Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

# POND

## CODE 378

(no)

## DEFINITION

A water impoundment made by constructing an embankment, excavating a dugout, or 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 using a combination of the excavation and 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.

## PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Store water for:
  - Livestock
  - Fish and wildlife
  - Recreational use
  - Fire control
  - Erosion control
  - Flow detention
- Improve water quality

## CONDITIONS WHERE PRACTICE APPLIES

This practice  applies to all excavated ponds. It also applies to embankment ponds that meet all criteria for low-hazard potential dams as listed below:

- The 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 acre-feet$^2$. Storage is the capacity of the reservoir in acre-feet below the elevation of the crest of the lowest auxiliary spillway or the elevation of the top of the dam if there is no open channel auxiliary spillway. The effective height of the dam is the difference in elevation, in feet, between the lowest open channel auxiliary spillway crest and the lowest point in the original cross section taken on the centerline of the dam. If there is no open channel auxiliary spillway, use the lowest point on the top of the dam instead of the lowest open channel auxiliary spillway crest.
- The effective height of the dam is 35 feet or less.

## CRITERIA

### General Criteria Applicable to All Ponds

Plan, design, and construct the pond to comply with all Federal, State, and local laws and regulations. Notify landowners and/or contractor of their responsibility to locate all buried utilities in the project area, including drainage tile and other structural measures. The landowner is also required to obtain all necessary permits for project installation prior to construction.

The landowner is responsible for acquiring land rights from adjoining landowners for any permanent or temporary storage created by the planned structure.

The designer must complete Form IA-ENG-40 for inventory dams. Submit the form to the State Conservation Engineer upon completion of construction. Dams are included in the inventory of NRCS assisted dams if any of the following conditions are met:

- The dam is classified as Significant or High Hazard
- Iowa DNR permit dams (see requirements below)
- All dams with an overall height of 35 feet or more
- All Watershed Project detention-type structures regardless of size or hazard class

See NRCS Title 210, National Engineering Manual, Part 520, Subpart C, “Dams” (210-NEM-520) for more details and definitions for inventory dams.

Design a minimum sediment storage capacity equal to the design life of the structure, or provide for periodic cleanout. Protect the drainage area above the pond to prevent sedimentation from adversely affecting the design life.

Design measures necessary to prevent serious injury or loss of life according to the requirements of NRCS 210-NEM-503, “Safety.”

Seed or sod the exposed surfaces of earthen embankments, earth spillways, borrow areas, and other areas disturbed during construction in accordance with the criteria in Iowa NRCS Conservation Practice Standard (CPS) Critical Area Planting (Code 342). When necessary to provide surface protection where climatic conditions preclude the use of seed or sod, use the criteria in Iowa NRCS CPS Mulching (Code 484) to install inorganic cover material such as gravel.

**Iowa Department of Natural Resources Permit Dams**

Approval by the Iowa Department of Natural Resources (IDNR) for construction, repair, or modification of any dam shall be required when the dam exceeds the thresholds under rule 567—73.3(455B) of the Iowa Administrative Code:

- Height at least 25 feet and storage at the top of dam elevation of 15 acre-feet or more; or
- Storage at the top of dam elevation of 50 acre-feet or more and a height of at least 6 feet.

Height is the vertical distance from the top of the dam to the natural bed of the stream or water source measured at the downstream toe of the dam or to the lowest elevation of the outside limit of the dam if it is not across a water source.

Dams regulated under Iowa Administrative Code, Section 567, Chapter 73 shall comply with the following:

- A water storage permit shall be required for all regulated dams in order to legally impound water. Application for a dam construction permit shall constitute application for a water storage permit if the appropriate fee is received with the application [73.11(2)].
- The minimum separation between a water source, other than a major water source, and a confinement feeding operation structure is 500 feet [73.18(1)].

- The $Q_{100}$ freeboard design flood shall be passed without overtopping of the dam [73.19(2)].
- The $Q_{10}$ design flood shall be passed by the principal spillway without need for operation of an auxiliary spillway [73.19(2)].
- The spillway discharge capacity shall be sufficient to evacuate at least 80 percent of the volume of water temporarily stored during the principal spillway design flood within ten days. If this cannot be accomplished, the auxiliary spillway and freeboard design flood routings shall be made beginning with the impoundment level at the ten-day drawdown elevation [73.19(15)]
- If an auxiliary spillway is proposed, it shall be analyzed, designed, and constructed adequately to establish and maintain stability during the passage of design flows without blockage or breaching. Open-channel auxiliary spillways shall have a minimum depth of 2 feet and minimum width of 10 feet and be designed with appropriate curvature and slopes to prevent excessive erosion [73.20(6)].

**Cultural resources**
Evaluate the existence of cultural resources in the project area and any project impacts on such resources. Provide conservation and stabilization of archeological, historic, structural, and traditional cultural properties when appropriate.

**Site conditions**
Select or modify the site to allow runoff from the design storm to safely pass through a natural or constructed auxiliary spillway, a combination of a principal spillway and an auxiliary spillway, or a principal spillway.

Select a site that has an adequate supply of water for the intended purpose through surface runoff, ground water, or a supplemental water source. Water quality must be suitable for its intended use.

Divert runoff water from barnyards, feedlots, septic tanks, barn drains, or other sources of contamination to prevent effluent from entering the reservoir when used for drinking water supply, livestock water supply, or recreation.

**Reservoir**
Provide adequate storage volume to meet user demands for all intended purposes. Account for sedimentation, season of use, evaporation loss, and seepage loss when computing the storage volume.

The minimum surface area of ponds to be used for fish production is 0.5 acre. The pond must provide at least 8 feet of water under at least 25% of the surface area at the principal spillway elevation except in the northern 2 tiers of counties where the minimum depth under at least 25% of the surface area shall be 10 feet.

## Additional Criteria for Embankment Ponds

**Geological investigations**
Use pits, trenches, borings, and reviews of existing data or other suitable means of investigation to characterize materials within the embankment foundation, auxiliary spillway, and borrow areas. Classify soil materials using ASTM D2487-17e1, “Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).” Determine from the investigations if problem soils exist at the embankment pond site for defensive design measures. Problem soils, include but are not limited to dispersive clays, collapsible soils, soft clays, expansive clays, low internal erosion resistance soils, loose coarse-grained soils, high soluble content soils, and caliche soils.

**Foundation cutoff**
Design a cutoff of relatively impervious material under the dam and up the abutments as required for preventing seepage, but no lower than the principal spillway crest. Locate the cutoff at, or upstream from, the centerline of the dam. Extend the cutoff deep enough to intercept flow and connect with a relatively impervious layer. Combine seepage control with the cutoff as needed. Use a cutoff bottom width adequate

to accommodate the equipment used for excavation, backfill, and compaction operations but no less than 8 feet. Design cutoff side slopes no steeper than 1.5 horizontal to 1 vertical.

**Seepage control**
Include seepage control if—

- Foundation cutoff does not intercept pervious layers.
- Seepage could create undesired wet areas.
- Embankment stability requires seepage control.
- Special problems require drainage for a stable dam.

Filter zones may be required in some embankment designs to address the problem of cracking and internal erosion of the embankment for sites with problematic conditions such as dispersive clays, steep abutments, and other issues.

Control seepage with—

- Foundation, abutment, or embankment filters and drains.
- Filter diaphragms.
- Reservoir bottom blanketing.
- A combination of these measures.

**Top width**
Table 1 provides the minimum top widths for dams of various total heights. Total height is the vertical distance between the settled top of the dam and the lowest elevation at the downstream toe.

Design a minimum width of 16 feet for one-way traffic and 26 feet for two-way traffic for the top of a dam used as a public road. Design guardrails or other safety measures where necessary and follow the requirements of the responsible road authority. For dams less than 20 feet in total 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 a Dam.

| Total Height of Dam* (feet) | Top Width (feet) |
|---|---|
| Less than 15 | 10 |
| 15.1–25.0 | 12 |
| 25.1–35.0 | 14 |
| 35.1 or more | See TR-60 |

*Total height is the vertical distance between the settled top of dam and the lowest elevation at the downstream toe.

**Side slopes**
Design each side slope with a ratio of three horizontal to one vertical (3:1) or flatter, except for embankments built entirely of glacial till soil on foundations of glacial till soil may have side slopes not steeper than 2.5:1. As required, design benches or flatten side slopes to assure stability of all slopes for all loading conditions. Flatter slopes may be required for stability for some problematic embankment or foundation soils such as highly plastic embankment soils or very soft clays. Downstream or upstream berms can be used to help achieve stable embankment slopes.

Borrow area in the pool within 6 vertical feet of the permanent water elevation must have a minimum side slope of 2.5:1. All other borrow areas below crest must have a minimum side slope of 1.5:1.

**Slope protection**
Design special measures such as berms, riprap, sand-gravel, soil cement, or use special vegetation as needed to protect the slopes of the dam from erosion. Use NRCS Engineering Technical Release (TR) 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,” as applicable.

Design the upstream wave berm on small dams to meet or exceed the following limits:

- When the pond surface area is 1 acre or less the berm may be omitted.
- When the pond surface area is greater than 1 acre but less than or equal to 2 acres extend the berm around the inlet for a distance of not less than 10 feet.
- When the pond surface area is greater than 2 acres design the berm 8 feet in width or wider at the normal pool elevation to dampen out wave action. Extend the berm across the earthfill to the abutments. The berm may be constructed as much as 6 inches above the permanent pool elevation to allow for settlement.
- When the pond surface area is greater than 6 acres design a sloping berm in accordance with Technical Release 56, “A Guide for Design and Layout of Vegetative Wave Protection for Earth Dam Embankments”.
- Rock riprap or other structural measures shall be used for dams where vegetation will not provide effective protection, for multiple-purpose dams, and for dams with fluctuating normal water levels. Rock riprap shall extend at least 1 foot above the maximum wave height and at least 3 feet below normal pool elevation.

When a downstream berm is needed on the downstream slope for slope stability, as an erosion control measure, or as a crossing, use a minimum width of 10 feet (measured on the horizontal projection). Downstream slopes may be flattened in lieu of berms. Berms may be built level or drain back towards the fill and laterally to safe outlets.

**Freeboard**
Design a minimum of 1 foot of freeboard between design high-water flow elevation in the auxiliary spillway and the top of the settled embankment. Design a minimum 2 feet of elevation difference between the crest of the auxiliary spillway and the top of the settled embankment. See the “Auxiliary Spillways” section for design criteria when the pond has no auxiliary spillway.

**Settlement**
Increase the height of the dam by the amount needed to ensure that the settled top elevation of the dam equals or exceeds the design top elevation. Design a minimum settlement allowance of 5 percent of the total height of the dam associated with each dam cross section, except where detailed laboratory soil testing and settlement analyses or experience in the area shows that a lesser amount is adequate.

**Principal spillway**
A pipe with needed appurtenances shall be placed under or through the dam, except where rock, concrete, or other types of lined spillways are used, or where a vegetated or earth spillway can safely handle the rate and duration of the design flow.

Design a minimum of 6-inches difference between the crest elevation of the auxiliary spillway and the crest elevation of the principal spillway when the dam has a drainage area of 20 acres or less. Design a minimum of 1 foot difference when the dam has a drainage area of over 20 acres.

**Table 2. Minimum Principal and Auxiliary Spillway Design Capacity**

| Drainage area (Acres) | Minimum Pipe Diameter (Inches) | Effective Fill Height[1] (feet) | Storage[1](acre-feet) | Frequency of minimum design,24-hour duration storm | |
|---|---|---|---|---|---|
| | | | | Principal Spillway Capacity(Year) | Auxiliary Spillway Capacity(Year) |
| 0-20 | 4 | 0-20 | ≤50 | —— | 10 |
| 0-20 | 4 | 20-35 | ≤50 | 2 | 25 |
| 20-80 | 6 | 0-20 | ≤50 | 5 | 25 |
| 20-80 | 6 | 20-35 | ≤50 | 5 | 50 |
| 80-250 | 10 | 0-20 | ≤50 | 10 | 25 |
| 80-250 | 10 | 20-35 | ≤50 | 10 | 50 |
| All Others | 15 | 0-35 | All | 25 | 50 |

[1]Defined under “Conditions where Practice Applies”

[2]If the structure requires an IDNR permit, more restrictive criteria may apply.  See IAC 567 – Chapter 73.3.

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.

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

Provide an anti-vortex device to handle pressure flow in the principal spillway pipe. Design the inlet and outlet to function for the full range of flow and hydraulic head anticipated.

Design adequate pipe capacity to discharge long-duration, continuous, or frequent flows without causing flow through the auxiliary spillway, see Table 2. Design a principal spillway pipe with a minimum inside diameter of 4 inches. See Table 2 for additional limits on pipe diameter.  Design pipe with a minimum inside diameter of 1-1/4 inches for water supply pipes or for pipes used for any other purpose.

Design pipe using ductile iron, welded steel, corrugated steel, corrugated aluminum, reinforced concrete (precast or site-cast), or plastic. Do not use cast iron or unreinforced concrete pipe if the dam is 20 feet or greater in total height.

Design flexible pipe such that the maximum height of fill listed in table 3 (PVC pipe) and table 4 (corrugated aluminum and galvanized steel pipe) is not exceeded for the sizes and materials specified.

If the maximum height of fill exceeds the limits of Table 3 or Table 4 for flexible pipe, the flexible pipe is not included in Table 3 or Table 4, or if rigid pipe is used, design and install pipe to withstand all external and internal loads without yielding, buckling, or cracking. Design rigid pipe for a positive projecting condition. Design flexible pipe according to the requirements of NRCS Title 210, National Engineering Handbook , Part 636, Chapter 52, “Structural Design of Flexible Conduits” (210-NEH-636-52) with the following conditions:

- Design flexible pipe with a maximum deflection of 5 percent.
- Assume a modulus of elasticity for PVC pipe as one-third the amount designated by the compound cell classification to account for long-term reduction in modulus of elasticity.  Different reduction in modulus may be appropriate for other plastic pipe materials.

Refer to 210-NEH-636-52 for additional design guidance for flexible pipe.

**Table 3. Acceptable PVC Pipe for use in earthen dams**

| Nominal Pipe Size (inches) | Pipe Material | Maximum Depth Over Pipe (Feet) |
|---|---|---|
| 4, 6, 8, 10, 12 | ASTM D2241, SDR 26 | 13 |
| 4, 6, 8, 10, 12 | ASTM D2241, SDR 21 | 17 |
| 4, 6, 8, 10, 12 | ASTM D2241, SDR 17 | 24 |
| 10, 12 | ASTM D1785, Schedule 40 | 8 |
| 6, 8 | ASTM D1785, Schedule 40 | 13 |
| 4 | ASTM D1785, Schedule 40 | 20 |
| 10, 12 | ASTM D1785, Schedule 80 | 20 |
| 6, 8 | ASTM D1785, Schedule 80 | 24 |
| 4 | ASTM D1785, Schedule 80 | 25 |
| 4, 6, 8, 10, 12 | AWWA C900 Class 165 | 13 |
| 4, 6, 8, 10, 12 | AWWA C900 Class 235 | 18 |
| 4, 6, 8, 10, 12 | AWWA C900 Class 305 | 25 |

**Table 4a. Minimum gage for corrugated metal pipe (CMP) for 2 2/3 inch x 1/2 inch corrugations[1]**

| Fill Height Above Pipe (Feet) | Steel Pipe Nominal Diameter (inches) | | | | | | Aluminum Pipe[2] Nominal Diameter (inches) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | <21 | 24 | 30 | 36 | 42 | 48 | <21 | 24 | 30 | 36 |
| 1-15 | 16 | 16 | 16 | 14 | 12 | 10 | 16 | 16 | 14 | 14 |
| 15-20 | 16 | 16 | 16 | 14 | 12 | 10 | 16 | 16 | 12 | 12 |
| 20-25 | 16 | 16 | 14 | 12 | 10 | 10 | 16 | 12 | 10 | —-[3] |

**Table 4b. Minimum gage for corrugated metal pipe (CMP) for 3 inch x 1 inch corrugations[4]**

| Fill Height Above Pipe (Feet) | Steel Pipe Nominal Diameter (inches) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 36 | 42 | 48 | 54 | 60 | 66 | 72 | 78 | 84 | 90 | 96 |
| 1-15 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 14 | 12 | 12 | 10 |
| 15-20 | 16 | 16 | 16 | 16 | 14 | 14 | 14 | 12 | 10 | 8 | —-[3] |
| 20-25 | 16 | 16 | 14 | 12 | 10 | 8 | 8 | 8 | —-[3] | —-[3] | —-[3] |

[1] Pipe with 6, 8, and 10 inch diameter has 1 ½ x ¼ inch corrugations

[2]Riveted or helical fabrication

[3]Not permitted

[4]n = 0.027

Design connections of flexible pipe to rigid pipe or other structures to accommodate differential movements and stress concentrations. Design and install all pipes to be watertight using couplings, gaskets, caulking, water stops, or welding. Design joints to remain watertight under all internal and external loading, including pipe elongation due to foundation settlement.

Design a concrete cradle or bedding for pipe if needed to reduce or limit structural loading on the pipe and improve support of the pipe.

Design outlet structures, such as cantilever pipe outlet sections and impact basins, to dissipate energy as needed. Design the outlet section a minimum of 20 feet long with a minimum of 8 feet overhang downstream from the centerline of prop or from the intersection of the flow line of the pipe and design fill slope when no prop is used. The pipe must project beyond the toe of the fill in all cases. The slope of the propped outlet must be within the limits shown in Table 5.

**Table 5. Allowable Slope of Cantilever Outlet**

| Diameter (inches) | Minimum | Maximum |
|---|---|---|
| 4-15 | 2% | 20% |
| 16-24 | 2% | 12% |
| 26-48 | 2% | 7% |
| Over 48 | 2% | 4% |

Design the invert of the pipe at the outlet end a minimum of 1 foot above a constructed channel or gully bottom. In situations where sediment accumulation in outlet channels may be a problem, raise the outlet or use a chute or slotted flume outlet. A slotted flume may be used on metal pipe conduits.

Use a chute outlet when downstream sedimentation is expected, downstream gully banks may be sloped at a later date, or outlet submergence may occur from downstream works of improvement.

Construct chute outlets for concrete pipe conduits of reinforced concrete and to meet the requirements for outlets for chute spillways.

Chute outlets for monolithic conduits will meet the same criteria as outlined for chute spillways in Iowa NRCS Conservation Practice Standard (CPS) Grade Stabilization Structure (Code 410). Other suitable devices such as a Saint Anthony Falls stilling basin or an impact basin may be used to provide a safe outlet.

**Corrosion protection**
Provide protective coatings for all steel pipe and couplings in areas that have traditionally experienced pipe corrosion or in embankments with saturated soil resistivity less than 4,000 ohm-cm or soil pH less than 5. Protective coatings may include asphalt, polymer over galvanizing, aluminized coating, or coal tar enamel.

**Ultraviolet protection**
Use ultraviolet-resistant materials for all plastic pipe or provide coating or shielding to protect plastic pipe exposed to direct sunlight.

**Cathodic protection**
Provide cathodic protection 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 for and importance of the structure warrant additional protection and longevity. If the original design and installation did not include cathodic protection, consider establishing electrical continuity in the form of joint-bridging straps on pipes that have protective coatings. Add cathodic protection later if monitoring indicates the need.

**Internal erosion**
Install filter diaphragms for internal erosion control or anti-seep collars to reduce hydraulic gradient along the pipe extending through the embankment with inverts below the peak elevation of the routed hydrograph when the effective height of the dam is 15 feet or greater.

**Filter diaphragms**
Design the filter diaphragm according to the requirements of 210-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. Use a minimum earthfill cover of 3 feet.  See 210-NEH-628-45, Appendix A, Section “Location of the Conduit Referenced to Centerline of the Embankment” for more specific guidance on the location of the filter diaphragm.

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.

Design the filter diaphragm with a minimum thickness of two feet and extend the filter diaphragm in all directions from the surface of the pipe a minimum of two times the outside pipe diameter.

Ensure that the filter diaphragm functions both as a filter for adjacent base soils and as a drain to intercept seepage. Materials for the filter diaphragm must meet the requirements of 210-NEH-Part 633, Chapter 26, "Gradation Design of Sand and Gravel Filters".

When the embankment base soils are Category 2, soils having between 40 and 85 percent finer than the #200 sieve (after regrading the #4 sieve), design the filter diaphragm with sand meeting the requirements of ASTM C33 for fine aggregate. If the embankment base soils do not meet Category 2, or ASTM C33 fine aggregate does not meet the required filter or capacity requirements, design a site-specific filter diaphragm using 210-NEH-633-26.

**Anti-seep collars**

Anti-seep collars can be used in lieu of a filter diaphragm where the following soil and site conditions apply:

- Embankment soils are documented to be non-dispersive by crumb testing or evidence that the site is located in geologic formations that are known to be non-dispersive.
- Soils tests show that embankment soils have a plasticity index (PI) equal to or greater than 15.
- The water content of the soils at the time of construction is such that a 1/8-inch diameter thread 1/2-inch long may be rolled out on a flat surface without breaking or falling apart.
- Natural or excavated ground slopes transverse to the embankment centerline in the vicinity of the conduit are no steeper than 2 horizontal to 1 vertical.
- Laboratory or field tests show that the foundation soils left in-place under the embankment and principal spillway are medium to very stiff in saturated consistency or medium dense to very dense depending on if these soils are cohesive or cohesionless, respectively.

When using anti-seep collars in lieu of a filter diaphragm, ensure a watertight connection to the pipe. Limit the maximum spacing of the anti-seep collars to 14 times the minimum projection of the collar measured perpendicular to the pipe, or 25 feet, whichever is less. Locate anti-seep collars no closer than 10 feet apart. Use a collar material that is compatible with the pipe material.

Locate the first (most upstream) anti-seep collar 15 to 25 feet downstream of the principal spillway inlet.

Design the collars to increase the seepage path along the pipe within the fill by at least 15 percent.

Determine the number of anti-seep collars required using the following formula:

$$N = \frac{L}{7(V - D)}$$

Where:

- L = Length of pipe lying within the saturated zone in feet.
  - In MLRA 107, L = the distance from the inlet of downstream face of the riser to the centerline of the embankment drainage system or to the downstream toe if no embankment drainage system is planned.
  - Remainder of State, L = The distance from the inlet or downstream face of the riser to the downstream edge of the top plus 60% of the distance from the downstream edge of the top to

the downstream toe.

- V = Vertical height of the anti-seep collar in feet.
- D = Outside diameter of principal spillway pipe or outside height of a monolithic conduit in feet.

**Trash guard**
Install a trash guard at the riser inlet to prevent clogging of the pipe, unless the watershed does not contain trash or debris that could clog the pipe.

**Pool drain**
Provide a pipe with a suitable valve to drain the pool area if needed for proper pond management or if required by State law. The designer may use the principal spillway pipe as a pond drain if it is located where it can perform this function.

**Auxiliary spillways**
A dam must have an open channel auxiliary spillway, unless the principal spillway is large enough to pass the peak discharge from the design hydrograph and the trash that comes to it without overtopping the dam. The minimum criteria for acceptable use of a closed pipe principal spillway without an auxiliary spillway consists of a pipe with a cross-sectional area of 3 square feet or more, an inlet that will not clog, and an elbow designed to facilitate the passage of trash.

When an auxiliary spillway will not be provided, design the principal spillway and any associated temporary storage for 50-year–24-hour runoff and provide at least 2.0 feet of freeboard. This requires approval of the state conservation engineer.

Design the minimum capacity of a natural or constructed auxiliary spillway to pass the peak flow expected from a total design storm of the frequency and duration shown in table 2, less any reduction creditable to the principal spillway discharge and detention storage.

Design the auxiliary spillway to safely pass the peak flow through the auxiliary spillway, or route the storm runoff through the reservoir. Start the routing either with the water surface at the elevation of the crest of the principal spillway or at the water surface after a 10-day drawdown, whichever is higher. Compute the 10-day drawdown from the crest of the auxiliary spillway or from the elevation attained from impounding the entire design storm, whichever is lower. Design the auxiliary spillway to pass the design flow at a safe velocity to a point downstream where the flow will not endanger the dam.

A constructed auxiliary spillway consists of an inlet channel, a control section, and an exit channel. Design the auxiliary spillway with a trapezoidal cross-section. Locate the auxiliary spillway in undisturbed earth or in-situ rock. Design stable side slopes for the material in which the spillway is to be constructed. Design a minimum bottom width of 10 feet for dams having an effective height of 20 feet or more.

Design a level inlet channel upstream from the control section a minimum distance of 30 feet. If necessary, curve the inlet channel upstream of the level section to fit existing topography. Design the exit channel grade according to 210-NEH-628, Chapter 50, “Earth Spillway Design,” or between 1 percent and 10 percent.

Design a straight exit channel that extends beyond the downstream toe of the dam with the full channel depth. If curvature of the exit channel is required for free outflow of the auxiliary spillway, design the tangent point of the curvature downstream of the downstream toe of the dam. Where necessary to prevent spillway discharge from damaging the main fill, construct a dike along the exit channel and maintain the full depth to a point beyond the downstream toe of the dam. Design the dike with a minimum top width of 10 feet, side slopes no steeper than 2.5:1, and sufficient height along the length of the dike to prevent spillway discharge from damaging the main fill. Maximum permissible velocities for auxiliary spillways can be found in Table 6. Additional design guidance may be found in Title 210-NEH-628-Ch 50, Earth Spillway Design.

**Table 6. Permissible velocities for vegetated spillways**

| Vegetation | Permissible Velocity (feet/second) | | | |
|---|---|---|---|---|
| | Erosion Resistant Soils[1] | | Easily Erodible Soils[2] | |
| | Slope of Exit Channel | | Slope of Exit Channel | |
| | 0-4.9% | 5.0-9.9% | 0-4.9% | 5.0-9.9% |
| Smooth Bromegrass | 8.75 | 7.5 | 6.25 | 5.0 |
| Tall Fescue | 8.75 | 7.5 | 6.25 | 5.0 |
| Sod-forming grass-legume mix | 6.25 | 5.0 | 5.0 | 3.75 |

[1]Erodibility will be determined by the texture of the soil horizon that is exposed after construction. Erosion resistant soil textures are loam, sandy loam, loamy sand, clay loam, sandy clay loam, and clay.

[2]Easily erodible soil textures are silt, silt loam, fine sandy loam, loamy find sand, silty clay loam, and silty clay.

**Structural auxiliary spillways**
Design chute spillways or drop spillways according to the principles set forth in 210-NEH, Part 650, “Engineering Field Handbook”; and 210-NEH, Section 5, “Hydraulics”; Section 11, “Drop Spillways”; and Section 14, “Chute Spillways.” Design a structural spillway with the minimum capacity required to pass the peak flow expected from a total design storm of the frequency and duration shown in Table 2, less any reduction creditable to the pipe discharge and detention storage. When the drainage area is greater than 900 acres or the vertical drop is greater than 10 feet, design a structural spillway with the minimum capacity required to pass the peak flow expected from a 100 year-24 hour total design storm.

## Additional Criteria for Excavated Ponds

**Site Selection**
Sufficient soil borings will be taken to determine if the soil is impervious enough to hold water for surface-fed ponds or to establish the presence of adequate groundwater for groundwater-fed ponds. If the soils are shallow and are underlain by gravel or sand the seepage rates may be excessive and another site should be selected.

**Capacity and Size Requirements**
Design the minimum storage volume of the pit for the average number of livestock expected during the design period when livestock water is a project purpose.

Design the bottom width 10 feet or more and the length 40 feet or more. The minimum bottom area shall be 500 square feet at the designed depth.

**Runoff**
Design a minimum of 1 foot of freeboard above the peak elevation of the design hydrograph. Design a pipe and auxiliary spillway that meets the capacity requirements of table 2. Consider runoff flow patterns when locating the excavated pond and placing the spoil.

**Side Slopes**
In the excavated area, design side slopes that are no steeper than one and one-half horizontal to one vertical (1.5:1) nor flatter than 3:1 except where livestock water directly from the pond. If livestock will water directly from the pond, provide a watering ramp at least 10 feet wide. Extend the ramp to the anticipated low water elevation at a slope no steeper than 5:1. See Iowa CPS Watering Facility (Code 614) for more details.

**Inlet Protection**
Protect the side slopes from erosion where surface water enters the pond in a natural or constructed channel.

**Excavated material**
Place the material excavated from the pond so that its weight does not endanger the stability of the pond side slopes and so that the soil will not wash back into the pond by rainfall. Dispose of excavated material in one of the following ways:

- Uniformly spread to a height that does not exceed 3 feet, with the top graded to a continuous slope away from the pond.
- Uniformly place and with side slopes assuming a natural angle of repose. Place excavated material at a distance equal to the depth of the pond, but not less than 12 feet from the edge of the pond.
- Shape to a designed form that blends visually with the landscape.
- Provide for low embankment construction and leveling of surrounding landscape.
- Haul material offsite.

## CONSIDERATIONS

**Visual Resource Design**
Carefully consider the visual design of ponds in areas of high public visibility and those associated with recreation. The shape and form of ponds, excavated material, and plantings are to relate visually to their surroundings and function.

Shape the embankment to blend with the natural topography. Shape the edge of the pond so it is generally curvilinear rather than rectangular. Shape excavated material so the final form is smooth, flowing, and fitted to the adjacent landscape rather than angular geometric mounds. If feasible, add islands to provide visual interest and attract wildlife.

**Fish and Wildlife**
Locate and construct ponds to minimize the impacts to existing fish and wildlife habitat.

When feasible, retain trees in the upper reaches of the pond and stumps in the pool area. Shape upper reaches of the pond to provide shallow areas and wetland habitat.

If operations include stocking fish, use NRCS CPS Fishpond Management (Code 399).

**Watering ramp**
When wildlife or livestock need access to stored water, use the criteria in NRCS CPS Watering Facility (Code 614) to design a watering ramp.

**Vegeation**
Stockpile topsoil for placement on disturbed areas to facilitate revegetation.

Consider selecting and placing vegetation to improve fish habitat, wildlife habitat, and species diversity.

**Water Quantity**
Consider effects on 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 the environment such as wetlands, aquifers, and social and economic impacts to downstream uses or users.
- It is generally recommended that the permanent pool volume not exceed the estimated annual runoff.

**Water Quality**

Consider the effects of—

- Erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances that runoff carries.
- Short-term and construction-related effects of this practice on the quality of downstream watercourses.
- Water level control on the temperature of downstream water to prevent undesired effects on aquatic and wildlife communities.
- Wetlands and water-related wildlife habitats.
- Water levels on soil nutrient processes such as plant nitrogen use or denitrification.
- Soil water level control on the salinity of soils, soil water, or downstream water.
- Earth moving potentially uncovering or redistributing toxic materials.
- Livestock grazing adjacent to the pond. Consider fencing to prevent livestock activities having direct contact with the pond and dam.

## PLANS AND SPECIFICATIONS

Prepare plans and specifications that describe the requirements for applying the practice according to this standard. As a minimum, include—

- A plan view of the layout of the pond and appurtenant features.
- Typical profiles and cross sections of the principal spillway, auxiliary spillway, dam, and appurtenant features, as needed.
- Structural drawings adequate to describe the construction requirements.
- Requirements for establishing vegetation or other ground surface protection, as needed.
- Safety features.
- Site-specific construction and material specifications.
- Utility location and notification requirements.

The following list of Construction Specifications is intended as a guide to selecting the appropriate specifications for each specific project. The list includes most, but may not contain all of the specifications that are needed for a specific project:

- IA-1 Site Preparation
- IA-3 Structure Removal
- IA-5 Pollution Control
- IA-6 Seeding and Mulching for Protective Cover
- IA-11 Removal of Water
- IA-21 Excavation
- IA-23 Earthfill
- IA-24 Drainfill
- IA-26 Salvaging and Spreading Topsoil
- IA-31 Concrete
- IA-45 Plastic (PVC, PE) Pipe
- IA-51 Corrugated Metal Pipe Conduits
- IA-52 Steel Pipe Conduits
- IA-61 Loose Rock Riprap
- IA-81 Metal Fabrication and Installation

- IA-83 Timber Fabrication and Installation
- IA-92 Fences
- IA-99 Cathodic Protection for Buried Metal Structures

## OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan for the operator.

As a minimum, include—

- Periodically inspect all structures, earthen embankments, spillways, and other significant appurtenances.
- Promptly repair or replace damaged components.
- Promptly remove trash from pipe inlet and trash rack.
- Promptly remove sediment when it reaches predetermined storage elevations.
- Periodically remove trees, brush, and undesirable species.
- Periodically inspect safety components and immediately repair if necessary.
- Maintain vegetative protection and immediately seeding bare areas, as needed.
- Prevent the establishment of woody vegetation on constructed embankment fill and around spillway appurtenances.

## REFERENCES

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