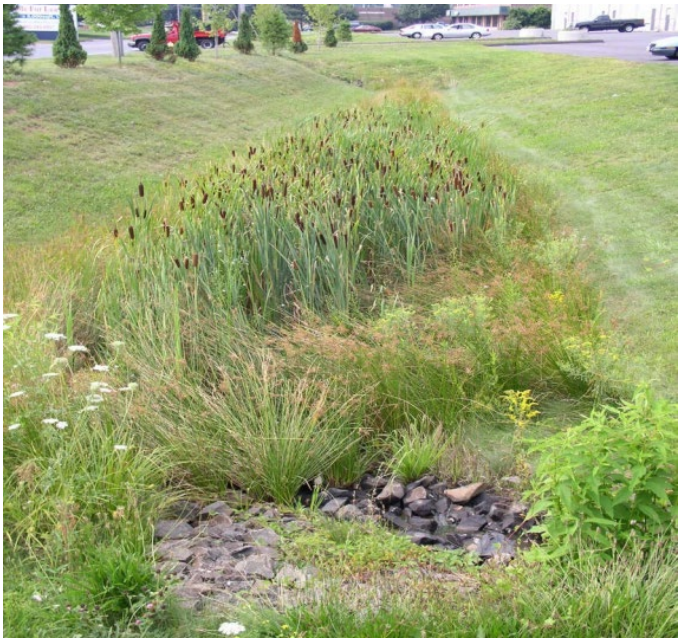
Wet Water Quality Swale



Stormwater BMP Type

Pretreatment BMP	□
Infiltration BMP	□
Filtering BMP	□
Stormwater Pond BMP	□
Stormwater Wetland BMP	□
Water Quality Conveyance BMP	■
Stormwater Reuse BMP	□
Proprietary BMP	□
Other BMPs and Accessories	□

Stormwater Management Suitability

Retention	□
Treatment	■
Pretreatment	□
Peak Runoff Attenuation*	■

*On-line systems only

Pollutant Removal

Sediment*	**High**
Phosphorus	**Moderate**
Nitrogen	**Moderate**
Bacteria	**Low**

*Includes sediment-bound pollutants and floatables (with pretreatment)

Implementation

Capital Cost	**Medium**
Maintenance Burden	**Medium**
Land Requirement	**Medium**

Description

Water quality swales are shallow vegetated open channels designed to treat and convey stormwater runoff. Water quality swales provide higher pollutant removal than traditional grass drainage channels, which are designed strictly for conveyance.

Wet water quality swales (also referred to as "wet swales") temporarily store and treat stormwater runoff from the water quality storm. However, unlike Dry Water Quality Swales, wet swales are constructed directly within existing soils and are not underlain by a bioretention soil media or underdrain system. Wet swales store stormwater runoff within a series of cells within the channel, which may be formed by berms or check dams. Wet swales are designed to remain saturated, maintaining wetland plants and conditions. The pollutant removal mechanisms in wet swales are similar to those of Stormwater Wetland BMPs, which rely on sedimentation, adsorption, and microbial breakdown.

Wet water quality swales are primarily used for treatment and conveyance of stormwater runoff. They do not provide stormwater retention, runoff volume reduction, or groundwater recharge because they are constructed in groundwater and are not designed for infiltration. Wet swales may also be used to provide stormwater quantity control when designed as on-line facilities.

Advantages

- Wet water quality swales are an alternative to stormwater pond and wetlands where the site requires a sloped base or must convey runoff between points.
- Provide runoff conveyance and can provide some peak runoff attenuation by reducing runoff velocity and providing temporary storage.
- Can be used on sites with high groundwater or poorly drained soils.

Limitations

- Do not provide stormwater retention, runoff volume reduction, or groundwater recharge.
- May be impractical in areas with steep topography.
- Large area requirements for highly impervious sites unless used with another stormwater BMP solely to provide additional treatment along with stormwater conveyance.
- May not be practical in areas with many driveway culverts or extensive sidewalk systems.

Siting Considerations

- **Potential Locations:** Linear nature makes swales ideal for use within roadway right-of-way areas, along shared-use paths, and around the perimeter of parking lots.

- **Drainage Area:** The maximum contributing drainage area is 5 acres to any single inlet, unless the flow enters the wet swale via sheet flow along a linear feature such as a road.

- **Soils:** Wet swales are best suited to sites with poorly drained soils (HSG C and D soils). Although feasible if constructed with an impermeable liner similar to those used with stormwater ponds and wetlands, wet swales are generally impractical for use in HSG A and B soils.

- **Land Use:** Wet swales can be used in most land use settings where stormwater can be conveyed in surface channels. Wet swales are not recommended in residential areas or within commercial parking lots with significant foot traffic because of the potential for stagnant water and other nuisance ponding.

- **Water Table and Bedrock:** Wet swales should only be used where the water table is at or near the soil surface. The bottom of a wet swale should be constructed at or below the seasonal high groundwater table (SHGT). At least 1 foot of separation is recommended between the bottom of the swale and bedrock. Test pits or soil borings are required at the location of the proposed system to verify soil types, depth to SHGT, and depth to bedrock in accordance with the soil evaluation guidance provided in Chapter 10.

- **Horizontal Setbacks:** Wet swales should be located at least 50 feet downgradient of on-site subsurface sewage disposal systems for single family residential use, and at least 75 feet downgradient from on-site subsurface sewage disposal systems for all other uses.

Soil Evaluation

- Conduct an evaluation of the soil characteristics and subsurface conditions at the location of the proposed system including soil type, depth to the seasonal high groundwater table, and depth to bedrock. Perform test pits or soil borings in accordance with the soil evaluation guidance in Chapter 10.

Design Recommendations

Pretreatment

- Incorporate pretreatment measures at locations where runoff enters the swale in accordance with the Pretreatment BMPs section of this Manual.

- Acceptable pretreatment measures include vegetative filter strips, sediment forebays, pretreatment swales, oil grit separators, and proprietary pretreatment devices.

- Sediment forebays should have a minimum storage volume of 10% of the Water Quality Volume (WQV), while flow-through Pretreatment BMPs should treat at least the equivalent Water Quality Flow (WQF).

Sizing and Dimensions

- Wet Swale Dimensions
    - Wet swale length, width, depth, and slope should be designed to temporarily store the Water Quality Volume through surface ponding. The permanent pool may be included in the static storage volume calculation and system sizing.
    - Install check dams as necessary to store the Water Quality Volume and to accommodate slopes greater than 2%. The volume of water retained behind check dams should be included in the design storage volume calculation.
    - The soil bed below wet swales should consist of undisturbed soils. The underlying soil should be inundated as the bottom of the swale should be at or below the SHGT.
    - Wet swales should not be constructed in highly permeable soils that cannot easily support dense vegetation.

- Ponding Depth
    - Maximum ponding depth for water quality storm: 12 inches at longitudinal mid-point of swale; 18 inches at downstream end of swale
    - Maximum ponding depth for overflow events: 36 inches
    - Minimum freeboard for overflow events: 6 inches above the 10-year, 24-hour storm water surface elevation to top of swale

- Bottom Width
    - Minimum: 2 feet
    - Maximum: 8 feet

- Bottom Slope
  - Wet swales should have a maximum longitudinal slope of 2% without check dams, provided flow velocities are non-erosive (e.g., flow velocities should not exceed 3 feet per second for grassed surfaces).
  - Wet swales can have slightly steeper slopes (up to 6%) if designed with check dams.
  - Check dams should be designed to reduce the effective slope of the bottom of the wet swale to 2.0% or less for optimum water quality performance. Consider designing as a terraced system with check dams and relatively flat bottoms in each cell.

- Side Slopes
  - 3(H):1(V) slopes or flatter are preferred especially on vegetated slopes where mowing is required.
  - In ultra-urban locations or space constrained areas, side slopes of 2(H):1(V) may be utilized if properly designed to account for erosion and slope stability. Stabilize the slope with turf reinforcement matting or equivalent if the slope could potentially erode.

- Water Velocity
  - For water quality storm: 1.5 feet per second (maximum)
  - Peak flow design storm: 5.0 feet per second (maximum)

Check Dams

- Check dams should be evenly spaced and designed with a maximum height of 18 inches. Check dams should be designed to pass the design flow over the top of the check dam without exceeding maximum ponding depths.

- Spacing of check dams should be a function of both the longitudinal slope of the swale and the design volume that must be retained behind the dams. Space such that the upstream limit of ponding from one check dam is just below the downstream edge of the adjacent check dam.

- Check dams should be constructed of washed crushed stone, gabions, granite or concrete curbing, or precast/poured-in-place concrete.

- Anchor check dams into swale side slopes to prevent washout. Each side of the dam should extend 2-3 feet into the swale side slopes.

- Protect downstream side of check dams from scour with stabilized surface protection measures.

Inlet

- Design the inlet in accordance with the Inlet and Outlet Controls section of this Manual.

- Runoff can be introduced to the wet swale through overland flow, curb cuts, inlet structures, swales/channels, and/or pipes.
- Design the system in an off-line configuration to the extent feasible if runoff is delivered by a storm drain pipe or is along the main storm conveyance system.

Outlet & Overflow

- Design the outlet in accordance with the Inlet and Outlet Controls section of this Manual.
- Outlets are typically a stabilized spillway, gabion berm, concrete weir, curb cut opening, precast concrete structure, or polyethylene/polyvinyl chloride riser structure.
- Wet water quality swales should have an outlet sized to convey the 10-year, 24-hour storm event, at a minimum. Off-line systems should be designed with a bypass or overflow for flows in excess of the water quality storm.

Materials

- Vegetation
    - Emergent wetland plants are the preferred type of vegetation for wet water quality swales.
    - Select vegetation and provide a planting plan with the guidance provided in Appendix F of this Manual.
        - Native vegetation is preferred for enhanced biodiversity and wildlife habitat.
        - Vegetation should be suitable for sustained inundation and/or a high water table.
        - If to be used near a road that is subject to winter salt operations, the vegetation must also be salt tolerant.
    - Establish a dense vegetative cover throughout swale and any upgradient areas disturbed by construction before runoff can be accepted into the facility.
    - Trees should be planted only along the perimeter of the facility.
    - Trees should not be planted in wet swales.
- Check Dams
    - Construct of washed crushed stone, gabions, granite or concrete curbing, or precast/poured-in-place concrete. If constructed of granite or concrete curbing, curbing shall conform to State of Connecticut Department of Transportation Standard Specifications, Section M.12.06 (Stone Curbing) and Section 8.11 (Concrete Curbing).
- Poured-in-place Concrete
    - If used, should be an appropriate class of concrete based on the application and conform to State of Connecticut Department of Transportation Standard Specifications, Section 6.01 (Concrete for Structures).

- Turf Reinforcement Matting (TRM)
  - Stabilize the side slopes of the swale with TRM to limit erosion in locations where flow velocities exceed 3 to 5 feet per second (depending on soil and vegetation types) for the 1-year, 24-hour storm event.
  - If used, shall be a woven material included on the CTDOT Qualified Products List that exceeds the design velocity of the design storm and allows for the growth of the proposed vegetative species.

Other Considerations

- Roadway stability can be a design issue when installing swales along roadways. It may be necessary to provide a vertical impermeable barrier to keep water from saturating the road's sub-base. The barrier should be capable of supporting H-20 loads.

Winter Operations

- Swales should not be used as dedicated snow storage areas. To the extent feasible, locate and design the system to avoid snow storage areas and potential damage from snow plowing activities. Refer to Chapter 7 for general design considerations related to winter operations.

Construction Recommendations

- The designing qualified professional should develop a detailed, site-specific construction sequence.

- The designing qualified professional should inspect the installation during the following stages of construction, at a minimum:
  - After excavation of the swale and scarification of bottom and sidewalls of excavation
  - After installation of bypass, outlet/overflow, and inlet controls
  - After vegetation and wetland plants/seed mix has been installed

- The designing qualified professional should provide an as-built plan of the completed system along with a certification that the system was designed in accordance with the guidance contained in this Manual and other local or state requirements and that the system was installed in accordance with the approved plans.

- The entire contributing drainage area should be completely stabilized prior to directing any flow to the system. Adequate vegetative cover must be established over any pervious area adjacent or contributing to the system before runoff can be accepted.

- Erosion and sediment controls should be in place during construction in accordance with the Connecticut Guidelines for Soil Erosion and Sediment Control and the Soil Erosion and Sediment Control (SESC) Plan developed for the project.

- Temporary dewatering may be required if excavation extends below the water table. Appropriate sedimentation controls will be required for any dewatering discharges.
- During clearing and grading of the site, measures should be taken to avoid soil compaction at the location of the proposed system.
- The system should be fenced off during the construction period to prevent disturbance of the soils.
- The system should be excavated to the dimensions, side slopes, and elevations shown on the plans. The method of excavation should avoid compaction of the bottom of the swale. A hydraulic excavator or backhoe loader, operating outside the limits of the system, should be used to excavate the system. Excavation equipment should not be allowed within the limits of the system.
- Install vegetation in the swale in accordance with the planting plan and plant schedule on the plans. Water vegetation thoroughly immediately after planting and as necessary until fully established.

Maintenance Needs

- Swales should be designed with easy access to all components of the system for maintenance purposes. Refer to Chapter 7 for general design considerations to reduce and facilitate system maintenance.
- Detailed inspection and maintenance requirements, inspection and maintenance schedules, and those parties responsible for maintenance should be identified on the plans and in the Stormwater Management Plan.
- Maintenance should be detailed in a legally binding maintenance agreement.
- Maintenance activities such as sediment removal, mowing, and repairs should be performed with rakes and light-weight equipment rather than heavy construction equipment to avoid soil compaction and damage to vegetation. Heavy equipment may be used for sediment removal and other maintenance activities if the equipment is positioned outside the limits of the system. Heavy construction equipment should not be allowed within the limits of the system for maintenance purposes.

Recommended Maintenance Activities

- Inspect after major storms (1 inch or more of precipitation) in the first few months following construction.
- Inspect swale annually.
- Refer to Appendix B for maintenance inspection checklists, including items to focus on during the inspections.

- Remove trash and organic debris (leaves) in the Spring and Fall.
- Remove sediment from the sediment forebay or other pretreatment area when it accumulates to a depth of more than 12 inches or 50% of the design depth. Clean outlet of sediment forebay or other pretreatment measures when drawdown time exceeds 36 hours after the end of a storm event.
- Remove sediment from the swale surface when the sediment accumulation exceeds 2 inches or when drawdown time exceeds 48 hours after the end of a storm event, indicating that the system is clogged.
- Periodically mow vegetation within swale. Maintain a healthy, vigorous stand of vegetation; re-seed as necessary.
- Prune woody vegetation in wet swales where dead or dying branches are observed. Plant reinforcement plantings as necessary.
- Maintain vegetated filter strips or grassed side slopes of swale in accordance with maintenance recommendations in the Pretreatment BMPs section of this Manual.
- Periodically remove grass clippings to prevent clogging of the surface of the swale.
- Mowing should not be performed when the ground is soft to avoid the creation of ruts, soil compaction, and damage to vegetation.

Figure 13-31. Wet Water Quality Swale Schematic