The Water Center ◆ Fact Sheet January 2001

Pilot scale constructed wastewater treatment wetland

Introduction

Artificially created wetlands known as "constructed" or "treatment" wetlands are an accepted method for treating wastewater. Natural wetlands possess water-cleansing properties which are recreated and put to use treating pollutants such as organic matter, suspended solids, metals, coliform bacteria, and nutrients such as phosphorus and nitrogen.

Pollution abatement and prevention costs private industry approximately $30 billion each year; agriculture spends about $500 million every year, and the federal and state governments fork out about $10 billion and $500 million respectively. Municipalities spend approximately $23 billion each year, the bulk of this is spent on wastewater, potable water treatment, and storm water abatement.

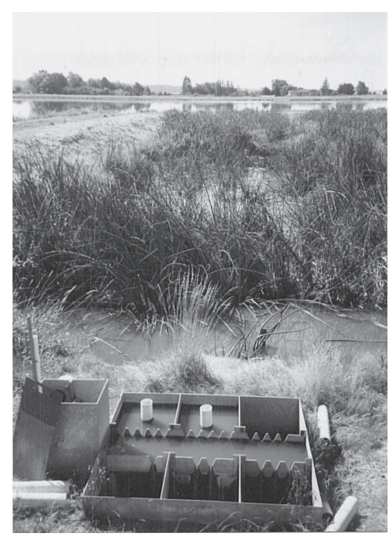
Although constructed wetlands can require a large amount of land, they have several potential benefits. Constructed wetlands are less costly than traditional systems and may be more practical and affordable for smaller communities. These jurisdictions have the potential to benefit greatly by this technology when it is designed and operated appropriately. Another benefit of these systems is the creation of wetland ecosystems which are currently being lost at a rate of approximately 100,000 acres (40,000 ha) per year, mostly due to agriculture development, road construction, and residential development.

A pilot-scale constructed wetland at the city of Stanwood's wastewater treatment facility, Snohomish County. Shown are two Scirpus acutus (bulrush) dominated marsh components, separated by a gravel berm.

The technology

The two types of constructed wetlands are "free water surface" (FWS) wetlands and "subsurface flow" (SSF) wetlands. In the FWS wetlands, wastewater runs above and in the shallow depths of a generally impervious soil surface, usually at depths less than 0.5 m and generally through a dense growth of vegetation. Open pools may or may not be incorporated. In the SSF wetlands, the effluent runs beneath a coarse substrate such as a gravel bed matrix, at depths not more than 0.6 m. Both types of wetlands can be used by wildlife for habitat and by humans for recreational and/or educational purposes.

Constructed wetlands treat all types of wastewater, from agri/aquacultural to industrial to municipal to mining waste. They usually consist of connected cells of differing wetland ecotypes (i.e., marsh vs. wet meadow) that have different treatment capabilities. As the wastewater enters low flow areas, particulates settle out. In alternating oxygenated and anoxic zones, other pollutants undergo various microbial transformations to cleaner states (e.g., organic carbon to carbon dioxide, ammonium to gaseous nitrogen). While this can be and often is accomplished with the use of a "wet pond," such processes can be more fully utilized by running the wastewater through vegetation, which confers several attenuation properties itself. It is worthwhile, however, to note that the distinction between a wet pond and a wetland is fuzzy—there is no precise division.



After undergoing primary treatment in a partially aerated pond,wastewater flows to a "splitter box" with V-notches that control the loading rates into four wetland cells.

Role of vegetation

Plants are an integral component of a wetland system and are often considered the defining characteristic of a wetland. In a treatment wetland, vegetation serves to leak oxygen to the root zone, shade out algae, and provide substrate for microbes (many of which are the same species as those found in conventional wastewater treatment systems). Plants also alter the hydrologic budget via evapotranspiration, provide wildlife habitat, and act as a natural filter for suspended solids. They take up nutrients as well, though the extent of this may be insignificant, and certain pollutants like phosphorus are re-released with the decay of plant litter.

Design considerations

Design considerations in treatment wetland construction include wetted areas (shape and size), retention time, loading rate (the amount of water going in), plant type and species, and water depth. These in turn are constrained by regulations and by effluent water quality goals. Constructed wetlands are dynamic systems influenced by a wide suite of factors from the regional climate and geology to the local vegetation to land-use patterns. There has been little consensus on approaches for successful wetland system operation and management, however, and that information that standardizes system design and summarizes successful techniques is scattered. Although wetland technology is highly site-specific, studies at a western Washington pilot project provide recommendations on the most important design variables for FWS wetlands treating primary municipal effluent in cool-temperate, humid regions like western Washington (see table).

Parameter	Important design variables
organics	lower loading rate, marsh, growing season
suspended solids	wet meadow, growing season
phosphorus	longer HRT, lower loading rate, wet meadow
nitrate + nitrite	higher temp., longer HRT, lower loading rate
ammonia	higher temperatures, longer HRT, lower loading rate, wet meadow

Warmer temperatures, lower loading rates, longer HRTs (amount of time water resides in the wetland), and the type of wetland components are all extremely important. Plant species and abundance play minimal roles in the effectiveness of these systems. Resources should be expended primarily on the construction of muti-component wetlands with optimum loading criteria, since maintenance of optimal temperatures is probably not viable.Unless an educational component is desired, expending significant time or money to maintain a specific plant cover percentage or dominance by certain plant species is unwarranted. In cool regions like western Washington, these systems are probably best employed as the final “polishing” step before effluent is discharged into the receiving body of water.

References

Brix, H. 1997. Do macrophytes play a role in constructed treatment wetlands? Wat. Sci. Tech. 35(5):11-17.

Crites, R. W. 1994. Design criteria and practice for constructed wetlands. Wat. Sci. Tech. 29(4):1-6.

Kadlec, R. H. and Knight, R. L., 1996. Treatment Wetlands. Lewis Publishers, Boca Raton, FL, 893 p.

US EPA Office of Water web site on Constructed Wetlands for Wastewater Treatment and Wildlife Habitat <http://www.epa.gov/owow/wetlands/construc/freewatr.html>

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