Alabama Department of Environmental Management

Tennessee River Basin

Rivers and Reservoirs Monitoring Program

# Dry Branch Embayment
# Wheeler Reservoir
# Intensive Basin Survey 2018 & 2021

**WHEL-7:** Dry Branch immediately downstream of Alt. Hwy 72 bridge (Morgan Co 34.62081/-86.00064)

## BACKGROUND

The Alabama Department of Environmental Management (ADEM) began monitoring lake water quality statewide in 1985, followed by a second statewide survey in 1989. In 1990, the Reservoir Water Quality Monitoring Program [now known as the Rivers and Reservoirs Monitoring Program (RRMP)] was initiated by ADEM.

The current objectives of this program are to provide data that can be used to assess current water quality conditions, to identify trends in water quality conditions, and to develop Total Maximum Daily Loads (TMDLs) and water quality criteria. Descriptions of all RRMP monitoring activities are available in ADEM's 2017 Monitoring Strategy (ADEM 2017).

In 2018 and 2021, ADEM monitored the Dry Branch (Wheeler Lake) tributary embayment as part of the intensive basin assessment of the Tennessee River under the RRMP (Figure 1). This site was selected using historical data and previous assessments. The purpose of this report is to summarize data collected in the Dry Branch (Wheeler Lake) embayment (WHEL-7) during the 2018 and 2021 growing seasons (Apr-Oct). These are the fifth and sixth intensive basin assessments of the Tennessee River since ADEM began sampling on a basin rotation. Monthly and/or mean concentrations of nutrients [total nitrogen (TN); total phosphorus (TP)], algal biomass/productivity [chlorophyll *a* (chl *a*); algal growth potential testing (AGPT)], sediment [total suspended solids (TSS)], and trophic state [Carlson's trophic state index (TSI)] were compared to ADEM's historical data and established criteria.

**Figure 1**. Dry Branch (Wheeler Lake) at WHEL-7.

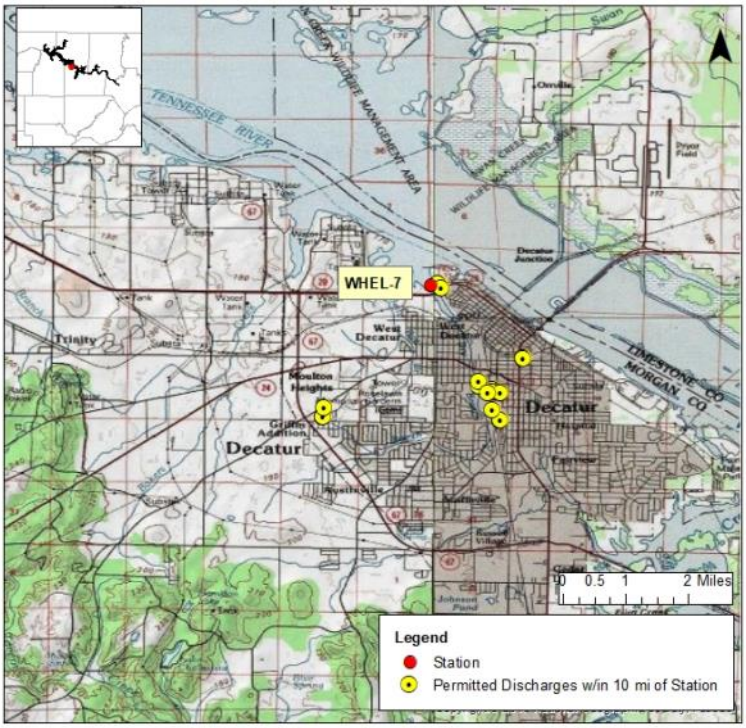



**Figure 2**. Map of the Dry Branch (Wheeler Lake) embayment. Though additional discharges may occur in the watershed (Table 1), only permitted discharges within 10 miles of the station are displayed on the map.

## WATERSHED CHARACTERISTICS

Watershed land uses are summarized in Table 1. Dry Branch (Wheeler Lake) embayment is classified *Fish & Wildlife (F&W)* and located in the Eastern Highland Rim ecoregion (71g). Based on the 2021 National Land Cover Dataset, land use within the 5 $mi^2$ watershed is predominantly developed (95%) (Figure 3). As of February 13, 2024, ADEM has issued permits for a total of 18 NPDES outfalls within the watershed (Figure 2).

**Table 1.** Summary of Watershed **WHEL-7**

| | | |
|---|---|---|
| Basin | | Tennessee R |
| Assessment Unit | | AL06030002-1102-311 |
| Drainage Area ($mi^2$) | | 5 |
| Ecoregion[a] | | 71g |
| % Landuse | | |
| Open Water | | 1% |
| Developed | Open Space | 16% |
| | Low Intensity | 47% |
| | Medium Intensity | 20% |
| | High Intensity | 12% |
| Barren Land | | <1% |
| Forest | Deciduous Forest | 1% |
| | Evergreen Forest | <1% |
| | Mixed Forest | <1% |
| Shrub/Scrub | | <1% |
| Herbaceous | | <1% |
| Hay/Pasture | | 1% |
| Cultivated Crops | | 0% |
| Wetlands | Woody | 1% |
| | Emergent Herb. | <1% |
| # NPDES outfalls[b] | TOTAL | 18 |
| Industrial General | | 14 |
| Municipal | | 3 |
| State Indirect Discharge | | 1 |

a. Eastern Highland Rim
b. #NPDES outfalls downloaded from ADEM's NPDES Management System database, Feb 13, 2024.

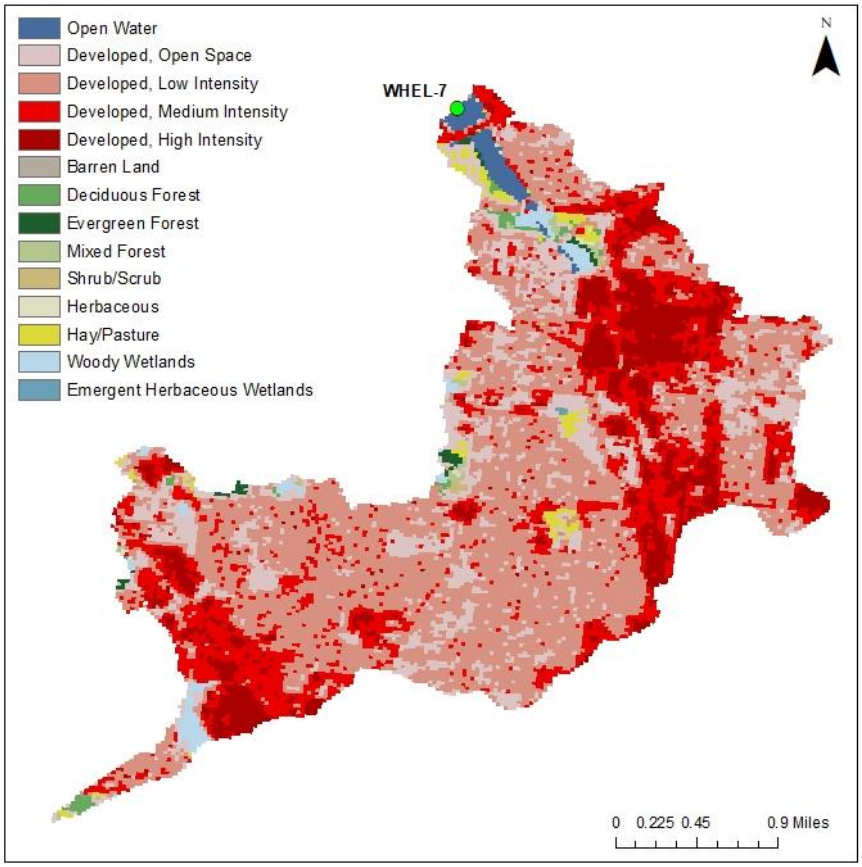



**Figure 3**. Land use within the Dry Branch (Wheeler Lake) watershed at WHEL-7.

## SITE DESCRIPTION

Draining into Wheeler Reservoir near river mile 303, the Dry Branch (Wheeler Lake) embayment at WHEL-7 is located near the center of downtown Decatur, AL. Nearly the entire watershed is contained within its city limits. It is a shallow embayment and had a mean bottom depth of 1.8m in 2018 and 1.6m in 2021 (Table 2) at the sampling location. There is no aquatic vegetation present in this embayment

## METHODS

Water quality samples were conducted at monthly intervals, April-October in 2018 and 2021. All samples were collected, preserved, stored, and transported according to procedures in the ADEM Field Operations Division Standard Operating Procedures (ADEM 2021), Surface Water Quality Assurance Project Plan (ADEM 2018a), and Quality Management Plan (ADEM 2018b).

Mean growing season TN, TP, chl *a*, and TSS were calculated to evaluate water quality conditions. Monthly concentrations of these parameters were graphed with discharge data, if available, and ADEM's previously collected data to help interpret the 2018 and 2021 results. Carlson's TSI was calculated from the corrected chl *a* concentrations (Carlson 1977).

## RESULTS

The following discussion of results is limited to those parameters which directly affect trophic status or parameters which have established criteria. A summary of all water chemistry analyses are presented in Table 2. The axis ranges of the graphs in Figures 4-7 were set to maximum values reservoir-wide so that all embayment reports on the same reservoir could be compared.

Mean growing season TN values increased 2003 to 2013 but then decreased 2013 to 2021, with the 2021 mean being the lowest overall (Figure 4). Monthly TN concentrations were highest in April in 2018 and in June in 2021 (Figure 5).

Mean growing season TP concentrations decreased 2003 to 2015 and have appeared stable since then (Figure 4). In both 2018 and 2021, the highest monthly TP value was observed in April (Figure 5).

**Table 2**. Summary of water quality data collected April-October, 2018 and 2021. Minimum (Min) and maximum (Max) values calculated using minimum detection limits. Median (Med), Mean, and standard deviations (SD) values were calculated by multiplying the MDL by 0.5 when results were less than this value.

| WHEL-7 2018 | N | Min | Max | Med | Avg | SD |
|---|---|---|---|---|---|---|
| **Physical** | | | | | | |
| Turbidity (NTU) | 7 | 11.4 | 43.0 | 14.8 | 22.1 | 14.1 |
| Total Dissolved Solids (mg/L) | 7 | 58.0 | 123.0 | 97.0 | 88.7 | 23.3 |
| Total Suspended Solids (mg/L)[J] | 7 | 11.0 | 19.0 | 15.0 | 14.1 | 2.8 |
| Hardness (mg/L) | 4 | 59.8 | 69.8 | 66.1 | 65.4 | 4.2 |
| Alkalinity (mg/L) | 7 | 56.7 | 69.9 | 63.9 | 63.2 | 4.7 |
| Photic Zone (m) | 7 | 1.20 | 2.00 | 1.80 | 1.70 | 0.26 |
| Secchi (m) | 7 | 0.54 | 0.76 | 0.64 | 0.66 | 0.08 |
| Bottom Depth (m) | 7 | 1.2 | 2.1 | 1.9 | 1.8 | 0.3 |
| **Chemical** | | | | | | |
| Ammonia Nitrogen (mg/L) | 7 | < 0.007 | 0.116 | 0.004 | 0.023 | 0.042 |
| Nitrate+Nitrite Nitrogen (mg/L)[J] | 7 | < 0.004 | 0.273 | 0.007 | 0.064 | 0.100 |
| Total Kjeldahl Nitrogen (mg/L) | 7 | 0.414 | 1.350 | 0.616 | 0.771 | 0.353 |
| Total Nitrogen (mg/L)[J] | 7 | < 1.263 | 4.869 | 0.663 | 0.835 | 0.443 |
| Dis Reactive Phosphorus (mg/L)[J] | 7 | < 0.004 | 0.034 | 0.002 | 0.007 | 0.012 |
| Total Phosphorus (mg/L) | 7 | 0.030 | 0.084 | 0.035 | 0.042 | 0.019 |
| CBOD-5 (mg/L) | 7 | < 2.0 | 5.0 | 3.2 | 3.1 | 1.2 |
| Chlorides (mg/L) | 7 | 3.3 | 6.8 | 6.2 | 5.8 | 1.2 |
| **Biological** | | | | | | |
| Chlorophyll a (mg/m³) | 7 | 3.20 | 29.90 | 23.10 | 20.70 | 9.03 |
| E. coli (MPN/DL)[J] | 4 | 6 | 420 | 8 | 110 | 206 |
| **WHEL-7 2021** | **N** | **Min** | **Max** | **Med** | **Avg** | **SD** |
| **Physical** | | | | | | |
| Turbidity (NTU) | 7 | 3.8 | 14.1 | 10.4 | 9.3 | 3.4 |
| Total Dissolved Solids (mg/L)[J] | 7 | 72.0 | 115.0 | 81.0 | 84.9 | 14.3 |
| Total Suspended Solids (mg/L)[J] | 7 | 5.0 | 16.0 | 11.0 | 10.6 | 3.8 |
| Hardness (mg/L) | 4 | 61.3 | 77.8 | 66.6 | 68.1 | 7.1 |
| Alkalinity (mg/L) | 7 | 55.4 | 68.1 | 62.3 | 61.8 | 4.5 |
| Photic Zone (m) | 7 | 0.78 | 2.20 | 1.63 | 1.61 | 0.43 |
| Secchi (m) | 7 | 0.52 | 0.95 | 0.78 | 0.75 | 0.14 |
| Bottom Depth (m) | 7 | 0.8 | 2.2 | 1.6 | 1.6 | 0.4 |
| **Chemical** | | | | | | |
| Ammonia Nitrogen (mg/L) | 7 | < 0.016 | 0.046 | 0.023 | 0.021 | 0.006 |
| Nitrate+Nitrite Nitrogen (mg/L) | 7 | < 0.003 | 0.151 | 0.002 | 0.049 | 0.069 |
| Total Kjeldahl Nitrogen (mg/L)[J] | 7 | < 0.324 | 0.611 | 0.162 | 0.282 | 0.172 |
| Total Nitrogen (mg/L)[J] | 7 | < 0.490 | 1.838 | 0.313 | 0.330 | 0.154 |
| Dis Reactive Phosphorus (mg/L)[J] | 7 | < 0.004 | 0.007 | 0.004 | 0.004 | 0.002 |
| Total Phosphorus (mg/L) | 7 | 0.013 | 0.083 | 0.037 | 0.043 | 0.022 |
| CBOD-5 (mg/L)[J] | 7 | < 2.0 | 3.6 | 2.3 | 2.3 | 1.1 |
| Chlorides (mg/L) | 7 | 3.8 | 5.8 | 5.1 | 4.9 | 0.8 |
| **Biological** | | | | | | |
| Chlorophyll a (mg/m³) | 7 | 3.20 | 43.50 | 23.50 | 22.69 | 13.30 |
| E. coli (MPN/DL)[J] | 4 | 2 | 86 | 18 | 31 | 39 |

J= one or more of the values is an estimate; N= # samples.

## RESULTS (con't)

Mean growing season chl *a* concentrations decreased slightly from 2003 to 2013, then decreased sharply in 2015 (Figure 4). Values returned to means in the 20s in 2018 and 2021. In 2018, monthly chl *a* concentrations were highest in October (Figure 5). June was the highest monthly concentration recorded in 2021.

According to mean annual TSI, the productivity of the Dry Branch (Wheeler Lake) embayment has been eutrophic every sampling year (Figure 4). In 2018, monthly TSI calculations indicated eutrophic conditions in all months sampled except April, which was mesotrophic (Figure 5). In 2021, the site was eutrophic in all months except October, which was mesotrophic.

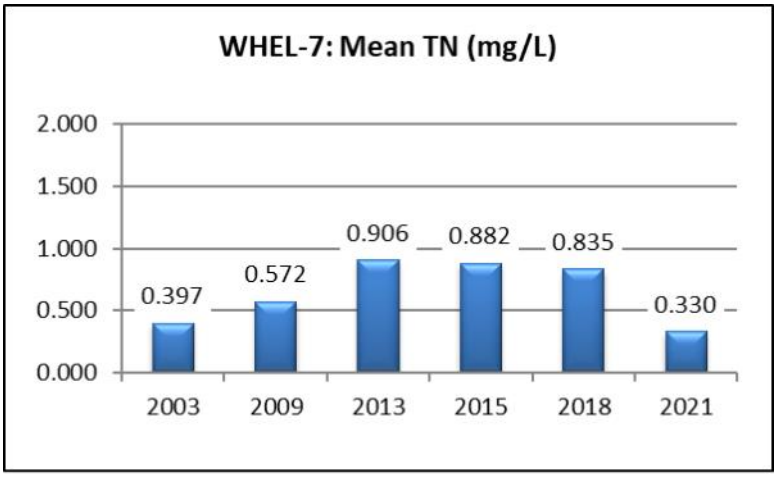
Mean growing season TSS concentrations showed little fluctuation since 2009, though the 2021 mean was the lowest calculated for all sampling years (Figure 4). In 2018, there was little variability among monthly TSS concentrations with values ranging from 11 to 19 mg/L (Figure 6). In 2021, the highest monthly concentration was recorded in September.

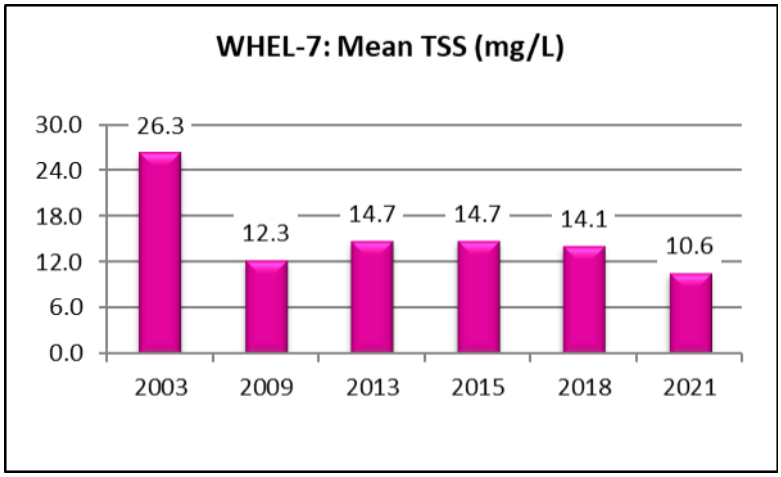
AGPT results show that Dry Branch (Wheeler Lake) was nitrogen-limited all years sampled (Table 3). All samples were near or below the maximum standing crop (MSC) value of 5.0 mg/L that Raschke and Schultz (1987) found protective of reservoir and lake systems.

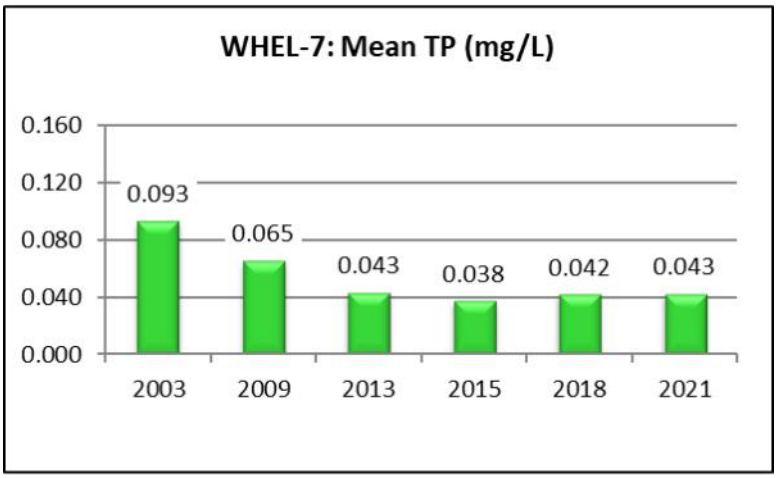
Dissolved oxygen (DO) concentrations at WHEL-7 were above the ADEM minimum criteria limit of 5.0 mg/L at 5.0 ft (1.5 m) in all months sampled during both 2018 and 2021 (ADEM Admin. Code R. 335-6-10-.09) (Figure 7).

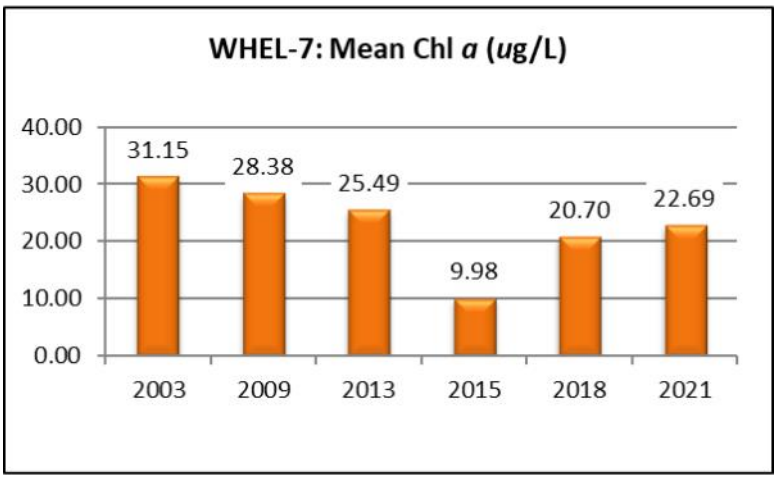
**Table 3.** Algal growth potential test results (expressed as mean maximum standing crop (MSC) dry weights of *Selenastrum capricornutum* in mg/L) and limiting nutrient status. MSC values below 5 mg/L are considered to be protective in reservoirs and lakes (Raschke and Schultz 1987).

| Year | Mean MSC | Limiting Nutrient |
|---|---|---|
| 2003 | 5.52 | Nitrogen |
| 2009 | 3.32 | Nitrogen |
| 2013 | 3.60 | Nitrogen |



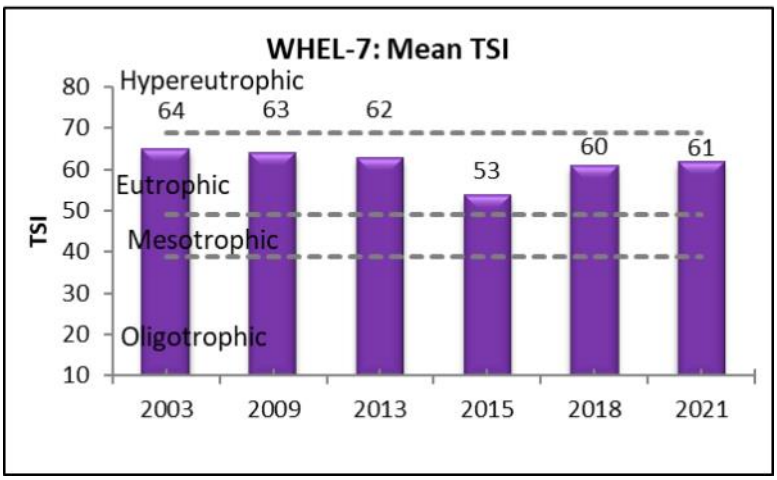
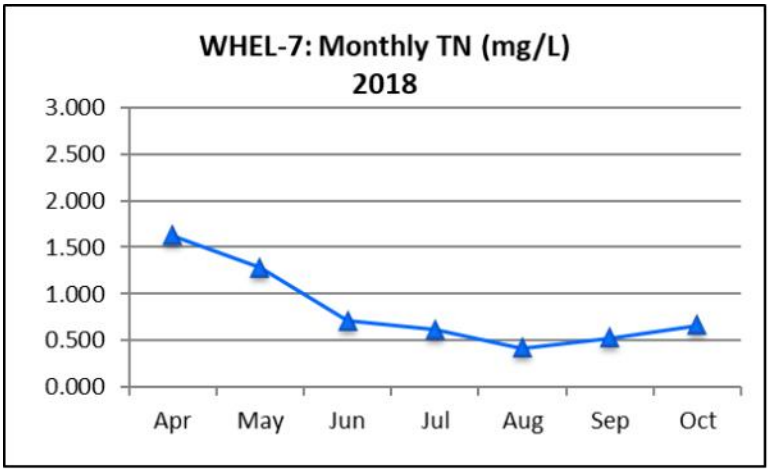
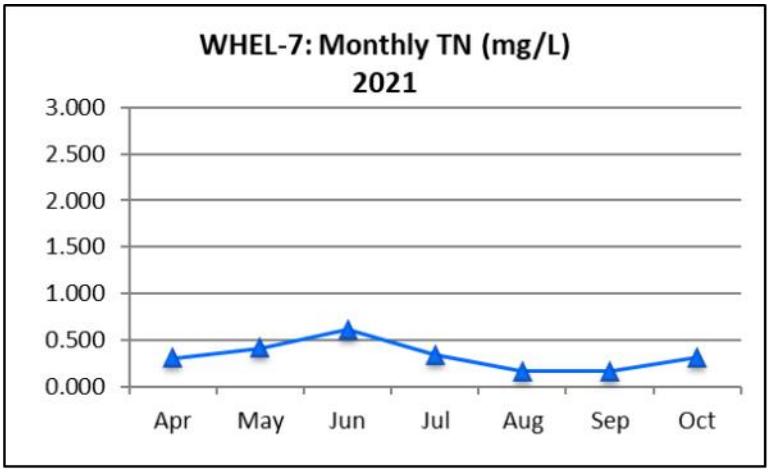
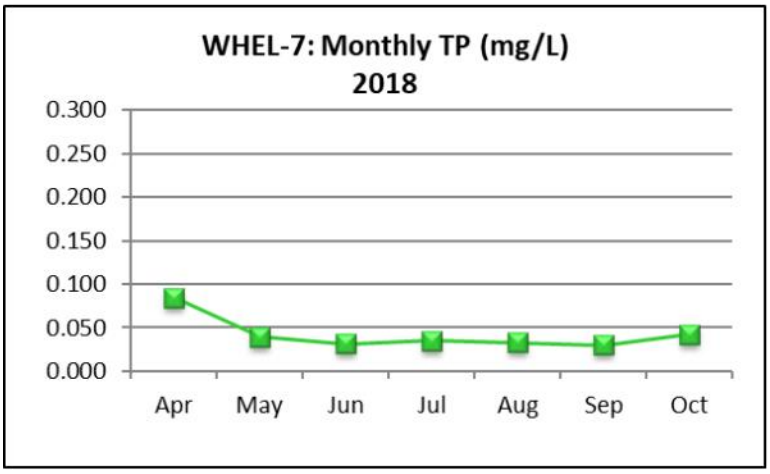
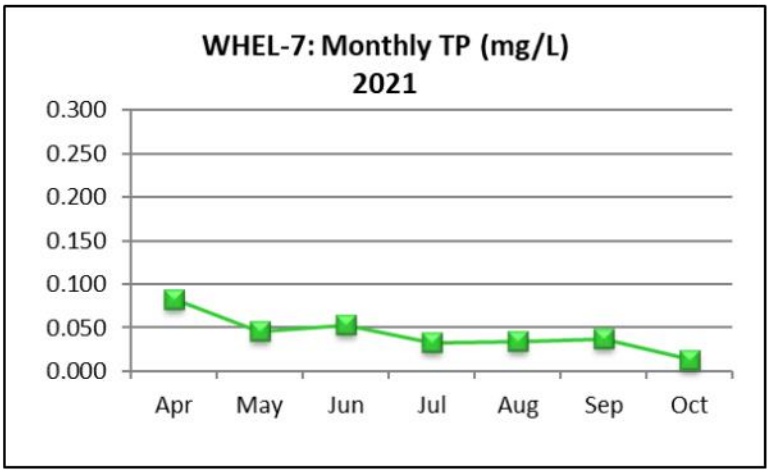



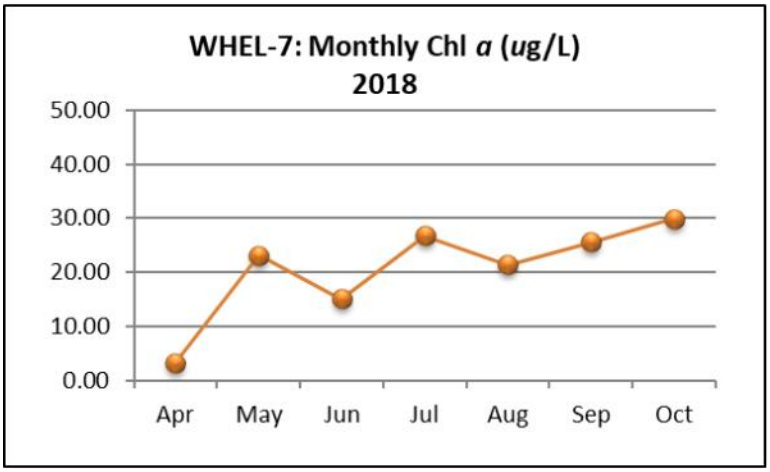

**Figure 4**. Mean growing season (2003-2021). TN, TP, chl *a,* and TSI measured in the Dry Branch (Wheeler Lake) embayment (WHEL-7)**.** Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

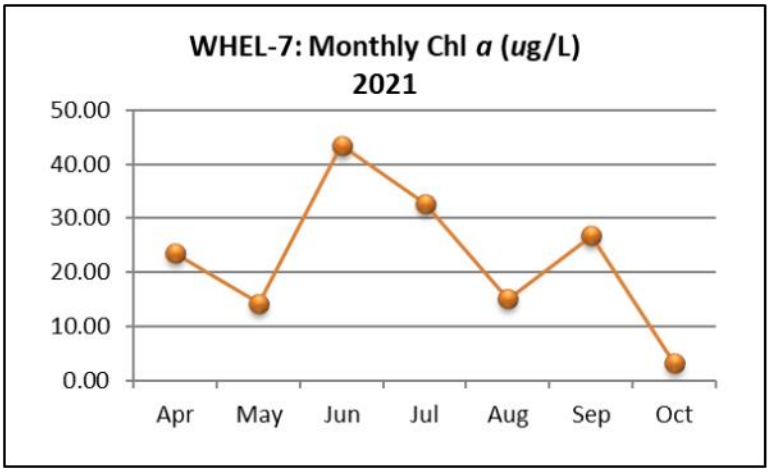


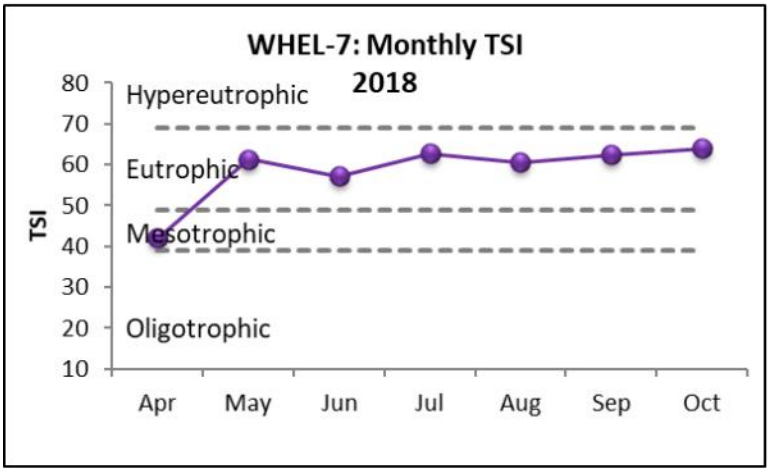



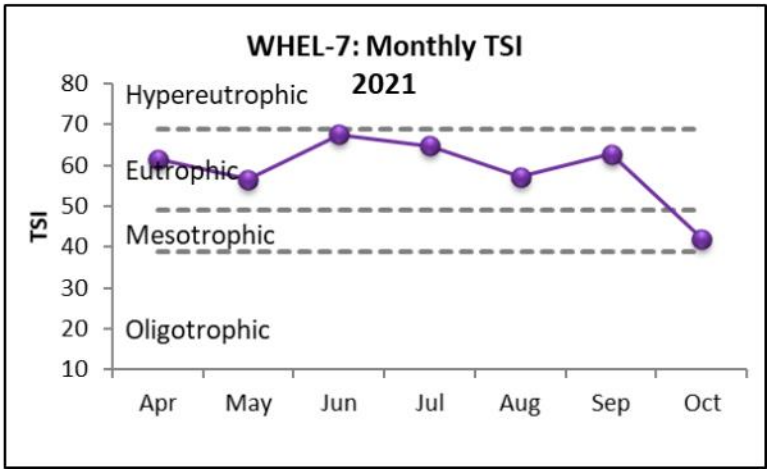




**Figure 5**. Monthly (April-October, 2018 & 2021) TN, TP, chl *a,* and TSI measured in the Dry Branch (Wheeler Lake) embayment (WHEL-7)**.** Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

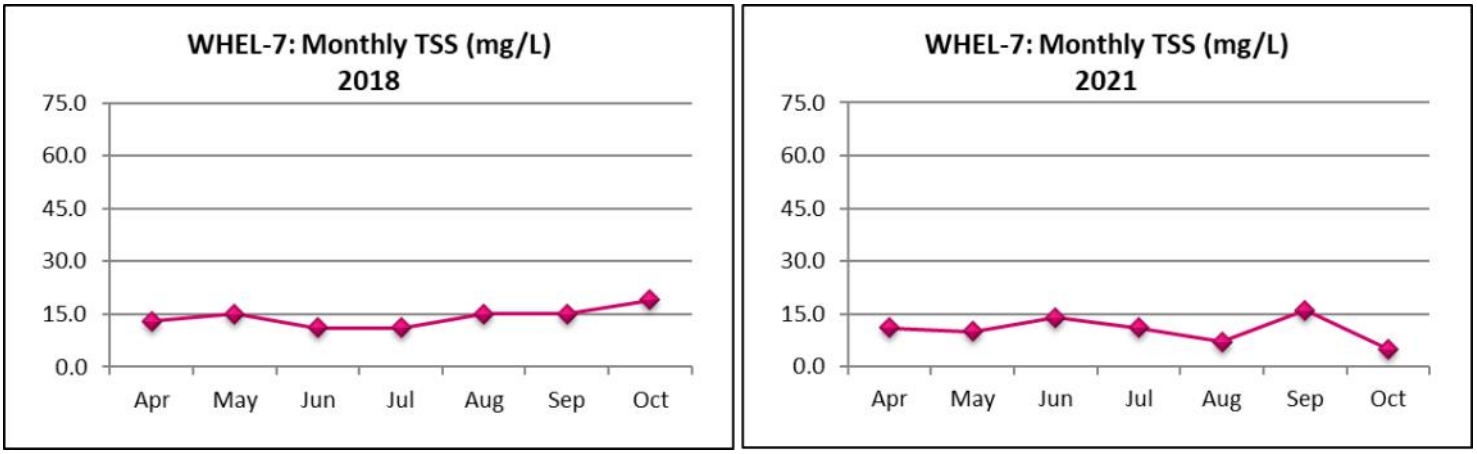



**Figure 6**. Monthly TSS measured in the Dry Branch (Wheeler Lake) embayment (WHEL-7) in 2018 and 2021.

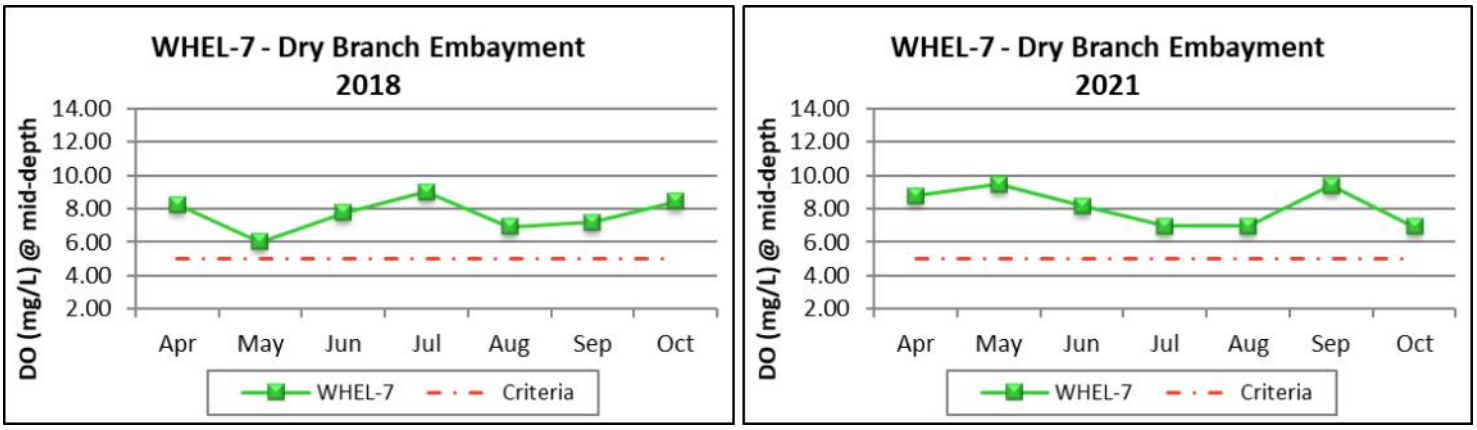



**Figure 7**. Monthly DO concentrations at 1.5 m (5 ft) for Dry Branch (Wheeler Lake) embayment (WHEL-7) collected April-October 2018 and 2021. ADEM Water Quality Criteria pertaining to reservoir waters require a minimum DO concentration of 5.0 mg/L at this depth.

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