CVEN 6345

Water Quality Modeling/Monitoring

Part 3 (C & D)

Aalok Sharma Kafle

Station 10599 : Comprehensive Analysis

Station 10599 (Pine Is Bayou at LNVA Pump St) is located at 30.169987N and 94.154517W in River Section 0607 (Pine Island Bayou). The basin properties and river characteristics of this subbasin along with all other basins on the upstream are tabulated below, where L_{ca} is length along the channel to the centroid of the area.

Watershed Name	**Watershed Area** sq. miles	**Length** miles	**L_{ca}** miles	**Slope** %-Rise	**Slope** ft/mile
10599	12.74	3.9	3.8	1.74	91.87
10602 (C749)	312.29	17.2	19.4	1.11	58.61
10607	293.19	31.0	16.2	0.64	33.79
15367	89.13	21.0	10.7	0.90	47.52

National Land Cover Database (NLCD) is then used to get following properties:

Watershed Name	**% Developed**	**% Impervious**	**SCS Curve Number**
10599	23.29	7.95	84.2
10602 (C749)	9.16	2.15	86.2
10607	4.69	1.01	85.6
15367	0.52	0.32	89.3

Now, looking at all types of land cover for the subbasin 10599 (12.74 sq. miles), the distribution of various types of lands is tabulated below:

Land Type	**% Cover**
Open Water	2.29
Developed, Open Space	8.83
Developed, Low Intensity	8.24
Developed, Medium Intensity	4.45
Developed, High Intensity	1.78
Barren Land	0.09
Evergreen Forest	5.15

Land Type	**% Cover**
Mixed Forest	1.59
Shrub/Scrub	1.09
Herbaceous	1.40
Hay/Pasture	1.59
Cultivated Crops	0.10
Woody Wetlands	59.77
Emergent Herbaceous Wetlands	3.63

Evidently, the sub basin has a higher proportion of developed land at 23.29%, while most of the region are woody wetlands, at 59.77%. If we look at the landcover of other basins on the upstream (i.e., 10602, 10607, and 15367) on Appendix A, they also contain a significant portion of Forests and Hay/Pasture.

Now for the analysis of the water quality data for the station, we have non-continuous data of various parameters dated between 08/25/1987 to 03/02/2022. To find the abnormal data on the stream station, the following water quality parameters are used as defined on ***2022 Texas Integrated Report – Assessment for Basin 6 - Neches River***. In the report, station 10599 is identified as Assessment Unit 01 for River Segment 607 (AU_ID : 0607-01).

Table 1 Water Quality Criteria for AU_ID 0607_01

Parameter	**Criteria**
Dissolved oxygen Grab	5
Nitrate (Domestic Water Use)	10 mg/L
Total Dissolved Solid	300 mg/L
Sulfate	50 mg/L
Chloride	150 mg/L
High pH	8.5
Low pH	6
Total Phosphorous	0.69 mg/L
Nitrate (Aquatic Life Use)	1.95 mg/L
Chlorophyll-a	14.1
Ammonia	0.33 mg/L
Water Temperature	35 C
E. Coli (Recreation Use)	126 colonies/100ml

Some other quality parameters whose data were available were also accessed for abnormality based on the criteria set by various sources. The Criteria for Specific Metals and Organic Substances in Water for Protection of Aquatic Life developed by TCEQ, present for this station along with some other parameters are tabulated below.

Parameter	Maximum Allowable Concentration
Total Kjeldahl Nitrogen	0.33 mg/L (TCEQ)
Nitrate plus Nitrite	1.95 mg/L (TCEQ)
Phosphorous (Orthophosphate)	0.1 mg/L as P (Mackenthun 1973)
Alkalinity, Low	20 mg/L
Alkalinity, High	400 mg/L
Aluminum (1988 Recommendation)	750 μg/L
Aluminum (2018 Revision)	1 – 4800 μg/L (EPA)
Hardness (moderately hard)	75 mg/L
Arsenic (human use)	10 μg/L
Arsenic (aquatic use)	70 μg/L (TCEQ)
Barium	1000 μg/L
Cadmium, acute	1.8 μg/L (EPA 2023)
Chromium, acute	16 μg/L (EPA 2023)
Mercury, acute	1.4 μg/L (EPA 2023)
Nickel	470 μg/L (EPA 2023)
Iron, domestic use	0.3 mg/L (USEPA 1976)
Iron, freshwater aquatic life	1.0 mg/L(USEPA 1976)
Manganese, fish consumption	100 μg/L (USEPA 1976)
Lead, acute freshwater	65 μg/L (EPA 2023)
Selenium	8.5 μg/L (USEPA 1976, Beaman 2016)
Silver	3.2 μg/L (Stephan, Mount et al. 1985)

Total Kjeldahl Nitrogen

It can be present in water from various sources such as organic matter, debris, sewage, fertilizers, animal waste, and agricultural runoff. (Chavez 2022) The allowable limit for this parameter is 0.33 mg/L.

Alkalinity

The Chemical Concentration Criterion(CCC) for alkalinity is 20 mg/L, the minimum amount for it to be considered as healthy water. Even concentrations as high as 400 mg/L are not considered to pose a danger to human or environmental health (Anderson, Nagar et al. 2007).

Aluminum

EPA recommends that it is advised to ensure that the one-hour average concentration of aluminum does not surpass 750 μg/L more than once every three years on average, when the ambient pH lies between 6.5 and 9.0. This is recommended to prevent acute toxicity and ensure protection. (Gostomski 1990) However, 2018 revision by EPA has provided this criterion to be between 1 and 4800 μg/L based on the water chemistry of the site. For our station, nationally recommended criteria of 750 μg/L is considers.

Hardness

In general, hardness is not considered toxic to aquatic life, but extremely high levels of hardness can have negative impacts on aquatic organisms. The level of toxicity can vary depending on the specific species and environmental conditions. Classification of water by hardness content classifies water above 75 mg/L as hard water, so it is considered as criteria for our location. Natural source of hardness principally are limestones which are dissolved by percolating rainwater which again shows up as surface water downstream. (USEPA 1976)

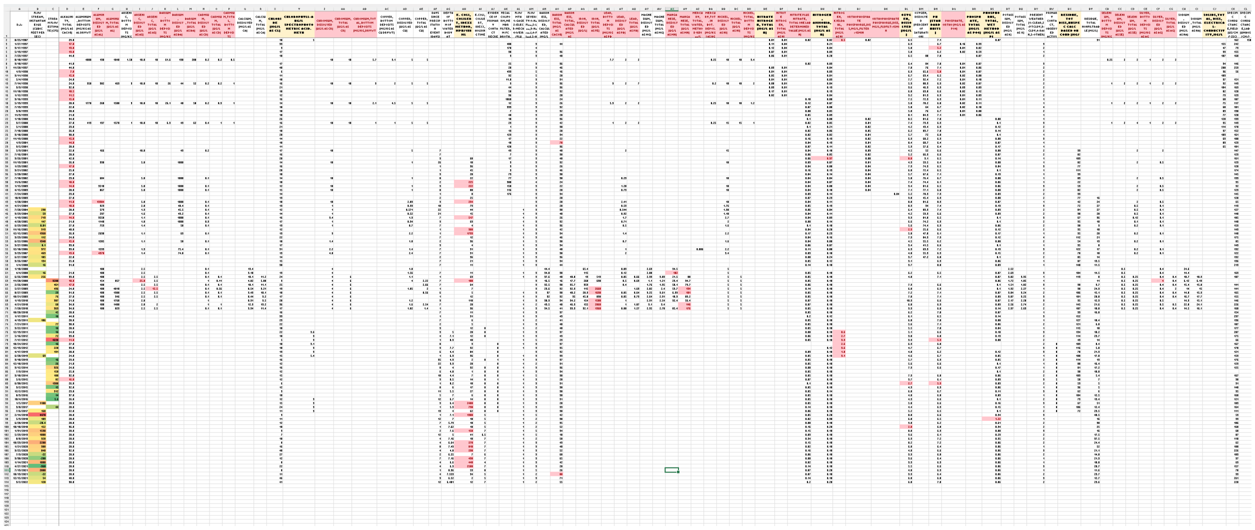
Arsenic

Concentration 5 μg/L representing nominal background concentration and 10 μg/L representing the EPA Maximum Contaminant Level for human. (Robert C. Reedy 2018) For aquatic use, 70 μg/L is recommended for section 0607.

Barium

EPA has recommended MCL for Barium to be 1000 μg/L, originally published on the 1976 Red Book of water quality (USEPA 1976).

Based on these criteria, the data from station 10599 was analyzed, and the **excel sheet is attached** with this report.



The number of exceedances for various parameters are listed below:

Parameter	Number of exceedances
NITROGEN, AMMONIA, TOTAL (MG/L AS N)	1
OXYGEN, DISSOLVED (MG/L)	4
PH (STANDARD UNITS)	4
PHOSPHATE, TOTAL (MG/L AS PO4)	1
E. COLI, COLILERT, IDEXX METHOD, MPN/100ML	17

Evidently, E. Coli is of major importance here while trying to understand the water quality data of this subbasin. E. Coli as a non- point source can be occurring from various sources.

1. **Agricultural runoff:** Contaminated water from livestock and poultry operations, as well as manure and fertilizer applications, can lead to E. coli contamination in nearby water bodies.

2. **Wildlife and domestic animals:** Wild animals and domestic pets can carry and shed E. coli bacteria into the environment, where it can contaminate water and soil.
3. **Faulty septic systems:** Septic systems that are not functioning properly or are poorly maintained can release E. coli bacteria into the environment, contaminating nearby water sources.
4. **Stormwater runoff:** Heavy rain events can wash E. coli bacteria from surfaces such as streets, parking lots, and rooftops into storm drains and nearby waterways.
5. **Human waste:** Improperly treated sewage can discharge E. coli bacteria into water bodies, posing a risk to public health.

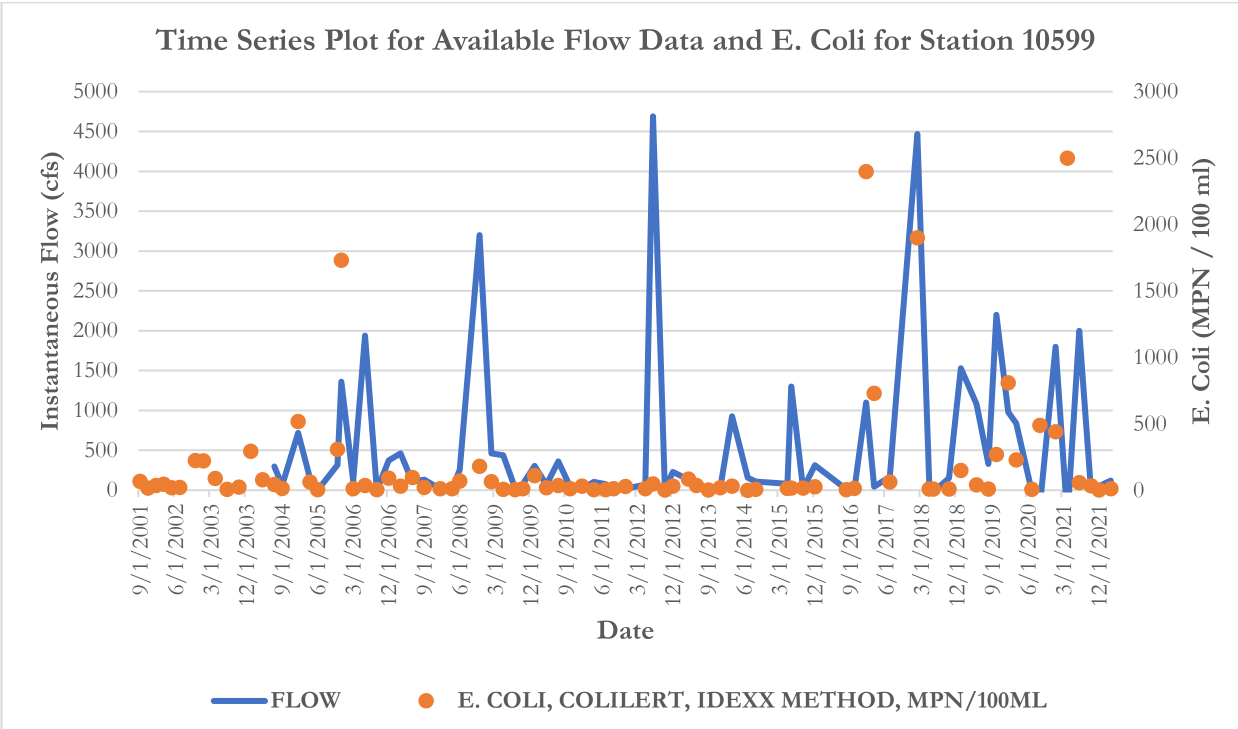
Now, looking at various sources of E. Coli and cross checking them with the land cover of this region, the exceedances may have been caused by the developed lands on the region producing human wastes, faulty waste disposal system with leakages and corresponding stormwater runoffs.

To analyze the relation between the quality parameter and flow, first flow data is necessary for each measurement of E. Coli. Two types of flow data are available in the quality data.

- Flow Stream, Instantaneous (cubic feet per sec)
- Stream flow Estimate (cfs)

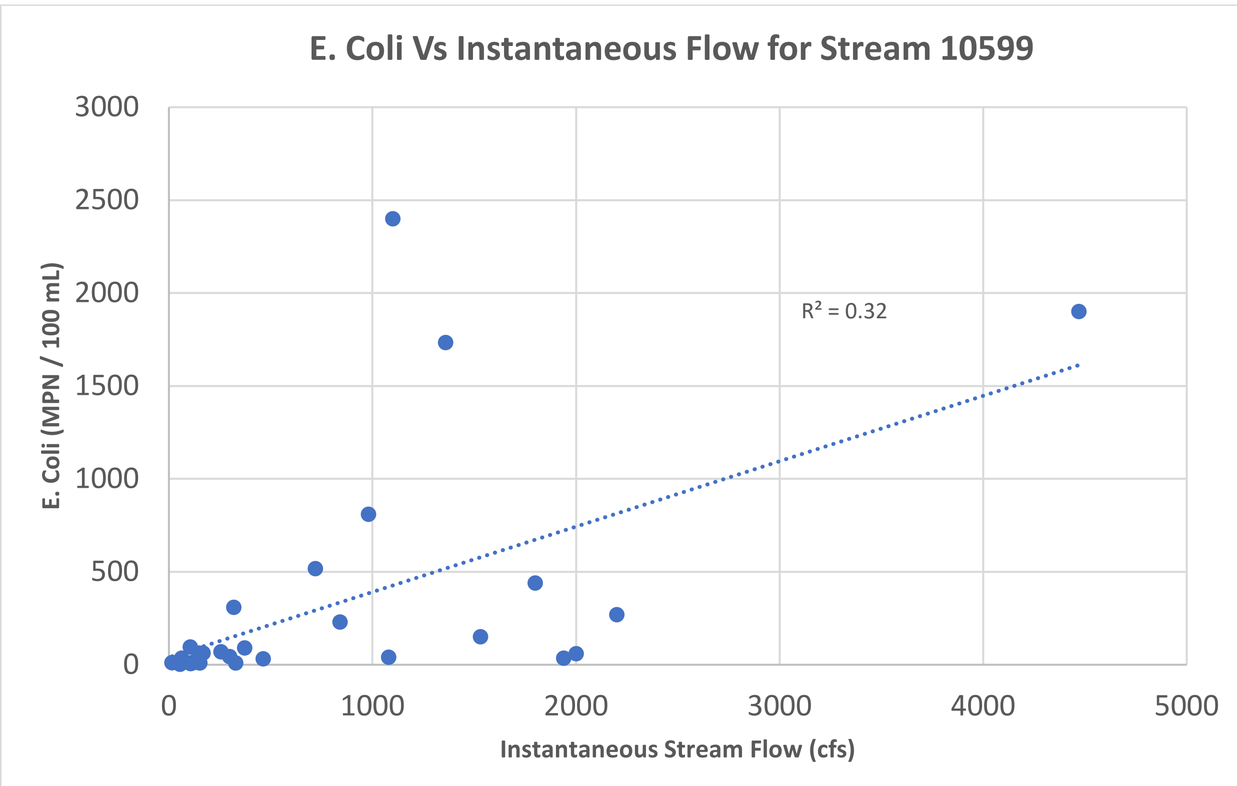
For the data points were instantaneous flow data is not available, it is filled with the stream flow estimate values and a table is prepared with Available Stream Flow Data and E. Coli Measurement for that day.

Now, plotting the available flow data and E. Coli on a time series plot gives following result:

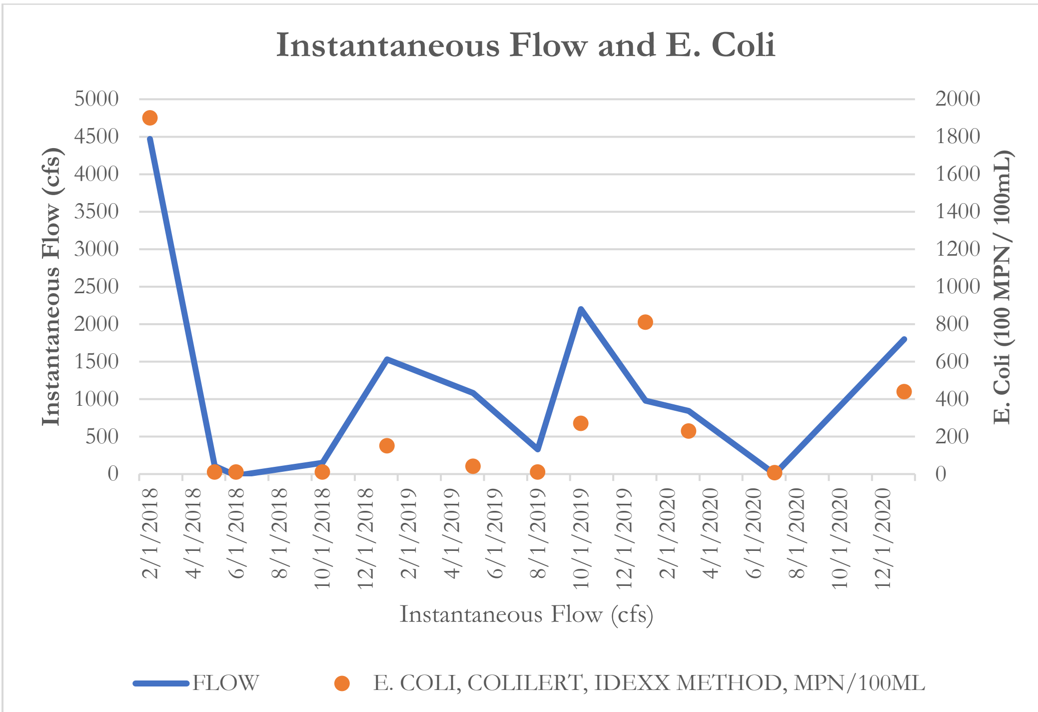


Although rise in flow does not always seem to exactly increase the concentration of E. Coli, we see some distinct time period where flow increase is resulting in higher levels of E. Coli. This can be because of the runoff from the developed region bringing in E. Coli through places like faulty septic tanks, or other pollutions spread across the watershed. The **Pearson Correlation** of **Available Flow(>0) and E. Coli(>0)** is calculated to be **0.4186.**

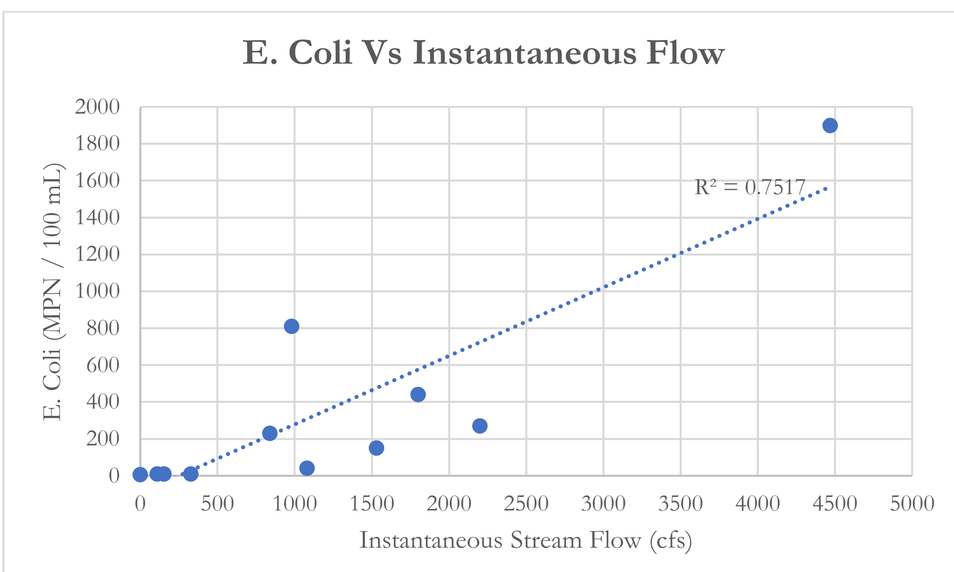
Next, if the data points which only have instantaneous flow are analyzed separately, the X-Y plot of Flow and E. Coli concentration is observed as below. The **Pearson Correlation** of **Instantaneous Flow(>0) and E. Coli(>0)** is calculated to be **0.5657**. It is because the instantaneous flow is measured at the same time and location as the E. Coli measurement, so it shows more correlation when compared to the flow estimate.



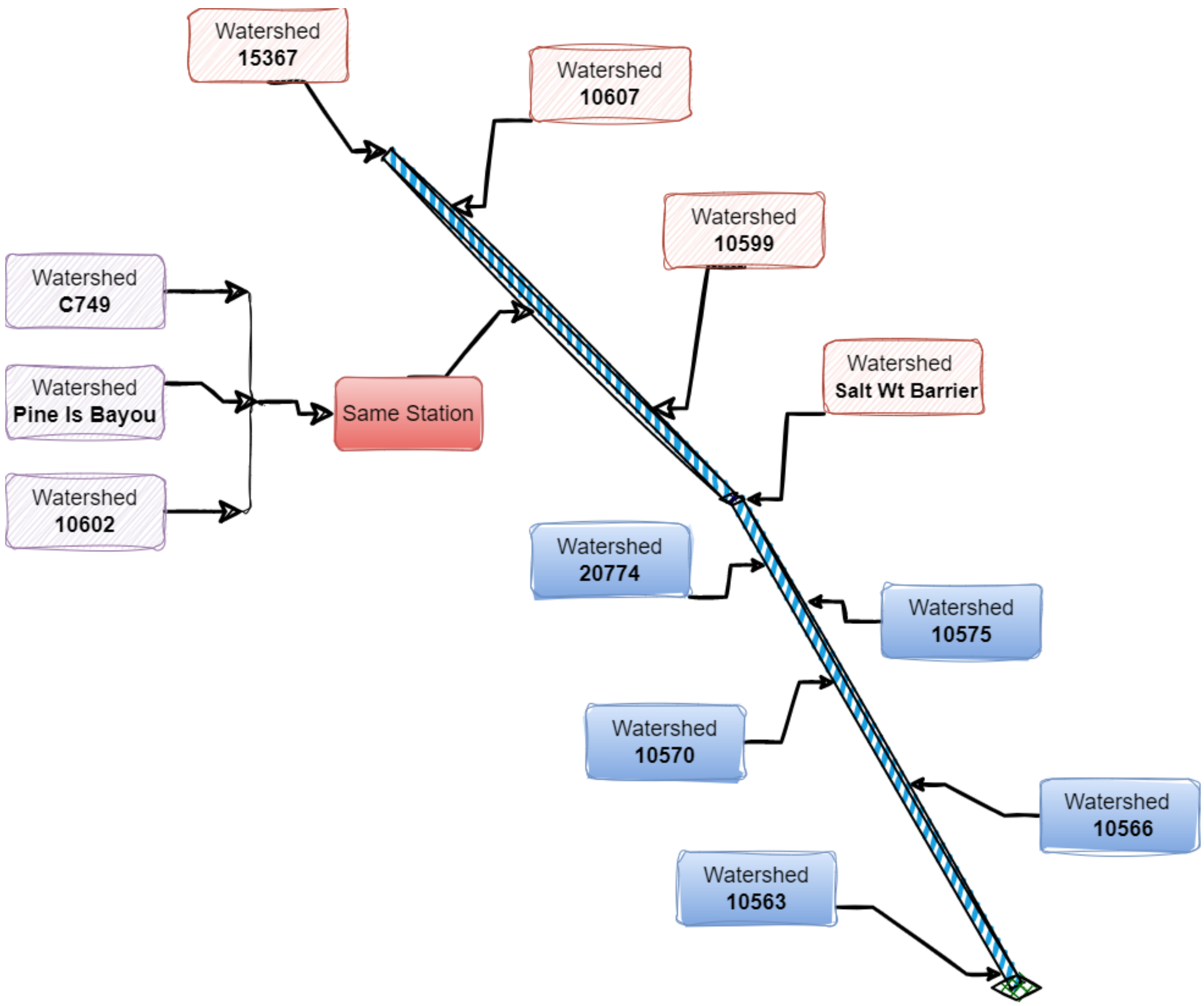
Now focusing on specific time-period of 02/14/2018 and 01/14/2021, this part of the data can be extracted separately (for non-negative flows) and plotted on a time series graph.



For **this time-period of data**, the **Pearson Correlation** rises to **86.7%.**



Now, let's look at other stations for sections 601 and 607. First, the order of subbasin is as presented in the figure below:



For the analysis of other subbasin, similar method is employed to find the correlation between flow and pollutant of interest. From the above analysis, it is clear that flow VS Pollutant timeseries overlay plot is a strong tool to identify the correlation between the parameters even without finding the actual correlation value, so similar techniques will be applied for other station.

Station 15367

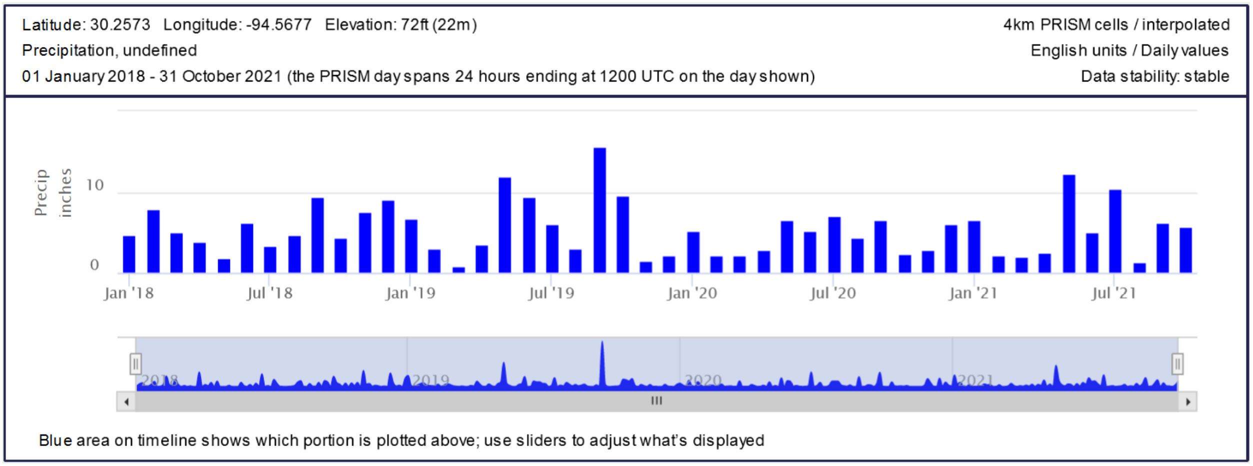
This station collects water from approximately 90 square miles of watershed, 55% of which is covered with forest and 28% is covered with woody wetlands. Following the above-mentioned standards, E. Coli is the major concern for the region over the years with 37 instances of exceedance.

Flow data, however, is very sparsely available for the region with lots of zero flow condition, with high pollutant concentration. This can either be an erroneous data entered or measurement of data on stagnant water which might still be the indication of watershed condition following earlier rainfall. The years 2018 to 2021 do show consistent exceedance of E. Coli levels, but due to lack o proper flow data we cannot verify the source of pollution (point or non-point) by seeing its relationship with the flow of the moment.

With the lack of flow data, I went and looked at the PRISM precipitation data for a point in the watershed to quickly see of there were any relatively big rainfall events before the preceding the E. Coli exceedance measurement date. I am especially looking at the following exceedances.

Date	E. Coli
02/15/2018	410
05/23/2019	24000
12/31/2019	3300
09/29/2020	620
12/16/2020	2400
10/13/2021	230
01/12/2022	290
04/05/2022	130

Although the PRISM Precipitation Data is not accurately showing rain across the watershed, it can be used as an indicator of nig rainfall events, considering that it occurred through the region including the selected coordinate in following graph.



There does exist a relatively higher rainfall event before every E. Coli exceedance, so I consider it as a non-point source for the region.

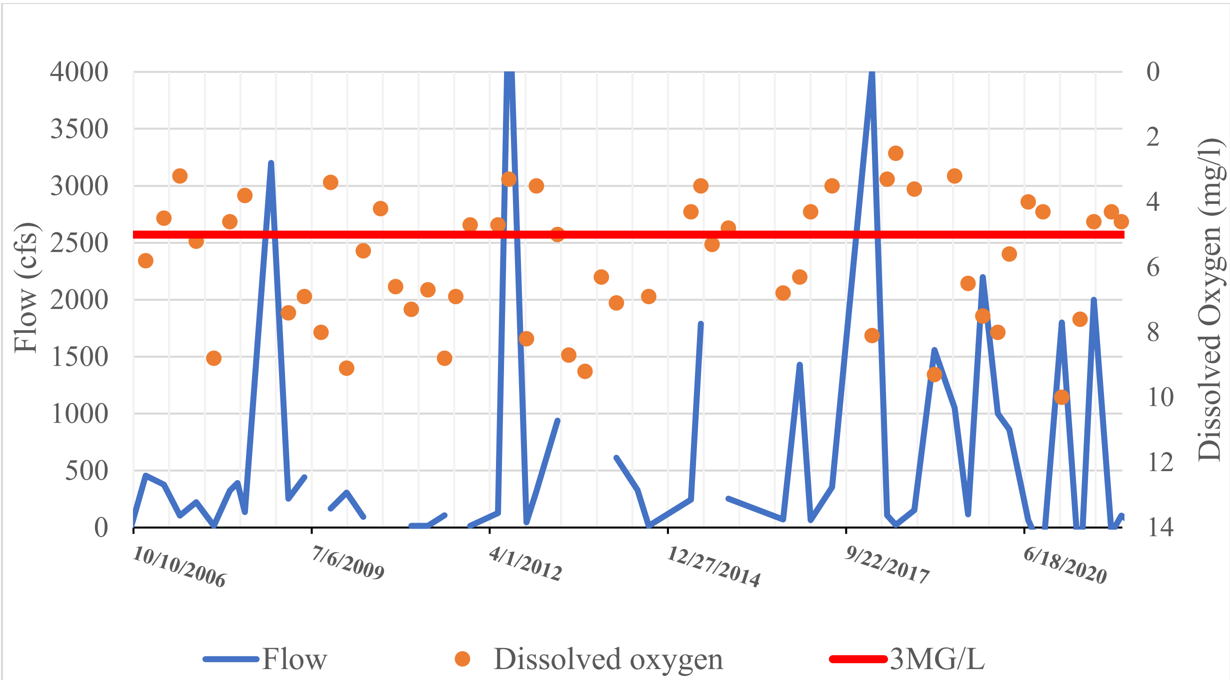
Station 10602

Following the exceedance condition provided by ***2022 Texas Integrated Report – Assessment for Basin 6 - Neches River,*** all available parameters were analyzed for abnormality, the major number of exceedances being seen on Dissolved Oxygen and E. Coli concentration.

Parameter	**Number of exceedances**
Dissolved Oxygen	129
E. Coli	28

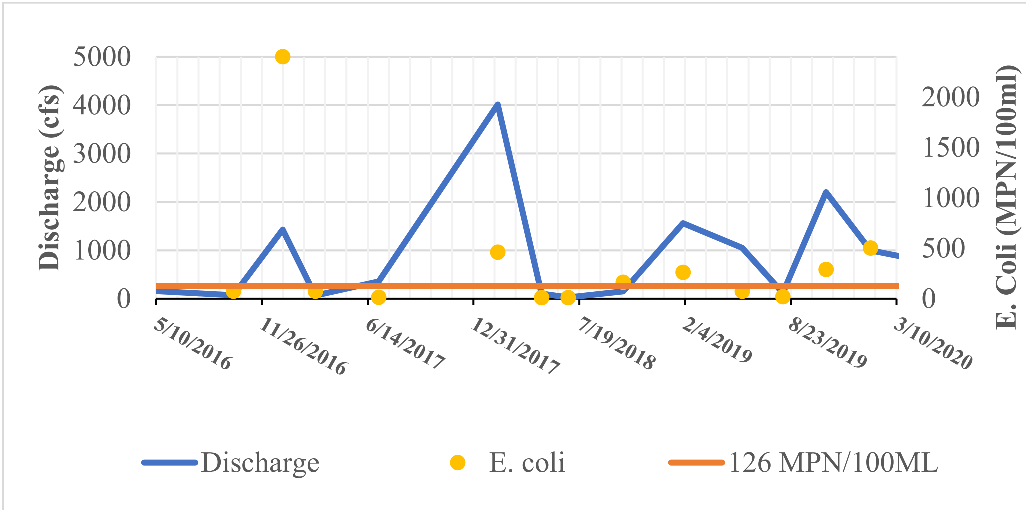
Dissolved oxygen shows the most exceedances in this station in abnormal range (i.e., less than 3mg/L). The following graph represents its relationship with flow.

Plot of Dissolved Oxygen with Flow

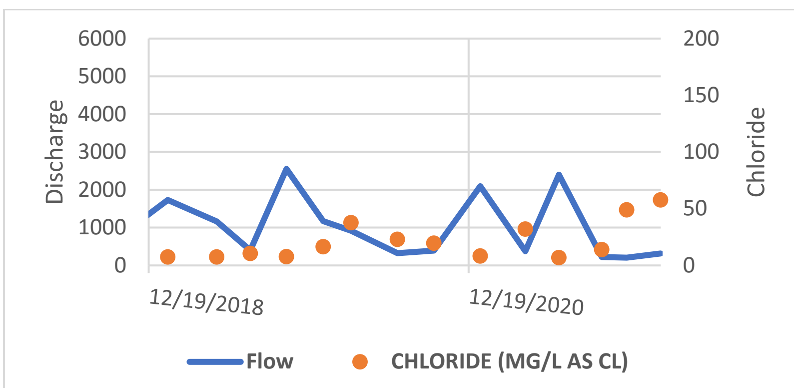


Here, I have inverted the axis for **dissolved oxygen** so that values above the red line show abnormal condition. Looking at its correlation with flow, the time period between **October 2016 and October 2018** shows an indication of **non-point source** as high flow is yielding lower value of dissolved oxygen. For the same time period, E. Coli can also be plotted with flow as seen in the following figure. This also showed increased concentration of E. Coli for high flow condition, again giving us more indication of non-point source pollution during this time period.

Plot of E. Coli with Flow



Plot of Chloride with Flow



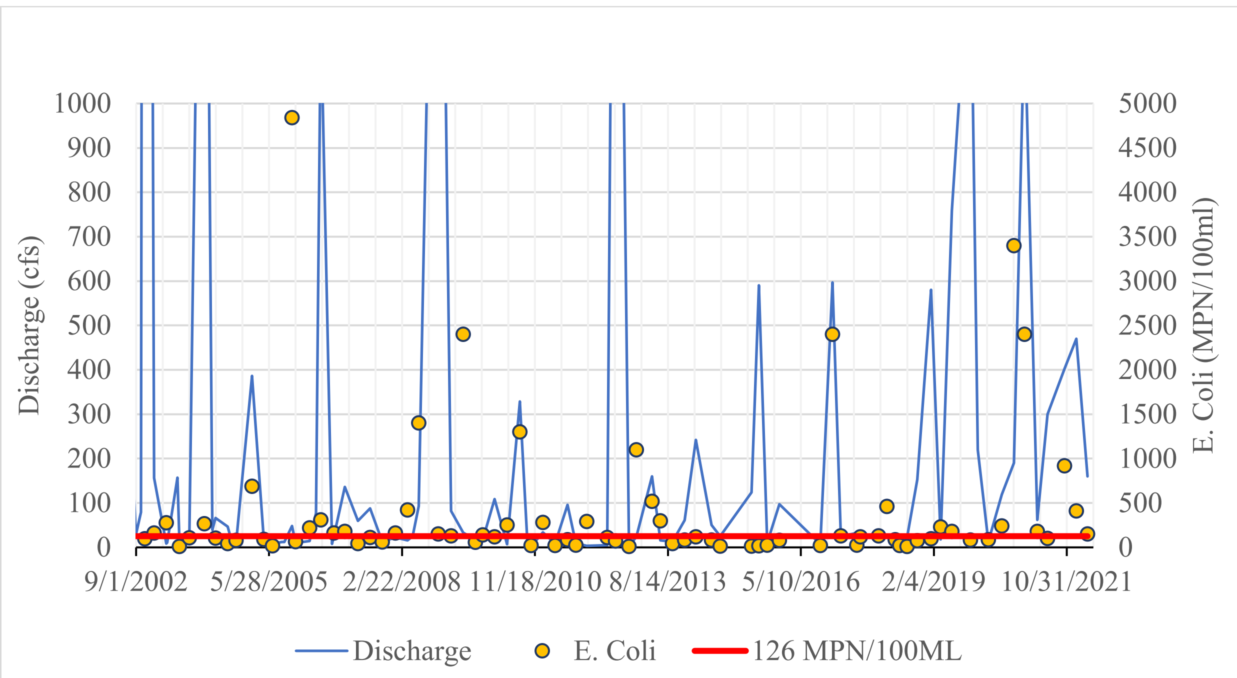
Here, we can see more time periods showing indication of non-point source:

- Dissolved Oxygen - July 2010 to June 2012.
- E. Coli in 2012 / 2013.
- E. Coli 2019 – 2021
- Chloride 2019 – 2020

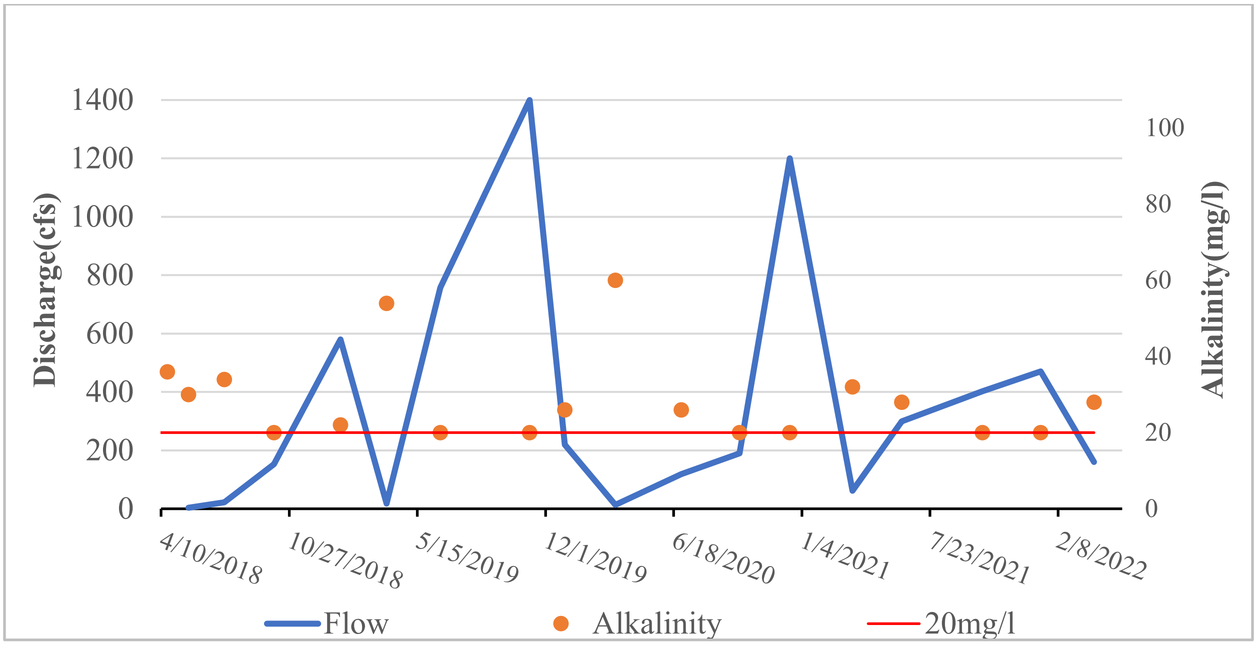
Station 10607

E. Coli is very visibly related with flow as seen in the following plot with higher values of E. Coli on most of the high flow events. The y-axis limit is set to 0 to 1000,to properly visualize these trends. **E. Coli as a non-point source** can be observed in the following time periods.

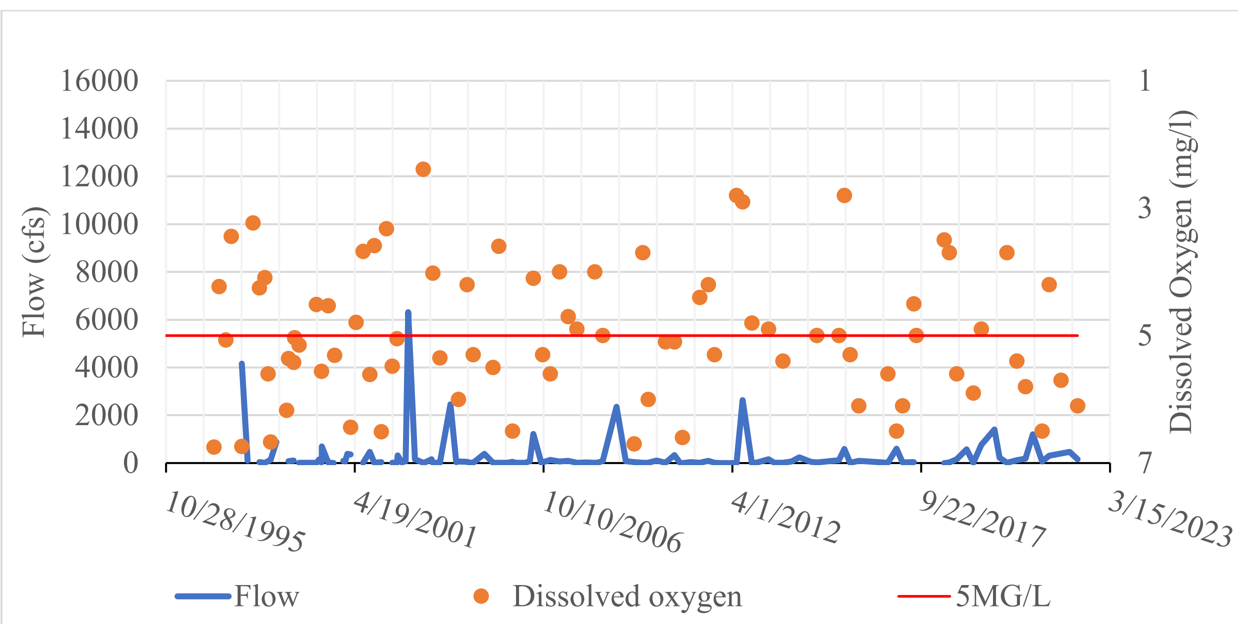
- 2007 – 2010
- 2004 – 2006
- 2016 – 2018
- 2020 – 2021



For this station, the following shows plot of Alkalinity with flow.



Although, we don't see high flow exactly at higher alkalinity concentration. But we see a distinct lag of higher alkalinity concentration and higher flow condition. Here, we see **2018 Spring and Jan-July 2021** as non-point source for **alkalinity**.



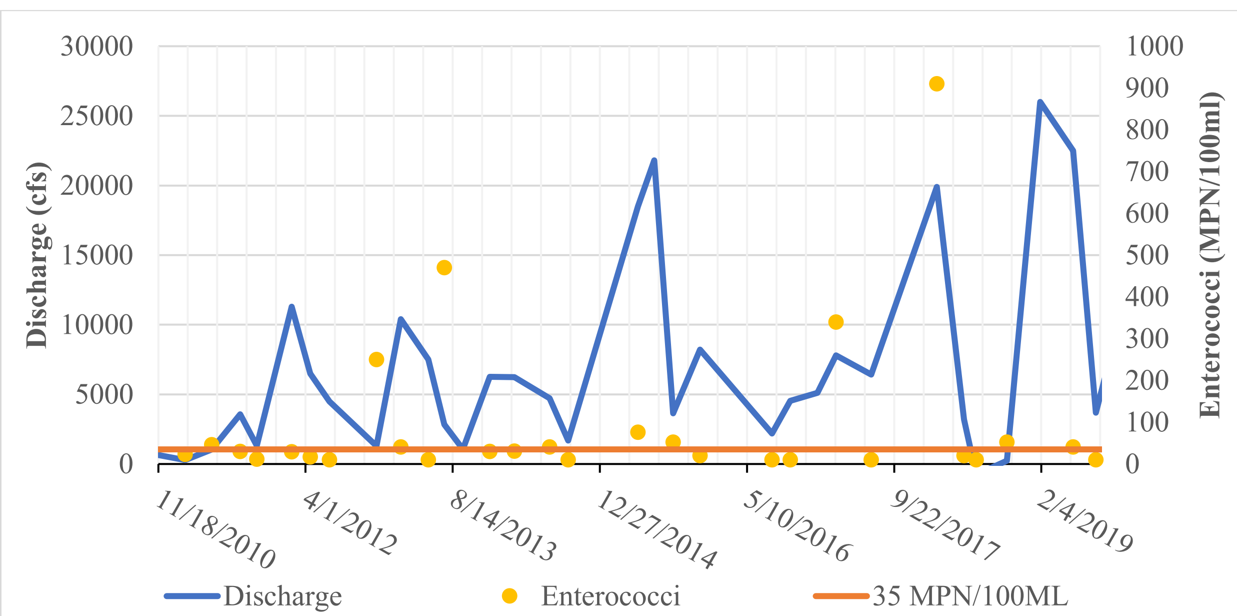
Looking at the relation of dissolved oxygen with flow, following time period shows higher flow condition correlating with lower concentration of **dissolved oxygen**:

- 2000 – 2002
- 2011 – 2012
- 2016 – 2018
- 2019 – 2021

Station 20774

This station shows a consistent abnormality in pre-2013 for most of the measured parameters (Chloride, hardness, Alkalinity, TDS, Specific Conductivity and Sulphate). The period of Nov-2010 to March 2012 can be attributed as a non-point source for all these parameters as their abnormal measurement corresponds to high flow condition and vice-versa.

Besides pre-2014, there is also a strong indication of non-point source for **E. Coli** for this region between **2012 August – 2013 December** and **2017 March – 2018 October**.



Station 10575

Looking at the **plots in Appendix C** labeled for Station 10575 (labeled in plot title), following time periods can be identified for non-point source across the parameters:

Enterococci

- June 2009 – April 2012
- March 2004 – October 2006
- July 2012 – May 2015

Dissolved Oxygen

- June 2009 – April 2012
- March 2004 – October 2006
- December 2016 – October 2017
- June 2020 – March 2021

Specific Conductivity

- June 2009 – April 2012
- March 2004 – October 2006

Individual Pollutant and respective flow overlay **Plots** for station 10575 are presented in **Appendix-C**.

Station 10570

Fluoride, Chloride, Enterococci in **April 2011 – January 2012** shows an indication of **point source** as it is occurring even during low flow condition. This period also aligns with the drought period for this region, so higher pollutant concentration at any time during this period is an indication of present of point source of pollutant. This can be from any of the industries in the watershed or diminished level of flow with low dilution power for the regular pollutant from municipal districts in any of the above watersheds. Pollutant and Flow overlay **Plots** for the station are presented in **Appendix C**.

For the same parameters (**Fluoride, Chloride, Enterococci)**, we see a strong indication of **non-point source** during **April 2012 – December 2014** and **March 2016 – October 2018**.

Station 10566

Results are very similar to the upstream station 10570, probably due to similar reasons. **Enterococci** in **April 2011 – January 2012** shows an indication of **point source** as it is occurring even during low flow condition.

For **Enterococci, TDS, and Specific Conductivity** we see a strong indication of non-point source during **April 2012 – December 2014** and **March 2016 – October 2018**. Additionally, **Specific Conductivity** also has a strong correlation with flow during **October 2020 – October 2021** period. Pollutant and Flow overlay Plots for the station are presented in Appendix C.

Station 10563

For this station , similar to the above two stations, strong indication of point source of **E. Coli and Chloride** abnormality from **point** source during **April 2011 – January 2012**.

Regarding non-point source pollutants, E. Coli is correlating to high flow condition in following three time periods:

- Jan 2007 – July 2010
- April 2012 – December 2014
- Jan 2017 – July 2017

Pollutant and Flow overlay **Plots** for the station are presented in **Appendix C**.

References

Anderson, A., et al. (2007). "Spatial and temporal trends in surface water quality in a segment of the San Antonio River, Texas." Developments in Environmental Science **5**: 591-608.

Beaman, J. (2016). "Aquatic Life Ambient Water Quality Criterion for Selenium in Freshwater 2016—Fact Sheet." United States Environmental Protection Agency.

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Stephan, C. E., et al. (1985). Guidelines for deriving numerical national water quality criteria for the protection of aquatic organisms and their uses, US Environmental Protection Agency Washington, DC.

USEPA (1976). Quality criteria for water. EPA 440/9-76-023, DC Washington.

Appendix A

Landcover by percentage and SCS Curve Number

15367					
Land type Code	**COUNT**	**NLCD Land Type**	**% Cover**	**CN**	**Weighted CN**
11	68	Open Water	0.03	100	0.03
21	6942	Developed, Open Space	2.70	79	2.13
22	1120	Developed, Low Intensity	0.44	82	0.36
23	203	Developed, Medium Intensity	0.08	86	0.07
24	12	Developed, High Intensity	0.00	93	0.00
31	17	Barren Land	0.01	88	0.01
41	821	Deciduous Forest	0.32	79	0.25
42	98815	Evergreen Forest	38.44	85	32.68
43	39552	Mixed Forest	15.39	82	12.62
52	9442	Shrub/Scrub	3.67	83	3.05
71	17349	Herbaceous	6.75	80	5.40
81	6981	Hay/Pasture	2.72	78	2.12
90	71129	Woody Wetlands	27.67	86	23.80
95	4581	Emergent Herbaceous Wetlands	1.78	83	1.48
TOTAL	*257032*		*100*		**83.99**

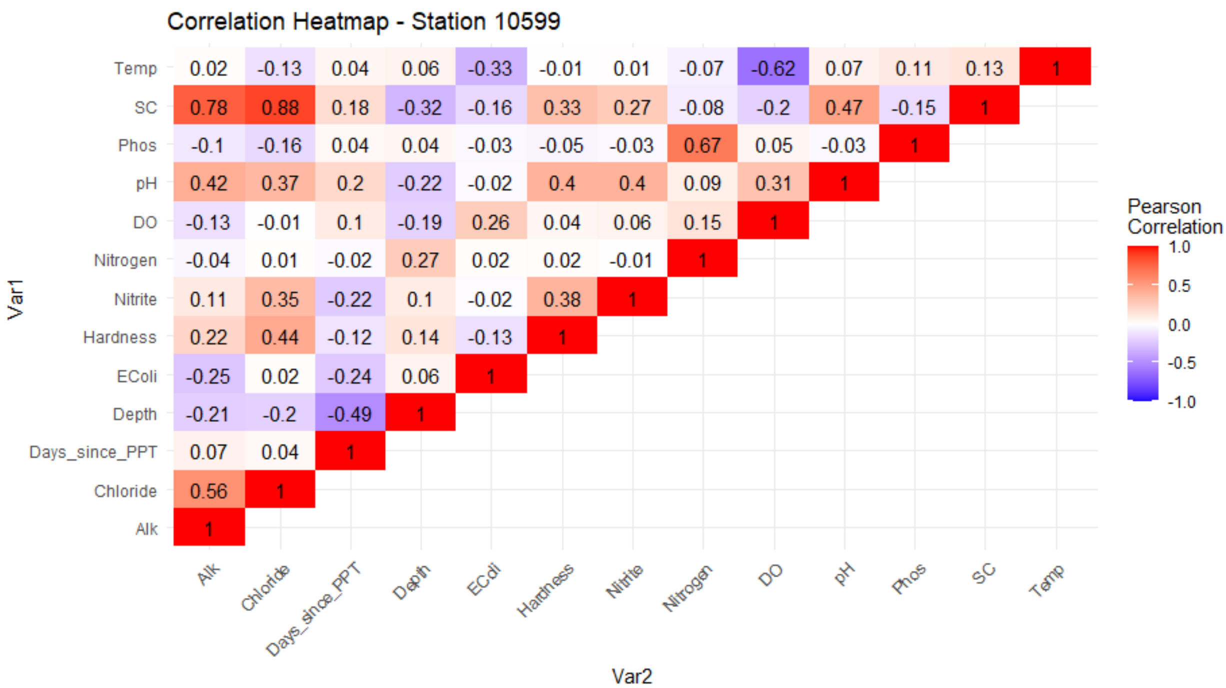
10607					
Land type Code	**COUNT**	**NLCD Land Type**	**% Cover**	**CN**	**Weighted CN**
11	2360	Open Water	0.28	100	0.28
21	21574	Developed, Open Space	2.55	79	2.02
22	14092	Developed, Low Intensity	1.67	82	1.37
23	3188	Developed, Medium Intensity	0.38	86	0.32
24	784	Developed, High Intensity	0.09	93	0.09
31	472	Barren Land	0.06	88	0.05
41	1034	Deciduous Forest	0.12	79	0.10
42	111097	Evergreen Forest	13.15	85	11.18
43	112384	Mixed Forest	13.31	82	10.91
52	15769	Shrub/Scrub	1.87	83	1.55
71	16625	Herbaceous	1.97	80	1.57
81	199965	Hay/Pasture	23.68	78	18.47
82	20073	Cultivated Crops	2.38	86	2.04
90	298032	Woody Wetlands	35.29	86	30.35
95	27106	Emergent Herbaceous Wetlands	3.21	83	2.66
TOTAL	*844555*		*100*		**82.96**

10602 (C749)					
Land type Code	**COUNT**	**NLCD Land Type**	**% Cover**	**CN**	**Weighted CN**
11	3136	Open Water	0.35	100	0.35
21	45143	Developed, Open Space	5.02	79	3.96
22	24770	Developed, Low Intensity	2.75	82	2.26
23	10130	Developed, Medium Intensity	1.13	86	0.97
24	2322	Developed, High Intensity	0.26	93	0.24
31	592	Barren Land	0.07	88	0.06
41	723	Deciduous Forest	0.08	79	0.06
42	230107	Evergreen Forest	25.58	85	21.74
43	118932	Mixed Forest	13.22	82	10.84
52	41901	Shrub/Scrub	4.66	83	3.87
71	41184	Herbaceous	4.58	80	3.66
81	62839	Hay/Pasture	6.99	78	5.45
82	3906	Cultivated Crops	0.43	86	0.37
90	297074	Woody Wetlands	33.03	86	28.40
95	16750	Emergent Herbaceous Wetlands	1.86	83	1.55
	899509				**83.79**

Basin 10599					
Land type Code	**COUNT**	**NLCD Land Type**	**% Cover**	**CN**	**Weighted CN**
11	844	Open Water	2.29	100	2.29
21	3254	Developed, Open Space	8.83	79	6.97
22	3038	Developed, Low Intensity	8.24	82	6.76
23	1640	Developed, Medium Intensity	4.45	86	3.83
24	657	Developed, High Intensity	1.78	93	1.66
31	32	Barren Land	0.09	88	0.08
42	1899	Evergreen Forest	5.15	85	4.38
43	588	Mixed Forest	1.59	82	1.31
52	403	Shrub/Scrub	1.09	83	0.91
71	517	Herbaceous	1.40	80	1.12
81	588	Hay/Pasture	1.59	78	1.24
82	38	Cultivated Crops	0.10	86	0.09
90	22036	Woody Wetlands	59.77	86	51.40
95	1337	Emergent Herbaceous Wetlands	3.63	83	3.01
	36871				**85.03**

Appendix B
Station 10599 (Segment 607)
Pine Island Bayou Subbasin

Relationship between Water Quality Parameters

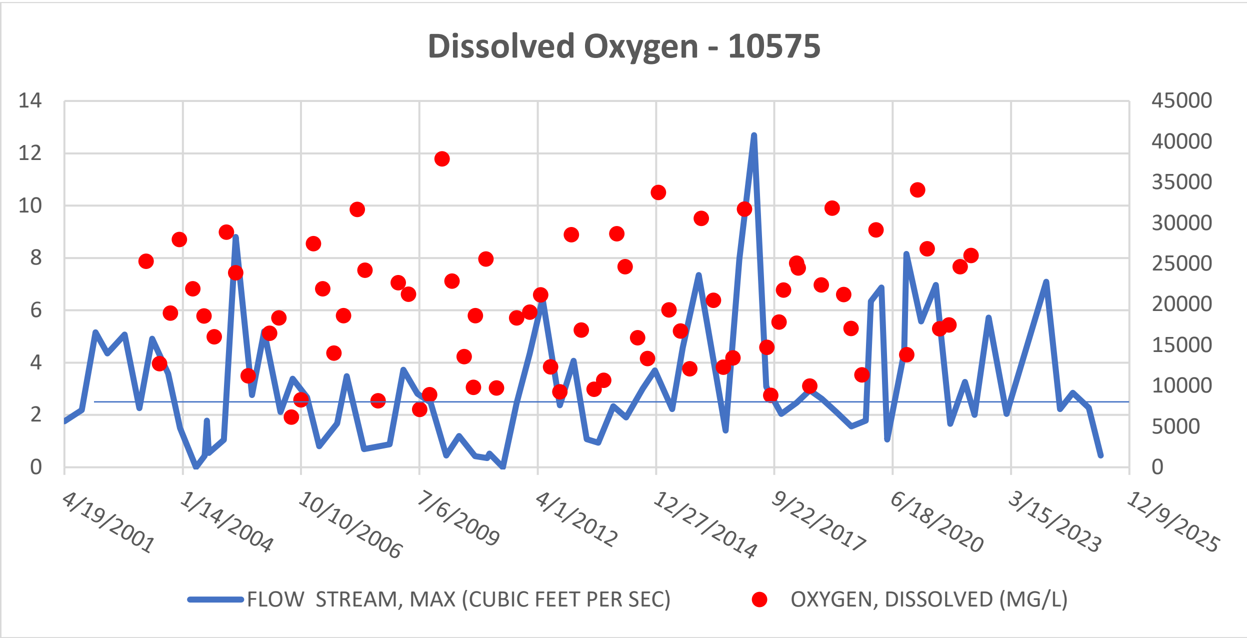


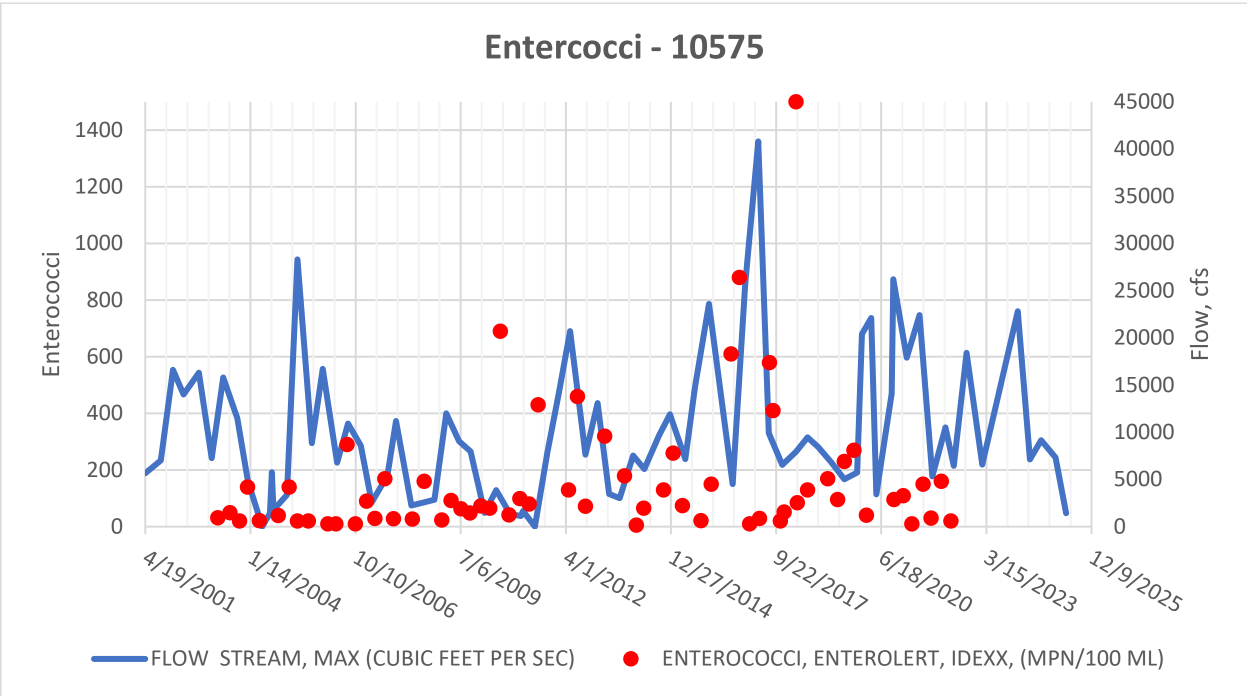
Relationship of Water Quality Parameters with Flow

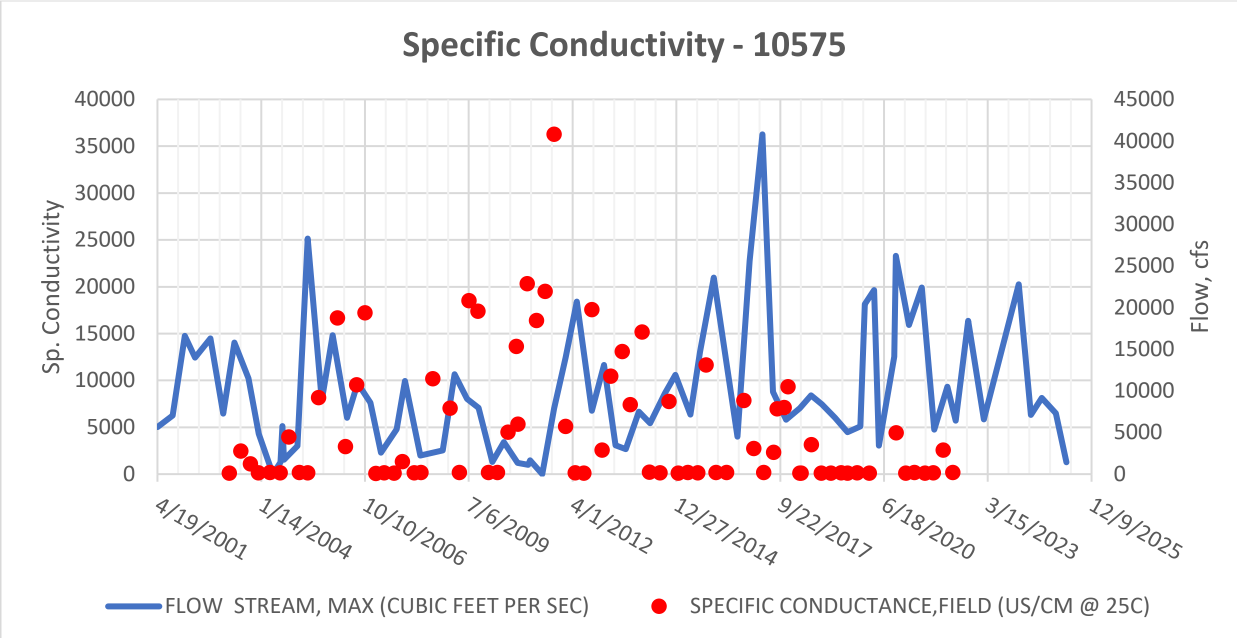
Parameter	Correlation with Flow
Alkalinity	0.072
Chloride	0.038
E. Coli	-0.236
Hardness	-0.12
Nitrite	-0.221
Nitrogen	-0.021
DO	0.105
pH	0.199
Phos	0.038
Sp. Condu.	0.176
Temp	0.044

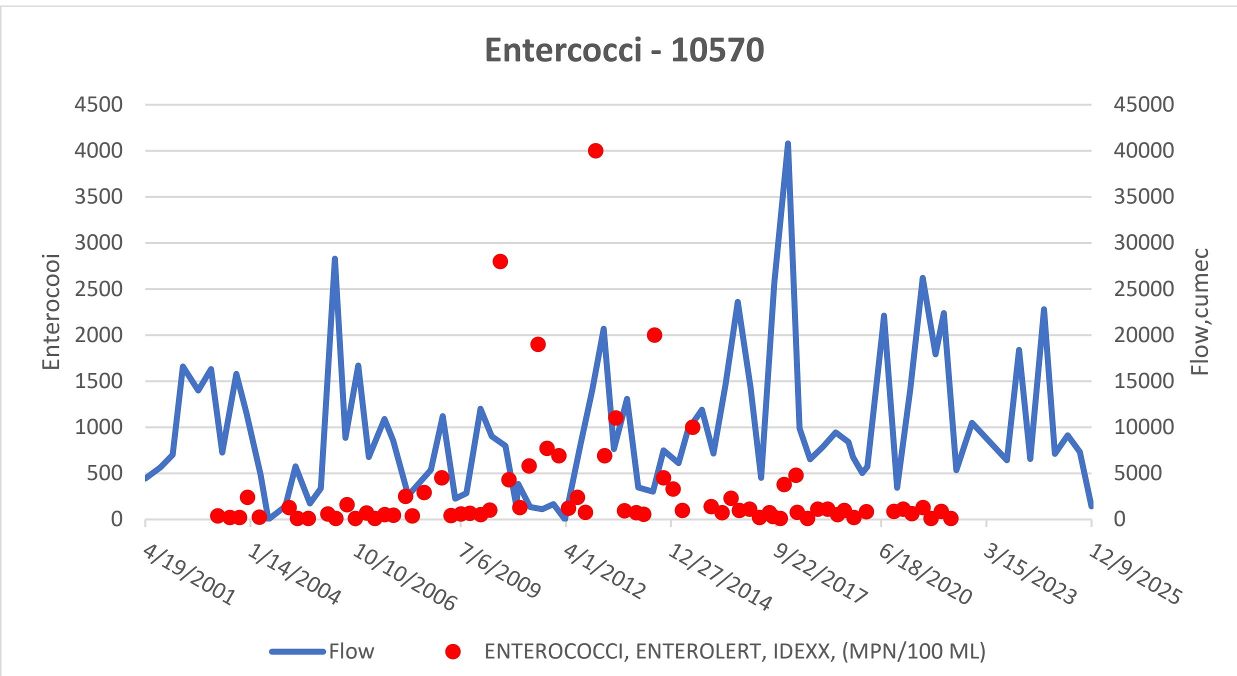
Appendix C

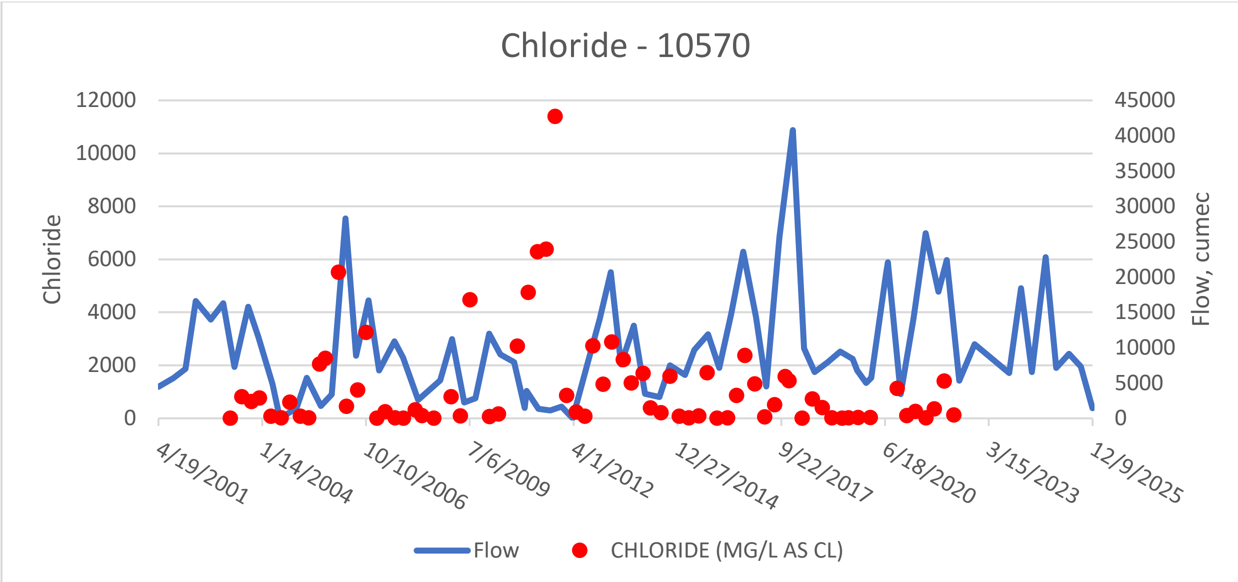
Time Series Overlay of Water - Quality Parameter and Flow



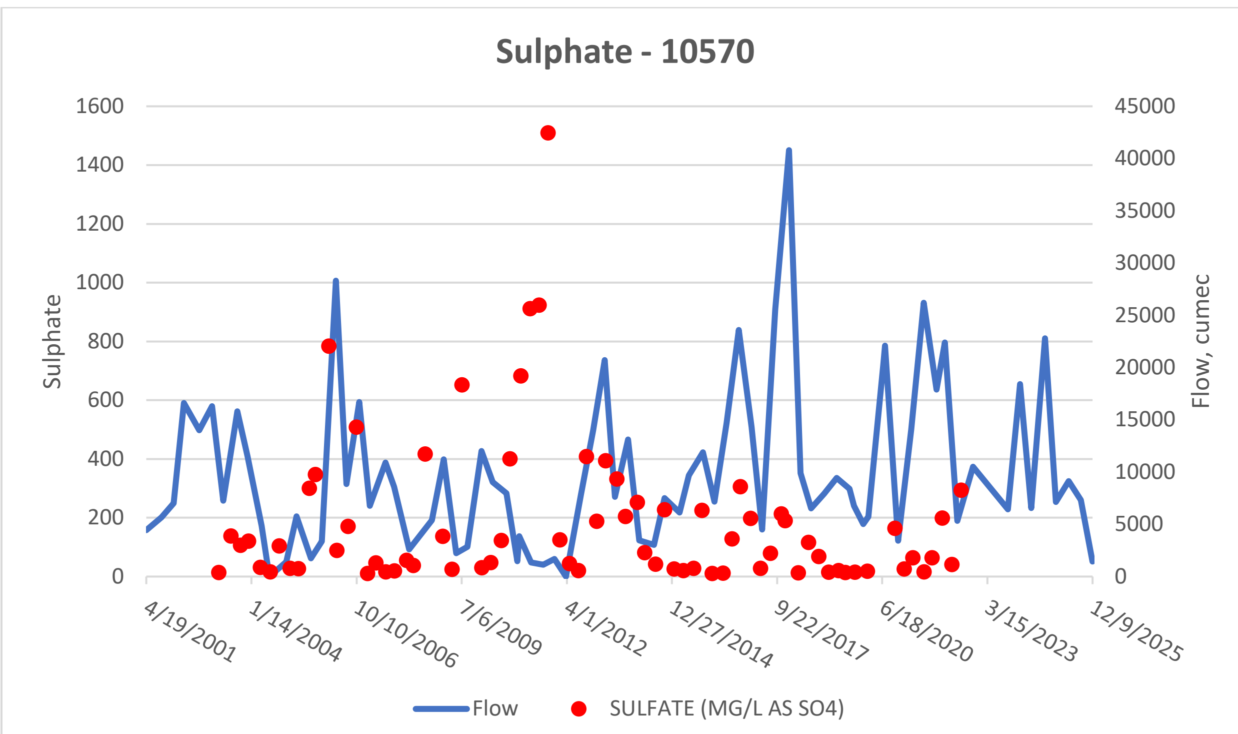



Specific Conductivity - 10575
Sp. Conductivity
Flow, cfs
40000
35000
30000
25000
20000
15000
10000
5000
0
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
4/19/2001
1/14/2004
10/10/2006
7/6/2009
4/1/2012
12/27/2014
9/22/2017
6/18/2020
3/15/2023
12/9/2025
FLOW STREAM, MAX (CUBIC FEET PER SEC)
SPECIFIC CONDUCTANCE,FIELD (US/CM @ 25C)

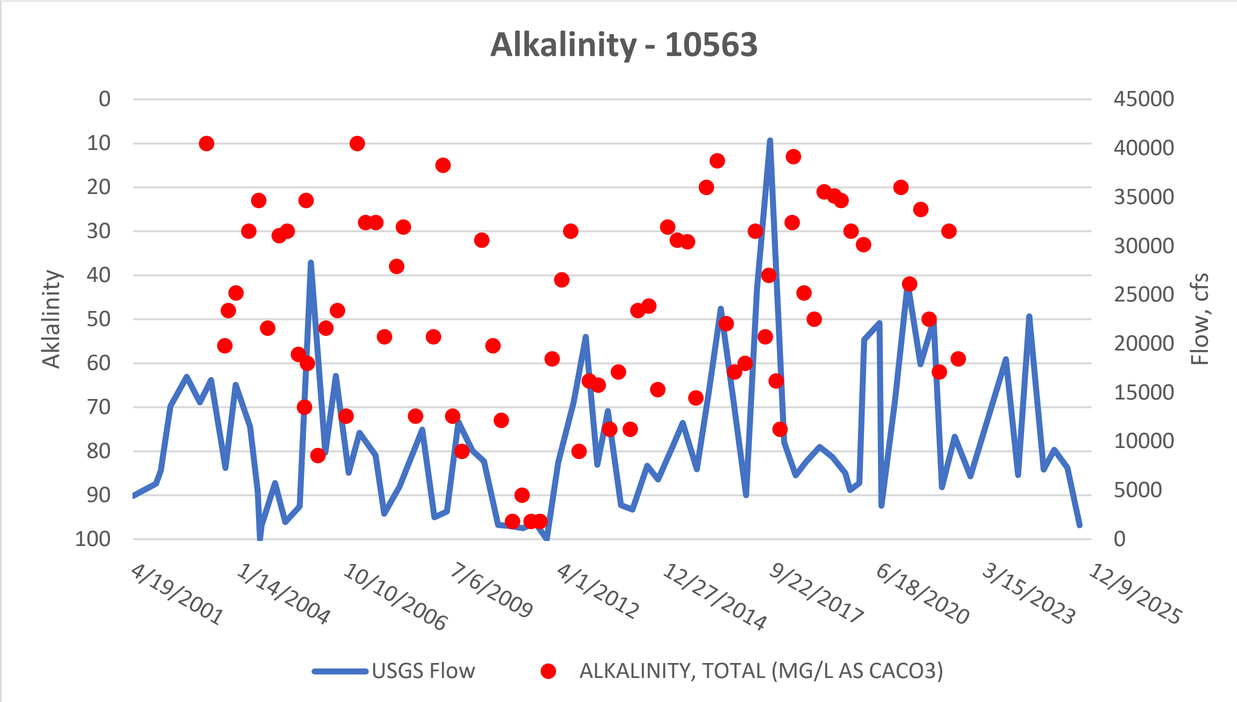

Entercocci - 10570
Enterocooi
Flow,cumec
4500
4000
3500
3000
2500
2000
1500
1000
500
0
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
4/19/2001
1/14/2004
10/10/2006
7/6/2009
4/1/2012
12/27/2014
9/22/2017
6/18/2020
3/15/2023
12/9/2025
Flow
ENTEROCOCCI, ENTEROLERT, IDEXX, (MPN/100 ML)

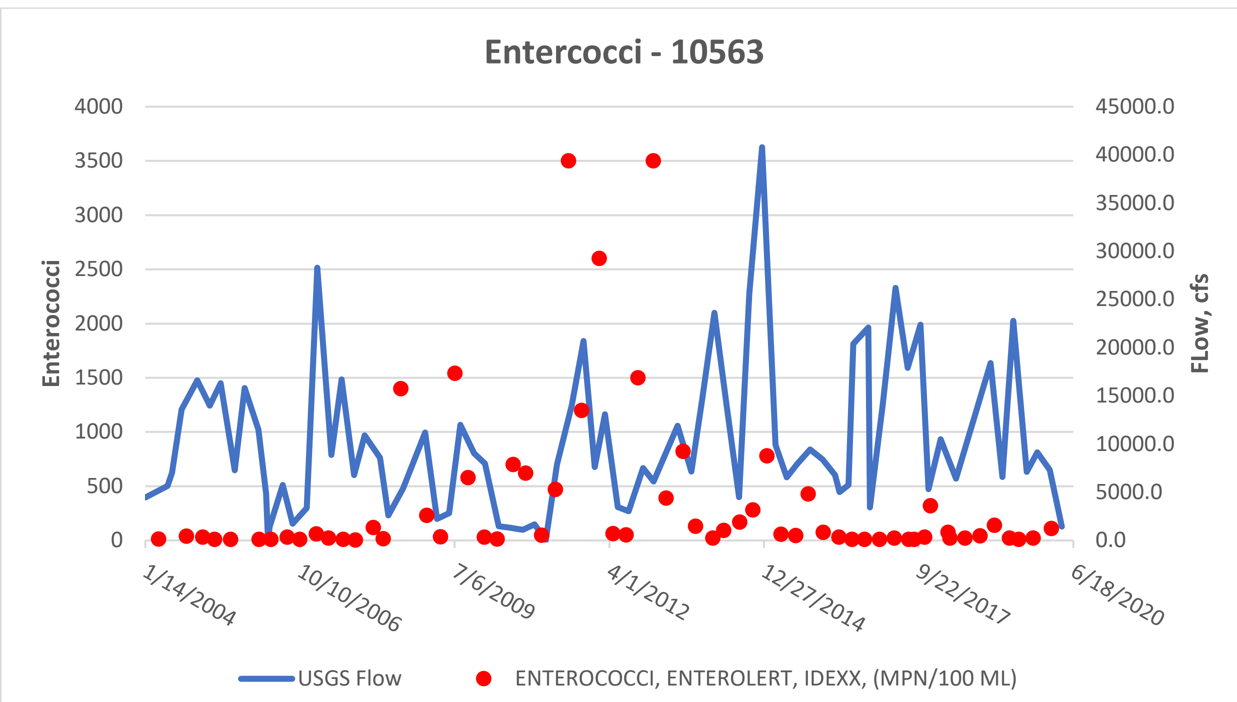


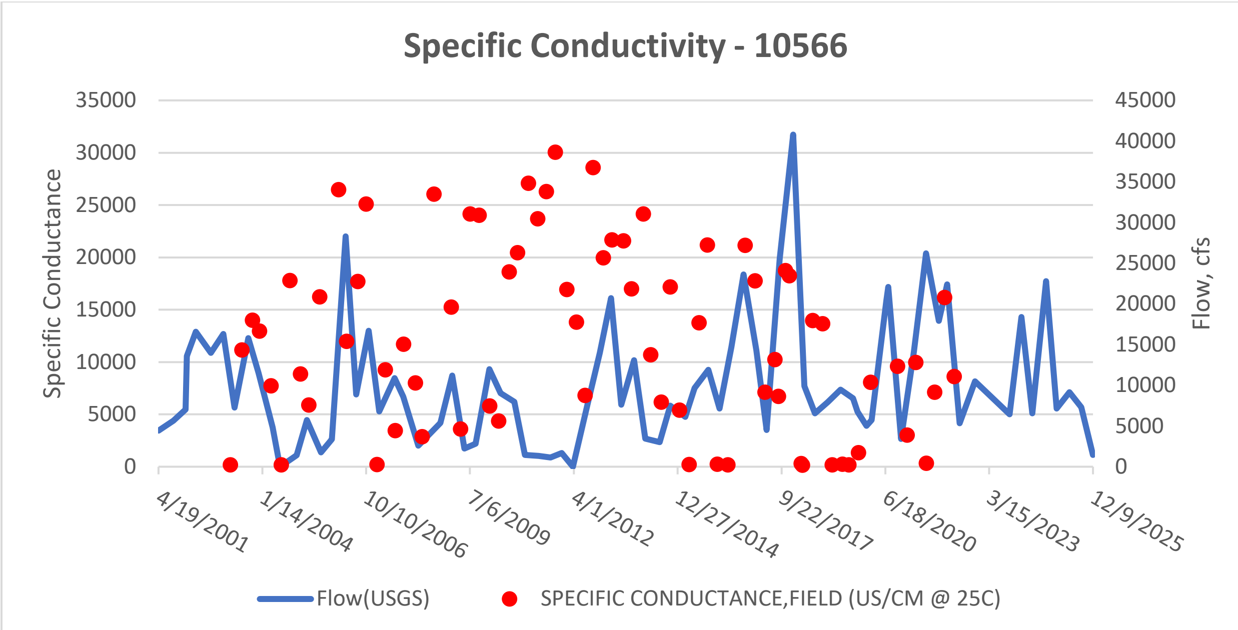
Chloride - 10570
Chloride
Flow, cumec
12000
10000
8000
6000
4000
2000
0
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
4/19/2001
1/14/2004
10/10/2006
7/6/2009
4/1/2012
12/27/2014
9/22/2017
6/18/2020
3/15/2023
12/9/2025
Flow
CHLORIDE (MG/L AS CL)



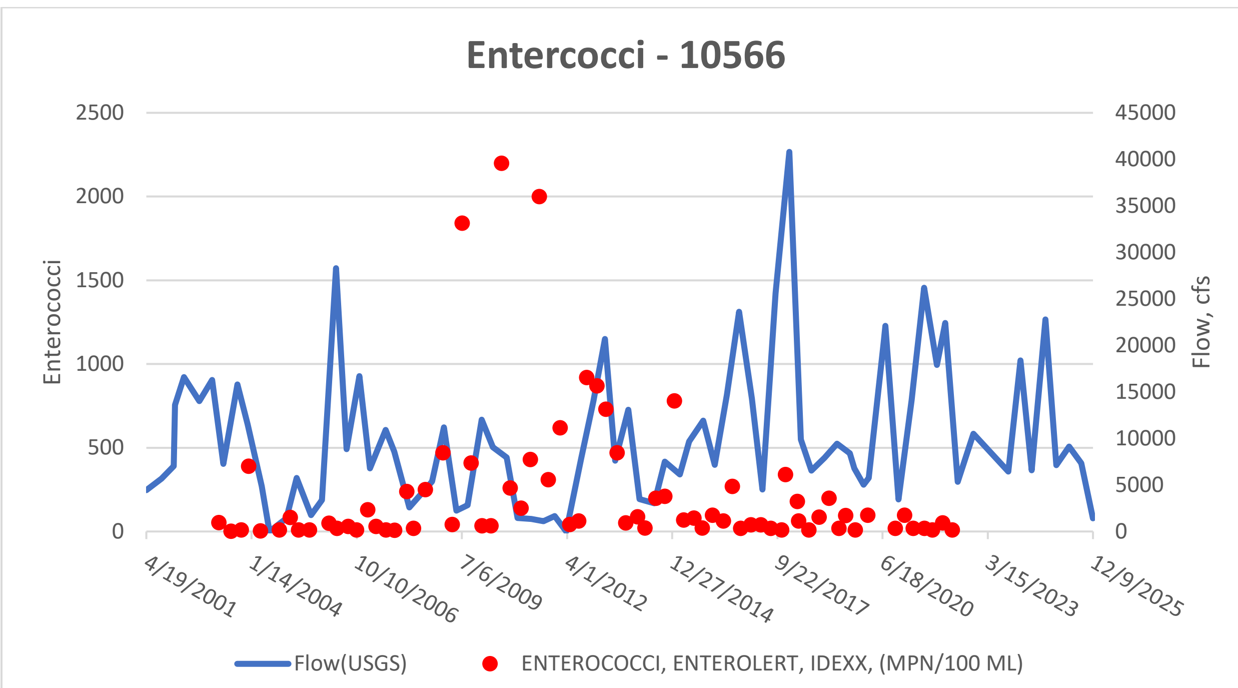
Sulphate - 10570
Sulphate
Flow, cumec
1600
1400
1200
1000
800
600
400
200
0
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
4/19/2001
1/14/2004
10/10/2006
7/6/2009
4/1/2012
12/27/2014
9/22/2017
6/18/2020
3/15/2023
12/9/2025
Flow
SULFATE (MG/L AS SO4)


Alkalinity - 10563
Aklalinity
Flow, cfs
0
10
20
30
40
50
60
70
80
90
100
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
4/19/2001
1/14/2004
10/10/2006
7/6/2009
4/1/2012
12/27/2014
9/22/2017
6/18/2020
3/15/2023
12/9/2025
USGS Flow
ALKALINITY, TOTAL (MG/L AS CACO3)


Entercocci - 10563
Enterococci
FLow, cfs
4000
3500
3000
2500
2000
1500
1000
500
0
45000.0
40000.0
35000.0
30000.0
25000.0
20000.0
15000.0
10000.0
5000.0
0.0
1/14/2004
10/10/2006
7/6/2009
4/1/2012
12/27/2014
9/22/2017
6/18/2020
USGS Flow
ENTEROCOCCI, ENTEROLERT, IDEXX, (MPN/100 ML)



Specific Conductivity - 10566
Specific Conductance
Flow, cfs
35000
30000
25000
20000
15000
10000
5000
0
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
4/19/2001
1/14/2004
10/10/2006
7/6/2009
4/1/2012
12/27/2014
9/22/2017
6/18/2020
3/15/2023
12/9/2025
Flow(USGS)
SPECIFIC CONDUCTANCE,FIELD (US/CM @ 25C)



Entercocci - 10566
Enterococci
Flow, cfs
2500
2000
1500
1000
500
0
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
4/19/2001
1/14/2004
10/10/2006
7/6/2009
4/1/2012
12/27/2014
9/22/2017
6/18/2020
3/15/2023
12/9/2025
Flow(USGS)
ENTEROCOCCI, ENTEROLERT, IDEXX, (MPN/100 ML)