

Limestone Creek Embayment Wheeler Reservoir Intensive Basin Survey 2009

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 2009, 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 2009 growing season (Apr-Oct). This is the second 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 [chl *a*; algal growth potential testing (AGPT)], sediment [total suspended solids (TSS)], and trophic state [Carlson's trophic state index (TSI)] from 2009 were compared to ADEM's 2003 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 mi² watershed is predominantly hay/pasture (36%) and crops (24%) (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. 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

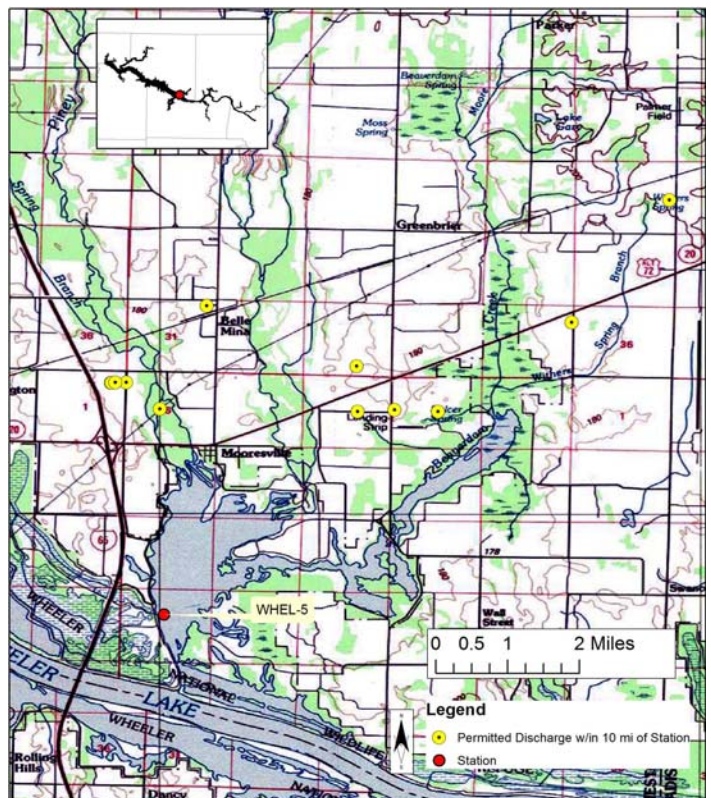


Figure 2. Map of Limestone Creek embayment of Wheeler Reservoir. Though additional permits may occur in the watershed (Table 1), only permitted discharges within 10 miles upstream of the station are displayed on the map.

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 2009), Surface Water Quality Assurance Project Plan (ADEM 2008a), and Quality Management Plan (ADEM 2008b).

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 2009 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
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 do wnlo aded from ADEM's NPDES Management System database, Oct 1, 2013.

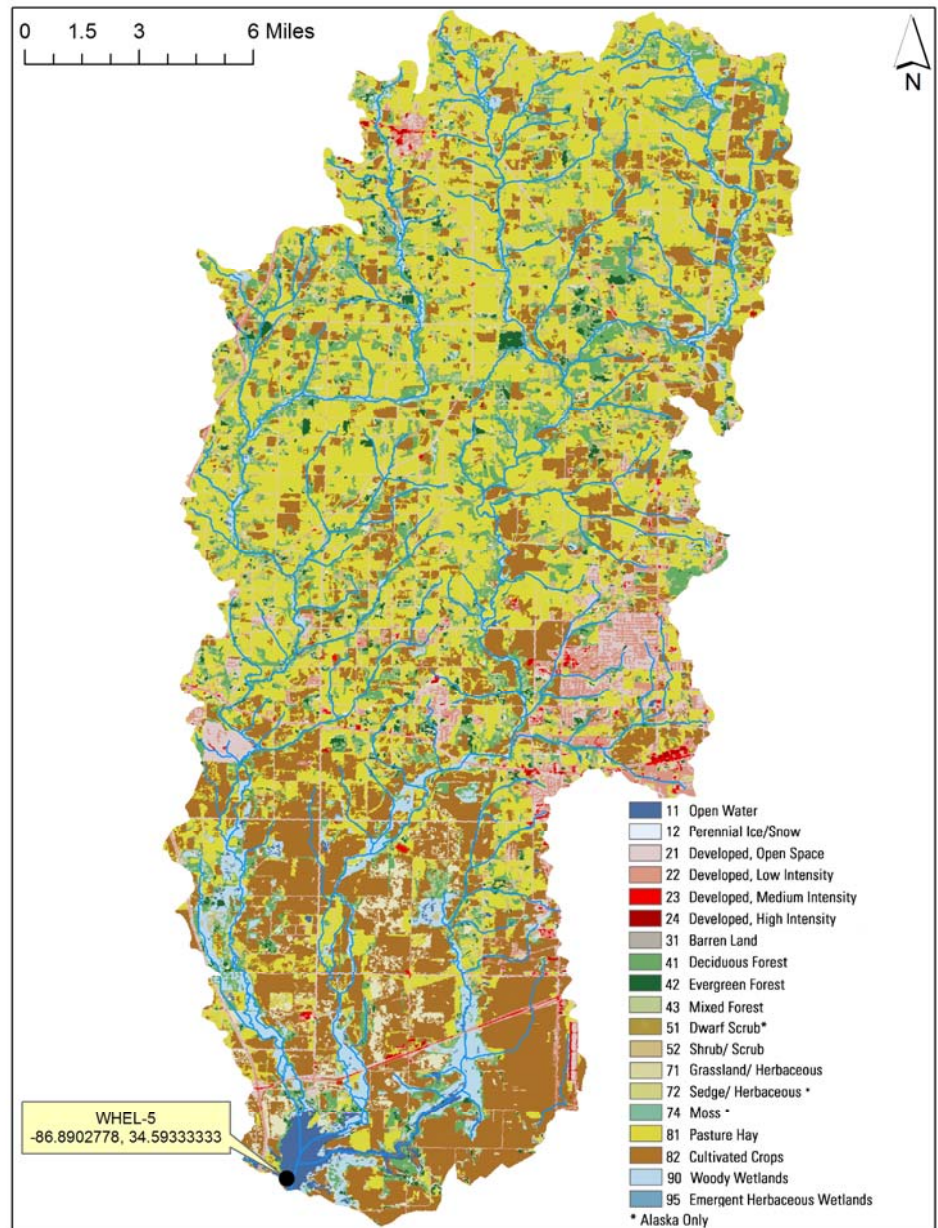


Figure 3. Land use within the Limestone Creek watershed at WHEL-5.

The mean growing season TN value was higher in 2009 than in 2003 (Fig. 4). Monthly TN concentrations generally decreased April-September.

The mean growing season TP concentration was slightly lower in 2009 (Fig. 4). Monthly TP concentrations were generally similar April-October.

In 2009, the growing season mean chl *a* value was lower than 2003 (Fig. 4). Monthly chl *a* concentrations peaked in July and declined through October.

Mean TSI was eutrophic in 2009, exactly the same as 2003. Monthly TSI in Limestone Creek was eutrophic April-September (Fig. 4).

The mean growing season TSS value was lower in 2009 than 2003 (Fig. 5). Monthly TSS concentration was highest in June and low most other months sampled.

AGPT results show that WHEL-5 was nitrogen limited in 2009 while it was phosphorus limited in 2003 (Table 3). Though higher in 2003, the mean maximum standing crop (MSC) value from 2009 was below the 5.0 mg/L value that Raschke and Schultz (1987) defined as protective of reservoir and lake systems.

The DO concentration in the WHEL-5 station was above the ADEM criteria limit of 5.0 mg/l at 5.0 ft (1.5 m) in all months (ADEM Admin. Code R. 335-6-10-.09) (Fig. 6).

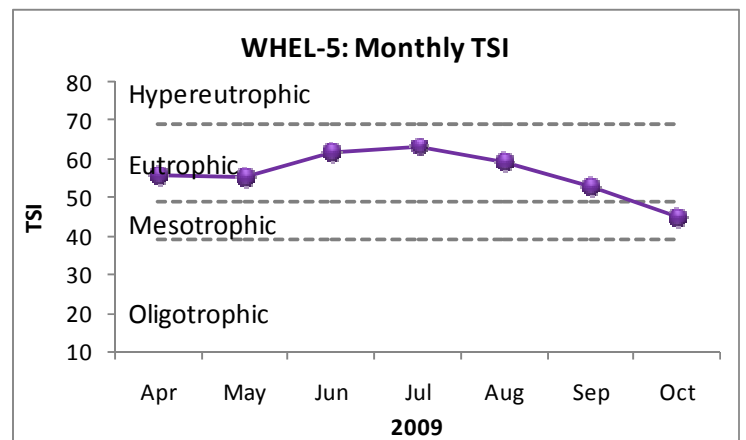
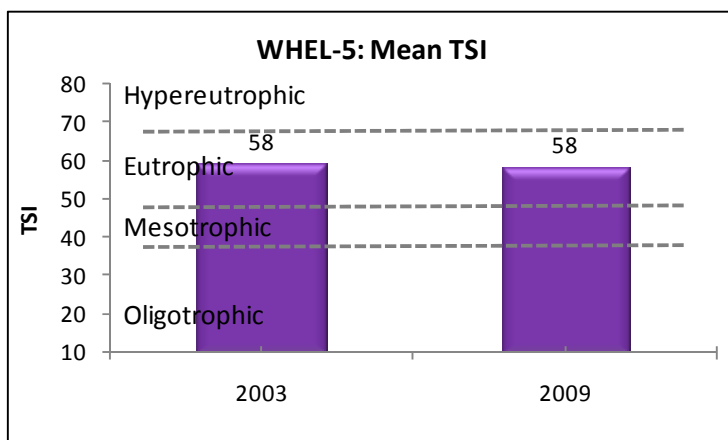
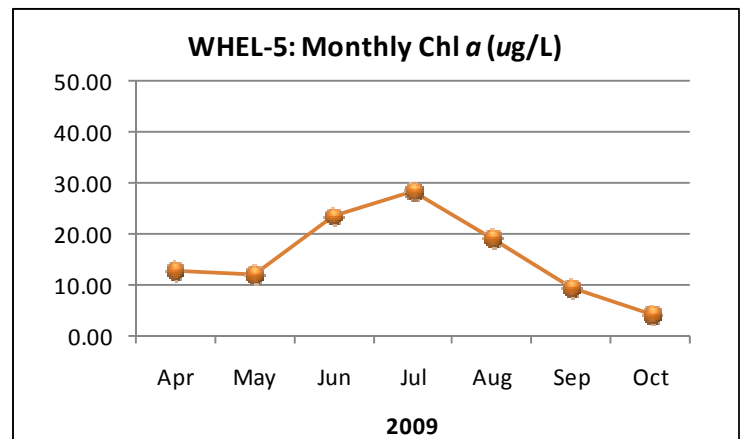
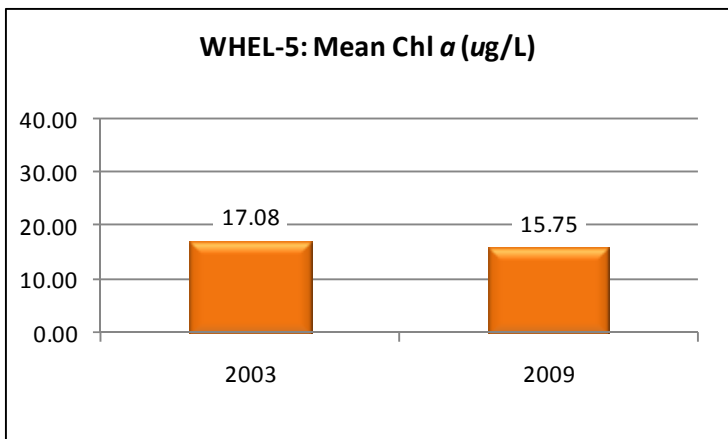
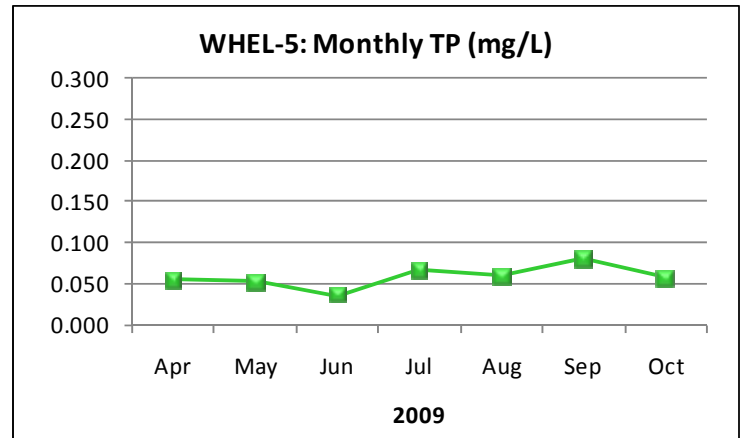
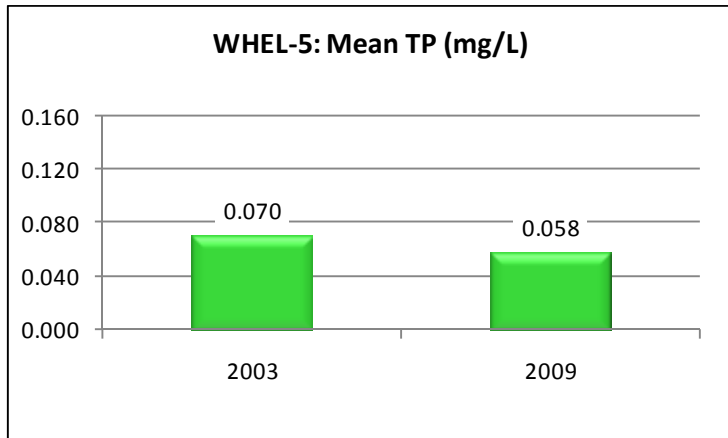
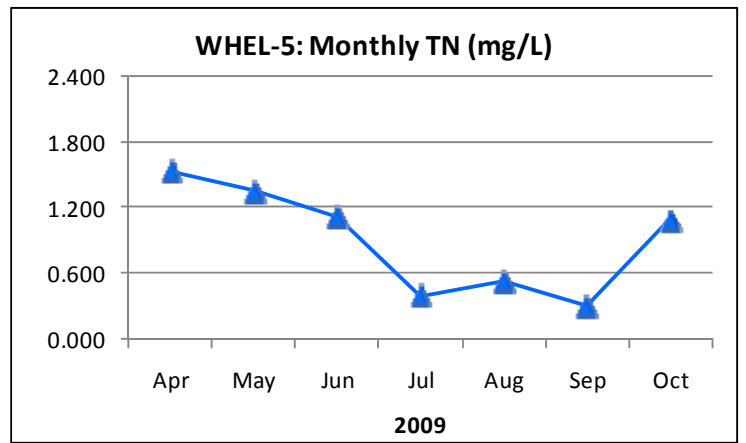
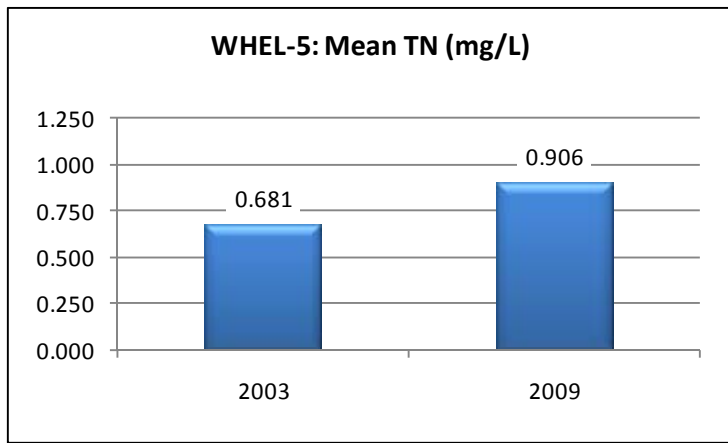


Figure 4. Mean growing season (2003-2009) and monthly (April-October, 2009) TN, TP, chl a and TSI measured in the Limestone Creek embayment of Wheeler Reservoir. Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.

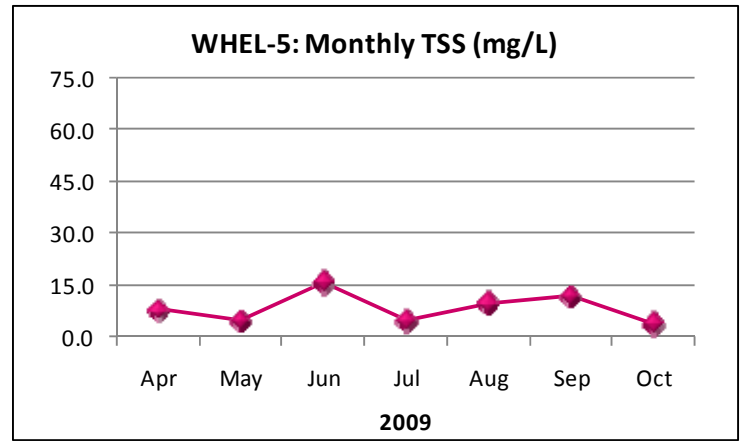
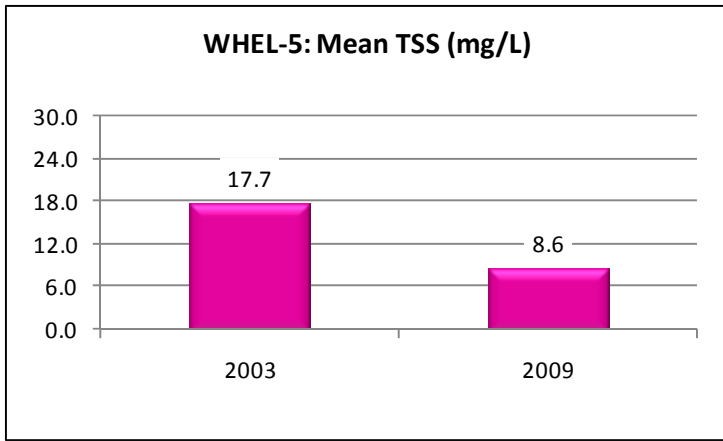


Figure 5. Mean growing season and monthly TSS measured in the Limestone Creek embayment of Wheeler Reservoir.

Table 2. Summary of water quality data collected April-October, 2009. 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)	7	11.1	18.2	13.7	14.3	2.8
Total Dissolved Solids (mg/L) ^J	7	26.0	128.0	96.0	90.9	31.9
Total Suspended Solids (mg/L) ^J	7	4.0	16.0	8.0	8.6	4.4
Hardness (mg/L)	3	47.2	62.5	53.7	54.5	7.7
Alkalinity (mg/L)	7	42.1	68.0	55.1	55.2	10.1
Photic Zone (m)	7	1.73	2.53	2.17	2.16	0.26
Secchi (m)	7	0.54	1.60	0.74	0.82	0.36
Bottom Depth (m)	7	3.90	4.82	4.50	4.34	0.39
Chemical						
Ammonia Nitrogen (mg/L)	7	< 0.006	0.023	0.007	0.010	0.008
Nitrate+Nitrite Nitrogen (mg/L)	7	< 0.002	0.944	0.394	0.457	0.389
Total Kjeldahl Nitrogen (mg/L)	7	< 0.089	0.728	0.464	0.449	0.210
Total Nitrogen (mg/L)	7	< 0.308	1.534	1.093	0.906	0.489
Dissolved Reactive Phosphorus (mg/L) ^J	7	0.005	0.046	0.008	0.015	0.015
Total Phosphorus (mg/L)	7	0.035	0.080	0.057	0.058	0.014
CBOD-5 (mg/L)	7	< 2.0	2.6	1.0	1.2	0.6
Chlorides (mg/L)	7	4.0	6.0	4.5	4.7	0.8
Biological						
Chlorophyll a (ug/L)	7	4.27	28.48	12.97	15.75	8.42
Fecal Coliform (col/100 mL) ^J	3	1	20	4	8	10

^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).

Year	Mean MSC	Limiting Nutrient
8/19/2003	7.04	PHOSPHORUS
8/19/2009	4.13	NITROGEN

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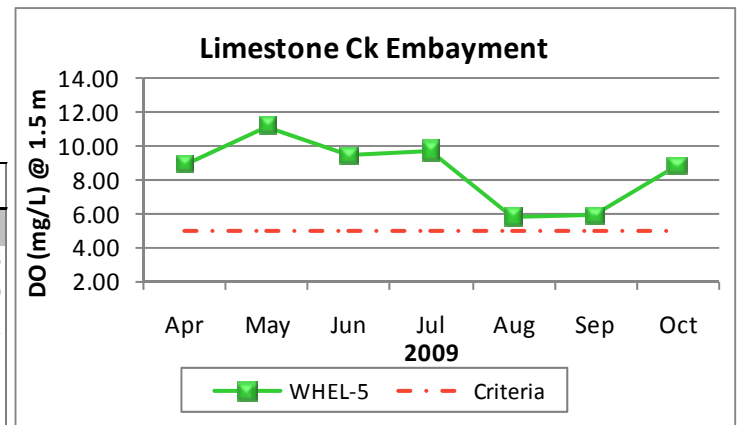


Figure 6. Monthly DO concentrations at 1.5 m (5 ft) for Limestone Creek embayment station of Wheeler Reservoir collected April-October 2009. ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/L at this depth.

REFERENCES

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