NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

POND
(NO)
CODE 378

DEFINITION

A water impoundment made by constructing a dam or an embankment or by excavating a pit or dugout.

In this standard, ponds constructed by the first method are referred to as embankment ponds, and those constructed by the second method are referred to 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 spillway elevation is 3 ft or more.

PURPOSE

To provide water for livestock, fish and wildlife, recreation, fire control, crop and orchard spraying, and other related uses, and to maintain or improve water quality.

CONDITIONS WHERE PRACTICE APPLIES

This standard establishes the minimum acceptable quality for the design and construction of ponds if:

1. Failure of the dam will not result in loss of life; in damage to homes, commercial or industrial buildings, main highways, or railroads; or in interruption of the use or service of public utilities. This standard is limited to NRCS Class (a) and Idaho Department Water Resources Low Risk Dams. Structure located in rural or agricultural areas where failure may cause minor damage to farm buildings, agricultural land, or country road. There is no danger to inhabited homes or to people.

2. The product of the storage times the effective height of the dam is less than 3,000. Storage is the volume, in acre-feet, in the reservoir below the elevation of the crest of the emergency spillway. The effective height of the dam is the difference in elevation, in feet, between the emergency spillway crest and the lowest point in the cross section taken along the centerline of, the dam. If there is no emergency spillway, the top of the dam is the upper limit.

3. The effective height of the dam is 35 ft or less, and the dam is hazard class (a).

4. Type 1 dams are less than l0 feet IDWR height and storing less than 50 acre-feet of water or less than 20 feet IDWR height and storing less than 10 acre-feet of water. Type 2 dams exceed the limits of Type 1 but are still less than 20 feet IDWR height and store less than 100 acre-feet. Type 3 includes all dams over 20 feet height or storing more than 100 acre-feet but with the product of storage times NRCS effective height less than 3,000. IDWR height is defined as the vertical distance from the natural bed of the stream or watercourse at the downstream toe of the dam, or from the lowest elevation of the outside limit of the dam, if it is not across a stream channel or watercourse, to the maximum water storage elevation. The IDWR definition of a “dam” is any artificial barrier together with appurtenant works, which is or will be 10 feet or more in height or has or will have an impounding capacity at maximum storage elevation of 50-acre feet or more.

Site conditions shall be such that runoff from the design storm can be safely passed through (1) a natural or constructed emergency spillway, (2) a combination of a principal spillway and an emergency spillway, or (3) a principal spillway.

The drainage area above the pond must be protected against erosion to the extent that expected sedimentation will not shorten the planned effective life of the structure. The drainage area shall be large enough so that surface runoff and groundwater flow will maintain an adequate supply of water in the pond. The quality of the water shall be suitable for the intended use.

The topography and soils of the site shall permit storage of water at a depth and volume that ensure a dependable supply, considering beneficial use, sedimentation, season of use, and evaporation and

seepage losses. If surface runoff is the primary source of water for a pond, the soils shall be impervious enough to prevent excessive seepage losses or shall be of a type that sealing is practicable.

DESIGN CRITERIA

All planned work shall comply with all Federal, State, and local laws and regulations.

Foundation cutoff. A cutoff of relatively impervious material shall be provided under the dam if necessary. The cutoff shall be located at or upstream from the centerline of the dam. It shall extend up the abutments as required and be deep enough to extend into a relatively impervious layer or provide for a stable dam when combined with seepage control. The cutoff trench shall have a bottom width adequate to accommodate the equipment used for excavation, backfill, and compaction operations. Side slopes shall not be steeper than one horizontal to one vertical.

Seepage control. Seepage control is to be included if (1) pervious layers are not intercepted by the cutoff, (2) seepage creates swamping downstream, (3) such control is needed to insure a stable embankment, or (4) special problems require drainage for a stable dam. Seepage may be controlled by (1) foundation, abutment, or embankment drains; (2) reservoir blanketing; or (3) a combination of these measures.

Earth embankment. The minimum top width for a dam is shown in Table 1. If the embankment top is to be used as a public road, the minimum width shall be 16 ft for one-way traffic and 26 ft for two-way traffic. Guardrails or other safety measures shall be used where necessary and shall most the requirements of the responsible road authority.

Table l.-Minimum Top Width for Dam

IDWR Dam Type	Total height of embankment	Top width
	ft	ft
1	15 or less	8
1	>15 to 20	10
2 and 3	10 or less	12
2 and 3	>10	W

Where W = (H/5) + 10: W = Top Width in feet and H = IDWR Height in feet.

The combined upstream and downstream side slopes of the settled embankments shall not be less than five horizontal to one vertical, and neither slope shall be steeper than two horizontal to one vertical. Flatter side slopes must be designed if needed to be stable for the site conditions. If needed to protect the slopes of the dam, special measures, such as berms, rock riprap, sand-gravel, soil cement, or special vegetation, shall be provided

The minimum elevation of the top of the settled embankment above the water surface in the reservoir with the emergency spillway flowing at design depth shall be the larger of the following: (1) A minimum of one foot for Type 1 and Type 2 dams with less than 20 acres of drainage area (2) A minimum of two feet for Type 1 and 2 dams having more than a 20 acre drainage area and for all dams more than 20 feet in effective height (3) The height of a wind generated wave (H) moving across the reservoir at maximum water surface by the equation $H = 1.95\ F^{0.5}$ where F = distance in miles across the water perpendicular to the dam, H = height in feet.

The design height of the dam shall be increased by the amount needed to insure that after settlement the height of the dam equals or exceeds the design height. This increase shall not be less than 5 percent, except where detailed soil testing and laboratory analyses show that a lesser amount is adequate.

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

The crest elevation shall be no less than 0.5 feet below the crest of the emergency spillway for dams having a drainage area of 20 acres or less, and no less than 1 foot for dams having a drainage area of more than 20 acres.

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

The capacity of the pipe conduit shall be adequate to discharge long-duration, continuous, or frequent

flows without flow through the emergency spillways. The diameter of the pipe shall not be less than 4 inches. If the pipe conduit diameter is 10 inch or greater, its design discharge may be considered when calculating the peak outflow rate through the emergency spillway.

Pipe conduits under or through the dam shall meet the following requirements. The pipe shall be capable of withstanding external loading without yielding, buckling, or cracking. Flexible pipe strength shall not be less than that necessary to support the design load with a maximum of 5 percent deflection. The inlets and outlets shall be structurally sound and made of materials compatible with those of the pipe. All pipe joints shall be made watertight by the use of couplings, gaskets, caulking, or by welding.

For Type 1 dams acceptable pipe materials are cast-iron, steel, corrugated steel or aluminum (close riveted or welded), concrete, plastic, and cast-in plane reinforced concrete. For Type 2 and Type 3 dams, all conduits shall be either concrete or metal pipe encased in reinforced concrete or cast in place reinforced concrete.

Plastic pipe that will be exposed to direct sunlight shall be made of ultraviolet-resistant materials and protected by coating or shielding, or provisions for replacement should be made as necessary. Connections of plastic pipe to lose flexible pipe or structures must be designed to avoid stress concentrations that could rupture the plastic. Pipe shall be watertight. The joints between sections of pipe shall be designed to remain watertight after joint elongation caused by foundation consolidation. Pipe shall have concrete bedding or a concrete cradle, when required to support the anticipated earth loads.

Cantilever outlet sections, if used, shall be designed to withstand the cantilever load. Pipe supports shall be provided when needed. Other suitable devices such as a Saint Anthony Falls stilling basin or an Impact basin may be used to provide a safe outlet. Protective coatings of asbestos bonded, asphalt coated, or vinyl coating on galvanized corrugated metal pipe, or coal tar enamel on welded steel pipe shall be provided in areas that have a history of pipe corrosion, or where the saturated soil resistivity is less than 4,000 ohms-cm, or where soil pH is lower than 5. Cathodic protection is to be provided 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 cathodic protection is not provided for in the original design and installation, electrical continuity in the form of joint-bridging straps should be considered on pipes that have protective coatings. Cathodic protection should be added later if monitoring indicates the need. Practice standard 430-FF provides criteria for cathodic protection of welded steel pipe.

Specifications in Tables 2 and 3 are to be followed for polyvinyl chloride (PVC), steel and aluminum pipe.

Table 2. - Acceptable PVC pipe for use in earth dams[1]

Nominal pipe size	Schedule for standard dimension ratio (SDR)	Maximum depth of fill over pipe
in		ft
4 or smaller	Schedule 40	15
	Schedule 80	20
	SDR 26	10
6, 8,10,12	Schedule 40	10
	Schedule 80	15
	SDR 26	10
Larger Dia	Special Design, max 5% deflection	

[1] polyvinyl chloride pipe, PVC 1120 or PVC 1220, conforming to ASTM-D 1785 or ASTM-D 2241.

Table 3. - Minimum gauge for corrugated metal pipe [2-2/3-in x 1/2-in corrugations][1]

Fill height (f t)	Minimum gauge for steel pipe with diameter (in) of - 21 and less	24	30	36	42	48	Minimum thickness (in) of aluminum pipe[2] with diameter (in) of 21 and less	24	30	36
1-15	16	16	16	14	12	10	0.06	0.06	0.075	0.075
15-20	16	16	16	14	12	10	.06	.075	.105	.105
20-25	16	16	14	12	10	10	.06	.105	.135	[3]

1 Pipe with 6-, 8-, and 10-in. diameters has 1-1/2 in x 1/4-in corrugations.
2 Riveted or helical fabrication.
3 Not permitted.

All pipe conduits shall be designed with seepage control. Seepage along pipes extending through the embankment shall be controlled by use of a filter and drainage diaphragm, unless it is determined that antiseep collars will adequately serve the purpose. The drain is to consist of sand, meeting fine concrete aggregate requirements (at least 15% passing the No. 40 sieve but no more than 10% passing the No. 100

sieve). If unusual soil conditions exist, a special design analysis shall be made. The drain shall be a minimum of 2 feet thick and extend vertically upward and horizontally at least three times the pipe diameter, and vertically downward at least 18 inches beneath the conduit invert. The drain diaphragm shall be located immediately downstream of the cutoff trench, approximately parallel to the centerline of the dam. The drain shall outlet at the downstream toe of the embankment, preferably using a drain backfill envelope continuously along the pipe to where it exits the embankment. Protecting drain fill from surface erosion will be necessary.

When antiseep collars are used in lieu of a drainage diaphragm, they shall have a watertight connection to the pipe. They shall be spaced between 7 and 14 times the projection of the cutoff collar out from the surface of the pipe measured perpendicular to the pipe. On pipes 4 inch and smaller antiseep collars shall project a minimum of 18 inches and on pipes larger than 4 inches the minimum projection is 2 feet. Collar material shall be compatible with pipe materials. The antiseep collar(s) shall increase by 15% the seepage path along the pipe. Reinforced concrete antiseep collars shall not be less than 4-inch thick, metal collars shall be constructed of 12 gauge or heavier materials with at least a Class B coating as defined in Practice Standard 430-FF.

Closed conduit spillways designed for pressure flow must have adequate antivortex devices. To prevent clogging of the conduit, an appropriate trash guard shall-be installed at the inlet or riser.

A pipe with a suitable valve shall be provided to drain the pool area if needed for proper pond management or if required by state law. The principal spillway conduit may be used as a pond drain if it is located where it can perform this function.

Supply pipes through the dam to watering troughs and other appurtenances shall have an inside diameter of not less than 1-1/4 inch. Pipes shall extend beyond the downstream toe of the embankment fill.

Outlet Controls. All conduits shall be controlled with either a vertical or inclined gate on the upstream end with an air vent directly downstream of the gate, unless otherwise approved by IDWR. Air vents shall be a minimum of one inch in diameter. All outlet controls shall be installed at a stable location on the crest or a platform which is readily accessible, but secured from unauthorized operation. Reservoirs storing water during the winter will have inclined gate controls encased and buried in the embankment. All guide and handwheel pedestals shall be constructed of reinforced concrete. Outlet controls are not required on Type 1 dams storing less than 10 acre-feet of water where an ungated riser is installed at some elevation below the crest of the emergency spillway.

Trash Racks. At least one of the sides of the inlet structure shall be open to allow water to flow into the outlet conduit and shall be covered with a trash rack. All top trash racks shall slope toward the reservoir. Top bars should all be placed in one direction for easier cleaning with long handled trash rakes. If fish screens are used they shall be placed over the trash rack and shall be removable for cleaning.

Emergency spillways. Emergency spillways convey large flood flows safely past earth embankments. An emergency spillway must be provided for each dam, 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 following are minimum criteria for acceptable use of a closed conduit principal spillway without an emergency spillway: a conduit with a cross sectional area of 3 ft^2 or more, an inlet that will not clog, and an elbow designed to facilitate the passage of trash.

The minimum capacity of a natural or constructed emergency spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 4, less any reduction creditable to conduit discharge and detention storage. The emergency spillway shall safely pass the peak flow, or the storm runoff shall be routed through the reservoir. The routing shall start 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. The 10-day drawdown shall be computed from the crest of the emergency spillway or from the elevation that would be attained if the entire design storm were impounded, whichever is lower. Emergency spillways shall provide for passing the design flow at a safe velocity.

Table 4. - Minimum spillway capacity

			Minimum Design storm[2]	
Drainage area	Effective height of dam[1]	Storage	Frequency	Minimum duration
acre	ft	acre-ft	yr	hr
20 or less	6 or less	Less than 50	10	24
20 or less	15 or less	Less than 10	10	24
More than 20	20 or less	Less than 50	25	24
More than 20	20 or less	Less than 100	50	24
All others			100	24

1 As defined under ""Condition Where Practice Applies"
2 Select rain distribution based on climatological region.

Constructed emergency spillways are open channels that usually consist of an inlet channel, a control section, and an exit channel. They shall be trapezoidal and shall be located in undisturbed or compacted earth. The side slopes shall be stable for the material in which the spillway is to be constructed. Side slopes for earth spillways shall normally be no steeper than two horizontal to one vertical. However, in deep excavations, the sideslopes can be steepened to a maximum of 1:1 above the maximum water level, provided it will be stable at the selected slope. Sideslopes may be vertical in hard rock excavation.

For dams having an NRCS effective height exceeding 20 ft, the emergency spillway shall have a bottom width of not less than 10 ft. Upstream from the control section, the inlet channel shall be level for the distance needed to protect and maintain the crest elevation of the spillway. The level reach shall be no less than 10 feet in length. The inlet channel may be curved to fit existing topography but must be in alignment with the exit channel when it reaches the control section. The grade of the exit channel of a constructed emergency spillway shall fall within the range established by discharge requirements and permissible velocities. The exit slope shall be in excess of critical slope at the control section. Three percent may be used in lieu of a designed grade. The exit channel shall terminate at a point well removed from any part of the embankment and where the design flow may be discharged without causing damage by erosion. In all cases, the spillway shall be adequate to carry the maximum inflow with a freeboard of one foot or more at flood stage. For Type 1 dams, an ungated principal spillway may be sufficient to meet outflow requirements.

Structural emergency spillways. If chutes or drops are used for principal spillways or principal emergency or emergency spillways, they shall be designed according to the principles set forth in the Engineering Field Manual for Conservation Practices and the National Engineering Handbook Section 5, Hydraulics; Section 11, Drop Spillways; and Section 14, Chute Spillways. The minimum capacity of a structural spillway shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 4, less any reduction creditable to conduit discharge and detention storage.

Design Criteria for Excavated Ponds

Runoff. Provisions shall be made for principal and emergency spillways when embankments are part of excavated pond designs. Spillways shall be designed to pass the 10 year-24 hour storm when the drainage area is less than 20 acres and the 25 year-24 hour storm for drainages 20 acres and larger.

Sideslopes. Side slopes of excavated ponds shall be stable and shall not be steeper than one horizontal to one vertical. Sideslopes in excavated ponds subject to sudden draw down of water shall be not steeper than two horizontal to one vertical. If livestock will water directly from the pond, a watering ramp shall be provided. The ramp shall extend to the anticipated low water elevation at a slope no steeper than three horizontal to one vertical. Ramps shall be surfaced with gravel or other surface protection as needed to provide firm footing for animals.

Inlet protection. Where surface water enters the pond in a natural or excavated channel, the slope of the pond shall be protected against erosion.

Excavated material.

Additional Design Criteria for Fish Ponds

Depth. Fish ponds shall have a minimum depth of six feet over a minimum of one-third of the surface area at the normal winter water level in the pond.

Excavated material. The material excavated from the pond shall be placed so that its weight will not endanger the stability of the pond side slopes and so that it will not be washed back into the pond by rainfall. It shall be disposed of in one of the following ways:

1. Uniformly spread to a height that does not exceed 3 ft, with the top graded to a continuous slope away from the pond.
2. Uniformly placed or shaped reasonably well, with side slopes assuming a natural angle of repose. The excavated material will be placed at a distance equal to the depth of the pond but not less than 12 ft from the edge of the pond.

3. Hauled away.

Visual resource design. The visual design of ponds shall be carefully considered in areas of high public visibility and those associated with recreation. The underlying criterion for all visual design is appropriateness. The shape and form of ponds, excavated material, and plantings are to relate visually to their surroundings and to their function.

CONSIDERATIONS

The embankment may be shaped to blend with the natural topography. The edge of the pond may be shaped so that it is generally curvilinear rather than rectangular. Excavated material can be shaped so that the final form is smooth, flowing, and fitting to the adjacent landscape rather than angular geometric mounds. If feasible, islands may be added for visual interest and to attract wildlife.

If the structures are to be used for recreation or are highly visible to the public, the perimeter or edge should be curvilinear.

Select off channel dam sites when possible.

Select vegetation to control erosion on embankment and spillway slopes compatible with pond uses and climatic conditions. Refer to Practice Standard, Critical Area Planting (342).

Consider and design fencing compatible with pond uses, needed animal or people control, vegetation establishment and maintenance.

Consider effects on the water budget, especially on volumes and rates of infiltration.

Consider effects on water flows and aquifers and the affect to other water uses and users.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared to show site layout, embankment and spillway cross sections, conduit details, cutoff/foundation details, drainage system details as applicable, elevational details.

OPERATION AND MAINTENANCE

The operation and maintenance of the system shall include typical items of removing or controlling undesired vegetation, repairing embankments, removing debris from spillways/conduits etc.

REFERENCES

-Engineering Field Manual

Chapter 2, Estimating Runoff and Peak Discharges

Chapter 3, Hydraulics

Chapter 4, Elementary Soil Engineering

Chapter 6, Structures

Chapter 11, Ponds and Reservoirs