Constructed Wetland

Practice Description

A pool that creates conditions suitable for the growth of marsh plants. Stormwater wetlands, wet ponds and retention ponds are effective in reducing the quantity of stormwater runoff and improving water quality by pollution removal through sedimentation and nutrient uptake. Urban runoff pollutants which can be treated include sediment, trace metals, nutrients, hydrocarbons, oxygen demanding substances and harmful bacteria. Wetlands and wet ponds can be created by constructing an embankment across a valley, constructing a perimeter berm or by excavating a shallow basin in natural soil. Stormwater wetlands differ from artificial or created wetlands because they lack the ecological functions of natural wetlands.

Stormwater wetlands require more management during the first three years to establish marsh conditions. Thereafter, maintenance requirements are similar to wet ponds.

NRCS. Maine.

Constructed wetlands can be used effectively to control stormwater runoff quantities, improve water quality and provide urban habitat for wildlife.

Recommended Minimum Requirements

Prior to construction, constructed wetlands should be designed by a registered design professional. Plans and specifications should be referred to by field personnel throughout the construction process. The wetlands should be built according to planned alignment, grade and cross sections.

- **Contributing Drainage Area:** At least 10 acres: 6 acres is needed for each surface acre of wetland; 10 acres is recommended to maintain a permanent pool

- **Detention:** Up to 72 hours for the entire range of design storms. The initial 1/2 inch of runoff should be detained for a minimum of 6 hours. This is the "first flush" of runoff which contains the largest concentration of pollutants.

- **Anti-seep Devices:** Either of the following is recommended:
  - At least 2 watertight anti-seep collars used around the outlet conduit; collars should project 1 to 3 feet from the pipe, or
  - a sand diaphragm (see *Glossary*)

- **Embankment Slopes:** 2.5:1 or flatter; 3:1 when maintained by tractor or other equipment

- **Contributing Slopes:** 3:1 or flatter

- **Soils:** Moderate to low permeability in NRCS hydrologic groups C or D (see *Glossary*)

- **Collector Channels (leading to the wetland):** Capable of settling out as much sediment as possible. Leave natural meandering channels with good streambank vegetation (100 feet wide), if possible. Constructed channels should be as long as possible.

- **Sediment Basin:** Constructed at the entrance to the wetland with 20 to 40 years of sediment storage available

- **Principal and Emergency Spillways:** Designed to pass the runoff from the design storm. The principal spillway should include a water control structure to draw down the permanent pool to manage wetland vegetation, clean sediment out of the basin and other maintenance.

- **Filter Strip:** 50-foot wide grass or natural vegetative buffer around wetland area and wet ponds; greater width may be necessary for steeper slopes and some landforms (see *Filter Strips*)

- **Embankments:** At least 10% of extra fill to allow for settlement; should not constrict the floodplain

Construction

Site Preparation

Locate the stormwater wetland away from natural wetlands (See *Glossary*) that may be subject to national, state and local laws and regulations. The stormwater wetland should be in an area of mild topography in NRCS hydrologic group C or D soils. A clay liner may be needed for wetlands located in NRCS hydrologic group A or B soils.

Determine the exact location of all underground utilities.

Follow all federal, state and local requirements on impoundment sites.

Clear, strip and grub the stormwater wetland or wet pond area. Remove all woody vegetation, rocks and other objectionable material. Depending on the type, some trees may be left in the wetland or wet pond area.

Dispose of trees, limbs, logs and other debris in designated disposal areas.

Grade the stormwater wetland area to allow surface drainage and the establishment of a good cover of vegetation.

Stormwater Wetland

Excavate a sediment basin where concentrated surface drainage enters the wetland. The sediment basin should be separated from the wetland by a berm or baffle which will be approximately 1 foot beneath the permanent pool elevation. Pipes may become clogged with sediment and are not recommended for transporting flow from the sediment basin to the wetland.

Excavate the wetland pool to a depth of 3 to 6 feet or according to the design plan.

Construct an embankment and a principal spillway to maintain a permanent pool in the wetland. Depending on the size of the watershed, an emergency spillway may be necessary.

Grade a gently sloping aquatic bench around the perimeter of the stormwater wetland. The bench should be approximately 10 to 25 feet wide and will provide a transition from the filter strip to the wetland.

Grade a filter strip around the stormwater wetland. The filter strip slope should be no steeper than 5:1 and no flatter than 20:1.

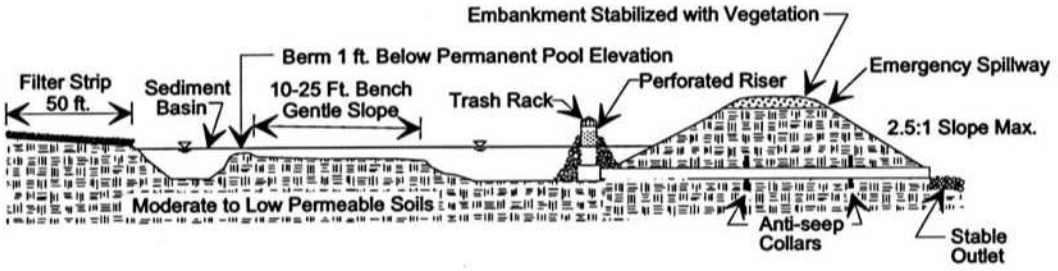

Figure 5.49 Constructed Wetland

Construct a maintenance right-of-way to the sediment basin for removing sediment. The right-of-way should include base material to support vehicle traffic but should also be capable of supporting vegetation. Concrete armor blocks and geotextile mats support the growth of vegetation and work well when constructed on good base material.

Excavate the foundation of the embankment (outlet apron first), stockpiling topsoil for later use.

Place the spillway pipe and riser on a firm, even foundation. Prepare the bedding for the pipe.

Principal Spillway

Place a 4-inch layer of moist, clayey, workable soil (not pervious material such as sand, gravel or silt) around the pipe and compact it with hand tampers to at least the density of the foundation soil. Don't raise the pipe from the foundation when compacting under the bottom of the pipe.

Construct the riser within the embankment. If the riser must be constructed in the pond, embed the base of the riser at least 12 inches into concrete (which serves as an anti-flotation block). The weight of the concrete should balance the buoyant force acting on the riser.

$$\text{Buoyant Force} = \text{Volume of Riser} \times 62.4 \text{ lbs/ft}^3$$

Connect a minimum 6-inch diameter pipe and valve to the riser at the drawdown elevation. The valve stem should be accessible for opening and closing the valve.

Perforate the top 12 inches of the riser with 1/2-inch diameter holes spaced 3 inches apart (or use a manufactured perforated riser). The perforations will allow stormwater detention of the first flush of runoff into the wetland.

For risers extending into the wetland, surround the riser with 2 feet of clean, uniformly graded stone. The top of the riser should be set at the permanent pool elevation of the wetland.

Place a trashrack around the riser inlet. Trashracks can be constructed by welding reinforcing steel (#4 rebar) in a grid with 4- to 6-inch openings.

Construct anti-seep devices.

At the pipe outlet, install a riprap or concrete apron at least 5 feet wide and 10 feet long to a stable grade.

Optional: A slotted or V-notch weir, constructed within an open channel spillway, can be used in place of a riser and conduit as a principal spillway.

Embankment

Scarify the foundation for the embankment before placing fill.

Use fill from predetermined borrow areas. It should be clean, stable mineral soil free of roots, woody vegetation, rocks and other debris and must be wet enough to form a ball without crumbling yet not so wet that water can be squeezed out.

Place the most permeable soil in the downstream toe and the least permeable in the center portion of the dam.

Compact the fill material in 6- to 8-inch lifts over the length of the dam. (One way is by routing construction equipment over the dam so that each layer is traversed by at least one wheel of the equipment.)

Protect the spillway pipe with 2 feet of hand-tamped fill before traversing over the pipe with equipment.

Construct and compact the wetland embankment to 10% above the design height to allow for settling.

Place a reference stake at the sediment clean out elevation in the sediment basin at the upstream end of the wetland (50% of design elevation).

Emergency Spillway

Construct the spillway in undisturbed soil around one end of the embankment. Locate it so that any flow will return to the receiving channel without damaging the embankment.

Erosion Control

Stabilize the spillway as soon as grading is complete; or install paving material to finished grade if the spillway will not be vegetated.

Minimize the size of all disturbed areas and vegetate as soon as each phase of construction is complete. Consult the Missouri Department of Conservation, Kansas Wildlife and Parks, NRCS or University Extension for wetland vegetation specifications and plant materials.

Use temporary diversions to prevent surface water from running onto disturbed areas.

Direct all runoff into the stormwater wetland or wet pond at low velocity. Establish the principal spillway outlet elevation to allow the stormwater wetland or wet pond to return to normal pool elevation within 72 hours.

Safety

Because stormwater wetlands and wet ponds permanently impound water, they can be hazardous:

- Avoid steep slopes; slopes around the stormwater wetland or wet pond should be kept as mild as possible (2.5:1 or flatter; 3:1 when maintained by tractor or other equipment).
- Fence area and post with warning signs if trespassing is likely.

Construction Verification

Check finished grade and cross sections of the constructed wetland. Verify dimensions of embankments, spillways and diversion waterways.

Troubleshooting

Consult with registered design professional if any of the following occur:

- Variations in topography on site indicate wetland will not function as designed; changes in plan may be needed.
- Design specifications for spillway pipes, trashracks and rock cannot be met; substitution may be required. Unapproved substitutions could result in the wetlands not operating as designed.

Maintenance

Initially, inspect the stormwater wetland or wet pond after each storm event. Once the operation of the structure has been established, inspect annually. Pay close attention to the amount of sediment in the sediment basin.

Remove and properly dispose of sediment collected in the sediment basin.

Intensive management of the water levels will be necessary during the first year to establish wetland plants.

Periodically check the embankment, emergency spillway and outlet for erosion damage, piping, settling, seepage or slumping along the toe or around the barrel; and repair immediately.

Remove trash and other debris from the riser, emergency spillway and pool area.

Common Problems

Piping failure along conduit; caused by improper compaction, omission of anti-seep collar, leaking pipe joints or use of unsuitable soil—repair piping damage and install preventative measures to prevent reoccurrence of problem.

Erosion of spillway or embankment slopes; caused by inadequate vegetation or improper grading and sloping—repair erosion damage and reevaluate erosion protection measures.

Slumping and/or settling of embankment; caused by inadequate compaction and/or use of unsuitable soil—return embankment to original configuration using properly compacted soil as specified in the original plans.

Slumping failure; caused by steep slopes—remove slide debris and replace with properly compacted soil.

Erosion and caving below principal spillway; caused by inadequate outlet protection—repair erosion damage and provide adequate erosion protection.

Difficult and costly sediment removal; caused by inadequate sediment basin access—consult registered design professional about relocating sediment basin access.

Inadequate sediment storage capacity; caused by basin constructed too small or sediment not properly removed—review sediment removal program and, if necessary, resize sediment basin.

Uplift damage to riser; caused by lack of anti-flotation device—repair damage to riser and retrofit anti-flotation device to riser.

Riser and pipe blockage; caused by lack of trash guard—remove blockage and install properly designed trashrack.

Overtopping of embankment; caused by principal and emergency spillway elevations too high relative to top of dam—repair erosion damage and reevaluate spillway design.

Improper disposal of accumulated sediment; caused by sediment disposal area not designated on design plans—remove improperly placed sediment and clearly define disposal area.

Frequent operation of emergency spillway; due to principal spillway being too small—reevaluate sizing of principal spillway.

Vegetation not established; due to improper management of water regimes, or failure to follow seeding or planting specifications—reseed or replant in accordance with design specifications.

Evidence of pollution exists; caused by pollutants such as trace metals accumulating in the bottom sediments—consult with registered design professional about testing or restricting access for people and wildlife.