19-500 Bayou DeView River Watershed Monitoring Project
Final Report
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Arkansas State University

1. Executive Summary

The objective of this project was to measure the effectiveness of conservation practices implemented in the Bayou DeView River Watershed. The Bayou DeView River is the main tributary to the Cache River. The Cache River (HUC #08020302) is listed on the 303d list of impaired waterways for excess turbidity, dissolved oxygen and lead (ADEQ, 2018); Bayou DeView is listed on the 2018 303d list for excess turbidity, dissolved oxygen, and sulfates. Agricultural activities within the watershed are thought to be the major source of contamination.

Sampling sites were established by Arkansas Natural Resource Commission and ASU ERF personnel for seven sampling sites within the Bayou DeView River Watershed. Three sampling sites were located within the Bayou DeView River main channel and four subwatersheds empty into the Bayou DeView (Figure 1). The main channel sampling sites include Town of Waldenburg, Town of Pittinger, and Old Channel Bayou DeView (Table 1). These sampling sites allow comparison of water quality changes from upstream to downstream in this main tributary of the Cache River. All sampling points are located within the Cow Lake Ditch HUC (0802030206) which is reported to have 80% cropland (watersheds.cast.uark.edu).

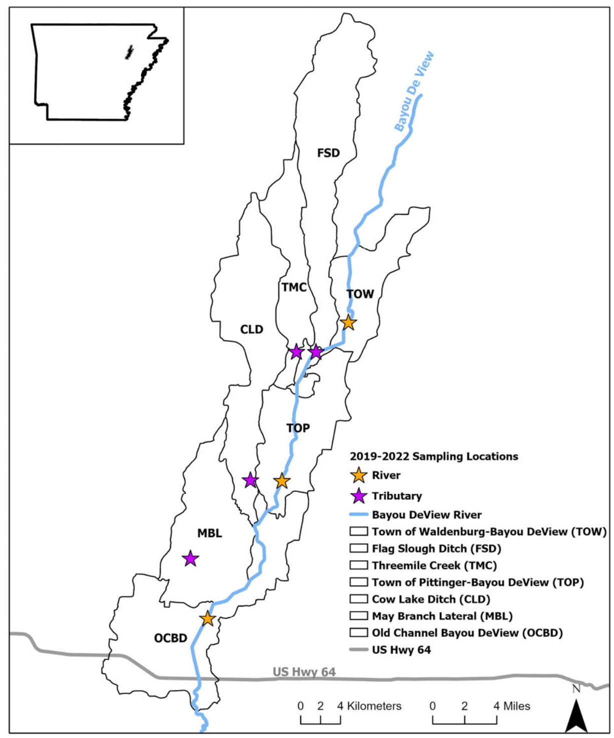

Figure 1. Sampling sites for the Bayou DeView River Watershed.

Subwatershed	Acronym	HUC#	% Cropland	% Forest
Town of Waldenburg*	ToW	080203020603	76%	10%
Flag Slough Ditch	FSD	080203020601	85%	6%
Three Mile Creek	TMC	080203020602	90%	5%
Town of Pittinger*	ToP	080203020604	77%	13%
Cow Lake Ditch	CLD	080203020605	87%	4%
May Branch Lateral	MBL	080203020606	82%	10%
Old Channel Bayou DeView*	OCBD	080203020607	67%	23%

Table 1. Sampling sites, acronym, HUC #, % cropland and % forest for each sampling subwatershed in the Cow Lake Subwatershed. * indicates Bayou DeView main channel sites. Sites are listed from upstream to downstream. Data from watersheds.cast.uark.edu.

The A-State Ecotoxicology Research Facility (ERF) began measuring weekly water quality parameters on October 5, 2019 and completed three years of water quality sampling on September 29, 2022. These analytes included total suspended solids (TSS), turbidity, dissolved oxygen, pH, conductivity, dissolved nitrates, nitrites, orthophosphates, and total nitrogen (N) and phosphorus (P). This grant completed six continuous years of weekly water sampling at the same seven sites. The first workplan (16-800) began in October 2016 and ended just prior to the current workplan (September 2019). The results in this report reflect only the current workplan (19-500), although sections of the conclusion contain comparisons over the six years of data.

Cow Lake Ditch (CLD) subwatershed had the greatest measured TSS and turbidity of any site and contributed to the sediment load in the main channel of the Bayou DeView. The increased sediment load from CLD did not coincide with high nutrient means as this sampling site had some of the lowest measured dissolved nutrient values (PO_4, NO_3, NO_2) of any of the subwatersheds. The construction, deforestation of the riparian area, and channelization of CLD most likely are still contributing to the increased sediment transport from that subwatershed. Although TSS and turbidity increased slightly from upstream to downstream in the three main channel sites, ToW, ToP and OCBD, dissolved nutrient values generally decreased.

TSS and turbidity had distinct seasonal patterns with greater sediment movement occurring during the winter and spring when fields typically lack vegetation or are being prepared for planting. Dissolved nutrient values had seasonal peaks which coincided with the addition of nutrients during the growing season. Total phosphorus followed the same pattern as sediment which can be expected as runoff from fields not in production will also result in movement of particulate matter concurrent with sediment from these bare fields. Total nitrogen more closely patterned dissolved nutrients throughout the 3 years of sampling.

This present project was funded at $563,349 with 44% match from A-State ($239,116) and federal funds from the ANRC ($297,233).

2. Project Chronology

Following confirmation of sampling sites, weekly collections began on October 5, 2019. Samples were collected from each site using a bucket rinsed in the respective site water, followed by filling the acid-washed sample bottles (1-L Nalgene bottles) as recommended by the ERF Standard Operating Procedure (SOP) and based on American Public Health Association methods (APHA, 2005). Filtered samples for nutrient analyses were accomplished on-site with a syringe and 0.45 µm filter filling two 15-mL centrifuge tubes and unfiltered samples were collected in a 50-mL conical tube for Total N and P. All samples were immediately labeled with site name, collection date and time, and initials of person(s) collecting sample; samples were then placed immediately on ice. Upon returning to the ERF, samples were warmed to room temperature and tested for TSS and turbidity while filtered samples for dissolved nutrients and unfiltered 50-mL subsamples for total N and P were frozen until analyzed. TSS was measured in triplicate using the filtration technique and 100-mL of sample and nutrients were measured using the Skalar SANS++ nutrient analyzer. All water quality tests followed the American Public Health Association (APHA 2005) guidelines.

Quality control and quality assurance was accomplished in this project as outlined in the QAPP and the ERF SOP. The ERF is EPA certified (AR#00917) for TSS and nutrients (nitrate, nitrite, orthophosphates) and certification requires bi-annual unknowns by the Arkansas Department of Environmental Quality (ADEQ). Annual re-certification requires reporting acceptable results on EPA unknowns for these parameters.

3. Results & Discussion

In the three main channel sites, mean turbidity and TSS for the 3-year study increased from the upstream site, from ToW to the downstream sites of ToP and OCBD (Figure 2). FSD and TMC enter the channel between ToW and ToP; CLD and MBL flow into the main channel between ToP and OCBD (Figure 1). The influence from these tributaries can be noted from the increased turbidity and TSS along the main channel. It should be noted that the greatest sediment transport during the study was from the CLD subwatershed (Figure 3). A complete deforestation of the riparian zone took place in the channel of Cow Lake Ditch in January 2018 and dredging followed in June 2018. This, along with additional dredging, is reflected in the annual means for CLD. Managing stream banks and channel manipulation can be sited as one cause of greater sediment entering the stream from this subwatershed. Although the single greatest turbidity and a high TSS value were measured from FSD on October 21, 2019 (Turbidity 2272 NTU; TSS 1004.7 mg/L) consistently high values measured from January through May each year from CLD resulted in the greatest 3-year mean turbidity and TSS values for all sampling sites (see appendices). TMC also had high turbidity and TSS values measured seasonally; values as great as 1776 NTU and 1078.7 mg/L were measured at this site. Elevated turbidity and TSS values from tributaries contributed to the increasing values in Bayou DeView channel sites from upstream to downstream. FSD and TMC flow into Bayou DeView prior to the ToP sampling site and CLD confluences prior to the OCBD sampling site, resulting in this upstream to downstream increase in sediment transport.

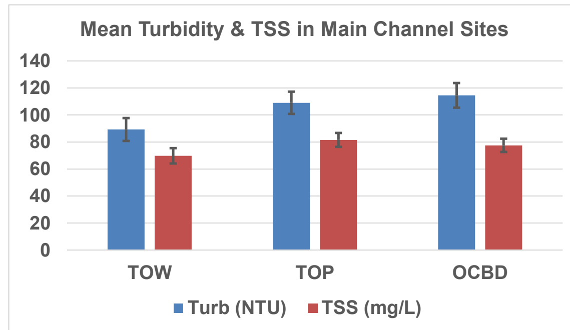

Figure 2. 3-year means of turbidity and TSS from Bayou DeView channel sites; Town of Waldenburg, Town of Pittinger, Old Channel Bayou DeView. Channel sites are presented upstream to downstream.

The three subwatersheds contributing to the greatest sediment transport also had the greatest amount of cropland and least amount of forested land (Table 1). The subwatersheds, FSD, TMC and CLD, support 85-90% cropland and only 4-6% forested (Arkansaswater.org). Intensive agriculture along with the influence of channel manipulation and clearing of riparian vegetation in CDL had a tremendous impact on sediment transport. Forested land has a filtering effect through remaining forested wetlands in the watershed. Past research in the Cache River has reported a decrease in turbidity and TSS through intact forested wetlands (Kleiss, 1996; Rosado-Berrios, 2016).

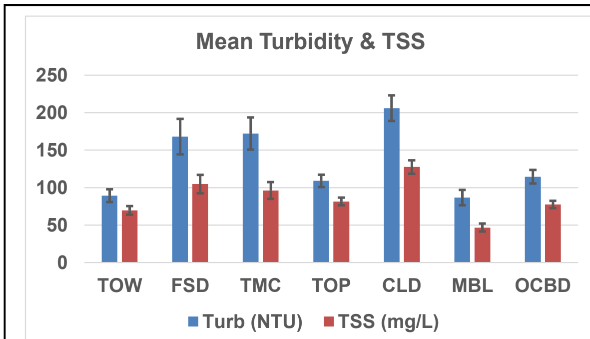

Figure 3. 3-year means of turbidity and TSS from Bayou DeView sampling sites from upstream to downstream.

The lowest 3-year mean values for turbidity and TSS were from the MBL subwatershed (Figure 3). MBL also had some of the lowest mean dissolved and total nutrient values for the 3-year sampling period (Figures 4 & 5). Spikes in turbidity and TSS followed the same trend as other subwatersheds (January – May) and dissolved and total nutrient spikes were seasonal – spiking during the growing season and fertilizer applications (see appendices).

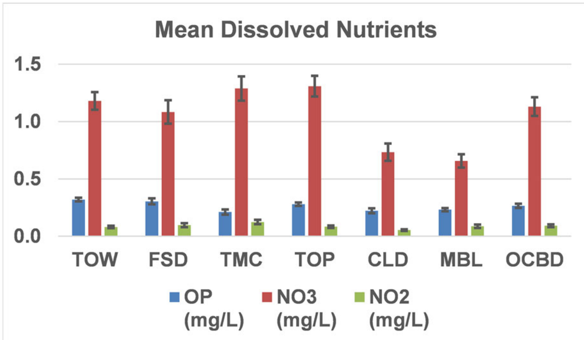

Figure 4. 3-year means of dissolved nutrients from Bayou DeView sampling sites from upstream to downstream.

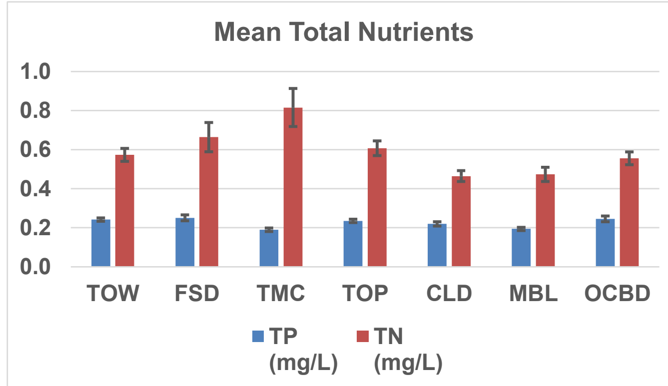

Figure 5. 3-year means of total nutrients from Bayou DeView sampling sites from upstream to downstream.

Interestingly, the mean total and dissolved nutrient values for CLD were some of the lowest of all the subwatersheds sampled (Figure 4&5). This indicates that much of the sediment load from this subwatershed originated from channel manipulation and deforestation of the riparian area as opposed to runoff from agricultural fields as this runoff would also increase nutrient values. The mean nutrient values do not reflect the same trends as the turbidity and TSS values for CLD as seen in Figure 3.

While turbidity and TSS tended to increase from upstream to downstream in the main channel Bayou DeView sites, dissolved PO_4 values decreased in these sites (ToW, ToP, OCBD) (Figure 6). Dissolved NO_3 increased slightly at the mid-site (ToP) and subsequently decreased to the lowest mean value at the most downstream site (OCBD). Mean Total P values were essentially the same at all three main channel sites and Total N followed the same trend as dissolved NO_3, increasing slightly at the mid-site and decreasing to the lowest mean at OCBD (Figure 5).

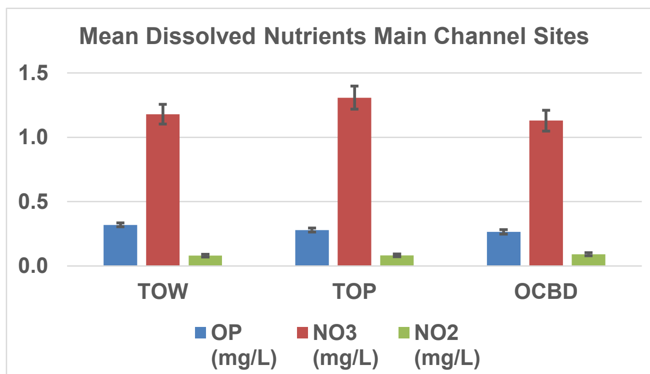

Figure 6. 3-year means of dissolved nutrients from Bayou DeView main channel sampling sites from upstream to downstream.

Through the sampling years, turbidity and TSS at all main channel sites tended to decrease from year 1 to 3 (Figure 7). The same trend was followed in the subwatershed sites (Figure 8). Precipitation for the three years was greatest for year 1 (1462mm) and approximately the same for years 2 and 3 (1177 and 1283, respectively) (Data from Beedeville, AR weather station).

There was a distinct seasonal variation in turbidity and TSS values for all sites with the greatest values measured in winter/early spring when the fields are unplanted (see appendices). Dissolved nutrients tended to increase during the production season (spring/summer) which is reflective of the loss of seasonal fertilizer applications on productive fields.
Total N and P generally showed the same seasonal variation as dissolved nutrients, however some spikes occurred when turbidity and TSS increased as they tend to be displaced from bare agricultural fields concurrent with sediment movement.

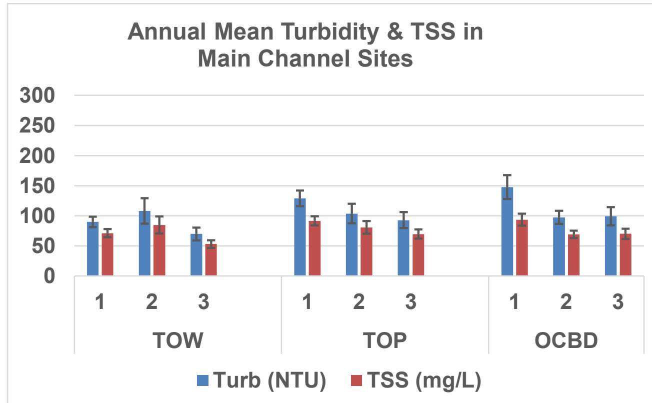

Figure 7. Annual mean turbidity and TSS from Bayou DeView main channel sites from upstream to downstream.

4. Lessons Learned
As indicated from the results of the three years of monitoring, sediment movement in the Bayou DeView River reflects the land and channel disturbances and lack of forest cover. Monitoring the main channel sites measures an increase in sediment movement, most likely resulting in the increased input from highly agricultural subwatersheds. The most downsteam main channel site, OCBD, has the greatest forest cover, thus offers a potential for contaminant mitigation prior to the Bayou DeView's confluence with the Cache River. The channel disturbances at CLD subwatershed which occurred in 2018 are still notable as measured in the increased sediment movement as noted in Figure 3. It is also interesting that the disturbance increased turbidity and TSS values but was not reflected in nutrient values measured at that site.

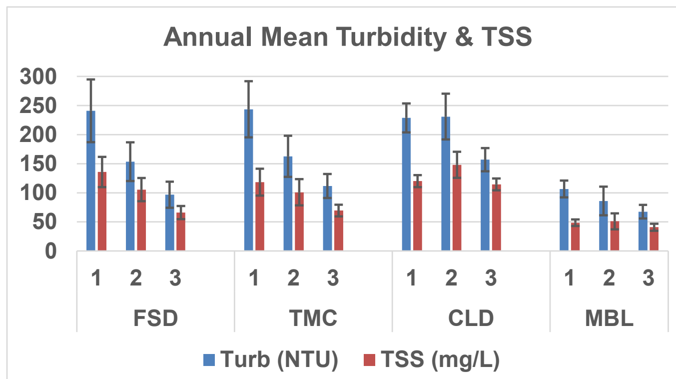

Figure 8. Annual mean turbidity and TSS from Bayou DeView subwatershed sites from upstream to downstream.

It is discouraging that nutrient values increase during the agricultural production season. However, it is encouraging that nonpoint contaminants tended to decrease over the 3 years of monitoring in this study. Perhaps the implementation of Best Management Practices in these subwatersheds are aiding in the reduction of contaminants entering the receiving streams. Loss of soil and nutrients from production fields is not economically beneficial to the land manager nor beneficial to managing water quality in the receiving streams. Better conservation measures could be implemented by land managers to contain these resources on production fields.

5. Technical Transfer
Results from this data are part of Brittany Singleton's dissertation with a planned graduation date of May 2024. These data have also been presented at local, regional and national/international meetings including the Arkansas Soil & Water Conservation meeting, Create@AState, MidSouth SETAC, SETAC North America and Young Environmental Scientists (YES) meeting. Brittany Singleton will also use the previous 3 years of data (Workplan 16-800) for her PhD dissertation. All data will be published in peer-reviewed publications. Published data are lacking in current literature that report water quality

information demonstrating improvements from agricultural BMPs. Brittany is modeling landuse of these subwatersheds and will provide excellent information reflecting landuse and water quality monitoring. Brittany has also sampled for lead analyses and that will be included in her dissertation as well. It has been observed that decreased sediment movement in the waterways also decreases lead values (Kilmer and Bouldin 2016; Rosado-Berrios 2018).

All data from this 3-year project has been entered into WQX and thus is available through that website.

6. EPA Feedback Loop

To provide a complete assessment of this study and the previous 3-year study of these same sites, the model constructed by Ms. Singleton will provide valuable information concerning these subwatersheds. This will aid in our understanding of which areas need additional conservation practices. The information from Brittany's dissertation will include the results of landuse modeling and will be shared with the ANRD as follow-up for the 6 years of continual data obtained from this (19-500) and the previous workplan (16-800). We look forward to sharing further assessments of these data on the Bayou DeView which is historically intensively agriculture and contributes to the nutrients and sediment in the Cache River discharge (Rosado-Berrios and Bouldin, 2016).

7. Conclusions / Outcomes

This project monitored changes in water quality parameters over a 3-year period. The previous 3 years of data have a mix of similarities, improvements, and potential deteriorations. Sediment movement continued from CLD but improved over time indicating a potential healing from the riparian deforestation and channelization stabilization. Mean turbidity and TSS values for CLD were lower in this recent monitoring plan and it is interesting that nutrient movement was not associated with sediment movement from this watershed.

For main channel sites, mean turbidity and TSS values in this current sampling period were lower at the most upstream sites of ToW (89.3 vs. 104.7 NTU; 69.7 vs. 71.4 mg/L) indicating less sediment load originating upstream of the sampling sites. Dissolved and total nutrients also followed this pattern and ToW nutrient means were significantly lower in this present sampling period than in the previous 3 years of sampling. For the downstream main channel sites (ToP and OCBD), mean values for turbidity and TSS did not change significantly, however, dissolved and total nutrients were lower showing improvement in nutrient retention; the single value that had a greater mean (dissolved PO_4 1.399 vs. 1.420) was not significantly different.

Mean turbidity and TSS values for other subwatershed sites (FSD, TMC, MBL) increased during the present 3-year study as compared to mean values for the previous 3 years. These increases may have resulted in the increase to the downstream sediment loading in the main channel sites (ToP and OCBD). However, the opposite trend for nutrients was noted in subwatersheds as in main channel sites; mean dissolved and total nutrients increased in FSD, TMC, and MBL as compared to the previous 3-year sampling results. Subwatershed CLD which improved in sediment loading from the previous 3-year sampling period also had lower mean dissolved and total nutrient values. This further indicates that the sediment movement from CLD is not associated with nutrient loading from this site. All sampling sites tended to follow seasonal trends with increased sediment movement in January through May and increased nutrient values during the production season.

The % forest in these subwatersheds range from 4-13% except OCBD which supports 23% forested land. Highly agricultural subwatersheds such as these tend to contribute more to nonpoint source contaminants due to the agricultural landuse as well as the loss of natural forested wetlands indigenous to the Cache River bottomlands. Conservation Practices and Best Management Practices can alleviate much of this nonpoint source contamination. These subwatersheds support from 67-90% row crop agriculture thus

BMPs are crucial to watersheds such as Bayou DeView. It is encouraging that sediment and nutrient loading showed an annual decrease during this present study. It is hopeful that this in an indication of improved land management or increased riparian vegetation which improves water quality by trapping contaminants from adjacent fields (Bouldin et al., 2004). The overall goal is to reduce nonpoint source contamination from this agriculturally-dominated tributary of the Cache River which ultimately contributes to the hypoxia in the Gulf of Mexico. Returning marginal land, especially land in close proximity to streams can greatly reduce the amount of sediment and nutrients transported downstream (Rosado-Berrios and Bouldin, 2016).

8. References

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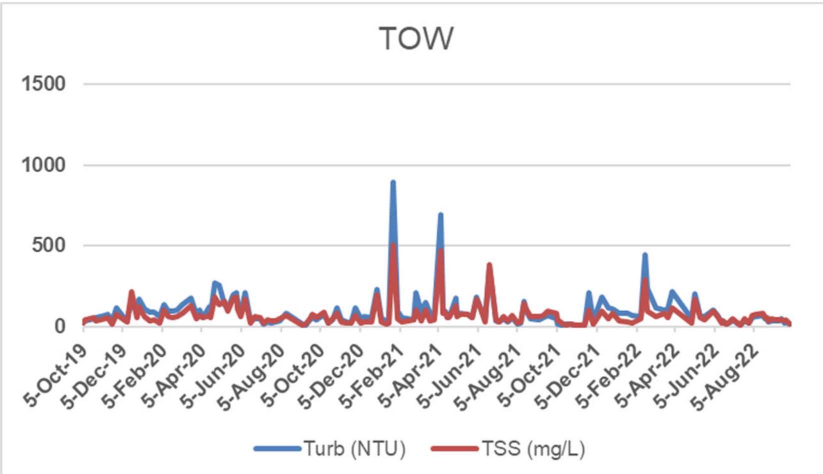
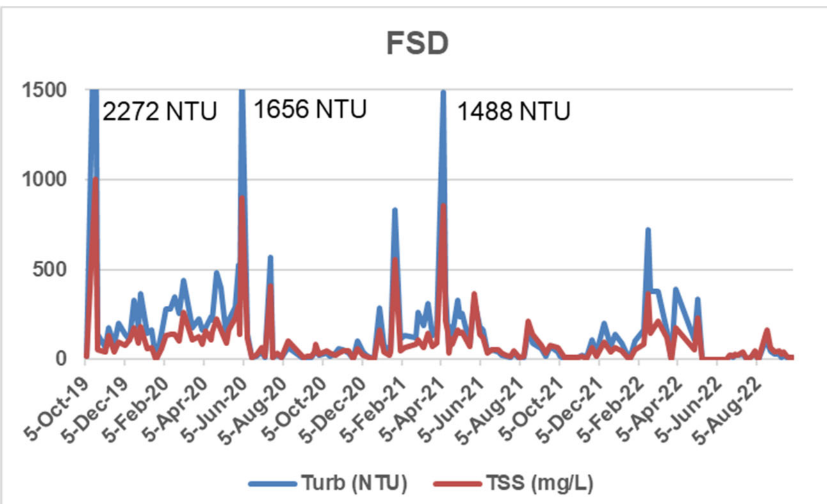
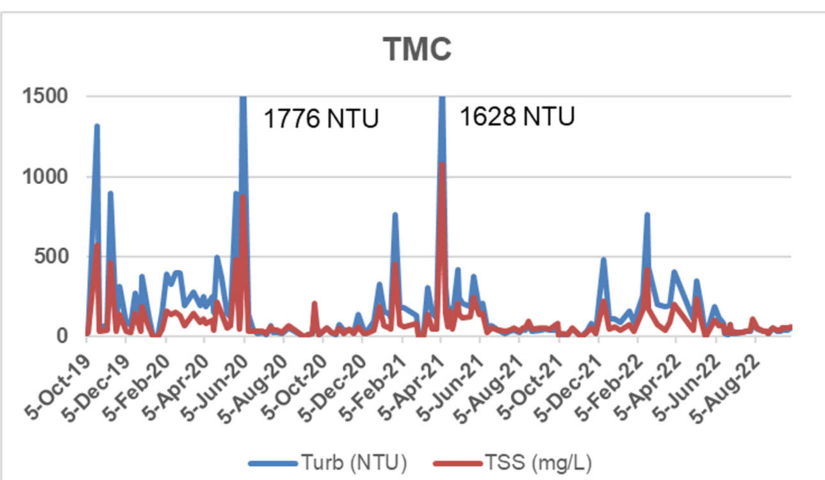
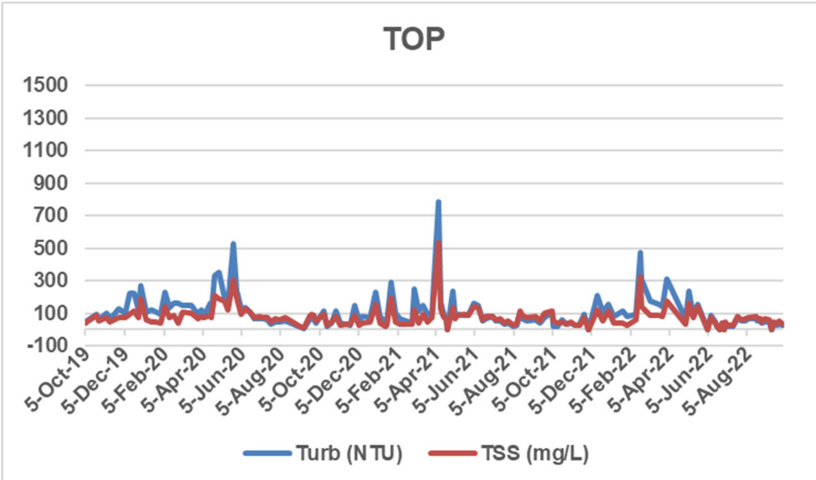
Appendix 1.
Turbidity and TSS figures for subwatersheds in the Bayou DeView. All figures reflect the same scale for easy comparison and are presented upstream to downstream.









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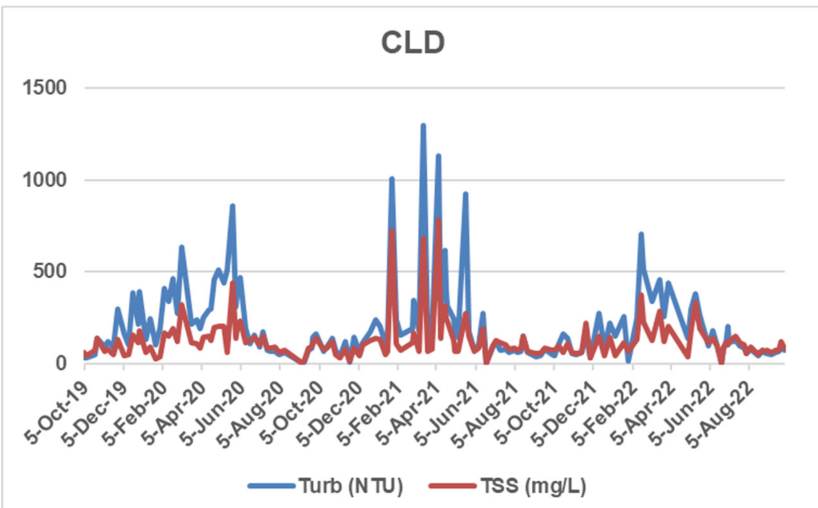
Turb (NTU)
TSS (mg/L)



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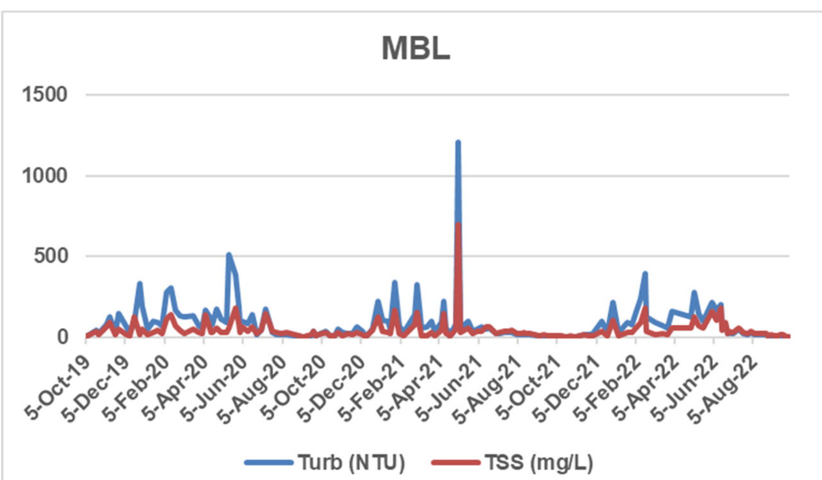
Turb (NTU)
TSS (mg/L)



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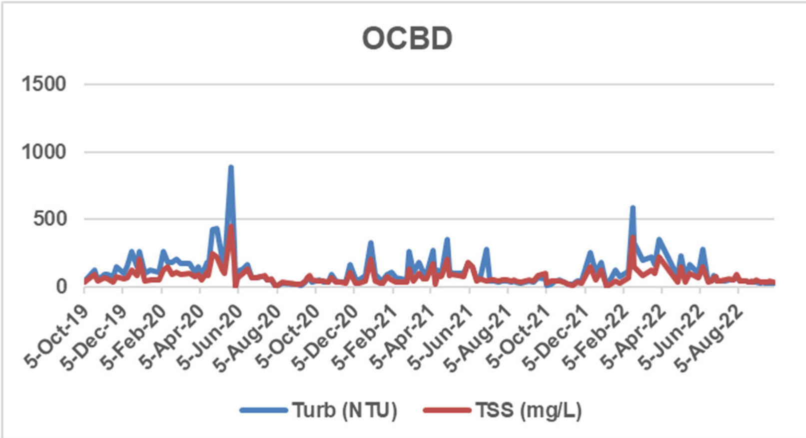
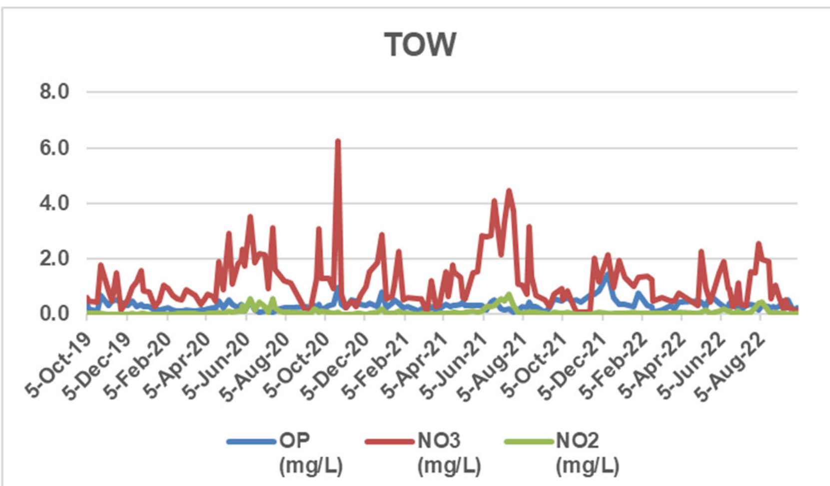
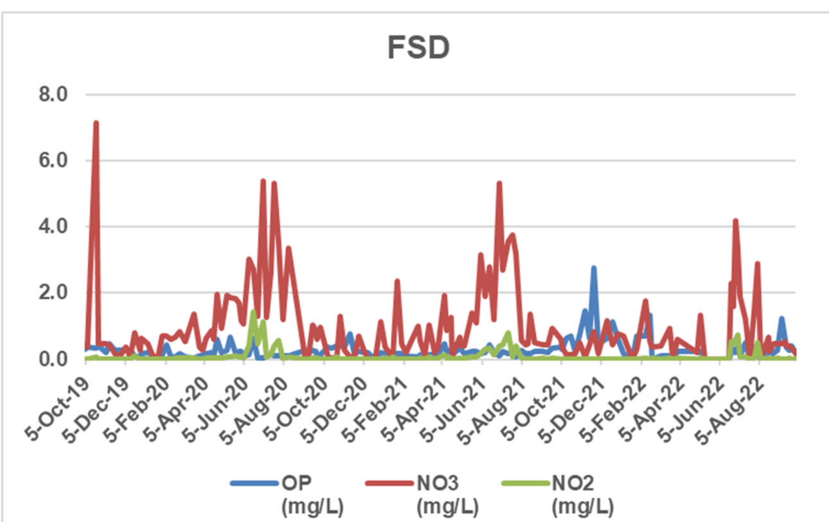
Turb (NTU)
TSS (mg/L)

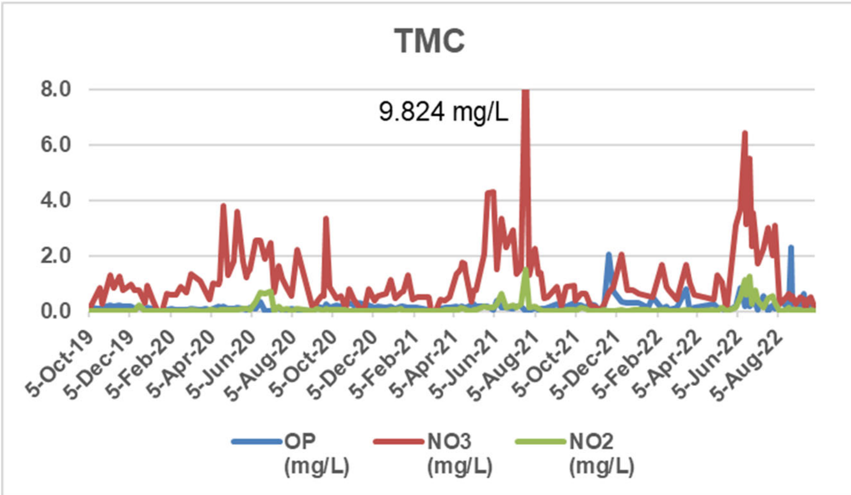


Appendix 2.

Dissolved nutrient figures for subwatersheds in the Bayou DeView. All figures reflect the same scale for easy comparison and are presented upstream to downstream.



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OP (mg/L)
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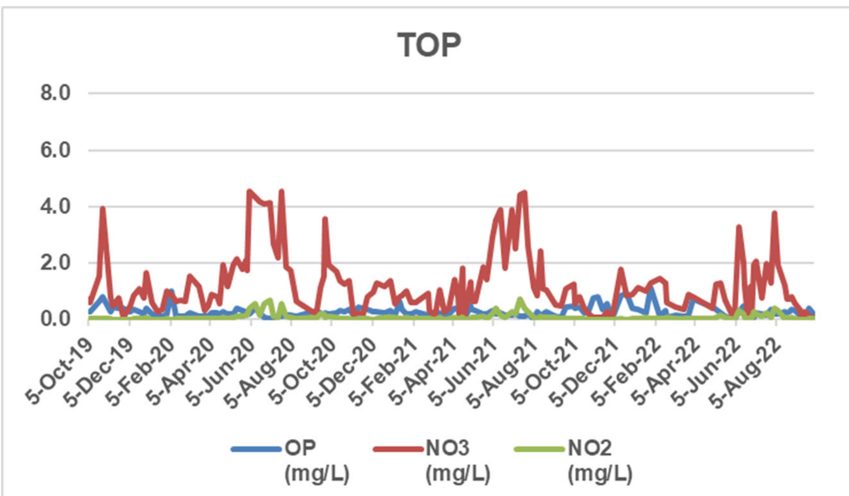
NO2 (mg/L)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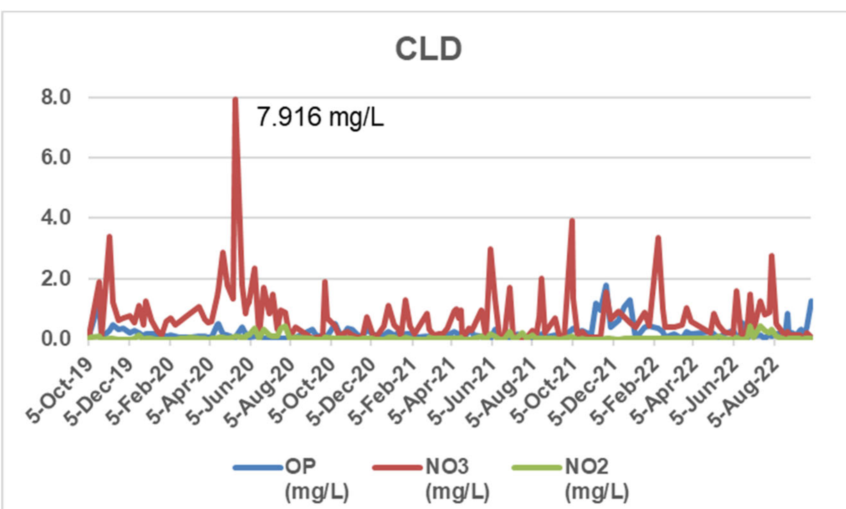
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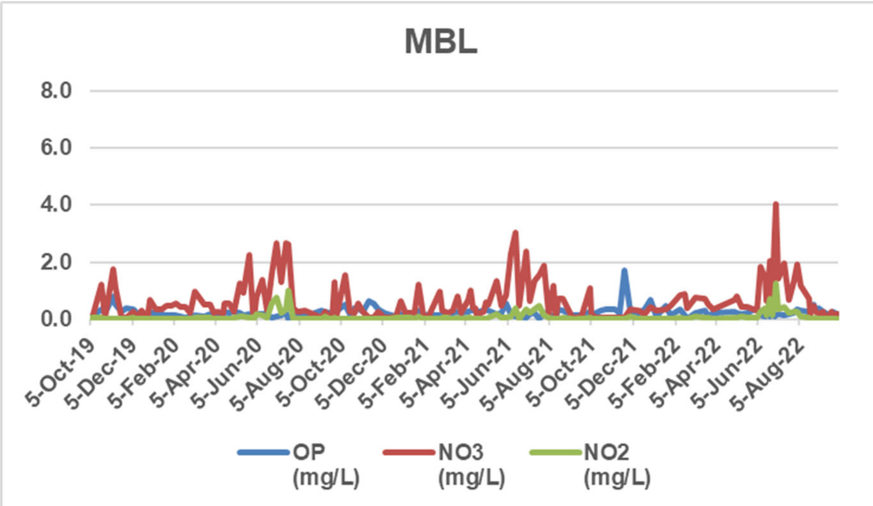
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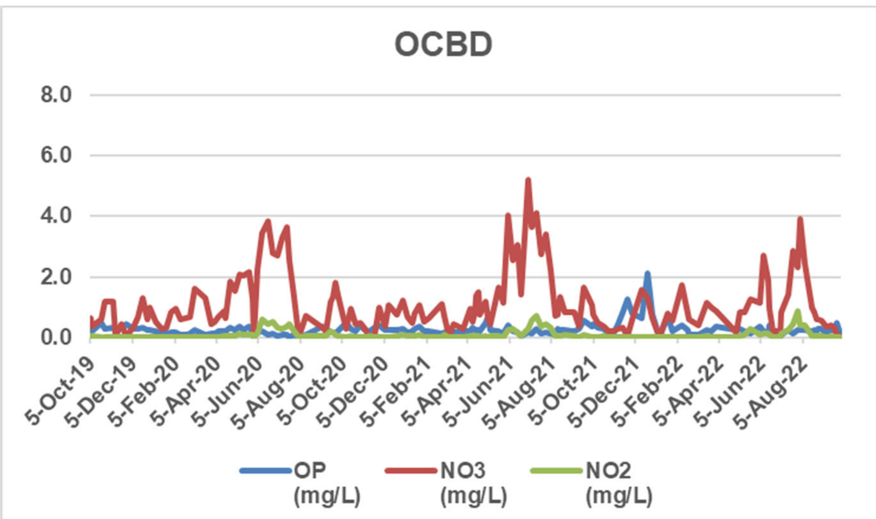
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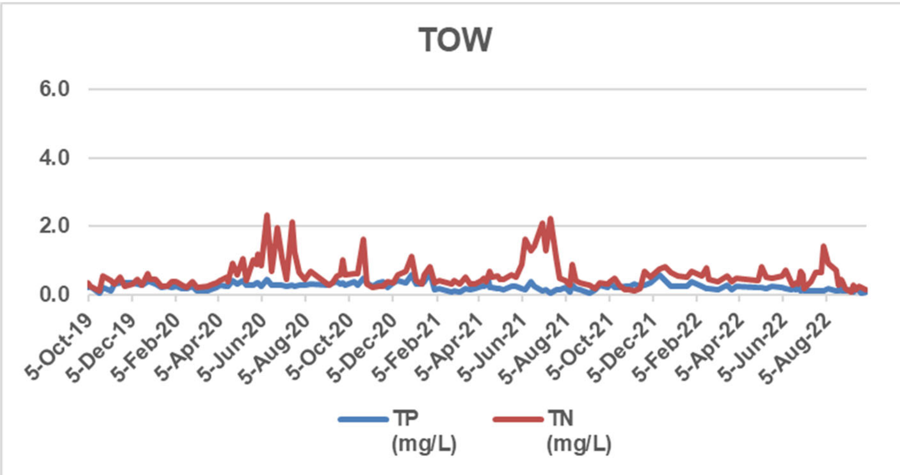
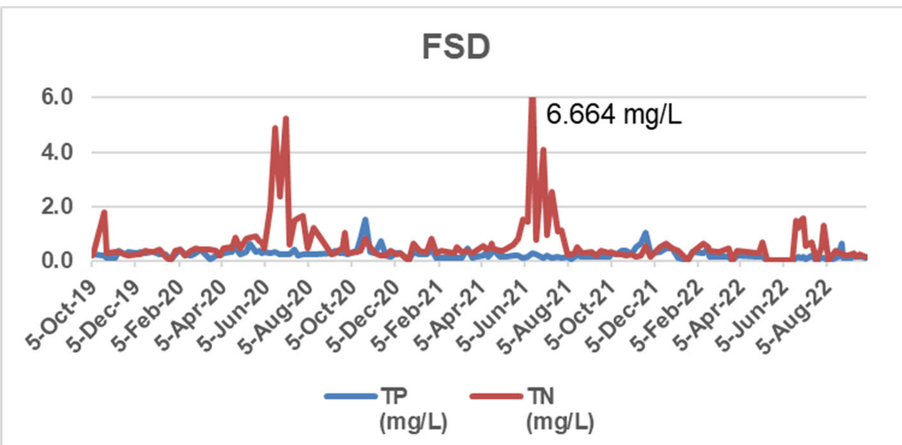
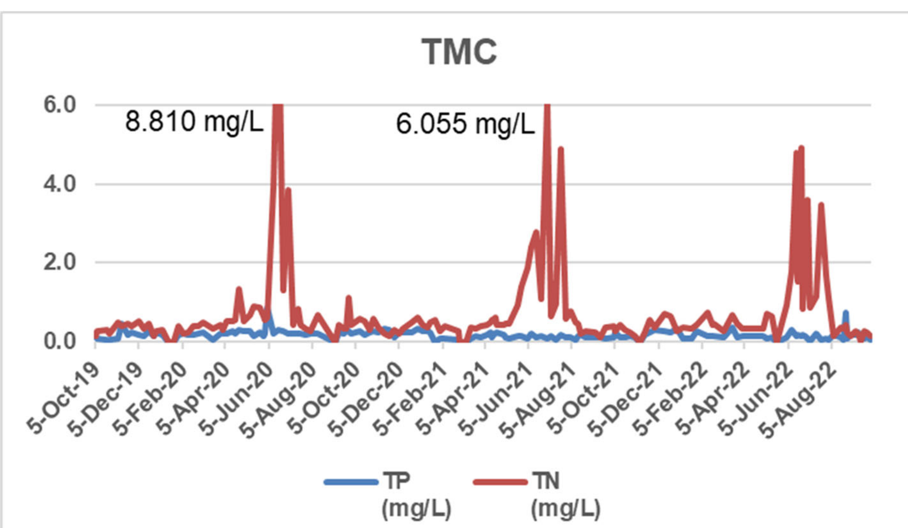
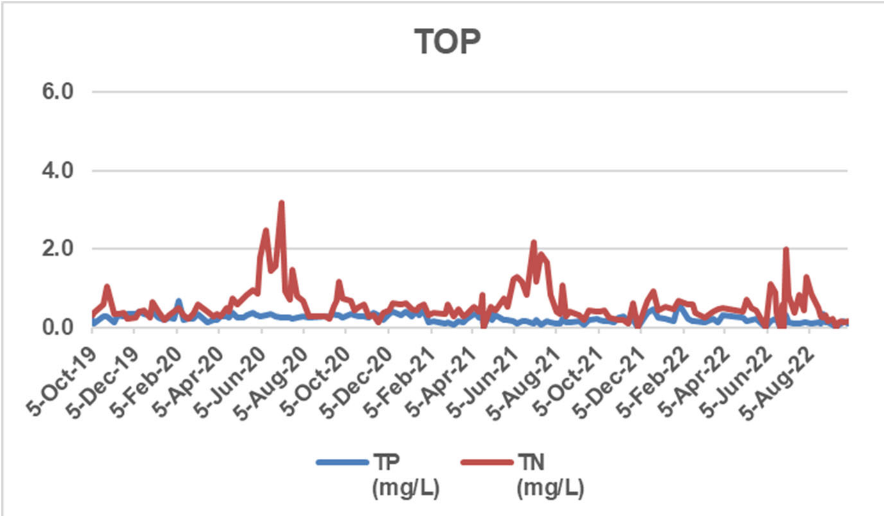
5-Dec-21
5-Feb-22
5-Apr-22
5-Jun-22
5-Aug-22
OP (mg/L)
NO3 (mg/L)
NO2 (mg/L)

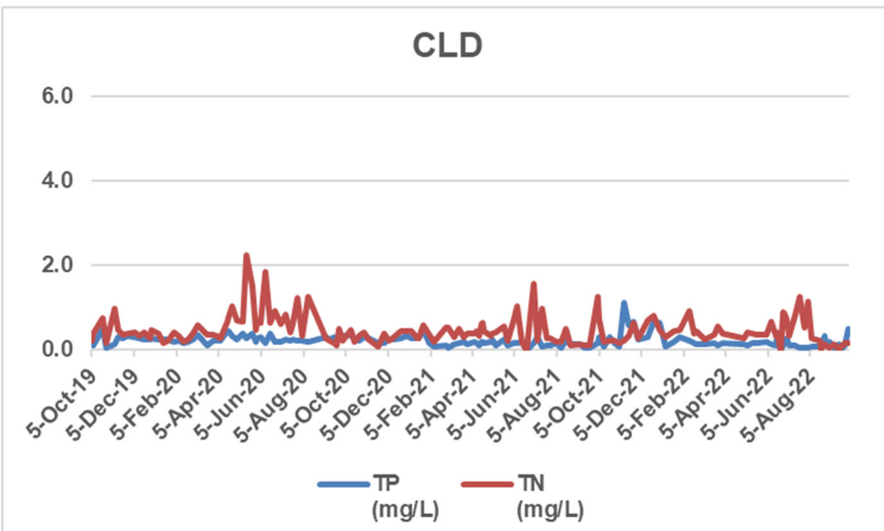
Appendix 3.
Total N and P figures for subwatersheds in the Bayou DeView. All figures reflect the same scale for easy comparison and are presented upstream to downstream.

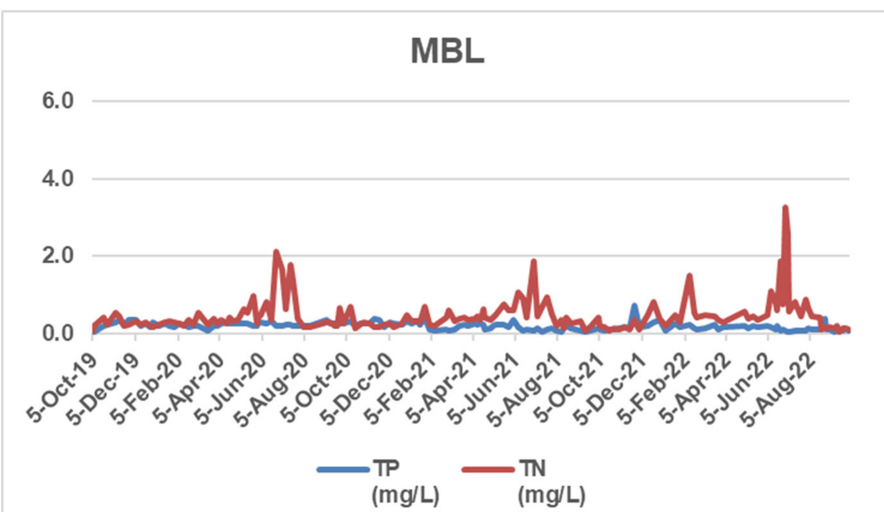







TOP
6.0
4.0
2.0
0.0
5-Oct-19
5-Dec-19
5-Feb-20
5-Apr-20
5-Jun-20
5-Aug-20
5-Oct-20
5-Dec-20
5-Feb-21
5-Apr-21
5-Jun-21
5-Aug-21
5-Oct-21
5-Dec-21
5-Feb-22
5-Apr-22
5-Jun-22
5-Aug-22
TP (mg/L)
TN (mg/L)


CLD
6.0
4.0
2.0
0.0
5-Oct-19
5-Dec-19
5-Feb-20
5-Apr-20
5-Jun-20
5-Aug-20
5-Oct-20
5-Dec-20
5-Feb-21
5-Apr-21
5-Jun-21
5-Aug-21
5-Oct-21
5-Dec-21
5-Feb-22
5-Apr-22
5-Jun-22
5-Aug-22
TP (mg/L)
TN (mg/L)


MBL
6.0
4.0
2.0
0.0
5-Oct-19
5-Dec-19
5-Feb-20
5-Apr-20
5-Jun-20
5-Aug-20
5-Oct-20
5-Dec-20
5-Feb-21
5-Apr-21
5-Jun-21
5-Aug-21
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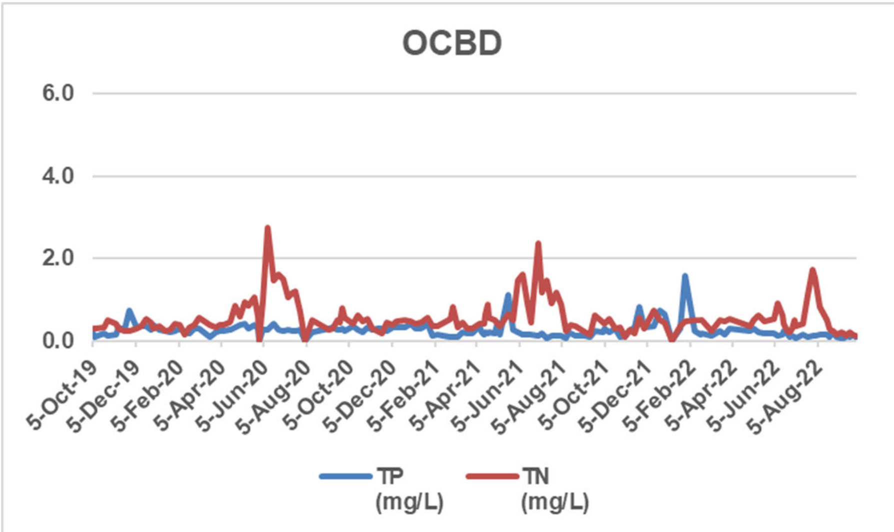
5-Dec-21
5-Feb-22
5-Apr-22
5-Jun-22
5-Aug-22
TP (mg/L)
TN (mg/L)



Appendix 4.
Excel spread sheet of all measured water quality parameters.