Description

Photograph CWC-1: Constructed wetland channels treat stormwater through straining, settling, and biological processes.

A constructed wetland channel is a conveyance BMP that is built, in part, to enhance stormwater quality. Constructed wetland channels use dense vegetation to slow down runoff and allow time for both biological uptake and settling of sediment.

Constructed wetlands differ from natural wetlands, as they are artificial and are built to enhance stormwater quality. Do not use existing or natural wetlands to treat stormwater runoff. Stormwater should be treated prior to entering natural or existing wetlands and other environmentally sensitive areas. Allowing untreated stormwater to flow into existing wetlands will overload and degrade the quality of the wetland. Sometimes, small wetlands that exist along ephemeral drainageways on Colorado's high plains may be enlarged and incorporated into the constructed wetland system. Such action, however, requires the approval of federal and state regulators.

Regulations intended to protect natural wetlands recognize a separate classification of wetlands constructed for water quality treatment. Such wetlands generally are not allowed to be used to mitigate the loss of natural wetlands but are allowed to be disturbed by maintenance activities. Therefore, the legal and regulatory status of maintaining a wetland constructed for the primary purpose of water quality enhancement is separate from the disturbance of a natural wetland. Nevertheless, any activity that disturbs a constructed wetland should be first cleared through the U.S. Army Corps of Engineers to ensure it is covered by some form of an individual, general, or nationwide 404 permit.

Constructed Wetland Channel	
Functions	
LID/Volume Red.	Somewhat
WQCV Capture	No
WQCV+Flood Control	No
Fact Sheet Includes EURV Guidance	No
Typical Effectiveness for Targeted Pollutants	
Sediment/Solids	Unknown
Nutrients	Unknown
Total Metals	Unknown
Bacteria	Moderate
Other Considerations	
Life-cycle Costs[4]	Moderate

[4] Based primarily on BMP-REALCOST available at www.udfcd.org. Analysis based on a single installation (not based on the maximum recommended watershed tributary to each BMP).

Site Selection

Constructed wetland channels provide conveyance of stormwater similar to a grass swale; however, this BMP is appropriate when a baseflow can be anticipated. A constructed wetland channel requires a net influx of water to maintain vegetation and microorganisms. This can be supplied by groundwater or a perennial stream. An ephemeral stream may not provide adequate water. In addition to water supply, loamy soils are needed in the wetland bottom to permit plants to take root. Wetland channels also require a near-zero longitudinal slope; drop structures can be used to create and maintain a flat grade.

A constructed wetland channel can be used in the following two ways:

- It can be established in a completely man-made channel providing conveyance and water quality enhancement.
- It can be located in a treatment train configuration, downstream of a stormwater detention facility (water quality and/or flood control) where a large portion of the sediment load has been removed upstream. This allows the wetland channel to benefit from the long duration of outlet flow and reduced maintenance requirements associated with pretreatment.

Benefits

- Wetland channels provide natural aesthetic qualities, wildlife habitat, erosion control, and pollutant removal.
- Provides effective follow-up treatment to onsite and source control BMPs that rely upon settling of larger sediment particles

Limitations

- Requires a continuous baseflow.
- Without proper design, salts and scum can accumulate and be flushed out during larger storms.
- Safety concerns associated with open water.

Designing for Maintenance

Recommended maintenance practices for all BMPs are provided in the BMP Maintenance chapter of this manual. As with many BMPs, poor maintenance of this BMP can result in reduced effectiveness (see inset). During design, the following should be considered to ensure ease of maintenance over the long-term:

- Ensure a continuous dry-weather baseflow. Without adequate water supply, salts and algae can concentrate in the water column and can be released into the receiving water in higher levels.
- Provide pretreatment when appropriate. If the influent concentrations are high, this BMP should be used in a treatment train approach. High levels of nutrients will overload the BMP causing algae growth. High solids will reduce capacity and increase maintenance requirements.

Design Procedure and Criteria

The criteria for a wetland channel presented in the following section differ somewhat from the criteria presented in the *Major Drainage* chapter of Volume 1. This is because of the water quality focus of this BMP. Before selecting this BMP, assess the water budget required so that the inflow of water throughout the year is sufficient to meet all the projected losses (such as evaporation, evapotranspiration, and seepage). An insufficient baseflow could cause the wetland vegetation to dry out and die.

The following steps outline the constructed wetland channel design procedure. Refer to Figure CWC-1 for its design components.

1. **Design Discharge**: Calculate the 2-year peak flow rate in the wetland channel using methods discussed in the *Runoff* chapter of Volume 1. Unless higher flows are diverted from the wetland channel, also calculate the 100-year peak flow rate.

2. **Channel Geometry**: Design the mature channel geometry to pass the design 2-year flow rate at 2.0 feet per second or less with a channel depth between 1.5 to 3.0 feet. The channel cross-section should be trapezoidal with stabilized side slopes of 2.5:1 (Horizontal:Vertical) or flatter. The bottom width should be no less than 3.0 feet. Unless higher flows are diverted from the wetland channel, ensure the

100-year peak flow rate can also be safely conveyed in the channel. See the *Major Drainage* chapter in Volume 1.

3. **Longitudinal Slope**: Set the longitudinal slope to meet channel geometry criteria using Manning's equation and a Manning's roughness coefficient of n=0.035 for the 2-year flow. If necessary due to the existing terrain, include grade control checks or small drop structures. Tie grade control structures into the bank a minimum of 0.50 feet above the 2-year water surface elevation. Design drop structures to satisfy the drop structure criteria of the *Major Drainage* chapter in Volume *1*.

4. **Channel Capacity**: Calculate the mature channel capacity during a 2-year event using a Manning's roughness coefficient based on the method for composite channels presented in the *Major Drainage* chapter of Volume 1. The channel should also provide enough capacity to contain the flow during a 100-year event while maintaining one foot of free-board. Increase the bottom width of the channel when additional capacity is needed.

5. **Grade Control Structures:** Grade control structures are frequently required to meet longitudinal slope and velocity recommendations. The structures should extend into the bank and at least 0.5 feet above the 2-year water surface elevation.

6. **Toe Protection**: Provide bank toe protection using type VL soil riprap or other stabilization methods as discussed in the *Major Drainage* chapter of Volume 1. Channel stabilization should include protection of the side slopes extending up to the 2-year water surface elevation. Carry this protection down 3 feet below the channel invert or place soil riprap in channel invert.

7. **Vegetation**: Vegetate the channel bottom and side slopes to provide solids entrapment and biological nutrient uptake. Cover the channel bottom with loamy soils to enable establishment of sedges and reeds. Side slopes should be planted with grasses.

8. **Maintenance Access**: Provide access for maintenance along the channel length. Maximum grades for maintenance vehicles should be 10% and provide a solid driving surface.

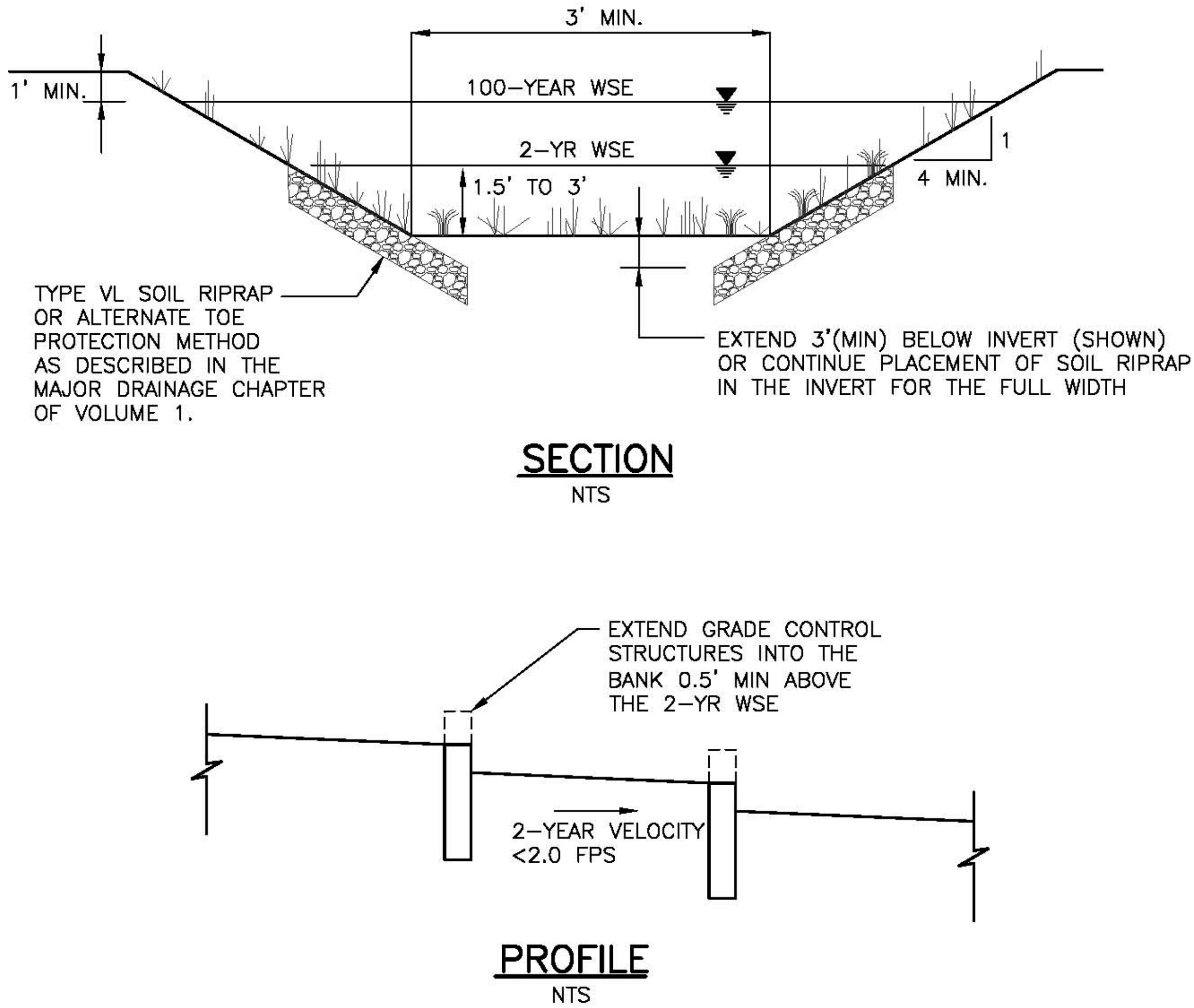

Figure CWC-1. Constructed Wetland Channel Plan and Section

Design Example

The *UD-BMP* workbook, designed as a tool for both designer and reviewing agency is available at www.udfcd.org. This section provides a completed design form from this workbook as an example.

Design Procedure Form: Constructed Wetland Channel (CWC)

Sheet 1 of 1

Designer: G. Damato
Company: BMP, Inc.
Date: November 29, 2010
Project: Subdivison F
Location: NW corner of 90th Ave. and 57th St.

1. Design Discharge A) 2-Year Design Discharge B) 100-Year Design Discharge	Q_2 = 15.00 cfs Q_{100} = 48.00 cfs
2. Channel Geometry (New Channel - No Wetland Veg. in Bottom) Channel Side Slopes (Z = 2.5 min., horiz. distance per unit vertical)	Z = 2.50 (H:V)
3. Longitudinal Slope (Based on Manning's *n* for the mature channel so as not to exceed the maximum given velocity)	S = 0.005 feet/feet
4. Channel Capacity (Based on Manning's n = 0.0018 * D2 ^ 2 - 0.0206 * D2 + 0.099 for D ≤ 5, and Manning's n = 0.0001 * Y ^ 2 - 0.0025 * Y + 0.05 for D > 5)	
A) Calculated channel geometry required to maintain the design discharge during a 2-year event with newly established and mature vegetation. Calculated resulting flow velocities for mature condition should be kept to 2 fps or less for the 2-year flow.	see 2-Yr. table below
B) Geometry and velocity to use for the 100-year discharge: Suggest the design for a 100-year capacity channel follow the guidance contained in the Major Drainage Chapter of Volume One. of the USDCM, or through the use of the UD-CHANNELS workbook. 100-Year depth with 1-foot freeboard is 3.4 feet. 100-Year top width with 1-foot freeboard is 20.1 feet.	see 100-Yr. table below
5. Grade Control Structures: Number required	5 number
6. Toe Protection Due to narrow channel bottom, provide soil riprap across width.	1.75 soil riprap thickness (feet)
7. Vegetation	☑ Wetland Seeding ☐ Wetland Plugs ☑ Willow Stakes ☐ Other (Describe):
8. Maintenance Access: Describe access along channel.	reinforced grass maintenance trail parallel to channel

	New 2-Yr. Channel		Mature 2-Yr. Channel	
D_2 =	1.10	feet	1.55	feet
B_2 =	3.0	feet	3.0	feet
T_2 =	8.5	feet	10.7	feet
V_2 =	2.39	fps	1.42	fps
n_2 =	0.035		0.071	
$Froude_2$ =	0.35		0.25	

	New 100-Yr. Channel		Mature 100-Yr. Channel	
D_{100} =	1.91	feet	2.43	feet
B_{100} =	3.0	feet	3.0	feet
T_{100} =	12.5	feet	15.1	feet
V_{100} =	3.24	fps	2.18	fps
n_{100} =	0.035		0.060	
$Froude_{100}$ =	0.47		0.32	

Notes: