Reconnecting a fragmented landscape: A multi-scale ecological approach to green space design in Wichita, Kansas

By

Caleb Parker

A REPORT

Submitted in partial fulfillment of the requirements for the degree

MASTER OF LANDSCAPE ARCHITECTURE

Department of Landscape Architecture and Regional & Community Planning
College of Architecture, Planning and Design

KANSAS STATE UNIVERSIY
Manhattan, Kansas

2020

Approved by:

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Dr. Hyung Jin Kim

ABSTRACT

As the impact of urbanization is felt more and more in cities around the world the preservation of nature has become less of a priority. This has led to a lack of nature in many urban cities which is causing many social and environmental problems. One of the main issues is the high degree of fragmentation that is occurring in cities, which disrupts natural processes and creates unequal access to nature for the city's residents. The City of Wichita, Kansas is currently experiencing some of these problems due to its sprawling development patterns.

The study objectives were: (a) to contribute to the development of a multi-scale ecological design approach that links spatial landscape analysis and ecological site-design modeling; and, (b) to reconnect fragmented landscapes by reclaiming and redistributing urban green spaces as social and ecological assets in Wichita, Kansas. This objective was accomplished through a two-phase process. The first phase focused on a city-level analysis. In this phase GIS and FRAGSTATS were used in combination to identify different patterns within the fragmented landscape. Solutions and suggestions were then made for each of the types of fragmentation that were found to be occurring. Following this analysis, one of the most fragmented sites was chosen. In the second phase, the selected site was then analyzed to determine which type or types of fragmentation were occurring. Using the typological solutions generated in phase one, a site design was developed to demonstrate how the higher-level ideas in phase one can be applied at the site level.

This project serves as an example of how landscape architects can use a more data-driven method to design green space in an urban context, such as landscape pattern analysis techniques which allows them to collaborate with other professionals more effectively.

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Abstract

As the impact of urbanization is felt more and more in cities around the world the preservation of nature has become less of a priority. This has led to a lack of nature in many urban cities which is causing many social and environmental problems. One of the main issues is the high degree of fragmentation that is occurring in cities, which disrupts natural processes and creates unequal access to nature for the city's residents. The City of Wichita, Kansas is currently experiencing some of these problems due to its sprawling development patterns.

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INTRODUCTION

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1.1 Dilemma

Cities across the world have been rapidly urbanized, due to this process, they have become increasingly disconnected from nature (Canedoli et al. 2018, McDonnell et al. 1997, Alberti 2005, Daniels et al. 2018). A product of this rapid urbanization is an increase in development. In many cases, the increase in development leads to the breaking up of large habitats or land areas into smaller isolated habitats, in a process known as landscape fragmentation (Figure 1.1) (Bogaert 2000, Canedoli et al 2018, Alphan and Nik 2016, Davidson 1998). The incorporation of nature has become increasingly important as cities adapt to rapid urbanization.

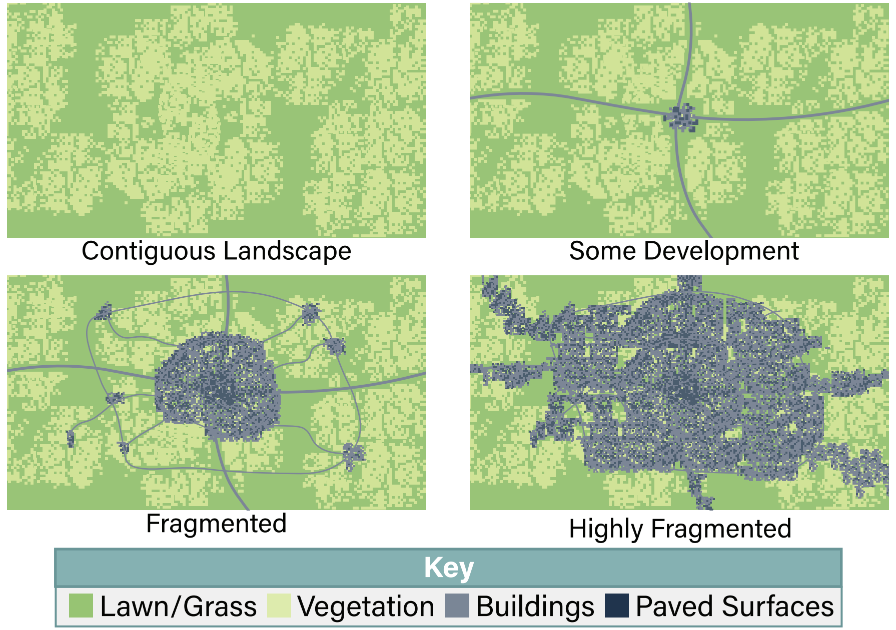


Figure 1.1: Urbanization and Fragmentation

Fragmented green space can be the cause of many social and environmental problems. Cities with fragmented green space often have an uneven disbursement of parks and nature experiences, which makes it harder for some residents to access nature on a regular basis (Stessen et al. 2017). In terms of ecology, fragmentation can lead to losses in biodiversity (Fan & Myint 2013, Zhang et al 2019, Fahrig 2003), decrease of ecosystem services (Canedoli et al 2018), the disruption of connectivity (Alberti 2005, Zhang et al 2019), and the reduction of habitat size and area (Fahrig 2003, Davidson 1998). In the City of Wichita, Kansas, urban sprawl has led to a wide expanse of low-density development, causing an inequitable distribution of green space. These development patterns make Wichita a good example of how urbanization can lead to landscape fragmentation. Like the City of Wichita, many municipalities, have begun

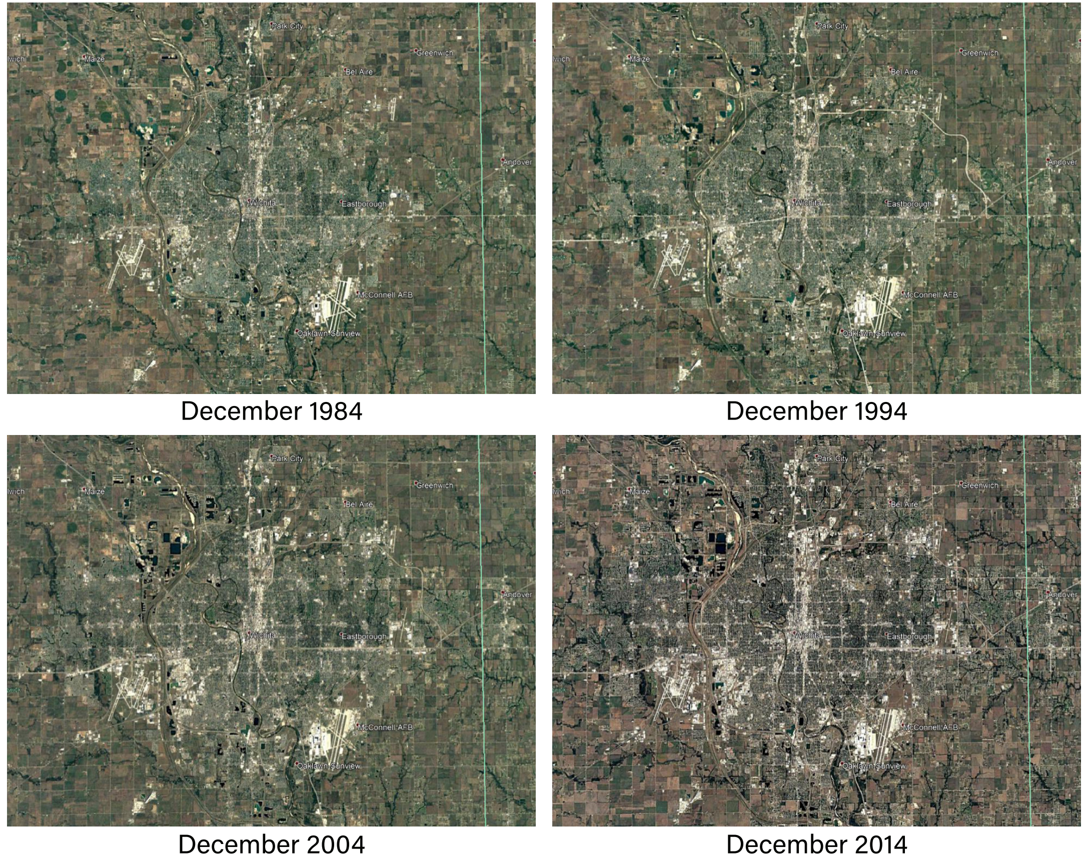


Figure 1.2: Urban Sprawl Evoluiton in Wichita, Kansas (Google Earth)

to realize that urban-scale landscape fragmentation, or at least a lack of nature is a problem (Wichita PROS 2016, Miami-Dade County Parks and Open Space Master Plan 2008, Oregon Metro Council 1992). Many of them are attempting to address this problem through large-scale design efforts but are struggling to address this problem effectively.

The complex nature of urban development, and the inherent complexities of natural systems, make combining the two a daunting task (Turner 1989). In order to successfully address this problem, it must be approached from a multi-scale perspective. Addressing the problem solely at the site scale can lead to a lack of cohesion within the context of the entire city. At the same time, observations at a more-localized scale offer a more accurate depiction of what is truly going on within the site (Reid et al. 2006). On the other hand, approaching the problem from a master planning perspective allows for the creation of a holistic vision, but fails to account for unique characteristics of each individual site.

Working across multiple scales allows a designer to arrive at a holistic solution that is still effective at the site-level. Working at multiple scales is also often associated with different research and design styles. Working at larger scales typically involves data-driven analysis which is often more generalized. Whereas working at a smaller scale is often more tailored to understanding the unique qualities of the site. In order to create a design that truly address all of the issues that a city faces, designers must find a way to implement the principals of a large-scale vision within their site-level designs (Reid et al. 2006).

Cross-scale interactions have also been found to be more significant than the aggregate difference between scales, because examining the relationship between both scales at the same time is a better representation of how actions at one scale will affect the other. The other benefit of working across multiple scales is that it can help facilitate discussions between many different types of people, and help them realize that multiple small-scale projects can contribute to the achievement of a larger cause (Reid et al. 2006).

There are many theories and methods for the design, planning and management of green space in urban areas; often these designs are based on inventory maps that are generated through simply looking at aerial photos of the site or visiting the site.

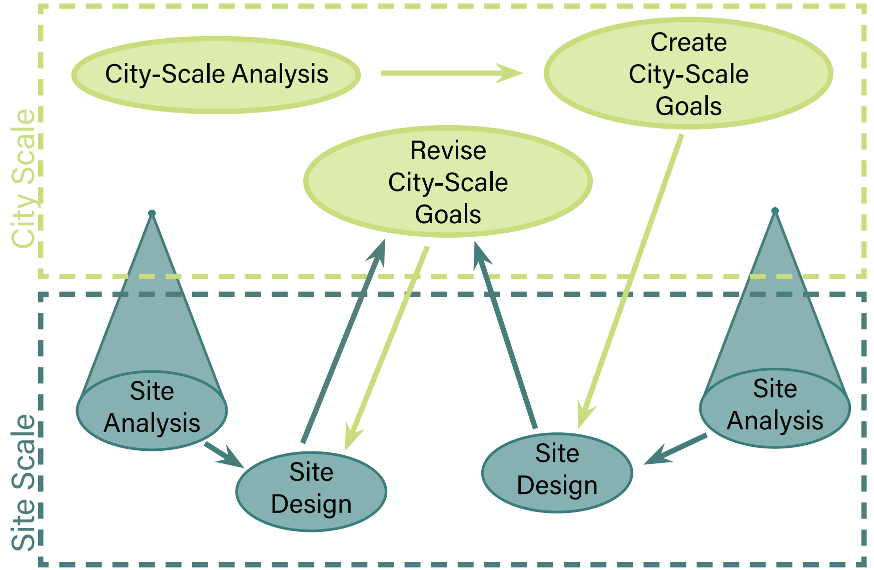


Figure 1.3: Mulit-Scale Ecological Design Approach

However, this approach is often unreliable because people perceive things differently.

As our society continues to innovate and create new technologies, it is important that designers find ways to apply them. Geo-spatial technologies can provide more accurate data on landscape spatial patterns that may be hard to find through general observation with the naked eye. The Geo-spatial tools that are used to analyze fragmentation can also produce a variety of different outcomes, depending on the metrics that are used to produce the data (Torres 2016, Canedoli et al 2018, McGarigal 1995, Davidson 1998, Bogaert 2000, Gustafson 1998, Fahrig 2003). Studies can be tailored to reveal different ecological functions of the landscape, which can help researchers analyze how fragmentation is affecting the environment (Fahrig 2003, Fan et al. 2013, Lam et al. 2018, Mitchell et al 2015). Studies that rely on data-driven techniques to analyze landscape fragmentation, can contribute to better design and planning of ecologically focused cities.

Analyzing fragmentation within the city at only one scale inherently has limitations. Often large-scale landscape analysis only accounts for the amount of green space. While the amount of green space is important, the quality of the spaces and the degree of fragmentation are equally important when determining ecological productivity (Zhang et al. 2017). On the other hand, fragmentation is a large-scale problem, and attempting to use only site-scale solutions to solve it will result in a lack of cohesiveness within the city's green spaces. Therefore, this study used a two-phased, multi-scale approach to create a new green space plan for the City of Wichita.

1.2 Research Questions

This study will focus on answering two interconnected questions:

- How can the use of a large-scale landscape analysis inform a site-level ecological design?
- How can a multi-scale ecological design approach be used to address and help reconnect fragmented landscapes in Wichita, Kansas?

In particular, this study will answer the following sub-questions for Wichita, Kansas:

- Where and to what degree is the green space fragmented at the city level?
- What patterns occur in the landscape disruption at the city level?
- How can design models that are informed by city-level data, be developed to reconnect landscapes through strategic site-level interventions?

1.3 Research Objectives

The overall goal of this study was to contribute to the development of a multi-scale ecological design approach, that links geo-spatial analysis and ecological site-design modeling. This will halp reconnect fragmented landscapes, by reclaiming and redistributing urban green spaces, and show cities how to utalize green space as a social and ecological asset. The specific objectives (1-1 through 2-2) were carried out in two phases:

Phase One (Urban-Scale):

Objective 1-1 Identify the degree of fragmentation to reveal patterns in landscape fragmentation.

Objective 1-2 Produce design solutions based on the landscape Fragmentation patterns identified.

Objective 1-3 Select a site that was experiencing a high degree of fragmentation for further exploration.

Phase Two (Site-Scale):

Objective 2-1 Analyze the site selected in phase one to gain an understanding of the type of fragmentation that is occurring.

Objective 2-2 Produce a projective design informed by the previous steps that addresses connectivity issues at the site level.

1.4 Study Significance

In this time of rapid urbanization, it is vital that we do not lose sight of the fact that nature in cities provides a variety of benefits for both humans and the environment, as we continue to design and redesign cities. Although there are many opportunities to integrate nature into cities, often times this is not the top priority, or cities struggle to figure out how to do so effectively. Thus, this project will serve as an example that helps leaders make more informed decisions as they attempt to design green space in their city.

This project also calls on the fact that landscape architects have the ability to think both theoretically and scientifically, but unfortunately do not always use them both. The data-driven approach pursued by this study provides a more in-depth and scientifically grounded perspective, for examining how ecological green space functions in the city context.

The use of a multi-scale approach also sets this project apart from others, by placing equal importance on spatial organization and site design. This allows the project to produce a holistic design that addresses connectivity issues at the city-scale, and then applies informed design solutions at the site-scale.

LITERATURE REVIEW

2

2.1 Literature Map

The literature map summarizes the main topics and resources that were used to create the literature review that is to follow. The main topics that help inform the effort to reconnect fragmented landscapes are: nature in cities, defining ecological green space, landscape ecology and quantifying landscape fragmentation (Figure 2.1).

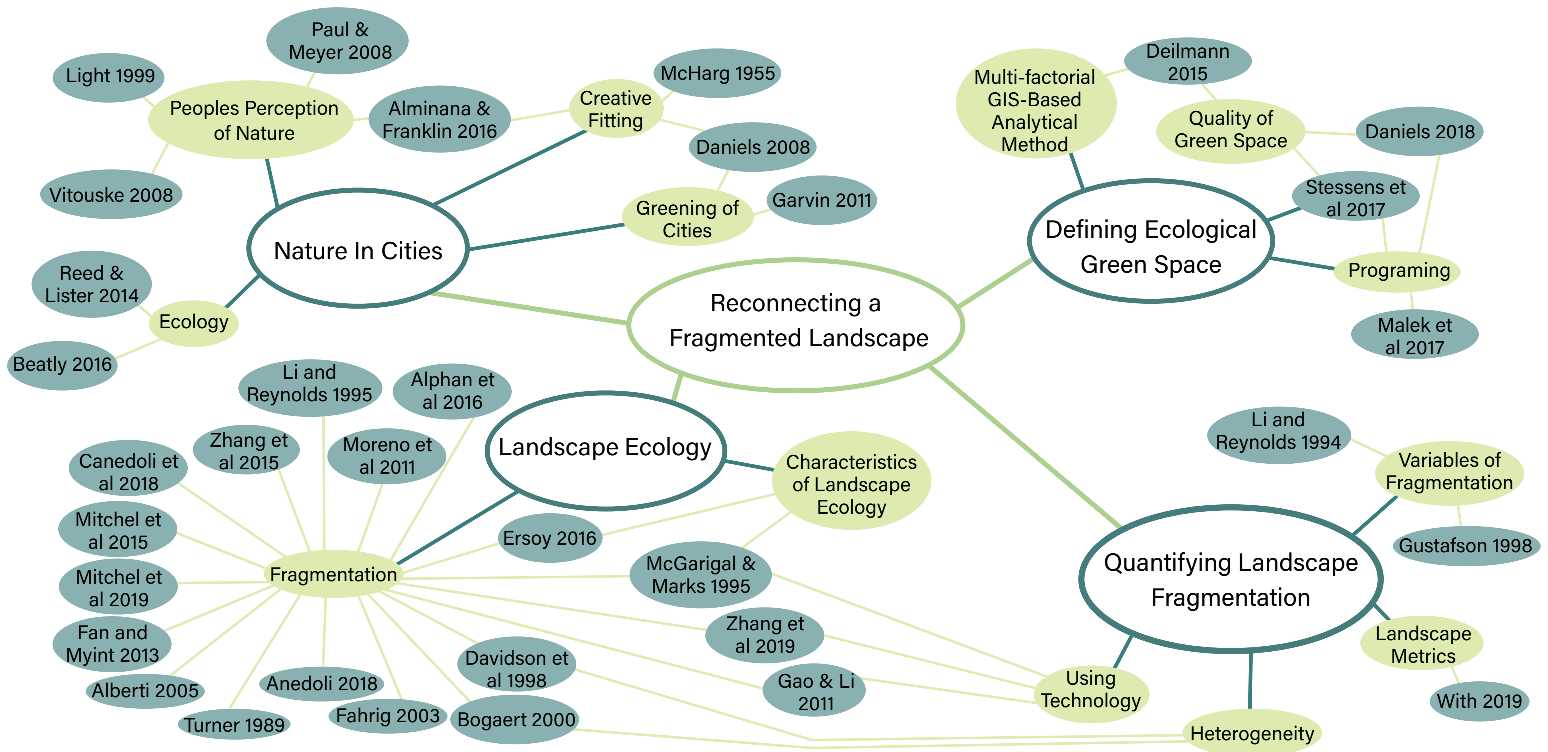


Figure 2.1: Literature Map

2.2 Introduction

In order to ensure that this paper is grounded, a literature review was done to create a foundation of relevant information. The first topic addressed in this literature review is nature in cities, including the way that people perceive nature, and some of the relevant theories that relate to nature in cities. The second topic is landscape ecology, which covers the characteristics of landscape ecology and fragmentation. The third topic includes methods for quantifying landscape fragmentation, which covers some of the common methods and technology used to understand fragmentation. The final section defines what ecological green spaces is based on program elements and quality of green space and investigates a few methods for measuring the ecological productivity of a space.

2.3 Nature in Cites

Peoples Perception of Nature

The way that people perceive nature is different depending on their background and life experiences, but as our society has evolved so has our general attitude towards nature. According to the classical view of wilderness, people thought that humans were on a higher plane of existence than any other being on earth, which made the ability to control nature a sign of human achievement. (Light 1999).

Light described the evolution of the way people used to perceive wilderness in three phases: 1) separation: get away from it because of all the bad things that happen to other people; 2) savagery: anything that lives in the wilderness is a nonhuman beast that should be vilified; and 3) superiority: in contrast to the wilderness the human civilization should be celebrated for its superiority over the wilderness. As cities became larger the general view of nature began to shift: cities became the wild dangerous places full of people, chaos, and evil, and nature became a place of beauty and wonderment that was a respite from the chaos of city life (Figure 2.1)(Light 1999).

People's perception of nature is still changing today, as

Figure 2.1: Lincoln Park in Chicago, is a great example of a naturalized space that functions as a respite for the residence of a large city (Ruppenthal 2019).

many people have begun to feel that nature should be a part of the city. As science and our civilization has advanced, it has become clear that our actions have a much bigger impact on the planet, and the other living things that we share it with, than we previously thought (Alminana & Franklin 2016). We realized that ecology is not just something that you can put into a city, but it is part of the city, which is part of an even bigger system (Paul & Meyer 2008). This means that we need to find ways to live in harmony with the rest of the ecosystem. Unfortunately, in many ways we are currently doing the opposite. Our current actions are degrading large portions of land, causing loss of biological diversity worldwide, and releasing large amounts of green house gasses into the environment (Vitouske 2008).

Ecology

Ecology is a very far-reaching topic that is being explored by many researchers, theorists, and sociologists in an attempt to understand the way certain events effect political, economic, and social dynamics (Reed and Lister 2014). This expanded definition of ecology makes landscape architects particularly useful, because of their wide range of skills that allow them to approach projects from a variety of scales and perspectives.

The "Biophilic City"

One increasingly accepted theory is the idea of the "biophilic city," which recognizes the global trend of urbanization and calls for the development of a new kind of city (Beatley 2016, 265). This concept exists within the urban environment and focuses on designing and planning cities in which nature is heavily incorporated within the urban fabric, in order to form a bond between people and the nature within the city and beyond its boundaries (Figure 2.2).

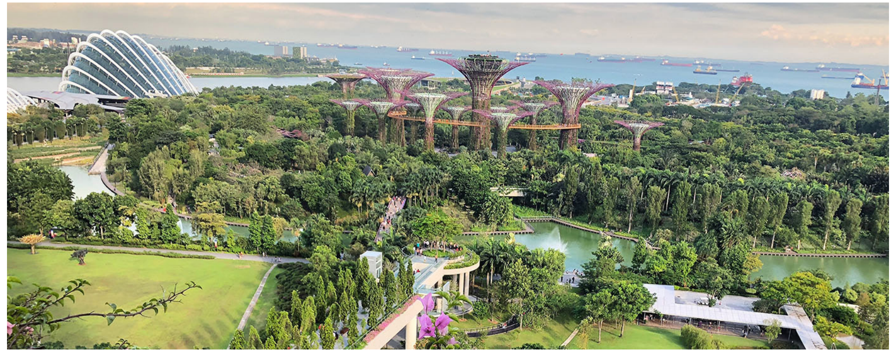


Figure 2.2: Singapore's Garden by The Bay employs may of the principals of biophilia, by providing visitors many different ways to experience nature (WorldGBC 2018).

The "biophilic city" concept is based heavily on outward thinking. The city officials should seek to understand how its policies and actions will impact not only themselves but the rest of the world. The biophilic cities pledge (Figure 2.3) was created to serve as a guideline for the way a biophilic city should function: 1) everyone should have an equal chance to experience nature on a daily basis, because deeper nature experiences should be within a short distance of every person; 2) people should spend time learning about the nature in their city; and, 3) nature should be made a priority by the government, and decisions should be made based on how much they revitalize or enhance connections to the natural environment. (Beatley 2016, 269).

Biophilic Cities Pledge

We hereby commit our city ________________, to become a Biophilic City, and to join together with other cities in the global network of Biophilic Cities.

We Understand that a Biophilic City is

- a city of abundant nature, where citizens, young and old, have rich daily (if not hourly) contact with the natural environment; where citizens have nature nearby, where larger natural areas and deeper nature experiences are an easy walk, bike or transit ride away; and where the urban environment allows for and fosters connections with a diverse flora, fauna and fungi;
- a city where citizens recognize, are curious about, and actively care for the nature around them; a city where citizens spend extensive time outside, learning about, enjoying, and participating in the natural world.
- a city where leaders and elected officials place nature at the heart of their decisionmaking, and where every major planning and development decision is judged by the extent to which nature is restored and connections with the natural environment enhanced;

Figure 2.3: The biophilic cities pledge, from the nature of cities, exemplifies what it means to be a biophilic city (Beatly 2016).

A concept that is embraced by the biophilic cities movement is the nature pyramid, which attempts to explain the types of nature experiences people should have, and the frequency at which they should occur. The nature pyramid is a guideline for a healthy "nature diet," similar to the way the food and nutrition pyramid serves as a guide to healthy eating (Beatley 2016). At the top of the pyramid are more immersive and intense experiences which are wonderful but, like the foods that we should eat only in small quantities, they are impractical and typically very costly (Beatley 2016). However, a combination of more practical experiences which occur at the neighborhood scale like green walls, street trees, urban forests and butterfly gardens, can still provide a wide range of benefits, at a more affordable and obtainable scale (Beatley, 2016). While many people cannot afford to travel long distances to experience nature on a regular basis, the presence of nearby nature can greatly impact the way people perceive and interact with nature.

Greening of Cities

Many cities are describing their sustainable efforts as greening. Unfortunately, the greening of cities is often an afterthought and acts as a secondary or tertiary aspect of development plans that concentrate more on the development of infrastructure (Garvin 2011). Recently city leaders have begun to realize that more nature in cities leads to a cleaner environment, which contributes to a better quality of life, and allows them to stay on par with the progression of the rest of the global economy (Daniels 2008). Creating more green space in cities not only increases the quality of life for residents, but decrease the city's ecological footprint and promote the idea of living in harmony with nature. The addition of these green spaces will contribute to the creation of a better world for future generations (Daniels 2008, 27).

"Creative fitting"

"Creative fitting" is another ecological approach that acknowledges the fact that all living things and the planet are interconnected and describes this relationship as a web (Alminana & Franklin 2016). This philosophy hinges on the fact that we are a part of the environment, we rely on it for survival and we are just a part of a bigger system that is affected by the actions of every member (Alminana & Franklin 2016). Since we are part of an interconnected system, our behavior has a direct result on the health of the environment. So, if we continue to degrade the environment, we are effectively harming ourselves.

McHarg (1955) introduced the concept of creative fitting, or the idea that negentropy, the movement from randomness to increased order and from simplicity to complexity and diversity, is actually a good thing. This is because nature is a dynamic system that should be allowed to be wild and organic, in order to sustain biodiversity (Alminana & Franklin 2016). Creative fitting suggests that designers should carefully examine the existing system and come up with creative ways to fit their project within that system, in order to improve the system.

Figure 2.4: The US. Coast Gard Headquarters in Washington D.C. is a great example of creative fitting. While this large building is interrupting this natural site it has one of the biggest green roofs in the world, which allows the site to maintain many of its original functions (Architect Magazine/Perkins and Will 2016).

Take Away

While there are may different ways that people have attempted to explain the relationship between nature and cities, there are two common themes among them all. First, our actions effect the environment, and we are currently not doing a good enough job of protecting our environment. Second, nature is a part of the city, and it is important that we find ways to incorporate nature into our cities. Designers have the ability to impact both of these areas and should keep them in mind as they continue to design cities.

2.4 Landscape Ecology

What Is Landscape Ecology?

Landscape ecology is a useful way of thinking about how land is organized and managed, because it allows designers to get a better feeling for how a landscape functions (McGarigal & Marks 1995). The three characteristics that landscape ecology focuses on are: 1) structure: the spatial relationship between land-cover types, or elements of the landscape, in terms of the amount of each land-cover type that occurs (composition) and the way it is arranged or distributed within the landscape (configuration); 2) function: the interaction between spatial elements in the form of flows of energy, materials, and species between different land-cover types; and, 3) change: the alteration in the structure and function of a landscape over time (McGarigal and Marks 1995, Ersoy 2016). The study of the relationship between these three attributes helps monitor the dynamics of spatial heterogeneity and how it is affected by development and other factors over time.

An additional aspect of landscape ecology involves applying these principles to formulate and solve real-world problems (McGarigal and Marks 1995). The ability to study the landscapes past, present and future helps designers make the appropriate design decisions. Landscape ecology also encourages collaboration across many professions in an effort to produce more wholistic designs that address fragmentation within cities from multiple perspectives (Ersoy 2016).

Landscape Fragmentation

Fragmentation, the breaking up of large habitats or land areas into smaller disconnected habitats (Figure 2.4) (Bogaert 2000, Canedoli et al 2018, Mitchel et al 2015), is the result of many anthropogenic activities like: the construction of roads, changes of land use, development of built-up areas, and many other human-driven activities (Zhang et al 2019, Gao and Li 2011, Alphan et al 2016, Moreno et al 2011, Davidson 1998).

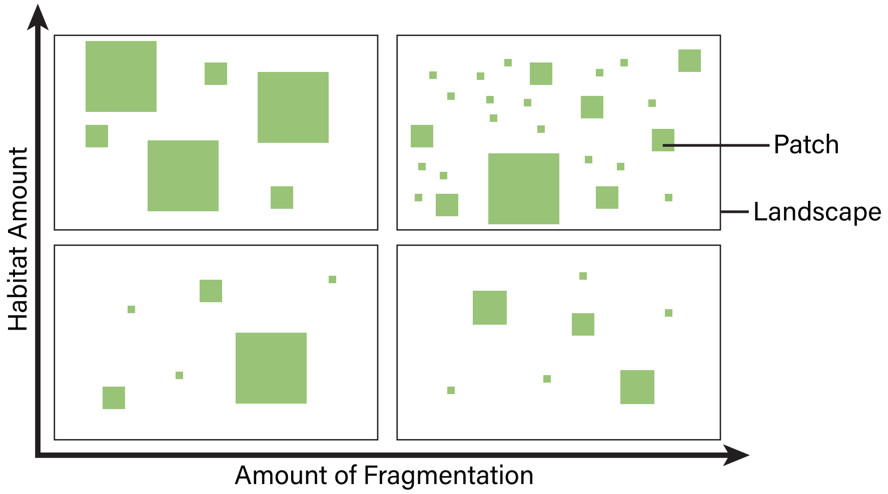


Figure 2.5: Landscape fragmentation can be analyzed by examining the relationships that patches have with one another (Parker 2020).

These activities are all products of urbanization, which is one of the main causes of change in landscape structure and function (Ersoy 2016). These changes due to fragmentation often lead to a lack of connectivity within ecological networks (Zhang et al 2019, Bogaert et al 2000, Alberti 2005, Davidson 1998), a decrease in patch size (Zhang et al 2019, Gao and Li 2011, Fahrig 2003), an increase of the number of patches (Zhang et al 2019, Bogaert et al 2000, Fahrig 2003), an increase of patch types (Li and Reynolds 1995), increased isolation of habitat patches (Gao and Li 2011, Bogaert et al 2000, Fahrig 2003), decreased complexity of patch shape (Gao and Li 2011, Bogaert et al 2000, Li and Reynolds 1995), higher proportions of edge habitat (Gao and Li 2011, Li and Reynolds 1995, Turner 1989), reduction of habitat area (Bogaert et al 2000, Fahrig 2003, Canedoli et al 2018, Davidson 1998), and a change in the distribution of patches (Turner 1989, Moreno et al 2011).

A combination of all these changes in landscape structure and composition contributes to a loss in biodiversity (McGarigal and Marks 1995, Anedoli 2018, Fan and Myint 2013, Zhang 2019, Moreno et al 2011, Mitchel et al 2019, Fahrig 2003, Alberti 2005), and reduces the ability of the landscape to provide ecosystem services (Mitchell et al 2015, Canedoli et al 2018).

Fragmentation also interferes with many of the natural processes that normally occur within landscapes. Reduction in connectivity and patch size along with patch isolation alter the ability of plants and animals to move within the landscape and reduces species richness. Many of the negative results of fragmentation are also ways in which it can be quantified or studied.

Figure 2.6: A simple thing like a land bridge that allows animals to cross over a road that run through their habitat can minimize the effects of fragmentation (Reza 2017).

Take Away

Landscape fragmentation is a serious by product of rapid urbanization that causes many disturbances in the ecosystem. Designers and other professionals can use the principals of landscape ecology to gain a better understanding of landscape fragmentation, and to find ways to reduce fragmentation in cities

2.5 Quantifying Landscape Fragmentation

Landscape indicators

Quantifying landscape fragmentation can be accomplished by analyzing the relationship between a variety of different landscape indicators. One indicator that is commonly associated with, and in some cases seen as synonymous with fragmentation is heterogeneity, which can be defined as the complexity and variability of a system property in time and space (Gustafson 1998, Li and Reynolds 1994).

Most studies use a combination of different landscape indicators to analyze landscape fragmentation (Bogart et al 2000). These landscape indicators are often the same things that are seen as side effects of fragmentation such as composition and configuration of patches, habitat loss, patch isolation, increased perimeter length, the number of patches, patch size, and patch connectivity (Li & Reynolds, Bogart et al 2000, and 1994 Davidson 1998).

Landscape Metrics

To quantify these different aspects of the landscape, researchers frequently use landscape metrics to understand different things about landscape spatial patterns. Landscape metrics are derived through the analysis of categorical maps which are representations of different land-cover classifications like buildings, open fields, green houses, orchards, beaches, dunes, water, and water surfaces, which are displayed in the form of a patch-based mosaic (With 2019).

Landscape metrics can be divided into two general categories: those that reveal characteristics of landscape composition, and those that reveal qualities of landscape configuration (Table 2.1). Landscape composition refers to the amount of a certain land-cover type that is present within the landscape. Although this is not a great indicator of landscape fragmentation, it is still important because landscape

Landscape Metric	Patch	Class	Landscape
Composition Metric			
Landscape richness (R)			X
Proportion of each land-cover class (p_i)		X	X
Landscape diversity measures (shannon, evenness, dominanace)			X
Configruaiton Measures			
Number of patches		X	X
Patch size (area, mean, area-weighted mean)	X	X	X
Perimeter (edge)	X	X	X
Patch Shape (perimeter-to-area-ratio, fractal dimension)	X	X	X
Edge contrasts/like-adjacencies (cell-based)	X	X	
Interspersion/juxtaposition (patch-based)		X	X
Aggregation/clumpiness index		X	X
Contagion		X	X

Table 2.1: These common landscape metrics are used to measure the composition or configuration of the landscape, that can be calculated at the patch, class, or landscape scale (Adapted from With 2019).

composition can have a great impact on the other landscape metrics. First, if there is no green space then analyzing fragmentation is not relevant, however, varying amounts of green will effect each landscape metric differently (Figure 2.7). Landscape configuration on the other hand is an indication of how patches of a certain type are arranged. These metrics look beyond the sheer amount of green space and indicate how the landscape is arranged (With 2019). Each of these metrics produce a different information, so researchers can target specific aspects of landscape fragmentation and perform more in-depth studies.

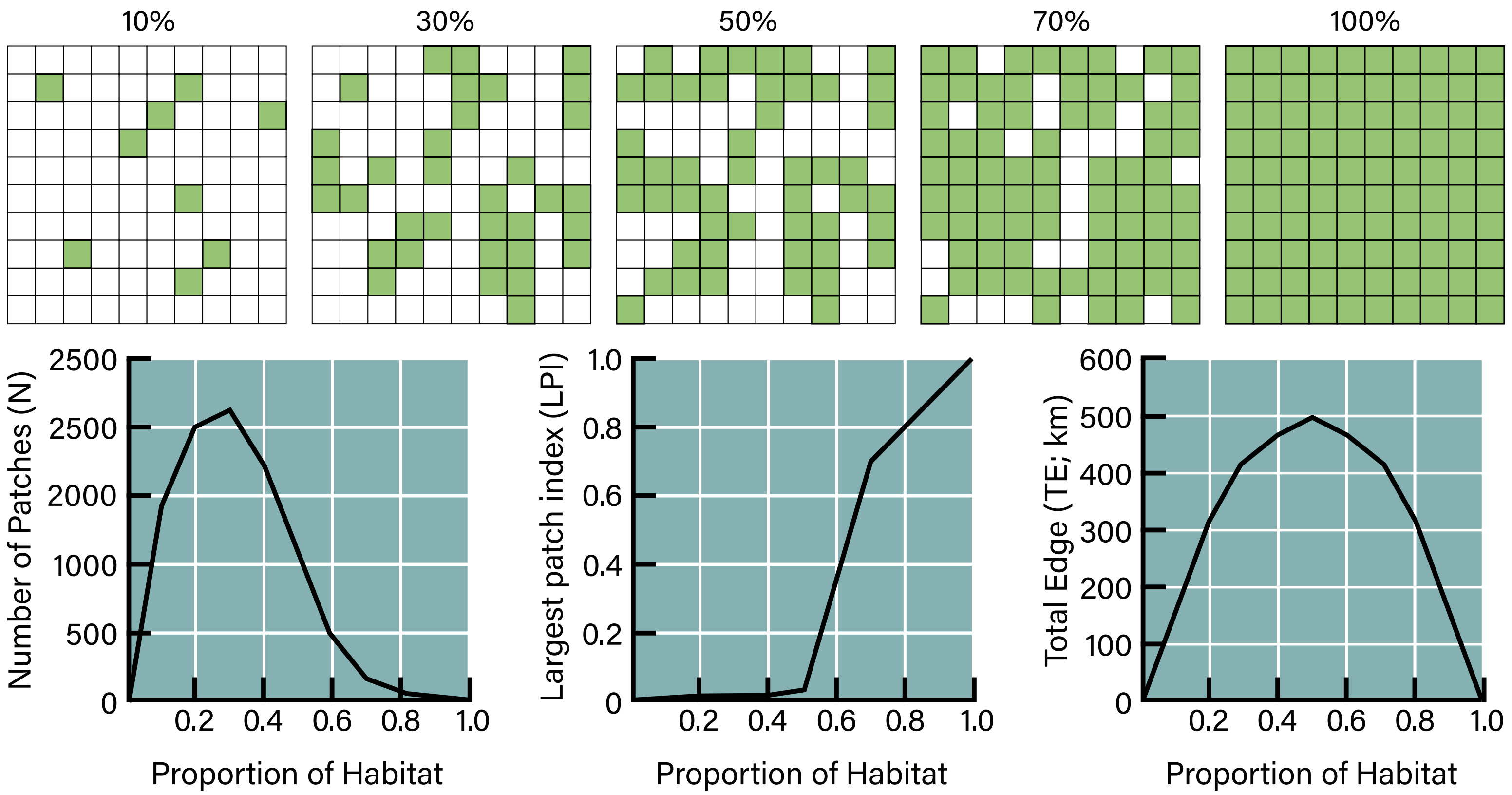


Figure 2.7: Several of the landscape metrics are greatly influenced by the amount of green space that is in the habitat. Smaller versions of the landscape are depicted above, and the graphs below depict how the landscape metrics are affected by the differing amount of green space present. (Adapted from With 2019).

Using Technology to Quantify Landscape Fragmentation.

Recent developments in technology have played a huge role in researchers' ability to understand and analyze landscape fragmentation. GIS has emerged as one of the leading applications for analyzing landscape fragmentation because of its ability to analyze satellite images (Zhang et al 2019).

Many researchers also utilize other user-generated computer programs to perform spatial analysis, because they allow the user to select metrics that can help them learn specific things about landscape spatial patterns, such as spatial simulation models. GIS is typically the software of choice because of its ability to produce graphics that are much higher quality than most other programs (McGarigal and Marks 1995).

One analysis software that is compatible with GIS and can perform landscape metric analysis is FRAGSTATS (Alphan and Celik 2016, Gao and Li 2011). FRAGSTATS is a landscape-analysis program that can be used to produce data on a variety of different landscape indices, based upon landscape classification maps that are produced in GIS (McGarigal and Marks 1995). GIS is a valuable tool because it can uncover useful data that may not be visible to the naked eye, which can help designers make more informed decisions.

Take Away

Landscape metrics can be used to measure landscape composition and configuration, which are the best indicators of landscape fragmentation. The best way to analyze these landscape metrics is by using spatial analysis programs like GIS and FRAGSTATS. The information generated in these programs can help designers understand what specific problems are occurring within the landscape.

2.6 Defining Ecological Green Space

The Quality of Green Space

Green space within a city is a valuable resource that provides a variety of different functions for its residents, but simply having more green space does not necessarily mean the city will be healthier. The quality of green space also refers to what is going on inside the space. There are two main components that should be considered when attempting to determine the quality of a green space, 1) the ecological contribution; and, 2) the social contribution, both of which deserve an equal amount of consideration (Figure 2.8) (Daniels et al 2017, Stassens 2017, Deilmann 2015).

Figure 2.8: Tianjin Qiaoyuan Wetland Park was strategically designed to collect rain water to irrigate the vegetation that remediates the soil on the site. While at the same time paths and bridges frame the landscape and provide human access to this functioning wetland (Landezine/Turenscape 2011).

One of the key indicators of a high-quality green space is diversity within the space. Studies have shown that people prefer spaces with a wide variety of program elements (Malek et al 2018, Stessens et al 2017). Diversity is also important from an ecological point of view; healthy landscapes should contain all types of landscape elements (Daniels et al 2017). While some studies have shown that distance is one of the most important preconditions for the use of green spaces, if the quality of the space is high enough, then people will be willing to travel farther to reach that experience (Stessens et al 2017).

Ecosystem Services

Examining quality of green space through the lens of ecosystem services helps bridge the gap between the social and environmental benefits by helping people quantify the benefits that the landscape provides. In order to effectively analyze ecosystem services, analysis should be performed at the site level because ecological properties and processes can only be recognized and accessed on a smaller scale (Daniels et al 2017).

Up to now, decision-making in practical management of green space has mostly been based on cost and aesthetic considerations and less on ecological or climatic criteria (Daniels et al 2017). This is a problem because urban open spaces should be the providers of ecological services in the urban environment. They should provide a safe environment for wild plants and animals, while also reducing atmospheric pollution and helping to regulate climate change (Daniels et al 2017, Deilmann et al 2015).

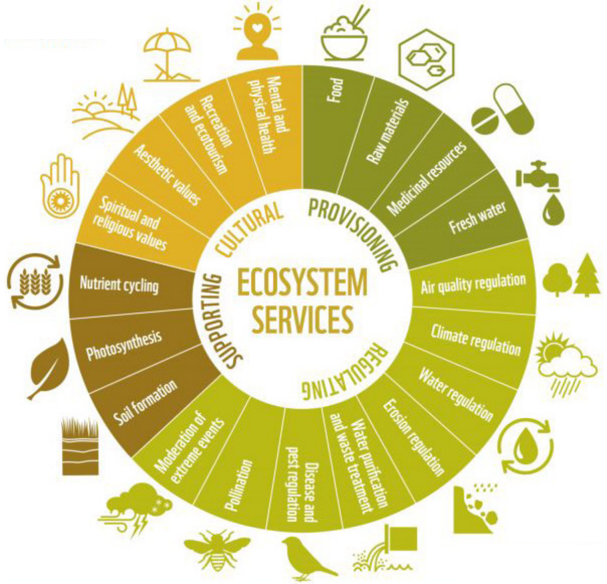


Figure 2.9: Ecosystem services is a method of quantifying the different ways that nature can enhance our quality of life. Many of these things are not easily observed, but they make a big difference in the quality of peoples life (Wirten 2016).

Quantitative Analysis of Green Space Quality

In 2015, Clemens Deilmann and his colleagues developed a GIS-based analytical method for determining the quality of urban green space and water bodies that is of particular relevance. The method uses three variables "potential at-risk areas" as well as the indicators "Euclidean distance," and "affected population" to perform this analysis. Potential at-risk areas are the built-up areas that are larger than one hectare and are not near any green spaces and/or bodies of water. Euclidean distance is the distance between densely built-up areas and the nearest green space or body of water.

The affected population was determined by measuring the areas and density of buildings in the at-risk area, to determine the number of people who live in the at-risk areas. The site was then analyzed using ATKIS-Basis DLM which used the existing urban fabric to generate a geometry that was representative of the site. This geometry was used to determine the coverage ratio, or which portion of the site was covered by nature and which portion of the site was developed.

To quantify Euclidean distance, the site was divided into 100 meter x 100 meter cells, then each cell was defined by the primary attribute value (natural or not natural), and the distance between natural areas was measured.
The at-risk population was determined by combining the potential at-risk map with census data. The same 100m x 100m grid was placed over the site and each cell was assigned a population value. The number of people in potential at-risk areas were added together (Delimann et al 2015).

This method is efficient because it does not rely on assumptions or people's opinions which may change over time, but the large scale of the analysis may keep it from being completely accurate. This type of analysis can help to analyze green space quality at a large scale in order to make some generalizations but should be paired with a site-level analysis to get a clearer understanding for how the site functions.

Take Away

The quality of green space within a city is not only determined by the amount of green space that it has. There are many other factors that influence green space quality, from both an ecological and social perspective. Incorporating diverse program and landscape elements can increase the quality of green spaces. It may also be hard for people to understand the value that green spaces provide, because many of the valuable things that green spaces do for our planet go unseen, causing them to be unappreciated. Raising awareness of the many ecosystem services that nature provides, can be a good way of helping people understand its value. There have been some efforts to quantify the value of nature using different technologies, but most of them are too broad and do not consider the value of nature at all scales, from the regional scale down to the individual parcel scale.

2.7 Summary

As time has moved forward, human perception of nature has changed,from fear of the wild and unknown to the idea that nature plays an important role in supporting and healing our society. Ecology is one way that people are attempting to understand how nature is and should be incorporated in cities. Some aspects of ecology deal with the way that people and nature live in harmony with one another. While landscape ecology is a more technical study of the way that landscapes are organized and managed that helps designers and scientists work together to create more functional landscapes.

One ecological concept that can reveal a lot about how green space in cities is distributed is fragmentation, or the breaking up of large habitats or landscapes into smaller more isolated habitats. Fragmentation is caused by a variety of different activities and processes, many of which are the direct result of human actions. Defining fragmentation is not a simple task, but can be done by cross-referencing data from many different landscape metrics, to uncover many characteristics of the landscape's spatial pattern.

The ecological benefits are not the only aspect of increasing green space that are valuable. The social benefits are also important, and both should be considered when developing a plan for the future. These ideas and concepts helped to inform and structure of this report.

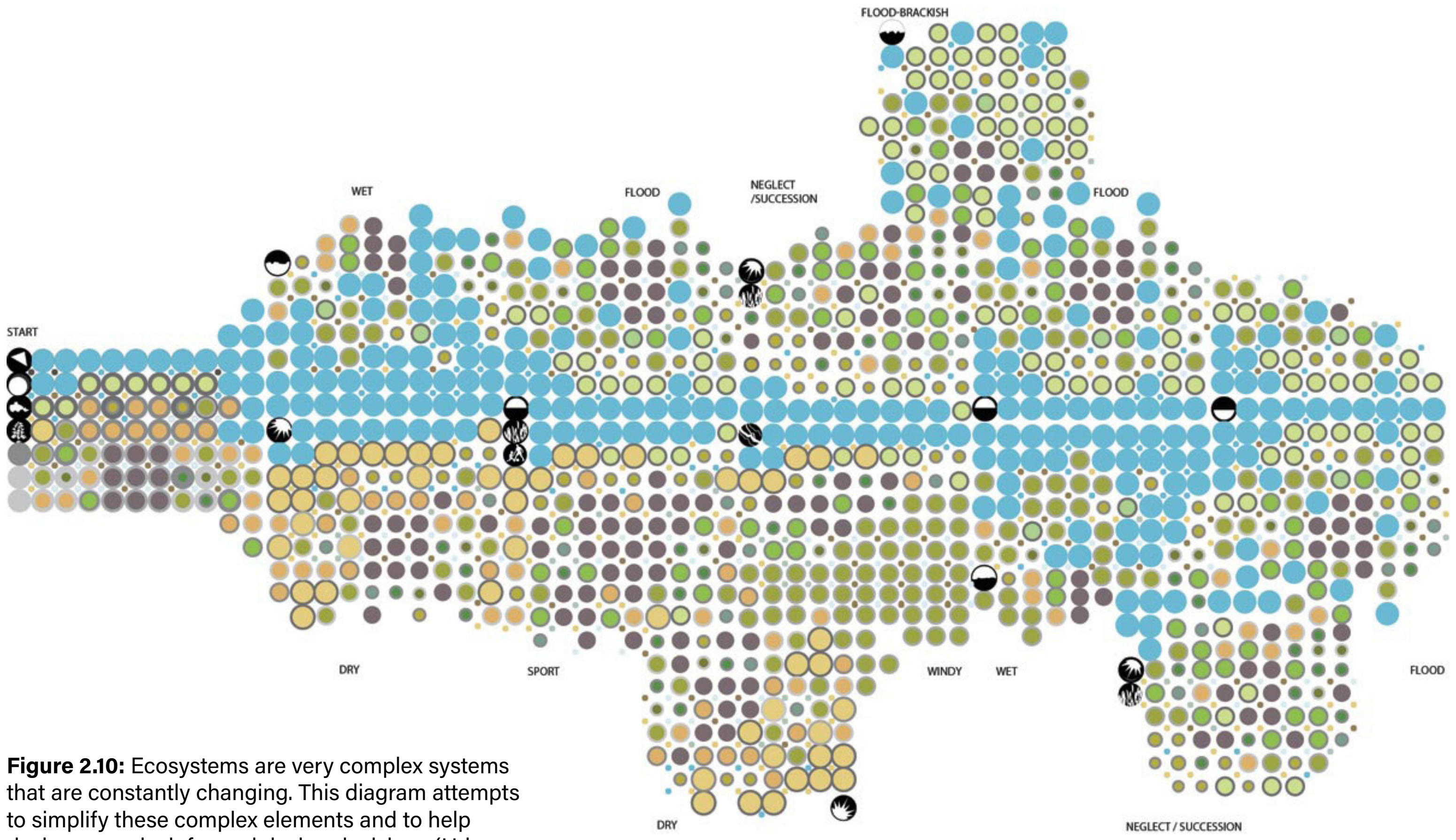


Figure 2.10: Ecosystems are very complex systems that are constantly changing. This diagram attempts to simplify these complex elements and to help designers make informed design decisions (Urban Next/Stoss 2010).

METHODOLOGY

3

3.1 Study Area

The City of Wichita is the largest city in the state of Kansas (Figure 3.2), and it is currently experiencing rapid population growth, like many other cities in the world. The city's current population of 385,500 is projected to increase by 101,500 by the year 2035 (City of Wichita Parks and Recreation 2016). With this projected population growth comes a projected increase in density from 2,359 people per square mile to 2,578 people per square mile. In addition there is a projected increase in are of 7% from 162.8 square miles to 173.8 sq. square miles (Figure 3.1).

Wichita was chosen as the site for this project because the size and growth predictions mean that the city is at a critical point, as they are still in the process of planning for this projected growth. Which means that this project could potentially have an impact on the how city decides to move forward. Wichita was also chosen because its population and size cause it to face many of the problems that are faced in both large and small cities.

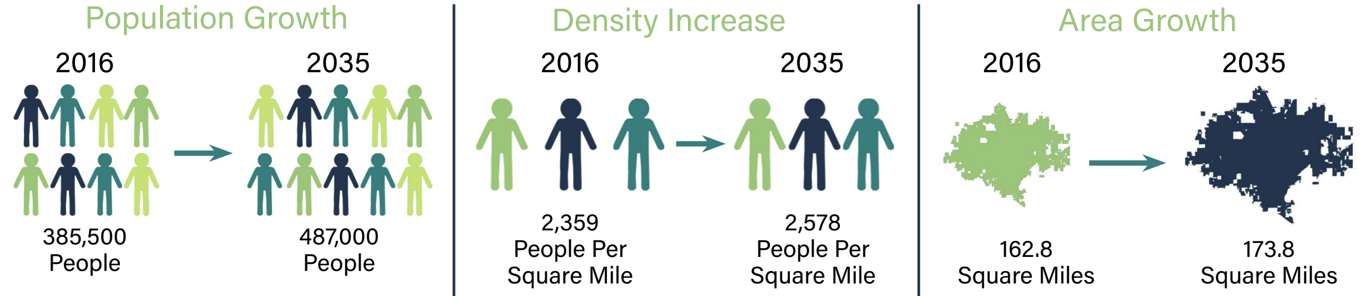


Figure 3.1: City of Wichita Growth Predictions (City of Wichita Parks and Recreation 2016)

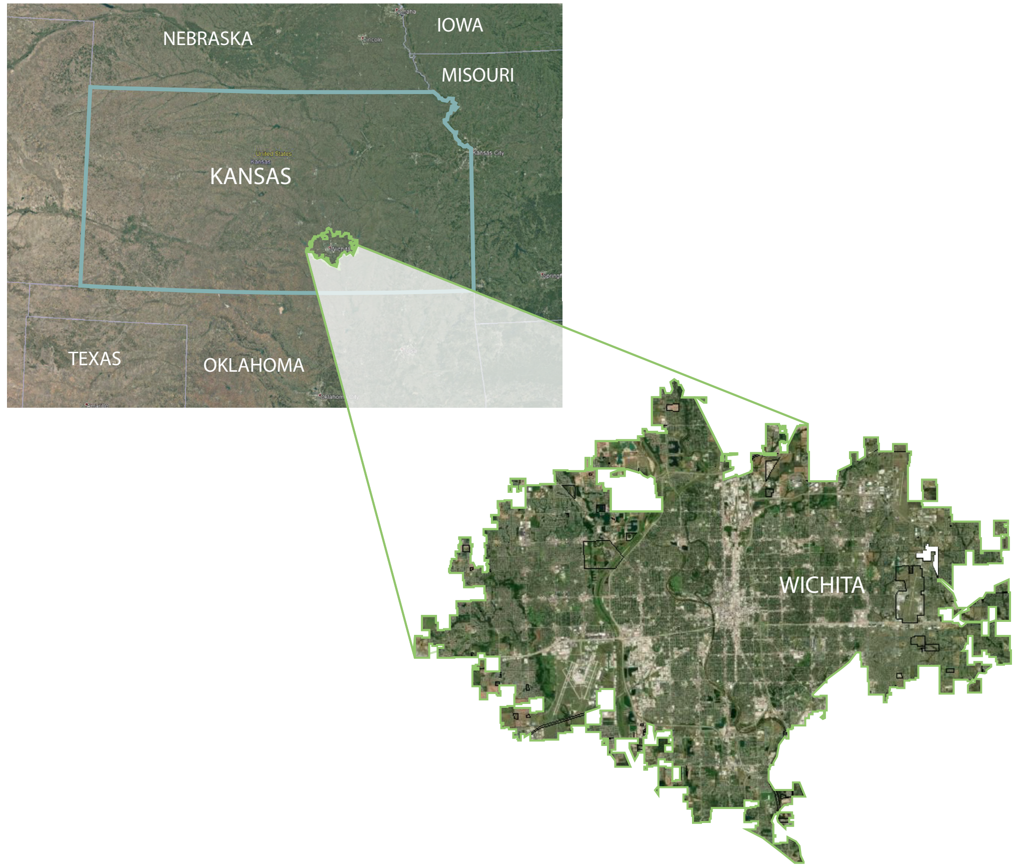


Figure 3.2: Map of Study Area (Google Earth)

3.2 Plan and Policy Review

Wichita Future Growth Concept

The 2035 Wichita Future Growth Concept Map below shows what the city envisions the future growth patterns may look like.

2035 Urban Growth Areas Map

Figure 3.3 shows how the city and some of the surrounding areas are projected to grow over the next 15 years. This large-scale plan confirms that the projected population growth will lead to increased development around the perimeter of the city.

2035 Wichita Future Growth Concept Map

Figure 3.4 shows that there are many areas around the perimeter of the city that will most likely be developed as the population grows and expands. Included in this plan is an indication of the areas that are projected to become developed as potential places for employment or residences, but there is no indication of potential green space preservation or development. While this is a very high level and assumptive plan, green space should still receive the same level of attention as the other elements of the city.

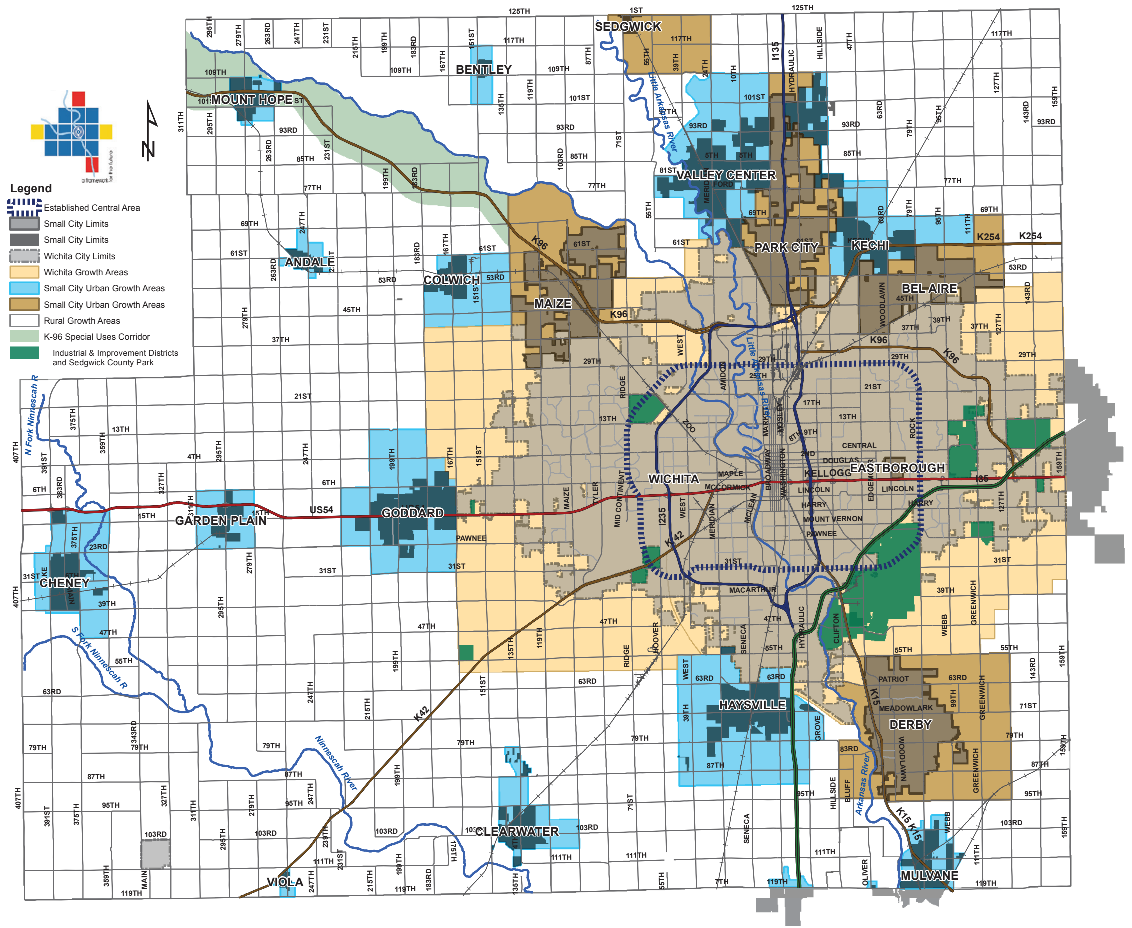


Figure 3.3: 2035 Urban Growth Areas Map (Sedgwick County 2015)

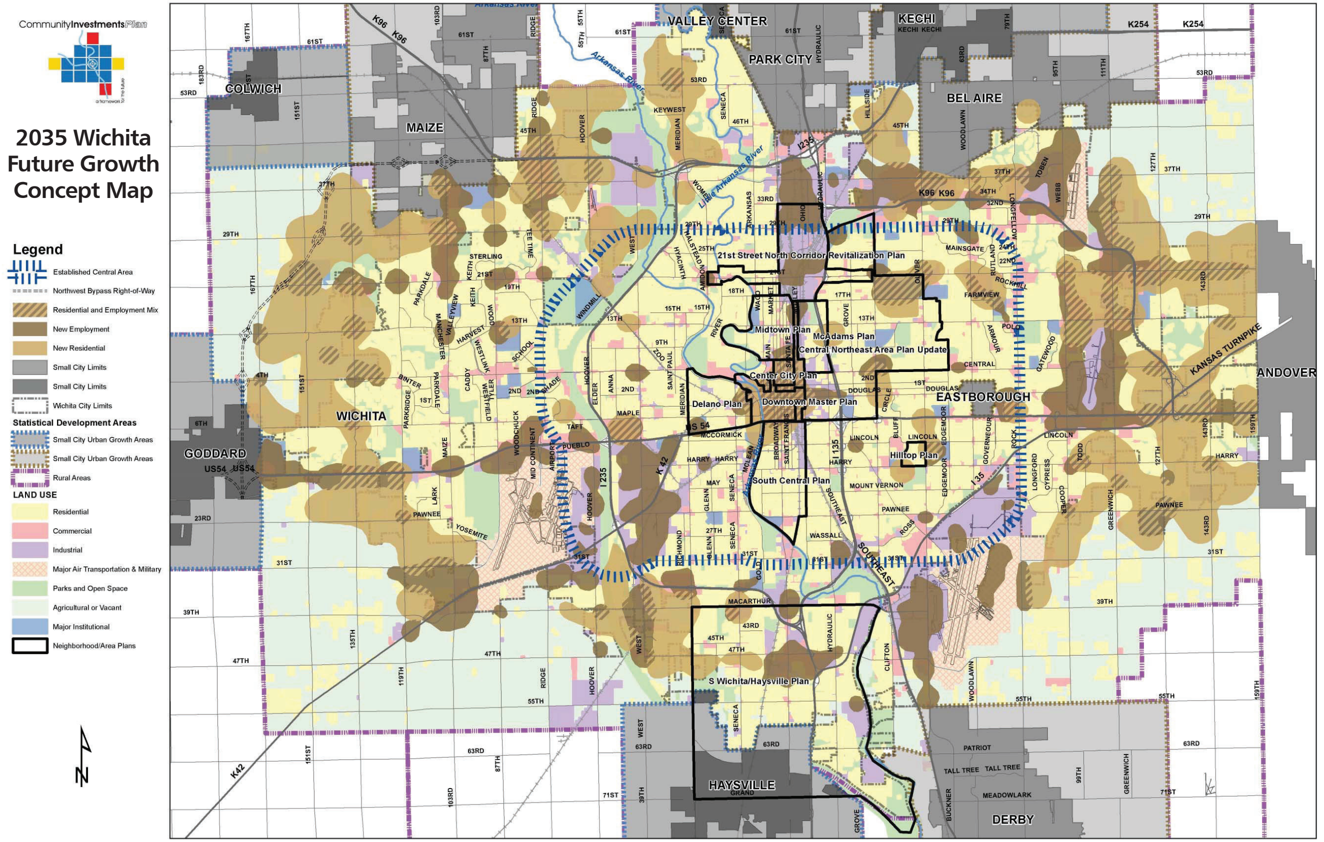


Figure 3.4: 2035 Wichita Future Growth Concept Map (Sedgwick County 2015)

Wichita Parks Recreation and Open Space Plan

In order to plan for this growth and expansion, the city has developed the Wichita Parks, Recreation and Open Space Plan (PROS) (City of Wichita Parks and Recreation 2016). This plan makes suggestions for where new parks and recreation facilities should be located, and which existing facilities should be revitalized. However, the Wichita PROS does not mention who produced this plan, which means there is a chance that no designers or ecologists were included in this process. Allowing designers and ecologists to be a part of this process, could provide a valuable perspective that helps shape a more ecologically focused vision for Wichita's future.

Current State of the Planning Area

Figure 3.5 shows the current state of Wichita's green spaces. From this map it evident that the amount of green space in the city is lacking. And while there are some mentions of ecology in the plan, it is certainly not one of the main focuses.

Current State of the Planning Area

Figure 3.6 pinpoints areas of the city that need to be renovated or redeveloped, and proposes locations for new parks. These proposed interventions occur mainly around the edge of the city in areas that have yet to be developed. While it is good to see that the city recognizes that green space is important, this plan fails to suggest any ways to improve ecological function. The new plan also fails to mention spatial organization or any of the important concepts that contribute to the reduction of landscape fragmentation.

Moving Forward

Before the city moves forward and begins to implement parts of this plan, it is important that decision makers consider not only how to improve people's lives, but also how to improve the environment.

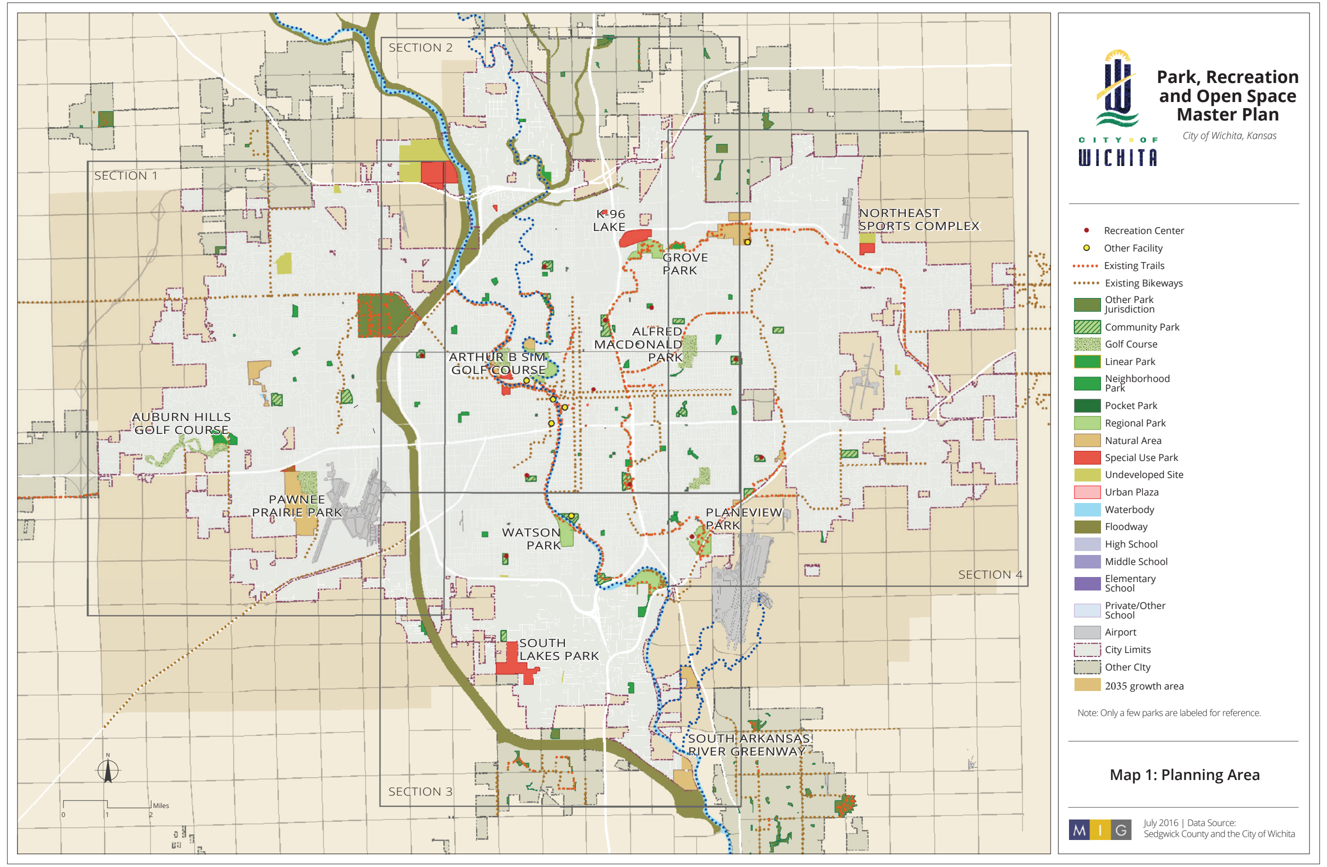


Figure 3.5: Current State of the Planning Area (City of Wichita Parks and Recreation 2016)

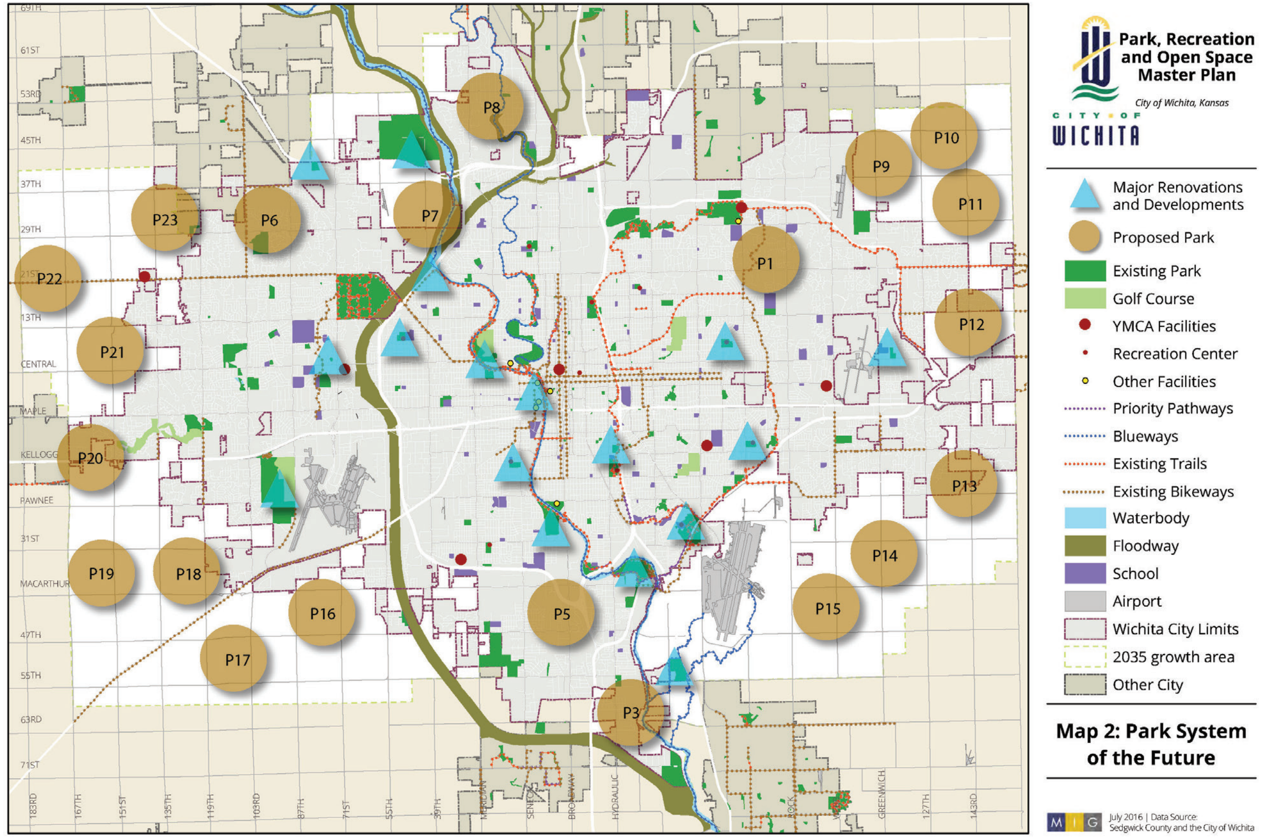


Figure 3.6: PROS Park System of the Future Plan (City of Wichita Parks and Recreation 2016)

3.2 Research Design

As mentioned in the first chapter (page 08), a two-phased approach was used to achieve the study's objectives. The first phase focused on landscape fragmentation analysis at the urban scale, and the second phase focused on ecological green space design at the site-level. Figure 3.6 gives a brief summary of the research methods and objectives that serve as the structure of the report. This is followed by a more in-depth explanation of each research method.

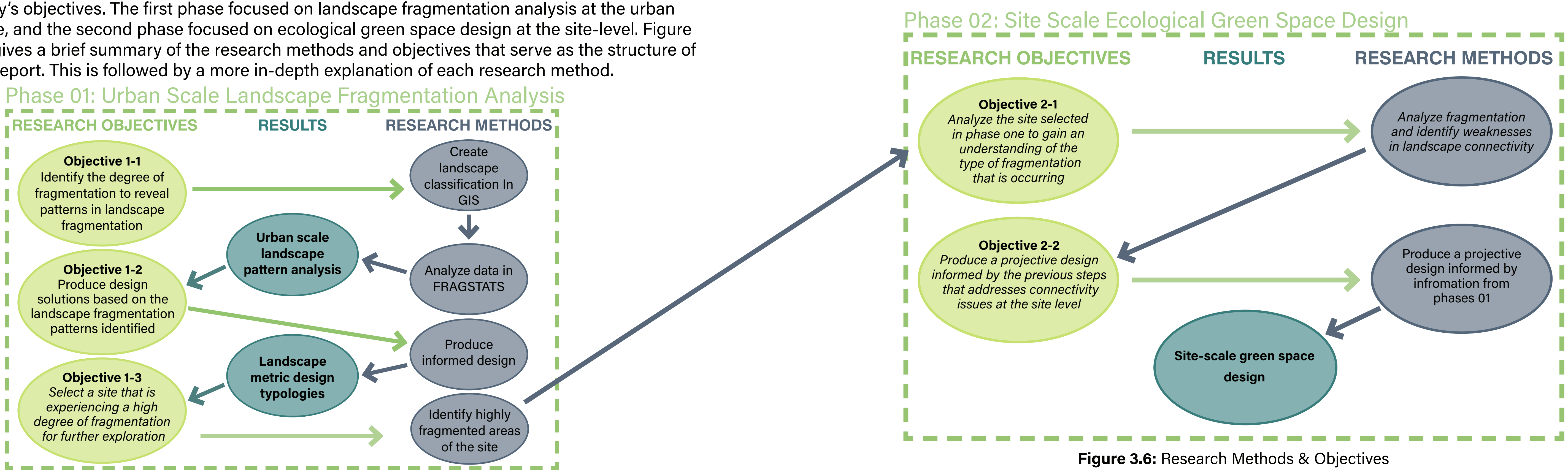


Figure 3.6: Research Methods & Objectives

Phase 01

Objective 1-1 *Identify the degree of fragmentation to reveal patterns in landscape fragmentation.*

First, aerial imagery was obtained from the USDA Farm Service Agency. Then Geographical Information Systems (GIS) mapping technology was used to generate a map with 5 classifications: grass, trees, water, buildings, and impermeable surfaces (Figure 1.2). This map was then divided into smaller units based upon the ZIP code boundaries (Figure 1.3). The data from those landscape classification maps was then analyzed in FRAGSTATS, a spatial analysis software that is compatible with GIS and can be used to generate data on the spatial characteristics of a landscape, which revealed patterns in landscape fragmentation.

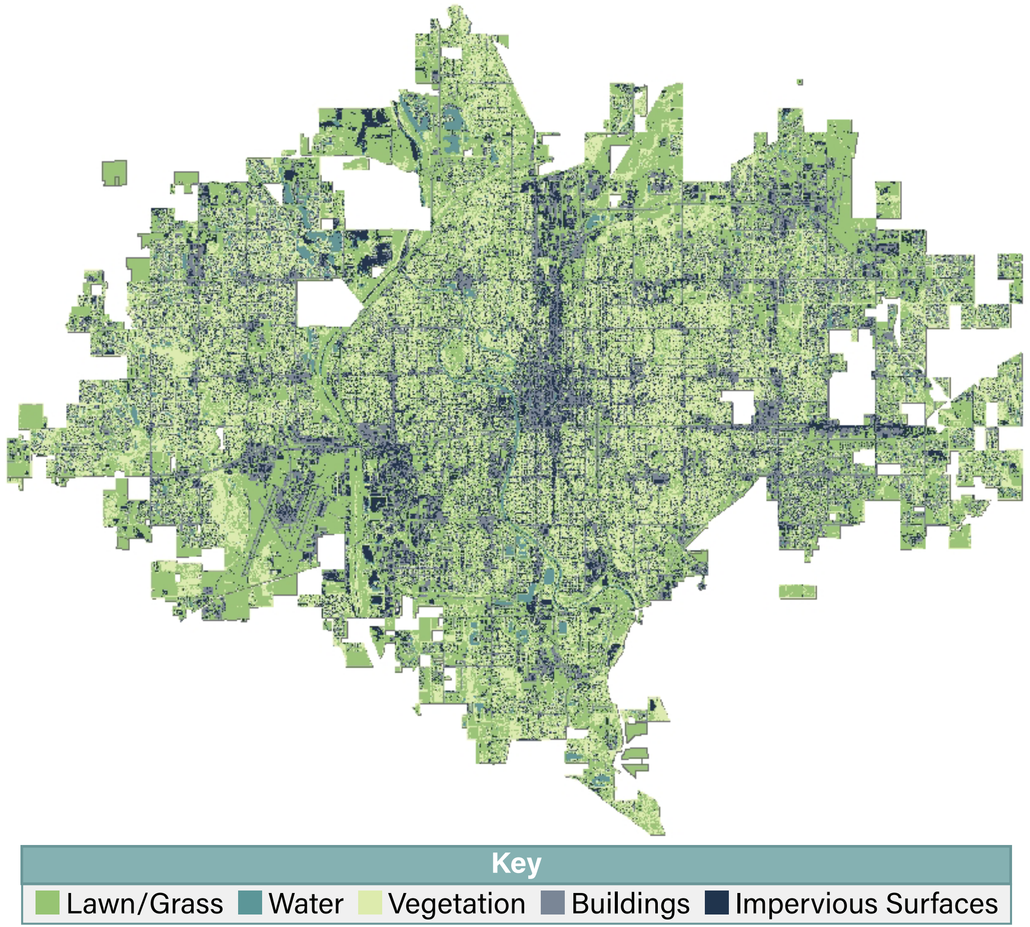


Figure 3.7: Classification Map

Objective 1-2 *Produce design solutions based on the landscape fragmentation patterns identified.*

The data produced in FRAGSTATS was used to compare the different ZIP code areas and determine which areas within the site were the most fragmented. The data was then examined, and the ZIP code areas that exhibited common trends in landscape fragmentation were identified and grouped together. Finally, one area from each group was selected, and a conceptual design solution was generated to solve the issues that were occurring in that area.

Objective 1-3 *Select a site that is experiencing a high degree of fragmentation for further exploration.*

A site was then chosen based on the information from the FRAGSTATS analysis and the relevance of the site location.

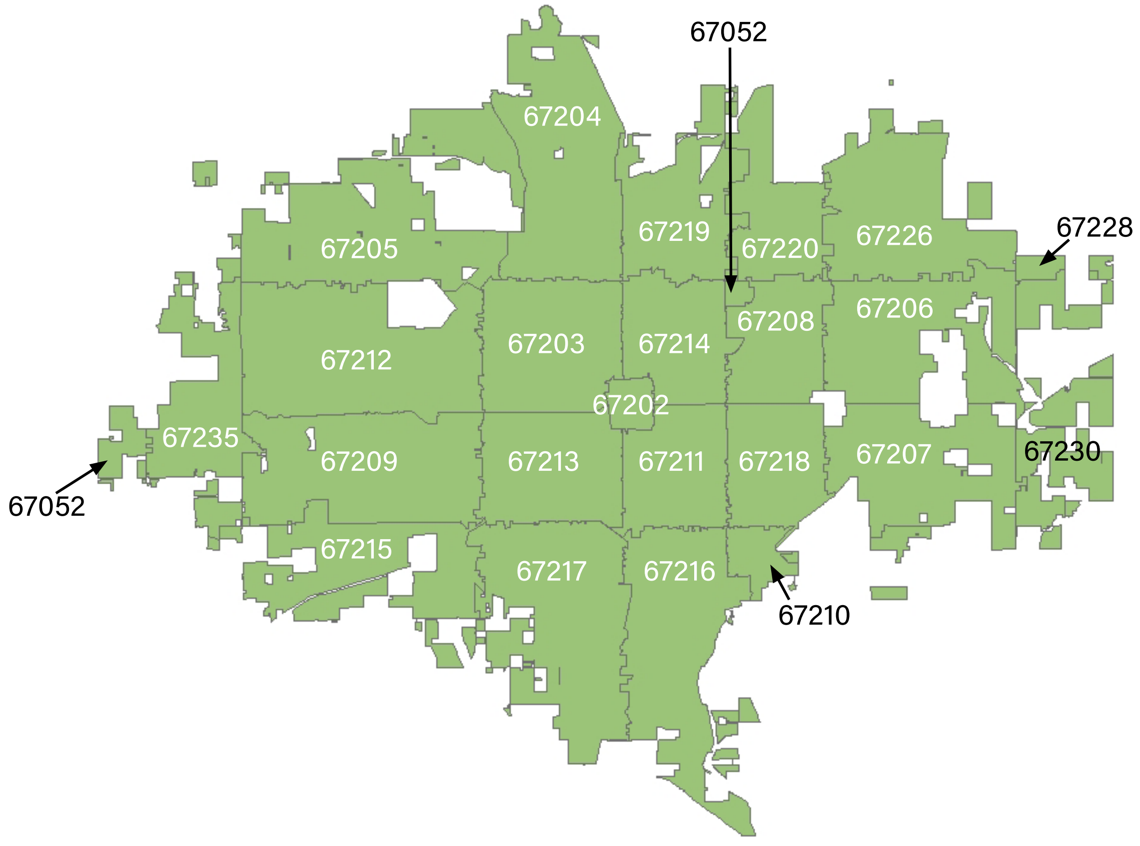


Figure 3.8: ZIP Code Boundaries

Phase 02

Objective 2-1 *Analyze the site selected in phase one to gain an understanding of the type of fragmentation that is occurring.*

A site analysis was conducted to gain an in-depth understanding of how and why the site was fragmented. A classification map was generated for the area within the site boundary, and then analyzed in FRAGSTATS. The results were then compared to the data for entire ZIP code area, to understand how the site differed from the area as a whole. A land use study was also done to determine where the green space was and where there were opportunities to create more green spaces. Then the existing green spaces, plazas, and vacant lots were examined to determine how well they were helping to reduce fragmentation on the site.

Objective 2-2 *Produce a projective design informed by the previous steps that addresses connectivity issues at the site level.*

The results of the analysis were used to decide which design suggestions should be applied within the narrowed focus area. These general concepts were then used to formulate a more specific site design. This design focused on several ecological design factors that help reconnect fragmented urban landscapes: Amount of green space, distance between green spaces, types of vegetation, and programmed elements. This ensures that the spaces are more equally distributed to promote equal access, and also attracts native flora and fauna to the site.

3.3 FRAGSTATS Metrics

FRAGSTATS offers a wide variety of landscape metrics and was designed with versatility in mind (McGarigal and Marks 1995). The program breaks down the metrics into three categories based on scale, including patch, class, and landscape.

Patch:

The patch category features metrics based on individual patches. FRAGSTATS measures this in two ways: the 4-cell rule and the 8-cell rule (figure 3.5). This project uses the 8-cell rule.

Class:

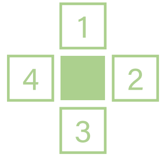
The class metrics examine the landscape composition and configuration of individual land-cover types.

Landscape:

Landscape metrics examine the composition and configuration of the landscape across all land-cover types.

Among these three categories, the class metrics were chosen because of their ability to examine patterns in a single land-cover type, since this project is only concerned with the spatial patterns of green space.

4-Cell Rule:
Accounts for the cells above, below, left, and right of each cell.



8-Cell Rule:
Accounts for the cells above and below and diagonal

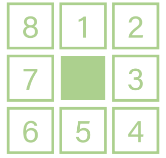


Figure 3.9: 4 Cell VS. 8 Cell Rule

FRAGSTATS divides the class metrics into five different categories, including area-edge, shape, core area, contrast, and aggregation. Each of these categories reveals different characteristics of the landscape pattern.

Area-Edge

Area metrics indicate the amount of a given land-cover type present in the landscape.

Shape

Quantifies landscape configuration related to a given land-cover type.

Core Area

Measure of metrics within an area adjusted by a user-specified edge-distance buffer.

Contrast

The degree to which different land-cover types are adjacent, which provides an indication of landscape configuration

Aggregation

A way of measuring the number of a given land-cover type are adjacent to one another; a measure of habitat clumping.

Among the five categories, this study focuses on the metrics that are under the Area-Edge category because the amount of green space present in the landscape often influences many of the other landscape metrics. The study also considered the metrics under the Aggregation category because they can reveal information about the distribution of the green space.

Each of the different class metric categories is composed of different landscape indices, each of which reveals different characteristics of the landscape.

Area-Edge

The following metrics were analyzed from the Area-Edge category.

Area Weighted Mean Patch Size (AM)

A measurement of the average patch area where each patch is weighted based on size to give a better indication of what the average patch size actually is.

Percentage of Landscape (PLAND)

The measure of what portion of the entire landscape is made up by a certain land-cover type.

Patch Area (AREA-?)

Indicates the average area of patches of the same type in the form of mean, median and standard deviation.

Total Area (CA/TA)

The amount, generally in hectares, of one land-cover type that is present in the landscape.

From the area-edge category percentage of landscape was chosen because the amount of green space present is often a good indicator of landscape composition. Area weighted mean patch size was chosen because the size of the patch often has a large impact on ecological function.

Aggregation

The following metrics were analyzed from the Aggregation category.

Number of Patches (NP)

The number of patches of a certain land-cover type present in the landscape.

Patch Density (PD)

The number of patches per unit of area which can reveal how close patches of the same type are to one another.

Aggregation Index (AI)

The likelihood that patches of the same type tend to be grouped together.

Patch Cohesion Index (COHESION)

The measure of physical connectedness between patches of the same type. The higher the amount of cohesion, the more physically connected the patches are.

Euclidean Nearest Neighbor Distance (ENN-?)

The distance between a patch and the nearest patch of the same type, which may be reported in the form of: mean, median and standard deviation. Indicates the tendency of one patch to be isolated from others.

From the aggregation category, number of patches (NP) was chosen because it is a good indication of patch disruption. Aggregation index (AI) was also chosen because it can help to gain a better indication of how the patches are grouped together, and how far they are from each other.

RESULTS 4

4.1 Landscape Classification (Phase 01)

GIS Aerial Imagery (Input)

High-resolution (1m x 1m) aerial photographs were obtained from the USDA Farm Service Agency through Kansas GIS, an organization that offers free GIS resources and imagery for the state of Kansas (Figure 4.1). After looking through many different resources, this imagery was chosen because it offered the highest-quality-resolution image which helped to create the most accurate image classification map in the next section.

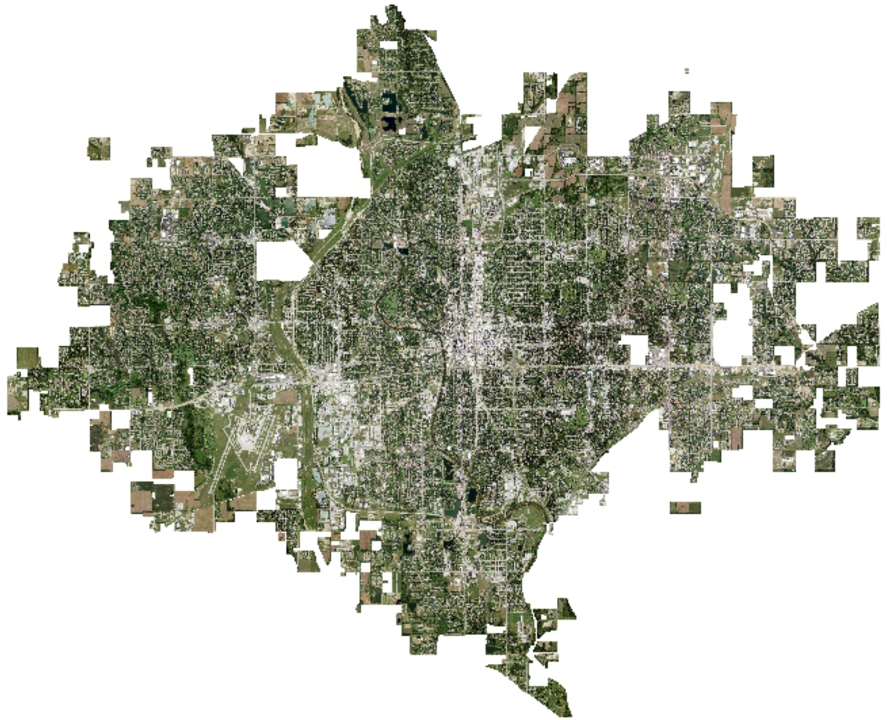


Figure 4.1: Aerial Imagery

Image Classification

The high-resolution imagery was then used to create a landscape classification map in GIS, by running a supervised training sample (Figure 4.2). The result was a map that classified each pixel of the image as: lawn/grass, water, vegetation, buildings or impervious surfaces. This classification map was then taken into FRAGSTATS, in order to conduct a landscape analysis.

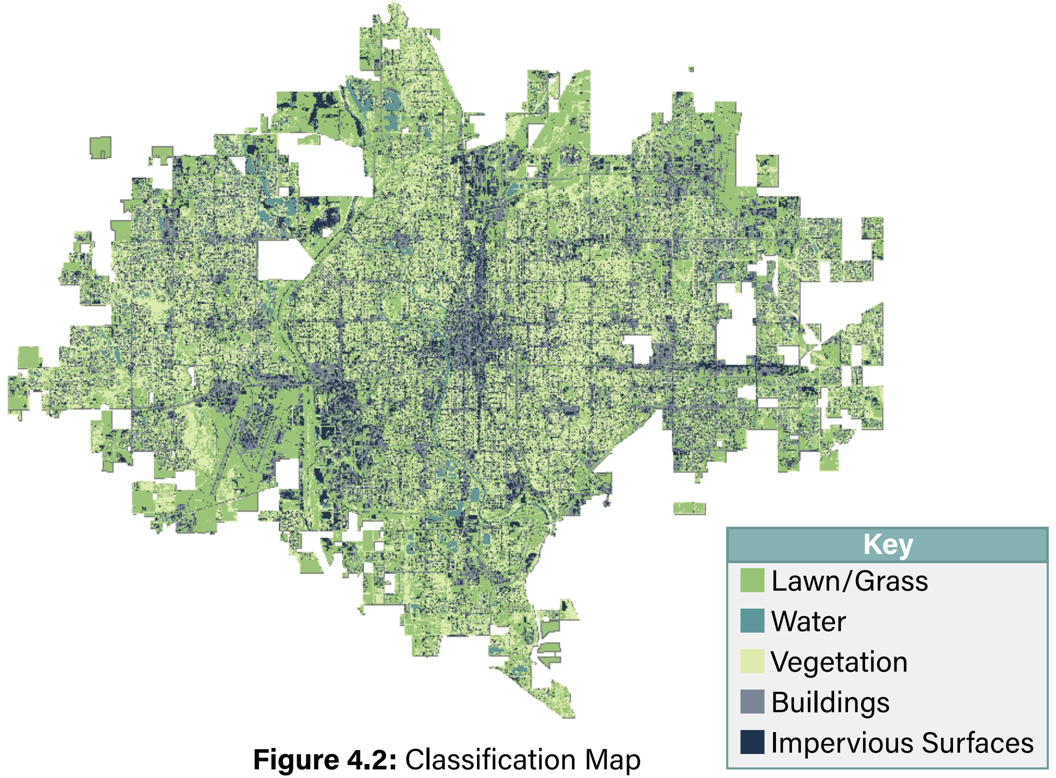


Figure 4.2: Classification Map

Spatial Analysis Units: ZIP Code Boundaries

The site was then divided into smaller areas for two reasons: first, the high-resolution imagery produces a very large file that FRAGSTATS is not able to handle, and second, FRAGSTATS only produces numerical data. So in order to effectively analyze the fragmentation and connectivity of different parts of the city, the site had to be divided into different areas so they can be compared to one another. Many different boundaries were considered in the process (Sedgwick County GIS):

- City Council districts
- Unified School District boundaries
- Board of County Commissioners districts
- Election precincts
- State Board of Education districts
- State Representatives districts
- State Senate districts
- ZIP codes

The ZIP code boundaries (Figure 4.3) were selected because they were the smallest and had the most consistently sized segments, which allows them to be compared to each other more effectively.

Once the boundaries were selected, the classification map was clipped to each of those boundaries. Each ZIP code classification map was then analyzed in FRAGSTATS.

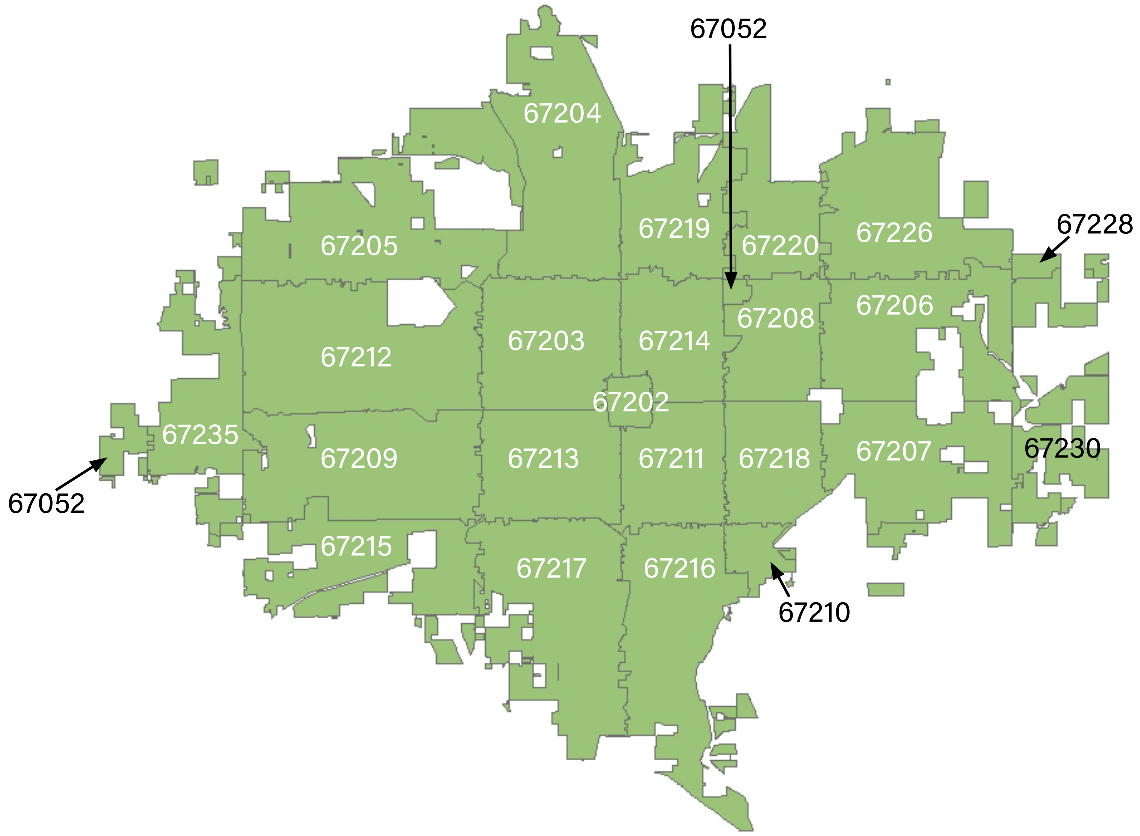


Figure 4.3: ZIP Code Boundaries

4.2 FRAGSTATS Analysis (Phase 01)

The FRAGSTATS program has three different basic metric categories, patch, class, and landscape. The class metrics were chosen because they allow for a better understanding of the spatial patterns that occur within a certain land-cover type .

(The full set of data collected from FRAGSTATS for each ZIP code area can be found in Appendix 01-25)

The four aspects of landscape pattern that were determined the most important to this study are:

- **Amount of green space**, which is important because if there is no green space then it really does not matter whether or not the area is fragmented.
- **Aggregation**, indicates the likelihood that patches of the same type will be close together.
- **Number of Patches**, is a good indicator of how disrupted the landscape is, because when there is a high number of patches they are generally smaller and more disrupted.
- **Average Patch Area**, gives an impression of what the average path looks like, higher average patch size is a good indication of how ecologically productive the landscape is.

The use of these metrics is what sets spatial analysis apart from observation with the naked eye. While it may be easy to tell the amount of green space that is present, it is very difficult to understand whether the landscape is experiencing problems with aggregation, the number of patches, patch area or some combination of the three.

The values for each landscape metric were organized based upon how each ZIP code area scored for that metric (Tables 4.1-4.4). Each ZIP code area was then classified as high, moderate, or low based upon a set scale, or the average and standard deviation for that data set. The data for each metric was then compiled in order to determine which areas were the most affected by urbanization (Table 4.5). Each metric score that was classified as high counted as two points, those classified as medium were counted as one point, and those classified as low were counted as zero points. A composite score was then generated for each ZIP code area by adding together the assigned values.

Amount of Green Space

The amount of green space was determined by combining the Percentage of Land (PLAND) metric for grass and trees in each ZIP code area. Table 4.1 and figure 4.4 display the amount of green space in each area. The data in this category reveals the percentage of green space that makes up each area, the higher the percentage the better.

Results

The results varied greatly, ranging from 83.57% to 12.25%. Areas with greater than 50% were seen to have a high amount of green space, those between 50% and 40% were deemed moderate and any area with less than 40% green space was classified as low. The areas with the highest amount of green space were located around the periphery of the city and the amount of green space steadily declined closer to the center of the city.

PLAND Green Sapce	
83.57	67052
59.81	67215
52.87	67226
50.73	67220
49.14	67217
49.02	67204
48.98	67205
48.76	67210
47.68	67219
44.64	67216
44.62	67209
42.83	67207
41.75	67228
40.01	67206
39.83	67235
38.31	67230
37.34	67212
35.66	67203
35.14	67213
30.71	67208
28.99	67211
28.91	67214
28.65	67218
20.85	67260
12.28	67202

Table 4.1

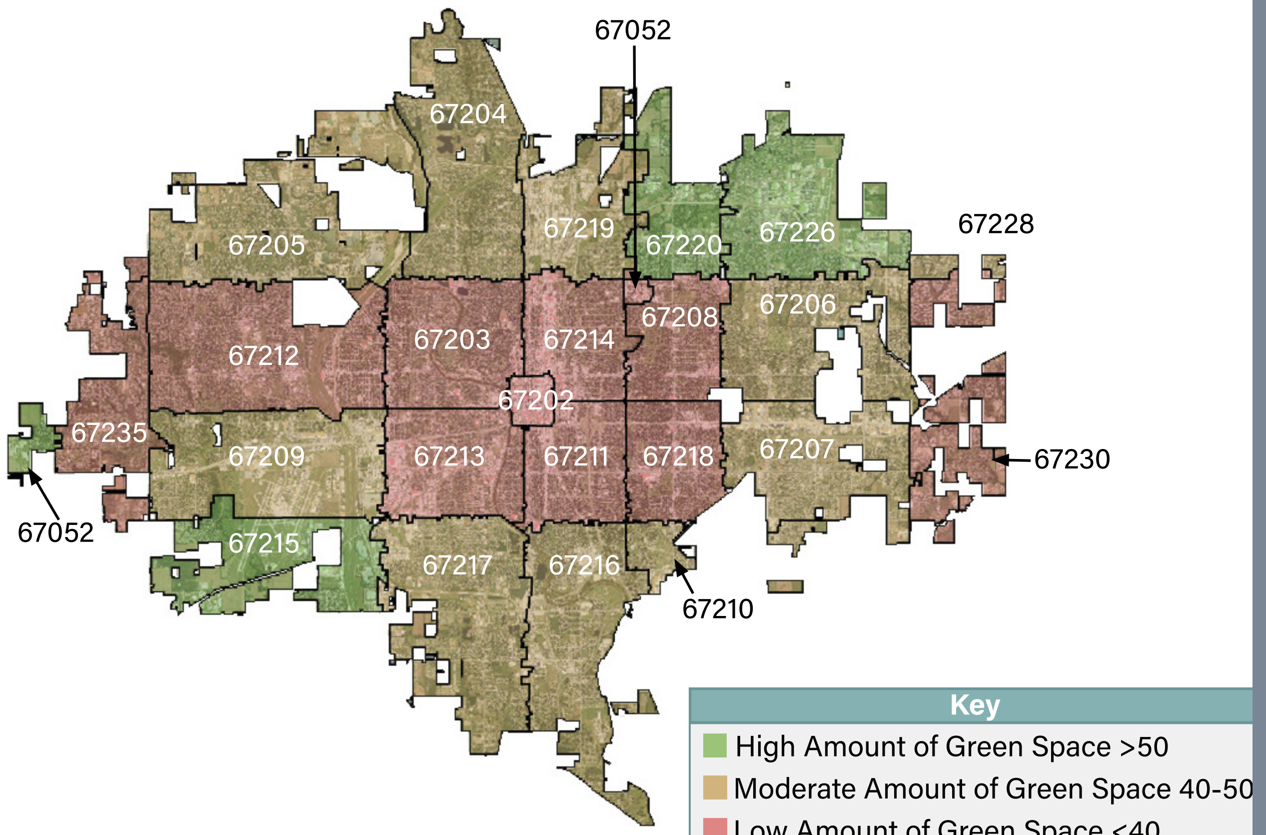


Figure 4.4: PLAND Green Space

Aggregation

The aggregation of green space patches was calculated by using the aggregation index (AI) metric for green space in each ZIP code area. Table 4.2 and Figure 4.5 display the aggregation index of green space. The aggregation index is calculated using the single count method, meaning that each cell side is only counted once. AI is expressed as a ratio of the number of shared edges for a given land-cover type compared with the potential number of shared edges of that same land-cover type (With 2019). This means that the higher the AI is, the more aggregated the patches are.

Results

The results ranged from 96.57 on the high end to 84.64 on the low end, with an average of 91.43 and a standard deviation of 3.20. The areas with an AI higher than 94.63 or above the standard deviation were considered highly aggregated. Areas with an AI score within the standard deviation, 94.63-88.23, were deemed moderate, while the areas with an AI score lower than 88.23 were labeled as low. The results revealed that the northwest and southeast sides of the city were fairly aggregated, but the central parts of the city were generally less aggregated.

Aggregation Grass	
96.5676	67226
96.4122	67215
96.0634	67052
95.2417	67219
94.6201	67209
94.5021	67220
94.0428	67210
93.7377	67205
93.4912	67217
93.2597	67204
92.7033	67207
92.5104	67216
90.7242	67206
90.4961	67213
90.0683	67235
89.9621	67228
89.6637	67212
88.9809	67214
88.7281	67230
88.5785	67203
87.742	67208
87.5675	67211
87.2603	67218
87.2155	67202
85.6381	67260

Table 4.2

Note: In Tables 4.2-4.4 4.3 the values of the index are classified into three categories based on standard deviation

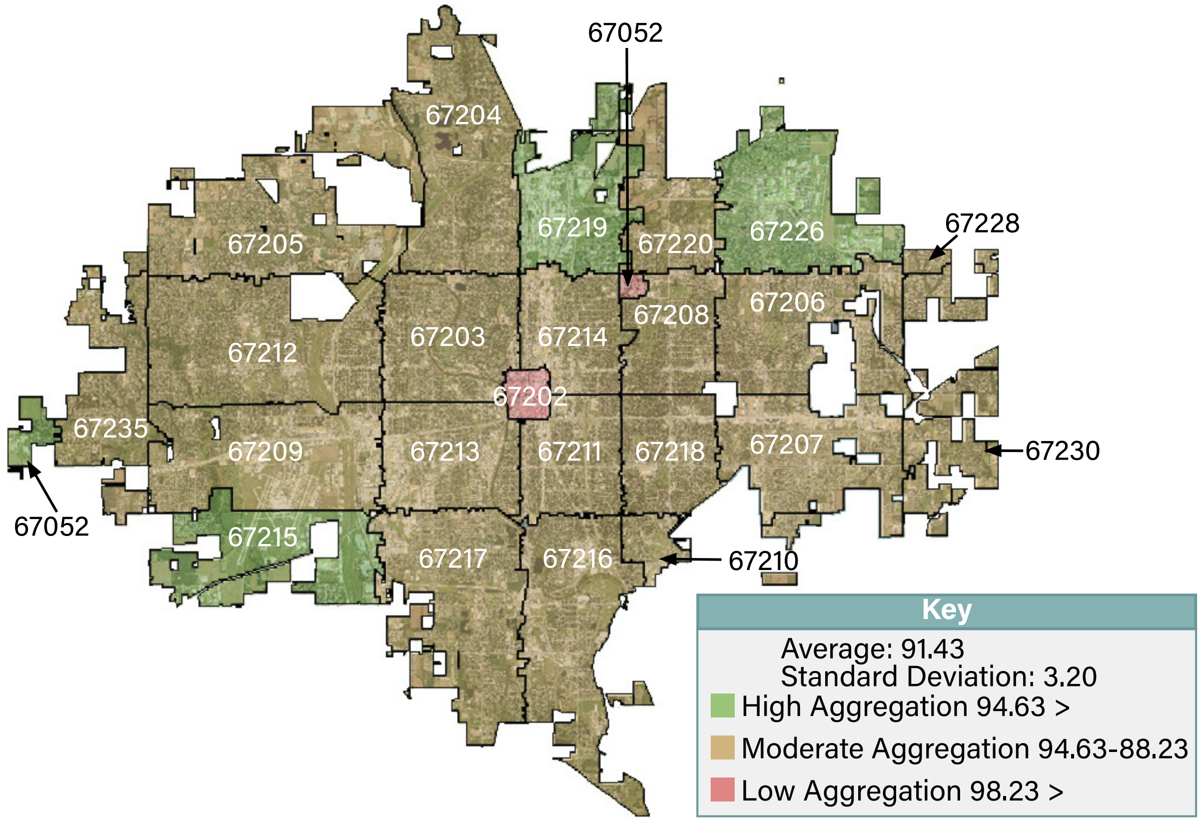


Figure 4.5: Aggregation Grass

Number of Patches

The number of patches was calculated by using the number of patches metric, the results are displayed in Table 4.3 and Figure 4.6. When the number of patches is very high, this often means that the landscape is more broken up therefore more fragmented. So, in this category a higher number of patches is generally worse. The number of patches was measured in the number of patches per 100 HA.

Results

The results ranged from 2,031 to 87,673 with an average of 38,477 and a standard deviation of 23,743. Areas below the standard deviation or less than 14,734 patches were considered to have a low number of patches, areas within the standard deviation 62,221 and 14,734 were deemed average, and those above the standard deviation or more than 67,221 patches were labeled as having a high number of patches. Surprisingly the very center of the city and the very eastern and western edges of the city had the least amount of the patches, and the majority of the rest of the city had a medium to high number of patches. This discrepancy could be explained by the amount of green spaces in these respective areas.

NP Grass (Per 100 HA)	
87673	67212
78527	67206
68167	67205
65507	67216
62970	67235
53884	67204
53754	67203
47998	67217
46600	67208
46261	67218
44637	67207
42661	67211
40792	67209
38784	67214
38715	67215
33047	67220
31420	67213
29257	67219
16430	67230
10722	67210
7531	67228
7296	67052
4555	67202
2717	67226
2031	67260

Table 4.3

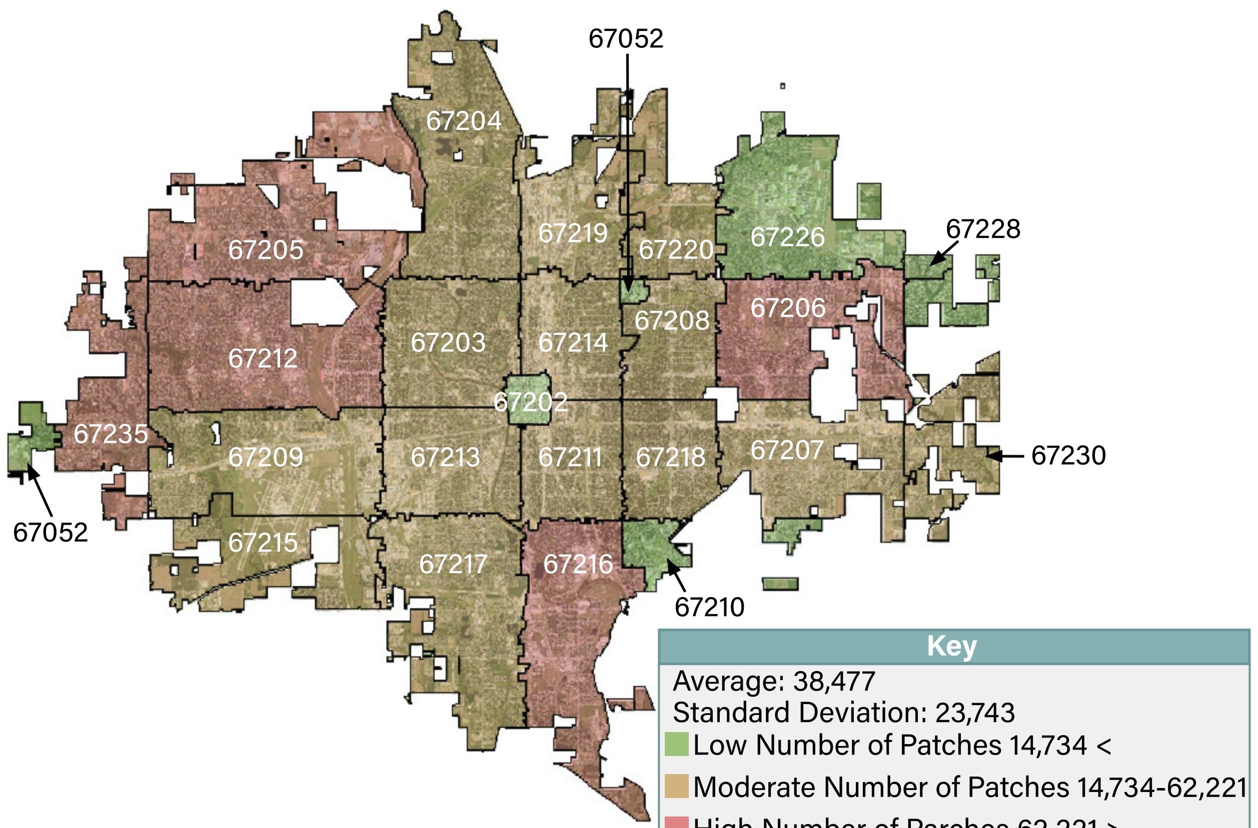


Figure 4.6: NP Grass

Average Patch Area

The average patch area was calculated using the area-weighted mean patch size metric for the grass land cover. The area-weighted mean patch size was chosen over mean patch area, because when calculating the mean patch area only the total class area and the number of patches is used, which often does not give an accurate description of what size the average patch actually is (With 2019). When calculating the area-weighted mean patch size, each patch is weighted based upon its proportion to the rest of the class. While this method is based more towards larger patches, that is okay because larger patches are generally more important to patch dynamics, therefore the higher the average patch size the better (With 2019). The results for average patch area are displayed in Table 4.4 and Figure 4.7.

Results

The results ranged from 73.63 to 0.29 with an average of 21.17 and a standard deviation of 20.58. Areas higher than the standard deviation or larger than 41.74 were considered to have a high patch area. Areas within the standard deviation or between 41.74 and 0.59 were deemed average size. Those below the standard deviation or smaller than 0.59 were labeled as having a low patch area. The areas around the edge of the city generally had larger average patch sizes, while the areas closer to center had smaller patches with the smallest being in the center of the city, which may be related to the fact that the amount of green space in those areas is very limited.

Area-Weighted Mean-Grass	
73.631	67226
62.894	67205
60.47	67215
48.744	67052
36.241	67220
34.819	67204
28.459	67219
26.549	67209
26.277	67217
18.205	67235
16.622	67216
15.753	67210
15.298	67207
12.973	67206
12.736	67212
9.024	67208
6.961	67203
5.036	67228
4.757	67230
4.424	67213
4.145	67218
2.633	67214
1.434	67211
0.782	67260
0.294	67202

Table 4.4

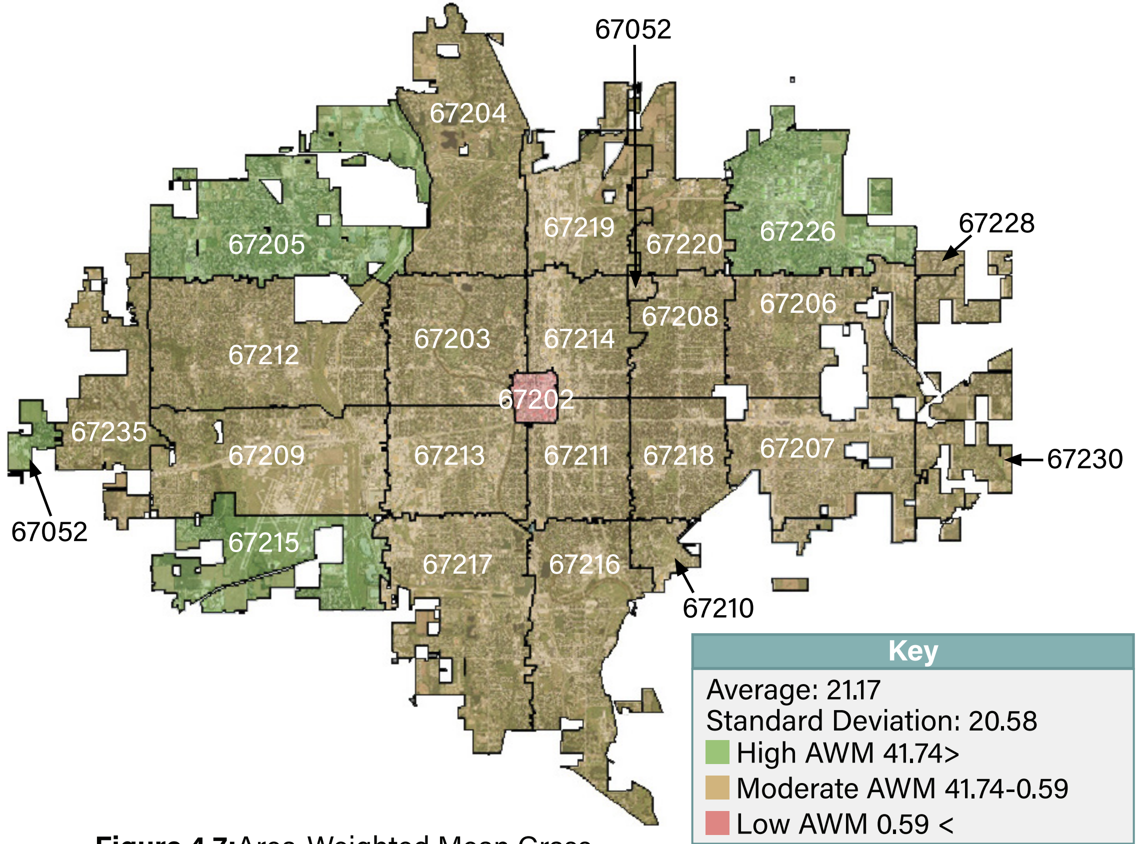


Figure 4.7: Area-Weighted Mean Grass

Aggregate Score & Summary

	Aggregation Grass (AGG)	NP Grass (NP)	Area Weighted Mean-Grass (AM)	PLAND Green Space (PLA)	Total
67052	2	2	2	2	**8**
67202	0	2	0	0	**2**
67203	1	1	1	0	**3**
67204	1	1	1	1	**4**
67205	1	0	2	1	**4**
67206	1	0	1	1	**3**
67207	1	1	1	1	**4**
67208	1	1	1	0	**3**
67209	1	1	1	1	**4**
67210	1	2	1	1	**5**
67211	1	1	1	0	**3**
67212	1	0	1	0	**2**
67213	1	1	1	0	**3**
67214	1	1	1	0	**3**
67215	2	1	2	2	**7**
67216	1	0	1	1	**3**
67217	1	1	1	1	**4**
67218	1	1	1	0	**3**
67219	2	1	1	1	**5**
67220	1	1	1	2	**5**
67226	2	2	2	2	**8**
67228	1	2	1	1	**5**
67230	1	1	1	0	**3**
67235	1	0	1	0	**2**
67260	0	2	1	0	**3**

Table 4.5: Aggregate Score

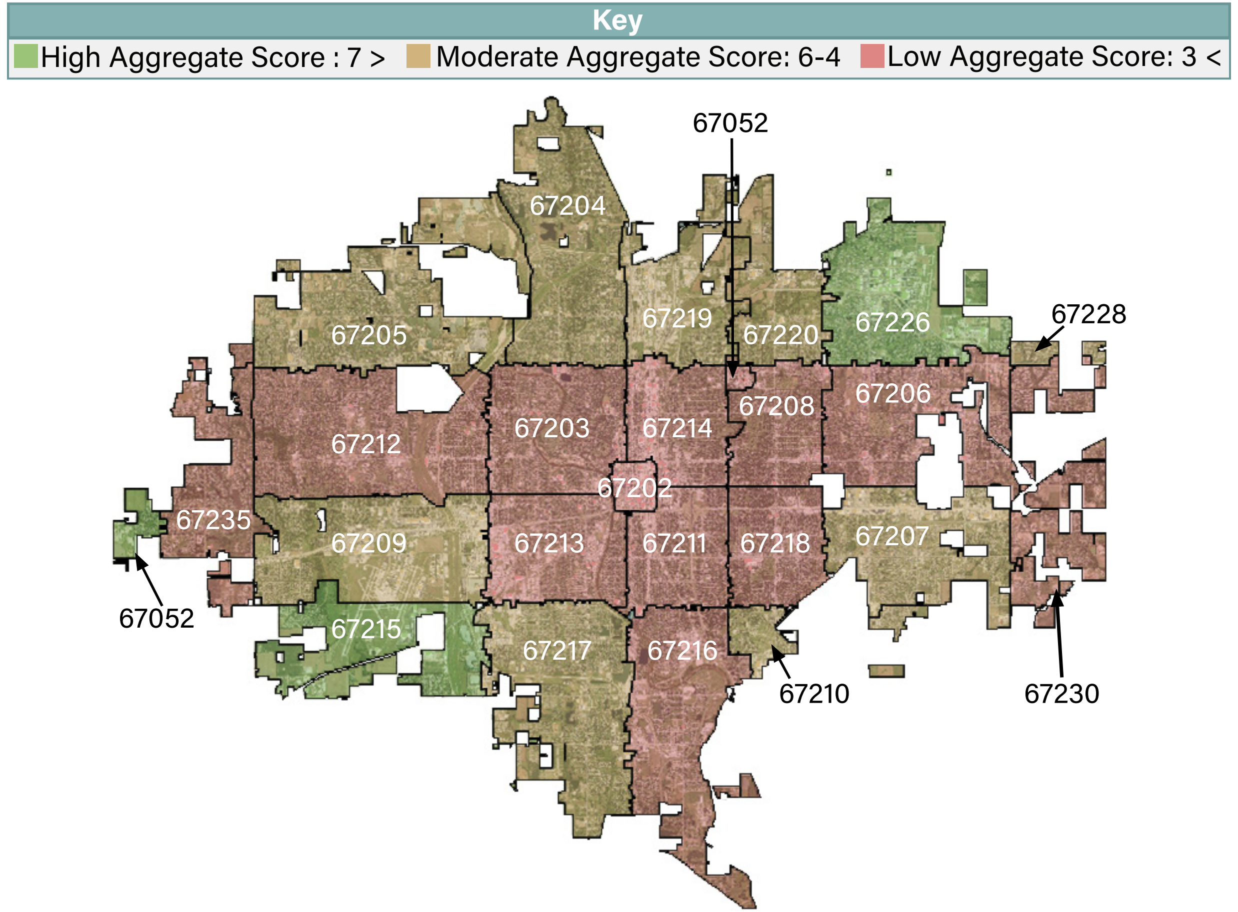


Figure 4.8: Aggregate Score

Aggregate Score & Summary

Table 4.5 and Figure 4.8. display an aggregation of all of the values from Tables 4.1-4.4. To arrive at these composite scores each variable was given a score of 0, 1 or 2, based on how each ZIP code area scored in that particular metric. A "0" was given for low scores (red), a "1" for moderate scores (yellow), and a "2" was assigned to metrics that scored high (green). A total score was then generated for each ZIP code area by adding up the individual metric scores for that area. The total score served as an indication of which areas would need the most attention moving forward.

Results

The composite scores occurred between 8, which is a perfect score, and 1. The areas that had a total score above 7 were considered to have a high score, areas scoring between 6 and 4 were deemed moderate, and the areas with a total score of 3 or lower were labeled low. The areas that scored the highest were located around the perimeter of the city, and as in many of the individual metrics the scores dropped closer to the center of the city.

Each of these landscape metrics indicate a different issue within the landscape pattern. Moving forward the next section discusses some design strategies that could be implemented in order to address each of these unique issues.

4.3 Design Considerations & Program (Phase 01)

After gaining a better understanding of what issues are causing fragmentation, and how they are affecting the different areas of the site, design solutions were generated to help combat these issues. First, design considerations were produced to provide a more in-depth understanding of what each landscape metric is, and how the relate to fragmentation. Second, some key concepts were outlined to combating these issues. These design considerations were paired with some conceptual suggestions, which are simple high-level strategies that can be applied to any area that is not up to par in the corresponding landscape metric category.

After the conceptual solutions were generated, programmatic suggestions were made, which give more specific ways that these design issues could be addressed at the site-level. These programmatic suggestions are applied applications of some of the higher-level concepts from the conceptual suggestions section.

Amount of Green Space

Design Considerations:
The amount of green space is an important metric because if there is no green space then the rest of the metrics really do not matter. The presence of green space is particularly important to the quality of people's lives, and even more important to the way that people perceive the quality of their life. The issue comes when designers only consider landscape composition and fail to investigate landscape configuration.

It seems fairly obvious that in order to increase the amount of green space present within the landscape, it is important to locate spaces that can be converted into green spaces (Figure 4.9). The important thing is that metrics are taken into consideration during the planning and design of new green spaces. It is also important that designers do not assume that an area is not fragmented just because it has enough green space.

Conceptual Suggestions:

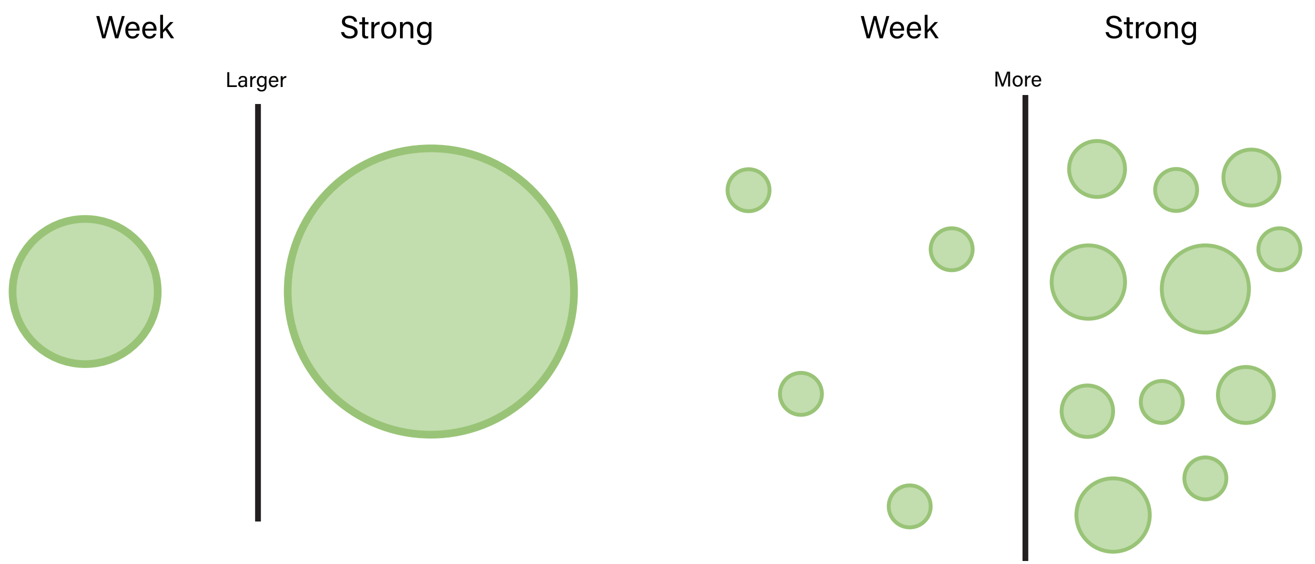


Figure 4.9: Spatial concepts for amount of green space (adapted from Kim 2010 and Dramsted 1996)

Aggregation

Design Considerations:
Aggregation is the measure of how likely patches of the same type will be located next to each other. The distance between patches plays a big role in the ability of organisms and other resources to move between patches. In many cases patch isolation can lead to higher chances of local extinction (Dramstad 1996).

To create more aggregated landscapes designers can incorporate and/or preserve smaller patches of green space between the larger patches. They can also implement linear green patches to provide a safe path of movement between patches. Finally, it is important to consider what is happening on the perimeter of and immediately adjacent to each patch, to ensure there is free movement in and out of the patch (Figure 4.10).

Conceptual Suggestions:

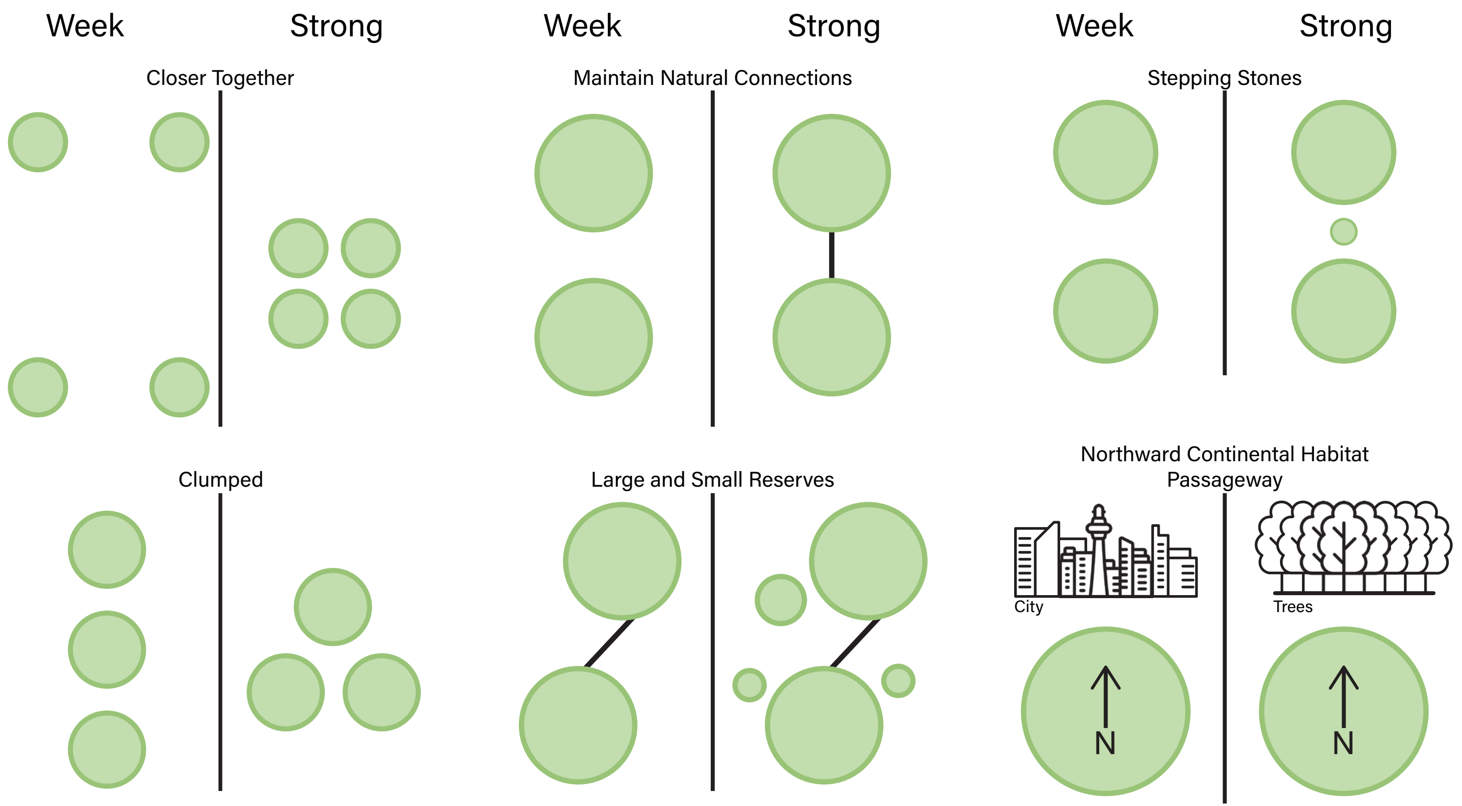


Figure 4.10 Spatial concepts for aggregation (adapted from Kim 2010 and Dramsted 1996)

Number of Patches

Design Considerations:
The number of patches is often a good indication of how fragmented a landscape is, because it can allude to how broken up a landscape is. While it may seem like having more green space patches is a good thing, this is not always true. A high number of patches often indicates that what was originally one large green patch is now divided into many smaller patches, which means the area is more fragmented.

To reduce the number of patches (Figure 4.11) and create a more cohesive landscape, designers should find areas were smaller green space patches can be consolidated, or connected by a smaller green space.

Conceptual Suggestions:

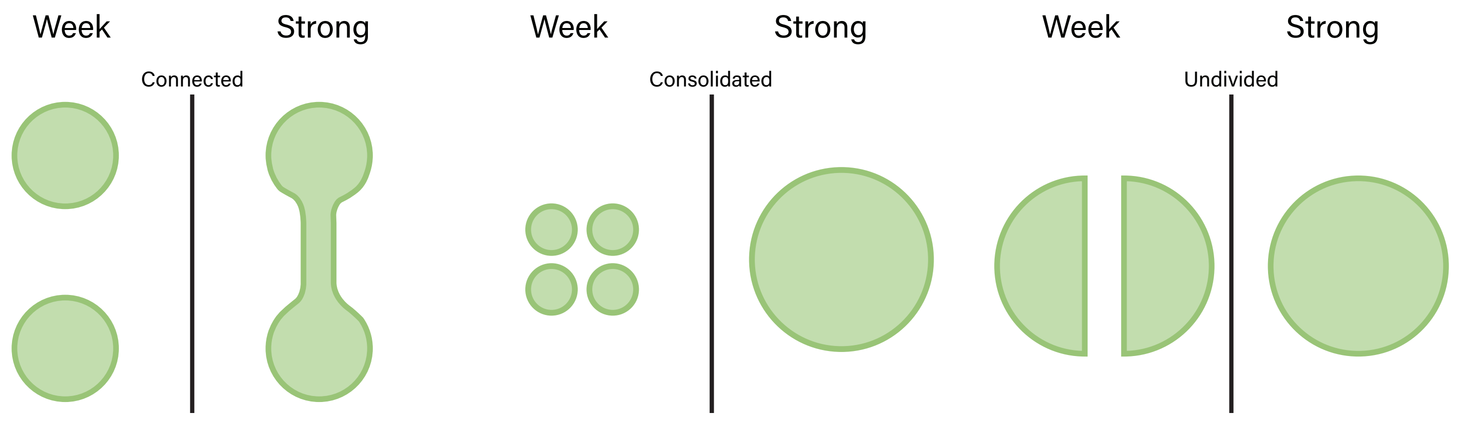


Figure 4.11 Spatial concepts for Numb of Patches (adapted from Kim 2010 and Dramsted 1996)

Average Patch Size

Design Considerations:
The average patch size is another indication of landscape fragmentation, because when the average patch is small, it means one of two things, either the landscape has very little green space, or the green spaces are very broken up. At the same time landscapes with larger patches have been proven to be capable of supporting more diverse and healthy ecosystems.

The average patch size can be increased by finding opportunities to expand green spaces, as well as finding ways to consolidate smaller spaces into one larger space (Figure 4.12).

Conceptual Suggestions:

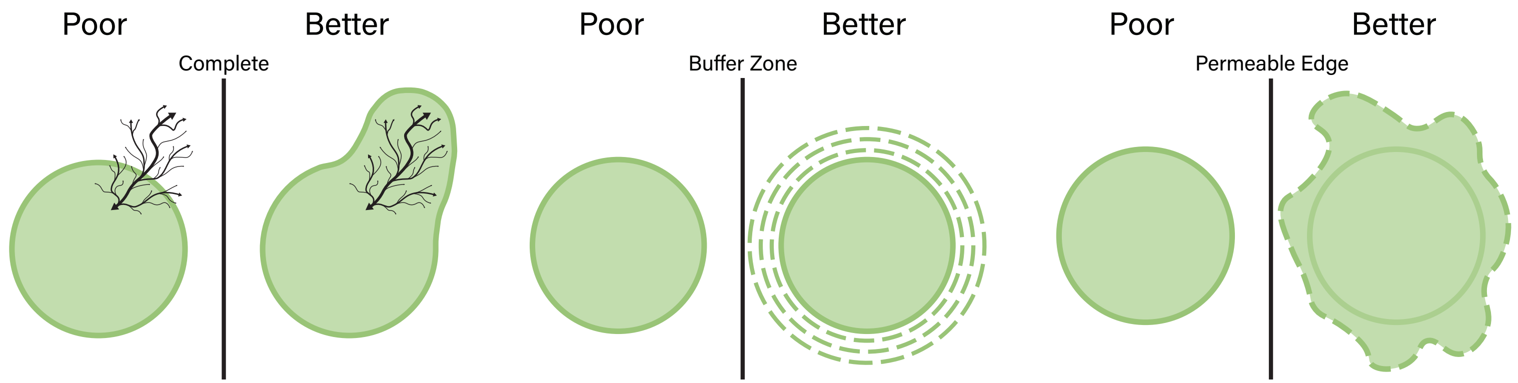
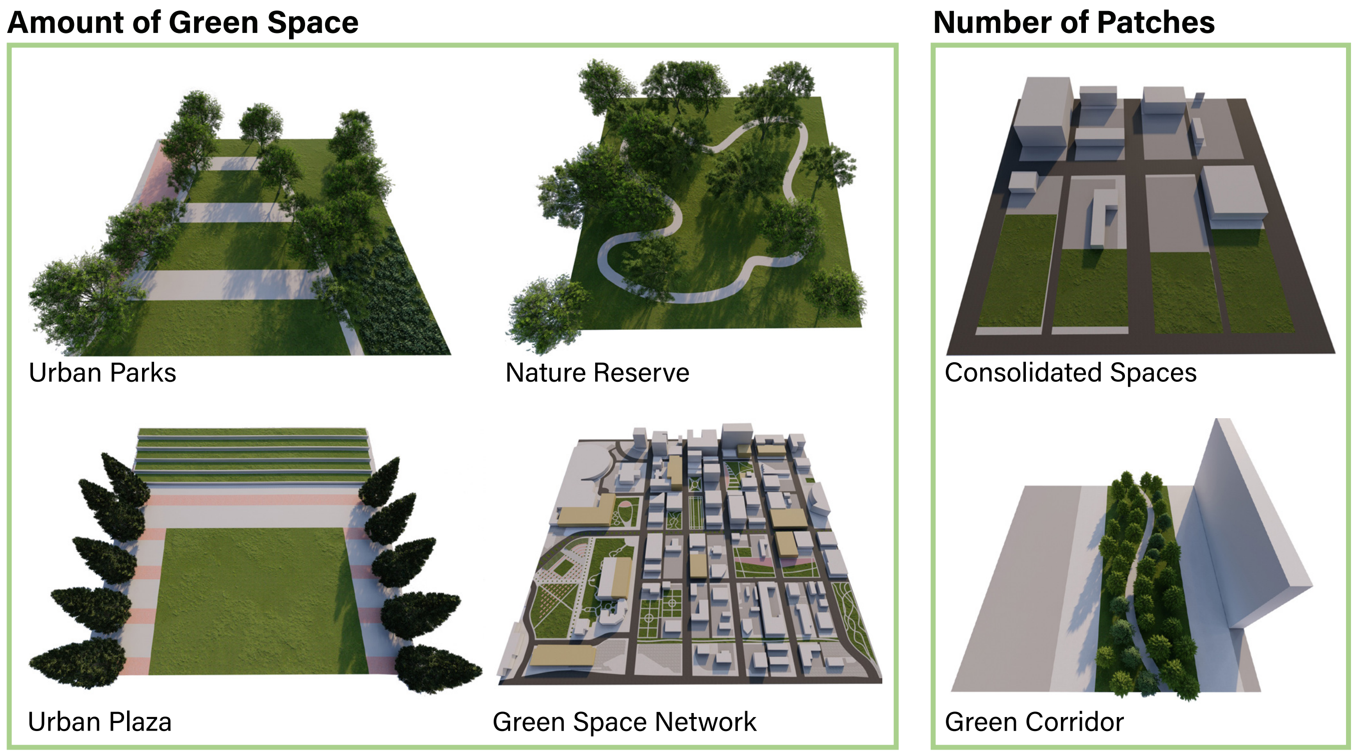


Figure 4.12 Spatial concepts for average patch size (adapted from Kim 2010 and Dramsted 1996)

Programmatic Suggestions for Landscape Metrics

These programmatic suggestions are applications of the conceptual suggestions in the urban setting. While some of these solutions can solve more than one of the problems, they have been placed into groups based upon which metric they most relate to (Figure 4.13).



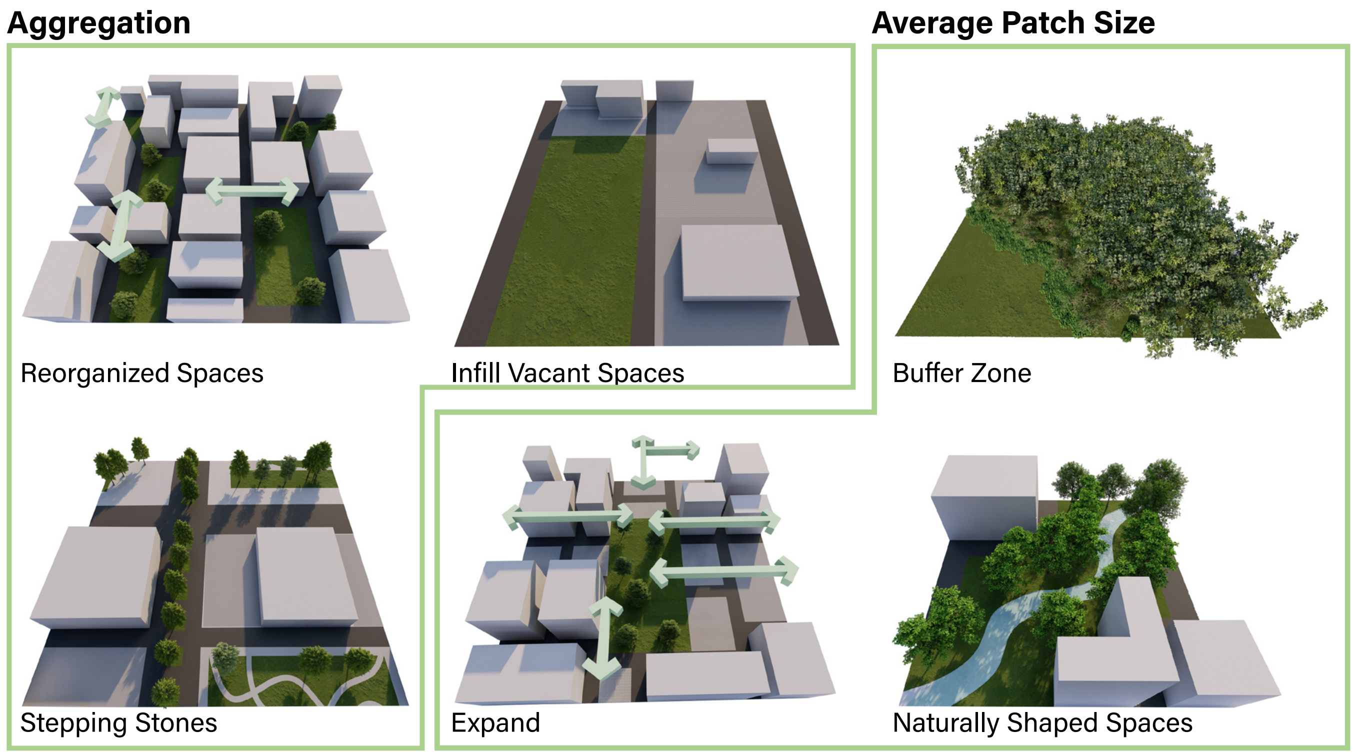


Figure 4.13: Programmatic Design Suggestions for landscape metrics.

Each of these programmatic suggestions is explored further in figures 4.14 through 4.26.

Progomatic Suggestions for Amount of Green Space

Urban Park

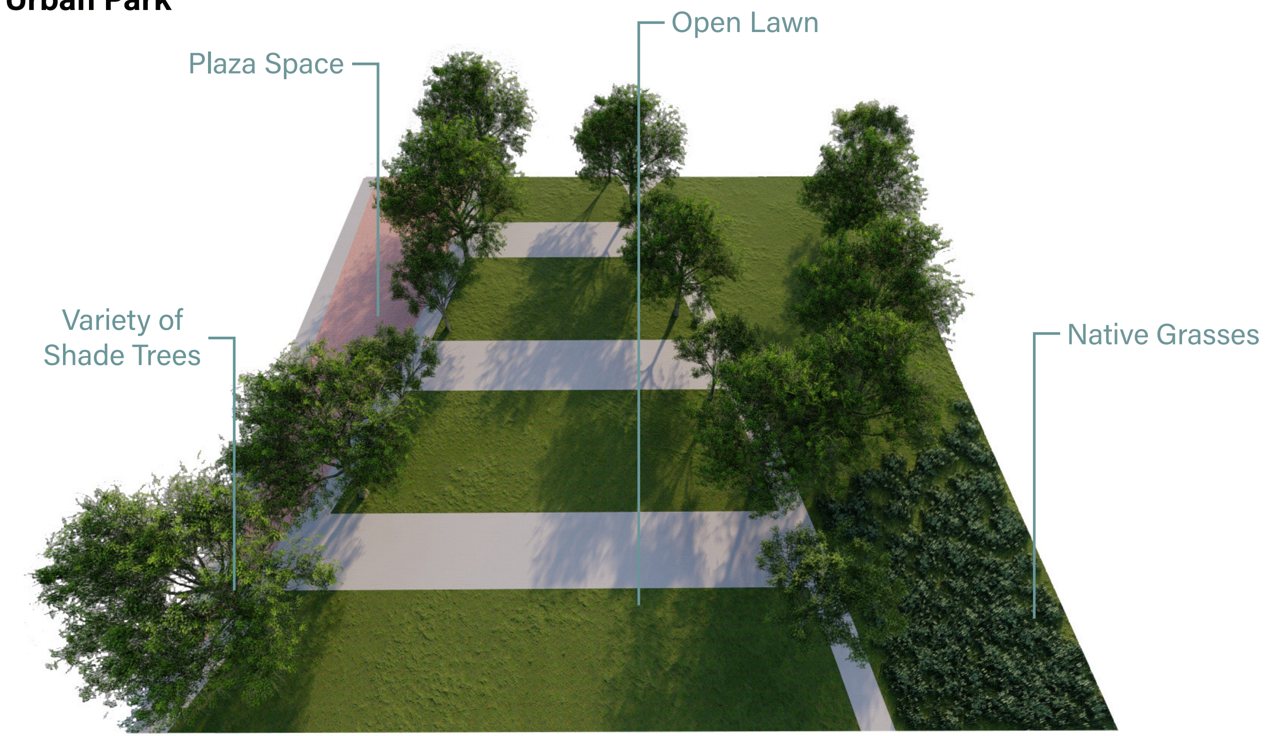


Figure 4.14: Urban Park

A park is not only a place where kids can go and play, but also spaces that can be very ecologically productive. Using diverse planting materials can create a variety of different habitats within and around urban parks .

Nature Preserve

Figure 4.15: Nature Preserve

Finding ways to preserve or restore patches of nature in the urban context is very important. At the same time allowing people to interact with these natural spaces in a minimally invasive way, can motivate them to care more about nature and ecology.

Urban Plaza

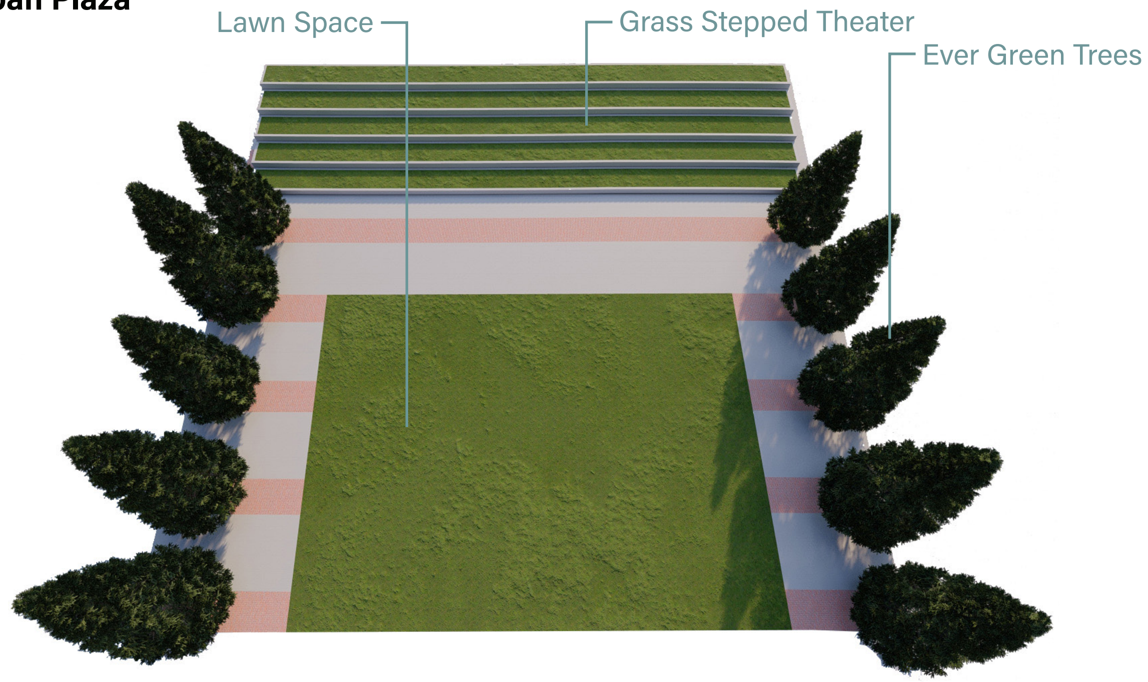


Figure 4.16: Urban Plaza

The conventional urban plaza is composed mostly of paved surfaces with maybe a few trees, but these spaces have the potential to be far more ecologically productive. By using plant material to accomplish some of the things that are usually done with hardscape, an urban plaza can become an effective way to introduce nature into the city.

Green Network

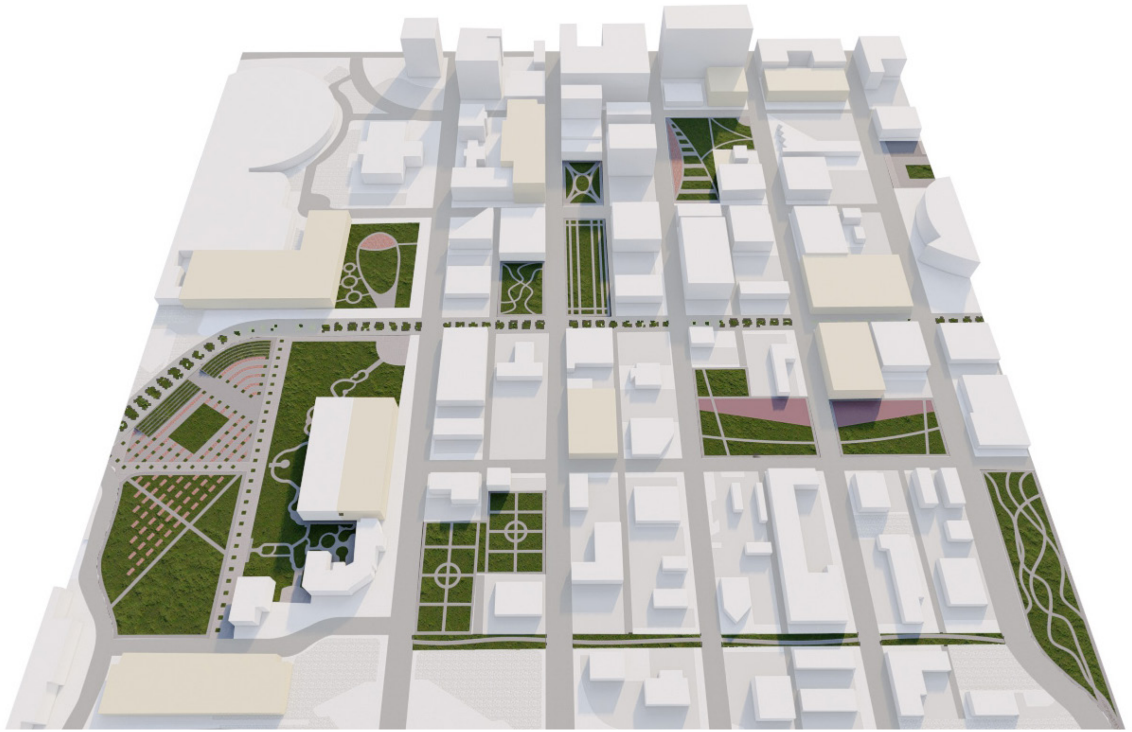


Figure 4.17: Green Networks

Simply adding one or two green spaces at a time with little guidance is not enough. There needs to be a large-scale plan that helps that organize and connect existing, potential and new green spaces within the city.

Progromatic Suggestions for Number of Patches

Consolidate Spaces

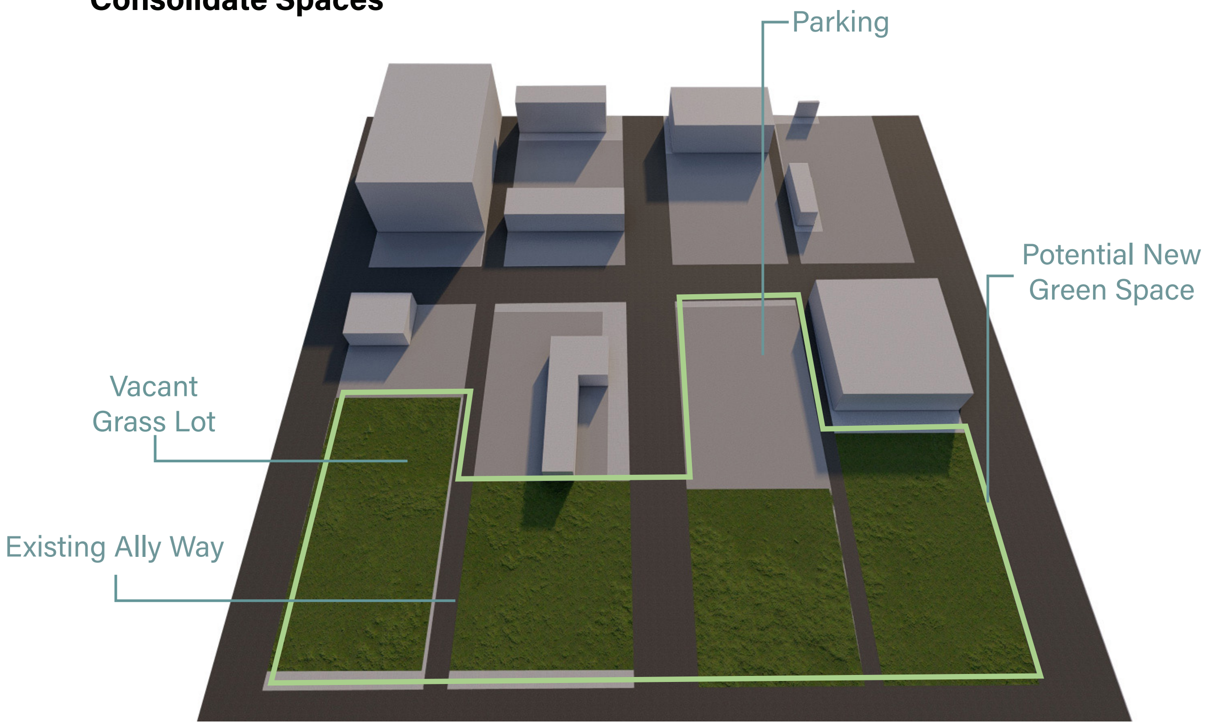


Figure 4.18: Consolidate Spaces

The urban environment is a mosaic of different land uses, and sometimes within this mosaic are areas where several vacant lots, and/or underutilized parking lots, are located close to one another. Designers can use this as an opportunity to transform these spaces into one large green space.

Green Corridor

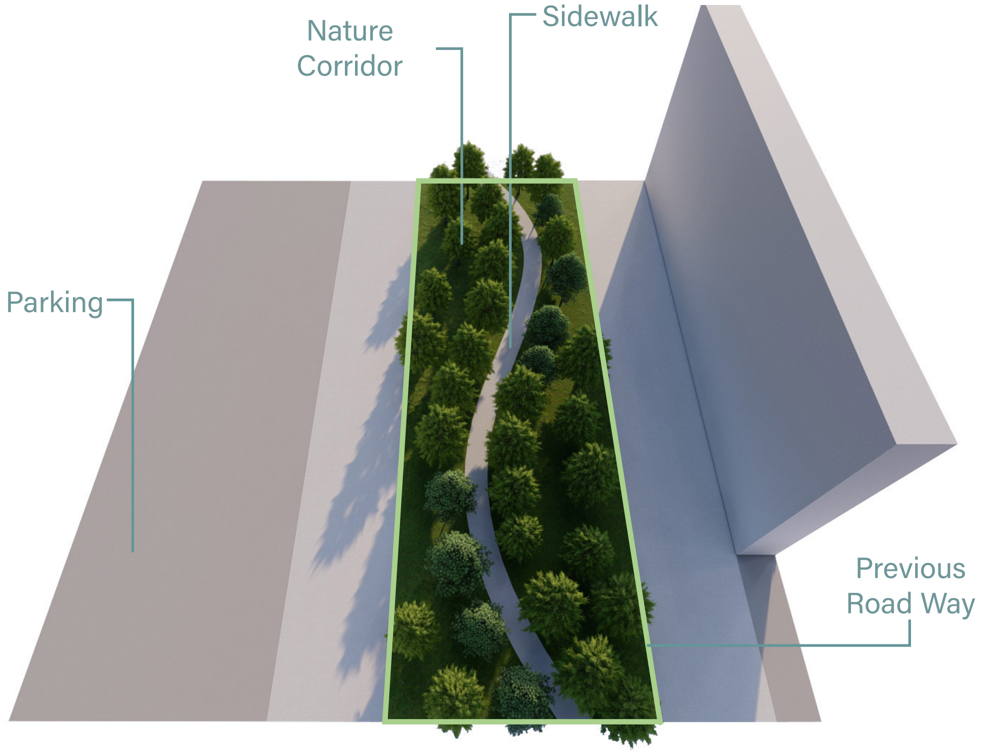


Figure 4.19: Green Corridor

Underutilized or unnecessary linear spaces like roads can potentially be converted into nature corridors, which can connect patches and help animals safely move between patches.

Progromatic Suggestions for Aggregation

Reorganize Spaces

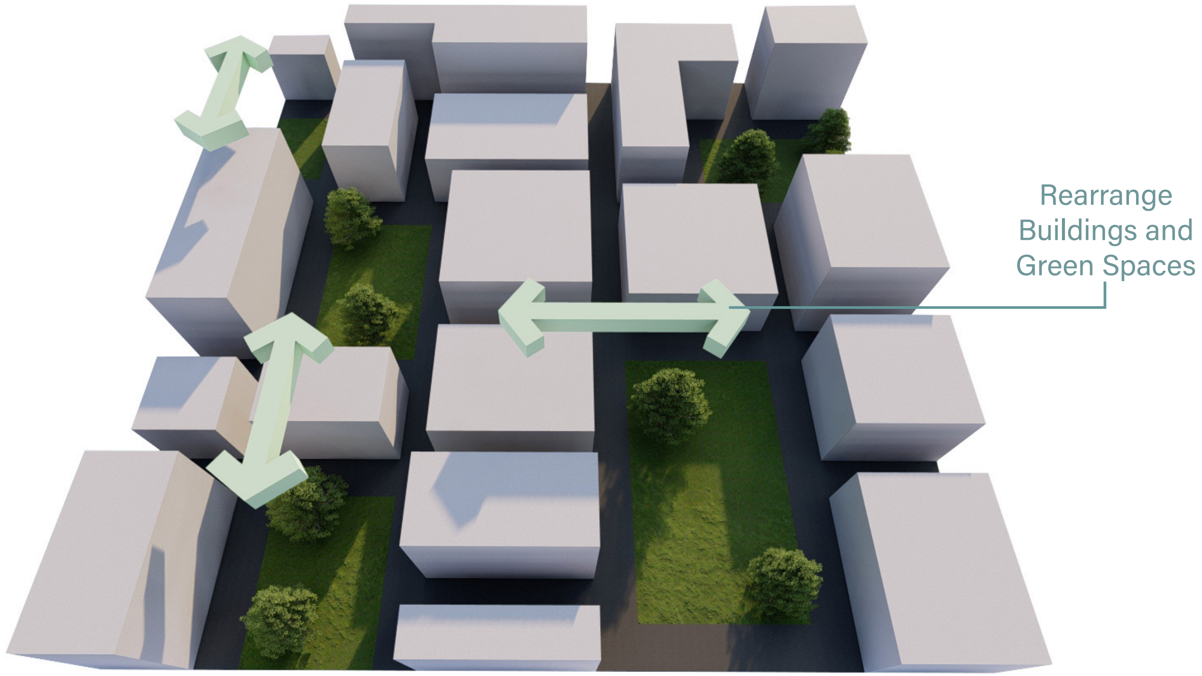


Figure 4.20: Reorganize Spaces

In some instances, green spaces are only surrounded by buildings, but in order to create less fragmented space, it may be necessary to move the buildings and green spaces around. While this may not always be possible in some cases it may be the only way to reduce fragmentation.

Infill Vacant Spaces

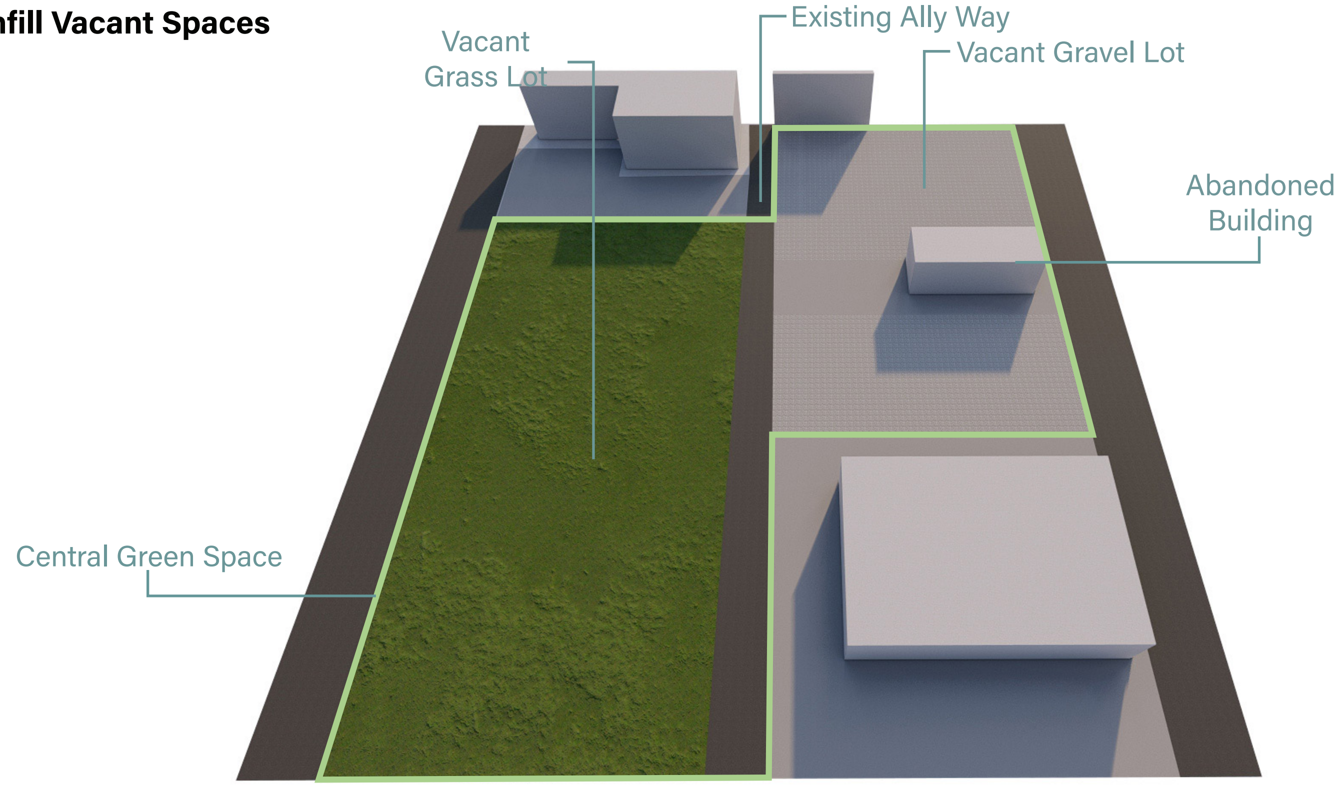


Figure 4.21: Infill Vacant Spaces

Areas with vacant lots or abandoned buildings are valuable spaces in the landscape, which have the potential to be developed as green spaces, especially when they are close to other green spaces.

Stepping Stones

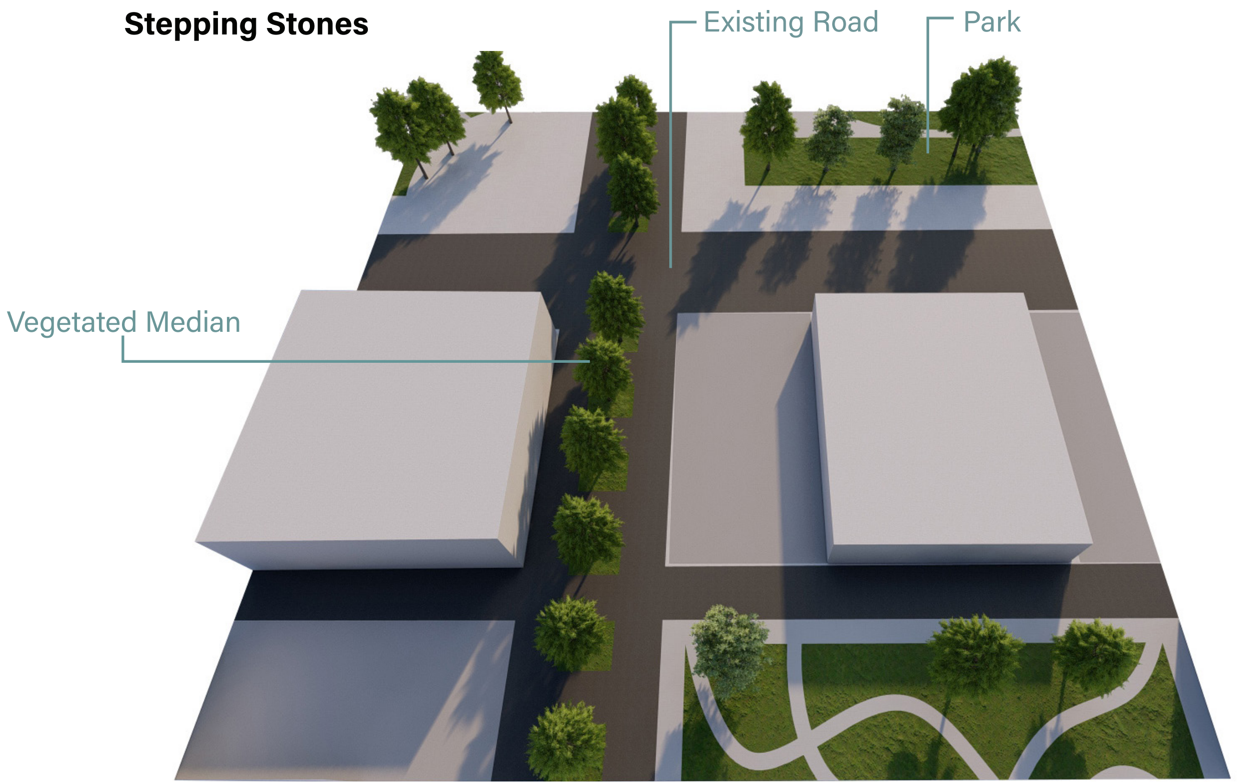


Figure 4.22: Steppingstones

Stepping stones are small patches that occur between larger habitats which reduce the distances that organisms must travel to move between habitats. This solution is particularly effective for the organisms that travel through the air.

Expand Green Spaces

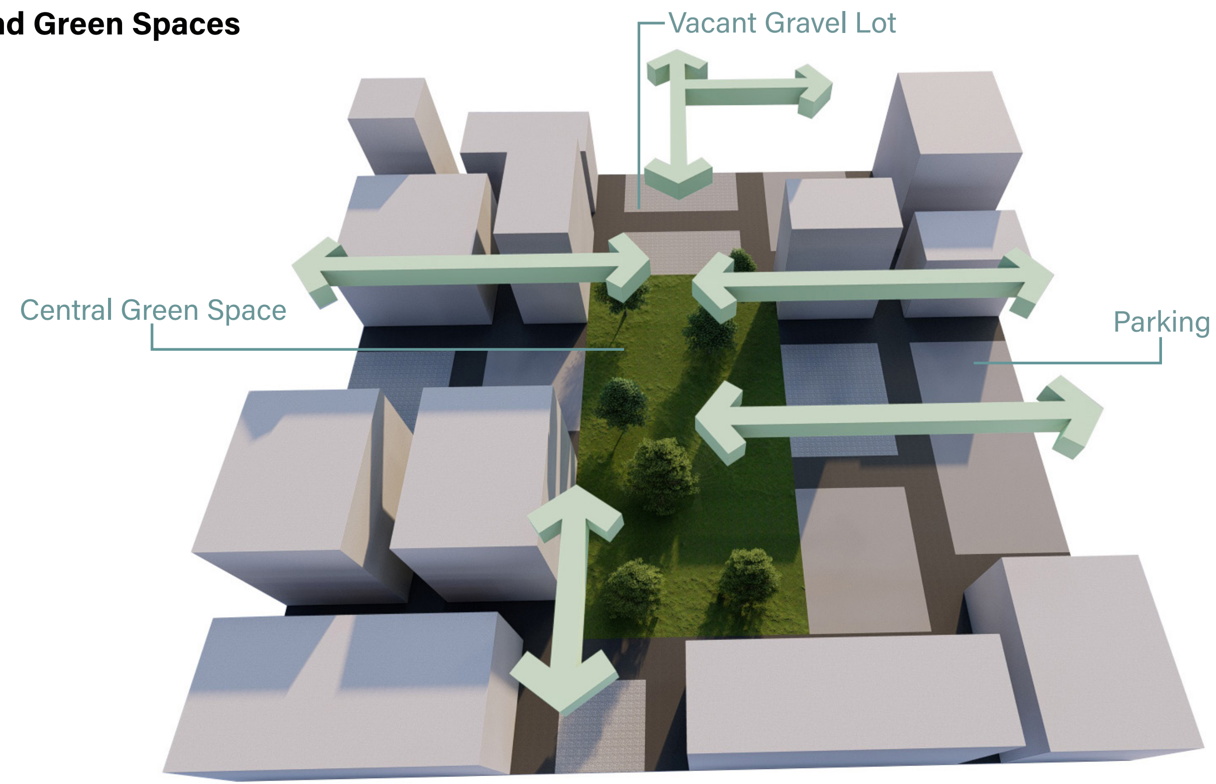


Figure 4.23: Expand Green Spaces

Often times green spaces are surrounded by vacant spaces or underutilized parking lots. This situation presents an opportunity to expand the green space and crate larger and more connected patches.

Buffer Zone

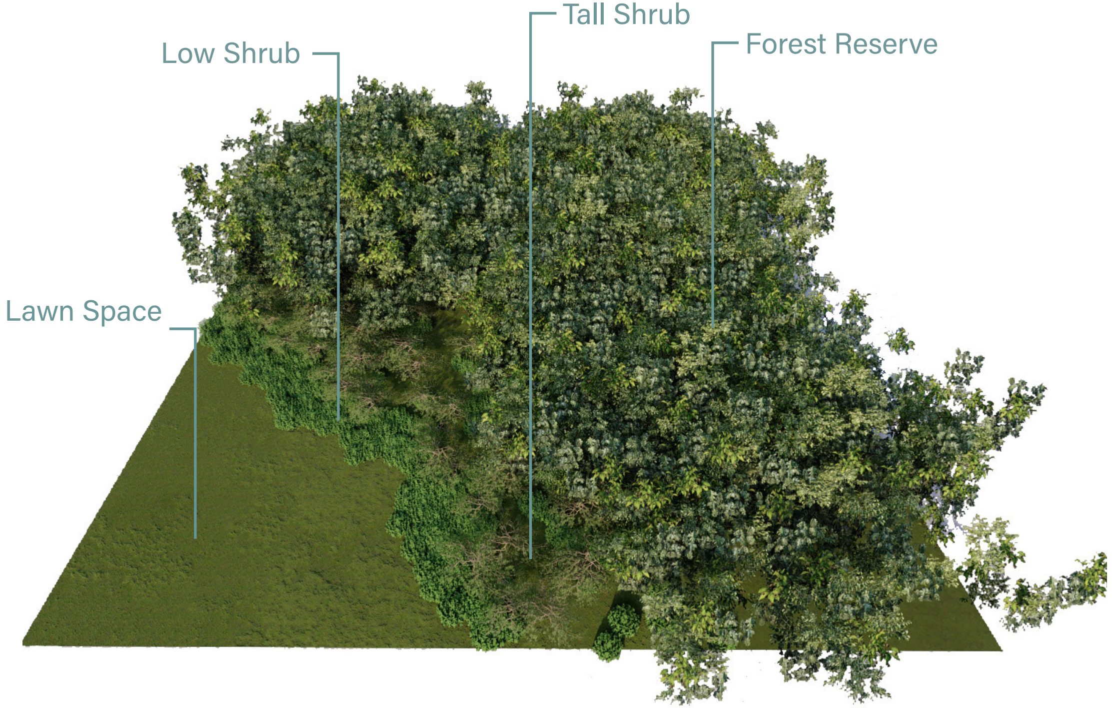


Figure 4.24: Buffer Zone

Creating a buffer zone in the landscape can help organisms realize when they are leaving a habitat, and make the transition between different habitat areas easier. They can also help people have some interactions with organisms without interrupting the organisms habitat.

Naturally Shaped Spaces

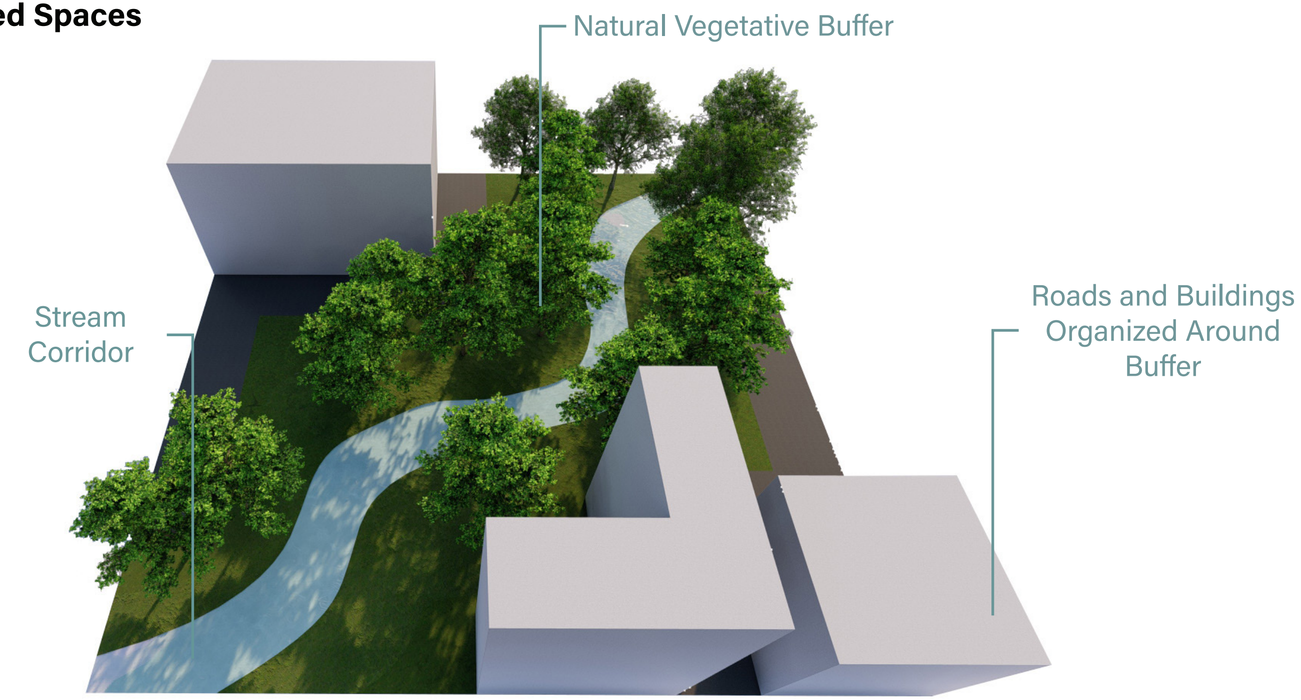


Figure 4.25: Naturally Shaped Spaces

There are certain elements in the landscape like stream corridors or topographic features that occur in organic shapes. When developing close to these areas, it is important to let these features maintain their natural shapes to promote the natural movement of organisms. This may mean developing in an unconventional pattern.

4.4 Landscape Metric Patterns (Phase 01)

To gain a better understanding of how and where to apply the design suggestions, the FRAGSTATS data was reexamined to identify patterns among the strengths and weaknesses of each ZIP code area (Table 4.6 and Figure 4.26). As a result, the ZIP code areas were placed into three different groups: 1) areas that scored high or moderate in each category; 2) areas that had a low number of patches; and, 3) areas with a low percentage of land, which often led to low scores in many of the other categories.

	Aggregation Grass (AGG)	NP Grass (NP)	Area Weighted Mean-Grass (AM)	PLAND Green Space (PLA)	Total
67052	2	2	2	2	**8**
67202	0	2	0	0	**2**
67203	1	1	1	0	**3**
67204	1	1	1	1	**4**
67205	1	0	2	1	**4**
67206	1	0	1	1	**3**
67207	1	1	1	1	**4**
67208	1	1	1	0	**3**
67209	1	1	1	1	**4**
67210	1	2	1	1	**5**
67211	1	1	1	0	**3**
67212	1	0	1	0	**2**
67213	1	1	1	0	**3**
67214	1	1	1	0	**3**
67215	2	1	2	2	**7**
67216	1	0	1	1	**3**
67217	1	1	1	1	**4**
67218	1	1	1	0	**3**
67219	2	1	1	1	**5**
67220	1	1	1	2	**5**
67226	2	2	2	2	**8**
67228	1	2	1	1	**5**
67230	1	1	1	0	**3**
67235	1	0	1	0	**2**
67260	0	2	1	0	**3**

Table 4.6: Landscape Metric Trends

Key
- All Moderate/High
- Low NP
- Low PLA

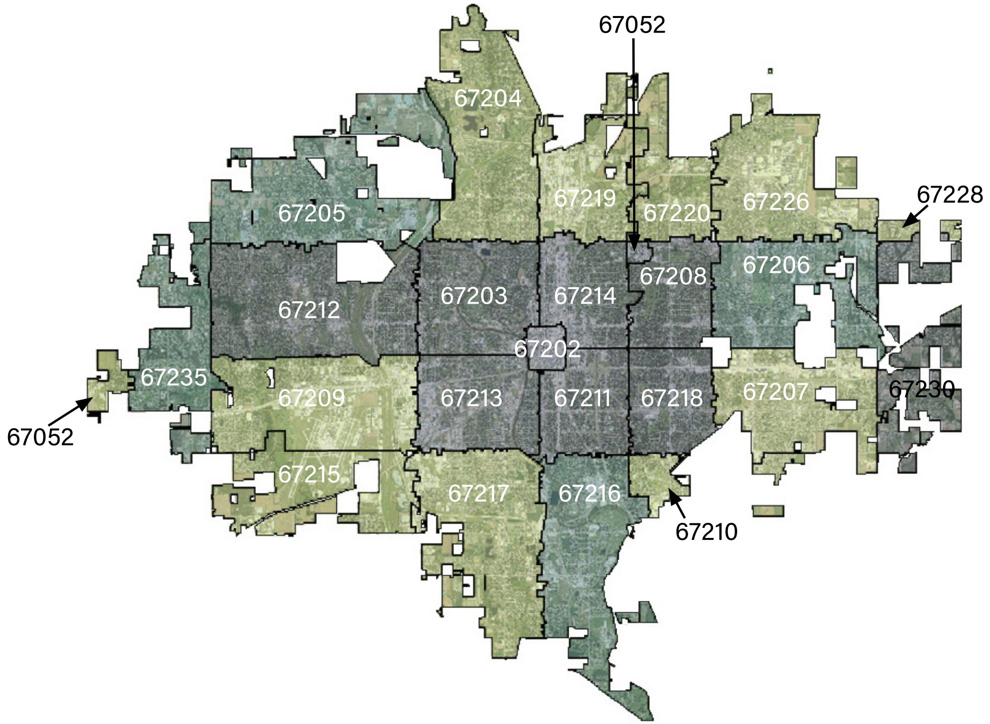


Figure 4.26: Landscape Metric Trends

These patterns are represented visually in figures 4.27-4.29 and tables 4.7-4.9. A graph was created by plotting the scores for each of the four metrics along four separate axes. The metrics that the area scored lower in were plotted closer to the center, and the metrics that scored higher were plotted closer to the edge. These graphs clearly display the common strengths and weaknesses that the ZIP code area groups were based upon.

Key

High Aggregate Score | Moderate Aggregate Score | Low Aggregate Score

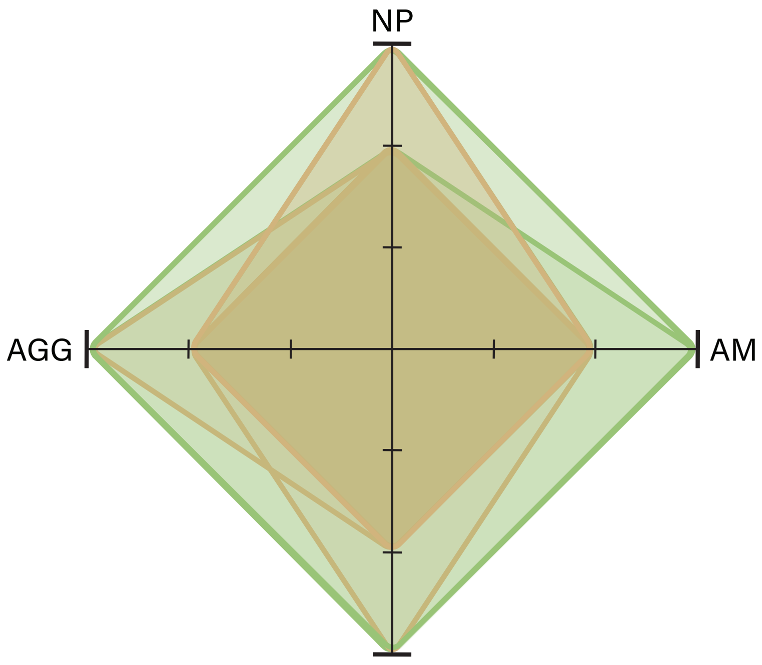


Figure 4.27: All Moderate/High

The ZIP code areas that were placed in this group scored high or moderate in every landscape metric category, resulting in total scores ranging between 4 and 8. This is clear in figure 4.27 as all the sides of the graph are occupied.

Table 4.7: All Moderate/High

	Aggregation Grass (AGG)	NP Grass (NP)	Area Weighted Mean-Grass (AM)	PLAND Green Space (PLA)	Total
67052	2	2	2	2	8
67204	1	1	1	1	4
67207	1	1	1	1	4
67209	1	1	1	1	4
67210	1	2	1	1	5
67215	2	1	2	2	7
67217	1	1	1	1	4
67219	2	1	1	1	5
67220	1	1	1	2	5
67226	2	2	2	2	8
67228	1	2	1	1	5

Key

High Aggregate Score | Moderate Aggregate Score | Low Aggregate Score

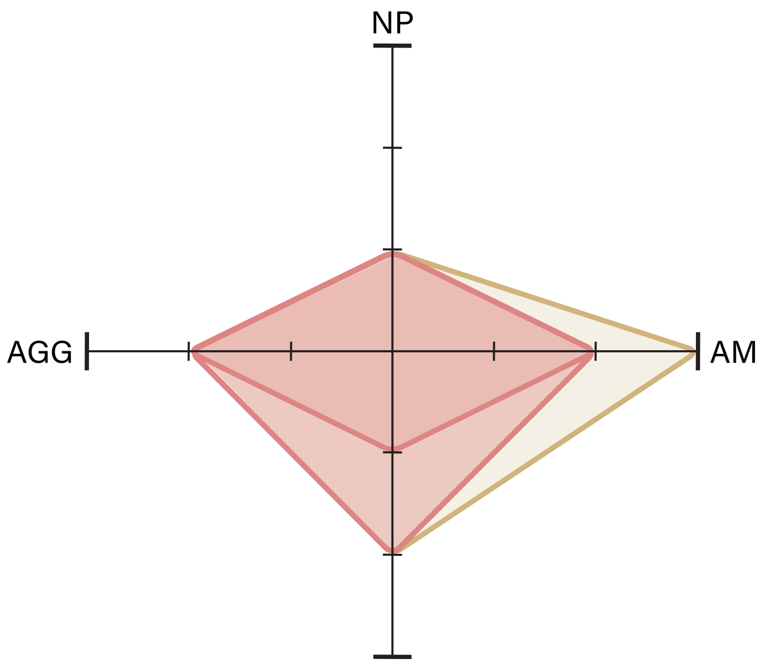


Figure 4.28: Low NP

The ZIP code areas that were placed in this category all scored low in the Number of Patches Category, and did pretty well in the other categories resulting in scores ranging from 2-4. This is reflected in figure 4.28 where the top portion is missing.

Table 4.8: Low NP

	Aggregation Grass (AGG)	NP Grass (NP)	Area Weighted Mean-Grass (AM)	PLAND Green Space (PLA)	Total
67205	1	0	2	1	4
67206	1	0	1	1	3
67216	1	0	1	1	3
67235	1	0	1	0	2

Key		
High Aggregate Score	Moderate Aggregate Score	Low Aggregate Score

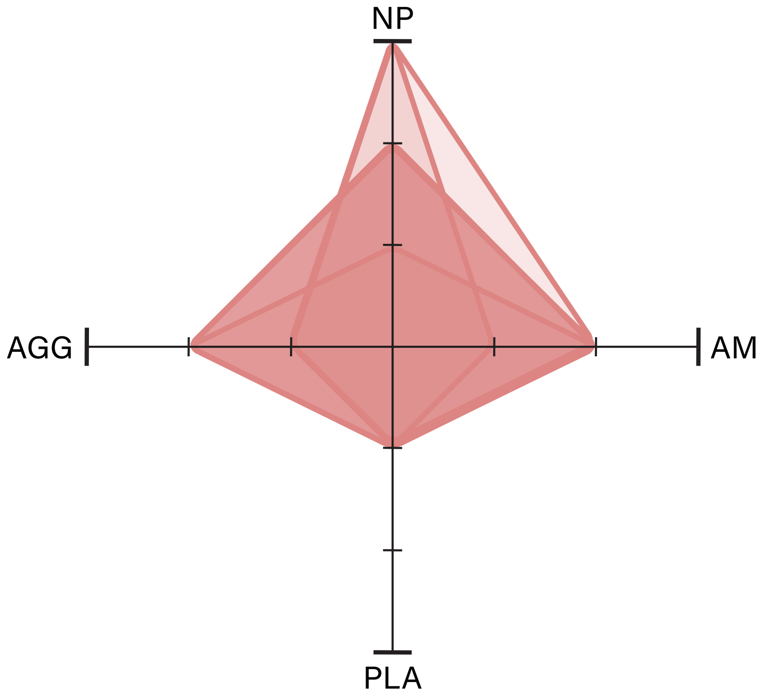


Figure 4.29: Low PLA

The ZIP code areas that were placed in this category all scored low in the Percentage of land category, and generally okay in the other landscape metric categories resulting in total scores of 2 and 3. This is clear in figure 4.29 as the bottom of the graph is empty.

Table 4.9: Low PLA

	Aggregation Grass (AGG)	NP Grass (NP)	Area Weighted Mean-Grass (AM)	PLAND Green Space (PLA)	Total
67202	0	2	0	0	**2**
67203	1	1	1	0	**3**
67208	1	1	1	0	**3**
67211	1	1	1	0	**3**
67212	1	0	1	0	**2**
67213	1	1	1	0	**3**
67214	1	1	1	0	**3**
67218	1	1	1	0	**3**
67230	1	1	1	0	**3**
67260	0	2	1	0	**3**

4.5 Urban Scale Landscape Design (Phase 01)

All Moderate/High

The ZIP code areas in this category are often located around the perimeter of the city and have the most undeveloped and agricultural land. As the city continues to expand these areas will most likely be developed. Figure 4.30 depicts the current state of ZIP code 67215 and figure 4.31 is an example of a potential development strategy for the area. The top priority for any design in these underdeveloped areas should be the preservation any naturalized areas. As the land gets developed buffer zones should be strategically implemented to create a transition between zones of human activity and nature (Dramstad 1996). The hedgerows in the agricultural areas could also be oriented in a way that allows them function as steppingstones between patches.

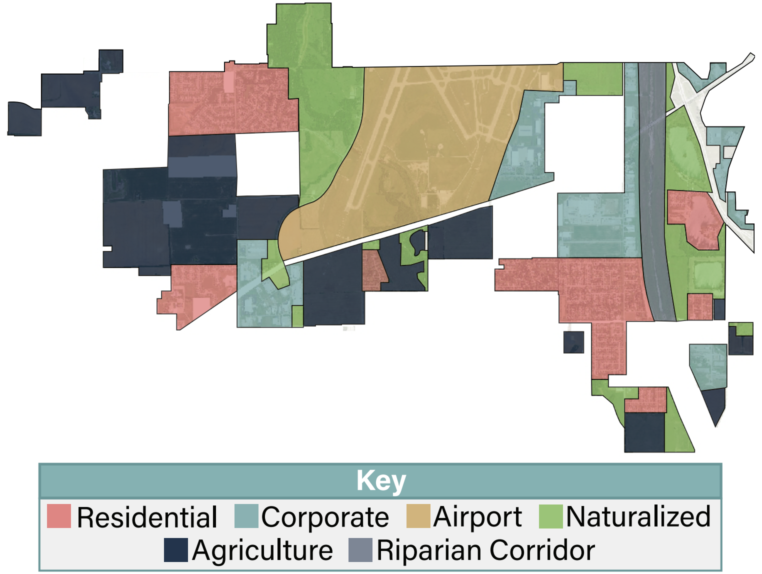


Figure 4.30: Study Area 01 (ZIP: 67215) Current State

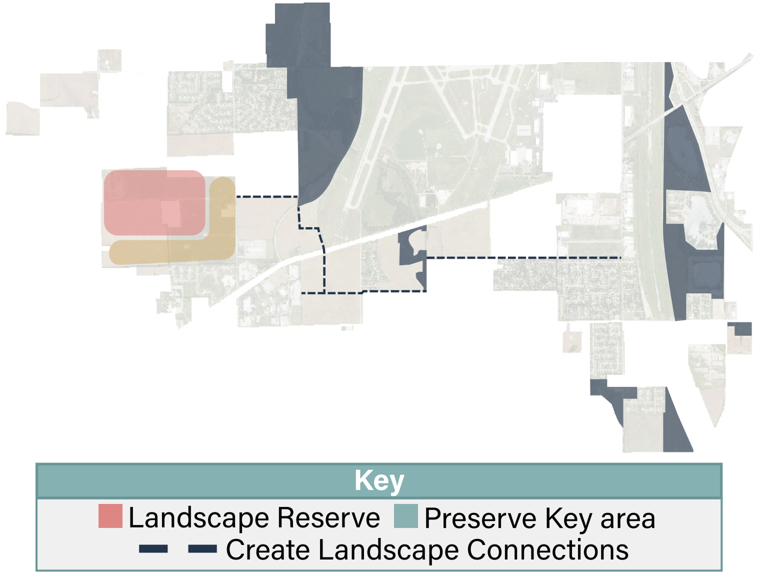


Figure 4.31: Study Area 01 (ZIP: 67215) Proposed Design

Low Number of Patches (NP)

The areas in this category also tend to be around the exterior of the city, but they typically did not to have as much green space. Figure 4.32 portrays ZIP code 67216 as it is today, and figure 4.33 introduces some design interventions that could help reduce the number of patches in the area. Introducing green passageways at some key points within the city could help provide connections between green spaces. There are also some opportunities to combine some of the green space, which would not only reduce the number of patches but also help increase patch area. A portion of the Arkansas River also runs through this area, which presents a unique opportunity to introduce a design feature that encourages people to interact with the river.

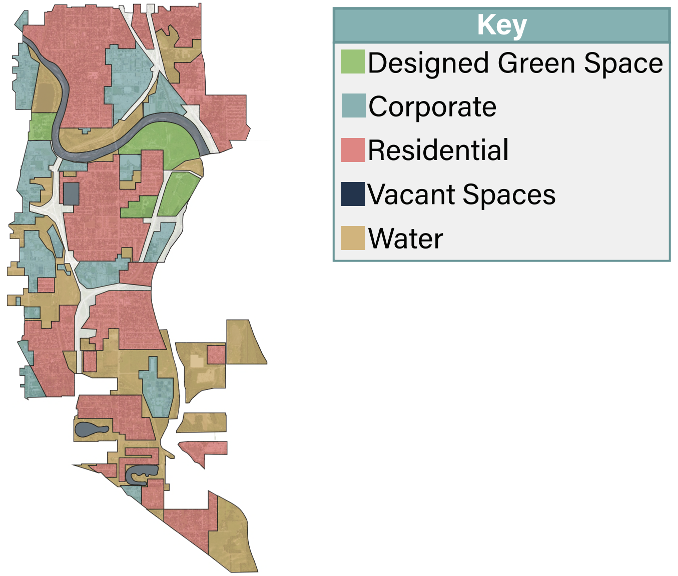


Figure 4.32: Study Area 02 (ZIP: 67216) Current State

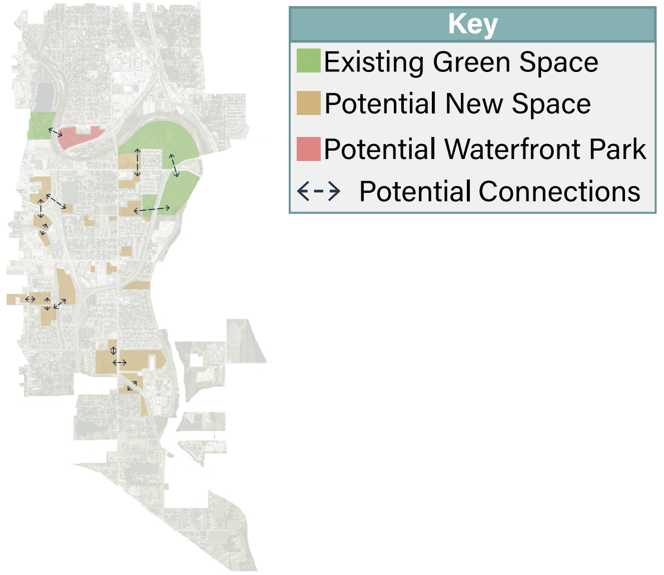
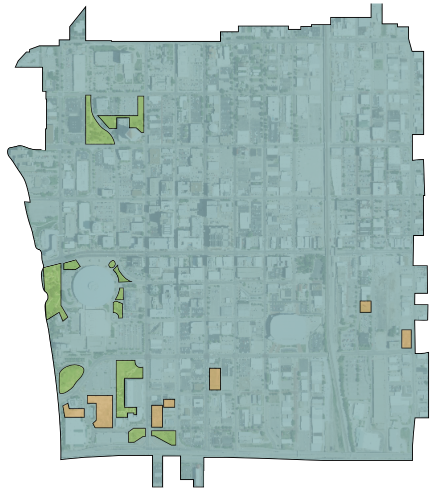


Figure 4.33: Study Area 02 (ZIP: 67216) Proposed Design

Low Percentage of Landscape (PLA)

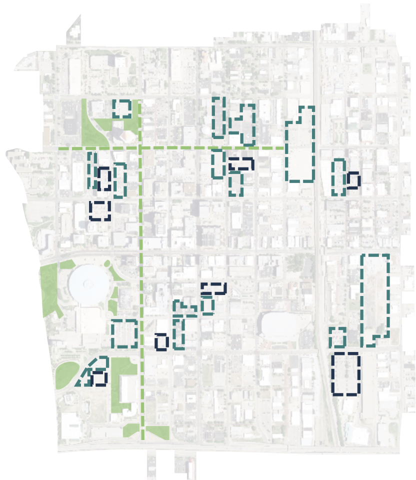
These areas are the most disturbed by development and tend to be closer to the urban core. The high level of development in these areas can make it difficult to find ways to incorporate green space. Figure 4.34 shows the current state of ZIP code 67202, and figure 4.35 identifies a few ways to increase the amount of green space in these areas. The area has a surplus of surface parking that is taking up a lot of valuable space. These surface lots could be consolidated into strategically placed parking garages. This would allow a good portion of the surface lots to be converted into urban green space. There is also a potential to create a few green corridors along some of the underutilized streets that run downtown, to create a more connected network of green spaces.



Key

Designed Green Space · Vacant Spaces · Built Up Areas

Figure 4.34: Study Area 03 (ZIP: 67202) Current State



Key

New Green Spaces · Proposed Green Corridor · Existing Green Space · Proposed Parking Structure

Figure 4.35: Study Area 03 (ZIP: 67202) Proposed Design

Site Selection

The first factor that went into selecting the site was the aggregate score for each ZIP code. There were three areas that tied for the lowest total score, all of which were located in the downtown core of Wichita. Out of these three ZIP codes 67202 was selected because within that area are some of the most important elements of the city. Venues such as Intrust Bank Arena and Century II, and major roads like Douglas Ave. along with Kellogg Ave. run through the area. The Arkansas River also runs adjacent to this area. Since this is still a fairly large area, the site boundary was limited to the area between Douglas Ave. to the north, Kellogg Ave. to the south, the Arkansas River on the East, and the railroad to the West (Figure 4.36).

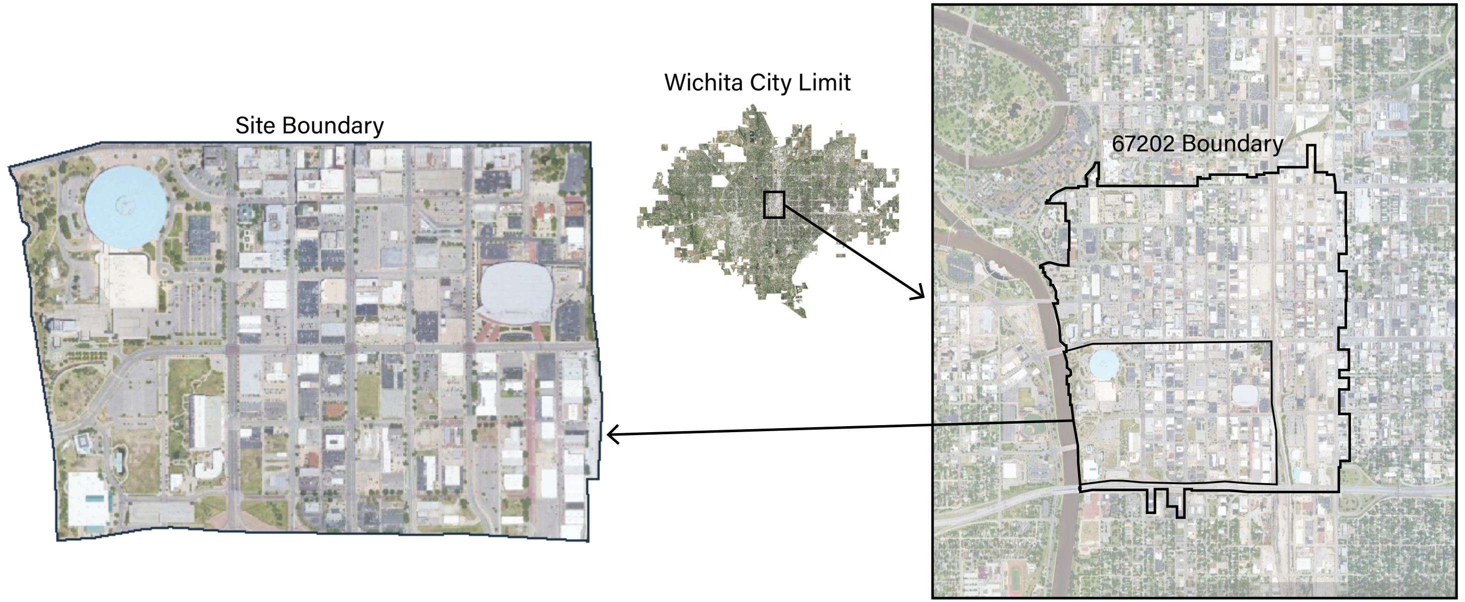


Figure 4.36: Site Scale Context

4.6 Site Scale Analysis (Phase 02)

Land Use Analysis

To create an effective green space design, you first have to understand the current state of the site. Surface parking makes up over 20% of the area, according to a parking analysis conducted in 2007 by Walker Parking Consultants. The study also revealed that only 52% of the parking spaces downtown are being used during peak occupancy hours, leaving over 15,600 empty parking spaces even at peak times (Parking and Mobility 2007).

The green spaces within the site boundary (Figure 4.38) are centered mainly around Century II and the riverfront. While these spaces do host a variety of different popular events throughout the year, they are not typically used on a day to day basis, and they are not very productive in terms of ecology.

The site also features a good number of vacant lots (Figure 4.45), some of which are unused grass fields, while the others are empty paved lots. The majority of these spaces are located in the southern part of the site near Kellogg.

There are also a few public and private plazas (Figure 4.46) throughout the site that provide opportunities for Wichitans to relax and enjoy the outdoors, but these spaces lack vegetation and other elements that could help reduce landscape fragmentation.

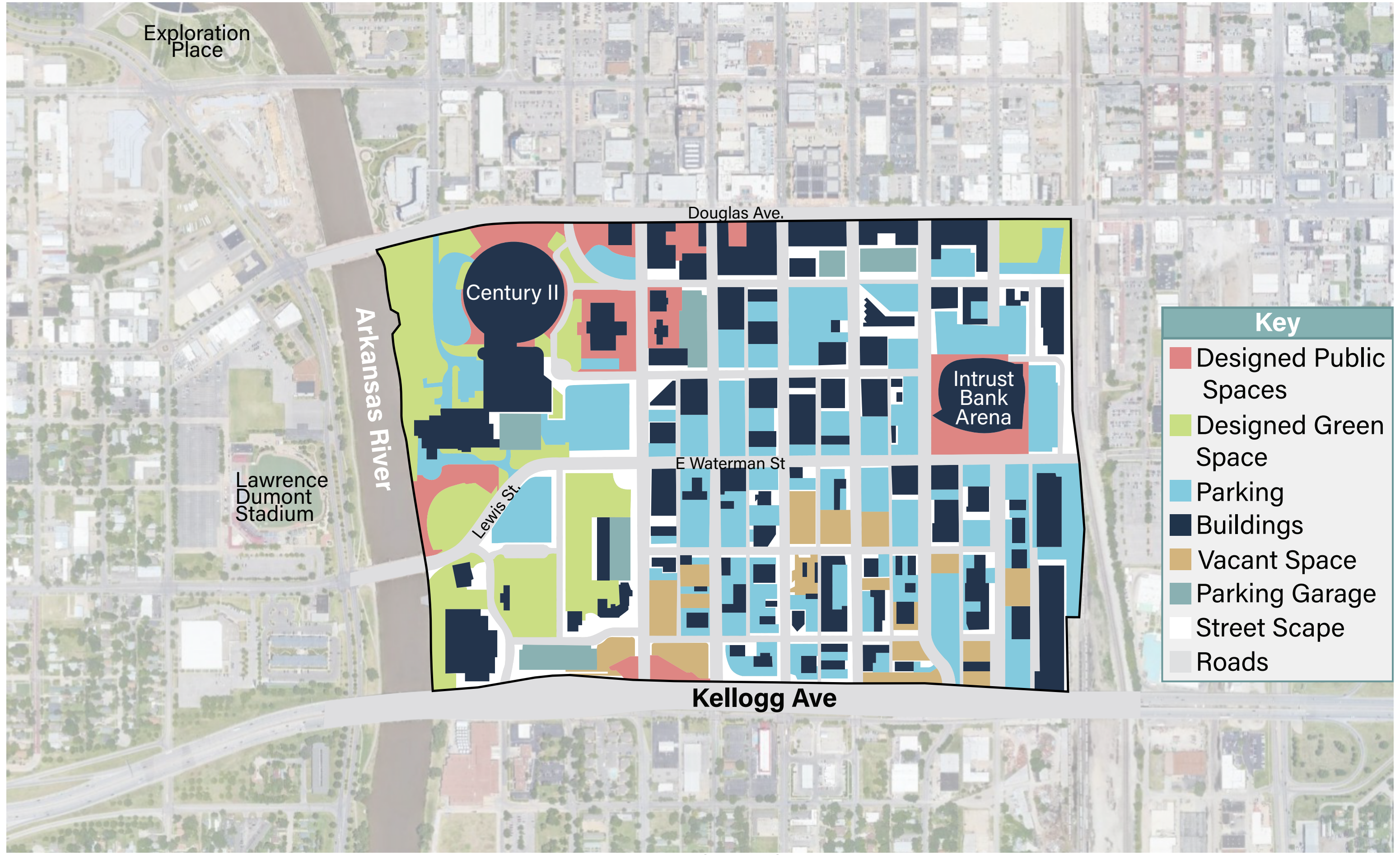


Figure 4.37: Site Land Uses

Existing Green Space

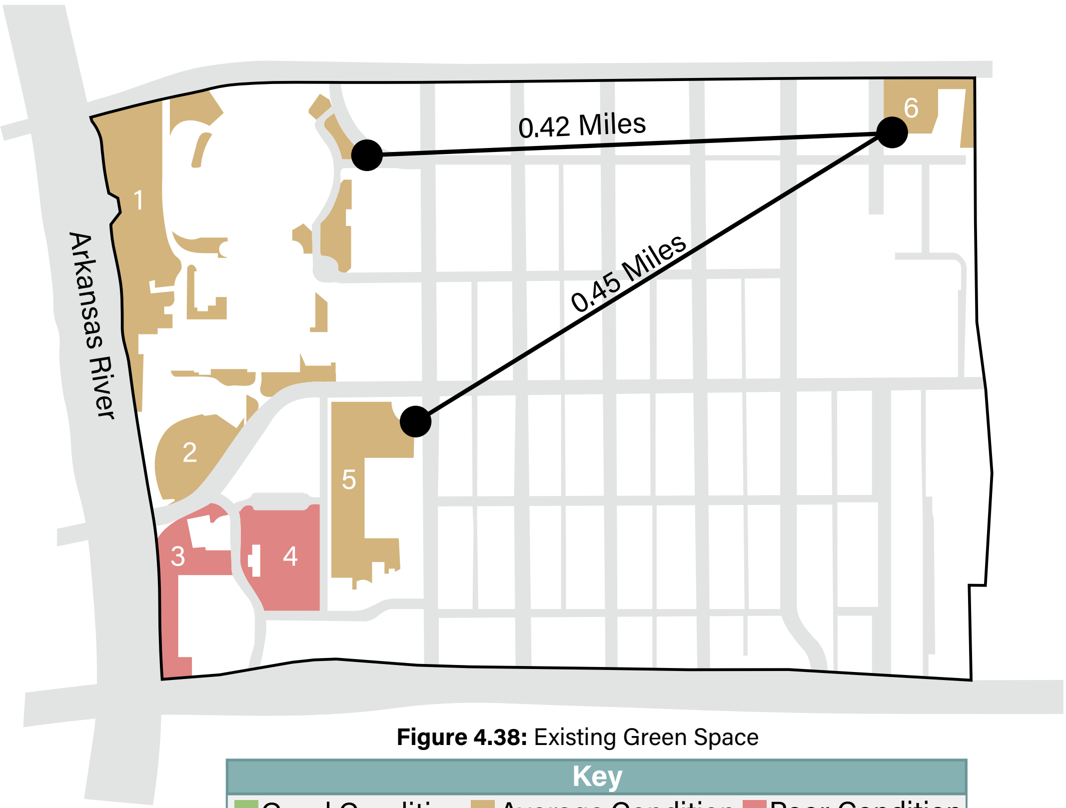


Figure 4.38: Existing Green Space

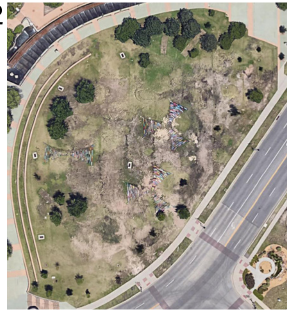
Key		
Good Condition	Average Condition	Poor Condition

This area of the city has very few green spaces, the majority of which are near or along the river. While these spaces are used at times throughout the year, enhancing the spaces could turn them into valuable assets that are used by a number of people on a daily basis.

#1

Century II Landscaping & Waterfront:
The landscaping around Century II features a variety of diverse green patches, however the river is very engineered in this area which limits its ecological function.

#2



Lewis Street Lawn:
This lawn is in a prime location next to the river and adjacent to the Hyatt water feature and fountain, and it features a number of different trees as well as some nice open space.

#3

Gander Mountain Landscaping:
The landscaping around the Gander Mountain building is mostly an empty lot. Along the river is a terraced landscape with many trees. The river its self is very controlled similar to the way it is further down.

#4

Fountains at Water Walk:
The fountains at the Water Walk feature a small fountain which could be a good source of water, but other than that is just an open lawn with very little biodiversity.

#5

Water Walk Apartments:
The area adjacent to the building is very nice and filled with a variety of different plants, along with a water feature and some lawn space. This small area is very productive but could be improved upon.

#6

Naftzger Park:
Naftzger Park is the only park space in the site boundary. It features a small pond and a diverse group of trees. While it is underutilized it is a valuable ecological asset. As part of a revitalization effort the park is in the process of being redesigned.

Vacant Spaces

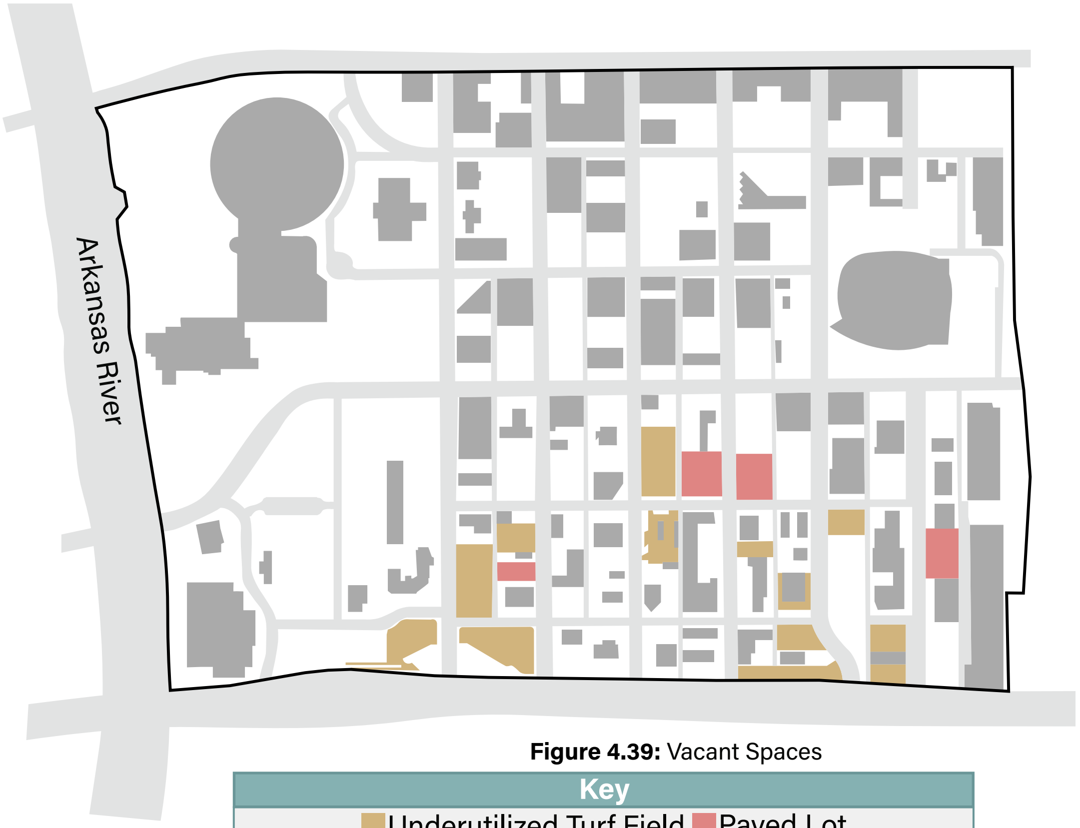


Figure 4.39: Vacant Spaces

Key
Underutilized Turf Field   Paved Lot

There are a variety of vacant spaces in the southern part of the site. Some of the lots are empty turf fields that are underutilized, the others are paved over lots that serve no purpose. Converting theses lots into useful and ecological diverse green spaces could be the first step towards creating a greener downtown.

Designed Public Spaces

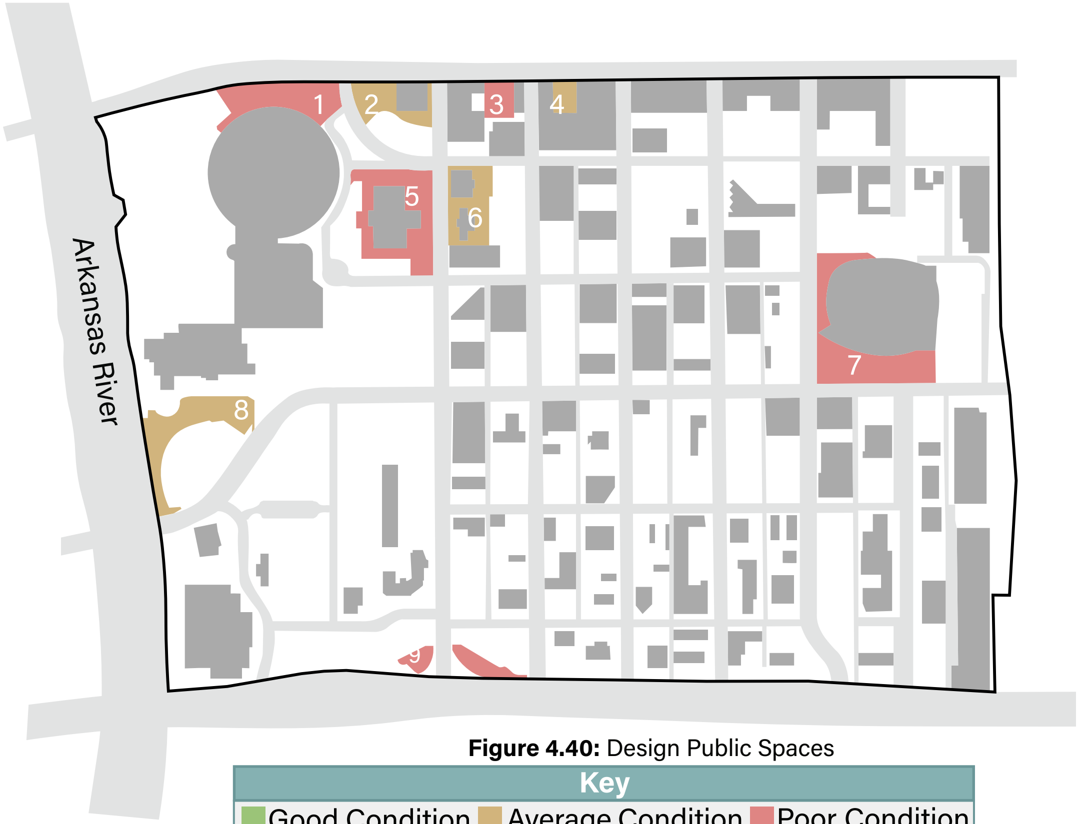


Figure 4.40: Design Public Spaces

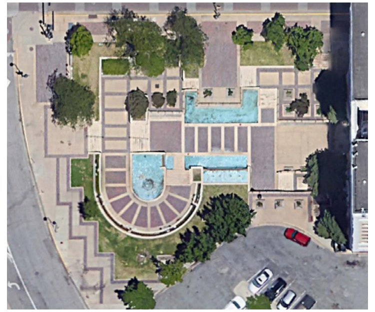
Key
Good Condition   Average Condition   Poor Condition

While there are not very many public plaza spaces within the site, the spaces that are present are some of the most relevant public spaces in the city. From an ecological prospective many of these sites could be improved. For the most part they are composed of hardscape and lack trees or other landscape features that would allow them to contribute to the ecological health of the site.

#1

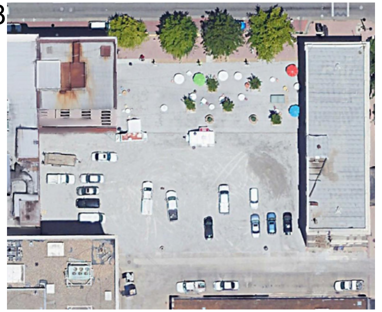
Century II Entry Plaza:
The entry plaza in front of Century II is a large paved over space that features two small water features and very few trees or vegetation, preventing it from reaching its ecological potential.

#2



Finlay Ross Park:
This sunken plaza has a diverse group of trees as well as some lawn space and few fountains, making it a pretty good stepping stone.

#3

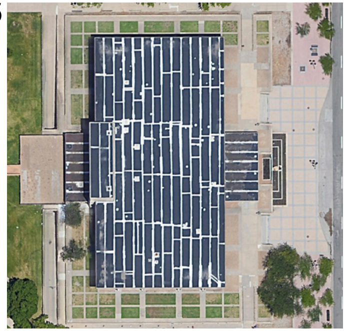


Douglas Popup Park:
This pop-up park mostly consists of a gravel lot with a few street trees on the northern edge. A lack of grass and other landscape features leaves a lot to be desired in terms of ecological productivity.

#4

Chester I Lewis Reflection Square Park:
This small urban plaza is very well-designed and does a good job of incorporating trees and shrubbery.

#5



Wichita Downtown Library:
The entry plaza and landscaping around the downtown branch of the library includes a few patches of lawn, making this area very plain and underwhelming. This asphalt roof also adds to the urban heat load.

#6

Lewis St. Lawn:
Heritage Square Park is a productive urban green space with a number of trees and other vegetation promoting ecological wellness.

#7

Intrust Bank Arena:
The plazas around the arena are mostly large paved surfaces with limited lawn and a few trees, all of which are the same species, which contributes to a lack of ecological diversity.

#8

Hyatt Fountains:
This fountain and the surrounding plaza are probably the most iconic water feature in downtown Wichita. The space does a good job of incorporating trees, but they are all the same species which may lead to a rapid decay if disease strikes.

#9

Kellogg and Main Intersection:
This intersection is a large visually interesting plaza, but it is mostly a sculptural space made entirely of brick. There are no trees in the designed portion of the space, but behind is a small lawn with a few trees.

Distance from Residence to Green Space

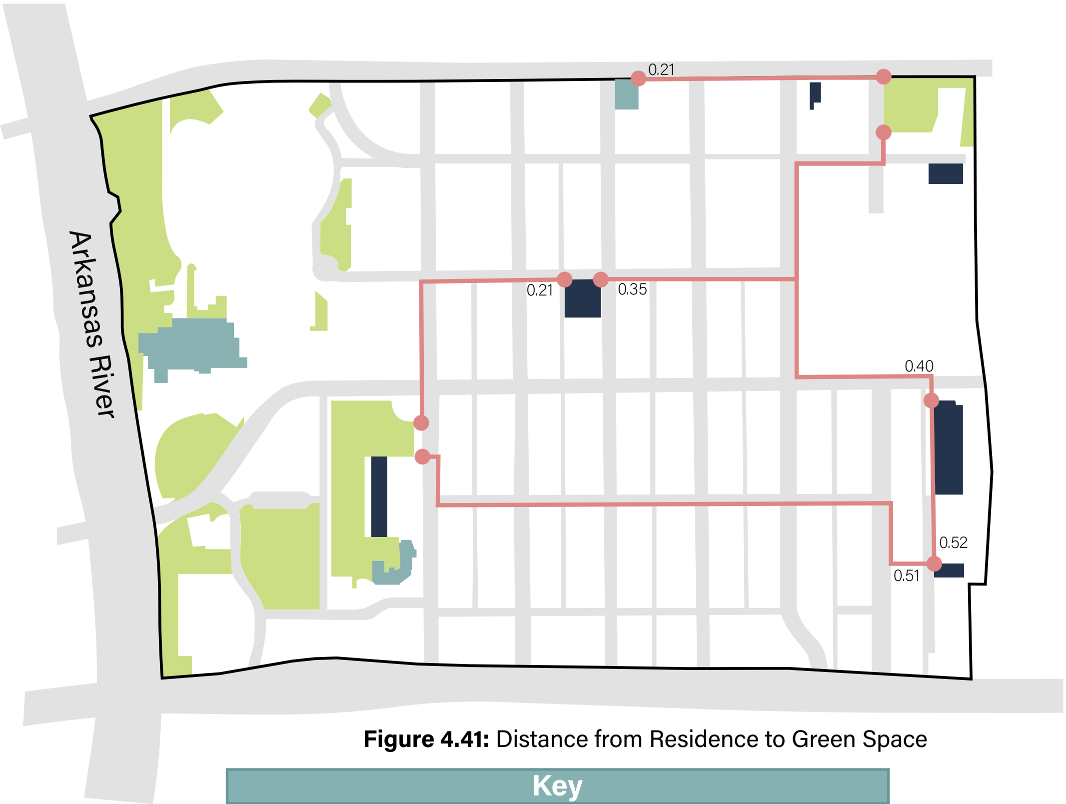


Figure 4.41: Distance from Residence to Green Space

Key		
Hotel	Apartment/Condo	Good Condition

There is a lack of green spaces in the south west part of the site causing one of the residences there to be over half a mile from the nearest green space. There are also three other residences and hotels that are between 0.20 and 0.4 miles from the nearest green space (Figure 04.56)

Composite Ecological Productivity

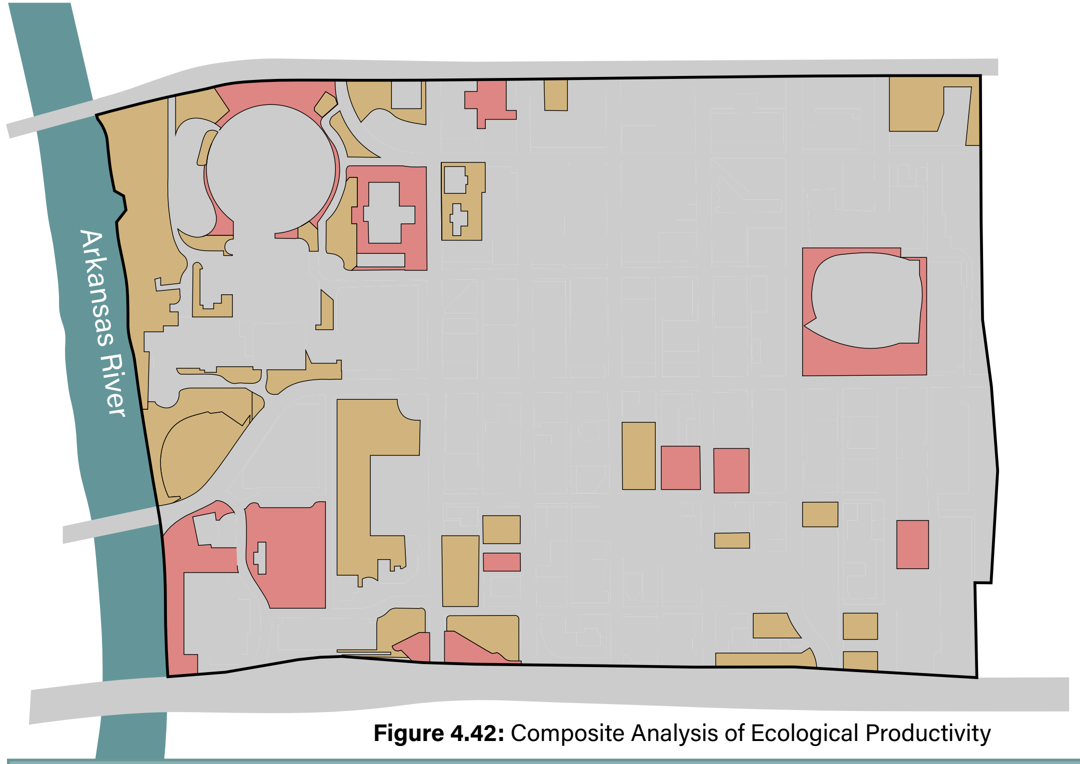


Figure 4.42: Composite Analysis of Ecological Productivity

Key			
High Ecological Productivity	Moderate Ecological Productivity	Low Ecological Productivity	Impervious Surfaces

From this composite map it is evident that this area has a low number of green spaces, and the size of the green spaces that are present is typically small. There is also a lack of connections between the existing green spaces. This confirms that the analysis from the first phase (Figures 4.5 & 4.6 on pages 70 & 95) of the project is true when it found that the site is lacking in many of the ecological categories.

FRAGSTATS Results

A classification map was generated for the site, because while the site lies within the 67202 ZIP code area, they are different in some ways. This site scores a little bit better in every metric category than the 67202 area as a whole, but the improvement is not enough that it makes a difference when comparing the site to the other ZIP code area.

67202 Results				
	Percentage of land	Number of Patches	Area Weighted Mean	Aggregation Index
Grass	10.5439	4555	0.2938	87.2155
Trees	1.7373	1785	0.0757	82.101
Water	3.1306	3584	0.0421	80.5243
Buildings	31.4112	16016	1.158	87.1804
Paved Surfaces	53.1771	4058	183.9318	93.4862

Table 4.10: 67202 FRAGSTATS Results

Existing Condition Results				
	Percentage of land	Number of Patches	Area Weighted Mean	Aggregation Index
Grass	14.6732	1520	0.4125	89.5526
Trees	1.5946	559	0.0556	82.482
Water	3.3879	1268	0.0506	80.8873
Buildings	33.631	4676	2.2078	88.3349
Paved Surfaces	46.7132	1280	50.5842	93.2052

Figure 4.11: Existing Condition FRAGSTATS Results

Summary

The site analysis was consistant with that the data produced in FRAGSTATS for ZIP code 67202 (Appendix 01) . The site has a very limited amount of green space, and the green spaces that are there are very spread out and have little to no functional connection to one another. While this partially visible by closely examining an aerial map, the FRAGSTATS program clearly displayed this with numerical data.

In sum, there are many different opportunities to implement green spaces in this area of the city. The surplus of surface parking provides an opportunity to convert underutilized paved spaces into productive green spaces. There are also a good number of vacant lots that have the potential to be a part of a green space network.

The few existing public spaces could be improved upon and become a key part of the proposed green space network, their prime location near the Arkansas River and Century II development makes them extremely valuable.

There are also a few underutilized roads and alleyways that could be converted into green corridors, to help form connections between the spaces.

4.7 Site Design (Phase 02)

Design Goals

The design goals for this site design were to: have and even disbursement of green spaces, increase the number of green spaces, create a diverse collection of green spaces, and develop a connected green spaces network.

Design Strategies

In order to achieve these goals the following design strategies were employed; The large amount of surface parking was consolidated in parking garages. The surplus of vacant and underutilized parking were converted into green spaces. Roads and alleyways that were lesser traveled were converted into green corridors. The existing spaces that were under performing were redesigned or revitalized. The design also incorporated many different types of program elements across the variety of spaces to promote Bio-diversity.

Conceptual Design Strategies

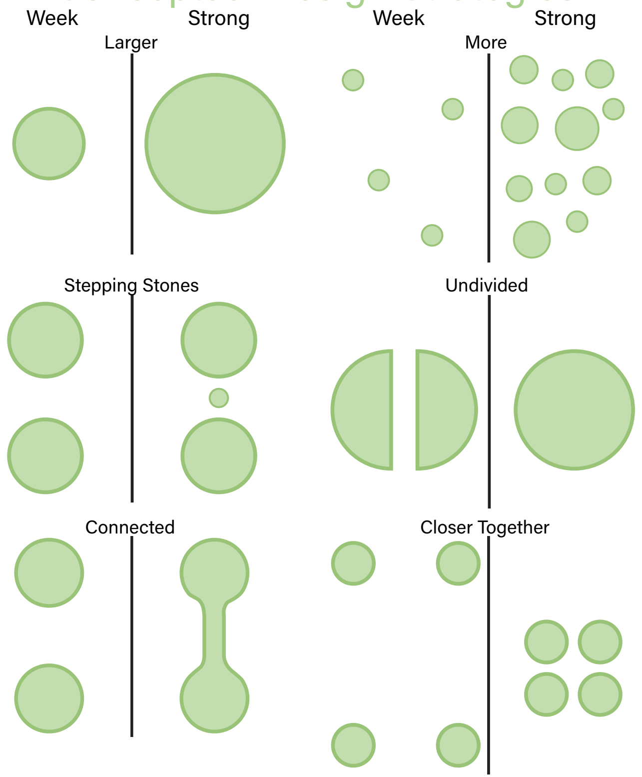


Figure 4.43: Conceptual Design Strategies

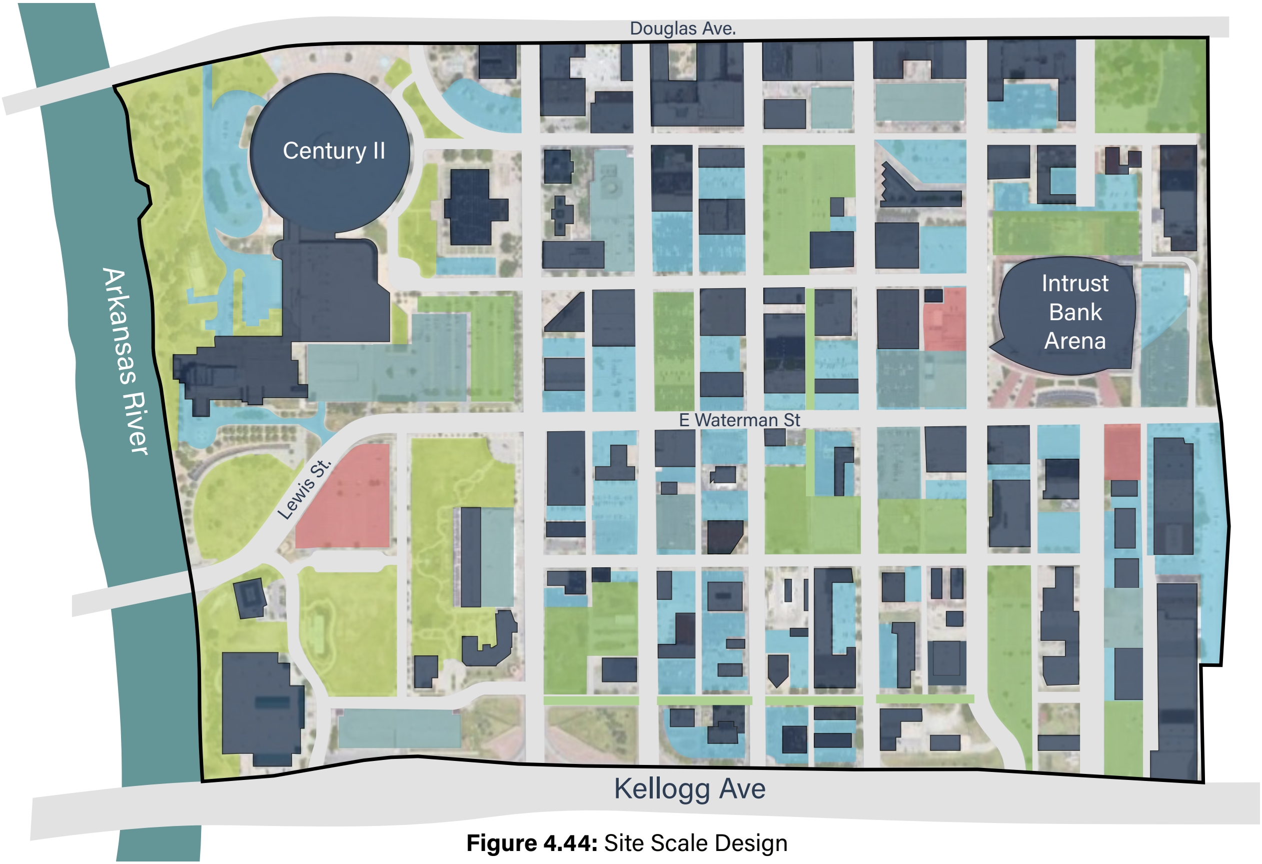


Figure 4.44: Site Scale Design

Key
New Green Space Redesigned Green Space New Urban Plaza Parking Garage
Existing Parking Roads Buildings Green Corridor

Existing Conditions

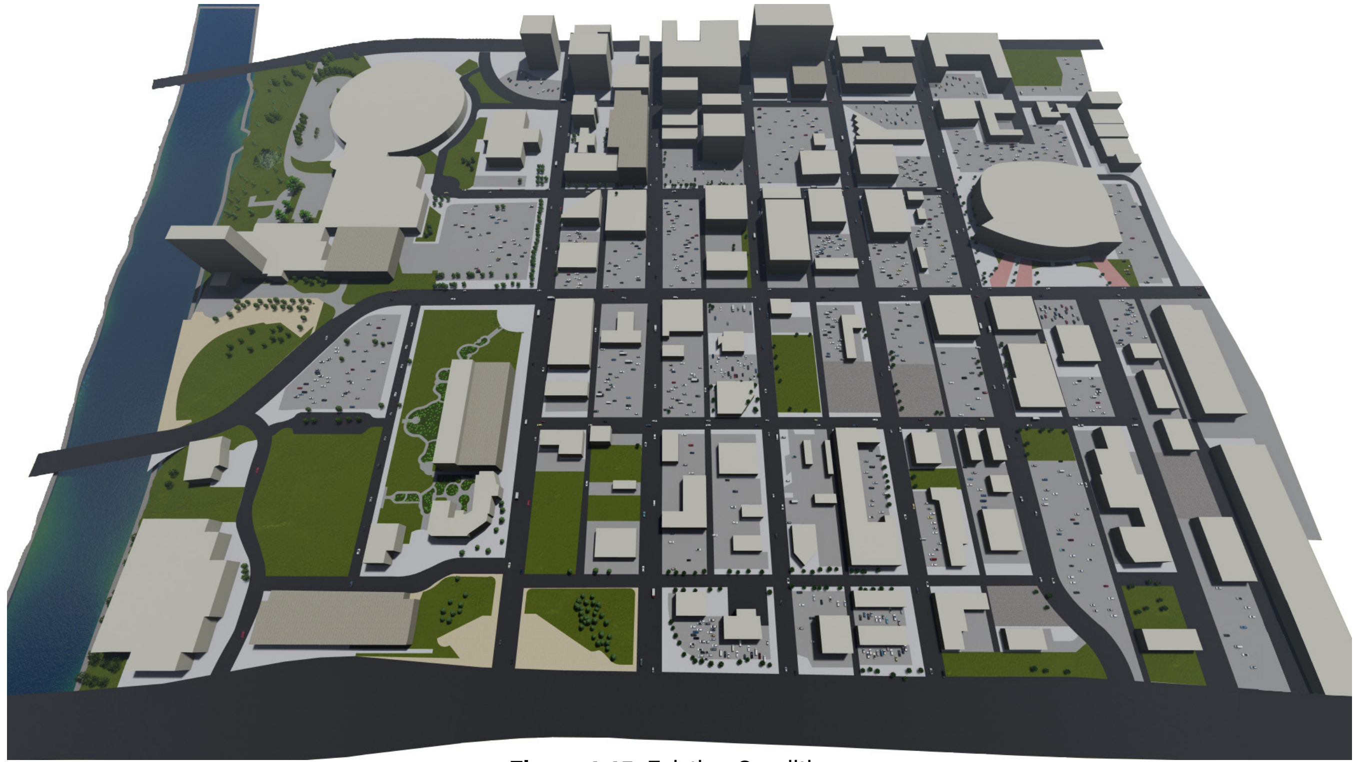


Figure 4.45: Existing Conditions

Figure 4.45 shows the site in the original state. This image makes it clear that currently the site has a lot of parking, and the green spaces are quite small and not well connected.

Site Design

Key

1. Riverwalk Pedestrian Zone
2. Butterfly Garden
3. Broadway Street Park
4. Naftzger Park Redesign
5. Arena Plaza
6. Waterman St. Median
7. City Porch
8. 8. Urban Nature Reserve
9. Nature Corridor
10. Urban Green Spaces

Figure 4.46: Site Design

The new site design features a green space network with many different parks, plazas and green ways. The amount of surface parking is also greatly reduced to allow for more green space. All of these changes help diminish the amount of fragmentation in the site.

Existing Conditions

After completing the site design, a comparative analysis was conducted to show how the design improved the quality of green space within the site. First Auto CAD was used to measure the area taken up by the following eight key categories(Figure 4.47): street scape, parking, vacant spaces, parking garages, plazas, green spaces, buildings and roads. In the existing site, parking takes up the most space at 26.16%, followed by buildings and roads. While green space only occupies 9.89% of the site.

As a part of this analysis the existing conditions of the site were also measured in FRAGSTATS to see how the landscape metrics of the current site compare to the new site design (Figure 4.10).

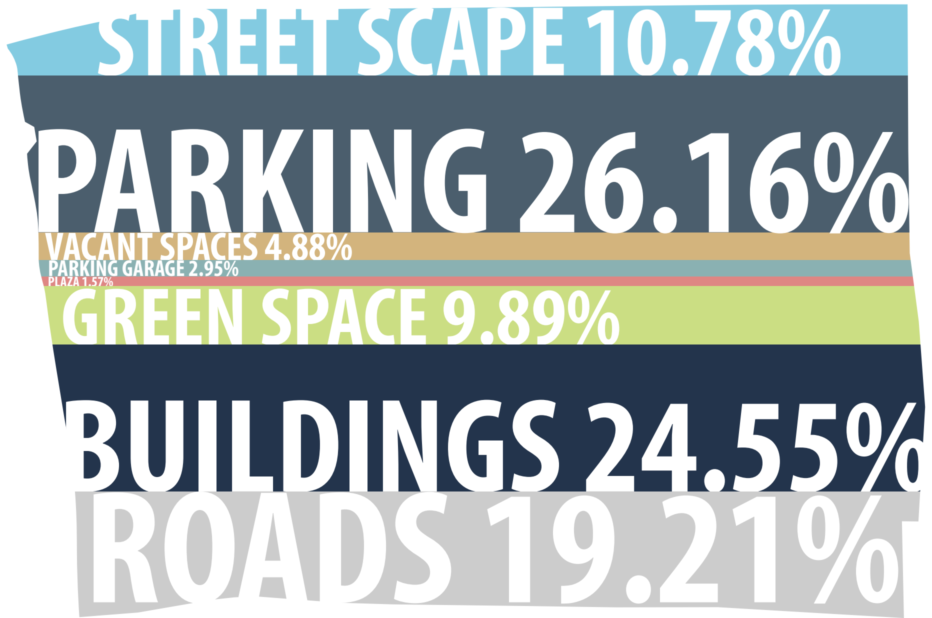


Figure 4.47: Existing Area Makeup

Existing Condition Results				
	Percentage of land	Number of Patches	Area Weighted Mean	Aggregation Index
Grass	14.6732	1520	0.4125	89.5526
Trees	1.5946	559	0.0556	82.482
Water	3.3879	1268	0.0506	80.8873
Buildings	33.631	4676	2.2078	88.3349
Paved Surfaces	46.7132	1280	50.5842	93.2052

Table 4.12: Existing Condition FRAGSTATS Results

Site Design

The measurements of the new site design shows that the amount of green space was increased dramatically, and the amount of parking was reduced and reallocated into parking garages (Figure 4.48).

The FRAGSTATS analysis conducted on the site design revealed that the amount of green space in the site increased, because while the percentage of land for grass dropped 4% the percentage of land for trees rose 10%. The results also indicate that the design strategies helped to decrease the number of patches, and increase the average patch area, which indicates an increase in landscape productivity. The aggregation index also rose, meaning that the green space patches are now closer together.

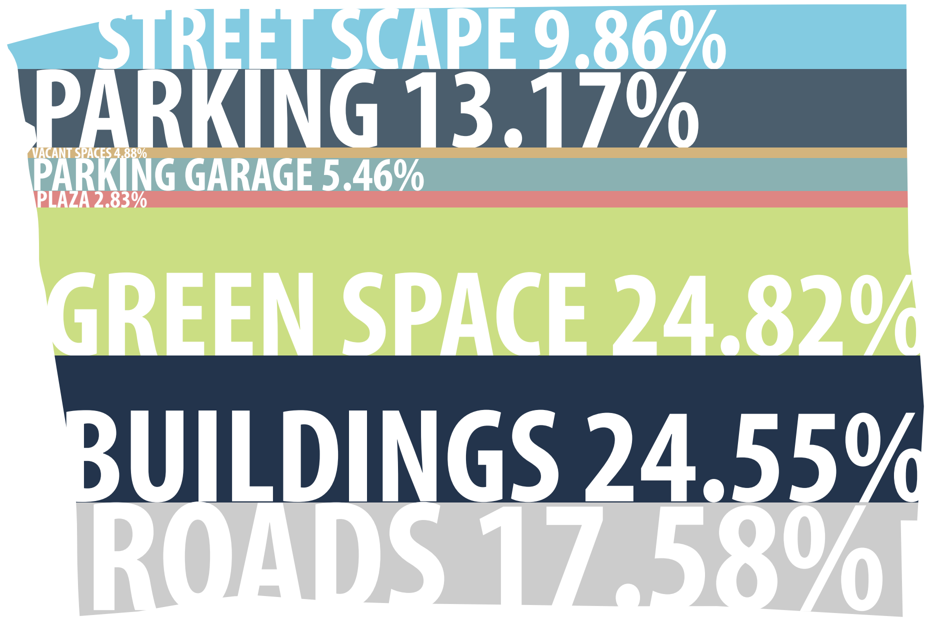


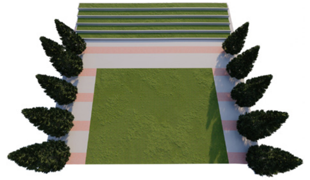
Figure 4.48: Design Area Makeup

Site Design Results				
	Percentage of land	Number of Patches	Area Weighted Mean	Aggregation Index
Grass	10.2577	645	0.6098	94.2322
Trees	11.2963	2093	0.3927	81.7677
Buildings	46.1325	6623	4.2872	89.8524
Paved Surfaces	32.3135	7898	28.2173	84.85

Table 4.13: Design FRAGSTATS Results

4.8 Site Scale Design Application (Phase 02)

Riverwalk Pedestrian Zone



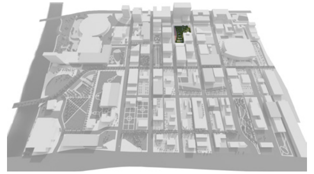
Urban Plaza

Expand

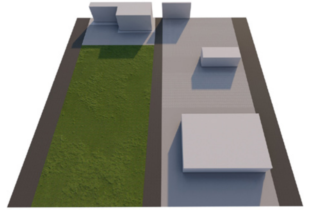
Figure 4.49: River Walk Pedestrian Zone

The Riverwalk pedestrian zone is not only a place where people can come to enjoy nature, but it also includes several different ecological habitats to helps bridge the gap between the green space near the river and those in the rest of the site.

Broadway Street Park



Parks



Infill Vacant Spaces

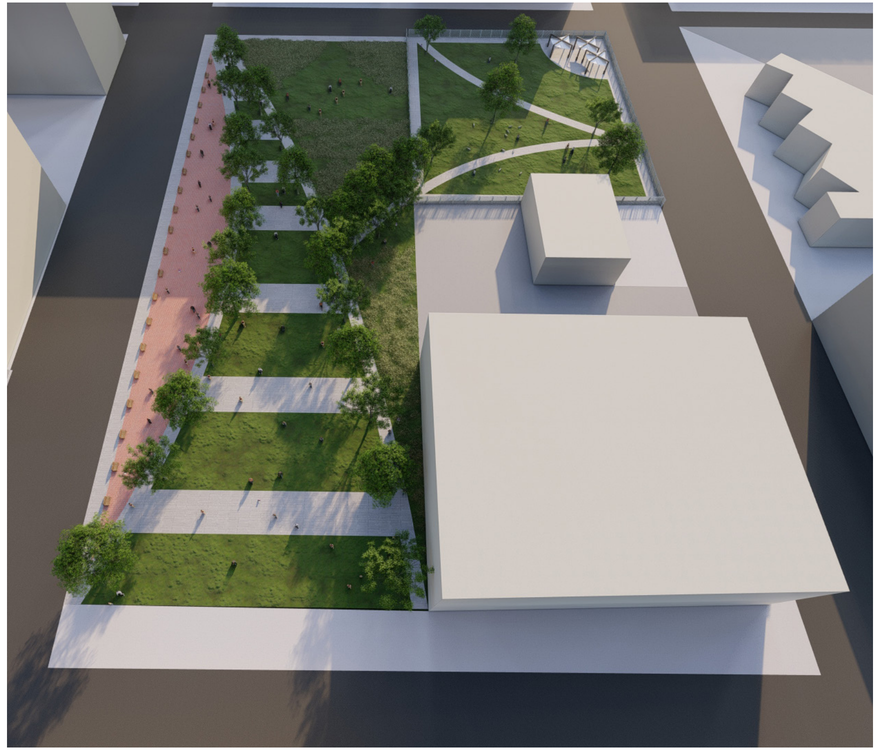
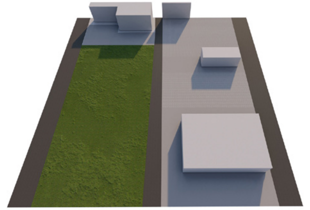


Figure 4.50: Broadway Street Park

The Broadway Street Park is an urban park that incorporates the native prairie along with a variety of trees that encourage biodiversity. The park also has a dog park where people can take their pets for some exercise.

Nature Park

Nature Reserve

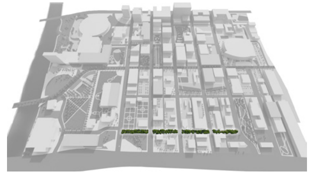


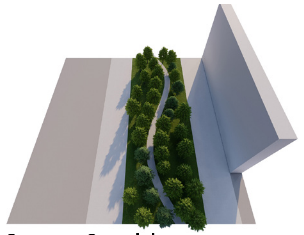
Infill Vacant Spaces

Figure 4.51: Nature Park

The nature park has aspects of both the prairie and the forest which helps people escape from the hectic pace of the city and supports a diverse group of ecosystems.

Green Corridor



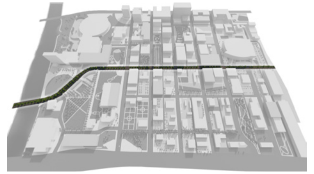


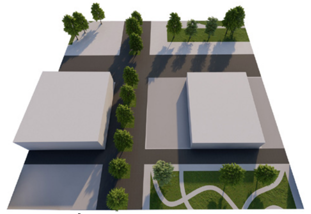
Green Corridor

Figure 4.52: Green Corridor

The green corridor turns a once under-utilized street into a green-way that runs through the city, creating ecological connections throughout downtown. This corridor also provides a safe nature-infused way to travel through the city.

Waterman Street Median



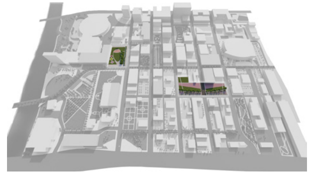


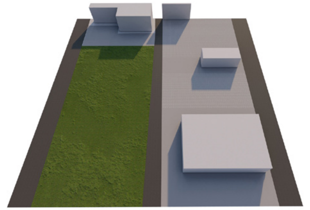
Stepping Stones

Figure 4.53: Waterman Street Median

The tree planted median along Waterman Street serves as steppingstones that improving connectivity for the organisms that move from space to space in the air. It is also much more aesthetically pleasing for those who are walking or driving along the street.

Pollinator Gardens





Infill Vacant Spaces

Figure 4.54: Pollinator Gardens

These pollinator gardens are not only visually pleasing but they also provide sources of pollen to help support the bee population, and provide habitats for many butterfly species.

5

Conclusion & Discussion

5.1 Conclusion

Urban green space is at an all-time premium, and as we continue to develop and expand it is important that green space design receives the same amount of attention as the other important elements of the urban city. The framework that is laid out in this project is a good example of how designers can use new technologies to inform green space design at the city and site level. The basic principles of the design framework can be adapted and applied to other city by designers in the future.

For Wichita, Kansas specifically, the first phase of the project revealed that the city is experiencing higher degrees of fragmentation near its center. While this is what most people would probably expect, using this data driven method allows designers to understand the different variables that contribute to how fragmented the landscape is. Once a designer know what problems are occurring, they can then tailor the design to help combat those specific issues. The design solutions and suggestions generated in phase one can be applied to any area that is experiencing these fragmentation issues.

While these design suggestions provide some guidance for how to solve some common problems caused by fragmentation, they do not do much good unless they are applied to the correct situations. This is why the second phase of the project is just as important as the first. The second phase displays how these ecological suggestions could be applied to a small piece of the city. The final result is an idealized vision of an ecologically focused design for downtown Wichita.

5.2 Limitations and Discussion

Limitations

One of the biggest limitations for this project was the time frame, cities are incredibly complex and understanding them and the problems that occur within them takes a long time. And it takes an even longer time to try and figure out how to solve those problems. This lack of time is why this project was only able to address one small portion of the site in phase two. Ideally this would be a much longer process that would allow the designer to move back and forth between scales and apply these principals to the entire site.

Choosing the correct aerial imagery was a very difficult process that took a lot of time because each of the different resolution levels have pros and cons. The finer grained images provide more accuracy when producing the classification maps, but these images are larger files and cause the project to take a much longer time. These finer grained images also break the site down into much smaller classification patches which can affect the results that are produced in FRAGSTATS. The larger grained imagery on the other hand is more efficient time wise but produces much less accurate results.

FRAGSTATS itself has some limitations, one being that it only produces numerical data which makes it difficult to compare the results in different parts of the site. The program is also limiting because even though you may think that one of the landscape metrics could be a good indicator, it may not produce data that varies enough for it to differentiate between the areas that you are trying to compare. This program can also be extremely time consuming to use, as it can take multiple hours to run and produce data, specifically if you are trying to determine the Euclidean Nearest Neighbor Distance.

The other limiting factor that may prevent other designers from being able to execute a project like this, is a lack of knowledge of the computer programs that were used. This project requires the knowledge of several different GIS features, and creating the classification maps takes a lot of trial and error. The user also needs to understand how to use the FRAGSTATS program, and how to interpret the results in a way people who are not familiar with the concepts of ecology can understand them.

Is FRAGSTATS useful for design projects?

Learning how to use the FRAGSTATS program is quite simple but running the analysis can take a good amount of time. This may make using the program on projects with a limited turnaround period unfeasible.

Interpreting the results that are produced by the FRAGSTATS analysis may also be a limiting factor, because it requires the user to have working understanding of many different ecological terms and concepts. Even if the reader can effectively interpret the results, they then have to find a way to communicate them to stakeholders and other professionals. This report accomplishes this by using a variety of different visuals (maps, color coded tables, graphs, and other diagrams), to simplify these concepts for more visual learners.

On the other hand, using FRAGSTATS forces designer to think about the project in a different way, by placing the focus on the many different landscape metrics. This allows them to create more specific design solutions that are tailored to site specific problems. It also helps the designer justify the decisions that they have made to their clients.

While it is time consuming and potentially difficult to communicate the results to others, I believe that FRAGSTATS produces valuable results that can help strengthen designs in the future. However, because of the limitations this may not be the most efficient program for every situation. It would be interesting to see if any other programs that could meet the objectives of this type of project.

What makes this project valuable to decision makers?

The primary goal of this project is to increase ecological productivity which should be attractive to decision makers, but unfortunately this alone may not be enough to get everyone on board. However, there are some other benefits that come from increasing the amount of green space in city. One benefit of increasing green space is that the value of properties that are adjacent to green spaces increase dramatically, so adding more green spaces can attract people to the area and help the economy. Increasing the amount of green space also increases the amount of pervious area, which can help the site handle runoff during storm events more efficiently. Improving stormwater management can reduce flooding and improve water quality in major water bodies, like the Arkansas River, by filtering runoff before it reaches them. While this may not seem like much, cities spend a lot of money on managing stormwater and solving that problem allows them to use that money to solve other problems.

5.3 Future Research

This project came long way in the short amount of time that was spent working on it, but there are many different ways that this topic could be explored. One way to push this project further could be to continue looking at smaller parts of the city and attempting to apply the design ideas to those areas. This would allow the designer to move between scales and create a more holistic design for the city.

Another way to move forward with this project could be attempting to use other data analysis programs, to see how they lend them selves to the design process. While FRAGSTATS proved to be a useful resource, there were some limitations that other analysis programs may not have. Finding the strengths and weakness of a few different data analysis programs could promote the use of more data driven methods, and help designers understand which programs lend themselves to certain types of projects.

It may also be interesting to see how this method could be applied to other cities that are larger or smaller than Wichita. The results may vary and some of the strengths and weakness of this method may be enhanced.

5.4 Personal Takeaways

The topic of nature in cities is very interesting to me and I hope to be able to find a job where I can work on projects like this for a living. I think that this project can serve as a foundation of knowledge that can help inform my future design career, and I believe that it demonstrates my ability to think critically about these types of complex problems.

I feel like this experience as a whole has helped me to understand how much work goes into a project like this. The project also taught me a lot about project management, while we did receive guidance from our advisor much of the organization was left up to us. I also feel like the opportunity to collaborate with professionals from different disciplines was a valuable experience, that helped enhance the quality of this report. Moving froward I hope to continue collaborating with professionals from many different disciplines.

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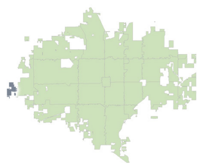
Appendix A - FRAGSTATS Data

ZIP: 67052

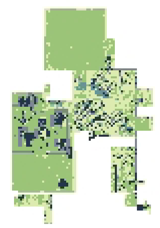
Location



Statistics

ZIP: 67052							
Area Edge							
Class	CA	PLAND	AREA_MN	AREA_MD	AREA_SD		
Grass	256.746	58.8769	0.0352	0.0003	1.3092		
Trees	107.682	24.6936	0.0187	0.0004	0.5541		
Water	6.7701	1.5525	0.0092	0.0006	0.0929		
Buildings	38.9546	8.933	0.0105	0.0004	0.116		
Paved Surfaces	25.92	5.944	0.0121	0.0004	0.2468		
Aggregation							
	NP	PD	ENN_MN	ENN_MD	ENN_SD	COHESION	AI
Grass	7296	1673.12	3.4293	2.8284	2.2508	99.5906	96.0634
Trees	5761	1321.11	4.5775	3	6.5777	99.5745	92.2917
Water	733	168.091	12.9149	5	30.0655	98.0402	90.6636
Buildings	3710	850.775	4.1156	2.2361	12.2361	98.4007	86.6652
Paved Surfaces	2134	489.368	4.9163	2.8284	6.4465	98.8893	89.6459

Classification Map



Key

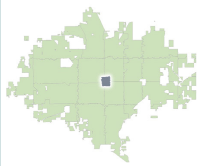
- Lawn/Grass
- Water
- Vegetation
- Buildings
- Impervious Surfaces

ZIP: 67202

Statistics

ZIP: 67202							
Area Edge							
Class	CA	PLAND	AREA_MN	AREA_MD	AREA_SD	AREA_AM	
Grass	42.0911	10.5439	0.0092	0.0009	0.0513	0.2938	
Trees	6.9351	1.7373	0.0039	0.0004	0.0167	0.0757	
Water	12.4971	3.1306	0.0035	0.0007	0.0116	0.0421	
Buildings	125.392	31.4112	0.0078	0.0004	0.0949	1.158	
Paved Surfaces	212.281	53.1771	0.0523	0.0004	3.1015	183.9318	
Aggregation							
	NP	PD	ENN_MN	ENN_MD	ENN_SD	COHESION	AI
Grass	4555	1141.04	5.8026	4	5.752	96.0511	87.2155
Trees	1785	447.148	8.6008	3.1623	12.148	92.9879	82.101
Water	3584	897.803	6.7641	4	7.7039	91.366	80.5243
Buildings	16016	4012.06	2.9559	2.2361	1.5773	97.7615	87.1804
Paved Surfaces	4058	1016.54	3.5873	2.8284	2.5905	99.963	93.4862

Location



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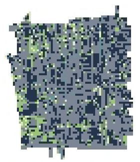
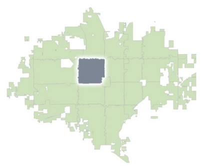


Key

- Lawn/Grass
- Water
- Vegetation
- Buildings
- Impervious Surfaces

ZIP: 67203

Location



Statistics

ZIP: 67203							
Area Edge							
Class	CA	PLAND	AREA_MN	AREA_MD	AREA_SD		
Grass	992.049	31.2956	0.0185	0.0005	0.3579		
Trees	138.426	4.3669	0.0236	0.0004	0.4246		
Water	1040.43	32.8218	0.0343	0.001	0.3975		
Buildings	485.342	15.3108	0.0064	0.0006	0.0722		
Paved Surfaces	513.685	16.2049	0.016	0.0008	1.3351		
Aggregation							
	NP	PD	ENN_MN	ENN_MD	ENN_SD	COHESION	AI
Grass	53754	1695.75	3.4512	2.8284	2.4182	98.9529	88.5785
Trees	5857	184.768	18.1842	8.9443	23.369	99.2989	96.8852
Water	30313	956.267	4.5768	3.1623	4.202	99.1727	92.9228
Buildings	76141	2401.98	3.3324	2.2361	2.6803	96.7355	80.6263
Paved Surfaces	32201	1015.83	5.5438	3.1623	5.3449	99.8044	90.6035

Classification Map

Key

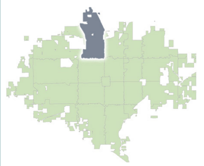
- Lawn/Grass
- Water
- Vegetation
- Buildings
- Impervious Surfaces

ZIP: 67204

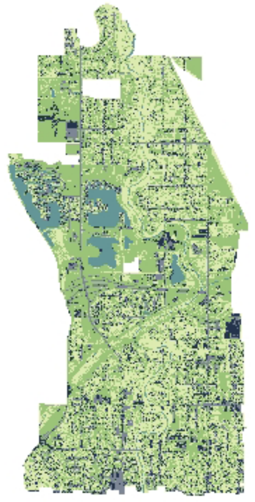
Statistics

ZIP: 67204							
Area Edge							
Class	CA	PLAND	AREA_MN	AREA_MD	AREA_SD		
Grass	1966.88	44.1092	0.0365	0.0004	1.1268		
Trees	219.187	4.9155	0.0536	0.0004	1.5098		
Water	1458.82	32.7156	0.0357	0.0008	0.7556		
Buildings	418.327	9.3814	0.0067	0.0006	0.0749		
Paved Surfaces	395.892	8.8783	0.0147	0.0008	0.8669		
Aggregation							
	NP	PD	ENN_MN	ENN_MD	ENN_SD	COHESION	AI
Grass	53884	1208.4	3.4937	2.8284	2.4057	99.5938	93.2597
Trees	4091	91.7448	24.0723	12	31.0725	99.5761	98.2625
Water	40871	916.574	4.4718	3	4.4775	99.4467	93.6653
Buildings	62802	1408.4	3.8637	2.2361	5.258	96.5685	79.8682
Paved Surfaces	26995	605.39	6.4308	3.6056	7.9543	99.6519	90.0175

Location



Classification Map

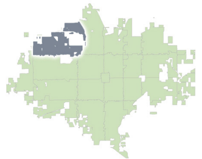


Key

- Lawn/Grass
- Water
- Vegetation
- Buildings
- Impervious Surfaces

ZIP: 67205

Location

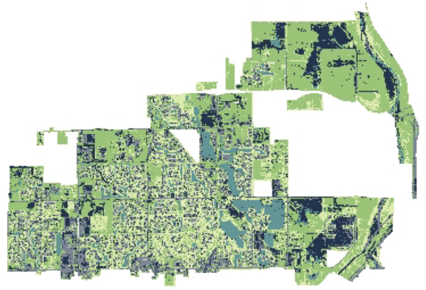


Statistics

ZIP: 67205					
Area Edge					
Class	CA	PLAND	AREA_MN	AREA_MD	AREA_SD
Grass	2125.86	41.9026	0.0312	0.0006	1.4002
Trees	359.012	7.0764	0.0288	0.0004	0.7884
Water	1066.34	21.0185	0.0224	0.0006	0.4343
Buildings	831.631	16.3921	0.0082	0.0004	0.4129
Paved Surfaces	690.503	13.6104	0.0203	0.0004	1.8929

Aggregation	NP	PD	ENN_MN	ENN_MD	ENN_SD	COHESION	AI
Grass	68167	1343.63	3.5252	2.8284	2.5523	99.5684	93.7377
Trees	12486	246.11	12.3567	6	20.0987	99.5036	96.9514
Water	47639	939.005	4.5414	3	5.2214	99.2848	91.8994
Buildings	101051	1991.8	3.3352	2.2361	3.7108	99.0346	86.1546
Paved Surfaces	33985	669.873	4.2397	2.8284	5.9368	99.8748	90.972

Classification Map



Key

- Lawn/Grass
- Water
- Vegetation
- Buildings
- Impervious Surfaces

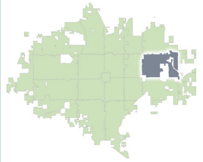
ZIP: 67206

Statistics

ZIP: 67206					
Area Edge					
Class	CA	PLAND	AREA_MN	AREA_MD	AREA_SD
Grass	1360.12	37.8575	0.0173	0.0004	0.4737
Trees	77.486	2.1567	0.0085	0.0002	0.1458
Water	984.533	27.4034	0.0204	0.0006	0.4291
Buildings	410.127	11.4155	0.0033	0.0004	0.0343
Paved Surfaces	760.469	21.1669	0.0275	0.0004	2.2289

Aggregation	NP	PD	ENN_MN	ENN_MD	ENN_SD	COHESION	AI
Grass	78527	2185.72	3.2043	2.2361	2.0167	99.1431	90.7242
Trees	9144	254.514	15.0765	7.0711	19.4568	97.5307	94.6587
Water	48228	1342.38	4.1895	3	4.1808	99.3162	91.1735
Buildings	122984	3423.13	3.0258	2.2361	2.5259	95.0252	75.4456
Paved Surfaces	27628	768.997	4.3798	2.8284	5.0075	99.8919	91.9134

Location



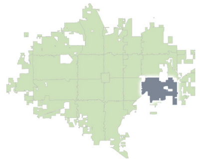
Classification Map

Key

- Lawn/Grass
- Water
- Vegetation
- Buildings
- Impervious Surfaces

ZIP: 67207

Location

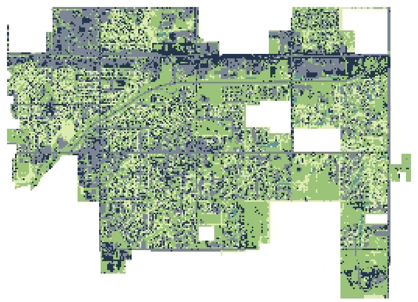


Statistics

ZIP: 67207					
Area Edge					
Class	CA	PLAND	AREA_MN	AREA_MD	AREA_SD
Grass	1397.88	41.7719	0.0313	0.0004	0.6915
Trees	35.3943	1.0577	0.0052	0.0002	0.0697
Water	537.959	16.0755	0.0121	0.0007	0.1425
Buildings	512.962	15.3285	0.0044	0.0004	0.0979
Paved Surfaces	862.259	25.7664	0.0327	0.0005	4.0512

Aggregation	NP	PD	ENN_MN	ENN_MD	ENN_SD	COHESION	AI
Grass	44637	1333.86	3.3149	2.2361	2.6782	99.3854	92.7033
Trees	6858	204.934	17.4428	8	22.7476	96.6129	91.9759
Water	44365	1325.73	4.6863	3	5.171	98.1446	89.3047
Buildings	117189	3501.89	3.0167	2.2361	2.3487	97.1244	79.5593
Paved Surfaces	26384	788.417	4.6011	3	4.8861	99.9512	92.9127

Classification Map



Key

- Lawn/Grass
- Water
- Vegetation
- Buildings
- Impervious Surfaces

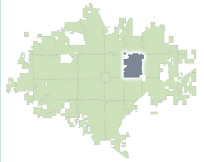
ZIP: 67208

Statistics

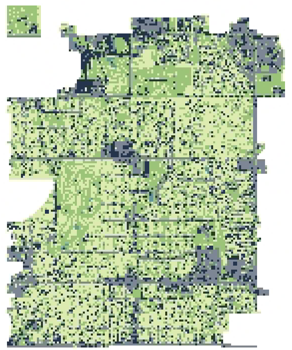
ZIP: 67208					
Area Edge					
Class	CA	PLAND	AREA_MN	AREA_MD	AREA_SD
Grass	609.85	30.2904	0.0131	0.0005	0.3434
Trees	8.4301	0.4187	0.0032	0.0003	0.0289
Water	776.7	38.5776	0.036	0.0007	1.0175
Buildings	277.6	13.788	0.0052	0.0006	0.096
Paved Surfaces	340.763	16.9252	0.0161	0.0008	0.7173

Aggregation	NP	PD	ENN_MN	ENN_MD	ENN_SD	COHESION	AI
Grass	46600	2314.56	3.3998	2.8284	2.2998	98.8595	87.742
Trees	2637	130.976	18.6514	5	31.6807	93.8992	85.1989
Water	21597	1072.69	4.2344	3	4.2109	99.677	93.197
Buildings	53748	2669.59	3.2429	2.2361	2.5492	96.7449	78.9984
Paved Surfaces	21172	1051.58	5.1226	3.1623	4.8775	99.5934	90.7801

Location



Classification Map

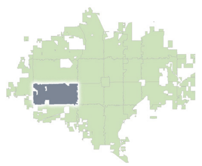


Key

- Lawn/Grass
- Water
- Vegetation
- Buildings
- Impervious Surfaces

ZIP: 67209

Location



Statistics

ZIP: 67209							
Area Edge							
Class	CA	PLAND	AREA_MN	AREA_MD	AREA_SD		
Grass	1882.73	43.2992	0.0462	0.0005	1.106		
Trees	57.4382	1.321	0.008	0.0005	0.1058		
Water	782.222	17.9896	0.0192	0.0006	0.5063		
Buildings	710.598	16.3424	0.0084	0.0005	0.1948		
Paved Surfaces	915.201	21.0479	0.0296	0.0005	3.5134		
Aggregation							
	NP	PD	ENN_MN	ENN_MD	ENN_SD	COHESION	AI
Grass	40792	938.138	3.804	2.8284	3.6797	99.4733	94.6201
Trees	7142	164.252	16.8147	8	22.4943	96.8604	92.0802
Water	40645	934.757	4.9132	3	6.498	99.3097	92.0087
Buildings	84556	1944.63	3.2981	2.2361	3.4105	98.6249	84.9623
Paved Surfaces	30913	710.94	4.6295	3	5.5765	99.9347	92.6992

Classification Map

Key

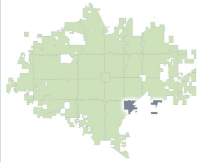
- Lawn/Grass
- Water
- Vegetation
- Buildings
- Impervious Surfaces

ZIP: 67210

Statistics

ZIP: 67210							
Area Edge							
Class	CA	PLAND	AREA_MN	AREA_MD	AREA_SD		
Grass	419.012	48.0729	0.0391	0.0004	0.7836		
Trees	5.9455	0.6821	0.0053	0.0003	0.0514		
Water	167.136	19.1754	0.0137	0.0005	0.152		
Buildings	123.34	14.1506	0.0068	0.0005	0.0878		
Paved Surfaces	156.185	17.919	0.0223	0.0006	0.7224		
Aggregation							
	NP	PD	ENN_MN	ENN_MD	ENN_SD	COHESION	AI
Grass	10722	1230.12	3.3219	2.2361	2.6113	99.3879	94.0428
Trees	1118	128.267	18.9424	5	29.5149	95.4258	88.0791
Water	12236	1403.82	4.3636	3	5.2232	98.4546	90.3508
Buildings	18155	2082.9	3.2707	2.2361	3.9592	97.2273	81.8261
Paved Surfaces	7010	804.25	5.0956	3.1623	5.0472	99.6712	91.8986

Location



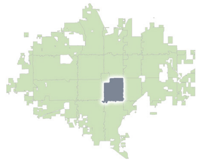
Classification Map

Key

- Lawn/Grass
- Water
- Vegetation
- Buildings
- Impervious Surfaces

ZIP: 67211

Location



Statistics

ZIP: 67211							
Area Edge							
Class	CA	PLAND	AREA_MN	AREA_MD	AREA_SD		
Grass	42.0911	10.5439	0.0092	0.0009	0.0513		
Trees	6.9351	1.7373	0.0039	0.0004	0.0167		
Water	12.4971	3.1306	0.0035	0.0007	0.0116		
Buildings	125.392	31.4112	0.0078	0.0004	0.0949		
Paved Surfaces	212.281	53.1771	0.0523	0.0004	3.1015		
Aggregation							
	NP	PD	ENN_MN	ENN_MD	ENN_SD	COHESION	AI
Grass	4555	1141.04	5.8026	4	5.752	96.0511	87.2155
Trees	1785	447.148	8.6008	3.1623	12.148	92.9879	82.101
Water	3584	897.803	6.7641	4	7.7039	91.366	80.5243
Buildings	16016	4012.06	2.9559	2.2361	1.5773	97.7615	87.1804
Paved Surfaces	4058	1016.54	3.5873	2.8284	2.5905	99.963	93.4862

Classification Map

Key

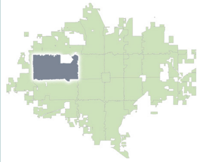
- Lawn/Grass
- Water
- Vegetation
- Buildings
- Impervious Surfaces

ZIP: 67212

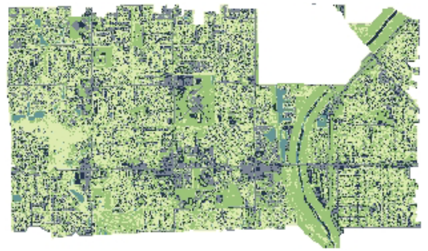
Statistics

ZIP: 67212							
Area Edge							
Class	CA	PLAND	AREA_MN	AREA_MD	AREA_SD		
Grass	1766.33	35.2002	0.0201	0.0006	0.5061		
Trees	107.312	2.1386	0.0071	0.0006	0.1793		
Water	1688.22	33.6435	0.0283	0.0007	0.6401		
Buildings	666.603	13.2843	0.0053	0.0005	0.051		
Paved Surfaces	789.491	15.7333	0.0163	0.0006	1.7068		
Aggregation							
	NP	PD	ENN_MN	ENN_MD	ENN_SD	COHESION	AI
Grass	87673	1747.18	3.2466	2.2361	2.5323	98.9922	89.6637
Trees	15137	301.657	15.7263	10	19.3457	97.3629	91.8311
Water	59567	1187.08	4.085	3	4.1229	99.302	92.4547
Buildings	126004	2511.06	3.1799	2.2361	2.6684	96.2599	78.528
Paved Surfaces	48305	962.642	5.058	3	5.9331	99.8519	90.1922

Location



Classification Map

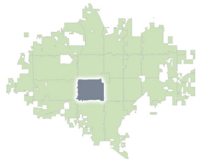


Key

- Lawn/Grass
- Water
- Vegetation
- Buildings
- Impervious Surfaces

ZIP: 67213

Location

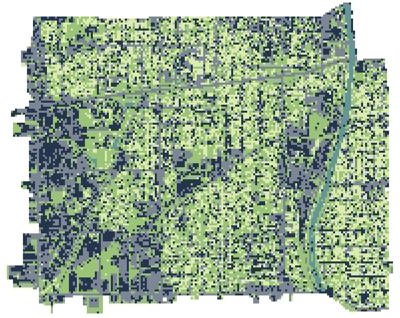


Statistics

ZIP: 67213					
Area Edge					
Class	CA	PLAND	AREA_MN	AREA_MD	AREA_SD
Grass	911.956	33.315	0.029	0.0006	0.3571
Trees	50.0731	1.8292	0.0105	0.0003	0.2905
Water	557.075	20.3507	0.0216	0.0012	0.1141
Buildings	584.04	21.3358	0.0085	0.0006	0.1671
Paved Surfaces	634.23	23.1693	0.0197	0.0008	2.2255

Aggregation	NP	PD	ENN_MN	ENN_MD	ENN_SD	COHESION	AI
Grass	31420	1147.82	3.6412	2.8284	3.1574	99.0659	90.4961
Trees	4775	174.437	18.9826	8.6023	25.4063	98.771	95.7449
Water	25780	941.779	4.9809	3.1623	5.8951	97.9058	91.4559
Buildings	68530	2503.49	3.1925	2.2361	2.2102	98.3316	83.6938
Paved Surfaces	32165	1175.03	5.0271	3.1623	4.3348	99.9034	91.5045

Classification Map



Key

- Lawn/Grass
- Water
- Vegetation
- Buildings
- Impervious Surfaces

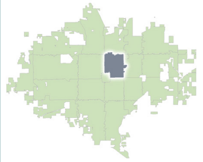
ZIP: 67214

Statistics

ZIP: 67214					
Area Edge					
Class	CA	PLAND	AREA_MN	AREA_MD	AREA_SD
Grass	1984.88	58.9272	0.0513	0.0003	1.76
Trees	29.6388	0.8799	0.0078	0.0005	0.1171
Water	682.827	20.2717	0.0186	0.0004	0.8962
Buildings	359.354	10.6685	0.0102	0.0004	0.2358
Paved Surfaces	311.662	9.2526	0.023	0.0005	0.6038

Aggregation	NP	PD	ENN_MN	ENN_MD	ENN_SD	COHESION	AI
Grass	38715	1149.37	3.4778	2.2361	2.8336	99.7659	96.4122
Trees	3780	112.221	15.0032	6	27.1724	97.4161	90.847
Water	36763	1091.42	4.2564	3	5.9953	99.6072	92.479
Buildings	35252	1046.56	3.8008	2.2361	6.4595	98.6982	87.3659
Paved Surfaces	13551	402.302	4.9483	3	12.1098	99.575	91.9138

Location



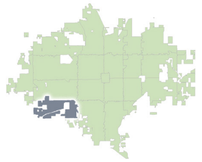
Classification Map

Key

- Lawn/Grass
- Water
- Vegetation
- Buildings
- Impervious Surfaces

ZIP: 67215

Location

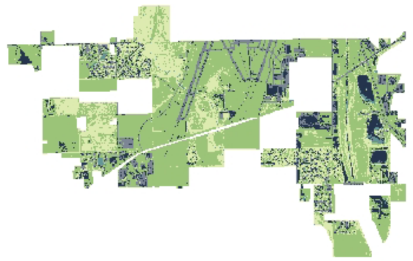


Statistics

ZIP: 67215					
Area Edge					
Class	CA	PLAND	AREA_MN	AREA_MD	AREA_SD
Grass	1701.41	41.0565	0.026	0.0004	0.6565
Trees	148.556	3.5848	0.0208	0.0004	0.5366
Water	1190.05	28.7169	0.022	0.0005	0.4392
Buildings	555.345	13.401	0.0078	0.0005	0.1276
Paved Surfaces	548.709	13.2408	0.0166	0.0006	1.5524

Aggregation	NP	PD	ENN_MN	ENN_MD	ENN_SD	COHESION	AI
Grass	65507	1580.74	3.4651	2.8284	2.7322	99.4463	92.5104
Trees	7134	172.15	16.4663	5.831	22.8239	99.158	96.4918
Water	54207	1308.06	4.1928	3	4.3413	99.2972	92.3229
Buildings	71560	1726.81	3.4922	2.2361	3.5795	98.0039	82.9835
Paved Surfaces	33001	796.344	5.2	3	6.2088	99.8377	90.8168

Classification Map



Key

- Lawn/Grass
- Water
- Vegetation
- Buildings
- Impervious Surfaces

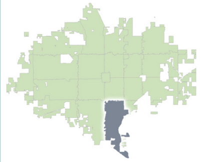
ZIP: 67216

Statistics

ZIP: 67216					
Area Edge					
Class	CA	PLAND	AREA_MN	AREA_MD	AREA_SD
Grass	1701.41	41.0565	0.026	0.0004	0.6565
Trees	148.556	3.5848	0.0208	0.0004	0.5366
Water	1190.05	28.7169	0.022	0.0005	0.4392
Buildings	555.345	13.401	0.0078	0.0005	0.1276
Paved Surfaces	548.709	13.2408	0.0166	0.0006	1.5524

Aggregation	NP	PD	ENN_MN	ENN_MD	ENN_SD	COHESION	AI
Grass	65507	1580.74	3.4651	2.8284	2.7322	99.4463	92.5104
Trees	7134	172.15	16.4663	5.831	22.8239	99.158	96.4918
Water	54207	1308.06	4.1928	3	4.3413	99.2972	92.3229
Buildings	71560	1726.81	3.4922	2.2361	3.5795	98.0039	82.9835
Paved Surfaces	33001	796.344	5.2	3	6.2088	99.8377	90.8168

Location



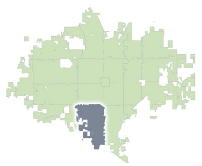
Classification Map

Key

- Lawn/Grass
- Water
- Vegetation
- Buildings
- Impervious Surfaces

ZIP: 67217

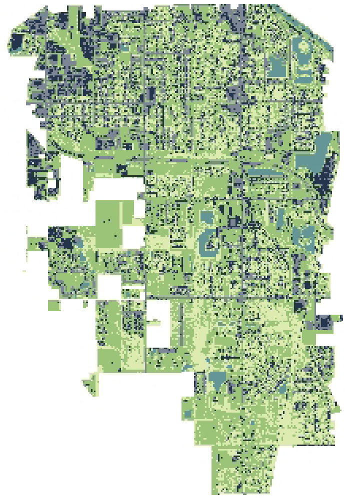
Location



Statistics

ZIP: 67217							
Area Edge							
Class	CA	PLAND	AREA_MN	AREA_MD	AREA_SD		
Grass	2136.56	45.409	0.0445	0.0004	1.0806		
Trees	175.769	3.7357	0.0267	0.0004	0.577		
Water	1091.82	23.2048	0.0206	0.0008	0.4395		
Buildings	660.034	14.0279	0.0081	0.0006	0.1159		
Paved Surfaces	640.964	13.6226	0.017	0.0007	1.6343		
Aggregation							
	NP	PD	ENN_MN	ENN_MD	ENN_SD	COHESION	AI
Grass	47998	1020.12	3.5663	2.8284	2.7684	99.6043	93.4912
Trees	6576	139.762	19.3899	8.0623	27.7547	99.0368	97.671
Water	53082	1128.17	4.7839	3.1623	5.0825	99.0531	92.0253
Buildings	81031	1722.18	3.4783	2.2361	3.64	97.7819	82.7595
Paved Surfaces	37646	800.102	5.4139	3.1623	5.9851	99.8482	90.866

Classification Map



Key

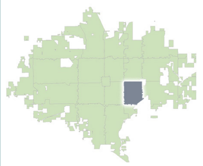
- Lawn/Grass
- Water
- Vegetation
- Buildings
- Impervious Surfaces

ZIP: 67218

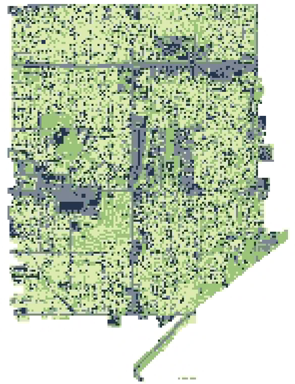
Statistics

ZIP: 67218							
Area Edge							
Class	CA	PLAND	AREA_MN	AREA_MD	AREA_SD		
Grass	588.175	28.405	0.0127	0.0005	0.2292		
Trees	5.1379	0.2481	0.0021	0.0003	0.0109		
Water	820.522	39.6259	0.0444	0.0008	1.0388		
Buildings	286.676	13.8446	0.0051	0.0006	0.0402		
Paved Surfaces	370.161	17.8764	0.0165	0.0008	1.2035		
Aggregation							
	NP	PD	ENN_MN	ENN_MD	ENN_SD	COHESION	AI
Grass	46261	2234.11	3.401	2.8284	2.3003	98.5195	87.2603
Trees	2470	119.285	18.0968	4.4721	31.5611	89.4071	77.2032
Water	18478	892.367	4.2514	3	4.3717	99.671	93.6141
Buildings	55667	2688.35	3.3055	2.2361	2.4842	95.3068	78.7508
Paved Surfaces	22471	1085.2	5.4888	3.6056	5.0493	99.7593	91.2765

Location



Classification Map

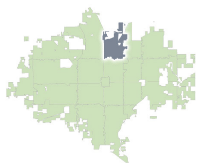


Key

- Lawn/Grass
- Water
- Vegetation
- Buildings
- Impervious Surfaces

ZIP: 67219

Location



Statistics

ZIP: 67219							
Area Edge							
Class	CA	PLAND	AREA_MN	AREA_MD	AREA_SD		
Grass	1245.52	45.7206	0.0426	0.0004	1.0999		
Trees	53.2698	1.9554	0.0118	0.0005	0.3865		
Water	488.385	17.9276	0.0166	0.0005	0.4103		
Buildings	426.73	15.6644	0.0096	0.0004	0.1799		
Paved Surfaces	510.297	18.732	0.0287	0.0005	2.9571		
Aggregation							
	NP	PD	ENN_MN	ENN_MD	ENN_SD	COHESION	AI
Grass	29257	1073.97	3.8618	2.8284	3.6354	99.5977	95.2417
Trees	4533	166.397	12.2412	4.1231	20.1315	98.4	94.06
Water	29483	1082.26	4.5962	3	5.7554	99.1734	91.8962
Buildings	44669	1639.71	3.468	2.2361	4.0463	98.7102	86.0685
Paved Surfaces	17799	653.365	4.5066	3	7.1329	99.9325	92.5424

Classification Map

Key

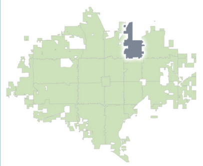
- Lawn/Grass
- Water
- Vegetation
- Buildings
- Impervious Surfaces

ZIP: 67220

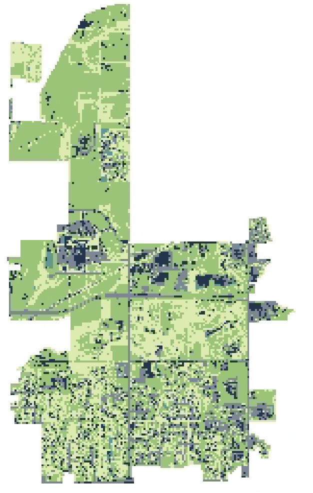
Statistics

ZIP: 67220							
Area Edge							
Class	CA	PLAND	AREA_MN	AREA_MD	AREA_SD		
Grass	1064.13	49.977	0.0322	0.0004	1.0798		
Trees	15.964	0.7498	0.0073	0.0004	0.0892		
Water	583.438	27.4014	0.0242	0.0005	0.7461		
Buildings	197.703	9.2852	0.0051	0.0005	0.0671		
Paved Surfaces	268	12.5867	0.03	0.0006	1.5767		
Aggregation							
	NP	PD	ENN_MN	ENN_MD	ENN_SD	COHESION	AI
Grass	33047	1552.06	3.5419	2.8284	2.5316	99.526	94.5021
Trees	2178	102.29	16.9739	5	28.1343	96.8329	91.3646
Water	24114	1132.52	4.1234	3	4.0183	99.525	92.9402
Buildings	38696	1817.37	3.3395	2.2361	3.8582	96.4879	79.8344
Paved Surfaces	8946	420.152	5.4378	3	8.3356	99.841	92.1268

Location



Classification Map

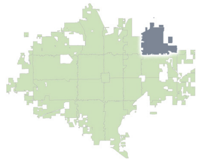


Key

- Lawn/Grass
- Water
- Vegetation
- Buildings
- Impervious Surfaces

ZIP: 67226

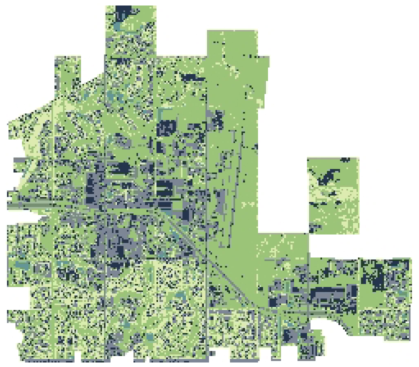
Location



Statistics

ZIP: 67226							
Area Edge							
Class	CA	PLAND	AREA_MN	AREA_MD	AREA_SD		
Grass	1914.08	51.1981	0.0419	0.0004	1.755		
Trees	62.669	1.6763	0.0231	0.0002	0.1888		
Water	578.192	15.4655	0.0124	0.0006	0.2048		
Buildings	441.125	11.7992	0.0046	0.0004	0.0935		
Paved Surfaces	742.516	19.8609	0.0403	0.0004	3.7688		
Aggregation							
	NP	PD	ENN_MN	ENN_MD	ENN_SD	COHESION	AI
Grass	45730	1223.19	3.2523	2.2361	2.3848	99.6217	94.791
Trees	2717	72.6745	23.3349	6.7082	45.787	98.6271	96.5676
Water	46710	1249.4	4.6121	3	5.3034	98.6327	89.5147
Buildings	96764	2588.25	3.0546	2.2361	3.4938	96.9015	79.4007
Paved Surfaces	18412	492.486	4.712	3	5.8609	99.9389	92.9891

Classification Map



Key

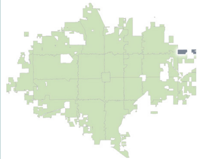
- Lawn/Grass
- Water
- Vegetation
- Buildings
- Impervious Surfaces

ZIP: 67228

Statistics

ZIP: 67228							
Area Edge							
Class	CA	PLAND	AREA_MN	AREA_MD	AREA_SD		
Grass	107.971	38.4182	0.0143	0.0005	0.2683		
Trees	9.3726	3.335	0.0195	0.0002	0.1493		
Water	75.1917	26.7547	0.0162	0.0005	0.2245		
Buildings	25.0362	8.9084	0.0025	0.0004	0.0118		
Paved Surfaces	63.4694	22.5837	0.0501	0.0006	0.9956		
Aggregation							
	NP	PD	ENN_MN	ENN_MD	ENN_SD	COHESION	AI
Grass	7531	2679.68	2.9981	2.2361	1.4663	98.5089	89.9621
Trees	481	171.15	21.6534	9.8995	24.1136	98.448	96.8904
Water	4647	1653.5	3.9	3	3.0502	99.0366	89.2736
Buildings	9946	3538.99	3.0455	2.2361	2.2845	92.29	68.8147
Paved Surfaces	1267	450.824	4.7201	3	5.4476	99.7568	92.8728

Location



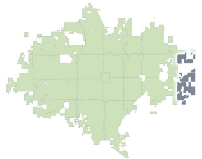
Classification Map

Key

- Lawn/Grass
- Water
- Vegetation
- Buildings
- Impervious Surfaces

ZIP: 67230

Location



Statistics

ZIP: 67230							
Area Edge							
Class	CA	PLAND	AREA_MN	AREA_MD	AREA_SD		
Grass	200.281	34.2206	0.0122	0.0005	0.2405		
Trees	23.9505	4.0922	0.0193	0.0002	0.1942		
Water	186.572	31.8782	0.0221	0.0005	0.4145		
Buildings	62.5501	10.6875	0.0034	0.0004	0.0348		
Paved Surfaces	111.912	19.1215	0.0297	0.0005	0.8032		
Aggregation							
	NP	PD	ENN_MN	ENN_MD	ENN_SD	COHESION	AI
Grass	16430	2807.27	3.175	2.2361	1.7555	98.6378	88.7281
Trees	1238	211.528	16.3868	6.5557	22.7289	98.4458	96.6138
Water	8434	1441.06	3.8738	3	3.4069	99.3318	91.0502
Buildings	18487	3158.74	3.1427	2.2361	2.4897	95.1792	74.7692
Paved Surfaces	3774	644.836	4.4522	3	5.6962	99.7084	91.9548

Classification Map

Key

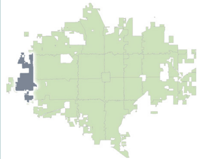
- Lawn/Grass
- Water
- Vegetation
- Buildings
- Impervious Surfaces

ZIP: 67235

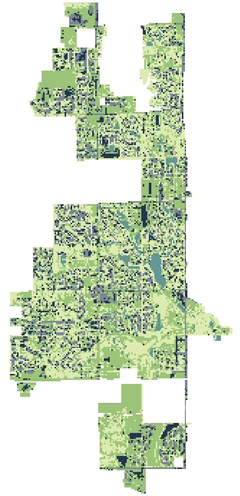
Statistics

ZIP: 67235							
Area Edge							
Class	CA	PLAND	AREA_MN	AREA_MD	AREA_SD		
Grass	941.432	36.1125	0.015	0.0004	0.5215		
Trees	96.7819	3.7125	0.0206	0.0006	0.3056		
Water	941.505	36.1152	0.0309	0.0005	0.74		
Buildings	268.014	10.2808	0.0048	0.0005	0.0569		
Paved Surfaces	359.214	13.7791	0.0254	0.0008	0.5865		
Aggregation							
	NP	PD	ENN_MN	ENN_MD	ENN_SD	COHESION	AI
Grass	62970	2415.47	3.1347	2.2361	1.9805	99.2912	90.0683
Trees	4706	180.518	14.7592	7.2801	23.3848	98.3345	96.2482
Water	30481	1169.22	3.7378	2.8284	4.3657	99.5824	92.6259
Buildings	55957	2146.46	3.1571	2.2361	3.6577	96.4324	77.7089
Paved Surfaces	14126	541.86	4.8833	3	7.0556	99.4869	90.9263

Location



Classification Map

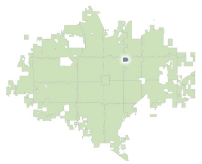


Key

- Lawn/Grass
- Water
- Vegetation
- Buildings
- Impervious Surfaces

ZIP: 67260

Location



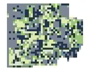
Statistics

ZIP: 67260					
Area Edge					
Class	CA	PLAND	AREA_MN	AREA_MD	AREA_SD
Grass	21.9809	19.331	0.0108	0.0006	0.0914
Trees	1.7314	1.5227	0.0048	0.0004	0.0218
Water	23.1124	20.3262	0.0165	0.0007	0.1094
Buildings	27.4259	24.1196	0.0085	0.0005	0.1694
Paved Surfaces	39.4571	34.7005	0.034	0.0005	0.6466

Aggregation

	NP	PD	ENN_MN	ENN_MD	ENN_SD	COHESION	AI
Grass	2031	1786.16	3.9776	2.997	3.3595	97.433	85.6381
Trees	361	317.481	11.1676	3.996	18.4338	93.8866	84.1407
Water	1403	1233.87	4.4551	2.997	4.2322	97.7731	91.2715
Buildings	3208	2821.27	3.1022	2.2338	2.0716	98.8975	85.7182
Paved Surfaces	1161	1021.04	4.3995	2.997	3.7252	99.6774	93.1749

Classification Map



Key

- Lawn/Grass
- Water
- Vegetation
- Buildings
- Impervious Surfaces

Appendix B - Precedent Study

Detroit Future City

A team of planners and designers led by Stoss Landscape Urbanism led the creation of a comprehensive strategic framework plan for the City of Detroit that focuses on improving the quality of life and business in Detroit. While this project focuses on creating linkages between social, economic, and ecological systems, it is still very useful specifically Stoss's part of the project because they focus mostly on the ecological aspects of the project. "Stoss's work seeks to redefine and diversify the traditional notion of landscapes as only recreation by showing the multiple ways landscapes can improve the overall health of the city and its residents" (Detroit Future City). This project also addresses the problems from multiple scales and generates typologies that solve different problems the city is experiencing similar to the way this project aims to (Figure 1.3).

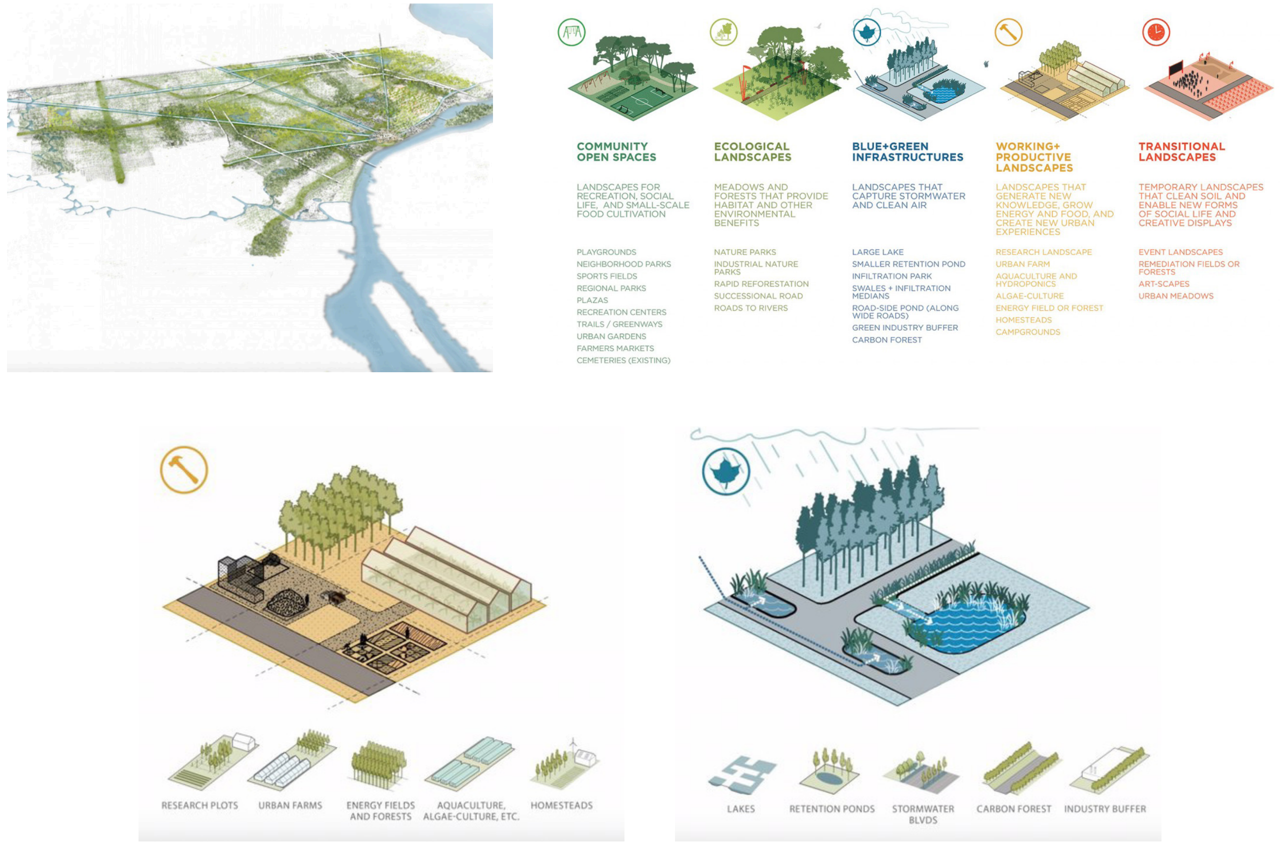


Figure 4.1: (Top Left) Rendered master plan. (Top Right) Ecological treatment typologies. (Bottom Left and Right) Blow up typologies (Detroit Future City).

Fasten Your Seat Belt

Fasten your seat belt is a project that won an international architecture competition that tasked applicants with creating a master plan for reimagining an abandoned military airbase. The winning proposal considers how the facilities can be reimagined and how the rest of the site can be repurposed as a multifunctional park that revitalizes the natural corridor. This is a good example of how a site-scale project can be reimagined to become part of a bigger network (Figure 1.4).

Figure 4.2: (Top Left) Relevant regional factors. (Top Right) Envisioning vegetation. (Bottom Left) Master Plan Rendering. (Bottom Right) Photo montage depicting character of new city (Fasten Your Seat Belt).

Mirada a Ponienta

This sea front project creates a master plan that features a linear park with different programed elements that vary in intensity to fit within a larger vision. The graphics do a good job of communicating how the project tailors site level designs to align with a larger vision (Figure 1.5).

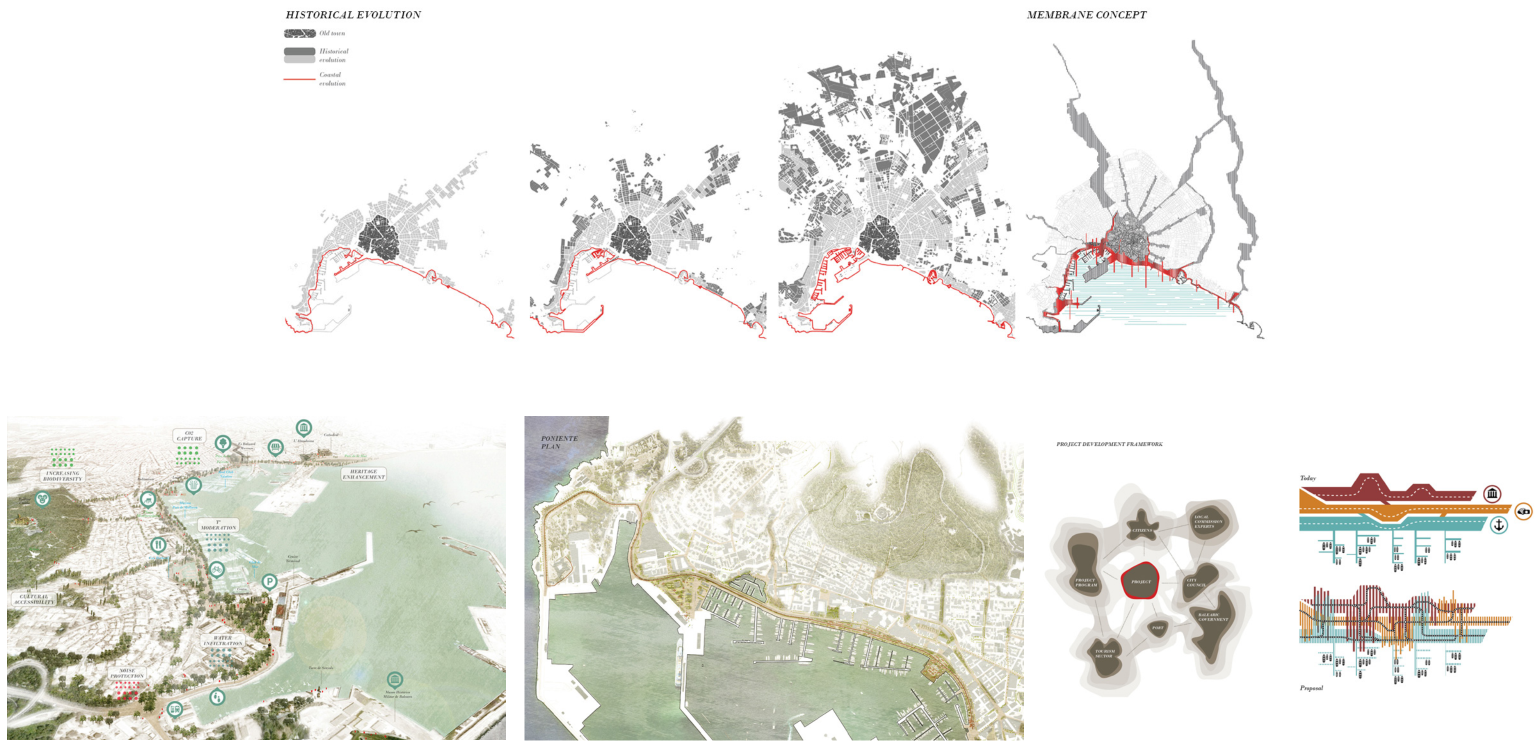


Figure 4.3: (Top Left) Illustrative plan showing network. (Top Right) Aerial perspective communicating ecology. (Bottom Left) Ecological phasing diagram. (Bottom Right) Concept communication diagram(Mirada a Poneinta).