INVESTIGATING INFLUENCE OF STREETSCAPE CHARACTERISTICS ON INDIVIDUAL PREFERENCE

by

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ABSTRACT

Streets and sidewalks are important public places for a wide variety of activities, such as social interaction and physical activities. Public spaces can provide numerous benefits, such as physical, psychological, social, spiritual, and aesthetic wellbeing; in order to maximize these benefits effective planning and design is critical. However, there is a need to increase empirical data which can support good planning for these public spaces. The purpose of this research study is to better understand how different elements of streetscape design influence a person's preferences for the design of the space. A streetscape consists of a variety of different infrastructure and natural forms, which are combined together to create a space centered on the movement of people. A survey was conducted with the aims to better understand how key design elements may influence users' preferences with regard to safety and attractiveness. The project study site is Moro Street in Aggieville Business District in Manhattan, KS. The study and survey were developed using the psychophysical approach, which employed a quantitative methods to analyze the perceptions of Aggieville patrons. The research methods consists of four main parts: variable selection, streetscape design, public survey, and data analysis. An ANOVA was conducted that revealed statistically significant effects related to the preference for streetscape design in terms of safety and attractiveness, as well as a combined average evaluation. Evidence shows that the on street parking (Parking) and green infrastructure (Green Infrastructure) are statistically significant ($p < .05$), whereas seating and biking had no statistically significant effect on the evaluation of attractiveness. Also, the on street parking (Parking), green infrastructure (Green Infrastructure) and bike lane (biking)are statistically significant ($p < .05$), whereas seating had no statistically significant effect on the evaluation of safety. Overall, on street parking (Parking) and green infrastructure (Green Infrastructure) are statistically significant ($p < .05$), whereas seating and biking had no statistically significant effect on the evaluation of both safety and attractiveness. These results support previous work from environmental psychologists, and provide additional empirical evidence to support effective street design.

Investigating Influence of Streetscape Elements on Individual Preference

Rebecca Liu
Kansas State University Year 2015
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TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF FIGURES, CHARTS AND TABLES

LIST OF FIGURES, CHARTS AND TABLES

Chapter 3 Methods

LIST OF FIGURES, CHARTS AND TABLES

LIST OF FIGURES, CHARTS AND TABLES

Chapter 5 DISCUSSION AND RESULT-BASED DESIGNS

Appendices

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To

My grandmother, Shirong Li

I love you.

PREFACE

The aim of the study is to deduce the specific design elements of streetscape, which are most influential for the "sense of place". "Sense of place" means a healthy and good place that makes people want to live, work, and play in the building environment. The impact of a good place includes physical, psychological, social, spiritual, and aesthetic outcomes. Overall, the major question of the study is as follows: "What are the best ways to develop Moro Street that attract people, lift their spirits, encourage them to socialize, and promote physical activity?" While this question cannot be answered by one Master's report, it is the intention that this project will be used to support this long-term goal.

CHAPTER 1 INTRODUCTION

1.1 Driving Forces and Problems

Streets and sidewalks are important public places for a wide variety of activities, such as social interaction and physical activities (Kuo et al. 1998). The positive impacts of a good public place include physical, psychological, social, spiritual, and aesthetic wellbeing (Frumkin 2003). In commercial districts, a walkable street is a key element for creating vibrant communities by providing a comfortable outdoor social environment, a pleasant visual experience, and potential financial benefits to local businesses (Jacobs 1995). Also, a walkable neighborhood is a social construct that has significant influence on the “sense of community” (LaGory 2002).

Directed by the New Urbanism movement, there is currently a call for increasing the walkability of American neighborhoods in the hope of emphasizing pedestrian-friendly development instead of vehicle-centric development (Toit et al. 2007; Speck 2013). Many research studies have focused on macro scale design elements such as sidewalk connectivity, land use and public transition systems (Campoli 2012). However, there is very little empirical information on the influence of micro design elements, such as green infrastructure, path design and street furniture in correlation to pedestrian and bicycle needs and preferences (Schwartz and Porter 2000).

This project focuses on the micro level design of a walkable area, especially in terms of how a street can facilitate users' safety and visual interest. The study area is on Moro Street in the Aggieville district of Manhattan, KS (Figure 1-1). This is a commercial district with a long history, if is also a hub of social activity for university students and the community in general. Moro Street is an area marked by mixed land-use (Figure 1-2). and high density, representative of the typical tone of Aggieville, and has a great potential for being a walkable place. Currently, Moro Street is a one-way road with two-sided on-street parking and narrow sidewalks on both sides. This means walking and cycling activities are disturbed by vehicles, narrow sidewalks, and poor aesthetics (Figure 1-3).

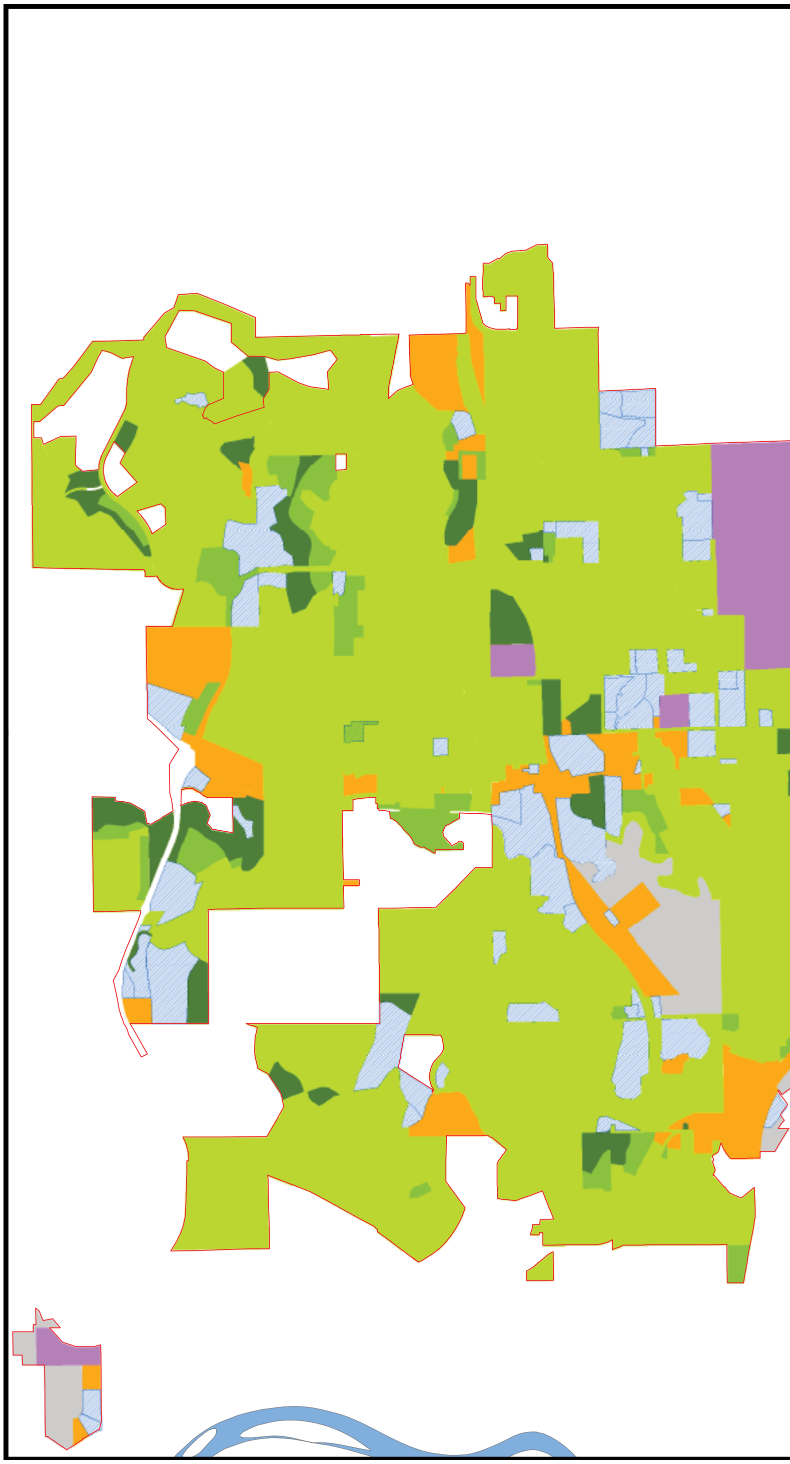


Figure 1-1 Zoning Map of Manhattan City and Location of Aggieville

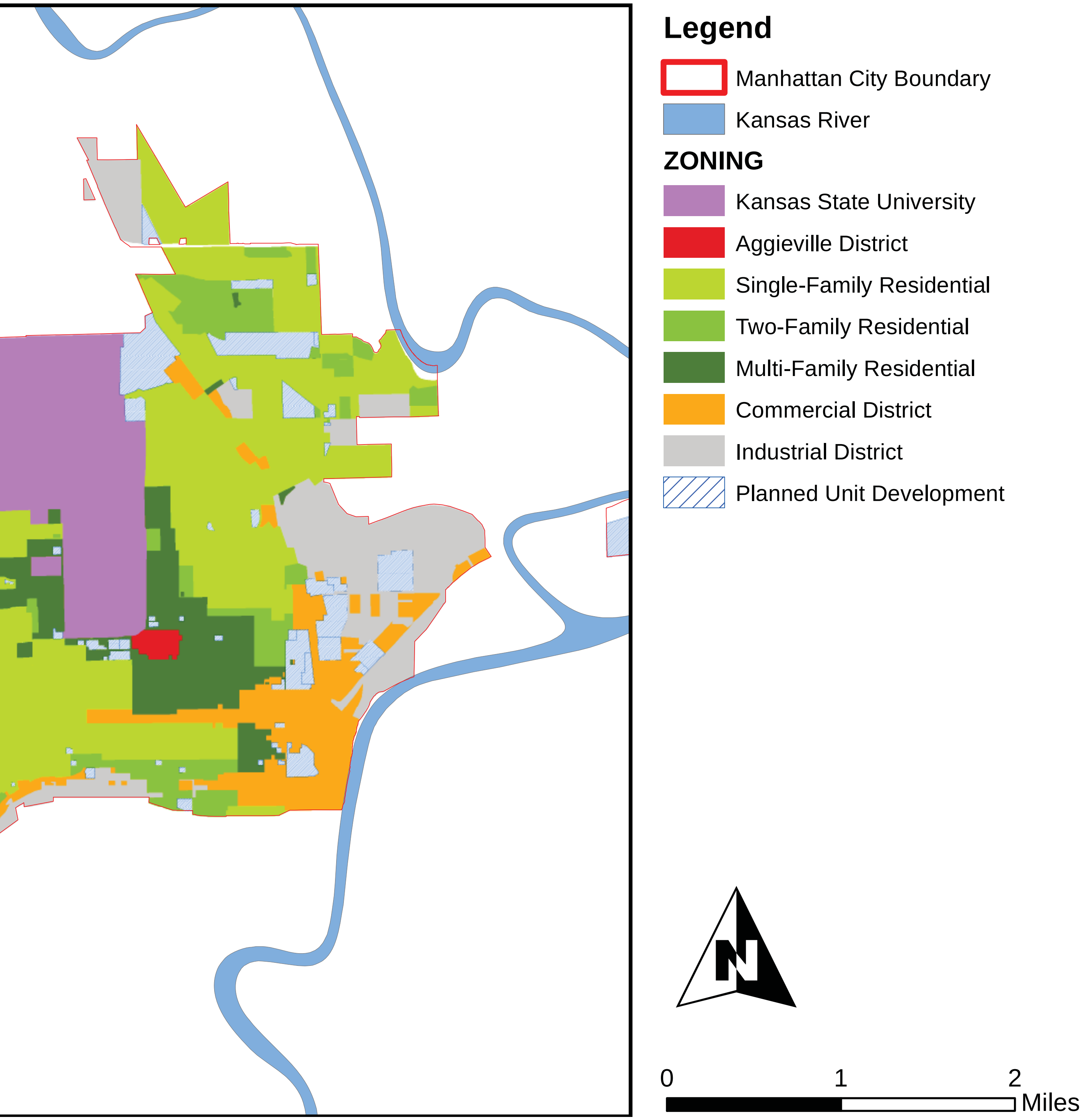

Legend
Manhattan City Boundary
Kansas River
ZONING
Kansas State University
Aggieville District
Single-Family Residential
Two-Family Residential
Multi-Family Residential
Commercial District
Industrial District
Planned Unit Development
N
0
1
2
Miles

Figure 1-2 Landuse of Moro Street

Figure 1-3 Existing Condition of Moro Street

1.2 Project Purpose

The purpose of this research study is to better understand how different elements of streetscape design influence a person's preferences for the design of the space. Streetscape consists of a variety of different infrastructure and natural forms combined together to create a space which is centered around the movement of people. This project aims to better understand how a few key design elements (on street parking, green infrastructure, bike lane and bench) may influence users' preferences in terms of safety and attractiveness when applied to Moro Street in AggieVille as the study site.

1.3 Research Question and Objectives

1.3.1 Research Question:

How do the design elements of streetscape influence an individual's preference in terms of safety and attractiveness?

1.3.2 Objectives:

- To determine which design elements most influence preferences for a streetscape in terms of safety and attractiveness.
- To identify if pedestrians' and cyclists' expectations of walkable streetscapes correlate to the preferences within different design elements.
- To develop some streetscape design strategies for Aggieville that can genuinely satisfy users' expectations.

1.4 Relevance to the Community, Local Business, and Contemporary Landscape Architecture

Nowadays, more and more planners and landscape architects believe that it is now time to start the New Urbanism movement, and that American cities need to move away from automobile dependency to more walkable cities (Speck 2013). This transition towards pedestrian will help eliminate such quality-of-life impairments as loss of open spaces and diminished feelings of community. Furthermore, increasing numbers of urban developments have started to incorporate pedestrian movement into their site layouts, by providing not only sidewalks, but also human-scale landscaping, lighting, and other features that promote streetscape quality and encourage people to utilize the space (Speck 2013). Figure 1-4 shows a pedestrian-only streetscape in Portland. It is a good example how American cities tried to make the streets more pedestrian-oriented.

However, compared to databases pertaining to macro-level analysis, there is very little solid information on the qualities of street design, such as green infrastructure, path design, and street furniture, in correlation to pedestrian and bicycle behavior and needs (Schwartz & Porter 2000).

Since this project aims to better understand how different elements of streetscape design influence a person's preferences for the design of the space,the research can provide solid empirical data about people's preferences for different street elements in pedestrian-friendly streetscape development.

Furthermore, a report based on public opinion can be used as a guideline for the future development of Aggieville. If Aggieville could be redeveloped based on pedestrian needs, the district will attract more and more people to walk, cycle, and gather there. This will benefit the city and its inhabitants in multiple ways, such as by promoting sociability, improving the local economy, and providing a healthy, safe, pedestrian environment for students and local residents. At the same time, a vibrant business district can help to increase local business opportunities.

Figure 1-4 Great Streetscape in Portland (Yue, 2013)

CHAPTER 2 BACKGROUND

2.1 Literature Review

2.1.1 Street Roles

Streets form the foundation of urban and suburban infrastructure (Marshall 2005). They are the “movement space” in cities that constitute a connective web in urban public spaces, whether they are on a micro scale of movement within buildings, or on a macro scale encompassing transportation throughout entire cities (Wood et al. 2008). Thus, the street combines movement, use, and frontage activities (Sallis, Bauman, & Pratt, 1998, Marshall 2005). Well-designed streets can help create communities, providing different experiences and memories both for locals and for people passing through (Jacobs 1995). The personality of a particular street is unique, meaning that each street has a variety of different characteristics that are simultaneously present at any given time (Guo 2009; Handy et al. 2002). Streets are used for a myriad of different activities, including walking, cycling, parking, and of course driving (Toit et al. 2007). Moreover, streets of commercial districts are designed to meet varying requirements, including those from social interactions as well as from economic benefits that create an atmosphere that is safe, accessible, and lively (Kuo et al. 1998; Handy et al. 2002; Toit et al. 2007).

2.1.2 Existing Issues

Before the automobile era, people depended on access by foot or slow-moving carts to get to jobs and marketplaces (Southworth 2005). However, after the nineteenth century, high-speed transport and the quest for efficiency killed the walkable city, and the pedestrian environment was ignored in favor of the automobile (Southworth 2005). As a result, streets lost their intimate scale and became mere service roads. In addition, pedestrian and cyclist experiments remained ignored and unable to freely navigate, being devoid of public life. Directed by the New Urbanism movement, there is a call to increase the walkability of American neighborhoods in the hope of emphasizing pedestrian-friendly development instead of car-dependent development (Leyden 2003; Toit et al. 2007; Speck 2013).

Although there are a lot of benefits to improving the walkability of a commercial area, there are still some impediments. Some retailers overlook the importance of a quality streetscape, and most of retailers consider parking quantity over quality (Mukhija & Shoup 2006). Ignoring pedestrian needs and the potential economic benefits are the biggest impediments, which generate poor attention to pedestrian-friendly development. Figure 2-1 shows a poor quality sidewalk in Huston City, which discourages pedestrian activities.

Figure 2-1 Poor Quality Sidewalk in Huston City (Campoli, 2013)

2.1.3 Defining Walkability

A neighborhood's walkability is thought to influence walking in a built environment (Toit et al. 2007). The quality of walkability has been widely referenced among different aspects, such as transportation planning, urban design, and landscape design (Southworth 2005). Southworth defines walkability "as a built environment [that] supports and encourages walking by providing for pedestrian comfort and safety, connecting people with varied destinations within a reasonable amount of time and effort, and offering visual interest in journeys throughout the network" (Southworth 2005). In addition, Forsyth states that walkability means encouraging physical activity and should involve a short distance to a destination, a safe environment in terms of perceived crime and traffic, and a continuously pleasant walking environment without barriers (Forsyth & Southworth 2008). Handy (2002) links pedestrian-friendly development to walkability, which means neighborhoods with relatively high densities of development, diverse land use, and urban design based on human-scale streets with high connectivity and attractive aesthetics (Figure 2-2).

A highly walkable environment means a safe and comfortable street space with street trees or other landscape elements, and minimized automobile dependence. The Wisconsin Pedestrian Policy Plan 2020 describes a walkable community as follows: "In a walkable community, walking is considered a normal transportation choice and is not a distraction or obstacle to motor vehicle traffic." Thus, the pedestrian-friendly path system should be attractive and engaging to be in while offering carried visual experiences with repeated encounters. It supports walking for utilitarian purposes, such as shopping or the journey to work, as well as for pleasure, recreation, and health.

Figure 2-2 Key Characteristics of Walkable Place

2.1.4 Why Walkability is Important

Recently, increasing numbers of Americans have realized the benefits of walking and cycling (Leyden 2003), so they are willing to drive less and be more physically active (Leyden 2003; Speck 2013). The pedestrian plans for Boulder and Portland strongly assert that walking is an essential and basic form of human transportation: "Walking is the oldest and most basic form of human transportation. It requires no fare, no fuel, no license, and no registration" (City of Portland 1998). The City of Boulder asserts, "Pedestrian travel is involved in every trip and is the basis for all other modes of travel" (City of Boulder 2003).

The benefits of walking are widely recognized. "Walking is clean, easy on the infrastructure, healthy for the individual, and integral to community livability" (City of Portland 1998).Like bicycling, walking is a "green" mode of transport that not only reduces congestion, but also has a low environmental impact, conserving energy without air and noise pollution (Newman & Kenworthy 1999).In addition, other benefits of walking, such as promoting sociability, improving the local economy, and contributing to physical as well as mental health, have been mentioned in several works (Southworth 2005; Kim & Kaplan 2004; Giles-Corti & Donovan 2002; Wood et al. 2008, Hoehner et al. 2005, Litman 2003, Barnett 2006).A walkable neighborhood is a social construct that has significant influence on the "sense of community" (LaGory 2002). A study in Galway, Ireland states that walking may also promote sociability (Leyden 2003). The study suggests that people who live in walkable neighborhoods have higher levels of "social capital", and are more likely to know their neighbors, participate politically, trust others, and be socially engaged (Leyden 2003). Walking also can promote mental and physical health (Southworth 2005). Among the health benefits are improved cardiovascular fitness, reduced stress, stronger bones, weight control, and mental alertness and creativity (Kim & Kaplan 2004).Walking may also contribute to mental health. For example, the high aesthetic qualities of a street can help improve individuals' wellbeing by helping people reduce stress (Ulrich 1983). A recent study of nearly 19,000 older women between the ages of 70 and 81 suggests that those who do more walking and other physical activity tend to have better cognitive function and less cognitive decline than those with less activity (Weuve et al. 2004). Since walking is the most accessible and affordable way to get exercise, and obesity has now become a major public health problem in the United States, several studies have been done that make connections between health and the design and planning of cities (Southworth 2005; Frank, Engelke, & Schmid 2003). The studies show that the pedestrian infrastructure and land use mix significantly contributed to increases in rental multi-family residential property values. Higher development density with higher street and sidewalk coverage were also favored by retail service uses. In relation to land use mix, mixing retail service uses, and multi-family residential rental uses helped make rental housings more attractive (Litman 2003; Sohn, Moudon; & Lee 2012). In commercial districts, a walkable street is a key element in creating vibrant communities by providing a comfortable outdoor social environment, a pleasant visual experience, and potential financial benefits to local businesses (Jacobs 1995).

2.1.5 The Evidence of Walkability

Sources ranging from personal opinion to empirical data show the evidence of walkable place design:

Some guidelines of walkable place design emerge from qualitative observational research. Jane Jacobs' careful scrutiny of Greenwich Village, New York, in the 1940s and 1950s walking its streets, visiting its shops, and lingering in her Death and Life of Great American Cities, and William Holly Whyte's detailed photography of the sidewalks, parks, playgrounds, and streets of New York as described in The Social Life of Small Urban Spaces and City: Rediscovering the Center, are classic examples. In the Made for Walking: Density and Neighborhood Form, Campoli (2012) backs up her evidence with studies showing that a holistic approach creates the most walkable neighborhoods: areas that combine the highest number of walkability factors have the lowest levels of driving and resulting CO_2 emissions. The study on extensive use of street photography helps to illustrate why people are so happy to walk along these streets in ways that pure statistics and analysis can never do justice.

Empirical studies of stated preference, published for the most part in environmental psychology literature, have yielded conclusions about what makes walkable places. Rachel and Stephen Kaplan (1989) have reviewed much of their work and that of others in <The Experience of Nature> and <With People in Mind>. Respondents are shown photographs of different kinds of places and asked to choose which they prefer. People were shown to consistently favor such features as a balance of trees and pasture, clear borders, and alluring paths that curve out of sight. The general features of preferred places that emerge include spatial definition, coherence, legibility, and mystery. These results suggest that views of trees have a salutary effect and, together with other evidence, support the notion that trees are part of a "walkable place".

2.1.6 The Criteria of Walkability

According to Southworth (2005), there are two different scales of criteria for designing a walkable space: one is at the macro level, which focuses on urban design and considers such aspects as density and scale. The other is at the micro level, focusing on street environment design.

On the macro level, a walkable space is one that 1) is connected to a pedestrian network system (Figure 2-3); 2) has a high land-use density (Figure 2-4); 3) is accessible to such diverse services as banks (Figure 2-6), grocery stores, restaurants, and schools; and 4) is within a walkable distance to public transportation (Campoli 2012, Southworth 2005, Hoehner et al. 2005) (Figure 2-6).

Figure 2-3 Sidewalk Network and Green Space of LoDo, Denver,Colorado (Campoli, 2013)

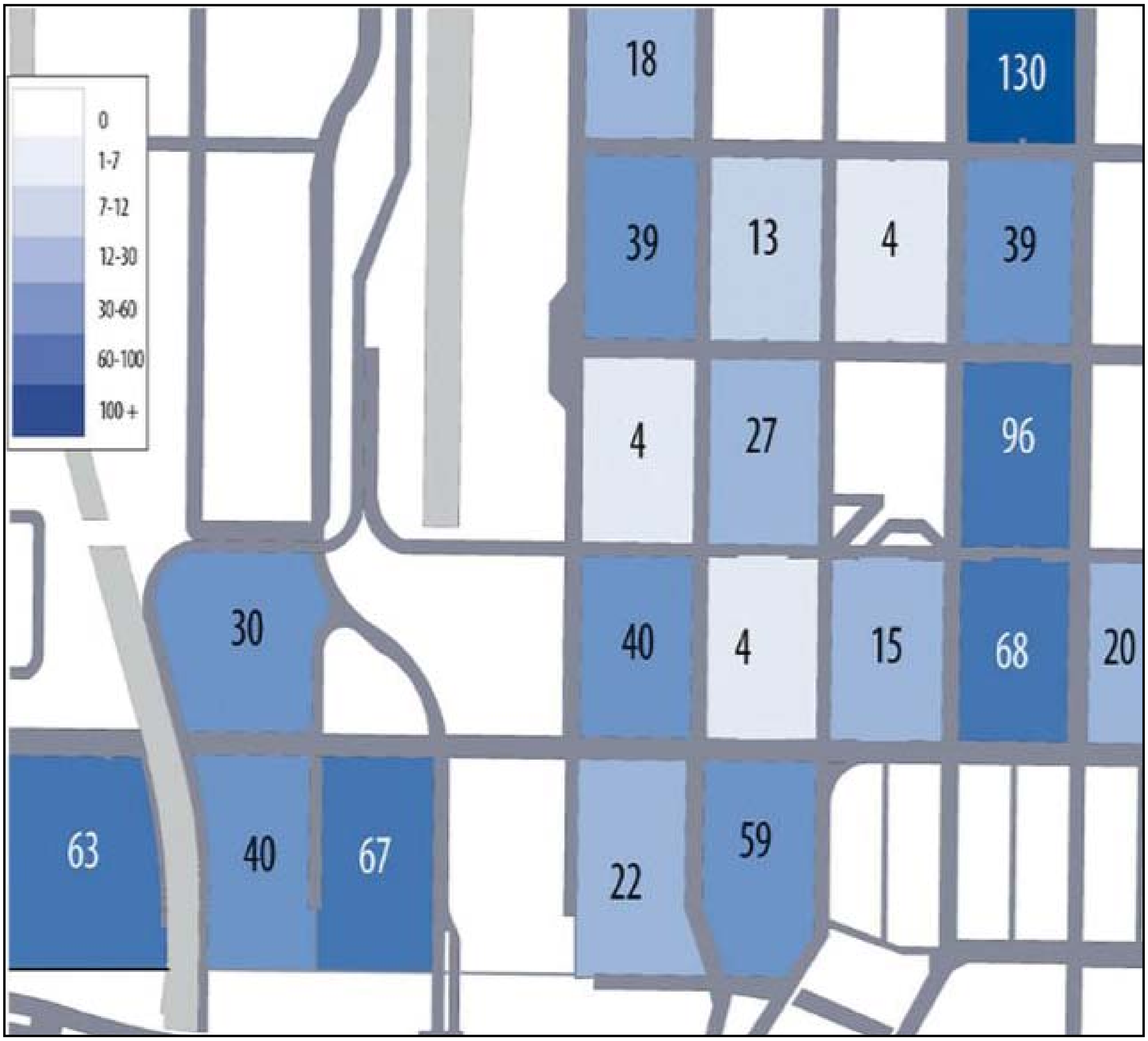


Figure 2-4 Housing Density of LoDo, Denver,Colorado (Campoli, 2013)

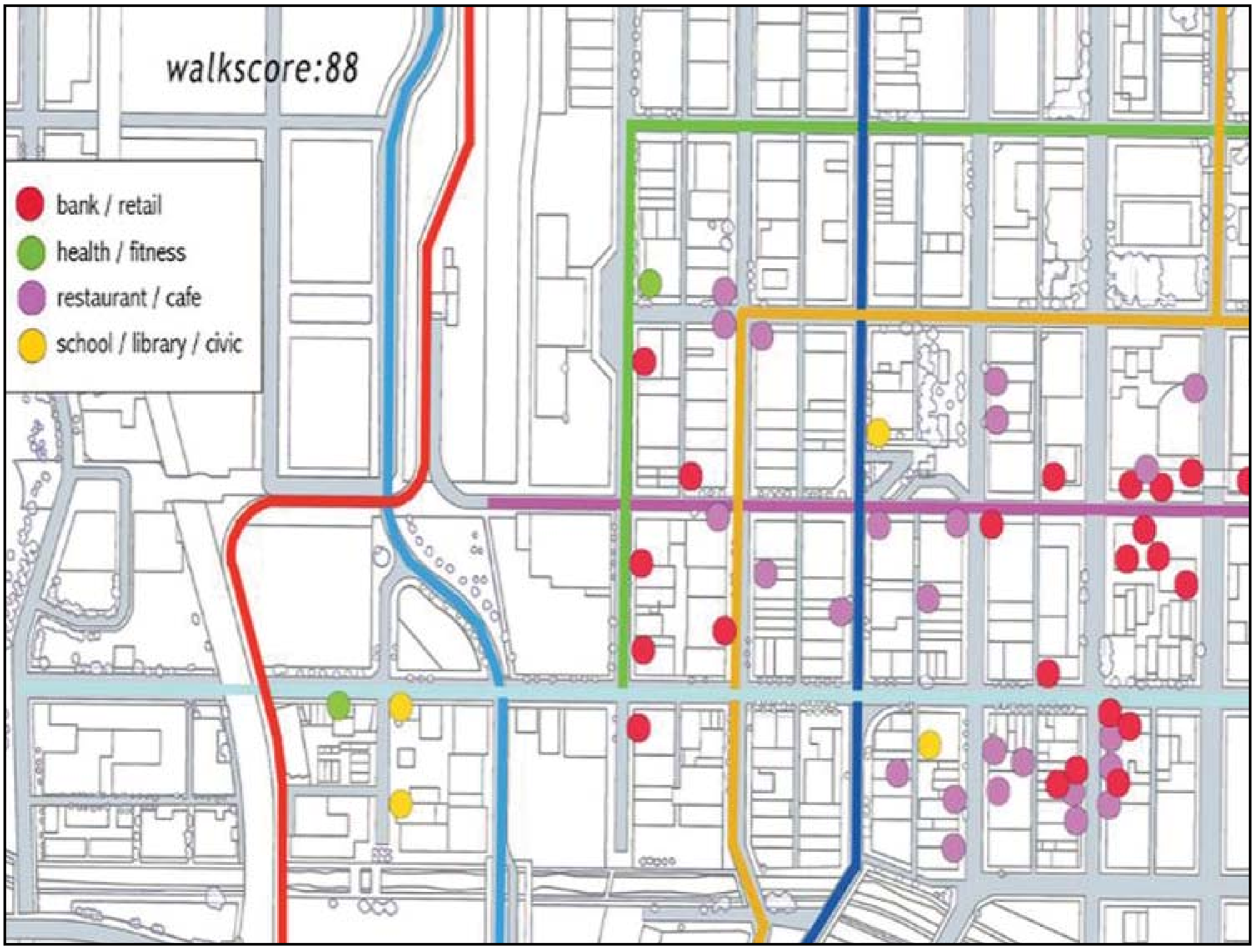


Figure 2-5 Services of LoDo, Denver,Colorado (Campoli, 2013)

On the micro level, a walkable space should be attractive and engaging with a pleasant streetscape,providing safety, social coherence, and a visual connection (Southworth 2005). The design focuses on a street scale, incorporates pedestrian movement into site layouts; it provides not only sidewalks, but also human-scale landscaping, lighting, and other features that promote streetscape quality and encourage people to utilize the space (Figure 2-6) (Speck 2013; Fukahori and Kubota 2002). Key characteristics of walkability should include the following: 1) connectivity of sidewalk network, both locally and in the larger urban setting; 2) linkage with other modes: bus, streetcar, subway, and train; 3) fine grained and varied land use patterns, especially for local serving uses; 4) safety, both from traffic and social crime; 5) quality of path, including width, paving, landscaping, signing, and lighting; and 6) path context, including street design, visual interest of the built environment, transparency, spatial definition, landscape, and overall explorability (Campoli 2012; Fukahori & Kubota 2002; Hoehner et al. 2005). The quality and context of the path are significant to the walkability, facilitating pedestrian comfort, safety, and visual interest (Southworth 2005). As is stated by Susan Handy, "Because the pedestrian sees, hears, smells, and feels much of the surrounding environment is likely to play a greater role in the choice to walk" (Handy 1996).

However, compared to databases pertaining to a macro-level analysis (sidewalk system, landuse, etc), there is very little solid information regarding the quality of street design, such as green infrastructure, path design and street furniture, that is correlated to pedestrian and bicycle behavior and needs (Figure 2-6) (Schwartz & Porter 2000). Furthermore, creating a pleasant walking environment for recreation and transportation that offers changing scenery, social encounters, and facility infrastructure has been the least understood and most ignored variable in walkability design (Figure 2-6)(Southworth 2005; Giles-Corti & Donovan 2002; Kelly et al. 2011).

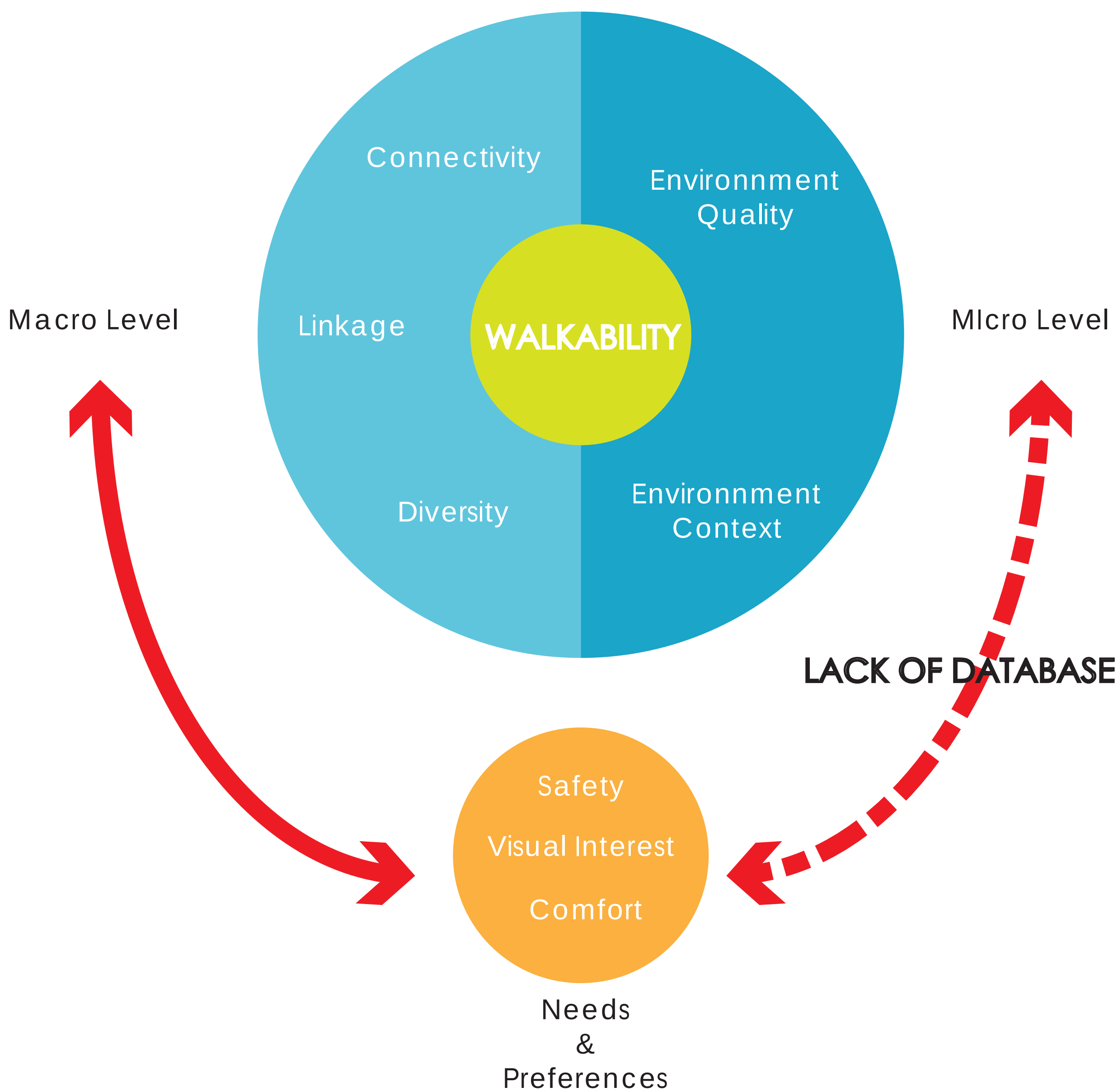


Figure 2-6 Lacking Database of Micro-Level Analysis of Walkability

2.1.7 The Benefits of Pedestrian-friendly Street (Figure 2-7)

Social interaction is noticeably more energetic in communities with more options for walking and biking when compared with more car-focused communities(Forsyth et al. 2008; Owen et al. 2004). Streets with desirable aesthetic qualities are often said to have a strong “sense of place” - a clear identity (Handy et al. 2002). Additionally, these alternative transportation methods result in residents becoming more aware of the environment around them, thereby creating an appreciation for the community’s natural areas and resources (Toit et al. 2007; Handy et al. 2002). This combination of increased social connection as well as a better appreciation for the community environment contributes to our sense of well-being, and may result in an increased willingness to participate in local government, volunteer for emergency services, or assist in organizing events. (New Hampshire 2013; Handy et al. 2002).

Pedestrian-friendly streets nurture social interactions and promote a healthy economy by combining accessibility, networking, convenience, and creativity in the daily routines of city dwellers (Litman 2003). Furthermore, communities that implement pedestrian oriented practices resulting in less traffic noise, traffic speeds, and vehicle-generated air pollution are more likely to generate higher property values compared to communities that neglect to take these steps (Litman 2003). Studies show a distinct trend pointing to increased home ownership and business startups in areas with high livability and walkability ratings (Crankshaw 2009). Likewise, tourism is also an industry that benefits from more walkable communities, and is an economic driver for local and state economies. The studies also show that the pedestrian infrastructure and land use mix significantly contributed to increases in the property values of multi-family rentals. Higher development density with higher street and sidewalk coverage was also favored by retail service uses(Litman 2003; Sohn, Moudon, & Lee 2012).

Over the past 30 years, the number of miles traveled by vehicles across the United States has increased three times as rapidly as the population (FHWA 1997). As this dependency on vehicles continues to grow, adverse environmental impacts are becoming more pronounced, including increases in greenhouse gas emissions, air pollution, and water pollution. These in turn affect environmental and human health (LaGory 2002). Design strategies for developing a pedestrian-friendly streetscape include enhancing and safeguarding local ecological conditions as well as providing great environmental benefits (Sallis, Bauman, & Pratt 1998). For example, green infrastructure enhance local habitat conditions for insects and bird species, and reduce the urban heat island effect by improving thermal comfort, moderating microclimatic conditions, and providing shade (Avissar 1996; Park et al. 2012; Taha 1997; US EPA 2014). Moreover, the use of green infrastructures, such as the utilization of above-ground swales in the capture, storage, and filtration of stormwater, can significantly improve the quality of surrounding water bodies, thus cleaning the run-off water of petroleum products and heavy metals from automobiles (Rottle & Yocom 2010; Bartens et al. 2008; Armson et al. 2012).

By encouraging social activities in these pedestrian-friendly streets, persons who are socially engaged with others and actively involved in their communities tend to live longer and be healthier both physically and mentally (Kaplan and Kaplan,1989).The health impact of a good public place includes physical, psychological, social, spiritual, and aesthetic outcomes (Frumkin 2003). Some studies have suggested that the quality of the walking environment influences the amount of walking people will do. A study shows residents of higher walkable neighborhoods engaged in 70 min more of physical activity in the previous week and had less obesity; 60% of residents in low walkability neighborhoods were overweight (Saelens et al. 2003). In Perth, Australia researchers found that people were 50% more likely to walk at the recommended levels on higher quality streets(Giles-Corti & Donovan 2003).Pedestrian-friendly streets may also contribute to mental health. For example, the high aesthetic qualities of a street can help improve individuals' wellbeing by helping people reduce stress (Ulrich 1983).

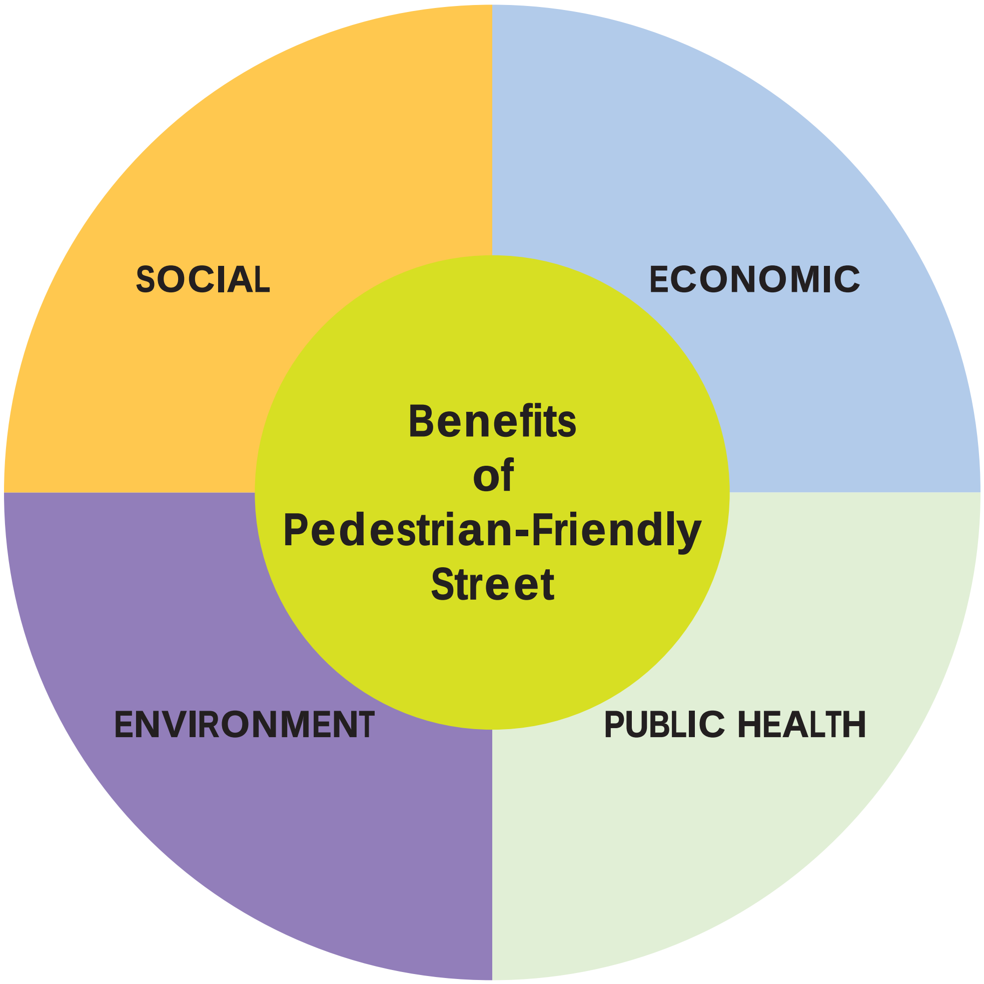


Figure 2-7 The Benefits of Pedestrian-friendly Street

2.1.8 The Design Guideline of a Pedestrian-friendly Street

The quality of the walking environment in terms of physical characteristics of streets is one of the significant parts of walkability (Landis, Vattikuti, Ottenberg, McLeod, & Guttenplan, 2001). The pedestrian environment can significantly affect the walking experience of a person, the physical activity of pedestrians, and the rates of participation (Owen et al. 2004; Guo 2009; Giles-Corti & Donovan 2002; Forsyth et al 2008). Figure 2-8 shows the highly popular pedestrian promenade of 16th Street Mall of Denver, CO, lots of pedestrian using the space in different ways. Recently, increasing numbers of Americans have realized the benefits of walking and cycling(Leyden 2003), so they are willing to drive less and be more physically active (Speck 2013). The Wisconsin Pedestrian Policy Plan 2020 provides a useful definition of "pedestrian", namely "a pedestrian is any person walking, standing, or in a wheelchair" (Wisconsin Department of Transportation, 2002). A large collection of resources conducted on a pedestrian-friendly street primarily fall within two categories: attractive scenery, and a safe environment for pedestrians, cyclists, and drivers (Frumkin 2003; Burden 1999; LaPlante & McCann 2008).

Attractiveness indicates places with desirable aesthetic qualities (Handy et al. 2002). The factors that contribute to improving attractiveness include the design of buildings and their location relative to the street; landscaping, particularly trees and the shade they provide; and the availability of public amenities, such as benches and lighting qualities (Handy et al. 2002).

Safety refers the continued sidewalk without interruptions and hazards, and accessible for people of varied ages and degrees of mobility (Southworth 2005, City of Boulder 2003). Pedestrian-friendly design guidelines of different cities have suggested some key considerations on improving street safety: a human-scale path width that accommodates pedestrian volume; features a narrower street, curb cuts, and ramps; reduces roadway crossing distances; calms traffic; and has a high-quality path surface (Washington State Department of Transportation 1997; City of Boulder 2003; Mukhija & Shoup 2006; LaPlante and McCann 2008).

"Streets and squares should be safe, comfortable, and interesting to the pedestrian. Pedestrians' experiences in public spaces should make them want to be there. They should be sheltered from sun and rain if possible, should feel buffered from moving automobiles, should have a varied visual experience, and should feel well oriented within their surroundings."

----- Ned Crankshaw

Figure 2-8 16th Street Mall of Denver,CO

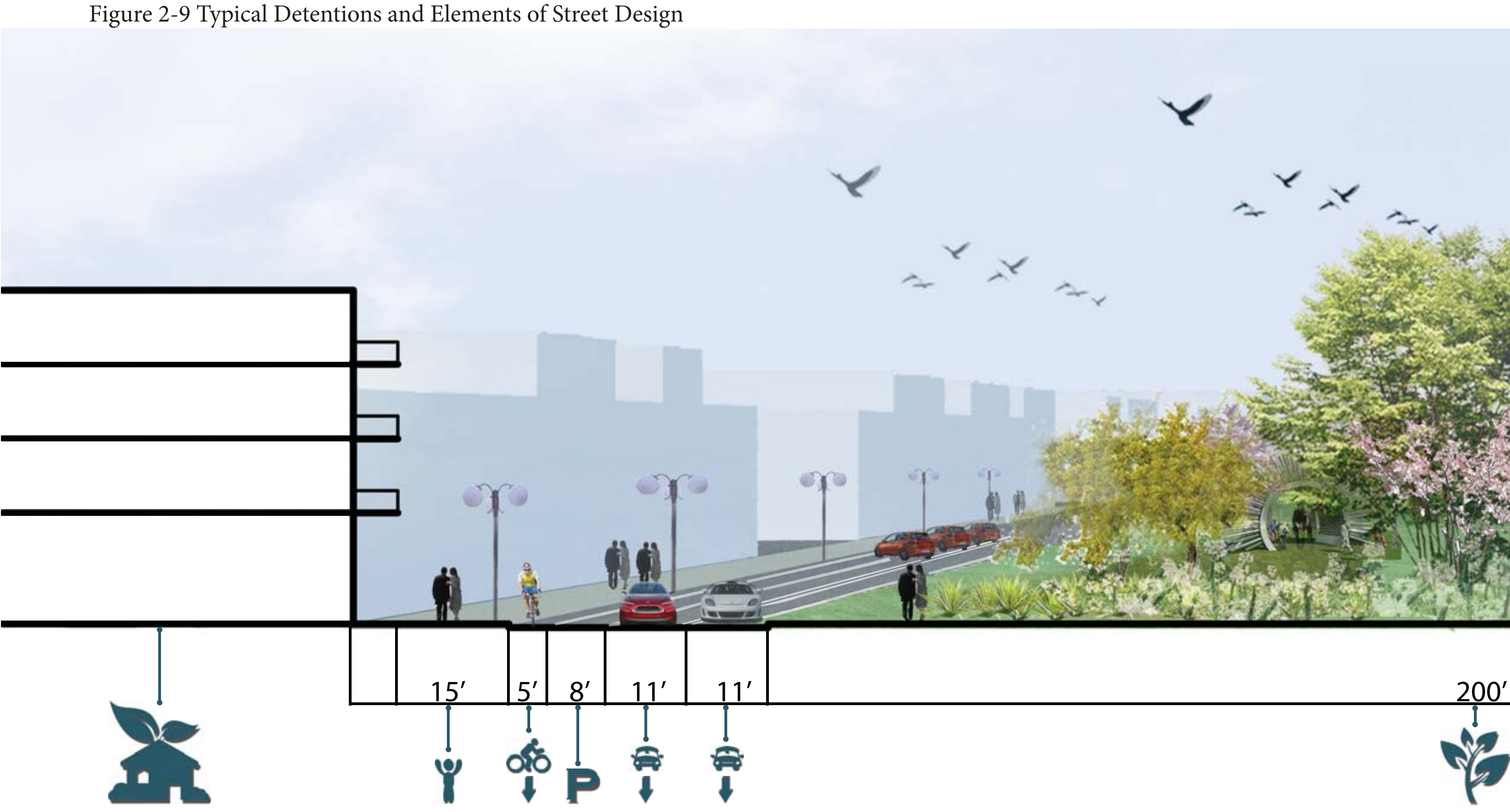
Traffic volume and parking spaces need to be seriously considered, and improvements to parking design will benefit both the community and retailers (Mukhija & Shoup 2006; Kelly et al. 2011). On-street parking disturbs pedestrian routes, and off-street parking overwhelms the physical landscape, expanding the distance between destinations and undermining walkability (Mukhija & Shoup 2006). A recent trend across the country has been "traffic calming," techniques for making streets more pedestrian friendly by slowing down traffic through a variety of devices, such as chokers, chicanes, speed bumps, raised crosswalks, narrowed streets, rough paving,landscaping, and other means (Southworth 2005).

Sidewalks, walkways, and paved or unpaved shoulders within the street right-of-way are all in the pedestrian domain (LaPlante and McCann 2008). Effective sidewalk width is the area of the walkway clear of any obstructions. It is important to retain as much effective sidewalk width as possible so that sidewalk users, including those with wheelchairs, are able to safely navigate their way towards their ultimate destination (Burden 2000). All street conveniences and landscaping should be arranged so that pedestrians have adequate space to travel. Neighborhood sidewalks need to be, at a minimum, of a width that accommodates two people walking side-by-side (Burden 2000) (Figure 2-9).

Plants positively affect the visual quality of the consumer environment, district perception, patronage behavior, and product prizing (Wolf 2005). Plants can also be effective in providing some of the most critical ecosystem services in the urban environment (Calkins 2012). Integrating green infrastructure elements with the street design as well as incorporating vegetation, soils, and natural processes can help in managing water and creating healthier urban environments (US EPA 2014). Bioswales, planter boxes, and trees are among the many green infrastructure features that may be woven into street designs (US EPA 2014).

Pedestrian- scale lighting and amenities are important in terms of providing a safe social environment (Landis et al. 2001; Kelly et al. 2011). According to the literature, the quality of bike lane has significant effects on the visual behavior of cyclist (Vansteenkiste et al. 2014). On the high quality bike lane, gaze was evenly distributed over the different areas

Figure 2-9 Typical Detentions and Elements of Street Design



of interest (Vansteenkiste et al. 2014). Also, the traffic density may also influence cyclists' gaze behavior (Vansteenkiste et al. 2014). Furthermore, regarding the concept Self-Explaining Road, an easily distinguishable bike lane can make people's behavior more consistent so that elicits safe behavior (Theeuwes and Godthelp 1995).

Other details should be considered in street design as well, including: curbs defining the edge of the roadway, improved safety achieved by separating pedestrians from vehicles, and the channeling of excess water into storm drains(Frumkin 2003; Burden 1999; LaPlante and McCann 2008). Signs orient us to locations, warn us of upcoming obstacles or changing conditions and regulate vehicle movements (Burden 1999; LaPlante and McCann 2008). Utilities and sewers, though often underground, are likewise important to the smooth functioning of streets (Burden 1999; LaPlante and McCann 2008).

2.2 Site Information

2.2.1 Site Location & History

Aggieville is a commercial district in Manhattan, Kansas, with a 125-year history as a place where people have gathered and shopped. It is in close proximity to the Kansas State University campus area and surrounded by a low- to medium-density residential area (Fig.2-10). As a vibrant commercial district marked by mixed land use and high density (Fig.2-11), it also has very good pedestrian accessibility (Fig.2-12).

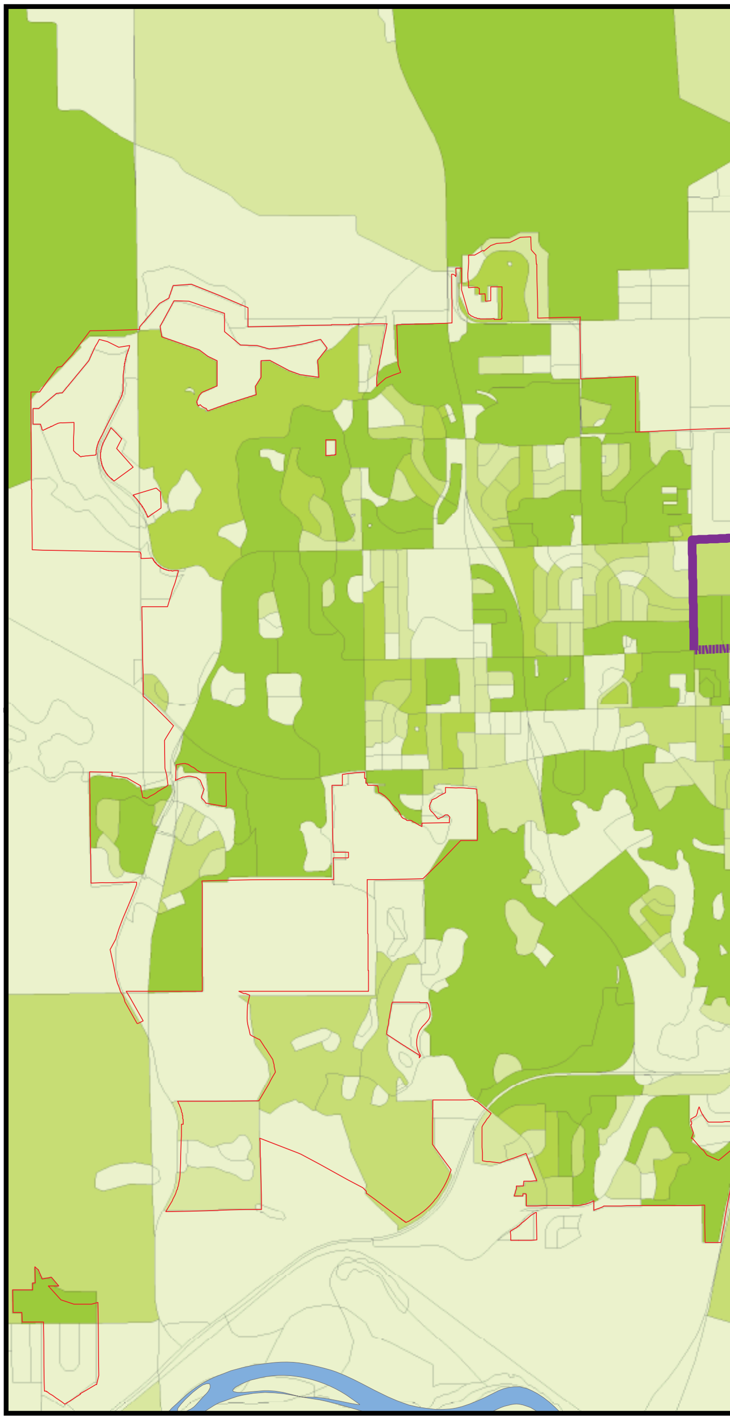


Figure 2-10 Relative Population Density of Manhattan City, KS

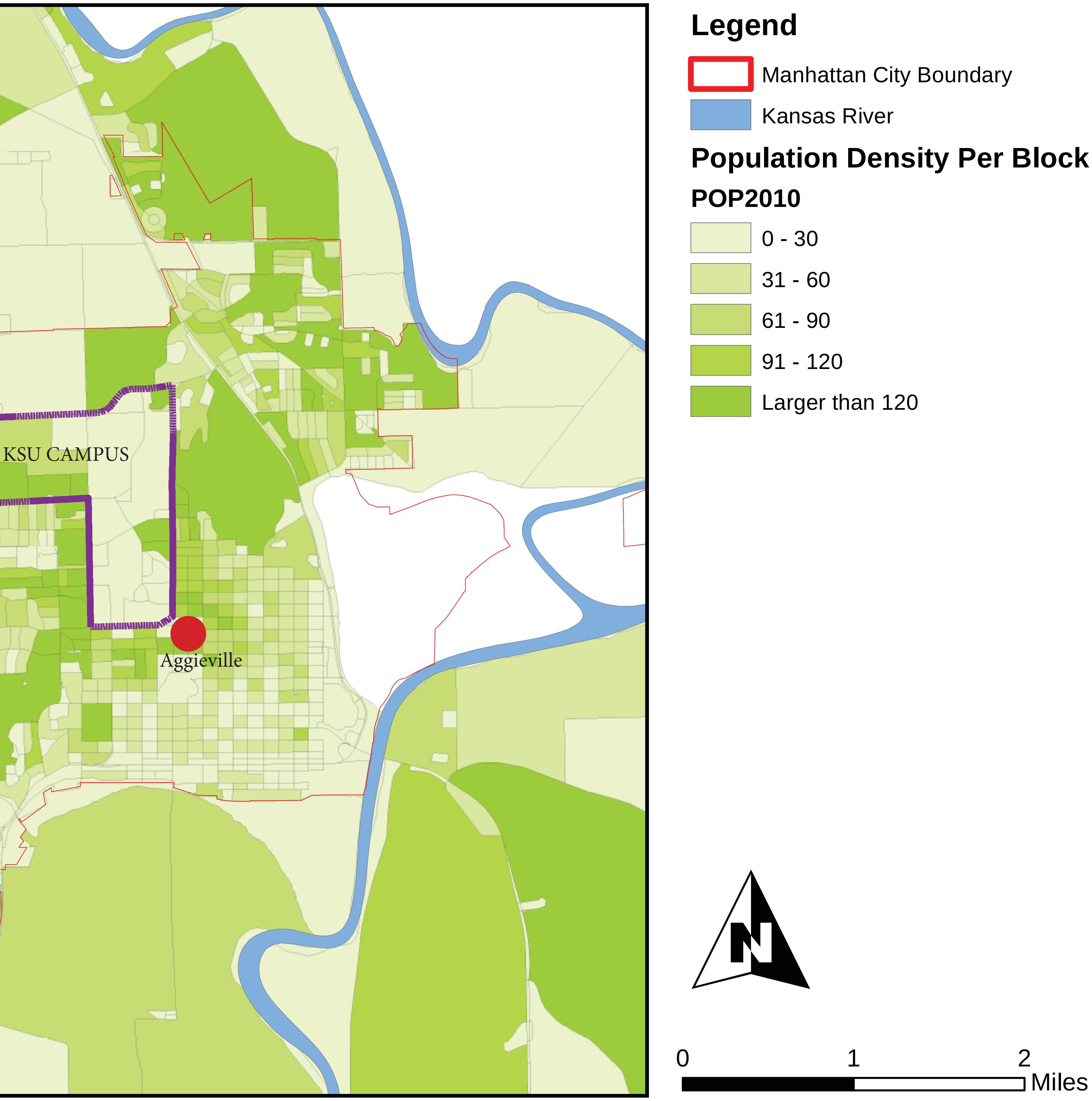
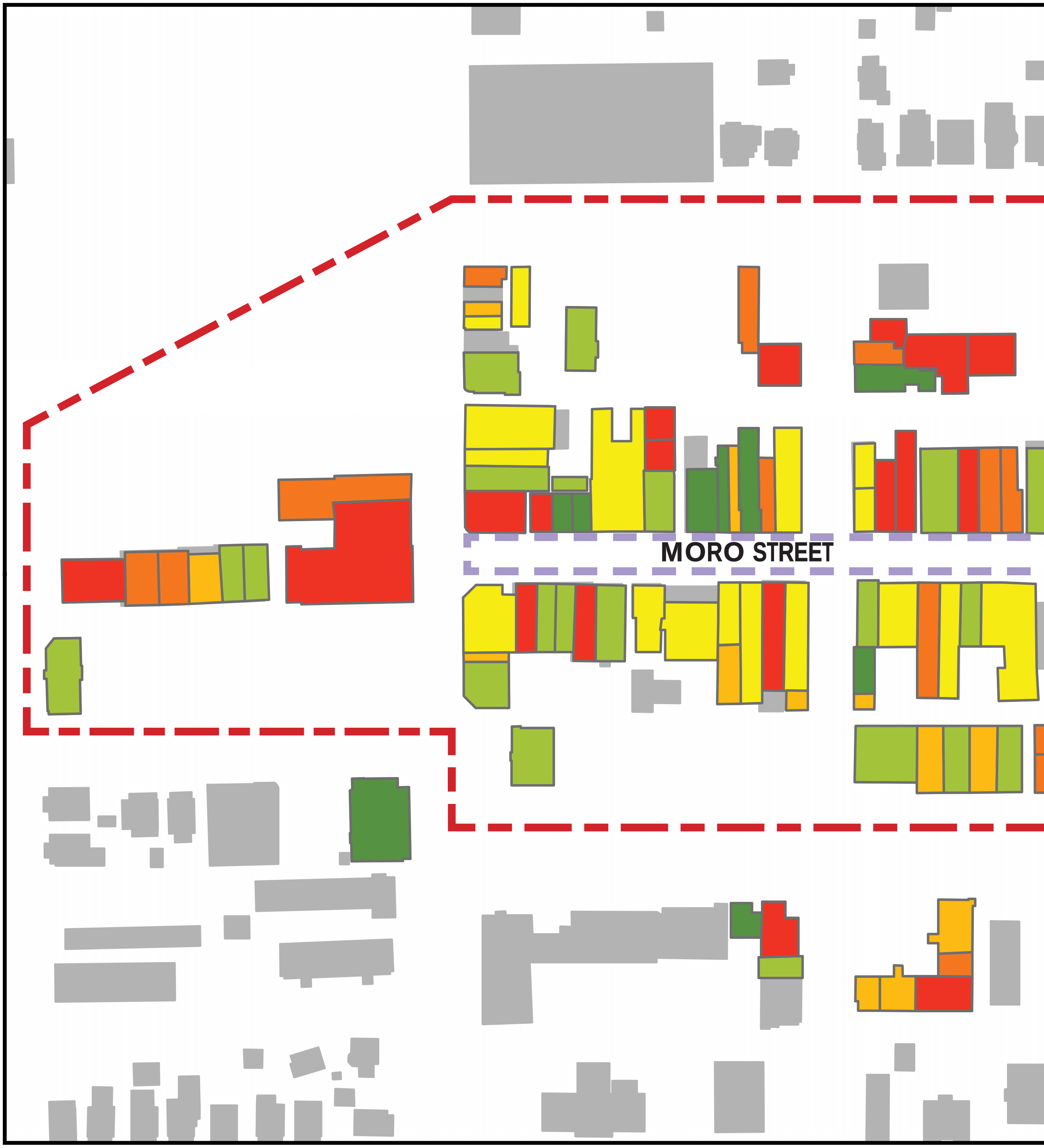

KSU CAMPUS
Aggieville
Legend
Manhattan City Boundary
Kansas River
Population Density Per Block
POP2010
0 - 30
31 - 60
61 - 90
91 - 120
Larger than 120
N
0
1
2
Miles

Figure 2-11 Landuse of Aggieville in Manhattan City, KS



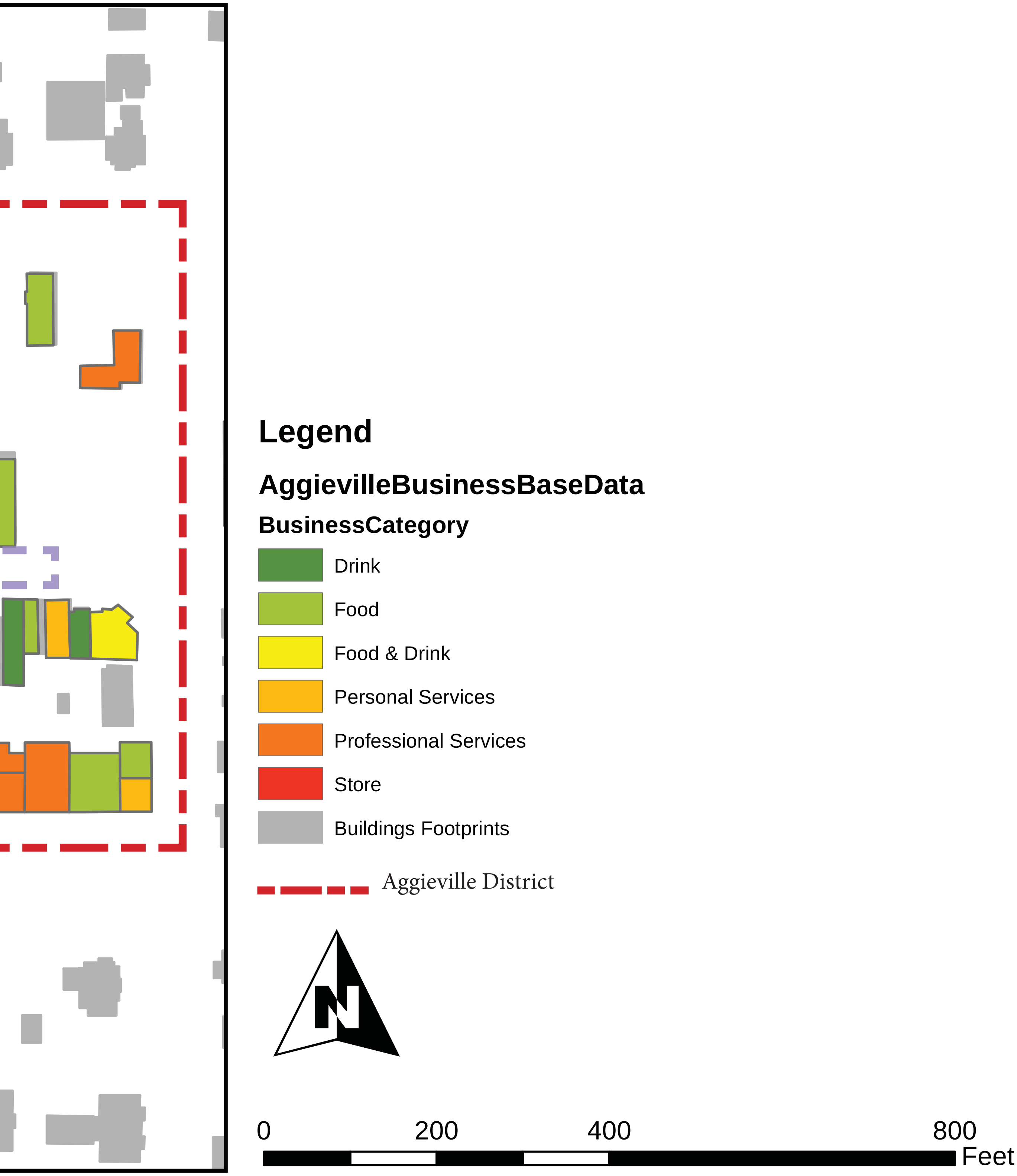
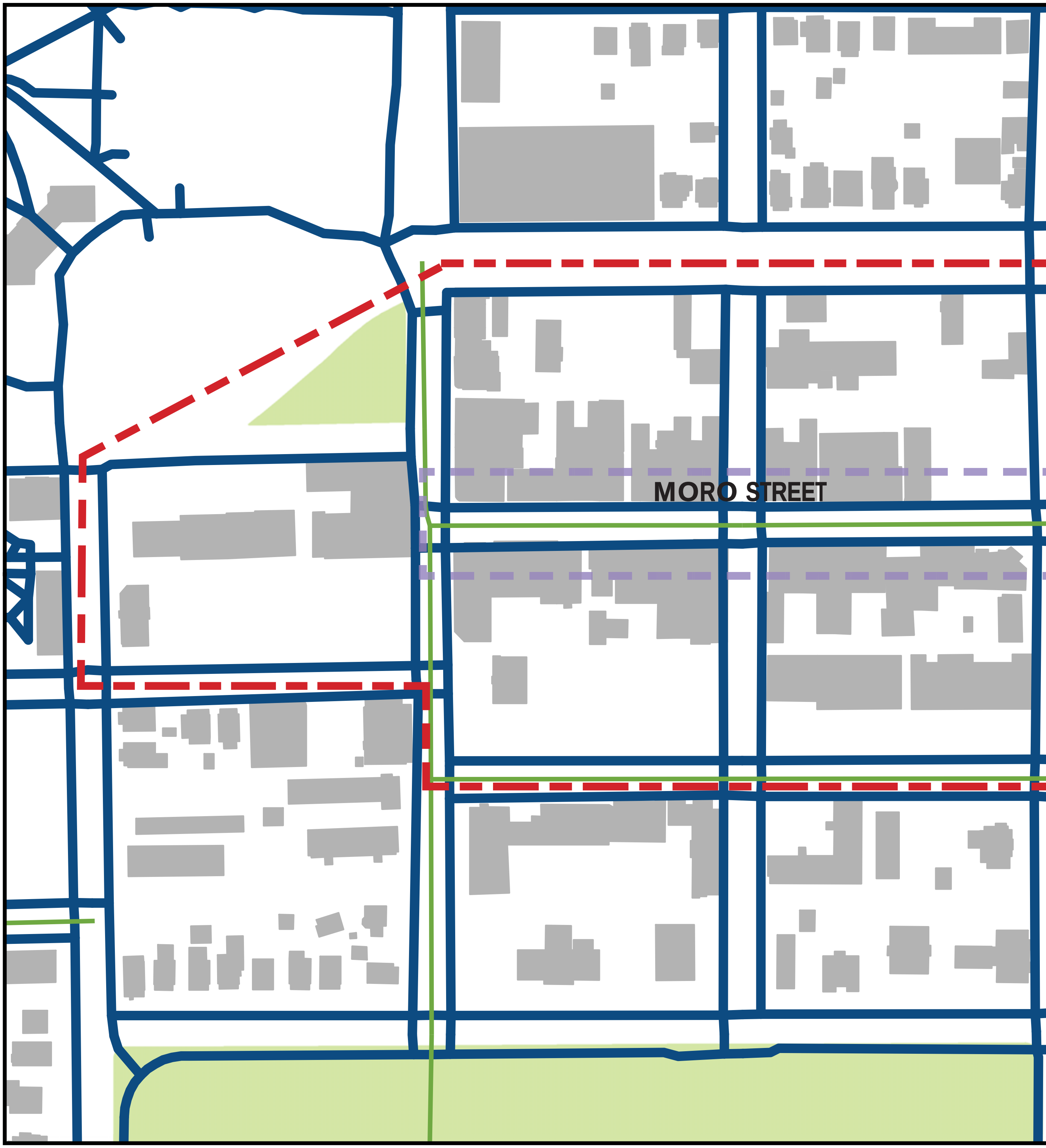
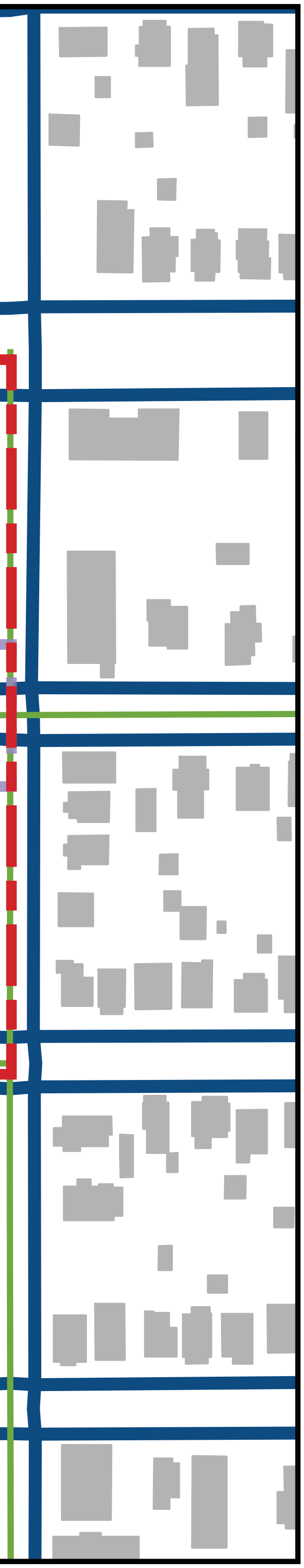
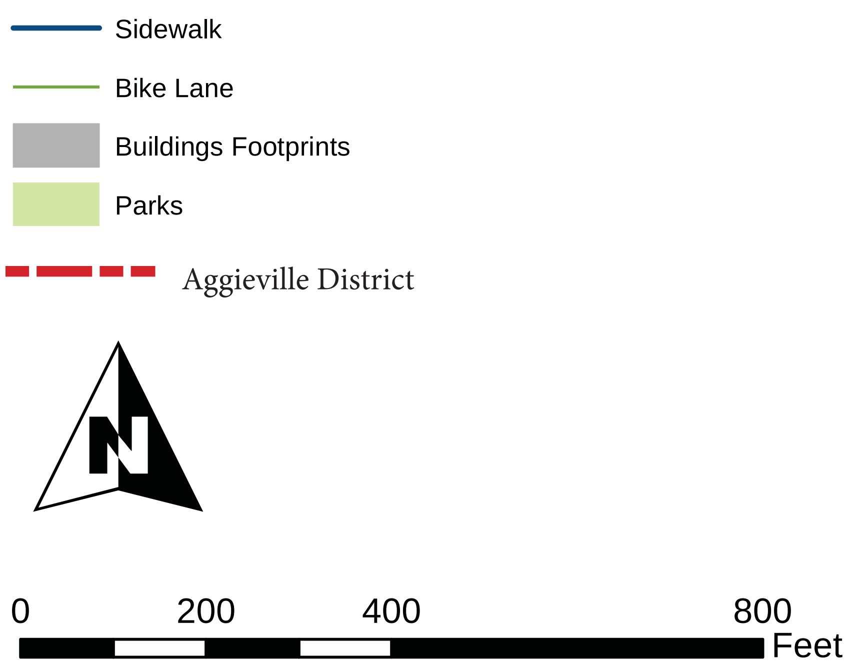

Legend
AggievilleBusinessBaseData
BusinessCategory
Drink
Food
Food & Drink
Personal Services
Professional Services
Store
Buildings Footprints
Aggieville District
0
200
400
800
Feet

Figure 2-12 Sidewalk System and Bike Lane of Aggieville in Manhattan City, KS





Legend

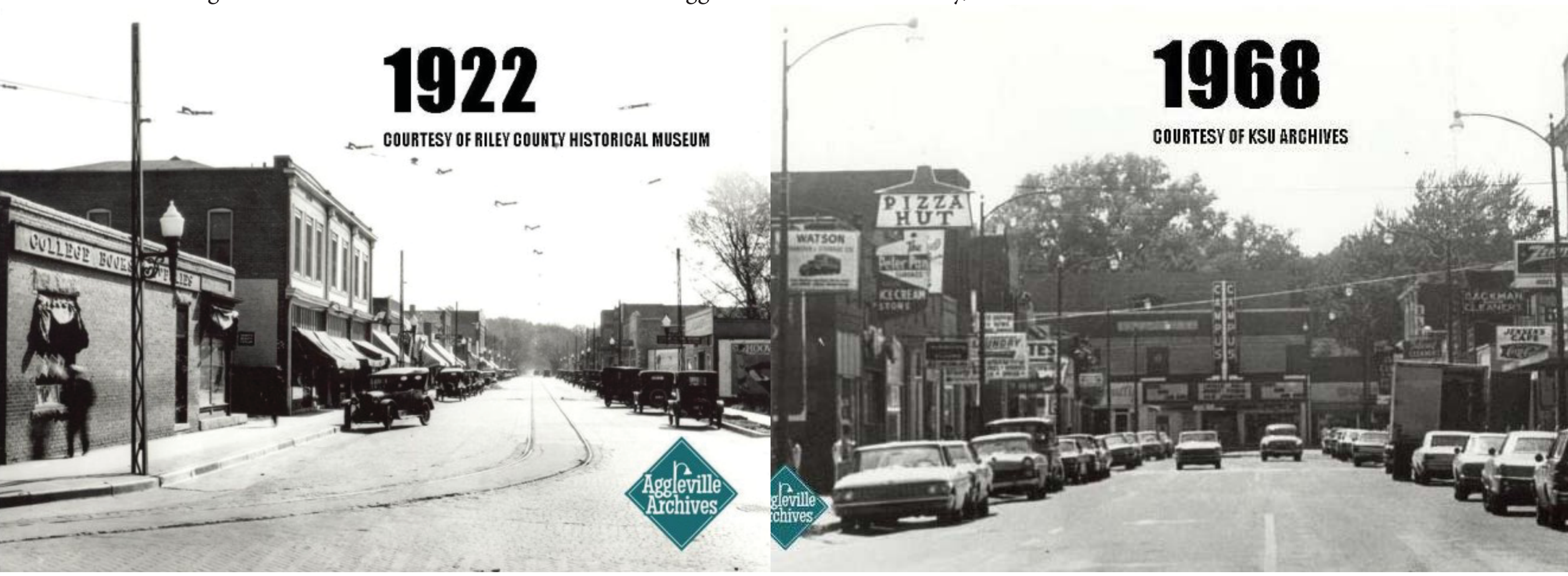


Sidewalk
Bike Lane
Buildings Footprints
Parks
Aggieville District
N
0
200
400
800
Feet

2.2.2 Site History

From 1915 to 1925, enormous growth of Aggieville took place with development occurring along Manhattan and Moro, consisting of an expanded College Book Store, a grocery store, clothing companies, apartments, and college State Bank (Walter 2001). In the late 50s and early 60s, several Aggieville cafes were forced out of business due to the opening of the K-State Student Union in 1956. In 1989, streetscapes in Aggieville were improved and angled parking was implemented along Moro Street. Furthermore, enrollment at the college nearly doubled over these 20 years, which caused the Aggieville businesses, consisting of shops, bars, and restaurants to boom (Walter 2001) (Figure 2-13). Nowadays, 66 of 91 businesses are locally owned.

Figure 2-13 Historic Pictures of Moro Street of Aggieville in Manhattan City, KS



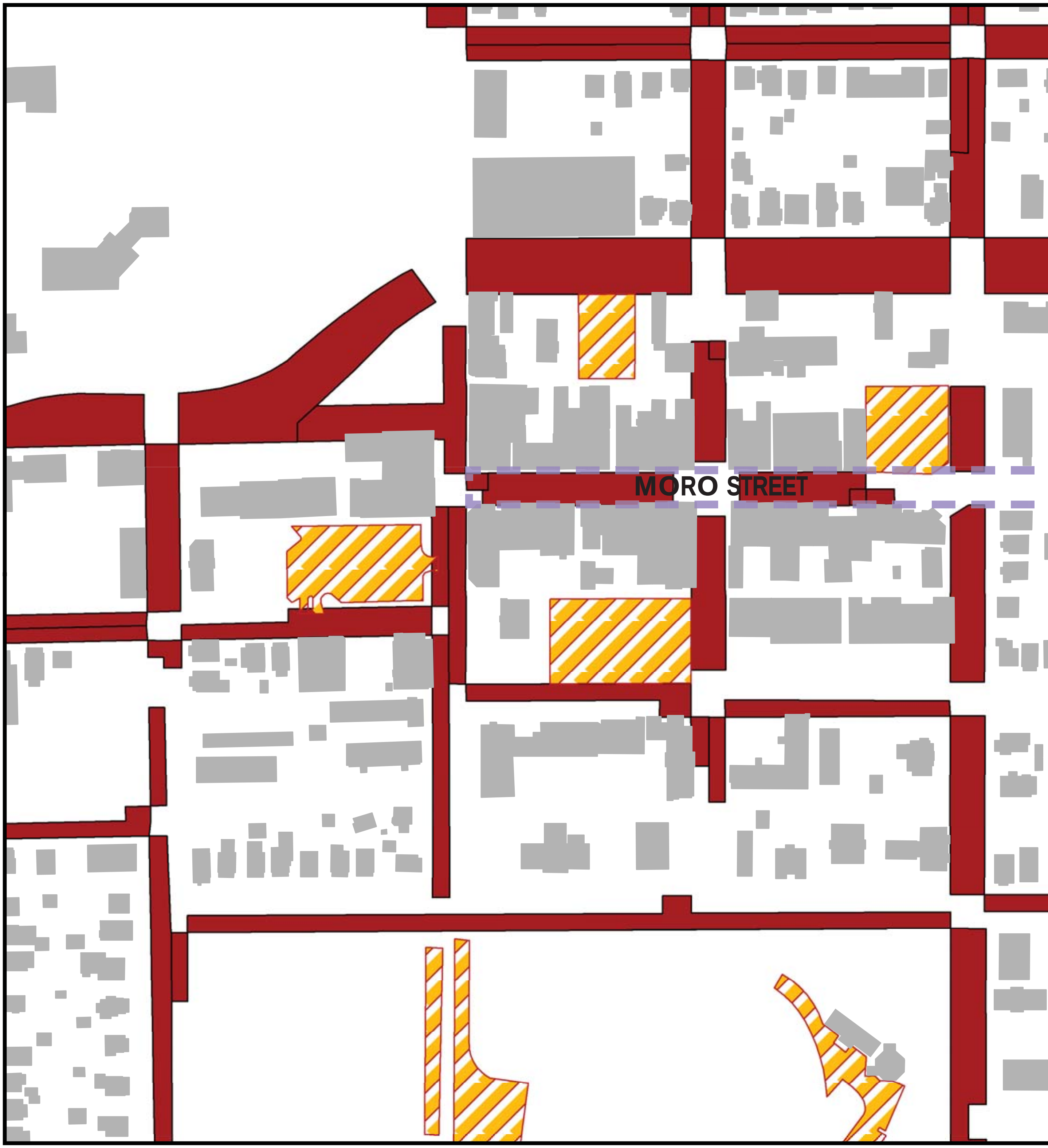
2.2.3 Site Context

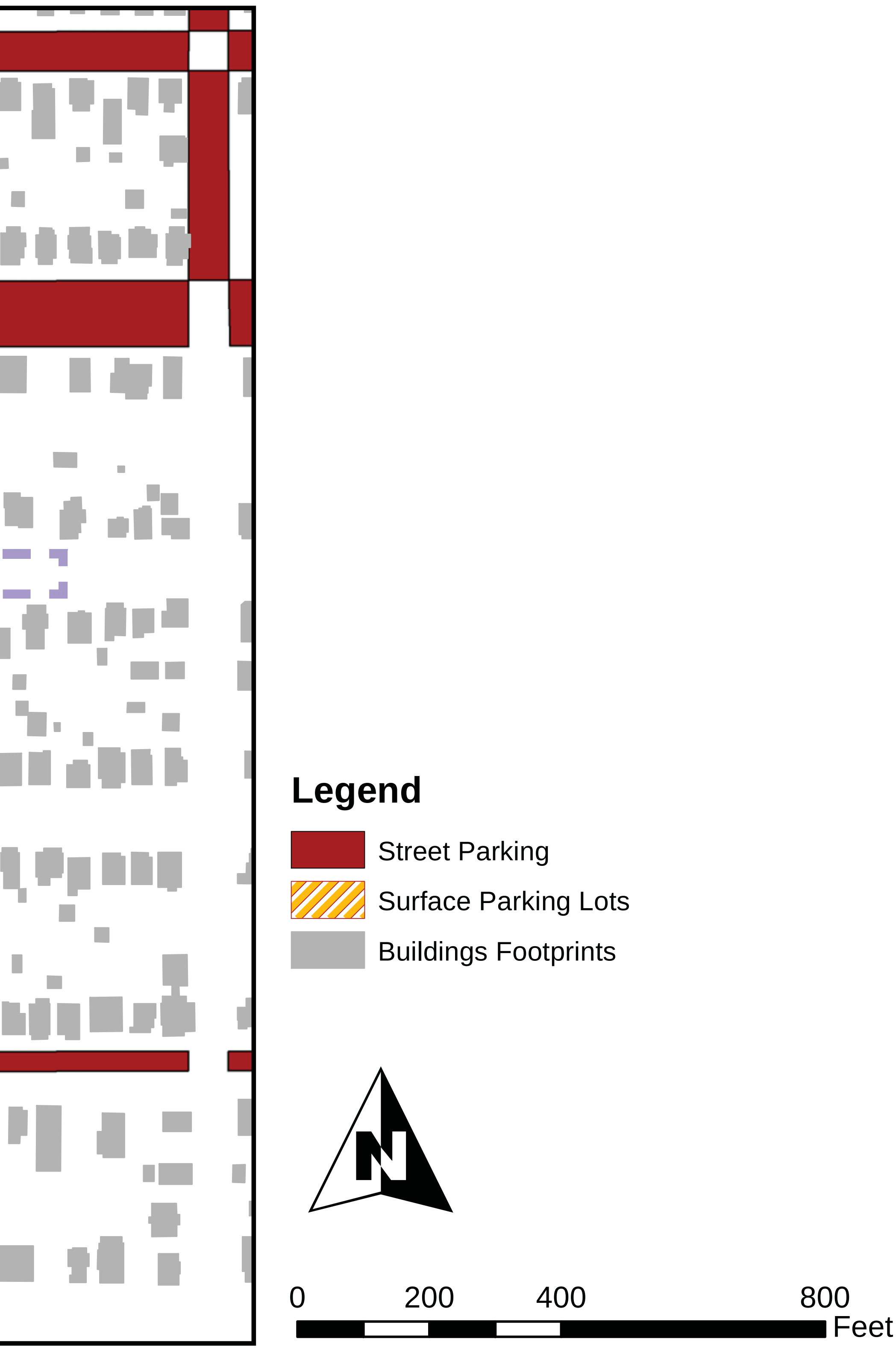
Currently, Moro Street is a one-way road with two-sided on-street parking and narrow sidewalks on both sides (Fig.2-14). This part has the highest building density within Aggieville, and there are different types of services, such as bookstores, restaurants, and bars along the street (Fig.2-11). Buildings are in good condition with different colors and advertisements, giving this street a vibrant tone (Fig.2-15). The cycle lane is marked on the road, but is not physically separated from the motor vehicle lane(Fig.2-14). Streetlights are on both sides of the street. Surface parking dominates outdoor land use and there are no civic spaces (Fig.2-16). No green infrastructure or benches are located at this site, causing the walking and cycling activities to be disturbed by vehicles, narrow sidewalks, and poor aesthetics.

Figure 2-14 Narrow Sidewalk in Moro Street

Figure 2-15 High Quality Building Facade of Moro Street

Figure 2-16 Surface Parking of Aggieville




Legend
Street Parking
Surface Parking Lots
Buildings Footprints
N
0
200
400
800
Feet

CHAPTER 3 METHODS

3.1 Research Methods

The focus of this study is on investigating pedestrians' preferences for attractive and safe streetscape alternatives along Moro St. in Aggieville. To conduct this investigation, the psycholphysical approach was employed. For the most part, empirical studies based on psychophysical approaches are published inenvironmental psychology literature. For instance, Rachel and Stephen Kaplan have reviewed much of their work and that of others in <The Experience of Nature> and <With People in Mind>. Respondents are shown photographs of different kinds of places and asked to choose which they prefer (Ulrich 1983; Kaplan & Kaplan 1989). This approach of quantitative study can demonstrate associations between certain aspects of place and preferences.

The research aims to investigate pedestrians' perceptions in the context of the street, and what design elements of a street will most influence users' choices in terms of safety and attractiveness. In order to accomplish this aim, images of different street designs for Moro Street were developed and then used to evaluate respondents preferences against. The research consists of four main parts: variable selection, streetscape design, public survey, and data analysis (Fig. 3-1).

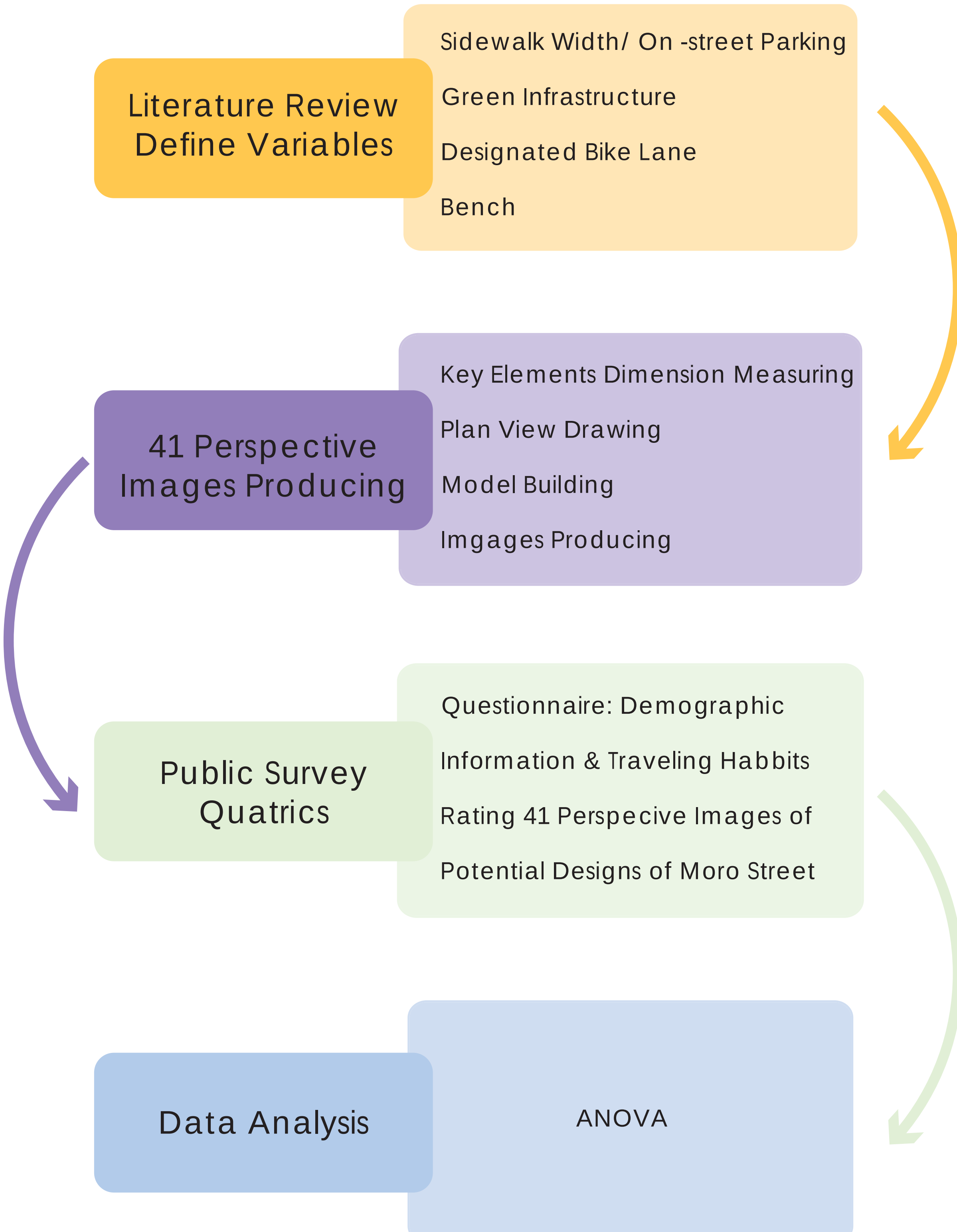


Figure 3-1 Research Methods

3.2 Variables of Design Element Identification

According to the available literature, a pedestrian-oriented street should function as a public place for physical and social activities (Sallis, Bauman, & Pratt 1998), and facilitate users' comfort and safety, as well as provide attractive scenery (Southworth 2005; Sallis, Bauman, & Pratt 1998). Such sources typically recommend good streets that include the following: 1) narrower streets incorporating traffic-calming strategies, 2) human-scale path widths, 3) streetlights, 4) green infrastructure, 5) street furniture, and 6) roadside buildings (Campoli 2012; Fukahori & Kubota 2002; Hoehner et al. 2005).

Along Moro Street, buildings are in good condition with different colors and advertisements, high-quality streetlights are on both sides of the street, the cycle lane is marked on the road but not physically separated from the motor vehicle lane, street parking and road dominate outdoor land use without civic spaces, and no green infrastructure or benches are located at this site. The well-established neighborhood makes Aggieville a unique place within Manhattan, Kansas, and consequently imparts the district with great potential as a walkable district. However, the walking and cycling activities are currently disturbed by vehicles, narrow sidewalks, and poor aesthetics, with large areas given over to surface parking (Fig. 3). Currently, the City of Manhattan wants to create a walkable neighborhood by providing active, pedestrian-oriented public uses through street-level design improvement in Aggieville (Aggieville Campus Edge District Plan 2013). As a result, it is necessary to improve the street environment and make changes in terms of street elements. Regarding the existing conditions of Moro Street, four design elements were worth investigating empirically, namely, 1) street parking/ sidewalk width, 2) green infrastructure, 3) a designated bike lane, and 4) benches.

In order to represent these four variables realistically within the images, the dimensions of the identified street parameters (Fig. 3-2 to Fig. 3-11) are determined by the street design guidelines as standard. The layouts of off-street parking follow the "Off-Street Parking Lot Configuration Standards of Manhattan City", and the driveway of Moro Street, which is to be used for one-way traffic, has a minimum 12' width. The planter of trees is 6'×6'. The trees are 45' in height with 32' canopies. The plant box width is 6', and the designated bike lane is 5' in width. Levels of each variable are provided in Table 3-1.

According to the literatures, there are many more elements and methods for street design that need testing, but in order to keep the variables limited and establish testing controls, the realistic images for the survey are carefully designed for the experiment to test preference for the fewest key design elements. As a result, certain factors are identified as being constant to ensure that as many street characteristics as possible can

Table 3-1 List of Variable Street Design Elements

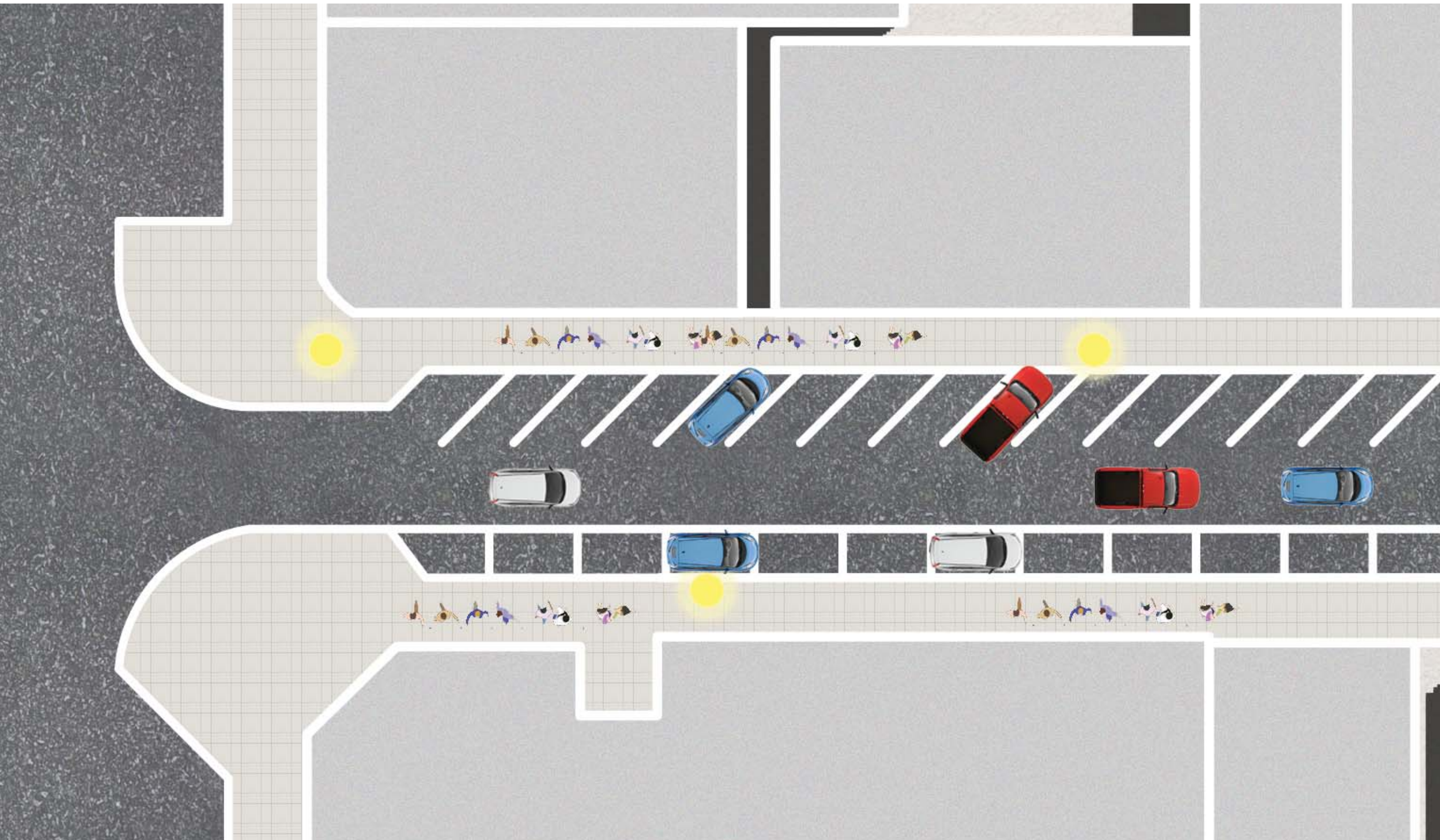
Variables	Levels	Levels of Variables				
Sidewalk/ On Street Parking	5	Existing: Narrow sidewalk on both sides; One-way traffic lane; Off- street parking on both sides Figure 3-2	Removing 40% of the On-street Parking Figure 3-3	Taking off one side of the on-street parking Figure 3-4	No on-street parking, wider sidewalks on both sides Figure 3-5	Pedestrian Only Figure 3-6
Green Infrastructure	4	Existing: No green infrastructure at all Figure 3-2	Street Trees on both sides Figure 3-7	Planter Box Figure 3-8	Planter Box & Street Trees Figure 3-9	
Bench	2	Existing: No seating provided for visitors Figure 3-2	More Seating on both sides Figure 3-10	* Green infrastructure refers to variations of two elements (presence of planter boxes and street trees).		
Designated Bike Lane	2	No Bike lane Figure 3-2	One side designated Bike lane Figure 3-11	Reference perspective images are provided in the Appendix II. Illustrative Diagrams are provided through Figure 3-2 to Figure 3-13		

be controlled. The area envisaged for the design processes is the part of Moro Street that represents the typical tone of Aggieville. All of the buildings retain their existing conditions (height, density, location, and color). The viewpoint of these perspectives is the same as what one would see from a certain distance and location. The images show the same noontime weather conditions. Table 3-2 gives further details regarding the constants that are controlled.

Table 3-2 List of Elements being Controlled and Varied

Design Elements	Constant	Description
Site Location	YES	Moro Street within Aggieville district will be the sole location for this project.
Viewpoint	YES	The specific distances and locations are the same in all the perspective images created.
Building	YES	All buildings will be kept in their existing conditions. (height, density, location, color)
Totol Width of Street	YES	The width of the street will remain as it is.
Sidewalk/ On Street Parking	NO	The width of the sidewalk is one of the variables, consisting of five levels.
Green Infrastructure	NO	Green Infrastructure plays a significant role in contributing environmental benefits and facilitating pedestrian comfort. It is one of the variables, consisting of four levels.
Benches	NO	Potential stopping and gathering place for pedestrian. It is one of the variables, consisting of two levels.
Designated Bike Lane	NO	Key element of a walkable street. It is one of the variables, consisting of two levels.

Figure 3-2 Illustrative Diagram:
Existing Condition: Narrow sidewalk on both sides; One-way traffic lane; Off- street parking on both sides; No green infrastructure at all; No seating provided for visitors; The existing condition is considered as having no bike lane.




9’-8.40”
12’
15’
8’-3.60”
10’
Sidewalk
On-street Parking
One-way Road
On-street Parking
Sidewalk

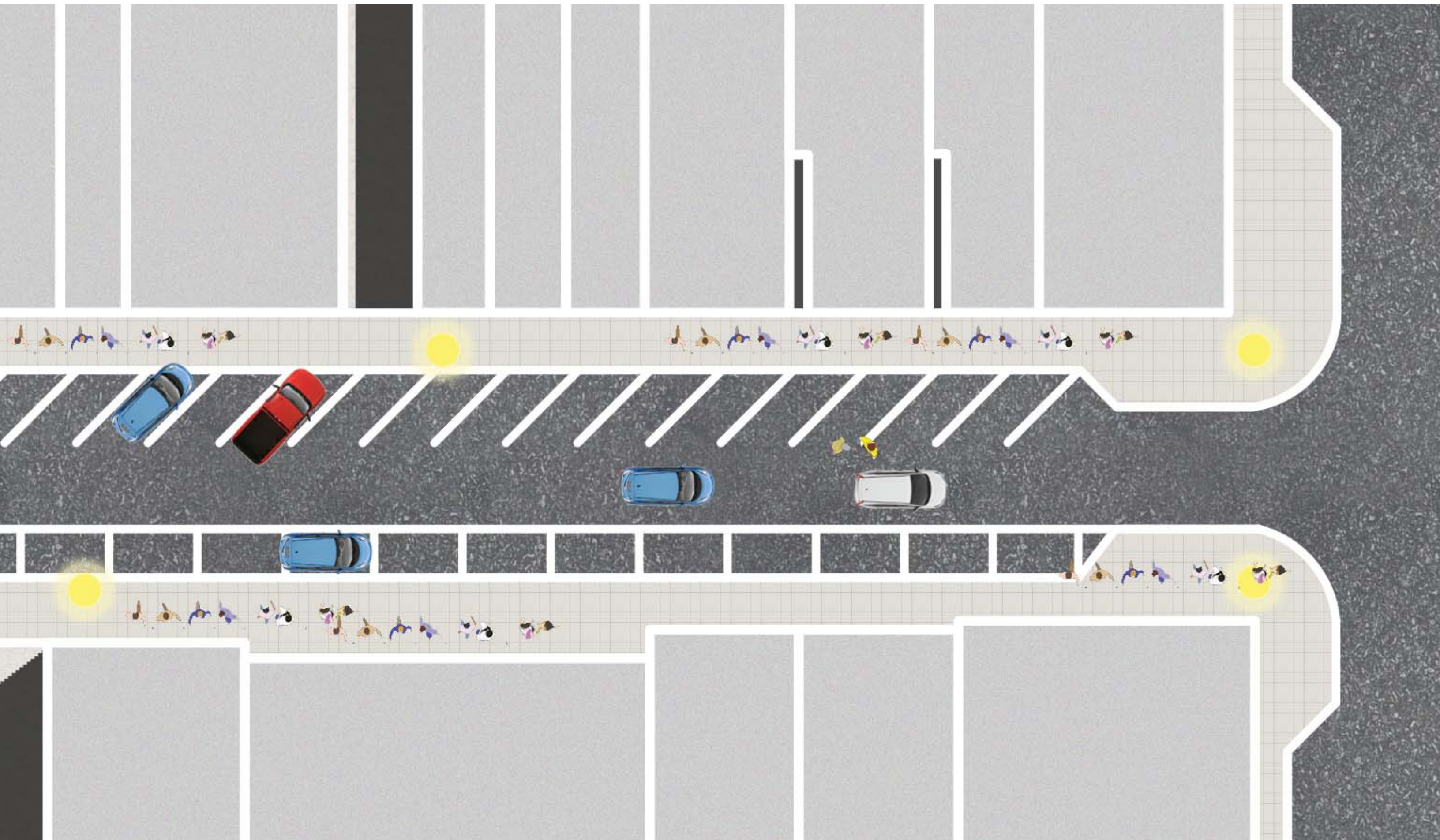


Figure 3-3 Illustrative Diagram: Removing 40% of the Parking Lot (20% of Each Side)

22’
14’-8.40”
18’-3.60”
Sidewalk
On-street Parking
One-way Road
On-street Parking
Sidewalk

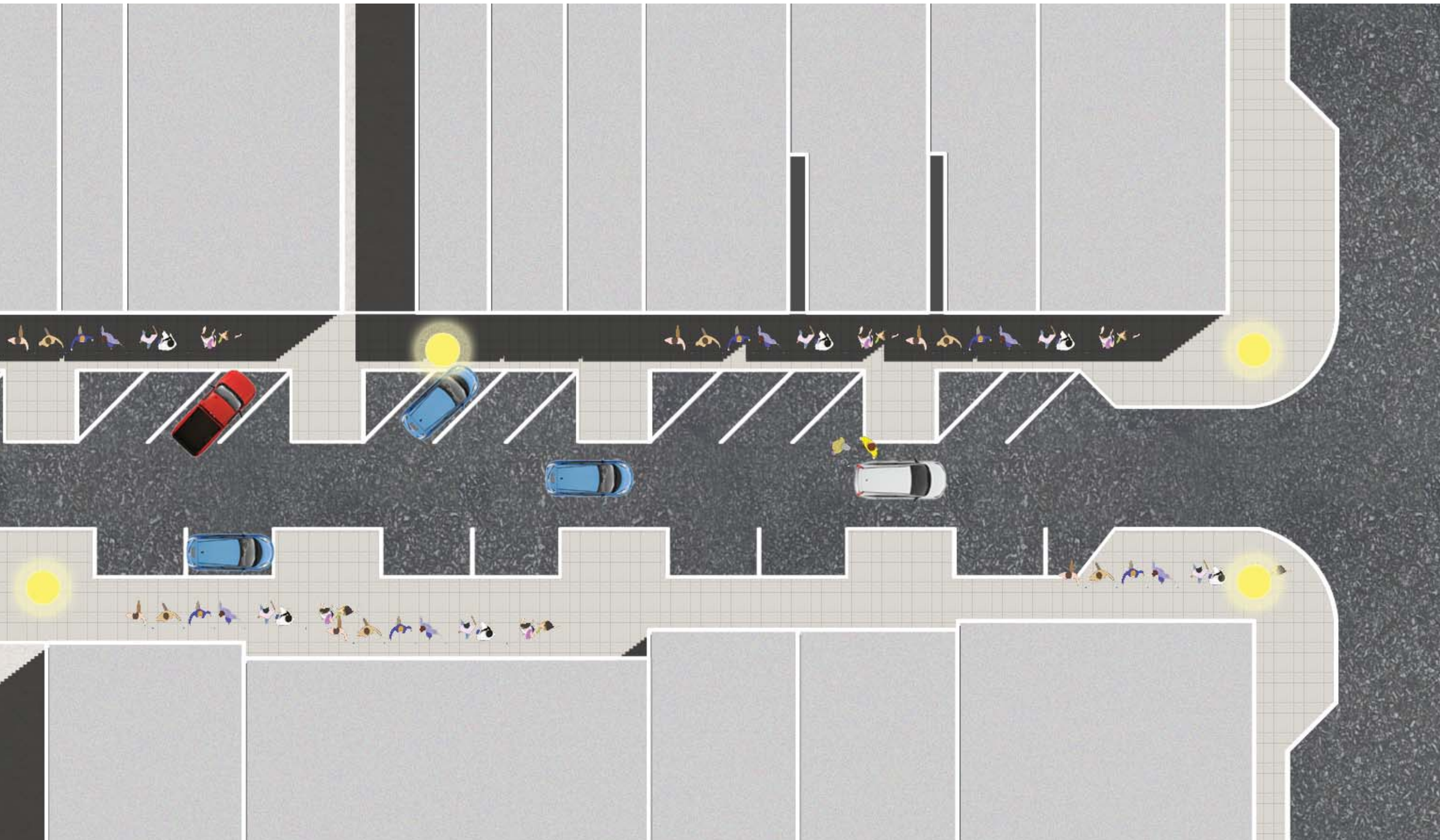
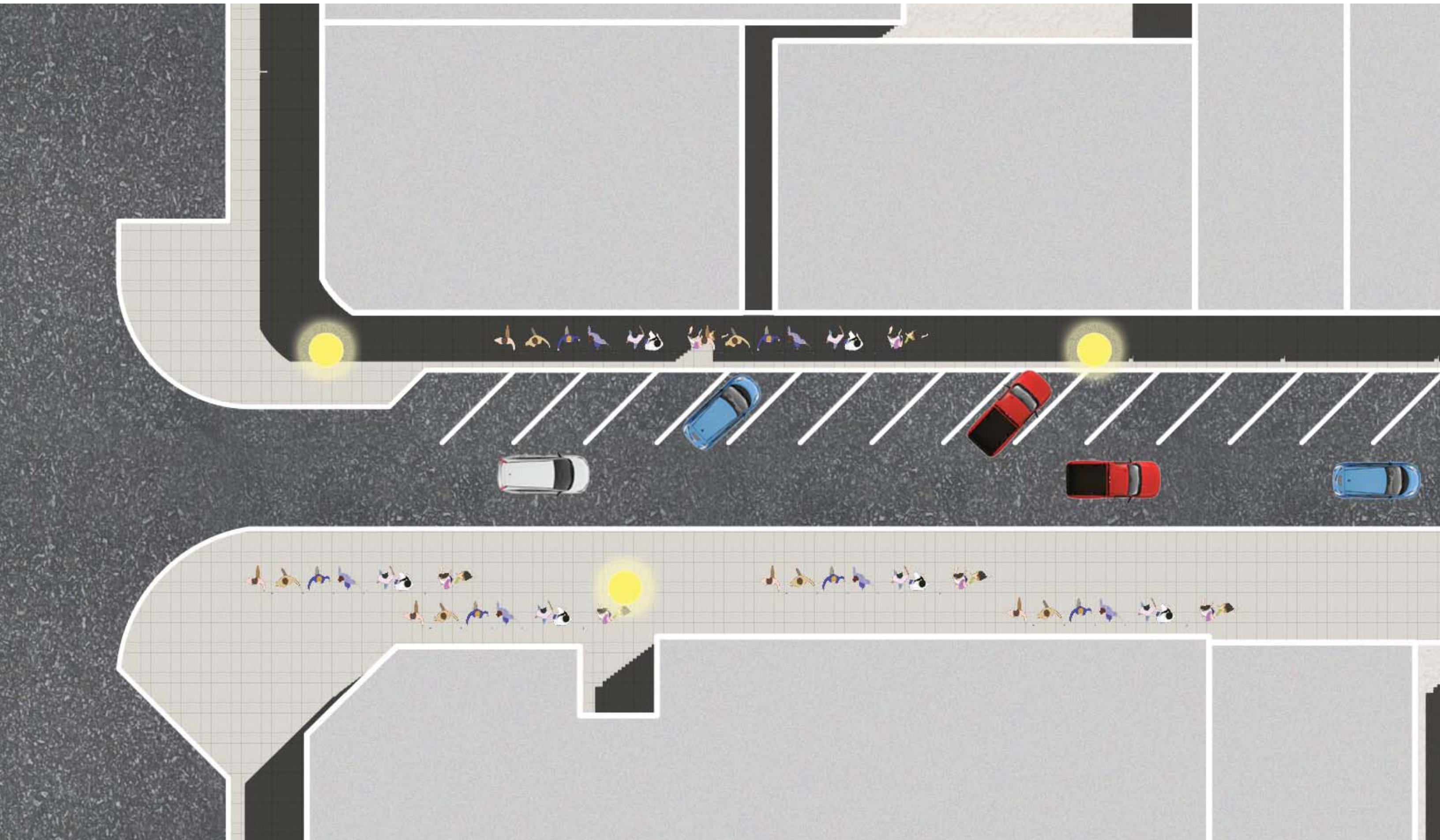
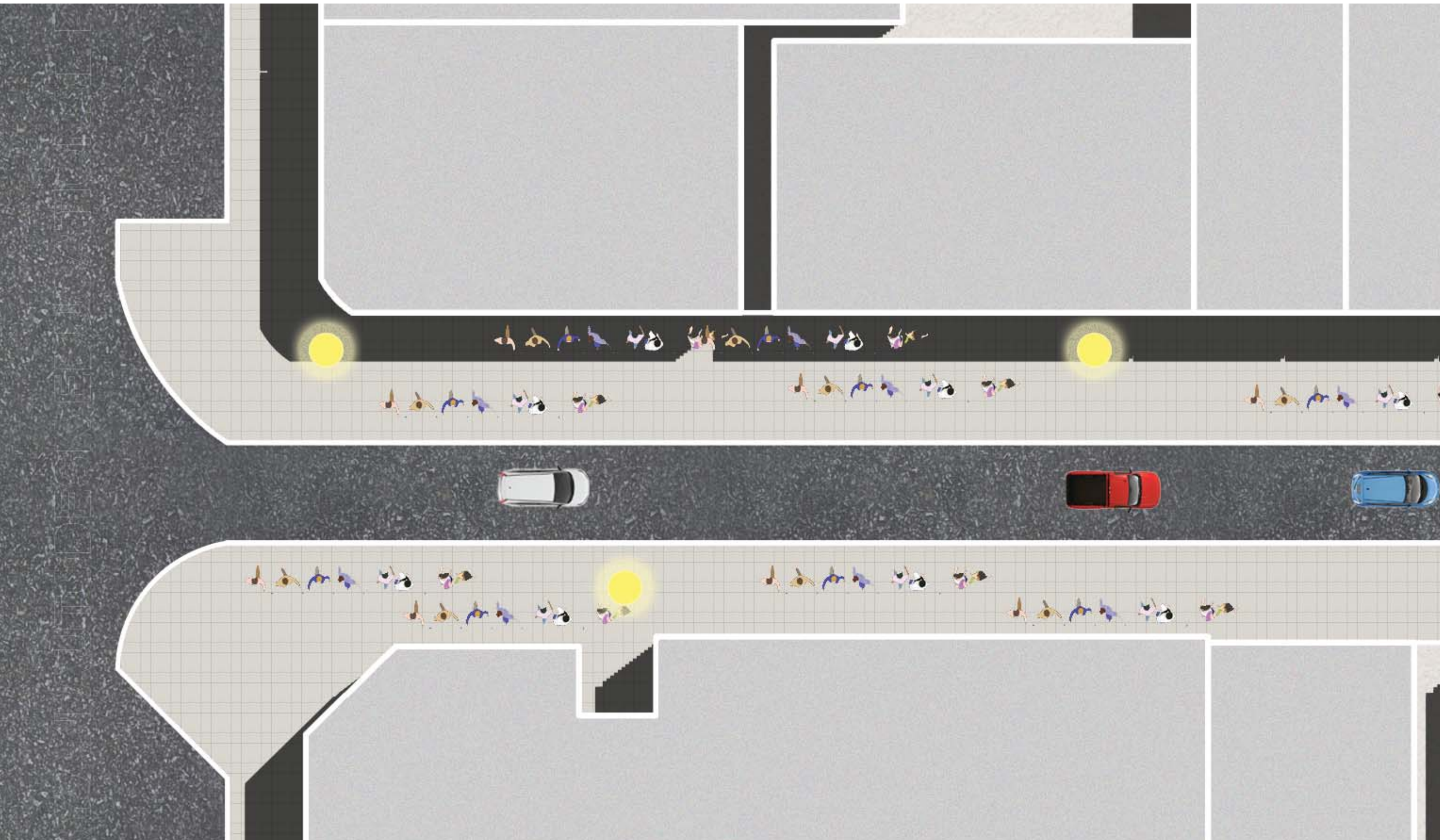


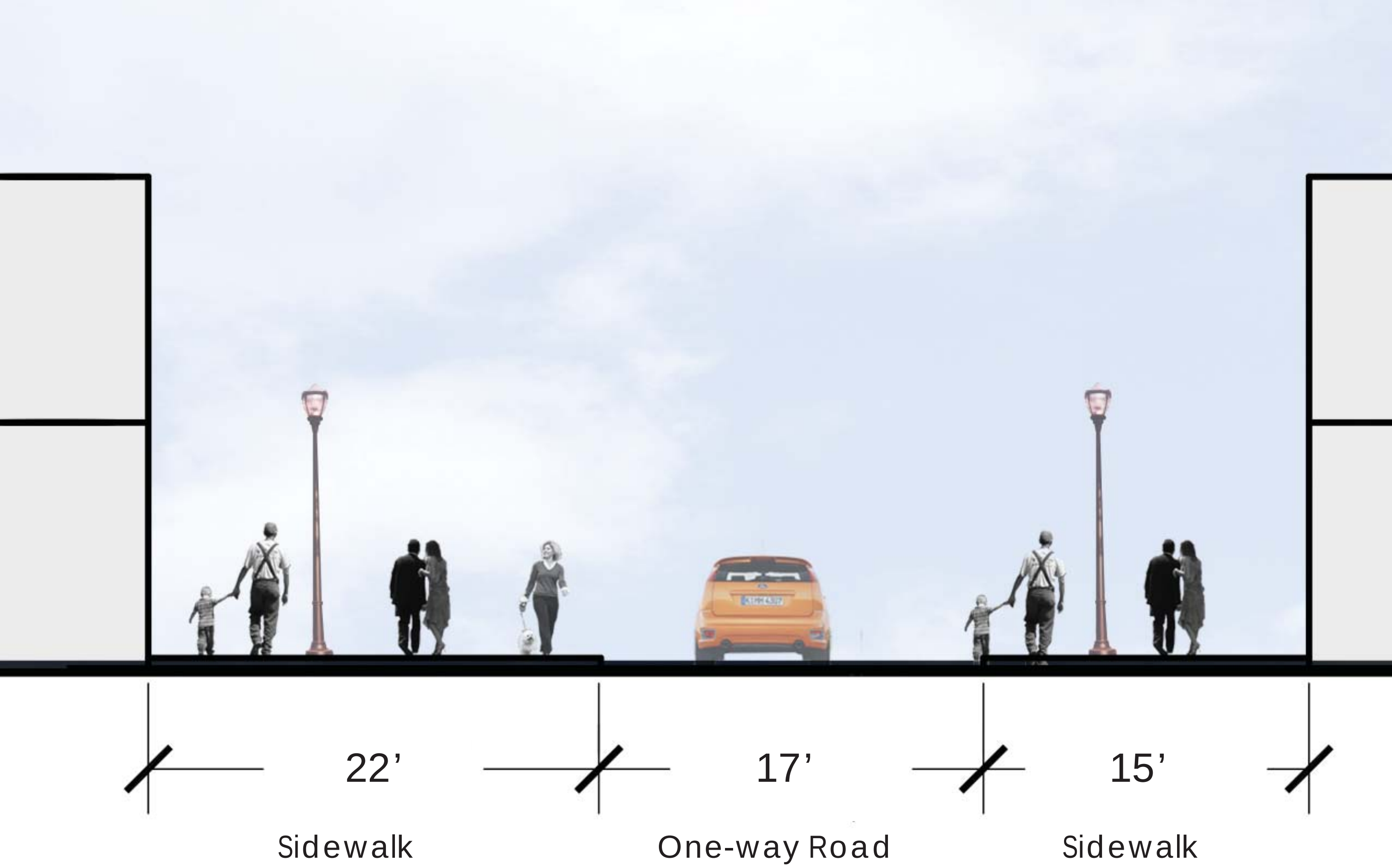
Figure 3-4 Illustrative Diagram: Taking off one side of the on-street parking




10’
22’
14’-8.40”
18’-3.60”
Sidewalk
On-street Parking
One-way Road
Sidewalk

Figure 3-5 Illustrative Diagram: No on-street parking, but wider sidewalks on both sides





22’
17’
15’
Sidewalk
One-way Road
Sidewalk

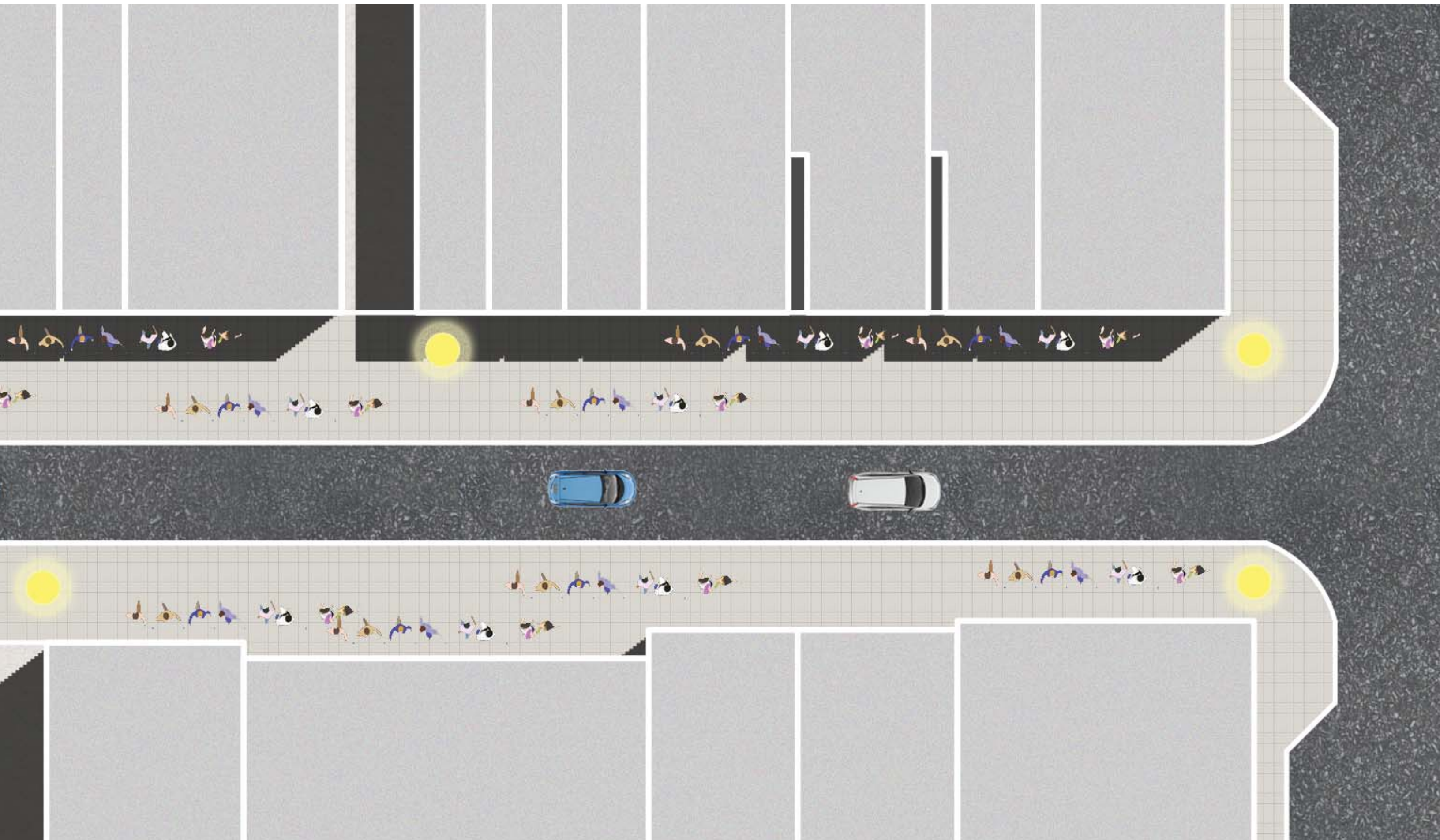
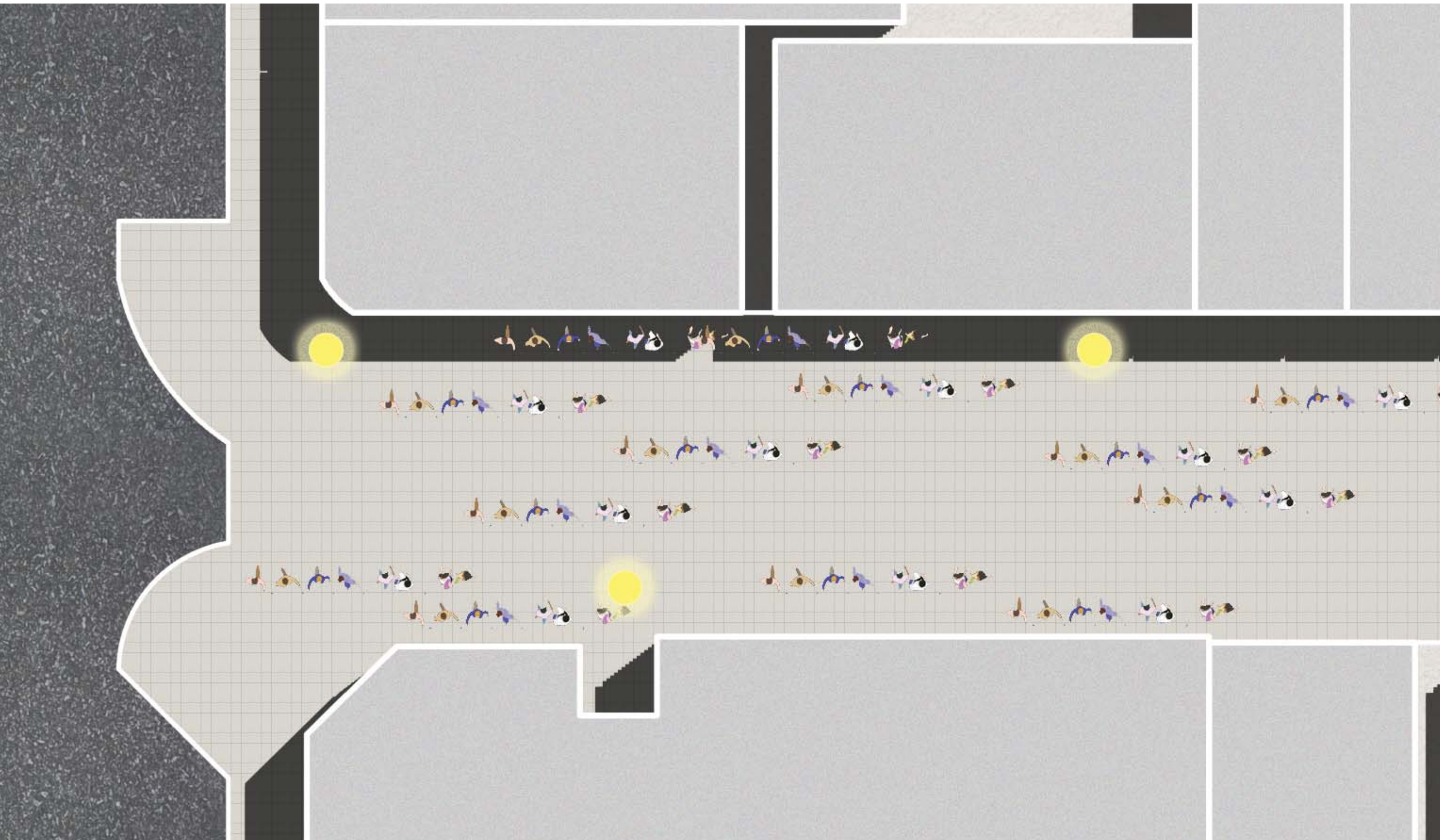
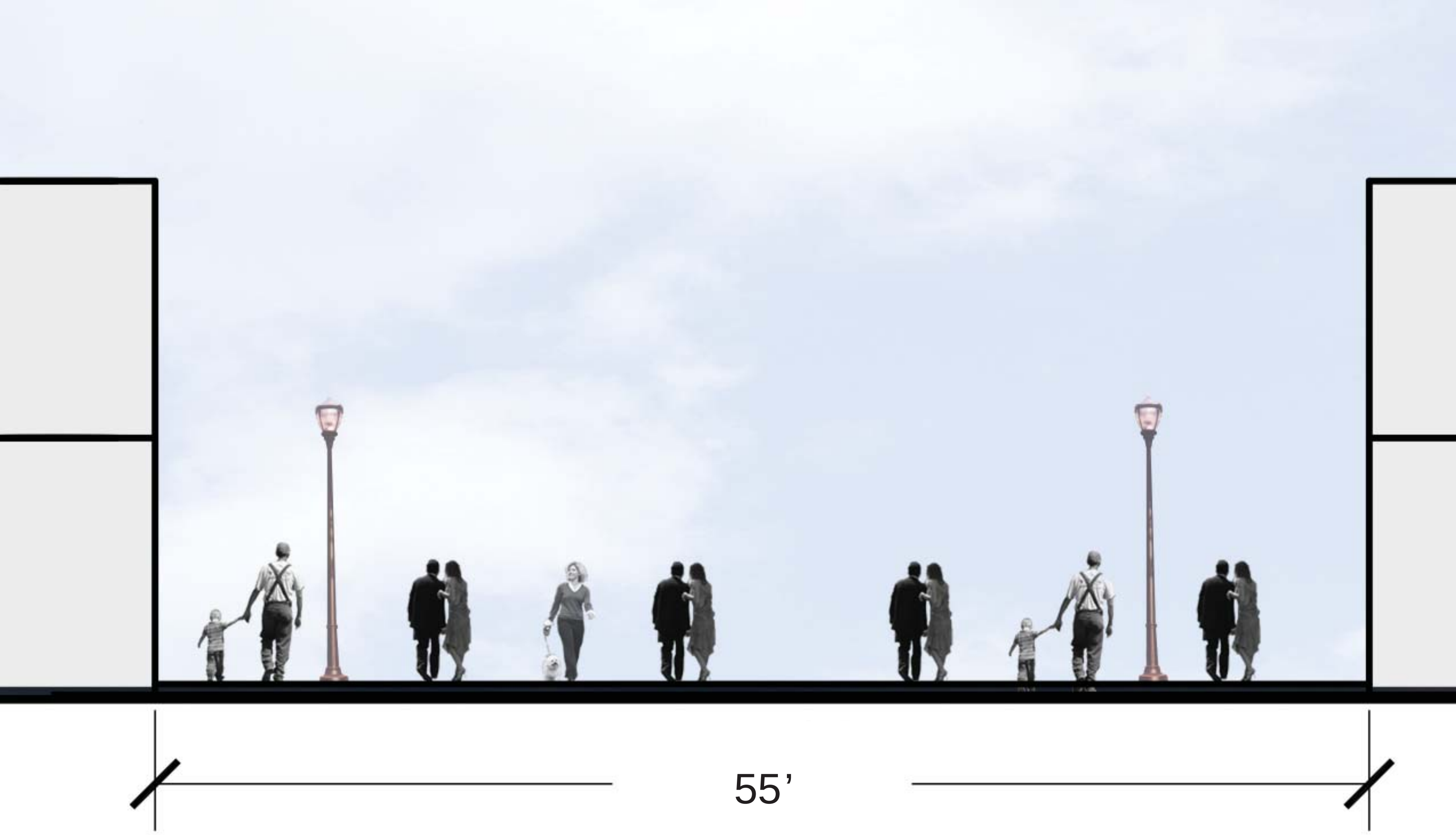


Figure 3-6 Illustrative Diagram: Pedestrian Promenade (Pedestrian Only Street)





Pedestrain Promenade

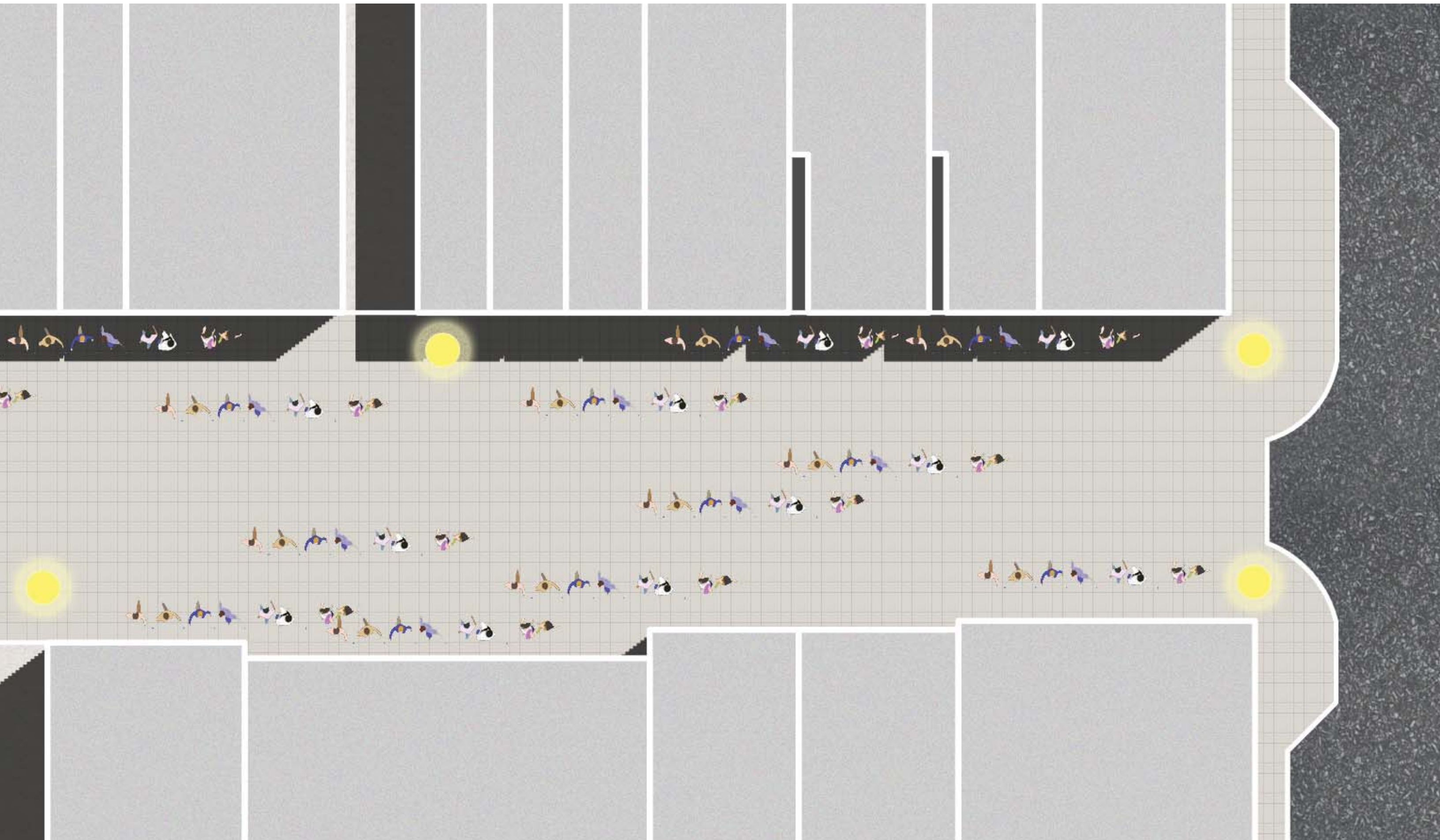
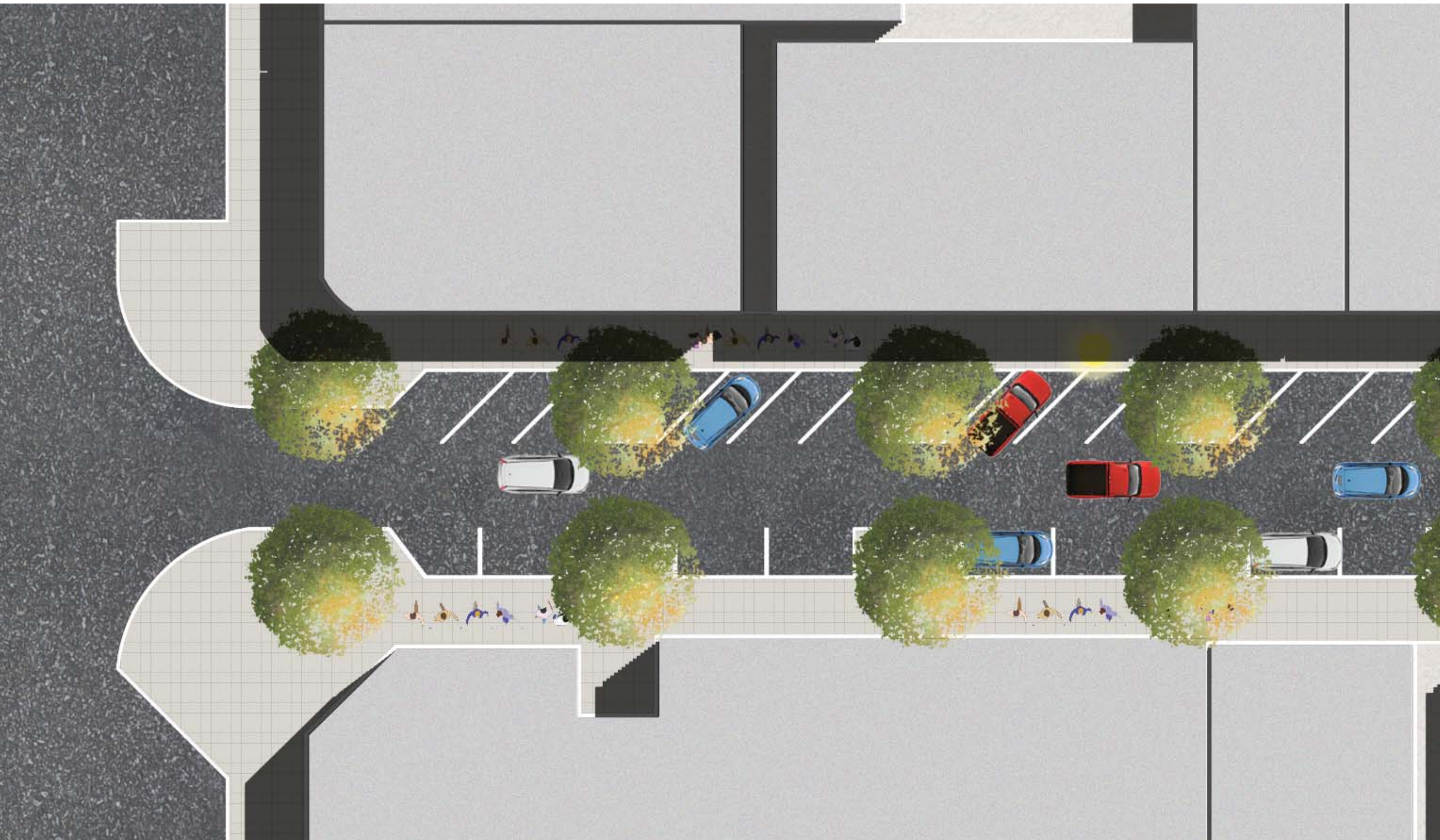


Figure 3-7 Illustrative Diagram: Street Trees on both sides



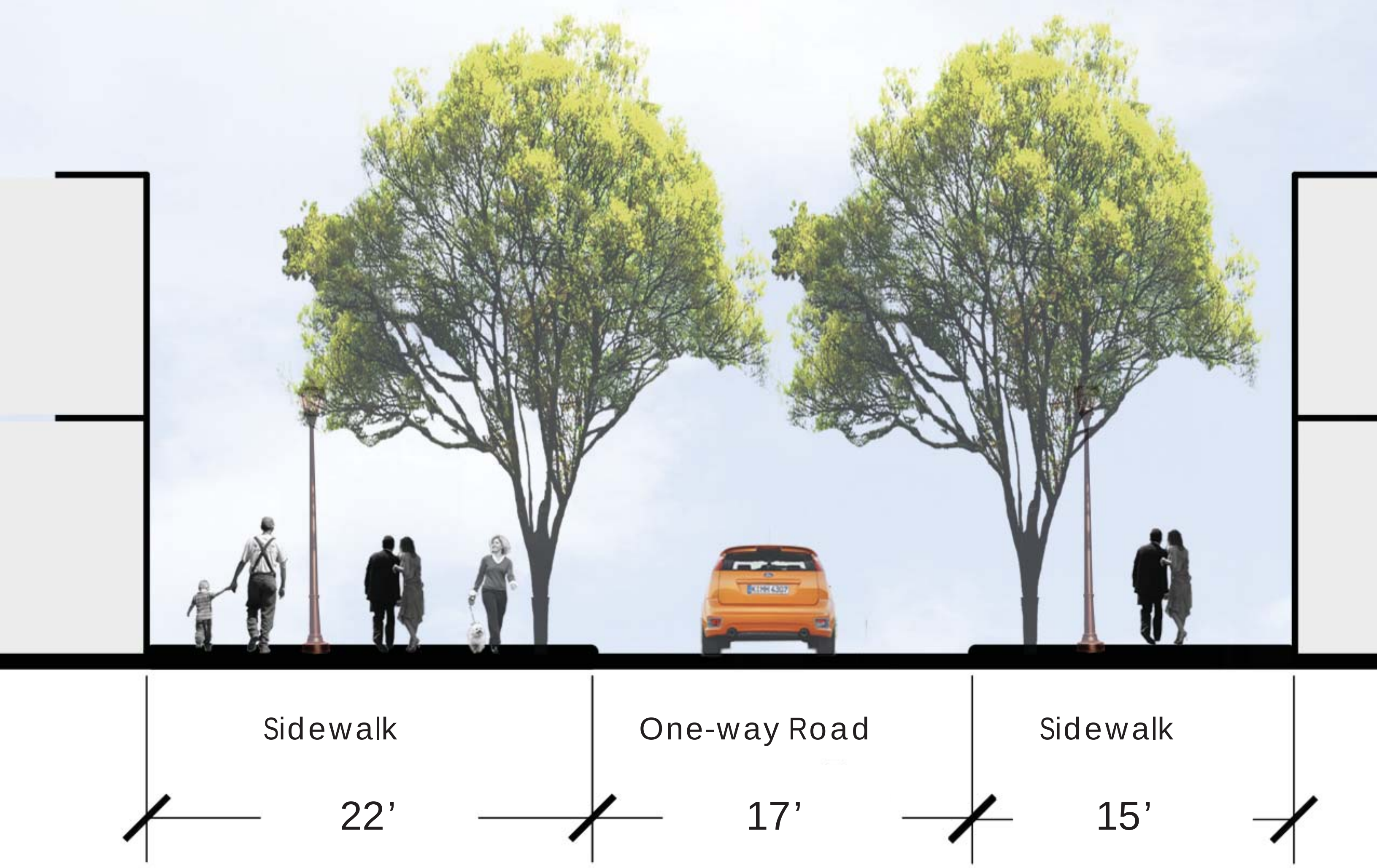
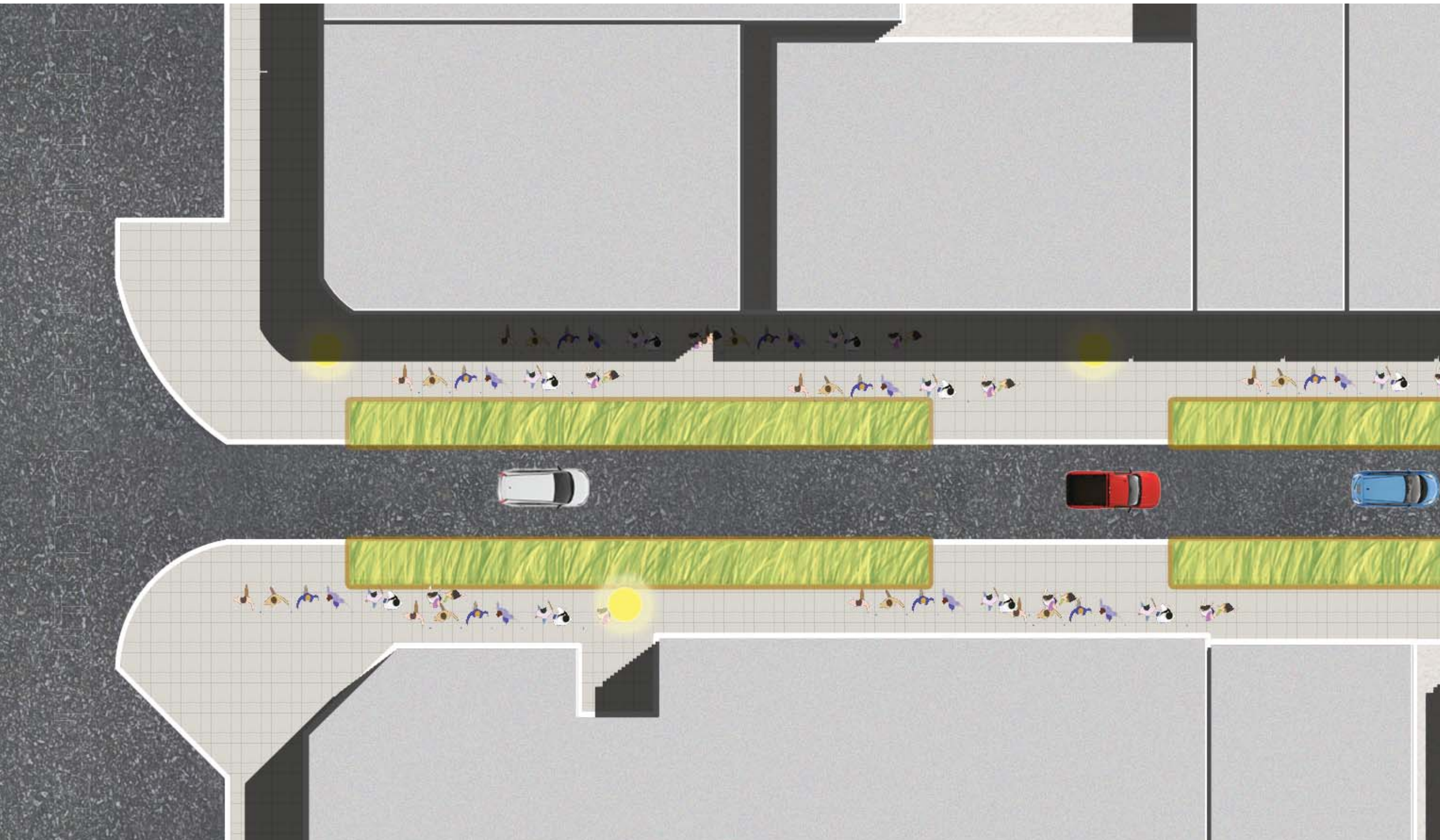
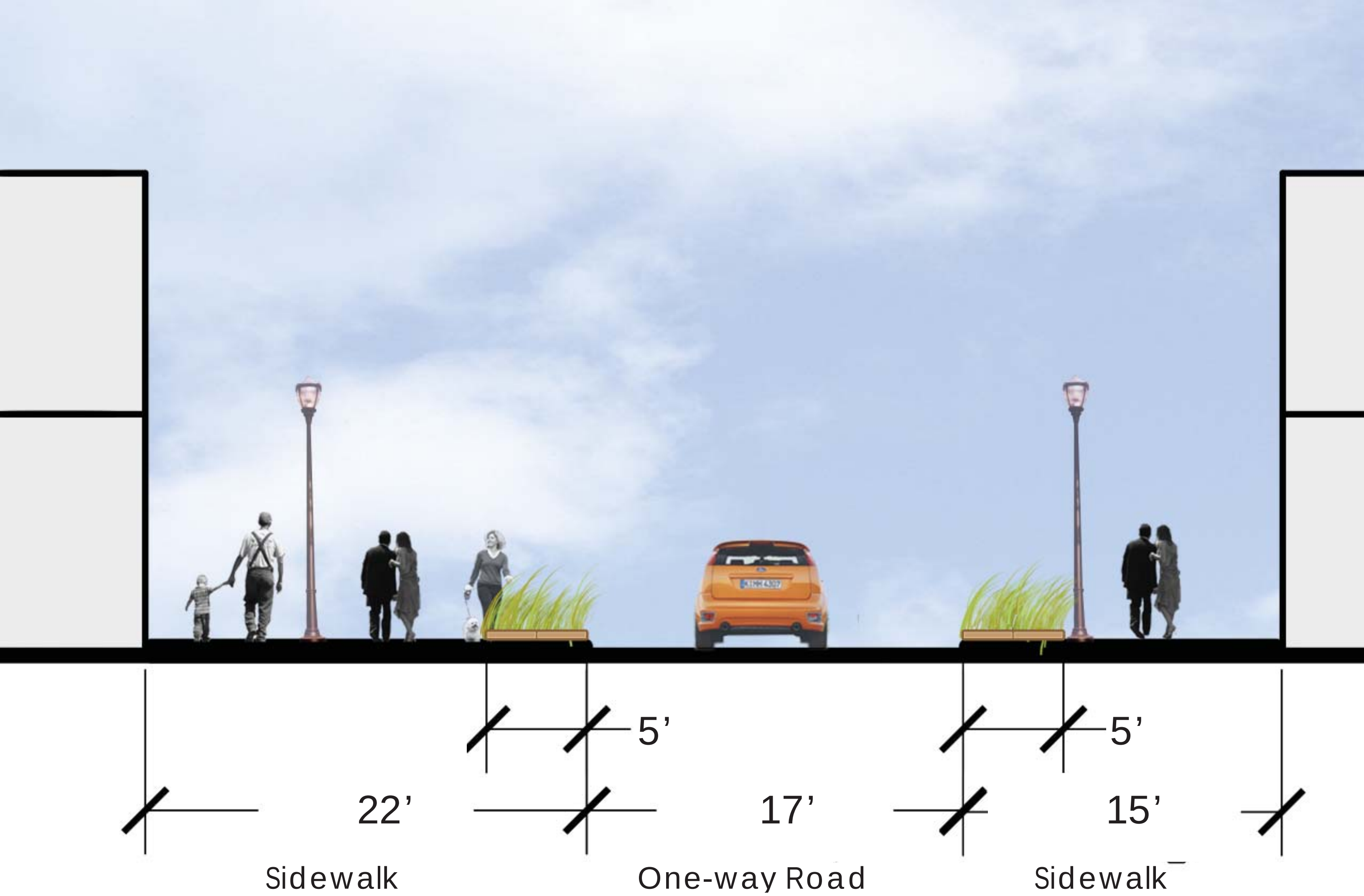

Sidewalk
One-way Road
Sidewalk
22’
17’
15’

Figure 3-8 Illustrative Diagram: Planter boxes on both sides





5’
5’
22’
17’
15’
Sidewalk
One-way Road
Sidewalk

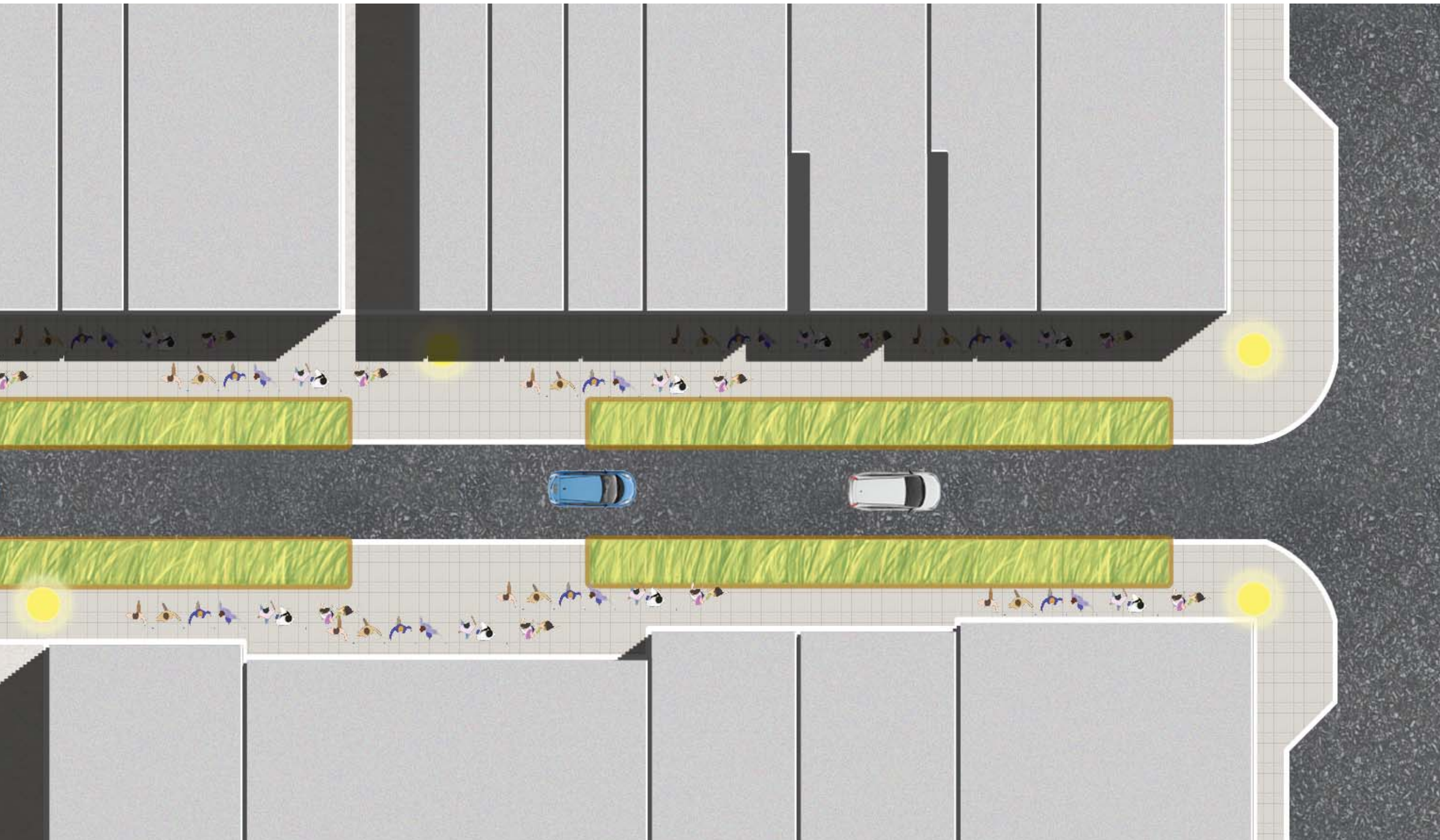
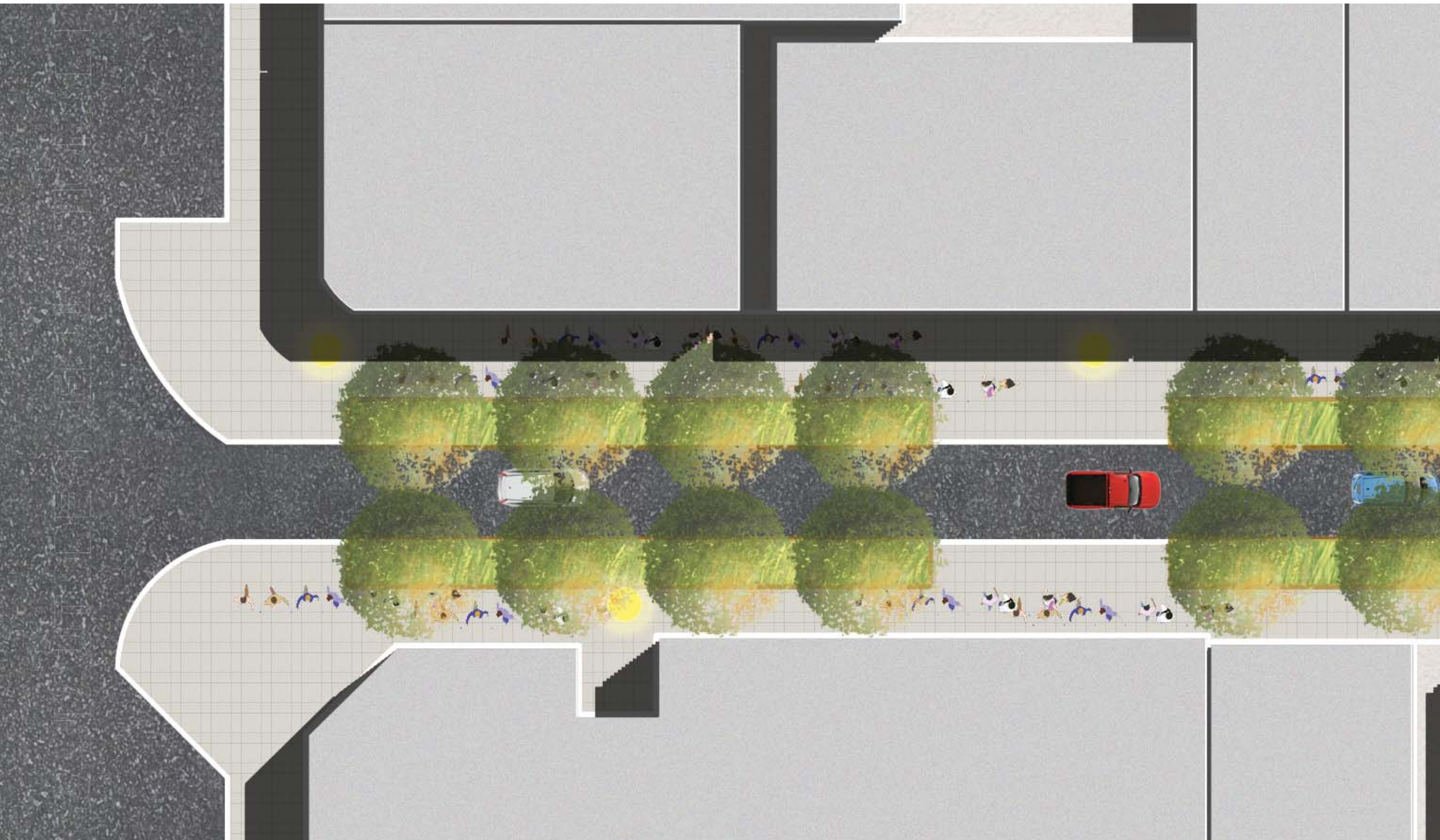
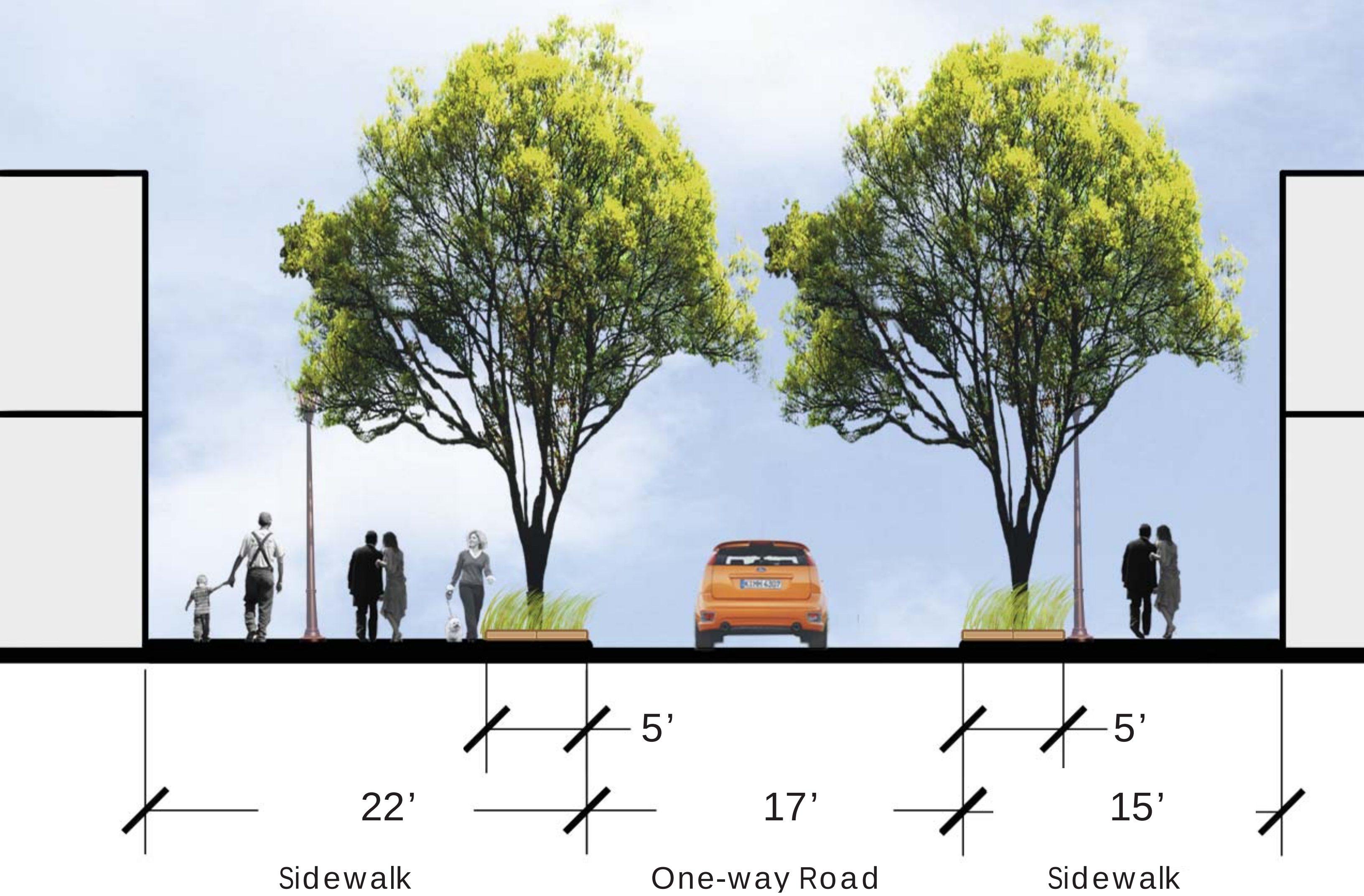


Figure 3-9 Illustrative Diagram: Planter boxes and Street Trees are provided on both sides




5'
5'
22'
17'
15'
Sidewalk
One-way Road
Sidewalk

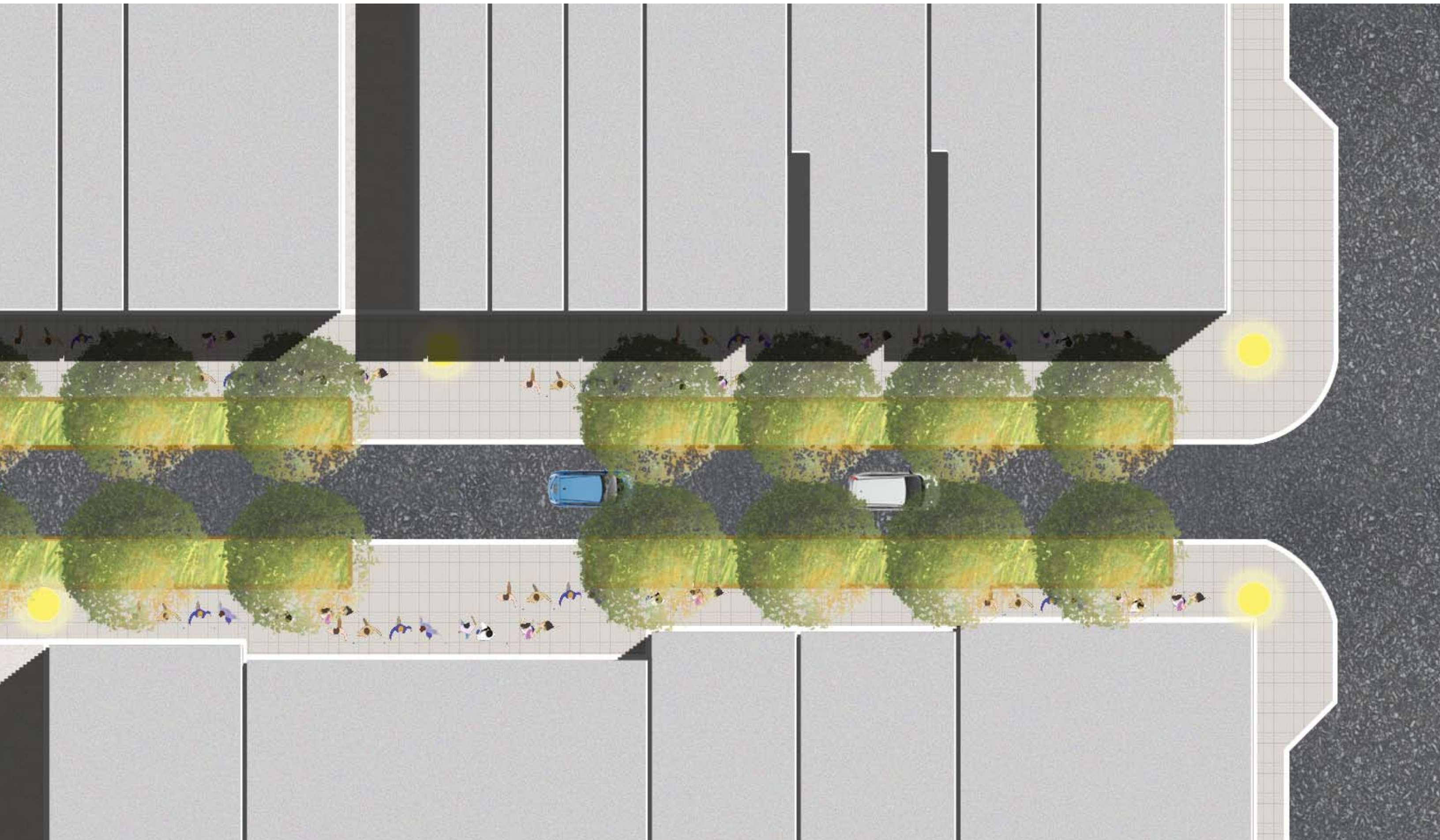
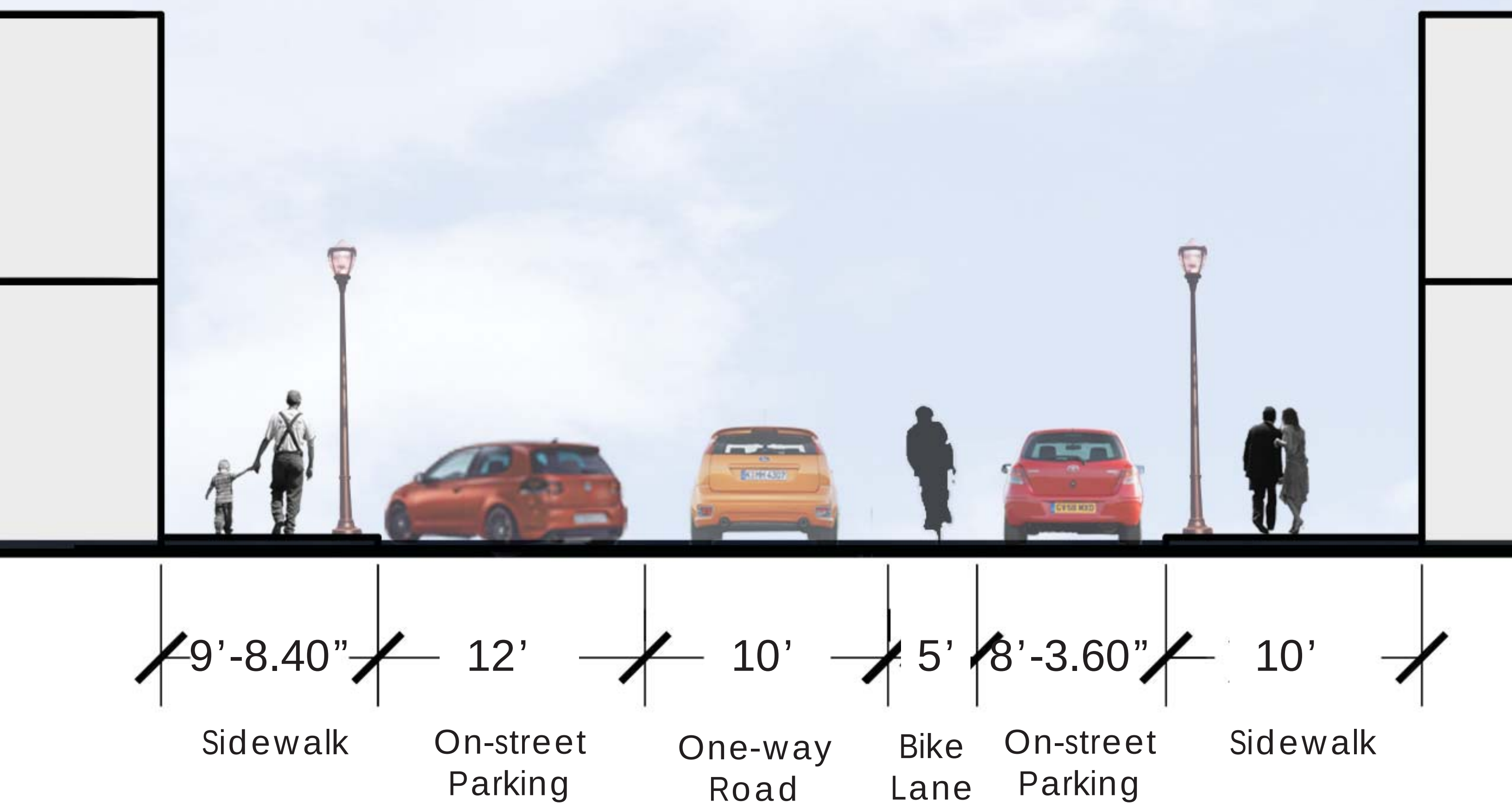
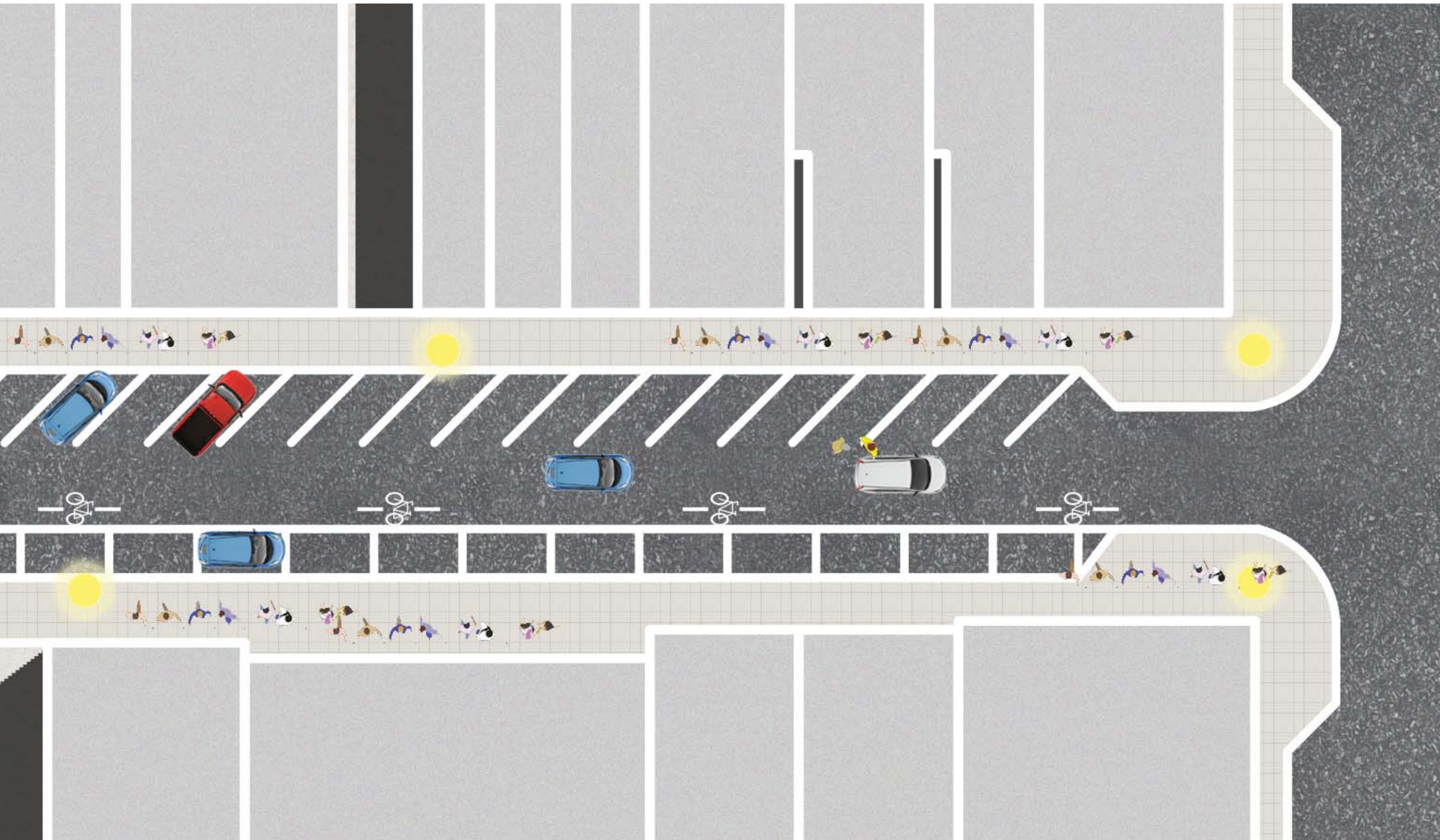


Figure 3-10 Illustrative Diagram: Benches are provided on both sides


Sidewalk
One-way Road
Sidewalk
22’
17’
15’

Figure 3-11 Illustrative Diagram: One side designated Bike lane

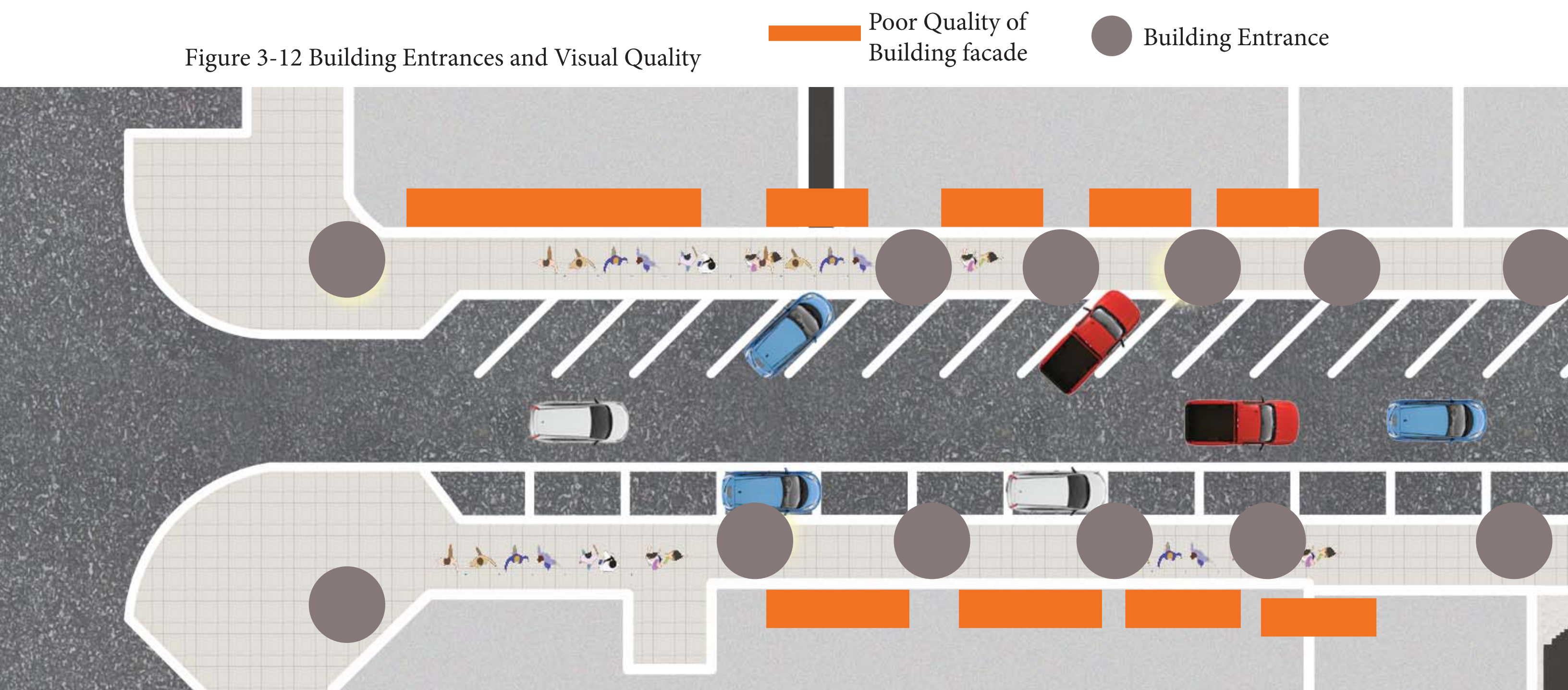

9'-8.40"
12'
10'
5'
8'-3.60"
10'
Sidewalk
On-street Parking
One-way Road
Bike Lane
On-street Parking
Sidewalk



3.3 Streetscape Design

The potential designs of the streetscape are produced by different permutations and combinations of different level variables. Regarding the limitation of the constant conditions, there are 41 potential combinations. The width of the road, sidewalk, and street parking all meet the requirements of street design guidelines as set out by Manhattan City. The minimum width of the road is 12', the minimum width of sidewalk is 9'. The location of the trees, bioswales, and benches are determined according to the existing building conditions (entries and façade quality, Figure 3-12) and the street width (Figure 3-13). Representative designs (of the 41 that are available)are shown (Figure 3-14, 3-15, 3-16, and 3-17). The designs shows such scenarios as the combination of a one-way road, designated bike lane, wider sidewalks, and benches (Fig. 3-14); the combination of a one-way road, designated bike lane, wider sidewalks, and street trees (Fig. 3-15); the pedestrian promenade that combines with bioswale (Fig. 3-16); and the pedestrian promenade with a designated bike lane, bioswale, benches, and street trees (Fig. 3-17). The rest of the designs are shown in Appendix II. All renderings will be perspective views under the same constant conditions.

Figure 3-12 Building Entrances and Visual Quality



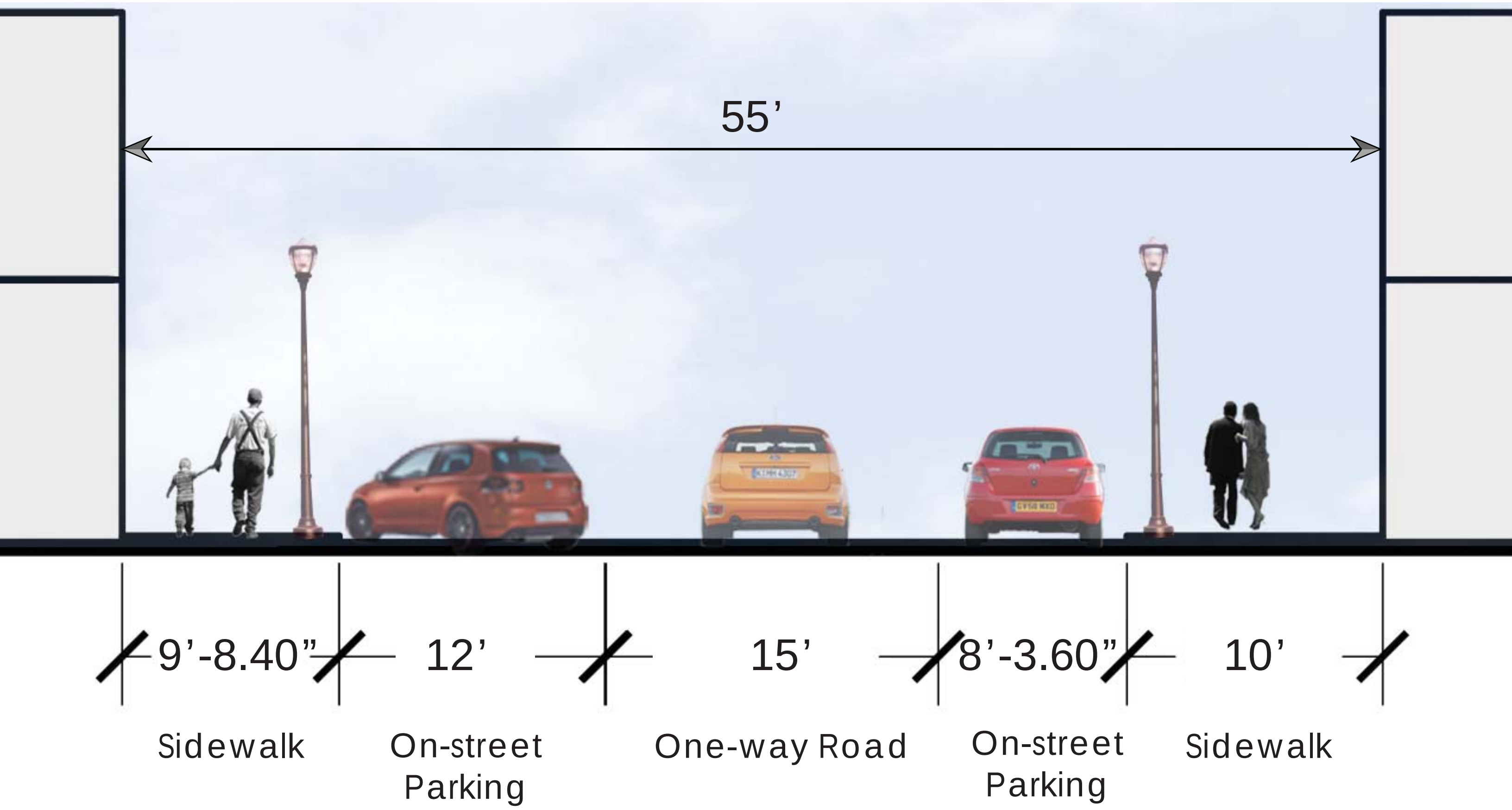


Figure 3-13 Existing Street Dimension

Figure 3-14 The combination of a one-way road, designated bike lane, wider sidewalks, and benches.

Figure 3-15 The combination of a one-way road, designated bike lane, wider sidewalks, and street trees.

Figure 3-16 The pedestrian promenade that combines with bioswale.

Figure 3-17 The pedestrian promenade with a designated bike lane, bioswale, benches, and street trees.

3.4 Public Survey

3.4.1 Data Collection Method

The survey was conducted at Radina's Coffeehouse, Varsity Donuts, and others in Aggieville with the permission of each manager, respectively. The subjects were students and residents, who were selected among those present in businesses using a convenience sampling method. The survey was conducted using a Qualtrics app on a 9.4" × 6.6" (2048 × 1536 resolution) tablet or laptop. All data was collected anonymously. Using a simple 1-7 point scale, 30 individuals were asked for their preferences of a particular image and which key elements they found most important. The four categories that correlate to a good place were summarized for the pilot study according to the literatures and the conditions of Moro Street. The order of the 41 images was randomized every time for each participant in order to avoid any invalid data.

According to the literatures (Washington State Department of Transportation 1997; City of Boulder 2003; Mukhija & Shoup 2006; LaPlante and McCann 2008) and the conditions of Moro Street, four categories that correlate to a good place had been summarized tor the pilot study:

- Enjoyable Outdoor Space: this can help to answer such question if the built environment could encourage more outdoor social activities.
- Safety: this has more correlation to the pedestrians and cyclists. It can help answer that the specific sidewalk width and the designed bike lane can provide people a safe walking/cycling experience.
- Convenience: aims to evaluate the accessibility and the proximity of the key destinations on the Moro Street. For example, people may think that it will make it inconvenient for them to get to places on Moro Street without on-street parking.

- Attractiveness: this aims to evaluate the overall attractiveness of the scenario in terms of enjoyment and visual quality of the environment.

However, after conducting a pilot study, some problems occurred: first, based on the follow-up, participants found the rating process (rating four categories for each image) to be too many, not always clear, and time consuming. In addition, "enjoyable outdoor space" was highly correlated to attractiveness , suggesting they were interpreted to have a very similar meaning (correlation coefficient > 0.9). In addition, the convenience value resulted in both a high variance and seemed to draw the most confusion from the participants. Therefore, after the pilot study, the snumber of preference questions were reduce to two: **attractiveness and safety.**

3.4.2 Procedures of the Survey

The survey was separated into 5 stages. These stages are summarized below:

STAGE 1: Consent Form and Introducing the survey

Providing a description of what the survey is about and what the participant will be asked to do. In particular, explaining the definition of safety and attractiveness to the participants.

- Safety: The degree of safety the design provides for drivers, pedestrians and/or cyclists.
- Attractiveness: The aesthetic quality of the streetscape, including charm, beauty, etc.

Figure 3-18 Practicing Example of User Interface Rating

STAGE 2: Questionnaire

This questionnaire(Appendix I) is intended to provide further demographic information and traveling habits about each participant, in order that we may understand the differences and similarities between all participants.

STAGE 3: User Interface Practicing

Showing an example image (Figure. 3-18) for participants to rate, so that they can become comfortable with the user interface and method for rating images.

STAGE 4: Example Images for Rating

Showing the 9 preview images (Figure. 3-19), to give the user the kind of variability in the designs that will be seen in the rating process. Users will be asked to use the whole range of the scale, and carefully look at each image and identify how they would rate each on a scale of 1 to 7 in terms of safety and attractiveness.

STAGE 5: Rating All the Images

Figure 3-19 9 Preview Images


WILD WINGS
GRILL & BAR


TRUCK
WILD WINGS
GRILL & BAR


WILD WINGS
GRILL & BAR


TRUCK
WILD WINGS
GRILL & BAR


WILD WINGS
GRILL & BAR


TRUCK
WILD WINGS
GRILL & BAR

CHAPTER 4 RESULTS

CHAPTER 4 RESULTS

An ANOVA was conducted that revealed statistically significant effects related to preference for streetscape design in terms of safety and attractiveness, as well as providing a combined average evaluation.

The results show the statistical information of the survey, which sampled 30 students and residents living in Manhattan City. In total, there were 16 males and 14 females (Chart 4-1), ranging in age from 19 to 78. 9 individuals considered themselves to be cyclists (Chart 4-2). 7 individuals usually travel to Aggieville on foot, 19 individuals usually travel to Aggieville by car(Chart 4-3). 7 individuals have biked to Aggieville many times (Chart 4-4). 27 individuals go to Aggieville more than once a week (Chart 4-5).

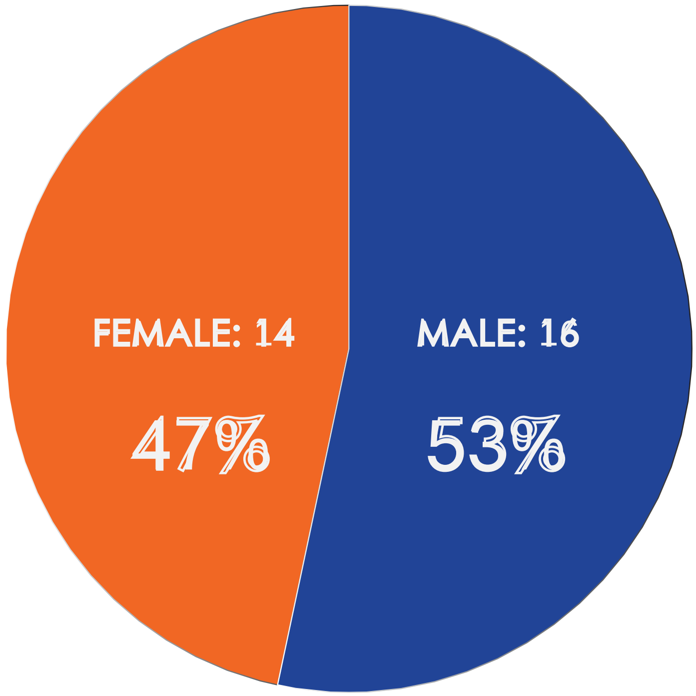


Chart 4-1 The Gender of the Participants

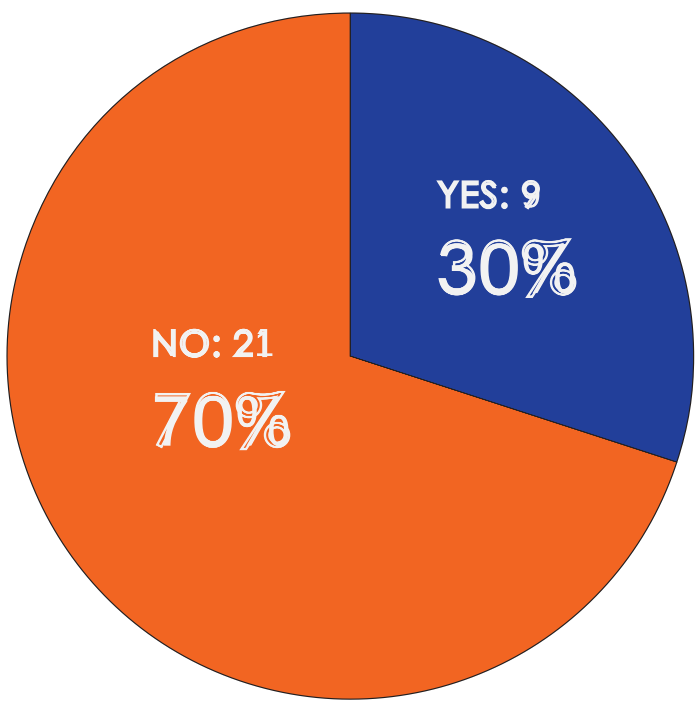


Chart 4-2 The Answers to “Do you consider yourself a cyclist?”

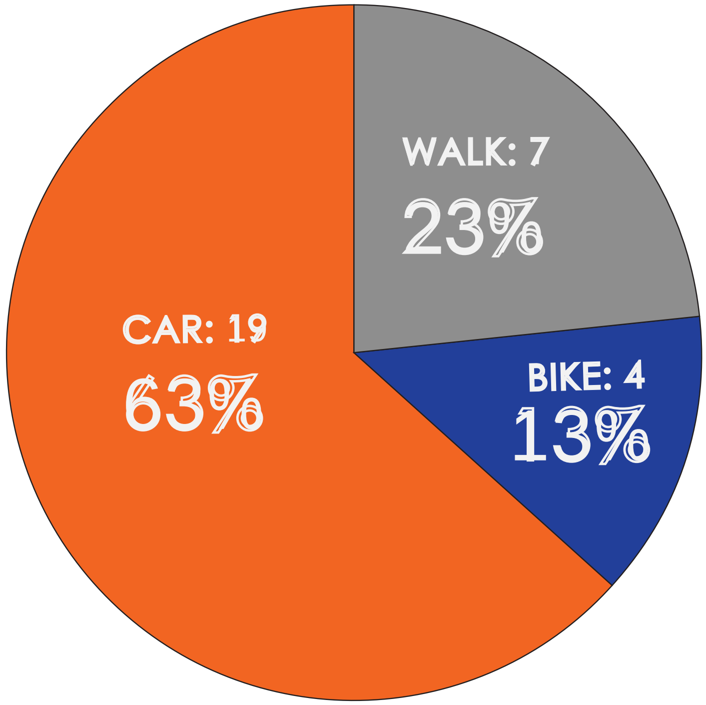


Chart 4-3 The Answers to “How do you usually get to Aggieville?”

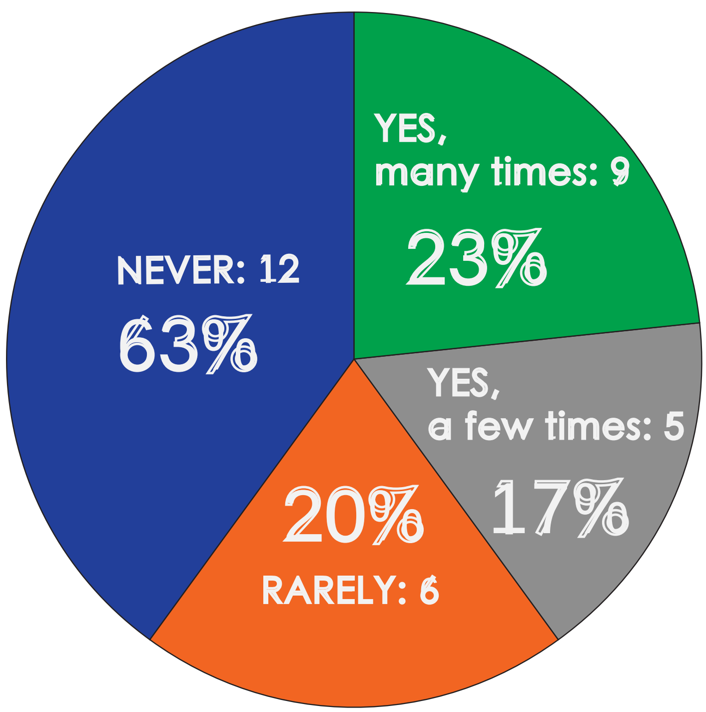


Chart 4-4 The Answers to “Have you biked in Aggieville?”

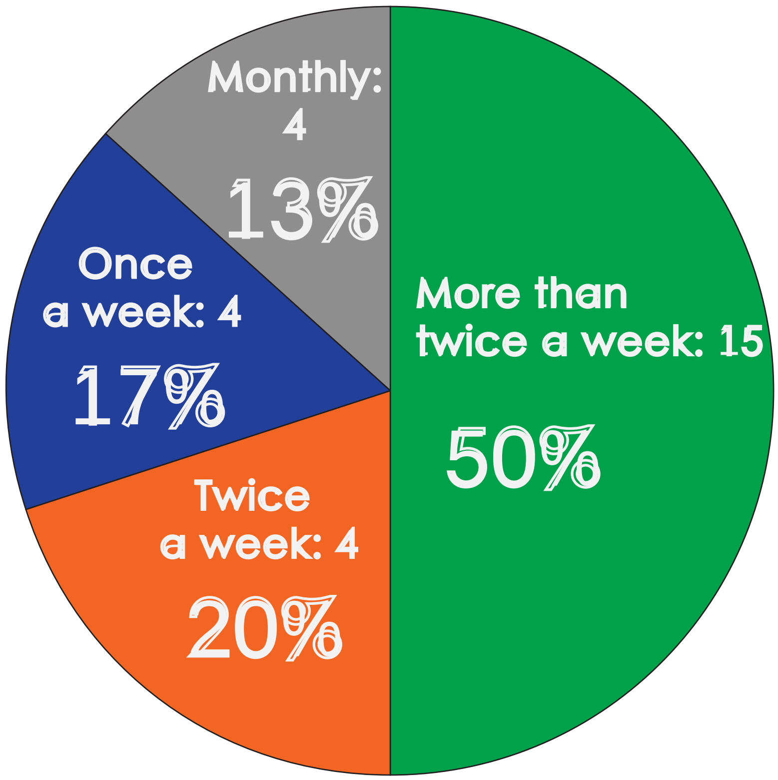


Chart 4-5 The Answers to “How often do you go to Aggieville?”

4.1 Attractiveness

Table 4-1 shows evidence that the on-street parking (Parking) and green infrastructure (Green Infrastructure) are statistically significant ($p < .05$), whereas seating and biking had no statistically significant effect on the evaluation of attractiveness. Table 4-1 shows the result of the ANOVA for the attractiveness rating using the four study variables (See Methods 3.1), as well as the intersections of those variables.

Table 4-1 ANOVA results of street design on attractiveness ratings

Variable	df	Mean squre	F ratio	p	Partial η^2
Sidewalk/ On Street Parking	4	7.472	3.086	0.015*	0.010
Green Infrastructure	3	184.266	76.096	0.000*	0.161
Bench	1	0.766	0.316	0.574	0.000
Designated Bike Lane	1	2.225	0.919	0.338	0.001
Sidewalk/ On Street Parking × Green Infrastructure	4	1.092	0.451	0.772	0.002
Sidewalk/ On Street Parking × Green Infrastructure	2	2.918	1.205	0.300	0.002
Sidewalk/ On Street Parking × Bench	3	0.856	0.353	0.787	0.001
Sidewalk/ On Street Parking × Designated Bike Lane	3	0.929	0.384	0.765	0.001
Green Infrastructure × Bench	3	1.925	0.799	0.494	0.002
Green Infrastructure × Designated Bike Lane	1	2.212	0.914	0.339	0.001
Sidewalk/ On Street Parking × Green Infrastructure × Bench	3	0.904	0.373	0.772	0.001
Sidewalk/ On Street Parking × Green Infrastructure × Designated Bike Lane	4	0.695	0.287	0.887	0.001
Sidewalk/ On Street Parking × Bench × Designated Bike Lane	2	0.293	0.121	0.886	0.000

*Statistically significant results at the $p = 0.05$ level.

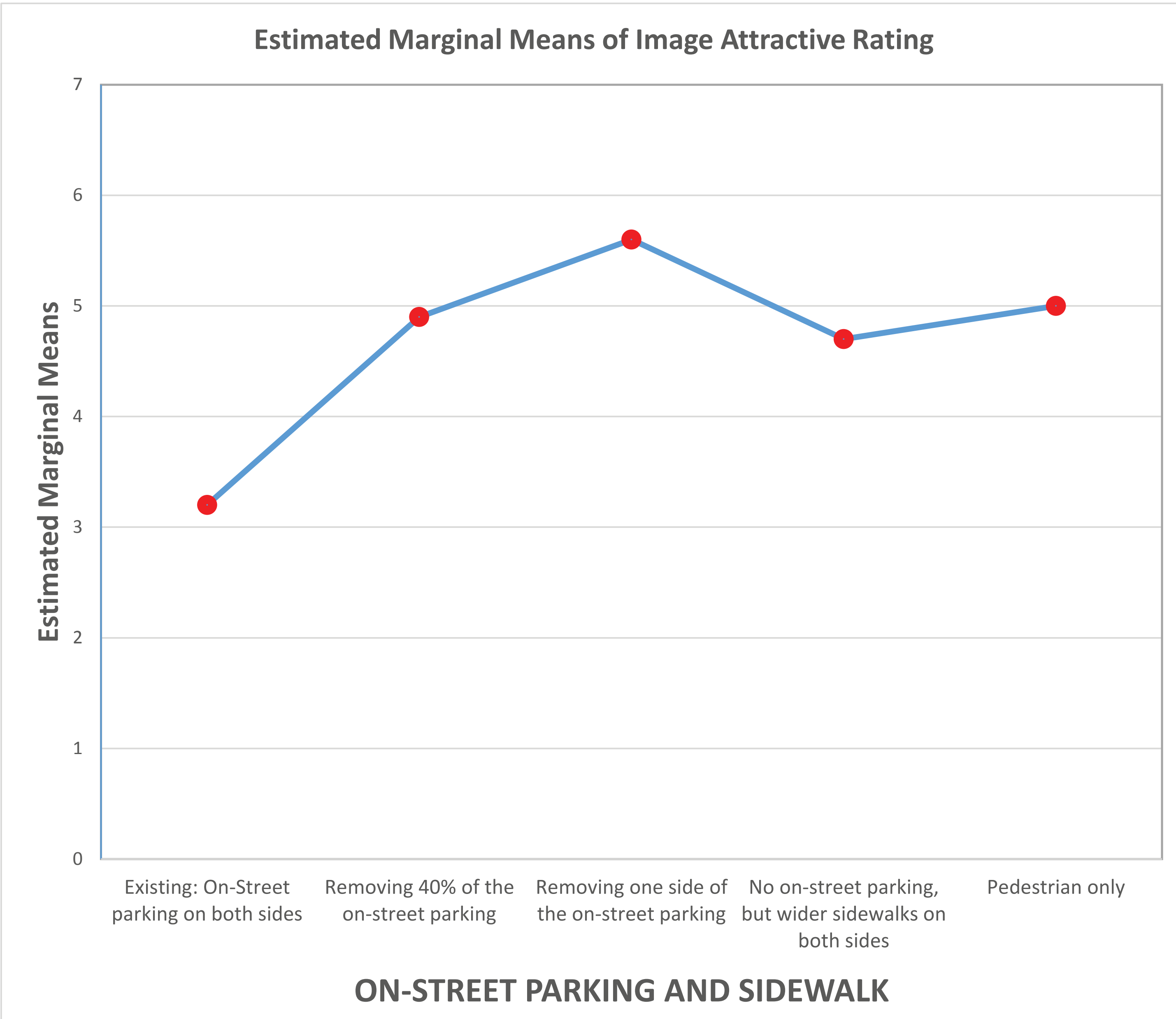

Estimated Marginal Means of Image Attractive Rating
Estimated Marginal Means
7
6
5
4
3
2
1
0
Existing: On-Street parking on both sides
Removing 40% of the on-street parking
Removing one side of the on-street parking
No on-street parking, but wider sidewalks on both sides
Pedestrian only
ON-STREET PARKING AND SIDEWALK

Chart 4-6

Chart 4-6 is a plot of the estimated marginal mean ratings for attractiveness versus the effect of the different parking designs. The lowest rated scenario is the existing condition (one way with two dies parking). All other parking configurations were rated higher, but there was no correlation between the amount of parking and the rating of attractiveness. The street with single-sided angled on-street parking was given 5.5, which was the highest estimated marginal mean score in terms of attractiveness. In the four new visions of the Moro Street design, the score for the design with no off-street parking was comparatively low in terms of attractiveness. Designs which featured no vehicle movement and removed 20% of street parking on both sides were given comparatively similar estimated marginal mean ratings in terms of attractiveness.

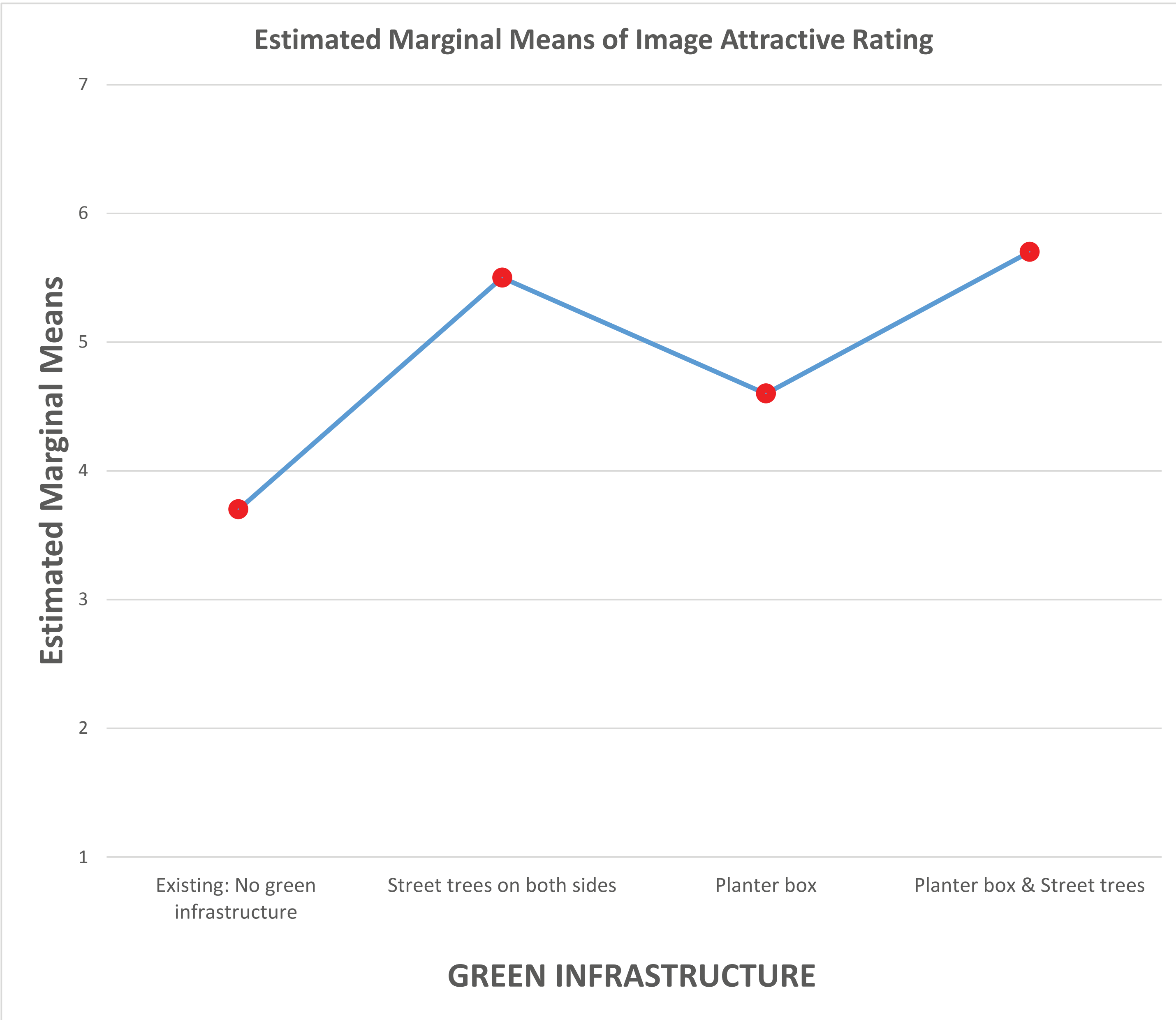

Estimated Marginal Means of Image Attractive Rating
7
6
5
4
3
2
1
Estimated Marginal Means
Existing: No green infrastructure
Street trees on both sides
Planter box
Planter box & Street trees
GREEN INFRASTRUCTURE

Chart 4-7

Chart 4-7 shows the results between four levels of green infrastructure (No Green Infrastructure, Street Trees only, Planter box only, both Street Trees and Planter boxes) versus the estimated mean ratings of street scenario attractiveness. The rating for scenarios that included trees (with or without Planter boxes) was 5.5, and is much higher than the existing street environment without any green spaces. The planter boxes also had a higher mean rating than no green infrastructure in terms of attractiveness, but its effect is less than that of street trees.

4.2 Safety

Table 4-2 shows evidence that parking, green infrastructure and bike lane had statistically significant effect($p < .05$), whereas seating had no statistically significant effect on the evaluation of safety. Table 4-2 shows the result of the ANOVA for the safety rating with the four study variables (See Methods 3.2), as well as the intersections of those variables. Of these intersections Parking x Biking was statistically significant. While green infrastructure caused a statistically significant effect the effect was not large.

Table 4-2 ANOVA results of street design on safety ratings

Variable	df	Mean squre	F ratio	p	Partial η^2
Sidewalk/ On Street Parking	4	113.452	58.589	0.000*	0.165
Green Infrastructure	3	5.053	2.609	0.050*	0.007
Bench	1	0.089	0.046	0.830	0.000
Designated Bike Lane	1	16.147	8.338	0.004*	0.007
Sidewalk/ On Street Parking × Green Infrastructure	4	1.635	0.844	0.497	0.003
Sidewalk/ On Street Parking × Green Infrastructure	2	0.156	0.081	0.922	0.000
Sidewalk/ On Street Parking × Bench	3	6.253	3.229	0.022	0.008
Sidewalk/ On Street Parking × Designated Bike Lane	3	0.374	0.193	0.901	0.000
Green Infrastructure × Bench	3	0.051	0.026	0.994	0.000
Green Infrastructure × Designated Bike Lane	1	0.081	0.042	0.838	0.000
Sidewalk/ On Street Parking × Green Infrastructure × Bench	3	0.781	0.403	0.751	0.001
Sidewalk/ On Street Parking × Green Infrastructure × Designated Bike Lane	4	2.451	1.247	0.289	0.004
Sidewalk/ On Street Parking × Bench × Designated Bike Lane	2	0.208	0.108	0.898	0.000

*Statistically significant results at the $p = 0.05$ level.

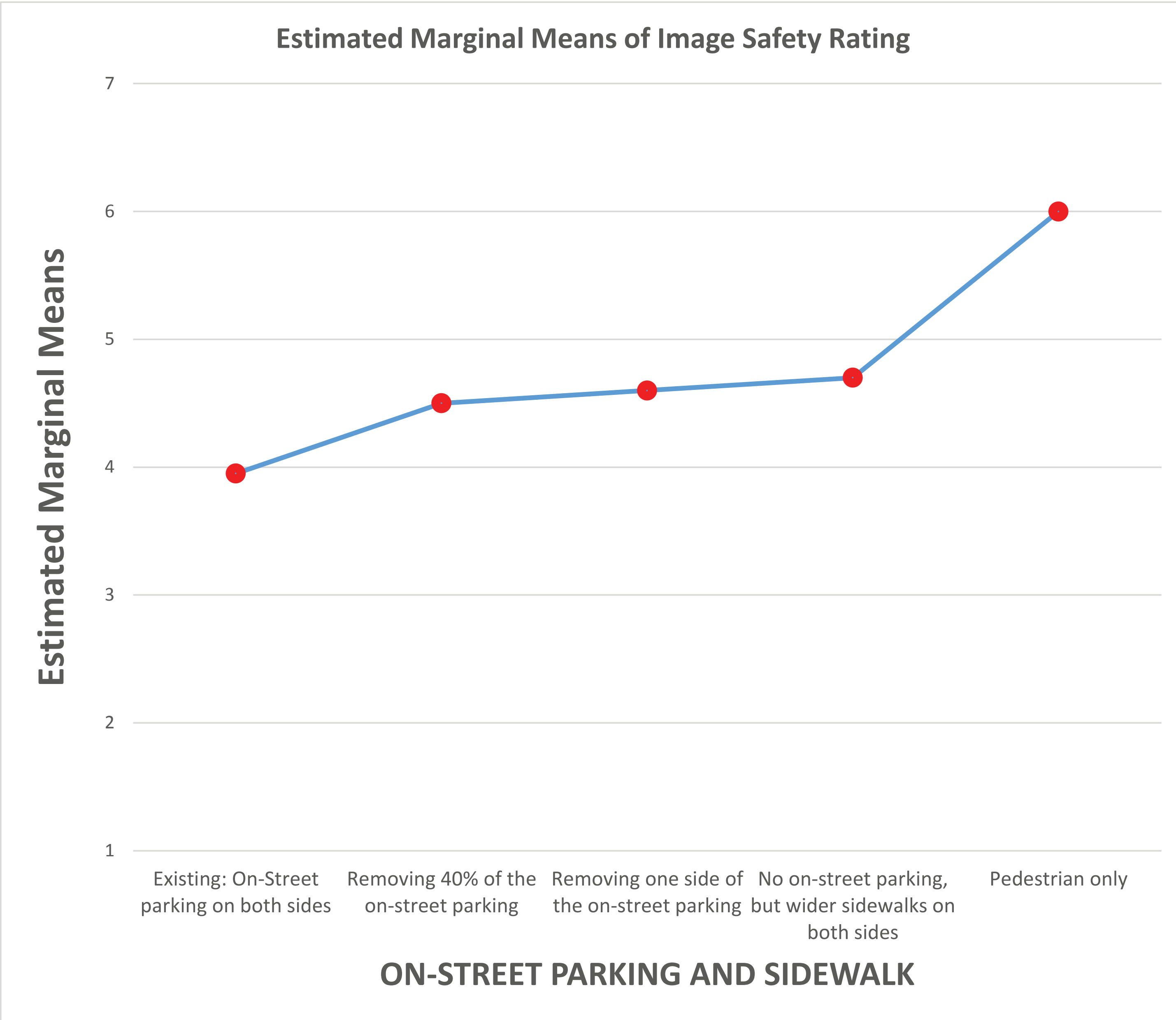

Estimated Marginal Means of Image Safety Rating
Estimated Marginal Means
7
6
5
4
3
2
1
Existing: On-Street parking on both sides
Removing 40% of the on-street parking
Removing one side of the on-street parking
No on-street parking, but wider sidewalks on both sides
Pedestrian only
ON-STREET PARKING AND SIDEWALK

Chart 4-8

Chart 4-8 is a plot of the estimate marginal mean ratings for safety, and the effect of the different parking designs. Participants rated the existing conditions as having the lowest safety of all street configurations. There is a correlation between the amount of parking and the safety rating; The fewer vehicles occupying the street, the safer users considered it to be. The street with pedestrian only had a score of 6, which was the highest estimated marginal mean rating in terms of safety.

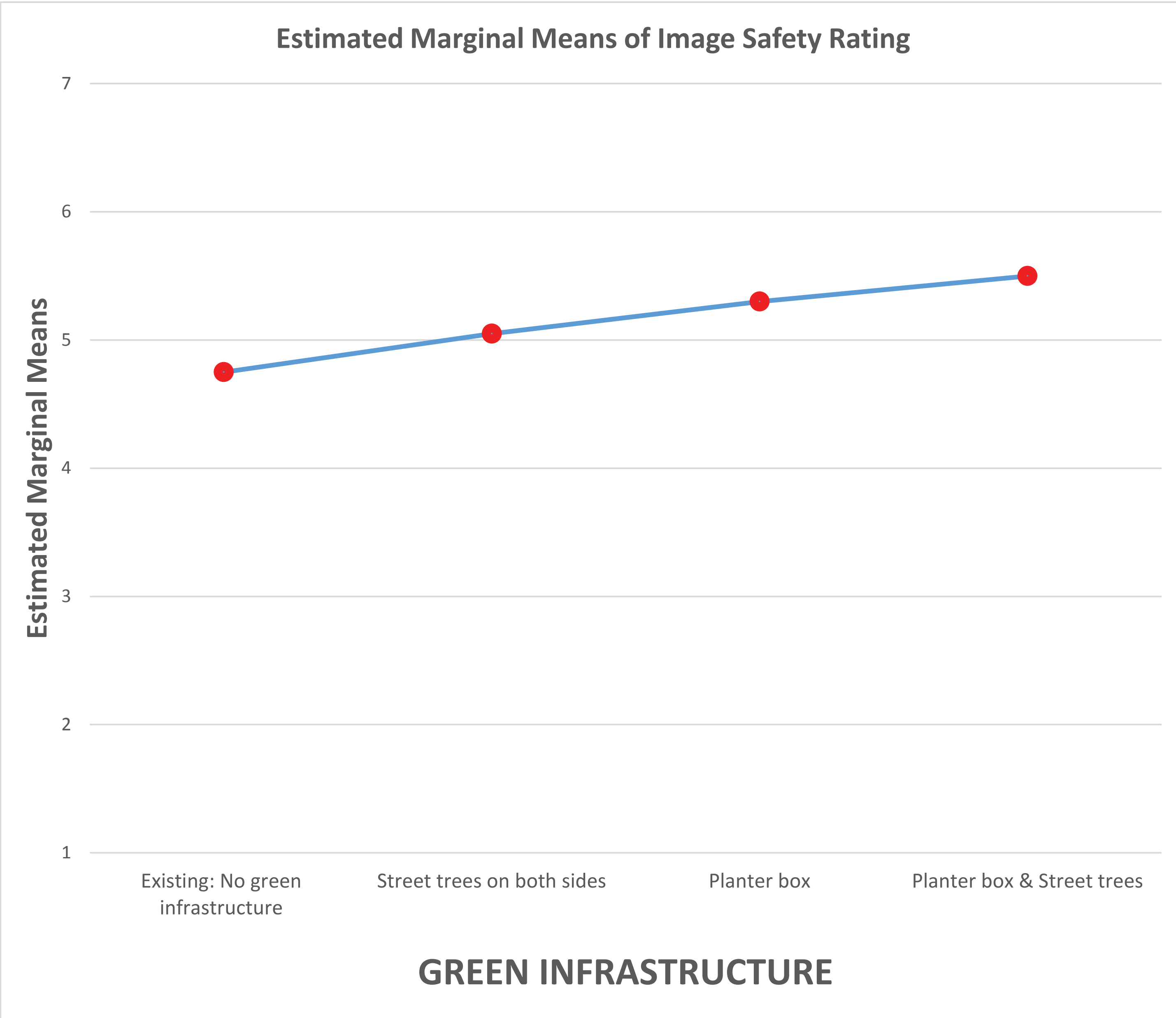

Estimated Marginal Means of Image Safety Rating
7
6
5
4
3
2
1
Estimated Marginal Means
Existing: No green infrastructure
Street trees on both sides
Planter box
Planter box & Street trees
GREEN INFRASTRUCTURE

Chart 4-9

Chart 4-9 shows the results that green infrastructure and the estimated mean rating had on street safety. Rated the existing condition (No Green Infrastructure) as the lowest in terms of safety of all street configurations. The mean rating of streets with planter boxes is comparatively lower than that for a street scenario with trees. The scenario that contains both trees and Planter boxes has the highest mean rating.

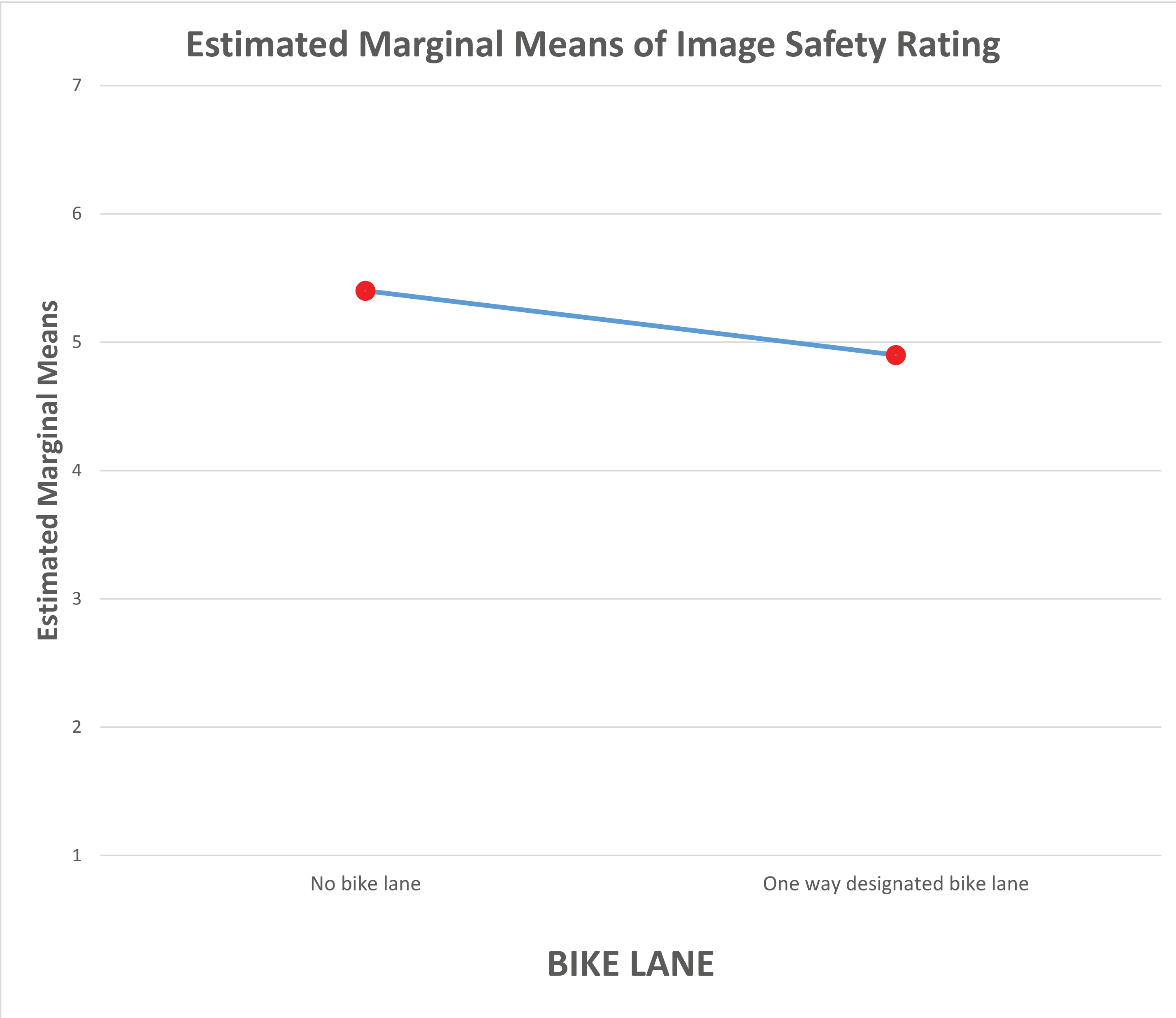

Estimated Marginal Means of Image Safety Rating
7
6
5
4
3
2
1
Estimated Marginal Means
No bike lane
One way designated bike lane
BIKE LANE
Chart 4-10

Chart 4-10 is a plot of the estimated marginal mean ratings for safety, and the effect of the different bike lane designs. The existing Moro Street is a one-way traffic lane shared with a bike lane. The existing bike lane is barely used by cyclists. Participants rated the street without bike lane as having the highest safety of all street configurations.

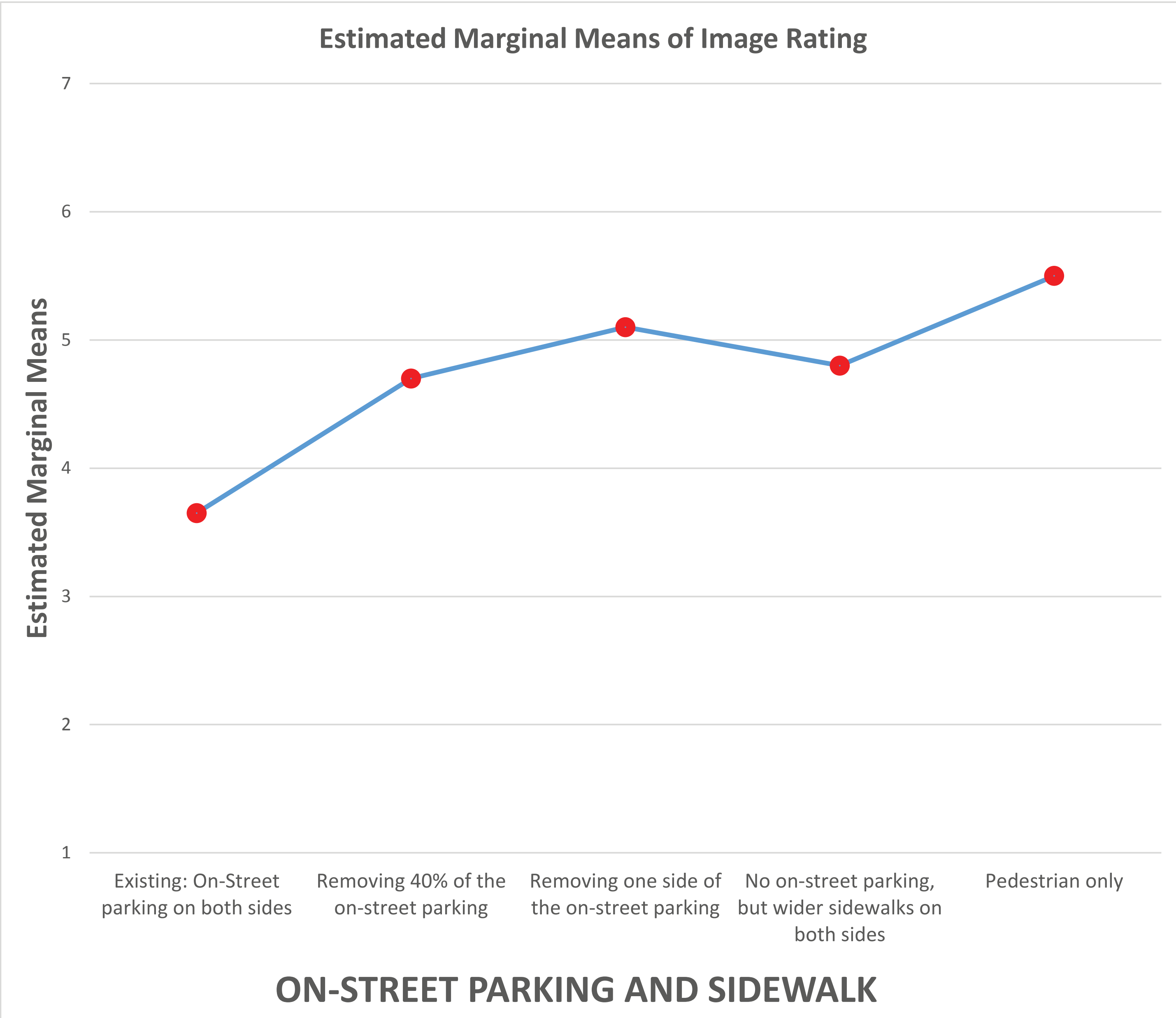
4.3 Composite (Attractiveness and Safety Combined)

Table 4-3 shows evidence that the on-street parking (Parking) and green infrastructure (Green Infrastructure) are statistically significant ($p < .05$), whereas seating and biking had no statistically significant effect on the evaluation of both safety and attractiveness. Table 4-3 shows the result of the ANOVA for the mean rating of both safety and attractiveness based on the four study variables (See Methods 3.2), as well as the intersection of those variables.

Table 4-3 ANOVA results of street design on Average ratings

Variable	df	Mean squre	F ratio	p	Partial η^2
Sidewalk/ On Street Parking	4	41.982	27.465	0.000*	0.085
Green Infrastructure	3	62.401	40.824	0.000*	0.093
Bench	1	0.345	0.225	0.635	0.000
Designated Bike Lane	1	1.596	1.044	0.307	0.001
Sidewalk/ On Street Parking × Green Infrastructure	4	1.166	0.763	0.549	0.003
Sidewalk/ On Street Parking × Green Infrastructure	2	0.461	0.302	0.740	0.001
Sidewalk/ On Street Parking × Bench	3	2.898	1.896	0.128	0.005
Sidewalk/ On Street Parking × Designated Bike Lane	3	0.279	0.182	0.908	0.000
Green Infrastructure × Bench	3	0.377	0.247	0.864	0.001
Green Infrastructure × Designated Bike Lane	1	0.785	0.513	0.474	0.000
Sidewalk/ On Street Parking × Green Infrastructure × Bench	3	0.718	0.470	0.703	0.001
Sidewalk/ On Street Parking × Green Infrastructure × Designated Bike Lane	4	0.896	0.586	0.673	0.002
Sidewalk/ On Street Parking × Bench × Designated Bike Lane	2	0.159	0.104	0.901	0.000

*Statistically significant results at the $p = 0.05$ level.



Estimated Marginal Means of Image Rating
Estimated Marginal Means
7
6
5
4
3
2
1
Existing: On-Street parking on both sides
Removing 40% of the on-street parking
Removing one side of the on-street parking
No on-street parking, but wider sidewalks on both sides
Pedestrian only
ON-STREET PARKING AND SIDEWALK

Chart 4-11

Chart 4-11 is a plot of the estimated marginal mean ratings for safety and attractiveness, and the effect of the different parking designs. The results and plots are nearly identical to attractiveness. There is a big difference in mean rating scores between the vehicle-dominated existing condition and the ‘no vehicle movement’ scenario. Participants rated the existing conditions (vehicle-dominated) 3.5 as having the lowest safety and attractiveness of all street configurations. The rating of the scenarios without vehicle movement had a score of 5.5, which was the highest mean rating of both safety and attractiveness. There is no correlation between the amount of parking and the mean rating. The street scenarios with less or no off-street parking had comparatively similar mean ratings.

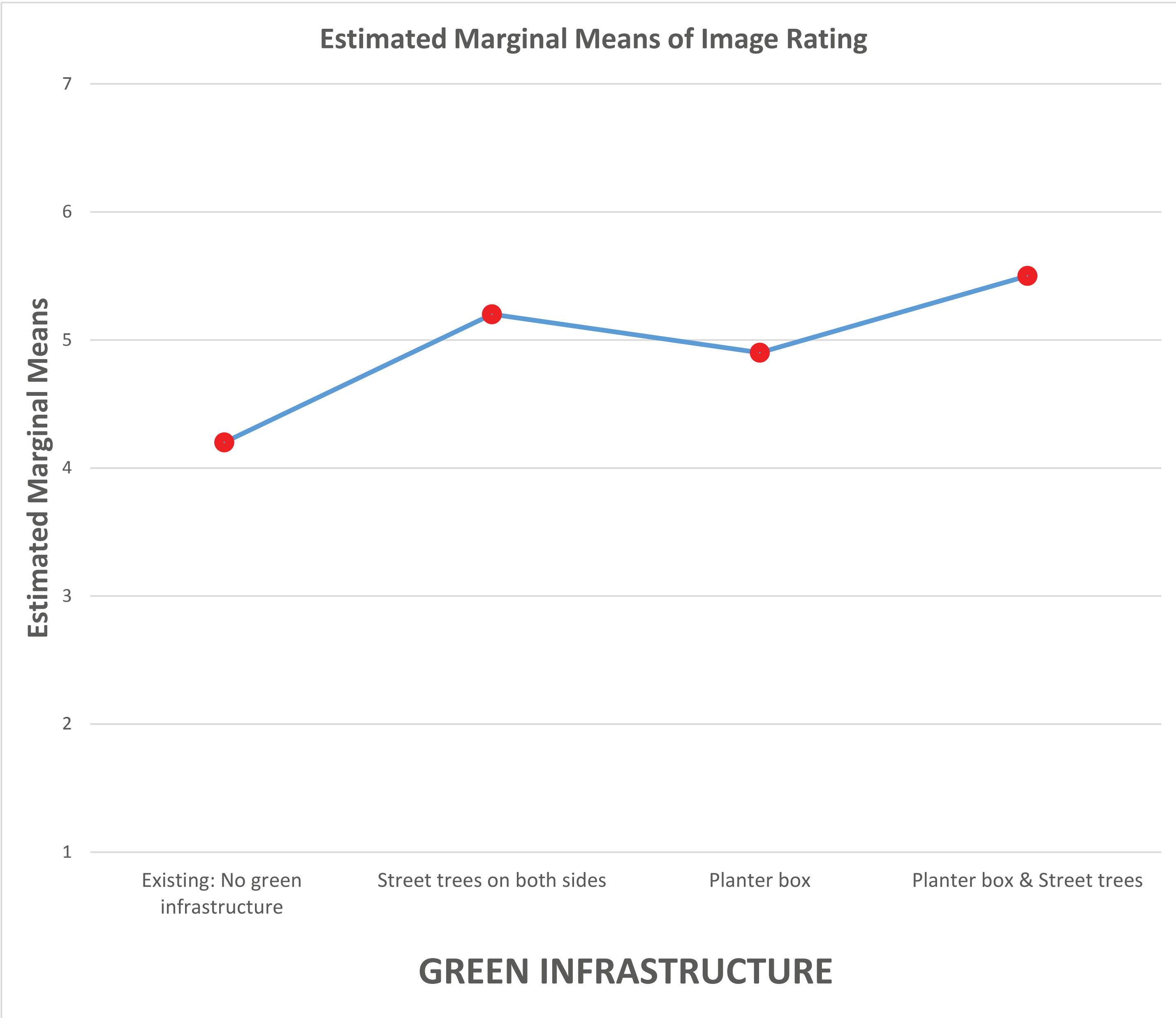

Estimated Marginal Means of Image Rating
Estimated Marginal Means
7
6
5
4
3
2
1
Existing: No green infrastructure
Street trees on both sides
Planter box
Planter box & Street trees
GREEN INFRASTRUCTURE
Chart 4-12

Chart 4-12 is a plot of the estimated marginal mean ratings for safety and attractiveness, and the effect of different green infrastructure designs. Participants rated the existing conditions (no green infrastructure) as having the lowest safety and attractiveness of all street configurations. There is no correlation between the type of green infrastructure and the mean rating. The rating of the scenarios containing street trees and planter boxes had the highest mean rating of all mean ratings. Scenarios with street trees had higher ratings than those with plant boxes nor those without green areas.

4.4 DEMOGRAPHICS AND TRAVELING HABITS EFFECTS

After testing for effects of demographic and traveling habits variables, the results showed that the age and visiting frequency had statistically significant effects on the evaluation of attractiveness and safety ($p<0.05$). As well, whether they consider themselves as a cyclist had a statistically significant effect on both attractiveness and safety rating ($p<0.05$).

4.4.1 Attractiveness Demographics and Traveling Habits Effects

One of the variables which was effected by two different age groups (< 28 >) is green infrastructure. For those younger than 28, green infrastructure had a statistically significance effect, whereas with those older than 28 there was no significant effect. Chart 4-13 shows that the younger group (age < 28) rated the scenarios with trees as a more attractive environment. In addition, both street parking design and green infrastructures had a statistically significance effect on those participants older than 27 . Chart 4-14 shows that the older group (age ≥ 28) rated the street configurations with single-sided angled on-street parking as the most attractive. The curve in Chart 4-15 is similar to Chart 4-13, where the street trees had a statistically significant effect on either older or younger people in terms of attractiveness. Likewise, green infrastructures and the street parking design had a statistically significant effect on those considered as cyclists ($p < 0.05$). Chart 4-16 shows that cyclists rated configurations with single-sided angled on-street parking as the most attractive. Chart 4-17 shows that the presence of trees had a statistically significant effect on cyclists. Meanwhile, only green infrastructure had a statistically significant effect on those not considered as cyclists ($p < 0.05$), and trees remained statistically significant for them. For those visiting Aggieville monthly, both street parking design and green infrastructures are statistically significance in terms of attractiveness ($p < 0.05$). Such visitors considered the designs only with pedestrian movement as the most attractive and preferred the combination of trees and planter boxes. Furthermore, green infrastructure is the only element that had a statistically significant effect on those visiting Aggieville more than once a week ($p < 0.05$). Evidence shows that trees had a statistically significant effect on three specific groups of people (namely, visiting frequency = once a week, visiting frequency = twice a week, and visiting frequency ≥ twice a week).

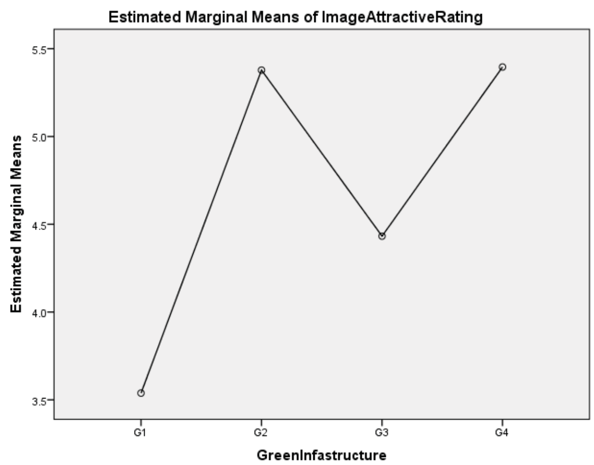


Chart 4-13

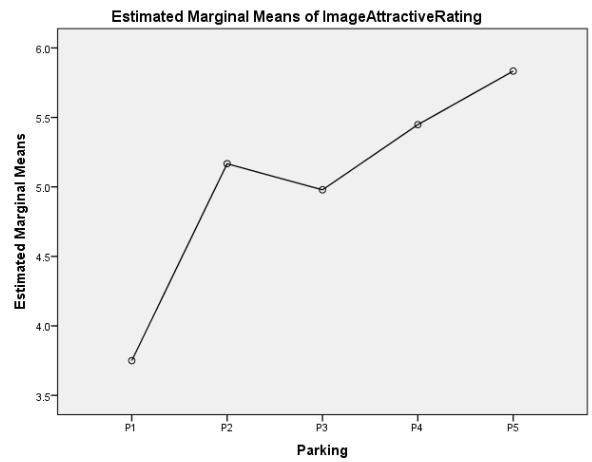


Chart 4-14

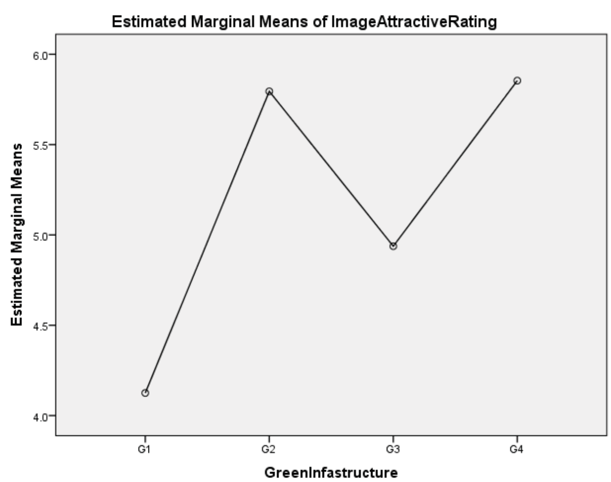


Chart 4-15

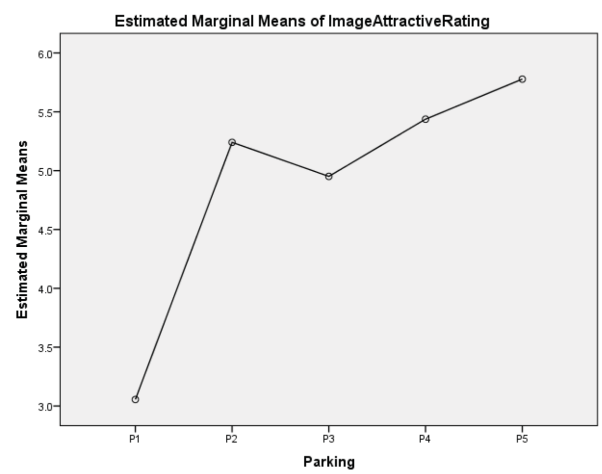


Chart 4-16

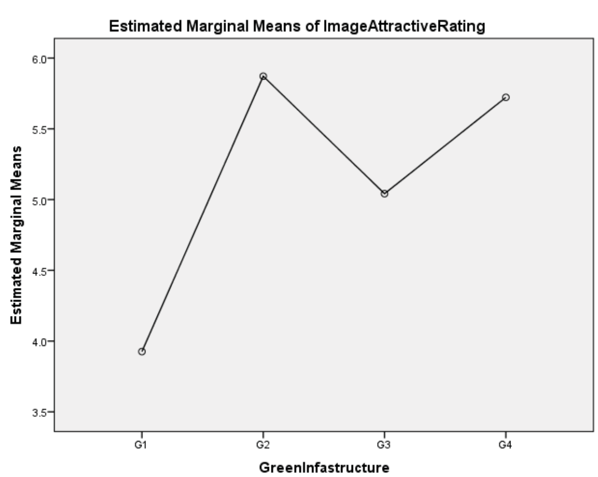


Chart 4-17

G1: Existing: No green infrastructure
G2: Street trees on both sides
G3: Planter box
G4: Planter box & Street trees

P1: Existing: On-Street parking on both sides
P2: Removing 40% of the on-street parking
P3: Pedestrian only
P4: Removing one side of the on-street parking
P5: No on-street parking, but wider sidewalks on both sides

4.4.1 Attractiveness Demographics and Traveling Habits Effects

An ANOVA was conducted, which revealed statistically significant effects related to demographics and traveling in contrast with the safety rating. The street parking designs, bike lanes, and intersection of on-street parking and bike lanes are statistically significant on those participants younger than 28. Chart 4-18 shows that the younger group (age < 28) rated designs only with pedestrians as the safest. Chart 4-19 shows that the younger group (age < 28) considered designs with bike lanes are less safe. Chart 4-20 shows that the younger people rated scenarios with pedestrians the safest regardless of the presence of a bike lane. At the same time, only the street parking design had a statistically significant effect on those participants older than 27. Chart 4-21 shows a different curve, with the older group (age ≥ 28) rating the street configurations with single-sided angled on-street parking as the least safe and environments only with pedestrians as the safest. The design of on-street parking, biking, and the intersection of on-street parking and bike lanes had a statistically significant effect on those considered as cyclists ($p < 0.05$). Chart 4-22 shows that cyclists rated the street configurations only with pedestrian movement as the safest. Chart 4-23 shows that bike lanes had a statistically significant effect on cyclists, and the designs with bike lanes are considered less safe. Chart 4-24 shows that cyclists rated scenarios only with pedestrians as the safest, regardless of the presence of bike lanes. Moreover, only on-street parking had a statistically significant effect on those not considered as cyclists ($p < 0.05$), who considered the designs only with pedestrian movement as the safest. For the group of people that visit Aggieville monthly, only on-street parking designs had a statistically significant effect on safety ($p < 0.05$). In addition, the curve shows that this group (visiting frequency = monthly) rated the street configurations with single-sided angled on-street parking as the least safe and environments only with pedestrians as the safest. The on-street parking designs and bike lanes had a statistically significant effect on those visiting Aggieville once a week. Such visitors rated the street configurations with single-sided angled on-street parking as the least safe, environments only with pedestrians as the safest, and the designs with bike lanes as less safe. For those visiting Aggieville twice a week, the design of on-street parking, green infrastructure, and the intersection of the bike lane and on-street parking had a statistically significant effect on safety ($p < 0.05$). The designs with less vehicle movement all had statistical significance. Chart 4-25 shows that this group of people (visiting frequency = twice a week) rated the combination of trees and planter boxes as the safest. Chart 4-26 shows that the designs without vehicle and bicycle movement are considered as the safest, while bike lanes with one-sided on-street parking had a statistically significant effect on safety. For those visiting Aggieville more than twice a week, the on-street parking designs as well as the intersection of bike lanes and on-street parking had a statistically significant effect on safety ($p < 0.05$). Chart 4-27 shows that this group (visiting frequency > twice a week) rated the street configurations without vehicle movement as the safest, regardless of the presence of bike lanes.

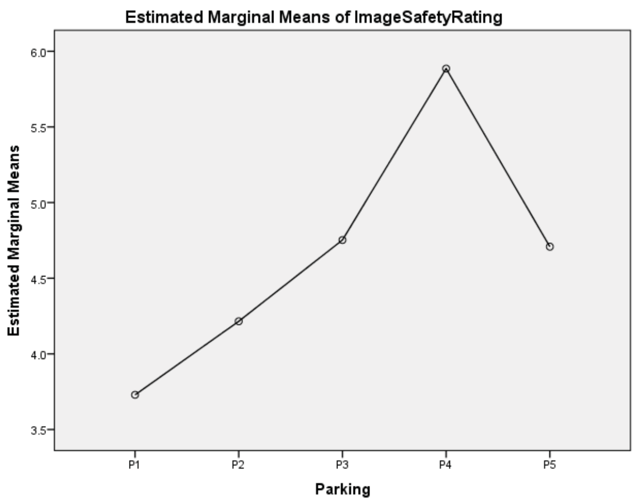


Chart 4-19

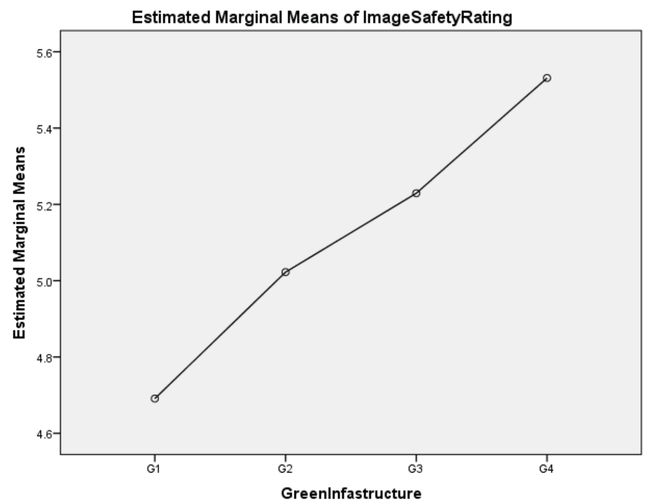


Chart 4-20

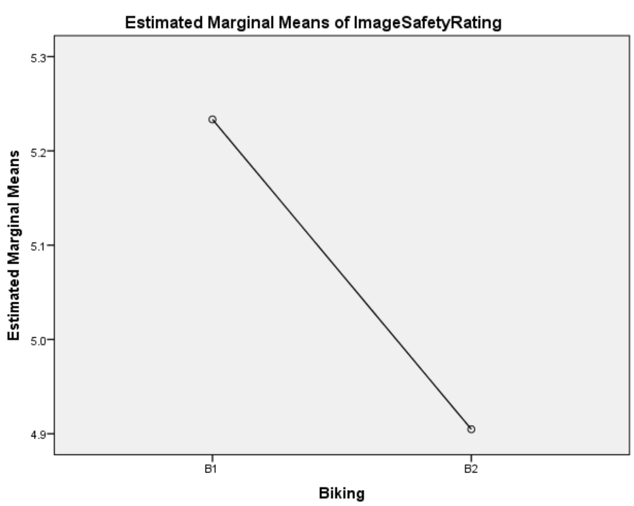


Chart 4-21

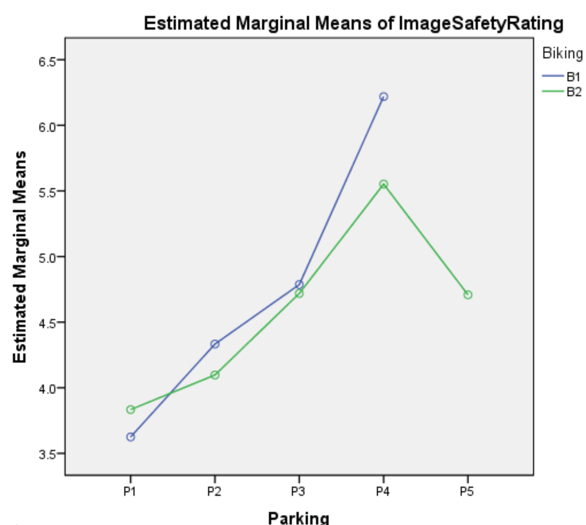


Chart 4-22

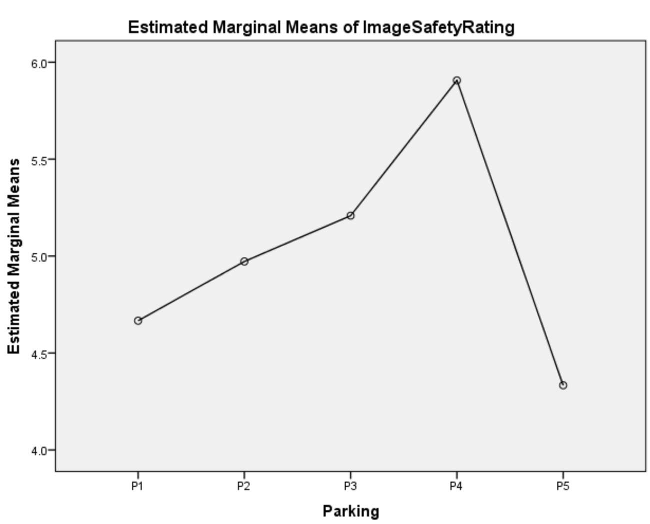


Chart 4-23

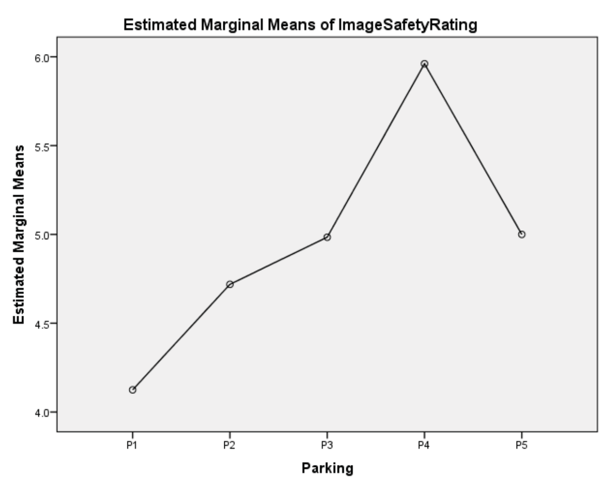


Chart 4-24

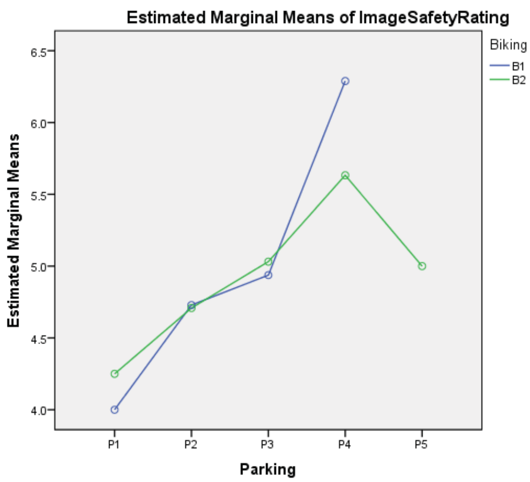


Chart 4-25

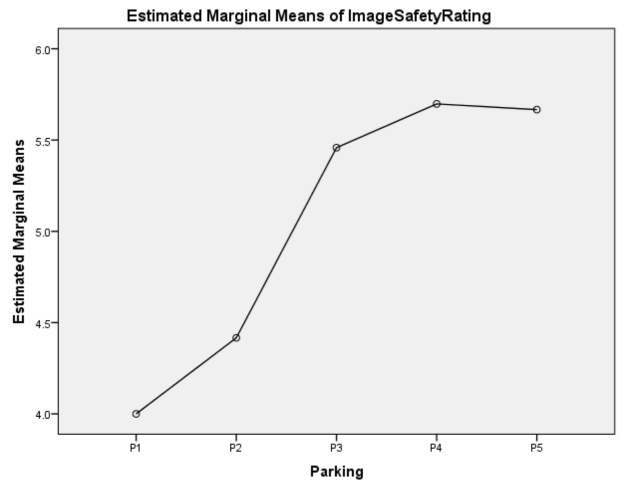


Chart 4-26

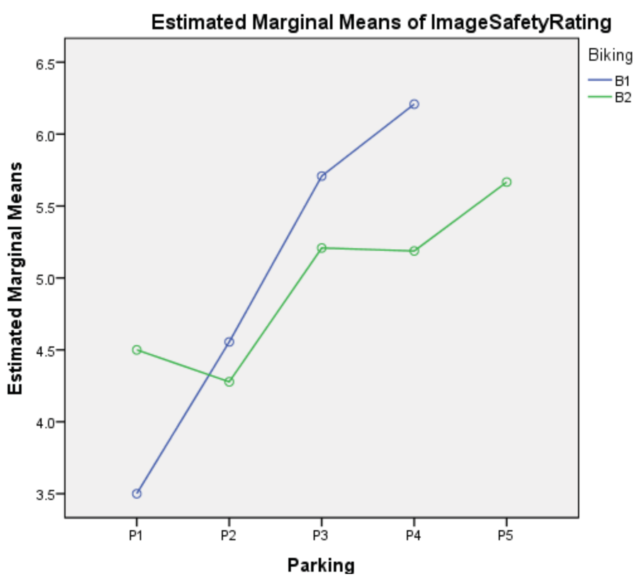


Chart 4-27

G1: Existing: No green infrastructure
G2: Street trees on both sides
G3: Planter box
G4: Planter box & Street trees

P1: Existing: On-Street parking on both sides
P2: Removing 40% of the on-street parking
P3: Pedestrian only
P4: Removing one side of the on-street parking
P5: No on-street parking, but wider sidewalks on both sides

CHAPTER 5 DISCUSSION AND RESULT-BASED DESIGNS

5.1 Green Infrastructure

5.1.1 Street Tree

According to the survey results, green infrastructure, generally, has a significant effect on safety, attractiveness, and overall mean rating. This supports previous literature of urban studies that shows that an urban image with trees is usually preferred, with well-designed green street facilities improving the attractiveness of a walking environment (Adkins, Dill, Luhr, & Neal 2012; Jacobs 1995; Kelly, Tight, Hodgson, & Page 2011; Forsyth, Hearst, Oakes, & Schmitz 2008; Wolf 2014). Trees not only positively affect the visual quality of the consumer environment, but also improve aspects of district perception, patronage behavior, and product prizing (Wolf 2005). As a vertical wall to frame streets, a defined edge, and a guide for motorists to assess their movements and speed, trees can reduce urban traffic speeds to more appropriate levels (Avissar 1996; Park et al. 2012). Street safety comparisons show reductions of run-off-the-road crashes and overall crash severity when street tree sections are compared with equivalent treeless streets (Burden 2008). Furthermore, by forming and framing visual walls as well as providing distinct edges to sidewalks, trees can create safer walking environments, enabling motorists to better distinguish their own environment and that shared with others (Burden 2008, 6).

In addition to providing benefits for safety and attractiveness, trees provide additional benefits. Street trees have been reported to benefit the air quality and the microclimate in a built environment of an urban area significantly (Calkins 2012; Bernatzky 1983; McPherson et al. 1997). Trees can not only enhance local habitat conditions for insects and bird species, but also reduce the urban heat island effect by improving thermal comfort, moderating microclimatic conditions, and providing shade (Avissar 1996; Park et al., 2012; Taha 1997). Large studies show that people prefer seeing trees in urban environments, which they perceive as nature (Nassauer 1995; Kaplan 1983;

Ulrich 1986). In this study, the results also show the same evidence that street trees play a significant role in creating an attractive and safe civic space.

5.1.2 Plant box

Planter boxes are ideal for space-limited urban environments as a streetscaping element (EPA 2013). They are designed with vertical walls and open bottoms that can collect and absorb runoff from sidewalks, parking lots, and streets (EPA 2013). They reduce the runoff flow rate, volume, temperature, and pollutants of stormwater; and recharge groundwater (EPA 2013; Rottle & Yocom 2010; Bartens et al. 2008; Armson et al. 2012). According to an empirical study in Wilsonville, Oregon, planter box configurations produced the largest stormwater retention and the longest delay in transmission of stormwater when passing through the boxes (Yeakley & Norton 2009). Using native plants as infiltration planters can achieve multiple goals: 1) reduce maintenance needs; 2) provide a beneficial habitat for native organisms; and 3) restore a sense of place to the regional design (Calkins 2012). In this project, participants rated the planter boxes comparatively lower than trees in terms of attractiveness. Literature suggests that many of the best-performing native plant species with too much diversity in the urban environment are also frequently considered "weedy" (Nassauer 1995, Calkins 2012). The balance between an ecosystem's function and appearance needs to be considered in the urban streetscape design. However, participants in the study gave the street scenarios with planter boxes a much higher score in terms of safety. Their answers suggest that planter boxes may be seen as having an edge that clearly defines the distinction between streets and sidewalks. Many projects in Portland, Oregon showed the success of using native species as infiltration vegetation in urban streetscapes. They are attractive and function well (Calkins 2012; EPA 2013). At an economic and maintenance standpoint, using infiltration planters are often less expensive than more conventional stormwater management facilities (Calkins 2012; EPA 2013). Moreover, carefully selected native species perform well in a wide range of conditions and require low maintenance (Calkins 2012; EPA 2013). The selection of planter species becomes very important in the detail design of a streetscape.

5.2 Parking

On-street parking is another important design element that has a significant effect on the safety, attractiveness and the overall mean rating. From the survey results, it can be seen that people prefer streets with single-side street parking as being the best of all scenarios in terms of attractiveness. However, when considering safety, participants rate street scenarios only with pedestrian as being the best. For overall consideration in terms of attractiveness and safety, participants chose the street scenario without vehicles as their favorite design. According to the literature, traffic volumes and parking spaces need to be seriously considered, and improvements to parking design will benefit both the community and retailers (Mukhija and Shoup, 2006; Kelly et al., 2011). On-street parking disturbs pedestrian routes, and overwhelms the physical landscape, expanding the distance between destinations and undermining walkability (Mukhija and Shoup, 2006). However, street parking has a significant effect on the accessibility and convenience of the street, suggesting that a certain amount of street parking in specific places is necessary. If removing traffic the street design would need to play a role in developing appropriate infrastructure for parking and accessibility.

5.3 Designated Bike Lane

Currently, Moro Street has a one-way traffic line that is shared with a bike lane, which has always been ignored by visitors to Aggieville. Many people bike on the sidewalk, which is a potential agent for accidents. In this survey, the existing condition is a one-way street without a bike lane. Based on the survey results, the bike lane does not have a significant influence on participants' preferences in terms of attractiveness, but was considered an important element influencing street safety. What's more, streets without bike lanes were rated safer than ones with a designated bike lane, thought the effect size is rather small. This effect seems counter intuitive, and likely needs further study and may merely be an isolated outcome of this survey.

In situations where bike lanes will be designed or shared with vehicular trafiic, there are some design considerations that may affect actual cyclist safety. For instance, the quality of a bike lane has a significant effect on the visual behavior of cyclists (Vansteenkiste et al. 2014). Where bike lanes are made well (flat smooth surface), the rider's gaze is evenly distributed over different areas of interest. This surface can create a more alert rider just by design. As well, traffic density may influence cyclists' gaze behavior , more density riders become more alert and therefore safe (Vansteenkiste et al. 2014). There is a notion in the literature called "Self-Explaining Road", tat argues and promotes for design elements that can create an easily distinguishable bike lane in order to cause drivers, pedestrians and cyclists to make choices which lead to safer behavior (Theeuwes & Godthelp 1995). For example, having such physical barriers as planter boxes, which separate bike lanes, roadways, and sidewalks; signs; and elevated pedestrian crosswalks can define the space of the pedestrian. These elements will help users to self-explain the categories and functions of each part of the street, thereby creating a safer street system . The intersection design is significant for creating a safe street system: at a non-signalized intersection, a major type of car-cycle crash is that in which a cyclist comes from the right and the driver is turning right (Summala et al. 1996). The reason for that is because the drivers' visual search behavior concentrates on major dangers but ignores less frequent dangers (Summala et al. 1996). Strategies for diminishing this type accident should be considered in street designs, such as having stop sign, countermeasures, vibrant bike path signs, and elevated crossing signs (Summala et al. 1996).

5.4 Bench

Benches have no significant effect on attractiveness. Nonetheless, according to the results of ANOVA, the intersection of sidewalk design and bench had statistically significant effect on the safety ratings, for some reason could be the older group had a preference for these benches. However, compared to green infrastructure and street parking, benches are a comparatively small element that most people largely ignored. Further considerations will be discussed in the following section.

5.5 DESIGN ALTERNATIVES AND CONSIDERATIONS FOR MORO STREET

Aggieville district in Manhattan, KS, is a commercial district with a long history, and is also a hub of social activities for university students and the community in general. Moro Street is an area marked by mixed land-use and high density, representative of the typical tone of Aggieville, and has a great potential for being a walkable area. Currently, Moro Street is a one-way road with two-sided on-street parking and narrow sidewalks on both sides. This means that walking and cycling activities are disturbed by vehicles, narrow sidewalks, and poor aesthetics. However, the most important role of streets is being a major outdoor space that consists of a variety of different infrastructure and natural forms combined together to create a space which is centered around the movement of people.

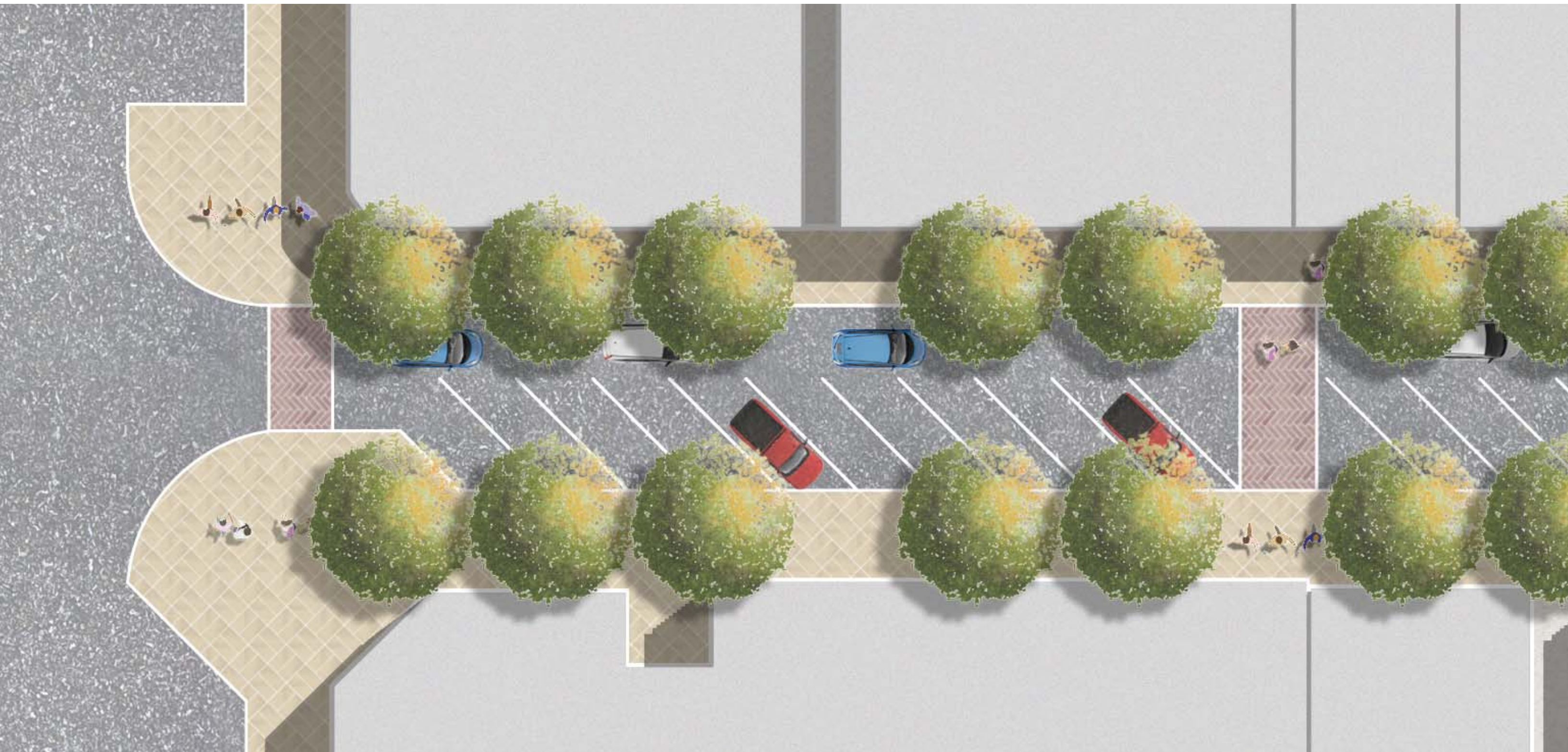
According to the available literature (Adkins, Dill, Luhr, & Neal 2012; Jacobs 1995; Kelly, Tight, Hodgson & Page 2011; Forsyth, Hearst, Oakes, & Schmitz 2008; Wolf 2014), and through statistical and quantitative analysis of these preference ratings, it can be seen that there are multiple aspects of streetscape design with a large potential for improvement. Firstly, Aggieville needs more green infrastructure. Both street trees and planter boxes can catch visitors' eyes and invite them to enjoy the outdoor space, and each provides their own unique benefits, particularly the presences of trees. Secondly, streets should be more centered on pedestrians, not vehicles. According to the survey, although there were many participants who regularly drive to Aggieville, taking out some of the street-parking would not bother them at all. Using previous literature and results from this survey, two different alternative designs have been created:

According to the survey results, possible alternative designs include the following:

Alternative Design 1: One-sided parking street with wider sidewalks and street trees

The first design aims to create a street system that has an easily recognizable, distinguishable, and interpretable environment as to elicit safe behavior simply by its design. In addition, it aims to provide a high-quality visual experience for visitors.

The design contains a one-way road with one-sided on-street parking. Wider sidewalks with street trees on both sides are provided for pedestrians. Crosswalks are elevated with different paving patterns and colors. Canopy trees play a significant role in contributing environmental benefits and facilitating pedestrian comfort, including positively affecting the visual quality and the microclimate of the built environment (Wolf 2005; Avissar 1996; Park et al. 2012; Taha 1997). Furthermore, by using the concept of the "Self-Explaining Road", street parking is clearly marked and different paving materials for roads, sidewalks, and crosswalks are used to make the functions of different part of the street easily recognizable and distinguishable (Theeuwes & Godthelp 1995). In addition, trees function as an edge line for vehicle and pedestrian movement. Curbs and elevated crosswalks clearly define the space for pedestrians and influence drivers and pedestrians' behaviors (Theeuwes & Godthelp 1995). By adding a stop sign at every crosswalk, this design encourages pedestrian to use certain safe paths to navigate the whole space and avoid driver ignorance of danger by controlling their speed (Summala et al. 1996). Lastly, although benches do not have the same influence as green infrastructure and



on-street parking, some benches should be provided for older people, and some outdoor seating can actually help restaurants or coffee shops invite more consumers to enjoy their outdoor spaces. Furthermore, providing tables and seating is an effective way to help people easily recognize the function of a space. This also helps to discourage those from biking on the sidewalk, which would have a propensity for such dangers as a bike-pedestrian crash.

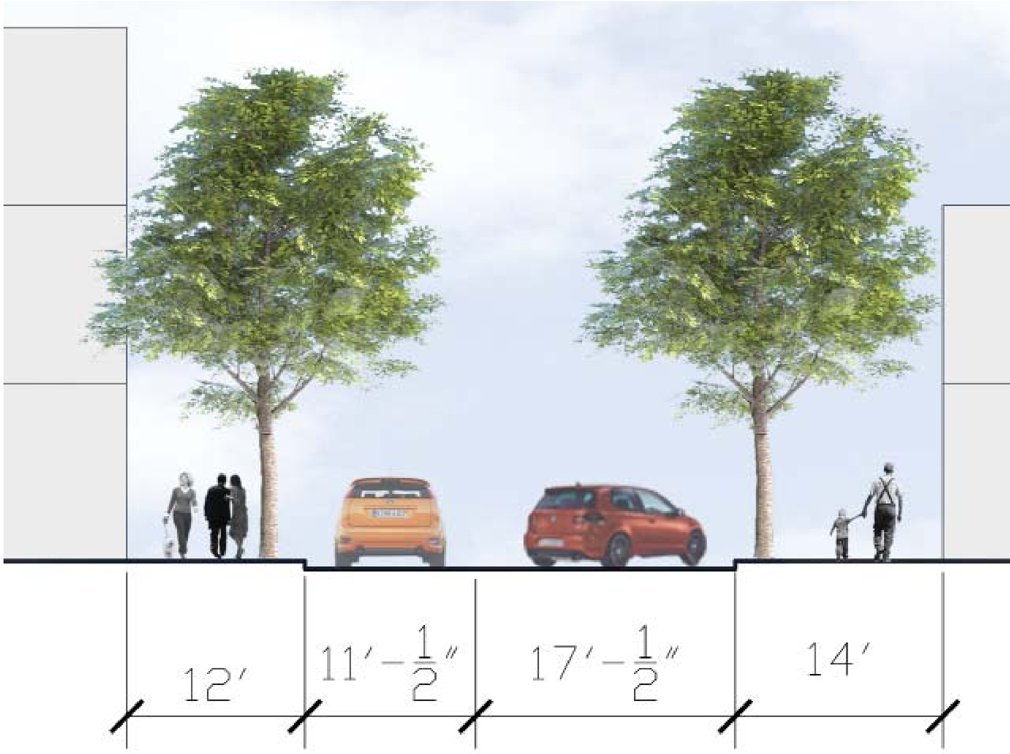
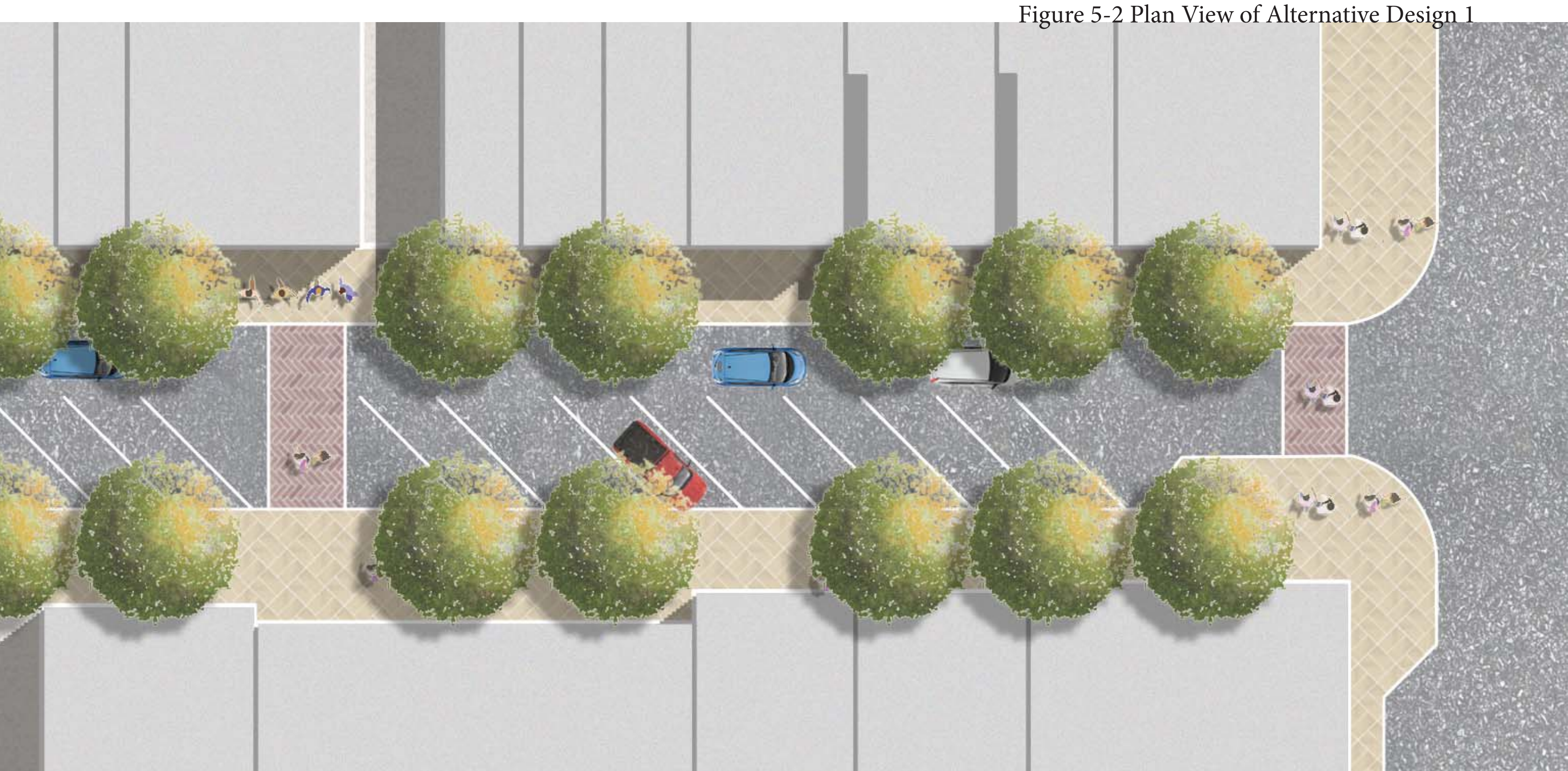


Figure 5-1 Section of Alternative Design 1

Figure 5-2 Plan View of Alternative Design 1



Alternative Design 1: One-sided parking street with wider sidewalks and street trees

Figure 5-3 Perspective View of Alternative Design 1


STOP

Alternative Design 1: One-sided parking street with wider sidewalks and street trees

Figure 5-4 Perspective View of Alternative Design 1

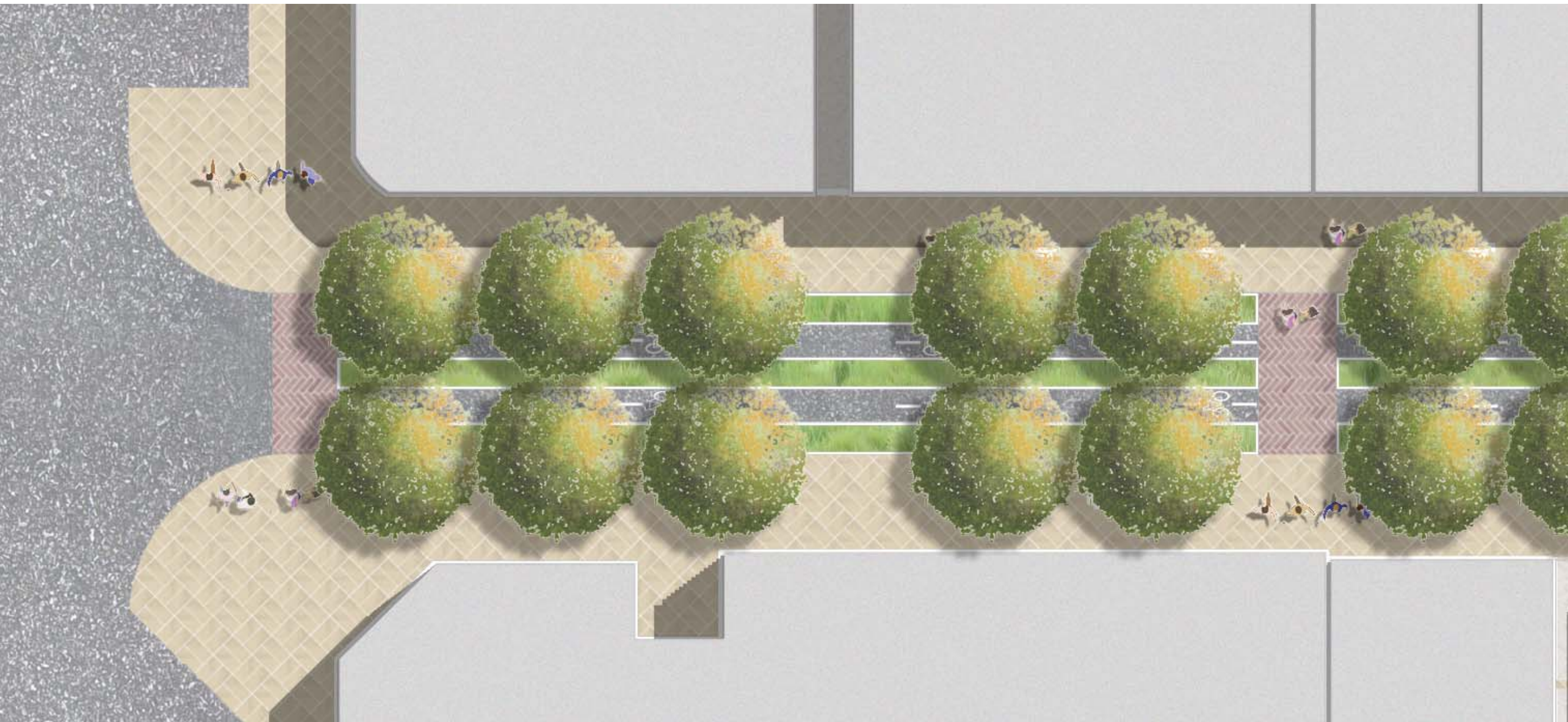

STOP

Figure 5-5 Perspective View of Alternative Design 1

Alternative Design 2: Central civic space for only pedestrians and cyclists

The second design aims to integrate green infrastructure elements into the street and create a civic space only for pedestrians and cyclists. The concept of the "Self-Explaining Road" is also implemented in this design for creating a safe biking and walking environment.

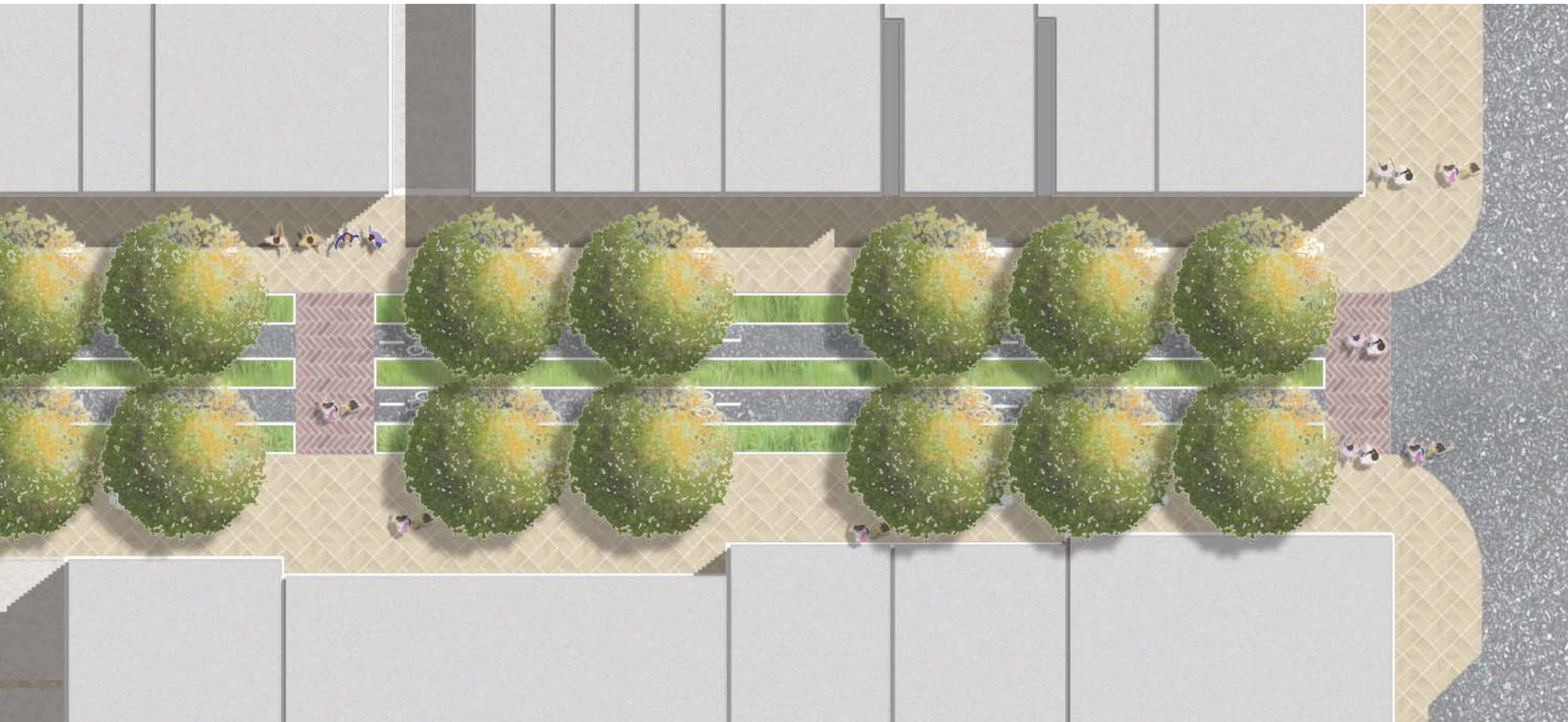
The design contains two designated bike lanes and wider sidewalks. Planter boxes can collect and absorb runoff from sidewalks and streets (EPA 2013). In this design, planter boxes serve as physical barriers to separate the whole space for pedestrians and cyclists. The two-way designated bike lanes are in the center of the space, with planter box liners in between them. Similar to the first alternative design, planter boxes, along with as different paving materials for bike lanes, sidewalks, and crosswalks, can make different parts and functions of the street easily recognizable and distinguishable (Theeuwes & Godthelp 1995). By adding small speed bumps before every crosswalk, this design encourages cyclists to become aware of pedestrian movements and to slowdown before getting to the crosswalk (Summala et al. 1996). The directions of the bike lane are continually marked on each bike track to clearly show its function and desired behavior to visitors. The planter boxes, tables, and seating could be provided in front of restaurants and coffee bars. This might provide a safe central civic space for pedestrians and cyclists (Figs. 5-5, 5-6, 5-7, 5-8). The selection of native plant species for planter boxes should consider the diversity and visual quality. A "weedy" environment will



reduce peoples' preference in terms of attractiveness (Nassauer 1995, Calkins 2012). Moreover, the height and color of plants selected should be considered carefully in order to create a broad visual field for cyclists to ride safely. Tables and seating are key elements that provide a comfortable social environment for consumers of restaurants, cafes, and bars (Landis et al. 2001; Kelly et al. 2011).

Figure 5-6 Section View of Alternative Design 2

Figure 5-7 Plan View of Alternative Design 2



Alternative Design 2: Central civic space for only pedestrians and cyclists

Figure 5-8 Perspective View of Alternative Design 2

Alternative Design 2: Central civic space for only pedestrians and cyclists

Figure 5-9 Perspective View of Alternative Design 2

Figure 5-10 Perspective View of Alternative Design 2

Figure 5-11 Perspective View of Alternative Design 2

5.6 Limitations and Future Research

In this project, an ANOVA was conducted, which revealed statistically significant effects on the preferences for a streetscape design in terms of safety and attractiveness, as well as a combined average evaluation. Such evidence showed that there are some specific design elements that influence people's preferences. This result can influence the streetscape design in the following ways: 1) Street trees are very important to attractiveness streetscape. 2) Native plants could positively influence the visual quality. 3) A one-sided street parking street with wider sidewalks are highly acceptable for all different users. 4) A bike lane is considered as an unsafe element in a high density of pedestrian and vehicle movement area. Physical barriers will make people feel safer if implementing a bike lane in a street.

However, in order to create a more walkable place, further planning and research needs to be conducted. First, a macro-level analysis of Manhattan City needs to be developed further. The connectivity of a sidewalk system and significant destinations within walking distance are important characteristics of walkability. In addition, a qualitative analysis on a micro-level street design is necessary. Although the project shows how the four main design elements (green infrastructure, street-parking, designated bike lanes, and benches) of a walkable space can influence people's preferences in terms of safety and attractiveness, there are more elements, which can influence people's choices. For instance, the number of crosswalks, lights, trees, and so on would positively contribute to a safer pedestrian commute. At a non-signalized intersection, a major type of car-cycle crash is when a cyclist comes from the right and the driver is turning right (Summala et al. 1996). This is caused by the drivers' visual search behavior concentrating on major dangers but ignoring less frequent dangers (Summala et al. 1996). Strategies for diminishing this type of accident, such as having a stop sign, countermeasures, vibrant bicycle path signs, and elevated crossing signs should be considered in street designs (Summala et al. 1996). Furthermore, paving patterns, style, bench arrangements, special configurations, and species of street trees and grasses are important for enhancing the attractiveness of the street (Nassauer 1995, Calkins 2012).

CHAPTER 5 CONCLUSION

Conclusion

Through statistical and quantitative analysis of these preference ratings, it can be seen that multiple aspects of the streetscape design with a large potential for improvement exist. The results of the study showed that green infrastructure, especially street trees, has a significant effect on the safety, attractiveness, and overall mean rating. On-street parking is another important design element that has a significant effect on both safety and attractiveness. From the survey results, it can be seen that people prefer streets with single-sided street parking as the best scenario in terms of attractiveness. However, when considering safety, participants rate street scenarios with only pedestrians as the best. The study is significant to deduce the specific design elements of streetscape, which are most influential for the "sense of place". However, in order to create a more walkable Aggieville district, further planning and research on both the macro-level and micro-level needs to be conducted.

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APPENDICES

APPENDIX I QUESTIONNAIRE

1. Age:

2. Gender

- o Male
- o Female
- o Other

3. How do you usually get to Aggieville?

- o Vehicle
- o Bike
- o Walking

4. Do you consider yourself a cyclist?

- o Yes
- o No

5. Have you biked in Aggieville?

- o Yes, many times
- o Yes, a few times
- o Rarely
- o Never

6. How often do you go to Aggieville

- o More than twice a week
- o Twice a week
- o Once a week
- o Monthly


THE VARSITY TRUCK
SHOT STOP
BUFFALO WILD WINGS
GRILL & BAR


THE VARSITY TRUCK
SHOT STOP
BUFFALO WILD WINGS
GRILL & BAR


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