VEGETATED SWALE CALCULATOR (flow-based)

This calculator sizes a vegetated swale to treat the Water Quality Flow Rate (WQf).

Input cell =		User enters value
Default value =		User should only change value if able to provide explanation for adjustment
Calculation cell =		User should not change cell

CALCULATOR

Vegetated Swales Calculator - by Water Quality Flow Rate

1	Water Quality Flow Rate - WQf	0.18	cubic feet per second
2	Swale Base Width	3	feet (between 2 to 10 feet)
3	Swale Side Slope (Horizontal/Vertical)	3	3:1 or flatter (enter ratio of horizontal to vertical, for example, 3 for 3H:1V)
4	Swale Slope	2	% (2% recommended, use check dams to keep slope less than 5%)
5	Manning's n for Low Flow	0.25	0.2 - 0.3 for water quality depth, recommend 0.25
6	**Depth at WQf**	**2.3**	inches (increase swale width if depth greater than 4")
7	**Velocity at WQf**	**0.25**	ft/sec (decrease slope if velocity greater than 1 ft/s)
8	Required Residence Time	9	min (use 18 min for continuous inflow swale)
9	**Required Swale Length**	**135**	feet (minimum length is 100 feet)
10	Offline or Online	Online	
11	Max Design Depth for Conveyance	1.00	feet (for online systems, enter depth used to convey storms larger than the WQ event)
12	Freeboard	0.50	feet, recommend 0.5 ft for online, 0.25 ft for offline
	Total Swale Depth	1.50	feet
13	Top Swale Width	12.00	feet
14	**Total Swale Area**	**1,618**	square feet
15	Manning's n for High Flow	0.040	recommend 0.035 - 0.045 for vegetated channel under high flows
16	Swale Capacity at Max Design Depth	23.6	cubic feet per second

INSTRUCTIONS

Use the steps below to determine the swale dimensions and length such that the WQf is met by the proposed design.

Step	
1	Enter the Water Quality Flow Rate (WQf) for the drainage management area (DMA). The WQf is calculated in Step 13 of the Water Quality Volume and Water Quality Flow Rate Calculator.
2	Enter the proposed base width of your swale. The sizer assumes the swale is trapezoidal. Base width should be between 2 to 10 feet.
3	Enter the side slope of the swale. The side slope should be no steeper than 3:1 (i.e., at least 3 feet horizontal for each 1 foot vertical).
4	Enter the longitudinal slope of the swale. The maximum slope for swale design is 5%, and 2% is preferred. Consider using a meandering design, terraces, or check dams to create a satisfactory slope. Enter the percentage as a whole number; for example, for 2%, enter 2 rather than 0.02.
5	Enter the Manning's n runoff coefficient. At the water quality depth, an n value between 0.2 and 0.3 is typical. The Manning's equation is an open channel flow equation used for drainage design.
6	The flow depth during the water quality event is calculated. The depth should be less than or equal to 4 inches, or 0.33 feet. If it's greater, increase the swale base width.
7	The velocity in the swale during the water quality event is calculated here. The velocity should be less than 1 ft/s.
8	To provide adequate treatment of the WQf, the recommended residence time in the swale is 9 minutes. If flow enters the swale continuously along its length rather than at the upstream end, entering an 18 minute residence time is recommended.
9	The swale length needed to provide the required residence time is calculated here.
10	Select whether the swale is designed as an online or offline BMP. The system is "online" if flows greater than the WQf are also directed to the swale. For "offline" swale systems, only flows less than or equal to the WQf are directed to the swale.
11	Enter the maximum design depth for the swale. For online systems, the depth is greater than the WQf depth in order to convey runoff from storms larger than the water quality event. For offline systems, enter the design depth from Step 6, divided by 12 to convert the depth to feet.
12	A freeboard of 0.50 ft for online systems and 0.25 ft for offline systems is recommended. This freeboard is added to the design depth to calculate the total depth of the swale.
13	The top width of the swale is calculated here.
14	The total swale area is calculated here. This includes the bottom and side slope area of the swale.
15	For online systems, enter the Manning's n at maximum design depth. Maximum depth is typically between 1 to 2 feet. For vegetated channels an n between 0.35 - 0.45 is recommended. However, the value of n can be highly variable based on the design depth and the degree of retardance in the swale (i.e., vegetation type and height, check dams, etc.).
16	For online systems, the estimated flow rate at the maximum design depth is calculated. This is the maximum capacity of the swale.

DEFINITIONS

Water Quality Flow Rate (WQf)	The required flow rate to be managed by the stormwater BMP such that the treatment requirements are met. The WQf is calculated by the Water Quality Volume and Water Quality Flow Rate Calculator.
Infiltration Rate (f)	The rate of water entry into the soil, generally expressed as inches/hour, and determined by geotechnical tests or estimated from soil maps. It equals the hydraulic conductivity of the soil times the hydraulic gradient.
Swale Base Width	The width of the bottom of the swale, when the swale is a trapezoidal shape.
Swale Side Slope	The slope of the sides of the swale, generally expressed as a ratio. The recommended steepest slope is 3:1.
Swale Slope	The longitudinal slope of the swale, this is calculated from your DMA contour survey or similar.
Manning's n	The Manning's roughness coefficient for the swale. Note: at depths less than the vegetation height (e.g., at the WQf depth), the Manning's n is significantly greater than at flooding depths.
Depth at WQf	The design depth of flow in the swale. Note for maximum effectiveness swales should flow with no deeper than 2/3 the height of grass in the swale, or, generally, at a flow depth of 4".
Residence Time	For adequate treatment a swale must provide at least 9 minutes residence time. Residence time is the amount of time that water is present in the swale (i.e. the time taken for water to travel from the start of the swale to the end).
Swale Length	The length of the swale needed to provide sufficient residence time for water treatment.
Max Design Depth	For online system, the depth used to convey storm events larger than the WQf. It equals the total swale depth minus the freeboard depth.
Total Swale Depth	Equals the maximum design conveyance depth plus the freeboard
Swale Width	The overall width of the swale, including base and side slopes, calculated at the total swale depth.
Swale Area	The length of the swale, multiplied by the overall swale width. This describes what area of the site will be occupied by the treatment swale.
Swale Capacity	This is the maximum flow rate that can be conveyed by the swale.