Walkability analysis for improvement: Prioritizing potential walkability projects in a high-vacancy environment

by

Scott Christopher Randall

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A REPORT

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Major Professor
Sara Hadavi, Ph.D

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Abstract

Neighborhood walkability has been associated with several benefits including Improved physical health, improved mental health and improved social capital. However, many cities have poor walking environments and consequently do not enjoy these benefits. While several walkability analysis tools have been developed to understand and identify walkability challenges, none account for urban vacancy. Furthermore, although these existing tools provide a wealth of data but do not directly support community members, designers and planners in comparing and selecting walkability improvement projects. This project focuses on evaluating walkability in a high-vacancy neighborhood in Kansas City, Missouri for the purpose of exploring the quality of the walking environment in a high-vacancy setting and rating areas of the project site to identify areas in greatest need of walkability improvement. The addition of considerations for urban vacancy add an additional dimension of analysis to provide some adjustment for the challenges of a high-vacancy setting. The framework for this case study is based on the Hierarchy of Walking Needs concept, which postulates that the decision to walk is the result of meeting several types of needs, and that certain basic-level needs must be met before higher level needs. This project focuses on the 2nd-, 3rd- and 4th-level needs which are accessibility (walking infrastructure), safety (safety from crime and traffic) and comfort (level of physical ease and sensory comfort afforded by the environment). GIS mapping and Google Earth were used to analyze the built environment of the project site to evaluate analyze walkability for the development of a tool that will help decision-makers and stakeholders by providing a structure to identify, evaluate and compare potential areas for walkability improvement. This tool, called the Walkability Improvement Prioritization Tool, is intended to help establish priority areas for walkability improvement to optimize the use of limited resources in high- and low-vacancy settings.

WALKABILITY ANALYSIS FOR IMPROVEMENT

PRIORITIZING POTENTIAL WALKABILITY PROJECTS IN A HIGH-VACANCY ENVIRONMENT

SCOTT RANDALL

LANDSCAPE ARCHITECTURE MASTERS REPORT

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This project is the result not only my research but a great deal of support, guidance and encouragement from many others. Many thanks to Professor Sara Hadavi for helping me explore the challenging topic of urban vacancy and taking on the role of Major Professor for this Project. Without her feedback and encouragement this project would not have been possible. Thank you as well to Professor Susmita Rishi and Katie Heinrich for their invaluable input as members of my supervisory committe. I am also grateful to Professor Hyung Jin Kim for his input on walkability evaluation and Professor Howard Hahn for a great deal of technical support with GIS mapping. Finally, a very special thank you to my wife and children for their unwavering support during not only this project but my time at Kansas State.

ABSTRACT

Neighborhood walkability has been associated with several benefits including Improved physical health, improved mental health and improved social capital. However, many cities have poor walking environments and consequently do not enjoy these benefits. While several walkability analysis tools have been developed to understand and identify walkability challenges, none account for urban vacancy. Furthermore, although these existing tools provide a wealth of data but do not directly support community members, designers and planners in comparing and selecting walkability improvement projects. This project focuses on evaluating walkability in a high-vacancy neighborhood in Kansas City, Missouri for the purpose of exploring the quality of the walking environment in a high-vacancy setting and rating areas of the project site to identify areas in greatest need of walkability improvement. The addition of considerations for urban vacancy add an additional dimension of analysis to provide some adjustment for the challenges of a high-vacancy setting. The framework for this case study is based on the Hierarchy of Walking Needs concept, which postulates that the decision to walk is the result of meeting several types of needs, and that certain basic-level needs must be met before higher level needs. This project focuses on the 2nd-, 3rd- and 4th-level needs which are accessibility (walking infrastructure), safety (safety from crime and traffic) and comfort (level of physical ease and sensory comfort afforded by the environment). GIS mapping and Google Earth were used to analyze the built environment of the project site to evaluate analyze walkability for the development of a tool that will help decision-makers and stakeholders by providing a structure to identify, evaluate and compare potential areas for walkability improvement. This tool, called the Walkability Improvement Prioritization Tool, is intended to help establish priority areas for walkability improvement to optimize the use of limited resources in high- and low-vacancy settings.

INTRODUCTION

Research Dilemma

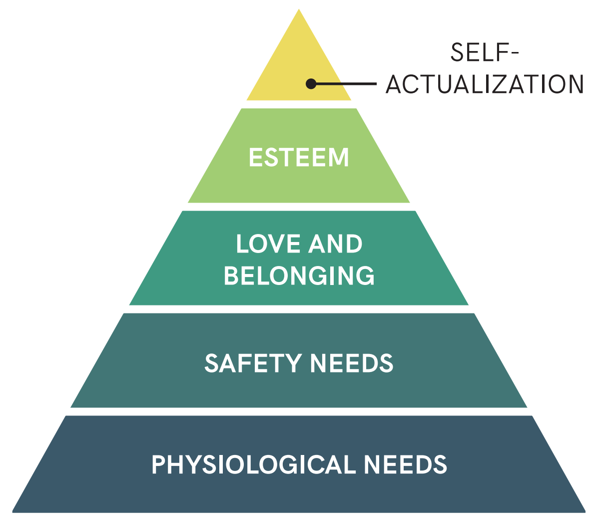
Modern American cities often suffer from poor walkability (Biernacka-Lievestro 2014). While basic, the act of walking is both important and beneficial to urban communities. Strong walkability can have several positive effects on communities, including improvements in public health, transportation, the local economy, and the environment (Al Shammas and Escobar 2019; Lovasi *et al.* 2009). The proliferation of poor walkability environments coincides with another challenge facing many cities: urban vacancy. Of the many factors associated with urban vacancy, walkability is relatively unexplored. Knight (2017) notes that low walkability neighborhoods in Buffalo, New York, are less economically viable. This argument is supported by research conducted in Washington, D.C., showing that a 1% increase in walkability can be associated with a 195% decrease in housing vacancy (Biernacka-Lievestro 2014).

While there are legitimate challenges for pedestrians in many urban environments, such challenges are not easily addressed. Improving walkability can provide notable benefits but it does require financial investment, and funding for improvements is likely to be limited. Due the large scale of walkability problems and the variety of factors affecting those problems, funding and resources need to be efficiently allocated based on the unique circumstances and context for walkability problems for any given location.

Although there is a significant amount of research on walkability, there is little content that explores walkability in high-vacancy settings. A high-vacancy setting offers a unique opportunity to explore the concept of prioritizing walkability projects due to the variety of potential challenges. This research project is based on two primary challenges: identifying walkability challenges in a high vacancy setting and prioritizing such challenges for improvement. This project seeks to use a combination of existing research and frameworks to identify a tool for prioritizing potential walkability improvement projects to optimize the use of limited funds. To effectively create such a tool, some exploration on the issue of identifying walkability challenges is needed as well as a framework for prioritizing those challenges and needs.

Evaluating Walkability

In *To Walk or Not to Walk? A Hierarchy of Walking Needs* (Alfonzo 2005), Mariela Alfonzo proposes that the decision to walk is based on how needs are met. Alfonzo formats this hierarchy based on Maslow's Hierarchy of Needs (Maslow 1943). Maslow's hierarchy proposes that certain basic needs of human existence, such as food and shelter, must be met before social or intellectual needs (see Fig. 1.1). Alfonzo's framework follows this same logic, proposing that the decision to walk requires that the first tier of needs (the ability to walk) must be met before subsequent tiers can be considered. For example, the need for a place to walk must be considered before the need for a safe walk. Alfonzo's framework has been used in several other projects to evaluate walkability and the physical environment (Day 2006; Lovasi *et al.* 2009; Moran *et al.* 2014; Ogilvie *et al.* 2007; Zhu and Lee 2008).

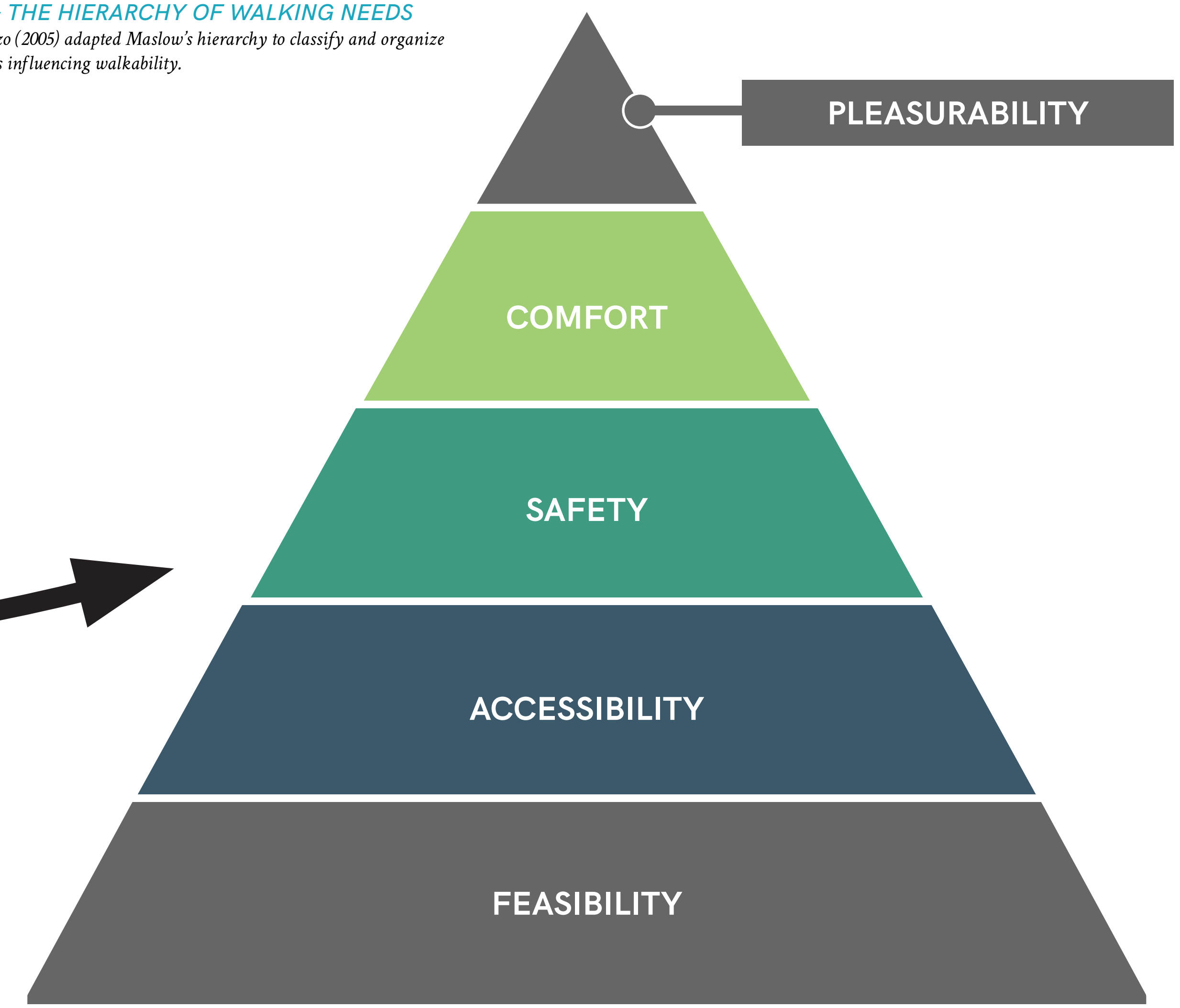


1.1 - MASLOW'S HIERARCHY OF NEEDS

Maslow (1943) proposed that human needs can be categorized in to tiers. Needs on lower tiers of the pyramid must be met before the next tier above can bet met.

1.2 - THE HIERARCHY OF WALKING NEEDS

Alfonzo (2005) adapted Maslow's hierarchy to classify and organize factors influencing walkability.



Research Question

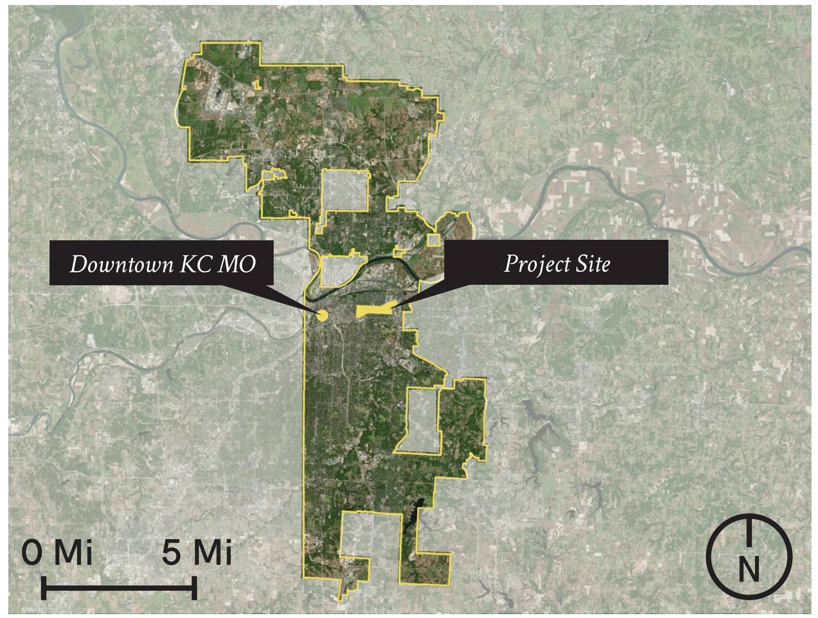
Based on existing research, it is clear that walkability is a complex topic that does not appear to have been extensively researched in the context of high-vacancy settings and that existing research does not focus on prioritizing improvements to optimize the use of limited funding. Therefore, the research question for this project is as follows: How can walkability challenges be organized and prioritized to make use of limited funding in a high-vacancy environment?

Research Framework

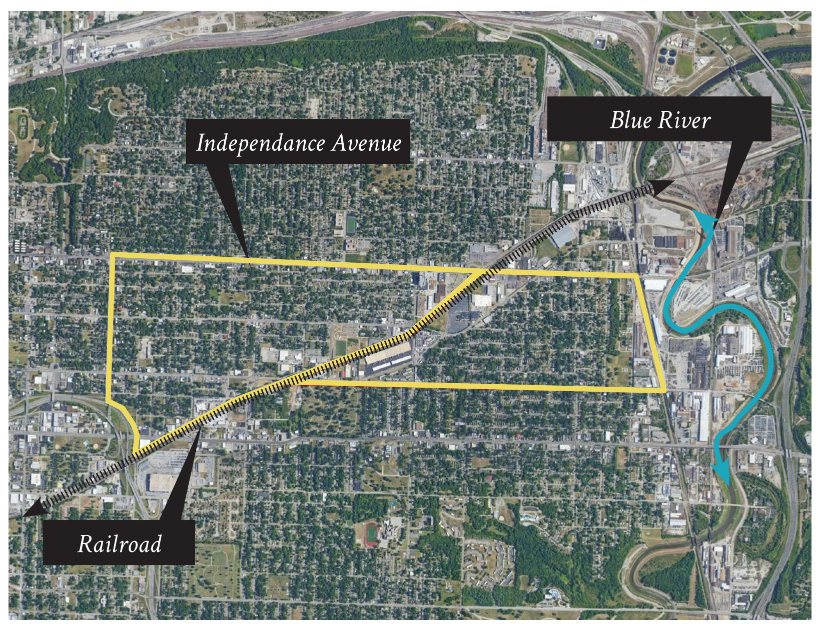
This project examined walkability in a high-vacancy environment to further understand the quality of the built walking environment in a high-vacancy setting, specifically focusing on three of Alfonzo's walkability factors (see figure 1.2): accessibility (available walking network), safety (from crime), and comfort (the quality of walking environment). Understanding the challenges affected by vacancy and those not impacted by vacancy will be important to developing a framework for prioritizing walkability improvement projects. Walkability is an important part of a healthy community. Benefits of walkability include improved community health, stronger local economies, and fewer traffic problems. However, in the context of urban vacancy, it is important to understand how a high concentration of vacant lots influences walkability. Fig. 1 outlines the framework for this study and its exploration of walkability and urban vacancy.

The Project Site

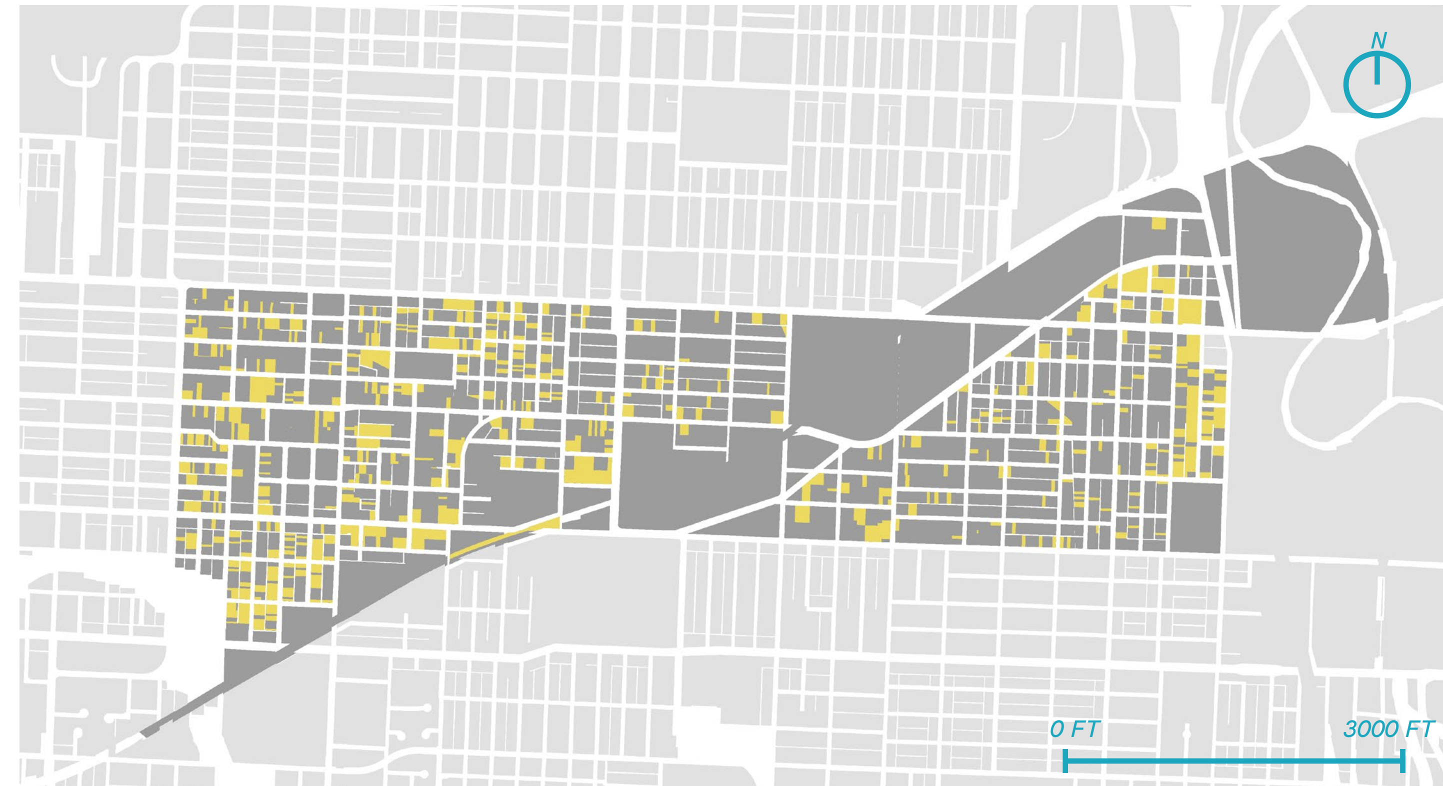
The site for this project is in northeast Kansas City, Missouri. The site is currently experiencing a high degree of urban vacancy. Approximately 20% of the combined residential and commercial areas are vacant, as measured by area and by parcel count. The site faces other challenges such as high crime rates, poor maintenance, and significant poverty. Using Alfonzo's (2005) framework, this project attempted to evaluate specific environmental factors associated with walkability to understand the quality of the pedestrian environment in this high-vacancy neighborhood. See Figures 1.3-1.5.



1.3 - SITE LOCATION
The project site is in a heavily urbanized area of Kansas City, just northeast of the downtown area.



1.4 - SITE CONTEXT
The project site is consists of two neighborhoods- Lykins (west) and Sheffield (East). The site is primarily residential with an industrial zone along the shared border and to the east of Sheffield.



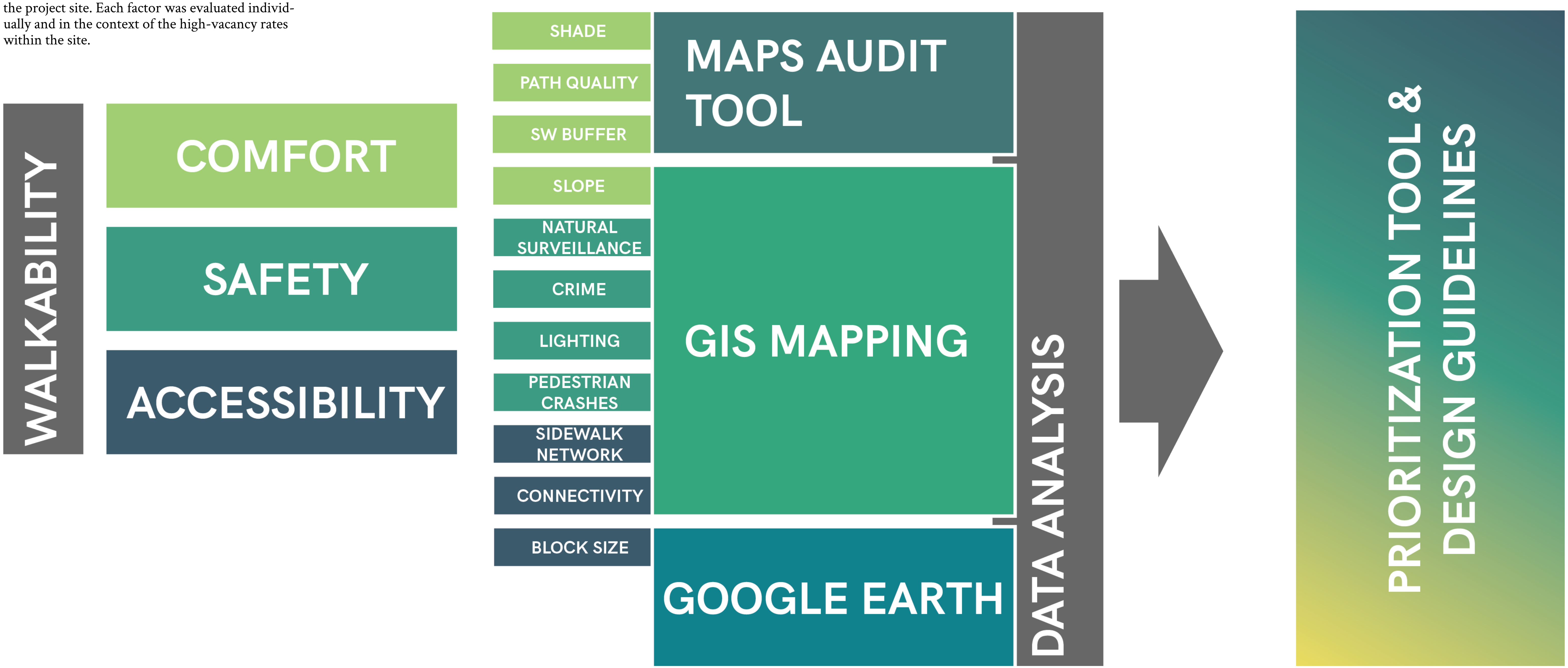
1.5 - SITE VACANCY
The project site is 20% vacant (by both area and lot count) for the residential and commercial zones.

Research Process

After finalizing the research question, a literature review was conducted to identify factors of the urban environment related to walkability. These factors served as the basis for the spatial analysis, primarily through geographic information system (GIS) mapping used to evaluate the walkability of the project site. Each factor was evaluated individually and in the context of the high-vacancy rates within the site.

1.6 - THE RESEARCH PROCESS

The goal was to create design guidelines for walkability in a high-vacancy environment based on spatial analysis and the literature review.



LITERATURE REVIEW

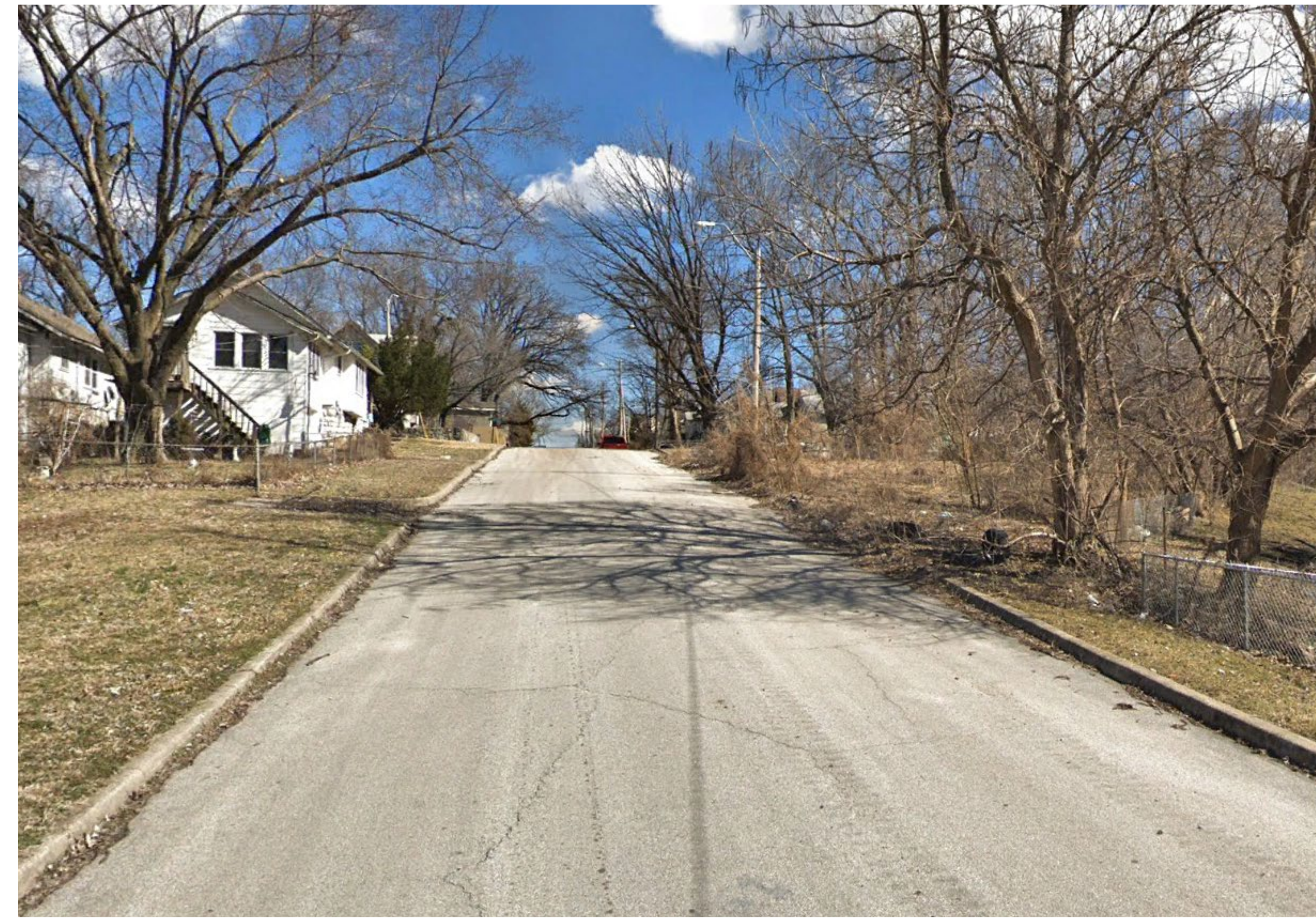
WALKABILITY AND VACANCY

The relationship between walkability and urban vacancy is relatively unexplored, thus one of the purposes of this study is to expand the existing body of knowledge on the relationship between these two complex topics. According to Smigielski (2014), vacant lots present an opportunity to improve factors related to walkability as identified by Southworth (2005), Handy (1996), Alfonzo (2005) and Franzini *et al.* (2010). While vacant lots may provide opportunities for pedestrian environment improvement, the relationship between walkability and vacancy must be better understood. This study will aim to examine the connection between vacancy and each of three major components of vacancy identified by Alfonzo (2005) namely accessibility, safety, and comfort. The first of these factors, accessibility, differs somewhat from the other two in that it may be somewhat more independent from vacancy, or possibility a contributing factor. For example, the presence of sidewalks (or the lack thereof) or barriers to pedestrian circulation may be associated with higher levels of vacancy. Regardless of the connection, the presence of pedestrian infrastructure precedes both safety and comfort- if pedestrians do not walk somewhere because there is no sidewalk, then safety and comfort are irrelevant.

ACCESSIBILITY

Defining Accessibility

Accessibility can be defined as the extent to which the physical environment supports pedestrian activity. For example, the presence of sidewalks and the physical layout of a city and city blocks. Handy (1996) references Hotzclaw (1994) who associates accessibility with continuous grids, street slopes, sidewalks, and traffic control. Parson, Brinkerhoff, Quade, and Douglas (1993) developed a metric called the "pedestrian environmental factor" based on ease of street crossing, sidewalk continuity, grid vs cul-de-sac ratio and topography (Handy 1996). In 1994, Cambridge Systematics examined residential and leisure options within a quarter mile of a given site. This may be an indicator that accessibility is related to convenience. Essentially people want an efficient network. Consequently, a well-connected street network with more intersections and fewer dead ends may be



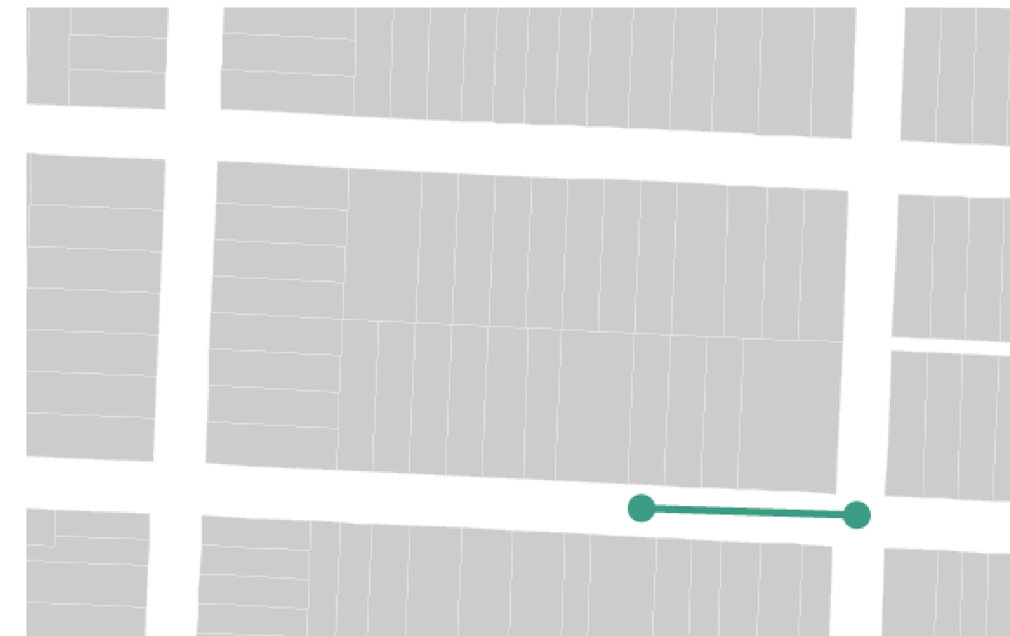
2.1 - A LACK OF WALKING INFRASTRUCTURE

Sidewalks or other paths to walk on are a critical part of walking infrastructure.

a crucial factor in pedestrian access. The presence of sidewalks was also a key factor (Handy 1996). Kitumara (1994) studied San Francisco communities using sidewalk and bike paths as two of their factors in travel studies (Handy 1996), further supporting the idea that the presence of physical infrastructure to support pedestrian activity is critical. A 2002 study used home age as an indicator for the presence of factors contributing to walkability such as sidewalks and densely connected street networks. The study found a connection between older homes (built before 1973) and the likelihood of walking more than 1+ miles 20 times or more per month (Berrigan, 2002). It is possible that these neighborhoods were developed close enough in time to the Federal Highway Act and other policies that have contributed to urban sprawl and the rise of the cul-de-sac. See Figures 2.2 and 2.3 on cul-de-sacs.

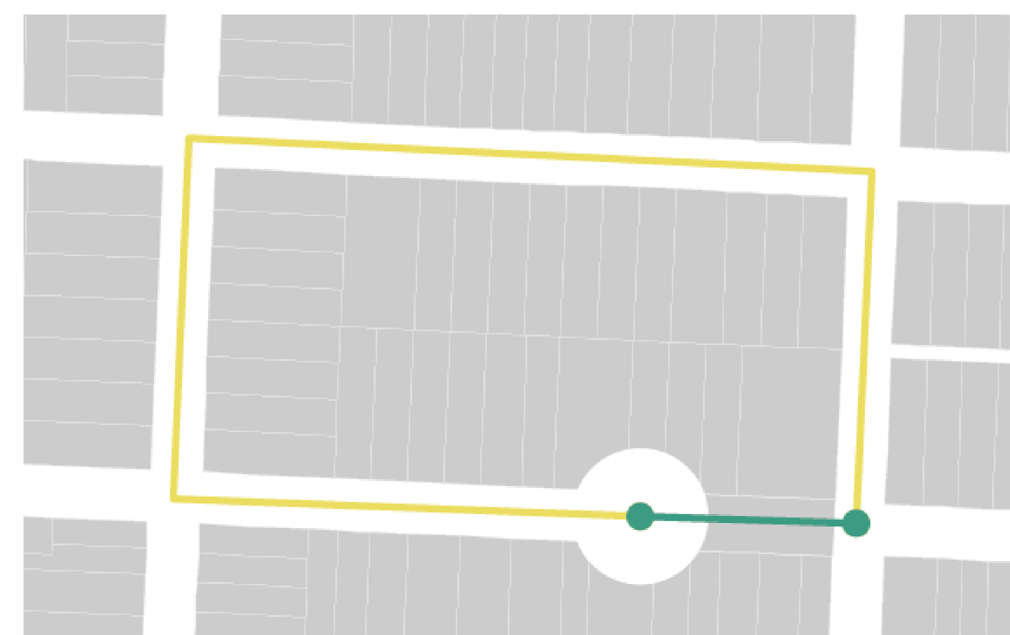
The Role of City Blocks

A 1995 study from the University of California at Berkley compared two neighborhoods. The first was designated as "pedestrian friendly" as characterized by several features, including a well-connected network of sidewalks and mid-block pedestrian paths. A black and white image of the street network shows a dense pattern of small blocks with few dead ends. The second neighborhood was designated as a poor pedestrian environment due to "elongated block faces and circuitous pathways" (Cervero and Radisch 1995). The study found that walking was a more common activity in the pedestrian-friendly neighborhood (10% higher share of non-work trips were walking), suggesting that the completeness of a sidewalk, based on network density and block size, is a critical component to walkability (Singh 2015; McDonald *et al.* 2012; Frank *et al.* 2010). Henson (2000) notes that features that unnecessarily extend pedestrian travel can negatively impact pedestrian walkability.



2.2 - A CLEAR GRID

Regular grids allow for direct access between destinations.



2.3 - CUL-DE-SACS DISRUPT GRIDS

Cul-de-sacs block direct routes and can force pedestrians to take extended routes.

A Network of Walking Infrastructure

Based on earlier research done by Holtzclaw (1994) and Parsons, Brinkerhoff, Quade, and Douglas (1996), the continuity of pedestrian facilities is a critical factor to walkability. The presence of dedicated space for pedestrian activity and movement is likely one of the most basic and vital indicators for pedestrian accessibility. In addition to the existence of a pedestrian network, other physical barriers or attributes that may influence the level of difficulty or physical limitation imposed by landform and urban form should be considered. Parsons *et al.* (1996) also acknowledge the influence of dead ends (specifically cul-de-sacs) as influential factors in the level of pedestrian network accessibility. Cervero and Radisch (1995), Berrigan (2002), and Hotzclaw (1994) each used the concept of network density and dead ends as methods of evaluating the connectedness of a pedestrian network. Furthermore, several more recent studies (Singh 2016; Frank *et al.* 2010) use connectivity measures that include intersection density as measure of pedestrian networks.

Application to the Project

This study focused specifically on the presence of sidewalks, the relative connectivity of the street network (the ratio of dead ends to intersections) and block size. Collectively, these factors can be used to gain insight into where pedestrians may go and the directness of available routes. Block size and relative connectivity are particularly important— high quantities of dead ends and large blocks extend travel routes in ways that are more burdensome to pedestrians than to drivers while smaller blocks and more intersections allow for more efficient pedestrian travel.

SAFETY

Safety related to walkability appears to be related to two primary types of safety: crime safety and traffic safety. The literature in this section is focused primarily on crime and the perception of crime while the pedestrian need for safety from vehicles is intuitive and obvious. Data from the Nation Highway Traffic Safety Administration (2019) shows that pedestrian collisions are a severe problem. From 2008 to 2017, pedestrian

2.4 - ACTIVE SOCIAL SPACES MAY DISCOURAGE CRIME

Socially active spaces such as this park in London, UK, can discourage crime and increase the community capacity to report crimes. (Bye 2016)

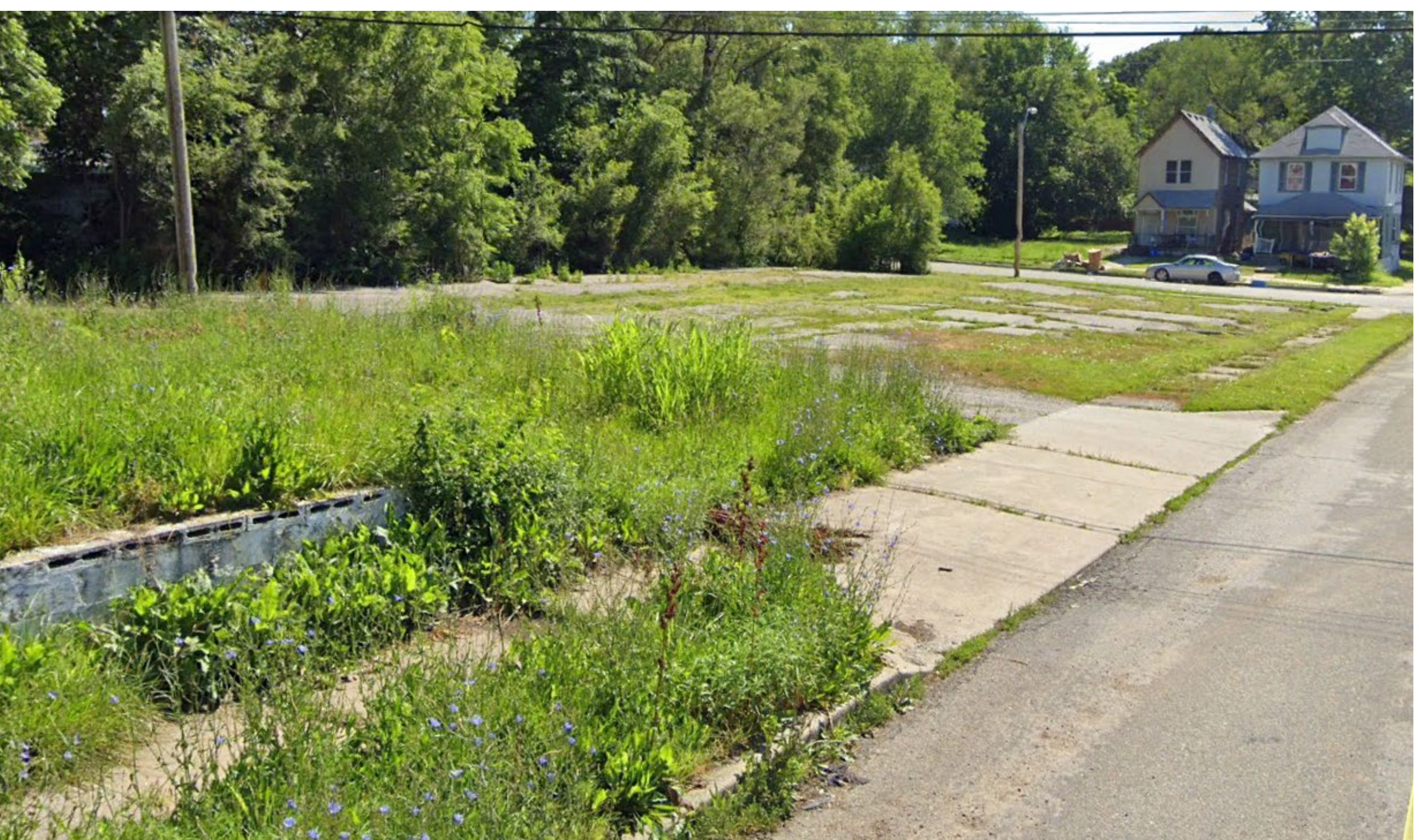
2.5 - VACANT LOTS CAN REDUCE NATURAL SURVEILLANCE

This vacant lot in Lykins represents a gap in programmed space and does not have amentities to support activities and attract users.

fatalities in the United States accounted for 12-16% of all collision fatalities. The total number of pedestrian fatalities in 2008 was 4,414 with consistent increases to approximately 6,000 in 2016 and 2017.

Crime and Walkability

Perhaps one of the most notable and intuitive effects of vacancy on walkability is crime (Handy 1996). High-vacancy neighborhoods are commonly associated with crime (and consequently lower safety). Tiwari (2014) notes that the walking environment is an important part of criminal activity according to the Routine Activity Theory (Foster *et al.* 2010), which maintains that crime occurs between nodes of interest rather than at nodes due to decreased surveillance between nodes. Given that urban vacancy and crime are related occurrences (Branas *et al.* 2012), this connection shows the importance of walkability in urban environments. A 2012 study (Branas *et al.* 2012) overlaid gun assaults, total assaults, and



2.6 - VACANT LOTS CAN REDUCE NATURAL SURVEILLANCE

This vacant lot in Lykins represents a gap in programmed space and does not have amentities to support activities and attract users.

2.7 - GARBAGE DUMPING SIGNALS DISORDER

Litter and garbagde dumping are signs of low social control and may signal that crime is tolerated thereby contributing to crime issues.

vacant properties, finding a significant association between violent crime and vacancy. Furthermore, Space Syntax Theory (Hillier and Hanson 1984) connects urban mobility and reduced levels of crime, further suggesting a negative relationship between walkability, crime and possibly vacancy.

The fear of crime when using public transit discourages the use of public transit, with the greatest risk being the trip between stops (Tiwari 2014). Routine Activity Theory (Foster *et al.* 2010), supports this theory and maintains that crime occurs between nodes of interest rather than at nodes due to decreased surveillance between nodes. Tiwari also notes that the presences of reduced setbacks, night lightings, front porches, natural surveillance, and active land use are associated with a stronger sense of personal safety (per Alfonzo 2005 and Mehta 2008). Potential places of concealment and blocked prospects or escapes are noted to be associated with lower perceptions of safety as well (per Nasar and Fisher 1993).

Space Syntax theory (Hillier and Hanson 1984) proposes that certain environmental factors create settings that attract more activity, including pedestrian and vehicular. The increased levels of activity can influence or even reduce levels of street crime. These environments facilitate elevated levels of movement from place to place within the overall urban setting, thereby increasing the amount of activity. This provides some support for the idea that increased walkability, by way of increasing movement within an urban system, may be able to contribute to a sense of safety and, therefore, increase walkability.

This concept of a negative correlation between crime and street activity is supported by the work of Aiyer *et al.* (2015), which explores factors that increase neighborhood safety in contrast to cues that indicate a lack of safety. Their work proposes that busy streets are generally safer streets by way of improving the social dimensions of a neighborhood, specifically social cohesion, trust, social capital, and collective efficacy (Aiyer *et al.* 2015). This argument ultimately is used to suggest that further research into positive factors would be an important addition to existing work that explores negative factors, specifically Broken Window Theory and Social Disorder Theory. Both of these theories maintain that structural deterioration is associated with a lack of social control, meaning that structural decay in urban environments signals that crime is tolerated in an area, which then attracts crime (Kelling and Coles 1996; Wilson and Kelling 1982). This research can be used to evaluate the safety dimension of walkability through the lens of urban decay: a neighborhood falling into disrepair (Figures 2.6 and 2.7) can be associated with lower safety or lower perceived safety, and therefore be less walkable.

One more factor that can contribute to overall safety is street lighting. While high crime rates are not necessarily attributable to one factor or cause, the presence of street lighting can play a role, both to reduce crime and increase the perception of safety (Nasar and Bokharaei 2017; Farrington and Welsh 2002; Deryol and Payne 2018). One study has even proposed that crime can be reduced by as much as 20% with proper lighting installation (Farrington and Welsh 2004).

This study will focus specifically on the potential for natural surveillance, the presence of crime, and traffic accidents involving pedestrians as indicators of pedestrian safety. These factors are important for at least two reasons. First, crime and natural surveillance influence the perception of safety, which is perhaps as important to walkability as actual safety. Second, these can be indicators of actual safety; areas with recurring crime and pedestrian vehicle collisions are inherently unsafe and therefore reduce the level of walkability. Vacant lots have been associated with increased levels of crime and therefore can be associated with both a perception of decreased safety and actual decreased safety.

COMFORT

The presence of shade on sidewalks has been used as a factor for comfort (Handy 1996). Tree canopies or other forms of cover supply an overhead plane, providing protection from direct sun and precipitation. In a 2009 study, Handy and Ewing used video imagery to study how users perceive the built environment to understand the perception of the physical environment to improve walkability through physical design. The study framework suggests physical features directly influence overall walkability while also indirectly influence walkability through their impact on urban design qualities and individual reactions to a physical environment. These individual reactions included a sense of safety, a sense of comfort, and a level of interest as a direct result of specific physical features or as the result of a cumulative effect of several physical features. The study ultimately concluded that several characteristics of the built environment can be directly associated with walkability. The urban design qualities used in the study were imageability, enclosure, human scale, transparency, and complexity (Ewing & Handy 1996).

2.8 (RIGHT) - TREES CAN INCREASE PEDESTRIAN COMFORT

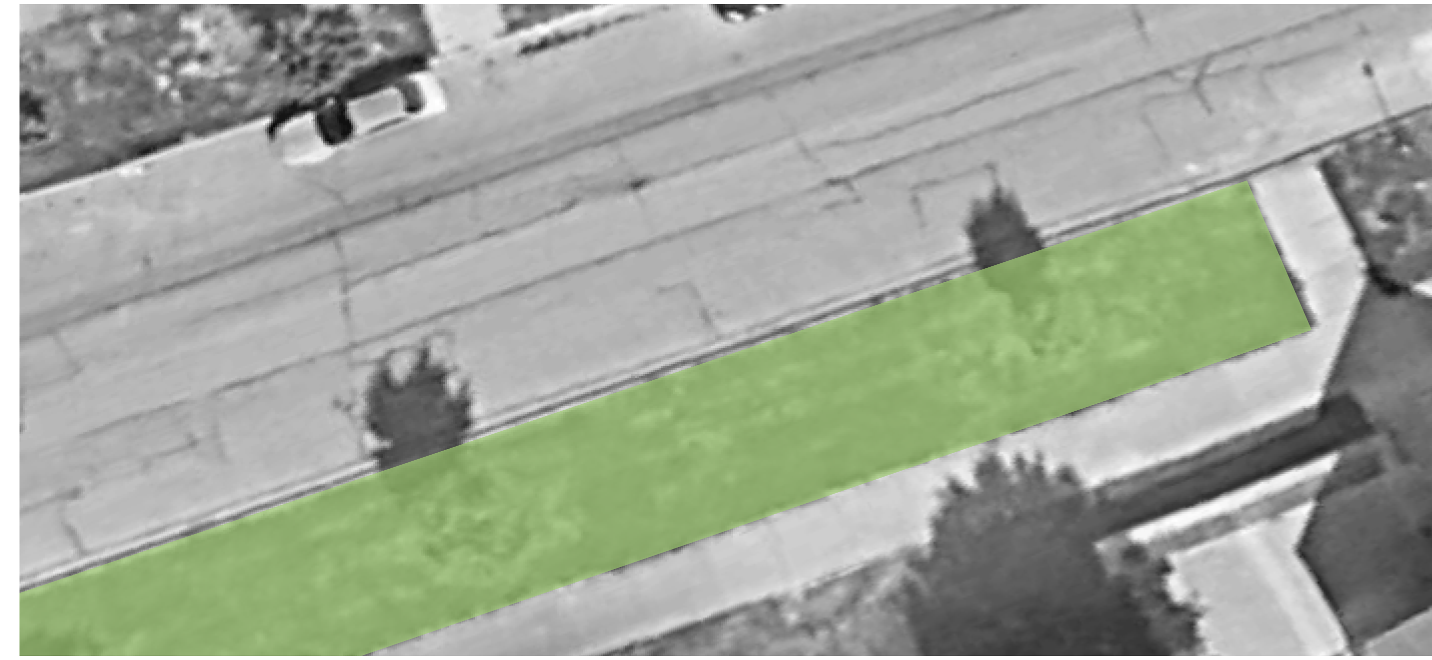
Shade and overhead cover are a valuable amenities for pedestrians, particularly in climates with hot summers or frequent precipitation.

Southworth (2005) describes several streetscape features as contributors to “path quality” that meet Alfonzo’s criteria for comfort. Southworth specifically refers to comfort for pedestrians of a variety of ages and physical capabilities as a critical component of walkability. Specific elements that Southworth lists include trees, wide paths, comfortable slopes and planted buffer areas between cars and pedestrians. Clark and Dornfeld (USFHWA 1994) seem to support this concept of traffic buffering in a study for the United States Department of Transportation. Furthermore, comfort can often be the result of a feeling that certain basic needs are met (Mehta 2014). In this case the effects of buffering spaces can be a form of shelter in the sense that street trees and buffer spaces provide a sense of shelter from the noise and movement of traffic. The presence of street trees seems to become particularly important to comfort as it supplies shelter from multiple uncomfortable environmental factors including weather and traffic (Mehta 2014).

This study focused primarily on slope and sidewalk quality, including shade (from both trees and structures), physical path condition and traffic buffering. Street tree canopies provide shade, a sense of spatial definition and improve the aesthetics of pedestrian environments, creating an overall more comfortable experience. Slope is an intuitive contributor to pedestrian comfort or discomfort. While slope is not necessarily influenced by urban vacancy, steep slopes can create a formidable barrier for pedestrians and should be accounted for when evaluating overall walkability.

WALKABILITY ANALYSIS TOOLS

A variety of tools have been developed for analyzing pedestrian walkability. These tools vary with regards to which specific streetscape features are measured. Existing tools generally account for infrastructure, safety, comfort, and aesthetics. Some specific common streetscape features measured or noted as part of these tools include trees, buffers, path quality, passive surveillance, pedestrian crossing features, path width and the presence of debris or garbage (Aghaabbasi *et al*, 2018). Three examples are reviewed in this chapter. However, there are no existing tools that account for vacancy.



2.9 WIDE BUFFER

A wider park strip creates more space between vehicles and pedestrians and provides a better setting for trees and pedestrian ameneties.

0′ 50′ N

2.10 MINIMAL BUFFERING

Small buffers or a lack of buffering can be uncomfortable and even dangerous for pedestrians. On-street parking can provide a physical barrier but does not afford shade or other physical comforts for pedestrians.

0′ 50′ N

Microscale Audit of Pedestrian Streetscapes (MAPS)

MAPS is an extensive audit tool that focuses both on analyzing pedestrian routes as whole entities comprised of several street segments and individual segment-based analysis. There are three main variations including a full version, an abbreviated version, and a "quick" version. The MAPS audit tool focuses on path quality, street corridor definition, shade, bicycle lanes, street crossing amenities, social features, and aesthetics. The tool is scored based on individual component assessment and groups of components called sub-scales. This is a robust tool that includes considerations for the top four levels of the Hierarchy of Walking Needs framework (K. Cain et al. 2012; K. L. Cain et al. 2014; Millstein et al. 2013).

Walking Suitability Assessment Form (WSAF)

This audit tool focuses on transportation and infrastructure such as traffic factors (volume, lanes, speed), sidewalk continuity and conditions, intersection walk signals, and lighting. As the name suggests, this audit is generally focused on what the Hierarchy of Walking Needs considers as accessibility (Emery *et al* 2003)

Pedestrian Environment Data Scan (PEDS)

PEDS is a segment-based analysis that divides into four main sections: environment (land use, slope, cul-de-sac), pedestrian facility (sidewalk presence and quality), road attributes (lanes, speed, etc.), and walking/cycling environment (includes safety, enclosure, wayfinding, lighting and amenities). This tool addresses elements of each of the upper four tiers of the Hierarchy of Walking needs and is moderately complex, longer than the abbreviated MAPS tool and shorter than the full tool (Aghaabbasi, *et al* 2018; Clifton, Livi, Smith, and Rodriguez 2007).

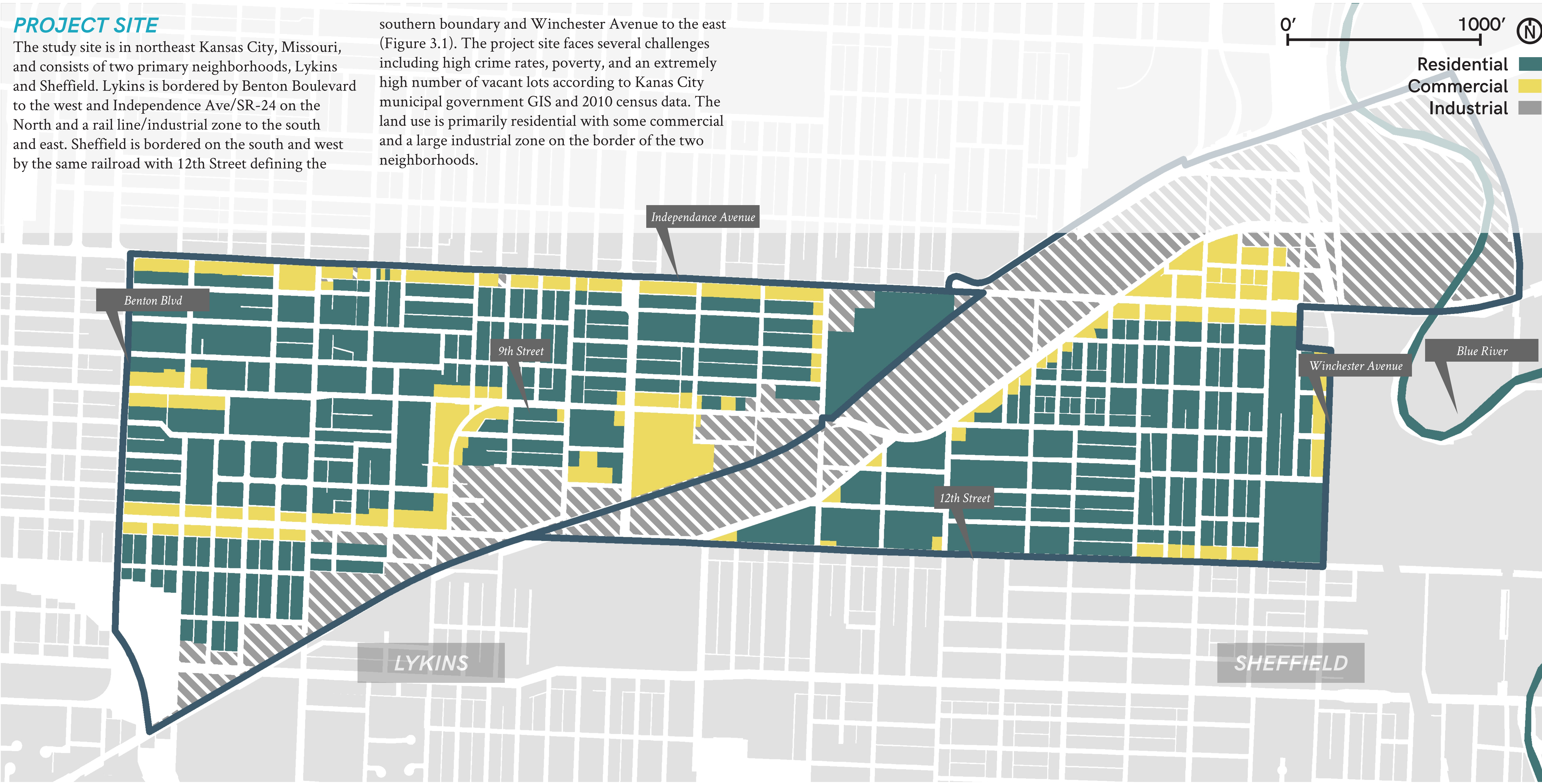
Walkability Tools for Improvement

While many existing walkability tools can be very useful for understanding the walking environment, and thus inherently useful for improvement, they do not necessarily provide a structure for identifying and prioritizing potential improvements or areas for improvement. This is not necessarily a shortcoming, but a potential area for an expanded role for walkability audits.

METHODS

PROJECT SITE

The study site is in northeast Kansas City, Missouri, and consists of two primary neighborhoods, Lykins and Sheffield. Lykins is bordered by Benton Boulevard to the west and Independence Ave/SR-24 on the North and a rail line/industrial zone to the south and east. Sheffield is bordered on the south and west by the same railroad with 12th Street defining the southern boundary and Winchester Avenue to the east (Figure 3.1). The project site faces several challenges including high crime rates, poverty, and an extremely high number of vacant lots according to Kanas City municipal government GIS and 2010 census data. The land use is primarily residential with some commercial and a large industrial zone on the border of the two neighborhoods.



DATA COLLECTION AND ANALYSIS APPROACHES

Random sampling

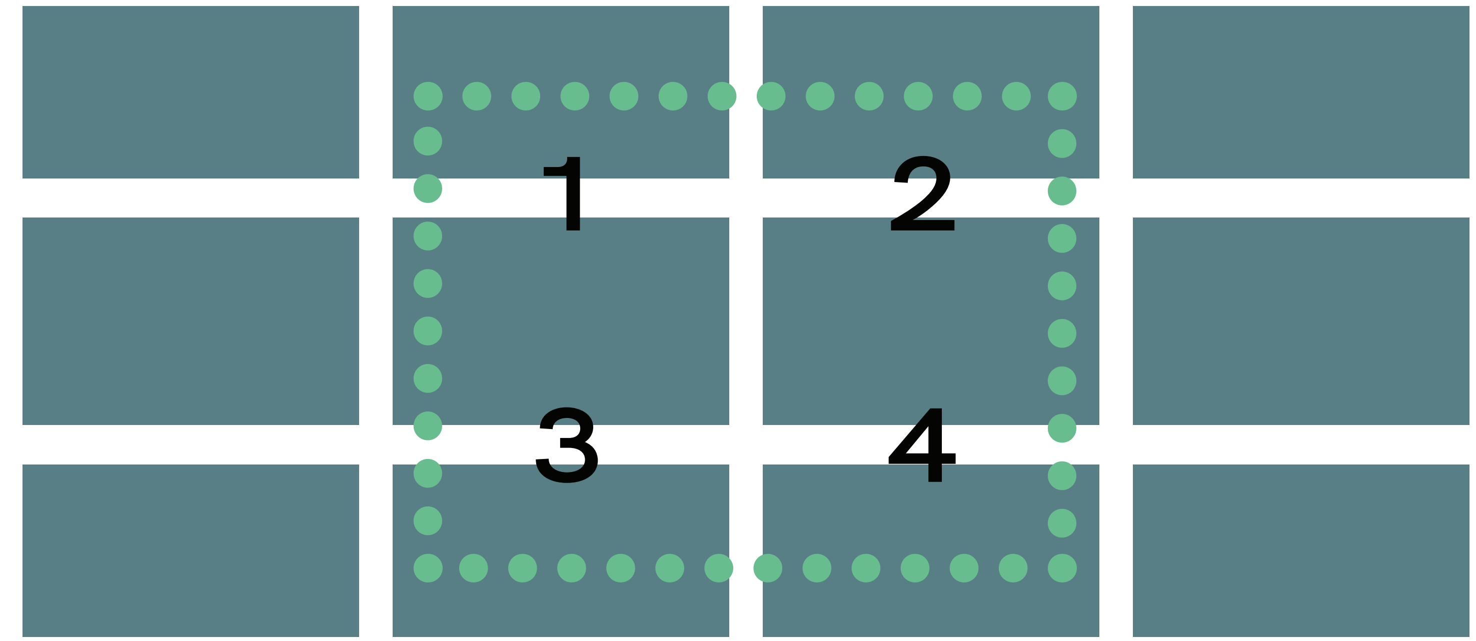
Data collection primarily used Kansas City municipal government GIS data with some use of Google Earth street view and aerial imagery. Data analysis was conducted using map layering and a combination of measurements to calculate ratios such as connectivity index (an indicator of what this study refers to as accessibility) and comparative natural surveillance ratings.

For some evaluation categories, random sampling was used rather than comprehensive evaluation due to time constraints. Street segments were selected for evaluations as follows:

- Street segments were grouped into two major categories: north-south streets and east-west streets.
- Street segments were grouped into fours within each category.
- One street from each group was randomly selected for evaluation. One-quarter of all street segments were evaluated for a total of approximately 80 streets (Figure 3.3).

This method was used to select a sample of streets evenly distributed across the site and to ensure that a similar percentage of east-west and north-south streets were selected. The sample size as a percentage of the total population exceeds the sample size used by Maddock *et al.* in a 2011 study.

Data collection, particularly data collected on randomly sampled street segments, excluded areas zoned for industrial use. These areas are not generally intended for public recreation or use



3.2 - STREET SELECTION METHOD

East-west streets were organized into groups of four. The groups were numbered and the segments within each group were numbered and one segment from each was slected. (Randall 2020)

3.3 - RANDOMLY SELECTED STREET SEGMENTS

and do not have dwellings or residents. It is important to note that industrial zones do influence the urban fabric and walking experience despite their exclusion from this study.

VACANCY

Vacancy was measured using GIS parcel and vacancy data from the City of Kansas City. Block area totals were calculated by adding the area of each parcel on each block. The total area of vacant lots on each block was then calculated to determine the total vacancy rate (by area) of each block. Vacancy was measured by area rather than parcel count (i.e. the percentage of vacant parcels on each block) due to the emphasis on spatial analysis in this project. The impact of a single small lot is presumed to be less than the impact of a large lot or a group of small lots.

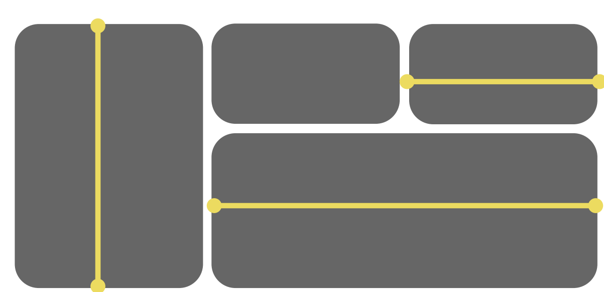
ACCESSIBILITY

The sidewalk network data was collected using shapefiles from the City of Kansas City database and verified with Google Earth street-view imagery when necessary. The verified sidewalk data was used to measure block size and network density. Block size used by Henson, 2000 and Dill, 2004) was measured based on the longest side of a block. To further measure site accessibility, the sidewalk network was analyzed using the connectivity index (also known as link-node ratio) (Bjornstad *et al.* 2017; Dill 2004). Link-node ratio is measured by dividing the total number of links (segments of sidewalk between nodes) by the total number of nodes (intersections of three or more streets). This is a general measure of pedestrian connectivity within the site. These scores can range from 0 (no intersections/no connectivity) to 2.5 (a perfect grid) (Bjornstad *et al.* 2017). The steps for calculating accessibility were as follows:

Sidewalk Network (Entire site)

- Collection City of Kansas City Sidewalk data via GIS shapefiles
- Analysis of gaps in sidewalk network for patterns or major gaps

Block Size (Entire site)



3.4 - BLOCK MEASUREMENT
Blocks are measured on the longest side.

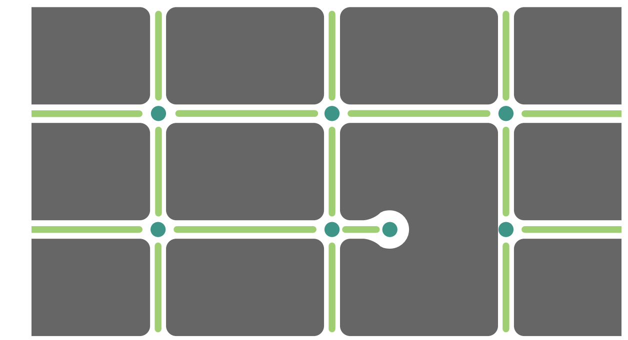
Blocks were measured using Google Earth and the Google Earth measurement tool. (See Figure 3.4)

Block sizes were noted in an Excel spreadsheet and compared to optimal numbers found in previous studies and articles.

Connectivity Index/Link-Node Ratio (Entire site)

GIS shapefile data from the City of Kansas City for road centerlines was acquired.

- The number of nodes was counted (intersections and dead ends/cul-de-sacs) in the project boundary
- The number of links was counted (street segments between two adjacent nodes, see Figure 3.5)
- The number of links was divided by the number of nodes (VDOT 2019)
- Analysis and discussion were based on resulting ratio and other research and articles. (connectivity index score) to planning standards



3.5 - CONNECTIVITY
Links (green) and nodes (blue) are counted. Links are divided by nodes. The higher the result, the more connected the area.

The accessibility measurements are intended to provide a general understanding of how the current infrastructure, consisting of city blocks, streets, and sidewalks, supports pedestrian activity.

SAFETY

Safety from crime was evaluated based on the “natural surveillance” concept, as noted by Tiwali (2014) and Foster *et al.* (2010), reported crime, street light distribution and traffic collisions involving pedestrians. Natural surveillance has been measured and studied by several scholars (Fujii, Fujikawa and Oikawa 2012). This concept effectively proposes that surveillance from buildings is associated with reduced crime. While it would be impractical to attempt to gauge the number of people in each building at a given time, GIS-mapped census data on population density and average household size is readily available. This information was used as a general indicator of the number of people available on a block to witness and report crimes. Per Busy Streets Theory (Aiyer *et al* 2015; Heinze *et al* 2018; Rupp *et al* 2019) the number of people in an area can be inversely correlated with crime levels as more people are available to witness and report crimes, thereby deterring the open occurrence of crime. It is important to acknowledge that crime data is only available as reported to the police. The actual levels of crime may differ but cannot be accurately measured with available information.

The methods for mapping and analyzing the safety data for natural surveillance, crime, lighting, and pedestrian collisions are as follows:

Natural surveillance potential (Randomly sampled blocks)

- Neighborhood block census data GIS files from the City of Kansas City were collected.
- The reported population of blocks to the north/south or east/west of street segments were recorded in an Excel file.
- The average population of the blocks associated with each street segment was calculated, resulting in an estimate of potential natural surveillance for each street segment compared to other street segments within the site.

Crime (Entire project site)

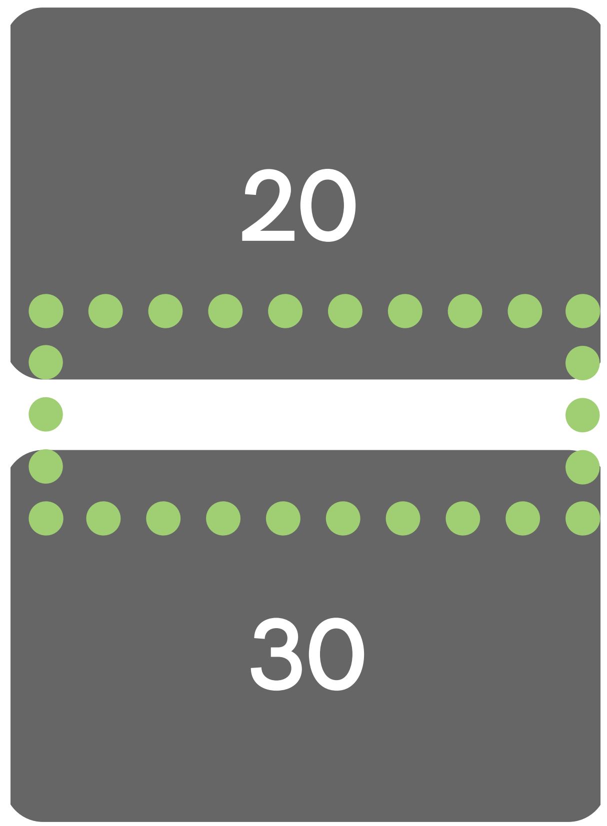
- Crime occurrence will be mapped using Kansas City GIS shapefile data.
- Crime occurrence maps were overlaid onto vacant lot maps to find correlations between vacant lots and crime occurrence.

Lighting (Entire project site)

- Lighting was mapped using Kansas City GIS shapefile data.
- The distribution of streetlights was evaluated to find gaps and/or patterns.

Traffic accidents involving pedestrians

- Traffic accidents involving pedestrians were mapped using GIS data from the Missouri State Highway Patrol.
- Maps were reviewed to look for patterns and identify potential high-risk areas for pedestrians.



3.6 - NATURAL SURVEILLANCE

The average of the top and bottom blocks is 25 ((20+30)/2 = 25)). 20 and 30 represent the population of their respective blocks per Kansas City block census data.

COMFORT

This study evaluated comfort in two ways: path quality (Alfonzo 2005; Mehta 2014; Southworth 2005) and slope (Alfonzo 2005; Southworth 2005). Path quality was measured using factors such as the quality of the sidewalk, the presence of overhead cover (including street trees), and the presence of buffers from traffic. This evaluation was conducted using a modified version of the abbreviated MAPS survey, developed for auditing the built environment to analyze walkability and perceived suitability for walking. MAPS has been used in a variety of studies and by a variety of authors (Cain *et al.* 2012; Cain *et al.* 2014; Millstein *et al.* 2013; Ussery *et al.* 2019; Zhu *et al.* 2017). See Appendix A for details. Lee *et al.* (2013) and Huang (2000) note the importance of traffic buffers.

Finally, GIS shapefiles from the City of Kansas City were used to evaluate slope. Slopes were mapped and categorized into three categories: ADA accessible (slopes 5% and under), steep slopes (5-10%) and very steep slopes (above 10%).

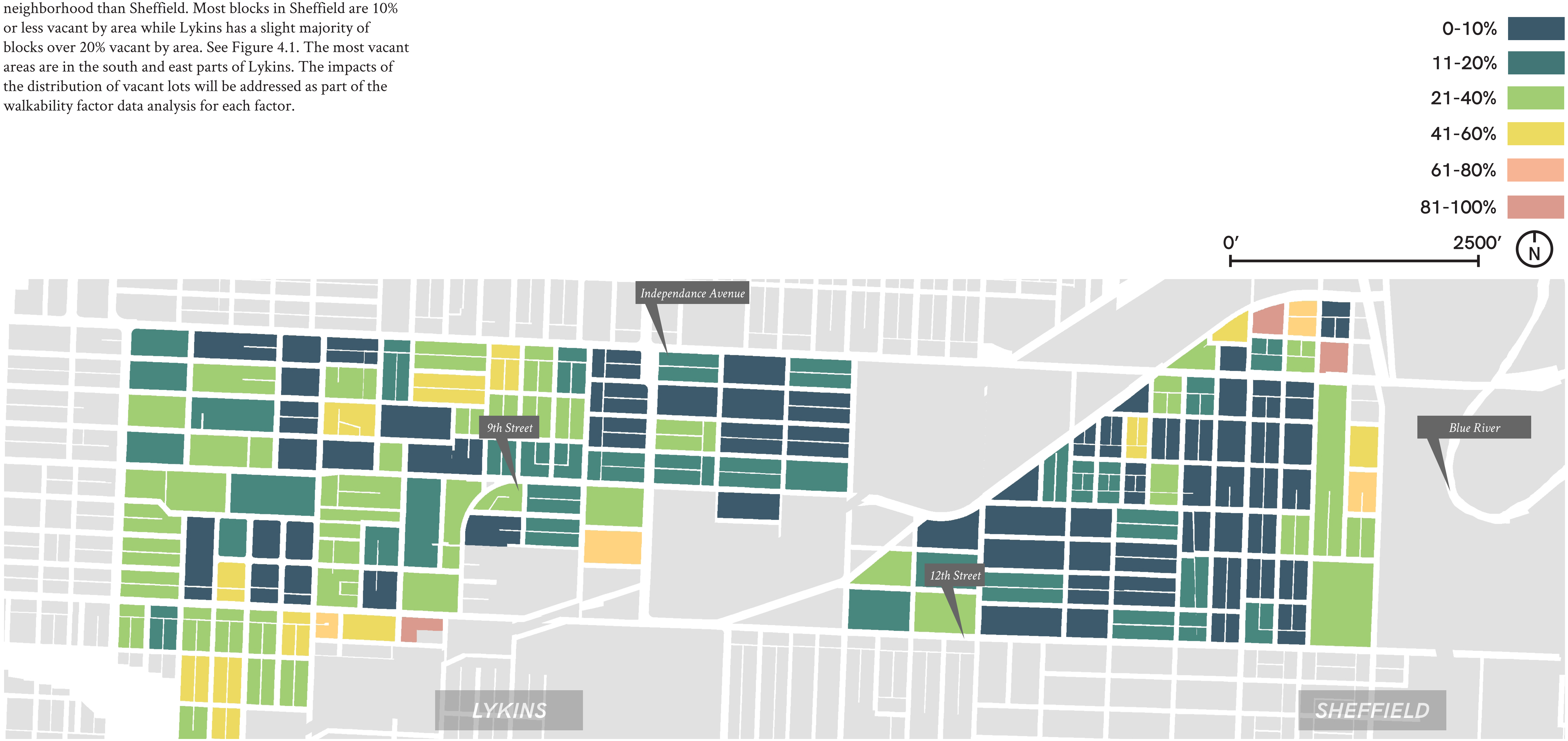
DATA ANALYSIS & RESULTS

VACANCY

Vacancy appeared to be generally higher (by area) in the Lykins neighborhood than Sheffield. Most blocks in Sheffield are 10% or less vacant by area while Lykins has a slight majority of blocks over 20% vacant by area. See Figure 4.1. The most vacant areas are in the south and east parts of Lykins. The impacts of the distribution of vacant lots will be addressed as part of the walkability factor data analysis for each factor.

4.1 - VACANCY BY AREA

Vacancy as determined by dividing the total area of vacant lots on a block by the total area of all lots on a block.



ACCESSIBILITY

Sidewalk network

In both the Lykins and Sheffield neighborhoods, the sidewalk network is generally continuous based on GIS mapping from the City of Kansas City. While minor gaps are present on every block, these small gaps of a few feet are almost always driveways, which are marked as a separate surface in the GIS files. There are, however, a handful of major gaps where the majority or entirety of a block is completely lacking a sidewalk on at least one side of the street. Major gaps are defined as gaps that span the length of at least one lot (driveway gaps are generally very small and span only a fraction of the lot's width or length). In nearly every instance of a major gap, there is at least one vacant lot that spans half the gap or more in the sidewalk network. In one case, the sidewalk gap is almost perfectly aligned with the boundaries of the vacant lot (or contiguous group of lots). In most of the cases of major sidewalk gaps, the sidewalk dead-ends into a thicket of shrubs or trees, creating a dense barrier for pedestrians that would require them to walk in the street or cross to the other side.

Given that the majority of street segments have a sidewalk on both sides of the street, and also segments with no sidewalk on either side of the street are very rare, it appears that the sidewalk infrastructure is generally well distributed and that pedestrians generally have somewhere to walk on most streets. While there are some extensive gaps in the sidewalk network, it seems that these can be avoided by crossing the street. Furthermore, since most of the gaps are on small residential streets that likely experience relatively little traffic, these gaps generally do not present a significant barrier to overall pedestrian circulation within the two neighborhoods. It appears that resources would be better spent on improving sidewalk quality rather than extent, although there are a few exceptions where new paving may provide noticeable benefit, particularly in the case of large blocks lacking a mid-block pathway or on streets with no sidewalk on either side of the street (Figure 4.2).

4.2 - SIDEWALK NETWORK

Sidewalk cover is extensive with only a few major gaps, generally near clusters of vacant lots.

Connectivity
Connectivity is a general measure of how well-connected an area is in terms of dead ends (generally cul-de-sacs) and intersections. Dead ends decrease the level of connectivity within a site by generally extending the distance of trips both within a given geographical area and trips to leave the area. Neighborhoods or other geographic areas with high connectivity have a more pedestrian-friendly block structure because they allow for shorter, more direct routes to given destinations, which in turn reduce the need for vehicular travel.

Connectivity in Lykins and Sheffield
Calculating connectivity is a straightforward process. A connectivity rating is the ratio of street segments (also called links) to the sum of nodes (intersections) and dead ends. A perfect grid has connectivity index of 2.5. A ratio of 1.4 or higher is generally considered healthy (Bjornstad et al. 2017). With a ratio of 1.63, the combined area of the Lykins and Sheffield neighborhoods can generally be considered well connected. Although there are no dead ends in the residential and commercial zones, there are several three-way intersections that lower the score below the maximum of 2.5. However, as previously stated, the overall connectivity of this area can be considered relatively high, indicating that generally speaking, pedestrians can take fairly direct routes to destinations in terms of being unencumbered by dead-ends forcing the use of longer routes.

Considering the high connectivity of the site, it does not appear that vacant lots are related to lower connectivity. Based on a "heat map" showing concentrations of vacant lots, two of the largest hotspots for vacant lots are in areas with perfect grids of four-way intersections. It is possible that the higher levels of access to areas with high connectivity are less preferable and therefore more likely to be abandoned and become vacant.

Block length
Block size in the project generally ranged from 270 feet to 860 feet with two outliers of 1030 and 2600 feet. The mean block size for the 154 observed blocks was 533 while the median was 460 and the most common was 420. Given that good pedestrian network blocks are around 350 or less, the average of 533 can be considered poor, with only slight improvement at 516 feet if the two largest blocks are excluded. These large blocks generally represent barriers to pedestrian mobility by extending pedestrian travel routes in a similar fashion to cul-de-sacs, thereby providing some incentive for vehicular use and overall decreasing the quality of the pedestrian network. While there are several blocks 350 feet or less in length, these represent just under 10% of the total population of blocks with approximately 9% of blocks measuring between 350 and 400 feet, meaning that approximately 80% of all blocks on the site are over 100 feet longer than the recommended length for pedestrian networks.

It is also important to note that the large blocks may reduce benefits from the generally high connectivity in the project site. While the connectivity index suggests that the site is well connected, the large blocks increase the distance between pedestrian nodes, unnecessarily lengthening the walking distance between destinations similar to the effect of dead ends.

These large blocks are not necessarily unique to a high-vacancy environment, but they may be more impactful. As noted in the crime analysis section, crime is a general problem on the project site, particularly in low-density areas such as industrial blocks and portions of the site with high concentrations of vacant lots. While block size is likely not a direct cause of crime, it may be a contributing factor to the decision to not walk for pedestrians. Mitigating the impact of large blocks could help improve pedestrians' chances of walking and thereby increase pedestrian activity in certain areas of the neighborhood. While the impact on crime rates may be negligible, increased pedestrian activity could still provide other health and social benefits for neighborhood residents.

It is also interesting to note that some of the relatively smaller blocks on the site also coincide with higher concentrations of vacant lots, however, there are also clusters of smaller blocks with lower concentrations of vacant lots, suggesting that in this site there is no easily discernable correlation between block size and vacancy.

SAFETY

Crime

Crime mapping of reported crimes in 2019 (Figure 4.3) generally shows an even distribution in terms of locations where at least one crime was reported. Crimes of various natures occurred in most areas of the site, although several locations were the site of multiple crimes creating a variety of "hotspots" (Figure 4.4) where crime appears more likely to occur. The most active hotspots appear to be along Independence Avenue or in areas with lower concentrations of vacant lots, suggesting that higher concentrations of people or residents can be associated with higher levels crime. It is important to note, however that this may be a function of the way the data were collected. This data set includes only reported crimes, and therefore the association between crime and vacancy may be the result of higher concentrations of people to witness and report crimes rather than an actual higher occurrence of crime in lower-vacancy areas.

4.3 - REPORTED CRIME (2019)

Crime is generally present in most areas of the site. Approximately 50% occurred during the day and approximately 50% at night. Data from Kansas City, MO Policde Department.

A total of 1,247 crimes were reported in 2019. Approximately, 25% of crimes (314) reported were assault while theft (including auto theft), robbery and burglary accounted for approximately 22% of crimes (276). Drug possession/sale/distribution accounted for 4.7% of crimes (59) and nearly 14% of crimes (174) involved a firearm. Other notable crime information includes seven homicides, 16 sex offenses (rape, sexual abuse, assault, etc.), 10 kidnappings, and five reports of arson. See Figure 4.5.

The lower activity hotpots and locations where a single crime has been committed are more evenly distributed throughout the residential areas. The distribution of moderate hotspots suggests that the site in general can be considered unsafe in terms of crime risk, particularly when considering that there are also possibly a number of unreported crimes, particularly in high-vacancy areas with fewer potential witnesses. In summary, vacancy may affect safety by making it more difficult to report crimes, particularly if vacant lots are creating blind spots where crimes can be committed with less or little fear of being caught or reported. Larger lots, especially deep lots, may provide darker areas with reduced visibility making observation difficult.

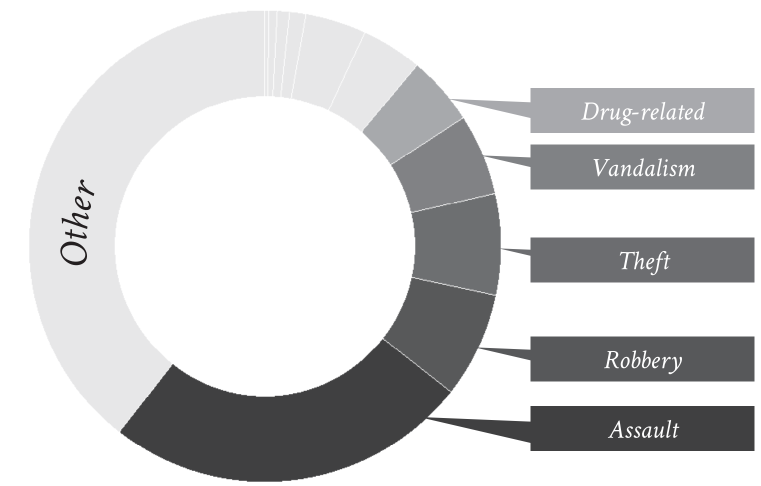
4.4 (BELOW) - REPORTED CRIME: HOT SPOTS (2019)

Crime is generally present in most areas of the site. Approximately 50% occurred during the day and approximately 50% at night. Data from Kansas City, MO Policde Department.

Vacant Lot

Low High

0′ 2500′ N



4.5- CRIME TYPE BREAKDOWN

Traffic accidents

From 2014 through 2018, there were a total of 28 pedestrian traffic accidents with several occurring on Independence Avenue (the north boundary of Lykins) including two fatalities. 9th street was the other street with a higher number of incidents during this period. The distribution of pedestrian collisions around Independence and 9th may be the function of several factors including inadequate buffer zones, higher traffic volumes (both pedestrian and vehicular) and the higher speed limits. Regardless of cause, this indicates that the pedestrian environment is safest around the interior areas of the site and most dangerous near the busiest roads.

It does not appear that vacant lots are a significant factor in pedestrian crashes. While some higher vacancy areas have crashes, a relatively similar number can be seen in low-vacancy areas of the site. Considering the small sample size, it does not seem possible to draw any significant conclusion on the impact of vacancy in pedestrian crashes (See Figure 4.6).

4.6 - PEDESTRIAN TRAFFIC COLLISIONS

Pedestrian collisions are most common along Independance Avenue and 9th Street with very few in the interior of the site.

Natural surveillance

The natural surveillance measurements (Figure 4.7.) may be most useful as an indirect indicator for other factors in this study. For example, these measurements, which are intended to estimate the number of people living on a given street segment, may be used to identify areas were crimes are less likely to be reported. Busy Streets theory (Aiyer *et al.*, 2015; Heinze *et al.*, 2019; Rupp *et al.*, 2019) proposes that increased positive activity on a street can provide positive community impacts, including the potential to reduce crime through improved social control. The relationship with between vacancy and natural surveillance is straightforward Each vacant lot on a block or street reduces the potential for natural surveillance and social activity. As vacant lots become occupied or programmed, the potential for natural surveillance will increase.

4.7 - NATURAL SURVEILLANCE

Lighting

Lighting is distributed very evenly across the site with a row of lights on one side of every street and very few gaps (See figure 4.8). These gaps tend to coincide with either sidewalk gaps or large open green spaces. Nearly all vacant lots are lit as well as occupied lots. Perhaps the primary limitation of the available lighting information is that it only includes streetlights. Given the high number of vacant lots, it would be useful to obtain data on other lighting to understand the degree of light on residential buildings businesses and vacant lots, particularly given that dark vacant lots could create a sense of unease for pedestrians after dark.

When compared with the distribution of crimes, it appears that the effect of lighting is somewhat limited given that crime is present to some degree in most of the site. This could show that the lighting does not provide adequate cover or that crime is simply so prevalent in the general area that even with the benefits of even lighting distribution that crime will still happen. Regardless, it appears that more lighting may not be the most effective use of resources given the more common walkability deficiencies found in other categories of analysis, both safety- and non-safety-related.
Lighting and vacancy may be somewhat correlated based on this mapping, though as noted there are very few gaps in the network. However, the two notable gaps are both aligned with areas where vacant lots appear to have overgrown a previously existing street boundary. In this case it may appear that lighting in undeveloped, cleared, or overgrown vacant lots is either removed or not installed.

4.8 - STREET LIGHTING

Most streets have lights on at least one side of the street. Some undeveloped/ vacant lots create small gaps in the light coverage.

Vacant Lot

Street Light

0′ 2500′ N

COMFORT

MAPS Evaluation

Aside from non-existent bike infrastructure, the tree subscale was the lowest average score, suggesting that the most common comfort deficiency is a lack of overhead cover from either trees or structures. Over half (56%) of all segments measured had 25% or less cover from trees. No shade structures were found. 40% of segments had between 25% and 75% tree cover, though most were 50% or below (Figure 4.9). Tree cover was inconsistent (in some cases non-existent) on 91% of all segments measured. Considering the generally uncomfortable temperature and humidity levels in Kansas City during summer months, the poor shade coverage could be a strong discouraging factor in the decision to walk or drive. Despite the high shade coverage scores for certain segments of the site, the general lack of continuity may discourage longer walking trips and encourage vehicle use across most of the site.

Comparing the tree scores to vacancy suggests some degree of relationship between vacancy and tree qualities in that tree scores in the areas with the highest concentrations of vacant lots generally do not have tree scores above 60% with the majority of segments falling to 40% or lower. It is difficult to make a strong statement, however, considering that this holds true for most of the site, but the general trend appears to indicate that trees cover is poorer in high-vacancy areas.

4.9 - MAPS AUDIT TREE SUBSCORES

Scores have been converted to percentage of the maximum score. Tree cover was generally very poor, often sparse and almost always inconsitent.

As previously noted, the sidewalk network is generally extensive. Most segments had sidewalks on at least one side of the street and nearly every street with a sidewalk had a buffer, however, maintenance problems were found to be common. Approximately one-third of all measured segments had at least two major obstructions (Figure 4.10), generally either broken/upheaved pavement or some form of debris. The other 66% of streets were not found to be entirely obstruction-free, but rather were found to have no more than one obstruction. Considering that a pedestrian trip of six blocks might include at least two major obstructions, the path quality issues appear to be quite significant and discouraging to pedestrian use.

The relatively common occurrence of trash and debris on sidewalk is one of the findings that may be linked to vacancy. High-vacancy neighborhoods are at risk for higher levels of physical disorder, particularly as vacant lots become overgrown or become sites for garbage dumping (Garvin *et al* 2013; Heinze *et al* 2018). Furthermore, this idea is supported by mapping the streets with at least three obstructions and comparing them to a vacancy map. Comparing the obstructed streets and vacant lots shows that the more severely obstructed streets tend to be found mostly in high-vacancy areas.

4.10 - SIDEWALK OBSTRUCTIONS

Approximately 30% of segments have 3 or more obstructions. Trash and overgrown vegetation are the most common though some sidewalks have significantly deteriorated.

4.11 - MAPS AUDIT TOTAL SCORES

Scores have been converted to percentage of the maximum score. No segments scored more than 80% of the maximum score and most were below 60%.

Vacant Lot

MAPS AUDIT SCORE (% OF MAXIMUM SCORE)

81-100%
61-81%
41-60%
21-40%
0-20%

0′ 2500′ N

Although not addressed in the literature review, bike infrastructure (either marked lanes or lanes marked with a raised curb) was included in the survey as an indirect measure of additional buffering between pedestrians and vehicles. Despite the narrow width of bike lanes, the added distance between cars and pedestrians afforded by bike lanes could be considered a buffer, particularly if the lanes are commonly used. Actively used bike lanes could potentially slow traffic in lanes adjacent to sidewalks thereby increasing pedestrian comfort and possibly safety.

Ultimately it appears that the low scores in the MAPS evaluations (Figure 4.11) can be generally grouped into two categories: maintenance and built infrastructure. The physical condition of the sidewalk is an example of a single factor that showed signs of both problems. In some cases, the concrete was in acceptable physical condition (only small cracks, no noticeable upheaval) but entirely obscured by trash. Other segments had deteriorated into fragments or gravel, creating a low-quality walking surface. The absence or irregular distribution of trees on many segments is another example of a challenge from the built environment while vegetation intruding over the sidewalk is another maintenance-related deficiency.

Slope

Significant portions of the site have slopes above the ADA maximum of 5%. While slopes of 6-10% may be physically possible for some adults, the greater the slope, the more difficult the walk and the poorer the walking experience. Sheffield in particular is dominated by steep slopes with a considerable part of the area covered by slopes of 15% or more. In Lykins, the 5-10% slope is more common. While these issues are considerable, streets tend to be less steep than areas within blocks, likely due to grade changes made during the paving process. These improvements have only moderate impact however, leaving a considerable number of streets above the ADA maximum, generally in the 6-10% range although Sheffield has approximately 20 segments with slopes predominately above 10%. (See Figure 4.12)

Considering that Lykins has a greater number of vacant lots while Sheffield has more steep slopes, and based on the distribution of vacant lots compared to the distribution of steep street areas, it does not appear that there is a noticeable connection between slope and vacancy on this site. It is also important to note that steep slopes are a problem specific to this project site that may not be a factor in other high-vacancy

4.12 - STREET SLOPES

Slope presents a major barrier to pedestrian comfort, particularly in Sheffield where many streets have slopes in excess of 10%.

DESIGN GUIDELINES

Addressing Walkability Challenges

Based on data analysis, it is clear that the Lykins and Sheffield neighborhoods face several walkability-related challenges. Although generally well connected in terms of sidewalk extent and the small number of dead ends, the large blocks diminish these benefits. Pedestrians are involved in a higher-than normal rate of traffic collisions and crime occurs in most areas of the site, and as a result safety is low. Finally, sidewalk obstructions are relatively common and tree canopy is generally inadequate while steep slopes further reduce the potential for pedestrian comfort. From these diverse challenges, it will be important to identify specific factors which cause, at least to some degree, the reduced walkability within the site. Doing so can highlight the areas of greatest need, which will help to build a framework for walkability improvements. This chapter focuses on two primary topics: prioritizing areas of need for walkability improvements and identifying a range of solutions based on the challenges found in the data analysis.

Design Guideline Overview

Solutions for addressing walkability issues in this chapter are divided into two categories: maintenance and construction. The following list provides an overview of a series of considerations and options for improving walkability in high-vacancy settings based on the results and analysis in Chapter 4.

Location Selection

Locations for improvement should be selected based on budget and impact. Spending a substantial portion of the budget on one area with a very high level of need may not be as impactful as spending smaller portions of the budget on several areas with moderate need. The cumulative effect of several small improvements may have a more significant overall effect on the site. Based on the data collected and the methods used in data analysis, particularly the MAPS audit survey, the tool (shown in Figure 5.1) has been developed for selecting areas for walkability improvement. This tool is designed to help community leaders, community members, designers, planners or other professionals, and stakeholders select project sites or areas for walkability improvement. Some sections of the tool may also be useful for identifying specific street segments for improvement, but the tool was created primarily for identifying potential project areas consisting of multiple blocks and street segments.

THE PRIORITIZATION TOOL

The intended function of the tool is to provide a framework for evaluating walkability and demonstrate its application in the context of high-vacancy settings. Evaluation factors from the literature review and methods section have been adapted for use in the tool. This tool is not intended to provide an absolute measure of exactly how walkable an area, region, or district may be, rather it is intended to facilitate the process of comparing potential project areas. In a sense it is an in-depth pro-con list that accounts for a variety of walkability factors based on this project and supporting literature. A lower score indicates better walkability and a lower priority for improvement.

5.1 - PRIORITIZATION TOOL (BELOW AND RIGHT)

Areas are rated according to the items on this sheet and scored on the score sheet. Areas with higher numbers are higher priority. Ties can be broken by comparing scores in the accessibility or safety subcategories.

AREA EVALUATION

Area ID				
CATEGORY	**EVALUATION**			
ACCESSIBILITY				
Block Length	700+	450-700	350-450	200-350
Connectivity	0.0-1.0	1.0-1.5	1.6+	
Existing Sidewalk	Both Sides	One Side	None	
SAFETY				
Crime	High	Moderate	Low	Very Low
Traffic Accidents	High	Moderate	Low	Very Low
Lighting	Yes	Some	None	
Natural Surveillance	High	Moderate	Low	None
COMFORT				
Slope	11%+	6-10%	0-5%	
Overhead Cover	0-25%	25-75%	75-100%	
Sidewalk Obstruction	3+	1-2	0	
VACANCY (BY AREA)				
	High	Moderate	Low	None

AREA SCORE SHEET

AREA ID	

ACCESSIBILITY

CATEGORY	SCORING	SCORE
AVERAGE BLOCK SIZE	700+ = 3 450-700=2 350-450=1 200-350=0	
CONNECTIVITY	0.0-1.0=2 1.0-1.5=1 1.6+=0	
EXISTING SIDEWALK	BOTH SIDES = 0 ONE SIDE = 2 NONE = 5	
TOTAL		

COMFORT

CATEGORY	SCORING	SCORE
PREDOMINANT SLOPE	11%+ = 3 6-10%=2 0-5%=0	
AVERAGE TREE COVER	0-25% = 2 025-75% = 1 75-100%= 0	
AVERAGE HAZARDS & OBSTRUCTIONS	3+=3 1-2=1 0=0	
TOTAL		

SAFETY

CATEGORY	SCORING	SCORE
CRIME	HIGH = 5 MODERATE=3 LOW=1 VERY LOW=0	
PEDESTRIAN CRASHES	HIGH=5 MODERATE=3 LOW=1 VERY LOW	
LIGHTING	YES=0 SOME=1 NONE=5	
NATURAL SURVEILLANCE	HIGH=0 MODERATE=1 LOW=2	
TOTAL		

VACANCY

SCORING	SCORE
HIGH=5 MED=3 LOW=1 NONE = 0	

TOTAL

CATEGORY	SCORE
CRIME	
PEDESTRIAN CRASHES	
LIGHTING	
VACANCY	
TOTAL	

INSTRUCTIONS FOR THE WALKABILITY IMPROVEMENT PRIORITIZATION TOOL

Connectivity

Block Length
Calculate by measuring the longest side of each block. Use the average of all blocks in the area.

Connectivity
Calculate by counting the number of road segments (sections of road between a within the boundary and the number of nodes (number of intersections + the number of dead ends/cul-de-sacs). Divide the number of road segments by the number of nodes. The resulting ratio is the connectivity score.

Existing Sidewalk
Only use "both sides" if 90% or more of the road segments have sidewalks on both sides. Otherwise use "one side". Only use "none" if more than 50% of segments do not have a sidewalk or if there is no continuous sidewalk route through the site.

Safety

Crime and Pedestrian Traffic Accidents
Calculate the number of crimes in each potential site for a given time period using the most recent data available (e.g. ,the most recent year or most recent five years available). Calculate the difference between the area with the most crimes and the least crimes over the selected time period. Divide into three equal ranges. For example, if area "A" has 100 crimes in a year and area B has 250, then the ranges would be 100-150, 151-200 and 201-250. Assigning a rating of "Low" to areas in the lowest third (in the example this is the 100-150 range), "Moderate" to the middle range, and "High" to the highest range. Only assign a score of "Very Low" to areas where crime is not regularly occurring (a few per year). This same process can be used to calculate ratings for pedestrian traffic accidents. Also use this process for natural surveillance and vacancy.

Lighting
A "Yes" rating indicates that lighting coverage is high or complete on every street segment and that there are no street segments without any lighting. Some indicates that there are noticeable gaps. None should only be used if lighting is on fewer than 20% of the street segments within the area.

Natural Surveillance
Calculate by taking the average street segment block population (the average population of both blocks adjacent to a street segment) for each block. Assign ratings using the same process as described for calculating crime ratings.

Comfort

Slope
Identify the slope of each street segment (or estimate to best ability using Google Earth Pro or a similar tool that provides spot elevation data). Assign rating based on most common slope number.

Overhead Cover
Use aerial imagery to calculate the approximate percentage of each street segment that is covered by trees or other sources of shade along the sidewalks (e.g., if the sidewalk on one side is 100% covered by tree canopy and the other sidewalk has 0% coverage, the street segment will be considered to have 50% coverage). Average the coverage percentage for each street segment within the site. Assign the area score based on the corresponding range.

Obstructions
Count the number of major hazards or obstructions on each street segment. Average the calculated number of obstructions for all segments in an area and assign the area score based on the corresponding range. Round up to the nearest whole number (e.g., 0.4 rounds to zero, 2.5 rounds up to 3).

Vacancy

Calculate using the process described for calculating crime and pedestrian traffic accidents ratings.

The Walkability Improvement Prioritization Tool includes major site attributes used to evaluate the three main walkability factors used in this project which were based the Hierarchy of Walking Needs—accessibility, safety, and comfort. In addition to these walkability factors, this tool includes a section on vacancy.

Each section of the tool has been weighted compared to the others based on the way the Hierarchy of Walking Needs proposes that certain basic needs must be met before satisfying higher needs. Vacancy is weighted to be overall less impactful than any given walkability factor section but heavily enough that it can have a significant impact on the overall priority score. This weighting was based on the conclusion that the walkability factors of accessibility, safety, and comfort are each influenced to some degree by vacancy in this project site. However, not every component of those factors appeared to have a relationship to vacancy. For example, while reported crime appeared to be related to vacancy, pedestrian crashes did not. This was the case for each walkability factor. Some attributes appeared to relate to vacancy while others did not.

Application of the Walkability Improvement Prioritization Tool to the Project Site

The Walkability Improvement Prioritization Tool was applied to the project site to identify areas in greatest need of walkability improvements. The results are shown in Figure 5.2 and the calculations are in Appendix B.

At 24, the cumulative score for Lykins Area 2 (top middle of the Lykins Neighborhood) was 4 points above the next highest score of 20 (Lykins Area 7) and 6 points above Lykins Area 6 and Sheffield Area 3 (both at 18). Based on these scores it would be recommended that walkability improvements on the project site begin in this area.

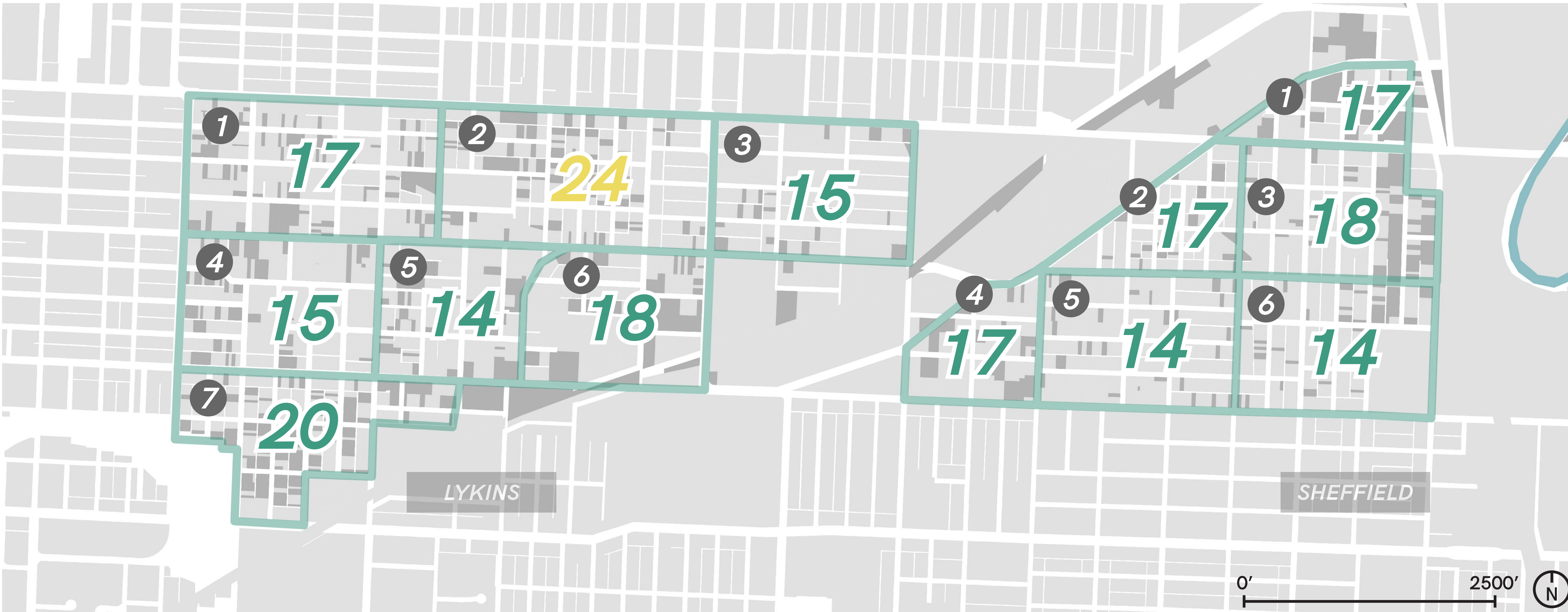
Lykins Area 2 had accessibility numbers similar to a few other areas but was the highest rated in need for safety improvements due to having a high occurrence of both crime and pedestrian crashes relative to other areas of the site. Lykins Area 2 also tied for the highest need for comfort improvements and had a maximum vacancy rating (high). Considering that the accessibility issues are on-par with other areas, it is recommended that safety improvements are first.

While safety improvements would have the greatest impact, they may also take more time and financial investment. However, some challenges could be addressed in the short term. In addition to the safety issues, Lykins Area 2 also tied for the highest comfort priority score, primarily due to a notable number of obstructed streets. Considering that most sidewalk issues were generally related to trash and overgrowth, a simple community maintenance event would likely be a cost-effective way to immediately improve walkability.

If all obstructions were removed, the priority score would drop from 24 to 21, still leaving Lykins Area 2 as the area in greatest need of improvement. This illustrates a potential use for the Walkability Improvement Prioritization Tool as not only a useful instrument for evaluating initial projects but also for categorizing areas as short- or long-term projects. Some areas may have several short-term needs that can be quickly addressed, while other areas, such as Lykins Area 2 have mostly long-term needs.

Application of Prioritization Tool

While this tool was developed in the context of a high-vacancy neighborhood, it is not limited to that context. The walkability measures and weighting are based on general walkability principles that have been applied to a high-vacancy environment. The tool has been configured to account for vacancy but does not depend on it. A low-vacancy environment would score a zero in the vacancy section, and the tool would still be effective for comparing potential walkability projects.



5.2 - PROJECT SITE PRIORITY SCORES

Using the scoring sheet developed as part of this project, the site was organized into groups and evaluated to identify high-priority areas for improvement. See Appendix B for individual scores for each area.

Vacant Lot

Area Number 1

Area Score 16

Advantages and Limitations of Walkability Improvement Prioritization Tool

The Walkability Improvement Prioritization Tool has three primary advantages. First, it is simple. Scoring is straightforward and the survey is brief. It allows for quick comparative analysis of potential projects and does not require extensive expertise to use. Second, it accounts for vacancy. Walkability is a complex topic with a variety of factors. This case study suggests that high concentrations of vacant lots could be related to certain walkability challenges that have not been addressed in other available analysis tools. Third, it does not require absolute measures or extensively detailed data, and only comparative information would be enough. While more detailed data will provide more accurate results, it is not vital to take several detailed measurements. This makes the application of the tool, easy and quick for decision-makers.

It is important to acknowledge that this tool does have limited scope. It has not been developed to make strong definitive statements about absolute levels of walkability and it may not be suitable for comparing projects in different regions. It also does not have the depth of the MAPS audit tool or other comparable walkability analysis tools. It is simply intended for quick, comparative analysis to identify and prioritize potential walkability projects. It is also very important to note that the tool should be refined with future use and research which was not possible due to project time constraints.

ACCESSIBILITY

Addressing Connectivity, Block Size and Sidewalk Continuity

The accessibility factors addressed in this report present an interesting challenge due to their inherent nature as part of the urban fabric and their physical definition by expensive paving infrastructure in the form of streets and sidewalks. The way blocks and streets are defined by near-permanent infrastructure can make it difficult to improve connectivity. The presence of homes, offices, businesses, and other structures makes it impossible to reduce block size on the study site. Given the permanence of the accessibility factors, construction solutions should be carefully considered, and maintenance solutions should be considered before undertaking major infrastructure improvements.

Maintenance

Sidewalk continuity is an example of a challenge that may be easily addressed by maintenance solutions, particularly if the gaps in continuity are a function of obstruction from plants, trash, or other forms of debris. Even when sidewalks have not been installed and would require the use of expensive materials and labor, it is still easier to fill in sidewalk gaps than to adjust roads and blocks. Considering the expense, it may be ideal to consider first pavement is necessary or if cheaper alternatives may be sufficient. For example, most streets in the project site have a sidewalk on at least one side of the street. While this is a positive step, the long-term goal should be to include sidewalks on both sides of the street whenever possible (Public Works Department 2009). In cases where pedestrian safety may be a concern but installation of an additional sidewalk is not possible, updating various street crossings with tactile strips or signals as appropriate would provide short-term improvement (Axelson et al., n.d.).

Construction

Despite the general permanence of blocks and streets, connectivity for pedestrians can still be improved and the impact of large blocks as barriers can be mitigated. Unlike neighborhoods with low levels of vacancy, high-vacancy neighborhoods may afford some unique opportunities to mitigate these issues by adding new infrastructure (Tachieva 2010). The high number of vacant lots, particularly undeveloped or cleared lots, can provide space for improvements that would not be present in lower vacancy settings. For example, vacant lots spanning a large block may provide an opportunity for a new mid-block pedestrian path, thereby allowing pedestrians to cut through rather than walk around. This principle is derived from the concept of mid-block street crossings (NACTO 2013a), which can also be used to mitigate the effects of block size by allowing more direct cross-street access. Although dead-ends are not generally found in the project site, their impact can also be mitigated by converting a portion of a vacant lot to a mid-block pathway for pedestrian use. The general downside of such solutions, however, is that the loss of space on the lot(s) may reduce their value or appeal for future development or occupancy.

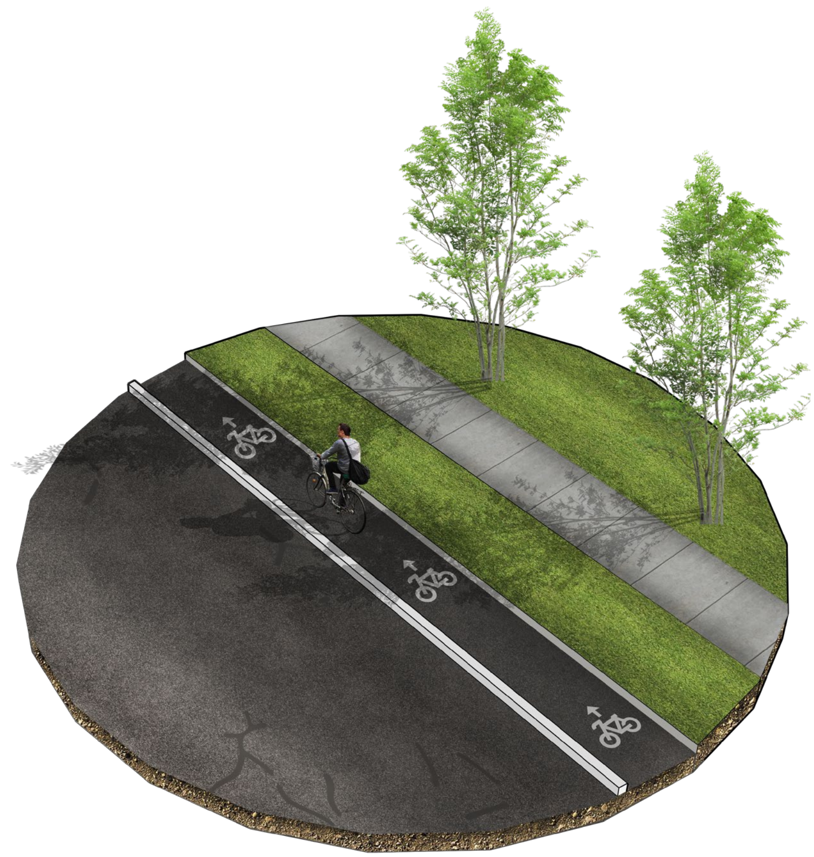
TRAFFIC SAFETY

Maintenance

Maintenance solutions for pedestrian traffic safety are somewhat limited to the addition of new signs (considered maintenance for this report because the physical form of the road, buffer, traffic flow and/or sidewalk are not generally changed). Ensuring that debris, vegetation, or structures do not impede drivers' ability to see pedestrians at crosswalks would be important (Mok, Landphair, and Naderi 2003), though this was not found to be necessary on the project site.

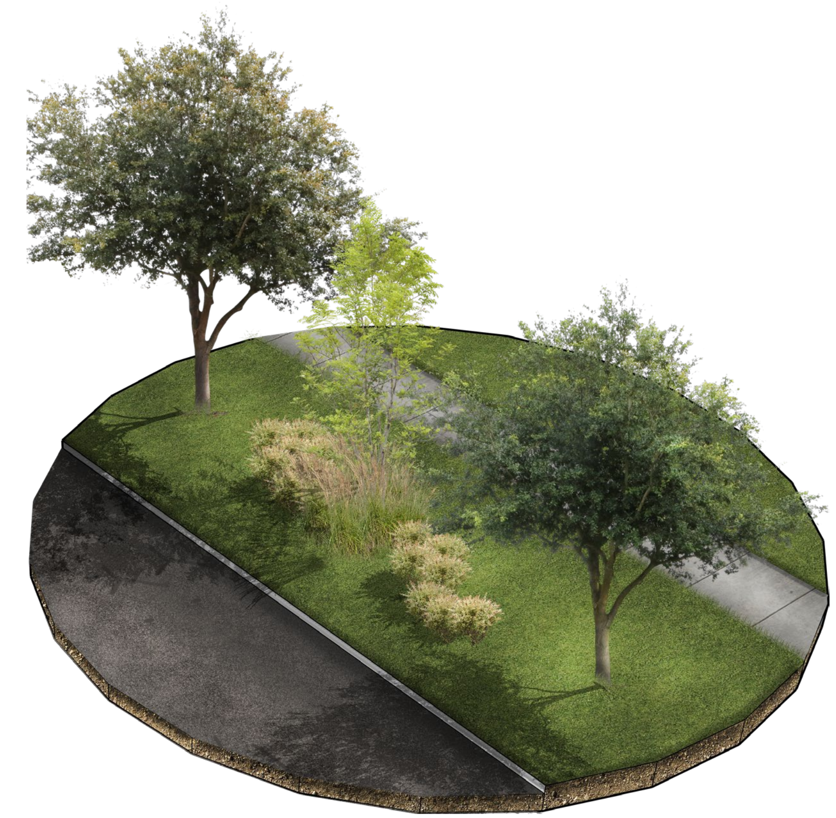
Construction

Traffic-related safety measures can be very expensive but there are a range of options depending on the speed and volume of traffic. Low-traffic, low speed streets have the most options while there are generally fewer solutions on the higher volume/speed streets. One option appropriate for nearly every type of non-freeway road is street width reduction (FHWA 2019). This can be accomplished in a variety of ways. The most expensive option would be to convert one or more lanes into buffer by extending curb several feet into the road. However, a more cost-effective solution may be to remove one or two lanes and convert the space into a marked bike lane or a bike lane with a curb, or to add on-street parking, or a combination of both. According to the National Association of City Transportation Officials (NACTO),



5.3 - CURBED BIKE LANE

A cubed bike lane can provide physical protection and add an additional layer of space between pedestrians and vehicles while being less expensive than a full -block buffer extension.



5.4 - FULL BUFFER EXTENSION

More buffer space allows greater flexibility and variety in potential uses of the buffer zone and create a more substantial barrier between pedestrians and vehicles. This can also be very costly.

the buffer zone is an important part of the sidewalk and can be used for cycling lanes (NACTO 2013b). The advantage to this approach is that it minimizes the amount of new concrete while still reducing the overall width of the street and lowering traffic speeds while adding an additional spatial layer to separate pedestrians and vehicles. A more expensive option may be the addition of curb extensions near the intersection in conjunction with the conversion of a lane into on-street parking. If jaywalking is a common problem, particularly on long street segments with great distances between crosswalks, the addition of a new painted crosswalk and a small addition to the sidewalk to access the crosswalk may be appropriate. These curb extensions would represent a significant financial investment but provide a cheaper alternative to extending the curb along the full width of the street, the most expensive route. The primary advantage of extending the curb is the additional space for other pedestrian improvements such as new trees or shade structures, benches or other amenities. Some research (Dumbaugh 2006) has demonstrated that mid-block pedestrian collisions have been reduced in frequency and severity by landscape improvements.

CRIME SAFETY

Maintenance

Maintenance and the perception of crime have an interesting relationship. According to Broken Window Theory, poorly maintained urban environments are associated with the perception of crime occurrence and may signal to criminals that crime is tolerated in the poorly maintained area (Gau and Pratt 2010; Gau, Corsaro and Brunson 2014; Hinkle and Yang 2014). Based on this concept, it is recommended that all possible aesthetic maintenance be conducted whenever possible. This includes mowing back overgrown grass, maintaining trees, shrubs and other vegetation, clearing trash from yards, lots and sidewalks, and other general property maintenance and repairs whenever possible. Additionally, city officials may consider working with residents to discuss the implementation of neighborhood or city rules and ordinances, or the enforcement of existing policies to ensure and facilitate regular maintenance. It is important to involve residents and community leaders of the areas in question to create achievable solutions and empower the community rather than attempting to force them to adhere to regulations that may not apply in the context of a high-vacancy neighborhood.

Construction

Although the lighting distribution on the current project site is extensive with very few minor gaps and no major gaps, this may not be the case for other high-vacancy neighborhoods. In settings with poor lighting distribution it may be beneficial to install new lighting infrastructure.

Considering the implications of Busy Streets Theory (Aiyer *et al.*, 2015; Heinze *et al.*, 2019; Rupp *et al.*, 2019), potential construction solutions may include the development of vacant lots to increase community use and social activity on streets with relatively lower potential for natural surveillance. This would potentially increase the sense of social control and possibly deter crime as well as increase the number of people to report criminal activity. Working with communities to establish appropriate and desirable programming will help obtain the best outcomes for this particular solution.

COMFORT

Maintenance solutions

Clean-up programs to clear debris and trash from sidewalks are an improvement solution with relatively low cost and high benefit. Most obstructed sidewalks had pavement of at least passible condition. A simple neighborhood cleanup program once or twice a year would greatly improve sidewalk conditions. While only one-third of streets had major obstructions, the most common obstacles appeared to be debris rather than sidewalk damage. Clearing the trash, vegetation, and debris could be a cost-effective solution to drastically improve pedestrian comfort on sidewalks. To prevent or mitigate the re-accumulation of debris, adding trash receptacles may be a valuable use for buffer space adjacent to the sidewalk (NACTO 2013b).

Regular maintenance of shade trees to ensure long-term tree health will help maintain existing tree cover, which is somewhat scarce in the project site despite the high value of tree cover in the hot Missouri summers. Urban environments are generally more stressful for trees, particularly given that trees are not generally placed in their natural plant communities. Pruning can be devastating to trees if done improperly.

Timely and efficient maintenance of sidewalks and other hardscape features is critical. Broken or displaced concrete should be ground down or sawn to mitigate the effects of sidewalk upheaval or cracking. Brick or other paving material may become dislodged and should be replaced as soon as possible.

Construction

Perhaps the most prevalent comfort problem in the project site that can be addressed through construction is the lack of shade or other overhead cover. Tree cover was generally sparse and often limited to a small portion or few locations on many street segments. Trees are a multi-benefit solution (NACTO 2013b) that can improve aesthetics, comfort, and safety. However, trees are increasingly expensive to install at later stages of maturity and may not provide much immediate impact. Species selection should be carefully considered, particularly in highly urbanized areas where many species of tree will struggle to thrive and reach their full potential as shade sources (Lilly 2010). Short-term solutions may include temporary shade structures or parklets that provide some form of respite from sun or precipitation, though these should be installed within the overall budget and at locations where they can provide maximum benefit to a larger number of pedestrians. Consideration should be given to the additional maintenance burden for these improvements and implemented with a clear understanding of who will maintain the improvements and what the standards of care will be. Even low-maintenance solutions will require some effort.

Slope, a particularly rampant problem in the project site, may not be an issue in every high-vacancy setting, but it should be addressed where present. Mitigating the impact of steep slopes, particularly through re-grading the topography can be exceedingly expensive and may rarely be appropriate. A more cost-effective solution is to provide an appropriate number of places to rest. In warm climates, these rest areas may include shade or possible drinking fountains, but a bench is a generally practical option, allowing users, particularly young children or seniors to rest rather than forcing them to traverse the entire slope at once.

While space is at a premium in high-occupancy neighborhoods, high-vacancy areas have several lots in need of some use. Vacant lots can be transformed, either temporarily or permanently, into places for pedestrians to rest. The addition of temporary shade structures, low-maintenance vegetation and a moveable bench can provide a place for people to rest as they walk steep streets while also programming a vacant lot that may otherwise be used as a place for trash dumping.

The addition of new vegetation may also increase comfort, particularly in the buffer area between the road and the sidewalk. Although it may provide little physical protection from cars, vegetation may provide perceptual separation from the road, thereby affording some amount of cognitive comfort to pedestrians and increasing the aesthetic value of the street. It is important to note that all vegetation requires some maintenance and that new plantings should always be accompanied by a maintenance plan that designates parties responsible for the care of the plantings.

SITE SELECTION OVERVIEW

Accessibility

- Accessibility and safety are closely related. Poor accessibility may lead or force pedestrians to undesirable or unsafe routes. Roads without sidewalks that provide direct access between destinations may lead people to walk on the shoulder or another unsafe part of the road.
- Safety is critical when adding new access. In instances where accessibility is high, safety is the top priority.
- Considerations for adding new access:
- What will the new route connect to?
- Are there important resources and amenities that are difficult to access without a car because of block length or sidewalk access?
- Do cul-de-sacs or other dead-ends limit access to resources and amenities?
- Local community member input is invaluable in identifying key destinations including resources (grocery stores, schools, medical facilities, etc.)

Safety

• Crime

- Can the route be more secure with improved lighting?
- Can the route be more secure with improved visibility?
- Is it possible to circumvent the most dangerous areas with new improved routes?
- Consider that perception may influence users as much as reality.

• Traffic

- Where are pedestrians most at risk for involvement in vehicle collisions?
- What is the speed limit in the most accident-prone areas?
- Is the speed limit well-enforced and clearly visible?
- Improving accessibility may improve safety. Pedestrians risk more dangerous routes if it means a shorter trip if they do not have access to a vehicle or if there is little or no access to their destination.

Comfort

- Where is the tree coverage lowest?
- Where is the path quality lowest?
- Where are the steepest paths?

STRATEGIES AND CONSIDERATIONS

FOR IMPROVEMENTS OVERVIEW

Improving for accessibility

- Research and identify key resources and recreational destinations. Community input is invaluable for identifying important routes and destinations that may not be obvious using other methods.
- Ensure that the surface is ADA accessibility. Steep slopes are not just comfort barriers- they may be accessibility barriers for users with physical limitations.

Improving for safety

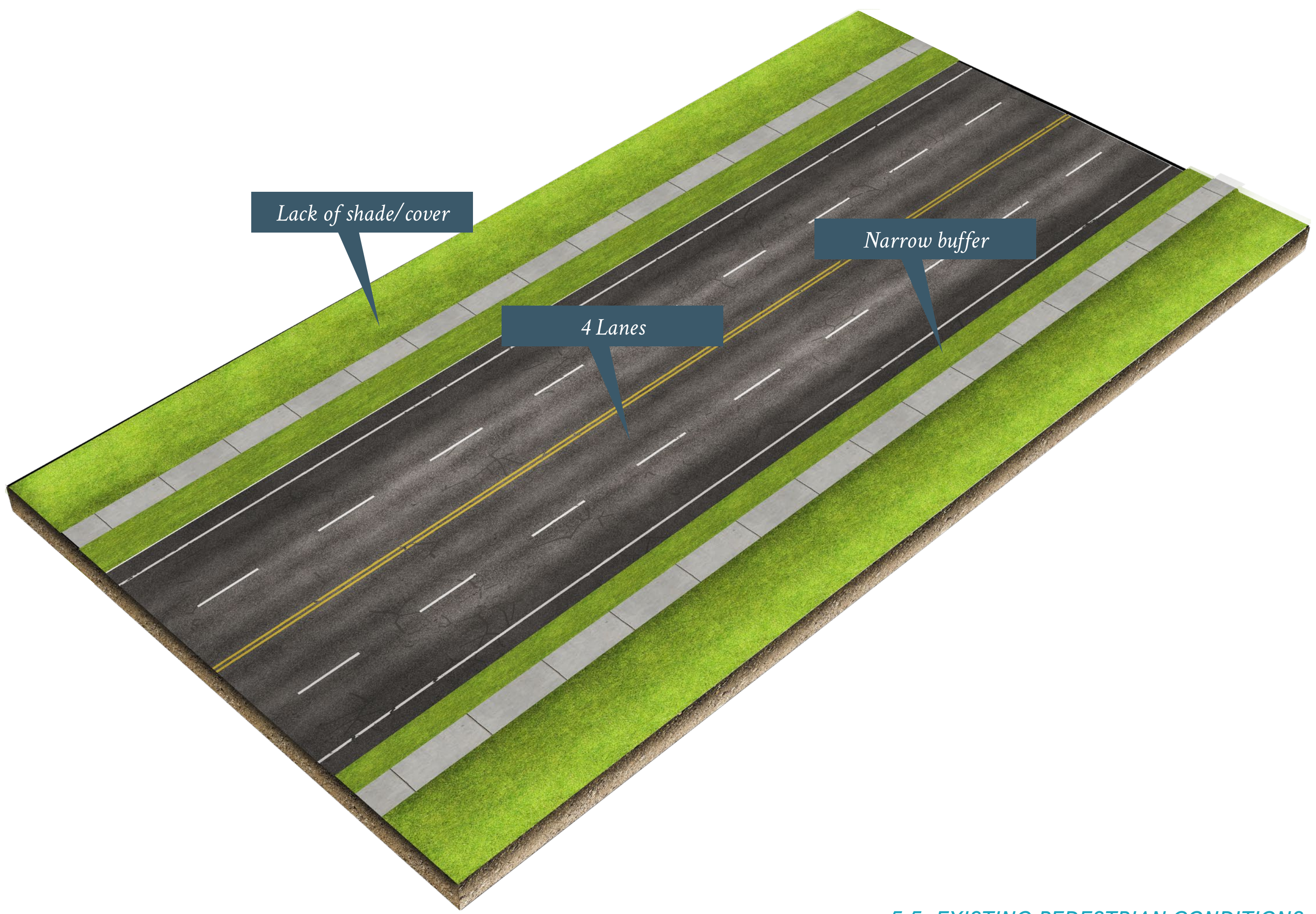
- Increase lighting in poorly lit areas
- Establishing good visibility in and out of walking areas
- Providing adequate buffer space using both horizontal distance and vertical elements that can act as physical barriers such as boulders or trees
- Implement traffic calming features (bulb-outs, chicanes, narrower lanes, fewer lanes etc.)

Improving for comfort

- Clear debris and garbage. Remove unattractive or obscuring vegetation.
- Add shade cover by planting trees (long-term solution) or installing structures (temporary or long-term)
- Add vegetation to buffer
- Add a buffer or add additional width/layers to existing buffer
- Add on-street parking
- Add bike lanes
- Widen the sidewalk buffer
- Add places to rest, particularly in steep areas
- Should NOT be in the buffer unless the buffer is particularly wide, particularly on high-speed or high-volume streets
- Ideally shaded
- Visible but not exposed

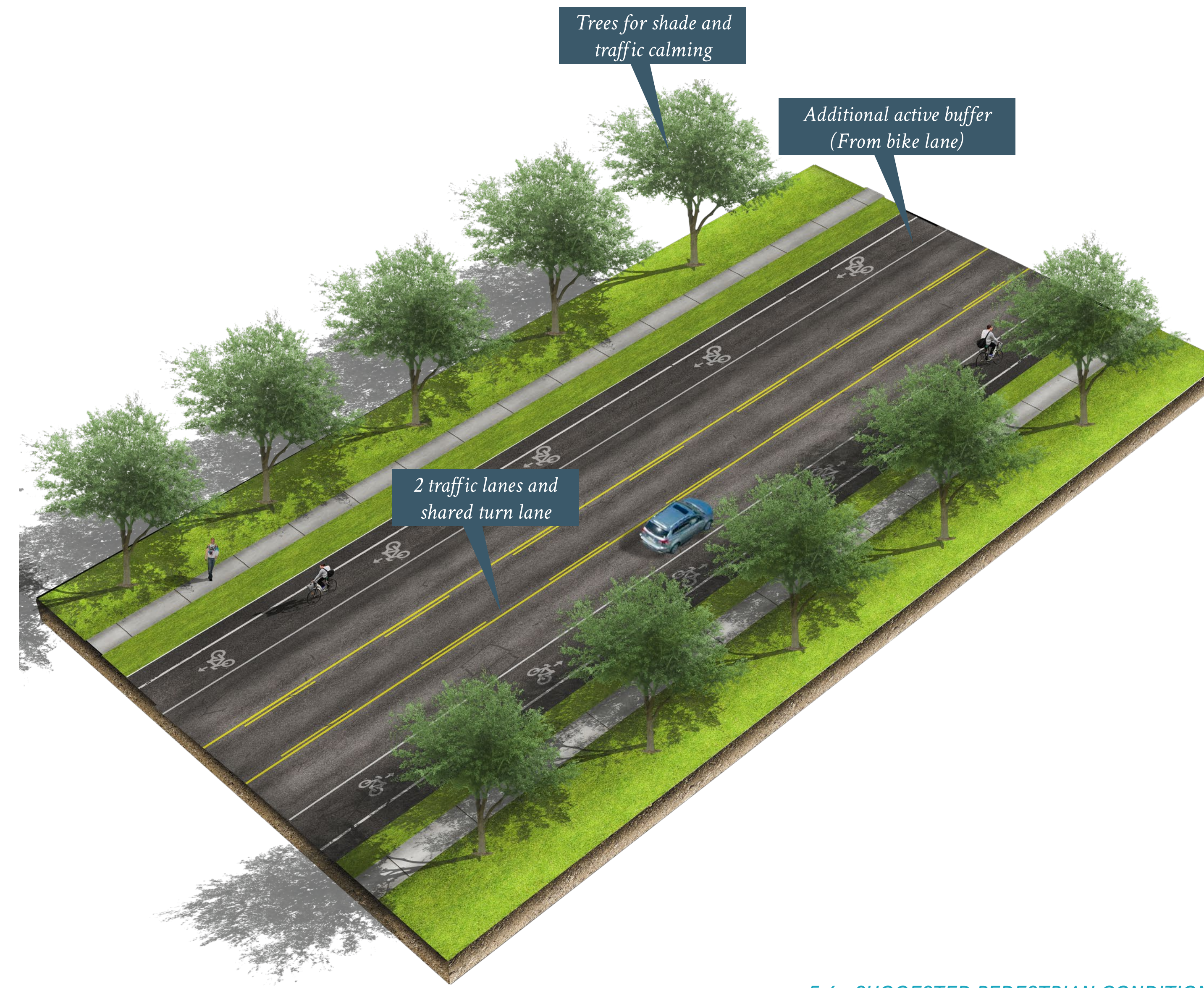
EXAMPLE GUIDELINE APPLICATIONS

The following diagrams and images represent possible walkability strategy applications based on this research. It is important to note that these are not intended as step-by-step instructions but rather as one example of a process for applying this research to improve walkability. The streets segments represented in these images are from the project site.



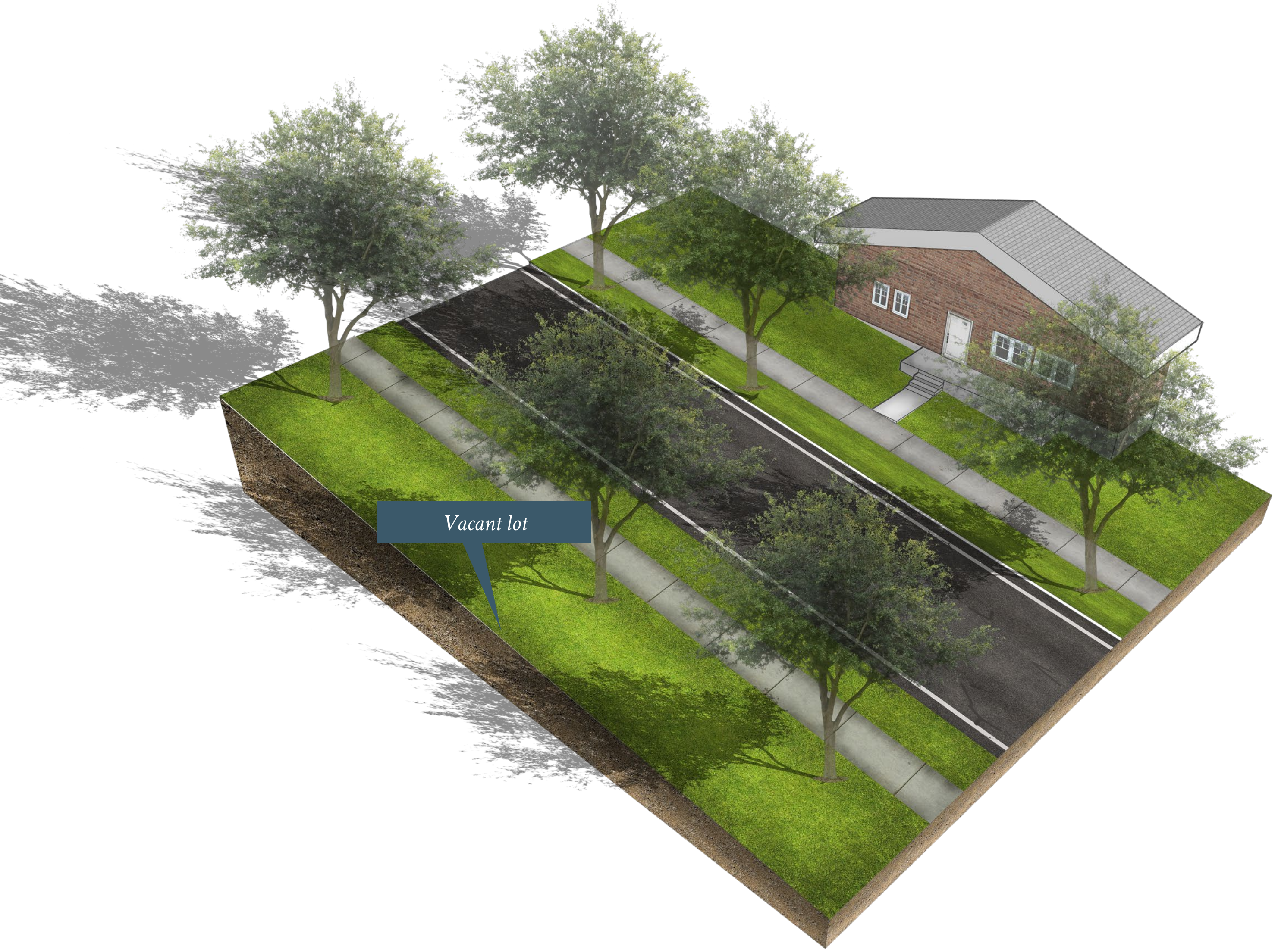
5.5- EXISTING PEDESTRIAN CONDITIONS- INDEPENDANCE AVENUE

Indepndance Avenue currently provides little buffering space between cars and pedestrians. Tree cover is extremele sparse or non-existent. It is also the site of the most pedestrian collisions in the site.



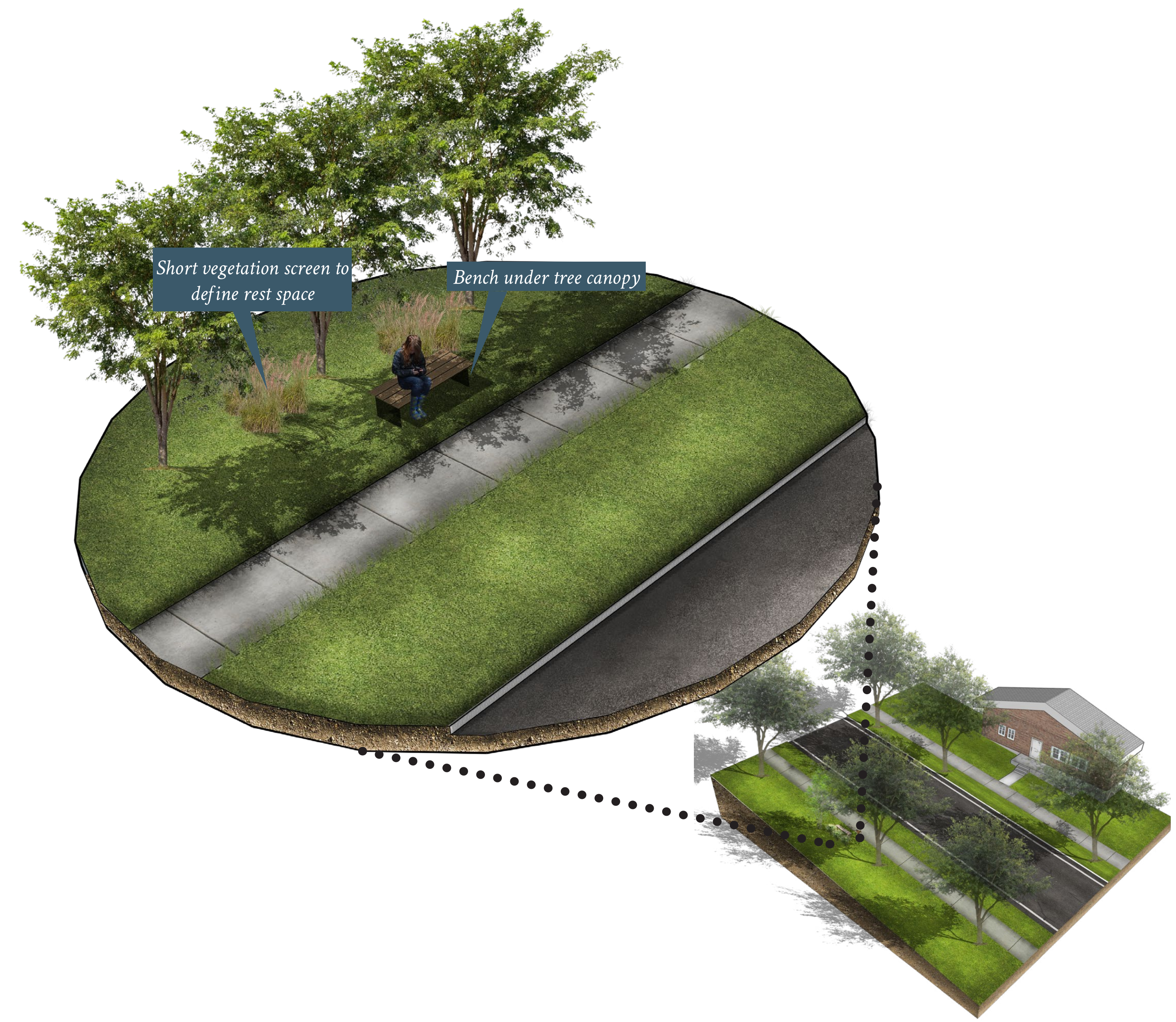
5.6 - SUGGESTED PEDESTRIAN CONDITIONS- INDEPENDANCE AVENUE

The addtion of marked bike lines and the removal of a dirving line provides additional space between cars and pedestrians . Trees improve pedestrian comfort by adding needed shade.



5.7 - EXISTING PEDESTRIAN CONDITIONS-
EAST 9TH STREET (SHEFFIELD)

Conditions are generally good in this case, however, slope (above 10%) could present a considerable challenge to pedestrians with accessibility needs or other physical limitations such as age.



5.8 - SUGGESTED PEDESTRIAN CONDITIONS-
EAST 9TH STREET (SHEFFIELD)

Although relatively small, the addition of a drinking fountain and a bench could provide much needed rest for weary pedestrians and provide an anchor point for future improvements to a vacant lot.

CONCLUSION

A Brief Review

Walkability and vacancy are complicated subjects. This study has only addressed three factors (accessibility, safety, and comfort) in the context of vacancy. While the results of this case study may not all be generally applicable, for the project site, the general results of this study indicate that high-vacancy neighborhoods can have a variety of challenges that decrease overall walkability. In this setting the most prevalent issues were safety (both crime- and traffic-related), shade/overhead cover, sidewalk maintenance and block size.

High-vacancy environments face a variety of complex and interrelated challenges. Walkability is among several factors of these urban environments that can and should be addressed to improve community health and enrich existing social activity. While improving walkability is not the solution to every challenge (or perhaps not even a problem in some cases) in high-vacancy neighborhoods, is worth the time and financial investments required for improvement.

Limitations

Time was the most significant limitation of this project. Due to time constraints it was not possible to evaluate more in depth or at a larger scale, therefore the results and recommendations in this study may only be a surface-level review of this complex topic.

Another limitation, related to time, was the use of the modified abbreviated MAPS survey. The full tool is considerably more comprehensive, both in the number of factors for evaluation and the depth of evaluation for each factor. Perhaps one of the most significant examples was the lack of quality evaluation for pedestrian buffers on the project site, which were present in a range of sizes and with varying quantities of vegetation. Furthermore, given that the abbreviated MAPS survey was adjusted to focus on specific factors addressed in the literature review, it is important to note that these scores would almost certainly differ from the scores of the unmodified survey.

This project site also may be unique in its proximity to several industrial zones, including a rail line. These factors certainly have some impact on the walkability and urban fabric of the site, but that impact could not be controlled for or explored within the limitations of this study.

Further Research.

The time constraints for this project eliminated a variety of other methods for investigating walkability in a high-vacancy setting, therefore the results of this project provide only a small insight into a deep and complicated topic. High-vacancy neighborhoods may face a variety of social and economic challenges that can potentially be eased through walkability improvements such as poverty, food scarcity, poor access to public and active transit, and crime. Given these challenges, it is critical that major investment into walkability is planned with considerable input from community members and leaders.

Due to the time constraints and the nature of this project, community engagement was not included in this project, but would be invaluable, particularly for identifying areas of maximum impact for walkability improvement. Community residents and leaders are the best resource for identifying key resources and pedestrian routes to improve or vital resources that are difficult to access due to sidewalk or streetscape conditions. The MAPS survey tool includes a framework for evaluating street segments as components to a pedestrian route. Further research in this area, in conjunction with community engagement could yield invaluable information for both general understanding of walkability in high-vacancy areas as well as specific projects.

Comparative research to understand common themes in high-vacancy settings would also be useful. One of the most self-evident limitations of this research is the focus on only one location in one city. Due to time limitations, a significant level of comparative evaluation of neighborhoods in different cities was not possible but if completed would yield valuable insight and allow for a more definitive understanding of universal walkability problems in high-vacancy settings. Similar benefit could be derived from applying this framework to a variety of neighborhoods with low vacancy rates to obtain a clearer understanding of problems both common and different for high- and low-vacancy settings.

BIBLIOGRAPHY

Aiyer, Sophie M., Marc A. Zimmerman, Susan Morrel-Samuels, and Thomas M. Reischl. 2015. "From Broken Windows to Busy Streets: A Community Empowerment Perspective." Health Education & Behavior 42 (2): 137–47. https://doi.org/10.1177/1090198114558590.

Alfonzo, Mariela A. 2005. "To Walk or Not to Walk? The Hierarchy of Walking Needs." Environment and Behavior 37 (6): 808–36. https://doi.org/10.1177/0013916504274016.

Al Shammas, T., and F. Escobar. 2019. "Comfort and Time-Based Walkability Index Design: A GIS-Based Proposal." International Journal of Environmental Research and Public Health 16 (16): <xocs:firstpage xmlns:xocs=""/>. https://doi.org/10.3390/ijerph16162850.

Axelson, Peter W., Denise A. Chesney, Dorothy V. Galvan, Julie B. Kirschbaum, Patricia E. Longmuir, Camille Lyons, and Kathleen M. Wong. n.d. "Designing Sidewalks and Trails for Access." United States Department of Transportation, 184.

Biernacka-Lievestro, Joanna. 2014. "Analyzing the Association between Walkability and Regional Economic Vitality." ProQuest Dissertations Publishing. http://search.proquest.com/docview/1651236684/?pq-origsite=primo.

Berrigan, David, and Richard P Troiano. "The Association between Urban Form and Physical Activity in U.S. Adults." American Journal of Preventive Medicine, INNOVATIVE APPROACHES UNDERSTANDING AND INFLUENCING PHYSICAL ACTIVITY, 23, no. 2, Supplement 1 (August 1, 2002): 74–79. https://doi.org/10.1016/S0749-3797(02)00476-2.

Bjornstad, Julie, John Close, Jordan Backman, Blaine Gehring, Tim Hereth, Ted Knowlton, Peter Matson, Angelo Papastamos, Brandon Rypien, and Mike West. 2017. "Utah Street Connectivity Guide - MAG." March 1, 2017. https://mountainland.org/utah-street-connectivity-guide.

Branas, Charles C., David Rubin, and Wensheng Guo. 2012. "Vacant Properties and Violence in Neighborhoods." ISRN Public Health; New York. http://dx.doi.org/10.5402/2012/246142.

Cain, K., R. Millstein, J. Sallis, T. Conway, C. Geremia, L. Frank, B. Saelens, and A. King. 2012. "Validity of the Microscale Audit of Pedestrian Streetscapes (MAPS)." Journal of Science and Medicine in Sport 15: S30–S30. https://doi.org/10.1016/j.jsams.2012.11.072.

Cain, Kelli L., Rachel A. Millstein, James F. Sallis, Terry L. Conway, Kavita A. Gavand, Lawrence D. Frank, Brian E. Saelens, et al. 2014. "Contribution of Streetscape Audits to Explanation of Physical Activity in Four Age Groups Based on the Microscale Audit of Pedestrian Streetscapes (MAPS)." Social Science & Medicine 116 (September): 82–92. https://doi.org/10.1016/j.socscimed.2014.06.042.
Cervero, Robert, and Carolyn Radisch. 1996. "Travel Choices in Pedestrian versus Automobile Oriented Neighborhoods." Transport Policy 3 (3): 127–141. https://doi.org/10.1016/0967-070X(96)00016-9.

Clarke, A. and Dornfeld, M.J. (1994) Traffic Calming, Auto-Restricted Zones and Other Traffic Management Techniques-Their Effects on Bicycling and Pedestrians, Case Study No. 19, National Bicycling and Walking Study, Publication No. FHWA-PD-93-028, Federal Highway Administration, Washington, DC

Day, Kristen. 2006. "Active Living and Social Justice: Planning for Physical Activity in Low-Income, Black and Latino Communities." Journal of the American Planning Association 72 (1): 88–99.

Deryol, Rustu, and Troy C. Payne. 2018. "A Method of Identifying Dark-Time Crime Locations for Street Lighting Purposes." Crime Prevention and Community Safety; London 20 (1): 47–62. http://dx.doi.org.er.lib.k-state.edu/10.1057/s41300-017-0035-2.

Dill, Jennifer. 2004. "Measuring Network Connectivity for Bicycling and Walking," 20.

Dumbaugh, Eric. 2006. "Design of Safe Urban Roadsides." Transportation Research Record 1961: 9.

Ewing, Reid, and Susan Handy. 2009. "Measuring the Unmeasurable: Urban Design Qualities Related to Walkability." Journal of Urban Design 14 (1): 65–84. https://doi.org/10.1080/13574800802451155.

Farrington, David P., and Brandon C. Welsh. 2002. "Improved Street Lighting and Crime Prevention." Justice Quarterly 19 (2): 313–342. https://doi.org/10.1080/07418820200095261.
———. 2004. "Measuring the Effects of Improved Street Lighting on CrimeA Reply to Dr Marchant." The British Journal of Criminology 44 (3): 448–67. https://doi.org/10.1093/crimin/azh045.

Federal Highway Administration." "Traffic Calming EPrimer - Safety | n.d. Accessed February 12, 2020. https://safety.fhwa.dot.gov/speedmgt/ePrimer_modules/module4.cfm.

Foster, Sarah, Billie Giles-Corti, and Matthew Knuiman. 2010. "Neighbourhood Design and Fear of Crime: A Social-Ecological Examination of the Correlates of Residents' Fear in New Suburban Housing Developments." Health & Place 16 (6): 1156–65. https://doi.org/10.1016/j.healthplace.2010.07.007.

Frank, L. D., J. F. Sallis, B. E. Saelens, L. Leary, K. Cain, T. L. Conway, and P. M. Hess. "The Development of a Walkability Index: Application to the Neighborhood Quality of Life Study." British Journal of Sports Medicine; London 44, no. 13 (October 2010): 924. http://dx.doi.org.er.lib.k-state.edu/10.1136/bjsm.2009.058701.

Franzini, Luisa, Wendell Taylor, Marc N. Elliott, Paula Cuccaro, Susan R. Tortolero, M. Janice Gilliland, JoAnne Grunbaum, and Mark A. Schuster. 2010. "Neighborhood Characteristics Favorable to Outdoor Physical Activity:

Disparities by Socioeconomic and Racial/Ethnic Composition." Health & Place 16 (2): 267–74. https://doi.org/10.1016/j.healthplace.2009.10.009.

Fujii, Takeshi, Yuko Fujikawa, and Kiyoaki Oikawa. 2013. "A Quantitative Analysis of Natural Surveillance at Elementary Schools -Evaluation Method Based on Perspectives from Both Outside Visibility and Visibility from Inside Buildings-." Journal of Asian Architecture and Building Engineering 12 (1): 17–23. https://doi.org/10.3130/jaabe.12.17.

Garvin, Eugenia, Charles Branas, Shimrit Keddem, Jeffrey Sellman, and Carolyn Cannuscio. 2013. "More Than Just An Eyesore: Local Insights And Solutions on Vacant Land And Urban Health." Journal of Urban Health 90 (3): 412–26. https://doi.org/10.1007/s11524-012-9782-7.

Gau, Jacinta M., Nicholas Corsaro, and Rod K. Brunson. 2014. "Revisiting Broken Windows Theory: A Test of the Mediation Impact of Social Mechanisms on the Disorder–Fear Relationship." Journal of Criminal Justice 42 (6): 579–88. https://doi.org/10.1016/j.jcrimjus.2014.10.002.

Gau, Jacinta M., and Travis C. Pratt. 2010. "Revisiting Broken Windows Theory: Examining the Sources of the Discriminant Validity of Perceived Disorder and Crime." Journal of Criminal Justice 38 (4): 758–66. https://doi.org/10.1016/j.jcrimjus.2010.05.002.

Handy, Susan. 1996. "Methodologies for Exploring the Link between Urban Form and Travel Behavior." Transportation Research Part D 1 (2): 151–165. https://doi.org/10.1016/S1361-9209(96)00010-7.

Heinze, Justin E., Allison Krusky-Morey, Kevin J. Vagi, Thomas M. Reischl, Susan Franzen, Natalie K. Pruett, Rebecca M. Cunningham, and Marc A. Zimmerman. 2018. "Busy Streets Theory: The Effects of Community-Engaged Greening on Violence." American Journal of Community Psychology 62 (1–2): 101–9. https://doi.org/10.1002/ajcp.12270.

Heinze, Justin E., Allison Krusky-Morey, Kevin J. Vagi, Thomas M. Reischl, Susan Franzen, Natalie K. Pruett, Rebecca M. Cunningham, and Marc A. Zimmerman. 2018. "Busy Streets Theory: The Effects of Community-Engaged Greening on Violence." American Journal of Community Psychology 62 (1–2): 101–9. https://doi.org/10.1002/ajcp.12270.

Hillier, Bill, and Julienne Hanson. The Social Logic of Space. Cambridge University Press, 1989.
Hinkle, Joshua C., and Sue-Ming Yang. 2014. "A New Look into Broken Windows: What Shapes Individuals' Perceptions of Social Disorder?" Journal of Criminal Justice 42 (1): 26–35. https://doi.org/10.1016/j.jcrimjus.2013.11.002.

Hinkle, Joshua C., and Sue-Ming Yang. 2014. "A New Look into Broken Windows: What Shapes Individuals' Perceptions of Social Disorder?" Journal of Criminal Justice 42 (1): 26–35. https://doi.org/10.1016/j.jcrimjus.2013.11.002.

Holtzclaw, John. n.d. "Using Residential Patterns and Transit To Decrease Auto Dependence and Costs," 52.

Huang, Herman F., and Michael J. Cynecki. 2000. "Effects of Traffic Calming Measures on Pedestrian and Motorist Behavior." Transportation Research Record 1705 (1): 26–31. https://doi.org/10.3141/1705-05.

Kelling, George. Fixing Broken Windows: Restoring Order and Reducing Crime in Our Communities. 1st Touchstone edition. New York: Simon & Schuster, 1997.

Kitamura, Ryuichi, Patricia L. Mokhtarian, and Laura Laidet. "A Micro-Analysis of Land Use and Travel in Five Neighborhoods in the San Francisco Bay Area." Transportation 24, no. 2 (1997): 125.

Knight, Jason, Russell Weaver, and Paula Jones. "Walkable and Resurgent for Whom? The Uneven Geographies of Walkability in Buffalo, NY." Applied Geography 92 (March 1, 2018): 1–11. https://doi.org/10.1016/j.apgeog.2018.01.008.

Lee, Gunwoo, Shinhye Joo, Cheol Oh, and Keechoo Choi. 2013. "An Evaluation Framework for Traffic Calming Measures in Residential Areas." Transportation Research Part D: Transport and Environment 25 (December): 68–76. https://doi.org/10.1016/j.trd.2013.08.002.

Lilly, Sharon. 2010. Arborists' Certification Study Guide. Urbana, Ill.]: International Society of Arboriculture.

Lovasi, Gina S., Malo A. Hutson, Monica Guerra, and Kathryn M. Neckerman. 2009. "Built Environments and Obesity in Disadvantaged Populations." Epidemiologic Reviews 31 (1): 7–20. https://doi.org/10.1093/epirev/mxp005.

Maddock, Jay E., Vickie Ramirez, Miaoxuan Zhang, I. Made Brunner, and Katie M. Heinrich. 2011. "A Statewide Observational Assessment of the Pedestrian and Bicycling Environment in Hawaii, 2010." Preventing Chronic Disease 9 (December). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3277384/.

Maslow, A. H. "A Theory of Human Motivation." Psychological Review 50, no. 4 (1943): 370–96. https://doi.org/10.1037/h0054346.

McDonald, Kelsey N, J Michael Oakes, and Ann Forsyth. "Effect of Street Connectivity and Density on Adult BMI: Results from the Twin Cities Walking Study." Journal of Epidemiology and Community Health (1979-) 66, no. 7

(2012): 636–40.

Mehta, Vikas. 2014. “Evaluating Public Space.” Journal of Urban Design 19 (1): 53–88. https://doi.org/10.1080/13574809.2013.854698.

Millstein, Rachel A., Kelli L. Cain, James F. Sallis, Terry L. Conway, Carrie Geremia, Lawrence D. Frank, Jim Chapman, et al. 2013. “Development, Scoring, and Reliability of the Microscale Audit of Pedestrian Streetscapes (MAPS),” 403.

Mok, Jeonghun, Harlow C Landphair, and Jody R Naderi. 2003. “Comparison of Safety Performance of Urban Streets Before and After Landscape Improvements,” 17.

Moran, Mika, Jelle Van Cauwenberg, Rachel Hercky - Linnewiel, Ester Cerin, Benedicte Deforche, and Pnina Plaut. 2014. “Understanding the Relationships between the Physical Environment and Physical Activity in Older Adults: A Systematic Review of Qualitative Studies.” INTERNATIONAL JOURNAL OF BEHAVIORAL NUTRITION AND PHYSICAL ACTIVITY 11 (1): 79. https://doi.org/10.1186/1479-5868-11-79.

Nasar, Jack L., and Saleheh Bokharaei. 2017. “Impressions of Lighting in Public Squares After Dark.” Environment and Behavior 49 (3): 227–254. https://doi.org/10.1177/0013916515626546.

NACTO, National Association of City Transportation Officials. 2013a. “Midblock Crosswalks.” National Association of City Transportation Officials. July 11, 2013. https://nacto.org/publication/urban-street-design-guide/intersection-design-elements/crosswalks-and-crossings/midblock-crosswalks/.
———. 2013b. “Sidewalks.” National Association of City Transportation Officials. July 11, 2013. https://nacto.org/publication/urban-street-design-guide/street-design-elements/sidewalks/.

National Highway Traffic Safety Administration. 2019. “2017 PEDESTRIANS Traffic Safety Fact Sheet.” Https://Crashstats.Nhtsa.Dot.Gov/. March 2019. https://crashstats.nhtsa.dot.gov/#/.

Ogilvie, David, Charles E. Foster, Helen Rothnie, Nick Cavill, Val Hamilton, Claire F. Fitzsimons, Nanette Mutrie, and Andersen. 2007. “Interventions to Promote Walking: Systematic Review.” BMJ: British Medical Journal 334 (7605): 1204–7.

Parsons Brinckerhoff Quade Douglas, 1993. The pedestrian environment. 1000 Friends of Oregon, Portland, Oregon

Public Works Department, City of Minneapolis, MN. 2009. “Access Minneapolis: Design Guidelines for Streets and Sidewalks.” Public Works Department, City of Minneapolis, MN. https://nacto.org/wp-content/uploads/2015/04/convert_256028.pdf.

Rupp, Laney A., Marc A. Zimmerman, Kathleen W. Sly, Thomas M. Reischl, Elyse J. Thulin, Thomas A. Wyatt, and John (Jack) P. Stock. 2019. “Community-Engaged Neighborhood Revitalization and Empowerment: Busy Streets Theory in Action.” American Journal of Community Psychology n/a (n/a). https://doi.org/10.1002/ajcp.12358.

Smigielski, Elysa. “Shrinking Cities as the Next Healthy Cities: Utilizing Vacancy to Create a Walkable City,” 2014.

Southworth, Michael. 2005. “Designing the Walkable City.(Author Abstract).” Journal of Urban Planning and Development 131 (4): 246–57. https://doi.org/10.1061/(ASCE)0733-9488(2005)131:4(246).

Tachieva, Galina. 2010. Sprawl Repair Manual. Washington DC, UNITED STATES: Island Press. http://ebookcentral.proquest.com/lib/ksu/detail.action?docID=3317500.

Trancik, Roger. Finding Lost Space: Theories of Urban Design. New York: Van Nostrand Reinhold, 1986.

United States Federal Highway Administration. “Traffic Calming, Auto-Restricted Zones and Other T.Pdf.” n.d. Accessed November 4, 2019. https://safety.fhwa.dot.gov/PED_BIKE/docs/case19.pdf.

Ussery, Emily N., John D. Omura, Prabasaj Paul, John Orr, Chad Spoon, Carrie Geremia, and Susan A. Carlson. 2019. “Sampling Methodology and Reliability of a Representative Walkability Audit.” Journal of Transport & Health 12 (March): 75–85. https://doi.org/10.1016/j.jth.2018.11.007.

Virgina Department of Transportation. “Examples of Link-Node Ration” “n.d. Accessed October 29, 2019. http://www.virginiadot.org/projects/resources/12.08Examples_of_Link-Node_Ratios.pdf.

Wasatch Front Regional Council “Utah Street Connectivity Guide.Pdf.” n.d. Accessed October 29, 2019. https://mountainland.org/img/transportation/Studies/Utah%20Street%20Connectivity%20Guide.pdf.

Zhu, Wenfei, Yuliang Sun, Jonathan Kurka, Carrie Geremia, Jessa K. Engelberg, Kelli Cain, Terry Conway, James F. Sallis, Steven P. Hooker, and Marc A. Adams. 2017. “Reliability between Online Raters with Varying Familiarities of a Region: Microscale Audit of Pedestrian Streetscapes (MAPS).” Landscape and Urban Planning 167 (November): 240–48. https://doi.org/10.1016/j.landurbplan.2017.06.014.

Zhu, Xuemei, and Chanam Lee. 2008. “Walkability and Safety Around Elementary Schools: Economic and Ethnic Disparities.” American Journal of Preventive Medicine, Theme Issue: Active Living in Diverse and Disadvantaged Communities, 34 (4): 282–90. https://doi.org/10.1016/j.amepre.2008.01.024.

FIGURE REFERENCES

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APPENDIX

Segment: Walkway/Sidewalks

Segment ID# ___________________

Auditor ID # ________

Type: Residential / Commercial

Street ________________Side N S E W

Starting Cross-street: ________________

Ending Cross-street: _________________

1. Is a sidewalk present?
   ☐ Yes ☐ No

2. What is the width of the majority of the sidewalk?
   ☐ < 3 ft. ☐ 3-5 ft. ☐ > 5 ft. ☐ No sidewalk

3. (a) Is there a buffer present?
   ☐ Yes ☐ No

4. Is the sidewalk *continuous* within the segment?
   ☐ Yes ☐ No ☐ No sidewalk

5. Are there poorly maintained sections of the sidewalk that constitute major trip hazards? *(e.g., heaves, misalignment, cracks, overgrowth)*
   ☐ None ☐ One ☐ A few ☐ A lot ☐ No sidewalk

6. How many traffic lanes are present (include all lanes that traffic can use; choose most predominant)?
   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7+

7. Is there a marked bicycle lane marked with a line or a raised curb?
   ☐ Yes ☐ No

8. Is there an informal path (shortcut), not on a cul-de-sac, which connects to something else?
   ☐ Yes ☐ No

9. How many trees exist within 5 feet of either side of the sidewalk/pathway (can be in buffer or setback; also count trees that are more than 5 feet away if they provide shade for the sidewalk/pathway)?
   ☐ 0 or 1 ☐ 2-5 ☐ 6-10 ☐ 11-20 ☐ 21+ ☐ N/A

10. How are the trees generally spaced?
   ☐ Evenly spaced ☐ Irregularly spaced ☐ N/A

11. What percentage of the length of the sidewalk/walkway is covered by trees, awnings or other overhead coverage?
   ☐ 1-25% ☐ 25-50% ☐ No coverage
   ☐ 51-75% ☐ 76-100% ☐ N/A

12. What is the smallest building setback from the sidewalk?
   ☐ No building ☐ <10 feet ☐ 10-20 feet
   ☐ 21-50 feet ☐ 51-100 feet ☐ >100 feet

13. What is the largest building setback from the sidewalk/walkway?
   ☐ No building ☐ <10 feet ☐10-20 feet
   ☐ 21-50 feet ☐ 51-100 feet ☐ >100 feet

14. What is the average height of buildings? *(Count both sides of the street)*
   ☐ No building ☐ 1-2 stories ☐ 3-5 stories
   ☐ 6-10 stories ☐ >10 stories

APPENDIX B

SITE PRIORITY MAP SCORE CALCULATION

Category	Lykins							Sheffield					
Accessibility	1	2	3	4	5	6	7	1	2	3	4	5	6
Block size (ft)	630	505	650	580	580	632	405	388	400	400	600	620	430
Connectivity	1.6+	1.5	1.6+	1.4	1.5	1.3	1.6+	1.5	1.6+	1.6+	1.6+	1.6+	1.6+
Existing Sidewalk	both	both	both	both	both	both	both	both	both	both	both	both	both
TOTAL													
Safety													
Crime	high	High	moderate	moderate	low	moderate	moderate	moderate	moderate	high	high	high	high
Pedestrian Crashes	moderate	high	high	very low	very low	low	moderate	very low	high	moderate	low	low	very low
Lighting	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Natural Surveillance	moderate	high	high	low	low	low	low	low	moderate	moderate	high	high	moderate
TOTAL													
Comfort													
Slope	6-10%	6-10%	0-5%	6-10%	6-10%	6-10%	6-10%	11%+	11%+	6-10%	6-10%	11%+	6-10%
Tree cover	25-75%	25-75%	25-75%	25-75%	25-75%	25-75%	25-75%	25-75%	25-75%	25-75%	0-25%	25-75%	25-75%
Hazards	0	3+	1-2	1-2	0	1-2	3+	1-2	0	1-2	1-2	1-2	1-2
TOTAL													
Vacancy													
Vacancy	moderate	high	moderate	moderate	high	high	high	high	moderate	moderate	moderate	low	moderate
Total													

Category	Lykins							Sheffield					
Accessibility	1	2	3	4	5	6	7	1	2	3	4	5	6
Block size (ft)	2	2	2	2	2	2	1	1	1	1	2	2	1
Connectivity	0	1	0	1	1	1	0	1	0	0	0	0	0
Existing Sidewalk	0	0	0	0	0	0	0	0	0	1	1	0	0
TOTAL	2	3	2	3	3	3	1	2	1	2	3	2	1
Safety													
Crime	5	5	3	3	1	3	3	3	3	5	5	5	5
Pedestrian Crashes	3	5	5	0	0	1	3	0	5	3	1	1	0
Lighting	0	0	0	0	0	0	0	0	0	0	0	0	0
Natural Surveillance	1	0	0	2	2	2	2	2	1	1	0	0	1
TOTAL	9	10	8	5	3	6	8	5	9	9	6	6	6
Comfort													
Slope	2	2	0	2	2	2	2	3	3	2	2	3	2
Tree cover	1	1	1	1	1	1	1	1	1	1	2	1	1
Hazards	0	3	1	1	0	1	3	1	0	1	1	1	1
TOTAL	3	6	2	4	3	4	6	5	4	4	5	5	4
Vacancy													
Vacancy	3	5	3	3	5	5	5	5	3	3	3	1	3
Total	17	24	15	15	14	18	20	17	17	18	17	14	14

RAW MAPS AUDIT SCORES

SEGMENT ID		Question Score										Total Score		Sidewalk Subscale		Tree Subscale		Buffer		Bike Lane		Informal Path	
DIR	NO.	1	2	3	4	5	7	8	9	10	11	Total	%	SW	SW%	T	T%	Buffer	%	BL	%	IP	%
NS	1	2	2	1	1	0	0	1	1	1	0	9	64.29%	5	83.33%	2	40.00%	1	100.00%	0	0.00%	1	100.00%
NS	2	2	2	1	0	1	0	1	1	0	0	6	42.86%	3	50.00%	1	20.00%	1	100.00%	0	0.00%	1	100.00%
NS	3	2	2	1	1	0	0	1	1	0	0	8	57.14%	5	83.33%	1	20.00%	1	100.00%	0	0.00%	1	100.00%
NS	4	2	2	1	1	0	0	1	0	0	0	7	50.00%	5	83.33%	0	0.00%	1	100.00%	0	0.00%	1	100.00%
NS	5	2	2	1	1	0	0	1	1	0	1	9	64.29%	5	83.33%	2	40.00%	1	100.00%	0	0.00%	1	100.00%
NS	6	2	2	1	0	1	0	1	1	0	0	6	42.86%	3	50.00%	1	20.00%	1	100.00%	0	0.00%	1	100.00%
NS	7	2	2	1	1	1	0	0	1	0	1	7	50.00%	4	66.67%	2	40.00%	1	100.00%	0	0.00%	0	0.00%
NS	8	2	2	1	1	0	0	1	1	0	1	9	64.29%	5	83.33%	2	40.00%	1	100.00%	0	0.00%	1	100.00%
NS	9	2	2	1	1	0	0	0	1	0	1	8	57.14%	5	83.33%	2	40.00%	1	100.00%	0	0.00%	0	0.00%
NS	10	2	2	1	0	1	0	1	1	0	0	6	42.86%	3	50.00%	1	20.00%	1	100.00%	0	0.00%	1	100.00%
NS	11	2	2	1	1	0	0	0	1	0	1	8	57.14%	5	83.33%	2	40.00%	1	100.00%	0	0.00%	0	0.00%
NS	12	2	2	1	1	0	0	1	1	0	0	8	57.14%	5	83.33%	1	20.00%	1	100.00%	0	0.00%	1	100.00%
NS	13	2	2	1	1	0	0	0	1	0	1	8	57.14%	5	83.33%	2	40.00%	1	100.00%	0	0.00%	0	0.00%
NS	14	2	2	0	0	0	0	0	0	0	0	4	28.57%	4	66.67%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
NS	15	0	0	0	0	0	0	0	1	0	0	1	7.14%	0	0.00%	1	20.00%	0	0.00%	0	0.00%	0	0.00%
NS	16	2	2	1	1	0	0	0	1	0	1	8	57.14%	5	83.33%	2	40.00%	1	100.00%	0	0.00%	0	0.00%
NS	17	2	2	1	1	0	0	0	1	0	1	8	57.14%	5	83.33%	2	40.00%	1	100.00%	0	0.00%	0	0.00%
NS	18	2	2	1	1	1	0	1	1	0	1	8	57.14%	4	66.67%	2	40.00%	1	100.00%	0	0.00%	1	100.00%
NS	19	2	2	1	1	0	0	0	1	0	0	7	50.00%	5	83.33%	1	20.00%	1	100.00%	0	0.00%	0	0.00%
NS	20	2	2	1	1	0	0	0	1	0	0	7	50.00%	5	83.33%	1	20.00%	1	100.00%	0	0.00%	0	0.00%
NS	21	2	2	1	1	0	0	1	0	0	0	7	50.00%	5	83.33%	0	0.00%	1	100.00%	0	0.00%	1	100.00%
NS	22	2	2	1	0	0	0	1	2	1	2	11	78.57%	4	66.67%	5	100.00%	1	100.00%	0	0.00%	1	100.00%
NS	23	2	2	1	1	1	0	1	1	0	0	7	50.00%	4	66.67%	1	20.00%	1	100.00%	0	0.00%	1	100.00%
NS	24	2	2	1	0	1	0	1	1	0	1	7	50.00%	3	50.00%	2	40.00%	1	100.00%	0	0.00%	1	100.00%
NS	25	0	0	0	0	0	0	0	1	0	0	1	7.14%	0	0.00%	1	20.00%	0	0.00%	0	0.00%	0	0.00%
NS	26	2	2	1	0	1	0	0	1	0	0	5	35.71%	3	50.00%	1	20.00%	1	100.00%	0	0.00%	0	0.00%
NS	27	2	2	1	1	0	0	1	1	0	1	9	64.29%	5	83.33%	2	40.00%	1	100.00%	0	0.00%	1	100.00%
NS	28	0	0	0	0	0	0	0	0	0	0	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
NS	29	2	2	1	1	0	0	0	1	0	0	7	50.00%	5	83.33%	1	20.00%	1	100.00%	0	0.00%	0	0.00%
NS	30	2	2	1	1	0	0	0	1	1	1	9	64.29%	5	83.33%	3	60.00%	1	100.00%	0	0.00%	0	0.00%
NS	31	2	2	1	1	1	0	0	2	1	2	10	71.43%	4	66.67%	5	100.00%	1	100.00%	0	0.00%	0	0.00%
NS	32	2	2	1	1	0	0	0	1	0	1	8	57.14%	5	83.33%	2	40.00%	1	100.00%	0	0.00%	0	0.00%
NS	33	2	2	1	1	0	0	0	1	0	0	7	50.00%	5	83.33%	1	20.00%	1	100.00%	0	0.00%	0	0.00%
NS	34	2	2	1	1	0	0	0	1	1	1	9	64.29%	5	83.33%	3	60.00%	1	100.00%	0	0.00%	0	0.00%
NS	35	2	2	1	0	1	0	0	1	0	1	6	42.86%	3	50.00%	2	40.00%	1	100.00%	0	0.00%	0	0.00%
NS	36	2	2	0	0	1	0	0	1	0	0	4	28.57%	3	50.00%	1	20.00%	0	0.00%	0	0.00%	0	0.00%
NS	37	2	2	0	0	1	0	0	1	0	0	4	28.57%	3	50.00%	1	20.00%	0	0.00%	0	0.00%	0	0.00%
NS	38	2	2	1	1	0	0	0	1	1	1	9	64.29%	5	83.33%	3	60.00%	1	100.00%	0	0.00%	0	0.00%
NS	39	2	2	1	1	0	0	0	1	0	0	7	50.00%	5	83.33%	1	20.00%	1	100.00%	0	0.00%	0	0.00%
NS	40	2	2	1	1	0	0	0	1	1	1	9	64.29%	5	83.33%	3	60.00%	1	100.00%	0	0.00%	0	0.00%
NS	41	2	2	1	0	0	0	1	1	0	0	7	50.00%	4	66.67%	1	20.00%	1	100.00%	0	0.00%	1	100.00%
NS	42	2	2	1	1	0	0	0	1	0	1	8	57.14%	5	83.33%	2	40.00%	1	100.00%	0	0.00%	0	0.00%

SEGMENT		Question Score										Total Score		Sidewalk Subscale		Tree Subscale		Buffer		Bike Lane		Informal Path	
DIR	NO.	1	2	3	4	5	7	8	9	10	11	Total	%	SW	SW%	T	T%	Buffer	%	BL	%	IP	%
EW	1	2	2	1	1	0	0	0	1	0	0	7	50.00%	5	83.33%	1	20.00%	1	100.00%	0	0.00%	0	0.00%
EW	2	0	0	0	0	0	0	0	1	0	1	2	14.29%	0	0.00%	2	40.00%	0	0.00%	0	0.00%	0	0.00%
EW	3	2	2	1	1	0	0	1	0	0	0	7	50.00%	5	83.33%	0	0.00%	1	100.00%	0	0.00%	1	100.00%
EW	4	2	2	1	1	0	0	0	1	0	0	7	50.00%	5	83.33%	1	20.00%	1	100.00%	0	0.00%	0	0.00%
EW	5	2	2	1	0	1	0	0	1	1	1	7	50.00%	3	50.00%	3	60.00%	1	100.00%	0	0.00%	0	0.00%
EW	6	2	2	1	1	0	0	0	2	1	1	10	71.43%	5	83.33%	4	80.00%	1	100.00%	0	0.00%	0	0.00%
EW	7	2	2	1	1	0	0	0	1	0	1	8	57.14%	5	83.33%	2	40.00%	1	100.00%	0	0.00%	0	0.00%
EW	8	2	2	1	1	1	0	0	1	0	0	6	42.86%	4	66.67%	1	20.00%	1	100.00%	0	0.00%	0	0.00%
EW	9	2	2	1	1	1	0	0	1	0	1	7	50.00%	4	66.67%	2	40.00%	1	100.00%	0	0.00%	0	0.00%
EW	10	2	2	1	1	1	0	0	1	0	0	6	42.86%	4	66.67%	1	20.00%	1	100.00%	0	0.00%	0	0.00%
EW	11	2	2	1	1	0	0	0	1	0	0	7	50.00%	5	83.33%	1	20.00%	1	100.00%	0	0.00%	0	0.00%
EW	12	2	2	0	1	0	0	0	0	0	0	5	35.71%	5	83.33%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
EW	13	2	2	1	1	1	0	0	1	0	0	6	42.86%	4	66.67%	1	20.00%	1	100.00%	0	0.00%	0	0.00%
EW	14	2	2	1	1	1	0	0	1	0	0	6	42.86%	4	66.67%	1	20.00%	1	100.00%	0	0.00%	0	0.00%
EW	15	2	2	1	1	1	0	0	2	0	1	8	57.14%	4	66.67%	3	60.00%	1	100.00%	0	0.00%	0	0.00%
EW	16	2	2	1	1	0	0	0	2	0	1	9	64.29%	5	83.33%	3	60.00%	1	100.00%	0	0.00%	0	0.00%
EW	17	2	2	1	1	0	0	0	1	0	1	8	57.14%	5	83.33%	2	40.00%	1	100.00%	0	0.00%	0	0.00%
EW	18	2	2	1	1	0	0	1	1	0	0	8	57.14%	5	83.33%	1	20.00%	1	100.00%	0	0.00%	1	100.00%
EW	19	2	2	1	1	0	0	0	1	0	0	7	50.00%	5	83.33%	1	20.00%	1	100.00%	0	0.00%	0	0.00%
EW	20	2	2	1	0	1	0	1	1	0	0	6	42.86%	3	50.00%	1	20.00%	1	100.00%	0	0.00%	1	100.00%
EW	21	2	2	1	0	1	0	1	1	0	1	7	50.00%	3	50.00%	2	40.00%	1	100.00%	0	0.00%	1	100.00%
EW	22	2	2	1	1	1	0	0	1	0	0	6	42.86%	4	66.67%	1	20.00%	1	100.00%	0	0.00%	0	0.00%
EW	23	2	2	1	1	0	0	0	1	0	1	8	57.14%	5	83.33%	2	40.00%	1	100.00%	0	0.00%	0	0.00%
EW	24	2	2	1	1	1	0	1	0	0	0	6	42.86%	4	66.67%	0	0.00%	1	100.00%	0	0.00%	1	100.00%
EW	25	2	2	1	1	0	0	0	0	0	0	6	42.86%	5	83.33%	0	0.00%	1	100.00%	0	0.00%	0	0.00%
EW	26	0	0	0	0	0	0	1	1	0	0	2	14.29%	0	0.00%	1	20.00%	0	0.00%	0	0.00%	1	100.00%
EW	27	2	2	1	1	0	0	0	0	0	0	6	42.86%	5	83.33%	0	0.00%	1	100.00%	0	0.00%	0	0.00%
EW	28	2	2	1	1	0	0	0	1	0	0	7	50.00%	5	83.33%	1	20.00%	1	100.00%	0	0.00%	0	0.00%
EW	29	2	2	1	1	0	0	0	1	0	1	8	57.14%	5	83.33%	2	40.00%	1	100.00%	0	0.00%	0	0.00%
EW	30	2	2	1	1	0	0	0	1	0	1	8	57.14%	5	83.33%	2	40.00%	1	100.00%	0	0.00%	0	0.00%
EW	31	0	0	0	0	0	0	1	0	0	0	1	7.14%	0	0.00%	0	0.00%	0	0.00%	0	0.00%	1	100.00%
EW	32	2	2	1	1	0	0	0	1	1	0	8	57.14%	5	83.33%	2	40.00%	1	100.00%	0	0.00%	0	0.00%
EW	33	2	2	1	0	1	0	1	1	0	1	7	50.00%	3	50.00%	2	40.00%	1	100.00%	0	0.00%	1	100.00%
EW	34	2	2	1	0	1	0	0	2	0	1	7	50.00%	3	50.00%	3	60.00%	1	100.00%	0	0.00%	0	0.00%
EW	35	2	2	1	1	0	0	1	1	0	0	8	57.14%	5	83.33%	1	20.00%	1	100.00%	0	0.00%	1	100.00%
EW	36	2	2	1	1	0	0	1	0	0	0	7	50.00%	5	83.33%	0	0.00%	1	100.00%	0	0.00%	1	100.00%

SUBSCALE SCORES

AVE TOTAL	AVE TOTAL %	
6.82	48.72%	Average score for all streets (out of 14 points or as a percent of possible points)

AVE SW	AVE SW %	
4.09	68.16%	Average sidewalk score (out of 6 possible points or as a percent of all points possible)

AVE TREE	AVE TREE %	
1.53	30.51%	Average tree score (out of 5 possible points or as a percentage of possible points)

AVE BUFF	AVE BUFF %	
0.87	87.18%	Average buffer score (out of 1) / Percentage of streets with buffers

AVE BIKE	AVE BIKE %	
0.00	0.00%	Average bike lane score (out of 1) / Percentage of streets with curbed/marked bike lanes

AVE PATH	AVE PATH %	
0.33	33.33%	Average informal path score (out of 1) / Percentage of streets with informal paths

Major Obstructions	Obstruction %	
25	32.05%	The number of sampled segments with major obstructions/precent of sampled segments with major obstructions

Low Tree Cover	Low Tree Cover %	
44	56.41%	Number of segments with low/no tree cover/percent of streets with low/no tree cover

Moderate Tree Cover	%	
32	41.03%	Number/percent of streets with moderate tree cover (25-75% cover)

Consistent Cover	Consistent Cover %	
10	12.82%	Streets with consistent/regularly spaced/even tree cover