

## **2005 Project Abstract**

For the Period Ending June 30, 2008

**PROJECT TITLE:** Restoration of Indian Lake ILID Portion

**PROJECT MANAGER:** Kevin Lindquist

**AFFILIATION:** Indian Lake Improvement District

**MAILING ADDRESS:** Gulden Ave. NW

**CITY/STATE/ZIP:** Maple Lake, Mn. 55358

**PHONE:** 320-963-6276

**FAX:**

**E-MAIL:** kevster@lakedalelink.net

**WEBSITE:**

**FUNDING SOURCE:** Minnesota Environment and Natural Resources Trust Fund

**LEGAL CITATION:**

[ML 2005, First Special Session, Chp. 1, Art. 2, Sec 11, Subd. 07(p)]

**APPROPRIATION AMOUNT:** \$ 16,001

### **Overall Project Outcome and Results**

Through the project, ILID personal helped BSU in the monthly water samplings, and the daily monitoring of the aerators. It is the plan of the ILID to continue the use of these aerators.

ILID applied for a permit for the shore land restoration of three types of plants. aquatic, terrestrial and shrub. The DNR ok'd these types of plants and issues a permit. ILID personal constructed waddles for the aquatic plants. The areas that these were used in there were great survival rates of the plants. In areas that there were no waddles the survival rte was very low. It is recommended that waddles (wave breaks) be used in all aquatic plantings regardless of how protected the shoreline may seem. The terrestrial and shrub survival rate is very high, over 90%.

### **Project Results Use and Dissemination : NA**

## LCCMR 2005 Work Program Final Report

-1-

**Date of Report:** June 30<sup>th</sup>, 2008  
LCCMR 2005 Final Work Program Report

### **I. PROJECT TITLE:** Restoration of Indian Lake ILID Portion

**Project Manager:** Kevin Lindquist **Affiliation:** Indian Lake Improvement District  
**Mailing Address:** 10928 Gulden Ave. NW  
**City / State / Zip:** Maple Lake, Mn. 55358  
**Telephone Number:** 320-963-6276  
**E-mail Address:** kevster@lakedalelink.net  
**Location:** *Corinna Township, Wright County, Minnesota*

<b>Total Biennial LCMR Project Budget:</b>	<b>Appropriation:</b> \$200,000.00
	<b>Minus Amount Spent:</b> \$79,507.13
	<b>Equal Balance:</b> \$120,492.87

**Note this balance reflects activity under the original approach to the project.**  
**This work program and budget reflects the new approach to the project.**

Balance	\$120,492.87		
Budget REVISED portion		LID portion	\$16,001
See also BSU portion work program for up to \$ 62,685			
<b>Legal Citation:</b> ML 2005, First Special Session, Chap1, Art.2, Sec.11, [Subd.7 (p)]			

\$100,000 the first year and \$100,000 the second year are from the trust fund to the commissioner of natural resources for agreements with Indian Lake Improvement District and Bemidji State University to demonstrate the removal of excess nutrients from Indian Lake in Wright County. This appropriation is available until June 30, 2008, at which time the project must be completed and final products delivered, unless an earlier date is specified in the work program, and is contingent on all appropriate permits being obtained.

This LID work program budget under the new approach is \$16,001.

### **II. AND III. FINAL PROJECT SUMMARY:**

Through the project, ILID personal helped BSU in the monthly water samplings, and the daily monitoring of the aerators. It is the plan of the ILID to continue the use of these aerators.

ILID applied for a permit for the shore land restoration of three types of plants. aquatic, terrestrial and shrub. The DNR ok'd these types of plants and issues a permit. ILID personal constructed waddles for the aquatic plants. The areas that these were used in there were great survival rates of the plants. In areas that there were no waddles the survival rte was very low. It is recommended that waddles (wave breaks) be used in all aquatic plantings regardless of how protected the shoreline may seem. The terrestrial and shrub survival rate is very high, over 90%.

#### IV. OUTLINE OF PROJECT RESULTS:

##### **Result 1:** Lake monitoring and shoreline improvement

**Description:** Indian Lake Improvement District to support BSU activities. ILID will also monitor the aerators in 2007 through the end of October. At which time the aerators and marker buoys will be removed. In November the aerators are to be serviced (cleaned and replace any components that may need to be replaced). The property owners to be reimbursed for the electricity use (years of 2006 & 2007) and from May 1<sup>st</sup> thru June 30<sup>th</sup>, 2008. The aerators will continue and be monitored from July 1<sup>st</sup> thru October 31<sup>st</sup>, 2008 at the cost of ILID.

<b>Summary Budget Information for Result 1:</b>	<b>LCMR Budget</b>	<b>\$10,695</b>
	<b>Amount Spent</b>	<b>\$ 9,272</b>
	<b>Balance</b>	<b>\$1,423</b>

**Completion Date:** June 30<sup>th</sup>, 2008

##### **Result 2:** Spawning Preserve and Shoreline Restoration

<b>Summary Budget Information for Result 2:</b>	<b>LCMR Budget</b>	<b>\$5,306</b>
	<b>Amount Spent</b>	<b>\$2,017</b>
	<b>Balance</b>	<b>\$3,289</b>

**Completion Date:** June 30<sup>th</sup>, 2008

**TOTAL LCMR PROJECT BUDGET: REVISED TOTAL \$ 16,001**

**All Results: Personnel: \$ 3,213**

**All Results: Equipment tools and supplies: \$ 12,788**

**TOTAL LCMR PROJECT BUDGET: \$ 16,001**

**V. OTHER FUNDS & PARTNERS:**

**A. Project Partners:** Dr. Fu-Hsian Chang, holds Ph.D. in Environmental Microbiology, M.S. degree in Biology and Biophysics, and B.S. degree in Agriculture Chemistry. He has participated as principal investigator, co-investigator and scientist in more than 20 research and consulting projects and has more than 70 publications. Dr. Chang will act as overall program manager.

**B. Other Funds being spent during the Project Period:** The Indian Lake Improvement District has spent \$5,000 for herbicide in 2005 and another \$5,000 in 2007 for the control of Eurasian Water Milfoil and Curly Leaf Pondweed.

**C. Required Match (if applicable):**

**D. Past Spending:**

Watershed residents have spent thousands of dollars in eliminating point and non-point pollution sources. Indian Lake is also a partner in the Wright County Cooperative Lake Monitoring Program.

**E. Time:** This project will end on June 30<sup>th</sup>, 2008

**VI. DISSEMINATION:**

**VII. REPORTING REQUIREMENTS:** Periodic Work Program Progress Reports will be submitted in Feb, 2008.  
A Final Work Program Report will be submitted in June 30<sup>th</sup>, 2008, but no later than July 15, 2008.

**VIII. RESEARCH PROJECTS: N/A.**

## Reimbursement Request – Invoice Summary Spreadsheet

### Instructions:

1. Enter your budget from your current approved work program (Attachment A)
2. Update the beginning balances with the ending balance from your previous Invoice Summary Spreadsheet.
3. Insert the amounts of your current invoice by category and provide the total.
4. Calculate the ending balances for this invoice.
5. Attach copies of invoices, checks and time cards.
6. Fill out and submit the Reimbursement Request Form
7. Send completed documentation to the authorized state contact person.

Project Title: Restoration of Indian Lake

Legal Citation: Laws of Minnesota 2005, Chapter 1, Art. 2, Sec. 11. [Subd.7(p)]

Period Covered by Reimbursement Request: 9/5/2007 TO 6/30/2008 .

### Budget for Results from Work Program

Budget Item	Result 1: (Insert Title of Result)				Result 2: (Insert Title of Result)				Project Total			
	Budget	Beginning Balance	Current Invoice	Ending Balance	Budget	Beginning Balance	Current Invoice	Ending Balance	Budget	Beginning Balance	Current Invoice	Ending Balance
ILID Personal (Curt Brekke / Kevin Lindquist)												
Monitoring of Aeration Pumps	\$1,113	\$1,113	\$1,113	\$0	\$637	\$637	\$175	\$462	\$1,750	\$1,750	\$1,288	\$462
Assisting BSU w / Sampling	\$392	\$392	\$392	\$0	\$147	\$147	\$221	-\$74	\$539	\$539	\$613	-\$74
Installing Aeration Pumps	\$70	\$70	\$70	\$0	\$70	\$70	\$35	\$35	\$140	\$140	\$105	\$35
Removal Aeration Pumps	\$70	\$70	\$70	\$0	\$0	\$0	\$0	\$0	\$70	\$70	\$70	\$0
Maintenance of Aeration Pumps	\$105	\$105	\$105	\$0	\$0	\$0	\$0	\$0	\$105	\$105	\$105	\$0
Installing / removal Spawning Bouys	\$7	\$7	\$7	\$0	\$42	\$42	\$0	\$42	\$49	\$49	\$7	\$42
Shoreland Planting	\$0	\$0	\$0	\$0	\$560	\$560	\$243	\$317	\$560	\$560	\$243	\$317
Other Direct Operating costs												
Electricity (Aeration Pumps)	\$3,000	\$3,000	\$2,445	\$555	\$750	\$750	\$150	\$600	\$3,750	\$3,750	\$2,595	\$1,155
Use of Pontoon	\$2,510	\$2,510	\$1,900	\$610	\$1,600	\$1,600	\$620	\$980	\$4,110	\$4,110	\$2,520	\$1,590
Equipment / Tools												
Weather Stations (2)	\$428	\$428	\$428	\$0	\$0	\$0	\$0	\$0	\$428	\$428	\$428	\$0
Other Supplies												
Repair and Betterment of Aeration Pumps	\$3,000	\$3,000	\$2,742	\$258	\$0	\$0	\$0	\$0	\$3,000	\$3,000	\$2,742	\$258
Spawning Bouys	\$0	\$0	\$0	\$0	\$1,500	\$1,500	\$573	\$927	\$1,500	\$1,500	\$573	\$927
<b>Column Total</b>	<b>\$10,695</b>	<b>\$10,695</b>	<b>\$9,272</b>	<b>\$1,423</b>	<b>\$5,306</b>	<b>\$5,306</b>	<b>\$2,017</b>	<b>\$3,289</b>	<b>\$16,001</b>	<b>\$16,001</b>	<b>\$11,289</b>	<b>\$4,712</b>

## **2005 Project Abstract**

For the Period Ending June 30, 2008

**PROJECT TITLE:** Restoration of Indian Lake, BSU Portion

**PROJECT MANAGER:** Dr. Fu-Hsian Chang

**AFFILIATION:** Bemidji State University

**MAILING ADDRESS:** 1500 Birchmont Dr. NE, Bemidji, mn 56601-2699

**WEBSITE:** (If applicable) [www.Bemidjistate.edu/Environmentalstudies](http://www.Bemidjistate.edu/Environmentalstudies)

**FUNDING SOURCE:** The Environment and Natural Resources Trust Fund

### **LEGAL CITATION:**

For 2005 the exact language is: ML 2005, First Special Session, Chp. 1, Art. 2, Sec. 11, Subd. 07 (P).

**APPROPRIATION AMOUNT:** \$ 116,143

### **Overall Project Outcome and Results**

The restoration of Indian Lake is a demonstration project that used mechanical aeration and biotechnology techniques (Bacta-Pur culture) to remove excess nutrients from the lake ecosystem to improve water quality to its natural state. Indian Lake has experienced deteriorating water quality and a diminished capacity to sustain its game fish population. The main objectives were to reduce nutrient concentrations and improved water quality and ecological productivity.

Monthly samples of water and sediment were collected to monitored for chemical characteristics: dissolved oxygen, chlorophyll-a, transparency, turbidity, ammonium, and nitrate nitrogen and total phosphorus; and for biological parameters; the occurrence and abundance of benthos organisms, phytoplankton and zooplankton.

Water quality parameters were improved significantly after three applications of Bacta-pur in August and September of 2006, dissolved oxygen increased while ammonium and nitrate nitrogen, chlorophyll-a, and phosphorus concentrations decreased in 2007 and 2008. Several diatoms and Cyanophyceae that are typical in eutrophic lakes were found abundant in late summer. A few species of zooplankton and benthic organisms were also found abundant. Microbial augmentation and aeration did offer beneficial effects. Due to the fact that too many variables are involved in the restoration process and Bacta-pur might not be the cause of lake water improvement. Therefore, no Bacta-pur was applied on Indian Lake throughout the completion of this project. Any possible observed benefits would require further test of Bacta-pur in the future in order to confirm any level of improvement achieved.

Three groups of vegetation (emergent plants, lakeshore species, and shrubs) were chosen for shoreline restoration. 11,063 plants that are native to the region were planted and restoration was a success. More than 85% vegetation survivorship was observed after the first month of planting.

### **Project Results Use and Dissemination**

This project has generated one B.S. degree Thesis entitled "The Restoration of Indian Lake: Biomanipulation from the Bottom-up" authored by Nathan T. Larson, one M.S. degree Thesis entitled "The Application of Biotechnology in the Restoration of Indian Lake " authored by Christine Ann Thorman. Two senior students Thomas Schufman and Theodore Toft did their internship on this project. Besides, two papers were presented at two International Meetings, they are "Application of Biotechnology in the restoration of Indian Lake" that was presented at the Preserving and Enhancing the Global Water Environmental Annual Meeting in San Diego, CA, on Oct. 13-19, 2007. Research paper was published in the Proceedings and Abstract. The other paper "Application of Mixed Bacterial Culture in the Restoration of Indian Lake in Central Minnesota" was presented at the ASA-CSSA-SSSA 2007 International Annual Meeting in New Orleans, LA on Nov. 4-8, 2007, and published in 2007 International Meeting Abstracts. Several Lake Associations have shown interest to use this demonstrated methods to restore their lakes.

**LCCMR 2005 Work Program Final Report**  
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**Date of Report:** June 30, 2008  
 LCMR 2005 Final Work Program Report

**I. PROJECT TITLE:** Restoration of Indian Lake BSU Portion

**Project Manger:** Dr. Fu-Hsain Chang **Affiliation:** Bemidji State University  
**Mailing Address:** 1500 Birchmont Drive N.E  
**City/State/Zip:** Bemidji, MN 56601  
**Telephone Number:** 218-755-4104  
**E-mail Address:** fchang@bemidjistate.edu  
**Fax Number:** 218-755-4107

**Location:** Indian Lake near Maple Lake city, Wright County

**Total Biennial Project Budget:** See the previous version of the work program for updates and budget status through Aug 2007.

**BSU portion budget -** \$63,000.00

**Amount spent to date** \$49,525.00

**Balance BSU portion only** \$13,475.00

**This requires a reallocation within the appropriation, adding \$53,143.00 to the BSU portion and taking that amount from the ILID portion. The \$63,000.00 includes the remainder of the \$9,857.00 balance for BSU as of the last status report. See the new attached attachment A for budget distribution**

**Legal Citation:** ML 2005, First Special Session [Chap. 1], Article [2] Sec. [11], Subd. [07p].  
 7(p) \$100,000 the first year and \$100,000 the second year are from the trust fund to the commissioner of natural resources for agreements with Indian Lake Improvement District and Bemidji State University to demonstrate the removal of excess nutrients from Indian Lake in Wright County. This appropriation is available until June 30, 2008, at which time the project must be completed and final products delivered, unless an earlier date is specified in the work program, and is contingent on all appropriate permits being obtained.

**II. AND III. FINAL PROJECT SUMMARY:**

The restoration of Indian Lake is a demonstration project that used mechanical aeration and biotechnology techniques (Bacta-Pur culture) to remove excess nutrients from the lake ecosystem to improve water quality to its natural state. Indian Lake has experienced deteriorating water quality and a diminished capacity to sustain its game fish population. The main objectives were to reduce nutrient concentrations and improved water quality and ecological productivity.

Monthly samples of water and sediment were collected to monitored for chemical characteristics: dissolved oxygen, chlorophyll-a, transparency, turbidity, ammonium, and nitrate nitrogen and total phosphorus; and for biological parameters; the occurrence and abundance of benthos organisms, phytoplankton and zooplankton.

Water quality parameters were improved significantly after three applications of Bacta-pur in August and September of 2006, dissolved oxygen increased while ammonium and nitrate nitrogen, chlorophyll-a, and phosphorus concentrations decreased in 2007 and 2008. Several diatoms and

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 Restoration of Indian Lake\2008-09-26 FINAL WP for BSU.doc

Cyanophyceae that are typical in eutrophic lakes were found abundant in late summer. A few species of zooplankton and benthic organisms were also found abundant. Microbial augmentation and aeration did offer beneficial effects. Due to the fact that too many variables are involved in the restoration process and Bacta-pur might not be the cause of lake water improvement. Therefore, no Bacta-pur was applied on Indian Lake throughout the completion of this project. Any possible observed benefits would require further test of Bacta-pur in the future in order to confirm any level of improvement achieved.

Three groups of vegetation (emergent plants, lakeshore species, and shrubs) were chosen for shoreline restoration. 11,063 plants that are native to the region were planted and restoration was a success. More than 85% vegetation survivorship was observed after the first month of planting.

#### **IV. OUTLINE OF PROJECT RESULTS:**

##### **Result 1: *Lake*. Monitoring**

##### **A. Monitoring of Water Quality in Terms of Physical-Chemical Properties And Assessing the Trophic Status:**

Water physical and chemical characteristics, such as secchi disc depth, dissolved oxygen, total phosphorus, dissolved inorganic nitrogen (ammonia, nitrite and nitrate), and chlorophyll-a concentration were analyzed in the field (Figure 1) as well as in the lab to assess the trophic status of the water body. Due to the imperfect correlation between these individual indicators three TSI parameters were combined into one single TSI (Figures 2 and 3).

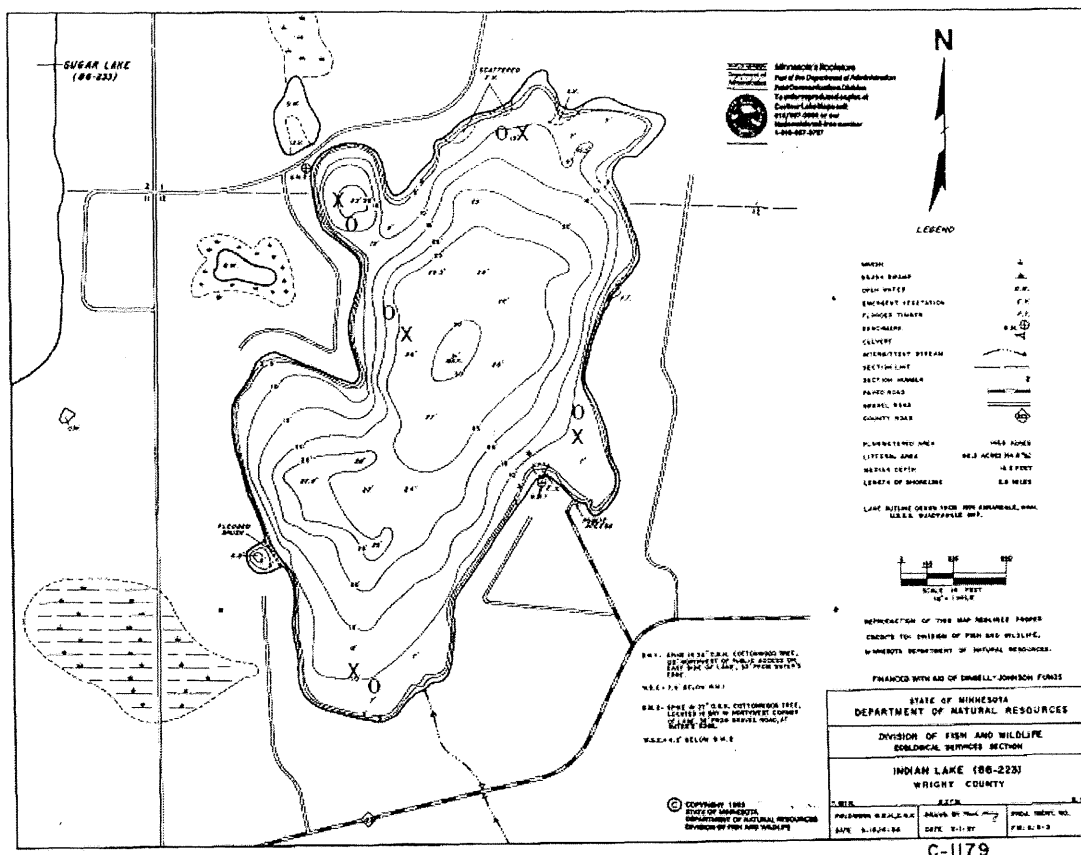
From the results obtained from the past three years it is apparent that lake water quality/clarity and water chemistry has improved significantly. On May 14, 2007, we found water clarity averaged 17 ft. and on May 28, 2007 RMB lab analysis showed that water clarity improved more than 50%, total phosphorus has been reduced to 29mg/l and trophic state index (TSI) reduced to 50 from 60 (an average of last 10 years)(Tables 1 and 2).

Due to the fact that too many variables are involved in the restoration process and Bacta Pur might have played insignificant side effects on lake water quality improvement. Therefore, no more Bacta Pur was applied on Indian Lake in 2007 throughout the completion of this project. Any possible observed benefits from Bacta Pur would require continuous additions of Bacta Pur in the future in order to conform any level of improvement achieved.

##### **Figure 1:**

**Map of Indian Lake and locations of mechanical aeration (O) and sampling sites (X) are shown in Figure 1. Five aeration unites were operated through the open water seasons. Monitoring sites were chosen near the aeration sites.**

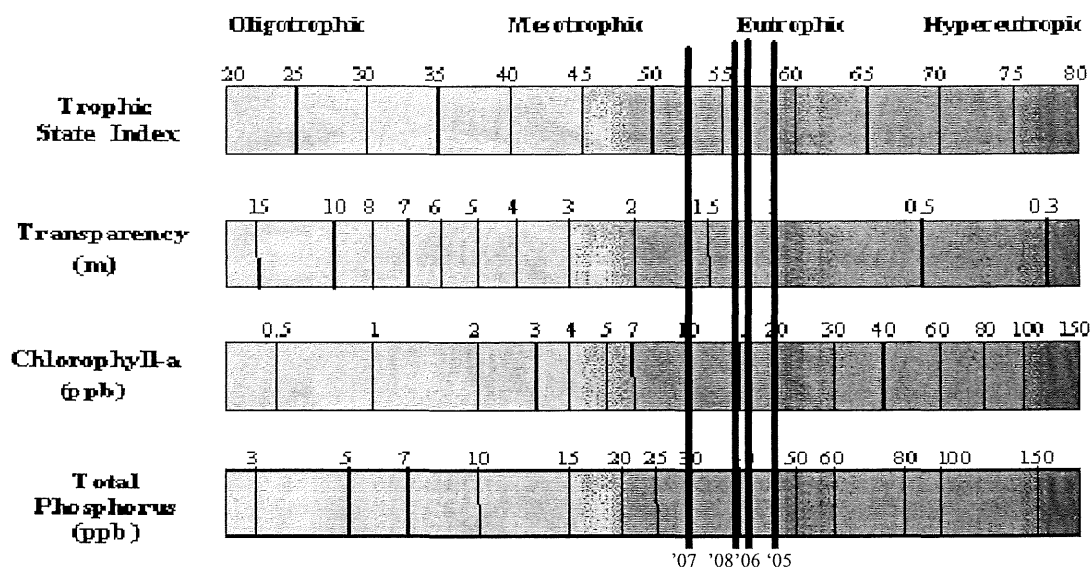




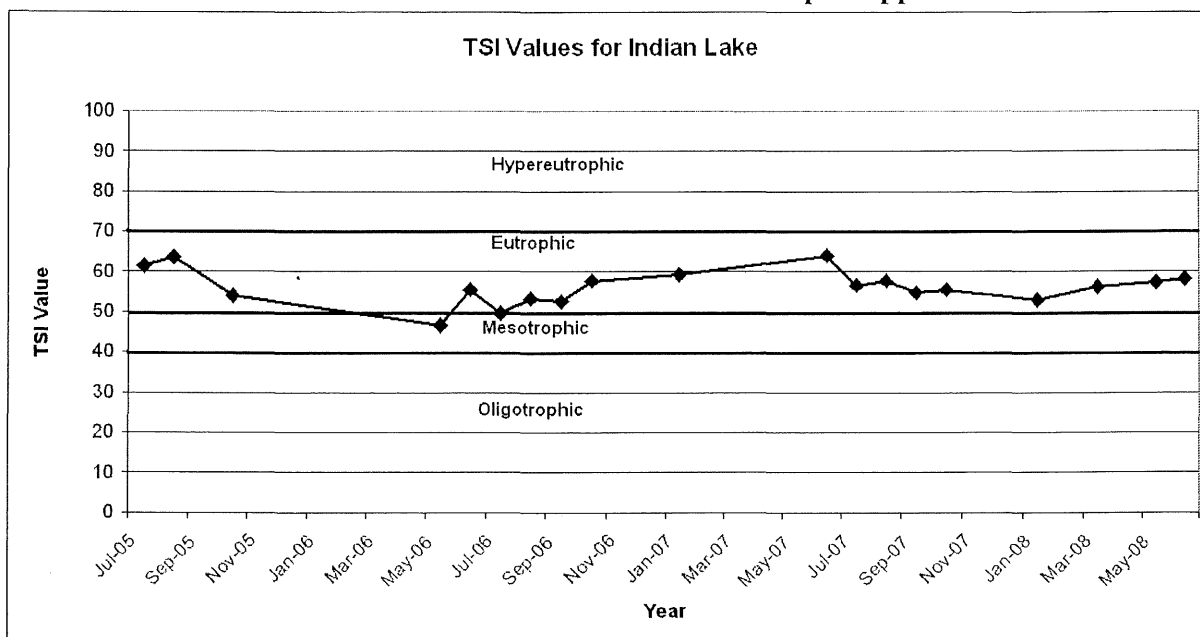
Univariate models indicate that there was a significant difference in years. The TSI summer values have declined from 63 (2005) to 56 (2007 and 2008). Figure 2 shows the improvements of the TSI values of Indian Lake between 2005 and 2008.

Indian Lake's overall mean TSI value between 2005 and 2008 had ranged from 47-64 with an average of 56, indicating that Indian Lake trophic index state had fluxed between highly eutrophic to a lower eutrophic/ mesotrophic boundary (Figures 2 and 3). The TSI values of Indian lake indicate that the higher TSI value implies that the waters were eutrophic with a dominance of blue-green algae, algal scums and extensive macrophyte problems compared to its low TSI value. The 2007 and 2008 TSI value signify that the water became more moderately clear, although there was still a high probability of anoxia in hypolimnion during summer.

**Figure 2:**  
**Trophic States of Indian Lake from 2005 to 2008.**



**Figure 3:**  
Seasonal Variation of TSI in Indian Lake Pre-and Post Bacta-pur Application



Indian Lake TSI values have shown fluctuations over the three-year period with a low value of 47 and a high value 64 (Figure 3). An univariate analysis of variance had indicated that the group means did differ significantly. Multiple comparison tests of significance (Tukey) indicated that all the independents had a significant relationship on the TSI value, 2005 ( $M=58.77$ ,  $SD=0.95$ ), 2006 ( $M=60.32$ ,  $SD=0.64$ ) and 2007 ( $M=56.46$ ,  $SD=0.22$ ) among each year when  $p<0.05$ .

Table 1 summarize annual average physical and chemical characteristics of water clarity, chlorophyll-a, inorganic nitrogen ammonium and nitrate and trophic status index for 2005 through 2008. It is clear that ammonium nitrogen concentration has been reduced in three years. Chlorophyll-a increased significantly post-application of Bacta-pur then decreased dramatically in 2007 and remained low (unchanged) in 2008. The transparency of Indian Lake water column

has shown improvement post-application of Bacta-pur in 2006 and it reached the most transparent (2.47 meters) in 2008 (Table 1). Nitrate nitrogen concentration decreased from 2005 to 2006 and 2007 but then increased back to almost the same level as that of 2005. This might be attributed to the applied Bacta-pur culture that utilized nitrate-N for proliferation. Increased nitrate-N concentration in 2008 caused by the process of nitrification, which oxidized ammonium to nitrate under oxidized (high dissolved oxygen) conditions. No significant annual change in trophic status index was found in 2005-2006 but was reduced post-application of Bacta-pur in 2007 and 2008 (Table 1).

**Table 1:**

**Average Chemical Characteristics of Lake Water**

	<b>Chlorophyll-a (ug/L); SD</b>	<b>Transparency (meters); SD</b>	<b>Ammonia (mg/L); SD</b>	<b>Nitrates (mg/L); SD</b>	<b>TSI; SD</b>
2005	23.42 ± 2.19	1.10 ± 0.17	24.50 ± 0.41	1.50 ± 0.05	58.78 ± 0.38
2006	53.48 ± 3.37	1.38 ± 0.03	3.76 ± 0.43	0.91 ± 0.003	60.33 ± 0.80
2007	18.25 ± 3.21	1.27 ± 0.10	1.97 ± 0.64	0.86 ± 0.21	56.88 ± 0.40
2008	19.07 ± 3.69	2.47 ± 0.06	0.48 ± 0.07	1.30 ± 0.04	56.17 ± 0.78

Table 2 shows comparative water quality data of Indian Lake that was obtained by RMB Environmental Laboratories, Inc. A significant reduction in total phosphorus in 2006-2008 compared to 2004-2005. Chlorophyll-a concentrations also show significant lower in 2006-2007, especially post-Bacta-pur application in 2007. However, chlorophyll-a concentration increased by 3-folds in first two months (May and June) of sampling in 2008 compared to average monthly data of 2007. (Table 2). Water transparency data also shows a significant improvement in 2006-2008 as compared to that of the previous two years 2004-2005. All three TSI (phosphorus, chlorophyll-a, and Secchi transparency) and the monthly average TSI have reduced significantly from 2005 to 2007 but then increased slightly in TSI phosphorus and TSI Secchi in 2008 than 2006-2007. This could have been resulted from three applications of Bacta-pur culture in August and Septemebr of 2006. No Bacta-pur application was made in 2007 which might have resulted in a significant increase of chlorophyll-a in 2008 and slight increase of TSI phosphorus and TSI Secchi in 2008 as compared to data post-bata-pur applications (Table 2).

**Table 2. Comparative Water Quality Data of Indian Lake**

(Source: RMB Environmental Laboratories, Inc.) 2004-2008

Year & Month*	2004	2005	2006	2007	2008
Parameter	M J J A S	M J J A S	M J J A S	M J J A S	M J
Total Phosphorus (mg/L) **	71 67 69 46 63 63.2 ± 9.0	53 35 62 60 62 54.8 ± 10.2	27 24 47 37 66 40.2 ± 15.2	29 41 22 44 80 43.2 ± 20.0	45 38 41.5 ± 3.5
Chlorophyll A (mg/L)**	36 54 79 28 40 47.4 ± 17.9	22 11 66 43 64 41.2 ± 22.0	18 12 16 16 37 19.8 ± 8.8	5.0 7.0 4.0 14 18 9.6 ± 5.5	46 28 37.0 ± 9.0
SecchiDisk/ Transparency (ft.)**	7.0 4.0 2.0 3.0 3.5 3.9 ± 1.7	6.5 5.0 2.8 3.0 2.8 4.0 ± 1.5	7.0 7.0 3.5 4.5 5.5 5.5 ± 1.4	6.5 6.5 3.0 3.5 5.0 4.9 ± 1.5	4.5 4.5 4.5 ± 0
TSI, Phosphorus **	66 65 65 59 64 63.8 ± 2.5	62 55 64 63 64 61.6 ± 3.4	52 50 60 56 65 56.6 ± 5.4	53 58 49 59 67 57.2 ± 6.1	59 57 58.0 ± 1.0

TSI, Chl-A **	66 70 73 63 67 67.8 ± 3.4	61 54 72 67 71 65.0 ± 6.7	59 55 58 58 66 59.2 ± 3.7	46 50 44 56 59 51.0 ± 5.7	68 63 65.5 ± 2.5
TSI, Secchi **	49 57 67 61 59 58.6 ± 5.9	50 54 63 61 63 58.2 ± 5.3	49 49 59 55 53 53.0 ± 3.8	50 50 61 59 54 54.8 ± 4.5	55 55 55.0 ± 0
TSI, Monthly Average	60 64 68 61 63 63.2 ± 2.8	58 54 66 64 66 61.6 ± 4.8	53 51 59 56 61 56.0 ± 3.7	50 53 51 58 60 54.4 ± 3.9	61 58 59.5 ± 1.5

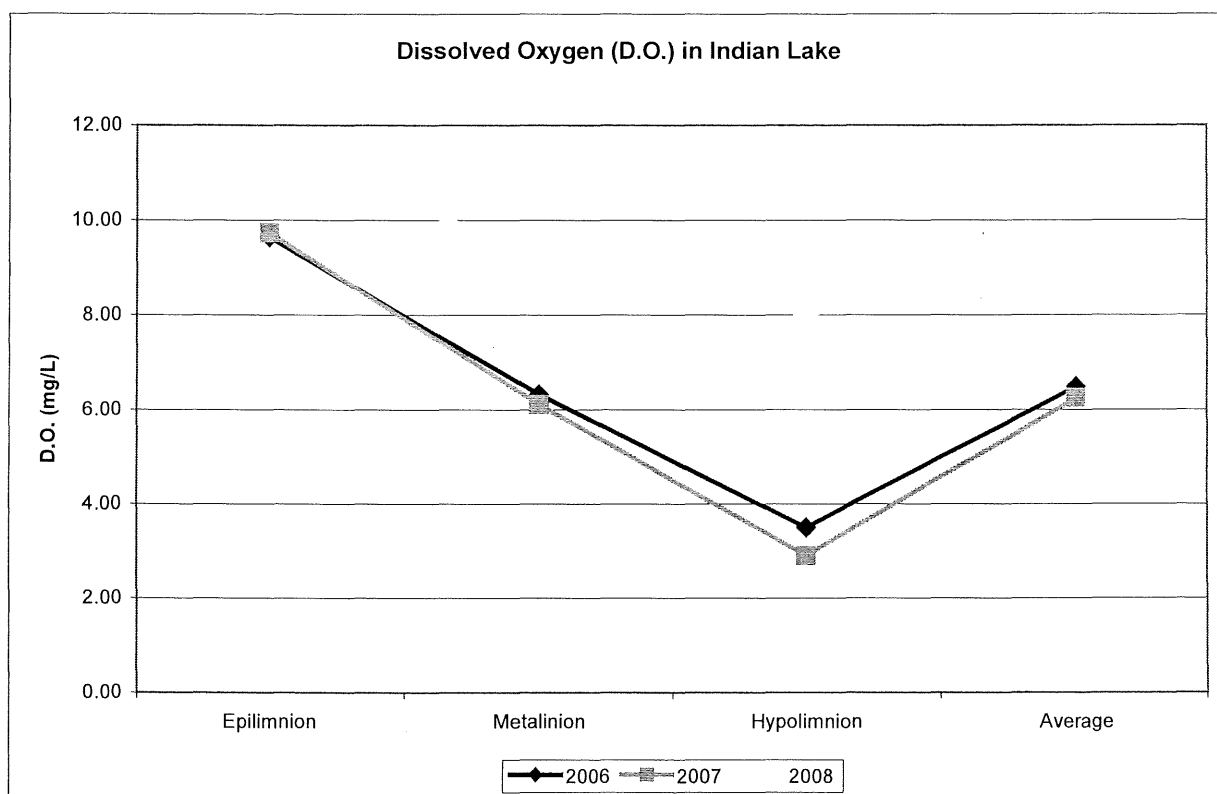
\* M = May, J = June, J = July, A = August, S = September

\*\* = Average of five months in each year plus minus standard deviation

*Dissolved oxygen.* According to the average composite dissolved oxygen levels, DO levels in the summer have increased from 5 mg/L in 2005 to 9.2 mg/L in 2008 (Figure 4). A univariate GLM also indicates a significant differences in years,  $F_{(2, 8)} = 37.89$ ,  $p = 0.0$ , but no difference among sites,  $F_{(4, 8)} = 0.52$ ,  $p = 0.73$ . Annual D.O. in the hypolimnion in summer months was found 2.47, 2.74, 2.95, and 7.5 for 2005, 2006, 2007, and 2008, respectively.

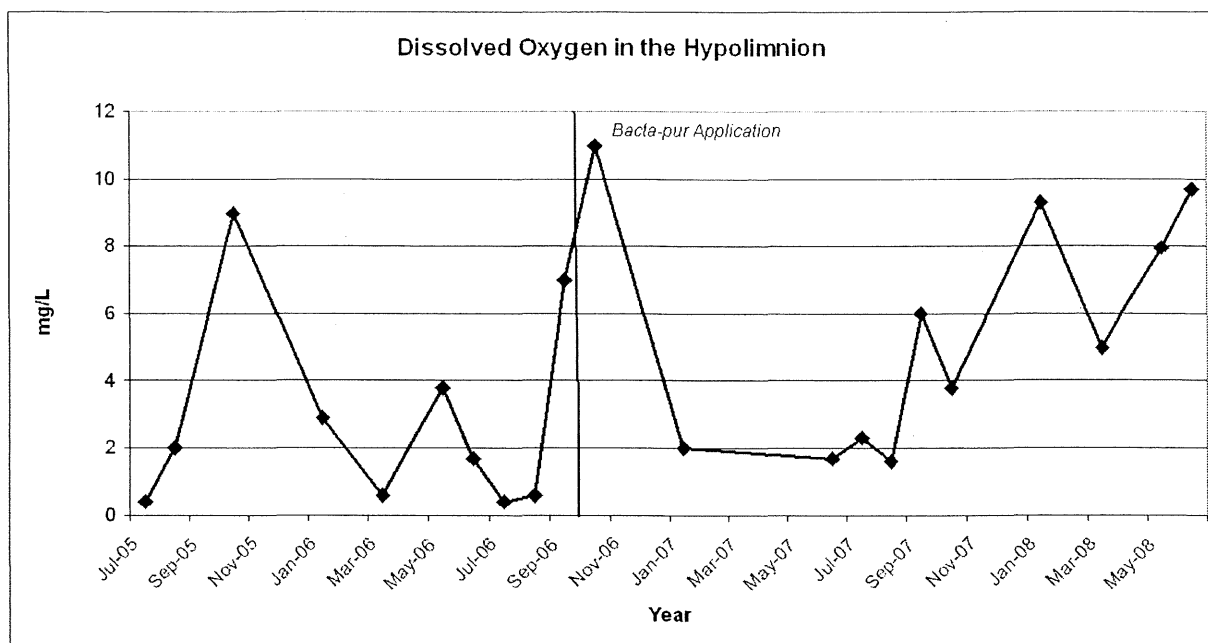
**Figure 4:**

**Dissolved Oxygen in Indian Lake.** The D.O in the lake was monitored in the three layers of the lake with an average of the entire lake during each open water season.



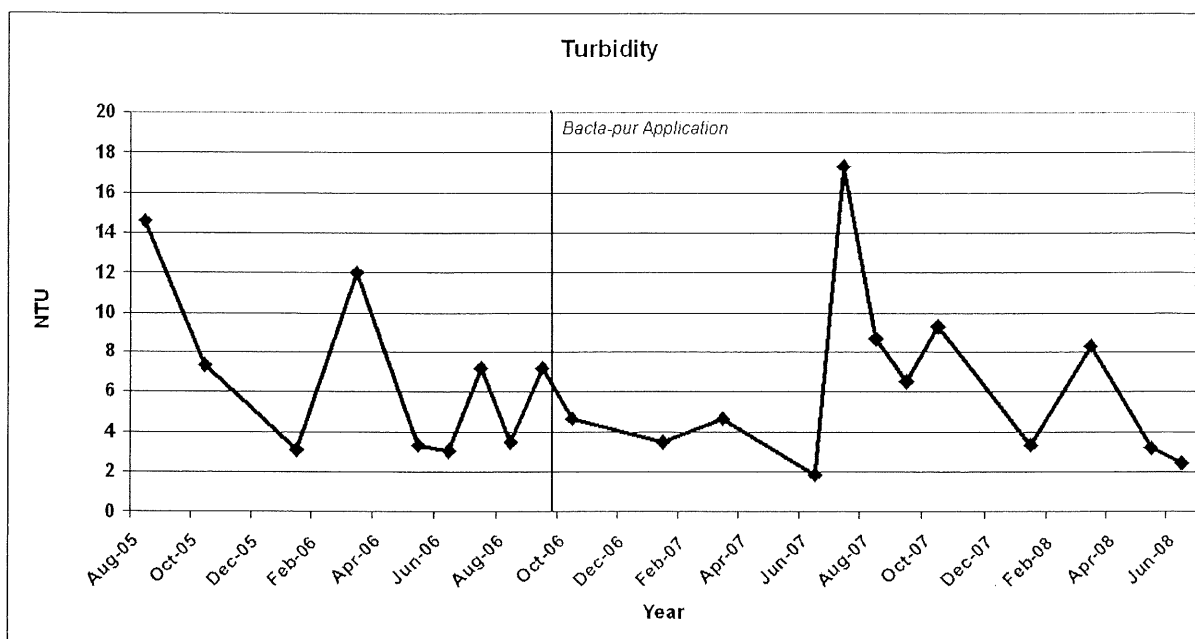
**Figure 5:**

**Seasonal Variation of Dissolved Oxygen in Hypolimnion Pre-and Post Bacta-pur Application**



*Turbidity.* The NCHR ecoregion water quality standard for turbidity is between 1-2 NTU. Indian Lake average turbidity is 7 NTU, clearly above the standard, with a high turbidity reading in July 2007 of 17 NTU and a low NTU of 2 in June 2007 and 2008 (Figure 6). According to the univariate GLM, there is a significant effect between years,  $F_{(2, 4)} = 6.48$ ,  $p = 0.02$ . Using Tukey's HSD for the Post Hoc analyses, the results show a difference between the group means of 2006 ( $M = 5.87$ ,  $SD = 0.61$ ,  $p = 0.02$ ) and 2007 ( $M = 7.85$ ,  $SD = 1.21$ ,  $p = 0.02$ ), although no difference between 2005 ( $M = 6.54$ ,  $SD = 1.02$ ,  $p = 0.49$ ) and 2006 ( $M = 5.87$ ,  $SD = 0.61$ ,  $p = 0.49$ ), indicating that there was an effect on water quality with the application of Bacta-pur® one year after (Figure 6).

**Figure 6:**  
**Seasonal Variation of Turbidity Pre-and Post Bacta-pur Application**

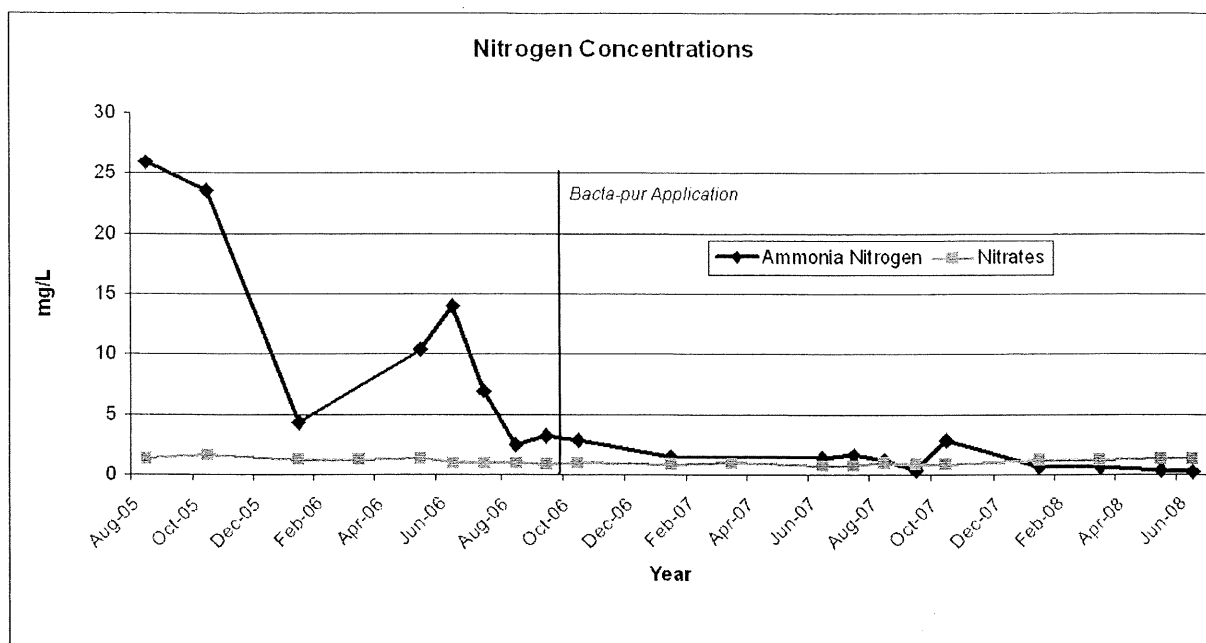


*Inorganic Nitrogen.* Average nitrate concentrations for Indian Lake have declined over three years during the summer months with average concentrations of 1.4 mg/L, 1.0 mg/L and 0.8 mg/L for 2005, 2006 and 2007, respectively (Figure 7). Univariate GLM model shows significant differences between 2005 and 2006, and 2005 and 2007,  $F_{(2, 8)} = 116.09, p=0.0$ . Tukey's HSD revealed differences in group means for 2005 ( $M=1.50, SD=0.12, p=0.0$ ) and 2006 ( $M=0.91, SD=0.01, p=0.0$ ), as well as 2007 ( $M=0.87, SD=0.04$ ). However, there was no difference between 2006 and 2007,  $p=0.79$ .

Mean ammonia nitrogen levels have significantly dropped from 25.9 mg/L to 2.9 mg/L (Figure 7). Moreover, univariate GLM model indicated significant differences among years,  $F_{(2, 8)} = 150.45, p=0.0$ . Post Hoc analyses using Tukey's HSD have indicated differences between 2005 ( $M=24.49, SD=1.02, p=0.0$ ) and 2006 ( $M=3.75, SD=1.07, p=0.0$ ), as well as 2007 ( $M=2.60, SD=2.97, p=0.0$ ). There was no difference between 2006 and 2007,  $p=0.71$ . Both nitrate (0.475 mg/L) and ammonium nitrogen (1.30 mg/L) were found low in 2008 with ammonium-N the lowest and nitrate-N the highest in three years. This is because the aeration has increased nitrification process that has converted  $\text{NH}_4^+\text{-N}$  to  $\text{NO}_3^-\text{-N}$  in lake water.

**Figure 7:**

**Seasonal Variation of Inorganic Nitrogen Concentrations in Lake Water Pre- and Post Bacta-pur Application**



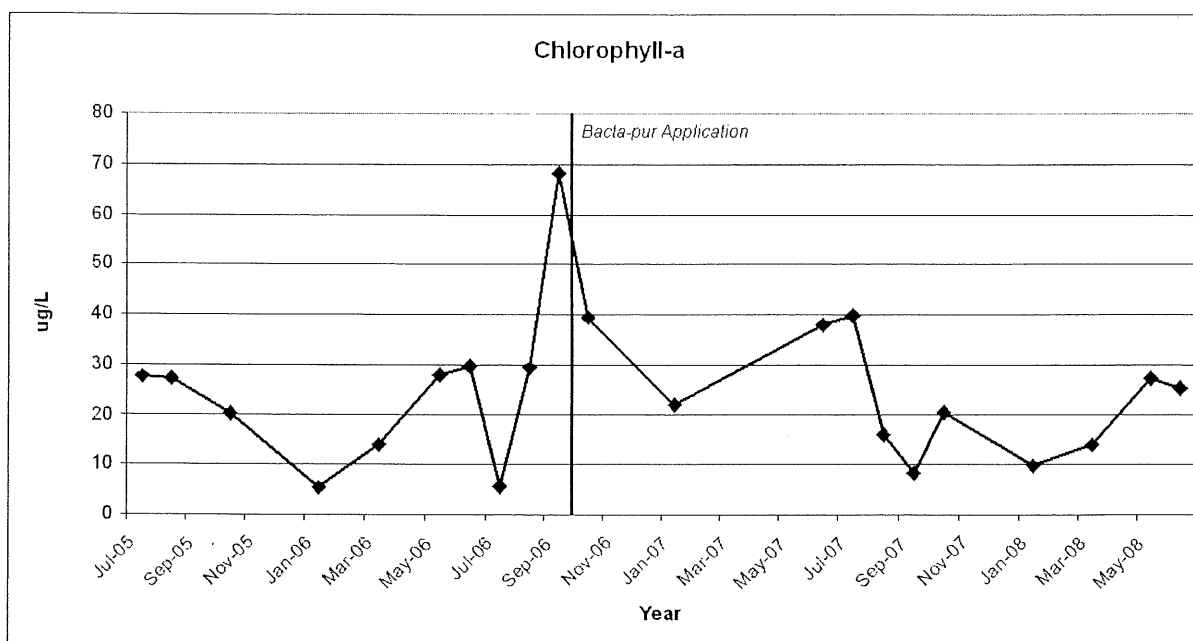
*Chlorophyll-a.* Within the North Central Hardwood Forest Ecoregion, chlorophyll-a concentration typically ranges between 5-22  $\mu\text{g/L}$ . Chlorophyll-a concentrations in Indian Lake showed a maximum reading after three applications of Bacta-pur® in August and September 2006 at 68  $\mu\text{g/L}$  (Figure 8). On average the summer chlorophyll-a readings for 2005 were 27  $\mu\text{g/L}$ , 2006 (22  $\mu\text{g/L}$ ), 2007 (31  $\mu\text{g/L}$ ) and 2008 (19  $\mu\text{g/L}$ ) (Figure 8).

The results from univariate analysis of variance indicated that the null hypothesis was rejected, since the group means of the years were significantly different (Figure 8),  $F_{(2,8)} = 74.15$ ,  $p=0.0$ . A Tukey test was conducted to determine which specific groups differed from one another. Results of that analysis indicate that 2005, 2006, 2007 and 2008 all have significantly different group means among three years ( $p<0.05$ ) (Figure 8).

According to Wetzel (2001), Indian lake's average summer chlorophyll-a mean of 27  $\mu\text{g/L}$ , with an average summer range of 6-40  $\mu\text{g/L}$  indicates that Indian Lake is eutrophic within a three year period. These values are also typical values of this ecoregion. The univariate model implies that the 2005 concentrations are average for the ecoregion, 2006 concentrations spiked with the application of Bacta-pur® and 2007 and 2008 concentrations were significantly lowered after the treatment year (Figure 8). The Bacta-pur® application denotes a consumption of bacteria by invertebrates. This promoted zooplankton populations growth and reproduction in high numbers due to the fact of the bacterial culture addition.

The chlorophyll-a concentrations later sharply decline from a mean of 68 to 40  $\mu\text{g/L}$  during the last Bacta-pur® application in late Fall of 2006 (Figure 8). The decline in chlorophyll-a is correlated to the decline in phosphorus levels; since the phosphorus availability influences phytoplankton crops (Moss, 1997) and phytoplankton populations increase the concentration of chlorophyll-a per unit cell biomass. Moreover, there is a strong correlation between phytoplankton populations (chlorophyll-a concentrations) and bacteria (Sigee, 2005) indicating that the spike in chlorophyll-a concentrations may be contributed to the first application of Bacta-pur®.

**Figure 8:**  
**Seasonal Variation of Chlorophyll-a Concentration in Lake Water Pre-and Post Bacta-pur Application**



#### B. Monitoring of Macrophytes and Phytoplankton:

All organisms in Indian lake are considered either mesotrophic or eutrophic indicator species during the sampling period (Table 3). Several diatoms that are characteristic for eutrophic conditions were found in Indian Lake. These species include *Asterionella*, *Fragilaria*, and *Stephanodiscus*. Diatoms are found in large amounts during the spring and later in the summer, although phytoplankton compositions change to Chlorophyceae (green algae), such as, *Pediastrum* and *Scenedesmus* during the summer in Indian Lake. Both *Pediastrum* and *Scenedesmus* are species that can co-exist together in nutrient-rich waters and found in Indian lake (Wehr and Sheath, 2003). *Pediastrum* and *Dictyosphaerium* (also noted in Indian Lake) are found in well-mixed shallow eutrophic lakes and are prevalent in the summer (Wehr and Sheath, 2003).

There were also noticeable increases in *Ceratium* from the winter of 2006 to 2007 (Table 3). Flagellates, such as, *Ceratium* can ingest bacteria under low light conditions or under ice. Therefore these species are at an advantage because they can switch between photosynthetic and bacterivorous metabolism (Wehr and Sheath, 2003). Also other eutrophic species found periodically in Indian Lake are *Gloeotrichia sp.* (colonizes shallow sediments or submersed plants in eutrophic lakes), *Gomphonema sp.* (tolerant of highly eutrophic waters), *Acanthoceras sp.* (forms ephemeral summer blooms in shallow, eutrophic waters) and *Peridinium sp.* (have high emergence rates in shallow lakes and correlated to high phosphorus levels) (Wehr and Sheath, 2003).

During late summer, the species composition changed again to Cyanophyceae (blue-green algae). *Anabaena*, *Microcystis* and *Aphanizomenon* are typical in eutrophic lakes and also abundant in Indian Lake during this time. In fresh water lakes rich in phosphate, nuisance cyanobacteria blooms of nitrogen-fixing *Anabaena* and *Aphanizomenon* are common (Graham and Wilcox, 2000). When algal species bloom in Indian Lake, *Aphanizomenon*, usually predominates. Indian Lake's periodic seasonality of *Anabaena* and *Microcystis* reflects mesotrophic or mildly eutrophic temperate lakes (Table 3).



There were also noticeable increases in *Ceratium* from the winter of 2006 to 2007 (Table 3). Flagellates, such as, *Ceratium* can ingest bacteria under low light conditions or under ice. Therefore these species are at an advantage because they can switch between photosynthetic and bacterivorous metabolism (Wehr and Sheath, 2003). Also other eutrophic species found periodically in Indian Lake are *Gloeotrichia* sp. (colonizes shallow sediments or submersed plants in eutrophic lakes), *Gomphonema* sp. (tolerant of highly eutrophic waters), *Acanthoceras* sp. (forms ephemeral summer blooms in shallow, eutrophic waters) and *Peridinium* sp. (have high emergence rates in shallow lakes and correlated to high phosphorus levels) (Wehr and Sheath, 2003).

Phytoplankton in eutrophic waters tend to have fewer species but higher densities compared to phytoplankton in oligotrophic waters (Maitland, 1978). Phytoplankton depth distribution is limited by light penetration (Henderson-Sellers & Markland, 1987). The major stressors that affect the phytoplankton assemblage are turbidity due to suspended solids and nutrient enrichment. Most typical occurrences in eutrophic lakes are frequent phytoplankton blooms of blue-green algae. Blue green algae tend to dominate for an increasing proportion of the growing season because they are able to fix dissolved elemental nitrogen, they require lower levels of dissolved carbon dioxide than other algae and they thrive when the N: P ratio are low. Algal bloom conditions occur when nitrogen and phosphorus concentrations are as follows phosphorus at 0.01 mg/L and nitrogen at 0.3 mg/L (Maitland, 1978). Typical phytoplankton found in eutrophic lakes are Cyanophyceae, e.g., *Microcystis aeruginosa*, *Aphanizomenon flos-aque* and *Anabaena flos-aque*. Moreover, dense blooms of *Aphanizomenon* and *Microcystis* represent great fluctuations in free nitrogen and nitrate content of lake water during different periods of the year (Prescott, 1951). *Microcystis* forms bloom in the spring in temperate zones and may persist throughout the summer in eutrophic lakes. Typically shallow lakes that contain Cyanobacteria will contribute to recycling phosphorus (internal loading) from sediments back into the water column (Wehr & Sheath, 2003).

*Anabaena*, *Aphanizomenon*, *Microcystis* and *Ceratium* all have an advantage in turbid, eutrophic waters due to their ability to remain buoyant by using their gas vesicles (Wehr & Sheath, 2003). Chlorophyceae (green algae) genera found in eutrophic waters typically include *Pediastrum* and *Scenedesmus* (Henderson-Sellers & Markland, 1987; Allen & Kramer, 1972; Thorp & Covich, 2001).

Several diatoms characteristic of eutrophic lakes are *Asterionella*, *Fragilaria*, *Aulacoseira granulata*, *Synedra* and *Stephanodiscus*. As for diatoms, Centrales species indicate eutrophic conditions, whereas Pennales are more eurytopic (Stoermer & Smol, 1999). Moreover, as eutrophication recedes, there is a reduction in numbers of *Stephanodiscus* sp. and *Aphanizomenon flos-aquae* and the reappearance of *Asterionella* (Wehr & Sheath, 2003). *Asterionella formosa* has an advantage in competing with other algae since it has a highly photosynthetic efficiency in low light due to turbidity (Wehr & Sheath, 2003), and it also exhibits regular peaks in the spring phytoplankton community along with *Tabellaria*.

Common genera of aquatic plants and phytoplankton with their habitats and distribution were identified and inventoried. This monitoring is important because these aquatic plants play an essential role in biogeochemistry and ecology. Macrophyte beds can provide important spawning habitat and shelter for small fishes. They can be central to lake food webs. Phytoplanktons constitute an important and diverse group in freshwaters and form the basis of many aquatic food webs. Indian Lake phytoplankton and macrophytes consisted of largely of flagellaria and rotifers during the summer months. During the winter months the populations of macrophytes and phytoplankton reduced significantly. This occurs because ice coverage reduces the amount of light provided to phytoplankton. There is also a reduction of cycling within the lake that reduces the amount of nutrients being recycled (Table 3).

There was a significant increase in phytoplankton found in Indian Lake from winter to early spring. The samples taken in May and June also showed an increase in numbers of phytoplankton and zooplankton. The most commonly found phytoplankton were Aulacoseira and Asterionella which are bacillariophyceae.

**Table 3:**  
**Population Density of Phytoplankton in Fall, 2005 – Spring, 2008**

	Summer & Fall 2005		Winter & Spring 2006		Summer & Fall 2006		Winter & Spring 2007		Summer & Fall 2007		Spring 2008	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Anabaena	201	34.4	43.0	21.7	380	172			30.0	-		
Microcystis	562	72.9	90.6	75.9	739	305					15.8	5.87
Ceratium	24.4	10.2	282	98.4	341	98.5	15.4	9.96	826		6.78	1.65
Asterionella	54.46	15.7	668	297	472	183	14.3	0	78.9	0	69.0	13.7
Aulacoseira	847	54.5	322	75.1	1192	340	147	188			730	180
Flagilaria	512	68.4	791	366	782	239	85.5	123	334	189	17.7	3.63
Nitzschia	3.75	0	67.0	52.1	53.1	34.2	9.31	35.2				
Stephanodiscus	115	31.3	165	46.0	188	47.0	35.9	35.2			13.2	1.31
Pandorina	66.7	21.2	16.7	2.69	117	56.6					3.76	0
Pediastrum	7.51	3.76	12.8	5.99	20.5	4.03	19.1	0.01			3.76	0
Staurastrum	3.75	0			25.2	5.82	13.4	-				
Aphanocapsa	28.2	16.9	5.53	1.11	65.8	38.8					12.5	2.04
Lyngbya	3.75	0	23.1	10.3	388	169	100	-	26.3	-	52.6	11.2
Vorticella	30.1	11.3			63.5	50.2						
Scenedesmus	8.76	5.01			29.2	14.2						
Aphanizomenon	11.2	7.47	966	765	464	206					3.76	0
Spirogyra	7.51	-	132	118	89.5	48.1					3.76	0
Dityosphaerium	3.75	-			89.5	69.6			26.3	-		
Cymbella			89.5	69.6								
Melosira			32.3	16.7	32.3	16.7			7.51	0		
Navicula			103	34.8	99.0	26.0	19.8	21.6	11.3	-	5.63	1.33
Tabellaria			18.3	4.37	20.4	3.74	14.3	-				
Closterium			63.0	48.1	83.1	39.5					3.76	0
Synedra			78.7	28.7	72.7	17.7	81.2	116	3.76	-	47.0	8.53
Peridinium					22.9	7.04						
Frustulia											3.76	-

Exotics macrophytes are most problematic for Indian Lake. Eurasian water milfoil (*Myriophyllum spicatum*) is a particularly aggressive plant that can out-compete most plant species in Indian Lake. Eurasian milfoil is a perennial submergent aquatic plant native to Europe, Asia and parts of Africa. This plant possesses a number of adaptations which allow it to proliferate, such as rapid vegetative propagation, a life cycle that favors cool weather and a number of mechanisms that enhance photosynthetic efficiency (U.S. EPA, 2006). The main cause of the overgrowth and abundance of Eurasian milfoil is directly related to excessive nutrients. Methods of control may include herbicide treatments, mechanical harvesting, manipulation of habitats and bacterial augmentation.

Curly-leaf pondweed (*Potamogeton crispus*) is also a submersed perennial exotic aquatic plant that has troubled the waters of Indian Lake. A member of the Potamogetonaceae, it is distinguished by alternating leaves that are toothed and tend to undulate along their length. Curly-leaf pondweed has a competitive advantage over other aquatic plants. This plant begins growth in late summer when its turions sprout in response to either shortening day length or decreasing water temperature. The new growth continues during the winter, and once the ice is off and the

temperatures warm to 40 degrees Fahrenheit curly-leaf pondweed begins to elongate more rapidly. This plant has a very high metabolic activity in cold water, and by early spring a dense canopy of curly-leaf pondweed is formed, restricting the growth of other species. In addition, an individual stem may spread locally by the growth of rhizomes, which may also play a part in the “over-summering” or perennation of the plant, and the turions will fall to the bottom and rest until the following fall for reproduction. Removal of curly-leaf pondweed may be important in removing a huge nutrient load from the lake. If left in the lake this plant may die back by mid-summer (mid-July) and dramatically increase phosphorus concentrations into the water column, causing algal blooms (U.S. EPA, 2006).

### C. Monitoring of Macroinvertebrates:

A qualitative and quantitative survey was conducted to obtain a spatial distribution of macroinvertebrates and their homogeneity of the habitat. An estimated total number of macroinvertebrate species and their variation were tabulated (Table 4). A cumulative number of invertebrate species in successive samples were analyzed and correlated with results obtained in macrophyte and phytoplankton.

Zooplankton and benthic organisms in eutrophic lakes also have few species, but high numbers (Maitland, 1978). Some rotifers and cladocerans also exhibit eutrophy; the following species or genera found in Indian Lake are good indicators of eutrophic waters: *Brachionus sp.*, *Filinia longiseta*, *Bosmina longirostris* and *Chydrous sphaericus* (Table 4)(Cloutman et al., 2006).

Larval midges were the most commonly found macroinvertebrates. The number of macroinvertebrates were relatively small but still had visible activity in the sediments.

*Keratella*, *Daphnia*, *Cyclopoida* and *Nauplius* are dominant zooplanktons in Indian Lake. Moreover, in these eutrophic waters the smaller species of rotifers, copepod nauplii and ciliates are more dominant than larger species (cited from Cloutman et al., 2006). *Daphnia* is the main genus in most mesotrophic and eutrophic lakes (Thorp and Covich, 2001), although not as abundant in Indian Lake as some other species. Benthic organisms commonly found in Indian Lake are *Chaoboridae* and *Chironomidae*. According to Rosenberg and Resh, both these species indicate poor water quality (1992). Sampling of benthic organisms was limited because of the ice-on seasons.

**Table 4:**

**Population Density of Dominant Zooplankton in Fall, 2005- Spring, 2008**

	Summer & Fall 2005		Winter & Spring 2006		Summer & Fall 2006		Winter & Spring 2007		Summer & Fall 2007		Spring 2008	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Asplanchna	4.00	3.00	3.16	1.05	4.08	1.18	1.62	1.76	1	-	0.56	0.13
Keratella	9.75	1.89	23.4	5.94	26.7	4.61	2.09	2.01	7	-	4.10	0.60
Ostracoda	1.00	-	2.56	0.71	2.78	0.58	0.89	-	2.82	3.01		
Kellicottia			1.34	0.79	1.42	0.38			2.00	1.19		
Daphnia	2.25	0.75	1.53	0.25	2.67	0.50	0.71	0.34			2.83	0.74
Nauplius	1.00		5.46	1.61	6.79	1.23	1.80	0.86			3.23	0.92
Cyclopoida	1.67	0.67	5.83	3.27	6.01	1.57	0.76	0.43	1	-	1.95	3.19
Calanoida			2.99	0.79	3.72	0.49	0.48	-	1	-	3.48	0.89
Brachionus	1.00	-	2.12	-	1.76	0.36			6	-		
Notholca			3.68	-								
Filinia	10.0	-	0.44	0.11	3.06	2.19						
Polyarthra	1.00	-			1.40	-	0.47	-	5	-		
Harpacticoida	1.00	-	0.94	0.28	1.19	0.16	0.47	0			0.70	0.14
Bosmina	3.00	-	2.86	0.81	2.45	0.45	1.78	-			1.8	0

Vorticella  
Chydorus

0.40

0.18

1.32

0.22

1.33

0.97

4

-

0.38

0

Zooplankton assemblages constitute an important piece of the food web by transferring energy from algae to larger invertebrates and fish. Many of these organisms have been widely used as indicators of nutrient condition and eutrophication in lakes, as well as, benthic organisms found in the bottom sediments that indicate the overall health of the aquatic community (Burgis & Morris, 1987). Zooplankton in eutrophic lakes also have few species, but high numbers (Maitland, 1978). In addition, zooplankton composition and abundance are variable in time, with numbers changing within weeks due in part to vertical migration. Zooplankton also respond to stressors such as nutrient enrichment, acidification and extension of fish stocks (O'Sullivan and Reynolds, 2004). These stressors can be detected through changes in species composition, abundance and body size distribution.

*Daphnia* is the main zooplankton genus in most mesotrophic and eutrophic lakes. High *Daphnia* densities also increase grazing pressure on phytoplankton, creating better water clarity. Some examples of zooplankton found in nutrient rich waters are *Asplanchna*, *Keratella cochlearis tecta*, *Trichocerca multirinis*, *Filinia longiseta* and *Ostracoda*. *Bosmina longirostris*, *Chydorus brevilabris*, *Chydorus spaeicus*, *Brachionus sp.* and *Cyclopoida* also increase with eutrophy (Cloutman, Beam, & Condiff, 2006; Thorp & Covich, 2001; Gannon & Stemberger, 1978; Brooks, 1959). *Cyclopoid copepods* may become more abundant in the most productive lakes, which are often characterized by blooms of colonial cyanobacteria (O'Sullivan & Reynolds, 2004). Moreover, zooplankton mean body sizes decrease with eutrophy and do not control phytoplankton populations (Henderson-Sellers & Markland, 1987). In hypertrophic lakes, smaller species of *Bosmina* replace *Daphnia*, particularly when fish predation is high (Scheffer & Jeppesen, 1998). As eutrophication progress, the food supply of zooplankton decreases because of the dominance of blue- green algae, which are too large to consume. Consequently, their successions occur as a result of changing predator- prey relationships rather than as a direct response to nutrient status (Henderson-Sellers & Markland, 1987).

The benthic macroinvertebrate assemblage in lakes is an important component of measuring the overall health of the aquatic community. Benthic organisms inhabit the sediment, bottom substrates and also live on aquatic vegetation. These organisms are involved in the mineralization and recycling of organic matter and play a vital part in the trophic sequence because their larval forms are major food sources for small fishes. The littoral zone of lakes usually supports larger and more diverse populations of benthic organisms than do the sublittoral and profundal habitats (Maitland, 1978). The profundal habitat, in the hypolimnion of stratified lakes, has a homogenous silt substrate and is hypoxic or anoxic in productive lakes. Three main groups usually dominate this habitat: large chironomid larvae (bloodworm), oligochaete worms and phantom midge (Chaoboridae) larvae (Hellowell, 1986).

The monitoring of benthic organisms is useful in detecting trends over time because many macroinvertebrates have relatively long life cycles of a year or more; they are usually immobile and are sensitive to both short and long term environmental stressors (U.S. EPA, 2006). The occurrence and abundance of benthic organisms will change depending on the concentrations of nutrients such as nitrogen and phosphorus. Available dissolved oxygen is a limiting factor in eutrophic lakes for many organisms. Benthic organisms, like Chaoboridae, are indicators of eutrophic waters where the oxygen concentrations are low (Maitland, 1978). Oxygen-reduced hypolimnetic waters are also inhabited by *Chironomus* (non-biting midges), which are tolerant of very low oxygen levels. Typically *Chironomus* midges are reliable indicators of eutrophic conditions or possibly organic pollution (Hellowell, 1986). Lakes that become more eutrophic may display shifts in the composition of both the Chironomidae and the oligochaetes.

*Potamothrix hammoniensis* is an Oligochaete known as an indicator of eutrophic lakes. Oligochaetes that are good indicators of oligotrophic lakes are *Stylodrilus heringianus*, *Spirosperma ferox* and *Tubifex tubifex* (Maitland, 1978; Hellawell, 1986; O'Sullivan & Reynolds, 2004). In extremely eutrophic lakes, benthic communities cannot exist in the profundal zone, as both the sediments and the hypolimnion are anoxic. However, if such a lake is restored by aeration, oligochaetes and other benthic organisms will recolonize the profundal sediments (O'Sullivan and Reynolds, 2004). In general, benthic organisms play several important roles in the aquatic community.

<b>Summary Budget Information for Result 1:</b>	<b>\$46,038.00</b>
BSU portion allocated Carry forward balance	
Amount spent	\$34,977.00
Balance	\$11,061.00

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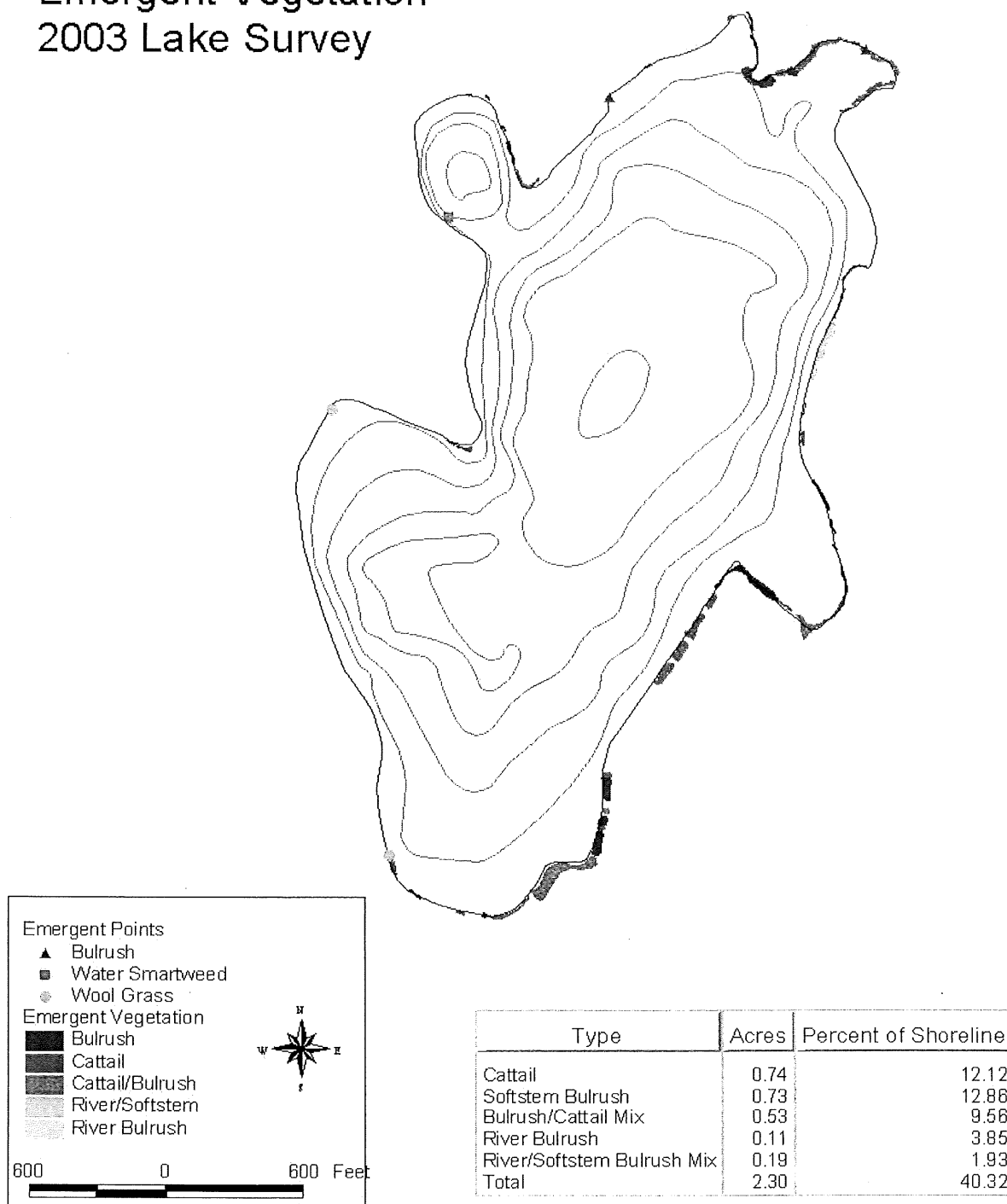
**Completion Date: June 30, 2008**

## **Result 2: Spawning Preserve & Shoreline Restoration**

Shoreline restoration preparation was initiated in late September 2007 and was completed at the end of October 2007. Natural plant species indigenous to the region was carefully surveyed (as shown in Figures 9 and 10) and three groups (emergent plants, lakeshore species and shrubs) of vegetation were selected for shoreline restoration.

Figure 9. Survey of Indian Lake Emergent Vegetation

# Indian Lake (86-223) Emergent Vegetation 2003 Lake Survey



Name of species and number of each species and their costs are shown as follows:

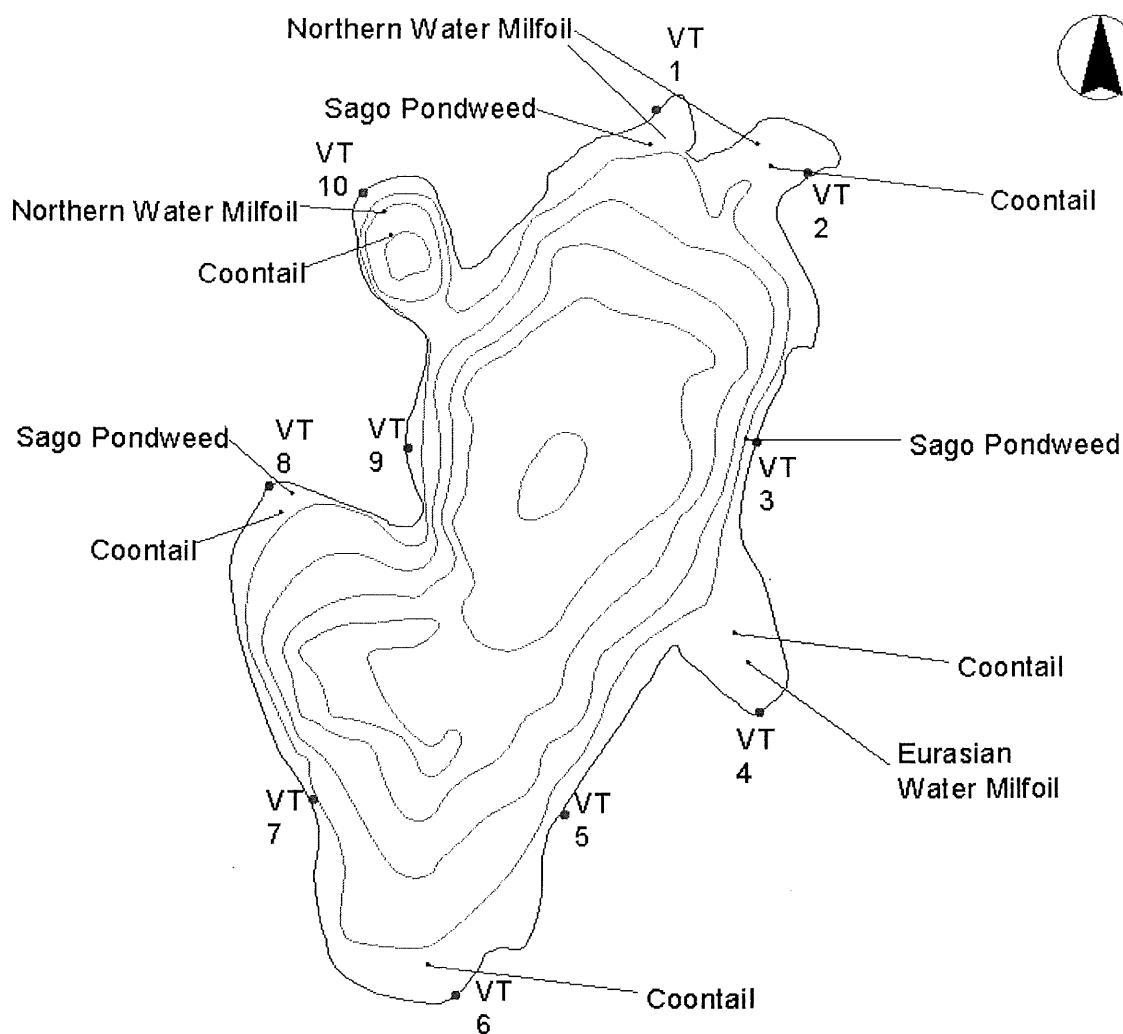
## I Emergent Plants:

J:\SHARE\WORKFILE\ML2005proj\2005 Work Programs\2005 Subd. 07 - Water\2005 7(p)  
Restoration of Indian Lake\2008-09-26 FINAL WP for BSU.doc

1. *Scirpus validus*-Softstem Bulrush- 4,260  
 Total- 4260 emergents x .67 cents ea. = \$2,854.20  
 2.5 inch potted emergents
  1. *Sparganium eurycarpum*- Giant Burreed-670 plants/\$1 ea. = \$670.00
  2. *Sagittaria latifolia*- Arrowhead-1340/\$1 ea. = \$1340.00
  3. *Scirpus fluviatilis*- River Bulrush- 670 plants/\$1 ea. = \$670.00  
 Total 2680 2.5 in. emergents x \$1.00 ea. = \$2,680
- Total Cost for emergents \$2,854.20 + \$2,680.00= \$5,534.20

Figure 10. Survey of Indian Lake Submersed Vegetation

# Indian Lake Submersed Vegetation



Plant locations based on lake survey vegetation transects (VT).  
 Plant species shown were rated as common or abundant on given transect.  
 Abundance rating of plants based on a maximum score of 30.  
 Data collected by the Montrose Area Fisheries Office.  
 Survey conducted 7/21/03.

Species	Frequency of Occurrence	Abundance Rating
Coontail	90	17
Sago Pondweed	90	13
Curled Pondweed	40	4
Northern Water Milfoil	30	7
Narrowleaf Pondweed	30	3
Eurasian Water Milfoil	10	1

500 0 500 1000 Feet

## II Lakeshore Species-

1. *Chelone glabra*- Turtlehead- 400 plants
2. *Eupatorium maculatum*- Joe Pye Weed- 400 plants



3. Eupatorium perfoliatum- Boneset- 400 plants
4. Glyceria striata- Fowl Manna Grass- 400 plants
5. Aster puniceus- Red Stemmed Aster- 400 plants
6. Iris versicolor- Blue Flag Iris- 400 plants
7. Liatris ligulistylus- MeadowBlazing Star 400 plants
8. Verbena hastate- Blue Vervain- 400 plants
9. Carex lacustris- Lake Sedge- 400 plants
10. Solidago riddellii- Riddell's Goldenrod- 400 plants

Total- 4000 x \$.67 cents ea.= \$2,680.00

### III Shrubs

1. Viburnum trilobum- American Cranberry- 61 plants 2 ft. tall
2. Cornus sericea- Red Osier Dogwood- 62 plants 2 ft. tall

Total- 123 x \$5.00 ea. = \$615.00

Total Plant Cost= \$8,829.20

Delivery Charge \$125.00 x 2 = \$250.00

Total Cost = \$9,079.20

A list of above plants/species/shrubs were submitted to Minnesota Department of Natural Resources for review and approval and a permit was granted in April 2008. Plants (11,063) were ordered from Ramsey County Correctional Facility in Maplewood, Minnesota on May 23, 2008. All of the ordered plants were delivered in two trips to Indian Lake on June 13, 2008. Restoration planting activity started on June 14, 2008 and completed on the 20<sup>th</sup> of June, 2008.

Table 5 and Figure 11 show names of landowner, shoreline footage, quantity of each plant species planted on each section of shoreline, shoreline property owner and their location on Indian Lake. These species were chosen based on existing vegetation, topography and physical characteristics of the soil and water availability.

Table 5 Names of Landowner, Shoreline Footage, Quantity of Each Plant Species and Aquatic Species

Landowner-footage	Shoreline Plant species	Quantity
Westpahl-20	Turtlehead	4
Westpahl	Joe Pye Weed	4
Westpahl	Boneset	4
Westpahl	Fowl Manna Grass	4
Westpahl	Red Stemmed Aster	4
Westpahl	Blue Flag Iris	4
Westpahl	Meadow Blazing Star	4
Westpahl	Blue Vervain	4
Westpahl	Lake Sedge	4
Westpahl	Riddell's Goldenrod	0
Westpahl	American Cranberry	1
	Red Osier Dogwood	1
Lorsung-60 feet	Turtlehead	4
Lorsung	Joe Pye Weed	4
Lorsung	Boneset	4
Lorsung	Fowl Manna Grass	4

Aquatic Species	QTY
Softstem Bulrush	
River Bulrush	100
Giant Burreed	
Arrowhead	

Softstem Bulrush	
River Bulrush	300
Giant Burreed	
Arrowhead	

Lorsung	Red Stemmed Aster	4
Lorsung	Blue Flag Iris	4
Lorsung	Meadow Blazing Star	4
Lorsung	Blue Vervain	4
Lorsung	Lake Sedge	4
Lorsung	Riddell's Goldenrod	4
Lorsung	American Cranberry	1
	Red Osier Dogwood	1
Arnezen-100 feet	Turtlehead	20
Arnezen	Joe Pye Weed	20
Arnezen	Boneset	20
Arnezen	Fowl Manna Grass	20
Arnezen	Red Stemmed Aster	20
Arnezen	Blue Flag Iris	20
Arnezen	Meadow Blazing Star	20
Arnezen	Blue Vervain	20
Arnezen	Lake Sedge	20
Arnezen	Riddell's Goldenrod	20
Arnezen	American Cranberry	3
Arnezen	Red Osier Dogwood	3

Softstem Bulrush	40
River Bulrush	
Giant Burreed	
Arrowhead	

Huber-50 feet	Turtlehead	10
Huber	Joe Pye Weed	10
Huber	Boneset	10
Huber	Fowl Manna Grass	10
Huber	Red Stemmed Aster	10
Huber	Blue Flag Iris	10
Huber	Meadow Blazing Star	10
Huber	Blue Vervain	10
Huber	Lake Sedge	10
Huber	Riddell's Goldenrod	10
Huber	American Cranberry	2
Huber	Red Osier Dogwood	2

Softstem Bulrush	15
River Bulrush	
Giant Burreed	
Arrowhead	

Vetsch-40 feet	Turtlehead	8
Vetsch	Joe Pye Weed	8
Vetsch	Boneset	8
Vetsch	Fowl Manna Grass	8
Vetsch	Red Stemmed Aster	8
Vetsch	Blue Flag Iris	8
Vetsch	Meadow Blazing Star	8
Vetsch	Blue Vervain	8
Vetsch	Lake Sedge	8
Vetsch	Riddell's Goldenrod	8
Vetsch	American Cranberry	2

Softstem Bulrush	10
River Bulrush	
Giant Burreed	
Arrowhead	

Vetsch	Red Osier Dogwood	2
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Daleiden-100 feet	Turtlehead	20
Daleiden	Joe Pye Weed	20
Daleiden	Boneset	20
Daleiden	Fowl Manna Grass	20
Daleiden	Red Stemmed Aster	20
Daleiden	Blue Flag Iris	20
Daleiden	Meadow Blazing Star	20
Daleiden	Blue Vervain	20
Daleiden	Lake Sedge	20
Daleiden	Riddell's Goldenrod	20
Daleiden	American Cranberry	3
Daleiden	Red Osier Dogwood	3

Softstem Bulrush	24
River Bulrush	
Giant Burreed	
Arrowhead	

Ciatti-30	Turtlehead	4
Ciatti	Joe Pye Weed	4
Ciatti	Boneset	4
Ciatti	Fowl Manna Grass	4
Ciatti	Red Stemmed Aster	4
Ciatti	Blue Flag Iris	4
Ciatti	Meadow Blazing Star	4
Ciatti	Blue Vervain	4
Ciatti	Lake Sedge	4
Ciatti	Riddell's Goldenrod	4
Ciatti	American Cranberry	1
Ciatti	Red Osier Dogwood	1

Softstem Bulrush	
River Bulrush	
Giant Burreed	
Arrowhead	

Zwack-80 feet	Turtlehead	16
Zwack	Joe Pye Weed	16
Zwack	Boneset	16
Zwack	Fowl Manna Grass	16
Zwack	Red Stemmed Aster	16
Zwack	Blue Flag Iris	16
Zwack	Meadow Blazing Star	16
Zwack	Blue Vervain	16
Zwack	Lake Sedge	16
Zwack	Riddell's Goldenrod	16
Zwack	American Cranberry	2
Zwack	Red Osier Dogwood	2

Softstem Bulrush	
River Bulrush	
Giant Burreed	
Arrowhead	

Salzl-30 feet	Turtlehead	4
Salzl	Joe Pye Weed	4
Salzl	Boneset	4

Softstem Bulrush	
River Bulrush	
Giant Burreed	

Salzl	Fowl Manna Grass	4
Salzl	Red Stemmed Aster	4
Salzl	Blue Flag Iris	4
Salzl	Meadow Blazing Star	4
Salzl	Blue Vervain	4
Salzl	Lake Sedge	4
Salzl	Riddell's Goldenrod	4
Salzl	American Cranberry	1
	Red Osier Dogwood	1

Arrowhead
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L&L Lang-70 feet	Turtlehead	12
Lang	Joe Pye Weed	12
Lang	Boneset	12
Lang	Fowl Manna Grass	12
Lang	Red Stemmed Aster	12
Lang	Blue Flag Iris	12
Lang	Meadow Blazing Star	12
Lang	Blue Vervain	12
Lang	Lake Sedge	12
Lang	Riddell's Goldenrod	12
Lang	American Cranberry	2
Lang	Red Osier Dogwood	2

Softstem Bulrush
River Bulrush
Giant Burreed
Arrowhead

Lindquist-60 feet	Turtlehead	8
Lindquist	Joe Pye Weed	8
Lindquist	Boneset	8
Lindquist	Fowl Manna Grass	8
Lindquist	Red Stemmed Aster	8
Lindquist	Blue Flag Iris	8
Lindquist	Meadow Blazing Star	8
Lindquist	Blue Vervain	8
Lindquist	Lake Sedge	8
Lindquist	Riddell's Goldenrod	8
Lindquist	American Cranberry	2
Lindquist	Red Osier Dogwood	2

Softstem Bulrush
River Bulrush
Giant Burreed
Arrowhead

Pietrzak-30 feet	Turtlehead	4
Pietrzak	Joe Pye Weed	4
Pietrzak	Boneset	4
Pietrzak	Fowl Manna Grass	4
Pietrzak	Red Stemmed Aster	4
Pietrzak	Blue Flag Iris	4
Pietrzak	Meadow Blazing Star	4
Pietrzak	Blue Vervain	4
Pietrzak	Lake Sedge	4

Softstem Bulrush
River Bulrush
Giant Burreed
Arrowhead

Pietrzak	Riddell's Goldenrod	4
Pietrzak	American Cranberry	1
Pietrzak	Red Osier Dogwood	1

Lemere-15 feet	Turtlehead	4
Lemere	Joe Pye Weed	4
Lemere	Boneset	4
Lemere	Fowl Manna Grass	4
Lemere	Red Stemmed Aster	4
Lemere	Blue Flag Iris	4
Lemere	Meadow Blazing Star	4
Lemere	Blue Vervain	4
Lemere	Lake Sedge	4
Lemere	Riddell's Goldenrod	4
Lemere	American Cranberry	1
Lemere	Red Osier Dogwood	1

Softstem Bulrush
River Bulrush
Giant Burreed
Arrowhead

Reese Lang-8 feet	Turtlehead	2
Lang	Joe Pye Weed	2
Lang	Boneset	2
Lang	Fowl Manna Grass	2
Lang	Red Stemmed Aster	2
Lang	Blue Flag Iris	2
Lang	Meadow Blazing Star	2
Lang	Blue Vervain	2
Lang	Lake Sedge	2
Lang	Riddell's Goldenrod	2
Lang	American Cranberry	0
Lang	Red Osier Dogwood	0

Softstem Bulrush
River Bulrush
Giant Burreed
Arrowhead

Skoog-60 feet	Turtlehead	12
Skoog	Joe Pye Weed	12
Skoog	Boneset	12
Skoog	Fowl Manna Grass	12
Skoog	Red Stemmed Aster	12
Skoog	Blue Flag Iris	12
Skoog	Meadow Blazing Star	12
Skoog	Blue Vervain	12
Skoog	Lake Sedge	12
Skoog	Riddell's Goldenrod	12
Skoog	American Cranberry	2
Skoog	Red Osier Dogwood	2

Softstem Bulrush
River Bulrush
Giant Burreed
Arrowhead

Brekke-10 feet	Turtlehead	2
Brekke	Joe Pye Weed	2

Softstem Bulrush
River Bulrush

Brekke	Boneset	2
Brekke	Fowl Manna Grass	2
Brekke	Red Stemmed Aster	2
Brekke	Blue Flag Iris	2
Brekke	Meadow Blazing Star	2
Brekke	Blue Vervain	2
Brekke	Lake Sedge	2
Brekke	Riddell's Goldenrod	2
Brekke	American Cranberry	0
Brekke	Red Osier Dogwood	0

Giant Burreed
Arrowhead

Villebrun-140 feet	Turtlehead	28
Villebrun	Joe Pye Weed	28
Villebrun	Boneset	28
Villebrun	Fowl Manna Grass	28
Villebrun	Red Stemmed Aster	28
Villebrun	Blue Flag Iris	28
Villebrun	Meadow Blazing Star	28
Villebrun	Blue Vervain	28
Villebrun	Lake Sedge	28
Villebrun	Riddell's Goldenrod	28
Villebrun	American Cranberry	7
Villebrun	Red Osier Dogwood	7

Softstem Bulrush
River Bulrush
Giant Burreed
Arrowhead

Nelson-60 feet	Turtlehead	12
Nelson	Joe Pye Weed	12
Nelson	Boneset	12
Nelson	Fowl Manna Grass	12
Nelson	Red Stemmed Aster	12
Nelson	Blue Flag Iris	12
Nelson	Meadow Blazing Star	12
Nelson	Blue Vervain	12
Nelson	Lake Sedge	12
Nelson	Riddell's Goldenrod	12
Nelson	American Cranberry	3
Nelson	Red Osier Dogwood	3

Softstem Bulrush
River Bulrush
Giant Burreed
Arrowhead

B&K Lieb-30 feet	Turtlehead	4
B&K Lieb	Joe Pye Weed	4
B&K Lieb	Boneset	4
B&K Lieb	Fowl Manna Grass	4
B&K Lieb	Red Stemmed Aster	4
B&K Lieb	Blue Flag Iris	4
B&K Lieb	Meadow Blazing Star	4
B&K Lieb	Blue Vervain	4

Softstem Bulrush
River Bulrush
Giant Burreed
Arrowhead

B&K Lieb	Lake Sedge	4
B&K Lieb	Riddell's Goldenrod	4
B&K Lieb	American Cranberry	1
B&K Lieb	Red Osier Dogwood	1

Brown-600 feet	Turtlehead	120
Brown	Joe Pye Weed	120
Brown	Boneset	120
Brown	Fowl Manna Grass	120
Brown	Red Stemmed Aster	120
Brown	Blue Flag Iris	120
Brown	Meadow Blazing Star	120
Brown	Blue Vervain	120
Brown	Lake Sedge	120
Brown	Riddell's Goldenrod	120
Brown	American Cranberry	20
Brown	Red Osier Dogwood	20

Naaktgeboren-250 Ft	Turtlehead	100
Naaktgeboren	Joe Pye Weed	100
Naaktgeboren	Boneset	100
Naaktgeboren	Fowl Manna Grass	100
Naaktgeboren	Red Stemmed Aster	100
Naaktgeboren	Blue Flag Iris	100
Naaktgeboren	Meadow Blazing Star	100
Naaktgeboren	Blue Vervain	100
Naaktgeboren	Lake Sedge	100
Naaktgeboren	Riddell's Goldenrod	100
Naaktgeboren	American Cranberry	7
Naaktgeboren	Red Osier Dogwood	7

Kotila-50 feet	NA	NA
Kotila	NA	NA
Kotila	NA	NA
Kotila	NA	NA

Foss-110 feet	NA	NA
Foss	NA	NA
Foss	NA	NA
Foss	NA	NA

Al Nelson-50 feet	NA	NA
Nelson-50 feet	NA	NA
Nelson-50 feet	NA	NA

Softstem Bulrush	
River Bulrush	
Giant Burreed	
Arrowhead	340

Softstem Bulrush	
River Bulrush	
Giant Burreed	
Arrowhead	500

Softstem Bulrush	
River Bulrush	270
Giant Burreed	
Arrowhead	

Softstem Bulrush	
River Bulrush	
Giant Burreed	
Arrowhead	

Softstem Bulrush	
River Bulrush	
Giant Burreed	

Nelson-50 feet	NA	NA
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Arrowhead
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Rosenow-10 feet	NA	NA
Rosenow	NA	NA
Rosenow	NA	NA
Rosenow	NA	NA

Softstem Bulrush
River Bulrush
Giant Burreed
Arrowhead

Otto-60 feet	NA	NA
Otto	NA	NA
Otto	NA	NA
Otto	NA	NA

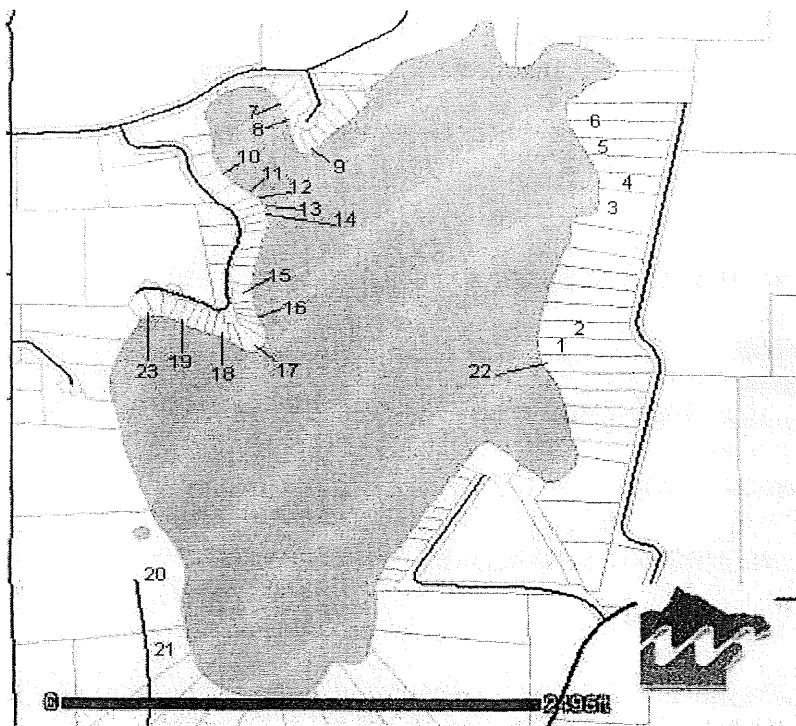
Softstem Bulrush
River Bulrush
Giant Burreed
Arrowhead

B&P Lieb-40 Feet	NA	NA
B&P Lieb	NA	NA
B&P Lieb	NA	NA
B&P Lieb	NA	NA

Softstem Bulrush	
River Bulrush	
Giant Burreed	100
Arrowhead	500



Figure 11 Shoreline Property Owner and Their Location on Indian Lake



Legend

1-Westpahl	13-Lemere
2-Lorsung	14-Lang
3-Arnezen	15-Skoog
4-Huber	16-Brekke
5-Vetsch	17-Villebrun
6-Daleiden	18-Nelson
7-Ciatti	19-Lieb
8-Zwack	20-Brown
9-Salzi	21-Naaktgeboren
10-Lang	22-Kotila
11-Lindquist	23-Lieb
12-Pietrzak	

Members of Indian Lake Improvement District (ILID) were requested to take care of those plants planted on their shoreline property. The president (Curt Brekke) and secretary (Kevin Lindquist) of ILID have been monitoring those planted vegetation since they were planted. These plants were watered immediately after planting and will be watered throughout the first growing season wherever plants are not in saturated or flooded situations.

Due to the uncontrolled nature of restoration sites, there are many threats to survival and establishment after planting. Wave action, flowing water, freeze-thaw, erosion, sedimentation, and herbivory all impose challenges for restoration efforts. As of July 31, 2008, before this

project final report was submitted to the LCCMR, the initial vegetation survivorship is high (greater than 85%).

<b>Summary Budget Information for Result 2:</b>	<b>LCMR Budget:</b>	\$16,962.00
	<b>Spent</b>	<b>\$14,548.00</b>
	<b>Balance:</b>	\$2,414.00

**Completion Date:** June 30, 2008

**V. TOTAL LCMR PROJECT BUDGET: \$63,000.00**

**All Results: Personnel: \$ 33,100.00**

**All Results: Equipment: \$4,000.00**

**All Results: Equipment and Supplies: \$14,000.00**

**All Results: Travel expenses: \$5,253.00**

**TOTAL LCMR PROJECT BUDGET: \$63,000.00**

**Proposed Budget Transfer and Amendment Request:**

In the original proposal “restoration of Indian Lake” \$137,950 of the \$200,000 was assigned to Indian Lake Improvement District (ILID) and the rest \$62,050. was allocated to Bemidji State University (BSU). Up to date, in result 1 BSU has \$9,857.00 left in the account. It is proposed and requested that LCCMR approve a budget transfer to allow ILID to transfer part of the balance from Result 1 and part of the balance from Result 2 with a total of \$53,143.00 to BSU’s account (account #520915) and the name of the project manager of BSU be changed to Fu-Hsain Chang, Professor of Environmental Microbiology and Biotechnology, Center for Environmental, Earth, and Space Studies. It is requested that the transferred funds be used as following: In “personnel,” A half-time graduate assistant (\$12,600 for stipend plus tuition waiver), to assist in this third year field and lab analysis work activity. Second request is to hire two more part-time undergraduate lab/field assistants (\$2,252) to do monitoring of macrophytes, phytoplankton, macro invertebrates and shoreline restoration to complete the project. Lastly, \$19,947 is requested to cover Fu-Hsain Chang’s 28 duty days of wages and benefits for supervising and managing the project.

None of the \$63,000.00 funding money will be used to pay the former project manager, Mark Hayes, by any means including, no compensation or reimbursement. Also, none of the money will in any way assists or supports my separate efforts to work with Bacta Pur on Indian Lake that includes no travel costs, no salary cost, no labor cost, no supplies or equipment purchase will be using this funding.

In the “Equipment/Tool” and “Lab Supplies” categories, it is requested \$4,000 on field sampling tools and (Biological dredge with sampling net, sediment sampling dredge, Kemmerer water bottle kit and Ward’s environmental science Trekker™ system with

various probes and sensors) and accessories replacement; \$267.00 spent on additional chemical reagents and lab supplies and \$10,000 for the purchase of lakeshore plants.. In "Travel", we like to request that \$4,077 of the transferred funds be used for in-state travel to Indian Lake in Maple Lake, MN to conduct monitoring and shoreline restoration activities.

## **VI. OTHER FUNDS & PARTNERS:**

### **A. Project Partners:**

Wright-Hennepin Electric: Donating the electrical hookup  
\$500 per year for shoreline restoration  
Indian Lake LID and Association: \$5,000 for 2005 herbicide.

### **B. Other Funds Being Spent During the Project Period:**

The Indian Lake LID has spent \$5,000 for herbicide in 2005 for the control of Eurasian Water Milfoil and Curly Leaf Pond Weed.

### **C. Required match (if applicable): Estimated In-Kind Match and Leverage Resources for That Time Frame:**

Following in-kind match was provided by Bemidji State through research release time, travel funds, and existing equipments.

BUDGET ITEM	In Kind Match for:			Total (Row)
	Result 1	Result 2	Result 3	
Personnel	\$15,240			\$15,240
Fringe Benefits	\$2,760			\$2,760
Chemicals and Supplies	\$1,000	\$1500		\$2,500
Travel in Minnesota	\$500			\$500
Travel outside Minnesota	\$500			\$500
<b>Total (Column)</b>	<b>\$20,000</b>			<b>\$21,500</b>

### **D. Past Spending:** Watershed residents have spent thousands of dollars in eliminating point and non-point pollution sources. MES has donated over \$2,000.00 in pro-bono work toward this project. Indian Lake is also a partner in the Wright County Cooperative Lake Monitoring Program.

### **E. Time:** This project will end on June 30 2008.

## **VII. DISSEMINATION:** This project has generated one B.S. degree Thesis entitled "The Restoration of Indian Lake: Biomanipulation from the Bottom-up" authored by Nathan T. Larson, one M.S. degree Thesis entitled "The Application of Biotechnology in the Restoration of Indian Lake " authored by Christine Ann Thorman. Two senior students Thomas Schufman and Theodore Toft did their internship on this project. Besides two papers were presented at two International Meeting, they are "Application of Biotechnology in the restoration of Indian Lake" that was presented at the Preserving and Enhancing the Global Water Environmental Annual Meeting in San Diego, CA, on Oct. 13-19, 2007. Research paper was published in the Proceedings and Abstract. The

other paper “Application of Mixed Bacterial Culture in the Restoration of Indian Lake in Central Minnesota” was presented at the ASA-CSSA-SSSA 2007 International Annual Meeting in New Orleans, LA on Nov. 4-8, 2007, and published in 2007 International Meeting Abstracts. Several Lake Associations have shown interest to use this demonstrated methods to restore their lakes.

**VIII. REPORTING REQUIREMENTS:** Periodic Work Program Progress Reports will be submitted on Feb 2008 and the final by July 15 2008.

**IX. RESEARCH PROJECTS:** N/A

### References

1. Allen, H. & Kramer, J. (1972). *Nutrients in natural waters*. New York: John Wiley & Sons.
  2. Brooks, J. (1959). *Freshwater biology*. 2<sup>nd</sup> edition. New York: John Wiley & Sons.
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  4. Cloutman, D., Beam, A. & Condiff, K. (2006). Environmental assessment of zooplankton in Beauty Lake, MN, during the summer 2006. Report to the Minnesota Pollution Control Agency. Department of Biology, Bemidji State University, Bemidji, Minnesota.
  5. Gannon, J. & Stemberger, R. (1978). Zooplankton as indicators of water quality. *Transactions of the American Microscopical Society*, 97, 16-35.
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  7. Hellawell, J. (1986). *Biological indicators of freshwater pollution and environmental management*. New York: Elsevier Applied Science Publishers.
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16. Stoermer, E. & Smol, J. (1999). *The diatoms: Applications for the environmental and earth sciences*. New York: Cambridge University Press.
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# Reimbursement Request – Invoice Summary Spreadsheet

## Instructions:

1. Enter your budget from your current approved work program (Attachment A)
2. Update the beginning balances with the ending balance from your previous Invoice Summary Spreadsheet.
3. Insert the amounts of your current invoice by category and provide the total.
4. Calculate the ending balances for this invoice.
5. Attach copies of invoices, checks and time cards.
6. Fill out and submit the Reimbursement Request Form
7. Send completed documentation to the authorized state contact person.

Project Title: Restoration of Indian Lake (W-61)

Legal Citation: Laws of Minnesota 2005, Chapter 1, Article 2, Section 11, Subdivision 7(p).

Bemidji  
State  
Universit  
y

DBURG  
520915-  
520916(20)  
AMENDED

Period Covered by Reimbursement Request: 05-19 to 6-30-08

## Budget for Results from Work Program

Budget Item	Result 1:				Result 2:				Result 3:	Project Total			
	Budget	Beginning Balance	Current Invoice	Ending Balance	Budget	Beginning Balance	Current Invoice	Ending Balance	Budget	Budget	Beginning Balance	Current Invoice	Ending Balance
Use information from Attachment A from Work Program													
<u>Personnel: Staff subtotal Expenses.</u> <u>Wages / Manage at this level</u>	33,100.00	11,225.65	8,514.96	2,710.69	6,647.00	6,647.00	4,480.38	2,166.62	N/A	39,747.00	17,752.65	12,995.34	4,757.31
<u>Personnel Expenses Subtotal</u>	25,500.00	x	x	x	5,147.00	x	x	x		30,647.00	x	x	x
BSU Grad student	9,000.00	2,712.65	1,074.15	1,638.50						9,000.00	2,712.65	1,074.15	1,638.50
BSU Undergrad Lab/Field Asst	6,000.00	4,283.42	2,374.13	1,909.29	1,200.00	1,080.00	871.50	208.50		7,200.00	5,363.42	3,245.63	2,117.79
BSU Faculty (F. Chang)	10,500.00	2,559.32	4,011.64	(1,452.32)	3,947.00	3,947.00	2,956.75	990.25		14,447.00	6,506.32	6,968.39	(462.07)
<u>Personnel - Staff Benefits Subtotal</u>	7,600.00	x	x	x	1,500.00	x	x	x		9,100.00	x	x	x
F. Chang	4,000.00	2,200.26	1,053.04	1,145.22	1,500.00	1,500.00	652.13	847.87		5,500.00	3,700.26	1,707.17	1,993.09
BSU Grad Asst Tuition	3,600.00	(530.00)	-	(530.00)						3,600.00	(530.00)	-	(530.00)
<u>Equipment/Tools</u>													
<u>Equipment/Tools Subtotal /</u> <u>Manage at this level</u>	4,000.00	2,918.72	1,650.46	1,268.26						4,000.00	2,918.72	1,650.46	1,268.26
Biological Dredge w/water Sampling Net	950.00	950.00	717.46	232.54						950.00	950.00	717.46	232.54
Sediment Sampling Dredge	800.00	800.00	404.00	396.00						800.00	800.00	404.00	396.00
Kenmeyer Water Bottle Kit	800.00	800.00	529.00	271.00						800.00	800.00	529.00	271.00
Ward's Env. Sci Trekker System W/Probes & Sensors	1,450.00	368.72	-	368.72						1,450.00	368.72	-	368.72
<u>Chemicals and Supplies</u>	4,000.00	x	x	x	10,000.00	x	x	x		4,000.00	x	x	x
Reagents & Supplies	4,000.00	2,343.58	(1,641.52)	3,985.10						4,000.00	2,343.58	(1,641.52)	3,985.10
<u>Other Supplies</u>													
Lakeshore Plants			-		10,000.00	10,000.00	9,380.22	619.78		10,000.00	10,000.00	9,380.22	619.78
<u>Travel Expenses</u>													
In Minnesota (Site)	4,938.00	\$3,731.27	634.46	\$3,096.81	315.00	219.00	471.38	(252.38)		5,253.00	\$3,950.27	1,105.84	2,844.43
Column Total	46,038.00	\$20,219.22	9,158.36	11,060.86	16,962.00	16,746.00	14,331.98	2,414.02	-	63,000.00	36,965.22	23,490.34	13,474.88