NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

POND

(No.)

CODE 378

DEFINITION

A water impoundment made by constructing 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 the auxiliary spillway elevation is three feet or more.

PURPOSE

To provide water for livestock, fish and wildlife, recreation, fire control, 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 low-hazard ponds where:

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. Storage is the volume, in acre-feet, in the reservoir below the elevation of the crest of the auxiliary spillway. The effective height of the dam is the difference in elevation, in feet, between the auxiliary spillway crest and the lowest point in the cross section taken along the centerline of the dam. If there is no auxiliary spillway, the top of the dam is the upper limit, and

The effective height of the dam is 35 feet or less.

CRITERIA

Laws and regulations. This practice must conform to all federal, state, and local laws and regulations. Laws and regulations of particular concern include those involving zoning, dam construction, water rights, land use, land disturbed by construction, pollution control, property easements, wetlands, preservation of culture resources, and endangered species. All required permits and approvals must be obtained before construction begins.

Site conditions. Site conditions shall be such that runoff from the design storm can be safely passed through a principal spillway and/or auxiliary spillway.

Drainage area. 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 50 percent chance annual yield exceeds the reservoir permanent water storage needed for the purposes. The quality shall be suitable for the water's intended use.

Reservoir area. The topography and geology of the site shall permit storage of water at a depth and volume that will ensure a dependable supply, considering beneficial use, sedimentation, season of use, evaporation, and seepage. Soils shall be impervious enough to prevent excessive seepage losses or shall be sealed or lined.

Vegetation. A protective cover of vegetation shall be established on all exposed areas of embankments, spillways, borrow areas, and spoil piles as climatic conditions allow, following Conservation Practice Standard Critical Area Planting (342).

Fencing. Fencing is encouraged for all sites and required on sites where vegetation is expected to be difficult to establish and/or maintain. Fencing

Conservation practice standards are reviewed periodically and updated if needed. To obtain the current version of this standard, contact your Natural Resources Conservation Service State Office or visit the electronic Field Office Technical Guide.

the reservoir is encouraged to benefit fish and wildlife, enhance water quality, and extend the useful life of the structure.

ADDITIONAL CRITERIA FOR EMBANKMENT PONDS

Geological Investigations. Geologic investigations must characterize materials within the embankment, foundation, auxiliary spillway, and borrow areas. Materials shall be classified using the Unified Soil Classification System. Tests for dispersive clays must be completed for sites west of the Missouri River.

Stripping. Foundations must be stripped to a minimum depth of 0.5 foot or to the depth of significant root development whichever is greater. The stripped area must be scarified.

Foundation cutoff. A cutoff of relatively impervious material shall be provided under the dam. Minimum depth of cutoff is two feet from original ground surface. The cutoff shall be located at or upstream from the centerline of the dam. It shall extend up the abutments at a minimum to the permanent high water elevation and shall extend a minimum of one foot 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. Trenches over four feet deep may require flatter slopes to meet OSHA regulations.

Seepage control. Seepage control is to be included if (1) pervious layers are not intercepted by the cutoff, (2) seepage could create 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 foundation, abutment, or embankment drains; and/or reservoir blanketing.

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

Table 1. Minimum Top Width for Dams

Total height of embankment, 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. Upstream slopes of the settled embankment shall not be steeper than three horizontal to one vertical. Downstream slopes shall not be steeper than two horizontal to one vertical. All slopes must be designed to be stable. Downstream or upstream berms can be used to help achieve stable embankment sections.

Slope protection. Slope protection should be considered on all structures when erosion is expected due to orientation and location of the reservoir. Class III and above designs must counter the effect of wave action whenever permanent pool surface area exceeds 10 acres, or permanent pool surface area exceeds five acres and wave heights exceed 0.5 feet when using TR-56 procedures.

If needed berms, rock riprap, sand-gravel, soil cement, special vegetation or other measures shall be provided. Technical Releases 56, “A Guide for Design and Layout of Vegetative Wave Protection for Earth Dam Embankments,” and 69, “Riprap for Slope Protection Against Wave Action,” contain design guidance.

Embankments where the depth of water at the permanent pool is less than five feet do not require slope protection.

Settlement. The design height of dam shall be increased as needed to insure that after settlement, height of dam equals, or exceeds design height. This increase shall not be less than five percent of the design height of dam.

Borrow area. The borrow area shall be stripped to remove all vegetation and material undesirable for fill. Stripped material may later be used as cover over the dam, spillway, or borrow area as needed for vegetation establishment.

Borrow material. Soils having total soluble salts exceeding 2 percent, or dispersion over 25 percent must not be used in earth fills except as designed by an engineer.

Principal spillway need. Except where rock, concrete, or other types of lined spillways are

used, a pipe conduit, with needed appurtenances, shall be placed under or through the dam when any of the following conditions are present:

Soils in the auxiliary spillway have high erodibility and/or will not support adequate vegetation;

The volume of water storage, less sediment design storage, in the dam at auxiliary spillway crest elevation is less than 50 percent of the 2-year frequency, 24-hour storm yield;

The volume of water storage at the auxiliary spillway crest exceeds 100 acre-feet;

The product of storage times effective height exceeds 2,000;

Significant quantities of water from wells, springs, or seeps flow into the reservoir.

Principal spillway details. The principal spillway crest must be at least 1.0 foot below the auxiliary spillway crest.

For dams requiring a principal spillway the required design storm must be contained between the crests of the principal spillway and auxiliary (emergency) spillway when flood routed. Table 2 shows the required design storm.

Table 2. Minimum Principal Spillway Capacity

Product of Height times Storage at the Auxiliary Spillway Crest (Ac.Ft.xFt.)[1/]	Min. design storm	
	Frequency (Years)	Min. Duration (Hours)
Less than 2000	2	24
2000-2499	5	24
2500-2999	10	24

[1/] As defined under "Conditions Where Practice Applies."

The principal spillway must have capacity to empty this flood pool in 10 days unless provisions are made to begin the routing of the auxiliary spillway storm from this 10 day drawdown elevation.

Minimum principal spillway pipe diameter shall be eight inches. When principal spillway discharge is considered in calculating peak auxiliary spillway flow, the principal spillway pipe must be at least 10 inches in diameter and must flow full before discharge occurs from the auxiliary spillway.

Principal spillways must have capacity to discharge long-duration, continuous, or frequent flows without auxiliary spillway flow.

Minimum drop inlet riser diameter is 1.25 times the horizontal pipe diameter. The riser and barrel for drop inlet spillways shall be designed to provide full pipe flow after weir flow is exceeded. Risers deeper than 12 feet that are located in semi-compacted fill must be designed to withstand fill settlement (vertical compression) loading.

Pipes designed for pressure flow must have adequate anti-vortex devices. Inlets and outlets must function satisfactorily for the full range of flow and hydraulic head anticipated.

Pipes in dams shall be ductile iron, welded steel, corrugated steel, corrugated aluminum, reinforced concrete, or plastic.

Pipes must withstand all external and internal loads without yielding (beyond design limits), buckling, or cracking. Rigid pipe shall be designed for a positive projecting condition. Maximum design deflection for flexible pipe shall be 5 percent, except maximum design deflection for corrugated polyethylene pipes buried less than 15 feet shall be 7.5 percent. The modulus of elasticity for PVC pipe shall be assumed as one-third of the amount designated by the compound cell classification to account for long-term reduction in modulus of elasticity. Different reductions in modulus may be appropriate for other plastic pipe materials.

Pipes shall be designed to withstand the pipe burial depth. For flexible pipes buried more than 15 feet, minimum wall thickness shall be SDR 26, Schedule 40, Class 100, or 16 gage as appropriate for the particular pipe material. Connections of flexible pipe to rigid pipe or other structures shall be designed to accommodate differential movements and stress concentrations.

All pipes shall be made water tight by means of couplings, gaskets, caulking, waterstops, or welding. Joints shall be watertight under all internal and external loading including pipe elongation due to foundation settlement.

Concrete cradle, bedding, or encasement of pipes shall be provided where needed to reduce or limit structural loading to allowable levels.

All steel pipe and couplings shall have protective coatings in areas where experience indicates corrosion should be expected, including in embankments with saturated soil resistivity less than 4,000 ohms-cm or soil pH less than 5. Protective coatings shall be asphalt, polymer over galvanizing, aluminized coating, or coal tar

enamel as appropriate for the pipe type. Plastic pipe that will be exposed to direct sunlight shall be protected from ultraviolet light.

Principal spillway pipe outlet. Where a SAF stilling basin, impact basin, flared outlet, or similar pipe outlet device is not used, principal spillway pipe outlets must be placed above outlet channel water level, and at least one foot above base grade of the outlet channel. When pipe supports are used, the outlet end of the pipe must extend at least five feet beyond the point where the downstream slope of the dam fill intersects the flow line of the outlet channel or waterway. When pipe supports are not used, the pipe must extend at least five feet downstream of the intersection of the fill and bottom of pipe.

The pipe outlet must be supported and held firmly in position by pipe supports, earth or rock fill, or other means. Pipe supports shall be provided for cantilever outlets 24 inches or larger pipe diameter.

For pipe outlets 18 inches or larger diameter, the cantilever outlet pipe slope must not exceed 5 percent except as designed by an engineer.

Cantilever outlets shall be designed to withstand full pipe cantilever load plus applicable external loads such as ice or snow.

Cathodic protection. Cathodic protection is to be provided for steel pipe and other steel structures where soil and resistivity studies indicate the need. If cathodic protection is not provided for in the original design and installation, electrical continuity joint-bridging straps should be considered.

Control of seepage along pipes and other buried structures. For dams exceeding 15 feet effective height and for dams with permanent water storage, seepage along pipes and other structures passing through or under the dam must be controlled by a filter drain or antiseep collars.

If a filter drain is used, it must consist of sand meeting fine concrete aggregate requirements of ASTM C-33 or must be designed by an engineer.

Drains for control of seepage along pipes and other structures shall be located downstream of both the cutoff and dam centerline. This vertical drain shall be at least two feet thick and extend from the pipe or structure vertically upward at least two times the outside vertical dimension of the pipe or structure except the drain is not required to extend above permanent pool level. The drain shall extend horizontally at least two times the vertical dimension of the pipe or structure except the drain is not required to extend more than five feet beyond excavation side slopes. The drain shall extend from the bottom of the pipe or structure vertically downward at least 1.5 feet, except the drain is not required to penetrate solid rock.

Outlets for drains shall be located downstream of the downstream embankment toe using a drain pipe or continuous drain backfill envelope along the pipe (or other structure) to where it exits the embankment. Exposed drain fill must be protected from erosion.

When anti-seep collars are used in lieu of a drainage diaphragm, they shall have a watertight connection to the pipe or structure. Maximum collar spacing shall be approximately 14 times the minimum projection of the collar measured perpendicular to the pipe but not more than 25 feet. Minimum spacing shall be 10 feet. Collar materials shall be compatible with pipe (or structure) materials. The anti-seep collar(s) shall increase the seepage flow path length along the pipe (or structure) by at least 15 percent.

Trash guard. To prevent clogging, appropriate trash guards shall be installed at pipe inlets.

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

Pipes through the dam for water supply to troughs, etc. shall be at least 1-1/4 inches in diameter and shall be 160 PSI minimum working pressure.

Auxiliary spillways. Auxiliary (emergency) spillways convey large flood flows safely past earth embankments.

An auxiliary spillway must be provided for each dam except as follows. Without an auxiliary spillway, the principal spillway and flood storage must handle the routed design storm (Table 3) plus freeboard without overtopping the dam.

Closed pipe spillways used without an auxiliary spillway, must have a cross-sectional area of three square feet or more, an inlet that will not clog, and an elbow designed to facilitate passage of trash.

Natural or constructed auxiliary spillways must pass the peak or routed flow expected from the

design storm in Table 3, less reductions creditable to conduit discharge and detention storage.

The routing shall start either with the water surface at principal spillway crest elevation or at the water surface after 10 days' drawdown, whichever is higher. The 10-day drawdown shall be computed from auxiliary spillway crest elevation or the elevation that would be attained if the entire design storm were impounded, whichever is lower. Auxiliary spillways shall pass the design flow at a safe velocity to a downstream point where the dam will not be endangered.

Constructed auxiliary spillways are open channels that usually consist of an inlet channel, a control section, and an exit channel. They shall be trapezoidal and located in undisturbed or compacted earth or in-situ rock or shall be stabilized by structures designed by an engineer. The side slopes shall be stable for the material in which the spillway is to be constructed, but shall not be steeper than 2:1 in earth materials. For dams having an effective height exceeding 20 feet, the auxiliary spillway shall have a bottom width of not less than 20 feet.

The layout and configuration of the auxiliary spillway shall conform to National Engineering Handbook (NEH), Part 628, Dams Chapter 50, "Earth Spillway Design."

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 (at least 30 feet in earth materials). The inlet channel may be curved to fit existing topography.

The grade of the constructed exit channel shall fall within the range established by discharge requirements and permissible velocities for the operating conditions. Allowable velocities in the exit channel and classification of retardance shall be in accordance with Exhibit 11-2, Chapter 11 of the NEH, 650, Engineering Field Handbook (EFH) except where a soils investigation has been conducted to establish parameters for a detailed stability and integrity design. In this case, methods outlined in Agricultural Handbook Number 667 and employed by the SITES computer program may be used.

For auxiliary spillways without a constructed exit channel downstream of the control section, the velocity of the water through the inlet section and upstream of the crest shall be less than five feet per second.

For all auxiliary spillways, the natural exit channel should be evaluated for long-term stability and maintenance requirements.

Structural auxiliary spillways. If chutes or drops are used for principal spillways or auxiliary spillways, they shall be designed according to the principles set forth in the Part 650, EFH, and the NEH, 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 or routed flow expected from a design storm of the frequency and duration shown in Table 3, less any reduction creditable to conduit discharge and detention storage.

Table 3. Minimum Auxiliary Spillway Capacity

			Min. design storm[2/]	
Drainage area (ac)	Effective height of dam1 (ft)	Storage (ac-ft)[1/]	Frequency (Years)	Min. duration (Hours)
20 or less	20 or less	< than 50	10	24
All others		< than 50	25	24
All others		> than 50	50	24

[1/] As defined under "Conditions where Practice Applies."
[2/] Select rain distribution based on climatological region.

Freeboard. Minimum elevation of settled top of dam shall be one foot above water surface in the reservoir with the auxiliary spillway flowing at design depth. Minimum difference in elevation between crest of the auxiliary spillway and settled top of dam shall be 2 feet for all dams having more than a 20-acre drainage area or more than 20 feet in effective height.

For dams without an auxiliary spillway, settled top of dam must be at least 1.5 feet above routed design hydrograph elevation.

ADDITIONAL CRITERIA FOR EXCAVATED PONDS

Runoff. Provisions shall be made for a pipe and auxiliary spillway, if needed, that will meet the capacity requirements of Table 2. Runoff flow patterns shall be considered when locating the excavated pond and placing the spoil.

Side slopes. Side slopes of excavated ponds shall be stable and shall not be steeper than 1.5 horizontal to 1.0 vertical. If livestock will water

directly from the pond, a watering ramp of ample width shall be provided. The ramp shall extend to the anticipated low water elevation at a slope no steeper than 4.0 horizontal to 1.0 vertical.

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

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 it will not be washed back into the pond by rainfall. Spoil must not be placed in a manner that will cause erosion, restrict runoff flow, limit floodplain capacity, or destroy wetlands (except as mitigated). It shall be disposed of in one of the following ways:

Uniformly spread spoil to a height that does not exceed three feet, with the top graded to a continuous slope away from the pond.

Uniformly place or shape spoil, 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 spoil to a designed form that blends visually with the landscape.

Use spoil for low embankment construction and leveling of surrounding landscape.

Haul spoil away.

ADDITIONAL CRITERIA FOR LIVESTOCK WATER

Minimum depth of storage reserved for livestock water shall be 10 feet east and 12 feet west of the Missouri River except as follows. For excavated ponds where ground water is encountered, the minimum depth may be reduced to 6 feet provided the bottom is at least 1.0 foot below average low ground water level. Ponds must have a minimum 500 square foot bottom area at the minimum allowable depth.

This practice must (1) improve grazing distribution, (2) meet water quantity and quality requirements of the livestock, and (3) be the most feasible method of providing the needed water supply.

Distribution of livestock watering places should limit livestock travel between forage and dependable water to one mile in gentle relief and one-half mile in rough topographic relief.

ADDITIONAL CRITERIA FOR FISHPONDS

This criteria applies to portions of ponds intended to meet the standard for Fishpond Management (399).

The drainage area must not include areas of concentrated organic wastes or other pollution.

Exclude livestock from shoreline areas except for limited lanes for livestock water. Provide a buffer of perennial vegetation at least 50 feet wide between the pond and cropland or barren areas.

Trout pond. For constant cold (45 to 60°F) inflow, minimum depth is 15 feet over 20 percent of the pond area, and minimum pond surface area is 0.5 acres.

For intermittent inflow, minimum depth is 20 feet over 20 percent of the pond area, and minimum pond surface area is 1.0 acre.

Warm water pond. Minimum pond size is 1.0 surface acre. For constant inflow, minimum depth is 12 feet over 20 percent of the pond area. For intermittent inflow, minimum depth is 15 feet over 20 percent of the pond area.

ADDITIONAL CRITERIA FOR RECREATION AND FIRE CONTROL

For recreation, livestock should be excluded from the pond shoreline. For water contact recreation, livestock must be excluded. Recreation ponds must have 50 feet or wider perennial grass buffers between the pond and cropland or barren areas.

For fire control, deep water (over 15 feet) located near the withdrawal location is most desirable.

ADDITIONAL CRITERIA FOR UPLAND WILDLIFE WATER

If purposes include upland wildlife water practice standard, Wildlife Watering Facility (648), and Upland Wildlife Habitat Management (645) must be met.

Water developments for wildlife must follow the wildlife habitat plan and species' needs identified on form SD-CPA-26.

The design must assure that the depth, duration of water presence, and shoreline slopes are adequate for the identified specie's habitat needs and the identified season of use.

Ponds designed for watering large wild animals (antelope, deer, elk, etc.,) must meet criteria for livestock water. Where livestock water is not a purpose, this standard may be used for large wild

animal water **only** where there is no other available source of surface water within a three mile radius of the proposed pond location.

Exclude livestock from wildlife areas except for limited lanes for livestock water. Protect wildlife areas from vehicle travel and other intrusions.

CONSIDERATIONS

Consider the potential for changes in the form or function of the watercourse and associated riparian corridor. Unacceptable negative impacts should be mitigated by design or dam operation.

Visual resource design. In areas of high public visibility or recreation uses, consider visual impacts. The underlying criterion for all visual design is appropriateness. Shapes and forms of ponds, excavated material, and plantings should relate visually to their surroundings and function.

Shape earthwork to blend with the natural topography. Reservoir edges may be shaped curvilinear rather than rectangular. Spoil can be shaped smooth, flowing, and blended to the adjacent landscape rather than angular geometric mounds. Both submerged and exposed islands add visual interest and attract wildlife.

Water quantity. Consider effects on downstream flows and environmental impacts to wetlands and aquifers, etc. Consider social and economic impacts to uses and users.

Consider the potential for depletion of downstream surface water resources resulting from runoff storage, evaporation, and seepage.

Consider the potential for additional deep percolation of reservoir seepage.

Water quality. Consider the effects of potential downstream water quality changes (temperature, sediment load, oxidation, etc.) Provide remedial measures as appropriate.

Consider increased instability of channel bed and banks due to reduced sediment load.

Consider the potential for degradation of water quality during construction.

Consider the potential for increases in soluble nutrients, pesticides, and other contaminants in deep percolating waters.

Fish and wildlife habitat. Project location and construction should minimize impacts to existing fish and wildlife habitat.

Avoid creating a competitive advantage for non-native or undesirable animals or plants.

Vegetation. Stockpiling topsoil for placement on disturbed areas can facilitate revegetation.

Consider placement and selection of vegetation to improve fish and wildlife habitat and species diversity.

PLANS AND SPECIFICATIONS

Plans and specifications for installing ponds shall meet this standard and describe requirements needed to achieve the purposes.

OPERATION AND MAINTENANCE (O&M)

An O&M plan shall be prepared for use by the owner/operator. The plan must include the items needed to achieve the purposes.