INTEGRATING DESIGN CRITERIA FOR MANAGEMENT OF URBAN ECOSYSTEMS

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Abstract. Urban streams are the confluence of human activity and natural system processes, oftentimes revealing the conflicting objectives of both. Ramifications of poor stream condition have not gone unnoticed as nationwide stream restoration efforts focus on restoring natural conditions based on criteria for ecological health and integrity. Urban watersheds suffer from poor water quality, degraded physical habitat and excessive stormwater runoff as a result of stream channelization, stream bank armoring and a high percentage of impervious landscape within the catchment. The objectives of this paper are to present current efforts in developing a framework for urban watershed management by integrating the concepts and principles of three design paradigms: 1) environmental design, 2) ecological design and 3) engineering design. The focus is to integrate the stream with its urban landscape through long-term management.

INTRODUCTION

Urban streams are an artifact of human society and not a product of natural processes. As such, these streams possess natural tendencies and have requirements for sustainability that may not be compatible with an urban landscape. Flooding, meandering, riparian integrity and suitable base flow are not necessarily accommodated by the built environment. Urban stream projects take on various descriptors based on project goals and objectives that are governed by the scope of the project and/or the clientele being served; e.g. restoration, rehabilitation, protection and management (Niemczynowicz, 1999; He, et al., 2000; Wali, et al., 2003). This paper summarizes recent efforts and the overall approach being taken for a small urban stream that has been significantly altered by landscape development.

APPROACH

Background

Tanyard Creek is a small urban stream located on property owned primarily by The University of Georgia, Athens-Clarke County and private landowners. Considerable effort has been devoted to understanding and improving the hydrological, and ecological condition of the stream for environmental and societal reasons, particularly through the monitoring and public education efforts of SEEDS (a UGA group of Students and Educators for Ecological Design and Sustainability). A design studio in UGA's College of the Environment and Design was held in the summer 2002 session to develop environmental design options for improving the integrity of the Tanyard drainage area. Students and faculty from UGA's Environmental Design, Ecology and Engineering provided input on constraints that are of particular concern to each discipline. Emerging from the debates and discussions fostered by this session, coupled with extensive literature reviews and research experiences of contributing faculty, it was concluded that some of the basic concepts of environmental, ecological and engineering design were not fundamentally contradictory but were certainly disconnected.

Data Collection

Hydrological, biological and land use data have been collected in the Tanyard drainage area for a number of years and indicate concerns: 1) water quality has been severely impaired, 2) physical habitat of the stream has been considerably altered, 3) biological diversity is absent, and 4) the stream functions primarily as a hydraulic channel for stormwater routing with pronounced incising and scouring. Preliminary analysis of existing data suggest that the drainage area has been developed with minimal consideration given to the hydroecological needs of the stream and that the stream network affords little, if any, aesthetic social

value to residents within the drainage area. Essentially, very few residents are even aware of the stream's existence - which may be attributed to the fact that over half of the stream is underground.

Scope, Goals and Objectives

Initially the focus was on stream restoration and rehabilitation, common terminology for similar efforts worldwide. However, from a science standpoint this seemed implausible for at least three reasons: 1) no hydroecological data exist on original stream conditions, 2) the landscape draining into Tanyard is "built", so goals of restoring the stream to original conditions are unrealistic, 3) the terms restoration and rehabilitation connote a terminus to the project, and 4) landscape alteration will continue. With this in mind, urban ecosystem management has been adopted as the project focus along with the following scope, goals and objectives.

Scope – the hydroecological, environmental and sociopolitical components within the Tanyard Creek drainage network
Goals – 1) ultimately preclude non-remediated stormwater routing to the stream 2) establish a rainfall water management paradigm rather than stormwater management 3) install monitoring facilities for rainfall, water quality and stream flows 4) develop a protocol for biological and ecological monitoring, and 5) establish a functional framework for stakeholders to provide input, guidance and alternatives to local government and University decision makers well in advance of landscape alteration---the process will likely be iterative.
Objectives - integrate the Tanyard stream network with its built landscape using an adaptive urban ecosystem management schema that formally integrates engineering, ecological and environmental design principles into planning and development.

DESIGN ISSUES

An urban ecosystem represents the interface of three design paradigms, wherein natural systems self-organize under the influence of landscape alteration by society. At issue are the fundamental principles governing the design process within each paradigm, and the integration of these principles as constraints across paradigm boundaries. A general description of the three is given as:

Environmental Design (Landscape Architecture)

- the art and science of analysis, planning, design, management, preservation and rehabilitation of the land

Ecological Design

- designing to meet human needs while preserving the health of planetary life

Engineering Design

- application of the principles of basic and engineering sciences to generate, organize and manage forces, energy and natural resources in the design of systems beneficial to society. Engineering may be described as taking available natural resources and reorganizing them at various scales into new structures to perform pre-determined functions.

It is the contention of the authors that, as a system, Tanyard is dominated by the engineering design paradigm. However, it is further contended that engineering should not be the focus of "blame"; rather, its dominance reflects the lack of integration and the disconnect of all three paradigms in the planning, development and overall management of Tanyard as a system.

A case in point –Tanyard ecohydrology

As development and alteration of the Tanyard landscape have continued, stormwater runoff associated with impervious surfaces has increased. The immediate focus has been to ensure that flooding of the transportation system (e.g. roads, parking lots) is prevented, with the solution trending toward routing additional stormwater directly to Tanyard stream. While the safety issues associated with street flooding have been accommodated, ecohydrological issues are typically relegated to "indicator" status; i.e. after an engineering design has been developed and implemented, the ecological consequences of an altered hydrology emerge, indicating problems associated with the initial design. In this approach, ecosystem function and structure are relegated to the output phase of the design process as indicators rather than constraints in the initial concept and design phase.

The constraint of principles on concepts

With engineering and ecological design constraints as necessary elements of urban ecosystem management, alternative stormwater technologies that are structurally and ecologically functional are necessary. Moreover, these alternative technologies must be economically feasible and socially acceptable – else they will not be

embraced by the human residents of the ecosystem. This introduces the need for the third design paradigm – environmental design (landscape architecture).

The concept and design of systems are constrained by fundamental principles based on specified goals and objectives. Management of urban ecosystems for ecological function, engineering infrastructure and architectural essence necessitate the integration of the design principles and concepts inherent to all three, as each serves to constrain the other to a certain extent. The conceptual design process for planning and developing should then be a concurrent process of the three paradigms rather than sequential where one is used merely as an indicator of another. The relationship between design principles across the three paradigms is summarized as,

Engineering design principles serve to:

- constrain environmental and ecological design concepts to be safe, as well as structurally functional and accommodating (tolerant) of nature's forces and the physical and chemical properties of natural resources

Ecological design principles serve to:

- constrain engineering design concepts to restore/maintain/enhance the health and integrity of ecosystem function, structure and stability
- constrain environmental design concepts to incorporate into the landscape biota that is ecologically functional within this setting

Environmental design principles serve to:

- constrain engineering and ecological design concepts to preserve an aesthetic essence-of-place for the residents of the landscape

CONCLUSIONS

The complexity of urban ecosystems can be attributed to the wide ranging gradient of issues affecting urban ecosystem function - social, political, environmental and technical. As with any holistic system, a single change propagates throughout the system, ultimately affecting its overall function. Changes to the fundamental blueprint of the system should then be subject to a concurrent, iterative design process with engineering, ecological and environmental design principles serving as fundamental constraints one to the other. The Tanyard urban ecosystem does not reflect a system constrained by engineering, ecological and environmental design principles; rather it is the result of the failure to integrate the three. Tanyard has not necessarily been over-engineered so much as it lacks ecological and environmental design principles and concepts in its long history of development.

FUTURE DIRECTION

The conceptual approach of integrating three traditionally disconnected design paradigms remains a daunting challenge. One difficulty lies with the difficulty of implementing change while measuring ecological and hydrological response within the political confines of an urban ecosystem. Clearly, experimental change requires crossing political boundaries and overcoming geopolitical conflicts. Within the past 2-3 decades urban watersheds have gained attention in research and academia. In general, efforts focus on stormwater quality, the riparian corridor, stream banks and physical habitat (U.S. Dept. of Commerce). While these remain concerns for Tanyard Creek, water volume is considered to be the most immediate as the stream is subjected to frequent flooding beyond bankfull flows. The authors argue that efforts in-stream and within the corridor will remain high maintenance and temporary if not accompanied by efforts to preclude or at least significantly reduce the generation of stormwater associated with buildings and highly impervious landscapes. We propose that stormwater be the initial focus of the project.

Excessive stormwater is an outcome of the dominance of the engineering design paradigm. The philosophical thrust for future work will be to shift from stormwater management to water/natural resource management. The success of this approach is enhanced by the fact that a significant portion of the land is owned by The University of Georgia, who is working diligently with faculty and students to integrate the three design paradigms through education and research efforts. This venture will facilitate a much needed study of a small urban ecosystem as a joint effort between research and a governing body to implement change coincident with appropriate monitoring to measure ecological and hydrological response.

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