Surface water remediation and waste water treatment using circulators

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RemTech 2006

* Who Are We?

* Circulators

* Surface Water Management

* Waste Water Treatment

* More Than Just Odour Control

* Benefits

* Conclusion

Sunset Solar Systems Ltd. & Dagaz Environmental Inc.

After 23+ years and 5,000+ energy efficient and renewable energy circulators in operation world wide, Sunset Solar Systems Ltd. and Dagaz Environmental Inc. are the world leaders in providing renewable energy equipment to remediate and treat surface water, waste water and liquid effluent systems. This remediation is achieved by enhancing both biological and natural chemical processes in aquatic (water based) environments.

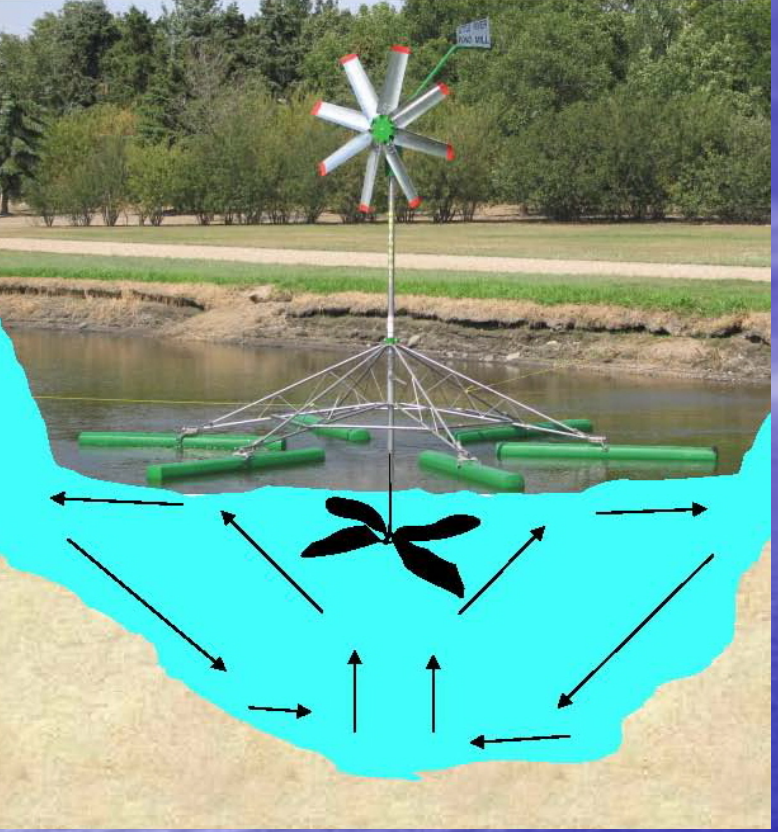
Electric

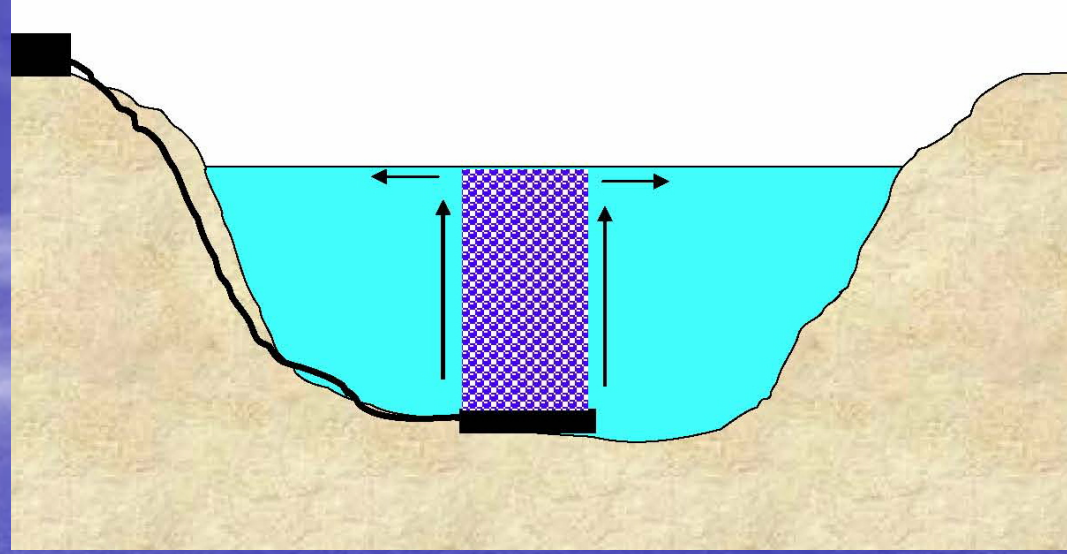
Wind

Solar

Circulators

The Little River Pond Mill® is a circulator, not an aerator. The most efficient Little River Pond Mill® circulator presently operates at more than $9m^3 s^{-1}$ (7.1 million Imperial gallons per hour) of flow.





Air injection ↑

← Circulator

Circulators are not aerators (air injection) – although they do promote significant aeration via re-aeration at the surface. Surface reaeration is upwards of 99% efficient for oxygen transfer efficiency (OTE), whereas air injection OTE is significantly below 40% on average.

All circulators are not created equal. Their efficiency is based on machine design characteristics such as the flotation system, machine aerodynamics, impeller design and impediments to flow (tubes, pontoons, legs, etc.) – all of which interact with fluid dynamics.

Little River Pond Mill® Circulator Gallery

Wind – Enviro 600

Solar – Enviro 610

Wind – Enviro 600 series RPD

Electric – Enviro 700

Electric – Enviro 200 series RPD

Electric – Enviro 200

Circulator Action Promotes

**The growth of desirable microorganisms that promote:*

-A reduction of solids

-Creation of beneficial enzymes and other metabolites, and when land applied can:

***Improve plant performance**

***Improve soil tilth**

***Improve soil health**

-Sequestration of carbon (organic matter) into microbial bodies

Circulator Action Promotes

An increase:

*In aquatic species diversity

*In dissolved oxygen (DO) that promotes:

- a reduction in biological and chemical oxygen demand (BOD/COD)

- mineralization/oxidation/alteration of nutrients and other elements when exposed to oxygen thereby reducing pollution loading e.g. N, S, P, Mn

- fish and aquatic organism survival

Circulator Action Promotes

An increase:

*In exposure to UV rays, its damaging effects on chemical bonds, and eventually the degradation of various pollutants including PCB's, hydrocarbons, as well as its effects on living organisms such as UV sensitive microbes, etc.

Circulator Action Promotes

A reduction of:

***Odorous and non-odorous gases (methane, hydrogen sulfide, ammonia, etc)**

-Greenhouse gases

-Acid rain gases

-Other

***Solids/sludge**

***Undesirable/nuisance organisms including pathogens (e.coli), vegetation (Eurasian Water-Milfoil, algae, Duck Weed), mosquitoes, etc.**

Circulator Action Promotes

A reduction of:

***Financial & Environmental Costs associated with treatment of surface water and waste water (industrial, commercial, municipal and livestock)**

***Social costs (legal, neighbour relations) due to use of eco-economic waste management & environmentally friendly management practices**

***Energy consumption when compared with other circulators and aerators**

(Winter 2003-04 – saved a swine producer $12,000 CDN in electricity charges)

Surface Water Management

Lake management - Australia

The Little River Pond Mill® circulator has successfully been used in surface water management for decreasing the effects of eutrophication in surface waters (lakes, ponds, etc.) for more than 23 years.

Before Installation

Without the use of chemicals !!!

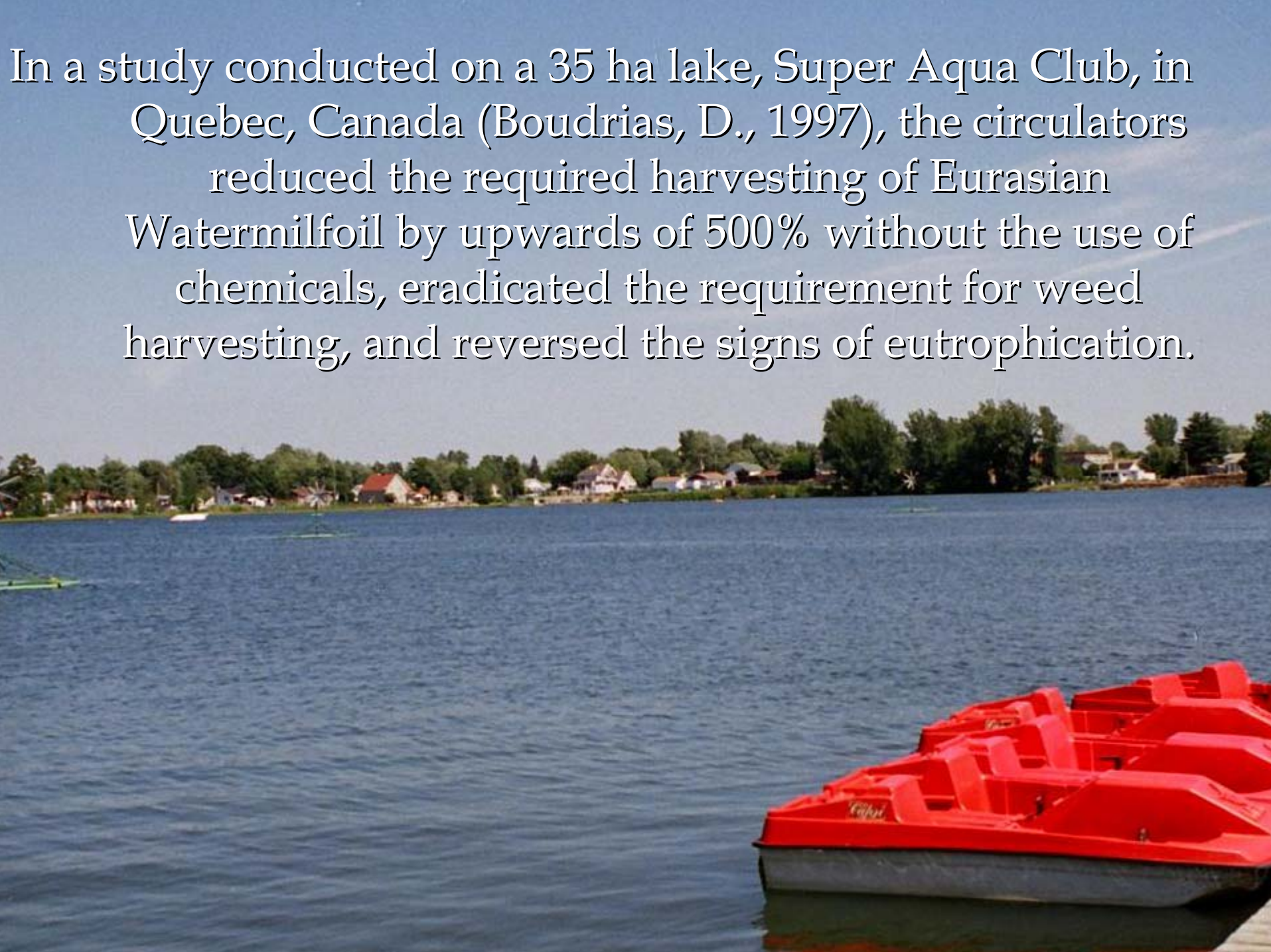
Duck weed infestation –

Dugout - Southern SK

One Month after installation

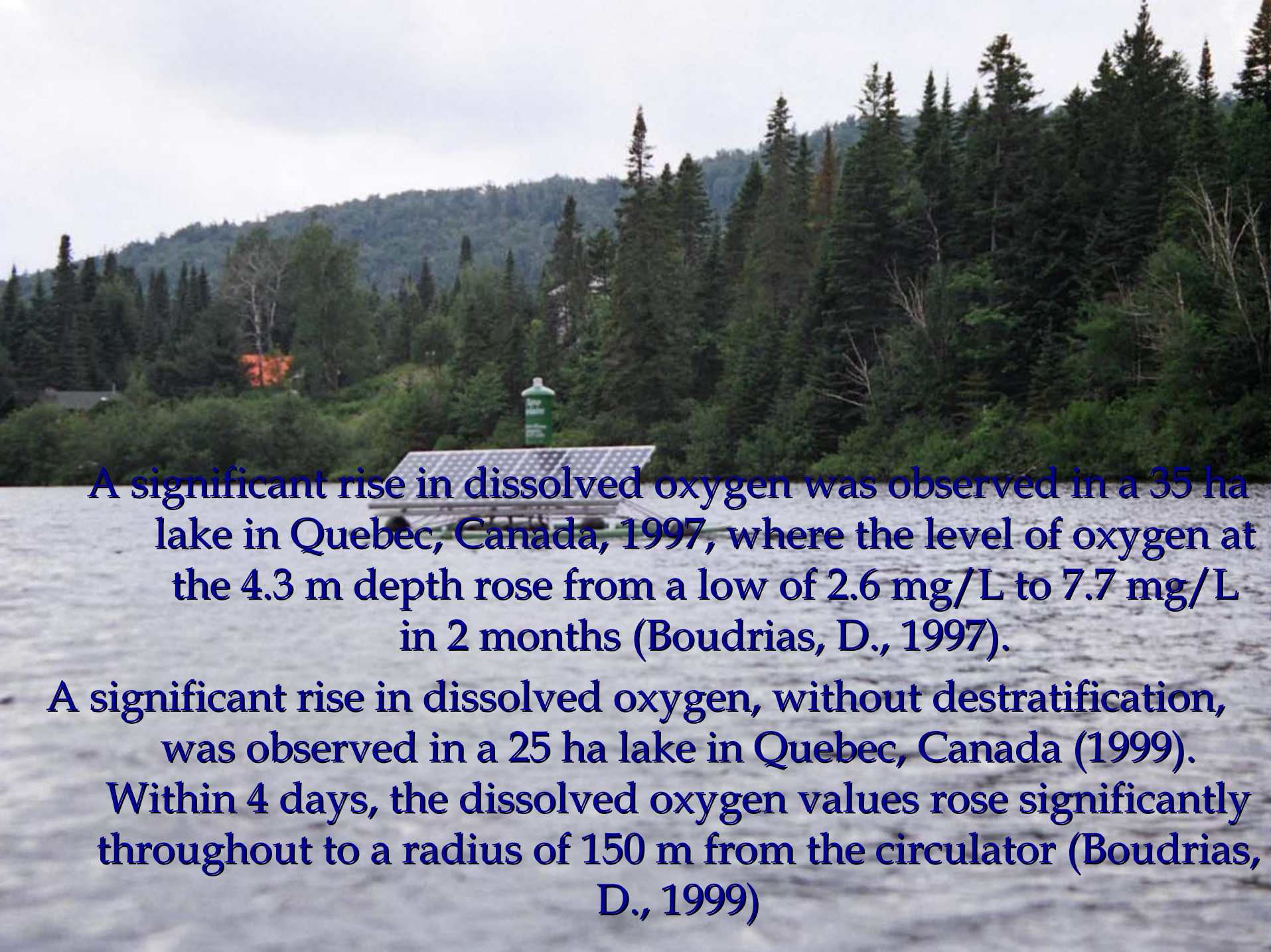
Little River Pond Mill® circulator installation for control of Eurasian Water milfoil, algae, and improving overall lake water quality – Quebec, Canada

Little River Pond Mill® circulator installation for control of Eurasian Water milfoil, algae, and improving overall lake water quality - Quebec, Canada, summer 2005


In a study conducted on a 35 ha lake, Super Aqua Club, in Quebec, Canada (Boudrias, D., 1997), the circulators reduced the required harvesting of Eurasian Watermilfoil by upwards of 500% without the use of chemicals, eradicated the requirement for weed harvesting, and reversed the signs of eutrophication.

At time of installation

Summer 2005



A significant rise in dissolved oxygen was observed in a 35 ha lake in Quebec, Canada, 1997, where the level of oxygen at the 4.3 m depth rose from a low of 2.6 mg/L to 7.7 mg/L in 2 months (Boudrias, D., 1997).

A significant rise in dissolved oxygen, without destratification, was observed in a 25 ha lake in Quebec, Canada (1999). Within 4 days, the dissolved oxygen values rose significantly throughout to a radius of 150 m from the circulator (Boudrias, D., 1999)

Increasing dissolved oxygen in a lake in Quebec, Canada, to a 14 m depth, using Little River Pond Mill® circulators

Depth (m)	Control Dissolved oxygen near circulator at time of installation (mg/L)	Test 1 Dissolved oxygen near circulator at 4 days after installation (mg/L)	Test 2 Dissolved oxygen at 150 m radius from circulator 4 days after installation (mg/L)
0	8.2	8.5	9.7
2	8.2	8.2	11.0
4	8.4	7.5	8.2
6	2.9	6.0	6.0
8	2.9	5.5	6.0
10	2.0	5.5	4.2
12	0.2	4.2	n/a
14	0.0	3.8	n/a

Increasing dissolved oxygen in a lake hypolimnion while using a Little River Pond Mill® circulator

Depth (m)	June 1997 Before circulators installation (mg/L)	July 1997 1 month after circulators installation (mg/L)
0.0	11.0	9.3
1.0	11.2	9.3
2.0	11.2	9.3
3.0	10.5	9.3
3.5	10.3	9.3
4.0	10.2	8.4
4.3	2.6	7.7

Maintenance of dissolved oxygen levels on a 30,000 m3 stocked fish pond – Kerrobert Fish & Wildlife (1998/99) Typically, dissolved oxygen values in February and March fall below 2.0 mg/L. Circulator was installed May 1998 – water visibility at time of installation was 5 cm. The winter of 1998/99 was the first time in 5 winters that the fish survived. Water clarity winter 1998/99 was 1.8 – 3 m.

Date	Oxygen (mg/L)
October 15, 1998	10.5
November 13, 1998	10.5
November 29, 1998	11.5
February 13, 1999	5.0
February 22, 1999	6.0
March 07, 1999	8.0

Decreasing eutrophication parameters in a lake in Quebec while using Little River Pond Mill® circulators

Parameters	July 1998	July 1999
Total Phosphorous (mg/L)	0.030	0.023
Chlorophyll-a (mg/L)	9.3	3.6
Transparency (m)	3.1	4.2
DO (mg/L) – 2 m depth	7.5	8.0
DO (mg/L) – 4 m depth	3.5	8.8
DO (mg/L) – 6 m depth	2.5	5.2
DO (mg/L) – 8 m depth	0.5	1.4
DO (mg/L) – 10 m depth	0.0	0.5

Water Lettuce Control

Estuary - France

Little River Pond Mill® circulator installation for eliminating hydrogen sulfide gas production and for improving overall lake water quality

Municipal water reservoir/lake – Wainwright, Alberta, Canada ↓

Congress dugout Saskatchewan 2005/06

Date	Turbidity
January 05, 2005	2.10
May 05, 2005	2.39
July 05, 2005	*2.60
August 05, 2005	*5.76
October 17, 2005	1.10
January 09, 2006	2.15
May 01, 2006	2.26
July 10, 2006	1.97

*Circulators installed July 28, 2005

3.0 Waste Water Treatment

Waste water treatment (odour abatement/gas emissions reduction, solids and BOD/COD reduction – municipal, livestock, industrial and commercial) for over 20 years

Dairy Waste Management



Dairy lagoons – USA



Dairy Lagoon Sewage Remediation

2 months after installation into 14 feet (18 months) of solids

5 months after installation

Solids reduction – producer was able to do a direct pump–out, without agitation, through pipeline and irrigation pivot

Alberta - Canada

Swine Waste Management

Swine Processing Lagoon

Ammonia (NH_3) emissions

-Secondary and finishing waste/water sewage lagoon (30 surface acres each)

-Major US swine processor – Central US (Midwest)

-16, 000 swine processed daily

-2 Million Gallons of water used daily

Secondary lagoon test results:

*Prior to pond mill installation: 110-120 ppm

*After pond mill installation:

< 2 ppm

Toombs study – Hog & Dairy Waste

	VFA's (mg/l)	Total Phenolics (mg/l)	Odour Potential (ou/l)	Methane (mg/l) Liquid	Hydrogen Sulfide (mg/l) Liquid
Control	7,537	3.7	143,199	431	23
Test	82	0.4	44,263	411	28

Significant odour reduction regardless of regular inflow to test tank

VFA's below 230 mg/L correspond to a liquid manure without offensive odours

Toombs study

Significant reductions in VFA's, Total Phenolics, and Odour Potential are observed regardless of continued manure inputs to the Test tank (every 7-10 days)

Although there are not significant changes in methane and hydrogen sulfide production, the process maintained similar values regardless of continued manure inputs to the Test tank (every 7-10 days)

This study used 1 - 600 series machine at half the recommended machine installation numbers (at the time); we presently only recommend using the 700 series machines in waste management due to increased machine efficiency, regulations, and a general overall requirement to decrease greenhouse gas emissions

Swine Lagoon Remediation

Ontario - Canada

Day of pond mill installation

3 months after pond mill installation

Significant reduction in accumulated solids/sludge in a livestock/poultry manure lagoon, Nebraska, USA, 1995.

Date	Accumulated solids/sludge (m)
Installation - February 24, 1995	2.4
3 months 1 week - June 01, 1995	0.3

Swine & Dairy Lagoon Remediation
Southern SK - Canada

Shortly after pond mill installation

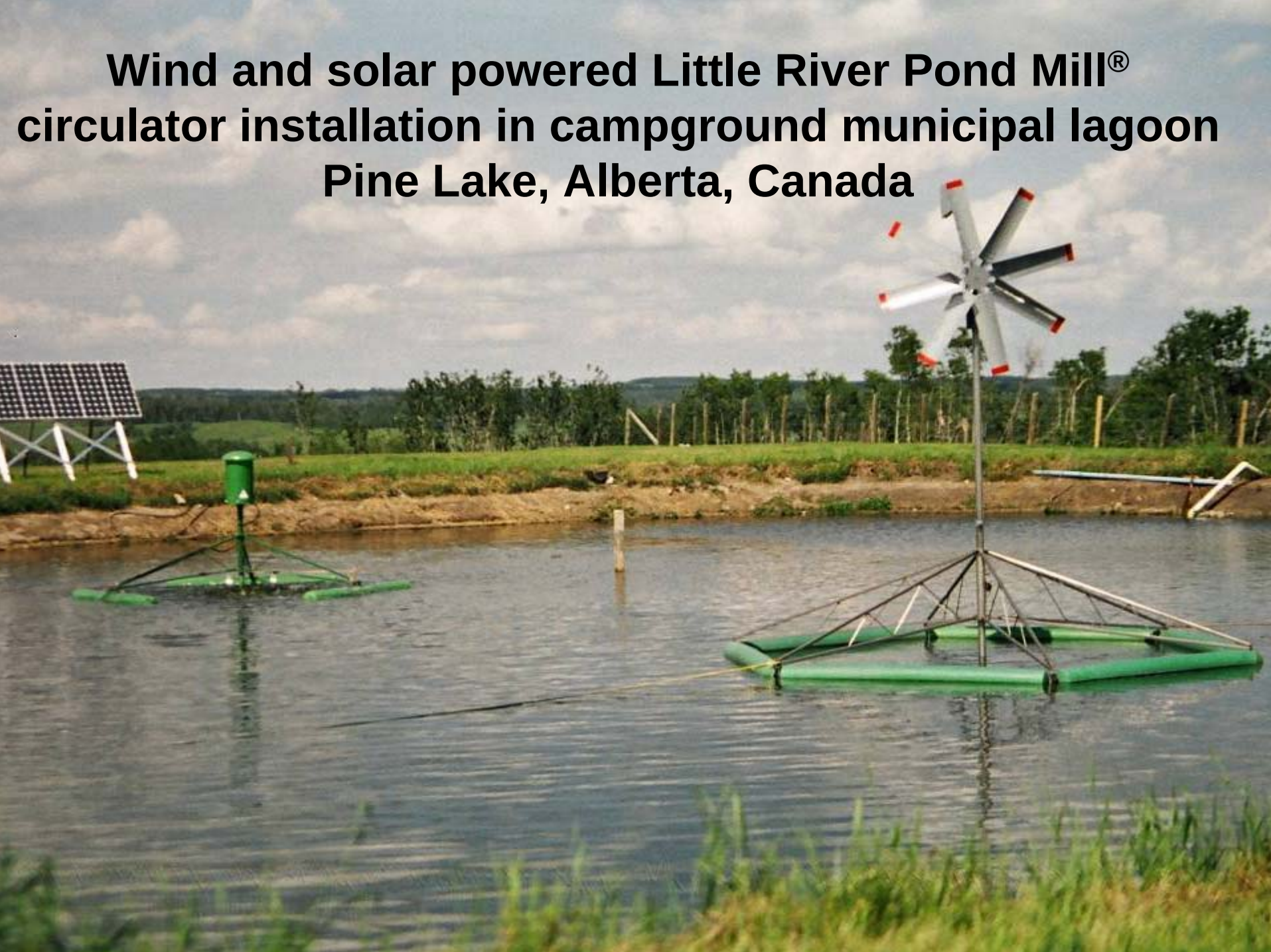
2.5 months after pond mill installation

Municipal & Commercial Waste Water Treatment

At time of installation – Municipal lagoon

Manitoba, Canada

Municipal lagoon – Ontario, Canada


Wind and solar powered Little River Pond Mill®
circulator installation in campground municipal lagoon
Pine Lake, Alberta, Canada

Municipal lagoon system (with carrot & potato processor) Bassano, Alberta, Canada

Before

After

Little River Pond Mill® circulator installation for treatment of potato processing waste water – Alberta, Canada

Little River Pond Mill® circulator

installation for municipal waste water treatment – Australia

Little River Pond Mill® circulator

installation for municipal waste water treatment – Australia

Little River Pond Mill® circulator

installation for municipal waste water treatment – Australia

Little River Pond Mill® circulator installation for winery waste water treatment – Australia

Dissolved Oxygen

Municipal lagoon, Nebraska, USA;
Little River Pond Mill® circulators
installed May 25, 1995

- **May 25, 1995 - 2.3 ppm @ 3 feet**
- **July 29, 1995 - 8.9 ppm @ 3 feet**

Biological Oxygen Demand (BOD)

Municipal waste water – Ontario, Canada 1991
Influent BOD range: 68 – 167 mg/L
Effluent BOD range: 0.5 – 5.0 mg/L

Municipal waste water – Ontario, Canada 1994
Influent BOD range: 125 – 220 mg/L
Effluent BOD range: 0.5 – 3.0 mg/L

Municipal waste water – Quebec, Canada August 1998

Influent: 167 mg/L Effluent: 1.1 mg/L

Municipal effluent lagoon (trailer court); Nebraska, USA March 25, 1995

Reduced ammonia emissions from a trailer court municipal waste water lagoon while using a Little River Pond Mill® circulator

Date	Ammonia (mg/L)
March 09, 1995 – Prior to installation	10.6
June 21, 1995 (27 days)	2.2

Municipal waste water – Ontario, Canada 1991

Reduced ammonia emissions from a municipal waste water lagoon in Ontario, Canada in 1991 while using Little River Pond Mill® circulators

Date	Ammonia range (mg/L)
Influent	12 - 50
Effluent	0.0 – 3.0

Municipal waste water – Ontario, Canada 1994

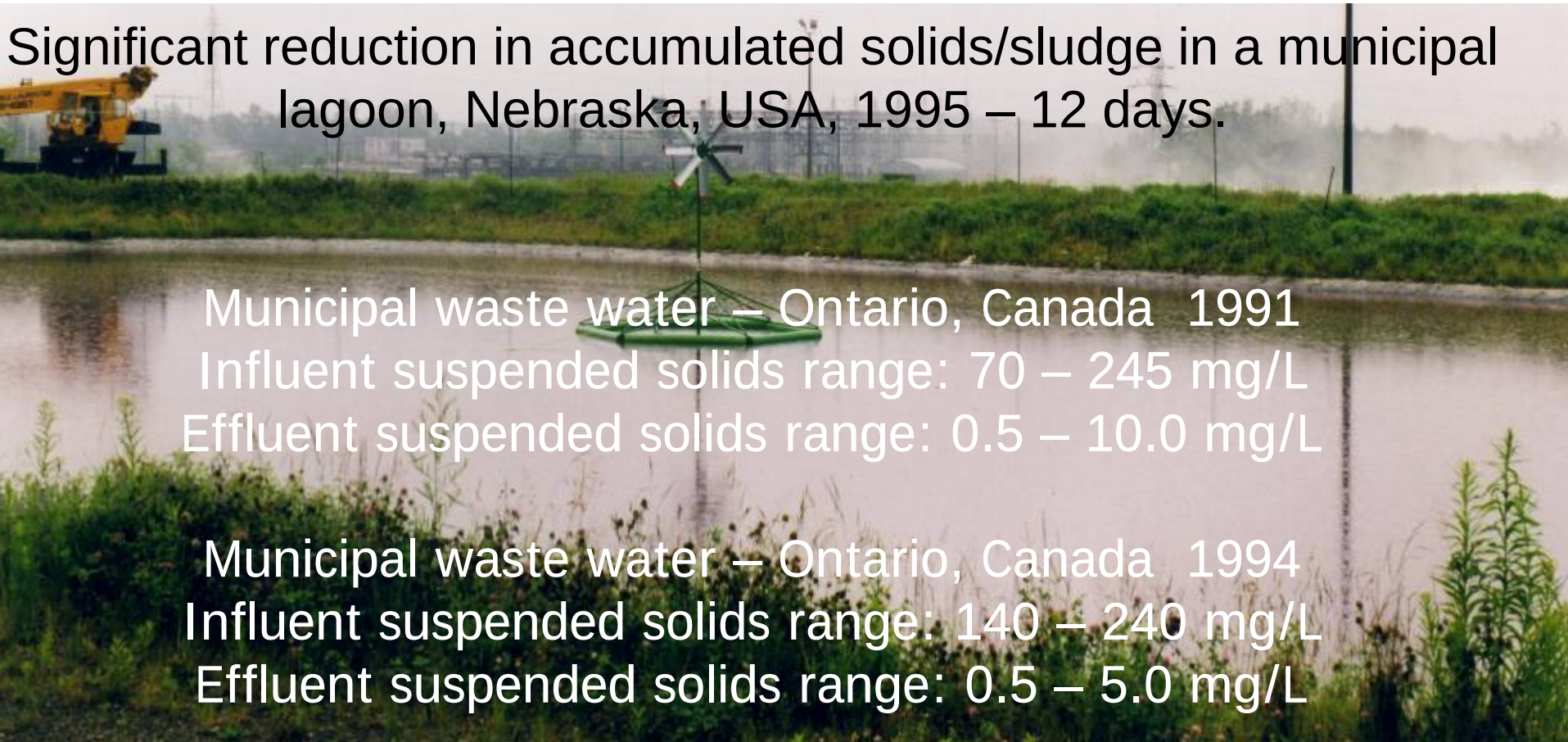
Reduced ammonia emissions from a municipal waste water lagoon in Ontario, Canada in 1994 while using Little River Pond Mill® circulators

Date	Ammonia range (mg/L)
Influent	18 - 37
Effluent	0.0 – 2.0

Suspended Solids/Sludge

Date	Accumulated solids/sludge (m)
Installation - May 25, 1995	0.3
2 weeks - June 06, 1995	0.0 - 0.3

Significant reduction in accumulated solids/sludge in a municipal lagoon, Nebraska, USA, 1995 – 12 days.



Municipal waste water – Ontario, Canada 1991
Influent suspended solids range: 70 – 245 mg/L
Effluent suspended solids range: 0.5 – 10.0 mg/L

Municipal waste water – Ontario, Canada 1994
Influent suspended solids range: 140 – 240 mg/L
Effluent suspended solids range: 0.5 – 5.0 mg/L

More Than Just Odour Control

Create - a homogeneous nutrient solution throughout the lagoon

Create – an in-situ bioreactor, i.e. use the sump, lagoon, lake or pond as the containment cell

Promote - conversion of S & N into bioavailable and stable forms thereby decreasing volatile nutrient losses to the atmosphere

Promote - precipitation of Fe, Mn, P, thereby improving water quality

Provide - farmers with saleable commodities – fertigation liquid and carbon credits

Efficient - power usage when compared with other circulators/aerators

Microbial Growth & Pathogen Control

Central Alberta, Canada – Hog lagoon - 2001

	Total Coliforms (cfu/ml)	Fecal coliforms (cfu/ml)	Aerobic plate count (cfu/ml)
Installation	700,000	400,000	5,700
Pump out	< 1	< 1	26 zillion

Microbial Growth & Pathogen Control

Fecal Coliforms

Recreational urban lake with water slide – Quebec, Canada

Prior to pond mills installation:

300 cfu/100 ml

After pond mills installation: < 2 cfu/100 ml

Municipal effluent from Assiniboia, Saskatchewan in 1991 with a population of 3,000 persons and a small industry addition to the lagoon system (oil waste, non-point source pollutants, etc.)

Microbial population shift and potential pathogens reduction while using Little River Pond Mill® circulators
The town used ¼ of the recommended number of circulators; remediated liquid was used for crop irrigation.

Date	Fecal Coliforms
Prior to installation – March 14, 1991	9300 mpn orgs/mL
June 11, 1991	40 mpn orgs/mL

Analysis conducted by Water Quality Branch
Saskatchewan Environment & Public Safety

Nutrient alteration & pH stabilization

TKN

Municipal waste water - Ontario, Canada 1991

Influent TKN range: 20 – 64 mg/L

Effluent TKN range: 0.8 – 5.0 mg/L

Phosphorous

Municipal waste water – Ontario, Canada 1994

Influent P range: 5 – 11.6 mg/L

Effluent P range: 0.2 – 0.8 mg/L

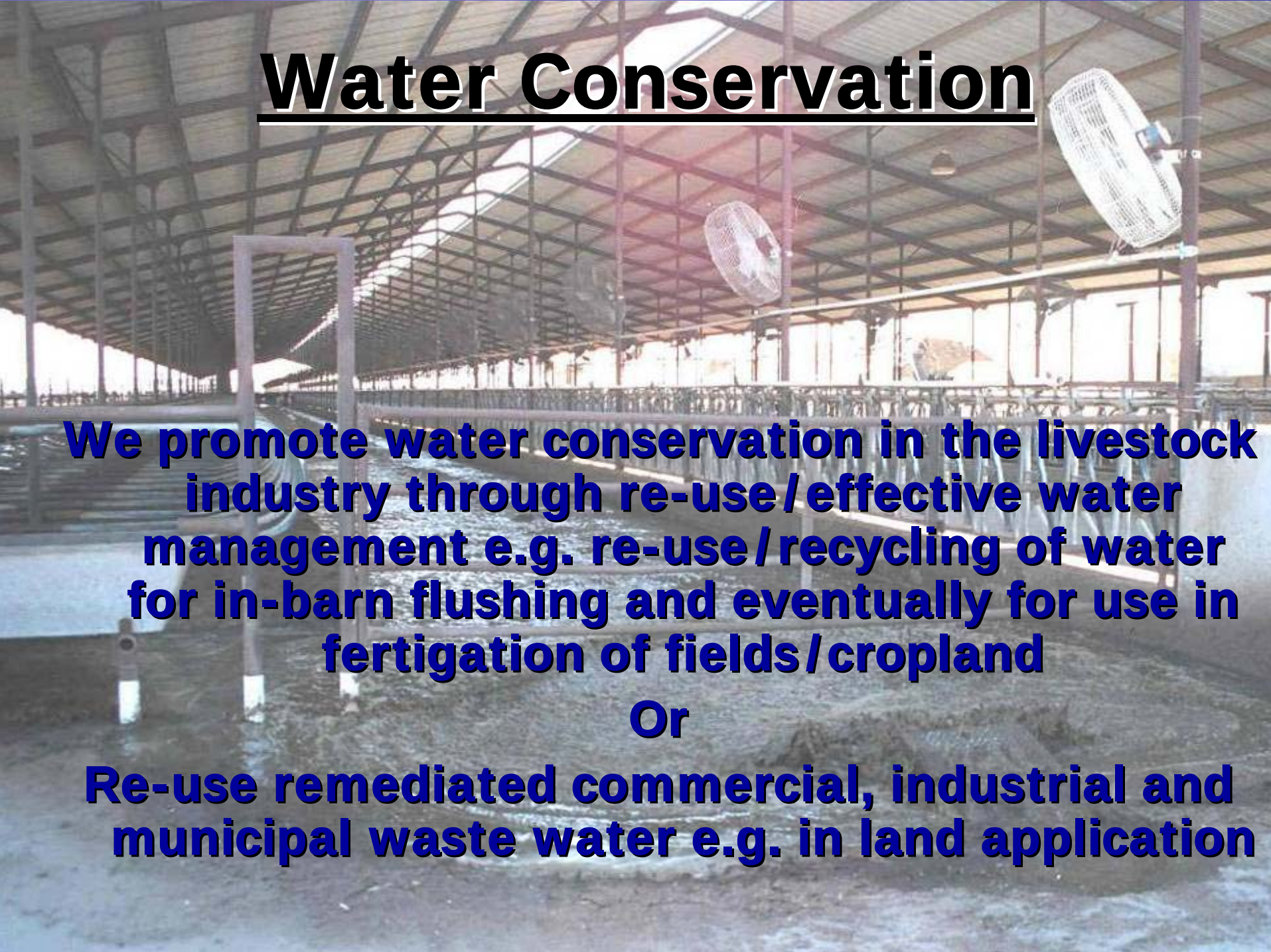
pH

pH decrease and stabilization in a municipal waste water lagoon, Ontario, Canada, 1994

Influent pH range: 7.9 – 8.3 mg/L

Effluent pH range: 7.1 – 7.6 mg/L

Water Conservation



We promote water conservation in the livestock industry through re-use/effective water management e.g. re-use/recycling of water for in-barn flushing and eventually for use in fertigation of fields/cropland

Or

Re-use remediated commercial, industrial and municipal waste water e.g. in land application

Energy Conservation

By providing equipment that is operated via wind, solar and low horse power electric

Little River Pond Mill® circulators have the potential to significantly reduce the production of greenhouse gases and other potentially harmful gaseous emissions to the atmosphere, as well as reduce energy consumption.

In one year (2003-2004) we saved a swine producer in Alberta over $12,000 CDN in electricity charges.

The City of Vancouver, Canada utilizes a circulator in one of its chlorination tanks and has significantly reduced energy consumption while increasing circulation efficiency. They were able to reduce their energy consumption from 21 hsp to ½ hsp while at the same time eliminating chemical hot spots.

Benefits

Benefits from using a Little River Pond Mill® circulator

*** Promote the "natural process" of biogeochemical remediation in surface waters and waste waters – an in-situ bioreactor**

*** Reduction of odorous and non-odorous gases, and toxic anaerobic respiration byproducts such as methane, hydrogen sulfide, ammonia, and others**

*** Potential for carbon credits**

- Use circulators to promote aerobic digestion and prevent the creation of anaerobic digestion gases

- Use circulators to promote carbon sequestration into microbial bodies

Benefits from using a Little River Pond Mill® circulator

*Reverse eutrophication in surface water bodies
-Increase recreation potential
-Enhance fish survival; revival of fisheries
-Increase and enhance species diversity; return of indigenous species
-Improve water quality, i.e. significantly reduce pathogens and other undesirable organisms

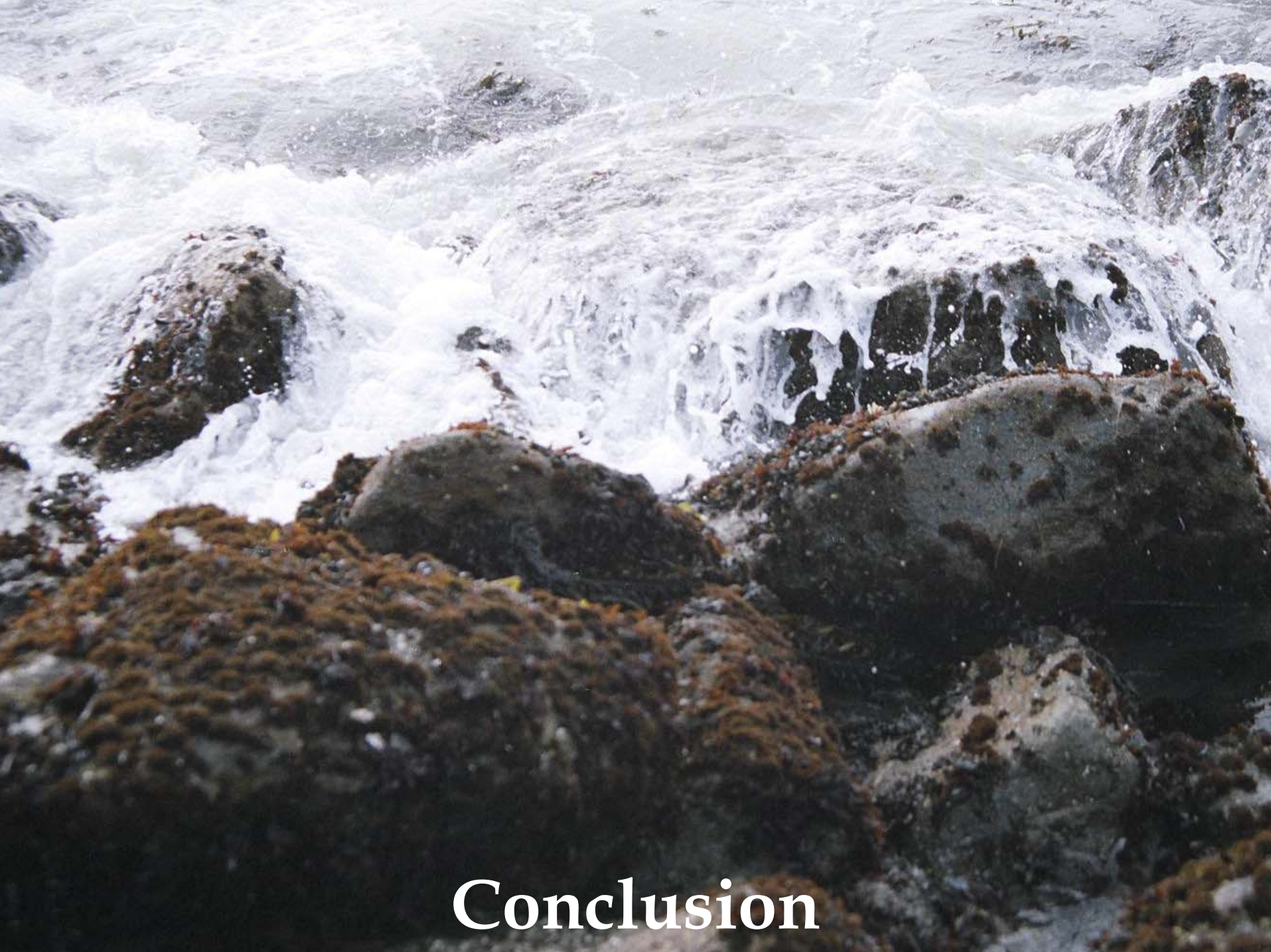
*Reduce treatment costs for potable water, waste water and hydrocarbon contaminated surface waters, i.e. sumps

Benefits from using a Little River Pond Mill® circulator

*Mineralization and stabilization of nutrients enhances fertilizer value, reduces pollution loading and nutrient loss to the atmosphere (sulfur, nitrogen)

*Fertigation liquid is homogeneous, easy to test, easy to work into a manure management plan, and easy to apply to land

*Reduction of environmental, economic, and social costs associated with surface water management & waste water treatment



Conclusion

The Little River Pond Mill® circulator is an effective ecosystem management tool that can be used to 'tailor-make' solutions in aquatic environments – surface water & waste water (industrial, commercial, municipal & livestock). A circulator does not have to be a stand-alone piece of equipment.

Whether your desire is to reverse eutrophication and enhance or maintain fish populations in a lake, reduce or eliminate odours and solids in a sewage lagoon or sump, or clean up a polluted aquatic environment, the Little River Pond Mill® circulator is an effective tool in aquatic environment management.

Important Message

Fit the design characteristics of the circulator to your desired end result. Remember, all circulators are not created equal and the operator must ensure that they take into consideration the limitations of the circulator they choose when fitting into their in-situ bioreactor system.

Thank you

- To our dealers & customers for allowing us to use their photos and information

- Michael R. Toombs (Evaluation of a Wind Powered Aerator to Control Odours from a Liquid Manure Storage – Ontario Ministry of Ag., Food and Rural Affairs, May 1997)

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