# *Opportunities for Wetlands Waste Water Treatment at Transportation Facilities*

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J. F. New and Associates, an environmental engineering firm located in Walkerton, Indiana, has for the last ten years designed and built artificial wetlands to treat various waste streams. Focusing on the biology of the systems, efforts have been applied toward maximizing the function of plants.

Figure 1

| Process | Role/Function |
|---|---|
| **<u>Physical</u>** | |
| Filtration | Particulate matter is filtered out as the water flows through the plant roots and media |
| Sedimentation | Flocculation and gravitational setting of solids |
| Adsorption | Adsorption of colloidal solids by interparticular molecular forces |
| **<u>Chemical</u>** | |
| Precipitation | Formation and precipitation of insoluble compounds |
| Decomposition | Oxidation, reduction, and irradiation of less stable compounds |
| Adsorption | Adsorption of heavy metals by the plants |
| **<u>Biological</u>** | |
| Bacterial Metabolism | Degradation of organic pollutants by bacteria |
| Plant Growth | Uptake of nutrients and trace metals by the plants |
| Evapotranspiration | Increases concentration of pollutants by naturally dewatering the waste stream |
| Residence Time | Natural decay of pathogens and other organisms |
| | Reference: Hydrobiologia 340: 323-331, 1996 |

In subsurface flow wetlands the root zones of plants play a major role in the treatment process.

Three species most frequently used in the United States are common reed (*Phragmites australis*), hybrid cattail (*Typha glauca*), and bulrush (*Scirpus* species). When the root zones of cattail and bulrush were examined they were found to be severely lacking in the massive development of root hairs necessary to carry out treatment processes. Additionally the use of phragmites and nonnative or non-regional genotypes is prohibited by many state regulatory agencies.

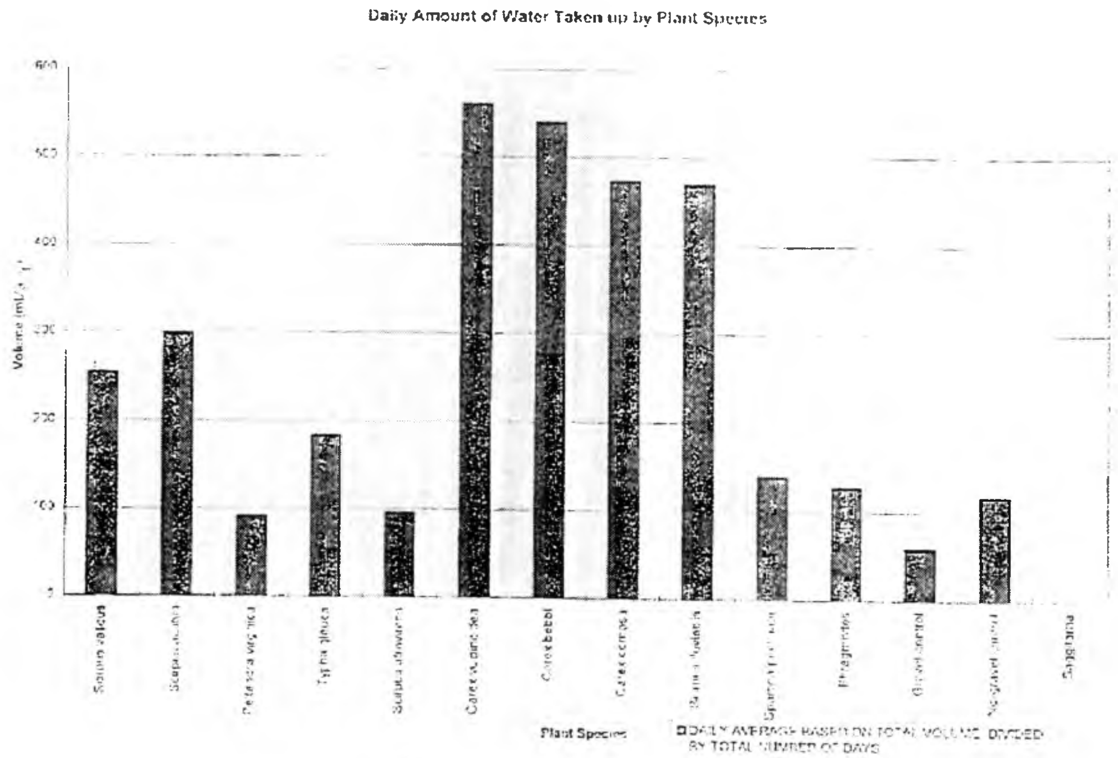
Studies were undertaken to find hydrophytic species that exhibited strong root development and that were from regional genetic stock. Using the expertise of botanists the studies showed huge variability in root development among species.

Figure 2

Examinations comparing volume of wastewater inflow and outflow from several systems indicated a larger volume of water was being lost through evapotranspiration. It was determined that using pollutant concentrations (mg/l) was not giving a true picture of the wetlands' treatment performance. Examination of actual mass pollutant removal showed these systems treatment capabilities were greatly understated.

Recognizing the value of evapotranspiration in the treatment process, studies were undertaken to find which species were most efficient. Because of the value of quality root development only those species with those characteristics were examined. Our company botanist again provided the necessary plant characteristics to be examined. Studies showed large variation among the species studied. The commonly used species in these systems showed evapotranspiration similar to controls of gravel with no plants and pan evaporation.

Figure 3

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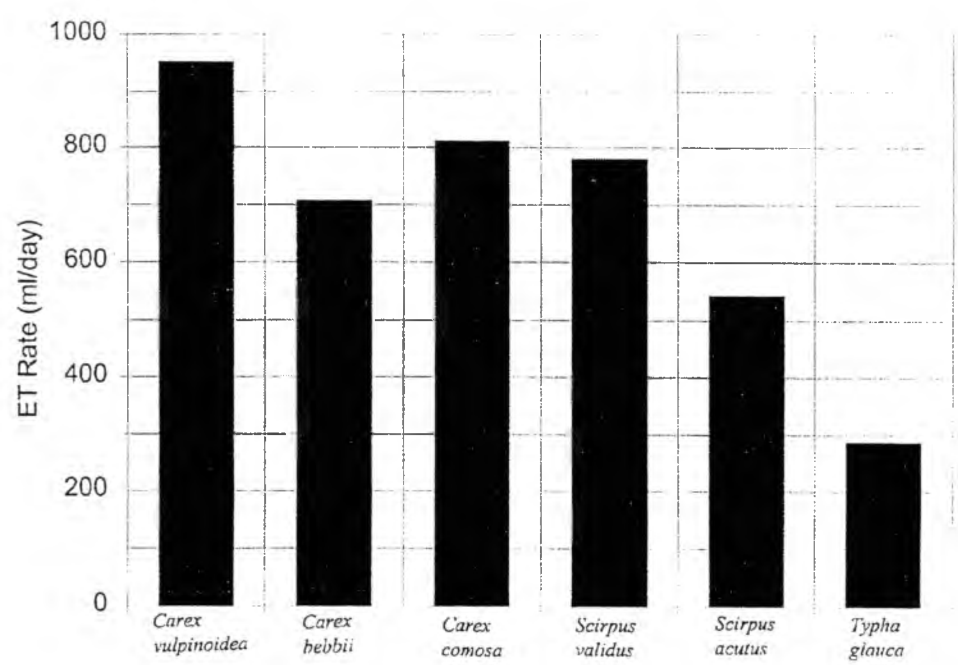
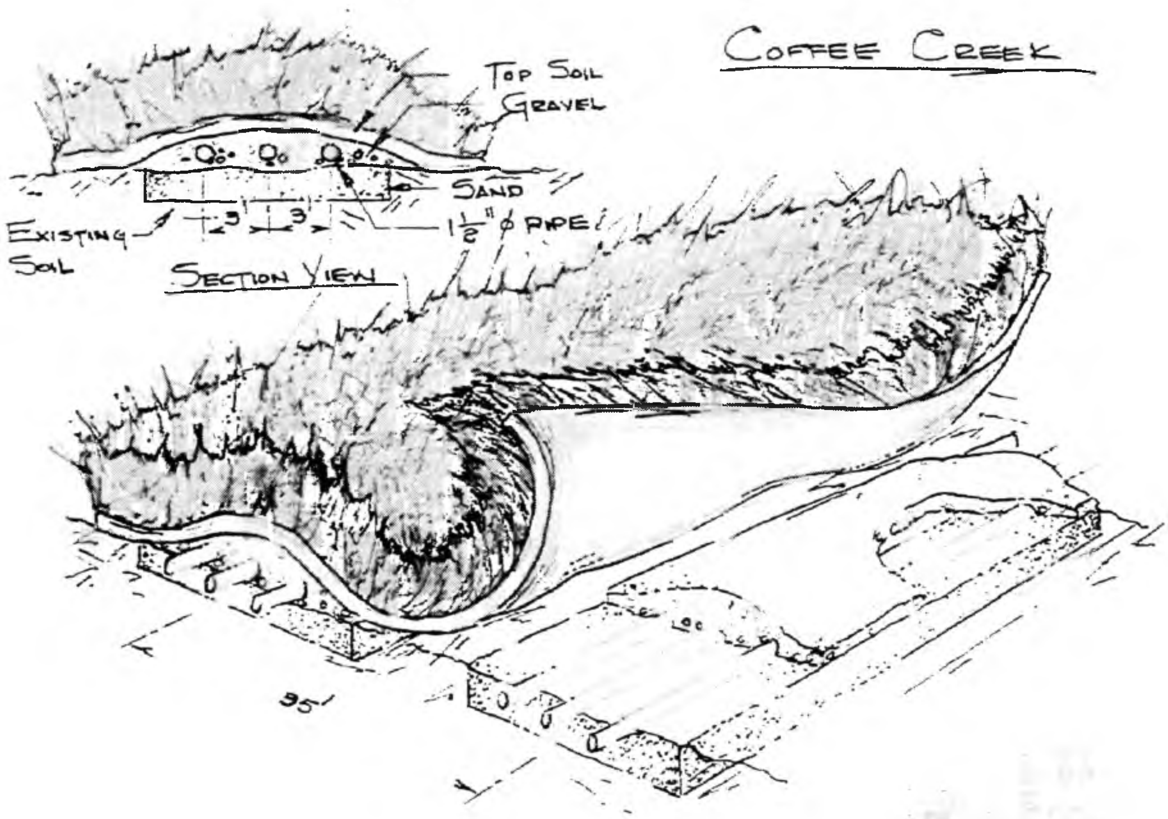
Wetland and Prairie Nursery • Lake and Stream Enhancement
Natural Systems for Wastewater Treatment

**Average Daily ET Rate**
Mature Plants - Nov 1997-Sept 1998



Artificial wetlands combined with designed biofields can easily produce water that far exceeds drinking water quality standards. (6) To be successful several disciplines must be understood, certainly engineering, soils and hydrology play important roles. It is the botanist, however, that must be relied on to provide the proper plants that drive the entire system.




The technology of using artificial wetlands to treat and clean water is rapidly being accepted and applied throughout the world. They are proving reliable and cost effective in regions with tight soils or highly permeable soils where septic systems perform poorly. Because they are easily decentralized they can be built where they are needed rather then spending huge amounts of money on collection systems to bring waste to a single treatment facility. They are easy to build in a short time frame and can therefore be built sequentially as treatment needs increase instead of a complete conventional system up front with anticipation of growth. Developers are recognizing the additional value in owning wetland treatment systems as a private utility. Because they use natural processes, operation and maintenance costs are very low compared with conventional treatment.

Wetlands are certainly not the answer to every water pollution problem. As more and more systems are put on line and our knowledge grows we will definitely find wetlands playing an ever-increasing role in cleaning our polluted waters.

Recent changes in environmental regulation within the Great Lakes Region are stressing "nondegradation" to all waterways. These regulations virtually eliminate point source discharges to these waterways. Treated waste streams from new systems therefore must be discharged to the land either by irrigation on the surface or subsurface via leach fields. Because of the expense in providing "storage" during the frozen ground winter months, infiltration is often the most economical method.

Subsurface wetlands with their considerable reduction in hydrology and very low BOD provide a complementary treatment for subsurface discharging. In order to meet drinking water quality standards for water with in the ground water, additional treatment is often necessary for nitrogen and phosphorous.

Wetlands typically discharge nitrogen in the ammonium/ammonia forms. Conversion of ammonium/ammonia to nitrates is accomplished by dosing a shallow aerobic zone immediately beneath the tile leach field. The anaerobic digestion of nitrate requires a renewable carbon source. This process is often required with in low infiltration soils. The needed increase in permeability is accomplished by using deep-rooted native plants. These plants can improve permeability from less than 0.5 inches per hour to more than 10 inches per hour by penetrating the soils with porous root channels. Additionally these plants can sequester more carbon beneath the soil surface than forests can above ground. During warm dry periods these plants dry out the soils through evapotranspiration, then leave the soil porous and rich in carbon during wet periods. Using chloride to verify hydraulic dilution, biofields (5) have demonstrated excellent water quality within 50 feet down gradient of the leachfields.

Other species showed sustained evapotranspiration of more than1000mg/l per square foot per day.