



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-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. If there is no open channel auxiliary spillway, use the lowest point on the top of the dam instead of the lowest open channel auxiliary spillway crest.
- The effective height of the dam is 35 feet or less.

CRITERIA

General Criteria Applicable to All Ponds

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

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

Design measures necessary to prevent serious injury or loss of life according to the requirements of NRCS National Engineering Manual (NEM) (Title 210), Part 503, "Safety."

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

Cultural resources

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

Site conditions

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

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

Reservoir

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

Additional Criteria for Livestock Water Ponds

Where livestock water is an intended purpose, the following criteria shall apply:

Geological Investigations

Use pits, trenches, borings, reviews of existing data, or other suitable means of investigation to characterize the on-site material within the reservoir area. If surface runoff is the primary source of water for the pond, the investigations shall show that all material from the surface to the planned depth of the pond are impervious enough to prevent excessive seepage losses or are of a type that make sealing practicable (see Conservation Practice Standard 520, 521, or 522, as appropriate).

Depth

The minimum depth should meet the guidelines shown on drawing number 4-L- 29476 plus any additional depth needed for sediment storage. Up to 2 feet may be added for sediment storage unless site-specific calculations show that more is required.

Capacity

The pond should be large enough to meet the minimum depth requirement over 25% of the reservoir area. The pond should have a minimum capacity based on the number of animal units served as shown in Table

1, or the pond should be sized to meet a site-specific water budget that accounts for livestock demand, evaporation, seepage, and sedimentation.

The capacities shown in Table 1 may be reduced to account for other water sources within the same operating unit, but the minimum capacity for each pond should still meet the minimum depth requirement over 25% of the reservoir area.

Table 1. Minimum Capacity Based on Animal Units Served

Climate*	Minimum Capacity (Cubic Yards / Animal Unit)
<i>Humid</i>	15
<i>Moist Sub-humid</i>	25
<i>Dry Sub-humid</i>	55
<i>Semi-arid</i>	90
<i>Arid</i>	110
*according to drawing number 4-L-29476	

Drainage Area

Unless an alternative water source exists that is adequate to meet the site-specific water budget, the size of the drainage area should meet the guidelines shown on drawing number 4-L-29475, or at a minimum the runoff volume from a 2-yr, 24-hr storm event should be adequate to fill the pond.

Additional Criteria for Embankment Ponds

Geological investigations

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

Sampling and testing for dispersive clays should always be a part of investigations unless extensive experience in an area or region has shown dispersive clays are not present and no problems have been attributed to dispersive clays in the area, or the project is located in an area where soils are derived from calcium rich parent materials.

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 two horizontal to one vertical.

The designer shall evaluate the need for a foundation cutoff in all cases, including soils typically considered relatively impervious but subject to significant desiccation cracking and/or blocky structure.

Seepage control

Include seepage control if—

- Foundation cutoff does not intercept pervious layers.
- Seepage could create undesired wet areas.
- Embankment stability requires seepage control.

- Special problems require drainage for a stable dam.

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

Control seepage with—

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

Top width

Table 2 provides the minimum top widths for dams of various total heights. Total height is the vertical distance between the settled top of the dam and the lowest elevation at the downstream toe.

Design a minimum width of 16 feet for one-way traffic and 26 feet for two-way traffic for the top of a dam used as a public road. Design guardrails or other safety measures where necessary and follow the requirements of the responsible road authority. For dams less than 20 feet in total height, maintenance considerations or construction equipment limitations may require increased top widths from the minimum shown in Table 2.

Table 2. Minimum Top Width for a Dam.

Total 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. 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.

The upstream slope of the settled embankment shall not be steeper than 3 to 1 unless a slope stability assessment is performed for the site. The designer should consider the impact of the steepness and slope length of the downstream slope relative to vegetation establishment, as appropriate for climatic conditions.

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 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 analyses or experience in the area shows that a lesser amount is adequate.

Increase the designed settlement to 10 percent for dams constructed with bulldozers and 20 percent for dams constructed with draglines. Where a combination of equipment is used, the type of equipment having higher percentage factor shall govern. Dragline construction shall be limited to 10 feet of total embankment height.

Principal spillway

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

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

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

Design adequate pipe capacity to discharge long-duration, continuous, or frequent flows without causing flow through the auxiliary spillway. 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 using ductile iron, welded steel, corrugated steel, corrugated aluminum, reinforced concrete (precast or site-cast), or plastic. Do not use cast iron or unreinforced concrete pipe if the dam is 20 feet or greater in total height.

Design and install pipe to withstand all external and internal loads without yielding, buckling, or cracking. Design rigid pipe for a positive projecting condition. Design flexible pipe according to the requirements of NRCS National Engineering Handbook (NEH) (Title 210), Part 636, Chapter 52, "Structural Design of Flexible Conduits."

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

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

Design outlet structures, such as cantilever pipe outlet sections and impact basins, to dissipate energy as needed.

When the 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, and the principal spillway shall be designed to prevent orifice flow.

Vertical inlets shall be designed structurally to withstand external pressure from soils and hydrostatic loading. A concrete base shall be used to prevent floatation of vertical inlets. Table 3, Gauges for Vertical Inlets and Table 4, Concrete Footing Dimensions may be used in lieu of detailed designs for inlet strength and floatation requirements.

Design of hooded inlets shall be in accordance with Technical Release No.3, Hood Inlets for Culvert Spillways, except the minimum head required to produce pressure flow shall be $1.8D$ measured from the invert of hood inlet. The anti-vortex shall meet the requirements of NRCS standard drawings. A cavitation check is not required if the total available head is less than 25 feet.

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.

Used welded steel pipe may be used for principal spillway fabrication provided it is approved by the designer or authorized designee as being essentially equal in quality to new pipe and the wall thickness is equal to or greater than the wall thickness in Table 5.

In lieu of individual loading designs for conduit; Tables 6, 7, and 8 may be used for corrugated steel, corrugated aluminum, and polyvinyl chloride (PVC) pipe.

A stability analysis of the principal spillway exit channel shall be made. If the outlet channel is unstable, grade control structures, pipe supports, or other acceptable measures shall be designed and installed to assure proper function of the principal spillway. Pipe supports shall extend below anticipated channel degradation and plunge basin scour hole. The outlet end of the pipe conduit shall extend sufficiently to assure that formation of the scour hole will not affect the downstream slope stability of the embankment. If a pipe support is not installed, as a minimum, the outlet end of the pipe shall extend the lesser of 2.5 times the conduit diameter or 8 feet beyond the downstream toe at the channel bed.

The end section of pipe shall extend into the embankment a minimum of one conduit diameter if a pipe support is installed and a minimum of three conduit diameters without a pipe support. The extension length shall be measured from the intersection of the pipe crown and embankment slope to the upstream end of the pipe section. The minimum depth of cover over a band coupler shall be 2 feet.

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.

Multiple Conduits

Multiple principal spillway conduits shall not be installed under the same embankment without the concurrence of the State Conservation Engineer.

Table 3. Gauges for Vertical Inlets

Steel Pipe						
<i>Diameter</i>	<i>Maximum Height of Inlet (Feet)</i>					
	<i>2-2/3" x 1/2" Corrugations</i>					<i>3" x 1" Corr.</i>
	<i>16 ga.</i> <i>(0.064")</i>	<i>14 ga.</i> <i>(0.079")</i>	<i>12 ga.</i> <i>(0.109")</i>	<i>10 ga.</i> <i>(0.138")</i>	<i>8 ga.</i> <i>(0.168")</i>	<i>16 ga.</i> <i>(0.064")</i>
24"	25*	25*	25*	25*	25*	25*
30"	25*	25*	25*	25*	25*	25*
36"	25*	25*	25*	25*	25*	25*
42"	25*	25*	25*	25*	25*	25*
48"	25*	25*	25*	25*	25*	25*
54"	25*	25*	25*	25*	25*	25*
60"	25*	25*	25*	25*	25*	25*
66"	21	25*	25*	25*	25*	25*
72"	16	20	25*	25*	25*	25*
78"	13	16	23	25*	25*	25*
84"	10	13	18	24	25*	25*
*maximum height limit is 25 feet for steel.						

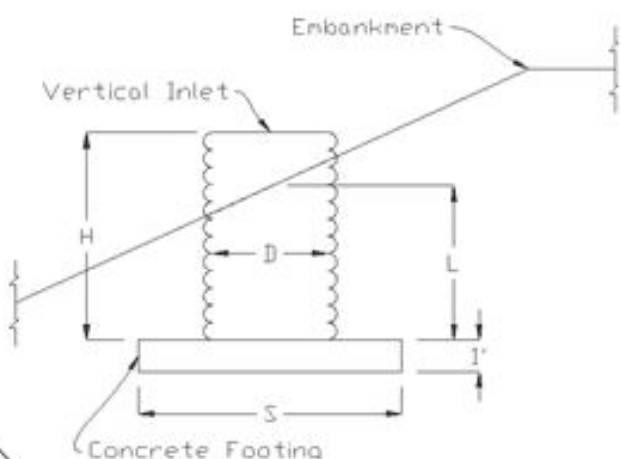
...Table 3 Continued

Aluminum Pipe						
<i>Diameter</i>	<i>Maximum Height of Inlet (Feet)</i>					
	<i>2-2/3" x 1/2" Corrugations</i>				<i>3" x 1" Corrugations</i>	
	<i>14 ga.</i> <i>(0.075")</i>	<i>12 ga.</i> <i>(0.105")</i>	<i>10 ga.</i> <i>(0.135")</i>	<i>8 ga.</i> <i>(0.164")</i>	<i>14 ga.</i> <i>(0.075")</i>	<i>12 ga.</i> <i>(0.105")</i>
24"	20*	20*	20*	20*	20*	20*
30"	20*	20*	20*	20*	20*	20*
36"	20*	20*	20*	20*	20*	20*
42"	17	20*	20*	20*	20*	20*
48"	12	17	20*	20*	20*	20*
54"	8	12	15	20*	20*	20*
60"	6	8	11	14	20*	20*
66"	5	6	8	11	20*	20*
72"	4	5	6	8	16	20*
*maximum height limit is 20 feet for aluminum.						

EXAMPLE: Find required gauge or thickness for a 66 inch vertical inlet that is 15 feet high.

<i>Dia.</i>	Steel		Aluminum	
	<i>2-2/3"x1/2"</i>	<i>3"x1"</i>	<i>2-2/3"x1/2"</i>	<i>3"x1"</i>
	66"	16 ga. (0.064")	16ga. (0.064")	None** 14ga. (0.075")
**maximum length for a 66" diameter, 0.164" thick vertical inlet is 11 feet.				

Table 4. Concrete Footing Dimensions



H (FT)	0	2	4	6	8	10	12	14	16	18	20	22	24
2	1.0577												
3	1.2054	2											
4	1.4058	1.2427	4										
5	1.0724	1.3553		6									
6	1.6320	1.4501	1.3010		8								
7	1.0788	1.5501	1.3758			10							
8	2.1154	1.0474	1.4400	1.3312			12						
9	2.2437	1.7338	1.5128	1.3802	8			14					
10	2.3051	1.8102	1.5700	1.4302	1.3480				16				
11	2.4805	1.8050	1.0384	1.4002	1.3025	10				18			
12	2.5008	1.9700	1.0078	1.5300	1.4350	1.3003					20		
13	2.0000	2.0434	1.7551	1.5874	1.4703	1.3007	12					22	
14	2.7084	2.1138	1.8100	1.0330	1.5105	1.4322	1.3085						24
15	2.8000	2.1818	1.8044	1.0700	1.5550	1.4000	1.3007	14					
16	2.0010	2.2478	1.9108	1.7230	1.5038	1.5008	1.4302	1.3747					
17	3.0837	2.3110	1.9077	1.7058	1.0311	1.5330	1.4001	1.4020	16				
18	3.1731	2.3743	2.0174	1.8077	1.0075	1.5003	1.4804	1.4287	1.3705				
19	3.2000	2.4351	2.0058	1.8480	1.7032	1.5080	1.5181	1.4540	1.4037	18			
20	3.3447	2.4044	2.1132	1.8880	1.7381	1.0202	1.5402	1.4807	1.4275	1.3834			
21	3.4273	2.5524	2.1505	1.9278	1.7723	1.0507	1.5730	1.5001	1.4500	1.4051	20		
22	3.5080	2.0000	2.2040	1.9002	1.8050	1.0807	1.0011	1.5310	1.4730	1.4200	1.3805		
23	3.5808	2.0044	2.2403	2.0030	1.8380	1.7102	1.0278	1.5555	1.4900	1.4477	1.4003	22	
24	3.0040	2.7188	2.2920	2.0400	1.8713	1.7482	1.0541	1.5700	1.5180	1.4085	1.4258	1.3802	
25	3.7305	2.7720	2.3350	2.0772	1.9032	1.7707	1.0800	1.0034	1.5410	1.4800	1.4450	1.4073	24
26	3.8130	2.8242	2.3770	2.1120	1.9345	1.8048	1.7055	1.0208	1.5027	1.5002	1.4040	1.4251	1.3914

S/D Factors

Example: $L = 10$ FT, $H = 15$ FT, $D = 4$ FT

From table, $S/D = 1.4669$

$S = (1.4669) (4) = 5.87$ FT, Use 6 FT x 6 FT Concrete Base

Table 5. Minimum wall thickness for steel*

Nominal Pipe Diameter (Inches)	Minimum Wall Thickness (Inches)	Weight Class	Nominal Weight (lb/ft), Plain End
4	0.237	STD	10.80
5	0.258	STD	14.63
6	0.280	STD	18.99
8	0.322	STD	28.58
10	0.365	STD	40.52
12	0.375	STD	49.61
14	0.375	STD	54.62
16	0.375	STD	62.64
18	0.375	STD	70.65
20	0.375	STD	78.67
24	0.375	STD	94.71
26	0.375	STD	102.72
*Reference: Table X2.2 ASTM A-53			

Table 6. Maximum Fill Height (Feet) over Corrugated Steel Pipe*

		Pipe Gage			
		10	12	14	16
		Wall Thickness (Inches)			
Pipe Corr.	Pipe Dia. (Inches)	0.138	0.109	0.079	0.064
1-1/2" X 1/4"	10 or less	25	25	25	25
	24 or less	25	25	25	25
2-2/3" X 1/2"	30	25	25	25	24
	36	25	24	22	21
	42	23	21	20	19
	48	21	20	19	19
	42 or less	25	25	25	25
3" x 1"	48	25	25	25	24
	54	25	25	23	22
	60	25	24	22	21
*for helical or riveted fabrication					

Trickle Tubes

For non-commercial fish ponds, embankment ponds with trickle tubes as a principal spillway should be constructed to remove water as follows:

- Ponds 6 feet deep or less - water shall be removed from the pond bottom.
- Ponds more than 6 feet deep - water shall be removed from a point at least 6 feet below the water surface.

Internal erosion

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

Table 7. Maximum Fill Height (Feet) over Corrugated Aluminum Pipe

		Pipe Gage			
		10	12	14	16
Pipe Corr.	Pipe Dia. (Inches)	Wall Thickness (Inches)			
		0.135	0.105	0.075	0.060
1-1/2" X 1/4"	10 or less	25	25	25	25
2-2/3" X 1/2"	18 or less	25	25	25	25
	21	25	25	25	24
	24	25	25	23	21
	30	22	21	20	19
	36	20	19	19	18
	42	19	19	18	18
	48	18	18	18	18
3" x 1"	30	25	25	25	25
	36	25	25	25	23
	42	25	24	22	21
	48	23	22	20	20
	54	21	20	19	19
	60	20	19	19	18
*for helical or riveted fabrication					

Table 8. Maximum Fill Height (Feet) over PVC Pipe*

Nominal Pipe Size (Inches)	Schedule or Standard	Maximum Fill Height over Pipe (Feet)
	Dimension Ratio (SDR)	
4 or less	Schedule 40	15
	Schedule 80	20
	SDR 26	10
6, 8, 10, 12	Schedule 40	10
	Schedule 80	15
	SDR 26	10
*PVC 1120 or PVC 1220, conforming to ASTM D-1785 or ASTM D-2241		

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

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

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 inlet to prevent clogging of the pipe, unless the watershed does not contain trash or debris that could clog the pipe.

Where required, the trash or safety guard shall be installed according to NRCS standard drawings.

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.

Non-commercial fish ponds should be designed with a drain pipe. Drain pipe should have sufficient capacity to drain the pond in 7-14 days.

Auxiliary spillways

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

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

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

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

Design a level inlet channel upstream from the control section for the distance needed to protect and maintain the crest elevation of the spillway. If necessary, curve the inlet channel upstream of the level section to fit existing topography. Design the exit channel grade according to 210-NEH-628, Chapter 50, "Earth Spillway Design," or with equivalent procedures.

The design capacity of earthen auxiliary spillways shall be based on the procedures and methods given in Engineering Field Handbook for Conservation Practices; Texas Engineering Technical Note No. 210-15-TX1, Erosion Control Practices; National Engineering Handbook - Part 628, Chapter 50, Earth Spillway Design; and SCS-TP-61, Handbook of Channel Design for Soil and Water Conservation; or based on water surface profiles.

Peak discharge shall be obtained using procedures contained in NEH Part 650, Chapter 2 – Estimating Runoff (also referred to as Engineering Field Handbook, Chapter 2 or EFH, Chapter 2) and the associated Texas Supplement, WINTR-55 Urban Hydrology for Small Watersheds, or another method approved by the State Conservation Engineer. Peak discharge may be reduced by flood routing.

If flood routed, TR-48 Structure Analysis (SITES) or other method approved by the State Conservation Engineer shall be used on Job Class V or larger and inventory size dams. Either Average Condition Runoff Curve Number (CN) shown on Figure TX650-2.4 in the Texas Supplement to EFH Chapter 2 or Antecedent Moisture Condition (AMC) II may be used to determine the runoff curve number or T_c .

Structural auxiliary spillways

Design chute spillways or drop spillways according to the principles set forth in 210-NEH, Part 650, "Engineering Field Handbook"; and 210-NEH, Section 5, "Hydraulics"; Section 11, "Drop Spillways"; and Section 14, "Chute Spillways." Design a structural spillway with the minimum capacity required to pass the peak flow expected from a total design storm of the frequency and duration shown in Table 9, less any reduction creditable to the pipe discharge and detention storage.

Additional Criteria for Excavated Ponds

Runoff

Design a minimum of 1 foot of freeboard above the peak elevation of the design hydrograph. Design a pipe and auxiliary spillway that meets the capacity requirements of Table 9. Consider runoff flow patterns when locating the excavated pond and placing the spoil.

Large drainage areas may be used as the source of water for excavated ponds provided the ponds can be located on sites where the flow is diverted away from the structure after the pit fills with water.

Reservoirs completely enclosed with an embankment may be used if adequate water supply can be pumped or otherwise diverted into the pond.

Seep Ponds

Seep type ponds may be used in areas where a subsurface water table will provide adequate supply for intended purpose. Seep type ponds will be designed with the same criteria as other excavated ponds with the following additional criteria:

- *The seep pond shall only be located where the static water level is within 4 feet of the average ground elevation.*
- *The maximum depth of the pond should be 10 feet or less below the static water level.*
- *The minimum depth should be at least 6.0 feet below the static water level.*
- *A sufficient number of borings shall be made and elevations recorded to determine the depth to the water-bearing strata, and to determine that the water-bearing strata is deep enough to provide adequate water.*
- *Any seep pond design shall be reviewed by the zone biologist to insure adherence with applicable wetland criteria and/or permits.*

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.
- Uniformly place and with side slopes assuming a natural angle of repose. Place excavated material at a distance equal to the depth of the pond, but not less than 12 feet from the edge of the pond.
- Shape to a designed form that blends visually with the landscape.
- Provide for low embankment construction and leveling of surrounding landscape. *When the excavated material and the cut bank form a continuous slope, the front slope of the excavated material and the cut bank shall not be steeper than 2.5 to 1 with the back slope on the normal angle of repose for the material. The maximum height of the excavated material shall not be more than 8 feet above normal ground. The top shall be made uniform and not left in a "moundy" condition.*
- Haul material offsite.
- *Spoil material shall meet the requirements for embankment ponds in any situation where water is stacked 3 feet or more against the spoil material.*

Auxiliary Spillway

Auxiliary spillways or bypass areas shall be as wide as practical to minimize flow depths and provide unobstructed flows. Auxiliary spillways or bypass areas shall provide for passing the design flow at a safe velocity to a point downstream where the pond will not be endangered.

Foundation Cutoff

The designer shall evaluate the need for a foundation cutoff in all cases where water will be stacked against spoil material, including soils typically considered relatively impervious but subject to significant desiccation cracking and/or blocky structure.

Table 9. Minimum auxiliary spillway capacity

Drainage area (acre)	Effective height of dam ¹ (feet)	Detention storage (acre-feet)	Minimum design storm ²	
			Frequency (years)	Minimum duration (hours)
20 or less	20 or less	< 50	10	24
20 or less	> 20	< 50	25	24
> 20	all	< 50	25	24
All others	all	all	50	24
1. Defined above in "Conditions where Practice Applies."				
2. Select rain distribution based on climatological region.				

CONSIDERATIONS

Visual Resource Design

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

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

Fish and Wildlife

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

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

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

Non-commercial fish ponds should:

- *Have a minimum surface area of 1 acre.*
- *Have a minimum depth of 4 feet over at least 80 percent of the pond area if the water surface is held at a constant level by wells, springs, etc.*
- *Have a minimum of ¾ of the shoreline at normal water depth constructed with side slopes of 3 horizontal to one vertical or steeper to a minimum depth of 3 feet. (Normal waterline is usually considered 2 feet below emergency spillway level on ponds without a trickle tube or principal spillway). The natural or undisturbed shoreline should be restricted to the upstream end of the pond surface.*

Watering ramp

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

Vegetation

Stockpile topsoil for placement on disturbed areas to facilitate revegetation.

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

Woody Vegetation

All brush, trees, stumps, and other major debris should be removed below the emergency spillway elevation in ponds which are to be intensively managed and fertilized. For those ponds not intensively managed and properly fertilized, 10 to 50 percent of the pond area below the emergency spillway elevation should be retained in standing woody vegetation. The amount of standing woody vegetation left will depend on the desires of the pond owner and the construction requirements of the pond. Brush piles (shelters) can be constructed in the deepest portion of the pond. These brush piles (shelters) should be firmly anchored to prevent floating debris.

Water Quantity

Consider effects on components of the water budget, especially—

- Effects on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge.

- Variability of effects caused by seasonal or climatic changes.
- Effects on downstream flows and impacts to the environment such as wetlands, aquifers, and social and economic impacts to downstream uses or users.

Water Quality

Consider the effects of—

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

PLANS AND SPECIFICATIONS

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

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

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 *including*:
 - *a review of the embankment with repairs in cases of excessive rutting or animal burrowing.*
 - *a review of the downstream toe area for wet areas or seeps. Report such instances to the designer.*
 - *a review of the downstream floodplain to assure life or property will not be threatened in the unlikely event of a dam failure. If a possible threat to public safety is identified, it should be reported to the designer.*
- 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 *including mowing (starting after nesting birds have hatched), immediate seeding of bare areas as needed, and fertilizing.*
- *Inspection after heavy rains for possible damage, repair of damage if found, and clearing spillways of accumulated trash.*
- Prevent the establishment of woody vegetation on constructed embankment fill and around spillway appurtenances.

REFERENCES

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