

## FAQ for Open Water Season Aeration- Aeration Systems in Natural Lakes

### Purpose:

This document addresses common questions and misconceptions, the authorization of aeration systems in natural lakes during the open water season and summarizes the current state of scientific evidence regarding aeration and water quality improvements.

### FAQ: Common Questions and Clarifications

- 1. Emerging and Non-Approved Water Treatment Technologies, what next?** Emerging technologies such as, nanobubbles, “restructured water”, and other proprietary treatment systems are still relatively new and require careful evaluation, particularly when they involve claims of nutrient removal, algal control, or sediment (muck) reduction in Minnesota’s natural lake systems.
  - **How does the DNR view emerging or non-traditional aeration technologies?** These aeration technologies are being evaluated cautiously due to insufficient lake-scale data demonstrating measurable and sustained water quality improvements. Uncertainties remain regarding potential impacts to thermal stratification, nutrient dynamics, oxygen distribution, and aquatic ecosystem impacts.
  - **Why is DNR cautious?** Protecting Minnesota’s public waters remains a top priority. When evaluating emerging technologies, we need to evaluate the site-specific conditions and potential ecological impacts associated with their use in natural lake systems because there is limited peer-reviewed research demonstrating long-term effectiveness and ecological safety in natural lake environments. Also, while it’s up to the individual to beware of unproven claims regarding the effectiveness of new technologies, we can be helpful in making decisions if we are aware of competent research and reporting on specific systems.
  - **What is so different about a natural lake system that is so different than the studies that are available?** Much of the available research conducted on emerging technologies has been used in wastewater treatment, agriculture settings or small or confined systems (*eg., golf course ponds, aquaculture*). Despite the promising findings within these types of controlled settings, Minnesota’s waters are complex ecological systems, and more rigorous evaluations are needed to understand the potential unintended consequences that may occur when altering oxygen dynamics, sediment chemistry, or nutrient cycling.
  - **How does the DNR do this?** The DNR is currently evaluating proposals for pilot-scale lake studies on new treatment technologies on a limited basis. Each pilot project is reviewed in coordination with multiple state agencies to ensure their use does not have negative unforeseen impacts on our public waters. The pilot studies help us ask the right questions, streamline permitting for systems that perform as marketed, and respond to questions from the public on the potential effectiveness of new technologies.

- **What if I have a pilot project and am interested in learning more?** Applicants are encouraged to review the DNR Nanobubble Factsheet and related guidance documents available on the DNR website prior to submitting a pilot project application for a non-approved treatment technology.

## 2. How Some Emerging Technologies Differ from Traditional Aeration?

- **What is considered an emerging technology or a non-approved aeration system?** Aeration systems that are not specifically authorized by rules or statute (e.g., typical mechanical aerators, bubblers, pump/baffle systems, surface aspirators) are generally not permitted because available research does not yet provide clear, consistent evidence of lake-wide ecological outcomes.
- **What do traditional aeration systems do during the open water season?** Minnesota Rules are generally intended to maintain localized open water areas for the possible prevention of summer fish kill and water quality permit use types.
- **How are emerging technologies different?** Often proprietary claims suggest broader ecosystem-level changes, such as, whole-lake nutrient reduction, sediment oxidation and muck reduction, and algal bloom suppression. There also tends to be little valid research to back up claims by marketers, making it hard for consumers to make informed decisions.
- **If I apply for a pilot project, am I guaranteed to receive a permit?** Authorization of any aeration system in public waters is evaluated on a case-by-case basis and must be consistent with applicable rules, statutes, and documented benefits supported by evidence-based data.

## 3. What does aeration actually do?

- Aeration introduces air into the water column via bubbles, mechanical mixing, or circulation.
- Depending on the system design and placement, aeration may influence water circulation patterns or vertical mixing within a localized portion of the waterbody.
- Aeration can increase dissolved oxygen (DO) locally and break up thermal stratification in enclosed systems.

**However:** Aeration's effectiveness depends on depth, scale, mixing patterns, and waterbody characteristics. In small systems (e.g., wastewater tanks, aquaculture ponds), when used properly, aeration can improve dissolved oxygen in localized areas but may not achieve long term water quality benefits and is not a cure-all for eutrophication problems.

## 4. What does the science says about aeration in the open water season?

**Short answer:** Depends on scale and lake characteristics

- Most peer-reviewed studies demonstrating benefits are in small or controlled systems (e.g., aquaculture ponds, recirculating aquaculture systems, urban or landlocked waterbodies) where aeration improved oxygen conditions and suggest, under certain conditions, changes in the phytoplankton community compositions reduced cyanobacteria (*blue-green algae*) dominance.
- Globally, some reports document positive and negative impacts of aeration techniques on the pigment that gives plants green color or *chlorophyll-a* concentrations and water transparency. Outcomes depend on system design, watershed characteristics (nutrient load), lake hydrology, and overall ecological

context. In some cases, reports show aeration can increase algae by resuspending nutrients or organic matter, potentially counteracting the intended water quality benefits.

**Summary:** There is limited peer-reviewed lake-scale evidence that aeration systems alone *improve water quality* (e.g., reducing nutrients or harmful algal blooms) in natural lakes without addressing nutrient inputs and larger ecological processes, especially at the scale of a whole lake with complex nutrient loading and dynamics.

**4. Can aeration help prevent fish kills or harmful low-oxygen events?** Fish require adequate dissolved oxygen to survive. When dissolved oxygen gets too low, generally below ~3–5 mg/L, can cause stress conditions and can lead to mortality for many species. Low DO is one of the most common drivers of fish kills in summer because warm water holds less oxygen while biological oxygen demand rises.

- **Aeration can potentially help prevent fish kills or harmful low-oxygen events in very specific conditions:**
  - In localized hypoxic zones (such as isolated pockets with little circulation), aerators have been shown to play a beneficial role in maintaining dissolved oxygen concentrations and *possibly* prevent fish kills in waterbodies that experience summer stratification or increased biological oxygen demand due to increased organic loading.
  - In stratified lakes during warm seasons, improperly managed aeration (like deep diffusers that break stratification too quickly) can actually trigger fish kills by bringing low-oxygen bottom water to the surface.
- **Does aeration reduce algae or nutrient levels?**
  - In natural lakes, nutrient reduction from aeration alone has not been widely documented in peer-reviewed lake studies and is not a substitute for reducing external nutrient inputs. Any reduction in nuisance conditions (e.g., surface muck or odors) must be interpreted cautiously and not equated with systematic control of nutrient loading or algal problems.
  - In controlled systems, such as in aquaculture ponds, aeration can help improve water quality by supporting natural bacteria that process fish waste and reduce toxic ammonia levels when integrated with biofilters.

**5. Are there risks associated with open-water season aeration in lakes?**

**Short answer: Yes,** which is part of the DNR’s regulatory concern.

- **Disruption of thermal stratification,** rapid mixing can bring deep low-oxygen water up into upper layers, potentially worsening fish stress or triggering fish kills if not managed carefully.
- **Aeration can** alter natural stratification and nutrient cycling, which could impact native species, plankton communities, and food web dynamics.
- **Scale and energy considerations:** Studies show that aeration systems can improve water quality mainly near the equipment, with less measurable change across the rest of the lake. Expanding the area of benefit may require additional equipment and higher energy use, increasing overall costs.

**6. What else should you know?**

- **Other permits or reviews may apply:** The DNR requires a permit to operate an aeration system in public waters; however, this authorization does not release the permittee from other permit requirements,

liabilities, or obligations under Minnesota statutes, federal law, or local ordinances. In some cases, a proposed project may also trigger environmental review requirements.

- **What is an environmental review?** In some cases, certain projects proposed in Minnesota’s public waters that will have an impact of an acre or more may require an environmental review before they can be permitted. Environmental review is a process established by Minnesota laws used to evaluate whether a proposed project may have the potential to cause significant environmental impacts. An Environmental Assessment Worksheet (EAW) is one type of review when projects meet specific thresholds established in state rules.
- **How might emerging technologies trigger an environmental review?** Some emerging technologies claim to reduce lakebed sediments, remove “muck,” or alter conditions at the bottom of a lake. If a project proposes actions that physically alter the lakebed or affect sediment across a large area of a public water, the project might meet the thresholds that require environmental review.
- **What does this mean for a project proposal?** The determination of whether your project will need to complete an EAW is determined on a case-by-case basis. The EAW process can often take 6-9 months and requires a public comment period. All permits and authorizations must wait until the environmental review process is complete.