Alabama Department of Environmental Management

Tennessee River Basin

Rivers and Reservoirs Monitoring Program

Limestone Creek Embayment
Wheeler Reservoir
Intensive Basin Survey 2013

WHEL-5: Limestone Creek approx 1 mi upstream of confluence with TN River (Madison Co 34.5107/-86.5141)

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, 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 2012 Monitoring Strategy (ADEM 2012).

In 2013, ADEM monitored the Limestone Creek tributary embayment of Wheeler Reservoir as part of the intensive basin assessment of the Tennessee River under the RRMP. This site was selected using historical data and previous assessments. The purpose of this report is to summarize data collected in the Limestone Creek embayment (WHEL-5) during the 2013 growing season (Apr-Oct). This is the third 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)] from 2013 were compared to ADEM's historical data and established criteria.

A consumption advisory was issued by the Alabama Department of Public Health in 2010 for mercury in fish from Limestone Creek. As a result, the embayment portion of Limestone Creek is listed on the 2012 Alabama's Clean Water Act (CWA) §303(d) list of impaired waters for not meeting its water use classifications.

WATERSHED CHARACTERISTICS

Watershed land uses are summarized in Table 1. Limestone Creek is classified as a *Fish & Wildlife (F&W)* stream located in the Eastern Highland Rim ecoregion (71g). Based on the 2006 National Land Cover Dataset, land use within the 285 mi^2 watershed is predominantly agriculture (60%) (Fig. 3). As of October 1, 2013, ADEM has issued a total of 160 NPDES permits within the watershed. Eleven of those permits are located within 10 mi of the station (Fig. 2).

SITE DESCRIPTION

The Limestone Creek embayment at WHEL-5 is a very large embayment fed by Piney, Limestone, and Beaverdam Creeks. The mean bottom depth at the sample location is 3.28m. It is located on the north side of the river just east of I-65, and south of I-565. There are numerous islands and grass flats in the bay, though the main channel is clear of aquatic vegetation.

Figure 1. Photo of Limestone Creek at WHEL-5.

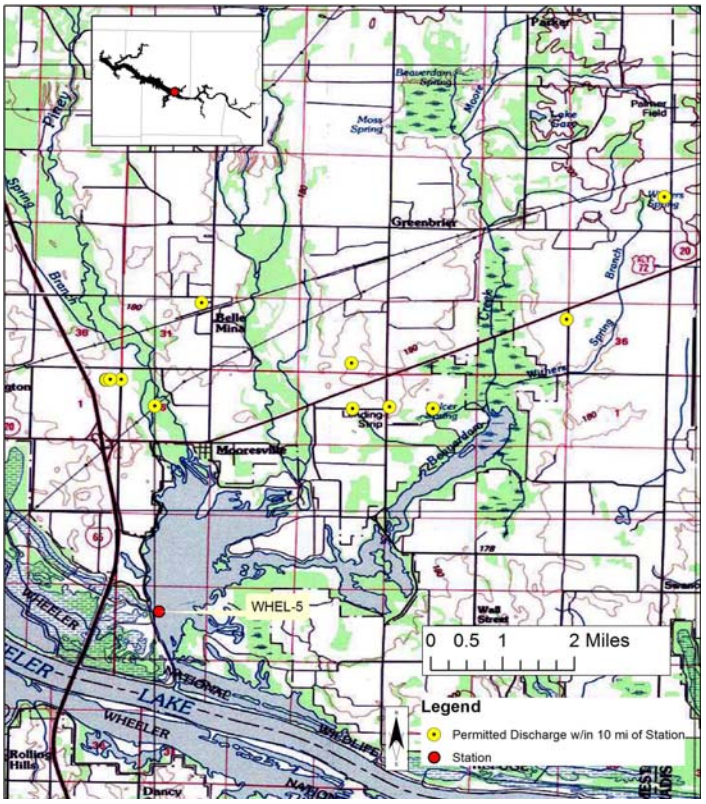


Figure 2. Map of Limestone Creek embayment of Wheeler Reservoir. Though additional permits may occur in the watershed (Table 1), only permitted discharges within 10 miles upstream of the station are displayed on the map.

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 2013b), Surface Water Quality Assurance Project Plan (ADEM 2012), and Quality Management Plan (ADEM 2013a).

Mean growing season TN, TP, chl *a*, and TSS were calculated to evaluate water quality conditions. Monthly concentrations of these parameters were graphed with ADEM's previously collected data to help interpret the 2013 results. Carlson's TSI was calculated from the corrected chl *a* concentrations.

RESULTS

The following discussion of results is limited to those parameters which directly affect trophic status or parameters which have established criteria. Results of all water chemistry analyses are presented in Table 2. The axis ranges of the graphs in Figs. 4-6 were set to maximum values reservoir wide so all embayment reports on the same reservoir could be compared.

Table 1: Summary of Watershed **WHEL-5**

Basin		Tennessee R
Drainage Area (mi^2)		285
Ecoregion[a]		71g
% Land use		
Open Water		1%
Developed	Open Space	7%
	Low Intensity	3%
	Medium Intensity	<1%
	High Intensity	<1%
Barren Land		<1%
Forest	Deciduous Forest	12%
	Evergreen Forest	2%
	Mixed Forest	3%
Shrub/Scrub		5%
Herbaceous		3%
Hay/Pasture		36%
Cultivated Crops		24%
Wetlands	Woody	4%
	Emergent Herb.	<1%
# NPDES Permits[b]	TOTAL	160
401 Water Quality Certification		10
Construction Stormwater		113
Mining		2
Industrial General		14
Municipal Individual		6
Underground Injection Control		15

a. Eastern Highland Rim

b. # NPDES permits downloaded from ADEM's NPDES Management System database, Oct 1, 2013.

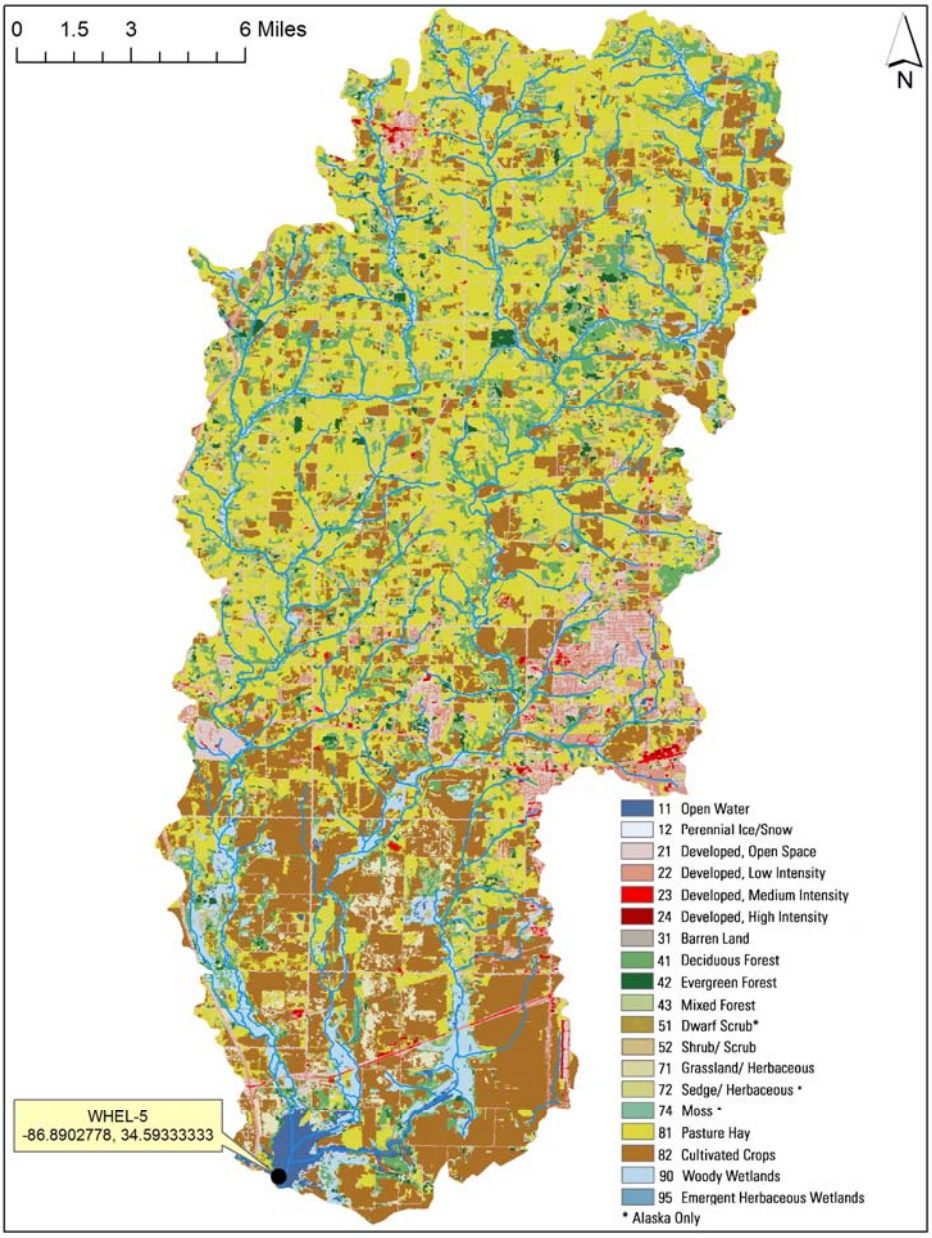


Figure 3. Land use within the Limestone Creek watershed at WHEL-5.

Mean growing season TN values increased from 2003 through 2013 (Fig. 4). Monthly TN concentrations were highest in April and declined through the growing season.

Mean growing season TP concentrations declined 2003 through 2013 (Fig. 4). Monthly TP concentrations varied little through the growing season.

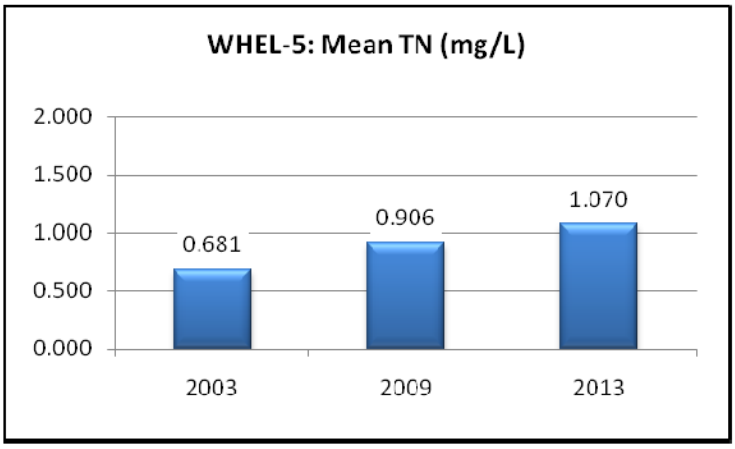
The growing season mean chl *a* value in 2013 was higher than 2009 and 2003 (Fig. 4). Monthly chl *a* concentrations were highest in April and declined through the growing season.

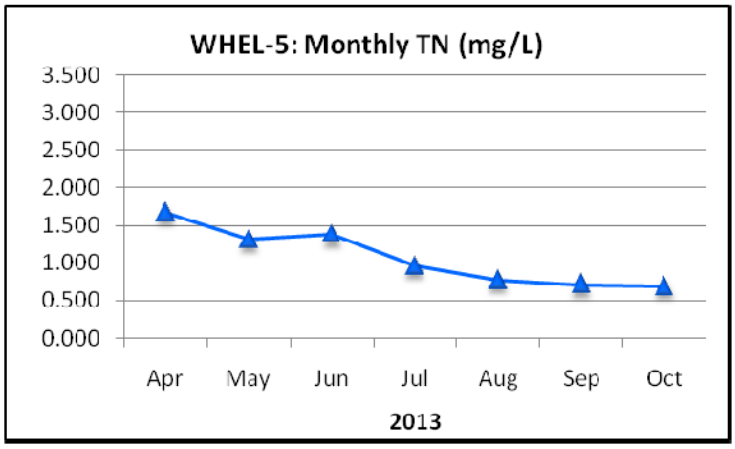
Mean TSI values have remained eutrophic all years monitored. Monthly TSI in Limestone Creek was eutrophic April-September (Fig. 4).

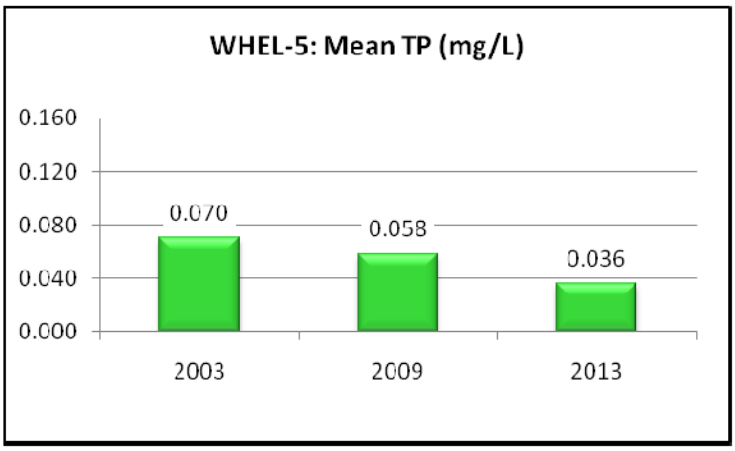
The mean growing season TSS value in 2013 was higher than 2009 but lower than 2003 (Fig. 5). The monthly TSS concentration was highest in July.

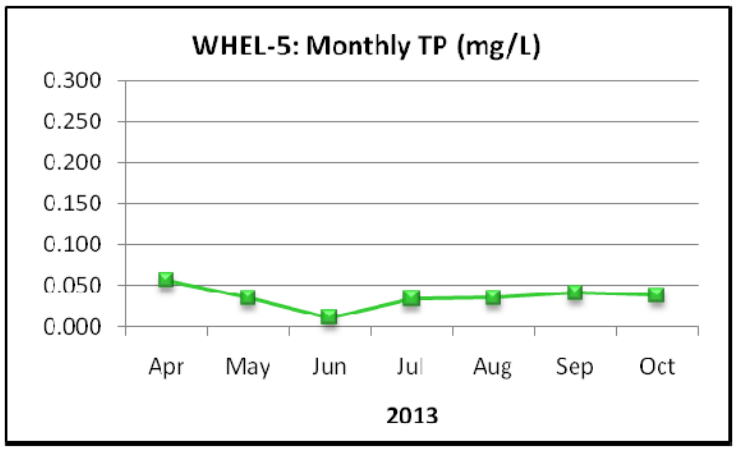
AGPT results show that WHEL-5 was phosphorus limited in 2013 and 2003 and nitrogen limited in 2009 (Table 3). The mean maximum standing crop (MSC) values in 2013 and 2003 exceeded the 5.0 mg/L value that Raschke and Schultz (1987) defined as protective of reservoir and lake systems.

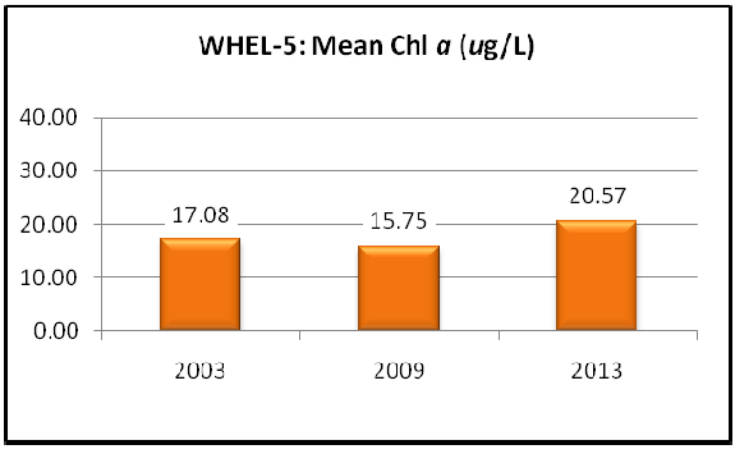
DO concentrations in the WHEL-5 station remained above the ADEM criteria limit (ADEM Admin. Code R. 335-6-10-.09) of 5.0 mg/l at 5.0 ft (1.5 m) April through October (Fig. 6).

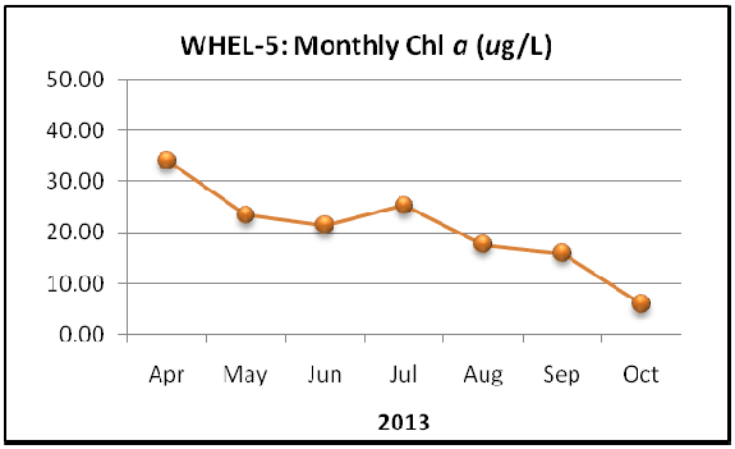


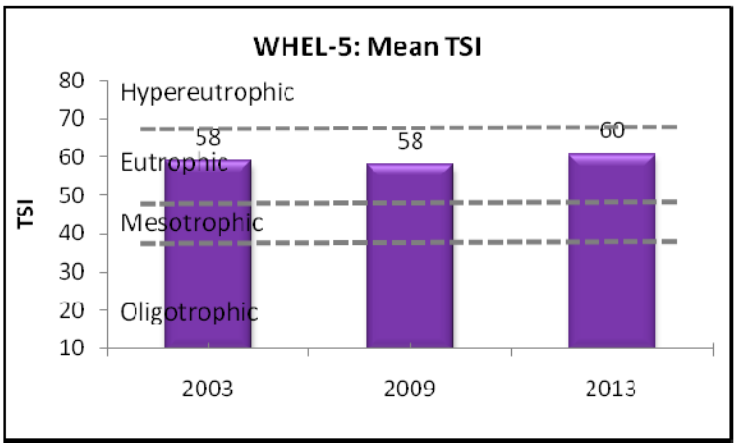












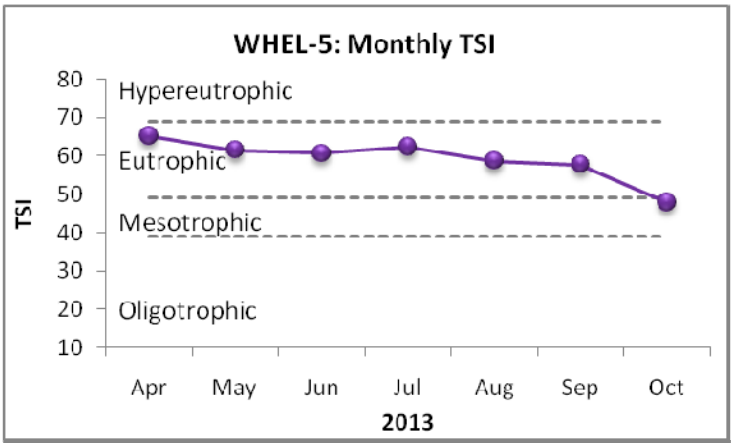
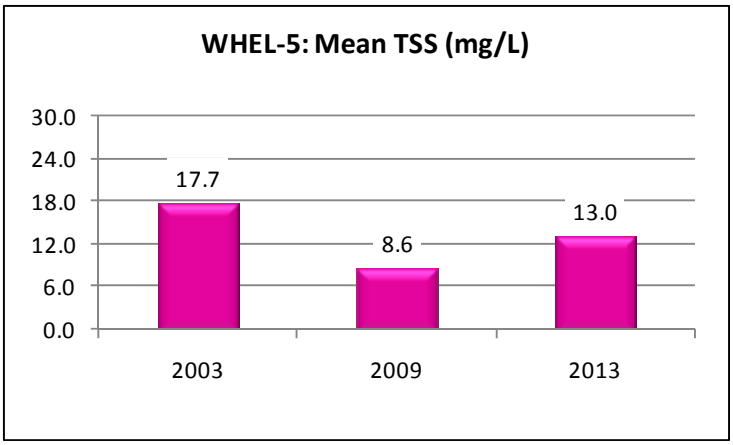


Figure 4. Mean growing season (2003-2013) and monthly (April-October, 2013) TN, TP, chl a and TSI measured in the Limestone Creek embayment of Wheeler Reservoir**.** Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.



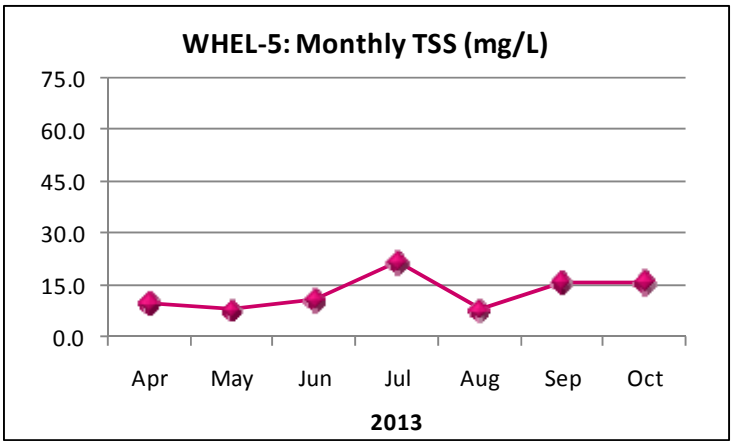


Figure 5. Mean growing season and monthly TSS measured in the Limestone Creek embayment of Wheeler Reservoir.

Table 2. Summary of water quality data collected April-October, 2013. 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-5	N		Min	Max	Med	Mean	SD
Physical							
Turbidity (NTU)	8		8.6	17.4	11.6	11.9	3.0
Total Dissolved Solids (mg/L)[J]	7		67.0	117.0	94.0	89.4	16.7
Total Suspended Solids (mg/L)	7		8.0	22.0	11.0	13.0	5.2
Hardness (mg/L)	4		39.9	79.4	61.8	60.7	16.8
Alkalinity (mg/L)[J]	7		18.1	50.2	42.0	38.9	11.9
Photic Zone (m)	7		1.53	2.44	2.25	2.14	0.31
Secchi (m)	7		0.60	1.11	0.77	0.82	0.16
Bottom Depth (m)	8		2.90	3.73	3.31	3.28	0.35
Chemical							
Ammonia Nitrogen (mg/L)[J]	7	<	0.015	0.064	0.014	0.023	0.022
Nitrate+Nitrite Nitrogen (mg/L)	7		0.069	0.751	0.250	0.321	0.250
Total Kjeldahl Nitrogen (mg/L)	7		0.451	1.280	0.693	0.750	0.279
Total Nitrogen (mg/L)	7		0.693	1.671	0.957	1.070	0.384
Dissolved Reactive Phosphorus (mg/L)	7	<	0.007	0.041	0.010	0.012	0.013
Total Phosphorus (mg/L)	7		0.011	0.056	0.035	0.036	0.013
CBOD-5 (mg/L)[J]	7	<	2.0	2.5	1.0	1.2	0.6
Chlorides (mg/L)[J]	7		4.4	5.8	4.7	4.9	0.5
Biological							
Chlorophyll a (ug/L)	7		5.87	34.20	21.40	20.57	8.80
E. coli (col/100mL)[J]	3	<	1	7	6	5	4

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

Table 3. Algal growth potential test results (expressed as mean 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).

WHEL-5	MSC	Limiting Nutrient
8/19/2003	7.04	PHOSPHORUS
8/19/2009	4.13	NITROGEN
8/21/2013	12.3	PHOSPHORUS

FOR MORE INFORMATION, CONTACT:
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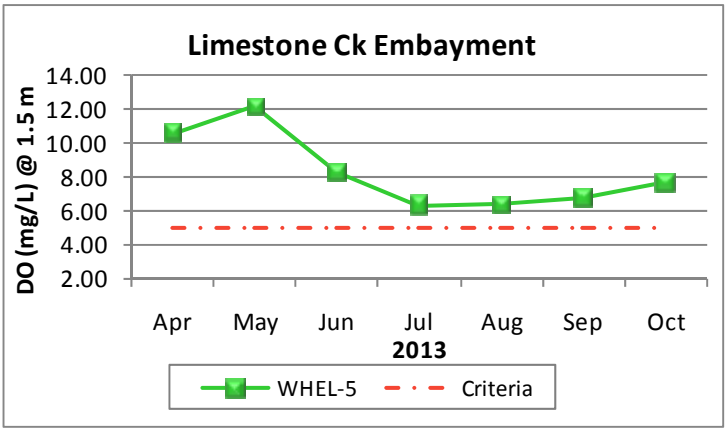

Figure 6. Monthly DO concentrations at 1.5 m (5 ft) for Limestone Creek embayment station of Wheeler Reservoir collected April-October 2013. ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/L at this depth.

REFERENCES

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