Natural Treatment

Constructed wetlands for treating storm water runoff

Constructed wetlands are an effective tool for treating storm water runoff. Similar to the natural wetlands from which this technology evolved, each constructed system is unique to the local landscape and required treatment needs. Although simplified design guidelines exist as best management practices, they are typically the minimum design requirements. It is important to consider how the system will function in the landscape in order to harness the natural benefits of constructed wetlands.

By Tara Dougherty & Elizabeth C. Kennedy

Design parameters—including site hydrology and soils, runoff pollutant concentrations and required effluent water quality—should be clearly defined at the beginning of a project. Consideration should also be given to construction feasibility, costs and ongoing operations and maintenance of the system. The technical feasibility of wetlands for storm water treatment is an important element of their implementation, and clearly understanding the local regulatory environment will aid in the process.

Constructed Wetlands

Wetlands are commonly defined by soils that are saturated with water for a sufficient time period to sustain wetland vegetation. In nature, these ecosystems have been observed to have higher rates of biological activity than most ecosystems, and as a result, they are capable of transforming common wastewater pollutants into harmless byproducts or essential nutrients that are used to feed additional biological productivity. Typically, these systems evolved as a result of natural flow patterns and self-organized into an essential component within the environment.

The greatest difference between constructed wetlands and natural wetlands is the hydraulic regime. In natural wetlands, the flow in and out is a result of seasonal meteorological events and groundwater patterns. Conversely, in constructed wetlands, the hydraulic regime is strictly controlled by inlet distribution headers, outlet collection systems, water level-control devices and liners. Additionally, constructed wetlands are designed with a purpose—to remove specific pollutants, namely sediment, organic matter and nutrients.

In general, there are two types of constructed wetlands. The first is referred to as a free water-surface (FWS) wetland. These wetlands resemble shallow ponds in which the water is less than 3 ft, and emergent, submerged and floating plant species are usually planted.

The second type is a subsurface-flow (SF) wetland. In SF systems, water is maintained at a constant depth below the surface of the growing media (typically gravel). The depth of gravel in a wetland ranges from 0.6 to 0.9 meters. If soil types with low permeability do not exist in the project location, an impermeable liner is installed beneath the gravel to prevent seepage and contamination of the groundwater. In cold-weather regions, approximately 6 in. of mulch is applied to the top of the gravel, providing essential insulation during the winter months and minimizing water loss during warmer, drier periods. Plant species utilized in SF wetlands are currently limited to emergents and others that can tolerate saturated soil conditions for extended periods of time.

Storm Water Appeal

Constructed wetlands are typically used for water quality treatment, but some forms, such as the FWS, can be designed to control water quantity events as well. The application of constructed wetlands in storm water systems depends on a myriad of parameters, including location within the landscape, topography, solar orientation, storm water consistency and personal preference. An additional consideration—not addressed in many storm water management guidelines—is the source of the storm water and the expected levels of constituents to be treated.

The interest in constructed wetlands for storm water treatment has increased in recent years among developers. The interest is driven both by the desire to gain support for the development from municipal authorities and the local community, as well as for marketing the development to prospective buyers.

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In areas where a watershed is stressed by nutrient or sediment loadings, community-based watershed protection groups have a formal role in the development agreement process. Innovative storm water management practices that provide nutrient removal are favored by these groups and tend to gain support early in the process. In areas where watershed groups are not involved in the development agreement process, constructed wetlands are seen as going above and beyond the requirements for storm water management and offering a way to gain support of council and expedite the agreement process.

Constructed wetlands are seen by some urban developers as a way to gain attention for their development. Replacing conventional detention/retention basins with attractively landscaped and natural-looking constructed wetlands brings a natural amenity to a development that can be enhanced through walking trails and in some cases, interpretive signs. Water features create interest and aesthetic appeal in a community and may be a selling feature for prospective buyers. Highlighting the innovative use of wetlands for storm water management also raises the environmental profile of development companies in general and may be used as a marketing tool.

A Multifaceted Solution

A treatment system must work today and well into the future. Constructed wetlands provide biological complexity instead of mechanical complexity. Rather than relying extensively on external energy inputs—chemicals, heat or electricity, for instance—wetlands often are designed to maximize the use of natural energy inputs: solar energy, wind energy and atmospheric diffusion. Due to low energy inputs, constructed wetland systems have low carbon footprints compared with other biological and chemical processes used for water treatment.

As engineers, industries and regulators worldwide look to solve complex environmental problems, many are finding that constructed wetlands can provide significant cost savings and high-quality treatment and create valuable, natural public amenities. WWD

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