



Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

WETLAND RESTORATION

CODE 657

(ac)

DEFINITION

The return of a wetland and its functions to a close approximation of its original condition as it existed prior to disturbance on a former or degraded wetland site.

PURPOSE

This practice is used to accomplish the following purposes:

- To restore conditions conducive to hydric soil maintenance
- To restore wetland hydrology (dominant water source, hydroperiod, and hydrodynamics)
- To restore native hydrophytic vegetation (including the removal of undesired species, and/or seeding or planting of desired species)
- To restore original fish and wildlife habitats

CONDITIONS WHERE PRACTICE APPLIES

This practice applies only to natural wetland sites with hydric soils which have been subject to the degradation of hydrology, vegetation, and/or soils. These sites may have been completely converted to non-wetland conditions by filling, draining, or other hydrologic changes, or they may still meet wetland criteria but have impaired functions due to hydrologic and/or vegetative modifications.

On sites where hydrology has been altered, this practice is applicable where the natural hydrologic conditions can be approximately restored by actions such as modifying drainage; restoring stream/floodplain connectivity; removing diversions, dikes, and levees; and/or by using a natural or artificial water source to provide conditions similar to the original, natural conditions.

This practice does not apply to:

1. The treatment of point and non-point sources of water pollution. Refer to the conservation practice standard for Constructed Wetland (656);
2. The rehabilitation of a degraded wetland, the reestablishment of a former wetland, or the modification of an existing wetland, where specific wetland functions are augmented beyond the original natural conditions; possibly at the expense of other functions. Refer to the conservation practice standard for Wetland Enhancement (659);
3. The creation of a wetland on a site that was historically not a wetland. Refer to the conservation practice standard for Wetland Creation (658);
4. The management of fish and wildlife habitat on wetlands restored under this standard. Refer to the Delaware conservation practice standard for Wetland Wildlife Habitat Management (644).

CRITERIA

General Criteria Applicable to All Purposes

The purpose, goals, and objectives of the restoration shall be clearly defined in the restoration plan, including soils, hydrology, vegetation, and fish and wildlife habitat criteria that are to be met and are appropriate for the site and the project objectives.

These planning steps shall be done with the use of a functional assessment-type procedure or a state approved equivalent. The objectives will be determined by an analysis of current and historic site functions. They will be based on those functions that can reasonably be supported by current site constraints. Data from historic and recent aerial photography and/or other remotely sensed data, soil maps, topographic maps, stream gage data, intact reference wetlands, and historical records shall be utilized to the extent feasible.

The soils, hydrology, and vegetative conditions existing on the site, the adjacent landscape, and the contributing watershed (if applicable) shall be documented during the planning process.

Where known nutrient and pesticide contamination exists, the nutrient and pesticide tolerance of the plant and animal species likely to occur shall be evaluated. If hazardous wastes are suspected on the site, test for the presence of hazardous waste in accordance with local, state, and federal requirements to identify appropriate remedial measures. If remedial measures are not possible or practicable, the practice shall not be planned.

Upon completion, the site shall meet soil, hydrology, vegetation, and habitat conditions of the wetland that previously existed on the site to the extent practicable.

Where offsite hydrologic alterations or the presence of invasive species impact the site, the design shall compensate for these impacts to the extent practicable.

Additional Criteria to Restore Hydric Soil

Wetland restoration sites shall be located on hydric soil. If the hydric soil is covered by fill, sediment, spoil, or other depositional material, the material covering the hydric soil shall be removed to the extent needed to restore the original soil functions.

Soil hydrodynamic and bio-geochemical properties, such as permeability, porosity, pH, or soil organic carbon levels, shall be restored to the extent needed to restore hydric soil functions.

Additional Criteria to Restore Hydrology

The hydroperiod, hydrodynamics, and dominant water source of the restored wetland shall approximate the conditions that existed before alteration. The restoration plan shall document the adequacy of available water sources based on groundwater investigation, stream gage data, water budgeting, or other appropriate means.

The work associated with restoring the wetland shall not adversely affect adjacent properties unless agreed to by signed written agreement or easement.

Timing and level setting of water control structures, if needed, will be based on the actions needed to maintain a close approximation of the original, natural hydrologic conditions.

The original natural water supply shall be used to reestablish the site's hydrology to approximate the hydrologic conditions of the wetland type, to the extent feasible. If this is not possible, an alternate natural or artificial water supply can be used; however, these sources shall not be diverted from other wetland resources. If the alternate water source requires energy inputs, these shall be estimated and documented in the restoration plan.

A variety of structural measures, including but not limited to embankments, surface drain plugs, subsurface drain plugs, removal of fill material, and shallow excavation, may be used as needed to restore hydrology. (Refer to “Additional Criteria for Structural Measures to Restore Hydrology.”) These measures may not be needed on restoration sites where the natural hydrology has not been significantly modified.

On sites that have been in long-term agricultural use, grading and shaping shall be used as needed to restore the diverse macro- and microtopography that occurs naturally in wetlands.

A soils investigation shall be performed to determine conditions for minimizing seepage losses; suitability of materials for embankment construction; adequacy of subsurface water supply; and capability to support desired plant species, as applicable.

After the site is restored, the soil shall generally remain undisturbed so that the wetland will perform its natural functions, including (but not limited to) accumulation of organic matter, nutrient and contaminant sequestration, and retention of surface and subsurface water.

Additional Criteria for Structural Measures to Restore Hydrology

Removal of Fill Material

See “Additional Criteria to Restore Hydric Soil.”

Shallow Excavation

A wetland may be restored by excavating below the existing ground surface to create a shallow basin that will hold surface water and/or intercept groundwater. The basin shall permit storage of water at a depth, frequency, and duration as closely as possible to the original hydrologic conditions on the site.

Surface Drain Plugs

In areas where open ditches were constructed to provide drainage, wetland hydrology may be restored by constructing surface drain plugs, using a pipe riser or other structures within the ditch to control the water level, or by filling a surface drain to the original ground line. Refer to the criteria for Embankments when fill will be placed on the ditch banks.

Provisions shall be made to store, pass through, or divert excess runoff. Use the Engineering Field Handbook, Chapter 14, to design the structure capacity.

Where practical, fill shall be relatively impermeable and be compacted to achieve the density of adjacent materials. Crown the fill a minimum of one foot above the top of the lower existing channel bank to account for settling. If site constraints require the use of organic fill, double the length of the plug as described below.

The minimum length of surface drain plugs shall be $(6H + 4)$ feet. “Minimum length” refers to the length as measured along the top of the plug. “H” is measured from the settled top of the plug to the low point along the centerline of the surface drain.

Subsurface Drain Plugs

In areas where subsurface drains were used to lower the water table, wetland hydrology may be restored by removing or plugging the drain or replacing the perforated drain with a non-perforated drain. The minimum length of drain to be removed or plugged shall be as follows:

Length of Drain	Average Hydraulic Conductivity of Soil
50 feet	<0.6 inches/hour
100 feet	0.6 to 2.0 inches/hour
150 feet	>2.0 inches/hour

All envelope filter material or other flow enhancing material shall also be removed for this length. The trench used to alter the drain shall be filled and compacted to achieve a density equal to adjacent natural soil material.

When subsurface drains also function as outlets for other drained areas, appropriate measures must be incorporated to keep the upstream drainage systems functional. A non-perforated pipe shall replace the perforated pipe through the wetland area to be restored, and shall extend beyond the wetland in all directions at least the minimum distance previously specified for Length of Drain to be removed or plugged. Drains may also be rerouted around the wetland at the same minimum distances from the wetland, or where topography permits, setting a water control structure at a level that does not affect upstream drainage.

A water control structure may be placed on the inlet of an existing drain. The water control structure shall be attached to a non-perforated conduit that extends at least the minimum distance previously specified for Length of Drain to be removed. The connections of the water control structure and the non-perforated pipe shall be watertight.

Embankments

Embankments may be used to impound water and provide wetland hydrology. Embankments that meet the definition and criteria for an embankment pond as described in the Delaware conservation practice standard for Pond (378) are not included as components of this standard.

Fills that will be entirely within a surface drainage ditch shall be designed according to the criteria for Surface Drain Plugs, as described previously in this standard.

Embankments shall be no more than 4 feet in height, with a minimum top width of 4 feet. On embankments with top widths of 6 feet or more, the combined upstream and downstream side slopes shall be a minimum of 5:1. On embankments with top widths of less than 6 feet, the combined upstream and downstream side slopes shall be a minimum of 6:1. Side slopes shall not be steeper than 2:1 in either case. When necessary, appropriate measures shall be taken to minimize seepage losses through the embankment and subsoil.

Spillways

A pipe conduit, vegetated spillway, or combination of both shall be provided where needed for safe passage of water. The minimum diameter for pipe conduit spillways is 6 inches. Trash racks are required on inlets to pipe conduit spillways, and rodent guards are required on outlets with diameters less than 12 inches.

The spillway capacity and freeboard shall be appropriate for the site conditions and potential damage to the feature or other areas on or off site due to erosion, breaching, or overtopping. Spillways installed in drainage systems shall have a minimum capacity based on drainage removal rates determined by Chapter 14 of the Engineering Field Handbook. Spillways installed to release surface runoff shall be designed to pass the 10-year, 24-hour storm. Provide a minimum of 0.5 foot of freeboard above the design flow depth.

Spillways installed for the slow release of water shall be designed to release the volume of the 10-year, 24-hour storm. The amount of time needed for release of excess water from a specific site shall be determined based on the depth of inundation and the species of wetland plants desired on the site.

Generally, wetland plants can tolerate excess inundation for periods of five consecutive days or more during the growing season.

Stabilization of Structural Measures

Embankments and surface drain plugs shall be vegetated according to the following criteria:

1. Slopes in woodland planned for natural regeneration to trees and shrubs - Use Mix 4 of the Delaware conservation practice standard for Critical Area Planting (342) with Virginia Wild Rye (*Elymus virginicus*) and without Deertongue. Apply mulch as per the criteria in the Mulching standard (484);
2. Slopes other than in 1 (above), steeper than 4:1, and vegetated spillways - Specify site treatment

and plantings according to the Delaware conservation practice standard for Critical Area Planting (342). When feasible, select plant species that are native to Delaware and/or beneficial to wildlife;

3. Slopes other than in 1 (above), 4:1 or flatter - For optimum wildlife habitat on most sites, specify seeding mixes in accordance with the Delaware conservation practice standard for Conservation Cover (327). In lieu of permanent seeding, natural regeneration may be used if all of the following conditions are met:

1. There is an adequate natural seed source of desired species in adjacent areas or in the soil seedbank;
2. Site conditions are favorable for establishing the desired number and distribution of plants within a specified time period;
3. Noxious or invasive species are not likely to jeopardize the natural regeneration process; and,
4. A nurse crop of 20 pounds per acre of annual ryegrass (not cereal rye), or 40 pounds per acre of oats, wheat, or barley, is planted to provide temporary cover.

If dense permanent cover is needed in a short period of time (e.g., the site will be intensively used, severe site conditions are present, or significant erosion control is needed), then use the Delaware conservation practice standard for Critical Area Planting (342) to specify the appropriate site treatment and plantings.

Erosion and Sediment Control

Construction operations shall be carried out in such a manner that erosion will be controlled and water and air pollution minimized both on-site and off-site. State and local laws concerning pollution abatement shall be followed. Construction plans shall detail erosion and sediment control measures to be employed during the construction process.

Site Preparation

Areas designated for borrow areas, embankment, and structural works shall be cleared, grubbed and stripped of topsoil. All trees, vegetation, roots, and other debris shall be removed from embankment fill. All cleared and grubbed material shall be disposed of outside the limits of the wetland.

When specified, stockpile a sufficient quantity of topsoil in a suitable location for use on the embankment and other designated areas. Selected woody debris shall also be stockpiled for use within the restored wetland, when specified.

Final Grading

All upland borrow areas shall be graded to provide proper drainage and left in a stable condition.

Pipe Conduits

Pipe conduits shall conform to the requirements in the Delaware conservation practice standard for Pond (378). Anti-seep collars are not required on embankments with a height of less than 4 feet.

Concrete

Concrete shall meet the requirements of USDA, NRCS, Delaware Material Specification 201, Concrete.

Rock Riprap

Rock riprap shall meet the requirements of USDA, NRCS, Delaware Material Specification 213, Rock for Riprap

Geotextile

Geotextile materials shall be placed under all riprap and shall meet the requirements of USDA, NRCS, Delaware Material Specification 222, Geotextile Fabric Woven and Nonwoven.

Additional Criteria to Restore Vegetation

Invasive species, federal/state listed noxious plant species, and nuisance species (e.g., those whose presence or overpopulation jeopardize the practice) shall be controlled on the site as necessary to restore

wetland functions. No plant listed by the state of Delaware as an invasive species shall be planted on the wetland restoration site. Noxious weeds shall be controlled as required by state law.

Hydrophytic vegetation shall consist of species typical of the wetland type(s) being established and the varying hydrologic regimes and soil types within the wetland. Adequate substrate material and site preparation necessary for proper establishment of the desired plant species shall be included in the restoration plan. Organic matter shall be added to the site as needed. (Refer to "Additional Criteria to Provide Organic Matter.")

Planting shall be used as appropriate to hasten establishment of desired species or to supplement the natural regeneration process. The use of species native to Delaware is required for all permanent plantings (not including temporary seedlings or nurse crops) in the wetland.

Site preparation and planting to establish vegetative cover shall be done at a time and manner to insure survival and growth of selected species. Provide supplemental moisture if and when necessary to assure early survival and establishment of selected species.

Only viable, high quality seed and planting stock shall be used. The method of planting shall include hand or machine planting techniques, suited to achieving proper depths and placement for the selected plant species.

Protect the planting from unacceptable impacts due to pests, wildlife, livestock, or wildfire. Exclude livestock as needed to establish the planting.

All plant materials shall be correctly handled before planting. In general, plant rooted and unrooted materials as soon as possible after receiving them from the supplier. For bare-root seedlings, keep the roots moist at all times and keep the plants out of direct sunlight as much as possible. Keep seed cool and dry until planting.

Where natural colonization of acceptable species can realistically be expected to occur within 5 years, sites may be left to revegetate naturally. Natural regeneration shall be the preferred method of establishing the natural plant community where:

1. Seeds, rootstocks, and other propagules of desired species are already present in the soil or are likely to be transported to the site from nearby sources;
2. Site conditions are favorable for establishing the desired number and distribution of plants within a specified time period; and,
3. Noxious or invasive species are not likely to jeopardize the natural regeneration process.

Areas within the restored wetland that need short-term herbaceous cover to control erosion and to help build the organic components of the soil, shall be stabilized with an appropriate seed mix for wetlands. Temporary or non-competitive permanent mixes may be needed in areas where natural regeneration is planned, woody species will be planted, or other permanent plantings will be delayed. Plantings for short-term cover shall be non-competitive to the introduction and establishment of the desired species.

Refer to the appropriate sections of the Delaware Conservation Planting Guide for recommended planting dates and selected lists of herbaceous and woody species suitable for planting in wet sites.

Wetland vegetation shall meet the following criteria for areal coverage and density, regardless of whether natural regeneration or planting is used:

1. Herbaceous vegetation shall be designed to achieve a minimum 85 percent areal cover of the desired plant community within five years;
2. Woody vegetation shall be designed to achieve a minimum density of 200 trees and/or shrubs per acre (5 plants/1,000 SF) within five years.

Additional Criteria to Provide Organic Matter

Topsoiling

Spread stockpiled topsoil to a depth of 4 to 6 inches where needed to provide a suitable medium for plant growth. Do not redistribute topsoil that is known to contain invasive or noxious weeds.

Organic Matter Amendments for Inundated Areas

If an insufficient quantity of topsoil is available, add organic matter such as straw, composted manure, or wood chips where needed on portions of the site that will be inundated with shallow water. Organic matter (organic carbon) is necessary to restore the natural functions of a wetland, including sustaining beneficial microbes and aquatic invertebrates.

If the soil surface horizon (the "A" horizon) has a Munsell value and chroma <3, it will normally contain at least 1% organic matter and does not need to be augmented. However, if the surface layer has a Munsell value or chroma >3, then use one of the following options to add organic matter to the wetland area:

1. Straw - Spread straw over the soil surface to a minimum thickness of 3 inches (1.5 to 2 tons per acre); or,
2. Composted Manure - Spread composted cow or horse manure to a minimum thickness of 4 inches (500 cubic yards per acre); or,
3. Wood Chips - Spread hardwood chips (not bark) to a minimum thickness of 4 inches (500 cubic yards per acre).

It is not necessary to incorporate the organic matter into the soil if the inundated areas are intended to remain as shallow open water, or if they will be allowed to revegetate naturally. If the inundated areas will be revegetated by planting, mix the organic matter into the top 4 to 6 inches of soil.

Note: Specific programs may dictate criteria in addition to, or more restrictive than, those specified in this standard.

CONSIDERATIONS

Consider the long-term land use objectives of the client. If the client is interested in providing wildlife habitat, consider the wildlife species or groups of species to be supported and the habitat needs which can be met on the managed area.

Consider the natural availability of plant species in the soil seed bank vs. the need for planting in the restored wetland. Except for grasses, seeding is usually not a preferred method for wetland plant establishment, due to the lack of information about seed viability, germination, and seedling growth requirements for the majority of wetland plant species.

Consider the need for temporary water level management to promote seedling survival when vegetation is planted in the wetland.

Consider the effects of the natural topography and soils of the site on the water regime and vegetation prior to design.

Consider potential adverse impacts to adjacent properties, roads, septic systems, and other features resulting from raising the water table.

Consider the need for additional conservation practices, such as Riparian Herbaceous Cover (390) and/or Riparian Forest Buffer (391), to establish a vegetative buffer around the wetland. Buffers can help to reduce movement of sediment and other pollutants into the wetland and can also provide wildlife habitat.

Consider the adverse impacts of nearby populations of nuisance wildlife, such as muskrats, beavers, or resident geese, on the establishment and maintenance of the site. Also consider the potential for attracting nuisance wildlife into an area.

For muskrat control, consider building a 6-foot wide flat bench along the embankment, with normal water depth of 3-4 inches. This will discourage muskrats from burrowing into the embankment.

Take note of other constraints such as economic feasibility, access, regulatory or program requirements, social effects, and visual aspects, such as compatibility with the natural landscape.

Consider long-term maintenance requirements of the restored wetland.

Refer to Chapter 13 of the Engineering Field Handbook for further discussion of these planning considerations. For additional information concerning specific design and management criteria for selected wildlife species, refer to fact sheets and other publications (see the References section of this standard), or contact the Delaware Private Lands Biologist for assistance.

This practice has the potential to affect National Register listed cultural resources or eligible (significant) cultural resources. These may include archeological, historic, or traditional cultural properties. Care should be taken to avoid adverse impacts to these resources. Follow NRCS state policy for considering cultural resources during planning.

PLANS AND SPECIFICATIONS

Plans and specifications for this practice shall be prepared in accordance with the previously listed criteria. Plans and specifications shall contain sufficient detail to ensure successful implementation of this practice. Documentation shall be in accordance with the section "Supporting Data and Documentation" in this standard.

Supporting Data and Documentation

The following is a list of the minimum data and documentation to be recorded in the case file:

1. Location of the practice on the conservation plan map;
2. Assistance notes. The notes shall include dates of site visits, name or initials of the person who made the visit, specifics as to alternatives discussed, decisions made, and by whom.

Planning Information, Field Data, and Survey Notes

Record on survey note paper, SCS-ENG-28 & 29, and/or in the conservation plan folder, as appropriate. The following is a list of the minimum data and documentation to be recorded in the case file:

1. Description of the objectives of the project, including the desired functions that the wetland is expected to provide;
2. Soil investigation logs and notes;
3. Inventory of existing vegetation on the site. If applicable and available, note the agrichemicals that have been used on the site during the past 5 years;
4. Topographic survey of the site, as appropriate for site conditions and the proposed design;
5. Description of existing drains and extent of existing blockage (if any).

Design Data

Record on appropriate engineering paper. For guidance on the preparation of engineering plans see Chapter 5 of the Engineering Field Handbook, Part 650. The following is a list of the minimum required design data:

1. Hydrologic and hydraulic design computations;
2. Normal and design storm water surface elevations;
3. Cross-section(s) of embankment for quantities determination;

4. Profile of vegetated spillway, as appropriate;
5. Detail of water control structure, as appropriate, including profile, elevations, and materials specifications with type and gauge/thickness of pipes;
6. Planned blockage of drainage systems, including cross sections and lengths of drain plugs;
7. Plan view(s) to scale with north arrow and stationing showing topographic contours, planting zones for vegetation, soil borings and locations of other features, as appropriate;
8. Seeding and/or planting requirements, including species selected for each planting zone, stocking/seeding rates, and the size and type of planting stock to be used (e.g., bare-root seedlings, containerized stock, etc.), shown on plans;
9. Quantities estimate;
10. Show job class on plans;
11. Operation and maintenance plan.

Utilities Notification

1. Forms ENG-5 and ENG-6 can be used to assist in tracking utility notifications;
2. Document on CPA-6 initial discussion about the landowner's responsibility to notify Miss Utility;
3. Document on CPA-6 any information from the landowner about the existence and location of known utilities;
4. Document on CPA-6 assurances from the landowner that Miss Utility has been notified, including staking by the utilities.

Construction Check Data/As-Built

Record on survey notepaper, SCS-ENG-28, or other appropriate engineering paper. Survey data shall be plotted on plans in red. The following is a list of minimum data needed for as-builts:

1. Check notes recorded during or after completion of construction, and plans showing as-built conditions of all structures;
2. Note plant species as-installed, including species used, quantities, date(s) planted, and arrangement of plants within each planting zone;
3. Final quantities and documentation for quantity changes and materials certification;
4. Sign and date checknotes and plans by a person with appropriate approval authority. Include statement that practice meets or exceeds plans and NRCS practice standards.

OPERATION AND MAINTENANCE

An Operation and Management (O&M) plan shall be prepared and is the responsibility of the client to implement. The O&M Plan shall provide specific instructions for proper operation and maintenance of each component of this practice, and shall detail the level of repairs needed to maintain the effectiveness and useful life of the practice. This plan shall be reviewed with and provided to the client.

Appropriate fact sheets may serve as the management plan, as well as supporting documentation, and shall be reviewed with and provided to the client.

At a minimum, the following components shall be addressed in the O&M plan, as applicable:

1. Inspect all embankments and structures at least once per year and after every major storm. Promptly remove trash and obstructions, fix leaks, and make other repairs as needed;
2. Inspect the site periodically (at least annually) to determine whether the desired vegetation is present in suitable quantity, quality, and distribution to meet the objectives of the project;
3. On embankments to be maintained in herbaceous cover, spot mow or burn infrequently (not more than once every 2 to 3 years) if needed to reduce encroachment of trees and shrubs. To protect

- ground-nesting wildlife, do not mow or burn between April 15 and August 15;
4. Control noxious weeds and other invasive plants by spot treatment, using mechanical methods or approved herbicides. Control of noxious weeds is required by state law. Noxious weed control can be conducted during the primary nesting season (April 15 to August 15), but may require prior approval if the site is enrolled in a financial assistance program. Contact your local weed control specialist concerning recommendations for spot-treating the weed problem.
 5. Deter colonization of undesirable plants (e.g., cocklebur, phragmites, cattails, red maple, sweetgum) by conducting regular site inspections and spot treatment using mechanical methods or approved herbicides;
 6. Nuisance animals, such as beavers and muskrats, may be removed in accordance with state game regulations. Geese can be discouraged by minimizing areas of open water and promoting the growth of tall vegetation in the wetland and adjacent buffers;
 7. Avoid noisy activities, such as mowing or use of recreational vehicles, in or near the wetland when waterfowl are present. To the extent possible, do not allow livestock and other domestic animals to have uncontrolled access to the site;
 8. Avoid the use of pesticides on the site to prevent harm to wildlife that use the wetland area;
 9. Describe the acceptable uses (e.g., flash grazing, cropping, timber production, hunting, nature preserve, etc.) and time of year or frequency of use restrictions, if any. *Pay particular attention to program requirements as they relate to acceptable vs. restricted uses and other management restrictions.*

REFERENCES

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