United States Department of Agriculture

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

POND

(Number**)**

CODE 378

DEFINITION

A pond is a water impoundment made by constructing an embankment, by excavating a dugout, or by a combination of both.

In this standard, NRCS defines ponds constructed by the first method as embankment ponds, and those constructed by the second method as excavated ponds. Ponds constructed by both the excavation and the embankment methods are classified as embankment ponds if the depth of water impounded against the embankment at the auxiliary spillway elevation is 3 feet or more above the lowest original ground along the centerline of the embankment.

PURPOSES

A pond stores water for livestock, fish and wildlife, recreation, fire control, erosion control, flow detention, and other uses such as improving water quality.

CONDITIONS WHERE PRACTICE APPLIES

This standard establishes the minimum acceptable quality for the design and construction of low-hazard ponds where:

Failure of the dam will not result in loss of life; damage to homes, commercial or industrial buildings, main highways, or railroads; or in interruption of the use or service of public utilities.

The product of the storage times the effective height of the dam is less than 3,000. Storage is the volume, in acre-feet, in the reservoir below the elevation of the crest of the auxiliary spillway or to the top of fill if there is no auxiliary spillway. The effective height of the dam is the difference in elevation, in feet, between the auxiliary spillway crest and the lowest point in the cross section taken along the centerline of the dam. If there is no auxiliary spillway, the top of the dam is the upper limit.

The effective height of the dam is 35 feet or less, and the dam is hazard class (a). See National Engineering Manual 520.23 (b) for documentation of hazard classification.

CRITERIA

General Criteria Applicable to All Purposes

Use of this standard requires compliance with all applicable federal, state, and local laws and regulations.

Native plant species will be used whenever possible. Known invasive species will not be used.

Vegetation. All vegetation will be established according to the guidelines in the IN NRCS Seeding Tool and/or Tables in Indiana (IN) Field Office Technical Guide (FOTG) Standard (342) Critical Area Planting.

A protective cover of vegetation will be established on all exposed areas of embankments, spillways and borrow areas as climatic conditions allow.

Permanent vegetation will extend and be maintained on all exposed areas of embankments, spillways and to a minimum of 50 feet on all sides of pond and 100 feet upstream of the pool area. Open areas to be vegetated will be limed, fertilized, seeded and mulched according to the construction specification. No woody vegetation will be planted on or within 25 feet of the embankment or spillway.

Site Conditions. Site conditions will be such that runoff from the design storm can safely pass through (1) a natural or constructed auxiliary spillway, (2) a combination of a principal spillway and an auxiliary spillway, or (3) a principal spillway.

Drainage Area. The drainage area above the pond must be protected against erosion to the extent that expected sedimentation will not shorten the planned effective life of the structure. The drainage area will be large enough so that surface runoff and groundwater flow will provide an adequate supply of water for the intended purpose unless an alternate water source exists to serve this purpose.

The quality will be suitable for the water’s intended use. Sources of contamination such as runoff water from barnyards, feedlots, septic tanks, barn drains, or other sources will be diverted so as not to flow into ponds.

Reservoir Area. The topography and geology of the site will permit storage of water at a depth and volume that will ensure a dependable supply, considering beneficial use, sedimentation, season of use, and evaporation and seepage losses. If surface runoff is the primary source of water for a pond, the soils will be impervious enough to prevent excessive seepage losses or will be of a type that sealing is practicable.

Minimum depth will be 8 feet over at least 25 percent of pond or pit area at permanent water level, or where underlying rock prevents excavation to that depth, a minimum of 6 feet over at least 50 percent of the area.

The surface area will be adequate for the intended purpose, with a minimum of 0.15 acre for excavated ponds and 0.25 acre for embankment ponds.

Design Criteria for Embankment Ponds

Geological Investigations. Pits, trenches, borings, review of existing data or other suitable means of investigation will be conducted to characterize materials within the embankment foundation, auxiliary spillway and borrow areas. Soil materials will be classified using the Unified Soil Classification System (ASTM D2487).

Foundation Cutoff. A cutoff of relatively impervious material will be provided under the dam if necessary to reduce seepage through the foundation. The cutoff will be located at or upstream from the centerline of the dam. It will extend up the abutments as required and be deep enough (2 foot minimum) to extend into a relatively impervious layer or provide for a stable dam when combined with seepage control. The cutoff trench will have an 8-foot minimum bottom width to accommodate the equipment used for excavation, backfill, and compaction operations. Side slopes will not be steeper than one horizontal to one vertical.

The most impervious material available will be used to backfill the cutoff trench and to construct the core of the dam.

Seepage Control. Seepage control is to be included if (1) pervious layers are not intercepted by the cutoff, (2) seepage could create swamping downstream, (3) such control is needed to ensure a stable embankment, or (4) special problems require drainage for a stable dam. Seepage may be controlled by (1) foundation, abutment, or embankment filters and drains; (2) reservoir blanketing and sealing; or (3) a combination of these measures.

Embankment. The minimum top width for a dam is shown in Table 1. If the embankment top is to be used as a public road, the minimum width will be 16 feet for one-way traffic and 26 feet for two-way traffic. Guardrails or other safety measures will be used where necessary and will meet the requirements of the responsible road authority. For dams less than 20 feet in height, maintenance considerations or construction equipment limitations may require increased top widths from the minimum shown in Table 1.

Table 1. Minimum top width for dams

Total height of embankment *feet*	Top width *feet*
Less than 10	6
10 – 14.9	8
15 – 19.9	10
20 – 24.9	12
25 – 34.9	14
35 or more	15

Side Slopes. The combined upstream and downstream side slopes of the settled embankments will not be less than five horizontal to one vertical, with the upstream slope never steeper than two and one-half horizontal to one vertical, and the downstream slope never steeper than two horizontal to one vertical. All slopes must be designed to be stable, even if flatter side slopes are required. Downstream or upstream berms can be used to help achieve stable embankment sections. The downstream slope will be two and one-half horizontal to one vertical or flatter, if the dam is to be mowed.

Slope Protection. If needed to protect the slopes of the dam from erosion, special measures, such as berms, rock riprap, sand-gravel, soil cement, or special vegetation, will be provided (Technical Releases 210-56, "A guide for Design and Layout of Vegetative Wave Protection for Earth Dam Embankments" and TR-210-69, "Riprap for Slope Protection Against Wave Action" contain design guidance).

Freeboard. The minimum elevation of the top of the settled embankment will be 1 foot above the water surface in the reservoir with the auxiliary spillway flowing at design depth. The minimum difference in elevation between the crest of the auxiliary spillway and the settled top of the dam will be 2 feet for all dams having more than a 20-acre drainage area or more than 20 feet in effective height. Design a minimum of 1.0 feet of freeboard above the peak elevation of the routed design hydrograph to the top of the settled embankment, when the pond has no auxiliary spillway.

Settlement. The design height of the dam will be increased by the amount needed to ensure that after settlement the height of the dam equals or exceeds the design height. This increase will not be less than 5 percent of the height of the dam, except where detailed soil testing and laboratory analyses or experience in the area show that a lesser amount is adequate.

Principal Spillway. A pipe conduit, with needed appurtenances, will be placed under or through the dam, except where rock, concrete, or other types of lined spillways are used; for drainage areas less than 10 acres not fed by springs or seeps; or where the rate and duration of flow can be safely handled by a vegetated or earth spillway.

For dams with a drainage area of 20 acres or less, the principal spillway crest elevation will not be less than 0.5 feet below the auxiliary spillway crest elevation. For dams with a drainage area over 20 acres, this difference will not be less than 1.0 feet.

When design discharge of the principal spillway is considered in calculating peak outflow through the auxiliary spillway, the crest elevation of the inlet will be such that the design discharge will be generated in the conduit before there is discharge through the auxiliary spillway.

Pipe conduits designed for pressure flow must have adequate anti-vortex devices. Design the inlet and outlet to function for the full range of flow and hydraulic head anticipated.

The capacity of the pipe conduit will be adequate to discharge long-duration, continuous, or frequent flows without flow through the auxiliary spillways. The minimum diameter of pipe, minimum frequency design and detention storage will be determined from Table 2 for the principal spillway.

If the pipe conduit diameter is 10 inches or greater, its design discharge may be considered when calculating the peak outflow rate through the auxiliary spillway.

Table 2. Minimum requirements for structures located in predominantly rural or agricultural areas and incorporating water detention and/or retention storage in their design where (1) the hazard class of the structure is “a”, (2) the product of the storage[1] times the effective height of dam[2] is less than 3000, and (3) the effective height of dam[2] is 35 feet or less.

<table>
<tr><th>Drainage Area</th><th>Effective Height of Dam 2/</th><th>Storage 1/</th><th>Principal Spillway (24-hour Storm AMCII)</th><th>Auxiliary Spillway (24 hour Storm) 4/</th><th>Top of Settled Fill</th></tr>
<tr><td>10 acres or less without Conduit 3/</td><td>Less than 20 feet</td><td rowspan="4">Less than 50 acre feet</td><td>See Note 3</td><td rowspan="2">Route Q_{10} 6/</td><td rowspan="5">Minimum of 1 foot freeboard above the Hp value for the auxiliary spillway, but at least 2 feet above the crest of the auxiliary spillway for all dams having more than 20 acres drainage area or more than 20 feet in effective height. 9/</td></tr>
<tr><td rowspan="2">20 acres or less 5/</td><td>Less than 20 feet</td><td>1.0” Detention Storage (minimum) or Route Q_{2}. 8/</td></tr>
<tr><td>20 feet or more</td><td rowspan="2">1.5” Detention Storage 7/ minimum or Q Route 5 yr. freq. 8/</td><td rowspan="2">Route Q_{25} 6/</td></tr>
<tr><td>Over 20 Acres 5/</td><td>20 feet</td></tr>
<tr><td>ALL OTHERS 5/</td><td></td><td></td><td>2.0” Detention Storage 7/ (minimum) or Q Route 10 yr. freq. 8/</td><td>Route Q_{50} 6/</td></tr>
</table>

1/ Storage is defined in “Conditions Where Practice Applies”.

2/ Effective height of dam is defined in “Conditions Where Practice Applies”.

3/ Where the pond is spring fed or other source of steady base flow, a pipe will be installed with a capacity at least equal to the maximum spring or base flow.

4/ Auxiliary spillway crest will be set above the storage requirements of the principal spillway, but not lower than the elevation at which the principal spillway conduit flows full. The crest of the auxiliary spillway will be at least 0.5 feet above the crest of the principal spillway for less than 20 acres drainage area and at least 1.0 feet above the crest of the principal spillway for greater than 20 acres drainage area.

5/ A principal spillway conduit is required. Minimum pipe diameter will be 4 inches smooth pipe or 6 inches corrugated metal pipe.

6/ Flow through the principal spillway will not be included if the pipe diameter is less than 10 inches.

7/ Minimum pipe diameter will l be 10 inches.

8/ Storage may be determined by short cut methods on Engineering Field Handbook pages 11.55a, 11.55b, and 11.55c; or Win-Pond computer program.

Where Indiana Department of Natural Resources (IDNR) approval is required, additional freeboard may be required. Consult the NRCS State Conservation Engineer for instructions.

Pipe conduits under or through the dam will meet the following requirements. The pipe will be capable of withstanding external loading without yielding, buckling, or cracking.

Design rigid pipe for a positive projecting condition. Design flexible pipe conduits in accordance with the requirements of NRCS National Engineering Handbook (NEH), Part 636, Chapter 52, Structural Design of Flexible Conduits.

Pipe conduits will be ductile iron, welded steel, corrugated steel, corrugated aluminum, reinforced concrete (pre-cast or site-cast), or plastic. Pipe conduits through dams of less than 20 feet total height may also be cast iron or unreinforced concrete.

All pipe conduits will be designed and installed to be water tight by means of couplings, gaskets, caulking, waterstops, or welding. Joints will be designed to remain watertight under all internal and external loading including pipe elongation due to foundation settlement.

Flexible Pipe. Flexible pipe will be designed for a maximum deflection of 5 percent. The modulus of elasticity for PVC pipe will be assumed as one-third of the amount designated by the compound cell classification to account for long-term reduction in modulus of elasticity. Different reductions in modulus may be appropriate for other plastic pipe materials.

Connections of flexible pipe to rigid pipe or other structures will be designed to accommodate differential movements and stress concentrations.

Pipe strength will not be less than that of the grades indicated in Table 3 or 4 for plastic pipe.

Plastic pipe that will be exposed to direct sunlight will be ultraviolet-resistant and protected with a coating or shielding, or provisions provided for replacement as necessary.

Table 3. Acceptable PVC pipe for use in earth dams.[1/]

Nominal pipe size (inches)	Schedule for standard dimension ratio (SDR)	Maximum depth of fill over pipe (feet)
6 or smaller	SDR 26	10
	Schedule 40	15
	Schedule 80	20
8, 10, 12	SDR 26	10
	Schedule 40	
	Schedule 80	15

1/ Polyvinyl chloride pipe, PVC 1120 or PVC 1220, that conform to ASTM-D-1785 or ASTM-D-2241.

Table 4. Acceptable HDPE pipe for use in earth dams.[1/]

Pipe Values	Maximum height of fill over the top of pipe[2/] (feet)
SDR 21-32.5 PS 34-50	10
SDR 17 PS 100	11.5

1/ High density polyethylene pipe, ASTM-D3350 flexural modulus cell class 4 or greater, conforming to ASTM F714 for smooth wall HDPE pipe or AASHTO M-252 or M-294 for double wall HDPE pipe. These materials will typically have standard dimension ratio (SDR) values ranging from 32.5 to 21 or pipe stiffness (PS) values ranging from 34 to 100 psi respectively.

2/ The maximum height of fill over top of the pipe. This is based on 0 degree bedding (line support at the invert only). Backfill is assumed to be at 85 to 95% of maximum standard proctor density

Rigid Pipe. Rigid pipe will be designed for a positive projecting condition. Pipe strength will not be less than that of the grades indicated in Table 5 for corrugated steel or aluminum.

Table 5. Minimum sheet thickness for corrugated steel pipe (2-2/3 in x ½ in corrugations). 1/, 2/

Diameter of pipe (inches)	Fill height (feet)		
	1 to <15	15 to <20	20 to 25
21 and less	0.064	0.064	0.064
24	0.064	0.064	0.064
30	0.064	0.064	0.079
36	0.079	0.079	0.109
42	0.109	0.109	0.138
48	0.138	0.138	0.138

Minimum sheet thickness (in) of aluminum pipe. 3/

Diameter of pipe (inches)	Fill height (feet)		
	1 to <15	15 to <20	20 to 25
21 and less	0.060	0.060	0.060
24	0.060	0.075	0.105
30	0.075	0.105	0.135
36	0.075	0.105	4/

1/ Pipe with 6, 8 and 10-inch diameters has 1-1/2 in x ¼ in corrugations.

2/ Conforming to ASTM A760, A762 and A885.

3/ Riveted or helical fabrication, that conforms to ASTM B745 and B790.

4/ Not permitted.

All steel pipe and couplings will have protective coatings in areas that have traditionally experienced pipe corrosion, or in embankments with saturated soil resistivity less than 4000 ohms-cm or soil pH less than 5. Protective coatings will be asphalt, polymer over galvanizing, aluminized coating or coal tar enamel as appropriate for the pipe type.

Concrete pipe will have concrete bedding or a concrete cradle.

Inlets and Outlets. Inlets and outlets will be designed to function satisfactorily for the full range of flow and hydraulic head anticipated. Inlet and outlet materials will be structurally sound and made of materials compatible with those of the pipe.

Risers or inlets for pipe conduits will be of the same material as the conduit, or of comparable life materials such as reinforced concrete, concrete blocks, concrete culvert pipe, welded steel pipe or corrugated metal pipe. Hooded or canopy inlet may be used in lieu of a riser.

Risers will have a cross-sectional area at least 1.5 times that of the principal spillway conduit which outlets from it, but not less than 18 inches diameter.

Risers will have a height adequate to ensure full pipe flow in the barrel. All pipe risers will have an extra foot of length below the invert of the conduit encased in concrete to the invert of the conduit.

When concrete pipe is used for the conduit, concrete will also be placed around the outside of the riser enclosing the first joint of the conduit.

The riser or inlet will be protected from ice and floating debris by a semi-circular berm not less than 4 feet from the riser. No berm is necessary when a hooded or canopy inlet is used but the invert of the inlet will project one (1) foot vertically above the fill slope.

Cantilever outlet sections, if used, will be designed to withstand the cantilever load. Pipe supports will be provided when needed. Other suitable devices such as a Saint Anthony Falls stilling basin (SAF) or an impact basin may be used to provide a safe outlet.

Where the downstream channel conditions are stable, the pier may be omitted for conduits of 15 inch diameter or less with the outlet invert one (1) to two (2) feet above the stable channel bottom. The outlet section will be a minimum of 20 feet in length with four (4) feet to eight (8) feet overhang downstream from the intersection of the flow line of the pipe and the design fill slope.

For conduits larger than 15-inch diameter, conduits with outlets higher than two (2) feet above the grade of the channel bottom or conduits outletting in unstable outlet channels, a cantilever propped outlet or other suitable devices such as a S.A.F. stilling basin, or impact basin will be provided. For cantilevered (propped) outlets, the outlet section of pipe will be a minimum of 20 feet long, with the prop (or pier) located at or downstream from the intersection of the fill slope and the outlet channel grade. Approximately one-third of the outlet pipe section (minimum of 8 feet) will be downstream of the pier centerline. A stilling basin will be excavated and lined with riprap if necessary to prevent erosion at the outlet.

Cathodic Protection. Cathodic protection is to be provided for coated welded steel and galvanized corrugated metal pipe where soil and resistivity studies indicate that the pipe needs a protective coating, and where the need and importance of the structure warrant additional protection and longevity. If cathodic protection is not provided for in the original design and installation, electrical continuity in the form of joint-bridging straps should be considered on pipes that have protective coatings. Cathodic protection should be added later if monitoring indicates the need.

Seepage Control. Seepage control along a pipe conduit spillway will be provided in the normal saturation zone if any of the following conditions exist:

- The effective height of dam is greater than 15 feet.
- The conduit is of smooth pipe larger than 8 inches in diameter.
- The conduit is of corrugated pipe larger than 12 inches in diameter.

Seepage along pipes extending through the embankment will be controlled by use of a drainage diaphragm, unless it is determined that anti-seep collars will adequately serve the purpose.

Filter Diaphragm. When the effective height of the dam is 15 feet or greater and the effective storage of the dam is 50 acre-ft. or more, provide filter diaphragms to control seepage on all pipes extending through the embankment with inverts below the peak elevation of the routed design hydrograph. Design filter diaphragms or alternative measures as needed to control seepage on pipes extending through all other embankments or for pipes with inverts above the peak elevation of the routed design hydrograph.

Design the filter diaphragm in accordance with the requirements of NEH, Part 628, Chapter 45, Filter Diaphragms. Locate the filter diaphragm immediately downstream of the cutoff trench, but downstream of the centerline of the dam if the foundation cutoff is upstream of the centerline or if there is no cutoff trench.

Ensure filter diaphragm functions both as a filter for adjacent base soils and as a drain for seepage that it intercepts. Materials for the filter diaphragm will meet the requirements of NEH Part 628, Chapter 45, Filter Diaphragms, Section 628.4503(d), Filter and Drain Gradation.

To improve filter diaphragm performance, provide a drain outlet for the filter diaphragm at the downstream toe of the embankment. Protect the outlet from surface erosion and animal intrusion.

Anti-seep Collars. When anti-seep collars are used in lieu of a drainage diaphragm, they will have a watertight connection to the pipe. Maximum spacing will be approximately 14 times the minimum projection of the collar measured perpendicular to the pipe or 25 feet, whichever is less. The minimum spacing will be 10 feet. Collar material will be compatible with pipe materials. The first collar will not be more than 14 feet downstream of the inlet. The anti-seep collar(s) will increase by at least 15 percent the seepage path along the pipe.

Trash Guard. To prevent clogging of the conduit, an appropriate trash guard will be installed at the inlet or riser unless the watershed does not contain trash or debris that could clog the conduit.

Other Outlets. A pipe with a suitable valve will be provided to drain the pool area if needed for proper pond management or if required by State law. The principal spillway conduit may be used as a pond drain if it is located where it can perform this function. The drain will be large enough to draw the pond down 8 feet in 2 weeks (approximately 16 GPM or 0.04 cfs. per A.F. of storage).

Auxiliary Spillways. Auxiliary spillways convey large flood flows safely past earth embankments and have historically been referred to as “Emergency Spillways”.

An auxiliary spillway must be provided for each dam, unless the principal spillway is large enough to pass the peak discharge from the routed design hydrograph and the trash that comes to it without overtopping the dam. The following are minimum criteria for acceptable use of a closed conduit principal spillway without an auxiliary spillway: a conduit with a cross-sectional area of 3 ft^2 or more, an inlet that will not clog, and an elbow designed to facilitate the passage of trash.

The minimum capacity of a natural or constructed auxiliary spillway will be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 2, less any reduction creditable to conduit discharge and detention storage.

The auxiliary spillway will safely pass the peak flow, or the storm runoff with be routed through the reservoir. The routing will start either with the water surface at the elevation of the crest of the principal spillway or at the water surface after 10 days’ drawdown, whichever is higher. The 10-day drawdown will be computed from the crest of the auxiliary spillway or from the elevation that would be attained if the entire design storm were impounded, whichever is lower. Auxiliary spillways will provide for passing the design flow at a safe velocity to a point downstream where the dam will not be endangered.

Constructed auxiliary spillways are open channels that usually consist of an inlet channel, a control section, and an exit channel. They will be trapezoidal and will be located in undisturbed or compacted earth or in-situ rock. The side slopes will be stable for the material in which the spillway is to be constructed, but not steeper than two horizontal to one vertical except when cut in rock. The minimum auxiliary spillway bottom width will be 10 feet.

The control section will be level for a minimum distance of 10 feet. Upstream from the control section, the inlet channel will be level for the distance needed to protect and maintain the crest elevation of the spillway. The inlet channel will be at least the same width as the control section and may be curved to fit existing topography. The grade of the exit channel of a constructed auxiliary spillway will fall within the range established by discharge requirements and permissible velocities. The constructed exit channel will be straight and uniform to a point downstream of the toe of the dam.

Structural Auxiliary Spillways. If chutes or drops are used for principal spillways or auxiliary spillways, they will be designed according to the principles set forth in the Part 650, Engineering Field Handbook and the National Engineering Handbook, Section 5, Hydraulics; Section 11, Drop Spillways; and Section 14, Chute Spillways. The minimum capacity of a structural spillway will be that required to pass the peak flow expected from a design storm of the frequency and duration shown in table 2, less any reduction creditable to conduit discharge and detention storage.

Design Criteria for Excavated Ponds

General. This type of reservoir is generally constructed in flat land areas where an embankment pond is not feasible. The water supply is obtained from underground seepage, high water table, springs, subsurface drains or surface runoff. An adequate water supply which will maintain desired water level in pond must be assured.

Runoff. Provisions will be made for a pipe and auxiliary spillway, if needed, that will meet the capacity requirements of Table 2. Runoff flow patterns will be considered when locating the excavated pond and placing the spoil.

Side Slopes. Side slopes of excavated ponds will be stable and will not be steeper than the minimum side slopes shown in Table 6.

Table 6. Steepest Allowable Side Slopes

Texture	Horizontal:Vertical
Peat and Muck	1:1
Fine Sand	2.5:1
Coarse Sand and Gravel	2:1
Silt Loam or Loam	2:1
Sandy Loam	2:1
Clay Loam or Silty Clay Loam	1.5:1

Inlet Protection. If surface water enters the pond in a natural or excavated channel, the side slope of the pond will be protected against erosion.

Excavated Material. The material excavated from the pond will be placed so that its weight will not endanger the stability of the pond side slopes and it will not be washed back into the pond by rainfall. It will be disposed of in one of the following ways:

1. Uniformly spread to a height that does not exceed 3 feet, with the top graded to a continuous slope away from the pond.
2. Uniformly placed or shaped reasonably well, with side slopes assuming a natural angle of repose. The excavated material will be placed at a distance equal to the depth of the pond but not less than 12 feet from the edge of the pond.
3. Shaped to a designed form that blends visually with the landscape.
4. Used for low embankment construction and leveling of surrounding landscape.
5. Hauled away.

<u>Additional Criteria for Livestock Water</u>

Permanent Pool Volume. Permanent pool volume of the pond will be sufficient to meet the watering requirements of the livestock during the period of intended use.

Fencing. When embankment ponds are used for livestock water, the entire fill, spillways and pond area will be fenced to exclude livestock, except for limited and controlled access sites if livestock will water directly from the pond, a watering ramp of ample width will be provided.

Fencing will be a minimum of 30 feet from all sides of the pond and a minimum of 50 feet upstream of the pool area.

Watering facilities for stock will be provided outside the fenced area. All fencing will be in accordance with IN FOTG Standard (382) Fence.

Flash grazing is allowed only with a grazing plan according to IN FOTG Standard (528) Prescribed Grazing so adequate cover is maintained at all times.

Pipe Conduits. Pipes used solely as a supply pipe through the dam for watering troughs and other appurtenances will not be less than 1.25 inches in diameter.

Ramps. If livestock will water directly from the pond, a watering ramp of ample width will be provided.

The ramp will extend to the anticipated low water elevation at a slope no steeper than three horizontal to one vertical. Ramps will be designed according to the criteria found in IN FOTG Standard (561) Heavy Use Area Protection.

<u>Additional Criteria for Fish Production</u>

At least 75 percent of the shoreline will be steepened to a slope of three horizontal to one vertical to a depth of 3 feet below permanent pool level. Ponds primarily for fish production will have a minimum surface area of not less than 0.25 acre when stocked with a single species or a minimum surface area of 0.5 acre when stocked with two or more species.

Additional Criteria for Wildlife

Activities will be managed according to IN FOTG standard (645) Upland Wildlife Habitat Management and/or (644) Wetland Wildlife Habitat Management.

Designs will take into account specific aquatic species requirements (such as water depths, side slopes, vegetation, etc.).

CONSIDERATIONS

The considerations section contains information that is optional to the planner.

Drainage area. The ratio of pond area to drainage area should fall within the following guidelines:

(a) For slowly permeable soils (Hydrologic Group C & D soils) having slopes greater than seven (7) percent – not less than 1:4 or more than 1:20.

(b) For moderately permeable soils (Hydrologic Group B & C soils) and slowly permeable soils with less than seven (7) percent slopes – not less than 1:6 or more than 1:25.

(c) For permeable soils (Hydrologic Group A soils) – not less than 1:10 or more than 1:30.

Visual Resource Design. The visual design of ponds should be carefully considered in areas of high public visibility and those associated with recreation. The underlying criterion for all visual design is appropriateness. The shape and form of ponds, excavated material, and plantings are to relate visually to their surroundings and to their function.

The embankment may be shaped to blend with the natural topography. The edge of the pond may be shaped so that it is generally curvilinear rather than rectangular. Excavated material can be shaped so that the final form is smooth, flowing, and fitting to the adjacent landscape rather than angular geometric mounds. If feasible, islands may be added for visual interest and to attract wildlife.

Auxiliary Spillway. Consider using a trickle tube to keep auxiliary spillways from eroding from wetness when no principal spillway pipe is installed.

Fish and Wildlife. Project location and construction should minimize the impacts to existing fish and wildlife habitat.

When feasible, structure should be retained, such as trees in the upper reaches of the pond and stumps in the pool area. Upper reaches of the pond can be shaped to provide shallow areas and wetland habitat.

If fish are stocked, consider the criteria and guidance in IN FOTG standard (399) Fishpond Management.

Retain sufficient vegetative heights to discourage Canada geese from over-using the pond as appropriate.

Vegetation. Stockpiling topsoil for placement on disturbed areas can facilitate revegetation.

Consider placement and selection of vegetation to improve fish and wildlife habitat and species diversity.

Water Quantity. Consider effects upon components of the water budget, especially:

- Effects on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge.
- Variability of effects caused by seasonal or climatic changes.
- Effects on downstream flows and impacts to environment such as wetlands, aquifers, and; social and economic impacts to downstream uses or users.
- Potential for multiple purposes.

Water Quality

- Consider effects on erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances that are carried by runoff.

- Effects on the visual quality of onsite and downstream water resources.
- Short-term and construction-related effects of this practice on the quality of downstream water courses.
- Effects of water level control on the temperatures of downstream water to prevent undesired effects on aquatic and wildlife communities.
- Effects on wetlands and water-related wildlife habitats.
- Effects of water levels on soil nutrient processes such as plant nitrogen use or denitrification.
- Effects of soil water level control on the salinity of soils, soil water, or downstream water.

Potential for earth moving to uncover or redistribute toxic materials such as saline soils.

PLANS AND SPECIFICATIONS

Plans and specifications for installing ponds will be in keeping with this standard and will describe the requirements for applying the practice to achieve its intended purpose. Plans will include the following:

- Plan view
- Profile
- Cross section (typical or other)
- Location of excavation or borrow
- Pertinent structural details.
- Species of plants to be established.
- Seeding rates.
- Seeding dates.
- Establishment procedure.
- Planned rates and timing of nutrient application.
- Other information pertinent to establishing and managing the species or species of plants to be established.
- Safety features.
- If grazed, use a prescribed grazing plan according to NRCS IN FOTG Standard (528) Prescribed Grazing.

OPERATION AND MAINTENANCE

An operation and maintenance plan will be developed for the landowner in keeping with this practice standard.

At a minimum, the following items will be addressed:

- Remove any woody growth from embankments and spillway areas. Keep grasses mowed for better visual inspection.
- Remove debris and trash from spillways and outlets immediately. Inspect the outlet regularly, especially after storm events.
- Control burrowing animals. Repair any holes caused by burrowing animals on or near the embankment.
- Repair any erosion of the embankment.
- Inspect the embankment for seepage downstream

REFERENCES

American Society for Testing and Materials. Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System), ASTM D2487. West Conshohocken, PA.

USDA NRCS. Engineering Technical Releases, TR-210-60, Earth Dams and Reservoirs. Washington, DC.

USDA NRCS. National Engineering Handbook (NEH), Part 628, Dams. Washington, DC.

USDA NRCS. NEH, Part 633, Soil Engineering. Washington, DC.

USDA NRCS. NEH, Part 636, Structural Engineering. Washington, DC.

USDA NRCS. NEH, Part 650, Engineering Field Handbook. Washington, DC.

USDA NRCS. National Engineering Manual. Washington, DC..