



## ARCHIBALD LAKE FLOWERING RUSH CHEMICAL TREATMENT ANALYSIS

Steve & Karen Fleming

The following is a summary report of the Archibald Lake flowering rush research and chemical treatment between July 2011 to October 2015.

### **Background**

Archibald Lake is a 430 acre mesotrophic seepage lake in Northeast Wisconsin. The Maximum depth is 50 feet and the average depth is 19 feet. It has 7.5 miles of shoreline. There are two distinct lobes; the west lobe is highly developed, the east lobe has over 50% undeveloped shoreline. A large portion of the east lobe shoreline is national forest. The Archibald Lake Association is a volunteer organization and has 150 members out of a possible 160 lake properties. Figure 1 shows a map of the lake.

Archibald Lake is one of a number of lakes in Wisconsin to have flowering rush. Best estimates indicate that flowering rush has been in the lake since the early 1980's. Starting in 2008 the Archibald Lake Association has been researching different methods of trying to control this invasive plant. Figure 1 is a map of the flowering rush in Archibald Lake as of 2009.

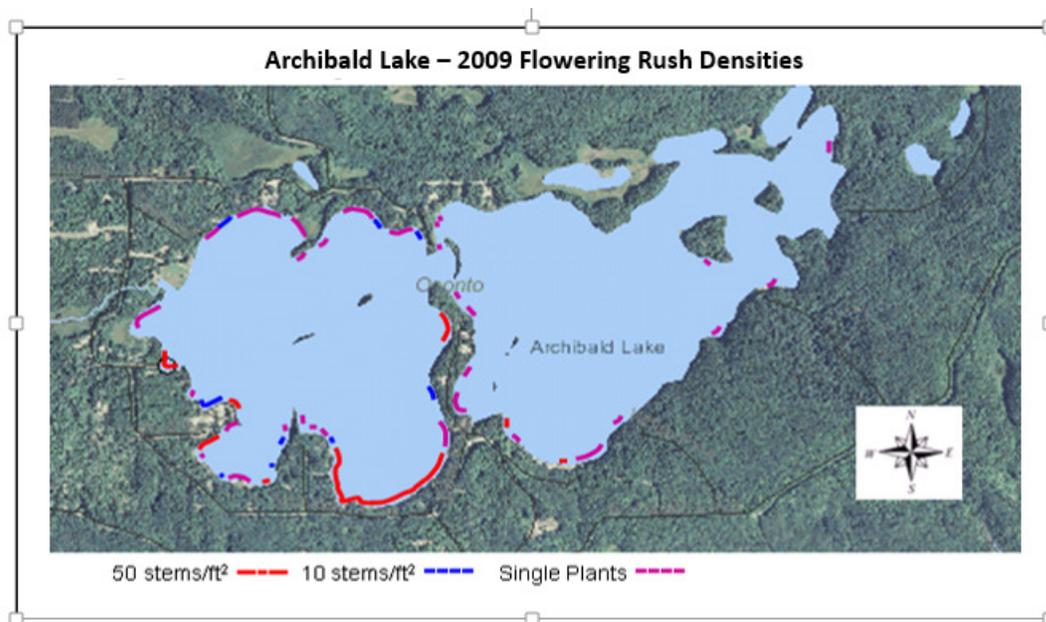


Figure 1

A number of methods have been tried with limited success. The methods tried have been hand digging, repeated cutting, and cutting flowering buds before they release their seeds.



In 2011, the Lake Association received a Research and Control Grant from the Wisconsin DNR. The grant was written in such a way that the Association could try different chemical treatment approaches until one was found that worked and then implement that method for control.

## **Chronology of Events**

- 2010 – Received WDNR Grant for Research and Control
- 2011 – Two trial areas / two chemicals – Aquathol Super K (Endothall) and Renovate Max G (Triclopyr / 2,4D)
- 2012 – No treatment due to timing to collect 2011 regrowth data
- 2013 – Two trial areas / two chemicals - Renovate Max G (Triclopyr / 2,4D) and two applications of Tribune (Diquat)
- 2014 – Continued trials using two applications of Tribune (Diquat) / larger application areas
- 2015 – Re-treated the same areas as 2014 using one Tribune (Diquat) application

## **Guidance and Support**

Initial guidance regarding chemical application and measurements was provided by Peter Rice, University of Montana and Greg Sevener, Wisconsin DNR. After the first year we received excellent advice and guidance from Brenda Nordin, Wisconsin DNR, Peter Rice, Dr. John Madsen, through his research in Detroit Lakes and Patrick Selter, PLM.

## **Executive Summary**

Overall, our data indicates that the treated areas of flowering rush in Archibald Lake have been significantly reduced as a result of the chemical treatments. Specifically:

- Renovate Max G (Triclopyr / 2,4D) showed a 59% reduction in overall plant densities. However, it showed a 71% reduction in submerged plant densities.
- Tribune (Diquat) showed a complete elimination of plants in the first year. One year regrowth showed a leaf reduction in excess of 51% after two application during a given year. Research by Dr. John Madsen indicates that complete plant elimination with Tribune (Diquat) could be attained by following a twice per year regimen of Tribune (Diquat) treatments for 3-5 years.
- Aquathol Super K (Endothall) had no impact measurable impact on plant densities.
- Figure 2 below shows an interval plot of 2011 plant density data as compared to early summer 2015 and late fall 2015 (The late fall data collection was done after the final 2015 Tribune (Diquat) treatment).

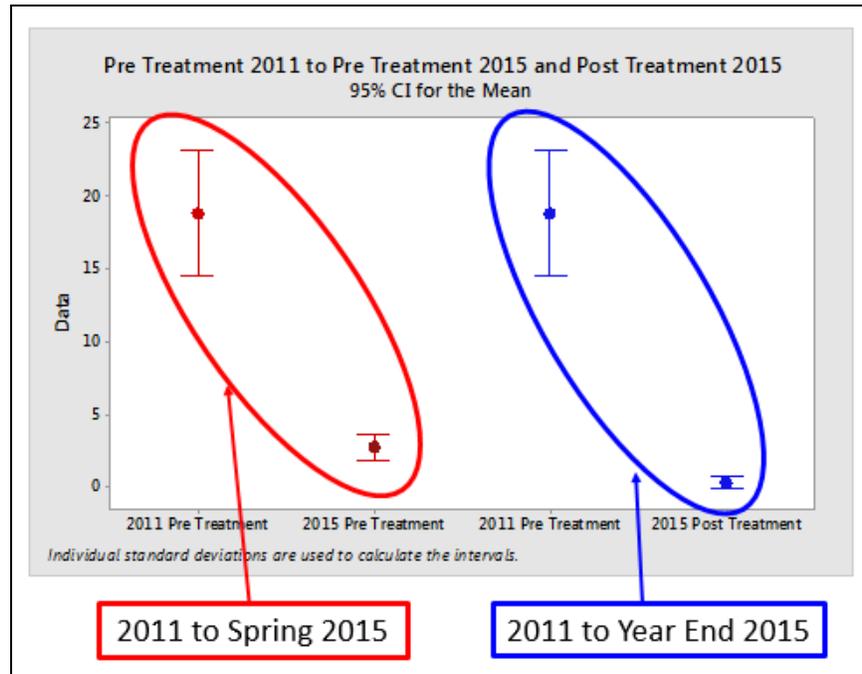


Figure 2

Note: Figure 2 is an interval plot. The center dot in each vertical line is the average leaf counts for at least thirty different locations within each treatment area. The vertical lines show the 95% confidence interval around the average for each location. All future data analysis in this report will be displayed using interval plots.

- The data shows an 86% reduction in overall plant densities from 2011 to the spring of 2015 and a 98% reduction in overall plant densities from 2011 to the fall of 2015. The reason we are presenting both numbers is that we do expect some regrowth by early summer 2016. We expect that the overall reduction will be somewhere between 86% and 98%.
- As with all analysis, it is important to determine whether our data matches our observations. Figure 3 and Figure 4 below are two typical water surface pictures showing before and after treatment. We have more pictures of other locations if anyone is interested.



**Archibald Lake – 2011 Before Any Treatment**



**Figure 3**

**Archibald Lake – 2014 After 2 Treatments**



**Figure 4**

- One concern, as a Lake Association, has always been the impact that these chemical treatments might have on native plants. Our post treatment plant survey done after the 2015 treatment showed that the treated areas have been mostly filled in by chara, water celery, water shield, water lilies, and bull rush. A



Wisconsin DNR Point Intercept Survey was also done in 2013 and showed little or no impact to the native plants in the surrounding areas.

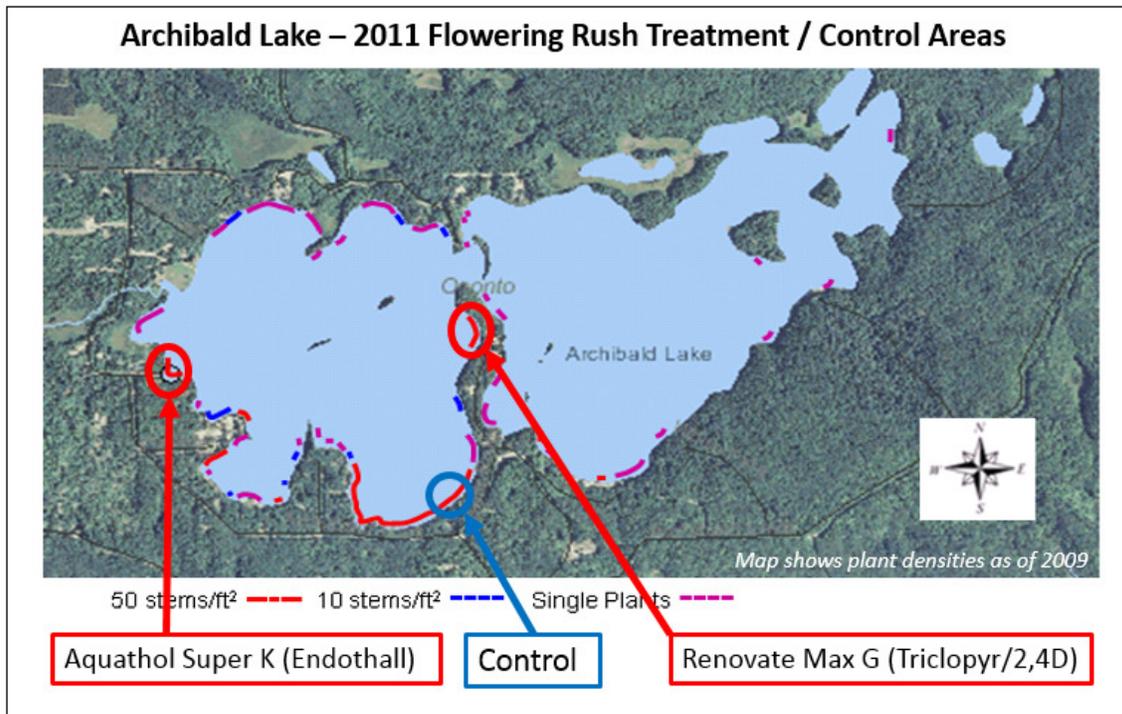
## Detailed Treatment and Analysis

### **2011 Chemical Treatment**

After final discussions with Peter Rice and the Wisconsin DNR, it was decided to do two trial chemical applications; one of Renovate Max G (Triclopyr / 2,4D) and one of Aquathol Super K (Endothall). The two locations were chosen such that they were over 1,000 feet apart. A third location was chosen as a “Control area.”

*Note: It is important to note that the littoral zone in Archibald Lake is relatively narrow due to the lakes depth. As a result, the flowering rush treatment areas were relatively narrow. In all cases the plants were growing within 100 feet of the shore and in water depths ranging from zero to eight feet.*

Plant densities were measured in all three areas before and after treatment. Figure 5 shows the 2011 treatment and control areas.



**Figure 5**

The “Before Treatment” plant density data was taken on 7/3/11 and the chemical application was completed 7/11/11. Water samples were gathered immediately following the treatment per the instructions provided by Jon Skogerboe, Army Corps of Engineers,



and John Heilman, Seapro. The chemical concentration data was analyzed and can be found in the appendix of this document as can the application rates for the two chemicals. The “After Treatment” plant density data was taken on 9/8/12. Plant densities for all measurements was done by dropping a one foot square PVC pipe into the water and counting the number of leaves present inside the square. The “before” and “after” plant density data for all three locations is shown in Figure 6.

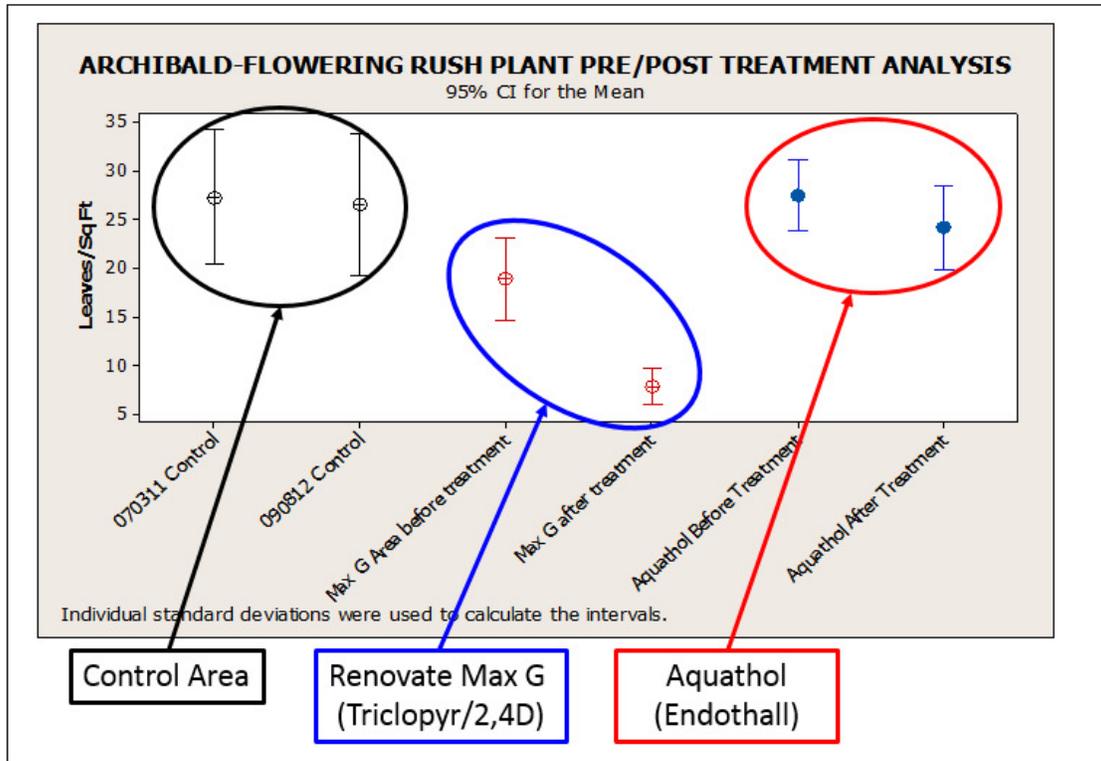


Figure 6

The “Control” area showed no significant density change between the pre-treatment and post-treatment data. Renovate Max G (Triclopyr / 2,4D) at an application rate of 3.01ppm showed a statistically significant 59% reduction and the Aquathol Super K (Endothall) at an application rate of 2.19ppm showed a slight reduction but it was not statistically significant.

After looking at the data more completely we found that the Renovate Max G (Triclopyr / 2,4D) had a different impact depending on whether the plant was submerged or partially emerged. Figure 7 shows the results of this analysis.

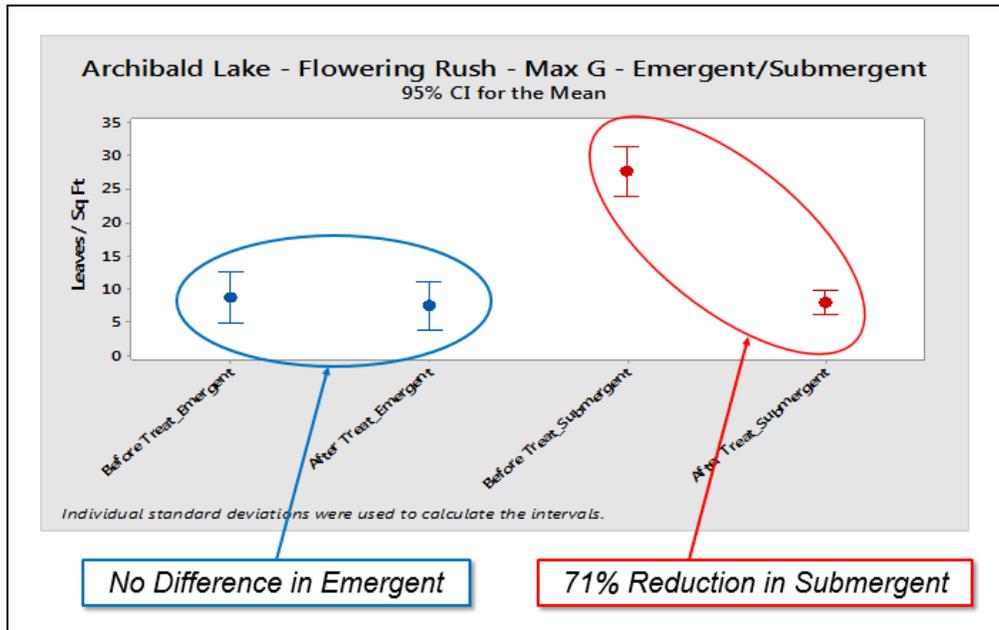


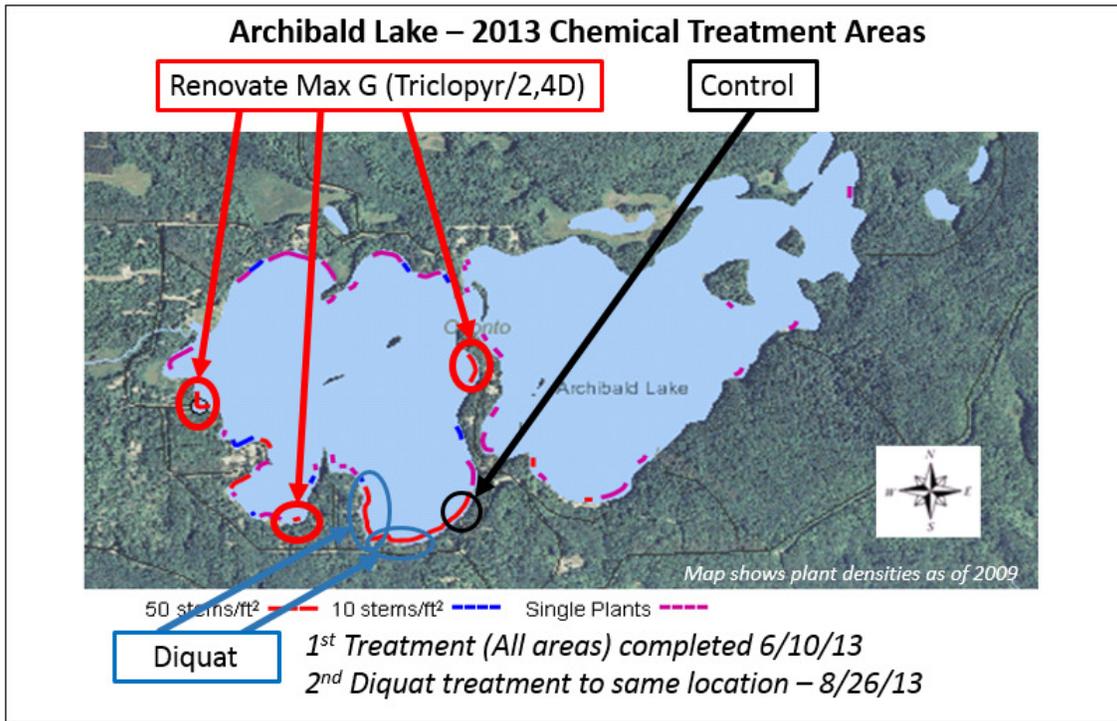
Figure 7

The before data was again taken in July, 2011 and the after data in September 2012. There was no difference in emergent leaf densities. However, the submergent leaf densities showed a 71% reduction in leaves per square foot.

Chemical application rates along with residual analysis, where it was done, for each year's application can be found in the appendix

### 2013 Chemical Treatment

Based on research from Detroit Lakes in Minnesota and our own experience it was decided to do two trials, one using Renovate Max G (Triclopyr / 2,4D) and one using Tribune (Diquat). The treatment areas are below in Figure 8.



**Figure 8**

The Renovate Max G (Triclopyr / 2,4D) total area increased in size from 1 acre in 2011 to 2.5 acres in 2013 and the Tribune (Diquat) area was 3 acres total. The Renovate Max G (Triclopyr / 2,4D) area at an application rate of 1.2ppm saw a 62% leaf reduction and the Tribune (Diquat) at an application rate of 0.301ppm saw an 86% reduction. The Renovate Max G (Triclopyr / 2,4D) trials again had significant impact in submergent plants and little or no impact on emergent plants. Tribune (Diquat) had a significant impact on both emergent and submergent plants. The data analysis results are shown in Figure 9. The “pre” data on Figure 9 was taken in June 2013 and the “post” data was taken in July 2014

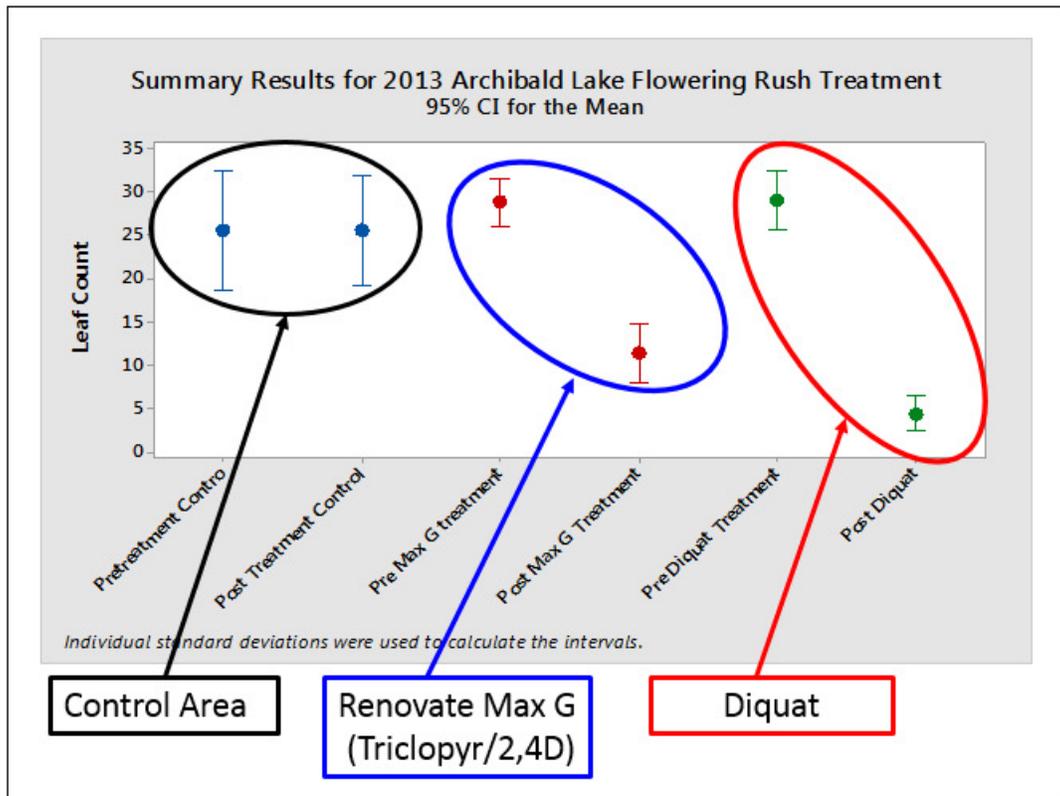


Figure 9

**2014 Chemical Treatment**

For 2014 we decided to treat larger areas using only Tribune (Diquat). The reason for this decision is that Tribune (Diquat) impacts both emergent and submergent and Tribune (Diquat) is cheaper to apply. However, Tribune (Diquat) needs two applications per year to be effective and from Dr. Madsen’s research in Detroit Lakes, he believes it will take 3-5 years of repeat Tribune (Diquat) treatment to completely kill the flowering rush rhizomes. Figure 10 shows the 2014 treatment areas.

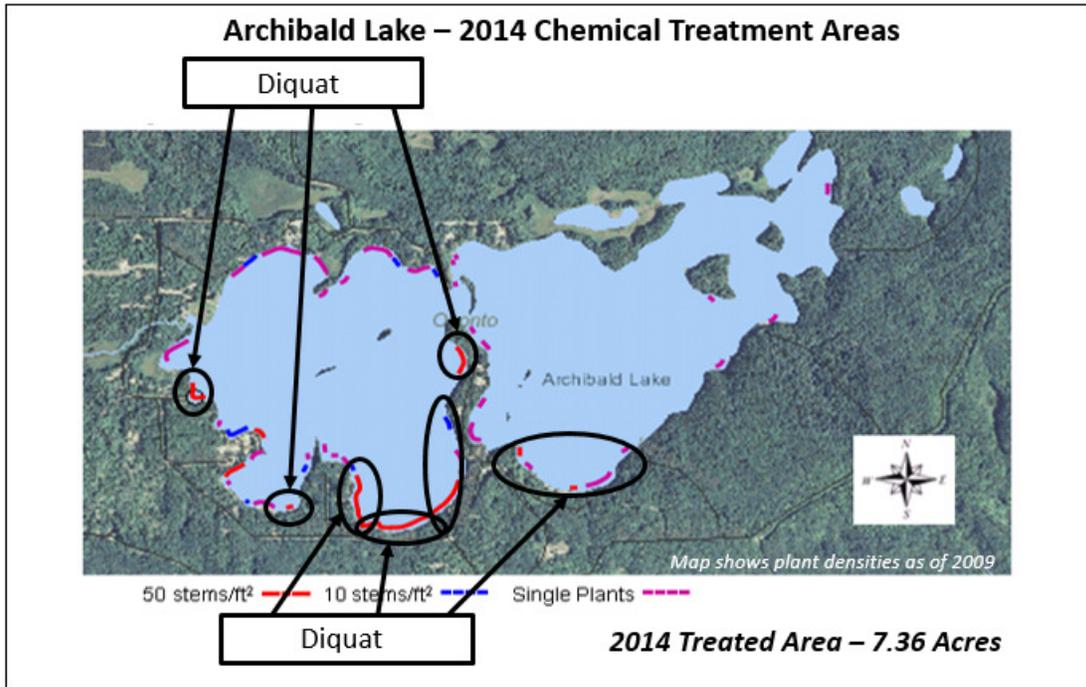


Figure 10

Overall leaf reduction as a result of the 2014 chemical treatment with Tribune (Diquat) at an application rate of 0.553ppm was 51%. The leaf count data was collected before treatment in 2014 and after plant growth began in 2015. Figure 11 provides a graphical look at the data.

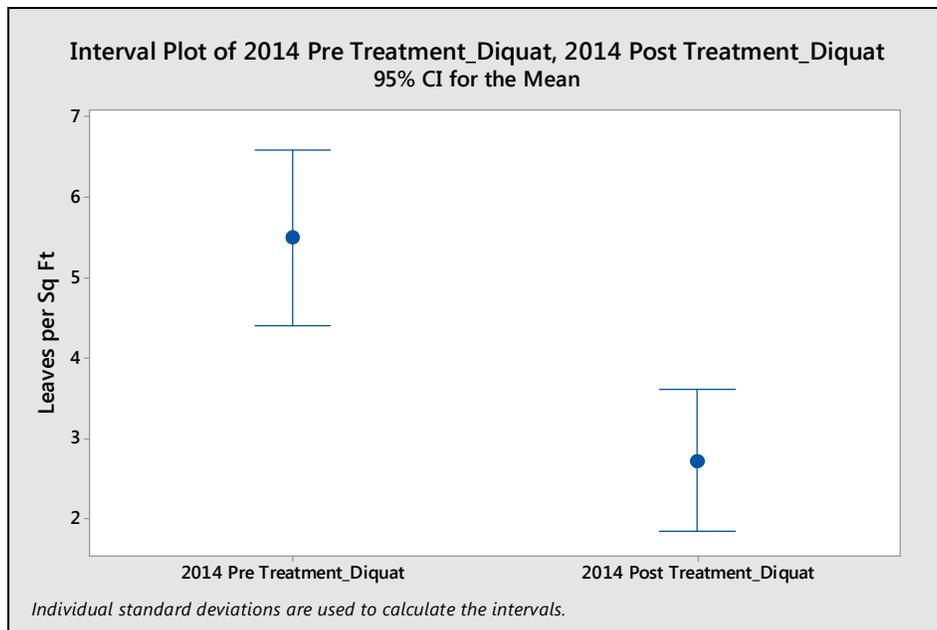
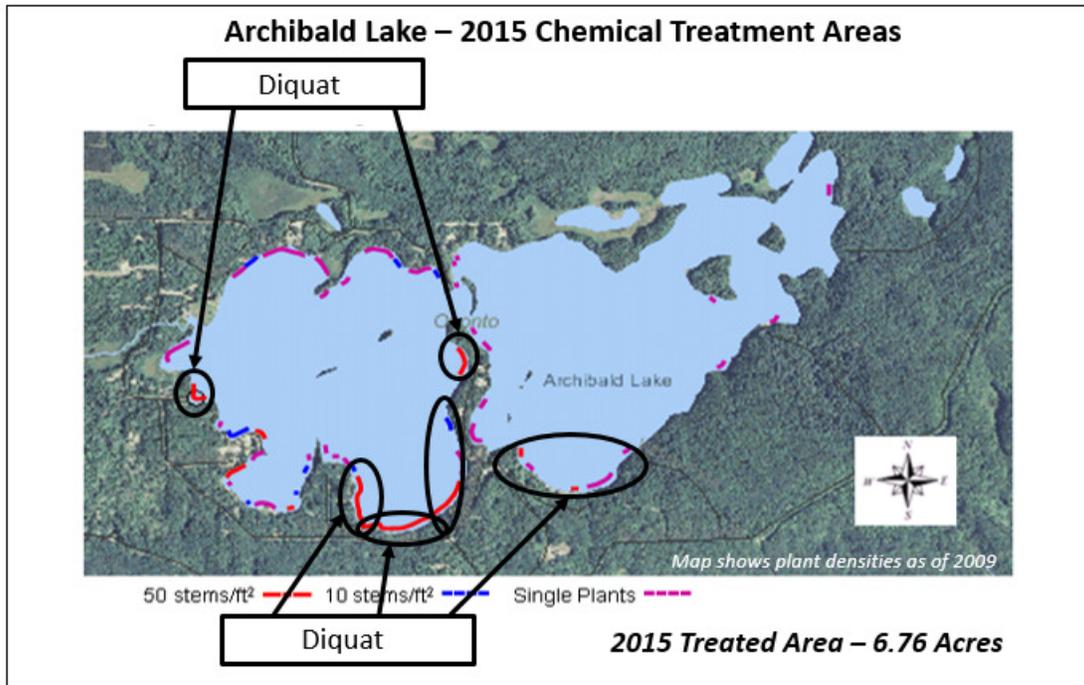


Figure 11



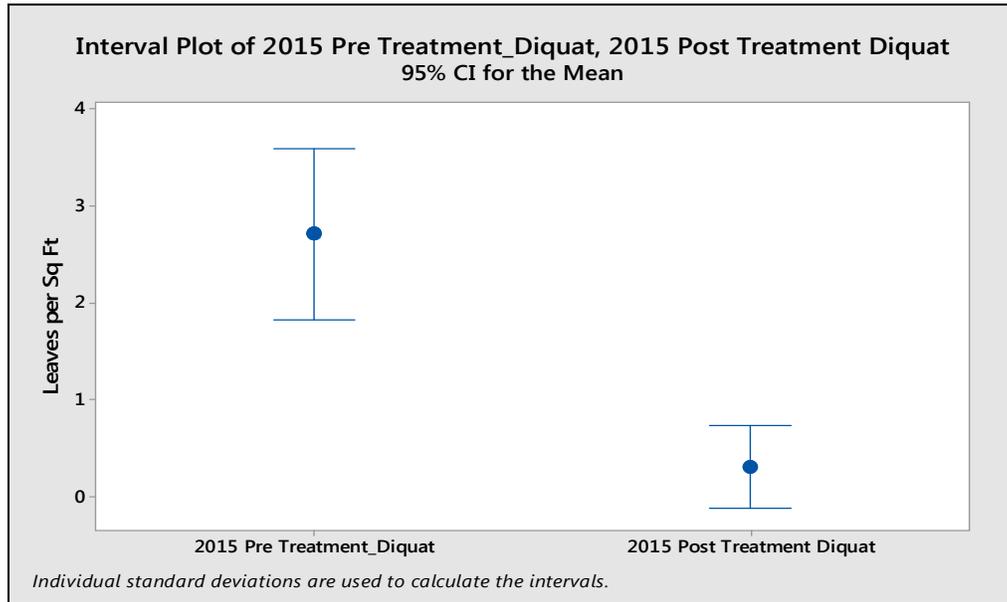
### 2015 Chemical Treatment

The 2015 chemical treatment was a repeat of the 2014 treatment with the exception that no treatment was done in areas that showed no flowering rush in the pre-treatment survey. The map of the 2015 treatment area is shown in Figure 12.



**Figure 12**

In 2015 overall leaf count showed a significant drop of 88%. However, it must be considered that Tribune (Diquat) is a contact herbicide and the post treatment data was taken in the same year as the treatment. Both treatment and final data collection were completed in 2015. To more accurately show the impact of this treatment we will need to collect data in early summer 2016. The leaf count data is shown in Figure 13.



**Figure 13**

### **2011 to 2014/2015 Results**

As was stated and has been shown in the “Executive Summary” (Figure 2 above), the data shows an 86% reduction in overall plant densities from 2011 to the spring of 2015 and a 98% reduction in overall plant densities from 2011 to the fall of 2015. The reason we are presenting both numbers is that we do expect some regrowth by early summer 2016. We expect that the overall reduction will be somewhere between 86% and 98%. Visually (Figure 3 and Figure 4) it is obvious that flowering rush growth has been significantly reduced in Archibald Lake.

### **Final Thoughts and Considerations**

We realize that this was a non-replicated trial performed over several years in one lake. In many cases, water sample data was not collected in the interest of time and cost. The purpose of this work was to provide as much scientific information as possible while solving an invasive plant problem in Archibald Lake. We did try to use as much rigor as possible in the data collection and analysis of the plant densities. Therefore, from a statistical and observation standpoint we are confident that Renovate Max G (Triclopyr / 2,4D) has the potential for long term control of submergent flowering rush. We are also confident that Tribune (Diquat) has the potential for long term control of both submergent and emergent flowering rush. There is no question that statistically and visually these chemical treatments have significantly reduced flowering rush in the areas that were treated in Archibald Lake.



## *Archibald Lake Association*



[www.archibaldlake.com](http://www.archibaldlake.com)

### **Next Steps**

Our original plan was to end this work and analysis with this report. After putting together the data and doing the analysis we realized that to finalize this work we really needed to collect one more set of data during the summer of 2016 to get the one year regrowth after the 2015 Tribune (Diquat) treatment. We will generate one final report after the 2016 data has been collected.

### **Acknowledgments**

The Archibald Lake Association would like to thank; first and foremost the Wisconsin DNR for the grant funding and Brenda Nordin for the many hours developing and reviewing treatment plans, Peter Rice for his willingness to share his wealth of knowledge and guidance, Dr. John Madsen for sharing his research and his thoughts / suggestions regarding our approach, John Skogerboe and the Army Corps for their chemical analysis and suggestions, and Seapro (Mark Heilman) for their chemical donations and for their chemical analysis.

If you have any questions or comments or suggestions please contact me at

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262.993.4228

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**Appendix**

**2011 Chemical Concentration data**

The following is the chemical analysis and provided by John Skogerboe

**Archibald Lake Residual Data Analysis, 2011**

Water Samples were collected from 2 sites in Archibald Lake, 11-14 July 2011, by lake resident volunteers. Samples were fixed with 3 drops of muriatic acid and stored in a refrigerator until they were shipped to the ERCL laboratory at the Center for Aquatic and Invasive Plants, Gainesville, FL.

Data showed rapid dissipation (Figure 1). The mean for each time interval and the standard error were calculated (Figure 2). Concentration data were log transformed and a linear regression was conducted to determine the mean,  $R^2$ , and half life (Figure

**Figure 1**

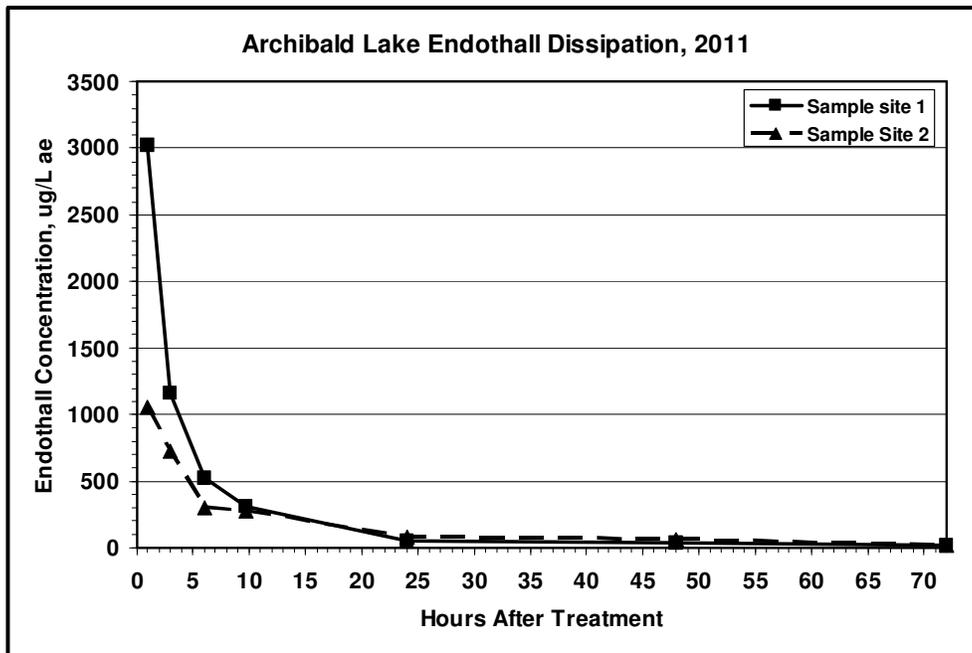




Figure 2

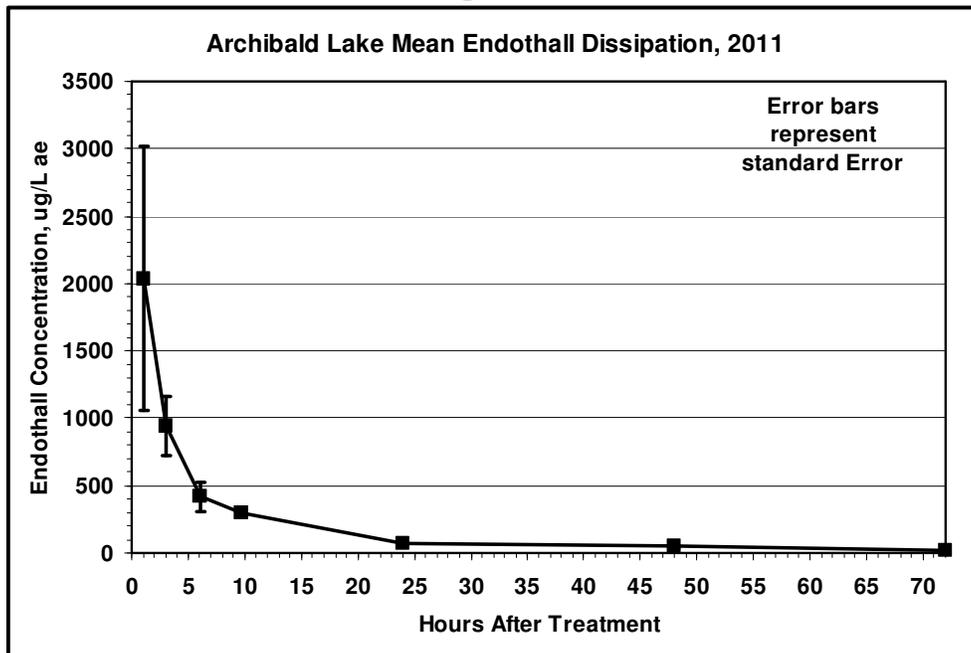
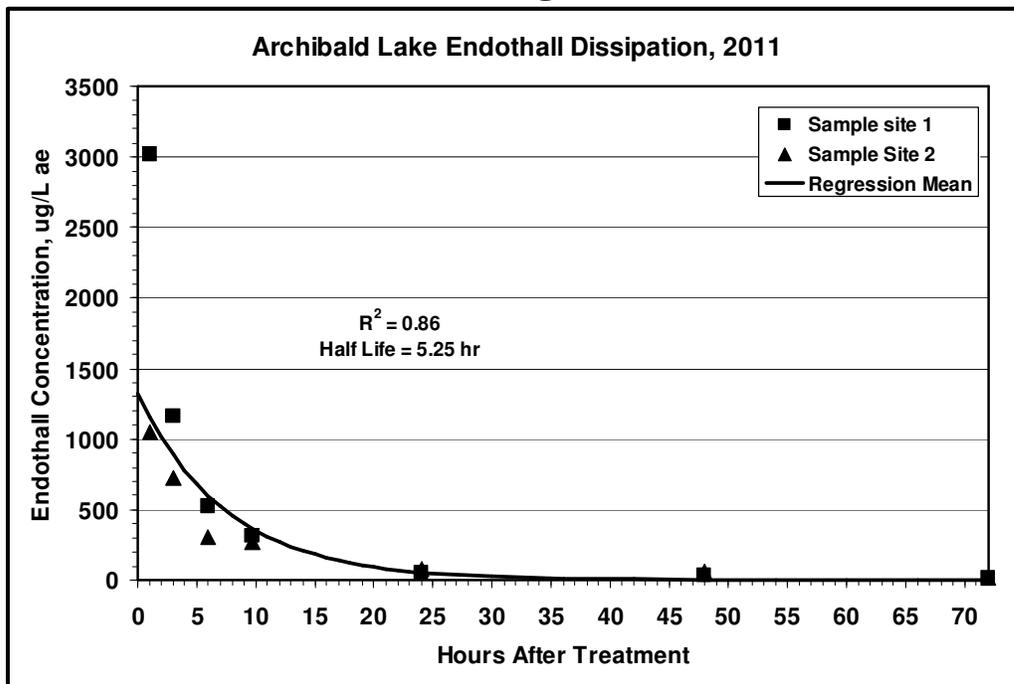


Figure 3





## Renovate Max G (Triclopyr / 2,4D) Residual Analysis

Sample Site ID	Date Treated	Date Sample Collected	Sample Location	Products	Acres Treated	Rate	Active	Result
1	07/11/2011	07/11/2011		Renovate MAX G - Tri	0	0	Triclopyr	0.135 ppm
1	07/11/2011	07/11/2011		Renovate MAX G - 24D	0	0	2-4D	486.4 ppb
2	07/11/2011	07/11/2011		Renovate MAX G - Tri	0	0	Triclopyr	0.101 ppm
2	07/11/2011	07/11/2011		Renovate MAX G - 24D	0	0	2-4D	375.4 ppb
1	07/11/2011	07/14/2011		Renovate MAX G - Tri	0	0	Triclopyr	0.001 ppm
1	07/11/2011	07/14/2011		Renovate MAX G - 24D	0	0	2-4D	7.7 ppb
2	07/11/2011	07/14/2011		Renovate MAX G - Tri	0	0	Triclopyr	0.000 ppm
2	07/11/2011	07/14/2011		Renovate MAX G - 24D	0	0	2-4D	4.7 ppb
1	07/11/2011	07/18/2011		Renovate MAX G - Tri	0	0	Triclopyr	0.000 ppm
1	07/11/2011	07/18/2011		Renovate MAX G - 24D	0	0	2-4D	3.6 ppb
2	07/11/2011	07/18/2011		Renovate MAX G - Tri	0	0	Triclopyr	0.000 ppm
2	07/11/2011	07/18/2011		Renovate MAX G - 24D	0	0	2-4D	3.8 ppb





# Archibald Lake Association

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<b>Pesticide Application Record</b> <b>Aquatics and/or Commercial Aquatic Pest Control Application</b>
<b>PLM Lake and Land Management Corp.</b> <i>Preserving Our Precious Natural Resources</i>

<b>Applicator's Company Name</b> PLM Lake and Land Management Corp	<b>Applicator's Company Address</b> 2509 Business Hwy 371
<b>Phone</b> (218) 568-5379	<b>Fax</b> (866) 527-6399
<b>City</b> Brainerd	<b>State</b> MN
<b>Zip</b> 56401	

<b>Customer's Name</b> Archibald Lake Association	<b>Customer's Address</b> 16570 Appleton Lane
<b>Phone</b> (262) 943-4228	<b>Fax</b>
<b>City</b> Townsend	<b>State</b> WI
<b>Zip</b> 54915	

<b>County</b> Oconto	<b>Lake Name or Other</b> Archibald	<b>DNR Permit No.</b> NE-2013-43-701	<b>Units Treated(acres):</b> 3
<b>Description of Application Site:</b> Flowering Rush Treatment for the Season.			

<b>Date Of Application</b> 8/26/2013	<b>Time of application</b> Started: 10:00 AM Finished: 10:30 AM		<b>Area Treated</b> 3 Acres  x	
<b>Avg Depth of Treatment Area</b> 5 Foot	<b>Water Temp</b> 76.1			
<b>Wind Direction</b> Calm	<b>Wind Speed</b> Calm	<b>Air Temp</b> 78		
<b>Target Pests</b> Nuisance and exotic aquatic plants and/or algae				
<b>Brand Name</b> Tribune	<b>EPA Reg No</b> 100-1390	<b>Quantity</b> 6		<b>Dosage</b> 2 Gallon per Acre
<b>Cidekick II</b>	<b>Not Required</b>	<b>1</b>		<b>.33 Gallon per acre</b>

<b>Applicator's Name</b> Patrick Selter	<b>Applicator's Signature</b> <i>Patrick M Selter</i>	<b>Applicator's License Number</b> 92580
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## 2014 Chemical Application Information

2 identical treatments as listed below.

Pesticide Application Record				
Category F, Aquatics and/or Commercial Aquatic Pest Control Application				
PLM Lake and Land Management Corp.				
<i>Preserving Our Precious Natural Resources</i>				
<b>Applicator's Company Name</b>		<b>Applicator's Company Address</b>		
PLM Lake and Land Management Corp		2509 Business Hwy 371		
<b>Phone</b>	<b>Fax</b>	<b>City</b>	<b>State</b>	<b>Zip</b>
1-866-OUR-LAKE	(866) 527-6399	Brainerd	MN	56401
<b>Customer's Name</b>		<b>Customer's Address</b>		
Archibald Lake Association		W292 N6973 Dom Road		
<b>Phone</b>	<b>Fax</b>	<b>City</b>	<b>State</b>	<b>Zip</b>
(262) 993-4228		Hartland	WI	53029
<b>County</b>	<b>Lake Name or Other</b>	<b>DNR Permit No.</b>	<b>Units Treated(acres):</b>	
Oconto	Archibald	NE-2014-43-179	8.000	
<b>Description of Application Site:</b>				
Treatment of Invasive Species Flowering Rush and Eurasian Water Milfoil				
<b>Date Of Application</b>		<b>Time of application</b>		<b>Area Treated</b> 7.59 acres of Flowering Rush .51 acres of EWM  x
6/16/2014		Started: 09:00 AM Finished: 11:03 AM		
<b>Avg Depth of Treatment Area</b>		<b>Water Temp</b>		
5 Foot		70.5		
<b>Wind Direction</b>	<b>Wind Speed</b>	<b>Air Temp</b>		
SSW	0-5	78		
<b>Target Pests:</b> Nuisance and exotic aquatic plants and/or algae				
<b>Brand Name</b>	<b>EPA Reg No</b>	<b>Quantity</b>	<b>Dosage</b>	
Tribune	100-1390	16	2.00 Gallon per Acre	
<b>Applicator's Name</b>		<b>Applicator's Signature</b>		<b>Applicator's License Number</b>
Patrick Selter				20088528

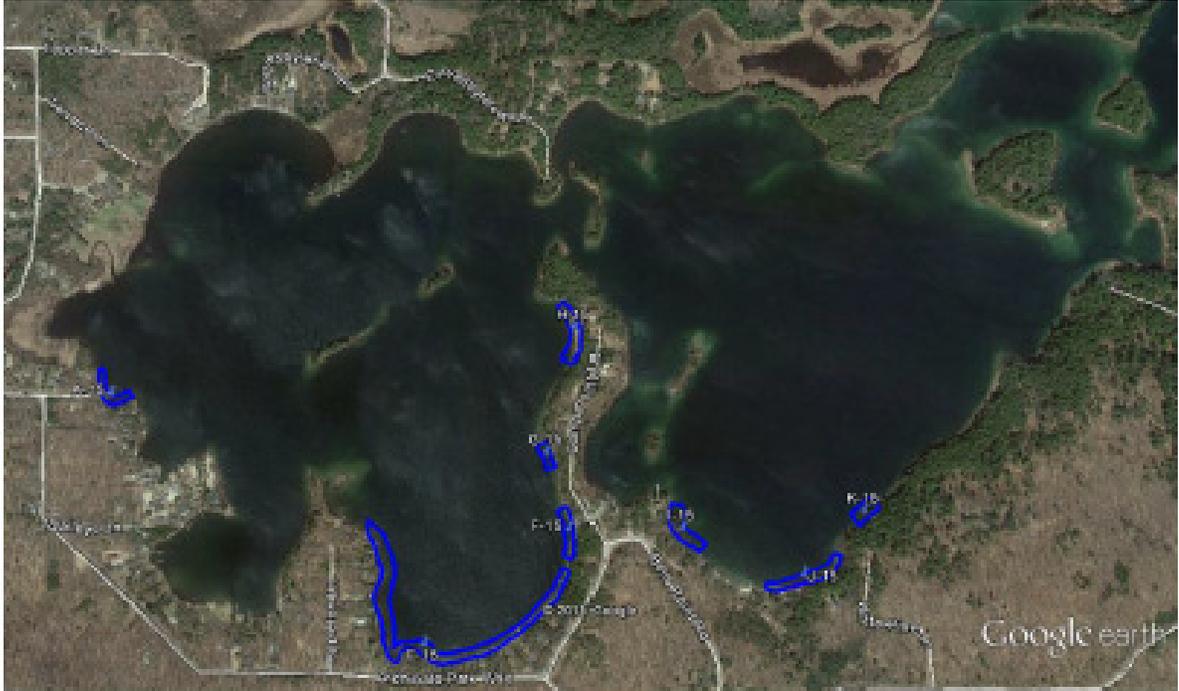
Minnesota Statutes, Chapter 18B.37

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**2015 Chemical Application Information**

**Treatment Site Layout**



Archibald Lake 2015 Treatment Area & Herbicide Rate Data				Reward (liquid diquat)	
ID	Acreage	Mean Depth Estimate	Volume	Qty/Acre	Total
A-15	0.4	3.0	1.2	2.0	0.8
E-15	3.3	3.0	9.9	2.0	6.6
F-15	0.5	3.0	1.5	2.0	1.0
G-15	0.2	3.0	0.6	2.0	0.4
H-15	0.6	3.0	1.8	2.0	1.2
I-15	0.6	3.0	1.8	2.0	1.2
J-15	0.7	3.0	2.1	2.0	1.4
K-15	0.3	3.0	0.9	2.0	0.6
<b>Total</b>	<b>6.6</b>		<b>19.8</b>		<b>13.2</b>