NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

CONSTRUCTED WETLAND
(Ac.)
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

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- Constructed wetlands for the purpose of wastewater treatment apply where a constructed wetland is a component of an agricultural wastewater management system.
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- 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, Wetland Restoration (657), Wetland Creation (658), or Wetland Enhancement (659), when the main purpose is to restore, create, or enhance wetland functions other than 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 of constructed wetlands must be followed.

Constructed wetlands for waste treatment shall not be designed to discharge to waters of the state unless permitted by state laws and regulations, and appropriate permits have been obtained to do so.

In addition, if discharge is permitted, the receiving surface water must have the capacity to assimilate the constructed wetland's effluent during low flow periods.

Type. Constructed wetlands shall be designed as surface flow systems consisting of adequate seepage control, a suitable plant medium, rooted emergent hydrophytic vegetation, and the structural components needed to contain and control the flow.

Influent. The influent to the constructed wetland shall be pretreated to reduce the concentrations of solids, organics, and nutrients to levels that will be tolerated by the wetland system and not cause excessive accretion within the wetland.

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 Field Office Technical Guide.

Where significant sediment and organic debris are expected in the wastewater or runoff to be treated, provisions for its entrapment before entry into the wetland must be provided.

Seepage control. The constructed wetland shall be located in soils with an acceptable permeability that meets all applicable regulations, or it shall be lined. Measures for controlling seepage shall be designed according to the procedures of NEH Part 651, Agricultural Waste Management Field Handbook, Appendix 10d, "Geotechnical Design and Construction Guidelines."

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

Constructed wetlands shall be located outside the limits of wetlands of any classification.

Constructed Wetlands shall be located in accordance with Arkansas Pollution Control and Ecology Commission Regulation 5, Liquid Animal Waste Systems, Section 5.403; Siting Requirements.

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 settlable 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 NRCS Conservation Practice Standard Pond (378).

The perimeter embankment shall have a minimum top width of 10 feet. Interior embankments shall have a minimum top width of 8 feet.

All embankment side slopes shall be a minimum of a 3 horizontal to 1 vertical for perimeter embankment 2 horizontal to 1 vertical for interior embankments.

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

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. Preference shall be given to native wetland plants with localized genetic material. Plant materials collected or grown from material collected within the same Major Land Resource Area (MLRA) are considered local.

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

Water budget. A water budget that evaluates runoff or wastewater volumes, precipitation, evaporation, and water use shall be used to determine the required hydraulic retention time in the wetland and storage requirements of the wetland pre-treatment and post treatment facilities when included.

Criteria Applicable to Wastewater Treatment

Topography. Site topography shall accommodate the requirements for length to width ratios of the wetland and the wetland cells, and the requirement that the wetland cells be level side to side with grades of less than 0.05 ft/ft lengthwise.

Inlet. An inlet structure that will allow control of flow discharged to the wetland and screening of influent to prevent debris from entering the wetland shall be provided. Design of the inlet structure shall assure its function throughout the life of the wetland considering accretion.

Influent. Constructed wetlands for wastewater treatment shall not allow for direct inclusion of contaminated and/or uncontaminated runoff.

Wastewater will be of sufficient volume and duration to keep the constructed wetland moist at all times or accommodations shall be made for the addition of supplemental water.

Surface Area. The surface area of the wetland shall be determined using a recognized design procedure in consideration of loading, temperatures, and the desired level of treatment.

Configuration. The constructed wetland shall have an overall length-to-width ratio of 1:1 to 4:1. Individual cells within the constructed wetland shall have a length-to-width ratio of 10:1 to 15:1. The wetland shall consist of at least two rows of parallel cells

Flow depth. The design depth shall be based on the most severe season of operation, the desired level of treatment, and the required littoral

zone of the plant species being used. The design depth shall be a minimum of 0.33 ft. and a maximum of 1.5 ft.

Embankments. Height of the constructed wetland perimeter embankment shall be the sum of the following:

- Design depth.
- Wetland accretion -- a minimum of 1 inch per year for the design life or in accordance with the Operations and Maintenance Plan.
- Normal runoff less evaporation on the surface area (at the design storage volume level) of the facility during the storage period.
- Normal runoff from the facility's drainage area during the storage period.
- 25-year, 24-hour precipitation on the surface (at the required design storage volume level) of the facility.
- 25-year, 24-hour runoff from the facility's drainage area.
- 12 inches of freeboard.

The height of wetland's interior embankments shall be the minimum of the sum of the following:

- Normal design flow depth.
- Wetland accretion -- minimum of 1 inch per year for the design life or as shown in the O & M Plan.

Overflow Device. Shall not apply.

Outlet. Constructed wetlands will discharge to storage facilities to allow for land application or recycled through the waste management system unless Federal, State and local regulation allows discharge to waters of the state.

Additional Criteria for Wetlands Constructed for Runoff Treatment

Design Storm. The constructed wetland system shall be designed to contain a 2-year storm runoff. Limited area sites handling only the "first flush" volume shall have a minimum capacity to store 0.5 inch of runoff volume from the entire drainage area. When less than full runoff is stored, bypass of the excess storm flow shall be provided.

Detention time and surface area. The detention time and surface area shall be calculated on the time required to achieve the required level of treatment based on the limiting contaminant present.

Wetland Cells. Length-to-width ratios are to be 4:1 to 10:1. Other dimensions and shapes that provide a more natural landscape appearance that meets treatment requirements can be used.

The standard for Dike (356) shall be used as appropriate. Refer to the Engineering Field Handbook, Chapter 13, "Wetland Restoration, Enhancement, and Creation," and Chapter 6, "Structures," for design information.

Existing drainage systems will be utilized, removed, or modified as needed to achieve the intended purpose.

Depth. Maximum water depth shall be 24 inches except in those instances where deep water areas are included as a special design.

Outlet. A water control structure to automatically regulate storage release in accordance with the design detention time shall be installed.

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

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

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.

Control seepage as necessary for similar wastewater management facilities.

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.

Provide an adequate access for cleanout and maintenance.

CONSIDERATIONS

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.

Measures for controlling seepage may be designed according to the procedures in NRCS National Engineering Handbook, Part 651, Agricultural Waste Management Field Handbook, Appendix 10d, “Geotechnical Design and Construction Guidelines.”

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.

Consider the potential of pollutants entering the wetland that may cause environmental problems due to accumulation, biological uptake, or release during maintenance operations.

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 NRCS Conservation Practice Standards Wetland Restoration (657), Wetland Enhancement (659), Wetland Creation (658), Wetland Wildlife Habitat Management (644), and Shallow Water Development and Management (646).

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.

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

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- 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.
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Operational requirements include:

- 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:

- 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).

REFERENCES

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

A Handbook of Constructed Wetlands, a guide to creating wetlands for: Agricultural Wastewater, Domestic Wastewater, Coal Mine Drainage, Stormwater in the Mid-Atlantic Region Volume 1, 2, 3, 4 and 5.

Constructed Wetlands for Animal Waste Management, Paul J. DuBowy

and Richard P. Reaves, Purdue University.

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