ALTERNATIVE DRAINAGEWAY DESIGN:  
A Case Study Analysis

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(ABSTRACT)

Numerous scholars are outlining design approaches to reweave natural and cultural landscapes together to restore and enhance the quality of both. Typically they identify the following exigent issues within the contemporary landscape which need solving: fragmented, dysfunctional ecosystems; low wildlife and plant diversity; resource consumptive design; divorce of the human/cultural environment from natural ecosystems; infrequent human interaction with the ecosystem; and lost landscape legibility and regional identity. Strategies to solve these issues are varied, however most strategies include the following: reestablish ecosystem balance and function; increase wildlife and plant diversity; enhance and promote regional identity and landscape legibility; reconnect human landscapes with ecosystems; promote human interaction with the ecosystem; use nature as a design model; and redefine aesthetics. Many writers suggest combining identified components within a single design scheme for successful amelioration of cultural and ecosystem damage.

Alternative drainageway design projects are typically concerned with ecosystem restoration, enhancement of regional identity features, and civic space design within public landscapes. As such, this design genre offers an ideal venue to actualize criteria outlined by scholars: restore ecosystem health, reconnect people to ecosystems, and promote regional identity. However many alternative drainageway design projects address only ecosystem restoration and ignore public space, while others address public space to the detriment of ecological balance. The potential of alternative drainageway design to address multiple issues at once is tremendous, yet are there existing projects which meet demands set forth by scholars?

This thesis seeks to answer that question by critical evaluation of a series of built alternative drainageway design projects. Criteria identified by scholars in the literature review are used as a framework to critically analyze and topically discuss selected projects. Because the same set of criteria is shared by reputed scholars, the derived criteria serve as a pertinent benchmark to evaluate the projects. Discussion and comparative analysis illustrates whether the projects embody identified criteria and identify if any projects meet rigorous multiple demands framed by scholars. By critically analyzing and identifying successful, multiple-solution projects, this thesis provides germane information to develop a foundation for twenty-first century drainageway design. The derived framework offers clear stepping stones for designers, based upon current theory and built projects, to effectively address pressing cultural and environmental issues of the late twentieth and early twenty-first century landscape. The derived framework thus forwards a methodology to re-weave natural and cultural landscapes together for the benefit both.

1 eco-system (əkˈsəs-təm) n. An ecological community together with its environment, functioning as a unit. (American Heritage Dictionary CDROM, 1995)
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INTRODUCTION

Numerous scholars are involved in investigating and defining design strategies to alleviate problems of environmental degradation and poor public space. Their strategies include: public reconnection to and interaction with the ecosystem, ecosystem restoration using nature as a model, redefinition of aesthetics, and enhancement of regional identity. The identified components are validated by scholar reputation and consensus. The suggested components address problematic issues including: aesthetics based on antiquated scenographic, pastoral imagery; public space divorced from ecosystems; homogenized, characterless places lacking regional identity; damaged ecosystems; and few opportunities for human activities to intertwine with ecosystems. Overall the criteria suggested by contemporary theory seeks to re-weave natural and cultural landscapes together in a way that benefits both.

Alternative drainageway design is a method typically concerned with public space and riparian restoration; accordingly it has potential to actualize suggested components in contemporary theory and give direction to twenty-first century drainageway design strategies. However many alternative drainageway design projects focus exclusively on public space while exacerbating environmental damage, while others concern themselves with environmental restoration and ignore human needs for well designed public space which is responsive to current lifestyles and interfaces with ecosystems. Projects which forward issues identified in current theory can provide astute direction to future design. This study seeks to critically analyze built alternative drainageway design projects and locate projects which seamlessly address critical issues of the contemporary landscape identified by scholars in the late twentieth century. Additionally critical analysis of projects might identify gaps in current theory which practitioners are forwarding in their work.

The literature review establishes fundamental components of a design strategy which addresses critical issues in the contemporary landscape. Through a brief historical review of drainageway design, two critical issues of drainageways emerge: repair ecosystem damage created by conventional drainageway design, and restore drainageway design to public space. In an effort

1 eco-system (ɪ kəˈsɪstəm) n. An ecological community together with its environment, functioning as a unit.
2 Alternative drainageway design is a term used inclusive of alternative stormwater management design. It refers to drainageway design that deviates from conventional design (cement channelized culverts, below ground piping and conveyance which seeks to move water off the surface as quickly as possible) and typically seeks multiple solutions within a single design scheme, while working with inherent ecosystem function.
to locate drainageway design projects which solve these issues, a series of built projects will be evaluated using criteria identified by scholars. Through this discussion, projects will be identified which successfully merge multiple criteria, as well as those which address a single criterion identified in the literature review. The analysis will determine how closely built alternative drainageway design projects correlate with contemporary theoretical strategies and will identify neglected elements in both projects and theory. By systematic analysis, any significant multiple strategy work will be highlighted.

The product of this analysis is development of a design framework which builds upon existing work and literature by identifying gaps in built projects and current theory. In this way, existing projects become significant studies in development of a cogent design strategy. This study thus constructively addresses compelling issues of the contemporary cultural and natural landscape by critically evaluating built work and deriving a framework for twenty-first century drainageway design.

Thesis Format

The Literature Review (Chapter 2) presents scholarly debate on needed components of topical design strategies. From the review, criteria or domains are derived based upon overlapping categories discussed by a range of writers. The criteria are then used as frames to discuss and critique built alternative drainageway design projects. Chapter 3 describes methodology employed in this thesis. Chapter 4 describes historical drainageway design, conventional drainageway design, and mid-twentieth century innovative drainageway design projects. This chapter illustrates the pivotal point drainageway design is in the late twentieth century and highlights critical issues in need of repair. Chapter 5 develops two bodies of work as case studies; selection was based upon the following: built within the latter half of the twentieth century in the United States; at least ten years old; located within a public landscape; and use of innovative techniques to solve critical landscape/drainageway issues. Case study data includes site visits, interviews and/or discussion with designer(s), photo documentation, conference proceedings, and published and unpublished articles, letters and papers. The case studies are discussed and analyzed pertaining to criteria established in the literature review. Findings from case studies are presented in verbal and graphic formats. Chapter 5 also summarizes case study analysis as it relates to derived criteria. Chapter 6 presents conclusions and Chapter 7 details implications for further research.
II LITERATURE REVIEW

Introduction
The Literature Review establishes the relevance of select elements needed in contemporary landscape architecture to solve critical ecosystem and public space issues. It presents the work of contemporary scholars exploring design strategies which might solve these issues. The basic principles of current theoretical design strategies are described followed by a summary of these theories. The more significant criteria are referenced across an extensive body of literature and thus are viable standards for evaluation of built projects. The subcategories include: ecosystem restoration using nature as a model, human reconnection to and interaction with the ecosystem, redefinition of aesthetics, and preservation and enhancement of regional identity.

Current theory is used to establish criteria for critical analysis of built alternative drainageway design projects. From this critical analysis in Chapter 5, a framework is developed in Chapter 6 which builds upon existing literature and built work and gives cogent direction for twenty-first century drainageway design. The primary objective of this study is to develop a design framework for drainageway design which might re-weave people and ecosystems together for the benefit of both.
DESIGN STRATEGIES & CRITERIA

To change the situation we require new symbols of possibility, and although the creation of those symbols is in some measure the responsibility of artists, it is in greater measure the responsibility of society.

Leo Marx

The landscape most acutely reflects the current conflict between nature and technology, and it is in the landscape that resolution of that conflict can most easily be found.

Robert L. Thayer Jr.

Many scholars are involved in articulating a design approach to solve compelling issues of the contemporary landscape. Several criteria are shared by writers: reconnection of people to a functioning ecosystem; interaction with the ecosystem to promote understanding of its function; ecosystem restoration using forms and processes of nature; restoration of regional landscape identity; and redefinition of aesthetics to include understanding of the ecosystem.

Overview of Strategies

Design names and definitions are myriad: Ecological Design (first sketched by Ian McHarg in the mid 1960s and refined by Jusuck Koh in 1982); The Ecological Garden (first proposed by Jens Jensen in 1939); Ecological Restoration (a late twentieth century movement); Blue-Green Design (environmental stormwater management defined in 1980); a Late Twentieth-Century Aesthetic (suggested by Catherine Howett in 1987); and Regenerative Design (described by John Lyle in 1994); and Sustainable Design (proposed by Robert Thayer Jr. and many others, in the 1990s). These design theories are summarized below.

- **Ecological Design** - (Ian McHarg) - design method preceded by ecological inventory; it is possessed of a value system based on energy.
  (Jusuck Koh) - ecological design is characterized by a holistic view of the human-environment system and by an evolutionary and open-ended view of culture, design and building.

- **The Ecological Garden** - [Jens Jensen (1939), Gerald Luckhurst (1984)] - a concept of nature that encourages integration of man and nature: ecology. Ecology is the model for this design approach. It accommodates the mutual impact and inter-relationships between man and other forms of life. It recognizes their common dependence on physical systems of the earth. The resultant garden (or design approach) seeks to express the inter-relationship of man and nature.

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3 scholars is used inclusive of scholars, writers, professionals, and other thinkers involved in critique of built work and current theory.


• **Ecological Restoration** - (John Cairns, Jr.) - preservation and restoration of natural systems; a benevolent act of human society toward natural systems which facilitates benign coevolution. Ecological restoration is an act of human self-interest because it increases the capacity of natural systems to provide ecosystem services.  

• **Blue-Green Stormwater Technology** - (Tourbier & Westmacott) - turns liability into an asset by integrating control measures in open space systems. This concept recognizes the potential of streams, river and other natural drainage ways as multi-use urban open space/water systems. “We must seek solutions which are lasting, functional and beautiful, a technology for stormwater management which is convivial, with life and of life.”

• **Late Twentieth-Century Aesthetic** - (Catherine Howett) - comprised of the new ecology (vision of natural world and human community’s place within its systems); semiotics (analogy between language and architecture); and environmental psychology (nature of place experience); an approach which seeks to substitute a looser, healthier landscape ‘style’, responsive to the whole range of interactive systems (soils, vegetation, wildlife, human community).

• **Sustainability** - (Robert L. Thayer Jr.) - *Sustainability* implies a limitation on the degree and rate of human impact such that the natural carrying capacity of the earth’s ecosystem can be perpetually maintained; a characteristic of a process or state that can be maintained indefinitely. It requires neither the disguise or elimination of human influence. A *sustainable landscape* is a place where human ecosystems can all be perpetually maintained. A sustainable technology is a technology which, when employed productively by humans, results in no loss of ecosystem carrying capacity, resource availability, or cultural integrity.

• **Regenerative Design** - (John Tillman Lyle) - *Regenerative design* means replacing the present linear system of throughput flows with cyclical flows at sources, consumption centers, and sinks. A *regenerative system* provides for continuous replacement, through its own functional processes, of the energy and materials used in its operation. The outcomes of regenerative design are life-enhancing, transcendent function, draw on ongoing processes of nature, make connections between realities of nature and people, and make visible the workings of a landscape.

**Criteria of Theories**

**Aesthetics**

Formerly aesthetics\(^{12}\) referred to a purely visual response to or condition of the landscape.

Scholars today seek to redefine aesthetics to include understanding of ecosystem function, and expression of the human-nature relationship. Catherine Howett describes a design aesthetic which allows people to contribute to the pattern of nature, and promotes understanding of a

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\(^11\) Lyle, 1994, ASLA Presentation, October, ASLA National Convention - San Antonio, Texas.

\(^12\) *aesthetics* or *es-thetics* (μ -θητικής) n. 1. (used with a sing. verb). a. The branch of philosophy that deals with the nature and expression of beauty, as in the fine arts. b. In Kantian philosophy, the branch of metaphysics concerned with the laws of perception. 2. (used with a sing. verb). The study of the psychological responses to beauty and artistic experiences. 3. (used with a sing. or pl. verb). A conception of what is artistically valid or beautiful. 4. (used with a sing, or pl. verb). An aesthetically beautiful or pleasing appearance, (Heritage Dictionary CD-ROM, 1995).
healthy, complex ecological image. When this is realized she feels our landscapes will embody “our understanding of the astonishing complexity, fragility, and beauty of the world and celebrate the new, more caring and loving relationship into which we wish to enter.” Robert Thayer disagrees with reliance on traditional aesthetics to solve pressing contemporary issues; “aesthetics” is too shallow to describe the unseen elements of sustainability. Gregory Bateson’s definition corresponds with Thayer: “By aesthetic, I mean responsive to the pattern which connects.”

Michael Hough discredits traditional aesthetics as having anything to do with cultural or natural working landscapes:

_It is apparent that the historical developments that have shaped the working landscapes that we admire for their sense of harmony and beauty today had, overall, as little to do with aesthetics as did the natural processes that made scenery._

Instead he suggests the aesthetic response to nature is a consequence of a seamless, mutually modifying relationship between people and natural form. Hough feels scientific interpretation and dissection of the working whole allowed aesthetics to operate independent of a healthy landscape. For example he cites diversion of whole river systems as a result of ignorance of how a river system actually behaves and is intertwined with the rest of the landscape. Similarly, modern parks are completely severed from a productive landscape, and contribute nothing to health and function of a self-sustaining place. Hough emphasizes a need to learn how environments work rather than formal design theory as model; his call is one for environmental literacy.

Hough suggests merging natural history and aesthetic enjoyment to create an “understanding of places, and development of a new and non-consumptive attitude to the regional landscape.” Howett agrees: “it is our understanding of what is at work that will enhance our pleasure in the denser, more complex images that an ecologically-grounded aesthetic will promote; the style of the new landscape is responsive to a “whole range of interactive systems.”

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13 Howett, p. 11.
14 Thayer, p. 103.
17 Hough, p. 52.
19 Howett, p. 7.
20 Howett, p. 11.
Reconnection and Interaction with Ecosystems

If aesthetics is to include understanding of ecosystem function as theory suggests, a means to promote that understanding is needed. Many scholars attribute lack of understanding about natural processes to lack of interaction with the ecosystem. This condition contrasts with a former seamless relationship; John Cairns maintains “In earlier times, direct and intimate interactions between hunters and gatherers and the natural systems affected these attitudes (relationship of people to natural systems).” Formerly, parts of nature revealed the process of creation and thus the universe: “to a primitive religious mind, the tree is the universe, and it is so because it reproduces it and sums it up...”

Michael Hough states people must be in daily contact with ordinary events and phenomena to foster true understanding and commitment to the environment:

The making of memorable places involves principles of evolving natural process and change over time. It involves variety and choice that evolve naturally through countless interactions between people and nature, providing a secure basis for ecological and social health.

Catherine Howett describes the result of a separation of human life from the larger ecosystem: “the ancient stories of the race and its ritual and dance no longer serve to illuminate our place within the cosmic order, giving meaning to daylight and darkness, seedtime and harvest, and the struggles of heroes, saints, and ordinary men and women.” Christopher Alexander sees bygone built form as expression of a seamless relationship between natural order and cultural environments which is largely missing in today’s built form:

In early times the city life was intended as an image of the universe—its form a guarantee of the connection between the heavens and the earth, a picture of a whole and coherent way of life.

Jens Jensen, an early proponent of the ecological garden sought to integrate native prairie and woodland ecosystem into the city to bring “an expression of freedom... to counter the city’s straight-jacket, squared at all angles.” His work represents naturalistic projects created for people which merged public space with native ecosystems as early as 1939. The outcome of this design approach places people, their dwelling, and activities within the ecosystem, connecting

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21 John Cairns, Jr., p. 1.
24 Hough, p. 210-211.
25 Catherine Howett, p. 8.
27 Jens Jensen, 1939, Siftings, Chicago.
them to their intrinsic landscape. The objective of this design movement seeks to connect people and landscape; the people must understand the ramifications of all operations.²⁸

David Kahn states²⁹: “If the traditional vernacular landscape is viewed as a fabric, people and natural processes would form individual strands, rubbing against each other, constituting something larger... The personal, experienceable rubbing between people and resources has diminished, and has been replaced by a dangerous experiential gap between modern society as a whole and the natural environment we exist within.” Kahn promotes ecological design as a way to weave human experience into relationship with natural processes.³⁰

Fragmentation of ecosystems has exacerbated lost connections between humans and ecosystems: “For modern urban man the friendship with a natural environment is reduced to fragmentary relations.”³¹ Yi-Fu Tuan records similar observations: “In modern life physical contact with one’s natural environment is increasingly indirect and limited to special occasions.” Yi-Fu Tuan professes that culture provides the frame for imbuing environments with meanings and values.³² Direct interaction with natural systems is very limited—most people live in cities and unaltered systems are fragmented.³³

To create a relationship with ecological systems, Christian Norberg-Schulz instructs one might understand places by starting with phenomena, available to the senses, which are used to symbolize a relationship with ‘nature’; “Dwelling above all presupposes identification with the environment.” Norberg-Schulz believes contemporary man must symbolize his understanding of landscape, or ‘nature’ through his form making: “The things thereby explain the environment and make its character manifest; the things become meaningful.”³⁴ He suggests landscape form, when it expresses natural processes, enables interaction, identification, and understanding. Norberg-Schulz states that all cultures have developed “systems of orientation” or “spatial structures” that allow an environmental understanding and thus identification with the environment to take place; it is this identification that enables true dwelling.³⁵ David Kahn also

²⁸ Luckhurst, p. 133.
³⁰ David Kahn, 1994, ASLA Presentation, San Antonio, October.
³¹ Norberg-Schulz, p. 21,23.
³² Yi-Fu Tuan, 1974, Topophilia: A Study of Environmental Perceptions, Attitudes, and Values, New Jersey, p. 95.
³⁴ Christian Norberg-Schulz, Date, Genius Loci: Towards a Phenomenology of Architecture, New York, p. 16-17.
requests contemporary ecological design to express phenomenal experience, specifically: resources, specific site, and inhabitation.\textsuperscript{36} Kahn maintains this will transcend former methods of design that communicated nature merely through symbols of nature. Similarly Howett states “things are meanings, and these meanings are points of expression of a field of relationships.”\textsuperscript{37}

Robert Thayer likewise calls for direct interaction with the environment to promote deeper appreciation for its complexity and declares an imperative to express the working sustainable landscape: “creative form-giving and artful interpretation of landscape elements are necessary in order to suggest possible physical futures which are at once sustainable, tangible and imaginable to society at large”.\textsuperscript{38} Thayer cites recent history, particularly the post-modern style, as having “given up seeking an underlying truth.”\textsuperscript{39} He states that “sustainable landscapes’ form and content will seek to reveal this ecological order through an interplay of surface and core unique to both place and culture.”\textsuperscript{40} Elissa Rosenberg states engineering has manipulated the landscape for human use and calls for a re-establishment of the relationship between meaning and function.\textsuperscript{41}

In a like manner, ecological designers are concerned with the interrelationship between humans and nature, participation of users in design, the energy-efficiency of the environment and preservation of human space; all represent “outcomes of the ecological and evolutionary fit between the built structure and its natural and cultural environment.”\textsuperscript{42} John Lyle labels the twenty-first century the Neo-technic era, which he believes will be guided by a concept of a productive, harmonious relationship between people and nature.

**Nature as Model**

Ecology as a model rejects the dualism of ‘man’ separate from ‘nature’, instead ‘dynamism and integration are its hallmarks.’\textsuperscript{43} John Tillman Lyle professes ecology will be the model as well as the context for design; for instance, when human activities interrupt a watershed’s flows, people must be cognizant of possible effects of their actions on the entire watershed. He suggests applying processes from nature that allow the disturbance to work with the natural system,\textsuperscript{44} and

\textsuperscript{36} David Kahn, 1994, ASLA Conference Presentation, October, San Antonio.
\textsuperscript{37} Howett, p. 8.
\textsuperscript{38} Thayer, p. 109.
\textsuperscript{39} Thayer, p. 315.
\textsuperscript{40} Thayer, p. 316.
\textsuperscript{41} Elissa Rosenberg, 1994, ASLA Convention Presentation, October.
\textsuperscript{42} Koh, p. 79.
\textsuperscript{43} Luckhurst, p. 129, 132.
\textsuperscript{44} Lyle, p. 147.
also making visible the workings of a landscape, to encourage understanding of its function.45
The Ecological Garden describes a design approach based upon ecology as the model.46 The
outcome of using nature as model for a design approach is an increased capacity of natural
systems to provide ecosystem services,47 drastically lowering energy inputs to maintain the
design.

Lyle stresses balancing energy use and production, a model taken from nature, not the machine.
This is not a new idea, Ian McHarg in the 1960s advocated a design approach with a value system
based on energy.48 Sustainability describes a system where ecosystems are perpetually
maintained with no loss of resources or carrying capacity.49 Similarly, Regenerative Design is
based on cyclical flows of energy that balance out consumption—replacing energy and materials
used in techniques employed.50

Landscape Identity
Michael Hough opens Out of Place, Restoring Regional Identity to the Regional Landscape with the
following question: “How can insights derived from natural and cultural processes provide us
with ways of re-establishing the identity and uniqueness of places in the contemporary
landscape?”51 The importance of identity or legibility of landscape is well known; Kevin Lynch
describes the importance of legibility in the urban environment: “A distinctive and legible
environment not only offers security but also heightens the potential depth and intensity of
human experience. Although life is far from impossible in the visual chaos of the modern city,
the same daily action could take on new meaning if carried out in a more vivid setting.”52

Transplanting streams, rivers and stormwater systems into engineered culverts not only creates
environmental damage but erases regional and city identity. Ian McHarg believes this
fragmented connection to the natural world has resulted from destroying extant landscape
features:
In many cities the given form has been lost irretrievably, buried under undiscerning building, unknown and
unexpressed—rivers confined, streams culverted, hills bulldozed, marshes filled, forests felled and escarpments graded
into inconsequence.53

45 Lyle, ASLA Presentation.
46 Luckhurst, p. 124.
47 Cairns, p. 4.
48 McHarg, p. 197.
49 Thayer, p. 106.
50 Lyle, ASLA Presentation.
51 Michael Hough, 1990, Out of Place, Restoring Regional Identity to the Regional Landscape, New Haven, p. 3.
53 McHarg, p. 19.
He recommends not providing a pretty background for recreation to solve this problem, but "to sustain nature as a source of life, milieu, teacher, sanctum, challenge... the source of meaning."54 Michael Hough describes the ravines of Toronto as "its most important linear natural feature, giving the city an unmistakable stamp of identity," and elaborates upon the consequences of moving geographic features:

The transfer of experiences from their places of origin to where they don't belong has become a universal phenomena of contemporary urban life and a major contributor to the sense of placelessness that massive urbanization has helped to create.55

Fritz Steele reinforces loss of identity in American suburbs: "they lack any geographic or regional identity, are homogenous and bland, and therefore are not stimulating in terms of spirit of place for either residents or visitors." He describes attributes that create a high quality sense of place:

Good facilities for one's activities; rich traces of history; features that give the setting a strong sense of identity or that create a mood of mystery; potent geographic characteristics that shape the lives of people. . . 56

Summary
Design, as an expression of our ideas about nature and our place in the scheme of things,57 is an ideal medium to realize the identified criteria. Current literature suggests the following components for contemporary design:

◊ restoration of the ecosystem using nature as a model, with particular emphasis on ecosystem function and enhancement of wildlife and plant community diversity;

◊ redefine aesthetics for the twenty-first century to include comprehension of natural processes facilitated through interaction;

◊ reconnection and interaction with the ecosystem to promote understanding and appreciation of the ecosystem, specifically use of a phenomenological approach to reconnect people to nature through interaction with the ecosystem; and

◊ enhance and preserve regional identity to promote human identification with the ecosystem.

Laurie Olin has formulated a list of criteria present in meaningful contemporary design; these ideas parallel derived criteria:

1. Ideas of Order.
2. Ideas of nature including a critique of past views as provoked by knowledge of ecology.
3. Ideas about the arrangement of cities and thereby society and its desires (as well as needs).
4. Ideas about the medium as an expressive one (the landscape as medium) revealing something about our methods and processes.
5. Considerations about the history of art and landscape design and the history of places—their archaeology.

54 McHarg, p. 79.
55 Michael Hough, p.96.
57 Olin, p. 8.
Olin elaborates that the best work researches past expressions and are new and healthy creations....it continues to carry an expression of our ideas about nature and our place in the scheme of things.\textsuperscript{58} The American Society of Landscape Architects echoes these concerns:

\begin{quote}
In facing the growing urgency of environmental issues confronting human societies, we must do more than sustain the earth; we must heal, enhance and manage the life-sustaining processes of the planet and ensure the integrity and strength of the global landscape which connects them.\textsuperscript{59}
\end{quote}

A summation of this new paradigm in design is forwarded in \textit{Ecology, Aesthetics and Design}\textsuperscript{60}: "Designs with Nature" are frequently scarified to market forces that demand a tidy and familiar aesthetic. Some "restored" landscapes attempt to mimic nature while failing to consider the nature of habitation. Sustainability is a concept in search of an aesthetic. Our profession has asserted, "We must heal, enhance and manage the life-sustaining process of the planet." What does this mean in DESIGN terms?"\textsuperscript{61} Overlapping categories described by scholars to answer this question are summarized in the following design strategy:

A holistic process of design that restores the ecosystem without exploitation or damage of resources. This approach reconnects people to the ecosystem and its processes through designed interaction in public spaces responsive to current lifestyles. Design reinforces regional identity by enhancing and preserving geographic features and objects of cultural meaning.

The derived criteria for case study analysis include:

1. \textbf{restoration of the ecosystem using nature as a model;}
2. \textbf{encourage human reconnection to and interaction with the ecosystem; and}
3. \textbf{enhance and preserve regional identity.}

\textsuperscript{58} Laurie Olin, 'Form, Meaning, and Expression in Landscape Architecture', \textit{Landscape Journal}, p. 167.
\textsuperscript{60} \textit{Ecology, Aesthetics, and Design}, Scholarly papers presented at the ASLA 1994 Annual Meeting, October.
III  METHODOLOGY

Methodology was chosen to accomplish the following:

II  Literature Review
1. This section researches contemporary theory describing design strategies to solve exigent issues in the twenty-first century landscape. It establishes relevance for and identifies criteria needed in current design to address critical environmental and cultural issues of the late twentieth/early twenty-first century landscape.

IV  Drainageway Design
2. This chapter briefly outlines conventional drainageway design and its outcomes, namely ecosystem damage and divorce of drainageways from public space.

3. It discusses early drainageway design projects which explored alternatives to conventional strategies: Paseo del Rio in San Antonio, Texas and Woodlands New Community in Texas.

V  Alternative Drainageway Design
4. This section critically reviews built alternative drainageway design projects in order to determine if they are addressing criteria established in the literature review.

5. Secondly this section analyzes how the case studies do or do not meet the selected criteria and identifies any projects which accomplish strategies set forth in the literature review.

VI  Conclusions
6. The concluding chapter draws conclusions about the case studies and builds a framework for 21st century drainageway design based upon case study analysis and literature review criteria.

Methodology for Case Studies
Techniques employed for the case study are qualitative research methods, including:

- interviewing (site and designer);
- data collection: letters, published & unpublished papers, journal and magazine articles; conference presentations; visual data: photographs, illustrations/slides provided by designers, photographed on site by author, or published, and site visits/observation of the built sites. The strength of the case study lies in employing many sources of information with overlapping data; the data thus supports claims within the case study.

Anne Whiston Spiri describes the importance of case compilation in *The Granite Garden*:

> Much valuable information already exists in pieces scattered in the files and archives of government agencies, in university research reports, in private construction documents, in government publications, and in the experience of local special interest organizations. Each separate piece of information is not terribly useful in itself, but gathered, integrated, and interpreted, the whole forms an invaluable resource. It is important that case studies of successful solutions to problems of the urban natural environment be collected and made readily accessible.61

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61 Anne Whiston Spiri, p. 254,259.
The collection of case studies and historical research in this thesis had the same motivations: to gather and critically discuss built projects, and illustrate the diversity of innovative, articulate, and functional approaches being executed in alternative drainageway design. From this analysis a framework will be derived which builds upon existing work, links current approaches to contemporary theory, and establishes a foundation for future alternative drainageway design.

It is essential that we begin to responsibly design our waterways and their secondary systems for the overall health of the environment and people. Through presentation of current theory, contemporary issues in drainageway design, and alternative design projects, dynamic possibilities for future design will be described. Roy Mann articulates his reasoning for presenting river case studies in *Rivers in the City*:

With their virtues and faults together, the fifteen examples of riverside use described on the following pages represent a body of experience of which most cities, preoccupied as they are with their own crises on the riverfront, may be largely unaware. Perhaps the reader, thus informed, may become more conscious of the harmonies that are possible between man, nature, and technology.\(^2\)

The following description of drainageway design and analysis of alternative drainageway design case studies provides direction for how these harmonies might be realized.

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\(^2\) Roy Mann, p. 20.
IV DRAINAGEWAY DESIGN

The word 'stream' describes a pattern of physical space and a pattern of events, at the same time. We do not separate the stream bed from the stream. There is no distinction between the bed of the stream, its banks, the swimming of the fish.

Christopher Alexander
A Timeless Way of Building

Historical Drainageway Design

In pre-industrial times drainageway design remained an integral part of civic space—serving to order civic space and convey meaningful values related to water. Elissa Rosenberg states:

The ancient power of water, for example, was understood through its physical presence in many forms: wells and cisterns, street fountains and aqueducts once occupied a significant place in organizing urban space. Now a vast system of underground pipes makes water magically appear at the turn of a faucet.53

Historic water design ordered public space and provided water supplies. Gary Strang describes a fountain system in Machu Picchu, Peru (300BC):

The fountains serve a number of purposes—they are ornamented terraces, an erosion control tool which collects runoff from the terraces and roofs of the buildings, an area of public interaction, a site boundary and a delineator of circulation. Water is brought to the site from a well in the nearby drainage just as prior logic had determined at Wina Wayna (another Mayan settlement). Four trees announce the arrival of water at the top of the site behind the library. A narrow rill of water crosses the trail here forming a threshold to the terrace.64

The fountains describe a system intimately connected to the hydrology of the site while eloquently expressing elevation change, water source, and ordering of civic space. The fountains at Wina Wayna, another Mayan settlement, similarly describe civic space: "a stair and fountain, which intercepts the flow of a drainage, connect a temple and functional buildings through a series of water basins which reflect changing levels of the seasons. The logic of the watershed was then evident within the urban context, whereas a contemporary fountain with a loop of recirculating water, functions irrespective of rainfall and gravity."65

Denis Cosgrove describes a 16th century Venice public works lagoon that was inseparable from the prevailing philosophy: altering nature for a larger purpose: to relate divine and human action.66 Similarly, Roman aqueducts were an integral element in public space that displayed architectural skill and engineering advances (water purification, and sheer volume of water provided) while tangibly connecting water design to the larger hydrologic regime.

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53Elissa Rosenberg, p. 9.
Conventional Drainageway Design

Sudden change for single purposes is the hallmark of conventional water design. John Lyle cites the outcomes:

*In the complex web of interactions that comprise an ecosystem, sudden change made for a single purpose usually means severe disruption of processes not directly a part of that purpose.*

The perception of landscape parts as unrelated to one another encourages water systems to be removed from their connected landscape system:

*Perception of isolated natural features, like rivers or street trees, as things in themselves rather than as part of ongoing processes to which they owe their form and continuing evolution, leads to expensive stop-gap measures to mitigate a hazard or protect a resource, rather than to solutions that strike at the heart of the problem, and often precipitates new, unforeseen problems.*

These unforeseen problems are numerous: pollution concentrations; lowered groundwater levels; lost floodplain irrigation and deposition; increase in velocity and volume of floodwaters; and lost habitat for plants, animals and organisms. Today, urban rivers express the affects of these ‘unforeseen’ problems:

*Can you find the river that first made the city? Look behind the unkempt industry, cross the grassy railroad tracks and you will find rotting piers and there is the great river, scummy and brown, wastes and sewage bobbing easily up and down with the tide.*

Water and the landscape are inseparable, like arteries to the body. The resources of the river and its connected parts are some of the most productive on earth, and modern drainageway design has failed to recognize the many roles a natural river or stream can play in the environment. As a result, the river is the “most intensively used and most often abused resource on earth.” Many cities have turned their backs on the river and placed it underground, becoming ‘rain and the rushing sound of underground rivers buried in storm sewers. Rivers

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67 A detailed drainageway historic review is located in Appendix A (page 85).
68 John T. Lyle, p. 141.
69 Anne Whiston Spirn, p. 230.
71 John Tillman Lyle, 1994, Presentation at ASLA Convention, paraphrased by the author, October.
73 Roy Mann, p. 13.
have become water from a faucet, delivered by pipes from some outlying river or reservoir, then used and washed away into the sewer, returning to the waters of rivers and the sea.”74 When rivers are paved over downstream flooding intensifies and the function of the waterwork system fails:

*All but the largest creeks and streams of the pre-city landscape have vanished from a modern map. Covered and forgotten, old streams still flow through the city buried beneath the ground in large pipes, primarily channels of a subterranean storm system. Their muffled roar can still be heard beneath the street after heavy rain; they are invisible, but their potential contribution to downstream floods is nevertheless unabated and magnified.*75

Attempts to straighten rivers and remove them from the soil has collapsed the functional abilities of river systems, “affecting as it does not only the health and welfare of nearby urban populations, but throughout, the courses of stream systems, related underground waters, and the seas of the planet... the floodplains are prime habitats for wildlife, aquatic species and birds... floodplains and wetlands absorb and hold rampaging floods, offering natural protection to downstream areas settled by man.”76

Theodor Schwenk characterizes the contrast between a healthy native river and an engineered culvert:

*The rhythm of its meanders is a part of the individual nature of a river. In a wide valley a river will swing in far-flung curves, whereas a narrow valley will cause it to wind to and fro in a “faster” rhythm. A brook running through a meadow makes many small often only tentative bends. Streams and surrounding terrain always belong together, and the vegetation unites both in a living totality. In comparison, a river that has been straightened out looks lifeless and dreary. It indicates the inner landscape in the souls of men, who no longer need to know how to move with the rhythms of living nature.*77

The form of the meander is integral to the healthy functioning of the whole river system. Luna B. Leopold analyzed a river’s functioning in *A View of the River*. The book’s conclusions stress that meander formation are a compromise between minimum total work and uniform distribution of energy. Meandering patterns are found throughout nature; for the river, it indicates a state when erosion and deposition continue in balance.78 Additionally the meandering pattern provides visual interest and relief from the ‘carpentered world’79 of the urban fabric.

John Lyle attributes infrastructure with “removing life-giving source from the landscape (water)--stealing the purpose of nature.”80 Water is conveniently available at the turn of a tap, reducing

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75 Anne Whistin Spirn, p. 130.
76 Roy Mann, p. 13-14.
77 Theodor Schwenk, p. 15.
79 Yi-Fu Tuan describes carpentered and noncarpentered in *Topophilia*, p. 75.
80 Lyle, 1994, ASLA Presentation, October.
its ability to make physical connections to the larger hydrologic system and its presence in public space. Gary Strang states: “The contemporary city can be seen as an elaborate plumbing system, transporting resources with a regularity and dependability that obscure the variability of nature.”81 Being removed from the visual scene, water’s role as life-giver to the larger ecosystem is forgotten. The missing hydrologic system reduces human interaction with, experience, and understanding of the landscape and its interrelation to the hydrologic system.

Water has become a convenient, exploitable substance in the modern western world. Theodor Schwenk describes the dilemma:

_The more man learned to know the physical nature of water and to use it technically, the more his knowledge of the soul and spirit of this element faded. Today he is able to subdue its might, to accumulate vast quantities of water artificially behind gigantic dams, and to send it down through enormous pipes as flowing energy into the turbines of the power stations. He knows how to utilise its physical force with astonishing effectiveness._82 The damaging affects of modern drainage system design on the public environment are just as deleterious. As water has become increasingly out of sight, it has become, “out of mind.” Elissa Rosenberg states modern infrastructure is ‘increasingly separated from urban design... divorced from civic meaning.’83

It is clear the outcomes of modern drainage system design result in environmental damage and public places lacking connection to ecological systems. A new approach is necessary to repair environmental damage and restore meaningful public space: “Whereas it then seemed profitable and advantageous to dry out the moors and make them arable, to deforest the land, to straighten the rivers, to remove hedges and transform landscapes, today it is being realised that essential, vital functions of the whole organism of nature have very often suffered and been badly damaged by these methods.”84

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84 Schwenk, p. 10.
PROJECTS

Technological advances and single-solution/single-aspect conventional water design in the twentieth century has caused numerous detrimental outcomes to the ecosystem. These outcomes are both environmental and social, and result from all scales of intervention—from dams to stormwater management (see Appendix A). Environmental health of drainageways has declined in part because water has been removed from its adjoining landscape, resulting in failed functions. The outcomes of conventional design include: intensified flooding, pollution concentrations, lost wildlife/plant habitat, siltation, waterlogged soils, and salt deposition. Socially, because water is out of sight, underground or contained in cement channels, interaction with water has been minimized. Lost interaction has produced poor understanding of water’s role in ecosystem function.

Several mid-twentieth century projects explored alternatives to conventional drainageway design. The following two projects deviated from conventional design by restoring an urban river as a highly public amenity and using an existing drainageway system as an ordering system in master planning while preserving open space. Their results were highly successful in simultaneously creating public space and solving functional water issues. The documented projects set two important precedents: an urban river was utilized as an amenity and existing drainageway system was preserved and used as an ordering element. These early works paved the way for later alternative design by exploring diverse opportunities and encouraging innovative thinking regarding multiple benefits possible in drainageway design. One of the earliest works that might be considered a forerunner of contemporary drainageway design is the San Antonio Riverwalk constructed in the late 1950s.

PASEO DEL RIO

SAN ANTONIO RIVERWALK

The San Antonio Riverwalk was a benchmark for future drainageway design, illustrating the potential of an urban drainageway to provide recreation, open space, a successful tourist destination, order built fabric, enhance regional and cultural identity, and create historic connection. The designer for the Paseo del Rio was Robert Hugman, an architect well known during the 1950s for regional preservation and prominent public space design in Texas. His San Antonio Riverwalk is a culmination of multiple efforts by the city and its citizens to save the river
and transform it into a pleasant corridor that celebrates the regional plant diversity and historical past of the city.

A brief history of the San Antonio river follows to illustrate the typical shift of urban rivers from inspiration for settlement and provider of life elements to that of a polluted receptacle behind buildings or underground. The "immemorial windings of the river" of San Antonio were preserved by a collective effort including citizens, an architect, and city representatives. The riverwalk is a successful example of saving a river from underground piping, integrating public space into a restored river system, creating a successful amenity, and providing a dynamic ordering element in an urban environment. While it doesn't repair the health of the river system and the water remains polluted, it deviates from single-solution, single-aspect engineering methods in several noteworthy ways.

The San Antonio Riverwalk is a redesigned urban river that correlates seamlessly with its cultural and regional legacy. The riverwalk has remained true to the river's original stature in providing civic space, adhering to past regional planting, and recreating spatial characteristics. The architect Robert Hugman was committed to an ecological planting scheme and regional plant representation; in so doing, the overall spatial characteristics and plant palette remain connected to its past. In addition, the river remains the civic center of the city and as such, continues to embody regional identity, historical connection, and important public space for citizens and visitors of San Antonio.

The San Antonio area was first explored in the late 1600s, and was described as "... very desirable and favorable for its pleasantness, location, abundance of water, and multitude of fish;" the river was described in 1691 as "...copious waters, which are clear, crystal and sweet...Its luxuriance is enticing for the founding of missions and villages, for both its plains and waters encourage settlement."86

The city's first settlement was established on the river in 1718 when Spain built the Mission San Antonio de Valero, or The Alamo. "It was water---cool, abundant, life-giving---that first drew

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86 Cecilia Steinweiz, San Antonio Wars, Seen Through a Magic Lantern, San Antonio, TX, p. 19.
of the river "with its life-sustaining waters." In 1856 Frederick Law Olmsted describes crossing the river in *Journey through Texas*: "We descend to the bridge, which is down upon the water... of a rich blue and pure as crystal, flowing rapidly but noiselessly over pebbles and between reedy banks." In 1872 Lanier described the river: "the lovely windings of the green translucent stream, flowing beneath long sprays of weeping willows and playing incessantly with the swaying stems of the water grasses... pleasant pale-green water upon the long swaying tufts of a grass which grows in the middle of the stream..."

In 1890, William Corner wrote in *San Antonio de Bexar* of water which "makes San Antonio the naturally charming place that it is... a swirling river of pure living waters and the arborous accompaniments of foliage, high canopies of greenery, broad groves, great trunks and tangled vines." It is clear the river played an instrumental role in the settlement of the missions, which led to the establishment of the city, and that it was a life-giving healthy river system heavily used and enjoyed by the public.

However it was not always a source of life for the city. The water's level was lowered by drilling of numerous wells, and as early as 1890 there was no longer "swimming everywhere." In 1921

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87 Ramsdell, p. 4.
88 Cecilia Steinfieldt, p. 19.
89 Ramsdell, p. 86.
90 Ramsdell, p. 87.
91 William Corner, 1890, *San Antonio de Bexar*, San Antonio, TX, p. 41.
92 Corner, p. 102.
a devastating flood caused millions of dollars in damages, and resulted in construction of stone retaining walls and a dam in 1929 to control flooding. After these interventions, the river served as a pollution receptacle for several years. It was saved by business leaders and community groups, and transformed into a center for the city, the second largest tourist attraction in Texas, and a thriving commercial and civic center. Today it is one of the most celebrated urban renovation successes of the twentieth century.

The renovation of the river was begun in 1939/40 by business owners along the river. Specifically one restaurant owner was tired of seeing a polluted river flow past his business and conceived the idea to make the river an amenity for the city. He pooled together other business owners along the river and began a citizen-based activist effort to save the river from its polluted, neglected state: “a dismal, sluggish trickle between banks festooned with weeds, adorned with dead cats, slain bottles, and other unsightly objects.”93 This, unfortunately, is a common picture of many urban rivers, and usually leads to placing the unsightly river underground.

The conservation group of San Antonio tapped into the initiative of the business owners when a group of citizens proposed paving over the river to provide a thoroughfare and control flooding. The women’s group conceived an idea of the river as a potential source of income for the city—providing an amenity and strong sense of identity. They proposed the river could be the “goose who laid the golden egg” for San Antonio. They presented a puppet play to this effect to the city fathers (city council) who bought the idea. The San Antonio River was saved from engineering destruction in downtown, but in other sections engineering solutions took

93 Corner, p. 102.
precedence. As recently as 1958 acres of groves were leveled by “ditch-happy engineers”, along the river near Mission San Juan Capistrano, where the woods had always been lush.\textsuperscript{4} Thankfully, through the foresight of business owners, designers, citizen groups, and city government officials, a primary stretch of the river was preserved and functions today to provide identity and civic space for the city, commerce through tourism, and an important ordering element to the built fabric.

The San Antonio Riverwalk has been an unprecedented success in restoring a river’s place of importance within an urban environment. The design is an important example of integrating public space into a drainageway design, maintaining historical integrity and creatively expressing contemporary issues and styles. The possibilities the riverwalk made visible for drainageway design are notable: a river’s presence in the city was not only saved but enhanced; the river became an ordering element for built form, with numerous businesses lining the walk; economically, the river has made the convention and tourism business San Antonio’s number one industry, and it is a space which reflects the historical spatial characteristics and showcases regional flora.

Important points of the riverwalk are preserving an urban river as an integral element of the built fabric, using it to order public space and create a tourist destination, acknowledging the importance of water as a public space amenity and speaking about the settlement history of the area and early spatial characteristics of the pre-developed river. What the riverwalk does not achieve is

\textsuperscript{4} Ramsdell, p. 11.
function of a river. The water level is controlled by flood gates and remains at a constant level throughout the seasons. The water is polluted and encased in a cement lined trough at a fixed depth of three feet. The economic success of the riverwalk has spurred new 'arms' to the original meander of the river in order to capitalize on the riverwalk's success. As a result, the San Antonio River today is merely a symbol of a river, an objectified 'river', which is not connected to seasonal flooding and does not provide habitat for wildlife other than humans.

Albeit no longer a river connected to and contributing to the balance of the larger ecosystem, the riverwalk remains an important early project. It has provided an outstanding example of using a river to order and create dynamic public space within an urban environment. While the form and function of the river are symbolic, they remain to remind the public of the role of rivers in the landscape and the power of water to transform space and mind.
WOODLANDS NEW COMMUNITY

Woodlands New Community was a forerunner to alternative drainageway design by setting a precedent of using an existing drainageway system to order a master plan and create an integrated public space system which doubled as the stormwater system. It differs in important ways from the San Antonio Riverwalk in that it does not capitalize upon the drainage system to create a highly public space with water as the central focus. It instead focuses upon using water to handle stormwater and determine where open space and preserved woodlands are to be located.

Woodlands New Community in Texas was designed by Wallace, McHarg, Roberts and Todd in 1971: (Ian McHarg was project manager). Woodlands is located 25 miles north of Houston and is comprised of 18,000 acres of pine-oak woodland with several large streams flowing through the site. The projected population will number 150,000. The developer, George Mitchell was able to realize his original vision—a city in rapport with the dynamics of nature in the midst of a forest. The comprehensive plan for development was produced using the overlay map technique which eliminated sensitive, steep, or unstable areas. Data included geology, surface and subsurface hydrology, vegetation, limnology, climate, and wildlife. The objectives were:

- preservation of a woodland environment;
- a natural drainage system which would utilize existing floodplains, drainage channels, ponds, and recharge soils;
- preservation of certain areas of vegetation noted for species diversity, high quality, stability, and uniqueness; and
- provision of wildlife habitat and movement so that wildlife now living on the site may remain.

The planning group’s belief was that nature should do the maximum work for people which will produce lower infrastructure costs: $4 million compared to $18 million for a conventional storm sewer system. Development goals were based upon the natural environment; thus the location of buildings, roads, parking lots and utility lines were determined by natural factors: the natural hydrologic regimen was disturbed as little as possible. Preservation of undisturbed drainage swales promotes soil water recharge, reduces runoff, controls erosion and siltation, protects large areas of vegetation in uncleared drainageways, and reduces cost. The objectives of the natural

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87 Wallace, p. 4.
drainage system are: maintain same surface outflow before development; optimize on-site drainage in permeable soils for stormwater storage and groundwater recharge; maintain aquatic communities of import; and reuse treated wastewater. These objectives or techniques gave value to existing ponds, swales and permeable soils.98

The functional, technical goals of the site are ultimately "social goals since the Woodlands will depend on the natural systems affected for its health and well being." Their concerns reflect the importance of the established criteria in Chapter 2: "The concern is with how the site, its opportunities and constraints, moderates these potentially conflicting goals. A program responsive to both nature and man will arise from the successful resolution of such conflicts."99 An initial site conflict was a site largely located in the 100 year floodplain which would severely limit development potential. The conventional solution—excavate steep-sided ditches and line them with concrete, was unacceptable from an environmental viewpoint and the economic considerations of cost for extensive ditching. The negative results of this conventional system are familiar: increased peak flows in streams, minimized local recharge, lowered water table, decreased base flow in streams, channelization of streams, degraded water quality, clearance of existing woodlands, and unpleasant visual affects.100

Rather than following conventional practices, a natural drainage solution was formulated that maximized forest preservation and functionally handled on-site drainage. This system was guided by the following principles: maximize recharge; minimize runoff; minimize clearing for drainage; minimize erosion and siltation; and minimize cost of system. The planners did not wish to contribute to the drawdown of the Chicot and Evangeline aquifers, supply for the city of Houston. To preserve soil structure, needed for recharge, construction was prohibited and vegetation preserved on designated sites. In order to preserve the existing woodlands, dependent on saturated soils, the hydrologic regime must be undisturbed as little as possible.101 The result was to leave a system of existing swales. The undisturbed corridor required to preserve these drainage swales and streams provide important amenities: vegetation, open space for passive recreation, greenway system through the new community, and boundaries for parcel ownership.

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98 Wallace, p.4.
100 Wallace, p. 43.
Woodlands successfully incorporated private and public open spaces into a functioning and effective storm drainage system—-it absorbs floodwaters and prevents downstream flooding. Its natural drainage system elucidates the benefits of combining storm drainage, flood control, water quality and conservation into one scheme. The wooded floodplain, drainage channels, and recharge soils form a townwide open-space system. The use of floodplains and drainage channels for open space offers important social advantages along with ecological benefits: spectacular trees, diverse, abundant native wildlife, hiking, equestrian, and bicycle trails that link all areas of the town. The successes of their natural drainage system are conveyed in statistics: peak flow increased by only 55%, compared to the average 180% with conventional development; water quality tests higher than neighboring developments; and a severe storm (9” in 5 hours) in 1979 caused no flooding while adjacent communities were inundated. Another successful finding from a study in 1975 revealed that the withholding of runoff in the Woodlands natural drainage and minimized disturbed areas are extremely valuable for improving stormwater quality. Additionally, the outstanding sales of property in the Woodlands New Community testifies to appreciation and preference of the diverse woodland setting over manicured lawns and specimen trees: one resident declares “We’ve never had problems with our area. We love it, especially the greenbelt behind our house.”

Woodlands’ natural drainage system has been an unparalleled success. It is an important example of employing drainageway design to unify public and open space within a community for abundant social and environmental benefits. It sets an important precedent of utilizing a drainageway system within a public landscape for multiple beneficial purposes, both social and environmental.

**Environmental**
- clean water
- eliminated flood damage
- ecosystem remains intact
- aquifer restored
- hydrologic regime preserved
- wildlife and native plant communities and corridor preserved
- aquatic populations preserved

**Social**
- dynamic identity for Woodlands community
- representation and preservation of regional identity
- community facilitated through shared green space linked by trails, civic spaces

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103 Spirn, p. 163.
104 Spirn, p. 166.
Summary

The San Antonio Riverwalk accomplished merging public space with a river system for social and economic benefits. The river’s place of import and link to settlement history attributable to the river was preserved. Regional flora and spatial qualities found on the river before and during early settlement were promoted in the planting scheme and design developed by Hugman. The river’s identity and spatial attributes today provide the top economic generator for the city: convention and tourism.

Woodlands New Community emphasizes the social and economic profits of ecosystem restoration combined with housing development. The master plan preserved extant woodland and wildlife communities, utilized the existing natural drainageway to handle all stormwater management, saved tremendous infrastructure expenses ($4 million rather than $18), and provided public space which doubles as the stormwater management system for the community. The accomplishment of the project is confirmed by high rates of property sales and homeowners preference for the woodland environment and unified green public space providing equestrian and walking trails and civic spaces. Functionally, the system successfully weathered a 1979 storm (9” rain/5 hours) without any flooding while adjacent developments were inundated, and the overall water quality is much higher than adjacent developments. Taken together, the San Antonio Riverwalk and Woodlands new Community helped paved the way for future design by creatively exploring the potential of drainageways to create vibrant, successful public space and solve environmental problems within a single design scheme.
V CASE STUDIES

Teams of ecologists, landscape architects, and engineers have now produced enough good examples of success in water conservation, reuse, aquifer recharge, flood control, recreation, and wildlife enhancement that the old, non-sustainable planning methods and overly hardened engineering solutions typical of the last 50 years now seem absurdly unsatisfactory.

Robert L. Thayer, Jr.

ALTERNATIVE DRAINAGEWAY DESIGN

Alternative drainageway design is a relatively new approach in water design; it was first referred to as natural drainageway design in the 1970s and Blue-Green Stormwater Management in the 1980s. Today it employs techniques of bioengineering, and natural systems—wetlands and meanders and swales to provide drainageway function. Alternatives to conventional water design found in alternative drainageway design include the following: water falls in either porous pavement, infiltration basins, or landscaped beds; these systems feed into open drainage swales planted with natives that channel water to irrigate other landscape plantings; these systems lead into the river system where extensive floodplain wetlands allow rising water space to flood and infiltrate, provides habitat for wildlife and plants, and irrigates rich agricultural land. This entire system is not behind closed doors; instead it becomes the ordering scheme for the built fabric. The beneficial outcomes are multiple: greenways buffer rivers and streams and these ribbons of diversity and health flow through the city to provide cool, clean air channels; recreation and open space amenities are created; wildlife and plant corridors restored; city identity enhanced; and designed public space reconnects people to a healthy landscape system. Alternative design can incorporate pollution reduction, recreation, flood control, habitat creation, and comprehensive city planning, resulting in a product that is "with life, lasting, functional and beautiful."\(^\text{10a}\)

Andropogon Associates, Ltd. and Wenk Associates were chosen as case studies because their work addresses ecological restoration within public space settings and employs innovative techniques. Analysis of their built projects will determine whether the work addresses criteria forwarded in current theory as well as determine gaps in contemporary theory’s strategies. All projects within each case study will be described chronologically, followed by analysis of the body of work.

\(^{10a}\) J. Toby Tourbier & Richard Westmacott, editors, 1980, Stormwater Management Alternatives, United States Environmental Protection Agency, ix- Introduction.
CASE STUDY I

ANDROPOGON ASSOCIATES, LTD.

Philadelphia, Pennsylvania

Water is a living system, an essential element, we should celebrate it in the landscape, not put it into a pipe.

By reuniting form and function, we're showing the way a landscape looks is how it works.

Carol Franklin

Stormwater management is best addressed over the entire watershed. The simplest approach usually is to seek multiple solutions at different points, rather than a single cure-all at the point of discharge.

The focus of restoration must be the whole environment, not just those lands we perceive as "natural" areas. The ragged fabric of our landscapes must be made whole again, for only in this context can we hope to sustain wildness. Biodiversity is not expressed simply in the places most rich in species, but is reflected in the richness of all landscapes.

Leslie Sauer

Andropogon Associates, Ltd. in Philadelphia was founded in 1975 by a team of graduate landscape architecture students from the University of Pennsylvania: Leslie and Rolf Sauer and Carol and Colin Franklin. The central mission of the firm is to repair disrupted natural places; Leslie Sauer declares "The emphasis from now on has to be on preservation of whatever areas remain reasonably intact."107 This is accomplished in their work by bioengineering, restoration of the native landscape, environmentally sound stormwater alternatives, and use of native plants; in short they seek to restore biological integrity while reintroducing native plant and animal species in their natural systems. They have a focused commitment to preserve and repair the eastern deciduous forest and its rich biodiversity.

The name of the firm refers to a native eastern U.S. native grass, little bluestem, which is one of the first plants to establish itself on damaged sites; providing groundwork for return of forest growth. The plant's repair of damaged sites parallels Andropogon Associates, Ltd. goal: to "weave the landscapes of man and nature together for the benefit of both."108 In addition to concentrating on preservation of native plant systems, they focus on alternative stormwater management and stream design with emphasis on stabilizing sites through native plant systems and bioengineering.

Their work encompasses ancient forests, urban plazas, corporate landscapes, residential planting plans, city parks, and more recently, large sites such as Stapleton Airport in Denver, Colorado.

The focus within this case study will be on their stormwater and stream design work. The works

108 "New Strategies for Ecological Site Design." 1986, brochure describing firm and Du Pont project, provided by firm.
chosen for this case study were visited in January, 1995 by the author and documented via notes, slides, photographs, conversation with one of the firm’s principles and a former employee, published and unpublished papers, journal and magazine articles, and materials provided by the firm. The projects chosen for this case study are: Morris Arboretum in Chester Hills, Pa., Smith-Klein Beckman Animal Research Center in Chester, Pa., The Du-Pont Corporate Headquarters in Wilmington, De., and Trexler Memorial Park in Allentown, Pa.

Leslie Sauer and Carol Franklin state “If a landscape architect’s conventional vocabulary is bed, border, bosque and allee, the ecological designer’s vocabulary includes meadow, old field, forest and swamp—forms which respond to the site and reveal pattern and process.” Aesthetic of their work derives from ecosystem function: “The way the whole thing works is the way the thing looks and the way the thing looks is the way the thing works,” and “The style of each place is derived from the natural patterns of vegetation, relief and drainage, and the cultural patterns of past and current land use.” They view their work as a vehicle to connect people to the environment and elucidate how the landscape works. Revealing how the landscape works for Andropogon means powerful design that spiritually connects people to the earth.

Andropogon emphasizes the importance of water in the future: landscape architects are ignoring problems related to water, but in 10 years, because of the global environmental crisis, “water, soil and vegetation will be everything. Landscape architecture will be forced to adopt an “organic aesthetic that reveals the process of the place.” This promotes understanding of how a functioning landscape looks and the many benefits associated with healthy ecosystems. Leslie Sauer has stated:

*These stream corridors speak volumes about the idea of runoff and illustrate the consequences of failing to include the conservation of natural hydrologic patterns as a primary regulatory goal. While our attention has been directed toward flood control and other narrow foci, the larger system has collapsed.*

Wendi Goldsmith explicates the importance of careful water design: “Beyond erosion, there are so many other ecosystem benefits we may manage for in rivers. Water is the lifeblood of all living

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109 Steiner & Johnson.
110 Leslie Sauer and Carol Franklin - “Fitness, Adaptability, Delight.”
111 McCormick, p. 90.
creatures, and as such it serves as a fascinating and essential focus for public education, particularly regarding water resource stewardship.”

Leslie Sauer emphasizes that stormwater management must be addressed throughout the entire watershed, rather than single ‘solve-all’ solutions at the point of discharge, “We must look first for solutions that most closely mimic nature’s solutions, which will likely maximize opportunities for recharge.” She recommends taking streams out of pipes, removing channelization, reestablishing natural meanders in channels, and planting vegetation (trees, perennials) along the corridor. Carol Franklin cites stormwater management as the key to every site: “Very often in landscape architecture, stormwater is the tail that wags the dog. It determines site design. It’s left to engineers, and more engineers are usurping the aesthetic by creating plumbing systems.”

Leslie Sauer cites environmental problems associated with traditional stormwater management: Current regulations address primarily flood control and, more recently, pollution reduction, but, with few exceptions, do not yet recognize the need for effective recharge to support the water table and the base flow of streams.

**Morris Arboretum**

Andropogon Associates, Ltd. was hired by the Morris Arboretum in the late 1970s with the following challenge: place a road and parking lot into our urban public garden and make them beautiful. The physical elements of programming included a new entry drive, parking lot, bridge, aisle, and trellis. The master plan, completed in 1978, met this challenge by employing innovative engineering and ecological methods.

The arboretum rests on a former Victorian estate designed in the English pastoral landscape tradition with several eclectic

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114 Goldsmith.
117 Carol Franklin, 1991, quoted in Kathleen McCormick’s “We don’t ‘Do’ Wetlands”, *Landscape Architecture*, October, p. 89.
gardens located on site. The master plan design decisions were based on both cultural and physical heritage of the site. Andropogon classified the landscape into natural, symbolic, and working categories which evidence the firm's dual commitment to the past and ecosystem restoration. Leslie Sauer describes the paradox: "There is something quite preposterous about our devotion to the landscape style of the seventeenth, eighteenth, and nineteenth centuries at a time when so much of our thoughts must address the future."\textsuperscript{120}

The process was facilitated by collaborative efforts including administrators, plant explorers, contractors, fund raisers, plant curators, craftsmen, lighting designers, landscape architects, engineers, neighbors, board members and volunteers.\textsuperscript{121} Andropogon staff and consultants presented conceptual working sketches of plans for the master plan throughout the process at community meetings.

The road was designed as a transitional space between the surrounding urban fabric and the formal, open gardens. It creates a powerful arrival experience, winding through native perennial meadows and across a stream. The road itself has meanders like a stream, and fits the topography - rolling around and over it, which in turn accentuates the landform's dramatic topography. The bridge crosses a floodplain and functions as a grate, allowing water to wash over and through it during a storm event. Gutters along the road are Belgian block granite pavers, a traditional material for Philadelphia streets, which allow stormwater to become a visual display, flowing over and highlighting the pavers. The paves are placed with minimal mortar, in

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Figure 8- DRAINAGeway IN MORRIS ARBoretum
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\textsuperscript{121} Hughes, p. 15.
keeping with the old Philadelphia road effect, but set in concrete to withstand weights of modern cars. The granite block 'gutters' channel water into perforated pipes and long infiltration trenches along the road.

The parking lots are porous paving over underground stormwater retention basins, creating an artificial aquifer that allows ample recharge into groundwater levels rather than producing volumes of stormwater runoff that creates erosion and flood volume peaks. The 'aquifer' is a 3-4' deep excavation under the parking lot, the width of each lot. A layer of filter fabric separates the soil from the excavation, which is filled with same size aggregate, allowing ample infiltration. The pavement itself also has evenly sized aggregate, allowing for water infiltration through the surface and into the recharge bed. A demonstration allows people to pour water through a cross-sectional model of porous pavement, watching and timing the flow.

Porous pavement has been around 15 years, yet is still not often used. Morris Arboretum's new parking lots, complete with educational boards illustrating cross-sections of the permeable paving and underground recharge beds, will expose more people to this environmentally beneficial technology.

Additional educational components inform visitors of research for the parking lot plants.
The seeds for the plantings were collected in Asia by Paul W. Myer, based upon urban tolerance. The selection criteria include: ability to withstand drought, soil compaction, impoverished soils, extreme temperature variations, winter deicing salts, disease and pest resistance.\textsuperscript{122} These educational elements are part of the didactic approach Andropogon takes in their work and mirrors the Arboretum's own philosophy about the work they do: "This project allowed us to turn a problem (accommodating cars in the landscape) into an opportunity to express our relationship with our past, with our environment, and with our community." The curator, Paul Meyer states: "Roads and parking lots are part of our society, for better or for worse, and if we are to serve modern society then we must make allowances for the automobile."\textsuperscript{123}

\textit{SmithKline Beckman Research Center}

\textsuperscript{122} Hughes, p. 76.
\textsuperscript{123} Hughes, p. 17.
In 1984 SmithKline Beckman Animal Health hired Andropogon to design a master plan for their Applebrook Research Center in suburban Philadelphia (Chester County). The mission was to rehabilitate a 100 acre corporate landscape designed in the 1960s. Andropogon employed many techniques that restore the ecosystem and lower maintenance.

Their first task was to remove unsightly rip-rap in swales used to dissipate stormwater velocity, and revegetate endless acres of clipped turf. A once degraded streambank was cleared of invasives and planted with woody and herbaceous plants: meanders were restored to disperse water, restore groundwater levels, dissipate flood velocity, and reduce erosion. Trees, shrubs, and plants at home in the water were established along the banks, and bioengineering techniques further stabilized the stream. Brush layering is one technique employed, which involves placing dormant branches into the bank, which grow roots and stabilize the stream bank. Fascines were also used---live willow stakes which hold bundles of elderberry, viburnum, and shrub dogwood branches which then take root and further stabilize the bank.

Open formerly mown fields became meadows of native flowers and grasses, interspersed with native trees: sycamores, tupelo, red maple, sweet gum, crab apple and nannyberry. A courtyard adjacent to one of the buildings was planted with native trees: spicebushes, magnolias, river birches, and native wildflower and grass meadows. Plant communities are emphasized over individual specimen plants. The forms of this design are old fields, wet meadows, meandering stream, and upland/lawland forest corridors. Workers jog through the site, have meetings and lunches on the grounds, and have become inspired by the master plan to create a wildlife habitat on their corporate campus.
Du Pont World Headquarters
E.I. Du Pont du Nemours & Co. hired the firm in 1984 to develop the site plan for their new World Headquarters Agricultural Products Department in historic Brandywine of Wilmington, Delaware. The goals of the corporation were to provide a pleasing work environment, evidence their ecological sensitivity, and avoid environmental damage in construction. Andropogon answered this call and developed a site design that enhanced the environment and provided an educational, aesthetic landscape that reflected native flora of the region. Problem-solving techniques employed were numerous, innovative and overlapped to create a holistic working landscape, including stream bank stabilization, stormwater management, landscape architecture, and forest reclamation.

During Andropogon's first visit to the site, the building stakes were actually in the stream. Working with the architectural firm, H2L2 of Philadelphia, Andropogon re-sited the buildings in response to the site. Because of Andropogon's proposal, the stream corridor, planned to be channelized, and the forest, slated to become a detention basin, instead became integral ordering elements.

124 Figures 16 - 23 are from New Strategies for Ecological Design marketing brochure by Andropogon Associates, Ltd., provided by firm.
for outdoor space simultaneously retaining the character of the place.

Figure 18 on the previous page shows the scenario proposed by prior site designers—all runoff from ample parking areas was directed behind the building into the stream which was to become a detention basin, killing the mature native forest trees. Figure 19 shows Andropogon’s solution, which saved the stream and created recharge beds under the porous parking lot, replenishing groundwater levels.

T.H. Cahill and Associates, engineers, used computer simulation to test the design of their new scenario. This proposal increased recharge volumes and protected properties located behind the corporation from storm flooding. The site design for DuPont’s headquarters reinforces regional identity, conserves water, and promotes biodiversity in a number of ways. First, native plant schemes were used in: parking lot islands, back, entry and dining courtyards, hedgerows, wildflower meadows and stream stabilization.

Recharge beds under the porous pavement parking lots contain perforated pipes which carry stormwater from roofs and open areas. These pipes allow water to infiltrate into the gravel recharge beds, trickle through filter fabric into the underlying soil where soil filters the water on its journey back to groundwater. The solution recharges sagging groundwater levels in this highly developed landscape and preserves a mature forest relic behind the corporate office buildings.
Forest reclamation and stream bank stabilization were two additional methods for safekeeping the site's character through preservation of stream corridor, water quality, and native eastern forests. Innovative techniques of bioengineering were used for stream bank stabilization. The interdisciplinary team included Robin Sotir of The Soil Bioengineering Corporation. Bioengineering techniques used extensively in Europe were employed: brush layering, fascines, rock walls, and live stakes.

Figure 30 - REHABILITATED FOREST
The preserved mature oak forest behind the complex was rehabilitated with a careful herbicide program to eradicate exotic invasives. The forest now provides an exceptional amenity to office workers—a meandering trail winds through the forest, punctuated by clusters of seating areas, exercise stops, tree identification, bridges providing access to stream viewing, and quiet spaces for repose and lunch.
Trexler Memorial Park

Trexler Memorial Park in Allentown, Pennsylvania is a 150 acre city park, originally designed by landscape architect J. Franklin Meehan in the 1920s in the English pastoral tradition. Little Cedar Creek flows through the park; the watershed for the stream section within the park is 5.6 miles, with 40% developed in subdivisions, apartment complexes and interstate highways. Development caused extensive erosion of the streambanks—leaving the banks unsightly and unhealthy and the stream filled with silt.\textsuperscript{125} Because of stream bank collapse due to erosion, the stream became shallower, and thus warmer; this eliminated habitat for the wild brown trout—a species with significant populations in Little Cedar, a creek declared “Class A Wild Stream.” In addition, erosion was reducing native plant communities. Non-point source pollution was increasing because of intensive development around the park, including an upstream golf course. The community banded together and sought help to repair the damage.

Andropogon answered their call for help in 1988; they were retained by the City of Allentown to produce a master plan with a program including new entryway and parking lot, new bridges, and redesign of the existing lake. The final plan included: reinforcing and stabilizing the stream bank, detaining floodwaters, restored stream side vegetation, recharged local groundwater, and upgraded aquatic conditions

for the brown trout. The master plan was again a multi-level effort: the firm took ideas from the community, the park service, historical investigation, Wildlands Conservancy of Emmaus, Pa. (researched/document the water quality and habitat degradation prior to the master plan), Sven Hoeger of Creative Habitat, and Lothar Bestmann of Bestmann Green Systems (stream bank repair design). The director of Allentown Parks describes Tresler: "We need to address the real hydraulic issues, but traditional engineering neglects the 'bio' aspect. This is our showcase park, so aesthetics are important and our public has expressed meaningful environmental concerns. We use a passive resistance approach by bolstering the natural processes." In addition to stream degradation problems, the city park service also needed a lower maintenance scheme as they were unable to afford continued extensive mowing.

Andropogon's solution began with a grading plan for the stream and floodplain. The floodplain was enlarged to buffer storm events and provide spaces for spillover; planting zones were clarified with specific elevation changes; and retention ponds and backwater channels funneled stormwater from the stream to the floodplain, allowing

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127 Don Marushak, quoted in Wendy Goldsmith, et al.
infiltration to groundwater. After initial grading, over 50,000 perennial plants (3 grasses, 5 woody-plant species, and 22 wet-meadow species) were planted in demarked planting zones and the flood plain; some of the species include: goldenrod, cardinal flower, aster, sheep fescue, ferns, and broom sedge. Floodplain plantings emphasize the distinct zones of a healthy stream system and help to slow water speed by providing friction and reducing runoff. In addition to perennials, native tree groves were planted on the flood plain edge: bald cypress, witch hazel and sweet gum. A gentle gradient was restored to the streambank, in keeping with its former structure.

To stabilize the streambank, innovative bioengineering techniques were employed. Fiber-Schines (20' coconut tube sections filled with vegetation and soil) were staked to the stream edge or toe of the bank, and Fiber-Carpet (wetland sod) was stacked over the Fiber-Schines. Fiberolls (Fiber-Schines) provide transitional stability for newly planted herbaceous materials to establish themselves in; they also trap and contain sediment, further stabilizing the bank until plantings take hold. In a few sections, additional Fiber-Schines were stacked on the lower roll, overhanging, to provide shady habitat for the brown trout and create eddies that trap trout food. These bioengineering devices were invented 15 years ago by Lothar Bestmann, an engineer in Germany. The Fiber-Carpet allowed species such as woolgrass and bogrush to establish. The stream was transformed from a shallow, sediment filled, warm trough to a regenerated swift, cold, clearer urban watershed with a rich ecology of plant and animal life. Since stabilization, a 100 year storm test the innovative bioengineering techniques—they upheld better than upstream gabions.128 “We know bioengineering works, we just have to prove it to a larger audience” Hollis Allen, ecologist with Waterways Experiment Station in Vicksburg, MS stated.

Analysis
The described projects illustrate alternative drainageway techniques which repair negative outcomes of conventional design and restore ecosystems within public landscapes. The following discussion critically analyzes the body of work based upon criteria derived in the literature review (p.12) including:

1. restoration of the ecosystem using nature as a model;
2. encourage human reconnection to and interaction with the ecosystem; and
3. enhance and preserve regional identity.

Restoration of the Ecosystem Using Nature as a Model
Restoring the ecosystem using nature as a model is the most successfully met criteria within the work of Andropogon Associates, Ltd. Restoration of the ecosystem in their work is directly tied to using nature as a model: “We must look first for solutions that most closely mimic nature’s solutions, which will likely maximize opportunities for recharge.”129 Because their design values are based upon preservation and enhancement of native ecosystems, this aspect drives all the documented projects. Their self-stated mission is to repair the eastern deciduous forest and disrupted natural places; their primary technique for actualizing these objectives is through use of native plant communities and bioengineering.

Andropogon’s drainageway design techniques rely principally on vegetation as a mediator between soil and water. Vegetation is used to stabilize eroded streambanks and damaged flood plains---promoting health, plant diversity, and biodiversity of the ecosystem. As the designers state: “The way the whole thing works is the way the thing looks and the way the thing looks is the way the thing works,” and “The style of each place is derived from the natural patterns of vegetation, relief and drainage, and cultural patterns of past and current land use.”130

Within Morris Arboretum, SmithKline Beckman, DuPont Headquarters, and Trexler Memorial Park, several techniques modeled after nature are employed:

- native plant communities,
- bioengineering,
- restoration of meanders,
- porous pavement over recharge beds, and
- stormwater channeled for infiltration

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130 Steiner & Johnson.
Through use of techniques modeled after nature, ecosystem restoration is successfully achieved. Native plant materials provide forage for wildlife, assist to preserve and showcase regionally specific plants, and are ideally suited to the unique geology and climate of a given region. Using native plant communities and specimens reduces irrigation, fertilizers and plant loss due to weather extremes. The overall effect\textsuperscript{131} is one of intense color and texture throughout the year. Restoring meanders increases infiltration, slows flood waters, reduces erosion, and creates wildlife and plant habitat. Use of porous pavement and infiltration beds recharge groundwater levels, and reduces runoff, erosion and flooding. Porous pavement mimics non-built conditions where water falls on soil and infiltrates to groundwater. Andropogon’s techniques modeled after nature have proven success: they repair and enhance ecosystems.

Reconnection and Interaction with Ecosystem

Reconnection and interaction with the ecosystem is accommodated in their work only through standard means and this is where their work fails to advance new ideas. Within Morris Arboretum, several built structures (bridge and stormwater gutters) convey water above ground and double to slow water and increase infiltration. Trexler Memorial Park and grounds adjacent to the Du Pont headquarters have several walking paths which pass areas of native plant communities, however they do not actively engage users of the park in these systems. The paths merely flow beside the restored areas. The planting areas are in keeping with a tidy corporate public landscape image and do not advance new forms which address natural and cultural systems. Like two ships passing in the night, the path flows through grass and past “islands” of native plants. While these islands showcase regionally specific plants, they do not transcend a planting plan stage to actively engage people in a more directed manner through new forms. Only minimal signage (Figure 26) indicates the processes of native plant communities in the restoration projects. Parking lots in Morris Arboretum and Trexler Memorial Park are great examples of making a frequently used and overlooked place something which can work with

\textsuperscript{131} Author’s opinion based upon site visit and published photo documentation.
natural systems to restore ecological health while showcasing regional plant species. However the parking lots continue to rely on traditional schemes and do not explore new forms to express the operation of this landscape system.

A more successful integration of pedestrian paths and restoration areas is within SmithKline Beckman and Du Pont’s preserved deciduous forest behind the corporate headquarters. SmithKline Beckman has a boardwalk located in the restored floodplain planted with native wildflowers, grasses, shrubs and trees and walking/jogging paths wind through the landscape. Du Pont’s walking trail behind the corporate headquarters is perhaps the most successful in achieving more direct interaction between people and restoration aspects of the project. A paved trail winds through the forest, complete with exercise stations which encourage stopping and activity within the restored ecosystem. Sitting areas are provided for small group meetings or individual escape from the corporate office. Eastern deciduous tree and shrub species are tagged for identification, providing education. Bridges cross the stream, allowing for visual and perceptual links to the preserved and restored waterway. Overall, the experience is one of being within a restored ecosystem reflective of the larger region.

Preservation and Enhancement of Regional Identity
Preservation and enhancement of regional identity occurs primarily through use of native plant communities and stream restoration in Andropogon’s work. Within Morris Arboretum some use of historically authentic materials are employed (granite blocks). Within the larger park setting the overall theme remains a pastoral landscape punctuated with eclectic gardens. While water’s
movement has been highlighted with open paved gutters beside paths and road, and the entry road works with topography. the overall affect is one of add-ons to an existing theme. The entry drive winds over a bridge and through restored native wildflower and grass meadows, however no opportunity exists for people to interact with these spaces other than through views from a moving car. No trails allow stream crossing or walking through meadows. Interaction might occur but the user is not encouraged to do so.

Public amenities (benches, plazas, gardens) remain centralized in the 'park/arboretum' area; as a result, opportunities to interpret and allow experience of the restored ecosystem are missing. The user experience remains that of a typical park with acres of grass and decorative elements.
## CRITERIA & PROJECT SUMMARY

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### Summary

Andropogon's work illustrates many successful and innovative techniques for ecosystem restoration using nature as a model, including: porous pavement, infiltration beds under parking lots and along drainage swales; restoration of native plant communities; use of native plants for specimens; bioengineering for streambank restoration; low water vehicular bridges which slow flood waters; grading and planting in zones for streambank restoration; and restoration of meanders to reduce flooding, lower erosion damage, increase wildlife diversity, and provide
plant habitat. Within the three categories derived by contemporary theory, their work achieves the most success in this category.

Enhancing and preserving regional identity occurs in their work primarily through employing native plant communities, preservation of the Eastern deciduous forest, removing exotic invasives, and restoration of drainageways. Unfortunately their work does not move beyond this realm, and preservation of regional identity occurs almost by default through ecosystem restoration. Larger geologic and natural processes are not actively engaged within public space, and become almost a transparent layer, buried in the work. Opportunities for interaction are minimized because Andropogon is so concerned with quiet interventions guided by the frequent theme “restore nature to its non-human state.” While many of their projects occur in heavily used public spaces, the restoration and regional enhancement aspects of their work are not effectively woven into human use of the space. Their restoration work runs parallel to existing structures and public amenities, trying hard to not call attention to itself.

Within water design, porous pavement and infiltration beds are employed, but once again are quietly tucked away, beneath the surface, and not made an integral element of site architecture. Movement of water is placed upon historically accurate granite pavers in Morris Arboretum, and while this does expose water’s movement, it does not express the eloquence, sculptural movement, and life-giving properties of water. Meanders are replaced and plant communities planted to restore water to the landscape in SmithKline Beckman, but are not created in conjunction with opportunities to actively engage people with the drainageway. People remain on the fringes of the restored waterway—visually connected but physically divorced.

Because regional identity is interwoven with human expression, it is an integral component in regional expression. While all projects documented are public landscapes, public space remains divorced from restoration interventions. Apparently people are not meant to interact with the restored ecosystems, because not even a path winding through native wildflower meadows can be found. The restoration projects remain pieces of a whole, not effectively interwoven into the larger cultural system of public space. A rich vocabulary is possible which might occur in conjunction with ecosystem restoration, clearly articulating a relationship between people and their ecosystem.
Reconnection and interaction between people and the restored ecosystem is minimally encouraged in their work. Andropogon has advanced light years to create spaces which are charged with texture, color and life by restoring native ecosystems, yet they provide few opportunities for people to actively interact with these systems. The most basic interaction opportunities are provided which can be found in most landscape architecture projects: conventional paths, boardwalks, footbridges, benches, and overt signage and demonstrations. These elements encourage some generic understanding of the function of a porous parking lot, the benefits of native plant communities, and views of restoration projects but they do not provide experiential opportunities within these restoration projects. These objects promote ‘viewing’ the scene, thereby perpetuating scenographic landscapes dependent on visual imagery.

Overall restoration aspects of their work are not effectively woven into the overall context in which they occur. For example within Morris Arboretum, restoration occurs under the parking lot and paths in recharge beds and native plant communities are planted in islands which paths move beside. A more integrative approach would be to create an ecological garden which has equal footing with the other eclectic gardens found in the park (Japanese, Rose, Sculpture). In this manner, the restoration is a part of the design, rather than a hidden element in programmatic pieces of the park and assists to advance education through experience of restoration rather than signage and demonstrations. This kind of element would fit well within existing typology of the arboretum, create a sense of place based on a restored ecosystem, and encourage interaction between users of the setting and a restored ecosystem.

Because Andropogon Associates Ltd. relies exclusively on restoring ecosystems to a pristine state and adding pockets of plant communities into extant scenes, their restoration efforts fail to engage the larger landscape inclusive of people and their activities. Thus many opportunities are lost for expressing the human cultural contributions to the landscape and promoting interaction while solving ecosystem restoration. Writers in the Literature Review suggest experience of place is most often fostered by active interaction; thus their work misses an ideal opportunity to not only restore the natural landscape but restore the inner landscape of people through encouraging their interaction in the restored landscape. This is particularly unfortunate considering the very public landscapes in which their work occurs.
Taken one step further, and replacing outdated modes of conventional expression such as pergola, granite pavers, and teak benches with a more expressive landscape architecture which actively engages users with ecosystem, the spirit of place, culture, and region might be conveyed in a fresh, dynamic way. This 'way' is what contemporary theory is seeking and what the twenty-first century is in need of. Critically needed ecosystem restoration, expression and interaction of the human/cultural element of the landscape, and preservation and enhancement of regional identity. By creating and expressing a new aesthetic, comprised of new forms and symbolic language in conjunction with ecosystem restoration, a relationship between people and the ecosystem can be advanced which expresses symbiosis rather than fragmentation and dualistic perceptions regarding the ecosystem and human's place within the ecosystem.

Review of Andropogon's work uncovered a gap in contemporary theory: failing to advance research into innovative techniques for ecosystem restoration beyond use of nature as a model. Techniques of recharge beds, bioengineering, and porous pavement, while modeled after nature, employ modern materials and technology and thus transcend "use nature as a model for restoration." Theory fails to promote merging contemporary technology with techniques found in nature. From the lack of innovative forms within the built language of Andropogon's work, another rift in contemporary theory is located: advancing new forms to express a new aesthetic. More specificity could elevate 'redefine aesthetic' to the implementation stage, transcending the realm of theoretical musing. It is not enough to redefine aesthetics to include understanding of the ecosystem, but some discussion needs to be made of how this understanding might be fostered through new forms.

In summary, what Andropogon's work does well is advancing new technologies of how functional design elements may work harmoniously with natural systems, particularly regarding the hydrologic cycle. Their work evidences the strength of using native plant communities for stabilization of streambanks, restoration of the eastern deciduous forest, and for specimens in a planned landscape. Where their work falls short is failing to use these systems to reconnect humans with the restored ecosystems through planned design elements, advance new forms which not only restore, but express human contributions and symbiotic relationship to the landscape, and which transcend imitation of nature and advance understanding of restoration in a more visible, expressive formalistic sense.
CASE STUDY II

Denver, Colorado

It is my belief that the design professions have only begun to explore the design potential of stabilizing and controlling flooding along rivers and streams in a manner that allows their aesthetic and natural values to be realized. 132

William E. Wenk

Wenk Associates in Denver, Colorado specializes in alternative drainageway design work; their projects encompass environmental restoration and public space design. William E. Wenk, president and founder of the firm, began his career in landscape architecture twenty years ago, after receiving degrees from Michigan State (undergraduate - landscape architecture) and the University of Oregon (graduate - landscape architecture). Their record of success is validated by homeowner satisfaction, citation in numerous professional conferences and publications, storm event statistics, water quality improvement, and successional plant establishment. The documented projects in some instances connect people to a restored ecosystem and provide inspiring public space.

In a March/1994 interview, Mr. Wenk stated when he began doing water projects twenty years ago he found engineers didn’t have all the answers, especially when it came to integrating a variety of issues into design. 133 He cited the main influence in his work was experience (20 years). He discovered the engineers did not have all the answers, and educated himself through trial and error on various projects to speak the engineer’s language and seek new forms to solve recurrent problems. Learning to use engineering language enabled him to communicate ideas about projects in a dialog they could both understand. Other cited influences cited were poetic water designs of Lawrence Halprin and Luis Barragan; The Quiet Crisis by Stewart Udall; Design With Nature by Ian McHarg; and pre-industrial agricultural practices.

The work documented for this case study is located in and around the Denver metropolitan area. To understand the context for these projects Denver’s drainageway history will be briefly examined. The city of Denver was founded in the late nineteenth-century during the westward migration. Possessed of a semi-arid climate, the area averages 15 inches of rainfall a year. This native high plains landscape possesses short grass prairie with sporadic trees along the drainageways. Growth has been rapid - with the last surge from 1970-1980. As a result, suburban sprawl has begun to dominate the outlying perimeter of the city, with cities such as

132 William E. Wenk, July 22, 1992, letter to Mr. Olguer Gelpi (letter provided by author).
133 Interview, March 7, 1994, at Wenk Associates in Denver, Colorado with William E. Wenk, conducted by Trenda Carter Leavitt.
Aurora, Littleton, Lakewood and Arvada flanking Denver. Rapid urban perimeter growth and the city's aging infrastructure prompted re-design of existing infrastructure, providing a favorable climate for alternative solutions to drainageway problems. The city itself is an inspiring example of an urban center which has implemented a comprehensive, integrated system for stormwater management. In 1965 fourteen inches of rain fell on the city in a few short hours; flood waters piled debris against bridges, forming dams that sent water spilling into the surrounding city and out of the channelized drainage system. This storm event cost over three hundred million dollars in property damages, bridge destruction, and building silt damage. Twelve lives were lost\textsuperscript{134}.

As a result of this devastation, the Denver Urban Drainage and Flood Control District was formed in 1969 to coordinate and standardize drainageway design (i.e. all local governments designing for the same storm event), and assist in development of watershed masterplans. Master plan studies encompass an entire drainage basin and involve coordinated efforts of engineers and local governments, who pay half the cost of the project(s). An example of coordinated planning is the Platte River Greenway: 450 acres of open space with 15 miles of trails. The greenway transformed the South Platte River into a series of connected parks.

The resultant park system and river restoration considerably improved a river once described as:

a sad, bewildered nothing of a river . . . a sand bottom, a wandering afterthought, a useless irritation, a frustration, and when you've said all that, it suddenly rises up, spreads out to a mile wide, engulfs your crops and lays waste your farms.\footnote{James Michener. 1978,\textit{Centennial}, New York, p. 65. (quoted in A.W. Spirn, p. 133).}

The Platte River Greenway is one of many river restorations resulting from Denver’s proactive stance on waterways improvement. Because of past environmental problems, a favorable climate for innovative solutions to drainageway design was created.

The projects of William E. Wenk parallel this transformation, improving rivers and streams in the Denver metropolitan area with innovative solutions that repair ecosystem damage caused by conventional drainageway design express the human, cultural component of the landscape, create recreational spaces for citizens, and reconnect people to drainageways. Each project described meets or exceeds federal requirements for preservation, protection, and enhancement of environmentally sensitive areas. In the past, drainageway improvements were designed by engineers with little regard for impacts on natural areas, recreation values or visual impacts on adjacent neighborhoods. More recently, collaborative efforts between engineers, hydrologists, landscape architects, city officials and neighborhood groups have facilitated drainageway design projects that repair ecological systems, enhance the cultural landscape by providing recreation and nearby nature for people, and visually provide open space and escape from the built fabric.

\textbf{George Wallace Park}

One of the earlier projects of Wenk Associates is George Wallace Park, located in suburban Denver, adjacent to the Denver Technological Center (Tech Center, a large office park development). Goldsmith Gulch divides the Tech Center from the suburban neighborhoods. The project was primarily funded by the Tech Center, who worked with the city of Denver and the Urban Drainage and Flood Control District to implement a regional stormwater detention pond along this drainageway. Goldsmith Gulch before development was a neighborhood and office park eyesore, replete with erosion and

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\caption{GOLDSMITH GULCH BEFORE DESIGN WAS IMPLEMENTED}
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dead vegetation, and lacking usable public space. The erosion was caused by upstream development and inadequate designs to handle flood velocity and volume. The redesign of George Wallace Park was completed in the early 1980s. This 25 acre suburban/office park doubles as a regional detention pond, storing stormwater during large storm events. This lowers the need for larger channels downstream in an older, intensely developed residential and commercial area. The Tech Center wanted the detention pond and drainage structures to facilitate a park for the neighborhood as well as their office workers. Passive recreation is accommodated in the ‘detention pond’, a large open grassed area that holds water during larger storm events and allows for soccer, walking, frisbee and jogging during dry weather.

Six foot high drop structures placed at regularly spaced intervals along the stream channel allow users from the office park and the local community to enjoy the water’s passage: falling, trickling, and rushing while they use the structures. The design was a result of brainstorming between Mr. Wenk and the engineers involved. Clay models were used in the studio to derive a form typology; Wenk calls the drop structures a “formal design composition, like a Mondrian study.”

\[136\] Michele Strutin, 1991, “Two parks that quiet the storm,” Landscape Architecture, October, p. 87.
In addition to providing interesting visual sculpture and linear movement in the landscape, these compositions serve functional purposes. Covered with water during a large storm event, they slow water by turning it in on itself, reducing turbulence and speed. When water is at normally low levels, they provide sitting space for office workers at lunch or children playing after school. The structures create a space to experience water—the structures highlight water’s movement, create falling water symphonies, and serve as a canvas—showcasing stormwater’s force and volume. Water has not been hidden in this design, instead the sculptural and evocative qualities of water are given space.

The resulting project operates on a number of levels: it exposes a drainageway to the public, highlighting and making accessible moving water through a landscape. The sculptural qualities of water are exposed through drop structure design that allow water to dance around baffle chutes, crescendo down elevation changes, and slice through a grass basin—symbolizing the life giving artery of a landscape.

Functionally, a stormwater detention basin has been created that allows for flood waters to fan out into the floodplain, allows for infiltration, stores the volume and releases it at a non-erosional, safe rate downstream. Recreationally, the basin is designed for passive recreational use and as a pleasant space to sit and have lunch or take an
afternoon stroll. This project embodies new approaches to design debated by contemporary scholars. The design addresses many issues at once: water remains part of the public landscape, flooding fans into the preserved floodplain during storm events, people and their needs are accommodated. Regional characteristics are expressed which in turn reinforce identity of place and native landscapes, and the presence of people are encouraged in the landscape.

Aesthetics are inspired from contemporary art, specifically from an artist (Mondrian) who exploded traditional views of symbolic representation and reintegrated spirituality in art, independent of recognizable symbols. Development of Mondrian forms were refined in clay models, precursors for Wallace Park's baffle chute drops. George Wallace Park hearkens back to the San Antonio Riverwalk in its use of water as symbol and metaphor.

An important issue not addressed in George Wallace Park is environmental restoration and improvement of water quality. Wenk describes these shortcomings: "Most people think Wallace Park is wonderful—a value to the community—but it degrades the water quality. . . . it's a concrete ditch, neat and tidy, with nothing left to chance. . . . The Environmental Protection Agency (at the time) was concerned about wetlands, but didn't have the legal teeth to
enforce what they believed."\textsuperscript{137} Wallace Park was created a decade ago, and later projects of William Wenk have begun to successfully incorporate environmental issues into design while maintaining consideration of function, region and aesthetics.

\textbf{Horseshoe Park}

Horseshoe Park is a later design that does repair ecosystems and purify water. Horseshoe Park, another neighborhood drainageway design, is located in a densely developed suburban area within the city of Aurora, Colorado, outside of Denver. A Y-shaped, 70 acre active and passive park; it is located at the confluence of West Tollgate Creek and Cherry Creek Dam’s overflow spillway. The normal flow of the creek is less than 10 cfs (cubic feet/second), with a 100 year storm event registering 15,000 cfs\textsuperscript{138}.

The drainageway length within the park is 1.6 miles. A sewage-treatment plant was located on the site in the 1960s. Wetlands were created ironically by runoff from new residential development and road construction across the lower end of the park. During storm events, the wetlands created flooding in some of the adjacent homes. Because of this flooding the city channelized the stream and wetlands in 1980; channelization caused erosion, exposed utilities, and evaporated wetlands.

\textsuperscript{137} Michele Strutin, "Two parks that quiet the storm," \textit{Landscape Architecture}, October 1991, p. 85,87.
\textsuperscript{138} William E. Wenk, "From liability to resource: The city of Aurora, Colorado’s changing approach to drainageway design", 1992 (unpublished paper provided by the author).
These problems prompted citizen activists to enact change. A team of engineers, ecologists, landscape architects and a city team comprised of representatives from Utilities, Public Works, and Parks and Open Space began brainstorming for solutions to the multiple problems on the site. Site concepts were produced collaboratively between the city, the consultant team, and neighborhood representatives; the resultant scheme restored the much loved and missed wetlands with weir structures that direct a portion of daily stream flow into braided channels which flow through the wetlands; re-introduced the meanders of the stream channel, removed channelization; and introduced drop structures to slow water flow and stabilize the channel. Construction was completed in 1988 for $2.5 million, and even included moving houses located in the flood plain. The trail system within the park is heavily used and connects to an extensive, linked network of trails in the Denver metropolitan area. Vegetation (mix of prairie grasses and flowers) is profuse, and successional plantings so mature today (1995) willows and cottonwoods tower over the stream.

In addition to restoration of the stream and wetlands, the park provides much needed open space relief from dense suburban development, wildlife habitat and corridor, recreational space, and irrigation of turf grass areas. The irrigation occurs in parklets, vegetated areas at the end of cul-de-sacs where run-off is distributed by level spreaders across the vegetated areas; this concept is a
wonderful solution that re-integrates stormwater into the landscape for irrigation and restoration of groundwater levels. In addition these small parks provide space for recreational sports and neighborhood gatherings. Some maintenance problems have resulted; maintenance has prevented the intended prairie grass and flower species from nature development. Horseshoe Park makes a significant leap from George Wallace Park as it transcends issues of recreation, function, and aesthetics to incorporate environmental components. The parklets and wetland areas reduce pollutants from stormwater runoff, provide habitat for native plant communities, and restores the hydrologic system in the landscape. The water system surpasses symbolic representation in the landscape and becomes a functioning drainageway that reconnects humans to the hydrologic pattern.

Space is allocated for a 100 year storm event without damage to any homes in the subdivision. This allows for inherent properties of a flood to occur: cleansing, washing of floodplain lands, deposition of silt for nutrient and soil replenishment, and irrigation of the higher elevation. More importantly, this park allows the people who use the park and live nearby to experience the flood's turbulent waters rising, floodplain cleansing, and rich soil deposition. The neighborhood citizens are thus reconnected to processes of a healthy, functioning landscape too often hidden underground in storm sewers.

The playful, evocative qualities of water have been reintroduced in this landscape; low water bridges enable users of the park to sit on the bridges, dangle feet in the water or watch the stream flowing, fish swimming or stones sparkling. Cattails, gaillardia, lupine, deer, songbirds, and waterfowl are now co-residents of the park. Horseshoe Park has transformed a lost, unsightly, eroded, channelized stream into a lush, healthy stream flowing through a healthy plant community. The impacts have
increased biodiversity, provided open space and recreation opportunities, and restored health and function to an urban drainageway.

Shop Creek, located in Cherry Creek State Park in nearby Aurora, Colorado was also a response to severe erosion problems, water quality problems, and recreational needs. Shop Creek differs from the first two projects in that it is located within a state park. The park’s adjacency to dense housing development comprised of condominiums created large peaks after storm events and increased levels of phosphorous. Shop Creek flows into Cherry Creek Reservoir, a flood control and recreation source for Denver. Phosphorous, inherent in the soil and intensified by fertilizers and pavement runoff, caused entrophication and algal blooms in the reservoir. Increased runoff from upstream development was causing sedimentation along the lake’s edge.

Wenk’s solution, working in conjunction with Black and Deach, hydrological engineers, Muller Engineering, hydrologists, and the Cherry Creek Basin Authority, was to create a series of drop structures at intervals along the length of the creek. These concrete crescent-shaped drop structures, or semi-natural reservoirs\(^{140}\) allow water to settle in the series of reservoirs and move slowly through meandering stream channels that create a series of linked wetlands. These wetlands and basins leach out the phosphorous. The structures halt erosion that had been deeply scouring Shop Creek’s banks.

\(^{139}\) Photograph from *Landscape Architecture Magazine*, “Two parks that quiet the storm”, October 1991, pg. 84 by Michele Stratin.

The solution resulted from discussions with the engineers about what would visually fit into the prairie landscape; what had formerly been proposed was a channelized stream with drop structures that would harshly slice through the landscape. The detailing of the consequent crescent forms derived from sedimentary rock formations found in Canyonlands National Park in the southwest. There, streams naturally create the crescent shape via erosional processes. The arms of the crescent turn inward to turn the water in on itself; the arms thus dissipate energy. A bump created by deposition is created in the middle of the crescent, this further dissipates energy and slows water. This form, created in an unaltered stream, is a punch bowl in engineering terminology.

A detention pond with limnetic zone for permanent settling and biologic uptake collects all water from the upstream condominium development. The water then slowly flows through braided wetlands punctuated by the crescent channel drop/reservoir structures. These 8' drops are constructed of soil cement, using on-site soils that blend the forms unobtrusively into the landscape. The soil cement mixture was rolled into crescents and stacked up like pancakes back into the hillside like a
staircase. As a result, the crescent shapes sit quietly in the landscape and recreate the gently sloping diagonal lines of the surrounding landscape. During storm events, water flows down the stairs, slowing the water before it falls into a plunge-pool, where the crescent arms turn the water in on itself, further slowing its movement. The bump between the crescent arms dissipates any water about to race downstream.

Wetland plants were transplanted from downstream to preserve the gene pool and were planted in zones responding to water depth. The reed beds bind phosphorous and provide habitat for ducks and red-winged blackbirds that dart among the cattails, wheatgrass, wildflowers and sand bluestem. Cottonwood and other species have established themselves, creating a true successional landscape. Trails and benches snake beside the drainageway accommodating joggers, walkers, bikers and equestrians. The overall effect addresses the required functional issues of the site (erosion, pollution, flooding), and enhances the visual and environmental landscape.

Shop Creek is an oft-cited work which effectively addresses contemporary issues within the landscape: environmental enhancement occurs through: improvement of a drainageway, creation of wildlife habitat, reduction of pollutants from water, and restoration of native plant communities. Functionally the design handles the 100 year storm event without adverse flooding or erosional effects, and visually blends into the landscape.

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When citing advantages of this approach to drainageway design, Mr. Wenk expresses salient views on stormwater and drainageway design. Reexamination of traditional stormwater practices provides an opportunity to explore new ways urban and suburban open space can be used for stormwater drainageways as well as parks and recreation corridors. A series of parks and open spaces, trail corridors, and wildlife habitats result that enliven and provide great amenities for residents. In addition, the above described solutions reduce capital improvement and maintenance costs for drainage and landscape irrigation. Water quality is improved and natural areas preserved while creating multiple purpose landscape networks.142

The following guidelines for alternative drainageway design have been developed by Mr. Wenk:

◊ Public officials are often unaware of the multiple use potential of stream corridors, or feel that hydraulic requirements preclude development of recreation, open space and habitat areas within the corridors. An awareness program should be developed to point out successful projects where a variety of issues have been addressed as part of the channel design.

◊ Assembly of a multi-disciplinary team is essential. All issues related to the project, especially those not directly related to hydraulic design considerations, should be identified prior to the assembly of the consultant team, and an appropriate team assembled. Each discipline on the design team is equally important. The team should be assembled of members who have mutual respect for, and knowledge of the other members’ capabilities. All disciplines should be involved from the onset of the project. Significant opportunities will be missed if professionals such as landscape architects or ecologists are brought in late in the design process. Often, the most creative responses are a result of on-going collaborations where each team member contributes significantly in formulating basic conceptual approaches.

◊ Municipalities should be open to innovative and new approaches to channel design and should encourage limited experimentation to address emerging issues, such as water harvesting and the use of alternative construction materials.

◊ Ongoing maintenance of areas other than channel structures may be important, and may require on-going collaboration between City departments and agencies. Higher levels of specialized maintenance during the initial establishment of natural areas can result in lower long-term maintenance costs.

◊ Minimal increases in project budgets can often result in significant increases in the recreation and open space value of urban channel improvements projects. Initial project budgeting should consider the potential benefits, beyond stormwater control, allowing for a greatly enhanced value of the project for the community. 143 (added italics)

142 Wenk, "From liability to...,” p. 5.
143 William E. Wenk, "From liability to resource: The city of Aurora, Colorado’s charging approach to drainageway design” (unpublished paper provided by author) 1992, p. 5.
He suggests the following principles to utilize the value of stormwater:

◊ Leave stormwater on the surface
◊ Slow the water down
◊ Spread the water out through a network that irrigates a range of landscape types

The following components are suggested to direct and manage water (drawings by William E. Wenk)144:

- **Water Gardens** create an entry to the green networks, clean urban run-off, and begin the process of distributing water on the landscape.

- **Canals** lined by maintenance/coldestrian paths carry major storm flows to drainages and irrigate linear groves of trees.

- **Natural Drainages** absorb stormwater that is not adsorbed by other components. Natural drainages are the organizing element of this open space network.

Figure 55: STORMWATER AS A RESOURCE

Analysis
The described projects of Wenk Associates illustrate alternative drainageway techniques which repair negative outcomes of conventional design and restore ecosystems within public landscapes. The following discussion critically analyzes the body of work based upon criteria derived in the literature review (p.72) including:

1. restoration of the ecosystem using nature as a model;
2. encourage human reconnection to and interaction with the ecosystem; and
3. enhance and preserve regional identity.

Restoration of the Ecosystem Using Nature as a Model
Wenk Associates employs ecosystem restoration using nature as a model in the following ways:
- braided wetlands
- detention ponds
- native plant communities planted in water depth zones
- restoration of meanders
- grading streambank for stabilization
- restoration of floodplain through grading to hold stormwater

These techniques are all highly successful in repairing damaging affects of conventional drainageway design and restoring the ecosystem. Their affects include: water purification; reduction of flood volume and velocity; lowered erosion; and creation of plant and wildlife habitat. These outcomes echo those found in the work of Andropogon Associates, Ltd., and meet in part the criterion of twenty-first century design strategies forwarded in contemporary theory.

Successful ecosystem restoration is achieved in Horseshoe Park and Shop Creek. A rich ecology now exists on what were formerly eroded and poorly functioning ecosystems. The earliest project documented, George Wallace Park successfully controls stormwater and highlights a drainageway; however this project does not assist in ecosystem restoration. Water is not purified, and flows through a concrete razor-straight ditch with mown grass extending to the edge of the water runnel, prohibiting plant or wildlife habitat.

While Wenk Associates employs techniques modeled after nature, their work transcends an obtuse interpretation of typology/form found in nature. For example, the dragon’s teeth baffle and drop structures in Wallace Park while modeled after obstructions inherently found in natural streams (boulders, bedrock, fallen trees and meanders) move beyond simplistic replication of those forms. Wenk Associates has created forms which mimic the function of obstructions.
(reduce velocity and slow flood waters) while expressing the surrounding built fabric and
drawing from a diverse, eclectic typology found in the cultural landscape fabric. The forms do
not try to emulate a boulder which would be out of context in the middle of a highly developed
 corporate landscape, but are expressions of the larger built, cultural context. In addition to being
sculptural forms, and functionally abating flood damage, they also serve as effective public space
by design: surfaces are flat and of a comfortable height and size for use by people. This is the
most successful public space within both case studies.

A second example of using natural form to derive a new vocabulary for the twenty-first century
landscape is Shop Creek’s drop structures. The crescents were modeled after landscape form in
canyonlands county, far from this site. Yet they are not mirrors of the inherent forms used for
modeling, they are expressive works on their own. While they also serve to functionally perform
needed stormwater duties, they also stand as quiet statements of human generated design. These
forms cannot be mistaken for natural form, and yet they resonate with the surrounding
landscape, a park, and thus express human design while fitting into their context. In this respect,
Wenk Associates’ work meets and exceeds demands set forth in the literature review and
exemplify work which effectively uses nature as a model or foundation for functional design
while simultaneously expressing active design intervention, cultural influences, and context.
Reconnection to and Interaction with Ecosystem

Within this criteria, Wenk Associates achieves varying levels of success due to site constraints and programming. Minimal success is achieved with Shop Creek because the project is within a park setting, serving less of a role as public space and more one of passive recreation and open space relief. Programming within this project relied heavily on water purification to restore water quality to Cherry Creek Reservoir, and this is achieved. Because the streambank was heavily eroded, restoration of the waterway has been achieved as well. However public space opportunities to interact with the created ecosystem is minimal. Paths follow the ridge above the braided wetlands and detention basins yet do not move through the restored vibrant ecology of plants and wildlife created in the riparian corridor. Only a horse trail crosses one of the wetlands. While a user can walk over the top of the drop structures and to the edge of the wetland areas, this is not promoted by a path system. Thus accommodating frequent use via popular activities (walking, jogging, biking), which would encourage frequent interaction within the restored ecosystem is lost.

Educational signage is provided which explains the wetlands and their purpose, yet no discussion is provided about the ecology created and how the ecosystem functions. The project is successful in providing space for highly valued contemporary activities: jogging, walking, and biking. Benches are provided which look into the wetland areas and yet they are rather tacked onto the overall plan. When using the benches, you are not within a space per se, but perched on a ridge without human scale elements which create a sense of comfort. If the benches were situated within a space nearer the wetland system, the user would have more direct interface with the texture and function of the system, rather than promoting a strictly visual or ‘view’ experience. Opportunities to learn about and experience the drop structures might promote some cognition of the underlying principles of ecosystem function as well. Considering the rugged open space setting however, Wenk Associates has been successful in merging some public space into their restoration project which responds to contemporary activity preferences. Additionally, placement of public space within and a part of this ecosystem would forward the notion of ecosystem inclusive of humans. Unfortunately a dualistic understanding is perpetuated by this design.

Horseshoe Park achieves greater success in merging public space into the drainageway restoration. Paths wind through a thick undergrowth of native plant communities, providing an
interior experience of a restored wetland habitat. Within the interior of the project, the paths allow users to visually leave the surrounding dense suburban fabric and immerse themselves in a 'nearby nature' or 'wild' experience. Low water bridges further encourage interaction with the drainageway and thus the larger ecosystem. The bridges are designed without handrails and are low enough to allow children and adults to touch the water or dangle their feet in the stream. The bridges are low enough to provide a strong visual and perceptual experience of the stream and its elements: water flowing, wildlife habitat, plant communities, water reflection, etc. The bridges and paths punctuate the larger drainageway restoration, providing an experiential interface with the ecosystem. Because the paths and bridges function to provide space for high demand contemporary activities, they promote a frequent interaction with this ecosystem and its multitude of variances throughout the seasons.

George Wallace Park both is the most successful public space created in documented Wenk Associates work and the least successful in meeting the overall objective of "reconnection and interaction with ecosystem." It is highly successful because it provides a vibrant language of form for public space. The public space elements are prominent features of design and not some afterthought tacked on beside the larger drainageway restoration project. The spaces created for users are almost in the stream—one can sit on a dragon's tooth structure and have feet and hands in the water while listening to the sound of falling water as it moves through the baffle chute drops. The baffle chute drops and dragon's teeth structures highlight water and express the eloquent sculpture of water's movement and inherent evocative qualities. Because it is a real drainageway, people are connected physically and perceptually to an ecosystem element.

Where Wallace Park falls short is that the reconnection and interaction which do occur because of this innovative design are not within a restored ecosystem. Thus the experience of a drainageway and its connected ecosystem replete with diverse plant and wildlife habitat is not provided. The language of this design however provides fabulous principles to draw upon in future design. The direct and integral public space design in this park provide a rich typology of form which would interface well with a restored ecosystem.

Enhance and Preserve Regional Identity
This aspect of contemporary theoretical design strategies is perhaps least present in Wenk Associates' work. George Wallace Park uses symbols of the larger region which are fixed in
concrete: native stone along some portions of the walkway. Because the Denver plateau is a high plains prairie, it does emulate this ecosystem in a symbolic sense by ample open space. However most of the design language is drawn from human influenced architecture and art rather than larger geologic, climate, or native plant communities.

Horseshoe Park before urbanization was not a wetland, but rather a simple stream with trees and shrubs concentrated along its banks. Construction of a major highway which originally created the wetlands. A second human intervention—channelizing the stream for flood control—destroyed the wetlands. Ironically it was citizens who wanted the human created wetlands back which is what Wenk Associates' design achieved. While wetlands are not native to this landscape, they do provide a habitat for native plant communities and wildlife. In this sense, the design does operate to express the larger region and promote regional identity in an unconventional manner.

Shop Creek is also a created wetland in a high plains prairie where a wetland has not existed in the known past. However wetlands work well to purify water, create habitat and reduce erosion and so the functional aspects of the scheme work well within programming requirements. Transplanting species from on site preserved the gene pool and thus promotes regional identity through planting schemes. The resulting wildlife habitat also assists to express regional identity by providing habitat for native species. Overall however, the wetland and detention basin elements of this design have little to do with the region and thus are not integral in promoting regional identity.
## CRITERIA AND PROJECT SUMMARY

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<td><strong>HORSESHOE PARK</strong> 1985</td>
<td>• Restoration of Meanders</td>
<td>• Paths Punctuating Restored Ecosystem</td>
<td>• Native Plant Communities</td>
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<td>• Created Wetland</td>
<td>• Low Water Bridges</td>
<td>• Resurfacing Drainageway</td>
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<td>• Native Plant Communities</td>
<td>• Signage</td>
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<td>• Low Water Bridges</td>
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<td><strong>SHOP CREEK</strong> 1986</td>
<td>• Restoration of Meanders</td>
<td>• Paths Above Restoration Area</td>
<td>• Native Plant Communities</td>
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<td></td>
<td>• Created Wetlands</td>
<td>• Benches Above Restoration Area</td>
<td>• High Prairie Landscape Preserved</td>
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<td>• Detention Basins</td>
<td>• Signage</td>
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<td>• Crescent Drop Structures</td>
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<td>• Native Plant Communities</td>
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### Summary

Consideration of Wenk Associates' work through contemporary theoretical criteria reveals several important lessons. George Wallace Park, while doing nothing to promote ecological restoration, does offer highly successful and innovative ideas for integration of public space into an urban drainageway. Two documented projects successfully restore the ecosystem using nature as a model while transcending overt imitation of natural form for restoration. They thus offer new research into form based on nature which simultaneously expresses the human cultural elements within ecosystems. In this respect Wenk Associates work communicates a more
symbiotic human/ecosystem relationship. While their work does little to promote regional identity, it does evidence use of landscape form (wetlands) which operate in conjunction with native plant and animal communities. In this respect, the work advances new ways of approaching restoration which includes a diverse, imaginative palette of possibilities.

Public space within documented projects, with the exception of Wallace Park, falls short of advancing new forms and order to interpret and promote a relationship between people and nature through interaction with the ecosystem. The same pattern found in Andropogon's work is found here: traditional public space elements are tacked on to a larger scheme and are not effectively woven into the larger ecosystem restoration.

The most successful aspect of Wenk Associates' work is that of deriving fresh, creative expressions of a possible symbiotic relationship between people and the ecosystem. Their work, particularly Shop Creek and Wallace Park, advance new ways of expressing this potential relationship and thus operate to promote this relationship.

Wenk Associates' work underscores gaps in contemporary theory identified in Andropogon's case study. Contemporary theory must push beyond mere suggestion of using nature as a model and begin advancing research which describes new forms based on natural function. These forms must continue to repair the ecosystem and create public space, while advancing a new language of form, expressive of the needed relationship between people and the ecosystem scholars seek. Only in this way can theoretical ideas become physical constructive elements within the landscape. This perhaps is the bridge between theory and practice. Theoreticians are in one camp talking about needed design strategies and practitioners are in another talking about design, construction and technology; a more active dialogue would promote not only cognition of new design strategies, but means to physically achieve the ideas in form. In this respect this thesis has been a bridge between theory and practice and revealed missing links in both.
CONCLUSIONS

Teams of ecologists, landscape architects, and engineers have now produced enough good examples of success in water conservation, reuse, aquifer recharge, flood control, recreation, and wildlife enhancement that the old, non-sustainable planning methods and overly hardened engineering solutions typical of the last 50 years now seem absurdly unsatisfactory.

Robert L. Thayer, Jr.

Alternative drainageway design has the potential to restore ecosystems; create vivid public space linked to the ecosystem; reinforce regional identity; and provide diverse recreation opportunities. While a range of projects in two case studies have shown innovative solutions to some of these issues, none meet rigorous multi-solution demands forwarded in contemporary theory (see Literature Review, chapter 2). Case studies of Andropogon Associates, Ltd. and Wenk Associates exhibit numerous public space and ecosystem restoration accomplishments including use of water as an ordering element in master plan design and employing cutting edge technologies to successfully repair ecosystem damage. While their work fails to address within a single project all criteria advanced in contemporary theory, within the body of each designer’s work all criteria are represented. Conversely, contemporary theory fails to advance research and thought into areas which the case studies have explored. Through this thesis’ dialogue between built work and contemporary theory a cogent framework can be advanced to guide twenty-first century drainageway design. A brief analysis of each case study is presented followed by critique of current theory based upon reviewed work.

Andropogon Associates, Ltd.

Restoration of the ecosystem using nature as a model is the most successfully met criteria within the work of Andropogon. Their work advances innovative techniques for ecosystem restoration including: bioengineering, porous pavement, infiltration beds, native plant communities, and restoration of meanders. However their work does not transcend the mechanics of restoration. Their restoration efforts are not effectively woven into public space design and thus dynamic, restored ecosystem elements remain transparent and divorced from public interaction in their work. Because restoration form is hidden (infiltration beds) or made to blend in with the surrounding landscape (restoration of native plant communities, subtle grading), opportunities are lost for exploration and derivation of a formal typology which might restore the ecosystem and express a symbiotic relationship between people and ecosystem.

Reconnection and interaction with the ecosystem within documented projects is not actively directed. While vibrant restoration projects have been sculpted, little opportunity for experience of these places is provided to users of the projects. Restored native plant islands are plopped into a corporate landscape and a path winds beside the island, never entering it. In another instance,
a stream is restored within a highly public landscape (Trexler Memorial) using 50,000 native perennials, however no opportunity was designed for people to move within the restoration to fully experience its vibrant texture and color.

Enhancement and preservation of regional identity occurs by default in the projects reviewed. Andropogon is committed to preservation of native ecosystems, particularly the eastern deciduous forest, and employ many techniques to achieve their goals including: native plant community plantings, restored native landscapes, removal of exotic invasives, and resurfacing drainageways. However with the exception of granite pavers in Morris Arboretum, enhancement of regional identity in their work stops at ecosystem restoration and does not engage elements of cultural expression or context, an integral component of regional character.

In summary, Andropogon’s work goes far to advance new techniques for ecosystem restoration using nature as a model, however opportunities to actively engage people in restored ecosystems, derive new forms within restoration techniques, and express cultural context and contributions to the landscape are missing. As a result, Andropogon fails to fully express and promote a seamless, symbiotic relationship between people and ecosystem which contemporary theory seeks.

Wenk Associates
Wenk Associates’ work also employs a diverse palette of techniques to restore drainageway ecosystems and provide public space for popular activities. Wenk Associates projects, with the exception of Wallace Park, are successful in ecosystem restoration using nature as a model. Their vocabulary of techniques is diverse and includes: braided wetlands, detention ponds, native plant communities, restoration of meanders, grading, drop structures, dragon’s teeth baffle chutes, and restoration of floodplains to detain floodwaters. The palette of techniques are not only diverse but the form of the techniques transcend their function and are expressive architectural works.

The forms for the most part are contextually appropriate while expressing human contributions to landscape architecture. Within George Wallace Park, drop structures slow water, dissipate velocity, and are modeled after forms found in nature. The geometric sculptures provide successful public spaces and are responsive to the surrounding built fabric. Shop Creek also transcends function and modeling after nature. The forms were derived from a canyonlands landscape, far from the site. They slow stormwater, create wetlands and detention basins for
water purification and fit well within the state park setting of high prairie. Whereas in Andropogon's work much of the interventions are transparent, seamlessly blending into the surrounding landscape, Wenk's crescent shapes are expressive human sculpture. There is no mistaking these forms were shaped by people; they are effective expressions of human cognitive abilities. Additionally they begin to derive a new typology of form which express ecosystem vibrance, restores the ecosystem, and are expressive architecture as well. Wenk Associates has created forms which mimic the function of natural form, while expressing site context and drawing from a diverse, eclectic typology found in the cultural landscape fabric.

Wenk Associates achieves varying levels of success within documented projects for reconnection and interaction with the ecosystem. The highly successful Shop Creek restoration fails to integrate public space within restoration aspects of the project. Benches and trails are placed high on a ridge overlooking the restoration, but only a horse trail actually passes through the restored ecosystem. The crescents are aesthetically sound sculptures which create a dynamic space, however no opportunities are provided for people to experience these spaces in a directed, actively designed manner. While the amenities provided do respond to contemporary preferences of activity (jogging, walking, bicycling), these activities are not placed close enough or within the restoration in order to effectively weave the two together. By a more deliberate placement of these structures within the restoration project, a relationship between people and ecosystem would be encouraged and an understanding of the ecosystem inclusive of people advanced. Horseshoe Park achieves greater success in integrating public space into the restored ecosystem. Paths wind through thick groves of native plant communities and low water bridges allow users to interact with the water. These amenities allow popular activities to occur within the ecosystem, thus promoting frequent interaction and reconnection. While George Wallace Park is by far the most creative public space linked to a restored drainageway, the restoration stops at resurfacing the waterway. The waterway is a concrete tunnel with mown grass along its edge. No native plant or animal communities are restored or encouraged by this scheme. So while the public space is dynamic, it does not promote interaction with a diverse ecosystem only a manipulated drainageway.

Ecosystem restoration in their work often relies on creating systems completely non-native to the site, as a result, expression of regional identity occurs not through dogmatic, imitative design. Within Shop Creek and Horseshoe Park created wetlands did not exist on these sites. Because they are effective for controlling flooding and purifying water, they were part of the restoration design. A result of these projects is provision of a place where native plant and animal
communities can re-establish themselves. Thus, the projects have shown regional expression can occur by creation of form not inherent in the native landscape. Wenk Associates’ projects evidence a range of innovative approaches which advance a landscape of function and architecture without overt imitation of natural form.

In summary, Wenk Associates’ work includes fabulous examples of ecosystem restoration, derivation of forms which serve multiple purposes, while creating vibrant public space. Both public space within Wallace Park and the form of restoration design within Shop Creek advance an architecture of symbiotic relationship between people and the ecosystem. However no one project successfully combines all criteria advanced in contemporary theory. The work does provide exceptionally articulate visionary examples of each criteria in separate projects. Ideas from several projects could be successfully combined within a single design scheme to actualize all criteria and thus address pressing issues of the contemporary landscape.

Summary

Andropogon Associates, Ltd. & Wenk Associates

The most noteworthy success within both firm’s work is ecosystem restoration. Dynamic, vibrant ecosystems are created by their restoration efforts comprised of a rich ecology of plant and animal communities. However the fundamental flaw of both firm’s documented projects is failing to effectively weave restoration into public space within the larger master plans. An important opportunity is lost to express the order and texture of the ecosystem to users of the projects. Consequently, interaction and thus experience of these systems is diminished and provided only in a tacit manner through signage, demonstrations, and improperly placed benches and paths. A scenographic experience of the landscape and larger ecosystem is perpetuated. No one project within both case studies effectively combines all criteria within a single design scheme, they do serve as cogent resources for development of a twenty-first century alternative drainageway design framework. Concepts derived from several projects can be developed into a design strategy which can guide future work to successfully merge the suggested criteria into a single design scheme.

Just as Andropogon Associates, Ltd.’s work pushed current theory to include new technologies in use of nature as a model, Wenk Associates pushes theory to include human expression and cultural context as part of forms derived from nature. Herein lies the strength of each designer: Andropogon’s lies with innovative technology to repair and fit within natural systems, and Wenk
Associates' lies within use of innovate form to repair the environment, create effective public space, and express twentieth century culture at once.

Successes

**Andropogon**

- Innovative restoration technologies modeled on nature
- Preservation of the eastern deciduous forest and other native landscapes
- Well researched environmental ethic and knowledge base
- Dogmatic adherence to regional ecosystem restoration
- Projects tied to larger environmental patterns (ex. bird fly-ways)
- Ecosystem restoration using native plant communities

**Wenk**

- Advancement of form to express human/nature balance
- Ecosystem restoration and public space interface within Horseshoe Park
- Derivation of new forms, based on natural forms' function, to solve functional problems and express human cultural contributions to landscape
- Dynamic public space created in George Wallace Park which abates flood damage

Failures

While both firms employ techniques and derive form based on nature, an exploration into new form is not advanced far enough. Wenk has achieved the most success in this arena through George Wallace Park and Shop Creek. Form within Andropogon's work is a transparent layer, albeit a functioning, restorative layer, within the larger projects. Opportunities to express a symbiotic relationship between people and nature and to advance a holistic notion of an ecosystem inclusive of humans are thus missed. Based upon critical analysis of the bodies of work chosen for review and subsequently analysis of criteria for a new design strategy, the following conclusions are drawn.

**Theory**

The work of Andropogon Associates, Ltd. and Wenk Associates advances theory in the following ways. Contemporary theory generalizes a concept of ecosystem restoration using nature as a model, but falls short of suggesting methods based on innovative twentieth century technologies. Andropogon's work goes far to advance new technologies (porous pavement, underground recharge beds, bioengineering), while modeling them on nature. A more diverse palette of techniques would be available with more rigorous research into the mechanics of using nature as a model.

While many scholars lament and call for human reconnection to the ecosystem, few promote mechanisms to achieve this state. Their discussion instead focuses upon what existed in the past, and current rifts between the built fabric and ecosystem. Carefully selected and critiqued
examples of how this relationship might be cemented and is being achieved would encourage transcendence from theoretical musings to actual concrete form and methods to achieve effective interaction.

Within enhancement and preservation of regional identity and increase of landscape legibility, once again, contemporary theory is eager to discuss what used to exist, how it has been paved over, and what has been lost. Where within their discussion are examples of designers who are successfully retrieving and employing regional patterns to promote a vibrant landscape legibility? Examples and research into built form possibilities would advance a vocabulary to enhance and preserve regional identity.

In summary, a rift exists between built work and theory, and with greater dialogue between the two: designers reading theory and theoreticians looking at built work, innovative techniques and subsequent form could be realized. This study has identified the following areas in contemporary theory in need of exploration.

1. Advance research into expressive form, not merely based upon nature as a model, but one which expresses a given culture, is functional, restores the ecosystem, and creates a public space interface with the ecosystem. Overlap function (both ecosystem restoration and public space) with expressive form.

2. Move beyond a generalized call for a ‘new aesthetic’ to investigate in detail what this design strategy might look like. Critically discuss built work and derive form based upon critique.

3. Give examples of how reconnection between people and ecosystem might be advanced. Are there examples which operate to create public space, reconnect people to the ecosystem, restore the ecosystem, and enhance regional identity simultaneously? This thesis sought work of this nature and was unsuccessful within the case studies chosen. A more active dialogue between practitioners and theoreticians would advance work which merges these issues into single design strategies. For example, within a theoretical discussion, investigate, present and critique built work to substantiate ideas. This would derive ideas for form in a way mere verbal bantering cannot achieve.

A framework for twenty-first century drainageway design based upon conclusions in this thesis includes the following directives.

1. Ecosystem restoration and design of public spaces created in conjunction with and in congruence with one another. Through symbiotic design, a fresh understanding of the integrative holistic function of ecosystems can be forwarded. Weave public space and restoration together; integrated elements of overall scheme.

2. Employ cultural patterning and context and materials along with ecosystem restoration elements.

4. Use nature as a model for form and function within design, utilizing innovative technologies derived from modern technology.

5. Forms derived from nature solve functional issues while doubling as an expressive architecture of human cultural contributions to the landscape. Transcend typical amenities and afterthought add-ons: bench, path, bridge, planting islands.

6. Overall objective: seamlessly integrate public space and ecosystem restoration while benefiting both.
IMPLICATIONS

This thesis clearly indicates discrepancies in contemporary theory and alternative drainageway design projects through cross-comparison. It has been demonstrated that built alternative drainageway design meet in part suggested criteria of contemporary theory. Alternative drainageway design has the potential to not only actualize criteria in contemporary theory but to expand contemporary theory through practice. However much research is needed to follow this report in order to make the information functional to decision makers and to further develop rudimentary theories suggested by the research. Some of the following are implications for further research suggested by this thesis.

1. Research on users within alternative drainageway design would clarify assumptions made in this thesis about these projects’ success or failure to promote reconnection and interaction with natural systems. Questions to be answered in the research might address: Have users’ understanding of natural processes and ecosystem interconnectedness been expanded? Do they feel a deepened connection to the ecosystem by daily interaction? Have conservation/preservation efforts been inspired by the projects (as was seen in Andropogon’s Applebrook Research Center)? These are important questions. Answers would further refine the responsiveness of alternative drainageway design to human needs and activity preferences and their understanding of what is at work in an ecosystem.

2. To further clarify the responsiveness of the design project to user needs, the users should be observed within the space. Behaviors recorded could indicate whether amenities and features of the design project were actually meeting the desired uses of the space. This research could be modeled on the ground-breaking work of William Foote Whyte’s plaza studies.

3. To solidify the future employment of alternative drainageway techniques, a compendium of described techniques associated with this design method needs to be compiled. The format should be user-friendly, to be used by city and town planners, developers of housing properties, parks and recreation departments, homeowners associations, and the individual citizens. By disseminating practical information on how to implement alternative
drainageway design, needed changes in drainageway design might begin to facilitate restored public landscapes. A suggested format would be to correlate techniques and outcomes with detailed implementation information.

4. This thesis has compiled only a few projects from a vast array of built works which accomplish suggested criteria and advance other important aspects such as expression of the evocative, eloquent aspects of water within a functional drainageway or stormwater management design (see the work of Richard Hansen). Further research might focus on one subject and illustrate it through case study presentation: regional identity, reconnection to ecosystem, interpretation of processes/techniques, expression of a new aesthetic, design which promotes daily interaction, and models which focus upon using nature as a model and low energy inputs (ex. Center for Regenerative Studies at CalPoly, Pomona - John Tilman Lyle, or John Todd's work in Providence, RI). Clarification of how these components are facilitated across a diverse range of projects would assist to implement and promote their application.

5. This thesis revealed that many of the more successful alternative drainageway design projects employed community input and interdisciplinary design teams from the outset. This area needs to be further developed, with detailed studies on how community input and interdisciplinary teams were facilitated and how it affected success of the final project.

6. Regional identity of place was suggested as an important criteria, achieved with some success in the San Antonio Riverwalk. Research might be done to correlate tourism information and resident description of their home town or city with the drainageway design projects. This information would clarify the importance of this design method for overall regional identity and satisfaction of place. Analyzed information might include articles in the local newspapers, tourism information at local chambers of commerce, signage and symbols of the city, and survey information taken from nearby residents and users of the projects.

7. A design thesis based upon the framework derived in this study would illustrate how alternative drainageway design might be implemented.
8. The historical chronology suggests a relationship between design and beliefs of its day. For example, historic precedent illustrated design as an intimate part of civic space; beliefs of the day include the presence of water in myths of creation and the importance of water as a life-giving element in belief systems. More subjective studies need to be done to correlate how attitudes toward nature or the ecosystem have been altered by design or how design has been affected by changing attitudes. Data could include analysis of creation myths over a period of time and description of surviving archaeological record of water design from the periods.

9. In a similar vein, analysis of the influence of technology on water design might reveal why water in the nineteenth and twentieth centuries became relegated to underground infrastructure and placed in channels. Early water design (2000 - 400BC) was massive in scale and sophisticated in technology. Research for this thesis indicates that nineteenth century water design technology was originally viewed as an interconnected web of the city, like arteries in the body. However as water remained underground and in channels, these holistic views were diminished. How were the views changed, were they independent of technology or did technology influence their changes?

10. The research indicates most people have exposure only to fragments of the larger ecosystem: suburban lawns, parks, plazas, tree allees and courtyards. Integrated ecosystems within the built fabric are unusual. How has limited exposure affected attitudes and understanding of the ecosystem? A comparative study could be done between an inner city population with little exposure to ecosystems and a population near an alternative drainageway project. This information might indicate the level of influence the ecosystem has on beliefs, understanding, and overall social and psychological health of populations.

11. Correspondingly, how have people's spiritual beliefs been affected by lowered interaction with the ecosystem? Is there a direct relationship between fractured spiritual beliefs today and the fractured environment? In the same genre, how have changing attitudes toward God and a spiritual life been influenced by people and events and have these changing attitudes then influenced human interaction with the ecosystem? (Socrates, Aristotle, Copernicus, Galileo, John Locke, Descartes, Newton, Industrial/Scientific Revolutions, Nietzsche, Heidegger)
12. Other studies are suggested to confirm conclusions and derived framework in this thesis through compilation of a number of case studies of alternative drainageway design.

13. Because nature is used as a model and design element in many alternative drainageway design projects, comparison between chaos theory as a design model and alternative drainageway design as a model might reveal a more complex form vocabulary for design that operates functionally and appeals to human needs for complexity in the environment. How are chaos theory design methods similar or dissimilar to alternative drainageway design projects' physical form?
APPENDIX A  WATER DESIGN HISTORY

As an architect I try to be guided not by habit but by a conscious sense of the past—by precedent, thoughtfully considered.\textsuperscript{145}

Robert Venturi

I now believe that any study of an organization or community must be built on a firm historical base... Without historical data, our theories of development and change are bound to be faulty.\textsuperscript{146}

William Foote Whyte

Early water design remained integrally connected to public space and employed advanced technologies for water purification and diversion. Because sophisticated earth excavation methods had not yet invented, water design remained integrally linked to public space. As such, water design continued to embody connection to the hydrologic regime and important stature in public space; these conditions promoted values of water as a life-giving, essential resource for life. The evolution from this state to twentieth century conventional water design that removes water from public space and has numerous detrimental outcomes is traced through the following historical chronology.

Pre-Twentieth Century Water Design

8000-1000BC

Alternative drainageway design is part of a long, diverse history of functional water design that began approximately 10,000 years ago. Manipulation by people of water marked the end of a 4.5 billion year inseparable relationship and coevolution between water and landscape.\textsuperscript{147} In 8000BC a shift occurred in human habitation from hunter-gatherer (nomadic) to sedentary cultivator (rise of city/state). Sedentary dwelling sites required water for domestic and agricultural supply; this need prompted the first manipulation of water—narrow ditches that guided water into the floodplain. These ‘designs’ were crude but revolutionary, beginning and changing the course of habitation.\textsuperscript{148} Thus water accessibility determined where ancient towns were located, and it was along great rivers that the first civilizations appeared: the Tigris and Euphrates rivers in Mesopotamia; the Nile in Egypt; and the Huang He, in China. The river dictated dwelling sites because it produced productive lands, ample water, transportation routes, energy source, and abundant wildlife and plants—all conditions humans were dependent upon. Cultivation of

\textsuperscript{147} John Tillman Lyle, 1994, Presentation at ASLA Convention, San Antonio, October.
\textsuperscript{148} Lyle, ASLA Presentation, October, 1994.
plants and animals led to the first human intervention in the watershed: overgrazing and soil erosion that led to pollution, flooding and silation of rivers.  

Cultivation of plants led to the second intervention: irrigation of crops. Irrigation works existed in prehistoric times (5000 BC - Egypt). As early as 3000 BC, Joseph's Well in Cairo was 295' deep, and water was harvested by a chain of buckets pulled by oxen to the surface. In 2000 BC Babylonians and Egyptians built canals and dams on the Euphrates and Nile rivers to control floods and provide irrigation. The Sumerian civilization had extensive irrigation for fields, as did the Chinese and Peruvians (1000 BC). The Indus civilization on the Indus river had running water in clay pipes, toilets and sewage systems as early as 2000 BC. In the United States the Native Americans irrigated 250,000 acres of land in Arizona before Europeans arrived. These simple structures changed the world: humans were now able to manipulate the environment and began to establish advanced civilizations.

**400BC - 1600AD**

The Romans had the most extensive system of aqueducts in the ancient world [India and Mesopotamia also had aqueducts, and Persia had qanats (runnels)], carrying as much as thirty-five million gallons of water a day from mountain slopes to cities. They were the first to engineer water treatment systems: a series of aqueducts transported water from the mountains into the city where it was purified in settling basins and filters along water mains. In 690 AD China had a grand canal with water level regulated by log gates. As early as 1502 Leonardo da Vinci proposed diversion of the Arno River in Italy into a canal. Florence would gain a navigable channel and Pisa would lose its river. Leonardo's illustrations were never implemented but his plan is an important example of economics driving river manipulation and design in early history.

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In the middle of the sixteenth-century, the force pump was invented in England; this allowed for creation of water supply systems; and in 1562 the first pumping waterworks was completed in England. Water from the Thames River was pumped to a reservoir 120' above the river; from here gravity allowed distribution through lead pipes to buildings. In the 16th century, the city of Venice publicly controlled a lagoon for flood control, maintenance of tidal flow to cleanse the lagoon, security, and navigation. Many cultures manipulated watersheds in sophisticated methods and at a massive scale, for agricultural/domestic supply, and to allow dwelling and cultivation far from water sources. Most of these systems remained united with the hydrologic regime and its connected landscape system, and continued to occupy important civic space. These early water designs thus connected humans to the hydrologic regime and expressed water's value in public space.

1700-1900AD
Modern industry began in early 1700s and late 1800s with transportation networks (canais and railroads). These were followed by sewers, stream pipes, water mains, telephone lines, subways, and electrical cables in the late 19th century. These developments were made possible by earth excavation tools that allowed engineering for major earthwork construction. In 1760 the first municipal pumping station in the United States was constructed in Bethlehem, Pennsylvania with pipes made of bored hemlock logs and a wooden pump; by 1800 a few United States cities had water-supply systems. With the rise of industrialism in the 19th century, engineering became the dominant force within the built environment at an ever increasing scale. With resource demand in factories escalating, their pollution increased, many times ending up in the rivers that provided their water supplies for industry. In 1850 a large scale water works infrastructure was installed underground in Paris. In the late 19th century a few sanitarians, landscape architects, and engineers viewed the city and its related infrastructure as a unified, interdependent system: "a vast, integrated unit with the efficient functioning of one part dependent upon the efficient functioning of all parts." As engineering works escalated in scale and became increasingly severed from public and natural landscapes in the twentieth century, the interdependence of city functions were separated from one another as well.

20th Century Water Design

Today the hydrologic cycle has escaped song and been broken into disciplines, categories, books.

Charles Bowden
Killing the Hidden Waters

While the scale of environmental modification is not new, the extent is unprecedented. Because of the extent and single-solution directive of modern (19th/20th century) engineering works, dilemmas have ensued: flooding, water pollution, loss of wildlife and plant habitat, lowered groundwater and aquifer levels, and erosion have occurred. These problems have occurred throughout the watershed, at all scales. Poor stormwater management design begins the destructive cycle of detrimental affects, which ultimately affect the entire watershed. The largest scale intervention in the watershed is the hydro-electric dam.

Dams & Levees
The largest scale manipulation is symbolized by enormous hydro-electric dams and their ensuing affects can be devastating to the environment and human dwelling. At the close of the nineteenth century the town of Marysville, California had built higher and higher levees to protect themselves from the increased siltation and flooding of the Yuba river, caused by hydraulic mining in the Sierra Nevadas. In 1875, the river flowed over the levees and filled the city with silt. The Aswan High Dam in Egypt was completed in 1960 and impounds one of the largest reservoirs in the world; since its completion the government has had to invest considerable finances to prevent salt deposition in the Nile Valley, once removed by annual floods. In addition waterlogging of soils, disruption of the long-standing water balance, and upstream silting has occurred. More recently in 1993, the Mississippi River flowed above levees all along its length, causing evacuation of 31 thousand people, flooding of 7 thousand homes and ten billion dollars in damages. This flooding was not an exclusive result of human activities, but the extent of damages increased because of levees, dams, and dikes. These examples indicate that human intervention which attempts to control the hydrologic process, results in exaggerated impacts to the entire watershed. The magnitude of these natural system disturbances is unparalleled; water systems removed from the hydrologic continuum and contained in elaborate

156 Rosalind Williams, p. 2.
infrastructure systems deplete water resources, deprive former landscapes of water’s benefits, create ground instability, cause flooding, and eliminate or reduce wildlife and plant habitat.

**Drainageway Design**

Many United States cities receive their water supply from extensive aqueduct systems: water is diverted hundreds of miles from its source in channelized infrastructure to supply cities. The Owen’s River is piped above its now arid landscape to supply 25% of Los Angeles’ water, and the Colorado River no longer empties into the Gulf of California because of diversion to supply Los Angeles.¹⁶¹ The most dramatic of diversions in the United States is the Colorado River that supplies Los Angeles (242 miles) 1 billion gallons of water per day.

Channelizing streams, rivers and stormwater courses attempt to contain flood volume and eliminate erosion caused by floodwaters. In actuality, these single-solution measures cause additional problems and exaggerate damaging conditions. A channelized water body is removed from the landscape, bypassing infiltration and irrigation and increasing water volume and downstream flooding. The friction coefficient of cement is very low, especially compared to replaced vegetation mass; this results in increased velocity—causing extensive flood damage. Lastly, because water is not infiltrating into soil, a natural filter, pollutants intensify in water bodies and reach harmful concentrations. Conventional channelization design destroys habitat for plants and animals and prevents deposition of topsoil in the floodplain—potentially prime agricultural land and an ideal corridor for wildlife and native plant communities.

Stormwater management attempts to alleviate flooding caused by dense development in the watershed and floodplain. Many cities in the United States have been devastated by floods because of upstream and floodplain development and poor stormwater management. The river is the primary system of the watershed and stormwater the secondary system; as such, they comprise the basic components of drainageway/stormwater design. Because the health of many rivers has been lost, their functional aspects have failed, causing devastation and pollution. These problems are exacerbated by current stormwater management practices. Stormwater management has far-reaching affects on the larger watershed(s) if the design is working against the function of the overall watershed. Anne Whiston Spirn describes these ‘management’ practices’ shortcomings:

Most of these models however consist of solutions to a single aspect of the water problem: either storm drainage and flood control, sewage water treatment, or water supply and conservation. . . . a few model(s) combine storm drainage, flood control, water quality, and water conservation in a single scheme (ex. Woodlands, TX).\textsuperscript{162}

The outcome is a by-passed hydrologic cycle that eventually is inundated by damaging water levels, velocities, and pollutants. Robert Thayer lists the problems of technology-based stormwater management:

1. Hardened surfaces mean the water has little chance of returning to earth near where it fell, thereby depriving the local groundwater of its ability to naturally recharge.

2. As water accumulates from all the other roofs and streets and flows through hardened pipes and channels, it has more volume and higher speed, creating higher flood dangers.

3. Since most of this path of urban stormwater runoff is in artificially impervious channels, few organisms, plants, or animals will benefit from or share use of this water while it is being conducted away from people.

4. Being largely out of human vision, the public gets little or no visual feedback as to the multifaceted role of water in sustaining ecosystems and other life forms.

The detrimental consequences of modern stormwater management are multiple: Increased flooding, dropping water levels, impoverished ecosystems, less diverse visual environments, and worst of all, a deadening of the public's perception of where they are in relation to the natural world.\textsuperscript{163}

\textsuperscript{162} Spirn, p. 143.
\textsuperscript{163} Robert Thayer, Jr., p. 261.
WATER DESIGN TIMELINE

Vitruvius
'Commodity, Firmness, and Delight'
1st Century
Roman Aqueduct

2nd Century
The rulers of Babylonia and Egypt constructed systems of dams and canals to impound the flood waters of the Euphrates
and Nile rivers, controlling floods and providing irrigation water throughout the dry. Such irrigation canals also
supplied water for domestic purposes. The first people to consider the sanitation of their water supply were the ancient
Romans, who constructed a vast system of aqueducts to bring the clean waters of the Appenine Mountains into the city
and built settling basins and filters along these mains to ensure the clarity of the water.

Aristotle
3rd Century
Division of disciplines; metaphysics;
science is empiricism & formalism

Renaissance - humans are the
measure of all things
14th Century
Galileo (1564-1642), Italian physicist and astronomer,
who, with the German astronomer Johannes Kepler,
initiated the scientific revolution that flowered in the work
of the English physicist Sir Isaac Newton

Math = Divinity
15th Century

... mathematical principles according to which the corporeal world was to be created are co-eternal with God, that God is the soul and
mind in the most supernaturally true sense of the world. 1598 (James Corner)

16th Century
Invention of the force pump in England in the middle of the 16th century greatly extended the possibilities of
development of water-supply systems. In London, in 1562, the first pumping waterworks was completed; it pumped
river water to a reservoir about 37 m (about 120 ft) above the level of the Thames River and from the reservoir the water
was distributed by gravity, through lead pipes, to buildings in the vicinity.

18th Century
Scientific Revolution
... the contemporary crisis of meaning is due in
large part to the epistemological break with
tradition during the 18th century. (James Corner)

The first municipal pumping station in the U.S. was erected about 1760 to supply water to the town of Bethlehem,
Pennsylvania. It consisted of a 13-cm (5-in) wooden pump that raised the water about 21 m (about 70 ft) through pipes
made of bored hemlock logs.

Industrial Revolution
19th Century
By 1800 some 15 U.S. cities had water-supply systems, and since that time almost every city and town in the country has
been provided with municipal waterworks, most of them publicly owned and operated. In addition to the municipal
systems, many state and federal developments provide water for irrigation, industrial, or domestic uses as a by-product
of navigation control, hydroelectric-power generation, and flood control.

20th Century
The existential purpose of building (architecture) is therefore to make a site become a place, that is, to uncover the meanings
potentially present in the given environment. Norberg-Schulz.

In early 20th century it was no longer required that art be imitative of nature or symbolic in its mediation between the mutable and
the eternal. James Corner

Drainageway design framework developed from built projects and 20th century theory review.

1950s-60s
San Antonio Riverwalk
Woodlands, TX
Village Homes, CA

1980s-90s
Andropogon - Philadelphia
Werk Associates - Denver

21st Century
NEW DESIGN STRATEGIES include:
ecosystem restoration, reconnection with
ecosystem, & enhanced regional identity.
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