Leesville Lake
Water Quality Monitoring Program

2009 Report

Prepared by

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CONTENTS

CONTENTS

FIGURES

TABLES

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EXECUTIVE SUMMARY

The Virginia Department of Environmental Quality (DEQ) monitors Leesville Lake water quality. Water quality monitoring by DEQ was on a six-year rotation, but DEQ recently changed to monitoring every other year. DEQ collected water quality data in 2009. Prior to 2009, DEQ last collected data in 2006. In addition to the past infrequent water monitoring by DEQ, there are too few DEQ monitoring stations to adequately understand bacteria levels in the lake. Therefore, the Leesville Lake Association (Association) initiated a Citizen Water Quality Monitoring Program in 2007.

The goals of the program are to:

- Obtain a better understanding of Leesville Lake water quality.
- Supplement the DEQ water quality monitoring.
- Raise the awareness of the importance of water quality.
- Educate residents about the factors that cause water quality to deteriorate and age the lake more rapidly than necessary.

The 2009 monitoring season began in early May and went through early October. Volunteers measured water clarity and collected water samples for bacteria testing from May 15th through September 4th on a biweekly basis and after major rain events. The Virginia Department of Environmental Quality (DEQ) loaned the Association a water quality monitoring probe that was used to measure dissolved oxygen (DO), temperature and pH from May 9th through October 1st on roughly a monthly basis.

The trophic status of Leesville Lake was monitored by measuring Secchi depth, which is an indicator of water clarity. Bacteria levels (E. coli) were monitored with the use of Coliscan Easygel® test kits. A DEQ Citizen Water Quality Monitoring Grant was used for expenses related to water quality monitoring, including purchase of Coliscan Easygel® test kits and other equipment and for fuel reimbursements.

<u>Conclusions – Trophic Status</u>

Based on the mean Secchi depth for all of the lake monitoring stations (excluding Pigg River data), the trophic state index (TSI) for 2009 is 51.3. That number is significantly lower than the mean for the DEQ data (1993 through 2003), which is 57.7, and slightly higher than the TSI for 2007 and 2008. The slightly higher TSI for 2009 compared to 2007 and 2008 is a result of more rainfall in 2009. The higher rainfall resulted in more runoff and more silt in the lake. More silt results in reduced water clarity, lower Secchi depth numbers and higher TSI. A lower TSI number is better from the perspective of lake aging.

Since non-algal turbidity such as silt affects Secchi depth and therefore TSI, it would be better if chlorophyll *a* and total phosphorus data were also collected. As part of its new license, Appalachian Power Company (Appalachian) will provide funding for water quality monitoring on Leesville Lake. That will allow the Association to form a partnership with Lynchburg College for future water quality monitoring. The Association and Lynchburg College submitted a proposed water quality monitoring plan to Appalachian that would include collecting chlorophyll *a,* total phosphorus and numerous other water quality data.

<u>Conclusions – Bacteria (Escherichia coli)</u>

Coliscan Easygel® test kits were used to measure E. coli in water samples. The mean E. coli level in 2009 lake water samples (excluding Pigg River samples) was 95 Colony Forming Units (CFUs)/100ml, compared to 22 CFUs/100ml in 2008 and 29 CFUs/100ml in 2007. The mean for 2009 was significantly higher than 2007 and 2008 because 2009 was a wet year compared to those years and two high numbers after major rain events skewed the mean. Even with the large rain events and collecting water samples shortly after the events, only two lake water samples out of the sixty-six tested during the season exceeded the state single sample standard (235 CFUs/100ml). The 2009 E. coli measurements in general indicate that the lake is safe for general recreational use. However, one should stay out of the water for several days after a major rain event, particularly between the Pigg River and Mile Mark 9, when the water is muddy. The Virginia Total Maximum Daily Load (TMDL) Program is addressing bacteria levels entering the lake through its major tributaries, the Pigg River and Old Woman's Creek. The TMDL Program will eventually reduce the quantity of bacteria entering the lake from those two tributaries.

Conclusions – Dissolved Oxygen, Temperature, and pH

In 2009, dissolved oxygen, temperature and pH data were collected at three stations: Toler Bridge, Mile Mark 6 and Mile Mark 1. Those three stations provide a good representation of the various sections of the lake: riverine (Toler Bridge), transition zone (Mile Mark 6) and lacustrine (Mile Mark 1). Data were collected at one meter increments from the surface to the bottom or to the end of the probe cable (15 meters). As expected, most of the dissolved oxygen (DO) values moved toward lower values as the summer progressed. In addition, DO generally decreased with increasing depth.

The DO and temperature values are relatively constant from the surface to the bottom at Toler Bridge on any given day. This is due to relatively high water flow rate and good mixing in this area.

At Mile Mark 6, the temperature data showed indications of stratification in early July. In July through August and early September, the thermocline moved down the water column. By October 1st, water temperatures near the surface had dropped and this section of the lake was no longer stratified. In early August, the dissolved DO below 8 meters depth was below 4 mg/l. By early September, DO was above 4 mg/l at all depths.

The section of the lake near Mile Mark 1 typically stratifies by late May. However, the large flows from the Pigg River in late May and early June delayed stratification until later in June. By October 1st, the water temperature was nearly the same from the surface to the bottom. In early July of 2008, DO was below 4 mg/l below 9 meters of depth at Mile Mark 1. However, in early July of 2009, DO was still above 4 mg/l in early July at all depths. In early August, DO was below 4 mg/l below 8 meters of depth. By early September, stratification had caused DO to drop below 4 mg/l at depths greater than 6 meters. By October 1st, DO was significantly above 4 mg/l at all depths. The data indicate that major rain events and the resulting large water flows, particularly from the Pigg River, can have a significant impact on lake stratification, water temperatures and dissolved oxygen.

None of the temperature data collected in 2009 exceeded the state standard (maximum 31 °C). The highest temperature recorded was 26.3 °C at Mile Mark 1 in early August.

The pH probe was difficult to calibrate/post check from May through early July and did not provide reliable data. During July, DEQ gave the pH probe an acid bath to improve its performance. Because the data collected early in the season are not reliable, the data are not included in this report. The 2009 pH numbers ranged from 6.9 to 7.8 and are generally lower than 2008 data. The pH data show that there was very little difference in pH on any given day at the three monitoring stations. The pH levels increased about 0.5 from August to September at Toler Bridge and Mile Mark 6, while pH data at Mile Mark 1 in August and September were similar. None of the pH data exceeded the state standard (range 6.0 to 9.0).

INTRODUCTION

Leesville Lake is the 3,270 acre lower lake in Appalachian Power Company's Smith Mountain pump-storage project. The Leesville Lake Association initiated a citizen water quality monitoring program in 2007.

The goals of the program are to:

- Obtain a better understanding of Leesville Lake water quality.
- Supplement the DEQ water quality monitoring.
- Raise the awareness of the importance of water quality.
- Educate residents about the factors that cause water quality to deteriorate and age the lake.

The Virginia Department of Environmental Quality (DEQ) monitors Leesville Lake water quality. Water quality monitoring by DEQ was on a six-year rotation, but DEQ recently changed to monitoring every other year. DEQ collected water quality data in 2009 and plans to collect data again in 2011. Prior to 2009, DEQ last collected data in 2006.

The 2009 monitoring season began in May. Volunteers measured water clarity and collected water samples for bacteria testing from May 15th through September 4th on a biweekly basis and after major rain events. The Virginia Department of Environmental Quality loaned the Association a water quality monitoring probe that was used to measure dissolved oxygen (DO), temperature and pH. The conductivity probe was not working, so no conductivity data were collected in 2009. Dissolved oxygen, pH and water temperature data were collected from May through October on roughly a monthly basis.

The trophic status of Leesville Lake was monitored by measuring Secchi depth, which is an indicator of water clarity. Bacteria levels (Escherichia coli) were monitored with the use of Coliscan Easygel® test kits. The Commonwealth of Virginia's bacterial standard uses Escherichia coli (E. coli) as the indicator organism. A DEQ Citizen Water Quality Monitoring Grant was used for expenses related to water quality monitoring, including purchase of Coliscan Easygel® test kits and other equipment and for fuel reimbursements.

Below is a table that lists the water quality monitoring stations. Data for the complete water column profile (DO, temperature and pH) were collected at three sites: Toler Bridge, Mile Mark 6 and Mile Mark 1. Those three sites provide a good representation of the various sections of the lake. Toler Bridge is far enough upstream that it provides data on the riverine section of the lake after the confluence with the Pigg River; Mile Mark 6 provides data in the transition zone and Mile Mark 1 provides data in the lacustrine section. Secchi depth and E. coli data were collected at seven sites: mouth of the Pigg River, Toler Bridge, Mile Mark 9, Tri-County Marina, Pit Stop Marina, Mile Mark 2 and Mile Mark 1. A map of the lake that shows the monitoring stations is on page 22 (Figure 14).

Table 1: Leesville Lake Water Quality Monitoring Stations

LVLA Station Number	DEQ Station ID	Station Location Description	Latitude	Longitude
1	LVLAROA153.47	Toler's Bridge	37.01090	-79.47530
2	LVLAROA149.94	Mile Mark 9	37.03993	-79.48233
3	LVLATER000.33	Tri-County Marina	37.05942	-79.44489
4	LVLAROA143.84	Mile Mark 3	37.06182	-79.42066
5	LVLAOWC000.58	Pit Stop Marina	37.05939	-79.39574
6	LVLAROA142.50	Mile Mark 2	37.06637	-79.40333
7	LVLAROA141.42	Mile Mark 1	37.08151	-79.40160
8	LVLAROA146.87	Mile Mark 6	37.06320	-79.47110
9	LVLAPGG000.47	Pigg River Mouth	37.00430	-79.48790

Trophic Status of Leesville Lake

The cloudiness of lake water and how far down one can see is often related to the amount of nutrients in the water. Nutrients promote growth of microscopic plant cells (phytoplankton) that are fed upon by microscopic animals (zooplankton). The more the nutrients, the more the plants and animals and the cloudier the water is. Measuring water clarity is a common, but indirect, way to roughly estimate the condition of the lake. The promotion of growth by nutrients is called eutrophication and is a natural aging process of lakes. Eutrophication is unnaturally accelerated by too many nutrients. Nutrients can come from many sources including fertilizers applied to agricultural areas and lawns, erosion of soil containing nutrients and sewage discharges.

A Secchi disk is commonly used to measure water transparency, or the depth to which you can easily see through the water. Secchi disk transparency, chlorophyll *a* (an indirect measure of phytoplankton) and total phosphorus (an important nutrient and potential pollutant) are often used to define the degree of eutrophication, or trophic status of a lake.

The concept of trophic status is based on the fact that changes in nutrient levels (measured by total phosphorus) cause changes in algal biomass (measured by chlorophyll *a*) which in turn causes changes in lake clarity (measured by Secchi disk transparency). A trophic state index is a convenient way to quantify this relationship. One popular index was developed by Dr. Robert Carlson of Kent State University. Carlson's index uses a logarithmic transformation of Secchi disk values as a measure of algal biomass on a scale from 0 - 110. Each increase of ten units on the scale represents a doubling of algal biomass. Because chlorophyll *a* and total phosphorus are usually closely correlated to Secchi disk measurements, these parameters can also be assigned trophic state index values. The Carlson trophic state index is useful for comparing lakes within a region and for assessing changes in trophic status over time.

Ranges of trophic state index values are often grouped into trophic state classifications.

- Oligotrophic lakes are very low in nutrients, so few algae grow and the water is very clear. Oligotrophic lakes have the lowest level of biological productivity and support very few plants and fish. These lakes have a visible depth greater than 12 feet and a tropic state index (TSI) of less than 40.

- Mesotrophic lakes are moderately productive, with slightly green water. Mesotrophic lakes have a visible depth between 8 and 12 feet and a TSI between 40 and 50.
- Eutrophic lakes are productive lakes with murkier water, and/or lots of plants, a visible depth of 3 to 8 feet and a TSI greater than 50.

A lake's trophic state can change over time. For many reasons, a mesotrophic lake can change into a eutrophic lake within a few years. That is why it is important to monitor lake clarity, chlorophyll *a* and phosphorus every year to determine trends.

As part of its relicensing process, Appalachian Power Company (Appalachian) conducted a water quality study on Leesville Lake. Part of the water quality study included a compilation of the water quality data collected by the Virginia Department of Environmental Quality (DEQ) from 1990 through 2006. Based on DEQ data for chlorophyll *a*, total phosphorus and Secchi depth, Leesville Lake is considered mesotrophic.

The Association collected Secchi depth data from May 15 through September 4, 2009. Below are charts showing the data. Also below is a table that lists the 2007, 2008 and 2009 mean Secchi depth data collected by the Association and the mean of the Secchi depth collected by DEQ from 1993 through 2003. The mean Secchi depth for all of the data collected in 2009 is 1.7 m. The mean Secchi depth for data collected in 2009 in the lake only (excluding Pigg River data) is 1.8 m. The mean Secchi depth for data collected in the lake in 2009 was slightly lower than data collected in both 2007 and 2008. This lower Secchi depth (reduced water clarity) is a result of the higher rainfall and more silt in the water in 2009. DEQ collected Secchi depth data from 1993 through 2003. The mean Secchi depth from 1993 through 2003 was 1.4 m. The year 2003 was a wet year and Secchi depths were lower than typical. If the 2003 data is excluded, the mean Secchi depth would have been 1.6 m. The mean Secchi depth for 2009 was higher than the mean from 1993 through 2003 with or without the 2003 data.

Based on the mean Secchi depth for all of the lake monitoring stations (excluding Pigg River data), the TSI for 2009 is 51.3. That number is significantly lower than the mean for the DEQ data (1993 through 2003), which is 57.7, but slightly higher than the TSI for 2007 and 2008. The slightly higher TSI for 2009 compared to 2007 and 2008 is a result of more rainfall in 2009. The higher rainfall resulted in more runoff and more silt in the lake. More silt results in reduced water clarity, lower Secchi depth numbers and higher TSI.

Table 2: Summary of Trophic State Indicators

	1993 – 2003	2007	2008	2009
Mean Secchi Depth, m	1.4	1.9	2.0	1.8
TSI	57.7	50.6	50.2	51.3

Since non-algal turbidity such as silt affects Secchi depth readings and, therefore TSI, it would be better if chlorophyll *a* and total phosphorus data were also collected. As part of its new license, Appalachian will provide funding for water quality monitoring on Leesville Lake, which will allow the Association to form a partnership with Lynchburg College for future water quality monitoring. The Association and Lynchburg College submitted to Appalachian a proposed water quality monitoring program that would collect chlorophyll *a,* total phosphorus and numerous other water quality data.

Figure 1 (below) shows mean Secchi depth at each monitoring station. Note that Secchi depth increases (clearer water) closer to the dam. Also note that the Secchi depth in the Pigg River is significantly lower than the Secchi depth in the lake. The lower Secchi depth in the Pigg River is primarily a result of the silt in the water. Even though the Pit Stop Marina is near Mile Mark 2, the Secchi depth at Pit Stop Marina is lower than Mile Mark 2 because of the silt from Old Woman's Creek.

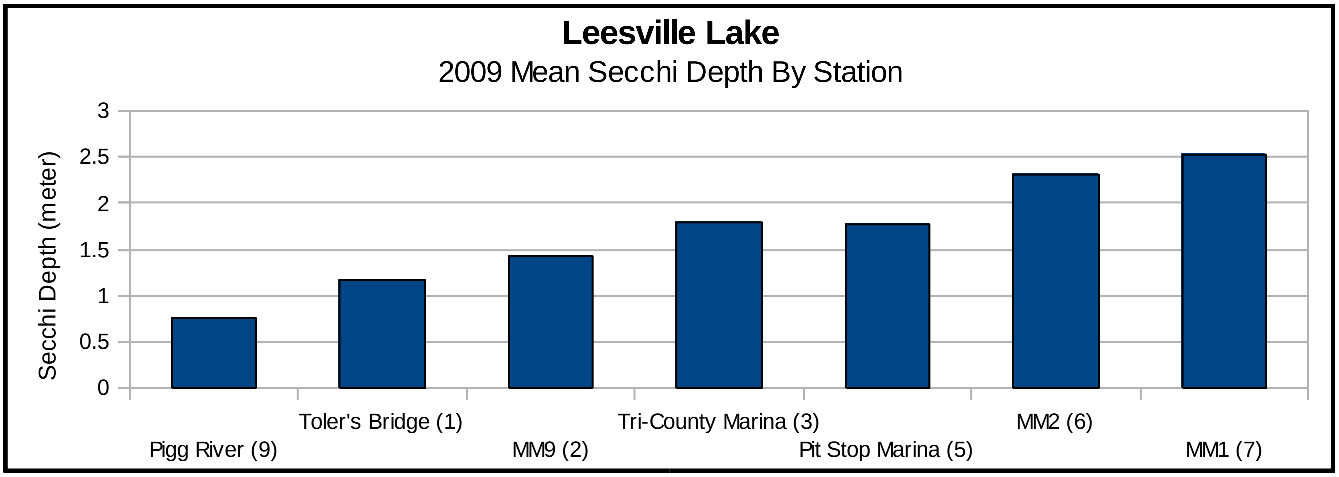

Figure 1: Mean Secchi Depth by Station
(Numbers in parentheses after station name are station numbers)

Figure 2 (below) shows how Secchi depth changed over the season. Secchi depth dropped substantially after over 4 inches of rain fell in late May and early June. Six days later, Secchi depths were still low, which indicates that it takes significant time for the silt to settle out of the water.

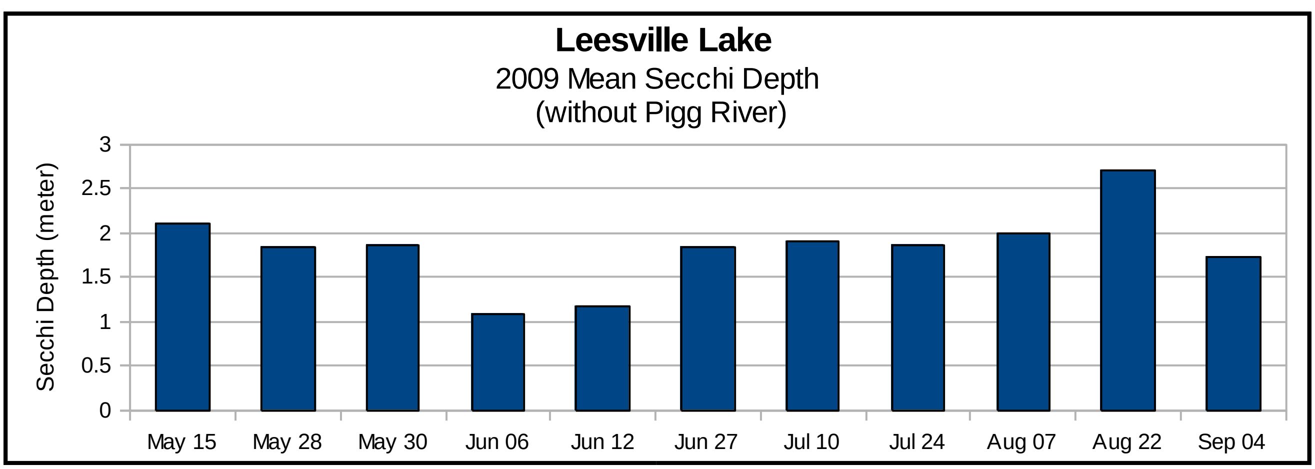

Figure 2: Mean Secchi Depth by Date (without Pigg River)

Bacteria (Escherichia coli) Profiles

Water samples collected from May 15th through September 4th from the following seven monitoring stations were tested for E. coli using Coliscan Easygel® test kits: Mile Mark 1, Mile Mark 2, Pit Stop Marina, Tri-County Marina, Mile Mark 9, Toler Bridge and near the mouth of the Pigg River. Samples were collected on a biweekly basis and after significant rain events.

Figure 3 (below) is a chart of the E. coli data by date. Unless there is a significant rain event, E. coli levels are well below the state single sample maximum standard (235 CFUs/100ml) and generally at the minimum detectable level for the Coliscan Easygel® test, which is 20 CFUs/100ml. From May 25 through May 30, over 2 inches of rain fell, so water samples were collected on May 30th. As a result of the rainfall, E. coli level in the Pigg River spiked to 1000 CFUs/100ml and the Toler Bridge sample contained 220 CFUs/100ml. From June 4 through 6, another two plus inches of rain fell and spikes in the E. coli levels were as follows: Pigg River: 3200 CFUs/100ml, Toler Bridge: 2600 CFUs/100ml and Mile Mark 9: 2100 CFUs/100ml. It is interesting to note that the E. coli level downstream at Tri-County Marina was at the minimum detectable limit, so the E. coli settled out fairly quickly.

Figure 4 (below) shows E. coli monthly profiles by monitoring station. There is only one set of data for September. The Toler Bridge water samples exceeded the state monthly average standard (126 CFUs/100ml) in June and the Pigg River samples exceeded the standard in May, June and August.

The mean E. coli level in 2009 lake water samples (excluding Pigg River samples) was 95 CFUs/100ml, compared to 22 CFUs/100ml in 2008 and 29 CFUs/100ml in 2007. The mean for 2009 was relatively high because 2009 was a wet year compared to 2008 and 2007 and two very high numbers after major rain events skewed the mean. Even with the large rain events and collecting water samples shortly after the events, only two lake water samples out of the sixty-six tested during the season exceeded the state standard. The Virginia Total Maximum Daily Load (TMDL) Program is addressing bacteria levels entering the lake through its major tributaries, the Pigg River and Old Woman's Creek. The TMDL Program will eventually reduce the quantity of bacteria entering the lake from those two tributaries.

The 2009 E. coli measurements in general indicate that the lake is safe for general recreational use. However, one should stay out of the water for several days after a major rain event, particularly between the Pigg River and Mile Mark 9, when the water is muddy.

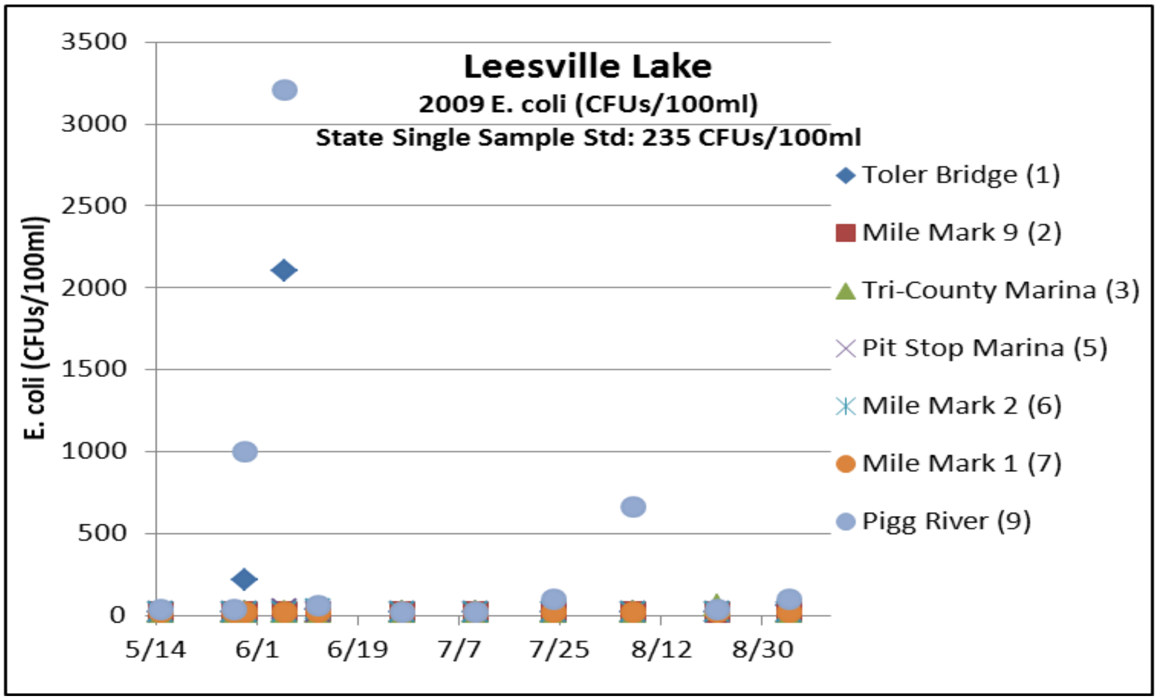

Figure 3: E. coli Profiles By Date
(Numbers in parentheses after station name are station numbers)

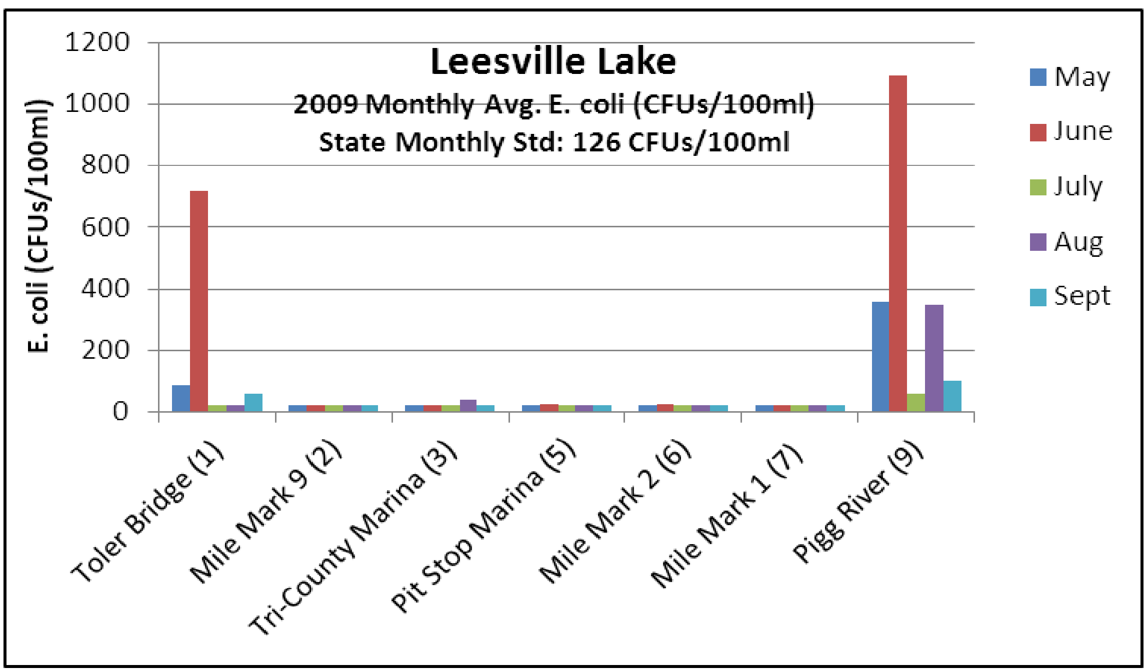

Figure 4: E. coli Monthly Profiles By Monitoring Station
(September is one set of data)
(Numbers in parentheses after station name are station numbers)

Dissolved Oxygen (DO), Temperature and pH Profiles

The Virginia Department of Environmental Quality (DEQ) loaned the Association a Hydrolab water quality monitoring probe with a 15-meter cable that was used to measure dissolved oxygen (DO), temperature and pH at three locations: Toler Bridge, Mile Mark 6 and Mile Mark 1. These three stations provide a good representation of the various sections of the lake. The Toler Bridge station is below the confluence with the Pigg River and represents the riverine portion of the lake. Mile Mark 6 is roughly in the transition zone between the riverine section and the lacustrine section. Mile Mark 1 is one mile from the Leesville dam and represents the lacustrine section of the lake.

DO, temperature and pH data were collected for the complete water column profile. That is, data were collected at the surface and then at one meter incremental depths down to the bottom of the lake or until the end of the cable was reached. The conductivity probe did not work, so no conductivity data were collected in 2009.

Dissolved oxygen is important to aquatic life in the lake. DO is also useful in evaluating the health and trophic status of the lake. The lacustrine and transition sections of the lake stratify during the warmer months. The warmer surface waters (epilimnion) are separated from the cooler bottom waters (hypolimnion) by a transition zone called the thermocline. Water temperatures change rapidly in the thermocline, which acts as a barrier to mixing between the epilimnion and the hypolimnion. The oxygen levels in the lower layer of the lake are depleted when nutrient enrichment increases algal production and the organic matter consumes the oxygen. Because of the thermal stratification, the oxygen in the surface layer does not mix with the bottom layer.

Water Temperature Profiles

Table 3 (page 14) contains the complete set of temperature data. Figures 5 through 7 (below) show the temperature profiles for the three monitoring stations: Toler Bridge, Mile Mark 6 and Mile Mark 1. Figure 5 (below) shows that at Toler Bridge, temperatures are relatively constant from the surface to the bottom most of the time. This is due to the fact that the lake is relatively shallow and narrow in that section, so flow rates are relatively high and there is good mixing. Temperature levels increased from early May through the end of August and then began to decrease.

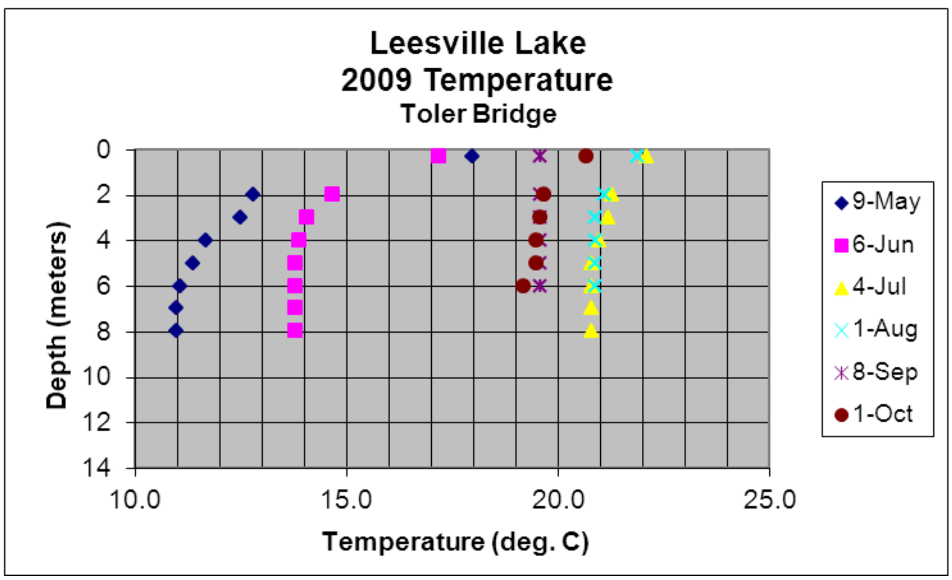

Figure 5: Water Temperature at Toler Bridge

Figure 6 (below) shows water temperature profiles at Mile Mark 6. The temperature data indicated stratification in early July. In July through August and early September, the thermocline moved down the water column. By October 1st, water temperatures declined and this section of the lake was no longer stratified.

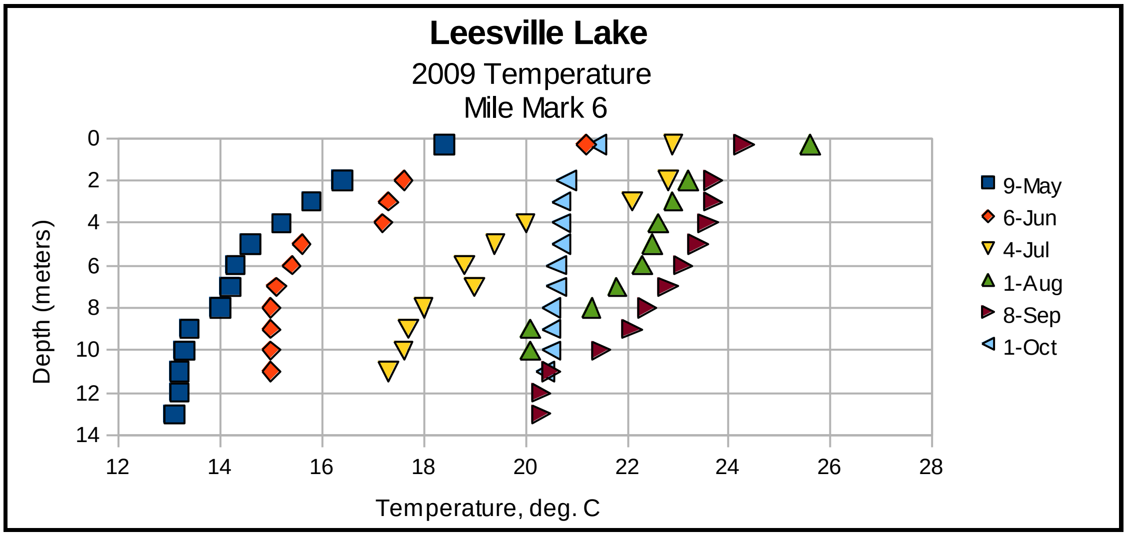

Figure 6: Water Temperature at Mile Mark 6

Figure 7 (below) shows the water temperature profiles at Mile Mark 1. This section of the lake typically stratifies by late May. However, the large Pigg River flows in late May and early June appears to have delayed stratification until later in June. By early September, this section of the lake was no longer stratified. By October 1st, the water temperatures were nearly the same from the surface to the bottom.

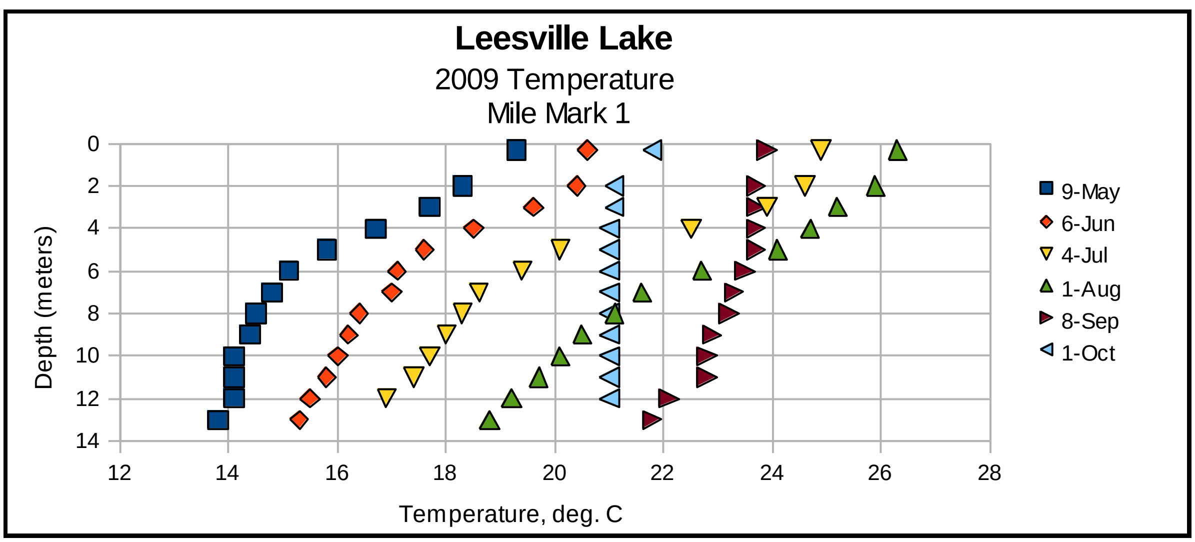

Figure 7: Water Temperature at Mile Mark 1

Table 3: Water Temperature Data
(Numbers in parentheses after site name are station numbers)

Leesville Lake
2009 Water Temperature (deg C)

Station	Depth (m)	9-May	6-Jun	4-Jul	1-Aug	8-Sep	1-Oct
Mile Mark 1 (7)	0.3	19.3	20.6	24.9	26.3	23.9	21.8
	2	18.3	20.4	24.6	25.9	23.7	21.1
	3	17.7	19.6	23.9	25.2	23.7	21.1
	4	16.7	18.5	22.5	24.7	23.7	21.0
	5	15.8	17.6	20.1	24.1	23.7	21.0
	6	15.1	17.1	19.4	22.7	23.5	21.0
	7	14.8	17.0	18.6	21.6	23.3	21.0
	8	14.5	16.4	18.3	21.1	23.2	21.0
	9	14.4	16.2	18.0	20.5	22.9	21.0
	10	14.1	16.0	17.7	20.1	22.8	21.0
	11	14.1	15.8	17.4	19.7	22.8	21.0
	12	14.1	15.5	16.9	19.2	22.1	21.0
	13	13.8	15.3		18.8	21.8	
	14						
Mile Mark 6 (8)	0.3	18.4	21.2	22.9	25.6	24.3	21.4
	2	16.4	17.6	22.8	23.2	23.7	20.8
	3	15.8	17.3	22.1	22.9	23.7	20.7
	4	15.2	17.2	20.0	22.6	23.6	20.7
	5	14.6	15.6	19.4	22.5	23.4	20.7
	6	14.3	15.4	18.8	22.3	23.1	20.6
	7	14.2	15.1	19.0	21.8	22.8	20.6
	8	14.0	15.0	18.0	21.3	22.4	20.5
	9	13.4	15.0	17.7	20.1	22.1	20.5
	10	13.3	15.0	17.6	20.1	21.5	20.5
	11	13.2	15.0	17.3		20.5	20.4
	12	13.2				20.3	
	13	13.1				20.3	
Toler Bridge (1)	0.3	18.0	17.2	22.1	21.9	19.6	20.7
	2	12.8	14.7	21.3	21.1	19.6	19.7
	3	12.5	14.1	21.2	20.9	19.6	19.6
	4	11.7	13.9	21.0	20.9	19.6	19.5
	5	11.4	13.8	20.8	20.9	19.6	19.5
	6	11.1	13.8	20.8	20.9	19.6	19.2
	7	11.0	13.8	20.8	20.9		
	8	11.0	13.8	20.8			

Dissolved Oxygen (DO) Profiles

Table 4 (page 17) contains the complete set of dissolved oxygen (DO) data. Figures 8 through 10 show the dissolved oxygen (DO) profiles for the three monitoring stations: Toler Bridge, Mile Mark 6 and Mile Mark 1. The state standard for dissolved oxygen for Leesville Lake is a minimum of 4 mg/l. However, the standard only applies to the epilimnion in the lacustrine portion of the water body when there is thermal stratification. When these waters are not stratified, the dissolved oxygen criteria apply throughout the water column.

Figure 8 (below) shows that at Toler Bridge, DO levels are relatively constant from the surface to the bottom. This is due to the fact that the lake is relatively shallow and narrow in that section, so flow rates are relatively high and there is good mixing. DO levels declined from May through early September and then began to increase. All of the DO levels were above the state standard (minimum 4 mg/l).

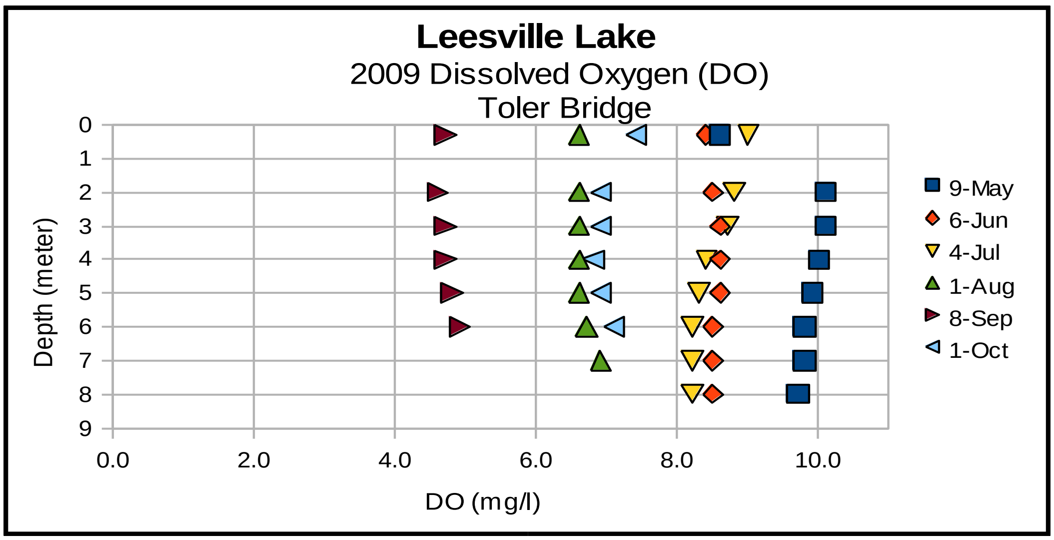

Figure 8: Dissolved Oxygen Profiles at Toler Bridge

Figure 9 (below) shows dissolved oxygen data for Mile Mark 6. As expected, DO declined as the season progressed and was lower in deeper water. In early August, the DO was below 4 mg/l below 8 meters depth. By early September, DO was above 4 mg/l at all depths.

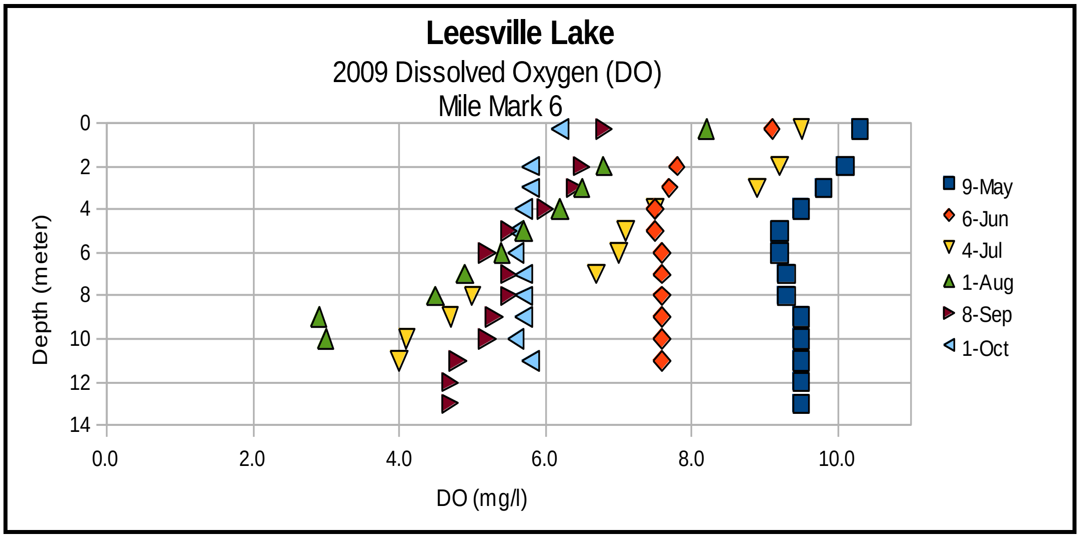

Figure 9: Dissolved Oxygen Profiles at Mile Mark 6

Figure 10 (below) shows dissolved oxygen data for Mile Mark 1. As expected, DO declined as the season progressed and was lower in deeper water. In early July of 2008, DO was below 4 mg/l below 9 meters of depth. However, in early July of 2009, DO was still above 4 mg/l in early July at all depths. On August 1st, DO was below 4 mg/l below 8 meters of depth. By early September, stratification caused DO to drop below 4 mg/l below 6 meters of depth. By October 1st, DO was above 4 mg/l at all depths.

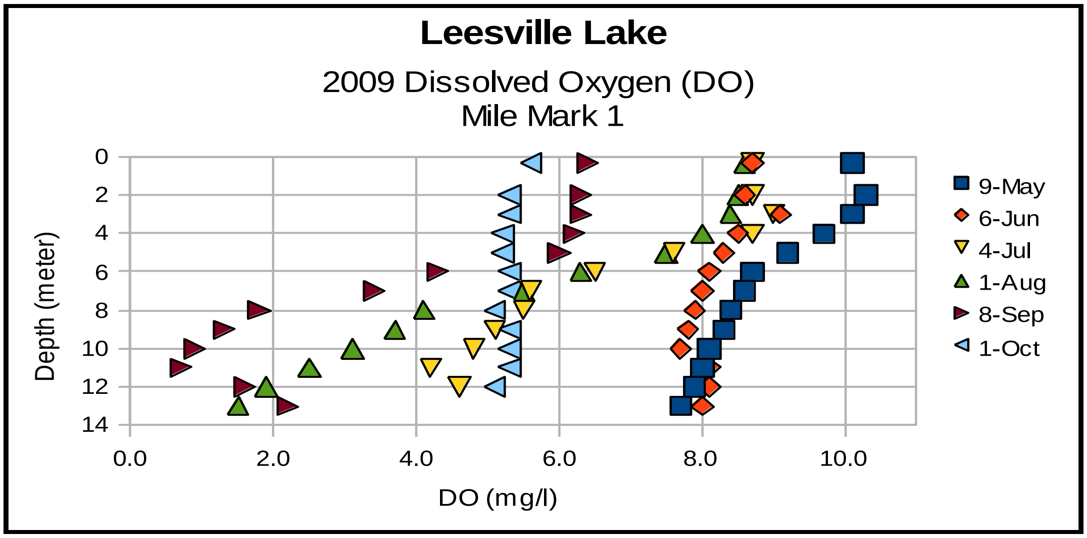

Figure 10: Dissolved Oxygen Profiles at Mile Mark 1

Table 4: 2009 Dissolved Oxygen Data
(Numbers in parentheses after station name are station numbers)

Leesville Lake
2009 Dissolved Oxygen (DO) (mg/l)

Station	Depth (m)	9-May	6-Jun	4-Jul	1-Aug	8-Sep	1-Oct
Mile Mark 1 (7)	0.3	10.1	8.7	8.7	8.6	6.4	5.6
	2	10.3	8.6	8.7	8.5	6.3	5.3
	3	10.1	9.1	9.0	8.4	6.3	5.3
	4	9.7	8.5	8.7	8.0	6.2	5.2
	5	9.2	8.3	7.6	7.5	6.0	5.2
	6	8.7	8.1	6.5	6.3	4.3	5.3
	7	8.6	8.0	5.6	5.5	3.4	5.3
	8	8.4	7.9	5.5	4.1	1.8	5.1
	9	8.3	7.8	5.1	3.7	1.3	5.3
	10	8.1	7.7	4.8	3.1	0.9	5.3
	11	8.0	8.1	4.2	2.5	0.7	5.3
	12	7.9	8.1	4.6	1.9	1.6	5.1
	13	7.7	8.0		1.5	2.2	
Mile Mark 6 (8)	0.3	10.3	9.1	9.5	8.2	6.8	6.2
	2	10.1	7.8	9.2	6.8	6.5	5.8
	3	9.8	7.7	8.9	6.5	6.4	5.8
	4	9.5	7.5	7.5	6.2	6.0	5.7
	5	9.2	7.5	7.1	5.7	5.5	5.6
	6	9.2	7.6	7.0	5.4	5.2	5.6
	7	9.3	7.6	6.7	4.9	5.5	5.7
	8	9.3	7.6	5.0	4.5	5.5	5.7
	9	9.5	7.6	4.7	2.9	5.3	5.7
	10	9.5	7.6	4.1	3.0	5.2	5.6
	11	9.5	7.6	4.0		4.8	5.8
	12	9.5				4.7	
	13	9.5				4.7	
Toler Bridge (1)	0.3	8.6	8.4	9.0	6.6	4.7	7.4
	2	10.1	8.5	8.8	6.6	4.6	6.9
	3	10.1	8.6	8.7	6.6	4.7	6.9
	4	10.0	8.6	8.4	6.6	4.7	6.8
	5	9.9	8.6	8.3	6.6	4.8	6.9
	6	9.8	8.5	8.2	6.7	4.9	7.1
	7	9.8	8.5	8.2	6.9		
	8	9.7	8.5	8.2			

pH Profiles

When algae grows during the day, it consumes carbon dioxide, which is a weak acid, and the water becomes more basic (pH increases). When algae and other organisms respire at night and carbon dioxide levels increase, the pH decreases. The pH increase and decrease from daytime to nighttime results in a diurnal pH cycle. High pH levels and large diurnal swings in pH and dissolved oxygen stress aquatic organisms. All of the 2009 pH data were collected mid-day, so there was no attempt to quantify the diurnal pH cycle. Table 5 (page 20) contains the complete set of pH data.

The pH probe was difficult to calibrate/post check from May through early July and did not provide reliable data. During July, DEQ gave the pH probe an acid bath to improve its performance. Because the data collected early in the season are not reliable, the data are not included in this report. The 2009 pH numbers ranged from 6.9 to 7.8 and are generally lower than 2008 data. The pH data show that there was very little difference in pH on any given day at the three monitoring stations. The pH levels increased about 0.5 from August to September at Toler Bridge and Mile Mark 6, while pH data at Mile Mark 1in August and September were similar. None of the pH data exceeded the state standard (range 6.0 to 9.0).

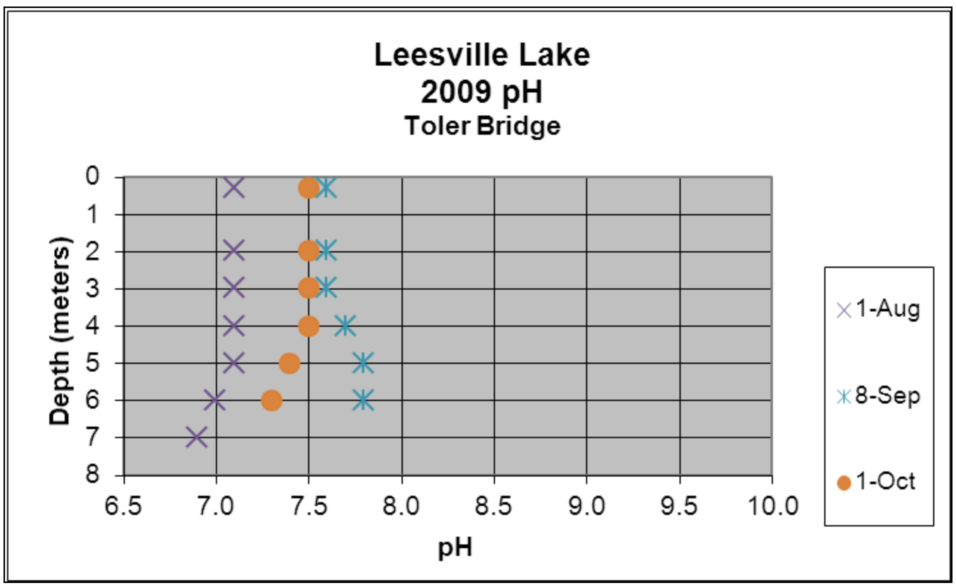

Figure 11: pH Profiles at Toler Bridge

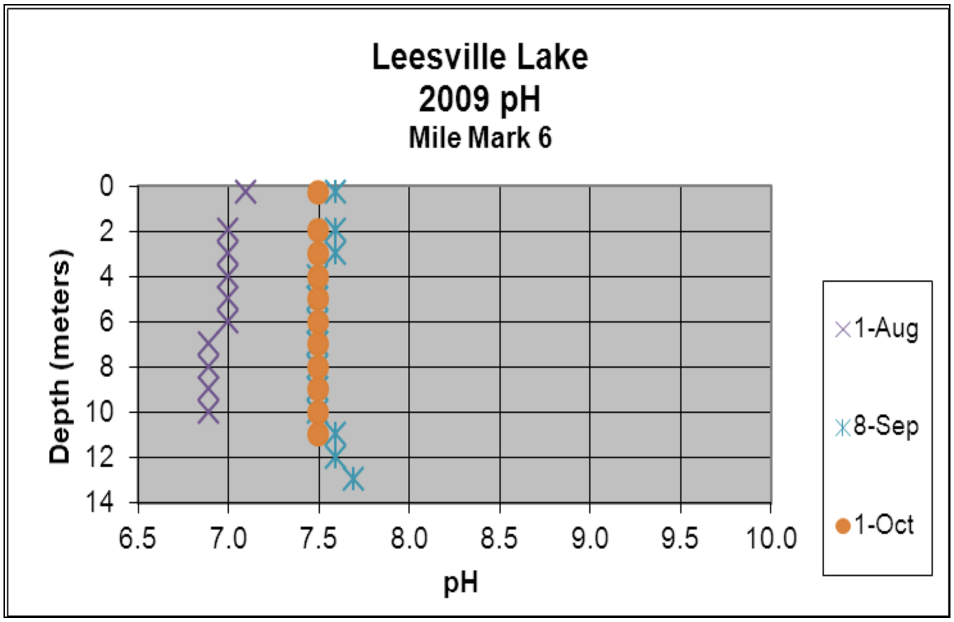

Figure 12: pH Profiles at Mile Mark 6

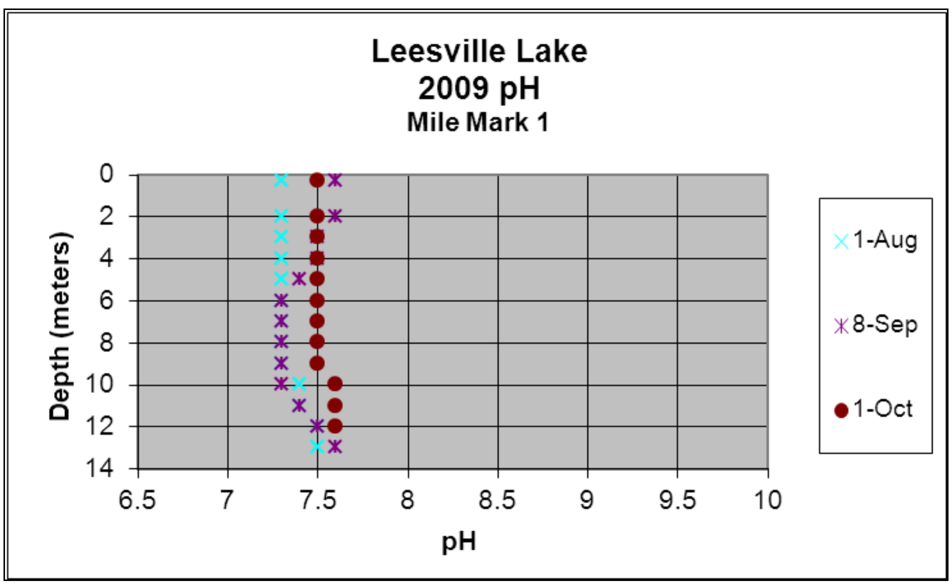

Figure 13: pH Profiles at Mile Mark 1

Table 5: 2009 pH Data
(numbers in parentheses after station name are station numbers)

Leesville Lake
2009 pH

Station	Depth (m)	1-Aug	8-Sep	1-Oct
Mile Mark 1 (7)	0.3	7.3	7.6	7.5
	2	7.3	7.6	7.5
	3	7.3	7.5	7.5
	4	7.3	7.5	7.5
	5	7.3	7.4	7.5
	6	7.3	7.3	7.5
	7	7.3	7.3	7.5
	8	7.3	7.3	7.5
	9	7.3	7.3	7.5
	10	7.4	7.3	7.6
	11	7.4	7.4	7.6
	12	7.5	7.5	7.6
	13	7.5	7.6	
Mile Mark 6 (8)	0.3	7.1	7.6	7.5
	2	7.0	7.6	7.5
	3	7.0	7.6	7.5
	4	7.0	7.5	7.5
	5	7.0	7.5	7.5
	6	7.0	7.5	7.5
	7	6.9	7.5	7.5
	8	6.9	7.5	7.5
	9	6.9	7.5	7.5
	10	6.9	7.5	7.5
	11		7.6	7.5
	12		7.6	
	13		7.7	
Toler Bridge (1)	0.3	7.1	7.6	7.5
	2	7.1	7.6	7.5
	3	7.1	7.6	7.5
	4	7.1	7.7	7.5
	5	7.1	7.8	7.4
	6	7.0	7.8	7.3
	7	6.9		

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- James Beckley, Stuart Torbeck, Mike Shaver and Amanda Gray, Virginia Department of Environmental Quality, for their advice and consultation.
- Stan Smith, Smith Mountain Lake Association, for his advice and consultation.

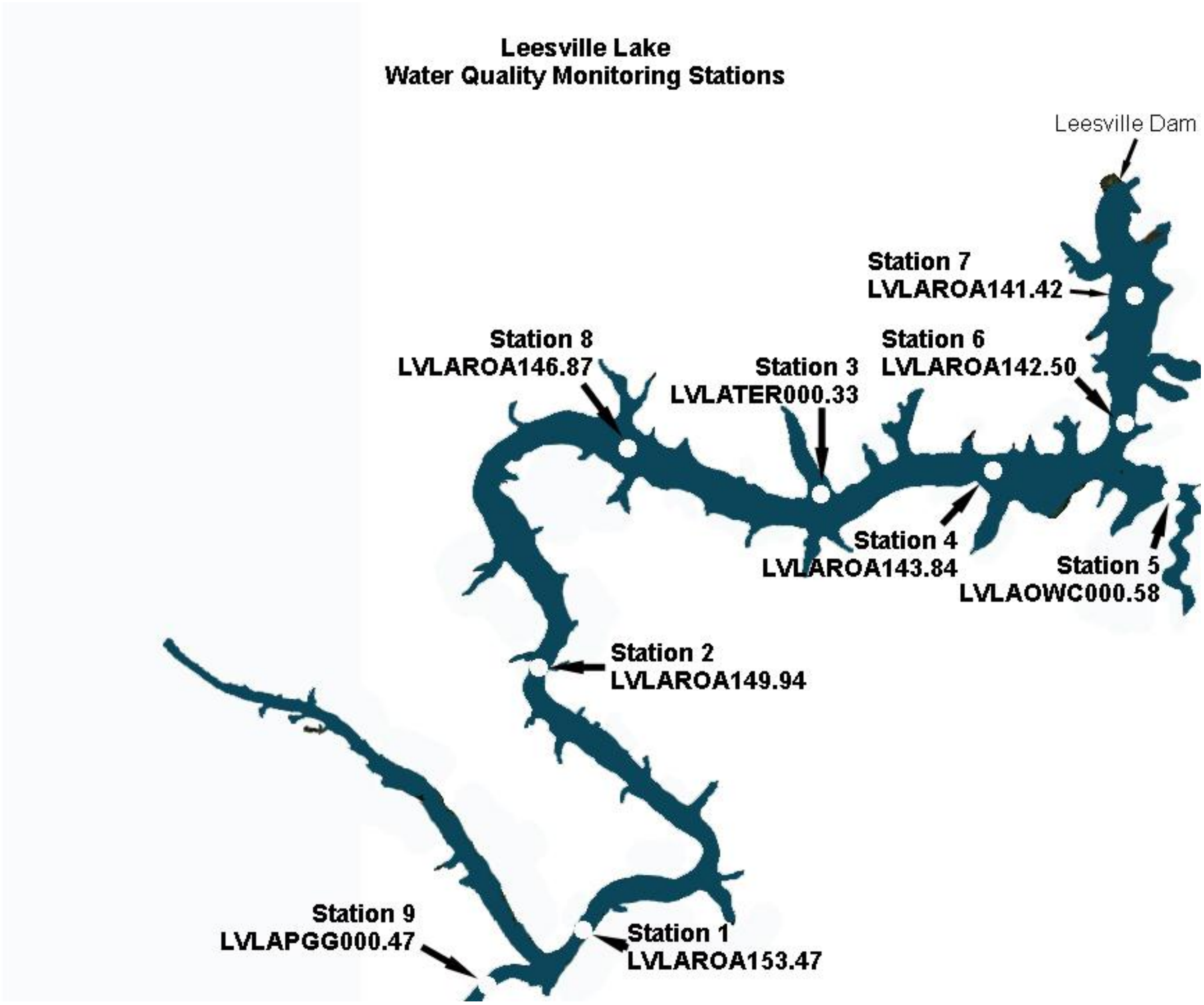

Figure 14: Leesville Lake Water Quality Monitoring Stations