FARM

WATER GUIDE

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TROUT FARM LIMITED

About Us

Smoky Trout Farm Ltd.

At Smoky Trout Farm we have worked with landowners, farmers, ranchers, and high-intensity ag operators across Western Canada for over 20 years. We help our clients identify the cause of their poor water quality challenges and then choose workable solutions.

Part of our work arises from the fact that we are intensive farmers, producing about 300,000 Rainbow trout per year, just west of Red Deer. We know what it is like to raise a crop, to look at each year with expectation and to invest in barns and equipment. Water quality is at the heart of everything we do.

This guide will help you because it asks the same questions, looks at the same science and seeks the answers we need and use to design the solutions that solve client water problems.

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Introduction

If your farm property or operation has surface water, you can successfully manage water quality for all your purposes:

- Livestock
- Raw water storage for irrigation, livestock and household uses
- Recreation
- Wastewater management (high-intensity agriculture)
- Land management and conservation

Successful management begins with understanding the factors that contribute to poor water quality including: insufficient dissolved oxygen levels; excess nutrients from natural and manmade sources; physical factors like water body depth and shape; and residence time (flow rate through the water body).

These factors can combine to form water quality problems like algal blooms, excessive muck buildup, fish kills, bad odours and overabundant aquatic plant growth. Left unmanaged these symptoms of eutrophication can greatly reduce the usefulness and ultimate value of farm water bodies.

Understanding the science of your pond, lake, reservoir, wastewater lagoon or dugout is the first step to a solution that is sustainable and effective.

Water is complex, there is no one size fits all solution. This guide is meant to help you understand the common factors that influence agriculture surface water quality and discover treatment approaches and options.

Benefits of Good Water Quality

There are many reasons for landowners who farm, ranch or produce food to invest in water quality management and best practices. Listed below are just some of the benefits of good water quality and water management best practices for agriculture.

Livestock
Clean water means healthier livestock. Studies done on cattle in Alberta and Saskatchewan have demonstrated a significant increase in the rate of weight gain for cattle supplied with treated and aerated drinking water. See the Effect of Water Quality on Weight Gain.

The Government of Canada recommends that you provide livestock water from another source for two weeks following a blue-green algae bloom and die-off. You can radically reduce the recurrence of blue-green algae blooms with active water management.

Irrigation
Reduce down-time and aggravation repairs to water intake pumps and filters by drastically reducing algae in your irrigation reservoir.

Sustainability and capacity
Muck reduction through active management:
Increases overall capacity in wastewater lagoons and dugouts used as reservoirs
Reduces supporting structures for coliforms
Reduces turbidity and improves potability
Is part of the intervention process for halting eutrophication (process by which water bodies become wetlands).

Ecological Conservation
Greater reserves of fresh water are better for the environment and everything that lives in it.

Recreation
- You can create water quality to sustain a private fishery.
- You can develop a water body ideal for swimming and other summer activities.
- You can develop a water body that is actively integrated in your farm layout for both aesthetic and practical uses.

Land Values
Improved surface water quality can increase the value of your homestead, land and operation.

Common Problems

Understanding Algae

Algae Basics

The vast majority of water quality issues in surface water can be attributed to algae. Similar to plants, true algaes are photosynthetic, but they are not plants, nor are they animals or fungi.

Some types of algae produce toxins and are directly harmful to humans and animals, including livestock. Harmful algae blooms (HABs) , are caused by cyanobacteria, commonly known as blue-green algae. Not a “true algae” blue-green algae are actually a photosynthetic bacteria that can produce toxins called microcystins that are harmful to people and animals. Under certain conditions these organisms can rapidly reproduce creating blooms that can produce potentially harmful levels of toxins, and by the time testing is complete, the level of toxicity may have changed. Compounding the matter, the harmful effects of the bloom may occur when the cyanobacteria is not generally visible.

While toxins from cyanobacteria are the most severe problem algae blooms can cause they are not the most prevalent. Excessive algae growth can lead to foul odours, accumulating muck levels, clogged screens and pumps, bad tastes and limited recreational value. Dead and decomposing algae and aquatic plants contribute to more sedimentation, leading to higher biological oxygen demand resulting in further nutrient release from the sediments, ultimately triggering more algal growth. This natural cycle is eutrophication and it will not reverse itself without some form of intervention.

Limiting the amount of available nutrients in your water column, sediments (muck) and watershed is often the best way to manage excess algae growth. Since phosphorus is most often the limiting nutrient for algae in freshwater it usually the target of nutrient limiting strategies.

Fundamentals of Phosphorus

Algae requires a number of nutrients to grow including nitrogen, phosphorous, iron and sulfur but phosphorus is usually the limiting nutrient in most freshwater situations. Algae requires very small amounts of phosphorus to grow so if the available phosphorus can be reduced or "limited" it will prevent the growth of algae even if there are large amounts of other nutrients present.

Generally phosphorus loading is classified as being either external or internal. The algae of an externally loaded lake gets its phosphorus primarily from watershed inflows. A cattle dugout surrounded by pasture land that primarily blooms on the days immediately after a rainfall would be an example of external loading. Algae in an internally loaded lake gets most of its phosphorus from sediments, usually when anoxic conditions cause iron bound phosphorus to be released. A reservoir that gets algae blooms on after periods of long hot sunny days in the summer is probably internally loaded. There are a number of solutions that can effectively limit phosphorus including:

- Aeration to keep it bound to iron in the sediments (assuming enough iron is present)
- Addition of a phosphorus inactivation agent like alum or lanthanum
- Introduction of bacteria that consume phosphorus and move it into biomass in the food chain.
- Physical removal such as dredging and plant and algae removal
- Watershed best management practices to reduce or eliminate the phosphorus flowing in to the water body

Limit phosphorus by determining the source. Once you have determined the source, you can determine treatment. On small water bodies this can often be accomplished by looking at the age, water source(s), land usage around it and some basic sampling data. Combined with an observation of the water quality an educated guess can be made as to what the sources of phosphorus are. On larger and more complex water bodies, it is recommended that a limnologist or aquatic scientist perform a phosphorus mass balance study to accurately determine the source of the phosphorus.

Common Problems

Muck, Foul Odours & Fish Kills

If you have ever taken a step, or watched livestock take a step, into apparently shallow water only to sink deep in brown goo, it is time to do something about it. Call the brown goo what you want: muck, sludge, or soft sediments, but it can have a negative impact on your water quality and if it is deep on the shoreline, it is even deeper further out into your pond.

Muck is formed over time as organic nutrients accumulate. As organic nutrients decompose the process uses up some of the oxygen that is dissolved in your water. As more and more organics build up there is more and more oxygen demand. Eventually, if no steps are taken, your pond can end up with oxygen levels that are low or nonexistent at the pond bottom.

When sediments are deprived of oxygen, nutrients like phosphorus are released into the water column and trigger algae growth. Addtionally, when the aerobic bacteria that are essential to nutrient break down are deprived of oxygen they are replaced by anaerobic ones that decompose organics more slowly and produce foul smelling gasses like hydrogen sulphide and methane.

If you stock your water body with fish, they need oxygen to survive. Some species, like rainbow trout, require dissolved levels to be maintained at 5 mg/l or higher in order to thrive. As the sludge layer consumes more of the available oxygen at the depths, it limits fish habitat to nearer the surface and creates the risk of a

pond turnover which often results in fish kills.

Excess muck can contribute to fish kills in other ways. When organics decompose one of the common byproducts is ammonia. Elevated free ammonia levels, especially when combined with higher pH levels, are deadly to fish. When muck levels increase so does oxygen demand, reducing the amount of oxygen available to the nitrifiers, a specialized bacteria that are needed to convert ammonia to nitrogen, in the water.

Turnovers

Turnovers happen when there is a sudden change in temperature, like a thunderstorm, which disturbs the thermal distribution of your water. In an effort to achieve balance, the pond, dugout or lake will “flip” or turnover the cold, anaerobic water on the bottom to the top of the water, and move the warm, aerobic (oxygenated) water to the bottom. This almost always results in some level of fish kill - fish cannot tolerate this type of themal change combined with reduced oxygen. As a general rule, the muck that comes up with a turnover smells bad.

Muck Supports Total Coliforms

Total coliforms are a group of bacteria that are widespread in nature. All members of the total coliform group can occur in human feces, but some can be present in animal manure, soil and submerged wood and in other places outside the human body. Types of total coliform include Citrobacter, Kiebsiella, Citrobacter, and fecal coliform like E. Coli. Fecal coliform is most commonly found in a wastewater process, and its removal is highly important. Muck reduction can help reduce the opportunity for total coliform proliferation. We encourage all water managers with contamination risks to test regularly for total coliforms. You can contact us for more background on this issue.

Assess The Situation

Define the Problem

Starting with the best available information will help you arrive at a sustainable solution.
Here are the general areas of information required:

Set a defined goal including desired timelines

Here are some examples:

- Remove algae from my pond, immediately.
- Reduce muck in my dugout over the next three seasons.
- Improve effluent quality in my wastewater lagoon by my next discharge.

Gather the data

Here is a basic list of the data needed to design a water management solution. In your situation, you may need more complex measurements or testing and analysis.

Bathymetrics

The length, width and depth of your pond. This is simple if you have a built dugout, reservoir or lagoon. If your water has variable depth you can get general depth measurements by rowing around the pond and doing depth sounding with a weighted, measuring line. Or, use a sonar fish finder if you have one handy. For accurate length and width, Google Earth can be used for the most accurate measurements. The GPS co-ordinates of you pond are a part of this process.

Measure the sediment depth

Determining how much muck build up you have on the bottom of your water body can help explain the problems you have been having and inform potential solutions.

This can be done by using a Sludge Judge or by simply extending a length of PVC pipe below a boat until some resistance is encountered, marking the waterline, firmly pushing it into the muck as far as possible and marking the new waterline. The distance between the two marks is the depth of your muck. This should be done in a grid across your entire water body. The more measurements you take, the more accurate your data will be.

Age of the water body

When was the water body constructed or is it natural? Along with the water source this can help determine how much nutrient loading may be present.

Water source

Each of these sources have a different general nutrient profile:

- Agriculture run-off
- Pasture run-off
- Urban run-off
- Well or spring water
- Wastewater from intensive agriculture or food processing

Sampling

Depending on the complexity of your water body, sampling and testing may make sense. For example: A biological oxygen demand (BOD) test in wastewater or a potable water test for a raw water reservoir.

Description of the problem

- Foul Odours
- Duckweed
- Algae
- High turbidity or, murky water
- Clogging pump screens
- Fish kills

Pictures of the problem at its worst are helpful.

Other factors

The following are considerations when determining the best solution:

- Budget
- Mitigation of the problem(s)
- Acceptable timelines
- Do it yourself or getting help

Assess The Situation

Sampling & Lab Analysis

Water is complex and there is a lot of sampling and lab analysis that can be done. Depending on your circumstances, goals and budget it may or may not be a practical option. You should work with a water professional to determine if sampling and analysis would be beneficial, or even cost effective in your situation.

Some things to keep in mind about testing. A single sample is a snapshot of conditions at a specific point in time and only provides data on what is happening at the time the sample is taken. It can provide some explanation for certain water quality conditions and help determine treatment dosages but it any knowledge gained will be very limited. To gain true insight into what is happening in a waterbody sampling should be done on a regular recurring basis over time, in combination with observations of weather, temperature and physical conditions to create a detailed data set that is an illustrative timeline of the conditions in a water body. This detailed data can be used to properly identify the causes of water quality problems and develop and effective water management plan.

Sampling needs are directly related to your goals, scope and budget. A small pond often doesn't have the scope and budget to pursue the extensive testing regime described above. However, collecting good observational data as described in the "Define the Problem" section above can usually allow an experienced water professional to identify issues and recommend effective solutions.

Below is a general description of some of the more common sampling and analyses that are used when working with farm water.

Common Surface Water Analyses

General Water Analysis

Detects common nutrients and metals that could be problematic in freshwater. Usually includes total nitrogen (TN) and total phosphorus (TP). Parmeters can also include the detection of coliforms and fecal coliforms.

Secchi Disk

20 centimetre opaque disk with black and white quadrants that measures the transparency or turbidity of water.

Chlorophyll A

Used to determine how much algae is present in the water. Usually done on a regularly recurring basis in conjunction with TP analysis and Secchi disk tests to develop a data set to understand and predict algal growth trends.

Liquid Chromatography for Algae Toxins

Determine if the toxins produced by Cyanobacteria (blue-green algae) are present.

Dissolved Oxygen

A meter is used to measure the amount of oxygen that is present in the water at a specific point in time. Ideally it should be measured at multiple depths and repeated, to create a profile over time.

Shows if you have sufficient oxygen levels at the water - sediment interface to support biological processes and to keep nutrients bonded in the sediments (see the Phosphorus fundamentals section for more info).

Algae Speciation

Determines what species of algae are present. Can be valuable when determining if a specific technology, like Ultrasonic Algae Control, will be effective.

Sediment sampling

This can test the sediments of a water body for a number of different parameters. Phosphorus fractionation is one that is sometimes used to determine how much phosphorus is present in the sediments, what it is bound to and how much of it is available to fuel algae growth.

Limnologist Dr. John Holz taking sediment cores on an Alberta lake.

Common Wastewater Analyses

BOD - Biochemical Oxygen Demand

Measure the amount of organic material “food” for bacteria in a water body.

Used when determining biological treatments for wastewater processes

5 day lab process

TOC - Total Organic Carbon

Measure amount of present organic carbon in the water body.

Requires a complex and costly lab equipment process.

COD - Chemical Oxygen Demand

Total measurement of all chemicals in the water that can be oxidized.

Simple, easy to do. About 2 lab hours to do the test.

Dissolved Oxygen

See Above.

Treatability Study

A sample of water, effluent and/or algae is sent to a laboratory where it is cultured to allow the testing of various treatment products for efficacy. Identifying the specific causes of problems can often be accomplished by determining what treatments are effective. This is labour intensive and can be expensive but it is an effective way to accurately identify solutions to troublesome problems.

Troubleshooting Lagoons

Wastewater treatment plants for dairy, hog operations, feedlots, other high intensity agriculture and food production can bring a distinct set of challenges. Most commonly, wastewater lagoons are utilized as an inexpensive and effective part of a treatment process for removing or mitigating nutrients and producing effluent that can be then be reused for purposes like irrigation or released into watersheds while meeting standards required by regulators.

Intensive agriculture supported by a wastewater system faces the additional challenge of being large enough to require complex solutions, but not so large as to have government size budgets. An improperly functioning lagoon system can impact the overall effectiveness of an operation, cause environmental damage and even lead to fines. This is why it is important to quickly determine what is causing any problems so they can be quickly managed. Common problems include, excess sludge build up, foaming, algae growth, and poor effluent quality.

Proper data including number and type of cells, surface area, depth, volume, nutrient types and sources , biological oxygen demand, and resi-

dence times are the starting point for trouble shooting lagoon problems. This can include sampling and analysis as well as dissolved oxygen measurements from multiple points from within the system. Good information will allow the proper identification of the problems and lead to the determination of the best possible solutions.

Often adding an aeration system or replacing an underperforming one can be a way to improve the efficiency, and ultimately the effluent quality of a lagoon system. There are also a number of specialized products utilizing probiotics and biocatalysts that can improve lagoon function significantly.

For example, excess sludge levels are often caused by the inability of microbes to effectively digest some insoluble fibres leading to decreased lagoon volume, potential aglae problems and poorer effluent quality. The right biocatalyst combined with the right strains of bacteria can make these fibres more susceptible to degradation, especially if combined with increased oxygen levels at the sediment levels, leading to a substantial decrease in sludge volumes.

Solutions

Aeration

What is aeration?

Aeration is the introduction of a gas into a material. In this guide we will be specifically referring to the introduction of atmospheric air (and occasionally pure oxygen) into a body of water.

Why aerate a body of water?

Whether you are dealing with a fishing pond, raw water reservoir, a cattle dugout or a wastewater lagoon, the number one reason to aerate is to improve or maintain water quality.

- In the case of a fish pond or other recreational water body, the goal is to achieve or maintain an aquatic environment of sufficient standards for not only a private fishery to thrive but one that can be enjoyed by the people using it for recreation.
- Livestock need clean water to stay healthy so keeping a dugout free of potentially harmful algaes, toxins and pathogens is important.
- Raw water storage, whether for irrigation or eventual drinking water treatment needs to be kept free from algae to prevent the clogging of pumps, screens and lines and also represents an opportunity for pretreatment to reduce the presence of other impurities such as total suspended solids (TSS), ammonia, carbon dioxide, hydrogen sulfide, iron and manganese.
- Aeration can be utilized in the treatment of wastewater from high intensity agriculture for mixing to keep solids in suspension. And to provide oxygen for microbial activity including the oxidation of ammonia and nitrites by autotrophic microbes and the consumption of carbon by heterotrophic microbes.

What are the different ways of aeration a water body?

There are two primary categories of aeration systems that are utilized in outdoor water bodies: surface aerators and diffused aeration systems. Both of these categories can be further broken down into subcategories.

Surface Aerators

Surface aerators are primarily intended to directly increase the amount of dissolved oxygen in water. When water contacts the atmosphere oxygen is driven from the air into the water until the oxygen "dissolved" in the water reaches saturation. The greater the surface area of water contacting the atmosphere - the higher the level of oxygen transfer into the water. A surface aerator creates more water surface area by mechanically agitating or splashing the surface of the water.

The most common type of surface aeration is the aerating fountain that jets water into the air in a similar fashion to a decorative fountain, just at a much higher volume.

There is a better option than fountains. In recent years turbine surface aerators have been developed that mix air and water at very high RPMs filling the water with very tiny bubbles. This creates a very large amount of surface area between the water and the air and results in very efficient oxygen saturation of the water.

Surface aerators generally only provide oxygen transfer into an area of the epilimnion (surface layer) immediately around their location. Without some means of circulating the water there is limited transfer of oxygen saturated water to other areas of the waterbody. This makes surface aeration appropriate for application like keeping fish alive in the winter or in wastewater treatment.

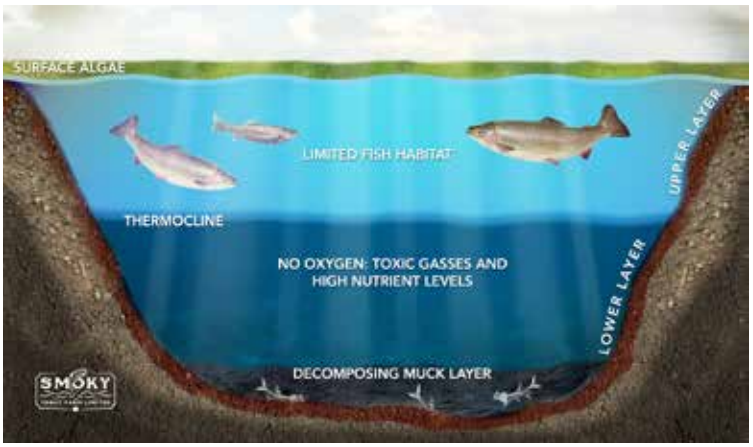
Diffused Aeration

Diffused aeration is when a gas — usually air from the atmosphere or sometimes pure oxygen — is forced by a compressor or blower to a diffuser that is placed under the water's surface. A diffuser takes the air and breaks it into smaller components (bubbles) in order to create a larger surface area between the water and the air. This increases the transfer rate of gases between the two mediums (oxygen in to the water and carbon dioxide into the air). Depending on the purpose of the system these bubbles can be coarse, medium, fine, ultrafine, micro or nano in size.

The goal of diffused aeration can be vary when used in different applications. Below are just a few examples. It should be noted that these are very broad generalized categories and they are often modified or combined to achieve specific results.

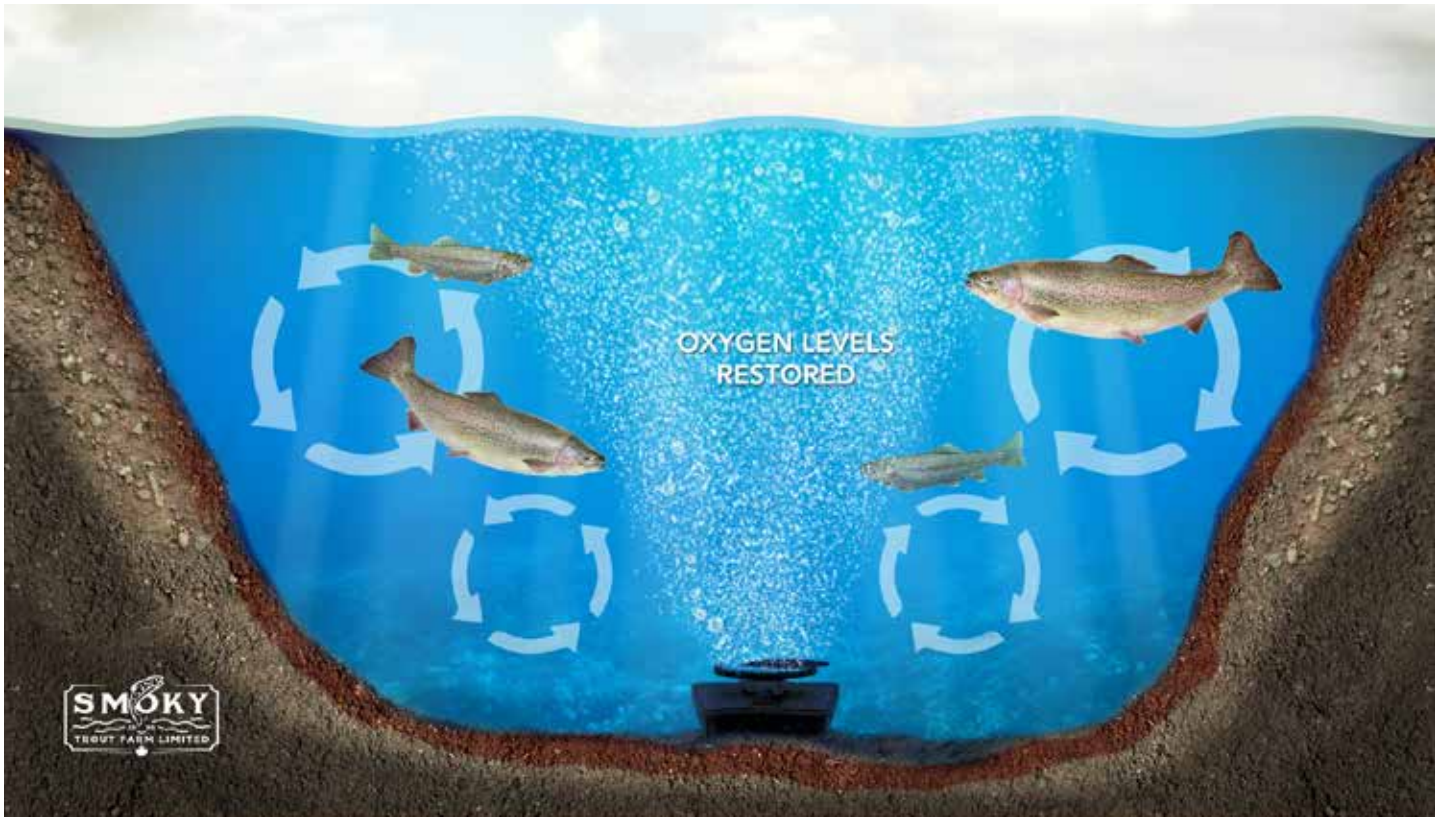
Solutions

Circulation is usually the intended goal in ponds, dugouts, raw water reservoirs and lakes. These water bodies often stratify, with oxygen saturated water being trapped at the surface and low or no oxygen conditions developing near the bottom. This can lead to poor degradation of organics and sludge accumulation; release of nutrients from the sediments and algae blooms and pond turnovers resulting in fish kills.



A properly sized aeration system will draw anoxic water from the bottom and deliver it to the surface where it becomes saturated with oxygen before being circulated back to the bottom - effectively delivering oxygen to the sediments. The advantage of this aeration application is that a comparatively small compressor can fully saturate a water body with oxygen. It is both cost and energy effective with the system ultimately acting has a high efficiency water pump.

This method should not be utilized in situations where it is desirable to maintain stratification as is the case with some large deep natural lakes.



Hypolimnetic aeration is used when it is desirable to have oxygen delivered to the hypolimnion (bottom layer) in a stratified lake or reservoir. This requires oxygenating the water at the bottom without changing the temperature or disturbing the stratification. There are variations of diffused aeration that can accomplish this utilizing nano bubbles. Nano bubbles are so small that they remain in suspension in the water instead of rising to the surface, allowing stratification to be maintained. Other technologies such as Speece cones can be used in hypolimnetic aeration.

Direct oxygen transfer is often required when there are higher levels of chemical oxygen demand (COD), total organic carbon (TOC) and biological oxygen demand (BOD) such as certain processes in wastewater treatment. Many of the bacteria that oxidize chemicals or consume organics require oxygen to function properly. In high nutrient situations the circulation method described above simply cannot deliver oxygen to the entire water body quickly enough. In these situations larger more powerful compressors or blowers are utilized to deliver higher volumes of air to large quantities of diffusers that are dispersed across the bottom of a lagoon cell or holding tank. In this situation, the vast majority of the oxygen transfer takes place under the water's surface between the bubbles and water.

In some circumstances if an even higher oxygen transfer rate is required, pure oxygen can be used with very fine diffusers. This method is commonly used in recirculating aquaculture facilities.

Mixing is used in applications where the goal is to keep solid particulate in suspension in water of effluent. This allows solid organics to have more contact time with oxygen and microbes, to speed up the pace of degradation. This can be combined with the direct oxygen transfer described above in some cells of wastewater lagoons.

Aeration surface boil

How do I determine which aeration type is right for my water body?

If you have a dugout, pond, reservoir or even a small lake, bottom diffused aeration set up to use the circulation method above will probably be the most cost effective way to aerate most surface water bodies. This basic concept is pretty simple, consisting of a high flow aeration compressor (do not use a shop compressor) that is designed for continual operation, some distribution hose and one or more diffusers. It is important that the system be properly sized so that the optimal number and type of diffusers are combined with the right compressor. The surface area, depth and shape of a water body are important factors when designing a system to achieve full circulation.

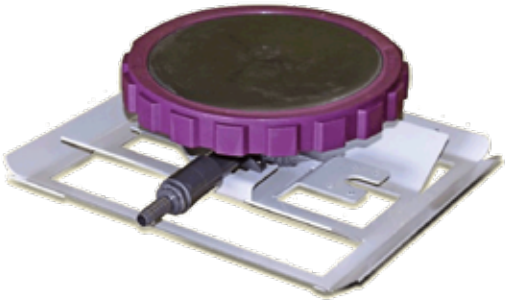
Shallow water (under 8ft in depth) is more challenging to aerate than deeper water as it is difficult to induce circulation. In some shallow water a direct oxygen transfer method is needed as circulation simply cannot be induced. In these situations a linear style diffuser is often used. It should be noted that shallow surface water is often unnecessarily aerated, as it is often already fully saturated with oxygen from wind action on the water surface.

If you are dealing with higher nutrient loads such as in wastewater, proper aeration design can be very complex. We recommend that you collect all of the data (bathymetry, sampling data, description of problems, etc) and work with a water professional to properly troubleshoot any lagoon problems. Water is complex. Wastewater even more so. In our experience attempts at DIY aeration designs seldom work out well.

Larger recreational water bodies like public lakes and reservoirs should never be aerated (or treated) without more scientific study. While some of the broad concepts remain the same there is much more that needs to be considered before modifying the environment of a lake. Studies by limnologists and/or other aquatic scientists need to be completed and approvals obtained from regulators before any solutions are tried. Successful management plans for public lakes and reservoirs are achievable but only with the participation of many stakeholders from individuals to municipal and provincial governments. The solutions may include aeration but may also include other strategies like the implementation of watershed best management practices and in-lake treatments.

Common Aeration Equipment

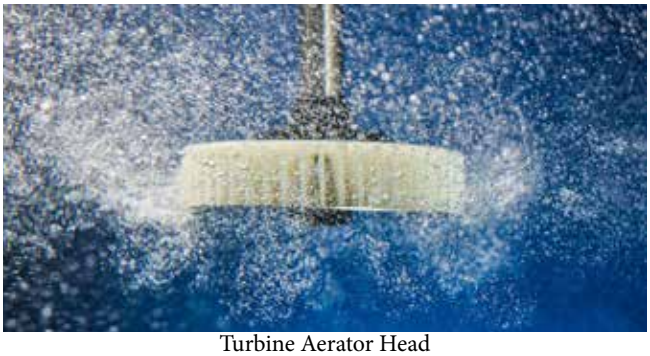
Linear Air Pump suitable for small shallow water applications



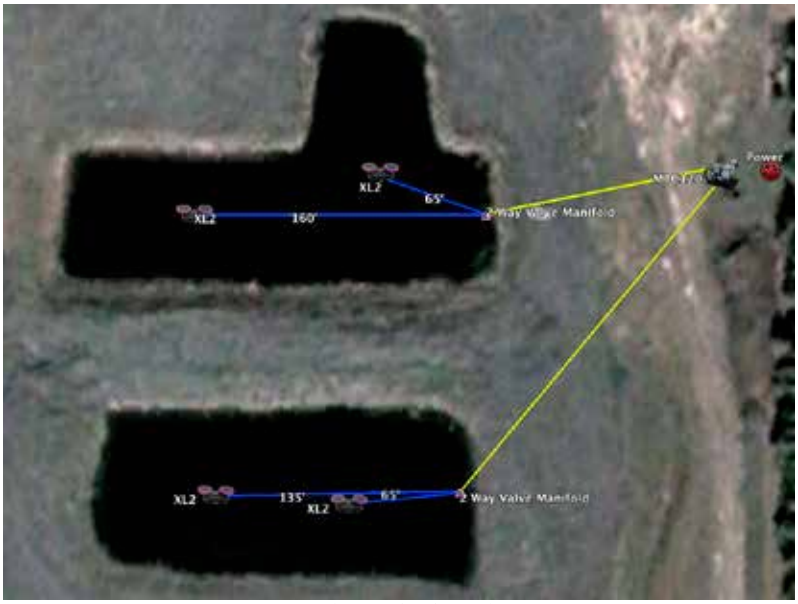
Disc Style Diffuser

1/2hp Rocking Piston Air Compressor

Bubble Tubing™ Linear Diffuser



Turbine Aerator Head



Aeration layout for farm dugouts

Surface Aerators

Off-Grid Aeration

For the greatest flexibility an aeration system should be able to operate up to 24 hours a day, so if you can trench an air line from a nearby power source, it will usually give you the best bang for your buck. Air lines can be successfully trenched for over 1km.

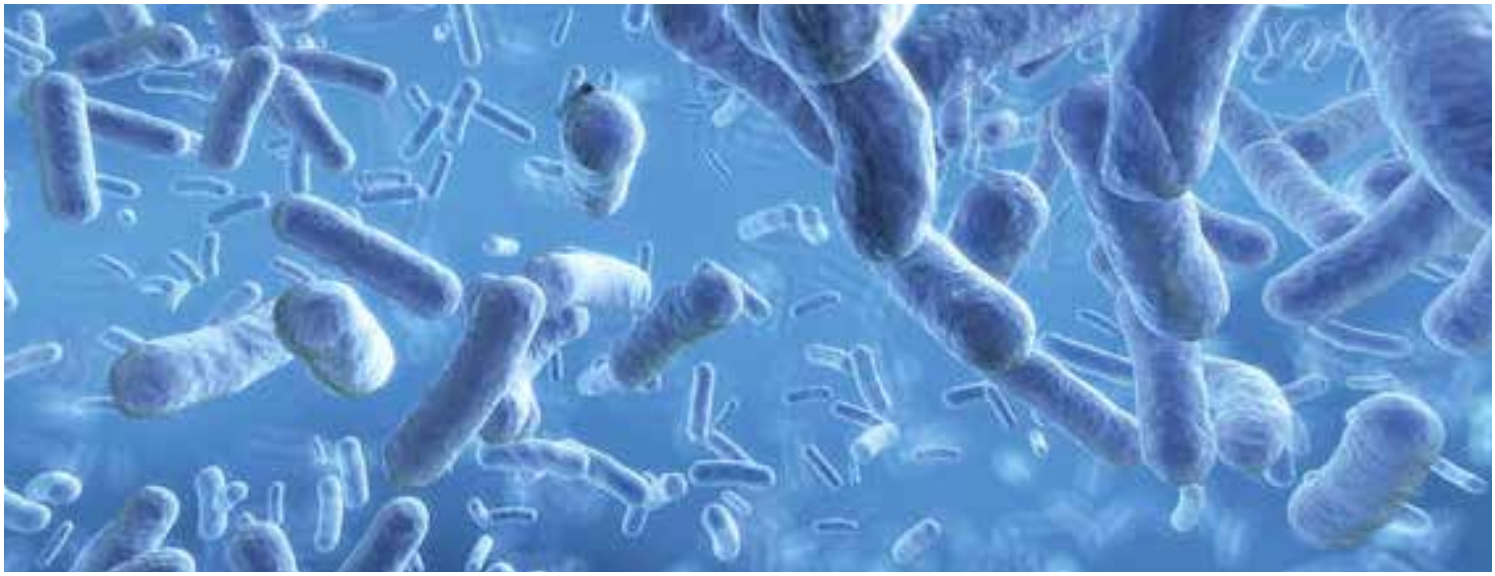
For completely off-grid systems we almost always recommend solar. Wind powered systems can have significant drawbacks with consistency of aeration. Unless the installation location is near perfect, wind driven aeration systems can go through extended periods with no air flowing to the water body. When wind levels are high, natural surface aeration is occurring as well. Periods of hot still weather with no wind generated aeration can create thermally stratified conditions which can lead to a fish kill.

Solar aeration maximizes available technology and the durability of the systems has improved. A direct drive solar aeration system has an efficient power transfer. This creates more oxygen injection at greater depths than past models.

Key components of a solar aeration system are:

- Oil-less air compressor rated for continuous use.
- Fan cooled weather-proof cabinet.
- Properly engineered voltage regulating hardware to achieve efficient and reliable long term operation.
- High efficiency diffuser(s) to maximize water circulation and oxygen transfer.
- Weighted hose to limit freeze-up issues.
- Engineered solar panel mounts to withstand heavy wind loads that larger solar panels endure.

The drawbacks are initial cost and less running time. Solar panels have steadily come down in price, but a solar system is still more investment than a traditional electric power aeration system. The final concern is the size of the pond, dugout or reservoir the larger the water body, the more investment in solar is required.



Solutions

Biological Treatments

It's no surprise to the agriculture industry that algae and macrophytes (plants) require nutrients to thrive. Too many nutrients in your water, combined with sunlight means thriving photosynthetic organisms and plants. Plants and algae die off in winter, rot in the bottom of your water, and release their nutrients back into the lifecycle. Poor water quality follows.

Hit any plant or living organism with enough chemical and you can kill it. Consistent heavy dosing of algaecides and herbicides create several challenges: how to maintain water quality for other purposes like livestock consumption. Or, how to keep algae and plant infestation from returning. And, how to maintain sustainable, healthy colonies of beneficial microorganisms in the aquatic ecosystem.

Longer term, the accumulation of dead material increases muck and sediments, releases remaining nutrients from the killed materials back into the water, and decreases available oxygen in the water. This sequence is the start of the eutrophication (swamp creation) process.

The cycle is intensified in part because the cells of algae and aquatic plants are "well-engineered" by nature. Made from complex proteins, carbohydrates, lipids and minerals, along with the chloroplast structures necessary for chlorophyll systems, algae and aquatic plants thrive in a biological framework that aids resistance to chemical treatments.

Solutions

The effective alternate solutions to heavy dose algaecides and herbicides are premised on three ideas inside the ecology of your pond, dugout, reservoir, lake or lagoon:

1. Address the nutrient load
2. Accelerate decomposition of materials thereby reducing nutrients and materials that contribute to repeat growth of algae and muck accumulation
3. Achieve balance in the microbiology of the water ecology

Each of these approaches requires a minimum level of dissolved oxygen and optimally works in a highly oxygenated water system, which is typically achieved through aeration.

Beneficial bacteria that consume the nutrients which support algae growth can be supported to "out-compete" algae. Probiotics, derived and cultured from indigenous strains, support bacteria growth. This healthy boost to your system, creates an ecology that can adequately deal with higher nutrient measurements.

An algaecide or herbicide leaves decomposing material behind. Speed up decomposition and create natural byproducts for bacterial consumption with a blended catalyst. A catalyst will reduce the dose requirements for contact and systemic algaecides by breaking down the cell walls of aquatic plants and algae.

Biostimulants are used to increase the rate of capacity of existing bacteria in specific capacities. For example, a biostimulant focussed on reducing muck will support the growth and work of bacteria that consume the nutrients inside the muck layer of your water, reducing the muck volume and the overall nutrient load in the pond.

Determine Products and Dosing

To determine the correct product type, two broad categories of factors are looked at:

Environmental factors: the natural environment in and around the pond
Cultural factors: the human usage in and around the pond

Environmental factors can include nutrient load in the surrounding land and watershed from run-off, climate, seasonal water temperature, and excess organic matter.

Cultural factors can include the age of the water body, fertilizer leaching or septic systems. These factors can increase dose rates to address non-natural levels of nutrient loading.

Solutions

Aeration installation is a cultural factor that reduces dosing rates. Aeration supports the optimum natural balance of a water body, enabling the lowest reasonable dose rates of treatment products.

Proper dosing matters for several reasons:

- It costs less money. This is true of under dosing, which requires longer cycles for slower results. And, over dosing, which delivers faster results, higher costs, and occasionally causes new problems.
- It's better for the health, life and quality of your water and its surrounding ecosystem.
- It's easier to manage a sustainable water quality plan. There are fewer upsets, turnovers or spikes in nutrient load.

Do I need both aeration and biological treatment products?

That depends on the water profile and your goals. Properly designed aeration will bring the right amount of oxygen into your water body. This will speed decomposition, reduce odours by mitigating anoxic conditions, and improve the overall water lifecycle. Depending on the age of your dugout or pond, surface water run-off profile, depth and temperature this may be enough to get water to the goals you have. It may not.

Here are some situations that almost always require chemical or biological treatment application

Shallow water (less than 12 feet) warms more quickly, which encourages the growth of plants and algae.

Run-off with high nutrient content will often be beyond the volume of water and oxygen available to either convert through nitrification, or allow to settle in the sediments.

If you have accumulated excess phosphorus, which is often the limiting nutrient for algae, you will not solve your algae problem with aeration alone.

If you have high volumes of muck, aeration will speed decomposition, slow and possibly reduce muck accumulation, but it will not eliminate all of the nutrients being released from the muck. Substantive, long-term muck reduction almost always requires biological treatment application.

And, if you have excess aquatic plant growth, aeration will solve water clarity issues, but will not remove plants. This requires a mixed approach of chemical and biological treatment application.

Probiotic: MD Pellets

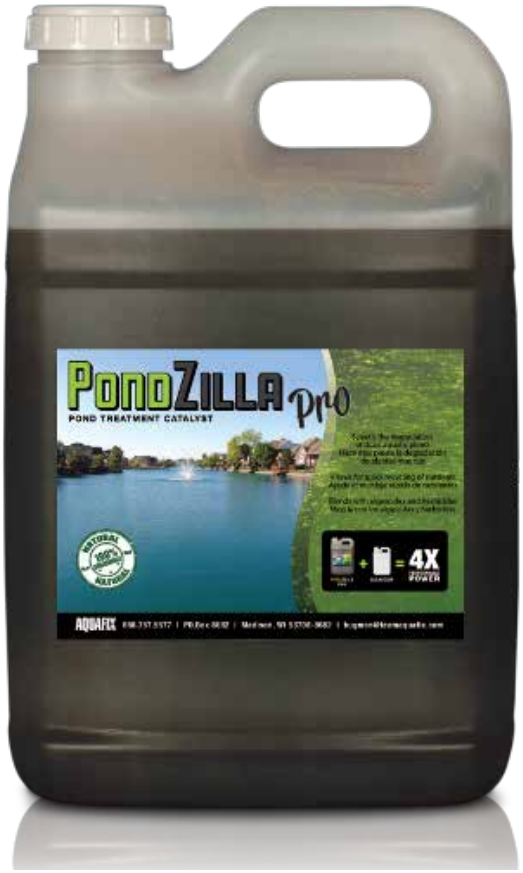
Excess nitrogen and phosphorus from animal or fish waste, stormwater runoff, grass clippings or leaves, and fertilizers from agriculture are a just a few examples of the nutrient pollution that eventually settles at the bottom of lakes and ponds. Lake and pond bottoms that are overloaded with these nutrients can experience oxygen depletions, fish kills, or harmful algae blooms that negatively impact the water bodies' recreation and economic uses.

Approach the problems of excess nitrogen and phosphorus from the direction of reducing the carrier medium for the nutrients. Muck is most often the storage system for nutrients in your water. This is true of natural ponds and lined dugouts and reservoirs.

Reducing muck buildup in an aquatic environment can lead to increased capacity, improvements in dissolved oxygen levels, reduced nitrogen and phosphorus compounds, and increased water quality. In tandem with reducing muck, you can improve the efficacy and efficiency of the microbial communities in the muck that do the work of natural digestion.

MD Pellets support the work of microbial communities that do the work of natural digestion of organic compounds that store nitrogen and phosphorus. Less muck diminishes the occurrences of harmful algae blooms and nuisance aquatic plant growth.

Biocatalyst: Pondzilla Pro



Sometimes you have to meet the problem with a direct hit. Algaecides and herbicides have their place in a water quality treatment plan. You can reduce algeacide and herbicide dose rates, improve and sustain overall water quality, and boost product effectiveness by working with on cellular structures of aquatic plants and algae to soften the cell walls. You can further improve the treatment cycle by boosting the decomposition process.

PondZilla Pro is a natural catalyst that accelerates chemical treatments by improving penetration. When mixed with an algaecide or herbicide it speeds the breakdown of dead algae and aquatic plants while stimulating naturally occurring bacteria to fixate nutrients liberated during this process.

This complex blend of enzymes, cultures, fungi, and stimulants dissolves the dead algae and aquatic plants on a cellular level, reducing their contribution of nutrients. By accelerating chemical reactions, PondZilla Pro improves copper algaecide performance. This is especially critical in hard water applications when copper solubility and performance is reduced. PondZilla Pro alone does not kill anything.

Probiotic: Water Column Clarifier

A weak microbial community can be a contributing factor leading to poor water quality and poor clarity. Chemical treatments, washouts, and runoff are all common events that can negatively impact the abundance or activity of microbes in an aquatic environment. Ailing microbes and poor floc-formation can limit the community's natural capabilities and lead to increased turbidity and nutrient overloading.

Water Column Clarifier is a high-performance liquid probiotic that clarifies water through enhanced biological flocculation. This formulation removes nitrogen and temporarily binds phosphorus in the water column. Designed for aquatic professionals, it quickly restores balance and improves clarity in lakes and ponds.

Water Column Clarifier excels when used alone or after algaecide treatments to flocculate and precipitate dead algal cells. For an extra boost, Water Column Clarifier can also be used in combination with AquaSticker (a biocatalyst that makes planktonic algae susceptible to algeacides) or PondZilla Pro.

Solutions

Ultrasonic Algae Control

Ultrasonic algae control destroys algae in two different ways:

1. Generating ultrasound waves in frequencies that breakdown the cellular walls of algae.
2. Generating ultrasound waves that rupture gas vacuoles that cyanobacteria (blue-green algae) uses to regulate buoyancy.

The ultrasonic waves are created by a device (either electric or solar-powered) suspended in the water body. The size and formation of the water body determine if more than one device is required.

The species of algae present determines how long it takes for the ultrasonic waves to break down the cell walls. The best step is to do water sampling and algae speciation testing to ensure that the units will work in your situation, prior to purchase and installation.

Consistent use of ultrasonic algae control can radically reduce the need for algaecides. This is a substantive benefit to ag operators using surface water for irrigation or livestock watering, as the algaecide is not second-hand distributed onto crops or ingested by livestock.

Ultrasound for algae is ideal for irrigation reservoirs, since the device can be set at frequencies that address your algae species as it grows, preventing a harmful algal bloom, which in turn prevents the fouling of pumps, filters and sprinkler heads.

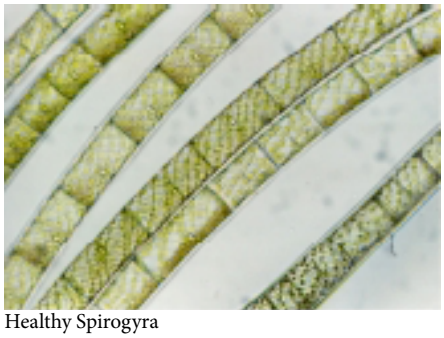
It's also an excellent solution for wastewater lagoons that have algal film. Because ultrasound does not add coagulants or flocculants to the management plan for a wastewater lagoon, it enables the water manager to make simpler decisions about nutrient load management and the total required amount of dissolved oxygen in the lagoon.

Feasible for remote applications the unit is removed from the water for winter and returned in the spring as the water warms up. Minor cleaning and maintenance may be required depending on the water quality. The single caution is that it may influence fish behaviour while the device is operating.

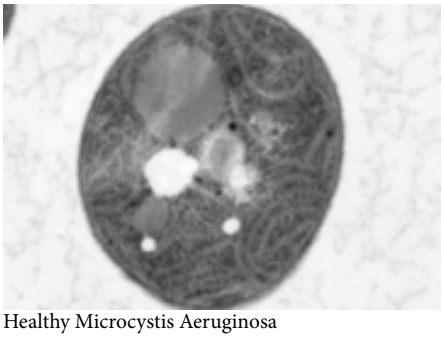
If you are considering ultrasonic algae control, depending on the species of algae present in your water, effectiveness timelines may be extended. In this situation, biological treatments are increased to deal with the immediate challenges.

In almost every situation, testing for algae species is recommended to understand timelines and frequency settings. We provide a listing of algae species that are managed by ultrasound as well as the short list of those species known to not be susceptible.

Ultrasonic algae control is effective, but not a short-term investment. We work closely with purchasers to ensure it is the right choice for their situation. To better understand the effectiveness and the science behind ultrasonic algae control, please comtact us for more detailed information.

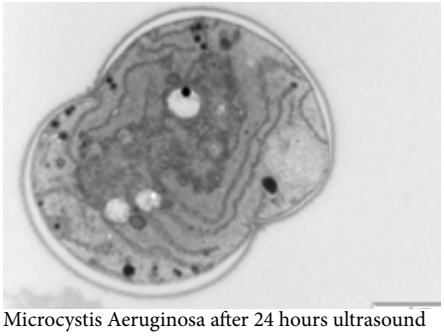


Healthy Spirogyra



Healthy Microcystis Aeruginosa

Spirogyra after 7-day ultrasound exposure



Microcystis Aeruginosa after 24 hours ultrasound exposure

Solutions

Phosphorus Inactivation

Algae requires a number of nutrients to grow and thrive. As we discussed on page 7 - in fresh water phosphorus is the limiting nutrient. It can be limited by when it forms a bond with iron in the sediments. This can only occur if oxygen is present at the sediment levels. In fact, if oxygen isn't present any iron bound phosphorus will be released to fuel potential algal blooms.

So what happens if there isn't enough oxygen or iron present to bind the phosphorus present in a water body?

On large bodies of water, where aeration isn't practical or sediments have low natural iron levels in-lake treatments can be a cost effective way to inactivate phosphorus and manage algae levels.

What products can be used to safely and permanently inactivate phosphorus?

The most cost effective product for permanently binding phosphorus is alum (aluminum sulfate). It has been used in drinking water treatment for hundreds of years and has been utilized in lake treatments for about 60 years. It has been thoroughly studied and has been demonstrated to be a safe and effective way to manage algal blooms through phosphorus limitation. It is abundant and inexpensive.

How can it be determined if alum is the right tool for a lake?

Study. Before it can be determined if alum is a suitable solution for managing algae in any lake a thorough study called a Phosphorus

Mass Balance needs to be done by a limnologist or other aquatic scientist. This determines when and where the phosphorus that is fueling algae growth is coming from. In order for alum, or any other phosphorus inactivation agent, the phosphorus feeding the algae growth should be predominantly coming from the sediments of the lake.

If it is determined that alum is a potential solution sediment coring of the lake bed needs to be done and a phosphorus fractionation completed to properly calculate dosing rates.

Is alum safe?

Yes, if it is applied properly. The dosage and application of alum should only be done be professional applicators. If alum is applied incorrectly it can cause changes to the pH in a lake a this can be harmful to fish and other aquatic life. Professional applicators monitor pH during application and buffer the alum with sodium aluminate to prevent pH changes.

How is alum applied?

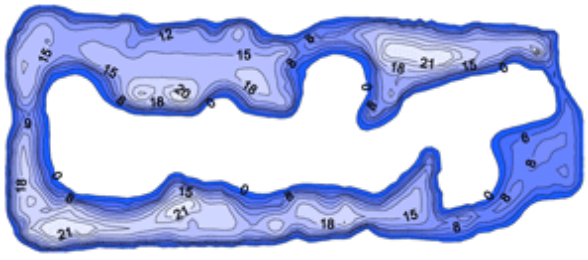
The best applicators utilize barges with specialized GPS controlled injectors to ensure the exact dose are delivered to the right part of a lake.

Are there alternatives to alum?

Yes, there are other products that can be used as an alternative to alum. Polyaluminum Chlorate (PAC) can be used and it does not require buffering like alum but it is more expensive than alum. Lanthanum, a rare earth metal, based products can also be used to inactivate phosphorus but they are much more expensive and the science is not as understood as they have not been used as long and they lack transparency as some of the formulations are proprietary.

Can i use alum on a private water body?

It is recommended that regional regulators be consulted before utilizing any chemical in any water body, especially if there is an outflow into the local watershed. As long as any necessary regulatory approvals are obtained and dosing maximums are not exceeded alum can be safely applied to most water bodies. Due to the potential buffering requirements of alum it is suggested that another aluminum product, like PAC, be used for those wanting to apply it themselves. It is also recommended that a water professional be consulted to properly determine dosing levels.



Alum application map

Water Management Checklist

Date: _____

Physical Location (Address, GPS Coordinates or Legal Land Description)

_____

Describe the purpose of the waterbody and the goals you have for it

_____

_____

_____

_____

Bathymetrics

Length _____ Width _____

Max Depth _____ Avg Depth _____

Max Sediment Depth _____ Avg Sediment Depth _____

If a full depth and/or sediment depth profile was measured provide a map indicating the location of your measurments. (see pages 10-11)

Estimated Age of Water Body _____

Water Source (y/n)

- ▫ Agriculture run-off
- ▫ Pasture run-off
- ▫ Urban run-off
- ▫ Well or spring water
- ▫ Wastewater

Description of issues and problems

_____

_____

_____

_____

NEXT STEPS

Whether you need help figuring out where to start or if you already know what you need, our team has the experience and expertise to help you acheive your water quality goals.

Contact Us

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EMAIL

(403) 342-5206

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