Eliminating Curbs and Gutters

Practice Description

This practice promotes grass swales as an alternative to curbs and gutters along residential streets. Curbs and gutters are designed to quickly convey runoff from the street to the storm drain and, ultimately, to a local receiving water. Consequently, they provide little or no removal of stormwater pollutants. Indeed, curbs often act as traps where deposited pollutants remain until the next storm washes them away. Many communities require curbs and gutters as standard elements of road sections. In fact, many communities discourage the use of grass swales. Revisions to current local road and drainage regulations are needed to promote greater use of grass swales along residential streets.

Planning Considerations

The use of engineered swales in place of curbs and gutters should be encouraged in low- and medium-density residential zones where soils, slope, and housing density permit. However, eliminating curbs and gutters is generally not feasible for streets with high traffic volume or extensive on-street parking demand (i.e., commercial and industrial roads). Nor is it a viable option in arid and semi-arid climates where grass cannot grow without irrigation.

Removal of curbs and gutters decreases the peak flow discharge to receiving waters. Furthermore, under the proper design conditions, grass swales can be effective in removing pollutants from urban stormwater (Schueler, 1996).

Engineered swales are a much less expensive option for stormwater conveyance than the curb and gutter systems they replace. Curbs and gutters and the associated underground storm sewers have been documented to cost as much as $36 per linear foot, which is roughly twice the cost of a grass swale (Schueler, 1995). Consequently, when curbs and gutters are eliminated, the cost savings can be considerable.

Design Criteria

A series of site factors must be evaluated to determine whether a grass swale is a viable replacement for curbs and gutters at a particular site.

Contributing drainage area

Most individual swales cannot accept runoff from more than 5 acres of contributing drainage area. Typically, they serve 1-2 acres each.

Soils

The effectiveness of swales is greatest when the underlying soils are permeable (hydrologic soil groups A and B). The swale may need more engineering if soils are less permeable.

Slope

Swales generally require a minimum slope of 1 % and a maximum slope of 5 %.

Water Table

For most designs, swales should be avoided if the seasonally high water table is within 2 feet of the proposed bottom of the swale.

Development Density

The use of swales is often difficult when development density becomes more intense than four dwelling units per acre, simply because the number of driveway culverts increases to the point where the swale essentially becomes a broken-pipe system. Typically, grass swales are designed with a capacity to handle the peak flow rate from a 10-year storm, and fall below erosive velocities for a 2-year storm.

Construction and Installation

Although there are different design variations of the grassed swale, some design considerations are common to all. An overriding similarity is the cross-sectional geometry. Swales often have a trapezoidal or parabolic cross section with relatively flat side slopes (flatter than 3:1 horizontal: vertical), though rectangular and triangular channels can also be used. Designing the channel with flat side slopes increases the wetted perimeter. The wetted perimeter is the length along the edge of the swale cross section where runoff flowing through the swale contacts the vegetated sides and bottom. Increasing the wetted perimeter slows runoff velocities and provides more contact with vegetation to encourage sorption, filtering, and infiltration. Another advantage to flat side slopes is that runoff entering the grassed swale from the side receives some pretreatment along the side slope.

Another similarity among designs is the type of pretreatment needed. In all design options, a small forebay should be used at the front of the swale to trap incoming sediments. A pea gravel diaphragm, a small trench filled with river-run gravel, should be constructed along the length of the swale and used as pretreatment for runoff entering the sides of the swale. Other features designed to enhance the performance of grassed swales are a flat longitudinal slope (generally between 1 percent and 2 percent) and a dense vegetative cover in the channel. The flat slope helps to reduce the flow velocity within the channel. The dense vegetation also helps reduce velocities, protects the channel from erosion, and acts as a filter to treat stormwater runoff. During construction, it is important to stabilize the channel while the vegetation is becoming established, either with a temporary grass cover or with natural or synthetic erosion control products. In addition to treating runoff for water quality, grassed swales must convey runoff from larger storms safely. Typical designs allow the runoff from the 2-year storm (i.e., the storm that occurs, on average, once every two years) to flow through the swale without causing erosion. Swales should also have the capacity to pass larger storms such as a 10-year storm safely.

The following discussion identifies design and construction practices for three variations of open-channel practices: the grassed channel, the dry swale, and wet swale. For a detailed discussion of *Grass Swales*, see *Volume 1 – Chapter 4*.

Grassed Channels

Of the three grassed swale designs, grassed channels are the most similar to a conventional drainage ditch, with the major differences being flatter side slopes and longitudinal slopes, and a slower design velocity for water quality treatment of small storm events. Of all of the options, grassed channels are the least expensive but also provide the least reliable pollutant removal. An excellent application of a grassed channel is as pretreatment to other structural stormwater practices. A major difference between the grassed channel and many other structural practices is the method used to size the practice. Most stormwater-management water quality practices are sized by volume. This method sets the volume available in the practice equal to the water quality volume, or the volume of water to be treated in the practice. The grassed channel is a flow rate-based design. Based on the peak flow from the water quality storm (this varies regionally, but a typical value is the 1 inch/24-hr storm), the channel should be designed so that runoff takes, on average, 10 minutes to flow from the top to the bottom of the channel. A procedure for this design can be found in Design of Stormwater Filtering Systems (CWP, 1996).

Dry Swales

Dry swales are similar in design to bioretention areas. These designs incorporate a fabricated soil bed into their design. The native soil is replaced with a sand/soil mix that meets minimum permeability requirements. An underdrain system is installed at the bottom of the soil bed. This underdrain is a gravel layer that encases a perforated pipe. Stormwater treated in the soil bed flows into the underdrain, which routes this treated stormwater to the storm drain system or receiving waters. Dry swales are a relatively new design, but studies of swales with a native soil similar to the man-made soil bed of dry swales suggest high pollutant removal.

Wet Swales

Wet swales intersect the groundwater and behave similarly to a linear wetland cell (see *Constructed Stormwater Wetland Practice*). This design variation incorporates a shallow permanent pool and wetland vegetation to provide stormwater treatment. This design also has potentially high pollutant removal. Wet swales are not commonly used in residential or commercial settings because the shallow standing water may be a potential mosquito-breeding area (“Grassed Swales,” USEPA 2006).

Common Problems

A number of real and perceived limitations hinder the use of grass swales as an alternative to curb and gutters:

The pavement edge along the swale can experience more cracking and structural failure, increasing maintenance costs. The potential for pavement failure at the road/grass interface can be alleviated by “hardening” the interface with grass pavers or geo-synthetics placed beneath the grass. Other options include placing a low-rising concrete strip along the pavement edge.

The shoulder and open channel will require more maintenance. In reality, maintenance requirements for grass channels are generally comparable to those of curb and gutter systems. The major requirements involve turf mowing, debris removal, and periodic inspections.

Some grass swales can have standing water, which make them difficult to mow, and can cause nuisance problems such as odors, discoloration, and mosquitoes. In reality, grass channels are not designed to retain water for any appreciable period of time.

Other concerns involve fears about utility installation and worries that the grass edge along the pavement will be torn up by traffic and parking. While utilities will need to be installed below the paved road surface instead of in the right-of-way, most other concerns can frequently be alleviated through the careful design and integration of the open channels along the residential street.

Maintenance

The major maintenance requirement for grass swales is mowing during the growing season, a task usually performed by homeowners. In addition, sediment deposits may need to be removed from the bottom of the swale every ten years or so, and the swale may need to be tilled and re-seeded periodically. Occasionally, erosion of swale side slopes may need to be stabilized. The overall maintenance burden of grass swales is low in relation to other stormwater practices, and it is usually within the competence of the individual homeowner. The only major maintenance problem that might arise pertains to “problem” swales that have standing water and are too wet to mow. This particular problem is often alleviated by amending the soil with rocks and well-drained soils to promote drainage.