

CONSERVATION PRACTICE STANDARD

CONSTRUCTED WETLAND

(No.)

CODE 656

DEFINITION

An artificial ecosystem with hydrophytic vegetation for water treatment.

PURPOSE

For treatment of wastewater and contaminated runoff from agricultural processing, livestock, and aquaculture facilities, or

For improving the quality of storm water runoff or other water flows lacking specific water quality discharge criteria.

CONDITIONS WHERE PRACTICE APPLIES

- Constructed wetlands for the purpose of wastewater treatment apply where a constructed wetland is a component of an agricultural wastewater management system.
- Constructed wetlands for the purpose of water quality improvement apply where wetland effluent is not required to meet specific water quality discharge criteria.

This standard should not be used in lieu of NRCS Conservation Practice Standards, Ponds (PA378), Wetland Restoration (PA657), Wetland Creation (PA658), or Wetland Enhancement (PA659), when the main purpose is to restore, create, or enhance wetland functions other than for wastewater treatment or water quality improvement.

CRITERIA

General Criteria Applicable To All Purposes

All federal, state, and local laws, rules, and regulations governing the use and the management of constructed wetlands for wastewater treatment, must be followed.

Constructed wetlands for wastewater treatment shall not be designed to discharge directly into water bodies, drainage courses, or other waters of the state.

Locate the wetland to minimize the potential for contamination of ground water resources, and to protect aesthetic values.

A water budget that evaluates runoff or wastewater volumes, precipitation, evaporation, seepage loss, and water use shall be used to determine the hydraulic retention time in the wetland, storage requirements of the wetland pretreatment and post treatment facilities when included, and the possible need for supplemental water.

Provide appropriate inlet control structures to prevent debris from entering the wetland, to control the rate of inflow during normal operations, and to control inflow as necessary for operation and maintenance.

Provide an outlet control structure capable of maintaining appropriate water depths to achieve the desired water treatment, and to meet the requirements of the hydrophytic vegetation.

The minimum height of interior embankments shall contain the design water depth and a sufficient depth for the accretion of settleable solids, decayed plant litter and microbial biomass. In the absence of an accretion rate analysis the minimum depth for accretion shall be 1 inch per year for either the design life of the practice or between scheduled debris and sediment removal maintenance operations.

Provide an auxiliary spillway or inlet bypass with sufficient capacity to pass the peak flow of the 25-year frequency, 24-hour duration storm and provide erosion protection for the perimeter embankment.

Unless otherwise specified, the spillway requirements, embankment configurations, excavated side slopes, protective cover on disturbed soils and disposal of excavated material shall comply with the general criteria, criteria for embankment ponds, and criteria for excavated ponds as appropriate as contained in Conservation Practice Standard, Pond (PA378).

Soils used in constructing the embankment shall be suitable for that purpose according to the Unified Soil Classification System.

The constructed wetland shall be located in soils with an acceptable permeability that meets all applicable regulations, or it shall be lined in accordance with Conservation Practice Standard, Pond Sealing or Lining (PA521). Measures for controlling seepage with a soil liner shall be designed according to the procedures of NEH Part 651, Agricultural Waste Management Field Handbook, Appendix 10d, "Geotechnical Design and Construction Guidelines". The use of soil dispersants shall conform to standard PA 521B, and the use of bentonite shall conform to standard PA 521C.

A flexible membrane liner conforming to standard PA521A may be used in place of a soil liner.

Use a planting medium that has a cation exchange capacity, pH, electrical conductivity, organic matter, and textural class that is conducive to wetland plant growth and retention of contaminants.

Select wetland plants that are suitable for local climatic conditions and tolerant of the concentrations of nutrients, pesticides, salts and other contaminants flowing into the wetland. Do not use invasive or non-native species that could be a problem in native habitats.

Provide supplemental water as necessary to establish and maintain plants in a condition suitable for the water treatment purpose.

Criteria Applicable to Wastewater Treatment

Locate outside the boundary area of natural wetlands of any classification.

Surface and subsurface waters shall be captured and diverted around the constructed wetland cells by means of conservation practices such as; Diversions (PA362), Subsurface Drains (PA606), or other related structures to meet the intended purpose.

When located in a floodplain, provide protection from inundation or damage from a 25-year frequency flood event.

Constructed wetlands shall be located to provide sufficient separation distances from structures such as residences and commercial buildings so prevailing winds and landscape elements such as building arrangements, landforms, and vegetation will minimize odors and protect aesthetic values. They shall be located with a separation distance that will minimize the potential for contamination of ground water resources. This distance shall be in accordance with laws, rules, and regulations.

Pretreat water flowing to the wetland to reduce the concentrations of solids, organics, and nutrients to levels that will be tolerated by the wetland system and to prevent excessive accumulation of solids within the wetland.

Provide sufficient storage upstream of the wetland to contain the wastewater and runoff from a 25-year frequency, 24-hour duration storm. The outlet of this storage shall deliver the water to the wetland at a rate consistent with the treatment objectives of the wetland.

Design the wetland system with a minimum of two rows of functionally parallel cells.

Determine the surface area using design procedures in NRCS National Engineering Handbook, Part 637, Chapter 3, *Constructed Wetlands*, or alternative design procedures that are recognized by the regulatory and academic conservation partners in the state.

Construct wetland cells with a sufficient length-to-width ratio to assure uniform and predictable hydraulic retention times.

Inlet and outlet plumbing shall be configured to allow any of the parallel cells to continue to operate if all the others are shut down for repairs, resting, replanting, etc.

Control seepage as necessary for similar wastewater management facilities.

The constructed wetland shall discharge to a wastewater treatment strip; Conservation Practice Standard (PA635), or a waste storage facility; Conservation Practice Standard (PA313) to allow for land application. The effluent can also be recycled through the waste management system. If a vegetated treatment strip is to be used, then dosing the treatment strip is required, as per Practice Standard (PA635). Discharge to the waters of the Commonwealth is not permitted.

Exclude livestock from the wetland.

Criteria Applicable to Water Quality Improvement

When located in a floodplain or watercourse provide protection from damage from a 10-year frequency flood event.

When used to improve the water quality of surface water runoff, design the wetland so that it will return to design operating levels within 72 hours after a 10-year frequency, 24-hour duration storm event.

When used in populated areas install safety fences and warning signs forbidding access by unauthorized persons.

CONSIDERATIONS

Consider using a constructed wetland, for treating only one (1) wastewater source. Multiple wastewater sources directed to a single wetland could potentially overload the wetland system. Larger agricultural operations, producing large volumes of wastewater, may want to consider other options for treating wastewater.

Consider limiting the hydraulic loading rate, to a wetland, to 2 inches/day and the nitrogen loading rate to 22.9 lbs total nitrogen (TN) per acre per day.

Consider establishing multiple wastewater treatment strips for treatment of the effluent out of the wetland. Enabling a treatment strip to periodically rest or dry out could enhance the efficiency of the treatment system.

Consider limiting a wastewater treatment strip location to only deep, well-drained or moderately deep, moderately well-drained soils or any combination thereof.

Consider not treating milk-house wastewater in a constructed wetland due to the possibility of generating undesirable odors in the wetland.

Consider not using the wetland for wastewater treatment until the hydrophytic plants have been established.

Consider increasing the hydraulic retention time in the wetland cells for winter time use.

Due to the possibility of high potassium and other nutrients being available in the vegetation in the wastewater treatment strip, caution should be taken when feeding this forage to cattle.

Consider the impact a constructed wetland could have on existing wetlands or other significant features in the landscape ecosystem.

Consider bat boxes, mosquito fish, and other measures to control vectors and nuisance insects when locating the wetland near residences, commercial buildings, and public use areas.

Consider seasonal storage of contaminated water upstream of the wetland during cold, dry, or excessively wet climatic conditions when the function of the wetland may be compromised.

Effluent from the wetlands may be stored for land application, recycled through the wastewater management system, or otherwise used in the agricultural operation.

Where wetland performance may be compromised by large, infrequent storm events, consider providing an inlet that captures the first flush of storm water runoff and allows excess flow to bypass the wetland.

Consider a sedimentation basin, and reaches of shallow and deep water within the wetland.

Provide inflow and outflow structures and cell geometries that promote cross-sectional mixing of water flowing through the wetland cell.

When selecting vegetative species, give priority to native wetland plants collected or

grown from material within the Major Land Resource Area (MLRA) of the Constructed Wetland location, and consider the potential to transport chemical contamination from the wetland plant site to the constructed wetland.

Select plant materials that provide habitat requirements for desirable wildlife and pollinators. The addition of native forbs and legumes to grass mixes will increase the value of plantings for both wildlife and pollinators.

Fences or other measures may be needed to exclude or minimize access of humans or animals that could be adversely affected by the constructed wetland or that would inhibit its function.

Consider access for animals that might be attracted to the wetland, and egress for fish that could be entrained and trapped. Flatter side slopes generally provide better habitat for wildlife. If there is a desire to use the constructed wetland for wildlife habitat, consult Conservation Practice Standards, Wetland Restoration (PA657), Wetland Enhancement (PA659), Wetland Creation (PA658), Wetland Wildlife Habitat Management (PA644), and Shallow Water Development and Management (PA646).

Consider providing embankment protection against burrowing animals.

Consider vegetative buffers (herbaceous and woody) around the perimeter of constructed wetland for additional filtering of pollutants entering and leaving wetland areas during precipitation events.

Consider the potential of pollutants and chemicals entering the wetland that may cause environmental problems due to accumulation, biological uptake, or release during maintenance operations. Chemicals could result from cattle foot baths, wash down of milk-house or milking parlor floors or equipment, or other similar locations or procedures.

Provide an adequate access for cleanout and maintenance.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for each specific field site where a constructed wetland

will be installed. Define the purpose, goals, and objectives of the practice and the soils, hydrology, and vegetation criteria. Include information about the location, construction sequence, and vegetation establishment.

Specifications shall include:

- Dimensions of the constructed wetland
- Species selection
- Seeding rates, sprigging rates or planting density of containerized plants.
- Planting dates, care and handling of the seed to ensure that planted materials have an acceptable rate of survival.
- Site preparation such as stabilizing crop, mulching, or mechanical means of stabilizing, fertilizer, and pH adjustment sufficient to establish and grow selected species.

OPERATION AND MAINTENANCE

Develop an operation and maintenance plan that is consistent with the purposes and intended life of the practice. Include the requirements for safety, water management, cleanout of sediment, maintenance of structures, embankments, and vegetation, control measures for vectors and pests, and containment of potential pollutants during maintenance operations.

Operational requirements include, but are not limited to:

- Maintenance of water level in wetland cells appropriate for vegetation
- Control flow to wetland according to water budget
- Monitoring of wetland performance
- Sampling effluent for nutrients prior to utilization
- Surveillance of inlet and outlet

Maintenance requirements should include, but are not limited to:

- Repair of embankments
- Control density of desirable vegetation.

- Removal of invasive and/or non-native species that could be a problem in native habitats
- Repair of fences or other ancillary features
- Replacement of wetland plants
- Repair of pipelines and spillways
- Control of unwanted animals (varmints) or vectors (mosquitoes)
- Periodic sediment removal

REFERENCES

USDA, NRCS. National Engineering Handbook, Part 637, Chapter 3. Constructed Wetlands.