Enhanced Swales

Swales are slight depressions, usually trapezoidal in shape which are used to convey runoff from surrounding impervious areas. They can either run along the contour of the land or perpendicular, as long as the longitudinal slope does not exceed 5%. In the past these runoff transporting mechanisms have simply been grassed, with a turf grass. Today we can design these features with various vegetation and interest, including mimicking a dry streambed. All swales fall into two typical design groups, the dry swale and the wet swale.

THINGS TO CONSIDER

- **Do not design with in 10 feet of foundation**
- **Do not back water up against buildings or foundations**
- **Be creative**

The following pages will assist you in designing, sizing and constructing enhanced swales.

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Dry Swale Design

A dry swale, also known as a grassed, vegetated or enhanced swale, is an open vegetated channel used to both treat the water quality and volume of and excess stormwater to the selected destination. An under-drain system is installed under an engineered soil mix placed under the base of the swale, similar to that of a bio-retention or rain garden in Western North Carolina to improve and promote infiltration and water quality.

Advantages:

- Swales can be designed to work with existing landscape and in small areas
- Minimal maintenance
- Works in small drainage areas
- Discourages long standing water
- Traps sediment and other pollutants
- Controls peak discharge, promoting infiltration

Disadvantages:

- Maximum slope of swale is 4%
- Drainage area is not to exceed 3 acres
- Impractical for flat or steep areas
- May erode when flow volumes and/ or velocities are high during certain storm events

Design Considerations:

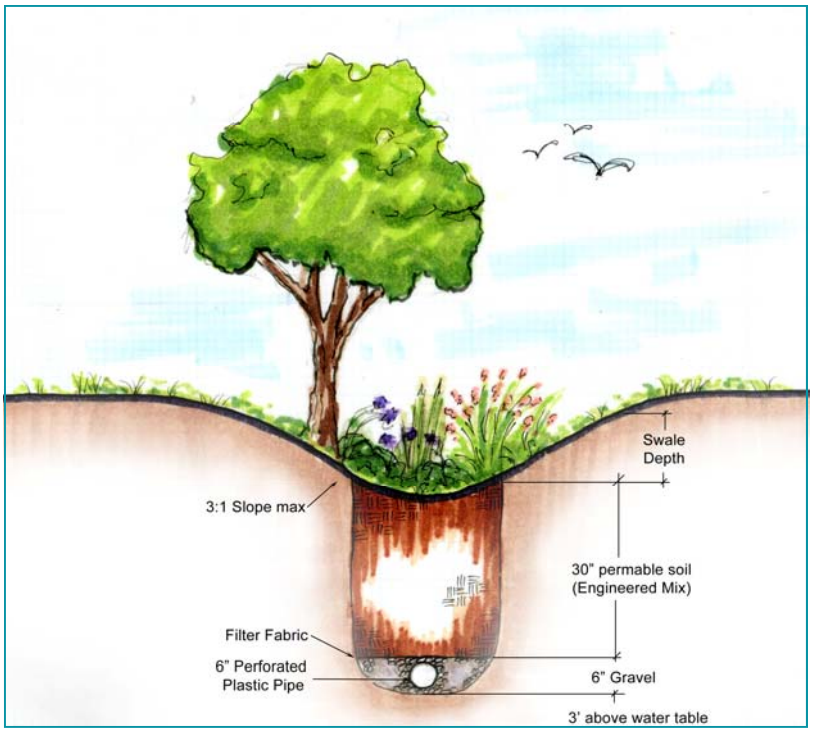
- Channel Shape: Trapezoidal or parabolic
- Bottom width: 2 ft. min. – 6 ft. max.
- Side Slope: 3:1 or flatter, so 1 foot of rise every 3 feet
- Channel Longitudinal Slope: 1% min. – 6% max. if over 3% slope check dams will need to be installed to reduce erosion within the channel
- Bottom of swale should be 3 feet above groundwater levels
- Do not place within 10 feet of a structure
- Ponding in the swale can be up to 18" depth maximum

Dry Swale Implementation

MATERIALS

- Site Analysis
- Site Map
- Site Plan Schematic
- Calculator
- A-frame Level
- Flagging or Marking materials
- Gravel
- 6” Perforated Pipe
- Permeable soil mix
- Filter Fabric
- Shovel
- Hard Rake
- Mattock
- Mulch
- Plants—Vegetation

Designing:



1. Begin by reviewing your overall site analysis, and based on advantages and disadvantages of various designs, determine locations of swales.
2. Once your location is determined, use the runoff volume calculation to determine the water storage capacity needed for a 1 inch storm minimum. Base the size and spacing on your site goals as well. See next page to determine swale size.
3. Lay out the centerline of the swale with flags or other means of marking, using the slope tools to check slope of swale.
4. Bring in additional soil to create the necessary berm size if needed.
5. Remove all existing vegetation.
6. Dig swale maintaining a parabolic base and max. 3:1 side slopes
7. Excavate 36”, lay 6” perforated pipe in bottom of excavation, along the centerline sloping down hill.
8. Surround pipe with 6” of gravel (#57).
9. Cover gravel with filter fabric.
10. Fill 30” excavation with permeabale soil mix.

Maintenance:

1. Keep free of weeds
2. Inspect for signs of scouring
3. Maintain plantings

Wet Swale Design

Wet swales are similar to dry swales in shape and purpose. The major difference is that a wet swale does not have an underdrain and permeable soil mixture under the swale base. Wet swales will have a tendency to retain water for longer periods of time than dry swales, specifically in Western North Carolina with our high clay content in the soil.

Advantages:

- Swales can be designed to work with existing landscape and in small areas
- Easy to construct
- Minimal maintenance
- Works in small drainage areas
- Traps sediment and other pollutants
- Controls peak discharge, promoting infiltration

Disadvantages:

- Maximum slope of swale is 4%
- Drainage area is not to exceed 3 acres
- Impractical for flat or steep areas
- May erode when flow volumes and/or velocities are high during certain storm events

Design Considerations:

- Channel Shape: Trapezoidal or parabolic
- Bottom width: 2 ft. min. – 6 ft. max.
- Side Slope: 3:1 or flatter, so 1 foot of rise every 3 feet
- Channel Longitudinal Slope: 1% min. – 6% max. if over 3% slope check dams will need to be installed to reduce erosion within the channel
- Bottom of swale should be 3 feet above groundwater levels
- Do not place within 10 feet of a structure
- Ponding in the swale can be up to 18" depth maximum

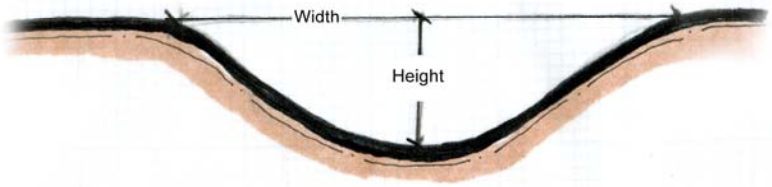
Wet Swale Implementation

MATERIALS

- Site Analysis
- Site Map
- Site Plan Schematic
- Calculator
- A-frame Level
- Flagging or Marking materials
- Shovel
- Hard Rake
- Mattock
- Mulch
- Plants—Vegetation

Designing:

1. Begin by reviewing your overall site analysis. Look at your design options and compare advantages and disadvantages to determine locations of swales.
2. Once your location is determined, use the runoff volume calculation to determine the water storage capacity needed for a 1 inch storm minimum. Base the size and spacing on your site goals as well. See next page to determine swale size.
3. Lay out the centerline of the swale with flags or other means of marking, using the slope tools to check slope of swale.
4. Bring in additional soil to create the necessary berm size if needed.
5. Remove all existing vegetation.
6. Dig swale, maintaining a parabolic base and max. 3:1 side slopes
7. Replant with selected plants.
8. In addition to plants these swales can be formed into Dry Stream Beds and/or you can add rocks for interest and check dams to slow runoff velocities if needed.



Maintenance:

1. Keep free of weeds
2. Inspect for signs of scouring
3. Maintain plantings

Sizing Swales

Calculating Stormwater (Runoff) Volume

Runoff is precipitation that flows over the land surface and is not absorbed into the ground. In urban areas runoff is high because impermeable surfaces like rooftops, paved roads and parking lots abound. This runoff moves quickly off site through stormwater drains that usually funnel directly to streams. This helps to eliminate standing water that can cause poor health conditions and keeps roads clear during storms but it does not allow water to infiltrate into the water table. In other words, the water doesn't hang around long enough to water your vegetable garden. You can change that by implementing any of the many stormwater management techniques described in this guide, but how much water can you expect to harvest? In a given storm event the amount of runoff depends on many factors making precise calculations complicated but a rough estimate is easily obtained by using runoff coefficients. In this method, runoff is calculated by multiplying the surface area by a coefficient (Table 1) that estimates the conditions of the particular conditions. This is then multiplied by the depth of rainfall to obtain a volume of runoff. To make the calculation easier you can assume that rainfall depth comes in units of 1 (1in or 1cm, etc.), that way you'll know, for instance, how much runoff you'll have per inch of rainfall.

Helpful Conversions

0.083 feet = 1 inch
0.01 meter = 1 cm
1 cubic foot = 7.48 gallons
1 cubic meter = 264.12 gallons

Table 1: Runoff Coefficients

Soil Groups A and B are sandier and Soil Groups C and D are more clayey. These soil classifications would be found in a county soil survey available at any Soil and Water Conservation District office or North Carolina Cooperative Extension center.

Land Use/Cover	Soil Group A	Soil Group B	Soil Group C	Soil Group D
100% impervious (parking lots, rooftops, paved sidewalks or patios)	0.98	0.98	0.98	0.98
Open space with grass cover <50%	0.68	0.79	0.86	0.89
Open space with grass cover 50% to 75%	0.49	0.69	0.79	0.84
Open space with grass cover >75%	0.39	0.61	0.74	0.80
Woods in fair hydrologic condition	0.36	0.60	0.73	0.79
Residential lot (1/4 acre)	0.61	0.75	0.83	0.87
Residential lot (1/2 acre)	0.54	0.70	0.80	0.85
Residential lot (1 acre)	0.51	0.68	0.79	0.84

(Table adapted from USDA-NRCS Curve Numbers, 1986)

Here's the equation:
Volume Runoff =
Surface Area x Runoff Coefficient x Rainfall Depth

Here's an example of how it works:

Step 1: Assess Site Conditions
In this example we will use a 600 ft^2 sidewalk

Step 2: Obtain Runoff Coefficient
Using the provided table (Table 1), look up the runoff coefficient that most closely resembles your site. In this case it is 0.98.

Step 3: Do the Math
Volume Runoff = Surface Area x Runoff Coefficient x Rainfall Depth
Volume Runoff = $600ft^2$ x 0.98 x 0.083ft = $48.8t^3$
Note: Make sure that "Surface Area" and "Rainfall Depth" are in the same units. It doesn't matter what you use just stay consistent — measurements in feet or meters are generally easiest.

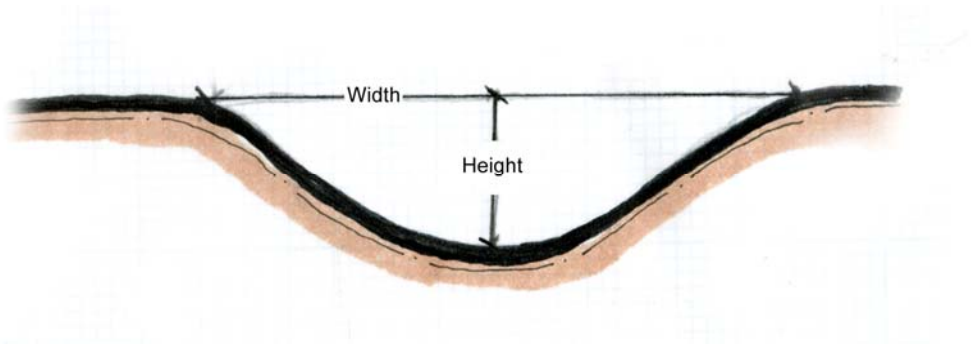
Step 4: Convert if Necessary
Most people have trouble thinking about water volume in cubic feet so we will convert to gallons multiplying by $7.48gal/ft^3$.
Volume Runoff = $48.8ft^3$ x 7.48 gal/ft^3 = 365 gallons

SO… In this example, for every inch of rain you will need an enhanced swale that can handle 365 gallons of water.

Sizing Swales

Calculating Swale Storage Volume

- Estimates amount of stormwater runoff that swales can hold given the depth, width and length of your berm and swale.



1. Water Holding Capacity

Volume of H2O Capacity = Area x Length
Area = 1/2 Width x Depth
Volume= (1/2 Width x Depth) x Length

Example:
Width = 10 ft, Length = 25 ft., and Depth of berm and swale is 2 ft.
Volume = 1/2 x 10 ft. x 2 ft. x 25 ft.
Volume = 250 cu. ft.

2. Water capacity per foot of length

Capacity= (1/2 Width x Depth) x 1 ft.

Example:
Width = 10 ft, Length = 25 ft., and Depth of berm and swale is 2 ft.
Volume = 1/2 x 10 ft. x 2 ft. x 1ft.
Volume = 10cu. ft.

3. Spacing Distance

Distance = Capacity (per ft.)/ (Runoff Coefficient x rainfall depth)

Example:
Width = 10 ft, Length = 25 ft., and depth of berm and swale is 2 ft.
Capacity per foot = 10 cu. ft.
Runoff Coefficient (See Table 1) = 0.79
See Chapter One for Soils Information
Rain fall depth= 1 inch = 1/12 = 0.083 ft.
Distance = 10 cu. ft. / (0.79 x 0.083)
Distance = 1 ft. Spacing