EVALUATING THE AESTHETIC AND AMENITY PERFORMANCE OF VEGETATED STORMWATER MANAGEMENT SYSTEMS

by

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A REPORT

submitted in partial fulfillment of the requirements for the degree

MASTER OF LANDSCAPE ARCHITECTURE

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2012

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Abstract

Stormwater management within the urban context has evolved over time. This evolution has been categorized by five paradigm shifts. (Novotny, Ahern, & Brown, 2010) The current paradigm of stormwater management utilizes hard conveyance and treatment infrastructure designed mainly to provide protection for people from typical 1-5 year frequency storms. Consequently, this infrastructure is sometimes unable to deal with larger sized, 50 to 100 year events which can have serious consequences.

Manhattan, Kansas has suffered multiple flooding episodes of severe proportion in the past decade. The dilemma of flooding within the Wildcat Creek watershed is a direct example of the current paradigm of stormwater management. This once ecologically healthy corridor is fed by conveyance systems that do not address the hydrologic needs of the watershed; decreasing the possibility for infiltration and groundwater recharge. Vegetated stormwater management systems must be implemented to help increase infiltration and address flooding problems within the Wildcat Creek watershed.

The aesthetic performance of designed landscapes has a tremendous effect on the appreciation and care given to them by the surrounding population. (Gobster, Nassauer, Daniel, and Fry, 2007) Landscape architecture has the ability to aid in the visual appeal and ecological design of vegetated stormwater management systems (SMS) by utilizing existing frameworks that address aesthetic reaction of the outdoor environment. (Kaplan, Kaplan, and Ryan, 1998) This document evaluates design alternatives of vegetated SMS in order to discern a set of variables that inform the relationship between each systems aesthetic and amenity performance and their ecosystem and hydrological performance.

Identified variables are combined into a set of guidelines for achieving different levels, or patterns of aesthetic performance found within the Understanding and Exploration Framework et al. (Kaplan, Kaplan, and Ryan, 1998) and amenity performance listed by Echols and Pennypacker's Amenity Goals et al. (2007) through vegetated SMS. These design guidelines illustrate how aesthetic theory can be applied through ecological systems in order to increase the coherence, legibility, complexity, and mystery (Kaplan & Kaplan, 1989) of existing sites. Creating spaces where ecological and socio-cultural activities can coexist addresses the local characteristics of aesthetics with the universal dilemma of stormwater management.

evaluating the **aesthetic** and **amenity** performance of vegetated stormwater management systems

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2012 Master Project
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acknowledgements

I would like to thank these specific individuals:

All of the talented professors that influenced and guided my scholastic career, especially my master committee: Dr. Timothy Keane for his guidance, patience, and sarcastic criticism that always provided a great deal of insight; Howard Hahn for his graphic insight and inspiration; and Eric Bernard for his encouragement and motivation throughout my masters process

My father for always encouraging me to work hard at everything I do in life, and never take anything for granted

My mother for always being there with a positive attitude about life, no matter what kind of problems came about

Allison for her patience and understanding

Russell for his countless answered questions and support in studio

My friends for the unforgettable memories, both inside and outside of studio

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The aesthetic performance of designed landscapes has a tremendous effect on the appreciation and care given to them by the surrounding population. (Gobster, Nassauer, Daniel, and Fry, 2007) Landscape architecture has the ability to aid in the visual appeal and ecological design of vegetated stormwater management systems (SMS) by utilizing existing frameworks that address aesthetic reaction of the outdoor environment. (Kaplan, Kaplan, and Ryan, 1998) Evaluations of design alternatives for vegetated SMS are utilized in order to discern a set of variables that inform the relationship between each system's aesthetic and amenity performance and their ecosystem and hydrological performance.

Identified variables are combined into a set of guidelines for achieving different levels, or patterns of aesthetic performance found within the Understanding and Exploration Framework et al. (Kaplan, Kaplan, and Ryan, 1998) and amenity performance listed by Echols and Pennypacker's Amenity Goals et al. (2007) through vegetated SMS. These design guidelines illustrate how aesthetic theory can be applied through ecological systems in order to increase the coherence, legibility, complexity, and mystery (Kaplan & Kaplan, 1989) of existing sites. Creating spaces where ecological and socio-cultural activities can coexist addresses the local characteristics of aesthetics with the universal dilemma of stormwater management.

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how to use this document

This book documents the process of evaluating vegetated stormwater management systems (SMS) on their aesthetic and amenity performance capabilities. Designs were developed for Frank Anneberg Park, Manhattan, Kansas in order to address possible solutions to help prevent flooding within the Wildcat Creek Watershed. Each design was assessed based on a framework for identifying patterns within a landscape, and a set of design goals for stormwater amenities. Each system location within the site of Anneberg Park utilized four design schemes to be evaluated. Each scheme illustrates different aspects of both the overall dilemma as well as the two identified frameworks.

The conclusions of these evaluations are utilized within a framework that suggests relationships between SMS structure and planting design, and the ability for these systems to perform aesthetically and as an amenity within the landscape.

The framework can be utilized to address three different perspectives, depending on the focus of a site design. Seeing as how no design dilemma is the same from site to site, it is important to provide a designer with the types of information that address solutions from different aspects. In addition, it is important to inform the designer of what can be expected of each set of criteria in regards to the other components of the framework. For example, if a design dilemma calls initially for stormwater management systems(SMS) on site, the framework will inform the designer as to what types of aesthetic performance patterns the system is best equipped to perform, as well as the amenity goals that support those patterns and inform the public as to the SMS importance within the landscape.

Figure 0.1 SMS Evaluation Relationship Diagram

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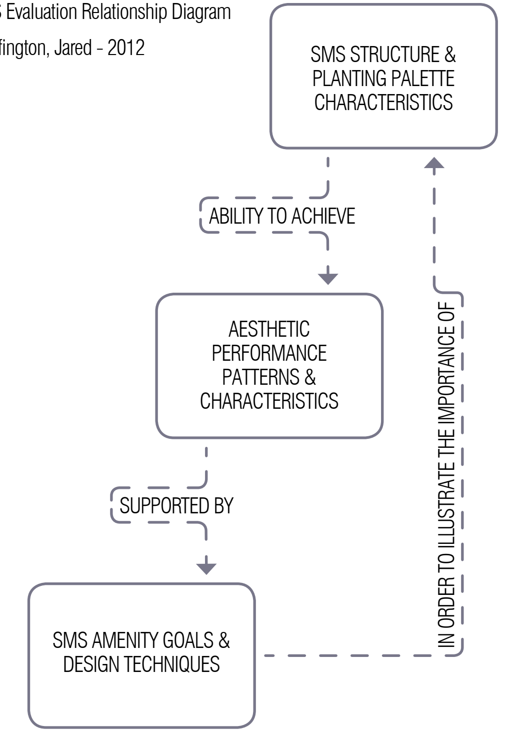

Chapter 01: Introduction, provides the dilemma and thesis that address both the needs of a local flooding problem within Wildcat Creek Watershed, Manhattan, Kansas, and a universal dilemma that deals with the negative aesthetic perception of vegetated stormwater management systems.

Chapter 02: Background - From Theory to Application identifies the topics that drove the research on human reaction within the landscape, the importance of an aesthetic-ecology relationship, and how stormwater management can facilitate an environmentally friendly interaction between humans and ecological systems. This chapter grounds the application of aesthetic and amenity characteristics within vegetated SMS in ecological, sociological, and aesthetic theory. This theory grounding justifies the utilization of each framework to identify associations between SMS and aesthetic performance patterns and amenity goals.

This portion of the book can be utilized to understand the basic characteristics of the Kaplan's information indicators: Coherence, Legibility, Complexity, and Mystery; the characteristics of Echols and Pennypacker's Amenity Goals: Education, Recreation, Public Relations, and Aesthetic Richness, and the basic theories that explain the perception that humans have on ecology and ecological systems.

Chapter 03: Design Evaluation Methods explains the methods used for SMS implementation and the evaluations of each system based on their aesthetic and amenity performance.

This portion the book familiarizes the reader with: landscape and design management patterns identified within the Understanding and Exploration Framework (Kaplan, Kaplan, & Ryan, 1998) and how they pertain specifically to SMS; the SMS Amenity Goals (Echols & Pennypacker, 2007); the types of SMS and their associated spatial, hydrologic, ecologic, and planting characteristics.

Chapter 04: Design Examples & Evaluations illustrates designs within Anneberg Park, a public park located within the Wildcat Creek Watershed, Manhattan, KS. The evaluations highlight each design alternative's planting scheme based on their aesthetic and amenity performance within the specific site context.

This chapter can be utilized for design examples pertaining to each system, as well as a reference for the evaluation of the amenity goals and the design and management patterns pertaining to how they can or cannot be effectively implemented by each SMS type. The evaluations within this chapter identify variables that inform characteristics affecting the coherence, legibility, complexity, and mystery of a site. These variables are utilized to indicate associations between characteristics of each evaluation category (SMS performance, aesthetic performance, and amenity performance) to include within a framework that informs designers of the capabilities of SMS to perform in ways that benefit ecology as well as humans. The final portion of this chapter illustrates characteristic, or variable, relationships between each evaluation category.

Chapter 05: SMS Characteristic Framework addresses specific information in regards to the planting materials within each SMS type, each system's ability to perform as landscape patterns, and the amenity goals best suited or applied through each SMS type.

The framework provides: specific planting material, and each plants ecological and aesthetic variables, suitable for pattern application for each system; the amenities best utilized to educate, publicly inform, and aesthetically enhance the understanding of each pattern application through SMS; and the ecological characteristics of SMS implementation.

01 INTRODUCTION

dilemma

Traditional water management within the urban context has been categorized into 4 paradigm shifts throughout history—I: Basic water supply, II: Engineered water supply and runoff conveyance, III: Fast conveyance with no minimal stormwater treatment, and IV: fast conveyance with end of pipe treatment (Figure 1.1). These paradigm shifts all show common characteristics; utilizing streets for the conveyance of people, waste products, and precipitation; but in varying degrees of importance.

As technology evolved, and with the implementation of the Clean Water Act (CWA) by the U.S. Congress in 1972 (Novotny, Ahern, & Brown, 2010) these systems (stormwater conveyance and wastewater distribution) were divided in order to help control the further pollution of our natural waterways.

However, current research indicates that our progression toward more environmentally friendly stormwater conveyance has been unsatisfactory, if not stalled. (Novotny, Ahern, & Brown, 2010) The hard conveyance and treatment infrastructure designed throughout the four paradigms to help eliminate unwanted pollutants and sewage products has undoubtedly enhanced direct and immediate public health. However, these conveyance systems are now contributing to unhealthy ecosystems because of the human preference for impervious surfaces over porous surfaces within the urban context; fast conveyance drainage infrastructure, rather than systems that slow down and detain runoff with the use of ponds and vegetation. The decisions made by humans over time have caused negative environmental outcomes. These outcomes are a collection of choices made by individuals in their self-interest (Bechtel & Churchman, 2002) of the 'here and now' without considering the repercussions that fast and hard conveyance systems will have downstream. On site solutions addressing stormwater infiltration and quality need to be implemented, striving to fulfill the goals of the 'here and now' while also taking into consideration the future health of our natural environment.

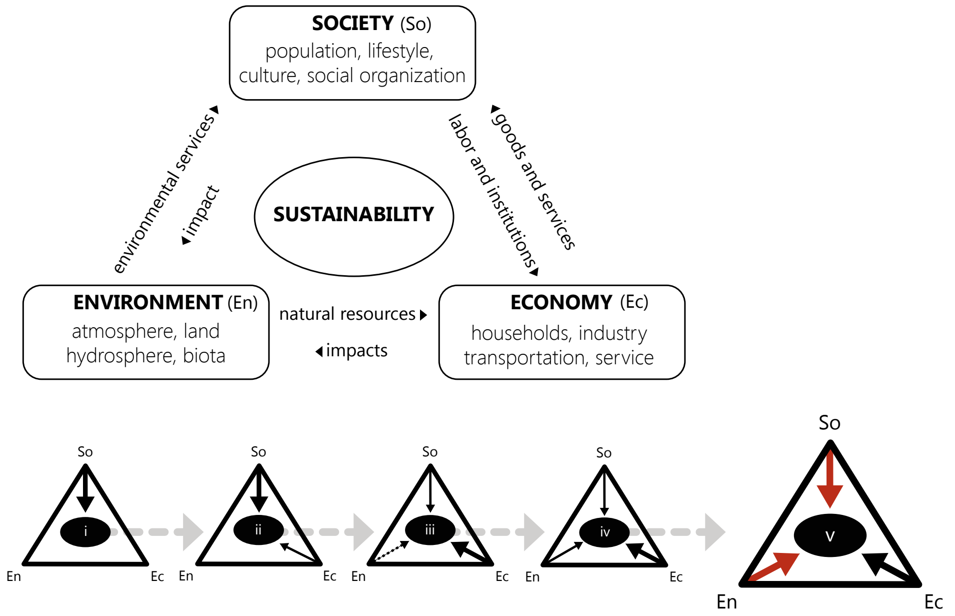

Figure 1.1 -- Stormwater management paradigm progression

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Source: (Novotny, Ahern, & Brown, 2010)

How can vegetated stormwater management systems address the hard conveyance and reduced infiltration problems of the current water management paradigm in order to have beneficial impacts on the health, natural environment, and social well-being of people?

The Wildcat creek watershed is a prime example of the identified current paradigm of stormwater management. This once ecologically healthy corridor is fed by conveyance systems that do not address the hydrologic needs of the watershed, decreasing the possibility for infiltration as well as natural open space that provides refuge from the urban environment for people. Frank Anneberg Park, Manhattan, Kansas, utilizes a stormwater management system that is based primarily on the characteristics of the current water management paradigm, disposing of water with fast conveyance impervious and pervious systems.

The above information leads to this dilemma: how can designed vegetated SMS demonstrated within Frank Anneberg Park provide possible water management solutions that help identify a set of variables informing the relationship between each systems' aesthetic and amenity performance and their ecosystem and ecological performance? This dilemma drives the research and focus on stormwater management systems in order to identify produce a framework that aids designers on how to shape meaningful aesthetic interactions between humans and ecological processes to help preserve and restore nature within the built environment for future generations.

thesis

Frank Anneberg Park serves as a site where design alternatives for vegetated SMS are evaluated on their aesthetic and amenity performance. Each system's design first addresses the hydrologic characteristics of the site; elevation and spatial limitations, soil makeup, basin delineation, and runoff accumulation. Second, designs address three alternatives, or schemes, for each identified system: natural planting scheme, hydrologic planting scheme, and a designed planting scheme.

The natural planting scheme is based solely on the utilization of planting material appropriate for each system type; infiltration, filtration, and constructed wetlands. A hydrologic planting scheme is based on water elevation within the system and the appropriate planting material associated with each elevation zone. A designed scheme utilizes a placement method that builds upon the hydrologic planting scheme. This scheme breaks down appropriate planting material within each water elevation zone into characteristics related to the basic design principles of form, line, shape, color, texture, space, and value.

By utilizing the existing programmatic elements within the park as spatial constants, not changing their location, each SMS design alternative showcases varying degrees of defining spaces, structure, and enclosure. In addition to providing spatial attributes, each design provides opportunities that help alleviate flooding problems by slowing down water flow and increasing infiltration.

These alternatives illustrate varying designs that showcase each system's ability to direct views, create degrees of spatial enclosure and overlapping space, encourage circulation, and provide interactive amenity opportunities to the surrounding public. These designs then are evaluated on their aesthetic and amenity performance, based on the Understanding and Exploration framework et al. (Kaplan, Kaplan, and Ryan, 1998) and the identified Amenity Goals et al. (Echols and Pennypacker, 2007).

These evaluations provide a range of results allowing discernment of variables for inclusion within a framework that identifies associated characteristics between aesthetic and amenity performance, and ecosystem and hydrological performance. The framework of the Kaplan, Kaplan and Ryan, and the SMS amenity goals of Echols and Pennypacker are grounded in aesthetic and ecological theory making their combination and application a strong sustainable building block for the further development of water management systems that address the needs of humans as well as the needs of our surrounding environment.

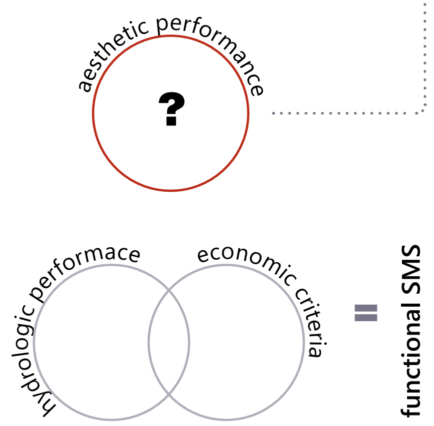

Figure 1.2 Existing stormwater management design criteria

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Traditional water management systems have focused on either economic or hydrologic factors.(Figure 1.2) It is important to illustrate the aesthetic and amenity capabilities of vegetated SMS so these systems can serve both ecological and social roles within the urban context. (Figure 1.3)

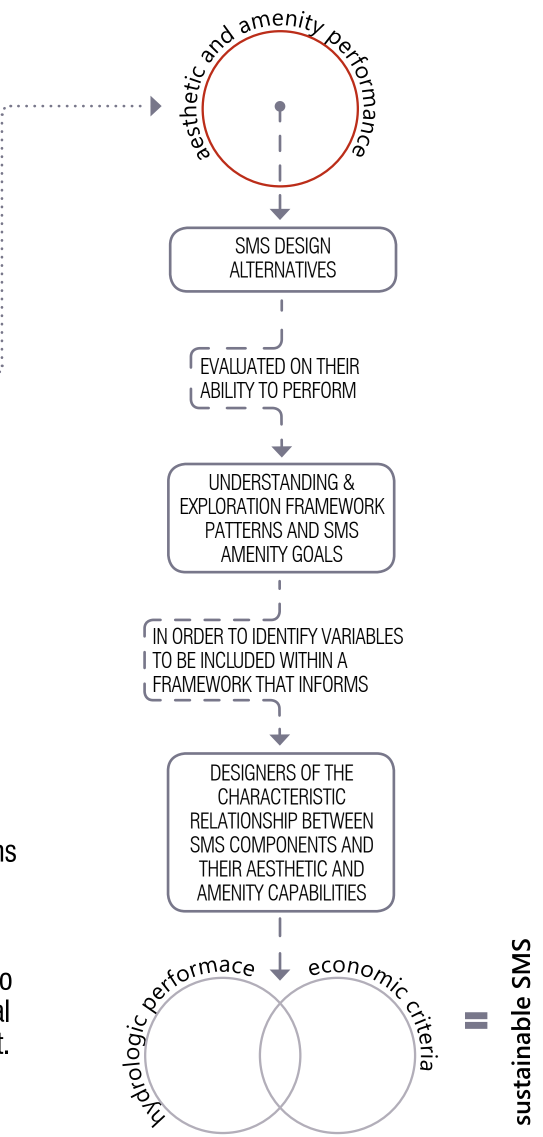

Figure 1.3 Process to discern SMS aesthetic and amenity performance characteristics

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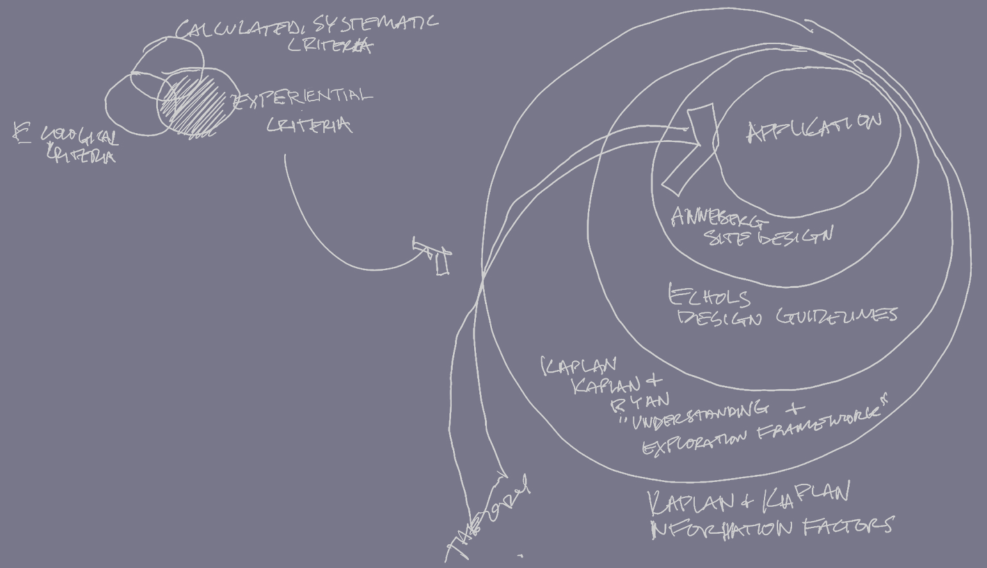
02 BACKGROUND



from theory to application

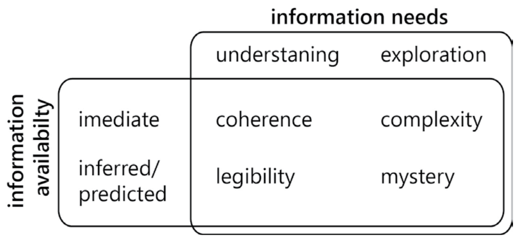


Figure 2.1 Preference Matrix (Kaplan & Kaplan, 1989)

It is important to ground design decisions with the use and application of theory. Theory justifies tested general propositions that can be used as principles, or frameworks, for the explanation and prediction of experiential phenomena. Kaplan & Kaplan et al. (1989) provide a theoretical framework that helps explain the psychological relationship between humans and our preference for nature categorized by four preference patterns--coherence, legibility, complexity, and mystery. These preference patterns, or information factors, form a “Preference Matrix” (Figure 2.1) that has the ability to categorize specific elements, or systems within the natural environment because of its broad, but well defined preference patterns. By categorizing design techniques, associations between the preference matrix and each technique can be made; identifying variables that help inform how to design systems within the natural landscape.

The Preference Matrix is utilized to categorize the amenity goals and techniques--education, recreation, public relations, aesthetic richness--of designed fluvial systems (Echols & Pennypacker, 2007) in the form of stormwater management in ways that benefit humans. (Figure 2.5) Amenity goal techniques are categorized based on their ability to increase the sites coherence, legibility, complexity, and mystery of the site in relation to SMS. By categorizing amenity goal techniques, each amenity goal’s relationship to the information factors of the Preference Matrix can be identified.

However, these categorized design goals and techniques are not as effective if not incorporated within a cohesive site design that addresses the ecological stormwater needs of the identified site. (Fry, Tveit, Ode, & Velarde, 2009) Kaplan, Kaplan, & Ryan et al. (1998) provide the results of experiential support from previous publications including Kaplan & Kaplan et al. (1989) through the “Understanding and Exploration” framework. The categories that make up the framework include: fears and preferences, way-finding, restorative environments, gateways and partitions, trails and locomotion, views and vistas, and places and their elements. This framework aids in identifying pattern opportunities within the landscape which address or benefit humans. The framework provides designers with the knowledge to assess the natural landscape based on not only its pattern content, but also the organization of these patterns. The organization of contents and patterns within an environment can make a significant difference in one’s ability to pursue the basic human needs of understanding and exploration. (Kaplan, Kaplan, & Ryan, 1998)

By combining the categorized amenity goals and techniques of Echols and Pennypacker et al. (2007) with Kaplan, Kaplan, & Ryan’s “Understanding and Exploration” framework, one can approach the assessment of natural environments that incorporate SMS in ways that benefit humans.

The assessment of natural environments based on two frameworks, or a set of guidelines is one thing. It is another thing to inform designers on the capabilities of SMS in order to provide and accomplish these design goals and patterns through SMS structure and planting material. How can we test a vegetated SMS’ ability to perform aesthetically and provide a social and ecological amenity for the surrounding environment? First a planting palette appropriate for SMS needs be identified for the specific region of the design at hand.

The selection of planting material must begin with a palette that includes species utilized for SMS. Schmidt & Shaw et al. (2003) provide a planting palette that is catered to the stormwater conveyance, filtration, infiltration, retention, and detention systems in the Midwest region of the United States. Schmidt and Shaw provide a plant matrix which identifies the plant characteristics: water level, frequency, depth, duration, design potential, and nursery. While the previously mentioned plant characteristics are useful to obtain SMS structural and ecological goals, the matrix does not categorize planting material by form, height, color, and density. These basic design characteristics must be categorized in order to show the potential of each system to perform the principals of spatial form and definition within the landscape.

The concluding framework of this book aids in the selection of plants that help address and improve the coherence, legibility, complexity, and mystery of a site through: framing, screening, layering and massing, degrees of enclosure, repetition, variety, balance.

The process of moving from the theory Kaplan and Kaplan et al. (1989) identify as a “Preference Matrix” to the application and organization of SMS that address human preferences, allows one to design ecological systems that focus both the goals of Echol’s and Pennypacker et al. (2007) and Kaplan, Kaplan, and Ryan et al. (1998). This process allows the creation of SMS that foster an ecological appreciation through aesthetic performance.

Stormwater Management Systems (SMS)

Stormwater management is the use of constructed or natural practices associated with the planning, maintenance, and regulation of facilities which collect, store, or convey stormwater to reduce, temporarily detain, slow down and remove pollutants from runoff. Traditionally these systems within the urban context have been utilized to divert stormwater to underground pipes and concrete conveyance systems, disposing of water as quickly as possible. (Echols & Pennypacker, 2008; Bechtel & Churchman, 2002; Novotny, Ahern, & Brown, 2010) Through this rapid-conveyance method, land is kept relatively dry. Calculated, systematic design criteria have driven the design of these systems, neglecting to address experiential criteria such as visual preference and aesthetic performance.

SMS in the form of green infrastructure, or designed vegetated SMS, have gained interest in addressing the ecological needs of natural systems that were once in place. However, these vegetated SMS tend to have the appearance of an unkept or "unattractive" aesthetic, associating them with a negative visual experience. But why is the experiential criterion important to the social acceptance of SMS? How can landscape aesthetic performance be categorized and utilized to serve alongside systematic design criteria and requirements to create sustainable vegetated SMS, ecologically and socially? These are questions that drove the design and evaluation of vegetated SMS in order to test the capabilities of accomplishing the aesthetic performance patterns of the Kaplans and Ryan et al. (1998) as well as the amenity goals of Echols and Pennypacker et al. (2007)

Human Interaction with the Landscape

The argument can be made that we should design self-sustaining, low maintenance stormwater management systems; systems that don't require maintenance after a certain period of time; systems that focus on native plantings. (Shaw & Schmidt, 2003) These are all important criteria when designing green infrastructure, from both ecological and economical standpoints. As we strive to design and implement best management practices (BMP's) that attempt to restore or mimic the natural processes that were once in place, we must acknowledge that humans will continue, and more frequently interact with and manipulate those processes, especially within the urban and suburban context. Understanding the role that humans play in the change and manipulation of natural processes is important to their continued functionality. However, understanding the magnitude and scales at which human interaction affects natural phenomena can be difficult. (Gobster, Nassauer, Daniel, & Fry, 2007)

The scale at which humans experience and interact with environmental phenomena is the scale of 'landscapes': or the physical patterns that humans perceive as making up their natural surroundings. Gobster et al. (2007) identifies this scale as the "perceptible realm." This is the scale at which landscape perception is the most vital process in linking humans with environmental phenomena. At this scale humans intentionally change landscapes and in turn these changes directly affect environmental processes.

How one perceives, understands, and interacts with the surrounding ecological processes is very important to how one prefers the surrounding landscape patterns. (Gobster, Nassauer, Daniel, & Fry, 2007) Preference is a direct, immediate, and holistic feeling that is strongly tied to ones understanding of the immediate situation or surrounding. Both perception and preference are closely related; perception being the main element of preference. (Kaplan & Kaplan, 1989) These factors--perceiving and preference--play a vital role in justifying the importance of landscape aesthetics within the realm of designed ecological systems.

Gobster further justifies that landscape aesthetics, or more specifically, landscape preference, is vital to the understanding, care, and purposeful manipulation of ecological systems by stating that:

> "landscapes that are perceived as aesthetically pleasing are more likely to be appreciated than are landscapes perceived as undistinguished or ugly, regardless of their less directly perceivable ecological importance." (Gobster, Nassauer, Danial & Fry, 2007, p. 960)

However the idea of strictly designing landscapes based on aesthetic criteria alone could in fact be counterproductive; changing and caring for landscapes in ways that are not consistent with or even destructive to ecological functions. A balance between aesthetic preference, or performance, and ecologically functioning designs must be addressed (Fry, Tveit, Ode, & Velarde, 2009) when creating SMS within the urban context. The aesthetic perception of the designed system must not take precedent over its ecological function, but help create an aesthetic appreciation for ecologically beneficial landscapes.

Aesthetic performance is not limited to just visual assessment. It also includes the other senses in which we experience the environment around us, both in the present and in the distant past. It is closely tied into our heritage, our culture. 'Cultural landscapes' are the product of human and natural interaction (Gkogkas, 2010). We not only find places to be aesthetically pleasing, but also the experiences we acquire within those spaces to be equally aesthetic. Gobster et al. (2007) refers to this as “aesthetic experience.” Landscape aesthetic experience is defined as a feeling of pleasure attributed to directly perceiving characteristics of spatially and temporally arranged landscape patterns.

It is important to acknowledge the relationship between landscape aesthetic theory and its application through ecological systems. By combining these aspects of design--aesthetic performance criteria and SMS characteristic criteria--people can be made aware of the ecological importance of SMS.

Stormwater management is a major component of almost all land-planning and site design projects (Echols & Pennypacker, 2008) making it a constant from one project to the next, spanning cultures, locations, and climates. While these systems are a constant within most design projects, they must address stormwater issues to varying degrees on a site by site basis. These constant issues are an example of a pattern within the landscape. Patterns describe different problems which occur over and over again within our environment. These patterns suggest relationships between environmental criteria. Each pattern then, at its theoretical basis, attributes a solution to the problem in such a way that it can be, and is, utilized within a multitude of situations. (Alexander, Ishikawa & Silverstein, 1977)

Kaplan & Kaplan et al. (1989) utilize the concept of patterns to address the psychological relationship between humans and nature. SMS can be applied as patterns that address the physiological relationship between humans and nature.

SMS relate to and can be utilized in design solutions addressing both ecological functions and human preference within the landscape. Combining aesthetics and ecological processes creates a possible tendency, based on evolutionary processes and cultural expectations (Gobster, Nassauer, Daniel, & Fry, 2007), to associate aesthetic quality with healthy ecological systems.

Literature Reviewed

Figure 2.2 is a literature map showing research conducted on the topical areas of this project: how humans perceive and prefer the landscape, stormwater management systems, and the link between ecology and aesthetics. The four preference patterns identified within Kaplan & Kaplan’s “Preference Matrix” et al. (1989) are defined and the research that has since been conducted supporting the Kaplan’s information factors are associated with each pattern.

The literature illustrated in the map helped to both support and supplement the Kaplans work on human preference within the landscape. The map also shows literature that focusses on SMS design and implementation, and illustrates how SMS and the Kaplans work can be combined to address an aesthetics-ecological relationship.

The following sections within this chapter are broken down into theory related to social and environmental psychological theory and categorized theory; both providing the basis for utilizing aesthetic performance within ecological systems in the urban environment.

Social and Environmental Psychological Theory

This literature addresses a broader range of understanding in relation to how people interact and perceive the environment. This section gives brief descriptions of the Kaplan’s Preference Matrix et al. (1989) and how preference plays a major part in how we perceive the landscape, as well as theories addressing human perceptions of ecological systems and our role as humans within these systems.

Categorized Theory

This section addresses literature that is still theory based, but is applied toward a specific set of instances. In this case the instance or defined topic is SMS performing as amenities within the urban landscape. This is still considered theory, or a theoretical framework because it is a set of ideas that is not applicable in every situation, making it theoretically applicable in many different ways in different situations.

Echols and Pennypacker’s amenity goals are a set of goals that theoretically increase or provide interaction with SMS through education, recreation, public relations, and aesthetic richness. This is important to increasing the understanding and appreciation of vegetated SMS.

Literature Map

Kaplan & Kaplan Preference Pattern Definitions and Guidelines

Aesthetic Performance Literature

author - relative importance

Coherence -- helps in providing a sense of order and in directing attention; extent to which the scene "hangs together" (repeating themes, textures, and structural features allow prediction, from one portion of a scene to another. Coherence involves little inference, relying on 2-dimensional aspects of a scene to make sense of the environment

- Fry, Tveit, Ode, Velarde - identifies overlap in visual and ecological indicators addressing coherence: holistic views and application, balance and proportion
- Gallagher - associated with familiarity and involvement with in the landscape
- Herbert - decreases with the increase of spaciousness
- Herzog - increases preference for other patterns when included (Mystery and spaciousness)

Complexity -- this indicator reflects how much is going on in a particular scene, the number of visual elements in a view; how intricate the scene is; its richness. Complexity addresses the 2-dimensional picture plane, as apposed to depth cues. Complexity can provide content or subjects to think about, but must be structurally coherent.

- Ellsworth - visual importance of biophysical diversity, importance of involvement components
- Fry, Tveit, Ode, Velarde - identifies overlap in visual and ecological indicators addressing complexity: diversity of landscape elements and land cover
- Herbert - variations of texture and spaciousness increased Coherence and Legibility
- Linderman-Matthies - identifies the importance of values attached to biodiversity by humans
- Ode & Miller - variation/shape of elements and patterns describe to what degree there is a variation in the landscape

Legibility -- allows prediction of the opportunity to function; finding one's way in, and finding one's way back; ease of forming a "mental map". Legibility is increased by utilizing memorable components that help with orientation. The objects must be identifiable and scene must be experienced as interpretable; 3-dimensionality

- Fry, Tveit, Ode, Velarde - identifies as "imageability; identifies overlap in visual and ecological indicators addressing imageability: uniqueness and distinctiveness, vividness
- Herbert - increases with complexity techniques such as varied textures and spatial definition

Mystery -- going into a scene seems likely to provide more information (it must appear possible to enter scene and go somewhere; promise of further information based on a change of vantage point). Mystery is based on inference and a sense of exploration addressing the 3-dimensional aspects of a scene.

- Ellsworth - preference of physical depth, foreground definition and involvement components
- Gallagher - concerns about landscape emerge form how it looks and not so much the design
- Gimblett - provides five physical attributes associated with "mystery"
- Herbert - increases with the presence of natural vegetation
- Herzog - important preference indicator; showed preference for older, established trees
- Kaplan, Kaplan, Brown - est. Mystery to be a significant information variable with a diminished role of Complexity in preference
- Kaplan - found mystery to be a positive predictor of preference across multiple viewing times

Aesthetics-Ecology Relationship

- Meyer
- Gkogkas
- Gobster, Nassauer, Daniel, Fry
- Fry, Tveit, Ode, Velarde
- Echols & Pennypacker

Addresses landscape aesthetics by providing an important linkage between humans and ecological process

Ecological SMS

- Novotny, Ahern, Brown
- Shaw & Schmidt
- Riley
- Hogan & Walbridge
- Diblasi
- Davis, Hunt, Traver, Clar

Literature addressing the importance of vegetation within stormwater management systems, or green infrastructure

Figure 2.2 Literature map - shows topics of research and supporting research.

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Preference Matrix Definitions: (Kaplan, Kaplan, & Ryan, 1998)

social and environment psychological theory

Social psychology - (Kaplan & Kaplan, 1989)

Preference is intimately tied to basic concerns. The Kaplans identify preference as an expression of underlying human needs. Preference within the landscape can be expected to be greater for settings in which an organism is likely to thrive, and diminished for those settings in which it may be harmed or rendered inactive.

Aesthetic reactions within the landscape reflect neither a casual nor a trivial aspect of the human makeup.(Kaplan, Kaplan, 1989) These reactions instead constitute a guide to human behavior that is both ancient and far-reaching. Underlying these reactions is an assessment of the environment in terms of its compatibility with human needs and purposes. Thus aesthetic reaction is an indication of an environment where effective human functioning is more likely to occur.

The research on preference tries to determine not only what people do and do not like but also what some of the categories are that constitute the basic patterns of daily experience. The Kaplans utilized preference to provide a means for discovering the categories of perception that make up the “Preference Matrix” (Figure 2.3). This matrix provides a theoretical framework made up of--coherence, legibility, complexity, and mystery--that helps explain the psychological relationship between humans and our preference for nature.

Nature for the context of the identified framework is defined as not being

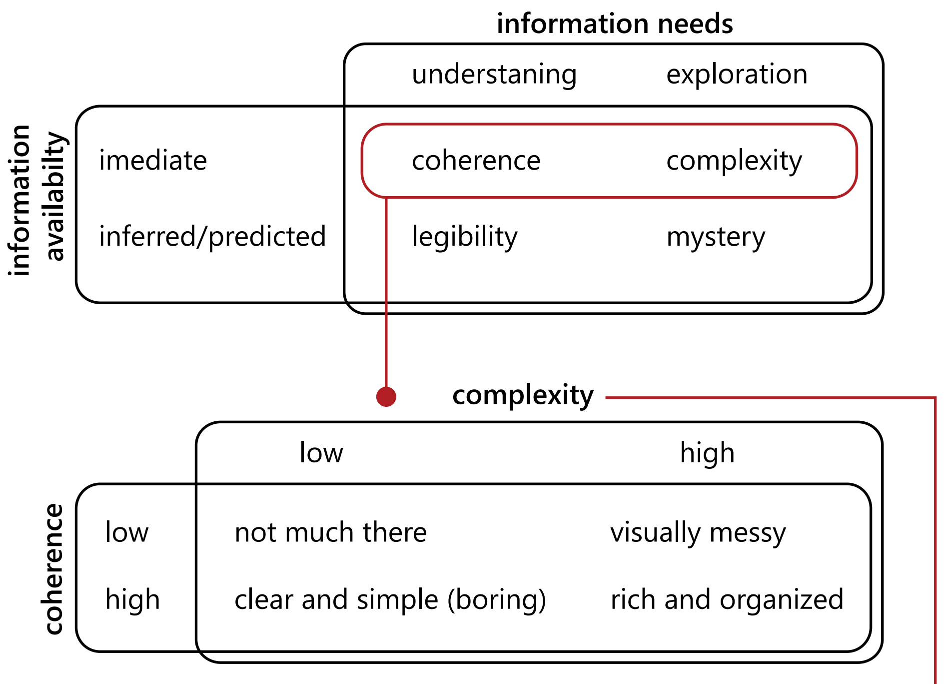
> “…limited to those faraway, vast, and pristine places designated as ‘natural areas’ by some governmental authority. Nature includes parks and open spaces, meadows and abandoned fields, street trees and backyard gardens.”(Kaplan & Kaplan, 1998, p.1)

The Kaplans are referring to places near and far, common and unusual, managed and unkempt, big, small, and in-between, where plants grow by human design or even despite it. The info-gragh to the right illustrates how the preference for settings, both natural and urban, relates to a settings complexity, and in turn how complexity relates to the coherence of a setting.

Vegetated stormwater management systems (SMS) are located in both natural and urban settings, occurring both naturally and man-made. These systems are a part of our everyday experiences whether we recognize them or not, which is why they need to find a balance between their complexity and coherence in order for them to be understood and appreciated.

The “Preference Matrix” has the ability to categorize and provide basic guidelines for how specific elements, or systems within the natural environment provide the basic pieces of information through defined preference patterns.

Preference Matrix



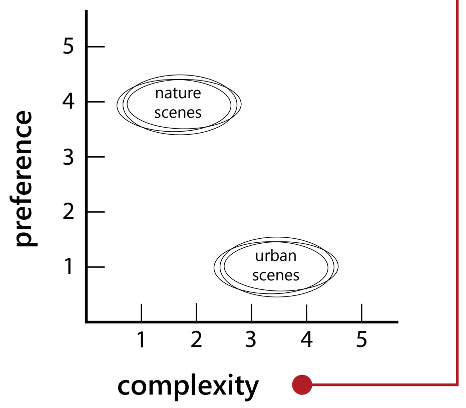


Figure 2.3 “Preference Matrix” - This info-graph illustrates the Kaplan’s Preference Matrix and how the immediate information components of coherence and complexity relate to the makeup of the setting at hand; being either natural or urban.

Produced by: Buffington, Jared

Source: (Kaplan & Kaplan, 1989)

categorized theory

Understanding and Exploration - (Kaplan, Kaplan, & Ryan, 1998)

Understanding the basic characteristics of human needs is important when designing and managing natural landscapes. The Preference Matrix (Kaplan & Kaplan, 1989) provides a set of informational indicators to categorize feelings of natural patterns within the landscape. But how can these feelings be attained and what types of reoccurring landscape patterns help achieve a greater understanding of landscape settings?

The Understanding and Exploration Framework et al. (1998) illustrated in Figure 2.4 provides a set of patterns that utilize the Preference Matrix to enhance the management and design of the natural landscape. The framework addresses not only patterns, but how those patterns can be combine to work together within the landscape based on human fears and preferences. It must be understood however that people are not alike and they understand the environment around them to different degrees. The Understanding and Exploration Framework identifies pervasive human characteristics that help to decrease confusion and increase the will to explore throughout a scene. Gateways and partitions, trails and locomotion, views and vistas, and places and their elements are patterns that address the design and management of natural settings. These patterns are not particular to any specific land pattern, but can be applied in many different situations, natural and urban. These design and management patterns are later utilized to evaluate vegetated SMS' ability to perform each pattern.

These design and management patterns are defined and described as follows based on Kaplan, Kaplan, & Ryan's interpretation et al. (1998):

Gateways and Partitions: help to orient the visitor within an area. Subdividing areas with partitions helps to break the space into identifiable regions. Gateways and partitions also help to define smaller settings, in turn reducing the amount of environmental information that needs to be considered or addressed at a given time. Gateways enhance orientation by serving as landmarks or destination points providing and directing views into the next setting. Gateways provide views from outside an area allowing one to anticipate what they could experience within the viewed setting creating choice points along circulation pathways. They allow and should encourage people to stop and consider where they have come from and where they should proceed to explore.

Trails and Locomotion: trails through natural areas bring individuals into contact with nature, allowing and directing observation and exploration. Trails invite individuals to proceed, enhancing a sense of security. A setting that lacks trails may be less clear that further exploration is appropriate.

Views and Vistas: enhance understanding and inform exploration. Views and vistas encourage cognitive involvementengaging the mind by revealing a "big picture," revealing the extent of what the surrounding area provides. Views and vistas must have both coherence and focus.

Places and Their Elements: Places are given form and distinction by their elements and the way those elements are arranged. The Kaplans within the Understanding and Exploration framework refer to elements such as trees, shrubs, flowers, lawn, and water, as well as human made elements such as buildings and footbridges. Identifiable senses of enclosure increase preference within a space, further justifying the importance in the arrangement of elements within a space.

The design and management patterns work in combination with Echols and Pennypacker's Amenity Goals et al. (2007) to guide the design of both site and 'point of interest' coordination. This coordination is aided by categorizing the amenity goal techniques by their ability to address the four information factors of the Preference Matrix.(Figure 2.5)

Understanding and Exploration Framework

Fears and Preferences	F1	Visual access	Visual access increases confidence
	F2	Enhancing familiarity	Familiarity helps people feel more comfortable
	F3	Human sign	Although indications of human presence can be a source of concern, human sign is often reassuring
	P1	Coherent areas	A small number of coherent areas makes a setting easier to understand
	P2	Smooth ground	Ground texture impacts preference
	P3	Mystery	Mystery encourages exploration
	P4	A sense of depth	Layers and landmarks enhance the sense of depth
	P5	Openings	Openings in the woods are comforting both when one is in them and when one can look into them
Way Finding	Way Finding Design		
	WF:D1	Regions	Coherent regions are helpful in way-finding
	WF:D2	Landmarks	Landmarks are most useful in way-finding when they are distinctive and not too many
	WF:D3	Paths and Signs	Getting there and back can be aided by paths and signs
	Way Finding Maps		
	WF:M1	Orientation for new visitor	Key decision points need to be easily identified
	WF:M2	Mapping for the minds eye	Avoiding the accuracy hang-up leads to a more easily remembered map
	WF:M3	Labels and symbols	Maps are more helpful if the information is where one needs it
	WF:M4	Which way is north?	Align a posted map with the viewer's position
	WF:M5	Check it out	Reactions from potential users can lead to surprising insights
Restorative Environments	R1	Quiet fascination	Natural settings can fill the mind and enhance restoration
	R2	Wandering in small spaces	Even a small space, if it has extent, can constitute a whole different world
	R3	Separation from distraction	The sense of being in a different world is easily undermined by intrusions and distractions
	R4	Wood, stone and old	The choice of materials can enhance restoration
	R5	The view from the window	Even if one is not in a setting, it can have restorative benefits
Gateways and Partitions	G1	Gateways need partitions	Partitions create opportunities for gateways
	G2	Gateways and orientation	A gateway provides information about what lies ahead
	G3	View through the gateway	A well designed gateway can provide both information and mystery
Trails and Locomotion	T1	Trails, narrow and curving	The promise of discovering what lies just beyond the bend in the road greatly increases preference
	T2	Views, large and small	What can be seen from the trail makes all the difference
	T3	The trail surface	Trail surfaces are important, both visually and functionally
	T4	The trail's path	Helping people stay oriented is an important function of a trail
	T5	Points of interest	Stopping points along the way can provide opportunities for resting and observing
Views and Vistas	VV1	Enough to look at	A vista is more engrossing if it has extent
	VV2	Guiding the eye	A captivating view provides information about where to look
	VV3	More than meets the eye	A vista engages the information
	VV4	Think view	Consider opportunities for providing views
Places and Their Elements	PE1	Trees	Trees help make special places
	PE2	The water's edge	The treatment of the water's edge impacts how the water is perceived
	PE3	Big spaces	Big areas become more interesting if divided
	PE4	Small spaces	To be highly prized, places need not be large
	PE5	A sense of enclosure	A sense of enclosure can make a place comforting and distinct

Figure 2.4 Understanding and Exploration Framework - The combination of the two factors, understanding and exploration, provides a theoretical basis for the framework presented above. This framework in turn provides insight as to how the natural landscape is designed and managed

Source: (Kaplan, Kaplan, & Ryan, 1998)

Categorized Amenity Goals

Figure 2.5 Categorized Amenity Goals - The diagram to the right defines the four Amenity Goals identified by Echols and Pennypacker et al. (2008) and categorizes the application suggestion of each goal by the Kaplan and Kaplan's four preference indicators: coherence, legibility, complexity, and mystery et al. (1989).

Kaplan & Kaplan's Information Factors
(Kaplan & Kaplan, 1989)

Echols & Pennypacker Amenity Goals
(Echols & Pennypacker, 2008)

Echols & Pennypacker Amenity Goals	coherence	legibility	complexity	mystery
Education -- understood as creating favorable conditions for learning about stormwater management and related issues; combine visual SMS with signage to create rich landscape narratives that follow visible/ legible water trails	• create systems that visibly collect and store trash and pollutants • provide simple sinage or exhibits with brief text and clear graphics	• make the STS visible and legible • create narrative of stormwater and hydrologic cycle	• include a variety of STS in design • provide a variety of riparian plant types and communities • provide a variety of interesting wildlife habitat by using plants that provide wildlife food, providing different water depths, and creating wildlife shelter	• make STS playful, intriguing or puzzling • create visual interest by varying the appearance of different parts of the STS • create a variety of spaces or groups to explore, gather or sit near the STS
Recreation -- providing conditions favorable for interacting with stormwater treatment systems in relaxing, amusing, or refreshing ways; Echols et al. (2008) categorizes this design goal into three categories: "view", "enter", and "play in"	• create overlooks with views of the STS • provide paths in strategic locations that ensure encounters with the STS • connect on-site trails to off-site trail systems and destinations that ensure encounters with the STS	• create destination points related to STS • provide clear points of entry into stormwater system that are visually inviting, mysterious and easily accessible • create systems that can be safely modified by the user such as small movable rocks and weirs	• provide a variety of small and large places to play in or explore the STS • make areas that invite climbing and physical exploration that balance perceptions of safety with adventure	
Public Relations -- pertains to either a discrete feature or character of the overall design makes a semiotic statement about the values of those who created and/or own the site	• use commonly available materials • use signage explaining stormwater treatment strategies to make the stormwater trail easy to find and follow • use restraint in diversity of materials and forms	• create small scale replica interventions • utilize common settings such as sidewalks and parking lots	• locate STS near entries, courtyards or windows for high visibility • make the STS touchable make the stormwater audible: plunge pools, downspouts • make stormwater move in different ways	• utilize new forms and materials • make stormwater trail mysteriously disappear and reappear
Aesthetic Richness -- the design is composed to create an experience of beauty or pleasure focused on the stormwater system; compositions may address visual, auditory, tactile, or olfactory experience	• create visual interest of themes with basins that hold plants and water: sunken, raised, orthogonal, curved, organic, geometric, small, large • create unified design themes by repeating systems of bioswales, basins, weirs, ponds, raingardens	• use downspouts, runnels, flumes, and bioswales to draw attention to the line of the stormwater trail, enhancing legibility, interest and curiosity • dramatize an implied axis by aligning treatment systems, basins and runnels connected by water trail	• contrast natural elements with man-made element: clipped lawn, steel and concrete • juxtapose river rock and riparian grasses for compositional contrast • create variety of sounds and volumes by allowing stormwater to fall from various heights onto different materials such as stone or steel • create changes in sound pitch by allowing stormwater to fall on different forms such as flat block, metal tubes, drums and ponds • create different sound rhythms by varying the amount and rate of stormwater falling and flowing through treatment system • use a variety of water related plants within visitors' reach, such as rushes and grasses • allow people to touch stormwater in different forms such as flowing, falling, splashing, standing, sheeting or damp surfaces where water can soak in or evaporate	• stack horizontal and vertical planes such as pools and falls to exploit the visual interest of stormwater flowing over surfaces, plunging down planes, through weirs or over edges

03 DESIGN EVALUATION METHODS

This portion of the document explains the methods used for SMS implementation and the evaluations of each system based on their aesthetic and amenity performance.

Aesthetic Performance Evaluation

The Understanding and Exploration framework created by Kaplan, Kaplan, & Ryan et al. (1998) provides insight as to the design and management of the natural environment. This framework addresses how the environment conveys information, both two-dimensionally (from a "picture plane" perspective), and three-dimensionally.

The two dimensional aspects of a scene provide primary information as to how complex and coherent the scene is perceived in terms of the number, grouping, and placement of the existing elements. The three-dimensional aspect of a scene involves the inference of what the scene could provide in relation to legibility and mystery. These four basic informational indicators--coherence, legibility, complexity, and mystery--make up the Preference Matrix. (Kaplan & Kaplan, 1989) These four indicators provide a basis for the suggested patterns within the Understanding and Exploration framework.

The pattern topics identified within the Understanding and Exploration framework include: gateways and partitions, trails and locomotion, views and vistas, and places and their elements. These patterns in combination with each other can increase the coherence, legibility, complexity, and mystery of a site. Examples of elements within the landscape that increase the components of the Preference Matrix are shown in this section, along with descriptions of how the four patterns relate to SMS.

Examples of how SMS can perform as landscape patterns are important in giving designers a basic visual understanding of how coherence, legibility, complexity, and mystery are represented through pattern applicaiton.

Information Factors Examples: Kaplan & Kaplan et al. (1989)

coherence

Coherence is the extent to which the available information of a scene makes sense in the context of the surrounding environment. Repeating themes, unifying textures, distinct regions or spaces, and limiting the number of contrasting elements help in achieving a high level of coherence within a designed environment. A coherent area allows one to predict how to maneuver throughout a site based on the unified materials and elements that direct views and circulation.

Figure 3.1 represents a designed entrance that attempts to meet the goals of a coherent space; directing circulation, views, and providing knowledge of what is to come with the use of an aerial vantage point. Vegetation and a alley of converging pillars create a funneled view of the destination overlook. An organic shaped walking grate is utilized to show the flow and direction of stormwater; adding another directional characteristic informing circulation.

Coherence in the context of this scene is increased with the use of landscape patterns such as partitions and gateways, views and vistas, and trails and locomotion.

legend

- directed view
- water feature
- [ ] destination point

Figure 3.1 Aerial showing circulation
Image Edited by: Jared Buffington - 2012
Source: http://cws.msu.edu/documents/Echols_Stormwaterasamenity.pdf

legibility

Legibility is heavily reliant on the distinctiveness of a scene. Legible spaces are meant to inform or give the user a sense of orientation and understanding about where they are within the site and how to maneuver through it. Techniques such as hierarchy of paving material and view directing components such as vegetation help to orient and direct the user as to where to go.

However, as the seen in Figure 3.2, unified paving material can be helpful but at the same time confusing. The circulation pathway below utilizes the same material throughout the site, in addition to utilizing trees to frame views at each pathway intersection. This is a good technique for circulation direction, but the design loses legibility when the spaces within each pathway are the same shape and of the same character. Situations like the one below could gain legibility and overall coherence with the addition of signage and alternating of trail intersection types.

Figure 3.2 illustrates how legibility is affected by such patterns as gateways and partitions, views and vistas, and trails and locomotion.

legend

- directed view
- circulation pathway

Figure 3.2 Aerial showing circulation
Image Edited by: Jared Buffington - 2012
Source: http://www.turenscape.com/english/projects/project.php?id=339

complexity

Complexity is a reflection of how much is going on in a particular scene, or the number of visual elements in a view. Typically with greater complexity, comes the greater chance for lack of coherence. Complex scenes need to be organized in such a way as to not impede coherence. Techniques that help to organize the patterns of brightness, size, and texture into congruent areas allow an increased amount of complexity without lost coherence. Varied patterns within a scene also increases the potential for variety, in turn encouraging exploration, suggesting that there are more different things available for discovery. (Kaplan & Kaplan, 1989)

Figure 3.3 illustrates patterns of brightness, size and texture within the design of SMS and pedestrian circulation. The SMS is viewed at varying heights, forming base plane and recessed base plane vantage points, with the height variation of the walkway and the terraces along the back wall. The terraces are divided by planting material varying in height as to create different vertical planes, directing views and helping to define space in the upper terraces. The final pattern is a variety of implemented agriculture within the SMS. The agriculture is broken up into equal sections as to create both unity and variety.

legend

separation of agriculture

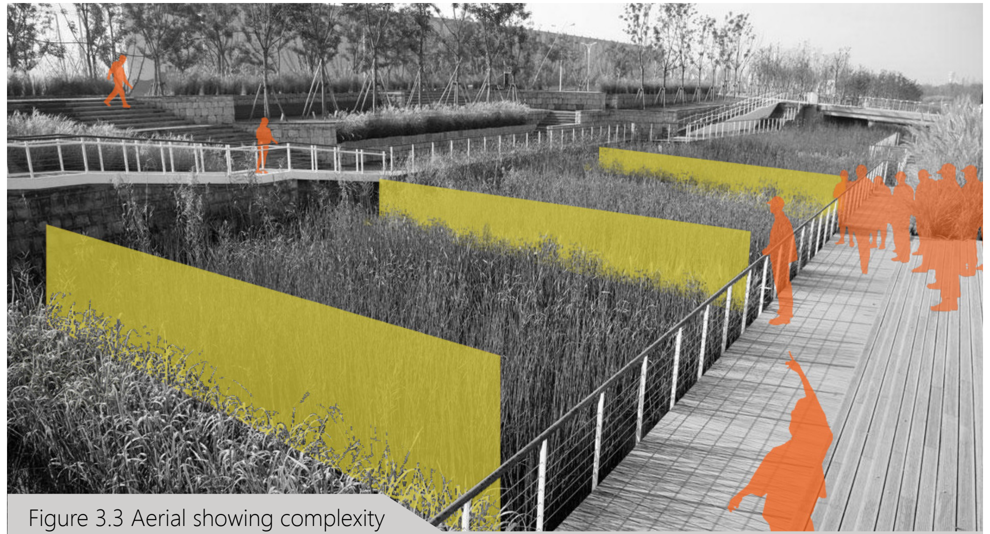


Figure 3.3 Aerial showing complexity
Image Edited by: Buffington, Jared - 2012
Source: http://www.asla.org/2010awards/006.html

mystery

Mystery is a major component that drives a human's need to explore, to acquire more information as to what seems to be going on within a scene. Screening, enclosure, physical accessibility, forest illumination, and relative lack of "distance of view" are techniques for achieving a level of mystery within a setting. (Kaplan & Kaplan, 1989)

Figures 3.4 and 3.5 illustrate two of the mentioned techniques for increasing mystery. The image on the lower left shows a winding path that utilizes vegetation on both sides to obstruct ones view of what is beyond. This technique utilizes screening, or partitioning, and the clearly identified pedestrian pathway to encourage exploration based on the idea that the path leads somewhere. The image on the lower right shows a destination point, but screens the circulation route to get there, limiting direct physical accessibility. The user must explore the provided pathway in order to gain knowledge of its destination. These two simple examples help to direct the circulation of the designed landscape.

Mystery is a component that can be increased with the use of all four landscape patterns; gateways and partitions, views and vistas, trails and locomotion, and places and their elements.

legend

screening element
circulation

Figure 3.4 Pathway illustrating mystery
Image Edited by: Buffington, Jared - 2012
Source: http://www.artfulrainwaterdesign.net/projects/show/33

Figure 3.5 View illustrating partition
Image Edited by: Buffington, Jared - 2012
Source: http://www.turenscape.com/English/projects/project.php?id=443

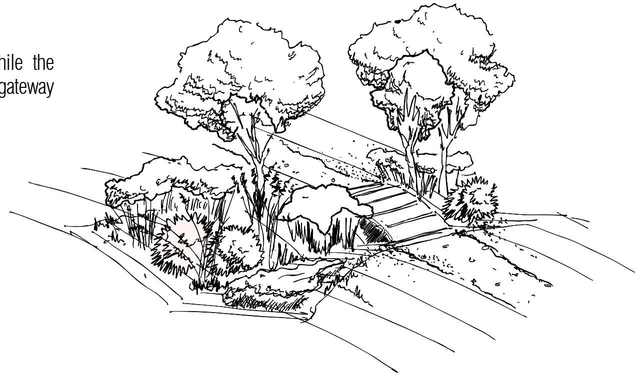


Figure 3.6 SMS performing as a partition, while the spillway between two retention areas serves as a gateway from one space to another

Image created by: Buffington, Jared - 2012

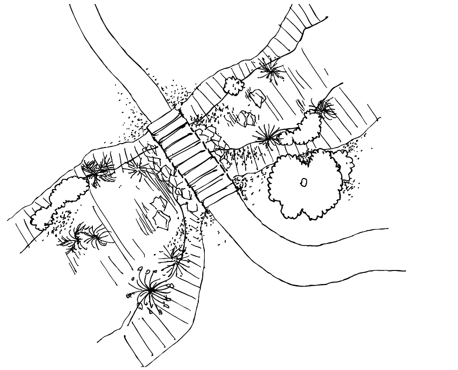
gateways and partitions

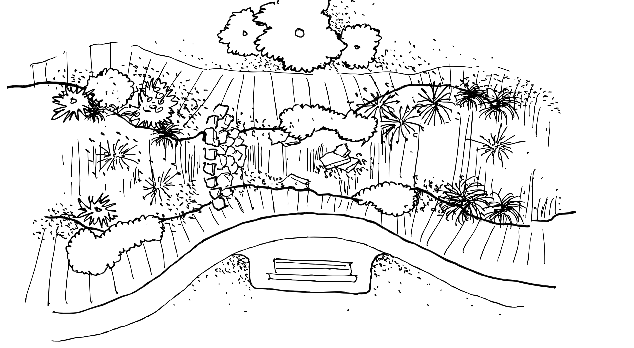
The Kaplans and Ryan et al. (1998) define a partition as being an object or set of objects that create a line or spatial definer such as a fence, hedge row, row of trees, or other form in order to divide an area. Partitions aid in orienting the visitor to an area and its components. By utilizing partitions to subdivide an area, smaller, more identifiable regions can be created. The process of breaking down an area into smaller identifiable regions reduces the amount of environmental information that needs to be processed at any given time. (Kaplan & Kaplan, 1989)

Gateways are breaks in partitions, marking a transition point between the “outside” and “inside” of an area. These breaks provide limited access to what lies ahead; making them decision points, or points of rest and contemplation. Giving a person the opportunity to make a choice is important to helping one consider where they are going and where they have been. Gateways can help decision making by providing a glimpse of what is to come within the directed view or scene. So how are gateways and partitions directly related or applied through vegetated stormwater management systems?

SMS must be utilized throughout a site to strategically direct water flow to varying degrees. These systems vary in size and function, just as different forms of partitions do. A spatial commonality between each system is that they provide opportunities for partitions between spaces. This characteristic is no different than how natural waterways divide landscapes on a much larger scale. Gateways within SMS can be represented by pedestrian circulation or features within the system structure that allow views or circulation such as gabion walls or spillways (Figure 3.6). While these crossing points provide both locomotive and visual access from one area to another, they also provide gateways that direct views and points of interest where the SMS can be seen and understood to some degree.

The different patterns of partitions and gateways and their application through each vegetated SMS type are discussed and evaluated within the following categories identified by the Understanding and Exploration framework. (Kaplan, Kaplan, & Ryan, 1998)





trails and locomotion

Tails and pathways are important to bringing humans into intimate contact with natural systems. (Kaplan, Kaplan, & Ryan, 1998) Trails and pathways for pedestrian use help to encourage exploration and observation of both designed and natural spaces while also enhancing a sense of security (Kaplan & Kaplan, 1989). Pathways and locomotion in relation to vegetated SMS are very similar to path-space relationships; pass by a space, path through a space, and terminate within a space. (Figure 3.7) There are specific path-space relationships that must be discussed that pertain to natural systems. First, the path configuration should conform to the SMS’s ground-plane design in order ensure that the ecological function of the system stays intact. Second, the pathway should utilize structural elements within the SMS such as gabion walls, berms, spillways, and vegetation for pass through a space, pass by a space, and terminate within a space interactions (mainly utilized where direct contact with a SMS is allowed). Finally, pathways must not utilize materials that contribute to excess sedimentation within the areas of the system that do not address sedimentation reduction. The orientation and direction of the pathway is ultimately designed in relation to the vegetated SMS. These systems are able to enhance the understanding and exploration of a site through pathway and system interplay. Trail and locomotive patterns identified by Kaplan, Kaplan, and Ryan et al. (1998) are utilized to evaluate the design alternatives within each selected area throughout Anneberg Park. Each pattern’s pertinence and relation to SMS in ways that enhance the coherence, legibility, complexity, and mystery of a site are discussed and variables are identified as to what patterns are more or less applicable through each design alternative. Each design alternative is evaluated based on its ability to perform each trail and locomotive pattern.

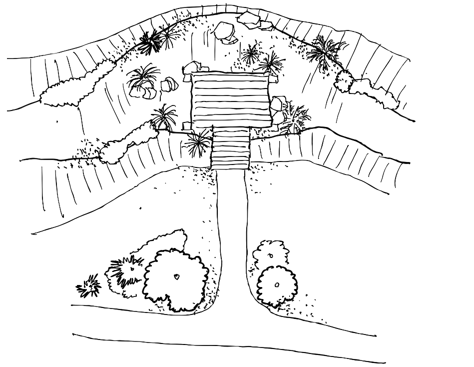


Figure 3.7 SMS Path Space Relationships - Top Left: pass through a space; Top Right: pass beside a space; Bottom: terminate within a space.

Image created by: Buffington, Jared - 2012

views and vistas

Views have positive implications on the health and well-being of humans. (Kaplan, Kaplan, & Ryan, 1998) Views help to enhance understanding of the scene at hand and ultimately can increase the will to explore. Vegetation has long been utilized to direct views toward points of interest, and hide views of areas thought to be not associated with the immediate setting. (Gobster, Nassauer, Daniel, & Fry, 2007).

The basic characteristics of creating and directing views can be found within vegetated SMS. The associated patterns with views and vistas identified by Kaplan, Kaplan, & Ryan et al. (1998) address how views are utilized to engage humans with the landscape, both physically and cognitively. Vegetated SMS are able to provide the aspects that create coherent areas while also providing elements that enhance the mystery and exploration within the landscape. The SMS design alternatives within Anneberg Park are evaluated on their ability to perform the following landscape patterns: enough to look at; guiding the eye; more than meets the eye; and think view. These patterns heavily rely on the Preference Matrix (Kaplan, Kaplan, 1989) to guide their application within different landscape settings to enhance the coherence, legibility, complexity, and mystery of a scene or setting. For instance, when views are obstructed or partitioned, the viewer cannot tell what possible lies ahead (mystery), whether there is a variety of patterns or elements to view (complexity), or whether they can coherently make their way into the space and back out (legibility).

places and their elements

Places are not only defined by their elements, but more importantly by the organization of their elements and the context to which they are arranged. The elements within a space should permit an understanding of what can and could be done within the allotted area of a space while also allowing for some interpretation or exploration by the user once they have ventured into the space. (Kaplan, Kaplan, & Ryan, 1998) Vegetated SMS have the ability to provide elements within a space, as well as provide the defining elements that enclose a space, in addition to providing an immediate ecological service to the surrounding environment. The 2-dimensional layout of different vegetated SMS provide a ground plane organizational element that helps to break larger areas into smaller, more comprehendible areas. The 3-dimensional structure of planting material within each systems provides visual and locomotive direction structure to how someone views and experiences a site. Landscape patterns related to places and their elements address how natural elements such as trees, shrubs, lawns, and water coordinate with man-made elements such as bridges and buildings increase a site's coherence, legibility, complexity, and mystery. Each vegetated SMS design alternative within Anneberg Park is assessed on its ability to apply the following landscape patterns: trees, the water's edge, big spaces, small spaces, and a sense of enclosure. Variables will be identified that link the system's ability to perform each pattern to its ecological and amenity benefit possibilities.

Amenity Performance Evaluation

Echols and Pennypacker et al. (2007) provide a set of goals and techniques that are related to the design of SMS within the urban context. These goals (education, recreation, public relations, and aesthetic richness) were derived from the research on urban stormwater designs that utilized conveyance in the form of troughs, runnels, or flumes to expose the water's path and inform the public. This technique is effective at drawing attention to the stormwater system, but it does not address BMP characteristics such as volume, frequency, duration, or quality. While conveyance systems can create awareness of stormwater, they do not aid in educating people about the environmental issues or SMS treatment potential.

Filtration, infiltration, and constructed wetland systems in contrast have been less of a stormwater-focused amenity. (Echols & Pennypacker, 2007) This lack of amenity focus is more than likely due to the fact that these systems focus less on fast conveyance of stormwater and more on volume, duration, and water quality through water retention and infiltration. In addition, these systems tend to need informative signage as to inform the public of their ecological importance.

The following examples provide visuals as to how the four amenity goals are applied through SMS. It is important to state that the examples displayed are mostly of conveyance techniques and not vegetated infiltration, filtration, or wetland systems. The examples are still relevant as to how goals are met through visual characteristics, even though they will be utilized to evaluate systems based mainly on their vegetation characteristics instead of their conveyance techniques. Both components evaluated, hard conveyance systems and vegetated systems, utilize basic design characteristics to that focus on the experience of storm water in a way that increases the landscape's attractiveness or value. The focus however on the evaluated systems within Anneberg Park is on each system's structure and planting material, instead of how hard conveyance systems are utilized.

SMS Amenity Goal Examples: Echols & Pennypacker et al. (2007)

education

Ways to Learn: Signage and programming acknowledging and explaining SMS is very important in educating the public of each system's importance, to the site and the surrounding environment. Figure 3.8 illustrates how signage is incorporated within a seat wall, explaining what the system consists of and how it works.

Ideas to Learn: It is important, in addition to signage, to make reference to the hydrologic cycle, water conditions, water treatment types, treatment system impacts, riparian plant types, and riparian wildlife through design techniques that engage the user visually, physically, and mentally. Figure 3.9 visually tells of the relationship between rainwater that falls in an urban setting and salmon that are local to the area. The salmon appear to be swimming toward the scupper when stormwater pours out during a rain event.

Context for Learning: Spaces and circulation that interact with stormwater management systems provide opportunities for educating users as to what the system is providing and how water moves throughout the site. Figure 3.10 shows how circulation allows the user to interact and view the SMS from different vantage points; up close, from a distance, and from an elevated perspective.

legend

- stormwater amenity feature
- circulation

recreation

View: Incorporating basic concepts of circulation: pass by a space, terminating space, and pass through a space; allow the pedestrian to experience the SMS in different ways, at different stages of the system's cleansing and purification process. Figure 3.10 shows how these basic concepts are utilized.

Enter: Clear points of entry and circulation throughout interactive SMS help people to understand the level of interaction that is allowed. Design techniques that are visually inviting or mysterious are important to engage people with natural processes. Figure 3.11 illustrates an effective use of vegetation and pillars to direct the user to a lookout point that provides an aerial perspective of the site and the flow of stormwater throughout the site.

Play In: Interaction with natural systems is important in making a connection to those systems and acknowledging their reality. Simple techniques that allow the user to touch and explore the system are affective ways to encourage thought about what the system is doing and why. Figure 3.12 shows how a cistern collects rainwater from a rooftop and directs it to a series of planters, allowing the user to touch and see where the water is going and what it is being used for.

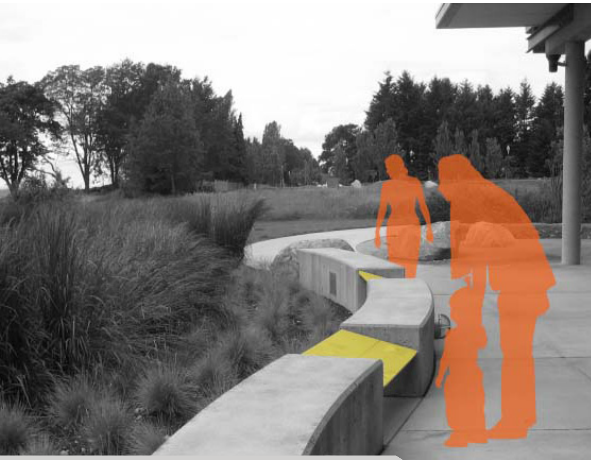


Figure 3.8 Ways to Learn
Image Edited by: Buffington, Jared - 2012
Source: http://www.artfulrainwaterdesign.net/projects/show/33

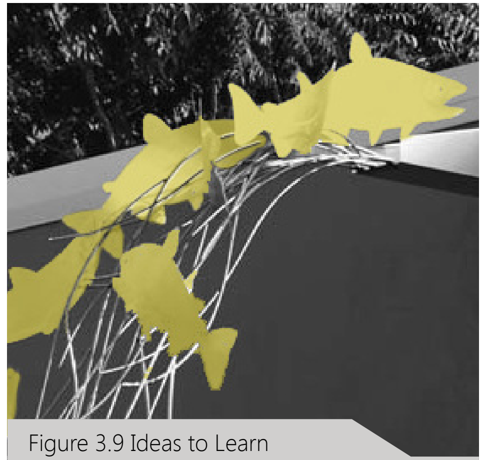


Figure 3.9 Ideas to Learn
Image Edited by: Buffington, Jared - 2012
Source: http://www.artfulrainwaterdesign.net/projects/show/30

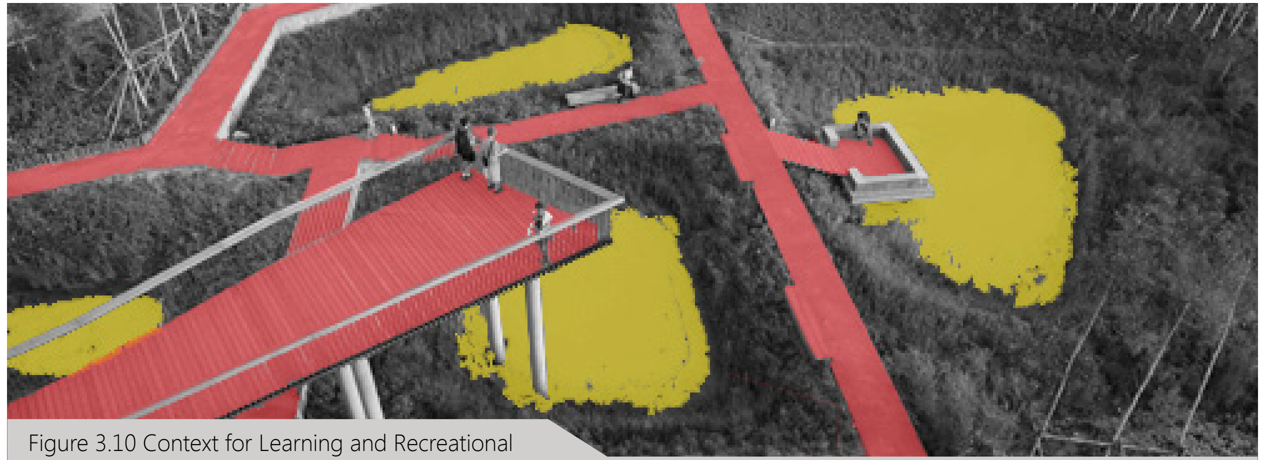


Figure 3.10 Context for Learning and Recreational View Image Edited by: Buffington, Jared - 2012
Source: http://www.turenscape.com/english/projects/project.php?id=435

Figure 3.11 Enter Recreation
Image Edited by: Buffington, Jared - 2012
Source: http://lornajordan.com/3/artist.asp?ArtistID=20609&AKey=2c782fms

Figure 3.12 Play in Recreation
Image Edited by: Buffington, Jared - 2012
Source: http://www.artfulrainwaterdesign.net/projects/show/27

public relations

We care: It is important to be aware of the impact that we as humans have on the environment. Implementing SMS near entries, courtyards, and highly visible areas plays a vital role in providing opportunities to educate people, as well as showing that the surrounding community cares about their ecological impact. (Figure 3.13)

We are progressive: New and innovative ways to display the flow of stormwater throughout a site help draw attention and make people aware of the designed stormwater system. Combining new ways to convey water with traditional treatment strategies makes a semiotic statement about the values of the designer or the owner of the site. Figure 3.14 utilizes downspouts and below-grade runnels to convey stormwater throughout the site into infiltration basins.

We are smart & sophisticated: Simple, elegantly designed SMS that utilize local, readily available materials show a degree of resourcefulness and distinction. Designed systems that incorporate multiple stormwater management practices while utilizing similar materials and implementation techniques point to a connection between design and natural processes. This connection between the needs of the surrounding environment and us humans is important to each systems utilization and sustainability. Fig. 3.15 shows how multiple SMS are utilized within a residential courtyard.

legend

stormwater amenity feature

aesthetic richness

Visual interest: Point, line, plane, volume, color and texture, axis, and rhythm and repetition are all basic components of spatial design. These components are directly applicable to the way SMS are visually designed and implemented to create exploratory, memorable experiences. Figure 3.16 shows how stormwater is elegantly directed throughout the site, disappearing and reappearing, encouraging further exploration of a meandering flow line.

Auditory interest: Sound can promote exploration and tranquility, encouraging one to find the source of the sound and encouraging one to sit and enjoy the sound. Figure 3.17 shows one component of the urban courtyard at 10th@Hoyt, Portland, Oregon. The courtyard utilizes a cistern that detains stormwater and recirculates it through flumes and corrugated chutes, dribbling across fountain surfaces, and dropping into river stone-filled basins.

Tactile interest: William H. Whyte et al. (1980) argues that touchable water features can be a major asset to public spaces, and to prohibit one from being able to touch the water is virtually a crime. Figure 3.18 shows how the designed “Cistern Steps” at Vine Street, Seattle, Washington, utilized steps that wrap around the basins of the catchment systems allowing pedestrians to interact with the flowing water as it pours out of the cantilevered scupper into the basin below.

Figure 3.13 We care
Image Edited by: Buffington, Jared - 2012
Source: http://www.artfulrainwaterdesign.net/projects/show/28

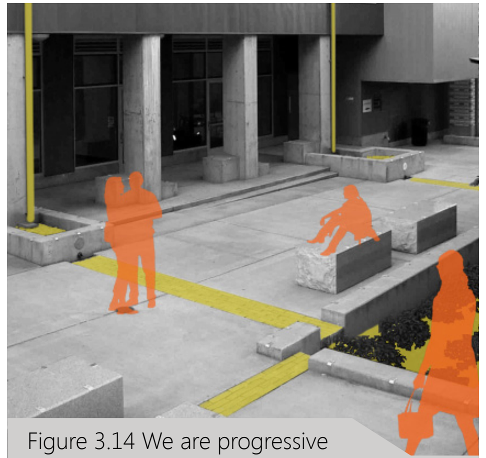


Figure 3.14 We are progressive
Image Edited by: Buffington, Jared - 2012
Source: http://www.artfulrainwaterdesign.net/projects/show/25

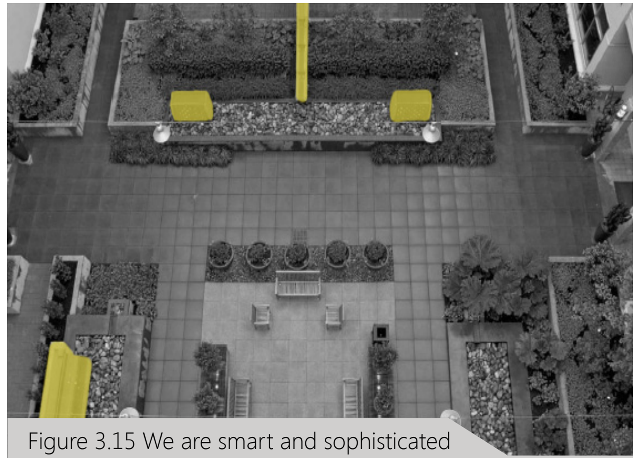


Figure 3.15 We are smart and sophisticated
Image Edited by: Buffington, Jared - 2012
Source: http://www.artfulrainwaterdesign.net/projects/show/1/

Figure 3.16 Visual interest
Image Edited by: Buffington, Jared - 2012
Source: http://www.artfulrainwaterdesign.net/projects

Fig. 3.17 Auditory interest
Image Edited by: Buffington, Jared - 2012
Source: http://www.artfulrainwaterdesign.net/

Fig. 3.18 Tactile interest
Image Edited by: Buffington, Jared - 2012
Source: http://www.artfulrainwaterdesign.net/projects/show/27

education

Education in the context of stormwater management systems (SMS) is understood as creating conditions for learning about stormwater systems, their associated vegetation, and issues related to their environmental importance. Education may occur as a “lesson learned” or, less didactically, in the form of an enriched experience of place.

Echols and Pennypacker et al. (2008) categorize the variety of educational opportunities they have found in case studies into three learning objective types: ideas to learn,ways to learn, and context for learning. These learning objectives are important in illustrating not only SMS ecological importance, but also their aesthetic capabilities.

Design techniques for providing education about SMS include how “ideas to learn” can be presented through visible and legible water trails or rich landscape narratives, and how descriptive signage provides effective “ways to learn” about both the environmental and aesthetic performance of plants within each SMS type evaluated; infiltration, filtration, and wetland systems.

Making the SMS visible and legible encourages visitors to notice and either instantly grasp the systems importance, or be compelled to explore the systems extent, by utilizing mystery, to hypothesize how the site manages runoff. Visible stormwater management systems combine effectively with signage to maximize educational opportunities. (Figure 3.19)

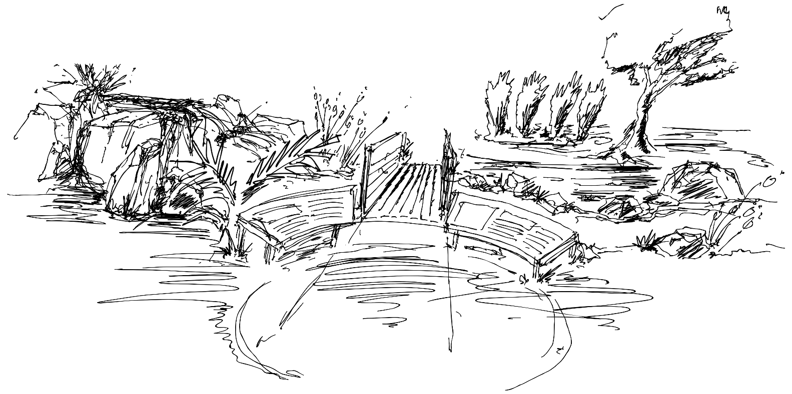


Figure 3.19 SMS Interpretive signage, split by pathway, illustrates the stormwater management system structure and importance.

Image created by: Buffington, Jared

recreation

Recreation in regards to SMS focusses on providing conditions favorable for interacting with the system in ‘relaxing’, ‘amusing’, or ‘refreshing ways’. In contrast to the education goal, the recreational goal addresses playful interaction; enjoyment is the primary intent. The distinction between education and recreation is very thin, but Echols and Pennypacker et al. (2007) present them separately to assist designers who may wish to focus on one goal instead of the other.

The three objectives of recreational interaction with SMS are: “view” (the opportunity to see water or the water system while relaxing within the landscape), “enter” (the ability to step into the water or water system and allow physical contact with it), and “play in” (the opportunity to engage with or modify the water or water system).

Some recreation focused design techniques were identified to be most evident and utilized: encouraging relaxed viewing through effective placement of seating; provide views of the storm water treatment SMS to people traveling along strategically placed paths; and the allowance of visitors to enter and play in the SMS.

To encourage viewing of a SMS, the most effective technique is providing adequate seating for viewing. Seating possibilities can range from wall, bench, or table and chairs, to a seat that invites people to pause and view their surroundings.

Recreational paths in strategic locations can also ensure that features are noticed. One strategy is to connect off-site destinations through on-site paths, compelling people to encounter the stormwater system as they traverse the site. (Echols & Pennypacker, 2007)

public relations

Public relations (PR) refers to either a specific feature or the character of the overall design that makes a symbolic statement about the values of those who designed or own the site. Echols and Pennypacker identify four broad PR objectives commonly utilized through SMS: “we care,” “we are progressive,” “we are smart,” and “we are sophisticated.”

The PR objectives “we care” and “we are progressive” should be communicated through clarity of the environmental objectives, or characteristics, of SMS. The design can exhibit what hydrological benefit is accomplished, and how. This characteristic overlaps that of education but the focus here is on the PR objectives and techniques; the values that are promoted and the ways that the SMS are designed in which to express those values.

PR can utilize educational techniques such as signage in the form of brightly colored signs with brief text and graphics. These types of signs should be strategically located along public sidewalks, briefly explaining how each facet of the SMS works and how the vegetation associated with it is utilized.

Education plays a mojor part in PR amenity goal applicaiton. However the major difference is that PR objects strive to inform the public not just of the importance of the identified system, but how someone might utilize SMS on their own lot to address stormwater conveyance and infiltration.

aesthetic richness

In SMS, aesthetic richness pertains to a design composition that creates an experience of beauty or pleasure focused on the stormwater and its vegetation. One could argue that aesthetic richness should be applied in all SMS goals presented; but richness of experience is sometimes created simply by the composition itself through an interacting combination of forms, colors, and sounds. Echols and Pennypacker et al. (2007) believe that an articulation of strategies that encourage attention to SMS strictly through compositional means should be utilized. In broadest terms, the composition may address visual, auditory, and tactile experience. Techniques such as a visually interesting line in the water trail, a strong rhythm through repetition of stormwater focused elements, a visual contrast between rocks and plants, an element of auditory interest, and an element of tactile appeal.

Visual emphasis on linear stormwater trails are frequently utilized SMS techniques: the line can be straight and entirely visible, making the trail very pronounced and bold; or it can meander or disappear in spots, making the trail puzzling or mysterious.

Another highly utilized compositional technique is repetition of stormwater elements to create visual rhythm (a strategy that also aids in hydrological function). By repeating a series of small treatment elements (bioswales, retention basins, or gabion walls) a designer can create a more effective and extensive stormwater treatment system than one limited to a single location.

Visual richness within SMS addresses contrast in color and texture by juxtaposing elements such as river rock and riparian grasses, especially rushes and sedges. Aesthetic richness within SMS is different than the Kaplans’ aesthetic performance in that this amenity goal focuses on engaging the public through conscious acknowledgement of SMS and what they provide. The Kaplans focus on aesthetic performance, or preference, in such a way that identifies unconscious evaluations of the landscape addressing what is preferred or not preferred in terms of a sites coherence, legibility, complexity and mystery.

vegetated stormwater management systems

Vegetated stormwater management systems have been increasing in application to retain and treat stormwater. (Shaw & Schmidt, 2003) These systems utilize natural processes such as microbial activity, filtration, infiltration, denitrification, nutrient reduction and evapotranspiration to achieve water-quality goals. Selecting plants suitable for SMS is not an easy process. Vegetated SMS are often affected by numerous different environmental conditions that are not conducive to sustainable plant growth. Environmental conditions that should be evaluated are prolonged flooding, fluctuating water levels, sedimentation, and pollution deposition. All of these factors address the tolerances or attributes that SMS planting material should have to some degree. Native plantings should be the initial focus of each SMS planting effort due to their hardiness, and the wide variety of functions they can provide. (Shaw & Schmidt, 2003) When selecting a planting palette for vegetated SMS you should utilize planting lists that have been researched and tested for their water quality treatment properties within the site design's geographical location.

The included SMS and their spatial, hydrologic, environment and economic, and planting palette characteristics are diagramed in relation to the example on the right. (Figure 3.20) The SMS provided are infiltration basins (Figure 3.21), on-lot infiltration systems (Figure 3.22), filter strips (Figure 3.23), bioretention systems (Figure 3.24), constructed wetlands (Figure 3.25), and wet swales (Figure 3.26). Adjacent to each diagram are the advantages and disadvantages for each system in relation to basic hydrologic, environmental, and economic criteria.

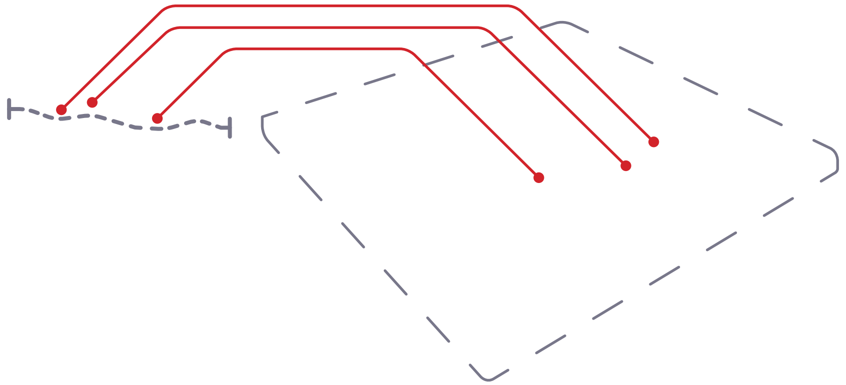
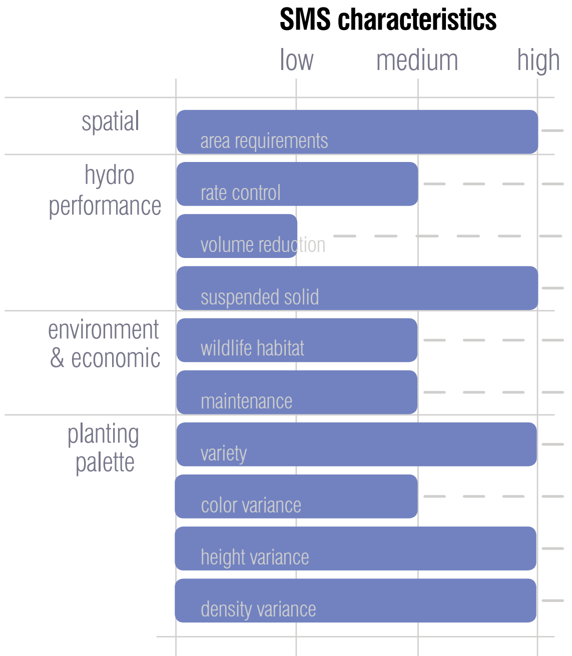


Diagram that shows an aerial perspective of each system's basic components and their relation to the system in section. This diagram is meant to show the basic structural elements of each system, however the images are not to scale.



Area requirements are determined for each system in relation to the percentage of the drainage basin in which the system must take up in order to perform hydrologically.

Rate control refers to a stormwater management system's ability to slow down and control the rate of which runoff moves across a site.

Volume reduction refers to a system's ability to reduce the amount of runoff that is distributed downstream from the location of the system. This helps to increase infiltration and decrease the amount of sediment carried downstream

Suspended solid refers to a stormwater management system's ability to reduce the amount of suspended particles carried by runoff; utilized as one way to indicate water quality

Wildlife habitat refers to a stormwater management system's ability to provide an adequate amount of resources for local and migrating fauna. This category typically relates directly to a system's spatial requirements.

Maintenance is indicative of each system's requirements for maintaining a working hydrologic amenity within the site, as well as the requirements to keep the system 'visually appealing.'

Planting variety is determined by the amount of different vegetation types that are best suited for each stormwater management system. Plant types include trees, shrubs, forbes and ferns, grasses, sedges and rushes; greater the type, higher the variety rating.

Color variance is indicative of each system's variety of color from plant to plant and through the each season. Higher the color variance and seasonal distribution of color, higher the color variance rating.

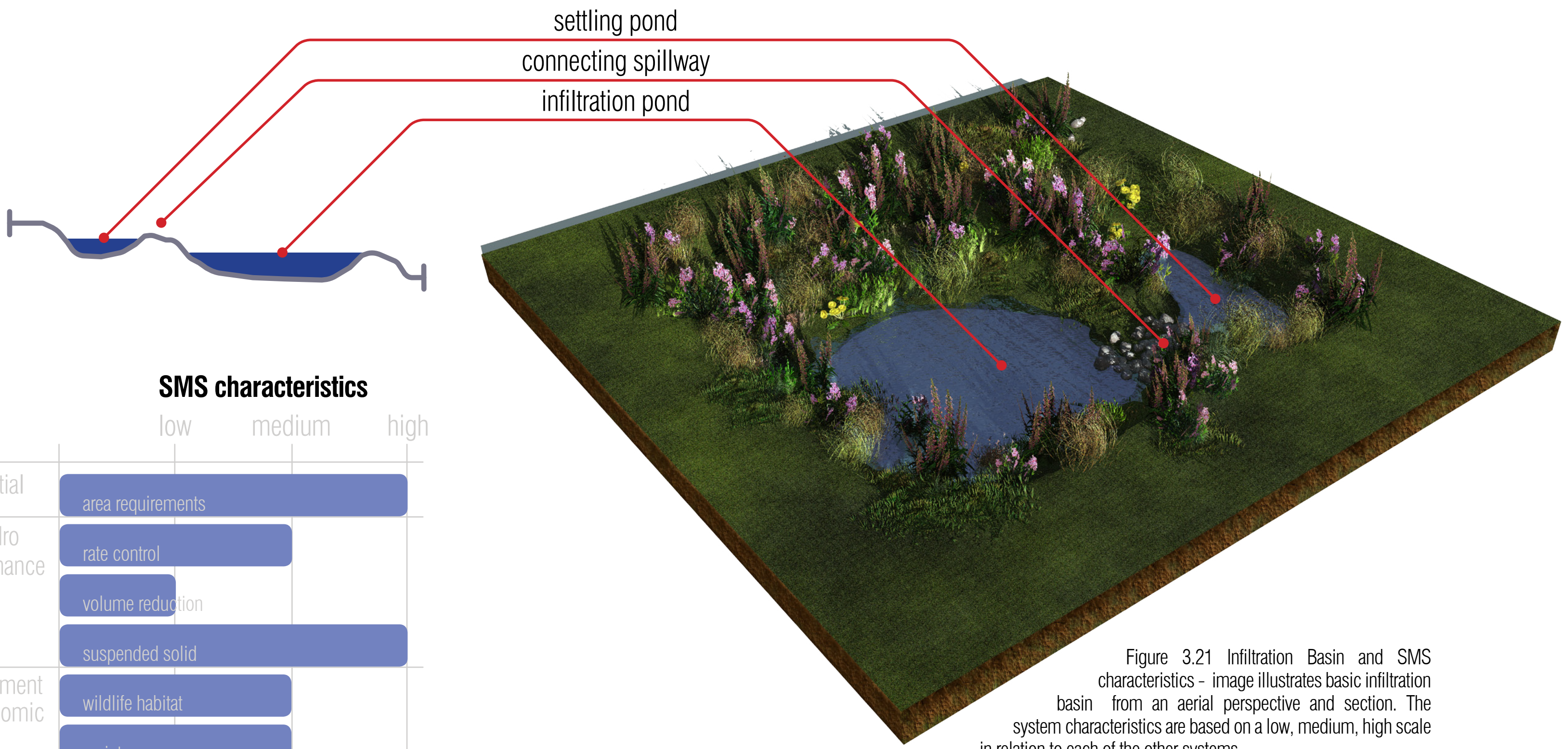
Height variance is determined based on four vegetation height categories and the variance of those categories within each system. The greater the variety of each system's height variance, the higher the rating.

Density variance is determined based on vegetation's growth habit density and its ability to screen views to varying degrees. The greater the density variety of each system's planting material, the higher the variance rating.

Figure 3.20 SMS diagram key with characteristic explanations

Image created by: Buffington, Jared - 2012

infiltration basin



SMS characteristics

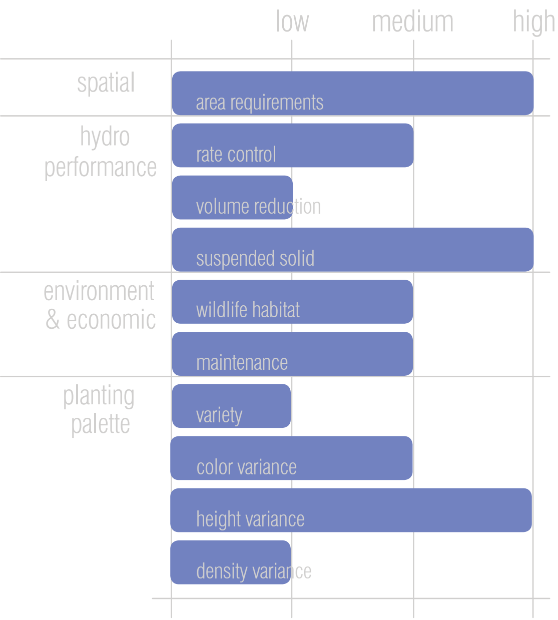


Figure 3.21 Infiltration Basin and SMS characteristics - image illustrates basic infiltration basin from an aerial perspective and section. The system characteristics are based on a low, medium, high scale in relation to each of the other systems.

Image created by: Buffington, Jared - 2012

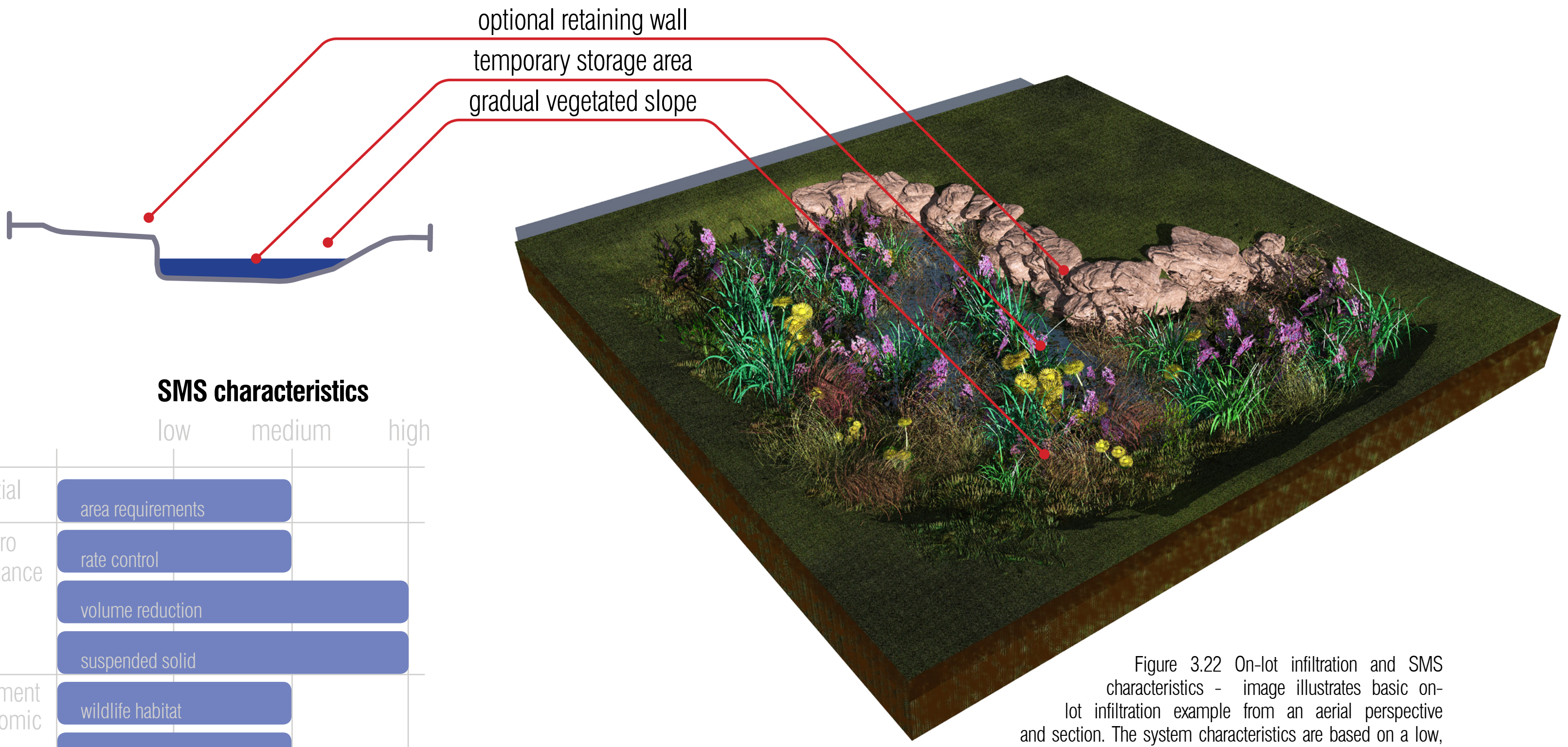
Advantages

Infiltration basins help reduce the volume of runoff from a drainage area; These systems can be very effective for removing fine sediment, trace metals, nutrients, bacteria, and oxygen-demanding substances; Reduces downstream flooding and protects stream bank integrity; Reduces the size and cost of downstream stormwater control facilities and/or storm drain systems by infiltrating stormwater in upland areas; Provides groundwater recharge and base flow in nearby streams; Reduces local flooding; Appropriate for small sites (2 acres or less) (Rozumalski, Hathaway, Anderson, Hellekson, Leuthold, Runke, Lindaman, & Kaul, 2001)

Limitations

Potentially high failure rates due to improper siting, design and lack of maintenance, especially if pre-treatment is not incorporated into the design; Depending on soil conditions and groundwater depth, a risk of groundwater contamination may exist; Not appropriate for treating significant loads of sediment and other pollutants because of clogging potential; Not appropriate for industrial or commercial sites where the release of large amounts or high concentrations of pollutants are possible; Requires a flat, continuous area; Requires frequent inspection and maintenance (Rozumalski, Hathaway, Anderson, Hellekson, Leuthold, Runke, Lindaman, & Kaul, 2001)

on-lot infiltration



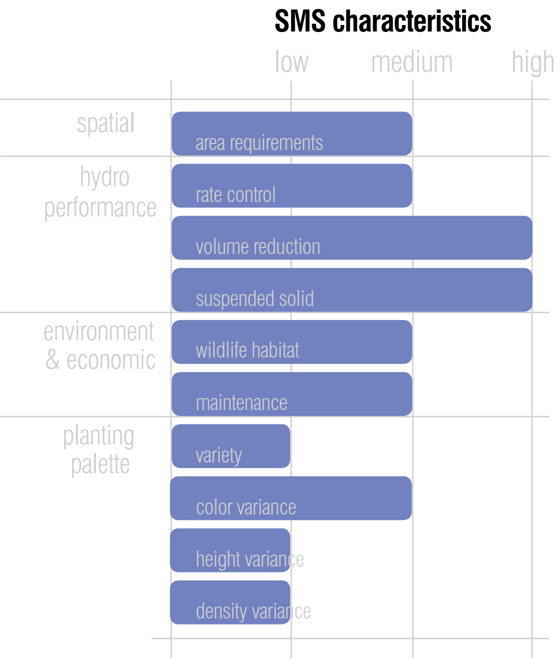


Figure 3.22 On-lot infiltration and SMS characteristics - image illustrates basic on-lot infiltration example from an aerial perspective and section. The system characteristics are based on a low, medium, high scale in relation to each of the other systems.

Image created by: Buffington, Jared - 2012

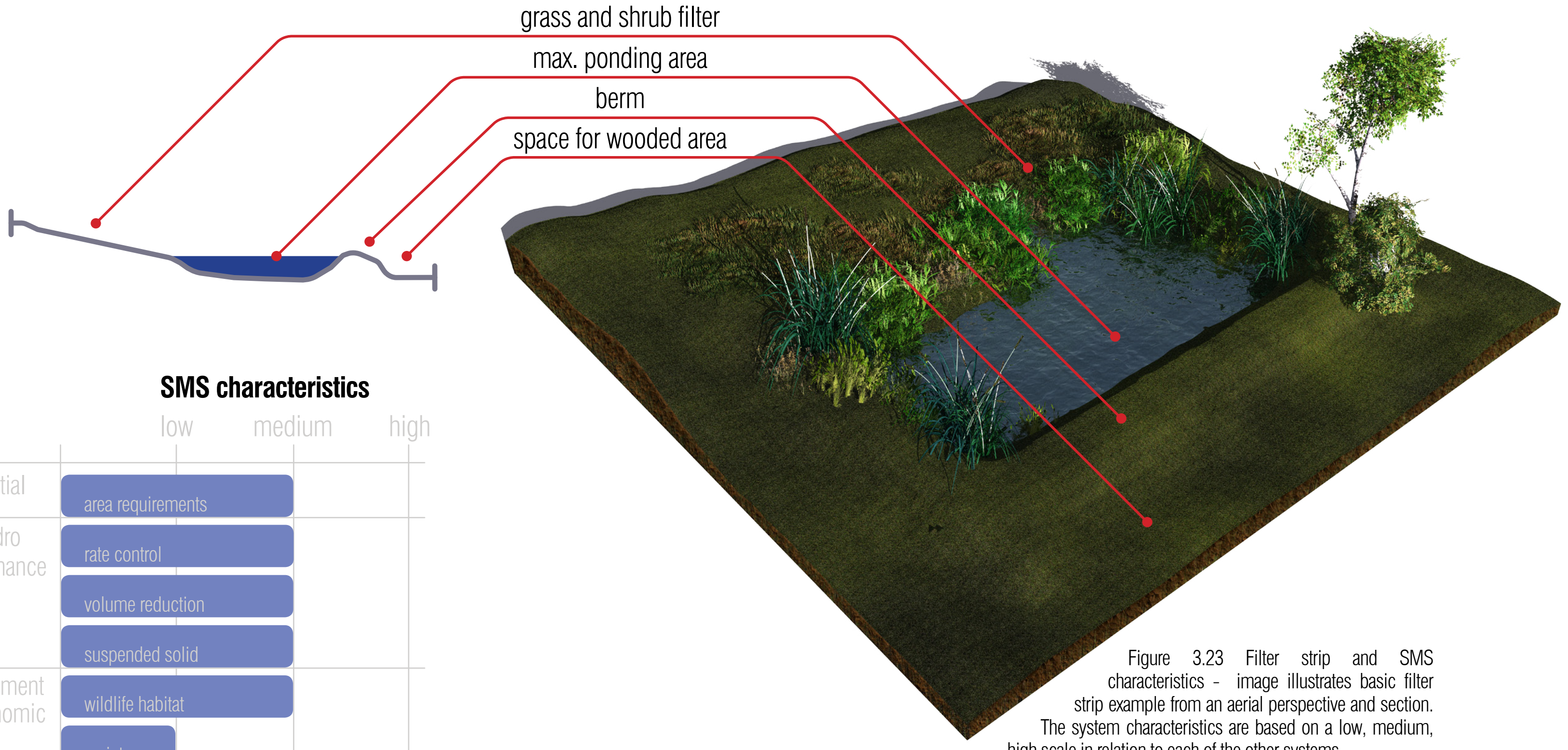
Advantages

Can reduce the volume of runoff from a site, thereby reducing the size and cost of downstream stormwater control facilities; Can be utilized in retrofit areas where space is limited and where additional runoff control is necessary; Rainwater gardens can provide an aesthetically pleasing amenity when designed to support perennial flowers in the summer and display vividly colored or patterned shrubs in the winter; The potential for clogging of rainwater gardens is reduced compared to end-of-pipe infiltration techniques (infiltration basins and trenches) because these systems generally accept runoff only from roofs or driveways, lawns and sidewalks; Can be used at sites where storm sewers are not available; Can provide groundwater recharge; Flowering plants and ornamental grasses incorporated into the design of rainwater gardens attract birds and butterflies (Rozumalski, Hathaway, Anderson, Hellekson, Leuthold, Runke, Lindaman, & Kaul, 2001)

Limitations

Only applicable in small drainage areas of a half-acre or less; Water ponding on lots may take 24 to 48 hours to drain, which may restrict some of the multipurpose land uses; Some maintenance (unclogging soak-away pits, periodically removing sediment from rainwater gardens) is required to ensure the proper functioning of these systems; However, sediment accumulation is indicative that the infiltration techniques are working; Not recommended for lots with high sediment loadings or contaminated runoff; If the infiltration rate of the native soils is low, these systems may not function as desired, The bottom of these structures should be a minimum of 3 feet above the seasonally high groundwater table to prevent the possibility of groundwater contamination (Rozumalski, Hathaway, Anderson, Hellekson, Leuthold, Runke, Lindaman, & Kaul, 2001)

filter strip



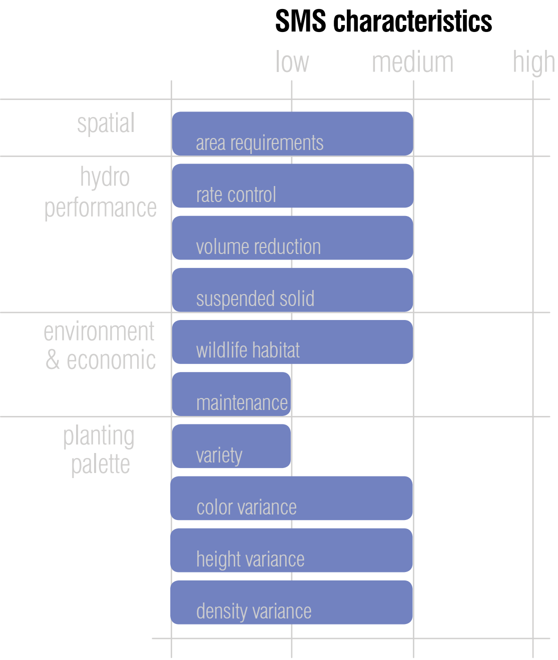


Figure 3.23 Filter strip and SMS characteristics - image illustrates basic filter strip example from an aerial perspective and section. The system characteristics are based on a low, medium, high scale in relation to each of the other systems.

Image created by: Buffington, Jared - 2012

Advantages

Filter strips help remove sediment and associated insoluble contaminants from runoff; These systems allow increased infiltration opportunity for soluble nutrients and pesticides to drain into the soil; Filter strips work well in residential areas, where they provide open space for recreation activities, help maintain riparian zones along streams, reduce stream bank erosion and provide animal habitat; Since they do not pond water on the surface for long periods, filter strips help maintain temperature norms of the water, thereby protecting or providing habitat for aquatic life; Filter strips can be useful as sediment filters during construction; Filter strips with taller, denser vegetation can help provide a visual barrier from such areas as roads, factories or recreation sites; Filter strips with dense native vegetation can trap dust blowing off a construction site; These systems are relatively simple and inexpensive to install, employing only planting and perhaps some earthwork, and are relatively low-maintenance practices; Filter strips tend to be low-cost as well, since their plantings and maintenance often overlap with what would be done on the site regardless of stormwater management practices (Rozumalski, Hathaway, Anderson, Hellekson, Leuthold, Runke, Lindaman, & Kaul, 2001)

Limitations

Systems are not appropriate for hilly or intensively paved areas due to high-velocity runoff; These systems are difficult to monitor, and thus there is less available data on their effectiveness for pollutant removal; Use of filter strips tend to be impractical in watersheds where open land is scarce and/or expensive; In general, filter strips should not accept highly contaminated “hotspot” runoff, since infiltration could result in groundwater pollution and damage to vegetation; Filter strips tend to be poor retrofit options since they consume a relatively large amount of space and cannot treat large drainage areas; Improper grading can render the practice ineffective; Since filter strips cannot provide enough storage or infiltration to significantly reduce peak discharge or volume of runoff, the practice may be best implemented as one of a series of stormwater BMPs; Filter strips are most effective if sheet flow can be maintained through the filter strip (Rozumalski, Hathaway, Anderson, Hellekson, Leuthold, Runke, Lindaman, & Kaul, 2001)

bioretention

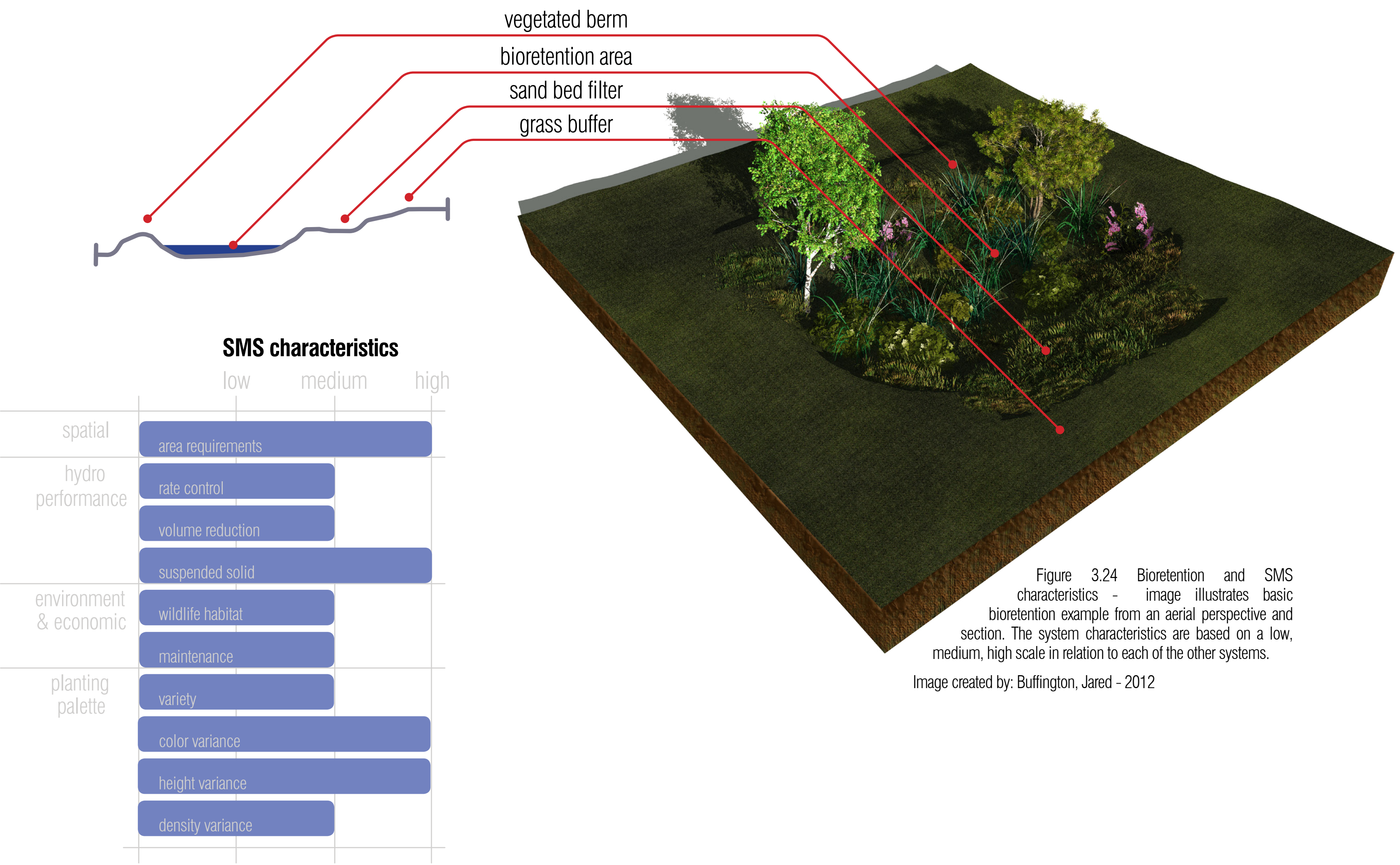


Figure 3.24 Bioretention and SMS characteristics - image illustrates basic bioretention example from an aerial perspective and section. The system characteristics are based on a low, medium, high scale in relation to each of the other systems.

Image created by: Buffington, Jared - 2012

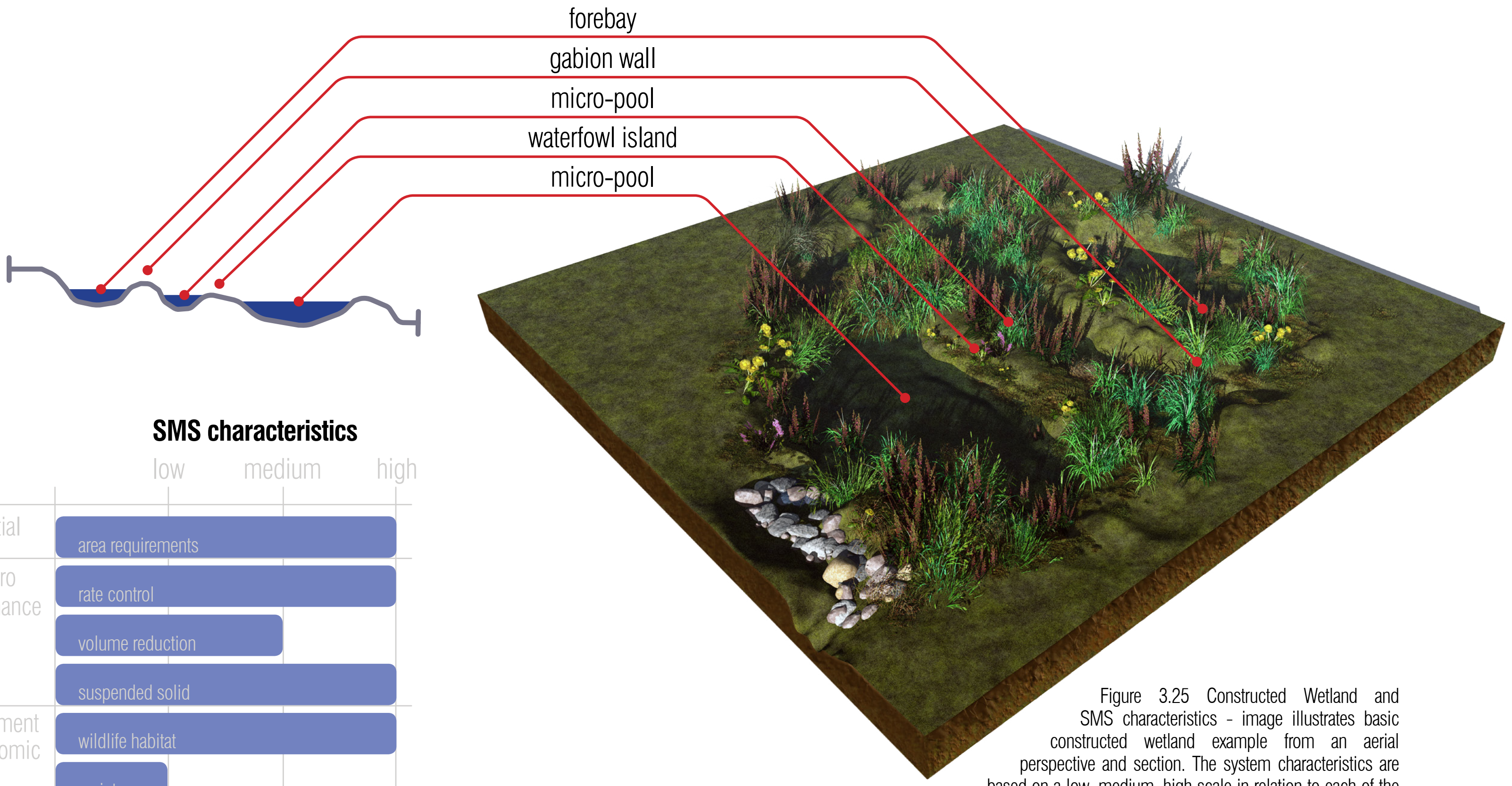
Advantages

When properly designed and maintained, system is more likely to be aesthetically pleasing than other types of filtration or infiltration systems due to incorporation of plants; Reduces the volume of runoff from a drainage area; Can be very effective for removing fine sediment, trace metals, nutrients, bacteria, and organics (Davis et al. 1998); Can be applied in many different climates and geologic environments, with some minor design modifications; Ideally suited to many highly impervious areas, such as parking lots; Reduces the size and cost of downstream stormwater control facilities and/or storm drain systems by infiltrating stormwater in upland areas; Reduces downstream flooding and protects stream bank integrity; Provides groundwater recharge and base flow in nearby streams, reducing local flooding; Can be used as a stormwater retrofit, by modifying existing landscaped areas, or if a parking lot is being resurfaced (Rozumalski, Hathaway, Anderson, Hellekson, Leuthold, Runke, Lindaman, & Kaul, 2001)

Limitations

Cannot be used to treat large drainage areas, limiting their usefulness for some sites; Susceptible to clogging by sediment, and therefore pre-treatment is a necessary part of design; Tend to consume space (usually around 5 percent of the area that drains to them); Incorporating bioretention into a parking lot design may reduce the number of parking spaces available; Construction cost can be relatively high compared with other stormwater treatment practices (Rozumalski, Hathaway, Anderson, Hellekson, Leuthold, Runke, Lindaman, & Kaul, 2001)

constructed wetland



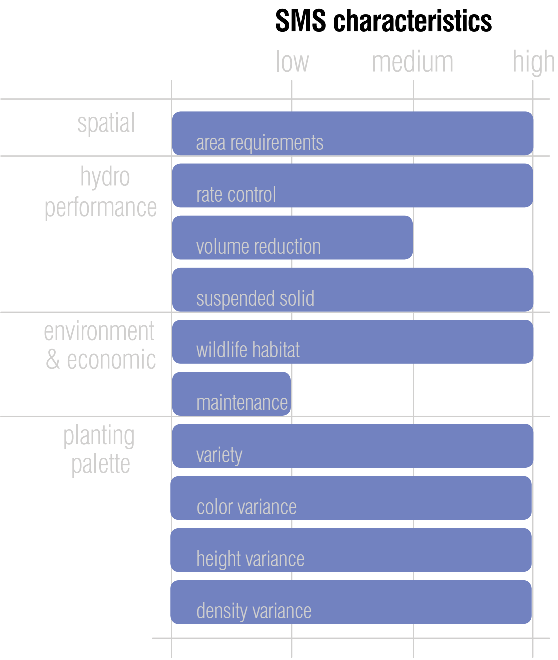


Figure 3.25 Constructed Wetland and SMS characteristics - image illustrates basic constructed wetland example from an aerial perspective and section. The system characteristics are based on a low, medium, high scale in relation to each of the other systems.

Image created by: Buffington, Jared - 2012

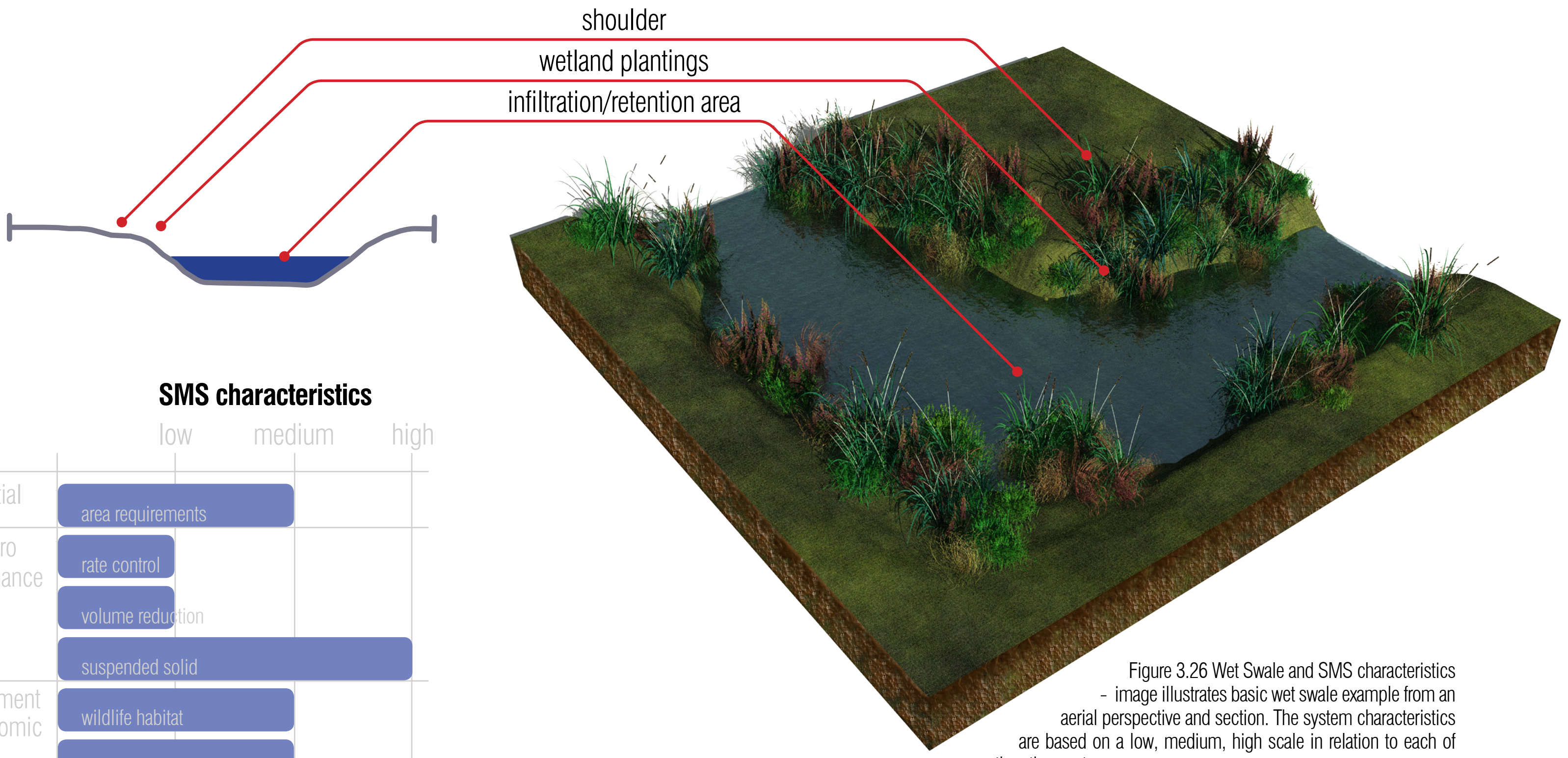
Advantages

Improvements in downstream water quality, settlement of particular pollutants, reduction of oxygen-demanding substances and bacteria from urban runoff, biological uptake of pollutants by wetland plants, flood attenuation, reduction of peak discharges, enhancement of vegetation diversity and wildlife habitat in urban areas, aesthetic enhancement and valuable addition to community green space, and relatively low maintenance costs (Rozumalski, Hathaway, Anderson, Hellekson, Leuthold, Runke, Lindaman, & Kaul, 2001)

Limitations

Release of nutrients in the fall, may be difficult to maintain vegetation under a variety of flow conditions; Geese may become undesirable year-round residents if natural buffers are not included in the wetlands design; May act as a heat sink and can change discharge warmer water to downstream water bodies; Larger land requirements than other BMPs; Until vegetation is well established – pollutant removal efficiencies may be lower than anticipated; Relatively high construction cost in comparison to other BMPs (Rozumalski, Hathaway, Anderson, Hellekson, Leuthold, Runke, Lindaman, & Kaul, 2001)

wet swale



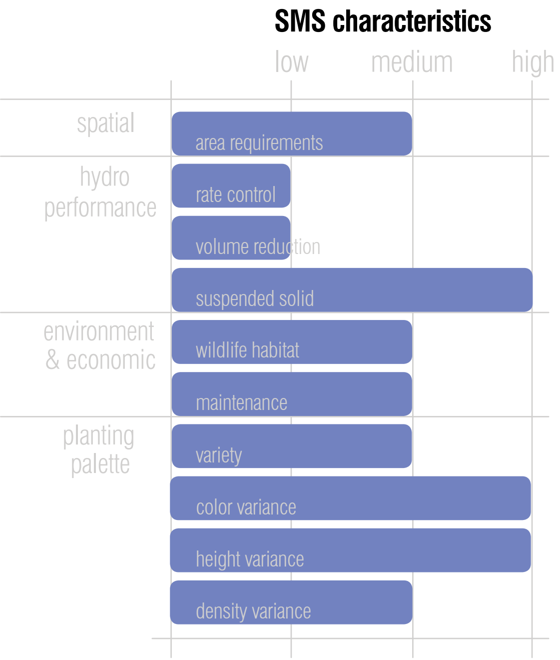


Figure 3.26 Wet Swale and SMS characteristics – image illustrates basic wet swale example from an aerial perspective and section. The system characteristics are based on a low, medium, high scale in relation to each of the other systems.

Image created by: Buffington, Jared - 2012

Advantages

Control peak discharges by reducing runoff velocity and promoting infiltration; Provide effective pre-treatment for BMPs in a series by trapping, filtering and infiltrating pollutants; Accents natural landscape; Reduces peak flows; Increases pollutant removal efficiency and promote runoff infiltration; Offer lower capital costs than traditional storm sewer systems; Convey water in properly protected channels; Divert water around potential pollutant sources; Provide water quality treatment by sedimentation and biological uptake; Enhance biological diversity and create beneficial habitat between upland and surface waters (Rozumalski, Hathaway, Anderson, Hellekson, Leuthold, Runke, Lindaman, & Kaul, 2001)

Limitations

Impractical in areas with very flat grades, steep topography, or wet or poorly drained soils; May erode when flow volumes and/or velocities are high during storm events; Area requirements can be excessive for highly developed sites; Roadside swales become less feasible as the number of driveway entrances requiring culverts increases (Rozumalski, Hathaway, Anderson, Hellekson, Leuthold, Runke, Lindaman, & Kaul, 2001)

04 DESIGN EXAMPLES & EVALUATIONS

SMS Design Alternatives

In order to evaluate SMS ability to perform aesthetically and as amenities, four different design approaches, or schemes, are utilized (Figure 4.1). By providing multiple design alternatives, a range of variables for each system can be identified. These variables illustrate components, both system structure and the planting material associated with each system, that enhance or diminish their aesthetic and amenity performance.

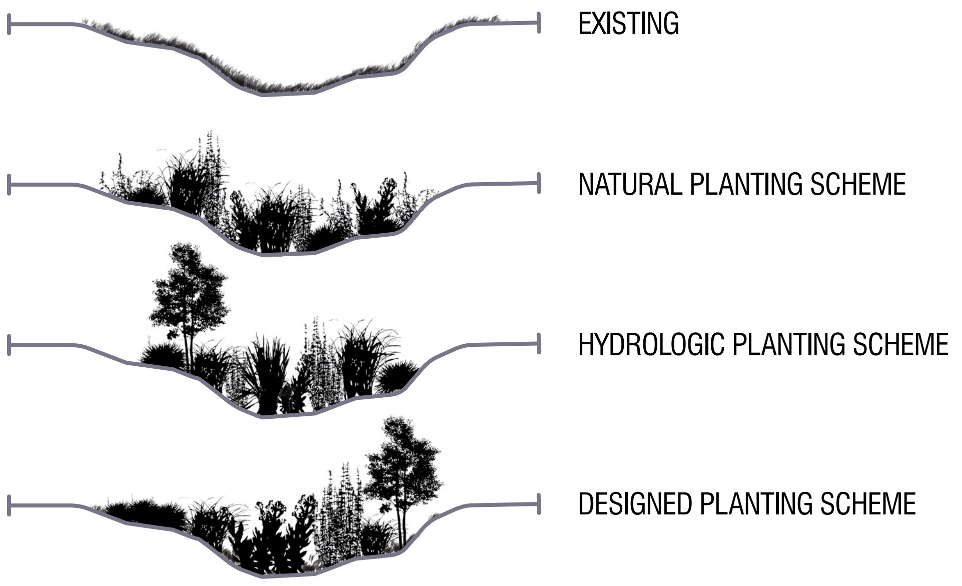


Figure 4.1 SMS Design Schemes - image illustrates simple sections of each SMS design scheme: existing, natural, hydrologic, and designed scheme.

Image created by: Buffington, Jared - 2012

Natural Planting Scheme:

This planting scheme is seen by most people to be one of the major aesthetic problems with vegetated stormwater management systems. (Echols, Pennypacker, 2007) A natural, or seemingly scattered planting scheme can appear unorganized and not well kept. However, studies have also shown that increased plant diversity has higher attributed landscape aesthetic to a some extent. (Lindemann-Matthies, Junge, & Matthies, 2010) While a varied planting scheme within SMS begins to address ecological and habitat characteristics, it neglects to accomplish a degree of organization that allows the design of coherent and legible spaces. SMS with a natural planting scheme provide very useful environmental and hydrological functions in relation to each type of system's design.

Hydrologic Planting Scheme:

A hydrologic planting scheme addresses the predicted water level (in relation to frequent rainfall amounts) within each system and applies plants that are best suited for water fluctuation within each zone. The four zones, or communities, utilized within this scheme are the emergent zone, wet meadow zone, floodplain zone, and upland zone. (Shaw & Schmidt, 2003) The emergent zone is approximately 0-18 inches deep and located generally where benches are designed within each system. Wet meadow zones are consistently moist and can become inundated. The floodplain zone is normally dry but may flood during large storms, requiring the planting material to be adapted to hydrologic extremes. The upland zone is seldom inundated allowing a wide variety of plant species; mostly depends on site conditions. This scheme allows an additional level of organization to SMS, increasing the survival and sustainability of the system from a hydrological standpoint.

Designed Planting Scheme:

The designed planting scheme builds upon the hydrologic scheme by further categorizing the identified planting zones by characteristics such as height, color, and texture to apply the basic design principles: form, line, shape, space, and value. This categorization allows application of different planting material best suited for aesthetic performance within the landscape. A designed scheme for each SMS within the context of Anneberg Park addresses the existing site characteristics and functions, as well as added points of interest produced by the SMS themselves. This design alternative is able to direct views and place planting material based on not only their hydrological performance, but also their aesthetic and amenity performance capabilities.

Aesthetic & Amenity Performance Evaluation

The Kaplan's research on human reaction within the landscape guides the assessment of design alternatives for SMS within Anneberg Park in ways that benefit people. Variables are identified within the evaluations that both support the understanding and exploration patterns and neglect to enhance the patterns. These variables are listed at the end of each system evaluation in relation to their pattern topic.

The evaluations are conducted in such a way that identifies each systems ability to enhance the coherence, legibility, complexity and mystery of a site through the application of the Understanding and Exploration framework. So, do the design alternatives in any way provide gateways or partitions, promote or direct locomotion through trail interaction, provide or direct views of the SMS itself or of vistas beyond, or provide elements within a place or enhance a place through spatial definition and degrees of enclosure? These are the questions that were asked to evaluate each system scheme on its aesthetic performance.

The concluding variables illustrate techniques that can aid site design in relation to how SMS can increase the aesthetic performance of a site.

Echols and Pennypacker et al. (2007) provide a set of goals and techniques that are related to the design of SMS within the urban context. These goals (education, recreation, public relations, and aesthetic richness) were derived from the research on urban stormwater designs that utilized conveyance in the form of troughs, runnels, or flumes to expose the water's path and inform the public. This technique is effective at drawing attention to the stormwater system, but it does not address BMP characteristics such as volume, frequency, duration, or quality. While conveyance systems can create awareness of stormwater, they do not aid in educating people about the environmental issues or SMS treatment potential.

Filtration, infiltration, and constructed wetland systems in contrast have been less of a stormwater-focused amenity. (Echols & Pennypacker, 2007) This lack of amenity focus is more than likely due to the fact that these systems focus less on fast conveyance of stormwater and more on volume, duration, and water quality through water retention and infiltration. In addition, these systems tend to need informative signage as to inform the public of their ecological importance.

The Kaplan's framework for designing and managing the natural environment works in combination with Echols and Pennypacker's SMS amenity goals by providing a way to address the design of the more natural, hydrologically important infiltration, filtration, and constructed wetland systems that are less utilized, or visualized as amenities within the landscape.

By evaluating these systems on both their aesthetic and amenity performance within the landscape, congruencies can be found as to what systems and their planting palettes can provide or foster a greater understanding of their hydrological importance in relation to the identified amenity goals.

Evaluations of four alternatives for three different SMS designs within Anneberg Park, Manhattan, Kansas are provided within this chapter. Each design includes a brief of the design intent within the site and an overview of the design evaluations for each scheme (existing location, natural planting scheme, hydrologic planting scheme, and a 'designed' planting scheme). Critical notes taken during each aesthetic and amenity performance evaluation are included in Appendix C.

Filtration - SMS design #1

Existing

The northern portion of Anneberg Park, just south of the maintenance facility (Figure 4.2), was chosen for filtration system implementation in order to address hydrologic and social dilemmas. The existing SMS utilizes grass swales and collection areas to direct runoff into underground piping, eventually emptying the runoff into the detention pond to the southeast. The conveyance system collects runoff from the northwestern soccer field as well as from portions of the street to the north, directs it southwest adjacent to the maintenance shed into a pipe inlet. The overflow from the pipe inlet is allowed to bypass the existing berm further to the west until the runoff reaches another pipe inlet that carries water to the detention pond.

The placement of this stormwater filtration system is important to helping filter out potential pollutants being carried by stormwater from the street and maintenance area to the north. In addition to the hydrologic dilemmas being addressed, the implementation of a SMS in this location will help address the need for a screening element between the adjacent pavilion and the maintenance area to the north.

Evaluation Overview

The existing swale system does not provide any type of visual barrier from the east side of Anneberg to the west side, failing to help break down the expansiveness of grass (Figure 4.3), decreasing overall site legibility an the opportunity for additional design complexity. The system also neglects to provide partitioning from the pavilion area to the maintenance shed to the north. This lack of partitioning limits the application of gateways in order to improve orientation within the site by directing views.

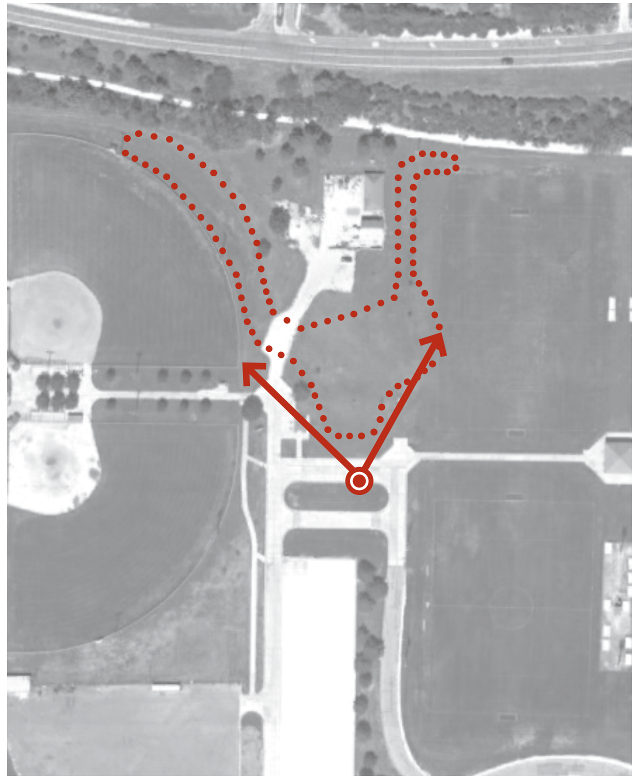
The existing system is adjacent to two pathways, a gravel trail to the north and a paved road to southwest. The system provides no directed views from any point along the two locomotion pathways, decreasing legibility and limiting the interaction between circulation and SMS.

In addition, the existing SMS does not provide an identified point of interest along either pathway due to its lack of distinctiveness, or legibility from the surrounding ground surfaces and its lack of vertical characteristics and degrees of enclosure. While the system is clearly visible from each circulation way, it neglects to address the specific characteristics of 'guiding the eye' to points of interest throughout the site. Ultimately, the existing SMS does not provide characteristics that encourage people to inquire as to what the system provides aesthetically or ecologically, decreasing opportunity for mystery and complexity within the site.

Existing area provides little to no characteristics of ways to learn about stormwater management through signage or context for learning through identified programming. While the area allows visibility, gathering, and interactivity within the system, none of these functions relate directly to the SMS aside from the fact that activities and circulation are allowed within the system.

The existing system is clearly visible within the landscape to the passerby, but neglects to address the specific characteristics of showing that the designers care about the publics view of the system in the form of an amenity; aside from the fact that the system directs flow and increases conveyance from existing amenities such as the soccer fields.

The existing grass swale and runoff accumulation system does not provide characteristics that directly accomplish the amenity or aesthetic performance goals and patterns to an extent that increases the overall site's coherence, legibility, complexity or mystery.



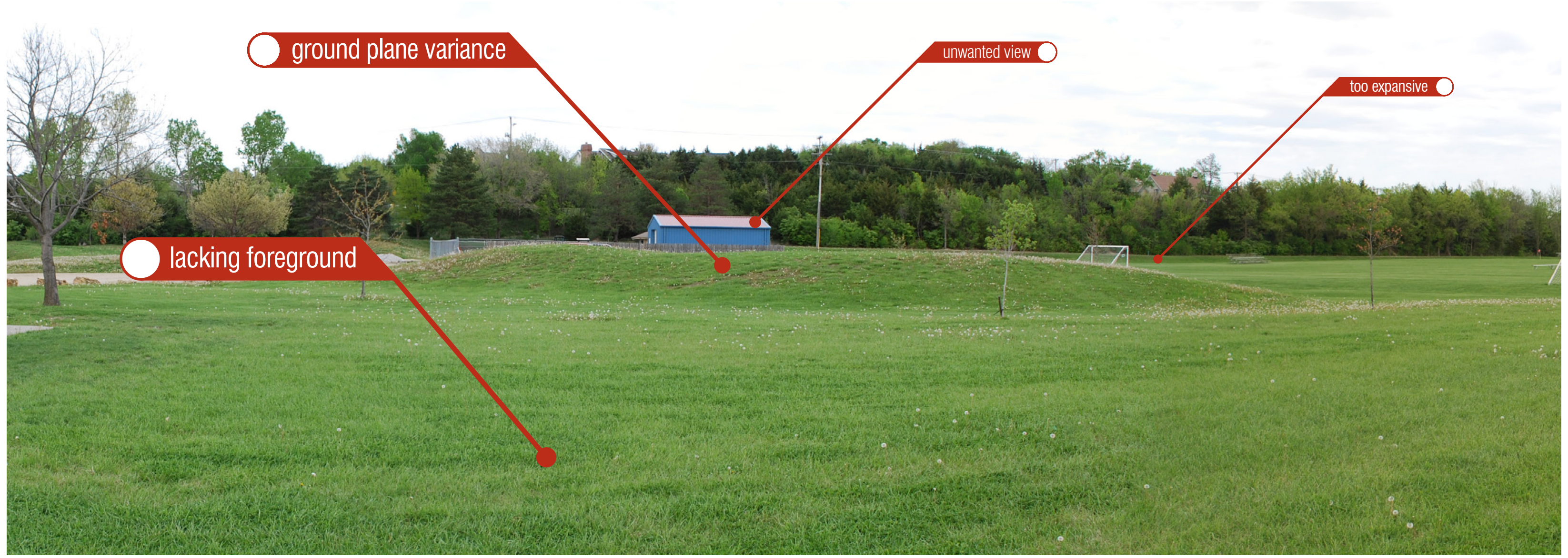


Figure 4.2 SMS Design #3 - Left: Existing location of SMS on Anneberg's north edge, plan view.

Edited by: Buffington, Jared   Source: Riley County GIS Data

Figure 4.3 SMS Design #3 - Top: Existing location of SMS on Anneberg's north edge, perspective image of existing aesthetic performance.

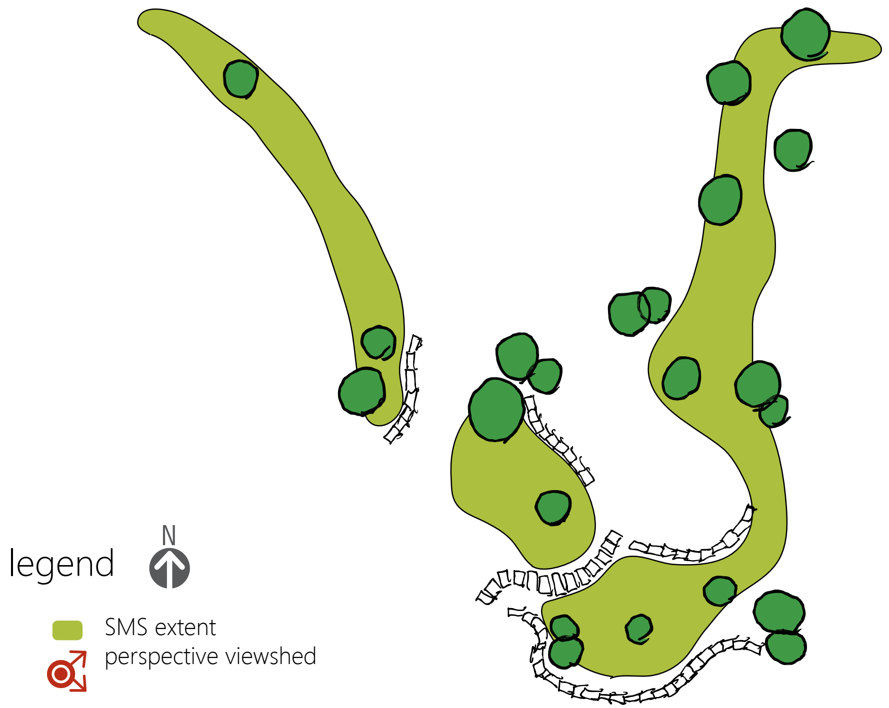
Image created by: Buffington, Jared - 2012

Natural Planting Scheme

The structural design of bioretention systems and filter strips typically make them ideal for application where there are spatial limitations at the edge of grass expanses. Gradual slopes help with the filtration process(dependent upon the overall basin size contributing to the trench), making them well suited for screening or partitioning, increasing coherence and legibility of spatial edges.

The natural planting scheme extent (Figure 4.4) utilizes the planting palette of both bioretention and filter strip systems to create varying degrees of partitions based on plant height, however with a sporadic planting placement gateways and unified partitions are not distinct and lack coherence in relation to locomotive and view direction. A natural scheme begins to perform as a successful partition on a larger scale (Figure 4.5), however it's coherent function on a smaller scale is not apparent due to its variety of height, color, and texture mixed together. The sporadic planting structure does however begin to increase orientation due to varying levels of planting material, limiting access to areas and informing circulation, increasing coherence within site context. A natural planting plan begins to limit and direct views and interplay with trails and locomotion, increasing orientation but still limits the coherence and legibility due to unspecified viewsheds. Small views of the system from the existing trail are evident in the foreground (Figure 4.5) but still larger views to the south part of the site are limited; reduces extent or depth cues, decreasing mystery and coherence.

A natural planting scheme provides a point of interest along the existing path, increasing a the possibility for orientation; but still lacks distinctiveness due to the sporadic planting plan.



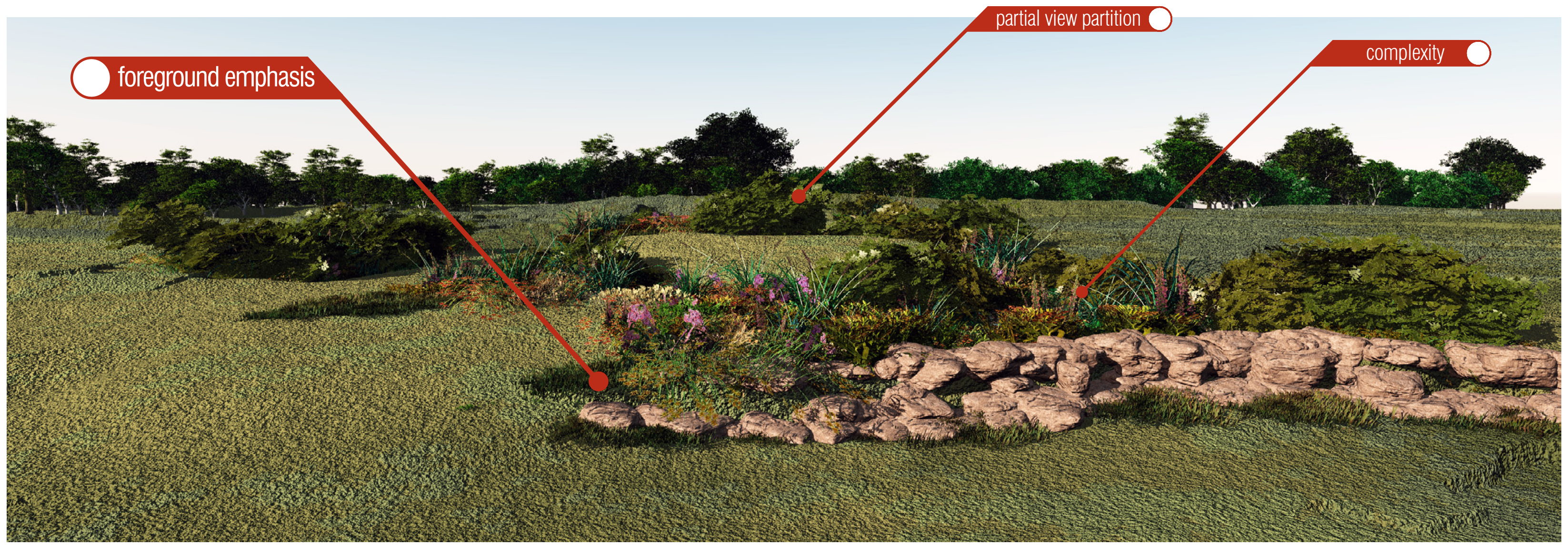


Figure 4.4 SMS Design #1 Alternative 2 - Left: Plan diagram indicating extent of natural planting scheme.

Figure 4.5 SMS Design #1 Alternative 2 - Right: Perspective illustrating and identifying aesthetic performance variables.

Images created by: Buffington, Jared - 2012

Filtration systems provide the opportunity for water interaction after rainfall events, but a natural planting scheme limits specific access to retained water.

A natural scheme within filtration systems incorporates basic information as to what the system provides hydrologically through signage, but understanding through plant association or location is limited due to sporadic plant placement. Ideas or techniques to learn are only illustrated by utilizing multiple stormwater treatment systems that include riparian vegetation, providing animal habitat to some degree.

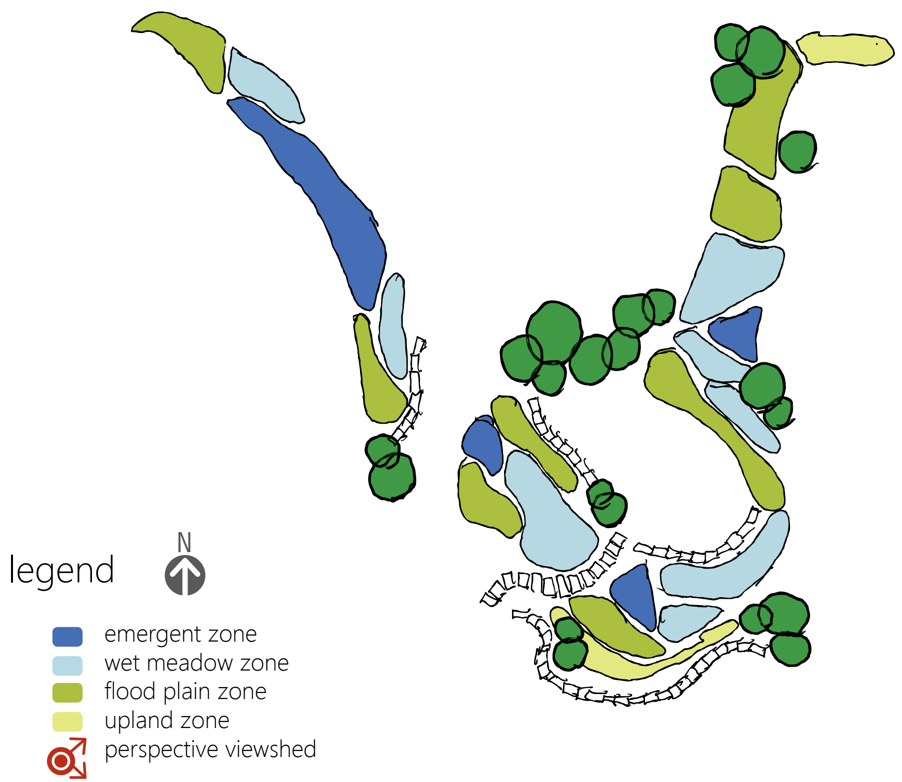
A natural scheme can provide insight as to how the application of a bioretention or filter strip benefits hydrologic and ecologic systems but only to the extent of what signage illustrates. Combining signage provides an informative ecological amenity but the design still lacks visual amenity characteristics through aesthetic performance.

The SMS is visible and identifiable as it winds between the north trail, the northeast soccer fields, pavilion, maintenance shed, and baseball fields to the west. However due to its sporadic planting scheme, the system as a whole does not perform perform or accomplish aesthetic patterns or amenity goals, limiting the increase of coherence, legibility, complexity, and mystery within the

Hydrologic Planting Scheme

A hydrologic alternative begins to break down the planting palette best suited for filtration systems into smaller groupings, limiting the variety of plants applied to each elevation within the systems hydrological structure, increasing its coherence to some extent. Increased coherence is attributed to an additional level of organization, decreasing the system's sporadic planting variation while maintaining a variety through the elevation differentiation.

The hydrologic planting scheme within the site context (Figure 4.6) provides the same characteristics in relation to trails and locomotion as the natural planting scheme (unless educated in SMS planting and hydrologic zones). However, an added level of design to system structure based on hydrologic zones, can increase the 'think view' characteristic of the system from a trail vantage point.



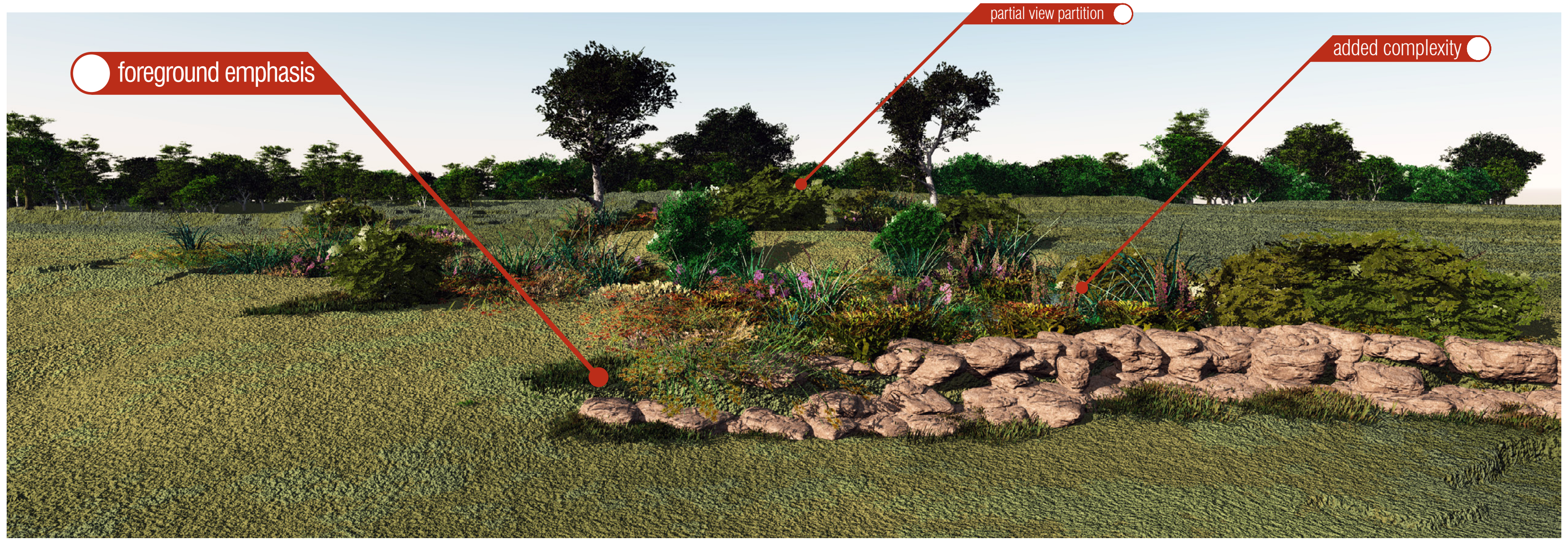


Figure 4.6 SMS Design #1 Alternative 3 - Left: Plan diagram indicating extent of hydrologic planting scheme.

Figure 4.7 SMS Design #1 Alternative 3 - Right: Perspective illustrating and identifying aesthetic performance variables.

Images created by: Buffington, Jared - 2012

An added level of design organization specific to hydrologic function that begins to address site specific characteristics in relation to where vegetation should be located, ultimately providing distinction and form specific to the system and its placement within the landscape. This helps to increase the complexity of the design (Figure 4.7), however it still limits the coherence of the system in relation to planting height, color, and density.

Without specific planting placement in terms of vertical structure, views and circulation have little guidance and direction from the northern trail and the paved road to the south. While this maintains a level of depth and extent, without focus in view direction and circulation its ability to increase complexity and maintain coherence is limited.

In terms of education, the hydrologic system in the context of the site, filtration systems can provide basic information as to what the system provides hydrologically through signage; an understanding through plant association or location is enhanced due to planting zone delineation.

This SMS location within Anneberg Park is visible from the existing pavilion and north trail, allowing the system to serve as spatial definers to some degree. This provides insight as to how the application of a bioretention or filter strip's hydrologic and ecologic systems can influence aesthetic patterns. Utilizing vegetated systems as spatial definers helps to illustrate stewardship through landscape and hydrologic focus; this association however is still limited to people with education in SMS and their associated planting material

The filtration systems as a whole provide an ecological and hydrological amenity but lack visual amenity characteristics through aesthetic performance

The hydrologic planting scheme does not specifically address basic design characteristics, but provides a diversity of planting material characteristics associated with defined planting zones. However, the basic principles of aesthetic richness and performance are not addressed to an extent that increases the site or systems coherence, legibility, complexity or mystery.

Designed Planting Scheme

Within the designed filtration scheme, vegetation height, color, and texture are utilized to help direct views, and create variety in color and texture within each hydrologic planting zone (Figure 4.8); increasing complexity but not at the expense of coherence and legibility.

Partitions are created by utilizing planting height categorization that screens the maintenance shed to the north. The system itself also creates a partition between the trail and the rest of the site to the south. These partitions allow the system to direct views to the south and distant pathways from the trail to the north (see Figure 4.11), increasing orientation and mystery, while also increasing comfortability by allowing views of the trail.

An additional pathway leading from the existing pavilion over a spillway to a terminating space within the filtration system allows the opportunity for mystery by adding screening vegetation at the system gateway. The added trail utilizes the system structure to cut through the stormwater system (see Figures 4.10 and 4.11), engaging the user with stormwater management processes (allowing interaction with the system, see related Amenity Goals pertaining to education and recreation). The terminating space provides a point of interest along the existing north trail, and also adjacent to the pavilion.

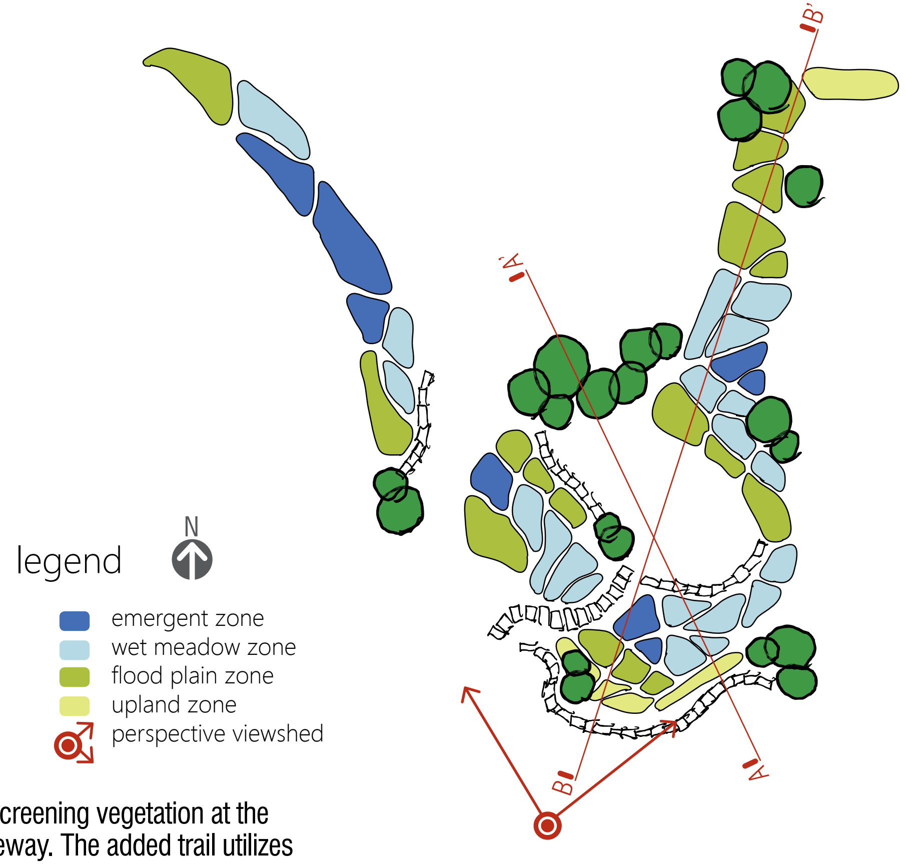


Figure 4.8 SMS Design #1 Alternative 4 - Plan diagram indicating extent of designed planting scheme.

Figure 4.9 SMS Design #1 Alternative 4 - Right: Perspective illustrating and identifying aesthetic performance variables.

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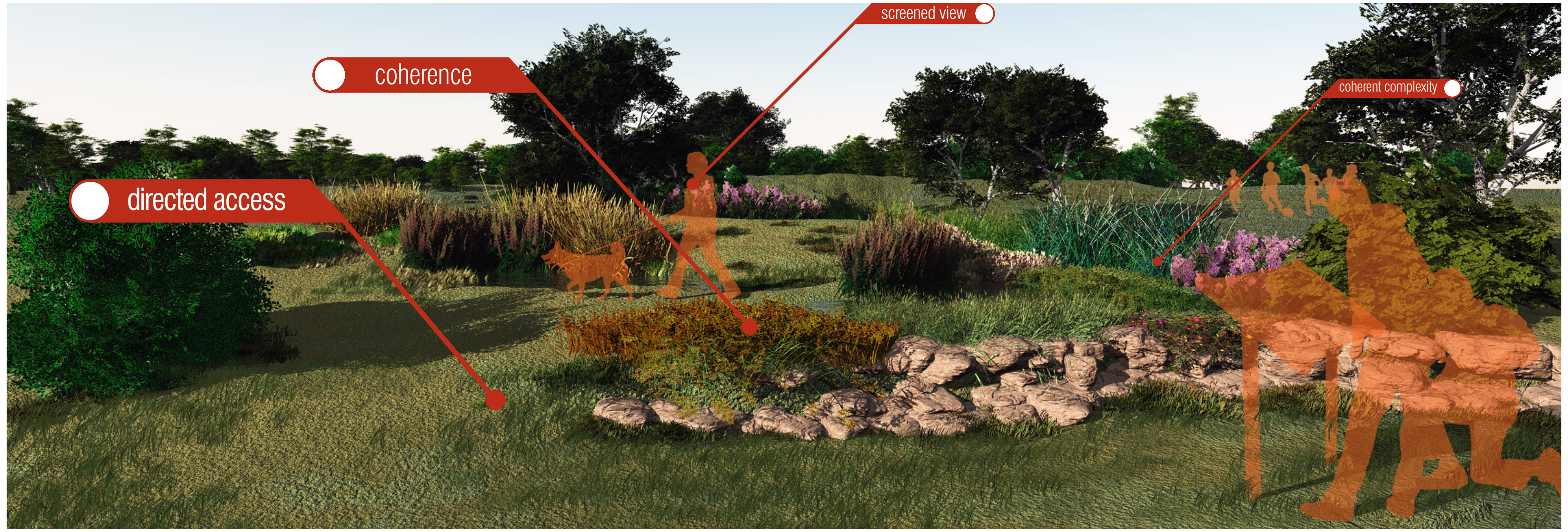


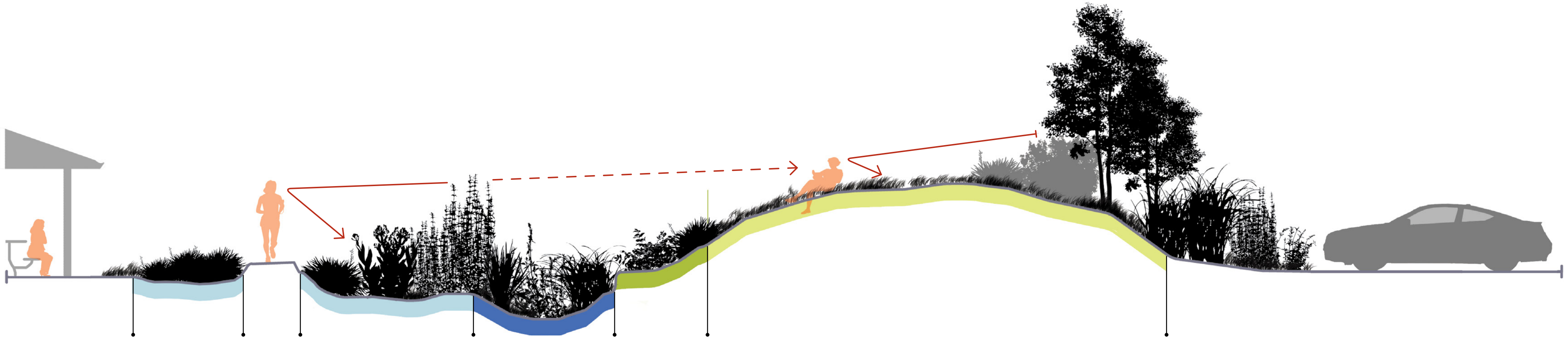
From the terminating space, near and far views are created of both the system and the extent of the site by utilizing specific vegetation suited for the located hydrologic zones, increasing legibility of the site and mystery of what areas can be explored.

The location of the system helps to divide the vastness of the soccer fields to the east from the baseball fields to the west, increasing coherence by breaking up an expansive area into smaller more comprehendible regions (Figure 4.9). The system's adjacency to the pavilion and trail fosters ideas to learn by utilizing multiple stormwater treatment systems that include specific riparian vegetation placement based on both hydrologic zones and view and circulation direction. The possibility of education is enhanced through plant grouping based on color, height, and texture, and each groupings relation to the hydrological zone delineation .

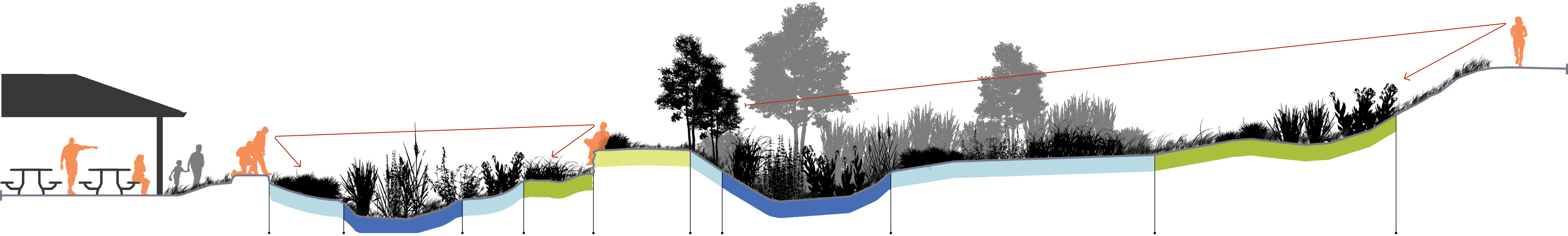
The designed planting scheme of a filtration system provides insight as to how the application of a bioretention and filter strip benefits hydrologic and ecologic systems. In addition, the system design focusses on plant location by further categorizing hydrologic zones by color, height, and density, illustrating stewardship through landscape and hydrologic care.

The design system ultimately provides an ecological and hydrological amenity as well as an aesthetic performance amenity by illustrating careful design and plant placement. The categorized hydrologic planting scheme begins to address basic design characteristics by utilizing color, line of site, volume and texture, view axis, and repetition to increase the coherence of the system and it's placement within the site.

The scheme allows aesthetic characteristics to become an association tool for identifying different hydrological zones, increasing aesthetic richness as well as the ability to learn about both hydrological and aesthetic performance characteristics.



A-A' Bioretention System Section - Facing west



B-B' Filtration System Section - Facing northwest

Sections illustrate the SMS hydrologic zones, planting height variance, and system and pathway interactions at spillways and gabion walls. Numbers correlate to aesthetic performance evaluations of Alternative 4: Designed Planting Scheme.

Figure 4.10 Top: SMS Alternate 4, Bioretention system section facing west.

Figure 4.11 Bottom: SMS Alternate 4, Filtration system section facing northeast.

Images created by: Buffington, Jared - 2012

legend

- emergent zone
- wet meadow zone
- flood plain zone
- upland zone
- obstructed view
- directed view
- blocked view

infiltration - SMS design #2

Existing

The western edge of Anneberg Park, just south of the baseball fields (Figure 4.12), was chosen for infiltration SMS implementation based on social and hydrological sight inventory. This portion of the site is located between a large parking lot, baseball fields, and a trail entrance that stretches over Wildcat Creek to the west, making it a transition area for different types of pedestrians; ones that arrive on site in a car and on foot.

The existing hydrology of the site directs sheet flow along the western edge of the baseball fields into a collection basin where it is then directed into Wildcat Creek. Sheet flow that is not directed into the collection basin continues to move southeast, across the gravel parking lot picking up sediment, eventually making its way to the large detention pond on site.

The placement of this set of infiltration systems was based on a need to decrease the direct flow of runoff carrying sediment from both the baseball fields and gravel parking lot into Wildcat Creek and the detention basin. In addition to the hydrological performance of this design, the system is meant to provide a visual barrier between the trail entrance and the parking lot, increase the degree of enclosure along a portion of the trail creating a more private transition space, and provide a partitioning element that helps to break up the expansiveness of the site; creating smaller, more comprehendible areas.

Evaluation Overview

The existing site provides little to no functional aesthetic in relation to gateways and partitions due to its limited vertical characteristics (Figure 4.13). Without elements to serve as partitions, gateways cannot be utilized to help direct views and circulation. This dramatically limits the opportunity for added mystery through complexity and encouraged exploration. Without vertical elements, focused views of foreground elements and distant views of vistas throughout the site are limited, if nonexistent. The existing area's characteristics lack a visual balance between open space and spatial definers, decreasing site coherence and degrees of enclosure.

The existing site location permits locomotion with no visual or locomotive barriers, increasing comfort in relation to legibility and coherence. However, the expansiveness of the area lacks characteristics of naturalness as well as a destination point along the perimeter trail (Figure 4.13); both important factors in trail design along with being able to separate the user from urban characteristics.

The existing conveyance system does not incorporate natural elements within or defining the space. This limits the areas potential for providing a point of interest or spatially defined area that directs or informs the public on the systems importance for stormwater management within the site.

In terms of amenity performance, the existing site does little to educate the public on the function of stormwater conveyance through signage, artful interpretation, or multiple types of stormwater treatment. While the grass conveyance system is adjacent to a trail, it does not provide a defined point of interest for resting and allows no specified interaction opportunities with the system (mainly due to the structural characteristics of a grass swale).

The existing grass SMS does not fulfill any of the public relation goals related to informing the public of the owner's or designer's care for stormwater management. The system does not illustrate how this sort of system can be utilized as a public amenity within the landscape through aesthetic richness techniques related to the basic design principles of point, line, volume

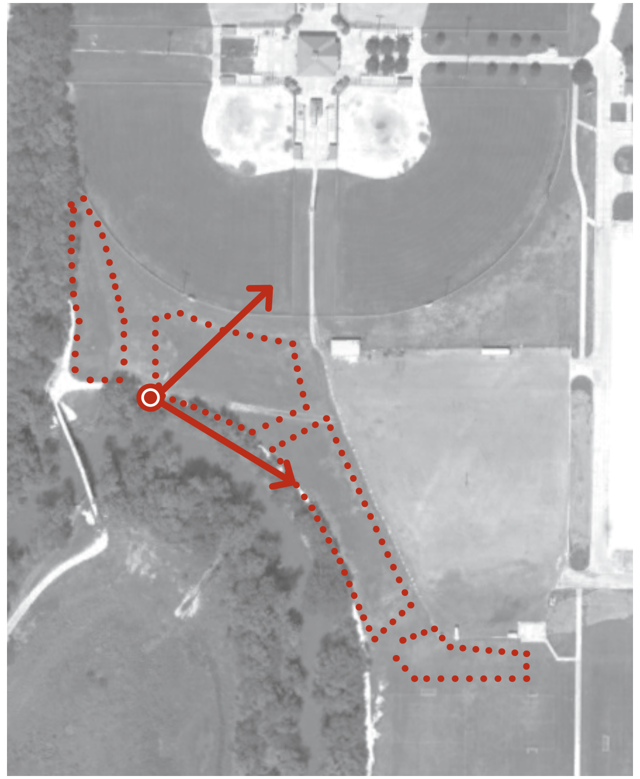


Figure 4.12 SMS Design #2 - Left: Existing location of SMS on Anneberg's west edge, plan view.

Edited by: Buffington, Jared   Source: Riley County GIS Data

Figure 4.13 SMS Design #2 - Right: Existing location of SMS on Anneberg's west edge, perspective image illustrating and identifying existing amenity performance variables..

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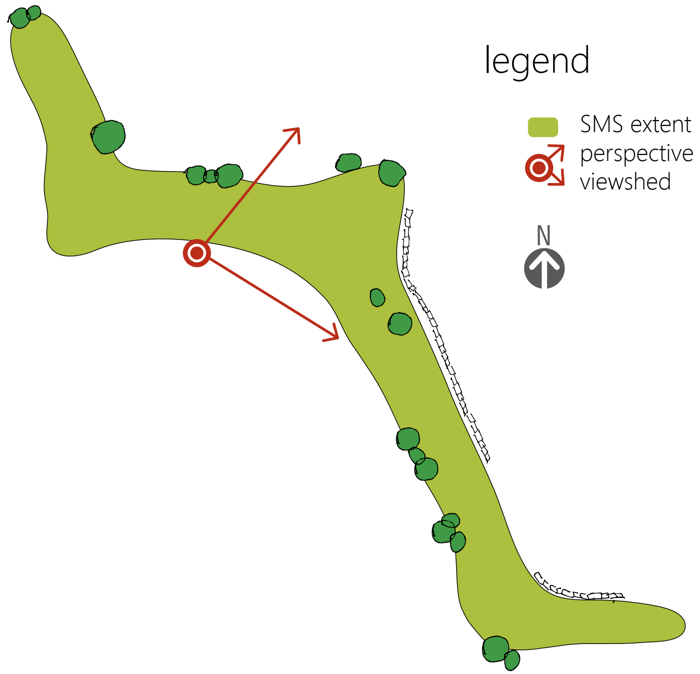

Natural Planting Scheme

The natural planting scheme extent (Figure 4.14) applied within this site context begins to spatially partition the trail from the parking lot, providing some degree of enclosure and begins to break up the expansiveness of the area. The added planting structure does allow circulation direction though, increasing the legibility of the immediate area. However, the natural characteristic of the planting scheme neglects to direct specific views toward points of interest, limiting the coherence of the system and the surrounding site beyond the foreground.

The added ground-plane structure of the proposed infiltration systems, infiltration basin and on-lot infiltration, aids in the application of partitions but limits the definition of gateways due to its seemingly sporadic planting placement (Figure 4.15). This initially increases the sites coherence by breaking down the space between the parking lot, trail entrance, and baseball field entrance to the south, but does not inform the user as to where points of interest or specific resting places along the trail might be by guiding the eye with planting material. Views and vistas are seemingly sporadic and have no direction towards the north east part of Anneberg Park, decreasing the amount of coherence and legibility of the site by increasing the amount of visual information for the user to interpret and compute.

To have a SMS that limits the site's coherence and legibility in a location where people might be first entering the park (from the trail entrance to the west) could reduce the understanding of how to maneuver throughout the space, reducing the user's level of comfort.

A natural planting scheme does however begin to provide a point of interest along the trail by encouraging visual interaction with

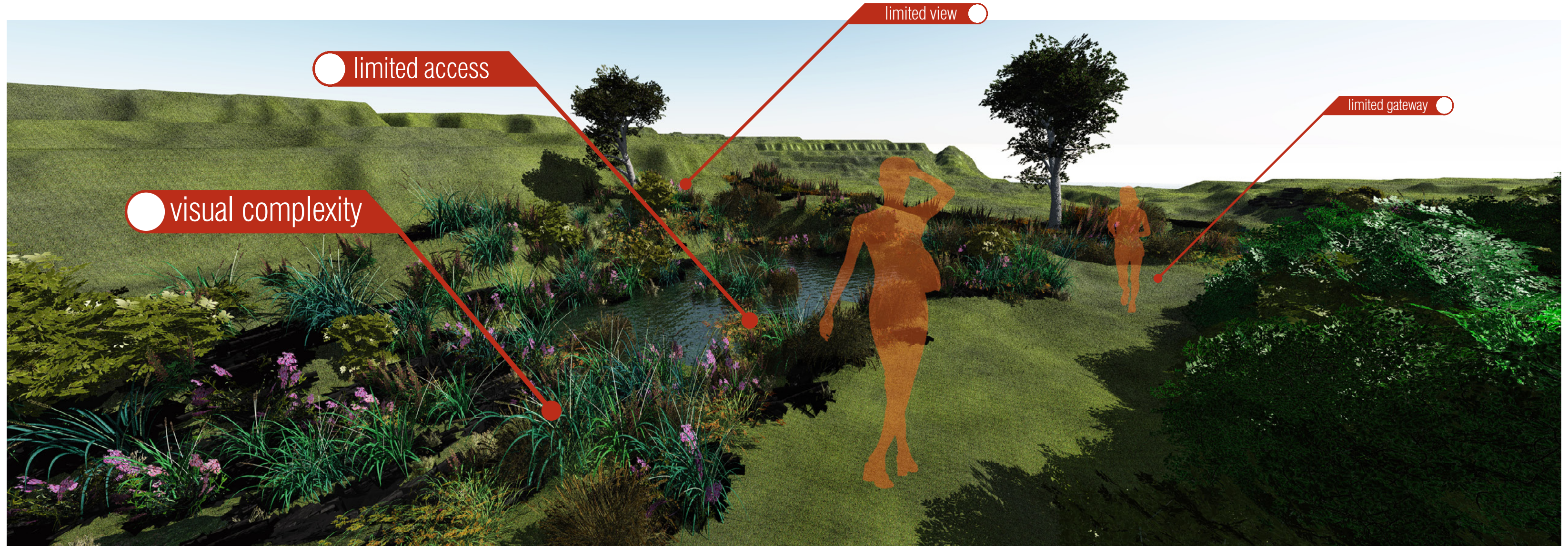

Figure 4.14 SMS Design #2 Alternative 2 - Left: Plan diagram indicating extent natural planting scheme

Figure 4.15 SMS Design #2 Alternative 2 - Right: Perspective illustrating and identifying amenity performance variables.

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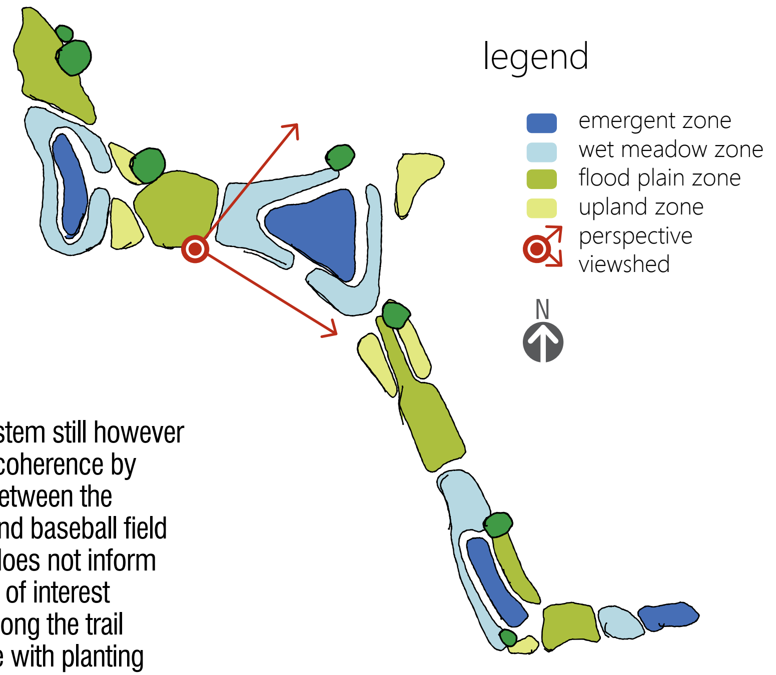
stormwater treatment. The problem with the natural planting scheme is that some people view them as messy or unkept, reducing their acceptability.

Infiltration systems provide the possibility to educate the public of their importance only through observation and the occasional informative sign. This still limits the amount of processable information to what the signage can illustrate. Education purely through adjacency to pathways is will not inform the passerby if they initially do not prefer the design or visual portrayal of he system through planting material.

The recreational opportunities with water within infiltration systems are limited because of their limited retention time. This characteristic is even more limited when combined with a natural planting scheme because it does not utilize vegetation that allows access to specific interaction points within the system.

The public relation goals for SMS begin to be addressed within infiltration systems by clearly identifying areas of temporary stormwater retention with the application of vegetation. The aesthetic richness of a natural planting scheme is limited however due to its sporadic color, height, and density characteristics.



Hydrologic Planting Scheme

A hydrologic planting scheme applied within this site context spatially provides a equivalent partitioning as a natural planting scheme between the trail from the parking lot and the baseball fields (Figure 4.16). The planting structure within a hydrologic scheme however still neglects to direct specific views toward points of interest such as the south baseball entrance (Figure 4.17); limiting the coherence of the system and the surrounding site beyond the foreground.

The ground plane structure of a hydrologic planting scheme does not alter the systems ability to serve as an immediate partitioning element. The planting scheme, although categorized based on hydrologic zone, still does not provide an organizational scheme that informs the viewer of what and where to look at. Specific directed views or identified points of access within the system are not enhance to a point that informs the user of key elements that might be found throughout the site. The system still however initially increases the sites coherence by breaking down the space between the parking lot, trail entrance, and baseball field entrance to the south, but does not inform the user as to where points of interest or specific resting places along the trail might be by guiding the eye with planting material. Views and vistas still appear ill defined due to the sporadic height and density characteristics associated with each planting zone. Views within this hydrologic planting scheme still give no specific direction towards the north east part of Anneberg Park, decreasing the amount of coherence and legibility of the site by increasing the amount of visual information for the user to interpret and compute; almost identical to natural planting scheme, but with added hydrologic importance.

Within this planting scheme comfort still poses a possible problem for people entering the park from the west trail entrance. While the system does provide some degree of enclosure, it still neglects to provide a point of interest along the trail by encouraging visual interaction and limitation within the stormwater treatment system. View are not limited to the point that both keeps the visual focus on the foreground in

Figure 4.16 SMS Design #2 Alternative 3 - Left: Plan diagram indicating extent hydrologic planting scheme.

Figure 4.17 SMS Design #2 Alternative 3 - Right: Perspective illustrating and identifying amenity performance variables.

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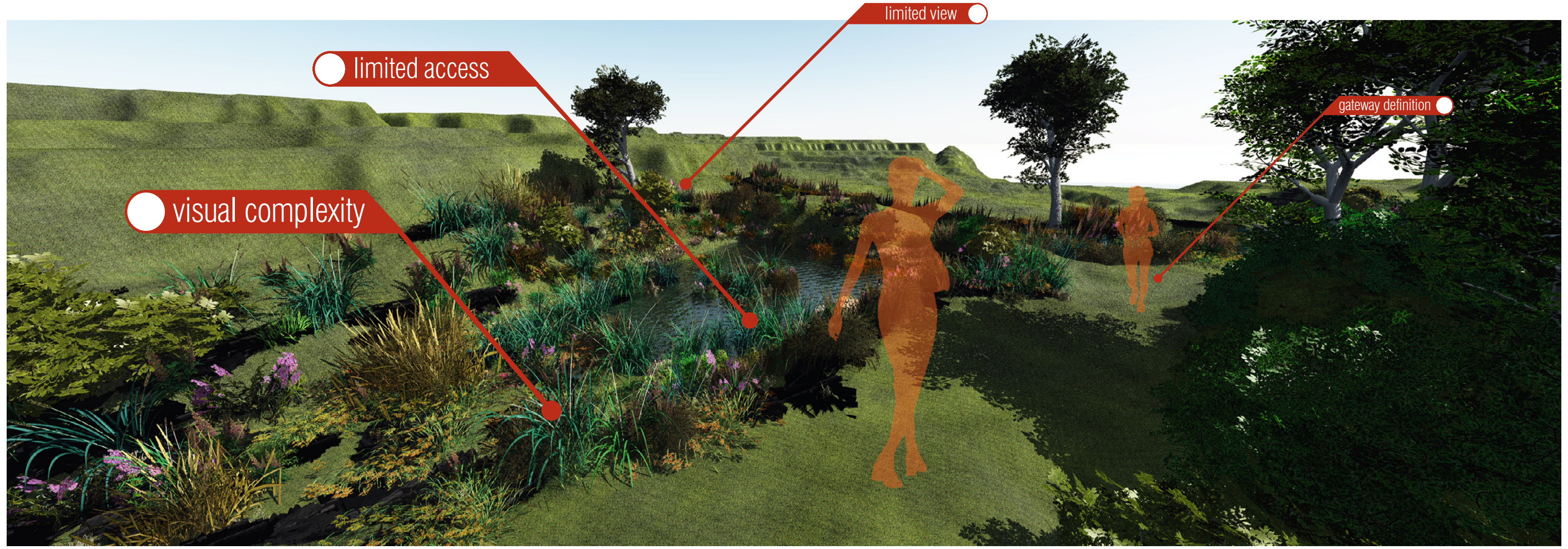
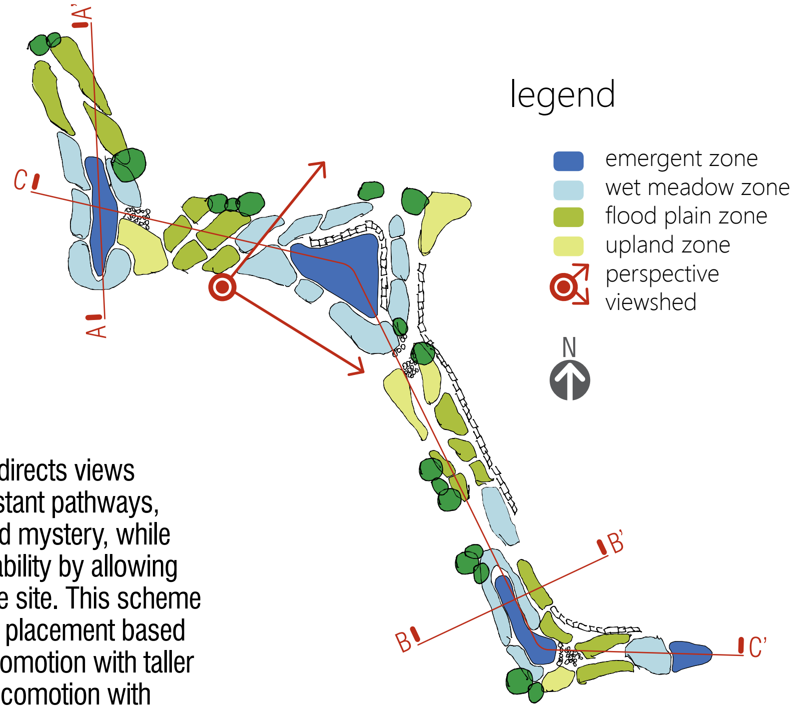


some areas and provide expansive views of the site in others. In addition, hydrologic planting schemes within infiltration basins and on-lot infiltration systems still pose the problem that some people view them as messy or unkept, reducing their acceptability.

Infiltration systems utilizing a hydrologic planting scheme provide an additional level of informative characteristics related to the hydrologic function of the system. This added organizational characteristic however still is limited to its informative abilities without either the knowledge of planting material suited for infiltration systems or through informative signage (which is still limited as to its ability to inform the public of the system's importance). The amount of processable information is still not decreased with the added level of organization because the variety of planting height, color and density is still sporadic. Education of the system is still limited to pathway adjacency and possibly informative signage that illustrates the systems importance, but does not increase the system's aesthetic or amenity performance; in turn limits the appreciation and visual preference of the system to the interpretation of the signage.

The recreational opportunities with water in infiltration systems does not change when a hydrologic plating scheme is utilized. This characteristic is still limited when combined with a hydrologic planting scheme because it does not utilize vegetation that allows visual and physical access to specific interaction points with the system (Figure 4.17).

The public relation goals for SMS begin to be addressed within infiltration systems by clearly identifying areas of temporary stormwater retention with the application of hydrologically specific vegetation application (these characteristics however would most likely require signage to inform the public). The aesthetic richness of a hydrologic planting scheme is still limited however due to its sporadic color, height, and density characteristics associated within each planting zone.



Designed Planting Scheme

A designed planting scheme within the proposed infiltration system utilizes vegetation height, color, and texture to help direct views, create variety in color and texture within each identified hydrologic planting zone (Figure 4.18). By grouping planting material based on similar characteristics, more comprehendible areas can be made that increase the legibility and coherence of the system and the site. By utilizing taller vegetation that can direct circulation and views, gateways are created at the southern entrance of the baseball fields and at the entrance into the series of retention systems shown in Section C-C' (Figure 4.22).

The system itself creates a partition between the trail and the rest of the site to the northeast, creating separation from the rest of the site increasing the level of enclosure, making the area more private and naturalized.

The designed system directs views to both gateways and distant pathways, increasing orientation and mystery, while also increasing comfortability by allowing views from the rest of the site. This scheme allows specified planting placement based on height that directs locomotion with taller vegetation, and allows locomotion with shorter ground cover up to the water's edge when the retention system is holding excess rainfall.

An additional pathway leading from the trail to the southern baseball field entrance is positioned along the curve in the trail and is curved itself. This allows the opportunity for mystery by adding view blocking vegetation at each gateway.

The scheme provides near and far views both of the system and the extent of the site by utilizing specific vegetation suited for the located hydrologic zones, increasing legibility of the site and mystery of what

Figure 4.18 SMS Design #2 Alternative 4 - Plan diagram indicating extent designed planting scheme

Figure 4.19 Right: SMS Design # 2 Alternate 4, infiltration basin section facing northwest.

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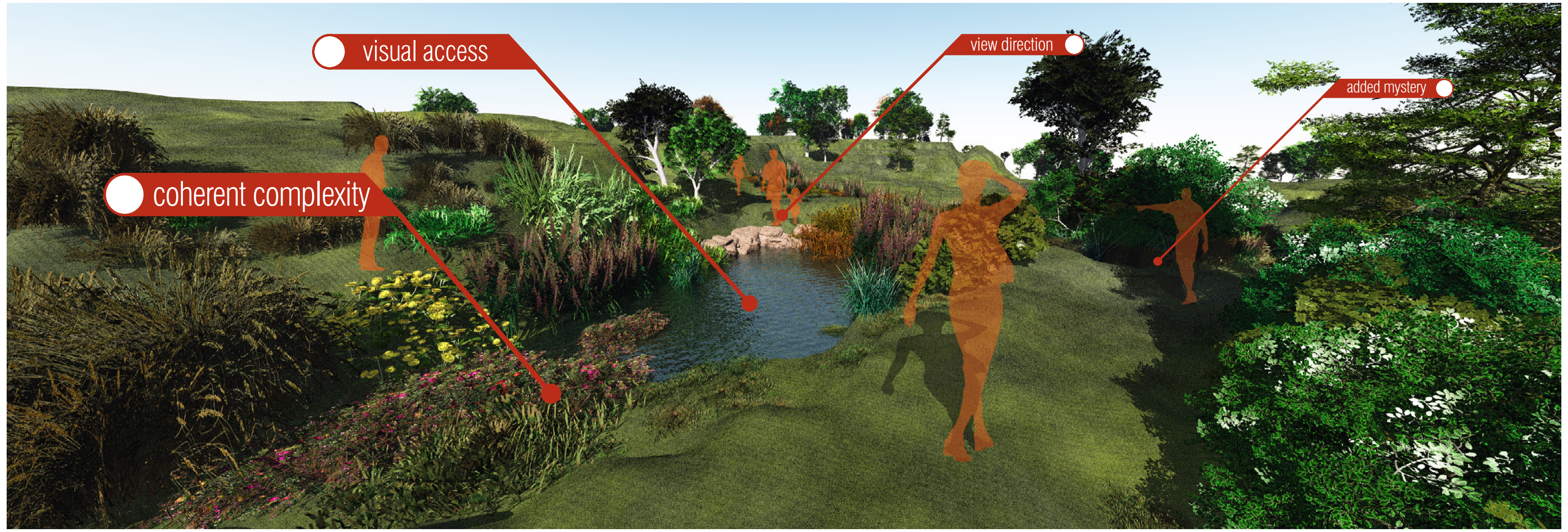


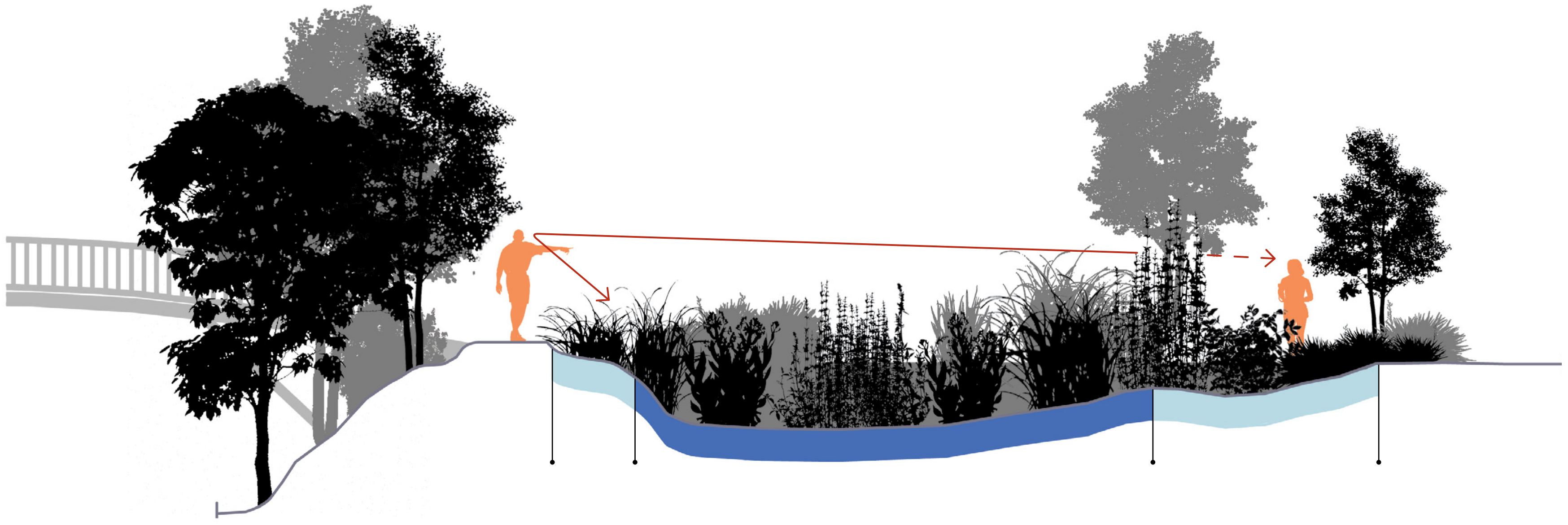
areas can be explored. This provides foreground and background emphasis in order to create extent, increasing complexity, but attempting to maintain a sense of coherence through grouped vegetation, illustrated by color, texture, and height in Figure 4.19.

Seen in Figure 4.19, the scheme utilizes trees for view direction and shading structures along added pathway to southern baseball field access, increasing mystery and coherence. The designed planting scheme also utilizes vegetation to prohibit access to water within the SMS to specified areas where interaction is allowed, creating a focal point and increasing legibility and coherence (Figures 4.19 & 4.22).

The location of the system is limited in regards to its division of a large space, however it does increase the 'naturalized' area of the treeline to the southwest, in turn decreasing the expansiveness of the parking lot to the east and increasing coherence by breaking up a large area into smaller more comprehendible regions. This added vertical structure helps create a sense of enclosure affording privacy and distinctiveness. This also allows for the user to visually track where they are within the site through specific vies of the site extent to the east; increasing coherence of the setting and legibility of orientation within the site.

A designed planting scheme can introduce basic information as to what the system provides hydrologically through signage. Understanding through plant association or location is then enhanced due to planting zone delineation as well as color, height, and density association.

Ideas to learn are illustrated by utilizing multiple stormwater treatment systems that include specific riparian vegetation placement based on both hydrologic zones and view and circulation direction.



Infiltration Basin Section A-A' Facing West

Figure 4.20 Top Left: SMS Design # 2 Alternate 4, infiltration basin section facing west.

Figure 4.21 Bottom Right: Infiltration Basin section facing northwest.

Images created by: Buffington, Jared - 2012

The SMS is visible from the existing and additional pathway (Figures 4.20, 4.21, & 4.22), while gathering spaces are more defined due to planting height and density association, allowing specific points of rest and interaction.

Designed infiltration systems based on both plant characteristics and hydrologic performance provides insight as to how the application of an infiltration system benefits hydrologic and ecologic systems, while illustrating to the public that these systems can be designed in such a way that is comprehendible and performs aesthetically.

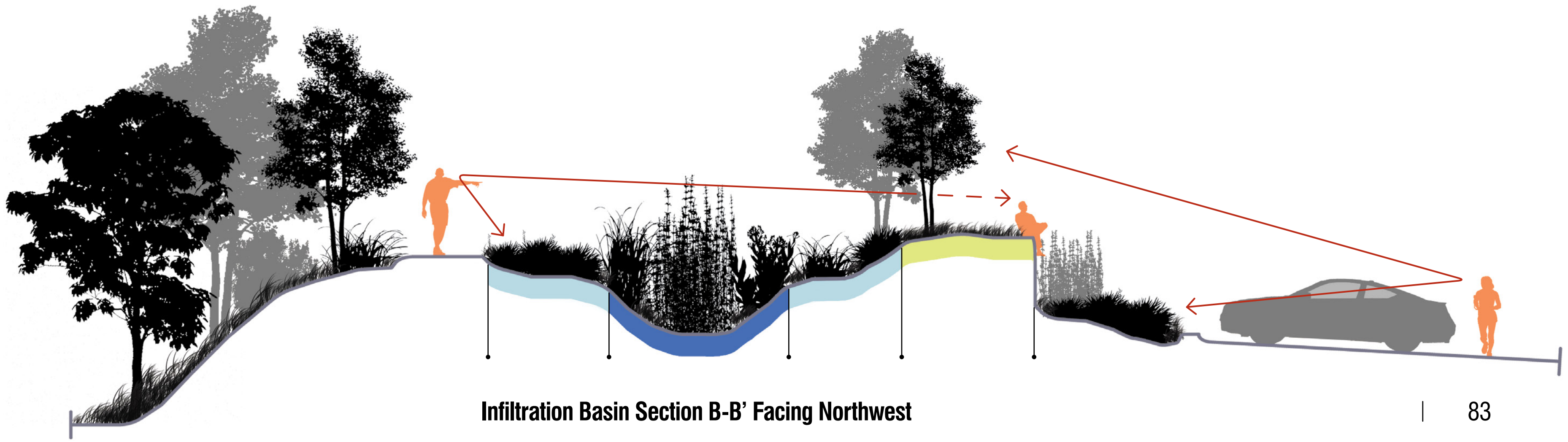
The additional level of system design applied to plant zone location by further categorizing hydrologic zones by color, height, and density, helps to illustrate stewardship through landscape and hydrologic care. The perception of these systems can be changed to show that these systems are not 'unkept' through plant characteristic association.

The previously utilized hydrologic planting scheme began to address basic design organization related to hydrologic processes. The additional layer of planting categorization allowed aesthetic richness characteristics such as color, line of site, volume and texture, view axis, and repetition (Echols & Pennypacker, 2008) to increase the presence of human interaction and stewardship through design, while not limiting the ecological performance of the SMS.

The included sections of the entire infiltration system design further illustrate the definition of each hydrologic zone. In addition, the sections show how planting height from one zone to another can coordinate to allow views with extent, screening views, and directed views. These added levels of design help to increase the coherence, legibility, complexity, and mystery of a site by utilizing suited vegetation to address landscape patterns and amenity goal application.

legend

- emergent zone
- wet meadow zone
- flood plain zone
- upland zone
- obstructed view
- directed view
- blocked view



Infiltration Basin Section B-B' Facing Northwest

legend

- emergent zone
- wet meadow zone
- flood plain zone
- upland zone
- gateway
- obstructed view
- directed view
- blocked view

Figure 4.22 SMS Design # 2 Alternate 4, system section facing northeast.

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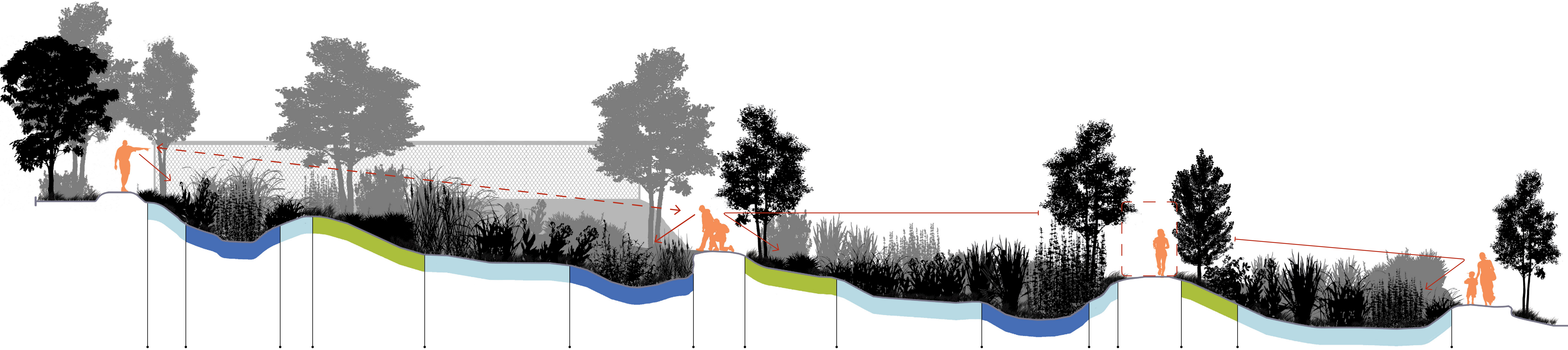


constructed wetlands - SMS design #3

Existing

The existing SMS provides little to no functional aesthetic in relation to gateways or partitions within the southwestern context of Anneberg Park (Figure 4.23). Limited vertical variance within the area creates spaces too large to comprehend, not allowing partitions to breakdown of spaces and create smaller, more comprehendible areas (Figure 4.24). Without partitions, gateways cannot be utilized to help direct views and circulation to the southwest soccer fields, decreasing legibility by not reducing the amount of information to process within a scene.

The existing SMS permits locomotion with no visual or locomotive barriers, increasing comfort in relation to legibility and coherence by allowing one to sense that they could readily enter and exit the space without any sort of obstructions. However, too much 'smooth ground' can cause an area to seem vast and monotonous, limiting the opportunity for mystery, spatial definition, and added complexity within a scene.

With the exception of Wildcat Creek that borders the park to the South, the southwestern corner of Anneberg lacks the characteristic of providing a more natural environment to interact with as well as a destination point to experience along the perimeter trail; important factors in trail design goals along with being able to visually separate the user from urban characteristics.

Due to the expansive grass areas, the system allows views of distant scenes, but does not provide visual direction due to the lack of vertical elements such in the form of vegetation, and provides no foreground emphasis of any kind. This creates visual imbalance between open space and spatial definers; trees do create spatial definition around the southwestern edge of the site,

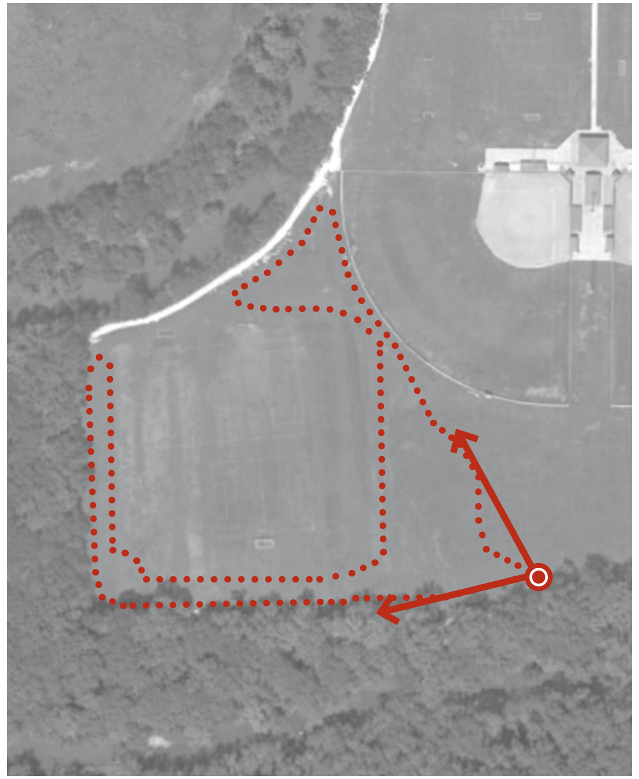


Figure 4.23 Left: SMS Design #3 - Existing location of SMS on Anneberg's north edge, plan view.

Edited by: Buffington, Jared Source: Riley County GIS Data

Figure 4.24 Top: SMS Design #3 - Existing location of SMS on Anneberg's north edge, perspective image.

Image created by: Buffington, Jared - 2012

but expansiveness of site limits the legibility of individual views and definitive areas (Figure 4.24).

The openness of this area does however allow visual interpretation of the surrounding landscape encouraging mental exploration throughout the site, but not with the aid of mystery pattern applications, ultimately limiting the user's desire to physically explore the area.

The existing grass swale system provides little to no characteristics related to ideas for learning through artistic interpretation, utilization of multiple types of stormwater treatment, or by incorporating riparian vegetation for habitat creation and observation. While this swale is located near a perimeter trail and bisects the southwest soccer fields and baseball fields increasing visual observation, it does not spatially define pause or rest areas. In addition, the system does not include wayfinding or informative signage related to the SMS. This limits the information that the public can gain from how stormwater is conveyed in Anneberg Park.

Ultimately, the existing SMS provides exploration within the system but does not encourage further exploration through the use of mystery or circulation directing elements. This also limits the interactive opportunities that could provided due to the stormwater conveyance characteristics of a grass swale.

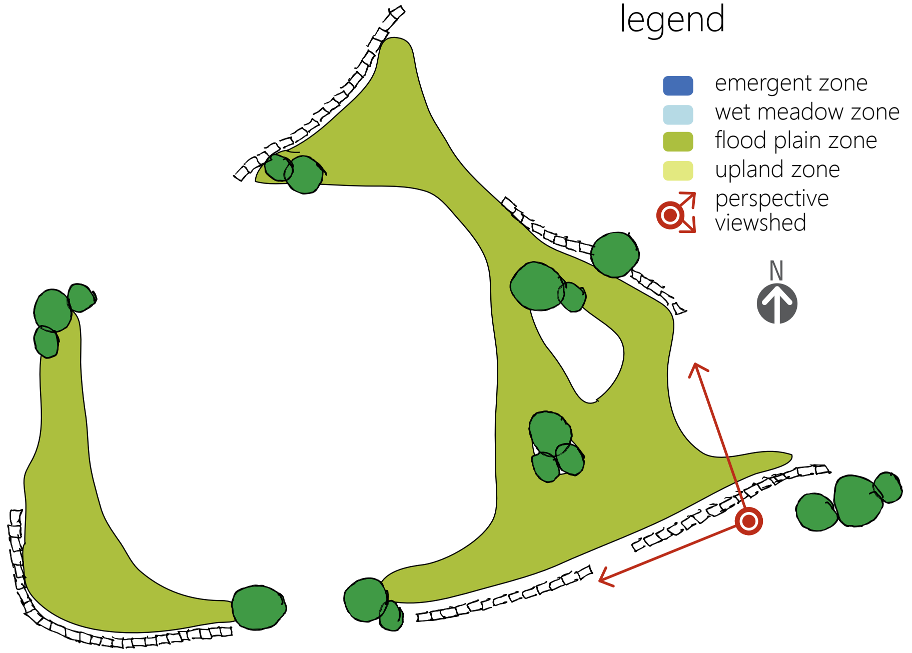
The existing grass swale does not utilize design characteristics such as point, line, plane, volume and texture, axis, and rhythm and repetition to convey stormwater. This severely limits its ability to perform aesthetically and as an amenity goal. The lack of a 3-dimenasional aspect of this system reduces the system's ability to increase the coherence, legibility, complexity, and mystery of the site.

Natural Planting Scheme

The structural design of constructed wetland systems make it an ideal application where there is little grade and plenty of space. This was one of the deciding factors for wetland implementation in the southwestern corner of Anneberg Park (Figure 4.25).

Constructed wetland systems as a whole are limited to their partition application on an individual space scale due to the relative size requirements of the contributing watershed size; coherence of the space is also limited due to its variety of height, color, and texture mixed together. This system can perform as a successful partition on a larger scale though, creating barriers between the trail and northeastern part of the site.

The natural planting scheme does not use planting material to direct specific views, limiting the system's coherence due to "messy" planting appearance; system structure also reduces legibility due to its expansiveness and lack of coherent grouping of vegetation; limits the direction of larger views to the west edge of the site, limiting extent or depth cues and decreasing mystery and coherence on a system scale.



The orientation of the space is increased due to the varying levels of planting material by limiting access to areas and informing circulation, increasing coherence in within site context. The natural planting scheme begins to limit and direct the placement and interplay of trails and locomotion, also increasing orientation but still limiting coherence and legibility due to the large variety of planting material associate with wetlands. Orientation is directly affected by this because direct access to southwest soccer fields seems limited until further exploration along the existing trail to the south and new trail to the northwest. This however does increase the sense of mystery, but still limits coherence due to sporadic planting scheme.

A natural planting scheme in within the site context provides a point of interest along the existing path, increasing the possibility for orientation. The system however lacks distinctiveness in the form of grouped, comprehendible plantings.

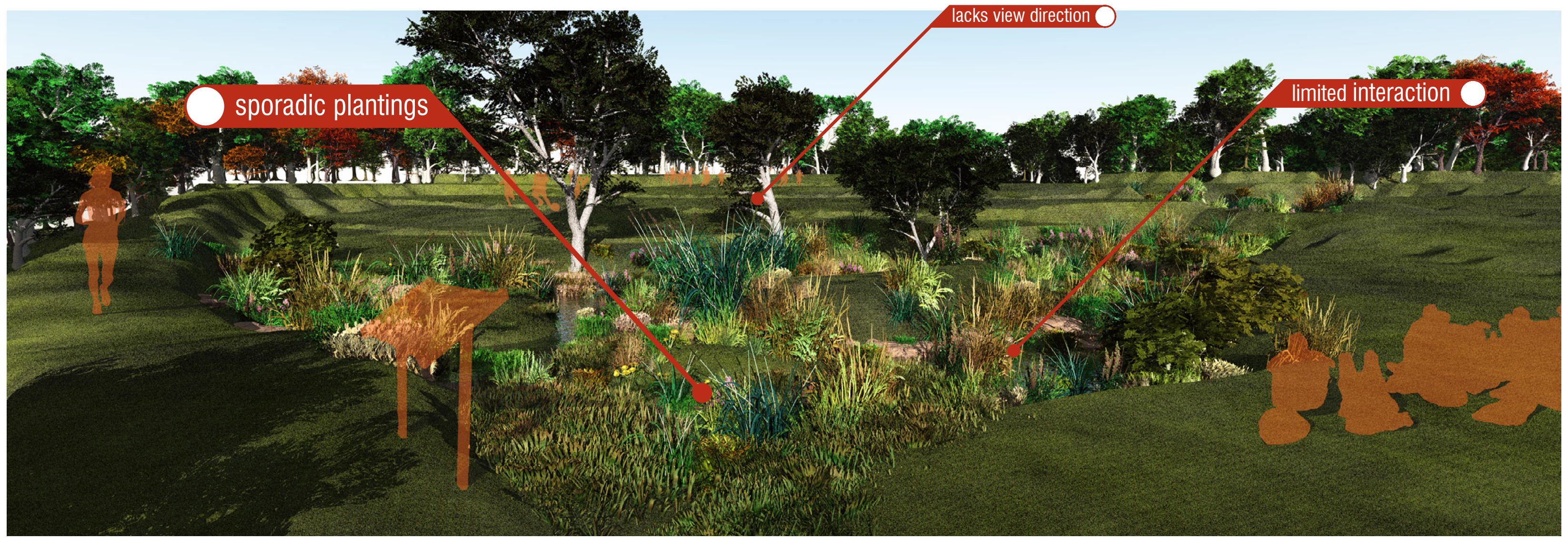


Figure 4.25 Left: SMS Design #3 Alternative 2 - Plan diagram indicating extent of natural planting scheme

Figure 4.26 Right: SMS Design #3 Alternative 2 - Perspective illustrating example or evaluated characteristics.

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The same characteristics provide some degree of enclosure and privacy depending on vegetation height and adjacency to the existing pathway, but still non-specific planting placement decreases the legibility of the area.

The natural scheme can facilitate basic information as to what system provides hydrologically through signage (Figure 4.26), but a greater understanding through plant association or plant location is limited due again to the sporadic plant placement. Being adjacent to the existing pathways, the system provides insight as to how the application of constructed wetland systems benefits hydrologic and ecologic systems. This however is made most evident with the use of didactic signage. Gathering spaces are also poorly defined and interactivity with the system is not allowed or defined due to varying planting heights and access inconsistency

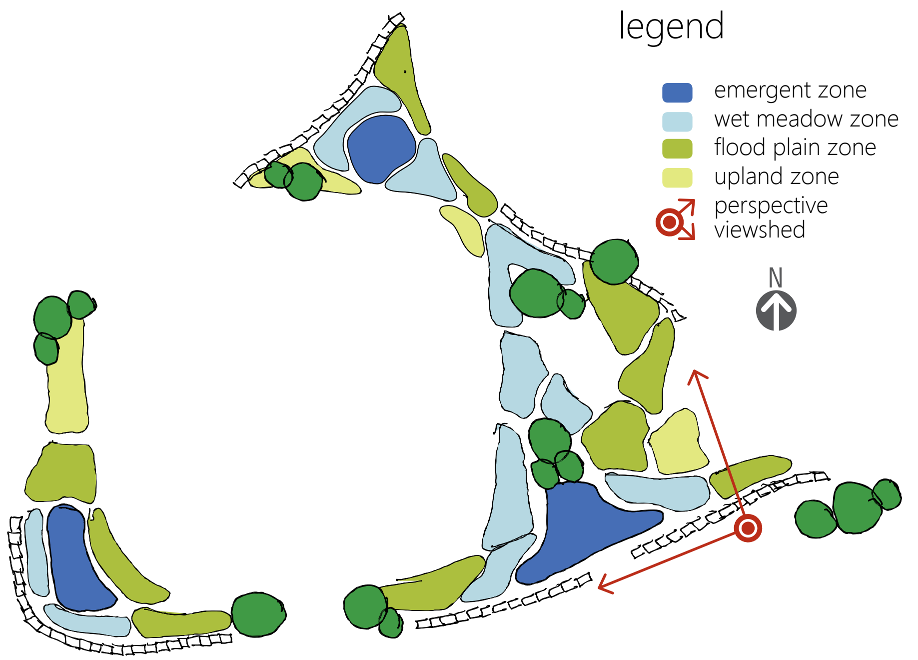
The constructed wetland system is visible and identifiable as it winds between the south trail, the southwest soccer fields, and baseball fields to the northeast. The system ultimately provides an ecological amenity but lacks visual amenity characteristics through aesthetic performance, mainly due to the natural planting scheme

The naturalized planting scheme does not specifically address basic aesthetic richness characteristics from a planting palette standpoint, but provides a diversity of planting material characteristics increasing complexity or variety within the site context of Anneberg Park.

Hydrologic Planting Scheme

A hydrologic planting scheme provides an added degree of plant characterization that allows discernment of specific vegetation best suited for each planting zone within a wetland system (Figure 4.27). Increased coherence within a wetland natural planting scheme is attributed to an additional level of organization or plant categorization. This helps to decrease the wetlands sporadic planting variation while maintaining a variety through the elevation differentiation and color difference.

The wetland systems provides the same characteristics in relation to trails and locomotion as the natural planting scheme (unless educated in SMS planting and hydrologic zones; however this mainly applies to Places and their Elements). Wetlands provide a variation in plant height, texture, color, and depth, increasing the possibility for views with depth cues and extent.



The hydrologic planting scheme begins to address site specific characteristics as to where vegetation is located, ultimately providing distinction and form specific to the system and its placement within the southwestern corner of Anneberg, increasing legibility as a system. The system is still limited as to its coherence due to the hard to distinguish planting scheme.

The added level of design related to water level helps to address hydrologic functions, while maintaining a variety of planting characteristics and a level of complexity. Without specific planting placement in terms of vertical structure views and circulation have little guidance and direction; maintaining a level of depth and extent but without focus, increasing complexity but hindering coherence.

The sense of enclosure is still limited and ill-defined along the trail, not distinguishing SMS and foreground elements from the extent of the scene to the west edge of site. The system's adjacency to the trail can provide basic information as to what the system provides hydrologically through signage; understanding through plant association or location is enhanced due to planting zone delineation.

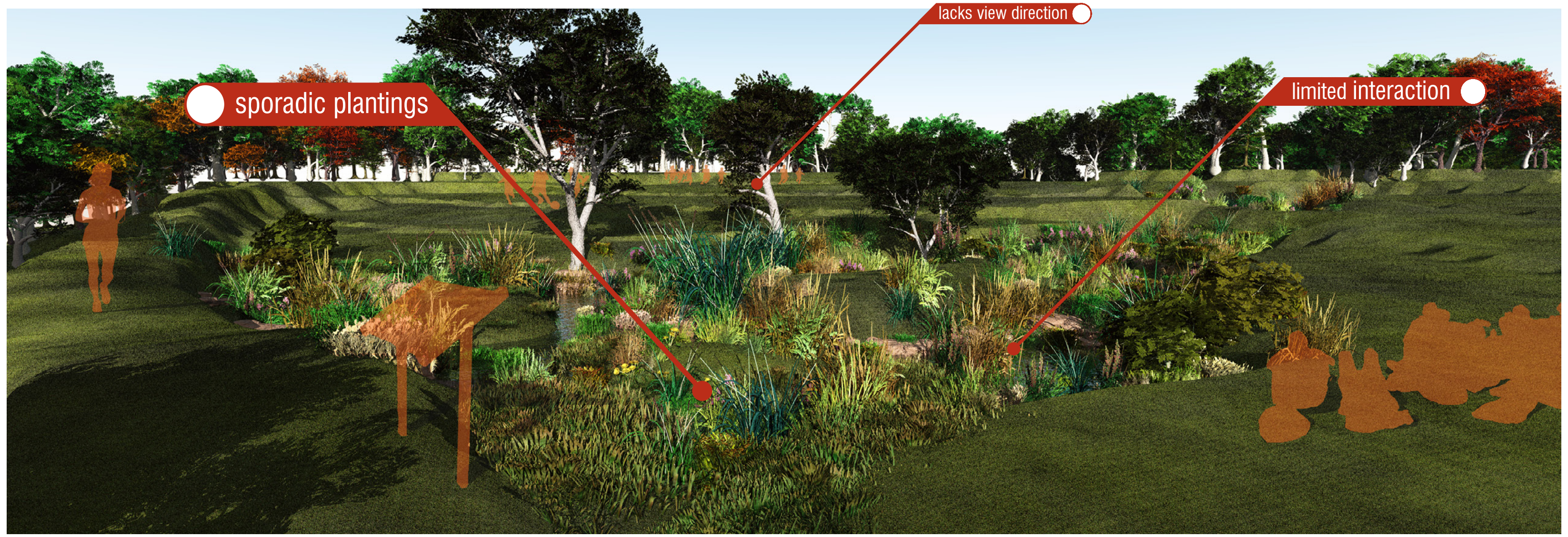


Figure 4.27 Left: SMS Design #3 Alternative 3 - Plan diagram indicating extent of hydrologic planting scheme

Figure 4.28 Right: SMS Design #3 Alternative 3 - Perspective illustrating and identifying amenity performance variables.

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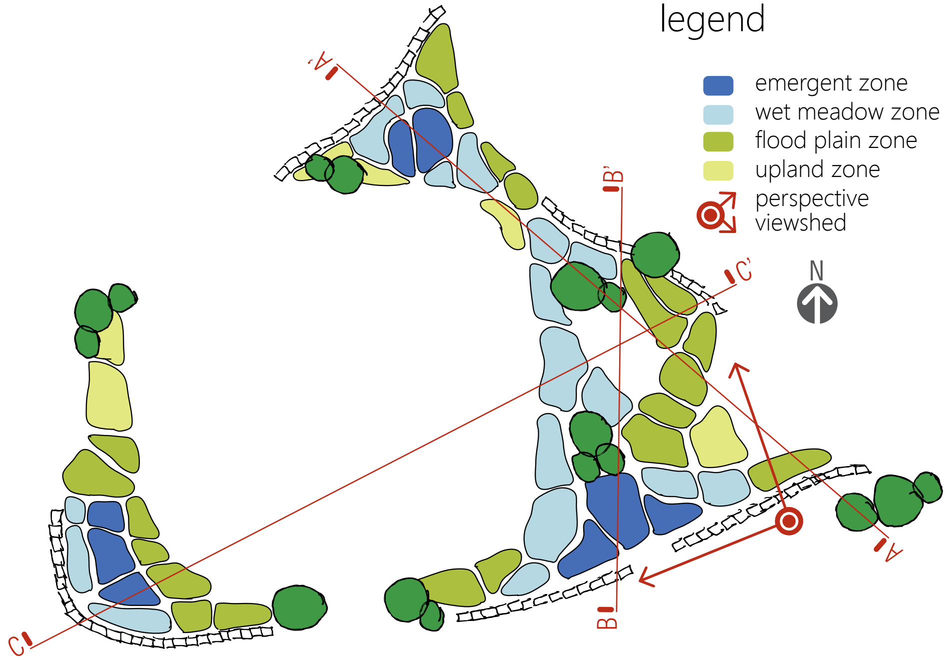
Ideas to learn are increased by utilizing multiple stormwater treatment systems that include specific riparian vegetation placement based on zones that provide both hydrologic function and wildlife habitat. The system still does not help to spatially define pause or rest areas due to sporadic height and density placement (Figure 4.28); doesn't imply interaction with lower vegetation. The trail adjacency also provides insight as to how the application of a constructed wetland addresses stewardship through landscape and hydrologic care; this association however is still limited to people with education in SMS and their associated planting material.

Ultimately a wetland hydrologic planting scheme provides an ecological and hydrological amenity for the southwestern corner of Anneberg Park. However it lacks visual amenity characteristics through aesthetic performance patterns (see Preference Matrix), limiting the overall areas coherence, legibility, complexity, and mystery.



Designed Planting Scheme

A designed planting scheme within the wetland system utilizes vegetation height, color, and texture to help direct views, create variety in color and texture in each planting zone identified within the hydrologic planting scheme (Figure 4.29), increasing complexity but not at the expense of coherence.

Partitions are created between the southern trail, soccer field, and baseball field to the northeast, allowing the breakdown of the expansive ground plane that reaches from children's playground to the southwest soccer fields. This breakdown helps to create gateways to enter the system and allows multiple terminating, pass by, and pass through spaces to occur (mainly attributed to the structural design of constructed wetlands).

The system directs views to the southeast soccer fields and distant pathway from the southern trail, increasing orientation and mystery, while also increasing comfortability and legibility by allowing views of the distant trail. The specific planting placement allowed by additional plant characteristic categorization aid in the system's ability to direct and allow locomotion through and up to the water's edge (Interaction, Figure 4.30). An additional pathway leading from the southeast corner of the soccer fields meanders through the wetland system over spillways, connecting to the perimeter trail north of the soccer field. This allows the opportunity for mystery and education opportunities by adding view blocking vegetation at the system gateways and engaging the user through locomotive interaction.

Strategically placed vegetation directs views from different points along the south trail toward near and far points of interest, both engaging the SMS and the extents of the site (Figures 4.31 & 4.33). The

Figure 4.29 Left: SMS Design #3 Alternative 4 - Plan diagram indicating extent of designed planting scheme.

Figure 4.30 Right: SMS Design #3 Alternative 4 - Perspective illustrating and identifying amenity performance variables.

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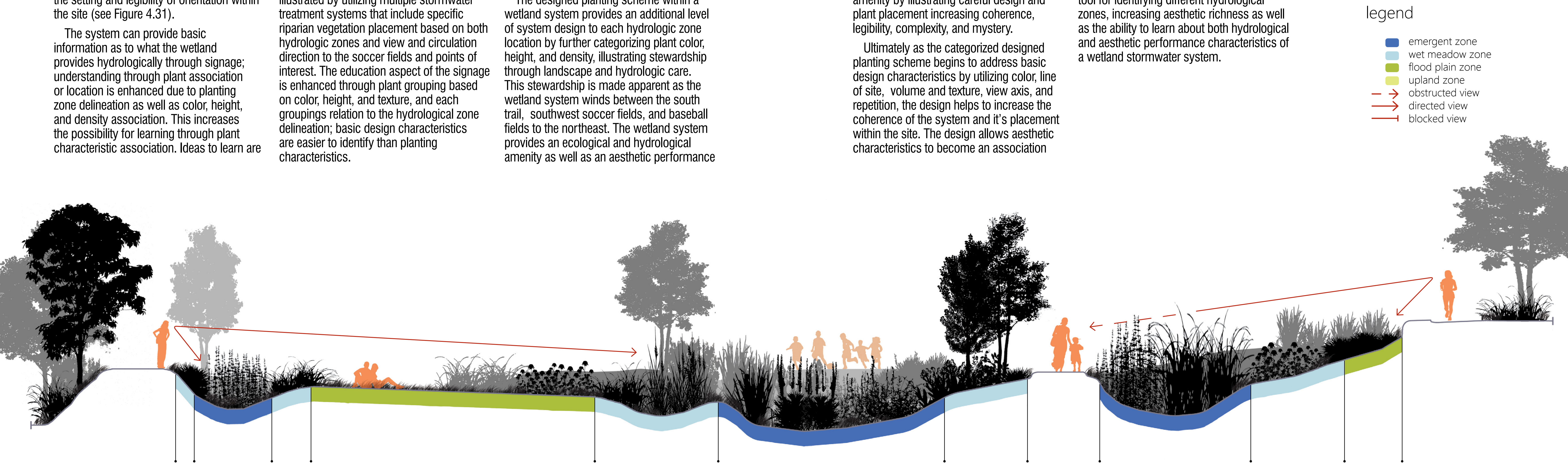
directed views increase the sites mystery, while allowing a degree of legibility through multiple orienting viewpoints and points of interest.

The specific planting placement of the designed scheme allows foreground and background emphasis in order to create extent (Figure 4.32), increasing complexity, but attempting to maintain a sense of coherence through grouped vegetation. A wetland system structure allows greater extent on a system scale due to its larger spatial requirements and high variance in hydrologic planting zones. The foreground emphasis along the trail utilizes vegetation to prohibit access to water within the SMS to specified areas where interaction is allowed, creating a focal point and increasing legibility and coherence. The location of the system helps to divide the vastness of the soccer fields to the west from the baseball fields to the east, increasing coherence by breaking up an expansive area into smaller more comprehendible regions. This helps to define smaller, more private spaces between the trail and the baseball fields. These defined smaller spaces provide a sense of enclosure affording privacy and distinctiveness while also allowing for the user to visually track where they are within the site through specific views of the site extent to the north; increases coherence of the setting and legibility of orientation within the site (see Figure 4.31).

The system can provide basic information as to what the wetland provides hydrologically through signage; understanding through plant association or location is enhanced due to planting zone delineation as well as color, height, and density association. This increases the possibility for learning through plant characteristic association. Ideas to learn are illustrated by utilizing multiple stormwater treatment systems that include specific riparian vegetation placement based on both hydrologic zones and view and circulation direction to the soccer fields and points of interest. The education aspect of the signage is enhanced through plant grouping based on color, height, and texture, and each groupings relation to the hydrological zone delineation; basic design characteristics are easier to identify than planting characteristics.

The designed planting scheme within a wetland system provides an additional level of system design to each hydrologic zone location by further categorizing plant color, height, and density, illustrating stewardship through landscape and hydrologic care. This stewardship is made apparent as the wetland system winds between the south trail, southwest soccer fields, and baseball fields to the northeast. The wetland system provides an ecological and hydrological amenity as well as an aesthetic performance amenity by illustrating careful design and plant placement increasing coherence, legibility, complexity, and mystery.

Ultimately as the categorized designed planting scheme begins to address basic design characteristics by utilizing color, line of site, volume and texture, view axis, and repetition, the design helps to increase the coherence of the system and it's placement within the site. The design allows aesthetic characteristics to become an association tool for identifying different hydrological zones, increasing aesthetic richness as well as the ability to learn about both hydrological and aesthetic performance characteristics of a wetland stormwater system.



Wetland System Section A-A' Facing Southwest

Figure 4.31 SMS Design #3 - Alternate 4: Constructed Wetland system section facing southwest.

Image created by: Buffington, Jared - 2012

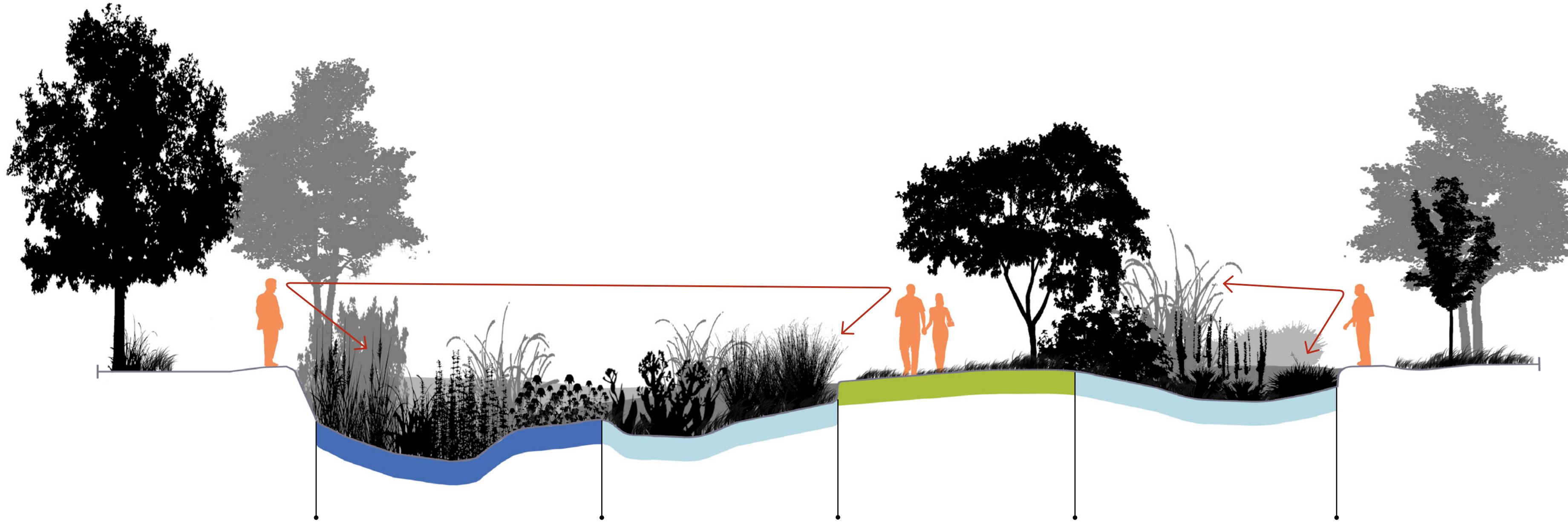
legend

- emergent zone
- wet meadow zone
- flood plain zone
- upland zone
- gateway
- obstructed view
- directed view
- blocked view

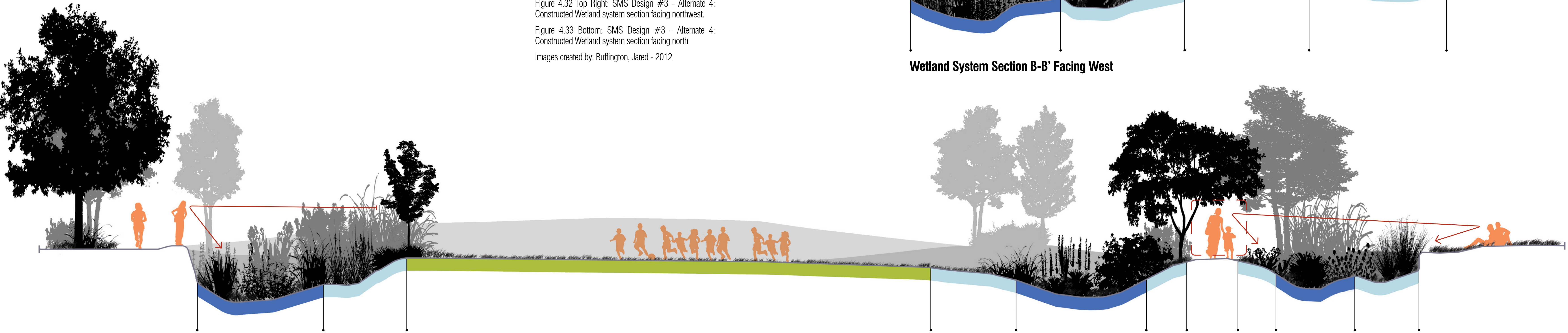
Figure 4.32 Top Right: SMS Design #3 - Alternate 4: Constructed Wetland system section facing northwest.

Figure 4.33 Bottom: SMS Design #3 - Alternate 4: Constructed Wetland system section facing north

Images created by: Buffington, Jared - 2012



Wetland System Section B-B' Facing West



Wetland System Section C-C' Facing North

05 SMS CHARACTERISTIC FRAMEWORK

Conclusions

Vegetated stormwater management systems (SMS) can serve as aesthetic amenities by 1) performing as landscape patterns to increase the coherence, legibility, complexity, and mystery of a site; and 2) by creating amenity opportunities that inform the public of each system's ecological and aesthetic value through categorized amenity goal applications.

Each vegetated SMS is able to perform or contribute to the application of landscape patterns (gateways and partitions, views and vistas, trails and locomotion, and places and their elements) to varying degrees based on each system's spatial requirements, and planting palette characteristics. The variables that ultimately contribute to a greater or lesser performance of SMS in terms of aesthetics and amenities are provided in this chapter.

Specific planting and spatial characteristics of each system that relate to the performance of different design schemes are identified as follows:

Existing SMS

The existing SMS of Anneberg Park utilize grass swales and grass retention systems to successfully convey stormwater away from recreational fields and pedestrian circulation ways. However, these systems neglect to address ecological performance characteristics such as providing animal habitat, increased infiltration, higher degrees of stormwater rate control and volume reduction, and aesthetic and amenity performance in regards to landscape patterns that address human preference.

Vegetated SMS, or best management practices (BMPs), have the ability to provide animal habitat, increased levels of infiltration, stormwater rate and volume control characteristics. However, some find these systems to be 'messy' or 'unkept.' The three planting schemes evaluated on their aesthetic and amenity performance (natural, hydrologic, and designed) illustrated how utilizing added levels of planting categorization can increase vegetated SMS aesthetic amenity performance to varying degrees.

Natural & Hydrologic Planting Schemes

The evaluations of the natural and hydrologic planting schemes for each type of stormwater management system (filtration, infiltration, and constructed wetlands) all had similar results in regards to their aesthetic and amenity performance. This means that each system and its location within Anneberg Park provided some degree of aesthetic and amenity performance beyond what was provided by the existing site. However, natural and hydrologic schemes did not appear to provide aesthetic and amenity performance to the extent that clearly increased the coherence, legibility, complexity, and mystery of the site.

A natural or hydrologic planting scheme contributes to the application of such patterns as gateways and partitions through vertical elements in the form of planting material. These planting schemes however lack continuity in directing specific views and locomotion, and providing adequate screens in order to block unwanted views. The sporadic characteristic of a natural planting scheme also neglects to address the majority of concepts related to views and vistas and places and their elements. Without specific planting placement, landscape patterns that 'guide the eye', provide 'enough to look at', create 'degrees of enclosure', provide identifiable 'points of interest', and provide 'large and small views' cannot be directly accomplished.

These aesthetic performance patterns are then limited as to their contribution in accomplishing or enhancing the goals and techniques addressing amenity performance within SMS. SMS goals related to education and public relations can be applied within a natural planting scheme, but are made most evident with the application of elements such as informative, didactic signage. Signage that briefly explains what the system does and provides can help people understand its hydrological importance. With hydrologic planting schemes informative signage can address specific types of plants that are best suited for different hydrological zones, increasing the amount of information available to the passerby.

There is however more that can be taught about SMS in addition to their hydrologic and ecological importance. Yet the problem with just informative elements is that aesthetic appreciation and performance is still limited; characteristics that humans associate with care within the landscape. (Gobster, Nassauer, Daniel, & Fry, 2007)

The ability for natural planting schemes within SMS to accomplish amenity goals related to recreation and aesthetic richness is very limited. The goals related to recreation rely heavily on both the type of vegetated SMS and clear, identifiable access to the system itself. Both of these characteristics, within vegetated SMS, are dependent on plant structure. If views and clear access points are not identified and allowed with the use of plant structure, then added elements would be required, ultimately decreasing the 'naturalness' of the system; either positively or negatively depending on the viewer's opinion.

Natural and hydrologic planting schemes within SMS provide an effective way to manage stormwater in terms of rate, volume, and suspended solid control. However, their ability to successfully provide aesthetic performance and meet SMS amenity goals are limited mostly due to their natural, varied planting placement and a lack of aesthetic and hydrologic characteristic association.

Designed Planting Scheme

Designed SMS planting schemes illustrated within the Anneberg Park design examples and evaluations allowed for the most substantial application of both aesthetic and amenity performance patterns and goals. By adding degrees of complexity related to planting palette characteristics, a designed scheme that utilizes both hydrological and aesthetic plant categorization can obtain a higher, more focused degree of aesthetic and amenity performance. This performance is enhanced by identifying specific planting material that is best suited for application in both hydrologic zones, and by positioning vegetation to increase coherence, legibility, complexity, and mystery based on specific site needs. 'Site necessities' refers to common requirements of site design in relation to visual screening, permitting or deterring locomotion, providing places for rest and recovery, and establishing points of interest. These site necessities, or common landscape patterns, can both serve aesthetic and amenity functions through vegetated SMS while providing an ecological amenity that informs the surrounding public of its importance.

By utilizing added levels of design complexity through plant categorization (related to plant height, color, and density), aesthetic performance patterns are not as limited to their contribution in providing or enhancing the goals and techniques addressing amenity performance within SMS.

SMS goals related to education and public relations can be applied within a designed scheme more effectively by using categorized plant characteristics in combination with informative, didactic signage. Signage that briefly explains what the system does and provides can help people understand its hydrological importance better through plant characteristic association. For people that are less familiar with plant identification, a simpler way of plant association addressing plant height, color and texture can be utilized to inform people of what different parts of the system provide in terms of both hydrologic and aesthetic performance related to vegetation. By informing people of the hydrologic processes with the use of aesthetic characteristics and organization, a level of learning and understanding can be provided as to SMS' ability to perform aesthetically. This added level of information is fueled with the aid of amenity performance goals. This association can foster a perception of care and aesthetic richness to SMS that perform important hydrologic processes.

The ability for designed SMS planting schemes to accomplish amenity goals related to recreation and aesthetic richness is dramatically increased from a natural or hydrologic scheme. Designed planting schemes provide the categorized plant structure that recreation application relies heavily on. By utilizing plant structure to direct views and access to SMS at specific points, both interaction and safety can be increased. Both of these characteristics, within vegetated SMS, are important to the education and public relations goals of amenity performance.

A designed planting scheme within SMS provides an effective way to manage stormwater in terms of rate, volume, and suspended solid control. Designed schemes in addition to their hydrologic performance, allow for aesthetic performance patterns to be applied through planting characteristics as well as amenity goals that enhance the understanding and perception of these systems. A designed scheme can in turn allow aesthetic and hydrologic characteristic association through color, height, and texture, in order to inform people of vegetated SMS importance through aesthetic richness characteristics.

The designed planting schemes illustrate vegetated SMS' ability to perform aesthetically within the landscape in order to change the perception of these systems as 'unkept' or 'messy' BMPs. By incorporating SMS Amenity Goals (Echols & Pennypacker, 2008) with the landscape perception and preference frameworks provided by the Kaplans and Ryan et al. (1989, 1998), a framework that informs the design of aesthetic and amenity performing SMS is provided. While the evaluations included in this book provide variables that inform designers as to what each system can provide, they also illustrated how these seemingly messy BMPs can be designed to perform as aesthetic amenities as well as hydrological amenities.

Framework Utilization

The following diagrams for each vegetated SMS include: ecological and hydrological characteristics, how SMS structure relates to aesthetic performance patterns in the landscape, what specific amenity goals can be implemented to increase the understanding and appreciation of these systems, and the specific planting material characteristics that support aesthetic and amenity performance.

The framework information can be utilized from various perspectives depending on site limitations and design focus; hydrologic performance, aesthetic performance, amenity performance. Designers that wish to initially focus on stormwater management systems, or hydrological performance, can expect certain aesthetic and amenity characteristics attributed to the specific type of SMS that best fits the spatial limitations and hydrological necessities of the given site.

Site designers that wish to focus on the aesthetic performance of vegetation, in relation to each SMS plant characteristics, are able to choose the system that has the greatest ability to fulfill aesthetic performance patterns. The designer can then expect certain hydrological and amenity characteristics attributed to the type of SMS that best fits the spatial limitations of the site.

Finally, site designers that wish to initially focus on the amenity performance of SMS can choose the system that provides the greatest opportunity for amenity goal application. These amenity goals are categorized by the Preference Matrix (Kaplan & Kaplan, 1989), showing which amenity goals are best suited to increase the coherence, legibility, complexity, and mystery of a site.

Each perspective of site design focus is connected to the other categories of site SMS application. The power of these associations is in the ability to apply different systems to different sites, in different organizations so as to achieve the highest level of hydrological, aesthetic, and amenity performance based on the site limitations and opportunities.

The importance of the previous evaluations and the following variable associations is to illustrate that SMS can be designed in such a way that address aesthetic performance while not limiting the hydrological performance of the system. Both the hydrological and aesthetic performance can then be celebrated through amenity goal application in order to foster a greater understanding of the hydrological importance of SMS and how they can be designed to function as aesthetic landscape patterns.

The info-graphic to the right (Table 5.1) illustrates the relationship between the stormwater management system spatial and planting characteristics and aesthetic and amenity performance characteristics. These relevant relationships show each SMS characteristic's influence in accomplishing the identified aesthetic performance pattern and amenity goals. This relationship is based on criteria identified within Chapter 03: Design Evaluation Methods.

The relationships identified within Table 5.1 were found to be consistent across each SMS evaluation, meaning that for each system evaluation variables were identified to have a relatively high, medium or low influence on the application of aesthetic performance patterns and amenity goals. The relative relationships are indicative of a system that would have high planting characteristics as a whole. Each system's spatial and planting characteristics then only have the ability to limit the system's relative aesthetic and amenity performance. For instance, in general, plant height was found to have a high influence on how well each system provided partitions and gateways within a site, and color had a relatively low to no apparent impact on the system's ability to perform as a partition or gateway. If the system had a high variety

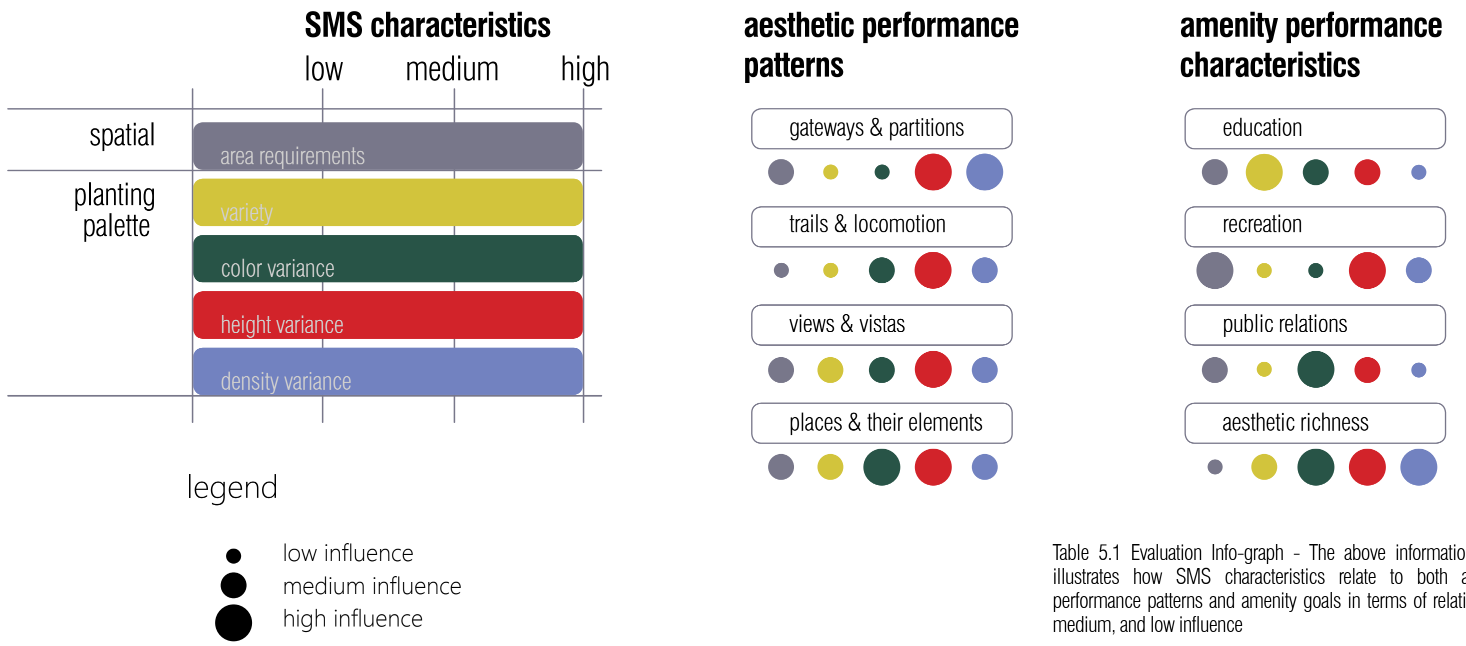


Table 5.1 Evaluation Info-graph - The above information graph illustrates how SMS characteristics relate to both aesthetic performance patterns and amenity goals in terms of relative high, medium, and low influence

Image created by: Buffington, Jared - 2012

of planting color, it would not increase the system's ability to perform as a gateway or partition. If a system has a high variety of planting color, it would not increase the system's ability to perform as a gateway or partition. On the other hand, a high variance in vegetation color has a high influence on patterns such as places and their elements. So if a system has a low color variance, then its ability to perform as patterns related to places and their elements is more limited than if the system had a high color variance.

These evaluations are then weighted as to how they coincide with each SMS's specific planting and spatial characteristics. For instance, if the system has a low spatial requirement and an aesthetic pattern or amenity goal is heavily influenced by the size of the system, then that system has a lower relative chance of fulfilling said aesthetic pattern or amenity goal, depending on site spatial limitations or allowances. Again, this is a relative comparison and is meant to initially give a general comparison, which can in turn be utilized to help in more specific site design and placement of SMS based on specific site inventory and analysis.

In addition to providing aesthetic and amenity performance relationships to SMS characteristics, specific planting material categorized by plant height and color are presented in Appendix B; each category is then broken down by hydrologic zone. These planting categorizations aid designers as to what types of vegetation, within any given hydrologic zone, in relation to each system that can aid in increasing the coherence, legibility, complexity, and mystery of a site through the aesthetic performance patterns and amenity goals.

The info-graphics provided for each stormwater management system not only illustrate relationships between hydrologic and planting characteristics, aesthetic performance patterns, and amenity goal techniques, but also provide an interactive component within the digital copy of this document. Aesthetic pattern performance and amenity goal performance have many overlapping and related characteristics as to how they are achieved through stormwater management systems. In order to facilitate an understanding of these relationships, the info-graphics for each SMS provide hyper-links to definitions, examples, and planting palettes related specifically to each aesthetic pattern and amenity goal. The info-graphics then allow designers to first visually compare systems to each other on their capability to perform hydrologically, aesthetically, and as amenities in relation to the identified relationships. The hyper-links allow designers to further compare systems based on what each system's planting palette and spatial structure provides.

The interactive portion of this document allows designers to quickly understand each system's capabilities in order to progress with more detailed designs in relation to site specific scenarios. The hyper-link system works by allowing users to click on the text that identifies SMS characteristics, aesthetic performance patterns, and amenity goals in order to gain additional information on each subject. Information provided by the hyper-links under SMS characteristics is specific to each SMS. The information provided under the aesthetic performance patterns and amenity performance characteristics is general information as to how each pattern or goal might be applied through SMS.

The diagram to the right (Table 5.2) illustrates what areas can be selected in order to link from the characteristic, pattern, or goal to additional information throughout the document.

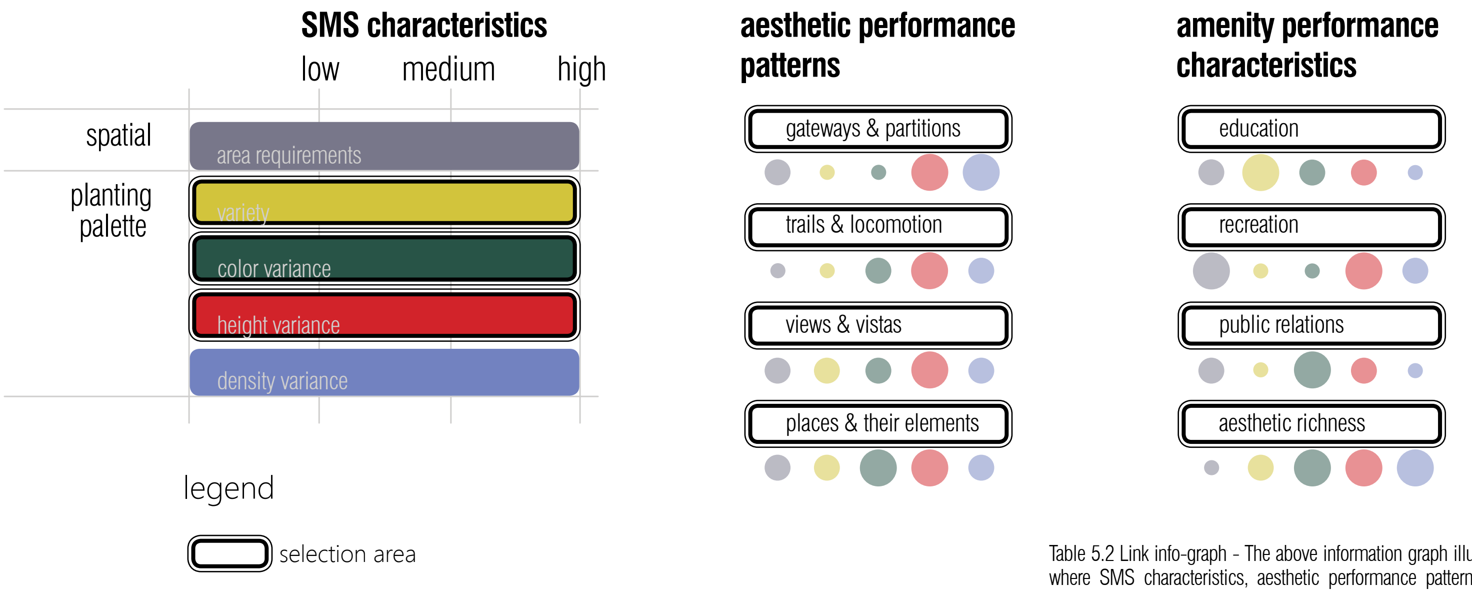


Table 5.2 Link info-graph - The above information graph illustrates where SMS characteristics, aesthetic performance patterns, and amenity performance characterisitcs can be selected, linking the user to additional information.

Image created by: Buffington, Jared - 2012

Infiltration System Types

infiltration basin aesthetic & amenity overview

Infiltration basins are utilized for stormwater runoff impoundment and designed to capture small amounts of stormwater runoff volume (Table 5.3), hold this volume and allow infiltration over a period of days. These systems do not retain water permanently, making them less likely to inform site users of their hydrological and ecological importance through visual association.

The spatial requirements of infiltration basins are typically high in relation to the watershed in which the system collects drainage. This requirement limits the application of infiltration basins due to its relative area requirements in relation to the site size.

The planting characteristics of infiltration basins suggest that they provide a limited variety of plant types and density variance, however still providing medium to high color and height variance (Table 5.4). These characteristics allow a greater degree of complexity in relation to color and height, while limiting complexity in terms of plant variety and density.

The amenity characteristics associated with infiltration basins are primarily attributed to system structure. Because these types of systems take up relatively large amounts of space, they provide opportunities for system interaction but also limit their application in spatially constricted areas. Temporary stormwater retention also limits the visual association between visible water and the systems important retention feature. Amenity goals such as informative signage, clear and defined interaction spaces with retained water, and grouped plantings that reflect basic aesthetic characteristics such as repetition, line, color, and point improve the systems ability to be viewed as an amenity that

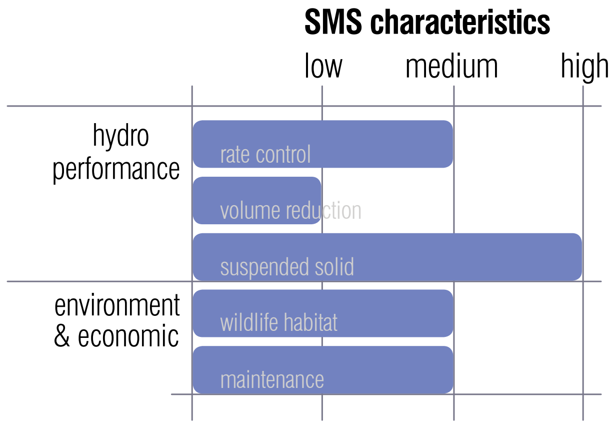
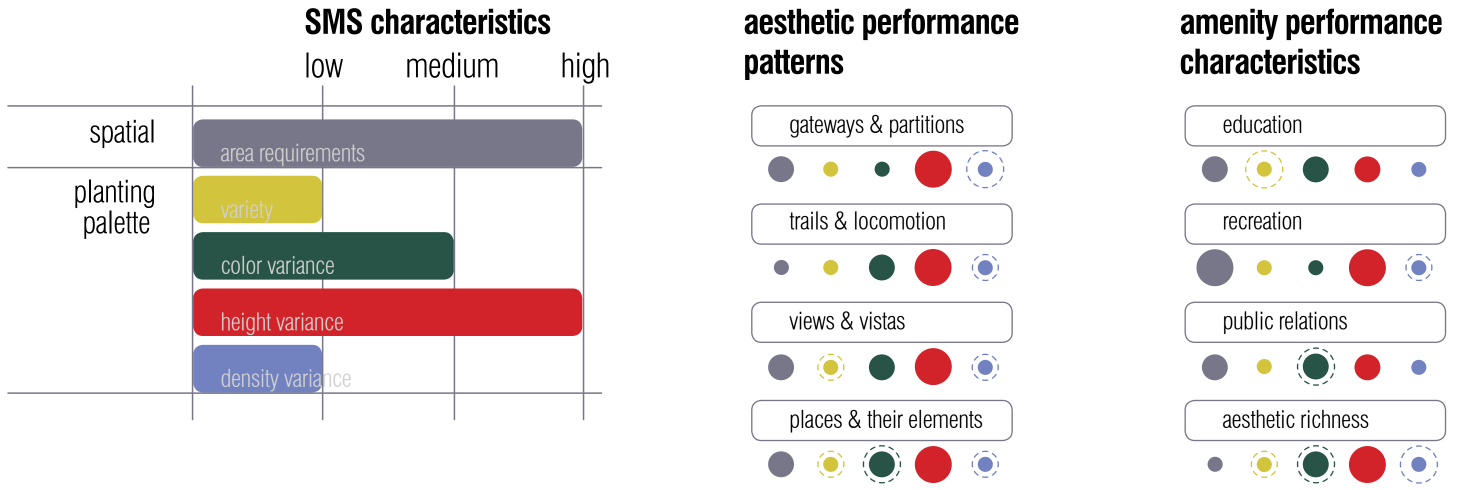


Table 5.3 Infiltration Basin Hydrologic, Environmental, and Economic Characteristics - The above information illustrates characteristics attributed to infiltration basin performance

Image created by: Buffington, Jared - 2012



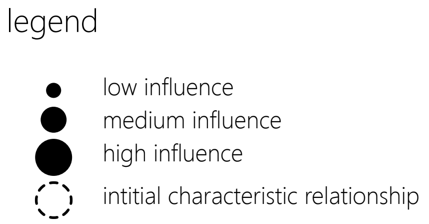


Table 5.4 Evaluation Info-graph - The above information graph illustrates how SMS characteristics relate to both aesthetic performance patterns and amenity goals in terms of relative high, medium, and low influence

Image created by: Buffington, Jared - 2012

on-lot infiltration aesthetic & amenity overview

On-lot infiltration systems are utilized for stormwater infiltration volume reduction on an individual lot scale, or in areas do not collect runoff form smaller watershed basins (Table 5.5). The main feature that separates these systems from infiltration basins is the scale in which they are applied, and that on-lot infiltration is utilized as an 'off-line' system instead of an end of pipe system. While on-lot infiltration practices do not retain water permanently, their applicability in smaller residential type situations makes them a great candidate for educating the public as to their importance and application.

The spatial requirements for on-lot infiltration systems are very low in relation to the basin or lot in which the system collects drainage (Table 5.6). This requirement limits the application on larger scales due to its relative area requirements in relation to the site size. These systems typically are not to be used when collecting runoff from areas greater that one acre. (Rozumalski, Hathaway, Anderson, Hellekson, Leuthold, Runke, Lindaman, & Kaul, 2001)

The planting characteristics of on-lot infiltration systems suggest that they provide limited plant type, density, and height variance, however still provide medium to high color variance (Table 5.6). These characteristics allow a greater degree of complexity in relation to color, but limit the systems ability to define space and direct views and circulation.

The amenity characteristics associated with on-lot infiltration systems are primarily attributed to system structure and their lower spatial requirements which makes them ideal for urban implementation. Because these types of systems take up relatively small amounts of space, they provide opportunities for system interaction in urban, spatially limited areas. Temporary stormwater retention also limits the visual association between visible water and the systems important retention feature. Amenity goals such as informative signage, clear and defined interaction spaces with retained water, and grouped plantings that reflect basic aesthetic characteristics such as repetition, line, color, and point improve the systems ability to be viewed as an amenity that performs hydrologically, and aesthetically.

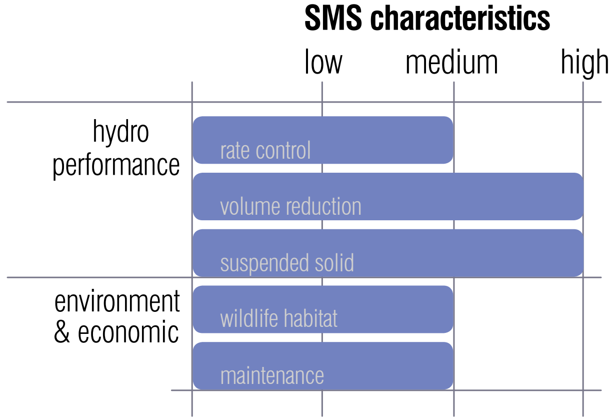


Table 5.5 On-lot Infiltration System Hydrologic, Environmental, and Economic Characteristics - The above information illustrates characteristics attributed to infiltration basin performance

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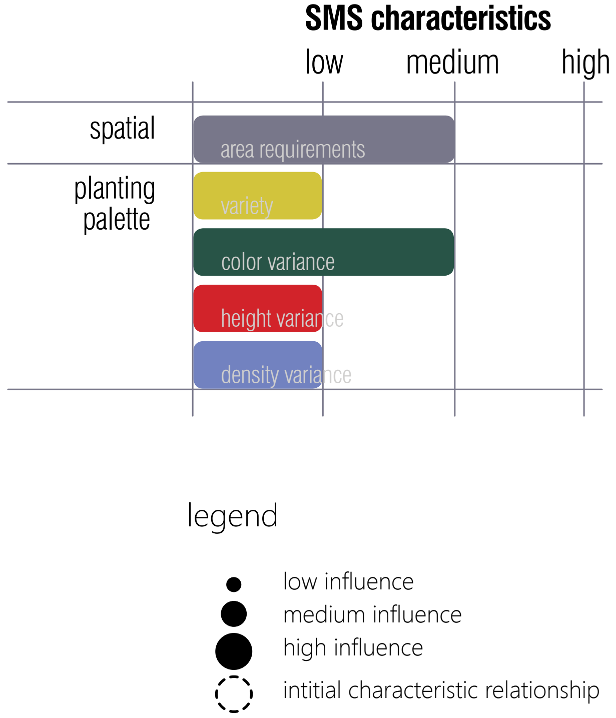

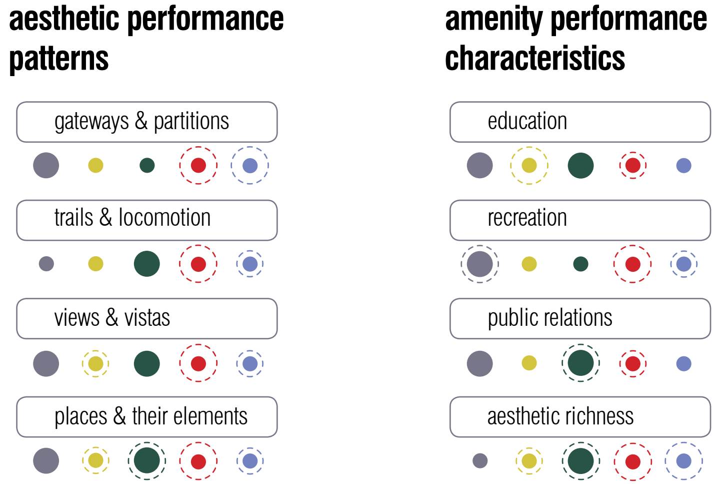

Table 5.6 Evaluation Info-graph - The above information graph illustrates how on-lot infiltration system characteristics relate to both aesthetic performance patterns and amenity goals in terms of relative high, medium, and low influence

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Constructed Wetland System Types

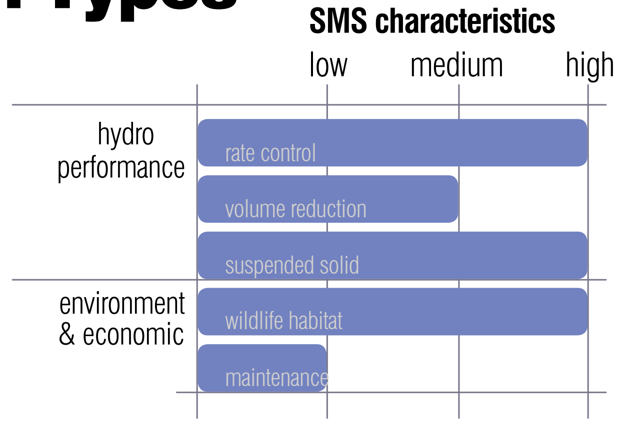

Table 5.7 Constructed Wetland system Hydrologic, Environmental, and Economic Characteristics - The above information illustrates characteristics attributed to infiltration basin performance

Images created by: Buffington, Jared - 2012

wetland aesthetic & amenity overview

Constructed wetlands are designed to maximize pollutant removal from stormwater runoff and help with flooding through rate control and volume reduction (Table 5.7). These systems require relatively large contributing areas, limiting their application within the urban environment. In addition to their high spatial requirements, constructed wetlands provide a high level of wildlife habitat, increasing the possibility for education, and requiring a relatively low maintenance obligation. These components play an important role in how these systems are perceived by the public.

The spatial and plant characteristics suitable for constructed wetlands give them a great opportunity to perform and be perceived as aesthetic amenities within the landscape (Table 5.7). Having a high rating for each of the planting palette categories fosters a broad range of applications, ultimately allowing for site specific designs that increase the coherence, legibility, complexity, and mystery of a site through aesthetic performance pattern and amenity goal application. A high planting height variance allows constructed wetlands to address all four aesthetic performance patterns to different degrees depending on a site's spatial necessities.

This is also true for plant variance, color, and density, all of which play a major role in the application of many of the performance patterns and amenity goals (Table 5.8). While constructed wetlands allow a great variety in planting material, they are limited as to where these systems can be implemented within the urban environment

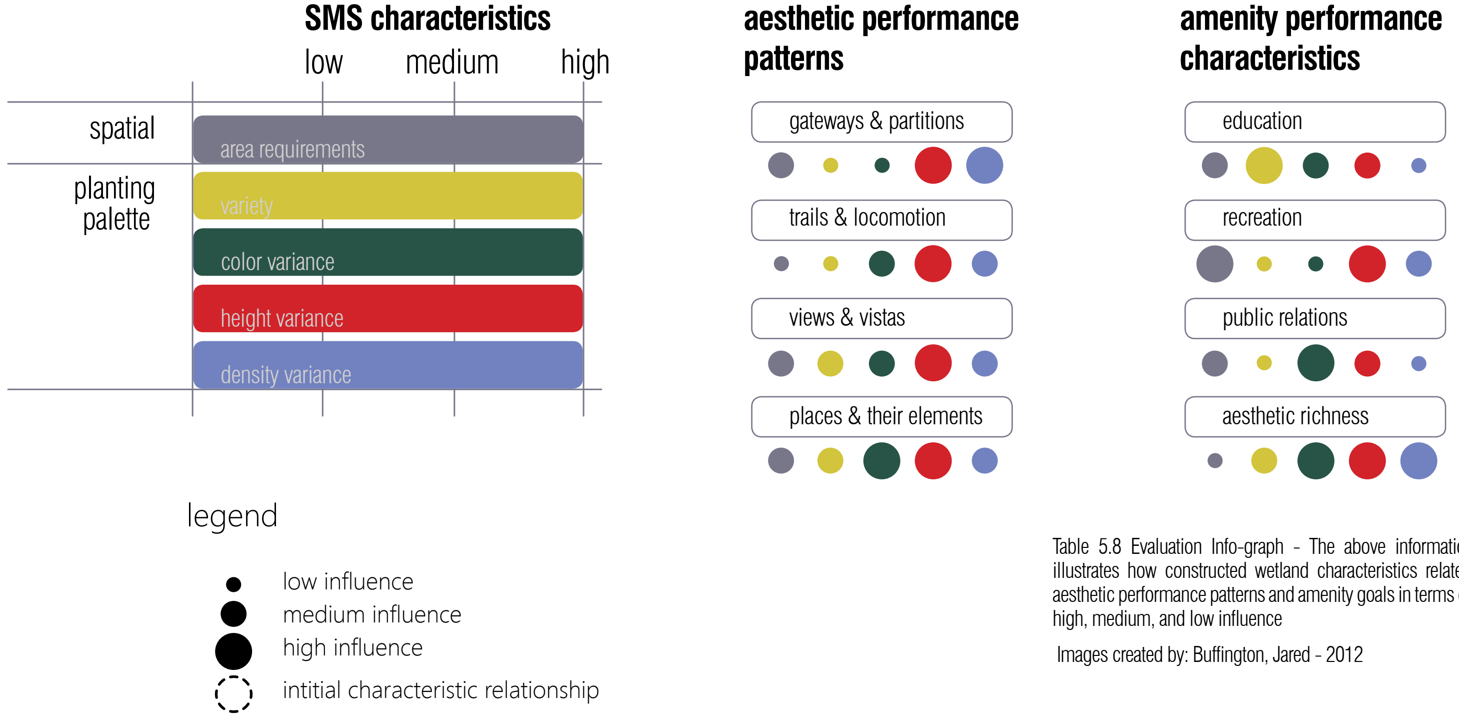

Table 5.8 Evaluation Info-graph - The above information graph illustrates how constructed wetland characteristics relate to both aesthetic performance patterns and amenity goals in terms of relative high, medium, and low influence

Images created by: Buffington, Jared - 2012

wet swale aesthetic & amenity overview

Wet swale systems are similar to constructed wetlands in their use of planting material to treat stormwater runoff. However wet swales provide a far less capability to control flow rate and reduce stormwater volume (Table 5.9). The feasibility of installing these systems is increased due to their lower spatial requirements compared to constructed wetlands; similarly dependent on the slope and contributing watershed area.

Wet swales have a lower plant variety and density variance than constructed wetlands, giving them a slightly less opportunity to fulfil the aesthetic and amenity performance of a site design (Table 5.10). However, wet swales have less of a spatial requirement, making them applicable in areas with lower amounts of open space.

Both wet swales and constructed wetlands are highly suited for aiding in the application of aesthetic performance patterns and amenity goals based on their planting characteristics as well as their ability to retain visible water for longer periods of time. This characteristic increases their ability to inform the public of their importance through visual association The deciding characteristic between the two are based on how their spatial requirements, hydrological performance, and environmental and economic characteristics relate to a sites necessities or a designs intent.

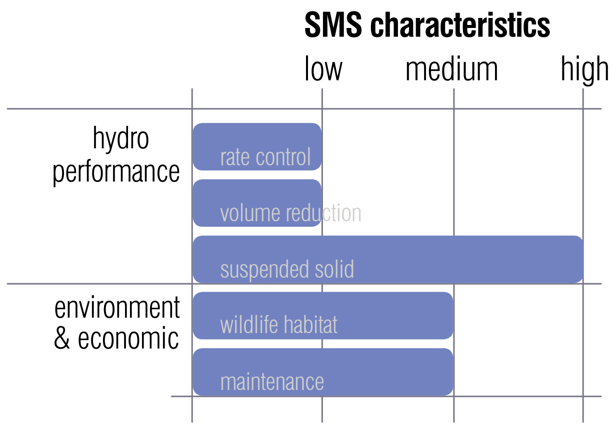

Table 5.9 Wet Swale Hydrologic, Environmental, and Economic Characteristics - The above information illustrates characteristics attributed to infiltration basin performance

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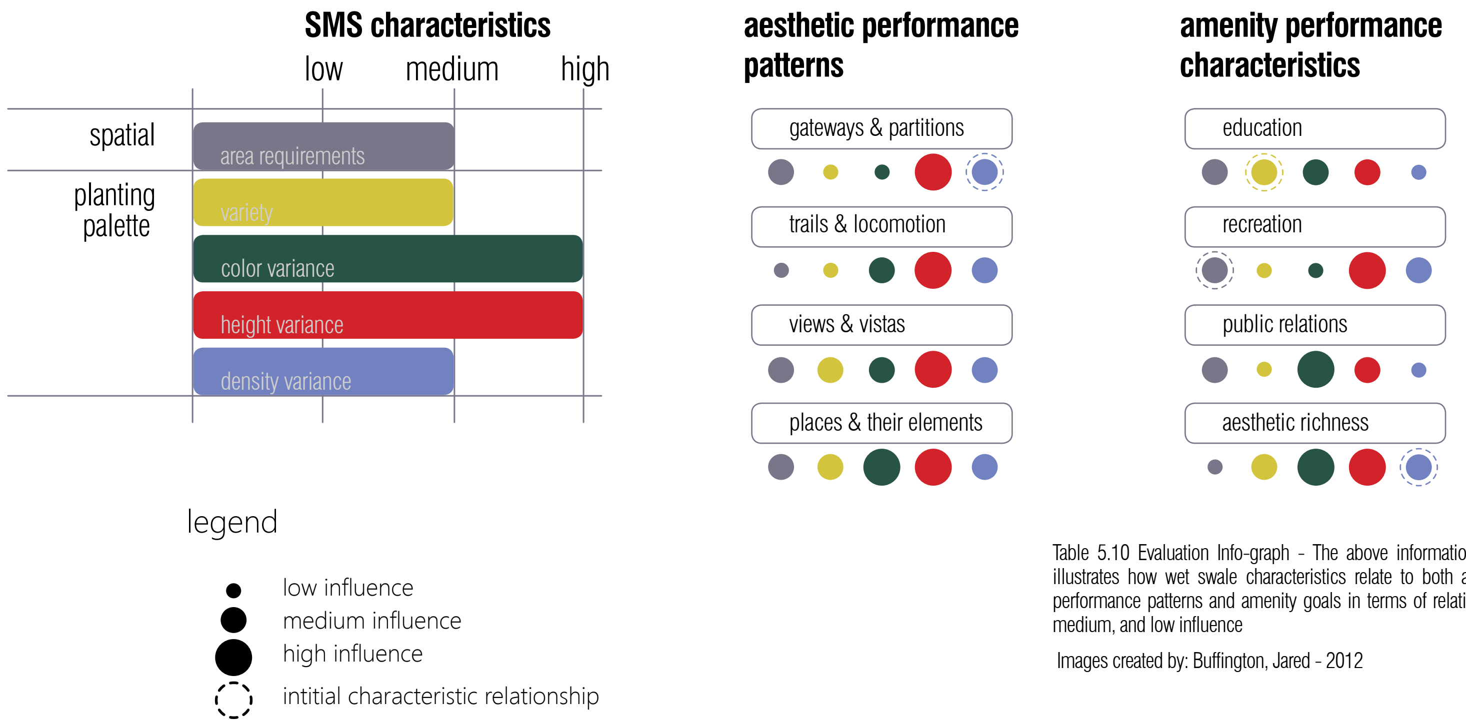

Table 5.10 Evaluation Info-graph - The above information graph illustrates how wet swale characteristics relate to both aesthetic performance patterns and amenity goals in terms of relative high, medium, and low influence

Images created by: Buffington, Jared - 2012

Filtration System Types

bioretention aesthetic & amenity overview

Bioretention systems are utilized to increase infiltration and pollutant removal through rate control and suspended solid reduction (Table 5.11). These systems typically have a high spatial requirement because they are utilized to collect runoff from parking lots or other hardscape areas that produce large amounts of runoff in short amounts of time.

The pollutant and suspended solid removal characteristic within bioretention systems is heavily dependent on specialized planting material. Planting material suited for bioretention systems provides a medium level of plant variance and density variety, in addition to a high color and height variance (Table 5.12). These characteristics allow bioretention systems to have a greater ability to aid in the application of aesthetic patterns such as gateways and partitions (highly dependent on plant height and density variance) and amenity goals such as public relations and aesthetic richness (heavily influenced by plant height and color variability).

Bioretention systems, like constructed wetlands, provide medium to high variances in plant variety, color, height, and density (Table 5.12), allowing a greater contribution to the application of aesthetic and amenity goals, but they are limited as to their application due to their high spatial requirements. Bioretention systems however are not suited to treat large drainage areas, limiting their application on some sites. This characteristic further reduces a bioretention system's application because it requires large amounts of relative space, but is limited to it's drainage capacity.

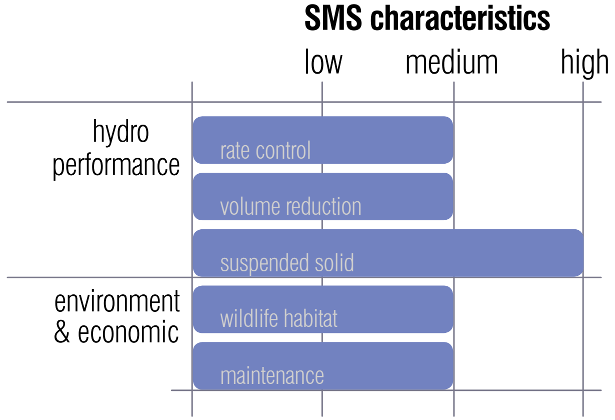

Table 5.11 Bioretention System Hydrologic, Environmental, and Economic Characteristics - The above information illustrates characteristics attributed to infiltration basin performance

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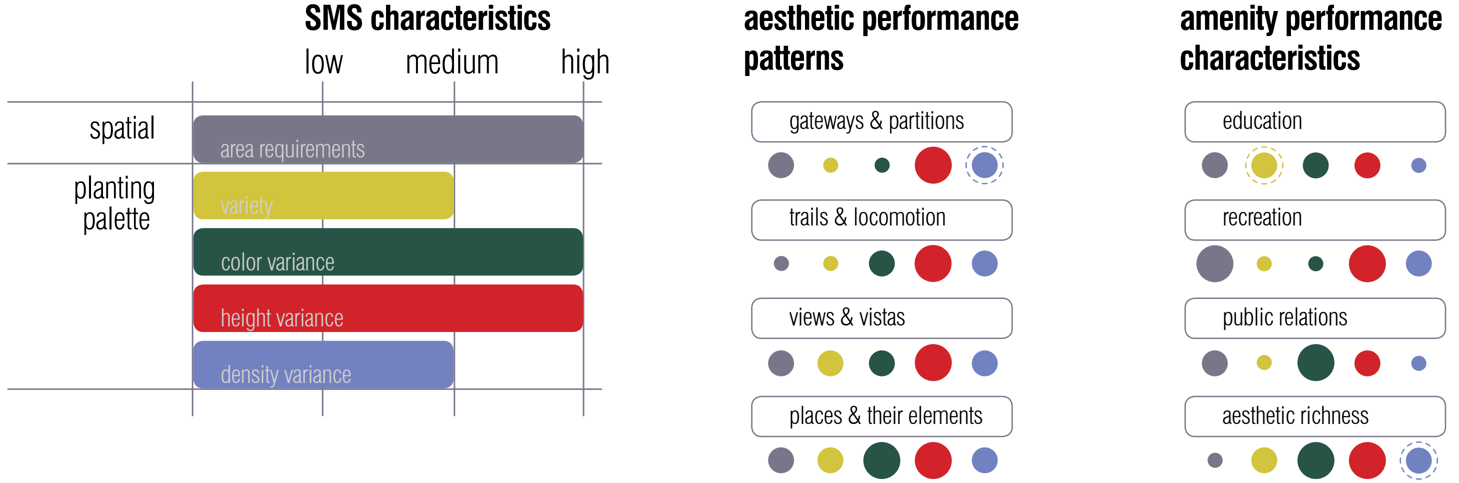

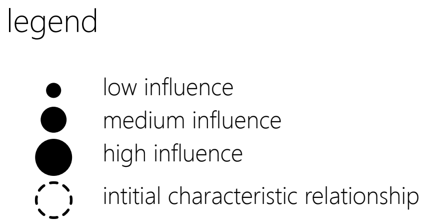

Table 5.12 Evaluation Info-graph - The above information graph illustrates how bioretention characteristics relate to both aesthetic performance patterns and amenity goals in terms of relative high, medium, and low influence

Images created by: Buffington, Jared - 2012

filter strip aesthetic & amenity overview

Filter strips utilize dense vegetation and uniform graded areas to treat runoff from adjacent impervious surfaces. These systems utilize rate control to slow runoff velocities in order to trap sediment and other pollutants, providing moderate levels of infiltration (Table 5.13).

Filter strip structure allows a variety of planting material to be utilized, from larger screening elements to turf grass that can be used for overlapping spaces. The planting palette best suited however is somewhat limited due to the broad hydrologic characteristics of the system; meaning that vegetation with higher degrees of tolerance are required.

The low variance in planting material does not however effect the systems color, height, and density variance (Table 5.14). These characteristics all have a medium rating which increases it's aesthetic and amenity application still to some degree.

Bioretention systems are very effective in urban environments in that they are low maintenance, they have well rounded hydrologic performance characteristics, have a moderate spatial requirement in relation to the contributing watershed or basin, and the planting palette can be utilized to a degree that does not completely limit its function as an aesthetic and amenity performer.

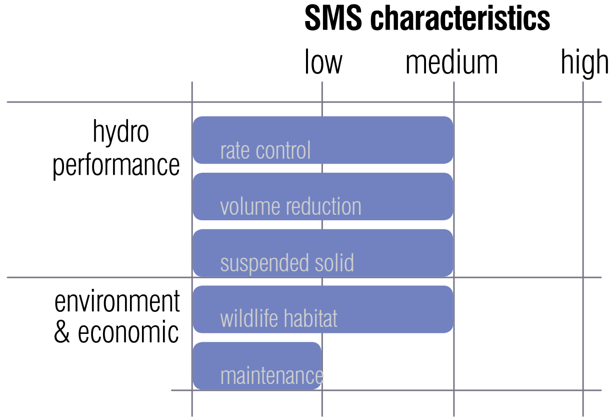

Table 5.13 Filter Strip Hydrologic, Environmental, and Economic Characteristics - The above information illustrates characteristics attributed to infiltration basin performance

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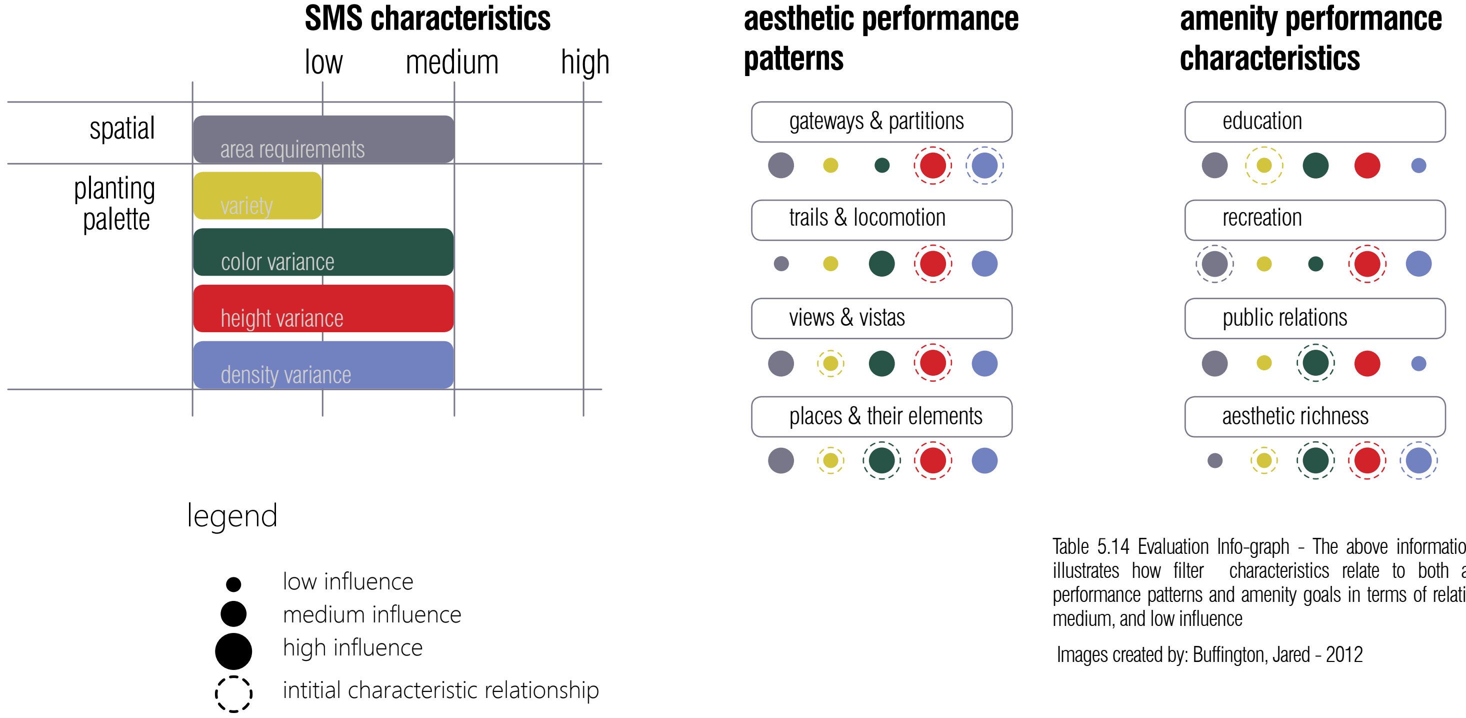

Table 5.14 Evaluation Info-graph - The above information graph illustrates how filter characteristics relate to both aesthetic performance patterns and amenity goals in terms of relative high, medium, and low influence

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appendices list of figures

appendices list of tables

APPENDIX B: SMS Plant Palette

APPX:A GLOSSARY

Basin – "A physiographic region bounded by a drainage divide; consists of a drainage system comprised of streams and often natural or man-made lakes." Another name for a watershed. (Bell, Eccles, Garber, Kerby & Swaffar, 2004)

Biological Characteristics – "A characteristic of water defined by the levels of bacteria, viruses, and microscopic animals present." (Bell, Eccles, Garber, Kerby & Swaffar, 2004) Characteristics that are used to determine water quality.

Channel - An area intended for a concentrated flow of water that is designed and built to handle stream flow/water movement. Some areas may be ephemeral, but during rain events, water fills the otherwise dry creek bed.

Categorize - To logically link or assign to a category

Classify - To arrange in classes according to shared qualities

Coherence – extent to which the scene "hangs together" (redundant elements, textures, and structural features allow prediction, from one portion of scene to another; organization causes elements to be perceived as groups)

Complexity – number of visual elements in scene; how much is going on

Constructed Wetland- An ecosystem that is produced by man to hold water and improve water quality. Plant selection and habitat are considered in this sustainable landscape feature.

Discharge – "The outflow of water, originating from either a pipe or stream, into a larger body of water." (Bell, Eccles, Garber, Kerby & Swaffar, 2004)

Ecosystem- "A group of plants or animals together with that part of the physical environment with which they interact." (Bell, Eccles, Garber, Kerby & Swaffar, 2004) Food, shelter, and water systems of an area working together to support each other.

Fauna – "The collection of animal species in a particular ecosystem." (Bell, Eccles, Garber, Kerby & Swaffar, 2004)

Filtration – "A treatment technology used to remove inorganic compounds from water." (Bell, Eccles, Garber, Kerby & Swaffar, 2004) Gravel or vegetative sources can be used to clean water as it passes through.

Flood Plain – A lowland area that has a high flooding risk. The official boundary is set by FEMA, causing higher insurance rates of developed land within this area.

Flora – "The collection of plant species in a particular ecosystem." (Bell, Eccles, Garber, Kerby & Swaffar, 2004)

Flow – "The rate of water discharged from a source expressed in volume with respect to time." (Bell, Eccles, Garber, Kerby & Swaffar, 2004)

Habitat- Location for wildlife and plants to have optimal food, water, shelter, and growing conditions. Bringing everything necessary for the species to survive and thrive in the area.

Holding Pond- "Pond or reservoir, usually made of earth, but built to store polluted runoff." (Bell, Eccles, Garber, Kerby & Swaffar, 2004)

Hydrologic Cycle- "Complete cycle through which water moves from the oceans, through the atmosphere, to the land and back to the oceans." (Bell, Eccles, Garber, Kerby & Swaffar, 2004) The cycle or evaporation, clouds forming, rain or snow falling, and runoff back into the water source.

Hydrology- "A study of water and its properties, circulation, principles and distribution." (Bell, Eccles, Garber, Kerby & Swaffar, 2004)

Identifiability – sense of familiarity (rather than actual familiarity); how easy to get to know the scene

Impermeable- "Geologic formations that resist water percolating through them." (Bell, Eccles, Garber, Kerby & Swaffar, 2004) Buildings, pavement (impermeable), infrastructure, and rock are some examples of impermeable surfaces that don't collect water and create higher levels of runoff.

Infiltration- Water seeping into the ground and creating moist soil, feeding plants through the root system, and preventing water from leaving the site. This is encouraged through the use of permeable materials, sandy soils, and vegetation.

Infiltration capacity- the maximum rate at which a soil in a given condition can absorb water or runoff

Legibility – prediction of the opportunity to function; finding one's way in, and finding one's way back; ease of forming a "mental map"Mystery – going into the scene seems likely to provide more information (it must appear possible to enter scene and go somewhere; promise of further information based on a change of vantage point)

Natural Flow- "Rate that water moves past a specific point on a natural stream. The flow comes from a drainage area in which there has been no stream diversion caused by storage, import, export, return flow, or change in consumptive use; caused by land use modifications." (Bell, Eccles, Garber, Kerby & Swaffar, 2004)

Paradigm- standards or model that guides design in a specific area (i.e.: water sensitive design paradigm)

Percolation- "The downward movement of water through the soil." (Bell, Eccles, Garber, Kerby & Swaffar, 2004)

Permeable - "A characteristic of underground formations which have pores or openings that permit liquids to pass through." (Bell, Eccles, Garber, Kerby & Swaffar, 2004). Areas or materials with high levels of infiltration.

Spaciousness – sense of space; how much room to wander

Regenerative Systems- "A regenerative system provides for continuous replacement, through its own functional processes, of the energy and materials used in its operation" (Lyle, 1994, p. 10). A system that can produce food and shelter for every species and have species work together to sustain its growth as a habitat.

Rip Rap- "Crushed and broken stone of varying sizes placed to cover soil. Used for landscaping and erosion control." (Bell, Eccles, Garber, Kerby & Swaffar, 2004)

Riparian- Area that is adjacent to the creek and helps increase infiltration, commonly wooded. The riparian area often is a protector of the creek and a boundary between development or agricultural land and the creek.

Runoff- Stormwater that leaves the original point source and continues onto another property or location. Finding ways to reduce runoff will reduce flooding. Part of flooding is a result of too much runoff from other locations descending into a new location.

Sedimentation- "The deposition of silt, soil, clay or sand particles in locations where slow-moving water loses its ability to hold heavier particles in suspension." (Bell, Eccles, Garber, Kerby & Swaffar, 2004) The changes in erosion processes will become critical in the RLA portion of the WARSSS analysis.

Storm Drain – any drain which drains directly into the storm sewer system, usually found along roadways or in parking lots.

Storm Sewer – an underground pipe system that carries runoff from streets and other surfaces and discharges directly to a stream or river without any form of pretreatment.

Stormwater– stormwater or snow melt runoff, and surface runoff and drainage.

Stormwater Management- "The collection, conveyance, storage, treatment and disposal of stormwater runoff to prevent accelerated channel erosion, increased flood damage, and degradation of water quality." (Montgomery County Planning Department, 2009.)

Stream Bank Stabilization- "Attempts to retard the banks from eroding by use of vegetation, weirs, riprap, etc." (Bell, Eccles, Garber, Kerby & Swaffar, 2004)

Sustainability- A blend of social, economic, and environmental features in the landscape that allow the site to survive and hopefully thrive into the future. (Triple Bottom Line)

Texture – how fine grained ground surface of surface or obstruction is

Topography- "The general configuration of the land surface including relief and position of natural and man-made features." (Bell, Eccles, Garber, Kerby & Swaffar, 2004)

Upland- Area within watershed that does not exist in the floodplain.

Washland- Land adjacent to a wetland that serves as an undeveloped floodplain. There is a focus in wildlife habitat and the ability to have flooding on site when needed. (Kyoung et al., 2007)

Water Reuse- Captured rainwater that is then given an alternative uses. Harvested rainwater is generally reused for non-potable uses and irrigation.

Wastewater- "water that has been used in homes, industries or businesses that can be reused if adequately treated." (Bell, Eccles, Garber, Kerby & Swaffar, 2004) Black and grey water are types of wastewater.

Water Table- "The upper portion of the part of the ground that is completely saturated with water. The water level in a well when the pump is not running." (Bell, Eccles, Garber, Kerby & Swaffar, 2004)

Watershed- Land that directs water into a concentrated water drainage way.

Watershed Planning- Process focusing on the means to "… resolve and prevent water quality problems that result from both point source and nonpoint source problems." Watershed planning process includes: Build partnerships, characterize watershed to identify problems, set goals and identify solutions, design an implementation program, implement the watershed plan and measure progress and make adjustments. (United States Environmental Protection Agency, 2008)

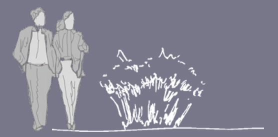
Wetland- An ecosystem that consists of physiochemical environment (e.g., soil, chemistry, and water quality), hydrology (e.g., water level flow, frequency, and water quantity), and biota (e.g., vegetation, animals, and microbes)

8'+ Tall

3-Demensional Landscape Definition and View Direction

4'-7' Tall

Provides Enclosure, Screens or Frames Views



18"-3' Tall

Provides Implied Enclosure, View and Circulation Direction

1"-16" Tall

Deters, or Allows Implied Access

APPX:B STORMWATER MANAGEMENT PLANT PALETTE

The included planting palette is provided by Shaw and Schmidt et al. (2003). The planting palette is broken down by SMS. The information provided by Shaw and Schmidt was added to and re-categorized based on seasonal change relationships, density variances, and height differences. These added characteristics are important factors when addressing the patterns of the Understanding and Exploration framework et al. (Kaplan, Kaplan, and Ryan, 1998) Included within Appendix B is a list of each plant utilized within the SMS designed and evaluated in this book, as well as plant lists for Detention and Retention Systems. Detention and Retention Systems were not covered in the evaluations.

infiltration basin planting palette

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Zizia aurea	Golden alexanders	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland
Aster pilosus	Frost aster	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow, Floodplain, Upland
Angelica atropurpurea	Angelica	forbes and ferns	1"-16"							flower						Wet Meadow, Upland
Asclepias tuberosa	Butterfly milkweed	forbes and ferns	1"-16", 18"-3'						flower							Wet Meadow
Allium stellatum	Prairie wild onion	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Zizia aurea	Golden alexanders	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland
Aster pilosus	Frost aster	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow, Floodplain, Upland
Bromus ciliatus	Fringed brome	grasses, sedges, and rushes	18"-3'						flower							Wet Meadow
Asclepias tuberosa	Butterfly milkweed	forbes and ferns	1"-16", 18"-3'						flower							Wet Meadow
Aster laevis	Smooth aster	forbes and ferns	18"-3'								flower					Wet Meadow, Floodplain
Eryngium yuccifolium	Rattlesnake master	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Allium stellatum	Prairie wild onion	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland
Boltonia asteroides	Boltonia	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow, Floodplain
Pycnanthemum virginianum	Mountain mint	forbes and ferns	18"-3'						flower							Wet Meadow
Aster lanceolatum	Panicle aster	forbes and ferns	18"-3'								flower					Wet Meadow, Upland
Osmunda regalis	Royal fern	forbes and ferns	18"-3'													Wet Meadow, Upland
Athyrium filix-femina	Lady fern	forbes and ferns	18"-3'													Wet Meadow, Floodplain

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Panicum virgatum	Switchgrass	grasses, sedges, and rushes	4'-7'							flower						Wet Meadow
Solidago rigida	Stiff goldenrod	forbes and ferns	4'-7'								flower					Wet Meadow
Eryngium yuccifolium	Rattlesnake master	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Boltonia asteroides	Boltonia	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow, Floodplain
Matteuccia struthiopteris	Ostrich fern	forbes and ferns	4'-7'													Wet Meadow, Floodplain, Upland
Andropogon gerardii	Big bluestem	grasses, sedges, and rushes	4'-7', 8+'													Wet Meadow, Floodplain

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Betula nigra	River birch	trees and shrubs	8+'				flower									Wet Meadow
Salix nigra	Black willow	trees and shrubs	8+'				flower									Wet Meadow
Fraxinus nigra	Black ash	trees and shrubs	8+'				flower									Wet Meadow
Cornus racemosa	Gray dogwood	trees and shrubs	8+'					flower								Wet Meadow
Viburnum lentago	Nannyberry	trees and shrubs	8+'					flower								Wet Meadow
Quercus bicolor	Swamp white oak	trees and shrubs	8+'													Wet Meadow
Andropogon gerardii	Big bluestem	grasses, sedges, and rushes	4'-7', 8+'													Wet Meadow, Floodplain

Table B.1 - Infiltration Basin Wet Meadow Plant Palette

Created by: Buffington, Jared - 2012

Source: (Shaw & Schmidt, 2003)

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Euthanmia graminifolia	Grass-leaved goldenrod	forbes and ferns	1"-16", 18"-3'							flower						Floodplain
Aster pilosus	Frost aster	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow, Floodplain, Upland
Amorpha fruiticosa	Indigo bush	trees and shrubs	1"-16"						flower							Floodplain
Smilacina racemosa	False Solomon's seal	forbes and ferns	1"-16", 18"-3'			flower						fruit				Floodplain
Aronia melanocarpa	Black chokeberry	trees and shrubs	18"-3, 4'-7'					flower								Floodplain, Upland

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Euthanmia graminifolia	Grass-leaved goldenrod	forbes and ferns	1"-16", 18"-3'							flower						Floodplain
Aster pilosus	Frost aster	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow, Floodplain, Upland
Carex vulpinoidea	Fox sedge	grasses, sedges, and rushes	18"-3'					flower								Floodplain
Smilacina racemosa	False Solomon's seal	forbes and ferns	1"-16", 18"-3'			flower						fruit				Floodplain
Aster laevis	Smooth aster	forbes and ferns	18"-3'								flower					Wet Meadow, Floodplain
Eryngium yuccifolium	Rattlesnake master	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Aronia melanocarpa	Black chokeberry	trees and shrubs	18"-3, 4'-7'					flower								Floodplain, Upland
Boltonia asteroides	Boltonia	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow, Floodplain
Athyrium filix-femina	Lady fern	forbes and ferns	18"-3'													Wet Meadow, Floodplain

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Celtis occidentalis	Hackberry	trees and shrubs	4'-7'				flower									Floodplain
Sorghasrrum nutans	Indian grass	grasses, sedges, and rushes	4'-7'								flower					Floodplain
Eryngium yuccifolium	Rattlesnake master	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Viburnum trilobum	High bush cranberry	trees and shrubs	4'-7', 8+'	fruit					flower					fruit		Floodplain, Upland
Aronia melanocarpa	Black chokeberry	trees and shrubs	18"-3, 4'-7'					flower								Floodplain, Upland
Boltonia asteroides	Boltonia	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow, Floodplain
Andropogon gerardii	Big bluestem	grasses, sedges, and rushes	4'-7', 8+'													Wet Meadow, Floodplain
Matteuccia struthiopteris	Ostrich fern	forbes and ferns	4'-7'													Wet Meadow, Floodplain, Upland

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Fraxinus pennsylvanica	Green ash	trees and shrubs	8+'				flower									Floodplain
Helianthus grosseserratus	Sawtooth sunflower	forbes and ferns	8+'							flower						Floodplain
Viburnum trilobum	High bush cranberry	trees and shrubs	4'-7', 8+'	fruit					flower					fruit		Floodplain, Upland
Andropogon gerardii	Big bluestem	grasses, sedges, and rushes	4'-7', 8+'													Wet Meadow, Floodplain

Table B.2 - Infiltration Basin Floodplain Plant Palette

Created by: Buffington, Jared - 2012

Source: (Shaw & Schmidt, 2003)

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Zizia aurea	Golden alexanders	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland
Solidago flexicaulis	Zig-zag goldenrod	forbes and ferns	1"-16", 18"-3'								flower					Upland
Aster pilosus	Frost aster	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow, Floodplain, Upland
Angelica atropurpurea	Angelica	forbes and ferns	1"-16"							flower						Wet Meadow, Upland
Aster macrophyllus	Bigleaf aster	forbes and ferns	1"-16"								flower					Upland
Tradescantia ohiensis	Ohio spiderwort	forbes and ferns	1"-16", 18"-3'				flower									Upland
Allium stellatum	Prairie wild onion	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Zizia aurea	Golden alexanders	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland
Solidago flexicaulis	Zig-zag goldenrod	forbes and ferns	1"-16", 18"-3'								flower					Upland
Solidago riddellii	Riddell's goldemod	forbes and ferns	18"-3'									flower				Upland
Aster pilosus	Frost aster	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow, Floodplain, Upland
Spiraea alba	Meadowsweet	forbes and ferns	18"-3, 4'-7'						flower							Upland
Heuchera richardsonii	Prairie alumroot	forbes and ferns	18"-3'				flower									Upland
Schizachyrium scoparium	Little bluestem	grasses, sedges, and rushes	18"-3'							flower						Upland
Liatris ligulistylis	Meadow blazingstar	forbes and ferns	18"-3, 4'-7'							flower						Upland
Allium stellatum	Prairie wild onion	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland
Liatris pychnostachya	Prairie blazingstar	forbes and ferns	18"-3, 4'-7'							flower						Upland
Monarda fistulosa	Wild bergamot	forbes and ferns	18"-3, 4'-7'							flower						Upland
Tradescantia ohiensis	Ohio spiderwort	forbes and ferns	1"-16", 18"-3'				flower									Upland
Aronia melanocarpa	Black chokeberry	trees and shrubs	18"-3, 4'-7'					flower								Floodplain, Upland
Galium boreale	Northern bedstraw	forbes and ferns	18"-3'						flower							Upland
Aster lanceolatum	Panicle aster	forbes and ferns	18"-3'								flower					Wet Meadow, Upland
Pteridium aquilinum	Bracken fern	forbes and ferns	18"-3'													Upland
Equisetum fluviatile	Horsetail	grasses, sedges, and rushes	18"-3'													Upland
Osmunda regalis	Royal fern	forbes and ferns	18"-3'													Wet Meadow, Upland

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Spiraea alba	Meadowsweet	forbes and ferns	18"-3, 4'-7'						flower							Upland
Illex verticillata	Winterberry	trees and shrubs	4'-7', 8+'						flower	fruit						Upland
Liatris ligulistylis	Meadow blazingstar	forbes and ferns	18"-3, 4'-7'							flower						Upland
Liatris pychnostachya	Prairie blazingstar	forbes and ferns	18"-3, 4'-7'							flower						Upland
Monarda fistulosa	Wild bergamot	forbes and ferns	18"-3, 4'-7'							flower						Upland
Viburnum trilobum	High bush cranberry	trees and shrubs	4'-7', 8+'	fruit					flower					fruit		Floodplain, Upland
Sambucus racemosa	Red-berried elder	trees and shrubs	4'-7', 8+'				flower		fruit							Upland
Aronia melanocarpa	Black chokeberry	trees and shrubs	18"-3, 4'-7'					flower								Floodplain, Upland
Agastache foeniculum	Giant hyssop	forbes and ferns	18"-3', 4'-7'						flower							Upland
Matteuccia struthiopteris	Ostrich fern	forbes and ferns	4'-7'													Wet Meadow, Floodplain, Upland

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Illex verticillata	Winterberry	trees and shrubs	4'-7', 8+'						flower	fruit						Upland
Lilium superbum	Turk's-cap lily	forbes and ferns	8+'						flower							Upland
Sambucus racemosa	Red-berried elder	trees and shrubs	4'-7', 8+'				flower		fruit							Upland
Physocarpus opulifolius	Ninebark	trees and shrubs	8+'					flower				foliage				Upland
Viburnum trilobum	High bush cranberry	trees and shrubs	4'-7', 8+'	fruit					flower					fruit		Floodplain, Upland
Acer saccharinum	Silver maple	trees and shrubs	8+'		flower											Upland
Larix laricina	Tamarack	trees and shrubs	8+'													Upland

Table B.3 - Infiltration Basin Upland Plant Palette

Created by: Buffington, Jared

Source: (Shaw & Schmidt, 2003)

on-lot infiltration planting palette

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Cephalanthus occidentalis	Buttonbush	trees and shrubs	18"-3, 4'-7', 8+'						flower							Emergent, Floodplain
Juncus effusus	Soft rush	grasses, sedges, and rushes	18"-3, 4'-7'							flower						Emergent, Wet Meadow

Table B.4 - On-Lot Infiltration Emergent Plant Palette

Created by: Buffington, Jared - 2012

Source: (Shaw & Schmidt, 2003)

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Lysimachia thyrsiflora	Tufted loosestrife	forbes and ferns	1"-16", 18"-3'						flower							Wet Meadow, Floodplain
Angelica atropurpurea	Angelica	forbes and ferns	1"-16"							flower						Wet Meadow, Upland
Carex comosa	Bottlebrush sedge	grasses, sedges, and rushes	1"-16", 18"-3', 4'-7'					flower								Wet Meadow, Floodplain
Aster puniceus	Red-stemmed aster	forbes and ferns	1"-16", 18"-3', 4'-7'	stem color							flower			stem color		Wet Meadow, Floodplain
Glyceria striata	Fowl manna grass	grasses, sedges, and rushes	1"-16", 18"-3, 4'-7'						flower							Wet Meadow
Chelone glabra	Turtlehead	forbes and ferns	1"-16"							flower						Wet Meadow
Gentiana andrewsii	Bottle gentian	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow
Scutellaria lateriflora	Mad-dog skullcap	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Floodplain
Onoclea sensibilis	Sensitive fern	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Upland

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Lysimachia thyrsiflora	Tufted loosestrife	forbes and ferns	1"-16", 18"-3'						flower							Wet Meadow, Floodplain
Helenium autumnale	Sneeze weed	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow
Thalictrum dasycarpum	Tall meadowrue	forbes and ferns	18"-3, 4'-7'						flower							Wet Meadow
Carex comosa	Bottlebrush sedge	grasses, sedges, and rushes	1"-16", 18"-3', 4'-7'					flower								Wet Meadow, Floodplain
Juncus effusus	Soft rush	grasses, sedges, and rushes	18"-3, 4'-7'							flower						Emergent, Wet Meadow
Asclepias incarnata	Marsh milkweed	forbes and ferns	18"-3, 4'-7'	stem color					flower					stem color		Wet Meadow
Lobelia cardinalis	Cardinal flower	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Lobelia siphilitica	Blue lobelia	forbes and ferns	18"-3'							flower						Wet Meadow, Floodplain
Aster puniceus	Red-stemmed aster	forbes and ferns	1"-16", 18"-3', 4'-7'	stem color							flower			stem color		Wet Meadow, Floodplain
Eupatorium maculatum	Joe-pye-weed	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow
Glyceria striata	Fowl manna grass	grasses, sedges, and rushes	1"-16", 18"-3, 4'-7'						flower							Wet Meadow
Physostegia virginiana	Obedient plant	forbes and ferns	18"-3'							flower						Wet Meadow, Floodplain
Gentiana andrewsii	Bottle gentian	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow
Boltonia asteroides	Boltonia	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow, Floodplain
Scutellaria lateriflora	Mad-dog skullcap	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Floodplain
Scirpus cyperinus	Woolgrass	grasses, sedges, and rushes	18"-3, 4'-7'													Wet Meadow
Osmunda regalis	Royal fern	forbes and ferns	18"-3'													Wet Meadow, Upland
Onoclea sensibilis	Sensitive fern	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Upland

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Panicum virgatum	Switchgrass	grasses, sedges, and rushes	4'-7'							flower						Wet Meadow
Silphium perfoliatum	Cup plant	forbes and ferns	4'-7'							flower						Wet Meadow, Floodplain
Helenium autumnale	Sneeze weed	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow
Solidago rigida	Stiff goldenrod	forbes and ferns	4'-7'								flower					Wet Meadow
Thalictrum dasycarpum	Tall meadowrue	forbes and ferns	18"-3, 4'-7'						flower							Wet Meadow
Spartina pectinata	Prairie cord grass	grasses, sedges, and rushes	4'-7'							flower						Wet Meadow, Floodplain
Carex comosa	Bottlebrush sedge	grasses, sedges, and rushes	1"-16", 18"-3', 4'-7'					flower								Wet Meadow, Floodplain
Juncus effusus	Soft rush	grasses, sedges, and rushes	18"-3, 4'-7'							flower						Emergent, Wet Meadow
Lobelia cardinalis	Cardinal flower	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Asclepias incarnata	Marsh milkweed	forbes and ferns	18"-3, 4'-7'	stem color					flower					stem color		Wet Meadow
Veronia fasciculata	Ironweed	forbes and ferns	4'-7'							flower						Wet Meadow, Floodplain
Aster puniceus	Red-stemmed aster	forbes and ferns	1"-16", 18"-3', 4'-7'	stem color							flower			stem color		Wet Meadow, Floodplain
Eupatorium maculatum	Joe-pye-weed	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow
Glyceria striata	Fowl manna grass	grasses, sedges, and rushes	1"-16", 18"-3, 4'-7'						flower							Wet Meadow
Veronicastrum virginicum	Culver's root	forbes and ferns	18"-3, 4'-7'					flower								Wet Meadow, Upland
Boltonia asteroides	Boltonia	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow, Floodplain
Scirpus cyperinus	Woolgrass	grasses, sedges, and rushes	18"-3, 4'-7'													Wet Meadow

Table B.5 - On-Lot Infiltration Wet Meadow Plant Palette

Created by: Buffington, Jared - 2012

Source: (Shaw & Schmidt, 2003)

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Lysimachia thyrsiflora	Tufted loosestrife	forbes and ferns	1"-16", 18"-3'						flower							Wet Meadow, Floodplain
Carex comosa	Bottlebrush sedge	grasses, sedges, and rushes	1"-16", 18"-3', 4'-7'					flower								Wet Meadow, Floodplain
Aster puniceus	Red-stemmed aster	forbes and ferns	1"-16", 18"-3', 4'-7'	stem color							flower			stem color		Wet Meadow, Floodplain
Scutellaria lateriflora	Mad-dog skullcap	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Floodplain

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Lysimachia thyrsiflora	Tufted loosestrife	forbes and ferns	1"-16", 18"-3'						flower							Wet Meadow, Floodplain
Carex vulpinoidea	Fox sedge	grasses, sedges, and rushes	18"-3'					flower								Floodplain
Carex comosa	Bottlebrush sedge	grasses, sedges, and rushes	1"-16", 18"-3', 4'-7'					flower								Wet Meadow, Floodplain
Lobelia siphilitica	Blue lobelia	forbes and ferns	18"-3'							flower						Wet Meadow, Floodplain
Aster puniceus	Red-stemmed aster	forbes and ferns	1"-16", 18"-3', 4'-7'	stem color							flower			stem color		Wet Meadow, Floodplain
Physostegia virginiana	Obedient plant	forbes and ferns	18"-3'							flower						Wet Meadow, Floodplain
Boltonia asteroides	Boltonia	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow, Floodplain
Cephalanthus occidentalis	Buttonbush	trees and shrubs	18"-3, 4'-7', 8+'						flower							Emergent, Floodplain
Aronia melanocarpa	Black chokeberry	trees and shrubs	18"-3, 4'-7'					flower								Floodplain, Upland
Lobelia cardinalis	Cardinal flower	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Scutellaria lateriflora	Mad-dog skullcap	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Floodplain

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Silphium perfoliatum	Cup plant	forbes and ferns	4'-7'							flower						Wet Meadow, Floodplain
Spartina pectinata	Prairie cord grass	grasses, sedges, and rushes	4'-7'							flower						Wet Meadow, Floodplain
Carex comosa	Bottlebrush sedge	grasses, sedges, and rushes	1"-16", 18"-3', 4'-7'					flower								Wet Meadow, Floodplain
Veronia fasciculata	Ironweed	forbes and ferns	4'-7'							flower						Wet Meadow, Floodplain
Aster puniceus	Red-stemmed aster	forbes and ferns	1"-16", 18"-3', 4'-7'	stem color							flower			stem color		Wet Meadow, Floodplain
Lobelia cardinalis	Cardinal flower	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Boltonia asteroides	Boltonia	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow, Floodplain
Viburnum trilobum	High bush cranberry	trees and shrubs	4'-7', 8+'	fruit					flower					fruit		Floodplain, Upland
Cornus sericea	Red-osier dogwood	trees and shrubs	4'-7', 8+'	twig		fruit		flower				fruit		twig		Floodplain
Cephalanthus occidentalis	Buttonbush	trees and shrubs	18"-3, 4'-7', 8+'						flower							Emergent, Floodplain
Aronia melanocarpa	Black chokeberry	trees and shrubs	18"-3, 4'-7'					flower								Floodplain, Upland

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Viburnum trilobum	High bush cranberry	trees and shrubs	4'-7', 8+'	fruit					flower					fruit		Floodplain, Upland
Cornus sericea	Red-osier dogwood	trees and shrubs	4'-7', 8+'	twig		fruit		flower				fruit		twig		Floodplain
Cephalanthus occidentalis	Buttonbush	trees and shrubs	18"-3, 4'-7', 8+'						flower							Emergent, Floodplain

Table B.6 - On-Lot Infiltration Floodplain Plant Palette

Created by: Buffington, Jared

Source: (Shaw & Schmidt, 2003)

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Angelica atropurpurea	Angelica	forbes and ferns	1"-16"							flower						Wet Meadow, Upland
Onoclea sensibilis	Sensitive fern	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Upland

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Rudbeckia subtomentosa	Brown-eyed-Susan	forbes and ferns	18"-3'							flower						Upland
Liatris ligulistylis	Meadow blazingstar	forbes and ferns	18"-3, 4'-7'							flower						Upland
Liatris pychnostachya	Prairie blazingstar	forbes and ferns	18"-3, 4'-7'							flower						Upland
Agastache foeniculum	Giant hyssop	forbes and ferns	18"-3', 4'-7'						flower							Upland
Aronia melanocarpa	Black chokeberry	trees and shrubs	18"-3, 4'-7'					flower								Floodplain, Upland
Veronicastrum virginicum	Culver's root	forbes and ferns	18"-3, 4'-7'					flower								Wet Meadow, Upland
Equisetum fluviatile	Horsetail	grasses, sedges, and rushes	18"-3'													Upland
Pteridium aquilinum	Bracken fern	forbes and ferns	18"-3'													Upland
Osmunda regalis	Royal fern	forbes and ferns	18"-3'													Wet Meadow, Upland
Onoclea sensibilis	Sensitive fern	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Upland

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Liatris ligulistylis	Meadow blazingstar	forbes and ferns	18"-3, 4'-7'							flower						Upland
Liatris pychnostachya	Prairie blazingstar	forbes and ferns	18"-3, 4'-7'							flower						Upland
Agastache foeniculum	Giant hyssop	forbes and ferns	18"-3', 4'-7'						flower							Upland
Illex verticillata	Winterberry	trees and shrubs	4'-7', 8+'						flower	fruit						Upland
Viburnum trilobum	High bush cranberry	trees and shrubs	4'-7', 8+'	fruit					flower					fruit		Floodplain, Upland
Aronia melanocarpa	Black chokeberry	trees and shrubs	18"-3, 4'-7'					flower								Floodplain, Upland
Veronicastrum virginicum	Culver's root	forbes and ferns	18"-3, 4'-7'					flower								Wet Meadow, Upland

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Illex verticillata	Winterberry	trees and shrubs	4'-7', 8+'						flower	fruit						Upland
Viburnum trilobum	High bush cranberry	trees and shrubs	4'-7', 8+'	fruit					flower					fruit		Floodplain, Upland
Lilium superbum	Turk's-cap lily	forbes and ferns	8+'						flower							Upland

Table B.7 - On-Lot Infiltration Upland Plant Palette

Created by: Buffington, Jared

Source: (Shaw & Schmidt, 2003)

constructed wetland planting palette

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Caltha palustris	Marsh marigold	forbes and ferns	1"-16", 18"-3'				flower									Emergent
Juncus balticus	Baltic rush	grasses, sedges, and rushes	1"-16", 18"-3'					flower								Emergent, Wet Meadow

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Caltha palustris	Marsh marigold	forbes and ferns	1"-16", 18"-3'				flower									Emergent
Carex stricta	Tussock sedge	grasses, sedges, and rushes	18"-3'				flower									Emergent
Acorus calamus	Sweet flag	forbes and ferns	18"-3', 4'-7'						flower							Emergent
Juncus balticus	Baltic rush	grasses, sedges, and rushes	1"-16", 18"-3'					flower								Emergent, Wet Meadow
Juncus effusus	Soft rush	grasses, sedges, and rushes	18"-3, 4'-7'							flower						Emergent, Wet Meadow
Polygonum amphibium	Water smartweed	forbes and ferns	18"-3'						flower							Emergent
Alisma trivale	Water plantain	forbes and ferns	18"-3', 4'-7'					flower								Emergent
Pontederia cordata	Pickerelweed	forbes and ferns	18"-3, 4'-7'						flower							Emergent
Sagittaria latifolia	Broadleaved arrowhead	forbes and ferns	18"-3, 4'-7'							flower						Emergent
Scirpus pungens	Three-square bulrush	grasses, sedges, and rushes	18"-3, 4'-7'													Emergent, Wet Meadow
Carex aquatilis	Water sedge	grasses, sedges, and rushes	18"-3'													Emergent
Carex lacustris	Lake sedge	grasses, sedges, and rushes	18"-3'													Emergent

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Acorus calamus	Sweet flag	forbes and ferns	18"-3', 4'-7'						flower							Emergent
Juncus effusus	Soft rush	grasses, sedges, and rushes	18"-3, 4'-7'							flower						Emergent, Wet Meadow
Scirpus acutus	Hardstembulrush	grasses, sedges, and rushes	4'-7', 8+'					flower								Emergent
Typha latifolia	Broad-leaved cattail	forbes and ferns	4'-7', 8+'					flower								Emergent
Alisma trivale	Water plantain	forbes and ferns	18"-3', 4'-7'					flower								Emergent
Pontederia cordata	Pickerelweed	forbes and ferns	18"-3, 4'-7'						flower							Emergent
Cephalanthus occidentalis	Buttonbush	trees and shrubs	4'-7', 8+'						flower							Emergent
Sparganiun eurycarpum	Giant burreed	forbes and ferns	4'-7'						flower							Emergent
Sagittaria latifolia	Broadleaved arrowhead	forbes and ferns	18"-3, 4'-7'							flower						Emergent
Scirpus fluviatilis	River bulrush	grasses, sedges, and rushes	4'-7'													Emergent, Wet Meadow
Scirpus pungens	Three-square bulrush	grasses, sedges, and rushes	18"-3, 4'-7'													Emergent, Wet Meadow

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Scirpus acutus	Hardstembulrush	grasses, sedges, and rushes	4'-7', 8+'					flower								Emergent
Typha latifolia	Broad-leaved cattail	forbes and ferns	4'-7', 8+'					flower								Emergent
Cephalanthus occidentalis	Buttonbush	trees and shrubs	4'-7', 8+'						flower							Emergent
Scirpus validus	Soft-stem bulrush	grasses, sedges, and rushes	8+'													Emergent, Wet Meadow

Table B.8 - Left - Constructed Wetland Emergent Plant Palette

Created by: Buffington, Jared - 2012

Source: (Shaw & Schmidt, 2003)

Table B.9 - Right - Constructed Wetland Wet Meadow Plant Palette (1"-3')

Created by: Buffington, Jared - 2012

Source: (Shaw & Schmidt, 2003)

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Aster pilosus	Frost aster	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow, Floodplain, Upland
Zizia aurea	Golden alexanders	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow
Lysimachia thyrsiflora	Tufted loosestrife	forbes and ferns	1"-16", 18"-3'						flower							Wet Meadow, Floodplain
Bidens cernua	Beggarsticks	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow
Angelica atropurpurea	Angelica	forbes and ferns	1"-16"							flower						Wet Meadow
Carex languinosa	Wooly sedge	grasses, sedges, and rushes	1"-16", 18"-3'				flower									Wet Meadow
Juncus balticus	Baltic rush	grasses, sedges, and rushes	1"-16", 18"-3'					flower								Emergent, Wet Meadow
Eleocharis obtusa	Blunt spikerush	grasses, sedges, and rushes	1"-16", 18"-3'						flower							Wet Meadow
Asclepias tuberosa	Butterfly milkweed	forbes and ferns	1"-16", 18"-3'						flower							Wet Meadow
Allium stellatum	Prairie wild onion	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow
Chelone glabra	Turtlehead	forbes and ferns	1"-16"							flower						Wet Meadow
Gentiana andrewsii	Bottle gentian	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow
Onoclea sensibilis	Sensitive fern	forbes and ferns	1"-16", 18"-3'													Wet Meadow
Scutellaria lateriflora	Mad-dog skullcap	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Floodplain

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Asclepias tuberosa	Butterfly milkweed	forbes and ferns	1"-16", 18"-3'						flower							Wet Meadow
Impatiens capensis	Jewelweed	forbes and ferns	18"-3, 4'-7'						flower							Wet Meadow, Floodplain
Bromus ciliatus	Fringed brome	grasses, sedges, and rushes	18"-3'						flower							Wet Meadow
Bidens cernua	Beggarsticks	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow
Zizia aurea	Golden alexanders	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow
Lysimachia thyrsiflora	Tufted loosestrife	forbes and ferns	1"-16", 18"-3'						flower							Wet Meadow, Floodplain
Aster pilosus	Frost aster	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow, Floodplain, Upland
Helenium autumnale	Sneeze weed	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow
Thalictrum dasycarpum	Tall meadowrue	forbes and ferns	18"-3, 4'-7'						flower							Wet Meadow
Carex languinosa	Wooly sedge	grasses, sedges, and rushes	1"-16", 18"-3'				flower									Wet Meadow
Carex crinita	Caterpillar sedge	grasses, sedges, and rushes	18"-3'					flower								Wet Meadow
Carex hystericina	Porcupine sedge	grasses, sedges, and rushes	18"-3'					flower								Wet Meadow
Leersia oryzoides	Rice-cut grass	grasses, sedges, and rushes	18"-3, 4'-7'						flower							Wet Meadow, Floodplain
Carex comosa	Bottlebrush sedge	grasses, sedges, and rushes	18"-3', 4'-7'					flower								Wet Meadow, Floodplain
Carex bebbii	Bebb's sedge	grasses, sedges, and rushes	18"-3'					flower								Wet Meadow
Carex stipata	Awl-fruited sedge	grasses, sedges, and rushes	18"-3'					flower								Wet Meadow
Juncus effusus	Soft rush	grasses, sedges, and rushes	18"-3, 4'-7'							flower						Emergent, Wet Meadow
Juncus balticus	Baltic rush	grasses, sedges, and rushes	1"-16", 18"-3'					flower								Emergent, Wet Meadow
Juncus torreyi	Torrey rush	grasses, sedges, and rushes	18"-3'							flower						Wet Meadow
Eleocharis obtusa	Blunt spikerush	grasses, sedges, and rushes	1"-16", 18"-3'						flower							Wet Meadow
Asclepias incarnata	Marsh milkweed	forbes and ferns	18"-3, 4'-7'	stem color					flower					stem color		Wet Meadow
Potentilla palustris	Marsh cinquefoil	forbes and ferns	18"-3'						fruit							Wet Meadow, Floodplain, Upland
Lobelia cardinalis	Cardinal flower	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Verbena hastata	Blue vervain	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow
Lobelia siphilitica	Blue lobelia	forbes and ferns	18"-3'							flower						Wet Meadow, Floodplain
Aster puniceus	Red-stemmed aster	forbes and ferns	18"-3', 4'-7'	stem color							flower			stem color		Wet Meadow, Floodplain
Aster laevis	Smooth aster	forbes and ferns	18"-3'								flower					Wet Meadow, Floodplain
Physostegia virginiana	Obedient plant	forbes and ferns	18"-3'							flower						Wet Meadow, Floodplain
Glyceria striata	Fowl manna grass	grasses, sedges, and rushes	18"-3, 4'-7'						flower							Wet Meadow
Eryngium yuccifolium	Rattlesnake master	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Eupatorium maculatum	Joe-pye-weed	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow
Allium stellatum	Prairie wild onion	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow
Gentiana andrewsii	Bottle gentian	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow
Aster lucidulus	Swamp aster	forbes and ferns	18"-3'								flower					Wet Meadow, Floodplain
Iris versicolor	Blueflag iris	forbes and ferns	18"-3'					flower								Wet Meadow
Pycnanthemum virginianum	Mountain mint	forbes and ferns	18"-3'						flower							Wet Meadow
Aster lanceolatum	Panicle aster	forbes and ferns	18"-3'								flower					Wet Meadow
Veronicastrum virginicum	Culver's root	forbes and ferns	18"-3, 4'-7'					flower								Wet Meadow
Boltonia asteroides	Boltonia	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow, Floodplain
Onoclea sensibilis	Sensitive fern	forbes and ferns	1"-16", 18"-3'													Wet Meadow
Scutellaria lateriflora	Mad-dog skullcap	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Floodplain
Calamagrostis canadensis	Canada blue-joint	grasses, sedges, and rushes	18"-3'													Wet Meadow
Carex lasiocarpa	Wooly needle	grasses, sedges, and rushes	18"-3'													Wet Meadow
Carex retrorsa	Retrorse sedge	grasses, sedges, and rushes	18"-3'													Wet Meadow
Eupatorium perfoliatum	Boneset	forbes and ferns	18"-3'													Wet Meadow
Osmunda regalis	Royal fern	forbes and ferns	18"-3'													Wet Meadow
Athyrium filix-femina	Lady fern	forbes and ferns	18"-3'													Wet Meadow, Floodplain
Scirpus pungens	Three-square bulrush	grasses, sedges, and rushes	18"-3, 4'-7'													Emergent, Wet Meadow
Scirpus cyperinus	Woolgrass	grasses, sedges, and rushes	18"-3, 4'-7'													Wet Meadow

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Impatiens capensis	Jewelweed	forbes and ferns	18"-3, 4'-7'						flower							Wet Meadow, Floodplain
Silphium perfoliatum	Cup plant	forbes and ferns	4'-7'							flower						Wet Meadow, Floodplain
Panicum virgatum	Switchgrass	grasses, sedges, and rushes	4'-7'							flower						Wet Meadow
Helenium autumnale	Sneeze weed	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow
Solidago rigida	Stiff goldenrod	forbes and ferns	4'-7'								flower					Wet Meadow
Thalictrum dasycarpum	Tall meadowrue	forbes and ferns	18"-3, 4'-7'						flower							Wet Meadow
Spartina pectinata	Prairie cord grass	grasses, sedges, and rushes	4'-7'							flower						Wet Meadow, Floodplain
Leersia oryzoides	Rice-cut grass	grasses, sedges, and rushes	18"-3, 4'-7'						flower							Wet Meadow, Floodplain
Carex comosa	Bottlebrush sedge	grasses, sedges, and rushes	18"-3', 4'-7'					flower								Wet Meadow, Floodplain
Juncus effusus	Soft rush	grasses, sedges, and rushes	18"-3, 4'-7'							flower						Emergent, Wet Meadow
Asclepias incarnata	Marsh milkweed	forbes and ferns	18"-3, 4'-7'	stem color					flower					stem color		Wet Meadow
Lobelia cardinalis	Cardinal flower	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Veronia fasciculata	Ironweed	forbes and ferns	4'-7'							flower						Wet Meadow, Floodplain
Verbena hastata	Blue vervain	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow
Aster puniceus	Red-stemmed aster	forbes and ferns	18"-3', 4'-7'	stem color							flower			stem color		Wet Meadow, Floodplain
Glyceria striata	Fowl manna grass	grasses, sedges, and rushes	18"-3, 4'-7'						flower							Wet Meadow
Glyceria grandis	Giant manna grass	grasses, sedges, and rushes	4'-7'						flower							Wet Meadow
Eryngium yuccifolium	Rattlesnake master	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Eupatorium maculatum	Joe-pye-weed	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow
Veronicastrum virginicum	Culver's root	forbes and ferns	18"-3, 4'-7'					flower								Wet Meadow
Boltonia asteroides	Boltonia	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow, Floodplain
Scirpus pungens	Three-square bulrush	grasses, sedges, and rushes	18"-3, 4'-7'													Emergent, Wet Meadow
Scirpus cyperinus	Woolgrass	grasses, sedges, and rushes	18"-3, 4'-7'													Wet Meadow
Scirpus fluviatilis	River bulrush	grasses, sedges, and rushes	4'-7'													Emergent, Wet Meadow
Scirpus atrovirens	Green bulrush	grasses, sedges, and rushes	4'-7'													Wet Meadow, Floodplain
Matteuccia struthiopteris	Ostrich fern	forbes and ferns	4'-7'													Wet Meadow, Floodplain, Upland
Andropogon gerardii	Big bluestem	grasses, sedges, and rushes	4'-7', 8+'													Wet Meadow, Floodplain

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Betula nigra	River birch	trees and shrubs	8+'				flower									Wet Meadow
Salix nigra	Black willow	trees and shrubs	8+'				flower									Wet Meadow
Fraxinus nigra	Black ash	trees and shrubs	8+'				flower									Wet Meadow
Viburnum lentago	Nannyberry	trees and shrubs	8+'					flower								Wet Meadow
Cornus racemosa	Gray dogwood	trees and shrubs	8+'					flower								Wet Meadow
Quercus bicolor	Swamp white oak	trees and shrubs	8+'													Wet Meadow
Andropogon gerardii	Big bluestem	grasses, sedges, and rushes	4'-7', 8+'													Wet Meadow, Floodplain
Scirpus validus	Soft-stem bulrush	grasses, sedges, and rushes	8+'													Emergent, Wet Meadow

Table B.10 - Left - Constructed Wetland Wet Meadow Plant Palette (3'-8'+)

Created by: Buffington, Jared - 2012

Source: (Shaw & Schmidt, 2003)

Table B.11 - Right - Constructed Wetland Floodplain Plant Palette

Created by: Buffington, Jared

Source: (Shaw & Schmidt, 2003)

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Euthanmia graminifolia	Grass-leaved goldenrod	forbes and ferns	1"-16", 18"-3'							flower						Floodplain
Lysimachia thyrsiflora	Tufted loosestrife	forbes and ferns	1"-16", 18"-3'						flower							Wet Meadow, Floodplain
Carex comosa	Bottlebrush sedge	grasses, sedges, and rushes	1"-16", 18"-3', 4'-7'					flower								Wet Meadow, Floodplain
Aster puniceus	Red-stemmed aster	forbes and ferns	1"-16", 18"-3', 4'-7'	stem color							flower			stem color		Wet Meadow, Floodplain
Amorpha fruiticosa	Indigo bush	trees and shrubs	1"-16"						flower							Floodplain
Alnus incana	Speckled alder	trees and shrubs	1"-16"			flower										Floodplain
Scutellaria lateriflora	Mad-dog skullcap	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Floodplain

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Elymus virginicus	Virginia wild rye	grasses, sedges, and rushes	18"-3'						flower							Floodplain
Euthanmia graminifolia	Grass-leaved goldenrod	forbes and ferns	1"-16", 18"-3'							flower						Floodplain
Lysimachia thyrsiflora	Tufted loosestrife	forbes and ferns	1"-16", 18"-3'						flower							Wet Meadow, Floodplain
Impatiens capensis	Jewelweed	forbes and ferns	18"-3, 4'-7'						flower							Wet Meadow, Floodplain
Leersia oryzoides	Rice-cut grass	grasses, sedges, and rushes	18"-3, 4'-7'						flower							Wet Meadow, Floodplain
Carex comosa	Bottlebrush sedge	grasses, sedges, and rushes	1"-16", 18"-3', 4'-7'					flower								Wet Meadow, Floodplain
Potentilla palustris	Marsh cinquefoil	forbes and ferns	18"-3'						fruit							Wet Meadow, Floodplain, Upland
Lobelia cardinalis	Cardinal flower	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Symplocarpus foetidus	Skunk cabbage	forbes and ferns	18"-3'			flower										Floodplain
Aster puniceus	Red-stemmed aster	forbes and ferns	1"-16", 18"-3', 4'-7'	stem color							flower			stem color		Wet Meadow, Floodplain
Lobelia siphilitica	Blue lobelia	forbes and ferns	18"-3'							flower						Wet Meadow, Floodplain
Physostegia virginiana	Obedient plant	forbes and ferns	18"-3'							flower						Wet Meadow, Floodplain
Eryngium yuccifolium	Rattlesnake master	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Aster lucidulus	Swamp aster	forbes and ferns	18"-3'								flower					Wet Meadow, Floodplain
Aronia melanocarpa	Black chokeberry	trees and shrubs	18"-3, 4'-7'					flower								Floodplain, Upland
Boltonia asteroides	Boltonia	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow, Floodplain
Scutellaria lateriflora	Mad-dog skullcap	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Floodplain

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Silphium perfoliatum	Cup plant	forbes and ferns	4'-7'							flower						Wet Meadow, Floodplain
Impatiens capensis	Jewelweed	forbes and ferns	18"-3, 4'-7'						flower							Wet Meadow, Floodplain
Spartina pectinata	Prairie cord grass	grasses, sedges, and rushes	4'-7'							flower						Wet Meadow, Floodplain
Leersia oryzoides	Rice-cut grass	grasses, sedges, and rushes	18"-3, 4'-7'						flower							Wet Meadow, Floodplain
Carex comosa	Bottlebrush sedge	grasses, sedges, and rushes	1"-16", 18"-3', 4'-7'					flower								Wet Meadow, Floodplain
Lobelia cardinalis	Cardinal flower	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Veronia fasciculata	Ironweed	forbes and ferns	4'-7'							flower						Wet Meadow, Floodplain
Aster puniceus	Red-stemmed aster	forbes and ferns	1"-16", 18"-3', 4'-7'	stem color							flower			stem color		Wet Meadow, Floodplain
Eryngium yuccifolium	Rattlesnake master	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Viburnum trilobum	High bush cranberry	trees and shrubs	4'-7', 8+'	fruit					flower					fruit		Floodplain, Upland
Cornus sericea	Red-osier dogwood	trees and shrubs	4'-7', 8+'	twig		fruit		flower				fruit		twig		Floodplain
Aronia melanocarpa	Black chokeberry	trees and shrubs	18"-3, 4'-7'					flower								Floodplain, Upland
Boltonia asteroides	Boltonia	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow, Floodplain
Cornus amomum	Silky dogwood	trees and shrubs	4'-7', 8+'					flower								Floodplain
Andropogon gerardii	Big bluestem	grasses, sedges, and rushes	4'-7', 8+'													Wet Meadow, Floodplain
Salix exigua	Sandbar willow	trees and shrubs	4'-7', 8+'													Floodplain
Scirpus atrovirens	Green bulrush	grasses, sedges, and rushes	4'-7'													Wet Meadow, Floodplain

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Helianthus grosseserratus	Sawtooth sunflower	forbes and ferns	8+'							flower						Floodplain
Viburnum trilobum	High bush cranberry	trees and shrubs	4'-7', 8+'	fruit					flower					fruit		Floodplain, Upland
Cornus sericea	Red-osier dogwood	trees and shrubs	4'-7', 8+'	twig		fruit		flower				fruit		twig		Floodplain
Cornus amomum	Silky dogwood	trees and shrubs	4'-7', 8+'					flower								Floodplain
Salix discolor	Pussy willow	trees and shrubs	8+'													Floodplain
Andropogon gerardii	Big bluestem	grasses, sedges, and rushes	4'-7', 8+'													Wet Meadow, Floodplain
Salix exigua	Sandbar willow	trees and shrubs	4'-7', 8+'													Floodplain

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Aster pilosus	Frost aster	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow, Floodplain, Upland
Solidago flexicaulis	Zig-zag goldenrod	forbes and ferns	1"-16", 18"-3'								flower					Upland
Arisaema triphyllum	Jack-in-the-pulpit	forbes and ferns	1"-16", 18"-3'							fruit						Upland
Aster macrophyllus	Bigleaf aster	forbes and ferns	1"-16"								flower					Upland
Tradescantia ohiensis	Ohio spiderwort	forbes and ferns	1"-16", 18"-3'				flower									Upland

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Spiraea alba	Meadowsweet	forbes and ferns	18"-3, 4'-7'						flower							Upland
Aster pilosus	Frost aster	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow, Floodplain, Upland
Solidago riddellii	Riddell's goldemod	forbes and ferns	18"-3'									flower				Upland
Solidago flexicaulis	Zig-zag goldenrod	forbes and ferns	1"-16", 18"-3'								flower					Upland
Rudbeckia subtomentosa	Brown-eyed-Susan	forbes and ferns	18"-3'							flower						Upland
Heuchera richardsonii	Prairie alumroot	forbes and ferns	18"-3'				flower									Upland
Epilobium angustifolium	Fireweed	forbes and ferns	18"-3'						flower							Upland
Arisaema triphyllum	Jack-in-the-pulpit	forbes and ferns	1"-16", 18"-3'							fruit						Upland
Potentilla palustris	Marsh cinquefoil	forbes and ferns	18"-3'						fruit							Wet Meadow, Floodplain, Upland
Schizachyrium scoparium	Little bluestem	grasses, sedges, and rushes	18"-3'							flower						Upland
Liatris ligulistylis	Meadow blazingstar	forbes and ferns	18"-3, 4'-7'							flower						Upland
Liatris pychnostachya	Prairie blazingstar	forbes and ferns	18"-3, 4'-7'							flower						Upland
Monarda fistulosa	Wild bergamot	forbes and ferns	18"-3, 4'-7'							flower						Upland
Tradescantia ohiensis	Ohio spiderwort	forbes and ferns	1"-16", 18"-3'				flower									Upland
Agastache foeniculum	Giant hyssop	forbes and ferns	18"-3', 4'-7'						flower							Upland
Galium boreale	Northern bedstraw	forbes and ferns	18"-3'						flower							Upland
Aronia melanocarpa	Black chokeberry	trees and shrubs	18"-3, 4'-7'					flower								Floodplain, Upland
Equisetum fluviatile	Horsetail	grasses, sedges, and rushes	18"-3'													Upland
Pteridium aquilinum	Bracken fern	forbes and ferns	18"-3'													Upland

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Spiraea alba	Meadowsweet	forbes and ferns	18"-3, 4'-7'						flower							Upland
Ratibida pinnata	Yellow coneflower	forbes and ferns	4'-7'							flower						Upland
Illex verticillata	Winterberry	trees and shrubs	4'-7', 8+'						flower	fruit						Upland
Sambucus racemosa	Red-berried elder	trees and shrubs	4'-7', 8+'				flower		fruit							Upland
Liatris ligulistylis	Meadow blazingstar	forbes and ferns	18"-3, 4'-7'							flower						Upland
Liatris pychnostachya	Prairie blazingstar	forbes and ferns	18"-3, 4'-7'							flower						Upland
Monarda fistulosa	Wild bergamot	forbes and ferns	18"-3, 4'-7'							flower						Upland
Agastache foeniculum	Giant hyssop	forbes and ferns	18"-3', 4'-7'						flower							Upland
Viburnum trilobum	High bush cranberry	trees and shrubs	4'-7', 8+'	fruit					flower					fruit		Floodplain, Upland
Aronia melanocarpa	Black chokeberry	trees and shrubs	18"-3, 4'-7'					flower								Floodplain, Upland
Matteuccia struthiopteris	Ostrich fern	forbes and ferns	4'-7'													Wet Meadow, Floodplain, Upland

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Illex verticillata	Winterberry	trees and shrubs	4'-7', 8+'						flower	fruit						Upland
Lilium superbum	Turk's-cap lily	forbes and ferns	8+'						flower							Upland
Sambucus racemosa	Red-berried elder	trees and shrubs	4'-7', 8+'				flower		fruit							Upland
Viburnum trilobum	High bush cranberry	trees and shrubs	4'-7', 8+'	fruit					flower					fruit		Floodplain, Upland
Physocarpus opulifolius	Ninebark	trees and shrubs	8+'					flower				foliage				Upland
Acer saccharinum	Silver maple	trees and shrubs	8+'		flower											Upland
Larix laricina	Tamarack	trees and shrubs	8+'													Upland

Table B.12 - Constructed Wetland Upland Plant Palette

Created by: Buffington, Jared

Source: (Shaw & Schmidt, 2003)

wet swale planting palette

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Caltha palustris	Marsh marigold	forbes and ferns	1"-16", 18"-3'				flower									Emergent
Juncus balticus	Baltic rush	grasses, sedges, and rushes	1"-16", 18"-3'					flower								Emergent, Wet Meadow
Sagittaria latifolia	Broadleaved arrowhead	forbes and ferns	1"-16", 18"-3, 4'-7'							flower						Emergent

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Caltha palustris	Marsh marigold	forbes and ferns	1"-16", 18"-3'				flower									Emergent
Carex stricta	Tussock sedge	grasses, sedges, and rushes	18"-3'				flower									Emergent
Juncus balticus	Baltic rush	grasses, sedges, and rushes	1"-16", 18"-3'					flower								Emergent, Wet Meadow
Juncus effusus	Soft rush	grasses, sedges, and rushes	18"-3, 4'-7'							flower						Emergent, Wet Meadow
Scirpus acutus	Hardstembulrush	grasses, sedges, and rushes	18"-3, 4'-7', 8+'					flower								Emergent
Polygonum amphibium	Water smartweed	forbes and ferns	18"-3'						flower							Emergent
Typha latifolia	Broad-leaved cattail	forbes and ferns	18"-3, 4'-7', 8+'					flower								Emergent
Alisma trivale	Water plantain	forbes and ferns	18"-3', 4'-7'					flower								Emergent
Sagittaria latifolia	Broadleaved arrowhead	forbes and ferns	1"-16", 18"-3, 4'-7'							flower						Emergent
Cephalanthus occidentalis	Buttonbush	trees and shrubs	18"-3, 4'-7', 8+'						flower							Emergent, Floodplain
Carex aquatilis	Water sedge	grasses, sedges, and rushes	18"-3'													Emergent
Carex lacustris	Lake sedge	grasses, sedges, and rushes	18"-3'													Emergent
Scirpus pungens	Three-square bulrush	grasses, sedges, and rushes	18"-3, 4'-7'													Emergent, Wet Meadow
Pontederia cordata	Pickerelweed	forbes and ferns	18"-3, 4'-7'						flower							Emergent

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Juncus effusus	Soft rush	grasses, sedges, and rushes	18"-3, 4'-7'							flower						Emergent, Wet Meadow
Scirpus acutus	Hardstembulrush	grasses, sedges, and rushes	18"-3, 4'-7', 8+'					flower								Emergent
Typha latifolia	Broad-leaved cattail	forbes and ferns	18"-3, 4'-7', 8+'					flower								Emergent
Alisma trivale	Water plantain	forbes and ferns	18"-3', 4'-7'					flower								Emergent
Sparganiun eurycarpum	Giant burreed	forbes and ferns	4'-7'						flower							Emergent
Sagittaria latifolia	Broadleaved arrowhead	forbes and ferns	1"-16", 18"-3, 4'-7'							flower						Emergent
Cephalanthus occidentalis	Buttonbush	trees and shrubs	18"-3, 4'-7', 8+'						flower							Emergent, Floodplain
Scirpus pungens	Three-square bulrush	grasses, sedges, and rushes	18"-3, 4'-7'													Emergent, Wet Meadow
Scirpus fluviatilis	River bulrush	grasses, sedges, and rushes	4'-7'													Emergent, Wet Meadow
Pontederia cordata	Pickerelweed	forbes and ferns	18"-3, 4'-7'						flower							Emergent

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Scirpus acutus	Hardstembulrush	grasses, sedges, and rushes	18"-3, 4'-7', 8+'					flower								Emergent
Typha latifolia	Broad-leaved cattail	forbes and ferns	18"-3, 4'-7', 8+'					flower								Emergent
Cephalanthus occidentalis	Buttonbush	trees and shrubs	18"-3, 4'-7', 8+'						flower							Emergent, Floodplain
Scirpus validus	Soft-stem bulrush	grasses, sedges, and rushes	8+'													Emergent, Wet Meadow

Table B.13 - Left - Wet Swale Emergent Plant Palette

Created by: Buffington, Jared - 2012

Source: (Shaw & Schmidt, 2003)

Table B.14 - Right - Wet Swale Wet Meadow Plant Palette (1"-3')

Created by: Buffington, Jared - 2012

Source: (Shaw & Schmidt, 2003)

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Lysimachia thyrsiflora	Tufted loosestrife	forbes and ferns	1"-16", 18"-3'						flower							Wet Meadow, Floodplain
Zizia aurea	Golden alexanders	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland
Carex languinosa	Wooly sedge	grasses, sedges, and rushes	1"-16", 18"-3'				flower									Wet Meadow
Angelica atropurpurea	Angelica	forbes and ferns	1"-16"							flower						Wet Meadow, Upland
Carex comosa	Bottlebrush sedge	grasses, sedges, and rushes	1"-16", 18"-3', 4'-7'					flower								Wet Meadow, Floodplain
Juncus balticus	Baltic rush	grasses, sedges, and rushes	1"-16", 18"-3'					flower								Emergent, Wet Meadow
Eleocharis obtusa	Blunt spikerush	grasses, sedges, and rushes	1"-16", 18"-3'						flower							Wet Meadow
Aster puniceus	Red-stemmed aster	forbes and ferns	1"-16", 18"-3', 4'-7'	stem color							flower			stem color		Wet Meadow, Floodplain
Glyceria striata	Fowl manna grass	grasses, sedges, and rushes	1"-16", 18"-3, 4'-7'						flower							Wet Meadow
Chelone glabra	Turtlehead	forbes and ferns	1"-16"							flower						Wet Meadow
Gentiana andrewsii	Bottle gentian	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow
Scutellaria lateriflora	Mad-dog skullcap	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Floodplain
Onoclea sensibilis	Sensitive fern	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Upland

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Impatiens capensis	Jewelweed	forbes and ferns	18"-3, 4'-7'						flower							Wet Meadow, Floodplain
Bromus ciliatus	Fringed brome	grasses, sedges, and rushes	18"-3'						flower							Wet Meadow
Zizia aurea	Golden alexanders	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland
Helenium autumnale	Sneeze weed	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow
Lysimachia thyrsiflora	Tufted loosestrife	forbes and ferns	1"-16", 18"-3'						flower							Wet Meadow, Floodplain
Carex crinita	Caterpillar sedge	grasses, sedges, and rushes	18"-3'					flower								Wet Meadow
Carex hystericina	Porcupine sedge	grasses, sedges, and rushes	18"-3'					flower								Wet Meadow
Carex languinosa	Wooly sedge	grasses, sedges, and rushes	1"-16", 18"-3'				flower									Wet Meadow
Thalictrum dasycarpum	Tall meadowrue	forbes and ferns	18"-3, 4'-7'						flower							Wet Meadow
Leersia oryzoides	Rice-cut grass	grasses, sedges, and rushes	18"-3, 4'-7'						flower							Wet Meadow, Floodplain
Carex bebbii	Bebb's sedge	grasses, sedges, and rushes	18"-3'					flower								Wet Meadow
Carex comosa	Bottlebrush sedge	grasses, sedges, and rushes	1"-16", 18"-3', 4'-7'					flower								Wet Meadow, Floodplain
Carex stipata	Awl-fruited sedge	grasses, sedges, and rushes	18"-3'					flower								Wet Meadow
Juncus torreyi	Torrey rush	grasses, sedges, and rushes	18"-3'							flower						Wet Meadow
Juncus balticus	Baltic rush	grasses, sedges, and rushes	1"-16", 18"-3'					flower								Emergent, Wet Meadow
Juncus effusus	Soft rush	grasses, sedges, and rushes	18"-3, 4'-7'							flower						Emergent, Wet Meadow
Eleocharis obtusa	Blunt spikerush	grasses, sedges, and rushes	1"-16", 18"-3'						flower							Wet Meadow
Potentilla palustris	Marsh cinquefoil	forbes and ferns	18"-3'						fruit							Wet Meadow, Floodplain, Upland
Lobelia cardinalis	Cardinal flower	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Asclepias incarnata	Marsh milkweed	forbes and ferns	18"-3, 4'-7'	stem color					flower					stem color		Wet Meadow
Verbena hastata	Blue vervain	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow
Aster puniceus	Red-stemmed aster	forbes and ferns	1"-16", 18"-3', 4'-7'	stem color							flower			stem color		Wet Meadow, Floodplain
Eupatorium maculatum	Joe-pye-weed	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow
Physostegia virginiana	Obedient plant	forbes and ferns	18"-3'							flower						Wet Meadow, Floodplain
Glyceria striata	Fowl manna grass	grasses, sedges, and rushes	1"-16", 18"-3, 4'-7'						flower							Wet Meadow
Eryngium yuccifolium	Rattlesnake master	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Aster lucidulus	Swamp aster	forbes and ferns	18"-3'								flower					Wet Meadow, Floodplain
Gentiana andrewsii	Bottle gentian	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow
Iris versicolor	Blueflag iris	forbes and ferns	18"-3'					flower								Wet Meadow
Lobelia siphilitica	Blue lobelia	forbes and ferns	18"-3'							flower						Wet Meadow, Floodplain
Pycnanthemum virginianum	Mountain mint	forbes and ferns	18"-3'						flower							Wet Meadow
Boltonia asteroides	Boltonia	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow, Floodplain
Aster lanceolatum	Panicle aster	forbes and ferns	18"-3'								flower					Wet Meadow, Upland
Veronicastrum virginicum	Culver's root	forbes and ferns	18"-3, 4'-7'					flower								Wet Meadow, Upland
Calamagrostis canadensis	Canada blue-joint	grasses, sedges, and rushes	18"-3'													Wet Meadow
Carex lasiocarpa	Wooly needle	grasses, sedges, and rushes	18"-3'													Wet Meadow
Carex retrorsa	Retrorse sedge	grasses, sedges, and rushes	18"-3'													Wet Meadow
Eupatorium perfoliatum	Boneset	forbes and ferns	18"-3'													Wet Meadow
Onoclea sensibilis	Sensitive fern	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Upland
Osmunda regalis	Royal fern	forbes and ferns	18"-3'													Wet Meadow, Upland
Scirpus cyperinus	Woolgrass	grasses, sedges, and rushes	18"-3, 4'-7'													Wet Meadow
Scirpus pungens	Three-square bulrush	grasses, sedges, and rushes	18"-3, 4'-7'													Emergent, Wet Meadow
Scutellaria lateriflora	Mad-dog skullcap	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Floodplain

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Panicum virgatum	Switchgrass	grasses, sedges, and rushes	4'-7'							flower						Wet Meadow
Solidago rigida	Stiff goldenrod	forbes and ferns	4'-7'								flower					Wet Meadow
Helenium autumnale	Sneeze weed	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow
Silphium perfoliatum	Cup plant	forbes and ferns	4'-7'							flower						Wet Meadow, Floodplain
Impatiens capensis	Jewelweed	forbes and ferns	18"-3, 4'-7'						flower							Wet Meadow, Floodplain
Thalictrum dasycarpum	Tall meadowrue	forbes and ferns	18"-3, 4'-7'						flower							Wet Meadow
Spartina pectinata	Prairie cord grass	grasses, sedges, and rushes	4'-7'							flower						Wet Meadow, Floodplain
Leersia oryzoides	Rice-cut grass	grasses, sedges, and rushes	18"-3, 4'-7'						flower							Wet Meadow, Floodplain
Carex comosa	Bottlebrush sedge	grasses, sedges, and rushes	1"-16", 18"-3', 4'-7'					flower								Wet Meadow, Floodplain
Juncus effusus	Soft rush	grasses, sedges, and rushes	18"-3, 4'-7'							flower						Emergent, Wet Meadow
Lobelia cardinalis	Cardinal flower	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Asclepias incarnata	Marsh milkweed	forbes and ferns	18"-3, 4'-7'	stem color					flower					stem color		Wet Meadow
Veronia fasciculata	Ironweed	forbes and ferns	4'-7'							flower						Wet Meadow, Floodplain
Verbena hastata	Blue vervain	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Aster puniceus	Red-stemmed aster	forbes and ferns	1"-16", 18"-3', 4'-7'	stem color							flower			stem color		Wet Meadow, Floodplain
Eupatorium maculatum	Joe-pye-weed	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow
Glyceria grandis	Giant manna grass	grasses, sedges, and rushes	4'-7'						flower							Wet Meadow
Glyceria striata	Fowl manna grass	grasses, sedges, and rushes	1"-16", 18"-3, 4'-7'						flower							Wet Meadow
Eryngium yuccifolium	Rattlesnake master	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Boltonia asteroides	Boltonia	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow, Floodplain
Veronicastrum virginicum	Culver's root	forbes and ferns	18"-3, 4'-7'					flower								Wet Meadow, Upland
Scirpus cyperinus	Woolgrass	grasses, sedges, and rushes	18"-3, 4'-7'													Wet Meadow
Scirpus fluviatilis	River bulrush	grasses, sedges, and rushes	4'-7'													Emergent, Wet Meadow
Scirpus pungens	Three-square bulrush	grasses, sedges, and rushes	18"-3, 4'-7'													Emergent, Wet Meadow
Andropogon gerardii	Big bluestem	grasses, sedges, and rushes	4'-7', 8+'													Wet Meadow, Floodplain
Scirpus atrovirens	Green bulrush	grasses, sedges, and rushes	4'-7'													Wet Meadow, Floodplain

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Betula nigra	River birch	trees and shrubs	8+'				flower									Wet Meadow
Cornus racemosa	Gray dogwood	trees and shrubs	8+'					flower								Wet Meadow
Viburnum lentago	Nannyberry	trees and shrubs	8+'					flower								Wet Meadow
Scirpus validus	Soft-stem bulrush	grasses, sedges, and rushes	, 8+'													Emergent, Wet Meadow
Andropogon gerardii	Big bluestem	grasses, sedges, and rushes	4'-7', 8+'													Wet Meadow, Floodplain

Table B.15 - Left - Wet Swale Wet Meadow Plant Palette (3'-8'+)

Created by: Buffington, Jared - 2012

Source: (Shaw & Schmidt, 2003)

Table B.16 - Right - Wet Swale Floodplain Plant Palette

Created by: Buffington, Jared

Source: (Shaw & Schmidt, 2003)

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Euthanmia graminifolia	Grass-leaved goldenrod	forbes and ferns	1"-16", 18"-3'							flower						Floodplain
Lysimachia thyrsiflora	Tufted loosestrife	forbes and ferns	1"-16", 18"-3'						flower							Wet Meadow, Floodplain
Carex comosa	Bottlebrush sedge	grasses, sedges, and rushes	1"-16", 18"-3', 4'-7'					flower								Wet Meadow, Floodplain
Aster puniceus	Red-stemmed aster	forbes and ferns	1"-16", 18"-3', 4'-7'	stem color							flower			stem color		Wet Meadow, Floodplain
Amorpha fruiticosa	Indigo bush	trees and shrubs	1"-16"						flower							Floodplain
Alnus incana	Speckled alder	trees and shrubs	1"-16"			flower										Floodplain
Scutellaria lateriflora	Mad-dog skullcap	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Floodplain

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Elymus virginicus	Virginia wild rye	grasses, sedges, and rushes	18"-3'						flower							Floodplain
Euthanmia graminifolia	Grass-leaved goldenrod	forbes and ferns	1"-16", 18"-3'							flower						Floodplain
Lysimachia thyrsiflora	Tufted loosestrife	forbes and ferns	1"-16", 18"-3'						flower							Wet Meadow, Floodplain
Impatiens capensis	Jewelweed	forbes and ferns	18"-3, 4'-7'						flower							Wet Meadow, Floodplain
Leersia oryzoides	Rice-cut grass	grasses, sedges, and rushes	18"-3, 4'-7'						flower							Wet Meadow, Floodplain
Carex comosa	Bottlebrush sedge	grasses, sedges, and rushes	1"-16", 18"-3', 4'-7'					flower								Wet Meadow, Floodplain
Potentilla palustris	Marsh cinquefoil	forbes and ferns	18"-3'						fruit							Wet Meadow, Floodplain, Upland
Lobelia cardinalis	Cardinal flower	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Symplocarpus foetidus	Skunk cabbage	forbes and ferns	18"-3'			flower										Floodplain
Aster puniceus	Red-stemmed aster	forbes and ferns	1"-16", 18"-3', 4'-7'	stem color							flower			stem color		Wet Meadow, Floodplain
Lobelia siphilitica	Blue lobelia	forbes and ferns	18"-3'							flower						Wet Meadow, Floodplain
Physostegia virginiana	Obedient plant	forbes and ferns	18"-3'							flower						Wet Meadow, Floodplain
Eryngium yuccifolium	Rattlesnake master	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Aster lucidulus	Swamp aster	forbes and ferns	18"-3'								flower					Wet Meadow, Floodplain
Aronia melanocarpa	Black chokeberry	trees and shrubs	18"-3, 4'-7'					flower								Floodplain, Upland
Boltonia asteroides	Boltonia	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow, Floodplain
Scutellaria lateriflora	Mad-dog skullcap	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Floodplain

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Silphium perfoliatum	Cup plant	forbes and ferns	4'-7'							flower						Wet Meadow, Floodplain
Impatiens capensis	Jewelweed	forbes and ferns	18"-3, 4'-7'						flower							Wet Meadow, Floodplain
Spartina pectinata	Prairie cord grass	grasses, sedges, and rushes	4'-7'							flower						Wet Meadow, Floodplain
Leersia oryzoides	Rice-cut grass	grasses, sedges, and rushes	18"-3, 4'-7'						flower							Wet Meadow, Floodplain
Carex comosa	Bottlebrush sedge	grasses, sedges, and rushes	1"-16", 18"-3', 4'-7'					flower								Wet Meadow, Floodplain
Lobelia cardinalis	Cardinal flower	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Veronia fasciculata	Ironweed	forbes and ferns	4'-7'							flower						Wet Meadow, Floodplain
Aster puniceus	Red-stemmed aster	forbes and ferns	1"-16", 18"-3', 4'-7'	stem color							flower			stem color		Wet Meadow, Floodplain
Eryngium yuccifolium	Rattlesnake master	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Viburnum trilobum	High bush cranberry	trees and shrubs	4'-7', 8+'	fruit					flower					fruit		Floodplain, Upland
Cornus sericea	Red-osier dogwood	trees and shrubs	4'-7', 8+'	twig		fruit		flower				fruit		twig		Floodplain
Aronia melanocarpa	Black chokeberry	trees and shrubs	18"-3, 4'-7'					flower								Floodplain, Upland
Boltonia asteroides	Boltonia	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow, Floodplain
Cornus amomum	Silky dogwood	trees and shrubs	4'-7', 8+'					flower								Floodplain
Andropogon gerardii	Big bluestem	grasses, sedges, and rushes	4'-7', 8+'													Wet Meadow, Floodplain
Salix exigua	Sandbar willow	trees and shrubs	4'-7', 8+'													Floodplain
Scirpus atrovirens	Green bulrush	grasses, sedges, and rushes	4'-7'													Wet Meadow, Floodplain

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Helianthus grosseserratus	Sawtooth sunflower	forbes and ferns	8+'							flower						Floodplain
Viburnum trilobum	High bush cranberry	trees and shrubs	4'-7', 8+'	fruit					flower					fruit		Floodplain, Upland
Cornus sericea	Red-osier dogwood	trees and shrubs	4'-7', 8+'	twig		fruit		flower				fruit		twig		Floodplain
Cornus amomum	Silky dogwood	trees and shrubs	4'-7', 8+'					flower								Floodplain
Salix discolor	Pussy willow	trees and shrubs	8+'													Floodplain
Andropogon gerardii	Big bluestem	grasses, sedges, and rushes	4'-7', 8+'													Wet Meadow, Floodplain
Salix exigua	Sandbar willow	trees and shrubs	4'-7', 8+'													Floodplain

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Angelica atropurpurea	Angelica	forbes and ferns	1"-16"							flower						Wet Meadow, Upland
Zizia aurea	Golden alexanders	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland
Tradescantia ohiensis	Ohio spiderwort	forbes and ferns	1"-16", 18"-3'				flower									Upland
Veronicastrum virginicum	Culver's root	forbes and ferns	18"-3, 4'-7'					flower								Wet Meadow, Upland
Onoclea sensibilis	Sensitive fern	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Upland

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Rudbeckia subtomentosa	Brown-eyed-Susan	forbes and ferns	18"-3'							flower						Upland
Zizia aurea	Golden alexanders	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland
Spiraea alba	Meadowsweet	forbes and ferns	18"-3, 4'-7'						flower							Upland
Potentilla palustris	Marsh cinquefoil	forbes and ferns	18"-3'						fruit							Wet Meadow, Floodplain, Upland
Liatris ligulistylis	Meadow blazingstar	forbes and ferns	18"-3, 4'-7'							flower						Upland
Liatris pychnostachya	Prairie blazingstar	forbes and ferns	18"-3, 4'-7'							flower						Upland
Monarda fistulosa	Wild bergamot	forbes and ferns	18"-3, 4'-7'							flower						Upland
Tradescantia ohiensis	Ohio spiderwort	forbes and ferns	1"-16", 18"-3'				flower									Upland
Agastache foeniculum	Giant hyssop	forbes and ferns	18"-3', 4'-7'						flower							Upland
Aronia melanocarpa	Black chokeberry	trees and shrubs	18"-3, 4'-7'					flower								Floodplain, Upland
Aster lanceolatum	Panicle aster	forbes and ferns	18"-3'								flower					Wet Meadow, Upland
Veronicastrum virginicum	Culver's root	forbes and ferns	18"-3, 4'-7'					flower								Wet Meadow, Upland
Equisetum fluviatile	Horsetail	grasses, sedges, and rushes	18"-3'													Upland
Onoclea sensibilis	Sensitive fern	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Upland
Osmunda regalis	Royal fern	forbes and ferns	18"-3'													Wet Meadow, Upland

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Spiraea alba	Meadowsweet	forbes and ferns	18"-3, 4'-7'						flower							Upland
Illex verticillata	Winterberry	trees and shrubs	4'-7', 8+'						flower	fruit						Upland
Liatris ligulistylis	Meadow blazingstar	forbes and ferns	18"-3, 4'-7'							flower						Upland
Liatris pychnostachya	Prairie blazingstar	forbes and ferns	18"-3, 4'-7'							flower						Upland
Monarda fistulosa	Wild bergamot	forbes and ferns	18"-3, 4'-7'							flower						Upland
Sambucus racemosa	Red-berried elder	trees and shrubs	4'-7', 8+'				flower		fruit							Upland
Viburnum trilobum	High bush cranberry	trees and shrubs	4'-7', 8+'	fruit					flower					fruit		Floodplain, Upland
Agastache foeniculum	Giant hyssop	forbes and ferns	18"-3', 4'-7'						flower							Upland
Aronia melanocarpa	Black chokeberry	trees and shrubs	18"-3, 4'-7'					flower								Floodplain, Upland
Veronicastrum virginicum	Culver's root	forbes and ferns	18"-3, 4'-7'					flower								Wet Meadow, Upland

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Illex verticillata	Winterberry	trees and shrubs	4'-7', 8+'						flower	fruit						Upland
Spiraea alba	Meadowsweet	forbes and ferns	18"-3, 4'-7'						flower							Upland
Lilium superbum	Turk's-cap lily	forbes and ferns	8+'						flower							Upland
Sambucus racemosa	Red-berried elder	trees and shrubs	4'-7', 8+'				flower		fruit							Upland
Viburnum trilobum	High bush cranberry	trees and shrubs	4'-7', 8+'	fruit					flower					fruit		Floodplain, Upland
Physocarpus opulifolius	Ninebark	trees and shrubs	8+'					flower				foliage				Upland
Tradescantia ohiensis	Ohio spiderwort	forbes and ferns	1"-16", 18"-3'				flower									Upland
Aronia melanocarpa	Black chokeberry	trees and shrubs	18"-3, 4'-7'					flower								Floodplain, Upland
Larix laricina	Tamarack	trees and shrubs	8+'													Upland

Table B.17 - Wet Swale Upland Plant Palette

Created by: Buffington, Jared

Source: (Shaw & Schmidt, 2003)

bioretention planting palette

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Cephalanthus occidentalis	Buttonbush	trees and shrubs	4'-7', 8+'						flower							Emergent
Juncus effusus	Soft rush	grasses, sedges, and rushes	18"-3, 4'-7'							flower						Emergent, Wet Meadow

Table B.18 - Top - Bioretention Emergent Plant Palette

Created by: Buffington, Jared - 2012

Source: (Shaw & Schmidt, 2003)

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Zizia aurea	Golden alexanders	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland
Lysimachia thyrsiflora	Tufted loosestrife	forbes and ferns	1"-16", 18"-3'						flower							Wet Meadow, Floodplain
Aster pilosus	Frost aster	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow, Floodplain, Upland
Angelica atropurpurea	Angelica	forbes and ferns	1"-16"							flower						Wet Meadow, Upland
Asclepias tuberosa	Butterfly milkweed	forbes and ferns	1"-16", 18"-3'						flower							Wet Meadow
Allium stellatum	Prairie wild onion	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland
Chelone glabra	Turtlehead	forbes and ferns	1"-16"							flower						Wet Meadow
Gentiana andrewsii	Bottle gentian	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow
Onoclea sensibilis	Sensitive fern	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Upland
Scutellaria lateriflora	Mad-dog skullcap	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Floodplain

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Bromus ciliatus	Fringed brome	grasses, sedges, and rushes	18"-3'						flower							Wet Meadow
Zizia aurea	Golden alexanders	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland
Helenium autumnale	Sneeze weed	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow
Lysimachia thyrsiflora	Tufted loosestrife	forbes and ferns	1"-16", 18"-3'						flower							Wet Meadow, Floodplain
Aster pilosus	Frost aster	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow, Floodplain, Upland
Thalictrum dasycarpum	Tall meadowrue	forbes and ferns	18"-3, 4'-7'						flower							Wet Meadow
Carex crinita	Caterpillar sedge	grasses, sedges, and rushes	18"-3'					flower								Wet Meadow
Carex hystericina	Porcupine sedge	grasses, sedges, and rushes	18"-3'					flower								Wet Meadow
Carex comosa	Bottlebrush sedge	grasses, sedges, and rushes	18"-3', 4'-7'					flower								Wet Meadow, Floodplain
Juncus effusus	Soft rush	grasses, sedges, and rushes	18"-3, 4'-7'							flower						Emergent, Wet Meadow
Asclepias tuberosa	Butterfly milkweed	forbes and ferns	1"-16", 18"-3'						flower							Wet Meadow
Lobelia cardinalis	Cardinal flower	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Asclepias incarnata	Marsh milkweed	forbes and ferns	18"-3, 4'-7'	stem color					flower					stem color		Wet Meadow
Eupatorium maculatum	Joe-pye-weed	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow
Allium stellatum	Prairie wild onion	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland
Lobelia siphilitica	Blue lobelia	forbes and ferns	18"-3'							flower						Wet Meadow, Floodplain
Aster laevis	Smooth aster	forbes and ferns	18"-3'								flower					Wet Meadow, Floodplain
Aster puniceus	Red-stemmed aster	forbes and ferns	18"-3', 4'-7'	stem color							flower			stem color		Wet Meadow, Floodplain
Physostegia virginiana	Obedient plant	forbes and ferns	18"-3'							flower						Wet Meadow, Floodplain
Glyceria striata	Fowl manna grass	grasses, sedges, and rushes	18"-3, 4'-7'						flower							Wet Meadow
Eryngium yuccifolium	Rattlesnake master	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Gentiana andrewsii	Bottle gentian	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow
Iris versicolor	Blueflag iris	forbes and ferns	18"-3'					flower								Wet Meadow
Aster lanceolatum	Panicle aster	forbes and ferns	18"-3'								flower					Wet Meadow, Upland
Pycnanthemum virginianum	Mountain mint	forbes and ferns	18"-3'						flower							Wet Meadow
Boltonia asteroides	Boltonia	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow, Floodplain
Veronicastrum virginicum	Culver's root	forbes and ferns	18"-3, 4'-7'					flower								Wet Meadow, Upland
Athyrium filix-femina	Lady fern	forbes and ferns	18"-3'													Wet Meadow, Floodplain
Osmunda regalis	Royal fern	forbes and ferns	18"-3'													Wet Meadow, Upland
Scirpus cyperinus	Woolgrass	grasses, sedges, and rushes	18"-3, 4'-7'													Wet Meadow
Eupatorium perfoliatum	Boneset	forbes and ferns	18"-3'													Wet Meadow
Onoclea sensibilis	Sensitive fern	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Upland
Scutellaria lateriflora	Mad-dog skullcap	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Floodplain

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Panicum virgatum	Switchgrass	grasses, sedges, and rushes	4'-7'							flower						Wet Meadow
Solidago rigida	Stiff goldenrod	forbes and ferns	4'-7'								flower					Wet Meadow
Helenium autumnale	Sneeze weed	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow
Silphium perfoliatum	Cup plant	forbes and ferns	4'-7'							flower						Wet Meadow, Floodplain
Spartina pectinata	Prairie cord grass	grasses, sedges, and rushes	4'-7'							flower						Wet Meadow, Floodplain
Thalictrum dasycarpum	Tall meadowrue	forbes and ferns	18"-3, 4'-7'						flower							Wet Meadow
Carex comosa	Bottlebrush sedge	grasses, sedges, and rushes	18"-3', 4'-7'					flower								Wet Meadow, Floodplain
Juncus effusus	Soft rush	grasses, sedges, and rushes	18"-3, 4'-7'							flower						Emergent, Wet Meadow
Lobelia cardinalis	Cardinal flower	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Asclepias incarnata	Marsh milkweed	forbes and ferns	18"-3, 4'-7'	stem color					flower					stem color		Wet Meadow
Veronia fasciculata	Ironweed	forbes and ferns	4'-7'							flower						Wet Meadow, Floodplain
Eupatorium maculatum	Joe-pye-weed	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow
Aster puniceus	Red-stemmed aster	forbes and ferns	18"-3', 4'-7'	stem color							flower			stem color		Wet Meadow, Floodplain
Glyceria striata	Fowl manna grass	grasses, sedges, and rushes	18"-3, 4'-7'						flower							Wet Meadow
Eryngium yuccifolium	Rattlesnake master	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Boltonia asteroides	Boltonia	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow, Floodplain
Veronicastrum virginicum	Culver's root	forbes and ferns	18"-3, 4'-7'					flower								Wet Meadow, Upland
Matteuccia struthiopteris	Ostrich fern	forbes and ferns	4'-7'													Wet Meadow, Floodplain, Upland
Andropogon gerardii	Big bluestem	grasses, sedges, and rushes	4'-7', 8+'													Wet Meadow, Floodplain
Scirpus cyperinus	Woolgrass	grasses, sedges, and rushes	18"-3, 4'-7'													Wet Meadow

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Betula nigra	River birch	trees and shrubs	8+'				flower									Wet Meadow
Salix nigra	Black willow	trees and shrubs	8+'				flower									Wet Meadow
Fraxinus nigra	Black ash	trees and shrubs	8+'				flower									Wet Meadow
Viburnum lentago	Nannyberry	trees and shrubs	8+'					flower								Wet Meadow
Cornus racemosa	Gray dogwood	trees and shrubs	8+'					flower								Wet Meadow
Quercus bicolor	Swamp white oak	trees and shrubs	8+'													Wet Meadow
Andropogon gerardii	Big bluestem	grasses, sedges, and rushes	4'-7', 8+'													Wet Meadow, Floodplain

Table B.19 - Bottom Left & Top Right - Bioretention Wet Meadow Plant Palette

Created by: Buffington, Jared - 2012

Source: (Shaw & Schmidt, 2003)

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Aster pilosus	Frost aster	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow, Floodplain, Upland
Euthanmia graminifolia	Grass-leaved goldenrod	forbes and ferns	1"-16", 18"-3'							flower						Floodplain
Lysimachia thyrsiflora	Tufted loosestrife	forbes and ferns	1"-16", 18"-3'						flower							Wet Meadow, Floodplain
Amorpha fruiticosa	Indigo bush	trees and shrubs	1"-16"						flower							Floodplain
Smilacina racemosa	False Solomon's seal	forbes and ferns	1"-16", 18"-3'			flower						fruit				Floodplain
Scutellaria lateriflora	Mad-dog skullcap	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Floodplain

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Aster pilosus	Frost aster	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow, Floodplain, Upland
Euthanmia graminifolia	Grass-leaved goldenrod	forbes and ferns	1"-16", 18"-3'							flower						Floodplain
Lysimachia thyrsiflora	Tufted loosestrife	forbes and ferns	1"-16", 18"-3'						flower							Wet Meadow, Floodplain
Carex vulpinoidea	Fox sedge	grasses, sedges, and rushes	18"-3'					flower								Floodplain
Carex comosa	Bottlebrush sedge	grasses, sedges, and rushes	18"-3', 4'-7'					flower								Wet Meadow, Floodplain
Lobelia siphilitica	Blue lobelia	forbes and ferns	18"-3'							flower						Wet Meadow, Floodplain
Eryngium yuccifolium	Rattlesnake master	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Physostegia virginiana	Obedient plant	forbes and ferns	18"-3'							flower						Wet Meadow, Floodplain
Aster laevis	Smooth aster	forbes and ferns	18"-3'								flower					Wet Meadow, Floodplain
Aster puniceus	Red-stemmed aster	forbes and ferns	18"-3', 4'-7'	stem color							flower			stem color		Wet Meadow, Floodplain
Smilacina racemosa	False Solomon's seal	forbes and ferns	1"-16", 18"-3'			flower						fruit				Floodplain
Lobelia cardinalis	Cardinal flower	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Aronia melanocarpa	Black chokeberry	trees and shrubs	18"-3, 4'-7'					flower								Floodplain, Upland
Boltonia asteroides	Boltonia	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow, Floodplain
Athyrium filix-femina	Lady fern	forbes and ferns	18"-3'													Wet Meadow, Floodplain
Scutellaria lateriflora	Mad-dog skullcap	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Floodplain

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Sorghasrrum nutans	Indian grass	grasses, sedges, and rushes	4'-7'								flower					Floodplain
Silphium perfoliatum	Cup plant	forbes and ferns	4'-7'							flower						Wet Meadow, Floodplain
Celtis occidentalis	Hackberry	trees and shrubs	4'-7'				flower									Floodplain
Spartina pectinata	Prairie cord grass	grasses, sedges, and rushes	4'-7'							flower						Wet Meadow, Floodplain
Carex comosa	Bottlebrush sedge	grasses, sedges, and rushes	18"-3', 4'-7'					flower								Wet Meadow, Floodplain
Lobelia cardinalis	Cardinal flower	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Veronia fasciculata	Ironweed	forbes and ferns	4'-7'							flower						Wet Meadow, Floodplain
Aster puniceus	Red-stemmed aster	forbes and ferns	18"-3', 4'-7'	stem color							flower			stem color		Wet Meadow, Floodplain
Eryngium yuccifolium	Rattlesnake master	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Cornus sericea	Red-osier dogwood	trees and shrubs	4'-7', 8+'	twig		fruit		flower				fruit		twig		Floodplain
Viburnum trilobum	High bush cranberry	trees and shrubs	4'-7', 8+'						flower					fruit		Floodplain, Upland
Aronia melanocarpa	Black chokeberry	trees and shrubs	18"-3, 4'-7'					flower								Floodplain, Upland
Boltonia asteroides	Boltonia	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow, Floodplain
Andropogon gerardii	Big bluestem	grasses, sedges, and rushes	4'-7', 8+'													Wet Meadow, Floodplain
Matteuccia struthiopteris	Ostrich fern	forbes and ferns	4'-7'													Wet Meadow, Floodplain, Upland

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Fraxinus pennsylvanica	Green ash	trees and shrubs	8+'				flower									Floodplain
Helianthus grosseserratus	Sawtooth sunflower	forbes and ferns	8+'							flower						Floodplain
Cornus sericea	Red-osier dogwood	trees and shrubs	4'-7', 8+'	twig		fruit		flower				fruit		twig		Floodplain
Viburnum trilobum	High bush cranberry	trees and shrubs	4'-7', 8+'	fruit					flower					fruit		Floodplain, Upland
Andropogon gerardii	Big bluestem	grasses, sedges, and rushes	4'-7', 8+'													Wet Meadow, Floodplain

Table B.20 - Left - Bioretention Floodplain Plant Palette

Created by: Buffington, Jared

Source: (Shaw & Schmidt, 2003)

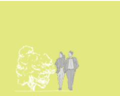
Table B.21 - Right - Bioretention Upland Plant Palette

Created by: Buffington, Jared

Source: (Shaw & Schmidt, 2003)

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Aster pilosus	Frost aster	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow, Floodplain, Upland
Zizia aurea	Golden alexanders	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland
Solidago flexicaulis	Zig-zag goldenrod	forbes and ferns	1"-16", 18"-3'								flower					Upland
Angelica atropurpurea	Angelica	forbes and ferns	1"-16"							flower						Wet Meadow, Upland
Arisaema triphyllum	Jack-in-the-pulpit	forbes and ferns	1"-16", 18"-3'							fruit						Upland
Allium stellatum	Prairie wild onion	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland
Tradescantia ohiensis	Ohio spiderwort	forbes and ferns	1"-16", 18"-3'				flower									Upland
Aster macrophyllus	Bigleaf aster	forbes and ferns	1"-16"								flower					Upland
Onoclea sensibilis	Sensitive fern	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Upland

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Spiraea alba	Meadowsweet	forbes and ferns	18"-3, 4'-7'						flower							Upland
Aster pilosus	Frost aster	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow, Floodplain, Upland
Zizia aurea	Golden alexanders	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland
Solidago riddellii	Riddell's goldemod	forbes and ferns	18"-3'									flower				Upland
Solidago flexicaulis	Zig-zag goldenrod	forbes and ferns	1"-16", 18"-3'								flower					Upland
Rudbeckia subtomentosa	Brown-eyed-Susan	forbes and ferns	18"-3'							flower						Upland
Heuchera richardsonii	Prairie alumroot	forbes and ferns	18"-3'				flower									Upland
Schizachyrium scoparium	Little bluestem	grasses, sedges, and rushes	18"-3'							flower						Upland
Arisaema triphyllum	Jack-in-the-pulpit	forbes and ferns	1"-16", 18"-3'							fruit						Upland
Allium stellatum	Prairie wild onion	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland
Liatris ligulistylis	Meadow blazingstar	forbes and ferns	18"-3, 4'-7'							flower						Upland
Liatris pychnostachya	Prairie blazingstar	forbes and ferns	18"-3, 4'-7'							flower						Upland
Tradescantia ohiensis	Ohio spiderwort	forbes and ferns	1"-16", 18"-3'				flower									Upland
Monarda fistulosa	Wild bergamot	forbes and ferns	18"-3, 4'-7'							flower						Upland
Agastache foeniculum	Giant hyssop	forbes and ferns	18"-3', 4'-7'						flower							Upland
Galium boreale	Northern bedstraw	forbes and ferns	18"-3'						flower							Upland
Aronia melanocarpa	Black chokeberry	trees and shrubs	18"-3, 4'-7'					flower								Floodplain, Upland
Veronicastrum virginicum	Culver's root	forbes and ferns	18"-3, 4'-7'					flower								Wet Meadow, Upland
Aster lanceolatum	Panicle aster	forbes and ferns	18"-3'								flower					Wet Meadow, Upland
Pteridium aquilinum	Bracken fern	forbes and ferns	18"-3'													Upland
Equisetum fluviatile	Horsetail	grasses, sedges, and rushes	18"-3'													Upland
Osmunda regalis	Royal fern	forbes and ferns	18"-3'													Wet Meadow, Upland
Onoclea sensibilis	Sensitive fern	forbes and ferns	1"-16", 18"-3'													Wet Meadow, Upland



SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Spiraea alba	Meadowsweet	forbes and ferns	18"-3, 4'-7'						flower							Upland
Ratibida pinnata	Yellow coneflower	forbes and ferns	4'-7'							flower						Upland
Illex verticillata	Winterberry	trees and shrubs	4'-7', 8+'						flower	fruit						Upland
Sambucus racemosa	Red-berried elder	trees and shrubs	4'-7', 8+'				flower		fruit							Upland
Liatris ligulistylis	Meadow blazingstar	forbes and ferns	18"-3, 4'-7'							flower						Upland
Liatris pychnostachya	Prairie blazingstar	forbes and ferns	18"-3, 4'-7'							flower						Upland
Monarda fistulosa	Wild bergamot	forbes and ferns	18"-3, 4'-7'							flower						Upland
Agastache foeniculum	Giant hyssop	forbes and ferns	18"-3', 4'-7'						flower							Upland
Viburnum trilobum	High bush cranberry	trees and shrubs	4'-7', 8+'	fruit					flower					fruit		Floodplain, Upland
Aronia melanocarpa	Black chokeberry	trees and shrubs	18"-3, 4'-7'					flower								Floodplain, Upland
Veronicastrum virginicum	Culver's root	forbes and ferns	18"-3, 4'-7'					flower								Wet Meadow, Upland
Matteuccia struthiopteris	Ostrich fern	forbes and ferns	4'-7'													Wet Meadow, Floodplain, Upland

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Lilium superbum	Turk's-cap lily	forbes and ferns	8+'						flower							Upland
Illex verticillata	Winterberry	trees and shrubs	4'-7', 8+'						flower	fruit						Upland
Sambucus racemosa	Red-berried elder	trees and shrubs	4'-7', 8+'				flower		fruit							Upland
Viburnum trilobum	High bush cranberry	trees and shrubs	4'-7', 8+'	fruit					flower					fruit		Floodplain, Upland
Physocarpus opulifolius	Ninebark	trees and shrubs	8+'					flower				foliage				Upland
Acer saccharinum	Silver maple	trees and shrubs	8+'		flower											Upland
Larix laricina	Tamarack	trees and shrubs	8+'													Upland

filter strip planting palette

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	January	February	March	April	May	June	July	August	September	October	November	December	Plant Community Zone
Zizia aurea	Golden alexanders	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland
Aster pilosus	Frost aster	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow, Floodplain, Upland
Angelica atropurpurea	Angelica	forbes and ferns	1"-16"							flower						Wet Meadow, Upland
Asclepias tuberosa	Butterfly milkweed	forbes and ferns	1"-16", 18"-3'						flower							Wet Meadow
Allium stellatum	Prairie wild onion	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	January	February	March	April	May	June	July	August	September	October	November	December	Plant Community Zone
Zizia aurea	Golden alexanders	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland
Aster pilosus	Frost aster	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow, Floodplain, Upland
Bromus ciliatus	Fringed brome	grasses, sedges, and rushes	18"-3'						flower							Wet Meadow
Pycnanthemum virginianum	Mountain mint	forbes and ferns	18"-3'						flower							Wet Meadow
Aster laevis	Smooth aster	forbes and ferns	18"-3'								flower					Wet Meadow, Floodplain
Athyrium filix-femina	Lady fern	forbes and ferns	18"-3'													Wet Meadow, Floodplain
Aster lanceolatum	Panicle aster	forbes and ferns	18"-3'								flower					Wet Meadow, Upland
Osmunda regalis	Royal fern	forbes and ferns	18"-3'													Wet Meadow, Upland
Asclepias tuberosa	Butterfly milkweed	forbes and ferns	1"-16", 18"-3'						flower							Wet Meadow
Allium stellatum	Prairie wild onion	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland
Boltonia asteroides	Boltonia	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow, Floodplain
Eryngium yuccifolium	Rattlesnake master	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	January	February	March	April	May	June	July	August	September	October	November	December	Plant Community Zone
Panicum virgatum	Switchgrass	grasses, sedges, and rushes	4'-7'							flower						Wet Meadow
Solidago rigida	Stiff goldenrod	forbes and ferns	4'-7'								flower					Wet Meadow
Eryngium yuccifolium	Rattlesnake master	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Boltonia asteroides	Boltonia	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow, Floodplain
Matteuccia struthiopteris	Ostrich fern	forbes and ferns	4'-7'													Wet Meadow, Floodplain, Upland
Andropogon gerardii	Big bluestem	grasses, sedges, and rushes	4'-7', 8+'													Wet Meadow, Floodplain

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	January	February	March	April	May	June	July	August	September	October	November	December	Plant Community Zone
Betula nigra	River birch	trees and shrubs	8+'				flower									Wet Meadow
Salix nigra	Black willow	trees and shrubs	8+'				flower									Wet Meadow
Viburnum lentago	Nannyberry	trees and shrubs	8+'					flower								Wet Meadow
Cornus racemosa	Gray dogwood	trees and shrubs	8+'					flower								Wet Meadow
Quercus bicolor	Swamp white oak	trees and shrubs	8+'													Wet Meadow
Andropogon gerardii	Big bluestem	grasses, sedges, and rushes	4'-7', 8+'													Wet Meadow, Floodplain

Table B.22 - Filter Strip Wet Meadow Plant Palette

Created by: Buffington, Jared - 2012

Source: (Shaw & Schmidt, 2003)

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	January	February	March	April	May	June	July	August	September	October	November	December	Plant Community Zone
Aster pilosus	Frost aster	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow, Floodplain, Upland
Euthanmia graminifolia	Grass-leaved goldenrod	forbes and ferns	1"-16", 18"-3'							flower						Floodplain
Smilacina racemosa	False Solomon's seal	forbes and ferns	1"-16", 18"-3'			flower						fruit				Floodplain

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	January	February	March	April	May	June	July	August	September	October	November	December	Plant Community Zone
Aster pilosus	Frost aster	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow, Floodplain, Upland
Euthanmia graminifolia	Grass-leaved goldenrod	forbes and ferns	1"-16", 18"-3'							flower						Floodplain
Smilacina racemosa	False Solomon's seal	forbes and ferns	1"-16", 18"-3'			flower						fruit				Floodplain
Aster laevis	Smooth aster	forbes and ferns	18"-3'								flower					Wet Meadow, Floodplain
Eryngium yuccifolium	Rattlesnake master	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Aronia melanocarpa	Black chokeberry	trees and shrubs	18"-3, 4'-7'					flower								Floodplain, Upland
Boltonia asteroides	Boltonia	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow, Floodplain
Athyrium filix-femina	Lady fern	forbes and ferns	18"-3'													Wet Meadow, Floodplain

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	January	February	March	April	May	June	July	August	September	October	November	December	Plant Community Zone
Celtis occidentalis	Hackberry	trees and shrubs	4'-7'				flower									Floodplain
Sorghasrrum nutans	Indian grass	grasses, sedges, and rushes	4'-7'								flower					Floodplain
Eryngium yuccifolium	Rattlesnake master	forbes and ferns	18"-3, 4'-7'							flower						Wet Meadow, Floodplain
Aronia melanocarpa	Black chokeberry	trees and shrubs	18"-3, 4'-7'					flower								Floodplain, Upland
Viburnum trilobum	High bush cranberry	trees and shrubs	4'-7', 8+'						flower					fruit		Floodplain, Upland
Boltonia asteroides	Boltonia	forbes and ferns	18"-3, 4'-7'								flower					Wet Meadow, Floodplain
Andropogon gerardii	Big bluestem	grasses, sedges, and rushes	4'-7', 8+'													Wet Meadow, Floodplain
Matteuccia struthiopteris	Ostrich fern	forbes and ferns	4'-7'													Wet Meadow, Floodplain, Upland

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	January	February	March	April	May	June	July	August	September	October	November	December	Plant Community Zone
Fraxinus pennsylvanica	Green ash	trees and shrubs	8+'				flower									Floodplain
Helianthus grosseserratus	Sawtooth sunflower	forbes and ferns	8+'							flower						Floodplain
Viburnum trilobum	High bush cranberry	trees and shrubs	4'-7', 8+'						flower					fruit		Floodplain, Upland
Andropogon gerardii	Big bluestem	grasses, sedges, and rushes	4'-7', 8+'													Wet Meadow, Floodplain

Table B.23 - Filter Strip Floodplain Plant Palette

Created by: Buffington, Jared

Source: (Shaw & Schmidt, 2003)

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Aster pilosus	Frost aster	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow, Floodplain, Upland
Solidago flexicaulis	Zig-zag goldenrod	forbes and ferns	1"-16", 18"-3'								flower					Upland
Zizia aurea	Golden alexanders	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland
Angelica atropurpurea	Angelica	forbes and ferns	1"-16"							flower						Wet Meadow, Upland
Allium stellatum	Prairie wild onion	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland
Tradescantia ohiensis	Ohio spiderwort	forbes and ferns	1"-16", 18"-3'				flower									Upland
Aster macrophyllus	Bigleaf aster	forbes and ferns	1"-16"								flower					Upland

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Spiraea alba	Meadowsweet	forbes and ferns	18"-3, 4'-7'						flower							Upland
Aster pilosus	Frost aster	forbes and ferns	1"-16", 18"-3'								flower					Wet Meadow, Floodplain, Upland
Solidago flexicaulis	Zig-zag goldenrod	forbes and ferns	1"-16", 18"-3'								flower					Upland
Solidago riddellii	Riddell's goldemod	forbes and ferns	18"-3'									flower				Upland
Zizia aurea	Golden alexanders	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland
Heuchera richardsonii	Prairie alumroot	forbes and ferns	18"-3'				flower									Upland
Schizachyrium scoparium	Little bluestem	grasses, sedges, and rushes	18"-3'							flower						Upland
Liatris ligulistylis	Meadow blazingstar	forbes and ferns	18"-3, 4'-7'							flower						Upland
Allium stellatum	Prairie wild onion	forbes and ferns	1"-16", 18"-3'					flower								Wet Meadow, Upland
Liatris pychnostachya	Prairie blazingstar	forbes and ferns	18"-3, 4'-7'							flower						Upland
Monarda fistulosa	Wild bergamot	forbes and ferns	18"-3, 4'-7'							flower						Upland
Tradescantia ohiensis	Ohio spiderwort	forbes and ferns	1"-16", 18"-3'				flower									Upland
Agastache foeniculum	Giant hyssop	forbes and ferns	18"-3', 4'-7'						flower							Upland
Galium boreale	Northern bedstraw	forbes and ferns	18"-3'						flower							Upland
Aronia melanocarpa	Black chokeberry	trees and shrubs	18"-3, 4'-7'					flower								Floodplain, Upland
Aster lanceolatum	Panicle aster	forbes and ferns	18"-3'								flower					Wet Meadow, Upland
Pteridium aquilinum	Bracken fern	forbes and ferns	18"-3'													Upland
Osmunda regalis	Royal fern	forbes and ferns	18"-3'													Wet Meadow, Upland
Equisetum fluviatile	Horsetail	grasses, sedges, and rushes	18"-3'													Upland

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Spiraea alba	Meadowsweet	forbes and ferns	18"-3, 4'-7'						flower							Upland
Liatris ligulistylis	Meadow blazingstar	forbes and ferns	18"-3, 4'-7'							flower						Upland
Liatris pychnostachya	Prairie blazingstar	forbes and ferns	18"-3, 4'-7'							flower						Upland
Monarda fistulosa	Wild bergamot	forbes and ferns	18"-3, 4'-7'							flower						Upland
Agastache foeniculum	Giant hyssop	forbes and ferns	18"-3', 4'-7'						flower							Upland
Aronia melanocarpa	Black chokeberry	trees and shrubs	18"-3, 4'-7'					flower								Floodplain, Upland
Viburnum trilobum	High bush cranberry	trees and shrubs	4'-7', 8+'	fruit					flower					fruit		Floodplain, Upland
Matteuccia struthiopteris	Ostrich fern	forbes and ferns	4'-7'													Wet Meadow, Floodplain, Upland

SCIENTIFIC NAME	COMMON NAME	PLANT TYPE	HEIGHT CATEGORY	Seasonal Interest												Plant Community Zone
				January	February	March	April	May	June	July	August	September	October	November	December	
Lilium superbum	Turk's-cap lily	forbes and ferns	8+'						flower							Upland
Physocarpus opulifolius	Ninebark	trees and shrubs	8+'					flower				foliage				Upland
Viburnum trilobum	High bush cranberry	trees and shrubs	4'-7', 8+'	fruit					flower					fruit		Floodplain, Upland
Acer saccharinum	Silver maple	trees and shrubs	8+'		flower											Upland
Larix laricina	Tamarack	trees and shrubs	8+'													Upland

Table B.24 - Filter Strip Upland Plant Palette

Created by: Buffington, Jared

Source: (Shaw & Schmidt, 2003)

APPX:C CRITICAL EVALUATION NOTES

Retention - SMS Design #1

Existing

The following critical notes are indicative of the existing SMS's ability to perform basic aesthetic functions in relation to the landscape patterns: gateways and partitions, trails and locomotion, views and vistas, and places and their elements. The existing location within Anneberg Park is evaluated on the system's ability to increase both the site's and system's coherence, legibility, complexity, and mystery in varying degrees through the application of the landscape patterns previously identified.

Aesthetic Evaluations

Gateways and Partitions

1. Existing system includes a grass swale that directs runoff to pipe inlet; provides little to no characteristics of gateway or visual partition performance
2. Swale system does not provide any type of visual barrier from the east side of Anneberg to the west side, failing to help break down the expansive of grass, decreasing overall site legibility and decreasing opportunity for additional complexity
3. Existing swale system neglects to provide partitioning from the pavilion area to the maintenance shed to the north
4. Existing system does not improve orientation within the site by directing views, mainly due to its location along the northern edge of the Anneberg Park
5. Without existing system providing partitions of any kind, gateways and views through them

Trails and Locomotion

6. The existing system along the north edge of Anneberg Park is adjacent to two pathways, a gravel trail to the north and a paved road to southwest. The system provides no directed views from any point along the two locomotion pathways, decreasing legibility and limiting the interaction between circulation and SMS
7. The trails surface adjacent to the existing system stays consistent, increasing coherence of circulation adjacent to the system, however the circulation pathway does not encourage or direct locomotive interaction with the SMS
8. Existing SMS does not provide an identified point of interest along either pathway due to its lack of distinctiveness, or legibility from the surrounding ground surfaces and its lack of vertical characteristics and degrees of enclosure

Views and Vistas

9. Existing system is clearly visible within the landscape to the passerby, but neglects to address the specific characteristics of 'guiding the eye' to points of interest throughout the site
10. Existing system does not provide 'enough to look at' because of its lack of legibility from the surrounding site
11. System does not provide characteristics of encouraging people to inquire as to what the system provides aesthetically or ecologically, decreasing opportunity for mystery and decreasing complexity
12. Provides few opportunities for visual layering of vertical elements, decreasing ability to provide 'more than meets the eye'

Places and their Elements

13. The existing SMS does not provide any characteristics addressing identified patterns in relation to Places and their Elements; patterns in the form of trees, the water's edge, big and small places, and a sense of enclosure

Amenity Evaluations

Education

1. Existing area provides little to no characteristics of ways to learn through signage or identified programming
2. Provides little to no characteristics of ideas to learn through artistic interpretation, utilization of multiple types of stormwater treatment, or by incorporating riparian vegetation for habitat creation
3. Existing system provides few characteristics addressing context for learning, but does indicate pipe inlets

   - Area (grass swale) provides visibility, gathering, and interactivity within the system, but none relate directly to the SMS aside from the fact that activities and circulation are allowed within the system

Recreation

4. Existing grass swale is located near a perimeter trail, allowing pass by a system opportunities, but does not spatially define pause or rest areas
5. System does not include wayfinding directly related to SMS and does not provide clear, identified access to system (mainly because the system does not prohibit entrance from any direction)
6. Existing SMS provides exploration within system but does not encourage exploration through use of mystery or circulation directing elements
7. No interactive opportunities are provided due to stormwater conveyance characteristics of a vegetated swale

Public Relations

8. Existing system is clearly visible within the landscape to the passerby, but neglects to address the specific characteristics of showing that the designers 'Care' about the publics view of the system in the form of an amenity; aside from the fact that the system directs flow and increases conveyance from existing amenities such as the soccer and baseball fields

Aesthetic Richness

9. The existing grass swale lacks design characteristics such as point, line, plane, volume and texture, axis, and rhythm and repetition to convey stormwater
10. Lacks elements that create auditory and tactile interest

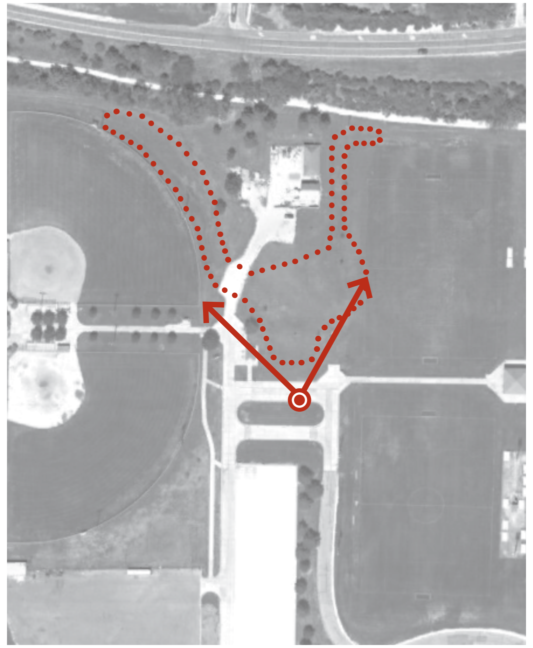


Figure C.1 Design #1 - Existing location of SMS on Anneberg's north edge, plan view.

Edited by: Buffington, Jared Source: Riley County GIS Data

Natural Planting Scheme

Aesthetic Evaluations

Gateways and Partitions

1. Structural design of bioretention systems and filter strips typically make them ideal for application where there are spatial limitations at the edge of expanses of grass, seeing as how they can utilize gradual slopes to help with the filtration process(dependent upon the overall basin size contributing to the trench), making them well suited for screening or partitioning, increasing coherence and legibility of spatial edges
2. Natural planting scheme utilizes the planting palette of both bioretention and filter strip systems to create varying degrees of partitions based on plant height, however with a sporadic planting placement gateways and unified partitions are not distinct and lack coherence as to locomotive and view direction
3. Performs as a successful partition on a larger scale, could be limited as to the coherence of what the system's function is on a smaller scale due to its variety of height, color, and texture mixed together.
4. System allows opportunity for partitions and gateways, but does not use planting material to direct specific views, increasing immediate legibility of site by breaking down expanses of grass, but limits system coherence due to "messy" planting appearance
5. Orientation is increased due to varying levels of planting material, limiting access to areas and informing circulation, increasing coherence within site context; starts to partition view of maintenance shed to the north but does not completely obstruct view due to varied planting heights
6. System provides opportunity for gateways but limits the gateways structure and definition in terms of informing and directing views due to natural planting plan, increases complexity to an unwanted level

Trails and Locomotion

7. A natural planting plan begins to limit and direct the views and interplay of trails and locomotion, increasing orientation but still limiting coherence and legibility
8. Direct access to maintenance shed is visually limited until further exploration along the existing paved walkway to the west, increasing sense of mystery and also helping to create visual barrier
9. System provides opportunity of small views of system from the existing trail but limits the direction of larger views to the south part of the site, limits extent or depth cues, decreasing mystery and coherence
10. Existing trail's surface material is prone to increasing sedimentation within a naturalized system
11. System provides a point of interest along the existing path, increasing a the possibility for orientation, but may be limited as to illustrating its distinctiveness and lack of coherence due to its sporadic planting plan

Views and Vistas

12. Natural planting scheme begins to allow views but lacks specific direction as to what to look at in the foreground and to vistas beyond to the south portion of the site
13. View direction is sporadic and ill-defined
14. Views of circulation are randomly blocked, creating irregular hierarchy of circulation and locomotion from both the paved pathway to the south and the gravel pathway to the north
15. Provides a distinct region that breaks up space, but lacks coherence on a system scale due to natural, or sporadic planting scheme

Places and their elements

16. System provides the opportunity for tree utilization, but limits placement for aesthetic function such as shading, view direction, and screening to the north
17. Provides opportunity for water interaction after rainfall events, but limits specific access to water
18. Allows acknowledgement of larger spaces but lacks visual direction to points of interest within the larger view from the north gravel trail, decreasing coherence
19. Provides degrees of enclosure and privacy depending on vegetation height and adjacency to the existing pathway, but still limited as to specific spatial definition with vertical elements

Amenity Evaluations

Education

1. Can provide basic information as to what system provides hydrologically through signage, but understanding through plant association or location is limited due to sporadic plant placement
2. Ideas to learn are only illustrated by utilizing multiple stormwater treatment systems that include riparian vegetation that provides wildlife habitat
3. SMS is visible from the existing pathways, but gathering spaces are poorly defined and interactivity with system is not allowed or defined due to varying planting heights

Recreation

4. Allows 'pass by' system opportunities, but does not spatially define pause or rest areas
5. Signage introduces system importance, but does not indicate the systems relation to the entire site
6. Does not provide clear access to interaction with SMS aside from added trail to terminate space
7. Allows exploration through SMS but is limited to surrounding berms and spillways

Public Relations

8. Provides insight as to how the application of a bioretention or filter strip benefits hydrologic and ecologic systems but only to extent of what signage illustrates
9. SMS is visible and identifiable as it winds between the north trail, the northeast soccer fields, pavilion, maintenance shed, and baseball fields to the west
10. Provides an ecological amenity but lacks visual amenity characteristics through aesthetic performance

Aesthetic Richness

11. Naturalized planting scheme does not specifically address basic characteristics, but provides a diversity of planting material characteristics
12. Auditory characteristics are limited to spillway gabion when system is releasing excess stormwater
13. Tactile interest is limited to still water and overflow water located at spillways, adjacent to pathway

Hydrologic Planting Scheme

Aesthetic Evaluations

Gateways and Partitions

1. Alternative begins to break down the identified planting palette into smaller groupings, limiting the variety of plants applied to each elevation within the systems hydrological structure, increasing its coherence to some extent
2. Increased coherence is attributed to an additional level of organization, decreasing the systems sporadic planting variation while maintaining a variety through the elevation differentiation.
3. Hydrologic planting scheme provides the same characteristics as the natural scheme exhibited

Trails and Locomotion

4. Hydrologic planting scheme within bioretention and filter strip systems provide the same characteristics in relation to trails and locomotion as the natural planting scheme (unless educated in SMS planting and hydrologic zones, however this mainly applies to places and their elements)

Views and Vistas

5. Hydrologic planting scheme within bioretention and filtration strip systems provide the same characteristics in relation to views and vistas as the natural planting scheme (unless educated in SMS planting and hydrologic zones, however this mainly applies to places and their elements)
6. Hydrologic planting scheme adds a level of design to system structure based on hydrologic zones, increasing the 'think view' characteristic of the system

Places and their elements

7. Hydrologic planting scheme begins to address site specific characteristics as to where vegetation is located, ultimately providing distinction and form specific to the system and its placement within the landscape, increasing legibility as a system
8. System is still limited as to its coherence due to its hard to distinguish planting scheme, unless familiar with hydrologic zones and the planting material suitable for each zone
9. Creates an added level of design that addresses hydrologic functions, while maintaining a variety of planting characteristics and a level of complexity
10. However, planting can still seem sporadic and unkept if one isn't familiar with the planting structure of the system, decreasing coherence
11. Without specific planting placement in terms of vertical structure views and circulation have little guidance and direction, maintaining a level of depth and extent but without focus, increasing complexity but hindering coherence,
12. The sense of enclosure is still limited and ill-defined, not distinguishing SMS and foreground elements from the maintenance shed to the north

Amenity Evaluations

Education

1. Provides basic information as to what system provides hydrologically through signage; understanding through plant association or location is enhanced due to planting zone delineation
2. System adjacency to pavilion increases ability to educate
3. Ideas to learn are illustrated by utilizing multiple stormwater treatment systems that include specific riparian vegetation placement based on zones that provide both hydrologic function and wildlife habitat
4. SMS is visible from the existing pavilion and north trail, allowing systems to serve as spatial definers to some degree

Recreation

5. Allows 'pass by' system opportunities, but does not spatially define pause or rest areas due to seemingly sporadic planting placement; these areas are limited to pavilion
6. Signage introduces system importance, but does not indicate the systems relation to the entire site in terms or visual direction (See Gateway and Partition evaluation)
7. Does not provide clear access to interaction with SMS due to seemingly sporadic planting placement
8. Allows exploration through SMS but locomotion is limited to surrounding berms and spillways

Public Relations

9. Provides insight as to how the application of a bioretention or filter strip's hydrologic and ecologic systems through signage
10. Provides additional level of system design based on plant zone location and illustrates stewardship through landscape and hydrologic care; this association however is still limited to people with education in SMS and their associated planting material
11. SMS is visible and identifiable as it winds between the north trail, the northeast soccer fields, pavilion, maintenance shed, and baseball fields to the west
12. Provides an ecological and hydrological amenity but lacks visual amenity characteristics through aesthetic performance

Aesthetic Richness

13. Hydrologic planting scheme does not specifically address basic design characteristics, but provides a diversity of planting material characteristics associated with defined planting zones
14. Auditory characteristics are limited to spillway gabion locations
15. Tactile interest is limited to still water and overflow water located at spillways, adjacent to pathway

Designed Planting Scheme

Aesthetic Evaluations

Gateways and Partitions

1. Vegetation height, color, and texture are utilized to help direct views, create variety in color and texture within each planting zone identified within the hydrologic planting scheme, increasing complexity but not at the expense of coherence, also increases legibility
2. Partitions are created that allow the screening of the maintenance shed to the north, allowing gateway to enter the system in and created terminating space within the system structure (allowing interaction with the system, see related Amenity Goals pertaining to education and recreation)
3. The system itself creates a partition between the trail and the rest of the site to the south and maintenance shed
4. The system directs views to the south and distant pathways from the trail to the north, increasing orientation and mystery, while also increasing comfortability by allowing views of the trail

Trails and Locomotion

5. This scheme allows specified planting placement based on height that directs and allows locomotion through and up to the water's edge when the filtration system is holding excess rainfall
6. An additional pathway leading from the existing pavilion over a gabion wall to a terminating space within the filtration system allows the opportunity for mystery by adding view blocking vegetation at the system gateway
7. Added trail utilizes a gabion wall to cut through the stormwater system, engaging the user with stormwater management processes (allowing interaction with the system, see related Amenity Goals pertaining to education and recreation)
8. Strategically placed vegetation directs views from different points along the north trail toward near and far points of interest, both engaging the SMS and the extents of the site
9. System provides a point of interest along the existing north trail, and also adjacent to the pavilion

Views and Vistas

10. Scheme provides near and far views both of the system and the extent of the site by utilizing specific vegetation suited for the located hydrologic zones, increasing legibility of the site and mystery of what areas can be explored
11. Provides foreground and background emphasis in order to create extent, increasing complexity, but attempting to maintain a sense of coherence through grouped vegetation
12. Vegetation placement guides eye in relation to points of interest location and circulation

Places and their elements

13. Scheme utilizes trees for view direction and screening from maintenance shed to the north, increasing coherence of systems aesthetic purpose of partitioning and defining space
14. Scheme utilizes vegetation to prohibit access to water within the SMS to specified areas where interaction is allowed, creating a focal point and increasing legibility and coherence
15. The location of the system helps to divide the vastness of the soccer fields to the east from the baseball fields to the west, increasing coherence by breaking up an expansive area into smaller more comprehendible regions
16. Scheme helps to define a smaller, more private space between the trail and the pavilion, and also creates more enclosure along trail to the north
17. Scheme creates a sense of enclosure affording privacy and distinctiveness but also allows for the user to visually track where they are within the site through specific views of the site extent to the south from the north trail; increases coherence of the setting and legibility of the site orientation

Amenity Evaluations

Education

1. Provides basic information as to what system provides hydrologically through signage; understanding through plant association or location is enhanced due to planting zone delineation as well as color, height, and density association
2. Ideas to learn are illustrated by utilizing multiple stormwater treatment systems that include specific riparian vegetation placement based on both hydrologic zones and view and circulation direction
3. SMS is visible from the existing and additional pathway, terminate space is more defined due to planting height and density association
4. Possibility of education is enhanced through plant grouping based on color, height, and texture, and each groupings relation to the hydrological zone delineation

Recreation

5. Allows 'pass by' system opportunities
6. Signage introduces system importance, and relation to rest of the site is enhanced through view direction toward addition SMS application
7. Specifically placed low growing vegetation allows clear access to interaction with SMS in addition to gabion wall
8. Allows exploration through SMS over gabion wall but locomotion is limited to surrounding berms and spillways

Public Relations

9. Provides insight as to how the application of a bioretention and filter strips benefits hydrologic and ecologic systems
10. Provides addition level of system design to plant zone location by further categorizing hydrologic zones by color, height, and density, illustrating stewardship through landscape and hydrologic care
11. SMS is visible and identifiable as it winds between the north trail, the northeast soccer fields, pavilion, maintenance shed, and baseball fields to the west
12. Provides an ecological and hydrological amenity as well as an aesthetic performance amenity by illustrating careful design and plant placement

Aesthetic Richness

13. Categorized hydrologic planting scheme begins to address basic design characteristics by utilizing color, line of site, volume and texture, view axis, and repetition to increase the coherence of the system and it's placement within the site
14. Allows aesthetic characteristics to become an association tool for identifying different hydrological zones, increasing aesthetic richness as well as the ability to learn about both hydrological and aesthetic performance characteristics
15. Auditory characteristics are limited to spillway gabion locations
16. Tactile interest is limited to still water and overflow water located at spillways, adjacent to pathway

Infiltration - SMS Design #2

Existing

The following critical notes are indicative of the existing SMS's ability to perform basic aesthetic functions in relation to the landscape patterns: gateways and partitions, trails and locomotion, views and vistas, and places and their elements. The existing location within Anneberg Park is evaluated on the system's ability to increase both the site's and system's coherence, legibility, complexity, and mystery in varying degrees through the application of the landscape patterns previously identified.

Aesthetic Evaluations

Gateways and Partitions

1. Existing SMS provides little to no functional aesthetic in relation to gateways or partitions.
2. Basic structure of grass detention basins and grass swales are limited to their vertical characteristics and serve only as ground-plane variations.
3. Allow locomotion and don't create visual barriers, increasing the immediate coherence and understanding of a space
4. Limited vertical variance within an area can also create too large of spaces to comprehend, not allow the breakdown of spaces through partitions to create smaller, more comprehendible areas
5. Without partitions, gateways cannot be created to help direct views and circulation, decreasing legibility because of not limiting the amount of information to process within a scene
6. Without vertical partitions and gateways the opportunity for mystery and encouraged exploration is limited, decreasing complexity and opportunity for mystery
7. Limited vertical components within grass swales and grass detention basins also decrease one's ability to orient themselves within a site, decreasing legibility of site

Trails and Locomotion

8. Permits locomotion with no visual or locomotive barriers, increasing comfort in relation to legibility and coherence by allowing one to sense that they could readily enter and exit a space without any sort of obstructions; however, too much 'smooth ground' can cause an area to seem vast and monotonous, limiting the opportunity for mystery.
9. Lacks the characteristic of providing a more natural environment as well as a destination point to experience along the perimeter trail within Anneberg Park; important factors in trail design goals along with being able to separate the user from urban characteristics.

Views and Vistas

10. Views of the area where the current grass swale is located are not blocked to any extent, decreasing the opportunity for mystery and limiting the degree of complexity within the scene.
11. The system allows views of distant scenes, but does not provide visual direction due to lack of vertical elements such as vegetation
12. Focal points can be identified from views but lack of directional elements and distinct regions decreases coherence
13. Views of the existing system and beyond lack depth due to monotonous ground plane
14. System lacks visual balance between open space and spatial definers
15. System allows visual interpretation of the surrounding landscape encouraging mental exploration throughout the site
16. Existing system does not provide 'think views', applied through gateways

Places and their elements

17. System does not provide natural visual elements within or defining the space
18. System does not incorporate trees within the design
19. Existing system does not provide the opportunity for water interaction except during rainfall events
20. Provides a large space to experience, this however increases the amount of information to process when viewing and can create difficulties in way finding if a pathway is not defined
21. Lacks ability to provide small spaces due to the systems lack of spatial definition
22. System does not provide vertical degrees of enclosure; can provide ground plane sense of enclosure

Amenity Evaluations

Education

1. Existing area provides little to no characteristics of ways to learn through signage or identified programming
2. Provides little to no characteristics of ideas to learn through artistic interpretation, utilization of multiple types of stormwater treatment, or by incorporating riparian vegetation for habitat creation
3. Existing system provides few characteristics addressing context for learning

    - Area (grass swale) provides visibility, gathering, and interactivity within the system, but none relate directly to the SMS aside from the fact that activities and circulation are allowed within the system

Recreation

4. Existing grass swale is located near a perimeter trail, allowing pass by a system opportunities, but does not spatially define pause or rest areas
5. System does not include wayfinding directly related to SMS and does not provide clear, identified access to system (mainly because the system does not prohibit entrance from any direction
6. Existing SMS provides exploration within system but does not encourage exploration through use of mystery or circulation directing elements
7. No interactive opportunities are provided due to stormwater conveyance characteristics of a vegetated swale

Public Relations

8. Existing system is clearly visible within the landscape to the passerby, but neglects to address the specific characteristics of showing that the designers 'Care' about the publics view of the system in the form of an amenity

Aesthetic Richness

9. The existing grass swale lacks design characteristics such as point, line, plane, volume and texture, axis, and rhythm and repetition to convey stormwater
10. Lacks elements that create auditory and tactile interest

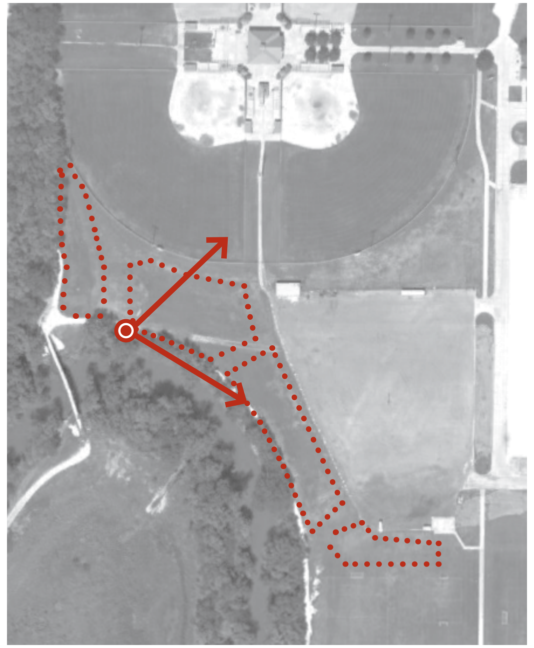


Figure C.2 Design #2 - Existing location of SMS on Anneberg's west edge, plan view.

Edited by: Buffington, Jared Source: Riley County GIS Data

Natural Planting Scheme

Aesthetic Evaluations

Gateways and Partitions

1. Structural design of infiltration trenches make it an ideal application where there are spatial limitations, seeing as how they tend to be linear in nature (also dependent upon the overall basin size contributing to the trench).
2. Infiltration trenches perform as spatial partitions without taking up a lot of space
3. Performs as a successful partition on a larger scale, could be limited as to the coherence of what the system's function is on a smaller scale due to its variety of height, color, and texture mixed together.
4. System allows opportunity for partitions and gateways, but does not use planting material to direct specific views, increasing immediate legibility of site by breaking down expanses of grass, but limits system coherence due to "messy" planting appearance
5. Orientation is increased due to varying levels of planting material, limiting access to areas and informing circulation, increasing coherence in within site context
6. System provides opportunity for gateways but limits the gateways structure and definition in terms of informing and directing views due to natural planting plan, increases complexity to an unwanted level

Trails and Locomotion

7. A natural planting plan begins to limit and direct the placement and interplay of trails and locomotion, increasing orientation but still limiting coherence and legibility
8. Direct access to baseball initially seems limited until further exploration along the existing trail to the east, increasing sense of mystery but limiting coherence
9. Natural planting scheme does not show evidence of an entrance point to baseball diamonds
10. System provides opportunity of small views of system from the existing trail but limits the direction of larger views to the east part of the site, limits extent or depth cues, decreasing mystery and coherence
11. Existing trail's surface material is prone to increasing sedimentation within a naturalized system
12. System provides a point of interest along the existing path, increasing a the possibility for orientation, but may be limited as to illustrating its distinctiveness due to lack of coherence

Views and Vistas

13. Natural planting scheme begins to allow views but lacks specific direction as to what to look at
14. View direction is sporadic
15. Views of circulation are randomly blocked, creating irregular hierarchy of circulation and locomotion
16. Provides a distinct region that breaks up space, but lacks coherence on a system scale due to natural, or sporadic planting scheme

Places and their elements

17. System provides the opportunity for tree utilization, but limits placement for aesthetic function such as shading or view direction
18. Provides opportunity for water interaction after rainfall events, but limits specific access to water
19. Allows acknowledgement of larger spaces but lacks visual direction to points of interest within the larger view, decreasing coherence
20. Provides degrees of enclosure and privacy depending on vegetation height and adjacency to the existing pathway, but still limited as to specific spatial definition with vertical elements

Amenity Evaluations

Education

1. Provides basic information as to what system provides hydrologically through signage, but understanding through plant association or location is limited due to sporadic plant placement
2. Ideas to learn are only illustrated by utilizing multiple stormwater treatment systems that include riparian vegetation that provides wildlife habitat
3. SMS is visible from the existing and additional pathway, but gathering spaces are poorly defined and interactivity with system is not allowed or defined

Recreation

4. Allows 'pass by' system opportunities, but does not spatially define pause or rest areas
5. Signage introduces system importance, but does not indicate the systems relation to the entire site
6. Does not provide clear access to interaction with SMS
7. Allows exploration through SMS but is limited to surrounding berms and spillways

Public Relations

8. Provides insight as to how the application of a retention swale or pond benefits hydrologic and ecologic systems
9. SMS is visible and identifiable as it winds between baseball fields and perimeter trail
10. Provides an ecological amenity but lacks visual amenity characteristics through aesthetic performance

Aesthetic Richness

11. Naturalized planting scheme does not specifically address basic characteristics, but provides a diversity of planting material characteristics
12. Auditory characteristics are limited to spillway gabion locations
13. Tactile interest is limited to still water and overflow water located at spillways, adjacent to pathway

Hydrologic Planting Scheme

Aesthetic Evaluations

Gateways and Partitions

1. Alternative begins to break down the identified planting palette into smaller groupings, limiting the variety of plants applied to each elevation within the systems hydrological structure, increasing its coherence to some extent
2. Increased coherence is attributed to an additional level of organization, decreasing the systems sporadic planting variation while maintaining a variety through the elevation differentiation.
3. Hydrologic planting scheme provides the same characteristics as the natural scheme exhibited

Trails and Locomotion

4. Hydrologic planting scheme within bioretention and filtration systems provide the same characteristics in relation to trails and locomotion as the natural planting scheme (unless educated in SMS planting and hydrologic zones, however this mainly applies to places and their elements)

Views and Vistas

5. Hydrologic planting scheme within bioretention and filtration systems provide the same characteristics in relation to views and vistas as the natural planting scheme (unless educated in SMS planting and hydrologic zones, however this mainly applies to places and their elements)
6. Hydrologic planting scheme adds a level of design to system structure based on hydrologic zones, increasing the 'think view' characteristic of the system

Places and their elements

7. Hydrologic planting scheme begins to address site specific characteristics as to where vegetation is located, ultimately providing distinction and form specific to the system and its placement within the landscape, increasing legibility as a system
8. System still limited as to its coherence due to its hard to distinguish planting scheme, unless familiar with hydrologic zones and the planting material suitable for each zone
9. Creates an added level of design that addresses hydrologic functions, while maintaining a variety of planting characteristics and a level of complexity
10. However, planting can still seem sporadic and unkept if one isn't familiar with the planting structure of the system, decreasing coherence
11. Without specific planting placement in terms of vertical structure views and circulation have little guidance and direction, maintaining a level of depth and extent but without focus, increasing complexity but hindering coherence

Amenity Evaluations

Education

1. Provides basic information as to what system provides hydrologically through signage; understanding through plant association or location is enhanced due to planting zone delineation
2. Ideas to learn are illustrated by utilizing multiple stormwater treatment systems that include specific riparian vegetation placement based on zones that provide both hydrologic function and wildlife habitat
3. SMS is visible from the existing and additional pathway, but gathering spaces are poorly defined and interactivity with system is not allowed or defined

Recreation

4. Allows 'pass by' system opportunities, but does not spatially define pause or rest areas
5. Signage introduces system importance, but does not indicate the systems relation to the entire site
6. Does not provide clear access to interaction with SMS
7. Allows exploration through SMS but locomotion is limited to surrounding berms and spillways

Public Relations

8. Provides insight as to how the application of a retention swale or pond benefits hydrologic and ecologic systems
9. Provides additional level of system design based on plant zone location and illustrates stewardship through landscape and hydrologic care
10. SMS is visible and identifiable as it winds between baseball fields and perimeter trail
11. Provides an ecological amenity and hydrological but lacks visual amenity characteristics through aesthetic performance

Aesthetic Richness

12. Hydrologic planting scheme does not specifically address basic design characteristics, but provides a diversity of planting material characteristics associated with defined planting zones
13. Auditory characteristics are limited to spillway gabion locations
14. Tactile interest is limited to still water and overflow water located at spillways, adjacent to pathway

Designed Planting Scheme

Aesthetic Evaluations

Gateways and Partitions

1. Vegetation height, color, and texture are utilized to help direct views, create variety in color and texture within each identified planting zone identified within the hydrologic planting scheme
2. Gateways are created at the southern entrance of the baseball fields and to the entrance into the series of retention systems
3. The system itself creates a partition between the trail and the rest of the site to the northeast
4. Separation from the rest of the site in this area helps to increase the degrees of enclosure, making the area more private and naturalized
5. The system directs views to both gateways and distant pathways, increasing orientation and mystery, while also increasing comfortability by allowing views in
6. This scheme groups planting material based on color, texture and height in order to create smaller, more comprehendible areas, increasing coherence and legibility

Trails and Locomotion

7. This scheme allows specified planting placement based on height that directs and allows locomotion through and up to the water's edge when the retention system is holding excess rainfall
8. An additional pathway leading from the trail to the southern baseball field entrance is positioned along the curve in the trail and is curved it self. This allows the opportunity for mystery by adding view blocking vegetation at each gateway
9. Added trail utilizes a spillway to pass through the stormwater system, engaging the user with stormwater management processes
10. Strategically placed vegetation directs views from different points along the trail toward near and far points of interest, both engaging the SMS and the extents of the site
11. System provides a point of interest along the existing trail

Views and Vistas

12. Scheme provides near and far views both of the system and the extent of the site by utilizing specific vegetation suited for the located hydrologic zones, increasing legibility of the site and mystery of what areas can be explored
13. Provides foreground and background emphasis in order to create extent, increasing complexity, but attempting to maintain a sense of coherence through grouped vegetation
14. Vegetation placement guides eye in relation to points of interest location and circulation

Places and their elements

15. Scheme utilizes trees for view direction and shading structures along added pathway to southern baseball field access, increasing mystery and coherence
16. Scheme utilizes vegetation to prohibit access to water within the SMS to specified areas where interaction is allowed, creating a focal point and increasing legibility and coherence
17. The location of the system does is limited in regards to its division of a large space, however it does increase the 'naturalized are of the treeline to the southwest, in turn decreasing the expansiveness of the parking lot to the east, increasing coherence by breaking up an expansive area in to smaller more comprehendible regions
18. Scheme helps to define a smaller, more private space between the trail and the baseball fields to the northeast
19. Scheme creates a sense of enclosure affording privacy and distinctiveness but also allows for the user to visually track where they are within the site through specific vies of the site extent to the east; increases coherence of the setting and legibility of the site orientation

Amenity Evaluations

Education

1. Provides basic information as to what system provides hydrologically through signage; understanding through plant association or location is enhanced due to planting zone delineation as well as color, height, and density association
2. Ideas to learn are illustrated by utilizing multiple stormwater treatment systems that include specific riparian vegetation placement based on both hydrologic zones and view and circulation direction
3. SMS is visible from the existing and additional pathway, gathering spaces are more defined due to planting height and density association

Recreation

4. Allows 'pass by' system opportunities
5. Signage introduces system importance, and relation to rest of the site is enhanced through view direction toward addition SMS
6. Specifically placed low growing vegetation allows clear access to interaction with SMS in addition to rock ledge
7. Allows exploration through SMS over spillway but locomotion is limited to surrounding berms and spillways

Public Relations

8. Provides insight as to how the application of a retention swale or pond benefits hydrologic and ecologic systems
9. Provides addition level of system design to plant zone location by further categorizing hydrologic zones by color, height, and density, illustrating stewardship through landscape and hydrologic care
10. SMS is visible and identifiable as it winds between baseball fields and perimeter trail
11. Provides an ecological and hydrological amenity as well as an aesthetic performance amenity that illustrates careful design and plant placement

Aesthetic Richness

12. Categorized hydrologic planting scheme begins to address basic design characteristics by utilizing color, line of site, volume and texture, view axis, and repetition
13. Auditory characteristics are limited to spillway gabion locations
14. Tactile interest is limited to still water and overflow water located at spillways, adjacent to pathway

Constructed Wetland - SMS Design #3

Existing

The following bullet points are indicative of the existing SMS's ability to perform basic amenity functions in relation to the topical goals of education, recreation, public relations, and aesthetic richness. These evaluations indicate to what extent wetland systems or components of the system either fulfill requirements of the identified goal, or provide the opportunity to fulfill the goal through the application of amenity techniques.

Aesthetic Evaluations

Gateways and Partitions

1. Existing SMS provides little to no functional aesthetic in relation to gateways or partitions; ground plane emphasis is limited to grass swale characteristics
2. Basic structure of grass swales are limited to their vertical characteristics and serve only as ground-plane variations.
3. System allows locomotion and doesn't create visual barriers, increasing the immediate coherence and understanding of a space but limits the level of complexity which can be seen as boring or monotonous
4. Limited vertical variance within an area can also create too large of spaces to comprehend, not allowing the breakdown of spaces through partitions to create smaller, more comprehendible areas; relates directly to level of complexity
5. Without partitions, gateways cannot be created to help direct views and circulation to the southwest soccer fields, decreasing legibility by not limiting the amount of information to process within a scene
6. Without vertical partitions and gateways the opportunity for mystery and encouraged exploration to the soccer fields and around them on the perimeter gravel trail is limited, decreasing complexity and opportunity for mystery
7. Limited vertical components within grass swales also decreases one's ability to orient themselves within a site, decreasing legibility of site

Trails and Locomotion

8. Permits locomotion with no visual or locomotive barriers, increasing comfort in relation to legibility and coherence by allowing one to sense that they could readily enter and exit a space without any sort of obstructions; however, too much 'smooth ground' can cause an area to seem vast and monotonous, limiting the opportunity for mystery, spatial definition, and added complexity within a scene.
9. Lacks the characteristic of providing a more natural environment as well as a destination point to experience along the perimeter trail within Anneberg Park; important factors in trail design goals along with being able to separate the user from urban characteristics
10. System does not provide any degree of visual separation in the form of partitions from the expanse of the soccer field

Views and Vistas

11. Views of the area where the current grass swale is located are not blocked to any extent, decreasing the opportunity for mystery and limiting the degree of complexity within the scene.
12. The system allows views of distant scenes, but does not provide visual direction due to lack of vertical elements such as vegetation, and provides no foreground emphasis of any kind
13. Focal points can be identified from views but lack of directional elements and distinct regions decreases coherence
14. Views of the existing system and beyond lack depth due to monotonous ground plane and foreground emphasis
15. System lacks visual balance between open space and spatial definers; trees do create spatial definition around the southwestern edge of the site, but expansiveness of site limits the legibility of individual views and definitive areas
16. System allows visual interpretation of the surrounding landscape encouraging mental exploration throughout the site, but not with the aid of mystery pattern applications
17. Existing system does not provide 'think views', applied through gateways to encourage further understanding of the site and system

Places and their elements

18. System does not provide natural vertical elements within or defining the space
19. Provides a large space to experience, this however increases the amount of information to process when viewing and can create difficulties in way finding if a pathway is not defined
20. Lacks ability to provide small spaces due to the systems spatial definition characteristics

Amenity Evaluations

Education

1. Existing area provides little to no characteristics of ways to learn through signage or identified programming
2. Provides little to no characteristics of ideas to learn through artistic interpretation, utilization of multiple types of stormwater treatment, or by incorporating riparian vegetation for habitat creation
3. Existing system provides few characteristics addressing context for learning, but does indicate pipe inlets

   - Area (grass swale) provides visibility, gathering, and interactivity within the system, but none relate directly to the SMS aside from the fact that activities and circulation are allowed within the system

Recreation

4. Existing grass swale is located near a perimeter trail and bisects southwest soccer fields and baseball fields, allowing pass by opportunities, but does not spatially define pause or rest areas
5. System does not include wayfinding directly related to SMS and does not provide clear, identified access to system (mainly because the system does not prohibit entrance from any direction)
6. Existing SMS provides exploration within system but does not encourage exploration through use of mystery or circulation directing elements
7. No interactive opportunities are provided due to the stormwater conveyance characteristics of a grass swale

Public Relations

8. Existing system is clearly visible within the landscape to the passerby, but neglects to address the specific characteristics of showing that the designers 'Care' about the publics view of the system in the form of an amenity; aside from the fact that the system directs flow and increases conveyance from existing amenities such as the soccer and baseball fields

Aesthetic Richness

9. The existing grass swale lacks design characteristics such as point, line, plane, volume and texture, axis, and rhythm and repetition to convey stormwater
10. Lacks elements that create auditory and tactile interest

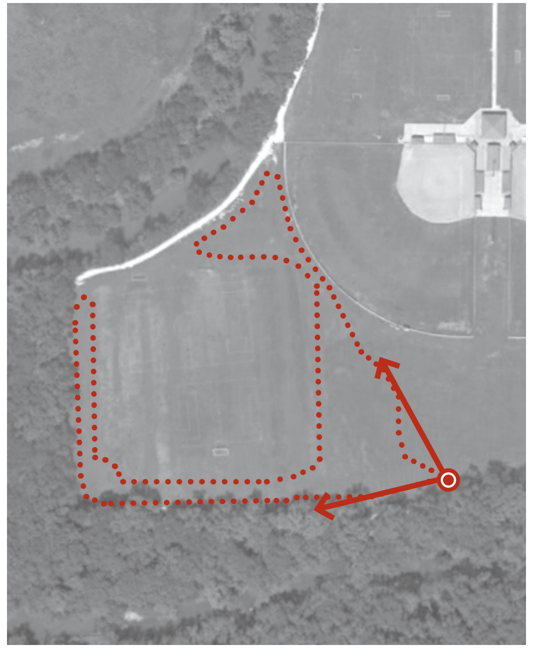


Figure C.3 Design #3 - Existing location of SMS on Anneberg's southwest edge, plan view.

Edited by: Buffington, Jared   Source: Riley County GIS Data

Natural Planting Scheme

Aesthetic Evaluations

Gateways and Partitions

1. Structural design of constructed wetland systems make it an ideal application where there is little grade and plenty of space
2. Constructed wetland systems perform as spatial partitions have limited application due to the relative size requirements based on the contributing watershed size
3. Performs as a successful partition on a larger scale, could be limited as to the coherence of what the system's function is on a smaller scale due to its variety of height, color, and texture mixed together.
4. System allows opportunity for partitions and gateways, but does not use planting material to direct specific views, increasing immediate legibility of site by breaking down expanses of grass, but limits system coherence due to "messy" planting appearance; system structure can also reduce legibility due to its expansiveness and lack of coherent grouping of vegetation
5. Orientation is increased due to varying levels of planting material, limiting access to areas and informing circulation, increasing coherence in within site context
6. System provides opportunity for gateways but limits the gateways structure and definition in terms of informing and directing views due to natural planting plan, increases complexity to an unwanted level

Trails and Locomotion

7. A natural planting scheme begins to limit and direct the placement and interplay of trails and locomotion, increasing orientation but still limiting coherence and legibility due to a large variety of planting material associate with wetlands
8. Direct access to southwest soccer fields seems limited until further exploration along the existing trail to the south and northwest, increasing sense of mystery but limiting coherence due to sporadic planting scheme
9. System provides opportunity for small views of system from the existing trail but limits the direction of larger views to the west edge of the site, limiting extent or depth cues and decreasing mystery and coherence on a system scale
10. Existing trail's surface material is prone to increasing sedimentation within to the south of constructed wetland system
11. System provides a point of interest along the existing path, increasing the possibility for orientation, but may be limited as to illustrating its distinctiveness due to lack of coherence

Views and Vistas

12. Natural planting scheme begins to allow views but lacks specific direction as to what to look at
13. View direction is sporadic and not defined
14. Views of circulation are randomly blocked, creating irregular hierarchy of circulation and locomotion
15. Provides a distinct region that breaks up space between southwest soccer fields and southwest baseball fields, but lacks coherence on a system scale due to natural, or sporadic planting scheme

Places and their elements

16. System provides the opportunity for tree utilization, but limits placement for aesthetic function such as shading or view direction
17. Provides opportunity for water interaction, but limits specific access to water directed by vegetation characteristics
18. Allows acknowledgement of larger spaces but lacks visual direction to points of interest within the larger view, decreasing coherence
19. Provides degrees of enclosure and privacy depending on vegetation height and adjacency to the existing pathway, but still is limited as to specific spatial definition with vertical elements such as vegetation

Amenity Evaluations

Education

1. System can facilitate basic information as to what system provides hydrologically through signage, but understanding through plant association or plant location is limited due to sporadic plant placement
2. Ideas to learn are only illustrated by utilizing multiple stormwater treatment systems that include riparian vegetation that provide wildlife habitat
3. SMS is visible from the existing pathways, but gathering spaces are poorly defined and interactivity with system is not allowed or defined due to varying planting heights and access inconsistency

Recreation

4. Allows 'pass by' system opportunities, but does not spatially define pause or rest areas
5. Signage introduces system importance and should educate the viewer as to how system relates to the rest of site SMS
6. Does not provide clear access to interaction with SMS aside from added trail to the northwest
7. Allows exploration through SMS but is limited to surrounding berms and spillways; further interaction can be created through added structures such as decks (See Recreation goal techniques)

Public Relations

8. Provides insight as to how the application of constructed wetland systems benefit hydrologic and ecologic systems but only to extent of what signage illustrates
9. SMS is visible and identifiable as it winds between the south trail, the southwest soccer fields, and baseball fields to the northeast
10. Provides an ecological amenity but lacks visual amenity characteristics through aesthetic performance, due to natural planting scheme

Aesthetic Richness

11. Naturalized planting scheme does not specifically address basic aesthetic richness characteristics from a planting palette standpoint, but provides a diversity of planting material characteristics increasing complexity or variety
12. Auditory characteristics are limited to spillway gabion when system is releasing excess stormwater
13. Tactile interest is limited to still water and overflow water located at spillways, adjacent to pathway

Hydrologic Planting Scheme

Aesthetic Evaluations

Gateways and Partitions

1. A hydrologic planting scheme provides an added degree of plant characterization that allows discernment of specific vegetation best suited for each planting zone to perform as gateway defining elements and partitions
2. Increased coherence is attributed to an additional level of organization or plant categorization, decreasing the systems sporadic planting variation while maintaining a variety through the elevation differentiation and color difference
3. Hydrologic planting scheme provides the same characteristics as the natural scheme exhibited

Trails and Locomotion

4. Hydrologic planting scheme within wetland systems provide the same characteristics in relation to trails and locomotion as the natural planting scheme (unless educated in SMS planting and hydrologic zones; however this mainly applies to Places and their Elements)

Views and Vistas

5. Hydrologic planting scheme within wetland systems provides a variation in plant height, texture, color, and depth, increasing the possibility for views with depth cues and extent(unless educated in SMS planting and hydrologic zones, however this mainly applies to places and their elements)
6. Hydrologic planting scheme adds a level of design to system structure based on hydrologic zones, increasing the 'think view' characteristic of the system

Places and their elements

7. Hydrologic planting scheme begins to address site specific characteristics as to where vegetation is located, ultimately providing distinction and form specific to the system and its placement within the landscape, increasing legibility as a system
8. System is still limited as to its coherence due to its hard to distinguish planting scheme, unless familiar with hydrologic zones and the planting material suitable for each zone
9. Creates an added level of design that addresses hydrologic functions, while maintaining a variety of planting characteristics and a level of complexity
10. Planting can still seem sporadic and unkept if one isn't familiar with the planting structure of the system, decreasing coherence and distinctiveness
11. Without specific planting placement in terms of vertical structure views and circulation have little guidance and direction, maintaining a level of depth and extent but without focus, increasing complexity but hindering coherence
12. The sense of enclosure is still limited and ill-defined, not distinguishing SMS and foreground elements from the extent of the scene to the west edge of site

Amenity Evaluations

Education

1. Provides basic information as to what system provides hydrologically through signage; understanding through plant association or location is enhanced due to planting zone delineation
2. System adjacency to pathways increases ability to educate
3. Ideas to learn are illustrated by utilizing multiple stormwater treatment systems that include specific riparian vegetation placement based on zones that provide both hydrologic function and wildlife habitat
4. SMS is visible from the existing southern trail, allowing systems to serve as spatial definers to some degree

Recreation

5. Allows 'pass by' system opportunities, but does not spatially define pause or rest areas due to seemingly sporadic planting placement; doesn't imply interaction with lower vegetation
6. Signage introduces system importance, but does not indicate the systems relation to the entire site in terms or visual direction (See Gateway and Partition evaluation)
7. Scheme does not provide clear access to interaction with SMS due to seemingly sporadic planting placement
8. Allows exploration through SMS but locomotion is limited to surrounding berms and spillways

Public Relations

9. Provides insight as to how the application of a constructed wetland hydrologic and ecologic systems through signage
10. Provides additional level of system design based on plant zone location and illustrates stewardship through landscape and hydrologic care; this association however is still limited to people with education in SMS and their associated planting material
11. SMS is visible and identifiable as it winds between the southern trail, the southwest soccer fields, and baseball fields to the northeast
12. Provides an ecological and hydrological amenity but lacks visual amenity characteristics through aesthetic performance characteristics (See Preference Matrix)

Aesthetic Richness

13. Hydrologic planting scheme does not specifically address basic aesthetic richness design characteristics, but provides a diversity of planting material characteristics associated with defined planting zones
14. Auditory characteristics are limited to spillway gabion locations
15. Tactile interest is limited to still water and overflow water located at spillways, adjacent to pathway

Designed Planting Scheme

Aesthetic Evaluations

Gateways and Partitions

1. Vegetation height, color, and texture are utilized to help direct views, create variety in color and texture within each planting zone identified within the hydrologic planting scheme, increasing complexity but not at the expense of coherence, also increases legibility
2. Partitions are created that allow the breakdown of the expansive ground plane that reaches from children's playground to the southwest soccer fields; creates gateway to enter the system and creates multiple terminating, pass by, and pass through spaces (mainly attributed to the structural design of constructed wetlands)
3. Allows interaction with the system (see related Amenity Goals pertaining to education and recreation)
4. The system itself creates a partition between the trail and the rest of the site to the northeast
5. The system directs views to the southeast soccer fields and distant pathway from the southern trail, increasing orientation and mystery, while also increasing comfortability and legibility by allowing views of the distant trail

Trails and Locomotion

6. This scheme allows specified planting placement based on height that directs and allows locomotion through and up to the water's edge
7. An additional pathway leading from the southeast corner of the soccer fields meanders through wetland system over gabion walls and spillways, connecting to the perimeter trail north of the soccer fields; allows the opportunity for mystery by adding view blocking vegetation at the system gateway
8. Added trail utilizes a gabion wall to cut through the stormwater system, engaging the user with stormwater management processes (allowing interaction with the system, see related Amenity Goals pertaining to education and recreation)
9. Strategically placed vegetation directs views from different points along the south trail toward near and far points of interest, both engaging the SMS and the extents of the site
10. System provides a point of interest along the existing southern portion of the trail

Views and Vistas

11. Scheme provides near and far views both of the system and the extent of the site by utilizing height categorized vegetation suited for the located hydrologic zones, increasing legibility of the site and mystery of what areas can be explored
12. Provides foreground and background emphasis in order to create extent, increasing complexity, but attempting to maintain a sense of coherence through grouped vegetation
13. Vegetation placement guides eye in relation to points of interest location and circulation
14. Wetland system structure allows greater extent on a system scale due to its larger spatial requirements and high variance in hydrologic planting zones

Places and their elements

15. Scheme utilizes trees for view direction and shading within created path-space relations, increasing coherence of systems aesthetic purpose of partitioning and defining space
16. Scheme utilizes vegetation to prohibit access to water within the SMS to specified areas where interaction is allowed, creating a focal point and increasing legibility and coherence
17. The location of the system helps to divide the vastness of the soccer fields to the west from the baseball fields to the east, increasing coherence by breaking up an expansive area into smaller more comprehendible regions
18. Scheme helps to define a smaller, more private spaces between the trail and the baseball fields, and also creates more enclosure along trail to the south by further defining gateways
19. Scheme creates a sense of enclosure affording privacy and distinctiveness but also allows for the user to visually track where they are within the site through specific views of the site extent to the north from the south trail; increases coherence of the setting and legibility of the site orientation

Amenity Evaluations

Education

1. Scheme provides basic information as to what system provides hydrologically through signage; understanding through plant association or location is enhanced due to planting zone delineation as well as color, height, and density association
2. Ideas to learn are illustrated by utilizing multiple stormwater treatment systems that include specific riparian vegetation placement based on both hydrologic zones and view and circulation direction to soccer fields and points of interest in relation to constructed wetland systems
3. SMS is visible from the existing and additional pathway; path-space relationships are more defined due to planting height and density association
4. Possibility of education is enhanced through plant grouping based on color, height, and texture, and each groupings relation to the hydrological zone delineation; basic design characteristics are easier to identify than planting characteristics

Recreation

5. Allows 'pass by' system opportunities
6. Signage introduces system importance, and relation to rest of the site is enhanced through view direction toward addition SMS application
7. Specifically placed low growing vegetation allows clear access to interaction with SMS in addition to gabion wall and spillway crossings
8. Allows exploration through SMS over gabion wall but locomotion is limited to surrounding berms and spillways

Public Relations

9. Provides insight as to how the application of constructed wetland systems benefit hydrologic and ecologic systems
10. Provides additional level of system design to plant zone location by further categorizing hydrologic zones by color, height, and density, illustrating stewardship through landscape and hydrologic care
11. SMS is visible and identifiable as it winds between the south trail, southwest soccer fields, and baseball fields to the northeast
12. Provides an ecological and hydrological amenity as well as an aesthetic performance amenity by illustrating careful design and plant placement increasing coherence, legibility, complexity, and mystery (See Preference Matrix)

Aesthetic Richness

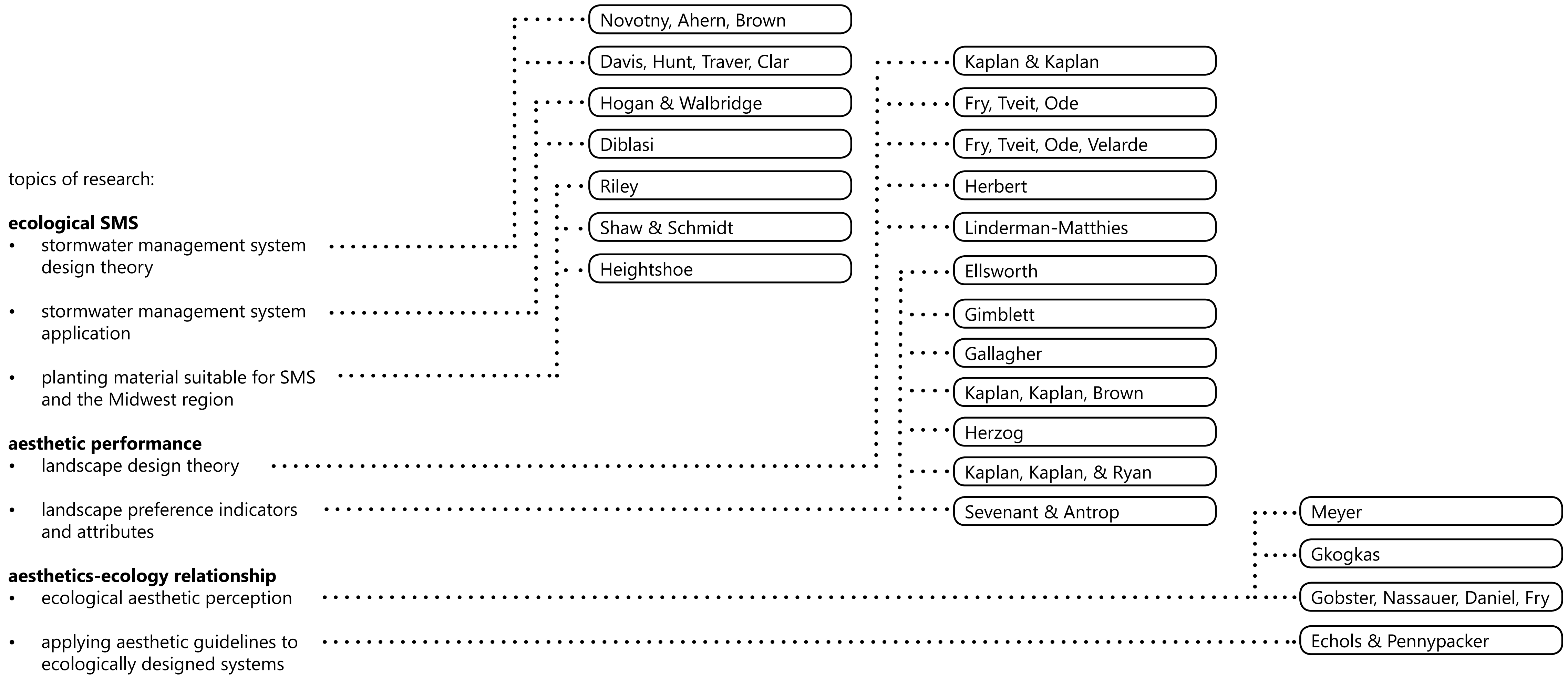
13. Categorized hydrologic planting scheme begins to address basic design characteristics by utilizing color, line of site, volume and texture, view axis, and repetition to increase the coherence of the system and it's placement within the site
14. Allows aesthetic characteristics to become an association tool for identifying different hydrological zones, increasing aesthetic richness as well as the ability to learn about both hydrological and aesthetic performance characteristics
15. Auditory characteristics are limited to spillway gabion locations
16. Tactile interest is limited to still water and overflow water located at spillways, adjacent to pathway

APPX:D LITERATURE REVIEWS

literature reviews

The studied literature can be grouped into three topical areas: aesthetic performance, ecological stormwater management systems, and aesthetic-ecology relationship. Each area of focused research is important to establishing the relevance of incorporating aesthetics into the design of vegetated SMS in order to foster an ecological appreciation through aesthetic performance.

Figure D.1 - Right - Literature association diagram
Created by: Jared Buffington



Novotny, V., Ahern, J., & Brown, P. (2010). Water centric sustainable communities: planning, retrofitting, and building the next urban environment. Hoboken, New Jersey: John Wiley & Sons, Inc.

Keywords: urban stream restoration, riparian zone design, water reclamation and reuse

This book explores the history of urban water, stormwater, and wastewater management while also discussing newly planned and constructed infrastructure and the retrofit and upgrading of existing infrastructure. Water Centric Sustainable Communities also provides case studies of successful implementations from around the world. Also, this reading provides guidance on connecting micro scale components (green roofs, pervious pavements, stream restoration and day lighting, riparian zone design, water reclamation and reuse, drainage, energy) in a distributed macro scale sustainable water ecosystem.

Water Centric Sustainable Communities combines landscape, water management, transportation, infrastructure, and triple bottom line assessment when addressing solutions for urban water problems. This is important to multiple types of projects because of its multidirectional approach.

Hogan, D. M., & Walbridge, M. R. (2007). Best management practices for nutrient and sediment retention in urban stormwater runoff. Journal of Environmental Quality, 36(March-April), 386-395.

Keywords: impervious surface cover (ISC), stormwater detention basin-best management practice

This article examines a study of two types of stormwater detention basins, SDB-BMPs (stormwater detention basin-best management practice), and SDB FCs (stormwater detention basin-flood control). Both are systems constructed to retain peak stormwater flows for flood mitigation. However, the article points out that the SDB-BMPs are also designed using basin topography and wetland vegetation to provide water quality improvement (nutrient and sediment removal and retention). The objective of this study was to compare SDB (both SDB-BREP and SDB-FC) surface soil P concentrations, P saturation, and Fe chemistry with natural riparian wetlands (RWs), using sites in Fairfax County, Virginia as a model system.

This information is important to the Wildcat Creek Watershed study because it provides basic background information on the specified stormwater management systems, while also providing a specific testing location with calculated data to refer to.

Shaw, D., & Schmidt, R. (2003). Plants for stormwater design: species selection for the upper Midwest. Saint Paul, Minnesota pollution Control Agency.

Keywords: stormwater management, plant species, flood depth duration

Plants for Stormwater Design provides a broad range of information on stormwater management practices and the planting material that is associated with each type of management system. It has a strong focus on native planting and addresses the environmental influences that effect plant growth and prosperity. These conditions include texture and organic content of soil, anticipated water levels or soil moisture, etc. However, the document mainly provides a guidebook utilized for plant selection for stormwater management systems in the upper Midwest.

This information is important to the Wildcat Creek watershed because it provides a starting point for identifying what types of vegetation work best in different types of ecological conditions, urban contexts, and in the upper Midwest region.

Heightshoe, G. L. (1988). Native trees, shrubs, and vines for urban and rural America: a planting design manual for environmental designers. New York: Van Nostrand Reinhold Company Inc.

Keywords: plant visual characteristics, ecological relationship, cultural requirements

Heightshoe provides amateur gardeners, students, and professionals with information that assists in simplifying plant-use decisions where native plants are desired. It is a resource for multiple professions addressing the plant selection of trees, shrubs, and vines. The book categorizes planting material native to the Midwest region of the United States in two ways: by plant characteristic and by specific plant. The plant characteristics are broken down into classifications that include visual characteristics--form, branching, foliage, flower, and fruit; ecological relationships--most suitable habitats, including flood and shade tolerance; and cultural requirements--soil, hardiness, silvical characteristics, urban conditions, and similar and associated species.

This planting design manual is important for the design of SMS because it can aid in both the spatial requirements of a design, as well as the ecological needs of the surrounding environment.

Davis, A. P., Hunt, W. F., Traver, R. G., & Clar, M. (2009). Bioretention technology: overview of current practices and future needs. Journal of Environmental Engineering, (117), 109-117.

Keywords: Sustainable development, filtration, biological treatment, hydrology, water quality, stormwater management, BMP's

This article addresses research done over the past decade showing that bioretention effluent loads are low for suspended solids, nutrients, hydrocarbons, and heavy metals. Pollutant removal processes include filtration, adsorption, and possibly biological treatment. Incorporating both filtration and infiltration, initial research into bioretention has shown that these facilities substantially reduce runoff volumes and peak flows. However, the article does go on to state that the exact nature and impact of bioretention maintenance is still evolving, which will dictate long-term performance and life-cycle costs.

This article is important in identifying what areas within the Wildcat Creek watershed can utilize these systems as to increase infiltration and filtration. It is also helpful as to the maintenance and evaluation practices that are associated with these systems.

Riley, A. L. (1998). Restoring streams in cities: a guide for planners, policy makers, and citizens. Covelo, California: Island Press.

Keywords: stream restoration, flood proofing strategies, bank stabilization

This book provides a history of urban stream management and restoration practices from an interdisciplinary point of view. It provides information on federal programs, technical assistance, and funding opportunities, however these may be somewhat out of date. Also the book provides in-depth guidance on implementation projects. These projects include such activities as collecting watershed and stream channel data, installing re-vegetation projects, and protecting buildings from over bank flows.

Restoring Streams in Cities approaches stream restoration from a multidisciplinary point of view, allowing the reader to address different situations of stream restoration. This book provides basic information on how to approach processes such as collecting watershed and stream data, which we could utilize in the near future on the Wild Cat Creek watershed.

Gobster, P. H., Nassauer, J. I., Daniel, T. C., & Fry, G. (2007). The shared landscape: what does aesthetics have to do with ecology?. Landscape Ecology, (22), 959-972.

Keywords: landscape perception, scenic beauty, ecological aesthetics, landscape change, context

This article looks at the relationship between ecology and aesthetics, and whether or not a framework or set of guidelines can be established addressing an "ecological aesthetic." This framework could then be utilized in landscape planning, design and management. The authors of the article discuss the complementary and sometimes contradictory implications of both an ecologically important landscape and an aesthetic landscape. They posit that a common ground can, and should be found between the two in order to identify strategies for making design decisions that more closely align human values with ecological goals.

This reading is very substantial in justifying the importance of introducing aesthetic criteria within the design guidelines of SMS. By combining ecologically beneficial systems through stormwater management with aesthetic preference, future landscape designs can be powerful ways to protect and enhance ecological goals.

Sevenant, M., & Antrop, M. (2009). Cognitive attributes and aesthetic preferences in assessment and differentiation of landscapes. Journal of Environmental Management, 90, 2889-2899.

Keywords: Perceptual attributes, landscape appraisal, landscape character

This journal article describes a study of theoretical concepts pertaining to aesthetic preference and cognitive rating. This process was conducted through questionnaires among graduate students in geography. The purpose of this examination was to find correlations between these two theoretical concepts--aesthetic preference and cognitive rating--in order to characterize the landscape related to preference. The statistical analysis of the compiled data showed substantial correlations between aesthetic and cognitive ratings, but the correlations were not found to be very strong.

"The findings argued for the necessity to distinguish between different ratings and landscape types instead of using unitary preference measures and generalized data when studying landscape preference" –p.2889

The article went on to describe the importance in acknowledging that different people cognitively 'code' images differently based on their expectations for what that specific place could offer. In conclusion, the article states that there is a necessity to "… empirically test the interrelationships between different preferences in varying landscape types in order to develop a comprehensive framework for landscape assessment. " –p.2898

aesthetic performance

Lindemann-Matthies, P., Junge, X., & Matthies, D. (2010). The influence of plant diversity on people's perception and aesthetic appreciation. Biological Conservation, 143, 195-202.

Keywords: Aesthetics, economic value, ecosystem services, perception

This article addresses the importance of values attached to biodiversity by humans. This is important to the acceptance of designed stormwater management systems because the article begins to attach aesthetic rating to degrees of plant diversity. This data could then be utilized for aesthetic justification, or landscape aesthetic assessment. By utilized assessment criteria, ideally one could then apply these criteria to selecting planting material to be implemented within the urban context. This could be important to the Wildcat Creek watershed because it begins to address the idea of data driven, or data influence design decisions, ultimately allowing for a greater degree of acceptance within the urban context.

Fry, G., Tveit, M. S., Ode, A., & Velarde, M. D. (2009). The ecology of visual landscapes: exploring the conceptual common ground of visual and ecological landscape indicators. Ecological Indicators, 9, 933-947.

Keywords: Indicator, visual quality, ecological, landscape, integrated

This article presents results of the analysis of the correspondence between ecological and visual indicators. This process was done in order to see whether there is common ground between the concept and operation of these indicators. The study found a 'candidate' set of indicators that identified important aspects of both ecological and visual quality.

"The strength of the approach is that it forces us to focus on the identification of what we wish to indicate by means of landscape theory and assessment that are relevant to a specific landscape context." –p.933

The article strongly expresses a need for theory based indicators: stewardship, coherence, disturbance, historicity, visual scale, imageability, complexity, naturalness, and ephemera. This is important because current landscape indicators are applied out of context, ultimately being utilized to measure completely different landscape qualities than what they were identified for. The article then goes on to identify a hierarchical framework that aids in the links between theory and indicator application.

Kaplan, R., & Kaplan, S. (1989). The experience of nature: A psychological perspective. New York: Cambridge University Press.

Keywords: Preference Matrix, informational indicators, natural patterns

This book addresses a basic framework for understanding natural patterns and how humans experience and prefer these patterns. Kaplan and Kaplan identify two basic informational necessities that humans have when assessing preference - understanding and exploration. These two informational necessities are then categorized by how readily the information is - immediate and inferred or predicted. The combination of these to domains creates four evident patterns of predictor variables. The matrix to the lower left illustrates the relationships between both domains.

These four information indicators have been utilized in landscape assessment literature. However, they have been defined in many different ways. Kaplan and Kaplan et. al. (1989) specifically state that the definitions utilized within their application are directly related to the context of the matrix. Kaplan and Kaplan however, also go on to state that the matrix is to inform intuition. It is to provide a framework, a structure for analysis.

This book is can be used to help categorize design goals and guidelines for stormwater management systems in order to show the correlation between human preference and the ecological goal.

Kaplan, R., Kaplan, S., & Ryan, R. L. (1998). With people in mind: Design and management of everyday nature. Washington D.C.: Island Press.

Keywords: understanding and information framework, landscape fears and preferences, way-finding, restorative environments, gateways and partitions, trails and locomotion, views and vistas, engaging people

This book provides further explanation of the Preference Matrix (Kaplan & Kaplan, 1989) and how it guides the application of patterns within the landscape addressing the interaction between the environment and how people react to each pattern. The identified relationships form an "Understanding and Exploration" framework that provides a basis for recommendations or possible solutions to recurring situations. The authors state however, that there is rarely a universal solution, and that the "correct" solution is one that addresses locally specific criteria in order to solve the problem at hand.

The emphasis of the book is on the interaction between people and setting. The authors stress the need for addressing human needs, but not at the expense of the environmental concerns. The importance of human needs and how they perceive the surrounding environment is important to the way that humans interact, understand, and care for environmental wellbeing.

This book is a design tool that helps people understand the relationship between human preference and landscape patterns. The Understanding and Exploration framework can guide the assessment of design and management of outdoor environments in ways that benefit people.

APPX:E CASE STUDIES

The purpose of the following case studies is to identify if and how their designs utilize stormwater management systems and/or vegetation to direct circulation, views, and create spatial enclosure. These design criteria play a major role in how a site is perceived and preferred by people and ultimately help to determine the coherence, legibility, complexity, and mystery of the organization of space. Precedent studies and examples include: a study conducted purely on the circulation of a site, and how circulation is directed and terminated with both vegetation and SMS; a study on a site that is focused around a linear wetland that incorporates water cleansing practices with pedestrian trails, meeting goals of both stormwater as an amenity and stormwater systems as spatially defining elements; and examples of the Kaplan's "Preference Matrix" et al. (1989) and Echols and Pennypacker's Stormwater Amenity Goals et al. (2008).

Boeing Longacres Industrial Park

location & size:

Renton, Washington
212 acres

date completed:

1994

designers:

Skidmore Owings & Merrill,
San Francisco

client:

The Boeing Company

design goals:

- minimize impact of development and restore function of the ecological systems
- reconnect existing water bodies on site and restore natural flow patterns

implemented programs:

- wetland
- six acre lake
- four acre marsh

design functions:

- retain stormwater
- filter runoff
- provide habitat for flora and fauna

The site utilizes a combination of extensively restored riparian vegetation and a geometrically ordered forest to create a variety of experiences. The gridded tree rows help to create contrast from the organic shapes of the wetlands and make reference to the agricultural past of the site. Permeable pathways were utilized to encourage passive activity throughout the site, will adding to the function of the site as a stormwater management system.

The pathways are carefully aligned to direct circulation towards the stormwater management systems. (Shown in figure E.1) The the tree lines also provide framed views of the ecologically sensitive systems, leading visitors to designated viewing areas where the systems can be observed from a safe and discrete distance.

relevance:

The Boeing Longacres Industrial Park master plan combines revitalized natural areas with formally laid out forests of native evergreen and deciduous trees to create a variety of areas with varying degrees of spatial enclosure. The circulation system utilizes curving pathways and directional framing, with the help of trees, to direct the pedestrian towards focal points and additional pathways that are not specifically known how to get to. This is illustrated in the diagram to the right. The arrows represent viewing directions that show additional circulation opportunities, but are physically cut off by either water bodies or vegetation. This technique increases the curiosity of the user, increasing the overall mystery of the site, encouraging further exploration. These techniques help encourage navigation through the site, allowing he pedestrian to gain further knowledge of the implemented stormwater systems.

Fig. E.1 Aerial showing circulation
All images --- Edited by: Jared Buffington Source: http://www.pwpla.com/projects/boeing-longacres-park

legend

- directed view
- pathway
- destination point

Fig. E.2
Trees frame view

Fig. E.3
Pathway directs view, vegetation blocks circulation route.

Fig. E.4
Trees frame view

The overall design of the Boeing Longacres Industrial park attempts to bridge the gap between humans and their interaction with nature, without increasing disturbance through their integrated stormwater management systems (SMS) and integrated pathways. However, lack of signage for both way finding and information on the SMS limits the understanding on how to maneuver throughout the site and of the importance and function of the observed systems. These two way-finding aspects of the design are needed in combination with the utilized circulation methods in order to create a well balanced site design that attempts to increase the coherence, legibility, complexity, and mystery of the site. (Kaplan & Kaplan, 1989, Kaplan, Kaplan, & Ryan, 1998)

Shanghai Houtan Park

location & size:

Shanghai, China
34.2 acres

date completed:

2010

designers:

Skidmore Owings & Merrill,
San Francisco

client:

Shanghai World Expo Land Development Co., Ltd.

design goals:

- create a green Expo, accommodate for a large influx of visitors during the exposition from May to October
- create a green Expo, accommodate for a large influx of visitors during the exposition from May to October
- demonstrate green technologies, transform a unique space to make the Expo an unforgettable event
- transition into a permanent public waterfront park after the Expo

implemented programs:

- constructed wetland
- urban agriculture
- flood protection barrier
- pedestrian path network with social gathering areas

design functions:

- treat contaminated water from Huangpu river - 500,000 gal per day
- showcase seasonal changes through urban farming and wetland plants
- provides flood protection buffer between 20- and 1000-year flood control levees
- path network with multiple entrances to account for massive pedestrian flows expected during the Expo.

design challenges:

The first challenge was to restore the degraded environment. The site is a brownfield littered with industrial and construction debris both on the surface and buried throughout the site. The site design was to transform a degraded industrial landscape into a safe and enjoyable public space. The second challenge was to improve flood control along the Huangpu River. These design challenges were approached with a solution that created a living system offering the ecological services of food production, flood control, water treatment, and habitat creation. These services were combined in such a way as to educate pedestrians of the ecological benefits of the site through aesthetic form and function.

The primary water management component is a one mile long, 15’-100’ wide linear wetland designed to create a reinvigorated waterfront as a living machine to treat contaminated water from the Huangpu River. Cascades and terraces are used to oxygenate the nutrient rich water, remove and retain nutrients and reduce suspended sediments while creating visually captivating water features. The wetland also acts as a flood protection buffer between the 20- and 1000-year flood control levees. The curvilinear wetland edge creates a series of thresholds enhancing visual interest and refuge from the adjacent urban context. The park provides opportunities for recreation, education, and research. Two of these three park amenities, education and recreation, are heavily grounded in the SMS Amenity Goals (Echols & Pennypacker, 2008) and the Information Indicators (Kaplan & Kaplan, 1989) that form the theoretical basis for applying preference indicators of the natural landscape to vegetated SMS. Houtan Park provides an example of a design that first addresses the needs of the surrounding hydrologic cycle, but also provides the surrounding public with a place that provides and encourages interaction with ecological systems.

The following images, E.6, E.7, E.8, and E.9, diagram the theories of Echols and Pennypacker and the Kaplans as they occur within Houtan Park. These examples will help inform later design dilemmas as to how to address ecological problems with human preferred elements, while not hampering the overall productivity of the SMS.

Houtan Park Water Quality Progression Plan

The diagram below illustrates how water is pumped from the Huangpu River at the southwest corner of the site, and gradually flows through water cleansing processes as it moves through the site. The color represents the water quality, brown being most polluted and blue being fully treated water.

The images on this page display Houtan Park's ability to meet the SMS Amenity Goals of Echols and Pennypacker et al. (2008) and to meet the information indicator criteria set by Kaplan & Kaplan et al. (1989)

legend

Degree of enclosure
Screening element

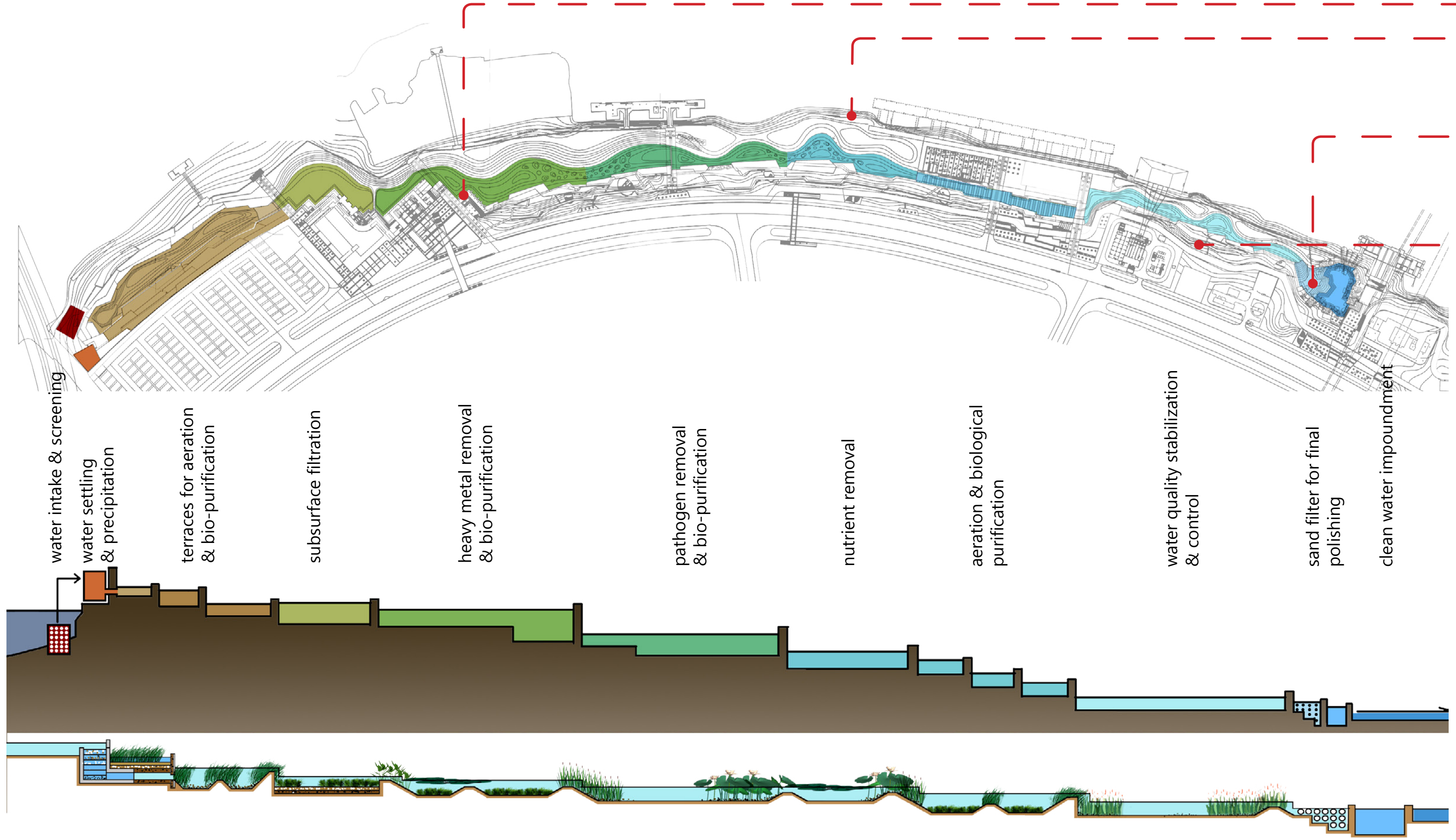
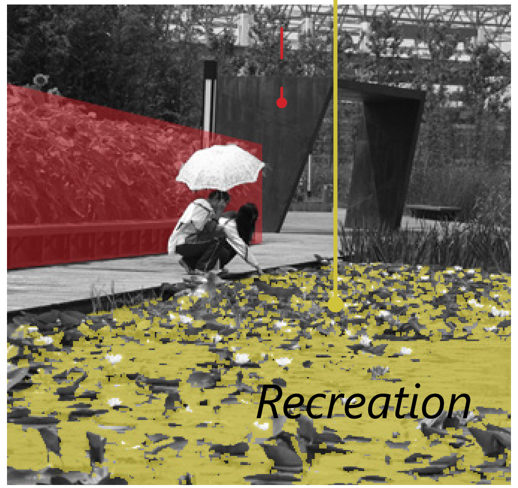


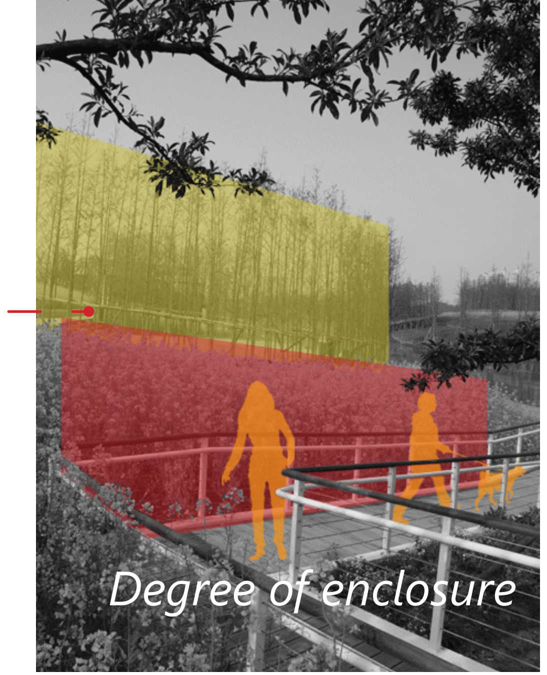
Figure E.5 Plan and Section of Houtan Park Wetland system. Edited by Jared Buffington

Source: http://www.turenscape.com/english/projects/project.php?id=443

legend

Degree of enclosure
Amenity Goal
Information indicator





Figures Left: E.6, Middle: E.7, Top Right: E.8, Bottom Right: E.9

Edited by Jared Buffington

Source: http://www.turenscape.com/english/projects/project.php?id=443

APPX:F SMS DESIGN INVENTORY

inventory

The process of collecting site inventory was directed by three topics: existing programmatic elements, the Kaplan & Kaplan et al. (1989) Preference Matrix components, and stormwater management systems (SMS). These topical areas encompass the information needed to address the site suitability for the implementation of vegetated SMS that serve both ecological needs as well as aesthetic and amenity performance in relation to the informational needs of humans.

Included Inventory:

Inventory needed to identify existing programmatic elements includes: who utilizes the site, vehicular and pedestrian circulation and frequency of use, land use, recreational field annual usage and frequency, and required parking for existing programs. These items of inventory form a basic knowledge of the function, and the frequency and intensity of each function. Each piece of programmatic inventory will aid in the further identification and synthesis of both stormwater management system and Preference Matrix inventory.

Stormwater management system inventory includes: topographic change or slope, water conveyance onto, within, and off of the site, soil type and related characteristics (erosion potential and infiltration rate), land cover, land use, flood plane extent for multiple sized storm events, existing utilized SMS and their role in conveying runoff throughout the site.

The inventory needed to analyze and synthesize the informational indicators of the Preference Matrix--coherence, legibility, complexity, and mystery, includes: pedestrian circulation, signage and wayfinding, key focal points or destination points and the lines of site from one point to the next, degrees of spatial enclosure, scenic or framed views, and gateways and partitions.

Frank Anneberg Park

Wildcat Creek Watershed

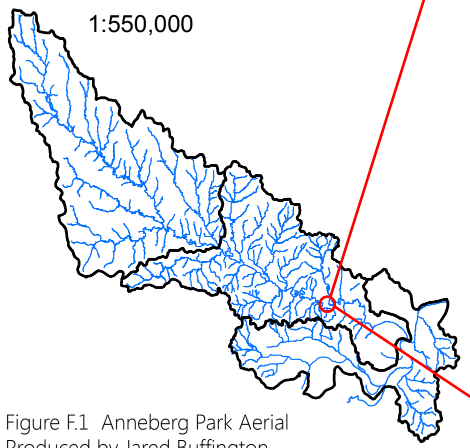


Figure F.1 Anneberg Park Aerial
Produced by Jared Buffington
Source: Riley County GIS data

site program inventory

location & size:
Manhattan, KS
110 Acres

date established:
1988

designers:
Schwab Eaton

client:
Manhattan Parks and Recreation Dept.

funded by: Manhattan's 1986 Quality of Life Bond Issue

implemented programs:
- Six softball fields
- Eight regulation soccer fields
- Three covered shelters
- Tennis and Racquetball courts
- Jerry Dishman Fishing Lake:
  5 acres, 10ft maximum depth
  -Fish: Bluegill, Channel Catfish, Crappie, Green Sunfish, Flathead Catfish, Large Mouth Bass
- Trail: 1.6 miles

Frank Anneberg Park is a multiuse community park and sports facility containing Twin Oaks Softball Complex and Manhattan Soccer Complex. Each athletic field, six softball diamonds and eight soccer fields, is of competition caliber and heavily utilized. The park also has a small fishing lake that was developed as both an amenity and to handle stormwater runoff from the site. Soil excavated during construction of the lake was used to raise the recreational fields and building foundations over the floodplain elevation, which covers nearly half of the site. (Figure X.X)

locomotion

The diagram to the right illustrates the identified pedestrian and vehicular circulation within Frank Anneberg Park.

legend

- Anneberg Park boundary
- Wildcat Creek
- Paved vehicular
- Gravel vehicular
- Trail
- Unimproved
- Softball fields (4)
- Soccer fields (8)
- Jerry Dishman Lake
- Softball fields (2)
- Playground
- Pavilion

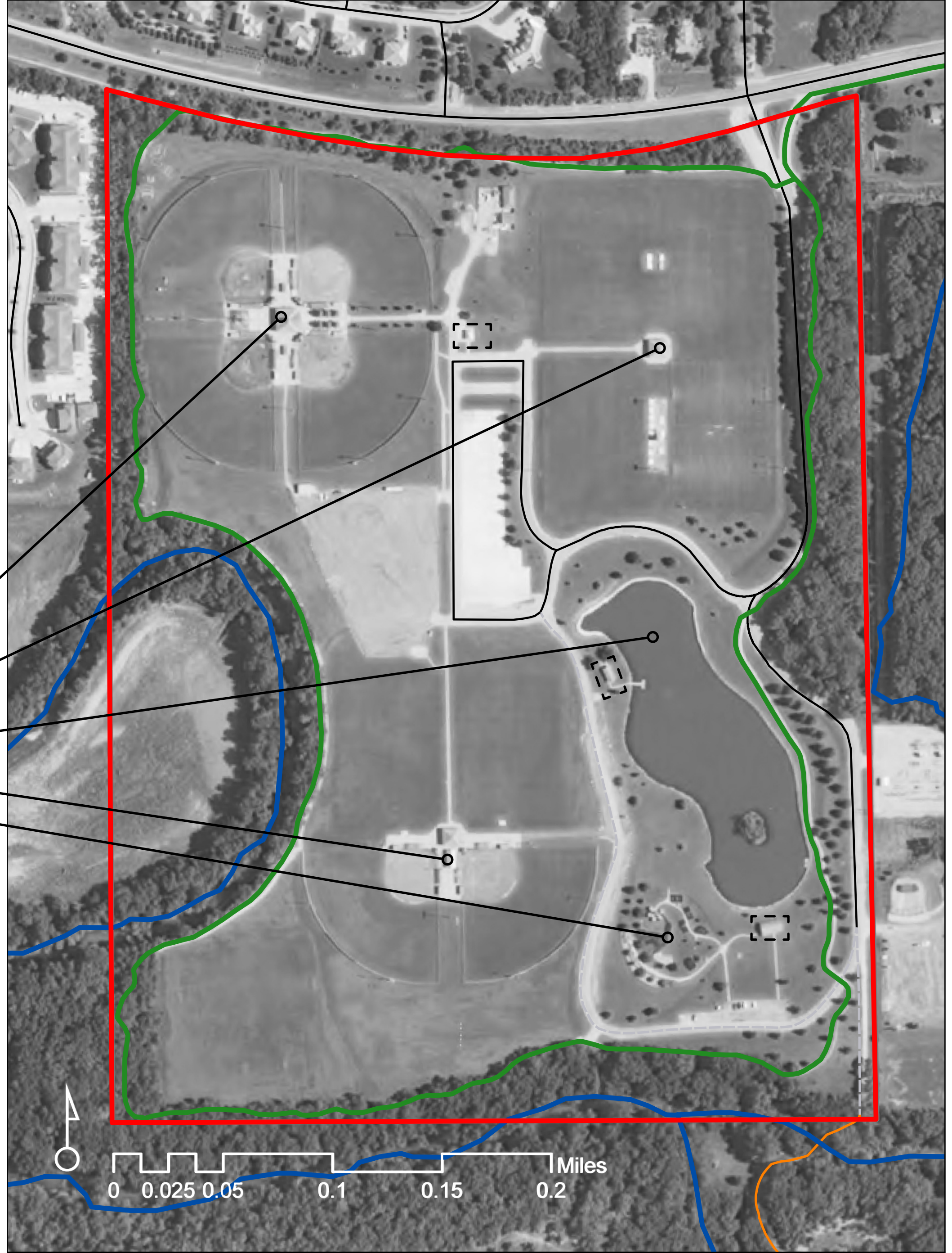


Figure F.2 Anneberg Park Circulation
Produced by Jared Buffington
Source: Riley County GIS data

points of interest and degrees of enclosure

The diagram to the left shows points of interest and degrees of enclosure within Anneberg Park. The points of interest are divided between primary (pavilions, playgrounds, and recreation facilities) and secondary (circulation crossings). Degrees of enclosure are important in identifying what type of space, public vs. private, exists and where there is potential for further spatial development for additional points of interest. Along the west side of the park there is potential for private space development where there are high degrees of enclosure.

legend

- High Degree of Enclosure
- Medium Degree of Enclosure
- Low Degree of Enclosure
- Primary Point of Interest
- Secondary Point of Interest

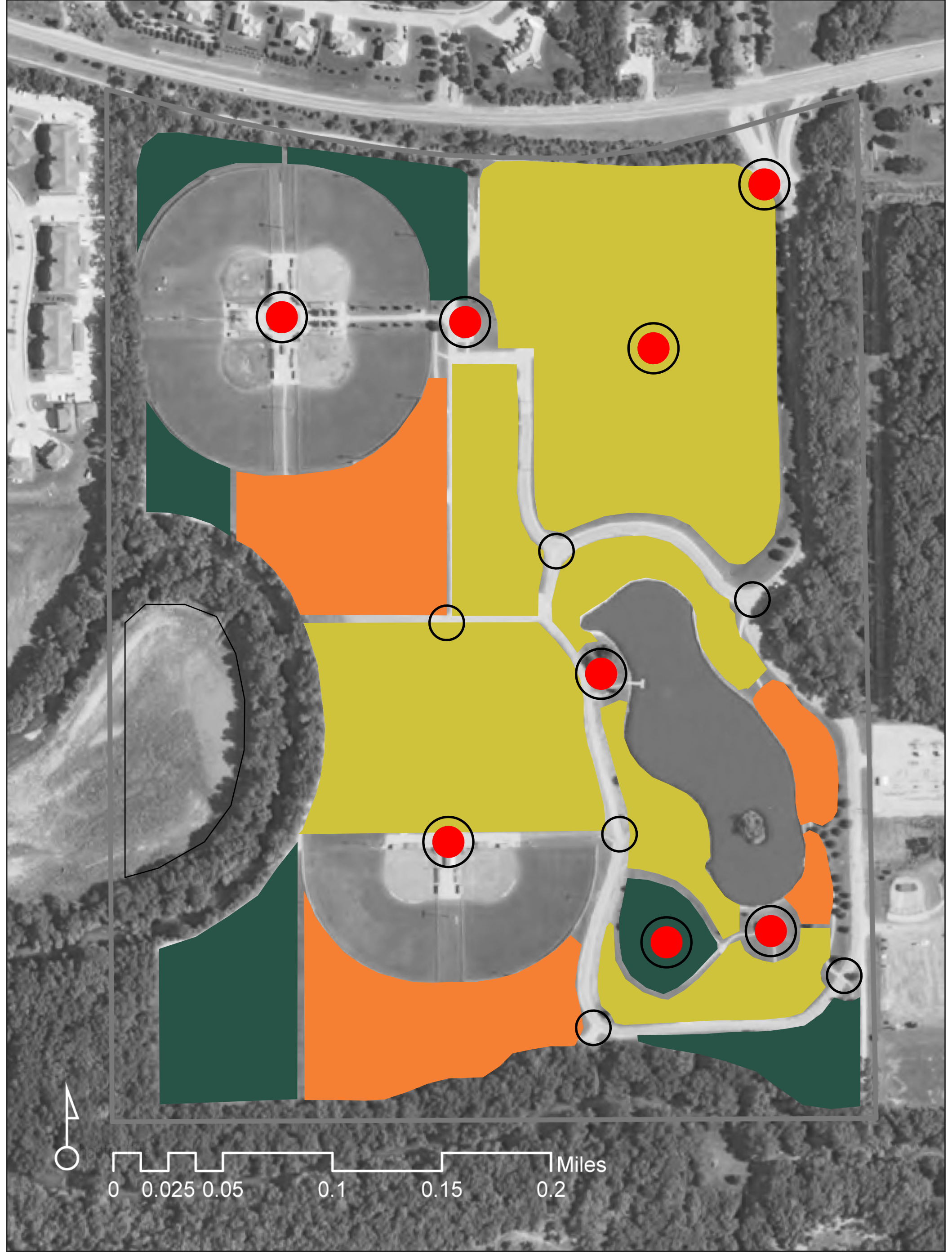


Figure F.3 Anneberg Park Enclosure
Produced by Jared Buffington
Source: Riley County GIS data

contours and hillshade

The hillshade and contour diagram to the Right was utilized to help delineate the sub-watersheds located within Anneberg Park. The site as you can see from the consistent slope is made up of mostly disturbed soil, caused by the grading of the recreational fields.

legend

Anneberg Park boundary

1ft contours

Figure F.4 Contours and Hillshade
Produced by Jared Buffington
Source: Riley County GIS data

slope

The slope diagram to the left is utilized to inform the most suitable locations for different types of stormwater management systems. Each system has different criteria for implementation in order to maximize their ecological benefit. The majority of the site has a 0-4% slope due to the extensive grading for the recreational fields. The existing areas most suitable for implemented SMS are mostly found along constructed drainage systems. See Figure X.X for existing SMS locations.

legend

Anneberg Park boundary
0-2%
2-4%
4-8%
8-25%
25%<

Figure F.5 Slope Classification based on Stormwater Management System Suitability
Produced by Jared Buffington
Source: Riley County GIS data

runoff flow accumulation

The diagram to the immediate right illustrates the flow accumulation of runoff within Anneberg Park. The dark blue lines show areas where greater accumulation occurs. Where these lines of accumulation end is typically where pipe inlets are located. Site visits were utilized to verify the locations of these inlets. The three diagrams on the opposite page illustrate the floodway, 1%, and .2% chance of flooding of Wildcat Creek Watershed as it occurs within Anneberg Park. The flooding diagrams will be used to assess possible areas for wetland implementation.

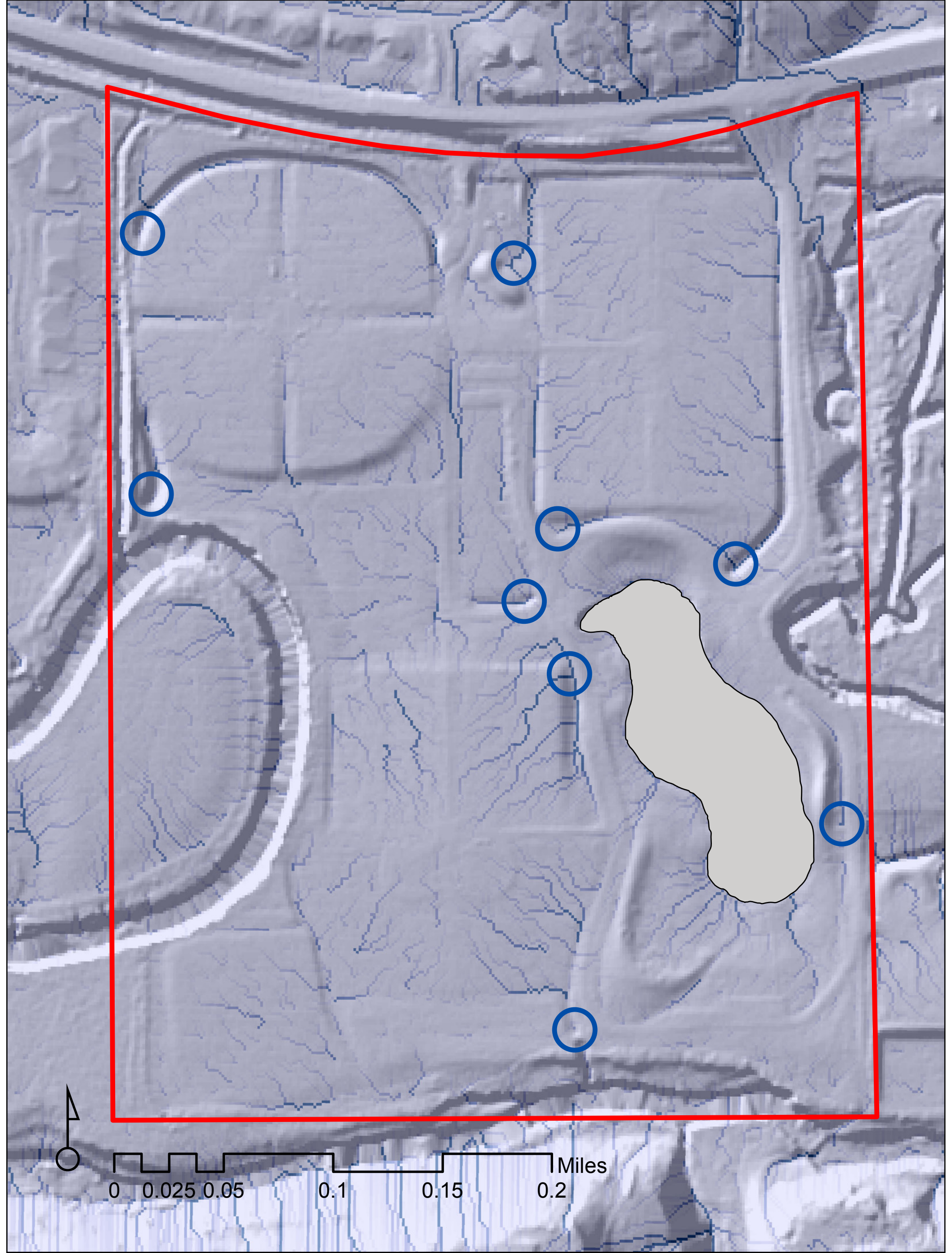
legend

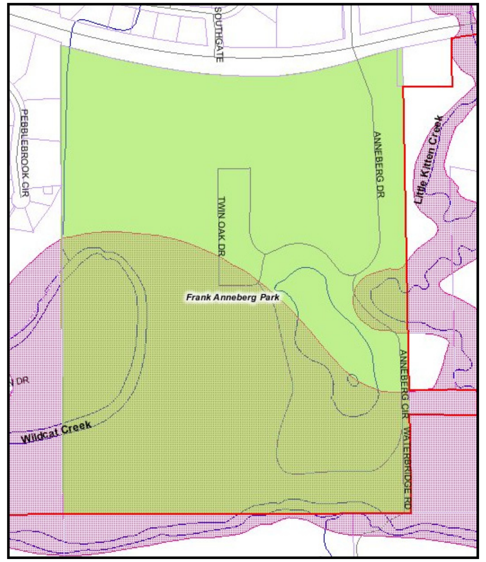
Anneberg Park boundary

runoff accumulation
 - flows from light to dark

Pipe Inlets

Figure F.6 Runoff Accumulation and Drainage points. Produced by Jared Buffington
Source: Riley County GIS data





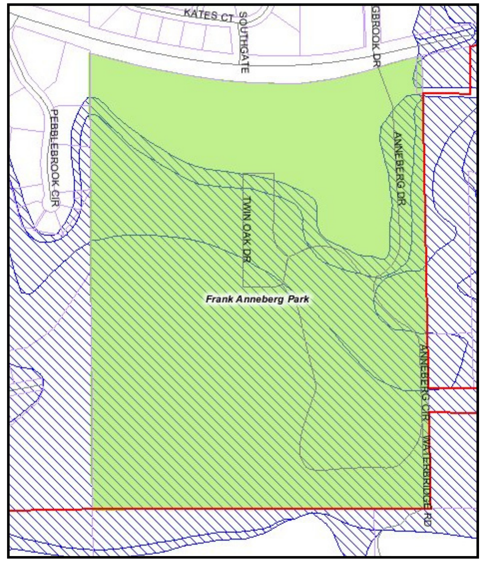
NTS

Floodway

Represents floodway boundary as defined by FEMA. The data was captured digitally from the certified FEMA FIRM (Flood Insurance Rate Map) Panels.

Figure F.7 - Floodway Extent in Anneberg Park

Source: http://gis.rileycountyks.gov/website/rileyco/layerContent.htm



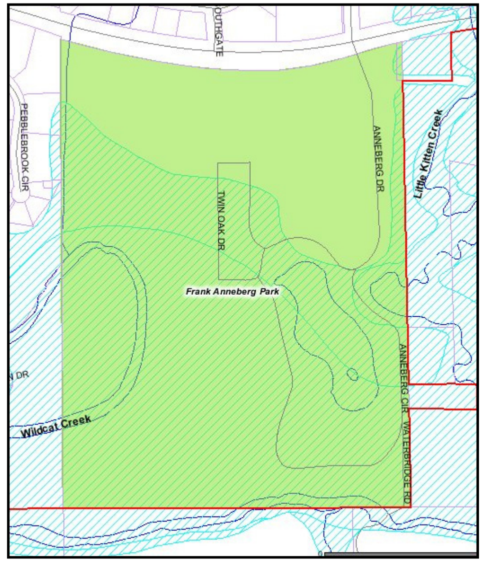
NTS

1% Annual Chance of Flood

Represents the 1% Annual Chance of Flood as defined by FEMA. The data was captured digitally from the certified FEMA FIRM (Flood Insurance Rate Map) Panels.

Figure F.8 - 1% Annual Chance of Flooding

Source: http://gis.rileycountyks.gov/website/rileyco/layerContent.htm



NTS

.2% Annual Chance of Flood

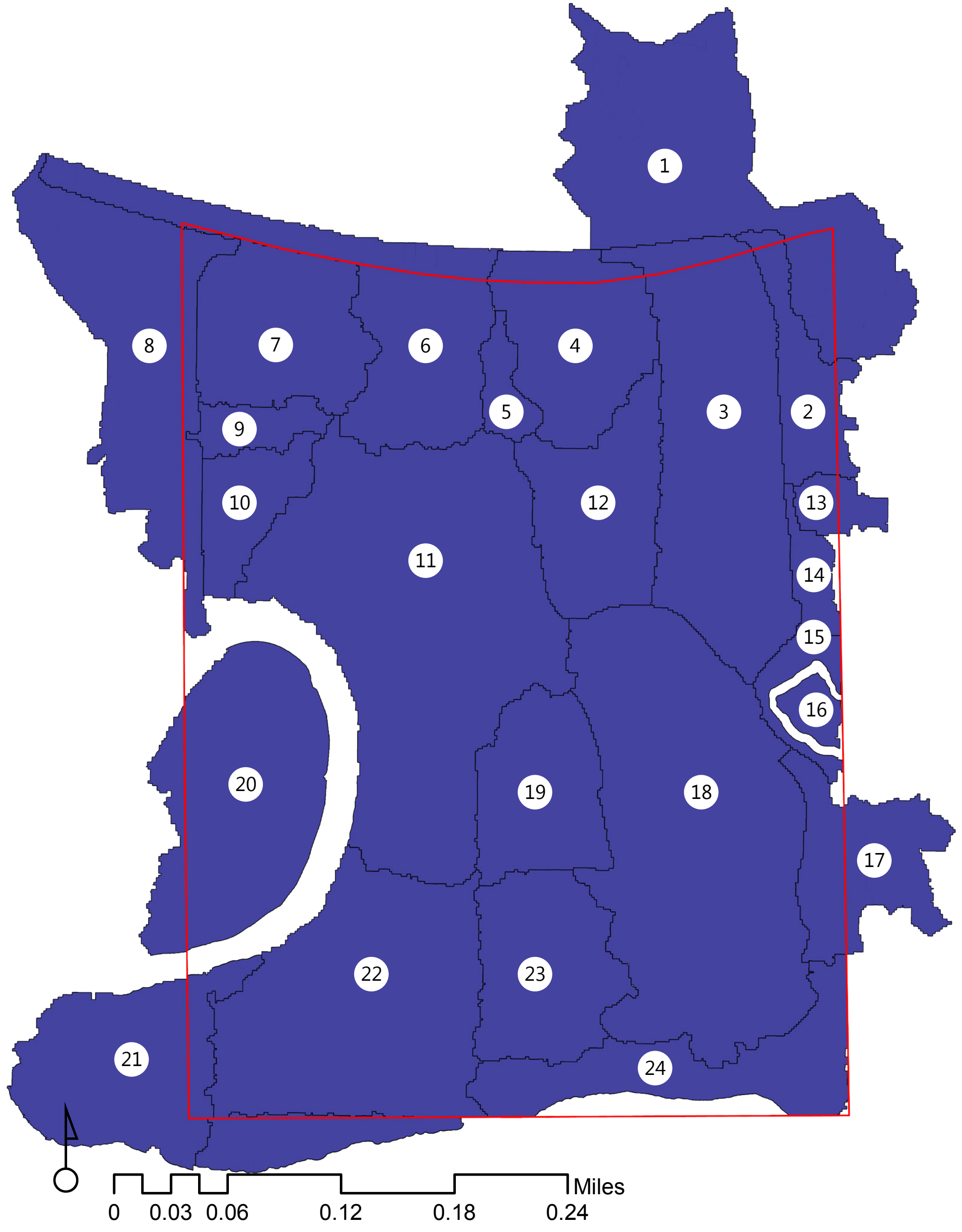
Represents the .2% Annual Chance of Flood as defined by FEMA. The data was captured digitally from the certified FEMA FIRM (Flood Insurance Rate Map) Panels.

Figure F.9 - 2% Annual Chance of Flooding

Source: http://gis.rileycountyks.gov/website/rileyco/layerContent.htm

watershed delineation

The diagram to the right illustrates the sub watersheds that flow onto, within, and off of Anneberg Park. These watersheds were delineated by overlaying contours, basins, and flow accumulation in addition to sight visits in order to identify what areas were contributing runoff to each drainage point on site. These sub-watersheds will provide runoff characteristics, coefficients, and amounts of runoff based on multiple storm sizes in order to aid in the design of vegetated SMS.



legend

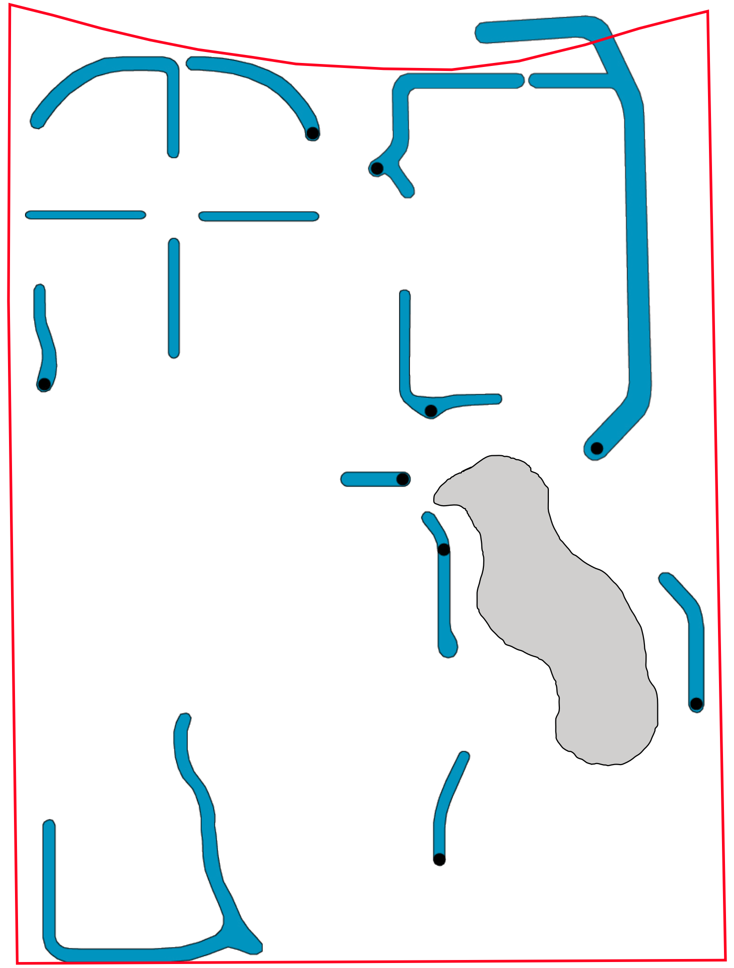
Anneberg Park sub-watersheds

Anneberg Park boundary

Figure F.10 Watershed Delineation
Produced by Jared Buffington
Source: Riley County GIS data

existing SMS conveyance systems

The diagram to the left identifies the stormwater conveyance systems designed to catch runoff from the surrounding recreation fields. The runoff is carried by grass swales and concrete ditches to inlets, where it is then directed to the detention pond located in the southeast portion of the site, or emptied into Wildcat Creek. The location of these systems in relation to points of interest will help to identify what set of design characteristics need to be accomplished through vegetated SMS in order to increase the sites aesthetic and amenity performance.



legend

Conveyance swales

Jerry Dishman Lake

Inlet

Anneberg Park boundary

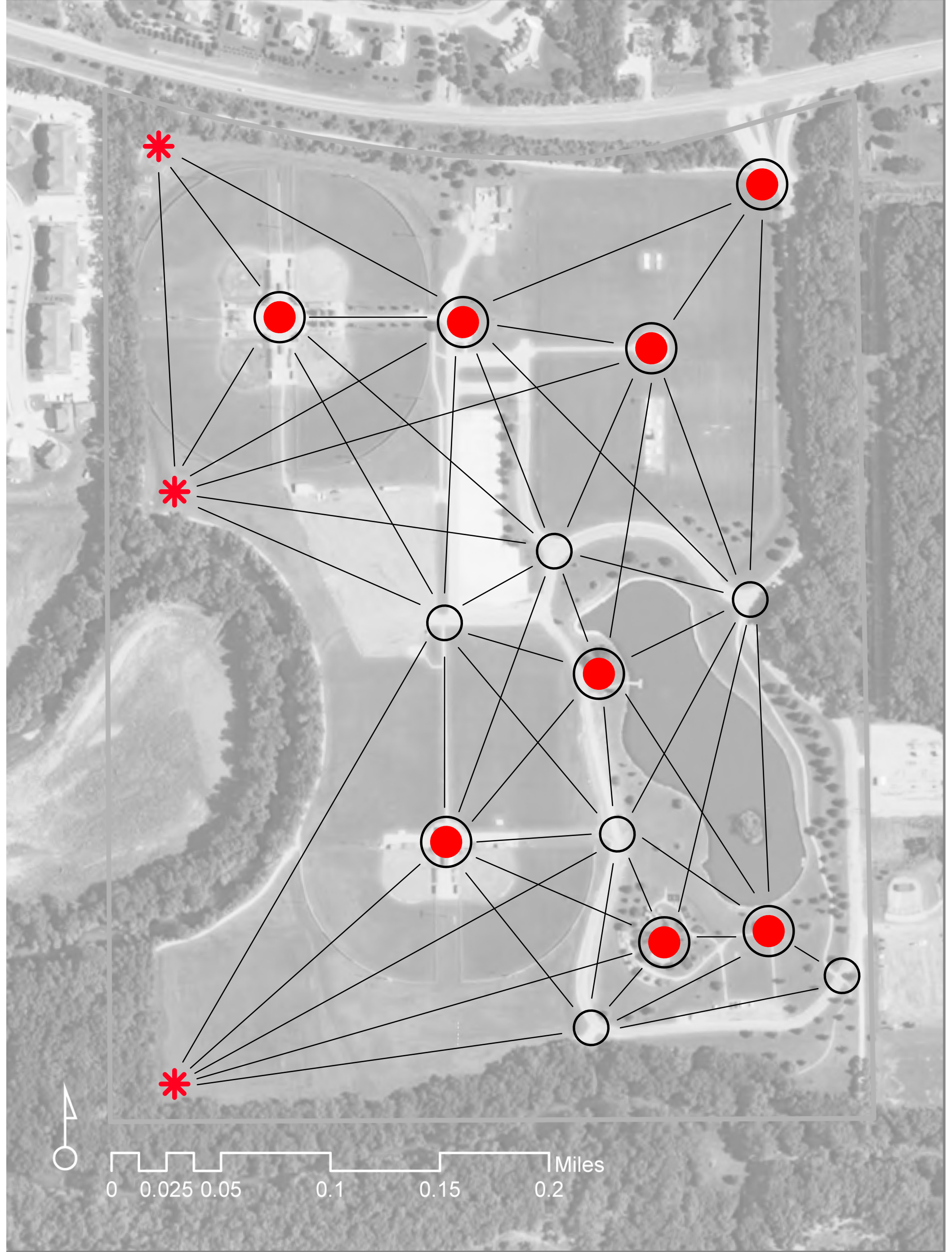
Figure F.11 Stormwater Conveyance Identification
Produced by Jared Buffington

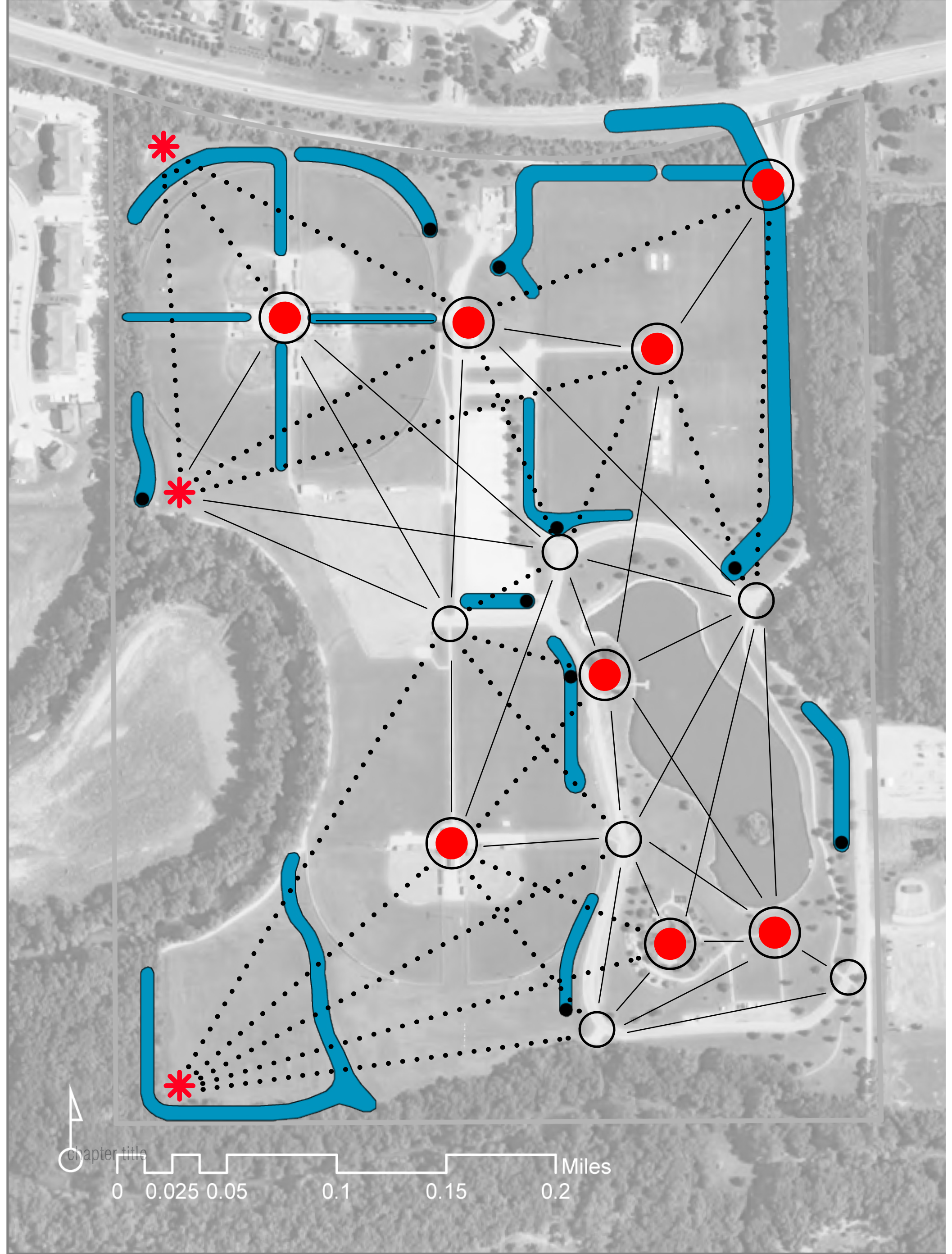
view assessment

The diagram to the immediate right shows each point of interest: primary, secondary, and three possible points of interest along the west side of the park. Each point is connected by a 'view direction' vector that shows the potential of seeing other points of interest based on the current openness of the site. This openness is frequently said to be uncomfortable and too open, and does not attempt to address the concept of mystery or provide partitioning of the site; major contributors to the preference of the natural environment (Kaplan & Kaplan, 1989)

legend

- conveyance swales
- inlet
- anneberg park boundary
- primary point of interest
- secondary point of interest
- possible points of interest
- view direction
- potential to alter view





The diagram to the immediate left shows the existing runoff conveyance systems within Anneberg Park, in addition to points of interest and their directional views to each adjacent point. However, this diagram illustrates the potential for altered views based on the 3-demensional possibilities of *vegetated* SMS if implemented within the existing conveyance systems. The dotted lines represent views that have the potential to be altered. Altering views from one point to the next helps break up long, expansive ground planes into more easily comprehendible spaces. (Kaplan, Kaplan, & Ryan, 1998)

Breaking larger expanses into smaller, more defined spaces increases the complexity of a site, increasing the variety and richness of the site and encouraging exploration. In order to account for possible added complexity, techniques addressing legibility and coherence must be taken. Signage, repetition of material, and pathway hierarchy are examples of how legibility can be increased. By combining basic elements of legibility and coherence with complex spaces, mystery of what is to come can be present by giving information of more to discover. (Kaplan, Kaplan, & Ryan, 1998)

Figure F.12 - Left: Anneberg Park Existing Views
Figure F.13 - Right: Proposed Views with SMS addition
Produced by Jared Buffington
Source: Riley County GIS data

point of interest assessment

The diagram to the immediate right overlays the existing conveyance systems and stormwater inlets with the points of interest in order to identify adjacencies between the two. These adjacencies are used to identify what types of SMS amenities and degrees of enclosure could be applied in order to address coherence, legibility, complexity, and mystery, from one point to another.

legend

Conveyance swales
Inlet
Anneberg Park boundary

Primary Point of Interest

Secondary Point of Interest

Possible Points of interest
View Direction
Potential to Alter View

Points adjacent to inlets

Points adjacent to conveyance

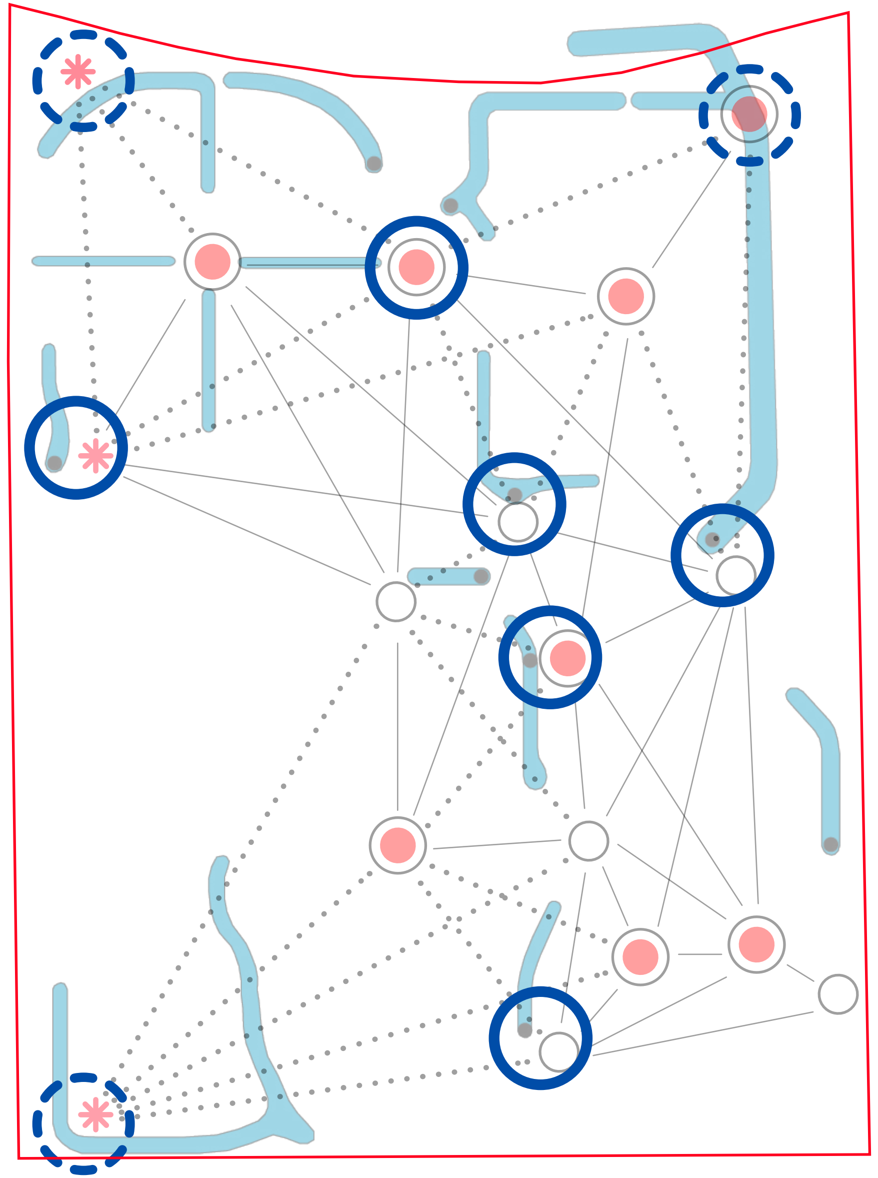


Figure F.14 - Point of interest and SMS correlation
Produced by Jared Buffington