# POND DESIGN AND MANAGEMENT

Delaware
Soil and Water
Conservation District
Helping You Help The Land

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# Pond Site Considerations

Proper construction is one of the most important parts in the development of a good pond. Many potential problems can be avoided through careful site selection and design before construction begins. The Natural Resources Conservation Service (NRCS) and the Delaware Soil & Water Conservation District (SWCD) staff can assist you on investigating the pond site. To get started, work through the following questions regarding your pond site.

## Why do you want a pond?

There are many good reasons to build a pond. Fishing, beautification, wildlife habitat, livestock watering, swimming, and irrigation are the most popular reasons. However, some of the other common reasons people install ponds are based on misconceptions about how a pond will impact their property.

A pond will not improve drainage or flooding issues on your property. Building a pond does not reduce the amount of water coming onto or leaving your property. A wet basement, pockets of standing water in your yard, or an erosion problem will not be solved by a pond. A more appropriate solution could include properly grading the soil away from your home's foundation, installing tile drainage, and/or constructing a grassed swale. The Delaware SWCD is available for drainage consultations to determine what alternatives are available for your property if needed.

Ponds require maintenance to stay healthy and attractive, so those looking to reduce landscaping requirements or increase property values may also want to reconsider. While some buyers consider a pond an asset, others may be turned off by the additional maintenance and reduced usable space.

## Do you have a good water source?

Before settling on a pond, verify that the watershed area that will drain into the pond is not too large or too small for the size of pond you would like. Too much watershed area will overwork the pond, increasing the likelihood of erosion and necessitating a large, expensive overflow structure. Too little watershed area will make it difficult to keep the pond full. Pond sizing is discussed in more detail in the Pond Design section, but the SWCD can determine the approximate watershed area that will be draining into your pond and whether you have room for a pond of the appropriate size.

The quality of the water coming into the pond should be a primary concern. The land use within the watershed will greatly impact the quality of the water draining into your pond. Poorly functioning septic systems, nutrient runoff from agricultural land use, and industrial runoff are all potential sources of pollutants in your pond. Poor water quality causes problems with vegetation and algae and can prevent successful fish stocking.

The ability to fill the pond should be considered long before construction begins. If the pond is constructed within a surface flow pattern, surface water should allow the pond to fill naturally once it is in place. Ponds may have to be filled manually if surface flow into the pond is not sufficient. Some alternative water sources are listed below.

Water Sources for Excavated Ponds

- Wells are generally not recommended because you need a strong flow to fill a pond. Using wells to fill ponds may affect neighboring well levels as large amounts of water are rapidly pulled from the groundwater. Groundwater also has very low levels of dissolved oxygen, which can make adding aquatic life to the pond difficult initially.
- A lift station from drainage tile is a slow but generally steady source of water if available. Outletting a drainage tile into a pond permanently is highly inadvisable.
- Pumping from a ditch or stream has several potential drawbacks. Streams have high nutrient levels that may accelerate weed growth, and you may introduce unwanted species of fish from the stream. Drainage ditches can also contain high levels of pollutants that may make this an unattractive option.
- A central water system or hauled bulk water can be used if available, but this can be cost-prohibitive. Treatment chemicals like chlorine and fluoride will need time to dissipate before fish can be added to the pond; therefore, do not add treated water after the initial pond fill, as it can kill fish.
- Rerouting runoff from building roofs is a limited but helpful water source.
- Other possibilities may be available in certain areas (e.g., springs).

## Is the soil type suitable for a pond?

Deep clay soils are desirable for ponds, as they hold water in the pond. Much of Delaware County has clay soil, but there are some areas with less suitable soils. Sand, gravel, or sedimentary rock may cause the pond to drain as water escapes. Soil information is available as a layer at delco-gis.org/auditor or at the USDA NRCS Web Soil Survey. This soil mapping can give a general idea of what soils are present in your area, but a soil sample is required to determine whether there are any irregularities on your property that may cause issues with your pond. If the native soil is not be suitable for pond construction, you may want to consult with an engineer regarding what alternatives are available to you. Bentonite clay or polyethylene liners can be used to construct a pond in unsuitable soils, but they may significantly increase the cost of the pond.

## What are the local regulations regarding ponds?

Delaware County does not implement any restrictions on ponds directly, but there may be municipal or township restrictions on your property. Check for any easements, setback requirements, or other restrictions before choosing a pond location. Permits may also be required from state or federal agencies depending on the location and features of your pond. See the Permits section under Construction Considerations for more information.

## What are the legal or financial implications?

Pond construction costs vary greatly with the size, type, and design of the pond, as well as the existing conditions on the site. Landowners should expect fairly significant costs for pond installation, as well as some ongoing maintenance costs to keep the pond in good condition.

Pond owners may be liable for injuries sustained from the pond or for property damage caused by a pond failure or an improperly constructed outlet. Ensure that your insurance is aware of the pond addition and implement any measures they require. See the Ohio State University Extension's Law Bulletin titled *Ponds and Legal Liability in Ohio* for more information and recommendations. Consult with a qualified attorney for any specific legal questions regarding your pond.

## Pond Planning & Construction Checklist

- ❑ Consider your motivations for building a pond, starting with the questions in the previous section, and evaluate whether a pond aligns with your priorities.
- ❑ Contact your local Township or Municipal Zoning Officer for any zoning ordinances relevant to pond construction.
- ❑ Check deed for easements (drainage, flood, etc.) or other restrictions.
- ❑ Verify location of septic system, wells, and any other infrastructure that may be present on the property.
- ❑ Meet with staff from the Delaware Soil & Water Conservation District to evaluate the potential pond site. Discuss existing drainage patterns, soil types, watershed size, spoil placement, design needs, construction techniques, and legal requirements.
- ❑ If any special circumstances are present that necessitate a permit, contact the permitting agency early in the planning process to coordinate design efforts with permit requirements.
- ❑ Notify your home insurance of the planned pond installation and follow any requirements.
- ❑ Devise a preliminary sketch of your pond site and spoil area.
- ❑ Conduct soil testing and/or infiltration tests.
- ❑ Contact contractors for cost estimates (at least 3 recommended).
- ❑ Check contractors' references.
- ❑ If you are completing any work yourself, call 811 or submit a ticket online several days before you dig.
- ❑ Construct pond.
- ❑ Vegetate all disturbed areas around the pond for erosion and sediment control.
- ❑ Plant aquatic vegetation, if desired.
- ❑ Stock pond with fish, if desired.
- ❑ Develop an expected annual maintenance plan based on the characteristics of your pond that can be updated based on the results of ongoing maintenance.
- ❑ Enjoy pond.

## Sources of Assistance

| | **Private fish hatcheries** | **SWCD** | **Private consultant or PE** | **Local Zoning Officials/ ODNR** | **Construction Contractor** | **ODNR Division of Wildlife** | **Ohio State University Extension** | **Agrichemical dealers** | **Licensed pesticide applicators** |
|---|---|---|---|---|---|---|---|---|---|
| *Note:* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* |
| Planning | | | ✓ | ✓ | ✓ | | | | |
| Construction | | ✓ | ✓ | | ✓ | | | | |
| Vegetation management information | | | ✓ | | | | ✓ | ✓ | ✓ |
| Fish stocking and management | ✓ | ✓ | ✓ | | | ✓ | ✓ | | |
| Nuisance wildlife | | | | | | ✓ | | | |
| Herbicide/ algaecide applicators | | | ✓ | | | | | | ✓ |
| Fish kills | | ✓ | | | | ✓ | ✓ | | |
| Construction laws and regulations | | ✓ | | ✓ | | | | | |
| Aquatic pesticides supply | ✓ | | | | | | | ✓ | |

*Adapted from Ohio Pond Management, Bulletin 374-99.*

1. ODNR Division of Wildlife (DOW) (614-265-6300) publishes a list, by county, of Licensed Fish Propagators.
2. Delaware Soil and Water Conservation District: (740-368-1921) or soilandwater.co.delaware.oh.us
3. Contact your county OSU Extension or SWCD office to inquire about Professional Engineers in the area.
4. Contact local zoning officials regarding local permits; contact ODNR Division of Water (614-265-6620) about dam laws and permits.
5. Contact your local SWCD office for a list of private pond construction contractors.
6. Contact your county OSU Extension or SWCD office for the name and phone number of the county wildlife officer, or contact ODNR Division of Wildlife (614-265-6300).
7. Call the State Extension Office (614-292-6181).
8. Look for "farm supply" or "garden center" stores or online vendors.
9. Look for "farming services," "farm supplies," or "pest control," or call your county OSU Extension office for recommendations.

## Pond Design

The Delaware SWCD can provide general guidelines and design best practices to help you successfully plan your pond. However, we do not provide engineering for pond design or construction. If you would like engineering services relating to your pond, engage the services of a licensed Professional Engineer (PE) to design the pond. The SWCD does not recommend or endorse any consultants, but a list of PEs that have requested to be made available to Delaware County residents is available at our office. A list of contractors is also available on our website.

Landowners sometimes inquire whether there is any funding available for pond construction, as certain agricultural conservation practices are sometimes eligible for cost-share programs through the USDA. Currently there are no cost-share opportunities for pond design or construction.

### Size and Shape

The following recommendations are adapted from NRCS Specification #378 Pond, linked in the Resources section.

**Surface**

The watershed to pond surface area ratio should be a minimum of 6:1 and a maximum of 40:1. Too little watershed flowing into the pond will make it difficult to fill and keep full. If you are interested in installing a pond that exceeds the maximum recommended ratio, consult a professional engineer to determine whether it is feasible on the site. The pond should have a minimum surface area of ¼-acre for fish stocking. The perimeter or pond edge should be shaped to a curvilinear or irregular form, and blend into the natural landscape as much as possible.

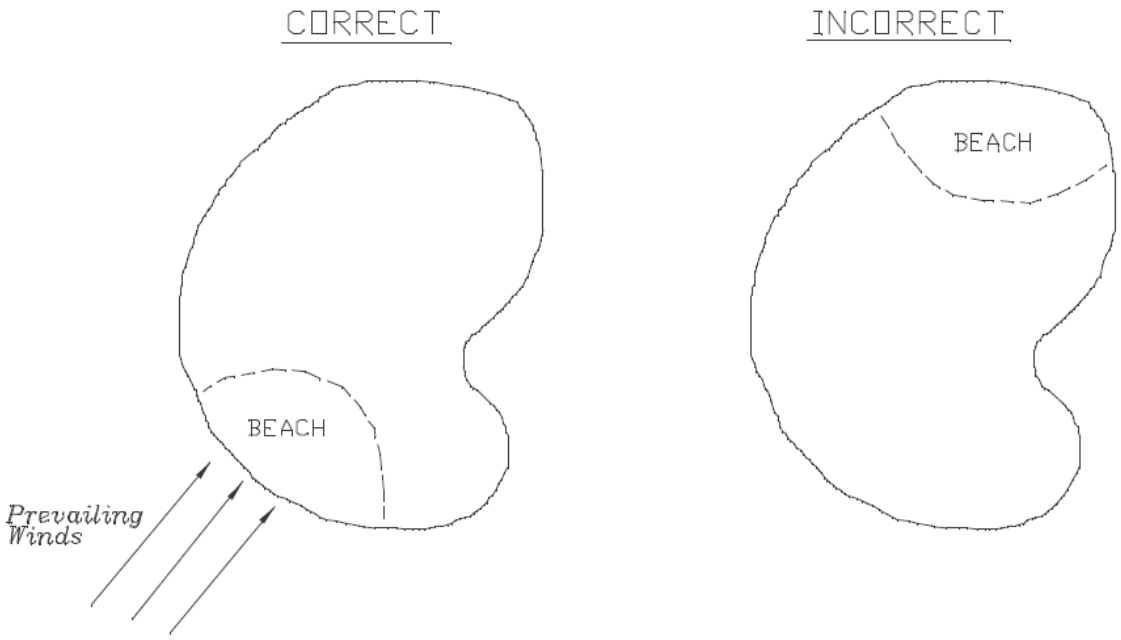
**Depth**

Pond depth should be a minimum of 8 feet over 25% of the pond bottom or 6 feet over 50% of the pond for fish stocking. To reduce unwanted vegetation growth, the sides should be cut to a 2:1 (horizontal to vertical) slope from the water line elevation to 4-foot depth. Side slopes of 3:1 or flatter can be used below 4 feet of depth and above the water line.

**Shoreline**

Shoreline erosion control may be desired on banks opposite prevailing wind direction. Use ODOT Type 1 & 2 limestone rock, 6-9 inches thick and set 1 foot above and 2 feet below normal water line.

Beaches are helpful safety features, allowing a person to climb out of the pond more easily if needed. If you would like a beach in your pond, it should be located in the narrowest portion of the pond. Beach areas are graded at 6:1 or 8:1 slope to a depth of 5 feet. Keep in mind that prevailing winds allow debris to collect on the pond bank. If possible, orient the beach area on the side of the prevailing winds.




## Placement

Pond placement is often covered by zoning; ensure that all requirements are followed. If you have room to work with once all property line and foundation setbacks are followed, the next consideration is how much drainage area is flowing into the proposed pond. Some areas on the property may be better suited to the size of pond you are looking for. The Delaware SWCD can help determine where you have the best opportunity for a successful pond.

If you have flexibility regarding location on the property, consider where ponds will get sufficient sunlight and wind. A pond that is shaded most of the day and sheltered from the wind will have less oxygen-rich waters, which can have a negative effect on fish and aquatic life. It is generally recommended that ponds get at least 4-6 hrs of sunlight per day. Fully shaded ponds will generally suffer from low oxygen levels, while ponds that sit in direct sunlight at all times may become too hot during the summer, especially if they are not deep enough to allow fish to take refuge in deeper, cooler waters.

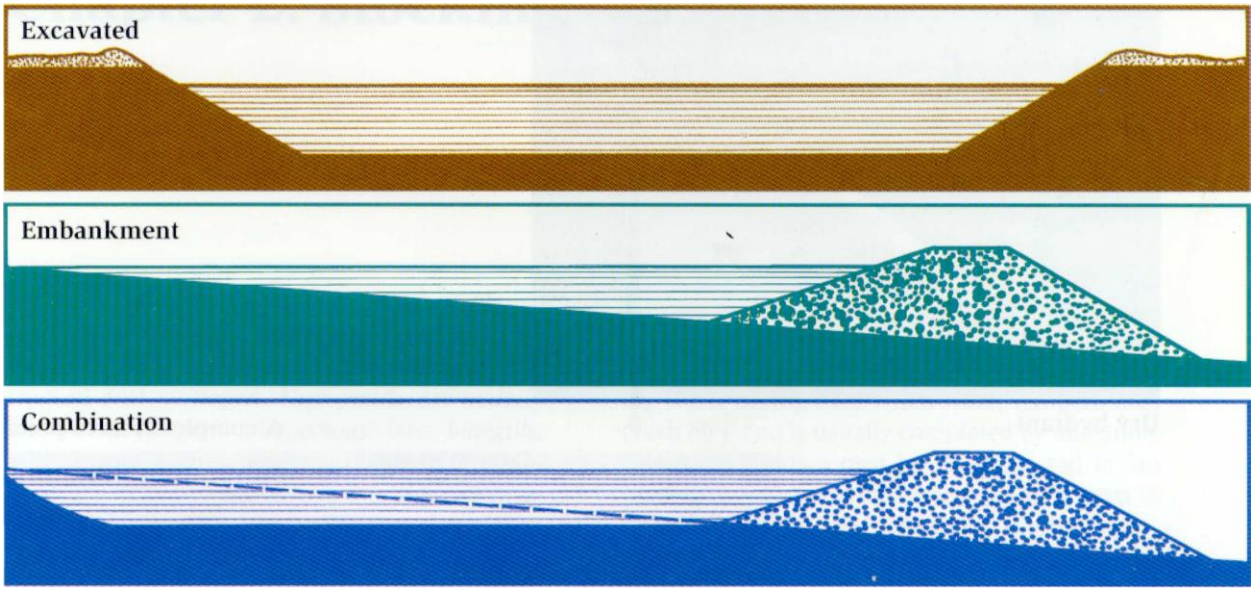
## Overflow

Ponds are continuously exchanging water as surface water flows into the pond and excess water flows out. Regardless of the type of pond being installed, consideration and/or design of an overflow is necessary. An improperly designed or constructed pond overflow that causes damage to another property may introduce liability for the pond owner.

A principal overflow is the mechanism for maintaining the normal water level in the pond. An auxiliary or emergency overflow spillway allows water to escape the pond when the primary overflow is already flowing at full capacity, protecting the structural integrity of the pond. See the excavated or embankment pond sections for details regarding the overflow systems typically installed in each.

If the overflow structure will include a pipe, consider the ease of maintenance of the overflow when choosing a location. When the pipe becomes blocked or clogged with debris, you will need to be able to access it. Overflow pipes should also be fitted with anti-vortex devices to maintain their effectiveness.

*The 3 Types of Ponds*




## Excavated Ponds

An excavated pond is constructed in a nearly level area where most of the water area and depth results from digging a pit in the ground. The excavated soil can be spread or piled and vegetated. Excavated ponds do require planning and careful excavation, but they are much simpler to design and construct than embankment ponds. Some ponds are built by combining excavation with a low embankment to increase capacity. If a pond will include an embankment, be sure to refer to the embankment pond section to verify that all embankment precautions are followed.

Excavated ponds are usually built in soils with slow permeability and high clay content. A test hole investigation may be necessary to check the soil suitability.

After the pond is initially filled, the water level should stay fairly constant from rainfall and evaporation. For excavated ponds, overflow system requirements are dictated by the amount of water flowing into the pond and should be calculated for the site and designed accordingly. Overflow structures vary from grassed spillways to pipe primary overflow structures with emergency spillways, depending on the size and structure of the pond and the amount of water flowing through.

## Embankment Ponds

An embankment pond is constructed by building a levee in order to impound water. The entire depth of a true embankment pond results from the height of the levee. Ponds can also be constructed using a combination of excavation with an embankment. If the depth of water impounded against an embankment is 3 ft or higher, it is considered an embankment pond regardless of additional excavated depth. It is crucial that the embankment, which is considered a dam, is designed and constructed properly to prevent failure, causing property damage and potential liability. It is recommended to engage a professional to design an embankment pond. Embankment ponds may be subject to regulation by the ODNR Dam Safety Program. Contact the ODNR Division of Water Resources to determine whether a permit will be needed for construction.

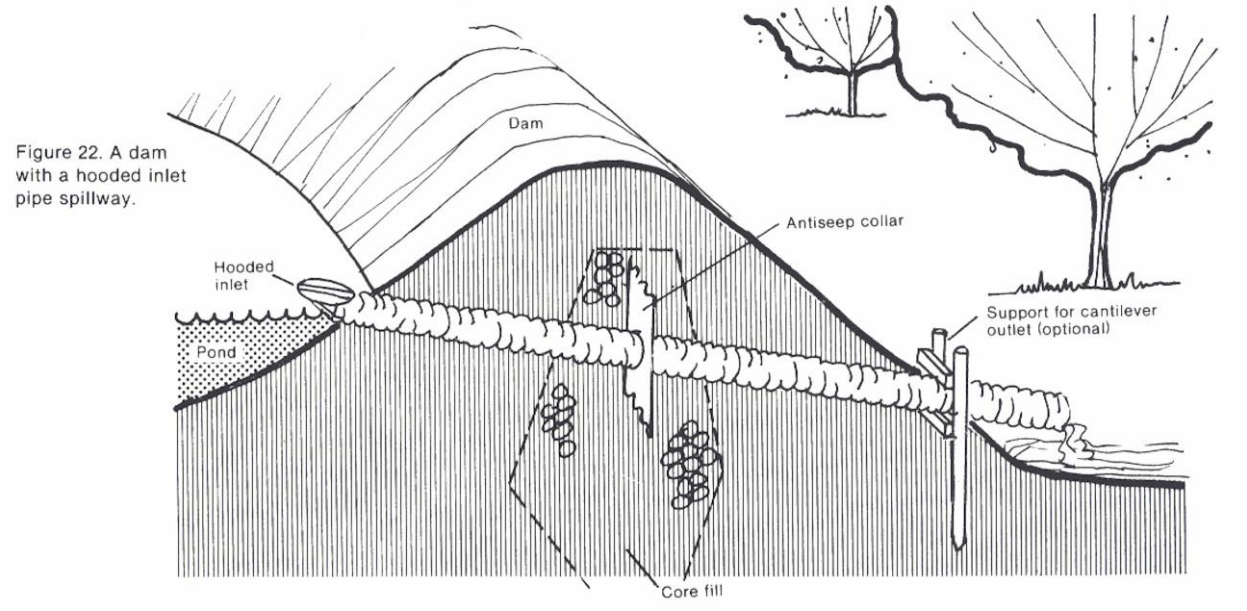
### Overflow Systems for Embankment Ponds

Consult NRCS Specification #378 for design specifications for an overflow system. For embankment ponds, both principal and emergency spillways are needed to keep the pond stable during times of high flow. The overflow structures are sized based on watershed size and other factors. Emergency spillways should never be directed over an embankment, which can lead to failure. Spillways should be constructed on ground that was not excavated as part of construction (referred to as in situ). Overflow pipes that pass through the embankment should have protection against failure due to seepage, such as filter diaphragms or anti-seep collars, as discussed in NRCS Specification #378.

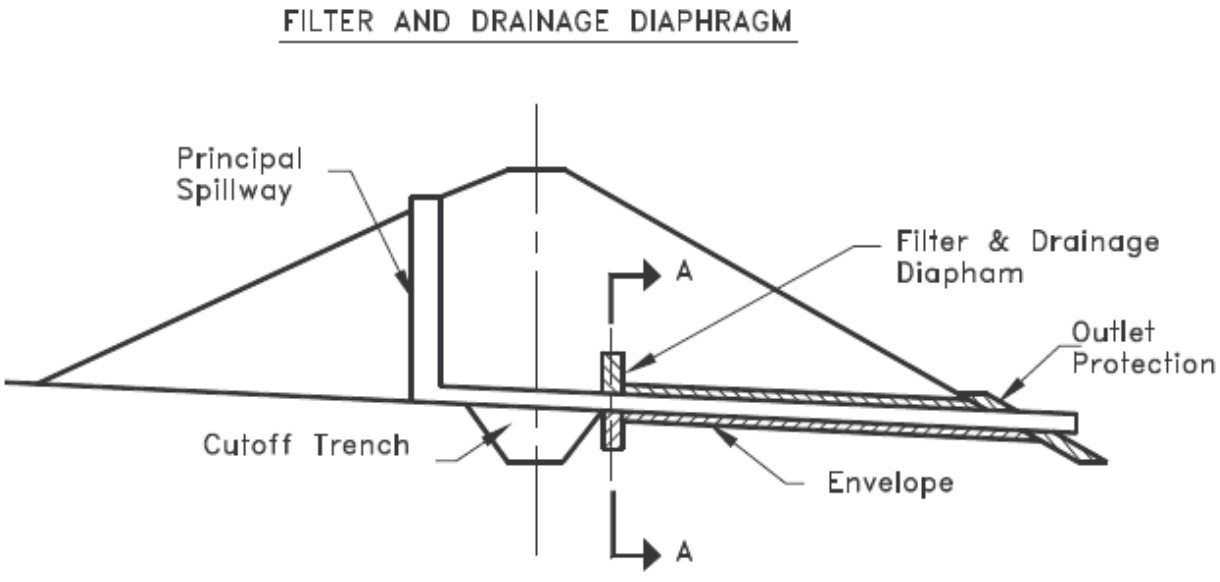
### The Core Trench

The core trench, also called the keyway or cutoff trench, is one of the most critical elements of embankment pond construction. The purpose of the core trench is to prevent water from seeping through the fill. When fill material is placed on top of existing ground, the interface area between the fill material and existing material is a weak spot even after compaction. Water is able to seep through the fill at this point, and it is difficult to maintain the water level in the pond. As water continues to weaken the dam at this point, the risk of a complete failure increases. A properly constructed core trench cuts off the seepage path of water at this point.

The most common kind of cutoff is made of compacted clayey material. A trench is cut along the centerline of the dam deep enough to extend into some kind of impervious material if possible. The sides of the trench should be cut at a 1:1 slope. The clay material is then compacted into the trench building it up layer by layer. This process is then continued into the dam creating a homogenous layer. Water that is trying to seep through the fill hits this trench, and is not able to seep out of the pond.




*Cross-section of a dam showing the Core Trench along with a hooded inlet and anti-seep collar.*




*Cross-section showing the location of the core trench.*

## Common Points of Failure

When planning your pond and moving forward into construction, pay close attention to the design and construction of the following common points of failure in a pond:

- Absence of or improperly installed core trench in an embankment: skipping the core trench or not constructing it properly, even in a small embankment, can easily lead to failure. The seam between the existing ground and the embankment is a weak point that is very easy for water to penetrate.
- Installing an emergency spillway on an embankment: Allowing water to flow over the embankment, which is not as strong as existing ground, can cause erosion and failure of the embankment.
- Improperly installed primary spillway: an overflow pipe underground creates a channel that allows water to travel along the outside of the pipe, creating a weak spot in the ground around the overflow structure.
- Failure to identify and remove all existing drainage pipes around the pond: even old, clogged drainage tile can easily drain a pond if they are left in place. See the section Preservation of Existing Drainage for more details.
- Trees, structures, or other items extending into the ground on or adjacent to the embankment: embankments should be planted with grasses, but woody plants or trees have larger root structures that will weaken the embankment and potentially contribute to failure. Trees should never be allowed to grow on an embankment; once the roots are present it is impossible to restore the embankment to its former strength without rebuilding.

## Construction Considerations


It is Ohio law to call Ohio Utilities Protection Service (OUPS) prior to any excavation. If you have hired a contractor, they are legally obligated to call 811. If you are completing the work yourself, you are required to call.

If contractors will be passing in the vicinity of any Home Sewage Treatment Systems (HSTS) or well locations to get to the pond site, it is advisable to mark these as well to prevent any damage to the systems from vehicle traffic or equipment. Information regarding the location and design of HSTS may be available on the Delaware County Health Department's website. Well information may be available from the ODNR Division of Geological Survey Water Wells Database.

### Permits

Generally, permits are not required for ponds in Delaware County. However, there are specific circumstances where a permit may be required from other entities, including but not limited to the following.

- Embankment ponds involve the construction of a dam and may be subject to regulation by the ODNR Dam Safety Program. If your pond involves constructing an embankment, contact the ODNR Division of Water Resources to determine whether a permit will be needed for construction.
- If the pond construction will be disturbing an area greater than one acre, if it is being constructed on an animal feeding operation, or if it is being implemented as a form of pollution control, contact the Ohio EPA Division of Surface Water about National Pollutant Discharge Elimination System (NPDES) permit requirements.
- If the pond will be constructed in the FEMA floodplain, a permit from Delaware County Building Safety is required.

As always, check with your municipal or township entity for any additional requirements. The landowner is responsible for determining whether any permits, including any not mentioned here, are required for the pond construction.

### Preservation of Existing Drainage

One of the most important things to keep in mind when planning construction of any kind is the existing drainage patterns that are present on the selected site. It is your responsibility to maintain the functionality of these existing pathways. To reduce liability for yourself, the basic tenet of Ohio drainage case law is that water should enter and leave your property at the same locations that it did prior to any projects or construction you completed on the land. Drainageways can be both surface and subsurface.

***Surface Drainage***

Surface drainage can be defined as any route by which water will travel over the surface of the ground on its way to some sort of outlet. The most important thing to remember with regard to surface drainage is the route of the water. Water must enter and leave a property at the same places and in the same characteristic that it has always done in the past. A landowner may re-direct surface water as they wish on their property as long as that water is not blocked from entering the property in its original course and it returned to the original course prior to leaving the property. Changing the nature of the water leaving the property, e.g. condensing sheet flow to a concentrated outlet, can introduce liability and should be mitigated by dispersing flow from an outlet over a rock pad or other erosion protection structure before it reaches the property line.

***Subsurface Drainage***

It can be easy to dismiss subsurface drainage when constructing a pond because it is hidden underground. Tile is a term for buried drainage pipes, historically made of clay, that help the soil drain excess water. Modern tile is often made of corrugated plastic; however, a variety of materials may be used. Because most tile was installed by landowners independently, there is often little information available as to the size and location of tile. Many tile lines in Delaware County were installed decades or even centuries ago. The SWCD may be able to help you identify clues as to the location of potential tile from historical aerial photography, but not all tile is identifiable in this manner. Whether or not you installed the subsurface drainage or were even aware of its existence, it is critical to preserve and/or repair any subsurface drainage lines damaged during construction.

Leaving a cut tile unrepaired is a common, and often costly, mistake. Never assume that a cut tile is confined to your property. Many old clay tiles were put in by hand, and cross modern property lines on an irregular course. Leaving a cut tile unrepaired can render any other connected subsurface drainage systems ineffective. This is why it is critical to re-route any damaged tile. If the cut tile is at the downstream end of your pond, the tile will drain your pond if it is not rerouted. If the cut tile is at the upstream end of the pond, it may be tempting to leave the tile in place, allowing the cut pipe to outlet into the pond. Out-letting a tile into a pond is not a viable alternative to re-routing the tile. As the water level in a pond rises, the efficacy of the tile is decreased. Constant water level in the tile will not allow the tile to drain, causing wet, saturated soil conditions. This restricted drainage may result in loss in farm/home land-use upstream and can create an adverse liability to the pond owner.

Any subsurface tile that is cut during pond excavation must be rerouted around the pond area using watertight conduit, and reconnected to the original tile at a point downstream of the pond. It is recommended to reroute the tile 50 feet from the edge of the pond. If spacing does not allow for 50 feet, a minimum of 25 feet is needed to prevent the tile from gradually draining the pond. Tile between the reconnection points and the pond should be removed to prevent water from the pond draining into the disconnected tile. Tile in the vicinity of the pond

that is not directly impacted by the pond construction may still affect the pond. Depending on the size and condition of the pipe and the soil type, tile can pull water from a very large area on each side of the pipe.

***IMPORTANT:** Never connect the pond overflow pipe to an existing subsurface drain line. Drainage tile was never designed (i.e., is too small) to carry surface water. Entry of surface water overloads the capacity of the downslope system for proper subsurface drainage, and it can carry sediment and debris into the line that may cause blockage and otherwise damage the system. It can also cause damage to your pond by not allowing excess water to leave as rapidly as a designed outlet would.

## Compaction

Proper compaction is crucial in pond construction. For excavated ponds, the base of the pond should be compacted adequately to prevent loss of water through seepage. For embankment ponds, a properly constructed and compacted core trench and embankment are essential to prevent failure of the pond.

Clean clay material is the best for compaction. You should never attempt to compact soil with rocks, grass, or other material present. Topsoil should be removed and set aside for use later, not compacted as part of the bottom surface of the pond or any embankment.

Proper moisture content must be achieved before compacting. Soil should not be too wet or too dry; a good rule of thumb is that the soil should hold its shape if you mold it into a ball in your hand. Refer to the NRCS specification for earthfill (linked in Resources) and make sure that your contractor is following the standards.

Compaction should ideally be completed with a sheepsfoot roller, which has long, relatively thin protrusions that can reach deep into a layer of soil and ensure that the compaction effort is not merely creating individual layers stacked on top of each other. If a sheepsfoot roller cannot be used due to lack of space or availability, compaction can be completed with rubber-wheeled equipment or padfoot rollers (which have larger, blunter protrusions), but thinner layers of soil should be compacted at a time if a sheepsfoot roller is not being used. Equipment with tracks is not suitable for compaction. The tracks are designed to spread the weight of the equipment over a larger area to improve traction; this greatly reduces the compacting force exerted by the equipment and renders them incapable of compacting adequately.

Compaction specifications call for a certain amount of “passes.” A pass is defined as every piece of surface being covered, which may require many trips of equipment back and forth. Four passes does not mean four trips back and forth; typically it will be many more than that (i.e. if using rubber-wheeled equipment, enough trips for the wheels to touch every portion of the surface four times).

If installing an overflow pipe, the backfill around the pipe will need to be compacted by hand or with small machinery that will not damage the pipe but will create sufficient compaction to prevent leakage around the pipe. Pipes are already a weak point in the pond; insufficient compaction will almost guarantee a seepage issue around a pipe.

## Excavated Material

Material excavated from the construction, often called spoil, will form a hill much greater than the size and depth of the pond. Removing soil from the site can be expensive, so many homeowners prefer to use the soil around their property. The Delaware SWCD can look at the elevations on your property and help you to identify the best opportunities for spoil placement, if needed.

Some guidelines to consider for soil placement:

- Soil can be used for a low embankment and/or leveled.
- Soil may be spread out to a height of 3 feet with the top graded away from the pond.
- Maintain a 12-foot minimum width between the water edge and toe of mound fill. Side slopes on mounds should be 4:1 or flatter for mowing.
- Soil can be used for landscaping mounds. Shape mounds or hills to a form that blends visually with the landscape.
- Soil should not be placed so as to block surface water from entering the pond or in a manner that creates water problems for neighbors.
- Do not use the spoil to fill in low areas around the property, as this will generally just move wet spots around the property and may cause even more drainage problems for you or your neighbors. When adding soil, it is generally best to make high spots higher to maintain natural flow paths.
- Soil can be used to build up around the house, encouraging positive drainage away from the structure.
- Stabilize bare areas with vegetation and maintain grass cover. See the NRCS specification for critical area planting instructions (linked in Resources).

## Post-Construction

### Reseeding

Vegetation should be planted in any disturbed area as soon as possible to prevent erosion. Native grasses are best for preventing invasive species and providing a beneficial habitat for wildlife. Woody species should not be allowed to grow in dams or embankments, as the roots will compromise the integrity of the structure. See the Resources section for detailed seeding recommendations from the NRCS.

### Establishing Aquatic Vegetation

If you do not plan to stock the pond with fish, especially if the pond is intended to be used to water livestock, you may choose not to plant any aquatic vegetation. Aquatic vegetation is necessary in order to keep fish in a pond, so if you plan to stock the pond you should plan for vegetation to be present in the pond. Conscientious vegetation choices when your pond is new may help with long-term maintenance. You can allow vegetation to be brought in by visiting wildlife, but this will often result in an unbalanced population of invasive plants. Establishing desirable native plants in a mix of submerged, floating, and emergent plant types can provide great fish habitat and help prevent total takeover of invasive species. See the ODNR Pond Management Handbook for more detailed information and recommendations for aquatic vegetation.

### Stocking the Pond

We have included some basic guidelines for stocking fish in a pond; pond handbooks can provide more detailed recommendations.

- Largemouth bass and bluegills are recommended for stocking a small pond. Stocking only these two greatly simplifies management of the fish population, but other fish can also be added if a more diverse population is desired.
- Channel catfish may be stocked in ponds that are at least ½-acre in surface area.
- Do not stock large fish with fingerlings.
- Do not stock Triploid White Amurs in a pond unless excessive leafy vegetation is present and you are aware of the long-term pros and cons of white amurs.

The Delaware SWCD hosts an annual fish sale in the fall that can help you stock or restock a pond. Call or check our website for more information. There are many commercial hatcheries throughout the state as well. A list is available on the Division of Wildlife (ODNR) website.

In addition to plants, some pond owners add structures to their ponds for fish habitat. There are many natural and artificial options for fish habitat structures to add to the pond, see the pond management handbooks listed in Resources for suggestions.

## Safety

Consider adding safety features like rescue devices, fencing, lighting, and signage. A few recommendations from the Ohio State University Extension's Law Bulletin titled *Ponds and Legal Liability in Ohio* are included below:

- Consider lighting near the pond if possible.
- Try to restrict access to the pond area with fencing or landscaping, but be sure the pond is clearly visible.
- Add signage to identify prohibited areas, indicate the depth of the pond, and/or warn of hidden hazards. If possible, use graphics in addition to words to communicate to children or in the case of a language barrier.
- Install a pond rescue post containing equipment such as climbing aids, nylon rope and buoy, communication equipment, etc.

# Maintenance

Ponds require regular maintenance to stay in good condition. When planning for a pond, you should create an annual maintenance plan that encompasses all of your priorities for your pond. Some maintenance activities, such as inspecting the outlet for debris or blockages, should be completed monthly or more frequently, while checking silt depth or water pH may be done annually or as-needed. Depending on the rate at which the pond builds up silt, occasional dredging or rehabilitation work may be needed. As a general rule of thumb, expect to perform some kind of rehab or repair on the pond by the time the pond is approximately 20 years old.

## Water Quality

Water quality is often both a cause and result of many other issues with the pond. Vegetation, algae, outside sources of pollution, and wildlife can all be causes and/or results of an issue with the water quality. A few water quality metrics are discussed below, more information on water quality is listed in the Resources section.

**Dissolved Oxygen**

Dissolved oxygen is one of the most important metrics for supporting aquatic life. Some oxygen is incorporated into water from surface diffusion and turbulence, but most is from photosynthesis carried out by algae and green plants. An unhealthy balance of vegetation, either too much or too little, will cause issues with dissolved oxygen.

If other forms of maintaining sufficient dissolved oxygen have been unsuccessful, an aeration system may be required to prevent fish kill due to suffocation. Aeration systems require proactive management to be successful and can actually do more harm than good if they are not operated correctly. If you are willing to put in the research and effort to properly operate an aeration system, they can be a great tool to maintain the long-term health of your pond.

**Nutrients**

Nutrients, primarily phosphorus (P) and nitrogen (N), allow plants and algae to grow in the pond. Without nutrients, aquatic life is not possible. With too much, algal blooms and excessive plant growth will occur. High nutrient levels indirectly cause low dissolved oxygen levels. A major source of nutrients is runoff from residential or agricultural fertilizer.

**Water Color and Turbidity**

Pond water in Ohio is rarely clear. Clay soils have very small particles that easily become suspended in the water. After rains or heavy winds, this is largely unavoidable. If muddy water persists for long periods, there are treatments to help settle the clay particles out of the water. See the recommendations in Ohio State University Extension Bulletin *Muddy Water in Ponds: Causes, Prevention, and Remedies* for a variety of potential treatments. If the vegetative cover on pond banks or in the watershed is damaged or removed, this will increase the amount of soil washing into the pond. Adequate vegetative cover should be maintained on the watershed, when possible, to prevent turbid, silty water. Excessively green water or transparent dark brown (unlike more opaque muddy water) often indicates an algal bloom.

## Vegetation and Algae Control

For ponds with fish, aquatic plants are necessary for oxygenating the water and providing food and habitat. However, in excess, vegetation can cause issues in the pond. The correct amount of vegetation for a pond is often subjective, based on the desired use of the pond and the preference of the landowner. For fish ponds, recommendations for vegetated area can vary from 5-40% of the pond's surface, depending on the type of vegetation present. However, too much decaying vegetation can decrease water quality, and personal preference or other uses of the pond may necessitate a much lower amount of vegetation.

Algae is a common issue for pond owners, especially when phosphorus levels in the water are high. Some types of algae produce toxins that may impact people and animals. Algae growth can look like mossy growth in the water, bluish or greenish paint spills, fine lawn clippings, unusual water color, etc. OSU Extension can help to identify unknown organisms in the pond.

Vegetation and algae can be controlled by physical removal, chemical treatment, or other management techniques. Consult OSU Extension for detailed information on weed control and pond care; vegetation must be properly identified before choosing a treatment and it is important, particularly for chemical or biological controls, that proper technique and dosing are used.

Use extreme caution with killing vegetation or algae during warm weather. As the vegetation begins to break down after dying, it consumes oxygen. Warm pond water is already lower in oxygen than cooler water, so the presence of a large amount of dead vegetation or algae during the heat of summer causes a steep drop in oxygen levels in the pond, which may cause a fish kill. Consult with a professional first if you would like to apply an herbicide in the summer.

## Fish Management

Depending on the blend of fish species you stock, there are often specific recommendations for fishing schedules to maintain a healthy population. The pond handbooks in the Resources section include several options for fish management plans. Water quality is imperative for fish health. Follow the recommendations in the previous sections for maintaining good water quality and vegetation control.

### Fish Kill

Fish kill, or fish die-off, is a term for many fish in a localized area dying within a short period of time. Properly stocked ponds will typically maintain their own population, with natural causes of death equalizing with birth rates. However, abnormally large amounts of fish can be killed off in a short period of time by unnatural causes such as disease, poisoning, or lack of oxygen.

- Lack of oxygen, causing suffocation, is the most common cause of fish kill. Oxygen levels in the water can be caused by turnover (cooler, oxygen-depleted layers of water rising to the surface, typically in late summer or early fall), excessive vegetative growth or decay (discussed in Vegetation Control), excessive algae, or snow and ice covering the water. See the article “Your Pond (and Fish) Emerging from a Potent Winter” or the ODNR Pond Management Handbook (both linked in References) for more information.
- Improper aeration management can cause a fish kill. Aeration oxygenates water by mechanically moving the water. Sudden mixing of layers of water, especially during warm weather, can cause fish to suffocate or can add high levels of nutrients or other materials that had settled to the bottom of the pond. There are procedures for the startup, continued use, and cessation of aeration. Always start slow, preferably during cooler weather, and follow procedures for the aeration system, pond size, and depth that you are working with.
- Disease can rapidly kill large numbers of fish, although disease often affects only one species. If the fish population is not very diverse, a large proportion of the fish can be impacted by a single disease.
- Pesticides can cause a fish kill if sufficient concentrations are carried into the pond through water or air. Depending on the type of chemical, long-term accumulation of lower concentrations may cause issues as well. Insecticides, herbicides, and fertilizers are all common chemicals used around ponds that could damage the fish population. Spills of fuel or other chemicals are also potential hazards. Fish kills due to pesticides or other foreign substances are very uncommon.

## Pest Control

Ponds provide wildlife habitat for a variety of wild animals. Rodents such as the groundhog, muskrat, and occasional beaver are attracted to these bodies of water and any dams impounding them. If not controlled, they can be quite dangerous to the structural integrity and proper performance of a dam. Holes around the waterline edge can be a nuisance and liability in some cases. It is important to make your pond as unattractive to these animals as possible; remember that by constructing a pond you are creating these animals' habitat and then asking them not to inhabit it. Preventing their establishment, when possible, is the best alternative for you and the animals.

**Check with your local Wildlife Officer or the Ohio Department of Natural Resources, Division of Wildlife before beginning any animal control strategy.

**Groundhog**

The heavily built, short legged groundhog is the largest member of the squirrel family. Groundhogs originally were scarce in Ohio, but increased with the clearing of forestland. These animals burrow along the edges of forests, brushy fencerows, creeks, and any other undisturbed area of cover, such as an un-mowed or overgrown dam.

Burrowing activity affects the structural soundness of the dam. An active groundhog may excavate 500 pounds of material through the dam, lowering the waterline and weakening the dam. Without intervention, the dam may collapse. Groundhogs will be discouraged from inhabiting the embankment if the vegetation is kept mowed, so prevention is the best strategy. Groundhogs can be controlled using fumigants if necessary. After the animal is removed, the burrow should be backfilled with a well-compacted material.

**Muskrat**

The muskrat is a stocky rodent with a broad head, short legs, small eyes, and short ears that barely extend above its fur. Muskrats live in either a lodge or a bank den. The upstream slope of a dam covered with cattails is very attractive to muskrats. Muskrat burrows start 6 to 18 inches below the water surface, and penetrate the embankment on an upward slant. At distances up to 15 feet from the entrance, a dry chamber is hollowed out above the water level. As this den approaches the crest of the embankment, it can cause a collapse, which reduces the freeboard. When the water level rises during a large storm, these dens allow water to seep further into the dam. Damage is compounded where groundhogs construct their burrows in dams opposite muskrat dens and then meet in the middle.

Flatter side-slopes in the top 1-2 feet of water can help prevent muskrat burrowing; this has to be weighed against the increased vegetation that flatter slopes cause. Removing cattails makes the habitat undesirable. Barriers to prevent burrowing can be used to protect dams. A properly constructed riprap and filter layer will discourage burrowing as well as a heavy wire fencing (openings smaller than typical chain-link, which they can fit through) laid flat across the slope.

Both barriers should extend several feet below and above the normal pool level. If needed, muskrats are generally controlled by trapping.

**Beaver**

Like the muskrat, the beaver is a large rodent that lives in and near the water. Beavers are the original creators of ponds; they very rapidly create dams in streams or rivers, creating a pond or wetland upstream of the dam. Beavers will occasionally burrow in embankments, like muskrats, but primarily they cause issues in ponds by building dams on pond outlets. If the dams are removed, they will continue to rebuild indefinitely. Trapping is a potential tool, but prevention is the best strategy. If you live in an area where beavers live and your pond is attractive to them, new pairs may continue to move in even if you choose to trap.

Generally only ponds near wooded areas are at risk of beavers taking up residence. If you think beavers are a potential issue for your pond, it is generally wise to construct the outlet with them in mind. The primary instinctual trigger for beavers to build a dam is the sound of running water. A primary outlet that does not make noise is necessary to help prevent the construction of a dam if beavers are present. An experienced pond designer can help choose a suitable option. Cages and barriers can be helpful, but if the beaver is inspired to build a dam by what is contained within the cage, they will simply build a dam around it.

**Geese**

Migratory water fowl do not usually cause issues with ponds, but large quantities of geese and ducks taking up residence can cause water quality issues due to the nutrients in their droppings. If you would like to deter geese from nesting around the pond, nets around the edge of the pond can help. Decoys of swans or coyotes are also sometimes used with the intention to deter geese.

# Resources

**Pond Management Handbooks**

Ohio Pond Management Handbook. *Ohio Department of Natural Resources.*

https://ohiodnr.gov/static/documents/wildlife/fish-management/Pond%20Management%20Pub432.pdf

Nebraska Pond Management Guide. *Nebraska Game and Parks*.

http://digital.outdoornebraska.gov/i/605475-nebraska-pond-management-second-edition/0?

Ponds – Planning, Design, Construction. *United States Department of Agriculture Natural Resources Conservation Service*.

https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_030362.pdf

**Permits and Legal Topics**

Delaware County Local Zoning Officers Contact List. *Regional Planning*.

https://regionalplanning.co.delaware.oh.us/resources/zon_officers/

Dam Safety Regulations. *Ohio Department of Natural Resources*.

https://ohiodnr.gov/wps/portal/gov/odnr/rules-and-regulations/rules-for-landowners/dam-safety

NPDES Permitting. *Ohio EPA*.

https://epa.ohio.gov/divisions-and-offices/surface-water/permitting

Floodplain Permitting. *Delaware County Building Safety*.

https://buildingsafety.co.delaware.oh.us/zoning-floodplain/

Surface Water Drainage Rights. *OSU Extension*.

https://farmoffice.osu.edu/sites/aglaw/files/site-library/Drainage%20Law%20Bulletin.pdf

Ponds and Legal Liability in Ohio. *OSU Extension*.

https://farmoffice.osu.edu/sites/aglaw/files/site-library/Pond%20Liability%20law%20bulletin.pdf

**USDA NRCS Specifications and Design Resources**

NRCS General Specification OH-23 Earthfill.

https://directives.sc.egov.usda.gov/ViewerFS.aspx?hid=35587

NRCS Specification # 342 Critical Area Planting.

https://efotg.sc.egov.usda.gov/api/CPSFile/19990/342_OH_CPS_Critical_Area_Planting_2017

NRCS Specification # 378 Pond

https://efotg.sc.egov.usda.gov/api/CPSFile/20854/378_OH_CPS_Pond_2018

NRCS Specification # 399 Fishpond Management.

https://efotg.sc.egov.usda.gov/api/CPSFile/20222/399_OH_CPS_Fishpond_Management_2017

ODNR Dam Safety Fact Sheets (covering a wide variety of topics)

https://ohiodnr.gov/discover-and-learn/safety-conservation/about-odnr/water-resources/ohio-dam-safety/z-dam-safety-documents

**Fish Stocking and Management**

Fish Species Selection for Pond Stocking. *OSU Extension*.

https://woodlandstewards.osu.edu/sites/woodlands/files/imce/0010_0.pdf

Placing Artificial Fish Attractors in Ponds and Reservoirs. *OSU Extension*.

https://woodlandstewards.osu.edu/sites/woodlands/files/imce/Lynch-Johnson-1998-Fish_Attractors-A-1-98.pdf

Your Pond (and Fish) Emerging from a Potent Winter. *OSU Extension*.

https://senr.osu.edu/YourPondUpdateWI2014

Winter and Summer Fish Kills in Ponds. *OSU Extension*.

https://woodlandstewards.osu.edu/sites/woodlands/files/imce/0008.pdf

Be a Responsible Grass Carp [White Amur] Owner. *Ohio Sea Grant and Stone Laboratory*.

https://soilandwater.co.delaware.oh.us/wp-content/uploads/sites/20/2020/12/OHSU-FS-1509_Be-A-Responsible-Grass-Carp-Owner.pdf

Sport Fish of Ohio identification. *ODNR Division of Wildlife*.

https://ohiodnr.gov/static/documents/wildlife/backyard-wildlife/Sport%20Fish%20of%20Ohio%20Field%20Guide%20pub334.pdf

**Pest Control**

Coping with Canada Geese. *OSU Extension*.

https://ohioline.osu.edu/factsheet/W-3

**Water Quality**

Muddy Water in Ponds: Causes, Prevention, and Remedies. *OSU Extension*.

http://agrilife.org/fisheries2/files/2013/09/Muddy-Water-in-Ponds-Causes-Prevention-and-Remedies.pdf

Understanding Water Quality Parameters to Better Manage Your Pond. *New Mexico State University*.

https://aces.nmsu.edu/pubs/_w/W104.pdf

Monitoring Pond Water Quality to Improve Production. *The Fish Site*.

https://thefishsite.com/articles/monitoring-pond-water-quality-to-improve-production

**General Resources**

Delaware Soil and Water Conservation District

https://soilandwater.co.delaware.oh.us/

Certified Soil Consultants in Ohio

https://www.ohiopedologist.org/consultant-list.html

Ohio Department of Natural Resources

https://ohiodnr.gov/

USDA Natural Resources Conservation Service

https://oh.nrcs.usda.gov/

Ohio State University Extension

http://ohioline.osu.edu/

## References

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Ohio Utilities Protection Service Logo retrieved from: https://www.oups.org/