

WETLAND ECOLOGY AND WATER RESOURCE MANAGEMENT

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Abstract

Studies of the Des Plaines River provide evidence that many existing streams did not have conspicuous channels and were not identified during presettlement times (prior to 1830s in the Midwestern U.S.) (Apfelbaum 1995). Many currently identified first-, second-, and third-order streams were identified as vegetated swales, wetlands, wet prairies, and swamps in the original land survey records of the U. S. General Land office. A review of historic data indicates increases in discharge during low, median, and high flows since settlement. The modern channels formed inadvertently or were created to drain land for development and agricultural uses. Current discharges may be 200- to 400-times greater than historic levels, based on data from 1888 to the present for the Des Plaines River in Illinois.

Land development has resulted in a change from diffuse overland flows to increased runoff, concentrated flows, and significantly reduced lag time. The opportunity to emulate historic stormwater behavior exists through integration of natural ecosystems in urban and agricultural landscapes. Solutions that are easier to maintain, less expensive, more attractive, and offer other benefits as compared to many conventional stormwater management solutions are now available.

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Introduction

Both now and historically, wetlands have played an important role in maintenance of regional water balances. They also contribute to other very important local, regional, national and global levels of performance of stormwater and floodwater management.

Historic evidence from major streams and river systems in the central United States suggests that they have changed substantially. It is important to understand the magnitude of these changes in rivers, wetlands, and their tributary upland ecosystems to comprehend the change in hydrology and hydraulics these systems have undergone. Future engineering approaches to stormwater management, even in highly urbanized environments with limited open space, could benefit greatly utilizing restored ecological systems (e.g. prairies, wetlands, forests, etc.) for creative and cost effective solutions. These ecological systems perhaps better address flood management and stormwater, and provide a series of secondary benefits (e.g. increased wildlife habitat, increased biodiversity, water quality enhancement, and additional open space) that may not be provided by conventional approaches to stormwater management design.

Historic Hydrologic System Functions

If rivers are indicators of watershed change, then a review of how the hydrology of rivers has changed should be useful. This understanding indicates the magnitude of the changes that may be addressed by thinking about wetlands, prairies, and other landscape elements of ecological systems as functional levels in water resources management.

Studies of the Des Plaines River have identified regional (watershed) hydraulic and hydrologic changes associated with development from initial land clearing associated with farming to present day urban development. Over 90% of the historic native vegetation in the Des Plaines River watershed including wetland, prairie, savanna and forest systems has been lost or severely degraded. This has resulted in increased water runoff and sediment loads; lessened stream geometry stability; decreased stream system functions; deteriorated water quality; lessened river habitat; and decreasing human quality of life opportunities.

What opportunities exist in urban and rural areas for reestablishing some percentage of the historic wetlands, prairies and

forests? What benefits might be realized? What are the associated costs? Are there other benefits besides water quality and flood management that might offset potential costs? These questions are all fundamental to ask when trying to understand the potential opportunities for incorporating natural systems and water resources. A series of residential and commercial projects have been constructed that have begun to answer these questions. Owners of these projects have decided that the benefits of restored prairies and wetlands are greater than the costs.

The Prairie Crossing Project

Typical urban development causes increased stormwater runoff rates and volumes, and an increased runoff of contaminants associated with developed land use. Contaminants include sediments, heavy metals, fertilizers, de-icing materials, and many other chemical constituents. Typical residential developments maximize building density and incorporate open space into individual lots. Public open space is only provided where required by ordinance for use as parks or for stormwater management purposes. Stormwater management for urban development is typically concerned only with minimizing onsite and downstream flooding, and other nuisance aspects of stormwater runoff. Consequently, most urban stormwater systems consist of storm sewers to convey runoff, a detention basin, and an outlet structure to control stormwater release rates.

The Prairie Crossing project, a large residential development in Lake County, Illinois, has taken a series of measures to reduce stormwater runoff rates, volumes, and pollutant loading (Apfelbaum et al. 1996). These measures include integrating source controls and large-scale restored landscapes into the development as a major element of the stormwater management system. The stormwater management system consists of upland prairie biofiltration, natural open swale conveyance systems, wetlands, and a lake. In combination, these increase lag time, increase opportunities for pollutant removal through settling and biofiltration, and reduce the rate and volume of runoff through enhanced infiltration opportunities. Prior to development, the site was farmed under an annual crop rotation; soils were modified by drainage improvements, including an extensive tile system, and the native biological communities were eliminated.

The Prairie Crossing project includes a high-density "village center" and an outer area of cluster homes. Open space is being restored to the prairie, wetland, wet prairie, and savanna communities

historically found on the site. This restored landscape provides a unique living environment for the residents of Prairie Crossing. An additional 150 acres of agricultural lands are integrated into the development to protect the rural agricultural landscapes of the area.

Stormwater Management "Treatment Train System"

The open space in the Prairie Crossing project was planned to provide stormwater management for the project. The stormwater system has been designed as a treatment train with components that contribute in sequence to treat water before it leaves the site (Figure 1). Stormwater runoff from residential areas outside the village center is routed into open conveyance swales planted with native prairie and wetland vegetation, rather than storm sewers. The swales provide initial stormwater treatment, primarily infiltration and sedimentation. The prairies are the second component of the treatment train. Prairies diffuse the flows conveyed by the swales. The lessened stormwater velocities maximize the prairie's sedimentation potential. Additionally, the natural sorption sites produced by the prairie soils will hold many contaminants. The aerobic condition of the soil will also promote hydrocarbon breakdown. The prairies are expected to infiltrate a substantial portion of the annual surface runoff volume due to their porous soils resulting from very deep root systems of the prairie vegetation. Wetlands provide both stormwater detention and biological treatment prior to runoff entering the lake, which provides stormwater detention, further solids settling, and biological treatment. The components of this stormwater treatment train management system were designed to treat the stormwater runoff and reduce the stormwater runoff peaks and volumes.

Figure 1. Functioning elements of the Stormwater Treatment Train and the anticipated general stormwater management and water quality benefits in each element (Apfelbaum et al.).

Conclusions

The Prairie Crossing development is unique in northeastern Illinois and probably most other parts of the country. However, it utilizes cluster development and stormwater best management practices that are not unique; it combines these elements into a management system that minimizes the need for stormwater structures, enhances the living environment, and minimizes the negative impacts of urban development. Based on published BMP effectiveness information and hydrologic modeling, the Prairie Crossing development is expected to reduce surface runoff volumes by 65% and reduce solids, nutrients, and heavy metals loads by 85% to 100%. Source controls will minimize the impacts of the development even further. The result not only reduces costs to the developer, but also reduces maintenance costs for the community.

Wetlands and prairies can provide years of essentially free service, but at a great cost if mismanaged. To maintain higher quality, desirable wetlands, stormwater supplied to these systems should be higher quality, and the delivery should be somewhat predictable. What this may require is pretreatment of water in systems likely to experience extremes. Not all wetlands are equal from the perspective of biodiversity, wildlife habitat, water quality cleansing, human-use, and aesthetic perspectives. Using wetlands for water quality management can compromise the opportunity for conservation of high quality wetlands. However, this should not discount their importance and feasibility for use in water resource management. It simply means that the engineer needs to work closely with other disciplines to present accurate and adequate information for decisions makers. In conclusion, an ecological system approach, not only a focus on the importance and use of wetlands in stormwater management, is an important future direction for water resources management.

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