Community and Commercial Stormwater Ponds

Water Movement

Stormwater ponds are built as flow-through systems to mimic the natural movement of rain across developed landscapes. These ponds receive nutrients from various sources, including impervious surfaces, residential homes and landscapes and natural organisms. The abundance of sources contributing to the nutrient load increases the demand for oxygen that would normally come from the atmosphere and plant photosynthesis. Natural water movement and pond design can positively impact water mixing and prevent stagnation, which leads to more oxygen availability.

Normally, much of the oxygen in the water column is diffused from the air above the pond. The interface of water and air at the surface of the pond can be problematic if stagnant water becomes heated by the sun, reducing the solubility of oxygen in the water. Additionally, stratification of the water column occurs when the surface water is heated while deeper water remains cool. In this case, the warm and cool layers will not mix, which further reduces the circulation of oxygen to deeper depths where undesirable compounds like hydrogen sulfide can accumulate. To stabilize treatment processes and maintain a healthy ecosystem, in some instances there may be a need to add mechanical aeration or circulation to ponds to increase oxygen levels and mixing.

▶ Impacts of Stratification

When water layers don't mix, the bottom layer becomes depleted of oxygen and limits aquatic organism productivity. In smaller ponds, this phenomenon increases the chances of pond "turnovers." In the autumn months when the temperature begins to drop, surface water temperature decreases. As temperatures become more uniform at various depths, the oxygen-depleted water on the pond bottom gradually mixes with the surface layer to homogenize and balance oxygen availability. However, in warmer seasons rapid turnovers can be induced by weather events, including large rain events, windstorms or the passage of cold fronts. Any rapid cooling of surface water will cause an abrupt mixing of layers, resulting in less oxygen available throughout the pond. This leads to hypoxic events, and potentially fish kills, in small pond spaces.

Pond design and construction are critical elements in managing stratification. Understanding the depth profile of a stormwater pond can help prevent turnovers. For instance, small ponds with deep sections can suffer from severe stratification because there is a larger volume of cooler, lower-oxygen water compared to the smaller oxygenated surface layer. Wider, shallower ponds have better mixing and sunlight penetration due to more of the total water volume being near the surface. Most stormwater ponds are designed with a depth of approximately four to six feet, but water flow can change the bottom contour through channeling or sediment buildup in certain areas. It is best to have a good understanding of pond depth and design before addressing any stormwater pond issue.

The simplest approach to management of pond turnovers is to control aquatic weeds and nutrients that lead to blooms. Thick aquatic vegetation can reduce circulation and cause stagnation. A common mitigation technique to promote mixing is through mechanical circulation. Some pond systems stimulate circulation by drawing water from depth for fountains or surface aerators, which causes mixing, while others use spray methods to increase water contact with the atmosphere to increase oxygen and cool the pond.

Fountains draw water from depth

▶ Types of Circulation

There are several different methods for mechanical water circulation in stormwater ponds. The objective of circulation is to pump water from deep, cool layers and expose it to the atmosphere to increase oxygen and mixing. One system involves deploying diffusers on or near the pond bottom. Air compressors are used to pump air to the diffusers, causing air bubbles to rise to the surface through the cooler bottom layers. These bubbles cause a mixing effect as water is pushed toward the top, helping to alleviate stratification and increase oxygen at greater depths. Water pumps can also be used if installed correctly. Suction lines should be positioned to draw water from the bottom, cooler layers to promote mixing of temperature. When pumping water from near the bottom, it is critical to position the suction intake above the sediment to reduce the risk of clogging. Permanent pipe installations at depth can be prone to clogging from sediment, plants or debris, while floating pipes that extend to the proper depth may not work if the water level varies significantly due to irregular rainfall patterns.

Pumping water from cooler depths through fountains or other aeration devices can serve a dual purpose for mixing the water column and creating added oxygen for surface conditions. The standard pond fountain draws water from near the surface, which results in minimal impacts on stratification. These systems should be designed to pump water from depth to help with mixing. Any mechanical circulation or aeration device should be installed by a licensed professional with electrical knowledge. If a stratified stormwater pond contains a fish population, pumping and mixing should be carried out gradually, starting with 30 minutes per day and increasing to 24 hours per day over three to four weeks.

Benefits and Problems with Circulation

Some of the benefits of water circulation include:

1. Water column mixing reduces stratification and potential turnover.
2. Movement of water will decrease the risk of stagnation that can lead to low dissolved oxygen.
3. In some cases, circulating water can provide additional dissolved oxygen to the water column if systems are designed appropriately.
4. Mixing reduces the competitive advantage of certain algae species (i.e., blue-green algae) that thrive in stagnant water.
5. Healthier pond ecosystems result from stabilized water temperatures and increased oxygen for natural nutrient reduction.
6. Circulation promotes the decomposition of organic matter in the bottom layers, reducing the conditions that can lead to production of odorous gases.

Some of the problems with water circulation include:

1. Increased maintenance and utility usage to properly maintain the mechanical units.
2. Impacts on water clarity from circulating sediments and organic matter.
3. Reduced settling of solids and sediments, which can lead to downstream clogging.
4. Small ponds can experience erosion effects from constantly moving water on the edge of the pond (even with waves of only two to three inches) or where systems are in close proximity to the bank.

Resources:

AEC807/WC468: Frequently Asked Questions about Stormwater Wet Ponds (*https://edis.ifas.ufl.edu/publication/WC468*)
Storm Water Permit Resources | Louisiana Department of Environmental Quality (*https://deq.louisiana.gov/page/storm-water-protection*)
Stormwater Pond Problem Solving (www.clemson.edu/extension/water/stormwater-ponds/problem-solving/index.html)
Stormwater Wet Pond and Wetland Management Guidebook, February 2009 (*www.epa.gov/sites/default/files/2015-11/documents/pondmgmtguide.pdf*)

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