United States Department of Agriculture

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 lowest settled top of the dam if there is no auxiliary spillway. The **effective height** of the dam is the difference in elevation, in feet, between the lowest auxiliary spillway crest and the lowest point in the original cross section taken on the centerline of the dam. If there is no auxiliary spillway, use the lowest point on the settled top of the dam instead of the lowest open channel auxiliary spillway crest.
- The effective height of the dam is 35 feet or less.

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.
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CRITERIA

General Criteria Applicable to All Ponds

Plan, design, and construct the pond to comply with all Federal, State, and local laws and regulations.

Utilities

Notify landowners and/or contractor of their responsibility to locate all buried utilities in the project area, including drainage tile and other structural measures.

Permitting

The landowner is required to obtain all necessary permits for project installation prior to construction. All conditions listed within the permits shall be followed during the installation of the practice.

This conservation practice is not exempt from receiving coverage under TDEC's (Tennessee Department of Environment and Conservation) ARAP permits. When this NRCS conservation practice is planned in a location that will place fill material in wetlands, impound flow, or directly impact jurisdictional streams and wetlands when installed (e.g. outletting into a stream), it will require an ARAP permit. All pond conservation practices located within the Tennessee River drainage area in what the Tennessee Valley Authority (TVA) describes in 18 CFR Part 1304 as "upstream tributaries" and located within the stream or the 100-year floodplain of a perennial stream must go through the TVA 26a permit process. All conservation practices that are structural or form a barrier (e.g., fence) that are located within streams or reservoirs listed in Tables 1 and 2 in 18 CFR, Part 1304 or the listed stream or reservoir's 500-year flood plain require a TVA permit. The TVA 26a rules do not change the permitting requirements for the U.S. Army Corps of Engineers permits (404), the Tennessee Department of Environment and Conservation permits (ARAP), or any permits that may be required by local units of government.

In accordance with the Tennessee Safe Dams Act of 1973, the Safe Dams Program within the TDEC Division of Water Resources is responsible for issuing permits to dam owners for operation, alteration, and construction of dams and requiring compliance with regulations. Under the Safe Dams Act, a dam is defined as any structure that is at least 20 feet high (measured from the lowest settled top of dam elevation to the natural bed of the stream or watercourse at the downstream toe of the dam) or that has an impoundment volume of at least 30 acre-feet (measured at the lowest settled top of dam elevation). However, any barrier that is less than 6 feet in height (measured from the lowest settled top of dam elevation to the natural bed of the stream or watercourse at the downstream toe of the dam) or that has a maximum impoundment volume of 15 acre-feet or less (measured at the lowest settled top of dam elevation), shall not be considered a dam.

Certain classes of dams are exempt from regulation under the Safe Dams Act. The main exemption is for "farm ponds". Farm ponds are defined in the regulations as "... any impoundment used only for providing water for agriculture and domestic purposes such as livestock and poultry watering, irrigation of crops, recreation, and conservation, for the owner or occupant of the farm, their family, and invited guests, but does not include any impoundment for which the water, or privileges or products of the water, are available to the general public." A farm pond is exempt if, in the judgment of the Safe Dams Program, such a barrier creates an impoundment used only as a farm pond. A farm pond is exempt from the Safe Dams Act but may not be exempt from other permitting requirements such as ARAP.

NRCS Inventory Dams

Some dams have greater significance than others because of their potential to affect public safety. Because of this and the need to manage an overall NRCS program for dam safety, each State Conservation Engineer (SCE) must maintain a state inventory of NRCS inventory dams. NRCS inventory dams are defined in NRCS NEM (Title 210), Part 520, "Soil and Water Resource Development," Subpart C, "Dams." Report all NRCS inventory dams to the SCE.

Safety

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."

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. 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.

Vegetation
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) and NRCS CPS Mulching (Code 484). 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.

Livestock Access
Protect the shoreline, embankment, and spillways from livestock by using a fence to exclude access to the pond. The fence must meet the criteria in NRCS CPS Fence (Code 382). Controlled grazing within the fenced pond area is allowed. When wildlife or livestock need access to a fenced pond for use as a watering facility, use the criteria in NRCS CPS Watering Facility (Code 614) to design a watering ramp.

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, reservoir, 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 or geology 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 foundation cutoff of relatively impervious material under the dam and up the abutments as needed for reducing seepage and internal erosion. Locate the foundation cutoff at, or upstream from, the centerline of the dam. For zoned embankments, the foundation cutoff must also be located within the footprint of the core fill. Extend the foundation cutoff deep enough to intercept seepage and/or to connect with a relatively impervious layer. Combine seepage control with the foundation cutoff as needed. Use a foundation cutoff bottom width adequate to accommodate the equipment used for excavation, backfill, and compaction operations. Design foundation cutoff side slopes no steeper than one horizontal to one vertical. The foundation cutoff shall extend to an elevation below the constructed pond bottom.

Seepage control
Include seepage control as needed if—

- Foundation cutoff does not adequately intercept seepage or connect with relatively impervious layers.
- Seepage could create undesired wet areas on the backslope of the dam or swamping downstream.
- 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 lowest settled top of the dam elevation and the lowest elevation at the downstream toe. The lowest elevation at the downstream toe is often located at the natural bed of the stream or watercourse or at the bottom of the constructed outlet channel.

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. The minimum top width for private or farm roads is 15 feet. 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[1] (feet)	Top Width (feet)
Less than 10	8
10–14.9	10
15–19.9	11
20–24.9	12
25–35	15

[1]. Round up to nearest tenth of a foot.

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 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.

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.

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 when the dam has more than 20 acre drainage area and/or more than 20 feet in effective height.
- Design a minimum of 1 foot of freeboard above the peak elevation of the design hydrograph to the top of the settled embankment 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 analysis or experience in the area shows that a lesser amount is adequate.

Principal spillways

A principal spillway is a closed pipe or closed conduit with needed appurtenances used to safely convey water downstream of the dam. A principal spillway must safely handle the rate and duration of the design flow.

- Design a minimum of 0.5 feet 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 between the crest of the auxiliary spillway and the crest of the principal spillway when the dam has a drainage area of over 20 acres.
- For pressure flow principal spillways: When the principal spillway design discharge is considered in calculating peak outflow through the auxiliary spillway, full pipe flow shall be generated in the principal spillway 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.
- Capacity: Design adequate principal spillway capacity to discharge long-duration, continuous, or frequent flows. Design the minimum capacity of the principal spillway to pass the peak flow expected from the principal spillway design storm shown in Table 2, less any reduction creditable to detention storage, without causing flow through the auxiliary spillway. When the pond has no auxiliary spillway, design the minimum capacity of the principal spillway to pass the peak flow expected from the auxiliary spillway/total capacity design storm shown in Table 2, less any reduction creditable to detention storage.
- Design a principal spillway pipe with a minimum inside diameter of 4 inches. Design pipe with a minimum inside diameter of 1-1/4 inches for water supply pipes or for pipes used for any other purpose. If the pipe inside diameter is 10 inches or greater, its design discharge may be considered when calculating the peak outflow rate through the auxiliary spillway.
- Pipe Materials: Design pipe using ductile iron, welded steel, corrugated steel, corrugated aluminum, reinforced concrete (precast or site-cast), unreinforced concrete (precast or site-cast), cast iron, polyvinyl chloride (PVC), or annular corrugated profile-wall high density polyethylene (HDPE).
    - Cast iron or unreinforced concrete pipe may only be used if the dam is less than 20 feet in total height.
    - Annular corrugated profile-wall HDPE pipe may only be used for dry storage structures where the head is 10 feet or less. **Head** is the difference between the peak elevation of the routed design hydrograph and the elevation of the center of the pipe at the outlet. If the design tailwater elevation exceeds the elevation at the center of the pipe at the outlet, then head is the difference between the peak elevation of the routed design hydrograph and the design tailwater

elevation.

- Pipe Design: 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 Table 3, Table 4 and Table 5. Pipes not listed in the tables shall be designed according to the requirements of NRCS National Engineering Handbook (NEH) (Title 210), Part 636, Chapter 52, “Structural Design of Flexible Conduits.” Flexible pipe shall be designed for a maximum deflection of 5 percent. The modulus of elasticity for PVC shall be assumed as one-third the amount designated by the compound cell classification to account for long-term reduction in modulus of elasticity. Different reductions in modulus may be appropriate for other plastic materials.
- Connections and Joints: 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.
- A hood inlet may be used when the pipe is installed in the dam abutment with any sized barrel. The hood must be installed on a continuous section of pipe with a length of at least 12 feet. The hood shall consist of an anti-vortex baffle on top of the pipe and project three-fourths of the diameter of the pipe. The vertical distance between the invert of the pipe and the crest of the auxiliary spillway shall be no less than 1.5 times the diameter of the pipe.
- 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. Pipe supports shall be provided as needed.
- Include riser anchor blocks, pipe supports, or other components as needed to resist buoyancy.

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 and anti-seep collars
Provide filter diaphragms for internal erosion control on all pipes extending through the embankment with inverts below the peak elevation of the routed design hydrograph when the effective height of the dam is 15 feet or greater and the storage is 50 acre-feet or more.

Provide filter diaphragms for internal erosion control or alternative measures, such as anti-seep collars to reduce the hydraulic gradient along the pipe, on all pipes extending through the embankment with inverts below the peak elevation of the routed design hydrograph when any of the following conditions exist:

- The effective height of the dam is greater than 15 feet.
- The pipe exterior is smooth and has an approximate inside diameter of greater than 8 inches.
- The pipe exterior is corrugated and has an approximate inside diameter of greater than 12 inches.

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.

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 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”.

Anti-seep collars

Anti-seep collars can be used 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.
- 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 pipe 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, 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.

Design the collars to increase the seepage path along the pipe within the fill by at least 15 percent. The seepage path (S) length is defined as the pipe barrel length within the embankment fill (L) plus two times the minimum collar projection (C) of each anti-seep collar.

When C is the same length for each collar and N is the number of anti-seep collars, $S = L + 2NC$. Consequently, $N = LP / 200C$ where P is the percentage increase in S. Round N up to the nearest whole number to determine the number of anti-seep collars required.

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.

Animal guard
Install an animal guard at the outlet of the principal spillway for all pipes with and inside diameter of less than 10 inches.

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

An auxiliary spillway is an open channel or open structure used to safely convey water downstream of the dam. An auxiliary spillway may be natural or constructed. A dam must have one or more auxiliary spillways, 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. Vegetated or earth auxiliary spillways are not adequate if long duration, continuous, or frequent flows are expected.

- 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.
- Capacity: Design the minimum capacity of an auxiliary spillway to pass the peak flow expected from the auxiliary spillway/total capacity design storm of the frequency and duration shown in Table 2, less any reduction creditable to the principal spillway discharge and/or 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.
- Design constructed auxiliary spillway channels to consist 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 bottom width of no less than 10 feet..
    - Design an 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 control section to fit existing topography. The control section shall be constructed to a minimum length of 25 feet at the design crest elevation. Design the exit channel grade according to 210-NEH-628, Chapter 50, “Earth Spillway Design,” or with equivalent procedures.
- Design structural auxiliary spillways, such as 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.”

Additional Criteria for Excavated Ponds

In addition to the additional criteria below, design excavated ponds to meet the same criteria as for embankment ponds.

Runoff

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 horizontal to one vertical.

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. Place excavated material at a distance equal to the depth of the pond, but not less than 12 feet horizontally from the edge of the pond at the settled top of dam elevation. Placed material side slopes shall be 2:1 or flatter.

- Shape to a designed form that blends visually with the landscape.
- Provide for low embankment construction and leveling of surrounding landscape.
- Haul excess materials offsite.

Table 2. Minimum Spillway Capacity

Drainage area *(acre)*	**Effective height**[1] ***(feet)***	**Storage**[1] ***(acre-feet)***	**Frequency of minimum design, 24-hour duration strom**[2] **(years)**	
			Principal Spillway Capacity	**Auxiliary Spillway/Total Capacity**
20 or less	20 or less	< 50	2	10
20 or less	> 20	< 50	2	25
> 20	20 or less	< 50	5	25
> 20	> 20	< 50	5	50
All others	all	all	10	50

[1]. Defined above in “Conditions where Practice Applies.”

[2]. Select rain distribution based on climatological region.

Table 3. Minimum Acceptable Plastic Pipe for use in Earth Dams[1]

Type of PVC Plastic Pipe	**Nominal Pipe Size (Inches)**	**Maximum Depth of Fill Over Pipe (Feet)**
Smooth Wall PVC Pipe[2]		
SDR 32.5	4, 6, 8, 10, 12	8
SDR 26	4, 6, 8, 10, 12	13
SDR 21	4, 6, 8, 10, 12	17
SDR 17	4, 6, 8, 10, 12	24
Schedule 40	10, 12	8
Schedule 40	6, 8	13
Schedule 40	4	20
Schedule 80	10, 12	20
Schedule 80	4, 6, 8	25
Annular Corrugated Profile-Wall HDPE[2]		
HDPE	4 - 18	12
HDPE	24 - 36	9

[1]. Polyvinyl chloride pipe (PVC), PVC 1120 or PVC 1220, conforming to ASTM D2241 (for SDR) or ASTM D1785 (for Schedule).

[2]. Annular corrugated profile-wall high density polyethylene (HDPE) pipe conforming to AASHTO M252 (for 3 in to 10 in)/M294 (for 12 in to 60 in) and ASTM F2306 or ASTM F2648 (allows recycled materials). Joints must be watertight (WT) and have gaskets conforming to ASTM F477 and ASTM D3212 (10.8 psi requirement). For use limitations refer to Criteria for Embankments Dams - Principal Spillway - Materials.

Table 4. Minimum Gage for Corrugated Metal Pipe (2-$^{2}/_{3}$-inches x $^{1}/_{2}$-inches corrugations)[1]

Fill Height Over Pipe (Feet)	Steel CMP Diameter (Inches)					Aluminum CMP[2] Diameter (Inches)			
	24 or less	30	36	42	48	21 or less	24	30	36
1 to < 15	16	16	14	12	10	16	16	14	14
15 to < 20	16	16	14	12	10	16	16	12	12
20 to 25	16	14	12	10	10	16	12	10	———[3]

[1]. Pipe with 6, 8, and 10 inch diameters have 1-$^{1}/_{2}$ in x $^{1}/_{4}$ in corrugations.

[2]. Riveted or helical fabrication.

[3]. Not Permitted

Table 5. Minimum Gage for Corrugated Metal Pipe (3 inches x 1 inch corrugations)[1]

Fill Height Over Pipe (Feet)	Steel CMP Diameter (Inches)					
	36	42	48	54	60	72
1 to < 15	16	16	16	16	16	16
15 to < 20	16	16	16	16	14	14
20 to 25	16	16	14	12	10	8

[1]. n = 0.027

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.

Provide adequate water depths for target species.

If operations includes stocking fish, use 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 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.

Fire Control

Consider incorporating into the structure design an underground piping system that connects the reservoir to a dry hydrant. Use NRCS CPS Dry Hydrant (Code 432).

Recreation

The water balance (including seepage and evaporation losses) should maintain sufficient reservoir levels for its intended use. The water quality in the reservoir should be adequate for its intended use.

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.
- Known utility locations and utility notification requirements.

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

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