Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

FISH RACEWAY OR TANK

Code 398

(No.)

DEFINITION

A channel or tank with a continuous flow of water constructed or used for high-density fish production.

PURPOSE

A fish race way or tank provides—

- A facility containing flowing water of suitable temperature and quality for dependable production of fish.
- Allows for the manipulation of chemical, physical, and biological factors to enhance fish production.

CONDITIONS WHERE PRACTICE APPLIES

This standard applies to raceways or tanks that conduct flowing water to produce fish. It applies to earthen channels as well as channels and tanks constructed of concrete, concrete block, timber, rock, fiberglass, or other materials.

CRITERIA

General Criteria Applicable to All Facilities

Design a facility to provide protection from flooding, sedimentation, and contamination by pollutants from outside sources.

Design raceway or tank dimensions based upon the available water and planned production level.

Water Quantity. Maintain a water supply of sufficient volume to produce the desired species, either by gravity flow or by pumping. Generally, this amount would equate to two complete water exchanges per hour for a raceway length of 80 to 100 ft. Measure the water volume during periods of low flow.

Water Quality. Supply water free of harmful gases, minerals, silt, pesticides, and other contaminants. Conduct a water analysis before design and construction unless previous use or experience indicates the satisfactory water quality for the desired species. Table 1 provides an example of water quality requirements for trout and catfish. Unique water quality parameters may apply to other species.

Table 1. Water quality requirements

Quality parameter		Species	
		Trout	Catfish
Dissolved oxygen	Desirable minimum	8 ppm or > 5 ppm	5 ppm or > 3 ppm
Temperature (ºF)	Desirable min./max.	55 – 64 45 / 70	75 – 84 70 / 90
pH	Desirable min./max.	6.5 – 9.0 6.0 / 9.5	6.5 – 9.0 6.0 / 9.5
Carbon dioxide	Desirable min.*/max.	2 ppm or < 0 / 3 ppm	5 ppm or < 0 / 10 ppm

**Toxicity varies with dissolved oxygen concentration, temperature and pH.*

Predator control. As needed, provide fences, screens, nets, wires, or other materials to prevent the loss of fish to predators. Place traps or other devices potentially harmful to humans, livestock, or pets in secure locations not normally accessible except through special effort. A State agency may require a license or permit to perform such activities.

Waste management. Develop plans for treatment, storage, or use of waste generated or caused by the operation of fish raceways or tanks. Such components may include the construction of NRCS Conservation Practice Standard (CPS) Waste Storage Structures (Code 313), CPS Waste Treatment Lagoons (Code 359), settling basins, or other facilities. Spread waste in accordance with CPS Nutrient Management (Code 590). Discharges into streams must meet State standards for the stream, based on size of the operation, and comply with National Pollutant Discharge Elimination System (NPDES) regulations.

Criteria Applicable to Linear Channel Raceways

Raceways generally consist of linear channels where water flows in at one end and exits at the other end. Linear channel raceways generally consist of two types:

- **Concrete or concrete block construction**—Design and construct raceways in accordance with NRCS National Engineering Manual, Part 536, Structural Design. When designing concrete or concrete block raceways, use the same design material for the bulkheads or check dams.
- **Earthen channels constructed with a trapezoidal or parabolic cross section**—Design raceways with a trapezoidal or parabolic cross section. Design bottom widths based on the volume of water available, but not less than 4 ft. Design side slopes 1:1 or flatter, depending on a slope stability analysis. Design and construct side slopes and bottoms of raceways with smooth and uniform surfaces to minimize dead water areas.

Grade. Wherever possible, design and construct raceways with a minimum bottom grade of 0.5 ft. per 100 ft. The raceway outlet will control the water surface grade.

Length. Determine the maximum length of each raceway section by site topography and need for reaeration of the water, but no more than 100 ft. For the design of raceway sections in series, install a bulkhead or check dam at the lower end of each section.

Width. Select the width of individual raceways considering the available water supply, harvesting equipment and operating and maintenance needs of the system.

Freeboard. The minimum difference in elevation between the water surface in the raceway and the top of the bulkhead, dike, or levee alongside the raceway is 0.5 ft.

Dikes and levees. Design a 6 ft.-minimum top width of an earthen dike or levee. Use 2:1 or flatter side slopes for portions of earthen dikes and levees above the water surface. Use a 14 ft.-minimum top width and 3:1 or flatter side slopes when using the top of the dike or levee as a road.

Bulkheads. Place structural or earthen barriers called bulkheads across raceway channels to create shorter sections, to establish and maintain the desired water levels, and to provide aeration of the water. In addition to serving as a barrier, they shall have an opening or throat section that allows complete drainage to the bottom of the raceway channel unless providing other drainage facilities.

Design bulkheads using earth, concrete, concrete block, rock masonry, steel or other durable metal, treated timber or a combination of these as follows:

- Provide a minimum top width of 4 ft. and side slopes of 2:1 or flatter for earthen bulkheads.
- Provide a minimum top width of 6 in. and a minimum bottom width of 8 in. for reinforced concrete bulkheads.
- Extend concrete, concrete block, rock masonry, or steel bulkheads used in earthen raceways at least 24 in. into the sides and bottom of the channel.
- Design the opening or throat section of bulkheads using concrete, concrete block, wood, or metal.
- Provide slots or grooves along the vertical face that allow installation of flashboards and screens.
- Fill openings and cores in concrete blocks with either concrete or a mortar mix.

Drains. Provide a pipe drain with a minimum diameter of 6 in. at the bottom of the bulkhead or provide for flashboard removal to allow complete drainage. Where possible, design each unit in a series to allow drainage independent of the other units.

Screens. Provide screens at the inlet of the system if necessary to exclude wild fish. Provide screens at each bulkhead between sections and at the exit end to prevent loss of fish. Place screens at least 6 to 8 in. upstream from the flashboards and extend screens at least 6 to 8 in. above the expected water level to prevent fish escape from jumping. Design screen openings based on the size range of fish requiring separation. Maintain water velocity through screens slow enough to prevent impinging of fish against the screen.

Aeration. Fit each bulkhead with a weir overfall such as flashboards in the opening or throat section of the bulkhead. Design the width of the weir or weirs equal to the bottom width of the raceway, but not less than 4 ft. where using flashboards to establish the desired water level. Design two or more weirs separated by rigid center sections when the width of the raceway exceeds 8 ft. To increase aeration as part of the design, arrange a splash board or series of boards to create successive splashes or place nozzles in the tank above the water surface. Set the weir crest at least 1 ft. above the downstream water surface elevation.

Criteria Applicable to Tanks

Tanks generally have a circular, rectangular, or oval shape. Water enters a tank through nozzles or jets in a manner that creates a rotary circulation within the tank and typically discharge through the tank center by means of a standpipe or bottom drain.

Construct tanks using concrete, metal, fiberglass, or other suitable material capable of providing the strength and durability for the anticipated use. Noncircular tanks must have an interior dividing wall to obtain proper circulation. Construct tank raceways at locations accessible to water supplies, management personnel, and feed and harvest equipment.

Water supply. Install jets, nozzles or similar devices that provide a tangential force to the water in the tank. Locate submerged nozzles above the tank bottom to minimize the uplift of waste particles. In the Northern Hemisphere, position nozzles to direct flow counterclockwise; in the Southern Hemisphere, position nozzles to direct flow clockwise.

Waste removal. Incorporate provisions for waste removal in the design. Provide bottom troughs, screens, or center-positioned drainpipe as part of the tank construction.

CONSIDERATIONS

Fish and wildlife

Consider the impacts of cultivated nonnative fish on endemic fish populations.

Vegetation

Stockpile topsoil for placement on disturbed areas to facilitate revegetation. Consider selecting and placing vegetation to improve fish habitat, wildlife habitat and species diversity.

Water quantity

Consider effects upon components of the water budget, such as—

- Effects on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and groundwater recharge.
- Variability of effects caused by seasonal or climatic changes.
- Effects on downstream flows and impacts to environment such as wetlands, aquifers, and social and economic impacts to downstream uses or users.

Water quality

Consider the effects of—

- Erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances that runoff carries.
- Short-term and construction-related effects of this practice on the quality of downstream watercourses.
- Water-level control on the temperatures of downstream water to prevent undesired effects on aquatic and wildlife communities.
- Wetlands and water-related wildlife habitats.
- Water levels on soil nutrient processes such as plant nitrogen use or denitrification.
- Soil water level control on the salinity of soils, soil water, or downstream water.
- Potential for earth moving to uncover or redistribute toxic materials.
- Movement of dissolved organic and inorganic chemicals downstream and towards groundwater recharge areas.

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 facility and appurtenant features.
- Typical profiles and cross sections of the facility and appurtenant features as needed.
- Structural drawings adequate to describe the construction requirements.
- Requirements for vegetative establishment and/or mulching, as needed.
- Safety features.
- Site-specific construction and material requirements.

OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan for the operator.

As a minimum, include the following items in the operation and maintenance plan:

- Periodic inspections of all structures, earthen embankments, and other significant appurtenances.
- Prompt repair or replacement of damaged components.
- Prompt removal of sediment when it reaches predetermined storage elevations.
- Periodic removal of trees, brush, and undesirable species.
- Periodic inspection of safety components and immediate repair if necessary.
- Maintenance of vegetative protection and immediate seeding of bare areas as needed.

REFERENCES

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

Timmons, M.B., Ebeling, J.M., Wheaton, F.W., Summerfelt, S.T. & Vinci, B.J. 2001. Recirculating Aquaculture Systems. Cayuga Aqua Ventures. Ithaca, NY.

USDA NRCS. NEH, Part 633, Soil Engineering. Washington, DC.

USDA NRCS. NEH, Part 650, Engineering Field Handbook. Washington, DC.

USDA NRCS. National Engineering Manual. Washington, DC.