

## Big Spring Creek Embayment Guntersville Reservoir Intensive Basin Survey 2015 & 2018

Tennessee River Basin

**GUNM-9:** Big Spring Creek immediately upstream of AL Hwy 227 bridge (Marshall Co 34.34520/-86.29182)

### 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 2015 and 2018, ADEM monitored the Big Spring Creek tributary embayment of Guntersville Reservoir 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 Big Spring Creek embayment (GUNM-9) during the 2015 and 2018 growing seasons (Apr-Oct). This is the fourth and fifth intensive basin assessment 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.

### WATERSHED CHARACTERISTICS

Watershed land uses are summarized in Table 1. Big Spring Creek is classified as a *Public Water Supply/Swimming/Fish & Wildlife (PWS/S/F&W)* stream located in the Sequatchie Valley ecoregion (68b). Based on the 2016 National Land Cover Dataset, land use within the 69 mi<sup>2</sup> watershed is predominantly forest (41%) and agriculture (35%) (Figure 3). As of January 28, 2016, ADEM has issued a total of 71 NPDES permits within the watershed. Six of those permits are located within 10 mi of the station (Figure 2).

### SITE DESCRIPTION

The Big Spring Creek embayment at GUNM-9 is located near Guntersville, AL. It is a large embayment with a fairly deep channel and flows into the Tennessee River near the US 431 bridge crossing. Big Spring Creek has a mean bottom depth near 7.5 m at the sampling location (Table 2).



Figure 1. Big Spring Creek at GUNM-9.

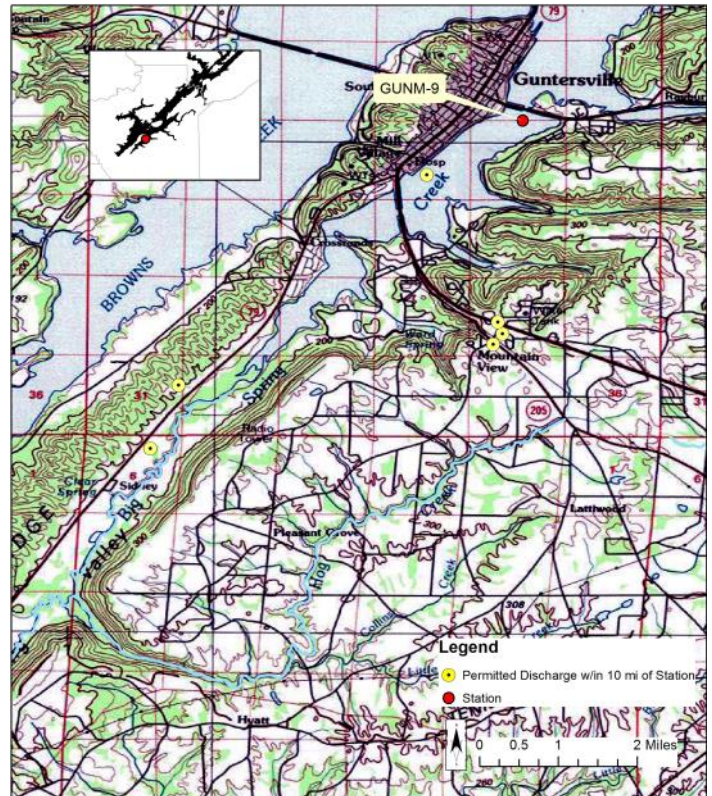
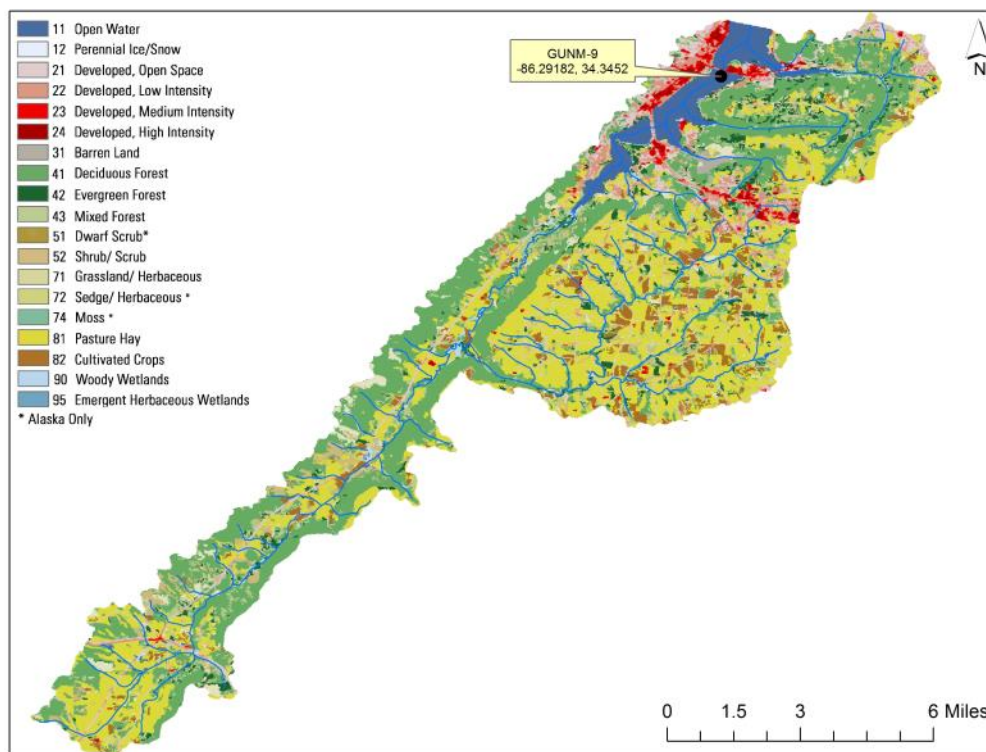


Figure 2. Map of the Big Spring Creek embayment of Guntersville Reservoir. Though additional discharges may occur in the watershed (Table 1), only permitted discharges within 10 miles of the station are displayed on the map.



**Figure 3.** Land use within the Big Spring Creek watershed at GUNM-9.

## METHODS

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

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 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 4-6 were set to maximum values reservoir-wide so that all embayment reports on the same reservoir could be compared.

The mean growing season TN value declined from 2013 to 2015 but increased slightly in 2018 (Figure 4). Monthly TN concentrations were highest in August in both 2015 and 2018.

The mean growing season TP concentration has steadily decreased since sampling began in 2003 (Figure 5). In 2015, the highest monthly TP concentration was measured in August. The highest monthly TP concentration of 2018 was measured in April.

The mean growing season chl *a* value was higher in 2015 than in 2018 (Figure 5). The highest monthly chl *a* concentrations were measured in August during 2015 and in September in 2018.

The mean TSI decreased from 2015 to 2018 (Figure 5). However, mean TSI has remained eutrophic for all years sampled. In 2015, monthly TSI in Big Spring Creek was oligotrophic April-June, increasing to eutrophic in July. Eutrophic conditions were observed throughout the growing season in 2018.

**Table 1.** Summary of Watershed **GUNM-9**

Basin		Tennessee R
Drainage Area (mi <sup>2</sup> )		69
Ecoregion <sup>a</sup>		68b
Assessment Unit		AL06030001-0903-111
% Landuse		
Open Water		4%
Developed	Open Space	6%
Low Intensity		<1%
Medium Intensity		<1%
High Intensity		<1%
Barren Land		<1%
Forest	Deciduous Forest	30%
Evergreen Forest		4%
Mixed Forest		7%
Shrub/Scrub		5%
Herbaceous		3%
Hay/Pasture		30%
Cultivated Crops		5%
Wetlands	Woody	1%
Emergent Herb.		<1%
# NPDES outfalls <sup>b</sup>		TOTAL
Construction Stormwater		18
Mining		2
Small Mining		2
Industrial General		34
Industrial Individual		8
No Exposure		2
Underground Injection Control		5

a. Sequatchie Valley

b. #NPDES outfalls downloaded from ADEM's NPDES Management System database, Jan 28, 2016.

**Table 2.** Summary of water quality data collected April-October, 2015 and 2018. 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.

GUNM-9 2015	N	Min	Max	Med	Avg	SD
<b>Physical</b>						
Turbidity (NTU)	7	2.7	6.9	5.5	5.1	1.4
Total Dissolved Solids (mg/L)	7	86.0	117.0	107.0	102.9	12.0
Total Suspended Solids (mg/L)	7	< 1.0	11.0	5.0	5.2	3.5
Hardness (mg/L)	4	65.7	79.9	74.2	73.5	6.1
Alkalinity (mg/L)	7	63.2	78.2	67.9	68.5	5.0
Photic Zone (m)	7	2.76	5.92	3.46	3.97	1.38
Secchi (m)	7	0.86	3.16	1.54	1.68	0.80
Bottom Depth (m)	7	7.4	7.8	7.6	7.6	0.1
<b>Chemical</b>						
Ammonia Nitrogen (mg/L) <sup>J</sup>	7	< 0.007	0.048	0.017	0.022	0.017
Nitrate+Nitrite Nitrogen (mg/L) <sup>J</sup>	7	0.001	0.272	0.006	0.048	0.099
Total Kjeldahl Nitrogen (mg/L) <sup>J</sup>	7	0.118	1.170	0.458	0.558	0.420
Total Nitrogen (mg/L) <sup>J</sup>	7	0.124	1.196	0.553	0.606	0.404
Dis Reactive Phosphorus (mg/L) <sup>J</sup>	7	0.002	0.004	0.003	0.003	0.001
Total Phosphorus (mg/L)	7	0.017	0.038	0.022	0.024	0.008
CBOD-5 (mg/L) <sup>J</sup>	7	< 2.0	2.0	1.0	1.0	0.0
Chlorides (mg/L)	7	4.8	7.9	7.0	6.6	1.0
<b>Biological</b>						
Chlorophyll a (mg/m <sup>3</sup> )	7	< 1.00	40.00	27.00	19.23	17.25
E. coli (MPN/DL)	3	3	15	4	7	6
GUNM-9 2018	N	Min	Max	Med	Avg	SD
<b>Physical</b>						
Turbidity (NTU)	7	2.7	6.0	3.7	3.9	1.1
Total Dissolved Solids (mg/L)	7	84.0	101.0	91.0	91.6	5.7
Total Suspended Solids (mg/L) <sup>J</sup>	7	2.0	8.0	5.0	4.6	2.4
Hardness (mg/L)	4	62.0	70.9	64.8	65.6	4.2
Alkalinity (mg/L)	7	61.6	65.9	62.8	63.3	1.3
Photic Zone (m)	7	2.46	5.15	4.59	4.41	0.94
Secchi (m)	7	0.87	1.48	1.29	1.24	0.22
Bottom Depth (m)	7	7.2	8.0	7.7	7.7	0.3
<b>Chemical</b>						
Ammonia Nitrogen (mg/L) <sup>J</sup>	7	< 0.015	0.050	0.008	0.021	0.020
Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.007	0.235	0.004	0.040	0.086
Total Kjeldahl Nitrogen (mg/L)	7	0.170	1.450	0.519	0.579	0.407
Total Nitrogen (mg/L)	7	< 0.174	1.454	0.522	0.619	0.410
Dis Reactive Phosphorus (mg/L) <sup>J</sup>	7	< 0.004	0.010	0.002	0.005	0.004
Total Phosphorus (mg/L) <sup>J</sup>	7	0.007	0.032	0.014	0.016	0.008
CBOD-5 (mg/L)	7	< 2.0	2.0	1.0	1.0	0.0
Chlorides (mg/L) <sup>J</sup>	7	3.5	5.5	4.4	4.5	0.8
<b>Biological</b>						
Chlorophyll a (mg/m <sup>3</sup> )	7	11.70	20.30	14.40	14.80	2.89
E. coli (MPN/DL)	4	1	15	7	8	6

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

## RESULTS (con't)

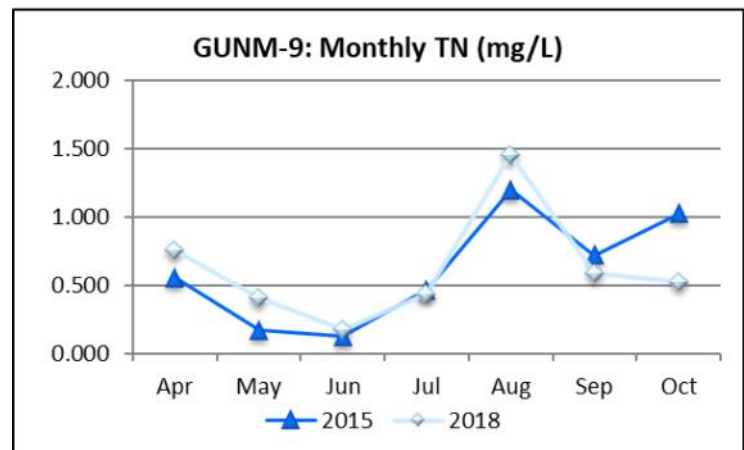
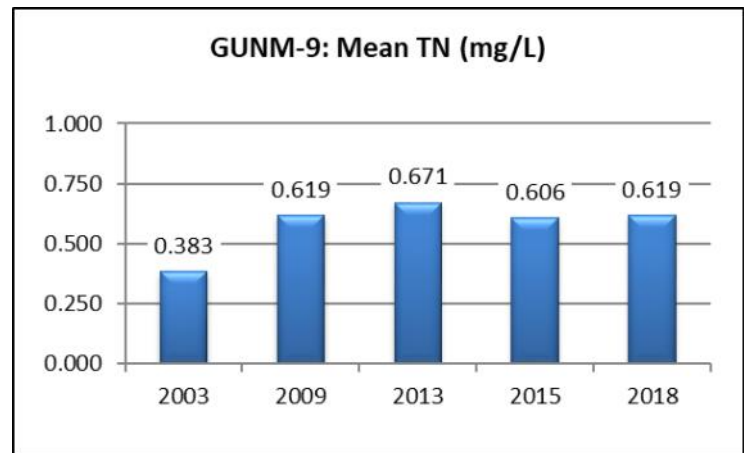
The mean growing season TSS value decreased from 2015 to 2018 (Figure 5). Monthly TSS concentrations were highest in July during 2015 and in October during 2018.

AGPT results show that Big Spring Creek was co-limiting in 2013 (Table 3). Raschke and Schultz (1987) found that maximum standing crop (MSC) values below 5.0 mg/L are considered to be protective of reservoir and lake systems. The 2013 MSC value was 5.44 mg/L. No AGPT samples were collected during the 2015 or 2018 sampling seasons.

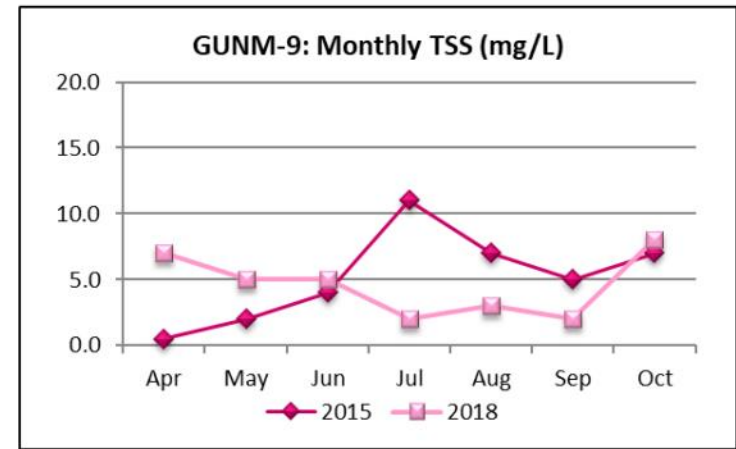
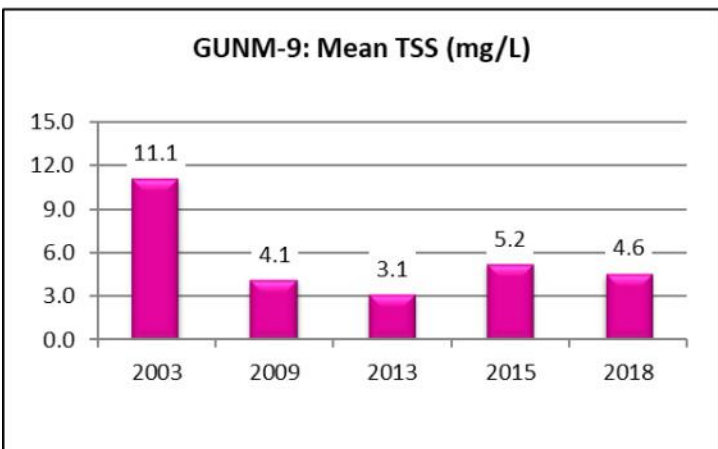
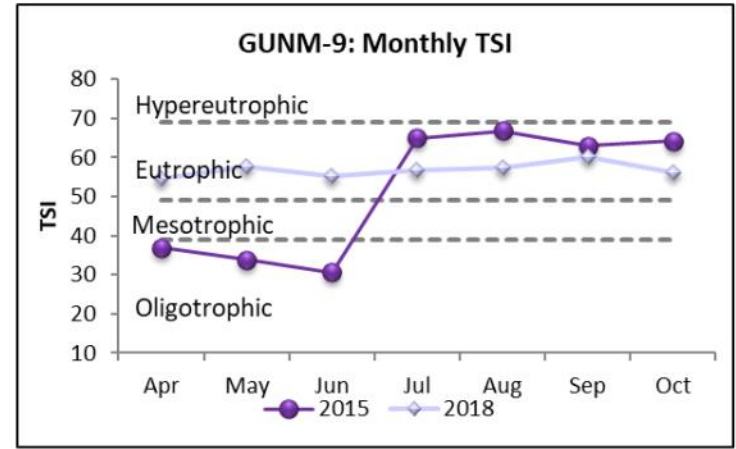
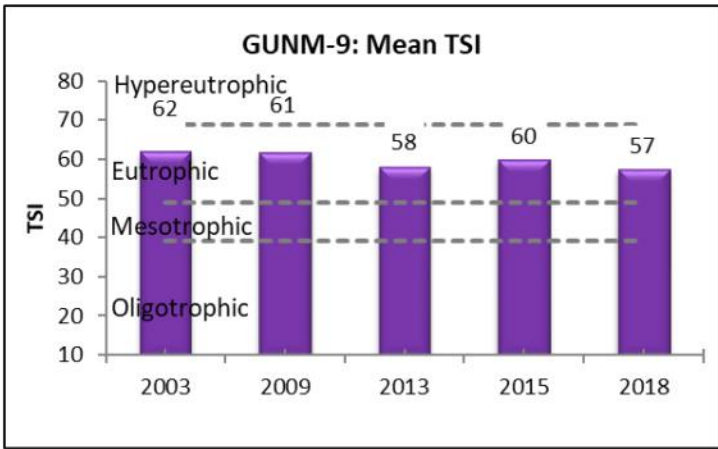
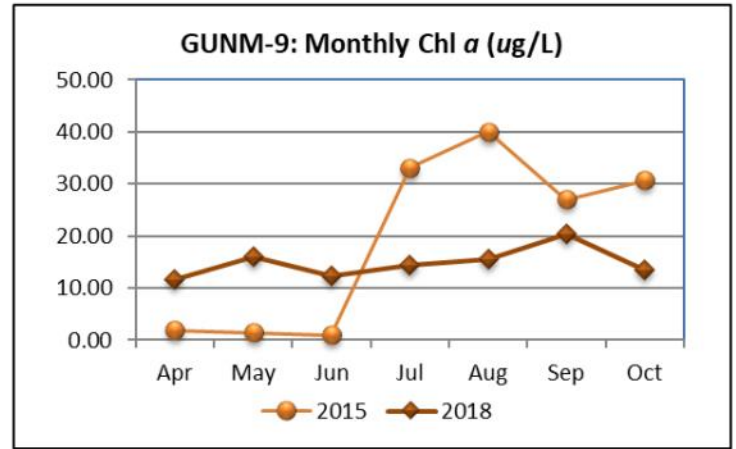
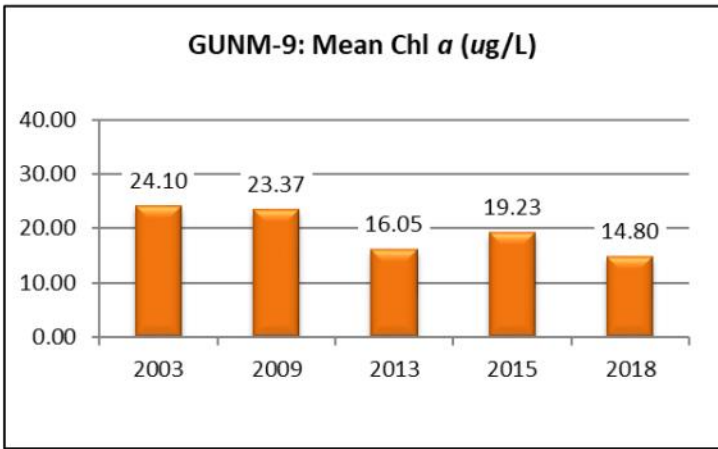
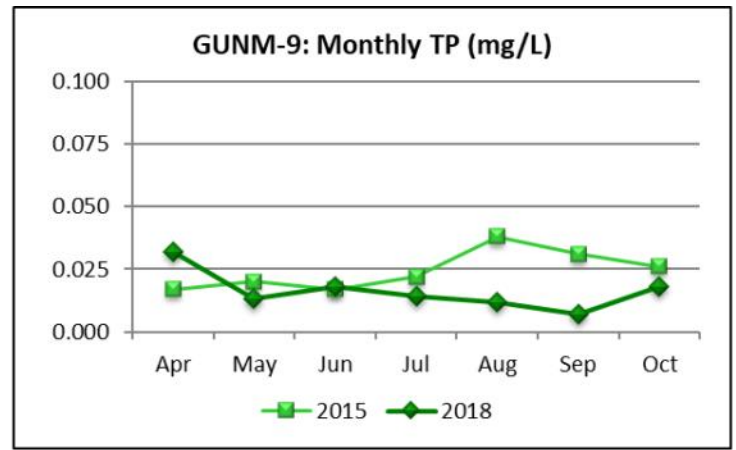
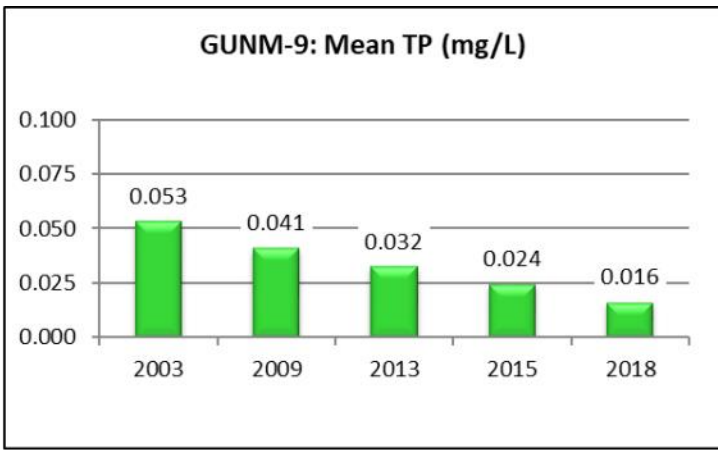
DO concentrations at the Big Spring Creek station were above the ADEM criteria limit of 5.0 mg/L at 5.0 ft (1.5 m) for all samples collected during the 2015 and 2018 growing seasons (ADEM Admin. Code R. 335-6-10-.09) (Figure 6).

**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).

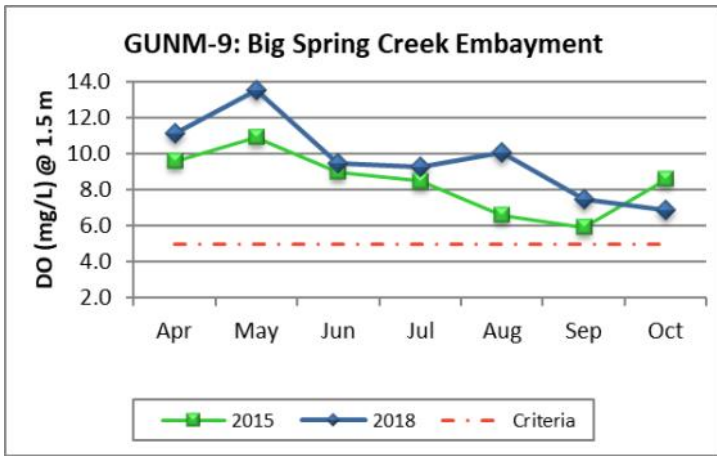
Year	Mean MSC	Limiting Nutrient
8/20/2003	4.23	PHOSPHORUS
8/18/2009	3.01	NITROGEN
8/21/2013	5.44	CO-LIMITING



**Figure 4.** Mean growing season (2003-2018) and monthly (April-October, 2015 and 2018) TN measured in the Big Spring Creek embayment (GUNM-9) of Guntersville Reservoir. Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.



**Figure 5.** Mean growing season (2003-2018) and monthly (April-October, 2015 and 2018) TP, chl *a*, TSI, and TSS measured in the Big Spring Creek embayment (GUNM-9) of Guntersville Reservoir. Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.



**Figure 6.** Monthly DO concentrations at 1.5 m (5 ft) for Big Spring Creek embayment station (GUNM-9) of Guntersville Reservoir collected April-October 2015 and 2018. ADEM Water Quality Criteria pertaining to reservoir waters require a minimum DO concentration of 5.0 mg/L at this depth.

## REFERENCES

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- ADEM. 2018a. Standard Operating Procedures Series #2000, Alabama Department of Environmental Management (ADEM), Montgomery, AL.
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