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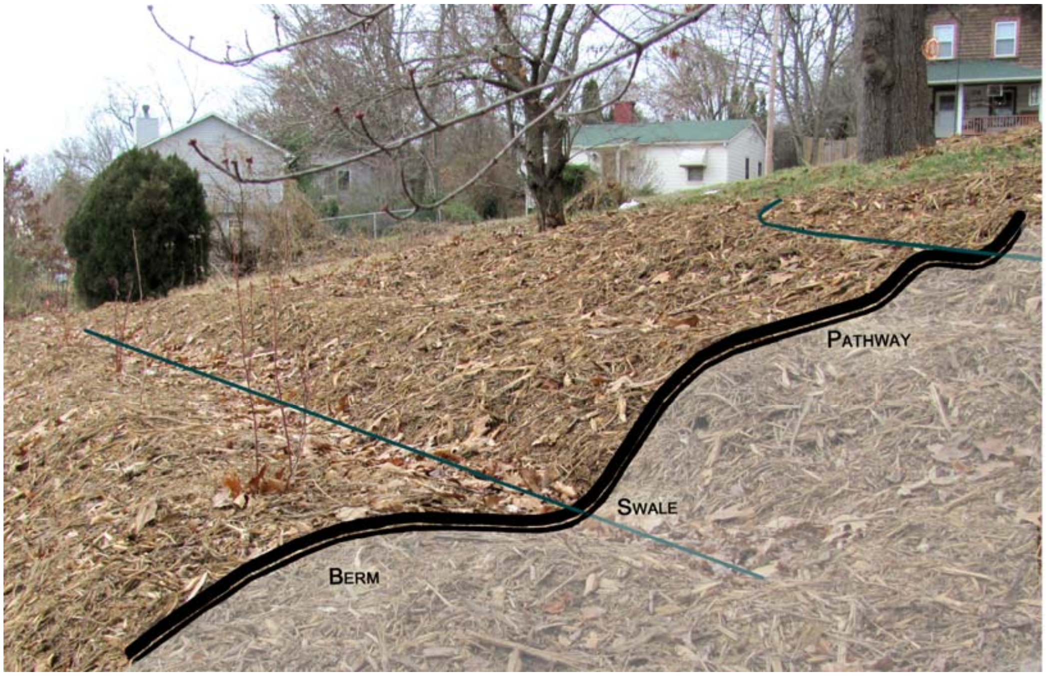
Berm and Swale Complex

Berm and swale systems are utilized in the landscape to capture, direct and infiltrate rainwater into the soil specifically where it is needed. This complex allows a homeowner to develop a natural watering system focusing on maintaining vegetation needs. There are numerous variations on the basic berm and swale design. The variations are explained in the *Enhanced Swale* and *Check Dam* chapters. Reviewing BMPs in series is also beneficial. As the series becomes more complex, specifically when working in areas with steep slopes, you may want to consult one of the designers listed in Appendix C.

The following pages will assist you in designing, sizing and constructing a berm and swale complex.

THINGS TO CONSIDER

- Do not design within 10 feet of foundation
- Do not back water up against buildings or foundations
- Berms can double as paths and trails
- Berms and swales are great places for vegetation
- Swale/Basin can occur around existing vegetation if you excavate around the tree or shrub carefully
- Be creative
- Review variations on the berm and swale complex prior to designing



Berm and Swale Complex Designed by Zev Friedman of Living Systems Design.

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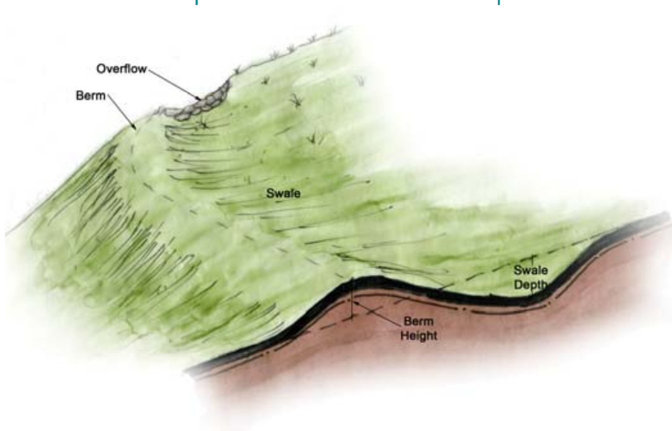
Design

Berm and swales work in two parts. The swale is a swale or depression, excavated running parallel to the slope, with little to no horizontal slope. The berm is located down slope and parallel to the slope. The berm is mounded soil either from the excavated swale or additional earth, or the berm can be made of brush and rock. The basin catches water and allow water to seep into the berm. The basin and berm can both be planted and mulched.

Advantages:

- Used on slopes from 50:1 to 4:1 (2%-25%)
- Berms and swales can be designed to work with existing landscape
- Easy to construct
- Minimal maintenance



Disadvantages:

- Only work on slopes
- Swales with gradients greater than 10% may need additional components and structure. See Section on Check Dams and Consult the Experts
- Design for correct water quality storage
- Design errors typically lead to concentrated flow, gullies, and berm breaching

Design Considerations:

- Utilized on slopes from 50:1-4:1.
- Make berms bigger rather than smaller to reduce the risk of the berm failing during a large storm event. (water breaching the berm, creating a gully).
- Berms have 3:1 slopes.
- Berms can double as paths and trails, make sure to flatten the trail portion of the berm and maintain the 3:1 side slopes.
- Leave a 1-foot wide undisturbed area between each berm and swale series.
- Can bring in soil to create berms if mature landscape is established.

Implementation

Designing:

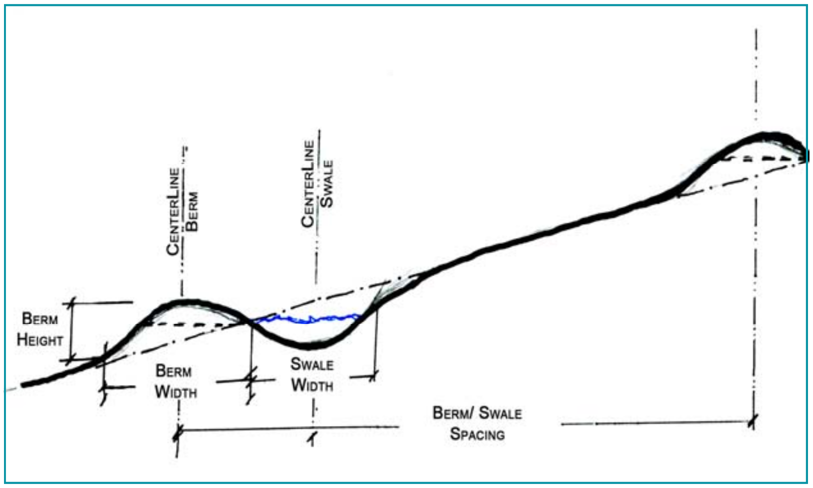
1. Begin by reviewing your overall site analysis based on the design considerations, advantages and disadvantages to determine locations for berms and basins.
2. Once your location is determined, use the runoff volume calculation to determine the water storage capacity needed for a 1-inch storm minimum. Base the size and spacing on your site goals as well. See next page to determine swale size.
3. Use an A-frame level to layout the centerline of the berm and basin with flags or other means of marking.
4. Lay out all berms and basins, then determine if there is opportunity to connect them or if they are independent of each other.
5. Start at the top and dig basin just up slope of basin, using the excavated soil to build the berm below. You can leave established shrubs and trees within the basin; simply dig around them.
6. Bring in additional soil to create the necessary berm size if needed.
7. Level and tamp the berm under human weight and power only.
8. Locate appropriate spillways for the overflow, zig-zag to spread and infiltrate the runoff, minimizing concentrated flows. Always design the spillway flow path.
9. Revegetate or mulch any exposed soil as soon as possible after construction.

MATERIALS

- Site Analysis
- Site Map
- Site Plan Schematic
- Calculator
- A-frame Level
- Flagging or Marking materials
- Hand Tamper
- Shovel
- Hard Rake
- Mattock
- Mulch
- Plants—Vegetation
- Stone (optional, size varies by site)

Maintenance:

1. Check berms OFTEN for stability and possible areas of breaching, specifically after large storms.
2. Keep free of weeds.
3. Maintain mulch base (3” suggested)
4. Maintain level slope of swales to minimize the possibility of erosive runoff velocities.



Sizing Berms & 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 roads stay 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 Coeficients

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 200 ft^2 patio

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 = $200ft^2$ x 0.98 x 0.083ft = $16.3ft^3$

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.

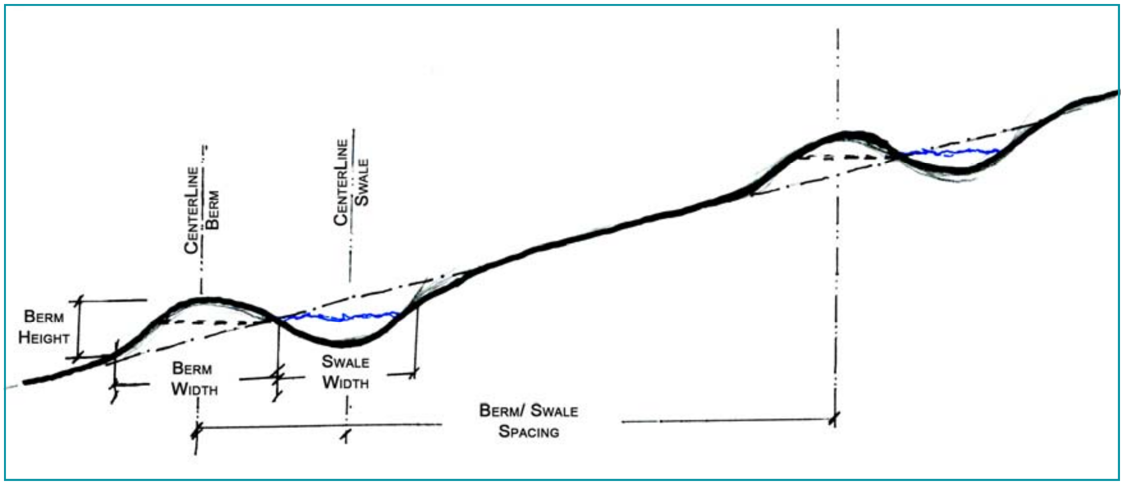
Step 4: Convert if Necessary
Most people have trouble thinking about water volume in cubic feet so we will convert to gallons multiplying by $7.48gal/ft^3$.
Volume Runoff = $16.3ft^3$ x 7.48 gal/ft^3 = 121.7 gallons

SO… In this example, for every inch of rain you will need a berm or swale that can handle 122 gallons of water.

Sizing Berms & Swales

Calculating Swale Storage Volume

- Estimates amount of stormwater runoff the 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 Berm Height
Volume = (1/2 Width x Berm Height) 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 Berm Height) 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