Phosphorus management recommendations

Environmental Studies 402:

People, Environment and Sustainability

Water Quality & Nutrient Management—Fall 2017

Phosphorus Management Suggestions for Dane County

Overview:

The purposes of this report include assessment of current approaches to nutrient management that have potential for phosphorus reduction in Dane County's lakes and watershed system. Building upon initiatives Wisconsin, and comparing initiatives with other states, three options towards nutrient management proved most compelling.

Buffer Strips:

Riparian buffer strips act as a filtration system for farmland runoff. Buffer strips collect a variety of nutrients including sediment, nitrogen, and phosphorus.

Width

The width of the buffer strips depend on a variety of factors that include, volume of runoff, steepness of the slope, soil permeability, and type of vegetation[12]. A main contributor of phosphorus contamination is from sediment deposition. Multiple studies show that a 50 foot buffer strip can prevent up to 95% of sediment deposition, which is a major source of phosphorus contamination[27]. As stated previously, the steepness of the slope is a factor. As the steepness of the slope increases, the speed of the water flow through the channelized flow increases thus carrying more sediment and nutrients. We suggest that areas where this channelized flow occurs, a wider buffer strip is necessary to slow down the runoff and absorb more nutrients[16]. Due to all these variables, there is not a one size fit all approach to riparian buffer strips. We suggest a minimum riparian buffer strip width of 30 feet and an average buffer width of 40 feet be established. This flexibility allows certain buffer strips to be wider in areas that need to be and implements a law that requires a riparian buffer strip for every farm.

Vegetation

The type of vegetation that is put in place in riparian buffer strips has dramatic impacts on the effectiveness of the buffer strip. Multiple studies show that the best approach to a buffer strip consists of three layers: grass buffer along the crop, shrubs and then trees along the water boundary[12]. Grass buffers maintain sheet erosion and prevent it from turning into rill and gully erosion. We recommend the thickness of this grass layer should be between 15-20 feet[12]. It should also consist of native vegetation and this layer can be grazed as long as it maintains its functionality. The second layer should consist of shrubs. This layer should consist of native vegetation and be 10-15 feet wide. The third layer should dominantly consist of woody species. The roots of the trees stabilize the soil and absorb large amounts of phosphorus that was not already absorbed in the first two layers. This layer should not be disturbed and should be around 20-30 feet wide[13]. These recommendations will provide the most effective nutrient management strategy.

Implementation

Minnesota has passed a law that has mandated a 30 foot minimum and 50 foot average riparian buffer strip [8]. If Wisconsin can model its buffer strip initiative after Minnesota's, our water systems will be much healthier. Incentives and payments to farmers can be done through federal incentives. Federal incentives are coming from the Farm Bill which provide cash payments directly to the farmer for the reduction of crop production [19]. Minnesota is paying $40 per acre each year for each tillable acre converted to a water quality buffer strip[8]. Statewide efforts also need be increased to assist farmers in the implementation process. Seed mixes should be Wisconsin DNR approved so farmers can plant the correct vegetation for optimal phosphorus removal. Also, conservation and water districts need to give hands on assistance to farmers that are either not complying to the law and find alternative approved practices, or to farmers that need assistance in planning, implementation, or mechanical assistance. The idea is not to punish the farmer, but to work together to improve our water quality.

Manure Transportation:

Dane County should provide farmers financial assistance to help with the cost of moving manure from animal operations with excess manure to other farms, or to other facilities that can use the product in an environmentally safe manner.

Maryland and Delaware

Maryland and Delaware currently have Manure Transport Programs in place which provide cost-share grants to help cover transportation, loading and handling cost associated with moving manure from poultry, dairy, beef or other animal operations. This started as an effort to clean up the surrounding bodies of water, much like Dane County is attempting to do. Both states have had similar issues with agricultural runoff affecting its waterways, especially the Chesapeake Bay in Maryland. Animal waste is blamed for more than a third of the nitrogen and more than half of the phosphorus that is in the bay[7]. Even though these other plans are more focused the poultry industry, which is a different focus than what Dane county would have, the idea would still translate well to Dane County.

Important Parts

A key part of Maryland's program that would be very beneficial for Dane County to use is a manure matching service[5]. This service connects farmers that have excess animal manure to farmers or "alternative use projects" that can use the manure in a better way. Giving farmers with excess manure the connections and resources to transport their manure would help prevent the over application of the phosphorus rich manure to soil that is already high in P. This reduction in overapplication, especially on farms in the Northeast portion of the county where the Mendota watershed is, would result in a reduced amount of phosphorus entering the lakes.

Who Can Apply

We would suggest that you closely follow the guidelines outlined in Maryland and Delaware's manure transport programs. The applicants outlined in the Maryland manure transport program include: farm operations that produce manure and have insufficient land to use the product, farm operations that can use manure safely as a nutrient source based on a current nutrient management plan, farm operations that produce manure but need to transport it (more than seven miles for poultry litter and more than one mile for all other types of manure) due to phosphorus over-enrichment in production fields within these distances, manure brokers registered with the Department of Agriculture, Trade and Consumer Protection, and alternative use facilities/operations[4].

Requirements for Sending Operations
Producers that are seeking grants for transportation within their own operation may be eligible, as long as they are transporting it farther than the distances stated in the above section. The manure that is being transported needs to be analyzed to measure its nitrogen and phosphorus levels before transportation. An up to date nutrient management plan is needed. When transporting the manure, all rules and regulations regarding manure transportation in Wisconsin need to be followed.

Requirements for Receiving Farm Operations
Current nutrient management plans are required for farms receiving manure. Farms with soil nitrogen and/or phosphorus levels above the optimum threshold, as defined by current soil test levels for Wisconsin, should not be allowed to receive manure through this program. The farms receiving the manure must provide a safe unloading site that does not pose a risk to surrounding water quality, which would be determined by the county. If the receiving operation does not apply the manure right away, it must be stored safely, in a way that prevents nutrient movement. Further rules and regulations may apply, depending on the situation.

Cost
In Maryland, about two thirds of the money for the program comes from taxes. For the plan this fiscal year, $357,000 of the state's money that was spent on the program is coming from general state tax receipts and $750,000 comes from the state's Chesapeake and Atlantic Coastal Bays Trust Fund[7]. That fund is financed with revenue from Maryland's gas and rental car taxes. The remaining $527,000 in the program comes from poultry companies, manure brokers and farmers[7]. Since the focus of this project is just on Dane County and not a whole state, the cost of a program like this would be cheaper. Funding would most likely come from local taxes and companies/organizations located in the county that have a role in this problem. However, there are also a number of federal cost-share assistance programs such as the Agricultural Conservation Easement Program or Environmental Quality Incentives Program that could aid applicants investing in conservation systems.

Other Tasks of the Program
In addition to safely transporting manure to environmentally friendly storage facilities to areas of low phosphorus or to one of Wisconsin's Anaerobic Digester (AD) facilities, such a program could go further by including emphasis on education and coordination of those in the dairy industry, legislators, and those in AD industries. In a 2009 study, the most limiting factors of investment in wastewater renewable energy included inadequate understanding of the technology were the most limiting factors to producing energy from and a 2017 study of AD restraints included lack of industrial facility interaction and discussion of options with local wastewater treatment facilities [19, 28]. Such a program could take advantage of partnering opportunities between industry, regulators, and the public through increased communication.

Approaches to Removing Existing Phosphorous from Lakes:

Preventing further phosphorus from getting into our lakes is a crucial part of keeping them clean, however, this does not account for the existing phosphorus stored in the sediment and the algae blooms. One method that has been trialed in lakes around the world, is the addition of aluminum and lanthanum modified bentonites. The common name for the aluminum used in the study I researched was called ALUM, which is short for aluminum sulfate. The ALUM removes existing phosphorus in lakes when it is

released into the water, it forms a fluffy aluminum hydroxide with the H_2O that then binds with the phosphorous. The aluminum phosphate compound is not soluble with water and therefore the phosphorus cannot be used as food for algae. It also brings other particles down with it and clears the water of the lake. The bottom of the lake becomes a phosphorus barrier as it is released from the sediment[3].
This method was trialed in 114 different lakes in various regions of the world from Minnesota to Florida to Sweden and Germany. After releasing the ALUM dosages in the lakes, the researchers monitored the lakes for about 8-10 years. Their findings revealed that the total phosphorus, SEcchi depth (water clarity), and Chl A (biomass of planktonic algae) all improved after the ALUM treatment in most of the lakes. The treatment lasts for about eight years in mostly shallow lakes. The reduction was not significant in lakes where high external P (phosphorous) loading was not effective. The factors affecting the aluminum treatment longevity include lake shape, lake fetch, water column stability, and lake pH. Data revealed that the aluminum is not toxic to aquatic life in correct doses as long as the pH remains in the 5.5-9.0 range. Benthic insects increased in diversity in some Wisconsin lakes, but many have been successful when treatments are pH buffered. Benthos are aquatic insects with no backbones, live on rocks or sediment, and are important to food chain especially for fish. One essential factor in maintaining the lake for future management is being knowledgeable on the amount phosphorus and water inputs of the lake which would result in accurate estimates of how much Al is needed[1].

Another research experiment that has been done with the aim of managing the eutrophication of lakes did so by using the Flock and Lock method. The Flock and Lock method is like the aluminum addition strategy but differs in that chemical being released is $FeCl_3$ rather than PAC or aluminum sulfate. The determination of which chemical to use on the lake depends on the P-loadings of the lake. The experiment took place in Denmark, at Lake De Kuil. This method uses a combined flocculant which is a substance that promotes the clumping of particles, especially one used in treating wastewater. Sustainable reduction of sediment P-release compromises the top 10 cm of the sediment. Flock-and-Lock method is using the flocculent polyalumniumchloride to bind with the phosphorus released from the sediment during anoxic events. The researchers used dissolved $FeCl_3$ (flocculent and lanthanum modified bentonite, eats algae) rather than PAC (polyaluminumchloride). While PAC is a better alternative, the $FeCl_3$ was used because a permit could not be obtained to use in lake. Flocculent and ballast (heavy material placed on a low Bessel to improve its stability) removes a bloom of cyanobacteria from the water column. Since the treatment in 2009, no swimming bans have occurred due to cyanobacterial blooms. Oligotrophication is the process of nutrient depletion in aquatic ecosystems. P. rubescens, which is a cyanobacteria, can proliferate the lake after oligotrophication occurs because total phosphorus concentrations are low because the lake is in recovery and therefore the nutrient cycle is vulnerable. By using this Flock and Lock method, the internal P-recycling was reduced, and therefore water quality improved. After further management and analysis, the lake eventually went from a eutrophic state to a mesotrophic one[2].

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About UniverCity Year

UniverCity Year is a three-year partnership between UW-Madison and one community in Wisconsin. The community partner identifies sustainability and livability projects that would benefit from UW-Madison expertise. Faculty from across the university incorporate these projects into their courses with graduate students and upper-level undergraduate students. UniverCity Year staff provide administrative support to faculty, students and the partner community to ensure the collaboration's success. The result is on-the-ground impact and momentum for a community working toward a more sustainable and livable future.

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