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Emerald Lakes Village, Oakland County *September 30th, 2014*

Sandshores Lake - Water Quality Report

The goal of this testing protocol was to monitor various water quality parameters of the lake, compare results to historical data, and identify any potential risks to the health of Sandshores Lake. Water samples were taken from the middle of the lake and tested for various parameters. Field tests and water samples were taken on May 23rd, August 5th, and September 23rd. This report describes conditions at the times the samples were taken. The quality of the water was tested only to the parameters listed below.

Parameter	May 23rd	August 5th	September 23rd	Target Range
Temperature	69.4 ˚F	79.0 ˚F	66.4 ˚F	Less Than 75 ˚F
Dissolved Oxygen	8.4 mg/L	8.6 mg/L	7.7 mg/L	4.0 – 12.0 mg/L
Total Phosphorus	70 ppb	40 ppb	20 ppb	0 – 100 ppb
Phosphate	30 ppb	10 ppb	10 ppb	0 – 100 ppb
Nitrate	572 ppb	616 ppb	660 ppb	0 – 1,000 ppb
Chlorophyll-α	4.8 ppb	6.1 ppb	3.3 ppb	0 – 7.3 ppb
Transparency	5.4 feet	4.3 feet	3.6 feet	More than 6.5 feet
pH	8.0	8.6	8.3	7.0 – 9.0 S.U.
Total Dissolved Solids	405 ppm	434 ppm	423 ppm	0 – 1,000 ppm
Conductivity	803 µS	866 µS	846 µS	0 – 1,500 µS
Alkalinity	171 ppm	196 ppm	157 ppm	0 – 250 ppm
Hardness	206 ppm	231 ppm	179 ppm	100 – 300 ppm
Total Salinity	450 ppm	430 ppm	420 ppm	0 – 500 ppm
Chloride	132 ppm	119 ppm	104 ppm	0 – 230 ppm
Trophic State Index – Transparency	53	56	59	Oligotrophic: 0 - 40 Mesotrophic: 40 – 50 Eutrophic: 50 – 70 Hypereutrophic: 70+
Trophic State Index – Total Phosphorus	65	57	47	
Trophic State Index – Chlorophyll-α	46	48	42	

	Temperature Profile(˚F)			Dissolved Oxygen Profile (mg/L)			Salinity Profile (ppm)		
Depth (ft.)	May 23rd	August 5th	Sept. 23rd	May 23rd	August 5th	Sept. 23rd	May 23rd	August 5th	Sept. 23rd
0	69.4	79.0	66.4	8.4	8.6	7.7	450	430	420
3	69.0	78.8	66.3	8.2	8.5	7.9	450	430	420
6	67.8	78.3	66.1	7.6	8.3	7.6	460	430	420
9	66.3	77.8	65.8	6.8	8.1	7.0	470	430	420
12	65.1	77.2	65.5	6.4	7.8	6.4	470	440	430

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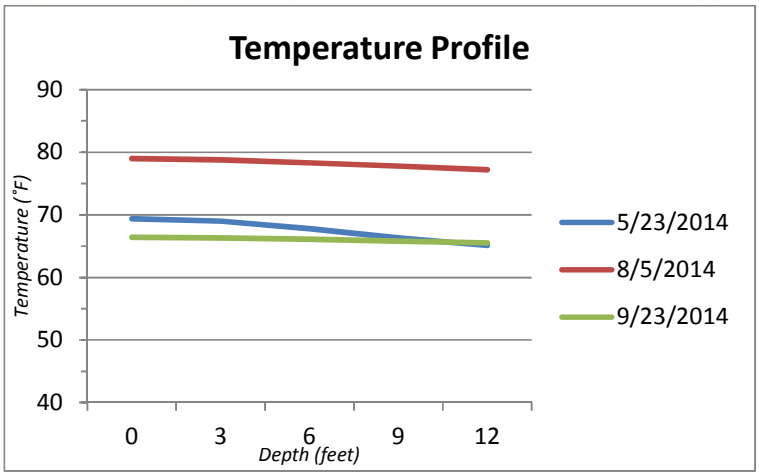
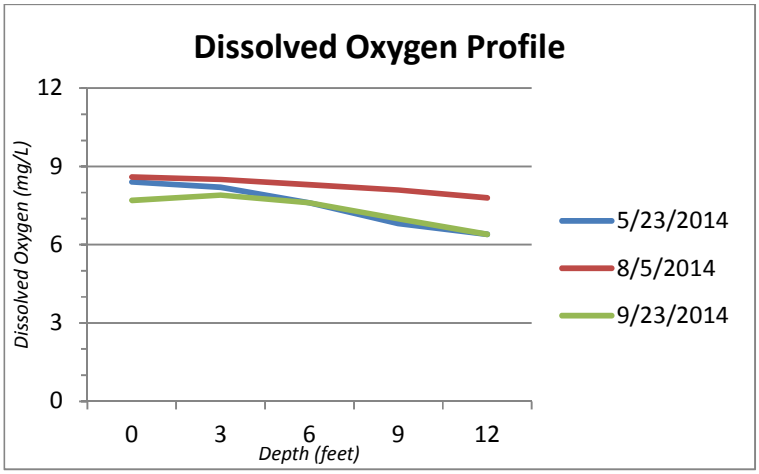
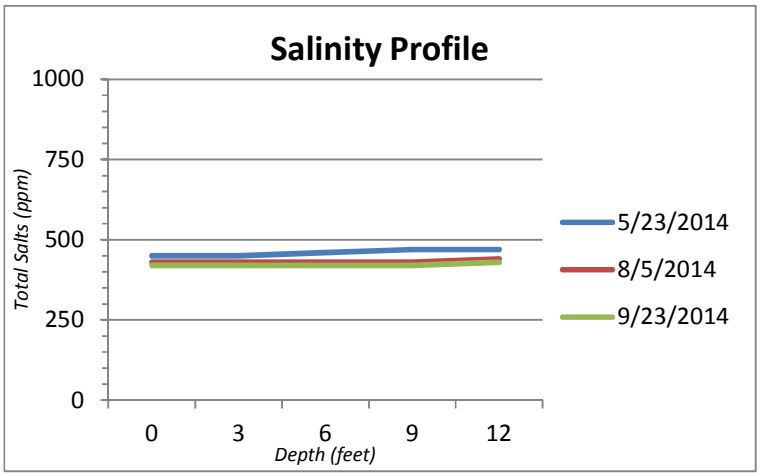






Spring Discussion

The results from the spring testing showed that the lake was in good shape to start the summer. Only one parameter was outside the target range – Transparency. In the fall of 2013, the lake had reduced transparency

due to blue dye applications. Prior to this test, LakePro already applied the initial dose of dye for the year. Therefore, we expected the transparency to be low.

We corrected the target range for Total Salinity to be less than 500 ppm, and the spring reading was within that range. For the first time, we tested for Chloride, which has a target range of less than 230 ppm. The result for chloride was less than that limit, so the salts in the lake were at acceptable levels to start the summer.

Mid-Summer Discussion

Similar to last year, this summer brought above-average rainfall to southeast Michigan. This abundant rainfall had many effects on the lake, which were apparent in the mid-summer test results.

First, the temperature of the lake was up, but not into the 80's as we'd seen in past years. This showed the cooling effect of the rain on the lake. A cooler temperature meant the water was able to hold more dissolved oxygen for the fish. The dissolved oxygen was, in fact, up from the spring test.

The Transparency of the lake was up from the spring test, but was still below the target range. This was because LakePro applied blue dye throughout the summer to decrease sunlight penetration and slow plant growth.

The Total Dissolved Solids and Conductivity increased slightly from the spring tests. However, the Total Salinity and Chloride both decreased over that same time, showing the rain flushed more salts than were delivered over the summer.

The Total Phosphorus of the lake was lower than in the spring and the Nitrates were slightly higher. The increase of Nitrates showed that the rain runoff carried some nutrients into the lake. However, because homeowners stopped using fertilizers with phosphorus, there was no source of phosphorus, and this nutrient was flushed from the lake.

Fall Discussion

The third water quality test was later this year than in previous years, which resulted in lake temperatures to be lower than normal for the third test. This drop in water temperature started the "winterization" of the lake that included more dissolved oxygen and lower Chlorophyll-α (plant production).

The Transparency decreased slightly from the summer test. This was a result of the multiple dye applications that LakePro made to the lake.

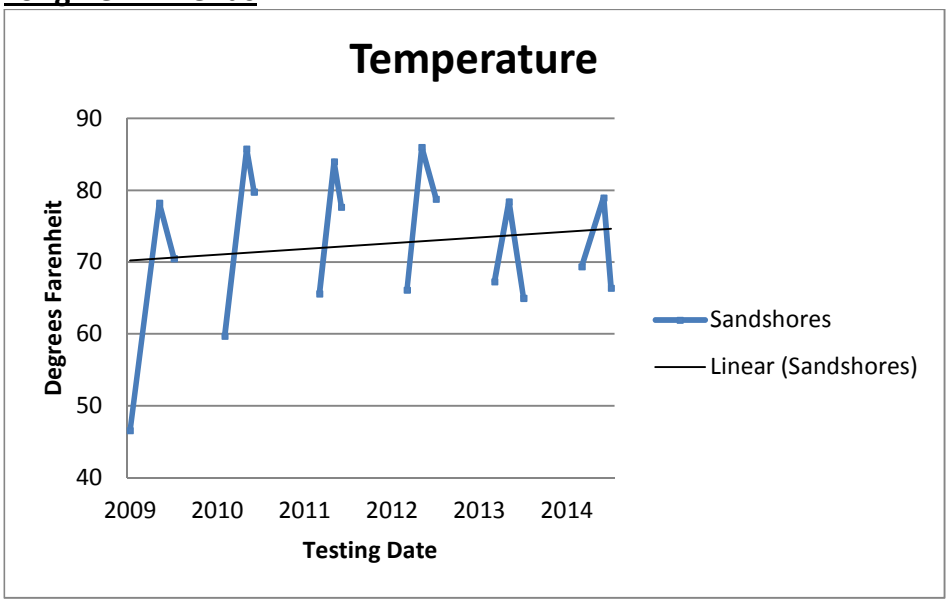
The Salinity and Chloride continued to decrease late in the year.

Despite the cooler temperatures, the dissolved oxygen decreased slightly from the summer test. This was most likely due to less plant production late in the year. Another reason for the decrease was fall turnover. During fall turnover, the surface water cooled and sank into the lake, pushing up the warmer water from the bottom. During the summer, the bottom water carried the least amount of oxygen, so when it came to the top, it appeared as if the dissolved oxygen decreased. Over time, this water will cool off and absorb more oxygen from the air.

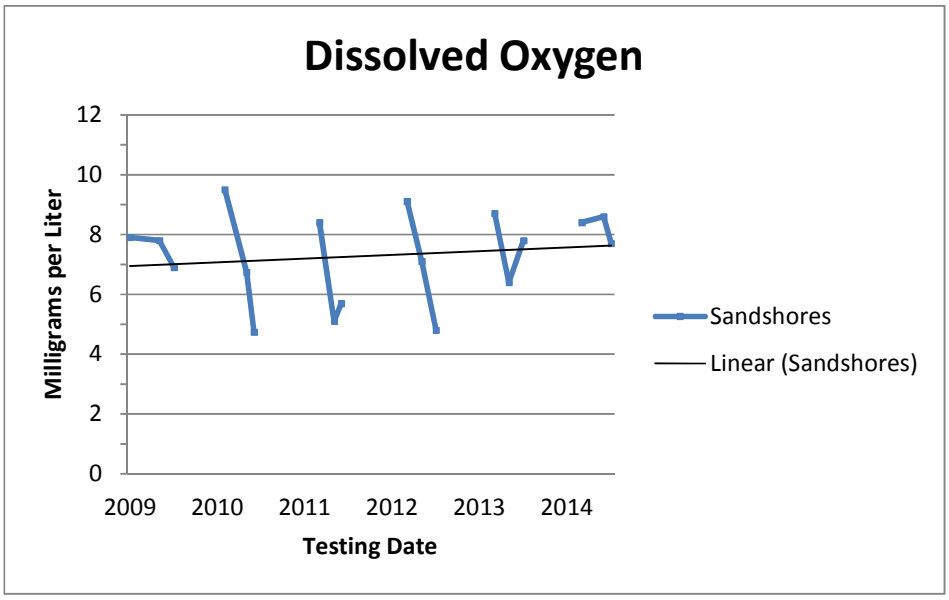
Total Phosphorus decreased, but Nitrates continued to increase. Sustained runoff bringing fertilizers into the lake and lesser plant production in the lake lead to increased nutrient concentrations. The decrease in

Phosphorus was a positive change because it showed that homeowners are continuing to observe the ban on phosphorus-laden fertilizers.

Long-Term Trends



The temperature showed a slightly upward trend since our testing began in 2009. This year was slightly cooler than most years. The temperature was affected by the dates selected for testing and the particular weather of each year. As we collect data in subsequent years, the trend line should become a more accurate indicator of the changes in the lake.



As the temperature increased, the water was able to hold less dissolved oxygen. Despite the temperature trending upward, the dissolved oxygen also increased. This was a positive for the lake, showing that even with temperature increases the ecosystem maintained enough oxygen to support the aquatic biota.

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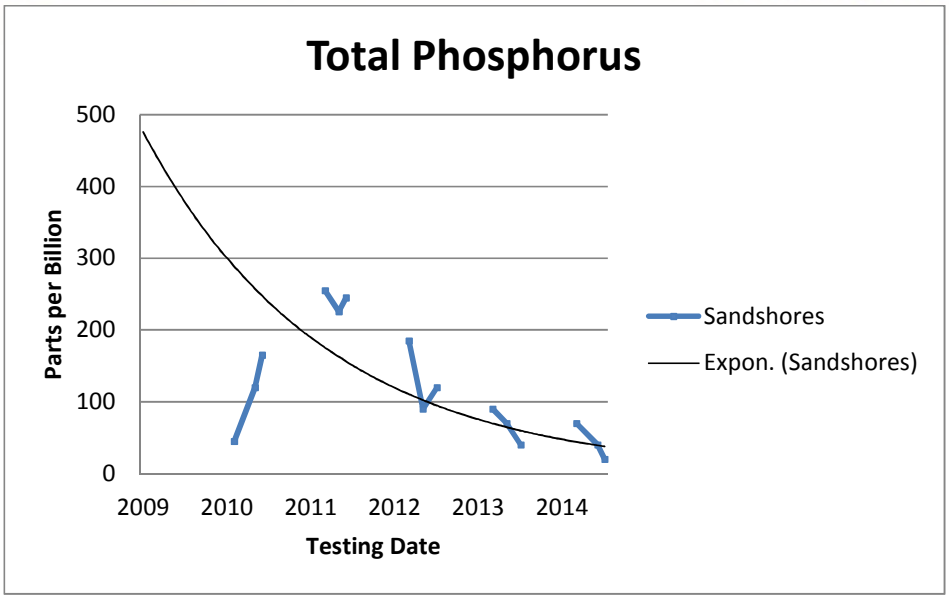
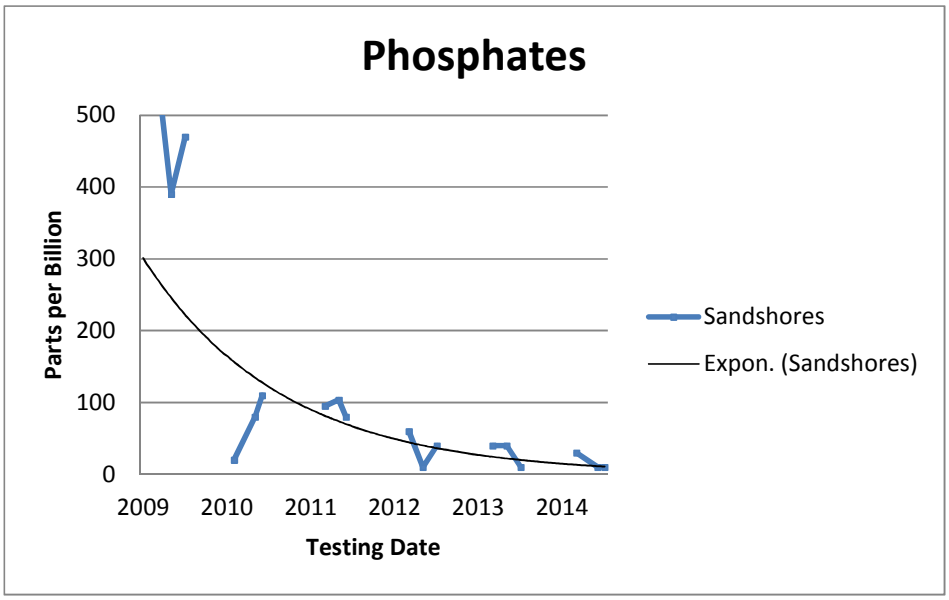


The Total Phosphorus concentration decreased again in 2014. There was a very large drop from 2009 to 2010, and a gradual decrease from that point. The state law banning phosphorus fertilizers, proper maintenance of catch basins and storm drains, and active plant management all helped decrease the phosphorus load of the lake.



Phosphate is the form of Phosphorus that is usable to aquatic plants. The concentration of this nutrient showed the same pattern as the Total Phosphorus and approached minimal levels in the lake.

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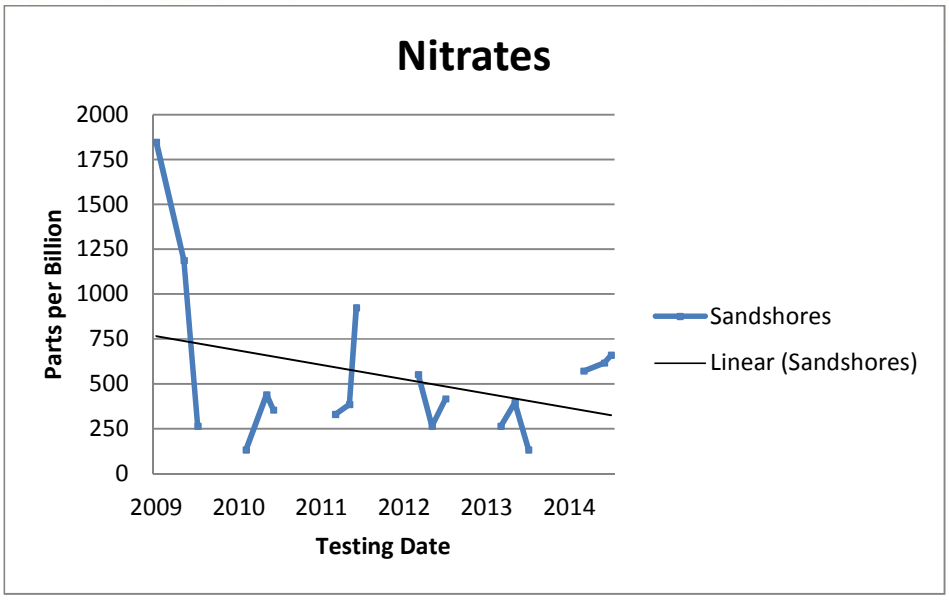
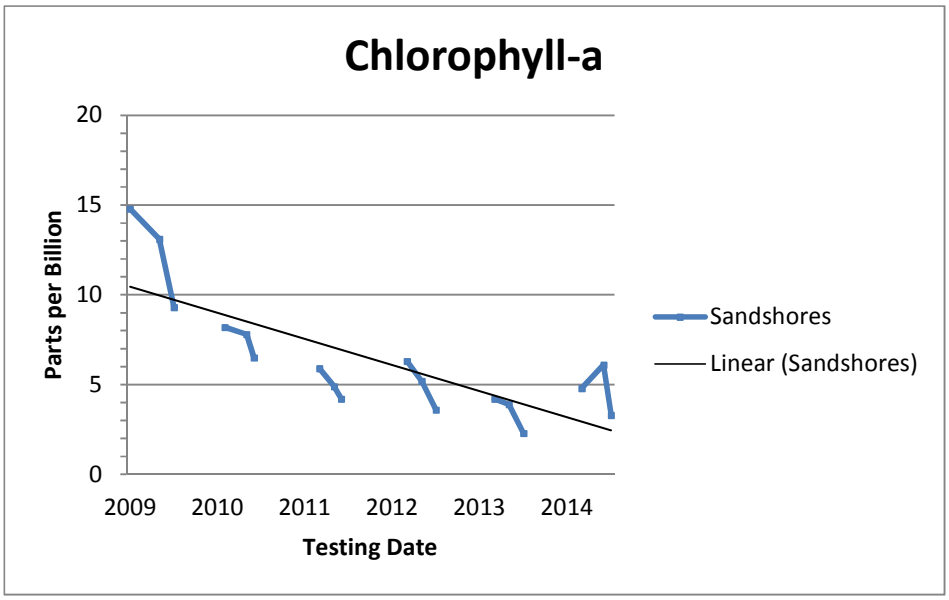
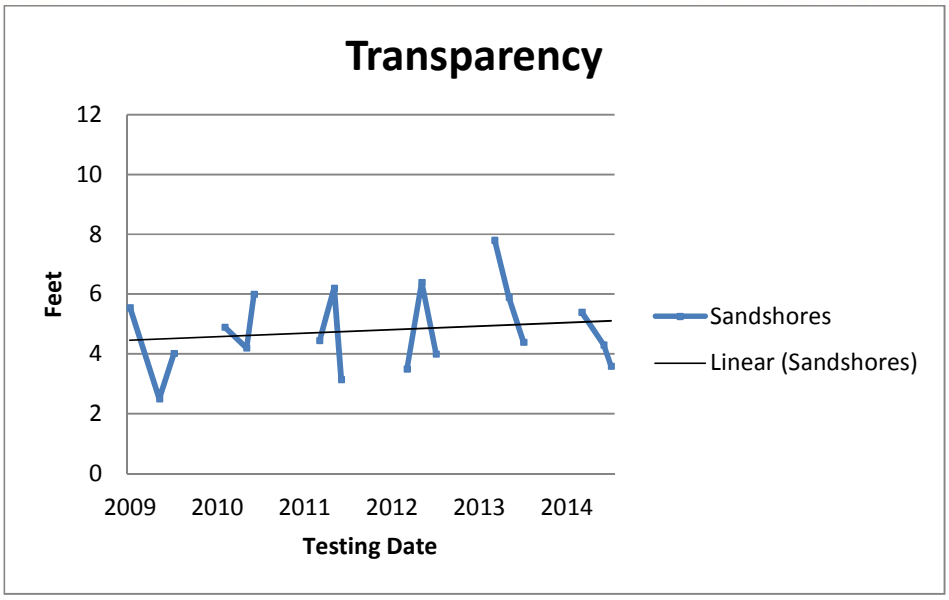


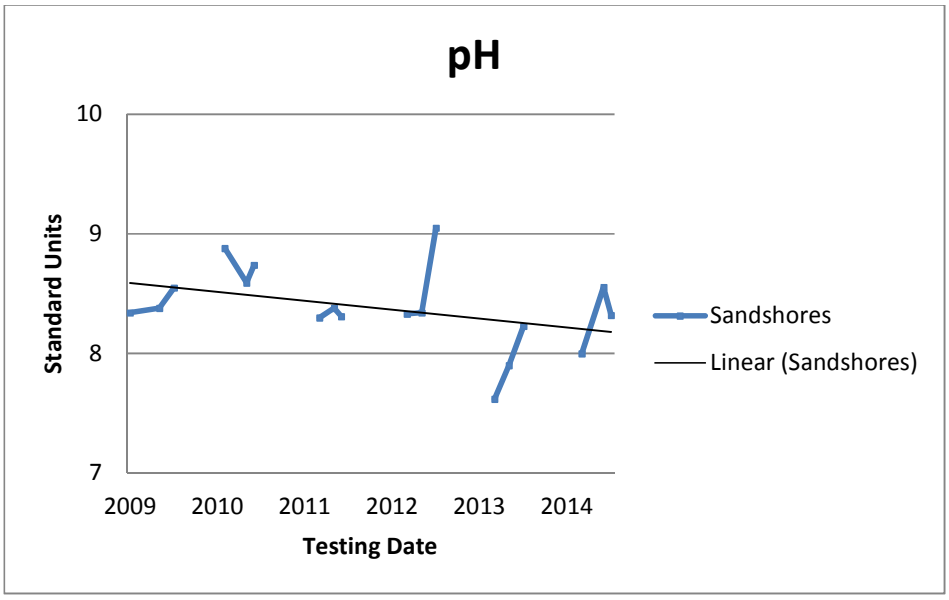
Nitrate is another vital nutrient for the growth of aquatic plants. The long-term trend has been downward, but there was a marked increase from last year to 2014. With plenty of rainfall this summer, the increase was most likely due to lawn fertilizers washing into the lake with runoff. It is important that your residents continue responsible fertilizing in order to keep this nutrient level trending downward.



Chlorophyll indicates the plant production in the lake. The long-term trend has been downward, but there was a marked increase from last year to 2014. This trend strongly correlated with the nitrate graph. The relationship showed that while the phosphate was very low, there was still enough to support plant growth. Therefore, the plant growth changed with the nitrate levels. Managing the nitrate levels in the lake is extremely important to limit the nuisance plant growth in the lake.



Transparency was affected by different factors including total dissolved solids, total suspended solids, algae growth, blue water dye, and rain frequency and amount. Overall, the transparency of the lake decreased slightly in 2014, but not due to different amounts of blue water dye. LakePro applied less dye in 2014 than any other year. The TDS of the lake decreased, which helped improve clarity. Increased chlorophyll levels (algae growth) and stronger rainstorms were responsible for the lower transparency this year.



There was a slight decrease in pH over the years, but it stayed in the target range of 7 to 9. We will look for the pH to level off or increase slightly in future years. If the pH continues to decrease toward 7 S.U., we will start looking for the cause of this decrease in order to mitigate the trend.

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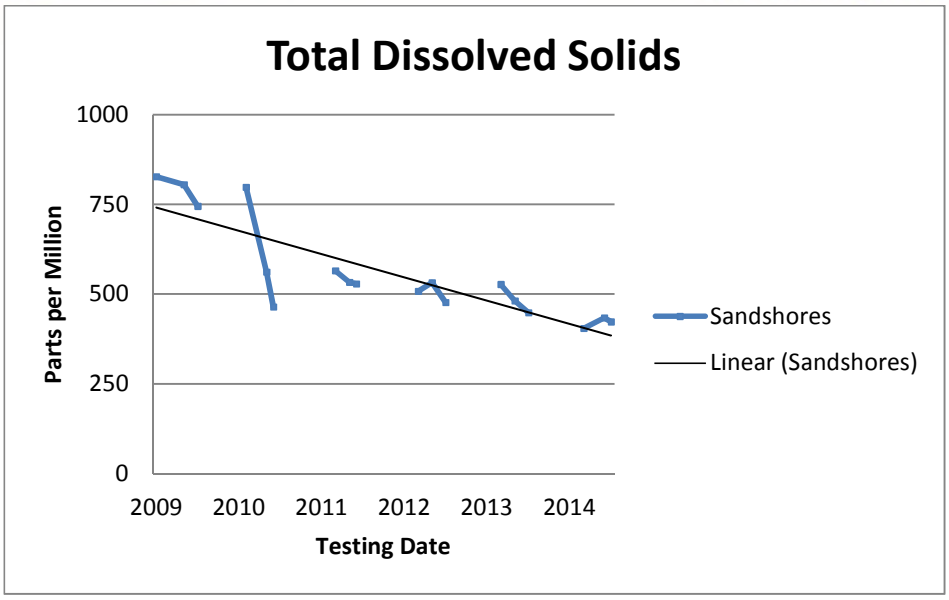
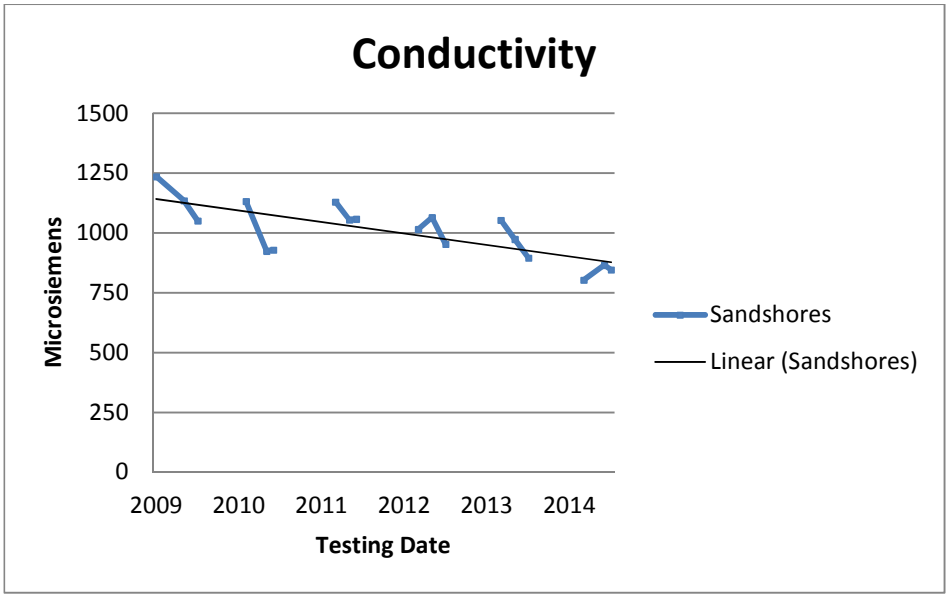


The Total Dissolved Solids decreased steadily since testing began. This was a positive trend for the lake and showed that excess molecules were flushed from the lake and are being prevented from reaching the lake.



Like the TDS, Conductivity decreased slowly over the years. Conductivity is an extension of TDS and measures the amount of ionic molecules in the water (which conduct electricity, usually salts). We will look for this trend to continue in future years of testing.

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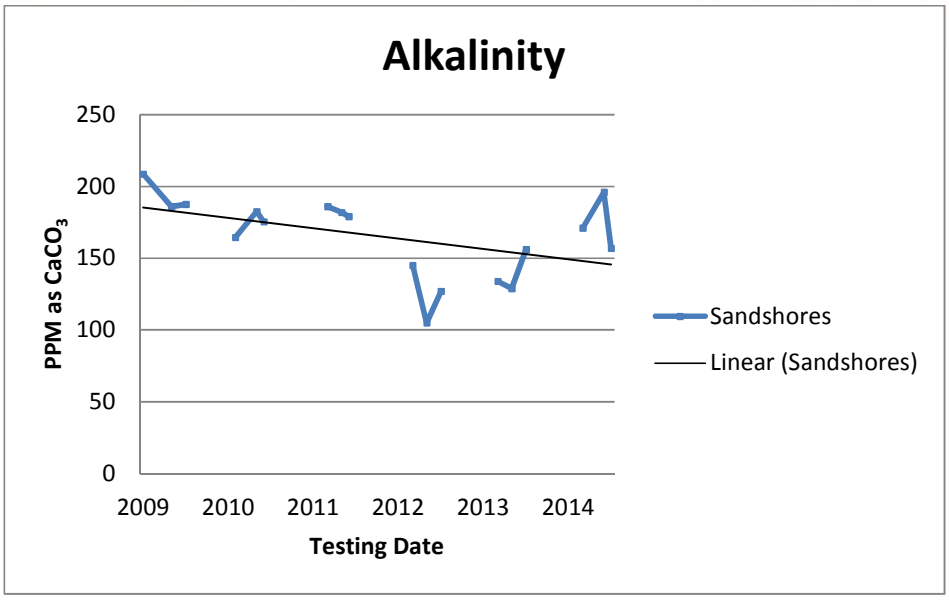
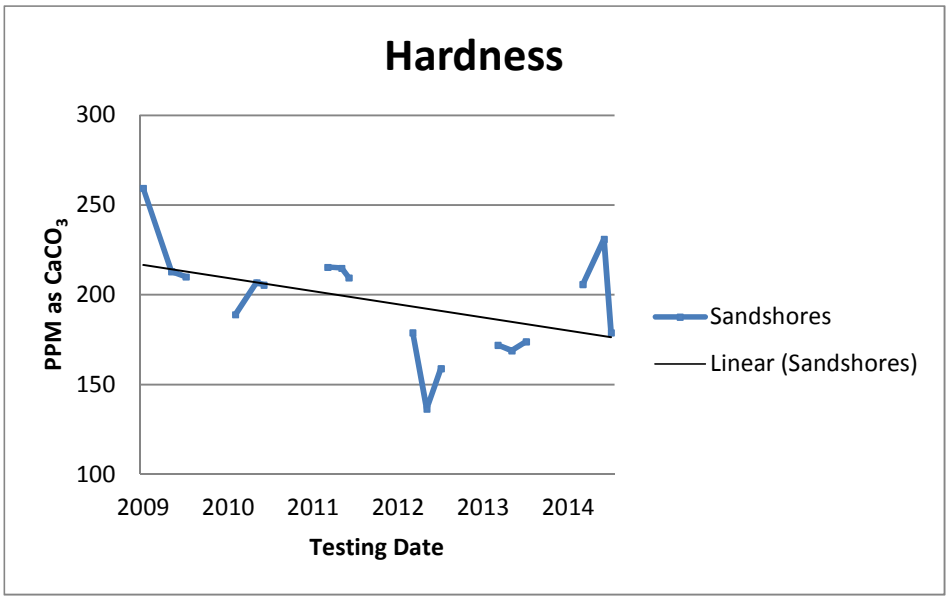


The Alkalinity trended downward, but 2014 showed an increase from previous years. Alkalinity works as a buffer to stabilize the pH when foreign substances enter the lake, such as acidic rainwater. Therefore, the increase in alkalinity coincided with the slight increase in pH. As rainwater infiltrated the ground, it entered the lake as groundwater, which carries carbonates that replenish Alkalinity.



While alkalinity measures the acidic neutralizing capacity, mainly in the form of carbonate, hardness measures the polyvalent cations, such as calcium ions. Since one of the most commons salts in the water is Calcium Carbonate, hardness generally followed alkalinity.

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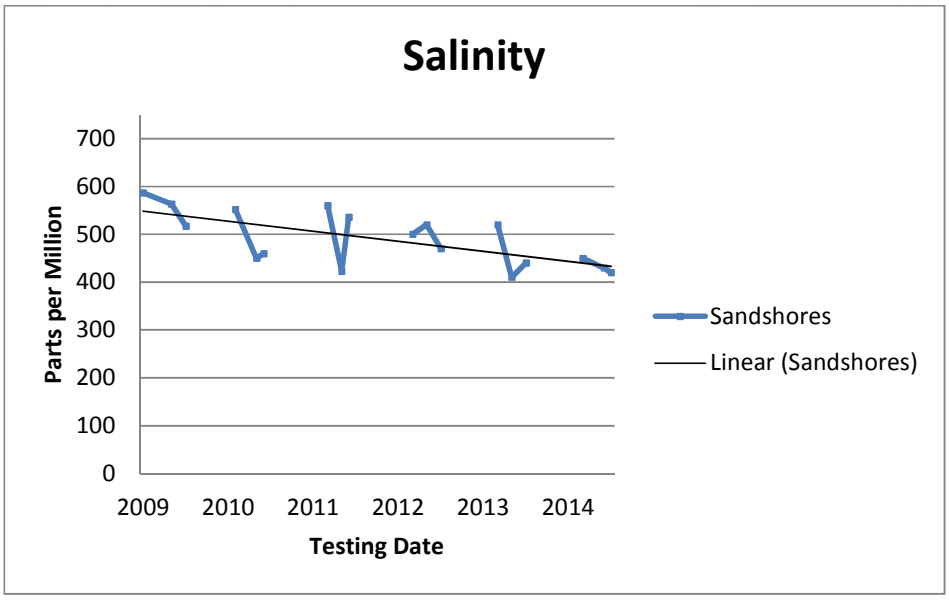
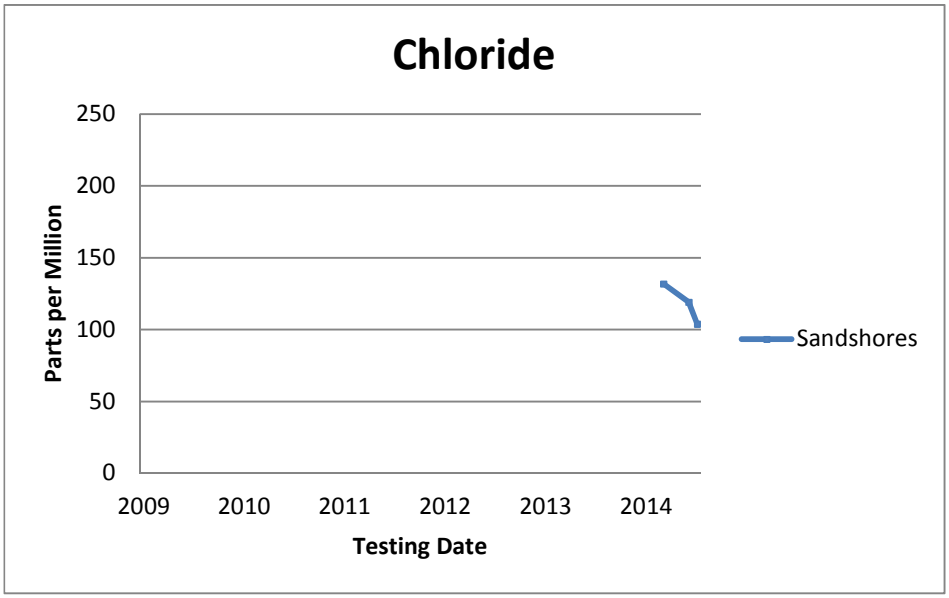


The salinity decreased since testing began and reached the lowest average concentration in 2014. Overall this was a positive change for the lake, however, the Salinity should not decrease to zero because some salts (e.g. Calcium Carbonate) are needed for good water quality.



Chloride is the anion constituent of many different salts, the most common of which is Sodium Chloride. Some chloride will be present in ground and surface water, but elevated levels are indicators of pollution. One source of Chloride loading is road salt, which enters the lake in the spring as the snow and ice melts off the roads and drainage ditches. For that reason, Chloride is usually highest in the spring and decreases throughout the summer as it is flushed from the lake.

The Chloride results matched the Total Salinity data, which was a steady decrease from spring to fall. As we gather more data in future years, the trend line will show how Chloride is changing in the lake. Most likely, this trend line will closely follow that of Total Salinity.

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Summary & Conclusion

Throughout the entire year, the water quality of Sandshores Lake was very good. The only parameters not in the target ranges were Temperature and Transparency. The graphs and included trend lines above show that the overall water quality of the lake improved since testing began.

The temperature has trended in the wrong direction, but the temperature cannot be manipulated. Despite the increase in temperature, the dissolved oxygen increased over the same time.

The Phosphorus, Phosphate, and Nitrates all showed long-term decreases, which was great for the lake. It is vital that residents continue to do everything possible to limit the amount of nutrients entering the water. The Chlorophyll level showed a downward trend, due to less nutrients and appropriate plant management. LakePro will continue to work hard to minimize algae and plant growth to non-nuisance levels.

The Transparency trended upward over the course of our testing. This parameter increased due to less Chlorophyll, but was heavily influenced by the amount of dye LakePro added to the water to manage plant growth, so these results were not necessarily indicative of the natural water clarity.

Finally, the water chemistry parameters were all within their target ranges and decreased over the course of our testing.

Despite a highly developed watershed, Sandshores Lake is a valuable water resource with great water quality. There will always be areas that the quality of the water could improve, but Sandshores remains among the best that we test. Emerald Lakes Village should take pride in this lake and continue your hard work in improving it.

Completed and Certified by: _____ Date: September 30th, 2014

Peter Filpansick, B.S.
Aquatic Biologist