ALABAMA COOPERATIVE Extension SYSTEM

ALABAMA A&M AND AUBURN UNIVERSITIES

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Municipal Wastewater Treatment

Constructed Wetlands: A New Concept In Treating Wastewater

During the past few years a new technology for treating municipal and industrial wastewater has emerged. This technology involves the construction of “artificial wetlands,” which use the physical, chemical, and biological processes in nature to treat wastewater. These specially built wetlands are also referred to as “constructed wetlands” or “created wetlands.”

Constructed wetlands can be designed for whole communities, subdivisions, private developments, and even for individual homes suffering from failing on-site septic systems. Interest has steadily increased because of their low cost (one-tenth to one-half that of conventional treatment), efficiency, and near non-existent maintenance.

What Is A Constructed Wetland?

A constructed wetland is an engineered, marsh-like area where specially established organisms and plants feed on the organics and nutrients that are in the wastewater. Pollutants are transformed into basic elements, plant biomass, and compost.

How Do Constructed Wetlands Work?

Constructed wetlands offer all the treatment capabilities of natural wetlands but without constraints associated with discharging to a natural ecosystem. Like natural wetlands constructed wetlands accomplish water improvement through a variety of physical, chemical, and biological processes.

Constructed wetlands are established with special vegetation including cattails, bulrushes, reeds, sedges, and certain mosses and algae. They may also contain a variety of submerged plants.

The specially established vegetation obstructs the flow and reduces the velocity of the wastewater. When wastewater is slowed, suspended and dissolved material can settle out. The vegetation also provides surfaces for the attachment of bacteria films, aids in filtration and adsorption of wastewater constituents, transfers oxygen into the water column, and controls the growth of most algae by restricting penetration of sunlight.

Constructed wetlands have a shallow water depth (usually 4 to 24 inches) and may cover a relatively large area. This improves dissolved oxygen content and thus enhances decomposition of organic matter and oxidation of dissolved metals.

The decomposition process in constructed wetlands is similar to the decomposition occurring in most conventional water treatment plants except for the scale of the treatment area and the composition of microbial populations, which are likely to be different. In both cases, an optimal environment is created and maintained for microorganisms to conduct desirable biochemical transformations of water pollutants. Subsurface flow systems can be designed for secondary or even advanced treatment of pretreated wastewaters. These systems consist of channels or trenches with relatively impermeable bottoms filled with sand or rock media to support emergent vegetation.

What Are The Advantages Of Constructed Wetlands?

Advantages of constructed wetlands include relatively low construction costs (essentially grading, dike construction, and vegetation planting) and low operating costs (monitoring water level and plant vitality and collecting samples). Properly designed and constructed systems do not require chemical additions or other procedures used in conventional treatment systems.

Typically, construction costs range from one-tenth to one-half of those for conventional treatment systems. For example, a TVA-designed system for treatment of municipal wastewater at Benton, Kentucky cost $260,000 in 1986 compared to a 1972 estimate of $2.5 million for a comparable conventional treatment system involving chemical additives. Two other systems designed for secondary and tertiary treatment of municipal wastewaters for communities of 500 (Hardin, Tennessee) and 1000 users (Penbroke, Tennessee) varied from $212,000 to $366,000. Operating costs for these systems are less than

$10,000 per year. A TVA wetland controlling acid mine drainage cost $28,000 for construction and plant establishment, about the same as the annual cost of chemicals alone to provide comparable conventional treatment. Operating costs for these municipal systems other than monitoring, sample collection, and analysis have been less than $500 per year.

The efficiency of these constructed wetlands systems for wastewater treatment has been very good, especially in terms of biological oxygen demand, total suspended solids, and fecal coliform bacteria. With proper design and adequate treatment area, removal of nitrogen compounds and phosphorus are readily accomplished. Metallic ion removal even from strongly acidic waters is excellent. Slight increases in pH are common when influent seep water is moderately acidic.

What Are The Disadvantages Of Constructed Wetlands?

Constructed wetlands require relatively level landscapes and much more land area than do conventional treatment plants. Where land costs are high (large cities, rugged terrain), artificial wetlands are more expensive to construct than conventional systems although lower operating costs for a 20- or 30-year plant lifetime must be factored into the decision process. Current design recommendations specify 15 to 50 acres of treatment area per million gallons of influent per day depending upon the level of pretreatment and the desired discharge limits. However, present design, construction, and operating criteria are imprecise because wetland systems either natural or constructed are complex, dynamic systems about which we have only limited understanding.

Although constructed wetlands of the size to replace many conventional wastewater treatment facilities are generally cheaper to build and operate, the initial cost of on-site systems for individual homes, depending on conditions, may be more than double that of a septic tank system. However, the wetland systems work best in wet and poorly drained soils where septic tank absorption systems are most likely to fail.

Another disadvantage of artificial wetlands is their delayed operational status. Because peak removal efficiencies of constructed wetlands are dependent upon vegetation growth and establishment, design efficiencies are not likely to be attained until after two or perhaps three growing seasons.

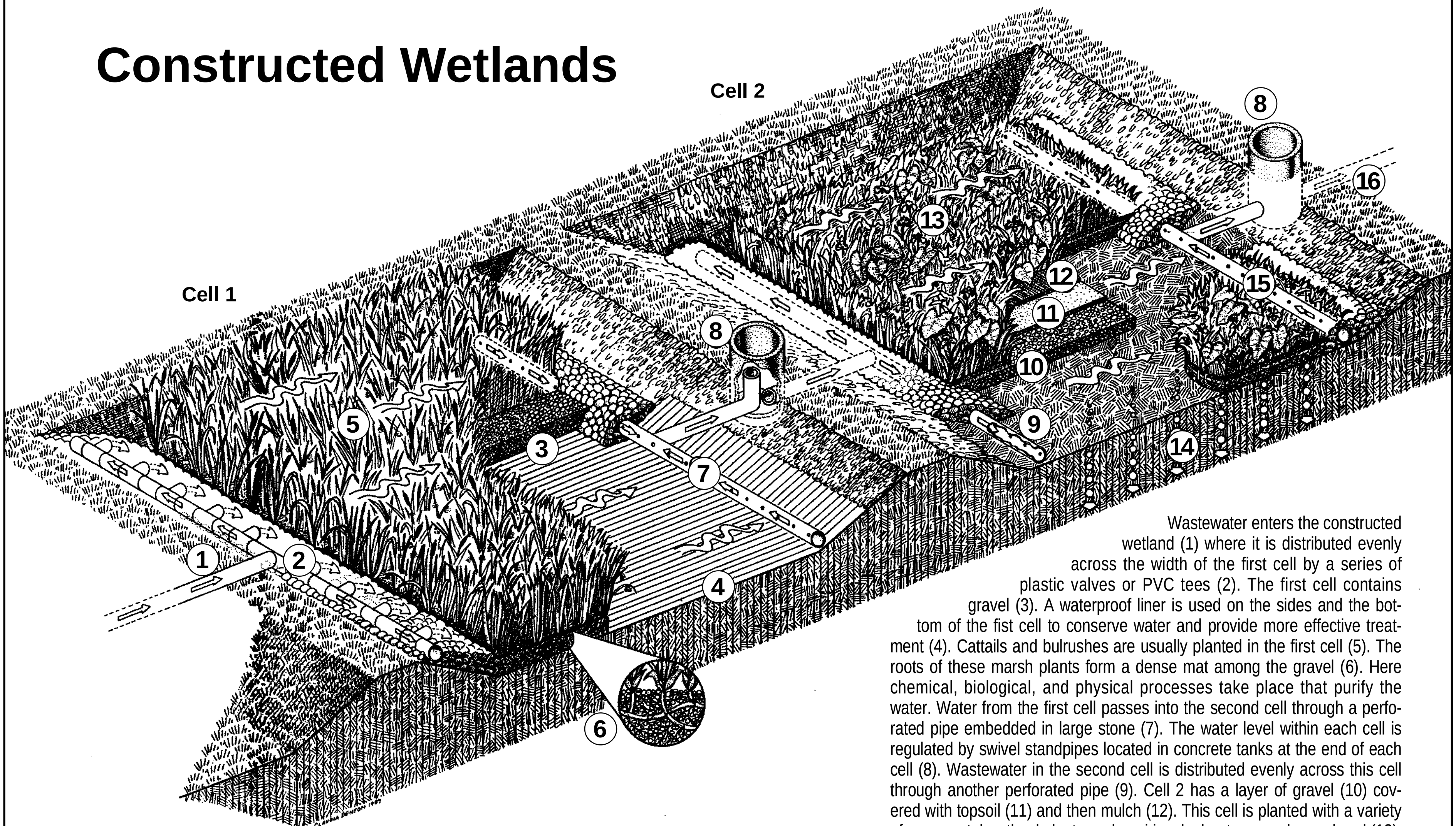
Long-term effectiveness is poorly documented since no system has been in operation for more than 10 years. Some research indicates that these wetlands may have problems with removing ammonium-nitrogen. Nevertheless, because these systems simulate natural wetland ecosystems that have functioned to purify water for thousands of years, system efficiency is not likely to be detrimentally impacted by age. Artificial constraints, however, may require modifications of these systems or restarting them after some period of time. Accumulation of deposits from acid mine drainage may need to be recycled or mined, for example, and litter accumulations in municipal systems or agricultural systems may need to be cleared or purified.

Conclusion

Public concern during the past 20 years has strengthened state and federal legislation regulating wastewater discharges and resulted in substantial progress in treating point sources of water pollution, especially for large cities and major industries. Widespread implementation of the "constructed wetland" treatment technology may accomplish similar objectives for small communities, small industries, and livestock operations. This technology seems amenable to a substantial range of hydraulic and pollutant loading levels and may fill the pressing need for low cost technology systems acceptable to industry, farmers, developers, and communities.

Although constructed wetlands may be an important alternative method of wastewater treatment, their effluent discharge to a water source must be permitted as with any other point source of pollution. Efficiency and capability of constructed wetlands for various types of wastewater treatment is not yet well understood, especially under variable climatic conditions. Stabilization ponds below the wetland may be needed in some cases to meet discharge requirement or to allow for recycling of discharge water if that is a design feature. This would substantially increase land requirements.

Constructed Wetlands



Wastewater enters the constructed wetland (1) where it is distributed evenly across the width of the first cell by a series of plastic valves or PVC tees (2). The first cell contains gravel (3). A waterproof liner is used on the sides and the bottom of the fist cell to conserve water and provide more effective treatment (4). Cattails and bulrushes are usually planted in the first cell (5). The roots of these marsh plants form a dense mat among the gravel (6). Here chemical, biological, and physical processes take place that purify the water. Water from the first cell passes into the second cell through a perforated pipe embedded in large stone (7). The water level within each cell is regulated by swivel standpipes located in concrete tanks at the end of each cell (8). Wastewater in the second cell is distributed evenly across this cell through another perforated pipe (9). Cell 2 has a layer of gravel (10) covered with topsoil (11) and then mulch (12). This cell is planted with a variety of ornamental wetland plants such as iris, elephant ear, and arrowhead (13). The water in cell 2 eventually seeps into the soil below (14) or passes into another perforated pipe (15) where it is released into a drainfield similar to those used with conventional septic tanks (16).

Source: Steiner, Watson, and Choate 1991.

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Tennessee Valley Authority. Wastewater Treatment By Constructed Wetlands. Water Quality Branch. Chattanooga, TN.

To obtain additional information on constructed wetlands of any scale or use contact the Tennessee Valley Authority, Water Quality Branch, 270 Handley Building, 311 Broad Street, Chattanooga, TN 37402-2801.

To obtain additional information on the use of constructed wetlands as an alternative to treat household sewage, contact the Alabama Department of Public Health, Division of Community Environmental Protection, On-Site Sewage Branch, 434 Monroe Street, Montgomery, AL 36130-1701 (334-613-5373).

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