

# Installation & Maintenance Requirements for Roadside Swales

## Introduction

A swale is an example of a stormwater control measure (SCM) designed as a shallow channel with gently sloping sides primarily with the goal of pollutant removal and the safe conveyance of flows from large storm events (e.g., 10-year storm event). Grass swales are one of the most common SCMs used all over the world and continue to be a popular option because of their relatively simple design and low construction and maintenance costs.



*Figure 1: Swales are used world-wide, such as those (left to right) on NCSU campus (Raleigh, NC), under a bridge deck in Knightdale, NC, and serving a parking lot in Albany, New Zealand.<sup>1</sup>*

## Design and Installation Recommendations

The following are the Minimum Design Criteria (MDC) for Swales as determined by the North Carolina Department of Environmental Quality (NCDEQ).<sup>2</sup>

1. The design storm intensity shall be 0.75 inch per hour.
2. Minimum Hydraulic Residence Time shall be four minutes.
3. Flow depth for the design storm intensity may not exceed six inches.
4. Cross-sectional side slopes stabilized with vegetative cover shall be no steeper than 3:1 (horizontal to vertical). Steeper vegetated slopes may be considered on a case-by-case basis provided that it is demonstrated that the soils and vegetation will remain stable in perpetuity.
5. Swales shall be trapezoidal with a maximum bottom width of six feet.
6. Swale length shall be determined based on a minimum hydraulic retention time of four minutes.
7. Swales shall not be excavated below the seasonal high water table (SHWT).
8. The grass species in the swale shall be non-clumping, deep-rooted and rigid.
9. Grass height shall be managed at an average of six inches. The grass shall not be cut lower than four inches.
10. Swales shall non-erosively pass the ten-year storm.

<sup>1</sup> Hunt, W.F., E.A Fassman, and R.J. Winston. NCSU Stormwater Publications, 2016, NCSU Urban Waterways Factsheet: Designing Dry Swales for the Water Quality Event.

<sup>2</sup> NCDEQ. NCDEQ Stormwater Design Manual, 20 Nov. 2020, C-11. Treatment Swale.

11. Any swale may be designed in accordance with the MDC for bioretention cells, infiltration systems or stormwater wetlands, and the design volume may be credited in accordance with the appropriate device.
12. Recommendation: Swales shall provide a minimum freeboard of six inches for the ten-year storm.

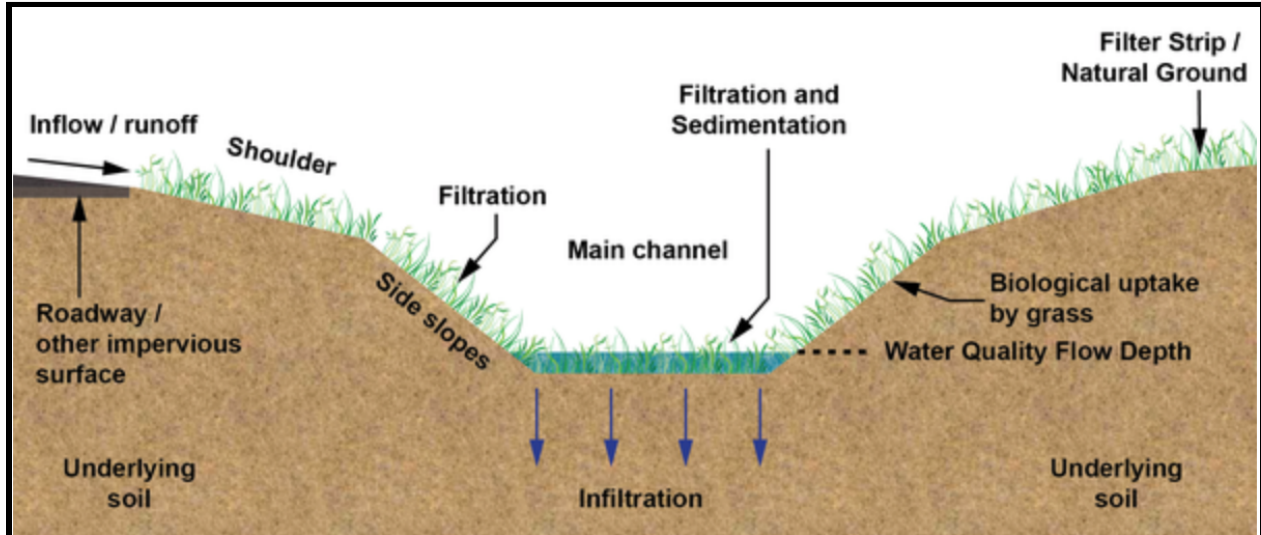


Figure 2: Typical cross section of a grass swale and its stormwater treatment process<sup>3</sup>

## Maintenance Recommendations

It is recommended by the NCDEQ for the drainage area of the treatment swale to be carefully managed to reduce the sediment load to the treatment swale. Fertilizer should not be applied to the treatment swale after the initial fertilization to establish the grass in the swale. Inspections of the swale will be completed quarterly along with records of each visit. Maintenance provisions are also listed in section C-11 of NCDEQ's Stormwater Design Manual.

## Research on Swales at NC State University

NC State University is partnering with the North Carolina Department of Transportation to explore the benefits of alternative vegetated and non-vegetated linings to maintenance and water quality requirements of roadside swales. A total of 8 swales (4 conventional grass-lined swales and 4 bioswales) located at NC State's Sediment and Erosion Control Research and Education Facility (SECREP) are being utilized for this research. Swale parameters to be tested include swales lined with riprap vs. deep-rooted, native grasses, a slope of 1% vs. 4%, and conventional vs. bioswale. Each swale will be tested with a small and large storm event (i.e. a 0.75-inch and a 1.5-inch event, respectively) to examine the water quality effects. During the simulated storm events using synthetic runoff, flow volumes and discharges will be measured

<sup>3</sup> Ekka, Sujit, and Bill Hunt. NC State Extension Publications, 10 Feb. 2020, Swale Terminology for Urban Stormwater Treatment.

and water quality samples will be collected for TKN,  $\text{NO}_{2-3}\text{-N}$ , TN,  $\text{O-PO}_4^{3-}$ , TP, TSS, dissolved Cu, dissolved Pb, and dissolved Zn.<sup>4</sup>

The type of grass lined in the swales should be non-clumping, deep-rooted, and rigid, as well as be managed at a height of six inches, as stated above. Some of the other specifications for grass type include the slope tolerance, sun/shade preference, saturation of soil, wet/dry conditions, and areas of NC to which they are native. Of several grasses that were considered, a 50/50 combination of River Oats (*Chasmanthium latifolium*) and Big Bluestem (*Andropogon gerardii*) was chosen for this study. River Oats is shade tolerant while Big Bluestem spreads quickly and provides a good density. Plug size should be a minimum of 3x3 and planted in staggered rows (similar to bowling pins) approximately 4-6 inches apart. We are extremely grateful to have John Hoffman, of Hoffman Nursery located in Rougemont, NC, as the primary supplier for this study, as well as for the NCDOT. Hoffman is a national expert on native grasses, sedges, and rushes and has been an integral part of the development of this project.

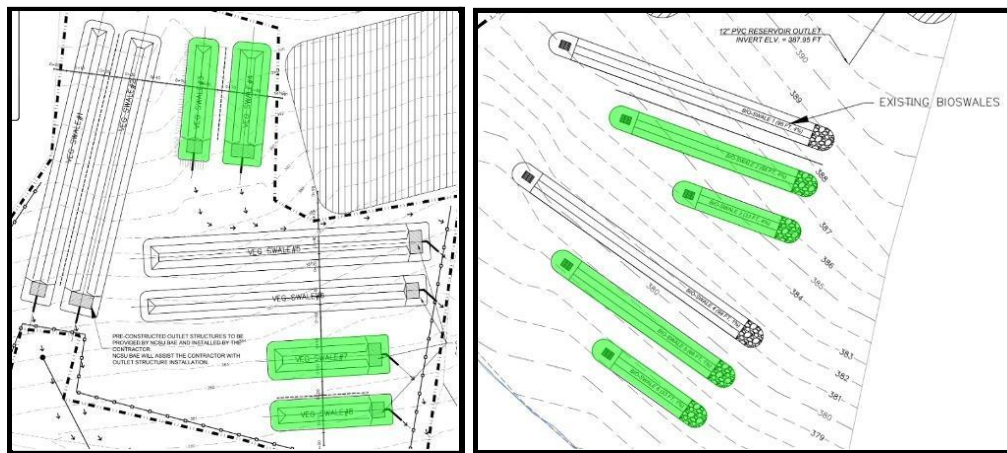


Figure 3: (Left) Grass-lined (conventionally-drained) swales constructed at SECREF. Four of these eight conventional swales will have their channel lining adjusted (as noted in green highlight). (Right) Bioswales at SECREF. Four of the six bioswales (as noted in green highlight) will be tested.<sup>5</sup>

## Meet the Presenter

Emily Leupp is a first-year masters student in the Biological and Agricultural Engineering department at NC State University. She is working under Dr. Bill Hunt on researching evaluating maintenance requirements and water quality benefits of alternative vegetated and non-vegetated linings in roadside swales. Emily earned her bachelor's degree in Biosystems and Agricultural Engineering from Oklahoma State University (Go Pokes!). She enjoys spending time with friends, hiking, reading, and embroidering. Feel free to contact her via email at [eclleupp@ncsu.edu](mailto:eclleupp@ncsu.edu).

<sup>4</sup> Hunt, Bill. NCSU BAE, 2020, NCDOT Full Research Proposal; Evaluating Maintenance Requirements and Water Quality Benefits of Alternative Vegetated and Non-Vegetated Linings in Roadside Swales.

<sup>5</sup> Ibid., p. 7.