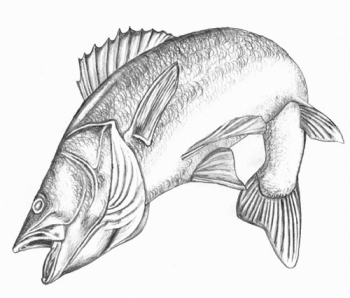

ISU Fisheries Extension

Managing Iowa Fisheries

Building Quality Ponds

Introduction

Ponds with good water quality are a joy to look at whether in the country or surrounded by urban homes. However, pond owners usually also want to use them for fishing, swimming, or boating activities. Clean water is needed not only for aesthetics, but also for the health of wildlife contained in these systems. The term "clean water" as used in this publication means water that has low levels of both suspended solids and dissolved nutrients, principally nitrogenous and phosphorus compounds.

Domestic and livestock water uses usually require water to be relatively free of sediment. With a reasonably clean watershed and a sediment basin, ponds can meet these needs. Irrigation water may not need to be rid of all sediments, but it should not plug the irrigation system. Where water supplies are limited, however, trickle irrigation systems are becoming more common, and require even clean pond water to be filtered. The cleaner the water is, the better the system operates. Similarly, those who sprinkle vegetative crops do not want clay particles left on the vegetation. Water quality for fire protection is not critical as long as the dry fire hydrant is not plugged with sediment; hence, a clean pond would decrease maintenance of the hydrant.

Dissolved nutrients are as important as sediments, in terms of the overall health of a pond. Dissolved nutrients are introduced into the water from the surrounding watershed. These nutrients combined with the influx of sediments often allow for an ideal habitat for aquatic weed growth (due to shallow pond depth and enriched nutrients). Such ponds have too many weeds that make it difficult to harvest fish.

A quality pond stores clean water, or the cleanest water possible, for a given location. This publication will describe suitable water sources and the design and maintenance of water impoundments.

Types of Ponds

Ponds can be placed into two general categories, excavated or embankment. Excavated ponds are holes dug in the ground that fill with water or into which water is pumped. Embankment ponds are formed when a water course is dammed with an embank-ment, usually earth material, and surface runoff water is impounded. Most of the following discussion will pertain to embank-ment ponds, but some also will apply to excavated ponds that have water pumped in. A water storage permit is needed if natural runoff is captured and stored, e.g., a dam across a waterway, and the permanent storage is in excess of 18 acre feet (1 acre foot equals 1 acre in area, 1 foot deep). Contact the Iowa Department of Natural Resources (IDNR) for more information regarding these permits.

Site Selection

Watershed/pond size

The size of the watershed area determines the volume of water that will enter a pond during a storm. A ratio of watershed area to pond surface area of 10–to-1 to 20-to-1 is ideal in most Midwestern states. This means that a 10- to 20-acre watershed will supply enough water for a 1- to 2-acre aesthetically pleasing pond. It also will be a nice size for swimming and fishing.

Watershed land use

Land treatment can affect water quality as well as quantity. Protected timber is preferred as watershed cover. A parking lot will yield a lot more water than

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a prairie grass watershed. A cultivated row-crop field or a construction site can yield increased influxes of sediment. But a grassed or forested watershed will yield high quality water inputs into a pond. Hence, both present and future land use can affect the choice of pond sites. Allowing for future changes in land use may mean allowing space for the location of a sediment basin and bypassing suspended clay particles in the inflow.

Alternative water sources

Alternatives to running all the water from a watershed through an impoundment include selectively pumping or diverting water from a stream when the sediment content is low, or pumping from a shallow well. Pumping from deep aquifers or pumping the volume of a large pond may be cost prohibitive and usually is not done. A water withdrawal permit (from IDNR) is required if withdrawal from a groundwater or surface water source is more than 25,000 gallons per day.

Sediment control

A sediment basin may be justified when the watershed contains cultivated land, construction sites, gravel roads, or other sources of sediment. A small basin, 1/4 acre in size, can trap a large percentage of the sediment that otherwise would end up in the main pond. A good sediment basin should be easy to clean out, usually should be shallow (less then 3 feet deep) so particles and adsorbed nutrients can be deposited in a short distance, and should have an outlet pipe that skims the cleanest water off the surface. However, preventing sediment from moving from the watershed is the best control measure.

Soils for dam construction

A location may have a good watershed, but it also needs the right soils to build a dam. Soils that can be compacted into a low permeability dam usually are at least 20 percent clay and are low in fibrous organic matter. That means topsoil, tree roots, and drain tile must be removed from the construction site and from the location from which the fill is to be obtained. County soil survey maps published by the

National Resource Conservation Service (NRCS) offer a general guide of soils in a given location. If the site looks promising, then a detailed site survey should be requested from NRCS or from other trained personnel.

Accessibility for use and abuse

A location may have a suitable watershed and soils, but the location also needs to meet the user's needs? Consider whether it is too remote to be enjoyed, or so visible that it will attract too many uninvited people and become a nuisance and liability.

Wind

Determine how the wind will affect the pond and activities on the pond. Also consider whether the location will clear an area that exposes the home and other property to the wind or blowing snow. Although some wind action is good for a pond—e.g., aeration—too much wind can have adverse effects a pond. Space for wind breaks and riprap on the dam may need to be considered. Wave action on other shorelines may not endanger the pond, but could add turbidity to the water and cause steep banks near the water's edge.

Construction

Dam: slopes, berms, safety for mowing

The dam should be constructed not only to impound water, but also to be easily and safely maintained. Mowing the dam to prevent trees from perforating the dam with their roots has long been recommended. The dam should be constructed with slopes flatter than 3-to-1 (slopes 3 feet horizontally to 1 foot vertically) for safety and to prevent wheel slippage or rollover with common mowers. For ease of mowing, construct the slopes of the dam that are above water at 3.5-to-1 or 4-to-1. To prevent the mower (and pedestrians) from sliding into the water, construct an 8-foot wide berm (nearly level strip of earth) on the upstream side of the dam, 1 foot above water level. This berm also discourages muskrats from burrowing into the dam (no head space for their den) and provides extra protection against wave action. The berm makes placing riprap easier. This berm is shown in figures 1 and 2.

Spillways—bottom vs. surface withdrawal

The spillway can be the key to storing clean water in a pond. Muddy water entering a pond flows along the bottom to the deepest point because it is more dense

Figure 1. Profile of bottom-withdrawal spillway.

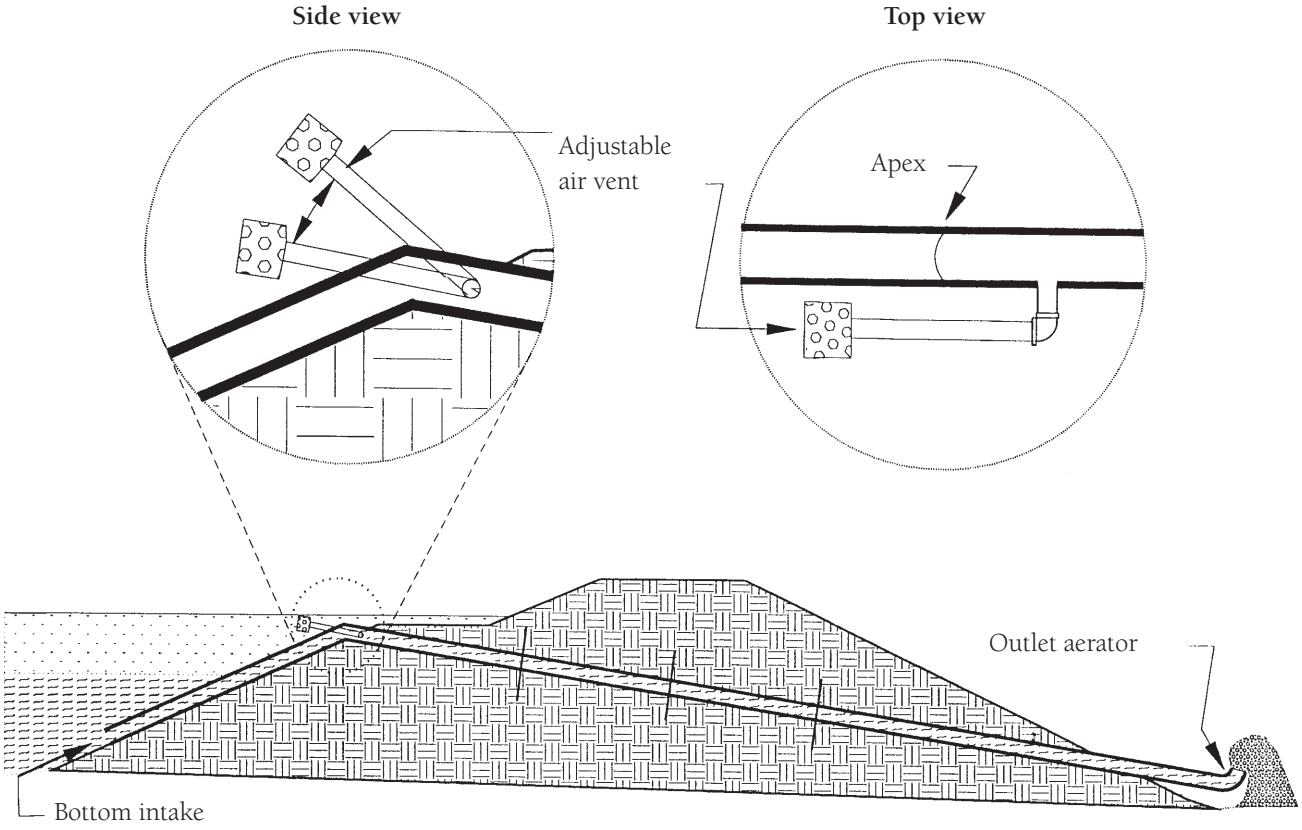
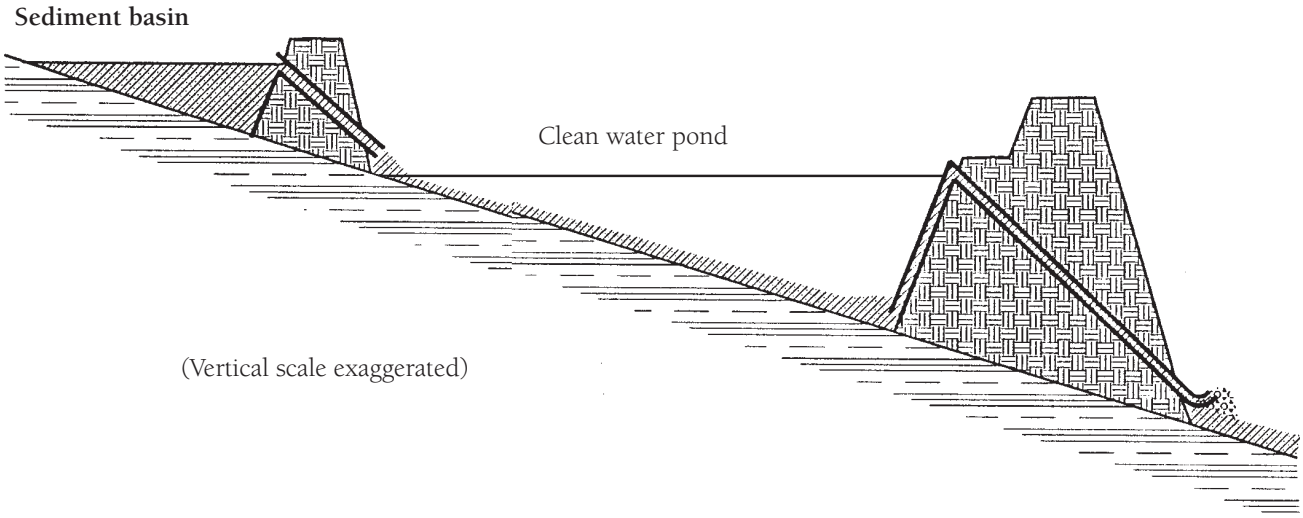


Figure 2. Clean water pond with upstream sediment basin.



than clean water. If the spillway discharges surface water, the pond will fill with the muddy (inflow) water. If the spillway discharges from the bottom of the pond, the clean surface water will remain and the muddy water will be discharged. Discharg-ing water from bottoms of fish ponds is quite common and also can be done for other clean-water ponds. The bottom-withdrawal spillway shown in figure 1 is one such spillway that stores the clean water. The spillway pipe acts like a siphon when the water level rises above the high point of the pipe and the air vent is under water. This quickly discharges the muddy water before the clay particles settle out. Another essential element is the outlet elbow that serves as an air lock to help start siphoning and acts as an aerator to restore oxygen to any water coming off the pond bottom. Additional information concerning the bottom-withdrawal spillway may be found in University of Missouri publications: UMC Guide 1530, Operation of a Bottom-withdrawal (Lake-cleaning) Spillway, and UMC Guide 1531, Design Criteria for a Bottom-withdrawal (Lake-cleaning) Spillway.

Water in the bottom of the pond accumulates decaying plant life, which uses up the oxygen in the water during warm weather. Low oxygen levels in water cause sediments to release phosphorus to the water. Discharging the bottom water helps prevent the accumulation of nutrients in the pond as well as the buildup of sediment.

Shaping pond banks for weed control

Aquatic plants can cause problems in an aesthetically pleasing pond. Rooted aquatic plants and algae usually begin growing in shallow water (less than 2 feet deep). Edges of new and existing ponds should be deepened so shallow water areas are minimized. This is best done during the construction of the dam. The shore should be sloped 3-to-1 to a depth of 6 feet except in wading areas or areas of inflowing water. Wading areas should be sloped less than 5-to-1 for a few feet into the pond and then become flatter throughout the rest of the wading area. The wading area should be roped off to prevent accidental wading into deeper water.

Sediment basin(s)

Sediment basins are a preventive measure to lengthen the life of a pond. The cost of dredging a pond can be at least 10 times the original construction cost, but the cost of cleaning a sediment basin is less expensive and disruptive than draining and hauling out sediments from a pond. Therefore, the sediment basin, as shown in figure 2, should be at an elevation where it can be drained for easy removal of sediment without interfering with pond use. If it is to be emptied without draining, it should be narrow enough so a dragline can reach halfway across. Peninsulas built into the sediment basin can be used to prevent short-circuiting of the water between the inlet and the outlet; peninsulas also can be used as operating locations for the dragline.

Clean water withdrawal plumbing

A floating intake can be used to remove the cleanest water from the pond for domestic or livestock uses. This intake floats 2 to 3 feet below the water surface, may have a replace-able filter, and is connected to a pump or goes through the dam with a flexible pipe. The filter can

remove much of the algae as well as numerous aquatic organisms. The quality of this water usually is good enough for livestock use without treatment. Further treatment is needed for household use.

Renovation of Existing Ponds

Spillway modification

Existing ponds can be upgraded by adding a bottom-withdrawal spillway. If the pond has a hooded or canopy spillway, it can be modified by adding a length of pipe to extend the inlet to the bottom of the pond along with adding an air vent and outlet elbow (figure 1). Ponds without a spillway pipe can have one added without draining the pond. Just trench from the water's edge on the dam, through the dam, to a suitable waterway below. Place the bottom-withdrawal spillway pipe with one or two anti-seep collars into the trench and carefully backfill. Drop-inlet spillways are more difficult to modify. They will require elevating the riser (the vertical portion of a drop inlet) and placing a siphon into the riser. If the drop-inlet spillway has any deterioration, it may be easier to replace it with a bottom-withdrawal spillway system instead of modifying it.

Draining

Draining an existing pond for renovation may be easiest if the bottom-withdrawal spillway is installed first. Then siphon the water down to where other renovations can be made. The bottom-withdrawal spillway can be manually primed by

1. capping the outlet,
2. pumping water into the air vent (allowing air to escape as needed) until the pipe is at least half full,
3. plugging the air vent, and
4. removing the outlet cap.

The air remaining in the pipe will be removed by the turbulence in the pipe until it is flowing at full capacity. A pipe flowing at 1 cubic foot per second (cfs) will remove 2 acre-feet of water per day from the pond. Maintaining the siphon at low flows can be difficult—both ends must remain submerged and no air leaks in the piping are allowed.

Removing sediment/deepening/shaping

An overabundance of rooted vegetation in the pond means the water depth is too shallow and too many nutrients are available for plant growth. This requires removing accumulated sediment and/or making the shoreline steeper and deeper. (See construction criteria previously described.) Accumulated sediments often are slow to dry; it may take years for the pond bottom to dry sufficiently to be able to support heavy equipment. The alternative is to remove all the sediment down to the solid clay base, allowing the heavy equipment to operate efficiently.

Maintenance

A quality pond requires preventive main-tenance, which is likely to be cheaper than solving problems later. For example, fencing out livestock is easier and cheaper than reshaping the shoreline and removing the turbidity they cause.

Likewise, periodically removing suspended nutrients in the bottom of the pond is easier than killing algal growth each year. The best time to remove suspended nutrients is in late summer before fall turnover. Ponds in the summer often are stratified—the cooler water in the bottom has low oxygen levels (due to decomposition of organic wastes), and the top layer is warmer and has high levels of oxygen. Turnover occurs when the surface waters cool down to a temperature lower than the water below. Since cooler water has greater density than warmer water, the surface water falls down in the water column and the nutrient-rich water from below rises to the surface. During this time period, there may be odor problems until oxygen levels are restored.
If conditions downstream allow the discharge of this nutrient-rich water, the bottom-withdrawal spillway can be used to lower the water level of the pond by a couple feet. This can be accom-plished by manually priming or lowering the air vent to 2 feet below the water surface and waiting for the next storm to cause outflow. If evaporation has lowered the water level, it may take a large storm to cause any outflow, and fall turnover may have already taken place.

Mowing the dam prevents trees from damaging the dam as well as discouraging den dwellers from digging into the dam. Mowing paths and other recreational areas makes them more enjoyable for people to use. However, leaving some areas unmowed will encourage wildlife use of the pond. Not mowing right next to the pond (except for the dam) allows the vegetation to intercept much of the sediments and associated dissolved nutrients from the watershed.

Management for Wildlife

The basic needs of most wildlife species are rather simple. These requirements include food, shelter, water, and space. A limitation of one or more of these

needs will limit population numbers of individual species. Buffer strips of tall grass or shrubs adjacent to farm ponds will provide critical nesting and denning habitat, as well as escape cover and winter cover for wildlife. For more information about buffer strips, see IDNR publication Attracting Backyard Wildlife, and Iowa State University Extension publication PM 1626B, Buffer Strip Design, Establishment, and Maintenance—Stewards of Our Streams.

All requirements for wildlife and erosion control can be met when adequate areas adjacent to the pond are properly managed. One program of importance in both erosion control and wildlife nesting is the seeding of suitable areas to grass or legumes. Suitable plants include alfalfa-bromegrass and some of the native warm season grasses, e.g., switch-grass, indian grass, or big bluestem, all of which are excellent for providing wildlife habitat.

Aquatic Plant Management

Management methods

Aquatic plant control is a management plan that incorporates preventive methods (proper pond construction and maintenance), biological methods [grass carp (Ctenopharyngodon idella)] when appropriate, and the use of labeled aquatic herbicides. Developing an aquatic plant management plan depends upon correctly identifying the problem plants and selecting control methods that are compatible with pond usage (animal watering, aquaculture, hunting, sport fishing, swimming, or wildlife viewing).

Aquatic plants that interfere with the intended uses of a pond may be considered weeds to be controlled. To determine which of these techniques to use, consider the target weed species, the management objective for the pond, secondary water uses, and the cost of treatment options.

Preventive methods

It is easier and less costly to prevent weed problems than to control them once they develop. Careful pond site selection and proper pond construction and watershed practices are the first steps in preventing aquatic weed problems.

Decreasing the pond water level exposes shallow areas to freezing temperatures and drying, and can effectively limit certain types of submersed plants. For a drawdown to be effective, the water level should be lowered in the late fall and not allowed to refill until the early spring. Some weeds, such as cattail (Typha spp.), are tolerant to drawdown and cannot be controlled by this method. Such activities may promote growth of these plants.

Biological control methods

The grass carp is a practical and economical way to control certain types of pond weeds. Grass carp effectively control submergent weeds with tender succulent vegetation, such as coontail and watermilfoil, but are ineffective in controlling weeds that have tough, woody vegetation, such as waterlily and cattail. Prospective users of grass carp should be aware that while submergent plants can be controlled using this technique, ponds with grass carp often become quite turbid due to increased planktonic growth arising from increased amount of nutrients available due to the control of vascular plants. The current stocking recommendation for Iowa ponds are 4 to 5 fish per surface acre. This number may need to be increased in ponds that have a rich and productive plant fauna. Initial plant control should be noticed 18 months after initial stocking. If the pond already has a large prey base, e.g., largemouth bass, the landowner should stock grass carp that are 8 inches or longer to enable them to escape predation. These fish will need to be restocked after 5 to 6 years.

Mechanical methods

Various types of aquatic weed cutters and harvesters have been developed for canals and large reservoirs. Use of these machines is not practical in fish ponds. Early manual removal of weeds by seining or raking can reduce some weed problems.

Chemical control methods

Herbicides may be used to control plants in fish ponds. The first step in successful chemical control is accurate identification of the problem plant. Plant identification assistance is available through ISU Extension and IDNR offices. After the plant has been identified, a herbicide that is labeled for aquatic use may be selected. Users should read and fully understand the herbicide label before application. Additional information concerning aquatic herbicides and aquatic plant management may be found in the following ISU Extension publications: PM 1352A, Managing Iowa Fisheries: Water Quality; PM 1352D, Managing Iowa Fisheries: Calculations and Conversions for Fisheries; PM 1352I, Managing Iowa

Fisheries: Use of Copper Compounds in Aquatic Systems; PM 1352J, Managing Iowa Fisheries: Aquatic Plant Management; and CS 17, Aquatic Pest Control, Category 5: A Guide for Commercial Pesticide Applicators.

Integrated weed management

Herbicides should be considered as a tempo-rary control method. Depending upon the herbicide selection and the weed species, duration of control can range from a few weeks to several months. Long-term control can be achieved by using a combination of recom-mended aquatic plant control methods. For example, use of the proper herbicides followed by grass carp stocking will effectively control and prevent the reoccurrence of most sub-mersed weed problems. The best long-term control is to intercept the flow of nutrients into the pond through modifications of land use practices or use of small wetlands to filter the runoff. The use of the bottom-withdrawal spillway also will reduce nutrient accumulation.

Summary

Quality ponds are designed to store the cleanest water possible for a given location. In new construction, site selection obviously plays an important role in the quality of water available for storage in a pond. Sediment control is best achieved by preventing erosion in the watershed, backed up with a sediment basin to trap incoming silts and sands, and a bottom-withdrawal system to by-pass the suspended clays.

An existing pond can be renovated or upgraded to a quality pond by using the same criteria. Canopy and hooded spillways can be converted to bottom-withdrawal without draining the pond. However, removing sediment accumu-lation and shaping the shoreline where rooted weed growth is a problem may make it more practical to drain the pond and start dry. The dam also should be shaped to make main-tenance easy and safe, which in turn will discourage burrowing animals and deep-rooted trees from perforating the dam.

In addition to shaping the shoreline, aquatic plant management can be enhanced with an integrated management plan that takes into account all uses of the pond. A high quality pond can be useful to both landowners and wildlife that live in or around it.

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