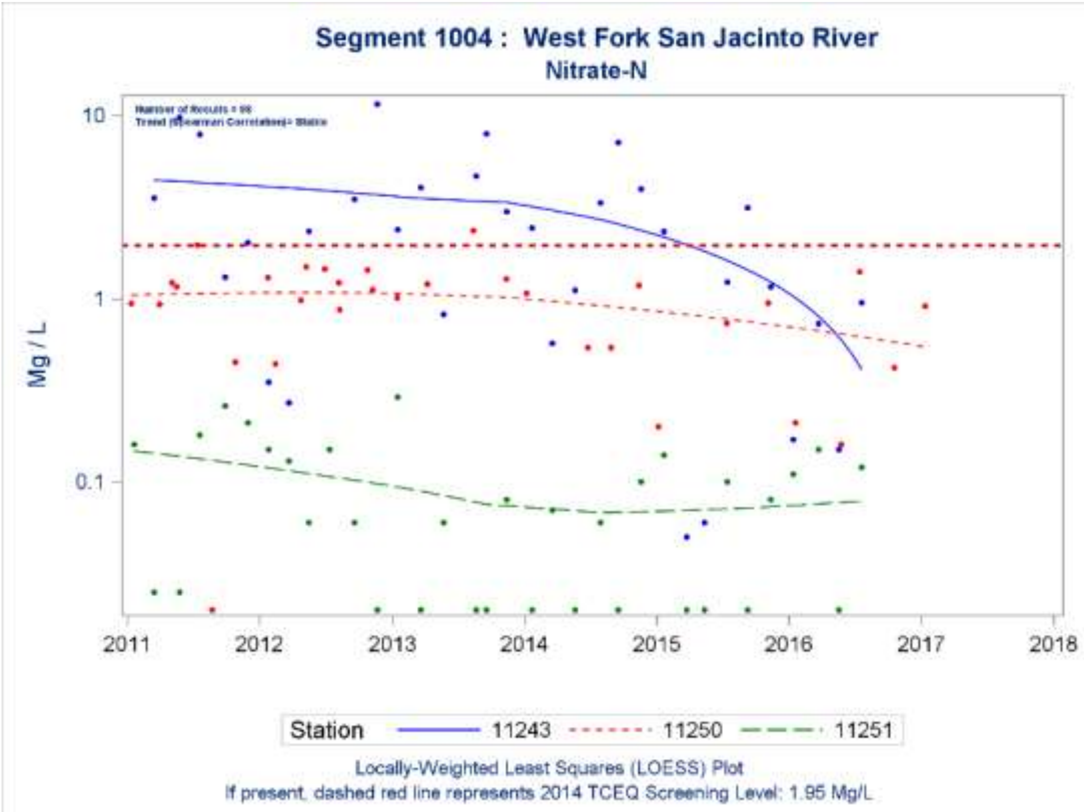


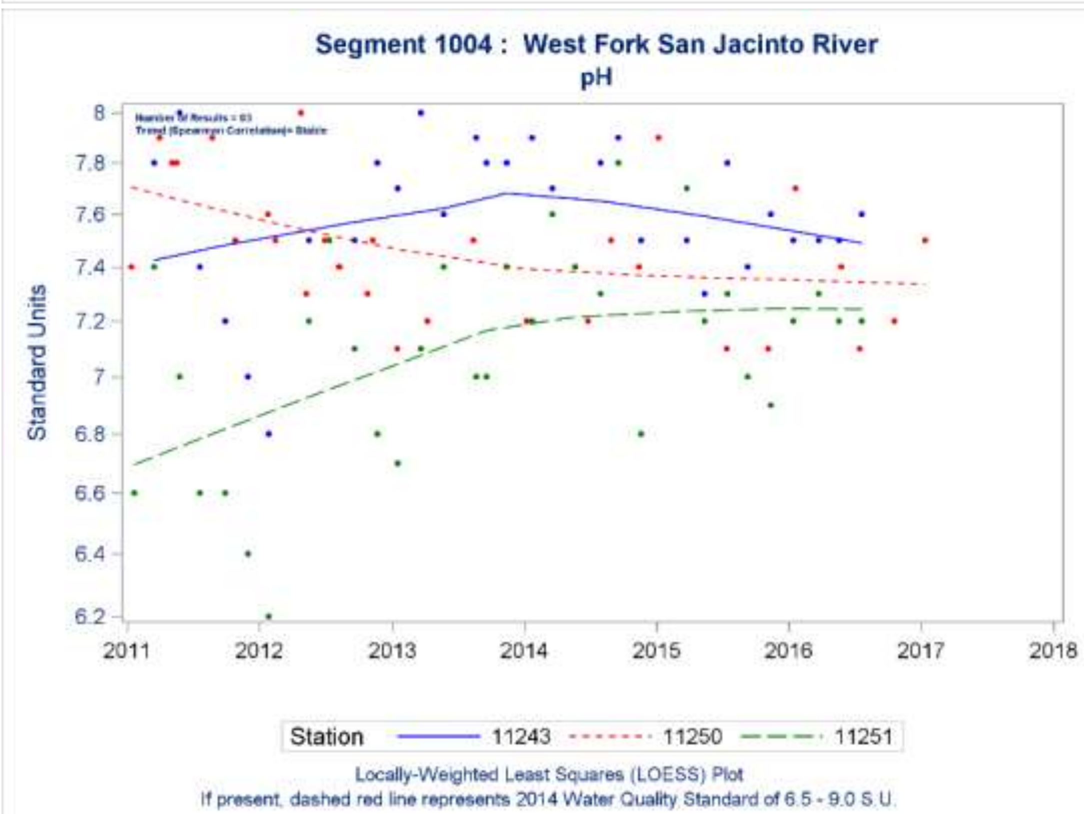

Segment 1004 : West Fork San Jacinto River
Chlorophyll a
Trend (Spearman Correlation)= Increasing
Micrograms / L
22.5
17.5
12.5
10
7.5
5
2.5
2011
2012
2013
2014
2015
2016
2017
2018
Station
11250
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 14.1 Micrograms / L

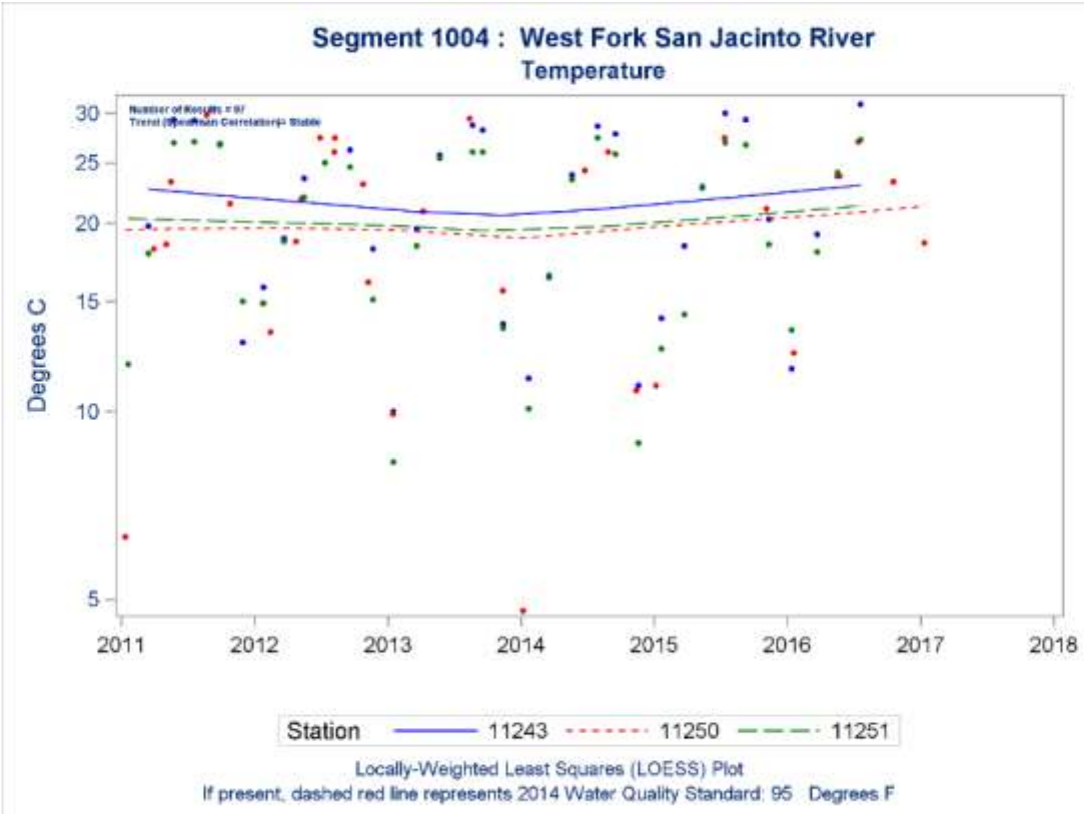

Segment 1004 : West Fork San Jacinto River
Dissolved Oxygen
Trend (Spearman Correlation)= Stable
Mg / L
12
11
10
9
8
7
6
5
4
2011
2012
2013
2014
2015
2016
2017
2018
Station
11243
11250
11251
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2016 TCEQ Screening Level: 3.0mg/L

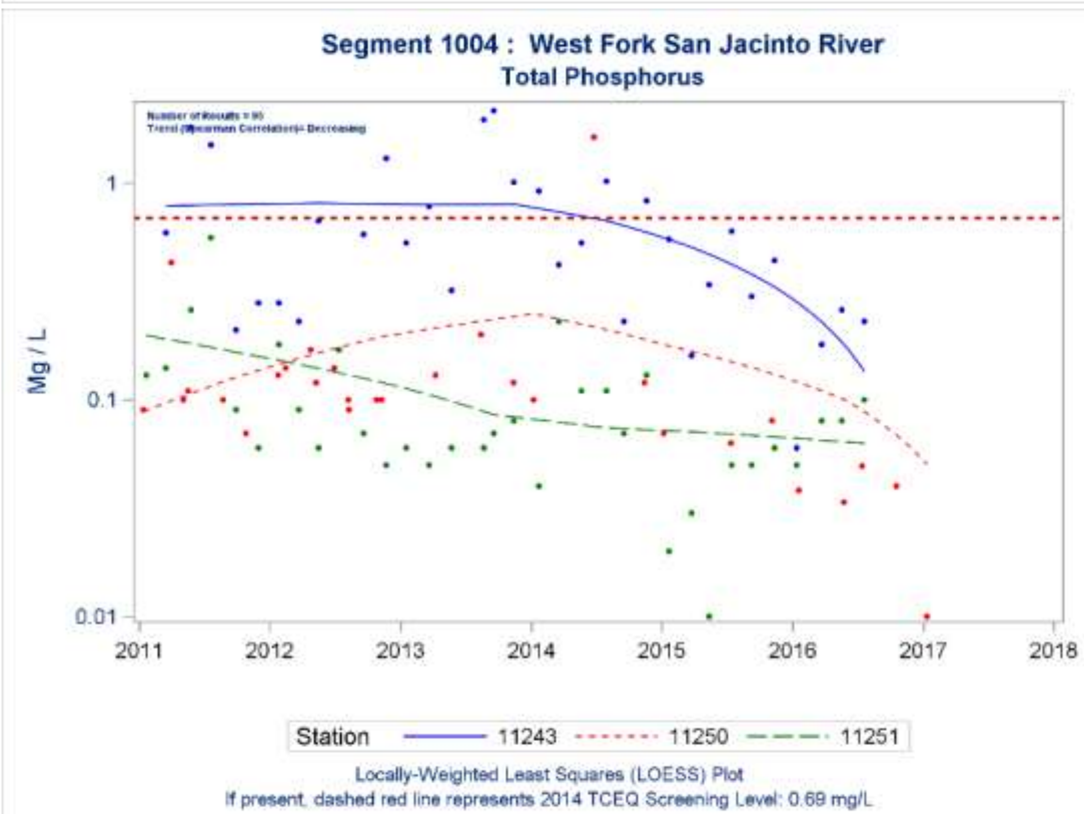

Segment 1004 : West Fork San Jacinto River
E. Coli
Trend (Spearman Correlation)= Stable
MPN / 100 mL
100000
10000
100
100
10
2011
2012
2013
2014
2015
2016
2017
2018
Station
11243
11250
11251
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 126 MPN/100 mL

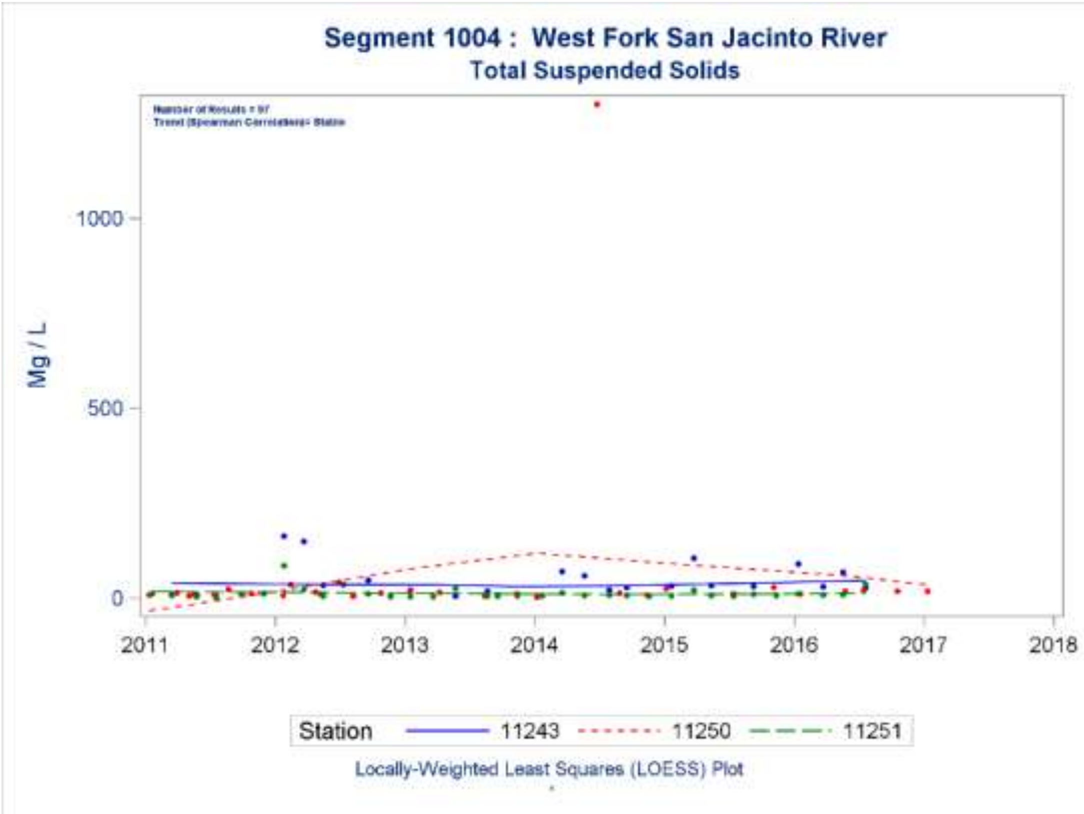

Segment 1004 : West Fork San Jacinto River
Instantaneous Flow
Trend (Spearman Correlation)= Stable
CFS
10000
1000
100
10
1
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
11250
11251
Locally-Weighted Least Squares (LOESS) Plot


Segment 1004 : West Fork San Jacinto River
Nitrate-N
Mg / L
10
1
0.1
2011
2012
2013
2014
2015
2016
2017
2018
Station
11243
11250
11251
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 1.95 Mg/L

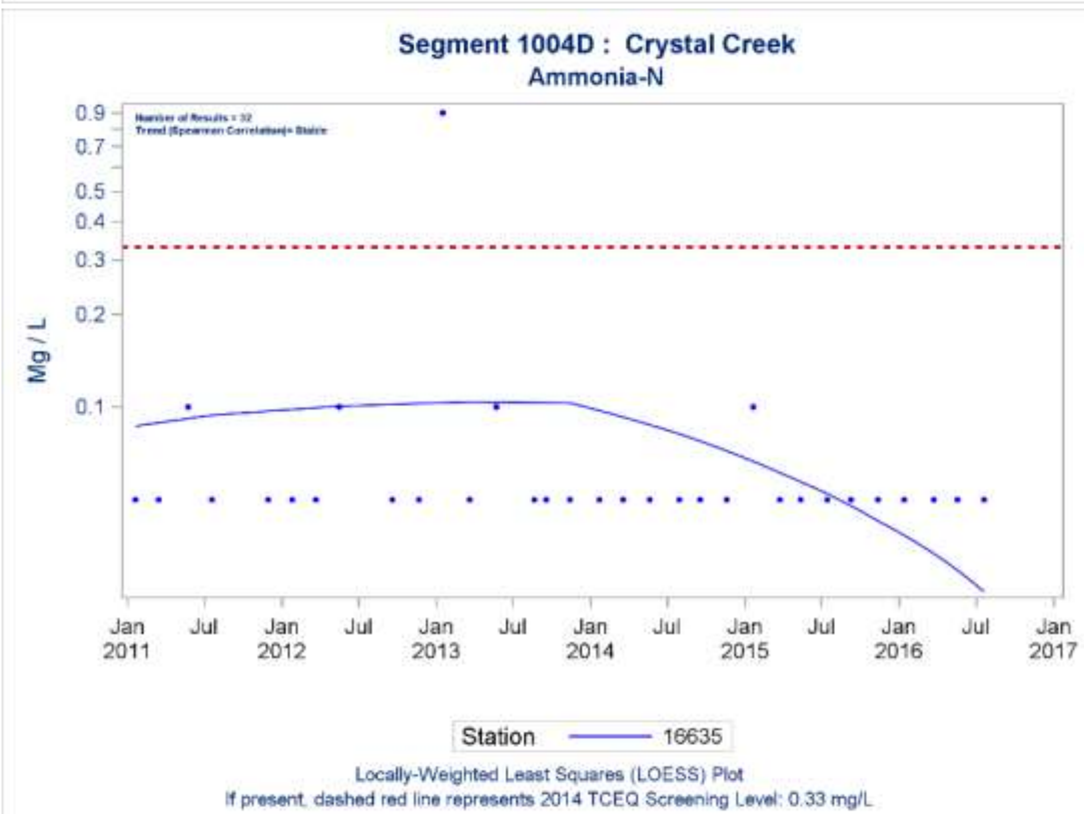

Segment 1004 : West Fork San Jacinto River
pH
Standard Units
8
7.8
7.6
7.4
7.2
7
6.8
6.6
6.4
6.2
2011
2012
2013
2014
2015
2016
2017
2018
Station
11243
11250
11251
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard of 6.5 - 9.0 S.U.


Segment 1004 : West Fork San Jacinto River
Temperature
Degrees C
30
25
20
15
10
5
2011
2012
2013
2014
2015
2016
2017
2018
Station
11243
11250
11251
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 95 Degrees F

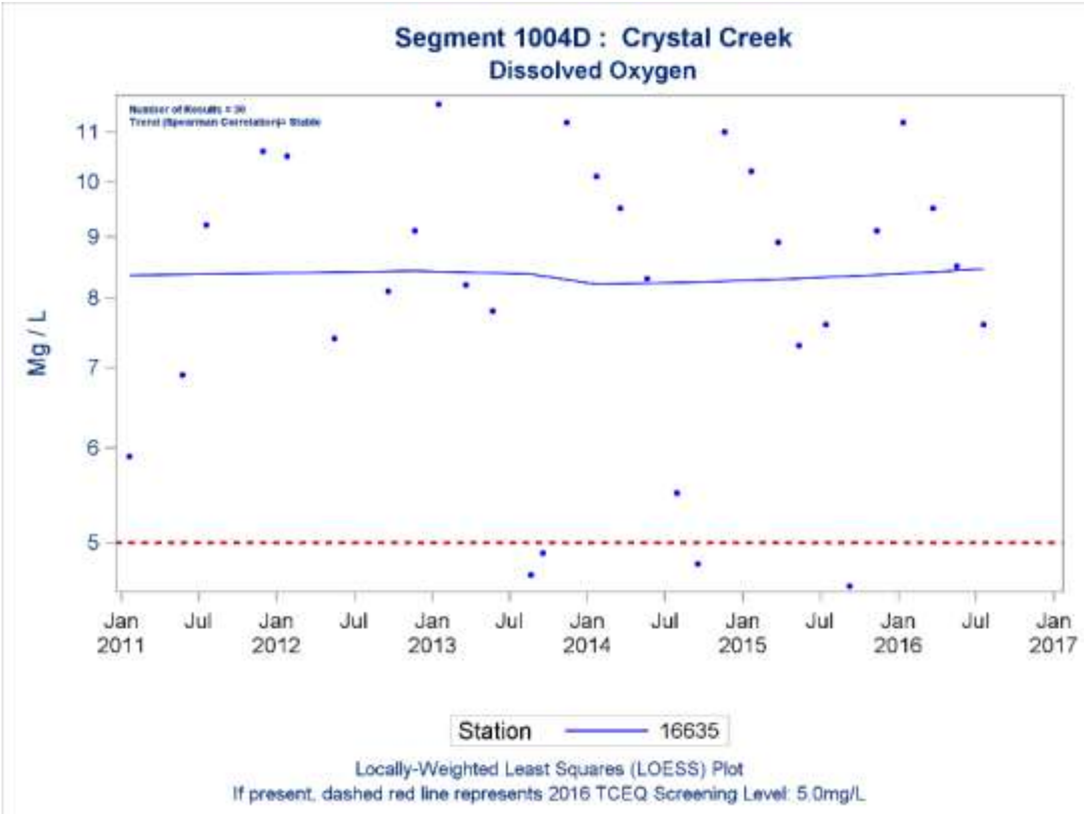

Segment 1004 : West Fork San Jacinto River
Total Phosphorus
Mg / L
1
0.1
0.01
2011
2012
2013
2014
2015
2016
2017
2018
Station
11243
11250
11251
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.69 mg/L

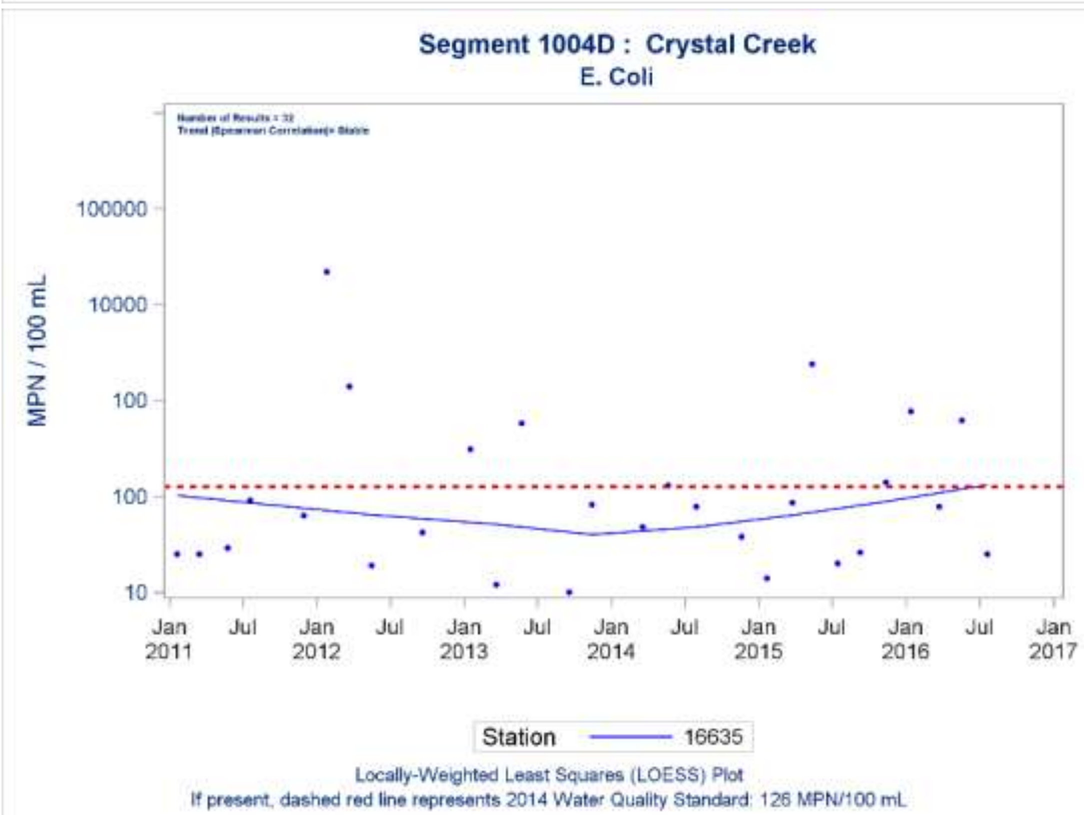


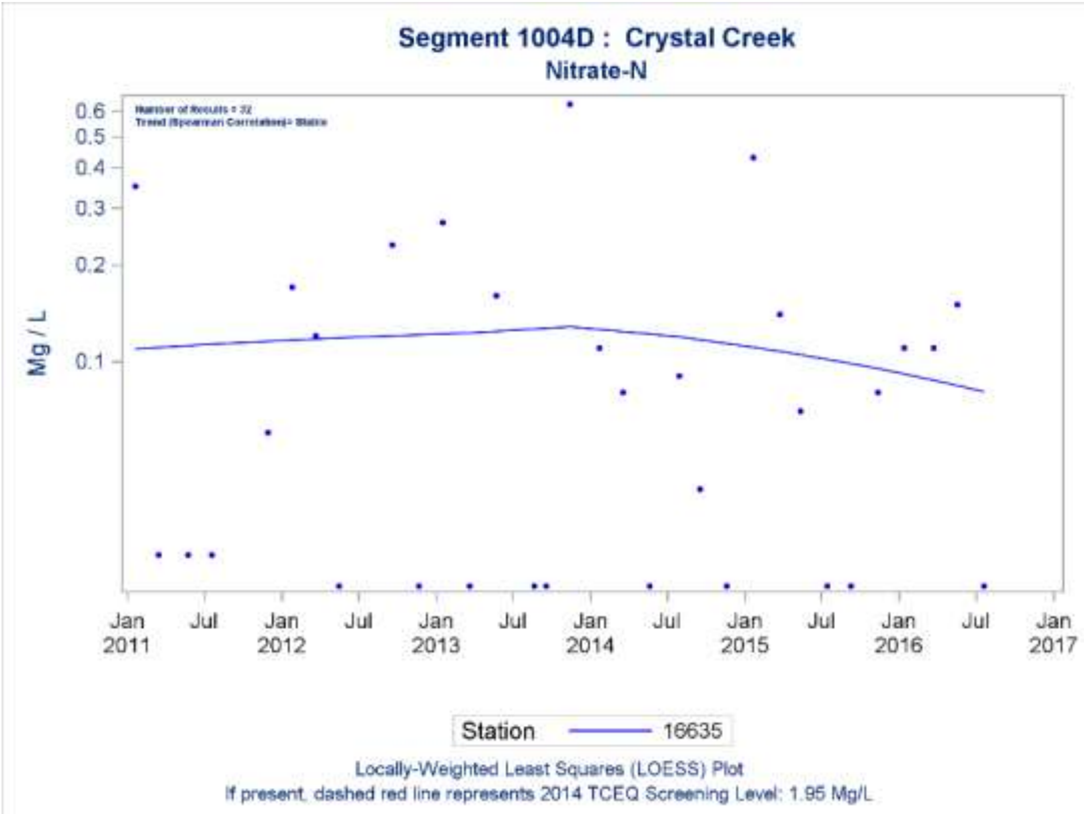
Segment 1004 : West Fork San Jacinto River
Total Suspended Solids
Mg / L
1000
500
0
2011
2012
2013
2014
2015
2016
2017
2018
Station
11243
11250
11251
Locally-Weighted Least Squares (LOESS) Plot

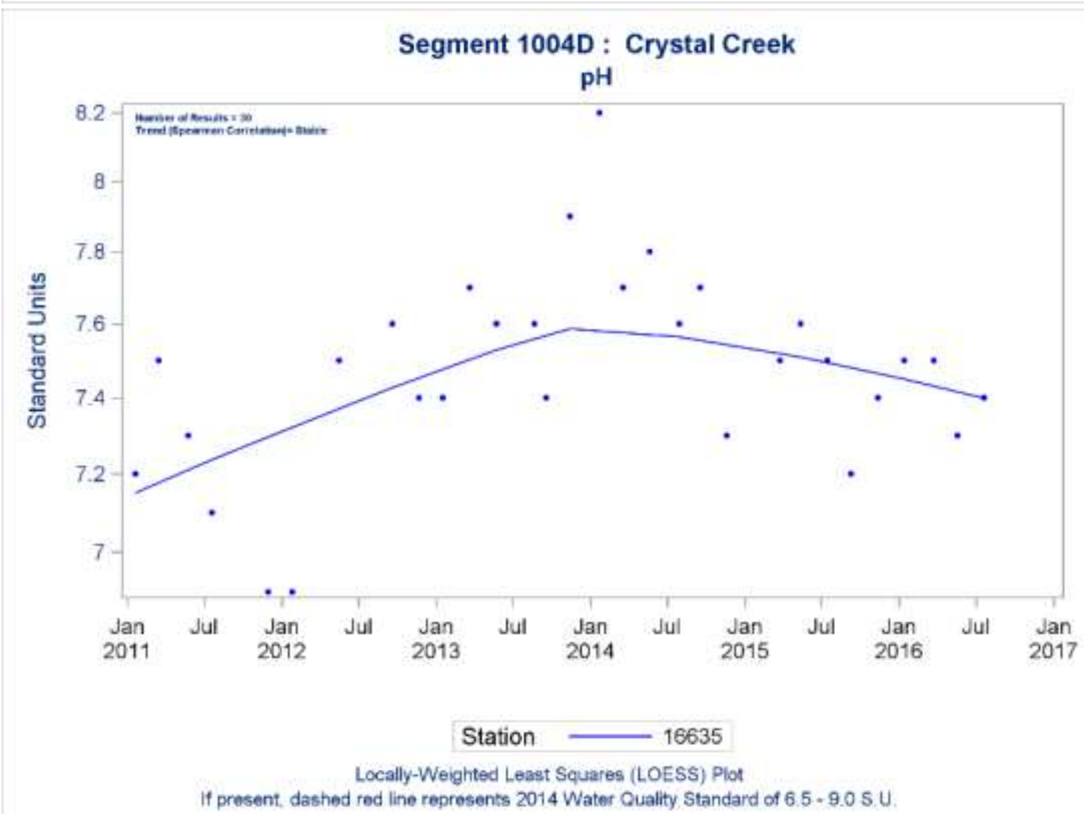


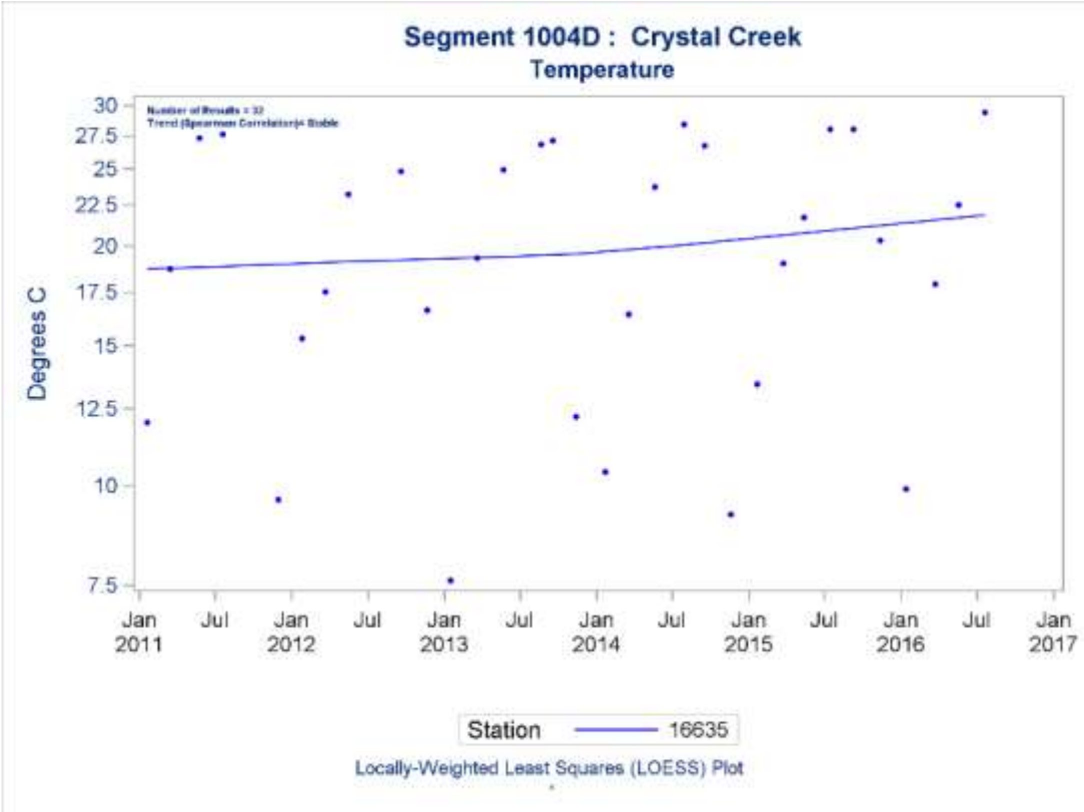
Segment 1004D : Crystal Creek
Ammonia-N
Mg / L
0.9
0.7
0.5
0.4
0.3
0.2
0.1
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16635
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.33 mg/L

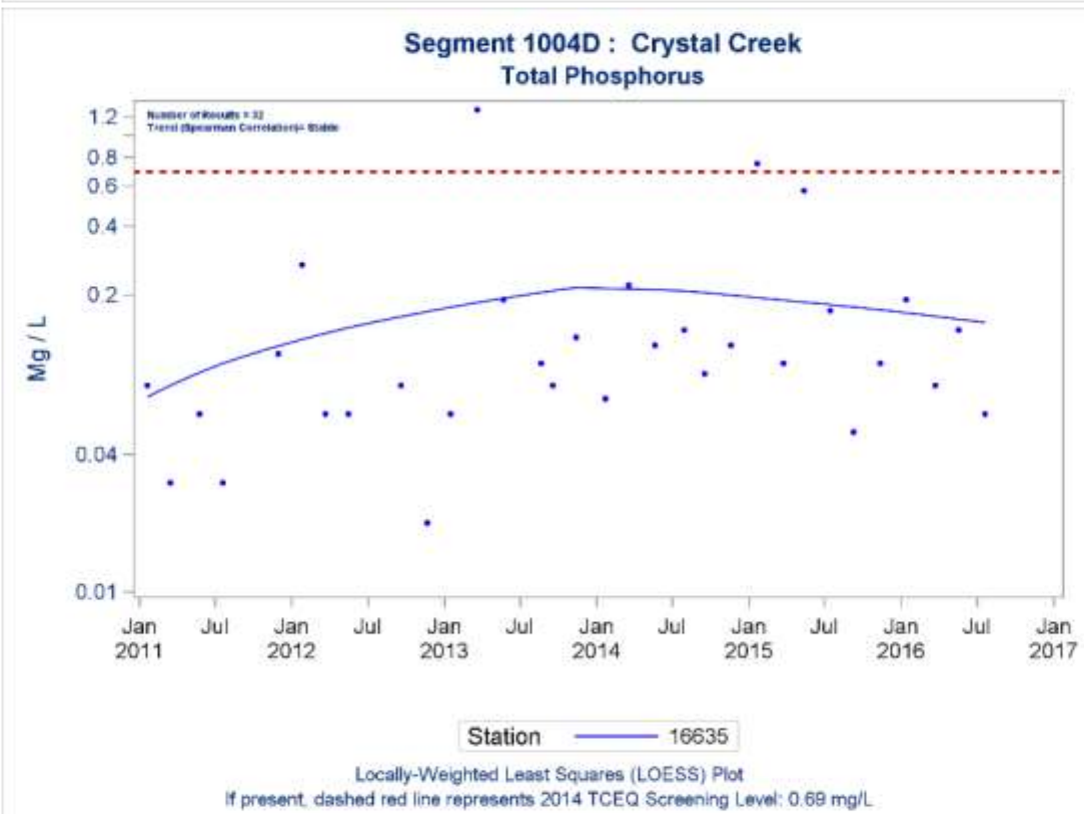

Segment 1004D : Crystal Creek
Dissolved Oxygen
Mg / L
11
10
9
8
7
6
5
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16635
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2016 TCEQ Screening Level: 5.0mg/L

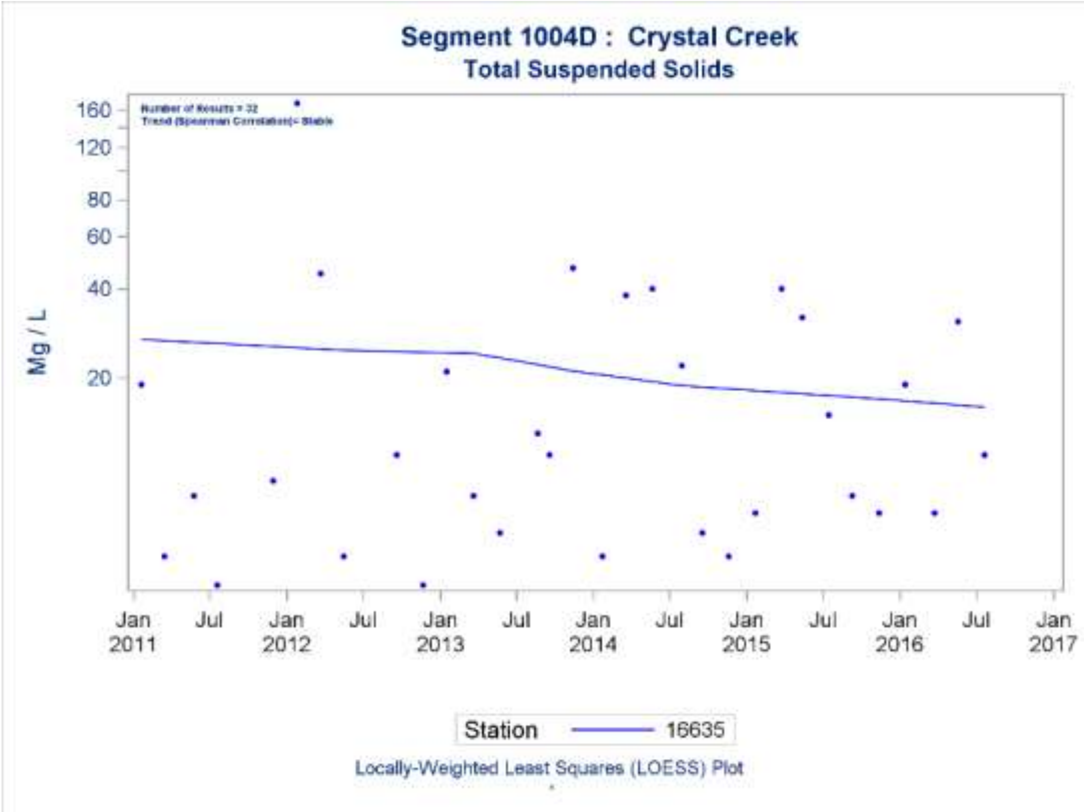

Segment 1004D : Crystal Creek
E. Coli
MPN / 100 mL
100000
10000
100
100
10
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16635
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 126 MPN/100 mL


Segment 1004D : Crystal Creek
Nitrate-N
Mg / L
0.6
0.5
0.4
0.3
0.2
0.1
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16635
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 1.95 Mg/L

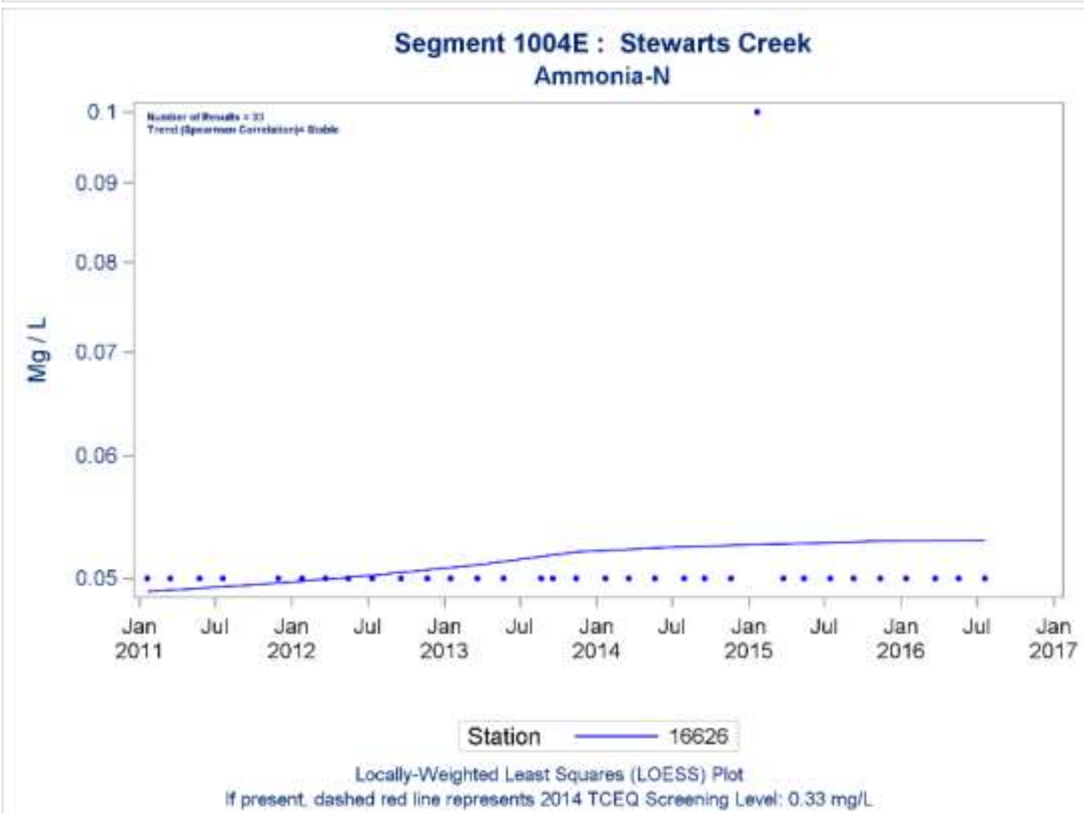

Segment 1004D : Crystal Creek
pH
Standard Units
8.2
8
7.8
7.6
7.4
7.2
7
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16635
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard of 6.5 - 9.0 S.U.


Segment 1004D : Crystal Creek
Temperature
Degrees C
30
27.5
25
22.5
20
17.5
15
12.5
10
7.5
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station 16635
Locally-Weighted Least Squares (LOESS) Plot

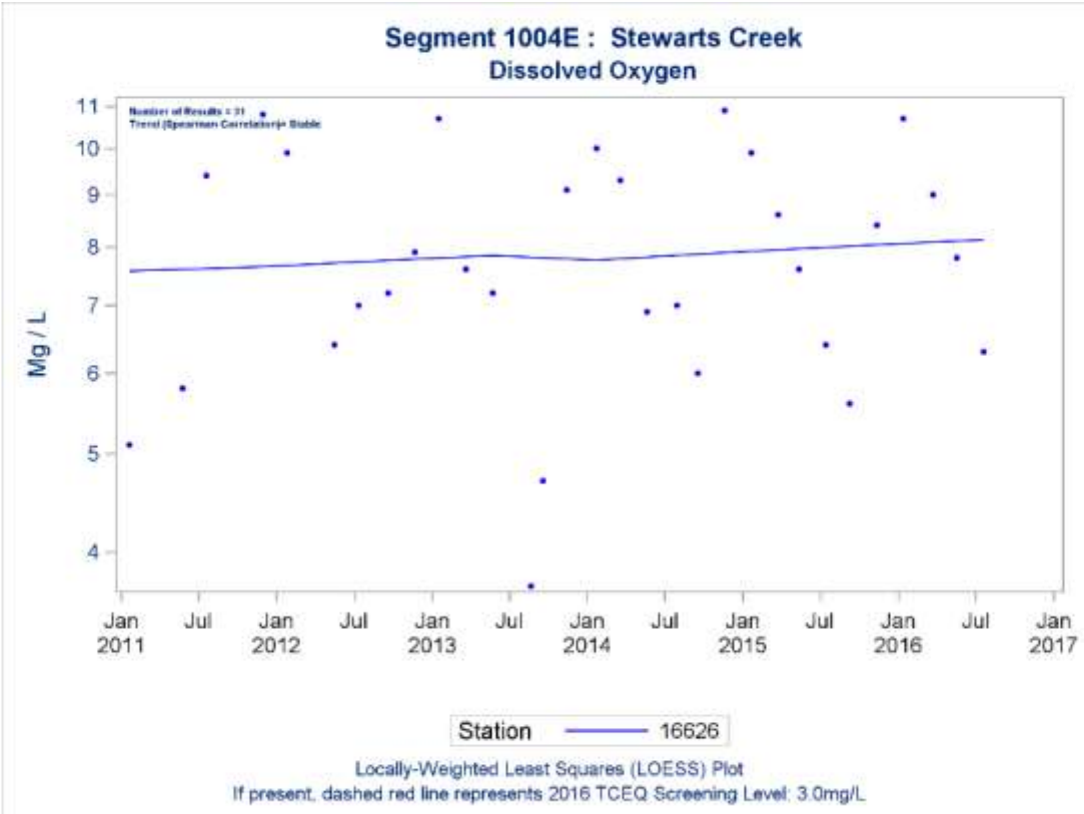

Segment 1004D : Crystal Creek
Total Phosphorus
Mg / L
1.2
0.8
0.6
0.4
0.2
0.04
0.01
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station 16635
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.69 mg/L

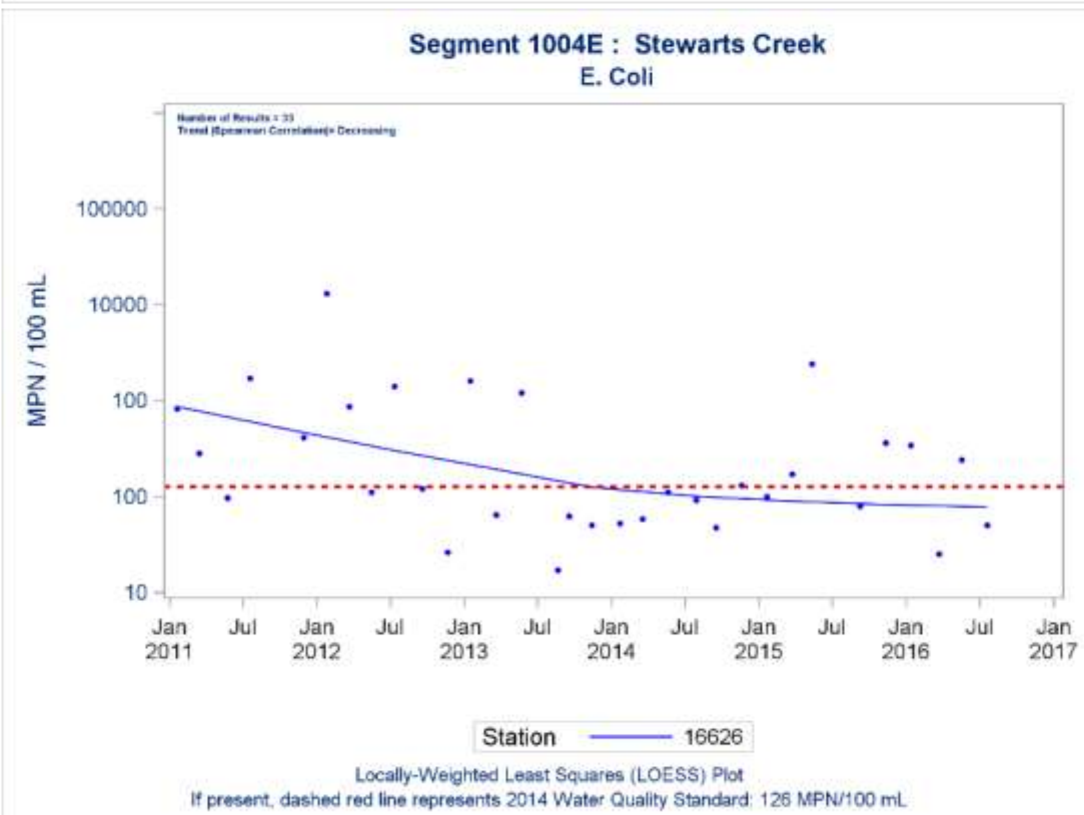


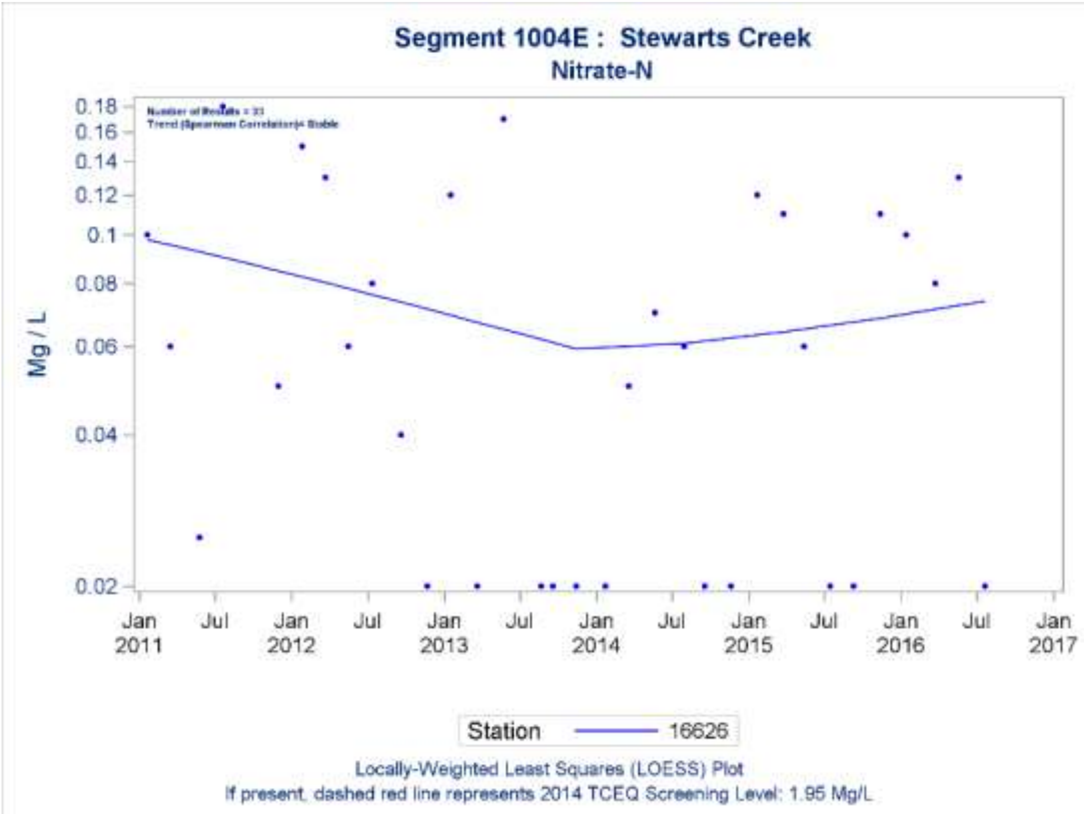
Segment 1004D : Crystal Creek
Total Suspended Solids
Mg / L
160
120
80
60
40
20
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16635
Locally-Weighted Least Squares (LOESS) Plot



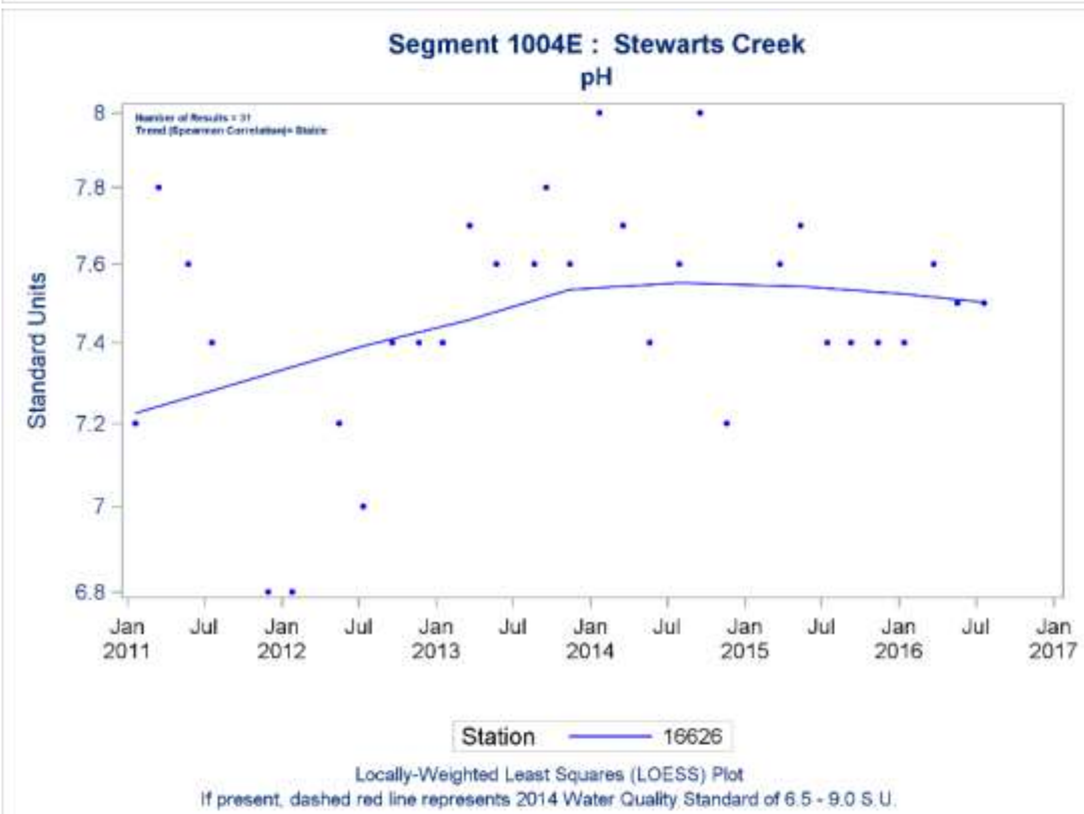
Segment 1004E : Stewarts Creek
Ammonia-N
Mg / L
0.1
0.09
0.08
0.07
0.06
0.05
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16626
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.33 mg/L


Segment 1004E : Stewarts Creek
Dissolved Oxygen
Number of Results = 31
Trend (Spearman Correlation)= Stable
Mg / L
11
10
9
8
7
6
5
4
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16626
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2016 TCEQ Screening Level: 3.0mg/L

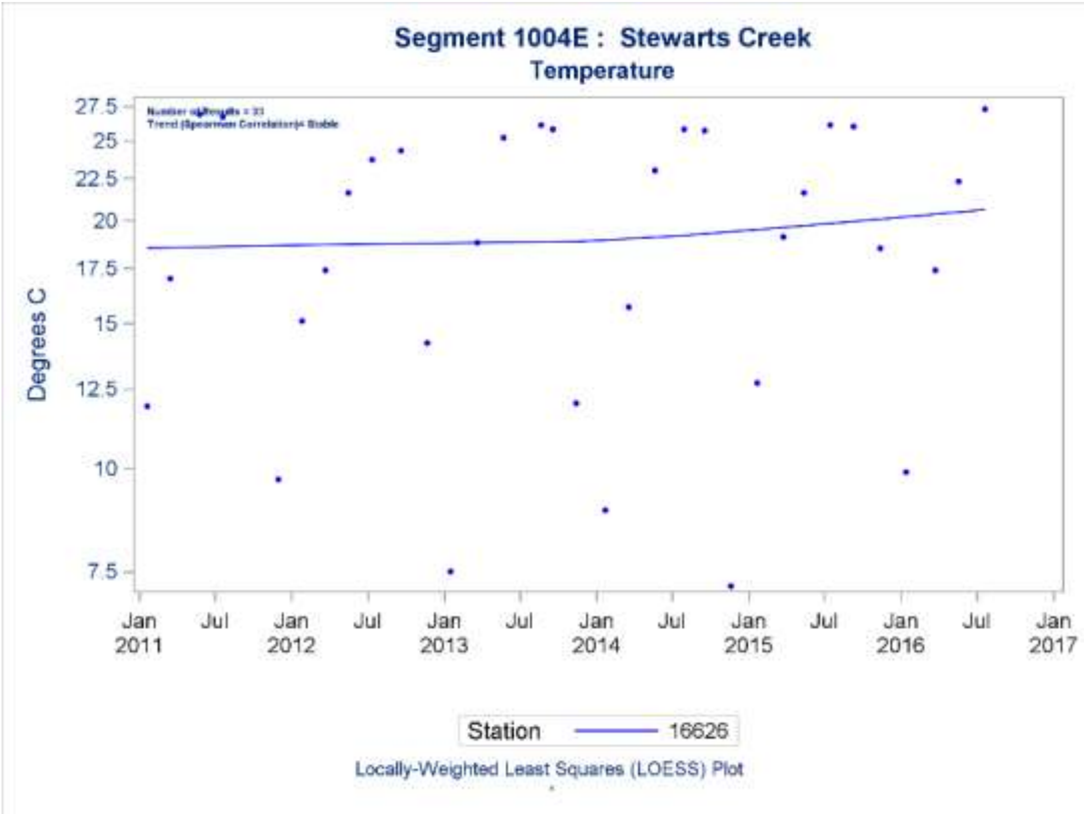

Segment 1004E : Stewarts Creek
E. Coli
Number of Results = 33
Trend (Spearman Correlation)= Decreasing
MPN / 100 mL
100000
10000
100
100
10
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16626
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 126 MPN/100 mL

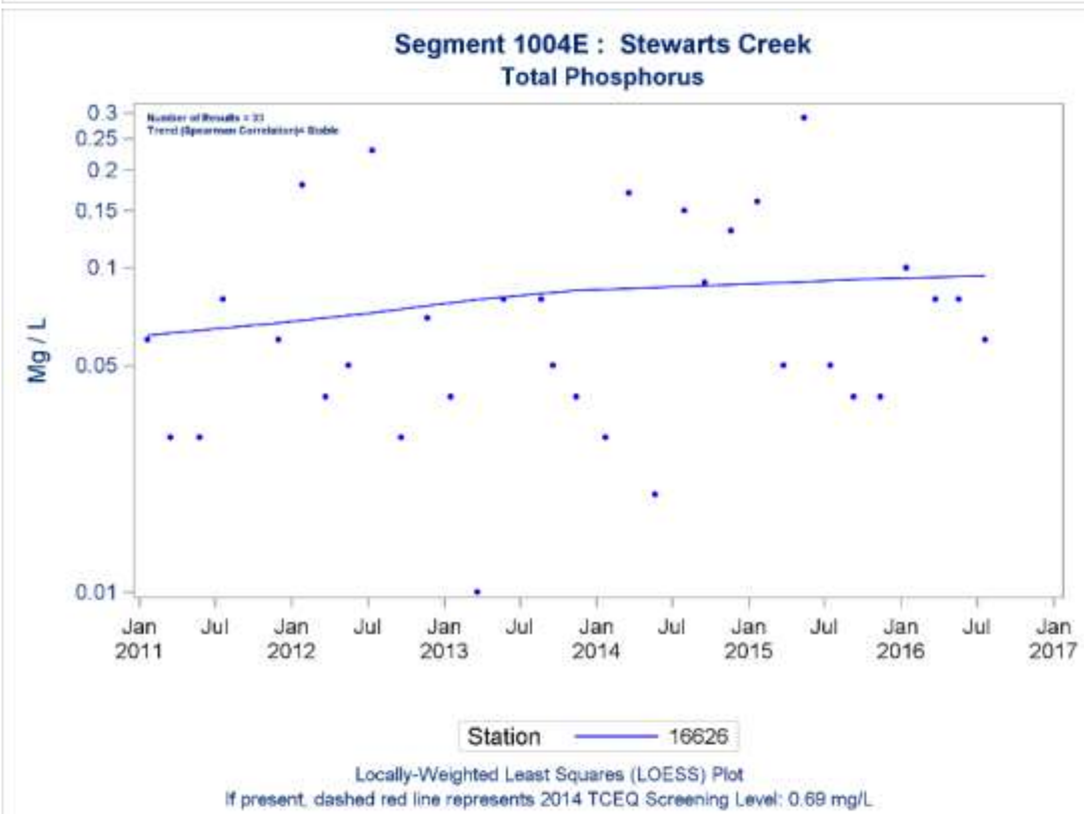


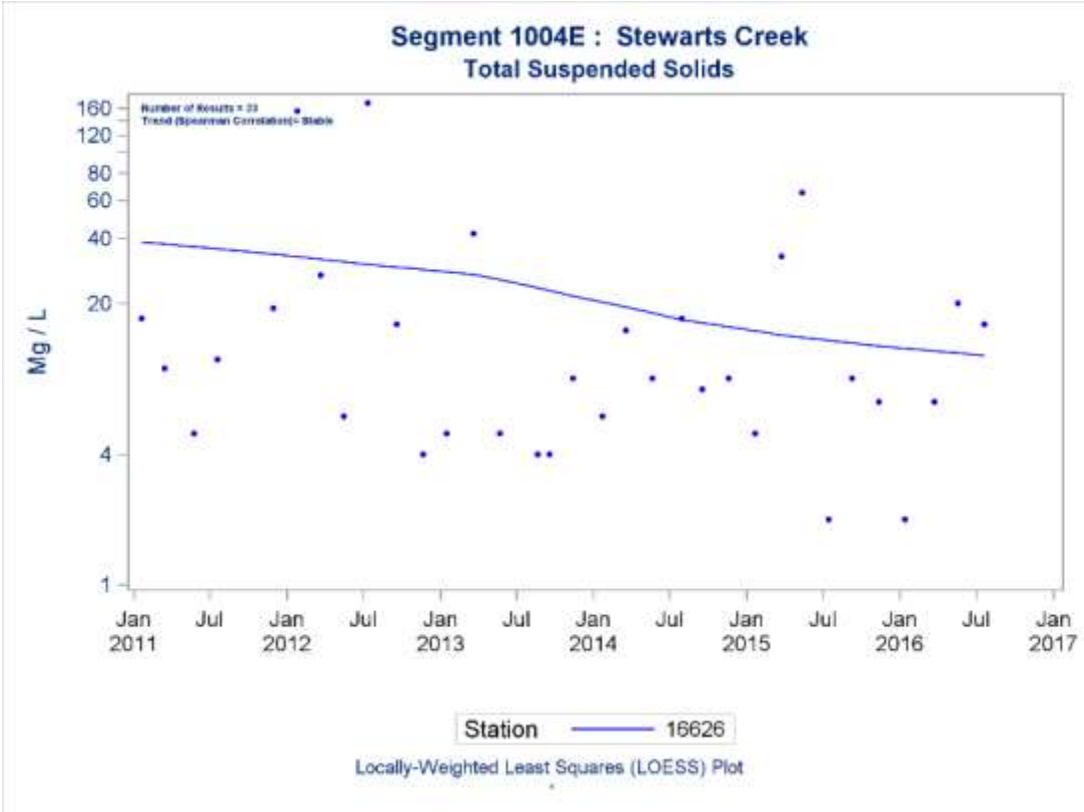
Segment 1004E : Stewarts Creek
Nitrate-N
Mg / L
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16626
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 1.95 Mg/L

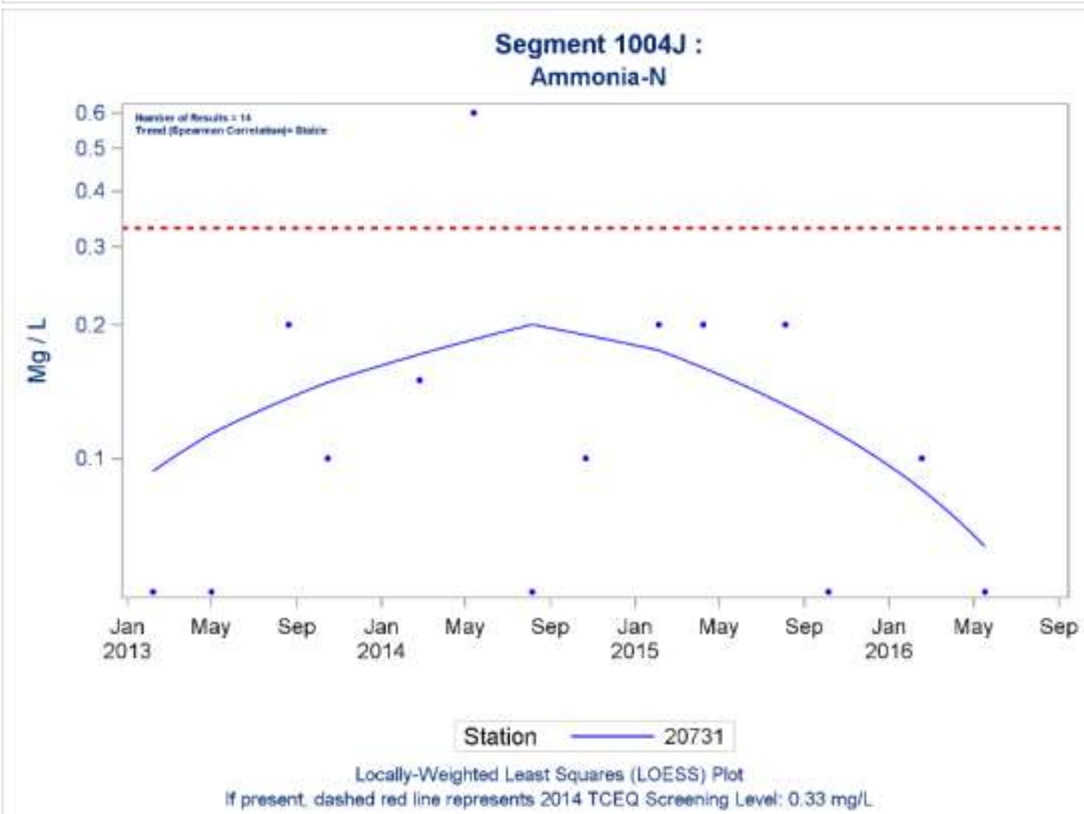


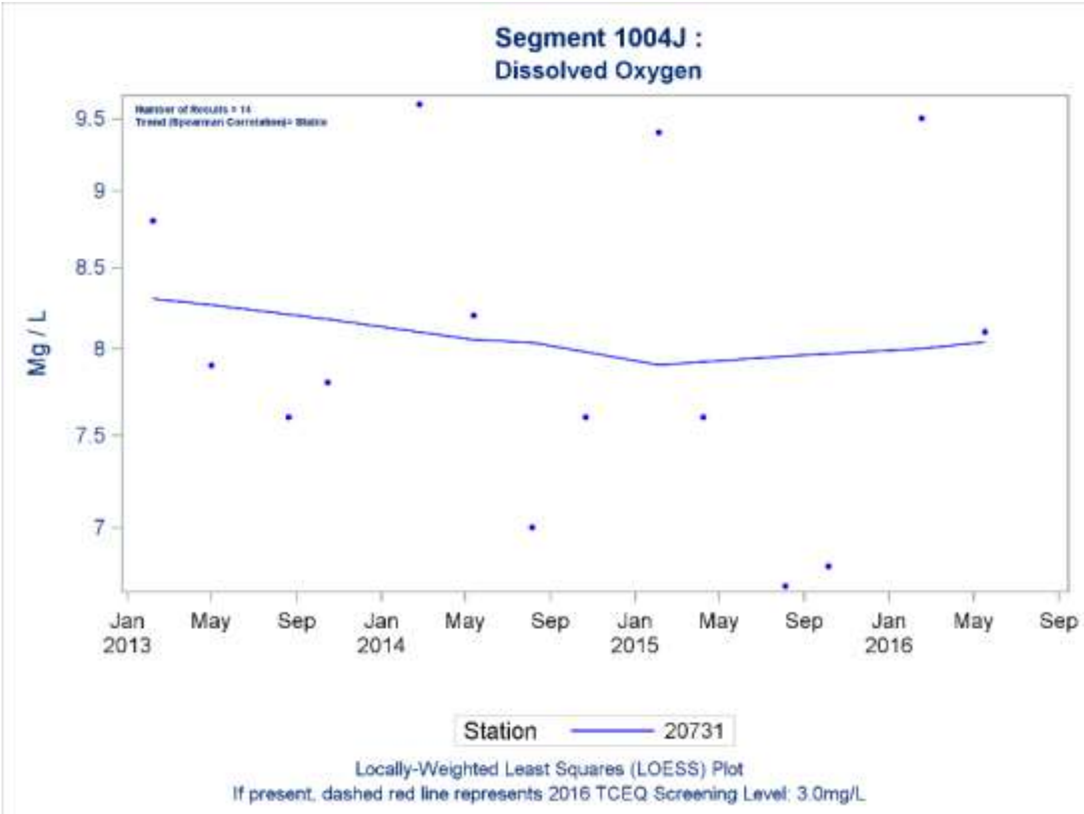
Segment 1004E : Stewarts Creek
pH
Standard Units
8
7.8
7.6
7.4
7.2
7
6.8
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16626
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard of 6.5 - 9.0 S.U.

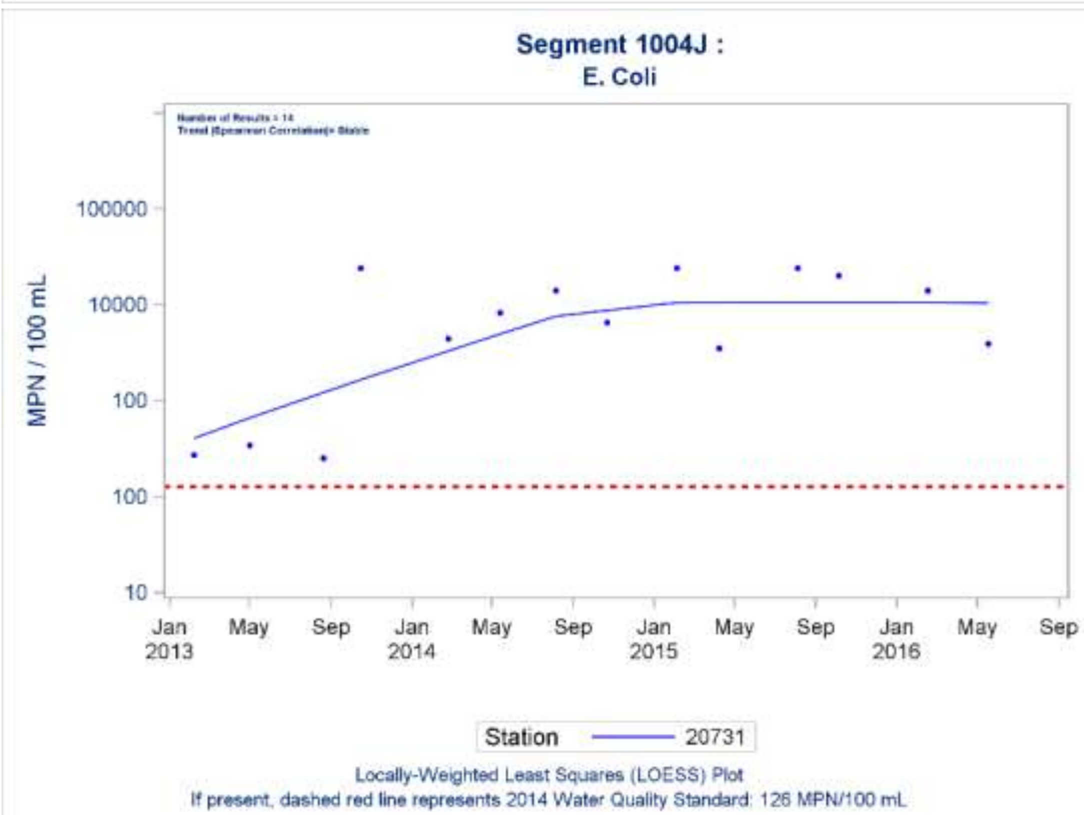

Segment 1004E : Stewarts Creek
Temperature
Degrees C
27.5
25
22.5
20
17.5
15
12.5
10
7.5
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16626
Locally-Weighted Least Squares (LOESS) Plot

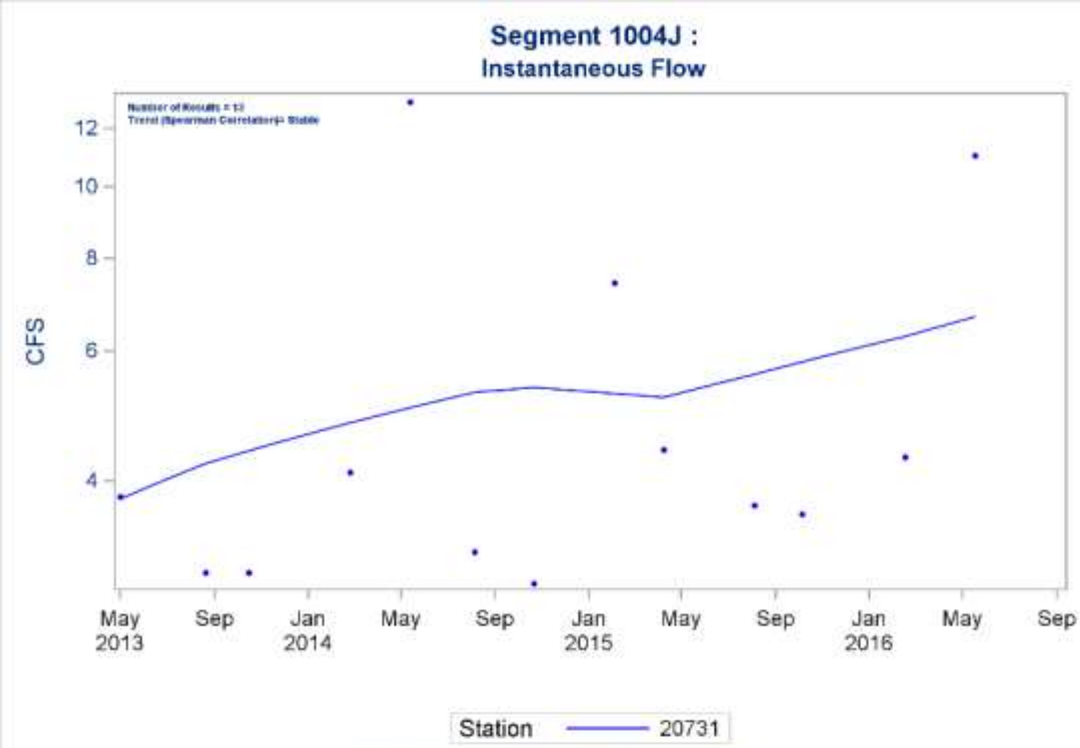

Segment 1004E : Stewarts Creek
Total Phosphorus
Mg / L
0.3
0.25
0.2
0.15
0.1
0.05
0.01
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16626
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.69 mg/L


Segment 1004E : Stewarts Creek
Total Suspended Solids
Number of Results = 33
Trend (Spearman Correlation)= Stable
160
120
80
60
40
20
4
1
Mg / L
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16626
Locally-Weighted Least Squares (LOESS) Plot

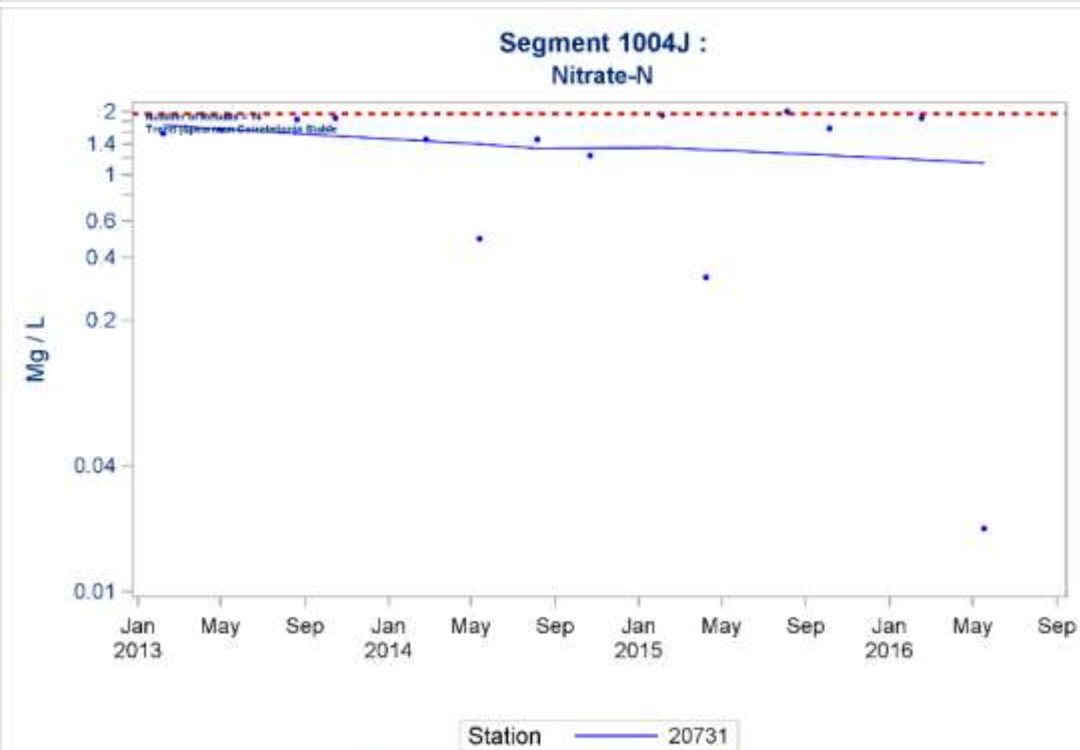

Segment 1004J :
Ammonia-N
Number of Results = 14
Trend (Spearman Correlation)= Stable
0.6
0.5
0.4
0.3
0.2
0.1
Mg / L
Jan 2013
May
Sep
Jan 2014
May
Sep
Jan 2015
May
Sep
Jan 2016
May
Sep
Station
20731
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.33 mg/L


Segment 1004J :
Dissolved Oxygen
Number of Results = 14
Trend (Spearman Correlation)= Stable
Mg / L
9.5
9
8.5
8
7.5
7
Jan 2013
May
Sep
Jan 2014
May
Sep
Jan 2015
May
Sep
Jan 2016
May
Sep
Station
20731
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2016 TCEQ Screening Level: 3.0mg/L


Segment 1004J :
E. Coli
Number of Results = 14
Trend (Spearman Correlation)= Stable
MPN / 100 mL
100000
10000
100
100
10
Jan 2013
May
Sep
Jan 2014
May
Sep
Jan 2015
May
Sep
Jan 2016
May
Sep
Station
20731
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 126 MPN/100 mL

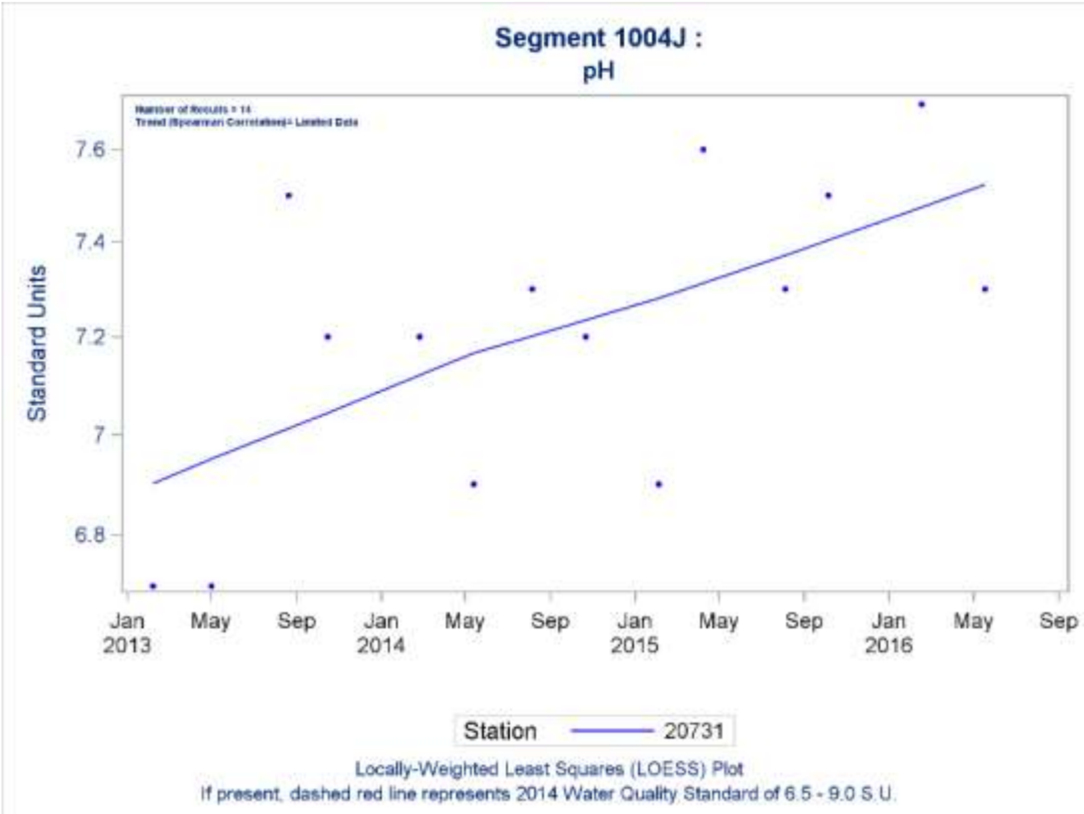


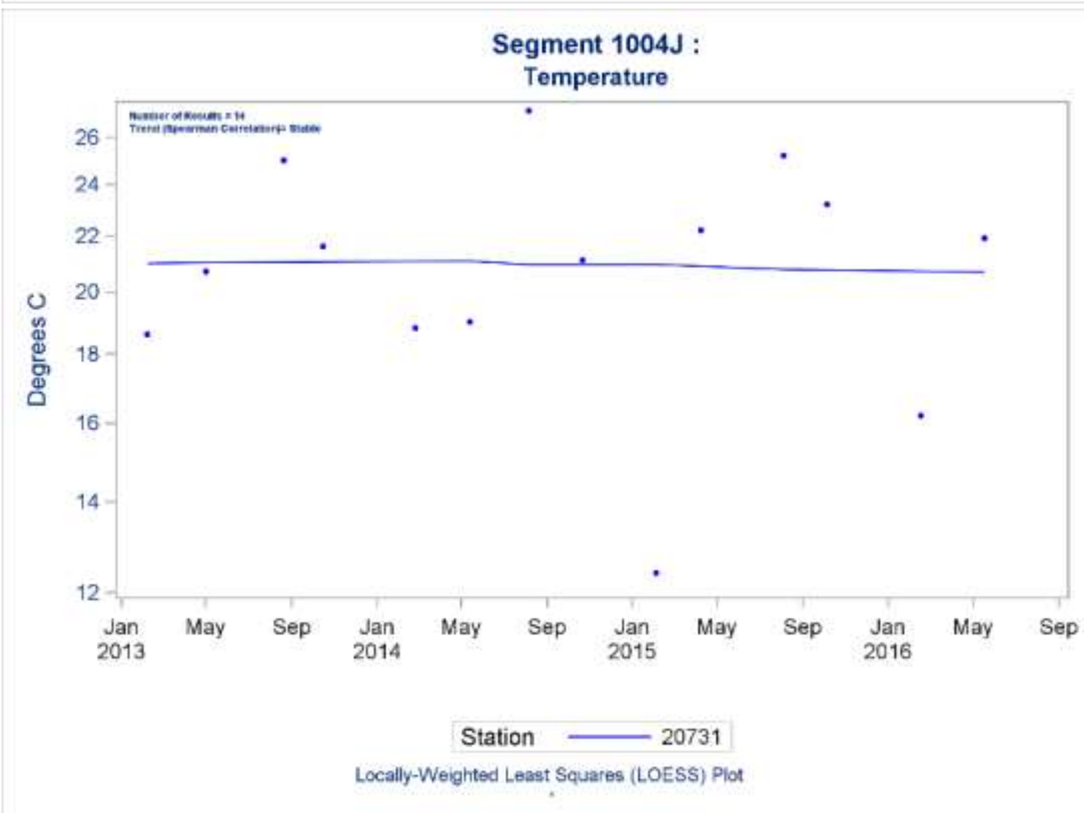
Locally-Weighted Least Squares (LOESS) Plot

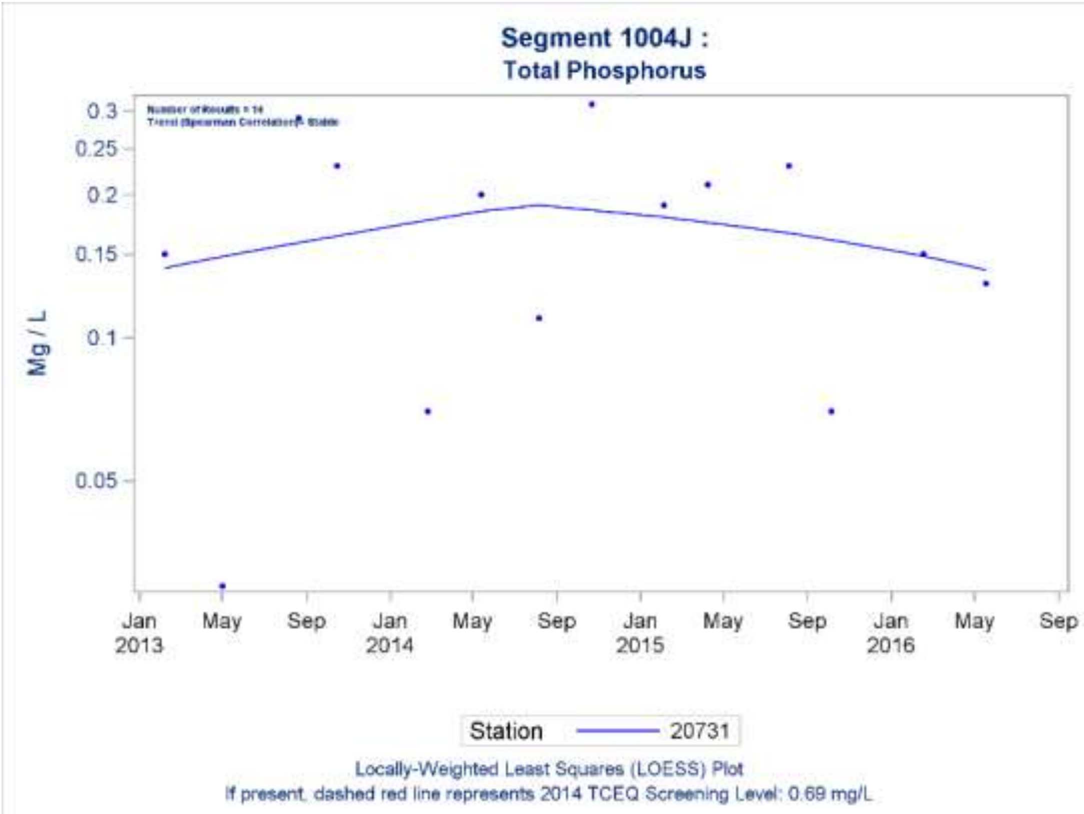


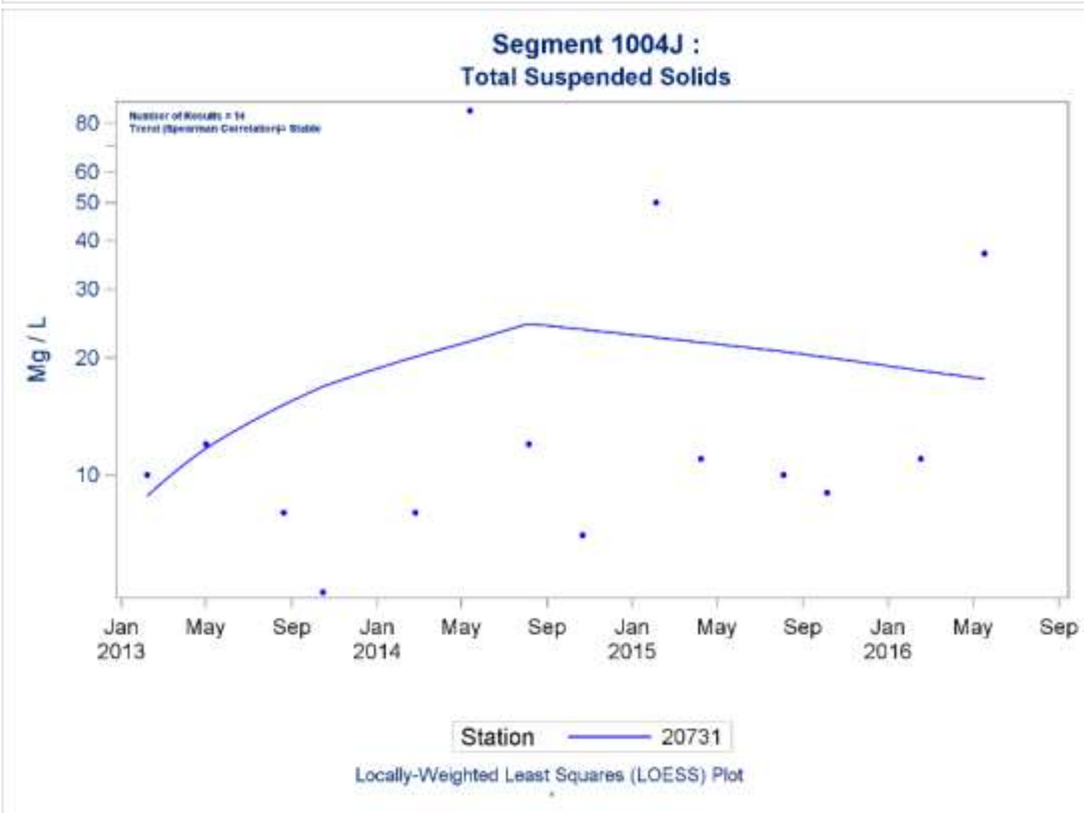
Locally-Weighted Least Squares (LOESS) Plot

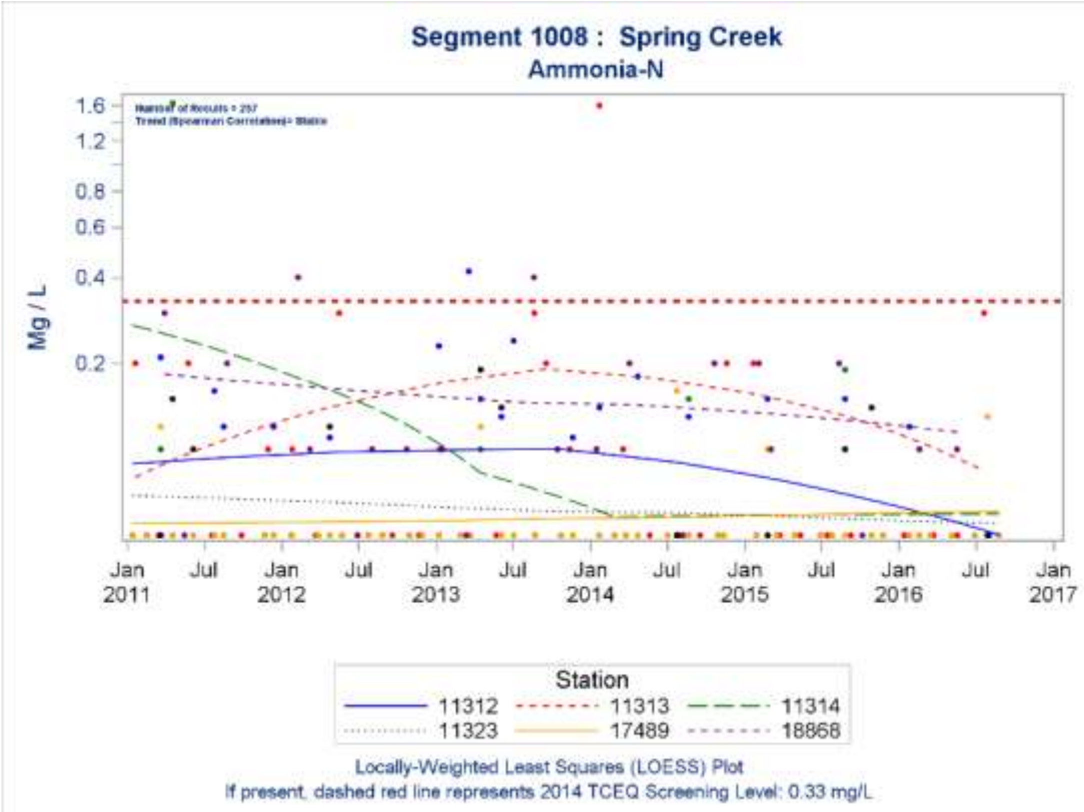
If present, dashed red line represents 2014 TCEQ Screening Level: 1.95 Mg/L

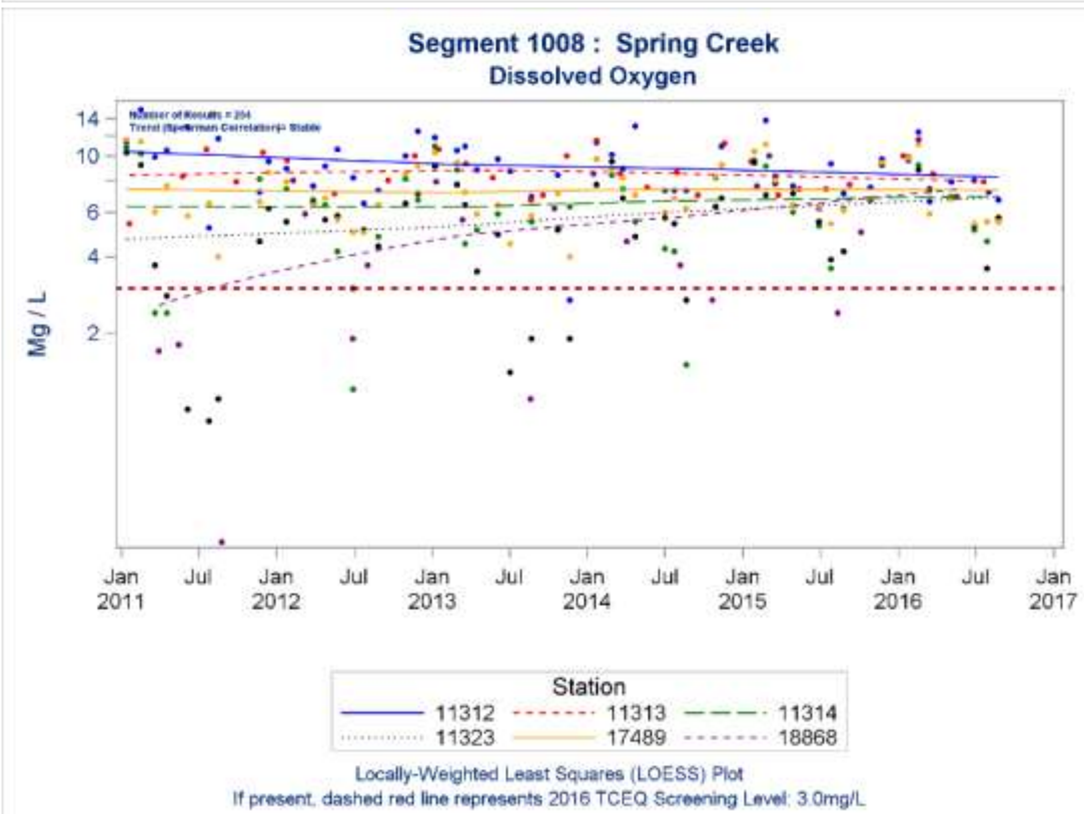

Segment 1004J :
pH
Standard Units
7.6
7.4
7.2
7
6.8
Jan 2013
May
Sep
Jan 2014
May
Sep
Jan 2015
May
Sep
Jan 2016
May
Sep
Station
20731
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard of 6.5 - 9.0 S.U.

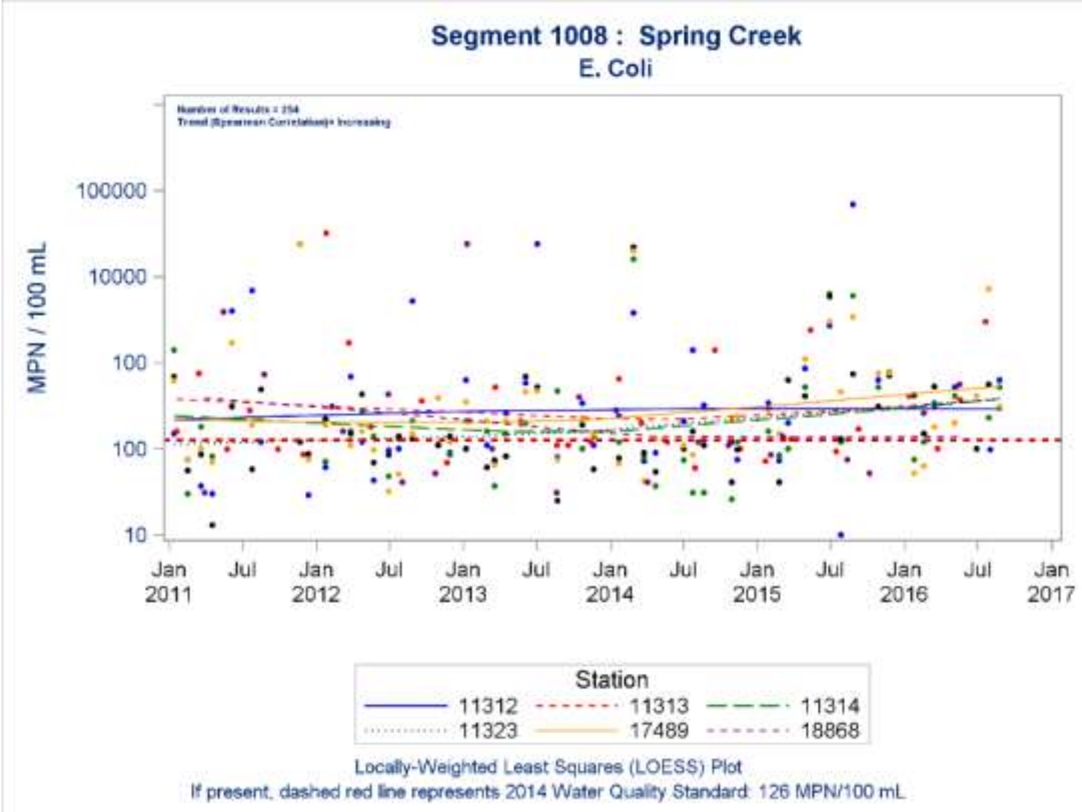

Segment 1004J :
Temperature
Degrees C
26
24
22
20
18
16
14
12
Jan 2013
May
Sep
Jan 2014
May
Sep
Jan 2015
May
Sep
Jan 2016
May
Sep
Station
20731
Locally-Weighted Least Squares (LOESS) Plot

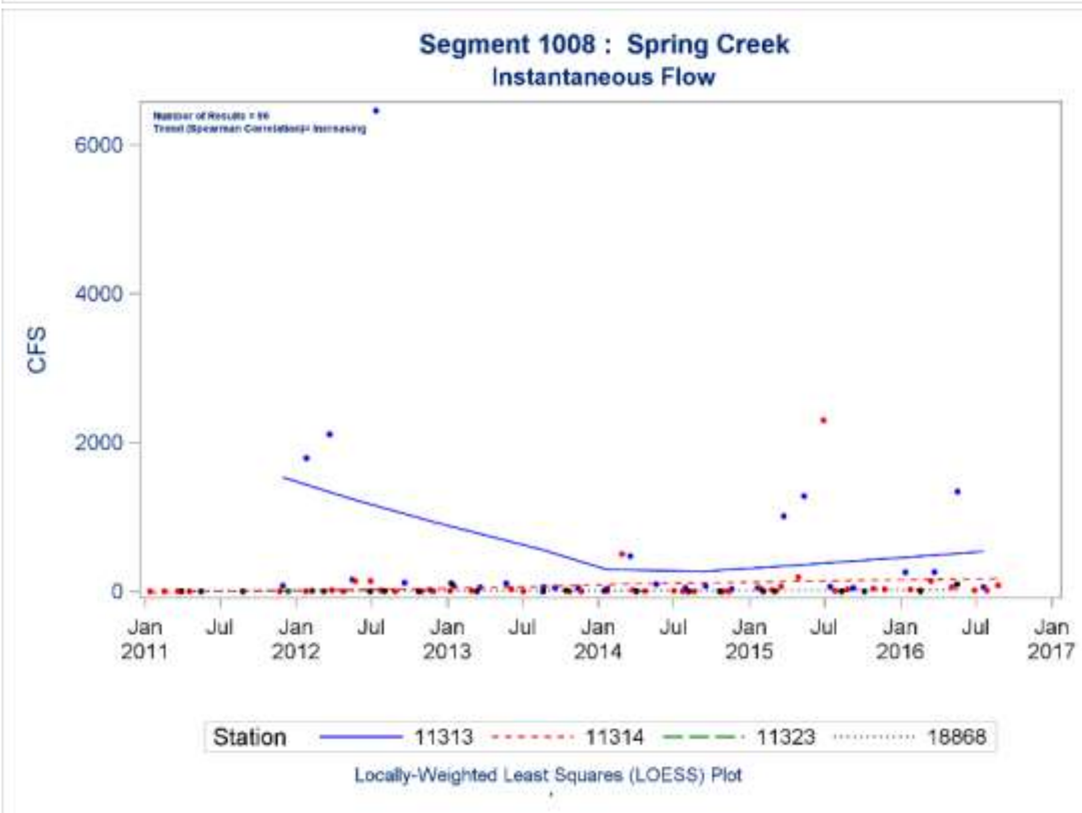

Segment 1004J :
Total Phosphorus
Mg / L
0.3
0.25
0.2
0.15
0.1
0.05
Jan 2013
May
Sep
Jan 2014
May
Sep
Jan 2015
May
Sep
Jan 2016
May
Sep
Station
20731
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.69 mg/L


Segment 1004J :
Total Suspended Solids
Mg / L
80
60
50
40
30
20
10
Jan 2013
May
Sep
Jan 2014
May
Sep
Jan 2015
May
Sep
Jan 2016
May
Sep
Station
20731
Locally-Weighted Least Squares (LOESS) Plot


Segment 1008 : Spring Creek
Ammonia-N
Mg / L
1.6
1.2
0.8
0.6
0.4
0.2
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
11312
11313
11314
11323
17489
18868
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.33 mg/L

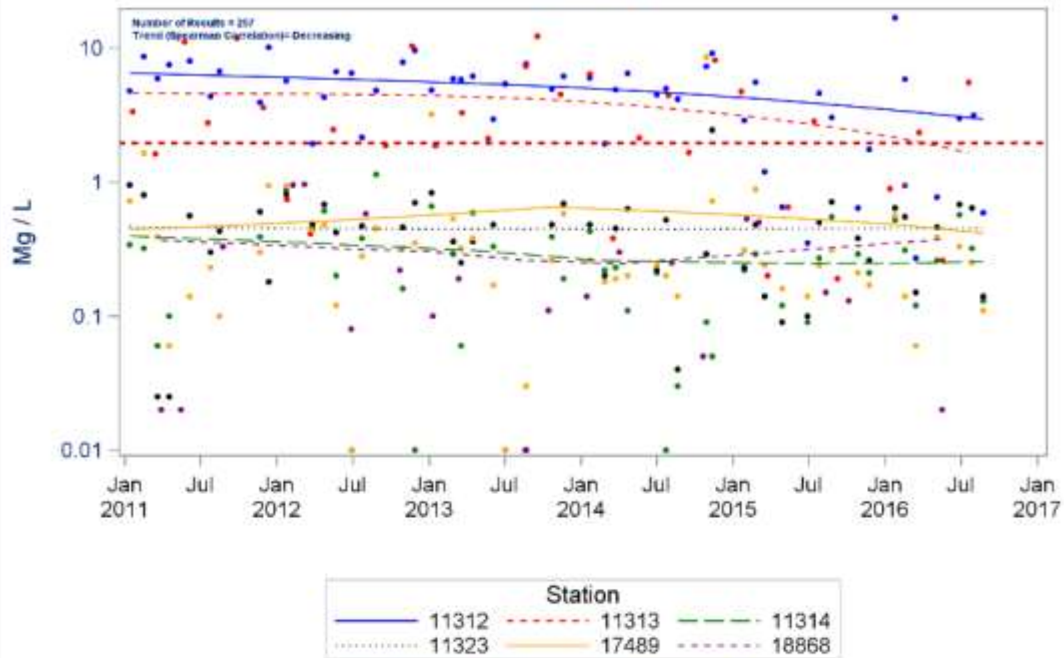

Segment 1008 : Spring Creek
Dissolved Oxygen
Mg / L
14
10
6
4
2
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
11312
11313
11314
11323
17489
18868
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2016 TCEQ Screening Level: 3.0mg/L


Segment 1008 : Spring Creek
E. Coli
MPN / 100 mL
100000
10000
100
100
10
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
11312
11313
11314
11323
17489
18868
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 126 MPN/100 mL


Segment 1008 : Spring Creek
Instantaneous Flow
CFS
6000
4000
2000
0
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
11313
11314
11323
18868
Locally-Weighted Least Squares (LOESS) Plot

Segment 1008 : Spring Creek

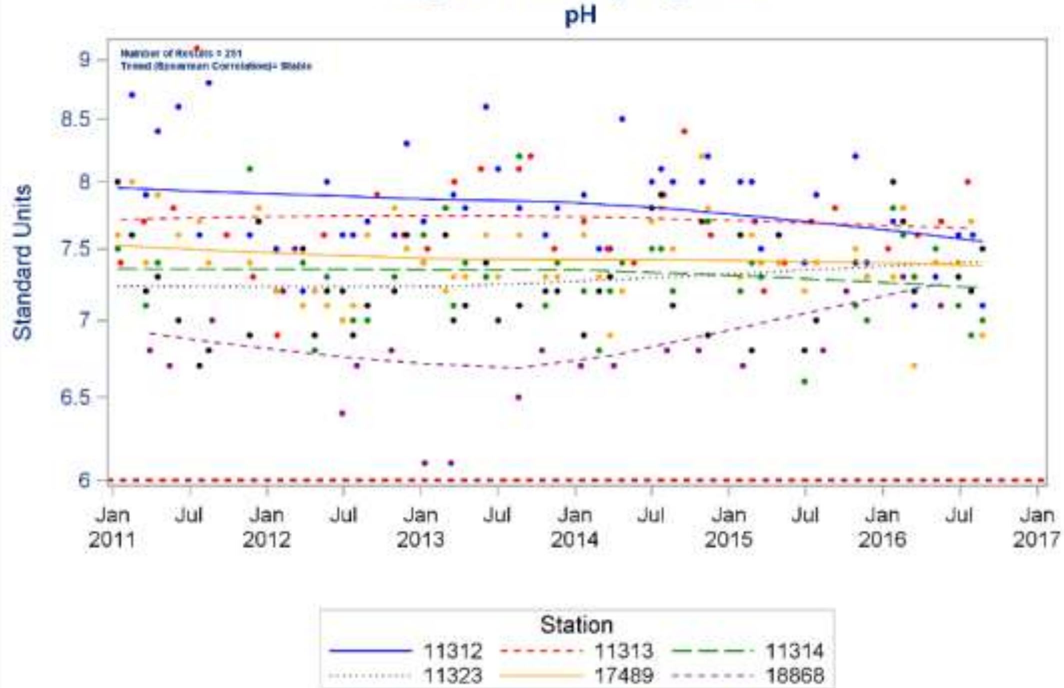
Nitrate-N



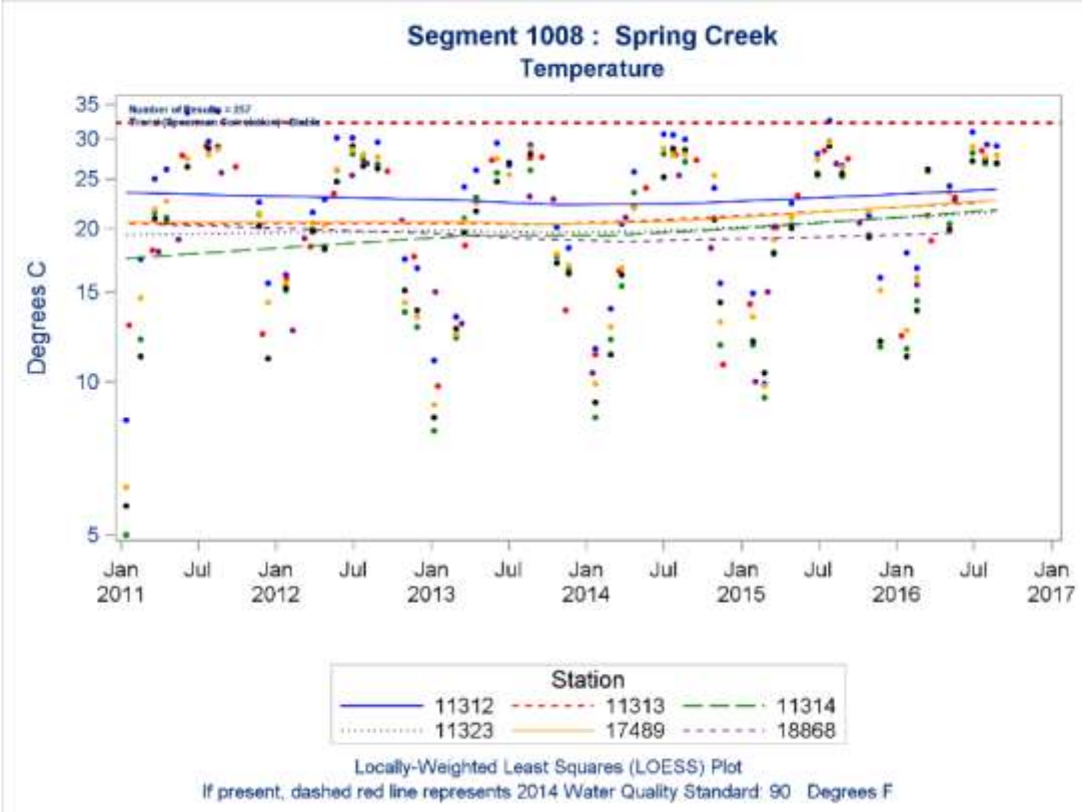
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 1.95 Mg/L

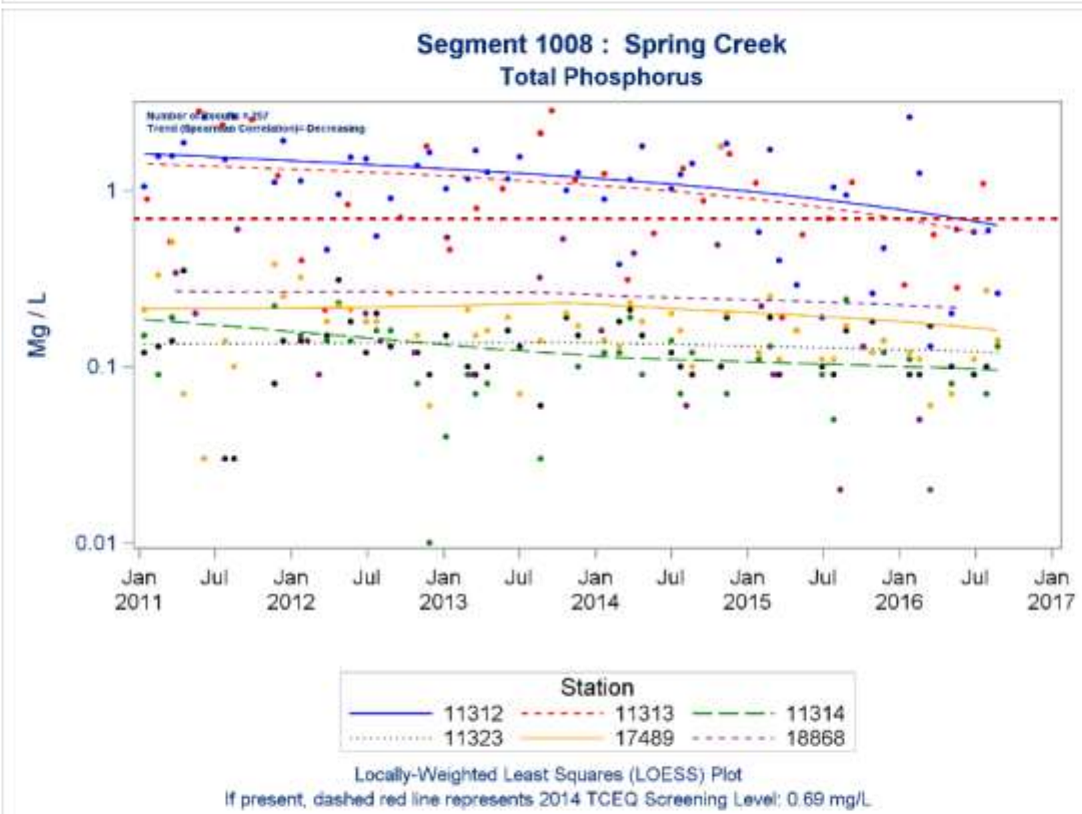
Segment 1008 : Spring Creek

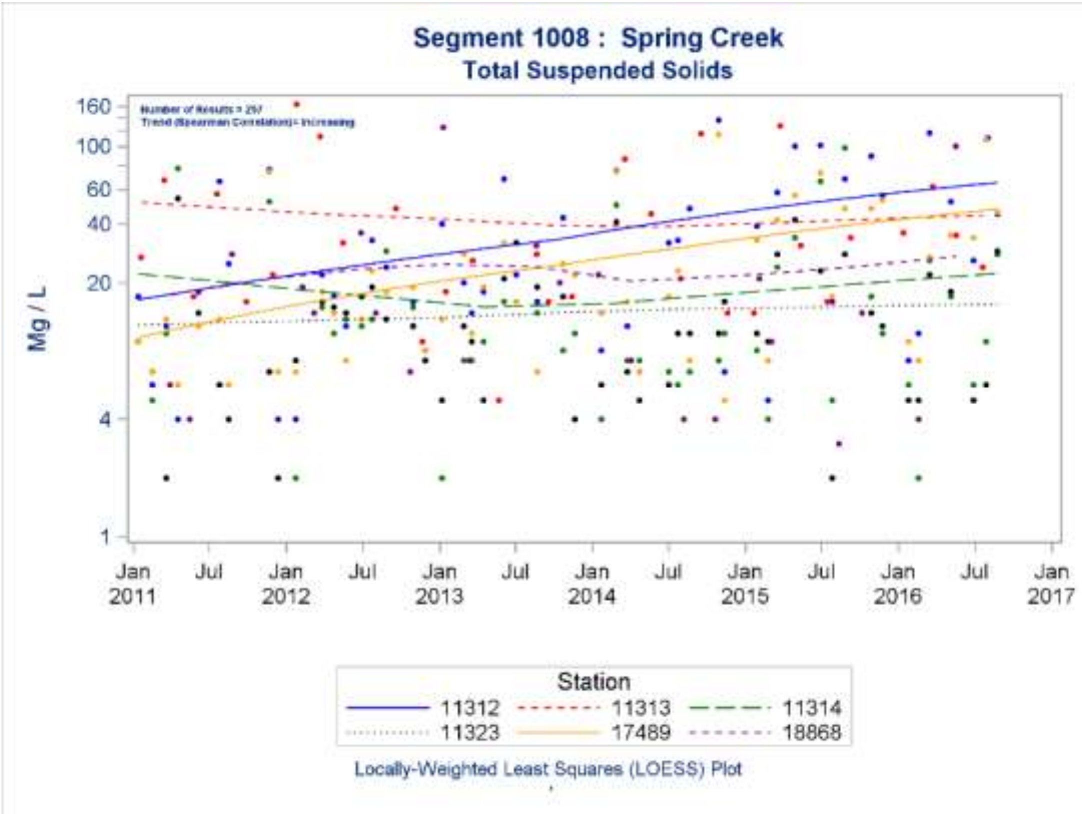
pH

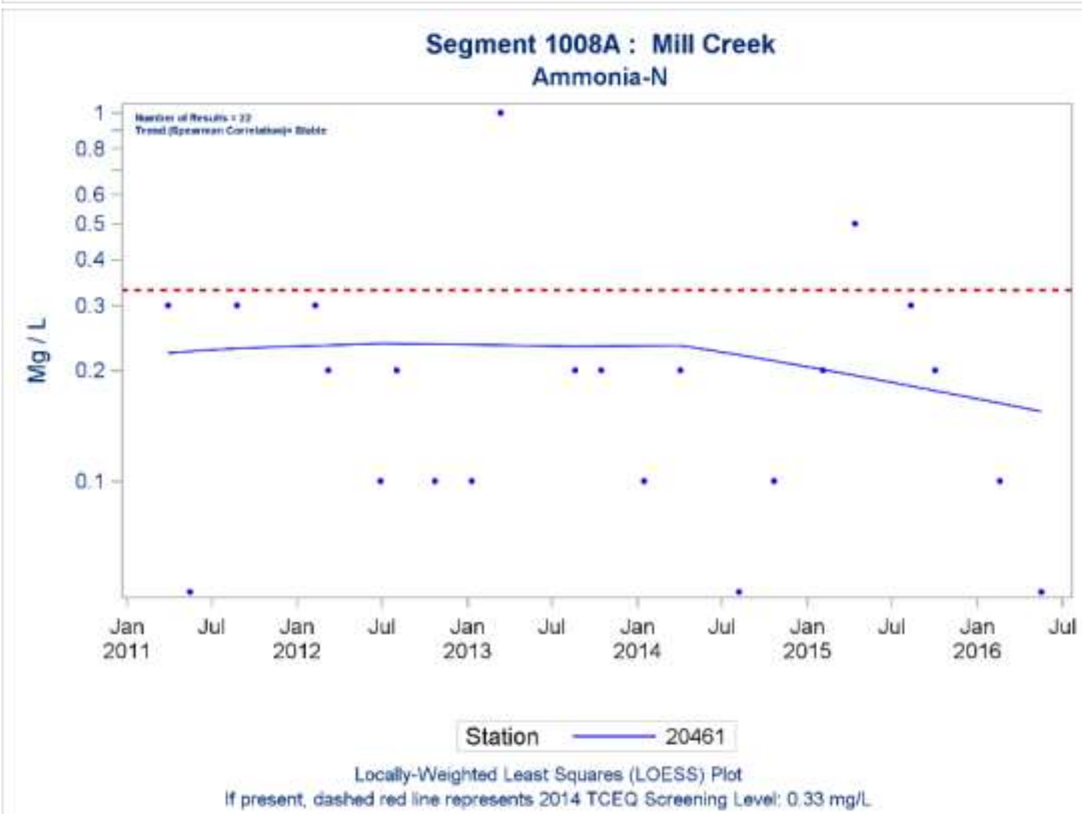


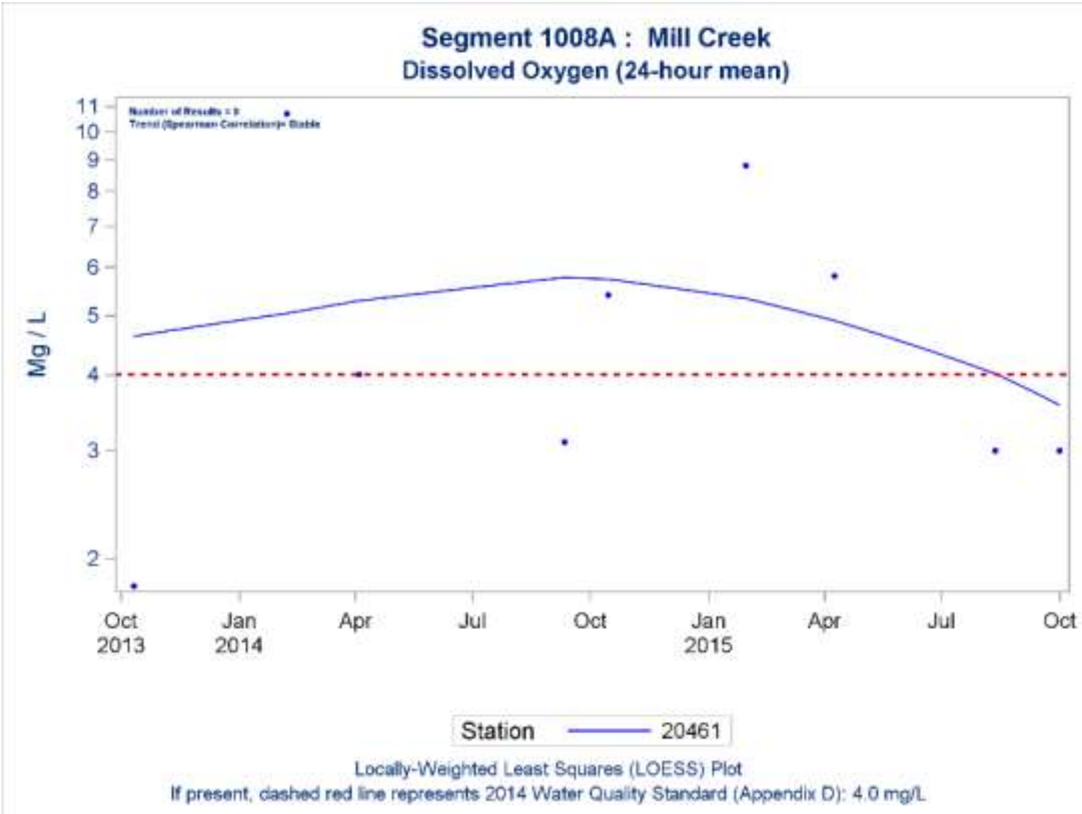
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard of 6.5 - 9.0 S.U.

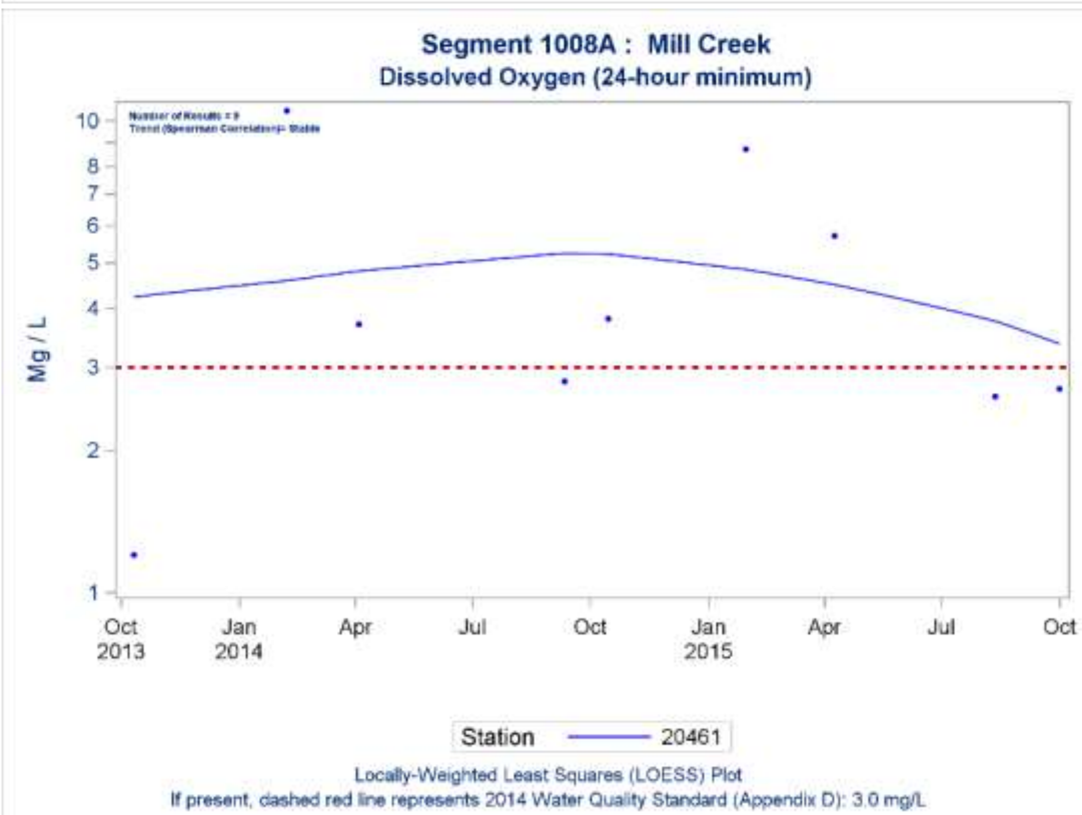

Segment 1008 : Spring Creek
Temperature
Degrees C
35
30
25
20
15
10
5
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
11312
11313
11314
11323
17489
18868
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 90 Degrees F

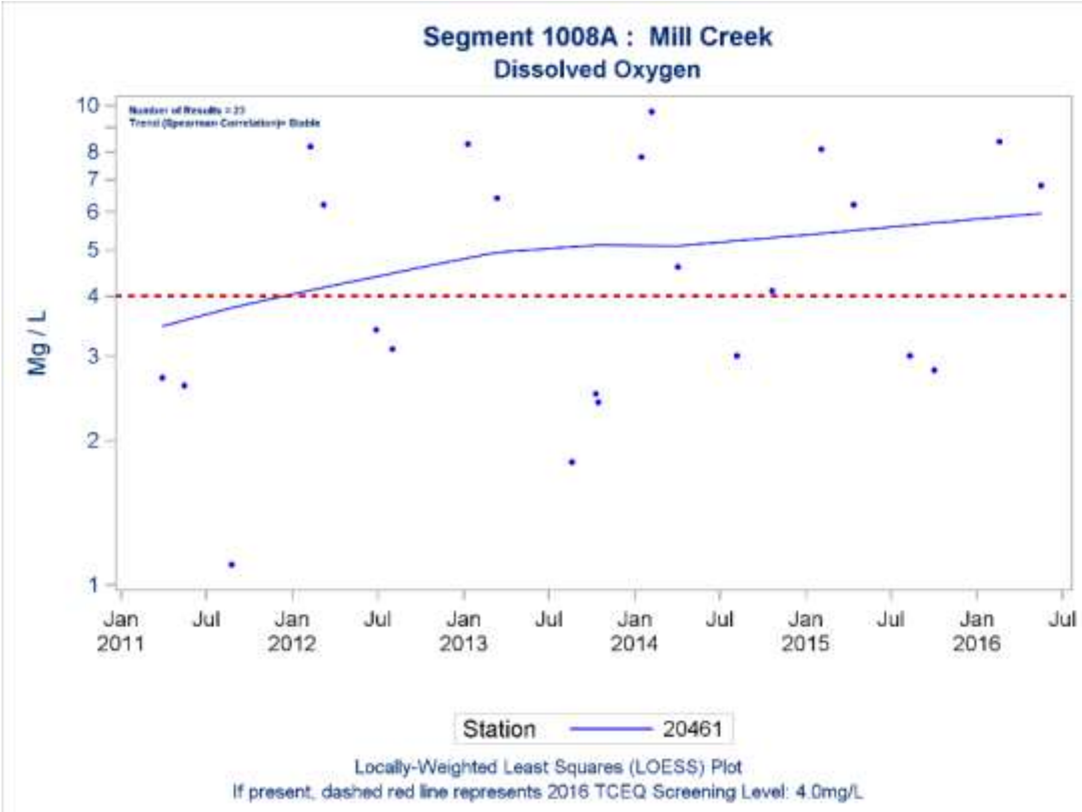

Segment 1008 : Spring Creek
Total Phosphorus
Mg / L
1
0.1
0.01
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
11312
11313
11314
11323
17489
18868
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.69 mg/L

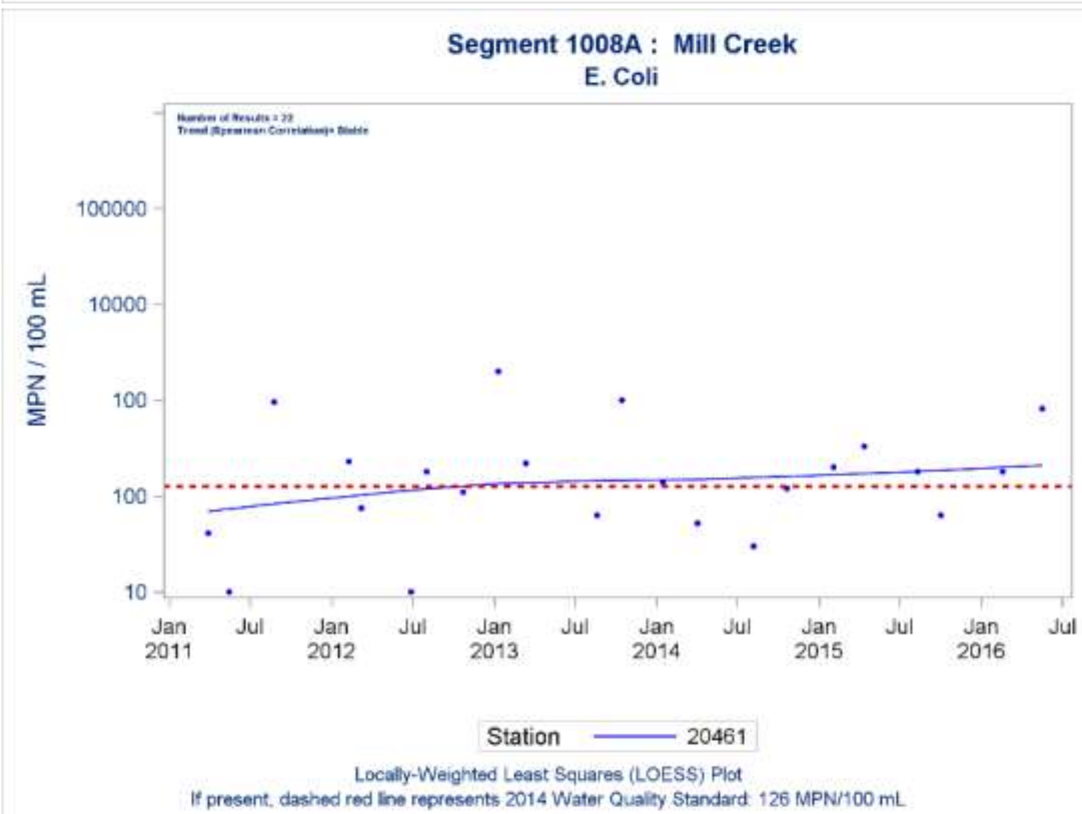

Segment 1008 : Spring Creek
Total Suspended Solids
Trend (Spearman Correlation)= Increasing
Mg / L
160
100
60
40
20
4
1
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
11312
11313
11314
11323
17489
18868
Locally-Weighted Least Squares (LOESS) Plot

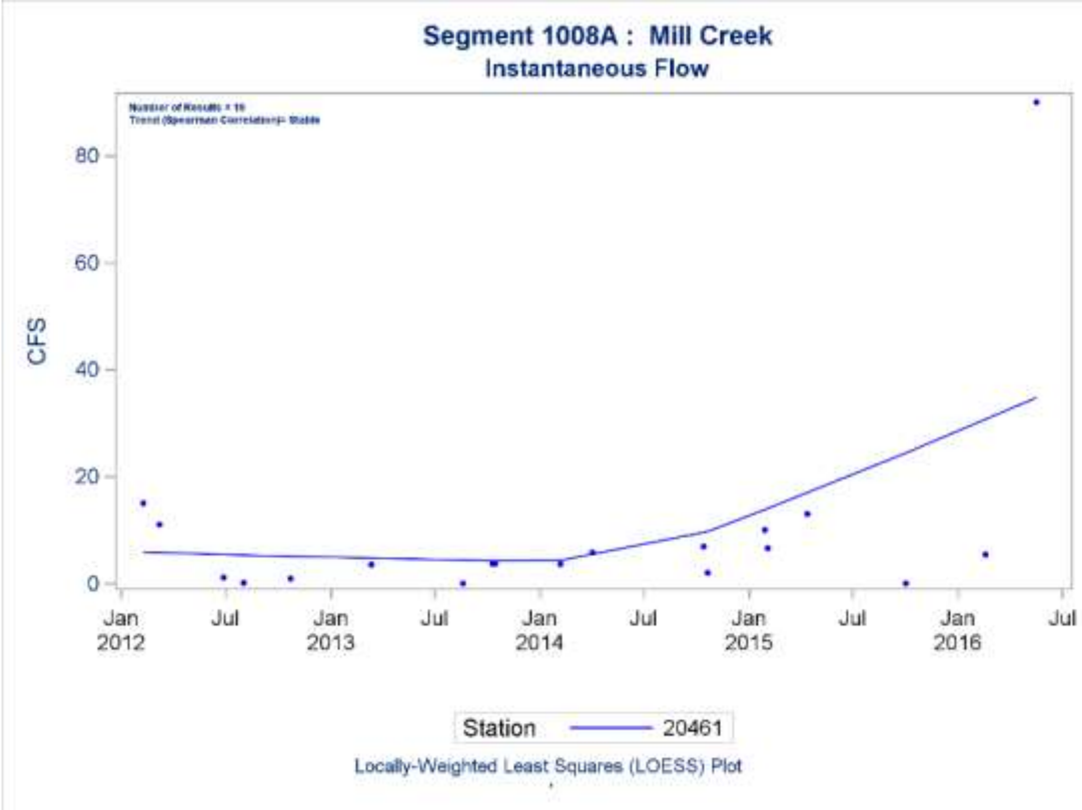

Segment 1008A : Mill Creek
Ammonia-N
Trend (Spearman Correlation)= Stable
Mg / L
1
0.8
0.6
0.5
0.4
0.3
0.2
0.1
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station
20461
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.33 mg/L

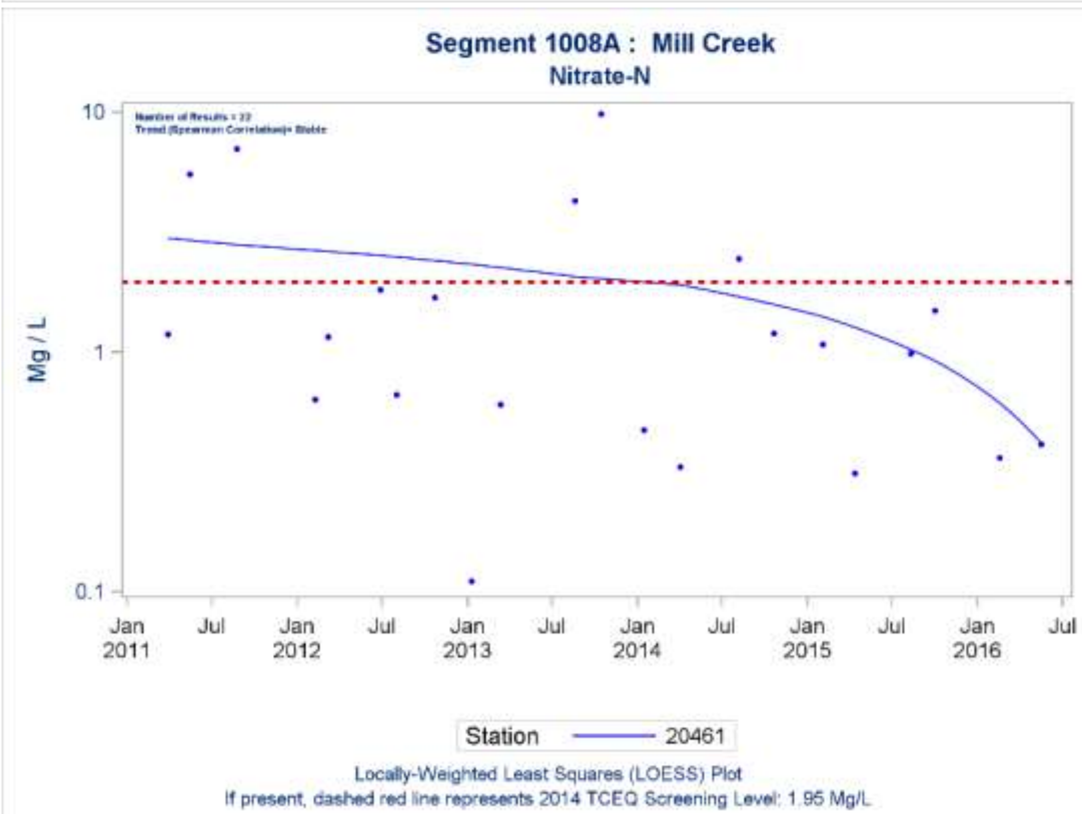

Segment 1008A : Mill Creek
Dissolved Oxygen (24-hour mean)
Mg / L
11
10
9
8
7
6
5
4
3
2
Oct 2013
Jan 2014
Apr
Jul
Oct
Jan 2015
Apr
Jul
Oct
Station
20461
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard (Appendix D): 4.0 mg/L

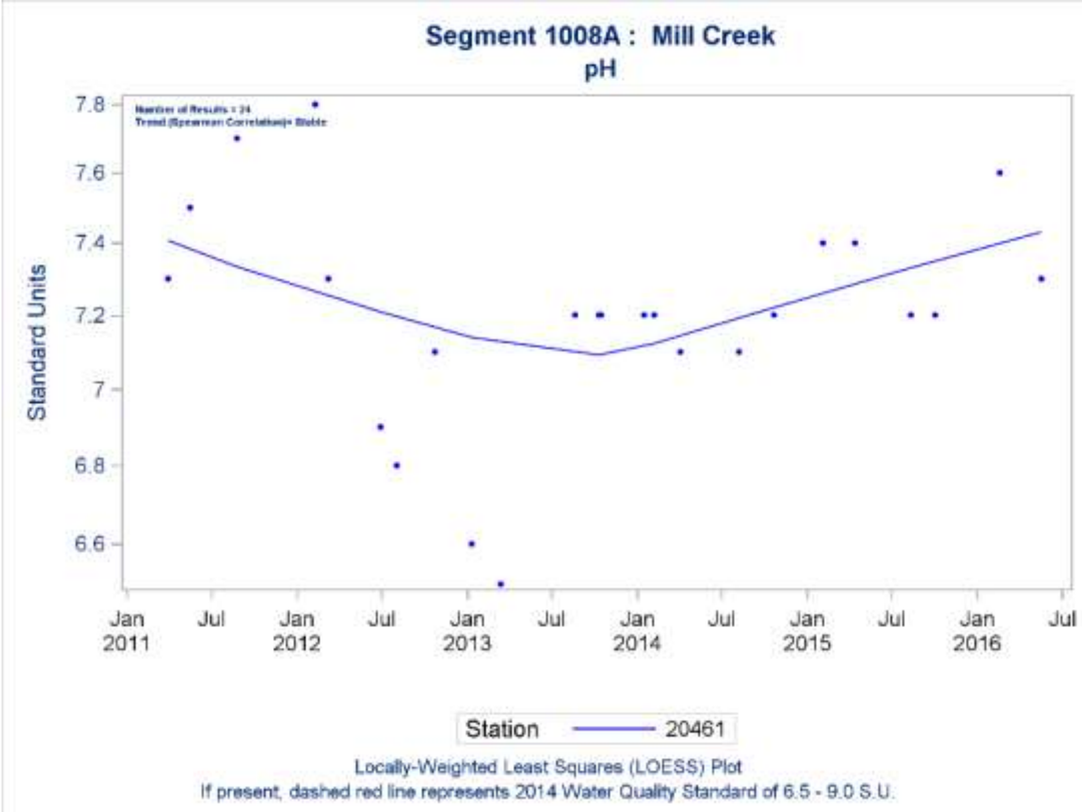

Segment 1008A : Mill Creek
Dissolved Oxygen (24-hour minimum)
Mg / L
10
8
7
6
5
4
3
2
1
Oct 2013
Jan 2014
Apr
Jul
Oct
Jan 2015
Apr
Jul
Oct
Station
20461
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard (Appendix D): 3.0 mg/L

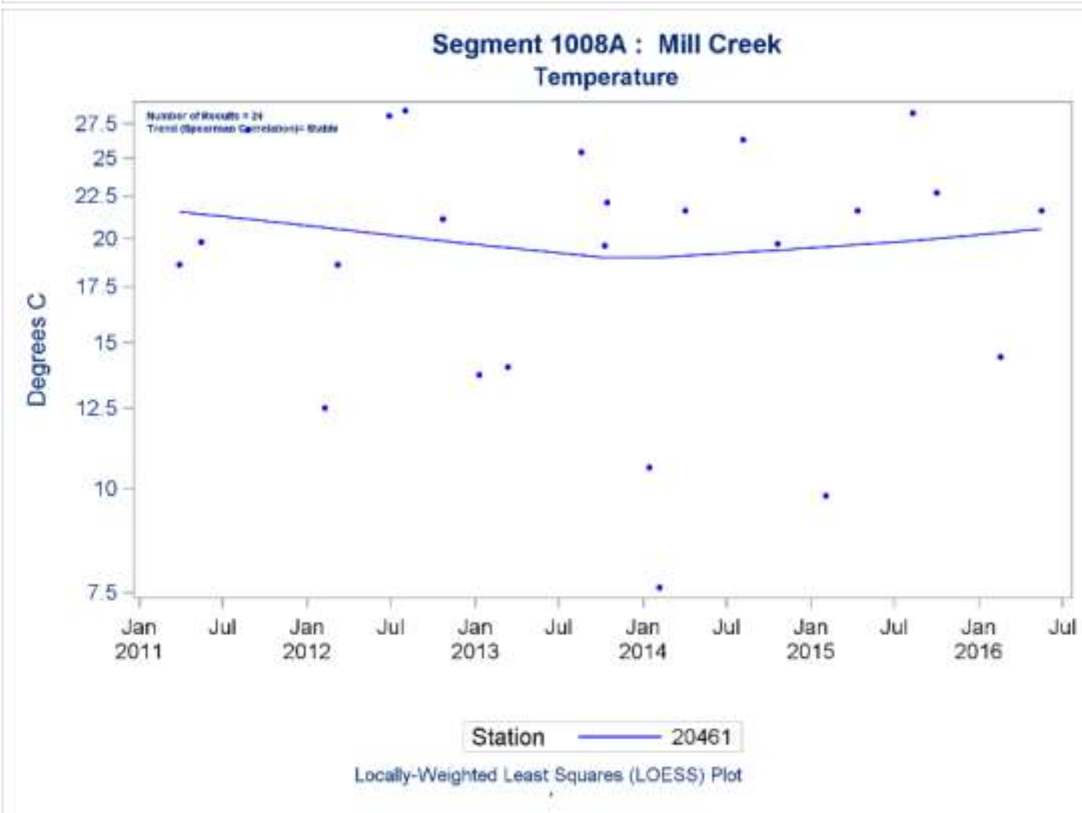

Segment 1008A : Mill Creek
Dissolved Oxygen
Mg / L
10
8
7
6
5
4
3
2
1
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station
20461
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2016 TCEQ Screening Level: 4.0mg/L

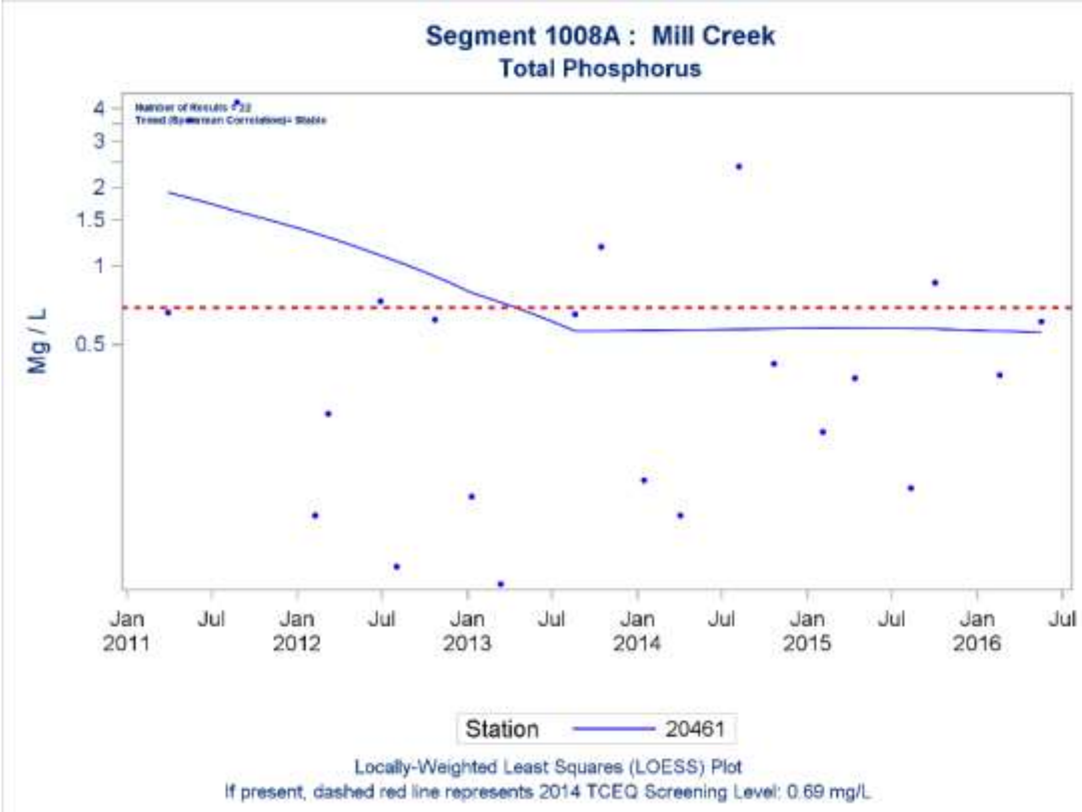

Segment 1008A : Mill Creek
E. Coli
MPN / 100 mL
100000
10000
100
100
10
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station
20461
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 126 MPN/100 mL

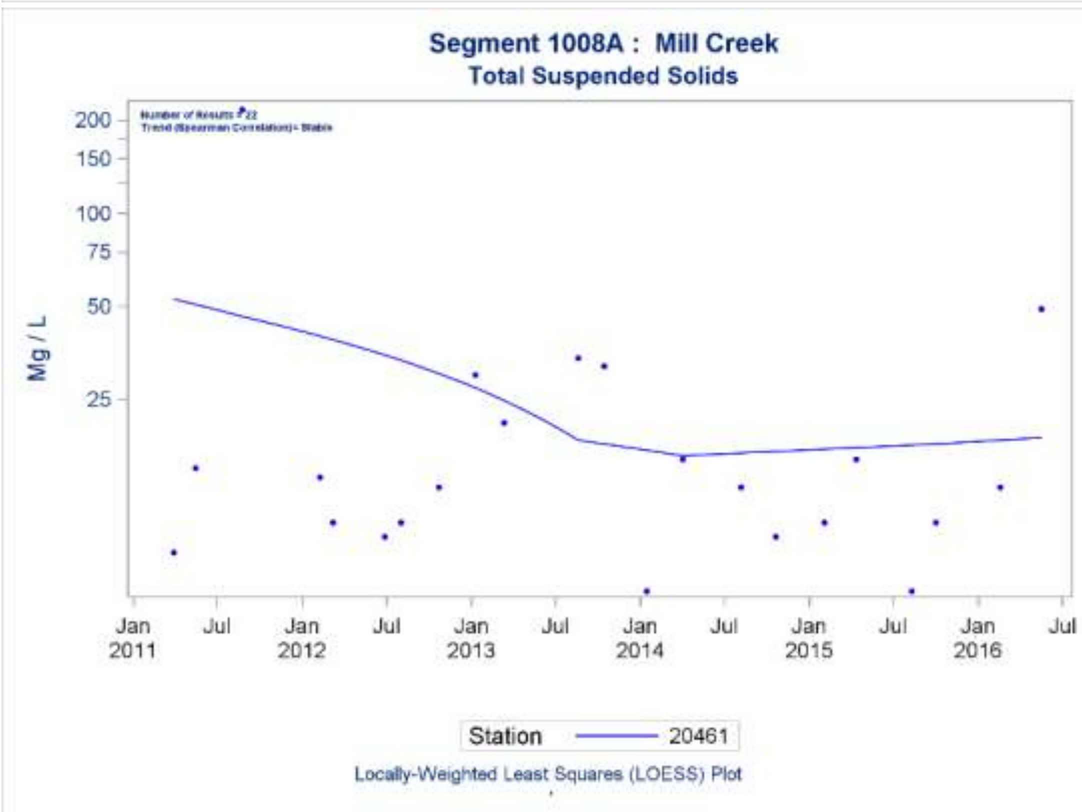

Segment 1008A : Mill Creek
Instantaneous Flow
CFS
80
60
40
20
0
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station 20461
Locally-Weighted Least Squares (LOESS) Plot

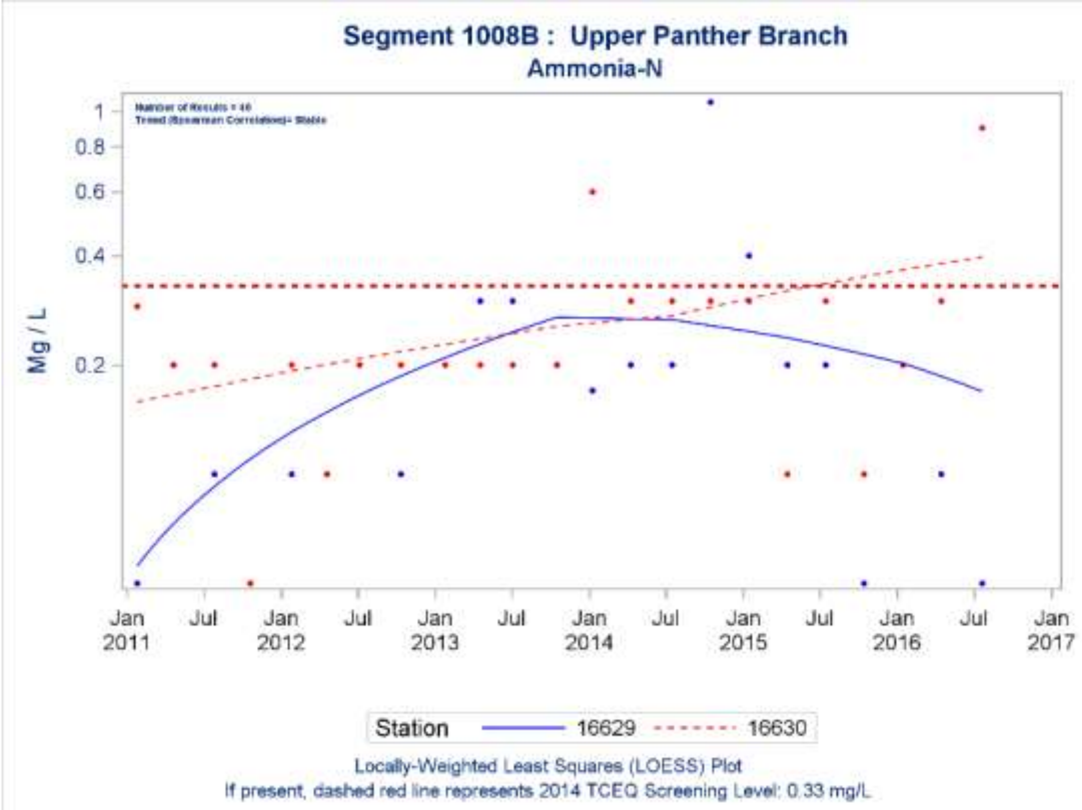

Segment 1008A : Mill Creek
Nitrate-N
Mg / L
10
1
0.1
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station 20461
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 1.95 Mg/L


Segment 1008A : Mill Creek
pH
Standard Units
7.8
7.6
7.4
7.2
7
6.8
6.6
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station
20461
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard of 6.5 - 9.0 S.U.

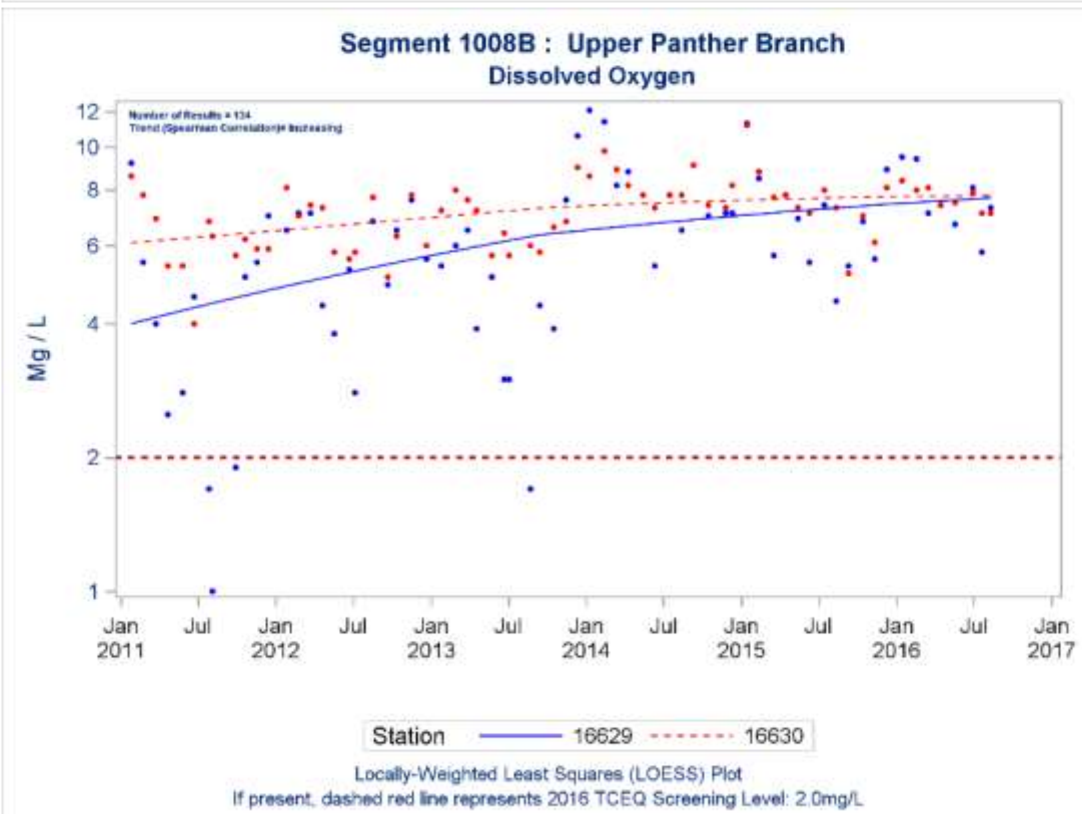

Segment 1008A : Mill Creek
Temperature
Degrees C
27.5
25
22.5
20
17.5
15
12.5
10
7.5
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station
20461
Locally-Weighted Least Squares (LOESS) Plot


Segment 1008A : Mill Creek
Total Phosphorus
Mg / L
4
3
2
1.5
1
0.5
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station
20461
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.69 mg/L

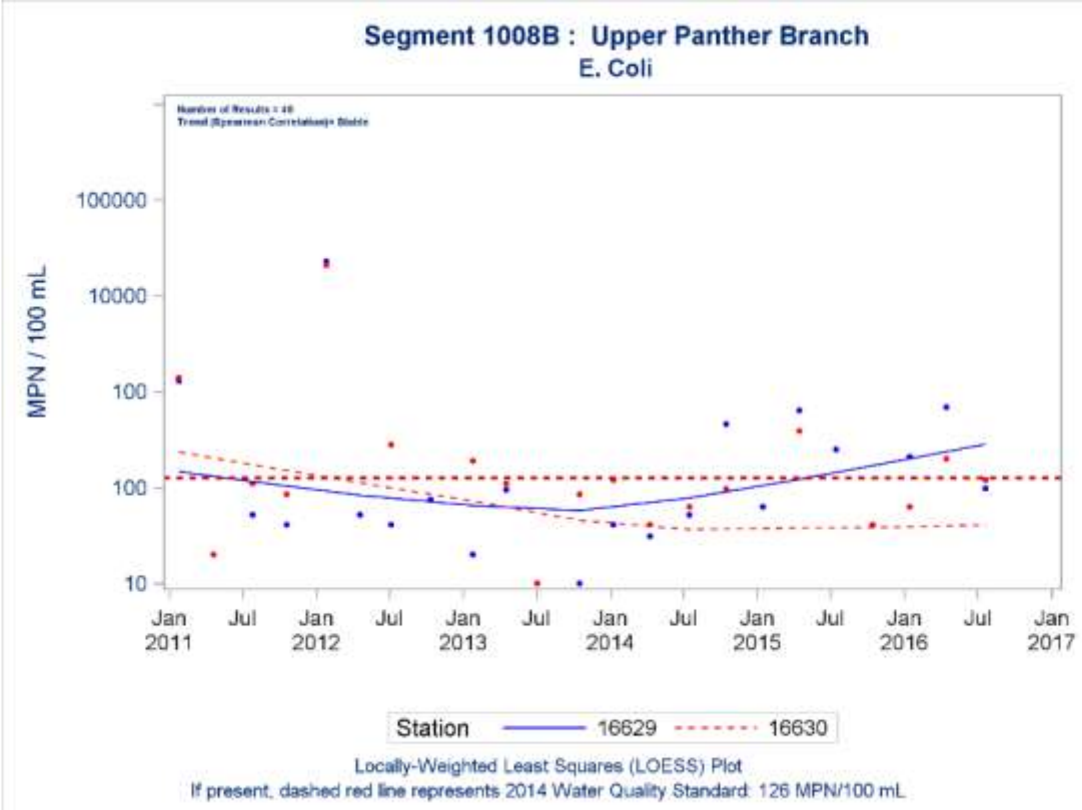

Segment 1008A : Mill Creek
Total Suspended Solids
Mg / L
200
150
100
75
50
25
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station
20461
Locally-Weighted Least Squares (LOESS) Plot

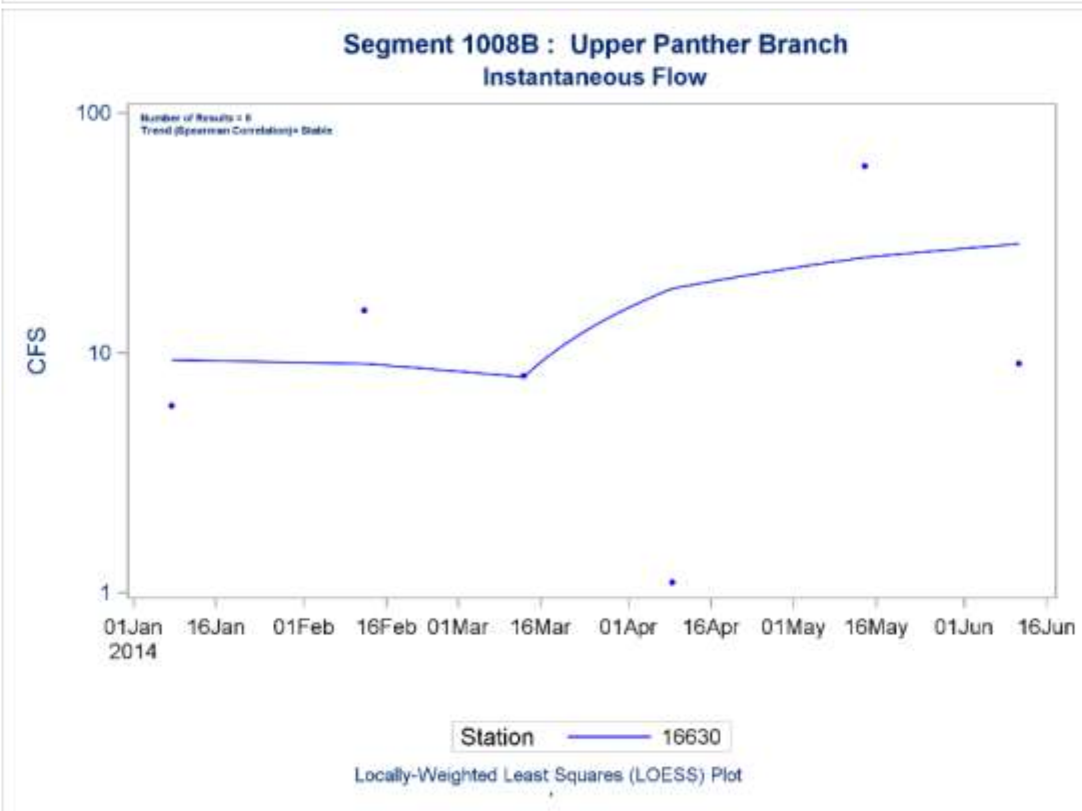


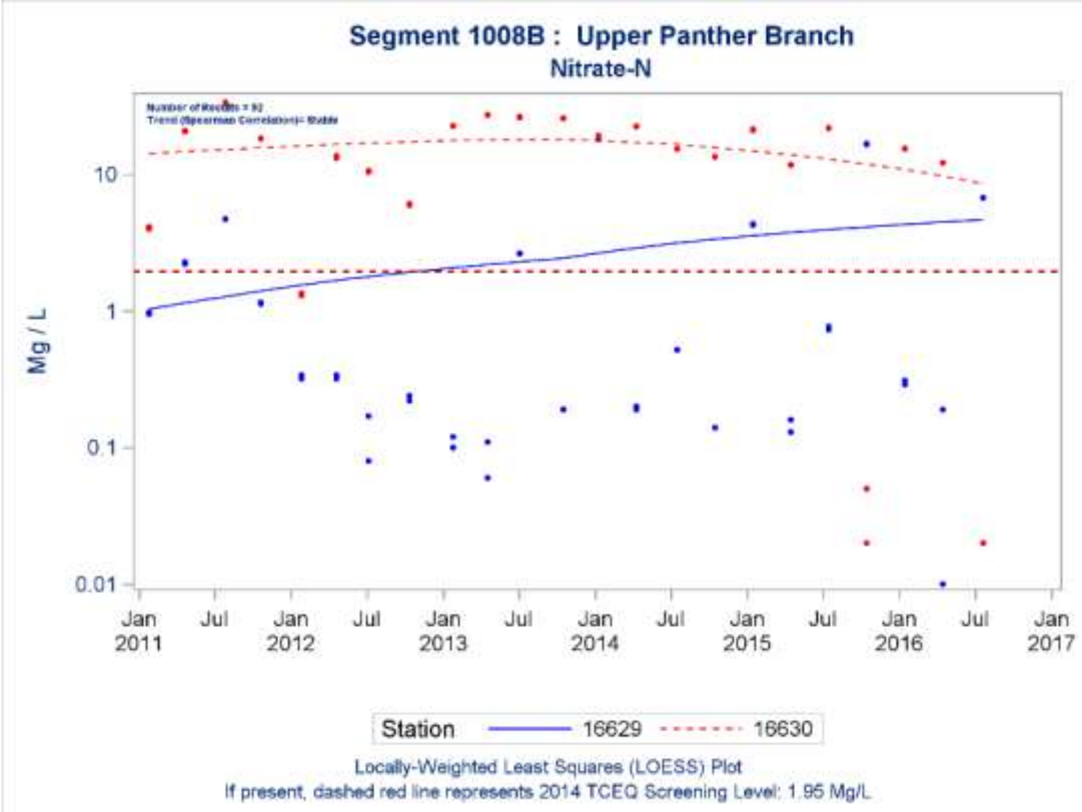
Segment 1008B : Upper Panther Branch
Ammonia-N
Mg / L
1
0.8
0.6
0.4
0.2
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16629
16630
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.33 mg/L

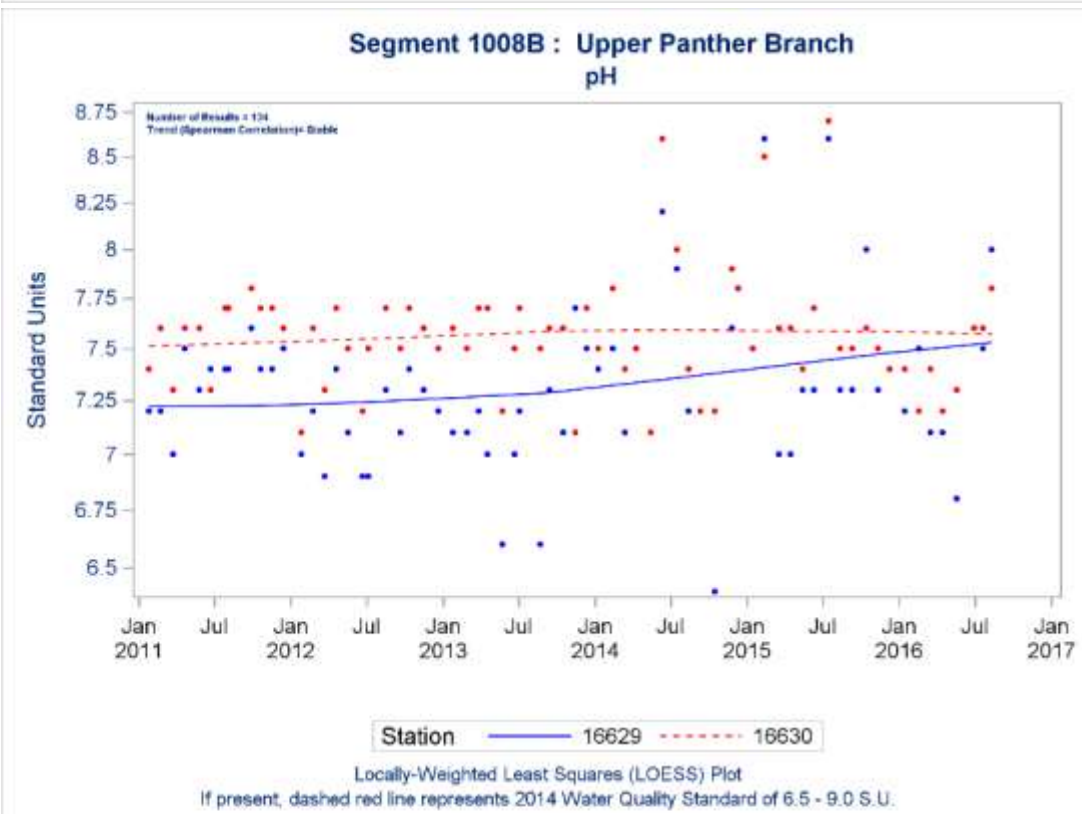


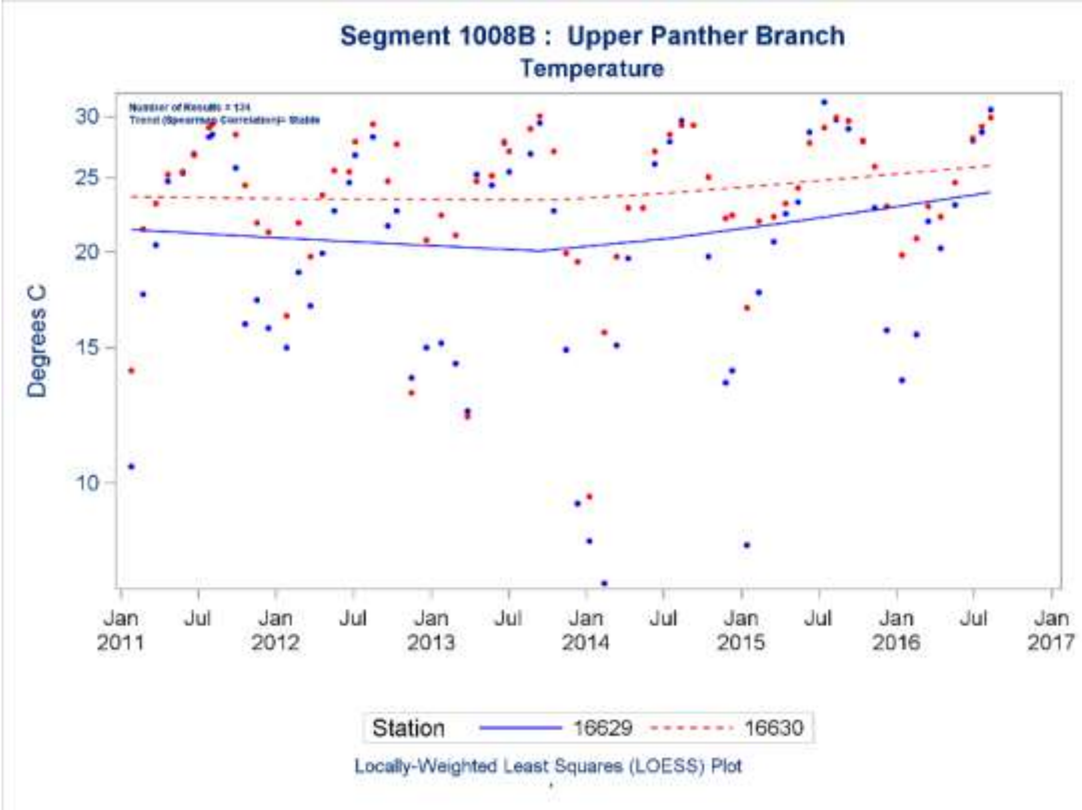
Segment 1008B : Upper Panther Branch
Dissolved Oxygen
Number of Results = 134
Trend (Spearman Correlation)= Increasing
Mg / L
12
10
8
6
4
2
1
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16629
16630
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2016 TCEQ Screening Level: 2.0mg/L

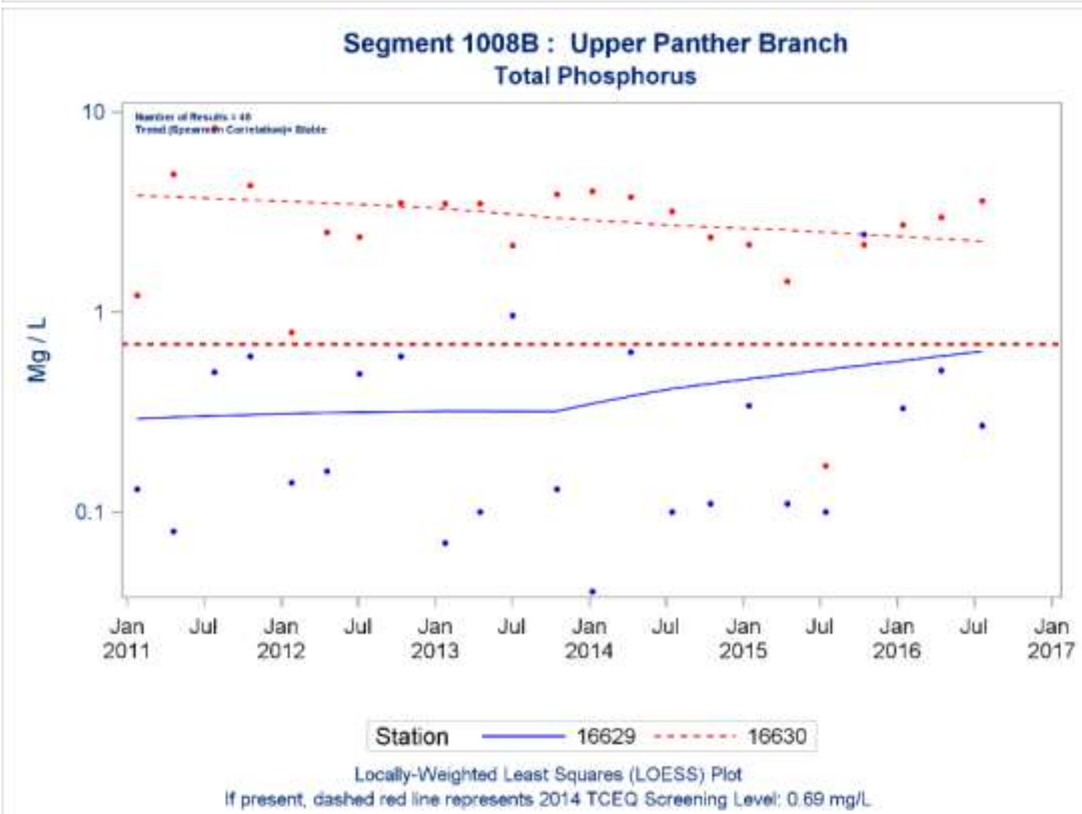

Segment 1008B : Upper Panther Branch
E. Coli
Trend (Spearman Correlation)= Stable
MPN / 100 mL
100000
10000
100
100
10
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16629
16630
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 126 MPN/100 mL

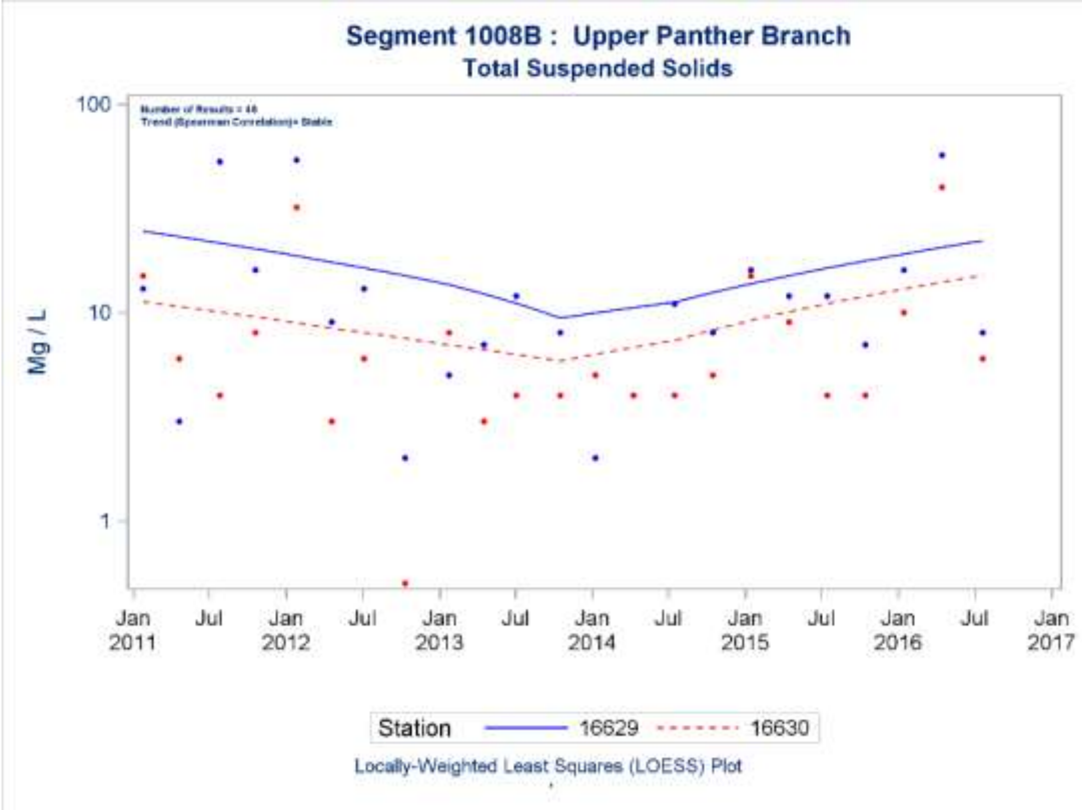

Segment 1008B : Upper Panther Branch
Instantaneous Flow
Trend (Spearman Correlation)= Stable
CFS
100
10
1
01Jan 2014
16Jan
01Feb
16Feb
01Mar
16Mar
01Apr
16Apr
01May
16May
01Jun
16Jun
Station
16630
Locally-Weighted Least Squares (LOESS) Plot

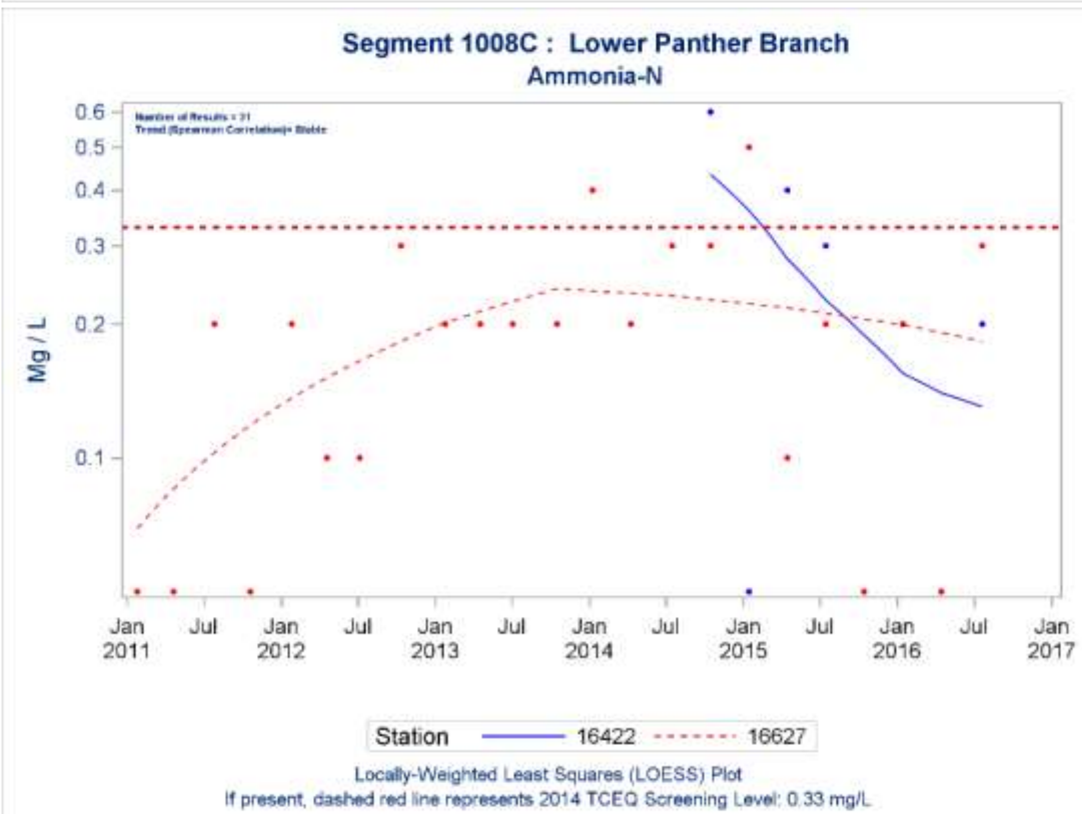

Segment 1008B : Upper Panther Branch
Nitrate-N
Mg / L
10
1
0.1
0.01
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16629
16630
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 1.95 Mg/L

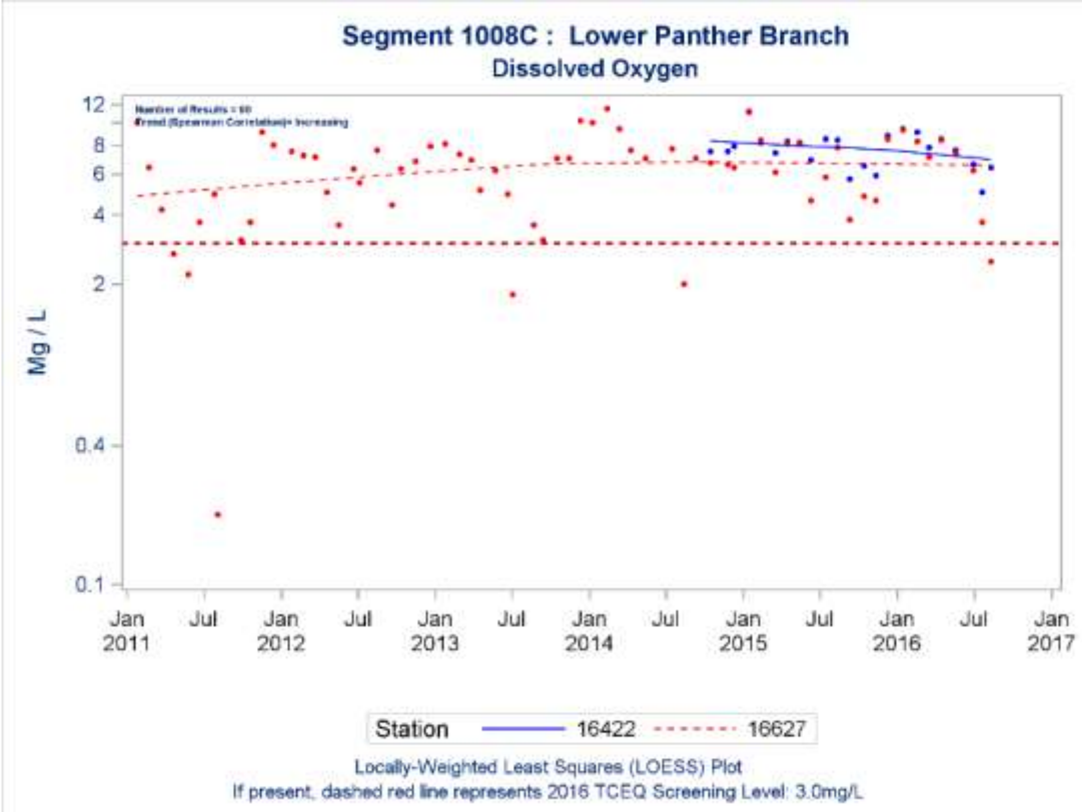

Segment 1008B : Upper Panther Branch
pH
Standard Units
8.75
8.5
8.25
8
7.75
7.5
7.25
7
6.75
6.5
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16629
16630
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard of 6.5 - 9.0 S.U.

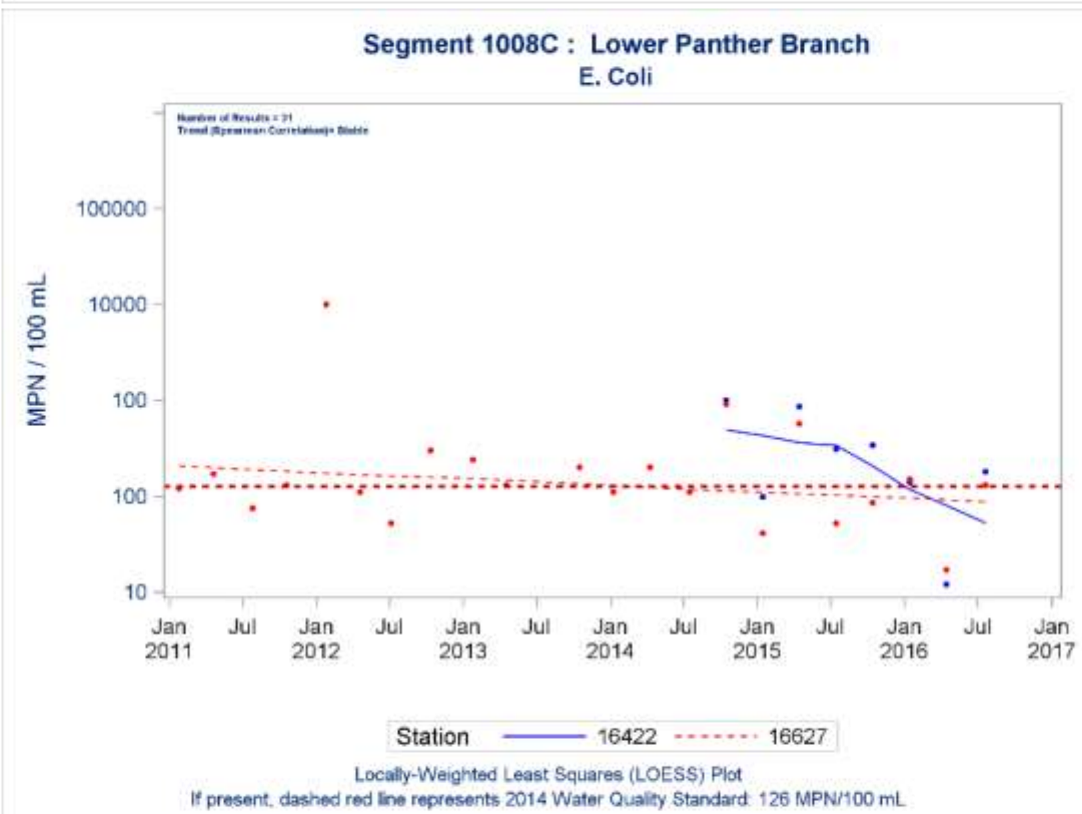

Segment 1008B : Upper Panther Branch
Temperature
Degrees C
30
25
20
15
10
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16629
16630
Locally-Weighted Least Squares (LOESS) Plot

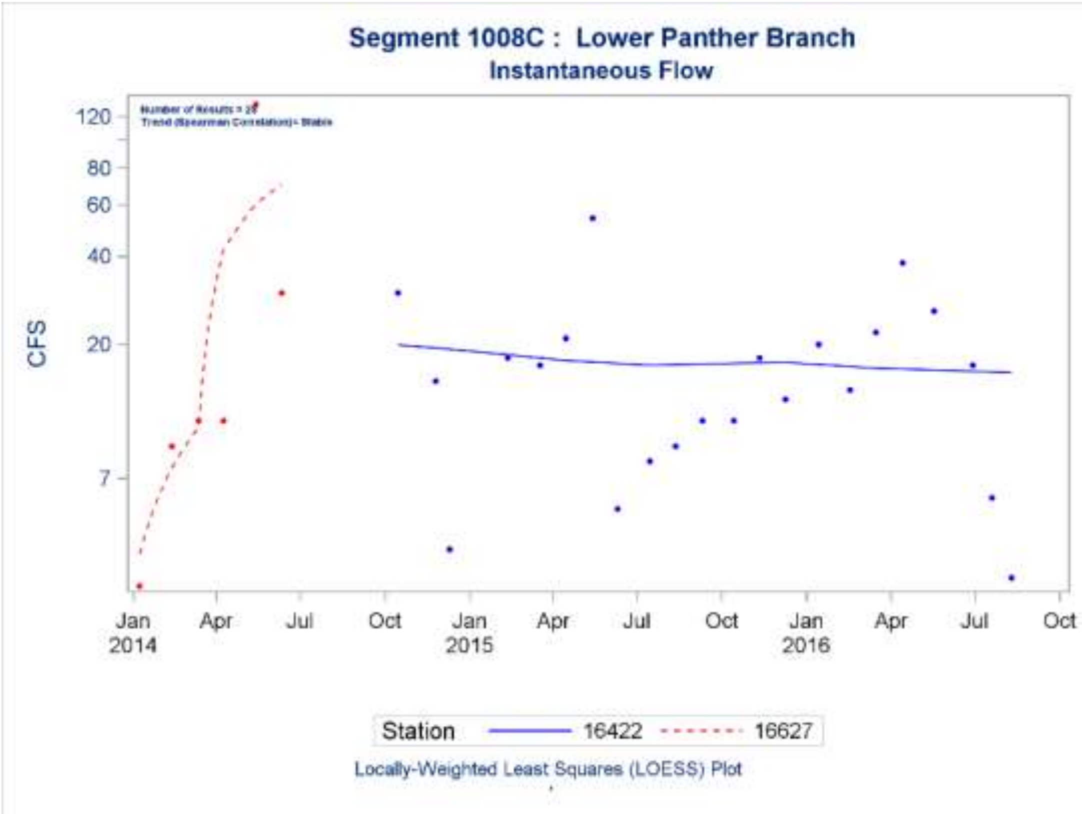

Segment 1008B : Upper Panther Branch
Total Phosphorus
Mg / L
10
1
0.1
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16629
16630
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.69 mg/L


Segment 1008B : Upper Panther Branch
Total Suspended Solids
100
10
1
Mg / L
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16629
16630
Locally-Weighted Least Squares (LOESS) Plot

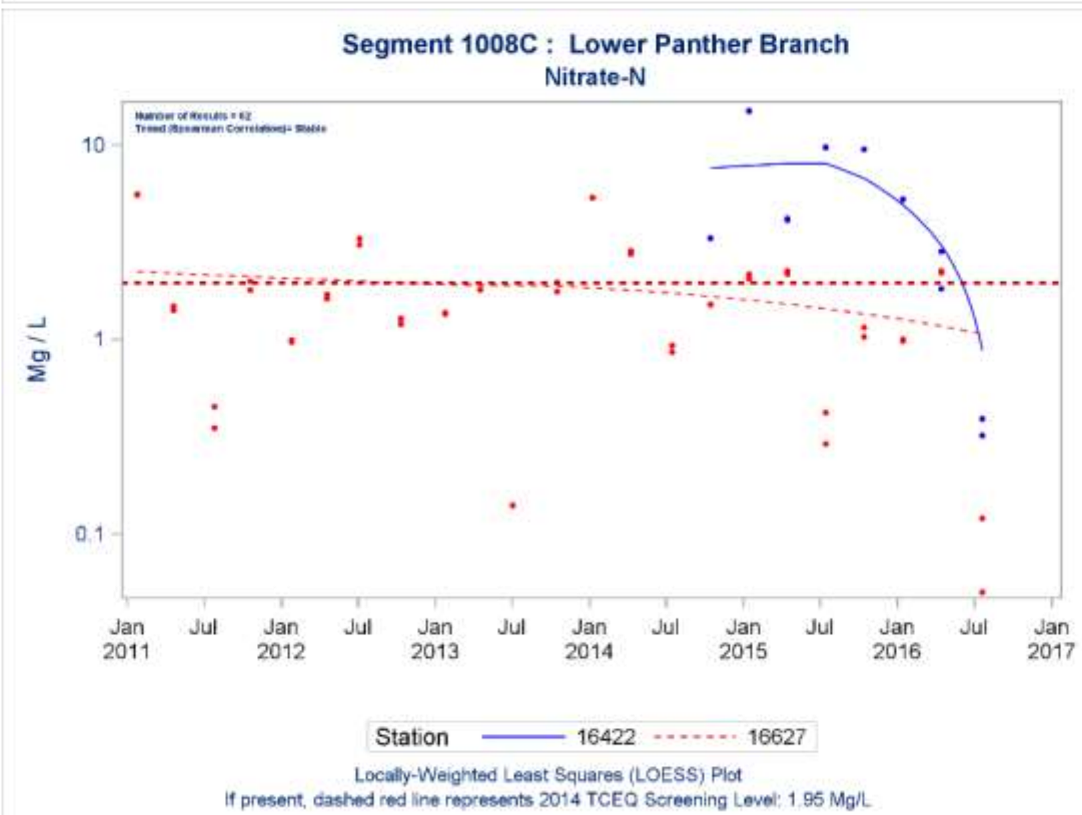

Segment 1008C : Lower Panther Branch
Ammonia-N
0.6
0.5
0.4
0.3
0.2
0.1
Mg / L
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16422
16627
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.33 mg/L


Segment 1008C : Lower Panther Branch
Dissolved Oxygen
Mg / L
12
8
6
4
2
0.4
0.1
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16422
16627
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2016 TCEQ Screening Level: 3.0mg/L

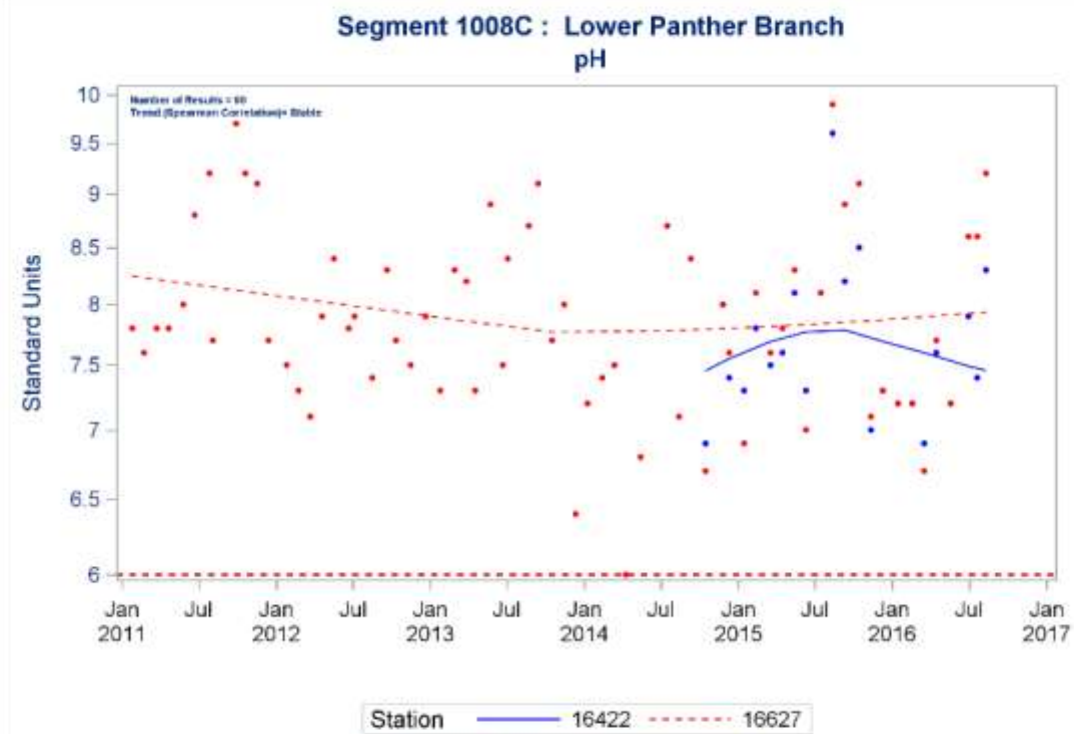

Segment 1008C : Lower Panther Branch
E. Coli
MPN / 100 mL
100000
10000
100
100
10
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16422
16627
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 126 MPN/100 mL



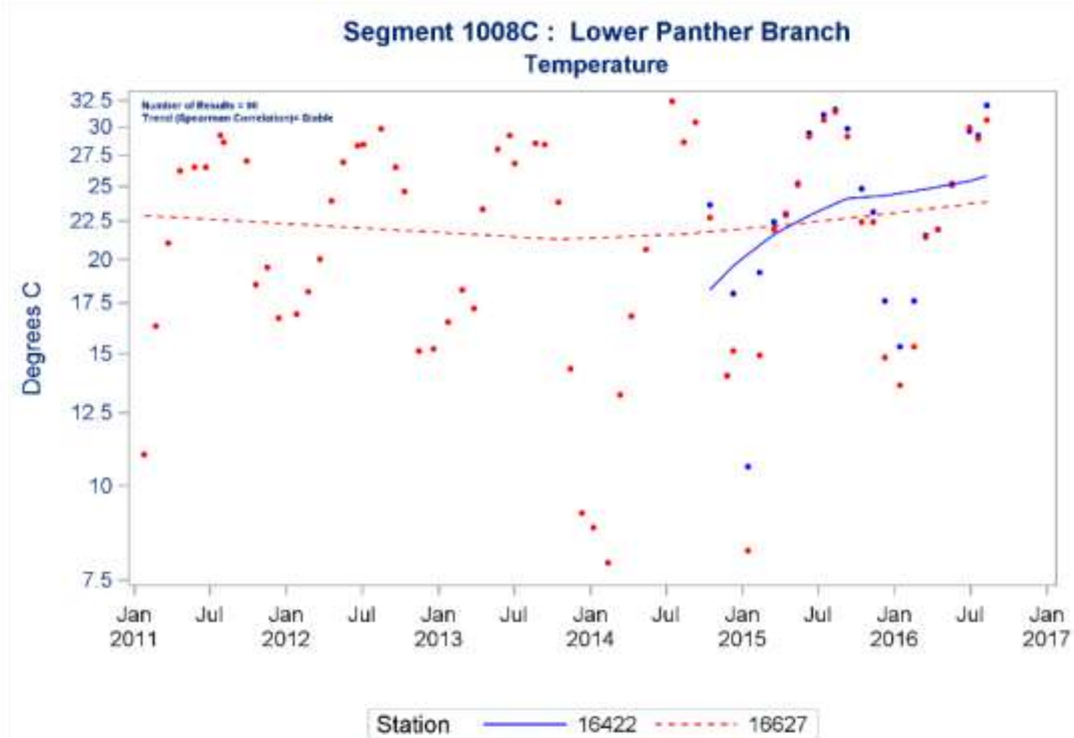
Segment 1008C : Lower Panther Branch
Instantaneous Flow
CFS
120
80
60
40
20
7
Jan 2014
Apr
Jul
Oct
Jan 2015
Apr
Jul
Oct
Jan 2016
Apr
Jul
Oct
Station
16422
16627
Locally-Weighted Least Squares (LOESS) Plot



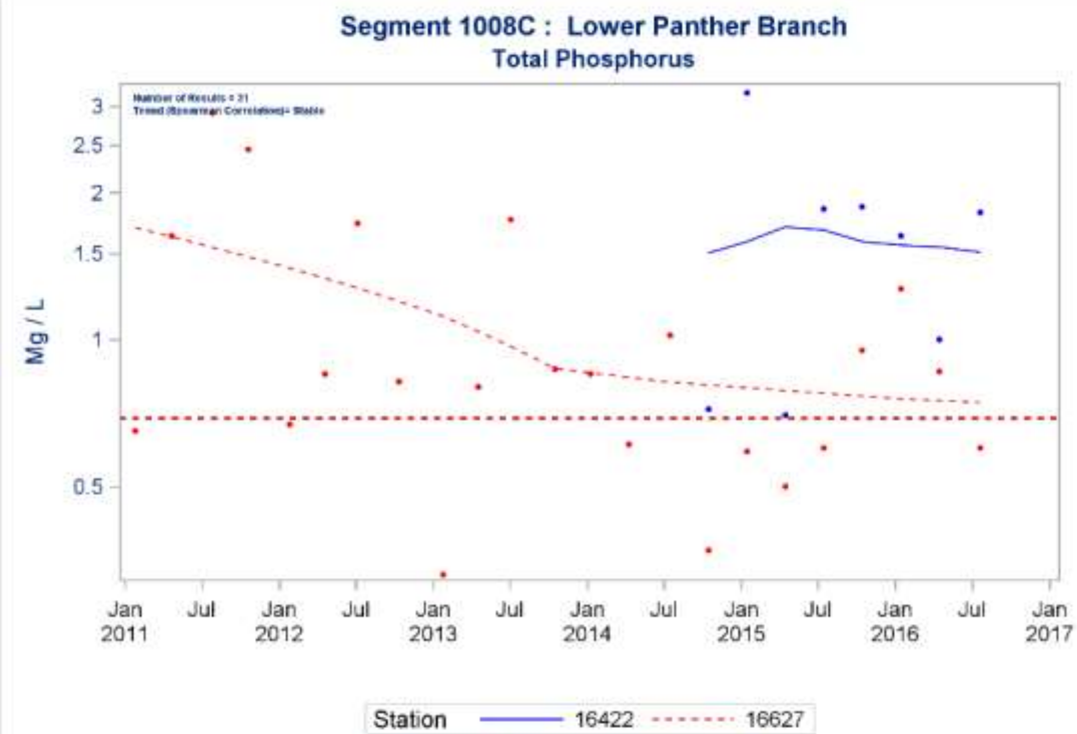
Segment 1008C : Lower Panther Branch
Nitrate-N
Mg / L
10
1
0.1
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16422
16627
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 1.95 Mg/L



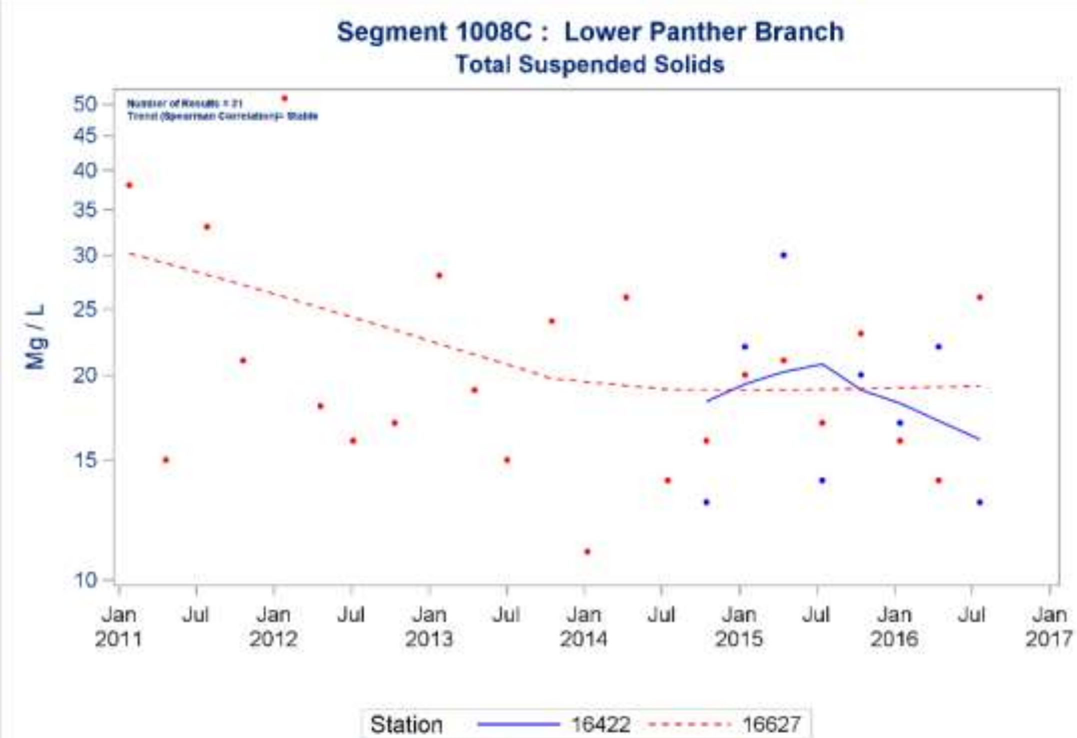
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard of 6.5 - 9.0 S.U.



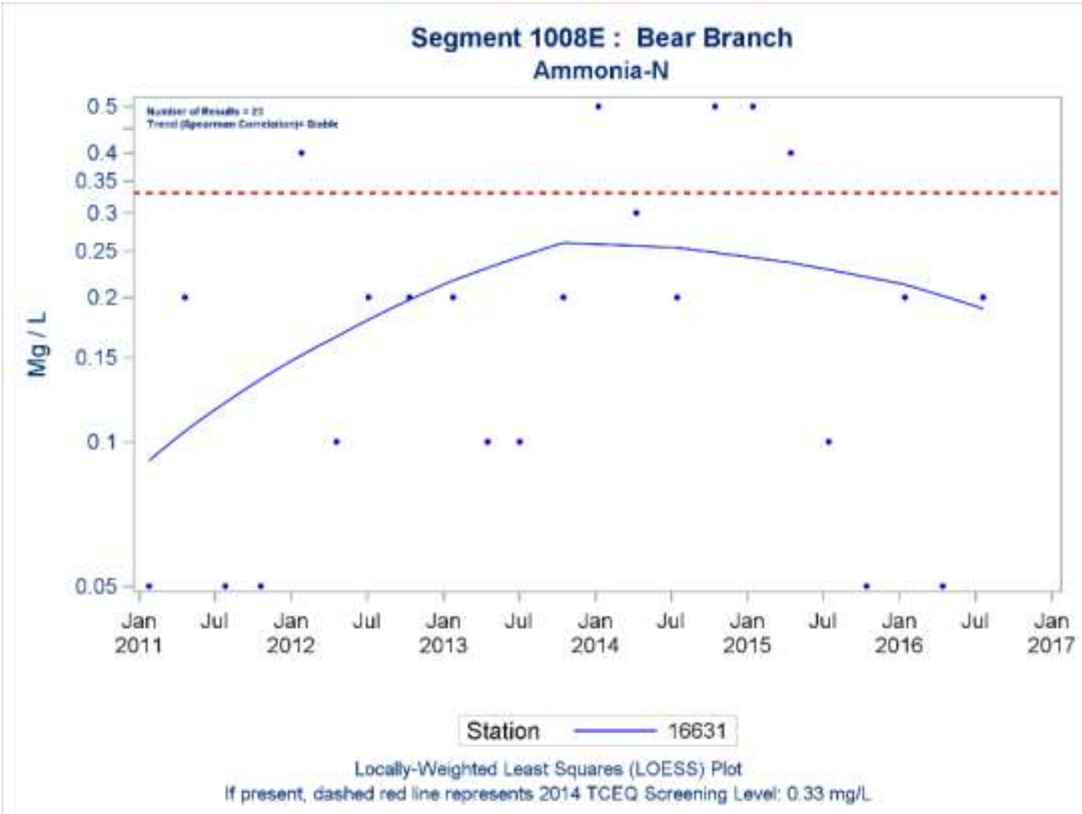
Locally-Weighted Least Squares (LOESS) Plot

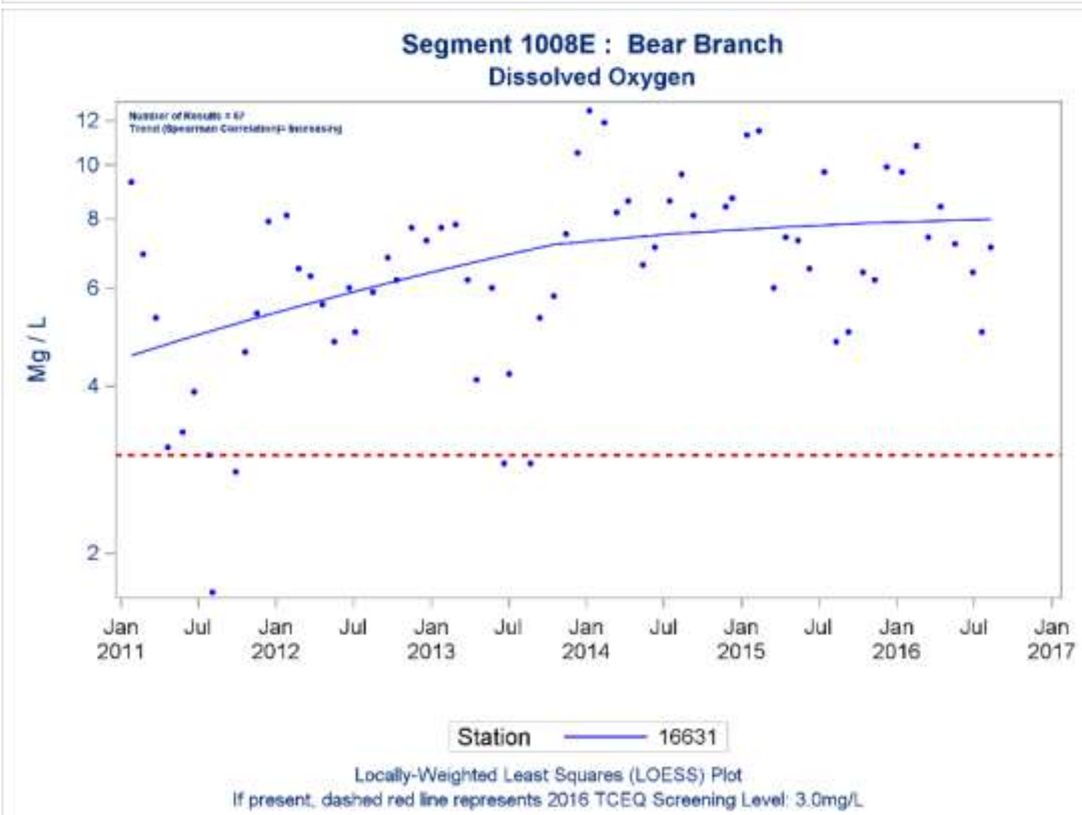


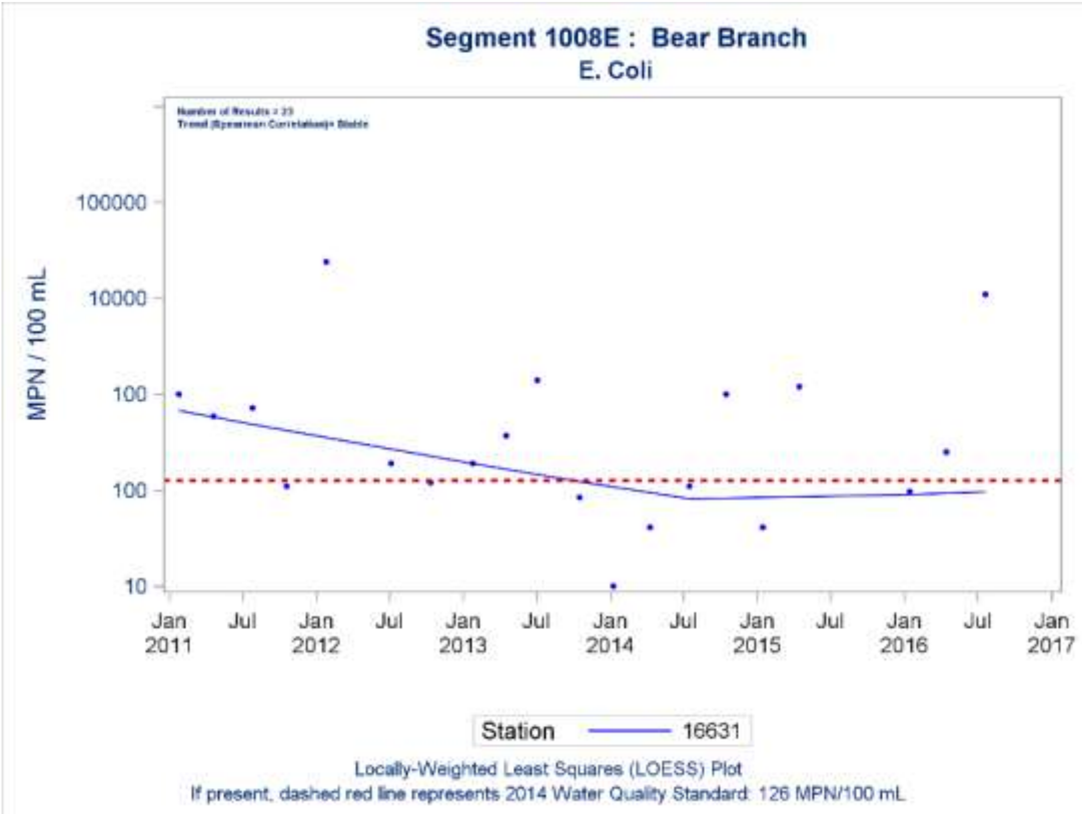
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.69 mg/L

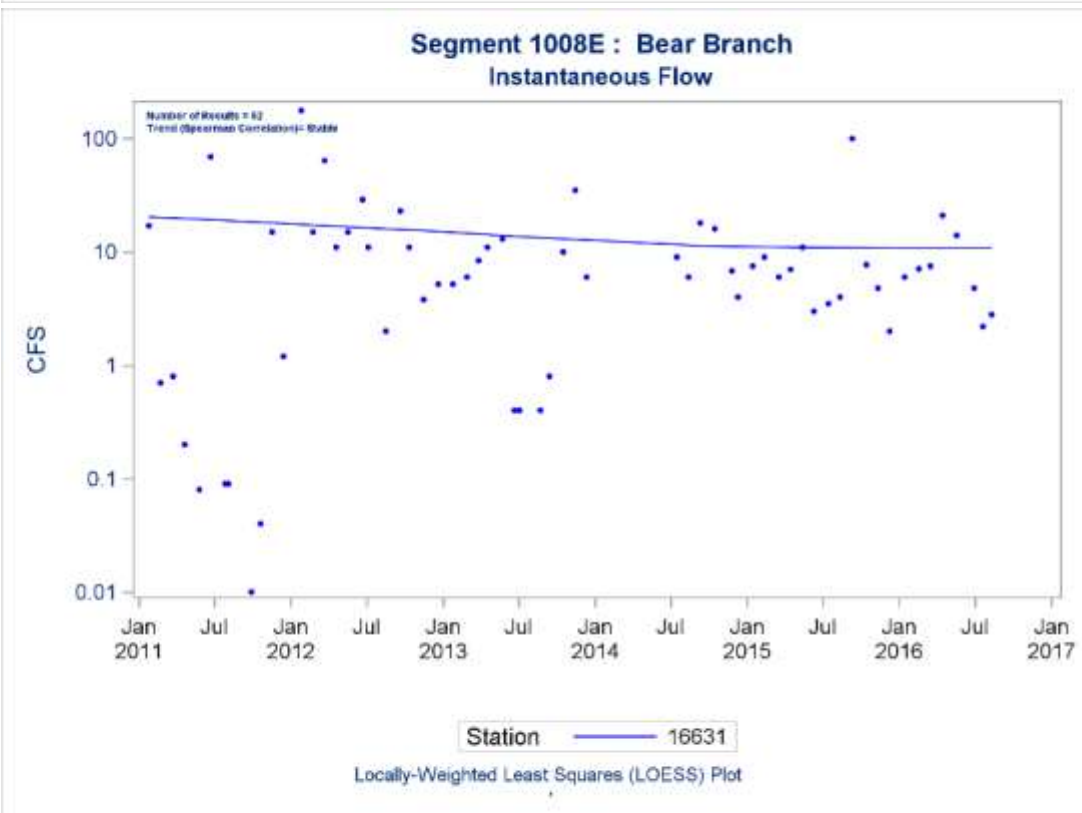


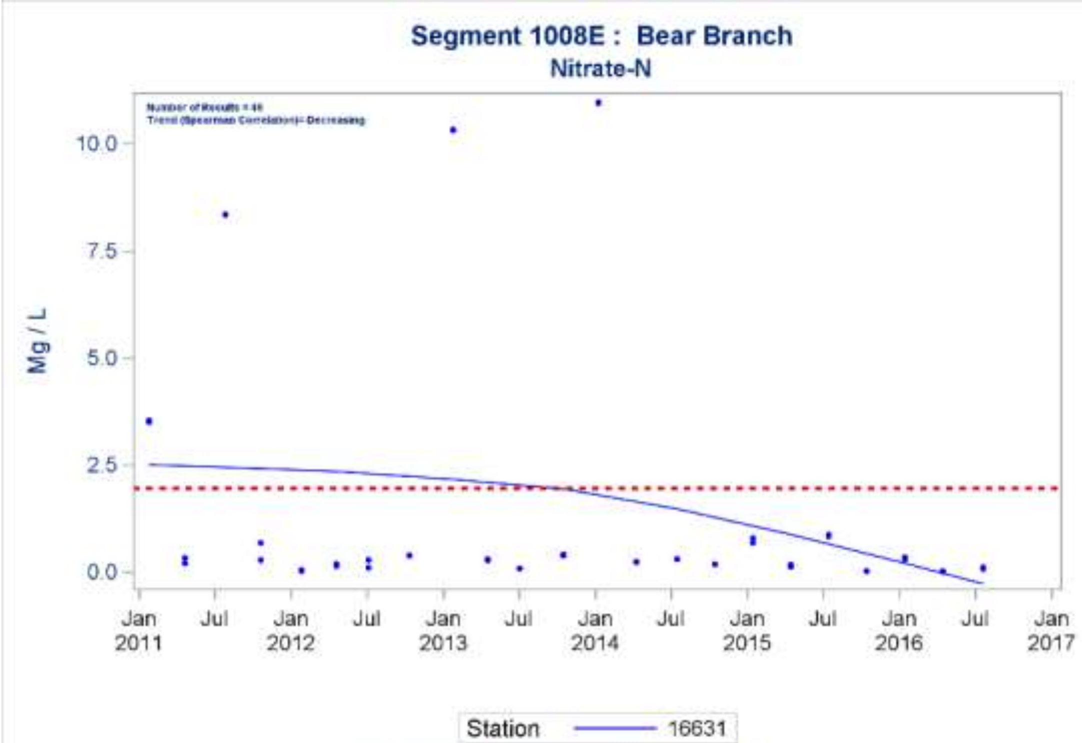
Locally-Weighted Least Squares (LOESS) Plot


Segment 1008E : Bear Branch
Ammonia-N
Mg / L
0.5
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16631
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.33 mg/L

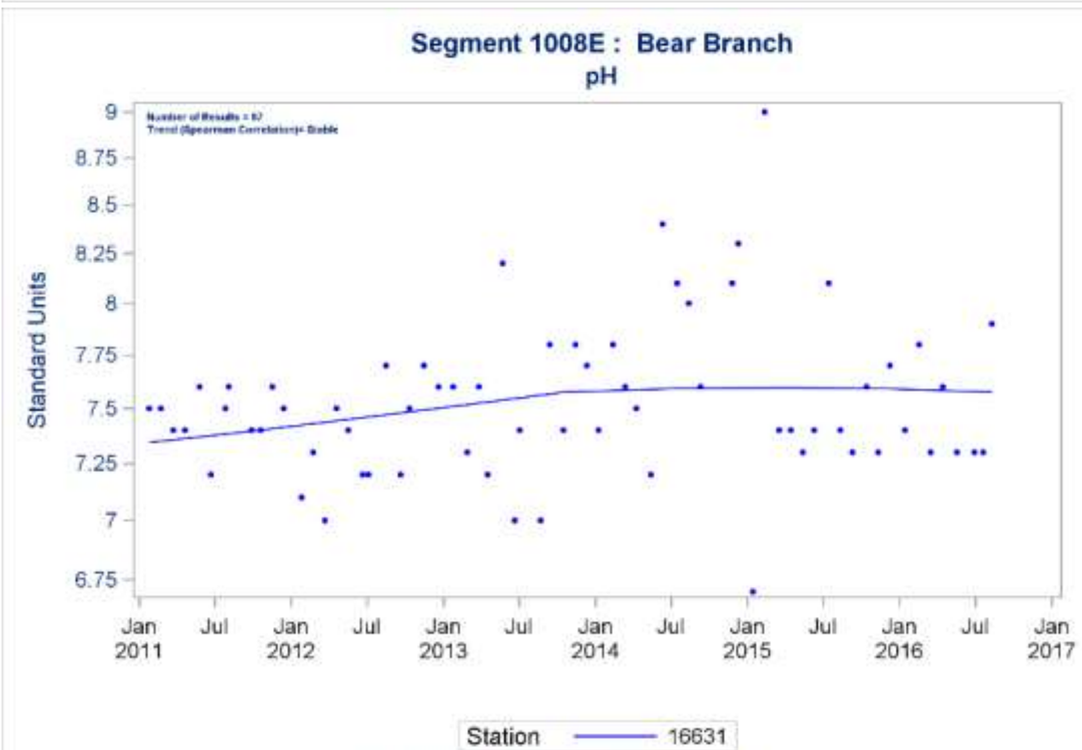

Segment 1008E : Bear Branch
Dissolved Oxygen
Mg / L
12
10
8
6
4
2
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16631
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2016 TCEQ Screening Level: 3.0mg/L


Segment 1008E : Bear Branch
E. Coli
MPN / 100 mL
100000
10000
100
100
10
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16631
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 126 MPN/100 mL

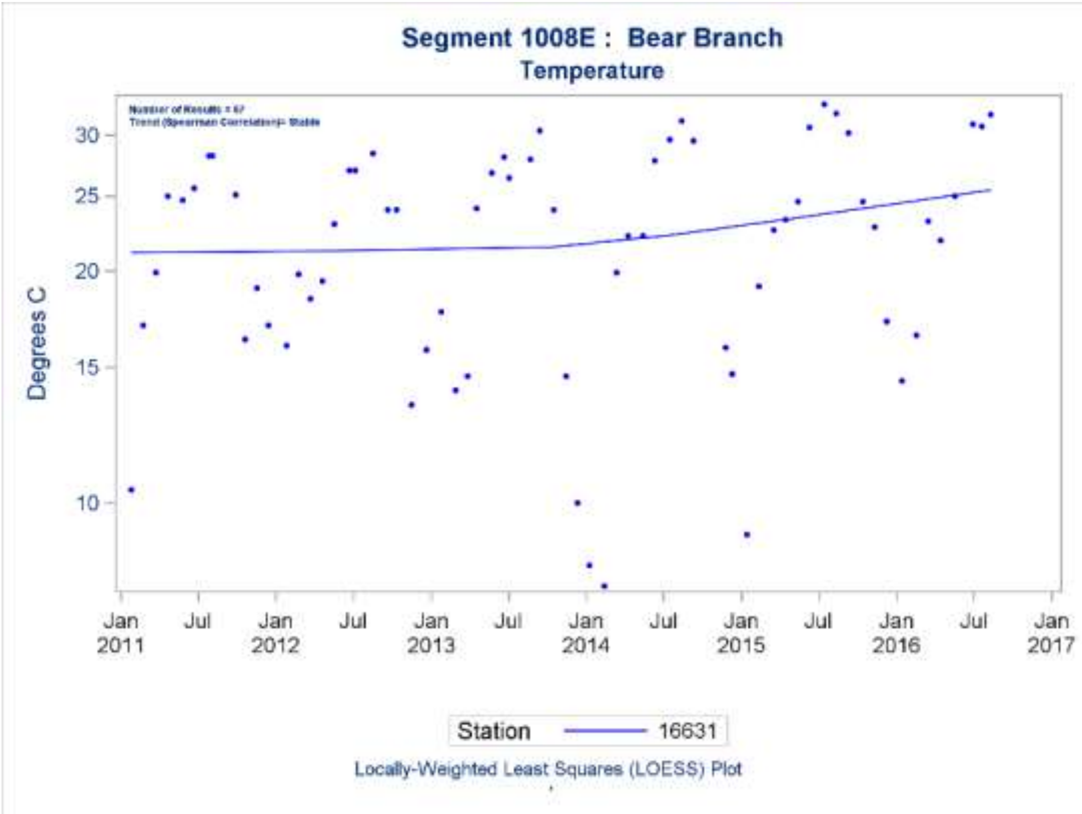

Segment 1008E : Bear Branch
Instantaneous Flow
CFS
100
10
1
0.1
0.01
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16631
Locally-Weighted Least Squares (LOESS) Plot

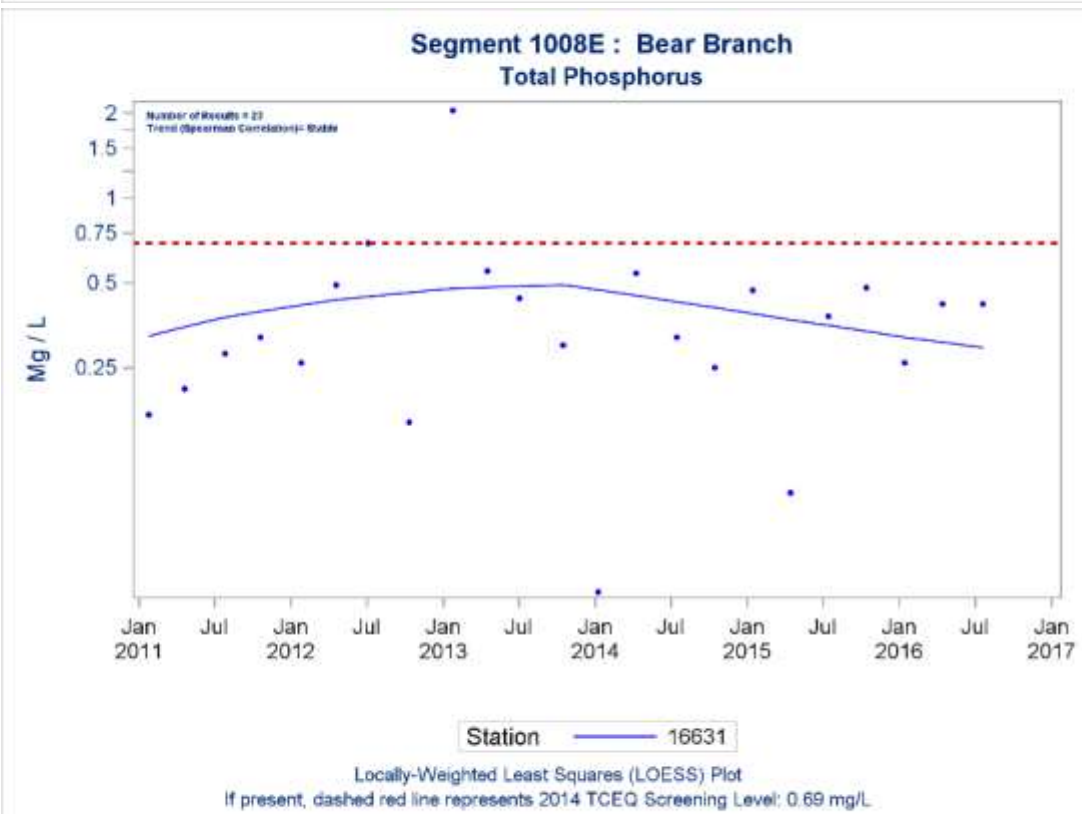


Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 1.95 Mg/L

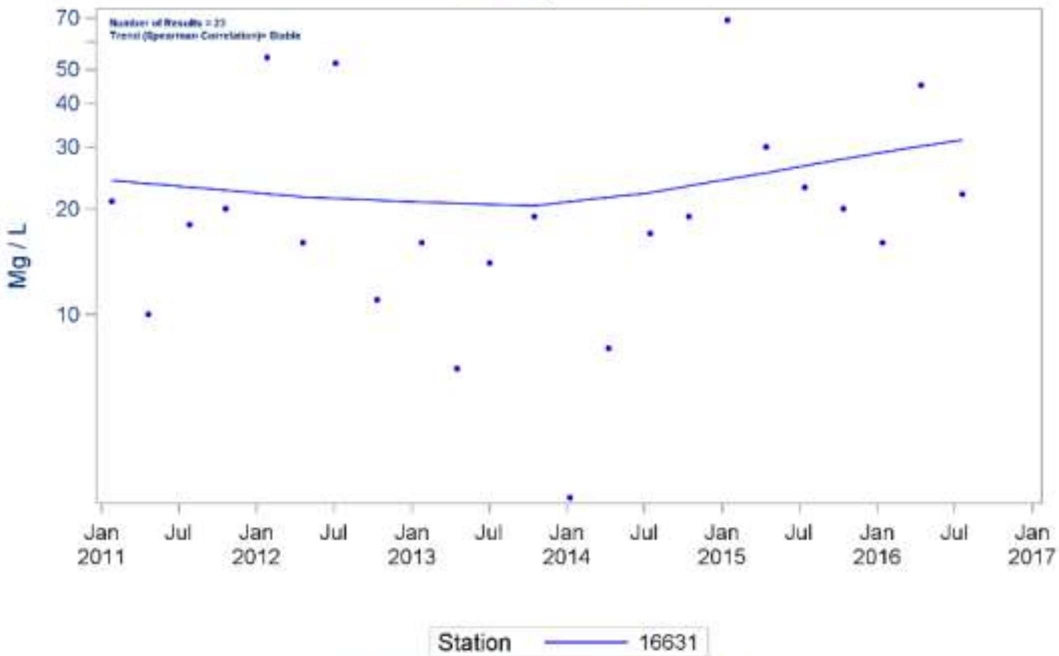


Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard of 6.5 - 9.0 S.U.


Segment 1008E : Bear Branch
Temperature
Number of Results = 67
Trend (Spearman Correlation)= Stable
Degrees C
30
25
20
15
10
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16631
Locally-Weighted Least Squares (LOESS) Plot

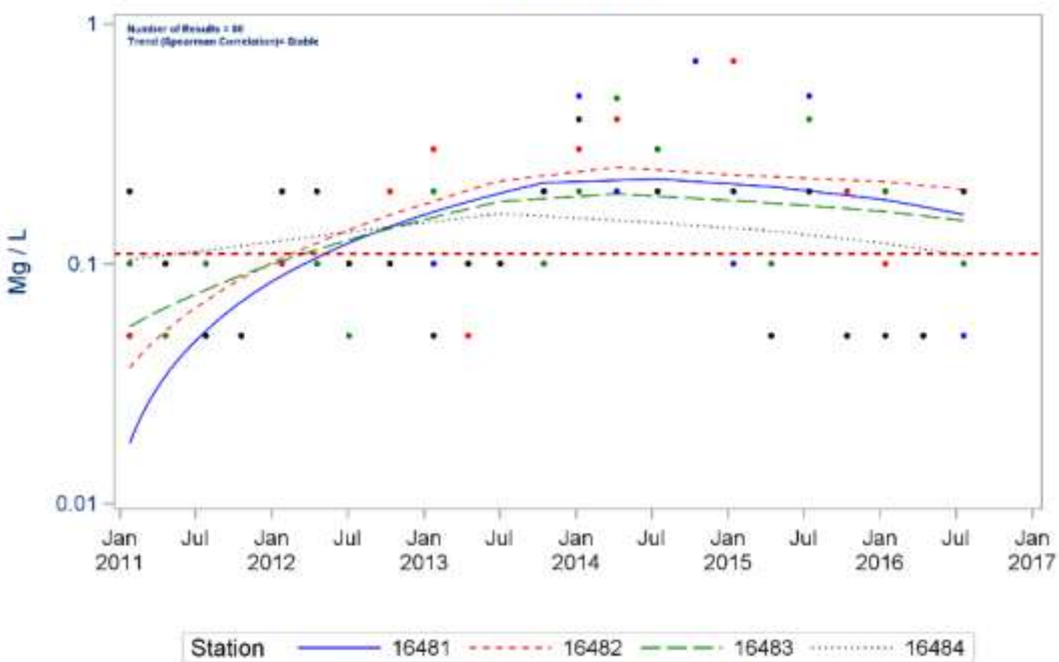

Segment 1008E : Bear Branch
Total Phosphorus
Trend (Spearman Correlation)= Stable
Mg / L
2
1.5
1
0.75
0.5
0.25
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16631
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.69 mg/L

Segment 1008E : Bear Branch
Total Suspended Solids



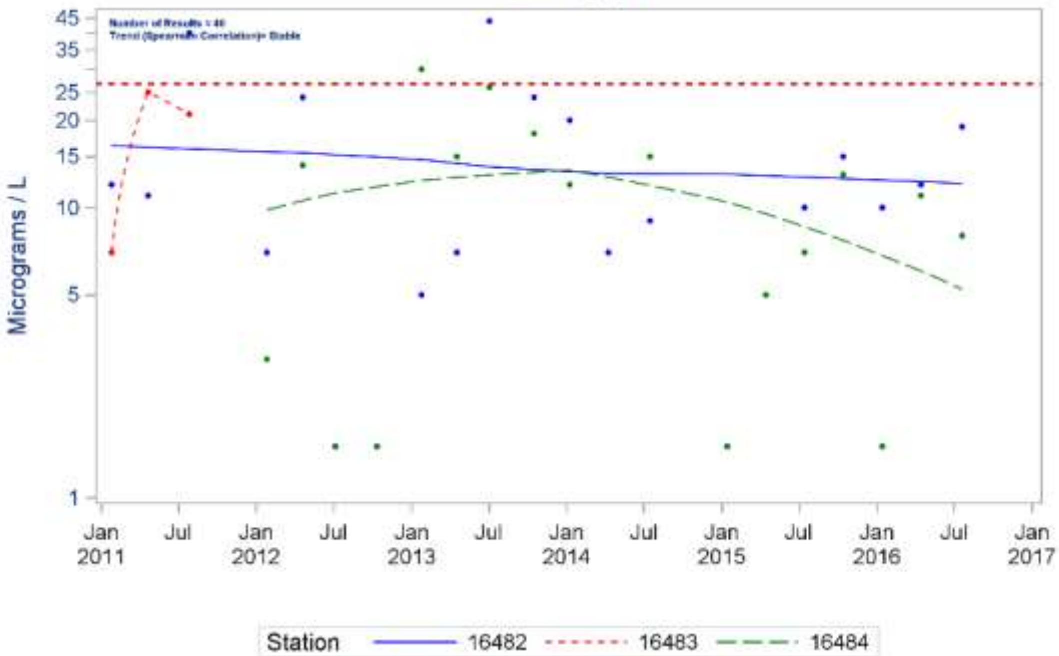
Locally-Weighted Least Squares (LOESS) Plot

Segment 1008F : Lake Woodlands
Ammonia-N



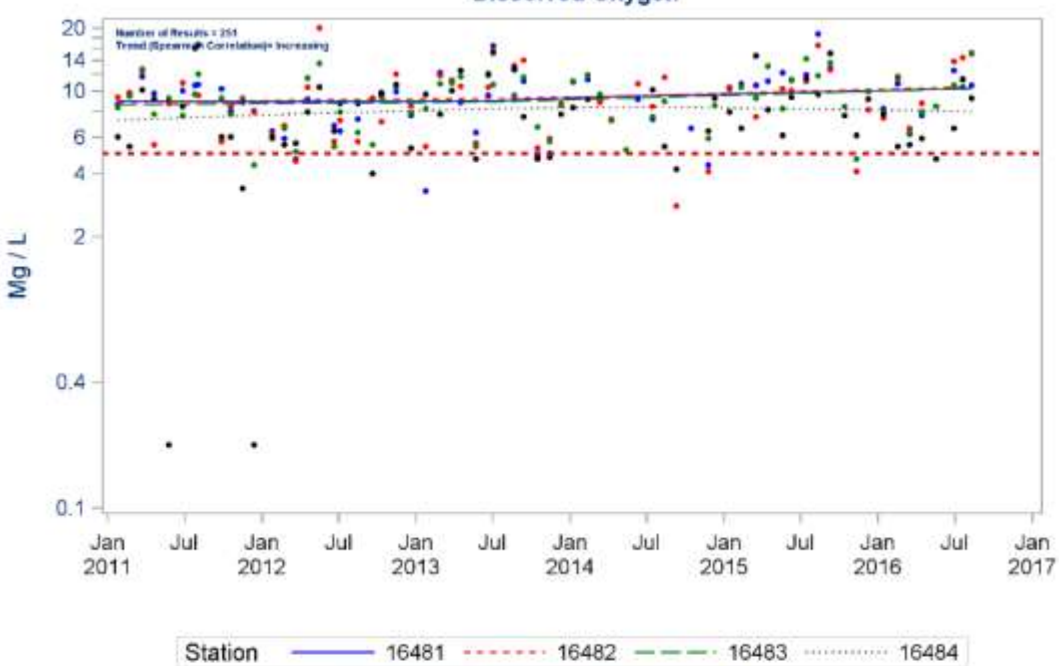
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.11 mg/L

Segment 1008F : Lake Woodlands
Chlorophyll a

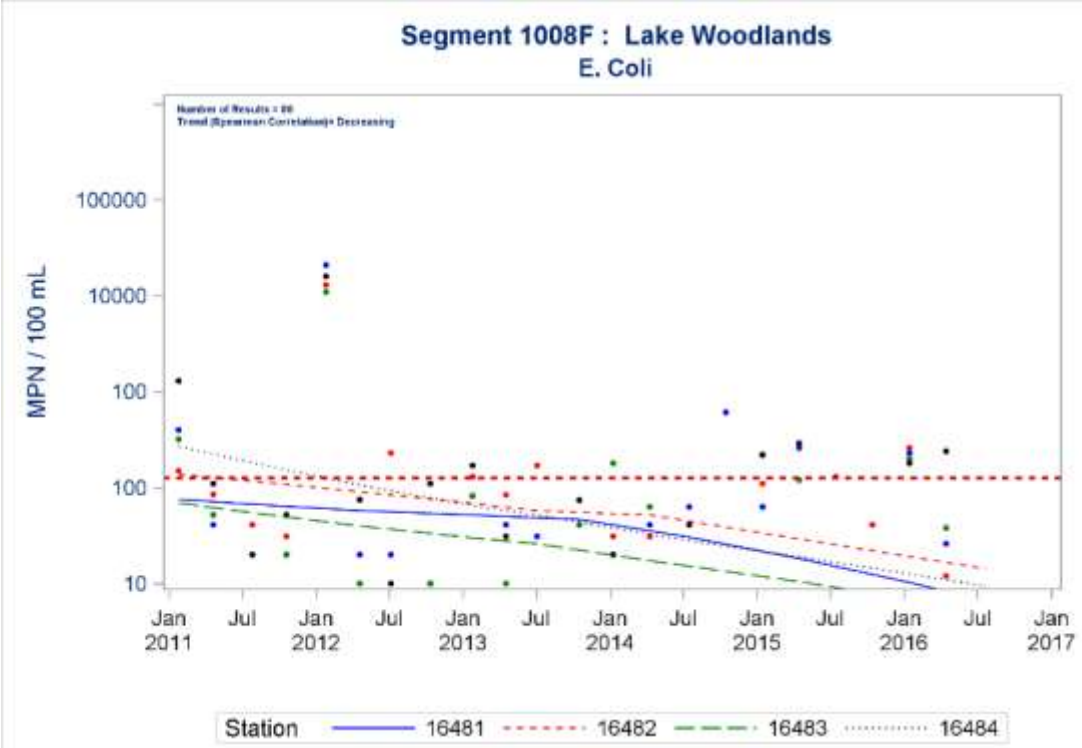


Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 26.7 Micrograms / L

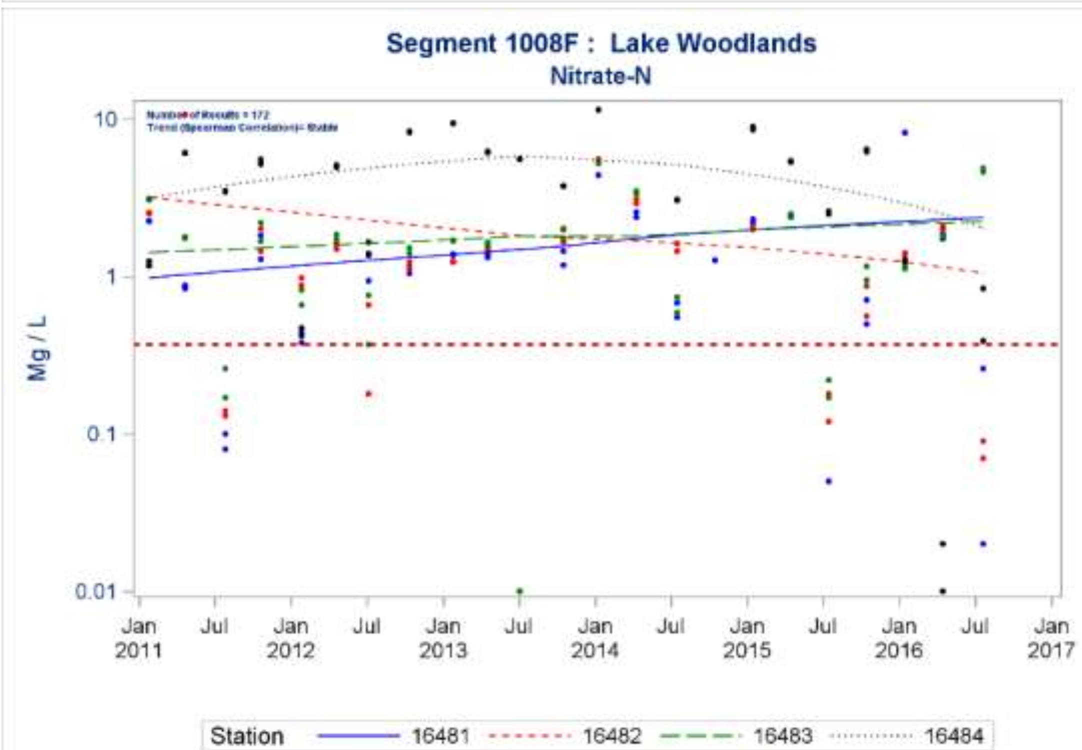
Segment 1008F : Lake Woodlands
Dissolved Oxygen



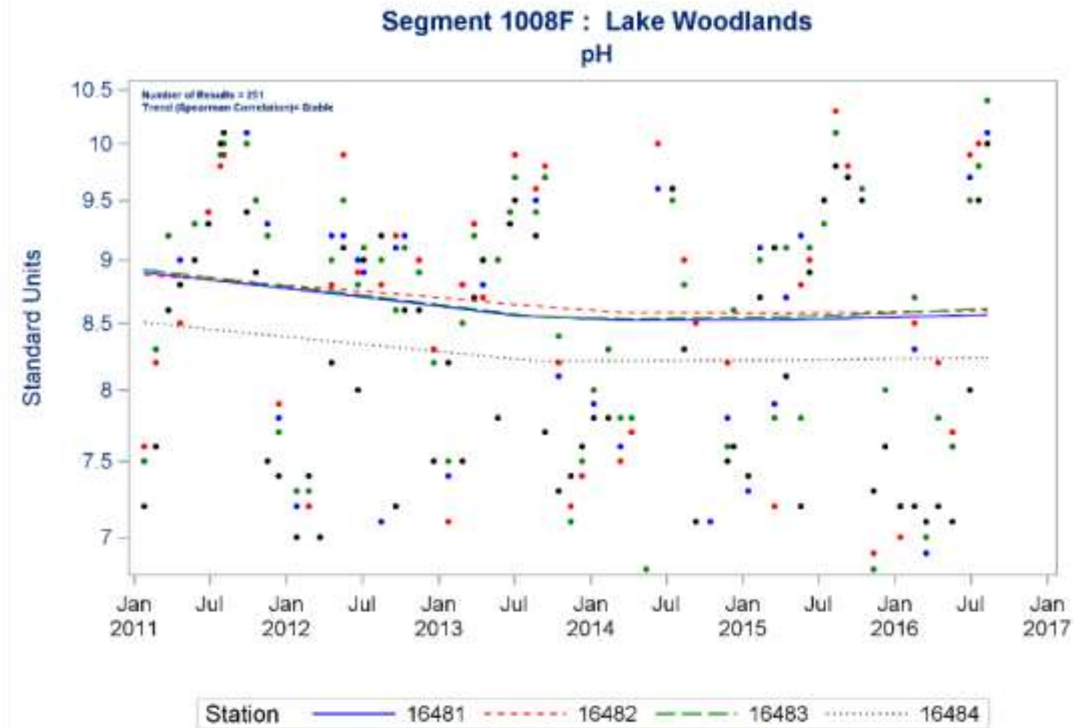
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2016 TCEQ Screening Level: 5.0mg/L



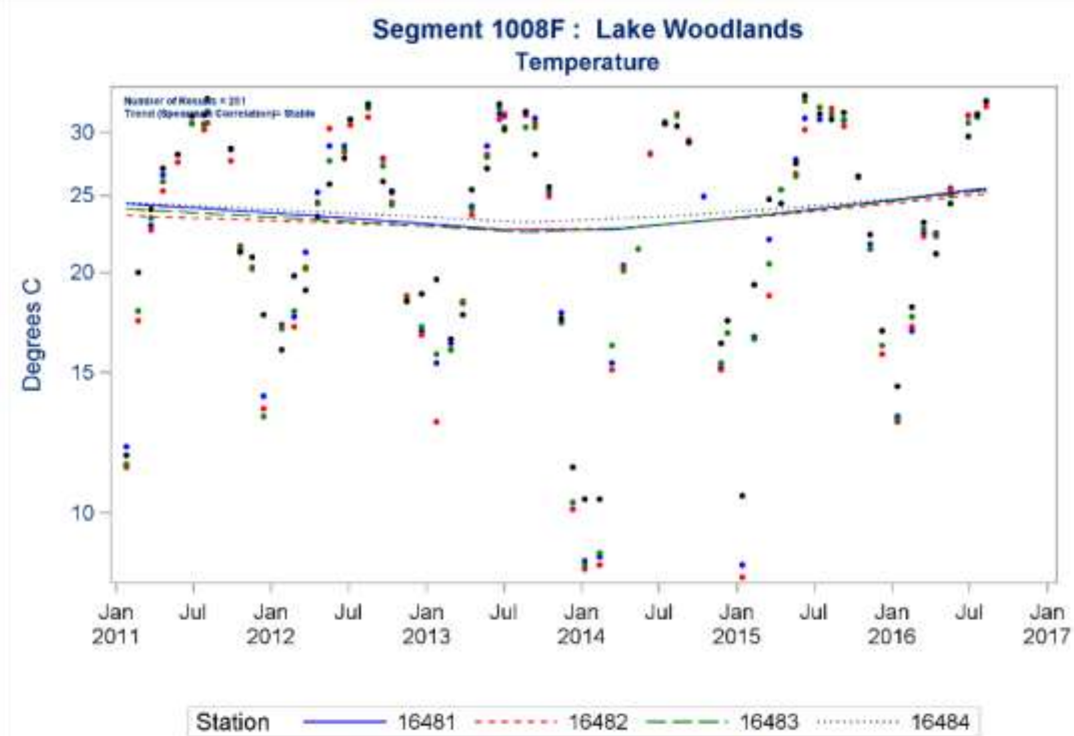
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 126 MPN/100 mL



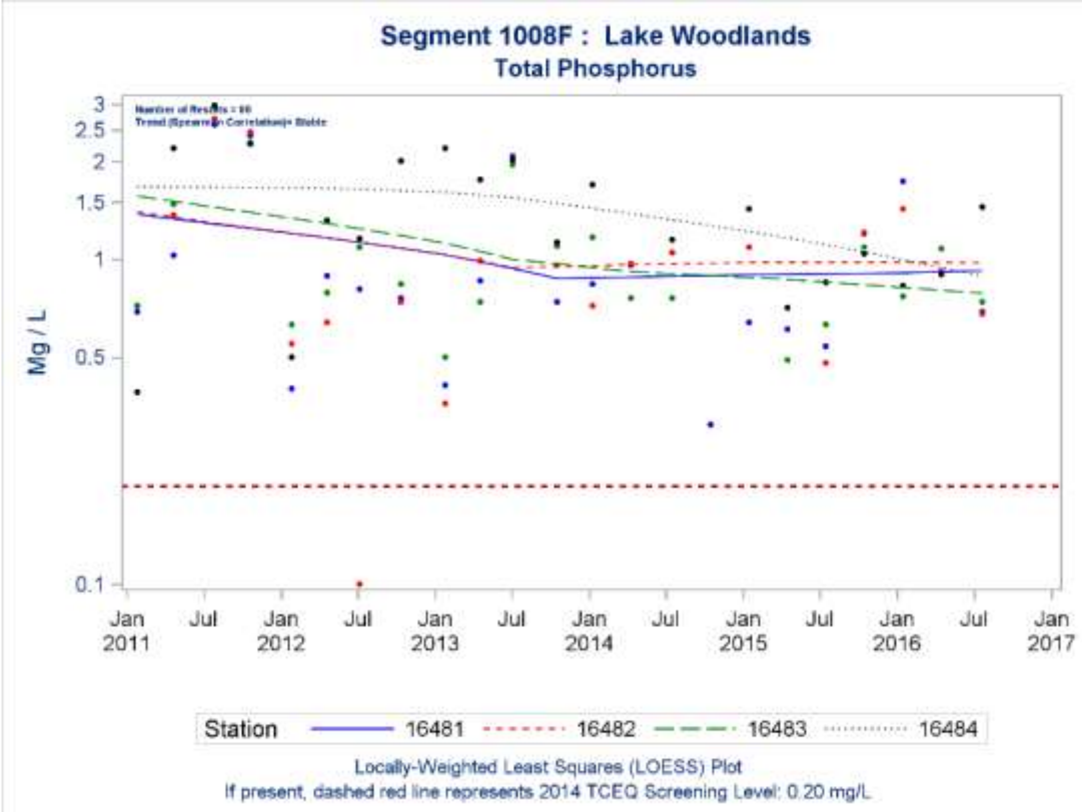
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.37 mg/L

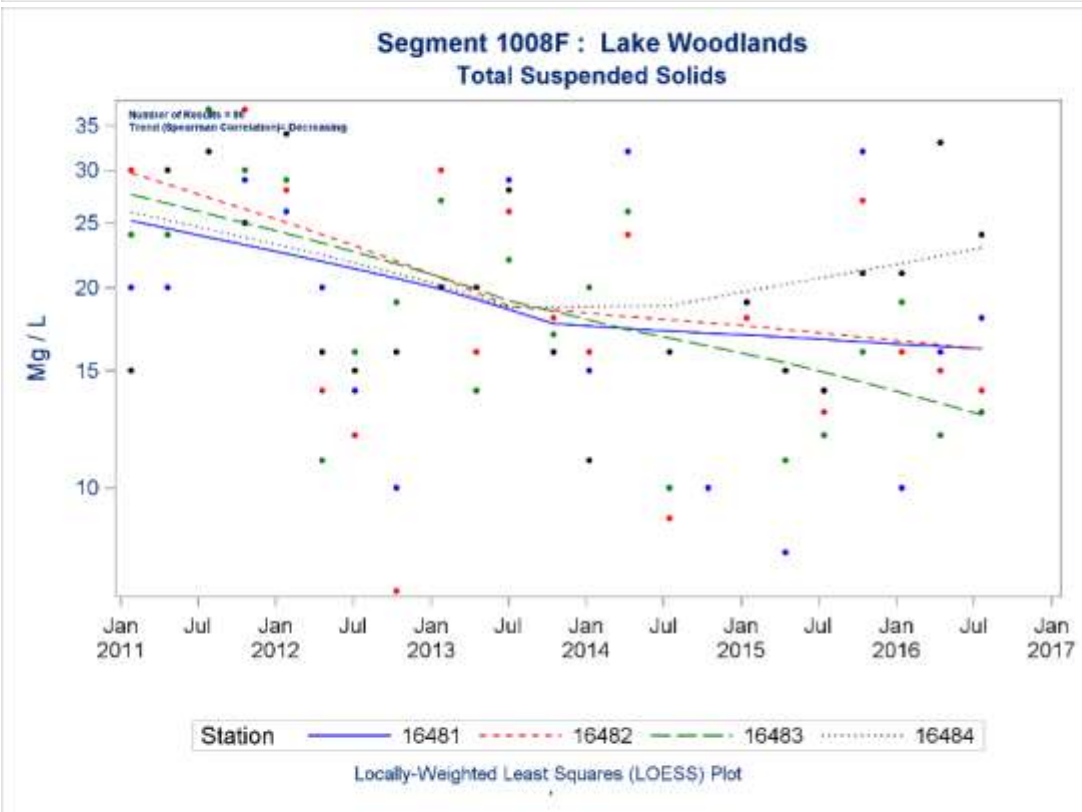


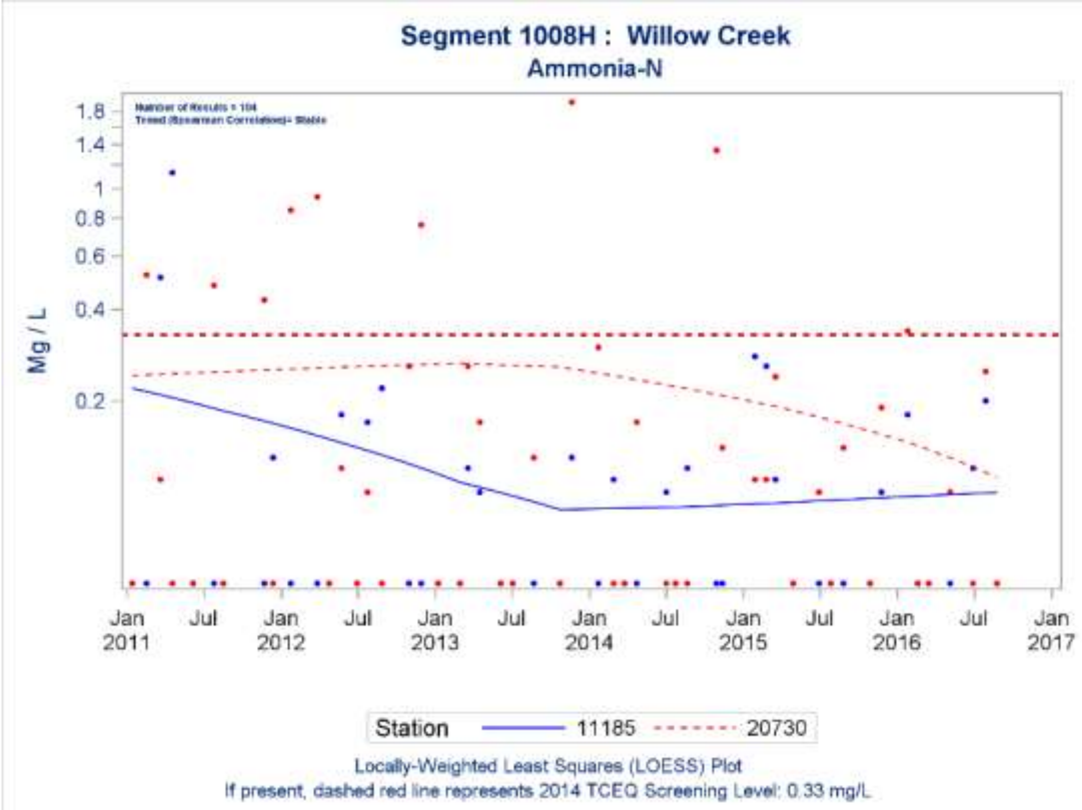
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard of 6.5 - 9.0 S.U.

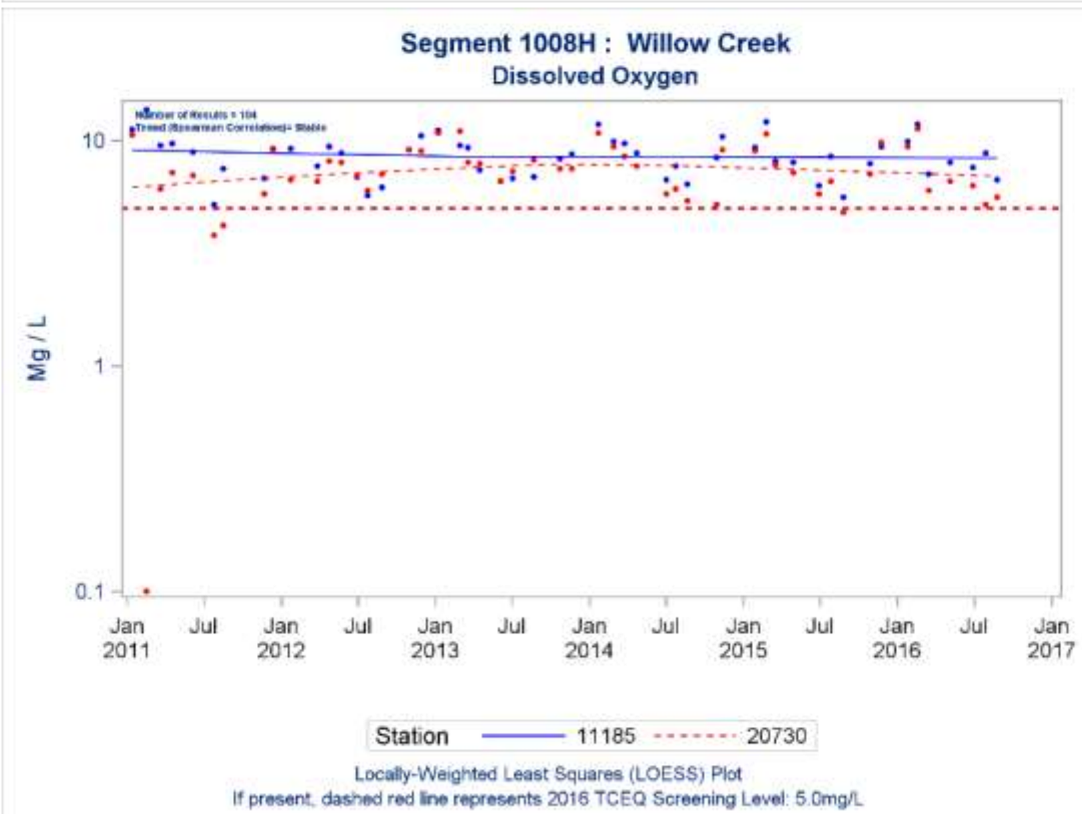


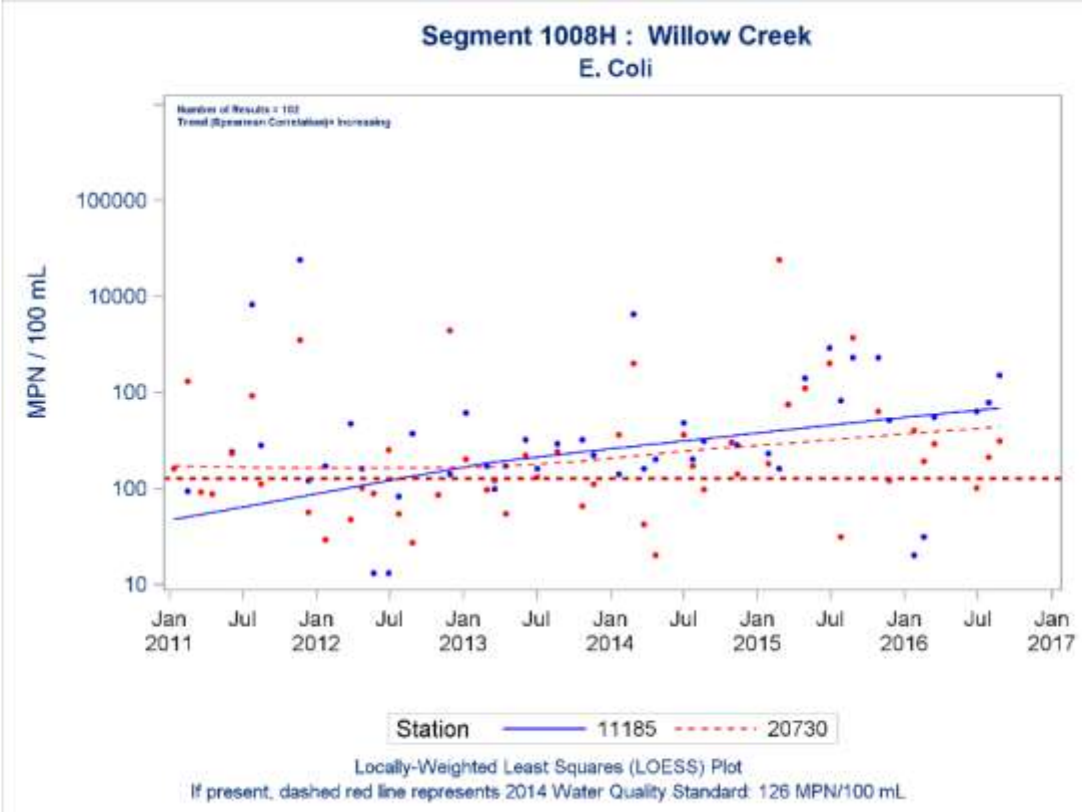
Locally-Weighted Least Squares (LOESS) Plot

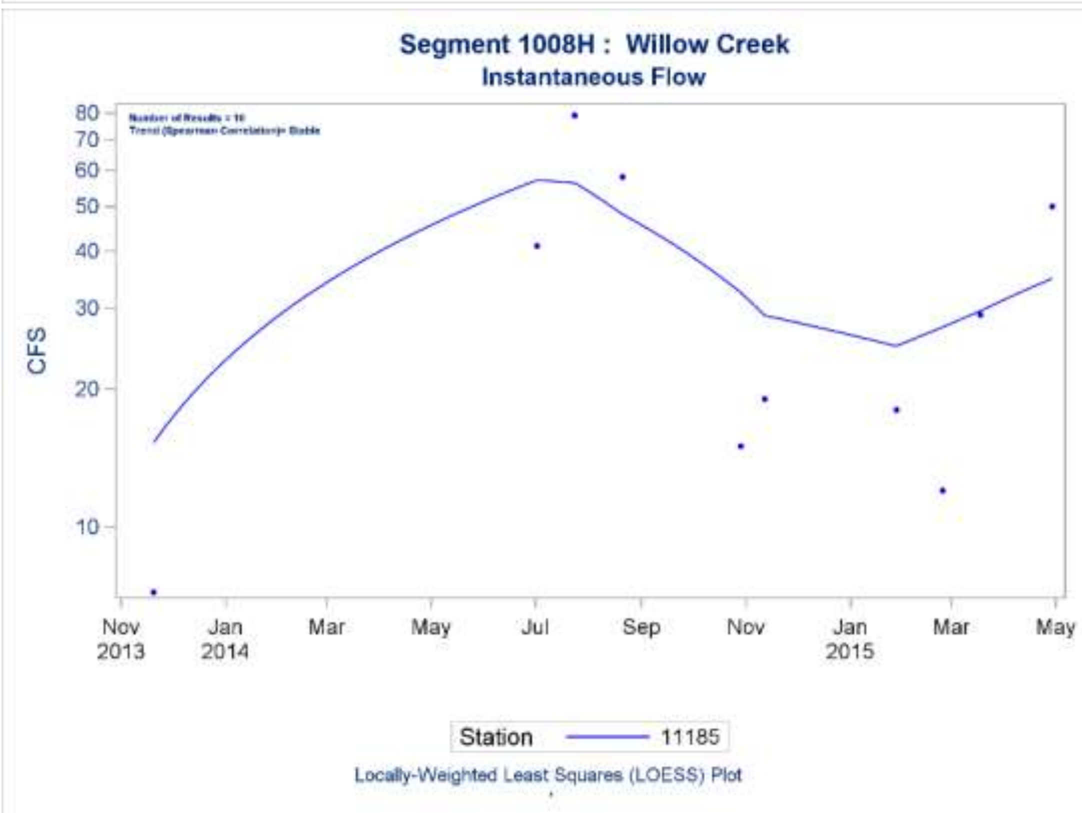

Segment 1008F : Lake Woodlands
Total Phosphorus
Mg / L
3
2.5
2
1.5
1
0.5
0.1
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16481
16482
16483
16484
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.20 mg/L

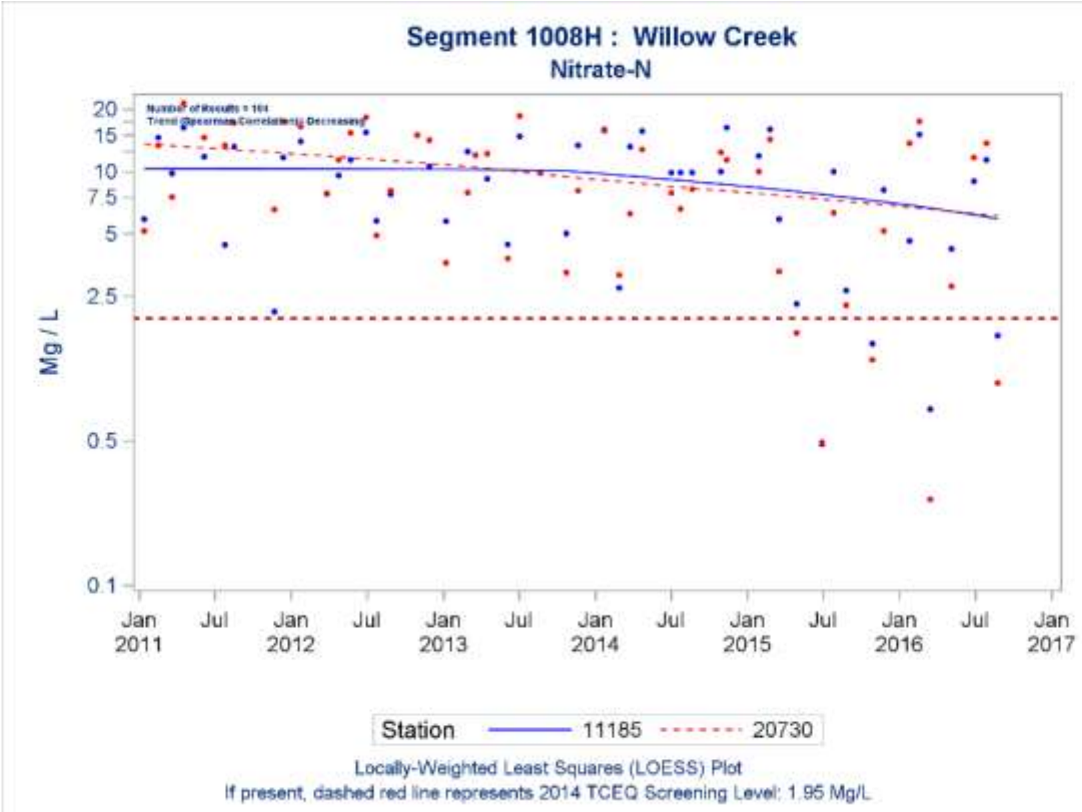

Segment 1008F : Lake Woodlands
Total Suspended Solids
Mg / L
35
30
25
20
15
10
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
16481
16482
16483
16484
Locally-Weighted Least Squares (LOESS) Plot

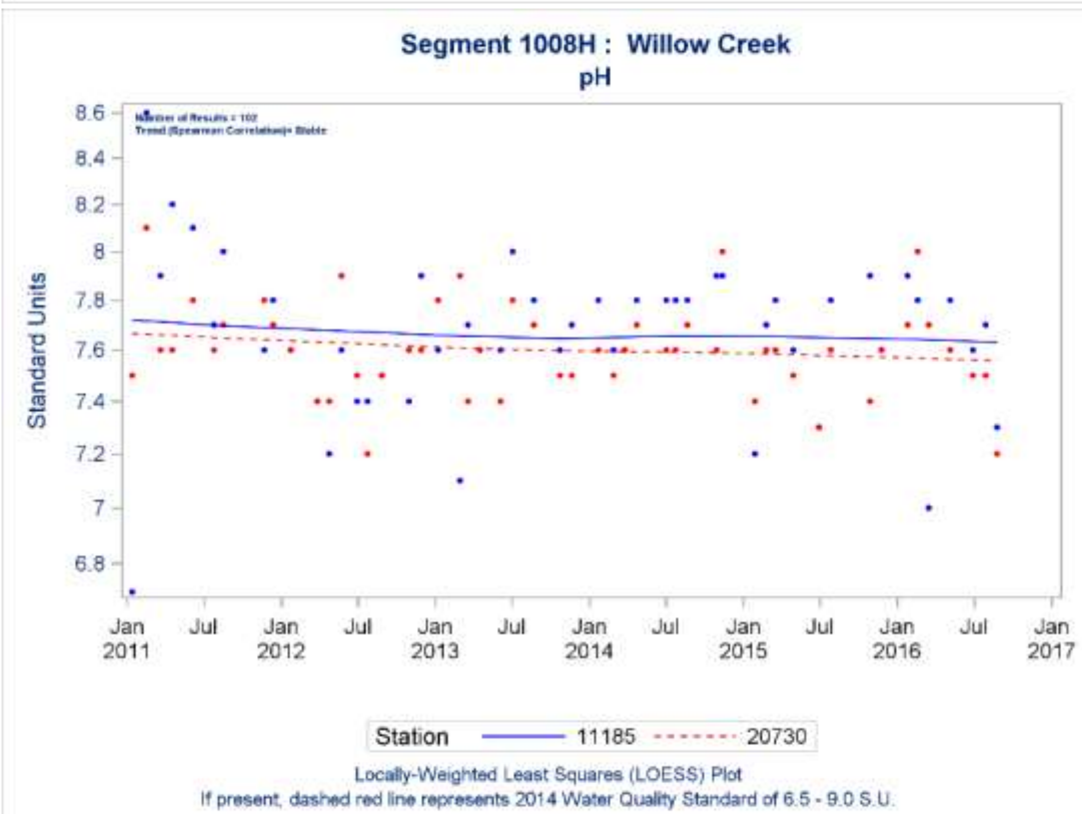

Segment 1008H : Willow Creek
Ammonia-N
Mg / L
1.8
1.4
1
0.8
0.6
0.4
0.2
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
11185
20730
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.33 mg/L

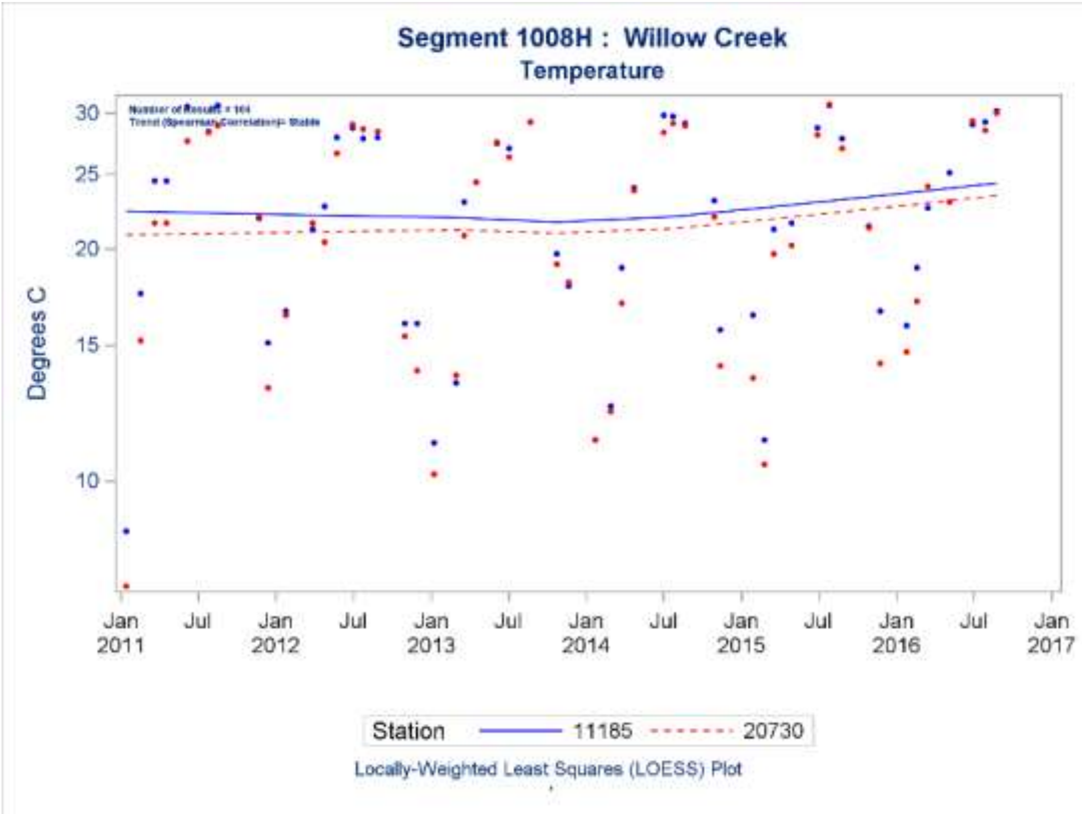

Segment 1008H : Willow Creek
Dissolved Oxygen
Mg / L
10
1
0.1
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
11185
20730
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2016 TCEQ Screening Level: 5.0mg/L

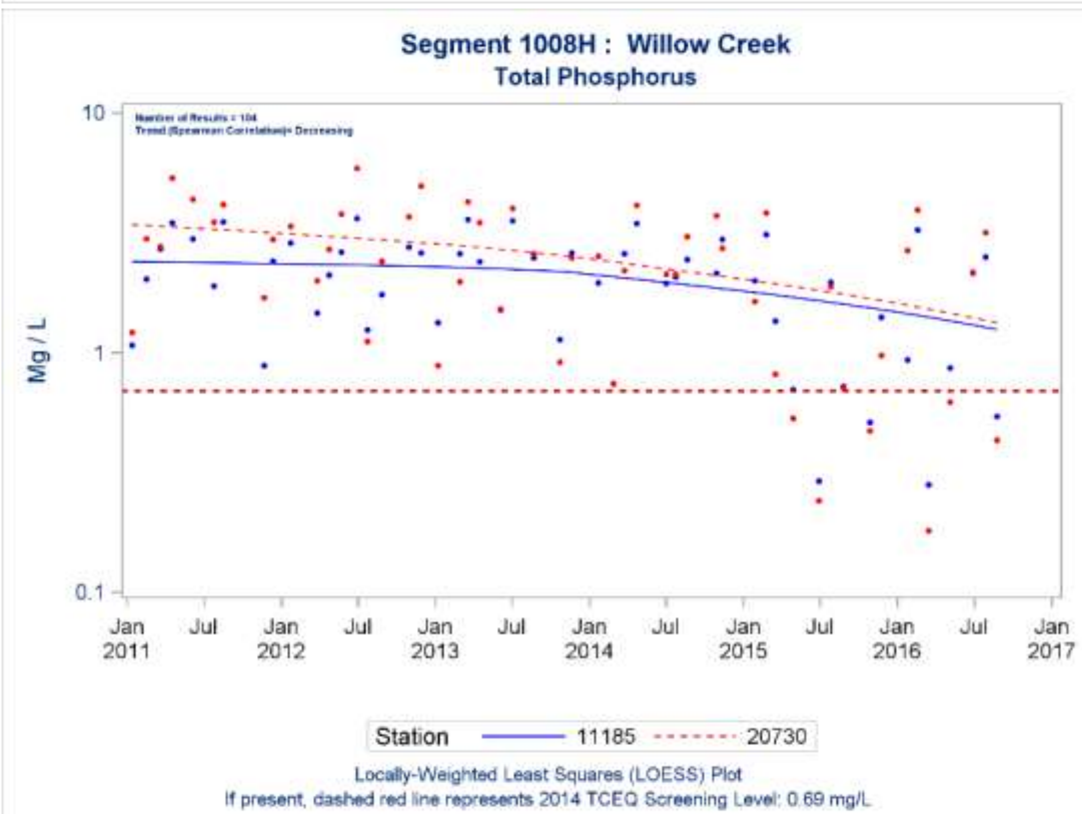

Segment 1008H : Willow Creek
E. Coli
MPN / 100 mL
100000
10000
100
100
10
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
11185
20730
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 126 MPN/100 mL

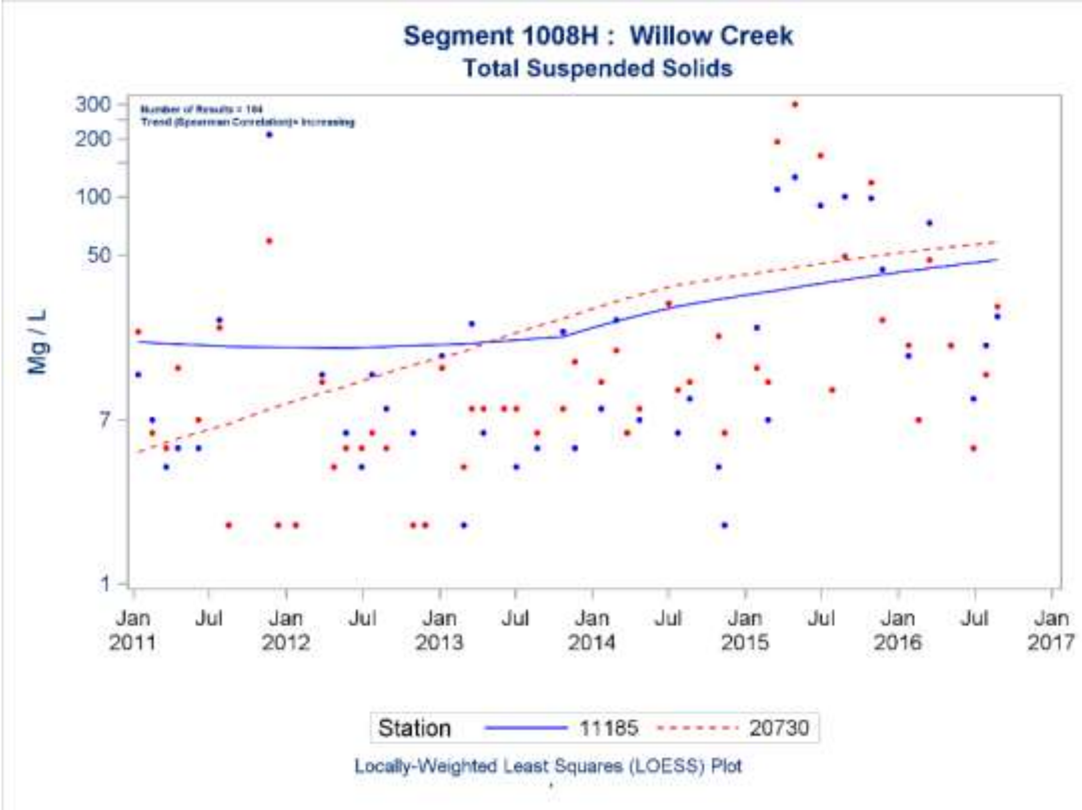

Segment 1008H : Willow Creek
Instantaneous Flow
CFS
80
70
60
50
40
30
20
10
Nov 2013
Jan 2014
Mar
May
Jul
Sep
Nov
Jan 2015
Mar
May
Station
11185
Locally-Weighted Least Squares (LOESS) Plot

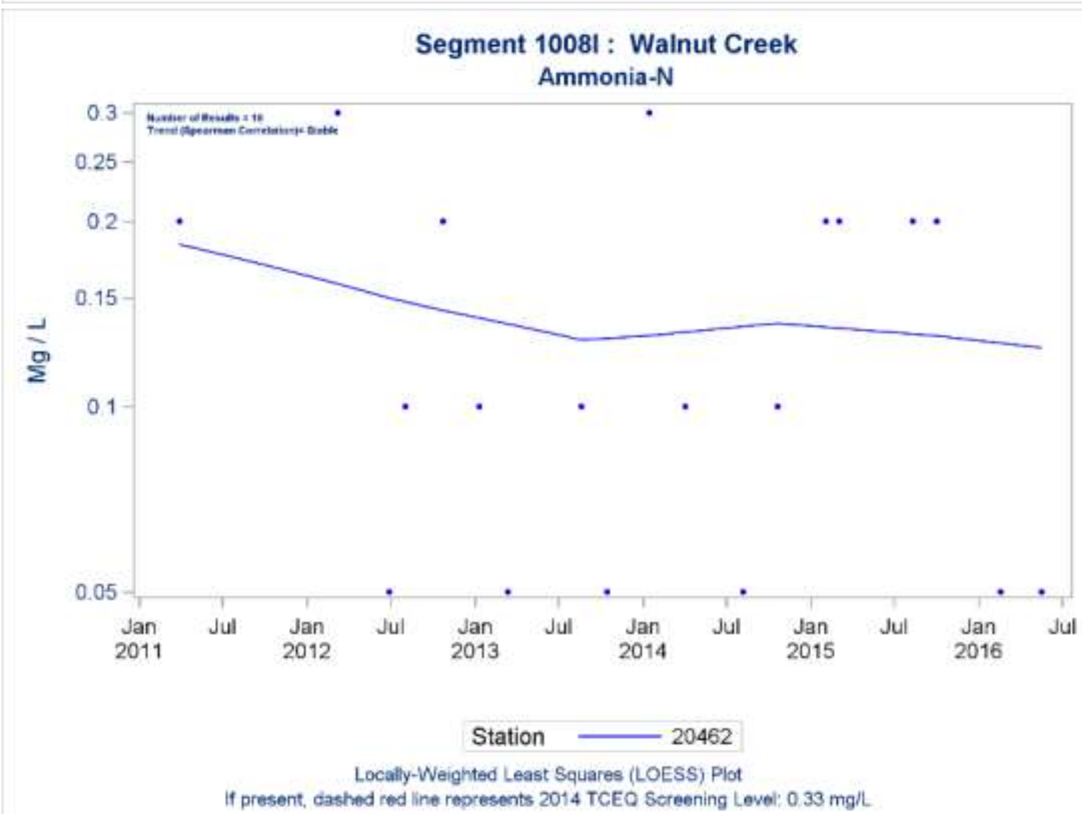

Segment 1008H : Willow Creek
Nitrate-N
Mg / L
Station 11185 20730
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 1.95 Mg/L

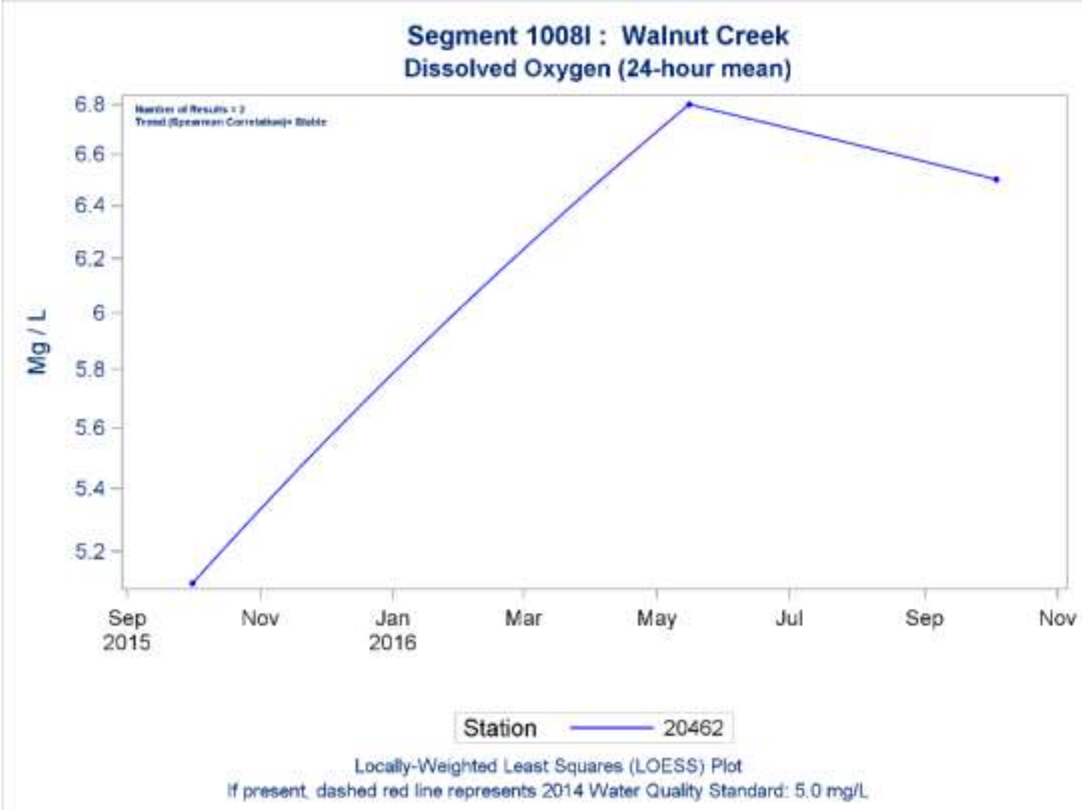

Segment 1008H : Willow Creek
pH
Standard Units
Station 11185 20730
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard of 6.5 - 9.0 S.U.


Segment 1008H : Willow Creek
Temperature
Number of Results = 104
Trend (Spearman Correlation)= Stable
Degrees C
30
25
20
15
10
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
11185
20730
Locally-Weighted Least Squares (LOESS) Plot

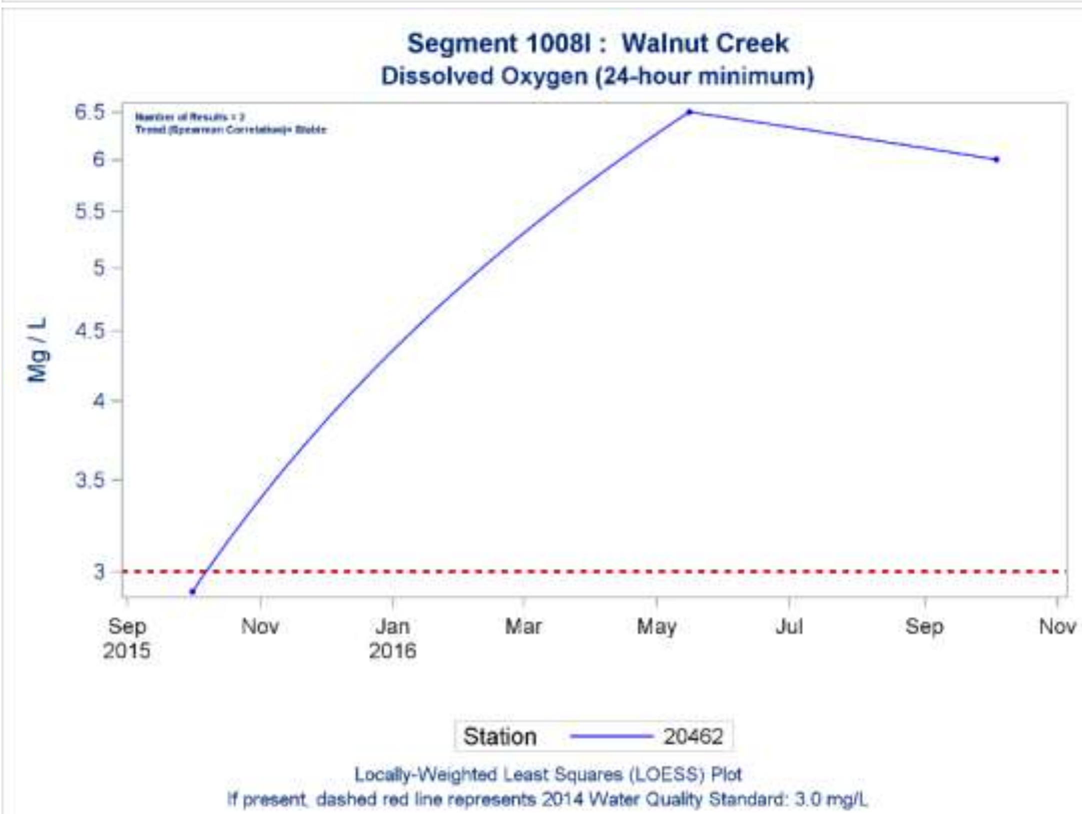

Segment 1008H : Willow Creek
Total Phosphorus
Number of Results = 104
Trend (Spearman Correlation)= Decreasing
Mg / L
10
1
0.1
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
11185
20730
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.69 mg/L


Segment 1008H : Willow Creek
Total Suspended Solids
Mg / L
300
200
100
50
7
1
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
11185
20730
Locally-Weighted Least Squares (LOESS) Plot

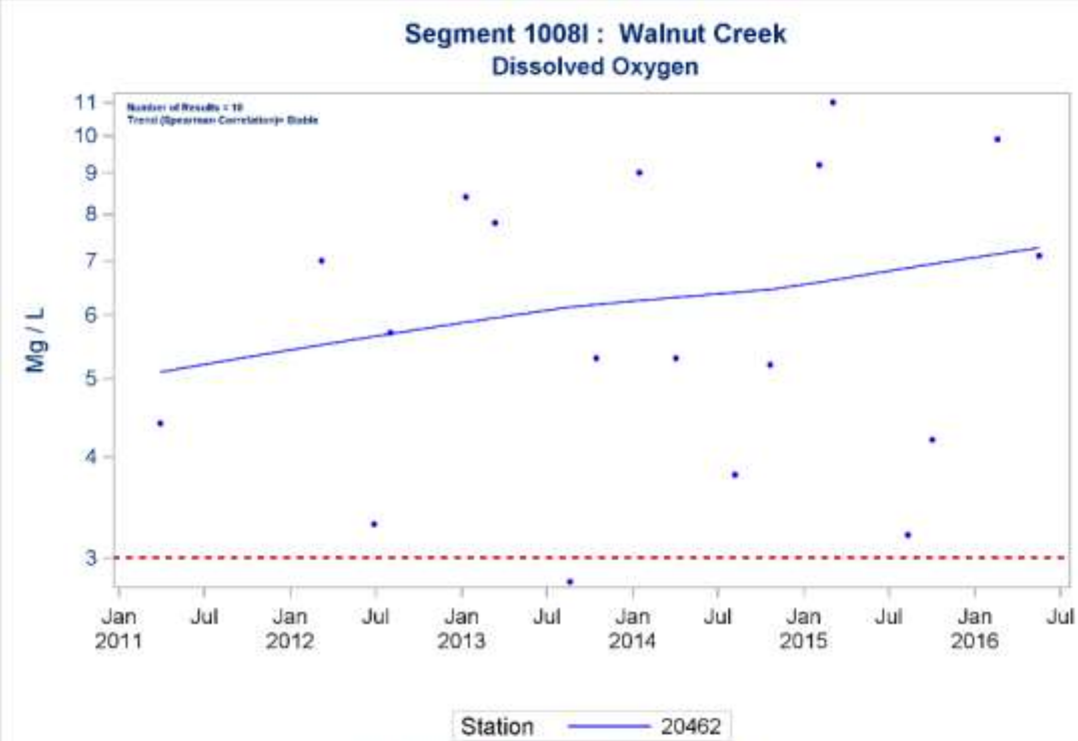

Segment 1008I : Walnut Creek
Ammonia-N
Mg / L
0.3
0.25
0.2
0.15
0.1
0.05
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station
20462
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.33 mg/L



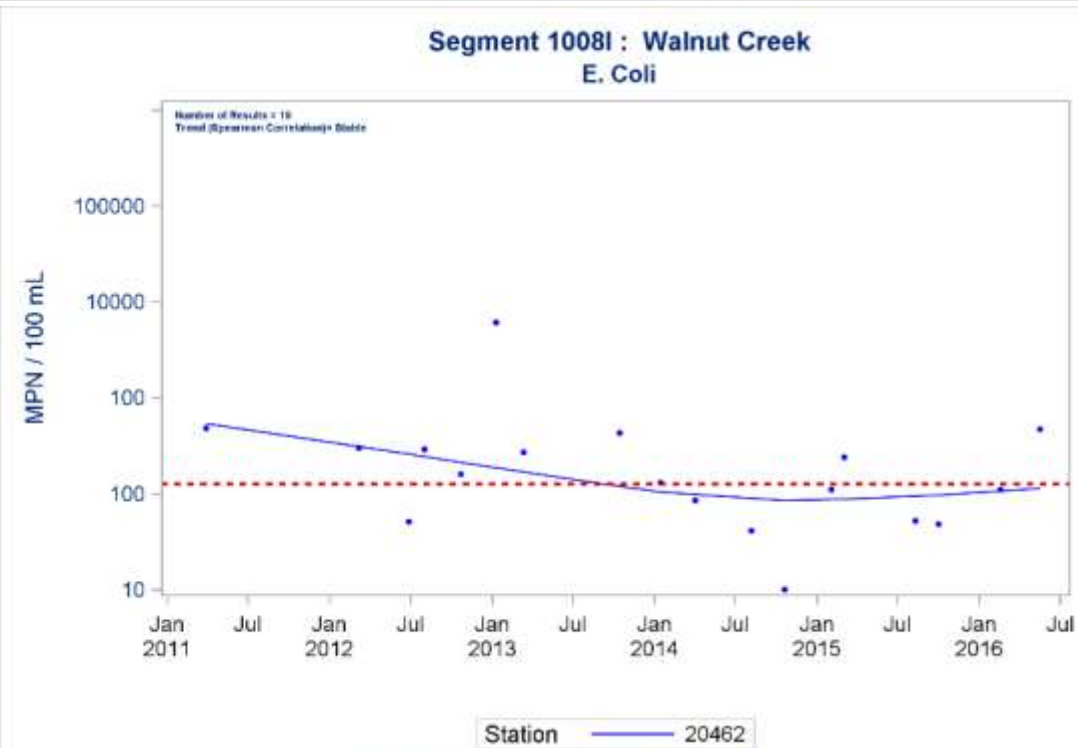
Segment 1008I : Walnut Creek
Dissolved Oxygen (24-hour mean)
Mg / L
6.8
6.6
6.4
6.2
6
5.8
5.6
5.4
5.2
Sep 2015
Nov
Jan 2016
Mar
May
Jul
Sep
Nov
Station 20462
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 5.0 mg/L



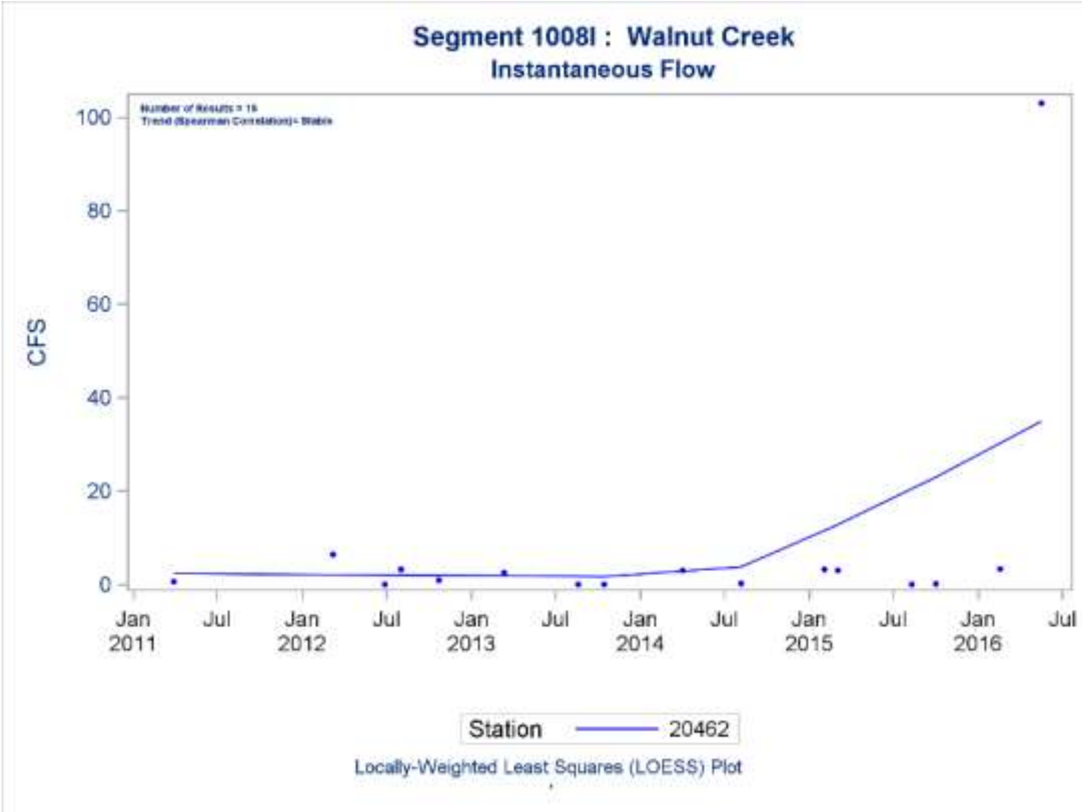
Segment 1008I : Walnut Creek
Dissolved Oxygen (24-hour minimum)
Mg / L
6.5
6
5.5
5
4.5
4
3.5
3
Sep 2015
Nov
Jan 2016
Mar
May
Jul
Sep
Nov
Station 20462
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 3.0 mg/L

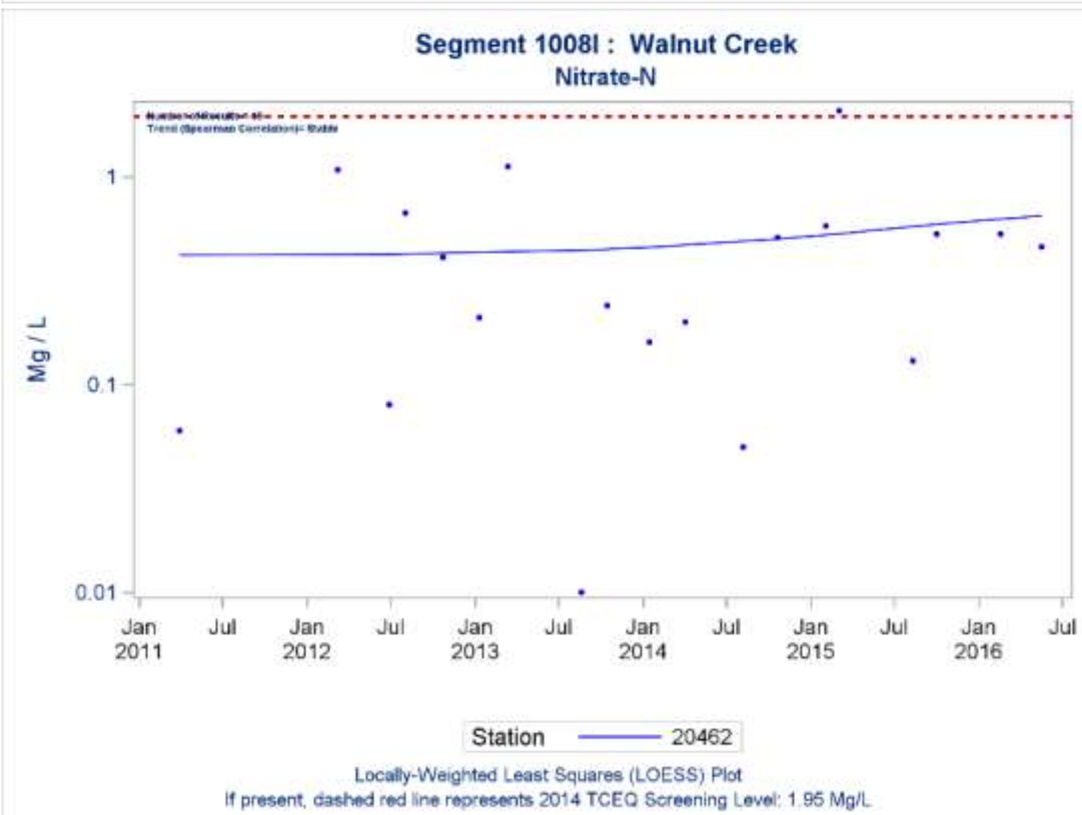


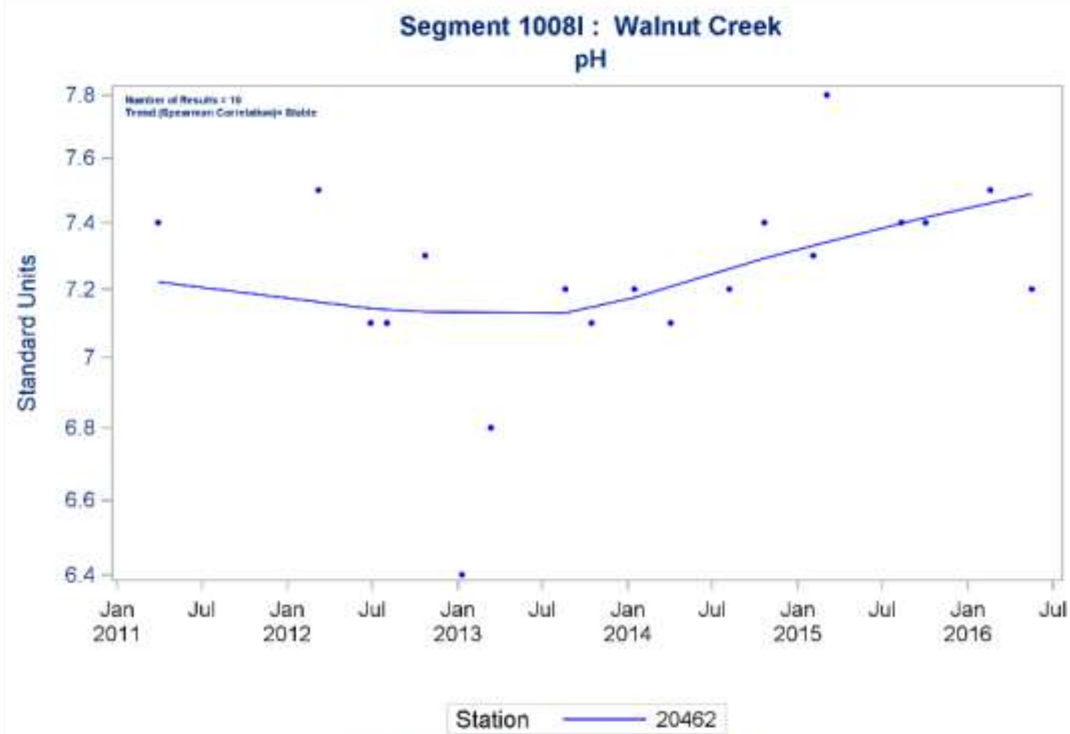
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2016 TCEQ Screening Level: 3.0mg/L



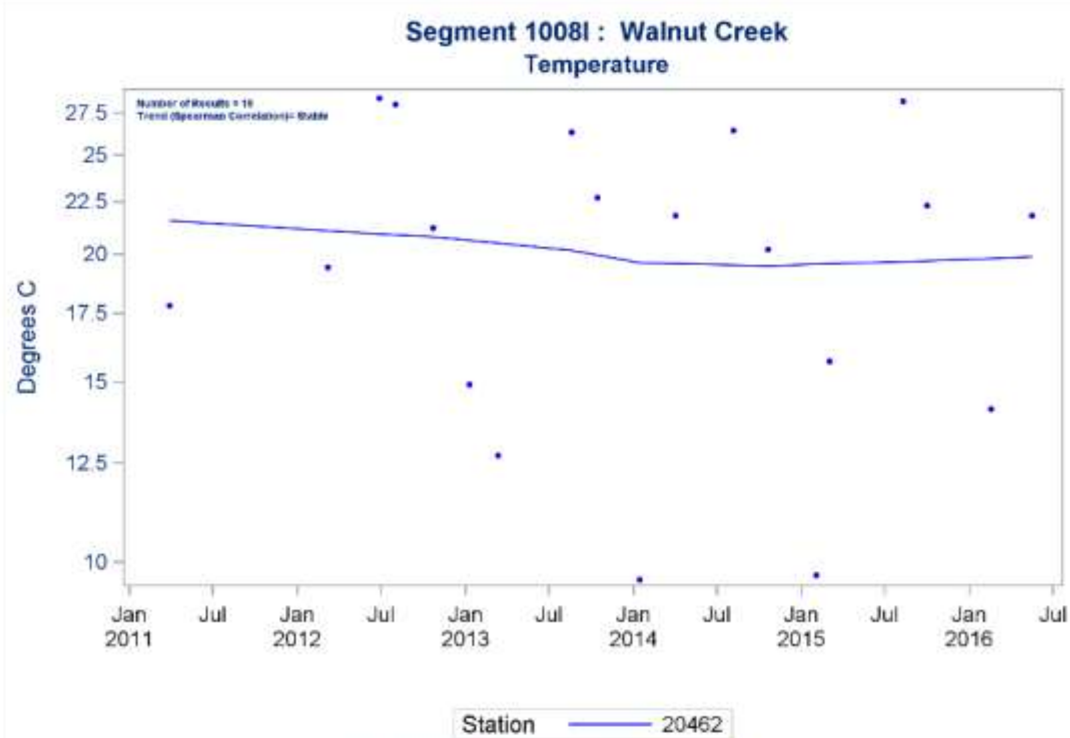
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 126 MPN/100 mL


Segment 1008I : Walnut Creek
Instantaneous Flow
CFS
100
80
60
40
20
0
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station
20462
Locally-Weighted Least Squares (LOESS) Plot


Segment 1008I : Walnut Creek
Nitrate-N
Mg / L
1
0.1
0.01
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station
20462
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 1.95 Mg/L

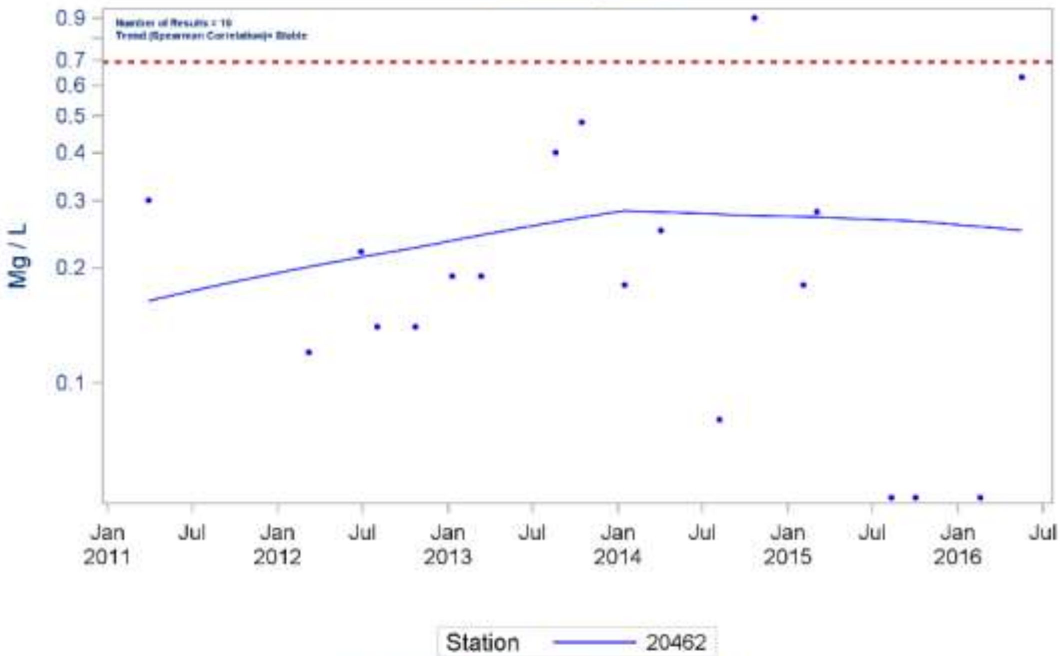


Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard of 6.5 - 9.0 S.U.



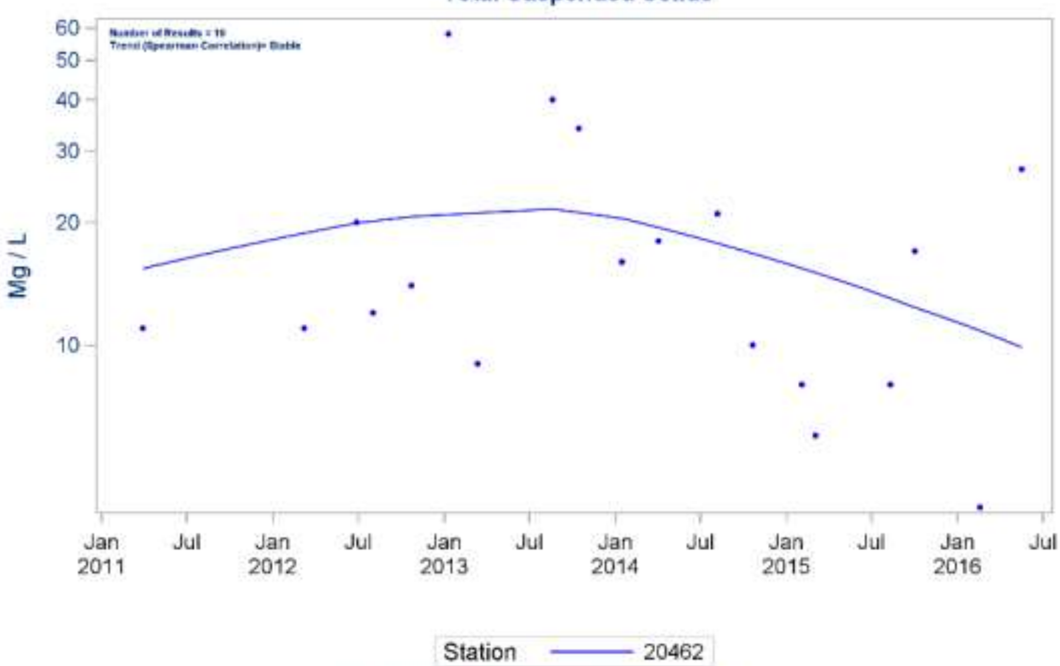
Locally-Weighted Least Squares (LOESS) Plot

Segment 1008I : Walnut Creek
Total Phosphorus

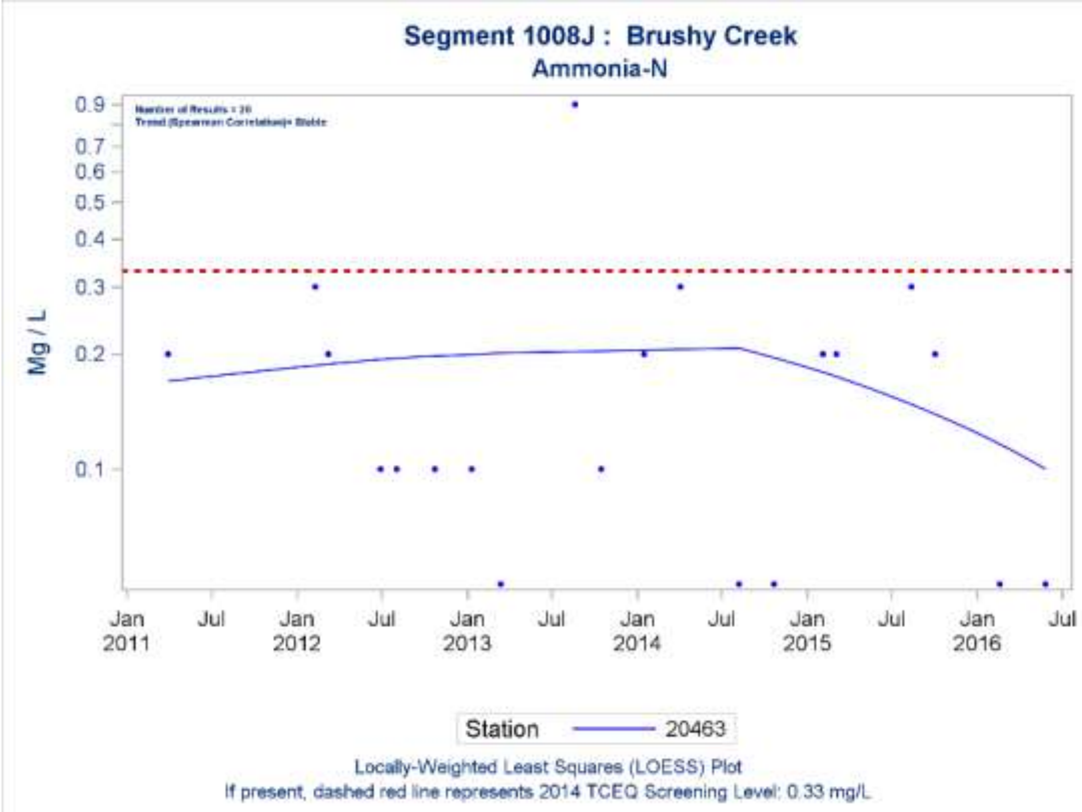


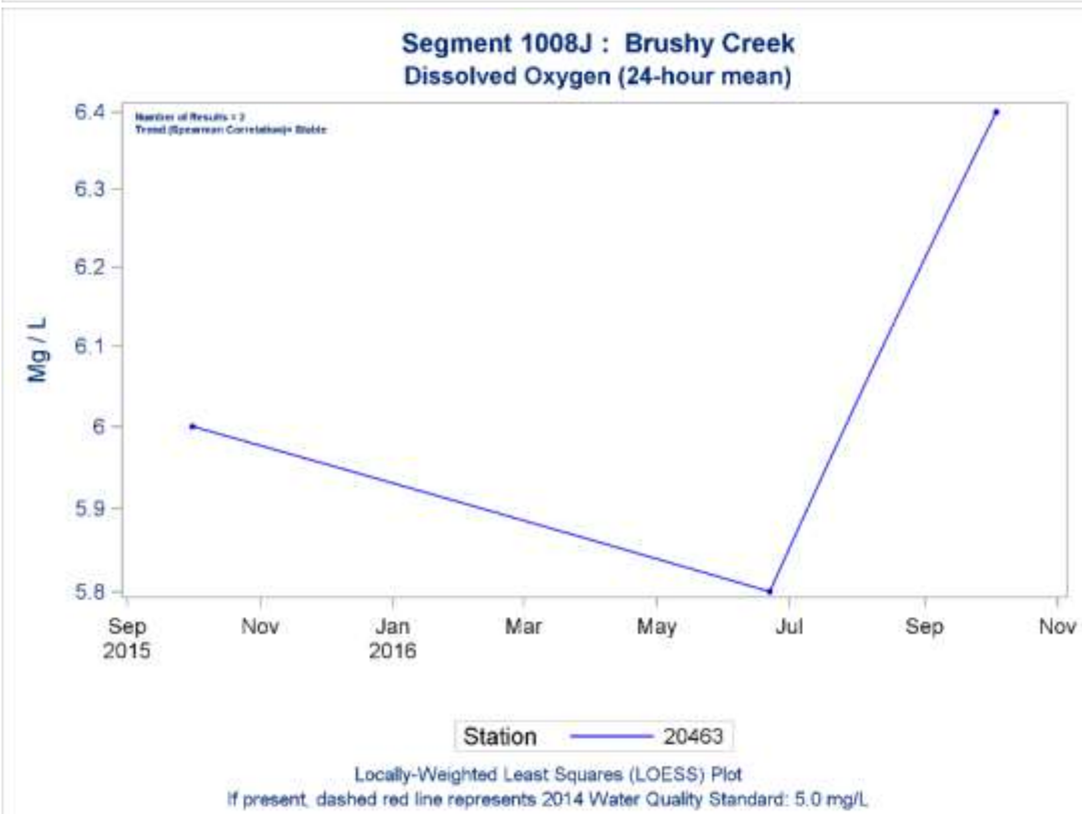
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.69 mg/L

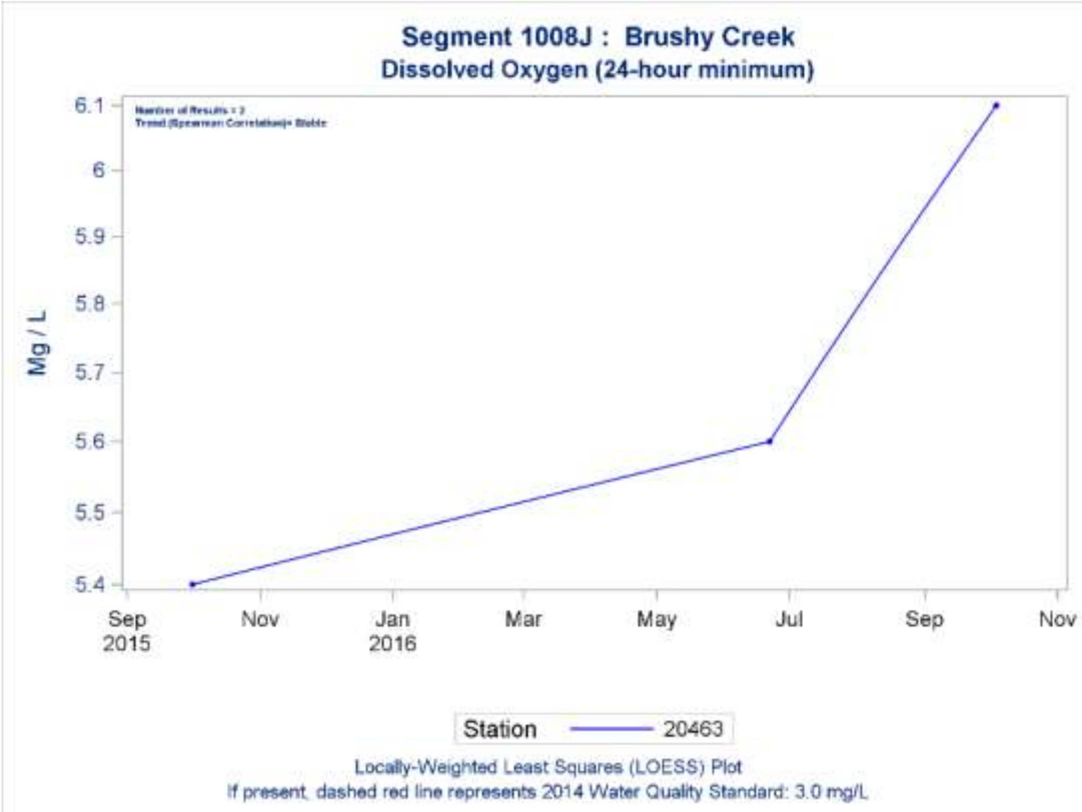
Segment 1008I : Walnut Creek
Total Suspended Solids

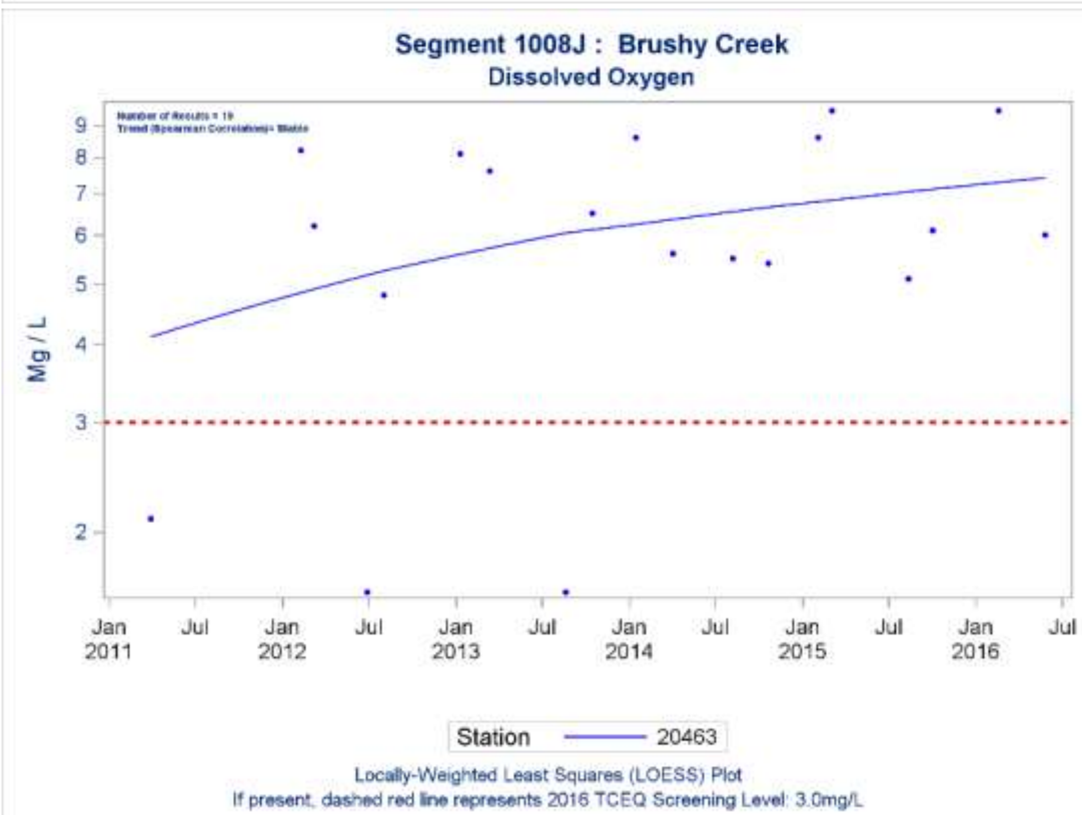


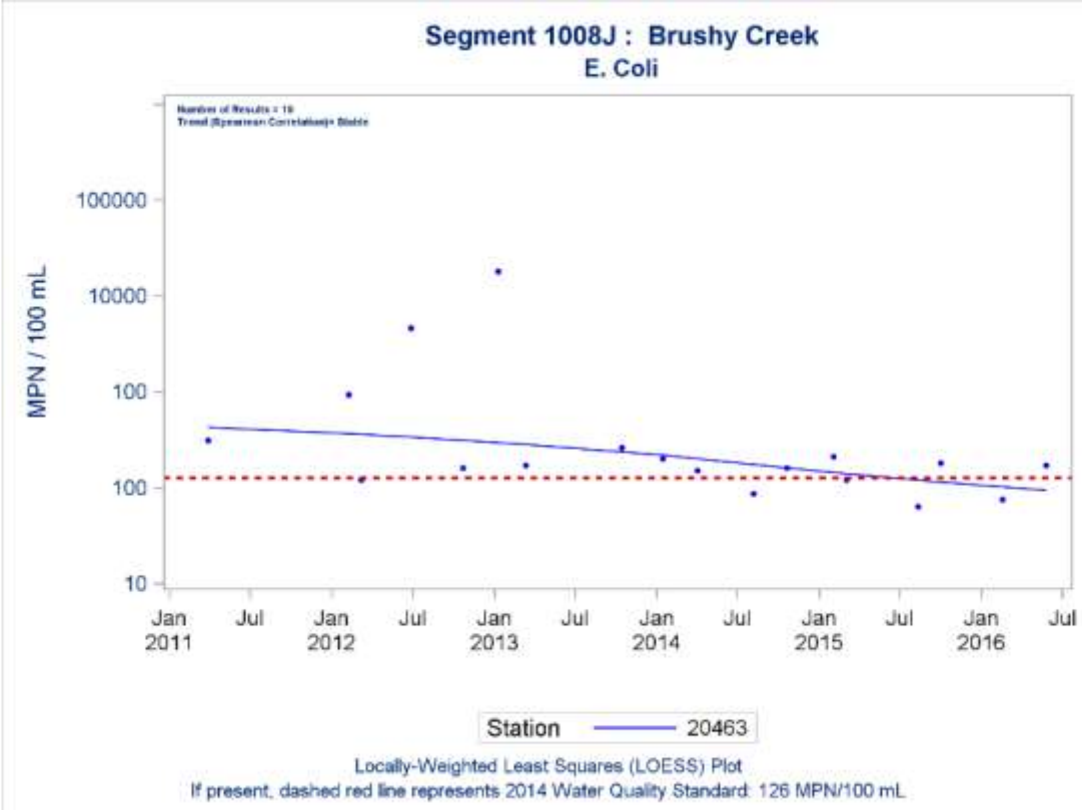
Locally-Weighted Least Squares (LOESS) Plot


Segment 1008J : Brushy Creek
Ammonia-N
Mg / L
0.9
0.7
0.6
0.5
0.4
0.3
0.2
0.1
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station 20463
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.33 mg/L

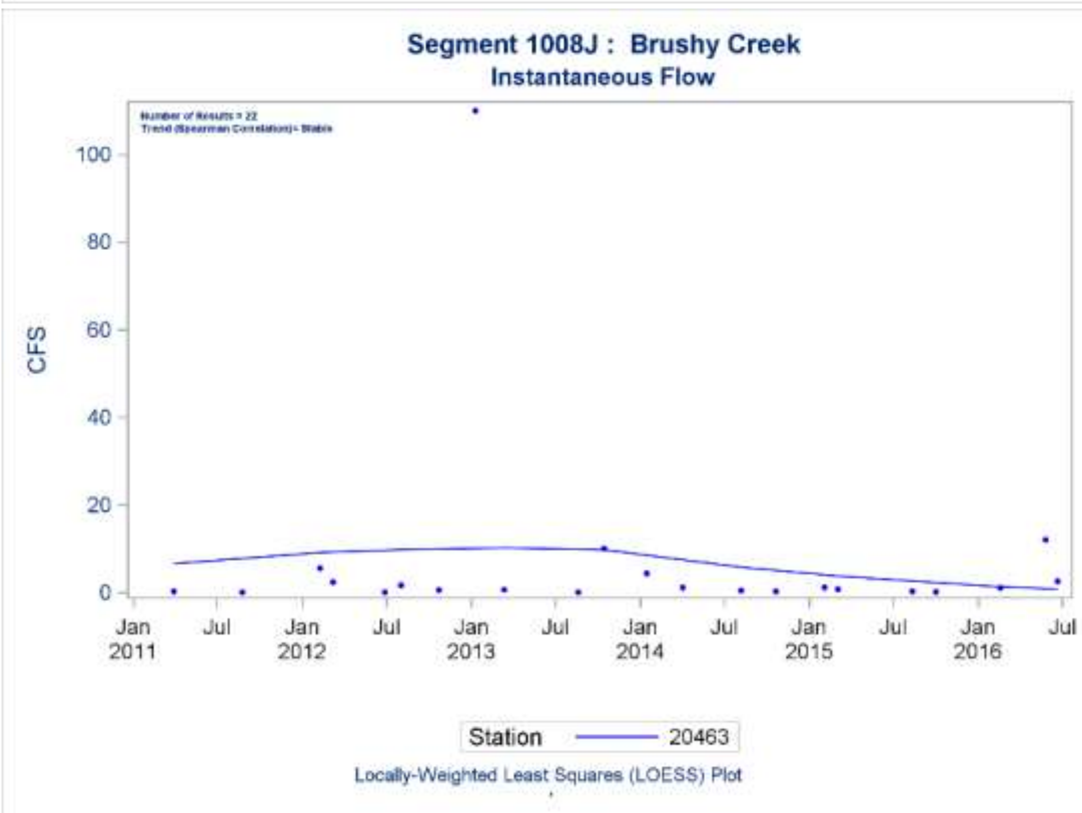

Segment 1008J : Brushy Creek
Dissolved Oxygen (24-hour mean)
Mg / L
6.4
6.3
6.2
6.1
6
5.9
5.8
Sep 2015
Nov
Jan 2016
Mar
May
Jul
Sep
Nov
Station 20463
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 5.0 mg/L


Segment 1008J : Brushy Creek
Dissolved Oxygen (24-hour minimum)
Mg / L
6.1
6
5.9
5.8
5.7
5.6
5.5
5.4
Sep 2015
Nov
Jan 2016
Mar
May
Jul
Sep
Nov
Station
20463
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 3.0 mg/L

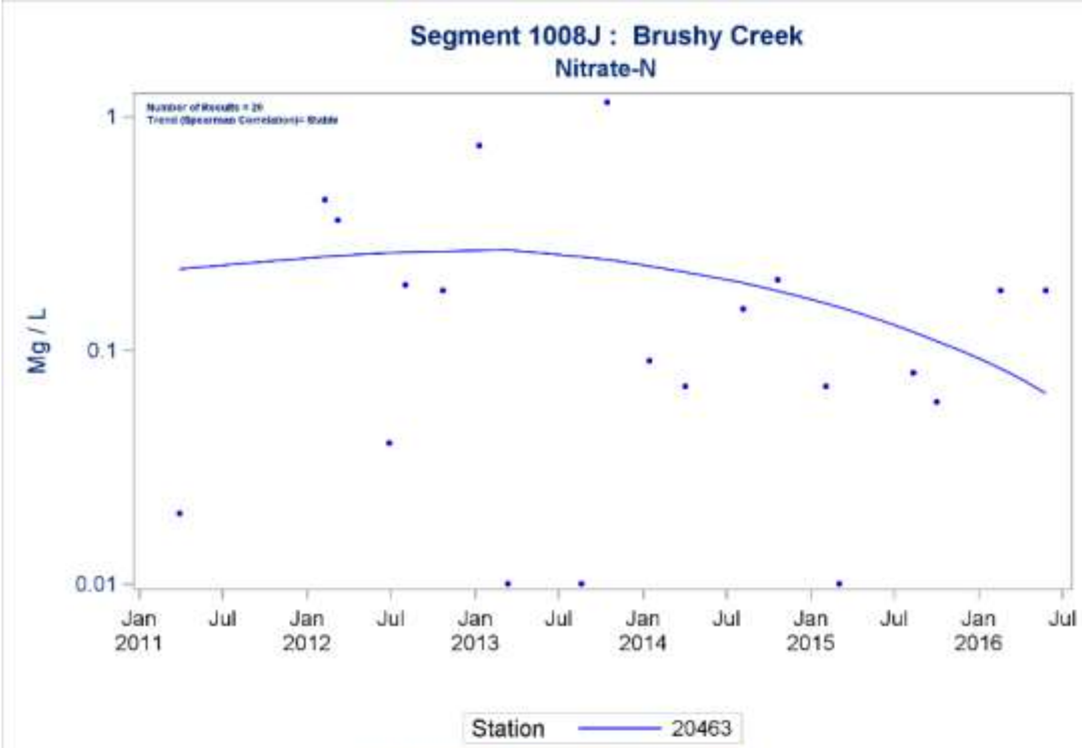

Segment 1008J : Brushy Creek
Dissolved Oxygen
Mg / L
9
8
7
6
5
4
3
2
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station
20463
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2016 TCEQ Screening Level: 3.0mg/L



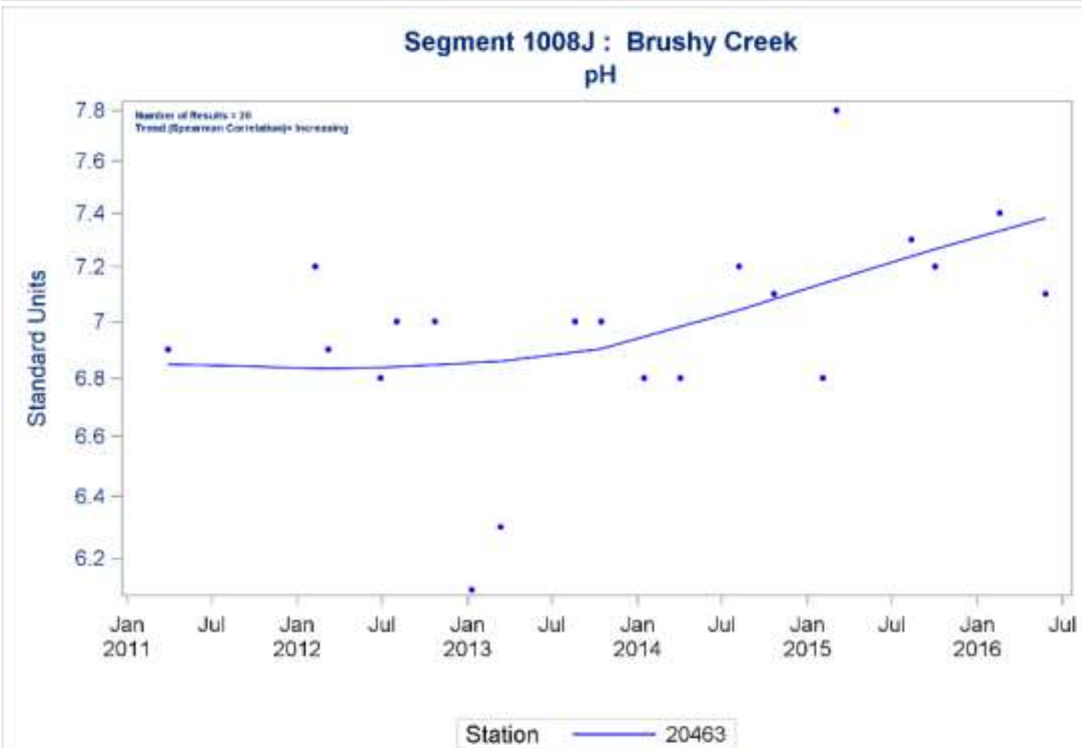
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 126 MPN/100 mL



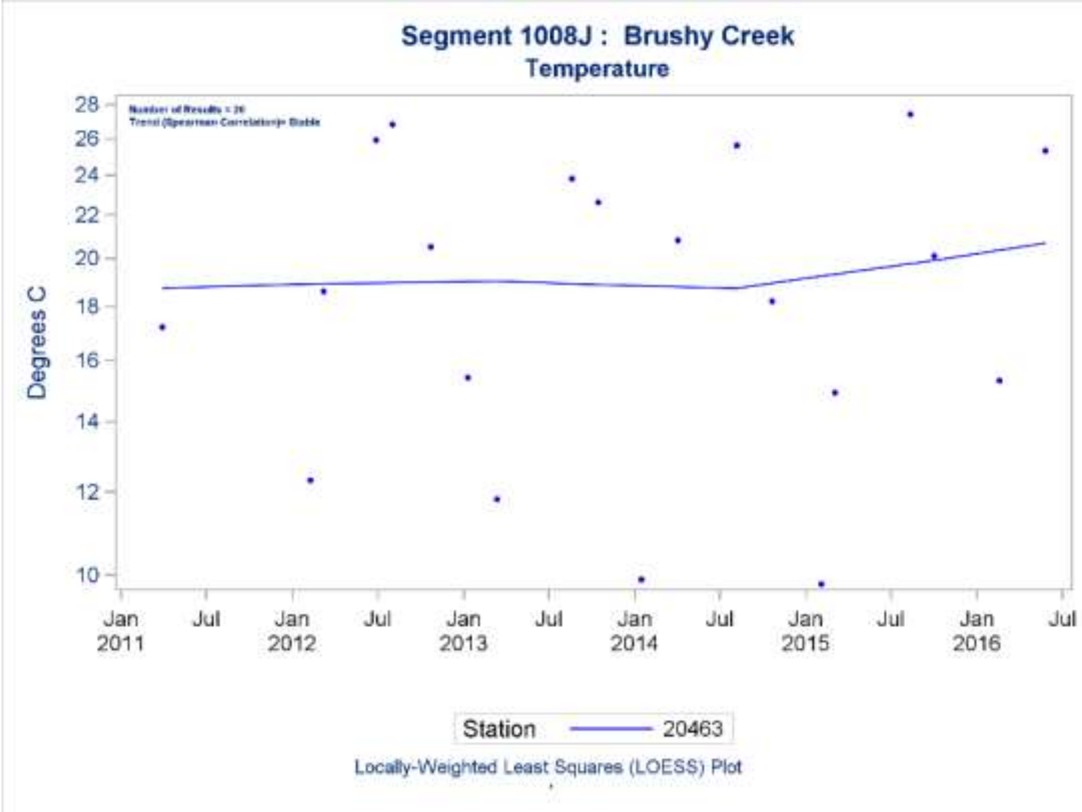
Locally-Weighted Least Squares (LOESS) Plot

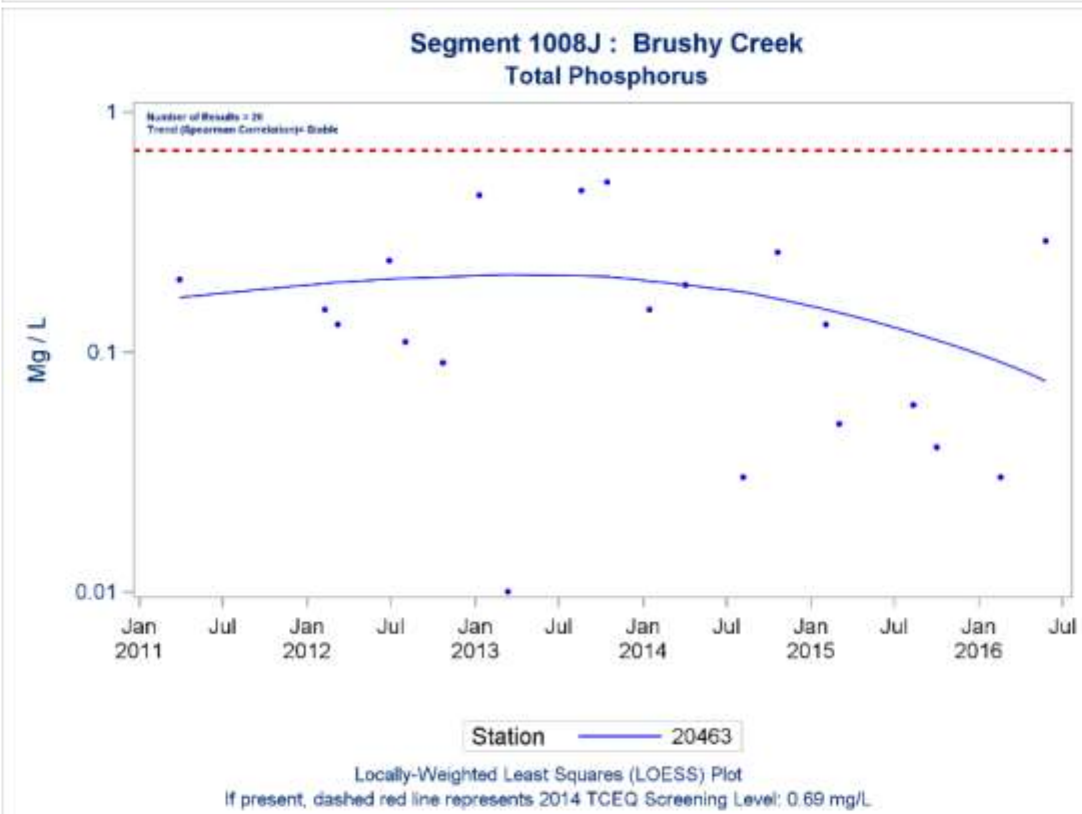


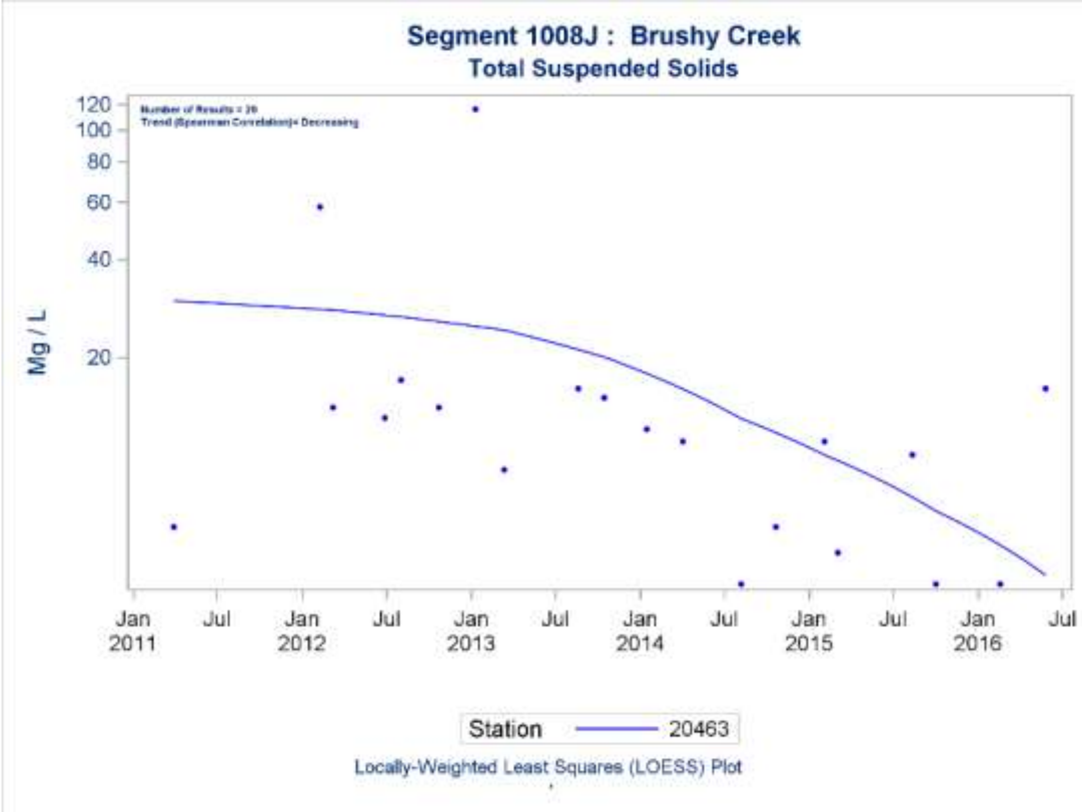
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 1.95 Mg/L

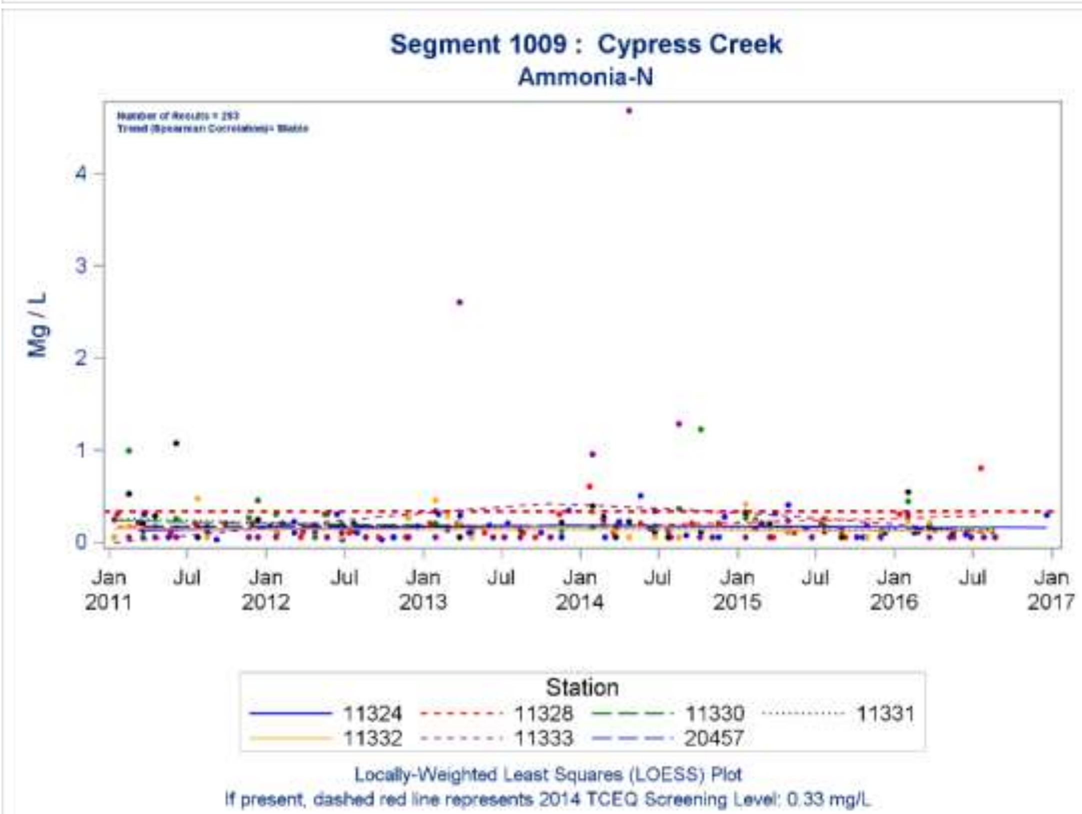


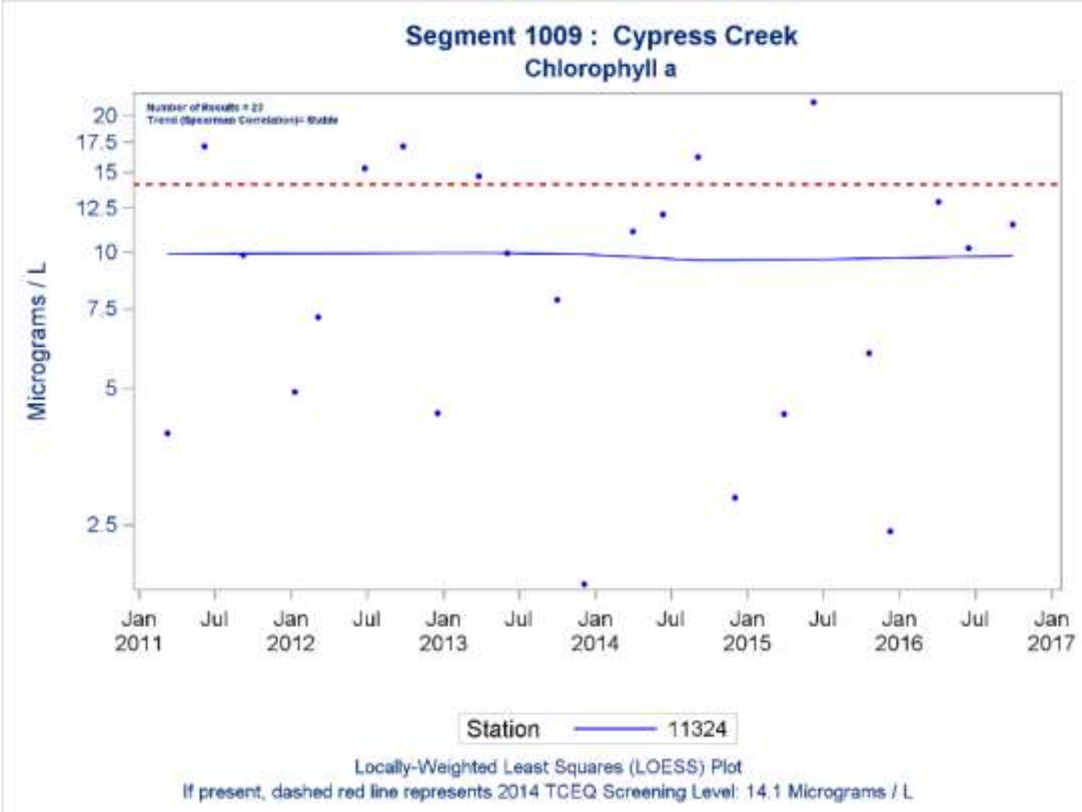
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard of 6.5 - 9.0 S.U.

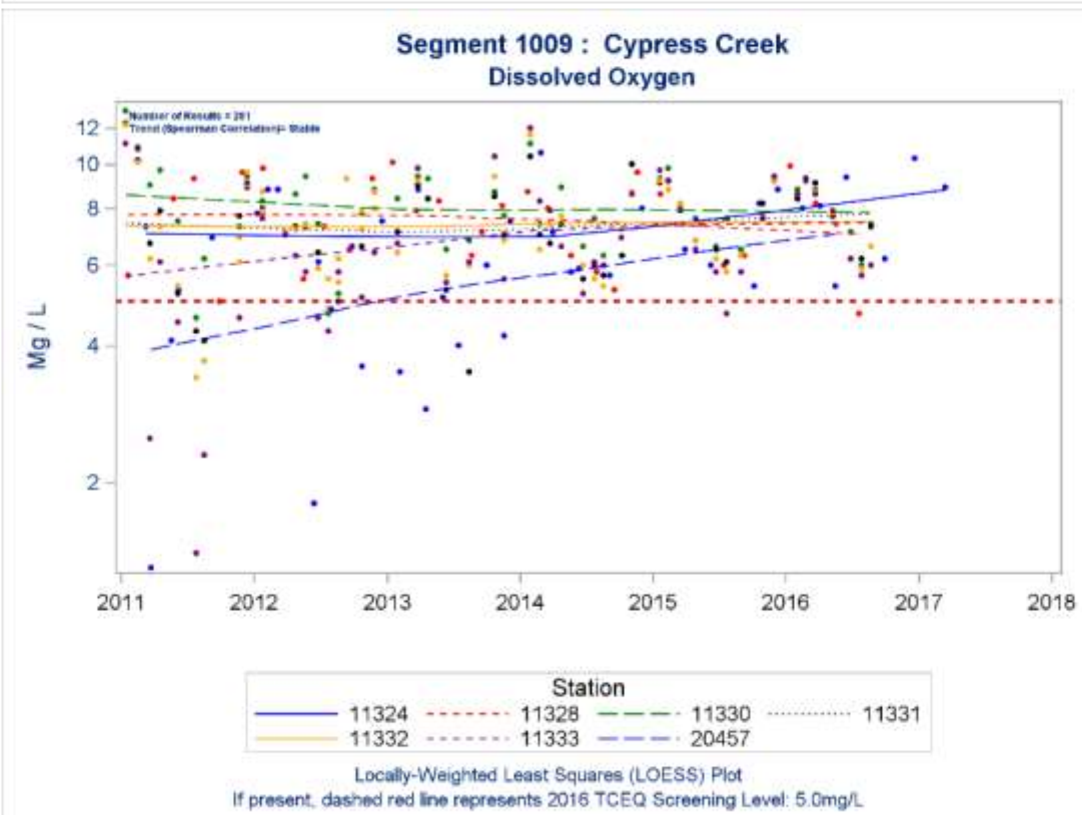

Segment 1008J : Brushy Creek
Temperature
Degrees C
28
26
24
22
20
18
16
14
12
10
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station
20463
Locally-Weighted Least Squares (LOESS) Plot

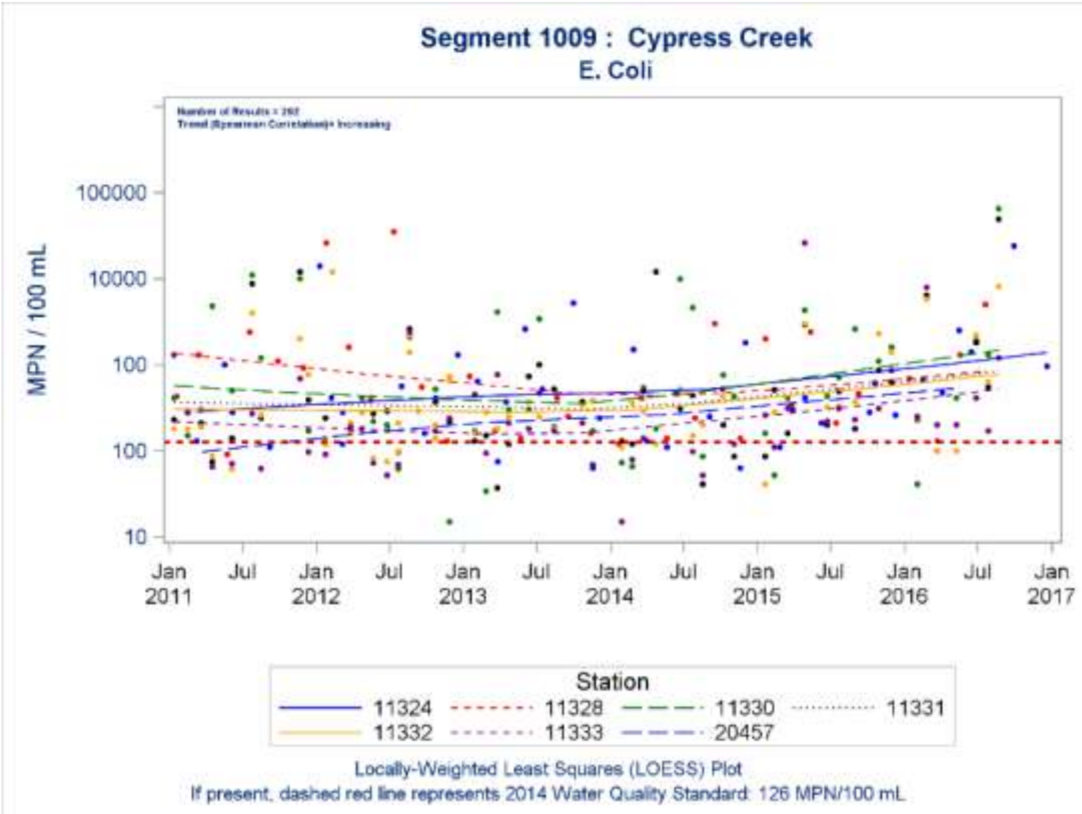

Segment 1008J : Brushy Creek
Total Phosphorus
Mg / L
1
0.1
0.01
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station
20463
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.69 mg/L

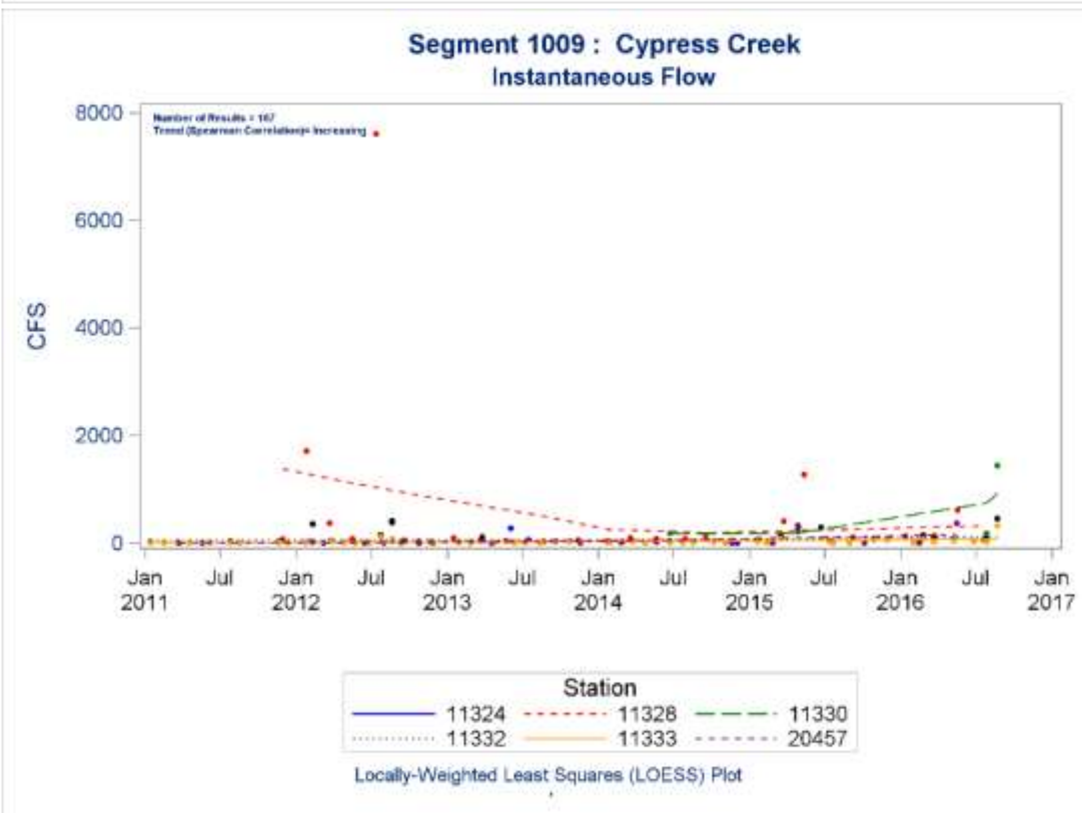

Segment 1008J : Brushy Creek
Total Suspended Solids
Trend (Spearman Correlation)= Decreasing
Mg / L
120
100
80
60
40
20
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station
20463
Locally-Weighted Least Squares (LOESS) Plot

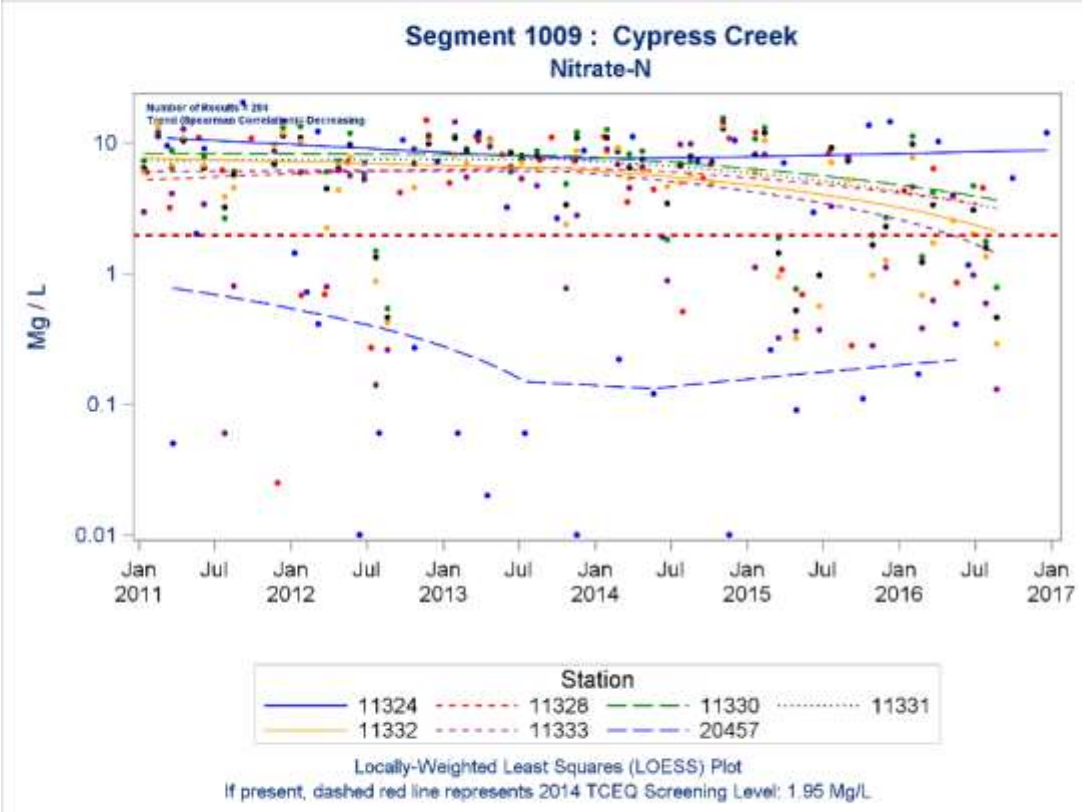

Segment 1009 : Cypress Creek
Ammonia-N
Trend (Spearman Correlation)= Stable
Mg / L
4
3
2
1
0
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
11324
11328
11330
11331
11332
11333
20457
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.33 mg/L

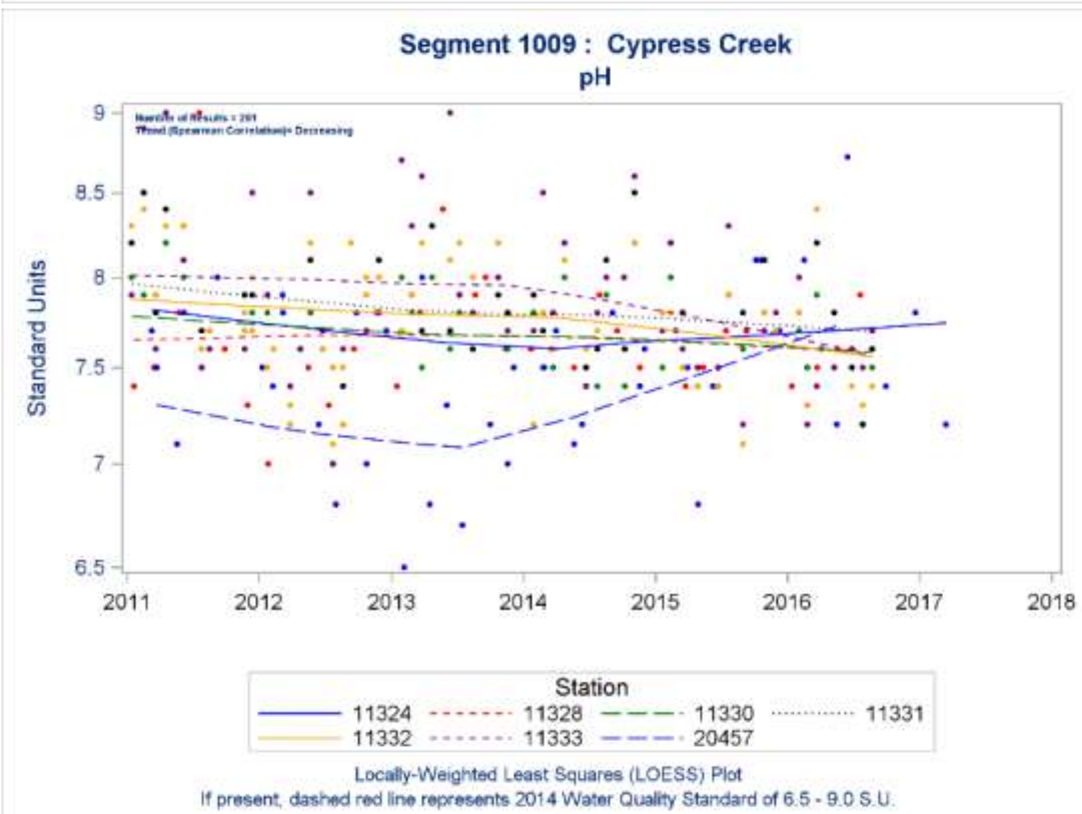

Segment 1009 : Cypress Creek
Chlorophyll a
Micrograms / L
20
17.5
15
12.5
10
7.5
5
2.5
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
11324
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 14.1 Micrograms / L

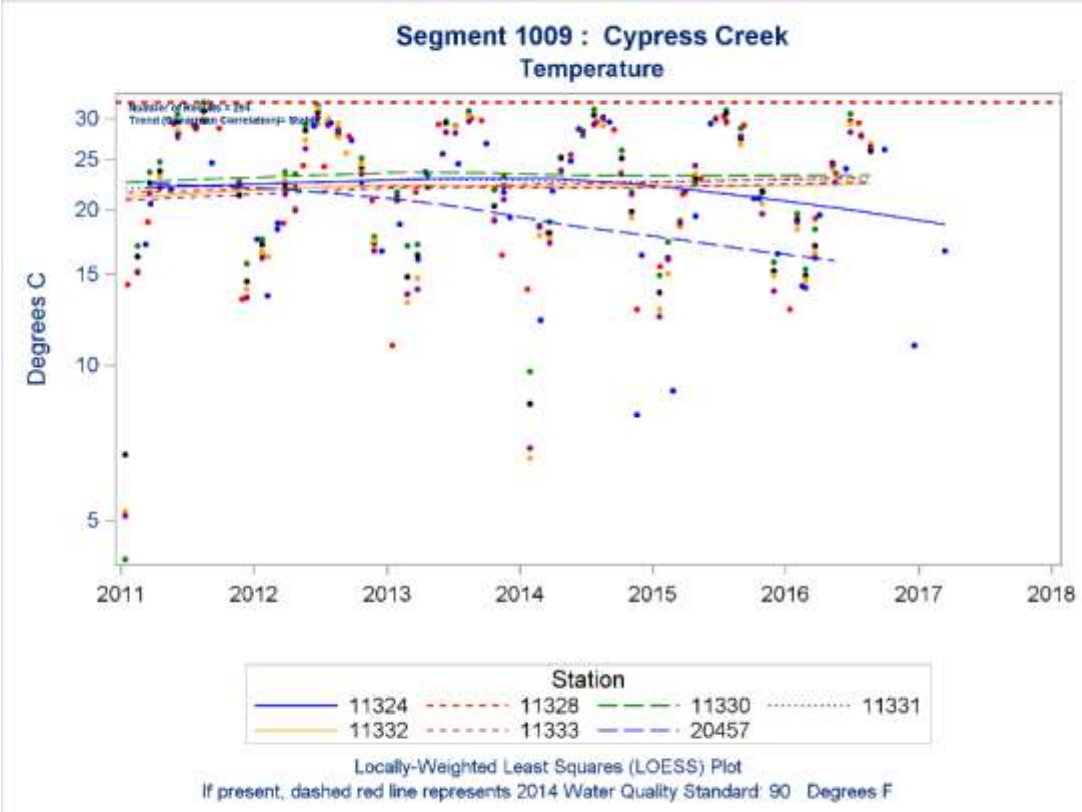

Segment 1009 : Cypress Creek
Dissolved Oxygen
Mg / L
12
10
8
6
4
2
2011
2012
2013
2014
2015
2016
2017
2018
Station
11324
11328
11330
11331
11332
11333
20457
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2016 TCEQ Screening Level: 5.0mg/L

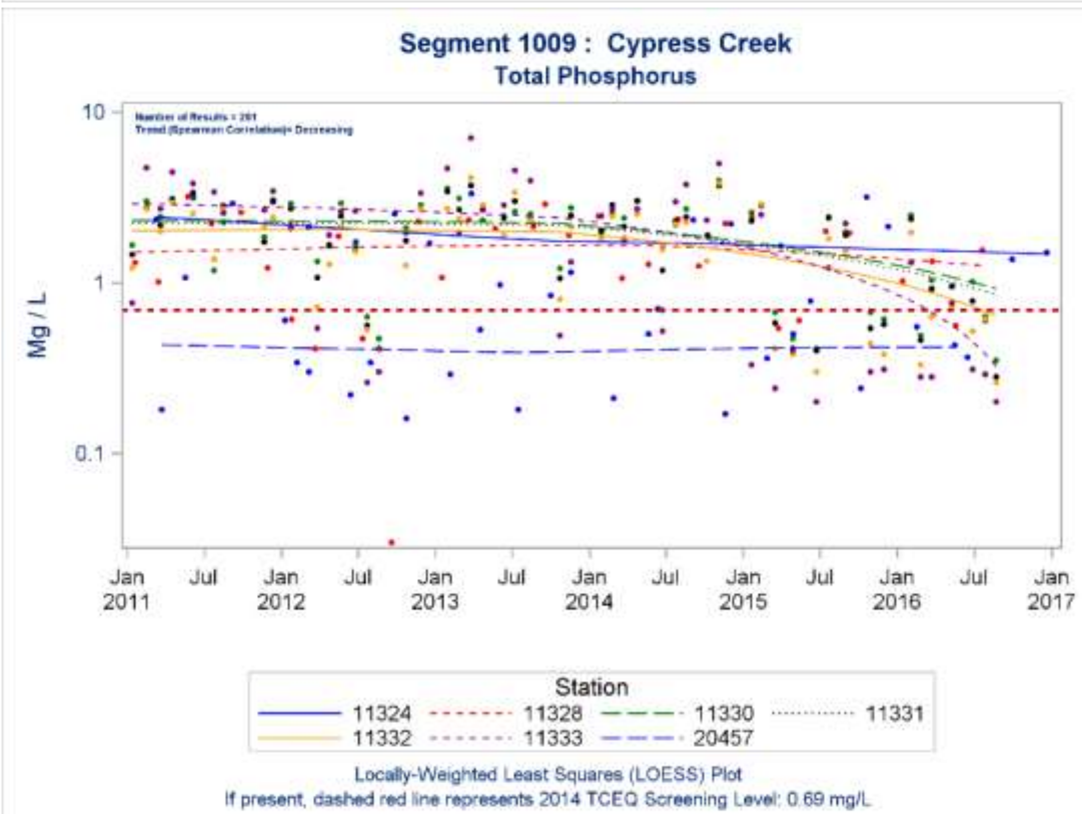

Segment 1009 : Cypress Creek
E. Coli
Trend (Spearman Correlation)= Increasing
MPN / 100 mL
100000
10000
1000
100
10
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
11324
11328
11330
11331
11332
11333
20457
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 126 MPN/100 mL

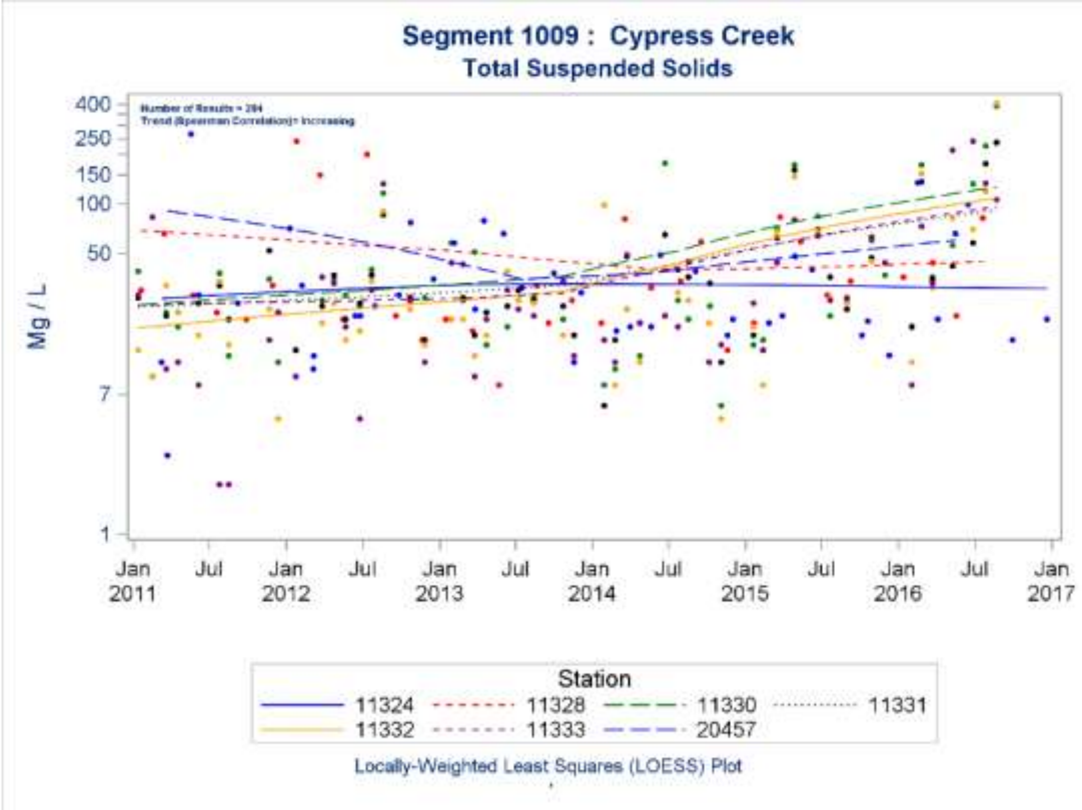

Segment 1009 : Cypress Creek
Instantaneous Flow
Trend (Spearman Correlation)= Increasing
CFS
8000
6000
4000
2000
0
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
11324
11328
11330
11332
11333
20457
Locally-Weighted Least Squares (LOESS) Plot

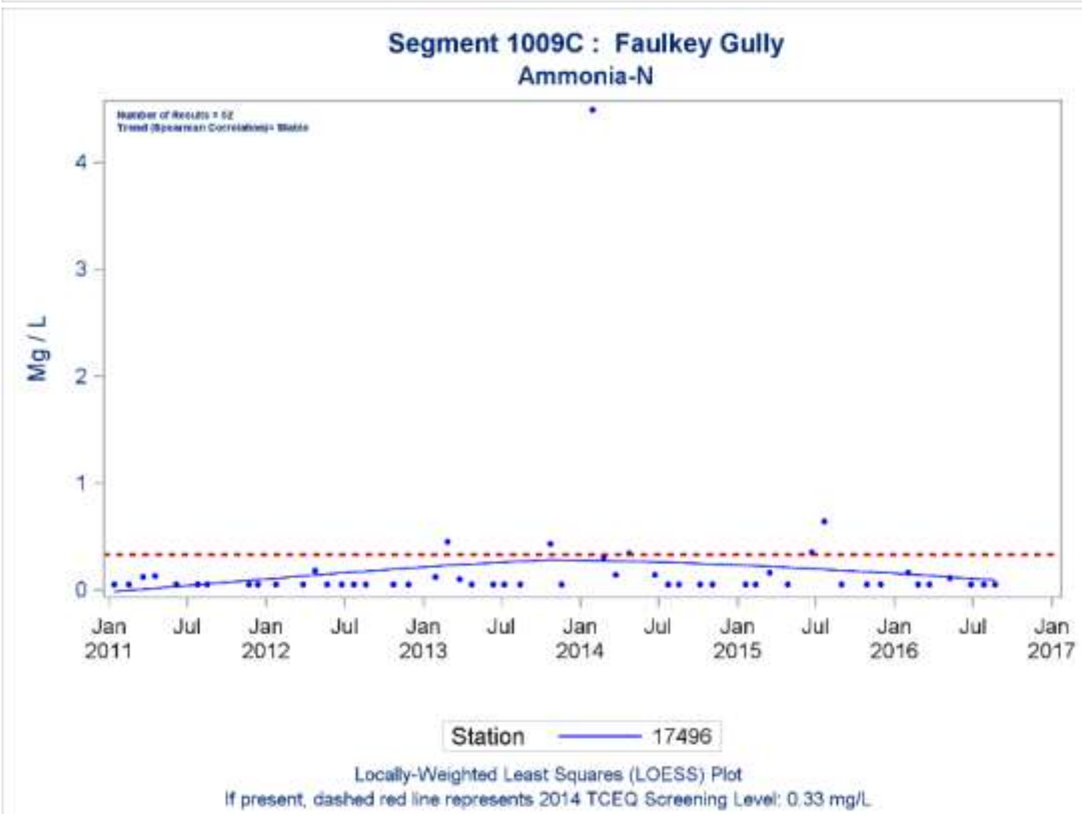

Segment 1009 : Cypress Creek
Nitrate-N
Mg / L
10
1
0.1
0.01
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
11324
11328
11330
11331
11332
11333
20457
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 1.95 Mg/L

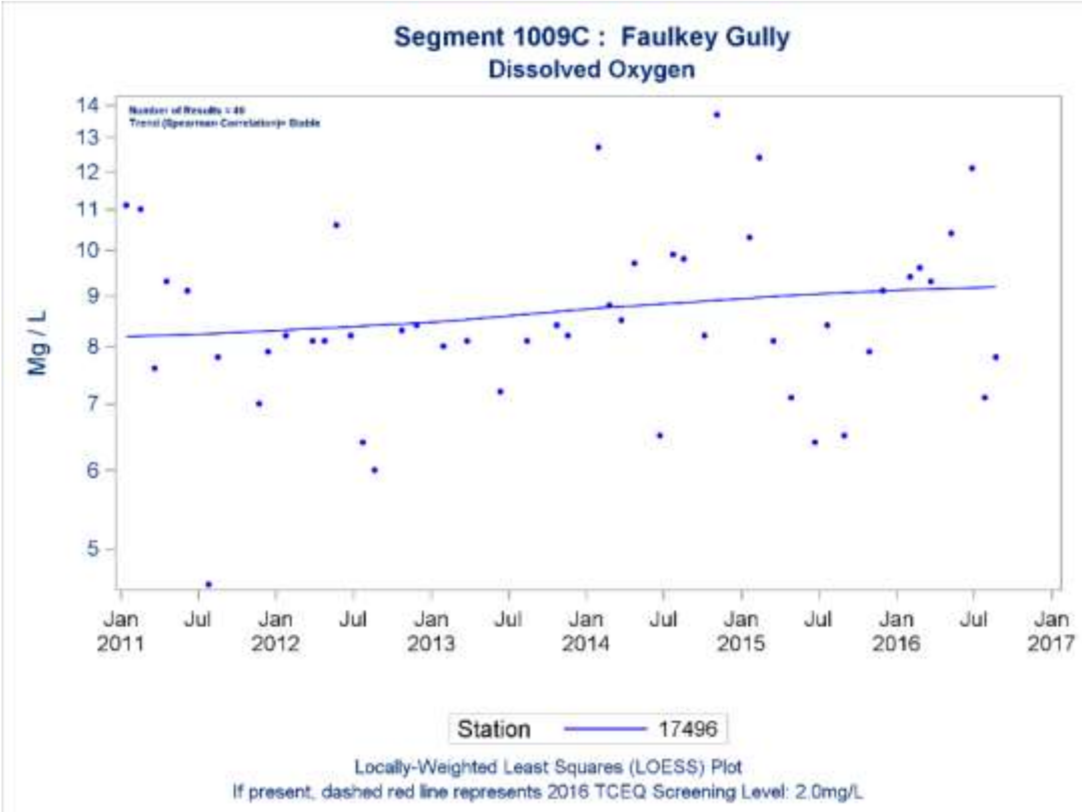

Segment 1009 : Cypress Creek
pH
Standard Units
9
8.5
8
7.5
7
6.5
2011
2012
2013
2014
2015
2016
2017
2018
Station
11324
11328
11330
11331
11332
11333
20457
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard of 6.5 - 9.0 S.U.

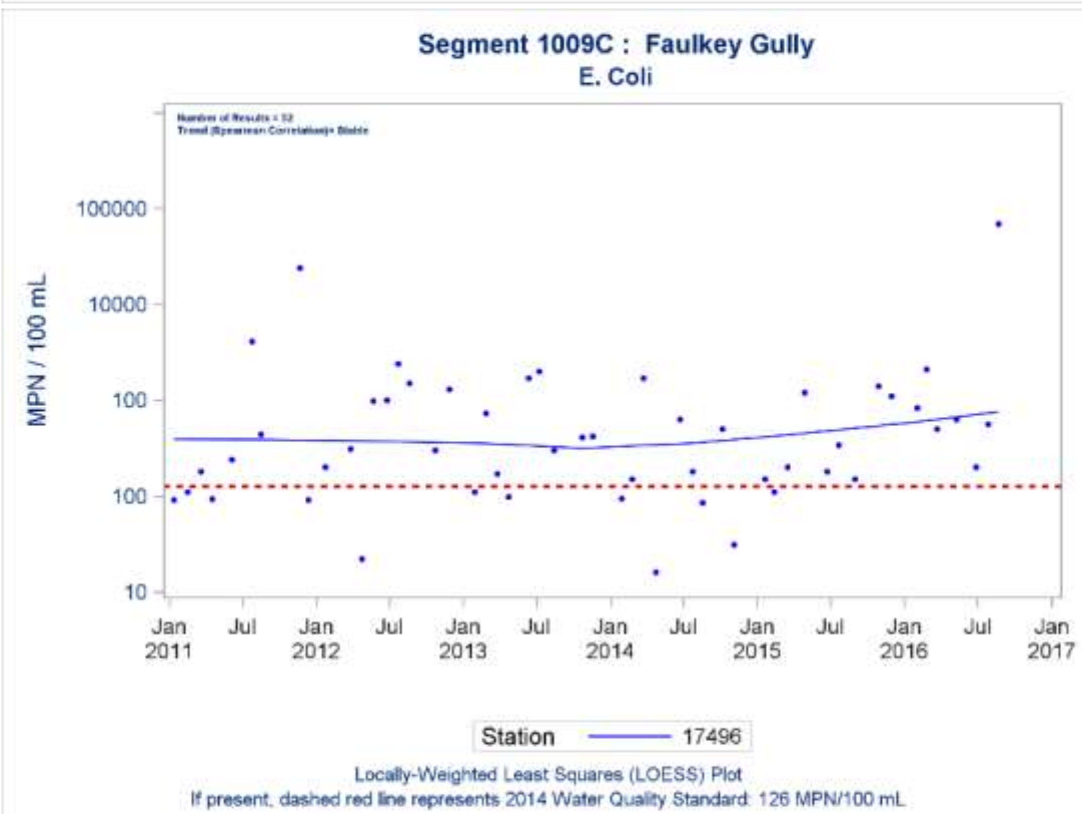

Segment 1009 : Cypress Creek
Temperature
Degrees C
30
25
20
15
10
5
2011
2012
2013
2014
2015
2016
2017
2018
Station
11324
11328
11330
11331
11332
11333
20457
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 90 Degrees F

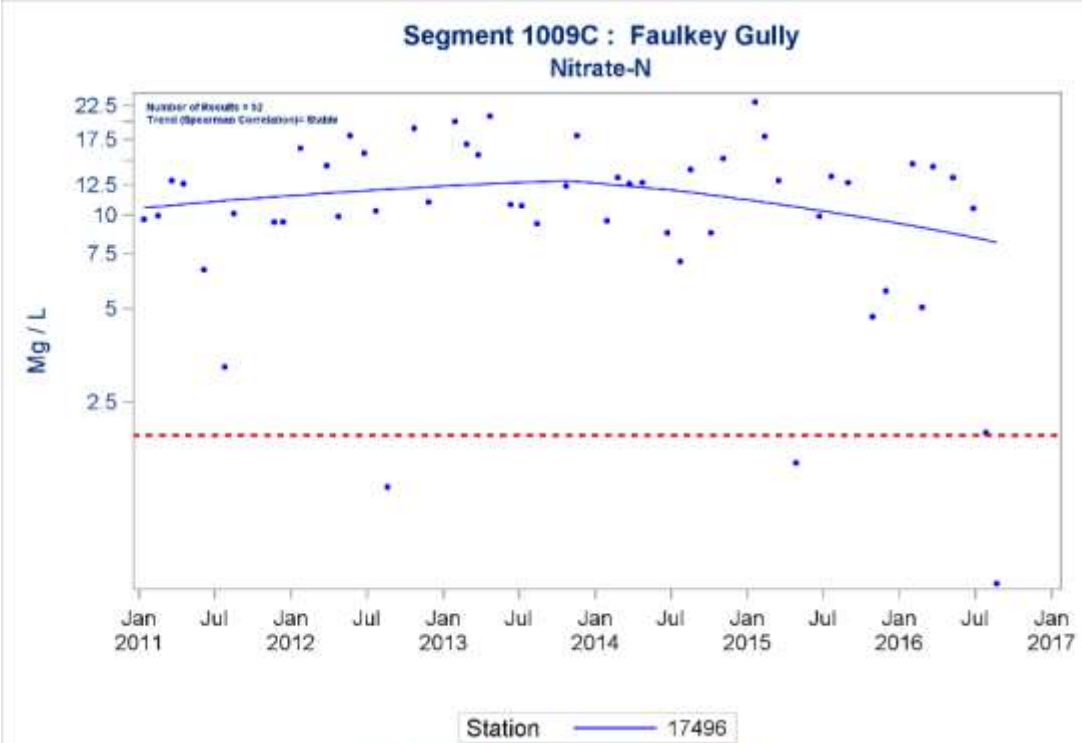

Segment 1009 : Cypress Creek
Total Phosphorus
Trend (Spearman Correlation)= Decreasing
Mg / L
10
1
0.1
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
11324
11328
11330
11331
11332
11333
20457
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.69 mg/L


Segment 1009 : Cypress Creek
Total Suspended Solids
Mg / L
400
250
150
100
50
7
1
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
11324
11328
11330
11331
11332
11333
20457
Locally-Weighted Least Squares (LOESS) Plot

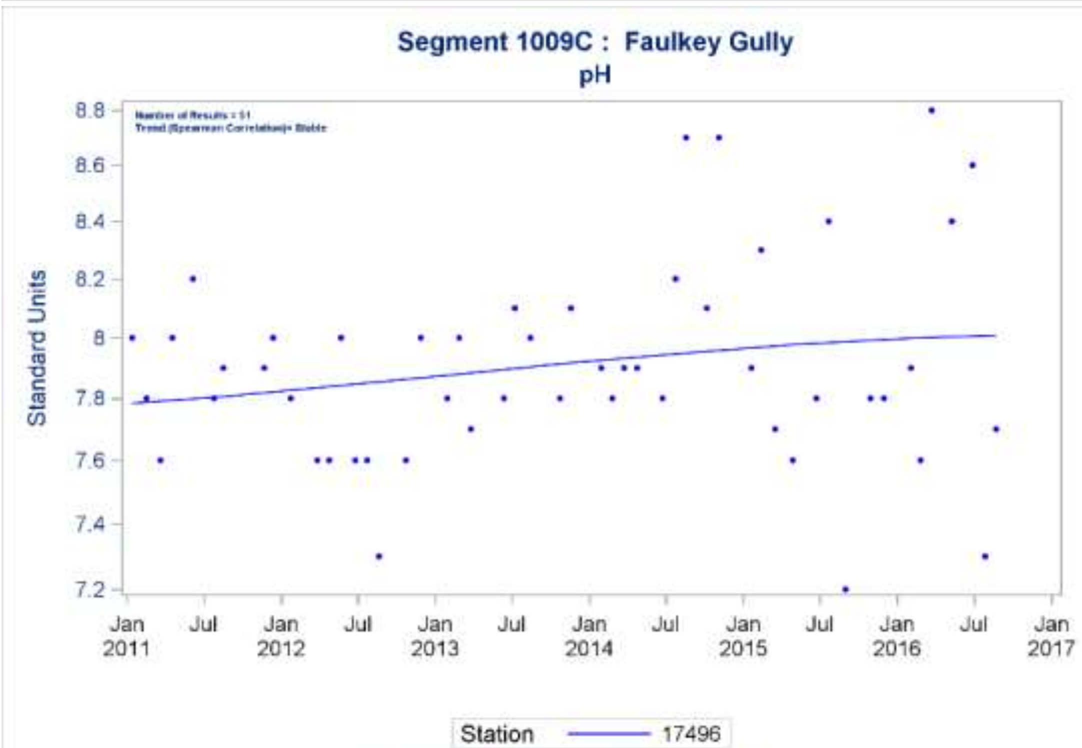

Segment 1009C : Faulkey Gully
Ammonia-N
Mg / L
4
3
2
1
0
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
17496
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.33 mg/L


Segment 1009C : Faulkey Gully
Dissolved Oxygen
Mg / L
14
13
12
11
10
9
8
7
6
5
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
17496
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2016 TCEQ Screening Level: 2.0mg/L

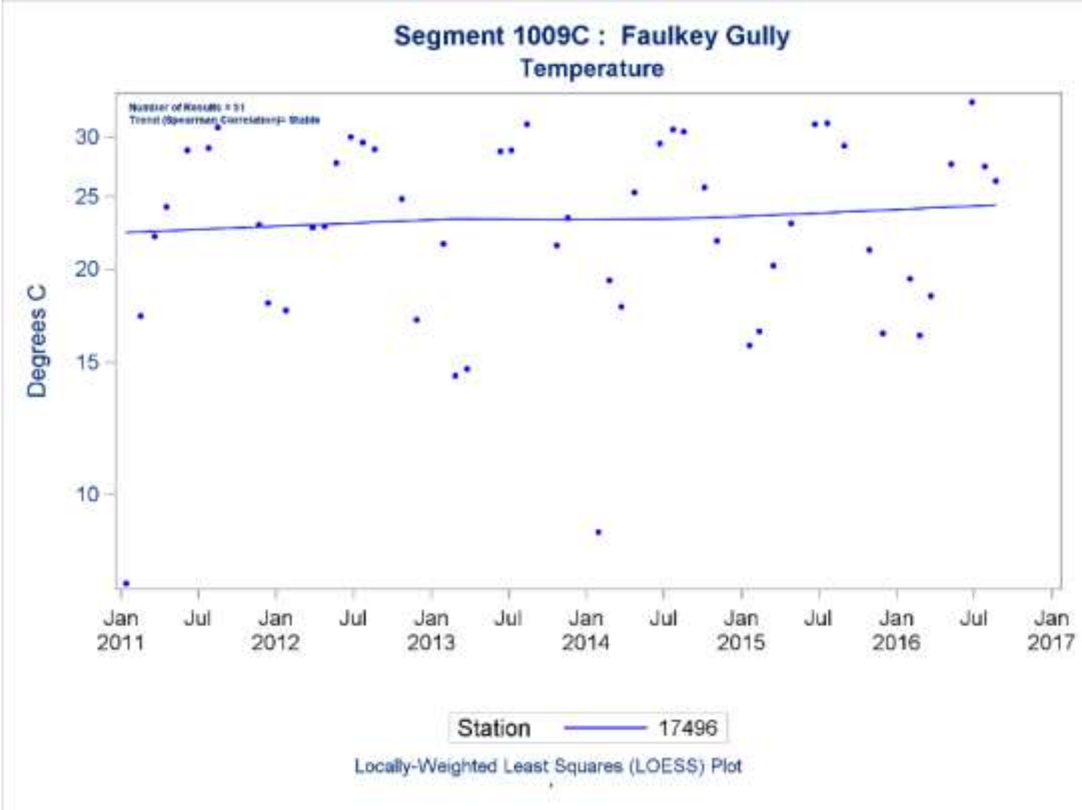

Segment 1009C : Faulkey Gully
E. Coli
MPN / 100 mL
100000
10000
100
100
10
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
17496
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 126 MPN/100 mL

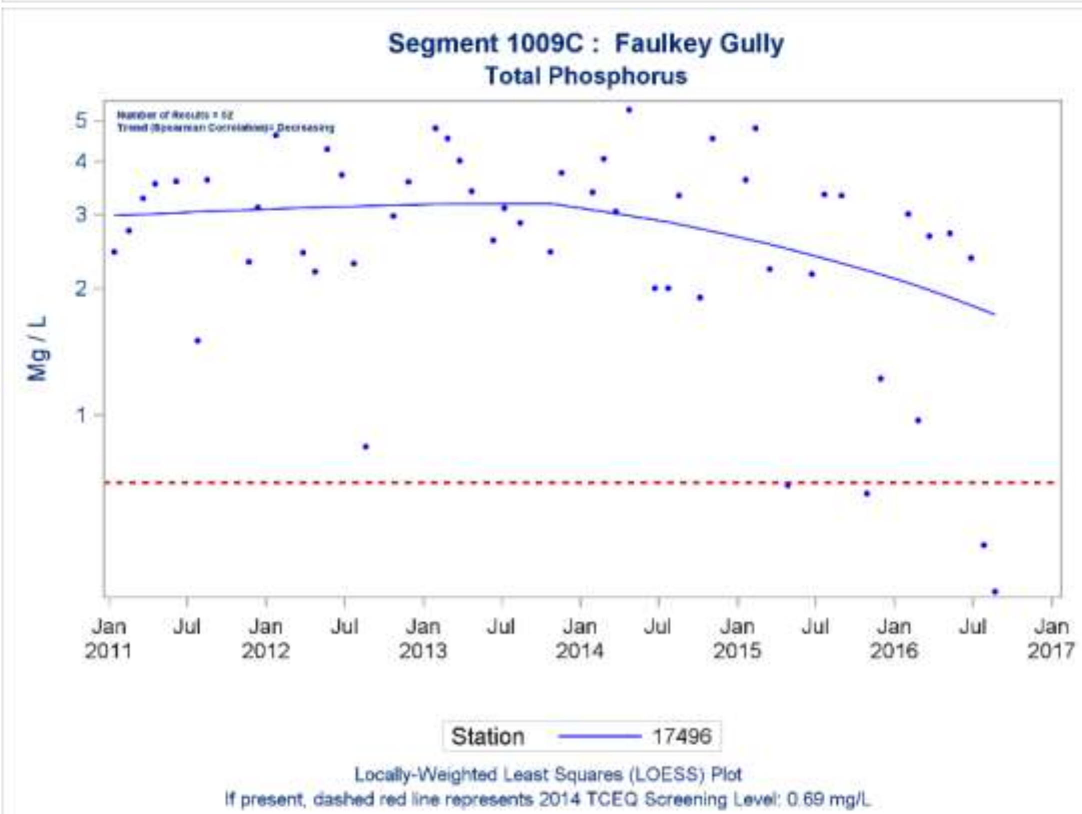


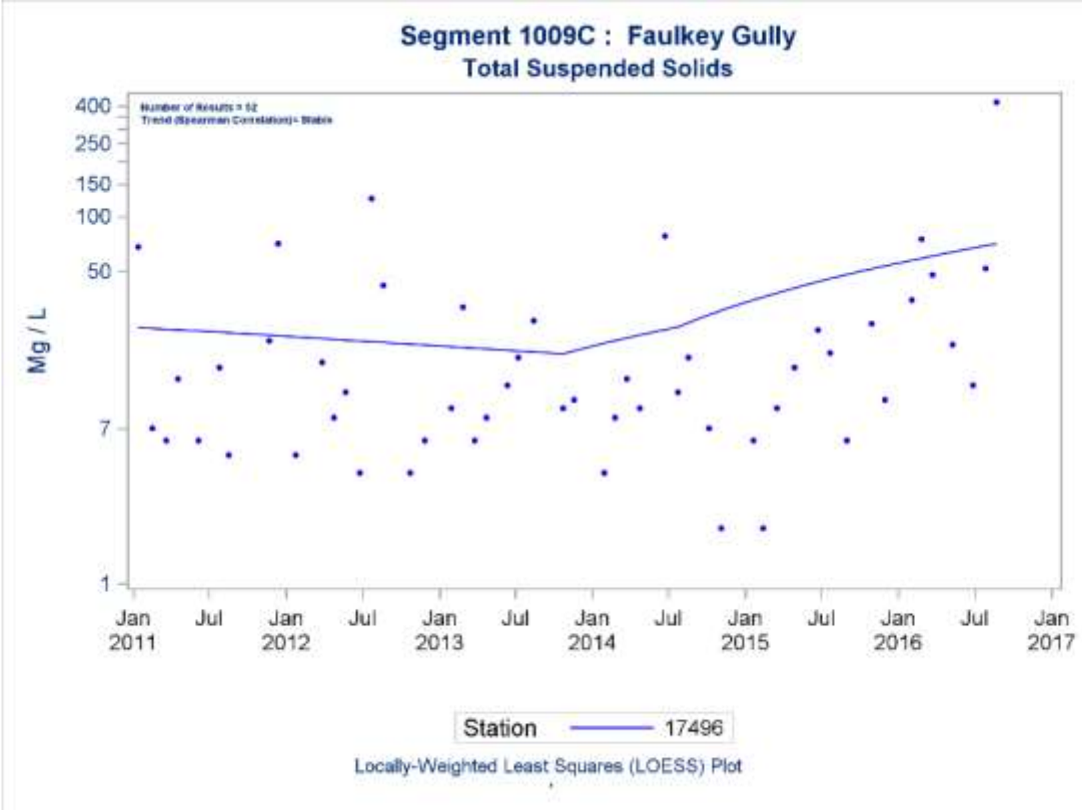
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 1.95 Mg/L

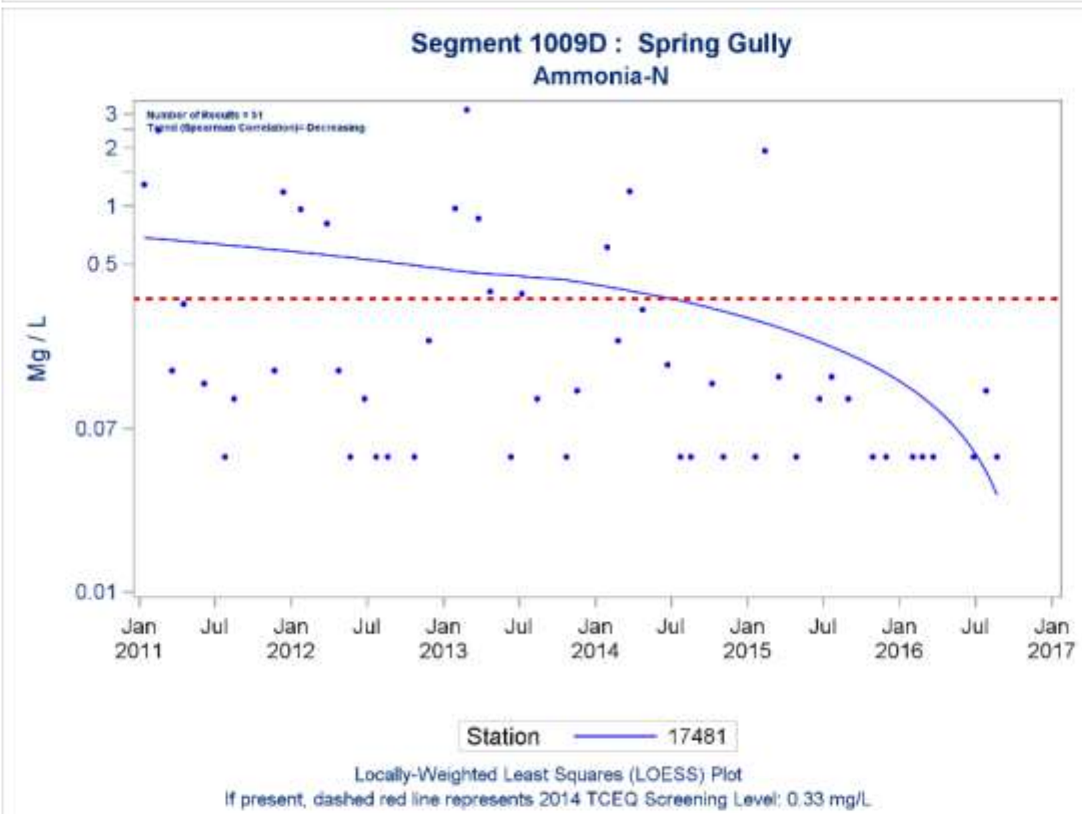


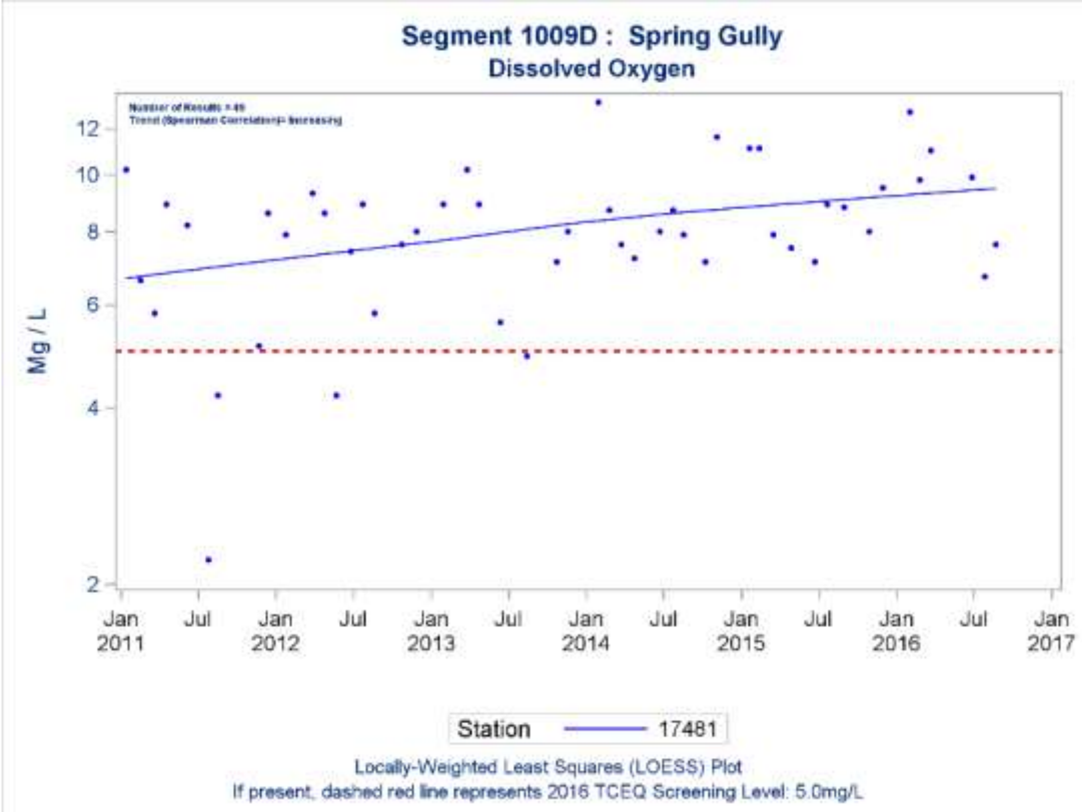
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard of 6.5 - 9.0 S.U.

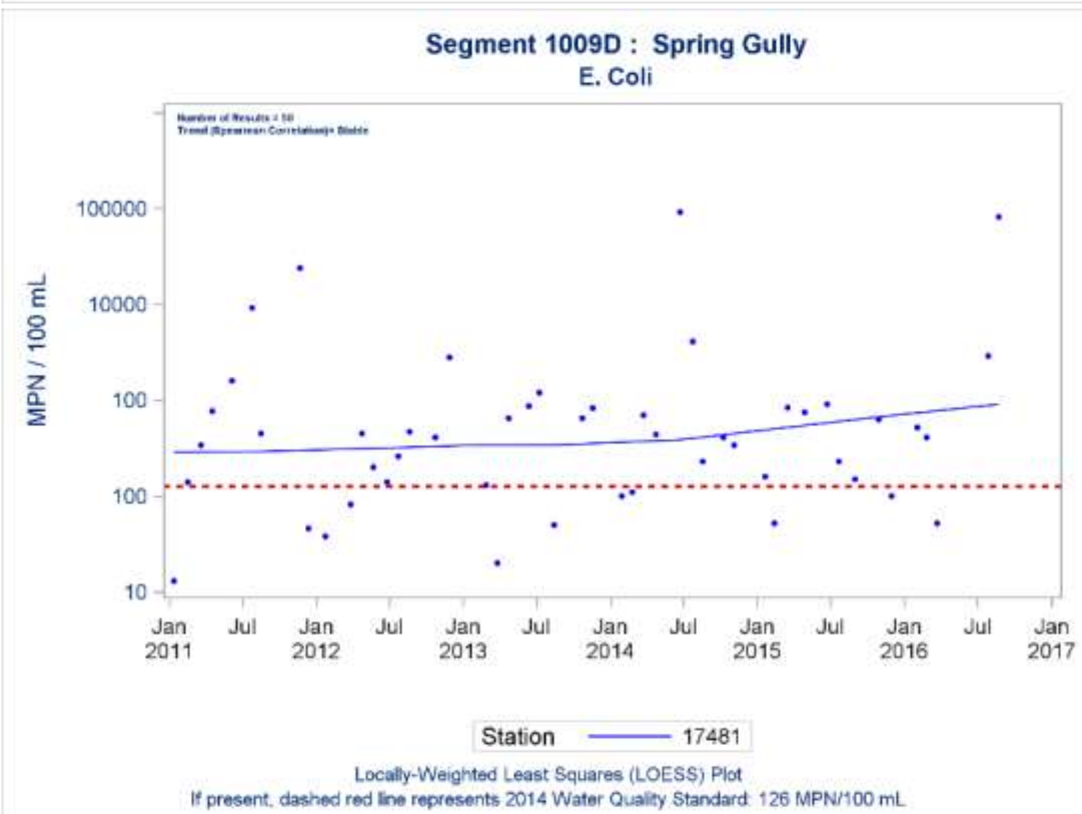

Segment 1009C : Faulkey Gully
Temperature
Number of Results = 51
Trend (Spearman Correlation)= Stable
Degrees C
30
25
20
15
10
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
17496
Locally-Weighted Least Squares (LOESS) Plot

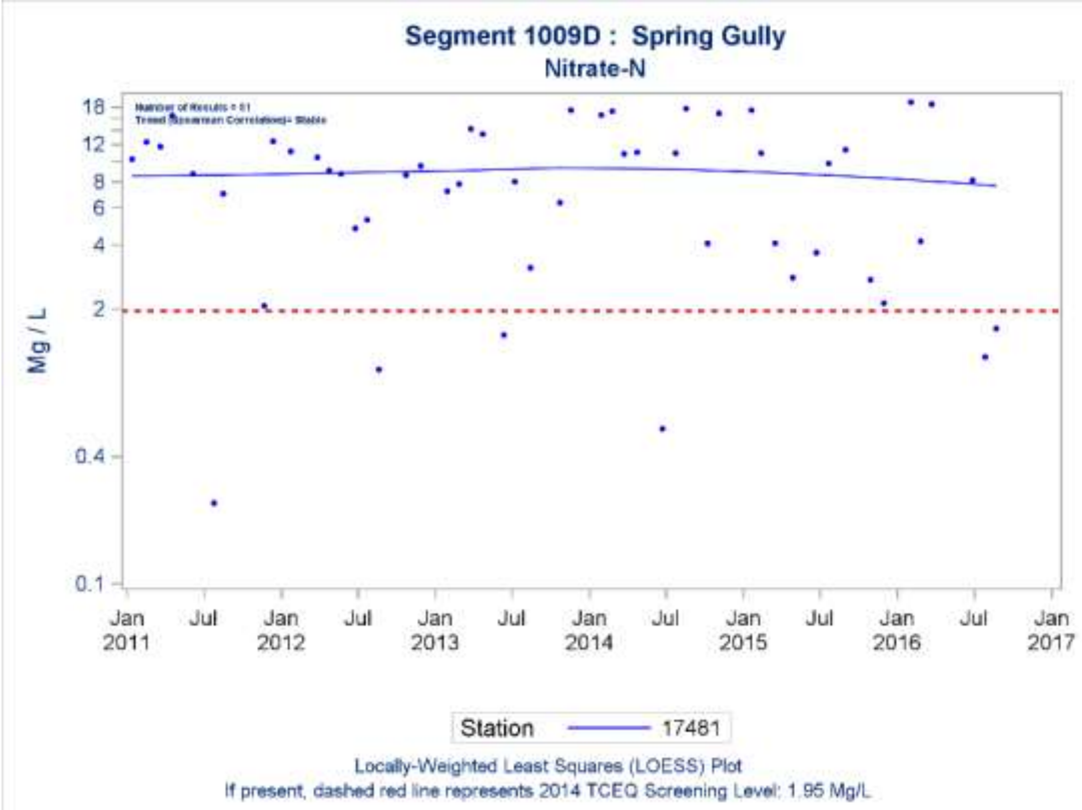

Segment 1009C : Faulkey Gully
Total Phosphorus
Number of Results = 52
Trend (Spearman Correlation)= Decreasing
Mg / L
5
4
3
2
1
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
17496
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.69 mg/L

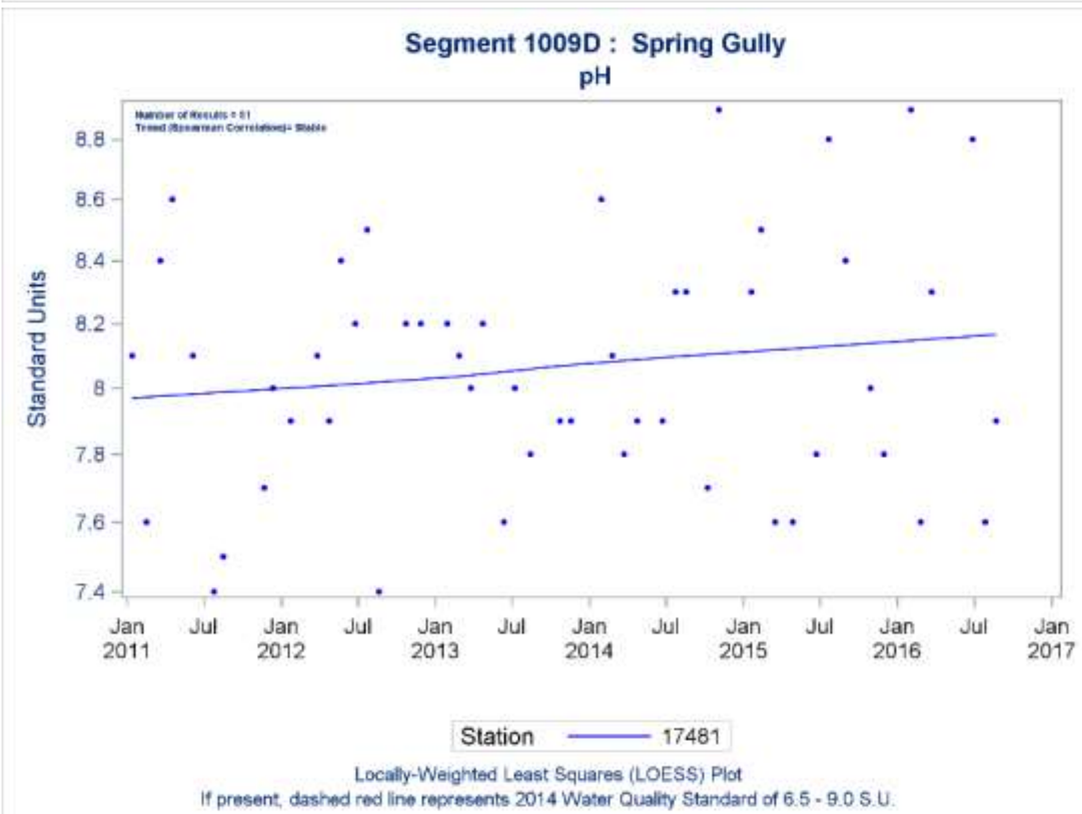

Segment 1009C : Faulkey Gully
Total Suspended Solids
Trend (Spearman Correlation)= Stable
400
250
150
100
50
7
1
Mg / L
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
17496
Locally-Weighted Least Squares (LOESS) Plot

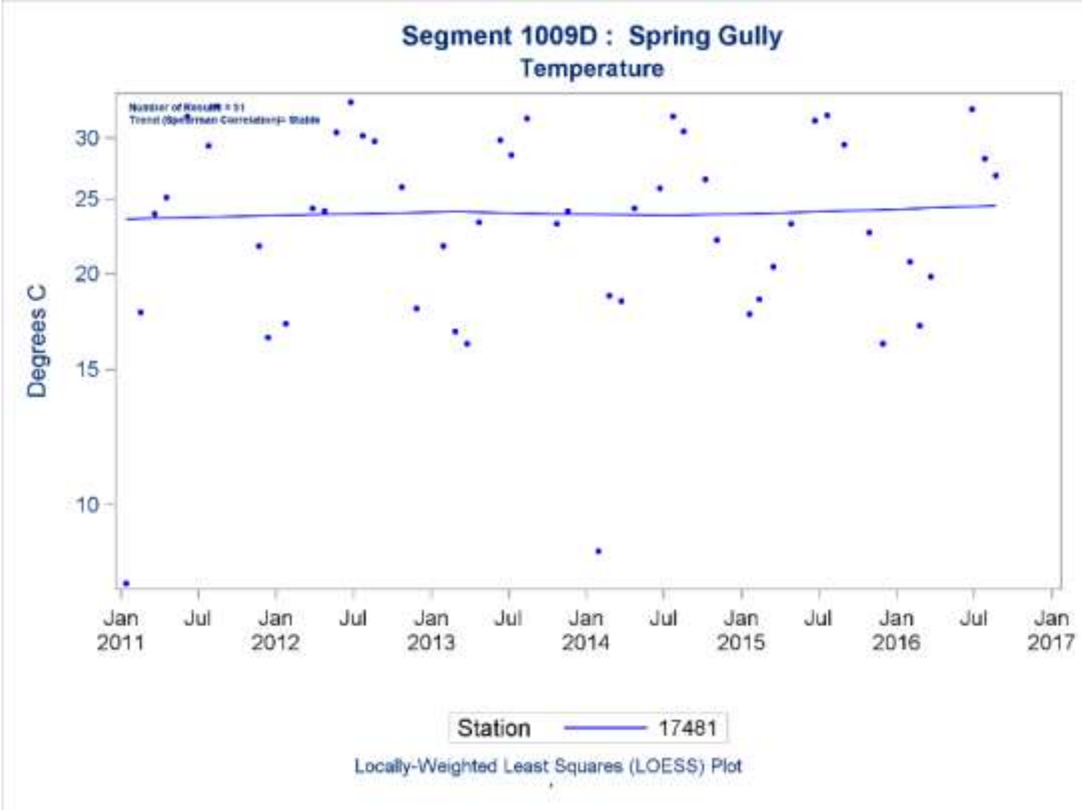

Segment 1009D : Spring Gully
Ammonia-N
Trend (Spearman Correlation)= Decreasing
3
2
1
0.5
0.07
0.01
Mg / L
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
17481
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.33 mg/L

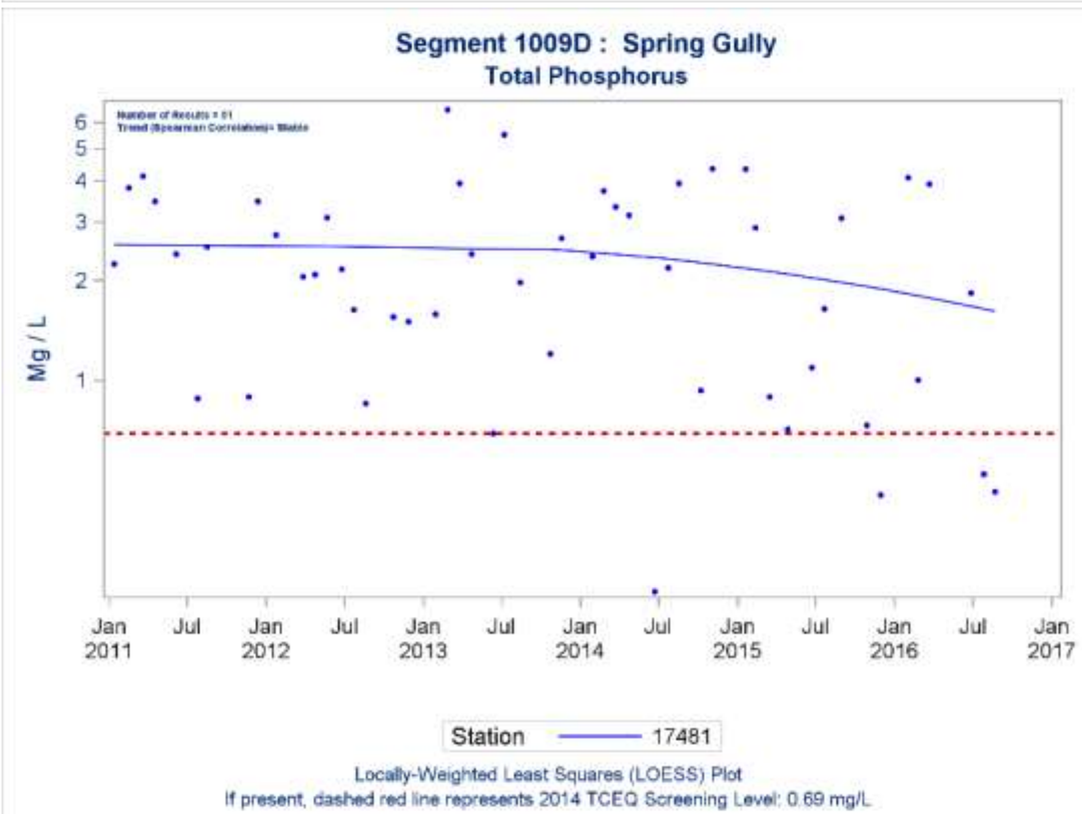

Segment 1009D : Spring Gully
Dissolved Oxygen
Mg / L
12
10
8
6
4
2
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
17481
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2016 TCEQ Screening Level: 5.0mg/L

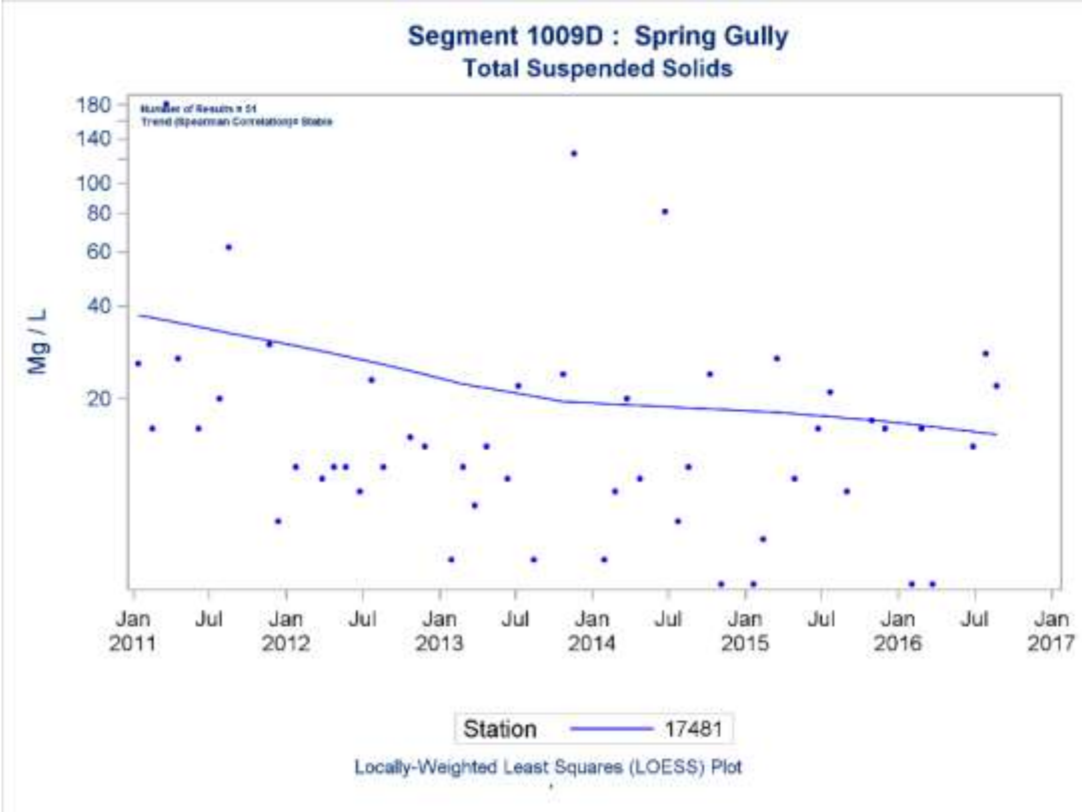

Segment 1009D : Spring Gully
E. Coli
MPN / 100 mL
100000
10000
100
100
10
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
17481
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 126 MPN/100 mL

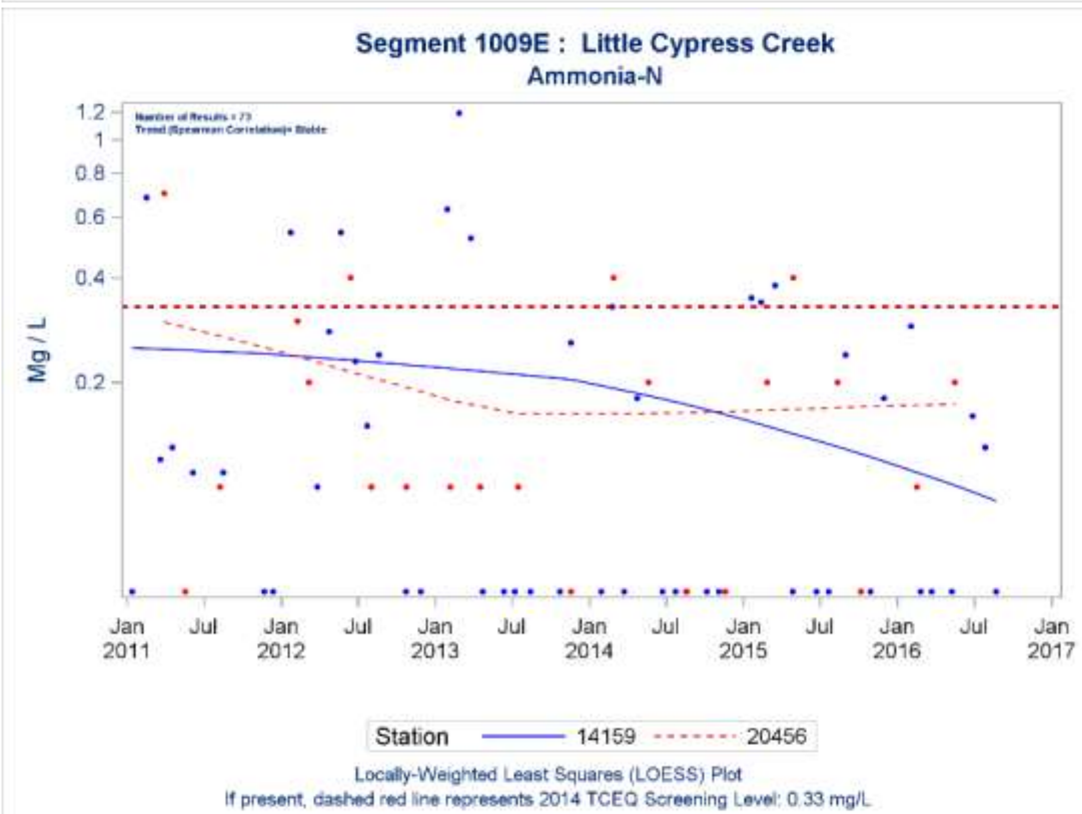

Segment 1009D : Spring Gully
Nitrate-N
Mg / L
Station 17481
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 1.95 Mg/L

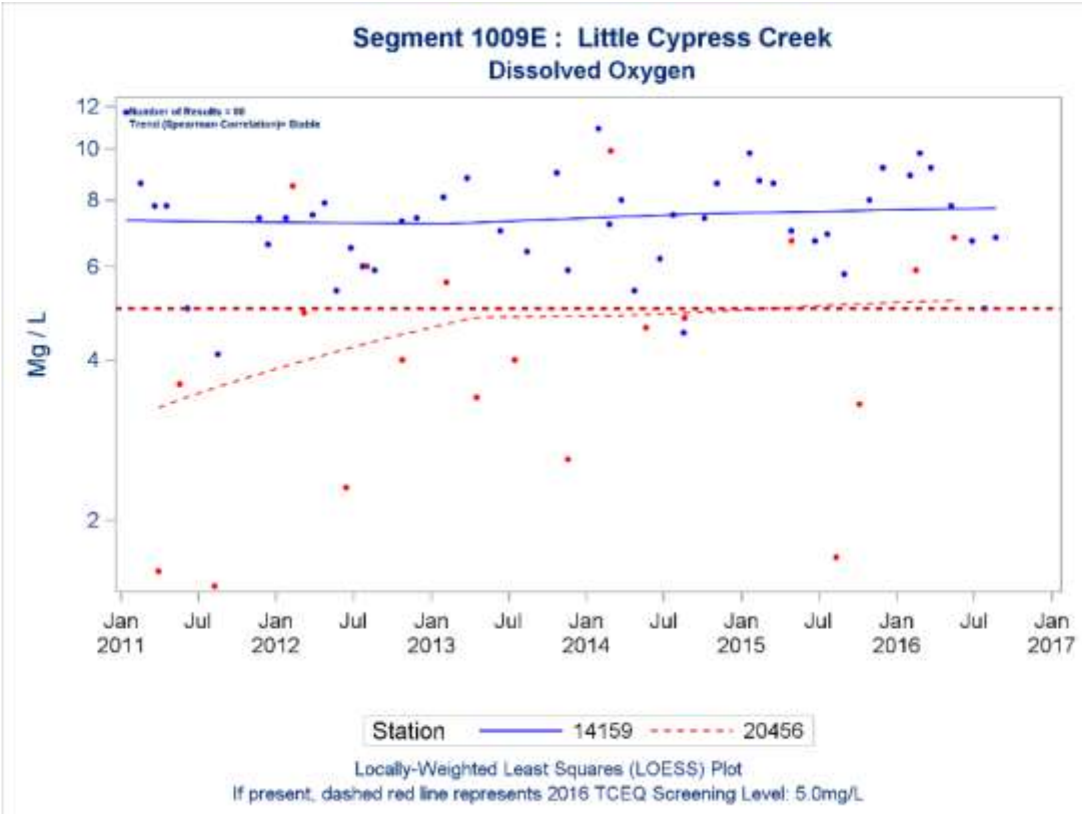

Segment 1009D : Spring Gully
pH
Standard Units
Station 17481
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard of 6.5 - 9.0 S.U.

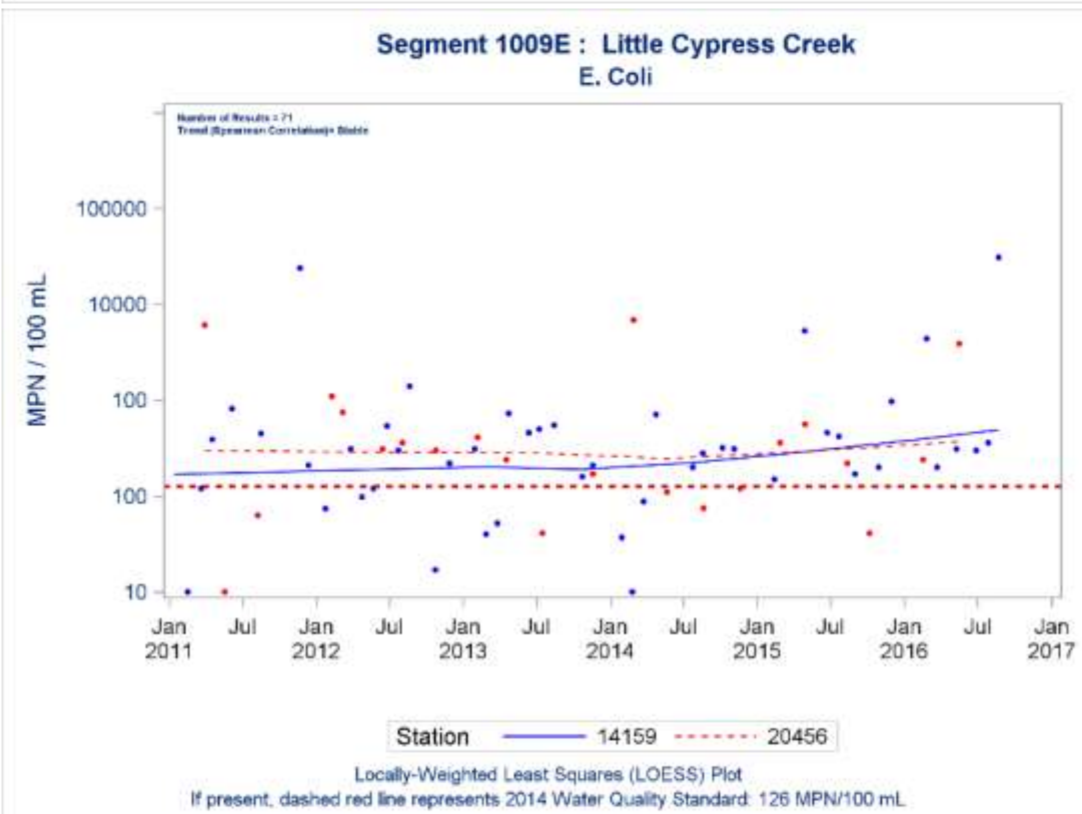

Segment 1009D : Spring Gully
Temperature
Degrees C
30
25
20
15
10
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
17481
Locally-Weighted Least Squares (LOESS) Plot

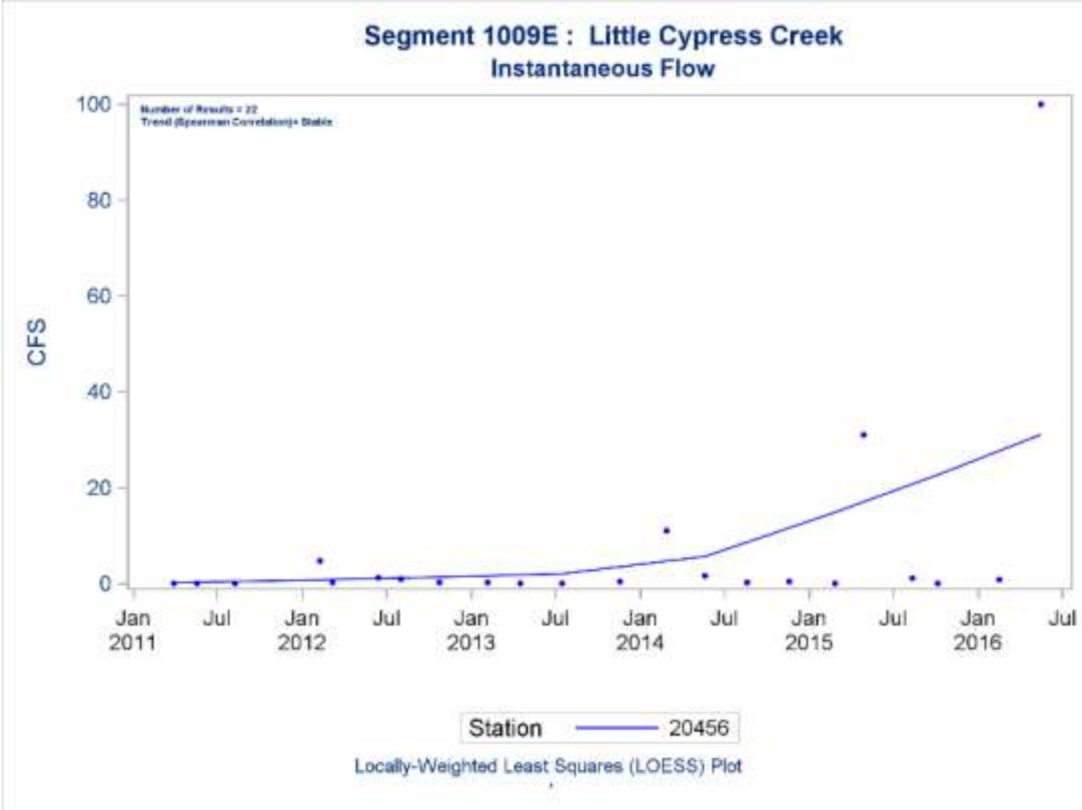

Segment 1009D : Spring Gully
Total Phosphorus
Mg / L
6
5
4
3
2
1
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
17481
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.69 mg/L


Segment 1009D : Spring Gully
Total Suspended Solids
Mg / L
180
140
100
80
60
40
20
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
17481
Locally-Weighted Least Squares (LOESS) Plot

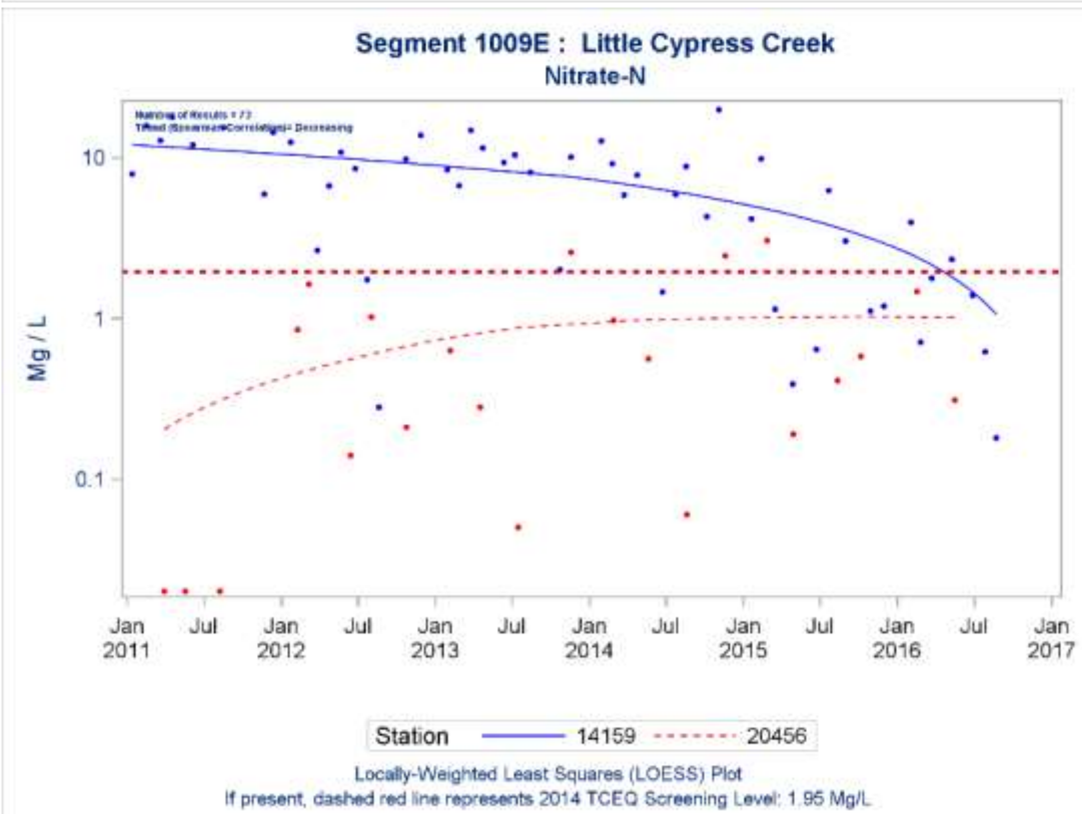

Segment 1009E : Little Cypress Creek
Ammonia-N
Mg / L
1.2
1
0.8
0.6
0.4
0.2
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
14159
20456
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.33 mg/L


Segment 1009E : Little Cypress Creek
Dissolved Oxygen
Mg / L
12
10
8
6
4
2
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
14159
20456
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2016 TCEQ Screening Level: 5.0mg/L

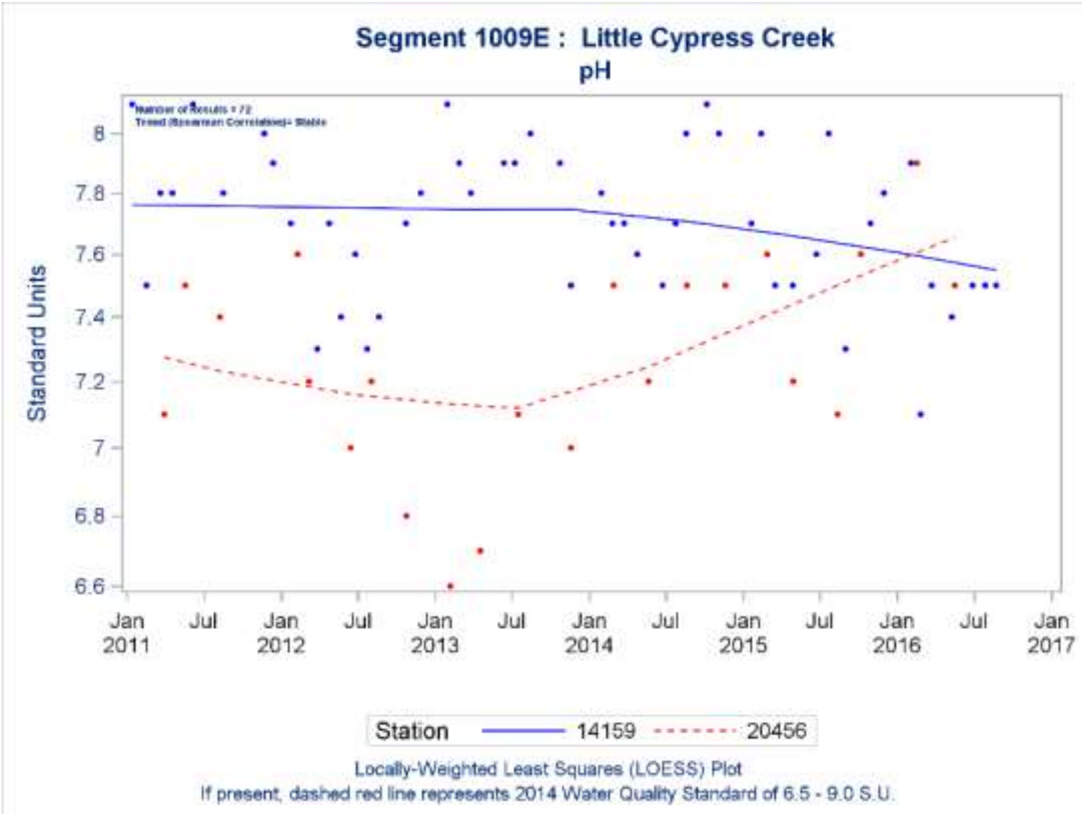

Segment 1009E : Little Cypress Creek
E. Coli
MPN / 100 mL
100000
10000
100
100
10
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
14159
20456
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 126 MPN/100 mL

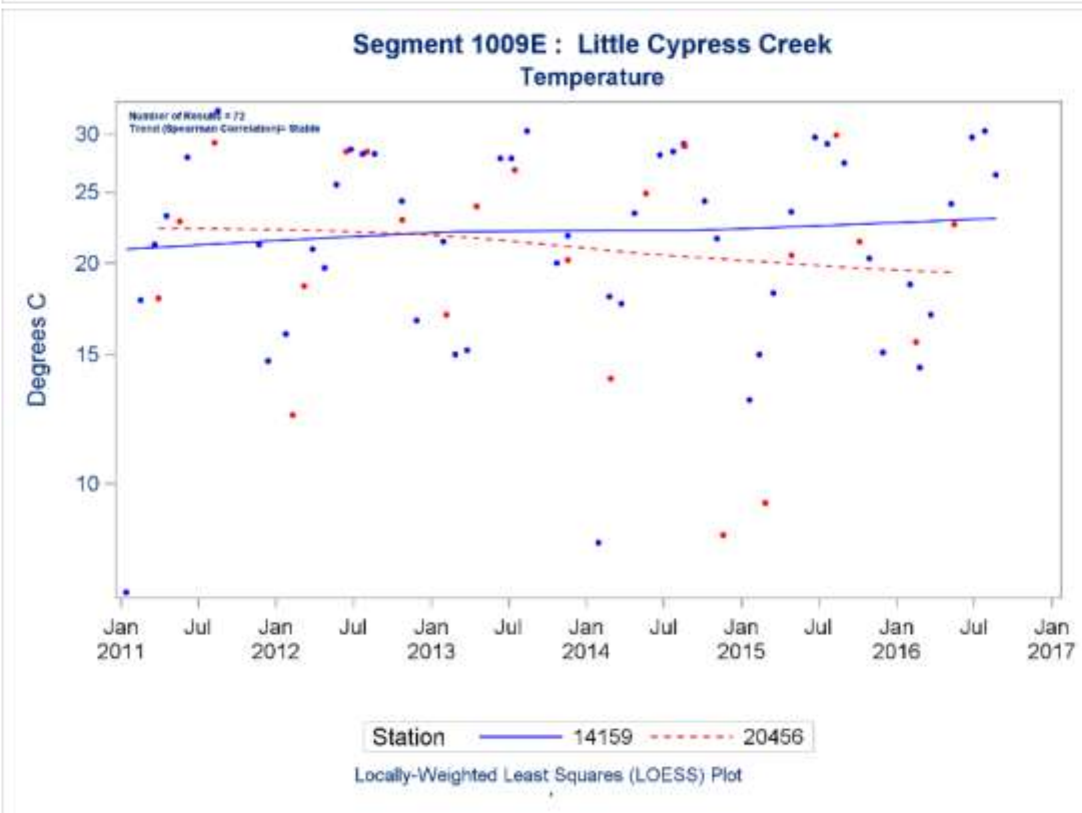


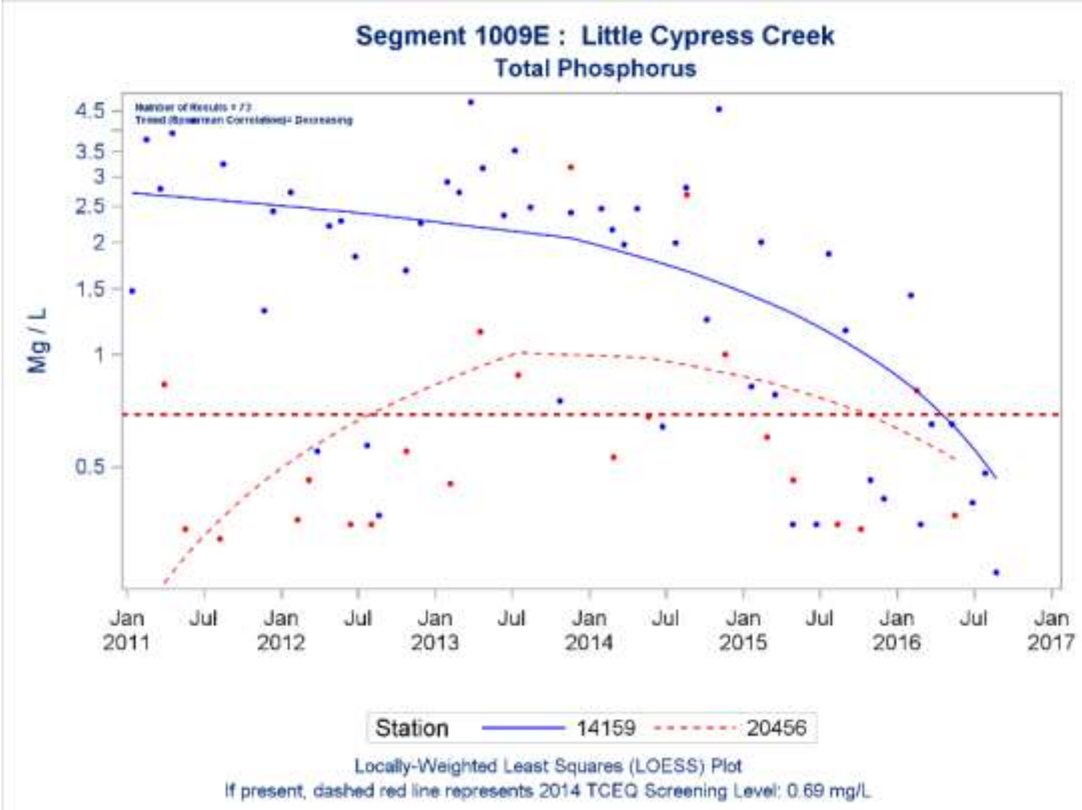
Segment 1009E : Little Cypress Creek
Instantaneous Flow
Number of Results = 22
Trend (Spearman Correlation)= Stable
CFS
100
80
60
40
20
0
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station
20456
Locally-Weighted Least Squares (LOESS) Plot

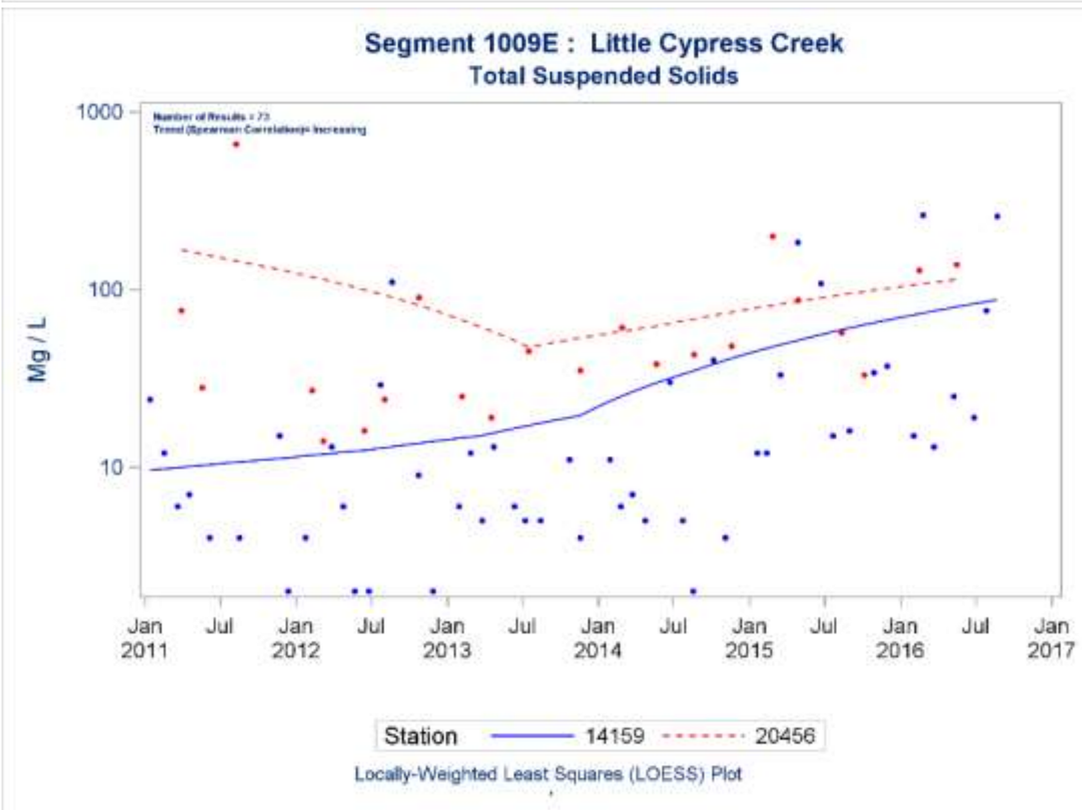


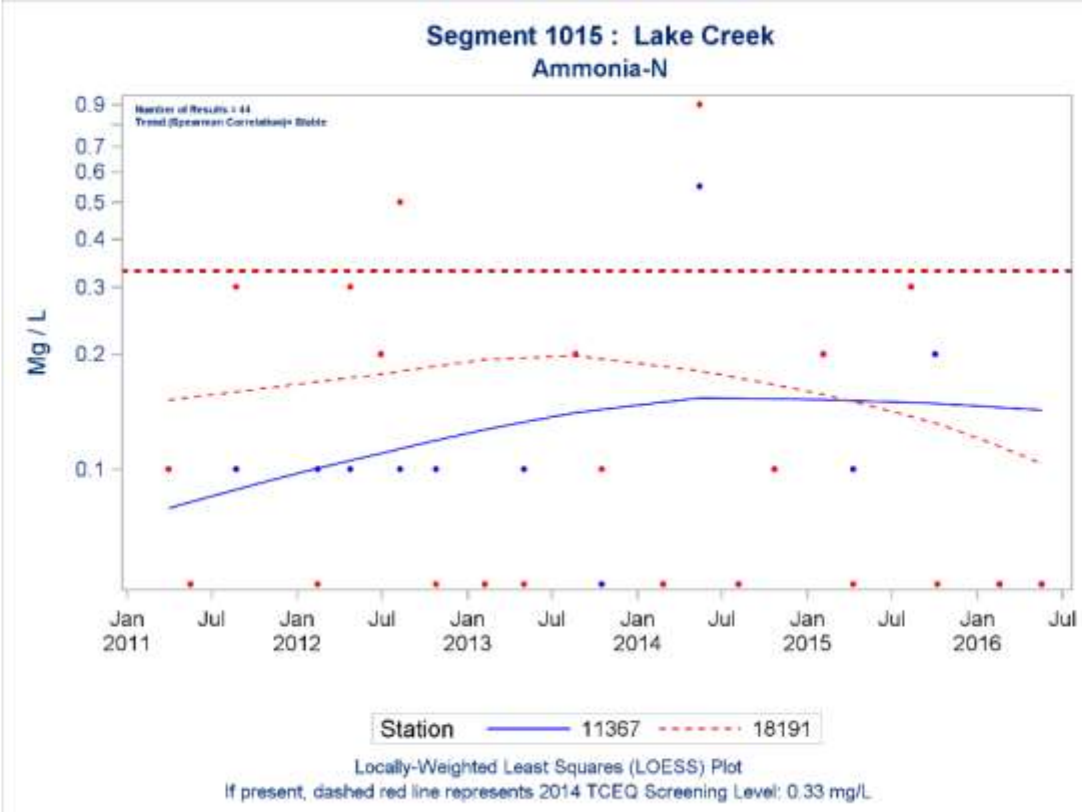
Segment 1009E : Little Cypress Creek
Nitrate-N
Trend (Spearman Correlation)= Decreasing
Mg / L
10
1
0.1
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
14159
20456
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 1.95 Mg/L

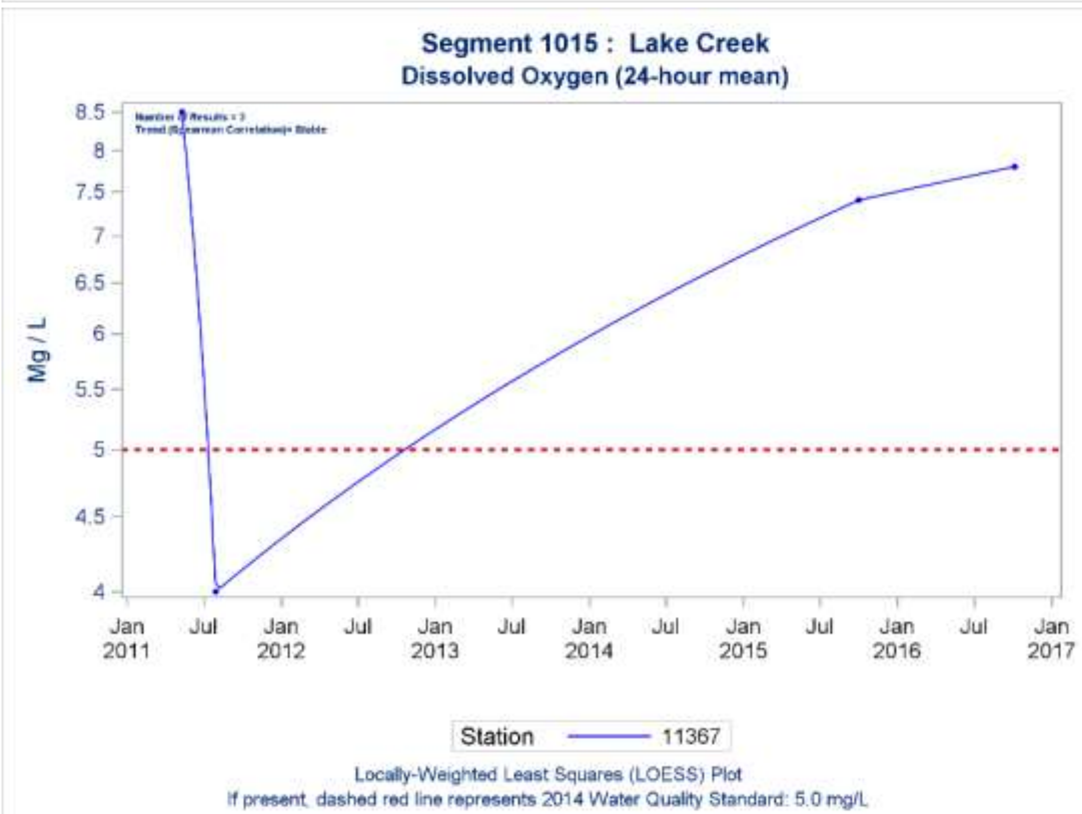

Segment 1009E : Little Cypress Creek
pH
Standard Units
8
7.8
7.6
7.4
7.2
7
6.8
6.6
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
14159
20456
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard of 6.5 - 9.0 S.U.

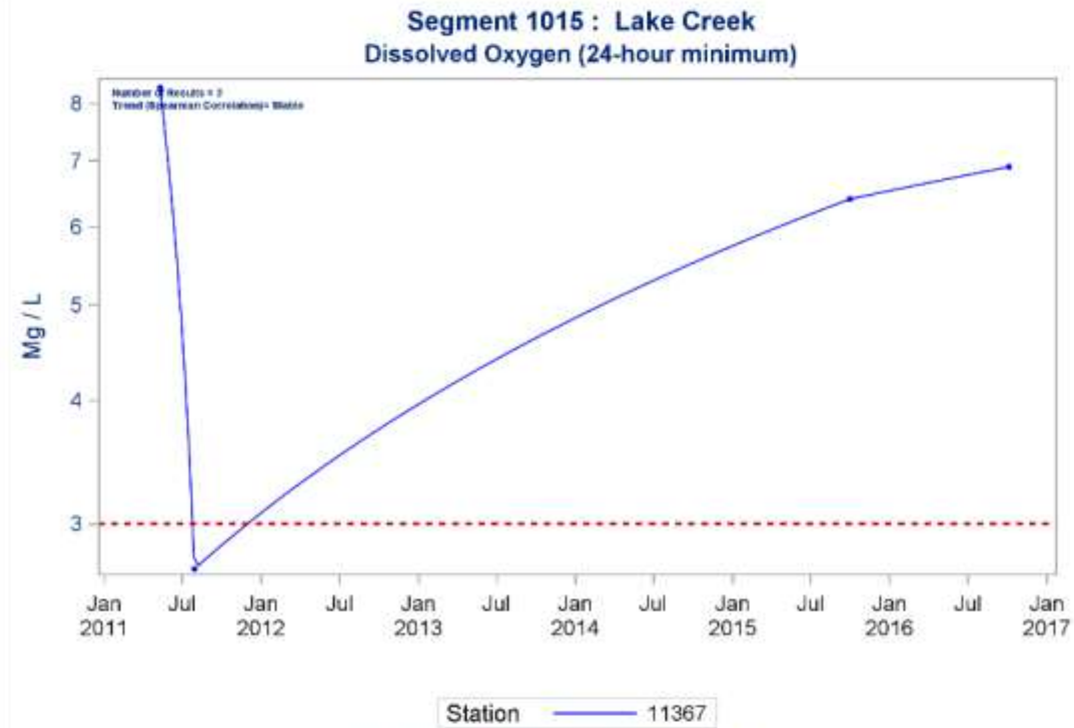

Segment 1009E : Little Cypress Creek
Temperature
Degrees C
30
25
20
15
10
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
14159
20456
Locally-Weighted Least Squares (LOESS) Plot


Segment 1009E : Little Cypress Creek
Total Phosphorus
Trend (Spearman Correlation)= Decreasing
Mg / L
4.5
3.5
3
2.5
2
1.5
1
0.5
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
14159
20456
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.69 mg/L

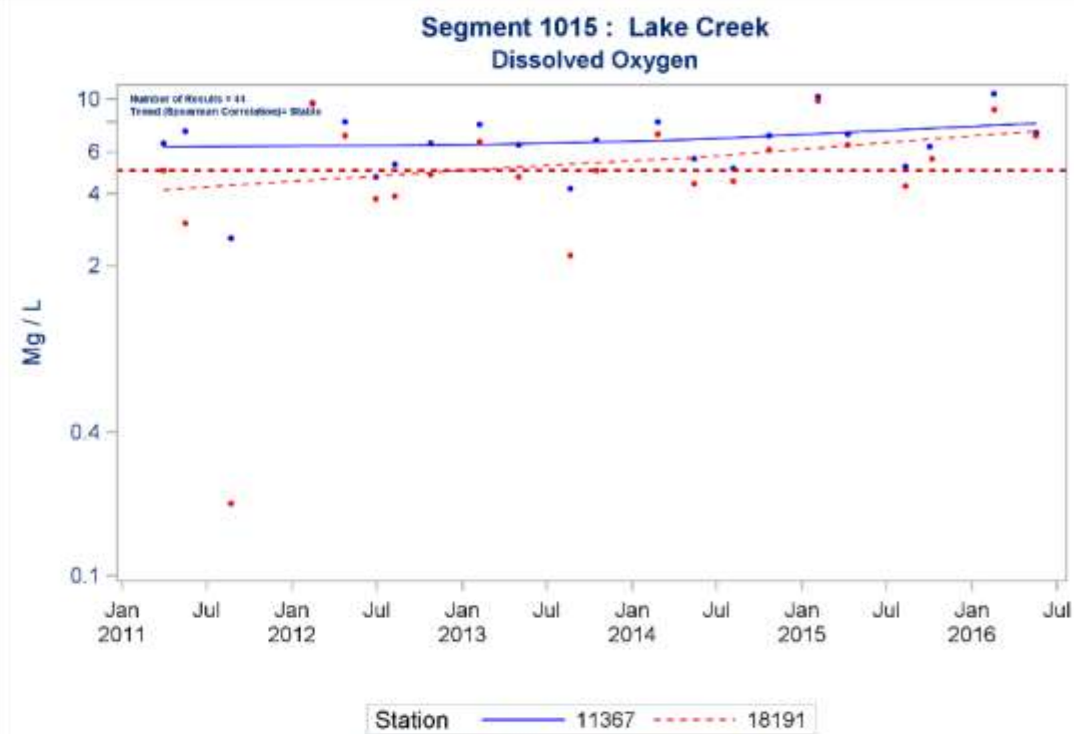

Segment 1009E : Little Cypress Creek
Total Suspended Solids
Trend (Spearman Correlation)= Increasing
Mg / L
1000
100
10
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Station
14159
20456
Locally-Weighted Least Squares (LOESS) Plot


Segment 1015 : Lake Creek
Ammonia-N
Mg / L
Station 11367 18191
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.33 mg/L

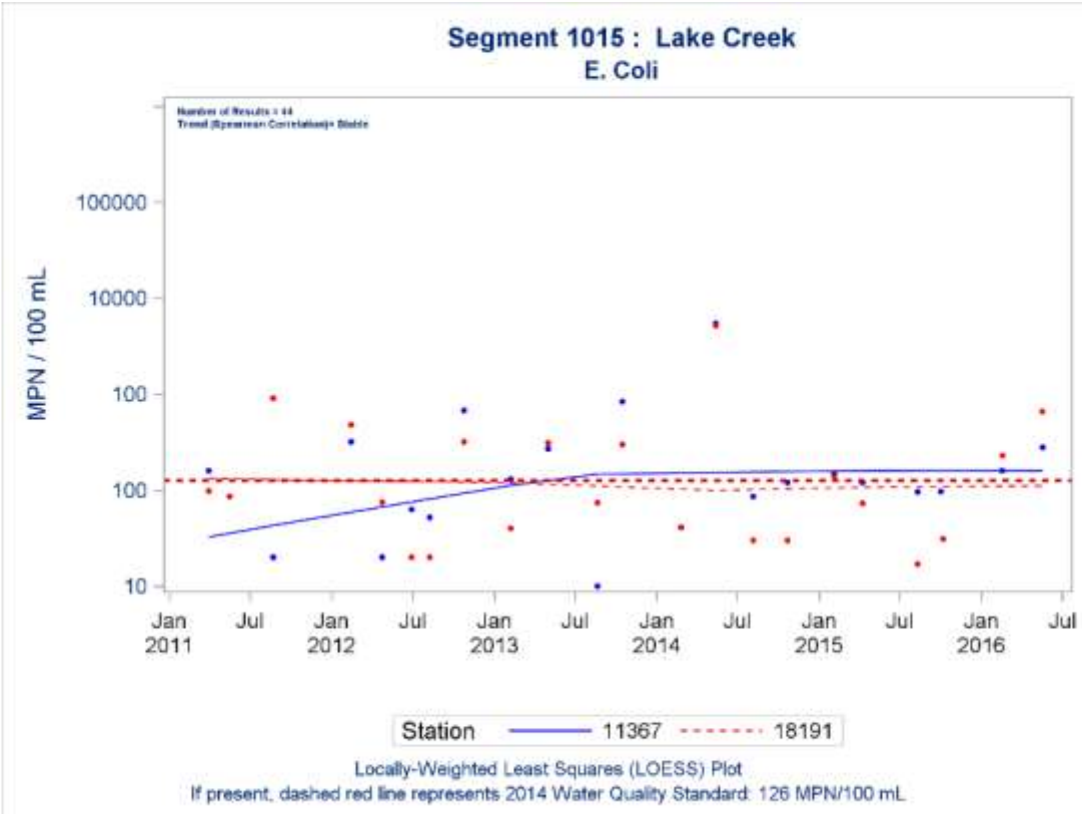

Segment 1015 : Lake Creek
Dissolved Oxygen (24-hour mean)
Mg / L
Station 11367
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 5.0 mg/L

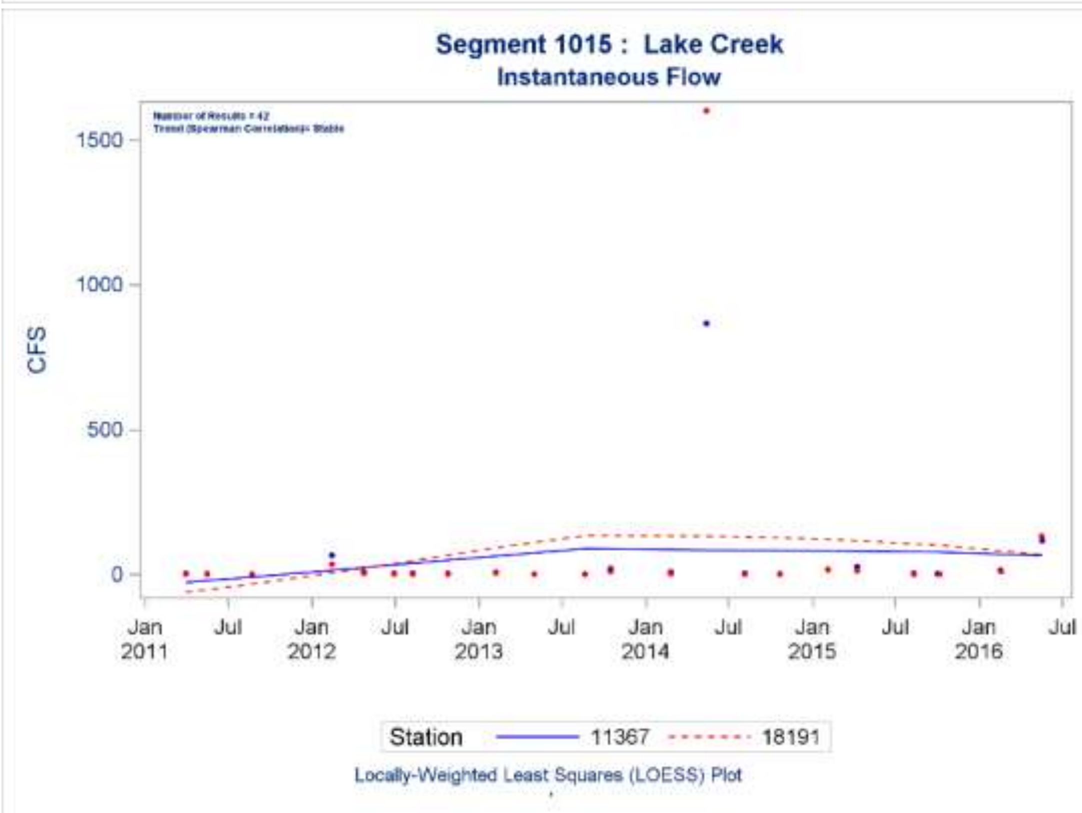


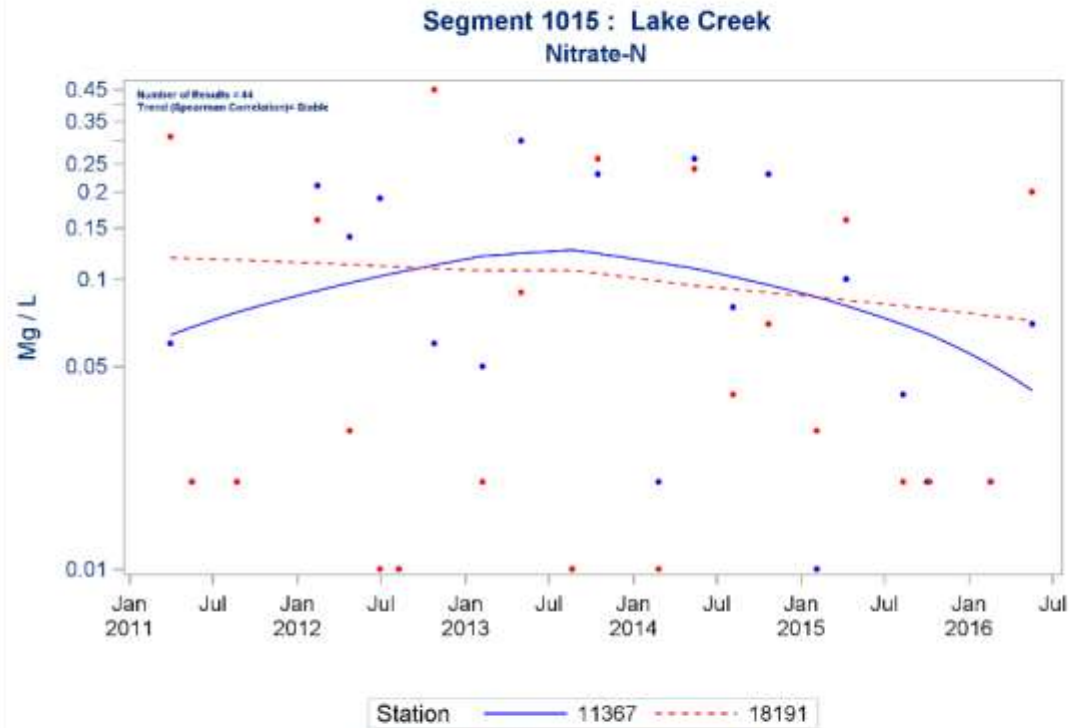
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 3.0 mg/L



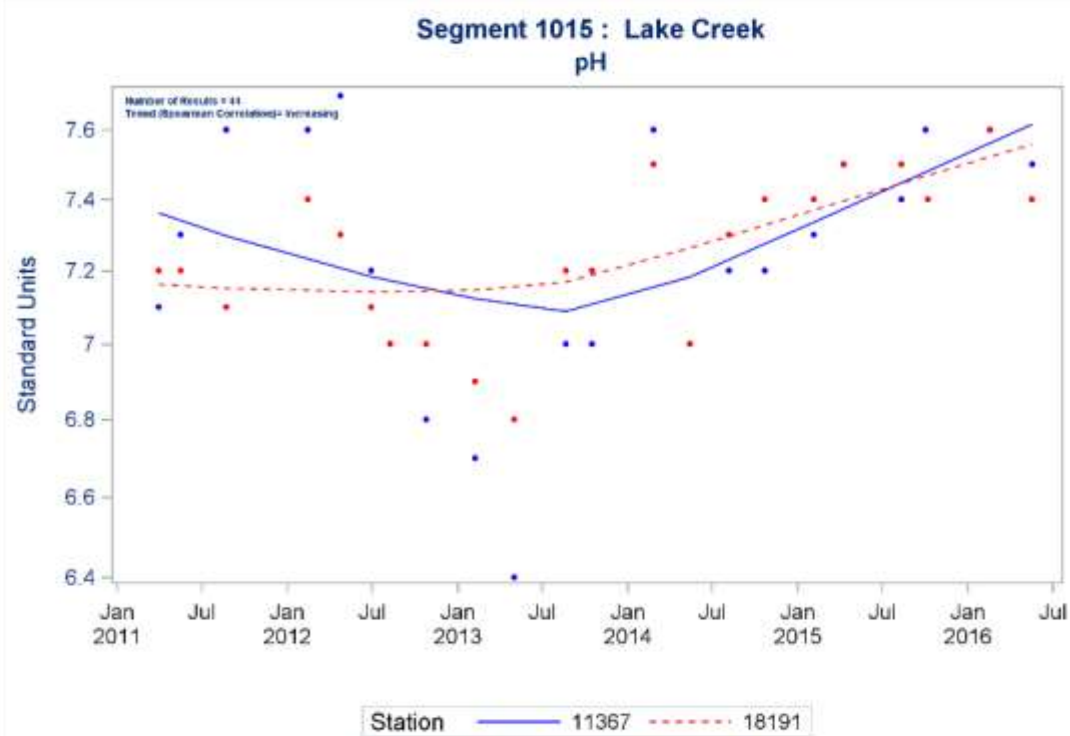
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2016 TCEQ Screening Level: 5.0mg/L


Segment 1015 : Lake Creek
E. Coli
Number of Results = 44
Trend (Spearman Correlation)= Stable
MPN / 100 mL
100000
10000
100
100
10
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station
11367
18191
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 126 MPN/100 mL

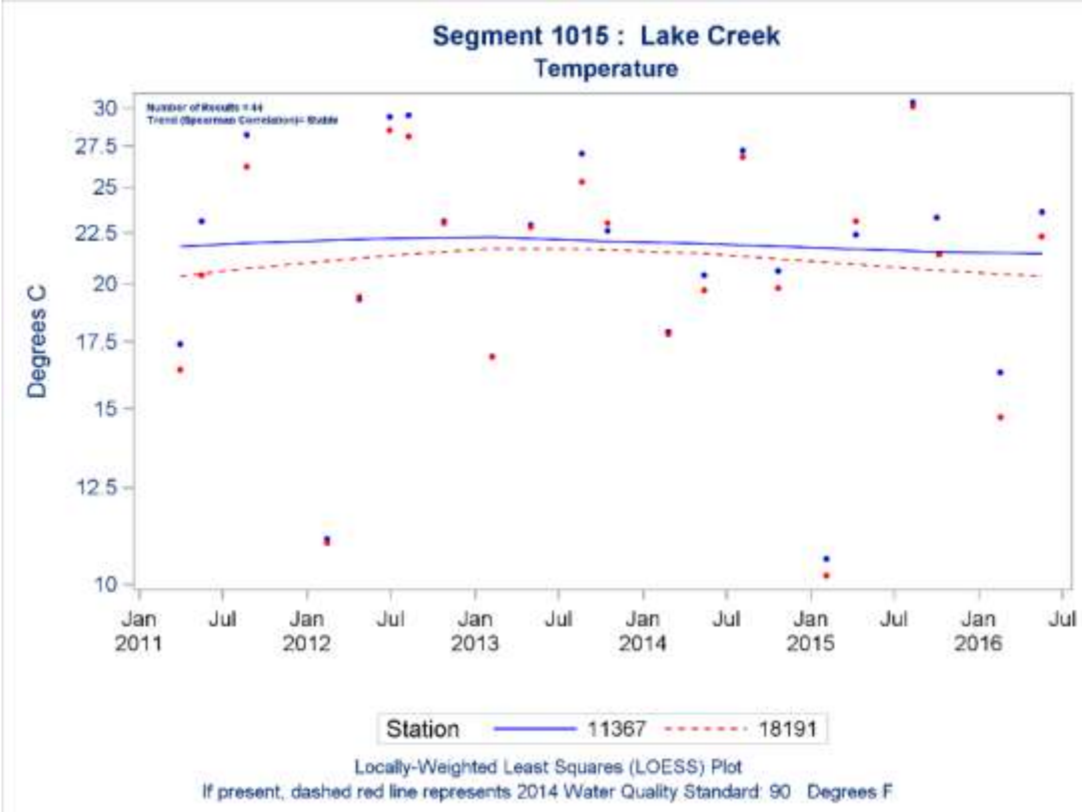

Segment 1015 : Lake Creek
Instantaneous Flow
Number of Results = 42
Trend (Spearman Correlation)= Stable
CFS
1500
1000
500
0
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station
11367
18191
Locally-Weighted Least Squares (LOESS) Plot

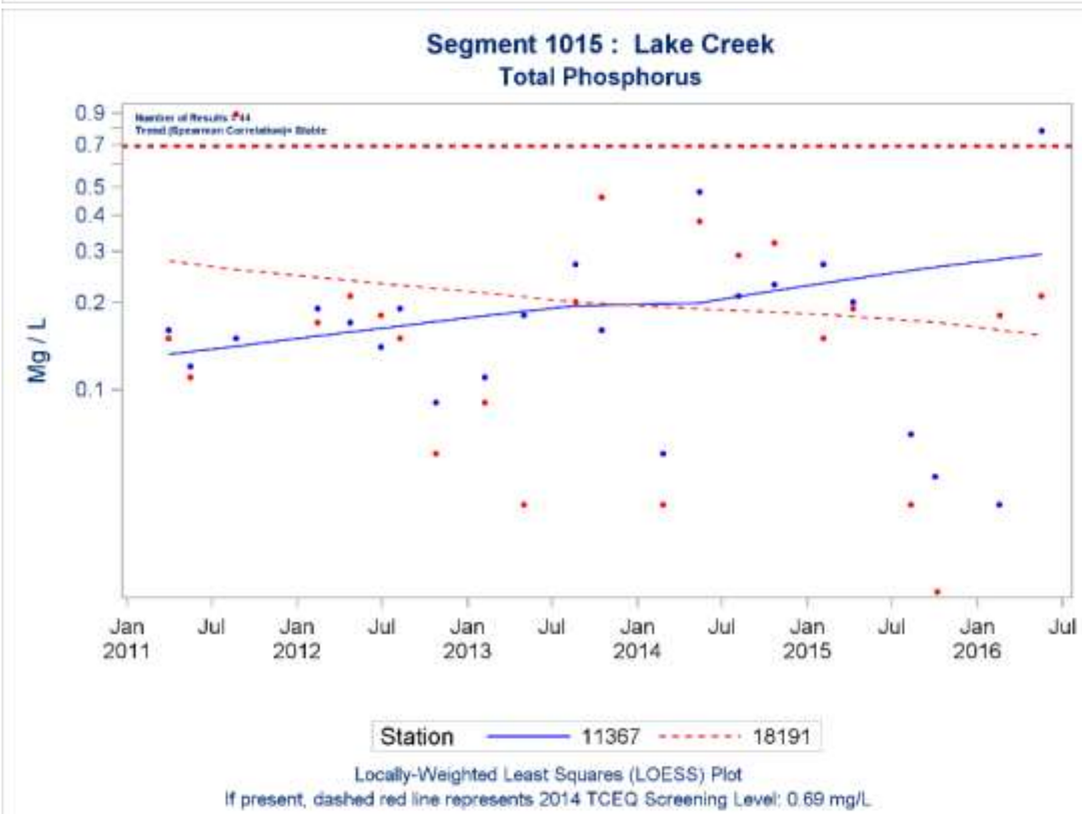


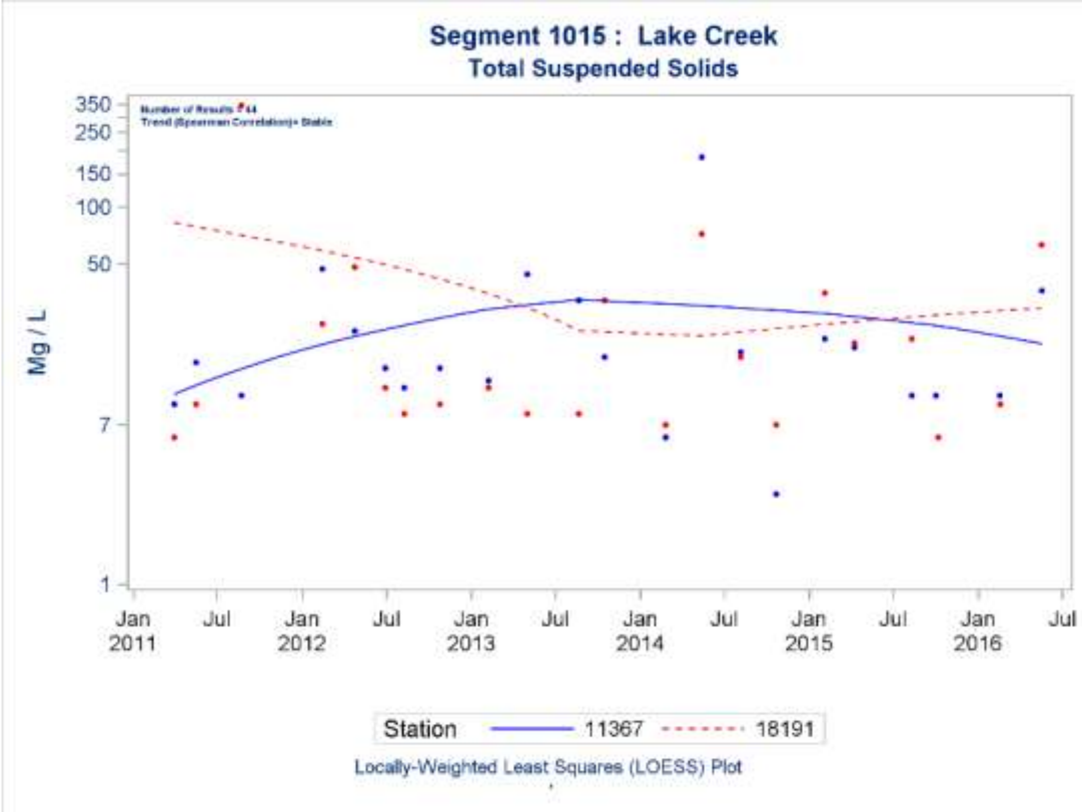
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 1.95 Mg/L



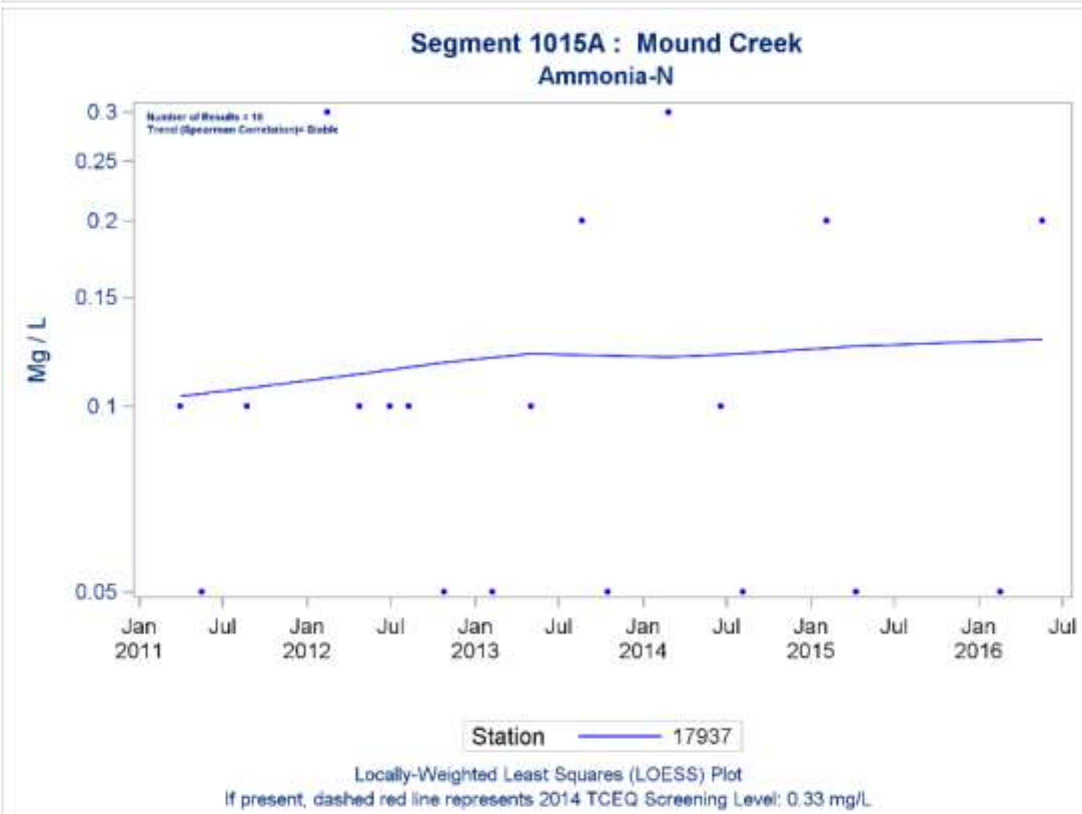
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard of 6.0 - 9.0 S.U.


Segment 1015 : Lake Creek
Temperature
Degrees C
30
27.5
25
22.5
20
17.5
15
12.5
10
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station
11367
18191
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 90 Degrees F

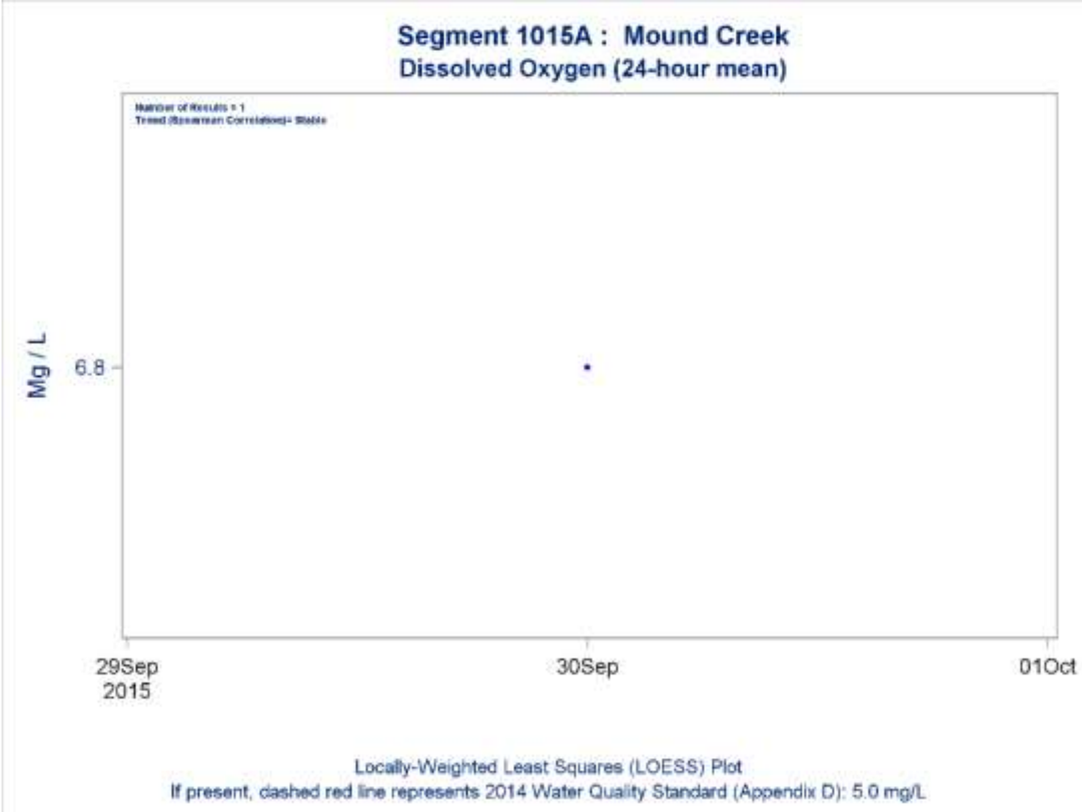

Segment 1015 : Lake Creek
Total Phosphorus
Mg / L
0.9
0.7
0.5
0.4
0.3
0.2
0.1
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station
11367
18191
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.69 mg/L

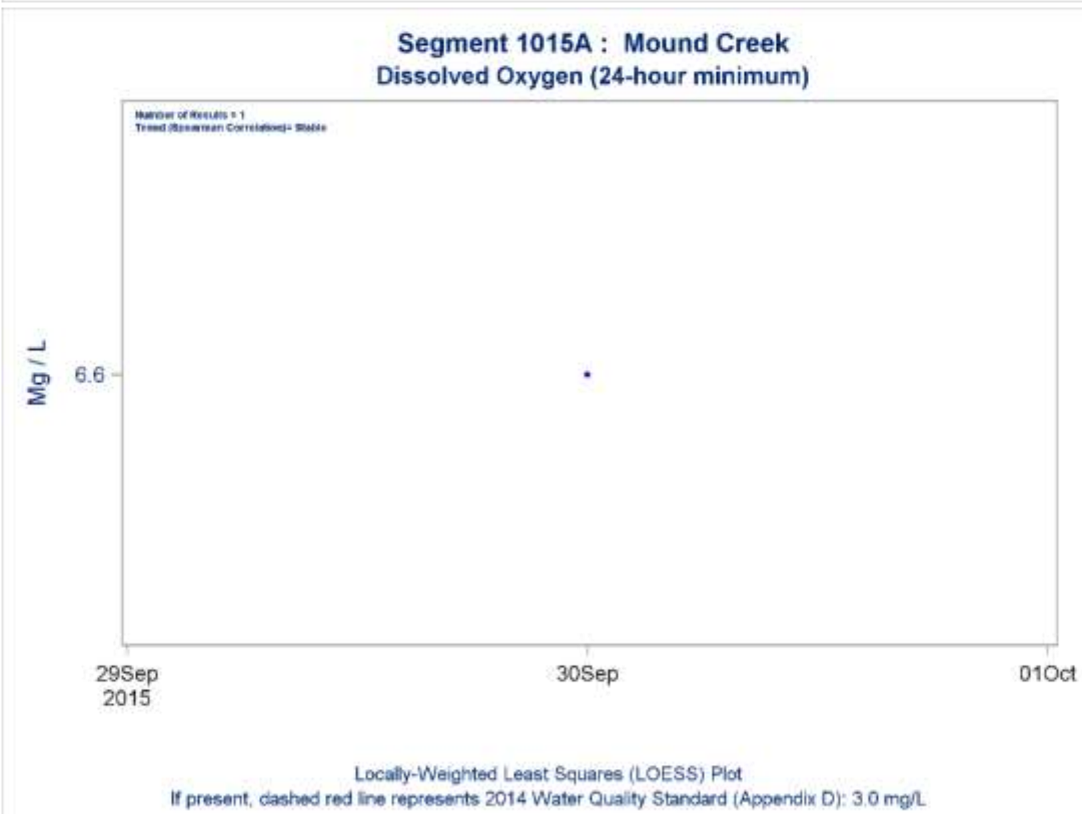


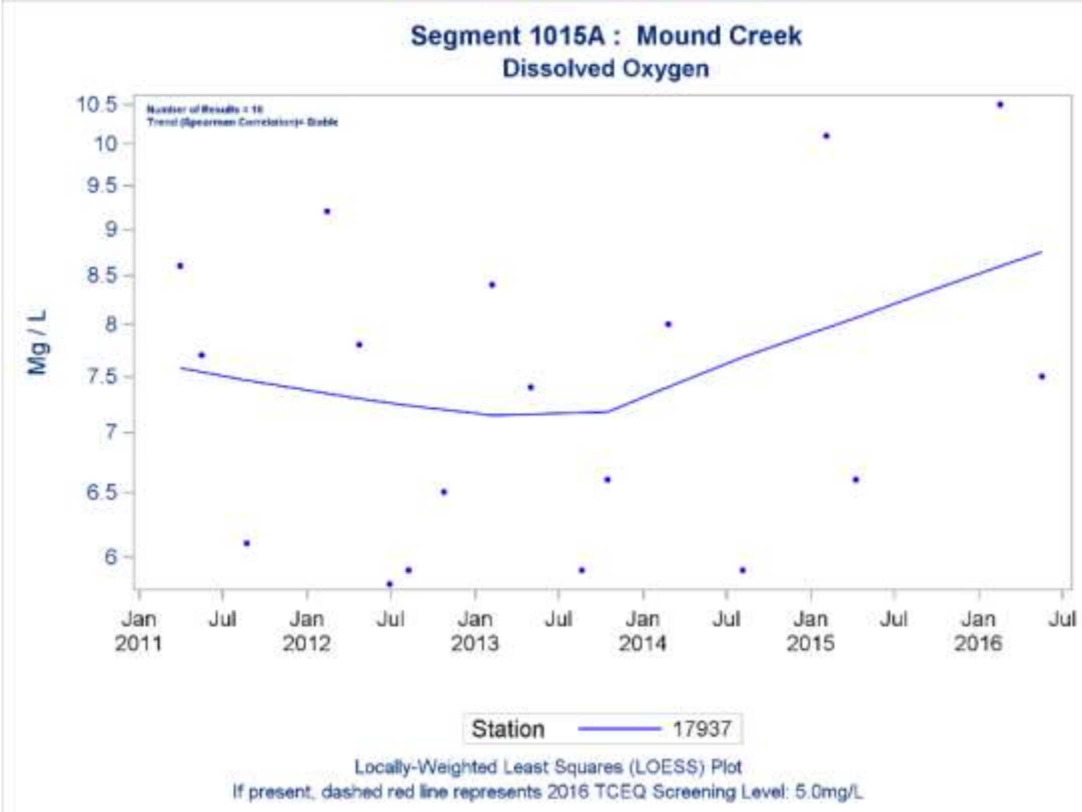
Locally-Weighted Least Squares (LOESS) Plot

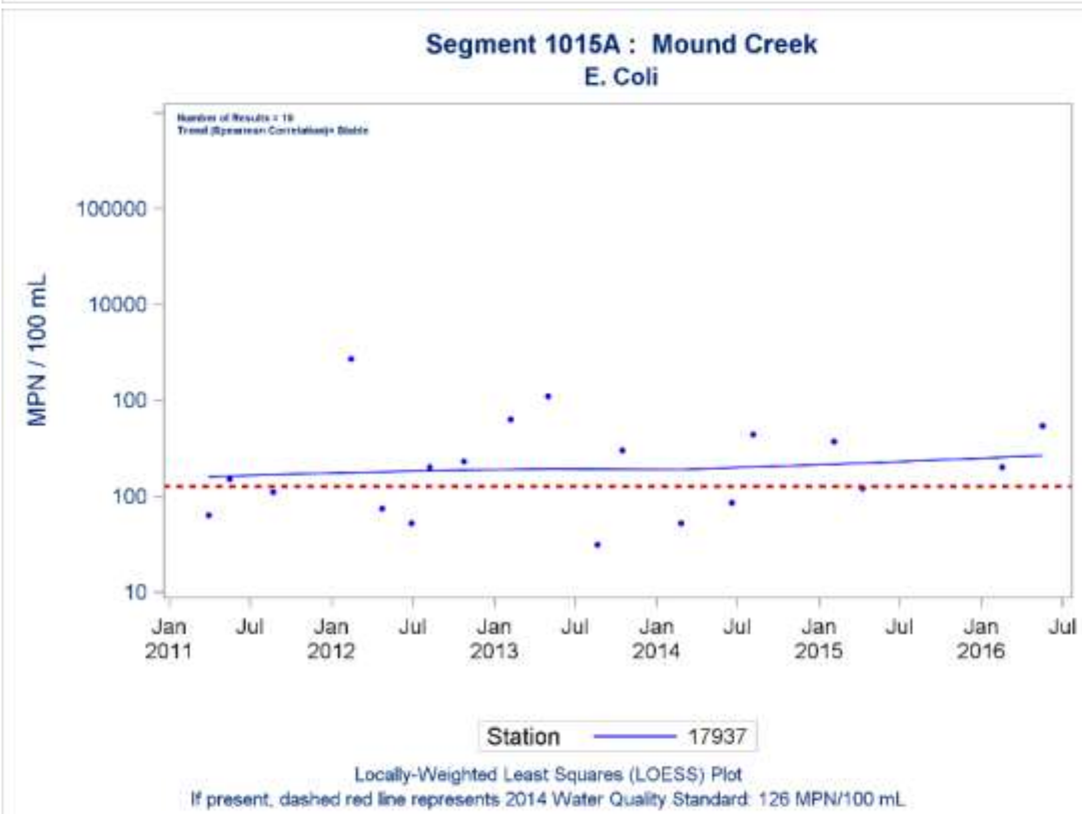


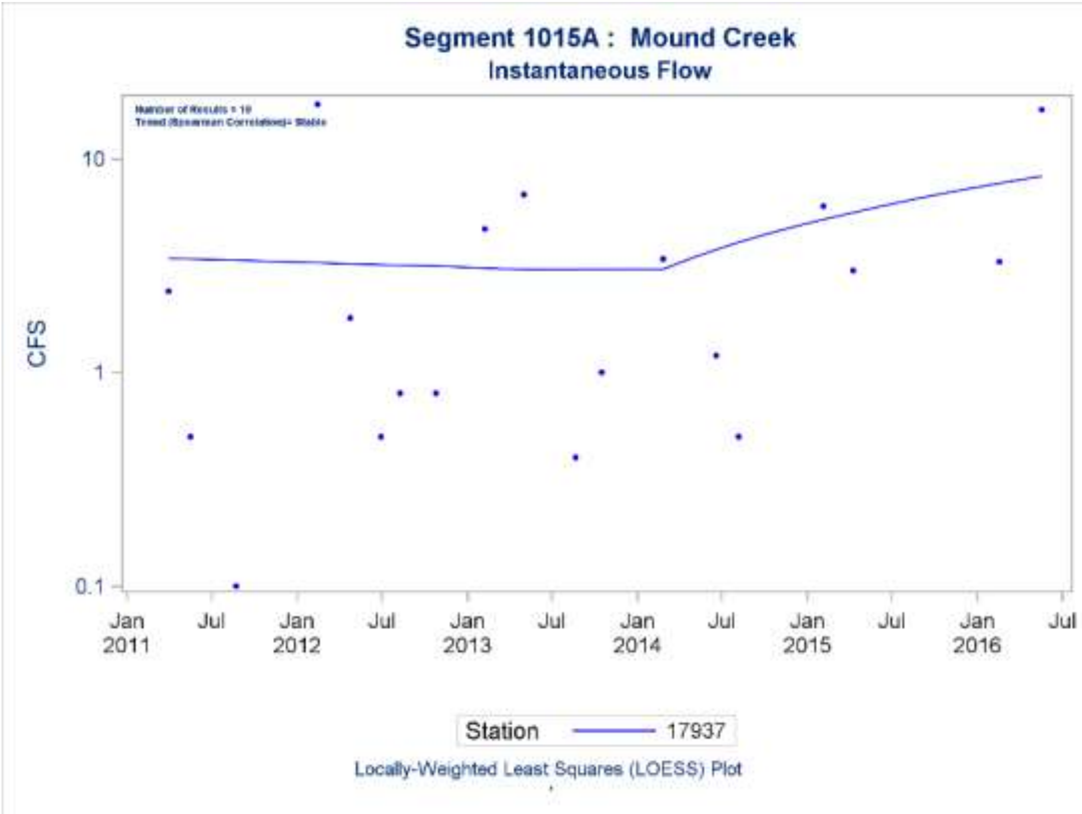
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.33 mg/L

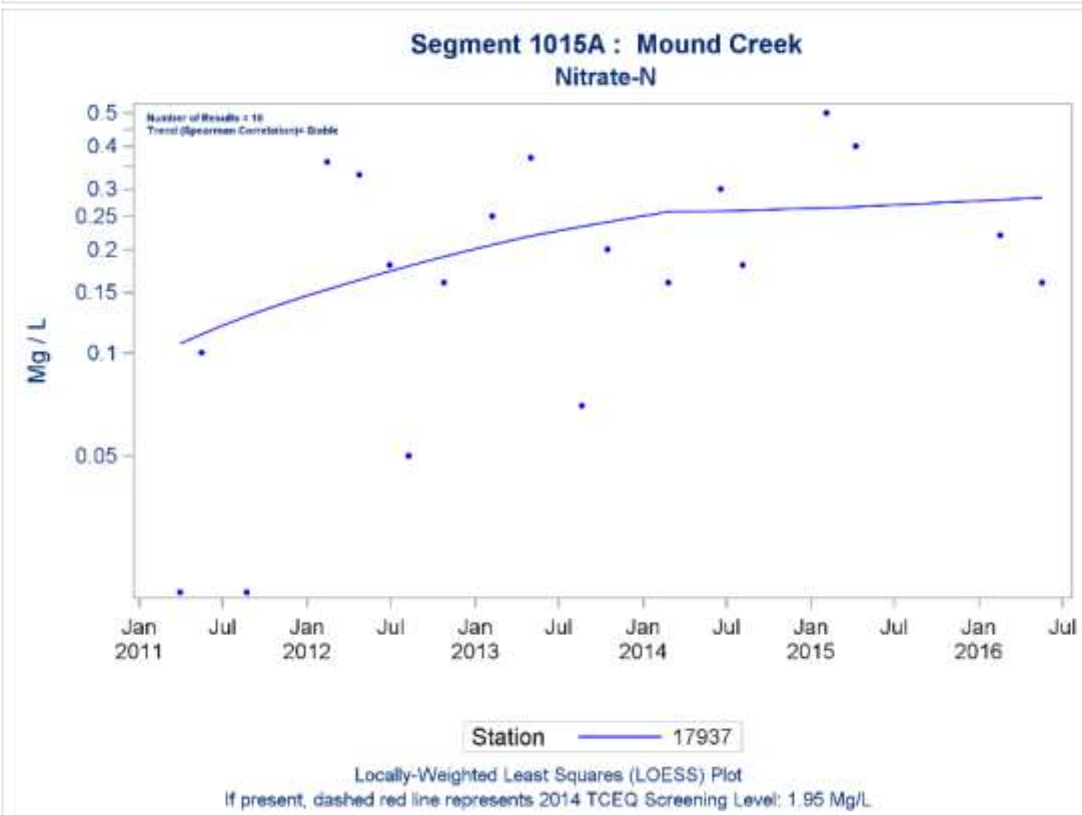

Segment 1015A : Mound Creek
Dissolved Oxygen (24-hour mean)
Number of Results = 1
Trend (Spearman Correlation)= Stable
Mg / L
6.8
29Sep
2015
30Sep
01Oct
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard (Appendix D): 5.0 mg/L

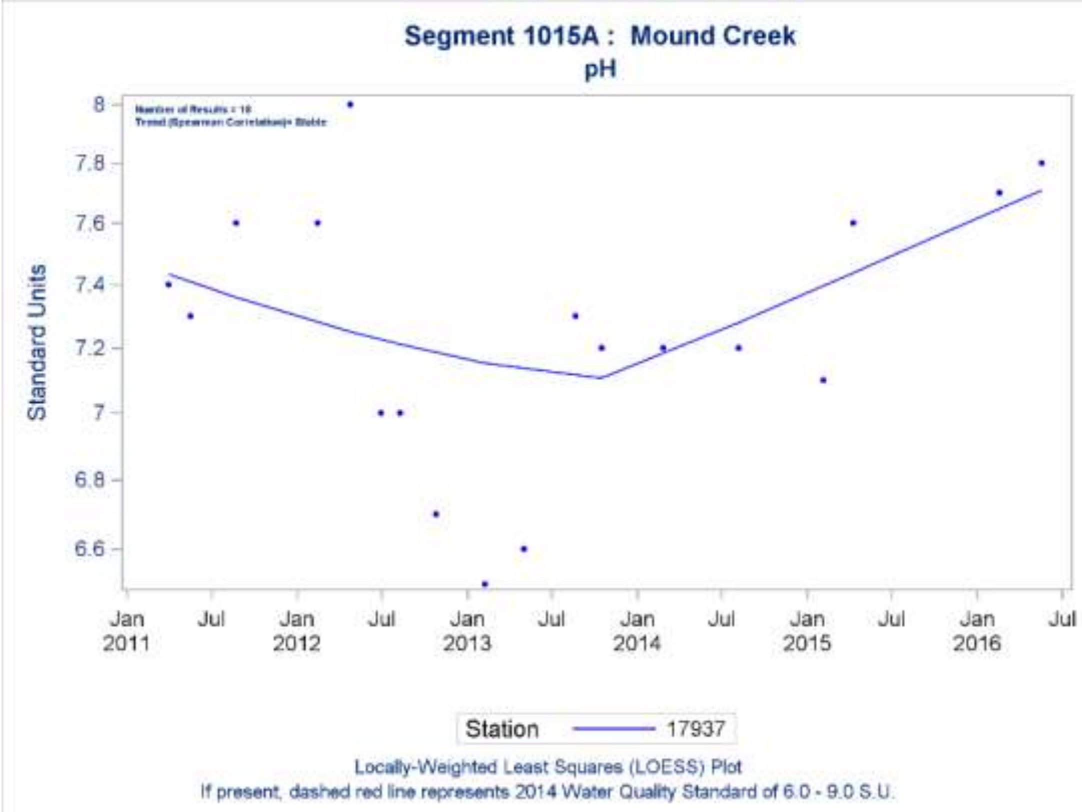

Segment 1015A : Mound Creek
Dissolved Oxygen (24-hour minimum)
Number of Results = 1
Trend (Spearman Correlation)= Stable
Mg / L
6.6
29Sep
2015
30Sep
01Oct
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard (Appendix D): 3.0 mg/L

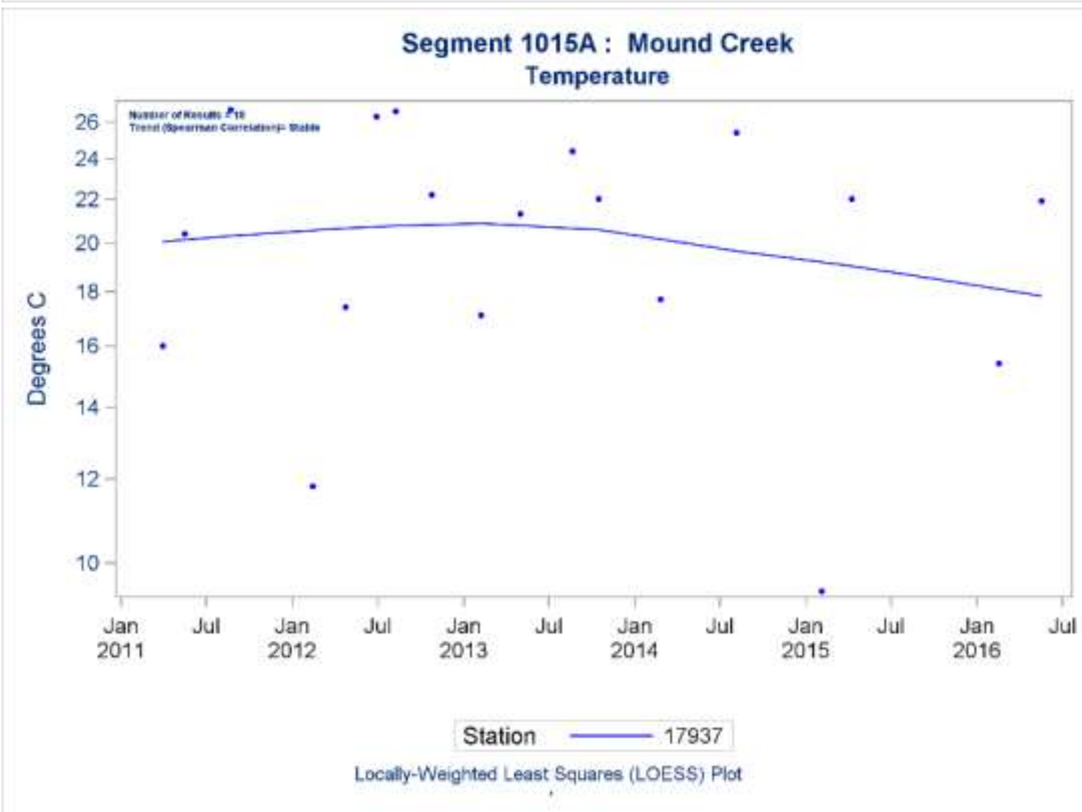

Segment 1015A : Mound Creek
Dissolved Oxygen
Mg / L
10.5
10
9.5
9
8.5
8
7.5
7
6.5
6
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station
17937
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2016 TCEQ Screening Level: 5.0mg/L

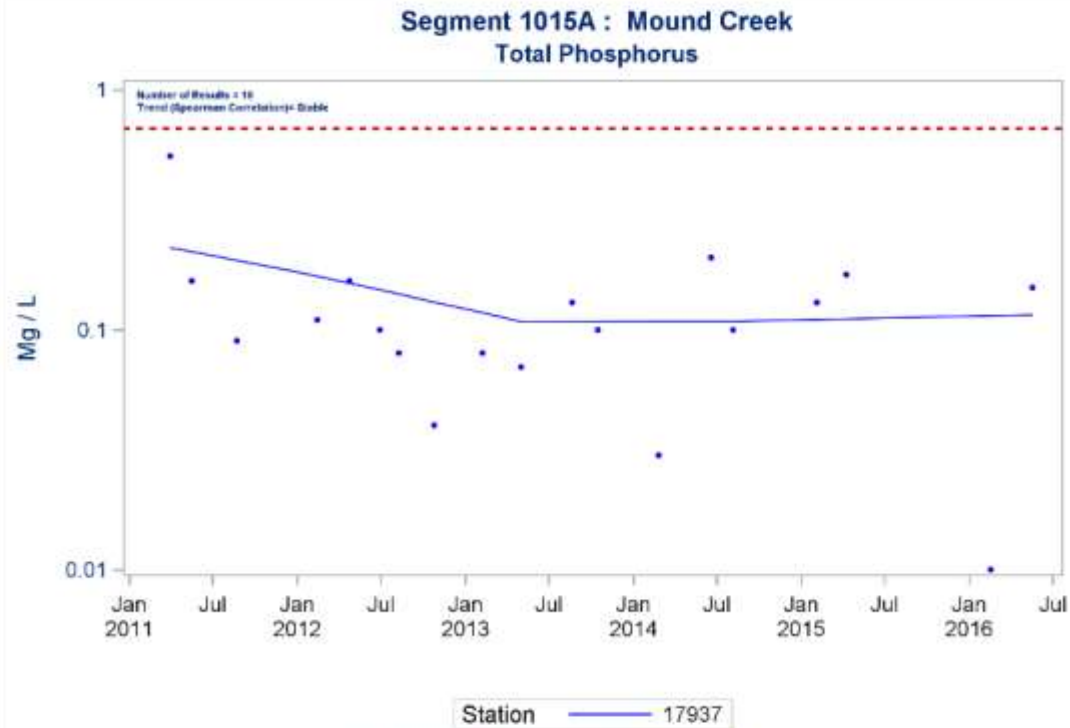

Segment 1015A : Mound Creek
E. Coli
MPN / 100 mL
100000
10000
100
100
10
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station
17937
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard: 126 MPN/100 mL


Segment 1015A : Mound Creek
Instantaneous Flow
CFS
10
1
0.1
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station
17937
Locally-Weighted Least Squares (LOESS) Plot

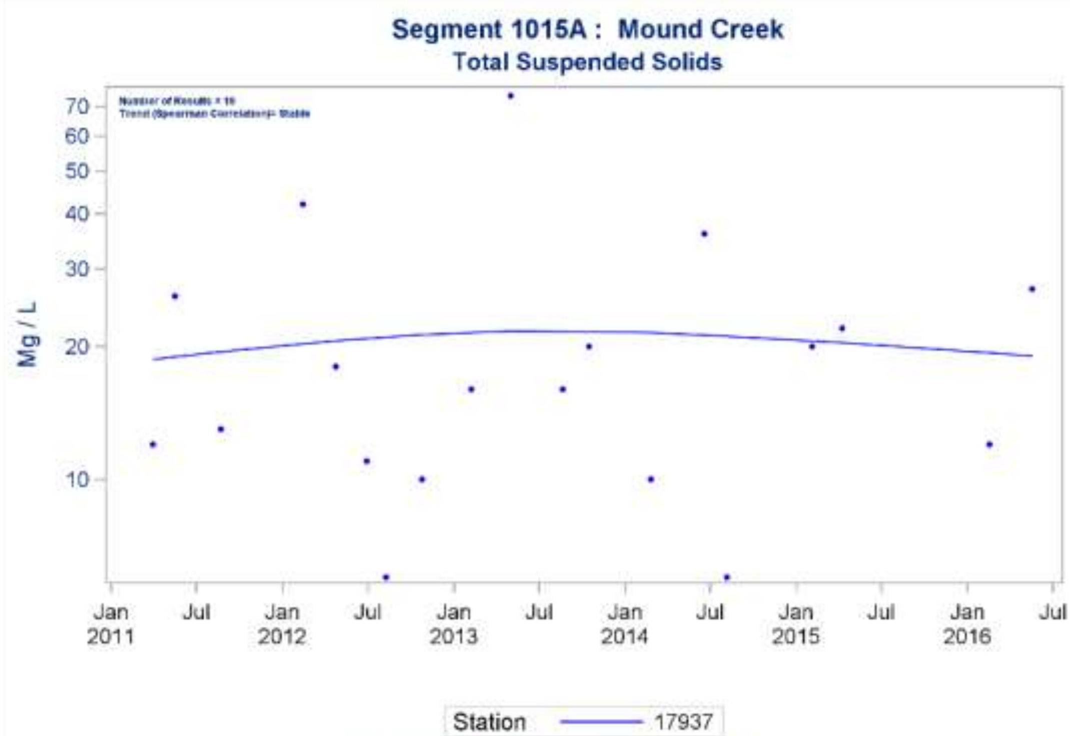

Segment 1015A : Mound Creek
Nitrate-N
Mg / L
0.5
0.4
0.3
0.25
0.2
0.15
0.1
0.05
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station
17937
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 1.95 Mg/L


Segment 1015A : Mound Creek
pH
Standard Units
8
7.8
7.6
7.4
7.2
7
6.8
6.6
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station
17937
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 Water Quality Standard of 6.0 - 9.0 S.U.


Segment 1015A : Mound Creek
Temperature
Degrees C
26
24
22
20
18
16
14
12
10
Jan 2011
Jul
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Station
17937
Locally-Weighted Least Squares (LOESS) Plot



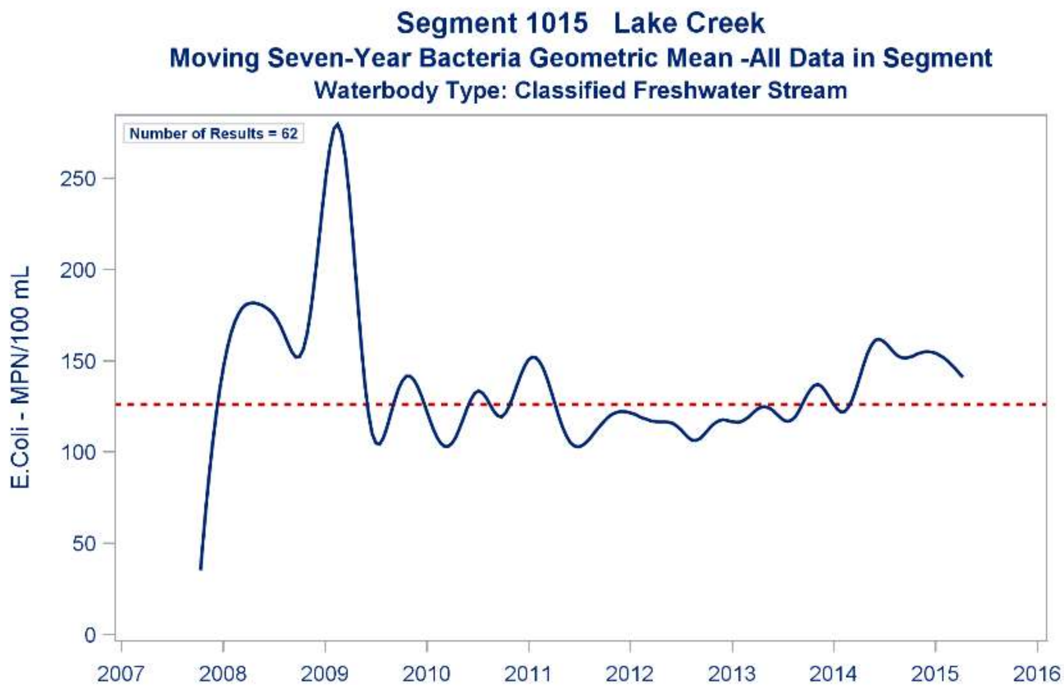
Locally-Weighted Least Squares (LOESS) Plot
If present, dashed red line represents 2014 TCEQ Screening Level: 0.69 mg/L



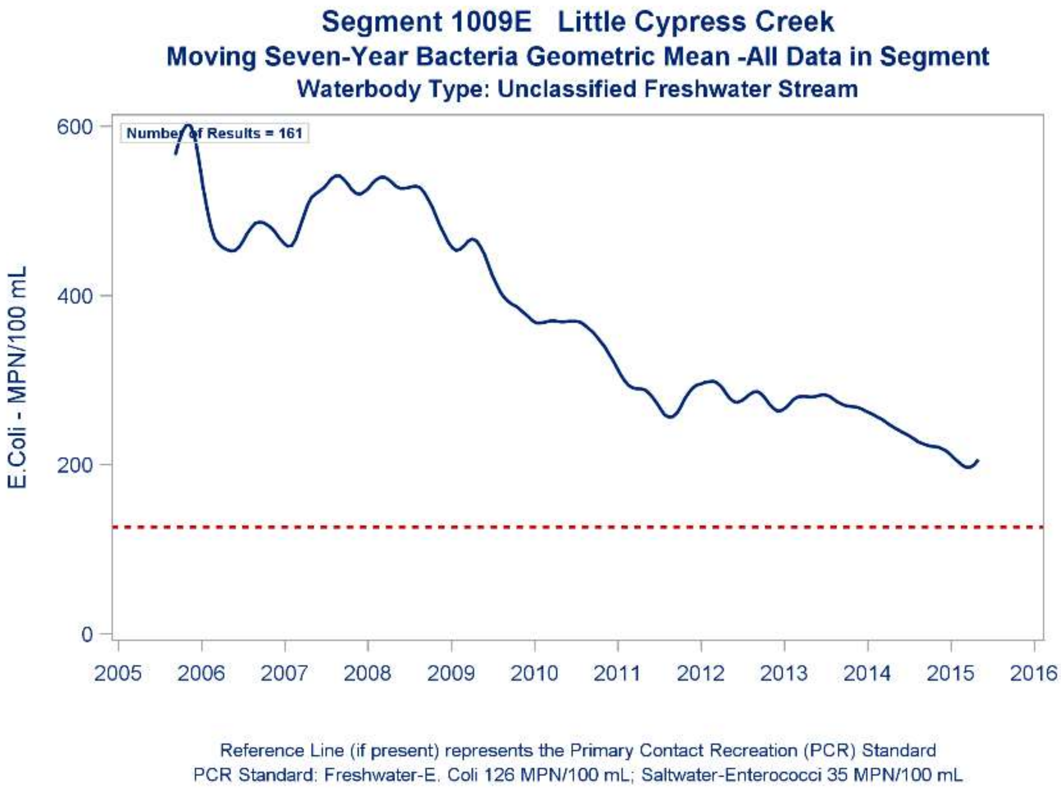
Locally-Weighted Least Squares (LOESS) Plot

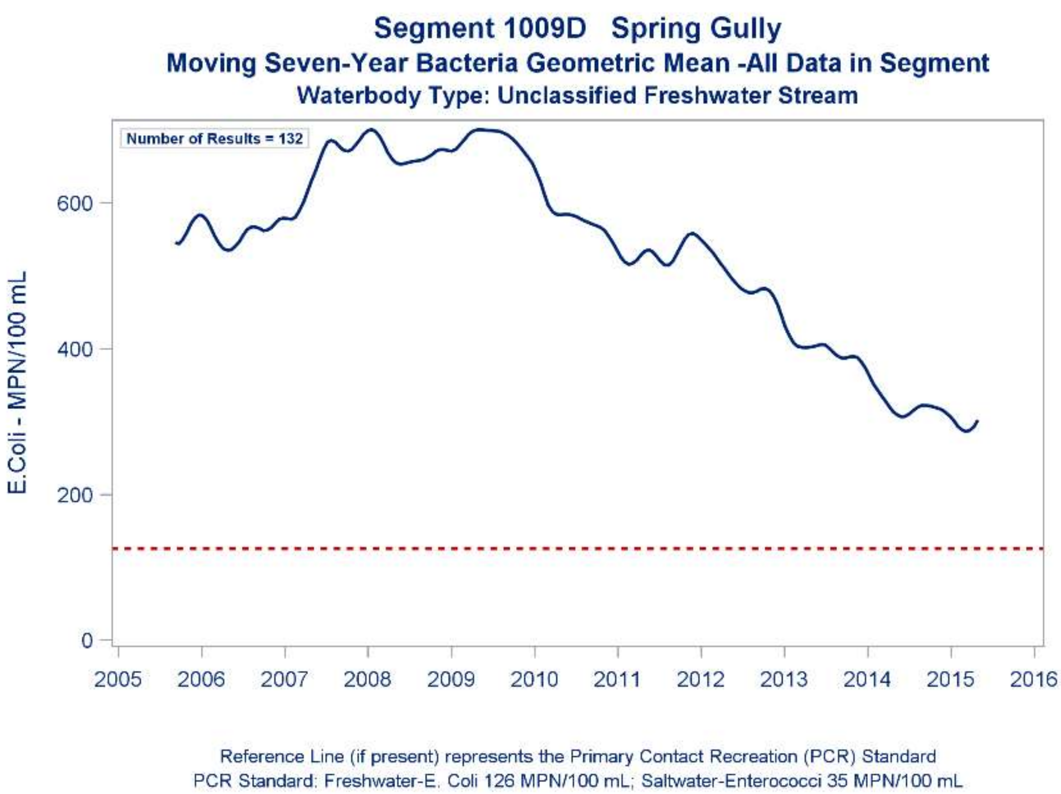
Appendix C – Moving 7-Year Geomeans (original analyses, 2012-2017)

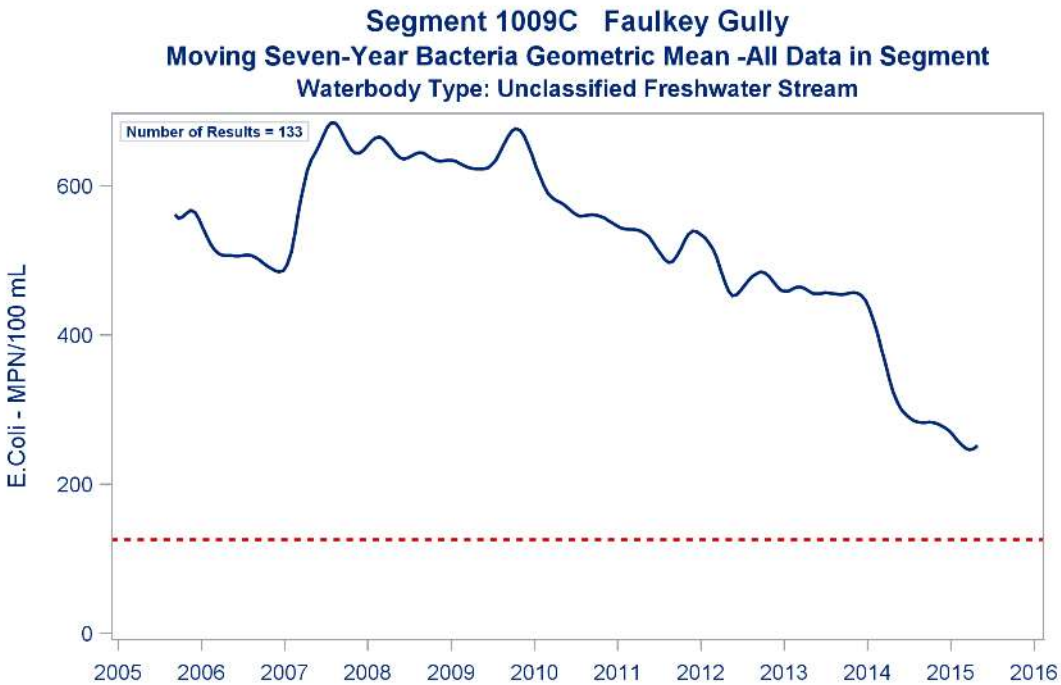
The graphs in this Appendix represent a plot of the moving seven-year geomeans for bacteria in all project segments and unclassified tributaries (for which data exist).



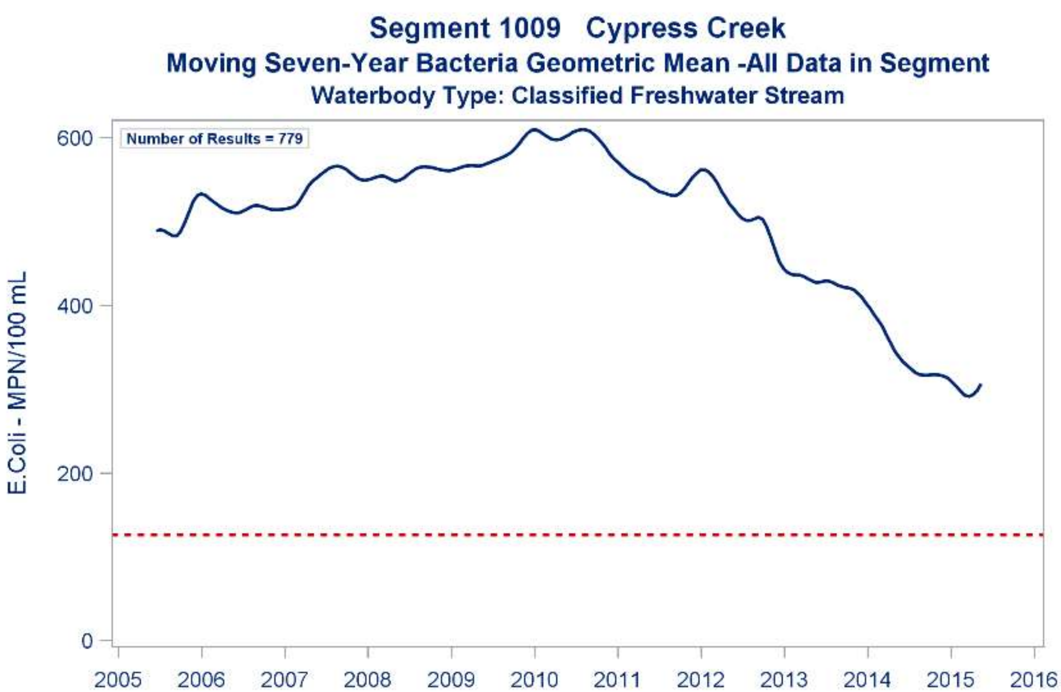
Reference Line (if present) represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL


Segment 1009E Little Cypress Creek
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Unclassified Freshwater Stream
Number of Results = 161
E.Coli - MPN/100 mL
0
200
400
600
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Reference Line (if present) represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL

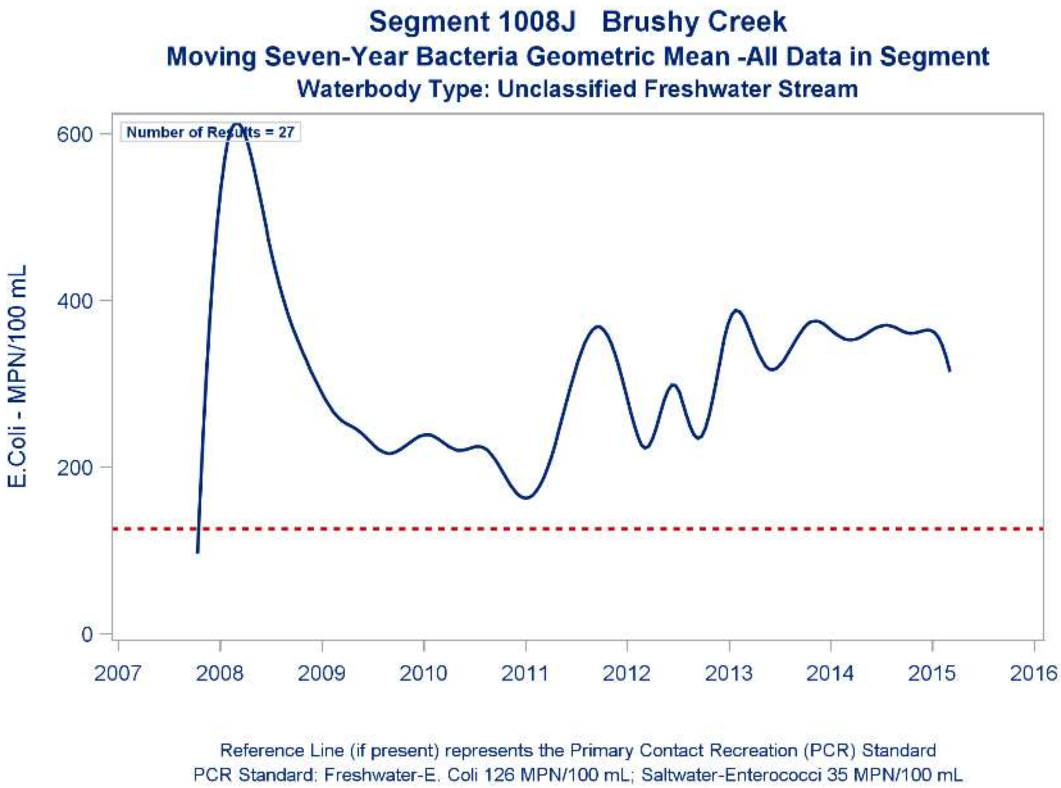

Segment 1009D Spring Gully
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Unclassified Freshwater Stream
Number of Results = 132
E.Coli - MPN/100 mL
0
200
400
600
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Reference Line (if present) represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL



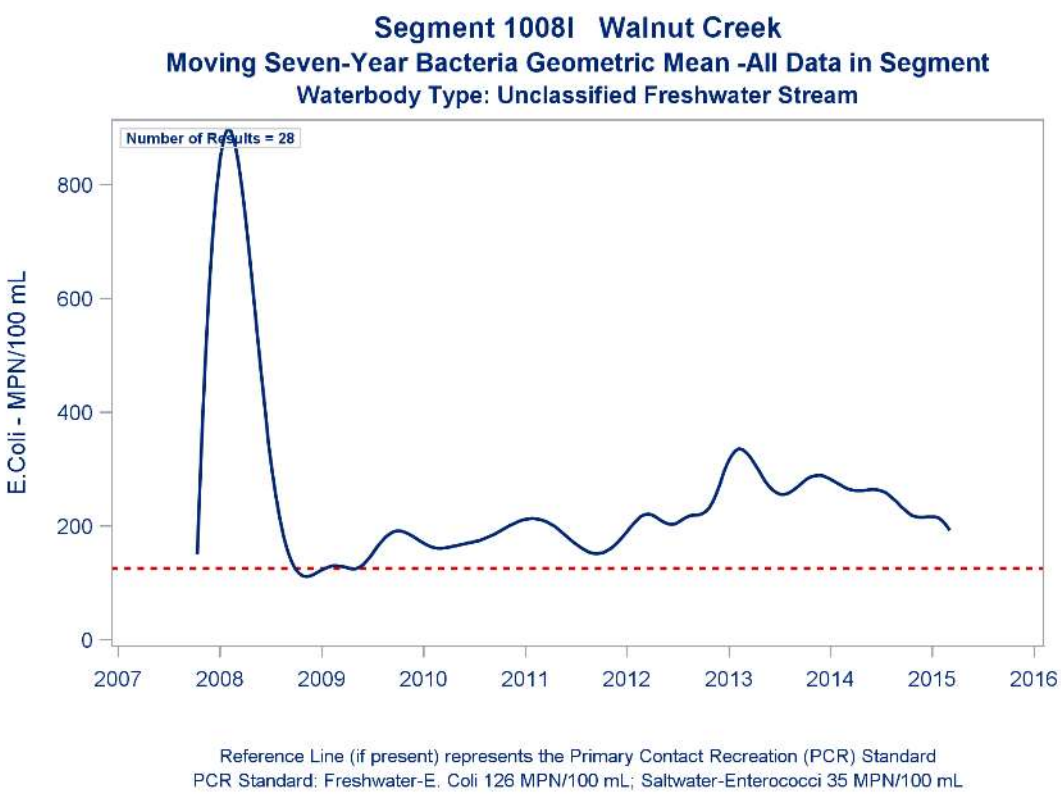
Reference Line (if present) represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL



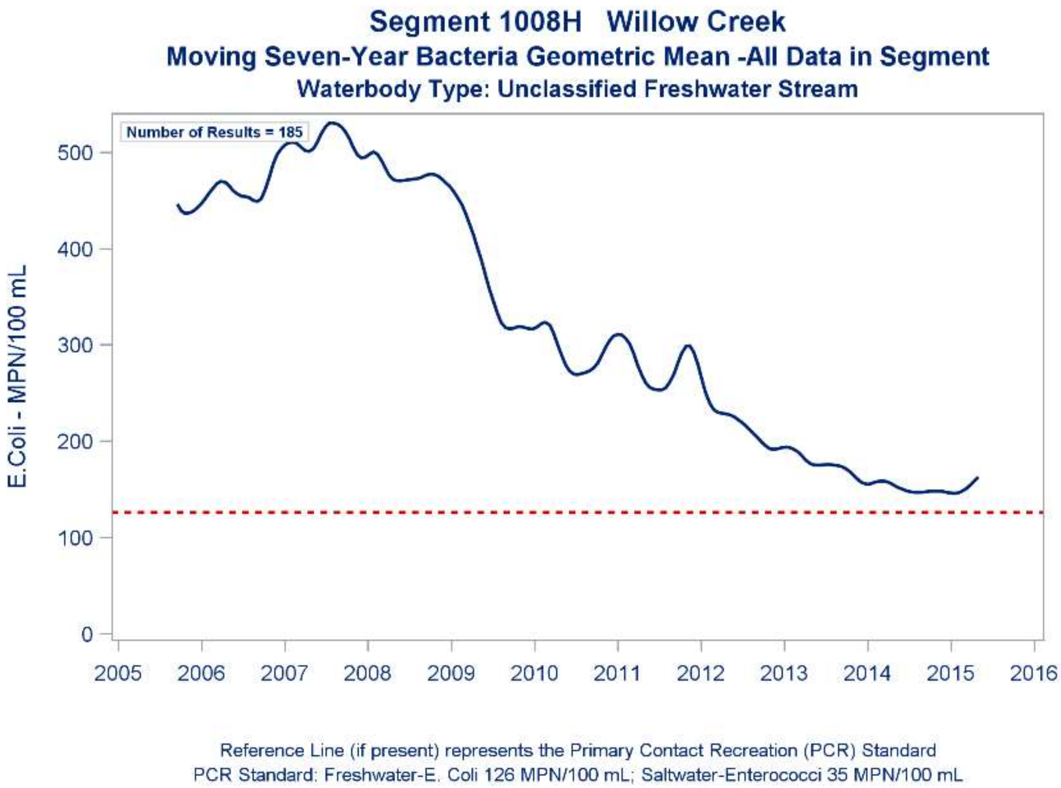
Reference Line (if present) represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL

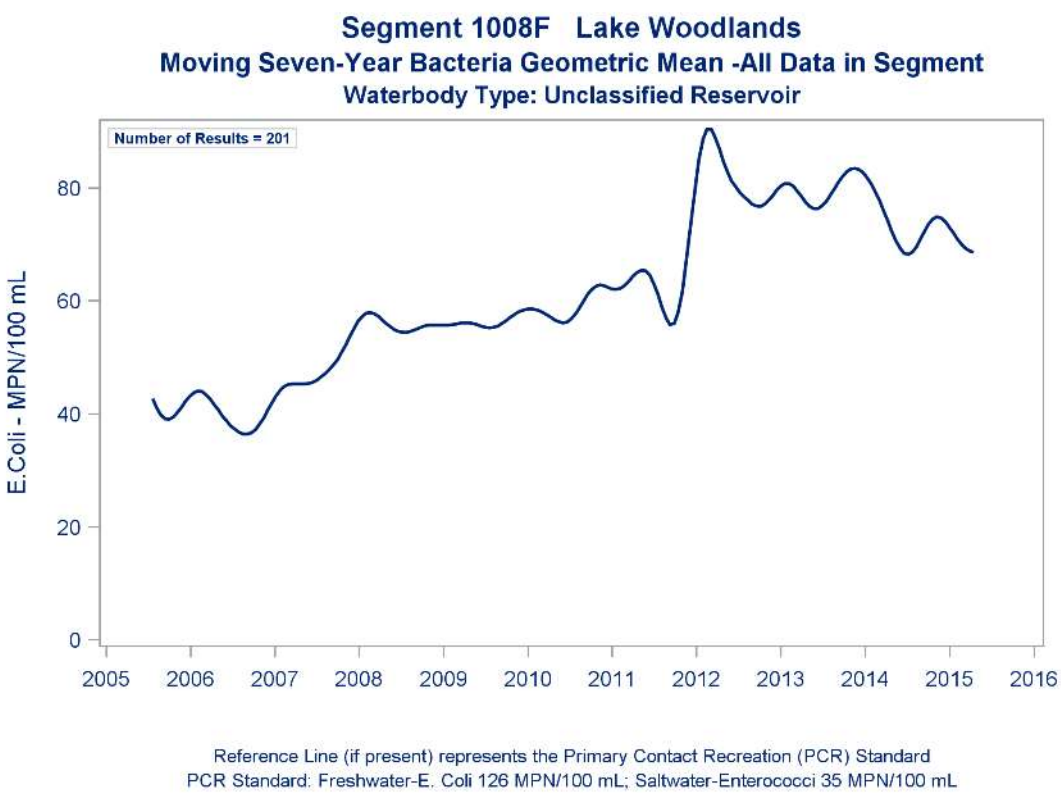


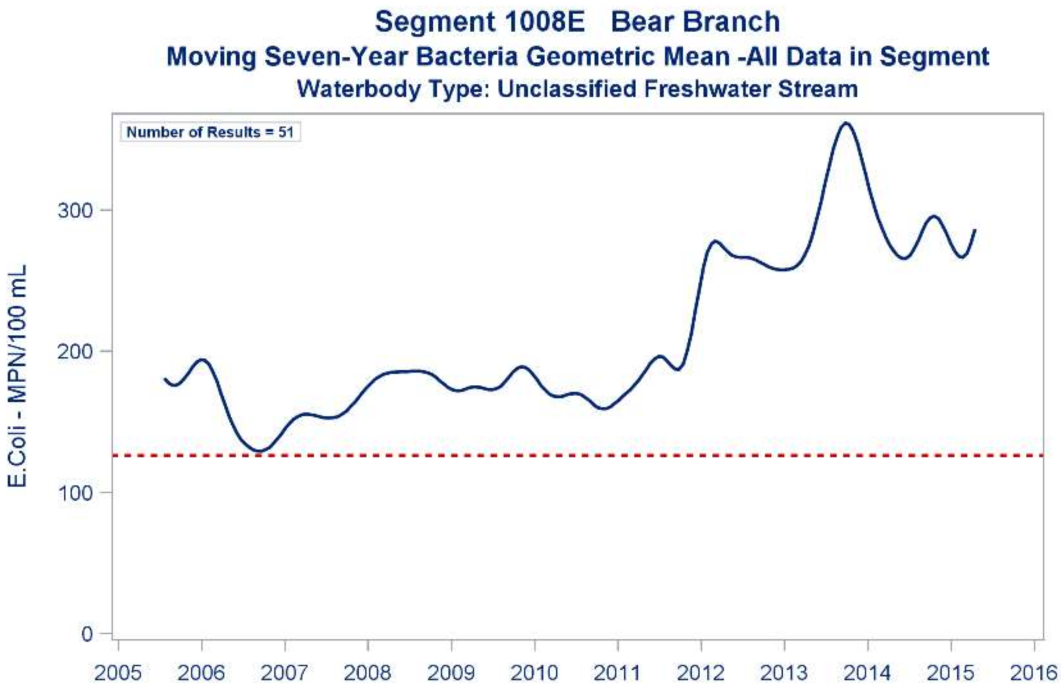
Segment 1008J Brushy Creek
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Unclassified Freshwater Stream
Number of Results = 27
E.Coli - MPN/100 mL
0
200
400
600
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Reference Line (if present) represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL



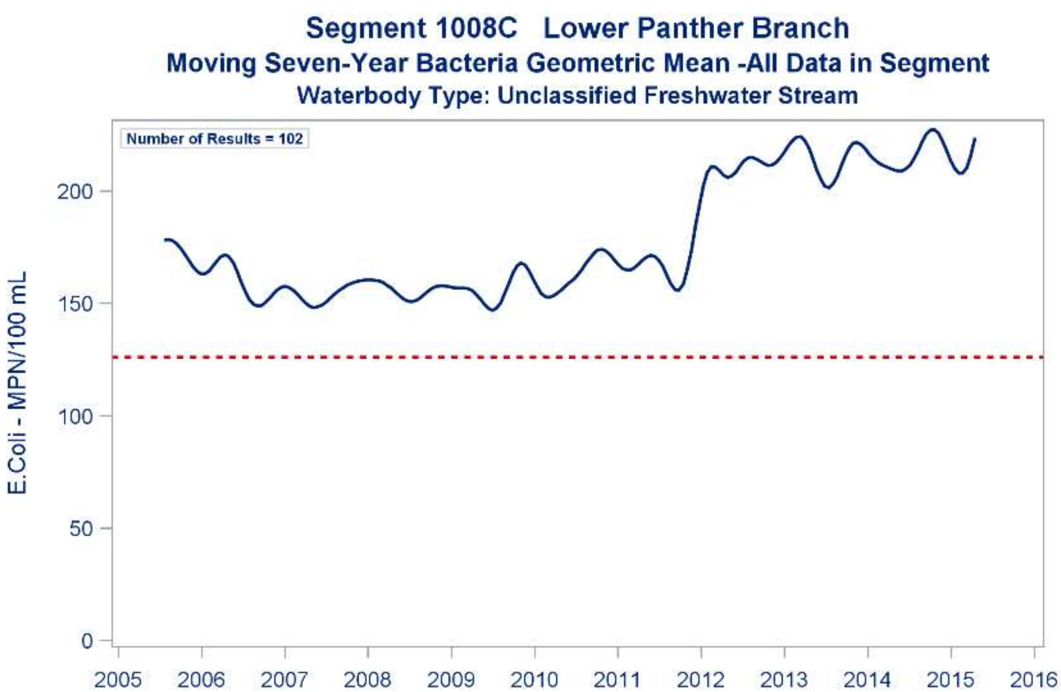
Segment 1008I Walnut Creek
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Unclassified Freshwater Stream
Number of Results = 28
E.Coli - MPN/100 mL
0
200
400
600
800
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Reference Line (if present) represents the Primary Contact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


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

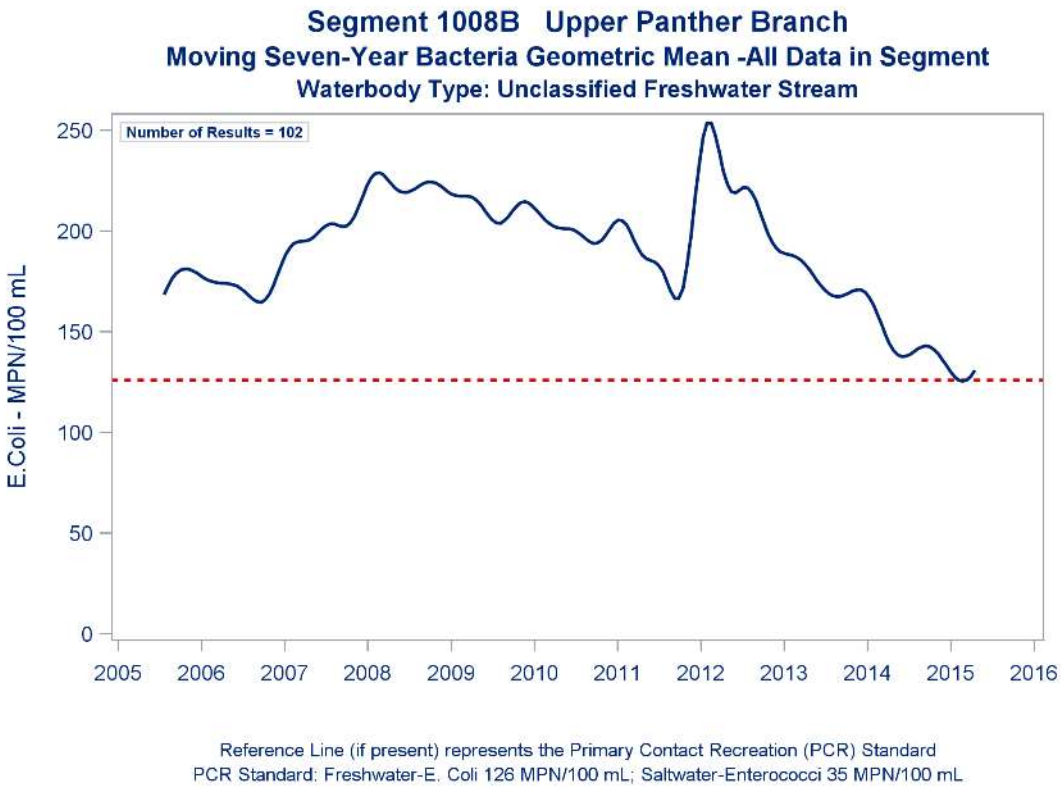

Segment 1008F Lake Woodlands
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Unclassified Reservoir
Number of Results = 201
E.Coli - MPN/100 mL
0
20
40
60
80
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Reference Line (if present) represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL

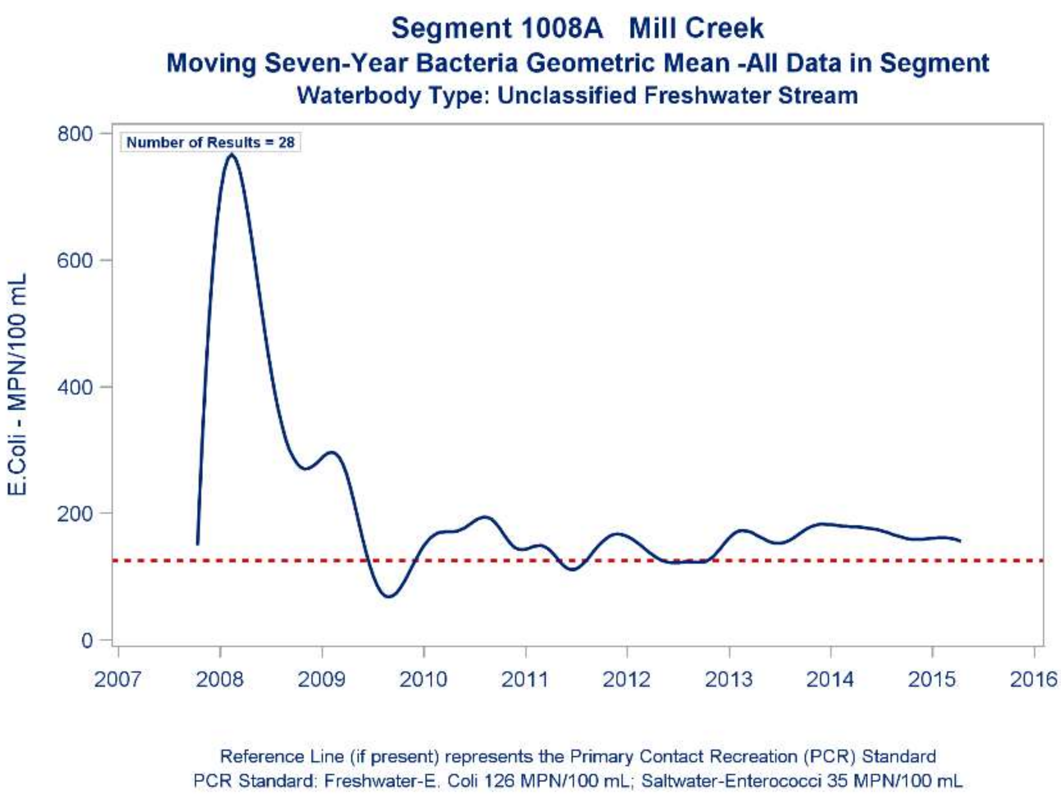


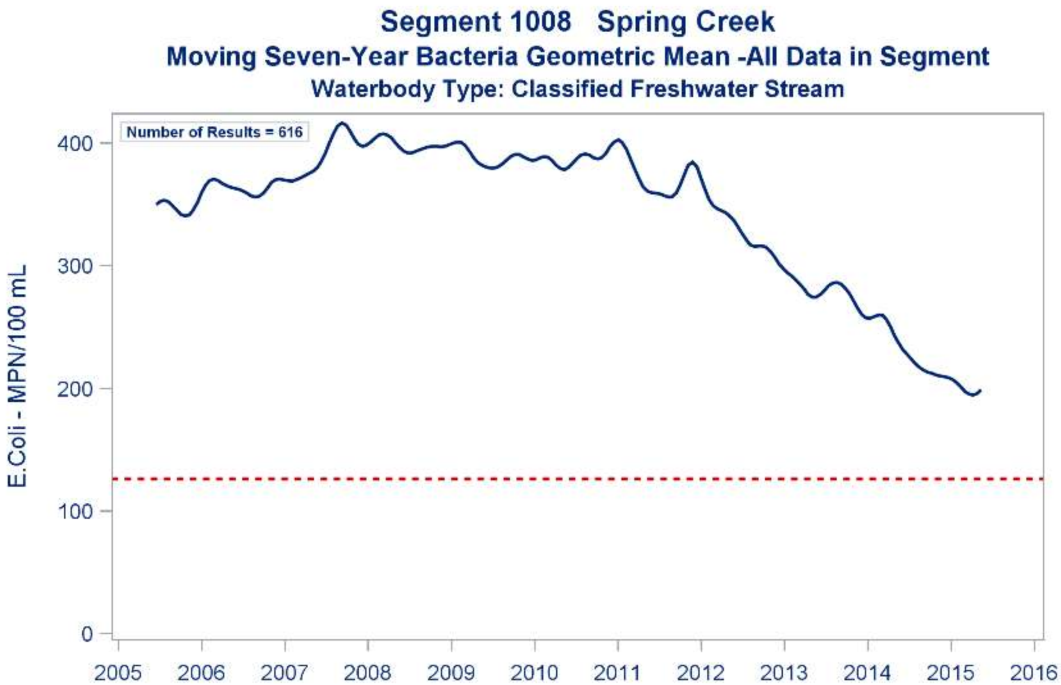
Reference Line (if present) represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL



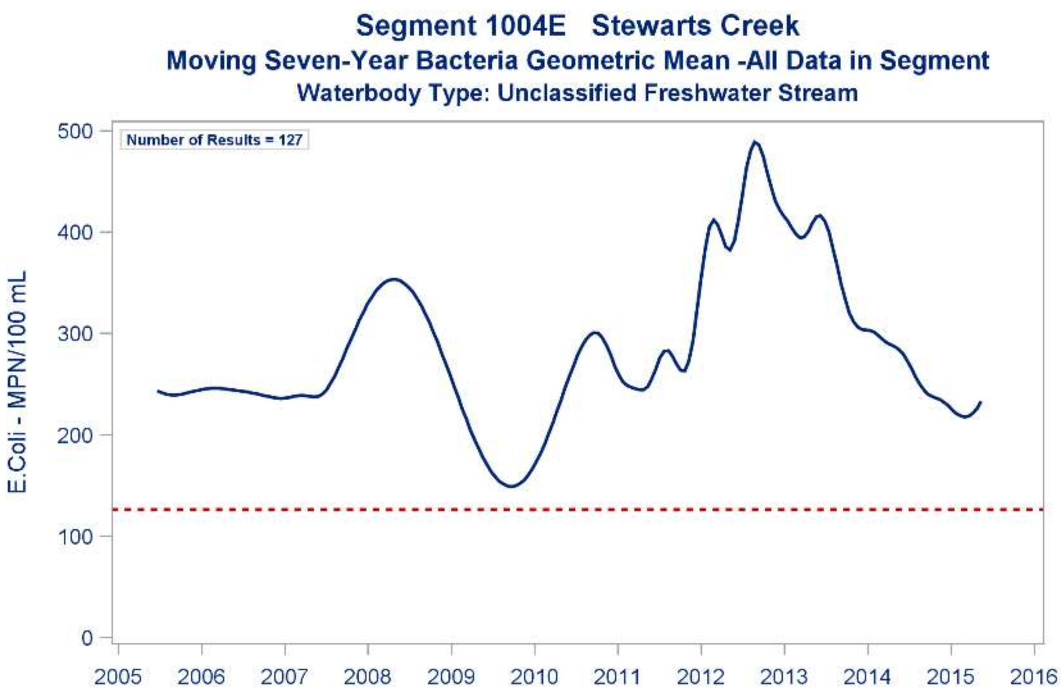
Reference Line (if present) represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL


Segment 1008B Upper Panther Branch
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Unclassified Freshwater Stream
Number of Results = 102
E.Coli - MPN/100 mL
250
200
150
100
50
0
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Reference Line (if present) represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL


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

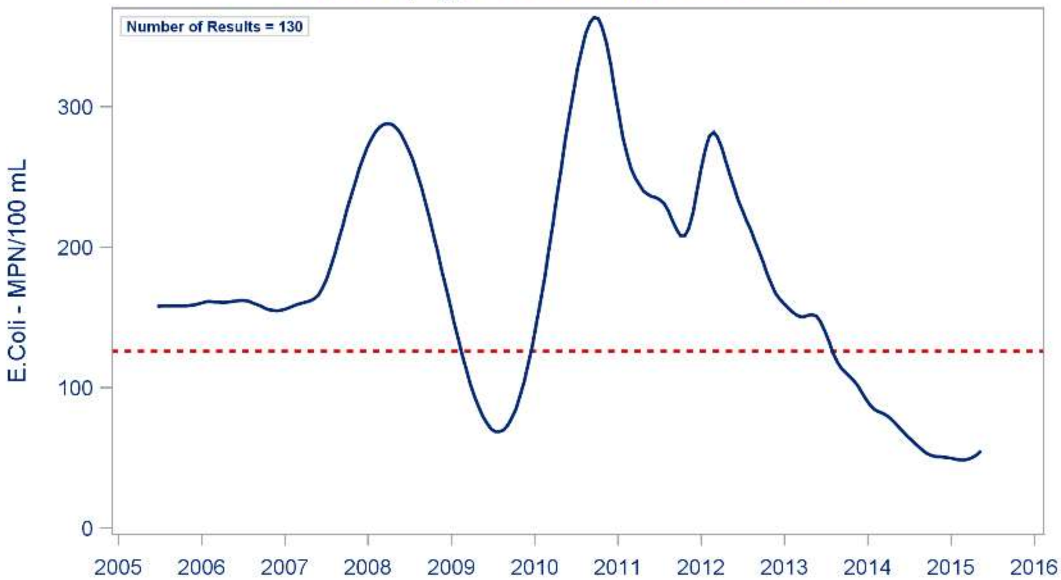


Reference Line (if present) represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL



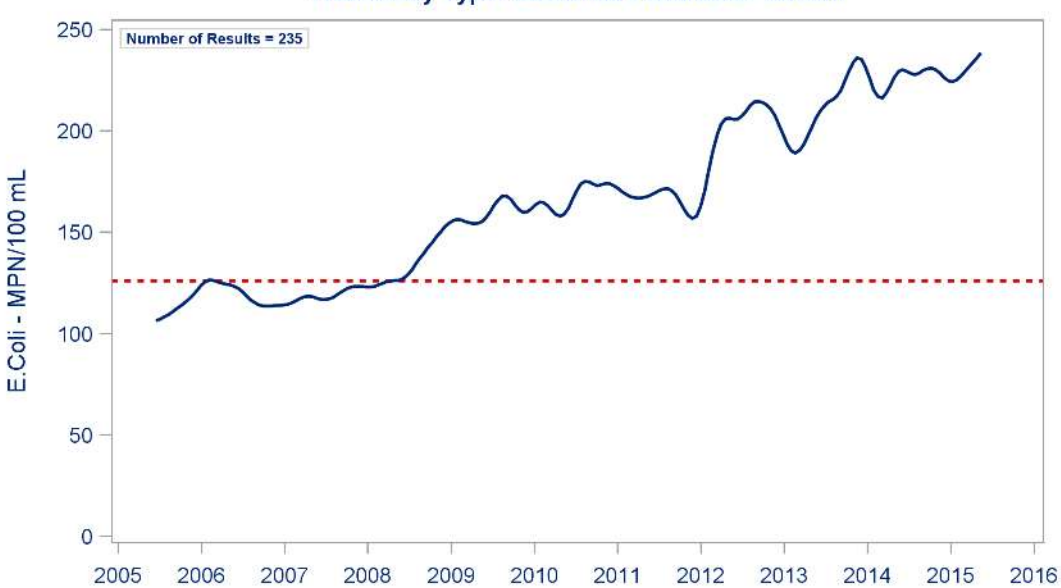
Reference Line (if present) represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL

Segment 1004D Crystal Creek
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Unclassified Freshwater Stream

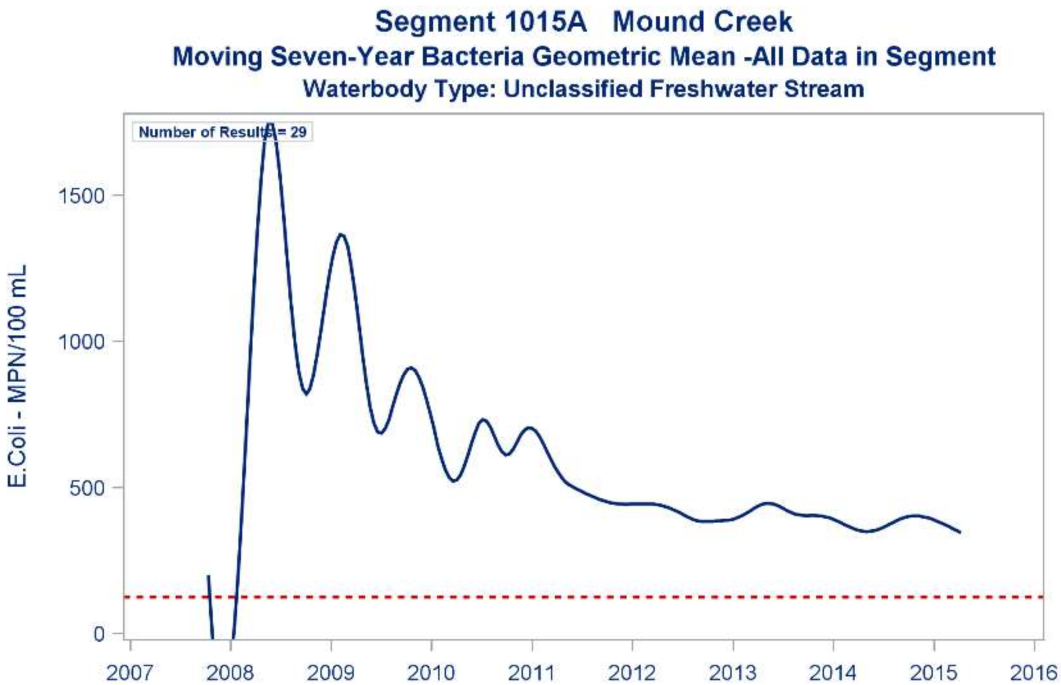


Reference Line (if present) represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL

Segment 1004 West Fork San Jacinto River
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Classified Freshwater Stream



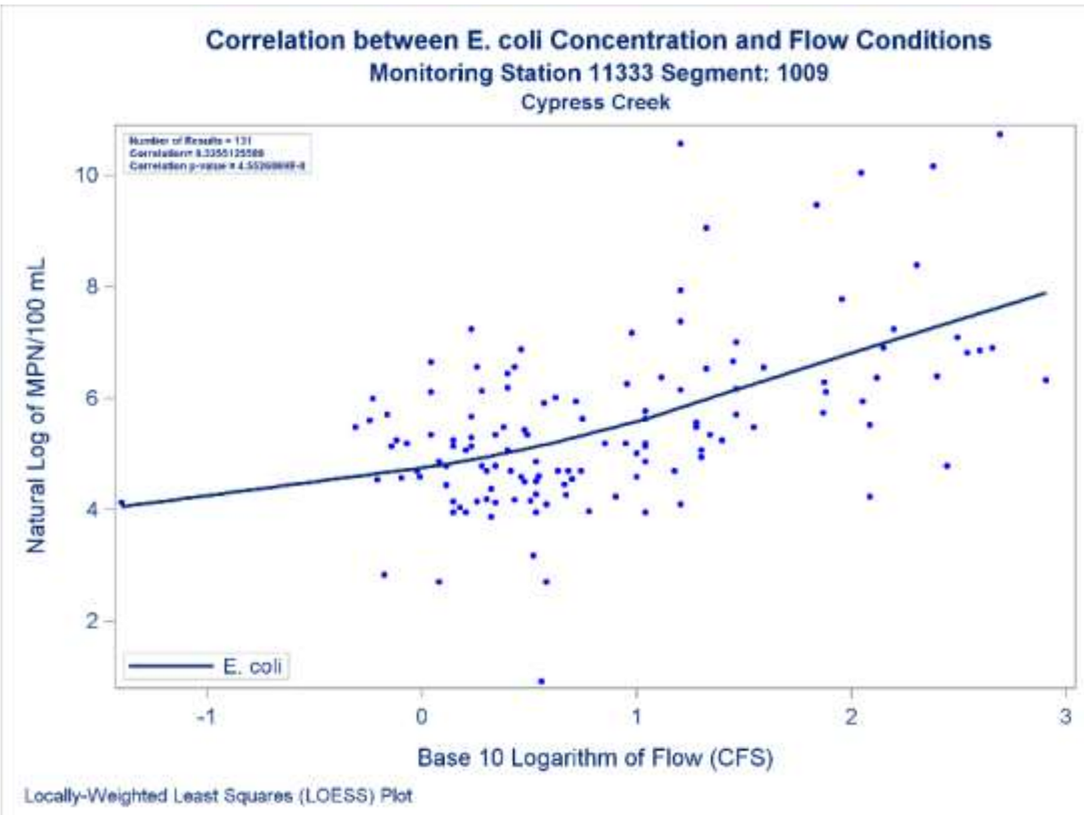
Reference Line (if present) represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL

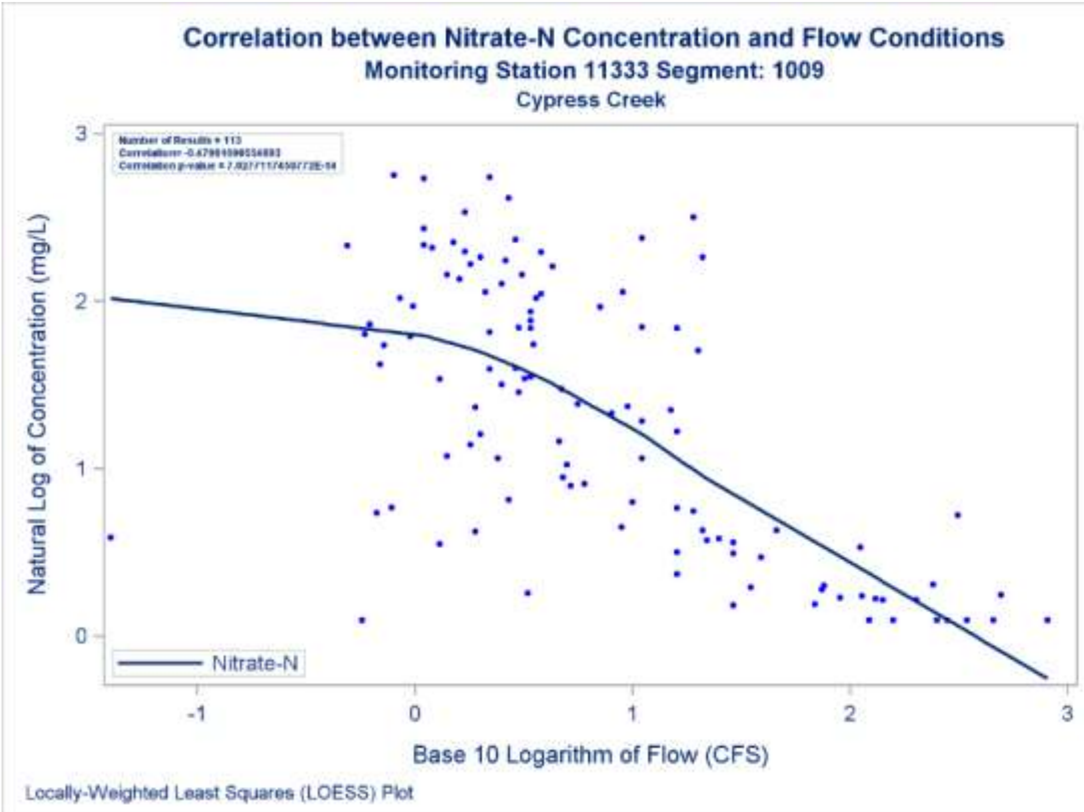


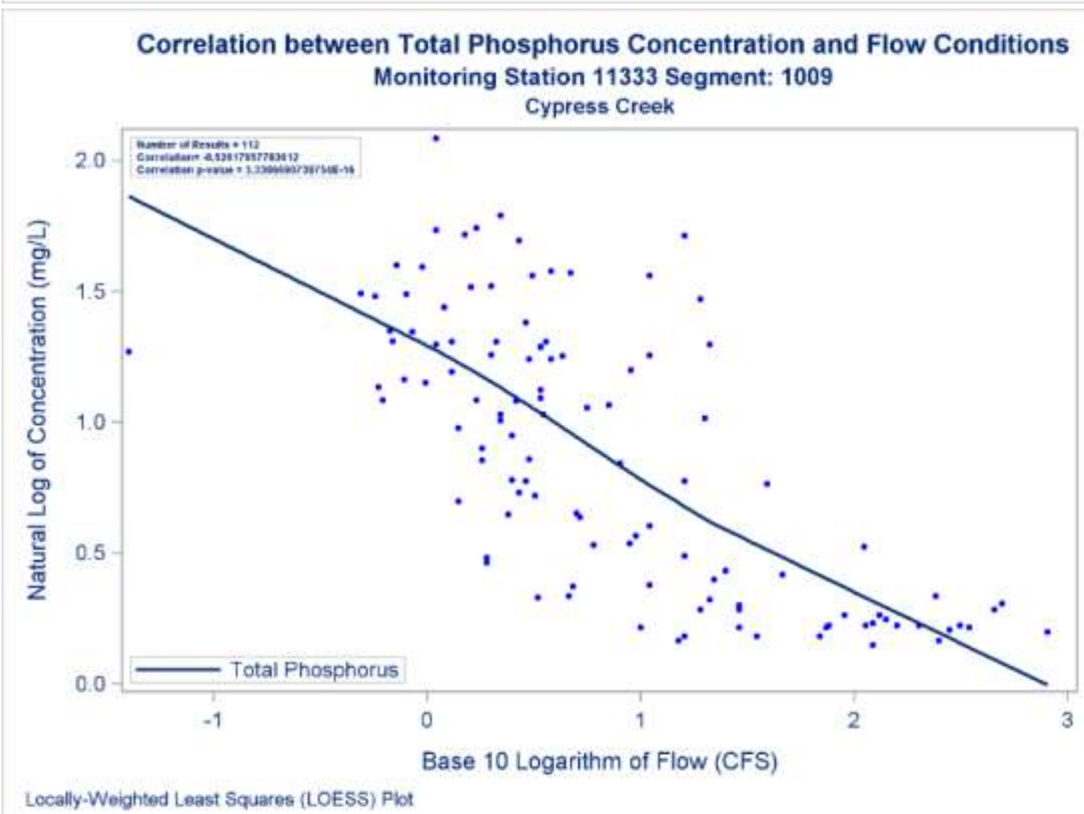
Reference Line (if present) represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL; Saltwater-Enterococci 35 MPN/100 mL

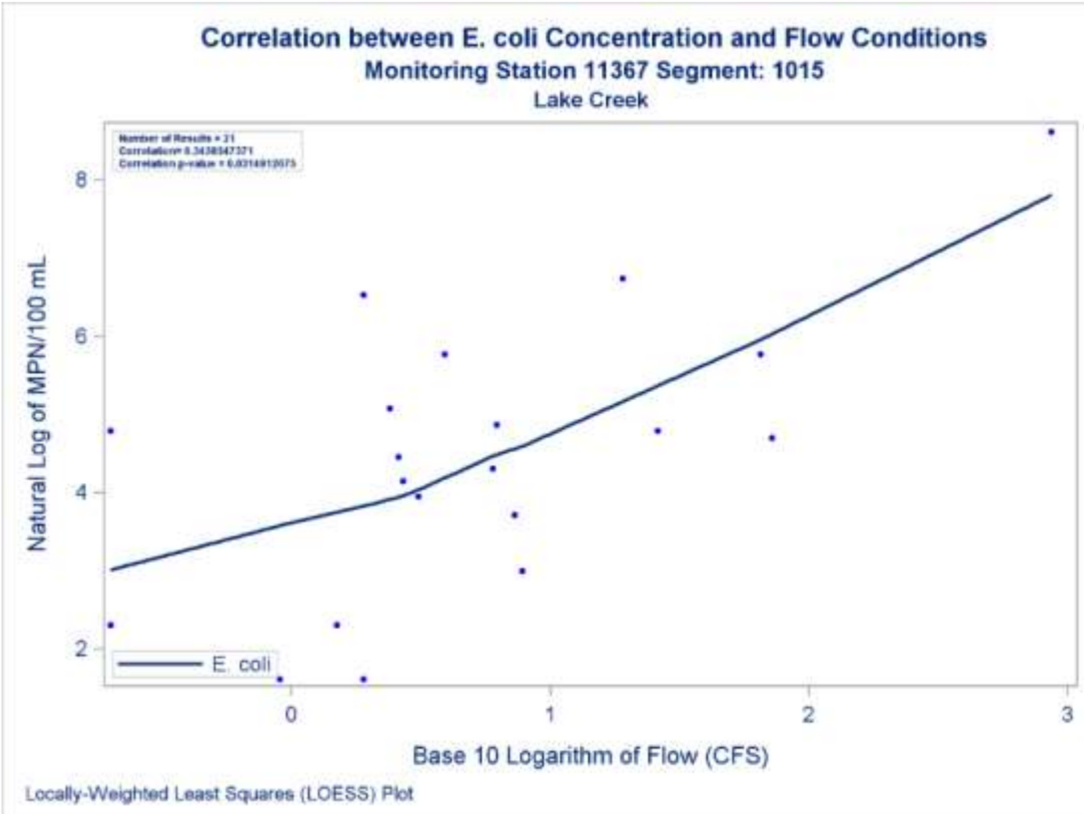
Appendix D – Flow Correlations (original analyses, 2012-2017)

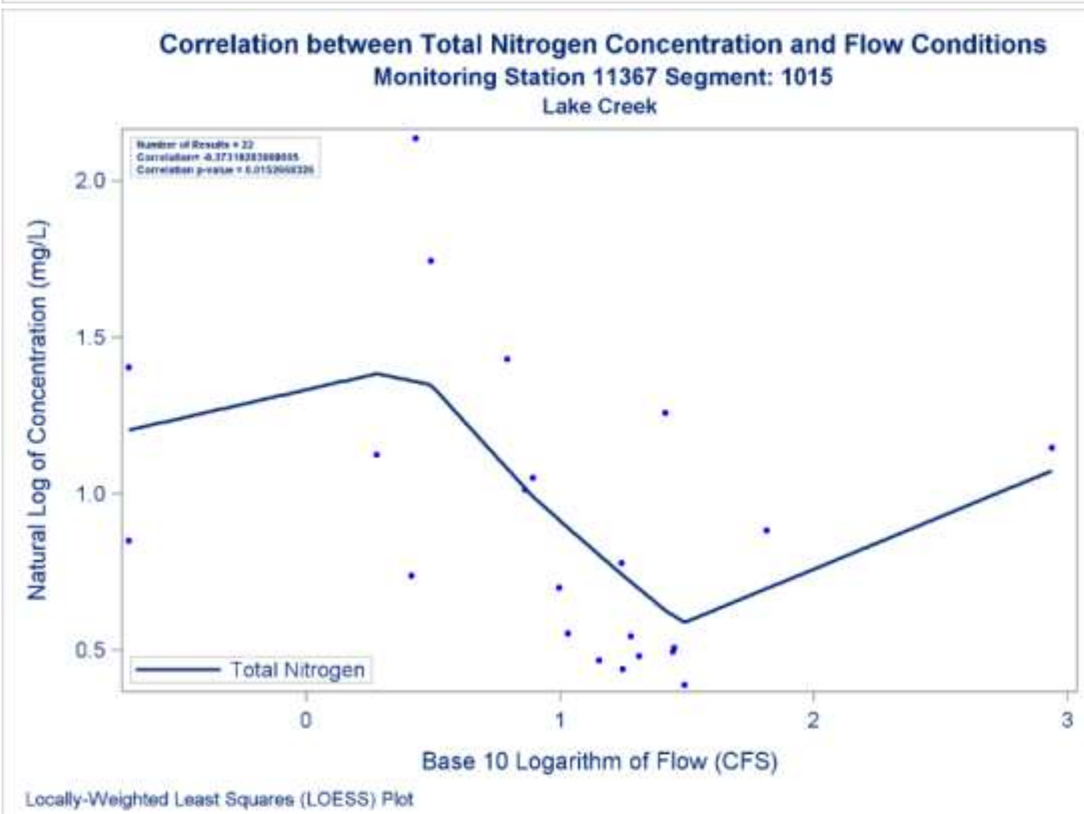
The graphs in this Appendix represent statistically significant relationships between flow and constituents of concern in the waterways.



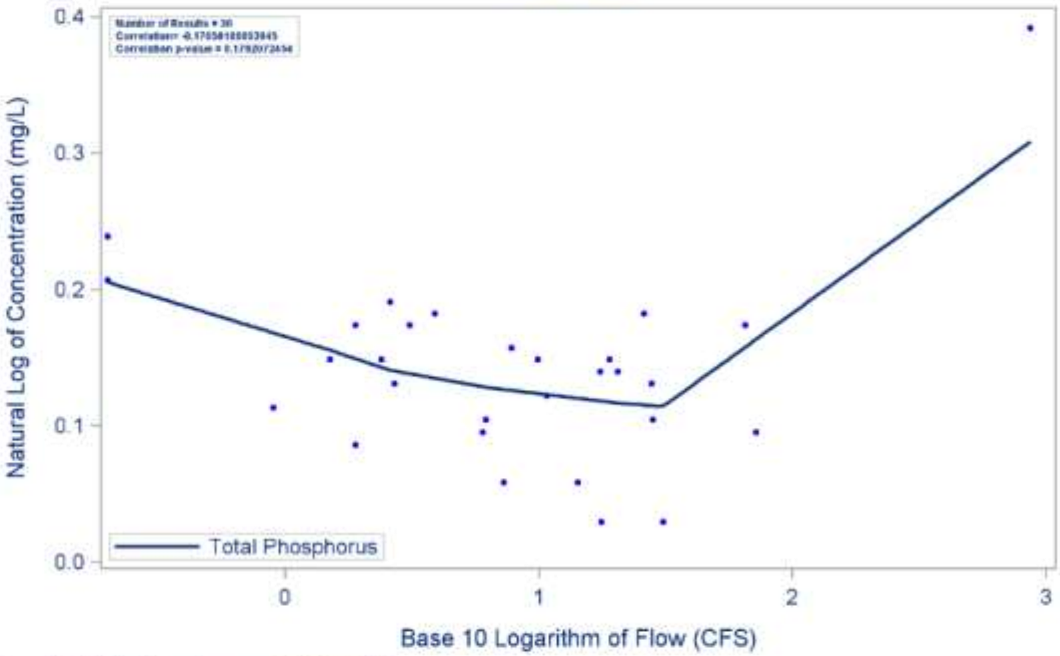

Correlation between Nitrate-N Concentration and Flow Conditions
Monitoring Station 11333 Segment: 1009
Cypress Creek
Number of Results = 113
Natural Log of Concentration (mg/L)
Nitrate-N
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot


Correlation between Total Phosphorus Concentration and Flow Conditions
Monitoring Station 11333 Segment: 1009
Cypress Creek
Number of Results = 112
Natural Log of Concentration (mg/L)
Total Phosphorus
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot


Correlation between E. coli Concentration and Flow Conditions
Monitoring Station 11367 Segment: 1015
Lake Creek
Natural Log of MPN/100 mL
Base 10 Logarithm of Flow (CFS)
E. coli
2
4
6
8
0
1
2
3
Locally-Weighted Least Squares (LOESS) Plot

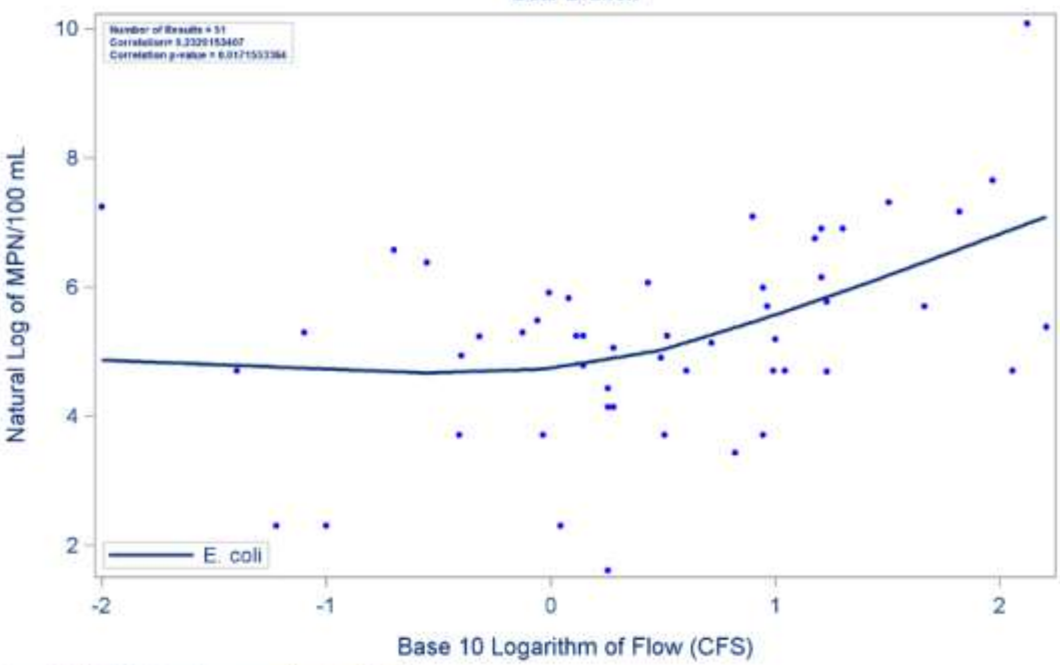

Correlation between Total Nitrogen Concentration and Flow Conditions
Monitoring Station 11367 Segment: 1015
Lake Creek
Natural Log of Concentration (mg/L)
Base 10 Logarithm of Flow (CFS)
Total Nitrogen
0.5
1.0
1.5
2.0
0
1
2
3
Locally-Weighted Least Squares (LOESS) Plot

Correlation between Total Phosphorus Concentration and Flow Conditions
Monitoring Station 11367 Segment: 1015
Lake Creek

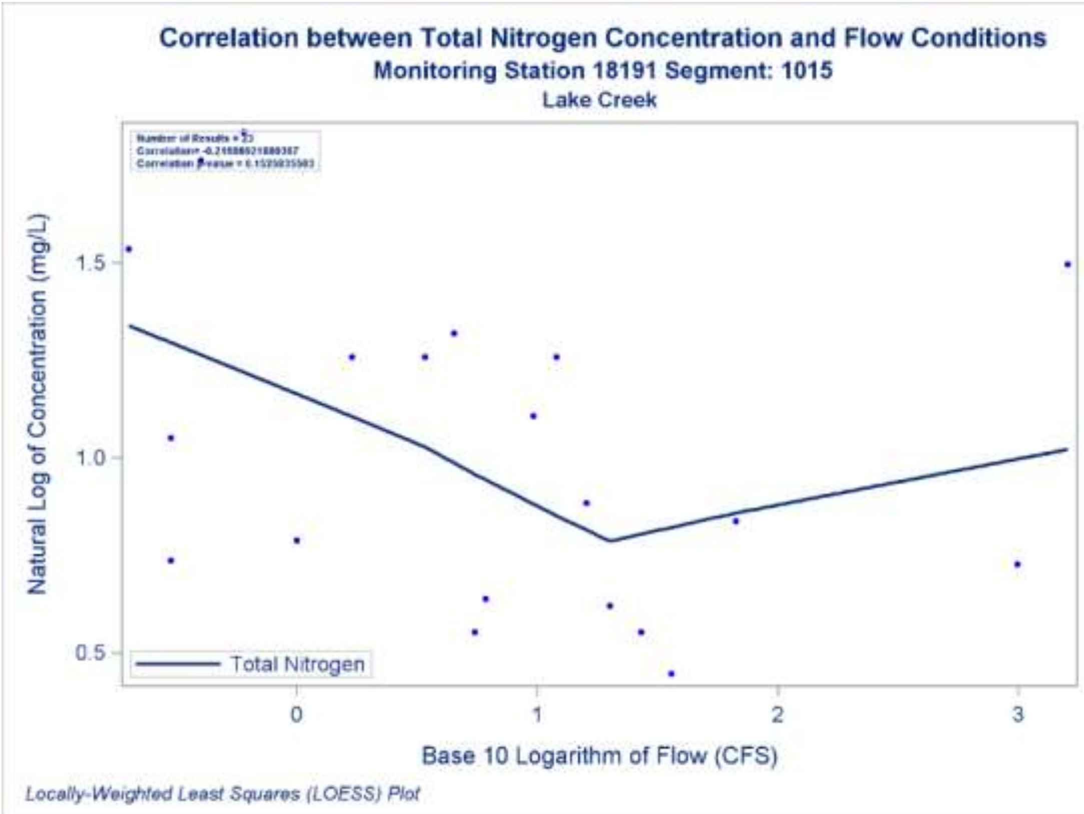


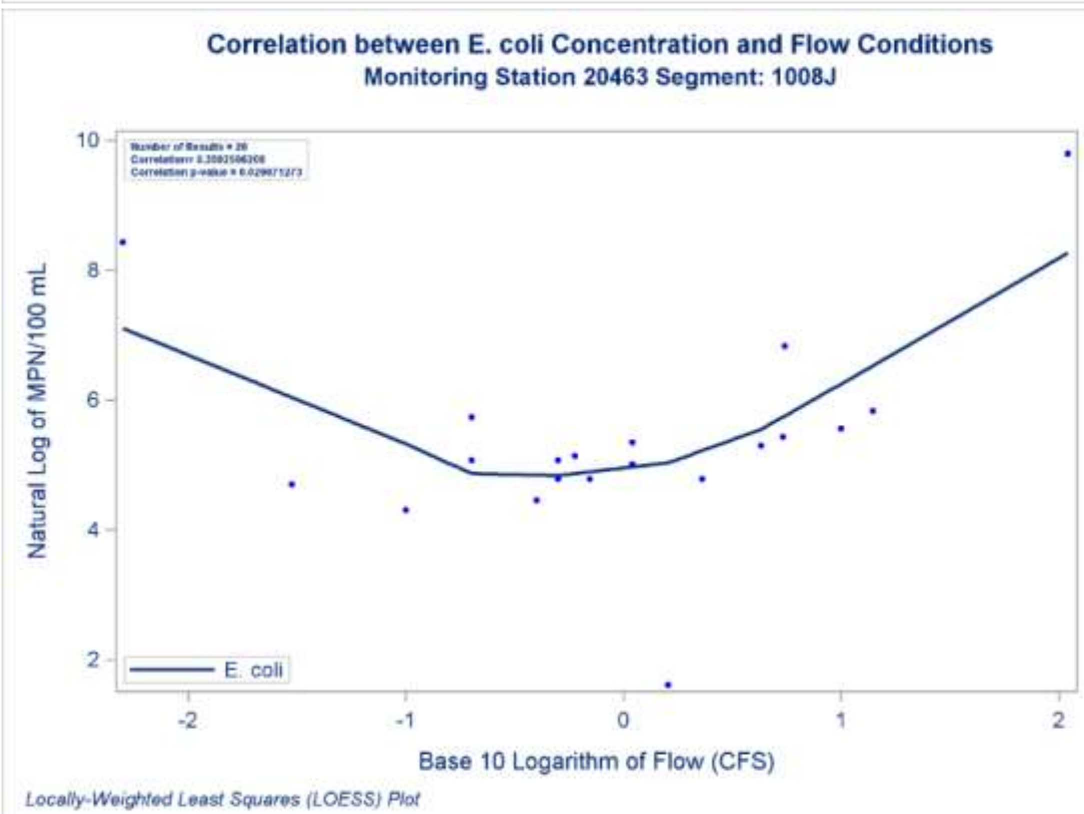
Locally-Weighted Least Squares (LOESS) Plot

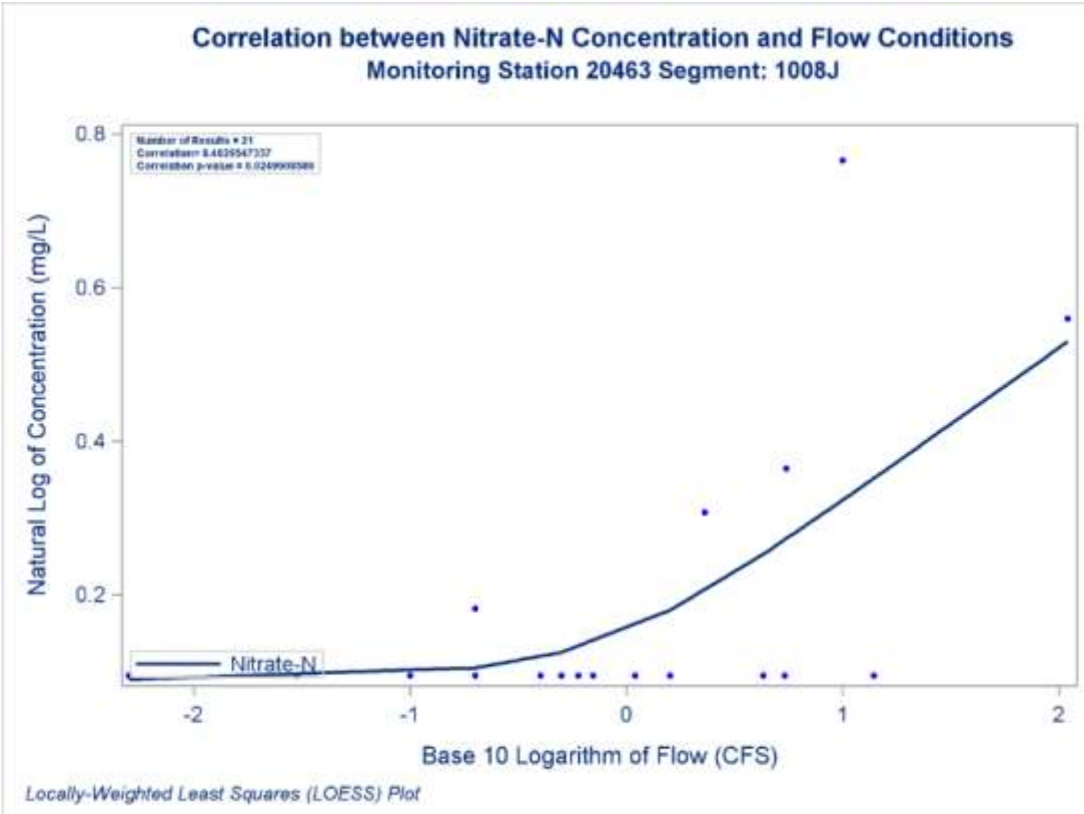
Correlation between E. coli Concentration and Flow Conditions
Monitoring Station 16631 Segment: 1008E
Bear Branch

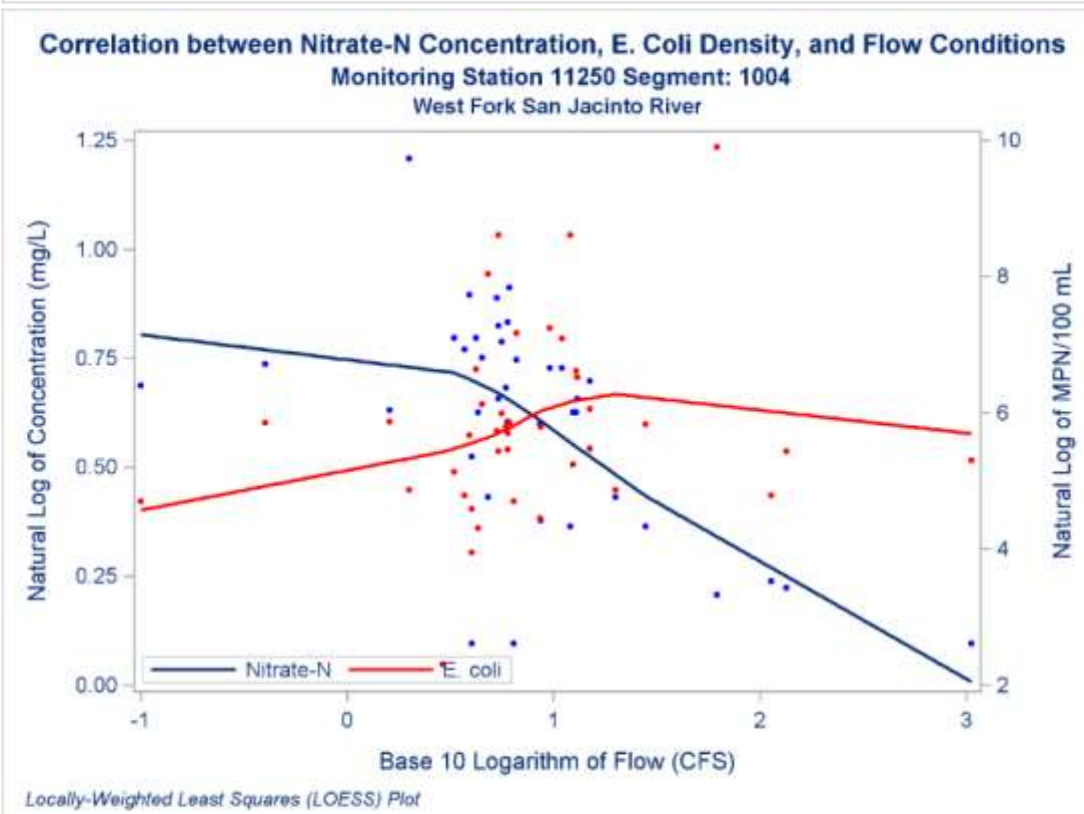


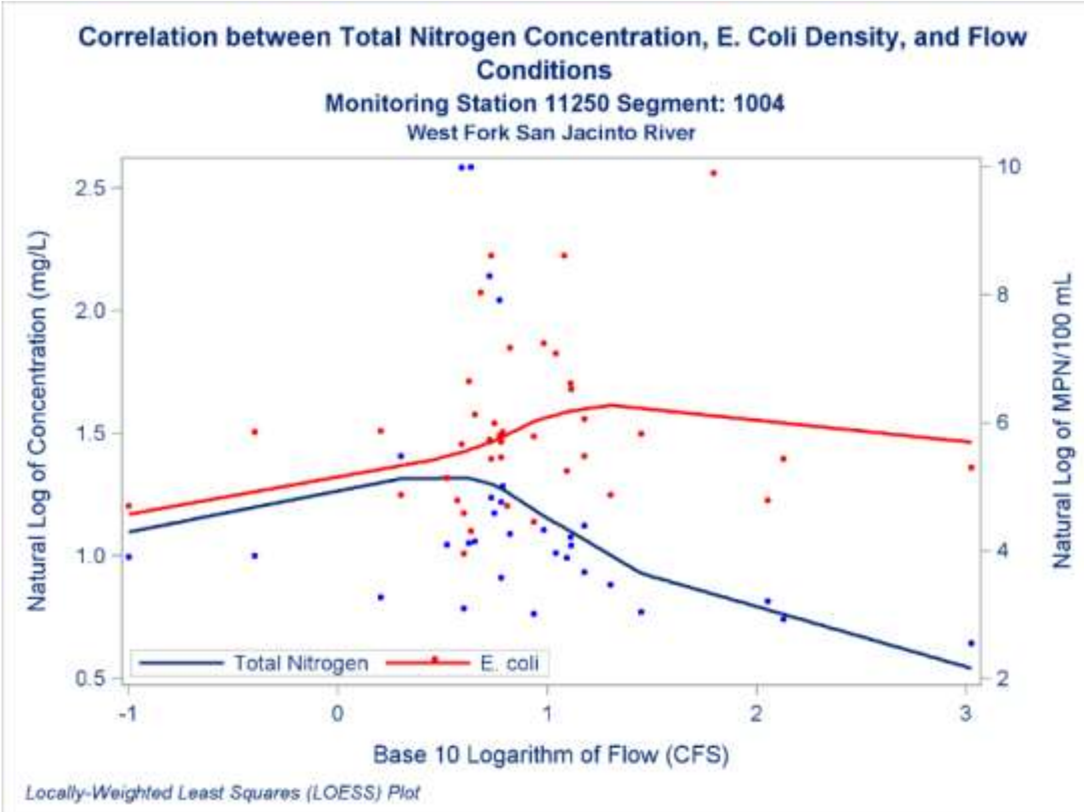
Locally-Weighted Least Squares (LOESS) Plot

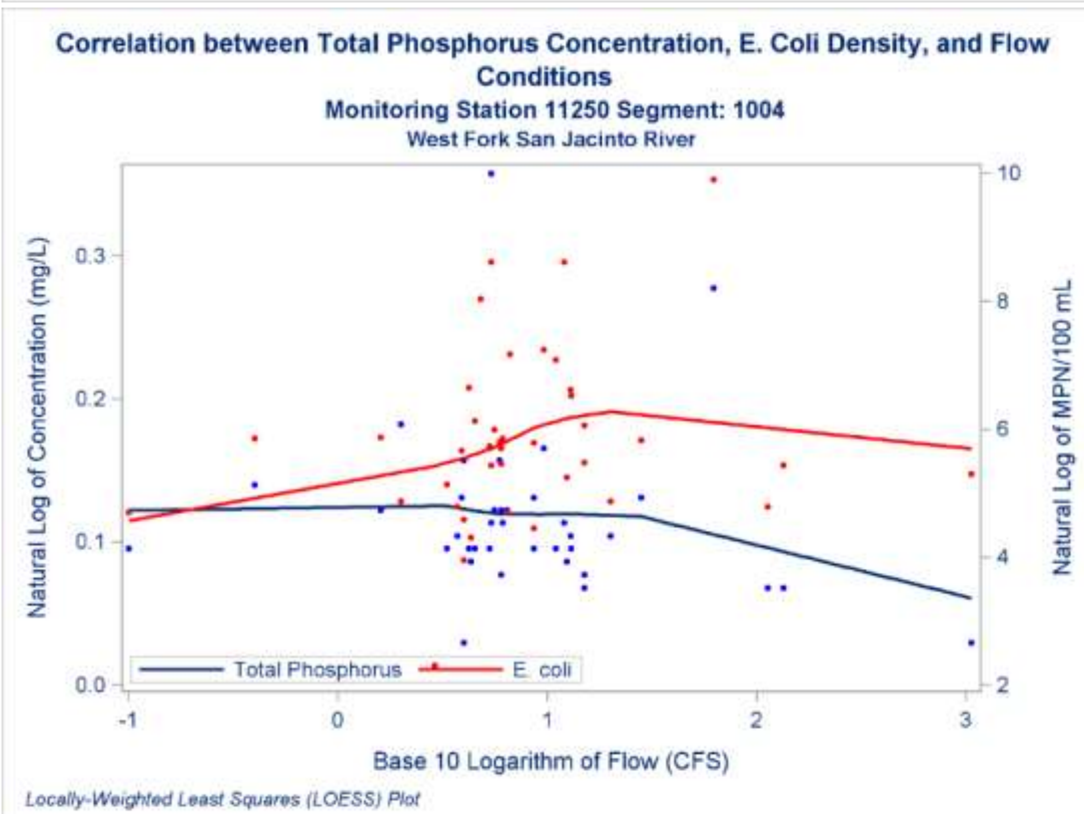

Correlation between Total Nitrogen Concentration and Flow Conditions
Monitoring Station 18191 Segment: 1015
Lake Creek
Natural Log of Concentration (mg/L)
1.5
1.0
0.5
Total Nitrogen
0
1
2
3
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot

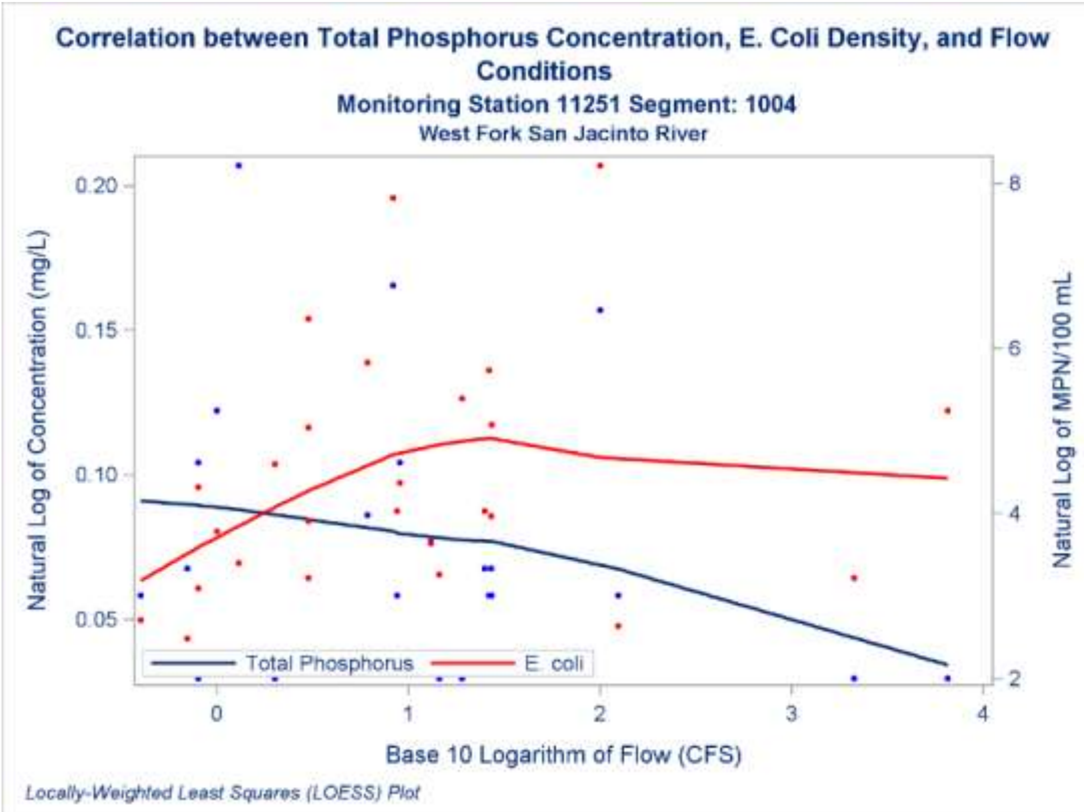

Correlation between E. coli Concentration and Flow Conditions
Monitoring Station 20463 Segment: 1008J
Natural Log of MPN/100 mL
10
8
6
4
2
E. coli
-2
-1
0
1
2
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot

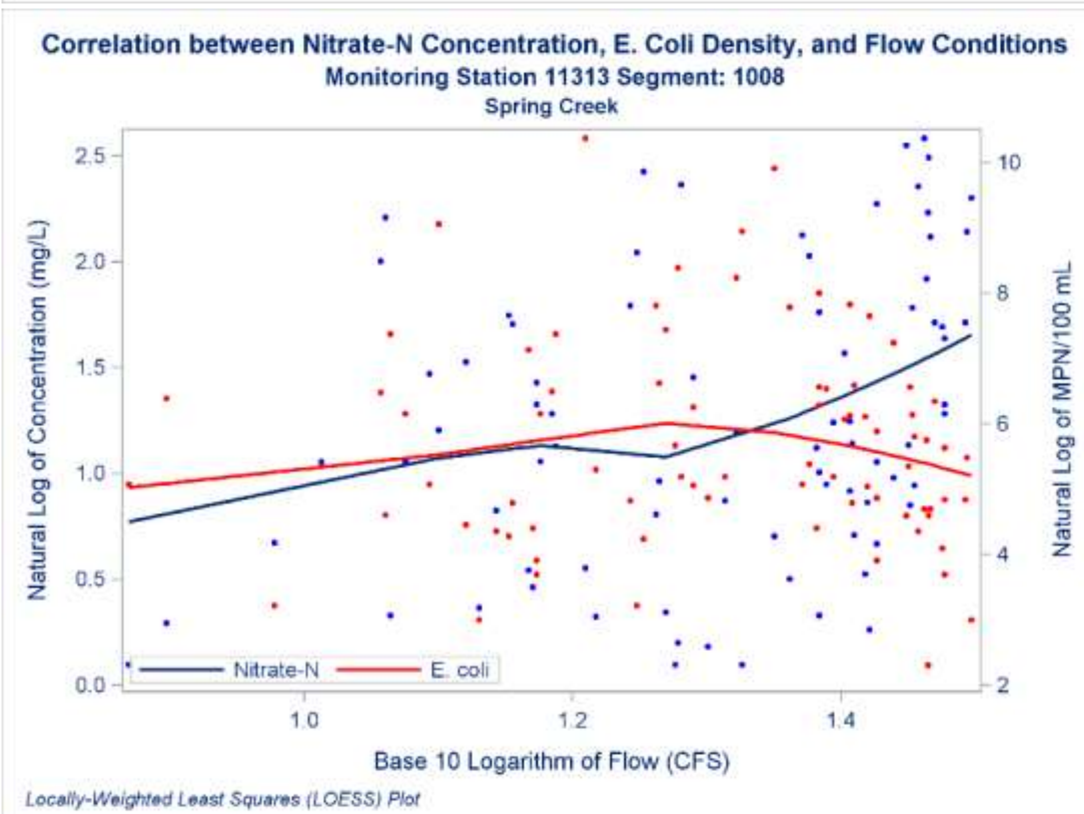

Correlation between Nitrate-N Concentration and Flow Conditions
Monitoring Station 20463 Segment: 1008J
Number of Results = 21
Natural Log of Concentration (mg/L)
0.8
0.6
0.4
0.2
Nitrate-N
-2
-1
0
1
2
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot

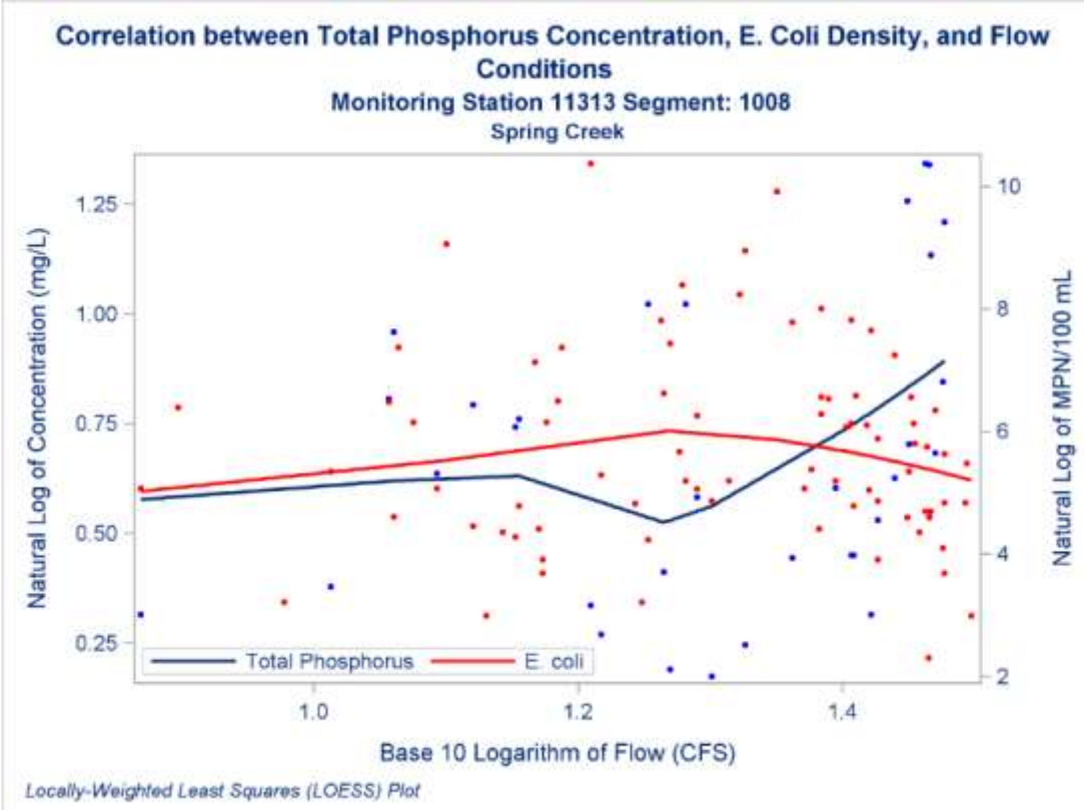

Correlation between Nitrate-N Concentration, E. Coli Density, and Flow Conditions
Monitoring Station 11250 Segment: 1004
West Fork San Jacinto River
Natural Log of Concentration (mg/L)
1.25
1.00
0.75
0.50
0.25
0.00
Natural Log of MPN/100 mL
10
8
6
4
2
Nitrate-N
E. coli
-1
0
1
2
3
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot

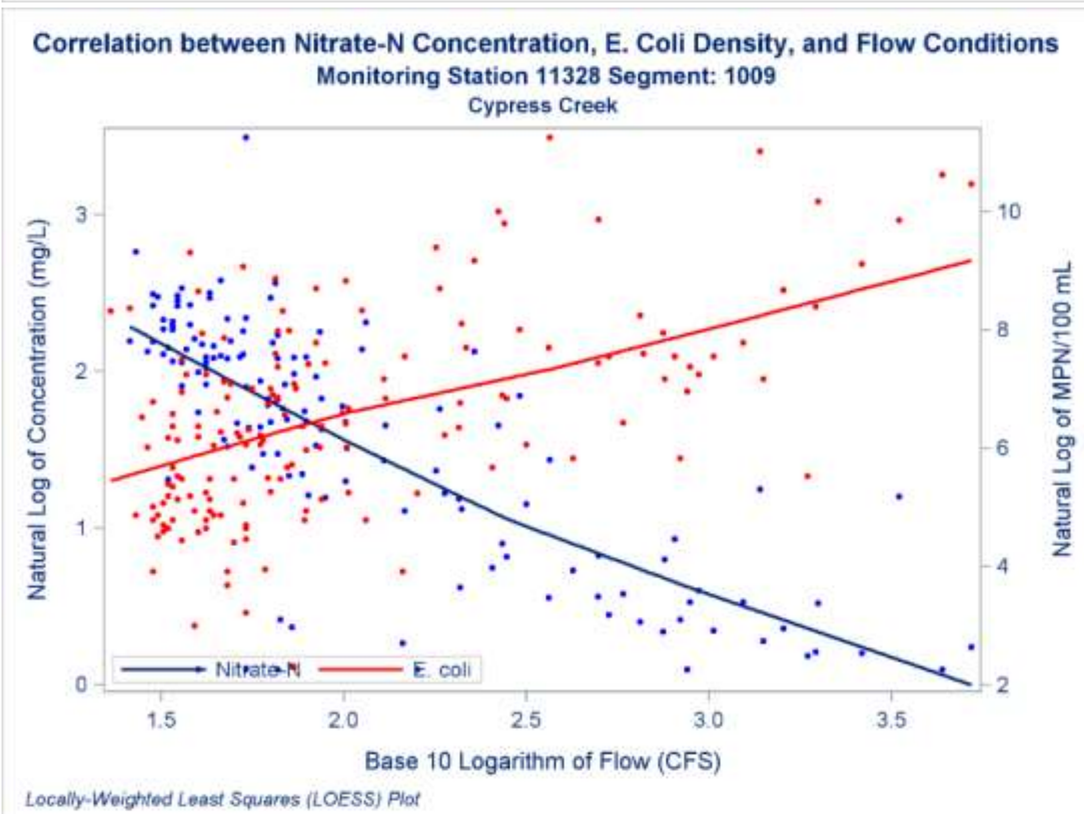

Correlation between Total Nitrogen Concentration, E. Coli Density, and Flow Conditions
Monitoring Station 11250 Segment: 1004
West Fork San Jacinto River
Natural Log of Concentration (mg/L)
Natural Log of MPN/100 mL
Total Nitrogen
E. coli
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot

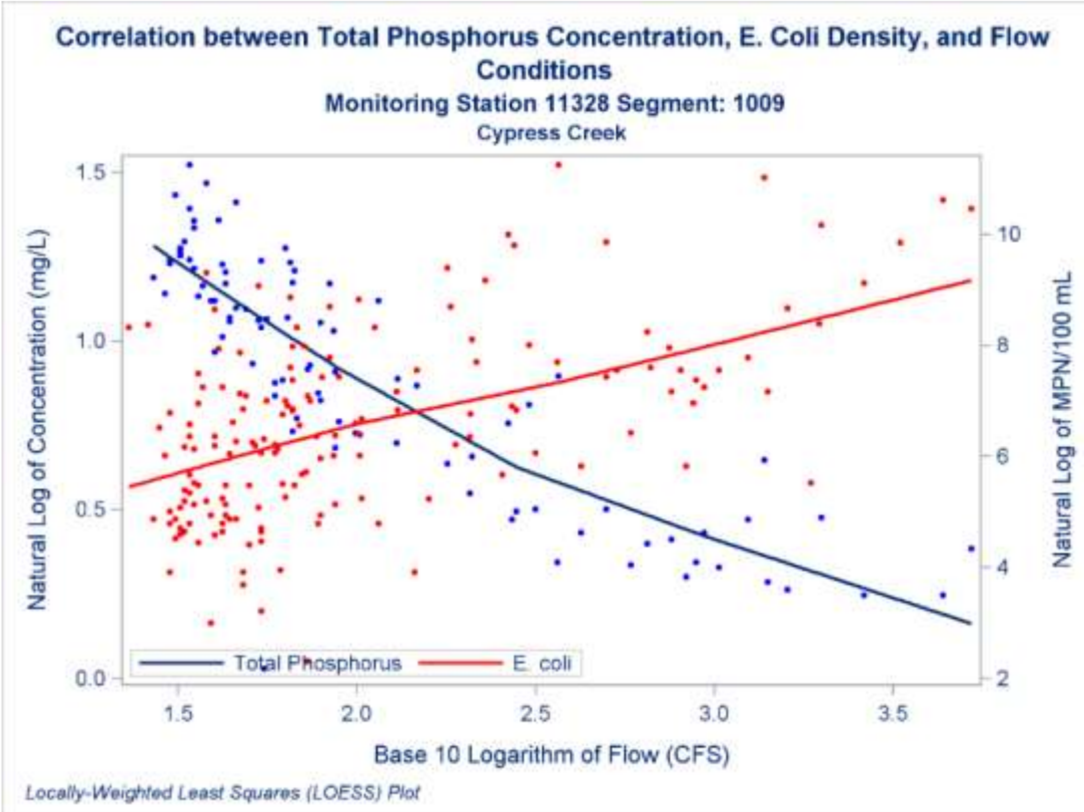

Correlation between Total Phosphorus Concentration, E. Coli Density, and Flow Conditions
Monitoring Station 11250 Segment: 1004
West Fork San Jacinto River
Natural Log of Concentration (mg/L)
Natural Log of MPN/100 mL
Total Phosphorus
E. coli
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot

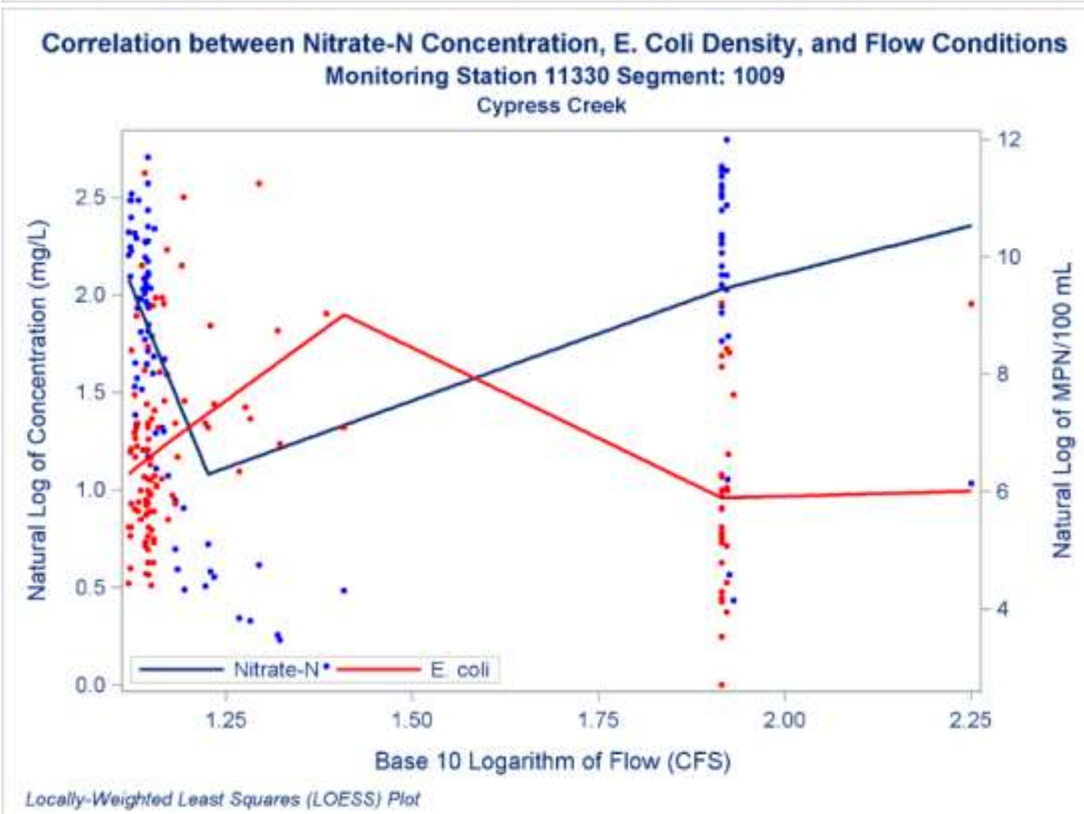

Correlation between Total Phosphorus Concentration, E. Coli Density, and Flow Conditions
Monitoring Station 11251 Segment: 1004
West Fork San Jacinto River
Natural Log of Concentration (mg/L)
Natural Log of MPN/100 mL
Total Phosphorus
E. coli
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot

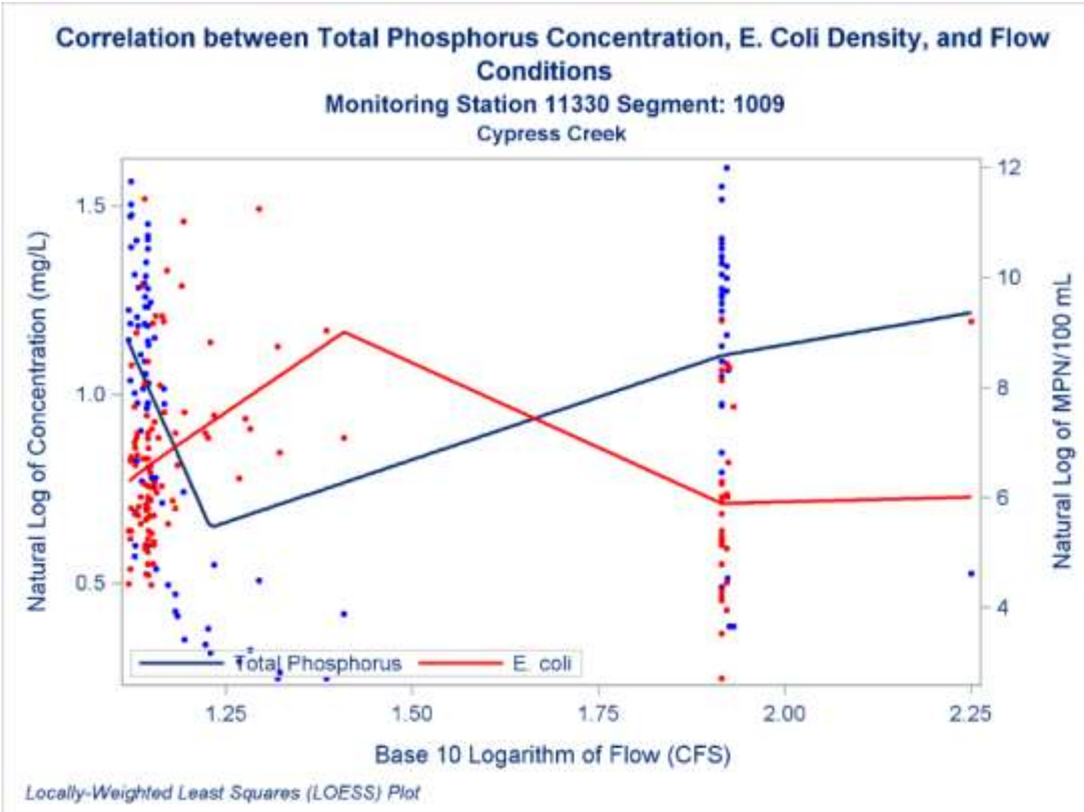

Correlation between Nitrate-N Concentration, E. Coli Density, and Flow Conditions
Monitoring Station 11313 Segment: 1008
Spring Creek
Natural Log of Concentration (mg/L)
Natural Log of MPN/100 mL
Nitrate-N
E. coli
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot


Correlation between Total Phosphorus Concentration, E. Coli Density, and Flow Conditions
Monitoring Station 11313 Segment: 1008
Spring Creek
Natural Log of Concentration (mg/L)
Natural Log of MPN/100 mL
Total Phosphorus
E. coli
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot

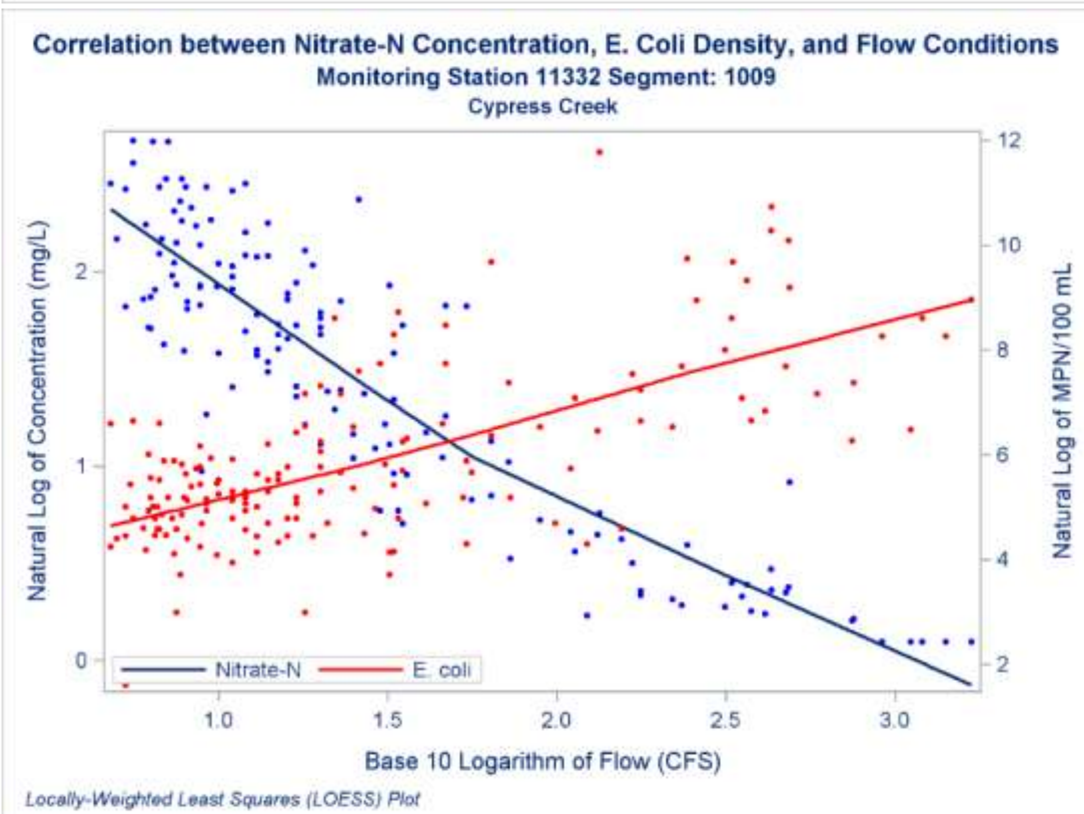

Correlation between Nitrate-N Concentration, E. Coli Density, and Flow Conditions
Monitoring Station 11328 Segment: 1009
Cypress Creek
Natural Log of Concentration (mg/L)
Natural Log of MPN/100 mL
Nitrate-N
E. coli
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot


Correlation between Total Phosphorus Concentration, E. Coli Density, and Flow Conditions
Monitoring Station 11328 Segment: 1009
Cypress Creek
Natural Log of Concentration (mg/L)
Natural Log of MPN/100 mL
Total Phosphorus
E. coli
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot

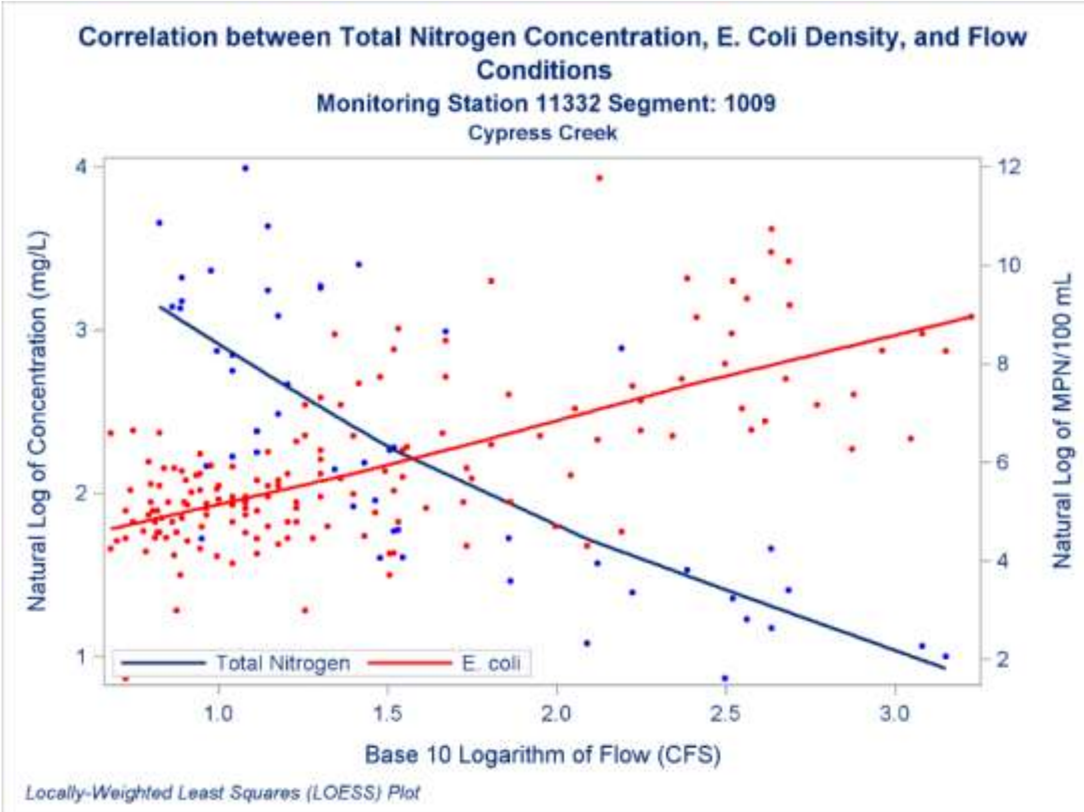

Correlation between Nitrate-N Concentration, E. Coli Density, and Flow Conditions
Monitoring Station 11330 Segment: 1009
Cypress Creek
Natural Log of Concentration (mg/L)
Natural Log of MPN/100 mL
Nitrate-N
E. coli
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot

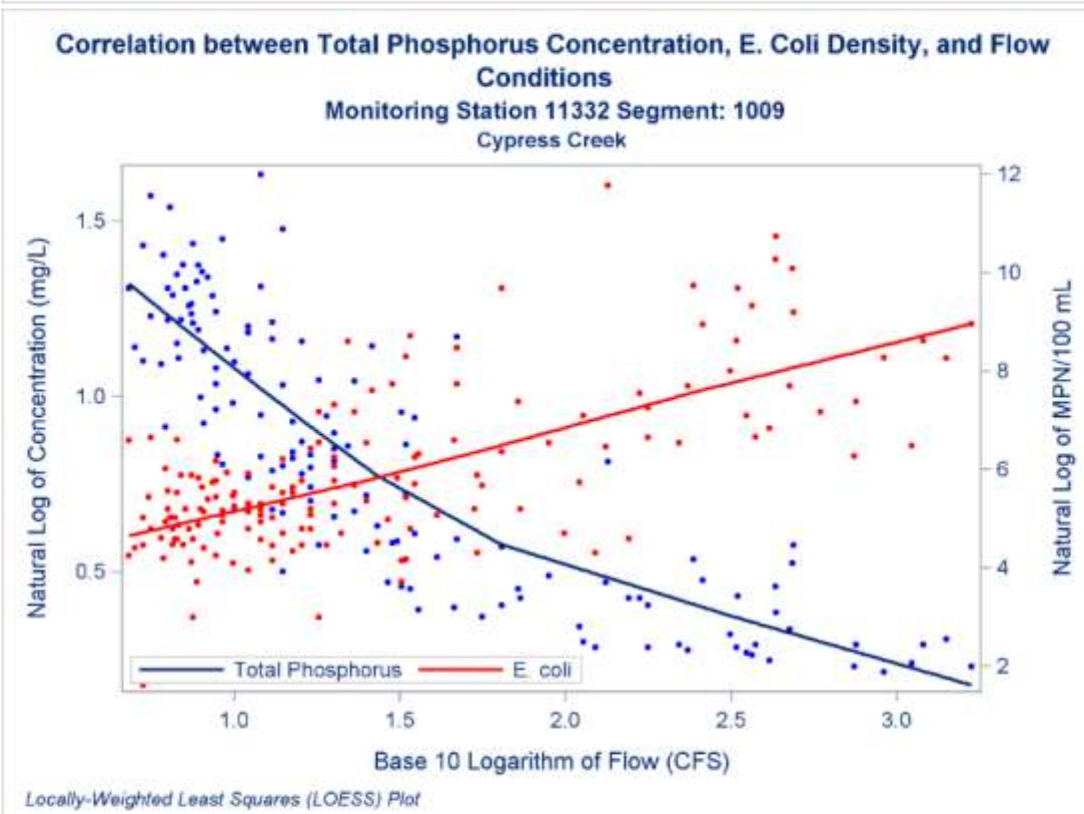


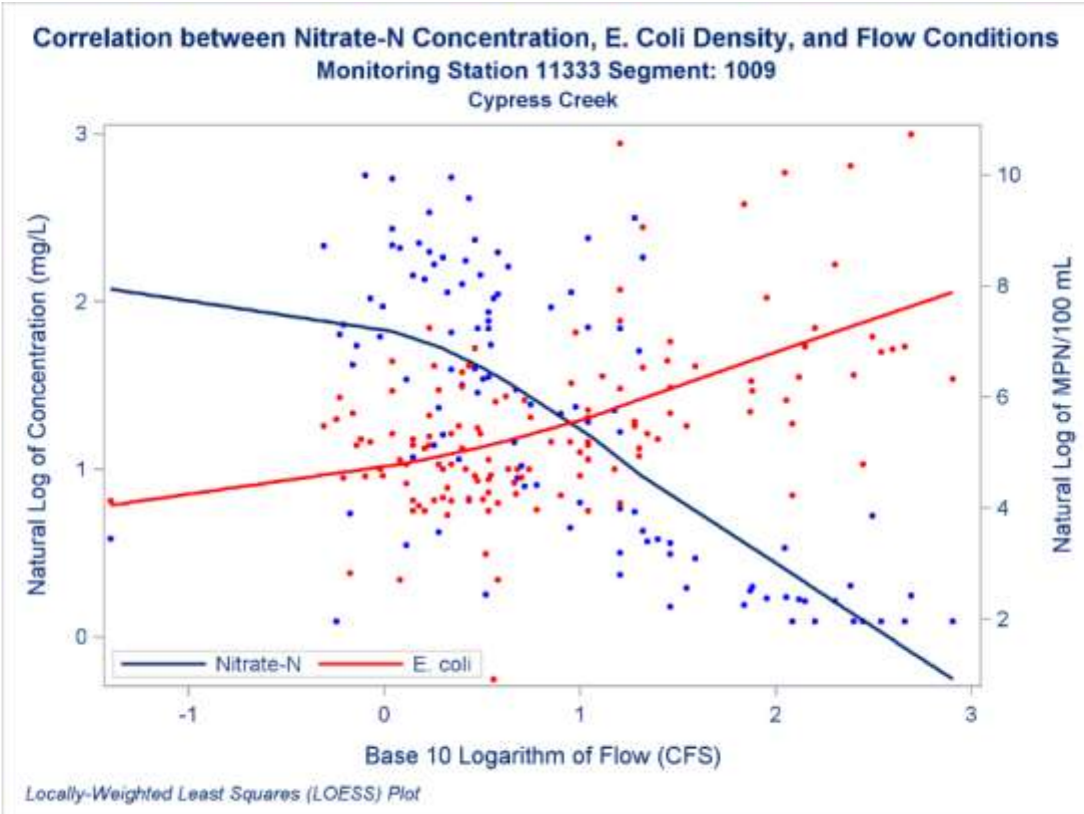
Correlation between Total Phosphorus Concentration, E. Coli Density, and Flow Conditions
Monitoring Station 11330 Segment: 1009
Cypress Creek
Natural Log of Concentration (mg/L)
Natural Log of MPN/100 mL
Total Phosphorus
E. coli
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot

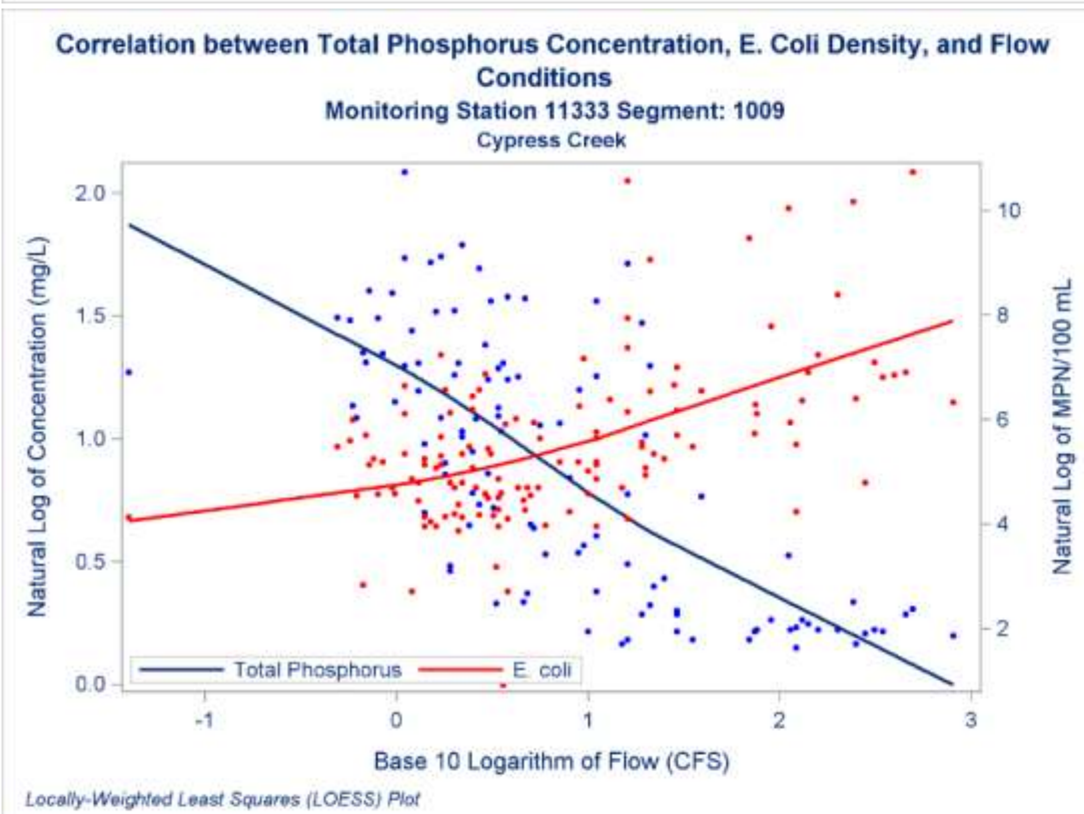


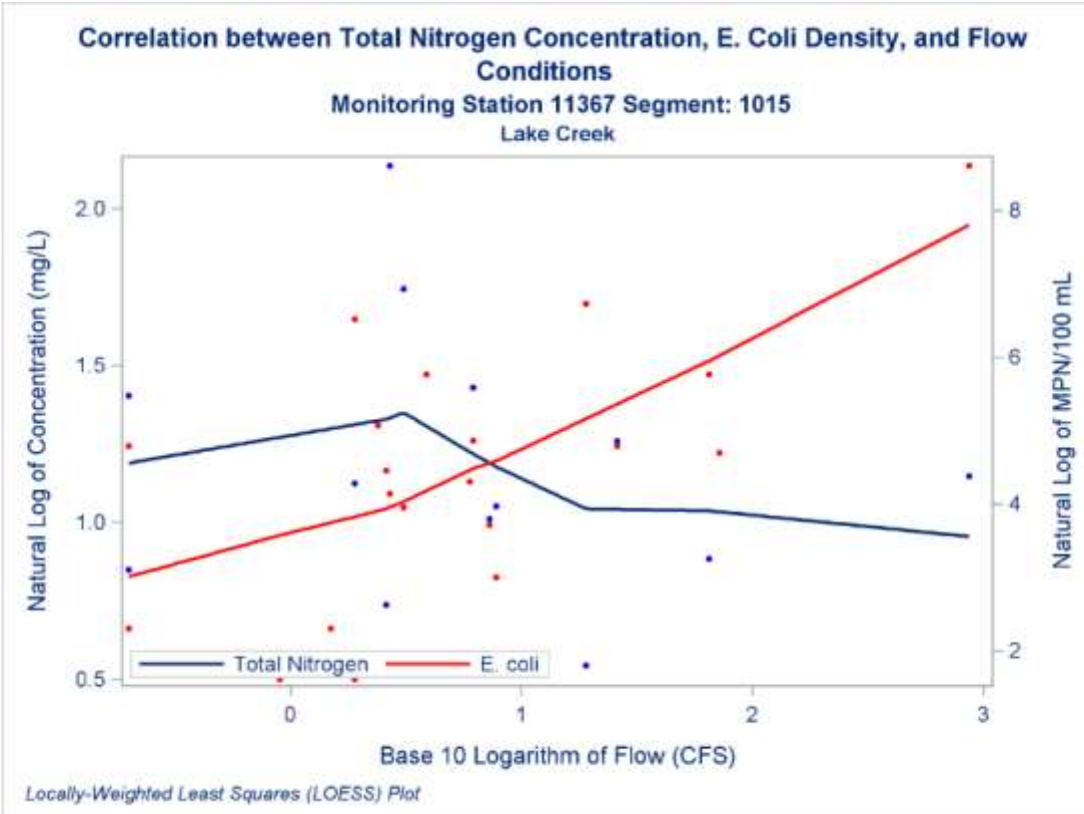
Correlation between Nitrate-N Concentration, E. Coli Density, and Flow Conditions
Monitoring Station 11332 Segment: 1009
Cypress Creek
Natural Log of Concentration (mg/L)
Natural Log of MPN/100 mL
Nitrate-N
E. coli
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot

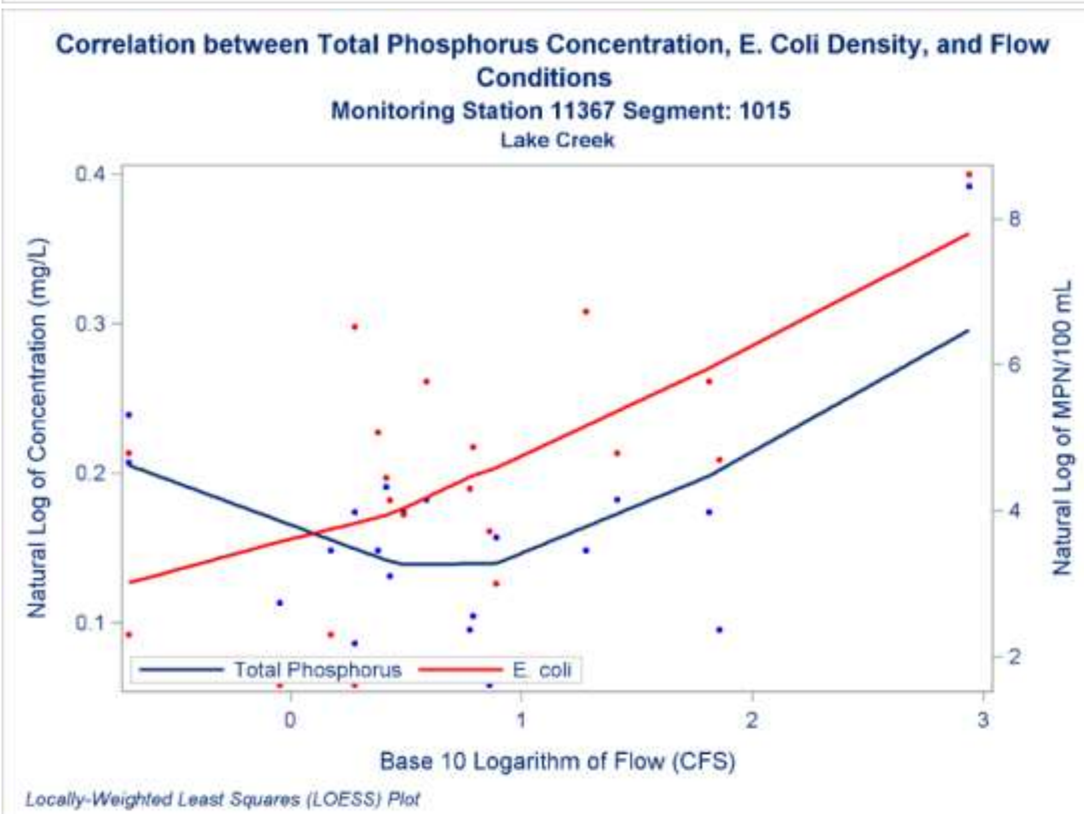

Correlation between Total Nitrogen Concentration, E. Coli Density, and Flow Conditions
Monitoring Station 11332 Segment: 1009
Cypress Creek
Natural Log of Concentration (mg/L)
Natural Log of MPN/100 mL
Total Nitrogen
E. coli
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot

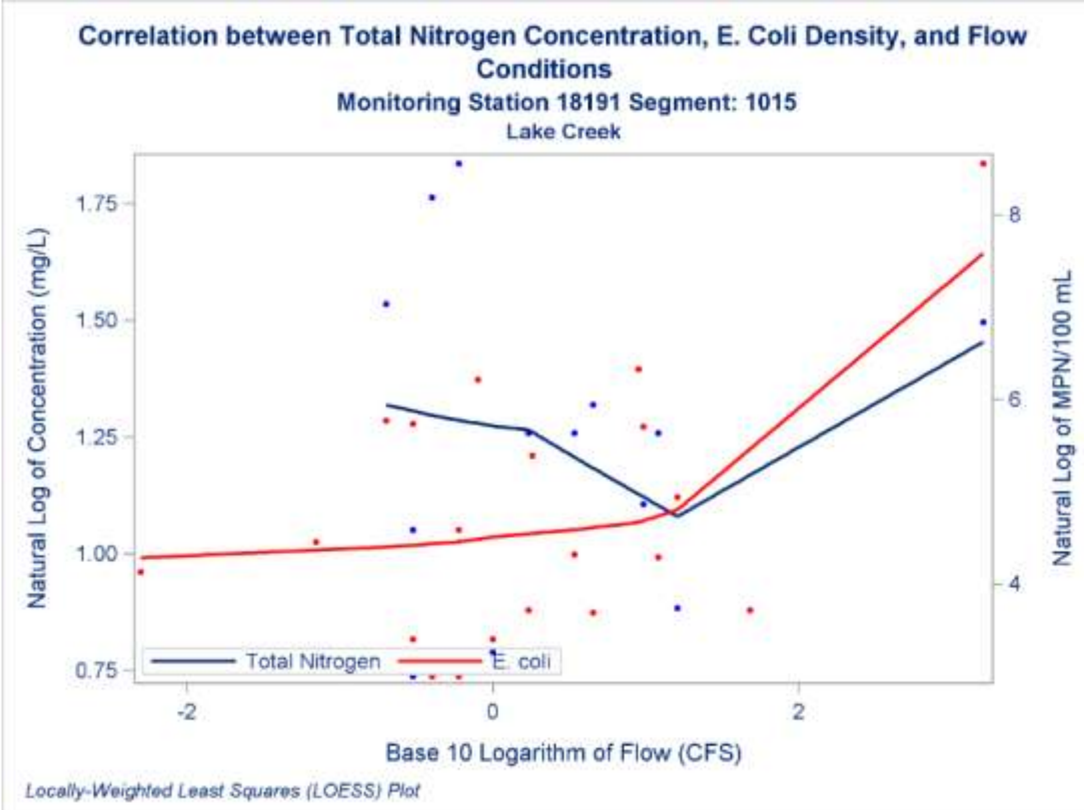

Correlation between Total Phosphorus Concentration, E. Coli Density, and Flow Conditions
Monitoring Station 11332 Segment: 1009
Cypress Creek
Natural Log of Concentration (mg/L)
Natural Log of MPN/100 mL
Total Phosphorus
E. coli
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot

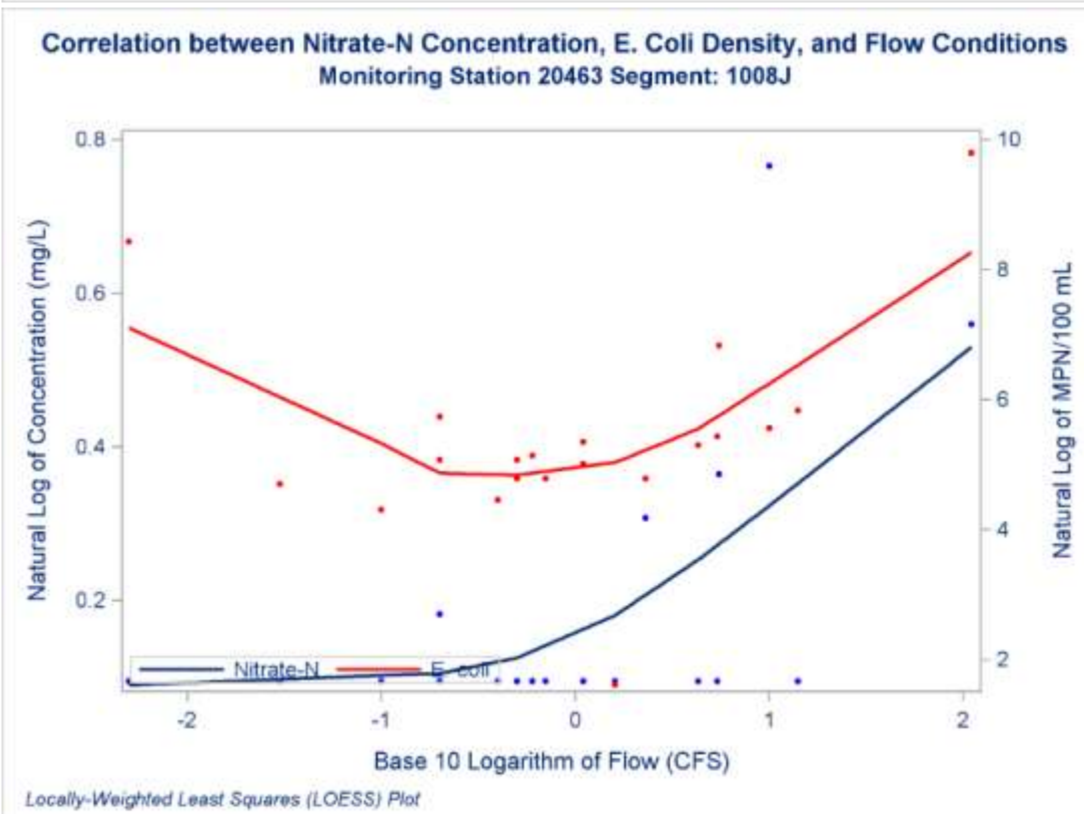

Correlation between Nitrate-N Concentration, E. Coli Density, and Flow Conditions
Monitoring Station 11333 Segment: 1009
Cypress Creek
Natural Log of Concentration (mg/L)
Natural Log of MPN/100 mL
Nitrate-N
E. coli
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot

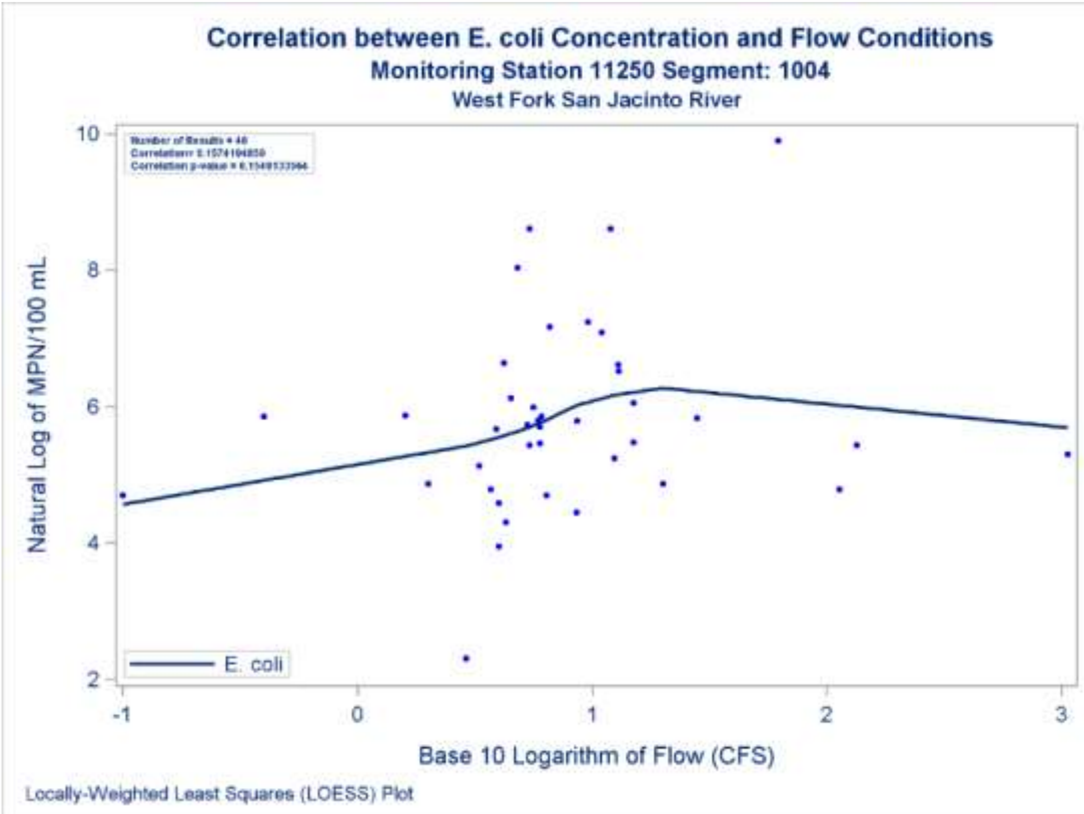

Correlation between Total Phosphorus Concentration, E. Coli Density, and Flow Conditions
Monitoring Station 11333 Segment: 1009
Cypress Creek
Natural Log of Concentration (mg/L)
Natural Log of MPN/100 mL
Total Phosphorus
E. coli
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot

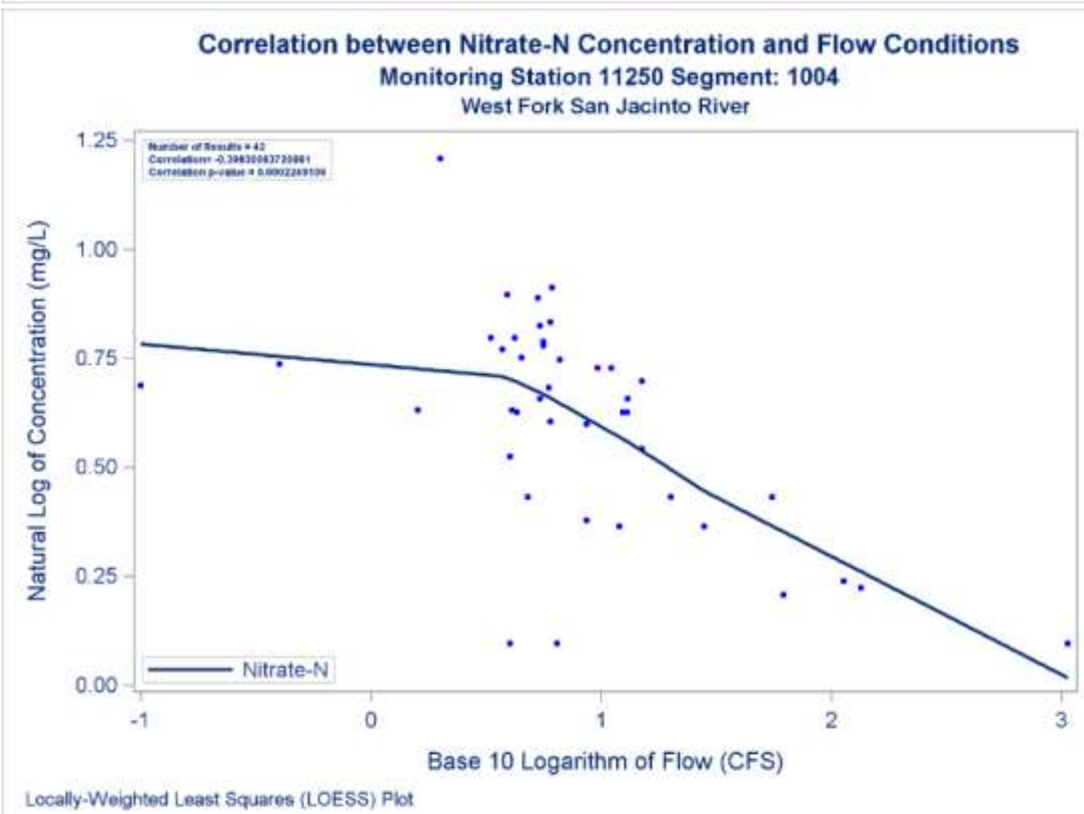

Correlation between Total Nitrogen Concentration, E. Coli Density, and Flow Conditions
Monitoring Station 11367 Segment: 1015
Lake Creek
Natural Log of Concentration (mg/L)
Natural Log of MPN/100 mL
Total Nitrogen
E. coli
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot

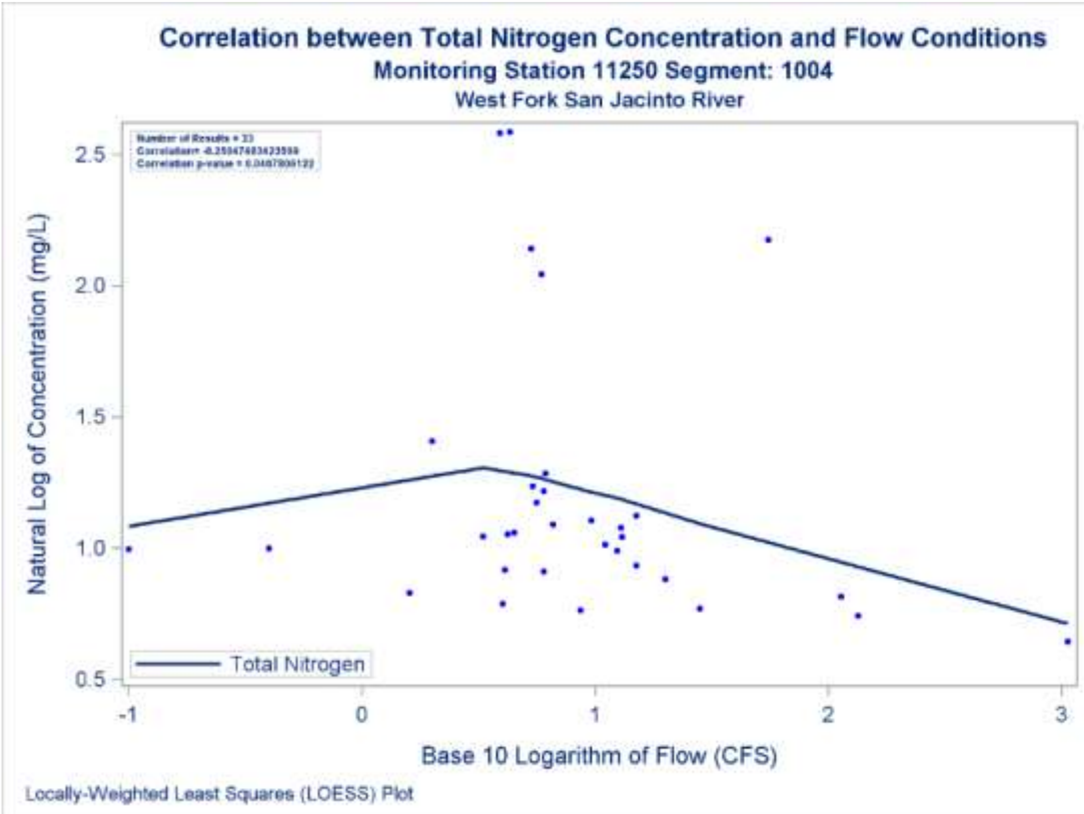

Correlation between Total Phosphorus Concentration, E. Coli Density, and Flow Conditions
Monitoring Station 11367 Segment: 1015
Lake Creek
Natural Log of Concentration (mg/L)
Natural Log of MPN/100 mL
Total Phosphorus
E. coli
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot

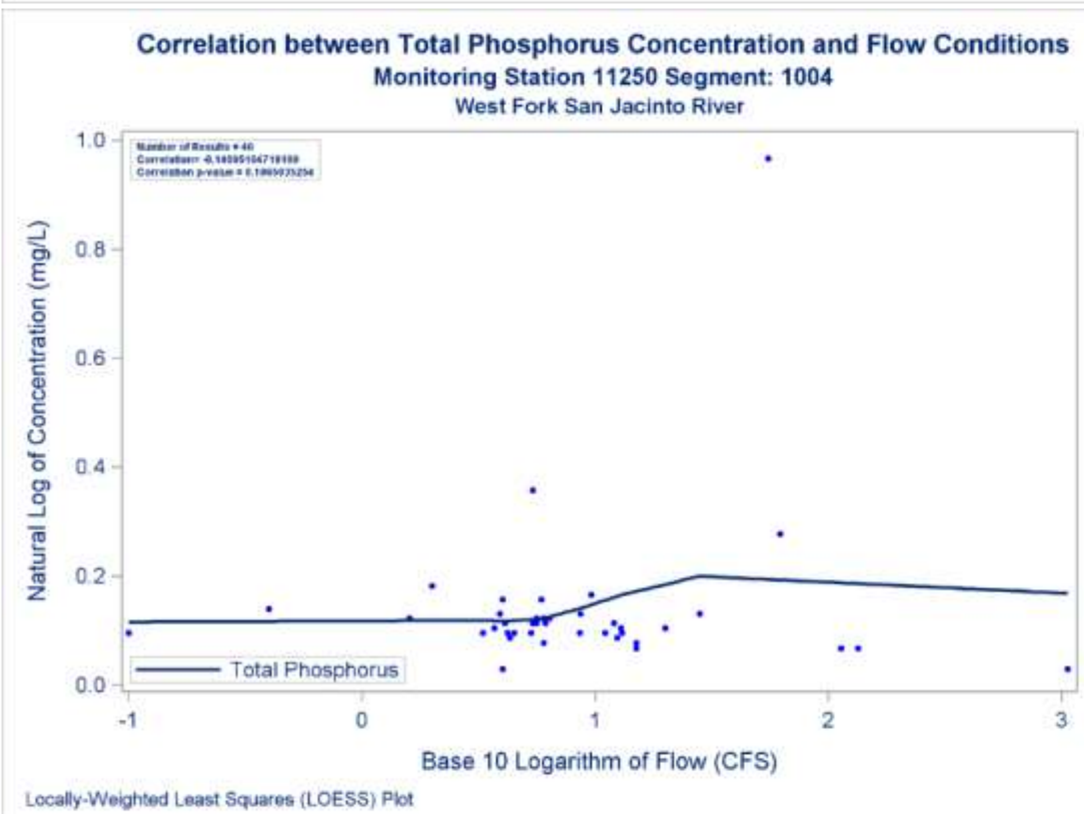

Correlation between Total Nitrogen Concentration, E. Coli Density, and Flow Conditions
Monitoring Station 18191 Segment: 1015
Lake Creek
Natural Log of Concentration (mg/L)
Natural Log of MPN/100 mL
Total Nitrogen
E. coli
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot

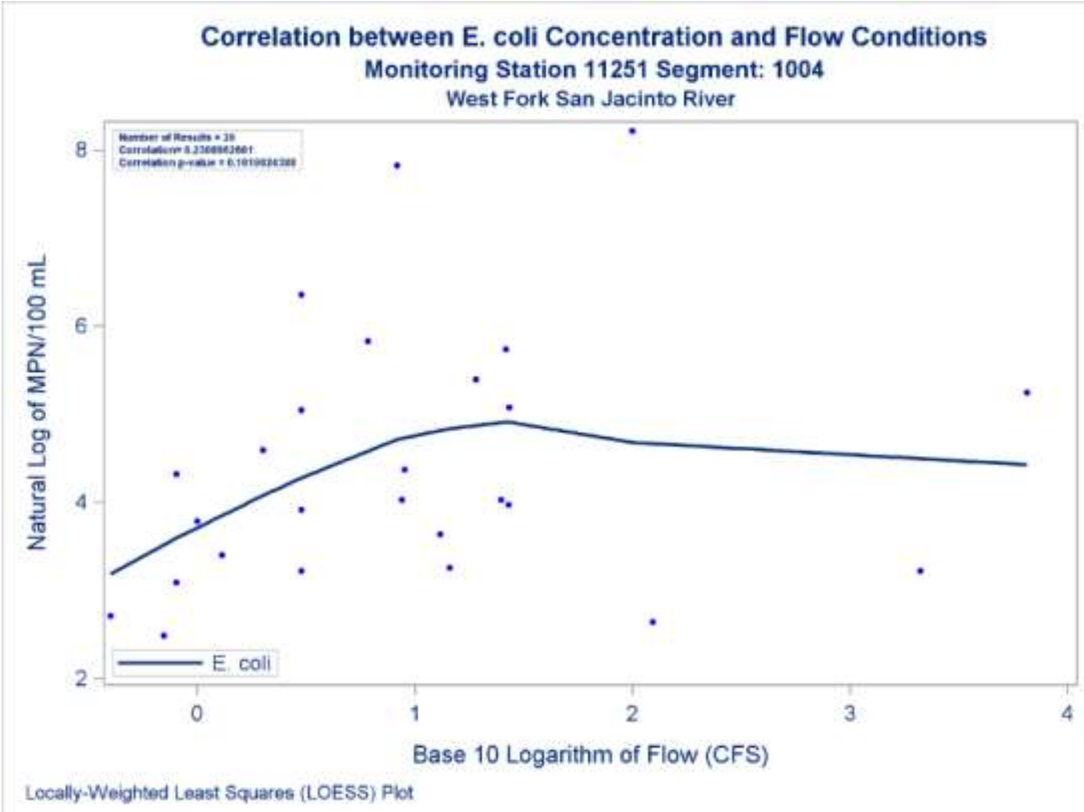

Correlation between Nitrate-N Concentration, E. Coli Density, and Flow Conditions
Monitoring Station 20463 Segment: 1008J
Natural Log of Concentration (mg/L)
Natural Log of MPN/100 mL
Nitrate-N
E. coli
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot

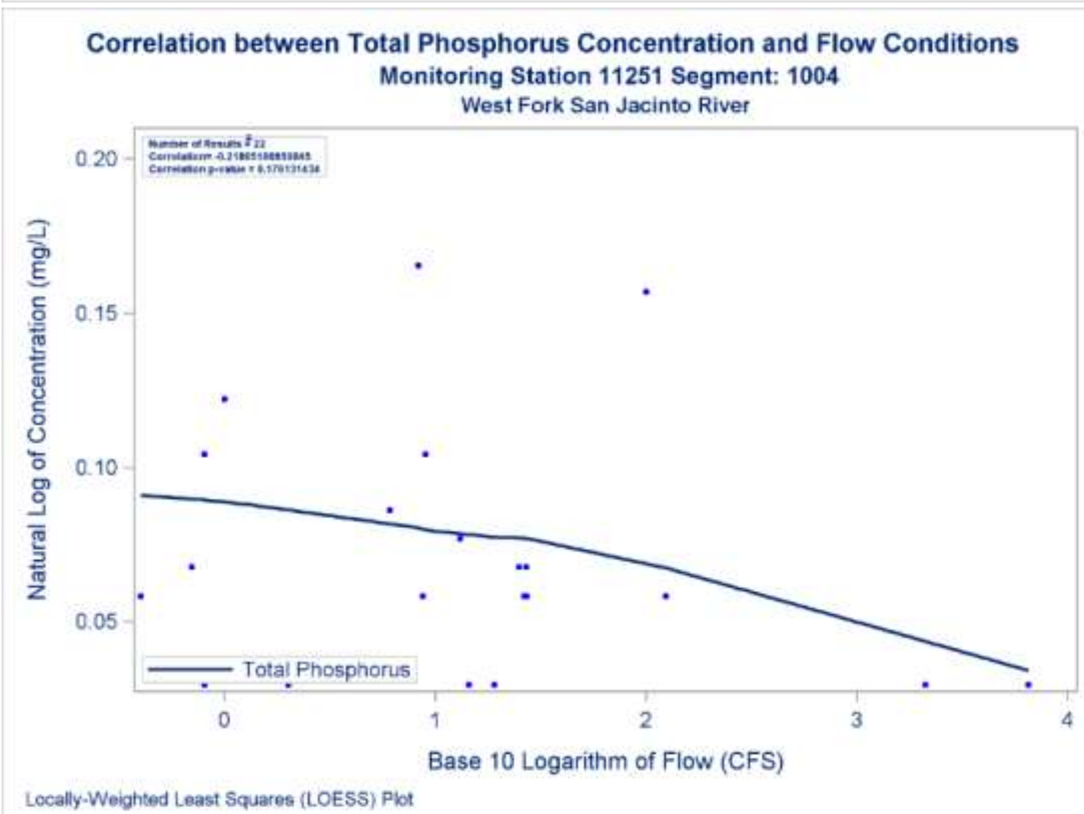

Correlation between E. coli Concentration and Flow Conditions
Monitoring Station 11250 Segment: 1004
West Fork San Jacinto River
Natural Log of MPN/100 mL
10
8
6
4
2
E. coli
-1
0
1
2
3
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot

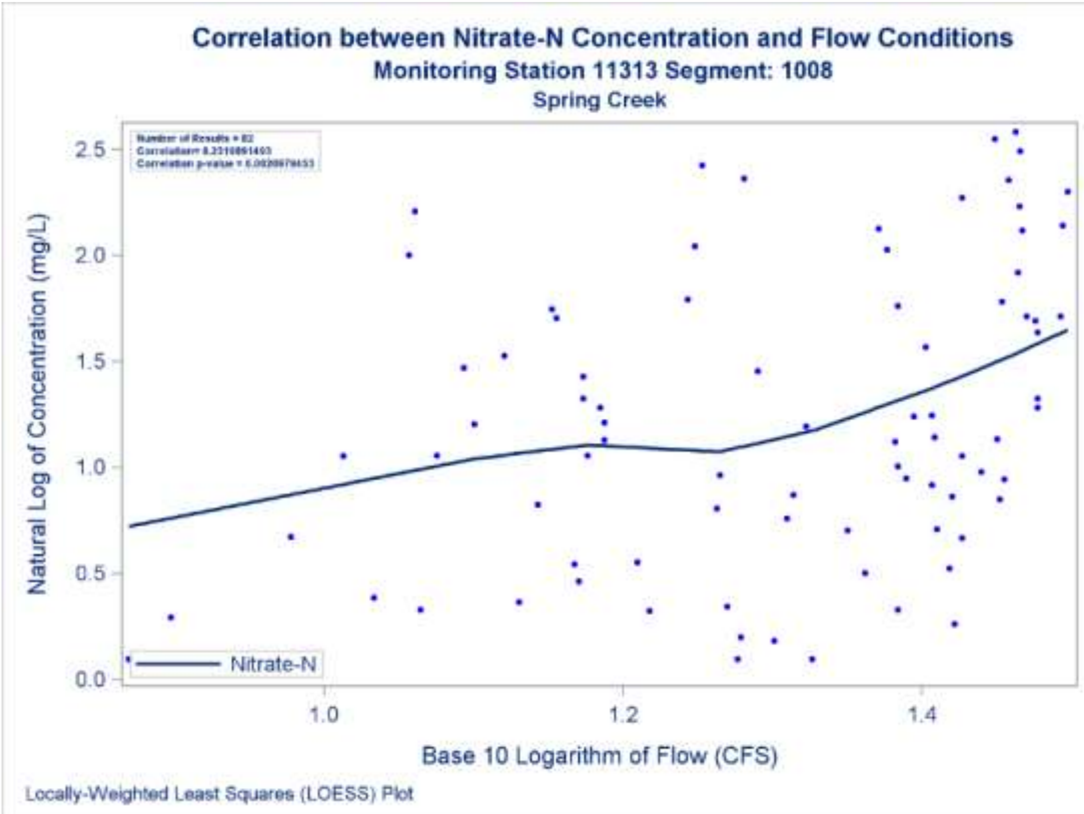

Correlation between Nitrate-N Concentration and Flow Conditions
Monitoring Station 11250 Segment: 1004
West Fork San Jacinto River
Natural Log of Concentration (mg/L)
1.25
1.00
0.75
0.50
0.25
0.00
Nitrate-N
-1
0
1
2
3
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot

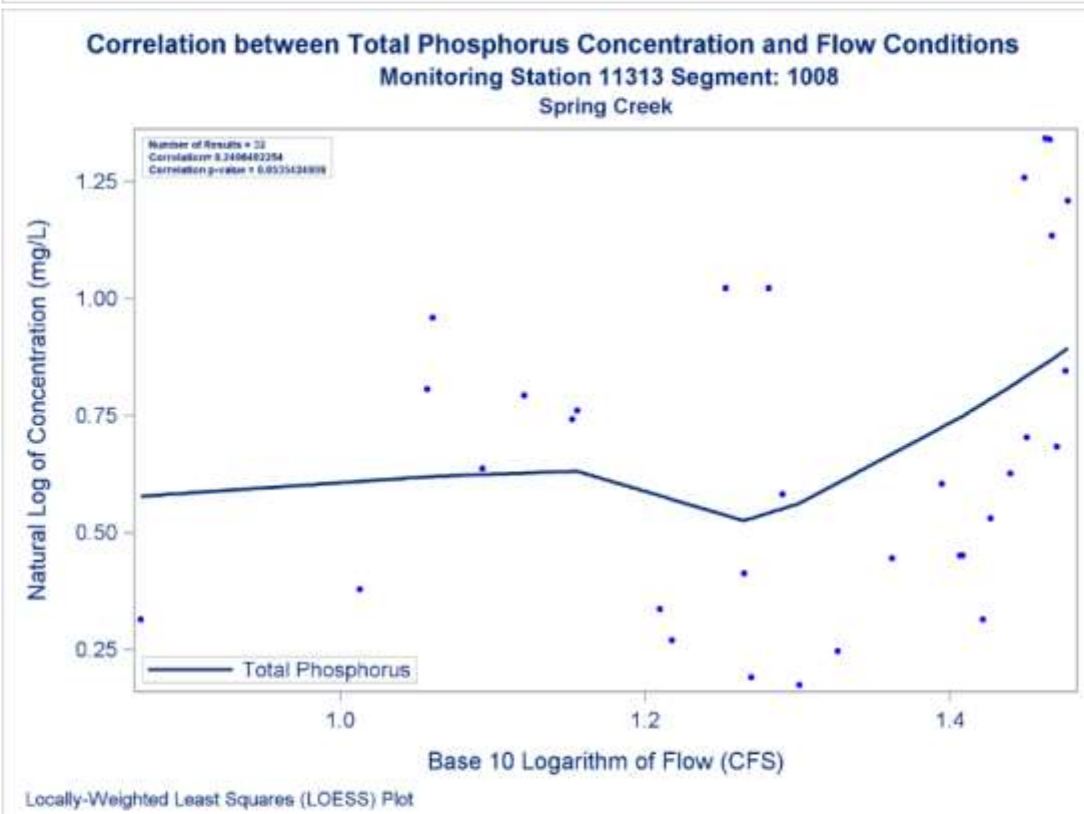

Correlation between Total Nitrogen Concentration and Flow Conditions
Monitoring Station 11250 Segment: 1004
West Fork San Jacinto River
Natural Log of Concentration (mg/L)
2.5
2.0
1.5
1.0
0.5
-1
0
1
2
3
Total Nitrogen
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot

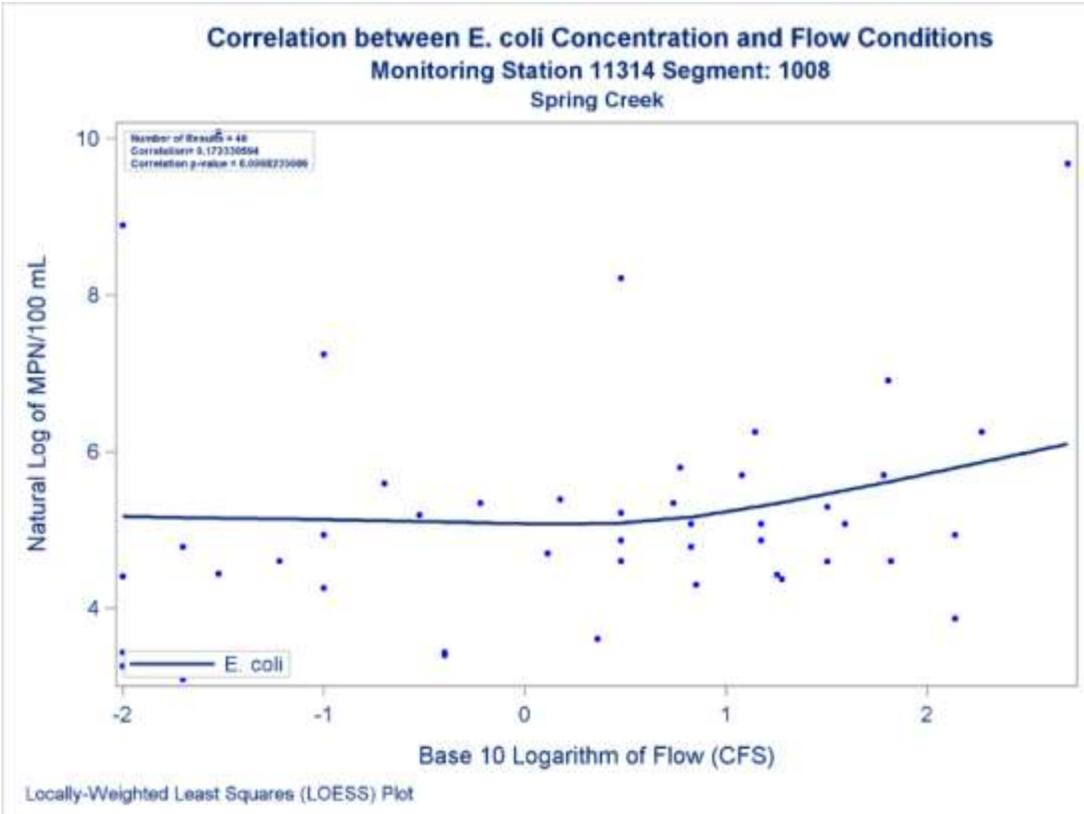

Correlation between Total Phosphorus Concentration and Flow Conditions
Monitoring Station 11250 Segment: 1004
West Fork San Jacinto River
Natural Log of Concentration (mg/L)
1.0
0.8
0.6
0.4
0.2
0.0
-1
0
1
2
3
Total Phosphorus
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot


Correlation between E. coli Concentration and Flow Conditions
Monitoring Station 11251 Segment: 1004
West Fork San Jacinto River
Natural Log of MPN/100 mL
Base 10 Logarithm of Flow (CFS)
E. coli
Locally-Weighted Least Squares (LOESS) Plot

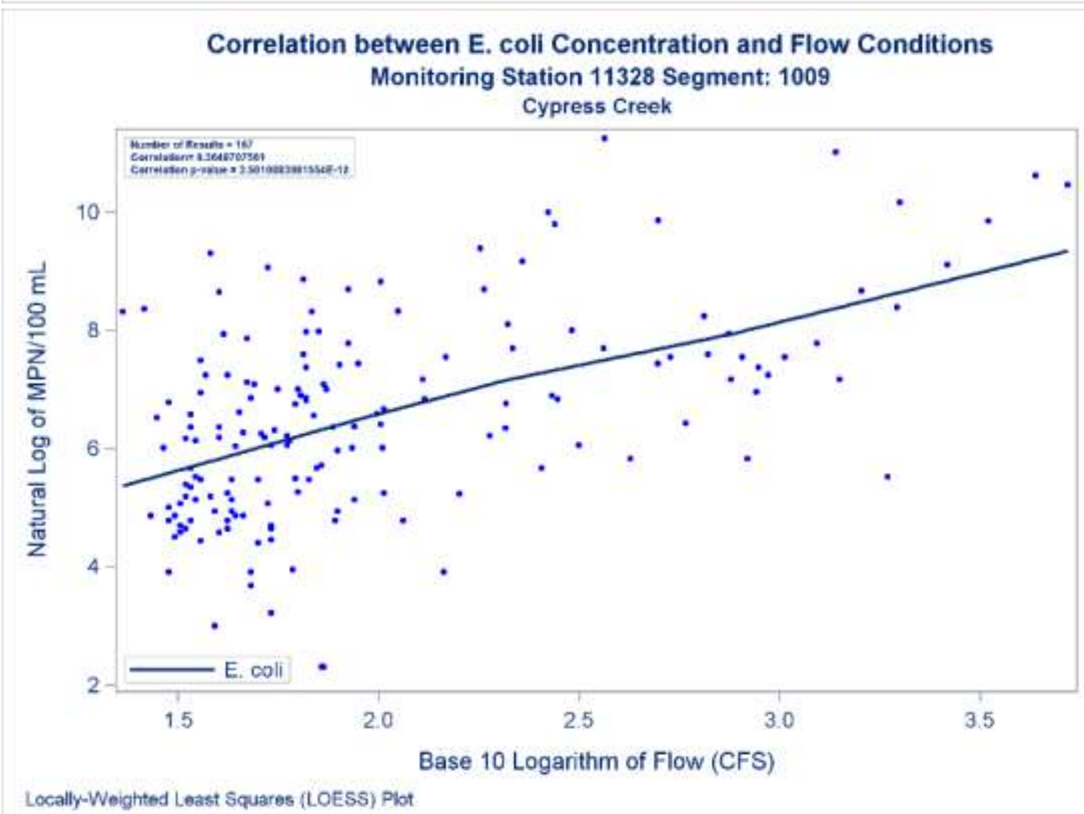

Correlation between Total Phosphorus Concentration and Flow Conditions
Monitoring Station 11251 Segment: 1004
West Fork San Jacinto River
Natural Log of Concentration (mg/L)
Base 10 Logarithm of Flow (CFS)
Total Phosphorus
Locally-Weighted Least Squares (LOESS) Plot


Correlation between Nitrate-N Concentration and Flow Conditions
Monitoring Station 11313 Segment: 1008
Spring Creek
Natural Log of Concentration (mg/L)
2.5
2.0
1.5
1.0
0.5
0.0
Nitrate-N
1.0
1.2
1.4
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot

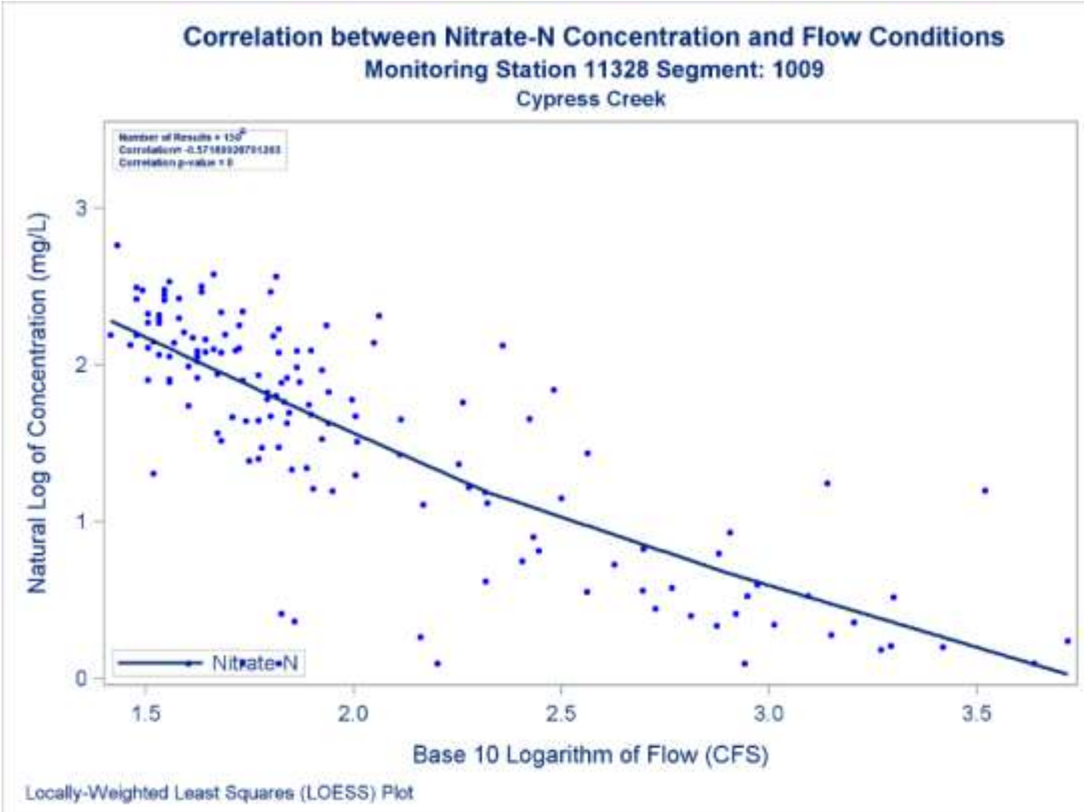

Correlation between Total Phosphorus Concentration and Flow Conditions
Monitoring Station 11313 Segment: 1008
Spring Creek
Natural Log of Concentration (mg/L)
1.25
1.00
0.75
0.50
0.25
Total Phosphorus
1.0
1.2
1.4
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot



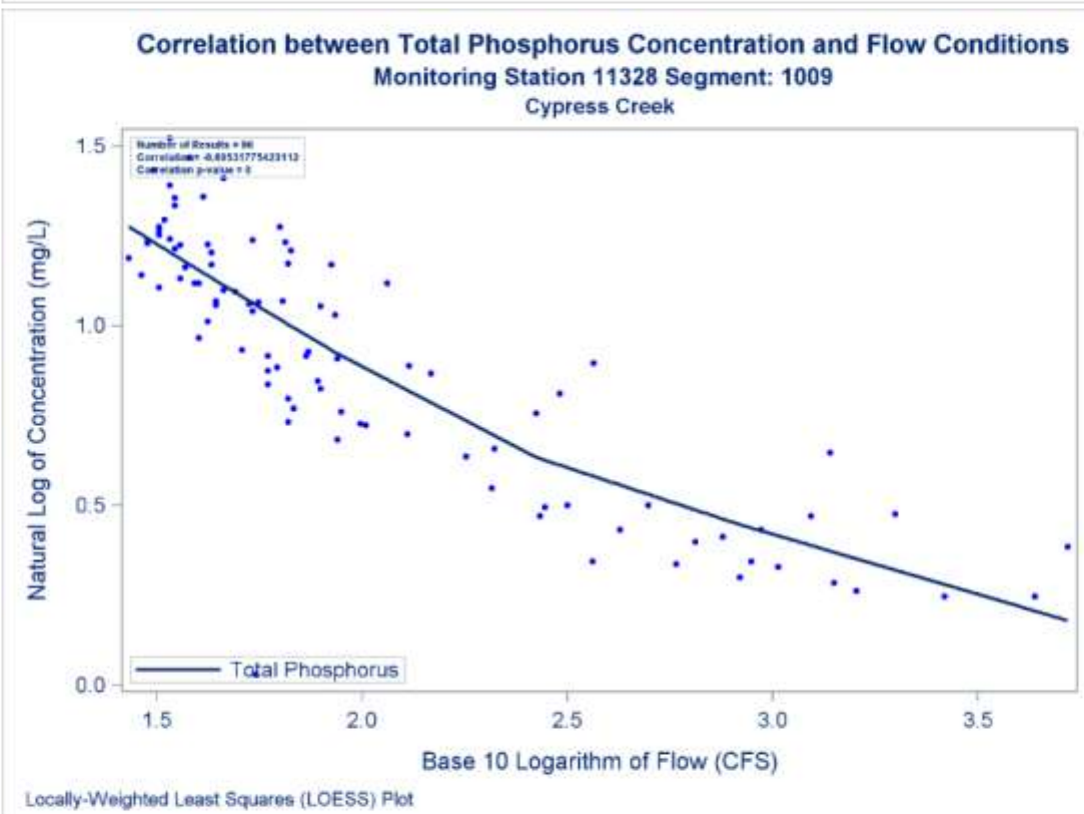
Correlation between E. coli Concentration and Flow Conditions
Monitoring Station 11314 Segment: 1008
Spring Creek
Natural Log of MPN/100 mL
10
8
6
4
E. coli
-2
-1
0
1
2
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot



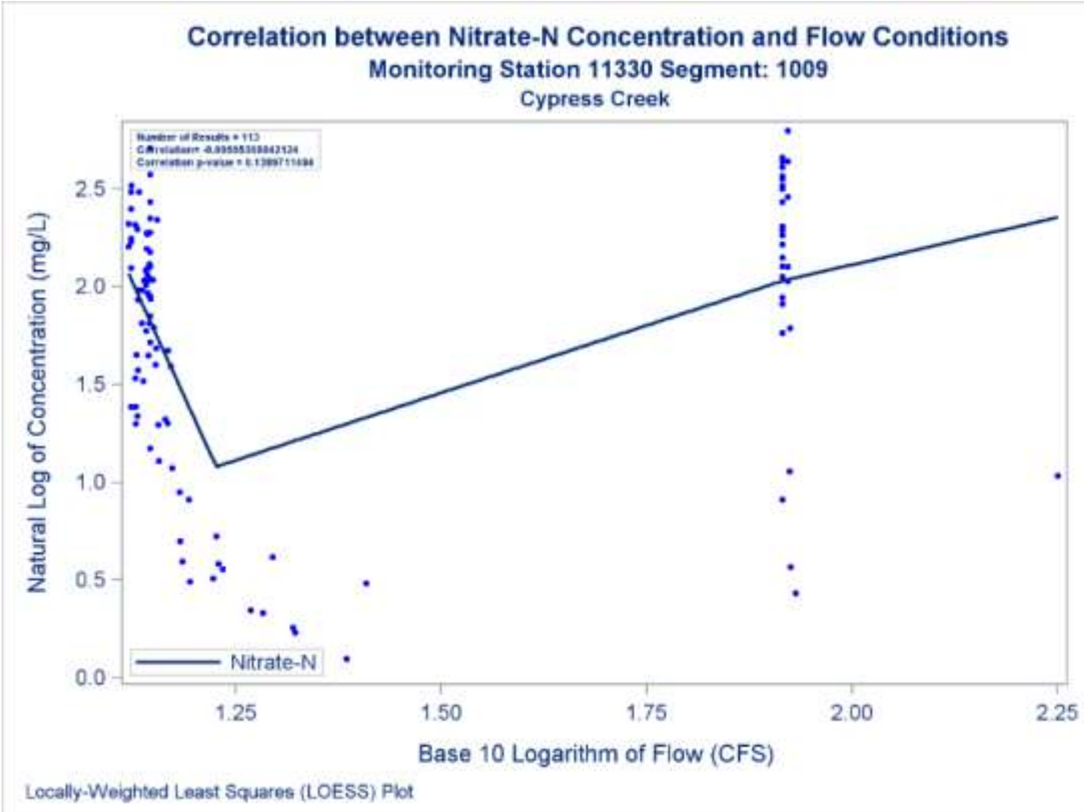
Correlation between E. coli Concentration and Flow Conditions
Monitoring Station 11328 Segment: 1009
Cypress Creek
Natural Log of MPN/100 mL
10
8
6
4
2
E. coli
1.5
2.0
2.5
3.0
3.5
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot

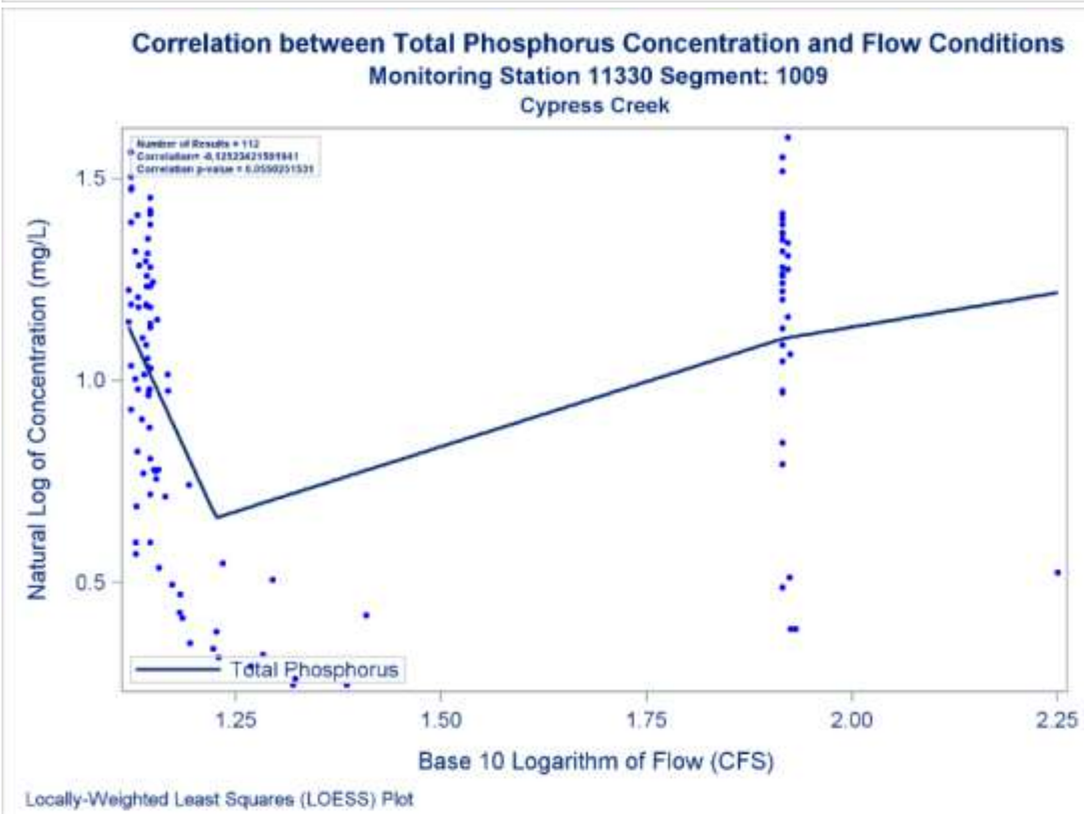


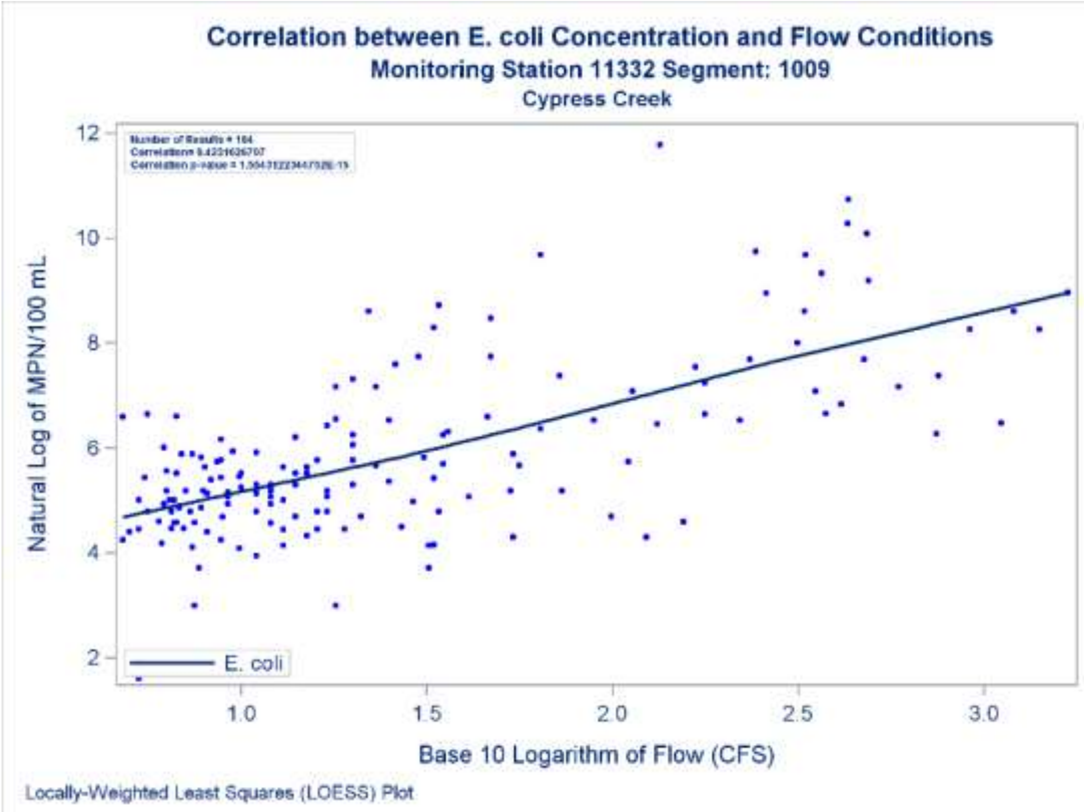
Correlation between Nitrate-N Concentration and Flow Conditions
Monitoring Station 11328 Segment: 1009
Cypress Creek
Natural Log of Concentration (mg/L)
Base 10 Logarithm of Flow (CFS)
Nitrate-N
Locally-Weighted Least Squares (LOESS) Plot

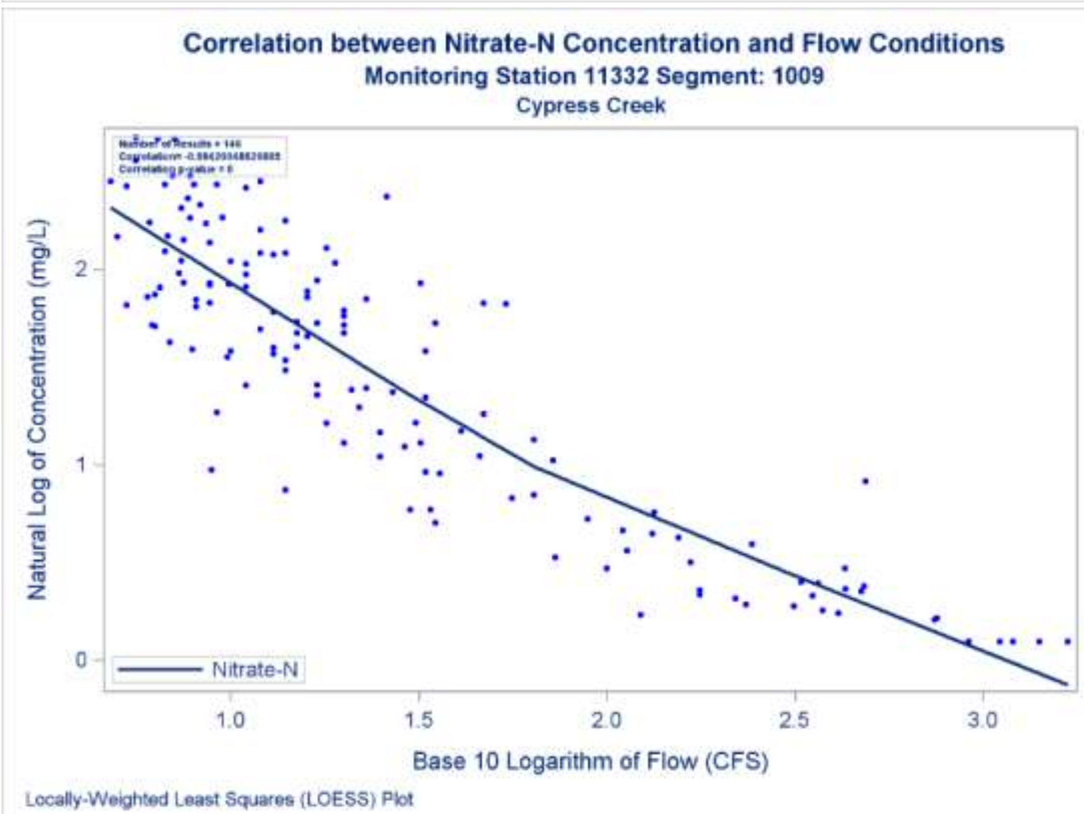


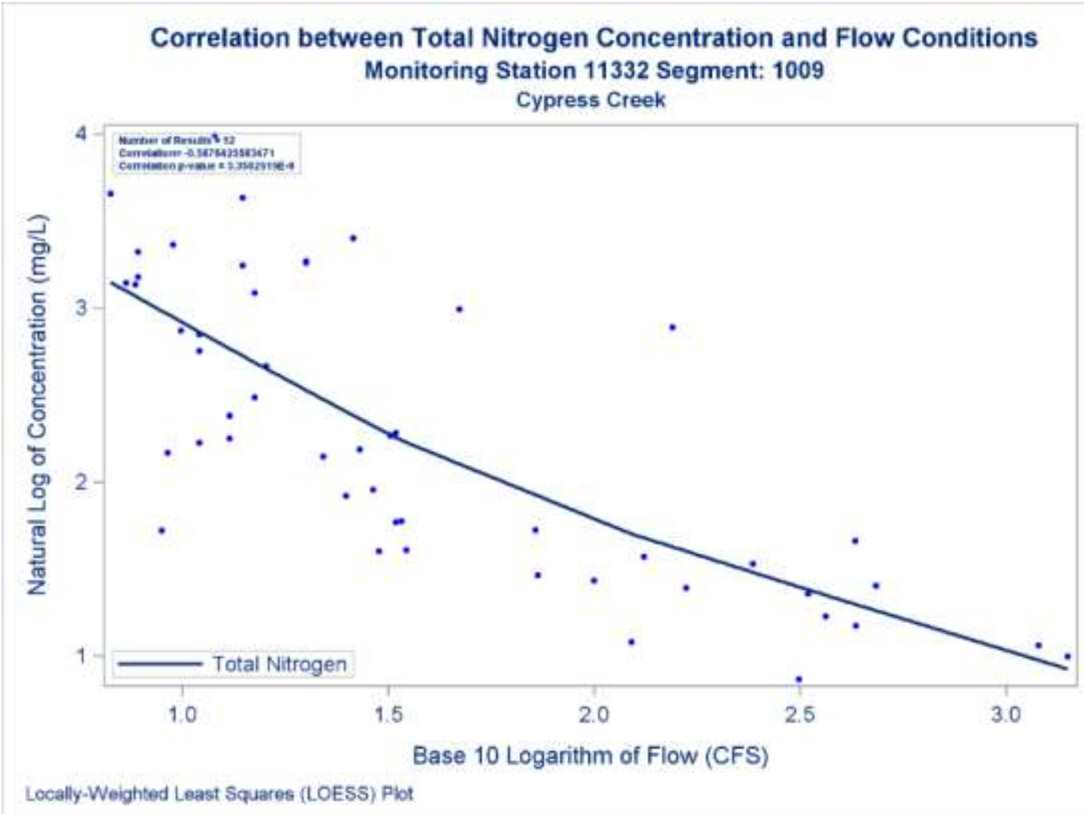
Correlation between Total Phosphorus Concentration and Flow Conditions
Monitoring Station 11328 Segment: 1009
Cypress Creek
Natural Log of Concentration (mg/L)
Base 10 Logarithm of Flow (CFS)
Total Phosphorus
Locally-Weighted Least Squares (LOESS) Plot

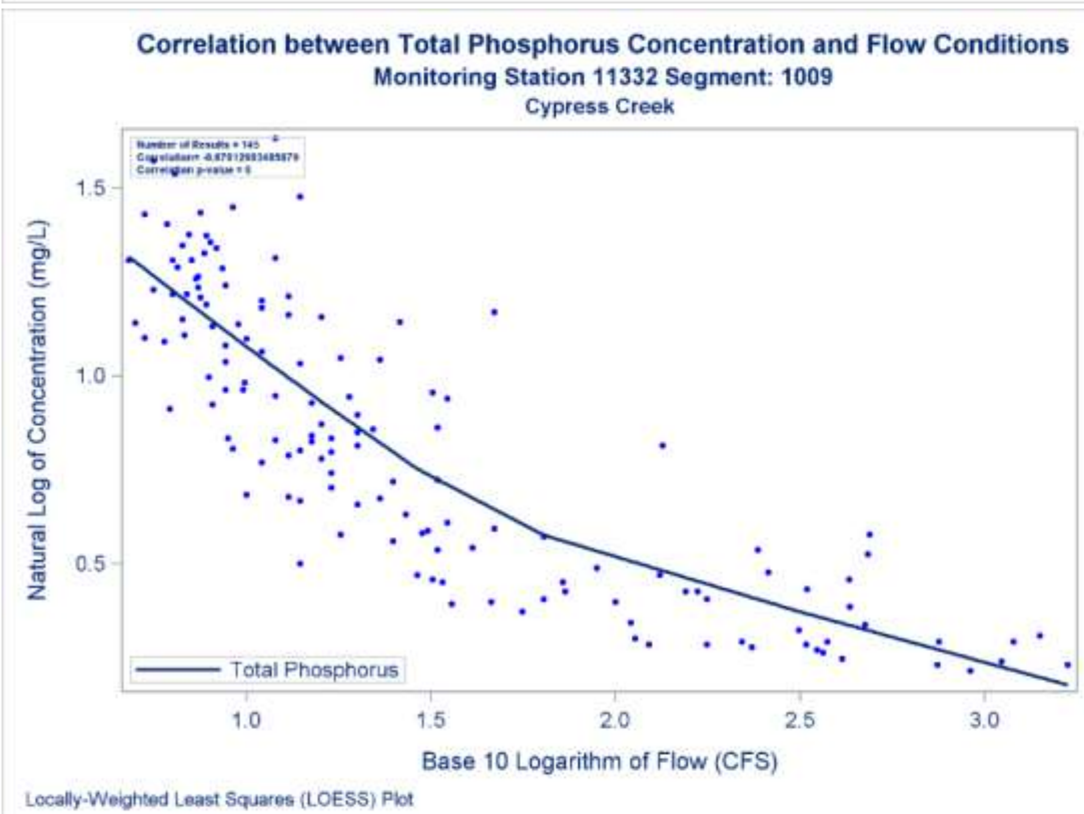

Correlation between Nitrate-N Concentration and Flow Conditions
Monitoring Station 11330 Segment: 1009
Cypress Creek
Number of Results = 113
Natural Log of Concentration (mg/L)
0.0
0.5
1.0
1.5
2.0
2.5
Nitrate-N
1.25
1.50
1.75
2.00
2.25
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot


Correlation between Total Phosphorus Concentration and Flow Conditions
Monitoring Station 11330 Segment: 1009
Cypress Creek
Number of Results = 112
Natural Log of Concentration (mg/L)
0.5
1.0
1.5
Total Phosphorus
1.25
1.50
1.75
2.00
2.25
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot


Correlation between E. coli Concentration and Flow Conditions
Monitoring Station 11332 Segment: 1009
Cypress Creek
Natural Log of MPN/100 mL
12
10
8
6
4
2
E. coli
1.0
1.5
2.0
2.5
3.0
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot


Correlation between Nitrate-N Concentration and Flow Conditions
Monitoring Station 11332 Segment: 1009
Cypress Creek
Natural Log of Concentration (mg/L)
2
1
0
Nitrate-N
1.0
1.5
2.0
2.5
3.0
Base 10 Logarithm of Flow (CFS)
Locally-Weighted Least Squares (LOESS) Plot


Correlation between Total Nitrogen Concentration and Flow Conditions
Monitoring Station 11332 Segment: 1009
Cypress Creek
Natural Log of Concentration (mg/L)
Base 10 Logarithm of Flow (CFS)
Total Nitrogen
Locally-Weighted Least Squares (LOESS) Plot


Correlation between Total Phosphorus Concentration and Flow Conditions
Monitoring Station 11332 Segment: 1009
Cypress Creek
Natural Log of Concentration (mg/L)
Base 10 Logarithm of Flow (CFS)
Total Phosphorus
Locally-Weighted Least Squares (LOESS) Plot