



Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

POND

CODE 378

(no)

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.

PURPOSE

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

- Store water for livestock
- Store water for fish and wildlife
- Store water for recreation
- Store water for fire control
- Store water for erosion control
- Store water for 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 of the criteria for low-hazard 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.
- 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 Purposes

Plan, design, and construct this practice to comply with all Federal, State, and local regulations. The owner and/or operator is responsible for securing required permits. Permitting authorities should be contacted during the planning phase of the project. This standard does not contain the text of the federal, tribal, state or local laws.

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, trenches, 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:
 - a. The number and distribution needed to characterize the subsurface.
 - b. The elevation of bedrock and bedrock type, if encountered, such as sandstone, limestone, dolomite, or granite.
 - c. 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.
 - d. Soil test results.
3. Locations and elevations of sinkholes and other karst features within 500 feet of the pond.
4. Locations and 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 hazard potential classification.
6. An estimate or measurement of the base flow rate, when present.
7. Identification of potential navigability, water quality and wetland issues 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 in accordance with requirements of NRCS National Engineering Manual (NEM), 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 WI NRCS 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 WI 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 archaeological, 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 (1) a natural or constructed auxiliary spillway, (2) a combination of a principal spillway and an auxiliary spillway, or (3) a principal spillway.

Select a site that has an adequate supply of water for the intended purpose via surface runoff, groundwater, 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. Acceptable methods are included in WI 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).

Criteria Applicable to 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 adequate to accommodate the 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 (1) foundation cutoff does not intercept pervious layers, (2) seepage could create undesired wet areas, (3) embankment stability requires seepage control, or (4) special problems require drainage for a stable dam. Control seepage by foundation, abutment, or embankment filters and drains; (2) reservoir blanketing; or (3) 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 dams used as public roads. 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 dams

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
25-34.9	14
35 or more	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.

Slope Protection

Design special measures such as berms, rock riprap, sand-gravel, soil cement, or 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. Design a minimum of 1.0 feet of freeboard between design high-water-flow elevation in the auxiliary spillway and the top of the settled embankment. Design a minimum 2.0 feet of elevation difference between the crest of the auxiliary spillway and the top of the settled embankment when the dam has 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.

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 of 5 percent of the design fill height of the dam associated with each dam cross section, except where detailed soil testing and laboratory analyses or experience in the area shows that a lesser amount is adequate.

Principal Spillway and Pipe Conduit through the Embankment

Design a pipe conduit with needed appurtenances 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 base flow.

Design a minimum of 0.5-foot 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 1.0-foot difference when the dam has a drainage area of over 20 acres.

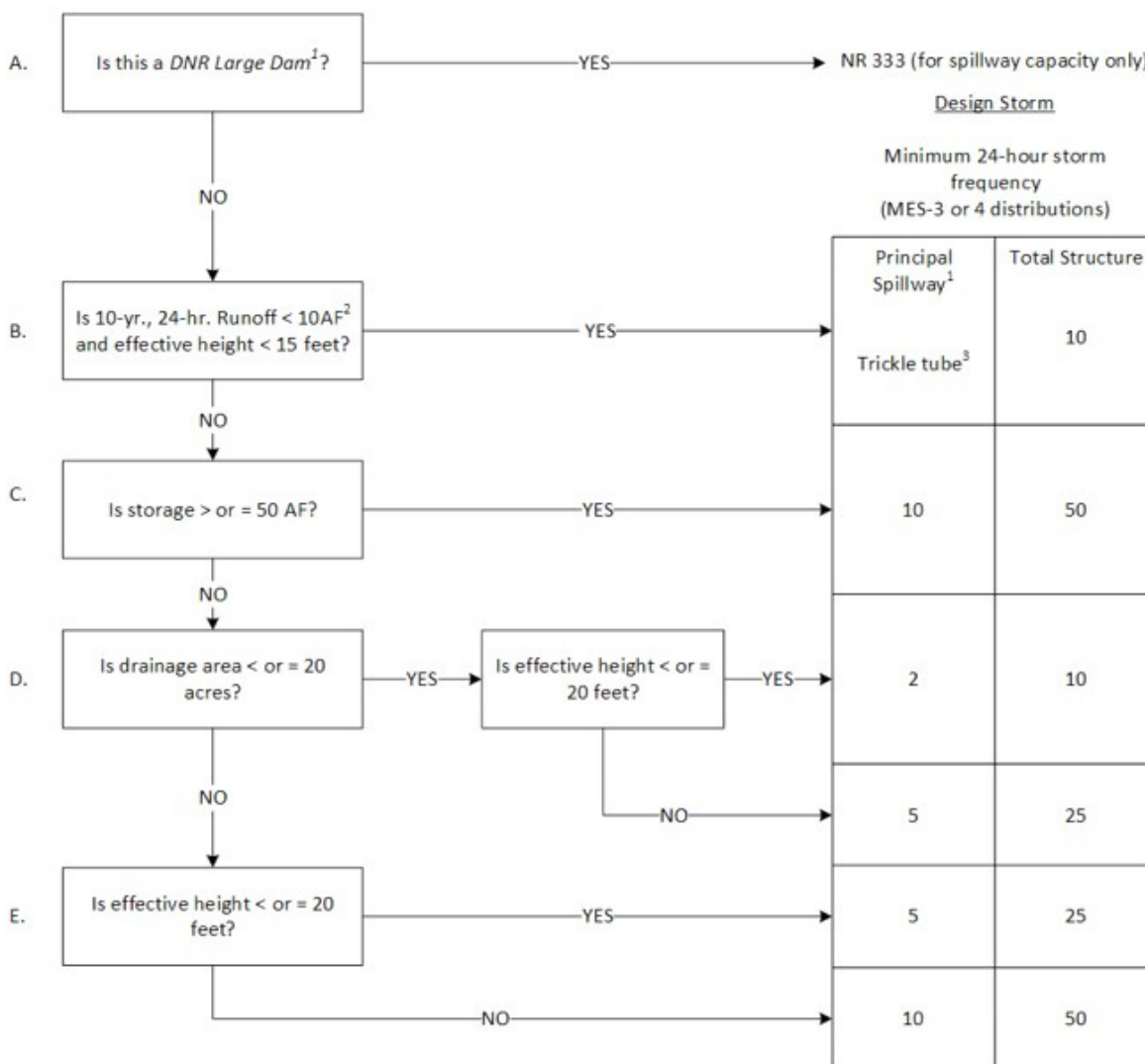
Polyethylene or plastic in-line water level control structures, typically used in drainage water management, may be used for wetland restoration principal spillways when their manufactured depth 6 feet or less.

Table 2. Trickle Tube Separation

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

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 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.

Design adequate pipe conduit 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 conduits to withstand all external and internal loads 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. 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 pipe conduits 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.

Provide an anti-vortex device for a pipe conduit designed for pressure flow. Design the inlet and outlet to function for the full range of flow and hydraulic head anticipated.

Design a concrete cradle or bedding for pipe conduits if needed to reduce or limit structural loading on 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

For dams 20 feet or less in effective height, acceptable pipe materials are corrugated steel or aluminum, pre-cast simple or reinforced concrete, Polyvinyl Chloride (PVC), High Density Polyethylene (HDPE) ASTM D3350, and cast-in-place reinforced concrete.

For dams more than 20 feet in effective height, conduits shall be corrugated steel or aluminum, pre-cast reinforced concrete, PVC, or cast-in-place reinforced concrete.

Concrete pipe shall be laid in a concrete bedding or have a concrete cradle, if required. A detailed structural analysis is required if concrete pipe is used.

All annular corrugated metal pipe (CMP) shall be caulk seamed and close riveted.

The inlets and outlets shall be structurally sound and made of materials compatible with those of the pipe.

The maximum height of fill over any principal spillway corrugated steel or corrugated aluminum pipe must not exceed 25 feet.

Specifications in Tables 4 and 5 are to be followed for PVC, corrugated steel, and corrugated aluminum pipe. Specifications in Table 6 are to be followed for HDPE pipe.

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 12 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 for stability. 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 cantilever outlets of plastic conduits, the outlet end of plastic 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. A pipe support located a maximum of 3 feet from the end of the pipe shall be provided. The pipe support may be constructed by using an earthfill or gravel-fill pad, wood, wood-metal combinations, 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.

Filter diaphragms

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. Design filter diaphragms or alternative measures (Anti-seep collars) as needed to control seepage on pipes extending through all other embankments.

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.

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.

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 shall meet the requirements of NEH Part 628, Chapter 45, Filter Diaphragms, Section 628.4503(d), Filter and Drain Gradation.

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.

When using anti-seep collars, 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 conduit, unless the watershed does not contain trash or debris that could clog the conduit.

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 conduit 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 routed design hydrograph and the trash that comes to it without overtopping the dam. The minimum criteria for acceptable use of a closed conduit principal spillway without an auxiliary spillway consist of a conduit with a cross-sectional area of 3 feet² 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 conduit 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 10 days 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 or compacted earth or in-situ rock. Design for 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. The minimum length of the level section shall be 20 feet. If necessary, curve the inlet channel upstream of the level section to fit existing topography. Design the exit channel grade in accordance with NEH Part 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

When used for principal spillways or auxiliary spillways, design chute spillways or drop spillways according to the principles set forth in NEH, Part 650, Engineering Field Handbook; and 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 conduit discharge and detention storage.

Criteria for Excavated Ponds

Runoff

Design a minimum of 1.0 feet of freeboard above the peak elevation of the routed design hydrograph. Design a pipe and auxiliary spillway that will meet 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.

Watering Ramp

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

Inlet Protection

Protect the side slopes from erosion where surface water enters the pond in a natural or excavated 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 off-site.

Table 4. Acceptable PVC Pipe For Use in Earth Dams

Normal Pipe Size (in.)	Schedule or Standard Dimension Ratio (SDR)	Maximum Depth of Fill Over Pipe (ft.)
4 or smaller	SDR 26	15
4 or smaller	Sch 40, 80 or SDR 17, 21	20
6 or 8	Sch 40 or SDR 21, 26	14
6 or 8	Sch 80 or SDR 17	20
10, 12 or 16	Sch 40	12
10, 12 or 16	SDR 21, 26	15
10, 12 or 16	Sch 80 or SDR 17	20

¹Polyvinyl chloride pipe, PVC 1120 or PVC 1220, conforming to ASTM D 1785 or ASTM D 2241.

²Unit weight of soil = 120 lb/ft³ 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	0.06	0.06	0.075	0.075
15-20	16	16	16	14	12	10	16	16	16	16	14	14	0.06	0.075	0.105	0.105
20-25	16	14	12	10	8	<u>4</u>	16	16	14	12	10	8	0.06	0.105	0.135	<u>4</u>

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	Maximum Height of 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

General 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 to their function.

Shape the embankment to blend with the natural topography. Shape the edge of the pond so that it is generally curvilinear rather than rectangular. Shape excavated material so that the final form is smooth, flowing, and fitting 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 structures such as 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 WI NRCS CPS, Fishpond Management (Code 399).

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 upon components of the water budget, especially:

- Effects on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and groundwater 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.

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 temperatures 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.
- Potential for earth moving to uncover or redistribute toxic materials.
- Livestock grazing adjacent to the pond. Consider fencing to keep livestock activities out of 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. This should include the following items:

- 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 the following items in the operation and maintenance plan:

- Periodic inspections of all structures, earthen embankments, spillways, and other significant appurtenance

- Prompt repair or replacement of damaged components
- Prompt removal of sediment when it reaches predetermined storage elevations
- Periodic removal of trees, brush, and undesirable species
- Periodic inspection of safety components and immediate repair if necessary
- Maintenance of vegetative protection and immediate seeding of bare areas as needed

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. 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.

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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).

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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). 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

