Alabama Department of Environmental Management

Tennessee River Basin

Rivers and Reservoirs Monitoring Program

Flint Creek Embayment
Wheeler Reservoir
Intensive Basin Survey 2013

WHEL-6: Flint Ck approx 1 mi downstream of CR67 bridge at public access area (Madison Co 34.558/-86.948)

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 Flint 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 Flint Creek embayment (WHEL-6) 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 Flint Creek. As a result, the section of Flint Creek from AL Hwy. 67 to the railroad bridge 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. Flint 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 457 mi^2 watershed is a mix of hay/pasture and forest (35%) (Fig. 3). As of October 1, 2013, ADEM has issued a total of 100 NPDES permits within the watershed. Ten of those permits are located within 10 mi of the station (Fig. 2).

SITE DESCRIPTION

The Flint Creek embayment at WHEL-6 is located approximately 1 mile upstream from Point Mallard Water Park, flowing into the Tennessee River at mile 308. The station is at the confluence of Flint Creek and Branch Creek. The Flint Creek embayment is generally shallow with a mean bottom depth of 4.42 m at the sampling location.

Figure 1. Photo of Flint Creek at WHEL-6.

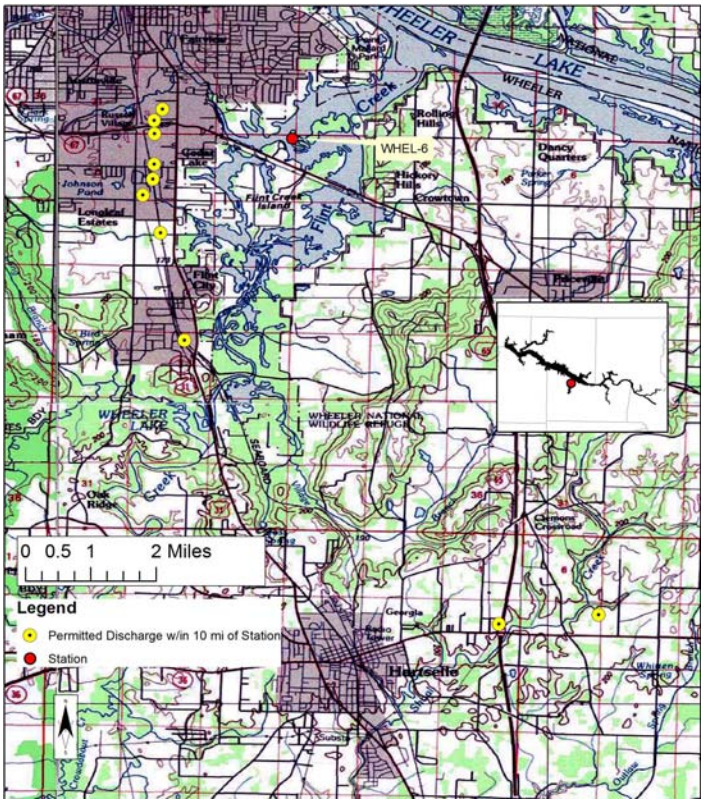


Figure 2. Map of Flint Creek embayment of Wheeler Reservoir. Though additional permits may occur in the watershed (Table 1), only permitted discharges within 10 miles upstream of the station are displayed on the map.

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.

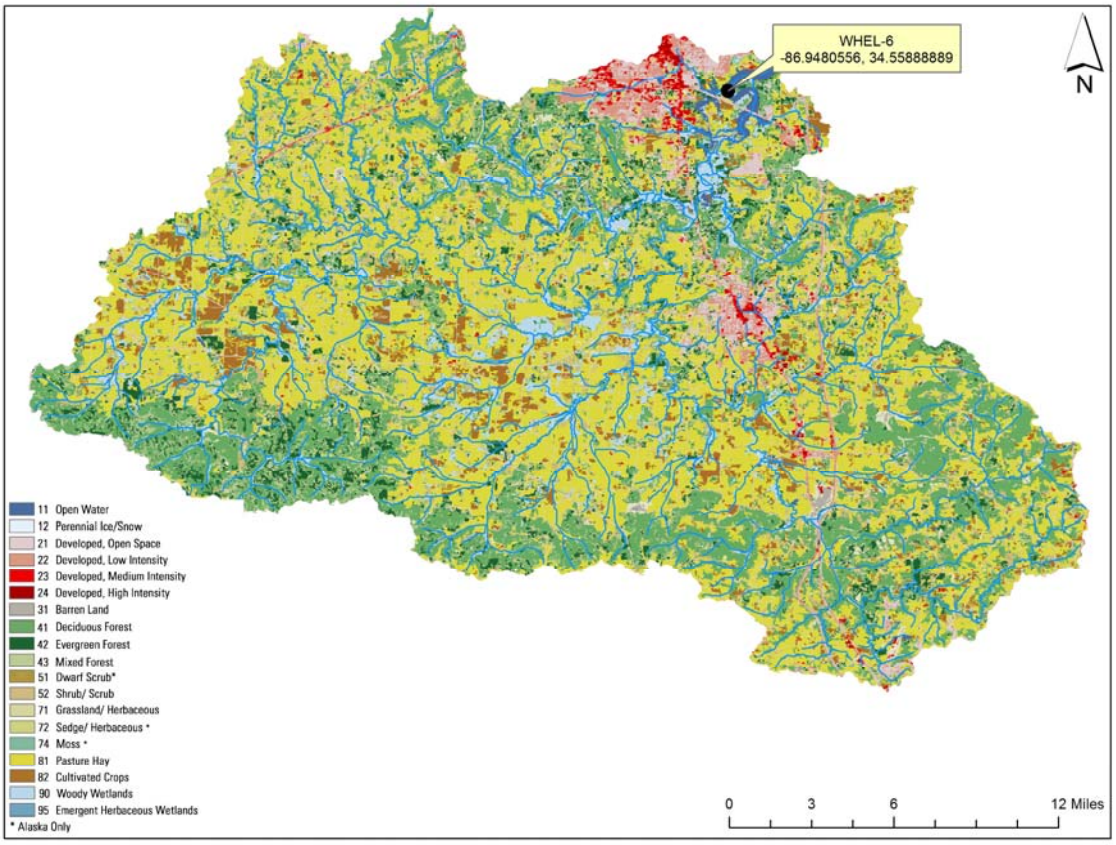


Figure 3. Landuse within the Flint Creek watershed at WHEL-6.

Table 1: Summary of Watershed **WHEL-6**

Basin		Tennessee R
Drainage Area (mi^2)		457
Ecoregion[a]		71g
% Land use		
Open Water		1%
Developed	Open Space	6%
	Low Intensity	2%
	Medium Intensity	1%
	High Intensity	<1%
Barren Land		<1%
Forest	Deciduous Forest	23%
	Evergreen Forest	6%
	Mixed Forest	6%
Shrub/Scrub		7%
Herbaceous		2%
Hay/Pasture		37%
Cultivated Crops		5%
Wetlands	Woody	5%
	Emergent Herb.	<1%
# NPDES Permits[b]	TOTAL	100
401 Water Quality Certification		5
Construction Stormwater		39
Mining		3
Small Mining		4
Industrial General		31
Industrial Individual		2
Municipal Individual		5
Underground Injection Control		11

a. Eastern Highland Rim

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

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 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.

Mean growing season TN values have increased from 2003 through 2013 (Fig. 4). Monthly TN concentrations were highest in October.

The mean growing season TP concentration was lower in 2013 than in 2009 and 2003 (Fig. 4). The highest monthly TP concentrations were measured in August and October.

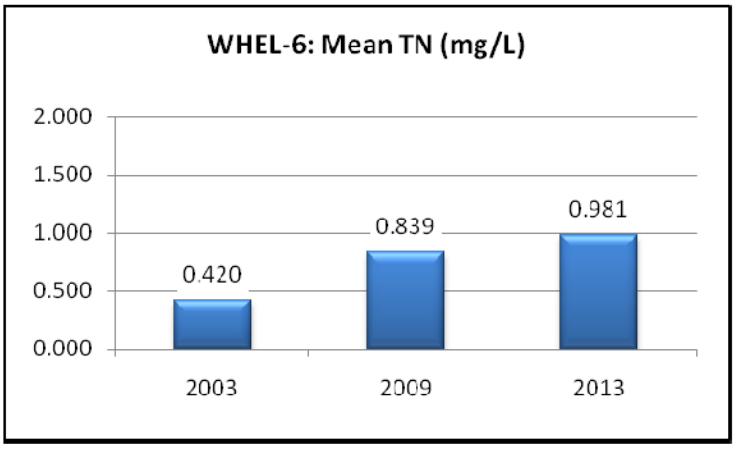
In 2013, the growing season mean chl *a* value was higher than 2009 and similar to 2003 (Fig. 4). Monthly chl *a* concentrations were highest in May and July.

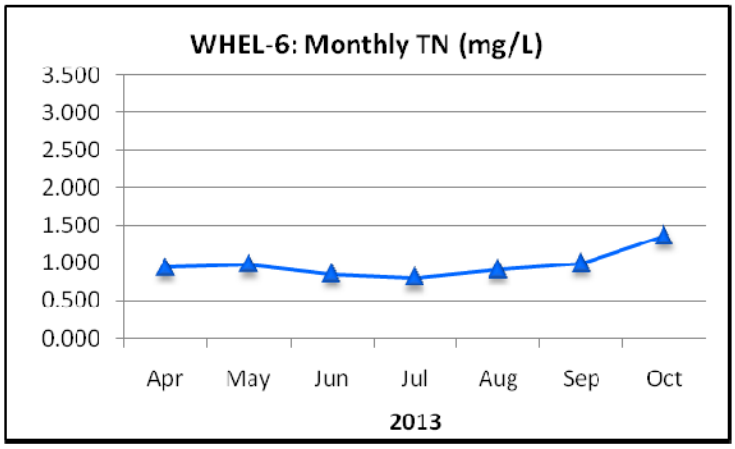
Mean TSI was in the upper eutrophic range in 2013 and 2003. Monthly TSI in Flint Creek was eutrophic all months monitored and near hypereutrophic in May and July (Fig. 4).

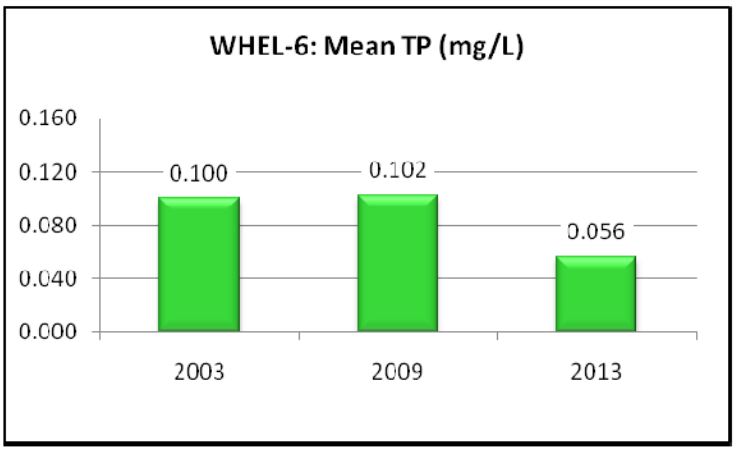
The mean growing season TSS value in 2013 was similar to 2009 and lower than 2003 (Fig. 5). Monthly TSS concentrations were highest in September and October but varied little through the growing season.

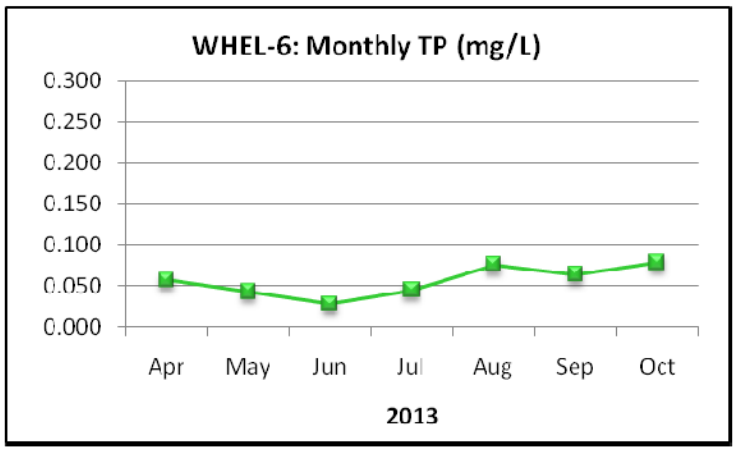
AGPT results show that WHEL-6 has remained nitrogen limited all years monitored (Table 3). The mean maximum standing crop (MSC) values from all years monitored are less than the 5.0 mg/L value that Raschke and Schultz (1987) defined as protective of reservoir and lake systems.

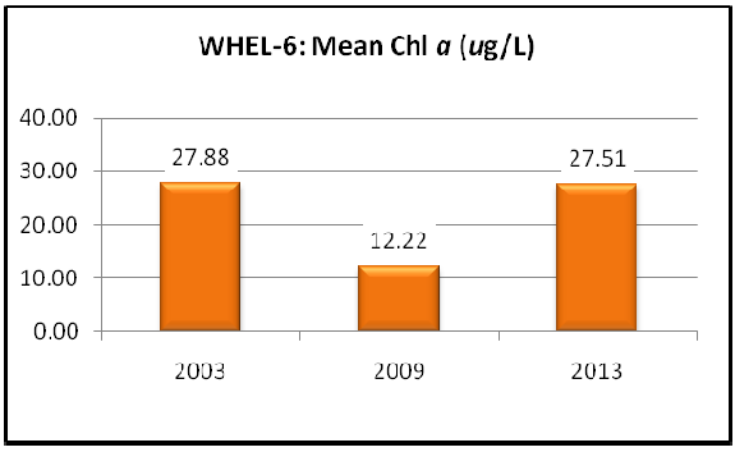
DO concentrations in the WHEL-6 station remained above the ADEM criteria limit (ADEM Admin. Code R. 335-6-10-.09) of 5.0 mg/l at 5.0 ft (1.5 m) April through October (Fig. 6).

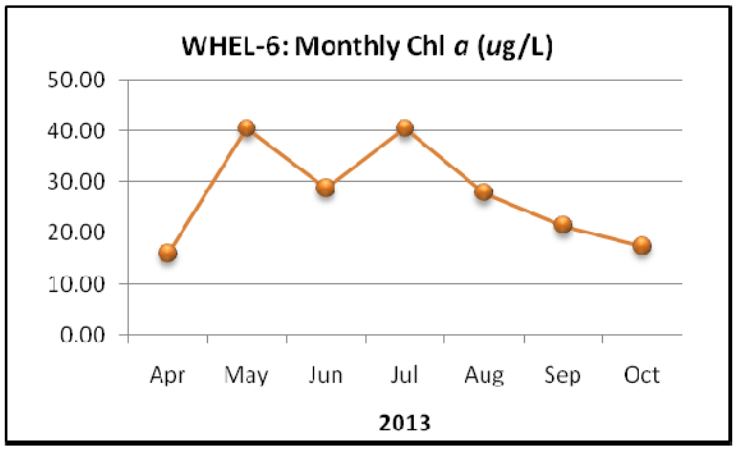


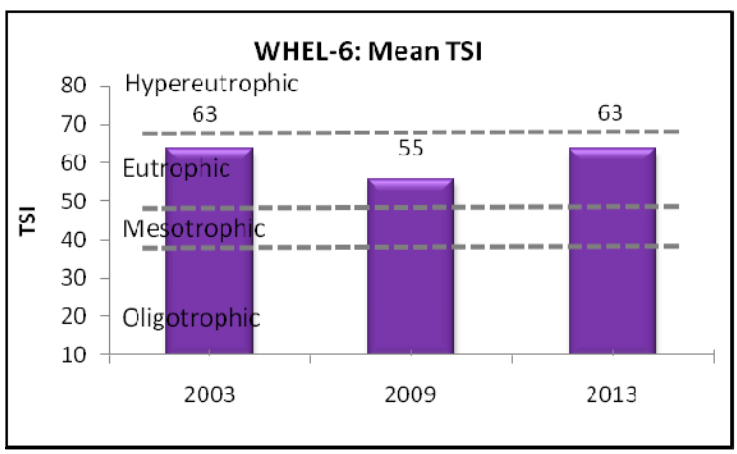












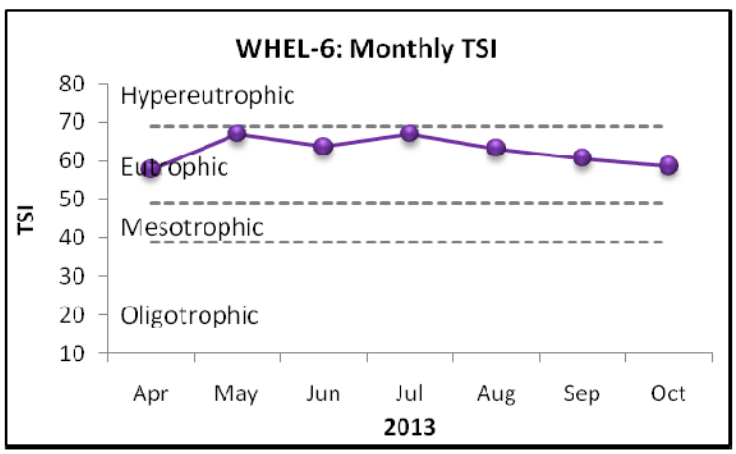
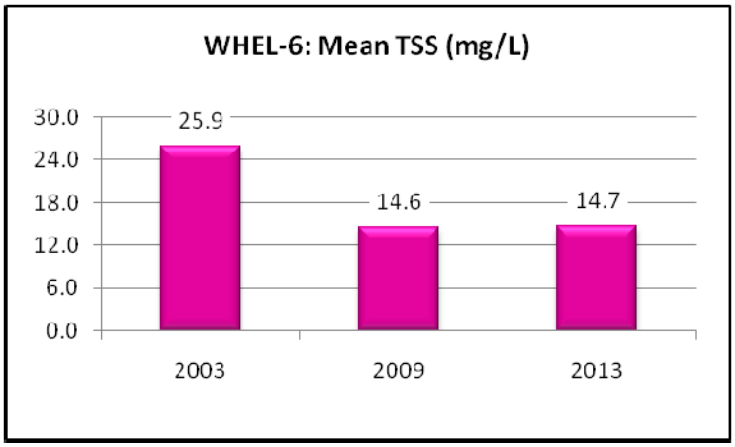


Figure 4. Mean growing season (2003-2013) and monthly (April-October, 2013) TN, TP, chl a and TSI measured in the Flint Creek embayment of Wheeler Reservoir**.** Vertical axis ranges are set to maximum values reservoir-wide for comparability between embayment reports within the same reservoir.



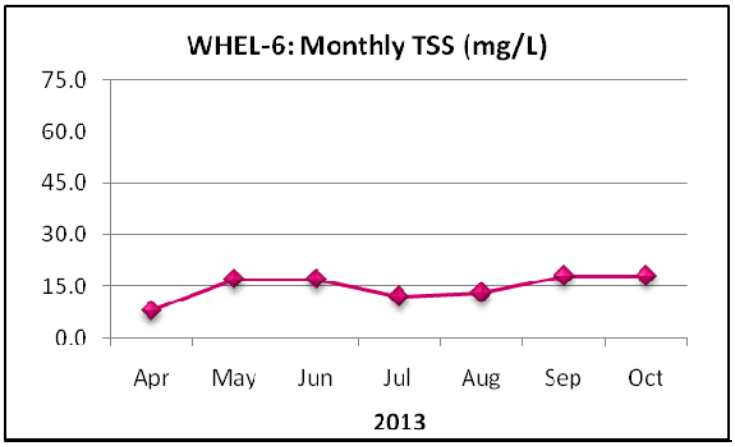


Figure 5. Mean growing season and monthly TSS measured in the Flint Creek embayment of Wheeler Reservoir.

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-6	N		Min	Max	Med	Mean	SD
Physical							
Turbidity (NTU)	8		9.7	19.9	14.7	14.2	3.4
Total Dissolved Solids (mg/L)[J]	7		106.0	145.0	126.0	127.0	15.5
Total Suspended Solids (mg/L)	7		8.0	18.0	17.0	14.7	3.8
Hardness (mg/L)	4		88.7	106.0	99.0	98.2	7.6
Alkalinity (mg/L)	7		65.6	92.7	80.9	77.5	9.8
Photic Zone (m)	7		1.56	2.42	1.79	1.85	0.30
Secchi (m)	7		0.58	0.84	0.65	0.67	0.08
Bottom Depth (m)	8		3.90	4.90	4.49	4.42	0.46
Chemical							
Ammonia Nitrogen (mg/L)[J]	7	<	0.015	0.095	0.008	0.022	0.032
Nitrate+Nitrite Nitrogen (mg/L)	7	<	0.003	0.212	0.004	0.048	0.082
Total Kjeldahl Nitrogen (mg/L)	7		0.728	1.360	0.878	0.932	0.207
Total Nitrogen (mg/L)	7	<	0.800	1.364	0.940	0.981	0.183
Dissolved Reactive Phosphorus (mg/L)[J]	7	<	0.007	0.013	0.009	0.008	0.004
Total Phosphorus (mg/L)	7		0.028	0.078	0.057	0.056	0.018
CBOD-5 (mg/L)[J]	7	<	2.0	3.6	1.0	1.7	1.0
Chlorides (mg/L)[J]	7		3.0	4.4	3.5	3.6	0.6
Biological							
Chlorophyll a (ug/L)	7		16.00	40.60	27.80	27.51	10.14
E. coli (col/100mL)	3		4	13	11	9	5

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-6	MSC	Limiting Nutrient
8/19/2003	3.09	NITROGEN
8/19/2009	3.84	NITROGEN
8/21/2013	3.65	NITROGEN

FOR MORE INFORMATION, CONTACT:
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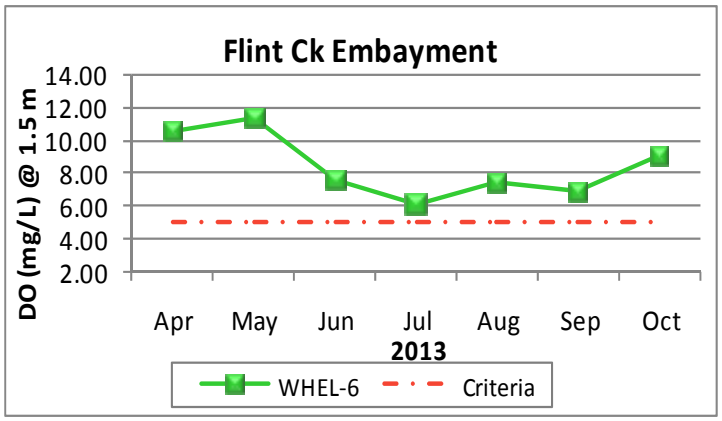

Figure 6. Monthly DO concentrations at 1.5 m (5 ft) for Flint Creek embayment station of Wheeler Reservoir collected April-October 2013. ADEM Water Quality Criteria pertaining to reservoir waters require a DO concentration of 5.0 mg/L at this depth.

REFERENCES

ADEM. 2012. Quality Assurance Project Plan (QAPP) for Surface Water Quality Monitoring in Alabama. Alabama Department of Environmental Management (ADEM), Montgomery, AL. 78 pp.

ADEM. 2013a. Quality Management Plan (QMP) for the Alabama Department of Environmental, Alabama Department of Environmental Management (ADEM), Montgomery, AL. 58 pp.

ADEM. 2013b. Standard Operating Procedures Series #2000, Alabama Department of Environmental Management (ADEM), Montgomery, AL.

ADEM. 2012. State of Alabama Water Quality Monitoring Strategy June 19, 2012. Alabama Department of Environmental Management (ADEM), Montgomery, AL. 88 pp.http://www.adem.alabama.gov/programs/water/wqsurvey/2012WQMonitoringStrategy

Alabama Department of Environmental Management Water Division (ADEM Admin. Code R. 335-6-10-.09). 2010. Specific Water Quality Criteria. Water Quality Program. Chapter 10. Volume 1. Division 335-6.

Alabama Department of Environmental Management Water Division (ADEM Admin. Code R. 335-6-10-.11). 2010. Water Quality Criteria Applicable to Specific Lakes. Water Quality Program. Chapter 10. Volume 1. Division 335-6.

Carlson, R.E. 1977. A trophic state index. Limnology and Oceanography. 22(2):361-369.

Raschke, R.L. and D.A. Schultz. 1987. The use of the algal growth potential test for data assessment. Journal of Water Pollution Control Federation 59(4):222-227.