



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
- Recreation
- 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.

NRCS reviews and periodically updates conservation practice standards. To obtain the current version of this standard, contact your Natural Resources Conservation Service State office or visit the Field Office Technical Guide online by going to the NRCS website at <https://www.nrcs.usda.gov/> and type FOTG in the search field.

USDA is an equal opportunity provider, employer, and lender.

NRCS, WI
November 2024

- The product of the storage times the effective height of the dam is less than 3,000 acre-feet².
- The effective height of the dam is 35 feet or less.

This standard does not apply to ponds with the primary purpose of controlling solids loading and attached pollutants. Such ponds shall meet the criteria set forth in Wisconsin Department of Natural Resources (DNR) Standard for Wet Detention Basin (1001).

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.

A site assessment shall be conducted, documented, and incorporated into the design. The assessment shall be performed to determine physical site characteristics that will influence the placement, construction, maintenance, and environmental integrity of a proposed pond. The assessment shall include input from the owner/operator. The site assessment shall include:

1. *Locations and elevations of buildings, roads, lanes, soil test pits, property lines, setbacks, easements, springs, wells, floodplains, surface drains, drain tile, utilities, overhead lines, cultural resources, wetlands, and potential contamination sources.*
2. *Geological investigations. Use pits, borings, 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 the Unified Soil Classification System (ASTM D2487). Test pits or test holes shall be recorded to include:*
 - *The number and distribution needed to characterize the foundation or borrow areas.*
 - *The elevation of bedrock and bedrock type, if encountered, such as sandstone, limestone, dolomite, or granite.*
 - *Saturation indicators, if encountered, such as seepage from sand and gravel lenses, lens thickness, and elevation. Groundwater maps and well construction logs may be included when available and applicable.*
 - *Soil test results.*
3. *Locations and elevations of sinkholes and other karst features within 500 feet of the pond.*
4. *Locations, elevations, soil volumes, soil samples, and reclamation plans of any borrow areas.*
5. *Identification of potential impacts from failure of the embankments, liners, or structures. Document potential hazard classification.*
6. *An estimate or measurement of base flow, when present.*
7. *Identification of potential navigability, water quality, and wetlands that may require permits.*
8. *Community wells, existing or proposed private wells, ponds, or springs.*

The pond owner must have ownership or legal control of the pond site and impoundment including the right to flood all land in the impoundment up to the 1% flood event. Legal control is usually obtained through permanent easements recorded on the deed of the affected property.

A pond may not be constructed with a horizontal separation distance less than 25 feet to an existing or proposed private well, pond, or spring OR 400 feet of an existing or proposed community well. This distance is measured from the edge of the pond formed during the 1% flood event, unless the well is properly decommissioned in accordance with Wisconsin Administrative Code Chapter NR 812 and

Wisconsin NRCS Conservation Practice Standard (WI NRCS CPS), Well Decommissioning (Code 351).

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 National Engineering Manual (NEM) (Title 210), Part 503, "Safety." *Appropriate safety measures such as warning signs, rescue facilities, visual barriers, safety shelf, and other applicable features shall be incorporated as appropriate for the site.*

Construction operations shall be carried out in such a manner and sequence that erosion and water pollution will be minimized. Sources for acceptable construction site erosion/sediment control practices can be found in NRCS FOTG Section IV, NRCS Wisconsin Standard Detail Drawings for Conservation Practices, DNR Construction Site Erosion Control Best Management Practices (BMPs), and Chapter 10 of the Department of Transportation (DOT) Facility Development Manual.

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 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 NRCS CPS Mulching (Code 484) to install inorganic cover material such as gravel.

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.

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.

When seepage losses from the pond area are expected to compromise the intended use, the pond area shall be sealed. Applicable methods are included in NRCS CPS, Pond Sealing or Lining, Compacted Soil Treatment (Code 520), Pond Sealing or Lining, Geomembrane or Geosynthetic Clay Liner (Code 521), or Pond Sealing or Lining, Concrete (Code 522).

Additional Criteria for Embankment Ponds

The area under the footprint of the embankment shall be cleared of all sod, roots, vegetation, organic matter, and other undesirable materials.

Soils should be suitable for construction and water retention. Soils should not contain any hazardous or toxic substances.

Foundation cutoff

Design a cutoff of relatively impervious material under the dam and up the abutments as required for preventing seepage. 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 that accommodates equipment used for excavation, backfill, and compaction operations. Design cutoff side slopes no steeper than one horizontal to one 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 *diaphragms* 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 *or anti-seep collars as stated in the Filter Diaphragms and Anti-seep Collars section.*
- Reservoir bottom blanketing.
- A combination of these measures.

Top width

Table 1 provides the minimum top widths for dams of various total heights.

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.

Design Fill Height of Dam(feet)	Top Width(feet)
Less than 10	6
10–14.9	8
15–19.9	10
20–24.9	12
25 or greater	15

Side slopes

Design each side slope with a ratio of two horizontal to one vertical or flatter. Design the sum of the upstream and downstream side slopes with a ratio of five horizontal to one vertical or flatter. 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 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.

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.

A berm at least 6 feet wide shall be constructed across the embankment at normal pool elevation on the upstream side and extend to the abutments on all dams with a permanent pond area of more than 2 acres or when the pond has an exposure of more than 500 feet of fetch.

A semicircular berm at normal pool elevation extending not less than 5 feet from the edge of any pipe inlet shall be installed on all dams not covered by the preceding paragraph to protect the inlet from damage by ice or floating debris.

Freeboard

This criteria applies to boxes a, c, and e of Table 3. Evaluate the following criteria and select the freeboard condition that applies to the site. If multiple freeboard conditions apply to a site, use most restrictive criteria.

- 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.
- When the dam has more than 20-acre drainage area or more than 20 feet in effective height, design a minimum 2 feet of elevation difference between the crest of the auxiliary spillway and the top of the settled embankment.
- When the pond has no auxiliary spillway, design a minimum of 1 foot of freeboard above the peak elevation of the design hydrograph to the top of the settled embankment.

For ponds that meet the criteria in box b or d of Table 3, the freeboard shall be a minimum of 0.3 feet.

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 design fill 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 or pipe conduit through the embankment

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.

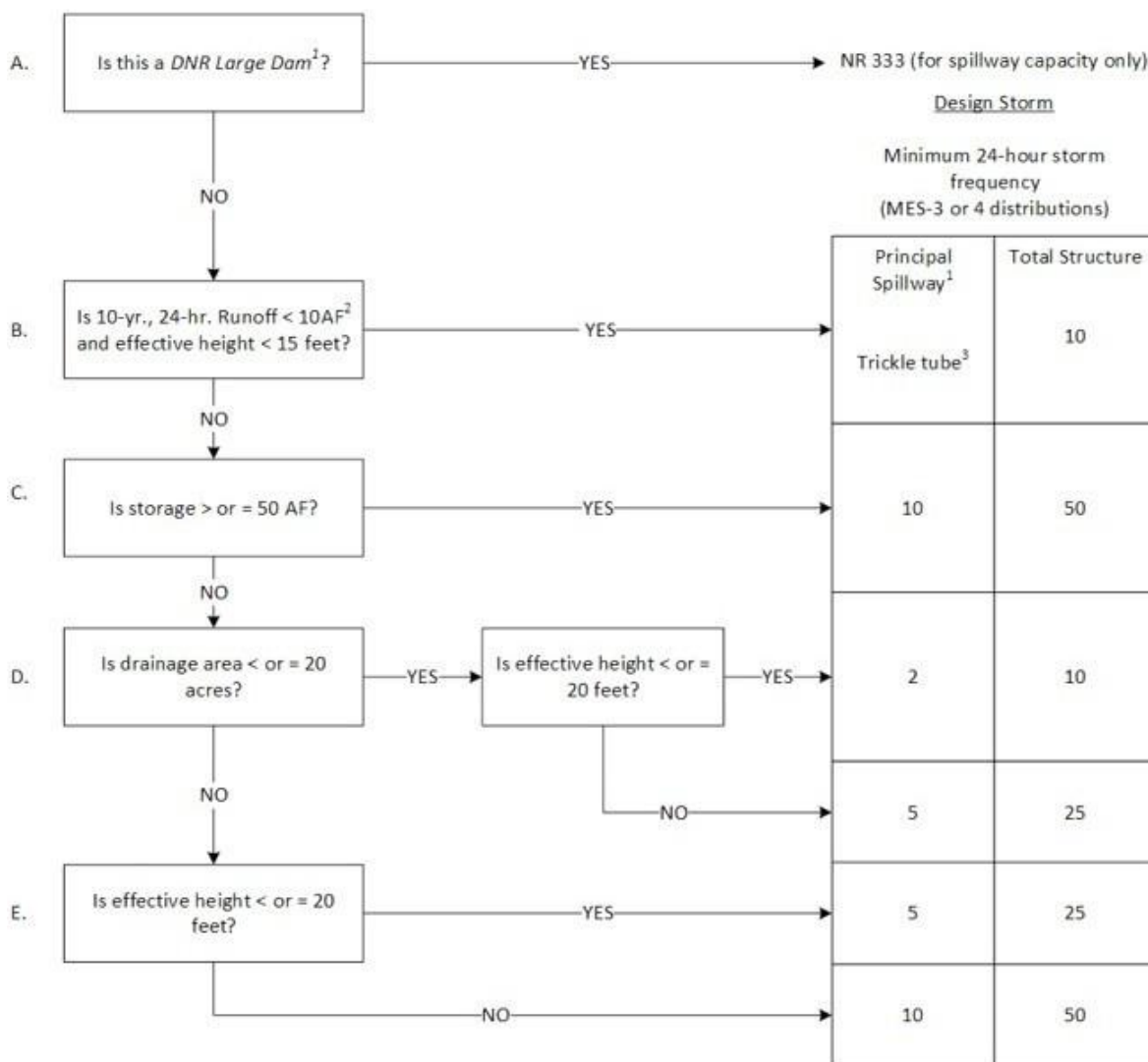
Design a minimum of 6-inches difference between the crest elevation of the auxiliary spillway and the crest elevation of the principal spillway when the dam has a drainage area of 20 acres or less. Design a minimum of 1 foot difference when the dam has a drainage area of over 20 acres.

Polyethylene or plastic in-line water level control structures, typically used in drainage water management, may be used for wetland restoration principal spillways when their manufactured depth is 6 feet or less.

For designs without a principal spillway but with a trickle tube, see Table 2 for the separation distance between the trickle tube invert elevation and the auxiliary spillway elevation, or the top of dam if there is no auxiliary spillway. An armored auxiliary spillway capable of handling the expected rate and duration of flow may be used in lieu of a trickle tube for designs without a principal spillway.

Table 2 Trickle Tube Separation

<i>Effective Height (feet)</i>	<i>Separation Distance (feet)</i>
≥ 10	2
6-9.9	1.5
≤ 5.9	1

Table 3. Minimum Spillway Capacity

¹ Consideration should be given to increasing principal spillway design storm frequency to reduce the frequency of the auxiliary spillway's use.

² AF = acre-feet

³ Trickle tube or other type of principal spillway required. If another type of principal spillway is used, it shall meet the separation distances required for a trickle tube. If a trickle tube is used, it shall be a 4-inch diameter minimum conduit, or the size required to pass 2 times the base flow. Trickle tube material shall meet the requirements of WI NRCS CPS, Underground Outlet (Code 620).

The minimum capacity of the principal spillway shall be that required to pass the peak discharge from the design storms (Table 3) less any reduction creditable to detention storage between the crest of the principal spillway and the crest of the auxiliary spillway. Flood-routing methods are in NRCS NEH Part 650, EFH Chapter 11, NRCS NEH Part 630, Hydrology, and in NRCS Technical Releases 20 (TR-20) or 55 (TR-55).

When design discharge of the principal spillway is considered in calculating peak outflow through the auxiliary spillway, the crest elevation of the inlet shall be such that the full flow will be generated in the conduit before there is discharge through the auxiliary spillway. The inlets and outlets shall be designed to function satisfactorily for the full range of flow and hydraulic head anticipated.

Provide an anti-vortex device to ensure 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. Design a principal spillway pipe with a minimum inside diameter of 4 inches.

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.

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 National Engineering Handbook (NEH) (Title 210), Part 636, Chapter 52, "Structural Design of Flexible Conduits." *Flexible pipe strength shall not be less than that necessary to support the design load with a maximum of 5 percent deflection. The modulus of elasticity for plastic pipe shall be assumed as one-third of the amount designated by the compound cell classification to account for long-term reduction in modulus of elasticity values for the pipe. The minimum thickness of flexible pipe shall be SDR 26, Schedule 40, Class 100, or 16 gage as appropriate for the particular pipe material.*

Hood and canopy inlets shall have a minimum vertical distance between the invert of the inlet and the crest of the auxiliary spillway of 1.8 times the diameter of the pipe. The minimum size for box drop inlets in combination with hood inlets shall be two times the diameter of the pipe in both directions if square, or two times the diameter if circular. The minimum depth of the box will be 1.25 times the diameter of the pipe. An anti-vortex device shall be attached.

The minimum diameter of a riser pipe shall be at least 1.25 times the diameter of the conduit.

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.

Materials

The maximum height of fill over corrugated steel or corrugated aluminum pipe must not exceed 25 feet. Refer to Table 5 for minimum gauge of metal pipes.

Annular corrugated metal pipe (CMP) shall be caulk-seamed and close-riveted.

The maximum height of fill over plastic pipe must not exceed 20 feet. Refer to Table 4 for minimum dimension ratio or schedule for PVC pipe and Table 6 for HDPE (ASTM D3350) pipe.

A structural analysis shall be performed to determine the strength requirements of pre-cast concrete pipe. Concrete pipe shall be installed with concrete bedding. A concrete cradle shall be designed to support exposed pipe cantilevered over a support pier.

Outlets

The outlet section of all CMP conduits flowing under pressure and over 10 inches in diameter shall have a minimum length of 20 feet. The minimum length of the outlet section of PVC pipe shall be 10 feet for pipe that has cemented couplings and 20 feet for gasket-type couplings. The slope of the outlet section of pipe conduits over 16 inches in diameter shall not exceed 5 percent.

*Cantilever outlet sections, if used, shall be designed to withstand the cantilever load. Pipe supports shall be provided when needed. Other suitable devices such as a Saint Anthony Falls stilling basin or an impact basin may be used to provide a safe outlet, see NRCS Technical Release 54 (TR-54), *Structural Design of Saint Anthony Falls Stilling Basins*.*

For non-plastic cantilever outlets, pipe supports shall be provided for all conduits 18 inches in diameter or larger. Pipe supports for smaller diameters will be provided if required to prevent pipe buckling or maintain pipe joints. The outlet end of pipe conduits shall extend a minimum distance of 5 feet downstream from the point where the flow line of the downstream channel and the back slope of the embankment intersect or from the pipe support if used. This distance shall be increased to 8 feet for outlet pipes larger than 18 inches in diameter.

For plastic cantilever outlets, the conduits shall extend a minimum of 5 feet downstream from the point where the flow line of the downstream channel and the back slope of the embankment intersect. Install a pipe support at a maximum distance of 3 feet from the end of the pipe. The pipe support may be constructed by using an earth fill or gravel-fill pad, timber or timber-metal support pier, or CMP to encase the plastic conduit.

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 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 and anti-seep collars

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.

To improve filter diaphragm performance, provide a drain outlet for the filter diaphragm at the downstream toe of the embankment, *refer to standard drawing WI-248. Refer to NEH Part 650, EFH Chapter 4, Fig 4-43 for additional embankment drain configurations.* Protect the outlet from surface erosion and animal intrusion.

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 dam effective height is 15 feet or greater, anti-seep collars shall meet the following soil and site conditions:

- 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.

If the pipe is installed in a trench, excavate the side slopes flatter than 1 horizontal to 1 vertical.

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

Trash guard

Install a trash guard at the riser or 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. *(This criteria applies to Table 3 boxes a, c, and e) (A conduit with a minimum diameter of 4 inches is required for Table 3 boxes b and d without*

an auxiliary spillway).

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 3, less any reduction creditable to the principal spillway discharge and detention storage.

Design the auxiliary spillway to safely pass the peak flow 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 for the distance needed to protect and maintain the crest elevation of the spillway. 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 with equivalent procedures. The exit channel shall be straight until at least as far as the downstream toe of the embankment.

Natural auxiliary spillways may be used wherever there is a good vegetative cover in the spillway area and the topography is suitable. Natural or earth spillways must be designed by using the procedure described in NRCS NEH Part 650, EFH Chapter 11.

If an access road crosses the auxiliary spillway, the downstream edge of the road shall be located upstream of the level section but need not be greater than 30 feet upstream of the control section.

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 3, less any reduction creditable to the pipe discharge and detention storage.

Additional Criteria for Excavated Ponds 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 3. Consider runoff flow patterns when locating the excavated pond and placing the spoil.

Side Slopes

Design stable side slopes in the excavated area. The maximum slope for various soil materials shall be as follows:

- *Sand: 3 horizontal to 1 vertical*
- *Peat: 1 horizontal to 1 vertical*
- *Muck and other: 2 horizontal to 1 vertical*

Wildlife ponds shall have at least 50 percent of the side slopes 5 horizontal to 1 vertical, or flatter and have at least 40 percent of the perimeter less than 5 feet deep.

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 or shape reasonably well, 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.

Table 4. Acceptable PVC Pipe for Use in Earth Dams

<i>Normal Pipe Size (in.)</i>	<i>Dimension Ratio (DR), Schedule or Standard Dimension Ratio (SDR)¹</i>	<i>Maximum Height of Fill Over Pipe (ft.)²</i>
<i>4 or smaller</i>	<i>SDR 26, C900 DR25</i>	<i>15</i>
<i>4 or smaller</i>	<i>Sch 40, 80 or SDR 17, 21, C900 DR18</i>	<i>20</i>
<i>6 or 8</i>	<i>Sch 40 or SDR 21, 26, C900 DR25</i>	<i>14</i>
<i>6 or 8</i>	<i>Sch 80 or SDR 17, C900 DR18</i>	<i>20</i>
<i>10, 12, or 16</i>	<i>Sch 40</i>	<i>12</i>
<i>10, 12, or 16</i>	<i>SDR 21, 26, C900 DR25</i>	<i>15</i>
<i>10, 12, or 16</i>	<i>Sch 80 or SDR 17, C900 DR25</i>	<i>20</i>
¹ Polyvinyl chloride pipe, PVC 1120 or PVC 1220, conforming to ASTM D 1785 or ASTM D 2241. Or PVC conforming to AWWA C900.		
² Unit weight of soil = 120 lb/ft ³ and wheel loading = 16,000 lbs (H20)		

Table 5 Minimum Gages¹ for Corrugated Metal Pipe

Fill Height (ft)	Minimum Gage for Steel Pipe (2-2/3 in. x 1/2 in. corrugations) ² with Diameter (in.) of:						Minimum Gage for Steel Pipe (3 in. x 1 in. corrugations) ² With Diameter (in.) of:						Minimum Thickness (in.) of Aluminum Pipe ³ (2-2/3 in. x 1/2 in. corrugations) ² With Diameter (in.) of:			
	≤ 21	24	30	36	42	48	36	42	48	54	60	66	≤ 21	24	30	36
1-15	16	16	16	14	12	10	16	16	16	16	16	16	.06	.06	.075	.075
15-20	16	16	16	14	12	10	16	16	16	16	14	14	.06	.075	.105	.105
20-25	16	14	12	10	8	— ⁴	16	16	14	12	10	8	.06	.105	.135	— ⁴

¹16-gage pipe - thickness of 0.064 inch

¹14-gage pipe - thickness of 0.079 inch

¹12-gage pipe - thickness of 0.109 inch

¹10-gage pipe - thickness of 0.138 inch

²Pipes with diameters of 6, 8, and 10 in. have 1 1/2 in. x 1/4 in. corrugations

³Riveted or helical fabrication

⁴Not permitted

Table 6 Acceptable HDPE Pipe for Use in Earth Dams¹

Pipe Values	Fill Over the Top of Pipe ² (feet)
SDR 21-32.5	10
SR 17	11.5

¹High density polyethylene pipe, ASTM-D3350 flexural modulus cell class 4 or greater, conforming to ASTM F714. These materials will typically have standard dimension ration (SDR) values ranging from 32.5 to 21 or pipe stiffness (PS) values ranging from 34 to 100 psi respectively.

²The 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.

Specific Use-based Criteria

1. Fish and Wildlife

Management potential of cold and warm water fishponds vary widely according to available water quality and quantity and land resource area. Similarly, various design features including size, depth, side slopes, spacing, and site selection affect the management potential of wildlife ponds. Minimum surface area of the pond varies from 0.1 to 1.0 acre, depending on the design purpose. Additional planning and design criteria are contained in WI NRCS CPS, Fishpond Management (Code 399), Wildlife Wetland Habitat Management (Code 644), and Wetland Restoration (Code 657).

2. *Crop and Orchard Spraying*

If the pond will be used as a water supply for field or orchard spraying the following minimum amounts of water will be needed per application:

- *100 gal/acre for field spraying*
- *1000 gal/acre for orchard spraying*

3. *Recreation*

If the pond will be used for recreation, basic criteria can be found in Corps of Engineers Engineering Manual 1110-1-400 and DNR Design Standards Handbook, Chapter 20 (Swimming Beaches).

4. *Fire Control*

If the pond will be used as a water supply for fire control, basic criteria can be found in the National Fire Protection Association (NFPA) Standard 1142. Some factors that can affect the suitability of a site can include: distance to structures to be protected; accessibility for fire control equipment to the water, such as ingress and egress to the pond, adequate surfacing of the loading site, location of the pump within 20 feet of the static elevation of the anticipated drought water level, and compatibility of dry hydrant requirements; drought conditions; and dependability of water supply. Contact the local Fire Chief to clarify local design requirements.

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.

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.

Vegetation

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.

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—

- *Location map*
- *Site plan view with existing contours, dam layout, dimensions, and appurtenant features*
- *Benchmark descriptions and elevations*
- *Typical profiles and cross sections along centerline of dam, principal spillway (or maximum cross section if no principal spillway), auxiliary spillway, and appurtenant features*
- *Soil boring symbol logs*
- *Elevations of inlet and outlet of conduit and other appurtenant features*
- *Structural drawings adequate to describe the construction requirements*
- *Site-specific construction and material requirements*
- *Construction site pollution control measures*
- *Reclamation plans of any borrow areas.*
- *Requirements for vegetative establishment and/or mulching, as needed*
- *Safety features*

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

American Society for Testing and Materials, Standard Guide to Site Characterization for Engineering, Design, and Construction Purposes, ASTM Standard D 420.

American Society for Testing and Materials. ASTM D2487-17e1, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System). West Conshohocken, PA. DOI: 10.1520/D2487-17E01

USDA NRCS. 2019. Engineering Technical Releases, TR-210-60, Earth Dams and Reservoirs. Washington, D.C. <https://directives.sc.egov.usda.gov/>

USDA NRCS. 2008. National Engineering Handbook (Title 210), Part 628, Dams. Washington, D.C. <https://directives.sc.egov.usda.gov/>

USDA NRCS. 2017. National Engineering Handbook (Title 210), Part 633, Soil Engineering. Washington, D.C. <https://directives.sc.egov.usda.gov/>

USDA NRCS. 2008. National Engineering Handbook (Title 210), Part 636, Structural Engineering. Washington, D.C. <https://directives.sc.egov.usda.gov/>

USDA NRCS. 2012. National Engineering Handbook (Title 210), Part 650, Engineering Field Handbook. Washington, D.C. <https://directives.sc.egov.usda.gov/>

USDA NRCS. 2017. National Engineering Manual (Title 210). Washington, D.C. <https://directives.sc.egov.usda.gov/>

National Fire Protection Association, Water Supplies for Suburban and Rural Fire Fighting, Standard 1142.378-15 NRCS, WI 7/11

United States Department of Agriculture – Natural Resources Conservation Service, Agriculture Handbook Number 590 (Ponds – Planning, Design, Construction).

Wisconsin NRCS Home Page www.wi.nrcs.usda.gov

United States Department of Agriculture – Natural Resources Conservation Service, Wisconsin Standard Detail Drawings For Conservation Practices.

Wisconsin Department of Natural Resources, A Guide to Planning and Installing Dry Fire Hydrants.

Wisconsin Department of Natural Resources, Wisconsin Construction Site Best Management Practice Handbook, Publication WR-222 92 Rev, 1992.

Wisconsin Department of Transportation, Facilities Development Manual, Chapter 10 (Erosion Control and Storm Water Quality), 1997.

DEFINITIONS

1% flood event. A flood determined to be representative of large floods, which in any given year has a 1% chance of occurring or being exceeded. The 1% flood is based on a statistical analysis of lake level or streamflow records available for the watershed or an analysis of rainfall and runoff characteristics in the watershed, or both. This is commonly referred to as the 100-year event or regional flood.

Allowance for settlement. The product of the design fill height and the settlement factor. See Figure 1.

Auxiliary spillway. The auxiliary spillway is the spillway designed to convey excess water through, over, or around a dam. This has been commonly referred to as an “emergency spillway”.

Bedrock. The solid or consolidated rock formation typically underlying loose surficial material such as soil, alluvium or glacial drift. Bedrock includes but is not limited to limestone, dolomite, sandstone, shale and igneous and metamorphic rock.

Constructed Elevation. The sum of the design elevation and the allowance for settlement. See Figure 1.

Control section. The control section of an open channel spillway where accelerated flow passes through critical depth.

Design elevation. Design elevation is the required top elevation of the embankment along the centerline before allowance for settlement has been added. See Figure 1.

Design Fill Height. (Table 1) The difference in elevation between the design elevation and foundation elevation after stripping along the centerline of embankment. See Figure 1.

DNR Large Dam (Table 3). Any dam with a structural height of more than 6 feet and impounds 50 acre- feet or more of water at the design elevation or has a structural height of 25 feet or more and impounds more than 15 acre-feet of water at the design elevation. See Figure 1. Structures meeting this definition must be designed in accordance with the standards of Wisconsin Administrative Code NR 333.

Earth spillway. An earth spillway is an open channel spillway in earth materials without vegetation.

Effective height. 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 prior to stripping. If there is no open channel auxiliary spillway, the design elevation for the top of the dam is the upper limit. See Figure 1.

Exit channel. The exit channel of an open channel spillway is the portion downstream from the control section which conducts the flow to a point where it may be released without jeopardizing the dam.

Fetch. The longest distance that wind can blow across a body of water to the embankment.

Freeboard. Freeboard is the additional depth or elevation required above computed design requirements.

High hazard potential. Dams assigned the high hazard potential classification are those where failure or mis-operation will probably cause loss of human life.

Inlet channel. The inlet channel of an open channel spillway is the portion upstream from the control section.

Karst. Refers to areas of land underlain by carbonate bedrock (limestone or dolomite). Typical land features in karst areas include sinkholes, disappearing streams, closed depressions, blind valleys, caves, and springs.

Low hazard potential. Dams assigned the low hazard potential classification are those where failure or mis-operation results in no probable loss of human life and low economic and/or environmental losses. Losses are primarily limited to the owner's property.

Principal spillway. (Table 3) The principal spillway is the lowest ungated spillway designed to convey water from the reservoir (pond) at predetermined release rates.

Significant hazard potential. Dams assigned the significant hazard potential classification are those dams where failure or mis-operation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

Sinkholes. Closed, usually circular, depressions that form in karst areas. Sinkholes are formed by the downward migration of unconsolidated deposits into solutionally enlarged openings in the top of bedrock.

Spillway (Auxiliary Spillway) (Table 3). A spillway is an open or closed channel, conduit, or drop structure used to convey water from a reservoir. It may contain gates, either manually or automatically controlled, to regulate the discharge of water.

Storage. 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.

Structural height (DNR Large Dam). The difference in the elevation between the design elevation and the lowest elevation of the natural stream or lake bed at the downstream toe of the embankment. See Figure 1.

Trickle tube. (Table 3) A trickle tube is a minimum 4-inch diameter conduit intended to draw down the pool to a level below the auxiliary spillway. The Trickle tube discharge is not credited in the design, nor is it considered the principal spillway.

Vegetated spillway. A vegetated spillway is a vegetated open channel spillway in earth materials.

Figure 1

