ECOSYSTEM RESTORATION

Ecological Laboratories network of In-Field Water Treatment Experts have restored both man made and natural bodies of water including retention and drainage ponds, streams and rivers, estuaries and municipal water management operations worldwide for over 40 years.

MICROBE-LIFT® Technology for the 100% natural restoration of health, quality, and ecological balance to polluted waterways including....

- Ponds
- Rivers & Streams
- Retention Ponds
- Estuaries
- Municipal Waterways

For more information on MICROBE-LIFT® Technology contact

Ecological Laboratories Inc.
www.EcologicalLabs.com

CS17000

Made in the USA

AQUATIC ECOSYSTEMS APPROACH

Ecological Laboratories' combined educated technical knowledge of environmental process and problems allows the company the ability to address and resolve a wide range of difficult to resolve environmental problems to include, but not limited to aquatic ecosystem water restoration, the enhancement of wastewater processes, soil bioremediation, agriculture soil and plant enhancement, and the ability to resolve residential on-site wastewater water problems. These unique capabilities are the result of **Ecological Laboratories'** staff (and management team) undergoing rigorous in-house education training that combines their university knowledge with a full understanding of practical environmental processes achieved through real world exposure to factors responsible for the causes of difficult to resolve environmental problems.

Product Technology and Capability...

Ecological Laboratories Inc's expertise combines novel bio-technology not available within the general market with a level of real world technical capability and experience that effectively address esand resolves a wide-range of environmental problems, offering natural/effective solutions few companies are capable of providing, allowing ELI the capability to address and resolve most environmental problems.

Capability...

ELI's advanced knowledge of biological processes and pathways provide the company with the capability to recommend solutions that remediate environmental pathways and processes. These solutions are achieved through the use of **ELI's** bio-technology to restore natural process within a balanced environment thereby controlling pollution and managing nutrient recycling.

These achievements include the ability to address a wide range of pollution concerns, fully restore aquatic eutrophic ecosystems, achieve odor abatement, eliminate hydrogen sulfide and corrosion, through using the company's unique natural non-chemical methods.

For more information on MICROBE-LIFT® Technology contact

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17100 LARGE RECREATIONAL PONDS

The case study results listed above were achieved with MICROBE-LIFT® Technology and products, formulated and manufactured by Ecological Laboratories Inc., with technical support for administering the products provided by Ecological Laboratories Inc., in support of their worldwide representatives.

For more information on MICROBE-LIFT® Technology contact

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MICROBE-LIFT® Restores Beauty to a Popular Municipal Pond in Huntingtin, NY

Location: **Huntington, NY**

Background: Heckscher Park is located on Main Street in Huntington, NY, a pleasant town on Long Island close to New York City. This park is a popular recreation site for community enjoyment with its attractive, landscaped walking paths around a beautiful pond.

Fig.1: *View of restored Heckscher Pond*

Objective: The pond was experiencing excess nutrients from waterfowl, upland runoff, and vertical mixing which resulted in filamentous algae matting two-thirds of the water surface, a situation that is aesthetically unpleasant and discourages the hobbyists who sail radio-controlled model boats.

The pond is large, covering three acres with a volume of water approaching 4 million gallons and an 8% daily replacement volume. The town considered dredging the pond to help eliminate the algae, however, the financial commitment and permitting requirements were more than they could afford. Over a two-year period, various algae control treatments had been tried and failed.

The town's Environmental Control Department advised that the town institute a trial of Ecological Laboratories' MICROBE-LIFT® technology. A plan was developed and implemented.

Results Achieved: Based on treatment with MICROBE-LIFT® technology, the pond showed a dramatic reduction in algae throughout the warm season for the first time in many years. A testimonial from the town's engineer is available.

For more information on MICROBE-LIFT® Technology contact

Ecological Laboratories Inc.
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CS17101

Microbe-Lift® Restores Pond at Housing Development in Bowling Green, Ohio

Location: Larch Landing Development, Bowling Green, OH

Background: This development includes a water retention pond in a scenic, restful area. Unfortunately this pond became overloaded with algae, building scum on the surface and greatly distracting from its beauty.

Fig. 1 & 2: *In the pictures, the ducks are living in an unhealthy environment. The picture below shows the surface scum, a condition that is not only unsightly but interferes with natural cycles that provide a healthy environment for wildlife.*

Microbe-Lift® Restores Pond at Housing Development in Bowling Green, Ohio

Objective:

This development had an active association that sought a solution to this problem. When they learned that MICROBE-LIFT® technology could restore the natural health of this pond without the use of harmful chemicals they decided to run a trial.

Results Achieved

Using standard dosage rates of MICROBE-LIFT®/PL they were able to turn the situation around in a few months.

Fig. 3: *This picture shows happy homeowners next to a completely restored pond. Note the surface is so clear that we see their reflection as a perfect image on the water.*

MICROBE-LIFT® products act by restoring the natural microbial balance in ponds. The specialized microbes in MICROBE-LIFT® metabolize the excess nutrients that encourage algal growth, eliminate sulfur and other unpleasant odors, and degrade the organics that cause turbidity, toxicity, and oxygen depletion. A MICROBE-LIFT® treated pond is a clean, stable ecosystem that supports fish and other wildlife growth.

For more information on MICROBE-LIFT® Technology contact

Ecological Laboratories Inc.
www.EcologicalLabs.com

CS17102

Microbe-Lift® Technology Restores A Lake at A College in Ireland

Location: Terenure College, Dublin, Ireland

Background:

Terenure Collage is a secondary school located in the Terenure area of Dublin, Ireland. Founded in 1860, the college comprises a primary and secondary school. The school is part of the popular "Rugby Belt" or Leinster Schools Rugby playing institutions. With a strong rugby tradition, it has won the Leinster Schools Senior Cup 10 times.

Fig. 1: *Ternenure College.*

The lake at Terenure College is one of the main features of the grounds. It is 330m long running along the length of the playing fields and is estimated to be between 15,000m³ and 20,000m³ in volume. The lake is fed by surface water as well as some local spring water.

Fig. 2: This picture shows the massive amount of algae and surface solids accumulated on the lake surface.

For many years a combination of natural organic decay, surface water pollution, and nutrient run-off from adjacent playing fields has produced a build-up of organic sludge and inorganic silt in the pond. The resultant nutrient imbalance led to cloudy water, pungent malodors, and regular algae blooms across the entire lake.

Objective:

In May 2012 the College was approached with a recommendation to apply a natural bacterial product, MICROBE-LIFT® formulation to supplement the ecosystem within the lake and restore the natural balance. Nova-Q, began treatment of the lake at the end of June with a relatively high dose inoculation to kick start the process followed by a standard treatment protocol.

Results Achieved

With ongoing treatments Nova-Q was able to use the non hazardous, natural bacteria MICROBE-LIFT® technology to remediate the lake and restore the micro-nutrient balance in a manner that was of no risk to the natural wildlife of the area, the college students, staff or visitors.

As part of the "Environment and Heritage" aspect of their 150th Anniversary Celebrations during the academic year 2009/2010, Terenure College developed the Lake Wildlife Walk. The walk provides a little known quiet zone in the Terenure area that is growing in popularity. With a restored pond, the walk has now become a more pleasant experience for young and old alike.

Fig. 2: *This picture shows a totally recovered, clean pond with no algae or other surface solids*

The Benefits of Treatment with Microbe-Lift® Technology

The benefits of treatment with MICROBE-LIFT® technology include the following:

- Restores the ecosystem balance clearing ponds of algae and surface solids
- Eliminate noxious odors
- Reduces contamination including nitrogenous compounds ammonia and organics restoring oxygen levels.
- Breaks down organic sludge

These benefits are accomplished with natural biological technology that restores ecological balance.

For more information on MICROBE-LIFT® Technology contact
Ecological Laboratories Inc.
www.EcologicalLabs.com
CS17103

Microbe-Lift® Revives Pond at the Sanctuary Housing Development in Jacksonville, FL

Location: **Sanctuary Housing Development, Jacksonville Beach, FL**

Background: Sanctuary housing area was developed in the early 1990's along the inter-coastal waterway. This development had a 2-acre pond surrounded by homes that are 10 to 15 feet away from the edge of the pond and pollution was a problem. At this point there was active construction on the last phase of the housing development. They had experienced 3 fish kills between August 2004 and March 2007.

The primary points of pollution are fertilizer run-off and grass clippings from lawn care companies, debris from neighborhood trees, dust blowing into the pond from the construction site and fill material leaching into the pond through the silt fence from the construction site. A company that used copper sulfate and blue dye to abate algae had previously treated the pond with less than satisfactory results.

In search alternative remediation technology, the management company discovered MICROBE-LIFT® technology. MICROBE-LIFT®(ML) is a series of biological products developed and manufactured by Ecological Laboratories Inc. (ELI).

Objective: When contacted, ELI's technical staff assessed that the pond had a very large amount of string and mat algae. Additionally, the proximity of the houses to the pond provided significant nitrogen and phosphorus loading. ELI physically removed approximately 50% of the algae from the pond by raking it from the bank, then implemented a MICROBE-LIFT® dosage schedule as follows:

Dose	ML	ML SA	ML PBD	ML BSP
	Gal	Gal	8 oz packets	40 lb bags
Initial Dosage	8	3	20	5
Weekly doses (4)	2	1	4	
Monthly Maintenance	2	.25	2	

***Note:** *Due to budgetary constraints the pond was treated at half the normal rate recommended for a 2-acre pond.*

Results Achieved: The pond treatment was initiated in April 2007. The pond has not had one fish kill since initiation of treatment. Approximately 85% of the algae was gone by August and 95% was gone by October. Less than 5% of the algae remained. Continued maintenance dosage will improve water clarity as construction activity continues and supplies dust and run-off to the pond. Additionally, as the pond goes through a turbidity causing inversion during cold weather the maintenance dosage will help restore and maintain water clarity.

Comparison

BEFORE AFTER

Fig. 1: *The "before" picture on the left is not indicative of the actual coverage of algae on the pond because the wind had blown it to one side. On a calm day the coverage was actually 80% of the surface area.*

The office park management was very pleased with the results and the relatively inexpensive, small maintenance dose required to assure a clear and aesthetic pond.

For more information on MICROBE-LIFT® Technology contact
Ecological Laboratories Inc.
www.EcologicalLabs.com
CS17104

MICROBE-LIFT® Technology Reduces Total Phosphorus Level in Two Different Ponds by >70%

Location: Cason & Associates, Berlin, WI

Background: Cason & Associates is a professional company specializing in the environmental management of lakes, ponds, rivers, and wetlands.

Objective: Most environmental problems in natural waterways result from excess nitrogen and phosphorus nutrients caused by fertilizer run-off, dead organic matter breakdown, and animal waste pollution. MICROBE-LIFT® technology is well recognized for effective remediation of high nitrate levels. It contains a proprietary consortium of highly effective denitrifying bacteria that promote the natural cycling of nitrogen forming nitrogen gas that returns to the atmosphere. Since algae and other less desirable biological life forms require both nitrogen and phosphorus for growth, reduction of nitrate levels can curtail this growth.

However, for a truly pristine environment, phosphorus nutrients should be removed as well. Since phosphorus cannot be recycled to the atmosphere, removal is more difficult.

Based on successful phosphorus removal by MICROBE-LIFT® technology achieved at Islesworth, FL and other locations, Chad Cason, Senior Biologist at Cason & Associates, planned a test of MICROBE-LIFT® in a two-pond contaminated site that he was restoring.

Two ponds, an upper and lower pond, had high total phosphorus levels. As assayed by an outside laboratory on July 6, 2012, prior to treatment, the Lower Pond was determined to have 160 ug/l total phosphorus and the Upper Pond contained 120 ug/l total phosphorus.

Results Achieved: On October 14, 2012 after 4 ½ months of treatment with MICROBE-LIFT® laboratory results showed that the phosphorus levels had been reduced to 40 ug/l total phosphorus in the Lower Pond and 35 ug/l total phosphorus in the Upper Pond. Treatment achieved a dramatic 75% reduction in the Lower Pond and 71% reduction in the Upper Pond. "That's pretty impressive," stated Chad "I'm sure we will be purchasing more".

This trial was one more well-documented field test validating MICROBE-LIFT® technology's ability to not only eliminate excess nitrate but to also control excess phosphorus restoring ponds to a more natural, pristine condition.

For more information on MICROBE-LIFT® Technology contact
Ecological Laboratories Inc.
www.EcologicalLabs.com
CS17105

Independent Laboratory Results Confirm Bioremediation Dramatically

Reduced Fecal Coliforms at Jacksonville Zoo

Location: **Jacksonville Zoo, Jacksonville, FL**

Background: The ½ acre swan pond at Jacksonville Zoo was contaminated with an unacceptably high level of fecal coliforms. Well known for the leading pond maintenance technology, **Ecological Laboratories Inc. (EL)** was called in to help remediate the pond.

Fig. 1: *Shows the very popular swan pond at Jacksonville Zoo.*

Objective: **EL** first evaluated the water quality assaying pH, organic and nutrient loading, and accumulated pond bottom solids, and then MICROBE-LIFT was dosed according to protocol.

Fecal coliforms were reduced from 36,000 cfu/ml to 4,600 cfu/ml in just a few weeks of treatment. In addition, the water and surfaces were significantly cleaner as shown in the data below:

Analyte	Method	Units	Pretest 15 Jan	Test 1 5 Feb	Test 2 10 Feb	Test 3 18 Feb	Reduction Improvement
BOD	SM185210E	mg/L	16	9.7	1	1	94%
COD	SM 5220D	mg/L	240	85	120	35	85%
Nitrate N	EPA 300.0	mg/L .	60	.31	BDL	BDL	100%
Nitrite N	EPA 300.0	mg/L	.23	.13	BDL	BDL	100%
TSS	SM 2540D	mg/L	62	56	106	25	60%
Fecal Coliform	SM 9222D	CFU/ 100ml	36,000	10,000	14,000	1,200	96%

Fig. 2: *Analysis validates reduction in fecal coliforms plus increased cleanliness of the pond water.*

The lab report summary above shows the nitrates and nitrites have been reduced to below detectible limits and the water is much cleaner with BOD/COD/TSS levels significantly lowered.

In addition to providing cleaner water, MICROBE-LIFT® technology has reduced the bottom sludge by some 4 to 6 inches. There was a noticeable visual difference in the water quality and the zoo caretakers see an improvement in the general health of the swans.

For more information on MICROBE-LIFT® Technology contact

Ecological Laboratories Inc.

www.EcologicalLabs.com

CS17106

Private Equestrian Park Uses MICROBE-LIFT® to Restore Two Ponds

Location: **Private Equestrian Park, St. Johns County, FL**

Background: The design of this privately held, large equestrian park included 3 acre, 1 acre, and 0.5 acre ponds. These ponds became polluted from dust from construction activity and fertilizer run-off from its use on surrounding grass and other landscape features. Algae had built surface scum and there was no longer fish in the ponds. Unwanted insects were also a problem.

In search of a solution, the management discovered MICROBE-LIFT® technology. MICROBE-LIFT® (ML) is a series of biological products marketed by Applied & Experimental Microbiology (AEM) of Jacksonville, FL, often under the private label of Quantum Growth. This biotechnology-based product line is manufactured by **Ecological Laboratories Inc.**

Objective: When contacted, AEM's technical staff assessed that the ponds had very little bottom solids or leaves and twigs but did have high levels of nutrient, which caused the algae growth. They implemented a Quantum growth dosage schedule to the one acre pond as follows:

Dose	ML Gal	ML SA Gal	ML PBD 8 oz packets	ML BSP 40 lb bags
Initial Dosage	8	3	20	5
Weekly doses (4)	2	1	4	
Monthly Maintenance	2	.25	2	

***Note:** *Dosage for the one-acre pond is provided. Dosages for the other ponds were extrapolated from this dosage.*

The pond treatment was initiated in December 2006. The algae was substantially reduced in the following few months. The most notable observations were made on the pond's ecosystems. Predatory waterfowl and snakes were observed the following May. An alligator sighting was reported by a construction worker in June. The most notable observation was the absence of mosquitoes around the ponds.

For more information on MICROBE-LIFT® Technology contact
Ecological Laboratories Inc.
www.EcologicalLabs.com
CS17107

MICROBE-LIFT® Restores a Natural Refuge for an Upscale Neighborhood

Location: **Appian Way Housing Development, Doylestown, PA**

Background: Appian Way is a beautiful community of upscale homes in Buck County. This development maintains a common area of nine acres and a one-acre pond.
In 2004, the property manager experienced a problem with an ugly algal bloom on the pond. In addition, sludge was building up with the development of 1 ½ to 2 feet of bottom solids, and the fish were not visible due to the turbidity of the water. They had experienced fish kills due to lack of oxygen in the water.

Fig 1: *Severe string and mat algal blooms destroy the beauty of this preserve. Turbidity and solids accumulating on shore detract further from this potential retreat. (pictures taken 4/21/2004)*

Objective: The facility management contacted **Ecological Laboratories** who developed a treatment program using MICROBE-LIFT® Technology. The goal of treatment was to eliminate ugly surface scum, which was mostly algae, reduce the mucky bottom solids, and clarify the water. Nutrient levels were monitored and a dosage schedule was initiated.

Results Achieved:

Dramatic results were seen the first year of treatment and management has continued to use the product annually as recommended. After three years of treatment, the pond ecosystem has been completely restored. During treatment 3 to 4 inches of shoreline muck and over 2 feet of bottom sludge had been digested, fish kills were eliminated, and you can see the pond bottom in many places even though the pond is over 8 feet deep.

For more information on MICROBE-LIFT® Technology contact
Ecological Laboratories Inc.
www.EcologicalLabs.com
CS17108

MICROBE-LIFT® Technology Restores Health and Balance to a Pond Ecosystem at South Seas Resort

Location: **South Seas Resort, Captiva Island, FL**

Background: South Seas is a family resort and wildlife sanctuary that promotes adventure and relaxation. All amenities are designed to take full advantage of the beauty of the existing landscape.

Objective: When their 3/4-acre round pond had become increasingly unbalanced they needed a plan to return it to a healthy state. This 6-foot deep pond experienced heavy nutrient loading, low oxygen levels, and lack of beneficial bacteria that could break down organics. These conditions resulted in algal blooms, heavy bottom sludge accumulation, foul odors, and a lack of water clarity.

A bioaugmentation plan was developed based on MICROBE-LIFT® technology. In addition they added an AquaMaster surface spray type aerator to supply dissolved oxygen to the pond to support aerobic digestion by the bioaugmentation strains. The MasterClear Muck B Gone was added to accelerate sediment reduction.

On initial application 6 gallons of each product was introduced into the pond. For the next 6 weeks, 1 gallon of each product was applied each week. A monthly performance dosage was then to be determined. The pond was monitored twice a month.

After eight weeks of treatment, improvement was noted. Algal blooms were less intense. Water was clearer and there appeared to be less sludge. No foul odor was present.

Results Achieved: After 16 weeks improvement was dramatic. Slight algal blooms were seen in only a few areas. Water clarity had improved significantly and all odors were gone. Sludge Reduction was dramatic. Originally, 6 inches of sludge was noted at the shallow shoreline areas and up to 2 feet at the center of the pond. After 16 weeks of treatment, sludge was negligible at the shore and less than 6 inches in depth at the center of the pond.

Oxygen levels increased throughout the water column. The pond water BOD (Biochemical Oxygen Demand), the measure of organic loading, was decreased. This shows that the pond is effectively replenishing oxygen consumed by biological activity. The higher oxygen level supports beneficial microbes for faster degradation of organics to maintain water clarification and sludge reduction. This pond's health, balance, and aesthetic appeal have improved substantially. The synergistic use of aeration and beneficial bioaugmentation should be very effective in maintaining this healthy pond ecosystem.

For more information on MICROBE-LIFT® Technology contact
Ecological Laboratories Inc.
www.EcologicalLabs.com
CS17109

Bioremediation of Occum Pond at Dartmouth College Clears Water and Eliminates Algae

Location: Occum Pond, Dartmouth College, PA

Background

Pine Park is a ninety-acre forest of 125-year-old pine trees at Dartmouth College. This park begins at the north end of campus, along the edge of the Hanover Country Club golf course, and extends along the Connecticut River from Ledyard Canoe Club northward. The trees were saved from the Diamond Match Company in 1900 by local residents who later turned the land over to the College and to the Town of Hanover.

The park is a pristine area where forest and river ecosystems interface, home to a rich mix of water and forest wildlife. Many trails that wind through the woods provide` excellent walking, cross-country skiing and jogging often with a spectacular sense of isolation from the human world.

This site includes a 10-acre pond designed to add to its enjoyment.

Unfortunately the pond had not been well maintained. It had built a large layer of bottom sludge; the water had turned murky, algae contributed to surface scum, and a malodor had developed.

With limited budget and the size of the pond it was doubtful if it could ever be returned to its pristine state.

Fig. 1: *This picture taken May 15, 2006 shows the turbidity of the water.*

Fig. 2: *Also taken of the pond surface on May 15, 2006 this picture is a close up showing turbidity and surface scum.*

Objective:

The College worked with Ecological Laboratories (EL) to develop a biological augmentation program using MICROBE-LIFT® technology to clean the pond. The purpose of the program was to speed the biological degradation of all accumulated organic matter within the pond's ecosystem: along the shore (litteral zone), on the surface of the open water (limnetic zone), and the bottom sediment (benthic zone).

The program called for a year-long treatment initiated during the summer months.

Program goals include:

1. Reduce bottom solids 6-18" over a 12 month period
2. Assist in controlling algae blooms, in combination with pond management steps
3. Reduce pond malodors
4. Achieve a reduction of at least 20% in BOD, COD, and SS
5. Reduce pond nutrient concentrations
6. Improve water quality and clarity

Treatment was implemented from May 24 to October 13 in 2006 by a very competent Dartmouth team led by Stephen Glaholj and Robert Thebodo. **Ecological Labs** worked closely with the team to assure success.

Modifications to the program were made by **EL** as necessary based on weather and results. Dosage was reduced during heavy rainfall in May, June, and July while increased rates were applied in August and September when rainfall was lower. Data was tracked for the first six months of the program.

Results Achieved:

During the first phase of the bioaugmentation program from May to October 2006, the Occum Pond area experienced heavy rainfall with a reported 8 to 9 inches above average rainfall (reference "Rainfall in Lebanon, NH") The heavy rainfall impacted water volume and organic content as expressed by BOD, COD, SS, and TSS, and increased nutrient levels through excessive run-off from the surrounding area. There were no buffer zones to protect the pond from fertilizer and pesticide run-off.

Occum Pond's bottom solids level and percent organic content were determined at various points as indicated in the sediment chart. The first recorded baseline start points were incorrect due incorrect use of the sludge judge. Therefore bottom solids data review should be compared to the high data points shown about May 20th. This data point represents true baseline levels as determined prior to the first treatment on May 24th. Thereafter, solids data was compiled and monitored twice a month following the start of treatment.

Data indicates that bottom solids were reduced significantly during the treatment phase. This was accomplished in spite of excessive rainfall.

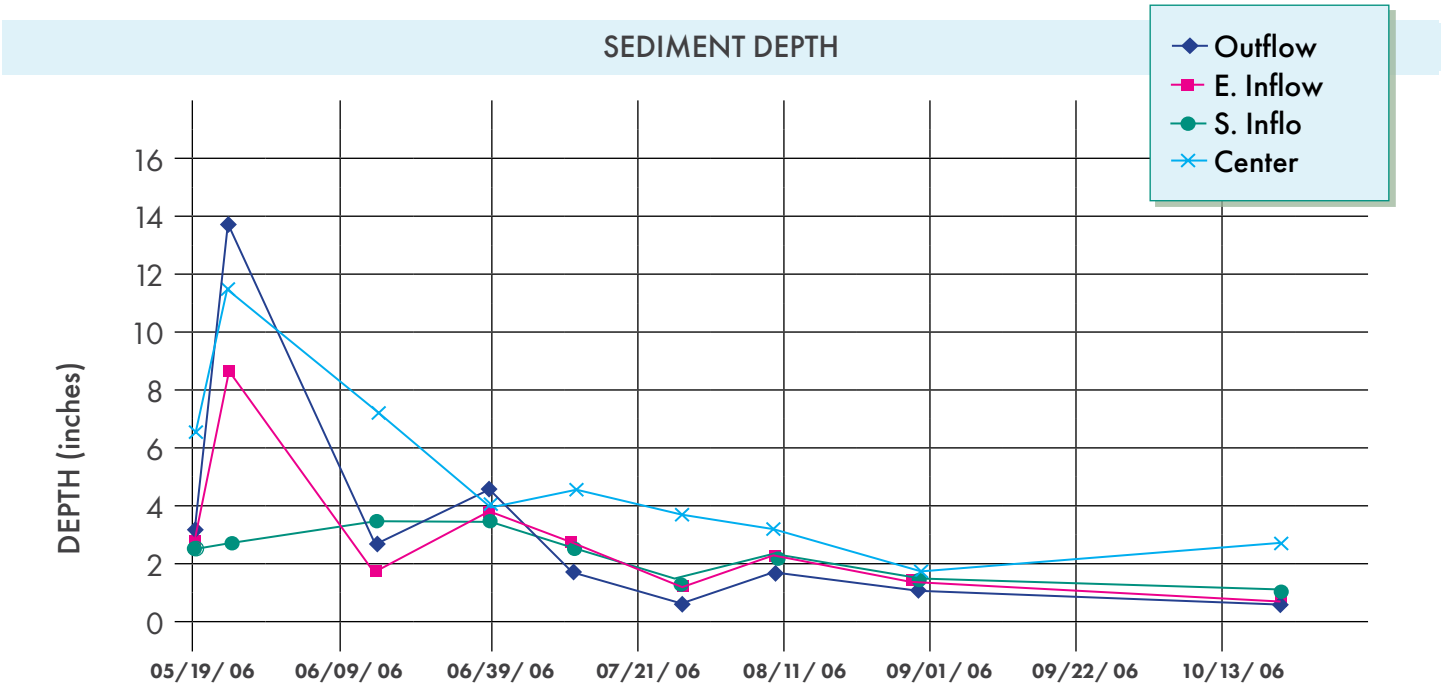

Chart 1: *This graph shows the reduction in sediment in bi-monthly recordings throughout the treatment program. The first data point was incorrect due to improper use of the sludge judge, making the second data point the true baseline.*

Microbial metabolism will continue to breakdown organic solids until mineralization is achieved, leaving only the inorganic portion of the sludge. The percentage of organic solids in the sludge determines the potential for biological removal. The data below indicates the organic portion of Occum Pond sediment is high, thus, the potential for a successful biological removal of sludge is high. **EL** estimates that it is reasonable to expect up to 6 to 12 inches of removal per year depending on temperature and other environmental factors.

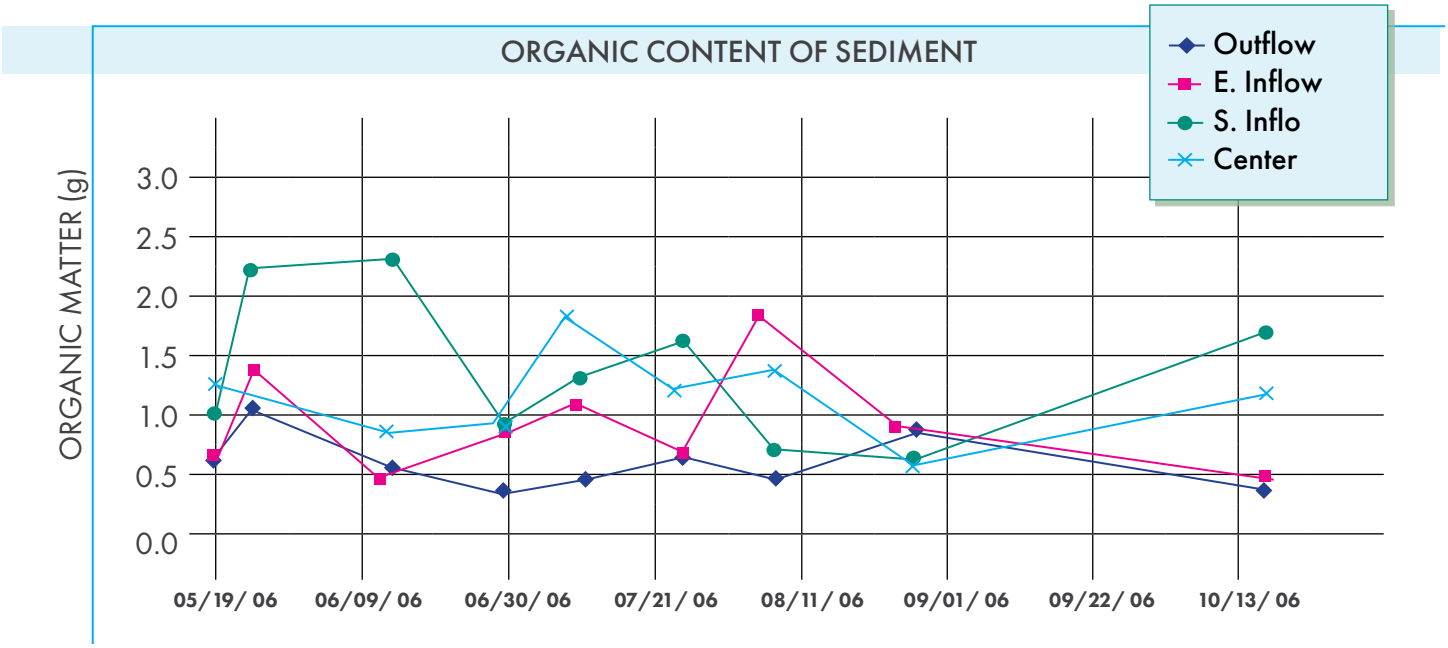

Chart 2: *Sediment is high, thus, the potential for a successful biological removal of sludge is high.*

During the biological oxidation of sludge organics, by-products will be released to the water column increasing the organic loading (BOD, COD) on the microbes in the water phase. This release may temporarily increase BOD results until the microbial activity from the bioaugmentation program balances.

The spikes in BOD in the above graph also coincide with high rainfall as the influent water carries organics in both particulate (settleable) and soluble form. The South influent zone indicates that the heavy rain events may have contributed unusually high organic matter to both pond water and sludge.

Nutrients were also tracked in the water phase. Ammonia levels are primarily developed by biological breakdown of organics containing nitrogen releasing ammonia or deamination. Various microbial metabolic processes can convert ammonia to nitrate, a form that can be utilized by plants or microbes or microbes can convert it completely to nitrogen gas whereby it is returned to the atmosphere. Since the Occum Pond has excess nutrients, microbial action is necessary to remove nitrogen.

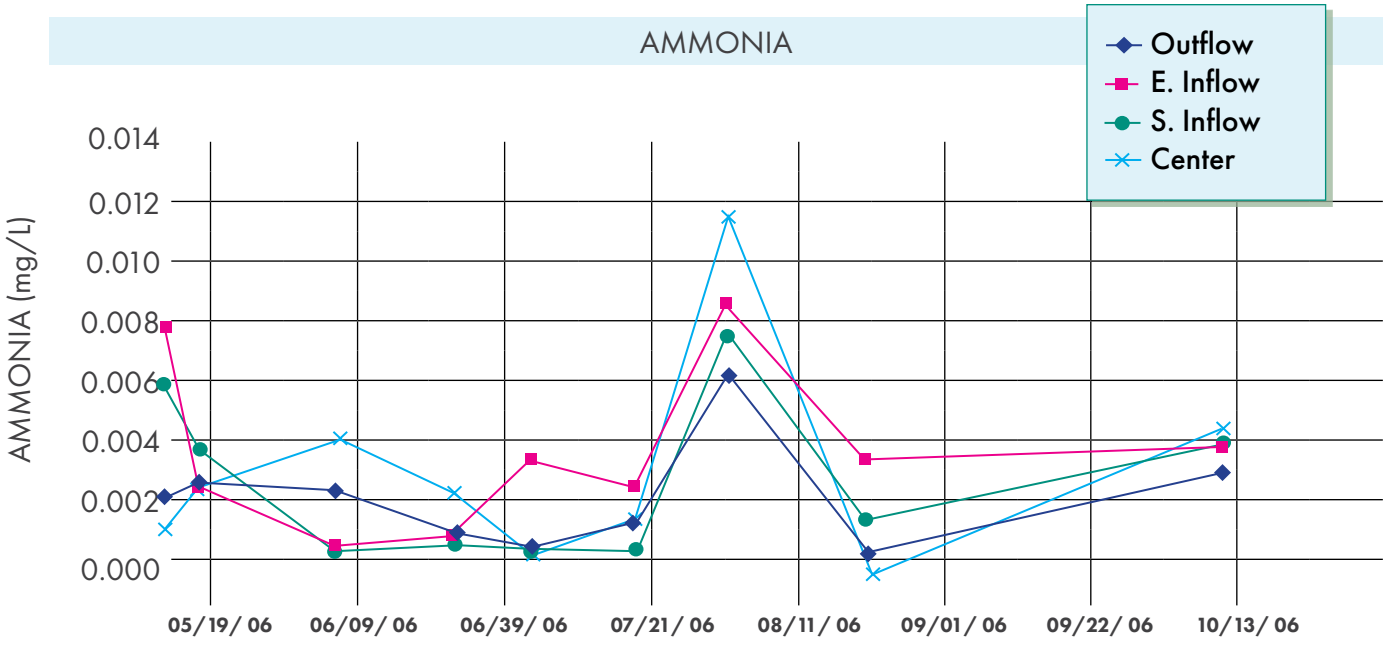

Chart 3: *Ammonia spikes occur after bioaugmentation in August and September.*

Aside from the normal pathway of oxidizing ammonia, nitrate builds to excess due to fertilizer run-off. Surface waters collect fertilizer and deposit it in ponds, rivers, and other waterways. Locations close to residential homes, golf courses, or farms are particularly vulnerable. As seen by the graph below, initial stages of high rainfall concentrates the nitrate contamination.

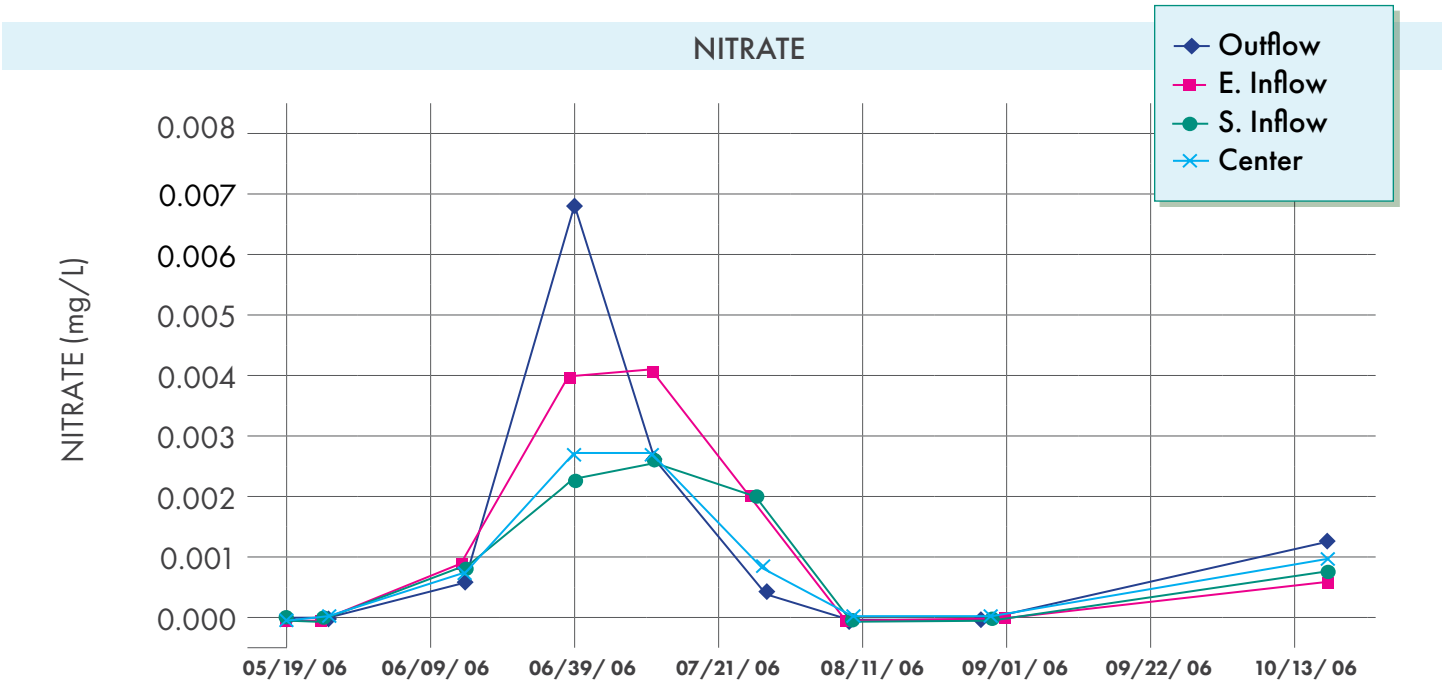

Chart 4: Initial stages of high rainfall concentrates the nitrate contamination.

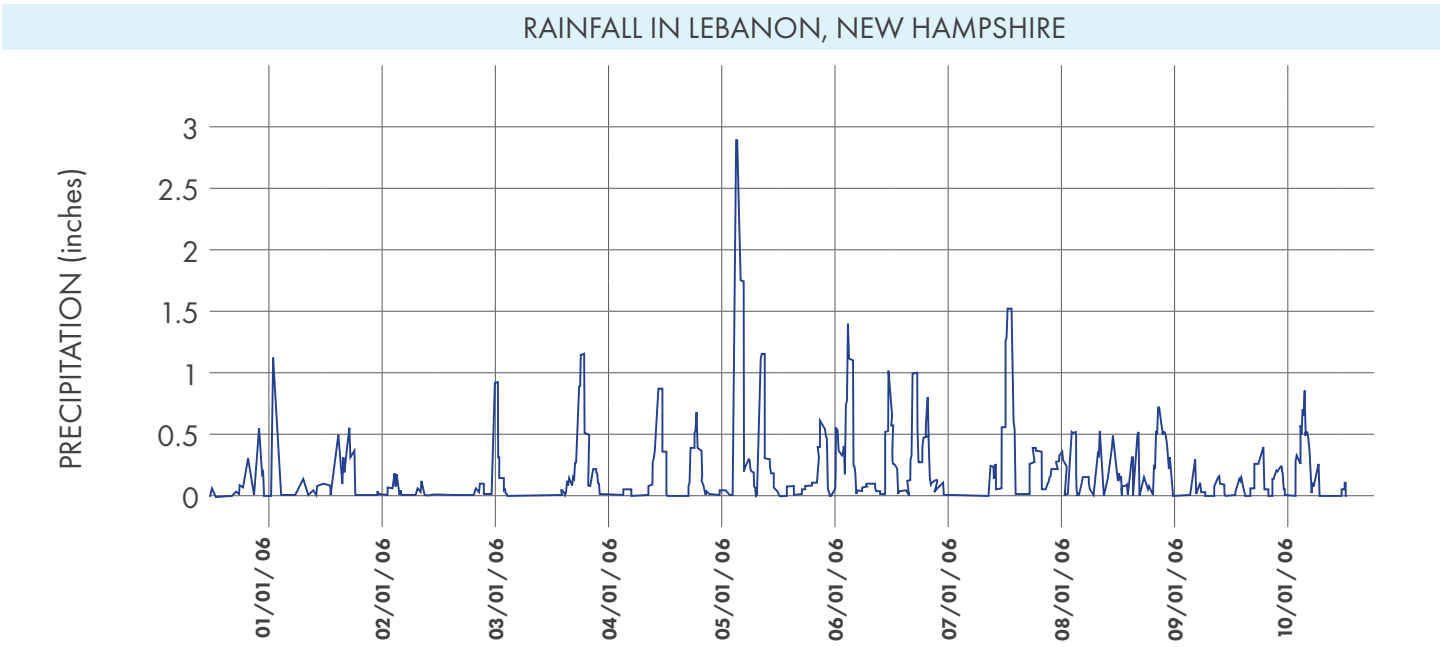

Chart 5: *Note how the spike in rainfall correlates to the spike in nitrate concentration in the pond.*

A high nitrate level is a problem because it encourages algae growth and excess bottom plant growth leading to eutrophication. Microorganisms capable of denitrification utilize nitrate for a terminal electron acceptor in place of oxygen releasing nitrogen gas. This occurs in the anaerobic sludge zones often producing bubbles on the water's surface where gas is released.

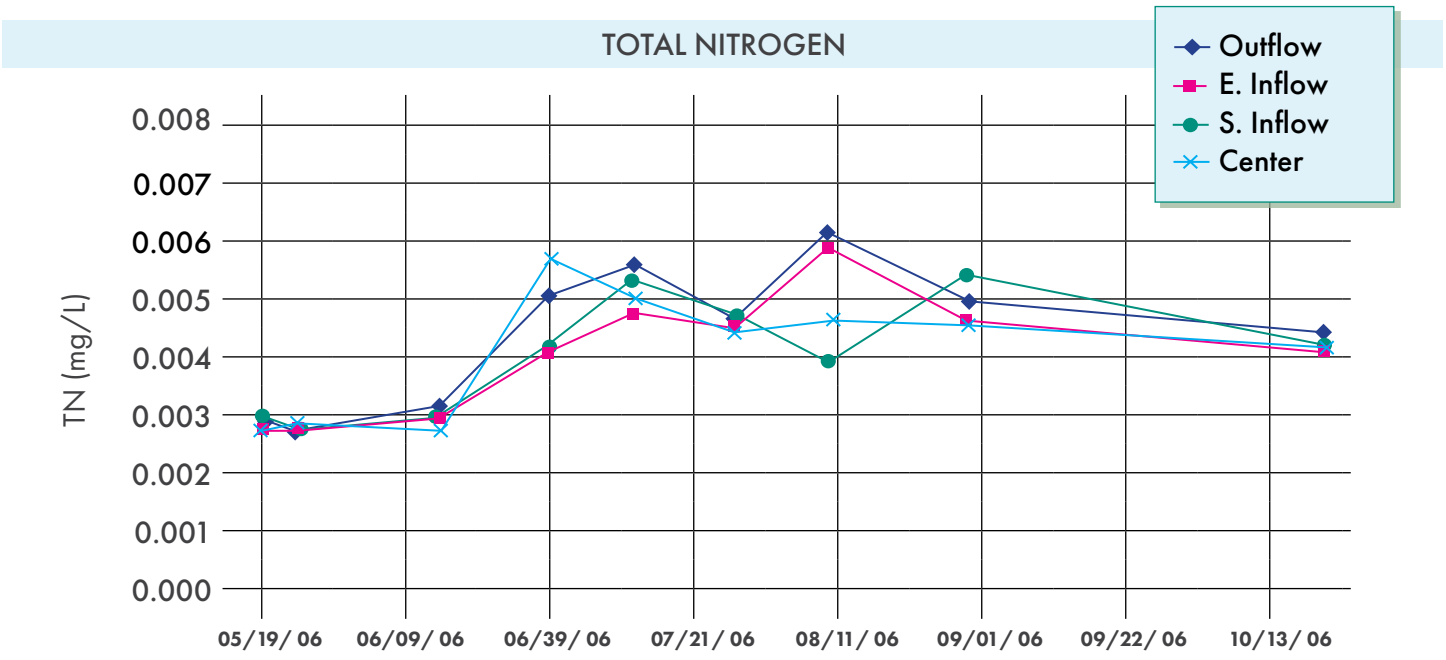

Chart 6: *Total nitrogen includes all forms of nitrogen: ammonia, nitrite, and nitrate plus the nitrogen in organic compounds. This curve shows the influence of the peaks in both nitrate and ammonia*

Phosphorus is another nutrient of concern as it is also a primary contributor to algae growth. Occum Pond sits in a bowl in close proximity to a golf course and borders home sites. These factors contribute to pond phosphate levels via fertilizer run-off. There is no buffer system to contain run-off which would ameliorate these factors.

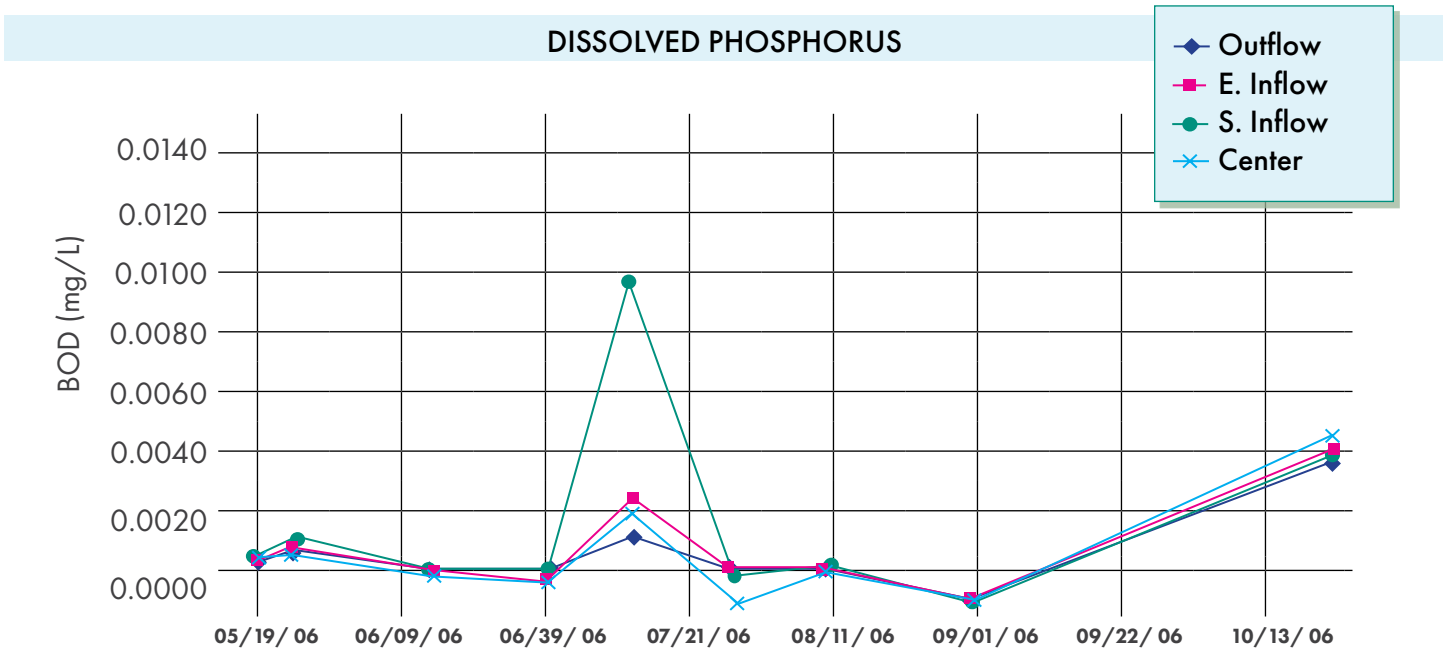

Chart 7: *Phosphorus also shows a peak that coincides with heavy rainfall.*

To compensate for heavy rainfall the augmentation treatment program was modified monthly with dosages changes as necessary to assure long-term effectiveness of the project.

Biochemical Oxygen Demand (BOD) or organic contamination of water results from a number of factors: a) soluble organic matter released from bottom solids, b) conversion of some COD or slow to degrade material to degradable material based on capabilities of selected microbes, and c) organic matter coming into the system in the influent waters or other natural sources such as animal waste. This chart shows increased deposit of organic matter with heavy rainfall peaking on June 30th.

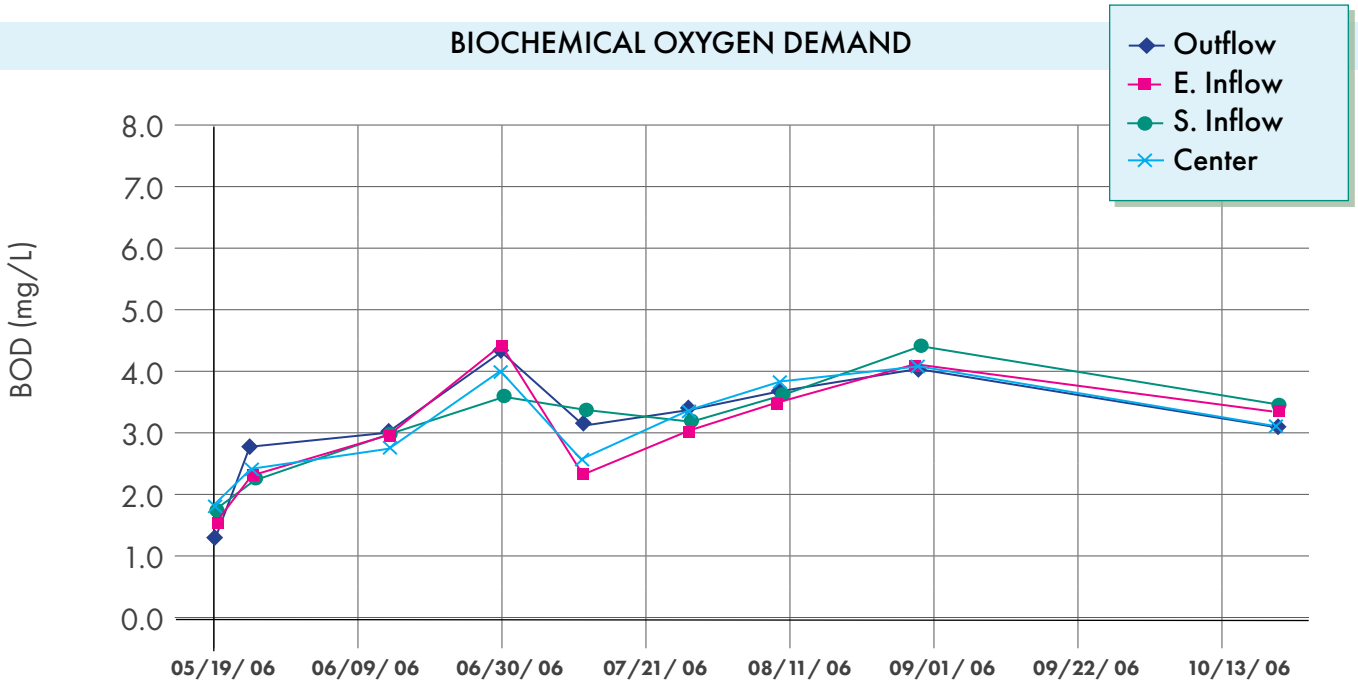

Chart 8: *Biochemical Oxygen Demand (BOD) shows increased deposit of organic matter with heavy rainfall peaking on June 30th.*

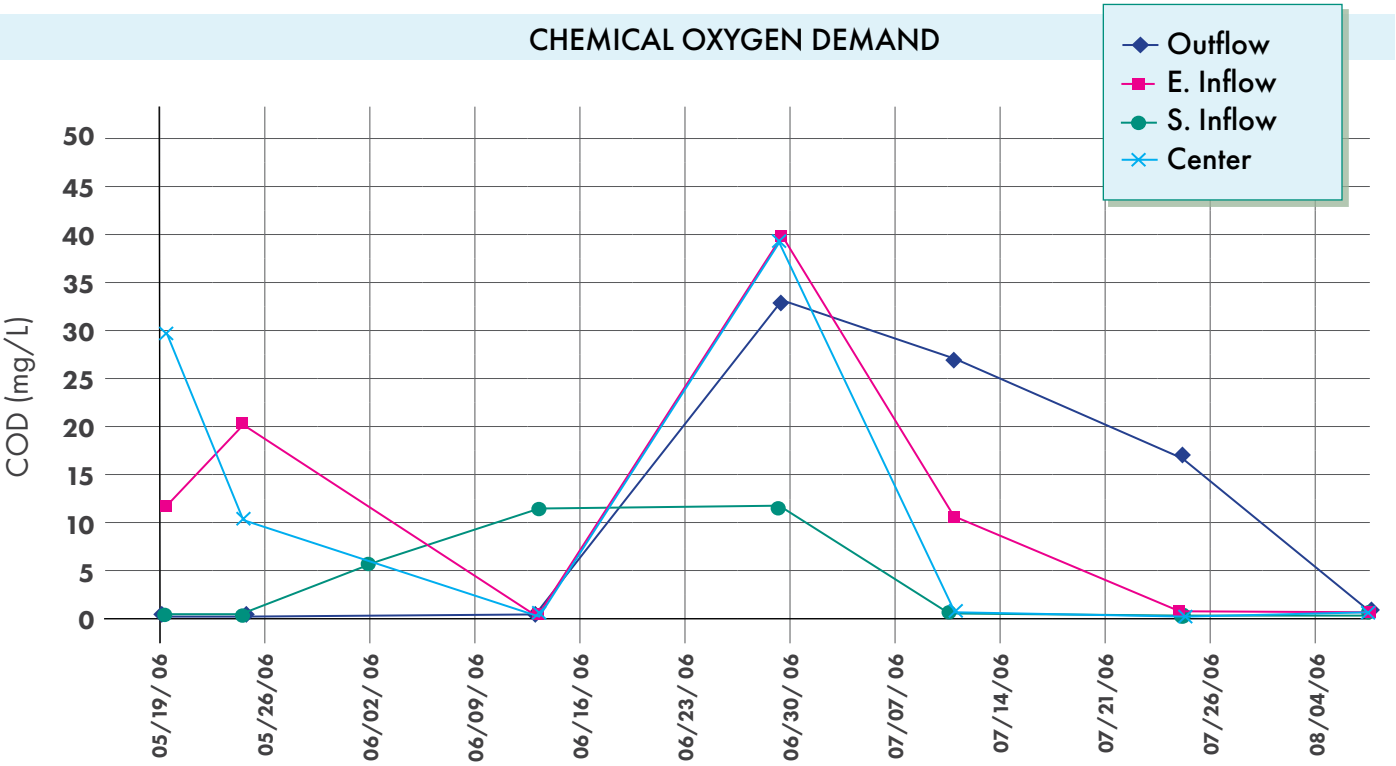

Chart 9: *Chemical Oxygen Demand (COD) shows an increase in influent in heavy rains that then decreases in the outflow as microbial action degrades the organics.*

Chemical Oxygen Demand (COD) is a measurement that includes the biologically degradable material (BOD) plus the non-biodegradable organics that usually require strong chemicals to breakdown. The COD in Occum Pond controlled largely by the introduction of slow-to-degrade and non-biodegradable matter via rain events and the increase in COD mirrors the increase in rainfall. There is also a reduction in the non-biodegradable fractions as the result of high rate microorganisms converting slow-to-degrade compounds to BOD followed by biological oxidation.

Conclusions and discussion:

This first phase of treatment with MICROBE-LIFT® technology was designed to span a period of twelve months. This report summarizes the first six months of treatment with a significant data collection plan. The goals of enhanced water quality, algae reduction, odor reduction and a primary goal of achieving a reduction in the level of bottom solids.

During this first six-month treatment, the augmentation program was negatively impacted by above average rainfall. The heavy rain events were countered by revisions in the treatment programs via changes in the application rates and time of application to assure the most effective treatment.

Based on the data collected, the bioaugmentation program has progressed at a satisfactory rate. Most impressive was the bottom solids reduction while still improving the water quality. In addition, the program achieved odor reduction by eliminating the hydrogen sulfide and other septic odors, and controlled the development of surface algae when compared to the pond history before treatment.

The data was so encouraging that the college made a commitment to continue the program for two years. The results follow:

Fig 3: *Recap: Water condition at the start of the program, May 14, 2006 prior of treatment*

Fig 4: Year one: *May 15, 2007 after one year of treatment*

Bioremediation of Occum Pond at Dartmouth College Clears Water and Eliminates Algae

SECOND YEAR RESULTS

Fig 5: Year 2: *May 15, 2008 After two years of treatment the pond water is very clear.*

Fig 6: *This pond has been returned to its pristine condition with two years of treatment with* MICROBE-LIFT® *technology. In fact, the water is so clear that one can even see the stocked goldfish as evident in the picture below.*

MICROBE-LIFT® products act by restoring the natural microbial balance in ponds metabolizing excess nutrients that encourage algal growth, eliminating sulfur and other unpleasant odors, and degrading the organics that cause turbidity, toxicity, and oxygen depletion. A MICROBE-LIFT® treated pond is a clean, stable ecosystem that supports fish and other wildlife growth.

For more information on MICROBE-LIFT® Technology contact

Ecological Laboratories Inc.
www.EcologicalLabs.com

CS17110

Lee County Health Park in Fort Meyers, FL Restores Pond Ecosystem with MICROBE-LIFT® Technology

Location: Lee County Health Park, Fort Myers, FL

Background: Health Park is a well-respected health facility in Fort Myers, FL that includes a scenic pond on the grounds.

When this 1.5-acre oval pond became unbalanced, they needed a plan to return it to a healthy state. This 6-foot deep pond showed signs of excessive nutrient loading from lawn fertilizer run-off and the water was becoming turbid. An accumulation of bottom solids and algal blooms indicated inadequate microbiological degradation or "cleansing".

Objective

When contacted for a solution, AquaMaster, a private label distributor of MICROBE-LIFT® technology evaluated the situation and developed a bioaugmentation treatment plan supplemented with AquaMaster surface spray aeration. MasterClear LSC was utilized to increase aerobic metabolism to clarify the water. It also contains denitrifying bacteria that utilize excess nitrate discouraging algae growth. MasterClear Muck B Gone microbial formulation was added to rapidly metabolize the accumulated bottom solids.

The plan called for an initial dosage of 6 gallons of Muck B Gone and 20 gallons of LSC (diluted mix) to be added to the pond. For the next six weeks, 1 gallon of Muck B Gone and 20 gallons of LSC (diluted mix) was applied each week. Thereafter, a maintenance dose of 10 gallons LSC (diluted mix) was added each month. During the program, the pond was monitored twice per month.

Results achieved

After the first six weeks of treatment, significant improvement was noted. The algal blooms were less intense, water clarity had improved, and it appeared that sludge reduction was starting to occur.

After 12 weeks improvement was very obvious. There were only few, slight algal blooms remaining. Water clarity had improved significantly.

Sludge reduction was very dramatic. Originally, 4 inches of sludge was noted at shallow, outer shoreline areas and up to 12 inches at the center of the pond. After 12 weeks of treatment, there was no muck at shallow areas and only 1 to 2 inches of sludge in the center of the pond, Oxygen levels throughout the water column were increased. The pond's BOD (Biochemical Oxygen Demand), the measure of organic loading, was significantly decreased. This shows that the biological activity has increased and degradation of organics or "cleansing" of the water has improved and, due to the aeration, the pond is no longer consuming oxygen faster than it can replenish it. This data indicates that the pond has been restored to an environment where the beneficial microbes can thrive and perform.

The water clarity had improved so greatly that AquaMaster's Bluzyme pond colorant/enzyme mix was used to shade the visible pond bottom from the sun's UV rays, thus, preventing growth of bottom plants.

In summary, the pond's health, balance, and aesthetic appeal have greatly improved as a result of the treatment program. The synergistic use of aeration and beneficial bioaugmentation proved to be a valuable tool in pond maintenance.

For more information on MICROBE-LIFT® Technology contact

Ecological Laboratories Inc.
www.EcologicalLabs.com

CS17111

MICROBE-LIFT® Restores Retention Pond at South Point Office Park in Jacksonville, FL

Location: South Point Office Park, Jacksonville, FL

Background: This 12-acre office park in Florida was designed with a one-acre pond at its bottom edge for water retention. However, as the surrounding areas were maintained with fertilizers and pesticides the pond became filled with algae scum creating a very unattractive eyesore. The primary points of pollution were run-off from fertilizer applied by the lawn care company, grass clippings from the lawn maintenance company, storm water from the parking lot, and debris from surrounding trees. The pond had been previously treated by a different company with chemical algaecide and blue dye to remediate algae but this treatment was not effective long-term.

Objective: In search of improved remediation technology, the management company discovered MICROBE-LIFT® technology. MICROBE-LIFT® (ML) is a series of biological products marketed by Applied & Experimental Microbiology (AEM) of Jacksonville, FL, often under the private label of **Quantum Growth®.** This biotechnology-based product line is manufactured by **Ecological Laboratories Inc.**

When contacted, AEM's technical staff evaluated the problem. They determined that the pond had a significant layer of debris, including leaves, branches, and 3 to 4 inches of bottom solids. In addition, there was high nitrogen loading from grass clippings and fertilizer. Initially, AEM removed approximately 35% of the algae scum from the surface by raking it off from the bank. Then they implemented a **Quantum** growth dosage schedule as follows:

Dose	ML Gal	ML SA Gal	ML PBD 8 oz packets	ML BSF 40 lb bag
Initial Dosage	8	3	20	1
Weekly Doses (4)	2	1	4	
Monthly Maintenance	2	.25	2	

Results achieved

After initiation of treatment in May of 2007, water clarity improved within 48 hours and the algae was completely gone by September (4 months).

MICROBE-LIFT® Restores Retention Pond at South Point Office Park in Jacksonville, FL

BEFORE

AFTER

Fig. 1: *The "before" pictures on the left are not indicative of the actual coverage of algae on the pond because the wind had blown it to one side. On a calm day the coverage was actually 80% of the surface area.*

The office park management was very pleased with the results and the very small maintenance dose required to maintain a clear and aesthetic pond.

For more information on MICROBE-LIFT® Technology contact

Ecological Laboratories Inc.

www.EcologicalLabs.com

CS17112

Sanctuary Housing Development Utilizes MICROBE-LIFT® Technology on Seven Lakes in Jacksonville, FL

Location: Sanctuary Housing Development, Jacksonville Beach, FL

Background: After a dramatically successful remediation of a pond in their upscale housing development using MICROBE-LIFT® technology, the management of this development chose to treat all the lakes within its borders.

MICROBE-LIFT® technology is incorporated into a series of bioremediation products developed and manufactured by Ecological Laboratories inc. This series includes the following formulations designed for lake or pond treatment:

- MICROBE-LIFT®/PL – for organic removal
- MICROBE-LIFT®/SA – for bottom solids reduction
- MICROBE-LIFT®/PDB – professional dry blend for leaves & twigs
- MICROBE-LIFT®/BARLEY (BSP) – binds nutrients

Initially it is important to first inspect pond and lake conditions by assessing water quality (nutrients and organics) and measure bottom solids to assess cause of pollution to determine proper product application. Establish baseline data for water clarity, pH, nutrient levels and presence of algae. Identify the type of algae present. Once the analysis is completed, a treatment plan is developed. General application rates per surface acre are listed below:

Product	Initial Dose	Weeks 3 - 5 Weekly Dose	Maintenance Dose (Monthly)
MICROBE-LIFT/PL	10 Gal	2 Gal	2 Gal
MICROBE-LIFT/SA	3 Gal	1 Gal	¼ Gal Based on Bottom Solids
MICROBELIFT/PBD	20 - 8 oz Packets	4- 8 oz Packets	2- 8 oz Packets
MICROBE-LIFT/BSP	40 Lbs	See Application Chart	See Application Chart

Fig. 1: *Dosage rates per acre/by product. Note that application rates may vary depending on site conditions.*

This development had a total of seven lakes and three creeks with a total surface area of 8.5 acres. The waters were all brackish with salinity between 10 and 17 ppt. The Intercoastal Waterway fills three lakes directly through creeks at high tide. The lakes are created by weirs that stop the water flow on outgoing tides. Another three lakes are fed directly from the Intercoastal Waterway annually during storm season through breaching the spillway systems. Lake number seven is totally landlocked. All lakes have loading from storm drains, watering from lawn-care companies, runoff, and natural debris. The homes are close to the waterways, some as close as four feet.

The following picture shows the position of the lakes and the general location of the homes. Lake two was the first lake treated with "before" pictures taken in February 2009 and “after” pictures taken in October 2009, eight months later.

Fig. 2: *Aerial view of the property showing all lakes to be treated, the location of homes, and the relationship to the Intercoastal Waterway.*

Each lake was assessed and treatment modified slightly based on conditions of each lake. Overall objectives are to decrease or eliminate surface scum of oils and algae, reduce bottom solids and organic debris, and improve water clarity.

Results Achieved: Lake #1:

This is a 2-acre lake with a spillway to the Intercoastal Waterway connected by two culverts that will backflow in the event of storms. While there was a healthy, beneficial population of natural plants growing in the southwest corner of the lake, there was erosion along the entire west bank. There was moderate nutrient loading from lawn care companies, run-off and natural debris. This lake had a history of moderate algae blooms

Fig. 3: *Overview of Lake #1.*

The pictures below show the condition of Lake #1 before and after treatment. The first set of pictures show the north shore of the lake.

Fig. 4: *These are pictures of before treatment (left) and after treatment (right). These are views of the north side of lake #1. Algae scum on the left has been completely removed.*

Fig. 5: *These pictures show the removal of the algae that was so evident prior to treatment in the pictures on the left versus the clear water in the right set of pictures resulting from* MICROBE-LIFT® *treatment. This is the south shore of lake #1.*

Results Achieved: Lake #2:

Lake #2 is a 2-acre lake connected to Lake #1 by one culvert. Heavy loading from lawn care companies, run-off, natural debris, and development on the east bank have degraded the water quality. There is no Intercoastal Waterway.

Fig. 6*.: Aerial view of lake #2*

Fig. 7: *Based on "before treatment" pictures on the left and "after treatment" pictures on the right,* MICROBE-LIFT® *treatments were very successful in #2.*

Fig. 8: Additional "before" (left) and "after" (right) pictures of lake #2.

Results Achieved: Lake #3:

Creek and Lake #3:

The creek and Lake #3 make an hourglass shape as seen on the right of this aerial view. This lake is fed by a creek from the Intercoastal Waterway transferring under the road as seen by the white section in this view. The creek is impaired at low tide by accumulated bottom solids of approximately 3 ft. Moderate load from lawn care and heavy load of natural debris are targeted for remediation.

Fig. 10: **Lake #3** *also shows dramatic results from* MICROBE-LIFT® *treatment. Pictures prior to treatment on the left show algae and scum, which is no longer present in pictures of treated lake on the right.*

Fig. 11: *The adjoining creek also showed benefits of treatment.*

Results Achieved: Lake #4:

Creek and Lake #4:

This one-acre lake is fed by a tidal creek from the Intercoastal Waterway. It is an elongated lake with the creek running under the white section in this aerial view. Heavy bottom solids have accumulated on the eastern section of the lake. There is good flow from the tidal creek to the Intercoastal Waterway.

Fig. 12: *Aerial view of Lake #4 and the creek feeding it.*

Fig. 13: Before and after pictures show results of treatment in Lake #4. Surface scum visible in "before" pictures on left are no longer visible and water clarity has substantially improved. Bottom solids have also been reduced.

Fig. 14: Likewise the river responded to treatment with less scum and dramatically increased water clarity.

Results Achieved: Lake #5:

Creek and Lake #5:
This is a 0.75-acre lake with a tidal stream that connects to the Intercoastal Waterway. Both the lake and creek have moderate to heavy bottom solids. There is a heavy load from the accumulation of natural debris.

Fig. 15: *The aerial view on the right shows the lake and the channel to the Intercoastal Waterway.*

Fig. 16: *Pictures below on the left prior to treatment show scum, turbidity, and debris that is no longer present in pictures on the right taken after treatment.*

Fig.17: *Before (left) and after (right) pictures of the creek.*

Fig. 18: *Additional pictures of the creek associated with Lake 5 show the increased clarity of water after treatment (right) as opposed to those taken prior to treatment (left). The major benefit was reduction in bottom solids, which provides additional turbidity to be degraded.*

Results Achieved: Lake #6:

Lake 6:

Lake 6 is a 1.5-acre lake with a spillway that flows into a creek totally obstructed by accumulated bottom solids that are overgrown with vegetation. This lake experiences moderate loading from lawn care, nutrient run off and natural debris.

Fig. 19: *Note the scum in pictures of untreated lake (l eft), which are dramatically reduced or eliminated with treatment (right).*

Results Achieved: Lake #7:

Lake 7:

A 0.75-acre lake connected to storm drains from the street, this lake has no connection to the Intercoastal Waterway. There is a great natural wetland on the southern edge of the lake. This lake still suffers from collected debris and increased nutrients from nearby homes.

Interestingly, MICROBE-LIFT® technology was able to remediate all seven lakes in spite of heavy influx of seawater and homes very close-by with associated debris and run off of harmful home care chemicals including fertilizer and pesticides. MICROBE-LIFT®'s reduction of bottom solids helps restore the natural and bioaugmented restorative powers of such waterways allowing reduction of dosage to maintenance levels for continued remediation.

Fig. 20: *Pictures demonstrate improved surface cleanliness and improved water clarity.*

For more information on MICROBE-LIFT® Technology contact
Ecological Laboratories Inc.
www.EcologicalLabs.com
CS17113

A Favorite Austrian Swimming Pond Was Restored by MICROBE-LIFT® Technology

Location: Municipal Parks & Recreation, Aschach, Austria

Background:

The swimming pond was a key attraction of this weekend community. The pond was created by a dam and was used solely for swimming. Due to the build-up of organics and grease from sun tan oil, the pond was experiencing algae blooms, causing a slimy coating on the pond's edges and on the floating diving board rafts. At various times during each season the pond would be closed due to these general water conditions and health risks which included higher than acceptable levels of Escherichia coli.

After some experiments and advice from "experts" this municipality had tried unsuccessfully with numerous products, including chemicals and microorganisms, to try to clear the algae. They never could stop the algae growth or maintain acceptable levels of coliforms.

Objective

When **Ecological Laboratories,** the creator of MICROBE-LIFT® technology for wastewater, learned of the problem they offered a solution. They evaluated the analysis of water conditions and proposed a bioaugmentation program.

The pre-trial water analysis (shown below) had been ordered from Steinbacher & Steinbacher Laboratories on 5/3/98 by Mr. Helmut Raab. Water quality results indicate high level of nitrate and nitrite, which contribute to conditions that favor the growth of algae. Often this indicates a relative deficiency of denitrifying microbes that can convert these compounds to nitrogen gas, which will be passed to the atmosphere.

	GUIDELINE VALUE	MEASURED VALUE
pH	6.5 - 8.5	7.1
electic conductivity		1190
hardness		31.9
carbonate hardness		24.5
magnesium hardness		7.4
Ca ++/ppm		175
Mg++/ppm		31,1
NH4+/ppm	0.05	0,01
NH4-Nippin N	0.04	0,006
NO3-/ppm	50	46
NO3-Nippan N	11,3	10,4
NO2-/ppm	0,01	0,003
NO2-Nippan N	0,003	0,009
Cl-/ppm	100	45
SO4-/ppm	250	115
Fe++/ppm	0,1	0,02
Mn++/ppm	0,05	0,00
H2S/ppm	not detectable	not detectable

Fig.1: ***Water quality prior*** *and during treatment.*

Note: -N: calculated with M(O)=16,M(H)=1, M(N)=14, results are reported in mg/l.

Results achieved

Inoculation with MICROBE-LIFT® formulation resulted in significant reduction in organics and reduction of Escherichia coli to well below the regulated limits. Visually, the slime coating was eliminated; In general the conditions of the pond were significantly improved. For the first time in many years, the pond was not longer forced to close for periods of time.

PARAMETERS	METHODS	UNIT	MEASURED VALUE
appearance	organoleptic	-	clear
color	organoleptic	-	colorless
odor	organoleptic	-	faint moldy
oxidizable	ONDRM M 6249	mg KMnO4/L	1,6
chlorophyll (a)	DIN 384 12-Teil 16	pg/L	<3
NH4-N	ONORM ISO 7150/1	mg N/L	0,02
NO2-N	ONORM M 6282	mg N/L	0,003
NO3-N	ONORM M 6283	mg N/L	0,25
P	ONORM M 623775	mg P/L	<0.010

***Fig. 2**: Results after treatment show reduction in nitrogenous compounds.*

	Guideline Value	New Anaysis before BTM--System	New Anaysis with BTM--System
NH4-N/ppm	0,04	0.008	0.02
NH4-N/ppm	11,3	10,4	0.25
NH4-N/ppm	0,003	0,009	0,003
Total Nitrogen	n.a.	10.417	0.273

***Fig 3:** This table highlights the critical data before and after treatment BTM –system.*

In the words of the Superintendent of Municipal Parks and Recreation, Mr. Helmut Ransomed,

*"Thanks to your analysis on site and your right combination of your products, we now have mastered the algae problem. About 3 weeks after initiation of treatment we could see a dramatic improvement of the situation. Even the persistent algae in the swimming part and around the spring stone and on the stones around the pond died away and were dismantled by the microorganisms! Additionally the water is now not only clear, it is crystal clear, and when you swim the feeling on your skin is comfy and soft. For me there is only one conclusion: If you're facing a problem concerning pond water, there is only one product to use...*MICROBE-LIFT®*."*

A Favorite Austrian Swimming Pond Was Restored by MICROBE-LIFT® Technology

Fig 4 & 5: *These pictures show the remediated condition of the swimming pond.*

For more information on MICROBE-LIFT® Technology contact

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CS17114

ECOSYSTEM RESTORATION

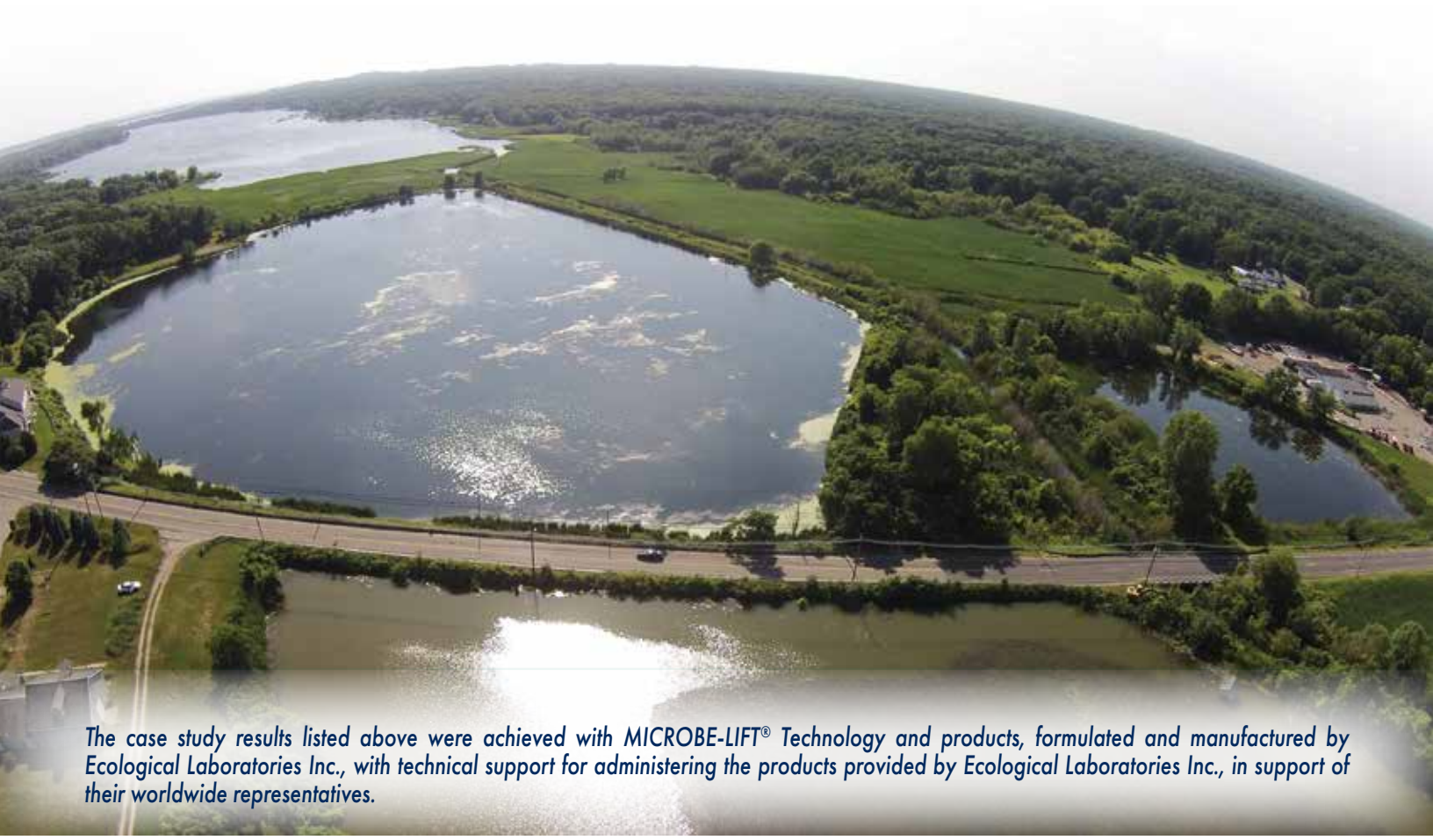
17200 River and Lake Clean-Up

17201 Engineering Research of the Microbial Revitalization of Xiba River with MICROBE-LIFT® Technology

17203 MICROBE-LIFT® Technology Restores River in the Heart of Kuching City

17204 National Seminar On Biological Application and Environmentally Friendly Protection of Malaysian Rivers

17205 Water Restoration and Enhancement of Pond at Winkler Bible Camp in Manitoba, Canada



The case study results listed above were achieved with MICROBE-LIFT® Technology and products, formulated and manufactured by Ecological Laboratories Inc., with technical support for administering the products provided by Ecological Laboratories Inc., in support of their worldwide representatives.

For more information on MICROBE-LIFT® Technology contact

Ecological Laboratories Inc.
www.EcologicalLabs.com

17200

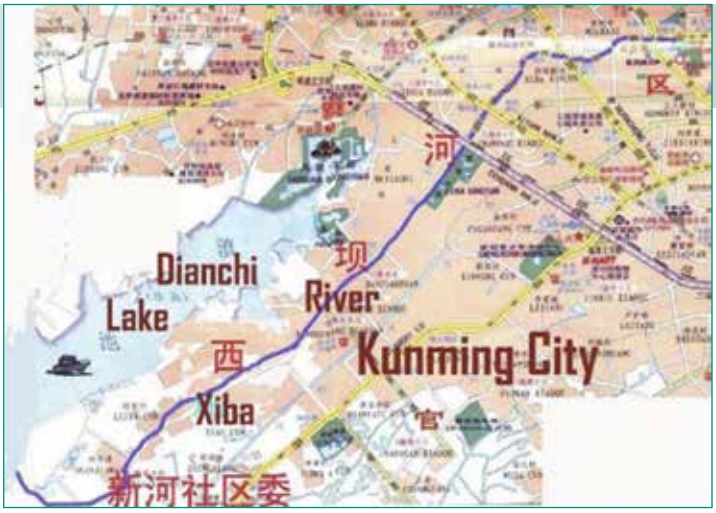
Made in the USA

Engineering Research of the Microbial Revitalization of Xiba River with Microbe-Lift® Technology

Location: **Kunming City, Yunnan Province, China**

Study conducted by Prof. Hu Kailin, Deng Liu, Wang Lifeng, Dang Yan, Chen Yusong, Han Bing and Wang Hao (Faculty of Environmental Science & Engineering, Kunming University of Science and Technology, Kunming) Project Advisor: Goh Kwang Beng. Project Period21 Nov 2004 to 22 April 2005.

Introduction:



"More than US$ 2 billion have been spent from 1993 to 2000 to clean up the Dianchi Lake in China's scenic Yunnan province. But the investments have produced little if any payoff because they have not addressed the root sources of pollution such as agricultural runoff. The central and provincial governments are now looking for innovative ways to address the problem." Quoted from an online April 2000 report by the U.S. Embassy Beijing.

According to a 1998 report by the State Environmental Protection Administration (SEPA), 185 million cubic meters of liquid waste were dumped into the Dianchi Lake in 1995, of which roughly 50 million cubic meters were industrial wastewater and 135 million cubic meters were domestic sewage. Pollution levels in the upper Dianchi Lake still regularly exceed the worst level (Five) on China's five-level water quality scale. Level-Five is defined as being suitable for agricultural use but not appropriate for swimming or for fishing. Water quality is somewhat better in the southern part of the Lake, usually measured at level-three (acceptable for swimming and fishing) or level-four (suitable for industrial and non-swimming recreational use) standards. The current target is to improve water quality throughout the lake to a minimum level-four standard by 2010.

The cleanup measures to date have failed to stem the pollution because they have focused almost exclusively on point sources around the lake's periphery. They have not addressed agricultural runoff or pollution of the Lake's tributaries. According to a recent press report, 80 percent of domestic sewage entering the 16 rivers that flow into the Dianchi Lake remain untreated. Meanwhile, heavy use of chemical fertilizers and pesticides on farm fields lying east of the Lake leads to extremely high runoff of nitrates and phosphates. According to the 1998 SEPA report, 1,021 metric tons of phosphorous and 8,981 tons of nitrogen entered the Lake in 1995. The Dianchi Lake Management committee is fully aware that the main cause of water pollution is water flowing into Dianchi from its 16 tributaries.

Ecological Laboratories authorized representatives from the United States presented a program for biological remediation of Dianchi Lake using Ecological's unique bacteriological based products in March 2004. The small, but badly polluted river was offered to Oakwell Engineering as a trial project using products formulated with Ecological's MICROBE-LIFT® proprietary technology. The Xiba River flows into the most polluted Northern part of Dianchi Lake, and was deemed to be good, but challenging test of open water bioremediation. Kunming

Engineering Research of the Microbial Revitalization of Xiba River with Microbe-Lift® Technology

University of Science & Technology was engaged as an independent research party to conduct the trial, and working as the local administrator for the project.

A preliminary laboratory test on the effectiveness of Ecological Laboratories products in treating the polluted water and sludge in Xiba River was conducted at the University in May 2004 with satisfactory results. However, the actual trial project was postponed to 21 November 2004 to avoid the rainy season in July and August. The project was carried out from 21 Nov 2004 to 22 April 2005.

Objective of the Xiba River Trial:

Formulations developed, manufactured and packaged by Ecological Laboratories were proposed as a bioremediation product for the Dianchi Lake rehabilitation in March 2004. The Dianchi Management Committee offered Xiba River to Oakwell Engineering Limited to conduct a trial testing the effectiveness of these products in treating polluted water in the Dianchi Lake. The river is a small, slow flowing tributary with extremely polluted water emanating a bad odor. The trial project was conducted to determine the effectiveness of this unique and novel biological treatment plan to eliminate odor, improve water quality and to accelerate river rehabilitation to reinstate higher forms of living organisms in the river.

What is MICROBE-LIFT® Technology?

MICROBE-LIFT® products are highly active liquid bacteriological consortiums designed specifically for use in polluted lagoons, lakes, rivers, industrial and municipal wastewater systems. This "core technology" contains a diverse blend of selected microorganisms with a specification of 387/450 million microorganisms/ml. The product, through Bio-augmentation, accelerates the biological oxidation of slow to degrade organic matter utilizing a broad spectrum of aerobic, anaerobic, facultative, chemo- and photo-synthetic bacteria.

Products manufactured with MICROBE-LIFT® formulas by **Ecological Laboratories** are very effective....
In enhancing the biological oxidation of the slow to degrade organic compounds various types of wastewater systems, as well as open water ponds, lakes, lagoons, and rivers. Treatment results have significantly improved overall system performance and environmental health and stability.

By increasing overall microbial oxidation rates, significantly increasing organic degradation performance. This unique microbial consortium provides reductions in final effluent BOD, COD, TSS, turbidity and improves effluent discharge into the rivers, lakes or sea, while reducing waste sludge volume that has been built up in the river bed over time.
The Xiba River has very high nitrogen and phosphorus content that supports eutrophication, which in turn causes serious algae problems in the lake. Bioremediation is the most cost effective means in reducing eutrophication and improving water quality in the river.

About Xiba River

The Xiba River is 4km long, with a width range from 4 to 9m, and a depth ranging from 0.5 to 1.0m. The average flow rate is 0.3 m3/s (26,000 m3 per day). The water is badly polluted and has a grayish color most of the time. It emanates bad odors, particularly during the dry months from April to August, that can be detected as far as 20m from the river bank.

The pollutants are mostly from illegal dumping of direct domestic sewer discharge, agricultural and animal farm wastewater, slaughter house wastewater as well as small industrial waste, including waste from cement plants. River flow can be extremely high during illegal discharge, occasionally completely upsetting trial results. The trial was conducted in the last 1.5km before the river mouth at Dianchi Lake.

Figure 2: *Condition of Xiba River before Trial Treatment on 21st November 2004*

Procedure of the Xiba River Trial.

The trial was conducted on the last segment of Xiba River on a stretch ranging 1,460m to 300m from Dianchi Lake. The segment from 750m to 1,260m was installed with our uniquely designed biomedia to increase the bacteria resident count. Fig 3 shows the dosing and water sampling locations. Dosing is applied daily based on water flow volume at approximately 1 ppm per day. The MICROBE-LIFT® formulation was poured directly into the designated dosing location. Water samples were taken from the river with a plastic cup with an extended arm scooping water from the river center at the sampling point.

Fig 3: *Dosing and water sampling location of the Xiba River trial*

The water parameters that were monitored were BOD5, CODcr, Total Nitrogen, Total Phosphorus, Turbidity, TSS and pH on a weekly basis. Appendix 1 tabulates the dosing volume, water parameter measurement record and weather record during the trial period.

Table1 shows the water parameters before treatment at the beginning of the trial. The ultimate desired standard of the authorities is Level-Three, as indicated in the last column of the table for reference.

Parameter	Before Treament April 5, 2004	Start of Treatment November 21, 2004	Level III Standard
COD (mg/l)	176	56.20	20
BOD (mg/l)	64.4	31.8	4
TSS (mg/l)	63	8.0	
TN (mg/l)	28.1	11.04	1.0
TP (mg/l)	2.58	1.0	0.1
Turbidity	130	39.8	
pH	7.29	7.0	6 - 9

Table 1. *Existing Water Parameter vs Level III standard*

Dosing Computation

A river is a continuous dynamic system with great variations in flow from time to time. It is not possible to accurately compute the water volume and retention time in the trial zone. We have computed the dosing based on the assumption that river flow is relatively low as has been noted at the site most of the time. The trial zone was designated from the 300m from the mouth of the Dianchi Lake upstream 1,460m, for a total treatment zone of 1,160m in length. The average width and depth at this section of the river is 6.0m and 0.9m respectively. This gives a total volume of 7,884 m3. The normal flow rate without major dumping or rain is 0.3 m3/s. This gives an average retention time of 7.3 hours. That means the water takes approximately 7.3 hours from the beginning of the test zone at D1 to the end of test zone at T4. Since the retention time is less than 24 hours in the test zone, dosing is computed based on daily flow rate as per manufacturer's recommendation.

Based on a 0.3 m3/s flow rate, daily volume of water flow is 26,000 m3 (6.8 million gallons). At 10 ppm inoculation, 68 gallons will be needed. At the time of project evaluation, the estimated flow was based on 3.2 million gallons per day as detected earlier. The inoculation was hence carried out with 32 gallons on 21 Nov 2004. The flow rate was subsequently detected at 6.8 million gallons per day, it was then recommended to maintain 4.7 ppm of daily flow rate per week for the next four weeks. Regular large volumes of untreated wastewater were found to have been dumped into the river, thus upsetting the water volume computation and trial progress.

It was decided that the dosing be converted to 6 gallons (0.88 ppm per day based on daily flow volume) dosed on a daily basis from 13 Dec 2004 onwards. There were some minor changes to actual dosing depending on site condition and progress. In general, the daily dosing was divided into 4 portions with 65% dosing at dosing point C just before the start of biomedia. Very low dosage was applied at dosing point A and B because the river at this section is very narrow and has a low water volume. 15% of the estimated dosing was applied at dosing point D at the middle of the biomedia section to ensure that is sufficient bacteria to flow to the last section of the trial. With a flowing river of this nature, a single point dosing is sufficient as experienced in this trial.

Water Quality Monitoring and Result Evaluation

Water samples from four locations as indicated in Fig 3 namely T1, T2, T3 and T4 were taken on a weekly basis for water parameter monitoring. T1 is located 90m before the first dosing point upstream. The water parameter at T1 represents pre-treatment water sample. T2 is located at the middle of the biomedia zone. The water here is subject to 2 to 3 hours of treatment as it flows from T1 to T2. T3 located further downstream, 650m from Dianchi Lake. The water at T3 has gone through approximately 5 hours of treatment under normal flow. T4 is the last water sample point at 300m before Dianchi Lake. The water at T4 has been treated for approximately 7 hours under normal flow rate.

The water parameter varies from day to day as upstream discharge changes. The water quality downstream is therefore greatly influenced by upstream water parameters, i.e. influent quality at T1. It is therefore meaningless to track the water quality over time like in a lagoon system. Our objective then is to track the improvement of water quality from T1 to T4 on the day of measurement.

The commencement of the trial period coincided with a very unfavorable period of cold temperature. Although Kunming City has the reputation of a city with eternal spring, there were two periods with sub-zero temperatures and snow which severely affected the effectiveness of MICROBE-LIFT®. The period from November to March falls in the dry season, however there were a few instances of heavy rainfall in addition to low temperatures during the trial period that changed the river water completely on 29th Nov 2004, 18th Dec 2004, 12th Jan 2005 and 23rd March 2005. Besides the weather factors, the regular dumping of huge volumes of untreated polluted water upset the trial further. This is reflected on 6th March and 27th March 2005. The water quality improved significantly from T1 to T4 from Feb 6th to Feb. 27th Feb 2004. However, the improvement was severely interrupted by further dumping of a huge volume of untreated agricultural wastewater on Feb 28th 2005.

Following the dumping on 28th Feb, there was unexpected snowfall on 3rd and 4th of March with temperatures ranging from -1 to 10°C. Dosing was called off on the 4th and 5th of March 2005 and resumed on the 6th of March. Despite the interruption, the trial zone recovered its earlier ecological balance within two weeks from 6th March as seen on 20th March 2005. The ecological balance this time round was, however, upset by a huge volume of very alkaline wastewater dumped by a cement factory upstream. The river was completely covered with milky water on 23rd March 2005. The dosing ended on 29th March 2005 due to a delay in new shipment. Dosing resumed on 10th April 2005. However, the trial continued to be interrupted by blatant dumping of huge volumes of untreated wastewater. The trial ended on 22nd April 2005.

Engineering Research of the Microbial Revitalization of Xiba River with Microbe-Lift® Technology

Xiba River Project

Selective Result Presentation.

T1 Untreated water Sample
T2 2nd water Sample at Biomedia Zone
T3 3rd water Sample 650 m from Dianchi Lake
T4 4th water Sample at 300 m from Dianchi Lake

BOD5 mg/l

Date	T1	T2	T3	T4	Remarks
11/21/2004	31.80	31.90	27.60	28.30	Inoculation
12/19/2004	38.80	41.50	38.30	41.90	Not much change noted
02/06/2005	14.30	12.50	7.07	7.67	about 50% improvement at T3 and T4
02/27/2005	20.90	30.60	13.00	8.81	About 60% improvement
03/06/2005	21.10	23.00	26.00	30.30	Affected by dumping and snow
03/20/2005	45.00	24.00	20.10	21.40	System recovered within two weeks
03/27/2005	30.40	38.80	31.60	26.20	Affected by cement factory waste

CODcr mg/l

Date	T1	T2	T3	T4	Remarks
11/21/2004	56.20	64.30	60.20	76.30	Inoculation
12/19/2004	90.00	88.00	92.40	94.00	Not much change noted
02/06/2005	100.00	76.00	58.00	52.00	about 50% improvement at T3 and T4
02/27/2005	53.35	71.14	43.47	39.52	about 25% improvement
03/06/2005	90.90	86.94	82.99	81.02	Affected by dumping and snow
03/20/2005	130.42	94.85	75.09	67.18	System recovered within two weeks
03/27/2005	88.92	90.90	86.94	81.02	Affected by cement factory waste

TSS mg/l

Date	T1	T2	T3	T4	Remarks
11/21/2004	8.00	5.50	4.50	2.50	Inoculation
12/19/2004	9.50	8.00	9.00	11.00	Not much change noted
02/06/2005	3.50	7.50	3.00	5.50	increase at T4, reason unknown
02/27/2005	23.00	8.50	4.00	6.00	80% improvement
03/06/2005	9.00	10.00	8.50	24.00	Affected by dumping and snow
03/20/2005	8.50	4.00	3.00	0.50	System recovered within two weeks
03/27/2005	3.00	4.00	2.00	1.50	Affected by cement factory waste

Turbidity (NTU)

Date	T1	T2	T3	T4	Remarks
11/21/2004	39.80	40.40	41.00	36.20	Inoculation
12/19/2004	67.60	67.70	68.20	60.50	Not much change noted
02/06/2005	30.50	23.20	11.20	12.90	about 60% improvement at T3 and T4
02/27/2005	11.40	28.10	12.20	2.80	Water clarity at T4 is about 1 m
03/06/2005	39.30	35.70	37.10	40.40	Affected by dumping and snow
03/20/2005	58.10	53.40	47.20	38.90	System recovered within two weeks
03/27/2005	45.70	52.10	49.20	42.60	Affected by cement factory waste

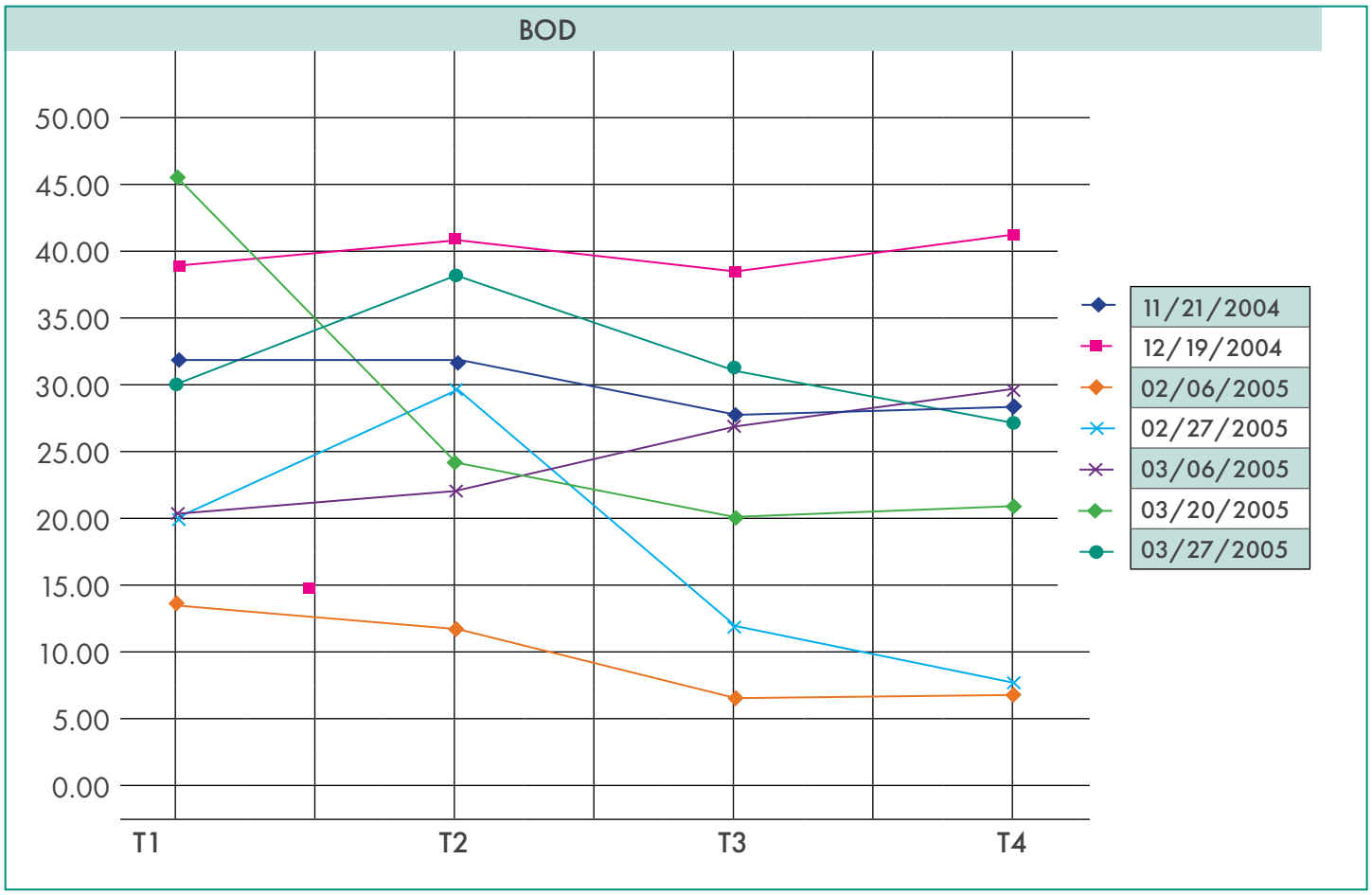
Total Nitrogen TN (mg/l)

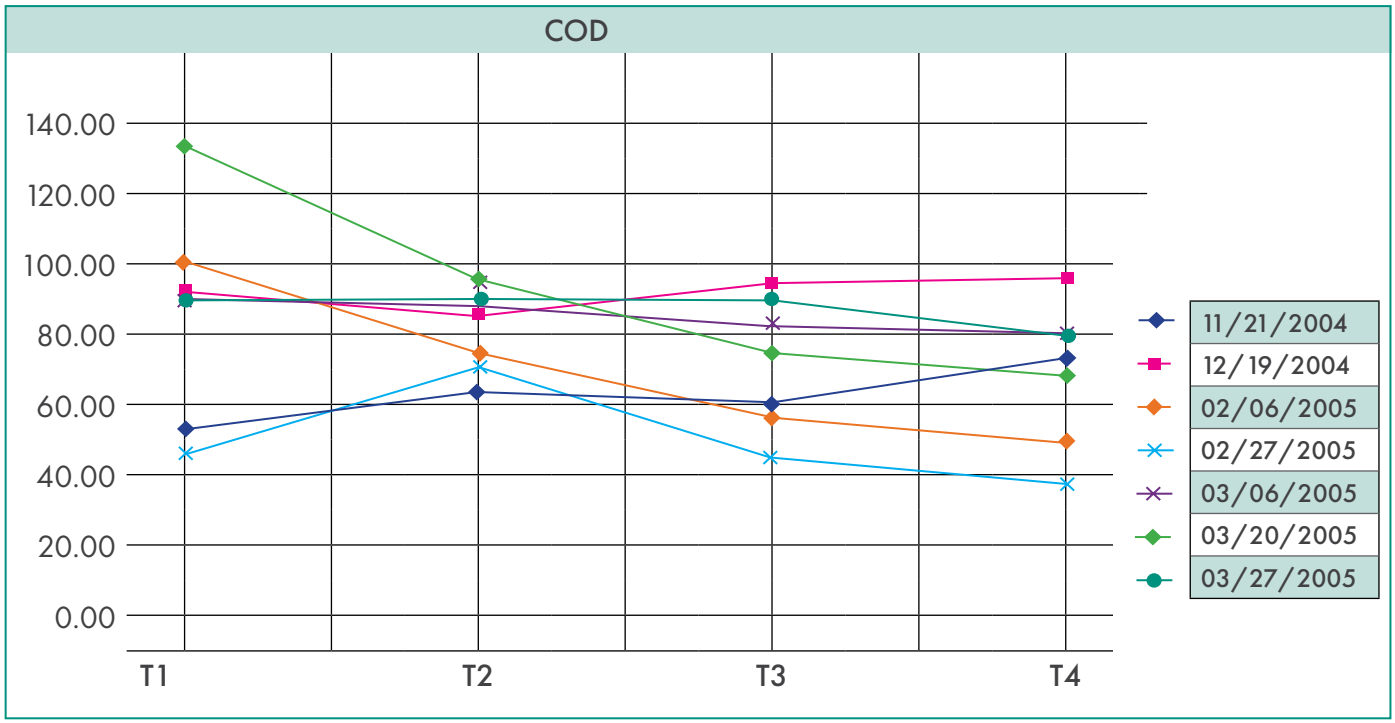
Date	T1	T2	T3	T4	Remarks
11/21/2004	11.04	15.15	16.12	15.34	Inoculation
12/19/2004	13.48	14.58	12.93	13.48	Not much change noted
02/06/2005	21.50	18.90	13.80	12.40	about 40% improvement at T3 and T4
02/27/2005	8.19	7.37	8.47	7.78	
03/06/2005	13.26	13.26	13.81	12.85	Affected by dumping and snow
03/20/2005	16.41	13.81	10.93	10.10	System recovered within two weeks
03/27/2005	14.77	9.29	9.70	8.50	Affected by cement factory waste

Total Phosphate TP (mg/l)

Date	T1	T2	T3	T4	Remarks
11/21/2004	1.90	1.64	1.73	2.03	Inoculation
12/19/2004	2.23	2.39	2.52	2.61	Not much change noted
02/06/2005	1.55	1.42	0.96	0.84	about 40% improvement at T3 and T4
02/27/2005	1.40	1.61	1.37	1.12	
03/06/2005	1.49	1.66	1.67	1.74	Affected by dumping and snow
03/20/2005	2.60	2.39	2.08	2.04	System recovered within two weeks
03/27/2005	1.68	1.93	1.71	1.75	Affected by cement factory waste

Engineering Research of the Microbial Revitalization of Xiba River with Microbe-Lift® Technology





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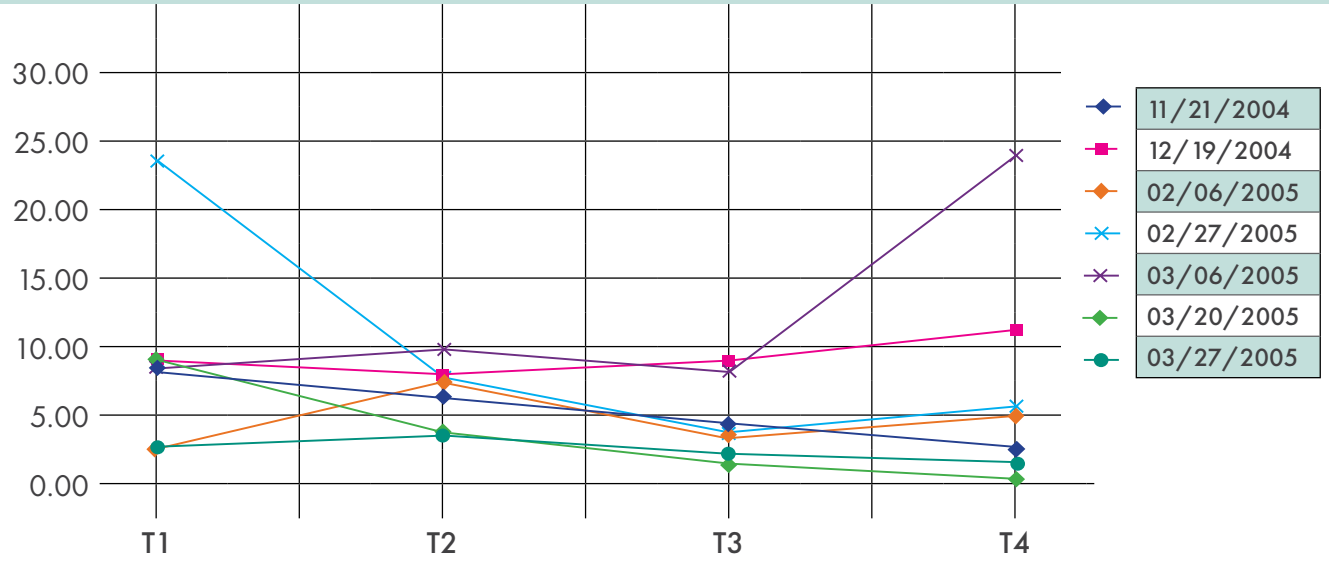
TSS



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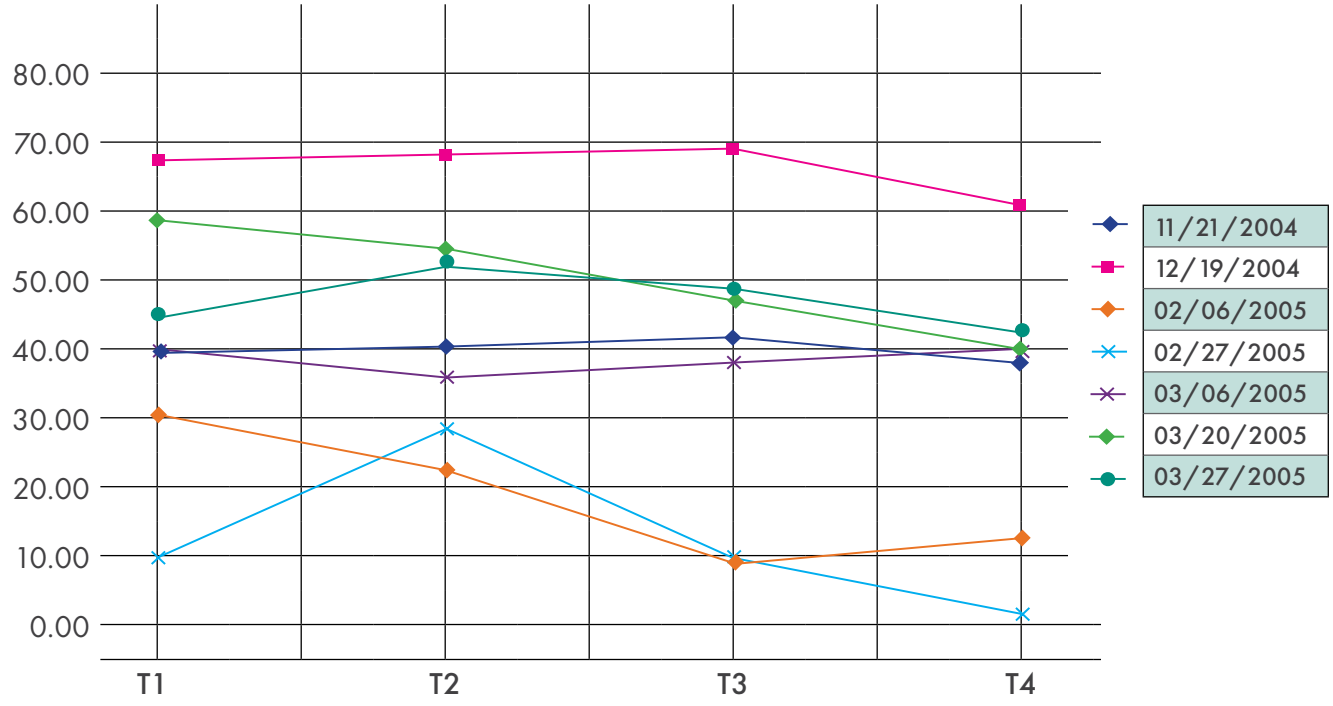

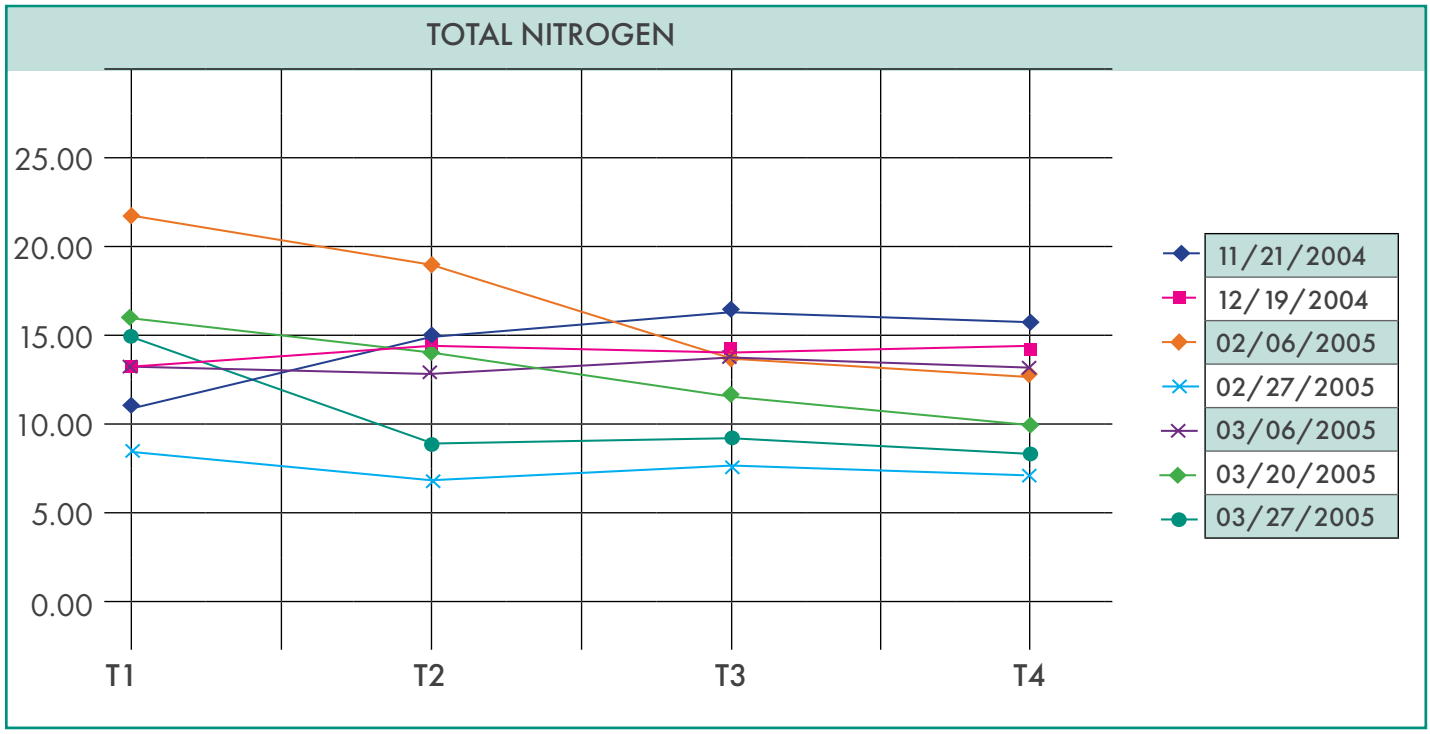

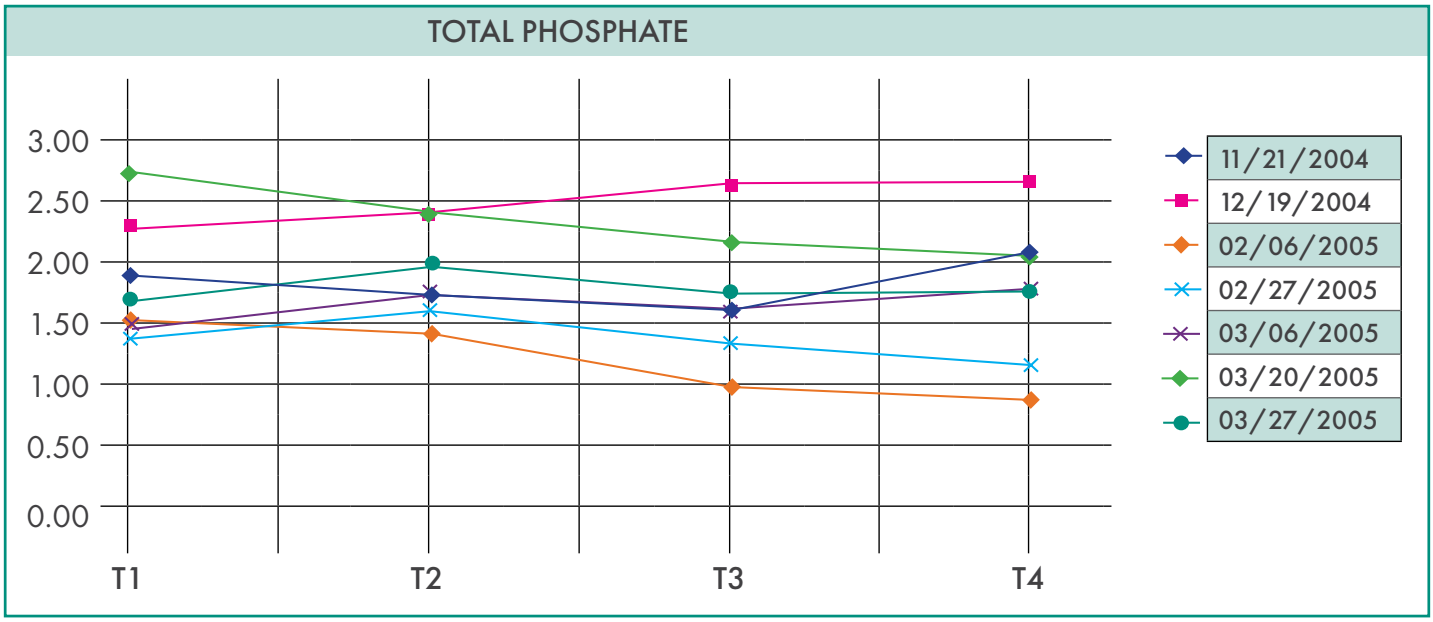

Fig. 10: *TSS of A, B, C, D sample for week by week*

The bad odor along the test zone was drastically reduced within one week of inoculation and was practically eliminated two weeks after inoculation. The river has remained odor free throughout the trial period. However, there was no change in bad odor upstream during the same period, thus confirming that Ecological Laboratories' Microbe-Lift Technology products are very effective in odor reduction. This has also been corroborated by verbal surveys with local residents along the river.

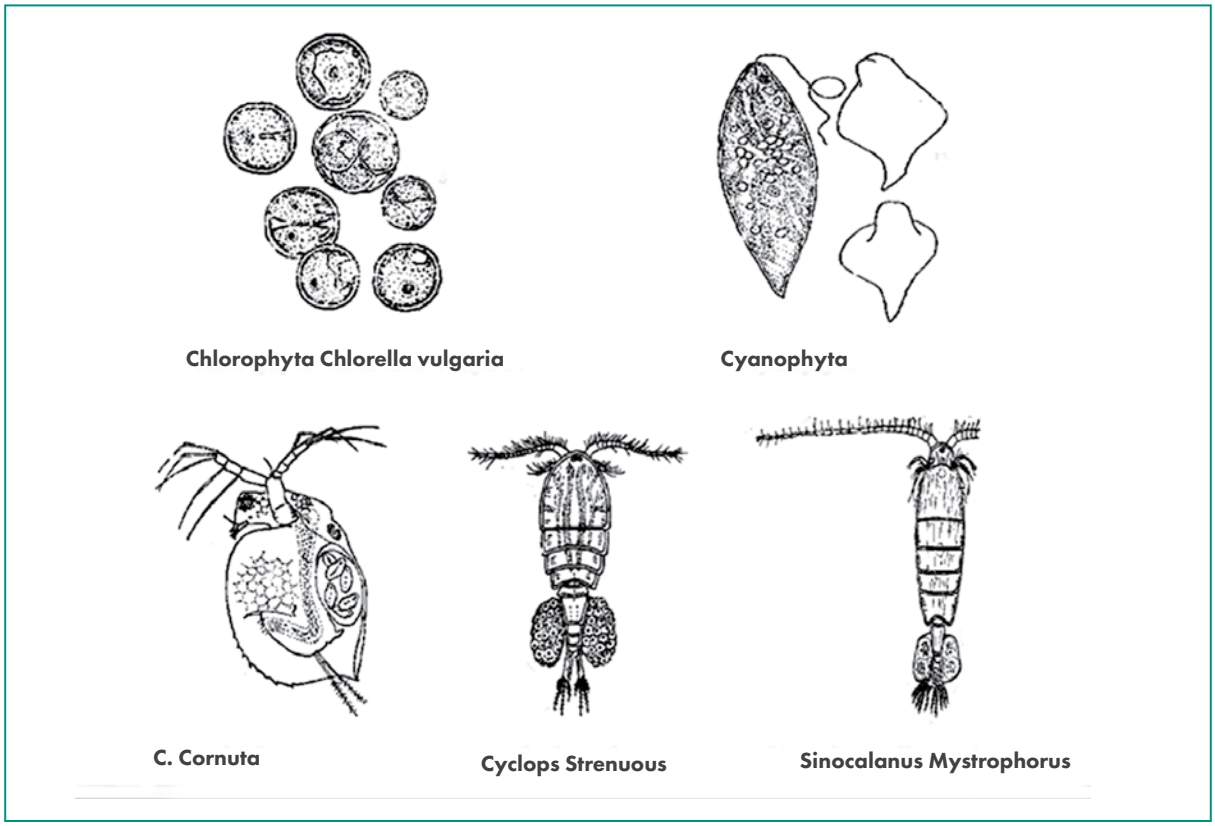

Fig. 4: *Microorganism found in Trial Zone water.*

The various types of microorganisms in the water were monitored during the trial period. 80% of plankton found at the beginning of the trial was Cyanophyta and Chlorophyta. The high percentage of these two types of plankton indicates that the water is heavily polluted. As the water quality improved in Feb 2005 at T3 and T4 locations, large amounts of Chrysophyta and Xanthophyta type of plankton appeared there, in line with water quality improvement. Protozoa type organisms were hardly seen in Xiba River before the trial. Large number of Protozoa and metazoan such as C. Cornuta, Cyclops strenuous and Sinocalanus Mystrophorus appeared at T3 and T4 locations in Jan and Feb 2005. Even kingfishers were attracted to the river by the presence of the small fish.

Fig 4 shows some of the microorganisms described above. Larger protozoa and metazoan such as Rotifera which live on small protozoa and plankton were found in extremely large quantities in late February 2005. Clusters of small fishes also appeared at T4 areas in late February 2005. Even kingfishers were attracted to the river by the presence of the small fish. Fig 4 shows some of the microorganisms described above.

On 26th Feb 2005, a very distinct improvement on the water from T1 to T4 was observed as shown in Fig 5 below.

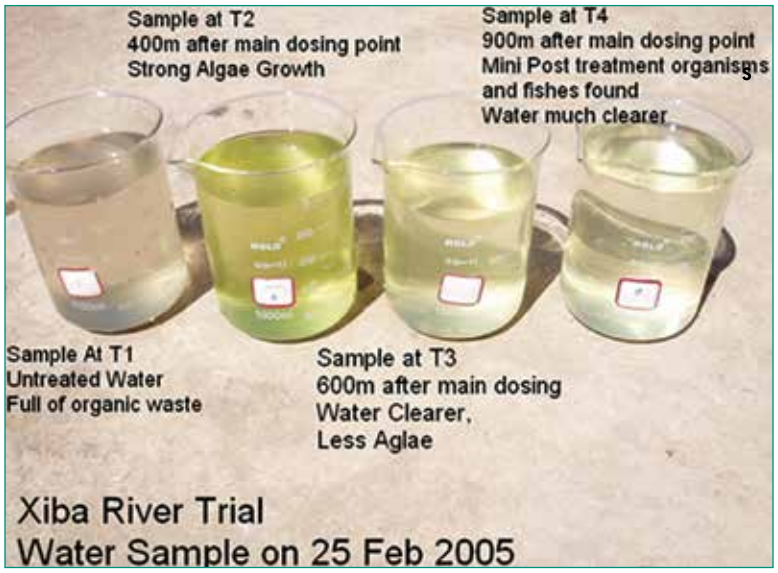

Fig 5: *Comparison of Water Sample from T1 to T4 on 25th Feb 2005*

The water before treatment at T1 was light grey with hardly any sign of life presence. At T2 where the biomedia is located, the water turbidity increased drastically due to the presence of large quantity of bacteria, plankton and algae. The water appeared very greenish. Protozoa and metazoan appeared at T3 further downstream, helping to reduce the algae content, giving the water a cleaner appearance. At T4, which is approximately 7 hours flowing time from D1, huge populations of larger protozoa and metazoan were eaten by the small fishes found there. The water looked very much cleaner with a transparency of more than 0.8m deep with underwater plants clearly visible. The presence of fish further confirms that **Ecologicals'** microbial formulations are non-pathogenic and NOT harmful to higher forms of living organisms. As the protozoa and metazoan moves upstream and more fishes move in the test zone, it is expected that water at T3 and T4 can easily achieve a standard close to level-three where there is significant water clarity and fishes swimming in the river. This ideal condition with fishes swimming gracefully in the river is the ultimate objective every government authority would like to achieve. It is possible, while using formulations manufactured by **Ecological Laboratories** to rehabilitate polluted rivers such as Xiba River with slow flowing water such that it attains the ideal environment with its natural ecological balance.

It is unfortunate in the case of Xiba River, the trial project was unable to sustain the above condition due to the regular blatant discharge of huge volumes of polluted wastewater although, despite this,, the river demonstrated more resiliency and the ability to recover faster from these events.

Fig.6: *D water sampling from Fig. 5*

Fig.7: *The fish appear in the Xiba River*

Conclusion

a) Ability of MICROBE-LIFT® technology products in rehabilitating river.

The trial project has concluded positively that treatment is effective in rehabilitating a flowing river as achieved on 27th Feb 2004. It took three months from inoculation to achieve significant water parameter reduction, a period which was in line with the manufacturer's expectations of 90 to 120 days. This was achieved even with the unexpected low temperatures in Nov and Dec 2004 and interruption of the project by repeated huge dumping of waste water into the river.

b) Effect on odor reduction by MICROBE-LIFT® technology

The trial project has also concluded very positively that treatment is very effective in odor reduction and is non-pathogenic and not harmful to fishes, as claimed by the manufacturer.

c) Effect of pH Changes

The water at Xiba River has a pH ranging from 7.0 to 7.8 which is ideal for the survival and multiplication of microbes. This is an ideal pH range for this technology.

d) Effect of Temperature Changes

The trial results do show that the product's effectiveness reduces in temperatures below 10°C.

e) Conclusion on parameter measurement

The positive results achieved in Feb 2005 leads to the conclusion that Ecological Laboratories product formulations are effective in bringing down BOD, COD, TSS, Turbidity, Total Nitrogen and Total Phosphorous by half from T1 to T4, which represents only an average of 7 hours retention time. Although the water parameter at T4 has not achieved a level-three standard as set out by the authorities, the product manufacturer is confident that a level-three standard or a standard at least close to level-three can be achieved in a complete river treatment where the bacteria has a much longer time to react and treat the water. Practical steps must be taken to prevent blatant dumping of huge volumes of untreated wastewater into the river, particularly chemical waste that inhibits the bacteria growth such as the highly alkaline cement plant waste.

f) Dosage

The experiment commenced with an inoculation at 4.7 ppm, which is, less than half the 10 ppm recommended by the manufacturer. However, it was subsequently adjusted to approximately 1 ppm per day based on the daily flow rate. This dosing is higher than the recommendation for a stagnant lagoon of 1 to 2 ppm per week. The higher dosing was recommended to compensate for the irregular flow pattern of the river and the short retention time of the test zone. In a complete river project where the length of treatment is long, a much lower dosing is recommended.

g) Effect of Biomedia

Although biomedia was introduced for a 510m long stretch at the beginning part of the trial zone, the actual effects of biomedia could not be measured because there are no control cases for comparison. We strongly believe that the biomedia helps in retaining part of the microbes as the water flows. This is likely one of the contributing factors for success in the trial.

h) Recommendations are proposed for future river treatment with MICROBE-LIFT® technology:-

1. It is strongly recommended that dosing of MICROBE-LIFT® technology for flowing rivers be done through a continuous automatic dripping dispenser rather than direct pouring into the river as has been done in this trial project. This is to prevent large quantity of bacteria being washed off if flow is inconsistent.
2. A holding pond of suitable size can be constructed to divert some wastewater into the pond to culture MICROBE-LIFT® bacteria, to increase the bacteria count before its release into the river. The continuous dripping can be done at the inlet of this breeding pond. In this way, the usage of MICROBE-LIFT® can be reduced by several fold thereby make any river treatment very economical. The principal supplier of MICROBE-LIFT® can provide a detailed project feasibility evaluation to the client.
3. Introduction of biomedia along the river with appropriate design and quantity is recommended for rivers with water flow rate exceeding 2 meters per minute. MICROBE-LIFT® principal supplier can advise the client on an economical biomedia design and sizing.

This report jointly prepared by Prof Hu Kailin of Kunming University of Science and Technology and Mr Goh Kwang Beng of **Ecological Laboratories.**

MICROBE-LIFT® Technology Restores River in the Heart of Kuching City

Location: Sungai Bintangor River, Kuching, Sarawak, Malaysia

Background:

Sg. BIntangor is situated in the heart of Kuching City. The river is about 0.65km long and 12-15m wide, forming as a tributary of the Sarawak River. It passes under a protocol road in Kuching and flows through Kpg. Masjid in Satok before joining the Sarawak River.

During high tide, the Sarawak Barrage at Sg Sarawak is closed to prevent the ingress of seawater; the water in Sg. BIntangor is rel atively stagnant. During heavy rains, the barrage is opened to prevent flooding.

On dry days, the water may eve n back flow from Sg. Sarawak when the barrage is closed as the water level in Sg. Sarawak rises faster than Sg. Bintangor due to rainfalls around the catchment area. During heavy downpour and low tide, the flow in Bintangor can be quite fast and the water is discharged within a few hours. The average depth of the water ranges from 0.5 to 1.5m.

The river emits foul odors, which are clearly noticeable at the protocol road located above the river. The pollutants include solid wastes, animal and fish entai ls, household garbage, oily and greasy scum and food remnants from surrounding eateries, workshops, and paint. It is a repulsive sight that adversely affects tourism. In addition, the dirty waters represent hygiene and health hazards. Of obvious hygiene concern, the dirty water also supports the breeding of harmful insects, such as mosquitoes.

A clean river is of paramount importance to blend in with the newly developed Sungai Bintangor riverbanks. At a recent survey of the catchment area of Sg. Bintangor, we found that the main pollutants came from four locations. These include food and sewage waste from the food courts, restaurants, hotels, lodging houses, housing estates, and the many makeshift food stalls along Jalan Nanas, Jalan Rubber, Jalan Satok, and Jelan Kulas.

One of the worst polluters is the Wet Market at Jalan Satok where a lot of animal and fish blood and entrails, left-overs, and vegetable and fruit wastes are simply flushed down drains without any type of filtration or grease traps.

Although most of the larger solid wastes are collected in rubbish bins provided by City Hall, most of the smaller and wet, untreated and unfiltered wastes, oils and greases, are washed down the culverts and storm drains, eventually ending up at the weir areas of Sungai BIntangor. Most of the time the weir area is covered in an ugly layer of smelly, dirty, and unsightly layer of grease scum.

Fig 1 & 2: *Pictures of Sg. BIntangor during low-level time prior to treatment in November 2007.*

This is very difficult remediation due to the very high level of contamination and the lack of retention time for biological treatment.

Objective:

Any successful remediation of this site has to be two-phased. The city is challenged to change practices of those discharging into the river while a program of bioremediation with MICROBE-LIFT® Technology was designed to help remove scum and soluble organics in the river stream. Due to the very low retention time in a flowing stream, AEM designed a system of biomedia cages which were installed at the weir area and at strategically located points along the full length of the river to retain as much microbial biomass as possible during heavy rain and in the presence of high and ebbing tides.

A permanent weir had been constructed at the upstream section of Sg. Bintanger near the road bridge to trap sold debris. The weir maintains the water level upstream at about 1.5m depth consistently and prevents the inflow of water from Sg. Sarawak. The water upstream the weir serves as an ideal location for the incubation of bacteria

Sometimes during thigh tide, the incoming water back-flows over the weir and at ebb tide, some floating debris and greasy scum trapped on the weir and not removed by the contractor, is carried over the weir and into Sarawak River. At certain times there is ingress of wastewaters from Sg. Sarawak into the Sg. Bintangor during high tide. This brackish water at the mouth of the river emits foul odor due to the untreated wastewaters from other tributaries discharging into the Sg. Sarawak. To prevent this malodor, all wastewaters discharging into Sg. Sarawak must be treated also.

In addition to inoculation with MICROBE-LIFT® technology, the treatment included use of BioAktiv, an oxygenation chemical to assure adequate aeration. Inoculation commenced on 1st December 2006 according to the dosage schedule listed below.

Fig.4: *Shows the installation of the biomedia cages in the river.*

In addition to inoculation with MICROBE-LIFT® technology, the treatment included use of BioAktiv, an oxygenation chemical to assure adequate aeration. Inoculation commenced on 1st December 2006 according to the dosage schedule listed on the following page.

Treatment

Date	Microbe-Lift® (gal)	BioAktiv (kg)	Remarks
12/01/2006	30	10	Inoculation dosing along the complete river.
12/02/2006	10	10	
12/03/2006	10		
12/04/2006	10	10	
12/05/2006	10		
12/06/2006	10		
12/07/2006	10	10	
12/08/2006	7		On the 8th day, 90% of the whole weir area was covered in a grayish and wrinkled layer of bubbling scum indicating active microbial in action. On the 9th day, bad odor was reduced by about 60% and surface scum at weir reduced by 50%.
12/09/2006	7		
12/10/2006	7		
12/11/2006	7		
12/12/2006	7		
12/13/2006	7		
12/14/2006	7	10	By the 14th day, bad odor has completely disappeared. Water after the weir turned greenish and cleaner, greasy scum reduced drastically. Lots of small bubbles were seen all over the weir area. Small fishes and marine creatures were found swimming along the river, especially at the weir area.
12/15/2006	7		
12/16/2006	7		
12/17/2006	7		
12/18/2006	7		
12/19/2006	7		However, as commercial solid debris continued to be dumped into the river and accumulate at tjhe weir area, part of the dosing exercise ws diverted to wste-water source further upstream.
12/20/2006	7		
12/21/2006	7	10	
12/22/2006	4		
12/23/2006	4		Water at weir area remained greenish and cleaner with noticeable marine life and the total absence of bad odor.
12/24/2006	4		
12/25/2006	4		
12/26/2006	4		
12/27/2006	4		
12/28/2006	4	10	
12/29/2006	4		

Fig. 5: *The dosage schedule specifies a total of 220 gallons* MICROBE-LIFT® formulation *and 70 gallons of BioAktiv to be introduced.*

Results Achieved

Water parameters were monitored. Samples were taken prior to treatment on 16th November, 2006, a relatively dry day. Almost two months into treatment, comparative samples show significant improvement.

	Location	BOD mg/l	COD mg/l	TSS MG/L	TN mg/l	Comments
11/16/2006	Mid stream	249	721	1350	111	pH 6.6. Very strong odor
12/20/2006	Influent	20	88	57	9	At the weir
12/20/2006	Effluent	4	18	30	11	At the river mouth, odor significantly reduced.

Fig. 6: *Pretreatment results demonstrate the extreme contamination of this site. The difference between influent and effluent parameters indicates efficiency of treatment.*

The early elimination of bad odor and the drastic reduction of surface scum are the first indication of the progress of remediation. Over the next two months, the MICROBE-LIFT® formulation will have established its optimum population in the biomedia cages at the weir and along the river maximizing the benefits. This treatment will be able to help reduce odors and scum and significantly reduce the organic loading. The introduction of hydroponic pl ants along the river will further improve organic reduction and help beautify the river, however, this site will not be fully remediated until the practice of dumping garbage into the river is changed.

For more information on MICROBE-LIFT® Technology contact

Ecological Laboratories Inc.
www.EcologicalLabs.com

CS17203

National Seminar On Biological Application and Environmental Friendly Protection of Malaysian Rivers

Location: **Penang, Malaysia**

Technical Paper by Magna Vappro (M) Sdn Bhd in collaboration with Oakwell Engineering Limited.

BIOREMEDIATION OF POLLUTED RIVERS, LAGOONS AND LAKES- THE MICROBE-LIFT® WAY

What Is Bio-remediation:

Biological treatment and reliance on bacteria is not new or novel; it has played a central role in conventional waste treatment throughout the history of mankind. What is new however, is our growing understanding of the natural processes and how we can utilize bacteria for industrial, agricultural and residential applications in breaking down organic waste thereby enhancing the bio-degradation process fundamental to natural recycling and sanitation clean-ups.

Bioremediation consists mainly of biostimulation, where nutrients or oxygen are added to soil or water to stimulate native bacteria a, and bioaugmentation, where select microorganisms, naturally occurring or engineered strains, are introduced to enhance the degradation process.

The primary use of biological agents has been in enhanced natural remediation and wastewater treatment of sanitation systems for residential and municipalities, lakes, rivers and ponds, once-through lagoons for agricultural and industrial activated wastewater systems. Bioremediation can usually be done in situ, without the need for existing system modification and saving large upfront capital cost in waste treatment equipment. Bioaugmentation, the purposeful inoculation of external microorganisms to a biological system with sufficient population of suitable types of bacteria will dramatically improved results where biostimulation alone has proven inadequate or ineffective. In order to understand the growing use and evolution of bioremediation, we need to understand in simple terms the biological function of bacteria (prokaryotes) and consider their role in the balance of nature.

"If there is food, some organism will eat it. If there is a place to live, some organism will live there. Every species has a great ability to produce offspring and its population expands until it runs out of food or it is limited by competition, its own waste products, or some other factor. Changes in climate or introduction of a new species from elsewhere can greatly affect the existing balance of nature."
This simple statement summarizes the interactions of all living things on Earth. Bacteria are single-cell organisms and most of them must find foods such as sugars, proteins and vitamins-nutriments to live. The various metabolic capabilities of bacteria are the key traits that we use to group and classify them into their genera/sub-species.

The ecosystem, both on land and in the water, depends heavily upon the activity of bacteria. The cycling of nutrients such as carbon, nitrogen, and sulfur is completed by their ceaseless labor. Organic carbon, in the form of dead and rotting organisms, would quickly deplete the carbon dioxide in the atmosphere if not for the activity of decomposers. This may not sound too bad to you, but realize that without carbon dioxide, there would be no photosynthesis in plants, and no food. When organisms die, the carbon contained in

their tissues becomes unavailable for most other living things. Decomposition is the breakdown of these organisms, and the release of nutrients back into the environment, and is one of the most important roles of the bacteria.

The cycling of nitrogen is another important activity of bacteria. Plants rely on nitrogen from the soil for their health and growth, and cannot acquire it from the gaseous nitrogen in the atmosphere. The primary way in which nitrogen becomes available to them is through nitrogen fixating bacteria. These bacteria convert gaseous nitrogen into nitrates or nitrites as part of their metabolism, and the resulting products are released into the environment. Some plants, such as liverworts, cycads, and legumes have taken special advantage of this process by modifying their structure to house the bacteria in their own tissues. Other denitrifying bacteria metabolize in the reverse direction, turning nitrates into nitrogen gas or nitrous oxide. When colonies of these bacteria occur on croplands, they may deplete the soil nutrients, and make it difficult for crops to grow.

Bacteria are also used in sewage treatment facilities. Solid matter, after having been separated from liquid wastes by screens and shredders, are added to a group of anaerobic prokaryotes. These bacteria decompose the material, converting it to material that can be used as landfill or fertilizer in land farming.

Bacteria are also used in solving environmental problems because of their selective capability to consume and degrade almost any compound. For instance, certain cultured bacteria are now being sprayed on oil spills and petroleum drilling lagoons, where they rapidly multiply and break down the oil molecules into less toxic compounds. In a similar way, bacteria can also clean up old mines. The water from old mines is filled with highly acidic heavy metals that are highly toxic and expensive to clean up. However, there is an increasing use of bacteria, especially a genus called Thiobacillus, which thrives in acidic water. These microbes can extract copper from the water, and other valuable metals, utilizing oxidize-sulfur to accumulate and extract the metals. These are just two examples of the ways that bacteria can be practically used to solve environmental problems, and over-time many more applications will be developed through selective breeding and mixed production of various bacteria cultures.

Basic Biological Treatment Processes Are Based on the Following Chemical Reactions:

Aerobic

$$BOD + N + P + O_2 \rightarrow CO_2 + H_2O + cells$$

Facultative

$$CO_2 + NO_3 + O_2 \rightarrow NO_3 + CO_2 + cells$$

Anaerobic

$$BOD + N + P \rightarrow CH_4 + H_2S + CO_2 + cells$$

Life Cycles

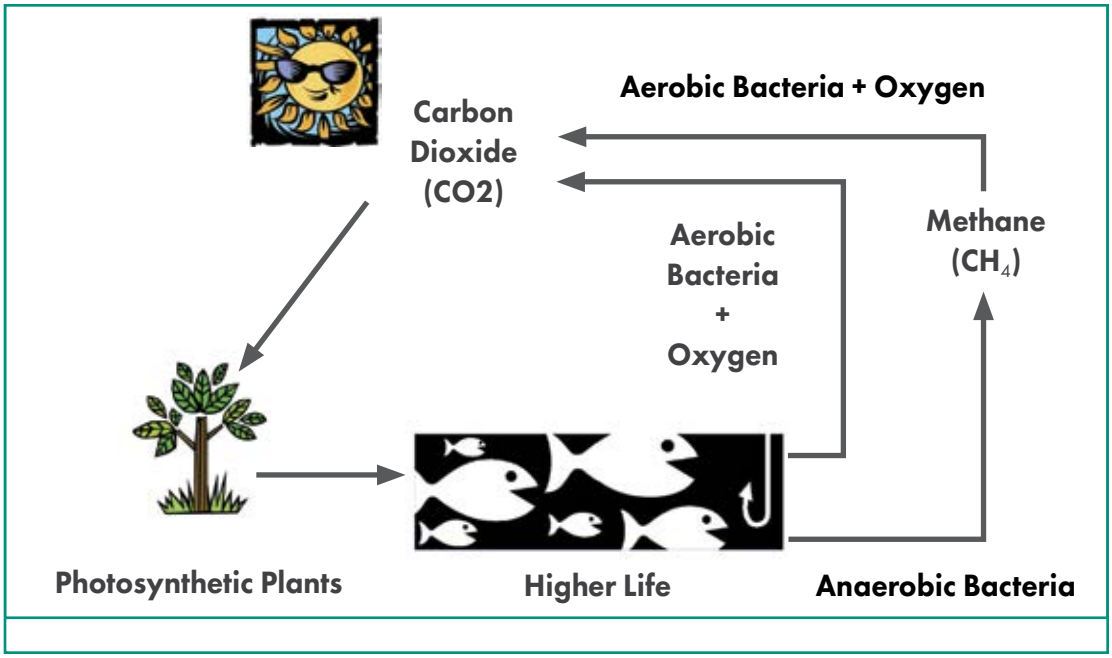

Fig 1: *The Carbon Life Cycle*

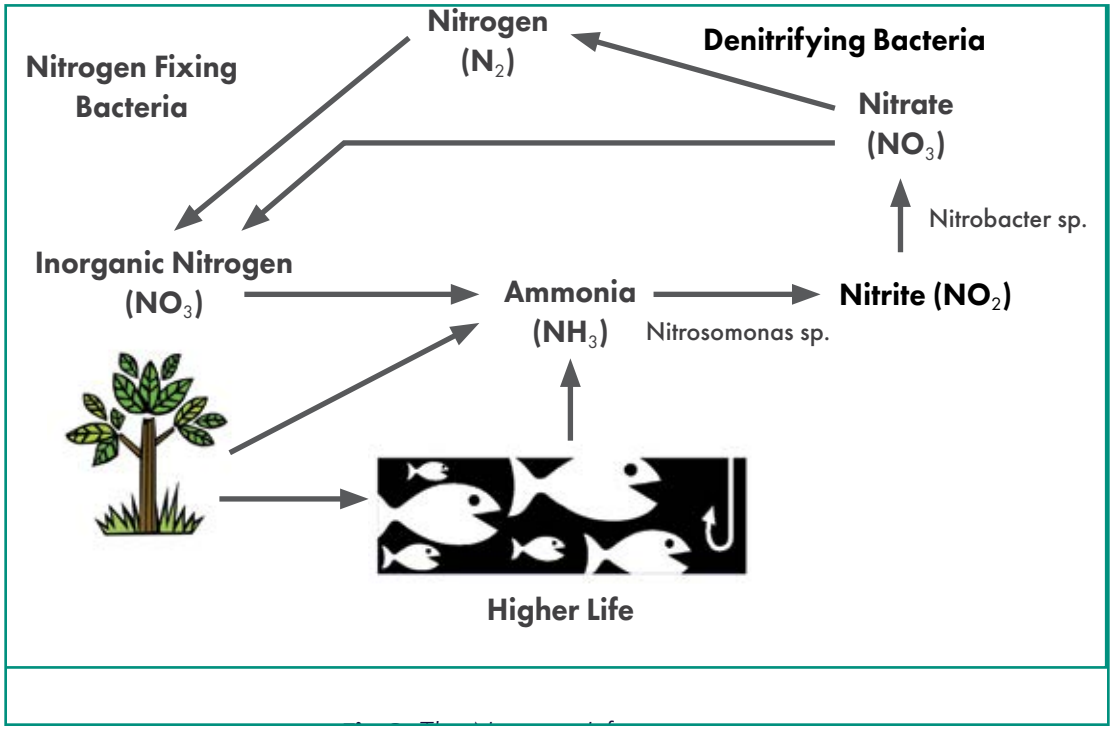

Fig 2: *The Nitrogen Life Cycle*

Bioremediation Operates On the Simplified Kinetic Model Below:

$$S_e = \frac{S_i}{1 + Xc\ Ks\ \Psi h} -$$

Where	S_e	-	**effluent concentrations of substrate**
	S_i	-	**influent concentrations of substrate**
	X_c	-	**cell mass in gm/L**
	K_s	-	**specific rate coefficient, gms/L ***
	day Ψh	-	**hydraulic residence time, days**

Fig 3: *Simplified Kinetic Model*

A successful bioremediation therefore require an adequate concentration of balance types of micro-organisms in the wastewater with appropriate pH and temperature to be treated for a sufficient amount of time for bacteria to multiply.

Augmentation Chemistry Vs. Stoichiometric Chemistry

Many engineers and operators are accustomed to having precise application information when using chemical products in chemical process systems. This is usually not the case with biological systems and biological products used in bioremediation process.

The reason for this is quite simple. Chemicals are non-living things and act in predictable stoichiometric ratios based on molecule for molecule interactions. A good example is pH, which is the measure of [H+] ions or [OH-] radicals in solution. To neutralize a solution which is either too acidic or too alkaline requires the addition of the reciprocal ions or radicals that combine in a direct one to one ratio to form water. For example, if a solution of hydrochloric acid, HCl, is added to an alkaline solution of sodium hydroxide, NaOH, the [H+] ions and [OH-] radicals will react to form water with the residual ions to form salt (NaCl) in a predictable, quantifiable reaction.

In biological systems, the dynamics are biochemical as opposed to chemical, and the active agents are living entities. Where one would have to increase the quantity of chemical proportionally to deal with a higher load of reactant, in a biological system the biological additive can grow to help compensate for increased loadings. While small increases in dosage may be required with increased loading, proportional increases are not required. The organisms grow in response to higher loads, so that the benefit is multiplied which makes biological additives much more cost effective than chemical additives. It also makes for dosage programs that do not seem to properly compensate for loading changes, as bacteria has an inherent ability to adjust to loading changes.

Bio-augmentation dosage programs typically follow a descending application schedule to accommodate the fact that the benefits of the addition are multiplied. These programs usually involve a "purge" or "inoculation" dosage to establish the required bacteria population quickly.

The "purge" or "inoculation" is followed by an intermediate maintenance dosage to support the development of the required population. Finally, a regular maintenance addition is used to maintain the required population to maintain the biochemical improvements, which have been realized through the "inoculum" and "intermediate maintenance" dosages.

On occasion, when a biological system experiences shock loads, either hydraulic or organic, it may be necessary to return to the "intermediate maintenance" dosages for a week or two to fortify and stabilize the bacteria population.

MICROBE-LIFT® Remediation Technique

MICROBE-LIFT® technology has proven to be one of the most successful bio-product to be used in Bioaugmentation for a broad spectrum of polluted bodies of water and various waste treatment systems. MICROBE-LIFT® technology is a combination of over 30 species of naturally occurring live bacteria suspended in a liquid medium used for the treatment of industrial, agricultural and residential organically contaminated wastewater. It is a product with high cell mass and specific coefficient.

MICROBE-LIFT® technology was developed in 1976 by **Ecological Laboratories** in the United States. With almost three decades of experience in bacteria culture selection and bio-product formulation, **Ecological Labs** has become one of the world's leading providers of live bacteria formulas for wastewater management. Over the years, their direct involvement in microbial treatment development and planning has lead to successful application programs for a broad spectrum of industrial, municipal and residential wastewater problems.

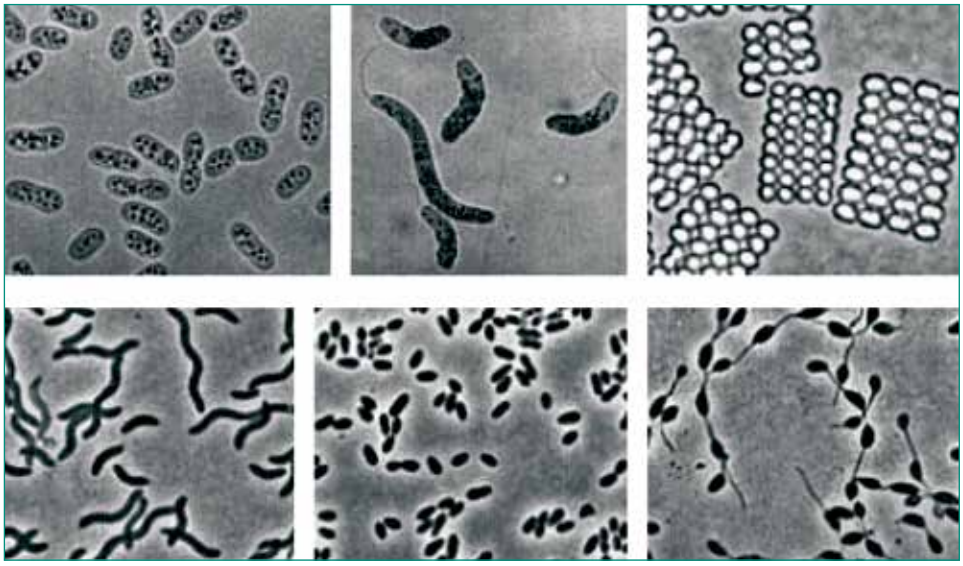

Fig 3: *MICROBE-LIFT® technology type of bacteria*

MICROBE-LIFT® bacterial culture contains aerobic and anaerobic species as well as chemo- and photo-synthetic stains. The microorganisms in MICROBE-LIFT® technology are natural occurring, non-toxic and non-pathogenic. They are living bacteria, held in a state of suspended animation in a liquid medium. The product formulas are not harmful to humans, animals, plants and all types of aqua culture. When MICROBE-LIFT® is added to a contaminated area, the bacteria immediately revive themselves and begin to feed, reproduce and attack that organic waste.

Areas of Application

The following are *Before and After* pictures of MICROBE-LIFT® treatment programs from around the world. Once you see them, you will want to know more about how the MICROBE-LIFT® method of bioaugmentation can help you and your community.

A Swine Production Waste Pond before Treatment

The same pond after 5 weeks of Aqua Clean Treatment

Domestic Sewerage Pond in Uruguay before Treatment

Domestic Sewerage Pond in Uruguay 72 days after Aqua Clean Treatment

Domestic Sewerage Pond in Uruguay before Treatment

Domestic Sewerage Pond in Uruguay 72 days after Aqua Clean Treatment

Grease Trap Pond in Panama-2002 Entire Lagoon was covered with oil, grease and solid

Domestic Sewerage Pond in Uruguay 72 days after Aqua Clean Treatment

MICROBE-LIFT® Technology Has Proven to Be Excellent In A Broad Range of Applications Utilizing Bio-Augmentation and Remediation:

1. Achieving ecological balance of natural bodies of water such as polluted lakes and lagoons, while reducing insect population.
2. Economical treatment of agricultural wastewater using simple oxidation ponds for swine, dairy, poultry and duck farms. Treated effluent has proven to improve fertilizer value as added benefit.
3. Enhancing the effectiveness of municipal and industrial wastewater treatment plants; increasing the operation efficiency and capacity by reducing COD, BOD, TSS, sludge and bad odor. The economic rewards reduce maintenance costs; lower capital expense and penalty charges.
4. Improving water quality in commercial fresh water shrimp and fish farming lagoons, reducing mortality rate and increasing yield and quality.
5. Commercial grease trap treatment of restaurant and hotels drastically reduces the cost for fat and grease removal and eliminates bad odors.
6. Rejuvenating failing leach fields and septic tanks reducing the need for expensive system removal and replacement, while eliminating odor.
7. Improving the ornamental pond water quality and significantly reducing the need for filter cleaning and maintenance.
8. Rapidly breaking down hydrocarbon pollution from oil spills and production ponds, as well as removal of hydrogen-sulfates helping to prevent tank corrosion.

Systems Program Approach

We provide total solutions and technical support to solve your water pollution and waste treatment problems by developing:

Innovative Treatment Plans

Identifying problems, establishing goals and defining criteria for success: we work with you to review your needs via systematic survey forms.

Sustainable Natural Solution

Providing environmental friendly treatment solutions to achieve ecological balanced system through natural microbial remediation and bioaugmentation technology. We maintain close technical support to review results and provide adjustments in order to continue sustainable long-term performance.

Cost Effective and Efficient

Natural solutions that in most cases are far more effective and efficient than chemical and mechanical methods, usually reducing the need for high upfront capital equipment investment.

Environmentally Safe

MICROBE-LIFT® technology uses only naturally occurring non-toxic and non-pathogenic bacteria based products that are safe for humans, animals and aquatic life. Approved by USA EPA and USDA.

Case Studies From Typical Applications Include:

1) Xiba River, Kunming Trial Project

Xiba River Project was a very interesting study of remediation in an open body of flowing water. Traditionally this type of problem has been extremely difficult to effectively treat, and many had failed in this effort. The Trial Project required that we develop a novel and unique application system, but utilized the basic principles of bio-remediation, and in the end we were able to provide a very cost efficient solution.

The Xiba River is an extremely polluted river flowing 4 km through Kunming, China. The river has an average flow rate of 26,000 m3 per day. The water is badly polluted from industrial, commercial and domestic waste. It had a grayish color, high turbidity, pungent odor and toxic effect had virtually eliminated signs of aquatic life.

The Pilot Study using MICROBE-LIFT® technology was carried out in the river's last 1.5km treating this section of the river as a plug flow reactor. The trial was carried out from Nov 2004 to March 2005 in collaboration with Kunming Technical University. The Project successfully demonstrates the efficacy of MICROBE-LIFT® bioaugmentation in an open river.

Measuring various water quality parameters along the river's pathway before and after treatment, the Environmental Graduate Students monitored the effects of MICROBE-LIFT® technology during the trial. The Project conclusively demonstrated MICROBE-LIFT® technology's ability to restore the polluted river to an ecologically balanced environment. Aquatic life returned to the River which also demonstrated MICROBE-LIFT® technology's non-toxicity to aquatic life; the odor was eliminated, water clarity was improved, and general health of the waterway was restored. MICROBE-LIFT® technology proved to be a cost effective, environmentally friendly, natural method of rehabilitation.

The various water parameters measured (such as COD, BOD, TSS, Total Nitrogen and Total Phosphate) were reduced by about 50% at monitoring station 1.4 km downstream from the point of inoculation. The average remediation (effective retention) time for 1.4km length was about 7 hours. Kunming Technical University is convinced that a much higher rate of degradation is achievable based on a complete river treatment that would significantly raises the effective retention time for the MICROBE-LIFT® treatment. The basic Kinetic Model for bio-remediation is built upon the effective rate of the selected bacteria to degrade the specific pollutants, the number of bacteria available, and the time allowed for the bacteria to interact on the pollutants. While pH, temperature, sunlight and other limiting factors will affect the results, the basic Kinetic Model is the primary focus for treatment.

The Xiba River posed a set of very challenging problems to overcome, retention time being the most difficult. Yet by developing a novel and inexpensive Bio-Media, we were able to increase the surface area and provide the treatment needed.

2) Pilot Study on Piggery Wastes Treatment at Poh Huat Pig Farm, Sarawak, Malaysia.

Searching for an effective, environmentally friendly method of treating animal farm wastewater, a pilot project was commissioned in collaboration with National Resource and Environment Board (NREB) of Sawarak in March 2004 at Poh Huat Pig Farm. The Project goal was to assess and confirm the results of MICROBE-LIFT® treatment in reducing BOD and COD in piggery waste. This is an area where MICROBE-LIFT® technology has been very successful in similar studies in the USA, Korea and Northern Europe.

The result of this Pilot Project confirmed that MICROBE-LIFT® technology would produce the same successful results in Malaysia. Characteristically, MICROBE-LIFT® 's bioremediation eliminated bad odors within one week after treatment, with significant reduction in COD and BOD. Over the next three weeks, as the bacteria began to breakup the organic sludge at the bottom of the pond, MICROBE-LIFT® technology again demonstrated its effectiveness in degrading hardened organic sludge built up over the years in an open waste lagoon. Once all the organic sludge has been degraded, the pond will achieve its ecological balance and help to maintain a clean environment.

Fig 5: *Pond Condition Before and After Treatment at Poh Huat Piggery Waste Treatment*

3) MICROBE-LIFT® Treatment to Sheraton Tower, Singapore Landscape Pond, Singpore

Sheraton Tower Hotel, Singapore has a 100m3 beautifully landscaped pond for display of koi fish. There were two small sand filters and no biological filters in place. The water was turbid with high COD and BOD, as well as a bad fishy smell. MICROBE-LIFT® remediation method was introduced to obtain and maintain a clean and ecological balance for this pond environment without the need for an elaborate and expensive biological filter.

4) Mosquito Larvicidal Evaluation by Insert Control & Research Inc., Baltimore, USA

MICROBE-LIFT® technology was evaluated for its potential as a killing agent against the aquatic stages of laboratory-reared Aedes aegypti. The efficacy of the bacteria product was assessed for its affect upon the egg stage, the larval stages, the pupal stage and the resulting emergence of adults.

MICROBE-LIFT® technology was effective on the egg stage, increasing egg mortality from 36.9% in the untreated control to 87.9% in the treatments.

5) Use of AquaClean in Freshwater Shrimp Production, Mississippi

Mississippi Gulf Coast Community College in Southeastern United States conducted an evaluation on MICROBE-LIFT® effect in the production of Macrobrachium Rosenbergii fresh water shrimp production in 2001.

The study indicates that MICROBE-LIFT® technology increases total production and average size of shrimp while improving the feed conversion and reducing production cost.

Benefits of MICROBE-LIFT®

- Total Shrimp Production: +17.4%
- Total Feed Consumption: -14.4%
- Total Weight per Shrimp: +22.4%

[A copy of the full report can be read in Case Study 12104]

6) Algae Control in Public Lagoon

MICROBE-LIFT® technology dtoes not eliminate algae, but controls algae population that is the real desired objective of most public lake and lagoons with fishes.

Further detail on Bioremediation and MICROBE-LIFT® technology is also available at **www.EcologicalLabs.com**

Prepared by
Goh Kwang Beng
29th October 2005

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Ecological Laboratories Inc.
www.EcologicalLabs.com
CS17204

Water Restoration and Enhancement of Pond at Winkler Bible Camp in Manitoba, Canada

Location: **Winkler Bible Camp, Winkler Manitoba, Canada**

Background: The following performance information was provided by Mr. Gerald Wiebe owner of Ecological Dynamics, Inc, Manitoba MB, Canada. Gerald has featured our technology for water enhancement and restoration successfully for over 12 years. Due to his success in natural biological water management he was contacted to address a water quality problem at Winkler Bible Camp.

The pond in question consists of a man made three acre pond with a maximum depth of 14 feet and is used for swimming and other recreational activities at the summer camp.

Objective: On June 14, 2016 the camp management contacted Ecological Dynamics with concerns of discolored water, excessive bottom sludge, and potential pathogenic water quality issues, making it unsafe for swimming.

- Water samples were taken and initial lab tests indicated a total coliform of 3260/cu/mg.
- Water turbidity was very poor with a layer of organic solids within the shoreline beach and on pond bottom, resulting in poor water quality and concerns for camp swimmers.

Solution: Treatment with MICROBE-LIFT®/PBL and MICROBE-LIFT®/SA started May 14th 2016.

Water Restoration and Enhancement of Pond at Winkler Bible Camp in Manitoba, Canada

The sand contained organic muck that would come to the surface as you walked on the sandy beach and had a poor rotten egg odor.

Photos of sand before treatment began.

Prior to MICROBE-LIFT® *treatment* *Five months of* MICROBE-LIFT® *treatment*

Results Achieved: Water quality improved dramatically within 30 days of treatment, odor was eliminated and biological pathogen control effectively reduced pathogen levels to acceptable levels of <10 Fecal coliforms and Total Coliforms of < 60, allowing summer camp children to once again enjoy the water and water events.

Look at the pictures left to right, review the reduction and elimination of the organic matter from the sand at shore line, and within the entire ponds ecosystem, i.e., benthic and littoral zone.

In September of 2016 camp management advised they were pleased with the recovery of their lake and requested the use of the MICROBE-LIFT® for 2017, treatment is currently being applied.

For more information on MICROBE-LIFT® Technology contact
Ecological Laboratories Inc.
www.EcologicalLabs.com
CS17205