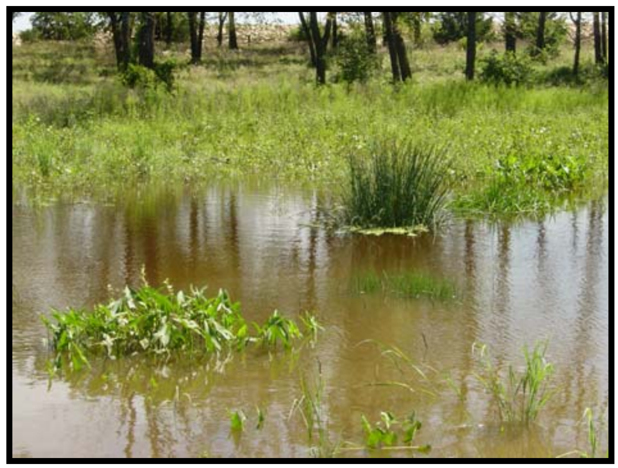
Flood Attenuation and Water Quality Benefits of Wet Prairie Ecobasins

As our understanding of natural ecosystems grows, there has been a realization of the environmental benefits that can be achieved when biological systems are incorporated into conventional engineered structures. More and more studies have shown how wetland soils and plants can improve water quality, provide valuable wildlife habitat, and be included in the built environment as attractive community assets. This knowledge has led to the design of detention basins which include native plants that are adapted to moist and saturated soil conditions instead of traditional dry detention basins planted in a turf grass monoculture. Interest in these projects has only grown with the implementation of NPDES Phase II requirements for non-point source pollution.

In the last decade, there has been a growing movement to mimic natural stormwater runoff conditions through various techniques, including constructed wetlands such as those found in wet prairie ecobasins, rain gardens, and bioretention areas. By matching natural hydrologic conditions as closely as possible, groundwater infiltration is increased and off-site runoff is reduced. This decreases the negative effects associated with the higher pollutant levels and higher volume and frequency of surface runoff that come with development and the increase of impervious surfaces.

Although these regional detention areas receive large amounts of water within relatively short periods of time, the wetland habitats that are established would be best described as a combination of wet prairies and emergent wetlands dominated by rushes, sedges, and bulrushes that are adapted to saturated and inundated conditions. Additionally, while this discussion is limited to regional detention ponds, the same water quality and wildlife habitat benefits achieved through the use of native wet prairie and wetland plants in wet prairie ecobasins can also be achieved through the use of wetland forebays.



Flood Attenuation

Regional detention basins that include wet prairies and wetlands offer relatively similar flood control benefits to traditional dry detention basins, with one major difference. In contrast to the shallow roots of fescue and bluegrass which line traditional detention ponds, the deep roots of wet prairie species commonly grow to ten feet or more below the surface. These deep root systems break up the soil and allow a much greater rate of infiltration, replenishing groundwater supplies. This infiltration results in a decrease in the *total volume* of runoff, in addition to the decrease in peak flows and velocity that are provided by conventional detention basins. As a result, wet prairie ecobasins can reduce the total amount of stormwater, rather than just temporarily detain it.

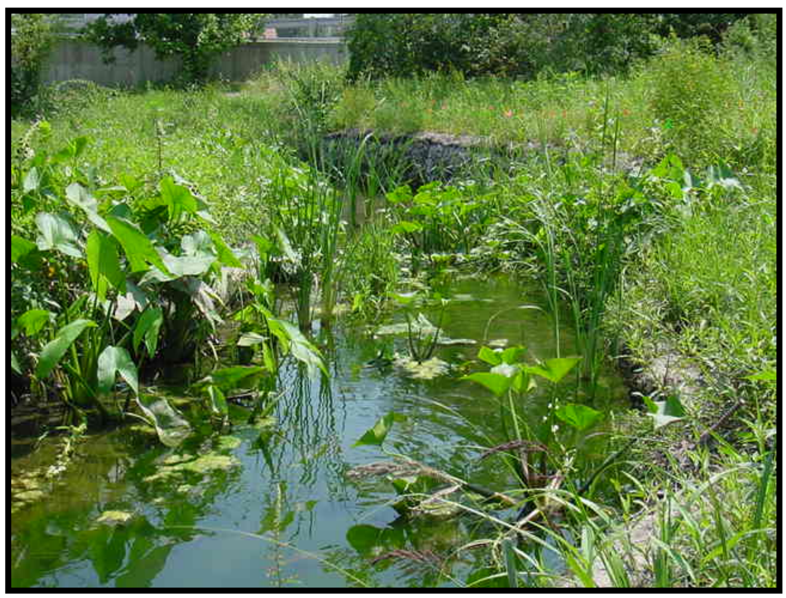
Water Quality Benefits

Environmental Impacts from Urban Runoff

Urban runoff has several negative impacts on ecosystems. As more natural areas are converted to impermeable surfaces, the amount of surface runoff drastically increases, causing a larger amount of water flowing through our waterways in a shorter period of time. This phenomenon initiates increased scouring and stream bank erosion, leading to slumping and slope instability. Additionally, urban runoff carries high amounts of non-point source pollution, such as sediments from construction sites, fertilizers and pesticides from lawns, road salts, heavy metals, oil and grease from automobiles, and viruses and bacteria from failing septic tanks. In many cities, these pollutants are carried untreated into our streams and rivers where they can harm wildlife and plants, reduce recreational opportunities, and spoil drinking water supplies.

Water Quality Benefits from Native Wet Prairie and Wetland Systems

Drier-end wetland systems like the ones discussed in this paper provide important water quality benefits. In fact, wetlands are commonly referred to as the kidneys of the landscape because of their reputation for providing a level of water purification. Since wetlands often exist in the transition zone between land and water, these ecosystems often serve as biological filters for water entering streams, rivers, and lakes.



The saturated soils found in moist detention basins, along with native plants adapted to wet soils, provide habitats for microorganisms that transform and store many harmful pollutants. These microorganisms are unique to wetland ecosystems and are responsible for the vast majority of the biochemical reactions that result in improved water quality.

The conversion and retention of nitrogen and phosphorus are two of the most important water quality benefits that wetlands, including wet prairies, provide. While many other pollutants are filtered or retained by wetlands, these two chemicals are very common in urban runoff and are removed to a fair degree by wetland systems. Nitrates from residential and agricultural runoff are readily metabolized by microorganisms and transformed into less toxic forms of nitrogen which are released to the air or are absorbed by plants or other microorganisms. The retention of phosphorus and heavy metals is achieved through adsorption onto clay soil particles or organic material as well as through interaction with the byproducts of the metabolism of microbes adapted to saturated soil conditions.

Because of their well known benefits to water quality, constructed wetlands are often added to wastewater treatment facilities. According to a compilation of 226 input-output differences in pollutant concentrations described in studies of created wetlands, three quarters of all studies showed that although there was a fair amount of variability between constructed wetlands, they can remove greater than 75% of a number of non-point source pollutants. A pilot operation in Michigan in the early 1970's that passed secondarily treated wastewater through a wetland system found that approximately 99% of nitrite and nitrate nitrogen, 95% of total dissolved phosphorus, and 70% of ammonia nitrogen were removed by the wetland soils and plants. Since that time, many tertiary treatment wetlands have been built across the country.

From a maintenance perspective, moist native plant systems offer advantages to conventional systems. Native plants have adapted to local conditions such as climate, extreme temperatures, droughts, local pests, and disease over hundreds of thousands of years. Additionally, they have formed a complex network of relationships with other plants, soil microbes, fungi, and animals through co-evolution. As a result, they are adapted to local conditions and, after they are established, they do not require fertilizer or watering. Once established, native systems will be self-sustaining and will require much fewer maintenance costs than conventional turf grass systems.

Wildlife Habitat & Aesthetic Benefits

In addition to water quality benefits, the use of native wet prairie vegetation in detention basins creates high quality wildlife habitat. A diversity of plant species contained both in the moist bottom and on the dry slopes and surrounding area creates a wide variety of food and shelter that allows for much greater biodiversity than conventional stormwater facilities. Birds, amphibians, butterflies, and other insects appear shortly after establishment to take advantage of the new habitats. Wet turf grass areas, such as those found in conventional dry detention basins, are prime mosquito habitats, while areas that are planted with diverse native plant habitats can support many natural predators of nuisance species, thus limiting the numbers of mosquitoes and other undesirable pests. Additionally, purple martin houses and bat houses can be included as part of the design to further limit mosquitoes.

Wet prairie detention basins also provide local residents with an attractive natural area that has a diversity of plants that bloom in a variety of colors and textures throughout the year. Plants like sunflowers, blazing stars, asters, and bur marigolds offer aesthetic benefits that are valued by nearby homeowners. Prairies also offer residents a sense of place and historical connection to the area's heritage.

Case Study: North Griffin Regional Detention Pond – Griffin, GA

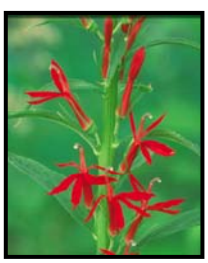
The city of Griffin, Georgia, built a regional detention basin to service a 180-acre urbanized area of the city because of flooding issues in a subdivision. As the project progressed into planning stages, the designers decided to incorporate wetland plants into the floor of the detention basin in order to improve downstream water quality. This allowed the city to receive funding for the project from the U.S. EPA through the Clean Water Act Section 319(h) grant program.

The detention basin achieved its goal of flood attenuation. Additionally, the project saw significant water quality benefits when compared to a traditional detention basin. The city installed four water quality monitoring stations and monitored the following pollutants:

- Total suspended solids (TSS)
- Total dissolved solids (TDS)
- Nitrate nitrogen (NO2)
- Nitrite nitrogen (NO3)
- Total Kjeldahl nitrogen (TKN)
- Biochemical oxygen demand (BOD5)
- Total phosphorus (P)
- Oil and grease
- Total petroleum hydrocarbons
- Fecal coliform bacteria
- Total copper
- Chemical oxygen demand (COD)
- Total lead
- Total zinc (Zn)

Table 1 summarizes the monitoring results related to the regional detention pond's ability to remove pollutants.

Table 1. Pollutant Removal Efficiency for Main Detention Pond						
	Location 1 (Inflow)		Location 2 (Pond Outlet)		Removal Calculations	
Constituent	Concentration	Loading	Concentration	Loading	Loading Removal	Removal Efficiency
TSS	50.00 mg/l	20,919 lb./yr.	29.4 mg/l	12,290 lb./yr.	8,629 lb./yr.	41.3%
NO_2	0.39 mg/l	162 lb./yr.	0.3 mg/l	107 lb./yr.	55 lb./yr.	34.1%
NO_2/NO_3	0.39 mg/l	163 lb./yr.	0.3 mg/l	138 lb./yr.	25 lb./yr.	15.4%
BOD	9.50 mg/l	3,975 lb./yr.	7.0 mg/l	2,929 lb./yr.	1,046 lb./yr.	26.3%
P	0.20 mg/l	82 lb./yr.	0.1 mg/l	50 lb./yr.	33 lb./yr.	39.6%
TKN	4.53 mg/l	1,895 lb./yr.	1.7 mg/l	690 lb./yr.	1,204 lb./yr.	63.6%
COD	52.00 mg/l	21,756 lb./yr.	43.1 mg/l	18,043 lb./yr.	3,713 lb./yr.	17.1%
Zn	0.13 mg/l	56 lb./yr.	0.1 mg/l	43 lb./yr	13 lb./yr.	22.8%



Because of its success, this project received an Engineering Excellence Award from the Consulting Engineers Council of Georgia and was recognized for its achievements by the U.S. EPA Clean Water Act Section 319(h) Program and the Georgia Environmental Protection Division.

Conclusion

Through the unique ecology of wetland soils and plants, wet prairie ecobasins offer several advantages when compared to traditional dry detention basins. These benefits include a decrease in total volume of runoff through increased infiltration as well as various water quality benefits brought about through the transformation or retention of many common pollutants. Finally, wet prairie ecobasins provide high quality

wildlife habitat for many species and are much more amenable to nearby homeowners because of their attractive array of wildflowers.

Sources:

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