United States Department of Agriculture

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 conservation practice standard (CPS), Natural Resources Conservation Service (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 the following purpose–

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

CONDITIONS WHERE PRACTICE APPLIES

This 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 acre-feet2. Storage is the capacity of the reservoir in acre-feet below the elevation of the crest of the lowest auxiliary spillway or the elevation of the top of the dam if there is no open channel auxiliary spillway. The effective height of the dam is the difference in elevation, in feet, between the lowest open channel auxiliary spillway crest and the lowest point in the original cross section taken on the centerline of the dam. For dams on existing roads or other sites without a measurable channel at centerline, the lowest elevation at the downstream toe will be used to determine effective height. If there is no open channel auxiliary spillway, use the lowest point on the top of the dam instead of the lowest open channel auxiliary spillway crest.
- The effective height of the dam is 35 feet or less and the overall height of the dam is less than 35 feet. Overall height is the difference in elevation in feet between the lowest elevation in the top of dam (excluding the auxiliary spillway) and the elevation at the lowest point on the toe of the dam at the end of construction.

Dams with an overall height of 35 feet or more shall meet the requirements of the Missouri Department of Natural Resources, Dam and Reservoir Safety Council; the requirements of NRCS CPS Dam (402); and shall meet or exceed the requirements of Technical Release 60 (TR-60).

Water impoundments that have the primary purpose to stabilize grade and control erosion shall meet the requirements of CPS Grade Stabilization Structure (410).

CRITERIA

General Criteria Applicable to All Purposes

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.

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 CPS Code 342, Critical Area Planting.

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 (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. Missouri supplement to the National Engineering Handbook (NEH) Part 650, Engineering Field Handbook (EFH) Chapter 11, may be used as a guide in determining minimum size of contributing drainage area. 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.

Ponds Primarily for Fish Production
For best management, minimum surface area should be 1.0 acre. Ponds shall be at least eight (8) feet deep over an area of approximately 1,000 square feet. Shoreline, excluding embankment and waterway outlets into the pond, shall be sloped 3 (horizontal) to 1 (vertical) or steeper from normal water surface to a depth of 3 feet. On ponds with a surface area of 6 acres or greater, this requirement may be reduced to 75 percent of the shore line. For ponds larger than 3 acres, provisions shall be made to drain the pond in a 14-day period. An available pumping system of adequate size will meet this requirement.

Fence
Where an adjacent area is used for grazing or is open to livestock, the pool area, earthfill, and vegetative spillway shall be fenced to exclude livestock. Where watering ramps are constructed in an excavated pond, the fence shall permit livestock access to the ramp area only. In other cases the fence will be located no closer than 25 feet (horizontal distance) from the normal water line. Fence materials and fence installation shall be as outlined in the standards and specifications for NRCS CPS Fence (382).

Where the pond is to be developed as wildlife land, the fence will be located no closer than 40 feet to the sides of the normal water and 70 feet from the upper end of the normal pool.

Fencing may be necessary to exclude traffic that may endanger the vegetative cover on the embankment and spillway areas and to prevent the use of the facilities for purposes other than intended.

National Inventory
The following dams are to be included in the National Inventory of NRCS assisted dams in accordance with National Engineering Manual (NEM) Part 520.21(f):

1. All Significant and High Hazard class;
2. Low Hazard Class dams more than 6 feet in overall height and with a storage capacity of 50 acre-feet or more; or
3. Low Hazard Class dams with an overall height of 25 feet or more and a storage capacity of more than 15 acre-feet.

Inventory dams shall be reported to the State Conservation Engineer using form MO-ENG-C94.

Criteria Applicable to Embankment Ponds

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). NEM - Part 531 and Missouri supplements regarding dam site investigations shall be followed.

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 and a half 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 (1) 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. The total height of the dam is the difference in elevation, in feet, between the low dam crest and the lowest point in the cross section taken along the centerline of the dam. For dams on existing roads or other sites without a measurable channel at centerline, the lowest elevation at the downstream toe will be used to determine total height.

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.

Total height of dam *(feet)*	Top width *(feet)*
Less than 10	6
10–14.9	8
15–19.9	10
20–24.9	12

Total height of dam *(feet)*	Top width *(feet)*
25–34.9	14
35 or more	15

Side slopes
Design each side slope with a ratio of two and one half horizontal to one vertical or flatter. Design the sum of the upstream- and downstream-side slopes with a ratio of six 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 stability shall be evaluated based on soil mechanics analysis or past experience in the surrounding area.

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 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*, and the Missouri supplement to TR-69 *Estimating the Need for Slope Protection for Dams* as applicable.

Potential wave erosion factors such as orientation, exposure, and fetch length should be considered for all ponds to determine if protection is needed. History of other sites in surrounding area shall be considered when evaluating wave protection. In some areas wave erosion is severe even on small pool areas.

Wave erosion protection shall be provided on the dam for all reservoirs exceeding 5 acres of surface area unless otherwise evaluated and approved by the responsible engineer. Minimum wave protection to be used: (1) an 8 foot berm at principal spillway elevation or (2) construct upstream slope 4 (horizontal) to 1 (vertical) or flatter. For pool sizes of 10 acres or more, compute wave height by TR-56 or TR-69. Wave heights over 1 foot may require sloping berms or rock riprap.

Freeboard
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.

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. The following minimum increase shall be met:

1. 3 to 5 percent increase where fill material is placed in 9-inch thick layers (before compaction) and compacted by heavy hauling equipment or liquid filled tamping roller. (Sheepsfoot or wedgefoot drum rollers are considered tamping rollers.)
2. 5 to 10 percent increase where fill construction and compaction is by bulldozer or light hauling equipment, i.e., unloaded scrapers. Individual layers shall be 5 inches in thickness or less (before compaction).

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

Table 2 gives the minimum requirements for sizing the principal spillway and determining the temporary water storage volume needed in determining the stage required between the crest of the principal spillway and the crest of the auxiliary spillway.

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 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. Design pipe with a minimum inside diameter of 1-1/4 inches for water supply pipes or for pipes used for any other purpose.

Design pipe conduits using ductile iron, welded steel, corrugated steel, corrugated aluminum as listed in Table 3, reinforced concrete (pre-cast or site-cast), or plastic as listed in Tables 4a and 4b. Do not use cast iron or unreinforced concrete pipe if the dam is 20 feet or greater in total height.

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 NEH, Part 636, Chapter 52, Structural Design of Flexible Conduits. Flexible pipe shall be designed for a maximum deflection of 5 percent.

Welded steel pipe shall meet tolerance requirements of ASTM A53 or equivalent specifications. Welded steel pipe shall be new, new reject, or high quality used pipe.

Minimum effective* wall thickness for welded steel pipe shall be:

1. 3/16 (0.1875) inches for pipe diameters 24 inches or less
2. 1/4 (0.25) inches for pipe diameters over 24 inches

* effective wall thickness - wall thickness minus maximum depth of rust or corrosion pits

Aluminum pipe will not be used in soils that are outside the pH range of 4 to 9.

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.

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.

Outlet pipe supports will be used on conduits larger than 18 inches for corrugated metal pipe and larger than 24 inches for welded steel pipe. For all pipe sizes, PVC plastic pipe shall not protrude from the embankment more than six (6) feet unless an outlet pipe support is installed. Pipe support will be according to an approved standard design and will be installed at the intersection of downstream slope of fill and outlet channel.

The conduit slope shall be adequate to provide positive drainage after consolidation has occurred. Slope of the outlet section for conduits 15 inches in diameter or greater shall not exceed 7 percent.

When conduit design requires an elbow, the outlet section from the elbow to outlet end shall not be less than 16 feet in length. The conduit extension beyond end support or downstream toe of fill shall not be less than 6 feet.

Invert of the outlet pipe section shall be no higher than 2 feet above the outlet channel flowline unless otherwise approved by the responsible engineer.

Other Pipelines
Supply pipes shall be installed in conjunction with a suitable intake device with strainer, valve, and provisions to avoid freezing.

When tanks or troughs are planned in conjunction with the supply pipe, the requirements of CPS Watering Facility (614) shall be met.

Dry hydrant installations may be planned with new pond construction. Dry hydrants through embankments shall be installed in accordance with principal spillway criteria.

Trickle tube capacity shall be at least equal to the maximum spring or base flow. Minimum tube size is 4 inch diameter. Crest elevation shall be at least 0.5 foot below the crest of the auxiliary spillway. Trickle tubes through the dam shall meet all requirements for a principal spillway except flood-routing is not required. Trickle tubes installed in the abutment around the end of the dam may be corrugated polyethylene or polyvinyl chloride tubing. Tubing may be installed through the dam at a point where the height of dam above natural ground is 3 feet or less and a minimum of 9 inches of sand backfill is placed all around the conduit, beneath the top width of the dam. Pipes or tubing with equivalent strength and durability may be used.

Corrosion protection
Provide protective coatings for all steel pipe and couplings in areas that have traditionally experienced pipe corrosion, 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 with inverts below the peak elevation of the routed design hydrograph. Design filter diaphragms or alternative measures as needed to control seepage on pipes extending through all other embankments or for pipes with inverts above the peak elevation of the routed design hydrograph.

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

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.

Anti-seep Collars
When using anti-seep collars in lieu of a filter diaphragm when the effective storage of the dam is less than 50 acre-feet, 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. Minimum collar projection is 1.0 foot

For design considerations, see Missouri supplement to Chapter 6 of the NEH Part 650, Engineering Field Handbook.

Trash guard
Install a trash guard at the riser inlet to prevent clogging of the conduit, unless the watershed does not contain trash or debris that could clog the conduit. For safety reason, all vertical drop inlets will be constructed to prevent accidental injury to livestock and humans. This may be accomplished by using a horizontal anti-vortex baffle, trash rack, or guard rail.

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.

Design the minimum capacity of a natural or constructed auxiliary spillway to pass the peak flow expected from a total design storm of the frequency and duration shown in Table 2, less any reduction creditable to the conduit discharge and detention storage. If the pipe conduit diameter is 10 inches or greater, its design discharge may be considered when calculating the peak outflow rate through the auxiliary spillway. When design discharge of the principal spillway is considered in calculating peak outflow through the auxiliary spillway, the crest elevation of the inlet shall be such that the design discharge will be generated in the conduit before there is discharge through the auxiliary spillway.

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 but side slopes shall be no steeper than 2-½ (horizontal) to 1 (vertical). 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 and shall be level for a minimum distance of 25 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.

Spillway dikes or shaped exit channels shall extend to the point downstream that ensures the spillway flows do not damage the earth embankment. Side slopes of the constructed spillway dike shall have a slope of 2-½ (horizontal) to 1 (vertical) or flatter, a minimum top width of 4 feet, and a minimum height of 2 feet above the spillway grade.

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 2, 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 2. Consider runoff flow patterns when locating the excavated pond and placing the spoil.

Side slopes
Design stable side slopes in the excavated area no steeper than 2-½ horizontal to 1 vertical.

Watering Ramp
When wildlife or livestock need access to stored water, use the criteria in NRCS CPS 614, Watering Facility, to design a watering ramp. The ramp shall extend to the anticipated low water elevation at a slope no steeper than 4 horizontal to 1 vertical.

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 offsite.

Table 2 — Minimum Spillway Capacities. This table gives minimum requirements for sizing principal and auxiliary spillways and for determining temporary storage volume. The minimum

design storm shall be Type II, 24 hour duration of frequency shown below. This table does not apply to pond dams having an overall height greater than 35 feet.

Drainage Area (Acres)	**Effective Height of Dam** (Feet)	**Storage** a/ (Acre-Ft)	**Condition of Vegetated Spillway** b/	**Principal Spillway Minimum Design Storm Frequency** c/ (Years)	**Auxiliary Spillway Minimum Design Storm Frequency** c/ (Years)
20 or less	20 or less	Less than 50	Good	d/	10
			Fair	e/	
			Poor	1	
20 or less	Greater Than 20	Less than 50	Good	e/	25
			Fair	e/	
			Poor	2	
Greater than 20	20 or less	Less than 50	Good	1 f/	25
			Fair	2 f/	
			Poor	5	
ALL OTHERS (WITH OVERALL HEIGHT 35 FEET OR LESS)			Good	2	50
			Fair	5	
			Poor	10	

a/ Total storage below crest of auxiliary spillway or top of dam if an auxiliary spillway is not provided.

b/ Description of condition from end of constructed auxiliary spillway channel to main channel or gully downstream from the dam. Good - Uniform slope with no drops to outlet channel, good sod. Fair - Uniform slope with small drops, good sod; or uniform slope with small drops, fair vegetation, and shrubby banks. Poor - Steep slopes or raw gully banks, sparse vegetation.

c/ For drainage areas up to 600 acres, storage may be determined using approximate reservoir routing methods in the Engineering Field Handbook Supplement to Chapter 11.

d/ No principal spillway is required except that where the pond is spring fed or there are other sources of steady base flow, a trickle tube shall be installed.

e/ A trickle tube shall be installed when a principal spillway is not designed.

f/ A trickle tube may be used when drainage area is 150 acres or less and the auxiliary spillway design flow is less than:

1. 200 cfs with good vegetated spillway condition.
2. 150 cfs with fair vegetated spillway condition.

Table 3 — Minimum gauges or thickness for corrugated metal pipe (2-2/3 inches x 1/2 inches corrugations)

Fill Over Pipe (feet)	**Steel Minimum Gauge**						**Aluminum[1] Minimum Thickness** (inches)			
	Pipe Diameter (inches)						Pipe Diameter (inches)			
	≤ 21	24	30	36	42	48	≤ 21	24	30	36
1-14.9	16	16	16	14	12	10	0.06	0.06	0.075	0.075
15-19.9	16	16	16	14	12	10	0.06	0.075	0.105	0.105
20-25	16	16	14	12	10	10	0.06	0.105	.0135	(-)2

[1] Riveted or helical fabrication.

[2] Not permitted.

Table 4a — Maximum allowable earthfill cover over Schedule SDR PVC pipe for earth dams[1,4]

Schedule for SDR (Standard Dimension Ratio)[2]	**Maximum depth of fill over pipe[3,4]** (feet)
SDR 26	16
SDR 21	22
SDR 17	35

Table 4b — Maximum acceptable earthfill cover (feet) over various other PVC Pipe Types [3, 4, 5]

Type	**Size** (Inside Diameter)				
	4”	6”	8”	10”	12”
AWWA C900					
DR 25 or 165 psi	17	17	17	17	17
DR 18 or 235 psi	30	30	30	30	30
DR 14 or 305 psi	35	35	35	35	35
ASTM D1785					
Schedule 40	28	18	15	14	13
Schedule 80	35	35	34	30	28
Schedule 120	35	35	35	35	35

[1] Polyvinyl chloride pipe, PVC 1120 or PVC 1220, conforming to ASTM D2241, D3034 or equivalent.

[2] SDR = outside diameter (inches) **5** wall thickness (inches)

[3] Fill depths are based on 5% pipe deflection in accordance with NEH 636, Chapter 52 – Structural Design of Flexible Conduits.

[4] Backfill around pipe shall be carefully placed and well tamped with a density equal to or greater than 85% of Standard Proctor.

[5] Polyvinyl chloride pipe, PVC 1120 or PVC 1220 conforming to ASTM D1785, AWWA C900, or equivalent.

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. If feasible, add islands to provide visual interest and to attract wildlife.

Fish and wildlife

Locate and construct ponds to minimize the impacts to existing fish and wildlife habitat. Where more than one site location exists, final location that disturbs the least amount of wildlife habitat should be selected. Consider landowner's priorities and select the site that best achieves the objectives with the least negative impact on other important resources.

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 CPS Code 399, Fishpond Management.

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. As a minimum, include the following items:

- 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 vegetative establishment and/or mulching, as needed
- Safety features

- Site-specific construction and material requirements

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 appurtenances
- 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

The following University of Missouri Agricultural Guide provides information on operating and maintaining structures with embankment dams: 1548 “Maintaining Small Dams”.

REFERENCES

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

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