Rathbun Lake and Watershed 2013 Monitoring Summary

Executive Summary

Rathbun Lake, a federal flood control reservoir located in Appanoose County, is currently listed as impaired for its Class A1 (primary contact uses) due to high levels of algal and non-algal turbidity in parts of the lake. The lake frequently experiences water transparency of less than 1 meter, and the arms of the lake frequently experience dense algae blooms in the summer. A watershed improvement project for Rathbun Lake began in the late 1990's. The Rathbun Land and Water Alliance (RLWA) has spearheaded efforts in the 6-county, 354,000 acre watershed and partnered with the Iowa Department of Natural Resources (IDNR), the United States Army Corps of Engineers (USACE) and others to monitor streams in the watershed and several points in the lake. 2013 marked a start of a new chapter for the project. Intensive monitoring began in April of 2013 to better understand how nutrients and sediment are being transported to the lake.

Weather continued to be variable for much of the watershed in 2013. Over the past five years, the watershed has experienced both extensive flooding (2010) and drought (2012). During the spring of 2013, the watershed experienced massive flooding and erosion from 5-9 inches of rain that fell during a single April storm. This event was followed by a very wet spring, followed by a hot and dry summer with much of the watershed receiving little to no rain for a 40-60 day period. As a result, monitoring in the spring was characterized by frequent rain events and low/no-flow in streams in late summer.

Table 1. BMPs installed in the Rathbun Lake watershed in 2013.

Best Management Practice (BMP)	Units Installed (Jan. 2013- Sept. 2013)
Water & Sediment Basins	41
Priority Land Seeding	58 acres
Grade Stabilization Structures	6
WIRB Structures	0
Terraces	57,225 ft.

Watershed improvements continued in 2013, with project partners working with producers to increase awareness about nutrient and sediment runoff and helping producers employ best management practices (BMPs) that will help both the land and Rathbun Lake. Table 1 summarizes BMPs installed in the watershed in 2013. Staff also organized and held the eighth annual Protect Rathbun Lake meeting. Other outreach efforts in 2013 included interviews for WHO radio, news articles in the Wallaces Farmer, the Farm Bureau Spokesman, Iowa Farmer Today, and local newspapers. Tours of the watershed were also given to Iowa Secretary of Agriculture Bill Northey and Congressman Dave Loebsack to promote watershed conservation activities. The RLWA also received the Governor's Environmental Excellence Award and the Conservation Districts of Iowa Outstanding Watershed Award in 2013.

Monitoring conducted to date continues to show high levels of phosphorus and sediment throughout the watershed, especially after heavy rains. Long term data (1997-2012) collected in the watershed, however; shows little change in nutrient and suspended solids concentrations at many of the watershed monitoring sites, in spite of massive land use changes (from grassland/pasture to row-crop agriculture) in the watershed over the past ten years. The lake continues to experience periods of extreme turbidity, especially after heavy rain events in the watershed) and frequent algae blooms in the arms of the lake. Data for the current monitoring study will continue to be collected through the fall of 2014. Extensive data analysis and modeling for the lake and watershed will commence in 2014 and 2015.

2013 Watershed Monitoring Results

Monitoring in 2013 was greatly increased from previous years. Routine grab samples were obtained beginning in April of 2013. Sampling efforts also included rain event monitoring, where composite samples were collected after periods of heavy rainfall in the watershed. Depth integrated sampling was also completed at two sites for both ambient and event samples to quantify how representative grab samples are across the stream channel. Samples were collected for total suspended solids, phosphorus, and nitrogen twice per month at 14 locations throughout the watershed (See Figure 1). Field parameters including stream discharge, dissolved oxygen, pH, and turbidity were also collected at each monitoring location. Sites sampled in 2013 are consistent with those sampled in previous years. Seven event samples events were at one or more of the automated sampler locations in 2013, capturing the very wet spring in the watershed (Figures 2 and 3).

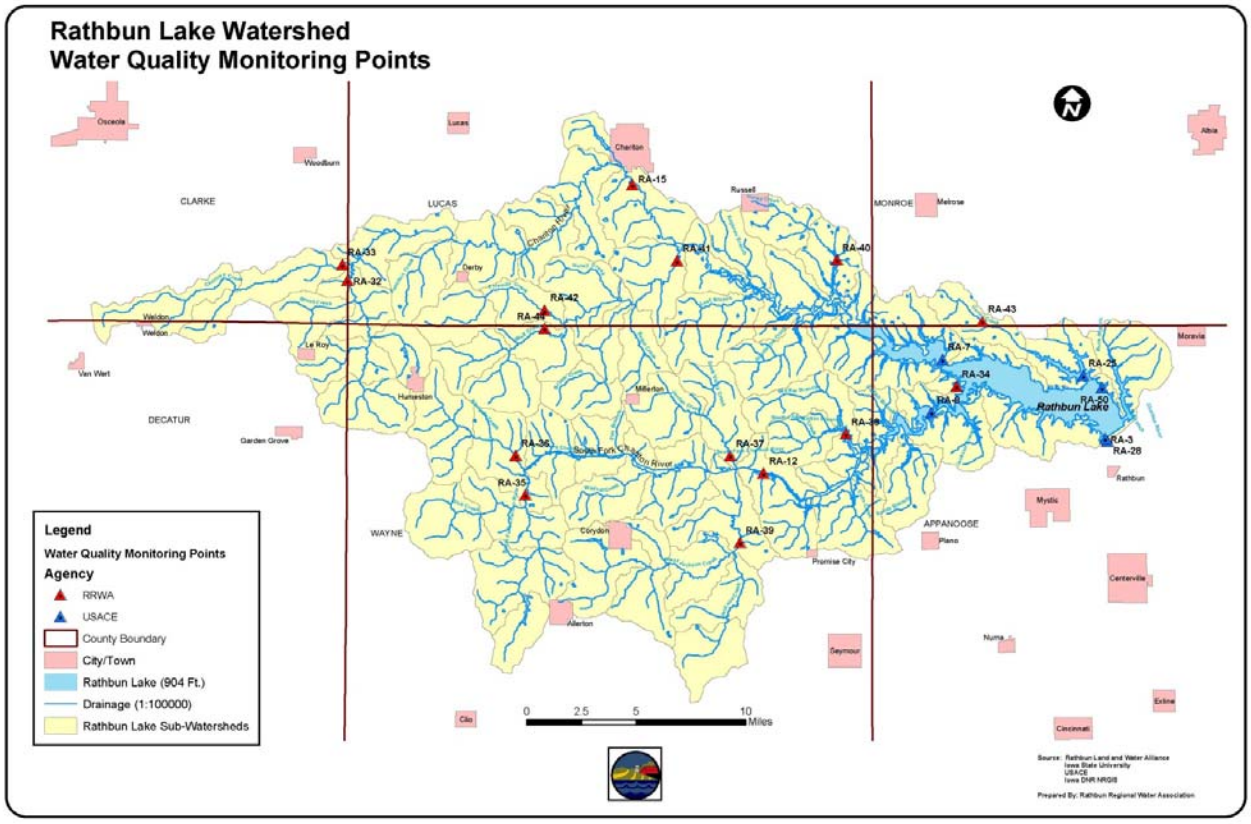


Figure 1. Monitoring locating in Rathbun Lake and the Rathbun Lake watershed.

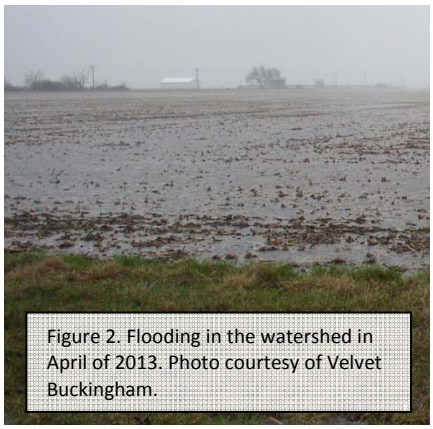


Figure 2. Flooding in the watershed in April of 2013. Photo courtesy of Velvet Buckingham.

High levels of nutrients and sediment were observed throughout the watershed, especially after rainfall events. As the summer progressed, and rainfall became sparser, concentrations of nutrients and sediment dropped significantly throughout the watershed. Composite samples collected during rain events at four of the watershed sites show average concentrations 2-3 times greater than average concentrations from ambient samples collected at the same location (Table 2).

Nitrate concentrations were generally higher in 2013 than in previous years (Figure 4). This trend was observed elsewhere in the state. This trend most likely occurred because of the drought of 2012 (where nitrogen built-up on the land), followed by the flooding and very wet spring of 2013 (flushing nitrogen on the land into streams). Compared to the rest of Iowa, the Rathbun watershed has very low levels of nitrogen.

Table 2. Average ambient and event sample results for April – October 2013 at sites in the Rathbun watershed where both types of samples are collected.

Sampling Location	Total Suspended Solids (mg/L)	Total Phosphorus (mg/L)	Nitrate + Nitrite as N (mg/L)
RA-12			
Ambient	480	0.36	1.06
Event	2886	2.02	1.89
RA-15			
Ambient	110	0.26	1.46
Event	902.5	2.32	2.85
RA-39			
Ambient	291	0.33	1.24
Event	710	0.65	2.1
RA-41			
Ambient	310	0.32	1.54
Event	1033	0.78	2.02

In spite of the very wet spring, average total phosphorus concentrations were lower in 2013 than in previous years with similar amounts of rainfall (Figure 5). Concentrations were generally high in early spring, when ground cover is limited, and decreased throughout the summer months. Concentrations were generally higher than in 2012; this likely reflects differences in annual precipitation rather than changes to land use and land management practices.

Total suspended solids concentrations were also higher than observed in 2012. Again, these results most likely reflect the timing, amount, and intensity of precipitation received in the Rathbun watershed in 2012 and 2013 (Figure 6).

Many land use changes have occurred in the Rathbun watershed since 2000. The RLWA has been very successful working with producers to implement best management practices on their land, however; changes to the CRP programs and increasing corn and land prices have led to land uses changes throughout the watershed.

Figure 3. Flood damage at Wolf Creek in spring of 2013. Grass on branches represents the peak water level from April floods. Photo courtesy of SHL.

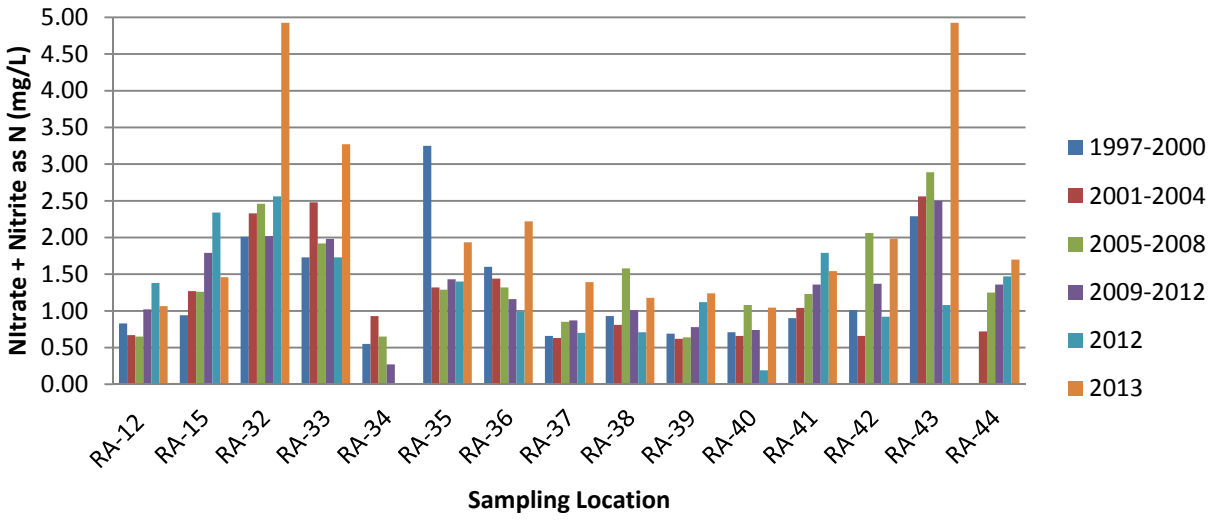


Figure 4. Average concentrations of nitrate + nitrite as N at sampling locations in the Rathbun watershed.

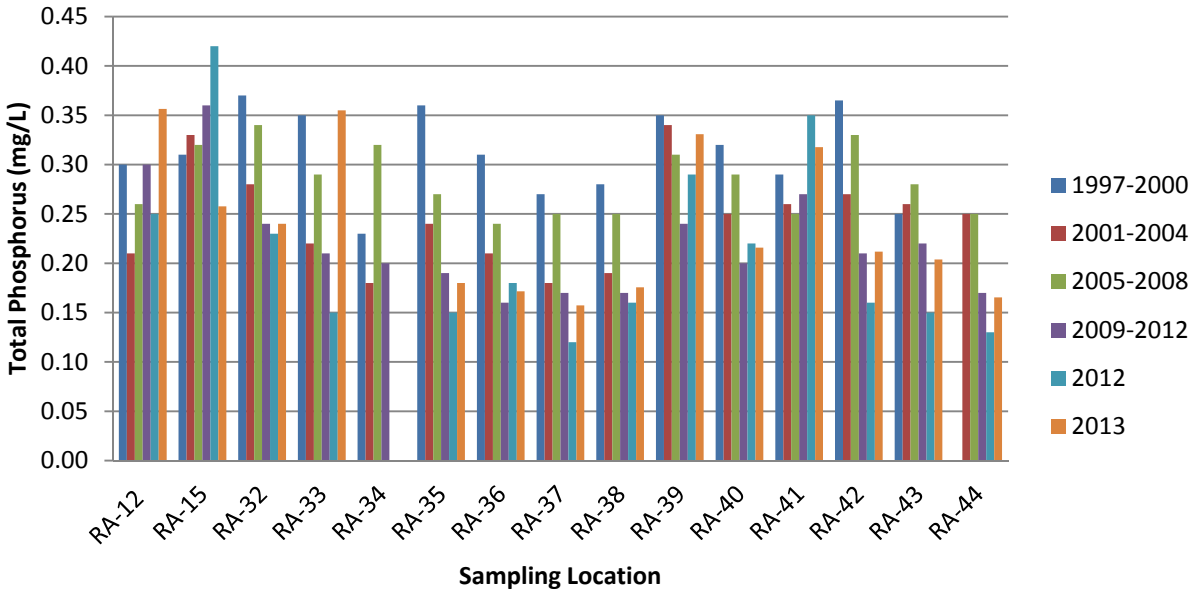


Figure 5. Average concentrations of total phosphorus at sampling locations in the Rathbun watershed.

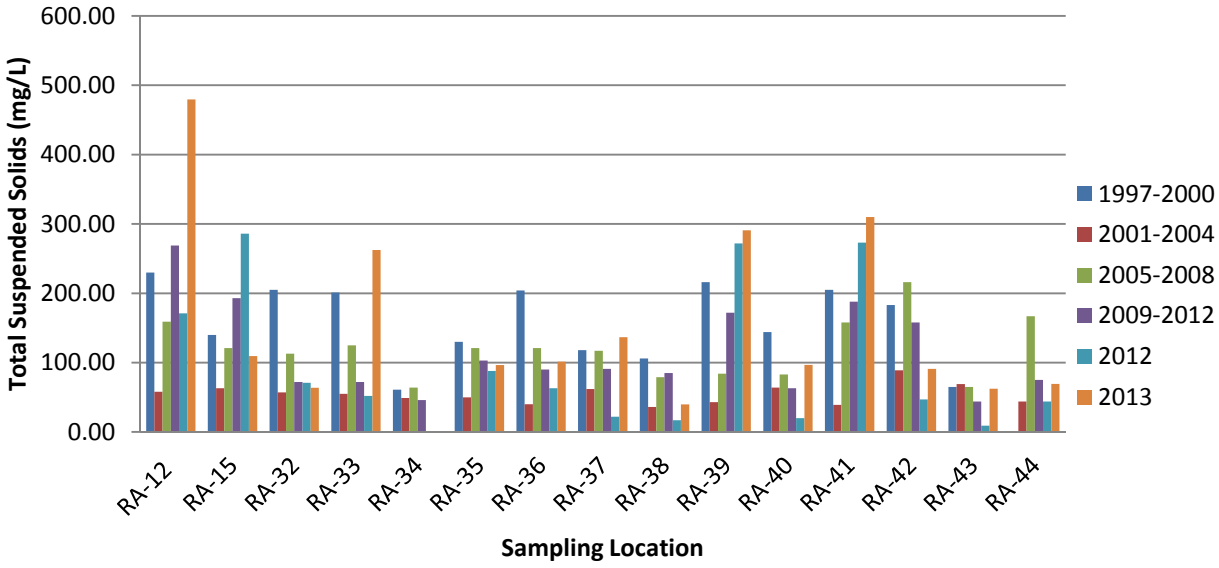


Figure 6. Average total suspended solids concentrations at sampling locations in the Rathbun watershed.

2013 In-Lake Monitoring Results

Monitoring was completed at several locations in the lake by the USACE from April to October of 2013. The IDNR ambient lake monitoring program also monitored site RA-3 thee times throughout the summer. Results presented as a part of this monitoring summary include all of the IDNR ambient lake monitoring program results, as well as results from April-June completed by USACE.

Rathbun Lake was very turbid during the spring and early summer because of high suspended solids moving to the lake from the watershed. Throughout the summer, many suspended solids began to settle and the lake water transparency improved. Rathbun Lake experiences a few small algae blooms in the arms of the lake. Figure 7 shows water transparency photos taken at Rathbun Lake (Site RA-3) with the Secchi disc at a depth of 0.2 meters.

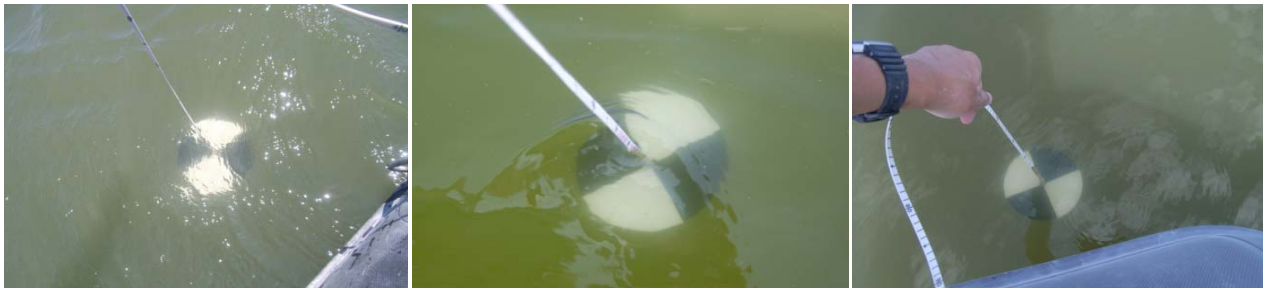


Figure 7. Secchi transparency photos (disc at 0.2 m depth) at site RA-3 from left to right: early summer, mid-summer, and late summer. Average Secchi depth in 2013 was 0.5 m. Photos courtesy of ISULL.

Phosphorus concentrations were consistent with those observed in other years (Figure 8). Concentrations were highest at sites RA-7 and RA-8, the primary inflows from the Chariton and South Fork Chariton Rivers. Very high April concentrations reflect the large amounts of rainfall pushing nutrients and sediment to Rathbun Lake.

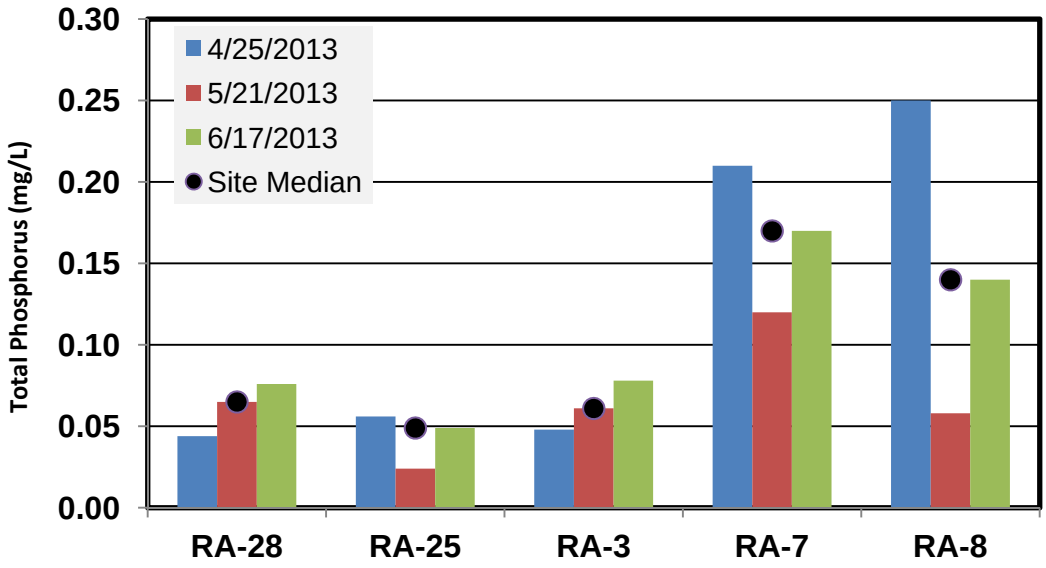
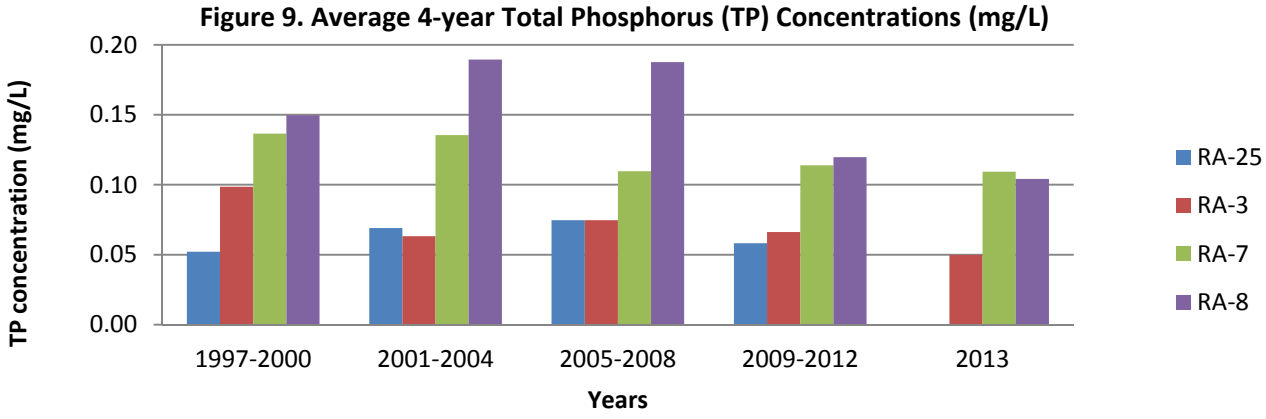


Figure 8. Total phosphorus concentrations at USACE monitoring sites for April – June 2013. Courtesy of USACE.

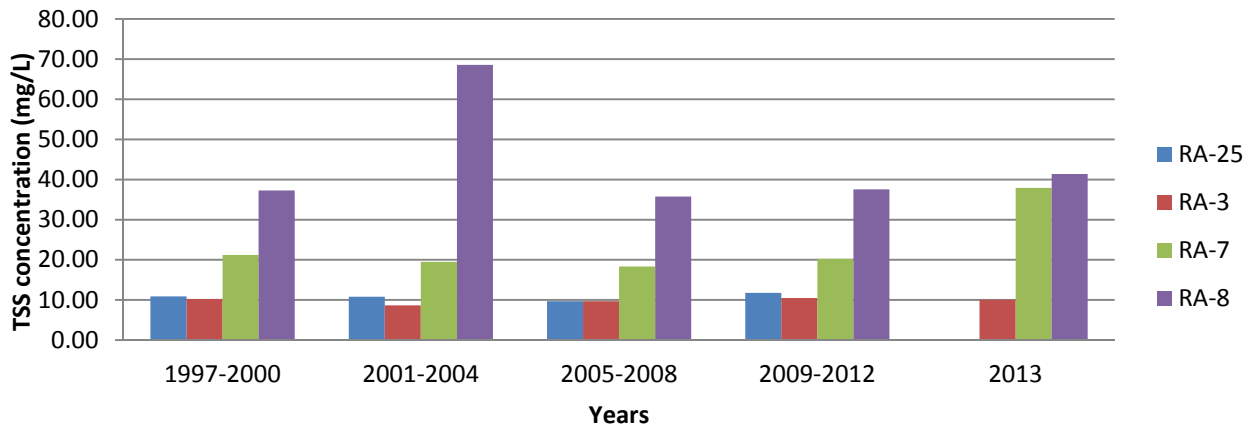
Long term trend show high levels of total phosphorus (TP) and total suspended solids (TSS) persist throughout the lake. Figure 9 shows 4-year average concentrations for total phosphorus as sites sampled by the USACE since 1997. Average TP concentrations have declined since the start of the monitoring program at several of the monitoring stations, including RA-8, the South Fork of the Chariton River Inlet into Rathbun Lake.



Total phosphorus has declined and remains lower in the main basin of the lake (RA-3) than in the arms of the lake. Both branches of the Chariton River contribute high amounts of phosphorus to Rathbun Lake, and the highest concentrations are observed in the spring, when land cover is limited and heavy rains are frequent. In spite of considerable land use change within the watershed since 2004, average TP concentrations in the arms of the lake have remained consistent or declined. This suggests one of several possibilities: watershed BMPs have helped stabilize P loads to the lake in spite of land use change, monitoring has missed periods of high P-loading to the lake following heavy rainfall events, or varying climate between years (wet vs. dry years) within a 4-year period have skewed averages. Continued monitoring is needed throughout the lake to better understand the fate and transport of phosphorus to the lake.

Unlike total phosphorus, total suspended solids (TSS) concentrations have increased at several of the sampling locations within the lake since the monitoring program began in 1997. This likely reflects the changes in land use observed throughout the watershed, coupled with sampling following heavy rainfall events. The Rathbun Lake watershed contains large areas of highly erodible soils, which contribute to high TSS concentrations in the arms of the lake. Re-suspension of bottom sediments also likely contributes to high TSS concentrations in the lake.

Figure 10. Average 4-year Total Suspended Solids (TSS) Concentrations (mg/L)



Other limnological parameters measured as part of the 2013 study were similar to results observed in other years. Table 3 summarizes water quality data from the USACE and IDNR studies.

Table 3. Average concentrations observed in 2013 at Rathbun Lake monitoring sites.

Sampling Location	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)	Chlorophyll a (µg/L)	Nitrate + Nitrite as N (mg/L)
RA-28	0.07	17	NA	1.10
RA-25	0.05	17	26	0.70
RA-3	0.06	14	5	1.10
RA-7	0.17	21	8	1.80
RA-8	0.14	27	3	1.50
IDNR RA-3	0.07	10	6	0.87

The IDNR uses Carlson's trophic state index to determine whether a lake is meeting its designated uses for the biannual Clean Water Act Assessments (Section 305(b) assessments and Section 303(d) impaired waters list). According to IDNR methodology, lake segments with a median TSI value for chlorophyll a or Secchi transparency of 65 or greater are considered as not meeting their primary contact recreation use, and thus, are considered impaired. Rathbun Lake was split into five segments starting with the 2006 integrated report (IR).

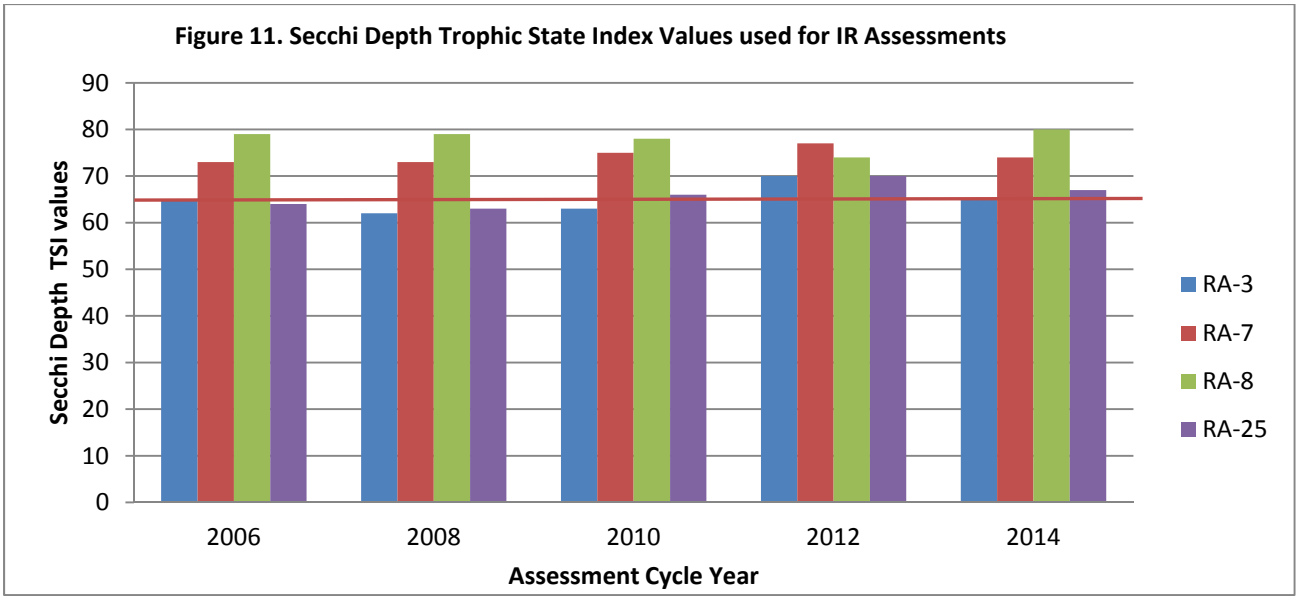


Figure 11 shows the median TSI values reported for the USACE monitoring at Rathbun Lake used to determine if water body segments are impaired for "aesthetically objectionable conditions" due to poor water clarity. All four segments monitored regularly are currently impaired poor water clarity due to high levels of non-algal turbidity. Median TSI values at each of the monitoring sites have remained relatively constant over the past 10 years, although it appears that median TSI values are increasing at RA-8 (South Fork Chariton River Arm), likely due to changes in land use, sediment re-suspension, and timing of sampling events relative to periods of heavy rainfall. The red line in the above figure indicates the threshold for impairment (median TSI = 65).

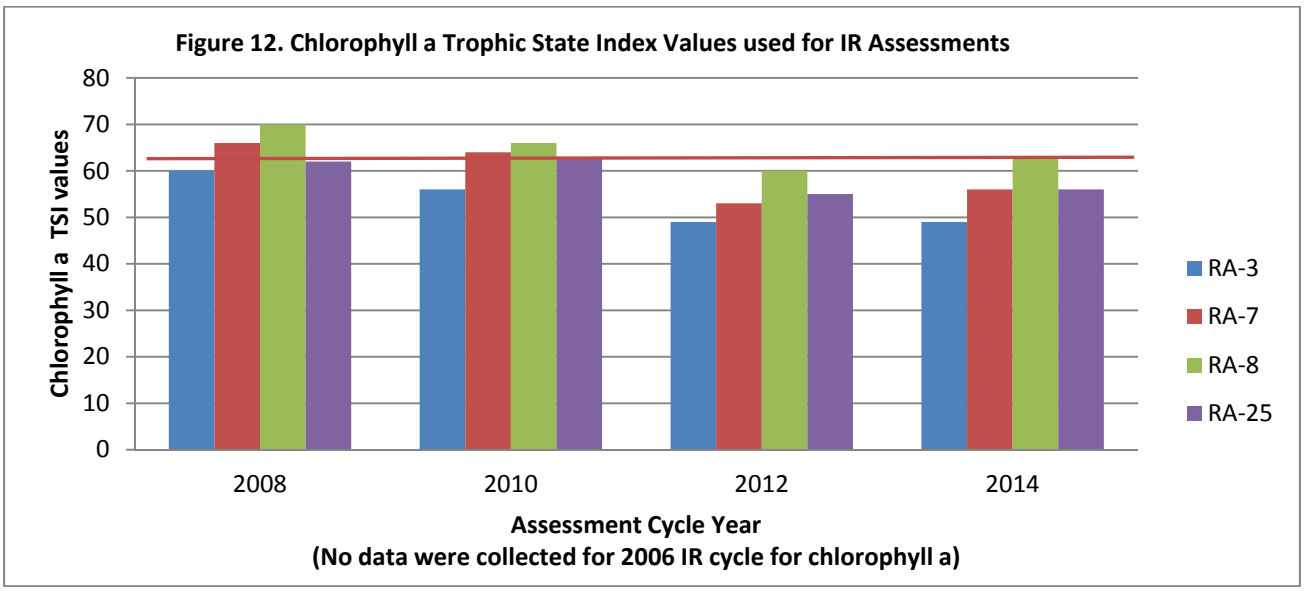
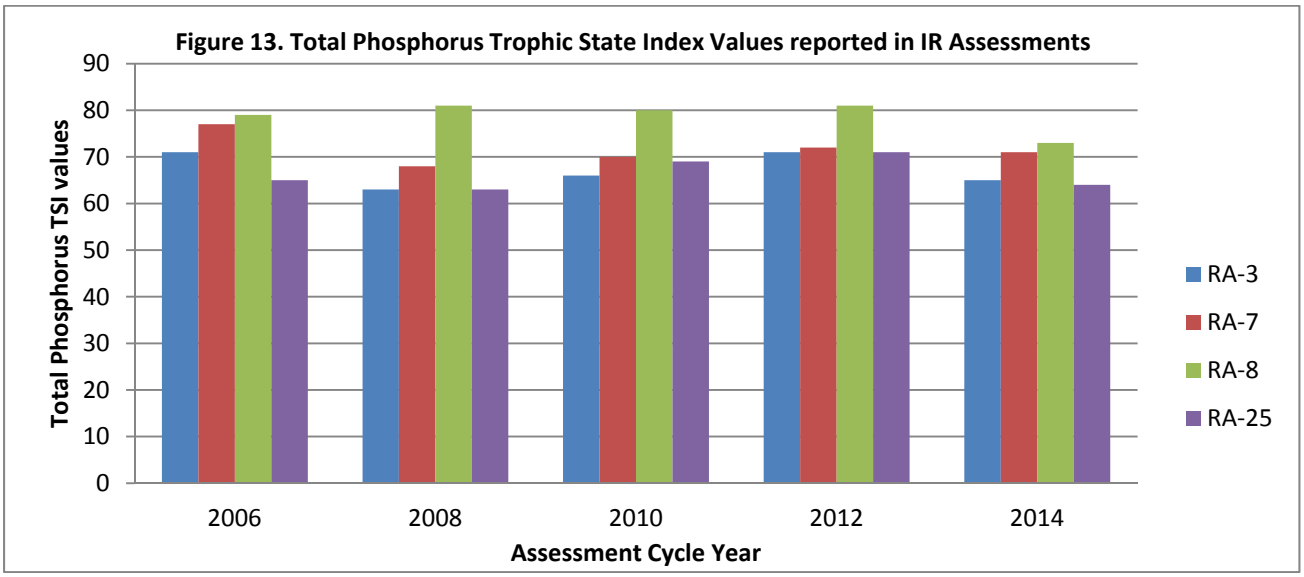


Figure 12 shows the median TSI values used for IR assessments since 2006 for water body segments located in Rathbun Lake. Currently, no segments are listed for algae impairments within Rathbun Lake. High phosphorus levels within the lake would likely result in large algae blooms if non-algal turbidity (suspended sediment) decreased. Thus, it is important to continue to target BMPs for both sediment and phosphorus reduction to prevent the formation of dense algae blooms as BMPs reduce sediment loads to the lake.

While the median total phosphorus TSI is not currently used for assessments, it should be noted that Rathbun Lake has very high phosphorus concentrations throughout the lake (Figure 13), which could fuel intense algae blooms if water clarity improves (through a reduction of suspended sediment in the lake).



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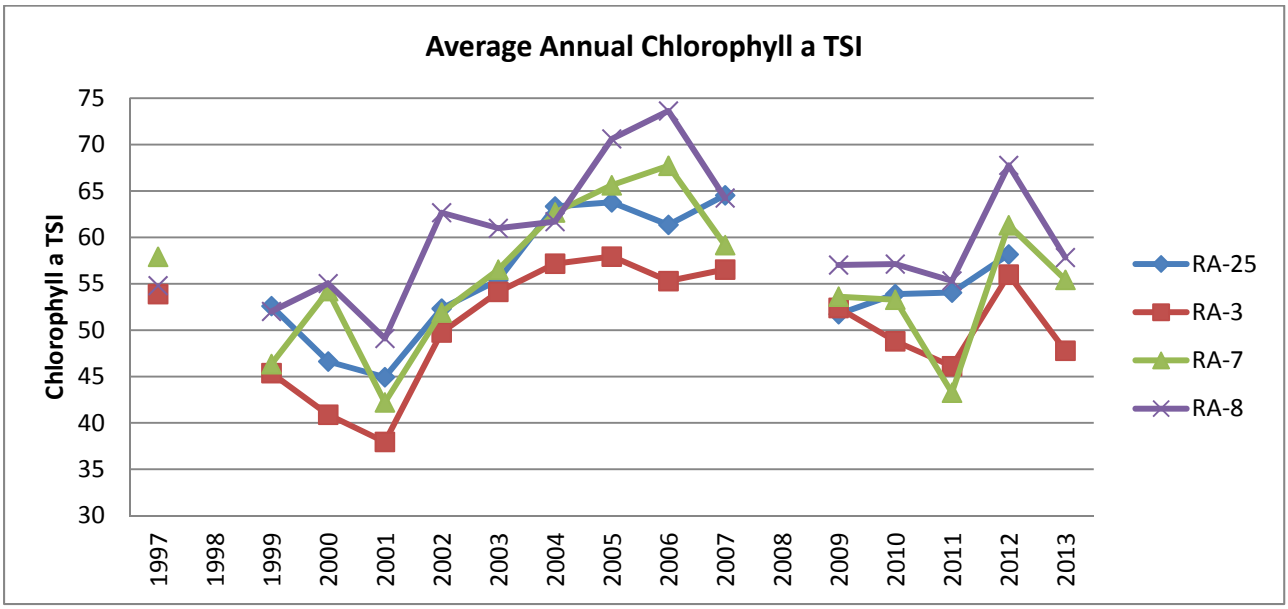
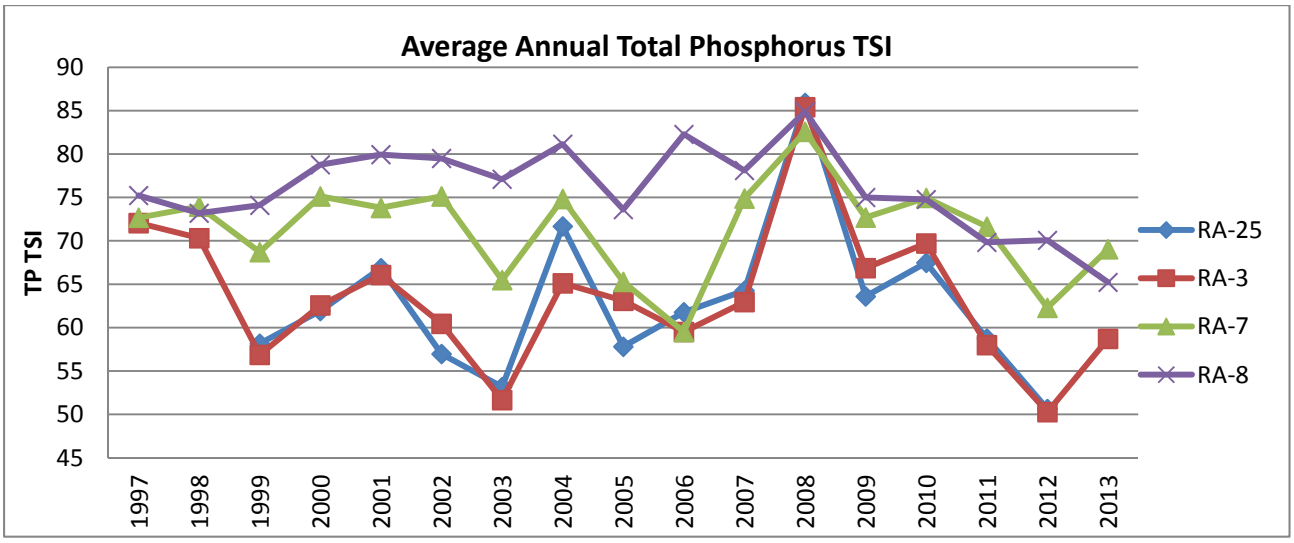
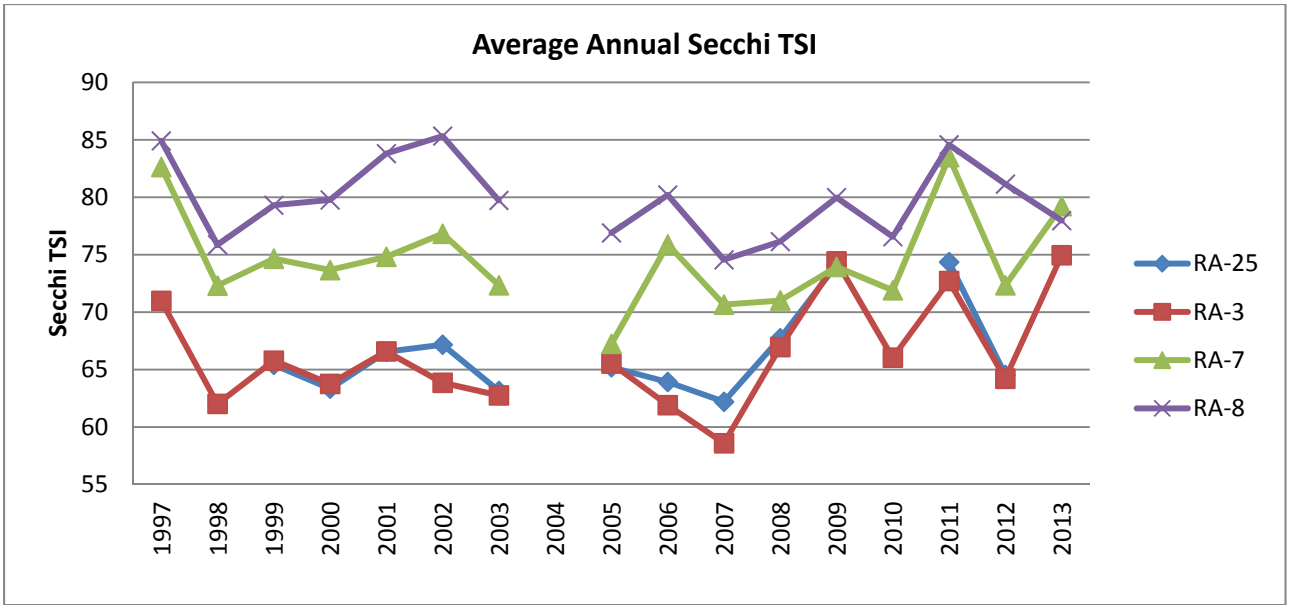
Appendix A. Average Annual TSI values for Rathbun Lake Monitoring Locations



Average annual TSI values for chlorophyll a track well with wet and dry years. Drought years show considerably higher chlorophyll a concentrations than wet years. Dry conditions, observed in 2006 and 2012, resulted in smaller than average sediment loads delivered to Rathbun Lake. Over the course of the summer, suspended sediment settled, thus improving water clarity and increasing the photic zone of the lake, and algae blooms formed utilizing available phosphorus in the lake. Years with especially wet springs, 2009, 2010, and 2013, are correlated with low summer chlorophyll a values in the lake, as high levels of suspended sediment reduces water clarity and prevent algae blooms from forming with the arms and main basin of Rathbun Lake.



Total phosphorus concentrations also track well with wet and dry years, as phosphorus often attaches to sediment as it is transported downstream. Annual average TSIs for phosphorus show decreased since the monitoring program began in 1997 for all sites, although it is difficult to determine what effects this decrease will have on aquatic life in the lake, given the variability between years and how phosphorus is often transported with sediment downstream.



Finally water clarity has remained relatively constant on an annual basis since the monitoring program began at Rathbun Lake, although, higher TSIs were observed in 2013, which likely reflect poor water clarity associated spring flooding and changes in land use in the watershed. Non-algal turbidity is the primary cause for low water clarity, especially in wet years. Thus, it is important to target BMPs that will reduce sediment transport to Rathbun Lake.