Title

The Topography of Wellness: Mechanisms, metrics, and models of health in the urban landscape

Author

Carr, Sara Jensen

Publication Date

2014

Peer reviewed|Thesis/dissertation

The Topography of Wellness:

Mechanisms, Metrics, and Models of Health in the Urban Landscape

by

Sara Jensen Carr

A dissertation submitted in partial satisfaction of the

requirements for the degree of

Doctor of Philosophy

in

Landscape Architecture and
Environmental Planning

in the

Graduate Division

of the

University of California, Berkeley

Committee in charge:

Professor Louise Mozingo, Chair
Professor Emeritus Michael Southworth
Professor William Satariano

Fall 2014

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ABSTRACT

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Professor Louise Mozingo, Chair

Within the past 10 years there has been a rapid growth in studies addressing the link between the built environment's relationship to physical activity and chronic disease. However, even in a time of rapidly expanding spatial data, researchers still struggle with how best to measure the built environment within this context. In the past, disease mapping and an etiologic approach to public health often led to the elimination of entire neighborhoods (and the relocation of vulnerable populations within). Today, the origins of these "man-made" illnesses are often a confluence of genetic, biologic, and small-scale environmental factors, exacerbated by today's urban landscape—an environment that is in no way accidental. Through the lens of current research on walkable neighborhoods and an eye towards health equity, this dissertation examines larger questions regarding both the historical and present relationship between urban landscape and health. To begin to address these complex interactions not only between individuals and neighborhoods, but between parts of the built environment itself, this research also proposes an alternative model for built environment measurement that maps multiple opportunities and barriers to well-being in the urban landscape.

Studies still often rely on coarse measures such as density and land use to judge the walkability of a neighborhood, and often neglect more nuanced features of the built environment. The promised effectiveness of "walkable neighborhoods" also still relies on certain foundational concepts that proved to be pitfalls in past movements focused on health and the built environment. Proponents of walkable environments advocate for a one-size-fits-all framework of the influence of the built environment. This overlooks the fact that vulnerable populations, such as the elderly and youth, tend to feel the effects of the environment more acutely, or that low-income populations don't have the same amount of leisure time available for physical activity. Another is the premise that all can choose to live in a neighborhood deemed healthy, a confounder often referred to as "self-selection" in the literature—a premise that is disconnected from today's economic landscape. It is also unclear how the plethora of research on built environment and physical activity will become realized while avoiding the mistakes of past movements centered surrounding health.

This dissertation traces the historical and theoretical foundations of health and the built environment to the current state, as well as possible implications of contemporary study. Using lessons learned from a case study of how active design research has become policy in Sacramento, California, I propose a flexible model of built environment measurement for chronic disease outcomes. These multiple mappings of the city can reveal where risk of illness and opportunities for well-being lie in the built environment for focused and thoughtful interventions.

CONTENTS

ACKNOWLEDGMENTS

This dissertation is not just the result of my own work in the PhD program at the University of California Berkeley, but represents an incredible amount of support both within and outside the halls of academia. I first have to thank my Committee. Louise Mozingo was the Chair and became a true mentor and advocate throughout this process, encouraging me to reach my potential as a scholar and professional. Michael Southworth gave incredibly generous and detailed notes throughout the process of writing, and this document is all the better for it. Bill Satariano provided valuable insight from public health, and his research on walking and the elderly will certainly influence how I conduct my future work. Other mentors at Berkeley include Linda Jewell and Nicholas de Monchaux, who also provided guidance as well as research and teaching opportunities during my time here.

My colleagues in the LAEP program, particularly the members of my cohort, Pedro Pinto, David de la Peña and Raymond Wong, are incredibly talented people whose future accomplishments will be of incredible value to the field. A special mention is required for Allison Lassiter, my peer and writing partner, who always drives me to do better, and helped fuel research and writing with long conversation, walks and donuts.

The members of Design 4 Active Sacramento led me to add an entirely new dimension to this dissertation. I am awed by their tireless work to improve their city. I am especially grateful to Judy Robinson and Dr. Edie Zusman, who have been incredible advocates for me. I am incredibly grateful that I will continue to work with these amazing women after this project is filed.

Dale Johnson proofread the final drafts of this dissertation. What you read now is vastly improved from the original version. His diligence and generosity are much appreciated.

Lastly and most importantly, I could not have even considered entering this program without the support of my husband, Maclean. He has always encouraged me to fulfill potential that I sometimes don't see in myself. He is a true partner in life and work, especially in this past year, which has seen not only the birth of this document, but the birth of our beautiful and energetic baby boy, Wyatt Oliver Carr. Now that the chapters you read here are completed, I look forward to writing all the chapters that will follow.

CHAPTER ONE: INTRODUCTION

In the United States, urban health and urban landscape have been intrinsically related since the Industrial Era. Mass migration to cities resulted in overcrowding, poor living conditions and resultant infectious disease. This led to the first institutional use of urban planning, which was due to the necessity of separating land uses for the protection of a city's constituents (Corburn, 2007). The landscape was permanently changed by the massive sanitary infrastructure, realignment of streets, and segregation of building typologies. Although the mechanisms between the environment and the body were still unclear, changing public health concerns about access to fresh air and clean water, plus opportunity for activity were still embodied in the landscape prototypes of the late 1800s and early 1900s. The intention was that those designs would influence healthy behaviors (Olmsted, 1971). However, with the rise of germ theory in the early to mid-twentieth century, medical study turned toward biological and genetic drivers of disease and mostly disregarded external or environmental drivers of disease for molecular level causes of illness. This new view essentially severed further explorations into the mechanisms between the environment and individual health (Susser and Stein, 2009). However, once technology progressed to the point where it could overcome basic sanitation and prevented infectious disease, the relationship between urban fabric and urban health became more ambiguous. Even so, the occurrence of chronic disease in the latter half of the twentieth century still exhibited spatial clustering, indicating some relationship with environmental changes.

In the 1970s, the work of psychologist Robert Ader presented the first opportunities to connect environmental influence, individual perception and the manifestation of disease. By proving that stress had significant negative effects on disease immunity, health researchers could no longer dismiss the human body as an autonomous system of molecules. In the early 1980s, cross-disciplinary research by social epidemiologists, most notably the work done by Roslyn Lindheim, an architect, and Leonard Syme, a psychologist, further connected social and spatial conditions of neighborhoods to disease resistance. Further research, mostly performed by environmental psychologists, showed that both the perception and presence of the landscape mattered. Kuo and Sullivan's study on Chicago's Cabrini-Green housing projects (2001b) found that simply providing a view of the landscape from individual units decreased rates of mental fatigue and aggression. This proved that the structure of the environment could be a key intervening factor between stress and stress-related disease. The scientific evidence further articulated the hypothesized links between the built environment, experience and health outcomes.

Our current era of chronic disease emerges from a complicated intersection of genetic, behavioral and environmental factors, making proof of causal paths difficult (Diez Roux, 2004). As a result of these difficulties, the public health community has increasingly stressed the importance of health promotion and the study of everyday behaviors over disease treatment (Zusman et al., 2014). Lack of daily activity is believed to be one determinant in the occurrence of obesity and obesity-related diseases such as diabetes and cardiovascular disease. Many researchers in both public health and urban planning point to the potential correlation of these chronic diseases with auto-centered planning and building over the past several decades in the U.S. (Frumkin, Frank, and Jackson, 2004). As a result, the number of studies examining how the built environment influences walking and biking activity has expanded significantly in the past 10 years (Ewing and Cervero, 2010; R. Jackson, Dannenberg and Frumkin, 2013).

Even so, the strength of environmental influence on health and health behaviors varies among several models, if mentioned at all (McMichael, 1999; Northridge, Sclar and Biswas, 2003; Susser and Susser, 1996). More problematic, even with expanded libraries of spatial data and analytical tools such as geospatial information systems (GIS) software, researchers still struggle to understand what characteristics of the built environment matter most when it comes to health. In the era of infectious disease, spatial sources of illness could be located to tangible sources such as tainted water wells or factory waste. However, the era of chronic disease requires a method that accurately reflects the multi-faceted, biopsychosocial model of the city rather than simply physical sources. Even in light of increasingly available spatial data, most studies instead persist in focusing on basic quantitative dimensions of the built environment, such as land use acres, street widths and density—often arriving at ambiguous conclusions regarding causality (Diez Roux, 2001). The results from environmental psychology indicate that there are factors in the landscape beyond pure functionality that motivate people to walk and socialize in their neighborhoods. Yet, most research into the built environment as it relates to health continues to define environments at these coarse scales. This method not only glosses over the more fine-grained interactions between components of the urban fabric and are only a portion of the spatial experience of the city (Lathey, Guhathakurta and Aggarwal, 2009), but are difficult to change without massive regulatory process of changes to the zoning code (Scheer and American Planning Association, 2010).

Theoretical Context and Relevant Literature

Studies specifically on walkability/active living are the only lens through which this dissertation attempts to understand the larger question of linking the built environment and health. This dissertation draws on two specific subsets of environmental design and public health theory in order to reach a more robust model for built environment characterization. Public health literature on environmental embodiment can help us to understand how external physical and social factors can contribute to disease outcomes. Concurrently, environmental design theory offers a framework of how people, urban form and landscape coexist in complex urban systems. These two bodies of literature are rarely linked, if at all. This dissertation does so through the lens of the relationship between the form of the public realm, behavior and health.

The relative newness of place and health studies poses many epistemological difficulties. The first requires the general public to think of health as the right to a state of collective well-being, instead of the individual result of biology or behavior (Barton, Tsourou and World Health Organization, 2000). Second is a more structured definition of place in order to study relationships and most importantly, possible interventions. Most health research simply defines “place” as all possible causes lying outside the individual body, whether environmental hazards, social stressors or built influences, with little articulation about how each influences the body differently (Diez Roux, 2001). “Place” in environmental design is rooted in the specificity of physical form, local culture and natural environment. This dissertation seeks a workable definition between the two. The infectious disease model viewed the environment as where “some” source of illness could be traced to a physical location and then eliminated. The nature of chronic disease required reconceiving the relationship between the environment and the individual.

A growing body of research views health and place as a multifaceted model of physical and social dynamic forces. The “ecosocial theory,” first introduced by Nancy Krieger (2001), evokes a “spiderless web of causation,” indicating that there was no single pathogen causing chronic disease, but instead macro and micro threads constantly intersecting, with no definite direction. A.J. McMichael (1999) would build on a Chinese box metaphor, indicating that even as the various realms of the “environment” grew larger and moved away from the individual, they were interlocked in a multilevel world that still impacted health, although that impact was not necessarily based on proximity. Northridge et al., (2003) would further break down social and physical factors at these proximal levels, but showed reciprocal relationships between each. These models were an attempt to specify different aspects of the built environment previously thought of as a “black box” of mechanisms on the individual (Krieger, 2011; Macintyre, Ellaway and Cummins, 2002; Susser and Stein, 2009).

However, without a deeper grounding in morphological theory, vocabulary and systems, public health studies on built environments still tend to default to categorizing neighborhoods in a binary of “healthy” or “unhealthy,” when it comes to physical activity. While neighborhoods across metropolitan regions do normally exhibit some sort of larger patterns across its gradient, they are far more varied today than the urban/suburban dichotomy that is often used, particularly in growth, since the 1960s. Patterns are often tied to when a neighborhood was built and local conditions, making the historical context of place crucial to an understanding of its fabric (Southworth and Owens, 1993; Wheeler, 2008). This sort of qualitative analysis of place is also often disregarded due to time, resources and the issue of subjectivity. However, researchers such as Wheeler (Wheeler, 2008; Wheeler, 2002) and Andres Sevstuk’s studies on pedestrian mobility (Sevtsuk, 2010) demonstrate the use of common GIS-based tools to at least arrive at more localized characterizations of urban form. This research asserts that a more nuanced view could greatly benefit studies on public health and place and complement the proliferation of quantitative studies. More importantly, this type of spatial analysis can give clearer guidance on how to thoughtfully intervene in vulnerable communities.

Research Imperative

In an age where there is an increasing pressure on cities, landscapes and buildings to be performative in respect to environmental and social goals, perhaps health is appealing because it appears to be a clear cut goal with definite benchmarks. In this context, few see health beyond the question of form and disease outcomes, but in reality it is a much more fraught subject involving history, policy, culture and economics. There has been a pronounced interest in finding connections between the built environment and public health from both the academic and professional spheres in recent years. The American Institute of Architects (AIA), American Society of Landscape Architects (ASLA) and the Urban Land Institute (ULI) all announced initiatives in 2013 stressing the importance of their respective fields to ensuring health in the built environment (American Institute of Architects, n.d.; American Society of Landscape Architects, 2014; Urban Land Institute, 2014). Primarily decrying the auto-centered development of the late twentieth century, these professional organizations have declared a new era of engaging health in design decisions, albeit all separately from one another. However, their "new" concentration on health is uncritical, overlooking the professions' very real, very detrimental contributions to urban health in the past. The introduction of the planning and public health guide, *Creating Healthy Places* states, "The modern America of depression and loss of community has not 'happened' to us; rather we legislated, subsidized, and planned it" (Dannenberg, Frumkin and Jackson, 2011, p. xvii). In a growing body of literature addressing health in the public sphere, many researchers assert that the past several decades of urban planning that have prioritized capital over public health. These priorities have resulted in an environment that instead has severe negative impacts on our health today. Prioritizing the commodification of land and housing has led to unrestrained growth and ill health effects, particularly as the fields of public health and urban planning diverged (Corburn, 2007; Frumkin et al., 2004).

Almost all studies regarding health and the built environment conclude with a recommendation for interdisciplinary research and action. However, there are several barriers to collaboration, not the least of which is the lack of common vocabulary and theory between fields, particularly when it comes to the built environment. In physical activity studies, the built environment is primarily defined as land use, transportation systems and urban design (Handy, Boarnet, Ewing and Killingsworth, 2002). The last is described as "the design of the city and the physical elements within it, including both their arrangement and appearance, and is concerned with the function and appeal of public spaces" (Handy et al., 2002, p. 65). Land use and transportation systems, which have easily quantifiable attributes, are far more studied as attributes of the built environment. Urban design and form, as well as what aspects of it relate to health, are much less understood (Jackson, 2003).

This issue highlights an underlying problem with the use of spatial data itself, in that a misunderstanding of urban form leads to hypotheses that are structured around what spatial data is available off the shelf, rather than seeking or processing data to answer a question (Diez Roux, 2001). A prime example of this can be seen in the oft-used unit of "the neighborhood" in public health studies. The sample frame of the neighborhood is normally derived by the aggregation of census tracts, or otherwise municipally defined neighborhoods. Instead, many studies have shown that people consider the spatial limits of their neighborhood vary depending on whether the question discusses their residential, social or active environment (Cummins, Curtis, Diez-Roux and Macintyre, 2007; Cutts, Darby, Boone and Brewis, 2009). Complicating these questions is the argument regarding the self-selection of residents into their neighborhoods, creating a confounding variable in a typically constructed scientific study. The hypothesis that those who are already predisposed to physical activity will select neighborhoods with urban form that supports active recreation in the public realm, and vice versa, is often used to dismiss the impacts of the built environment (Eid, Turner, Overman and Puga, 2008; Southworth, 2005). But in the age of foreclosure, changing attitudes and real estate values of urban and suburban environments, how much mobility residents have in choosing where they live is less studied or discussed. The false dualism about whether health is a result of the composition or context of a population clouds a larger issue about inequities in the environment (Macintyre et al., 2002).

These arguments aside, few deny that there is a clear spatial distribution of disease and factors of the built environment that have been determined to be health-relevant, if not explicitly causal (Cutts et al., 2009; Frank, Saelens, Powell and Chapman, 2007; Smith and Easterlow, 2005). The most recent census data release shows that sprawling suburban neighborhoods, generalized as "unhealthy" by most contemporary literature, are also increasingly occupied by minority and immigrant populations, groups that are often most vulnerable to the type of chronic disease associated with the built environment. In the absence of more exacting and nuanced spatial analysis, categorization of environments as either "urban" or "suburban" creates a false binary about the structure of American cities (Harris and Lewis, 1998; Leinberger, 2010) and only serves to cast further dispersion on the generically defined suburban environments. Historically, the disintegration of past environments that were deemed "unhealthy" and the deterioration or removal of the populations therein, signals a troubling aspect of the otherwise admirable active living movement. This is an important issue as there is a strong impetus to apply active living research to physical development, as seen in the recent publications such as in the Leadership in Energy and Environmental Design Neighborhood Development (LEED-ND) design standards, New York City's *Active Design Guidelines* or other cities that have adopted health as a priority for planning and design. This is only the latest iteration in movements dating back to the Industrial Era that have applied health data in order to reinvent the public realm, often in response to a perceived specific health crisis. However, while having tangible positive effects, often the short sightedness and zeal to rebuild was often at the cost of exclusion and removal of disadvantaged populations. Walkability research similarly has the potential to shape the urban environment, so predicting the potential effects of these studies are worthy of further examination.

The development of more fine-grained measurements that reflect the specificity of place can help characterize neighborhoods in a manner that allows for tactical intervention, rather than having to work through the channels of large-scale zoning change, which can take years just to enact (Scheer and American Planning Association, 2010). Reducing built environments to measurements as coarse or placeless as "density" and attributing it to the cause of disease, or using this measurement as the basis to reconfigure a neighborhood is potentially disastrous. While avoiding the determinism of past movements related to health (which often eliminated entire blocks, or even neighborhoods in the effort to eliminate perceived sources of disease), a more flexible framework for urban evaluation is still needed for more nuanced, place-based interventions focused on the prevention of disease rather than its elimination. Social epidemiologist Nancy Krieger (2000) argues that even if causality cannot be proved, in the face of overwhelming evidence of *some* connection, particularly if it inequitably affects vulnerable communities, action is required. The causality and self-selection arguments aside, the current wave of interest in re-engaging urban design, planning and public health requires multiple and complex frameworks of understanding the systems of the built environment and its connection to behavior and illness outcomes.

Research Questions

The articulation of the built environment is elusive, particularly to public health researchers who are often seeking an empiric method to quantify and correlate impacts of neighborhoods on health outcomes, or even to effectively represent them (Ewing and Handy, 2009; Jackson, 2003). This dissertation offers a model for urban landscape characterization through three primary research questions:

1) What is the historical context of past urban designs as driven by health concerns?

2) How is the urban landscape addressed explicitly in the growing contemporary literature and development guidelines for healthy neighborhoods, and what metrics are appropriate or overlooked in its measurement?

3) With these previous questions in mind, as we move from eras of infectious disease to one of chronic disease, what is an appropriate spatial method for evaluating both operability and equity of pedestrian networks on a metropolitan scale?

Research Contribution

The primary contribution to the literature offered here is a spatial methodology to evaluate the built environment for health opportunities and risks, specifically active living. However, I present alongside this model two key pieces of support. The first is a case study of how active design is implemented on the ground by using research, policy and community knowledge. The second is a framework of walkability implementation, based on linkages between public health research and environmental design theory and practices. The method here is not intended to be definitive, but rather an alternative to traditional methods of studying walkability. It is also intended to be a tool geared specifically toward interventions for walkable neighborhoods, which I hope in the future will set the stage for future research on the impacts of environmental change.

Methods

This dissertation triangulates between historical, theoretical and practical frameworks of health and urban form, and landscape to put "walkability" in a new context. This mixed-methods approach is key to constructing a pragmatic tool for built environment characterization in public health study. The approach is cognizant of the fallout from past urban design movements driven by health, which tended to be overly rationalist in execution, and that the vast amounts of data both public health and design researchers have access to today may lead them in the same direction. A plurality of data does not necessarily create a more exacting or deterministic solution, but it can provide more nuanced shading to differing levels of risk and prevention in the built environment if viewed on a larger scale and applied thoughtfully. Additionally, multiple interpretations will be more understandable across fields whether they are geared toward the public health researcher, designer or community member. To arrive at this multifaceted understanding, I employ the following methods.

Historical and theoretical research. If walkability is an idea that is particular to our era, the motivations driving it are not. Reviewing the historical literature places walkability and built environment data in context in order to understand repeating patterns of vulnerable and privileged populations, how data and measurements are used to justify design decisions and the changing understandings of environmental embodiment, so we can better predict the potential fallacies in research and practice today. An overview of theory from both public health and environmental design aims to show overlaps and gaps in considering the built environment influence, as well as to arrive at a model that is acceptable to both.

Metaanalysis/Review. A review of the quantitative studies on walkability, drawn from both public health and urban planning, reveals methods, strength of particular correlates to walking and activity, accessibility measures and common conclusions from and contradictions between studies. Most walkability studies begin with the extraction of certain objective and quantitative built environment features (most commonly density and land use) and the comparison of selected neighborhoods, and the health and travel behavior of their residents. Alternatively, several studies use a suite of subjective, micro-level measures to analyze the appeal of neighborhoods or open space for residents, therefore facilitating activity. There is, in fact, so much literature on what makes a walkable neighborhood that it appears there is little to add in terms of independent variables or simplistic assumptions about causality. What is deficient from these studies is a method to not simply aggregate these variables, but to use theory about urban form to understand how multiple variables work together and how they can be read in the landscape (Ewing and Handy, 2009).

Case Study. Sacramento is a unique locality given that it is a state capitol and because of its Delta region ecology, but it also grew in a similar manner to many modern American cities. It holds a distinct downtown core once supported by nearby agricultural business and the railroad. It was later shaped by urban renewal and freeway construction in the 1950s and 1960s and subsequent outward suburban growth, and an exurban wave from the last major period of building (Avella, 2003). They also faced many of the same health crises discussed in the historical chapters, from cholera to tuberculosis to obesity-related chronic disease today. Over the course of a year, I tracked and observed how two local advocacy groups, WALKSacramento and Design 4 Active Sacramento, worked to implement healthy design into building policy and guidelines, often by relying on empirical research on physical activity and the built environment, such as that reviewed in the previous chapter. My experience and interviews with these group members helped shape my understanding of how environments can be changed both at the municipal and neighborhood level, as well as formed the design of the spatial analysis tool below.

Spatial Analysis. This dissertation asserts that a GIS-based analysis to spatially define the variables established in the meta-analysis is crucial not only to take advantage of increased availability of data, but in framing walkability in the context of the entire city, and as a question of equity in access to resources and recreational space. Independent variables of the built environment are actually rarely mapped in the studies examined here. It is more likely that they are statistically correlated. The production of maps to show nuanced changes across the city serve to break down binary definitions of “suburban” or “urban” environments as well as to target more exacting, small scale interventions. The intertwined history of public health and the public realm has often relied on mapping in order to reconstruct timelines and extents of disease events (Koch, 2011), but these methods are more suited to the infectious diseases of the past. The emergence of chronic diseases requires alternative mapping methods that show the possibility of risk and opportunity for prevention. The spatial analysis defines new “neighborhoods” that are shaped by built environment factors rather than municipal boundaries. Once changes in the built environment and access are delineated, this dissertation will overlay data from the Greater Sacramento Region *2010 Community Needs Assessment* and the California Health Interview Survey to see if there are health correlations to these new mapped boundaries. Additionally, visual observation of both the built environment and activity in the public realm will be employed to study how the on the ground reality correlates and contradicts assumptions made from the spatial analysis.

The end goal of this work is to build a more robust model of built environment characterization that is accepted by both fields of public health and design, and provides a more manageable view of the built environment than aggregating independent variables as discrete elements. The work of previous research from all fields has greatly advanced the study of walkable neighborhoods and prioritized the importance of the built environment in public health study. This work furthers and synthesizes current research with the hopes of leading not just these researchers, but community members, to a wider understanding of how the built environment and health go hand in hand, as well as providing a decision-making tool for real-life interventions.

Structure of Dissertation

In response to the three research questions, this dissertation is structured in three parts: Mechanisms, Metrics, and Models.

The first section (Mechanisms) surveys the history and theory behind the built environment and health outcomes. Chapter Two provides a narrative of historical convergences of the public health and public realm, specifically how modern epidemics have shaped American urbanization, from the Industrial Revolution to the present. Chapter Three examines public health theory and how changing ideas and theory about disease pathology have re-opened the field to built environment concerns.

The second section (Metrics) examines how data, measurements and mapping of the built environment have been utilized to give agency to health and place connections and influenced form. Chapter Four surveys current empirical research on built environment and health, evaluating for common conclusions, contradictions and research gaps.

The last section (Models) features how these historical and current constructions converge in the real world. Chapter Five introduces Sacramento, California, as a case study for these issues by discussing the local environment and tracking the work of a local advocacy group, Design 4 Active Sacramento, who is using built and environment and health research to influence local policy. Chapter Six outlays a critique of the current walkablity movement and proposes how methods in environmental design could provide a more robust model for evaluating urban form. Chapter Seven discusses my own design for a GIS-based method for mapping the opportunity for health and risk of chronic disease in the urban landscape as applied to the Sacramento case study. Key to distinguishing this work from other walkability evaluations is the consideration of the urban landscape and neighborhoods as an integrated network, instead of discrete pieces.

CHAPTER 2: SHIFTING GROUNDS

Historical Frameworks of Landscape and Health

Introduction

The American urban public realm is both the battleground and laboratory of epidemics. The design of the contemporary urban landscape has been indelibly shaped by public health strategies over the decades, a continuous process of removal and redesign. The straight, wide streets, green parks and hard urban plazas we know today were not just planned as urban interventions, but envisioned as grafts onto sick urban tissues, driven by the idea that the design of the urban environment could physically remove sources of disease and shape healthier behavior of their inhabitants. When germ theory emerged in the late nineteenth and early twentieth centuries, it created a definitive schism between public health and design practice. Designers and planners struggled with how to design for health in mind once medical research shifted from the external to the internal. As research interests have turned toward chronic disease and back to environmental pathology, designers are once again in the position to potentially shape cities for wellness, but in a vastly different era of scientific knowledge and tools.

This chapter presents six chronological case studies of design responses to urban epidemics that still mark the visible contemporary American landscape, characterized by their social fallout as much as their medical advances (See Figure 1). Although grouped roughly by era for organizational purposes, as with any societal change, it is worth noting that there is always overlap and lag time between modes of thought, medical discoveries, planning initiatives and built work. However, each era was defined by the singular obsession with the elimination of one perceived cause of illness in the built environment. While there were definite gains in urban health, that narrow vision often led to unforeseen problems in the next era, most often affecting the health of minority and immigrant populations. Today, although the causes of our aliments have become more nebulous and the historically conventional narrative of unhealthy cities and healthy suburbs have flipped, the approach to health in the built environment is still largely driven by the strategy of elimination and graft, but at the expense of these same populations. Our struggles with contemporary public health are as much formed by living within the pastiche of these historical ideas as much as it is by the emergence of man-made chronic disease, but to tackle the issues of the present we must also examine the errors of the past.

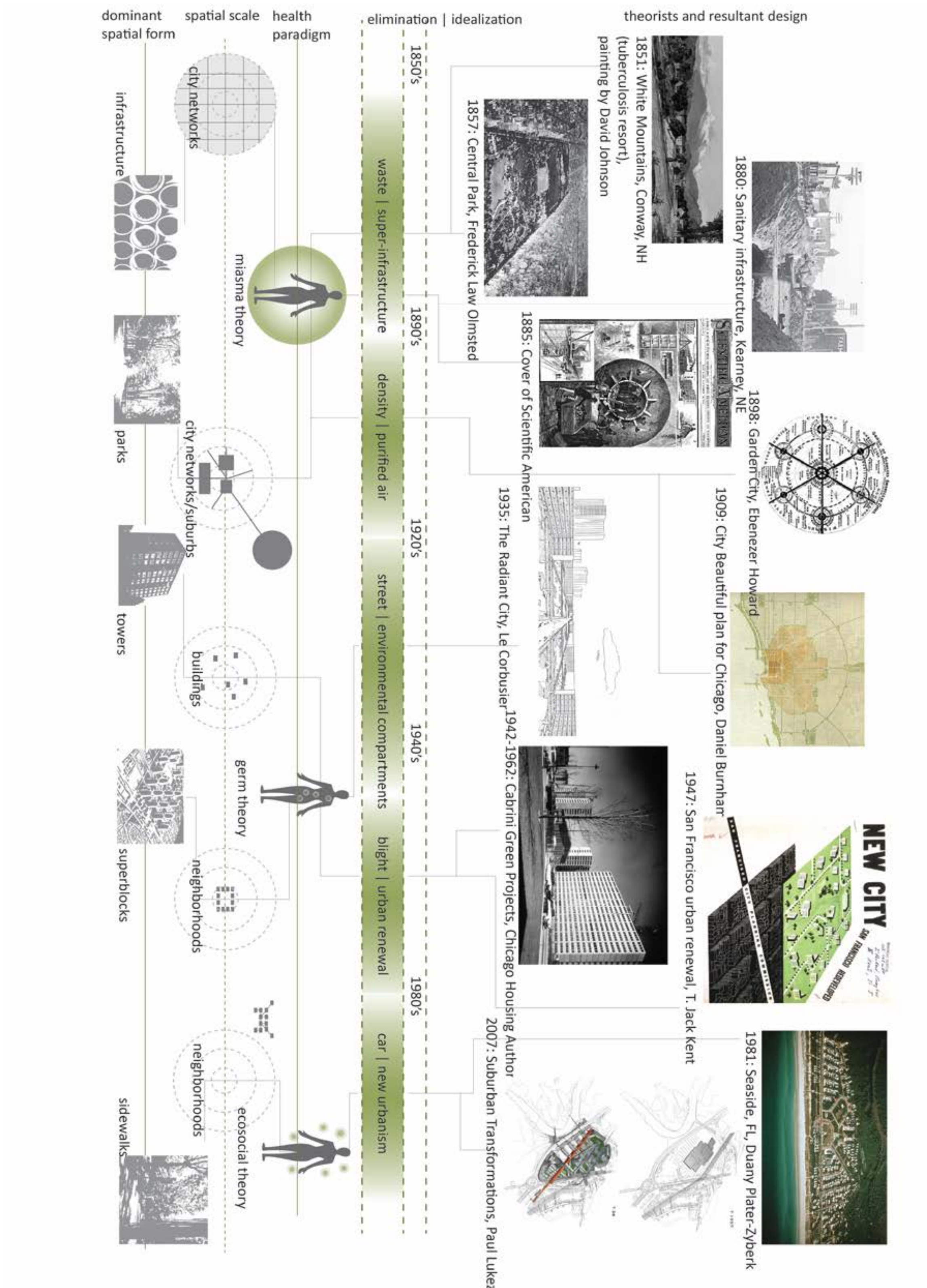

Figure 1: Historical Timeline of Public Health and the Public Realm

Eliminating Waste

The Industrial Revolution was not only the first instance of an urban movement integrating public health and design, but also when data and the spatial representation of disease began to play a major part in the reshaping of the city. Delineating the spatial distribution of infectious disease along with recording environmental conditions in the city united planners, designers and researchers in investigating how these epidemics spread, and enabled them to target certain areas of the city for rehabilitation. Their efforts were leveraged by this era's first institutionalization of the planning and public health professions in city government (Corburn, 2007). The American Medical Association, newly founded in 1855, established a committee on medical topography that would establish relations between locality and epidemic disease (Mitman and Numbers, 2003). The urban pattern and policy that guides city building today was indelibly shaped by the social and environmental conditions that plagued the first American cities and established how we conceive of disease in the city today.

As the American economy shifted from agricultural to industrial, the majority of the population similarly shifted from rural to urban areas (See Figure 2). The influx of people and factories greatly increased the amount of waste and sewage dumped in streets, rivers and lakes. However, this waste was the responsibility of each individual and business. With no municipal coordination for removal, it was not long until massive outbreaks of cholera, typhoid and yellow fever required coordinated action (Melosi, 2008). Most researchers also noted the tangible change in air quality in those neighborhoods most wracked by disease where population density was the highest—namely, where the majority of the working class lived in cramped housing conditions. Earlier medical research made a similar connection between disease and housing density during the yellow fever epidemic of the late 1700s, and their writings on how a density of people also often caused difference in air quality, sensed in noxious odors. These tangible causes of disease and their direct relationship to space were enough to mount citywide action (Koch, 2005). The theory of "bad airs" causing illness had been posited by Hippocrates almost 2,000 years prior, and carried through the eras of ancient Rome and the Renaissance. It still had relevance in the emergent urban condition (See Figure 3). However, there was disagreement of the root cause of illness. Was it the environment and the air, the proximity of people to each other, or the social condition? Those who subscribed to the first two schools of thought, respectively referred to as miasma and contagion theory, took a more clinical approach to analysis, and thus dominated discussions in the scientific community (Mitman and Numbers, 2003).

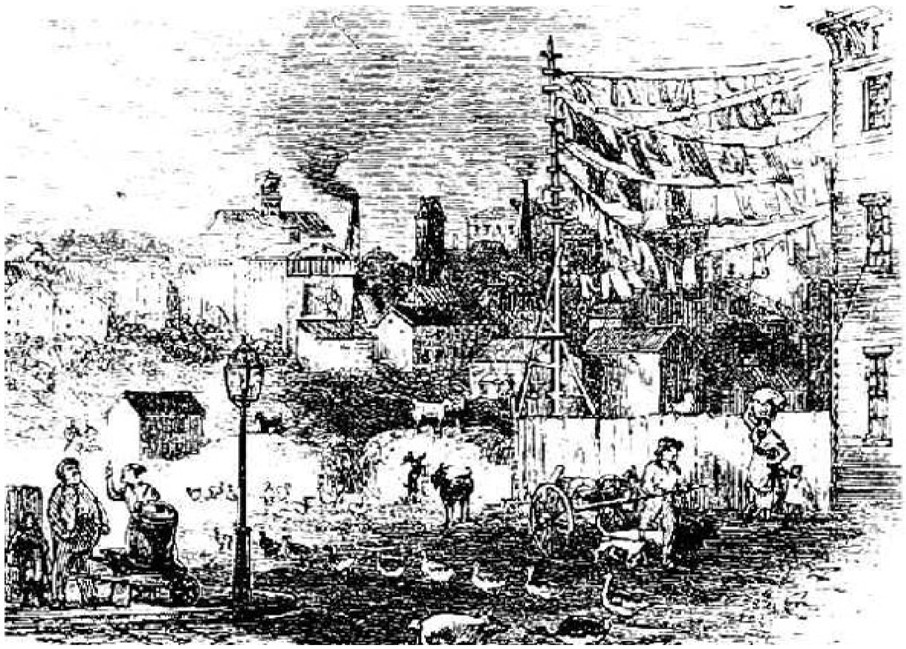

Figure 2: Depiction of Life in Newark, New Jersey During the Industrial Revolution (New York Public Library Collection)

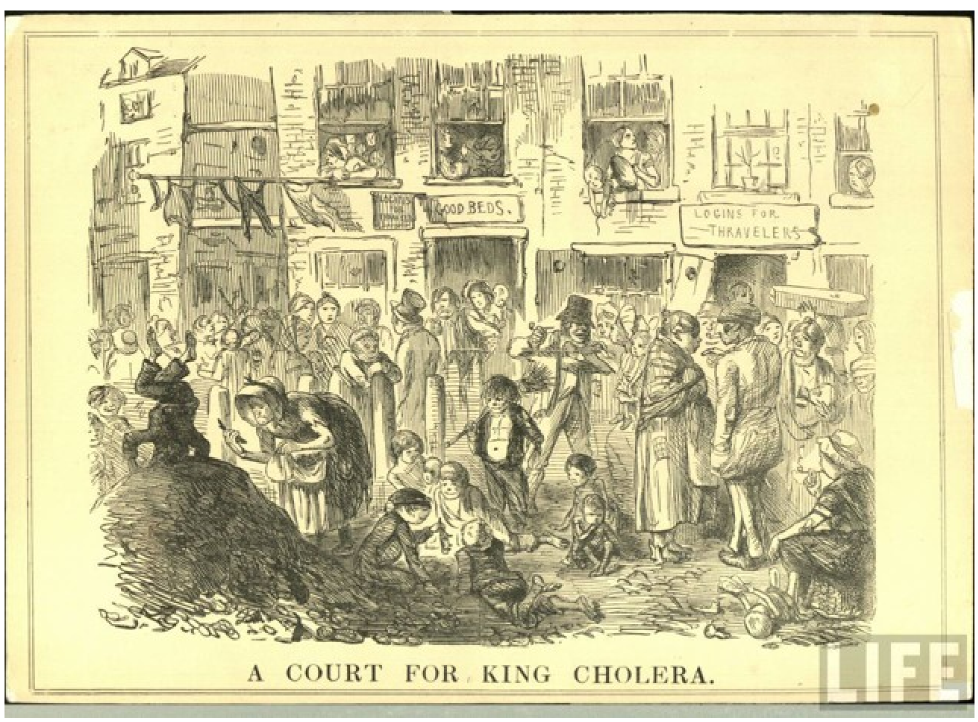

Figure 3: "A Court for King Cholera," from Punch Magazine (1852) (from LIFE Magazine Archives)

Which theory would prevail would have vastly different spatial implications. Although both miasma and contagion theory hypothesized that proximity is key to infection, inhalation damage was believed to be 300 to 400 yards away. Contagion could only occur, at a much closer proximity or even only upon immediate contact. Without the missing link of microscopy, a definitive answer could not be found (Koch, 2005). The pathology of contagion and the beginning threads of germ and organism theory proposed by Pasteur and Koch in the 1880s was still in the beginning stages of exploration and simply could not be explained to the public, or even other medical scientists, who grappled with how to reconcile their tentative discoveries about germs in the body with their Hippocratic roots in studying disease causes in the environment (Koch, 2011). Due to its long history in Hippocratic theory, miasma already had a significant foothold as a plausible cause. Previous eras had already seen illness stemming from the bad airs of excrement, decaying vegetable mater, marshy soils or stagnant water (Mitman and Numbers, 2003). Miasmic theory and these early connections between disease and the environment has was termed by Bill Luckin as "proto-environmentalism," in that it linked some health outcome to the environment even without the understanding of pathogenic organisms or ecological relationships (Mitman, 2005). Even though the pathways from bad airs to disease outcomes may not have been well understood, it still continued to drive much of the American urban design. As discussed in the next section, theory was also wielded in the City Beautiful movement of the Progressive Era as well (Hewitt and Szczygiel, 2000). The tangibility of miasma theory was enough to support a broad campaign of sanitation, as the causes of miasma were blamed collectively on density and waste.

In addition, the mapping and statistical work of sanitarian Edwin Chadwick and physician John Snow in England had linked disease outbreak to sources of contaminated water and rotting waste, giving credibility to miasma theory and driving the successful advocacy for engineered waterways and urban waste removal in Europe (Koch, 2005; Melosi, 2008). The first professional civil engineering programs in the United States coincided with this growing evidence, providing both the technological and administrative power to embark on major infrastructural programs (See Figure 4). In the United States, sewer systems became a mark not only of a healthy society, but the first step in a society that was civilized and had potential for economic, cultural, and social growth. An unidentified Baltimore engineer, albeit one who was competing for a sewer building contract, credited Europe's extensive sewer system for low mortality rates and its reputation as the center for the best "art, literature, science, and architecture" (Schultz and McShane, 1978). Philadelphia was the first city to build a public waterworks system in the 1790s. New York and Boston built theirs in the early 1800s, and by 1850 most major cities had a system in place. Although at this time most city services were privatized, water systems became public by necessity as no private firm could be convinced to serve entire populations, both rich and poor, purely out of concern for well-being (Melosi, 2008; Schultz and McShane, 1978). These systems, which combine both clean water supply and convey combined sewage and runoff waste, often are the same systems that operate in these major cities today.

This sanitation campaign formed the bones of the urban landscape we know today. Much like Paris' sewer system overhaul presented an opportunity to build Hausmann's grand boulevards, the new systems installed in the United States required straighter, longer streets

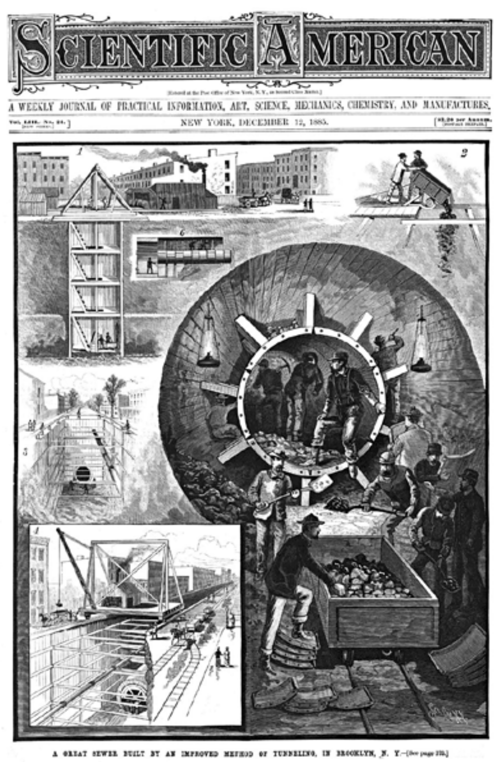

Figure 4: Installing Sanitary Infrastructure in Kearney, Nebraska, 1889, (Solomon Butcher, Nebraska Historical Society) (Top); From cover of Scientific American, 1885. (Collection of Jon C. Schladweiler, Pima County Wastewater Management Department) (Bottom)

for conveyance. At first, the new underground sewers took waste out of the street but noxious gases still escaped into the air. Per miasmic theory, the air expelled as matter decayed was potentially just as harmful as the water itself. Physicians and sanitary engineers advocated for steeply grading and paving surfaces to move water out and trap it underground (Schultz and McShane, 1978). Of course, much of this restructuring was done at the expense of dense and similarly “noxious” worker and immigrant housing, which were the first sectors to be torn down and rebuilt (Corburn, 2007). Still, though, the technology to move wastewater underground and garbage offsite preceded the technology to actually treat waste. Urban waterways and bodies were already being used as a dumping ground for factories, and eventually became the end point for urban waste as well, a strategy Jason Corburn (2007) refers to as “reducing pollution through dilution.” Over time, these naturally open waterways were contained in underground culverts and paved over. Even marshlands that was otherwise untouched by waste but still held brackish water and expelled stagnant air were filled in, which served the dual purpose of sanitizing them and accommodating urban expansion (Corburn, 2007; Melosi, 2008). And as cities expanded, the infrastructure expanded with it, with outfalls further and further away from where people lived, effectively disconnecting them from the detritus of daily urban life. Of course, relaying this history is not meant to imply that the sewers system was the only driver for straight streets and grand boulevards. The grid system has its origins in Roman town-planning to make conquered cities more readable for incoming soldiers. Hausmann’s boulevards were meant to exert power as much as they were to accommodate infrastructure (Kostof, 1985; Rogers, 2001). However, in American urban development, this particular piece of urban morphology was intrinsically tied to disease.

The success of the sanitary movement demonstrated “a new faith in the power of scientific control of the physical environment,” CEA Winslow said in *The Conquest of Epidemic Disease* (Winslow, 1980), a landmark future generations of planners and designers would use to seize on data-driven, formally rational solutions for combating health in the public realm. What fell by the wayside were the arguments for the less linear path between poverty and illness. Ultimately, while the environmental argument for health led to public intervention in the health crisis, the idea that disease disproportionately affected the poor because of insufficient hygiene habits or moral shortcomings persisted in popular opinion (Fitzpatrick and La Gory, 2000; Nash, 2006; Schultz and McShane, 1978). Even more uncomfortably, the sanitation movement and its removal of certain populations did have darker undertones—better housing and sanitation were the keys to a more efficient and well society, and indeed there are documented meetings between city planners and eugenics advocates during this time (Hall, 1996). The reliance and faith in data and the arguments of personal responsibility versus the overwhelming need for public, coordinated intervention in health crises are debates that would persist into the next several decades, even as the illness under discussion changed.

Eliminating Density

The Progressive Era in the United States represents the apex of a united public health and planning agenda, and saw the execution of several large scale projects. The successes of the sanitary era further empowered many prominent designers and planners, and they subsequently began to expand on how health in the urban landscape could be accomplished. With the technological specifics of eliminating solid and liquid waste from the city more or less accomplished, many began to harness emerging philosophy about man's relationship to nature to current thinking about disease pathology. The new straight, clean streets shaped by the infrastructure of the previous era received green grafts of manicured landscape. The urban nature of this period was purified, sanitized and often used as a way of alleviating urban density, a replacement of people with green. By this time, the concept of nature as healer was already popularized among the elite in the writings of philosophers such as Muir and Thoreau, who elevated their own experiences in the wilderness to advocate for a closer relationship between man and wild, emphasizing how the health of humans and urban society could be modeled by the ecological balance they found inherent in nature. This popular idealization of nature was not only seen in the city, but would also predicate the formation of the National Parks system. Greg Mitman notes that those particular authors' enthusiasm for the restorative effects of nature were more based in Muir's and Thoreau's specific personal experiences with consumptive illness. The symptoms were alleviated once they were in fresh air, out of the cramped confines of the city. But throughout this period nature would often be generalized as a cure-all for any urban affliction—physical and moral. However, for the most part, the desired pureness of nature was mostly accessible only to the upper class. Access to nature meant leaving the city. Elite vacation communities, designed to alleviate symptoms such as hay fever, began to arise in far-flung locations from the city like Vermont and upstate New York (Mitman, 2005).

Medical thought and popular media converged to support ideas about spatial relocation to less developed environs, primarily in the West, to cure symptoms. Western cities like Phoenix and Denver grew significantly by specifically recruiting asthmatics. Dr. Charles Denison's *Rocky Mountain Health Resorts* (1880) advertised that Colorado was often referred to as the "Switzerland of the Americas," evoking images of clean mountain air, and as in the previous era, the generally accepted superior moral values of Europeans. It was estimated that up to a quarter of people who settled in Colorado, Arizona, and California during this time did so for their health or family member's health. Ironically, agriculture and increasing irrigation supported plant growth in the future, and so many developed allergies (Keirns, 2012). Railroad expansion also encouraged travel and relocation. Ultimately, by 1890, Denver had grown by almost a third, with some 30,000 people moving there in an attempt to treat consumption. This rate of growth would persist for the next three decades. Health was not only an ideal, but an economic resource for new cities. The rise of pulmonary tuberculosis also spurred an interest in the relationship between climatology and disease. The American Climatological Association was formed in 1883, with a commitment to studying the origins of respiratory disease and pushing for climatology to be taught in medical schools. Meanwhile, even in the mid-1880s, the public health community was still struggling with explaining germ theory, particularly to the more vocal proponents of miasma. Buffalo physician FR Campbell dismissed germ theorists by stating that "… by their constant microscopical labors they have become intellectually myopic, and cannot see that there may be causes of disease which it is impossible to place beneath a cover glass" (Mitman and Numbers, 2003).

Back in the cities, planners were able to take advantage of this lack of consensus in the medical community. The evangelism regarding nature and wilderness, and institutional collaborations between the planning and public health fields began to wield an incredible influence in the shaping of the urban environment. At a planning conference Henry Morgenthau, banker and real estate figure said the planner should eliminate breeding places of "disease, moral depravity, discontent and socialism" (Hall, 1996). The job of a planner was to impose order on an uncertain, messy, seemingly threatening world—not just to eliminate epidemics, but elevate the moral morass of the inner city. Planners and designers were closely entwined with the urban public health institutions, making them de facto experts on urban health crises. Landscape architect Frederick Law Olmsted served as Secretary to the U.S. Sanitary Commission from 1861 to 1863 (Fisher, 2010). Olmsted's experience with the Commission convinced him that the generalized slum conditions seen in working-class neighborhoods were the root causes of disease, amplified through density, resulting in mass contagion (Olmsted, 1971). A few decades later, Olmstead's contemporary Daniel Burnham would admire Hausmann's transformation of Old Paris, with "its dirty, crowded, ill-smelling narrow, winding streets, the hotbeds of vice and crime," (Burnham, 1993, p. 15) through grand, tree-planted avenues. Burnham would also advocate for parks to be equally distributed ("one acre for each hundred people") and was successful in getting the Special Park Commission in the Chicago City Council to pass a resolution that recognized parks' value in "preventing crime, promoting cleanliness and diminishing disease" (Burnham, Bennett, Moore and Commercial Club of Chicago, 1993).

Of course, the value of green space to urban populations was not just the passive removal of undefined pollutants and germs, but to exhort upon them the benefits of outdoor exercise. Green space was privileged not just in Chicago but in Burnham's other city plans. Much like Hausmann's streets led people to parks and landmarks in Paris and to famous monuments in Washington, D.C., Burnham's grand boulevards often terminated or intersected in grand outdoor spaces. In his ultimately unbuilt plan for San Francisco, Burnham justified his radiating boulevards from Market and Van Ness by stating they would bring the city into "miraculous formal equilibrium" (equilibrium being a goal of health, and echoing the perceived balance of nature) and designed a continuous park strip leading to Golden Gate Park. Wide green parkways led to residential access roads or linked to civic parks, a design method that was later adopted by Robert Moses in New York in the 1960s (Hall, 1996).

Extensive planting of trees and green no longer had to be justified for purely aesthetic reasons. The proto-environmentalism of the sanitary era was sufficient to convince most that the roots and leaves had a cleansing effect on the air and groundwater. The planners and designers claimed science and rationalism behind their design. However, there was not exactly a "scientific" placement to the trees. The goal was simply to recreate a pastoral view of nature, seen as inherently good and healthful. Some historians have claimed that despite their claims, the Progressive Era's prevailing ideas about urban nature were not strictly prescriptive in their use of landscape, but rather a restorative factor that could build resistance to disease exposure (Hewitt and Szczygiel, 2000). Pathological specifics notwithstanding, Olmsted and Burnham were able to capitalize on this dominant medical thought, and even utilized a shared vocabulary with public health as a way to re-shape cities. Not all in the planning and design community were convinced, though. Critic Lewis Mumford called the Burnham approach in Chicago “municipal cosmetic,” comparing it to the planning of totalitarian regimes and criticizing it for ignoring housing, schools and sanitation. Similarly, Hall (1996) argues that the City Beautiful movement portended future practices of exclusionary zoning and was “planning without social purpose—even with a regressive one” (p. 41) as planning became further untethered from basic societal goals such as housing the poor. The ideal of the City Beautiful gave way to the “City Functional,” emphasizing zoning to benefit business over aesthetics when there ultimately wasn’t enough money to realize aesthetics on a grander scale (Hall, 1996).

Figure 5: Frederick Law Olmsted’s Central Park Alleviates the Density of New York City, 1925 (Library of Congress)

Meanwhile, despite the efforts in cities like Chicago, New York and San Francisco, the conception of the city as a breeding ground of disease and nature as its tonic persisted in popular thought, and those who could afford it sought to leave the city altogether for the literal greener pastures. Even with urban improvement projects in both Europe and in the U.S., the increased utilization of population data and medical topographies still revealed higher mortality rates in the city than in rural areas, strengthening those associations between density and disease (Hewitt and Szczygiel, 2000). *All About Santa Barbara, California: The Sanitarium of the Pacific Coast* (1878), a promotional pamphlet for a tuberculosis sanitarium warns:

Persons predisposed to consumption ought not to be allowed to live in cities. The absence of sunlight is a frightful cause of the prevalence of the disease. The streets are so narrow and the houses so high, that sunlight seldom reaches the sitting rooms. The schoolhouses are so situated that children can scarcely ever see the sun. The sun is the source of all light, life and beauty, and is as necessary to give color and health and life to animals and plants. It corrects musty smells, so prolific of disease. There is no surer way of promoting consumption than by the exclusion of sunlight. Sedentary life and inactivity, impure air and the absence of sunlight in cities produce a fearful mortality.Ebenezer Howard's *Garden Cities of Tomorrow* (1898) was a response to this thinking and sought to combine the mobility and economic robustness of the city with the perceived health of rural life. However, its realization could only be achieved by expanding development into heretofore undeveloped land. Howard was also directly influenced by Benjamin Ward Richardson's *Hygeia* (Richardson, 1876)—specifying low population density, good housing, wide roads, underground railway and open space. The Garden City model is purposely non-contextual so as to be universal, and goes beyond describing naturopathic ideas about the inherent goodness of country life and exposure to "green," to prescribing exacting economic and social relationships that are influenced by urban form (Howard and Osborn, 1965). The very goal of the Garden City was social and physical control, and to maintain rigid homogeneity.

However, the cities were never built as completely self-contained social and economic units due to the failure of the new society to re-adopt sustenance farming and the agricultural greenbelt restricting growth. Rather, they acted as corollaries to the cities they radiated out from, and set the pattern of residential suburbs' dependence on economic centers that characterized the United States for much of the twentieth century (Bruegmann, 2005). The problem of the Garden City was that agriculture was not sufficient enough to meet the economic and social opportunities the city has. Too distant from urban centers, or when manufacturing plants like the Ford Dagenham plant were built outside the city, there were not sufficient transportation links (Hall, 1996).

Many of Howard's ideas were translated to the United States via Raymond Unwin, a British engineer, architect and planner. Unwin's plans for Letchworth, England, considered the first built Garden City, and Hampstead Garden Suburb demonstrated the ideas he laid forth in his 1912 pamphlet *Nothing Gained by Overcrowding!* and was swiftly adopted by England's Ministry of Health as model housing. Unwin neglected to translate much of Howard's economic ideas in favor of formal styles and guidelines, as a direct rebuke to urban living—chiefly the dense living conditions—as stated clearly in the pamphlet's title. A specified minimum distance of 70 feet between houses, or 12 houses per acre, not only served to let miasmic airs dissipate and guard against the contagion of person-to-person contact, but also guaranteed a degree of sunshine and fresh air. Unwin also had to grapple with increasing use of the automobile. Fearing pedestrian safety he actually sought to reduce auto land use by cutting down the amount of road area from 40 to 17 percent, and subsequently raising garden and open space land from 17 to 55 percent (Unwin, 1912). Howard's and Unwin's models were translated into their most pure form in Radburn, New Jersey, planned by Clarence Stein and Henry Wright in 1928 and built by 1929 (See Figure 6). However, Stein and Wright were also influenced by the work of sociologist and planner Clarence Perry, who had attached social ideals to the concept of the neighborhood unit, and in his 1929 monograph further crystallized the concept of an ideal town based on a school catchment area of a half mile radius. Perry also emphasized the importance of a town square holding a flagpole and annual readings of the Declaration of Independence—implicitly, the idea was that immigrants would move out of the city and be civilized and assimilated by the form and planning of the neighborhood (Hall, 1996; Perry, et al.,

Figure 6: Radburn, New Jersey, 1928, Clarence Stein and Henry Wright (Source Unknown, courtesy University of California Visual Resources Center)

1929). Like Unwin, Perry also had a great deal of distaste for the automobile. His advocacy for the neighborhood unit was in fact a way to combat the “menace” he saw in its rise in popularity. On the other hand, Stein and Wright, while keeping to much of Howard’s and Unwin’s tenets particularly regarding density and a country home aesthetic, chose to accommodate the automobile but would separate pedestrian pathways from vehicle roads, allowing developers to sell Radburn as “A Town for the Motor Age” (Hall, 1996).

Unlike many Utopian planning schemes, Howard was actually keenly obsessed with sustainably and incrementally financing the Garden City through a system of payments to a general welfare fund after mortgages were paid off, and funneling increasing land values back into community amenities, including pensions for the town’s elderly. Ultimately those were cast aside in favor of the aesthetic of better living, which was actually not a focus of Howard’s work, rather more from Unwin’s pamphlets. Romantic cottage houses and personal realms of green space never utilized for productive farming, per Howard’s intent, proved the more alluring aspect of the town. Nor did the self-sustaining craftsmen Howard envisioned materialize. The centers of industry remained far outside these Garden Cities, not only making it inconvenient for the workers most in need of better health to live there, but for financiers to recoup their investment, the rent had to be set much higher than intended. Instead, these towns became the template for the eventual American suburb, as we “got the shell [of the Garden City ideal] without the substance” (Hall, 1996, p. 316).

Whether in urban or suburban neighborhoods, the commonality between The City Beautiful and Garden City movements was the faith in nature as a cure, and the strategy of relieving residential density through green. The concentration on bad airs, and to a lesser extent, waters being the source of disease was still a direct effect of miasmic theory (Hewitt and Szczygiel, 2000). Where previously cities had sought to neutralize miasmic gases by dumping waste into waterbodies, diluting and dispersing the source, the efforts of Olmsted, Howard, et al., sought to neutralize by dispersion of people themselves, setting a pattern for future thinking about healthful neighborhoods. The ideal density of the Garden City model was approximately 5,000 people per square mile, comparable to many inner-ring suburbs today; most contemporary suburbs have much lower residential densities. However, the legacy of low-density, segregated land-use planning and the broad application of green persisted long beyond the Progressive Era, shaping a majority of the American environment we live in today.

Eliminating the Street

While housing and personal lifestyles had always been a concern of reformers and progressives in the previous eras, they had to first attended to matters of the public realm, sanitizing the city through zoning, streets and parks. With these matters accomplished, the Modern Era marked a turn inward to the scale of dwellings, attempting to replicate robust urban systems at the scale of single buildings.

As opposed to the faith in nature that shaped healthful design the Progressive Era, the early modern era was defined by an absolute faith in science and technology. This didn’t mean the presence of landscape became absent in design and planning for health, but rather its utilization was justified on more scientific and rational grounds, particularly in relation to the architecture of this time period. Similarly, the development of germ theory in medical science took the forefront in disease treatment and research, pushing population health concerns into the background. The internal shifts in public health after germ theory are discussed in more detail in the following chapter, but the social lines of thought that followed this discovery are also key to understanding the reasoning behind the designs of this period. One caveat to the following discussion: we are temporarily leaving the context of the United States to examine how disease and medical thinking of this time influenced architecture, specifically the work of architect Le Corbusier, who has only one built work in the United States. However, Le Corbusier did discuss health extensively through his prolific writing and publication, and is both a logical progression from the sanitary design of the previous building, but his work is a direct precedent of American public housing prototypes, which are discussed in the subsequent sections. For the purposes of the larger discussion, his work is a crucial link between pre- and post-germ theory design for health. Although his actual work discussed here is mostly theoretical, the reasoning behind its design merits its own separate discussion.

In the medical community, the emergence of germ theory suddenly shifted the burden of health from the external to the internal, and more implicitly, from the state to the individual. Miasma was an affliction of the public realm and consequently encouraged an era of social ethics and responsibility. In the 30 years of the cholera epidemic, the general population would come to understand sickness as a product of interaction with an environment beyond their personal control, although the debate about personal morality was still in the background (Melosi, 2008). Consequently, although the previous eras saw a unification in planning, design and public health, the modern era marked their divergence. Scientists began to better understand the pathogenic relationships of microbes, and furthered the notion that all sickness could be eliminated at the molecular level source. Disease treatment, particularly through vaccination, was favored over taking preventative measures. More so, as bacteriology was better understood, the literally atmospheric concepts of epidemics dissipated. Health became the burden of the individual, associated with personal exposure and responsibility (Corburn, 2007; Susser and Stein, 2009).

Partly due to this divergence, but also due to the de-emphasis on public space's relationship to public health and public health in general, there are fewer lasting examples of (or scholarship on) designing for health than in the mid- to late-1800s and early twentieth century. However, germ theory also influenced a more sophisticated and nuanced understanding of the environment and the body. Some writers would still use the new terminology of infectious disease to convey that environmental health was still important to individual health. Physiologist Walter B. Cannon, author of *The Wisdom of the Body* (1932), advocated for an environmental ethic by hypothesizing that the body's processes were indelibly entwined with nature's processes, with sickness an indicator of disruption in the latter. He compared the concept to the pathology of diabetes, noting that the disease occurs when the pancreas, a perfect self-regulatory system, fails to produce the proper amount of insulin in response to blood sugar levels. Ecologist and writer Aldo Leopold would also conceptualize human health as an ecosystem, but also "land health" as a process similar to human health. He compared the eradication of deer in Wisconsin to the bacteriologist eradicating the singular bacteria that caused tuberculosis, but was critical of both for ignoring the wider context and ecological balance (Mitman, 2005).

Meanwhile, in design for health the concentration also went internal, from the urban environment to the scale of buildings. Architects now had technology that allowed them to build bigger and deal more efficiently with waste, air and light in every building. A 1934 building manual on the building of skyscrapers, *Sanitation in Modern Architecture*, outlines specifically how new engineering technology influenced architectural form. Just as the sanitary era hid and conveyed waste under the streets, the book decrees that skyscrapers should relegate their wastewater pipes to a mechanical central core, a vertical manifestation of the urban strategies of the past. Concealing the inner workings of the building also allowed for continuous glass facades to allow sunlight into tall office towers. To deal with impure urban airs (now caused by autos rather than waste), a tower was to be significantly set back from street, to allow wind to blow away the congestion of the traffic (Mathews, 1934).

Famed architect Le Corbusier was also concerned with issues of health but took it far beyond simple functionality so issues of light, air and waste dictated even the smallest details of his designs, albeit in a way that was truly "modern," i.e., presented in a manner that was scientific, rational and quantitative. Science literally ruled in the case of Le Corbusier's *Radiant City,* which dictated that this particular utopia would not be overseen by any kind of elected official, but rather by someone with the qualifications to understand "scientific principles" applied to the well-being of its citizens (Scott, 1998). The International Congresses of Modern Architecture (ICAM) advocated for a "scientific housing" that would even be taught to primary school children, emphasizing not just the importance of sunlight and fresh air to health, but also precise formulas on how to employ it in architecture. In the *City of Tomorrow, and its Planning* (1929), Le Corbusier applied these ideas about the compartmentalization of the environment to the urban scale, hypothesizing exact cubic meters of air, sunlight and open space needed per resident, and using these measures as a formula for town planning (Le Corbusier, 1971; Le Corbusier, 1967). Like Ebenezer Howard, who essentially planned the Garden City around the relationship of local jobs to housing needs, Le Corbusier similarly designed an entire city around the binary relationship of what he saw as basic human functioning to housing units, although it should be noted that these formulas have yet to be traced to any actual precedent science. Also like Howard, Le Corbusier's vision also could not be realized on anything but a blank slate. Unlike Howard, Le Corbusier's outlines for the administration and economics of the city were superficial and only tangentially dealt with at best, but per the thinking of the Modern era, he believed current and future "science" and rationality would prevail over any sort of government charter.

Le Corbusier would state that the goal of modularizing the outdoors was social and health equality, but pragmatically it was also a way to cope with the larger scale of superstructures allowed by new construction materials and methods. Units could be repeated ad infinitum, and the promise of technology in the modern era was the freedom to build without limits. Like Howard or Burnham, Le Corbusier essentially planned a town, but one that was completely encased in a residential tower. He envisioned all interactions as vertical and internal to the building itself, mostly to segregate people from the congestion of the street and reduce the danger of pedestrian and automobile accidents. This was an explicit goal of Le Corbusier, with one of the 14 principles of the Radiant City, "The Death of the Street." Besides internalizing the functions of the street in the form of corridors, hallways and elevators, the superblock planning eliminates the street in favor of expanses of undefined green space (Le Corbusier, 1967). It is not that Le Corbusier did not recognize the street as a social construct of community as well as a physical component, he was simply trying to re-contextualize it within the building itself for the protection of the buildings' citizens. His rejection of the urban street shows the carryover of popular thought about the city from the previous era, associating the city with pestilence, disease, darkness and disorder, and obsession with bad airs and waters. Along with the street, Le Corbusier's ideal city further improved on the present day city by eliminating the dank spaces of the subterranean. The underground is no longer occupiable, it only serves to bury piped infrastructure. Even in his singular works of architecture, you can see the architect's rejection of the spaces that normally collect moisture or dust—the Villa Savoye stands on piloti, with no dank cellar, and the flat roof serves as another living space instead of an attic (Gissen, 2009; Le Corbusier, 1967).

Of course, where Le Corbusier's prototypes differ most distinctly from Progressive Era planning is in his embrace of density. Unlike the previous movement to alleviate density by the insertion of parks and nature, or the removal of neighborhoods altogether, Le Corbusier accepted urban growth as a part of progress. He instead concentrated populations in the tower in order to leave more green space in between. Still, though, the uncritical, unexamined view of nature as healer remains the same. In Le Corbusier's Radiant City, the mere presence of green is enough to provide restorative benefits, and it is quantified in units with equal value, like light and air, but not articulated in terms of composition, placement and arrangement. While air and light are parceled out to each living unit, the appropriate units of green space are aggregated on the ground, rather than distributed out to each individual, per the Garden City plans. It is not that landscape isn't elevated to the same level of importance as light and air. There are several guidelines for its use and design in the Radiant City, and the fact that buildings and roads were designed for maximum density and efficiency left a copious amount of green on the ground floor. However, like the plans for the units themselves, the green space is anonymous and flat, to encourage flexibility of use. Although sun and fresh air could access the uppermost reaches of the building, the aggregated units of green space remain far away from the residential unit itself and actually further isolate each tower (Scott, 1998). A 2013 Museum of Modern Art exhibit in New York City on Le Corbusier's designs subtitled the show as "Embracing the Landscape." But even in the context of this reframing, Le Corbusier's drawings and buildings still only show the landscape is either contained and remote, viewed through the windows of his towers, or serving as a platform for structures. By keeping the landscape at arm's length, Le Corbusier is also showing his mastery over the wilder and unknown aspects of nature, keeping his imagined residents far away from the messiness of pollen or other allergens. Greenery also was also planted around the segregated auto roads as a buffer and still thought of as a filter for bad airs, even though the science around why trees worked this way was still unknown (Gissen, 2009). The designated active landscapes are so flexible to activity as to be indistinguishable from the other green spaces—that is to say, completely flat. A primary criticism of Oscar Niemeyer's Brasilia, the closest built realization of Le Corbusier's writings, is that once you are on the ground, the layout is difficult to navigate. Without differentiation in the landscape, the town instead becomes unnavigable.

While Le Corbusier explicitly discussed how his designs would liberate residents from the filth and disease of the city and reconnect them with nature, it is also interesting to note that his publications also coincided with the rise of tuberculosis in Europe and the United States. Linked to growing industrialization, the disease mainly affected younger men and women of working age. While architecture and planning had become institutionally separated from departments of public health, Le Corbusier, like many designers and particularly the modernists, still sought to link design to a social purpose, in his case, to create communities that were classless. Before a cure for tuberculosis was found, it was still common for many medical professionals to recommend the afflicted get as much sunlight and fresh air as possible. Sun treatments, called heliotherapy, treated the sun as a literal bacteriacide. Le Corbusier's flat roofs, deep patios, and white floors and walls would both reflect sunlight into the far reaches of their units, reflecting the medical thinking of this era (Campbell, 2005). Ironically, perhaps unknown or otherwise ignored by Le Corbusier, there were indications at this point that tuberculosis thrived in dense living conditions, the sort of which he was proposing (Wallace and Wallace, 1990). Moreover, though, there is a definite influence of modern architecture on sanitorias of the time, or perhaps vice-versa. Even though those who could afford it were still looking to uproot to drier, alpine airs to treat tuberculosis, the buildings themselves, like Le Corbusier's design for his unnamed city, negated sense of place and were ruthless in their neutrality. Not betraying any particular culture, taste or aesthetic, the buildings were literally cleansed of the possible disruption or messiness of place (Campbell, 2005).

The 1950s saw the discovery of several different tuberculosis vaccines and the epidemic was soon under control in the developed world. This particular case in both public health and design history both definitively marks the advent of germ theory and set adrift the guiding theory for design and health. As public health turned inward to the study of disease on microbial scales, so too would designers examine their work in the context of the psychological over physiological responses to design. This became especially true in the next era, where the ideals of Modernist design were applied with a broad brush that favored the economic efficiency of the schemes in order to address issues of public housing in the United States, and would subsequently became visually associated with the urban crises of the late-twentieth century.

Eliminating Blight

In the mid- to late-twentieth century, the perspective on the city remained decidedly negative. Journalism describing the "urban crisis" and the problems of "blight" began to appear in the mid-1960s, connecting the physical state of cities to immoral behavior of the urban working class (Frumkin et al., 2004). This public sentiment was soon matched by federal disinvestment in urban areas themselves. New highway construction re-routed residents to the suburbs, physically cutting off existing neighborhoods from the rest of the urban fabric, and the inner city was left to languish. While urban housing fell into deeper crisis, suburban neighborhoods were still held as the ideal standard for healthy living, although economically and through legally dubious practices such as redlining, they remained unavailable to minority populations (Frug, 2006).

Contrary to most scholarship asserting that medicine and city planning was unconcerned with issues of environmental public health (Corburn, 2007; Krieger, 2011; Susser and Stein, 2009), two minor publications of this period indicate otherwise. In 1960, the American Public Health Association's (APHA) Committee on the Hygiene of Housing published *Planning the Neighborhood*, and in 1977, the Centers for Disease Control (CDC) released *The Effect of the Man-Made Environment on Health and Behavior*: *Planning the Neighborhood* is decidedly a template for typical suburban neighborhoods of this time, although it purports to be a universal guide to planning, claiming that these "environmental standards for rural housing can be easily combined with those for urban and suburban housing" (American Public Health Association and Committee on the Hygiene of Housing, 1960, p. vi). However, the guidelines echo many of the tenets of the Garden City and its subsequent translations—neighborhood units based on school catchment areas, provisions for green space and the separation of vehicle and pedestrian roads. The primary concerns here are not environmental hazards like pollution and water quality, as these are assumed to be inner-city issues, but rather sanitation and sanitary services—even avoiding moral hazards such as taverns and nightclubs—shielding the planned community from the perceived causes of urban crisis. The booklet also remains fixated on ideal residential densities and lot size and floor/area equations, showing that the ideal way of living can be achieved through quantification.

As opposed to a planning document, *The Effect of the Man-Made Environment on Health and Behavior* is meant to be an overview of the state of the science regarding public health and the built environment. Like the APHA manual, there is a particular focus on residential environments. Unlike the APHA manual, the issues addressed in the book are explicitly urban, with the results often negative. Although also concerned with the science of evaluating the built environment and public health hypotheses models on the physical and social environments' impact on health outcomes, the essays collectively show the vision of the city in the late 1970s. Research on chronic disease at this time was still relatively new, and infectious disease was controlled by microbiology. Subsequently, the scientists here are more concerned with the "disease" of social problems such as poverty and racial tensions, but also with the environmental dangers the city still posed—such as traffic congestion, fossil fuel use and the still unknown threats of nuclear power. Donald Kennedy in a chapter entitled "Community Health and the Urban Environment" states outright, "American cities are unhealthy places in which to live, work, play or visit …" due to a number of environmental causes but also because the heterogeneity of the urban population, as "each person brings to the city a set of vulnerabilities and handicaps," leading to racial discrimination, civil disorder and crime" (p. 9). The diversity of the city is a distinct negative, an idea that would be reversed in later decades. Kennedy goes on to note that the "serious problems [are] associated with black minority groups," but exclusionary zoning had all but made the (preferred) environment of the suburbs inaccessible to them. The takeaway from *The Effect of the Man-Made*

Environment on Health and Behavior, is that because a scientific model for associating those outcomes with the physical environment was lacking, scientists concentrated on the effects of the social environment on unhealthy behavior. The book openly debunks what the environmental determinism designers and planners had claimed for years (Hinkle, Loring, and Centers for Disease Control, 1977). Despite the oft-cited contemporaneous writings of Jane Jacobs and Lewis Mumford that celebrated the social life of the city, it should be noted that the CDC book, along with the writings of sociologists like Robert Park and others in the Chicago School, described a picture of the urban environment that was inhospitable at best, and a denigration to health at worst (Nicolaides, 2006).

Metaphorical urban illnesses applied not just to people, but to the physical fabric itself. Many urban scholars used the language of disease and epidemiology to describe the spread of vacant buildings and their associated problems of squatters, fires, etc. In a chapter for *Urban Policy Making and Metropolitan Development* (1976), Michael Dear stated that "… contagion has major implications for our understanding of the dynamics of abandonment, and for later policy considerations," while Wallace and Wallace associated the expansion of urban municipal services, particularly fire protection, as "immunization" (Wallace and Wallace, 1983). With human epidemics assumed to be under control by vaccinations and other medical technologies, urban advocates now attempted to re-appropriate the language of disease to propose treatments. The fear that the urban blight would spread to the suburbs ideal lent both urgency and agency to what we now know as the urban renewal programs. And as in disease epidemics of the past, when "immunizations" such as increased municipal services and attempts to enforce stricter building codes did not show immediate progress, the answer instead was to "eliminate" the source of disease by leveling neighborhoods altogether (von Hoffman, 2008).

The health-related goals, and more crucially, the economic efficiency of modern housing proved appealing to federal and city governments who were now faced with the re-housing of the urban poor. Additionally, the demolition of urban renewal left behind a blank slate on which to rebuild, the dream scenario of any Modernist (Corburn, 2007). However, the high density of modern housing was also appealing due to the shrinking amounts of land available to build on. The 1949 Urban Redevelopment Act deemed much of the cleared land in city centers too valuable for housing and instead intended it to be improved with civic centers, schools or retail. Prominent architects and landscape architects of the 1960s such as Louis Kahn and Lawrence Halprin designed sleek, hardscaped urban plazas in the city centers—long, flat planes devoid of vegetation—the landscape corollary to European modern housing. Consequently, new public housing was built on land on the outskirts of the city, or otherwise left to degrade (von Hoffman, 2008). The aesthetics of modern housing sought to fight the public imagination of the slums, projecting an image of cleanliness and sleekness, a sterility echoing the increased emphasis on microbial sanitation in a germ theory era (See Figure 7). Among elite groups, public housing represented the vanguard of contemporary design. An entire 1938 issue of *Architectural Forum* was dedicated to featuring photographs and plans of new public housing design across the nation. In a 1940 issue of the *American Sociological Review*, F. Stuart Chapin studied the "Social Effects of Good Housing," with reams of data purporting to show improved aesthetics and improved psychological health among the residents of a housing project in the

Sumner Fields Homes of Minneapolis. The sheer amount of numbers cloud any real conclusive analysis, but the "science" of the study gave housing proponents increased leverage, even after Chapin published a follow-up study one year later showing no real difference in morale or psychological adjustment among the rehoused (Chapin, 1940; Hinkle, Loring and Centers for Disease Control, 1977). As more and more projects were built in the style, its use as a type did not elevate the living conditions of those within, but instead solidified a visual identity for public housing, and quickly identified those living there as poor and downtrodden (Von Hoffman, 1996). The features of modern housing meant to promote health instead attenuated the dangers of the city, particularly because of their subpar maintenance. The wide and labyrinthine corridors meant to replace the street and encourage leisurely interactions between residents were instead dark and confusing, allowing for intruders to hide and attack. The skip-stop elevators, ostensibly meant to encourage physical activity and increase mechanical efficiency, often broke down and were undersized, increasing resident frustration. Exposed steam piping burned children playing around the building (Comerio, 1981). Modernism's predominance in new public housing construction came to an end when the National Commission on Urban Problems officially condemned high rise housing in 1968. In later decades, most notably after President Clinton's HOPE VI legislation, lower-density townhouse style housing was phased in, seemingly in an effort to recreate a traditional, "healthier" neighborhood feel (Von Hoffman, 1996).

In *The Death and Life of Great American Cities* (J. Jacobs, 1961) Jane Jacobs notes that advanced statistical formulas made it easier to calculate material, budget, space and energy, but could not calculate the social costs of uprooting families, nor the public housing environment itself. At the risk of even more loss on investment and uprooting residents once again, even the new legislation never effectively got rid of the old public housing, so several housing projects remained, and even today their effects on health are still being articulated. More than 30 years after the condemnation of high-rise housing, sociologists Frances Kuo and William Sullivan studied the relationship between crime and visible vegetation in Chicago's Cabrini Green projects (built between 1942 and 1962), and found that there were significantly more crimes reported on sides of the buildings that did not have views of green space than those that did, with even less crimes on sides with more robust vegetation (i.e., high canopy trees). They attributed the difference to vegetation's effect on mental fatigue, which over time could lead to more acts of aggression (Kuo and Sullivan, 2001a).

Kuo and Sullivan's study highlights two interesting points about the role of nature in disadvantaged neighborhoods. One, that the study discounted much of the crime prevention literature of that time period which asserted that more greenery in high-crime neighborhoods encouraged crime as it hid undesirable activity. Two, that for all that ultimately failed in the translation of Modern design to the architecture of public housing, there was some credence to Le Corbusier's theory that just viewing nature was enough for it to have therapeutic benefits.

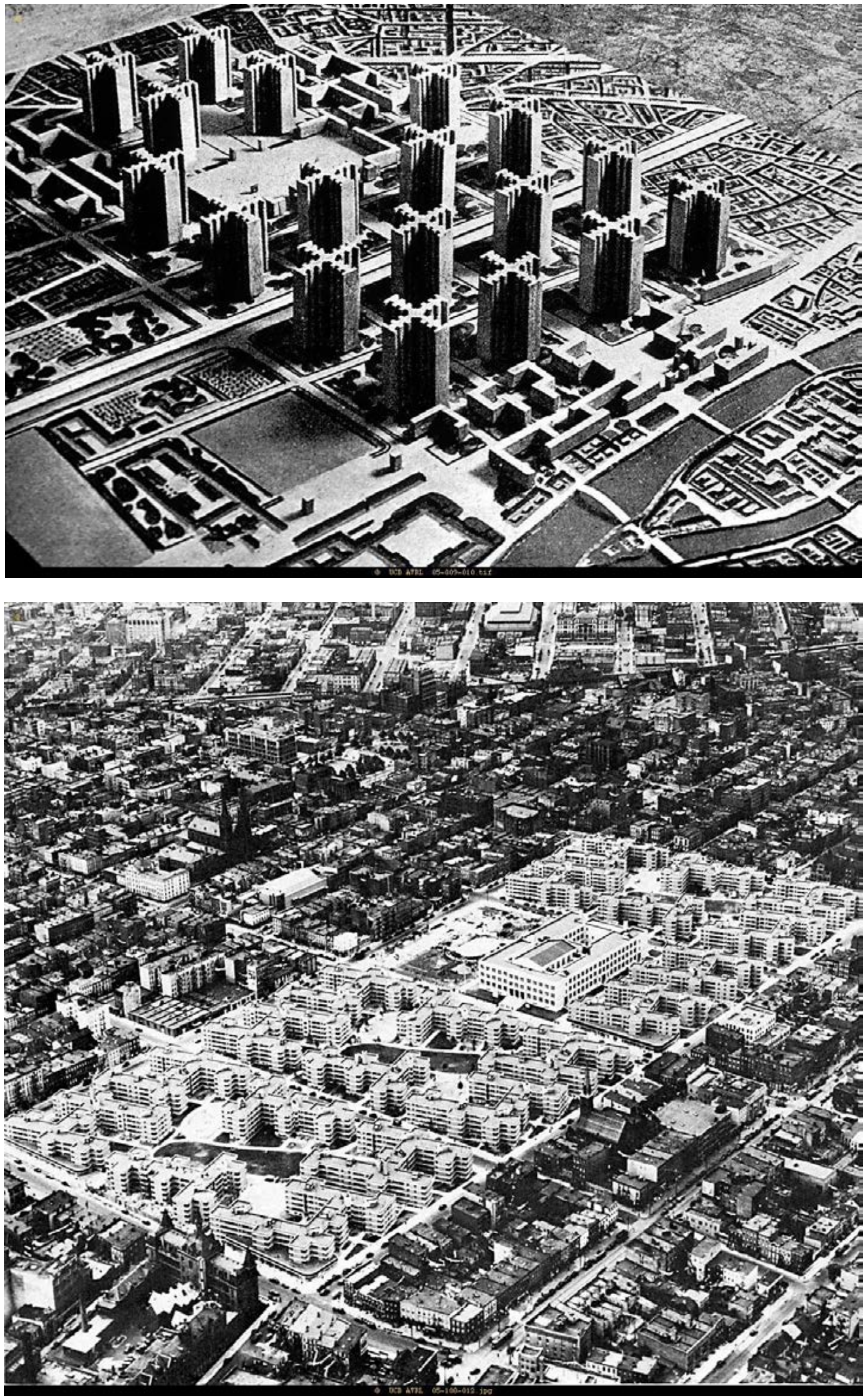

Figure 7: Voison Plan for Paris, Le Corbusier, 1925 (Source Unknown, courtesy University of California CED Visual Resources Center) (Top); Housing in Williamsburg, Brooklyn, 1934 (from *The Federal Presence: Architecture, Politics and Symbols in US Government Bu*ilding*, by Lois Craig)* (Bottom)

The post-Modern era reveals both the design and planning professions in flux when relating to public health matters. On one hand, while infectious disease had mostly been dealt with through germ theory research, the urban renewal programs recall the kind of neighborhood clearance seen in the era of the sanitary city, perhaps even on a larger scale. However, the key difference was that instead of eliminating a contagious epidemic such as cholera, governments were combating the less-defined epidemic of "blight," encompassing general disrepair and chaos, treating a social affliction as if its pathology was etiologic and could be eliminated at the source (See Figure 8). Ultimately, though, the end result did not remove the perceived source of ills in the physical environment—only the populations (Corburn, 2007). This idea was uncomfortably coupled with the idea that disease was tied to immoral behavior and supported the individualization of disease. Ill health was a product of personal actions, not of the environment, a concept furthered by the popularization of individual treatments such as vaccinations. The burden of public health was no longer on public agencies, reflected in the overall disinvestment from cites in the 1960s and 1970s and the disintegration of the urban fabric (Fitzpatrick and La Gory, 2000).

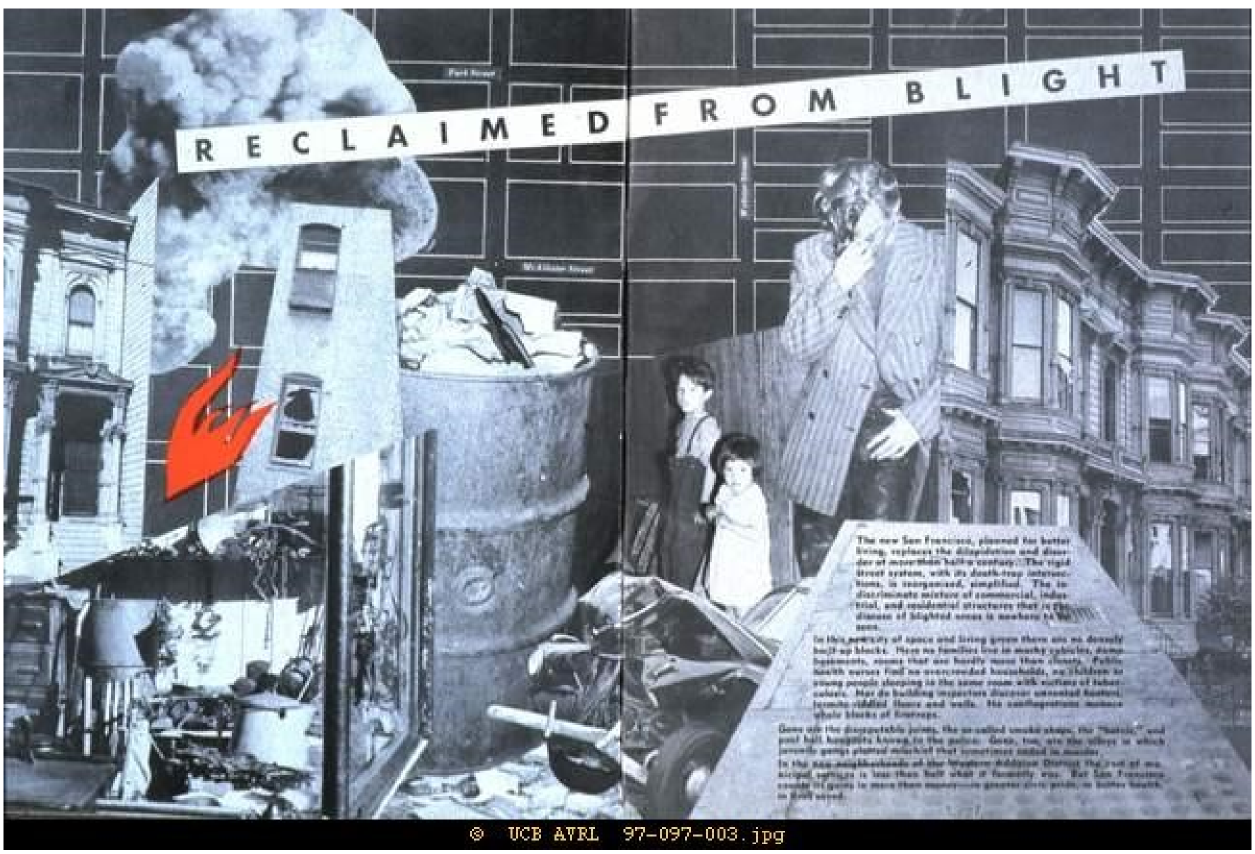

Figure 8: Collage by T. Jack Kent, San Francisco City Planner (from New City: San Francisco Redeveloped: San Francisco Planning Commission)

Combating the Auto

While the move to the suburbs was certainly not solely driven by health concerns, it is undeniable that the key to the promise of the suburbs was heavily staked in its pastoral green lawns, safety from urban crime and an escape from the congestion of the city. However, the explosive suburban growth of the mid- to late-twentieth century was also aided by government policy such as the Federal Housing Act of 1949, which expanded funding and restructured mortgage issuance for suburban housing units along with urban renewal projects, and the Federal Aid Highway Act of 1956 (Williamson, 2013). Comparable to the era when modernism was mutated by policy and economics to address the public housing problem, so were the ideals of the Garden City in order to form the suburbs we know today. Breugmann (2005) refutes that these were not the sole reasons of suburban growth, as often stated, but rather the increased wealth in the United States which made traditionally American desires for privacy, mobility and choice material in its new neighborhoods. It is likely safe to say that the confluence of many factors, both policy driven and an idealism about what the suburbs offered were behind the expansion.

Idealism would sour in the 1990s, although an academic backlash existed as early as the late 1950s and 1960s. While the popular culture of television and advertising, driven by developer capital, celebrated the moral virtues of the suburbs, a community of urban scholars including Jane Jacobs and Lewis Mumford decried sprawling growth as destructive to American community, and incubator to social dysfunction. Lewis Mumford had initially been an advocate of the Garden Cities model for its organic approach, and most importantly its emphasis on growth control, but was disillusioned with the suburbs that grew out of those original ideas. The “uniform, unidentifiable houses” and the endless repetitive street patterns that were built instead did not live up to the complexity of Howard’s work. These critics essentially defined the suburbs as a point by point rejection of what defined cities, chiefly in its density and diversity of buildings and populations. Like the arguments about the health of the city of the time, the critiques of the built environment of the suburbs was in how they engendered unhealthy social behaviors, although the chief critics of this time could not agree what precisely those outcomes were. William Whyte thought that the danger of the suburbs was in their encouragement of conformity by enforcing a strict social ethic; Jacobs and Mumford believed the scale and design of the environment encouraged isolationism. They all agreed it encouraged some type of social malaise, although this hypothesis was difficult to prove with empirical rather than anecdotal evidence (Nicolaides, 2006).

However, the diseases associated with the suburbs soon became physical as well as social. Over the past 40 years, the prevalent diseases in the United States have become chronic instead of infectious: first with the emergence of heart disease and cancer, and more recently by obesity-related diseases such as diabetes (Dannenberg, Frumkin and Jackson, 2011; Frumkin et al., 2004; Lindheim and Syme, 1983). The spatial clustering in incidences in obesity have led researchers to examine the built environment’s influence, and in particular how it promotes or restricts physical activity (Dunton, et al., 2009; Eid et al., 2008; Ewing, et al, 2003). Many of these public health researchers started to draw connections between larger patterns of change in society, ranging from food availability and technological attachment, but a great deal of literature has pointed to sedentary lifestyles encouraged by the unabated suburban growth oriented around the automobile. While the previous eras shaped the environment around pandemic disease from identifiable sources, public health was now faced with predominantly man-made, degenerative disease (Frumkin et al., 2004; Susser and Stein, 2009).

The evidence stacking up against the suburban environment dovetailed with a reversal in anti-urban sentiment. Contrary to the environmental concerns raised in publications such as *The Effect of the Man Made Environment on Behavior and Health*, books like David Owen's *Green Metropolis* (2009), argued that the density of the cities led to less energy use per capita, particularly in comparison to the auto dependency of the suburbs. This argument for the environmental health of the city was further echoed in pieces such as Witold Rybczynski's "Green Case for Cities" in *The Atlantic* (2009), not to mention the superiority of their job market (particularly creative class jobs) extolled by many urban scholars (Florida, 2002). The celebration of the city coincides with a recent popularity in media that goes even further than declaring a suburban crisis, but rather the imminent irrelevance of the suburbs altogether, as detailed in books like Leigh Gallagher's *The End of the Suburbs* (2013) and encouraged by the current foreclosure crisis which has left swaths of suburban and exurban land scarred by partially built and inhabited housing tracts, far from any discernible urban centers. In a far more conclusive blow to the suburban image, an increasing body of empirical evidence from public health related to the specific health concerns of the new era indicated the significant rise of obesity and obesity-related chronic disease was strongly associated with sprawling suburban form (Frank, Engelke and Schmid, 2003; Frumkin et al., 2004). Essentially, in a very short time period of a few decades, the narratives on cities, suburbs and health had flipped.

Echoing how Burnham, Le Corbusier, Kahn, et al., proposed solutions to remedying earlier urban crises, prominent designers declared their own solutions to fixing the suburbs. If previous eras were defined by the elimination of waste, density, streets and blight, these imagined redesigns were largely driven by the elimination of the automobile. Duany, Plater-Zyberk, and Speck's landmark publication, *Suburban Nation: The Rise of Sprawl and the Death of the American Dream* (2001), was not the first to characterize the suburbs as demographically, economically and physically homogeneous and ecologically unsustainable, but probably made the most significant impact by declaring an organized movement to accompany their design ideas. Alongside their published manifesto, Duany and Plater-Zyberk (DPZ) wrote the Ahwahnee Principles in 1991, which formed the ideological foundation for the Charter and Congress for New Urbanism (CNU), established in 1993. The goals of the CNU were to reshape neighborhoods to a more "traditional" way of building for environmental sustainability and a way to change everyday behavior (Calthorpe et al., 1991). The New Urbanists explicitly recommended returning to an older and centralized way of town building, directly citing Howard's Garden City plans as inspiration. After laying out their principles, DPZ's and many other New Urbanist practices made their success on widely publishing practical guides and form-based codes for neighborhood building as well as holding design charrettes (Southworth, 2003). Although not directly referenced, the APHA's *Planning the Neighborhood* from some 30 years prior is an obvious predecessor to the New Urbanist literature, particularly in the APHA's preoccupation with density formulas and land use, as well as a concentration on housing types as the primary unit of the neighborhood and architectural form of the dwelling, with less attention on city planning or landscape architecture. While health via everyday recreation was not initially the primary goal of the New Urbanists, the idea of de-emphasizing the automobile in neighborhood design was an explicit attempt to influence behavior (Duany, Plater-Zyberk and Speck, 2000). Going so far as to recall Howard's greenbelt with its "Countryside Preserve" ring, the idea of limited growth (or "smart growth," as Duany would term it in later writings), was meant to preserve untouched land, although this time around the idea of growth caps were a sustainability impulse rather than a population control one (Duany, Speck and Lydon, 2010).

Like the Garden City, or even Le Corbusier's unbuilt Radiant City, New Urbanist communities required massive land and financial commitment and an otherwise blank slate on which to build (See Figure 9). Consequently, the best known New Urbanist communities, such as Seaside, Florida or Celebration, Florida, were often built far out from any existing metropolitan centers and are hardly self-sustaining, despite *Suburban Nation's* advocacy for regional relationships (Duany and Talen, 2002). Meanwhile, New Urbanism alone could not abate suburban growth in the United States, as they only continued to develop, or languish, in the same patterns that had been built. More recently, New Urbanism has been seen in urban infill as opposed to new housing tracts, but these developments are often 15 acres or less, and their overall impact is still largely unknown (Ellis, 2004). Ultimately, form and aesthetics alone could not stem the tide of a tax base that favored retail and residential development and de-prioritized public and recreational infrastructure (Healthy Community Design Expert Workshop, Centers for Disease Control and Prevention (U.S.), and National Center for Environmental Health (U.S.), 2010).

Like the other urban ideas discussed in this chapter, the initial message of "New Urbanism" has ultimately been diluted by developers that have used it as a catchall term for many new developments that only superficially follow the principles. This issue is urgent enough that the CNU has taken to actively certifying projects that truly adhere to their guidelines (Southworth, 2003). The New Urbanists have also rebutted the widespread opinion that their type of development is too form-centric, ignores more diverse or complex issues of place, and exacerbates economic inequalities with the argument that few of the projects built truly reflect their original intention (Ellis, 2002). However, the message from the New Urbanists has changed direction in recent years. Their proposals were arguably as Utopian as Hygeia or any of the Modernist schemes, but the unforeseen iterations of New Urbanism, or its failure to truly transform existing development have lead Duany et al., to be more pointed and specific in their criticisms, as well as extend the reach of their proposals. Duany and Talen (Duany and Talen, 2002) expanded their ideas into the more expansive recommendations for "Transect Planning," and Smart Growth, which addresses the more regional, urban-to-rural aims of the movement. The most recent CNU conference also saw Duany call to designers for an "incremental urbanism," a far cry from the type of top-down planning DPZ was best known for which previously dictated everything from zoning to window trim (Duany, 2013).

Figure 9: Seaside, Florida, by Duany Plater Zyberk, 1996 (Photo by Alex MacLean) (Top); Garden City Letchworth, England (Source Unknown, courtesy University of California Visual Resources Center)

Where the New Urbanists have remained most successful, though, is convincing governments and public health officials that their methodology is best for encouraging daily activity. New Urbanists have more recently made real strides in changing street standards to more pedestrian-oriented activity, working closely with the Institute of Transportation Engineers (ITE) (Southworth, 2003). Jeff Speck, the third author of *Suburban Nation,* has turned from extolling the "New Urbanism," to more straightforward urbanism, publishing *The Walkable City* in 2012. Here, he maintains that the key to healthier, more robust cities is walkability. Walkability in neighborhoods has become a fairly simple idea for researchers, designers and policy makers to latch onto as a cure-all for both sustainability and health issues. What exactly the term means—is it the quality of the environment or access to daily needs—is less clear. However, it has become a quality that is associated with the "urban," and certainly not the "suburban." Like *Suburban Nation,* Speck's book is a manifesto, and largely anecdotal. It is telling that Speck's book, similar in voice to *Suburban Nation*, does not rely as much on numbers or advocating for the use of technology as it does draw on emotion and observations, much like Jane Jacobs' *Death and Life of Great American Cities* was a reaction against the scientific rationalism of the Modernists*,* although this is somewhat ironic given the New Urbanists' reliance on fairly rigid formulas of form, density and distribution of green space.

What has remained consistent between earlier and more contemporary iterations of New Urbanism is the steadfast belief that land use diversity, residential density and street design will encourage walking and its associated health benefits, both mental and physical. From *Suburban Nation* to *The Walkable City*, the proponents of New Urbanism not only promise a remedy to physical health but the strengthening of the social neighborhood. In their view, walking encourages incidental interactions, building relationships with those living within the physical proximity of the neighborhood (Duany et al., 2000). These ideas have not yet recognized how digital media has vastly transformed modes of social communication (Southworth, 2003) or a larger exploration of what constitutes "neighborhood" outside the half mile radius. Although the movement is essentially a continued rebuke to the follies of Modernism, the movement relies on the same tenets of environmental determinism. Form is universal, regardless of cultural, social or economic background, and plays an essential role in encouraging desired behavior outcomes.

However, as for exploring the connection between nature and human health, Duany, Speck, et al., do not maintain the generalized reverence of urban nature as his predecessors:

> Green spaces in cities are a lovely, salubrious, necessary thing. But they are also dull, at least in comparison to shopfronts and street vendors. Our kids may be suffering from nature deficit disorder, but they also know instinctively what we have been taught to ignore, which is that verdant landscapes do not entertain (Speck, 2012, p. 249).

Duany has also stated that rural nature has no place in the city, only squares and plazas, although he fails to elaborate nature's place between the city and rural outskirts, where the majority of American development lies (Duany and Talen, 2002). This echoes Jane Jacobs' similar critiques of large parks for the sake of simply adding green space, when she exhorted planners to “get away from the [Olmsteadian] notion that parks of the lungs of the city” (J. Jacobs, 1961). While Speck and Duany do not elaborate on this point much more, this seems to reinforce the binary that suburbs/country are inherently where nature resides, in opposition to the city. Jacobs’ point was more nuanced and should be seen in context as a rebuke to the large-scale planning of the modern era which cleared out entire neighborhoods in the name of large civic park gestures.

The place of nature or green in reviving the suburbs is a major differentiation between the New Urbanists and other contemporary strains of suburban re-design literature. In 2011, the Museum of Modern Art in New York City opened the exhibit “Foreclosed: Rehousing the American Dream.” The five high-profile, architect-led design teams selected for the exhibit took a decidedly higher-density approach to living. Entries such as WORKac’s “Nature-City” places a circular spiral tower at the center of their proposal with mid-rise housing surrounding it, in the interest of leaving more land to reintroduce ecosystem expanded urban forest or water systems (Williamson, 2013). The entry somewhat softens the approach to nature seen in Le Corbusier’s towers in the park strategy by bringing residents closer to the ground and bringing green onto the roofs of the spiral tower. The nature depicted in their proposal is not the manicured lawns long associated with suburban landscapes, though, rather a wilder green meant to symbolize wetlands and sublime urban forest—a compromise between the purified pastures associated with the City Beautiful movement and the idealization of wilderness described by Thoreau and Muir. Another high-profile design competition, the 2010 “Build a Better Burb,” sponsored by the Long Island Index, emphasized the inclusion of a small-scale agricultural component in their design, harking back to Howard’s original intents for the Garden City (Howard and Osborn, 1965; Williamson, 2013) (See Figure 10). “Foreclosed” is in the vein of broad, clean-slate visions such as Le Corbusier or the New Urbanists. A similar approach seen in Paul Lukez’s *Suburban Transformations* (Lukez, 2007) concentrates more on acupuncturial interventions, concentrating on transforming suburban typologies such as the strip mall, cul-de-sac, and the single-family home. However, both the speculative and pragmatic cures address the same health-related suburban maladies: low density, excess of space for automobiles (roads and parking lots) and lack of productive nature. While like earlier movements, these proposals are primarily driven by the transformation of form, books like *Retrofitting Suburbia* (Dunham-Jones and Williamson, 2009), do address how to accomplish these retrofits from a policy standpoint as well.

Figure 10: Adding Density to the Suburbs in 'burbs REDUXED (Lacoste + Stevenson), an entry in the "Build a Better Burb" competition.

The long-term impact of suburban re-imagining, retrofits and even a 20-year movement like New Urbanism is still unknown. Between 2000 and 2005, it is estimated that the number of New Urbanist developments of 15 acres or more have increased by 20 per cent more each year, and now house up to 1.4 million residents. However, half are built on greenfields, so their design impact is moot if not paired with a land preservation plan (Khattak and Rodriguez, 2005). Coincidentally, in the mid-1990s, New Urbanism was adopted as the standard architectural and planning style of public housing under the Clinton Administration's HOPE VI development plans, predicated on the same notion that the correct form is not only healthier for a population deemed unhealthy, but can also remedy social misbehavior. Much like the strong visual style of Modernism and shoddy execution stigmatized public housing of the mid-century. However, HUD has since abandoned the New Urbanist strategy in favor of what is termed the Choice Neighborhood Initiative, which aims to better integrate public housing into existing neighborhood styles (U.S. Department of Housing and Urban Development, 2012). To take a broader view, the direness of the larger American economic crisis and the physically overwhelming acreage of depreciating suburban land in the United States is daunting and will require coordinated federal and local policy to provide a corrective.

Conclusion: Recurring Patterns

The epidemics that have formed city structure over time are different, but there are several similarities between how they were combated in the urban environment. It is particularly important to examine today's arguments around walkability in the context of these past movements as the present body of scholarship tends to be singularly focused by either era and field (planning, public health or design), making it difficult to understand the chronological links between changing disease preoccupations and urban landscape as well as the potential recurring patterns. While each response was different formally and stylistically, there exists similar uncritical eagerness to adopt theories about the built environment and disease. The underlying reasoning behind each movement is rooted in assumptions about poverty, morality and disease, and a conflicted view of man's relationship to nature. Ultimately, the essence of each movement was twisted by both commercial interests and the adoption of each era's latest technology. Some successes notwithstanding, more often than not the "healthy" urban form of one era ended up as a root cause of an "unhealthy" urban form in the next.

First, though, it is also interesting to note what has changed in healthy design approaches over the years, particularly as the predominant public health issues changed from infectious to chronic. It is only recently that the city, and not the suburbs, which has been upheld as the healthier urban typology. However, this is also only since the type of dirty industries that bedeviled the working class—slaughterhouses, coal plants, and others—are now virtually nonexistent in urban areas. When infectious disease had been sufficiently combated, the fear of density subsided and is now even celebrated, as seen in the development of public housing projects and the return of the upper class to cities from suburbs. Urban waterways and waterfronts, which were used for waste disposal in the Industrial Era and subsequently buried underground or restricted, are now being uncovered, daylighted and returned to public access as a key part of many urban revitalization schemes.

The population density and earlier industrialization in Europe also meant that most of the movements discussed in this chapter originated overseas, particularly in the case of the Sanitarians and High Modernists. Although Utopian and social-minded (or even explicitly Socialist, in the case of Le Corbusier) in spirit, when translated to the American context those ideas often became misinterpreted or even sacrificed for more capitalist-minded strategies that favor the developer above all else (Hall, 1996; Scott, 1998). Emerging theories about health and the built environment were often impeded by social prejudices and politics on the medical side, or real estate interests and popular aesthetic tastes on the design and planning side. That said, designers and planners often also changed their intentions regarding healthy design in an eagerness to adopt the latest technologies. Although Le Corbusier would say the motivations for his modular approach to city building were health and social equality, in the essay "Yesterday's City of Tomorrow," critic Lewis Mumford would argue that the real driver for Le Corbusier's designs was simply super high-density building had become a technological possibility. The architect mated the skyscraper with an only slightly modernized pastoral landscape, without reflecting on mediating the scale of the human experience in relation to the scale of these new superstructures, resulting in what Mumford referred to as "a sterile hybrid" (Mumford, 1986). Of course, the technology that has most indelibly shaped the urban landscape is the personal automobile. The densities and distribution of green space proposed by Howard in the Garden City, and later by the APHA, were often adjusted not according to success or failure in earlier developments, but to accommodate its rapid adoption. With the original goals of social and economic equity mostly cast aside, the result was the sprawling urban fabric the New Urbanists and health-minded planners and designers today are attempting to combat.

While it is more generally accepted in contemporary public health research that certain conditions of poverty predispose populations to certain diseases, be it stress or environmental injustice, there has been a consistent line of thought that associates health with morality, therefore the poor are often more vulnerable to sickness due to their own actions, not circumstances beyond their means. In the sanitary era, Edwin Chadwick would argue that disease engendered by physical environment causes poverty, while social theorists such as Frederich Engels would say that poverty was the cause of illness (Krieger, 2011; Susser and Stein, 2009). A similar debate would occur in the era of urban renewal, with a conceptualization of health as an end result or a product of individual behavior, not of the environment, taking the burden of public health off public agencies (Fitzpatrick and La Gory, 2000). As discussed in more detail in Chapter Three, that debate persists today as many researchers argue how residential choice reflects ingrained behavior preferences that cannot ultimately be changed. The arguments over pathology and causality have ultimately clouded a larger discussion in equity of access to healthy environments.

So while efforts to improve health in the public realm were often meant to address issues that primarily existed in working class neighborhoods, ironically, healthy environments were mostly only available to those who could afford it, while the poor and working class were either simply relocated or removed as the easier solution, rather than tackling structural, social and physical problems (Corburn, 2007; Krieger, 2001).[1] When miasmic theory dominated medical thought, it was only the elite that had access to rural resorts to combat the effects of unhealthy urban airs (Mitman, 2005). Immigrant communities were often displaced during infrastructure construction during the sanitary movement (Corburn, 2007). Frederick Law Olmsted's explicit goal for Central Park was for a grand public space for democratic access, and where the working class could learn healthier behaviors from the elite (Schenker, 2003). However, the New York City Planning Commission instead regulated out working class slums and industrial warehouses in anticipation of the higher rates of real estate their new park-centered enclave would bring (Rogers, 2001). In the postwar era, suburban neighborhoods were generally only available to the white middle-class, and utilized covenants to preclude others from moving in (Bruegmann, 2005; Hayden, 2003). More recently, the few model New Urbanist communities built to full realization, such as Seaside, Florida, exist mainly as second-home resort communities (Al-Hindi and Staddon, 1997).

The view of nature remains mostly unchanged, despite the shifting paradigms of health and disease. Almost all movements, with the exception of some of the critiques of the New

[1] Although not an urban problem, Mitman (2005) notes that Native Americans were removed from National Parks lands after the National Park Act of 1916, again under the presumption that their habitation and activities sullied the "wildness" of the lands. It should also be noted that this era also saw the passage of the Quarantine Act of 1873, which granted municipal authorities the ability to move individuals to institutions or sanitariums (Corburn 2007).

Urbanists, saw the simple presence or quantity of nature in the form of urban forestry or parks as unequivocally healthy, often overlooking more nuanced considerations of quality. Consistently, designers and planners have idealized nature in the city, and often conceive of its value as being the diametric opposite of urban development and human activities, with the mythical view of "nature" only existing in its true and pure form in areas far flung from the city (Zardini, Borasi, Campbell and Centre Canadien d'Architecture, 2012). This view followed twentieth century popular thought about nature, which was heavily influenced by the writings of Thoreau and Muir, or even Aldo Leopold, who made the comparison of a perfectly functioning healthy body to that of an untouched, stable ecosystem (Leopold and Schwartz, 1970). Even in the recent *Imperfect Health: The Medicalization of Architecture* (2012), Borasi and Zardini similarly take this architectural view of nature, extolling the holistic view of nature as cure, describing the contemporary city in bodily metaphors, advocating for air circulation introduced through incision (streets) and green as a "salve" on the epidermis of the urban fabric. Meanwhile polluted areas and landfill—the end products of human activity–are described as "damaged tissue." This view of nature is narrow and somewhat dysfunctional, though. From Burnham and Olmsted's civic schemes to Le Corbusier's tower parks, the ideal is decidedly pastoral, with none of the chaotic wildness of truly untouched land. Urban forests could be robust, but only up to a point. Flat landscapes tended dominate the modern era not only because they echoed the sterile surfaces of the buildings, but also as new discoveries came to light about allergens originating from trees (Zardini et al., 2012). When it comes to health, there is a rejection of what Gissen (2009) would refer to as "subnature," or a second tier nature produced by urban development itself. Gissen calls out dankness, smoke, dust and weeds among his subnatures—all elements discussed here that were specifically eradicated in the name of urban health. Says Gissen, "subnatures force us to confront the implicit nonsocial character of nature" (Gissen, 2009, p. 211). Conversely, these subnatures can indicate a health other than that of humans residing there. The industrial city is defined by smoke, which signals productivity and economic health if not public health.

These various movements around health often succeeded in their immediate goals. The sanitary surveys and infrastructure of the industrial era was able to locate and address sources of infection and eliminated them. Burnham's City Beautiful Movement and Central Park are still regarded as great works of city improvement, and the New Urbanist principles have been applied successfully to revitalize many downtowns (Rogers, 2001; Speck, 2012). However, urban health relied most on strategies of isolation by choice (for the elite) and quarantine by building and economic policy (for the working class)—both modes of spatial relocation. This allowed cities to go about the business of eliminating (razing) the perceived cause of disease in the built environment. Ironically, what replaced the old built environment was often a design that was blamed for a different disease in the next era. The most direct examples of this dysfunctional chain can be seen in the translation of Garden City ideals to today's suburbs, and the adoption of modern architecture to American public housing.

While the issue may also lie in the political, economic and technological mutations discussed above, the approach of complete elimination is also a distinctly Western one, where illness is aggressively combatted (Zardini et al., 2012). In health terms, the study of a linear pathology of disease traced to its origin and causation is *etiology*, which is the model that has been applied to the built environment throughout history. Slowly, public health has tentatively moved away from this approach, to instead study multilevel influences on health outcomes and preventative strategies. In an argument for design to return to more holistic strategies as well, Borasi and Zardini note:

> The medicalization of our society has initiated a process in which the non-medical problems of daily life (from anxiety to infertility, from aging to death) are more and more treated as medical … Architecture and urban planning have since undergone a parallel process; they rely increasingly on medical rhetoric to describe problems and arrive at solutions defined in the medical milieu. An ever increasing number of urban, environmental and architectural problems are treated as medical, and remedies are sought for increasingly specific solutions. Tailoring requirements to particular groups of ill, or presumably ill individuals leads to conflicting, contradictory solutions, and finally to even greater segregation of various demographic groups. In this sense, architecture—subject to medicalization—should itself be considered a 'sick' body (Zardini et al., 2012) (p. 36).

Standardization and generalization were also key to medical and public health practice. Until the 1980s, when the World Health Organization (WHO) redefined health as a holistic quality of life issue, health was simply understood as the absence of disease (Barton et al., 2000). Germ theory, the major breakthrough of the modern era, had heretofore treated disease on the assumption that it could be eradicated on a molecular level without delving into the economic, social or behavioral histories of patients. The historical urban design approach to health, even up through New Urbanism, was similarly prescriptive and standardized in form and intent. It is only recently that public health has instead begun to embrace ideas of place, and specialized local knowledge, as discussed in the subsequent chapter. While that approach is much more ingrained in the contemporary approaches of most designers, particularly in the discipline of landscape architecture (Southworth, 2003), the current approach to walkability is still similarly standardized.

Each era utilized technological improvements, the application of scientific and rational formulae, and the controlled intersections and separations of certain populations. Where these movements went awry is in assuming the application of technological, rational and etiological paradigms could control the nuances of everyday behavior. The walkability and active design movement has spurred a nostalgic interest in "healthy designs" of the past, particularly among the New Urbanists, who cite and uncritically adapt Howard's Garden City models and the works of Frederick Law Olmsted. But there has been little reflection on what disease they were designed to target in the first place, how pathology was understood, the social context in which they arose, as well as the massive amounts of social and economic capital required to achieve them. Worse yet, the historical effects on the working class are overlooked. In a new era of built environment and epidemics, it is imperative that designers, planners and public health researchers understand the dimensions of the past before blindly applying them to the present.

CHAPTER THREE: ETIOLOGY TO EMBODIMENT

Hypothesizing the Connections Between Environment and Health

Introduction

Although the complex relationship between the built environment and health is considered a nascent field of study in public health, the foundational idea that disease or wellness can be externally influenced as well as internally determined dates back to the beginning of medical history itself. The Greek philosopher Hippocrates, in *Airs, Waters, Places* first posited the relationship between the environment and wellness. This relatively simple idea that passive exposure to environmental ills can cause physical sickness in the individual would persist as "miasmic theory" during the widespread urbanization of the Industrial Revolution (Hewitt and Szczygiel, 2000; Susser and Stein, 2009). Interest in external causes of disease waned with the advancement of germ theory in favor of treating disease at the molecular level, and the resulting etiologic paradigm of agent-exposure-host would remain prominent in both medical and design thinking for most of American urban history (Corburn, 2007; Lindheim R and Syme SL, 1983). The modern era of public health was dominated by the scientific, causal model of disease incidence, with the prevailing thought that any disease could be treated at the individual level. As a result, concern for "the public" languished, as well as the study of demographics and environments (Fitzpatrick and La Gory, 2000). As the environment is reconsidered as a determinant of disease and wellness, hypothesizing this pathology has become more complicated.

Public health practice, aided by theoretical contributions from the emergent field of social epidemiology, has course corrected, focusing on how the spatial distribution of disease, behaviors and the associated environment are interconnected. In the book *Eras in Epidemiology* (2009), Susser and Stein state that although the conditions surrounding epidemics are often considered purely biological, they are actually highly influenced by social forces of their specific era. The previous chapter examined how the design fields applied disease metaphors to guide major urban interventions from the nineteenth century to today. In this chapter, we discuss a parallel history of how recent public health theory helps explain environmental influence and embodiment in populations, and how recent trends and emergent study present an opportunity to bridge between urban design and health. Perhaps most controversially, these models demand a reconsideration of what can be considered "causal" to chronic disease, and therefore worth environmental intervention.

Health and the Environment

Krieger (2001) states that public health as a field is in need of more theoretical models to move the understanding of epidemics past traditional cause and effect thinking. Just as eras of planning and design have seen several different eras of trends, theories and understandings as new epidemics came to the forefront, the field of public health has also had to adjust its own causal models of disease in each of these eras, particularly framing the relationship of external social and physical factors to individual wellness.

In the earliest years of public health study, many scientists often sought environmental and social factors of disease. Louis-Renè Villermè undertook a mortality study in Paris in 1826 that addressed distribution, physical environment, and socio-economic standing. Rather than hypothesizing a cause, he began the study with numerous independent variables and individually eliminated each potential environmental cause of mortality over the course of the research. Among these factors were humidity, soil, winds, proximity to the Seine River, population density and congestion, and open space to housing ratio. At this time, Paris also exempted households under a certain income from paying taxes, so by using geographically referenced tax collection records. He was also able to relate poverty to disease. The extremely high rate of positive correlation between the two led him to declare that poverty *caused* disease, and while the directionality of this relationship would be quickly and widely disputed, it was the first study to make the social associations this explicitly. The nature of this declaration was widely debated. Sanitarians such as Edwin Chadwick would argue that disease engendered by physical environment causes poverty, while social theorists Frederich Engels would say that poverty was the cause (Krieger, 2011; Susser and Stein, 2009).

There was methodological stagnation of epidemiology's population concepts and quantitative methods in the mid-1900s due to new medical technologies, and vaccines were able to abate the spread of infectious disease (Corburn, 2007; McMichael, 1999; Susser and Stein, 2009). However, World War II marked the beginnings of the Chronic Disease Era, when incidences of mortality by illnesses such as cancer and heart disease overtook infectious disease in the developed world. As the causes of chronic disease were mostly unknown, epidemiologists started to leave behind the traditional notions of germ theory and instead began to re-conceptualize how surrounding phenomena related to disease clusters (Lindheim R and Syme SL, 1983; Susser and Stein, 2009).

By the 1960s the concept of "disease ecology" had developed, progressing past single variables like air, water and soil in the nineteenth century. Jacques May's *Studies in Disease Ecology* (1961) states, "Disease is the alternation of living cells or tissues that jeopardizes survival in their environment" (May, 1961, p. xvi). Ecology promotes or inhibits relationships between microbial agent (bacterial), vector of diffusion (insect, rat, tick) and human host. Disease is "maladjustment to the environment," and occurs from the convergence of environmental stimuli, agent response and culture. At this time, disease mapping and statistics to track these environments saw a slight resurgence, but still public health/epidemiology remained mostly aspatial and maps appeared without pattern recognition or interpretation (Koch, 2005). The multifaceted model of disease ecology opened the door to increased interest in the study of place. Studies relating place and health started to appear in journals in the 1980s and 1990s, coinciding with the rise of social epidemiology. Initially, the term "place and health" simply meant the disease distribution over a geographic area, but as chronic illnesses such as cardiovascular disease and cancer began to show strong correlations to neighborhoods and clustered populations, these studies began to focus more closely on neighborhood qualities or “place” effects external to the body. The political implications of doing so shifted responsibility to governments and the collective from individual lifestyles, a neoconservative viewpoint that had been widely adopted in both Europe and North America (Diez Roux, 2004; Macintyre et al., 2002; Smith and Easterlow, 2005).

This kind of empirical research has opened the door to more formal collaborations between the public health and planning fields, reconnecting two professions that have been working in mostly separate spheres and interests for the past several decades. However, the interest in re-integrating health into urban planning initiatives appeared in Europe almost a decade before the United States. In the late 1980s, the World Health Organization (WHO) launched its Healthy Cities program and commissioned a study and conference at Venice University to study how health and planning officials worked together in European countries (Barton et al., 2000). As a result of this meeting, WHO rewrote their standard definition of health as:

> … a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity. The enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being, without distinction of race, religion, political belief, economic or social condition (Awofeso, 2005).

This definition presented a significant break from the modern conception of health as disease treatment at the individual level, instead positioning it as a quality of life measure. This broader definition signaled the public health field’s interest in explicitly addressing the built environment for both research and practice. The WHO described the built environment with their 12 determinants of lifestyle health: Personal Lifestyles, Social Cohesion, Housing, Work, Access, Food, Safety, Equity, Air Quality and Aesthetics, Water and Sanitation, Soil and Solid Waste, and Global Climate (Aicher, 1998; Barton et al., 2000). Health concerns in Europe are vastly different than those in the United States, however. In contrast to the early Healthy Cities projects, which focused on traditional public health issues such as smoking cessation and air quality, built environment studies in the U.S. have increasingly addressed chronic diseases related to obesity, such as cardiovascular disease and diabetes. Many believe that the root of the obesity crisis lies in a combination of inactive lifestyles and diet/food availability, which are strongly influenced by the built environment. To understand how the environment influences behavior and lifestyles, though, required new models of health outcomes.

From Etiology to Embodiment

Conceptualizing how environment manifests in health outcomes requires building a body of guiding concepts and theory. Theory assists study design, allows predictions to be tested and choices to be made for action, even if they are different theories and different responses (Krieger, 2001; Susser and Susser, 1996). Says Nancy Krieger (2011) on the need for these frameworks:

> … data is not simply ‘observed’: there is active thinking behind the act of data acquisition. Not to mention the active thinking that guides data analysis, display and interpretation. And this active thinking is the stuff of theory. Meaning: contrary to its etymogic origins, data are not a ‘given’ … nor do data tell stories. People do. An important caveat, however, is that the stories that people who are scientists tell are not simply or simple ‘stories’: they are (or are supposed to be) transparent accounts, informed by theory, and premised on the public testing of ideas and explanations, using explicitly defined concepts and methods (p. 17).

To hypothesize the multifaceted interactions of place and health, it has been necessary for researchers in the field to move past traditional etiologic pathways to propose theories that are instead multi-directional and multi-faceted. This is difficult, as epidemiological theory has long been couched in the paradigm of cause-response infectious disease, even in environmental contexts (McMichael, 1999). Changing theory can lead researchers to find different origins of disease. In Hippocrates’ *Airs, Waters, Places* (400 BCE), a chapter is devoted to the ill health effects of ingesting “unwholesome” waters, characterized by its appearance and smell, and pinpointed as a cause after Hippocrates noted the enlarged spleens of the afflicted. In contemporary epidemiology, a researcher would point out that the water itself was not the cause, rather malaria is caused by protozoa and mosquitoes in the pools and spleens reacted to parasitic infection. As technology advances, so has the search for increasingly microbial causes, but the study of place necessitates a wider view, at least for the meantime. Susser and Stein note that epidemiology’s search for “universality” by moving to progressively smaller scales to potential causes may be short sighted and not necessarily correct for studies of place.

> The search for universal laws of the material world must deal with a paradox. The smaller the interacting microcosmic elements that such laws explain, the more likely those elements are to be universal. Universality implies a view of space and time expanding outward across the boundaries and horizons of our world and others, unimpeded by the local accretions and characteristics of intervening structures such as planets, continents or our biological world, including people. Some laws may hold across our planet for species and the evolutionary processes that produced them. But above the level of molecules, no biological entity can conform entirely to universal laws because of the overarching contexts and the interactions between levels within a biological structure. And the banal fact is that each society is influenced by its economic, political and cultural circumstances as well as by its mix of peoples, climate and topography. What is most universal is least biological and, most of all, least human (Susser and Stein, 2009, p. 318).

In fact, macro-scale factors of disease are crucial to the study of place. These “fundamental causes” often refer to factors such as the natural environment and sociostructural biases such as racism or classism (Krieger, 2001). The term "fundamental" does not indicate that the factor is static or unchangeable, but rather it is some factor that persists through time and influences multiple health outcomes through multiple pathways (Link and Phelan 1995). Fundamental causes are also referred to as "upstream causes," as they are not necessarily hyper-local factors, but instead are larger constructs that echo down to the neighborhood level such as racism, sexism and socioeconomic status. In essence, it is the linking of social factors to disease. While there is a wide body of literature on fundamental or upstream causes, it does not de-legitimize the strategy of intervening at lower (more proximate) levels (Link and Phelan, 1995; Phelan, Link, Diez-Roux, Kawachi, and Levin, 2004).

> Investigating area or neighborhood effects challenges us to theorize and investigate how large-scale macro processes—processes determining residential segregation, for example—ultimately trickle down to people and their bodies without ignoring the interdependencies and mutual influences between people, between places and between people and the places in which they live (Diez Roux, 2001, p. 1788).

However, upstream factors and a longstanding bias in the public health community toward social factors often overshadow the impact of the physical environment. Many conceptualize neighborhoods as an emergent effect of social interactions, and therefore the "neighborhood" itself cannot be a cause of disease (Oakes, 2004a). Often, place-based public health studies categorize geographical variations as compositional (characteristics of individual, sometimes referred to as exogenous factors), contextual (opportunity structure in social or physical environment, also called endogenous factors), or collective (socio-cultural and historical features, anthropological, temporal, psychosocial, i.e., social cohesion and capital) (Macintyre et al., 2002). A predominant attitude in public health indicates that researchers tend to prioritize the compositional effects. In other words, individuals sharing a proximally similar place will probably also share individual-level characteristics such as race, income and age. Therefore they are predisposed to diseases seen in people displaying those characteristics, unless there is a clear contextual attribute, such as a source of pollution, that provides a definite causal relationship. This may be due to the fact that these studies are based in sociology, and researchers are more comfortable working with these factors, or even simply because demographic data is more readily available and understood than analysis of the built environment. Macintyre, et al. (2002) have also proposed the "collective" effect of a population, where social norms determined by a group can exert pressure on an individual's eating and activity habits, as well as other related behaviors such as smoking or social interactions (Papas et al., 2007). There is a significant debate in the public health field over which set of place attributes have the more explanatory effect on health outcomes, and further disagreement over exactly into which category certain attributes fall. For instance, rampant unemployment is often categorized as a compositional factor (in that only individuals are unemployed), unless you were to look at larger patterns of economy or disinvestment in a community due to institutional biases.

As the pathways to disease become increasingly tangled, public health is increasingly looking toward developing ecological models of behavior which take into account the influence of multiple factors at various scales, from those that affect wide populations, such as policy and environment to the social and psychological spheres of the individual (Sallis, Owen and Fisher, 2008; Sallis et al., 2006). In terms of level of influence, physical environment is often thought to have a weaker effect than the immediate individual sphere. However, the ecological model of behavior is predicated on the notion that both the individual must make the lifestyle choice in question (through health promotion programs). In addition, the external infrastructure necessary to that choice (for instance, pedestrian amenities or healthy food availability, and the related policy) must be provided to that individual for a health intervention to be successful (Sallis et al., 2006). This ecological view forms the basis for many of the theories discussed in the subsequent chapter.

While early place and health studies established the inequality of chronic disease in distribution primarily as it relates to socioeconomic status, more recently there has been increased interest in finding how physical elements of neighborhoods influence behavior. Before finding solutions, though, there are several barriers to reconnecting the two fields. History has not been kind to many of the large scale planning and design ideas discussed in the previous chapter. However, these were mostly based on tenuous theoretical concepts of environment and health, where architects and urban planners adopted an etiologic view of disease when it came to the urban context. These ideas often hinged on searching for a single root cause to remove from the built environment and led to numerous unintended and disastrous results, and have more than likely led to a further disconnect between the fields.

Today's public health researchers have a more complex view of pathology and better statistical methods to determine correlates of wellness and illness in the built environment, but they are less adept at evaluating the nuances of its components, or how to best enact interventions via policy, initiatives and design. Additionally, a large portion of the public health community is still unconvinced of the physical environment's impact on health, which is one reason many Healthy Cities strategies overwhelmingly focused on healthcare availability or informational campaigns over modification of the built environment. Additionally, the epidemiological focus on causality, sequence and mechanisms has tended to devalue and stymie place studies in public health (Mitchell, Gleave, Bartley, Wiggins and Joshi, 2000). In the literature it is often described as an unknowable "black box" of mechanisms on the individual, citing the difficulty of disentangling place effects on health (Macintyre et al., 2002; Susser and Stein, 2009). Many researchers have grappled with the foundations, directionality and interrelationships of components of place, but the commonly accepted tenets are that place 1) is a predominantly social construct, 2) encompasses the material and the psychosocial realms, and 3) the overwhelming spatial evidence of concentrations of disease appear to indicate many chronic diseases have some sort of socio-physical environmental influence (Sampson, Morenoff, and Gannon-Rowley, 2002). The inherent issue with measuring social and economic "place effects" though, is that these factors are dynamic, requiring a longitudinal view of impacts, even if their current study often frames them as static phenomena (Susser and Stein, 2009). For that matter, many physical elements of place are dynamic as well, but how these change over time is even less studied.

The emerging fields of social and spatial epidemiology propose a multidirectional relationship between society, environment and biological health (Krieger, 2001). The origins of social-ecological models date back to the 1960s, but became much more prominent in the 1980s (Aicher, 1999). One of the field's forebearers was Leonard Syme, a professor at the University of California Berkeley, who used his background as a sociologist to apply epidemiological methods to the study of social variables and physical health. In a landmark study, he explored the connection between "social integration" (marital status, community group membership, family and friend contact) and mortality (Kaplan et al., 1988). With Roslyn Lindheim, an architecture professor also at the University of California Berkeley, he would also hypothesize that disease occurs more frequently among those with fewer meaningful social relationships, in lower hierarchical positions and disconnected from cultural heritage (Lindheim and Syme, 1983). That article made several proposals that provided the foundation to the field. The first was a counter proposal to the traditional hazard/exposure relationship that had been favored by public health. By re-conceptualizing place as a location of dynamic forces, they proposed that various elements of place instead affect the *resistance* of individuals over time and therefore their vulnerability to disease (Lindheim and Syme 1983) (See Figure 11). This relationship to place opened the door to looking at multiple factors in health outcomes.

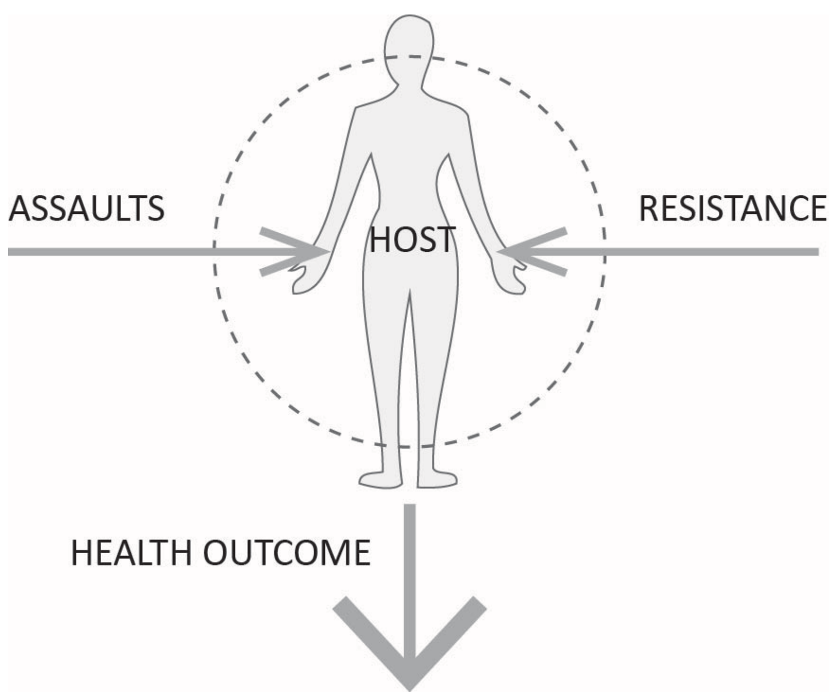

Figure 11: Lindheim and Syme's Host-Resistance Model

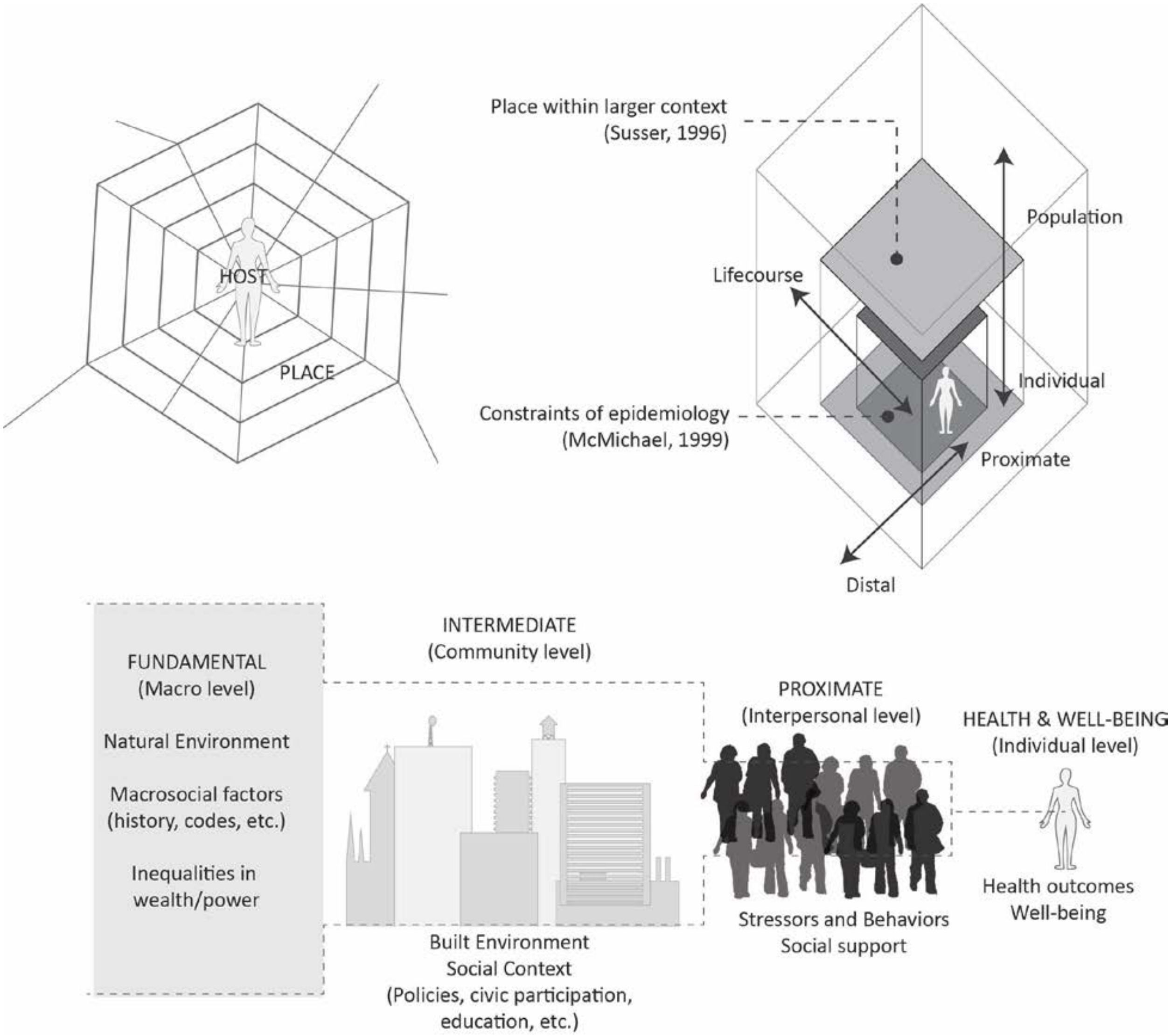

Figure 12: Models of Environmental Pathology: Krieger's spiderless web of causation (1994), Susser and Susser's (1996) and McMichael's (1998) Chinese Box, Northridge et al. (2003) social determinants of health (clockwise from top left)

Through the early 2000s, further work by social epidemiologists such as Ana Diez Roux, Nancy Krieger, and Robert Sampson would further investigate the "neighborhood effect," or why certain diseases, or even high-risk behavior such as violence or delinquency, is often spatially clustered (Sampson et al., 2002). The field embraced terms such as "lifecourse," which not only examines the current environment of an individual to understand health outcomes, but their experience leading up to the point of study; and "embodiment," or "a concept referring to how we literally incorporate, biologically, the material and social world in which we live, from in utero to death; a corollary is that no aspect of our biology can be understood absent knowledge of history and individual and societal ways of living" (Kreiger, 2001, p. 694). This new, expansive way of thinking about disease causation required new models of pathology that incorporated many possible scales of influence.

Hypothesized Pathologies

There are differing pathologies of built environment effects depending on the health outcome. One studies the built environment's contribution to pollution and climate change and the subsequent impact on disease, particularly respiratory and cardiovascular health (Younger, Morrow-Almeida, Vindigni and Dannenberg, 2008). These direct effects are generally more testable by traditional scientific methods, as well as lend themselves to clearer solutions, measurable standards and monitoring, such as sustainable building practices and lowering energy use in buildings through programs such as LEED. However, changing behavior is a much more nebulous relationship between built environment, motivation and influence on the individual. Furthermore, they require interventions in the public realm as opposed to a contained private property such as a building. Some researchers have tackled this conundrum by noting that steps to decrease auto use and increase pedestrian amenities both definitively reduce the direct negative health effects of pollution and could potentially increase the positive health effects of active transport (Frank et al., 2006). This is one way to advocate for built environment intervention until methods of measurement and theories of pathology are more generally accepted and standardized.

Since Lindheim and Syme's host/resistance model, many researchers have developed ecological models hypothesizing the multilevel influences and impact on health behavior and outcomes. Aicher (1998) proposes a direct descendant of Lindheim and Syme's model, hypothesizing that all elements of the environment can be classified as "stressors" or "supporters." Biochemist Hans Selye noted that stress is a biological response. The repeated exposure to these stressors will eventually weaken the body and make it more vulnerable to disease. Aicher notes that stressors can 1) do direct damage to the host (individual), 2) directly reduce host resistance, 3) create an indirect reduction in host response (in which case stressors may spur unhealthy coping behaviors such as smoking, overeating or risk taking) or 4) cause diseases of adaption to stress (such as elevated heart rate, ulcers or depression). Supporters are "protective factors or personal resources" (p. 5) which can help ward off the effects of stressors. Other researchers have proposed multilevel models which try to order specific stressors by magnitude of influence (See Figure 12). Krieger (1994) suggests that with chronic disease, a linear etiologic model is less appropriate than a spiderless "web of causation." This indicates that there is no single pathogen causing chronic disease, but instead macro and micro threads constantly intersecting—and with no definite direction. McMichael's (1999) ecological model notes the field's narrow focus on immediately proximal influences to the individual and encourages study of larger societal/environmental upstream factors affecting the population, as well as factors over time, also referred to as "lifecourse." Susser and Susser (1996) use a "Chinese box" metaphor (as opposed to the previously unknowable "black box" of place effects) to propose a hierarchy of external influences on the individual, each echoing down to lower levels, with the individual at the center affected by all. These models are largely unspecific about the influences themselves, but Schulz and Northridge (2004) propose a model specific to place effects, categorizing physical and social influences on health outcomes by scale, i.e., macro, meso and micro. Their model is also one of the few to delineate the difference in scales (and effect) between natural and built environments, as well as posit that health outcomes, behavior and social relationships have a reciprocal relationship on neighborhood environments themselves.

These models, however, are largely intended as frameworks for public health interventions for behavioral habits such as healthy eating or smoking. It is rarer to see an ecological model related to physical activity, the notable exception being that offered by Sallis et al., (2006). They propose that an active living environment targets both the social and the physical, and must have policies to support these as well. The researchers propose that the policy environment although least proximal to the individual, dictates or trickles down to form physical settings of recreation, transport, occupation and household, which in turn forms the "perceived environment" by the individual, whose activity is guided by demographics, biology, family situations and psychology. This also includes the "information environment" which is usually overlooked by most health promotion models, but indicates that media has some influence on our lifestyles. While it is one of the only models in the literature specified for walking and active lifestyles, its form seems to give policy more power than it actually has to shape neighborhoods, and does not account for the economic or cultural forces that also form urban fabric. While important, and often unrecognized by most environmental models, it appears to indicate no change can be made without changing policy, which seems inefficient, at best. Additionally, the conduciveness of the physical environment to active living person is not really specified beyond being "walkable" and having pedestrian and bike facilities. Of course, pinpointing elements of the built environment as they relate to walking is difficult, particularly when trying to avoid the implication that any element is "causal." However, as the next section and next chapter demonstrate, these are two primary (if largely unrecognized) dilemmas in the field.

Causality and Associations

The primary question in place and health studies still remains: *Does the physical environment influence health?* Given the difficulty in establishing a direct causal link between elements in the environment and the outcome of either physical activity or obesity, most studies can only point to correlations (Eid et al., 2008). Even Reid Ewing, a prominent proponent of the built environment's connection to health cannot safely say that urban form causes obesity, but rather is significantly associated (Ewing et al., 2003). While this may be sufficient for urban designers and some municipal leaders, correlations are not necessarily a strong enough relationship to justify the capital it takes to make interventions in the built environment, particularly given the disastrous effects of the past. Some insist that causality should be a central goal. Oakes and Kaufman (Oakes and Kaufman, 2006) write that a particular problem of observational research is proving causal inference:

> … we must state our analytic goals more clearly: does an author seek a causal, predictive or perhaps "merely" descriptive model? Unlike fields such as climatology, social epidemiologists are often interested in actually enacting policies or interventions in order to improve the public's health. We therefore need to privilege causal explanations and to aim to build causal models. The yardstick is not perfection but usefulness … (p. 9)

What may be required is a different framing of both questions and interventions:

> A lesson here is that among human beings, researchers can seldom if ever be assured of anticipated success of an intervention aimed at counteracting the observed effects of a deficiency or some other adverse factor. For one thing, many variables interact to cause an outcome. Interventions select but one or a few of these variables, thereby ignoring or bypassing unknown interaction effects. Even if the selected experimental interventions are exactly the obverse or the counterpart of adverse factors—and a degree of speculation must reside in the judgment that they are—the effect on the given outcome is of necessity uncertain. Results that invariably confirm existing ideas are suspect in science, which to a degree is sustained by its subversive challenge to existing belief (p. 211).

Establishing causation also requires that we disentangle the physical elements of place from attitudes, preferences and history (Frank et al., 2007). If we accept that these elements are indelibly tied to the design and sociological framework of place, this is virtually impossible. The neglect of social factors risks both biasing (deviating results in either direction from some "true" value that the study was designed to estimate) and confounding (a variable that is not of primary interest, but which is independently associated with both the outcome and the exposure variable under study). Failure to adjust appropriately for confounding can lead to bias. In the meantime, the lack of longitudinal studies of both of people's physical activity *and* how the built environment changes over a set period of time, assuming those people stay in one place, further reduces the acceptance of these studies. One of the few longitudinal studies on built environment (or "sprawl" and obesity) was inconclusive about the relationship.

However, many historical public health crises were successfully combated without first targeting a direct cause, with a large assist from spatial analysis. Plague outbreaks in the Middle

Ages were mostly halted by containment and quarantine, not by finding a root cause. It could be argued that Snow's cholera maps did not find the precise cause of cholera, but rather what elements of the environment predisposed people to the illness. Even in its time, Snow's arguments had compelling evidence, but "did so without the broader general theory of disease was to cause skeptics to question its focused thesis" (Koch, 2005, p. 84). Few discuss how he failed to convince contemporaries of his argument as it was a specific and narrow case, but ultimately not enough to challenge the popularity of miasma theory. In fact, the actual bacteria that caused cholera was later discovered by Robert Koch as *Vibrio cholera* (Koch 2005).

Studies on obesity, diabetes, asthma, etc. make an even tougher case for conviction, not only because of the indirect way they manifest, but due to health privacy issues and the nature of data distribution, researchers can really only show disease distribution by zip code or census tract. There has yet to be a workable theory of how these diseases "spread," but we do know that there are factors that promote and combat these health outcomes. And as Diez Roux (2004) notes, that in this most recent age of chronic disease, the preponderance of built environment correlation alone on certain outcomes should be enough to begin to take action.

These cases aside, the majority of place and health studies discuss the difficulty of confounding factors in reaching conclusions, most notably the agency of the individual in residential choice. The model of disease causation and the concentration on the individual in medicine constricts the utility of place and health studies. Individual level variables (behavior) can be a confounder or mediator, depending on question asked (Roux, 2001). In the structure of an epidemiological study, confounding factors such as socioeconomic variables and the accounting for all environmental exposures are the most difficult to overcome (Elliott and Wartenberg, 2004). In terms of walking, this is the premise that people who are less prone to want to walk recreationally will subsequently choose neighborhoods that prioritize automobile over pedestrian mobility (Eid et al., 2008; Southworth, 2005). Some studies have attempted to account for this self-selection factor (Chatman, 2009; Frank et al., 2007; Handy and Mokhtarian, 2005). Frank et al., (2007) mounts a fairly straightforward study design by asking respondents about neighborhood preference for high or low walkability and pairs it with the actual measured walkability of their neighborhood to measure the effect of the physical environment. Results showed that those without preference for a walkable neighborhood to begin with were not demonstrably motivated to walk by living in a walkable neighborhood. Also, there is a degree of "neighborhood mismatch" to contend with, when considering that those who might prefer a walkable neighborhood don't necessarily have the choice to live there due to housing availability and price. This caveat should be understood hand in hand with a 2010 Brookings Report showing that suburban (i.e., auto-oriented) neighborhoods are increasingly occupied by minority and economically disadvantaged populations (Kneebone and Garr, 2010), who are also more vulnerable to chronic disease (Ferdinand et al., 2012). Additionally, there exist significant vulnerable populations such as children, adolescents and the elderly, who may have limited physical ability and lack automobile mobility and transit access, meaning they are more significantly affected by their residential environment (Papas et al., 2007).

Additionally, if built environment study uses an ecologic model by necessity, they also risk the ecologic fallacy. The associations between factors at group or aggregate level cannot be inferred on individual health, another reason many place and health studies are treated with some skepticism in the field (Oakes, 2004b). However, factors such as obesity can only be measured at the aggregate or clustering level. Diez Roux (2001) and Oakes (2004) assert that the development of the multilevel analysis model, which can both study ecologic effects and control for individual-level variables, and if not definitive or "causal," they can be useful in generating hypotheses and contextual analyses (Diez Roux, 2001; Galea and Schulz, 2006).

A series of commentaries and responses in *Social Science and Medicine* between J. Michael Oakes (2004a; 2004b), Ana Diez Roux (2004), and S.V. Subramanian (2004) summarizes many of the biases related to causality in place and health study. Oakes notes that the lack of causal inference claimed by place and health studies diminishes their impact on the field, especially given the lack of study relating outcomes to biological mechanisms. However, Oakes also demonstrates a common but limited view of "neighborhood," not as an area with physically similar elements but solely social, i.e., defined by socioeconomic status (SES). He also points out that place and health study design cannot follow traditional scientific methods without difficulties. If neighborhoods are "treatments" then residents are "selected" and not randomized, and that any presumed neighborhood effect assumes people are exchangeable between them, which neglects other common correlates of disease, particularly SES. Any study geared toward intervention is bound to have disappointing results, be expensive, ethically difficult, and without established models, poorly designed. Furthermore, any study can only be limited to observational data rather than controlled. Asserting that the common approach of multilevel regression models does not make a case for causality (but may be helpful for theory development and preliminary testing), he cautions too much meaning is often attributed to these studies and recommends they be studied in a qualitative framework instead, specifically anthropological and social theory, even though these do not prove "causality" either. He offers an alternative quantitative model to separate out area effects.

Diez-Roux maintains that the supposed self-selection "confounder" should instead be treated in appropriate cases as a mediator. Subramanian also counters that not all neighborhood selection is *non*-random, meaning self-selection cannot completely refute all neighborhood effects. Diez Roux further argues that stratification by SES may not necessarily prove individual level associations as people of similar SES can live in very different neighborhoods. She also agrees that neighborhood interventions cannot be made if they remain uninformed. But a better refinement of quantitative methods may not be the answer. Rather, evidence from interventions, natural experiments and more focused observation should be used, even if not proven to be causal. She and Subramanian also argue against Oakes' assertion that all crucial neighborhood factors are endogenous, that is, formed and defined by its residents. Instead, they pointed out there are many neighborhood factors that are exogenous, or forces exerted on neighborhood residents beyond their control such as macroeconomic forces and policy. Both Diez Roux and Subramanian refute Oakes' dismissal of observational data as well, noting that neighborhood effects are not the only area of study where the method is employed, as well as the utility of Oakes' "causal" quantitative model, which they argue diminishes *any* neighborhood effect effectively nil.

Meanwhile, when it comes to influencing physical activity in the built environment, many researchers diminish their own results by submitting to a traditional view of causality. Almost every study you will read on the subject will come with the disclaimer that the experiment is not meant to imply causality, and as always, "more research is needed" on individual components of the built environment. Interestingly, designers are often the first to harp on public health's shortcomings in proving causality, perhaps due to the widespread rejection of environmental determinism after the disasters of urban renewal (Abu-Lughod, 1969; Lockton, 2011). In a particularly confusing case, a 2013 report from MIT's Center for Advanced Urbanism by Berger et al., dismisses much of public health's research on obesity and built environment from walking to food deserts, for its lack of causal proof on the subject, but still goes on to make design recommendations. These recommendations, however were not necessarily tied to any of the research, based on the overlay of environmental and health information at the very coarse scale of entire metropolitan areas. Ultimately, the issue of causality in the built environment has not, and will not stem the wave of communities, designers and planners looking to make proactive changes in their environment. However, different approaches to the problem at hand can advance the research past its current stagnation point. First, instead of creating interventions, researchers can be more proactive about looking for planned changes in the environment to study effects before and after (McCormack et al., 2004). We should also be aware of nuances in exactly which behavior we are looking to influence. Handy and Mokhtarian (2005) note that encouraging walking is normally more influenced by built environment changes than reducing driving, which is more influenced by income. Additionally, we should recognize the difference between someone who drives to the grocery store because there are none available nearby, or someone who drives merely because they prefer to shop somewhere else (Handy, Weston, and Mokhtarian, 2005).

What both researchers and designers can do is adopt different expectations for both research models and interventions. Parascandola (2011) notes that many in the biology and social sciences field have rejected the strict idea of causality for one of "probabilism," (as in X behavior raises the risk of Y outcome by Z percent) particularly in practice, and urge those in the epidemiology field to embrace a small degree of indeterminism in their interventions, to think about how they produce or modify risk instead of causing them. When it comes to interventions, Broadbent (2011) urges both researchers and policy makers to adopt the "what could possibly go wrong?" and instead seek "robust predictions" as opposed to causal inferences. For any intervention, he advocates for getting the best knowledge available, and seeks solutions that according to that data, could not "easily be wrong," as well ask more in depth *why* the predicted outcome will occur.

This is not to be flippant about interventions. Says Krieger (2011):

> Epidemiologists since the inception of the field have long reckoned with the knowledge that erroneous and inadequate explanations can cause

> damage—either literally harming particular individuals or else not averting preventable suffering, illness and death. At one level, the awareness of the potential of epidemiological research to do harm, not just good, is well recognized in the obligate discussion of 'Type I' and 'Type II' errors that routinely appears in epidemiological textbooks" (p. 270).

The Type I (alpha) error wrongly rejects a null hypothesis, declaring that a difference exists when it does not. The Type II (beta) error fails to reject a false null hypothesis, declaring that a difference does not exist when it does. Krieger also mentions the Type III error particularly to epidemiology, which is "wrongly assessing the causes of inter-individual variation within a population when the research question requires an analysis of causes of differences between population or time periods" (p. 270). Built environment studies are of course most subject to Type II and Type III errors, the latter of which is also known as the ecological fallacy. Ultimately, while great caution should be taken before proceeding with interventions based on research, it is not so much a question of causal and not causal as shades of gray in between.

Conclusion

This examination of public health theory, particularly when it comes to place and health is included here precisely because it is normally excluded from most discussions on public health theory. As demonstrated in the previous chapter, physical activity, obesity and obesity-related disease is the epidemic of our time, and only the latest iteration of illnesses traced it to the neighborhoods where we live. Even though public health has greatly expanded and specified their methods for studying environmental causes, very little of it is earnestly integrated into histories or urban development or empirical research. As shown in the next chapter, much of what has been outlined here does *not* enter the discussion of built environment, health and walking. The frameworks are largely limited to nonexistent. Everyday travel is arguably more dictated by the design of cities than other health related behaviors such as smoking and eating, yet there appears to be a reticence on the part of both public health researchers and planners/designers to embrace theory in order to make more targeted interventions. Two notable overviews of built environment and health, Aicher's *Making Healthy Cities* (1998) and Lopez's *The Built Environment and Public Health* (2012), in fact neglect to cover the physical activity aspect in much detail in favor of direct effect issues such as air quality, water and housing. However, both texts also expend quite a bit of space to indirect effects of the environment like mental health and social capital. Improving walkability will not necessarily be the sum effect of targeting each of these areas, but improving walkability does contribute to each of them.

Moreover, physical activity appears to be the arena where both fields will most quickly default to the causality argument in order to make interventions. This is understandable given the fraught history of changing neighborhoods for eliminating disease and encouraging desired behaviors, but as the subsequent chapters will demonstrate, it has also locked this particular field of research into a circular pattern, continually updating and splitting hairs about how to best explain the relationship of individual micro-elements of the environment to the occurrence of walking. Social epidemiology theory and a more nuanced view of how causality limits research could be key to pushing studies forward, as well as serve as a common foundation for the fields to push forward on the work.

CHAPTER FOUR: BRICK BY BRICK, STEP BY STEP

Reviewing Current Literature on Built Environment and Walking

Introduction

Public health is re-engaging with built environment study with increasingly sophisticated statistical methods and technology. Growing access to spatial data and analytical software has driven the proliferation of walkability studies in the fields of public health and urban planning research in the past 10 years, even though widespread acceptance of the relationship between physical and the built environment is still limited (Eid, 2008). Jackson, Dannenberg and Frumkin (2013) found that the terms “health” and “built environment” in a PubMed only yielded 39 studies between 1993 and 2003, but 675 between 2003 and 2013. The majority of the studies revolve around measuring walkability in the built environment (Ewing and Cervero, 2010). The use and dissemination of empirical study, not just through medical journals but through respected and well-funded entities such as the Robert Wood Johnson Foundation’s Active Living Research Initiative, have given the walkability movement a huge amount credence over the past decade-plus.

However, given that this interest is still nascent, the field’s understanding of the built environment is still somewhat limited, particularly in the analysis of how discrete physical factors cohere into spatial experience, and how perspective and influence of the built environment differs from individual to individual, and how these play a part in decision making. In this chapter, I explore the conclusions, contradictions and constructs of contemporary empirical evidence on the built environment and walkability, and discuss their implications for our own understanding of this connection between future planning and building policy.

Study Selection

This review primarily focused on cross-sectional, observational studies (with one exception of a longitudinal study) examining health outcomes and the built environment. This accurately reflects the majority of the studies on this subject, as longitudinal studies still struggle with reflecting lifecourse of subjects about how the physical structure of neighborhoods change over time (Kaufman and Cooper, 1999; Kuh and Ben-Shlomo, 1997). All studies examined a measure or multiple measures of the built environment regressed against some proxy for health outcomes, whether it was physical activity, body mass index (BMI), or in one case, cardiovascular disease. The aim of this evaluation was to find commonality between the major components of landscape infrastructure thought to have an impact on physical activity—namely, streets, neighborhood components and parks/open spaces. The goal of these studies is to control for certain variables, isolate others, and come to conclusions that can be applied to a wide variety of built environment contexts.

Thirty-eight peer-reviewed studies were initially selected for review, as well as 10 reviews and meta-analyses of the literature on the built environment and health outcomes (See Table 1). All selected studies were in English. Studies were selected by using the terms "landscape and physical activity," "built environment and physical activity," and "built environment and walkability," in the PubMed, Google Scholar, SAGE Urban Abstracts, Melvyl databases and from the Robert Wood Johnson Foundation's Active Living Research online library. Some articles were also drawn from the bibliographies of selected studies.

The dependent variable or outcome in 23 out of 38 studies was measured physical activity or number of trips, for either leisure or active travel. This was objectively measured with accelerometers or pedometers, or self-reported in surveys or travel diaries measured in minutes walked. Alternatively, in five studies the dependent variables were weight and height measurements translated to a BMI measurement, again either self-reported or measured. In two studies, both physical activity and BMI were measured. As people tend to underestimate their own BMI when self-reporting, the magnitude of which can differ depending on the method through which information is gathered (Ezzati, Martin, Skjold, Vander Hoorn and Murray, 2006) and gender (Gorber, Tremblay, Moher and Gorber, 2007), objectively measured is more desirable. Although BMI has been criticized as an inaccurate measure of health (Ahima and Lazar, 2013; Lewis et al., 2009), BMI persists as a measure of health in epidemiological study as it has been standardized and doesn't require special tools or training (Centers for Disease Control and Prevention, 2014a). The differences in actual and self-reported physical activity are less clear, as a review found that people tend to both overreport and underreport activity, depending on the method used to collect information (Prince et al., 2008). However, self-reporting is often methodologically easier and can garner wider samples. Other measures of health included self-reported health status, by survey hospitalization from obesity-related disease (such as hypertension and diabetes) and actual coronary events. Two studies sought to measure "attractiveness" as a precursor to finding its relationship to physical activity.

The specific nature of outcomes and the factors associated with their measures often differs depending on the field of literature each study comes from. Public health is more likely to focus on the direct health outcome (for example, BMI/obesity) and leisure physical activity. Planning literature focuses on walking itself as the outcome, and not necessarily the health effects, as well as active travel to specific destinations (most often home to work or amenities) over leisure activity. This often places the other major component of landscape infrastructure, parks and playgrounds, in the realm of public health study, since parks are used for leisure activity. Additionally, for the most part planning literature tends to focus on the operability or maximization of active travel networks and is more adept at analyzing how multiple factors work together in the environment (Saelens, Sallis, Black and Chen, 2003). More public health studies have attempted, albeit through some struggle, to translate such commonly measured features as density, diversity and design into more qualitative findings about the walking environment, particularly how they are psychologically perceived by the individual.

Citation		Primary Information		Variables					Type	Population units		Outcomes
Study	Authors	Objectives	Study Location	Independent Variables	Calculated as	Dependent Variable	Calculated as	Control variables		Population type	Sample Neighborhood	Primary Conclusions
Mixed land use and walkability: Variations in land use measures and relationships with BMI, overweight, and obesity	Brown, Yamada, et al. (2009)	Will alternative measures of land use diversity/mix exhibit a stronger relationship to BMI	Salt Lake City, UT	LAND USE Entropy scores (equal distributions of walkable land use); Distances to walkable destinations (parks and transit stops) walk to work measures and neighborhood housing ages via census Land use categories in entropy measures	Based on Frank et al. (2005,2006) - see article (sub land area for building floor area) Entropy: Scale of 0 (homogenous) to 1 (maximally heterogenous)	BMI	binary (0=healthy weight; 1=overweight and 0=healthy weight, 1=obese)	N/A	Objective	ADULTS 5000 randomly chosen licensed drivers, 25-64, using height and weight measures	1-km street network buffers (per Frank et al.), vetted for land use	presence of walkable land uses rather than equal mixture relates to healthy BMI
Residential choice, the built environment, and nonwork travel: evidence using new data and methods	Chatman (2009)	How does BE affect nonwork travel when taking into account self-selection/attitudes	San Diego, San Francisco, Oakland, San Jose	Search criteria variables: 0/1 based on whether seeking transit for any purpose BE variables: number of retail workers, residents per road mile (measures congestion), 4 way intersections, presence of heavy rail, presence of light-rail, distance to CBD, sidewalk on both sides of the street	N/A	Nonwork trips by auto, transit, or walk/bike	Number	household income, income squared, HH size, sex, children in HH, interaction of previous 2, worked outside home, day of survey (weekday v. weekend)	Objective	ADULTS Stratified random samples of households 999 respondents included	Metro-wide Households near rail stations oversampled BE variables within 1/4 to 1 mile (varies)	Households do take into account access, but does not bias BE effects, instead both underestimates and overestimates effects Some BE variables have stronger affects on households not predisposed to certain types of travel
City structure, obesity, and environmental justice: An integrated analysis of physical and social barriers to walkable streets and park access	Cutts, Darby, et al. (2009)	Using GIS to evaluate relationship between populations vulnerable to obesity and proximity to parks and walkable street networks	Phoenix, AZ	"Walkability" measured per Leslie et al. (2007) Park Proximity	Dwelling density: dividing # of households by residential land area Each census block group assigned index score Connectivity: intersection density Net retail area excluded High speed roads later excluded from intersection analysis Park size as surrogate for park quality	Latino/a immigrant factor African-American Youth population	Dasymetric population mapping in GIS	N/A	Objective	NONE	Census blocks displaying high Latino/immigrant or African American populations	Benefits of built environment may be offset by social characteristics Children under 18 underrepresented in regions deemed highly walkable/have access to parks
Unpacking Walkability: Testing the Influence of Urban Design Features on Perceptions of Walking Environment Attractiveness	Adkins, Dill, et al. (2012)	Can "walkability" (attractiveness) be sensitively unpacked into discrete components	Portland, OR	50 items ranging from sidewalk condition and width to level of maintenance; two subjective ratings of attractiveness and safety	Presence	Perception and influence of micro-scale elements (quality) Measure of attractiveness	Binary rating of segment attractiveness (choice based, conjoint analysis) Bivariate correlation matrix and ordinary least squares regression (OLS)	kerb ramps, kerb extensions, sidewalks, trees and sidewalk setbacks from kerb	Both	ADULTS Maps and surveys sent to 2163 households 748 individuals in 572 households respondent (26.4% response rate)	Four sub-areas within Lents Neighborhood (4.5 sq mi)	"Green streets" have high level of attractiveness, arterial streets have strongest negative influence Separation of walking environment from traffic also rates higher
Walkability of local communities: Using geographic information systems to objectively assess relevant environmental attributes	Leslie, Coffee, et al. (2005)	Can walkability measures from PLACE study be operationalized for GIS	Adelaide, Australia	Proximity and connectivity per Saelens et al (2003)	Dwelling density as dwelling number per residential land area on a scale of 1 to 10, Intersections with 3 or more unique intersecting streets/# per square kilometer then on scale of 1 to 10 (decile classification) Land Use: Entropy equation (see paper) Retail area: amt of floor area to land area	N/A (tool testing)	N/A	SES	Objective	NONE Thirty-two communties at highest and lowest quantiles for walkability	Contiguous clusters of CCDs, stratified on SES (156 CCDs in all): high walk/high SES, low walk/high SES; high walk/low SES; low walk/low SES	Measures mostly validated at ground level
Neighborhood of Residence and Incidence of Coronary Heart Disease	Diez Roux, et al. (2001)	Is neighborhood an independent predictor of health?	Forsyth County, NC; Jackson, MS; Minneapolis, MN; Washington County, MD	Neighborhood characteristics score: based on sum of z scores from factor analysis	Personal income, education, occupation, home values	Coronary events - hospitalization and death	Number of events per study area	SES, Race, Lifestyle CV risk factors	Objective	ADULTS Sampled populations 45 to 64 years old Cohort of 15,792 selected by probablility sampling	Proxy: Block groups containing an average of 1000 people	Living in a disadvantaged neighborhood is associated with coronary heart disease
Urban layout, landscape features and pedestrian usage	Jean-Christophe Foltete, Arnaud Piombini (2007)	Does the visual impact of urban features influence pedestrian behavior	Lille, France	Theoretical accessibility (A(x)) and Preferences (P(x))	A(x)= integration of the grid P(x) = landscape perceptions - 3 level scale of landscape variables starting with empty spaces, vegetation, visual obstacles, and built form	Pedestrian frequency (U(x))	Movement survey: counting the number of pedestrians who cross a segment of a street at an exact spot ("gates" method) or compiling exact routes used by a large number of pedestrians (density of origins and destinations proportionals to attractors)	N/A	Objective	UNSPECIFIED Pedestrians walking to city center (500 trips)	Interlocking areas in the middle of the city - 1900 street sections and 248 (approx 9 sq km and 1 sq km - see maps)	Visible landscape works hand in hand with layout

Table 1: Built Environment and Physical Activity Studies Examined for this Chapter

Study	Authors	Objectives	Study Location	Independent Variables	Calculated as	Dependent Variable	Calculated as	Control variables	Type	Population type	Sample Neighborhood	Primary Conclusions
Many Pathways from Land Use to Health: Associations between Neighborhood Walkability and Active Transportation, BMI, and Air Quality	Frank, Sallis, et al. (2006)	How does travel behavior relate to both individual health (obesity, respiratory disease) and VOC and Nox output (comprehensive look)	King County, WA	Walkability index (sum z scores): Net Residential density, Street connectivity density , Land use mix, Retail floor area ratio (FAR) Demographics: Gender, Age in years, Education, Ethnicity, annual HH income, children under 18	Net res density: units divided by acres in residential use, Street connectivity: intersections per square kilometer, Land use mix (A/(ln(N)) (see paper); FAR: Retail building floor area sf divided by retail land area (sf)	BMI and Transportation-related physical activity	Height/Weight and survey responses on International Physical Activity Questionnaire (IPAQ)	Sociodemographic information Stratification: Walkability index and median household income, decile classification	Objective	ADULTS 75 adults between 20 and 65 in each of 16 neighborhoods; final sample of 1,228 adults	Continguous block groups with at least 1000 households and 1-km network buffer of each respondent's place of residents	Results connect development patterns with factors that affect several prevalent chronic diseases Walkability strongest single-variable correlate in all the models
Design and Destinations: Factors influencing walking and total physical activity	Forsyth, Hearst, et al. (2008)	Do people walk more or less depending on physical character of their residential area	Twin Cities, MN	Street pattern, 'pedestrian-oriented' infrastructure and amenities, and mixed use or destinations (factor sets - total of over 200 individual factors)	Computer mapping and survey	Physical activity	survey, seven-day travel diary, and accelerometer	SES Density	Objective	ADULTS 715 participants from 36 focus areas	805 meter grid cells	Socially similar people do the same total amount of physical activity in different kinds of places and that level of activity is, on average, low Changing how people relate to their environment (i.e., pricing or education) would be more efficient than changing the built environment
Relative Influences of Individual, Social Environmental, and Physical Environmental Correlates of Walking	Giles-Corti and Donovan (2003)	What are the individual, social environmental, and physical environmental correlates of walking	Perth, Western Australia	Neighborhood characteristics score: based on sum of z scores from factor analysis	Survey, numerical scales or binary variable	Physical activity	"walking at recommended levels": 12 or more sessions of walking in 2 weeks totaling 360 minutes or more (yes/no, based in previous Australian studies)	Exclusion of individual with reasons not to engage in recreational physical activity	Perceptive	ADULTS Healthy homemakers and workers aged 18 to 59 years 1803 respondents from 277 districts	Unspecified (metro-wide)	Influences of individual, social environmental, and physical environmental factors found to be equally important Walking in conjunction with other physical activities will reach recommended levels of PA
Perceived and objectively measured greeness of neighborhoods: Are they measuring the same thing?	Leslie, Sugiyama, et al. (2010)	How close are the results of objective vs. subjective measures of greenness in agreement?	Warrnambool , Australia	"Greenness"	Objective: Mean value of NDVI in 400-m buffer around residential parcel; Perceived: 17 green items with a 1-4 scale of "greenness"; split into categories of street greenness, green expanse, sport facilities, and green amenity	N/A (tool testing)	N/A	Stratified between those living close and living far from town center - split on median of Euclidean distance	Both	ADULTS 237 and 232 parcels selected from high and low parcel extremes 94 adults	10-15 walking distance from home	Lack of agreement between the two meaning measures are capturing different aspects: Objective measures measure quantity while subjective measures quality
Association of Park Size, Distance, and Features with Physical Activity in Neighborhood Parks	Kaczynski, Potwarka, Saelens (2008)	Does park size, number of features in the park, and distance to a park relate to park use for physical activity	"Medium-sized city" in Ontario, Canada, each 1 sq mi in size	Park Amenities Average distance Safety and aesthetics	Environmental Assessment for Public Recreation Spaces (EAPRS) tool; Euclidean distance to park centroid (skews results with larger parks); Abbreviated version of NEWS rating elements on 1-4 agreement scale (500-m buffer)	Physical activity	7-day physical activity log booklet correlated with Godin-Shepard Leisure Time Exercise Questionnaire Use of parks or trails noted, coded for individual parks	Two neighborhoods characterized by grid like street patterns and mix of commercial/residential land use; 2 residential and curvilinear streets Containing 6-10 parks each (total of 33)	Objective	ADULTS 250 residential households per neighborhood randomly selected with multihousehold properties proportionately represented 585 residents polled 380 (18-88 years, mean age of 45.8) provided valid physical data	Municipally defined	Parks with more features more likely to be used for physical activity; size and deistance not significant predictors.
Increasing Walking: How important is distance to, attractiveness, and size of public open space?	Giles-Corti, Broomhall , et al. (2005)	Do various models and scales of accessibility modeling for public open space (POS) controlling for distance, attractiveness, and size associate with physical activity?	Perth, Australia	Distance to POS, with adjustments (see next)	3 models: distance only (assume all POS are equally attractive); adjusted for distance and attractiveness; adjusted for distance, attractiveness, and size; gravity models	Reaching recommended levels of actvity	Self-reported	SES; POS < 6 hectares; matched by POST scores	Both	ADULTS 1803 adults aged 18 to 59 years with 52.9% response rate 516 public open spaces over 2 acres	Use-shed defined by gravity model, all within a 408 sq km area of metropolitan Perth	Likelihood of using POS increased with increasing levels of access; effect greatest in model adjusting for distance, attractivness, and size Attractiveness strong factor after matching size and location
Retrofitting the Suburbs to Increase Walking: Evidence from a Land-Use-Travel Study	Boarnet, Joh, et al. (2010)	What land use patterns are most associated with pedestrian or driving activity? What is the pedestrian or auto-shed of users of commercial centers and linear auto corridors	South Bay area of Los Angeles County (15 incorporated cities and small parts of the City of Los Angeles south of LAX)	4 D's (per Cervero Kockleman 1997): Density, diversity, design, and destinations Diversity excluded given concentration on suburban areas	Destinations: NAICS and SIC codes at 6-digit level from INFO-USA database 2000 census Design: Avg street block size and percentage of intersections that are 4-way Density: residential housing units per acre	Travel behavior (trip purpose, mode choice, and trip distance) Number of walking or driving trips	Self-reported binary variables: Number of walking trips per person per day Number of driving trips Assessment of what fraction of travel is usually to their neighborhood center/corridor Usual travel mode when going to center/corridor	Demographics, attitudes, dummy variable of 1 if respondent lives in center	Objective	ADULTS 2125 residents	Eight neighborhoods, half with central commercial core, half with linear commercial corridor	Centers have more walking travel than corridors Pedestrian-oriented neighborhoods have to attract some drivers (outside neighborhood) to sustain business

Study	Authors	Objectives	Study Location	Independent Variables	Calculated as	Dependent Variable	Calculated as	Control variables	Type	Population type	Sample Neighborhood	Primary Conclusions
Association of access to parks and recreational facilities with the physical activity of young children	Roemmich et al. (2006)	Whether the neighborhood environment or number of televisions in the home environment are independently associated with physical activity and television time	Erie County, NY	Built environment	Housing density: housing units per residential acre within the child's neighborhood Percentage of park area of residential land use and percentage of park area plus non-park residential land of residential land use	Physical activity	accelerometer: 3 weekdays and 1 weekend day	sex, age, SES, adiposity, and television watching	Objective	CHILDREN 32 boys and 27 girls 4 to 7 years of age	Unspecified	Neighborhoods with increased proximity between homes and a greater proportion of park area are associated with greater physical activity in young children
Associations of neighbourhood greenness with physical and mental health: do walking, social coherence and local social interaction explain the relationships?	Sugiyama et al. (2007)	What are the associations of perceived greenness to physical and mental health	Adelaide, Australia	Perceived greenness Outdoor physical activity Social coherence/interaction	Neighborhood Walkability Scale (NEWS) Access to bicycle/walking paths Presence of tree cover or canopy Presence of greenery Presence of pleasant natural features International Physical Activity Questionnaire (IPAQ) Survey questions on a 1 to 5 agreement scale	Self-reported health	Short-form health survey (SF-12 v 1) mental and physical component scores	Sociodemographic variables	Objective	ADULTS 1895 surveys, 32 neighborhoods (randomly selected)	Unspecified	Perceived greenness more strongly associated with mental health than physical Walking link between greenness and physical health, but for leisure not transport (transport often shorter trips, healthier people walk more, transport walking occurs on streets not parks)
Associations Between Recreational Walking and Attractiveness, Size, and Proximity of Neighborhood Open Spaces	Sugiyama et al. (2010)	Associations of attractiveness, size, and proximity of neighborhood open spaces (NOSs) with recreational walking	Perth, Australia	Park attractiveness Park size Park Distance	Environmental audit with Public Open Space Tool (POST) "Expert panel" of 9 attributes for attractiveness (see Giles Corti Broomhall 2005) GIS	Participants' recreational walking within their neighborhood	Self-reported time walking for "recreation, health, or fitness"	N/A	Objective	ADULTS 1465 respondents in 74 new housing developments across Perth	1.6 km radius from respondent home location (identifying NOS) 10-15 minute walk from respondents' home	Presence of large high quality park within walking distance of one's home may be more important in promoting sufficient amounts of walking for health benefits than is mere presence within a shorter distance
Walkability and Body Mass Index: Density, Design, and New Diversity Measures	Smith, Brown et al. (2008)	Connection of neighborhood walkability as well as "novel" measures of land-use diversity to excess weight	Salt Lake County	Higher population density Pedestrian-friendly design (# of intersections within 0.25 mile of address) Proportion of people walking to work Median age of housing (Last two substitutes for land-use diversity) Meant to reflect 3 D's	GIS	BMI	Height/Weight from drivers' license records	Age, Neighborhood racial/ethnic composition (via census), median age of residents, and median family income	Objective	ADULTS 453,927 people 564 block groups (about 1500 residents each) Aged 25-64	Block groups or 0.25 mile straight line buffer	Increasing levels of walkability in neighborhood residents walking to work and neighborhood age decreases risks of excess weight (strongest correlate) Pedestrian-friendly street networks less consistently related to BMI/weight, but density least related
The effects of neighborhood density and street connectivity on walking behavior; the Twin Cities walking study	Oakes, Forsyth, Schmitz (2007)	Test recent research showing that residential neighborhood density and street connectivity affect walking with a "methodologically novel" multilevel study	Twin Cities, MN	Density Street Connectivity	Persons per gross hectare (excl. water bodies) Median block size	Walking	Self-reported diary 7-day accelerometry measures divided into travel walking, leisure walking, mean miles walked, and total physical activity per day	Socioeconomic status	Objective	ADULTS 716 persons across 36 neighborhoods on density/street connectivity stratum (20 residents from each neighborhood) temporally staggered to minimize seasonal affects	Neighborhood areas of 805x805 meters	Effects of density and street connectivity are modest to non-existent Larger block sizes correlate to more leisure walking (40%) High density areas have twice the odds of increased travel walking Travel/leisure walking results cancel each other out
Site Design and Pedestrian Travel	Hess, Moudon et al (1997)	Do pedestrian volumes to commercial centers in suburban vs. urban areas differ	Central Puget Sound region, WA	"Neighborhood site design"	Block size Length and completeness of sidewalk systems	Pedestrian travel	People per hour walking into commercial center	Population density (gross number per acre), land use mix, and income	Objective	UNSPECIFIED People utilizing commercial center	12 neighborhood commercial centers and 0.5 radius surrounding, for total area of 500 acres	Urban sites had 3 times as many pedestrians as suburban However, as many as 400-800 people still walked to commercial centers over the course of working hours despite supportive pedestrian infrastructure
Effects of Site Design on Pedestrian Travel in Mixed-Use, Medium-Density Environments	Moudon, Hess, et al. (1997)	Do pedestrian volumes to commercial centers in suburban vs. urban areas differ	Central Puget Sound region, WA	Route directness Completeness	Directness: Ratio of route directness to straight-line distance and walking contour (percent of residential w/in 0.5 mile) Completeness: ratio total length of sidewalk system to total length of block (optimum 1:1 (all sides have sidewalks))	Pedestrian travel	Volume of walking trips observed	[illegible] per acre), commercial center, walkable distance Topography, weather conditions, day of week, and time of day Median income and mean auto ownership, density of development, [illegible]	Objective	UNSPECIFIED People utilizing commercial center	12 neighborhood commercial centers and 0.5 radius surrounding, for total area of 500 acres	Size of commercial center not correlated with ped volumes Not one variable an explain volumes Majority of pedestrian trips occur along commercial streets, even in urban areas - not quiet commercial streets People still walked to commercial centers in suburbs

Study	Authors	Objectives	Study Location	Independent Variables	Calculated as	Dependent Variable	Calculated as	Control variables	Type	Population type	Sample Neighborhood	Primary Conclusions
Neighborhood Design and Physical Activity	Lee and Moudon (2008)	Are neighborhood environments associated with physical activity	King County, Washington State	Built Environment: 1) Transportation infrastructure (street connectivity, block size, transit, pavement/sidealks, bike lanes, traffic volumes, signals 2) Land use (density, composition, housing) 3) Topography 4) Destinations Perceived environmental variables	GIS analysis Distance is network distance Likert-scale regarding safety, social environment, visual quality, maintenance, presence of facilities	Physical activity BMI	self-reported	"Confounders": demographics/ income, behavior, health, attitude and self-selection active/sedentary behavior	Objective	ADULTS 608 respondents	1-km buffer	Traffic volume the most significant barrier, good lighting most important facilitator of walking
Contribution of Parks to Physical Activity	Cohen, et al. (2007)	Study how residents in low-income minority neighborhoods use public, urban parks and how they contribute to physical activity	Los Angeles, LA	Proximity to park, sex, "target area" of park - recreation areas	Unclear if network or radius distance - assumed to be radius	Physical activity	Observed and filled out via SOPARC	Race/ethnicity, sex	Objective	ADULTS 2000 individuals (direct observation); 713 park users and 605 residents interviewed	2 miles around park	49% of those living within 0.5 miles of park reported using it 5 or more times a week compared to 35% for 1 mile away and further; or People who lived within 1 mile of the park were 4 times as likely to visit the park once a week or more and had average of 38% more exercise sessions per week than those living further away
Recreational values of the natural environment in relation to neighborhood satisfaction, physical activity, obesity, and wellbeing	Bjork, et al. (2000)	Recreational values of park are important as well distance	Scania region, southern Sweden	Recreational values present within 100-300 meters of address	GIS (look up protocols)	Health	Time spent on moderate physical activity BMI Self-rated physical and psych health "Vitality" survey		Both	ADULTS 14,643 residents	300 meters from residence	Significant effects for recreational values w/in 300 meters on physical activity for lush, spacious, serene, and wild Weak negative correlation between number of values present and BMI, but more marked in renters
Measuring the Unmeasurable: Urban Design Qualities Related to Walkability	Ewing and Handy (2009)	Measuring urban design qualities in terms of physical characteristics of streets and edges to build operational definitions and and measurements	N/A	Imageability, enclosure, human scale, transparency, complexity	Visual assessment by panel and forced consensus in pairs on how it rated	N/A	N/A	N/A	Both	ADULTS 10 expert panelists	N/A	Substantial variations in rating street scenes; many characteristics thought to contribute to qualities found statistically insignificant.
Obesity Relationships with Community Design, Physical Activity, and Time Spent in Cars	Frank, Anderson, & Schmid (2004)	Evaluate relationship between the built environment around each participant's place of residence and self-reported travel patterns (walking and time in a car), BMI, obesity	Atlanta, GA	Community Design Hrs in Car Kms Walked per Day	Connectivity (number of intersections with more than 3 legs), Net residential density, Land Use Mix (available land use to number of landuse and eveness of distribution across 1-km buffer)	BMI	Self reported height weight Self reported survey SMARTRAQ survey	Age Income Educational attainment Gender	Objective	ADULTS 10,878 participants	1 kilometer network buffer	Land-use mix strongest association with obesity across all genders and ethnicities: 12.2% reduction for each quartile increase Each kilometer walked per day associated with 4.8% reduction in obesity Each addl hr spent in car 6% increase
Association of Street Connectivity with Road Traffic Speed with Park Usage and Park-Based Physical Activity	Kaczynski et al (2013)	Explore connection between intersection density and park-based physical activity	Kansas City, MO	Intersection density and traffic speed	Traffic speed: more than 35 mph Intersections: with 3 or more segments GIS	Park Use and Park-based physical activity (self-reported)	"some" or "none" /binary GIS	Age, sociodemographic characteristics (Race, income, BMI)	Objective	ADULTS 893 adults randomly selected	1-km road network buffer around each participant	Direct and safe access to parks through street network design and traffic speed reduction are important in addition to park proximity and park design
Factors Influencing whether children walk to school	Su et al (2013)	Use "novel land use configuratin merics to develop multi-level models to identify factors that promote or inhibit walking in a large cohort of children"	Los Angeles, CA	Number of grocery and fast food stores around school Traffic volume data Exposure to air pollution Uniform land use patches	Count around school CA DOT Functional Class (FC) data CALINE dispersion data FRAGSTATS (see study for more description)	Walking to school	Yes or No/binary Questionnaire	Age, sex, race/ethnicity, distance from home to school, asthma, parent education	Objective	CHILDREN 4338 from 10 communities	500m network buffer (grocery) 150m/300m network buffer (traffic) 500m network buffer (Home/school)	Walking rates positively associated with home to school proximity, older age, and neighborhoods with low traffic density Greater land use mix around the home associated with lower rates of walking
Neighborhood-Based Differences in Physical Activity: An Environment Scale Evaluation	Saelens et al (2003)	Comparing BMI and physical activity differences between two neighborhoods of different "walkability"	San Diego, CA	"Walkability"	Residential density Proximity/ease of access to non-residential land uses Traffic Safety Crime Safety Street connectivity Walking/cycling infrastructure Aesthetics	Physical Activity, Height and Weight	Accelorometer and self-report (PA), Self report (height and weight)	Proximity to local employment, average value of home, age of neighborhood, transit availability, regional accessibility	Objective	ADULTS 54/53 participants from each neighborhood	Census tract	Walking for errands more frequent in high walkability neighborhood Statisitically signficant higher BMI in low-walkability neighborhood No significant differences in mild to strenuous physical activity
Travel Behavior in Neo-traditional neighborhood developments: a case study in the USA	Khattak and Rodriguez (2005)	Comparing distance and mode of trips in neo-traditional (New Urbanist) and conventiional neighborhoods	Chapel Hill and Carrboro, NC	Conventional (Suburban) Neighborhood vs. Neo-Traditional (New Urbanist) neighborhood	Lot sizes, net density, type of residences, land use mix, street pattern, sidewalks, accessbility to stores, presence of walking/cycling infrastructure	Trips and trip modes	Self-report survey (Travel diary based on National Personal Transportation Survey)	Median income median resident age (NOTE: median income high - $100k to $150k)	Objective	ADULTS (122 households in conventional, 188 in neo-traditional)	Developer-defined neighborhoods 676 units/315 acres new urbanist 1030 units/646 acres conventional	Auto trips in neo-traditional 20% lower, fewer external trips, and fewer miles per day, but no significant time less spent travelling 17% of trips in NU are walking compared to 7.3% in conventional

Study	Authors	Objectives	Study Location	Independent Variables	Calculated as	Dependent Variable	Calculated as	Control variables	Type	Population type	Sample Neighborhood	Primary Conclusions
The impact of subregional variations in urban sprawl on the prevalence of obesity and related morbidity	Lathey et al (2009)	Correlate indicators of sprawl at the neighborhood level and correlate to obesity clusters	Maricopa County, AZ	Sprawl indicators	Compactness (population density plus distance from urban center), urban land use mix, connectivity, automobile dependency, walkability index (schools, churches, enterntainment places accessible to residences)	Obesity	Hospital discharge records for obesity and related morbidity (hypertension, heart disease, diabetes, lipoid metabolic disorder) and matching patients to neighborhoods	Demographics SES	Objective	ADULTS (percentage not stated) ELDERLY (percentage not stated)	649,513 patients diagnosed with stated chronic diseases matched to census block	SES (income and education) strongest indicator of obesity clustering Walkability index strongest of environmental predictors for disease: 1 percent increase in index indicates 50 percent reduction in likelihood of being in high disease cluster Public transit and commute burden highest likelihood of automobile dependency
Smart Growth Community Design and Physical Activity in Children	Jerrett et al (2013)	Objective measure of smart growth community and physical activity	Chino, CA	Smart growth or conventional neighborhood	Developer defined	Physical Activity	Accelerometer	SES (free lunch status)	Objective	CHILDREN (8-14 years, 147 participants)	Smart growth community (The Preserve) and 8 conventional communities within 30 minute drive further definition unspecified 500 m buffer around home	Smart growth community residence associated with 46% increase in neighborhood moderate to vigorous physical activity Smart growth could add 10 min of PA per day
Linking Objectively Measured Physical Activity with Objectively Measured Urban Form: Findings from SMARTRAQ	Frank et al (2005)	Objective measures of physical activity and built environment, control for sociodemographics	Atlanta, GA	"Walkability index"	Land use mix, Residential density, and intersection density	Physical Activty	Accelerometer	Sociodemographics (Gender, age, education, ethnicity)	Objective	ADULTS (20-70 years, 357 participants)	Census block group (for density) 1-km network buffer	Walkability index significant correlate, 30% more likely to record more than 30 minutes of actvity with each increase in walkability quartile
Lower-Body Function, Neighborhoods, and Walking in an Older Population	Satariano et al (2010)	Determine whether neighborhood characteristics moderate the association between lower body function and walking	Alameda County, CA; Cook County, IL; Allegheny County, PA; Wake and Durham Counties, NC	Walkability index	NEWS: perceived residential density, land-use mix diversity, land-use mix access, street connectivity, walking/cycling facilities, aesthetics, pedestrian/automobile traffic safety, and crime safety, no. and types of common destinations, street connectivity, housing unit density	Time spent walking	Self-report	**Look up covariates definition study site, age, gender, race, household income, education level, access to car	Both	ELDERLY (over 65, 884 participants)	400 meter buffer	Neighborhood type (residential vs. mixed use, residential walk less) and perceived crime safety significantly associated
Neighborhood Design and the Accessibility of the Elderly	Cao et al (2010)	Explore ability of neighborhood design to preserve shift from walking to driving/transit, examine whether design impacts travel of elderly more	Santa Rosa, Sacramento, Modesto, and Mountain View, CA	Traditional or suburban neighborhoods	Neighborhood age, street network, age and design of houses, location and type of commercial centers	Travel behavior (mode and time)	Self-report	Neighborhood characteristics, preferences, travel attitudes, and socio-demographics	Both	ELDERLY (251 responses)	Spatial limits unspecified, or developer/municipally-defined	Neighborhood design has limited effects on driving and transit use, but enhancing accessibility has a larger effect on the elderly than the younger
Relationships between street characteristics and perceived attractiveness for walking reported by elderly people	Borst et al (2008)	Find aspects of street most related to attractiveness	Schiedam, Netherlands	Presence of 25 micro-environmental aspects, see study	Presence of	Attractiveness	Self-report; presence of elements	Age, Neighborhood	Both	ELDERLY (ages 55-80, 288 responses)	Smart growth community (The Preserve) and 8 conventional communities within 30 minute drive further definition unspecified 500 m buffer around home	Most related to attractiveness were tidiness, scenic value, presence of activity/people
Influence of environmental street characteristics on walking route choice of elderly people	Borst et al (2009)	Establish resistance factors to elderly walking to minimize difference between estimated and reported trips; use methods and tools from transportation research	Schiedam, Netherlands	Presence of 12 micro-environmental factors	Presence of	Link resistance	Self-report; presence of elements	Age, Neighborhood	Both	----	Spatial limits unspecified - attitudinal study	Presence of pavement, gardens, dwellings negatively associated with resistance; litter, blind walls, slopes/stairs postively (latter despite ranking high on attractiveness in previous study); links passing through parks or around vegetation also had a positive correlation with link resistance

Frameworks and Definitions

Very few of the studies offered an agreed-upon definition of walkability, which allows neighborhood planning strategies such as Smart Growth and New Urbanist to proclaim their "walkability" without being held to a standard. The outcome of increased physical activity or a normal BMI is assumed to reflect a walkable neighborhood. This lack of definition also contributes to the confusion in measurement methodologies for urban form. Some literature from the planning and design field has instead attempted to categorize the components of urban form in order to begin to assess walkability. Most often, a neighborhood's walkability is based on the assessment of its qualities of origin and destination, area (neighborhood) and route (Moudon et al., 2006). Alternatively, Southworth's (2005) landscape-based approach defines walkability as increased street connectivity, linkages to other modes, fine-grained and varied land-use patterns, safety, quality of path and path context (visual interest, landscaping, spatial definition). Related to these above attributes, environments deemed to encourage walking shared the following common attributes: a presence of continuous and well-maintained sidewalks, universal access characteristics, path directness and street network connectivity, safety of at-grade crossing treatments, absence of heavy and high-speed traffic, pedestrian separation or buffering from traffic, land use density, building and land-use diversity or mix, street trees and landscaping, visual interest and sense of place as defined under local conditions, and perceived or actual security (Lo, 2009). These factors are widely accepted in the literature and were repeatedly analyzed in all of the studies examined here.

There are essentially two conceptualizations of the pathology between the built environment and health outcomes. The first, and generally more accepted model in public health, examines the built environment's contribution to pollution and climate change and the subsequent impact on disease, particularly respiratory and cardiovascular health (Younger et al., 2008). The second, which is the focus of this chapter and dissertation as a whole, is the much more nebulous relationship between built environment, motivation and influence on health behavior (i.e., physical activity) and its health outcomes. These two approaches tend to align themselves under architectural concerns (in that buildings consume energy and produce pollutants) and landscape/urban planning concerns (in that the public realm shapes lifestyles). So while the former can be proven based on an established scientific model of a linear path between exposure and outcome, the pathology between built environment, behavior and health outcome remains more complicated.

As previously discussed, it is difficult to prove causality in the built environment, and accordingly, almost any study on health and the built environment can only venture an association or correlation between components of the built environment and physical activity. To prove a causal association would require longitudinal studies, ethically dubious interventions in the built environment, and to find two neighborhoods alike in every single respect, physically, socially and demographically, but with one studied difference (Oakes, 2004a). Herein lies a major disadvantage walkability studies have in gaining traction in the realm of public health. A built environment study that uses a framework of climate change can simply measure pollutants expended by increased car use and trace pollutants to a respiratory or cardiovascular health outcome through established etiological routes, but when taking into account behavioral choices, there are several intervening social and psychological factors.

Even though they are more often applied to health choices such as smoking or diet as opposed to physical activity, the social epidemiology frameworks discussed previously [2] that delineate how varying impacts of place and population on individual level health could conceivably be of use in physical activity studies, as well as display why a comprehensive framework of social and physical environment, behavior and outcomes is needed. However, the use of conceptual models in empirical studies on walkability is rare, and interestingly, is found more frequently in planning literature as opposed to public health study, even though the above models come from that body of literature. Planning literature is more concerned with how pedestrian networks can be optimized to increase pedestrian capacity, rather than behavioral patterns or strength of health effects. Meanwhile, public health study also often includes food availability (and occasionally park availability and quality) as a major component of the built environment, while planning is more concerned with travel between home and work.[3]

In larger reviews of walkability study, some researchers have offered their own conceptual models of how choice and opportunity to walk are intertwined, noting the lack of existing frameworks (Alfonzo, 2005; Moudon and Lee, 2003). The split between concerns in each field can be seen in the models offered by Papas et al., (2007) and Saelens et al., (2003), reviews of health and planning literature, respectively. Papas et al. is concerned with obesity as an outcome, specifies levels of individual factors such as socioeconomic status, family and peer influence, and essentially lumps all of the "built environment" into a single factor. On the other hand, Saelens et al. (2003) are solely concerned with active travel as an outcome, whether it is for transport or recreation/exercise, and so food availability is not included as an influencing factor. While they do take income into account, they do not look at social neighborhood influence. However, they do break down the neighborhood physical environment into several components, including density, aesthetics and presence of physical activity facilities.

Delving more deeply into the spatiopsychological factors that play a part in decision making, Alfonzo (2005) offers a hierarchy of built environment factors that may influence the decision to walk or not to walk. Based on psychologist Abraham Maslow's hierarchy of motivation behind human behavior (Maslow, 1968), she hypothesizes that individuals decide to walk based on whether the progressive conditions of feasibility, accessibility, safety, comfort and pleasurability are met in both the individual and the environment (See Figure 13). The tier of feasibility is defined by the individual's physical ability to walk, and the tier of pleasurability is

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[2] Particularly Krieger's "spiderless web of causation" (Krieger, 2001), McMichael's "Chinese box" model of proximal effects (McMichael, 1999), and Northridge et al.'s conceptual pathways (Northridge, Sclar and Biswas, 2003).

[3] It should be noted here that mental health study is another burgeoning field of research that similarly focuses on benefits of landscape and nature perception. This dissertation does not cover this literature in depth, but for an introduction to the range of this type of research, see Bjork (2009), Velarde (2007), Pretty (2004) and Kuo and Sullivan (2001).

directly tied to personal aesthetic preference. In other words, it would be difficult to quantify or make interventions in the built environment in relation to these measures, as they are too specific to the individual. However, accessibility, safety and comfort could have or already have baseline objective measures that could be feasibly met by the public realm. Furthermore, certain aspects of the built environment could address more than one tier in the hierarchy. For instance, increased sidewalk width makes pedestrian networks more accessible, as they can accommodate more pedestrians with different abilities, and also makes them safer, as they buffer pedestrians from traffic. Using this hierarchy could help both researchers and planners prioritize factors in the built environment to study and implement to increase physical activity.

Moudon and Lee (2003) also offer an explicitly spatial model of evaluating the built environment for active travel, differentiating it from the other conceptual models discussed above. Physical components of walkability are broken down into qualities of origin/destination, route, and area (or neighborhood). The researchers note that in the 31 audits of the built environment reviewed, not a single one evaluated spatiophysical, spatiobehavioral and spatiopsychological factors together, indicating that there is still a need to combine established models from both the public health and planning spheres, particularly since all are targeting the same essential urban infrastructure. Moudon and Lee found that 144 of the factors measured

Figure 13: Alfonzo’s Hierarchy of Walking Needs

by their audit instruments were strictly physical, with behavioral or psychological factors only appearing 32 and 31 times, respectively. Additionally, there are several similarities between the recommendations made by the more widely-accepted studies that focus on the direct disease outcomes of air pollution and climate change and those that look at the environment's role on behavior, namely to look into strategies to redesign, with the goal of reducing auto travel and increasing urban forestry and green space. Harnessing recommendations for more walkable environments to climate change studies would demonstrate that certain strategies in the environment can have multiple positive outcomes, even if the pathology behind environment and behavior is less certain.

Neighborhoods and Areas of Influence

Almost all studies into the built environment's influence on health begin by using the "neighborhood" as a population sampling frame. It is also a building block, both social or physical, in examining how conditions change across the metropolitan gradient. Public health study presumes that the strongest area of influence on lifestyle, behavior and health outcomes is immediate to the home environment (Diez Roux et al., 2001). Local influences on well-being, such as availability of good quality services and environmental issues such as air quality are influenced more by overall metropolitan structure. Thus, the neighborhood is also a valuable sample for examining the local impact of larger policy decisions (Talen and Shah, 2007). For these reasons, measures of spatial limits of the "neighborhood" are crucial. However, similar to the lack of definitions for walkability, there is also a lack of procedures and definitions for neighborhoods, particularly as it relates to built environment study. As a result, the extent of the neighborhood varied the most between the selected studies, although the reasoning behind each sampling method was mostly unremarked upon. If the decision to walk is a combination of social and physical factors, the sampling frame used to measure neighborhood actually rarely reflects either.

Neighborhood effects are often studied at census block or tract level, even if data itself is primary. This is a longstanding method in social epidemiology, and is certainly a reasonable proxy in many studies (O'Campo and Caughy, 2006). Spatial limits of each tract or block are based on population, though, and are inconsistent geographically depending on the particular density of a study area. As such, they do not reflect any sort of physical character of the neighborhood, potentially problematic if studying the impact of different built environments. On the other hand, census units provide the richest sociodemographic population information, which are still key to interpreting the results of health behaviors. Additionally, health outcome information, such as rates of cardiovascular or respiratory disease, unless measured by individual survey, are often collected from hospital admission records and must remain aggregated at the zip code level for privacy issues.

The format of any scientific inquiry requires a specific sampling strategy, and therefore quantitative limits on what defines the neighborhood. As demonstrated by Talen (Talen, 2011) the spatial extents of a neighborhood can vary greatly whether it is the social or physical neighborhood that is being considered. It can be argued that walkability is a health behavior that is constricted or encouraged by the physical neighborhood more than the social. Whereas choices such as smoking and diet are arguably more strongly influenced by the social mores and groups, walking requires specific infrastructure that must be supplied by the city. [4] As a whole, there was little to no questioning of the “neighborhood” construct, or how these definitions may vary depending on the research question at hand.

A neighborhood sampling technique originating from the planning field, and now more commonly used in public health study as well, is the use of the half-mile or one kilometer radius around a residence as “the walkable neighborhood” (Guerra and Cervero, 2013; Schlossberg, 2006). This measurement follows the conception of the neighborhood as an area of service provision and thinking of it in terms of spatial proximity to facilities, in these studies most often cited as parks, schools and retail (Talen, 2002). The planning implications of using the half-mile radius is that providing these services within walking distance also makes for a more resilient and sustainable neighborhood, as residents will not have to be dependent on their automobiles to access services. However, even the half-mile/one kilometer measure is not consistent. For a long time, researchers have metered out the half mile distance based on a Euclidean measure, or what is sometimes referred to as the “as the crow flies” measure, a straight radial line originating from the residence or other point in question. Increasingly, though, more walkability studies are using what is referred to as network distance, a half-mile measured along street paths, which more accurately represents the distance one would walk from their residence. Out of the 38 empirical studies examined for this review, eight used the straight line buffer of roughly just under one quarter of a mile (300 meters) to two miles, five used network distance buffer of one kilometer, and some other predefined polygon area, ranging from census tract or block (seven), to development or municipally defined neighborhoods (three), to randomized grids of 805 meters of 805 meter cells (two). Whether or not they represent a sphere of influence, it is clear that each of these measures have different spatial implications and can encompass different amenities and physical characteristics, even when ostensibly looking at the same neighborhood.

Location of Studies

The majority of studies took place in the United States, often in mid-size cities such as Phoenix, Arizona, Minneapolis-St. Paul, Minnesota, Salt Lake City, Utah and Seattle, Washington. There is also a growing body of literature based in Australia, which deals with similar sprawl and obesity issues. The urban type most often studied were inner-ring or outer-ring suburbs. This appears to indicate recognition that the majority of development in these countries now and in the future is medium-density, as opposed to urban or rural environments. However, it also pins the problem of what is or isn’t walkable as an exclusively “suburban” problem while overlooking built environment issues that may be amplified in urban areas such as high traffic volumes, noise or crime. Residential or population density was the factor most

[4] While studies have shown that diet is highly influenced by culture and socioeconomics, it is also affected by the physical neighborhood structure, as the significant body of research on food deserts has shown. Diet perhaps lies in an even more ambiguous area between social and physical influence than walking, and could be (and has been) the subject of an entirely different dissertation altogether.

often used to define what was suburban, as well as employed as an independent variable to measure effects.

Overview of Common Variables

In a landmark study, Cervero and Kockelman (1997) categorize all active travel and built environment study under "the 3Ds": density, diversity (in land use) and design. This particular study, one of the first to examine the connection between the built environment and physical activity, is now one of the most cited pieces of literature in the field. Since its publication, Cervero has expanded the 3Ds to include destination accessibility, distance to transit and demand management (parking supply, for example) in subsequent papers (Ewing and Handy, 2009; Ewing and Cervero, 2001). Most recently, Cervero and Ewing (2010) have also cited a non-environmental variable, demographics, as another variable that is often examined, but as a confounder rather than an independent variable. It should be noted, though that Diez Roux (2004) notes that socioeconomic status (SES) should be treated as a mediator of disease rather than confounder.

As with the individual studies examined, the 3Ds of density, diversity and design persist in the majority of the literature, especially as density and diversity are easily and objectively measured with publicly available census and zoning data, although the review of these articles showed that these measures can be interpreted several ways with different implications for future recommendations. However, design remains a much more difficult element to both quantify and relate to the other two "Ds" (Jackson, 2003). First, variables that would fall in the design category are often intertwined with other elements of the built environment, namely the "design" of a street as opposed to functionality, so isolation of design to derive strength of association is methodologically difficult. Second, the effect of design is mostly interpreted as an aesthetic measure rather than a structural one, so when it is measured it is often on a Likert-type scale, relying on principles of environmental psychology or subjective scales that don't translate well to epidemiological models or policy measures, so its effect is often neglected.

A successful walkable environment must not only provide the means to walk, but also the psychological motivation to convince people to walk (Alfonzo, 2005; Gebel, Bauman, Sugiyama and Owen, 2010). Accordingly, much of the debate on how to measure walkability focuses on the reconciliation of research examining discrete, objectively measured elements of pedestrian infrastructure and how the accumulation of these elements are perceived by pedestrians themselves. While density and diversity of land use can often be definitively quantified, the elusive quality of design can be measured both objectively and subjectively. Structural issues of urban form such as size, quantities of elements such as street lights and connections, and length of routes are easily and often cataloged in walkability studies. Also extensively measured, but less conclusive, are the perceptions of comfort, safety or even the greenness of the public realm. Cervero's 3Ds of density, diversity and design, accurately described almost all the variables studied. Lee and Moudon (2008) was the only study that included topography, which is perhaps the only variable that does not fit into any of the previous categories, although it does affect accessibility and could arguably be considered a factor of design. Park studies, which are somewhat different in purpose when studying the built environment-health connection, most typically looked at material qualities of parks such as size, greenness, amenities offered and distribution of or distance to parks from respondents' homes. While there tends to be consistency in what variables are included, there are variations in how they were constructed or valuated from study to study.

Density. Historically, densities of neighborhoods are under the most scrutiny when it comes to health. We often hear that density is the key to more walkable neighborhoods and the future of neighborhood building, but as demonstrated in Chapter Two, the conception of a healthy density has changed over the years, particularly with the shift from infectious disease to chronic disease. Even today, density is not as conclusive a subject as we assume. When used as an independent variable, density is commonly measured by gross population per area unit (Forsyth, Oakes, Schmitz and Hearst, 2007; Lathey et al., 2009), number of residential units per gross area unit (Boarnet, Joh, Siembab, Fulton and Nguyen, 2011; Cutts et al., 2009; Leslie et al., 2005) or per residentially zoned area unit (Frank, Andresen and Schmid, 2004; Frank, Schmid, Sallis, Chapman and Saelens, 2005; Rodríguez, Khattak and Evenson, 2006; Roemmich et al., 2006). Common wisdom behind walkable communities states that increased density is best, so perhaps the most surprising finding is that in several studies, when coarse measures of density were isolated as an independent variable, when calculated as either population or residential, there was a low association with physical activity compared with other variables (Boarnet et al., 2011; Brown et al., 2009; Ewing and Cervero, 2010; Forsyth, Hearst, Oakes and Schmitz, 2008; Forsyth et al., 2007). That said, a variable that had much higher association with walking and health outcomes was proximity to resources, particularly parks. This casts further shades of gray into the argument for more density. While it is true that higher densities allow for more services such as grocery stores and jobs, parks also alleviate density within the urban fabric. Furthermore, if density is only calculated by people or residential units, it does not necessarily describe the environment. The space given to discussing density in walkable neighborhoods is arguably out of proportion with its actual impact on walking, and at the very least it is worth further discussion of how density can be better articulated in these studies—especially when translating to built environment solutions.

Land Use. Land use tended to be more positively associated with walking, at least when more accurately specified as the relationship between residential location and commercial amenities. Land use diversity was described a number of ways, from entropy scores (which describe the degree of homogeneity and heterogeneity in land use) to counting of resources like retail outlets. It can also be described as simple distance to whatever resources are in question. Brown et al., (2009) tested different measures of land use to judge which had the strongest association with walking: entropy scores, distances (to parks and transit stops) and what they called "proxy measures" of land use, or walk to work information and neighborhood housing age. They concluded that these sort of summary scores did not matter as much as what the land uses in particular were, such as schools and grocery stores. While consistent across most studies in encouraging walking, land use was rarely measured in conjunction with accessibility measures (Kaczynski, Koohsari, Stanis, Bergstrom and Sugiyama, 2014). This is key, as proximity to certain types of land use doesn't necessarily mean it is reachable by foot. High traffic streets, freeways or features such as canals and rivers can create barriers. Street lighting may be necessary to encourage people, especially women, to walk to transit stops and stores when it is dark after they get off work (Lee and Moudon, 2008). Also, in the case of Su et al., (2013) the researchers found that land use mix was actually a deterrent to children walking to school, most likely because parents were worried about their children being in areas with too many people around (or "stranger danger.")

Street Design. Design, the last of Cervero and Kockleman's 3Ds, encompasses the most factors and is the most difficult to define. While density and land use can be measured differently, they still have relatively straightforward quantifications. Additionally, unlike density and land use, there is often a lack of continuity in street design, even from block to block. The word "design" might appear to indicate that they are only measures that can be assessed subjectively. There are some aspects to street planning and design that have shown strong correlations to physical activity, namely street intersections. Density of street intersections in a study area is likely to indicate a greater number of route choices for walking as well as shorter block sizes and a gridded planning pattern—the kind exalted by proponents of New Urbanism and Smart Growth. Like density and land use, though, there are several methods to measure intersections. Some are more accurate representation of the built environment than others. Southworth's (2005) study of street pattern and walkability also takes into account the number of streets that feed into an intersection, noting that in the former method of measurement, a cul-de-sac or dead end would be counted as an intersection even though it stops a walking trip. Method of measurement notwithstanding, most studies measuring street intersections showed a positive correlation with increased walking. When measured solely against BMI, though, Smith, Brown et al., (Smith et al., 2008) found no significant relationship. It should also be noted that negative correlations were found between intersections and walking when studying the elderly (Borst, Miedema, de Vries, Graham and van Dongen, 2008) and children walking to school (Su et al., 2013), possibly because these are both populations that walk slower and are generally more vulnerable to traffic at crossings. Perhaps related to elderly walking behavior, some researchers have found that larger block sizes also correlated with more leisure walking (Forsyth et al., 2007). Counting the presence of pedestrian amenities can also conflict with conceptions of good aesthetics, which is why it is crucial the two are not conflated with each other as "design." Others have found that safety measures such as lights and crosswalks rated negatively on their attractiveness scale (Adkins, Dill, Luhr and Neal, 2012).

Greenness or Presence of Nature. Greenness, or the presence of nature, has proved to be a powerful palliative in healthcare settings. Its effect has been studied extensively in settings such as hospital or rehabilitation gardens with consistently positive health results, most notably lowered blood pressure and shortened recovery times from surgeries (Annerstedt and Währborg, 2011; Marcus and Barnes, 1999; Velarde, Fry and Tveit, 2007). However, hospitals are often highly controlled environments with definitive boundaries and small sample sizes, so how the conclusions scale up to a neighborhood level and in the public realm are less known, and is difficult to validate. However, studies at this scale have shown notable positive effects on mental health and fatigue, even if the relationship to physical activity is unclear (Pretty, 2004; Reynolds, 2013; Sugiyama, Leslie, Giles-Corti and Owen, 2008). There have been indications that greenness or the presence of landscape have a stronger positive correlation with leisure walking than active travel.

The studies that looked at some aspect of greenness in the built environment were few in comparison to those that studied density, diversity or distance to destinations. However, it is a variable that is used to measure qualities of both streets and parks. Most often used as a singular aesthetic quality (Saelens et al., 2003; Sugiyama et al., 2008), some also used "green" as a signal of a well-maintained street (Adkins et al., 2012; Foltête and Piombini, 2007), or as a proxy for assessing the location of recreational fields and parks in remote sensing studies (Leslie, Sugiyama, Lerodiaconou and Kremer, 2010). The difficulty in measuring green comes from this lack of definition, and perhaps because evaluating respondents' reactions starts to delve into the realm of environmental psychology, which is unfamiliar to both the planning and public health fields. There have been efforts to bridge subjective measures of green with objective ones to come to larger conclusions, but they often lack agreement (Leslie, Sugiyama, et al., 2010).

The measure of green alone is also difficult to translate into design standards. Adkins et al., (2012) looked at the effect of "green streets" in Portland, Oregon on walkability. Although the design of green streets has an ecological purpose to retain and filter stormwater runoff, in this study they are still categorized as only an aesthetic coating on the street, reinforcing the idea of landscape as superficial, as well as neglecting the indication that the investment in green streets may denote a neighborhood with more financial resources and less crime, as it is presumably better maintained. This is perhaps one of the most problematic aspects of relating green to physical activity—it is only treated as a single measure, meant to encompass all landscapes. This is reductive of its functional aspects, such the role of landscape in the mitigation of air pollution or temperature control. The low association with greenness in the studies is possibly obscuring its role in these factors, which have an arguably stronger association with physical activity. Instead, nature is treated uncritically and as an aesthetic aspect of streets, following a long historical pattern of the relationship between nature and health.

Demographics and Socioeconomic Status. In an addition to his original 3Ds, Cervero later added demographics as a confounder. The generally accepted assumption in public health and built environment study is that socioeconomic status has the strongest external influence on health outcomes. In 19 out of the 40 studies examined, income or socioeconomic status was used as confounder. However, this also makes it difficult to measure inequality in walkable environments. For a more detailed discussion of equity and walkability, see Chapter Six.

Scale and Interrelationships of Built Environment Components. Density, diversity, design and destinations sufficiently describes a wide variety of variables in the built environment. However, in most empirical studies, all elements are still treated as discrete components of the built environment, with varying strengths of association. Further reviews of the built environment and physical activity would likely benefit from a scalar framework of how built environment variables overlap or effect one another at different scales. For instance, while it certainly isn't a given, density does often beget proximity to resources such as retail, as well as the diversity of these resources, as their location is driven by population demand. Therefore, to claim that density has a strong correlation to walking often obscures or downplays the relationship the other two factors have to behavior as well. Additionally, they tend to enforce the idea that density is key to increasing physical activity in the built environment. An example of a relationship that is assumed but actually measures different aspects of the built environment would be block size and street connection density. Street connection density is often measured on the assumption that it offers the pedestrian increased route accessibility. Block size is often presumed to measure the same aspect of the built environment, but this neglects to take into account blocks that end in dead ends or cul-de-sacs. Additionally, multi-variable indices such as the Irvine-Minnesota Inventory counts both of these elements as different factors, presumably under the hypothesis that one will further confirm or reduce the strength of the other, but the two are just related enough that it may instead dampen the effect of both. An established set of protocols for built environment study, dependent on outcome measured, would go a long way toward clarifying the often contradictory results of this type of study.

A framework of scales for built environment variables would also help to better establish what effects we can expect from interventions and where research gaps are. As it stands, the most-studied variables are either at the macro- or micro- scale, primarily represented by density and land use at one end of the scale and street amenities like benches at the other. The meso-scale variables that describe aggregated neighborhood features, or qualities of trips are less examined. Should these findings be enacted, presumably they would affect entire urban populations (at the macro end) or will really only appeal to certain individuals depending on specific preferences (at the micro scale). This leaves a large gap of study of what can be affected on the neighborhood scale, in other words, the scale of the majority of these studies. There is also currently little study devoted to how changes at one scale (such as density) has downstream effects on smaller scales. A model of these interactions could be crucial to structured interactions.

Conclusions and Contradictions

The survey of built environment and physical activity studies reveals a few conclusions. First, studies on accessibility, walkability on street networks, and park use and access are mostly treated as separate spheres of research but are essentially looking at the same pedestrian infrastructure, meaning interventions in those areas could have multiple impacts. Second, the largest variation in studies is the spatial extent of pedestrian sheds and neighborhoods. A personal walkable area can be measured along a Euclidean distance radius or street network, and the choice of method can make a large difference in the area measured. Parks can have varying extents of influence depending on size, distance, etc. (Sugiyama, Francis, Middleton, Owen and Giles-Corti, 2010). In very rare cases, gravity or space syntax models were used to determine spatial market area (Foltête and Piombini, 2007; Giles-Corti et al., 2005).

Besides the wide variation in how they were measured, neighborhoods were also usually studied as an isolated unit. This neglects the inequity across metropolitan areas or their dependency on adjacent areas and wider areas of influence depending on the variable studied and mobility of the subjects (Lathey et al., 2009). This could be remedied by a multi-scalar approach and noting differences in outcomes when looking at micro- and macro- level groupings. Although the study was not explicitly studying walkability, Lathey, et al., (2009) used individual level obesity-related morbidity and health outcomes from hospital discharge data to examine variations in the effects of the built environment and socioeconomic factors. The Maricopa County, Arizona based study regressed against and controlled for demographic/socioeconomic characteristics, household tenure, automobile dependence, the authors' own indices for compactness (density plus distance from city center), urban land use mix, street connectivity, walkability (distance to resources) and used varying aggregations of census blocks units to evaluate changes and different scales and aggregations. While density was not a significant predictor of chronic disease at the neighborhood scale, their walkability index was. Dunton et al., (Dunton et al., 2009) also show that macro-urban characteristics (density, land use mix) are unrelated to BMI in children (the focus group of the study), and factors like sprawl, facility or equipment access and neighborhood pattern were more predictive. Cutts, Darby et al., (2009) demonstrate how neighborhoods deemed to be walkable by commonly used macro-measures of density, street connections and land use often have little relationship to micro-urban characteristics that have a large psychological impact on walking such as noise, aesthetics or crime.

The lack of standardization in measurements can partly explain these contradictions. As a whole, though, when individual aspects of the environment were teased out, there were low correlational relationships for individual physical activity or health outcomes in general (Forsyth et al., 2008). However, when researchers compiled a "walkability index" (Frank et al., 2004; Frank et al., 2005; Saelens et al., 2003; Satariano et al., 2010), relationships were stronger. This speaks to walkability as a function of many interlocking pieces, and certainly the need to move on from looking at single influence models. Before doing so, though, it is also necessary to look at the theoretical and practical gaps in these studies.

Research Gaps

The explosion of literature in the past 10 years on physical activity and the built environment has gone a long way in solidifying the connection between the two fields. Even after over a decade of research, though, there is consensus among most researchers that investigation into a few key aspects is needed. Most cite the limited conclusions that can be drawn from cross-sectional study and call for more longitudinal research, not only into health outcomes, but built environment changes over time. A few call for the integration of social factors and methods to account for, or further investigate self-selection into neighborhoods (Diez-Roux et al., 2001; Chatman, 2009; Lee and Moudon, 2008; Cohen et al., 2007). Most researchers struggle with defining objective measurements for the third "D" of design or as some call it, "attractiveness," and call for more investigation into refining these methods (Gebel et al., 2010; Giles-Corti and Donovan, 2003; Giles-Corti et al., 2005; Leslie et al., 2010).

There are a few other gaps that are problematic from a design perspective: First, the use of geospatial information systems (GIS) should be expanded. There are several roadblocks to improving its use in research, much of it simple pragmatic issues such as lack of technical expertise among researchers, to the availability of data in each city. The tool is still overwhelmingly used to examine simple distribution of resources and street features. However, only looking at distribution misses key issues of accessibility, such as how high-trafficked streets block use of resources (Kaczynski et al., 2014; Wolch, Wilson, and Fehrenbach, 2005) or their quality. Rarely are GIS or similar programs employed for their more sophisticated spatial analysis capabilities. There were a few notable exceptions. Su et al., (2013) used landscape metrics software FRAGSTATS to apply techniques of studying wildlife migration study to children walking to school. Lathey et al., (2009) was the only study examined to use the cluster analysis to measure built environment against disease clusters. As discussed in more detail in Chapter Six, GIS could potentially be used to validate or compare against environmental measures that are normally self-reported, but this is also rare. GIS can also be employed to visualize complex cognitive mapping to better understand perception, as it was in Talen and Shah (2007), who used it to examine different understandings of physical and social environments. Perhaps the most extensive, if not particularly complex, use of GIS is the set of protocols used by the Twin Cities Walking Survey (Forsyth, 2007), also known as the Irvine-Minnesota Inventory and discussed in more detail in Chapter Six, but at 238 pages, it is difficult to use by other researchers. The lack of standardization of how best to use the method between studies is at this point in time probably one of the largest oversights of the literature.

Second, are more nuanced descriptions of neighborhood typology, primarily the assumption that all fit into the dichotomy of suburban vs. traditional (or New Urbanist) neighborhoods without explaining the characteristics that define that neighborhood (Khattak and Rodriguez, 2005; Moudon, Hess, Snyder, and Stanilov, 1997; Rodríguez et al., 2006). To constantly set these two neighborhood types against each other, no matter how poorly defined, misrepresents the nuances of the American landscape, and at worst advances the narrative of “unhealthy” suburban neighborhoods. Moreover, these definitions are mostly set by density, which as discussed above has little impact on outcomes when separated out from other factors. It would be worthwhile to instead find variables that are unique to each context, and to propose different frameworks to better define how we can begin to intervene. To continue to do experiments in this way will only lead to the conclusion again and again that we need to heighten density in suburbs, which is a monumentally difficult task from a design point of view. Only two reviews studied, both of which used the same data, actually stratified neighborhoods by a measure of density (gross population for one, dwellings per acre for the other) as a basis for drawing more detailed conclusions about route quality (Lee and Moudon, 2008; Moudon et al., 1997).

Last, urban design theory is not “earnestly integrated” (Lo, 2009, p. 164) into pedestrian activity research. Design features are often treated as only an aesthetic, as opposed to a mode through which people navigate the neighborhoods. There are also some proxy measures used that may not necessarily ring true from a design perspective, for instance assuming census information on the age of a neighborhood naturally means higher densities and more street connectivity (Yamada et al., 2012). Again, if we are to draw conclusions about design, exactly how does one make a neighborhood older, and should we be building as we did in the past?

Additionally, to only treat design as "attractiveness" is problematic as it will always be subjective. Attributes of visual interest, sense of place and safety are elusive as they are based on personal experiences or even culture and age, and in particular, the perception of crime in the neighborhood (Brantingham and Brantingham, 1993). Measuring such factors as "objective" surmises a normative aesthetic standard which is not necessarily universal (Cranz and Boland, 2004; Flores–Xolocotzi and González–Guillén, 2007). Even those researchers that attempted to equate the presence of certain elements with perceived "attractiveness" (Adkins et al., 2012; Borst et al., 2008; Giles-Corti et al., 2005) conceded that the features with correlations to attractiveness, such as opportunities to "lose themselves" in parks are not practical for areas with high crime, etc. At the same time, in many studies "attractiveness" has had the largest influence on changing walking behavior (Handy 2005). What is needed is a more structured way to get at what specifically "attractiveness" means in the walking environment. Is it more easily navigable? Is it more tactilely comfortable (i.e., climate)? Does it feel safe?

There are no easy answers on how to proceed with walkability research, but as the research proliferates, it is important to harness it to a more expansive, non-linear design point of view. Perhaps some qualities of neighborhoods cannot be measured, and we need to draw a line between what can be quantitatively specified and qualitatively designed. To draw conclusions on other qualities would benefit simply by a framework that takes into account the social and physical context of place. The research can only go so far, and that limit is the difference between what makes an environment simply operable instead of holistically supportive.

CHAPTER FIVE: WALKABILITY ON THE GROUND

Implementing Active Design in Sacramento, California

Introduction

Initially, I chose Sacramento, California, as a case study city simply to try iterations of my spatial analysis, which is discussed in more detail in Chapter Eight. Sacramento was also chosen as it is largely its own urban entity, separate from the economic and social ecologies of the San Francisco Bay Area. It is heterogeneous in both population and built environment. According to the 2012 census, 45 per cent of the population is White, 26.9 per cent Hispanic or Latino, 16.6 per cent African American, 17.8 per cent Asian, 1.4 per cent Pacific Islander, 1.1 per cent Native American and 19.4 per cent are other races or two or more races. Its population in 2012 was calculated to be 475,516 (U.S. Census Bureau, 2014a), and its boundaries encompass roughly 100 square miles. Although its environmental context is unique, the history of Sacramento's development, described in the next section, is similar to the history of so many other mid-size American cities that its examination can be applicable to other environments.

However, over time I became interested in how active design gets implemented in a municipality and how the healthy cities movement reconnects design, planning, research and policy, which has operated largely in separate spheres for the past century. As I started to interview key informants in the city about Sacramento's development, notably Greg Taylor, Urban Designer in the Sacramento Community Development and Design Department, and Jeanie Hong, GIS Analyst with the Sacramento Area Council of Governments (SACOG), I was eventually led to the work of WALKSacramento, a longstanding nonprofit in the city dedicated to safe pedestrian environments. When I scheduled an interview with Teri Duarte, the executive director of WALKSacramento in March 2013, she also introduced me to Judy Robinson, Sustainability Manager for the County of Sacramento. They had just received a grant to help institute active design policies in Sacramento, and as I discussed my dissertation with them, they were interested in both the research I was doing and my spatial analysis. They eventually asked me to become part of their grant team, and I spent the next year and a half with them as a participant-observer to their process. It became apparent over time that there was a need for a tool that could be understood and utilized by community groups. Over the course of the year and a half, I was able to witness and be a part of Sacramento's first integration of healthy and active design into their building codes.

Natural and Built Environment Context

In the introduction to the book, River City and Valley Life: An Environmental History of the Sacramento Region, Steven M. Avella writes:

> Sacramento's history is a virtual case study of urban environmental development in California and other communities of the American West. It was first inhabited by native peoples, who created their own distinct tribal cultures in the area, then explored by Spain, traversed by early

> Angle visitors, and carved up into Mexican land grants—one of which was secured by the Swiss adventurer Johann Augustus Sutter. Sacramento 'took off' as a gateway to the gold fields of the Sierra which made the settlement an 'instant city' on the banks of the Sacramento River. Over the years it recreated itself again and again, refusing to be dominated or pushed out by the forces of nature or the whims of human decision making. Although raised in chaos, the solid, middle class core of its residents displayed enough moxie to land the state capital. It became the western terminus for the Central Pacific Railroad, whose repair shops became the economic mainstay of the city for many ears. As a railroad hub, Sacramento provided industrial jobs and created a food-processing and packaging center that drew from the abundant manufacturing and agricultural growth was its rising significance as the capital city of the growing state of California. Although its most dynamic population surge took place after WWII, Sacramento enhanced its respectability by erecting a magnificent capitol building and eventually installing activist governors and legislators who transferred the valley community into a city of rank. While it never replicated the charm of San Francisco or the fast-paced sprawl of Los Angeles, it held sway in California's growing interior as a good place to live and prosper. Yet, the Sacramento regions' unique sense of place and interaction with its surrounding environment was not often appreciated or understood by many of the state's residents. (p. 2)

Centered geographically on the confluence of the American River and Sacramento River, Sacramento's development was often tenuous in its early years, inundated by floods or parched by drought (Owens, 2013). "The rivers that embrace the California capital have both punished and rewarded. They created terrible floods and carried waterborne disease like cholera but also helped fashion the 'earthly Eden,' as one booster described Sacramento." (Avella, 2013, p. 3) Despite the abundance of water, Sacramento's water supply was notoriously poor for almost a hundred years following its founding (Sacramento County Historical Society, 1978a).

The city has had two periods of exponential growth. The first was in late 1849 after the gold strike in the California Mother Lode. Some 300,000 people came to the region over the next three years (Peterson, 1965). William Warner, William Sherman and Edward Ord quickly laid out a five square mile townsite, the flat terrain a perfect canvas for a relentless rectangular grid:

> Utterly simple, instantly self-evident, lacking any hint of adaptation to the physical setting, this plan is remarkably convenient for newcomers. Anyone can find a downtown Sacramento address with only a moment's orientation. But this convenience has always been offset by the lack of a central physical focus for the city. The opportune product of speculative mania in 1848 and 1849, Sacramento's design set aside no land for a civic

> plaza or courthouse square; it provided no public space that could be identified as the geographical core of Sacramento's official life; it gave the town no commercial or social focus (Owens, 2013, p. 43).

At the end of the 1850s, the four most prominent Californian merchants: Collis P. Huntington, Mark Hopkins, Charles Crocker and Leland Stanford joined to form the Central Pacific Railroad and found federal funding to complete the western portion of the nation's first transcontinental railroad (Owens, 2013). The railroad brought even more business and people to the town.

Due to the temporal nature of settler structures, fires plagued the city as much as floods. The first great fire of Sacramento was in 1849, followed by a great flood in 1850, then another fire in November 1852 that was even more devastating, burning 55 blocks. More destructive flooding happened in 1852–1853 and in 1861–1862, bringing the town close to ruin (Sacramento County Historical Society, 1978a). After the 1850 flood, the city government's first major project was to construct rudimentary levees, as well as to fill in Sutter Lake. Grading was done one block at a time. In addition the streets were very uneven until the 1860s, injuring many pedestrians (Owens, 2013). By the time of the 1861 flood, residents were more resilient, even if the infrastructure was not. The *Daily Alta* reported at the time:

> This time, the inhabitants were somewhat better prepared for the flood that inundated the city. There was something almost gay about the way they crowded balconies and porches and waved to the throngs passing in boats. Having once survived the deluge, they knew their strength … Merchants raised their goods onto high platforms. Stock owners drove their cattle to the high ground … with all streets navigable by boats, the legislature … voted to adjourn to San Francisco for the remainder of the season (Matthews, 1982, p. 20).

Sacramento has now arguably accomplished this control over the environment. The city has highly effective municipal systems for waste disposal and water, and has been called grade crazy by all the water infrastructure projects and mosquito eradication. The Sacramento Bee promoted a tree planting campaign in the late nineteenth century that helped beautify neighborhoods and moderate the climate, which swings widely from hot to cool seasonally (Owens, 2013). As Sacramento branched out into suburban development, it further transformed the natural environment.

> Sacramento to be sure, seems to suffer from multiple personality disorder at times. On the one hand, it builds water treatment plants, more dams, and powerhouse substations and kills off unthinkable amounts of wildlife and plant life. On the other hand, it imports camellias, a non-native plant, and with more than one million bushes in bloom, hosts a camellia festival, while it destroys many acres of wetland to build suburban tract housing and then plants trees in these same

suburbs so as to gain the designation "Tree City USA" (Sandul, 2013, p. 161).

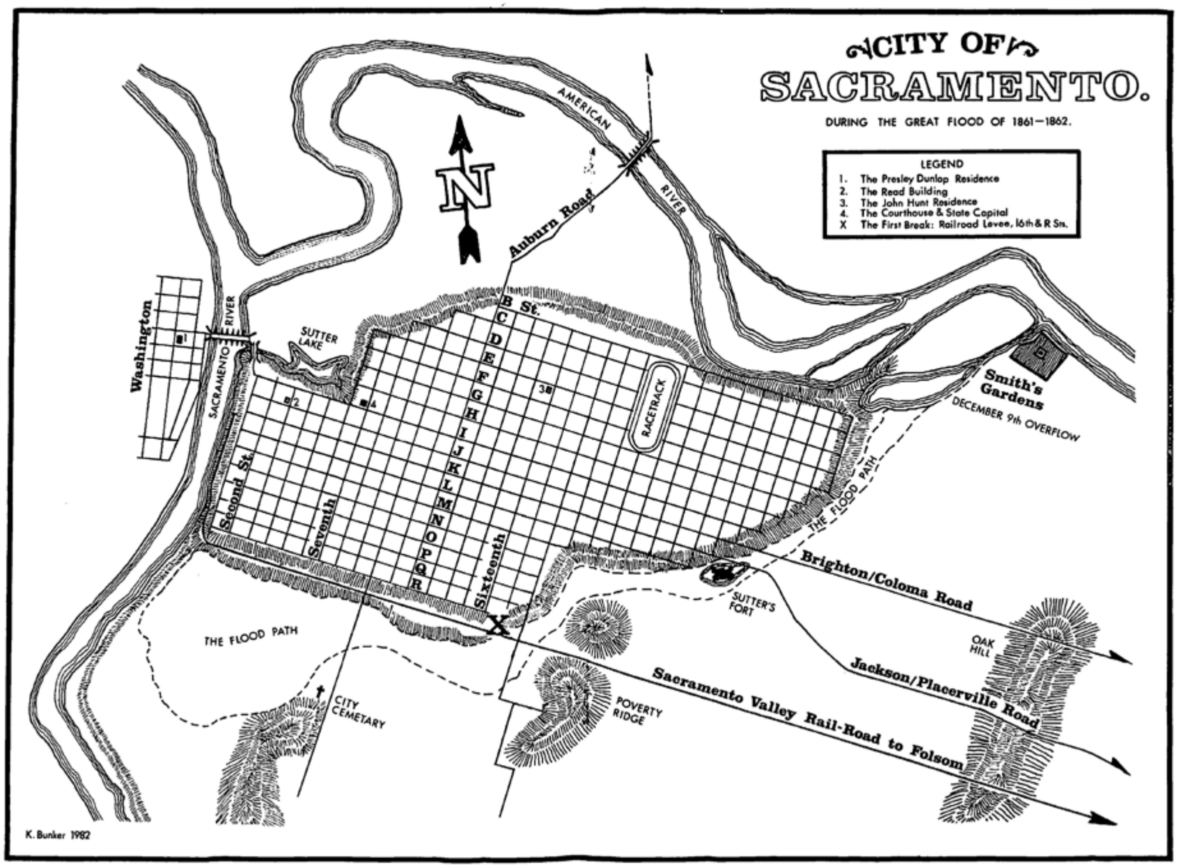

Figure 14: Sacramento in 1861 (Map courtesy Sacramento Historical Society)

In the twentieth century, Sacramento extolled its agricultural history to sell a rural (or anti-urban) ideal, commodifying its natural context for real estate purposes. Its outward expansion began when the Natomas Consolidated Company embarked on a land reclamation project to build suburban farm homes in the Natomas basin north of Sacramento, along the east side of the Sacramento River between 1907 to 1915. Streetcars expanded development to the east. Oak Park expanded the city to the southeast by 230 acres. Civic boosters would often refer to the city as a "Cowtown" or "Agriopolis," extolling both its rural ideals and metropolitan credentials (Sandul, 2013). Sprawl in the region grew exponentially in the late twentieth to early twenty-first century during the housing boom. From 2000 to 2010, 90 square miles of rural land—mostly converted productive farmland, was urbanized in the Sacramento region—an amount of land *almost* equivalent to City of Sacramento (Reese, 2011). While much of this development is outside the city proper, the capitol still serves as a hub and feels the environmental and health impacts of this growth. In a report for the Sacramento Bee, Philip Reese wrote on how much the growth had slowed commutes:

> In Elk Grove, for instance, residents spend, on average, about 60 minutes a day commuting, usually up Interstate 5 or U.S. 99 into Sacramento. That's about 10 percent longer, on average, than they spent in 2000, census figures show. On the other side of the county, new construction in North Natomas added 11 square miles of development—and several thousand frustrated drivers to the region. Even though their homes sit only five to seven miles from downtown, North Natomas commuters still spend, on average, about 50 minutes a day traveling to and from work, census figures show … 'We look at the traffic and the pollution that goes with it—it affects the quality of life,' said Shirley Peters, a retired teacher who has lived in Elk Grove since 1971.

He estimates that Sacramento commuters waste an average of 41 hours a year in traffic congestion, above the national average of 38 hours a year. Moreover, much of these outer developments are vacant since the recession, meaning these commuters are navigating an uneven patchwork of languishing development when they could possibly be living closer to work (Reese, 2011). The most recent Pedestrian Master Plan for Sacramento (Department of Transportation of City of Sacramento, 2006) notes that 2.7 percent of commuters walk to work, but this figure jumps to 18 and even over 20 percent when in the downtown grid. The plan also notes much of the population is within one mile of several key support destinations: 87 per cent for schools and community centers, 98 per cent for parks, 96 per cent for transit stops, and 92 per cent for neighborhood shopping (although the retail is not further specified). What this may indicate, though, is that walkability is not so much a distance issue as it is due to more nuanced issues in the built environment like missing or hostile infrastructure.

The Sacramento Area Council of Governments (SACOG) projects that the region's population will grow by 862,000 during the next 25 years, but is hopeful under the Blueprint 2020 plan Sacramento will expand its urban footprint at one-tenth the pace of recent decades by using infill strategies (Sacramento Area Council of Governments (SACOG), 2010). However, most development in the U.S. is still designed to succeed by expanding footprints and collecting taxes on that growth. Sacramento County has also preliminary approved a plan to open up 20,000 rural acres near Jackson Highway for development, and outlying areas Elk Grove and Folsom are each pushing to annex 8,000 and 3,500 acres respectively. Particularly as SACOG predicts that much of the development will be driven by retirees, it is a crucial time to ask what other issues can guide future development (Reese, 2011). Some nonprofit leaders and key players in local government have come together to advocate that health become one of those main priorities.

Health in Sacramento

Just as Sacramento's urban development is a microcosm of American urban development, so are the epidemics that sprung up around its growth dating from the first interactions between White settlers and the natives of Sacramento:

> … Indians who worked for Sutter risked infection with many newly introduced diseases. Because of their centuries of biological isolation from Europe, Asia and Africa, America's native peoples lacked any genetic resistance or acquired immunities to a wide range of illnesses unknown in the Western Hemisphere before the Euro-American invasion. As a result, smallpox, measles, influenza and other communicable epidemic disease killed Indians in immense numbers throughout the hemisphere (Hurtado, 2013, p. 27).

Beyond this, mining and hunting activity also destroyed many of the native food sources (Owens, 2013). Later, the Southern Pacific trains actually brought contagious disease as people hitched rides on the cars. The worldwide influenza epidemic of 1918–1919 spread by rails and came to Sacramento in October 1918. But the railroad also brought safer fresher foods, Central Pacific's employee health care program and railroad surgeons (Orsi, 2013).

At its founding and given its swampy conditions, Sacramento's environment was ripe for cholera, the urban epidemic of the era. As described in a document from the Sacramento Historical Society:

> In the year 1850 Sacramento underwent three major catastrophes: flood, squatter riots, and an epidemic of Asiatic cholera … the germ organism is carried chiefly by infected persons, but rags, clothing, and other articles which have come in contact with fecal discharges can also carry the disease great distances … Sacramento presented to all appearances a readiness for cholera. By virtue of its location in a low-lying place on alluvial soil near a river, Sacramento was more prone to cholera because the disease's best means of local dissemination is through infecting the local water supply if proper drainage for sewage is not provided (Nagel, 1957, p. 1).

Another document describes discarded fish, meat and vegetable matter in the streets and flies, which although later proven not to be a cause of cholera was thought to at time to be conducive to spread of disease (Sacramento County Historical Society, 1978b). There were an estimated 327 deaths between October 20 and November 12, 1850, perhaps 700–800 deaths by the end of the epidemic. The sickness also drastically slowed down the levee building (Jones, 1950).

Sacramento took on the same kind of sanitary measures many other cities did during this era. Citizens were warned about proper eating and drinking habits and a sanitary ordinance was passed requiring removal of rubbish or a $500 maximum fine. The city purchased a building at L and Second streets to use as an emergency cholera hospital. Interventions were made on the basis of miasma theory. China (Sutter) Slough was filled in due to its warm, humid stench, and the Chinese laundries, slaughterhouses and dairies, all outside city limits, were targeted. At this time, the city's sewers were not intended for human waste, just overflow, so personal waste was taken care of simply by digging privies in the ground. It took 15 years to build a sewer system, mostly on an ad hoc basis, some left open leaving citizens to fear winds that would move scents toward the city. However, the floods of 1861—1862 spurred the city to take more serious action in building an integrated sewer system (Sacramento County Historical Society, 1978b).

Moving forward from Sacramento's founding to today, the city now struggles with combating the chronic diseases afflicting most of the country. A Community Needs Assessment (CNA) for Greater Sacramento Region done in 2010 by Catholic Healthcare West, Kaiser Permanente, Sutter Health Sacramento Sierra Region and the University of California Davis suggested:

> 1) identify the unmet health needs of underserved residents in the Greater Sacramento region, 2) understand the challenges these populations face when trying to maintain and/or improve their health, 3) understand where underserved populations turn for services needed to maintain and/or improve their health, and 4) understand what is needed to help these populations maintain and/or improve their health (Ainsworth, Diaz, and Schmidtlein, 2010, p. 5).

The top five causes of mortality in the region are heart disease, cancer, stroke, chronic lower respiratory disease and injury. The authors also cite that among the obstacles to treatment facing underserved populations in particular are the affordability of healthcare and insurance, poor diet from lack of accessibility and affordability of healthy foods, cultural barriers and the overall stress of being poor. They posit that disadvantaged populations also face more drastic effects of disease due to what they term an "avoidance of care/escalation model," where many avoid treatment due to the aforementioned obstacles, hoping the disease will cure itself so as not to incur costs. The authors recommend increased access to affordable healthcare and insurance, improving the quality of healthcare delivered in low or no-cost settings and providing more healthcare information and education. What they do not mention are any possible built environment interventions or preventive measures, despite the predominant health needs of underserved populations being asthma, diabetes, mental health and hypertension, which are all diseases with strong ties to the built environment (Kasirye, 2014). In fact, in the report's map of their Community Health Vulnerability Index (CHVI), one can see that the highly vulnerable counties follow major highway corridors, although this is largely unremarked upon in the report. It is also of note that heart disease, which can often be effectively combated by preventive measures and active lifestyles, is the main cause of mortality in Sacramento, as opposed to cancer in other counties.

As for other chronic disease, the CDC reports that over half of all California adults are obese or overweight (defined as having over a BMI of 25), as well as one in three children (Ogden, Carroll, Kit and Flegal, 2012). These numbers are higher when looking at Sacramento County: two-thirds of adults and 43 percent of elementary school children are overweight/obese. In California, African-Americans have a 51 percent higher prevalence of obesity and Hispanics 21 percent as compared to Whites (Centers for Disease Control and Prevention (CDC), 2014b). The California Health Interview Survey, conducted biannually, reports that 63 percent of Sacramento County residents fail to meet recommended guidelines of 30 minutes of exercise per day (UCLA Center for Health Policy Research, 2012).

Dr. Olivia Kasiyre, Sacramento County Public Health Officer, told me in an interview that public health's approach to preventive care was mostly focused on health promotion, or "telling people to exercise or eat better." However, after hearing a talk by Dr. Richard Jackson about how the built environment limits choices, she became interested in the relationship as it gave her a way to "offer a solution instead of just saying how bad things are." A native of Uganda, she has an outsider's view of the United States and how its built environment is particularly car-centric. She recalled her own experience and difficulty using public transit when she was home with her daughter, and without a vehicle. She stressed the need for an environment that makes it easy to exercise—and that it is an equity issue. "People that have a good income or lifestyle can avail themselves of gyms and places to exercise," but low-income, elderly and youth populations are in need of safe parks and streets. She sees it as the public health field's responsibility to reach out to designers, road engineers and community members to advocate for themselves and for healthier environments, but acknowledged the tendency of public health to "nod their heads" and affirm their own conclusions instead of forging cross-sectoral relationships. Via her own relationships with key planning department staff, this was the first time the two had been connected, but it was not institutionalized. Another significant barrier is the financial structure of most public health departments, which gets individual pots of monies based on specific diseases and their direct treatment. Despite its share of healthcare costs, chronic disease and preventive health is underfunded.

Kasiyr acknowledged the increased difficulty of walkable access in the suburbs and its relationship to health. But as for socioeconomic trends, she noted that it is hard to track suburban poverty. The poor in the suburbs often remain invisible due to lack of social service centers, which in turn leads to a dearth of data on traditional markers of poverty such as food stamps. Transit access in these outlying areas is limited most by their own residents, who often don't want bus stops in their neighborhood, as they believe it will bring in poorer populations. She cited a recent transit plan summary for the El Dorado Hills/Folsom area (an outlying suburb of the City of Sacramento) which noted the lack of transit to those areas and that poorer populations would likely have financial difficulties owning a car and suffer from lack of transit. However, the report concluded that those people should just move to a neighborhood with transit. Self-selection and individual choice, she told me, is the same excuse that people used to dismiss people living in high crime areas or neighborhoods with high dropout rates. However, Kasirye said in all her presentations of built environment and health, she had little issue convincing people of the connection. Yet, she sees it more as a matter of getting the word out and being specific about how people can participate, particularly as people in low-income neighborhoods are accustomed to being neglected and often don't know how they can make a change.

A Year with Design 4 Active Sacramento

As many healthcare organizations still overlook the influence of the built environment, it has fallen to advocacy groups in Sacramento to emphasize the built environment and health connection as well as taking action in small projects in the region. From March 2013 to September 2014, I became involved with and tracked the efforts of Design 4 Active Sacramento (D4AS), a cross-sectoral, independent group working to implement active design programs in Sacramento.

The roots of D4AS spring from another long established local nonprofit, WALKSacramento. Founded in 1998, WALKSacramento began primarily as an advocacy group to ensure safe routes to schools, which still comprises the bulk of its work. In this respect, WALKSacramento's focus has mainly been on ensuring pedestrian safety, particularly for children. Among their accomplishments are initiatives such as getting the city of Sacramento to install pedestrian signals at certain intersections and instituting "walking school buses," where volunteers pick up children along a particular walking route to school to travel in groups. An initiative such as this addresses parents' fear of danger in the neighborhood, an example of a societal barrier to walking. More recently, the organization has expanded into looking at overall neighborhood health and walkability in the city, providing plan review for new developments and advising on building Complete Streets (Duarte, 2013). Teri Duarte, the executive director of WALKSacramento, has a Masters in Public Health and was a Program Manager for Sacramento County's Public Health Department for over 20 years prior to becoming the head of the nonprofit in 2011. She noted that she tried to get a built environment program started in the department for almost seven years prior to her departure as well as submitted public health related ideas for general plan updates, but the County simply wasn't interested.

In early 2013, Duarte and Judy Robinson, the Infill Director and Sustainability Manager for Sacramento County, were part of a team that had been chosen by the U.S. Centers for Disease Control to participate in the National Leadership Academy for the Public's Health (NLAPH), a 12-month training program designed to improve health outcomes in communities by guiding local leaders to influence the policies and systems that impact our health. Robinson had already started to advocate for small scale healthy neighborhood interventions, such as requesting a local gas station owner to have 15 per cent of merchandise as fresh fruits and vegetables in order to receive a permit for building improvements (Kasirye, 2014). They were joined by Kasirye, who originated the grant application and passed it on to Robinson, who she knew from other interactions had interests in the built environment and health connection. Robinson added Adrian Engel, Principal at Echelon Transportation and Monica Hernandez a Project Manager at the Sacramento Area Council of Governments (SACOG). Their required coach for their training program was Dr. Mark Horton, Kasirye's mentor and a former California State Public Health Officer and professor at the University of California Berkeley. Later, they also brought Dr. Edie Zusman, a neurosurgeon with Sutter East Bay Neuroscience Center and a neighbor of Robinson's, on board. They were one of 20 teams from across the nation that were selected and brought together in Atlanta in March 2013 for training to work collaboratively among different sectors to change the multiple interacting conditions that lead to public health outcomes (Center for Health Leadership and Practice, 2014). Together, these members represented a wide swath of public, private and nonprofit sectors in both health and planning. Calling themselves Design 4 Active Sacramento (as there were originally four members on the team before Hernandez joined later), the goals they set for themselves at the workshop were:

- Build consensus and leadership in the region and increase awareness of the importance of walkability to a healthy, prosperous community.

- Develop skills to communicate the health impacts of the built environment to inform decisions on policy and community development.

- Begin to incorporate health related policies and solutions into County zoning code, improvement standards and design review.

- Build support among healthcare leaders and employers for active design in the built environment.

The group was one of the few at the Academy to take on the built environment as a yearlong goal, most proposed more health promotion activities such as literacy and nutrition programs (Center for Health Leadership and Practice, 2014).

In a monthly meeting, Engel noted that he felt the best way to enact healthy design in policy was through "backdoor" channels, such as adding to the existing design guidelines, as it would be difficult to get planners and designers on board with following an entirely different and additional set of guidelines. He noted health is essentially a desirable goal similar to how sustainable or "green" practices were in the early 2000s. From the beginning, instead of attempting to write a comprehensive set of guidelines focused solely on active design, they pursued a three pronged approach to implementing active design.

The first strategy was to write active design guidelines for new developments in Sacramento, namely the Folsom Boulevard transit-oriented development. The Folsom Boulevard document frames the problem—the growing obesity crisis and lack of options for daily physical activity—and references empirical research, as well as lays out a series of health-relevant design objectives. Those objectives were street connectivity, traffic calming, access to resources and park design, and then details on how they can be achieved. Although heavily influenced by the New York City *Active Design Guidelines*, the document is tied to locality by citing Sacramento specific health data, more discussion of climate mediation (given Sacramento's wide yearly fluctuations) and using visual examples of other projects in the area. Targeting individual projects as a way to implement active design benefits both parties. The developers become eligible for community improvement or statewide climate change remediation grants. For the advocacy group, once the development is built, it can stand as a model project for people to inhabit or visit and experience walkable lifestyles, and in particular alleviate fears of density and mixed-use (Duarte and Robinson, 2014; Kasirye, 2014).

The second strategy was to emphasize health relevant factors in existing design guidelines and zoning code. Knowing that the Housing Element of Sacramento's General Plan was up for revision that year, D4AS was able to incorporate language making public health improvements a stated goal. Prior to this last round of guideline updates, health had not been a required element in any planning codes, but instead specified as a service delivery item (such as providing health and human services) that jurisdictions had the option to adopt or not. Because all jurisdictions build housing, embedding it in that code cements health was a priority for building (Duarte and Robinson, 2014). This update was accepted and adopted by the Board of Supervisors October 8, 2013 and the guidelines are effective through 2021.

The group took advantage of the County Design Guidelines for Commercial/Mixed Use, Multi-family, Single Family developments that were also being rewritten in 2013. This iteration of the guidelines was particularly important as Single Family residences are normally exempted from County restrictions (Duarte and Robinson, 2014). Engel developed an active design symbol and D4AS was able to stamp and endorse certain guidelines as health relevant to elevate their importance to future development (See Figure 15). They also wrote and attached an appendix document that described Sacramento County's specific health issues, further explained the concept of "Active Design," and provided a checklist for developers (Judy Robinson, personal communication to author, August 21, 2013). Last, they added language to the County Zoning Code directing users to both the Design Guidelines and its increased emphasis on building healthy communities (Judy Robinson, personal communication to author, March 13, 2014).

When these guidelines are properly applied to projects we achieve quality design, while also improving the individual and community's health, safety and livability. Throughout the Guidelines, standards and policies that incorporate active transportation and contribute to a built environment that supports public health have been highlighted with the walking person icon. The purpose of the icon is to identify "Active Design." Active Design shall be incorporated into all projects in order to reinforce the community's and County's goal to create a built environment that is sustainable, livable and promotes active transportation choices such as walking, bicycling, and accessing transit. There are many factors of the built environment that influence healthy choices and no single aspect of design can achieve this goal. By incorporating Active Design strategies into the built environment, physical activity and improved health can be achieved. More information about the synergies of the guidelines that support active design can be found in Appendix D.

Figure 15: D4AS Active Design Logo and explanation

The policy approach is arguably where D4AS has made their greatest impact. Robinson described how any project built must be consistent with design guidelines—short of demanding improvements, it is the way “closest to the ground” to integrate health-oriented design. She also emphasized the importance of targeting and connecting several hierarchies of planning policy—as D4AS did with the General Plan, County Design Guidelines and Zoning Code—to cover several scales of jurisdictions. The group set out simply calling out and endorsing existing guidelines instead of writing new ones in part because they knew it could was more likely to be accomplished within the yearlong confines of the NLAPH grant. Armed with the growing body of research, they could also stress the importance of fine-tuning some of the guidelines. For example, where a guideline may say, “parks must be within reasonable walking distances of a residential area,” changing it to say “within a 10 minute walk” makes that guideline more prescriptive, and therefore builds in accountability (Duarte and Robinson, 2014).

Last, D4AS made it its mission to advocate for active design through presentations while highlighting the work of, and building consensus with, other groups tackling built environment and health issues. They talked about the success of the “park prescriptions” program, which started as a partnership between 18 different parks and recreation agencies in Sacramento County with Dr. Kasirye in her capacity as a public health officer. The Park Directors wanted to highlight the abundance of parks in the county and improvements being done. Kasirye helped in their campaign to write “prescriptions” for residents to spend 30 minutes, five days a week, in local parks walking or participating in an activity of their choice. The use of parks is crucial as unlike a gym, it provides a location for recreation that doesn’t require a paid membership. The program was eventually taken over by the Sacramento Sierra Valley Medical Society, who developed it into a “Walk with a Doc” program, where physicians give short health talks in different park locations, and lead groups on strolls (Kasirye, 2014; Sierra Sacramento Valley Medical Society, 2014). The evolution of this program also shows how the built environment helped bridge a link between public health and healthcare, which are often considered different spheres. The group was also particularly strategic about Dr. Zusman’s deployment as a physician advocating on issues of the built environment and health at New York City’s FitCity conference and the Robert Wood Johnson’s annual Active Living Research conference.

D4AS is also aligning themselves with the Sacramento Tree Foundation and presented at the latter’s 2014 Greenprint Summit, which focused on the connection between urban forest and public health (Sacramento Tree Foundation, 2014b). The Sacramento Tree Foundation is also launching a “Green Rx” program to encourage tree planting throughout the city and has recently undertaken a project studying the connection between tree canopy and health outcomes. Their preliminary predictive modeling has so far shown that between two scenarios of 18 percent and 28 percent tree canopy, adult occurrence of Type 2 Diabetes and obesity were nearly 20 percent lower in the greater tree canopy scenario. Possibly related, vigorous physical activity was 10 percent higher, while overweight/obese and asthma were 10 percent lower. For children, ADHD was nearly 28 percent lower in the greater tree canopy scenario, and obesity 25 percent lower (Sacramento Tree Foundation, 2014a). Although the findings are extremely exploratory at the moment, the Sacramento Tree Foundation’s original research bolsters the work of D4AS.

The successes of D4AS just a few months into the grant spurred Robinson to call a strategic planning workshop on July 29, 2013 to discuss how to make the group a sustainable organization past the NLAPH funding period. In the end, they outlined the future direction of D4AS as a "*vision* of an environment that enables residents to incorporate healthy activities into their daily lives" and a "*mission* to influence decisions about the built environment in order to promote health." (Emphasis in original.) (Lori Moss, personal communication to author, August 12, 2013.)

They also set three specific goals and selected related tasks:

- To improve the built environment: through training of government officials and practitioners in active design principles and plan review, holding professional development workshops with continuing education units (CEU's) available and identifying areas of vulnerability through spatial assessment tools.

- To increase engagement of the community: through peer-reviewed publications, identifying stakeholders and potential partners in the active design mission, particularly healthcare partners and educating elected officials and the community on health and built environment issues.

- To create a sustainable organization: by developing a business plan, identifying an organizational location, forging relationships with potential funders and being precise about roles for each member in the next iteration of D4AS.

(Lori Moss, personal communication to author, August 12, 2013; Monica Hernandez, personal communication to author, December 20, 2013.)

This plan not only leveraged the cross-sectoral expertise of the team, but took advantage of each particular sphere of influence each person had, particularly in the city and county level planning spheres. Ultimately, D4AS became an organization/advisory board within WALKSacramento, which as an existing nonprofit offered a more visible profile, access to grants and revenue, and an organizational structure that could not be done within governmental structures. As of this writing, the merging of WALKSacramento and D4AS has paid off in one grant of $20,000 from The California Endowment to review and identify "active" guidelines in existing design standards in five Sacramento County cities. The merged group is also in the process of applying for funding from the California Strategic Growth Council Grant to educate and train planners and others on active design, update design guidelines of local jurisdictions and enhance regional GIS modeling tools for use in local planning.

Policy Context for Active Design

D4AS' strategy has its roots in a larger movement promoted by the American Public Health Association termed "Health in All Policies" (HiAP). The guide for governments was written by the California Department of Public Health, and is gaining a particularly strong foothold in this state. Recognizing that health is influenced by many upstream causes such as equity, economics and the physical and natural environment, the strategy asks that health be a consideration across all policy sectors. Its adoption by local governments gives health officials a larger role in governmental decision making (Rudolph, Caplan, Ben-Moshe and Dillon, 2013). The concept has already been adopted by country-wide governments in both Europe and Australia. One of the most notable examples of a HiAP approach being adopted alongside a practical Ordinance is in the City of Richmond, California, a historically disadvantaged community (City of Richmond, 2014). D4AS discussed the introduction of a bill that would require the public health officer to review future development plans (Judy Robinson, personal communication to author, August 5, 2013).

There is also an opportunity for federal healthcare policy to be used as a lever to institute active design. The passage of the Affordable Care Act (ACA), or Obamacare, means that healthcare organizations will be moving away from a traditional fee for service model, and instead financially rewarded for lower readmissions and penalized for higher ones, consequently raising their accountability level (Chen and Ackerly, 2014; McClellan, McKethan, Lewis, Roski and Fisher, 2010). As hospitals are forced to look into more preventive strategies to combat chronic disease, it will make sense to align themselves with local community groups doing the kind of work that D4AS is pursuing. There is already precedent for this in the region. In South Sacramento, Kaiser Permanente funded a three-year Healthy Eating Active Living (HEAL) Zone initiative in a low-income neighborhood near their hospital by reaching out to local community groups to promote healthy eating and host a farmers' market near the hospital. A group like D4AS could help facilitate connections between hospitals and active living and built environment initiatives. This is perhaps the best time to begin to integrate public health initiatives with private healthcare systems and funding, even though the two have traditionally been siloed (Zusman et al., 2014). Dr. Zusman noted in a D4AS meeting that the key to integrating the two sectors is to somehow show how private medical costs for treatment can be decreased with public health initiatives and promoting preventative health habits such as walking. Monetary figures on the savings active lifestyles bring are still difficult to find, but we do know that chronic disease now accounts for 75 per cent of the nation's healthcare spending (Robert Wood Johnson Foundation, 2014). In 2013, Kaiser Permanente was able to reduce the average days per beneficiary in post-acute facilities to 30 per cent of the days Medicare would normally pay for by emphasizing preventive care upfront, aided by programs such as a seven-week Self-Management Program for chronic disease patients and their families, developing preventive care apps and community programs such as the HEAL initiative (Davidson, 2013; Lorig, Sobel, Ritter, Laurent and Hobbs, 2001).

It is also important to recognize the specificity of Sacramento's policy environment and the people who make up D4AS. The group is unique because its members were already in positions of influence, specifically in the planning and public health departments and the SACOG advisory group. While these are traditionally underserved and underfunded departments in most governments, by banding together they were able to make a more direct impact, certainly more than most nonprofit groups normally would. Dr. Kasiyre also noted that being a member of D4AS, with people of various affiliations gave her a way to voice priorities she could not as herself and in her capacity as the public health officer. Robinson and Duarte repeatedly noted the importance of having a strong voice with governmental connections (in this case, Robinson) to "birddog" a specific issue such as active design. Change can come from outside governmental structures but still likely requires some champion inside. Robinson cited the example of an outside community leader swaying the mayor of Portland to take on walkability as a municipal issue. However, it is hard to imagine that D4AS would have had the success they saw in 2013–2014 without their inside members and deep local knowledge.

Conclusion: Moving Research into Policy

The Sacramento case study exemplifies how implementing active design harnessed research, advocacy and local knowledge. Concurrently, designers don't often consider policy environment, but it is going to be crucial as building codes, particularly in California, become more prescriptive (Berg, 2010). The framework for building doesn't come from private investors, but from local governments (Campoli, Lincoln Institute of Land Policy, 2012). Public health research on physical and the built environment was key in D4AS's mission to support their advocacy and help prioritize decisions. Robinson cited an example where the planning code had previously used the phrase "reasonable walking distance" to outline access to services, but how they were able to change the wording to be more descriptive, "within a 10 minute walk." As Robinson described it, using that kind of language helps enforce policy and is the "fire to hold people's feet to." Although data is rarely the primary driver for the policy making process (Innes and Booher, 2010), the fact that it is being wielded so prominently in health-related advocacy casts some responsibility on researchers to better structure their studies with practical applications in mind, as well as to find opportunities where interventions can be observed to advance the literature.

There are several barriers to changing standard American neighborhood design, though. As city planning has become increasingly more concerned with economics over time, the turn toward ensuring well-being represents a turn toward the old social goals of the past—which is not to say they are ultimately opposing forces. The active design movement is seeking to find ways to show how walkable neighborhoods can save health care costs, however, healthy planning doesn't necessarily directly favor the developer. Developers and city council often want more growth for more revenue, and are usually mostly concerned with building design, rather than what is in between (Duarte and Robinson, 2014). There is also resistance from the population at large. Duarte, Robinson and Kasirye all cited NIMBYism as most powerful force against building more walkable neighborhoods, particularly a lingering association between "density," urban areas and crime. Kasirye also noted an example of trying to build a connective walking path in a neighborhood that was ultimately blocked by residents because it would go behind backyards. In many cases, people have to see and experience a walkable community before they buy into its benefits. Last, while there has been much written about the disconnect between planning, policy and health, a surprising disconnect the members of D4AS have had to overcome is the split between public health and healthcare. Targeting this reconnection through papers and presentations given by Dr. Zusman, as well as finding partners in the Kaiser Permanente hospital organization gave more visibility to D4AS's efforts.

Unlike the past movements surrounding built environment and health, we are also in a new era of how policy itself governs building. The rational-comprehensive, top-down approach to city planning that instituted sweeping change of the past is very different than the policy development mode of planning today (Innes and Booher, 2010). While the first is designed to impose order, the latter is messy, slow and uncertain, but seeks to build some sort of consensus (Hall, 1996). Particular to the context of Sacramento, there are also lots of special districts for water, fire services, parks, schools, etc. No single document controls the built environment. Additionally, while the city is governed by municipal policies, its outlying suburban areas are governed by regional ones. Not only are these different built environments, but the city population tends to be more progressive than the county, so policies and strategies will differ (Duarte and Robinson, 2014).

When I asked Dr. Kasirye to reflect on the year, she said one of her biggest takeaways was that "a good solution solves multiple problems," and the environment addresses many health issues—access to work, exercise, food, social interactions and mental health. Change will take a community effort and cross-sectoral work, as not one agency has all the knowledge. This, of course, echoes much of what has been written about the reconnection of city planning and health, but in the case of D4AS, it is apparent that the inclusion of a few particular sectors—that is, Dr. Zusman's authority as a physician and Robinson's strategic outreach, planning policy knowledge and relationships, were key to their success.

Last, we also have yet to see how these advocacy and policy efforts manifest themselves in design. What is apparent, though, is that the move toward active design has changed the use of the landscape. One only has to look at the American River, which at Sacramento's founding was a source of miasma, flooding hazard and disease, but in today's incarnation is one of the most popular recreational trails in the city. How the new era of designing for health will reshape our neighborhoods, or simply change our perspective, has yet to be seen.

CHAPTER SIX: RETHINKING WALKABILITY

Gaps in Research and Practice

Introduction

The previous chapters served to build the historical, public health and practical contexts for designing for walkability. With these in mind, this chapter offers a critique of the current walkability movement through two central premises that are often overlooked, despite the considerable body of literature on the subject.

First, the contemporary concerns of developing walkable neighborhoods are part of a historical continuum of disease and urban design. In fact, improving walkability is often idealized as a way of returning to "the old way of building" (Duany et al., 2000) in order to combat the obesity and sedentary lifestyle-related diseases of today. It is a worthy reminder, though, that our "unwalkable" neighborhoods spring in part from suburban prototypes that were meant to encourage health in their own era. Making neighborhoods more walkable should be a priority for American development. However, proponents of walkability often overlook many of problematic associations with these past movements surrounding design and health, not the least of which is displacing or abandoning populations while idealizing certain kinds of places as healthful. We are already witnessing the trend of walkable (urban) areas only available to those who can afford them, and not necessarily those who need it most. As in the past, we are also seeing how low-income populations who face the largest burden of disease are often dismissed as victims of their own lifestyle choices. Walking has taken on the moral connotations that sanitation and crime had in the past. The motivation to combat the damage of auto-centered, unrestrained sprawl of the past few decades is urgently needed from both an environmental and health standpoint. Before we press ahead on declaring the "end of the suburbs," though, we should take into account what happens to the populations within.

Second, and also reminiscent of historical movements, walkability's concentration on the formal is problematic. This is encouraged by designers, who have historically and understandably always had this particular blind spot, but also by the structure of most public health and built environment study. Much of the empirical literature, and particularly audits used to observe the environment, frames physical context as a series of discrete factors and neighborhoods as independent units. In turn, this has inadvertently influenced the way audits and design guidelines are written and conceivably how they will be executed in the public realm. In research and in practice walking is not yet framed by the same kind of integrated public health frameworks used to encourage healthy eating habits and deter smoking (discussed in Chapter Three), which take into account social and physical environment. Most see the motivations for active lifestyles on each side of a binary—either as deterministic of the environment or as a purely personal choice that no amount of physical intervention would solve. Most baffling are cases where in-depth and highly specific research is done into built environment factors, only to dismiss further questioning by reverting to the causality argument. The case study of D4AS presented in the previous chapter exhibited that enacting walkability requires an integrated approach of policy, and outreach, and cross-sector understanding takes a significant amount of effort, time and outreach to people in charge. It takes not only the formal infrastructure in place, but also programs. The discussion surrounding walkable neighborhoods in both the public health and design realms is divorced from the political, financial and social reality of development, which in the end will stymie the successful adoption of the movement, or do the same kind of harm as past movements surrounding health and urban design. Walkability is subject to the same kind of social epidemiological frameworks as other health-related behaviors such as smoking and healthy eating, although it is often not mentioned in this context.

Walkability and Equity

Chief among the walkability movement's blind spots is the equity and socioeconomic context of walkable neighborhoods. In particular, two oft-cited conclusions overlook recent major demographic shifts. The first is that the form of urban areas are inherently "healthier" than suburban ones due to their density, diversity and design. Related to this is the concept of "self-selection," specifically that people not prone to walk or exercise choose to live in the suburbs (Berger, 2013; Eid J. et al., 2008; Southworth, 2005). These assertions are repeated frequently not just in scientific studies, but now echo throughout popular media. While it has been well-established that residents in less walkable and sprawling environments (broadly categorized as suburban neighborhoods) often have lower rates of physical activity (Frank et al., 2005; King, Satariano, Marti and Zhu, 2008; Saelens et al., 2003) and have higher rates of obesity and obesity-related chronic disease (Ewing, Schmid, Killingsworth, Zlot and Raudenbush, 2008; Frank et al., 2004; Giles-Corti, Macintyre, Clarkson, Pikora and Donovan, 2003; Lopez and Hynes, 2006). Less discussed are the demographics of these neighborhoods and their availability. Expanding the scope of literature to the economics of walkable neighborhoods, however, starts to construct a telling narrative.

Although the general assumption is that suburban areas are predominantly white and privileged (Duany et al., 2000), recent reports indicate otherwise. A Brookings Institute report analyzing 2010 census data identified trends of immigrants, minorities and low-income families moving to the suburbs, and young white wealthier residents moving back into city centers. Much of this is due to the availability of cheap housing in the suburbs, but this research is still developing (Kneebone and Garr, 2010). Post-financial crash, though, "Suburban poverty" has become a reality. Concurrently, obesity's relationship to chronic disease and the higher rates of obesity in minority and low-income populations (Lovasi, Hutson, Guerra and Neckerman, 2009) point to the potential of a health crisis in the suburbs aided by the environment. Lathey et al. (2009) showed evidence of this relationship with higher disease clustering in outlying, sprawling areas in Phoenix. The long commutes, social isolation and sedentary lifestyles associated with suburban commutes alongside the increasingly higher cost of owning a car may come from financial circumstance and not necessarily "choice" (Chatman, 2009).

Rarely discussed in any walkability literature is that upstream factors also potentially play a large part in dictating residential opportunity, indelibly linking social place and physical place. However, it has been a persistent theme from early public research. Theorists Fredrich

Engels and Karl Marx noted that where the working class lived was dictated by where factory owners wanted them to be (Susser and Stein, 2009). Lindheim and Syme also noted that not only are people influenced by their neighborhood environment, but those most prone to chronic disease also lack the mobility to move elsewhere. Nevertheless, the myth that every citizen has free choice of neighborhood of residence is especially prevalent in the United States. While the self-selection caveat in empirical studies assert that personal autonomy, not economic circumstances or available supply, is the primary driver of neighborhood choice, there is a significant issue of neighborhood "mismatch," where supply is not meeting demand. A survey of Houston residents conducted by the Rice University Kinder Institute (Rice University Kinder Institute for Urban Research, 2013) showed that 50 per cent of residents want smaller homes in a walkable area, but only 10 per cent of existing U.S. housing qualifies as such. In an Atlanta, Georgia based survey, Frank et al., (2007), also found mismatch between neighborhood preference and actual residence, pointing out that "the availability and cost of housing, real and perceived quality of schools, job location and other preferences require compromise" (p. 1900). Cost of housing is certainly a primary issue, as much has been made of the growing economic robustness of walkable neighborhoods (Leinberger and Alfonzo, 2012). Moser (Moser, 2013) found that neighborhoods in Seattle rated most walkable by Walkscore also had higher median monthly rates. As cities sprawl further and further out, and affordable neighborhoods are less accessible to jobs and public transit, these residents are forced to become reliant on cars and the associated costs that come with them, and spend more time commuting. Sprawl impedes social mobility and consequently, personal health (Krugman, 2013). Even when moving beyond urban and suburban designations, lower-income neighborhoods are also less likely to have simple pedestrian infrastructure such as traffic calming, crosswalks and lighting. A Bridging the Gap research report found that when looking at 10,177 streets across 154 American communities, 89 per cent of high-income neighborhoods had continuous sidewalks as opposed to 49 per cent of low-income neighborhoods (Gibbs, Slater, Nicholson, Barker and Chaloupka, 2012).

Although rarely stated explicitly, there are often moral implications attached to the discussion around sedentary lifestyles and the relationship to obesity-related chronic disease. The assertion that those who suffer from these illnesses, particularly those in low-income neighborhoods, "choose" not to exercise or eat well echoes other environmentally influenced epidemics such as those discussed in Chapter Two. In particular, we see similar shades in the sanitary movement, where many asserted that disease disproportionately affected the poor due to their cleanliness habits. This argument was also made for Olmsted's parks, that the working class's health would benefit by participating in the appropriate recreational activities of the elite (Fisher, 2010). However, like today, there were also advocates that noted that the poor faced limited choices due to their economic circumstances and spatial location. Activist and Congregational clergyman Andrew Mearns noted in his pamphlet *The Bitter Cry of Outcast London* (Mearns, 1883) that the reason the poor congregated at the center of the city was that they could not move to cheaper housing, or be further away from work. "The wretched people must live somewhere. They cannot afford to go out by train or tram into the suburbs … can they be expected—in addition to working twelve hours or more, for a shilling, or less—to walk three or four miles each way to take and fetch?" (p. 15).

Proponents of walkability often overlook the benefits of walking from a social equity standpoint in favor of the design aspects. However, walking is the only free form of transportation. Streets, sidewalks and public spaces can encourage social interaction and build social capital, empowering economically disadvantaged areas (Leyden, 2003). Enrique Penalosa, former mayor of Bogota, Colombia, noted that investing in better pedestrian environments should be prioritized as it benefits a larger part of the population than road or rail improvements (Lo, 2009). Essentially, the public realm is the one health resource freely available to all. However, the United States has been very wary to use urban design and planning as a policy lever given past fallout (Hall, 1996; Scott, 1998). The hesitance to move beyond a causal framework understandably prevents significant physical interventions, but this in conjunction with the self-selection argument, allows researchers to downplay further research into the concept that availability of physical environment exacerbates health inequalities. The deliberate control for socieconomic information is part of the methodology of scientific inquiry, so as not to bias results. Walkability maps and audits such as those mentioned above, also neglect to contextualize the results with demographic information. However, it is also worth noting that the majority of American walkability research has been confined to non-Hispanic White populations, which obscures further possible inequities and skews evidence (Khattak and Rodriguez, 2005; Papas et al., 2007).

Walkability must be cognizant of its upstream causes—the historical, social and economic context of active lifestyles. Many studies noted that respondents cited “lack of time” to exercise (Eyler, Brownson, Bacak and Housemann, 2003). With more time spent commuting or working, the poor also have a limited physical activity “budget,” particularly when it comes to leisure activity (Forsyth et al., 2008). In the literature, this is seen as an attitudinal barrier instead of an economic one, but as discussed above, low-income populations are increasingly moving further out and spend more time commuting, leaving little time to recreate. This kind of knowledge can be used to make interventions in the future; for instance, focusing on increasing opportunities for purposeful walking and active transportation over leisure infrastructure (although this should be provided for as well). Additionally, most evaluations only measure the distribution of neighborhood resources, not their quality. Research on walkable neighborhoods could benefit from growing literature on park access and equity, which has been more studied. Urban parks studies show an inequity of green space in low-income and minority neighborhoods in the inner city (Wolch et al., 2005). Studies that have looked specifically at the pedestrian accessibility of parks and streets have showed a dearth of green space in low-income and minority neighborhoods, a possible factor in high obesity rates among minority and lower income groups (Mokdad et al., 2003; Papas et al., 2007). A study by Wolch et al., (2005) showed that in Los Angeles, African-American, Latino and low-income neighborhoods had much lower access to parks and recreational facilities than predominantly White neighborhoods. Roots of these spatial patterns go back to the early twentieth century, where Jim Crow ideology often relegated sub-standard land to African American communities. Additionally, the pastoral park style preferred by the elite proved unsuitable for urban areas, as dense tree strips and hidden green pockets became crime havens (Young, 1995). Today, higher income neighborhoods also often receive more park funding, and the recent trend in park building through public/private partnerships between agencies and business improvement districts means parks will continue to be built in areas with pre-existing financial and social capital (Byrne and Wolch, 2009).

Historically, design has often tried to shape behavior while being ignorant of larger economic, political, cultural or social forces, the “physical fallacy” per Herbert Gans (Gans, 1968). Designers must be aware that the existing physical environment is a product of social interactions (Appleyard, 1979), and how to take these into account when attempting to achieve some objective. As Talen (2011) notes:

> The inclination to be cautious about direct translations of social agendas is justified. The application of urban design to something like social justice has not always translated well. The complete, socially just Garden City became the sprawling, exclusive garden suburb, and garden suburbs eventually translated to sprawl, physical separation and car dependence. The failure of modernist urbanism’s literal-minded articulation of equality in built form—sterile housing blocks and concrete towers—is another painful reminder of the failure of social ideas to translate well to built form (Mumford, 2002). Yet contemporary imperatives based on principles of sustainability are forcing a reappraisal of the application of social goals in design terms (Beatley, 2004). Another problem occurs when social goals are expressed quantitatively and in measured form, as a geospatial dimension is likely to require. Some may find the quantification of urbanism too limiting, and its application to urban design too constraining on the creative capacities of the designer. However, an explicit understanding of social geographies does not need to be construed as ‘planning by the numbers,’ so disdained by Jane Jacobs and others. Instead, it is an attempt to broaden the contextual understanding of urban design and to help generate a more informed range of design alternatives. In this the geospatial dimension can play a positive role. It helps make the translation between design and social objective transparent, creating a more exploratory, less deterministic relationship in which layers of information can be ‘turned on and off’, distance metrics changed, and the effects of varying locations evaluated. This exploratory process provides a useful way to understand investment priorities, particularly who is most affected by a particular design intervention.

Walkability will be a particularly precarious form of neighborhood improvement. Its benefits are significant, particularly to low income populations, such as the elderly, disabled and young, who cannot drive. As the fabric of urban neighborhoods becomes increasingly prized for its density, diversity and design, though, low-income and minority populations are being pushed out to the suburbs. The “economic promise” of walkability (Leinberger and Alfonzo, 2012) often looks much like gentrification. Resident displacement is increasingly considered as much a public health concern as obesity and chronic disease, only further driving health disparities (O'Brien, 2014). Researchers continue to overlook their contribution to the growing narrative that suburbs (and its residents) are universally dismissed as unhealthy, and claim they are only making recommendations on form. We should be especially cognizant of this when Jeff Speck, a prominent leader in the New Urbanist movement, advocated for an "urban triage" for more walkable cities, saying in terms of improvements, the worst off must be sacrificed for the greater good (Speck, 2012, p. 254), and not recognizing economic and social needs along with the physical. If the current socioeconomic context of the suburban/urban divide is ignored, then the walkability movement risks the same pitfalls as previous historical movements.

Audit Instruments and Tools

As research on built environment and public health has expanded over the past decade, so have tools to evaluate the built environment, particularly for walking. The "Tools and Measures" database of the Robert Wood Johnson-funded Active Living Research (ALR) site 19 audits directed at evaluating environments for recreation (Active Living Research, 2014), primarily focusing on parks and streets. A 2013 report by the Center for Resource Efficient Communities (CREC) at the University of California Berkeley identified that there are five primary areas of pedestrian environment assessment: accessibility models, suitability models, interrupted and uninterrupted level of service (LOS) models, multi-modal level of service (MMLOS) and travel demand/activity, and volume-based models. When evaluating pedestrian environments specifically for physical activity correlations, the first two dominate the survey type. Accessibility models are commonly characterized by quantitative measures of accessibility (and strongly emphasize density, intersections and land use mix), while suitability models include more subjective, qualitative measures. The quality of these elements was evaluated by conducting an inventory, route quality assessment, area quality assessment and/or estimating latent demand (Moudon and Lee, 2003). The audit instruments used or most mentioned in the review of physical activity and built environment studies in Chapter Four were the Neighborhood Environment Walkability Scale (NEWS) (Saelens et al., 2003), the Pedestrian Environmental Data Scan (PEDS) (Clifton, Livi Smith and Rodriguez, 2007), and the Irvine-Minnesota Inventory (Day, Boarnet, Alfonzo and Forsyth, 2006). All were developed with support from ALR, and when put into context with each other, exemplify the range and issues inherent in current neighborhood evaluations for public health. All have elements of both accessibility and suitability models, which are common in these types of audits (Eisenstein, Szibbo, Macdonald and Mozingo, 2014).

NEWS was one of the first American environmental audits (Saelens et al., 2003), and still one of the most utilized in public health research. Comprised of 83 questions (NEWS-A, the abbreviated version of the audit, is 54 items) the survey asks about distribution of residential building types that are meant to represent density (i.e., "how common are detached single-family residences/townhouses of 1–3 stories/apartments or condos of 7–12 stories in your neighborhood?"), how long it takes the respondent to walk to types of businesses and facilities and Likert-scale type questions about ease of access and presence of street design elements (i.e., intersections, walking routes, trees). Last, the survey asks about overall neighborhood satisfaction with streets, traffic, etc. What is most interesting about NEWS is that the first sections are asking for objective data (i.e., reporting on the presence of certain elements, like building types), but the phrasing forces the respondent to report through the lens of personal perception (by having the respondent make a judgment on whether it is “a few” or “most” of the buildings on the street). While this could be the jumping off point to look at differences between the objectively measured built environment and how people experience it, that is not the purpose of the survey. Instead, the researchers are using these questions to generate the objective data about density. Indeed, test-retest reliability was lowest when asking about presence of built environment elements (residential density, street connectivity, walking and cycling places), but higher when asking about aesthetics (neighborhood surroundings, crime safety) (Cerin, Conway, Saelens, Frank and Sallis, 2009). This may indicate that those conducting the survey were not altogether familiar with built environment terms, or that a Likert scale response, particularly the middle responses from “a few” to “most,” to asking “how common” built environment components are has great variability. It is also not clear how “neighborhoods” are spatially defined in order for further conclusions.

PEDS (Clifton et al., 2007) is in essence a response to NEWS. Like NEWS, it is based on the Australian audit Systematic Pedestrian and Cycling Environmental Scan (SPACES) (Pikora et al., 2002), but purports to measure microscale features more “reliably and economically,” keeping questions to one page and introducing a handheld computing input option. To increase reliability, the researchers emphasize a specific, “extensive” training protocol and ask that the survey be conducted in pairs. They also explicitly state that it is not a survey designed for community input. Surveys are done on street segments, instead of defining neighborhoods. The protocol had researchers measure each side of highly trafficked streets separately, recognizing the barrier issue of traffic few other surveys did. Like NEWS, it relies on the reporters to generate data about presence of elements, however, by only asking if there is or is not an element present, and not a judgment call on frequency. PEDS had a far higher agreement factor than NEWS in validation tests regarding built environment qualities, many in the 90 per cent or even 100 per cent range. On the other hand, questions about attractiveness has low reliability (50 per cent for walking attractiveness), although researchers found high agreement within individual surveys between perceived attractiveness and safety. Certain questions regarding perception of personal safety and crime, though, are structured similarly to NEWS, indicating agreement that these are factors best measured subjectively.

PEDS’ central claim of efficiency is still stymied by its conventional approach to surveying the built environment. The authors give an estimate of 10–12 minutes per 400 ft. segment per rater, including administration time. This time is reduced by two minutes when using the computerized handheld device, but this increases cost. Some of the questions could be answered by rudimentary GIS analysis, which would take an almost invisible fraction of that time. Considering the high agreement factor in asking about qualities such as land use and residential density, the utility of obtaining the data in survey form is questionable, particularly when researchers were already using GIS to determine segment lengths of under 700 feet. Even though this report was written in 2007, computing in environmental audits has also not advanced much past this elementary use of GIS and the mention of the handheld for tool for input.

The I-M Inventory (Day et al., 2006) also uses the Australian SPACES tool as a jumping off point. Unlike the PEDS researchers, they claim SPACES is too short at 37 items and consequently reduces certain multifaceted elements, such as nature and residences, to a single question. In the researchers' words, "A more comprehensive measure of built environment features is needed to test the wide range of hypotheses about relationships between the built environment and active living. The Irvine Minnesota Inventory was developed to fill this gap" (p. 46). The I-M Inventory was also designed with a few additional research questions in mind:

- Are new urbanist neighborhoods associated with more physical activity, compared to traditional suburban developments?
- Are more pleasurable settings associated with more physical activity?
- Which built environment features are associated with walking for travel versus walking for recreation?
- Are there differences in the associations between built environment features and physical activity for different groups (e.g., by gender, age)?

The I-M Inventory organizes its questions into categories of accessibility, pleasurability, safety from crime and safety from traffic. The questions are mostly focused on streetscape elements and appear to be designed for every possible context, asking about presence of uncommon items such as harbors, "nature features" of fountains or reflecting pools, decorative paving, garage doors and overhead wiring. Interestingly, it does not ask about some basic street elements, such as sidewalk widths and connectivity, that are often in most walkability audits. In fact, the I-M Inventory authors make note that if interested, users should use those other audit instruments in addition to the I-M Inventory. Although incredibly specific and wide-ranging in asking about built environment elements, the researchers also state that it is open to modifications for specific place types or expanding on certain issues like crime, etc. These caveats create a mixed message about the strength of the I-M Inventory as a tool, particularly as it claims to be the most comprehensive in the field.

The administration of the I-M Inventory is similar to PEDS, also to be administered by two observers, and like PEDS, uses street segments to spatially define service areas. Even in its specificity, the I-M Inventory asks some open ended questions about key accessibility and equity elements such as, "Is it possible for the general public to use these spaces?" In a combination of tactics from the previous two surveys, the I-M Inventory asks respondents to simply state the presence of some elements (such as building types), and then make a judgment on the proliferation of others, like blank walls in a Likert-scale response. On those questions, the middle range puts "some/a lot" as one category, which would appear to miss nuances between street segments and lead to fuzzy output. At 162 items on the survey, the I-M Inventory is certainly comprehensive, but by trying to include every possible streetscape item they may also be creating unnecessary noise in the results, begging the question that just because it can be measured, should it be? A noted difficulty in doing walkability studies is that the more variables there are to audit, the more labor and time-intensive it becomes to conduct the surveys, as well as the problem of linking these micro-scale audits to macro-scale planning measures. As for the factors themselves, there was no indication in any survey that researchers weighed certain factors more than others (which would be particularly problematic in a survey as detailed and expansive as the I-M Inventory), signaling that many still aren't certain about how to assign levels of influence to certain factors.

The audits, like the research, is also unclear or unintentional when it comes to spatial definitions. It is unclear how users will interpret or define the "neighborhoods" used in NEWS. While street segments for PEDS and the I-M Inventory are specified, it is unclear how the results would be aggregated in a network-based approach. The street segment method also ignores origins and destinations (Moudon and Lee, 2003) or differences across a metropolitan area. It is another signifier of walkability audits' issue of overlooking spatial dependencies, not only for street networks but also when studies only look at neighborhoods as discrete places (Lathey et al., 2009). The most utilized routes tend to be the trips between home and work, which raises the question if the right places are being evaluated in the first place (Clifton et al., 2007).

A major issue among all audits is that there is little agreement on what should be measured objectively or subjectively (Talen, 2002). While the physical and psychological elements of motivating people to walk requires both objective and subjective measures (McCormack et al., 2004), it would also be helpful to compare both objective and subjective measures of the same item to better specify what qualities affect walking. While the presence of buildings, sidewalks, etc. is often decided by planners, how these elements are perceived are detailed through design, and a study examining this would better target the several scales of walkability. There is little precedent or literature on these comparisons. Leslie, Sugiyama, et al. (2010) explored the difference between perceived and objective measures of "greenness" more in depth in an effort to understand how those measures might differ in a neighborhood walking study. Conceivably, the same structure could apply to density and street features. Certainly perceived access may be as crucial as actual access, as well as meeting specific user need and demand (Gebel et al., 2010). Even commonly accepted standards such as using only subjective data to understand the relationship between walking and perception of crime could be more fully understood with information on actual crime incidence. This information is fairly accessible from open data from police departments or even real estate sites such as Trulia, as well as how these discrepancies relate to overall health and well-being (O'Campo and Caughy, 2006). There is a generalized overreliance on self-reporting measures in public health study, as well as comparing how built environment attributes are measured across different studies, and a focus on how perceptions change across users—such as those from different socioeconomic backgrounds, children, the disabled and the elderly. Changing the population of focus can upend common agreements about walkability. Studies have shown that perceived residential density negatively related to walking in elderly (Borst et al., 2008). Greater land use also had a negative effect (Su et al., 2013). With the exception of the I-M Inventory, which noted in testing that the users were primarily white graduate students, which may have skewed subjective results, few discuss the targeted user of the audits, and less how the results could be interpreted and used, other than to further define correlations between built environment and physical activity.

An article by Gebel et al. (2009) examines the issue of objective vs. subjective measures, and hypothesizes that those who are already inclined to be more active are more aware of their environment, not that their environments are necessarily different. Future studies may want to take into account that the presence of certain elements may not influence walking if there is no awareness of them. Using NEWS as a survey tool, the misperception of objectively measured "high" walkability areas for low correlated with weight gain, notably where there was the largest difference in measuring overall walkability, land use mix and retail density. That characteristics of the respondents with that specific mismatch were often not university educated, had lower incomes, were overweight and walked fewer days per week for transport. The researchers also found that about one third of population "misperceives" walkability, from both ends of spectrum. The inverse of that mismatch had overall higher walking times and more positive cognitive variables. The study concludes by recommending "improving mismatched perceptions." They propose more physical activity promotion and persuasion strategies to address or promote those environmental attributes in lower income areas. Before thinking about radical re-design in neighborhoods, these issues exemplify the need for designers and planners to think about small environmental adaptation strategies, such as signage and cut-through pedestrian thoroughfares. However, it is also necessary to first explore the underpinnings of that mismatch to determine whether it is cultural or socioeconomic. Walking is another public health intervention that can benefit from the upstream causes research being advanced in the field.

In 2003, Moudon and Lee noted that public health is still at the beginning stages of research in environmental audits, however, over a decade later these methods have not changed significantly, even with rapid changes in technology. There are many audit instruments out there, many with insufficient validation (Moudon and Lee, 2003). There is also the question that with so many of them funded by Active Living Research (ALR), why there hasn't been a consolidation or more comparison across tools. Last, many are not designed for a lay audience or community based input (Moudon and Lee, 2003). Perhaps in that absence, many web-based walkability maps have proliferated in the past five years, but there is a distinct split between the goals of academic walkability audits and these more commercial applications. Sites such as Walkscore, Walkonomics, Walkshed.org and Ratemystreet are patent pending systems and smartphone apps that keep algorithms mostly hidden (Eisenstein et al., 2014). Their scores are also primarily driven by resource location. Walkscore (which was also developed partly with funds from ALR) is perhaps the best known and is unique in the fact that its variables can be crowdsourced and updated in real time via the website. This ease of interface and growing profile of Walkscore is potentially driving changes in physical environments. Walkscore is now a commonly used metric to sell real estate. Looking at several neighborhoods in Seattle, Moser (2013) found that neighborhoods rating 90 and higher (out of a score of 100) had median rents almost $1,000 more a month than neighborhoods with Walkscores in the mid-1940s to 1950s.

With the increasing desirability of walkable places, the metric is also an easy justification for developers to raise housing prices while demand is still decades from being met (Goodyear, 2014; Leinberger and Alfonzo, 2012). Making walkable neighborhoods is not yet a health proposition, but it is a profitable one.

However, there have also been significant criticisms of Walkscore's methodologies. The high weight given to commercial properties as opposed to street characteristics in the algorithm means that areas with large concentrations of stores and little residential land, such as famed edge city shopping mecca Tyson's Corner, Virginia, scores very high (Speck, 2012). Walkscore also doesn't account for crime, and its street measures are limited to block length and intersection density, which is a potentially redundant measure. Their grocery measure does not account for variety of food or even availability of fresh foods, an issue that was brought to light when the association tried their hand at a public health analysis and published a food access map (Bradley, 2013). A test of its validity found that it is a reasonable proxy to judge retail destinations, residential density and intersection density, but only at a one-mile buffer scale (not the shorter scales normally used in walkability analysis), but less so in judging physical aspects of the street such as whether the intersection is a four-way intersection, traffic speed or street width (Duncan, Aldstadt, Whalen and Melly, 2013). Walkscore recently announced that they will be adding a feature called "Street Smart" to their next version, which will take into account network distances instead of Euclidean measures as well as taking into account variety of choices in resources (Lerner, 2011). However, it still isn't clear if this "enhanced" version of Walkscore is being used as widely as the original version.

As mentioned above, technology has yet to be meaningfully integrated into walkability research as well, particularly in the realm of personal activity trackers, such as the FitBit, Jawbone or Garmin, which have become more widespread over the past five years. While these devices are much more expensive than pedometers, they could potentially be extremely helpful to built environment and physical activity research, as many of them come with GPS availability. Combining spatial tracking of individual routes with spatial environmental information could be crucial in linking hypotheses. Funding an experiment with this technology and similar sample size would be more difficult, but is certainly not outside the realm of possibility.

Design Guidelines and Policy

Despite the myriad issues associated with the walkability movement, much of the research mentioned here is starting to be integrated in municipal and community planning efforts across the country as well as private development. The previous chapter demonstrated how Sacramento is using public health research more abstractly in order to set the stage for smaller scale work.

It should be noted here that the design guidelines discussed here differ from Pedestrian Master Plans, which are common in many cities. Notable examples include those from Seattle, Denver, Oakland and of course, Sacramento. However, D4AS considered their efforts to institute active design separate from the city's Pedestrian Master Plan for a few reasons. First, the sidewalk plan is not a requirement for development. It simply identifies a road map to complete sidewalks, and in the case of Sacramento, can garner funding from either SACOG or the Safe Routes to School program for new developments should they choose to make street improvements around their property (Duarte and Robinson, 2014). Moreover, pedestrian master plans are not primarily geared toward increasing physical activity, but instead ensuring pedestrian safety and decreasing auto use through both increased walking and urban transit. While these are also health goals in their own right, these municipal plans speak to the fact that it is often easier to address the direct health effects of walkable streets, though, as opposed to the indirect effects of behavior intervention.

Of independent groups concerned with walkability guidelines, perhaps the most prominent are the LEED Neighborhood Development (LEED-ND) standards (U.S. Green Building Council, 2009), which assigns points for development projects in the same manner as their architectural guidelines. LEED-ND commissioned a lengthy report on the relationship between built environment and health, primarily looking at the indirect effects of the physical environment on health such as physical activity, mental health and social capital (Ewing, Kreutzer, Frank and Company, and Design Community and Environment, 2006). In the translation to guidelines, Walkable Streets is both a prerequisite and potential point area under Neighborhood Pattern and Design. For the prerequisite, the guidelines mostly address building entry to street relationship and sidewalk width. To gain points past the requisite, there are further details regarding building entry articulation, and one guideline regarding traffic speed. Landscape is not qualitatively discussed beyond providing trees on streets. Other elements of walkability are addressed in other sections, such as the Smart Location and Linkage chapter, but due to the structure of the LEED guidelines, any combination of these can gain points, meaning walkable streets are still largely considered a collection of discrete features rather than an integrated and prioritized system. The point system allows designers and developers to be selective about what they address in their designs, but it also deprioritizes formal and holistic aspects of neighborhood design. For instance, a “Tree-lined Street” (p. 72) and “Community Outreach and Involvement” (p. 75) are equivalent points.

The most glaring issue with LEED-ND is that it equates the process of building of a neighborhood to a stand-alone building. There is an implicit assumption that developments seeking this certification are brand new, as that is the only way several of the points can be earned. The way they are written makes it difficult to adjust for locality and context (Sharifi and Murayama, 2013). It is difficult to achieve such measures in an existing or even new development like supplying “Neighborhood Schools” within walking distance (p. 76) or enough Food Production to “improve nutrition” (p. 73) without the involvement of larger governmental bodies and long-range planning. Alleys and reconstructed existing sidewalks are excluded from sidewalk frontage calculations (p. 41). Much as LEED for buildings has been co-opted for short-term gains and developer tax credits (Frank, 2013). Its possible influence on future development is worthy of examination, though, particularly since the U.S. Department of Housing and Urban Development plans to apply its standards to decide on grant amounts (Campoli, 2012).

A more recent and prominent addition to the literature are the *Active Design Guidelines,* a joint publication by the New York City Departments of Design and Construction, Health and Mental Hygiene, Transportation and City Planning. The guide is meant as a supplement to the DOT's *Street Design Manual* and is geared explicitly toward "evidence-based practices for physical activity" (New York (N.Y.), New York (N.Y.)., Department of Design and Construction., New York (N.Y.)., Department of Health and Mental Hygiene., New York (N.Y.)., Department of Transportation., New York (N.Y.)., Department of City Planning., New York (N.Y.).,Office of the Mayor., 2010). Its creation included the Departments of Aging, People with Disabilities and Housing Preservation and Development, and was then tested among architects and planners to see feasibility of design guideline translation (Lee, 2012). Unlike LEED, each guideline begins with a larger objective (such as to provide recreation spaces for children) which is directly linked to evidence from empirical research, then multiple strategies on how to achieve them. Most crucially, the document's use in New York is not intended as a standalone product, and is more comprehensive in terms of scale, which ranges from urban design to building. After its publication, its authors instituted a continuing education program to raise awareness in the community and other city departments. The specificity of the guidelines to the City of New York allows the guidelines to link directly to the agency in charge of permitting, such as the Parks and Housing departments. Numerous visual examples are provided as case studies. However, it is also worth noting that the Center for Active Design, the newly formed city entity responsible for continuing outreach and coordination with the guidelines, is now under the administration of only architects and planners, with no public health researchers on board (Karen Lee, personal communication to author, September 11, 2014). This may point to a belief that the research used in the original writing is static, which is certainly untrue as shown by the overall arc of history concerning public health and the environment.

The *Active Design Guidelines* are in part successful because of their specificity of policy context. The paradox of LEED-ND is that it is both highly specific yet placeless. Where they both fall short is in supplying a framework for evaluating existing physical context for decision making, such as a toolbox or linking to an audit that would improve on the models discussed in the previous section. They are very much linked to present public health research (explicitly so, in the case of the New York City document) on walkability in the sense that they primarily focus on discrete, micro-scale elements, and think of neighborhoods as stand-alone units. There is also the issue of how the guidelines will be used to address issues. LEED-ND appears clearly designed for private development. In a municipal context, though, even guidelines with ostensibly the same goal can conflict with each other. While perceived safety from crime is a crucial piece of psychological motivation to walk, the Crime Prevention through Environmental Design (CPTED)-influenced strategies many cities adopted in the 1970s contradict most accepted healthy design guidelines by denying access rather than facilitating them (Lockton, 2011). On a basic functional level, any walkability guidelines would have to be integrated with roadway design policy, which still focuses on unimpeded movement of traffic instead of a holistically supportive environment. In fact, the Transportation Research Board's Highway Capacity manual (HCM) and American Association of State Highway and Transportation Officials (AASHTO) Green Book contradicts most current walkability research by focusing solely on vehicular function (Lo, 2009; MacDonald, Sanders, and Supawanich, 2008).

Last, many active design guidelines still struggle with how to incorporate landscape. This is evident in the pictures shown below (See Figure 16), which are two complete street buildouts in Sacramento, both built to specification from the guidelines. Both streets are "tree-lined," and in fact both plantings here are the same age, but lack of maintenance has severely stunted the tree growth on one street. These demonstrate the uncritical use of green which has characterized most movements surrounding built environment and health. Without maintenance or further specification about appropriate trees depending on microclimate, etc., the desired effect of shading and mediating climate cannot be reached. These pictures also demonstrate how even the most specific of guidelines can fall short.

Conclusion

The end goal of built environment and health research is ostensibly to better environments for goals of well-being. There are different approaches to this, and it is important not to prioritize one over the other. It is much simpler (albeit not simple) to address the direct effects of walkability by ensuring pedestrian safety and decreasing auto use and emissions. The indirect effects of walkability, i.e., changing behavior to combat sedentary lifestyles and obesity-related disease, is a far more complicated issue and cannot be achieved solely through form. This won't be achieved by the direct translation of most of current neighborhood audits and research, which is designed to look at neighborhoods or even individual streets as discrete units. Design guidelines, which take their cues from this literature, are primarily geared toward new standalone developments and ultimately amount to a kit of parts developers can pick and choose individual components from and won't necessarily add up to a walkable environment. It is not necessarily an issue of guidelines needing to be more rigid. California's 2030 General Plan, which is significantly more prescriptive and image-heavy than past iterations, is facing criticism that it will enforce a "theme park" look for its cities (Berg, 2010). The New Urbanists similarly faced this criticism with their form-based guidelines, and proponents of walkability can arguably face the same criticism. Jeff Speck (2012) extols the "walkable city" and mourns the loss of small town downtowns (as do most New Urbanists). Julie Campoli's book *Made for Walking* (2012) gives an excellent overview of walkable neighborhoods in many different North American contexts from Florida to British Columbia, but all examples are best described as "mid-rise" urbanism—buildings of three to eight stories and roads of two to four lanes. There are many other types of urban fabrics in the United States, most that cannot be neatly categorized by density, and they far outnumber the examples these advocates present. The purview of walkability must widen to different contexts if we are to repair, and not replace neighborhoods in need. What is sorely needed is a form of evaluation that takes into account both physical and social, a framework for intervening in different contexts and prototypes instead of aspirational images. Before we get to that point, a more expansive understanding of design must be applied back to the research.

Figure 16: Two Complete Street Buildouts in Sacramento, built to the same design guidelines and at the same time (Photos courtesy Judy Robinson)

CHAPTER SEVEN: TOWARD A WALKABILITY FRAMEWORK

Environmental Design Perspectives on the Public Realm

Introduction

The previous six chapters demonstrate that there is near universal consensus that walkability represents the convergence of external, physical factors and internal, psychological motivations. However, the research on the subject is spread across several disciplines. Frameworks hypothesizing how the environment manifests itself in disease outcomes lie in public health theory, primarily in the field of social epidemiology. The advances made in the field within the past decade also offer more nuanced alternatives to proving causality. There is a large body of empirical research on discrete elements of the environment in both public health and the planning/transportation fields, but they do not meaningfully integrate theories from the former field. They are also largely disconnected from the real world context of policy and development. When we ask ourselves how walkability "works," it requires a framework that unifies health pathology, measurement and policy. It must also include a crucial element that is largely missing from the discussion—theories of environmental design. I posit that theories and methods from this field not only link built environment elements to the elusive psychology of walking, which appears to be a chief struggle in the literature, but can also help guide context-appropriate interventions. Currently, the built environment is noted as a significant factor in encouraging walking, but is still largely unspecified. This chapter discusses how three crucial elements of standard measurements can be rethought from an environmental design point of view: the suburban/urban binary, density and the neighborhood unit.

As data on health becomes more available, the urge to spatialize health has become more widespread. There is a wide gamut of polls, and especially maps, that purport to find the "healthiest cities" or "healthiest states." There are number of ways these are determined. In an article on "America's Healthiest Metros," Richard Florida (Florida, 2012) ranks areas based on rates of smoking and obesity, finding that primarily metros on the West Coast are "healthiest" and those in the South and Midwest "least healthy." The Center for Disease Control national maps are understandably primarily concerned with indicators such as obesity (Centers for Disease Control and Prevention (CDC), 2014b). The Institute for Health Metrics and Evaluation (IHME) also measures indicators such as smoking, hypertension, obesity, physical activity, life expectancy and poverty at the county level (Institute for Health Metrics and Evaluation, 2014). Largely, the polls that measure health and place run counter to the current thinking in health, which encompasses access to services and quality of life, not merely "the absence of disease" (Awofeso, 2005). The measurement of built environment factors is even less discussed. By linking place to health without physical or social information, it only serves to stigmatize place and people without further exploration of context. In Gallup's Well-Being Index (2014), the states with the lowest levels of physical activity are denigrated in popular media as the "Laziest States in the U.S." without further explanation of environmental factors, although this would be difficult to claim at the aggregate level of states (Haiken, 2014a). This demonstrates that in popular thinking, active lifestyles are still mostly thought of as individual responsibility. However, increasingly more publications are including more environmental data in their rankings. The Robert Wood Johnson Foundation Healthiest County poll (Robert Wood Johnson Foundation, 2014) measured air pollution, obesity, access to exercise and parks and poverty, alongside health outcomes such as mortality, birth weight, etc. Forbes Magazine uses the American Fitness Index (AFI) from the American College of Sports Medicine, which measures health behaviors such as fitness and smoking, alongside health outcomes like obesity and environmental factors such as park spending, number of exercise facilities, and as of 2014, even WalkScore ratings (Haiken, 2014b).

Coincidentally, the origins of environmental design field theory is rooted in work dating from the 1960s and 1970s, the same time the social-ecological frameworks began to take hold in public health (Aicher, 1998; Gehl and Svarre, 2013). In part a response to destructive urban renewal, observational studies on public life and embracing a more activist stance toward equity and environment influenced the now-mainstream concepts of livability and sustainability in planning (Gehl and Svarre, 2013; Wheeler, 2002). There are a few precedents for using environmental design methodology to measure walking environments. Ewing and Handy (2009) note the problem of lining up discrete built environment elements with overall perception, and attempted to operationalize certain perceptual qualities into imageability, enclosure, human scale, transparency and complexity ratings. These qualities were primarily influenced by the work of Kevin Lynch (1960), but also the writings of notable thinkers in the field such as Gehl (1987), Allan Jacobs (1993), Cullen (1961) and Alexander et al., (1977). The experiment polled 10 expert panelists with video of different streetscapes from across the United States to break down what discrete elements appeared to add up to the larger perceptual qualities. While it is arguable that expert panelists in design would perceive streets differently than the average lay person, and that using video masks other experiential qualities of the street, the experiment is still worth noting in the context of this chapter. In the public health field there is also the increasingly popular method of photovoice, which asks respondents to take pictures of their walking environment and seeks patterns or markers in the returned surveys (Catalani and Minkler, 2010; Lockett, Willis, and Edwards, 2005; Wang, 1997). Particularly as modes of measurement explode, there is always the inherent danger that people resort to “planning by numbers,” the anti-Jacobsian bane of most contemporary planners and designers. However, what I hope to present here is a way to harness the more expansive view of environmental design to the preciseness of built environment measurement for health.

Urban Growth and Urban Type

Discussing the urban/suburban divide is central to many of the studies on walkability and physical activity. However, most studies default to measuring “suburban” neighborhoods against “urban neighborhoods” without qualitatively defining these terms. For the most part, researchers make the distinction based on density and sometimes homogeneity of land use. The aforementioned Brookings Institute report actually defines suburban as any municipality less than 100,000, without reference to wealth, demographics, location, etc., which is problematic if discussing specific strategies to combat poverty and inequity (Kriesberg, 2013).

That said, that report, as well as recent fine-grained Urban Institute mappings show the increasing segregation of poverty in neighborhoods increasingly further away from city centers (Badger, 2013), so it does behoove further research into the qualities of those environments, no matter how they are defined.

However, the false designations made by many of the studies only drive the narrative that the “suburbs are dead,” (Jaffe, 2013) without qualifying what constitutes a suburb, or much strategy beyond increasing density in neighborhoods, an extremely difficult task in existing areas. Hess, Moudon et al., (1999) define sites in their study from the starts as “urban” if they support walking travel, and “suburban” if they do not. More troubling is the term “traditionally built” neighborhoods, which are meant to evoke the more compact suburban neighborhoods of the early part of the twentieth century. Beyond being even less descriptive than urban/suburban, though, it is a culturally loaded word—especially given the elite and homogeneous history of the neighborhoods they are meant to evoke. Nevertheless, the term is uncritically accepted by many public health researchers. Khattak and Rodriguez’s (2005) definition of “neo-traditional” is mostly defined by the developers of the subdivision they are studying, after which they cite detailed characteristics its of density, street connections, etc. A RWJF research brief defines a traditionally designed neighborhood as having “safe sidewalks and intersections, and a street network that provides direct access to nearby shops and other destinations,” which leaves much room for interpretation. Of course, these broad terms are used to assign typologies of place in an effort to make results more generalizable, but I argue that given the history of health and urban places, it instead may reinforce biases toward certain urban patterns and by default, the people that live within them. It is also problematic when builders who seek to build a walkable neighborhood do so on the basis of just a few physical factors.

Nor can we assume that all cities display a gradient from center to edge, or that environments that show physical characteristics of walkable neighborhoods are not in need of other changes to their environment to make them more friendly to physical activity. Spatial studies have shown that strict patterns cannot be found in so-called “walkable” neighborhoods (Cutts et al., 2009). The cleave between inner cities and outer suburbs, a vast simplification of the Burgess model of the Chicago school, was largely adopted by social sciences (Harris and Lewis, 1998), so it is unsurprising that it is also widely used in public health study. However, it does not hold true for a number of North American cities. Many cities are now polynuclear, with several centers of business, retail and manufacturing extending from traditional city centers and gradients of development between (Harris and Lewis, 1998; Harris and Lewis, 2001). Reyner Banham (1959) described the post-modern city as a “scrambled egg,” as opposed to the traditional “hard-boiled” (inner city “yolk” clearly delineated by suburban “white” zone) egg structure of cities. Most crucially, the “suburbs” vs. “city” binary tends to be false politically. Many governments, including the case study of Sacramento proffered here, have moved toward regional planning strategies which is necessary for environmental and equity goals (Wheeler, 2002). It should be noted that promoting walkable development is one way of reaching those goals. However, increasingly planning decisions are made for all, and the binary of city and suburbs, if it even ever existed, should be dissolved in favor of more nuanced description.

Christopher Leinberger (2010) writes:

> Though, stepping back, Joel [Kotkin] and I agree on the main issue, the redevelopment of the central city and the transformation of the suburbs into more human scaled environments, the reason we may disagree on the magnitude of what I think is a structural shift in how we build is the continued use of obsolete terms and data sets.
>
> This happens all the time in social science research. It is best reflected in the story of a drunk who staggers out of a house late at night, dropping his keys near the front steps. He walks the 20 feet to the curb by the street light and starts looking for his keys there. A friend asks him why he is looking there since he dropped them at the front steps. The drunk replies he is looking for the keys by the curb because that is where the light is. Social scientists look for answers where the data sets are, not always where the 'keys' are.
>
> Our metropolitan data sets are compiled according to 'central city' and 'suburbs' classifications and have been for decades, providing longitudinal data particularly prized by researchers. Unfortunately, the concept of dividing the world into city versus suburbs is no longer so relevant. I have been dividing metropolitan places as either 'drivable sub-urban,' meaning low density, modular and dependent upon the car/truck for most trips; or 'walkable urban,' meaning at least five times more dense and integrated and dependent upon many transportation modes (transit, biking, and, yes, cars and trucks).

These large scale generalizations falsely characterize a wide swath of American development. I suggest that instead, it is necessary to dissolve false urban/suburban boundaries. Many prominent urban theorists favor a "landscape analysis" of morphology, focusing on graphically analyzing patterns of streets, buildings, lot sizes and shapes, and landscape for more exacting description. Bosselmann (2008) looks at urban growth over time and in context of natural features, instead of arbitrary designations of outer suburbs and inner cities. Southworth (2005) discusses the gradients of street patterns beyond "grid" and "sprawl." Last, Wheeler (2008) assigns landscape typologies based on urban patterns formed over time. These analyses are often done as simple figure-ground drawings but still provide a more robust description of the environment at hand and the particulars of place. Walkability design guidelines are largely written for new development, inadvertently or not. However, sustainable planning favors infill over expanding urban footprints, so an analytic approach that is more exacting about urban fabric can help guide small-scale intervention.

Density

History has demonstrated that density is one of the most fraught concepts in the discussion on built environment and health. Whereas in the past lower population and building densities were thought to alleviate stagnant airs and the chance of person to person contagion, current thinking favors higher density for the health benefits of more compact and sustainable development. When discussing density in relationship to walking, it has both a rational, direct and more abstract, psychological relationship. In walkability study, density is often measured as a proxy for proximity to and number of services, as well as a marker of social viability. Mostly treated as a neutral measure, the perceptual qualities of density are less discussed (Churchman, 1999). Many environmental designers have discussed both how this differs from quantitatively derived density and what other elements of the environment mediate the effect. Hester (Hester, 2006) notes that the measure of dwelling unit density per net acre of available residential land often used is quite different from "sensed" density, the accumulated effect of not just residential units, but traffic, proportions of spaces and general visual heterogeneity. Julie Campoli and Alex Maclean, in the book *Visualizing Density* (2007), affirm this by showing several neighborhoods at the same measured density, but contextualized with aerial photos, figure-ground patterns and birds-eye photos to display the difference in their visual qualities. Bosselmann (2008) discusses the use of transparency in buildings that can lower the visual effects of density.

Density as a perceptual quality for walking is also more difficult to parse as most agree there is a tipping point between density that encourages walking (by providing "safety in numbers" or the Jacobsian eyes on the street) and the feeling of crowding. It is a relative measure that depends not only on the interplay of physical variables but social and cultural background, as many Europeans will often feel more comfortable with higher levels of population density than Americans (Bosselmann, 2011; Gehl and Sverre, 2012). These cultural feelings regarding density often translate into development priorities, though. Aicher (1998), presumably speaking about Americans, says "for some people, territorial (or land) ownership may also meet an important psychological need for financial stability and security" (p. 34). Although he notes that low-density development is harmful to the environment on a per-capita basis, he also relates density to crime in inner cities and feelings of lack of privacy, a holdover of 1970s and 1980s concerns (per the *Effect of the Man-Made Environment on Health and Behavior*). While higher densities may be favored by planners and researchers now, densifying for health must also take into account particular concerns considering the loss of personal space, such as being cognizant of both the distribution and design of green space, how units meet the street and higher traffic volumes.

We must also think of density in terms other than purely in residential units. In the 1960s, when the American Public Health Association's *Planning the Neighborhood* tackled the dual goals of neighborhood planning and health, provisions were made almost solely for single-family residences with provisions for personal outdoor space, climate control (citing optimal temperatures), extremely detailed density and lot size, and floor/area equations. There is an entire chapter devoted to tables of ideal neighborhood density, based on different mixes of dwelling types. This quantification of ideal spatial units, applied across all regions is not extremely different than how Le Corbusier built his Radiant City; it was simply applied horizontally instead of vertically. However, there are few provisions for necessary services, landscape or streets as a measure of that density, all which make a transformative difference in the experience of space.

I propose that rethinking density from an urban landscape point of view must strive to measure people in conjunction with its urban fabric, as this is the perceptive "density" walkability studies are often striving for. This involves taking into account housing types and units or lot sizes combined with population density. Proximity to and distribution of services are usually otherwise accounted for in separate measures such as counting resources within walkable areas. When housing types are not available, gross residential density plus density of nominal services that have been proven to be conducive to walking (i.e., grocery stores, parks and schools) can also serve as proxy measure of "walkable density."

Neighborhood Unit and Neighborhood Structure

As discussed in Chapter Four, defining the spatial limits of the neighborhood is one of the largest unknowns in walkability study. This is partly due to differing approaches of planning and public health. The concept of the neighborhood unit as essential to the delivery of necessary public and commercial services is an idea long rooted in planning history, from Ebenezer Howard's Garden City (1898), to Robert Park (1925), who described neighborhoods as the "simplest and most elementary form of association" for understanding cities. Most associate the Neighborhood Unit with Clarence Perry (Perry et al., 1929), who defined it as the catchment area of the local elementary school. This essentially limits the unit to a certain population density, as distance defined the reach of services. Schools were always reachable in half a mile, with local shops at corners and placed within quarter mile and a central point. Perry's neighborhood unit was meant to be walkable, explicitly fighting the "automobile menace." However, the popularity of cars made this an ultimately futile exercise, and over time the importance of the neighborhood for accessibility became increasingly downplayed as technology transformed both spatial and social distances (Talen, 2002). Then there is the matter of the half-mile radius to define "neighborhood," the standard for most walkability research, which originated in transportation planning and ridership prediction. Cervero and Guerra (2013) found that there was negligible difference between using a quarter mile or half mile radius to predict use of public transit. They also found that there was little difference between using a radial or network measure and advise researchers to simply use the most efficient measure. However, it should be noted that their study was only examining people walking to work or transit to get to work. Other studies have found that everyday destinations such as retail, parks and public space have different degrees of gravity depending on quality and size (Cutts et al., 2009; Giles-Corti et al., 2005; Kaczynski, Potwarka, and Saelens, 2008).

The neighborhood unit is a much newer concept in public health. It often refers to any influence on health outside the body in conjunction with population clusters of disease determinants and outcomes. It is still somewhat ill-defined. The terms "neighborhood," "area" and "environment" are often used interchangeably in the literature. It is even more recent that “neighborhood effects” have included physical aspects of the neighborhood. Particularly in the context of social epidemiology, neighborhood was defined more through social contact and networks, or the “collective” health effects of a population in proximity (Sampson et al., 2002). A crucial component of sociological neighborhood theory often overlooked by walkability studies, though, is their place in larger urban structures. Although many studies treat neighborhoods as discrete and standalone units, this neglects the interdependence of neighborhoods on each other. Warren (1978) defines neighborhood typologies as: 1) extent of individual identification within the local area, 2) degree of social exchange between neighbors and 3) extent to which the area is linked to larger community. Any study of disease clusters or health relevant behavior, and as argued here, physical characteristics of said neighborhood, can only fully be understood by examining its ecological relationship to other neighborhoods (Sampson et al., 2002).

In summary, the planning field views the neighborhood as an area of service provisions. The public health field sees it as an area of influence on health outcomes, or at its most expansive, a geographic area that provides social structure, risks and opportunities for the population within (Mujahid, Diez Roux, Morenoff and Raghunathan, 2007). Although primarily thought of as “containers” of populations and resources, they can also be generated based on their coverage or strength of gravity of their respective centers (Talen, 2002). Others define it simply as social relationships in a proximal area (Galster, 2001). It also may not necessarily be the immediate physical environment, and is highly variable depending on specific effect studied (i.e., one may look at school districts for children’s behavior patterns). It is difficult to reconcile these divergent field-specific views for future study on walking, to say nothing of linking the physical and psychological aspects. Accordingly, it is extremely important to define boundaries in relation to the outcome, although many studies neglect this in favor of easily obtained spatial data census tracts or municipally defined neighborhoods as a proxy. Defining the neighborhood as a building block and as a meaningful pathway to active lifestyles and health asks not only how we can meet basic social and physical needs through design, but also to what extent residents are willing or able to satisfy those needs in their own neighborhoods (Talen and Shah, 2007). Talen (2011) suggests a “geospatial” approach to neighborhoods, generating neighborhoods by finding “centers” (such as schools, parks or public spaces) and edges (such as highways and railways) by a combination of digital analysis, community discussion and visual surveying. This method not only finds spatial limits of the neighborhood itself, but gives context to possible design interventions, for instance dissolving edges to instead act as “filters” where necessary. This bridges personal and physical interpretations of the unit. Says Talen (2011):

> Despite the social and cultural importance of the notion of ‘neighbourhood’, people have trouble defining what they are, given the wide spatial extent of human relationships. The point is often made that the definition of neighbourhood is in the eye of the beholder, since there are so many varied interpretations of what ‘neighbourhood’ means. However, for the urban designer, the geospatial parameters of the neighbourhood are essential because what happens within local contexts—shopping, social contact, community maintenance—is still

> meaningful. Establishing an overall neighbourhood structure is useful because it can help determine priority areas, for example, strengthening a neighbourhood's centre, or the mix and proximity of uses and facilities it contains, are concerns that gain relevancy through the articulation of a neighbourhood spatial structure. (p. 132)

I suggest that the landscape approach to analyzing walkability bridges both the planning and public health definitions of neighborhoods, while targeting built environment nuances that both overlook. It should also be noted that neighborhoods, as experienced socially and physically, are almost never the same size, either by population or in area, although this is the approach assumed by using census tracts and grid partitioning in walkability study. It makes little sense to define neighborhoods solely as a social unit in this context because there are real physical limits to walking. But a lesson we can take from public health is to recognize neighborhoods' relationships to each other, particularly when examining inequities across the city. This should also be done in conjunction with finding health-relevant built environment changes across the metropolitan gradient, which has yet to be effectively performed in walking study. From the planning side, while the half-mile radius is an effective measure, particularly when measured on the network, it can be made much more accurate by taking into account elements that both stop and slow walking. This can only be done by re-conceiving personal walkable areas as a function of time instead of distance. By doing so, this also allows us to see how neighborhood definitions differ for those with different abilities. A 10-minute walk for an elderly person would have different coverage than a 10-minute walk for a physically fit adult, or a child. The method offered here is by no means absolute, but allows for more flexible definitions of the "walkable" neighborhood.

Indeed, in the context of this specific study, which looks solely at built environment rather than population changes across a city, "neighborhood" may not be the correct term, particularly given the fraught associations with planning history and sociological study. They might be more accurately referred to as areas of morphological coherence, or typological districts. However, in public health and built environment study, it is still the commonly used term to indicate a defined area of study, even this is almost the only agreement across the literature. For this reason and in the interest of bridging the language of environmental design and public health, I continue to use the term "neighborhood."

Framework for Walkability

An editorial in the Journal of the American Medical Association's report on America's State of Health extols the need for a "unified theory," similar to particle physics, to measure risk factors for health outcomes (Fineberg, 2013). The framework for measuring the built environment of health here obviously does not purport to be that, but recognizes a need to better articulate the interactions between built environment components for health outcomes, specifically the indirect effects of encouraging active lifestyles. Considering the multiple sectors involved in built environment and health, it is also crucial that clear lines are drawn between research and action. This dissertation attempts to further specify the interactions between these components of built environment, which are often collapsed to one element or even sub-elements in public health frameworks. While this framework (see Figure 17) focuses on design, it also recognizes that in terms of health and behavior, design should be integrated with more expansive public health theory, integrate policy and people, and above all, is sensitive to context so as to avoid the issues of past health movements.

Research already done on the built environment and health has built a crucial foundation for future development. That research has greatly advanced the legitimacy of this kind of study in the field and is already being embraced by new trends in pedestrian-friendly and health-oriented design guidelines. What is missing, though, is a system of spatial evaluation and contextual understanding to determine where and how interventions are made. The traditional way of studying walkability uses a non-built environment based definition of neighborhoods (such as census tracts or otherwise defined). It then examines them as standalone units, seeking to control for every element except the particular aspect of study. However, there is a need to examine walkability as it changes across an entire city. Mapping is the most efficient way to evaluate this, but at the moment, that work is being done primarily in the context of real estate exploration, i.e., WalkScore. This also allows us to measure landscape infrastructure, in this case, streets and parks, as a network instead of discrete segments and polygons. The below framework takes a "geospatial" approach, per Talen (2011), which is not meant to be an anti-Jacobsian quantitative planning by numbers, but rather a way to broaden and inform the range of approaches for urban design.

However, in doing so, we should also recognize what the limits of the built environment are. Alfonzo's hierarchy of walking needs (2005), which re-appropriates Maslow's hierarchy of need, proposes that walking will most likely occur when the environment meets an individual's requirements of feasibility, accessibility, safety, comfort and pleasurability—in that order. The bottom tier of feasibility, which is based on an individual's ability level, and the top tier of pleasurability, which is rooted in personal lifestyles and cultural background, would be extremely difficult to determine baseline measures for. However, urban design can reasonably meet the middle tiers of accessibility, safety and comfort for most people. These are ultimately met by combinations of resources, street networks and the urban landscape of the built environment. The distribution and quality of these can be evaluated at the scale of the city and will largely be dictated by city governments, but their individual components and how they coalesce at the ground level are best evaluated at the neighborhood or ground-level scale. Finally, we should seek to make a neighborhood more "walkable" by looking for opportunities such as vacant lots, alleys and passthroughs at the block or parcel level to strengthen walking networks.

We also need to take into account social influence, a concept from public health that is rarely discussed in design. The power of community is particularly important here. A safe and supportive environment for walking brings more people into the public realm interacting with one another. This not only encourages healthy activity by offering "safety in numbers" and "eyes on the street," but by modeling healthy behavior and building social cohesion. The last item is the key to the feedback loop of everyday life and neighborhood design, as stronger local communities will lead people to advocate for themselves to change their own environments, particularly important in disadvantaged communities (Kasirye, 2014). It should also be noted here that physical interventions are part of a social ecology in and of itself, requiring community support, promoting health programs such as Park Prescriptions and ultimately changing policy. As noted by the leaders of Design 4 Active Sacramento, the best way to influence residents and decision makers is to get them to experience walkable environments in order for them to see their importance. Small changes can have innumerable ripple effects. Built environment interventions are not the end goal, but the beginning of continued evolutions of the urban landscape, hopefully ever for the better.

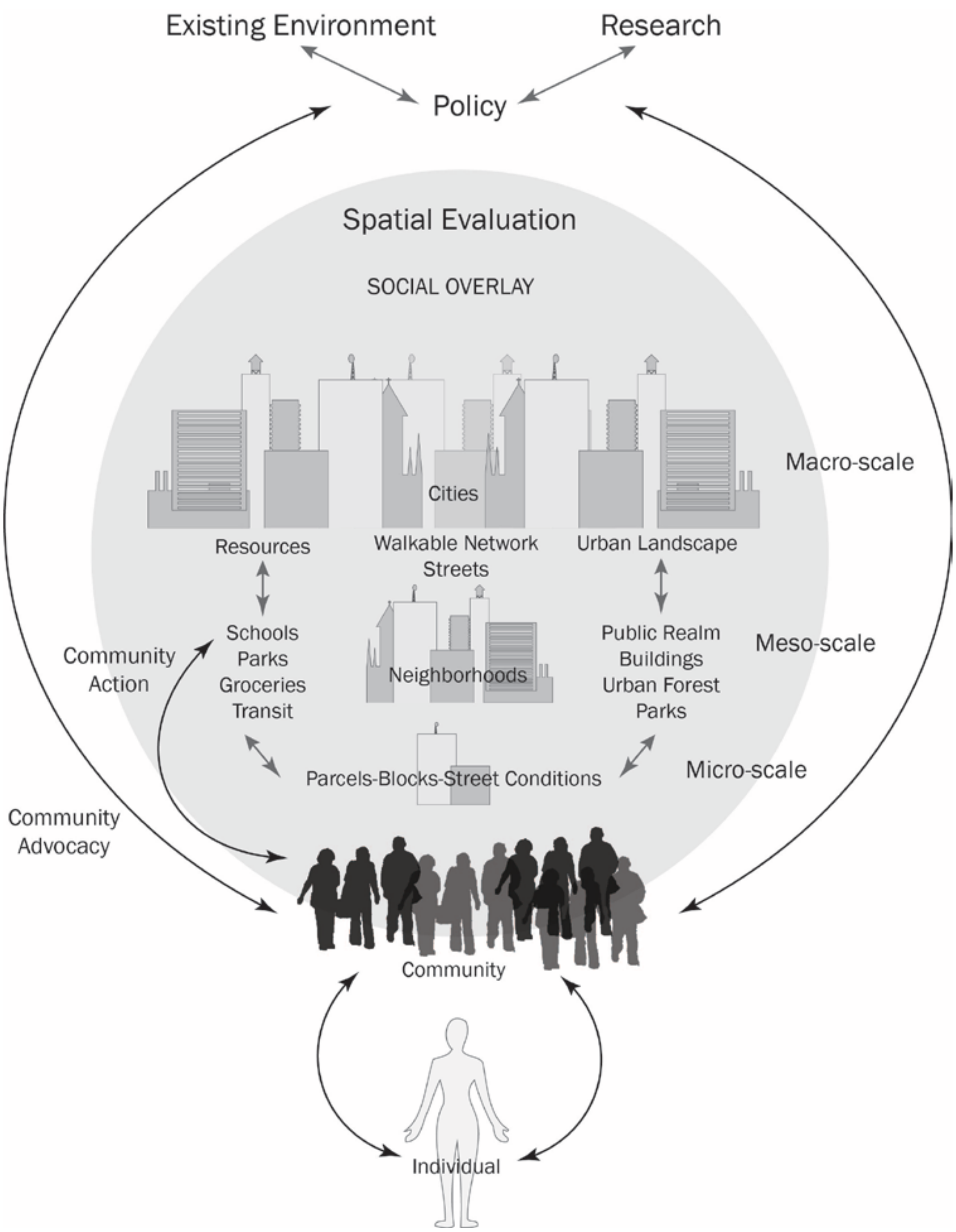

Figure 17: Proposed Framework for Walkability

Conclusion

Changing any health behaviors requires changes in internal motivation and external social structure (Sallis et al., 2008). What distinguishes walking apart from say, smoking or nutrition, is that it is a health behavior that is particularly promoted or restricted by the built environment. The built environment not only provides a physical infrastructure for walking, but the design of the built environment must coalesce so it is perceived as a supportive environment for pedestrian activity. Some dismiss the psychological aspects of walking as impossible to measure on anything but an individual scale. Alternatively, they make large generalizations about the "aesthetics" of the environment and what the general public finds appealing. Environmental design offers a mode to quantify and qualify design, and more important, the livability of neighborhoods. We should not only deign to measure the aspects of cities that are easily quantified, though, but strive to better understand urban systems so we can understand what exactly we are measuring.

> Cities are not a form of art; the visual, auditory, and kinetic experience of cities very rarely adds up to a *Gesamtkunstwerk*, the German word for artistic expression through multiple art forms. But cities are dynamic spatial networks with interrelated geometries, some messy and unresolved, others clear and intractable. Not only is it possible to measure the physical dimensions of such geometries, it is also possible to measure their implication on social, cultural and political, psychological, economic, and environmental conditions. Even though the scales for many quality-of-life parameters in cities are missing, it is possible to measure them in relative terms. The vitality of urban spaces can be measured by examining three qualities: mixture of activities, density, and public life. Attributes of livability include personal safety, well-managed traffic, ease of walking, centrality, and the presence of nature in cities; sense of place and sense of time are dimensions of the sense of belonging. These much used but ephemeral concepts, when systematically measured, can be validated or refuted. Without measurement they remain biases. (Bosselmann, 2008, p. 141)

Walkability research that reduces design to "aesthetics" is such a bias. As demonstrated here, while it may be outside the norm of traditional multilevel public health modeling, there are methods of capturing the environment without reducing it to a suite of discrete individual elements. Moreover, these environments are influenced by policy above and people within. With this in mind, the subsequent chapter offers one way of looking at the risks and opportunities for wellness in the urban landscape.

CHAPTER EIGHT: NEW TOPOGRAPHIES

An Alternative Spatial Model for Visualizing Risk and Wellness in the Urban Landscape

Introduction

In the eras of infectious disease, spatial analysis could help determine etiologic relationships in the environment. John Snow's cholera maps logged each incidence of disease, which eventually revealed a polluted water pump at the center of the outbreak. Valentine Seaman's 1798 yellow fever outbreak at the Roosevelt Street basin in New York City logged both mortality from the disease and atmospheric conditions at the dock. French and Shakespeare traced an 1885 typhoid breakout in Philadelphia to a supposedly pure mountain stream water source (Koch, 2005). Finding the roots of chronic disease is far more complicated, particularly when trying to uncover the indirect effects of the environment. However, increasing empirical evidence appears to indicate that there is some relation between aspects of neighborhood infrastructure, healthful habits and chronic disease. Although causality remains a fraught subject of discussion, "the preponderance of evidence" of environmental determinants' relationship to health per Diez Roux (2004) has been significant enough to start to tip many in the fields of public health, planning and design towards acceptance of these links.

This spatial analysis also attempts to address some apparent gaps in current research on built environment and walkability. Instead of adding to the already expansive body of literature on walkability that attempts to determine what discrete elements of the environment have the strongest correlation to walking or health outcomes, I chose to draw the topography of wellness for one American city, showing risk for ill health or opportunity for well-being in one's own neighborhood. Whether or not a neighborhood is walkable is only one factor in the "topography" of wellness, but even this singular factor is the result of many interactions in the landscape. As discovered in Chapter Four, empirical research has made great strides in establishing connections on walking, the built environment and health outcomes. Many of the ways public health models the environment can be done more efficiently on a metropolitan scale, which better reveals inequities across the city. Additionally, most walkability assessments default to measuring certain qualities at the macro scale (density, land use) and others at the micro scale (sidewalks, tree presence, intersections). To stay at the upper end of the scale neglects aspects of the pedestrian experience, to stay at the lower end is too small an area to make a significant impact when looking to intervene. Both overlook the meso-scale of the neighborhoods. However, a good portion of publicly available GIS information, while it will never effectively capture the psychological aspects of walking, can be grouped, processed and visualized to better capture the urban landscape as an urban system rather than a collection of discrete features.

Second, I posit that a significant barrier to understanding and acting on the relationship of the built environment to health is that health data is often disaggregated to boundaries that are administrative, i.e., census tracts, zip codes or municipally defined neighborhoods. While these are spatial units in the fact that they have area and are geographic units of a city, they have little association to morphological characteristics, particularly those with associations to walking. However, their use is in part due to how the nature of information has changed. John Snow and other early investigators of disease laboriously cataloged each individual instance of disease and drew every property line. Today, spatial and demographic information is easier to access and use at the individual level. On the other hand, health information, while more expansive, cannot be pinpointed to exact locations due to the nature of how is collected (such as through hospital discharge records) and associated privacy laws. As a result, this information is not necessarily delineated to the boundaries to any of several definitions of "neighborhood," social or physical. This method determines first how built environment features, determined to be health relevant by the reviewed literature, change across the metropolitan gradient and uses these new boundaries to correlate with health outcomes. This analysis subdivides the city in a manner that is intentional to built environment changes to encourage more nuanced and precise interventions without resorting to sweeping city scale change that can be insensitive to local context and take decades to enact, but can still be more impactful than remaking a few streets.

Third, much of the literature siloes built environment factors into aesthetics, operability or resources, or alternatively, attempts to weigh every aspect of the built environment evenly. Additionally, landscape factors are too often downplayed as "aesthetic" when it can actually be a powerful determinant in orientation and psychological motivation. Lynch (1960) demonstrated how streets, buildings and other features of the urban landscape cohere into nodes, edges, districts, paths and landmarks, which in turn help residents navigate their way through cities. Ewing and Handy (2009) attempted to operationalize Lynch's "imageability" into urban design components. As previously discussed, landscape can also ease fatigue from daily stresses (Kuo and Sullivan, 2001; Reynolds, 2013). On a purely practical level, landscape can also help to mitigate microclimate to make walking environments more comfortable. To relegate landscape to "aesthetic" or a purely subjective factor vastly underestimates its role in walking behavior and health outcomes.

This model groups various health-relevant factors under resources, landscape and streets, as these represent the major components of the built environment experience. Unlike an evaluation that looks at every element as a discrete component, this method shows where areas may be strong in one of these sectors, but in need of improvement in another.

Finally, all these factors are calculated by evaluating individual "neighborhoods" (walkable areas) by time instead of distance. A 10-minute walk for a healthy adult is generated around every possible residence in the city. The reasoning for doing it in this manner is to maintain flexibility for different individual's experiences of the city. While all the evaluations that follow calculate walkability for a different adult, the model allows one to first adjust coverage based on age and ability. For example, an elderly person or child would presumably cover a smaller area in a 10 minute walk. Additionally, while here all factors are weighted approximately the same, conceivably each built environment factor could be weighted differently based on research on specific age groups. For instance, street crossings add significantly more time to trips for both children and elderly. Higher residential densities are also negatively associated with walking in both groups, as well as affecting them more acutely (Borst et al., 2009; Su et al., 2013). The presence of senior centers would also obviously encouraging walking in the elderly and could be weighted more heavily as a destination, as would schools for children. The topography of wellness shifts and changes depending on the individual, adding up to different pictures of the city.

Spatial Method

The goal of the spatial method done within the limitations of this dissertation was primarily to rethink common geospatial data in a way that is closer to the perceptive experience of the built environment, but on a metropolitan scale, to sense changes in built environment across the city as relevant to health outcomes. It is not meant to be definitive or to find which elements most closely correlate to health. Rather, it is to see if interpreting the urban landscape from an environmental design standpoint can provide a better framework for health and activity studies.

The method shown here has two main influences. The first is the ecological view of public health, which recognizes multiple factors and scales of influence on health outcomes. This is only examining the built environment side of health outcomes and does not look into social influences, but recognizes that they have significant impacts on health behavior as well. That said, I propose a less discussed relationship—that there are multiple, ecological scales of influence within the built environment itself. Macro scale factors such as density and land use are normally measured coarsely by methods such as population density or entropy scores, which may not accurately reflect the perceptual qualities of the built environment. For these two qualities in particular, studies have shown that measuring residential dwelling density (Cutts, Darby et al., 2009) or business type (Brown, Yamada, et al., 2009) yields more accurate results. Additionally, changes to these qualities must come through policy and can take decades to take shape on the ground. On the other end, micro scale improvements such as benches or sidewalk maintenance are crucial to the on-the-ground experience, but take a massive effort to make record of beyond a few streets and can be highly subjective. While a truly comprehensive walking audit would categorize and analyze all scales, I seek to find methods of studying the meso scale of the built environment, which although rarely included in walkability study (Moudon and Lee, 2003) has relevance to both the on-the-ground experience and can be measured somewhat efficiently across an entire metropolitan area. The evaluation seeks to transform and combine commonly found spatial data to more closely approximate street-level experience, as well as find opportunities for infill and other small-scale interventions instead of the sweeping change or widespread eliminations of the past.

Another ecological framework borrowed from public health is thinking how individual personal realms coalesce into larger neighborhood patterns. That is made literal in this method. The walkable neighborhood has been calculated for every residential point in the city and evaluated. By layering with all adjacent properties, I hypothesize that certain patterns will start to appear. This also allows one to break through arbitrary designations of neighborhood boundaries or "urban" and "suburban" typologies, and see individual realms on their own merits.

This spatial method is obviously influenced by suitability analysis, based on the work of Ian McHarg (1969). The transparent overlay technique used by McHarg was a manual precursor to GIS. Again, it is crucial to note it is not meant to be a scientific analysis, but a decision making tool. Where the work here differs from the McHargian method, though, is that instead of finding the "most appropriate" or "highest or best use" deterministic use for land, I use the method to visualize gradients of built environment change across a city and find intersections between them.

The data used, described in more detail in the subsequent pages, was selected based on how strongly they correlated with health outcomes based on the literature and its potential to be processed in a way to capture the meso scale environment. Individual data files were categorized into resources, urban landscape and streets, a variation of Moudon and Lee's (2003) summarization of walkability as origin/destinations, area and streets. They were visualized separately and aggregated, again, to avoid assumptions about the association of density, street pattern, park access, etc. with urban core and outlying areas, but also to better express the idea that these groupings represent different, but complementary components of the built environment.

Data Collection

A critique levelled earlier in this dissertation was that many audit and survey tools used in walkability analyses are usually asking to report back on the presence of built environment qualities that are easily objectively evaluated with geospatial information systems. Many of the pedestrian audits discussed in Chapters Four and Six are highly academic in nature, though, and much of this data is held by local and federal governments. While cross-sector collaboration is often discussed as the key to understanding language and issues across fields, the importance of sharing data is rarely mentioned. Data collection is a difficult, albeit pragmatic, concern as physical, social and health information is normally spread across several agencies or research groups. Quality and availability are highly variable, as well as technical issues such as proper alignment and scale for analysis.

This proved true for this dissertation project as well. Data was collected from nine different sources, ranging from the City of Sacramento GIS Database, Sacramento Area Council of Governments (SACOG), and UCLA's Health Policy Center. Each file required further processing, transformation and cleaning, discussed briefly below.

General

The following data sources were used to build the urban "skeleton" and units of the analysis and are not health-relevant. They were used to determine the origin points of each analysis, as well as both walking networks and barriers.

Parcels. The primary parcel shapefile was downloaded from the Sacramento County GIS Data Library (Sacramento County, 2014). Land use descriptions giving zoning codes, building information, population density by parcel (based on building information), was downloaded from the same source and joined to the table.

Residential Parcels. Residential parcels were extracted from the above shapefile by selecting all parcels with an “R” prefix designation for land use.

City Boundary. The countywide parcel shapefile was clipped using a city boundary shapefile downloaded from the City of Sacramento Geographic Information Systems Data page (City of Sacramento, 2014).

Aerial Photos. The “world imagery” basemap integral to the ArcGIS and ArcMap software was utilized for the following maps. Imagery was collected from Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo and the GIS User Community.

Streets. A street file for Sacramento County with information on sidewalks and road speed was obtained through a contact at the SACOG.

Railways. Railways were downloaded from the City of Sacramento GIS Data page.

Hydrology. Rivers, drainage canals and other water features were downloaded from the City of Sacramento GIS Data page.

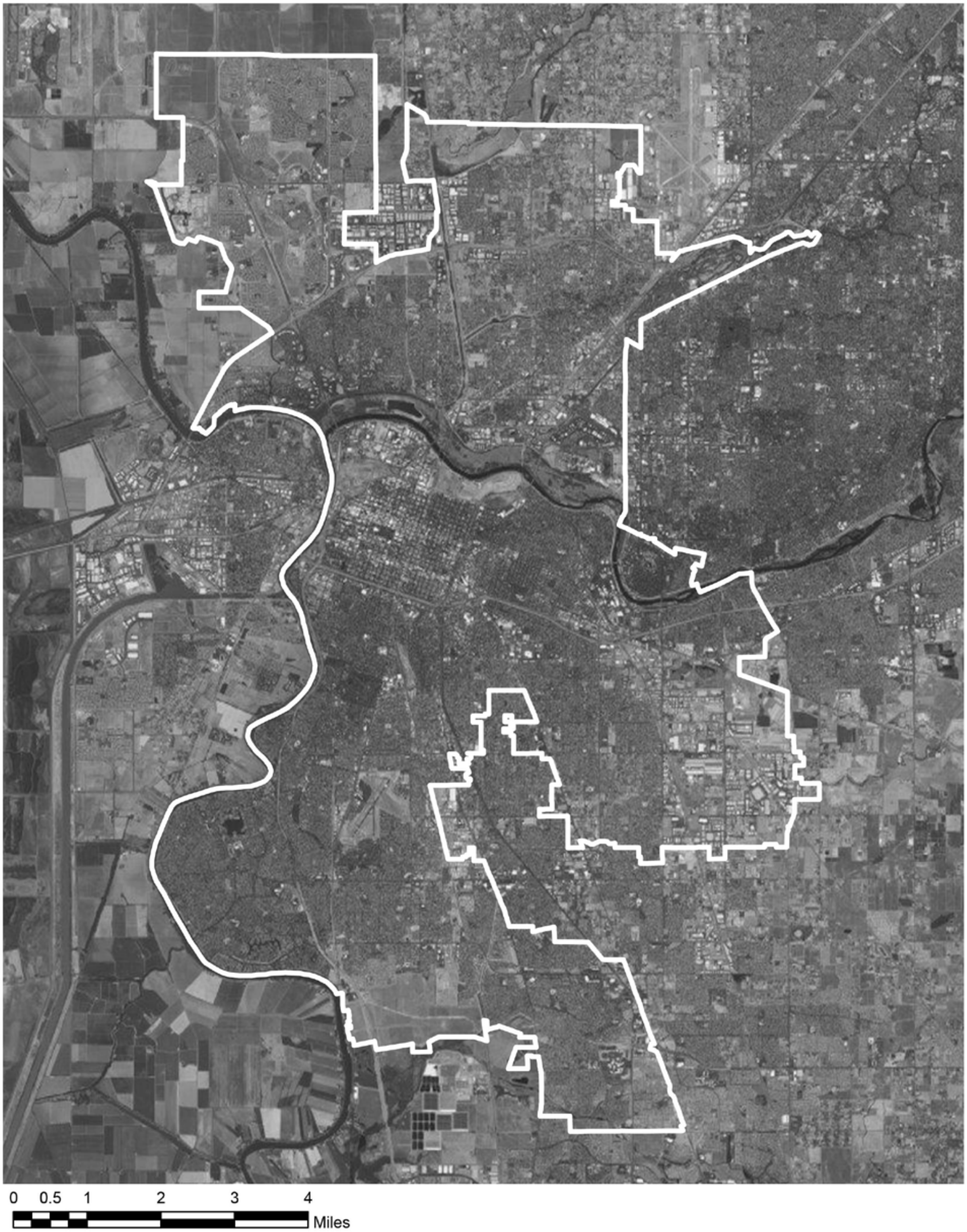

Figure 18: Aerial Photo and City Boundary

Resources

Destinations are key to encouraging walking as they motivate “purposeful” or incidental walking, as opposed to leisure walking, which is often difficult to budget time for, particularly for disadvantaged populations. As shown in the review of studies in Chapter Four, walking audits overwhelmingly focus on retail destinations and tend to weight them all equally, but I have instead elected here to only map four destinations that have merited separate studies in relationship to health outcomes. Of course, future analyses could include factors relevant to certain subgroups such as playgrounds, senior centers, churches or community centers.

Grocery Stores. Food availability is a built environment quality that is studied almost as in-depth as walking. The discussion of “food deserts” comprises a vast body of public health literature, and nutrition is a lifestyle behavior as crucial to health outcomes as daily activity (Papas et al., 2007). For this reason, grocery stores were included in the analysis.

A Google Maps search for “grocery stores” in Sacramento was converted to a kmz file to import into ArcGIS, which also generated a table of grocery store names, addresses and phone numbers. Using this information, I manually went through the list and deleted non-grocery stores that were inadvertently included, such as drugstores.

Parks. Parks provide opportunities for recreation and access to nature, and as discussed earlier, also comprise a wide body of literature in public health research (Sugiyama et al., 2010; McCormack et al., 2010; Wolch et al., 2005). Park names and locations were downloaded from the City of Sacramento GIS Data page.

Schools. With childhood obesity on the rise, supporting opportunities to walk instead of being driven to school is a key initiative of many public health advocacy organizations such as the Robert Wood Johnson Foundation (Su et al., 2013). It has also been a primary mission of WALKSacramento from its inception. School names and locations were downloaded from the City of Sacramento GIS Data page.

Light Rail Transit Stops. While most don’t live near places they work, availability of transit stops that takes people to their jobs introduces at least some walking at the origin and destination points (Wener and Evans, 2007). For the purposes of this analysis, I looked at light rail stop locations as these are a semi-permenant part of infrastructure, unlike bus stops, which can easily change at the last minute. Light rail stop locations were downloaded from the City of Sacramento GIS Data page.

Environment

Trees. As discussed above, trees mediate climate and have shown at least some positive correlation with walking behavior (Borst et al., 2008; Adkins et al., 2012). Latitude and longitude of city-owned trees were obtained from a contact at the Sacramento Municipal Utilities District (SMUD). This table was then converted into a shapefile to be used in ArcGIS.

Building Footprints and Characteristics. How buildings define a street edge and encourage walking and gathering is a largely unquantified area of study in public health, but far more studied in urban design literature particularly when discussing livability (Bosselmann, 2008; Campoli, 2012). This, in tandem with residential density can capture the kind of built environment density researchers are trying to capture. A building footprint shapefile was downloaded from the Sacramento County GIS Data Library, and then characteristics and population density by parcel from a table was downloaded from the same site, and appended to the footprint file.

Populations

Health. Health information was obtained from the UCLA Health Policy Center's California Health Interview Survey (CHIS). CHIS is conducted every two years, interviewing over 50,000 randomly selected, but statistically representative, respondents in all 58 counties of the state. Although it is self-reported, it is currently the nation's most comprehensive state-wide health survey, as well as one of the few giving special attention to traditionally underrepresented minority groups (UCLA Center for Health Policy Research, 2012). As discussed several times earlier in this paper, privacy is a major concern of health data, particularly when making spatial correlations. I was given a list of variables to select from for this project. After discussions with the CHIS researchers, I sent them an arbitrarily determined hexagonal grid spread across the city to aggregate their responses and correlate their data to, as to further anonymize results. Each cell was returned with a weighted frequency, which means the number of people expected the survey to have covered, and not the actual people interviewed. Even so, only some of the determined areas had a high enough response rate to actually visualize and map, which is discussed on the subsequent pages.

Mapping

Following are experiments in interpreting the built environment for health study, specifically looking at walking and its associated connections with chronic disease health outcomes such as diabetes, hypertension and heart disease. The following are essentially layered visualizations, revealing different patterns at different scales. They were created to identify changes across the city and to open the door for subtle and small-scale changes in neighborhood interventions. Each grouping of environmental factors—resources, street completeness, and urban landscape—are evaluated based on consistent findings from literature.

Pre-processing: Building a Street Network. The first step was to define the walkable street network (See Figure 19 through Figure 21). Normally, a GIS analysis is done on all streets in a predefined area without taking into account physical barriers or where pedestrians would actually walk. Using the speed properties of each road, I categorized the streets as follows and made them separate layers:

- On/off ramps were considered barriers.

- Streets 40 miles per hour and up, which in this instance included highways and interstates, were categorized as barriers to walking instead of traversable paths.

- Streets 30 to 40 miles per hour were not considered barriers to walking, but rather a friction element when crossing, estimated to add one minute to a walk and therefore limits the distance one could walk in 10 minutes.

- Streets 25 miles per hour and under comprised the pedestrian network. The ArcGIS Network Analyst extension is normally used to estimate drive time along a street network. But I reset the parameters to instead estimate pedestrian walking time, which for the purposes of this analysis was assumed to be a reasonably healthy adult who could walk one-half mile in 10 minutes. In doing so, I also set one-way roads to be considered equal in the network (considering a pedestrian would not be limited to one direction) and U-turns as the ends of streets/networks (considering a pedestrian would not traverse a dead-end street if the destination was not otherwise on it).

It should be noted that in lieu of this richness of information, another way of categorizing streets is offered by Schlossberg (2006), using the TIGER (Topologically Integrated Geographic Encoding and Referencing) street data, which is publicly available throughout the U.S. Census site (U.S. Census Bureau, 2014b). In that case, one would look at road classifications; any road with the prefix “A4” would be considered a neighborhood road. However, given the richness of the road data set I was able to obtain from SACOG, I chose to use that file instead. It is also worth mentioning here that width is another street characteristic often cited as affecting walking, but was not in this particular database. However, I believe street characteristics at this scale, and in this application, are sufficiently addressed by examining traffic speed and whether sidewalks are present.

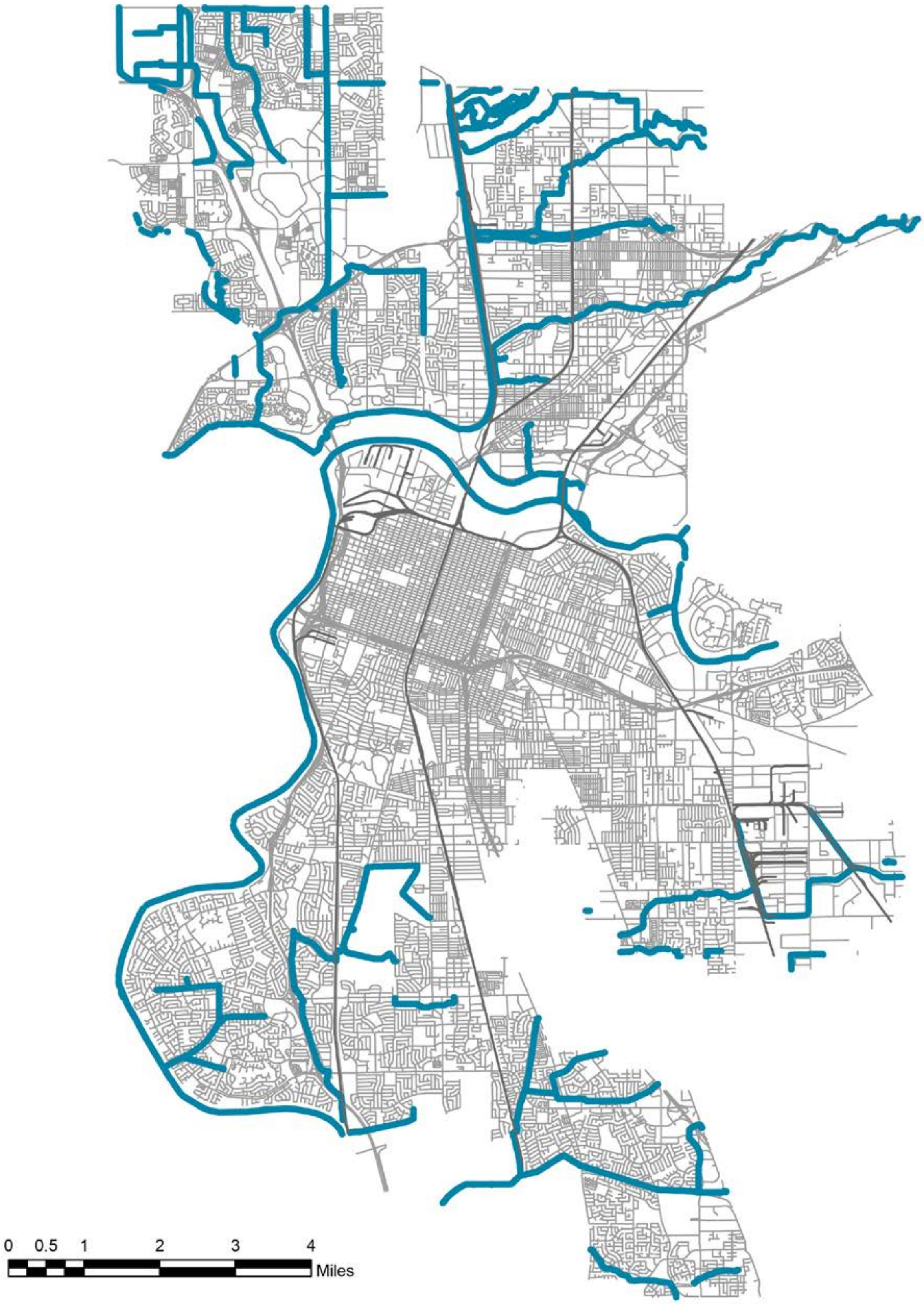

Figure 19: All Roads in City of Sacramento

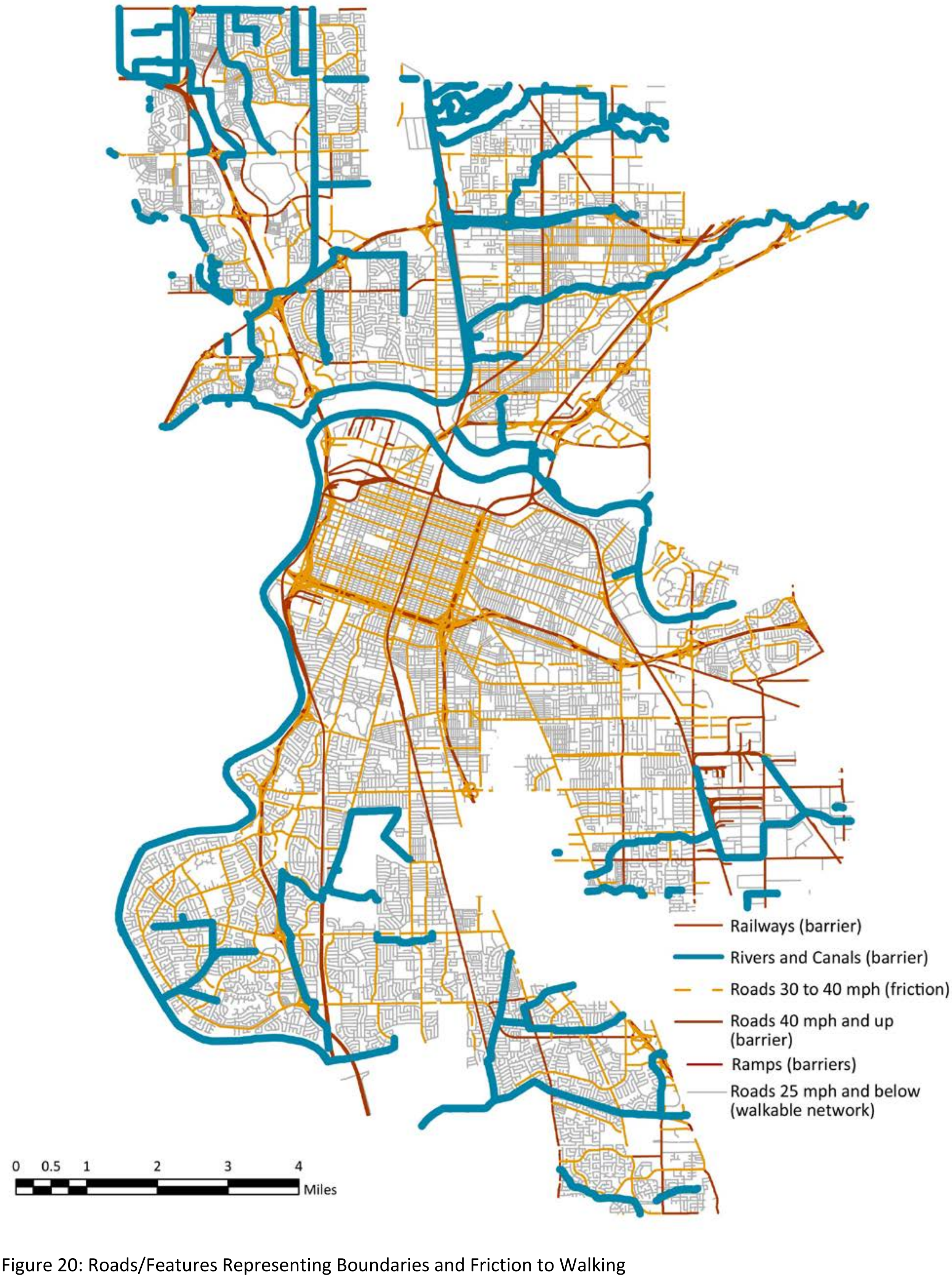

Figure 20: Roads/Features Representing Boundaries and Friction to Walking

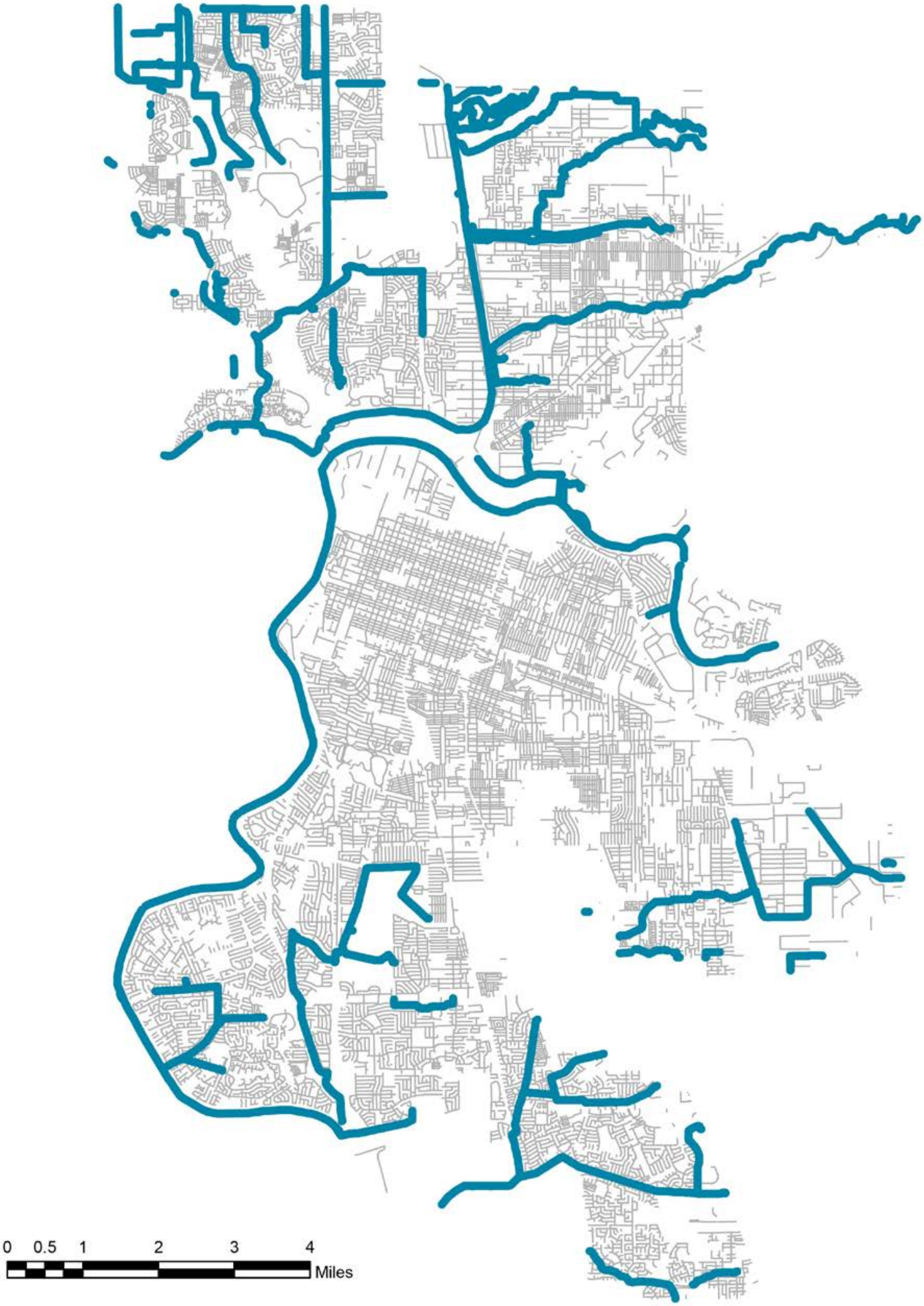

Figure 21: Resulting Pedestrian Network

Pre-processing: Defining Walkable Areas. Using time and distance parameters instead of only distance is where this model differs most drastically from traditional walkability spatial analyses. Although this analysis was done for a healthy adult, the parameter could easily be changed for the elderly, children or the disabled based on exercise literature. Including time also allows certain built environment elements to be considered to slow a walk rather than outright stopping it. I also chose to use network distance along streets instead of a half-mile radius, as this more closely estimates the pedestrian experience (Schlossberg, 2006). In addition to the streets mentioned above, I also included rivers, drainage canals and railways as barriers to walking.

I then generated a centroid for every residential parcel in the city of Sacramento and generated the 10-minute walkable area for each one. After selecting every residential parcel in the city of Sacramento, there were 132,846 resulting 10-minute areas generated. These areas were, of course, cut short by outright barriers or slowed when crossing medium traffic speed roads. The smallest walkable area was 77 square feet (a lot that could only be accessed by a high traffic road), the largest 13,837,192 square feet (317.65 acres). The differences between using a radial buffer, network distance and a network distance with friction elements and buffers is shown here. As demonstrated in areas with a mostly grid pattern, there is not a large distance, but in areas with more circuitous street patterns and a larger range of speeds, there can be a distinct difference in coverage (See Figure 22).

Spatial Method Description. For each of the components mapped here, I repeated the same essential method. For each category, the number of features within each walkable area was summed or averaged. In all cases, a higher value of the component in question was thought to be more conducive for walking. The walkable area was then shaded accordingly, darker areas indicating higher scores. The value of the entire walkable area was then transferred back to its origin point (the residential parcel centroid) and the “score” assigned to these points was indicated by both graduated symbols and colors. After examining the score for each parcel, I ran an inverse distance weighting function on all 132,846 points. This interpolates a continuous surface between similar values, making more evident clusters of like characteristics (Bolstad, 2002).

Resources. Counting resources in a walkable area is a fairly sound approach, although with GIS it can be done far more efficiently than individual surveys reporting back on presence, as is done with pedestrian audits. However, close attention should be paid to which resources are being counted. In more real estate-oriented audits such as WalkScore, amenities like coffee shops and general retail are weighted much more heavily. Pedestrian audits, even health-based ones, also evenly weight any type of retail. For the purposes of this analysis, I chose to focus on a smaller range of destinations. However, the locations chosen were those most frequently studied in built environment and health studies, particularly those that concentrated on single types of destinations. With that in mind, I mapped all grocery stores, parks, schools and light rail transit stops in Sacramento (See Figure 23 through Figure 26). Light rail transit stops were included as they are part of semi-permanent infrastructure, and cannot be changed easily, like a bus route. It should also be noted here that the stops, grocery stores and schools are represented on the maps as points. Park locations were also converted to points at the centroid of their location so they could be counted the same way in the walkable area. While a more accurate spatial method would be to put points at all access points of the park (Wolch et al., 2005), since the way most of the polygons were generated enveloped the park centroid, it was deemed acceptable for this citywide analysis. To represent them as one park, I also avoided inadvertently counting a park twice within a walkable area. Additionally, Sacramento's largest park, the American River Parkway, is split into several smaller parcels on both sides of the river, meaning it could be counted along its entire length. For this rough analysis, grocery stores, parks and schools weighted equally with the light rail receiving half that score, as they in themselves were not the end destination. Each walkable area was then valuated simply by counting the number of resources to come up with an aggregate score for each polygon, with the assumption that more resources would be a more favorable environment for walking.

Street Completeness. Street intersections is a simple but important measure but appears to have strong correlations to walking activity. Much like resource counts, there is not too much to improve on in terms of counting intersections, but it can be done much more efficiently and with more nuance. Using the pedestrian network (which excludes high-traffic streets) defined above, I ran a script that created a point for each street intersection and counted the number of streets feeding into that intersection (Beale, 2012). The maps show this intersection density by color coding each intersection according to how many streets feed into it two ways (See Figure 27). The street file from SACOG also included whether or not there were sidewalks present on one side, both sides or not at all. This is visualized in the subsequent map (See Figure 28).

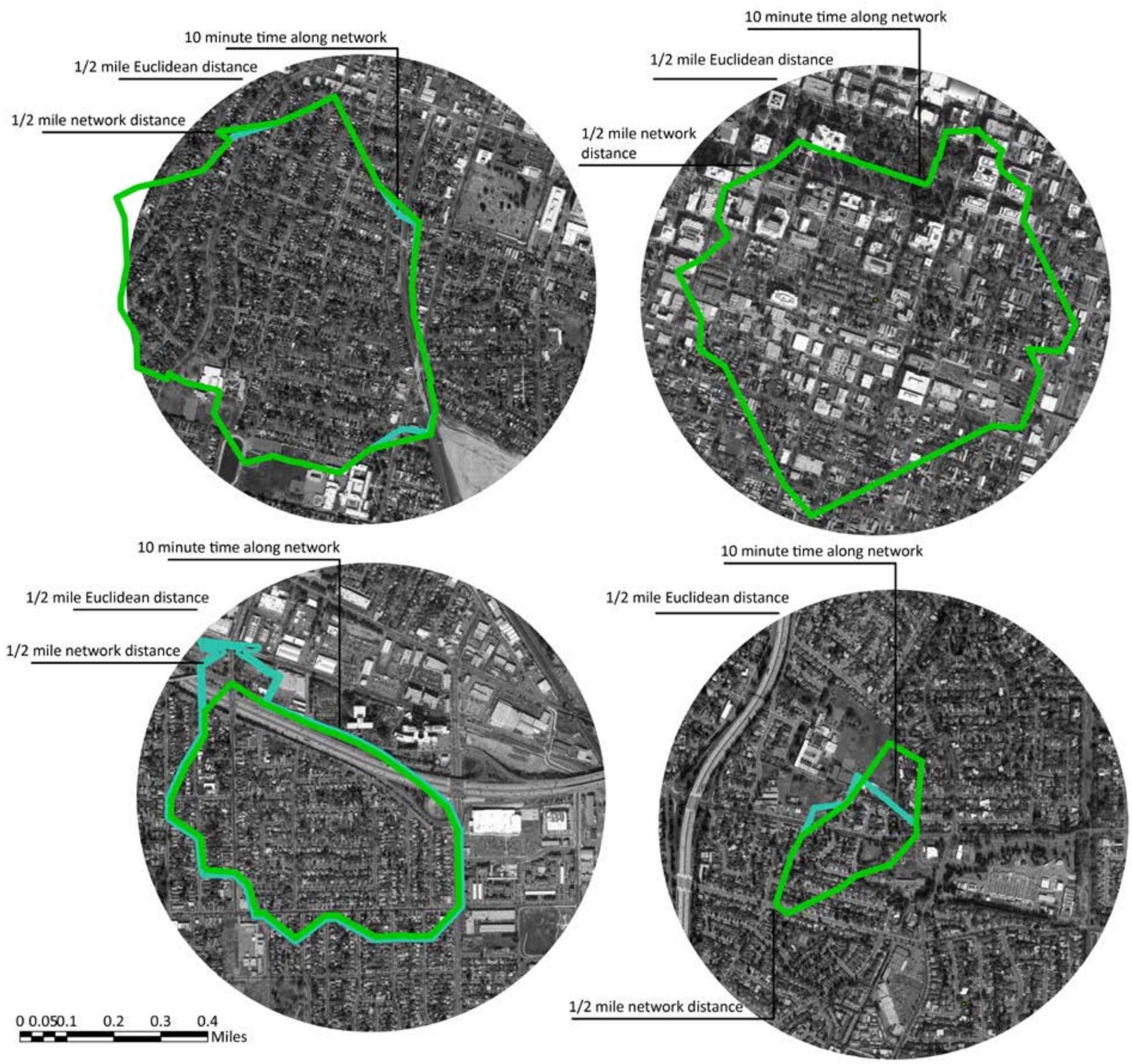

Figure 22: Differences in Walkable Area When Using Time, Distance and Network Measures

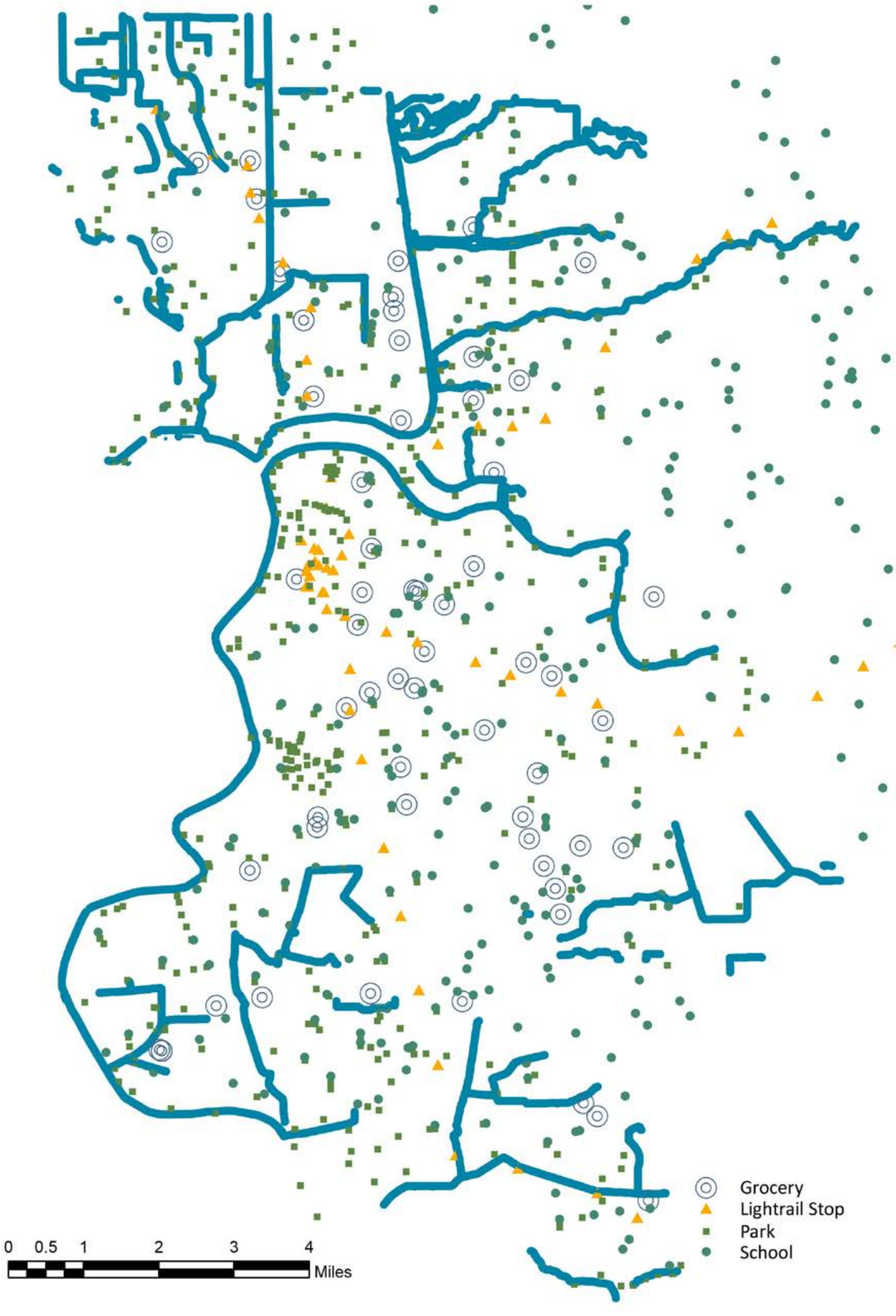

Figure 23: All Resources Mapped

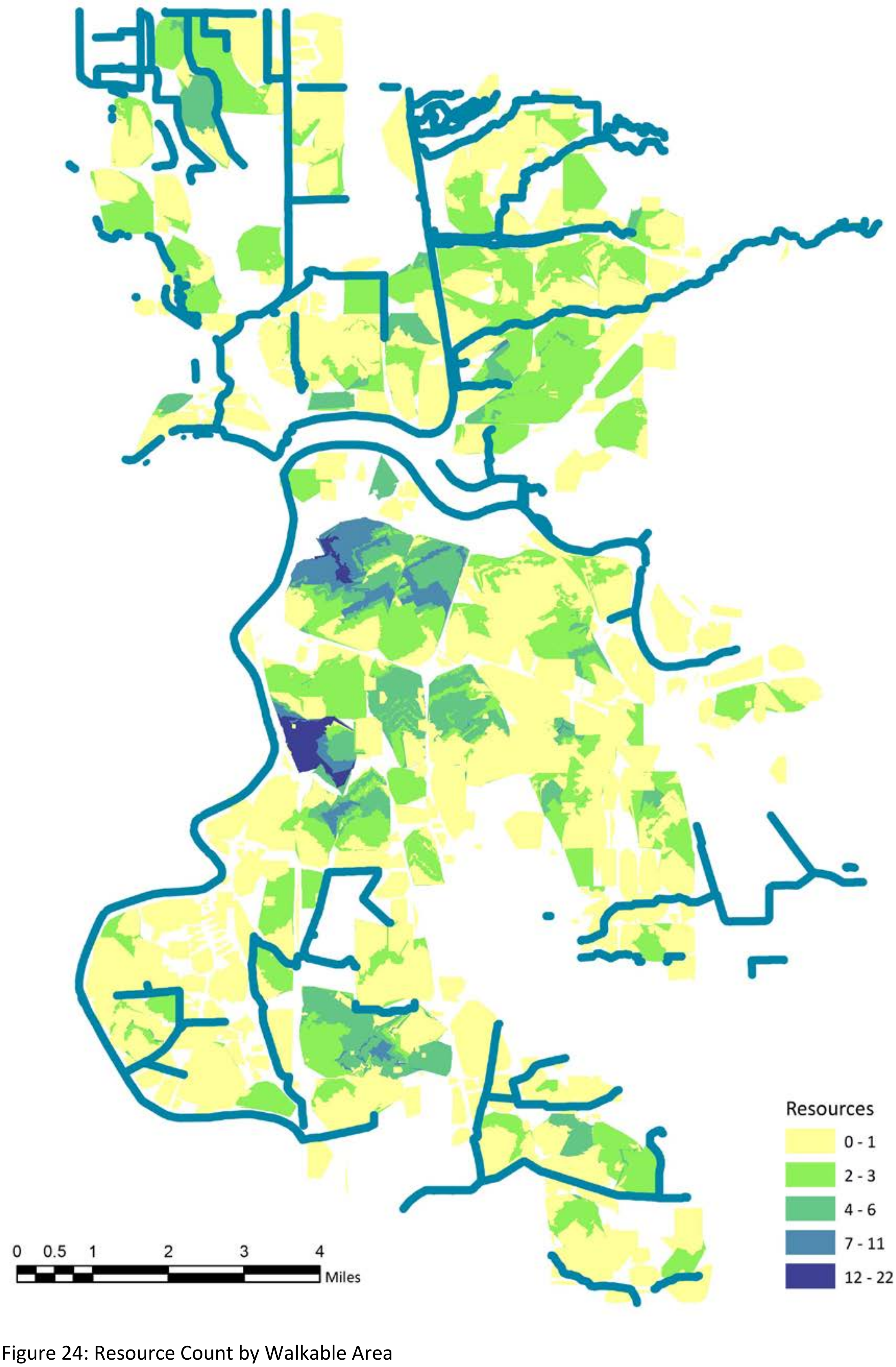

Figure 24: Resource Count by Walkable Area

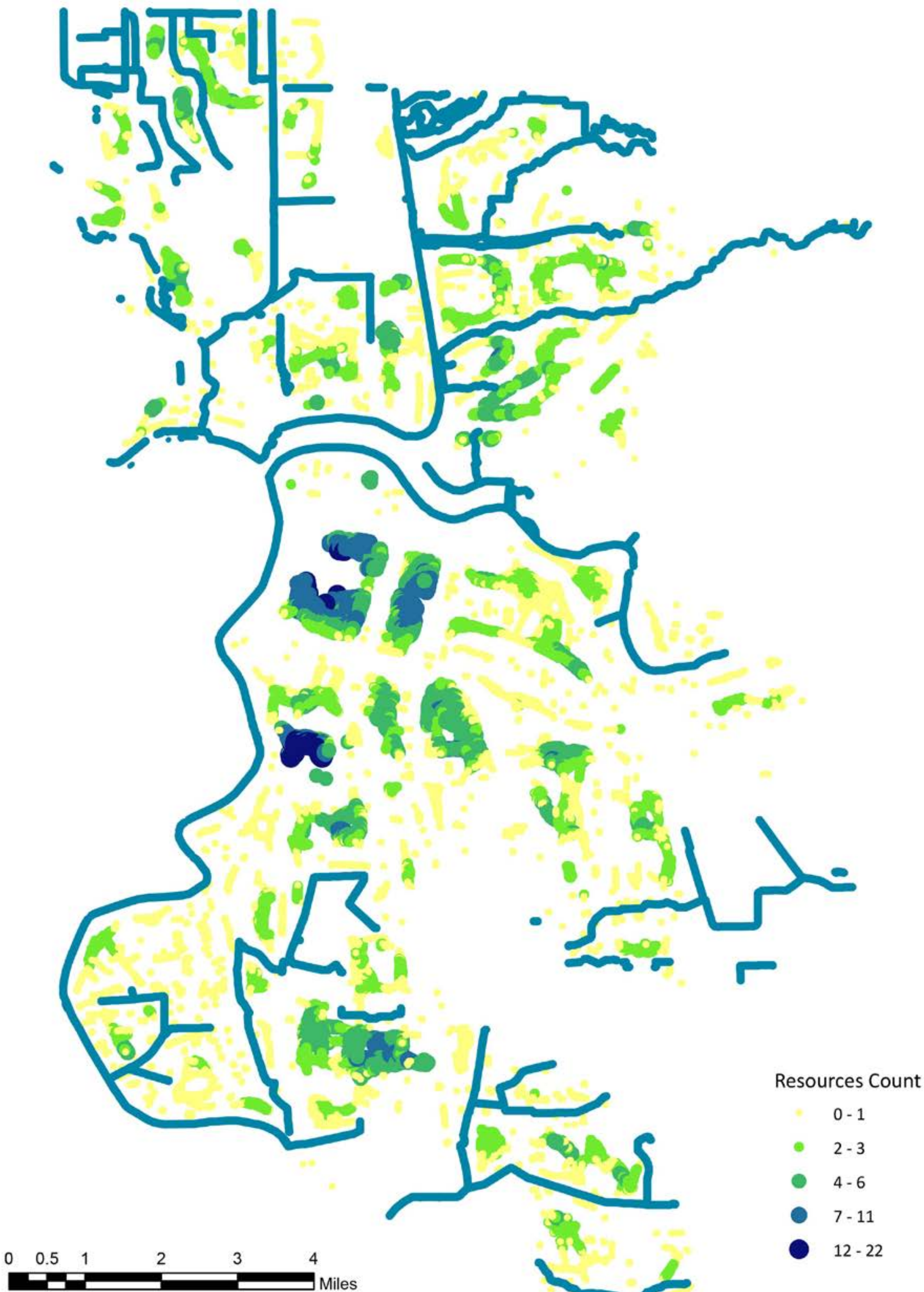

Figure 25: Resource Count Transferred Back to Points of Origin

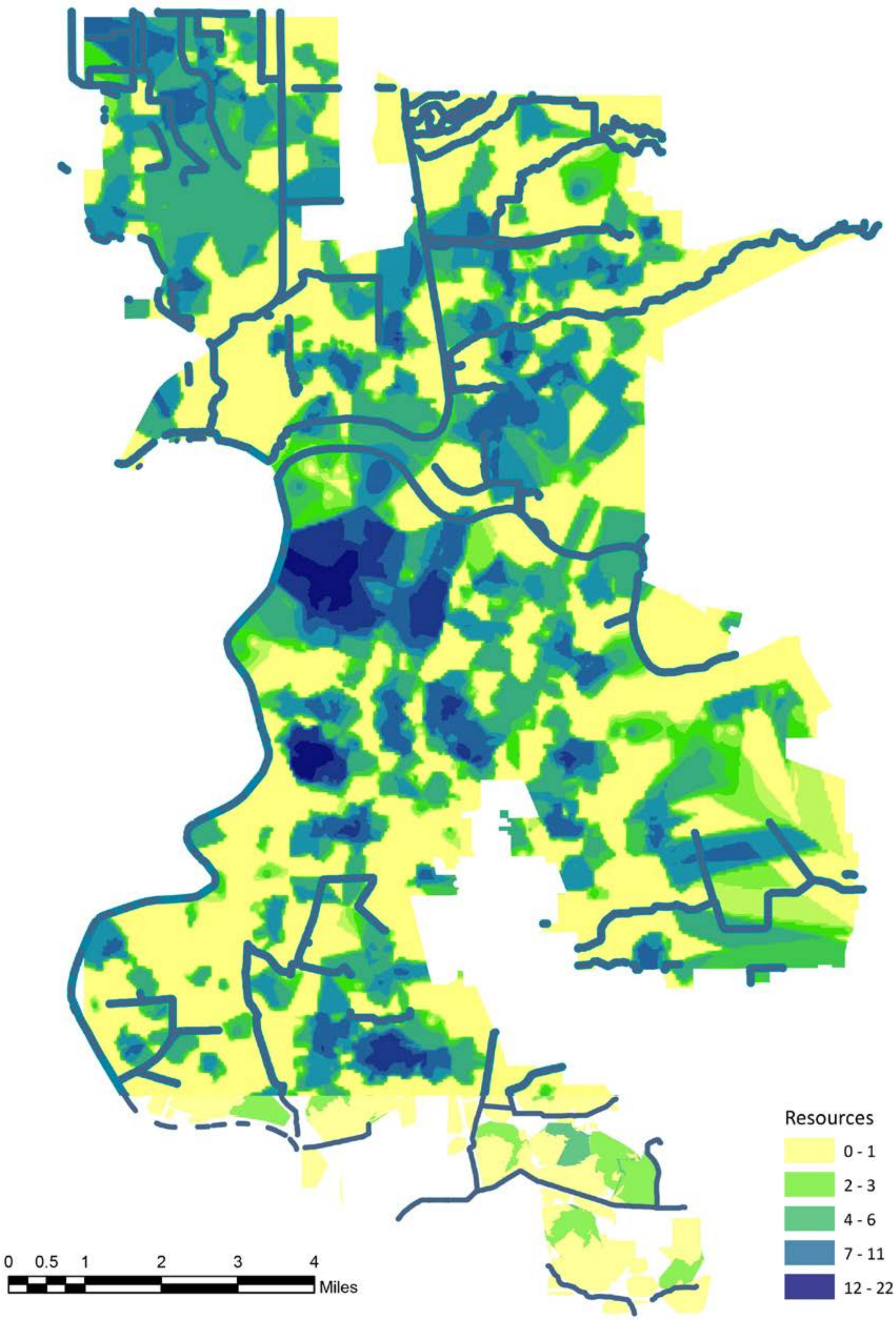

Figure 26: Resulting Topography of Resources

In order to come up with an aggregate score for street completeness in each walkable area, I counted the total length of sidewalk segments (so streets with sidewalks on both sides would count twice as much) as well as the value of each intersection (See Figure 29 through Figure 31). For instance an intersection with only two streets intersecting would add a score of 2, a four street intersection would add 4. The aggregate score of each evaluated polygon assumes that more sidewalks and more street intersections are a more favorable environment for walking.

Urban Landscape. The urban landscape is the most complicated aspect of measuring walkability, but there are ways to do it operationally. Here defining "urban landscape" as the aggregated effect of streets, landscape (in this case, trees and parks), the public face of buildings and people on the street. In order to capture these elements, I visualized population density by parcel, building coverage of lot and presence of landscape. Population density was provided by type of residential unit, i.e., a single-family home on a small lot is estimated to have 5.42 people per acre, and an apartment building may yield over 100 people (See Figure 32). Coverage on each lot was determined by calculating the area of the building footprint divided by the area of the lot size. For this calculation, parcels were aggregated to blocks in order to ease processing (See Figure 33). Landscape density was determined by counting the number of city-owned trees in each walkable area and park centroids. The park centroids were then weighted to have 20 times the effect of trees, an admittedly arbitrary number but intended to capture the stronger landscape effect of having a park in a neighborhood (See Figure 34).

To derive an aggregate score, for each walkable area I took the landscape score in conjunction with the average population density per parcel and average building to lot ratio, the latter two weighted by multiplying them by the calculated area of the polygon (See Figure 35 through Figure 37). For a more traditionally urban setting, it would be more necessary to parse the nuances between "too much" population and building density, but in the context of Sacramento, which is largely low-density, we assume here that a higher population density and building to lot ratio is favorable for walkability. For other contexts, particularly international ones where perceptions of density are influenced by culture, more specific research would be needed on what densities are positively correlated with walking.

Deriving Neighborhoods. By using the overlays and adjusting the transparency of the layers, the preceding maps essentially show topographical maps of opportunities and barriers to walking. However, the massive volume of walkable polygons equate to hundreds of layers at some locations—the McHargian method for an age of big data. Although the factors measured may be fewer than some walkability audits, the number of times the analysis is executed may be obscuring more subtle differences between lots. The method may be useful for a roughly sketched, macroscale view of the city, but for an alternate view, I transferred the values of each polygon back to their centers at each parcel. As one zooms in on areas in the city, one can start to see patterning from block to block. By using an inverse distance weighting function, one can also determine groups of parcels with like built environment characteristics in their 10-minute walkable areas, or built environment "neighborhoods."

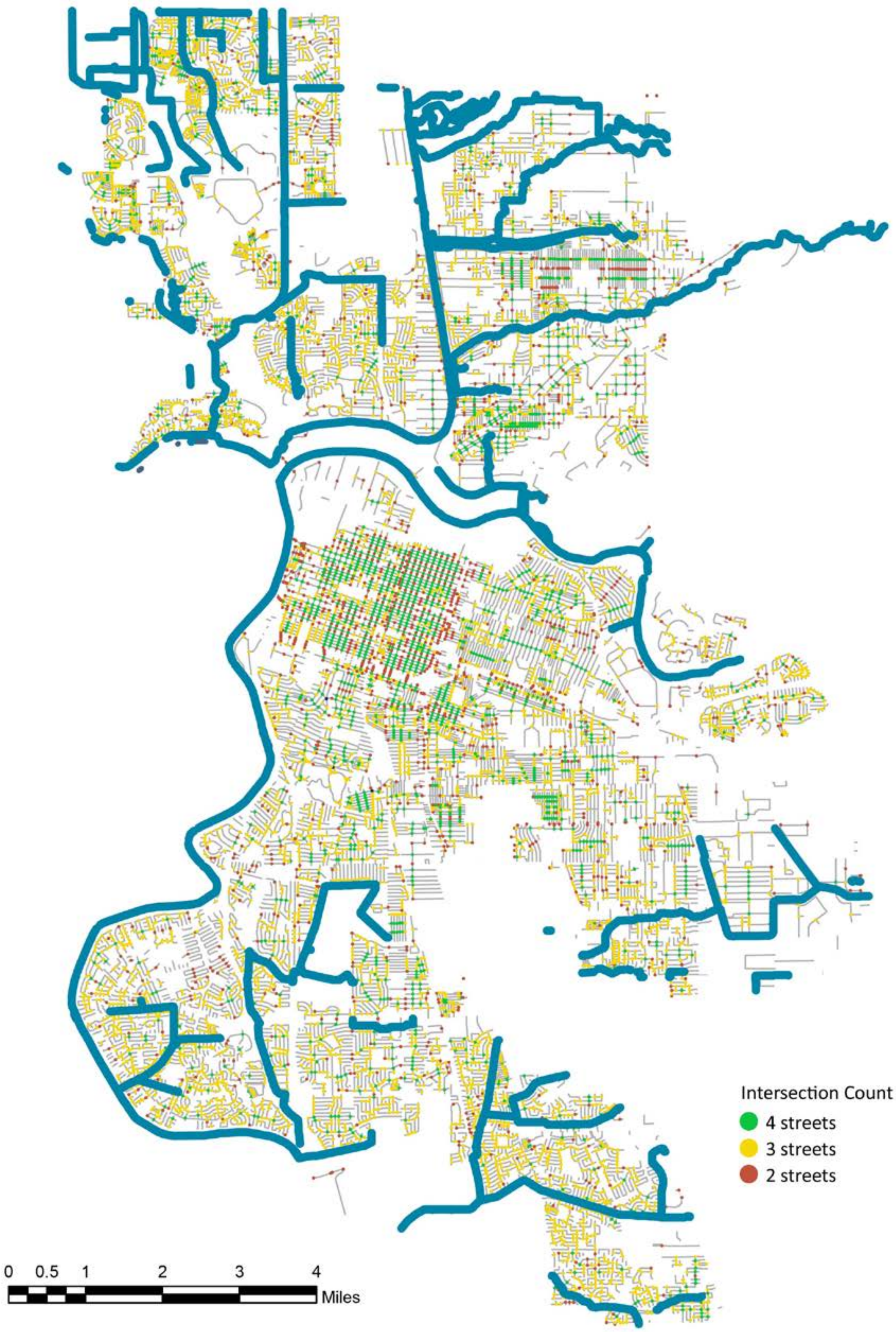

Figure 27: Street Intersections Coded by Number of Streets Feeding into Intersection

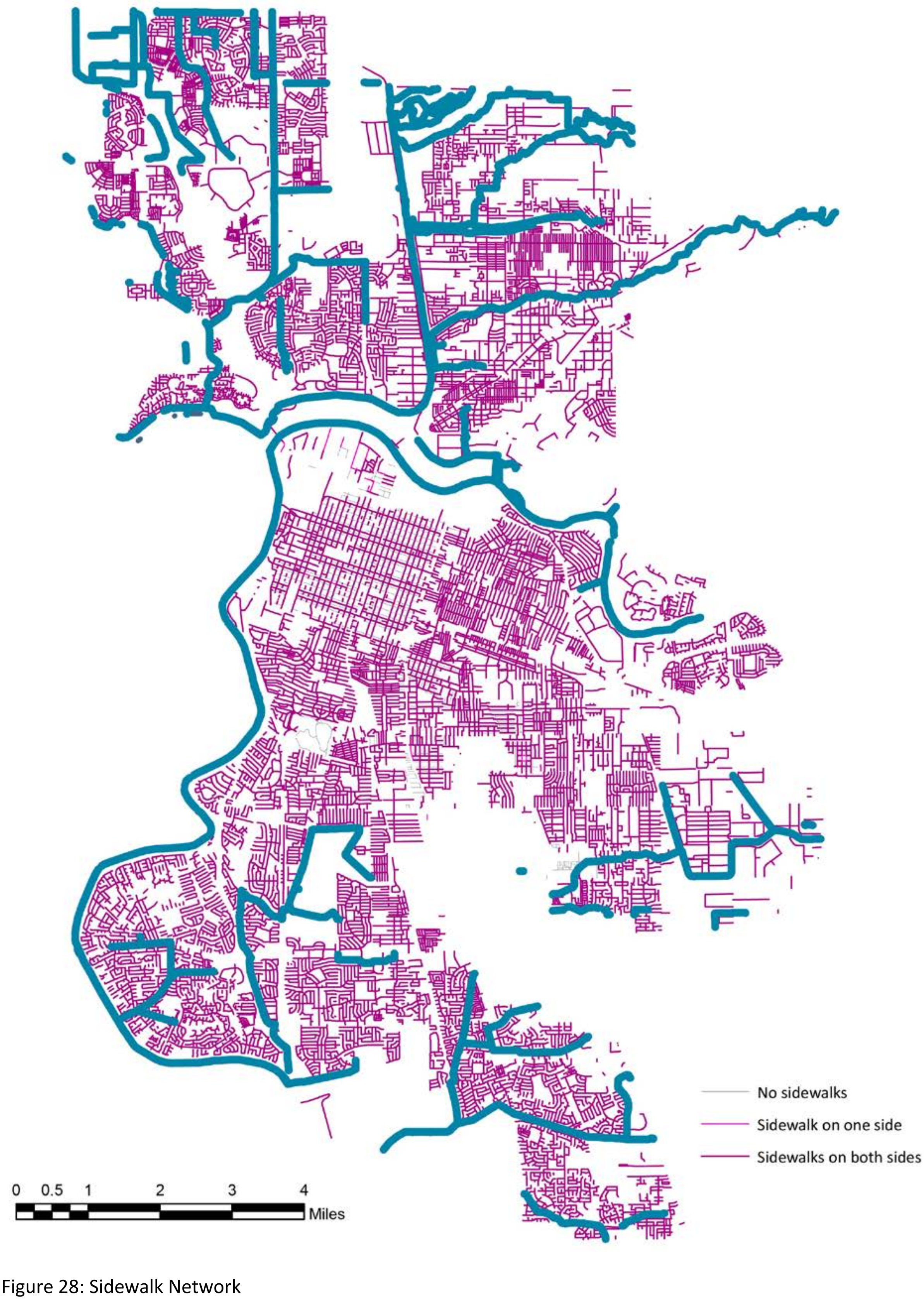

Figure 28: Sidewalk Network

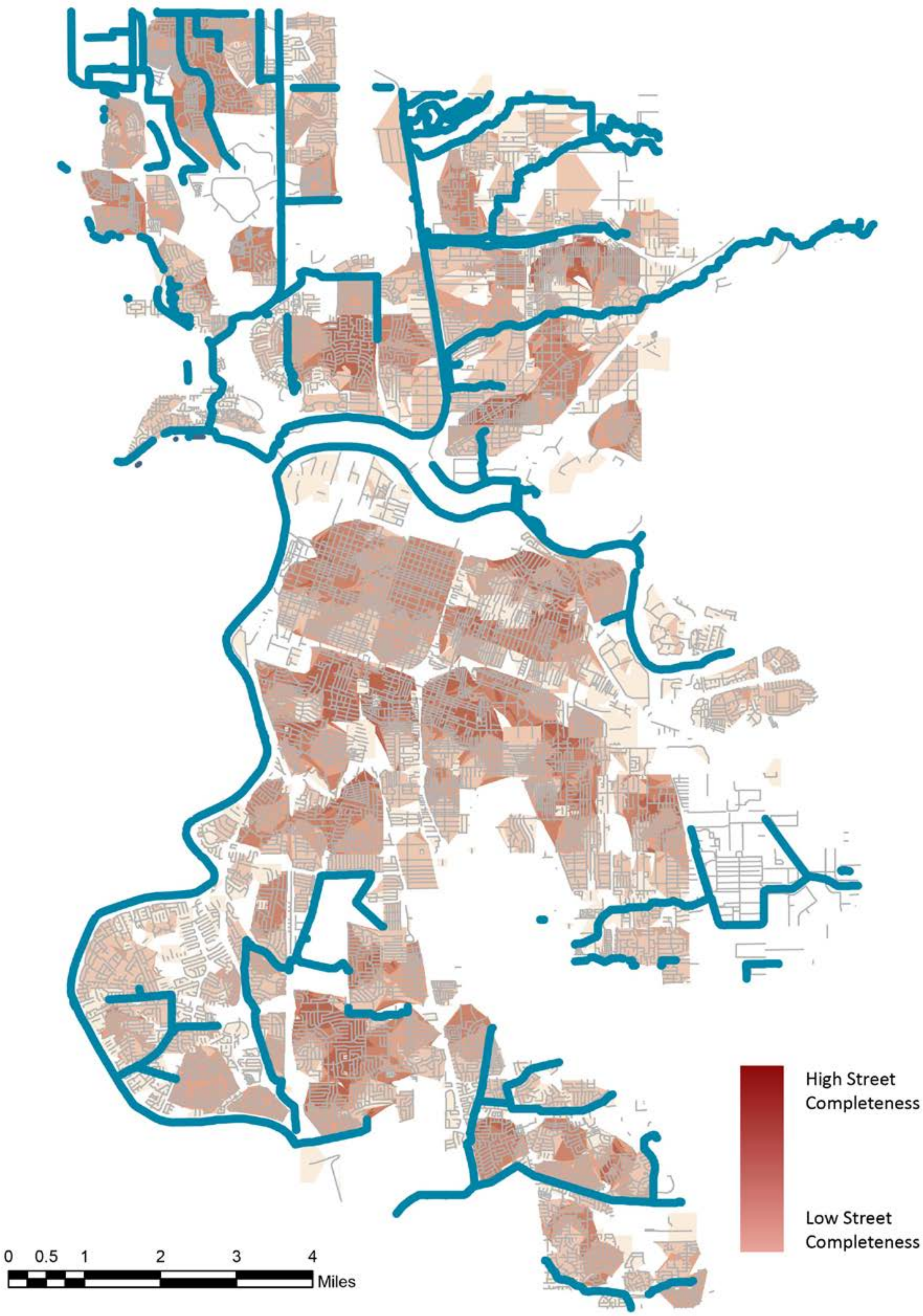

Figure 29: Street Completeness by Walkable Area

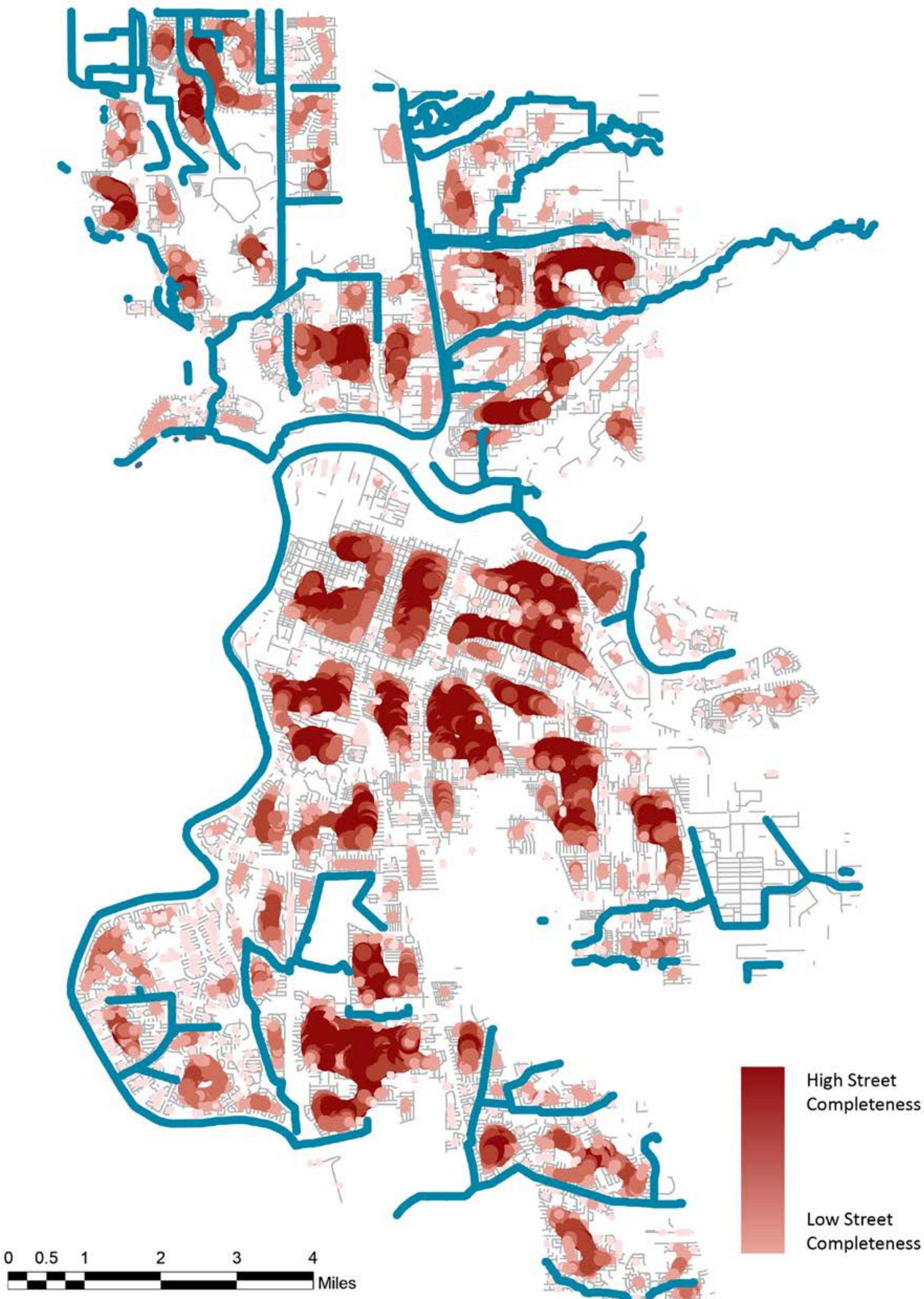

Figure 30: Street Completeness Score Transferred Back to Points of Origin

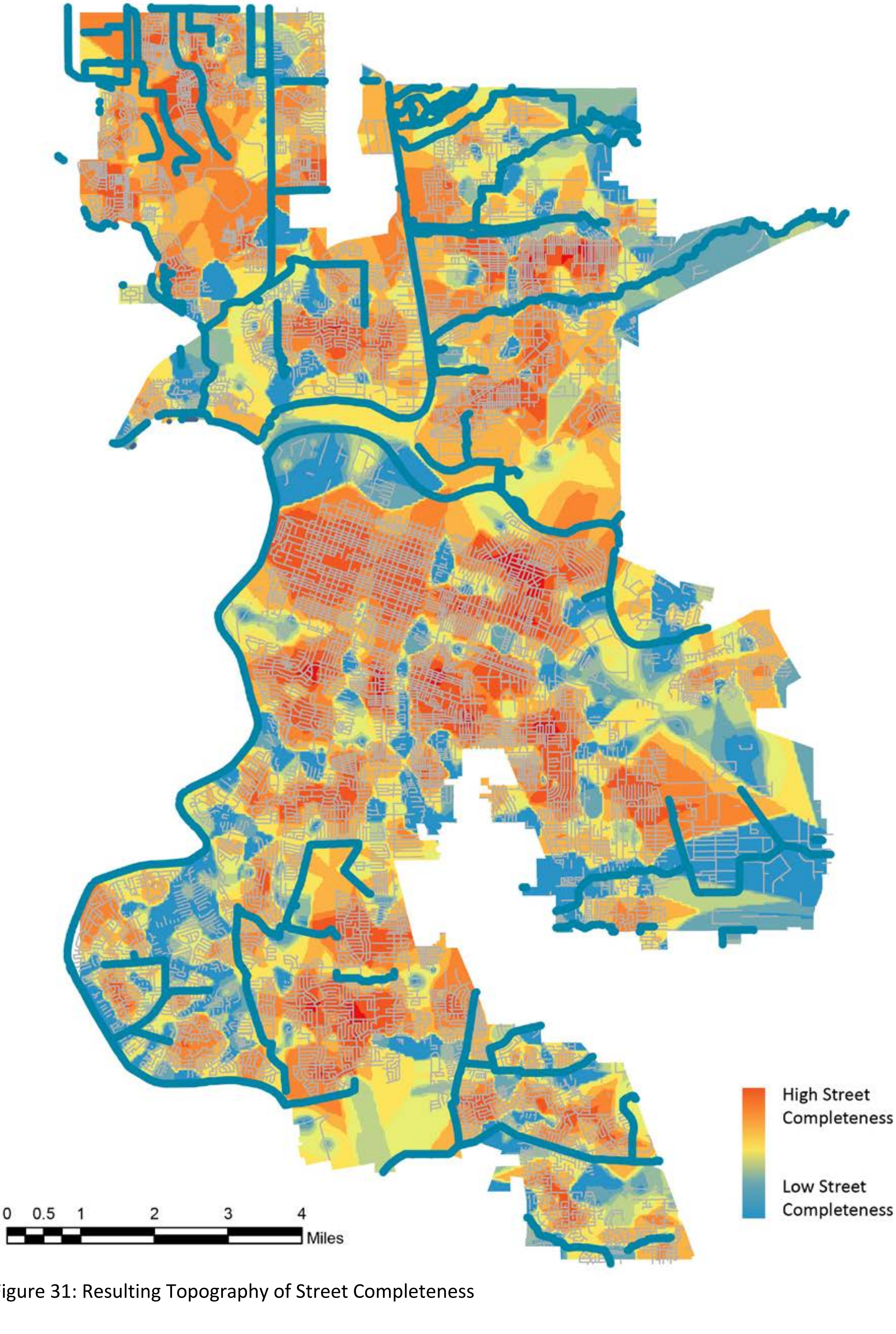

Figure 31: Resulting Topography of Street Completeness

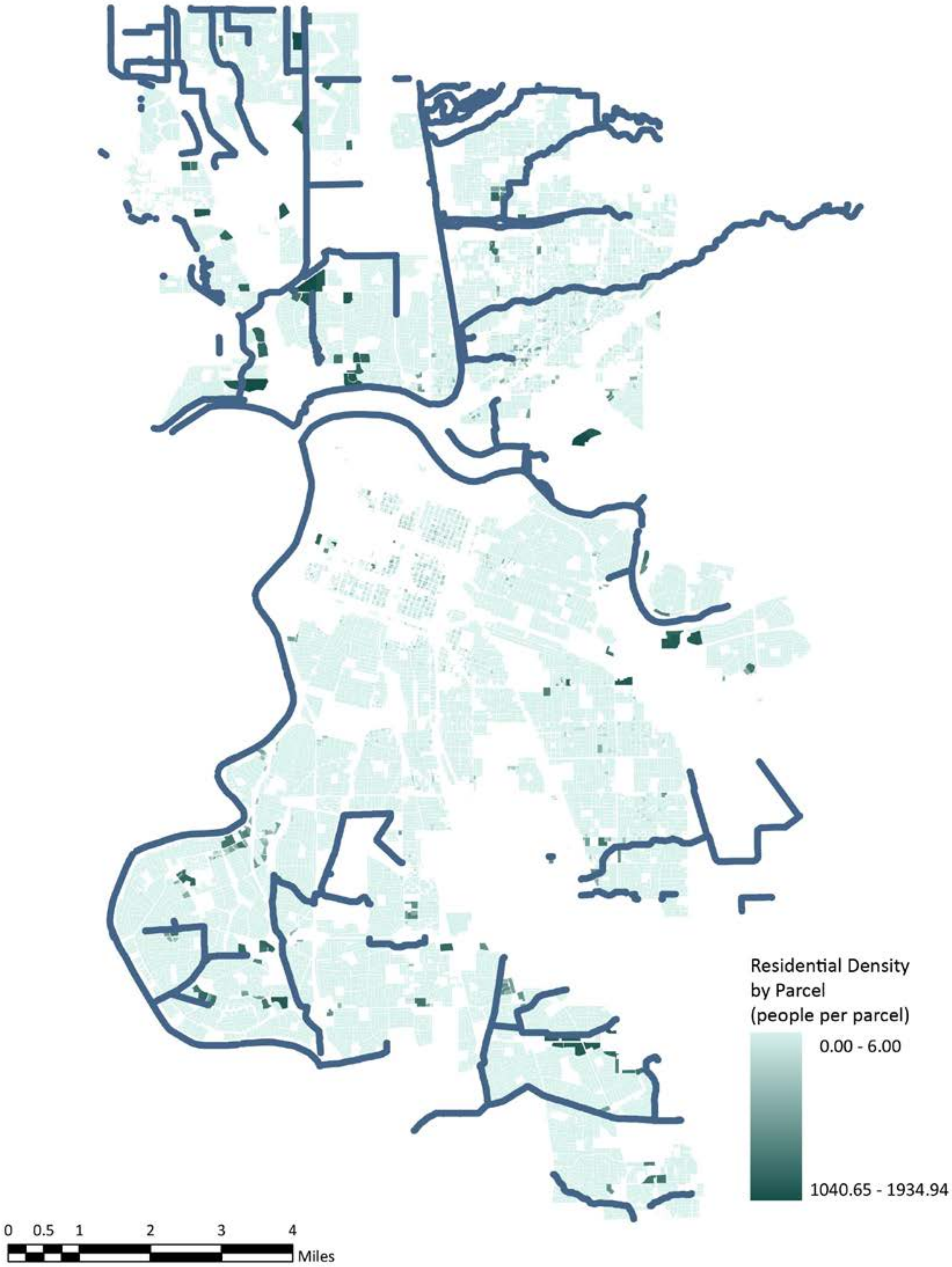

Figure 32: Residential Density per Lot

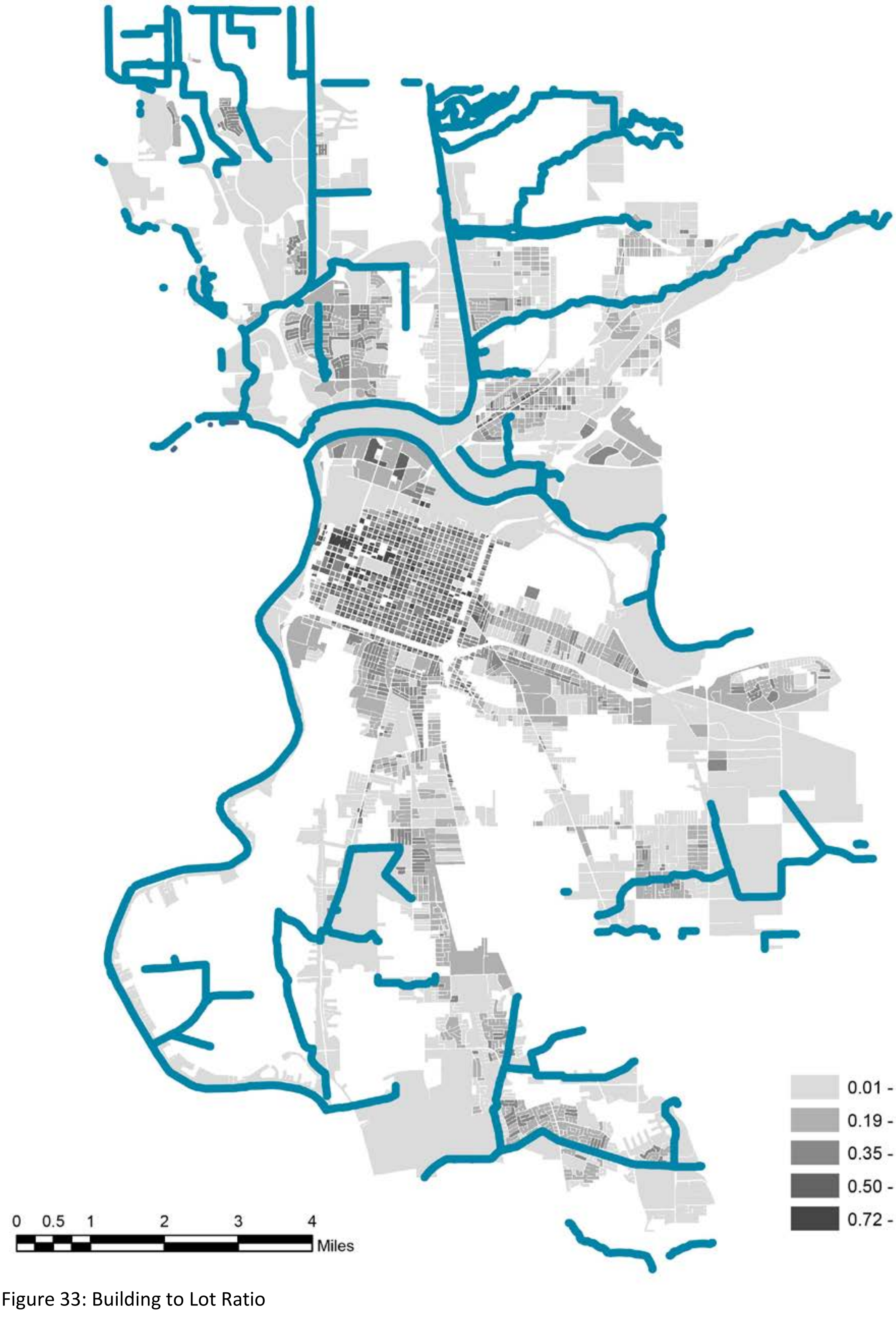

Figure 33: Building to Lot Ratio

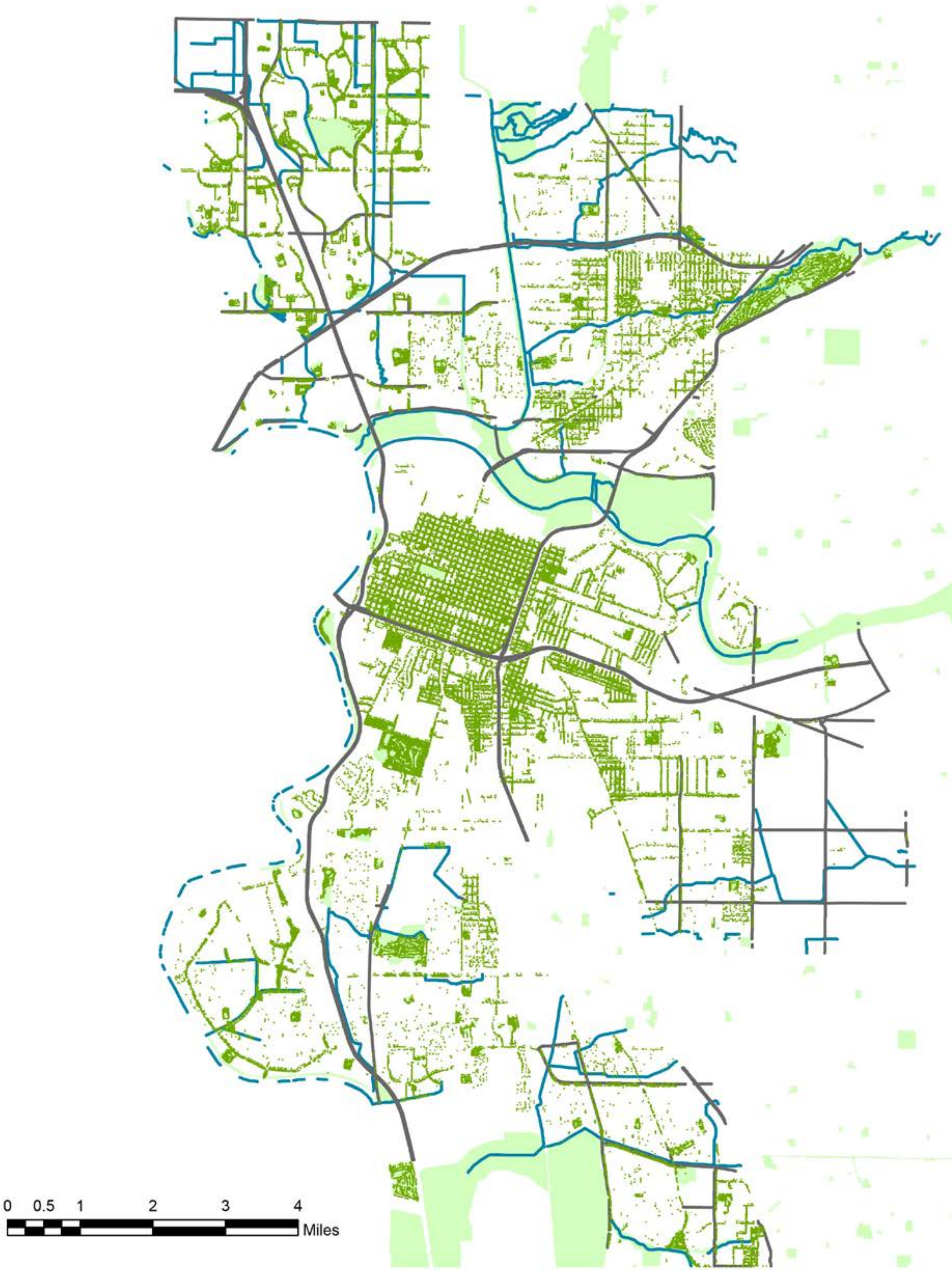

Figure 34: Trees and Park Coverage

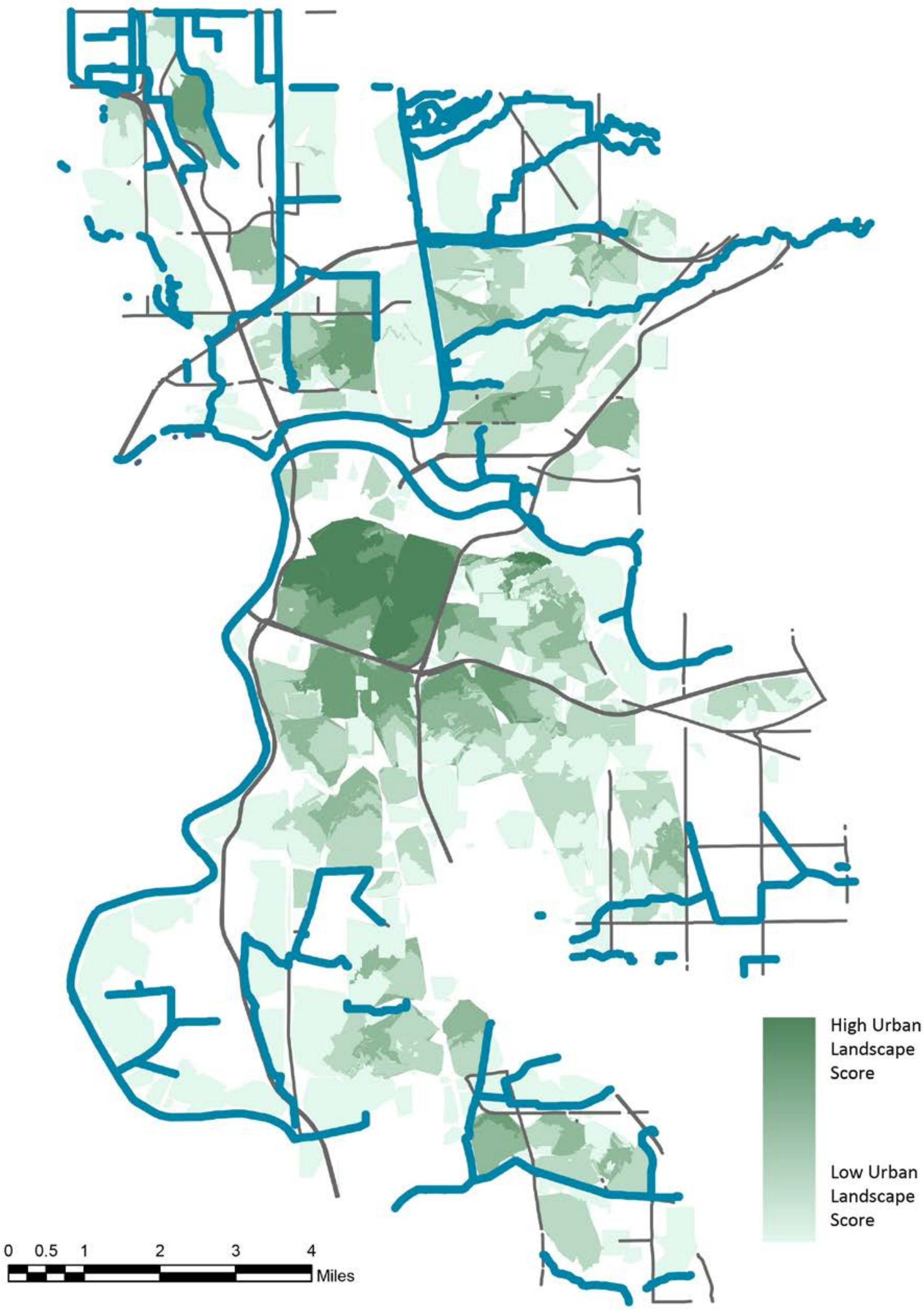

Figure 35: Urban Landscape by Walkable Area

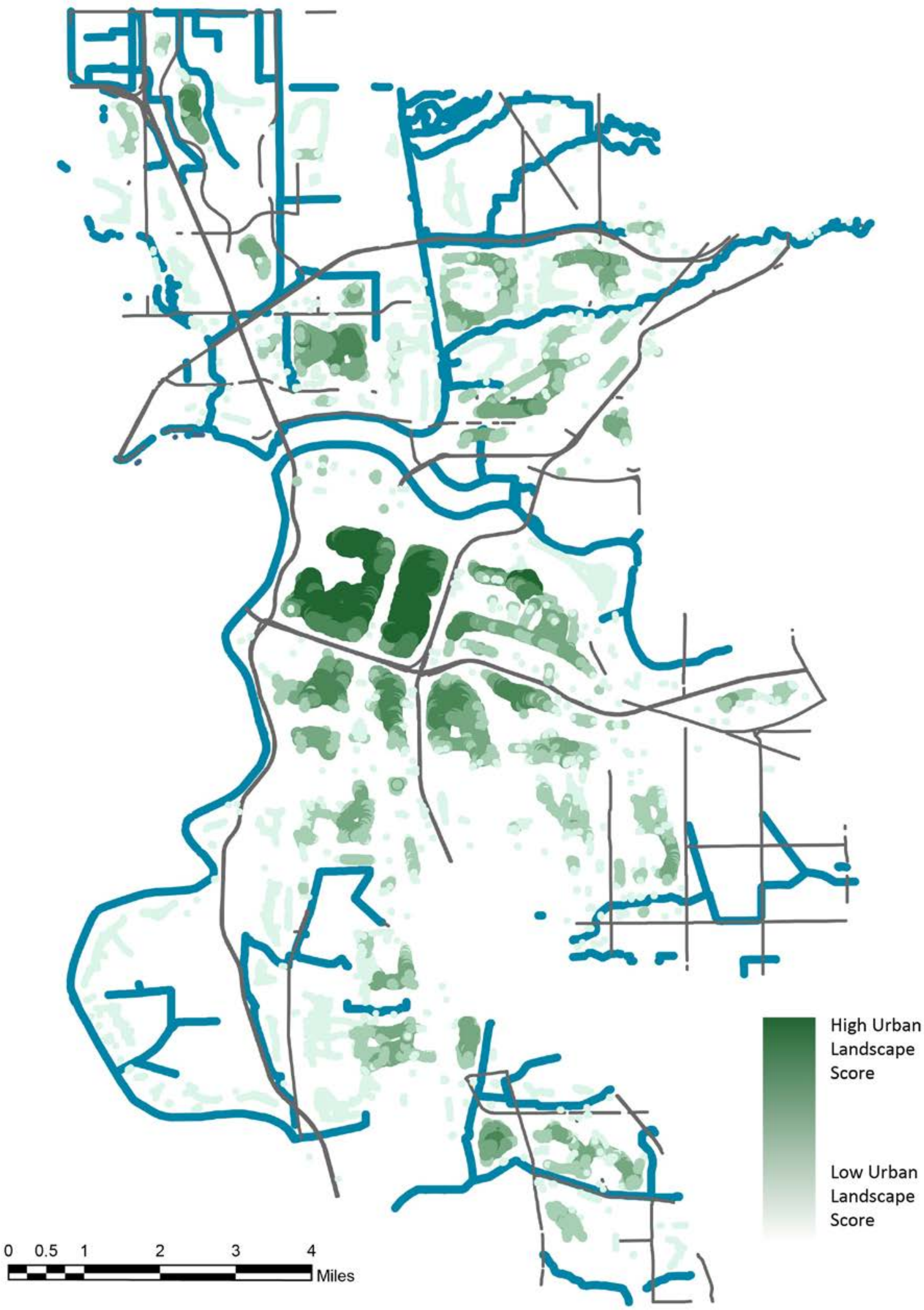

Figure 36: Urban Landscape Transferred Back to Point of Origin

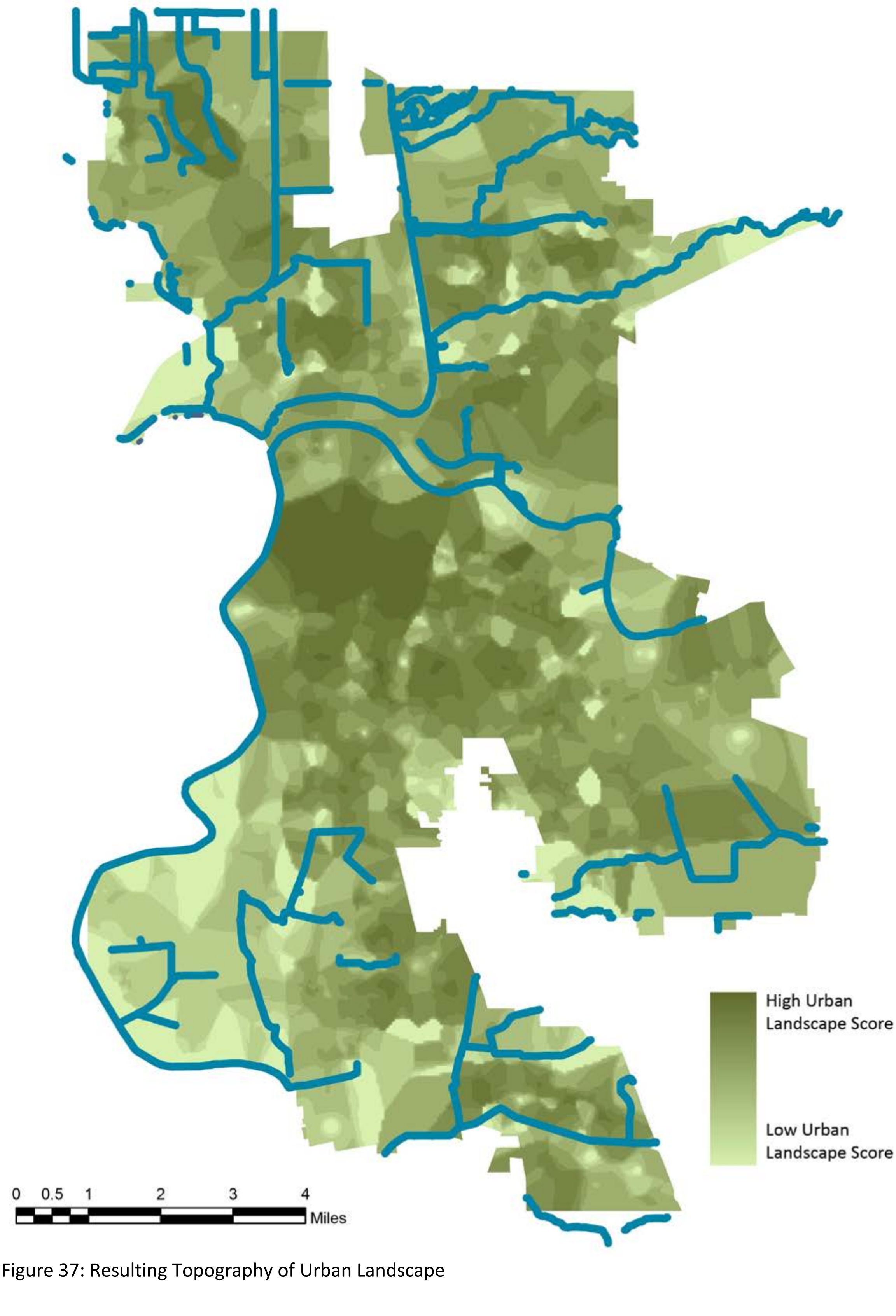

Figure 37: Resulting Topography of Urban Landscape

Health Overlay. Although the primary purpose of this investigation was to find changes in health-relevant built environment information across the city, I did want to explore if it was possible to correlate with health outcomes. From the CHIS survey, I requested the following variables.

- Average length of time walked for leisure
- Number of times walked at least 10 minutes for leisure past seven days
- ER/urgent care visit for asthma last 12 months: current asthmatics
- Walked at least 10 minutes for transport past seven days
- Walked at least 10 minutes for leisure past seven days
- Condition limits basic physical activity
- Average length of time walked for transportation
- Number of times walked at least 10 minutes for transport past seven days
- General health condition
- Currently taking medications to control high blood pressure
- Asthma episode/attack in past 12 months
- Type I or Type II diabetes

Understandably, health information, particularly at the meso-scale of neighborhoods, is difficult to obtain and parse. The necessary statistical transformations of the CHIS data, and the limited area of the city of Sacramento resulted in only a few areas with consistent data. For this analysis, ultimately I only mapped two variables: walking at least 10 minutes for leisure and transport in the last seven days. This was partly due to the practical limits of the data, i.e., response rate for the given area. However, it was also because the built environment analysis solely looked at walking relevant factors, and at this juncture and scale, I chose not to venture associations with actual disease outcomes. The maps show the number of people per designated area that answered “yes” to the above questions (See Figure 41 and Figure 42).

Discussion of Results

At first glance, the mapping generally does show that the downtown and gridded core of Sacramento rates high in walking opportunity as per expectations (See Figure 38 through Figure 40). Also, as one moves to the outer areas, the infrastructure appears to be more limiting. However, we also see certain areas, even further away from the downtown core that also display high opportunity. Much of this may have to do with Sacramento’s particular

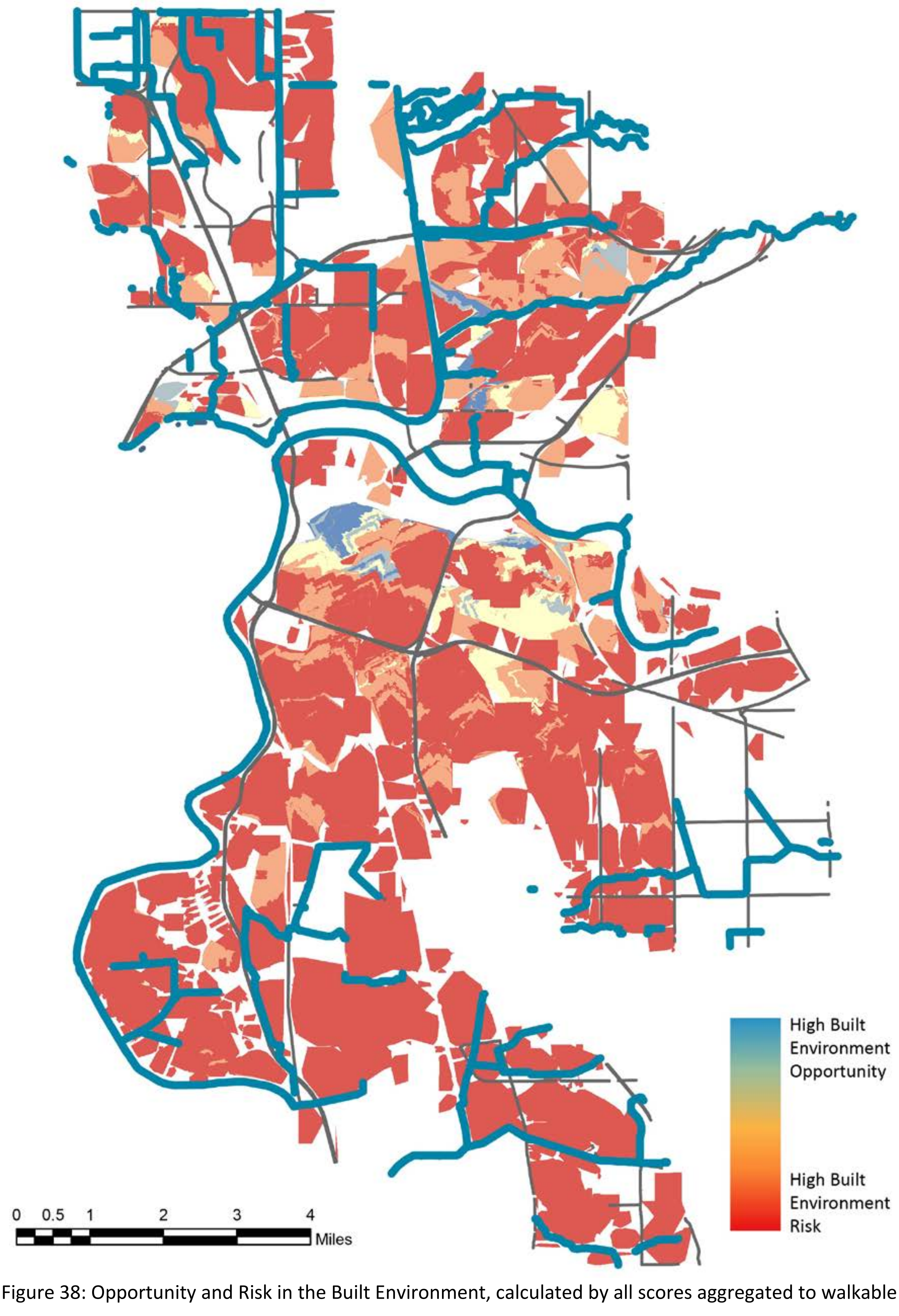

Figure 38: Opportunity and Risk in the Built Environment, calculated by all scores aggregated to walkable areas.

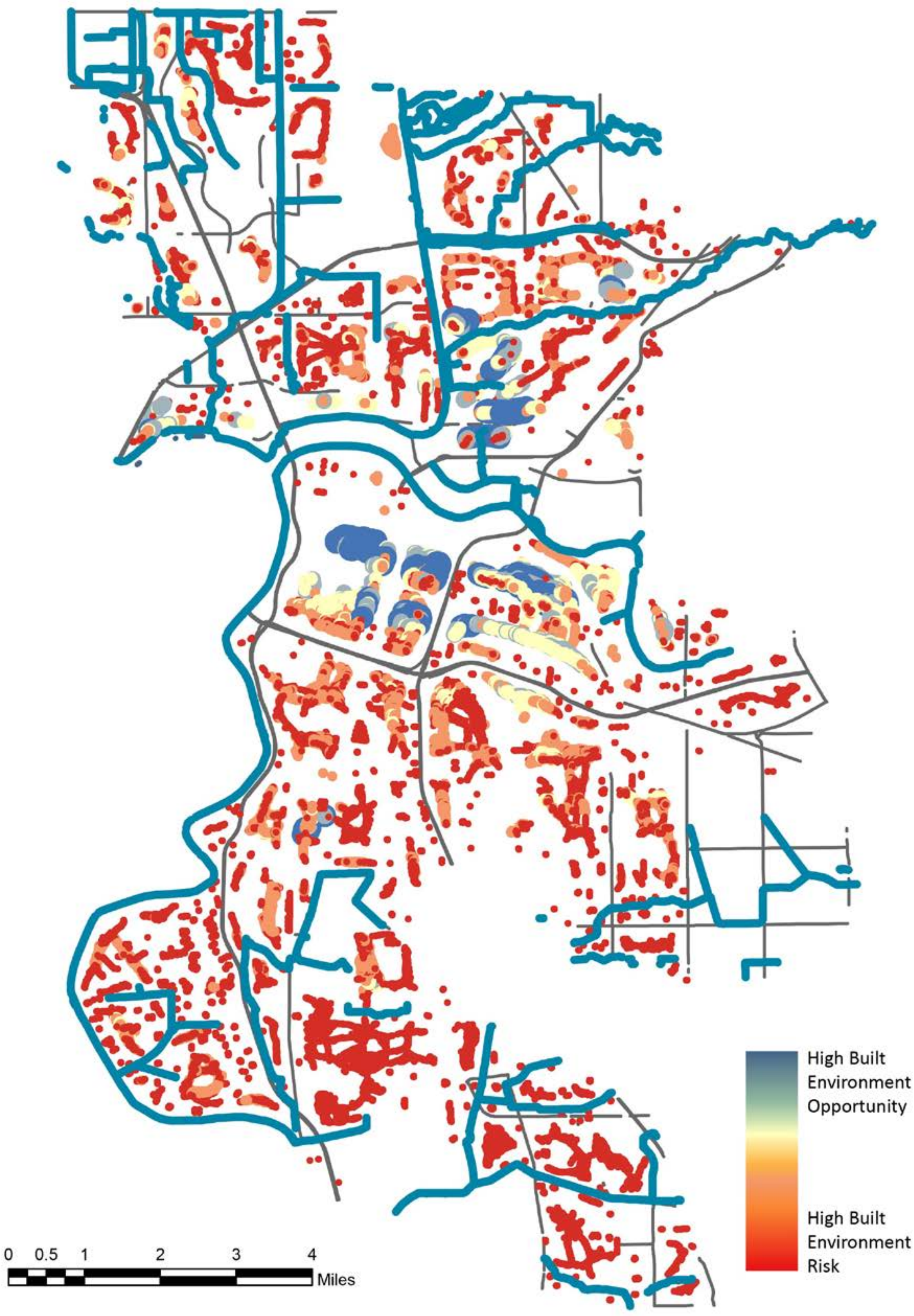

Figure 39: Opportunity and Risk in the Built Environment, by points of origin

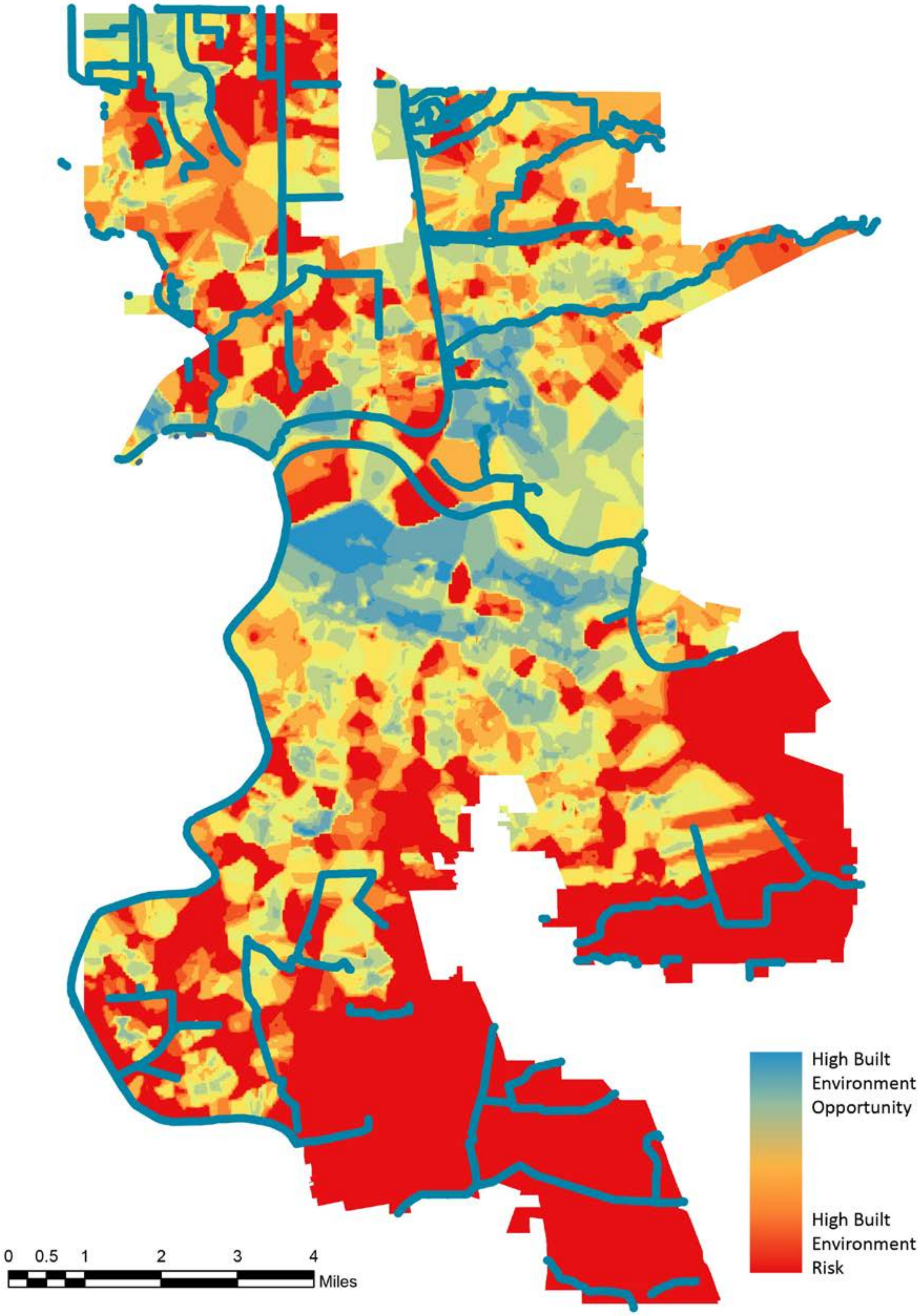

Figure 40: Topography of Wellness in the Built Environment

richness in parks (which are counted in both the resource score and urban landscape score) and urban forest. Additionally, because population density in Sacramento is generally low across the entire metropolitan area, that particular factor didn't heavily weight one area over another. What is most telling is that a median value of walkability (as defined by this dissertation) occurs in many areas of the city beyond the downtown core, indicating that in these areas there is a foundation to make more walkable neighborhoods without starting from scratch.

Many characteristics assumed to be associated with "urban" areas, or vice-versa, "suburban" areas, were observed in various pockets around the city. For instance, landscape density of trees and parks was heavier in the downtown core than in outlying areas, counter to the belief that suburbs are "greener." Perhaps most importantly, when looking at streets, the key infrastructure for walking, the map shows several clusters of intersection density, sidewalk completeness, and slow traffic. However, outside of the downtown core, these pockets are very small and disconnected from each other. Nor do they coincide with high landscape or resource scores. However, this indicates that while the infrastructure is there, small interventions like finding opportunities for parks and retail (such as on empty lots) and targeted urban design strategies, such as articulating street edges, can improve walkability. This also presented an opportunity to find how these areas can be connected to each other, discussed below. However, most crucially, it shows that automatically defining suburban areas as outlying to the urban core or not walkable is largely false, and that there is even less utility of automatically setting urban and suburban areas in opposition to each other in walking studies.

Once the results from the CHIS survey were overlaid, results became even murkier. For each polygon of health interview information, I took the average walkability "score" of the points contained within, and used that as the walkability metric to measure the survey results against. Admittedly, the metric of walking only 10 minutes in the past seven days is a low bar and nowhere near the American Medical Association recommendations, but even so, only a few areas had a high number of respondents reaching that bar. However, those areas with a high number of respondents that had walked in the past week for transport or leisure did not necessarily coincide with areas of high built environment opportunity, with the exception of a few locations (See Figure 43 and Figure 44).

The objective of the mapping is not to prove a causal relationship of certain built environment factors to health, but rather to see how built environment factors commonly thought to have a relationship to health change across an entire city. The goal for these maps are threefold. First, to translate built environment and health research to a spatial analysis. Second, to begin to delineate areas of morphological similarity for future health research, as neighborhood definitions often have little to do with built environment changes even if it is the subject at hand. Third, so that advocacy organizations or local governments can see more exactingly how areas of morphological similarity can be improved to be more supportive of walking. I do not advocate for any neighborhood intervention that is done without the usual levers of community participation and on the ground observation. These maps are simply meant to be the first step in finding areas for further study and potential improvement.

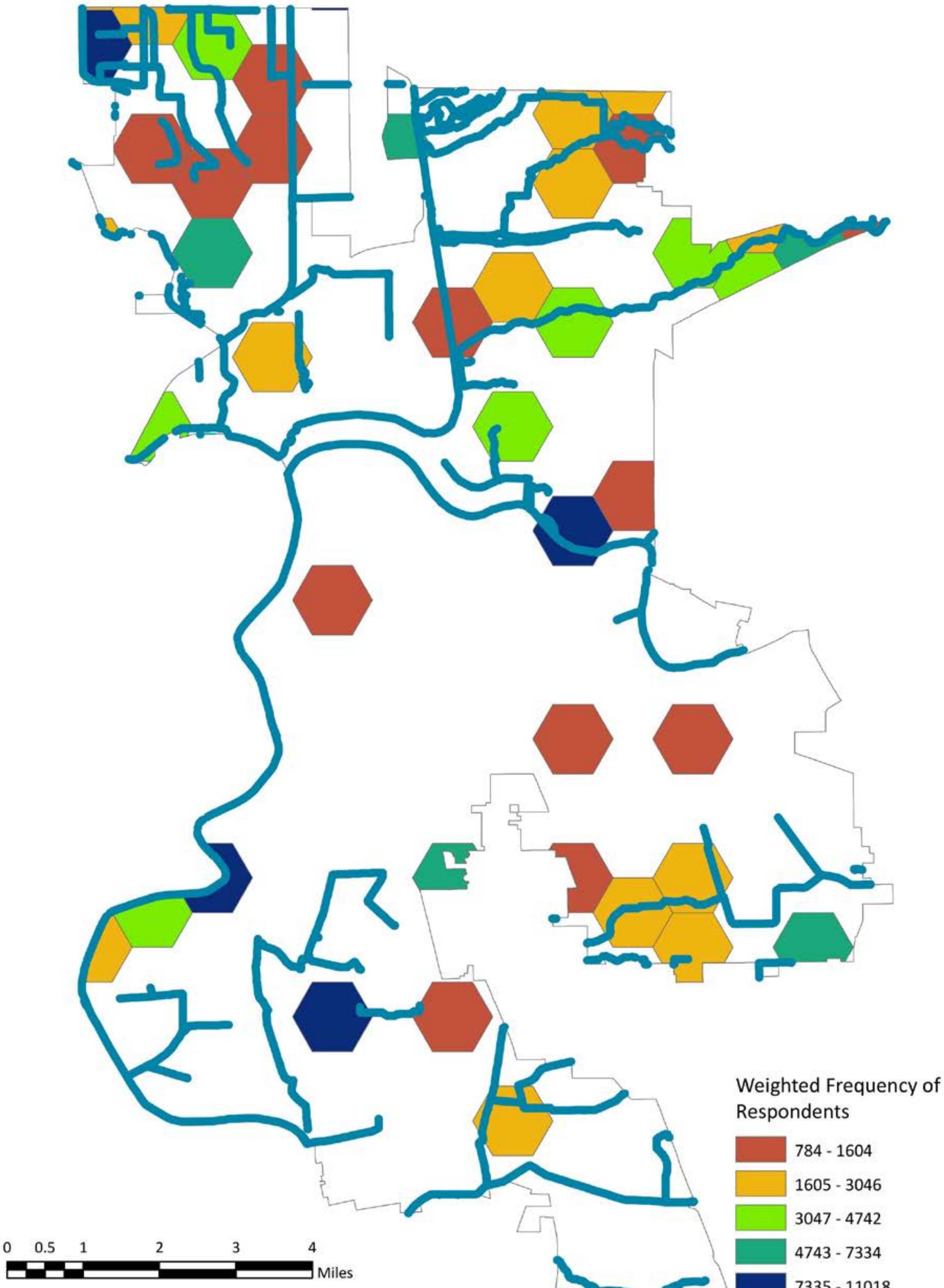

Figure 41: Respondents Having Walked at least 10 Minutes in the Last 7 Days for Leisure

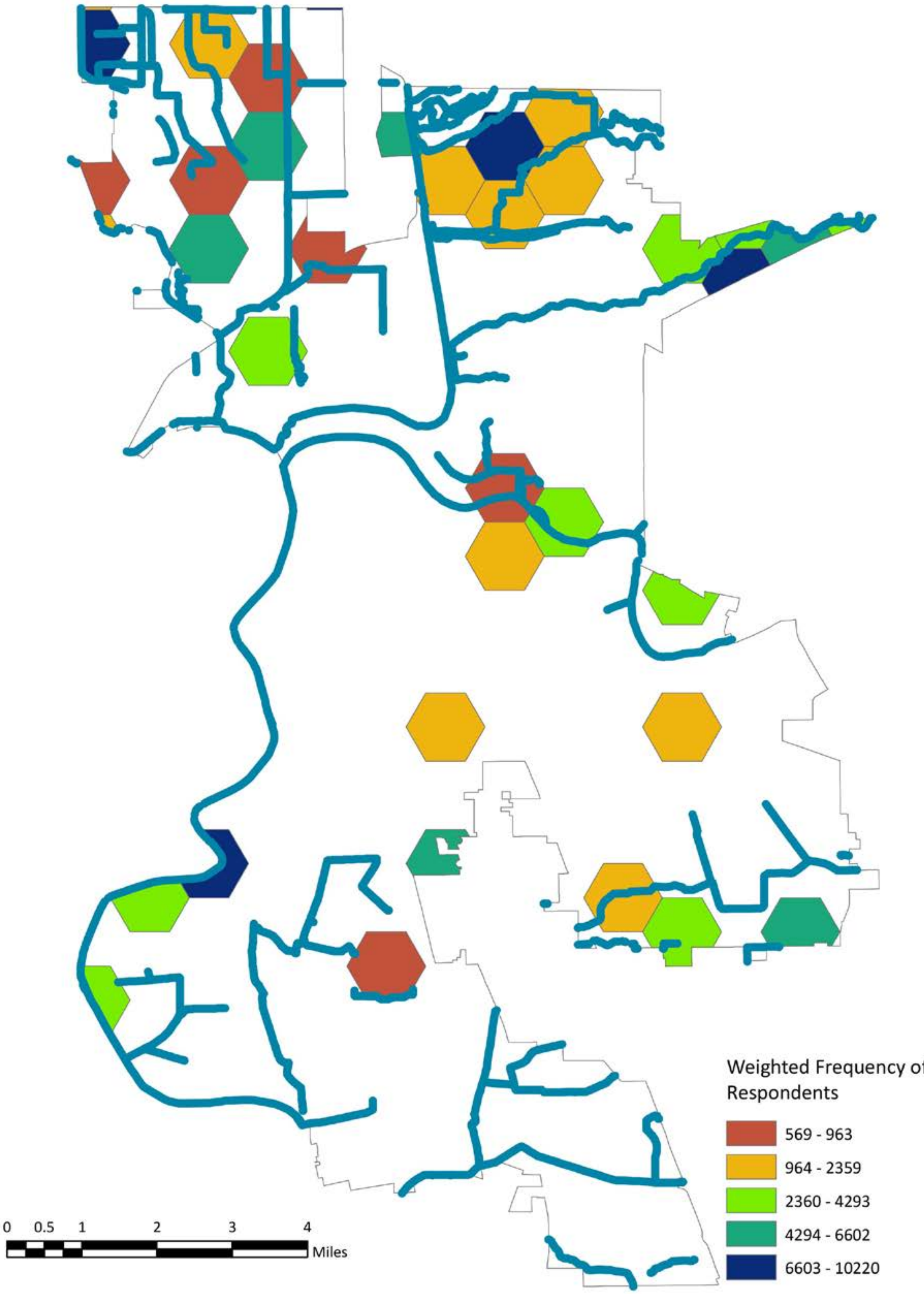

Figure 42: Respondents Having Walked at least 10 Minutes in the Last 7 Days for Transport

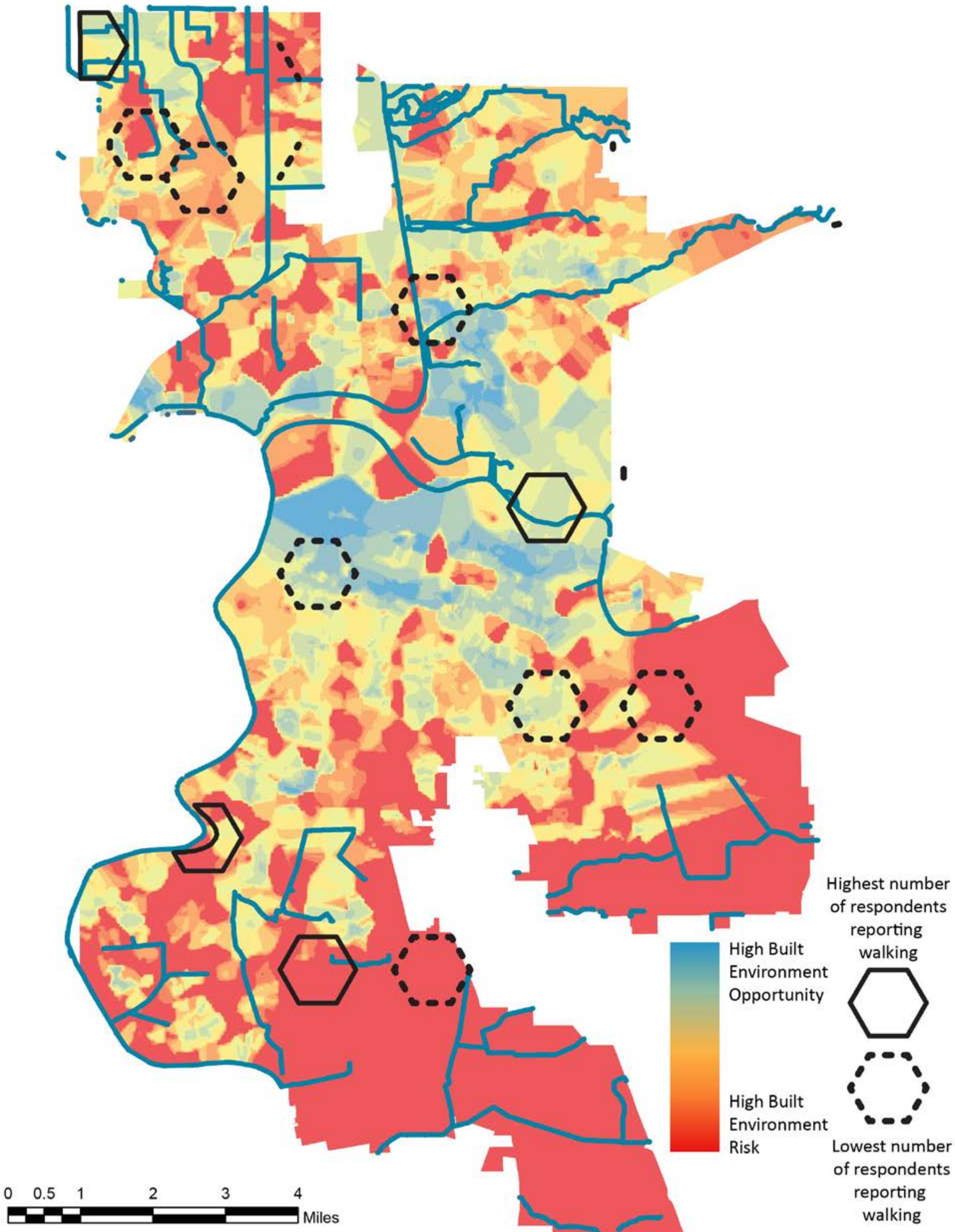

Figure 43: : Respondents having walked 10 minutes in the last 7 days for leisure, with built environment analysis

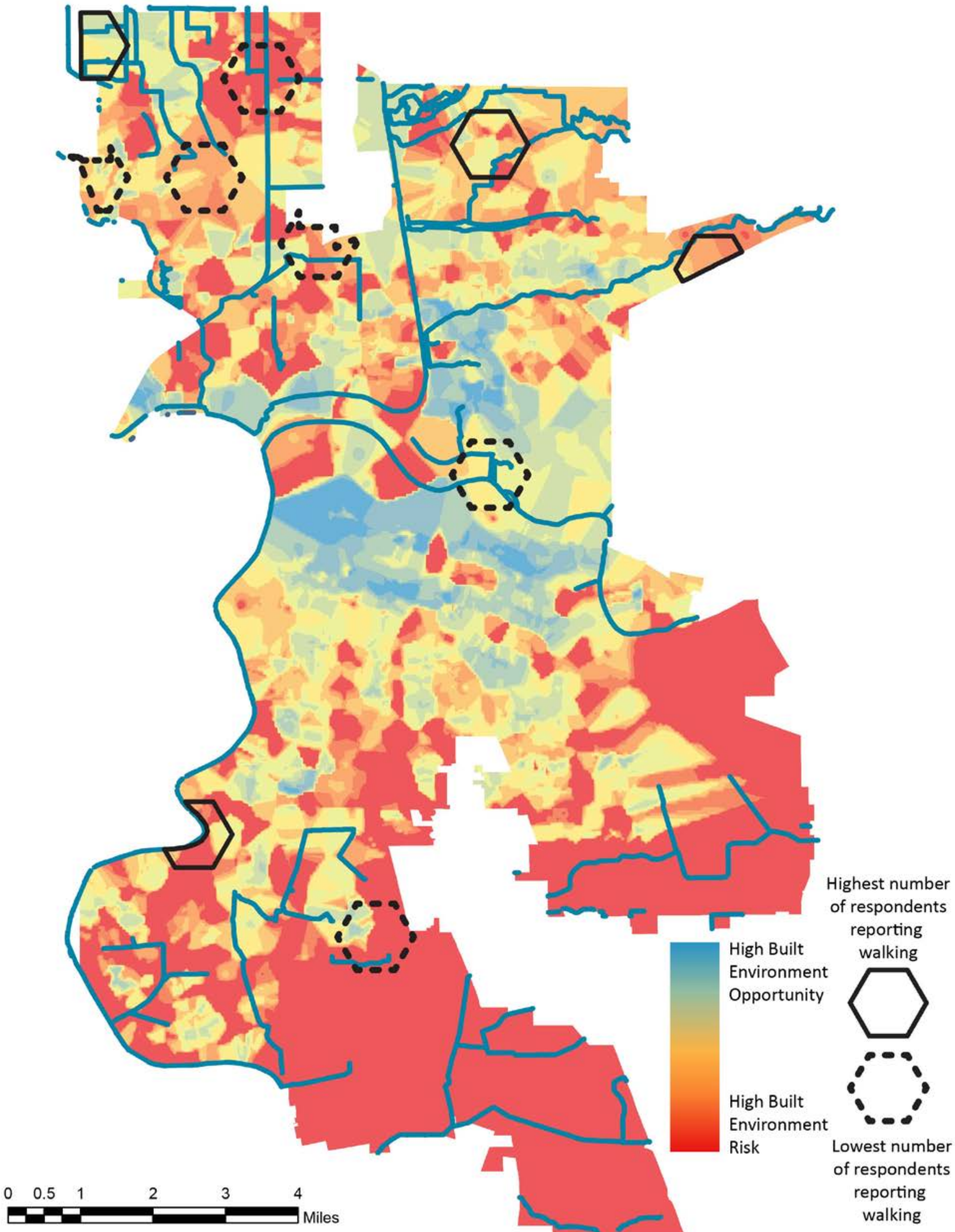

Figure 44: Respondents Having Walked 10 minutes in the Last 7 Days for Transport, with built environment analysis

Earlier, I posited that a landscape approach could uncover nuances about the built environment traditional study overlooks. Specifically, this method looks at the city in totality to contextualize features. Instead of discrete areas, this mapping reframes it as a continuous surface, and streets as a networked system. This differs from traditional walkability or health study, which seeks to extract neighborhoods as discrete units and anonymize them to generalize results. The landscape approach also recognizes the intricacy of urban systems. By looking at how components change both individually and in aggregate, we can better understand the uniqueness of neighborhoods, and what interventions are appropriate.

Networking the City

After the initial analysis was performed, I selected all parcel points that displayed medium to high walkability and mapped the street network between them (See Figure 45). The initial attempt to generate the network on only the pedestrian paths defined at the outset ultimately failed, as many of the outlying neighborhoods were fully disconnected. I had to reintegrate roads up to 40 miles per hour, even though they would not be ideal to walk along. Perhaps what this indicates, though, is the possibility of starting to adapt car-oriented infrastructure along this network to be more supportive of walking and biking in order to link stronger areas. Most crucially, it presents a spine into which to link areas of low opportunity and strengthen the built environment across the entire metropolis.

Koch (2005) discusses the use of maps to generate health hypotheses by relating the story of Joseph-Francois Malgaigne and his efforts in mapping the incidence of and finding the causes of hernias in France. One theory was that olive oil in cooking caused hernias, so he drew a line showing where people used olive oil in the southern part of the country, and where they used butter in the northern part. Says Koch:

> These lines of hypothesis were imposed on the landscape not because they represented objective data, 'real world things' observable in the landscape, but because they presented ideas that could be spatially articulated and graphically considered. They were artifacts of the researchers' thinking rather than obviously pertinent elements of the landscape. Each line framed an if/then proposition, each proposition representing a theory of hernia causation based upon regional differences. The result was a significant tool of investigation distinct from, but related to, that of statistical analysis (p. 47).

While this analysis does indeed measure "real world things," any mapping is an abstraction of the material world that attempts to clarify a relationship between visible and invisible phenomena. It is key to look at these maps both separately and together to understand the relationship between elements of the built environment and the strengths and weaknesses of neighborhoods on their own merits. When looking at certain elements of the built environment, sometimes it is just as important to leave out certain elements to find clarity as it is to include them all, a nuance that comprehensive walkability indices often overlook. For instance, resources play a significant role in accessibility, but less so in the comfort or safety of

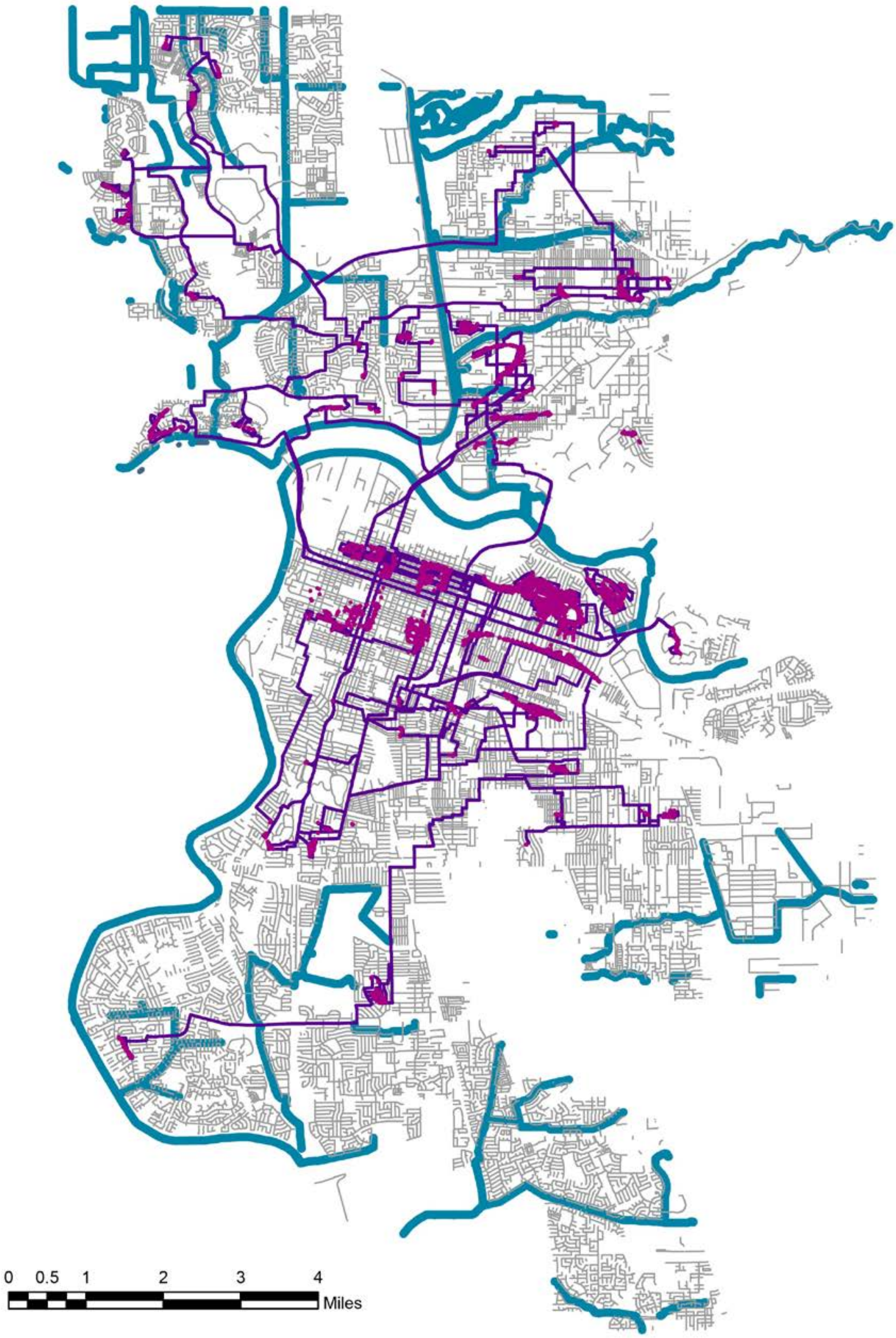

Figure 45: Networking Between Parcels of Greatest Opportunity

an environment. Urban landscape (as defined in this model), on the other hand, contributes greatly to the latter two, but less so to accessibility. Street networks mediate between the two. Additionally, evaluating these factors separately gives us a more robust idea of the built environment. For instance, a low instance of street intersections combined with low population density and lot coverage would indicate a less friendly environment for pedestrians, but an area with a higher number of street intersections with low population density and low lot coverage indicates an infrastructural potential to develop.

Moving Towards Intervention

This analysis is also meant to be the first step in crafting built environment interventions from large to small, but particularly for prioritizing the neighborhood scale. The method shown here is only the first tier of the framework proposed in the previous chapter. There are certain aspects of the environment that can only be understood by experiencing them, and ideally the next iterations of this evaluation would move down the scales shown on that theoretical model.

While recognizing that large scale change such as changing zoning regulation and major development is done by governmental bodies and major private enterprise, community organizations and local advocacy can be a powerful force to enact crucial changes, such as street upgrades or influencing what is built on individual parcels. On September 24, 2013, a preliminary version of the spatial model was shown to the the staff and advisory board members of WALKSacramento. They offered the following feedback on how it would be most useful to them as an organization:

- Primarily, most members emphasized that the tool that would be most useful to them was to attach costs to potential healthcare dollars spent for people that may be suffering from chronic disease due to built environment factors, or saved by making improvements. In addition, they cited the need for a cost per unit analysis to add pedestrian infrastructure such as greenery, streetlights and alleys to compare against the hypothetical healthcare dollars.

- Responding to a diagram shown similar to Alonzo's diagram of walking need hierarchy (2005), they talked about showing and prioritizing what kinds of interventions that would hit more than one tier on the hierarchy, for example, showing how trees offer both comfort and pleasure.

- Although it ultimately proved impossible to get for this particular analysis due to lack of citywide spatial data, they inquired about adding more fine-grained features such as stop signs, controls and curb cuts.

- Members also wanted a separate analysis for bikes. Moudon and Lee (2005) and Saelens, Sallis, and Frank (2003), among others, discuss the relationship of built environment, biking and health alongside walking. However, a spatial analysis of "bikability" would be looking at different infrastructures (bike lanes instead of sidewalks, for example), less emphasis on landscape factors (since speed is more important), and closer integration with traffic lanes. A comparison of how these requirements differ would be interesting, but considering “bikability” is its own wide body of literature, it is not further discussed here.

- Members wanted a way to find route optimization for walking.
- Members also wanted to include pedestrian injury as a health factor.
- Finally, they wanted to include the ability to see street by street issues.

From a designer’s standpoint, I see this analysis as a jumping off point to an improved toolkit for walkability. While there is no shortage of design guidelines for walkability out there, they often don’t have a view beyond remaking a single street or crossing, and without consideration of how it fits into a larger framework of urban contexts. Currently, while the New York City Active Design Guidelines are now the standard bearer in research-based design, one should keep in mind that the kinds of interventions right for a unique and super-urban place like New York City are not necessarily relevant to suburban or rural ones. Most of all, I maintain that walkability design guidelines must take into account analysis beyond small scale pedestrian audits to think more expansively about how to work within existing contexts. How can remaking vacant lots, adding passthroughs and alleyways, or even bridges improve the pedestrian network. The first step, though, is to recognize the generalized design patterns of walkability, or as described by Alexander (1977) “a problem that occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice” (p. x).

We should also think about environmental adaptation in conjunction with environmental intervention. Sometimes wayfinding, temporary markings or pop-up public spaces can make significant differences in a neighborhood. Nor can we overestimate the determinism of the physical environment, as designers and planners have done in the past. Successful interventions, particularly in places with drastic health inequities, should include some kind of program to encourage activity and become familiar with the aspects of the built environment (Stokols, 1992). For a comprehensive approach to improving walking, however, this sort of incremental urbanism should be done with the bigger picture in mind. That wider view includes looking at walking from the health equity or environmental justice standpoint. In most pedestrian plans, areas categorized as “high need” are only categorized as such from a physical environment view. Health and socioeconomic spatial analyses should come hand in hand with walkability audits in order to more meaningfully prioritize intervention.

CHAPTER NINE: CONCLUSION

Reflections On and Limitations of Research

While the scope of this dissertation's work is wide theoretically, pragmatically and methodologically it is admittedly small. At the outset of writing this dissertation, I believed casting a wide net of literature review was necessary, which is why almost the first half of this work is devoted to exploring the parallel histories and theories of public health and environmental design. As researchers from both begin to move between spheres, it is crucial that they (and I) are able to understand each other's language. By language, I mean something more than vocabulary—it is important to understand mindsets, methods and epistemology.

This is particularly crucial as the design fields make steps towards health-based interventions in the public realm. As discussed earlier, MIT's Center for Advanced Urbanism (CAU) has launched a "Health + Urbanism" initiative in conjunction with the American Institute of Architects and the Clinton Global Initiative. In co-director Alan Berger's words, the CAU aims for "real world impact," and to "transform one of these cities [selected for study] and their residents' health performance" (Green, 2013). Their first report, released in 2013, generated a great deal of press regarding its claims, most notably dismissing the existence of food deserts, the revival of the trope that people who are obese choose obesogenic environments that don't support physical activity (often characterized as suburbs), and most inflammatorily, that the majority of public health research is "soft" as it doesn't prove causality (Dizikes, 2013). Other, more nuanced revelations, also echoed here, were less discussed, such as the importance of looking at entire urbanized areas and systems in order to understand how to intervene, recognizing the uniqueness of each urban context and growing prejudice against suburban areas. However, the public health community understandably seized on the former assertions, resulting in a blistering public critique authored by Frumkin, Jackson and Dannenberg (2014). Saying the report "exemplifies a loose relationship with empirical evidence." (p. 2) and lamenting its "contrariness," these public health researchers obviously took the report as an affront to the past decade of health and built environment research and point out the lack of epidemiological or public health expertise, as well as pointing out many instances of misinterpreting cited research in the report. Berger and his colleagues in turn offered a rebuttal to the critique, accusing the researchers of ignoring their requests for collaboration and input and unstated affiliations with the Congress for New Urbanism. Yet they acknowledged that the report was not meant to be taken as a peer-reviewed paper, but the results of the first few months of a 10-year program (Berger, D'Hooge and Santos, 2014). While the public health researchers accuse the designers of sloppy methodology (which indeed is largely true—as of this writing, the original report has been scrubbed from the CAU website), the authors of the MIT report accuse the public health researchers of having a narrow view of what kind of design constitutes a "healthy" community. Both completely overlook the more nuanced critiques of each other's methods or opportunities to harness them together for more robust research. I have momentarily digressed to share this anecdote in order to demonstrate that for all the discussion of the need for cross-sectoral collaboration, there are still large cleaves in understanding between fields, which is why comprehensive exploration into the literature on both sides is so important.

As someone coming from the design field, it is also crucial to recognize the many limitations to the research contained in this dissertation. The objective of this mapping experiment was to see if interpreting the urban landscape from an environmental design standpoint can provide a better framework for health and activity studies. While the method shown here is successful in finding gradations of change in the built environment, ultimately, this method's effectiveness cannot be fully validated until defined geographic areas are drawn around areas of morphological similarity and used to execute a health survey. Additionally, a more comprehensive examination of components could include quality in addition to distribution, which would also illuminate equity of resources. For example, including information whether grocery stores offer fresh food, taking into account amenities in parks, and tree canopy cover, in addition to location, would more fully flesh out what kind of resources are available in each neighborhood.

Most studies on health and the built environment also discuss the limitations of cross-sectional studies, which I will repeat here. It will continue to be difficult to make true determinations on the effect of built environment on health until there are more longitudinal studies that look at health over the lifecourse in tandem with built environment changes. These would have to account not only for how the built environment in one place changes over time, but also for different kinds of urban contexts people may live in if they move to different neighborhoods. There is precedent about how to execute longitudinal studies on health outcomes and lifestyle behaviors, although that doesn't make it any less difficult or costly to execute them. However, there is almost no precedent on how to track changes in the physical environment, and methods for how to do so would be a significant contribution to the field.

While this research has shown that built environment information can be more effectively and efficiently measured for health research, obtaining a wide enough swath of health data to match is still an issue. As the mapping analysis has shown, even an interview survey as comprehensive as CHIS still leaves many gaps across a metropolitan area, making it difficult to measure at the same granularity of the built environment. Where this method can be of help is to find areas of interest for focused health surveys. This would be not only where high walkability coincides with positive health outcomes, or low walkability coincides with negative ones, but especially where empirical research is contradicted, such as where low walkability coincides with positive health outcomes and vice versa. These areas are most likely where yet unknown relationships can be found.

This particular mapping analysis was clearly done purely from an environmental design standpoint, and is only visual in nature. In order to come to more conclusive results, areas of interest would greatly benefit from a spatial statistics analysis. The limits of my own background, primarily in design, clearly highlight the need for cross-sector collaboration, particularly with someone better versed in epidemiology.

Future research on health should also make an effort to begin to translate health effects into dollar amounts and built environment interventions into possible savings. The changing structure of the American healthcare system favors preventive care over disease treatment, via subsidies and penalties for healthcare providers based on patients' return visits. The built environment will be a crucial component of physical activity-based efforts, and initiatives to improve our parks and streets could conceivably receive health funding in the future (Zusman, et al., 2014). Members of both Design 4 Active Sacramento and WALKSacramento emphasized that ways to show the unit cost of neighborhood and facility improvements against health savings benefits would be key to passing future reforms, and where a built environment analysis has the greatest implications for policy.

When these limitations are addressed through future research, the ultimate hope for this work is that it will be developed into a toolkit for intervention that works in different place contexts. As of this writing, I am continuing to work with Dr. Edie Zusman, Judy Robinson, and Dr. Karen Lee (leader of the New York City Active Design Guidelines) on developing the Active Design Exchange, an online wiki that will share policy and building toolkits on implementing active design from different groups across the nation.

The City and the Body: Final Thoughts on Health and Built Environment Research

There is a great deal of interest in health and the built environment right now, but when it comes to walking and the environment, the research stands at a crossroads. On one hand, it is starting to be utilized in writing design policy. Yet we are still years away from knowing how health-centered development will change daily lifestyles. Apart from this, though, current research is on the verge of folding over onto itself. The majority of literature that discusses walkability, or even health and the built environment in the more general sense, tends to reiterate the same, albeit important points: the need for cross-sector collaboration, the need for better metrics and more research on the psychological effects of the external environment. I offer five other pressing but undiscussed issues we as designers and researchers must also tackle in order to guide intervention, improve neighborhood health and avoid the pitfalls of the past movements surrounding the urban landscape and health.

1) Integrate research into a decision framework that includes spatial analysis. The spatial analysis discussed here is only a first attempt at clarifying the issues of built environment and walking. I also contextualize them to see where certain areas are lacking and in which respects. However, a systematic, standard protocol is needed, not just at the macro-scale of the city shown here, but at each subsequent scale down to street-level observation. Environmental design offers strong models not only to determine where there is need, but also to make decisions about how to act.

2) Consider what walkability means in different contexts. A standardized way of measuring and mapping the built environment for health will also give researchers a more nuanced idea of urban types beyond "urban" and "suburban." Many recommendations coming from the literature now—to increase density, diversify land use and even increase street intersections—would take years and policy changes to enact, and mostly apply to new development. Although many municipalities are positively moving in this direction, there are also opportunities to improve existing neighborhoods in the meantime through strategies such as utilizing vacant lots or finding pedestrian paths. There are simply formal and economic limits on how much we can "densify" certain areas. It is worthy to instead devote some energy to finding what kinds of interventions are right for neighborhoods from the rural to the inner-city.

3) Consider the urban landscape as an integrated system, not as a collection of parts. Despite claims to the contrary, much of the empirical research on walkability considers the built environment as discrete pieces. Making moves on the ground requires taking into consideration the ripple effects of changes. Even if the density of a neighborhood can be changed, how do we articulate building facades accordingly to make safe and friendly environments? If land use is changed, how will it impact landscape and traffic? How do sidewalk improvements lead into the network of the larger pedestrian infrastructure?

4) Approach walkability as a health equity issue. As discussed repeatedly here, there is a historic pattern of economic and actual abandonment when a certain urban typology becomes considered "unhealthy," in conjunction with a tendency to cast moral dispersions on the "unhealthy" residents who live within. We should reframe the discussion of walkable development to consider how it can help to right inequities in health, as well as to be aware of the risks of gentrification and displacement. This tenet is related to the next issue.

5) Approach interventions ecologically; harness physical change to social action. Changes to the built environment for health require social action on both the front end and the back end. It is important for communities to be informed of and have input into potential changes to their neighborhoods. Awareness of the environment will encourage residents to advocate for change they need and want. After intervention, health promotion programs are key to encouraging and continuing to support changes in lifestyles.

In addition, I suggest that advancing spatial analysis on built environment and health can answer two other crucial questions.

1) What is the "contagion" of chronic disease? As spatial tools and data gathering technology such as activity tracking gets progressively more advanced and we better articulate the pieces of the urban landscape, we may start to be able to come to a theory of chronic disease patterns, or "contagion" as it relates to the built environment. How types of chronic disease are confined to certain neighborhoods, how it spreads or how it misses other areas entirely is still largely unknown. Mapping and rigorous social science helped medical researchers of the past identify external causes of disease. Although chronic disease is far more dependent on the individual, the fact that it tends to occur in clusters merits further examination into the intersection of public health and the public realm.

2) How can network theory strengthen theories about walking behavior and health? Moving beyond the ever-lengthening and specified list of components that influence walkability to a more comprehensive view of the city also opens the door to other research questions, such as uncovering the spatial patterns of chronic disease itself. As urban analysis moves towards attempting to uncover the science of cities, looking for patterns of health and the built environment is a central question (Batty, 2012).

Many studying urban patterning argue that almost all aspects of the city such as economics, social interactions, etc. travel on networks (Batty, 2013; Bettencourt and West, 2010). Travel, particularly walking, is the primary network-based activity of all humans, but the actual and theoretical effects around that action have yet to be fully uncovered. Although most study is focused on what those are on the external, metropolitan scale, the value of walking reverberates to the inner life of the individual. Says author Rebecca Solnit in *Wanderlust: A History of Walking* (Solnit, 2000): *"*Walking, ideally, is a state in which the mind, the body, and the world are aligned, as though they were three characters finally in conversation together, three notes suddenly making a chord" (p. 5). "Walking, I realized long ago in another desert, is how the body measures itself against the earth" (p. 30).

All should be aware that it is impossible and even unwise to aim for a fully deterministic model of walking. Environmental design will always have a degree of uncertainty, a concept that is difficult for scientists, and indeed even many designers, to accept. However, a resilient and healthy neighborhood leaves room for change, and room for people to shape their own environments. One of the most difficult challenges to surmount is striking a balance between the rational and data-driven goal of health with the more abstract concepts of design. Perhaps instead, we should frame health as a rational goal that requires humanistic and artistic solutions. We have to accept a degree of uncertainty between the poetics and the mechanics of walking.

FIGURES

REFERENCES

Abu-Lughod, J. L. (1969). *The city is dead, long live the city; some thoughts on urbanity*. Berkeley: Center for Planning and Development Research, University of California.

Active Living Research. (2014). Tools and resources. Retrieved from http://activelivingresearch.org/toolsandresources/all

Adkins A., Dill J., Luhr G., and Neal M. (2012). Unpacking walkability: Testing the influence of urban design features on perceptions of walking environment attractiveness. *Journal of Urban Design, 17*(4), 499-510.

Ahima, R. S., and Lazar, M. A. (2013). The health risk of obesity--better metrics imperative. *Science* (New York, N.Y.), *341*(6148), 856-858. doi:10.1126/science.1241244 [doi]

Aicher, J. (1998). *Designing healthy cities: Prescriptions, principles, and practice*. Malabar, Fla.: Krieger Pub. Co.

Ainsworth, D., Diaz, H., and Schmidtlein, M. (2010). *2010 community needs assessment for greater Sacramento region.* (Community Needs Assessment). Sacramento, CA: Catholic Healthcare West; Kaiser Permanente; Sutter Health Sacramento Sierra Region; University of California, Davis Health System.

Alexander, Christopher, Ishikawa, Sara, and Silverstein, Murray. (1977). *A pattern language: Towns, buildings, construction*. New York: Oxford University Press.

Alfonzo, M. A. (2005). To walk or not to walk? The hierarchy of walking needs. *Environment and Behavior, 37*(6), 808-836.

Al-Hindi, K. F., and Staddon, C. (1997). The hidden histories and geographies of neotraditional town planning: The case of Seaside, Florida. *Environment and Planning D, 15*, 349-372.

American Institute of Architects. (n.d.). Practicing architecture: Design and health. Retrieved from http://www.aia.org/practicing/designhealth/

American Public Health Association. Committee on the Hygiene of Housing. (1960). *Planning the neighborhood.* Chicago: Public Administration Service.

American Society of Landscape Architects. (2014). Healthy and livable communities. Retrieved from http://www.asla.org/livable.aspx

Annerstedt, M., and Währborg, P. (2011). Nature-assisted therapy: Systematic review of controlled and observational studies. *Scandinavian Journal of Public Health, 39*(4), 371-388.

Appleyard, D. (1979). Environment as a social symbol: Within a theory of environmental action and perception. *Journal of the American Planning Association, 45:2*, 143-153.

Avella, S. M. (2003). *Sacramento: Indomitable city*. Charleston, SC: Arcadia Pub.

Awofeso, N. (2005). Re-defining 'Health'. *Bulletin of the World Health Organization, 83*, 802.

Badger, E. (July 2, 2013). Poverty maps from 1980 look astonishingly different compared to 2010. *The Atlantic Cities.* Retrieved from http://www.theatlanticcities.com/neighborhoods/2013/07/poverty-maps-1980-look-astonishingly-different-compared-2010/6084/

Banham, R. (1959). The city as scrambled egg. *Cambridge Opinion, 17*, 18-23.

Barton, H., Tsourou, C., and World Health Organization. Regional Office for Europe. (2000). *Healthy urban planning: A WHO guide to planning for people*. London: Published on behalf of the World Health Organization Regional Office for Europe by Spon.

Batty, M. (2012). Building a science of cities. *Cities, 29*, S9-S16.

Batty, M. (2013). The new science of cities. Cambridge, Mass.: MIT Press.

Beale, L. (2012). Line and junction connectivity. Retrieved from http://www.arcgis.com/home/item.html?id=3fa41b1f8b764879be8f21b4e7ffbabd

Berg, N. (2010). Specifically speaking: California's general plans get more prescriptive. *The Architect's Newspaper*. March 20, 2010. Retrieved from http://archpaper.com/news/articles.asp?id=4372

Berger, A. (2013). Report on the state of health and urbanism. (Academic Report). Cambridge, Mass.: Center for Advanced Urbanism.

Berger, A., D'Hooghe, A., and Santos, A.N. Time for Collaboration in Health and Urbanism. Retrieved at http://cau.mit.edu/sites/cau.mit.edu/files/attachments/news/Rebuttal_Report%20on%20the%20State%20of%20Health_Final.pdf

Bettencourt, L., and West, G. (2010). A unified theory of urban living. *Nature, 467*(7318), 912-913.

Boarnet, M., Joh, K., Siembab, W., Fulton, W., and Nguyen, M.T. (2011). Retrofitting the suburbs to increase walking: Evidence from a land-use-travel study. *Urban Studies, 48*(1), 129-159.

Bolstad, P. (2002). *GIS fundamentals: A first text on geographic information systems*. White Bear Lake, Minn.: Eider Press.

Borst, H. C., Miedema, H. M., de Vries, S. I., Graham, J., and van Dongen, J. E. (2008). Relationships between street characteristics and perceived attractiveness for walking reported by elderly people. *Journal of Environmental Psychology, 28*(4), 353-361.

Bosselmann, P. (2008). *Urban transformation: Understanding city design and form*. Washington, DC: Island Press.

Bradley, B. (2013). What Walk Score's food desert map misses about food access. *Next City,* October 20, 2014. Retrieved from http://nextcity.org/daily/entry/what-walk-scores-food-desert-map-misses-about-food-access

Brantingham, P. L., and Brantingham, P. J. (1993). Nodes, paths and edges: Considerations on the complexity of crime and the physical environment. *Journal of Environmental Psychology, 13*(1), 3-28.

Broadbent, A. (2011). What could possibly go wrong?—A heuristic for predicting population health outcomes of interventions. *Preventive Medicine, 53*(4), 256-259.

Brown, B. B., Yamada, I., Smith, K. R., Zick, C. D., Kowaleski-Jones, L., and Fan, J. X. (2009). Mixed land use and walkability: Variations in land use measures and relationships with BMI, overweight, and obesity. *Health and Place, 15*(4), 1130-1141.

Bruegmann, R. (2005). Sprawl: a compact history. Chicago: University of Chicago Press.

Burnham, D. H., Bennett, E. H., Moore, C., and Commercial Club of Chicago. (1993). *Plan of Chicago*. New York: Princeton Architectural Press.

Byrne, J., & Wolch, J. (January 01, 2009). Nature, race, and parks: past research and future directions for geographic research. *Progress in Human Geography, 33*, 6, 743-765.

Calthorpe, P., Corbett, M., Duany, A., Moule, E., Plater-Zyberk, E., and Polyzoides, S. (1991). *The Ahwahnee Principles*. Sacramento, CA: Local Government Commission. Retrieved from http://www.lgc.org/about/ahwahnee/principles

Campbell, M. (2005). What tuberculosis did for modernism: The influence of a curative environment on modernist design and architecture. *Medical History, 49*(4), 463-488.

Campoli, Julie. (2012). *Made for walking: Density and neighborhood form*. Cambridge, Mass.: Lincoln Institute of Land Policy.

Catalani, C., and Minkler, M. (2010). Photovoice: A review of the literature in health and public health. *Health Education and Behavior, 37*(3), 424-451.

Center for Health Leadership and Practice. (2014). NLAPH teams: National leadership academy for the public's health. Retrieved from http://www.healthleadership.org/team_nlaph

Centers for Disease Control and Prevention (CDC). (2014a). About BMI for adults. Retrieved from http://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/index.html

Centers for Disease Control and Prevention (CDC). (2014b). Obesity prevalence map. Retrieved from http://www.cdc.gov/obesity/data/prevalence-maps.html

Cerin, E., Conway, T. L., Saelens, B. E., Frank, L. D., and Sallis, J. F. (2009). Cross-validation of the factorial structure of the neighborhood environment walkability scale (NEWS) and its abbreviated form (NEWS-A). *The International Journal of Behavioral Nutrition and Physical Activity, 6*, 32-5868-6-32. doi:10.1186/1479-5868-6-32 [doi]

Cervero, R., and Kockelman, K. (1997). Travel demand and the 3Ds : Density, diversity, and design. *Transportation Research Part D, Transport and Environment, 2D*(3)

Chapin, F. S. (1940). An experiment on the social effects of good housing. *American Sociological Review, 5*(6), 868-879.

Chatman D.G. (2009). Residential choice, the built environment, and nonwork travel: Evidence using new data and methods. *Environment and Planning A, 41*(5), 1072-1089.

Chen, C., and Ackerly, D. C. (2014). Beyond ACOs and bundled payments: Medicare's shift toward accountability in fee-for-service. *Journal of the American Medical Association, 311*(7), 673-674.

Churchman, A. (1999). Disentangling the concept of density. *Journal of Planning Literature, 13*(4), 389-411.

City of Richmond (2014). Health in all policies: Richmond adopts a health in all policies (HiAP) strategy and ordinance. Retrieved from http://www.ci.richmond.ca.us/index.aspx?NID=2575

City of Sacramento. (2014). Geographic information systems data. Retrieved from http://www.cityofsacramento.org/gis/data.html

Clifton, K. J., Livi Smith, A. D., and Rodriguez, D. (2007). The development and testing of an audit for the pedestrian environment. *Landscape and Urban Planning, 80*(1-2), 95-110.

Comerio, M. C. (1981). Pruitt Igoe and other stories. *Journal of Architectural Education, 34*(4), 26-31.

Corburn, J. (2007). Reconnecting with our roots: American urban planning and public health in the twenty-first century. *Urban Affairs Review, 42*(5), 688-713. doi:10.1177/1078087406296390

Cranz, G., and Boland, M. (2004). Defining the sustainable park: A fifth model for urban parks. *Landscape Journal, 23*(2), 102-120.

Cullen, G. (1961). *Townscape.* New York: Reinhold Pub. Corp.

Cummins, S., Curtis, S., Diez Roux, A. V., and Macintyre, S. (2007). Understanding and representing `place' in health research: A relational approach. *Social Science and Medicine, 65*(9), 1825-1838.

Cutts, B. B., Darby, K. J., Boone, C. G., and Brewis, A. (2009). City structure, obesity, and environmental justice: An integrated analysis of physical and social barriers to walkable streets and park access. *Social Science and Medicine, 69*(9), 1314-1322. doi: 10.1016/j.socscimed.2009.08.020

Dannenberg, A. L., Frumkin, H. and Jackson, R. (2011). Making healthy places: designing and building for health, well-being, and sustainability. Washington, D.C.: Island Press.

Davidson, A. (2013). The president wants you to get rich on Obamacare. *The New York Times Magazine*. October 30, 2013. Retrieved from http://www.nytimes.com/2013/11/03/magazine/the-president-wants-you-to-get-rich-on-obamacare.html?pagewanted=all

Day, K., Boarnet, M., Alfonzo, M., and Forsyth, A. (2006). The Irvine–Minnesota inventory to measure built environments: Development. *American Journal of Preventive Medicine, 30*(2), 144-152.

Department of Transportation of City of Sacramento. (2006). *City of Sacramento Pedestrian Master Plan: Making Sacramento the walking capital*. Sacramento, CA: Department of Transportation of City of Sacramento.

Diez Roux A.V., Merkin S.S., Arnett D., Chambless L., Massing M., Nieto F.J., Watson R.L. (2001). Neighborhood of residence and incidence of coronary heart disease. *The New England Journal of Medicine, 345*(2), 99-106.

Diez Roux, A. V. (2001). Commentary - investigating neighborhood and area effects on health. *American Journal of Public Health, 91*(11), 1783.

Diez Roux, A. V. (2004). Estimating neighborhood health effects: The challenges of causal inference in a complex world. *Social Science and Medicine, 58*(10), 1953-1960.

Dizikes, Peter. (2013, November 21, 2013). 3 Questions: Alan Berger on cities and health. *MIT News.* Retrieved from http://newsoffice.mit.edu/2013/3q-alan-berger-on-cities-and-health-1121

Duany, A. (2013). Thursday morning plenary. *Living Community: The 21st Annual Event from the Congress of New Urbanism,* Salt Lake City, UT.

Duany, A., and Talen, E. (2002). Transect planning. *Journal of the American Planning Association, 68*(3), 245-266.

Duany, A., Plater-Zyberk, E., and Speck, J. (2000). *Suburban nation: The rise of sprawl and the decline of the American dream*. New York: North Point Press.

Duany, A., Speck, J., and Lydon, M. (2010). *The smart growth manual*. New York: McGraw-Hill.

Duarte, T. (2013, March 29, 2013). Interview with author.

Duarte, T., and Robinson, J. (2014, May 27, 2014). Joint interview with author.

Duncan, D. T., Aldstadt, J., Whalen, J., and Melly, S. J. (2013). Validation of walk scores and transit scores for estimating neighborhood walkability and transit availability: A small-area analysis. *GeoJournal, 78*(2), 407-416.

Dunham-Jones, E., and Williamson, J. (2009). *Retrofitting suburbia: Urban design solutions for redesigning suburbs*. Hoboken, N.J.: John Wiley and Sons.

Dunton, G., Kaplan, J., Wolch, J., Jerrett, M., and Reynolds, K. (2009). Physical environmental correlates of childhood obesity: A systematic review. *Obesity Reviews, 10*(4), 393-402.

Eid J., Turner M.A., Overman H.G., and Puga D. (2008). Fat city: Questioning the relationship between urban sprawl and obesity. *Journal of Urban Economics, 63*(2), 385-404.

Eisenstein, W., Szibbo, N., Macdonald, E., and Mozingo, L. (2014). *Pilot pedestrian rating tool for level of service (LOS).* Berkeley, CA: University of California Berkeley for the California Energy Commission.

Elliott, P., and Wartenberg, D. (2004). Spatial epidemiology: Current approaches and future challenges. *Environmental Health Perspectives, 112*(9), 998-1006.

Ellis, C. (2002). The new urbanism: Critiques and rebuttals. *Journal of Urban Design, 7*(3), 261-291.

Ewing R., and Cervero R. (2010). Travel and the built environment. *Journal of the American Planning Association, 76*(3), 265-294.

Ewing R., and Handy S. (2009). Measuring the unmeasurable: Urban design qualities related to walkability. *Journal of Urban Design, 14*(1), 65-84.

Ewing, R., Schmid, T., Killingsworth, R., Zlot, A., and Raudenbush, S. (2008). Relationship between urban sprawl and physical activity, obesity, and morbidity. *Urban Ecology,* 567-582.

Ewing, R. H., Kreutzer, R., Lawrence Frank and Company, and Design Community and Environment. (2006). *Understanding the relationship between public health and the built environment: A report prepared for the LEED-ND core committee.* Paris: Organisation for Economic Co-operation and Development.

Ewing, R., and Cervero, R. (2001). Travel and the built environment: A synthesis. *Transportation Research Record,* (1780), 87-113.

Eyler, A., Brownson, R. C., Bacak, S. J., and Housemann, R. A. (2003). The epidemiology of walking for physical activity in the United States. *Medicine and Science in Sports and Exercise, 35*(9), 1529-1536.

Ezzati, M., Martin, H., Skjold, S., Vander Hoorn, S., and Murray, C. J. (2006). Trends in national and state-level obesity in the USA after correction for self-report bias: Analysis of health surveys. *Journal of the Royal Society of Medicine, 99*(5), 250-257. doi:99/5/250 [pii]

Ferdinand, O.A., Sen, B., Rahurkar, S., Engler, S., Menachemi, N. (2012). The relationship between built environments and physical activity: A systematic review. *American Journal of Public Health, 102*(10), 7-13.

Fineberg, H. V. (2013, July 10, 2013). Editorial: The state of health in the U.S. *Journal of the American Medical Association.* E1-E2. Retrieved from http://jama.jamanetwork.com/article.aspx?articleid=1710485

Fisher, T. (2010, November 17, 2010). Frederick Law Olmsted and the campaign for public health. *Places Journal.* Retrieved from https://placesjournal.org/article/frederick-law-olmsted-and-the-campaign-for-public-health/

Fitzpatrick, K. M., and La Gory, M. (2000). *Unhealthy places: The ecology of risk in the urban landscape*. New York: Routledge.

Flores–Xolocotzi, R., and González–Guillén, M. d. J. (2007). Consideraciones sociales en el diseño y planificación de parques urbanos. *Economía, Sociedad Y Territorio, 6*(24), 913-952.

Florida, R. (2014, October 20, 2014). America’s healthiest metros. *CityLab.* Retrieved from http://www.theatlanticcities.com/arts-and-lifestyle/2012/01/healthiest-metros/367/

Florida, R. L. (2002). *The rise of the creative class: And how it’s transforming work, leisure, community and everyday life*. New York, NY: Basic Books.

Foltête, J. C., and Piombini, A. (2007). Urban layout, landscape features and pedestrian usage. *Landscape and Urban Planning, 81*(3), 225-234.

Forsyth A., Hearst M., Oakes J.M., and Schmitz K.H. (2008). Design and destinations: Factors influencing walking and total physical activity. *Urban Studies, 45*(9), 1973-1996.

Forsyth, A. (2007). Environment and physical activity: GIS protocols, version 4.1. Minneapolis: University of Minnesota.

Forsyth, A., Oakes, J. M., Schmitz, K. H., and Hearst, M. (2007). Does residential density increase walking and other physical activity? *Urban Studies, 44*(4), 679-697.

Frank, L. D., Andresen, M. A., and Schmid, T. L. (2004). Obesity relationships with community design, physical activity, and time spent in cars. *American Journal of Preventive Medicine, 27*(2), 87-96.

Frank, L. D., Schmid, T. L., Sallis, J. F., Chapman, J., and Saelens, B. E. (2005). Linking objectively measured physical activity with objectively measured urban form: Findings from SMARTRAQ. *American Journal of Preventive Medicine, 28*(2), 117-125.

Frank, T. (2013, June 13, 2013). In U.S. building industry, is it too easy to be green? *USA Today*.

Frank, L. D., Saelens, B. E., Powell, K. E., and Chapman, J. E. (2007). Stepping towards causation: Do built environments or neighborhood and travel preferences explain physical activity, driving, and obesity? *Social Science and Medicine, 65*(9), 1898-1914.

Frank, L. D., Engelke, P. O., and Schmid, T. L. (2003). *Health and community design: The impact of the built environment on physical activity*. Washington, DC: Island Press.

Frug, G. (2006). The legal technology of exclusion in North America. In Kruse, K. M., & Sugrue, T. J. (Eds). *The new suburban history* (pp. 205-220). Chicago: University of Chicago Press.

Frumkin, H., Frank, L. D., and Jackson, R. (2004). *Urban sprawl and public health: Designing, planning, and building for healthy communities*. Washington, DC: Island Press.

Frumkin, H., Jackson, R., and Dannenberg, A. (2014) Report on the State of Health + Urbanism: A Critique. Retrieved from http://www.architectmagazine.com/research/critique-of-report-on-the-state-of-health--urbanism_o.aspx

Galea, S., and Schulz, A. (2006). Methodological considerations in the study of urban health: How do we best assess how cities affect health? In N. Freudenberg, S. Galea and D. Vlahov (Eds.), *Cities and the health of the public* (pp. 277-293). Nashville, Tennessee: Vanderbilt University Press

Galster, G. (2001). On the nature of neighbourhood. *Urban Studies, 38*(12), 2111-2124.

Gans, H. J. (1968). *People and plans; essays on urban problems and solutions*. New York: Basic Books.

Gebel, K., Bauman, A., and Owen, N. (2009). Correlates of non-concordance between perceived and objective measures of walkability. *Annals of Behavioral Medicine, 37*(2), 228-238.

Gebel, K., Bauman, A. E., Sugiyama, T., and Owen, N. (2010). Mismatch between perceived and objectively assessed neighborhood walkability attributes: Prospective relationships with walking and weight gain. *Health and Place, 17*, 2, 519-524.

Gehl, J., and Svarre, B. (2013). *How to study public life*. Washington, DC: Island Press.

Gehl, J. (1987). *Life between buildings: Using public space*. New York: Van Nostrand Reinhold.

Gibbs, K., Slater, S., Nicholson, L., Barker, D., and Chaloupka, F. (2012). Income disparities in street features that encourage walking (Bridging the Gap Research Brief). Princeton, NJ: Robert Wood Johnson Foundation.

Giles-Corti, B., Broomhall, M. H., Knuiman, M., Collins, C., Douglas, K., Ng, K., Donovan, R. J. (2005). Increasing walking: How important is distance to, attractiveness, and size of public open space? *American Journal of Preventive Medicine, 28*(2), 169-176.

Giles-Corti, B., and Donovan, R. J. (2003). Relative influences of individual, social environmental, and physical environmental correlates of walking. *American Journal of Public Health, 93*(9), 1583.

Giles-Corti, B., Macintyre, S., Clarkson, J. P., Pikora, T., and Donovan, R. J. (2003). Environmental and lifestyle factors associated with overweight and obesity in Perth, Australia. *American Journal of Health Promotion, 18*(1), 93-102.

Gissen, D. (2009). *Subnature: Architecture's other environments: Atmospheres, matter, life*. New York: Princeton Architectural Press.

Goodyear, S. (2014, June 19, 2014). Making the real estate case for walkable places. *CityLab.* http://www.citylab.com/cityfixer/2014/06/making-the-real-estate-case-for-walkable-urban-places/372968/

Green, J. (2013, December 11, 2013) MIT's Advanced Urbanism. *The Dirt (Blog of the American Society of Landscape Architects)*. Retrieved from http://dirt.asla.org/2013/12/11/mits-advanced-urbanism/

Gorber, S. C., Tremblay, M., Moher, D., and Gorber, B. (2007). A comparison of direct vs. self-report measures for assessing height, weight and body mass index: A systematic review. *Obesity Reviews, 8*(4), 307-326.

Guerra, E., and Cervero, R. (2013). Is a half-mile circle the right standard for TODs? *ACCESS (42),* 17-21.

H. Edmund Mathews, OBE, FRIBA. (1934). Sanitation in modern architecture. *The Journal of the Royal Society for the Promotion of Health, 55*(4), 150-156.

Haiken, M. (2014a, March 13, 2014). The 10 laziest states in America - and the 10 most active. *Forbes.com*. Retrieved from http://www.forbes.com/sites/melaniehaiken/2014/03/13/the-10-laziest-states-in-america-and-the-10-most-active/

Haiken, M. (2014b, September 28, 2014). Top 20 healthiest cities in America 2014. *Forbes.com*. Retrieved from http://www.forbes.com/sites/melaniehaiken/2014/05/30/the-20-healthiest-cities-in-america-2014/

Hall, P. G. (1996). *Cities of tomorrow: An intellectual history of urban planning and design in the twentieth century*. Oxford: Blackwell Publishers.

Handy, S., and Mokhtarian, P. (2005). Which comes first: The neighborhood or the walking? *ACCESS* (26), 16-21.

Handy, S., Weston, L., and Mokhtarian, P. L. (2005). Driving by choice or necessity? *Transportation Research Part A: Policy and Practice, 39*(2), 183-203.

Handy, S. L., Boarnet, M. G., Ewing, R., and Killingsworth, R. E. (2002). How the built environment affects physical activity - views from urban planning. *American Journal of Preventive Medicine, 23*(2), 64.

Harris, R., and Lewis, R. (1998). Constructing a fault(y) zone: Misrepresentations of american cities and suburbs, 1900-1950. *Annals of the Association of American Geographers, 88*(4), 622-639.

Harris, R., and Lewis, R. (2001). The geography of North American cities and suburbs, 1900-1950: A new synthesis. *Journal of Urban History, 27*(3), 262-292.

Hayden, D. (2003). *Building suburbia: Green fields and urban growth, 1820-2000*. New York: Pantheon Books.

Healthy Community Design Expert Workshop, Centers for Disease Control and Prevention (U.S.) and National Center for Environmental Health (U.S.). (2010). Healthy community design expert workshop report. September 21-22, 2009.

Hess, P. M., Moudon, A. V., Snyder, M. C., and Stanilov, K. (1999). Site design and pedestrian travel. *Transportation Research Record: Journal of the Transportation Research Board, 1674*(1), 9-19.

Hester, R. T. (2006). *Design for ecological democracy*. Cambridge, Mass.: MIT Press.

Hewitt, R., and Szczygiel, B. (2000). Nineteenth-century medical landscapes: John H. Rauch, Frederick Law Olmsted, and the search for salubrity. *Bulletin of the History of Medicine, 74*(4), 708-734.

Hinkle, L.E., Loring, W.C., Center for Disease Control (1977). *The effect of the man-made environment on health and behavior: A report of the inter-university board of collaborators*. Washington, D.C.: Center for Disease Control, Public Health Service, U.S. Dept. of Health, Education, and Welfare.

Hippocrates, Adams, F., Brock, A. J., and Galen. (1955). *Hippocratic writings.* Chicago: Encyclopedia Britannica.

Howard, E., and Osborn, F. J. (1965). *Garden cities of to-morrow.* Cambridge, Mass.: M.I.T. Press.

Hurtado, A. L. (2013). John A. Sutter and the Indian business. In C. J. Castaneda, and L. M. A. Simpson (Eds.), *River city and valley life: An environmental history of the Sacramento region* (pp. 13-30). Pittsburgh, PA: University of Pittsburgh Press.

Innes, J., and Booher, D. (2010). *Planning with complexity*. London: Routledge.

Institute for Health Metrics and Evaluation. (2014). US health map. Retrieved from http://www.healthdata.org/data-visualization/us-health-map

Jackson, R., Dannenberg, A., and Frumkin, H. (2013). Health and the built environment: 10 years after. *American Journal of Public Health, 103*(9), 1542-4.

Jackson, L. E. (2003). The relationship of urban design to human health and condition. *Landscape and Urban Planning, 64*(4), 191-200.

Jacobs, A. B. (1993). *Great streets*. Cambridge, Mass.: MIT Press.

Jacobs, J. (1961). *The death and life of great American cities.* New York: Random House.

Jaffe, E. (2013, August 27, 2013). The suburbs are dead, long live the suburbs. *The Atlantic Cities.* Retrieved from http://www.citylab.com/housing/2013/08/suburbs-are-dead-long-live-suburbs/6680/

Jones, J. R. (1950). *Memories, men and medicine; a history of medicine in Sacramento, California; with biographies of the founders of the Sacramento society for medical improvement, and a few contemporaries.* Sacramento, CA: Sacramento Society for Medical Improvement.

Kaczynski, A. T., Koohsari, M. J., Stanis, S. A. W., Bergstrom, R., and Sugiyama, T. (2014). Association of street connectivity and road traffic speed with park usage and park-based physical activity. *American Journal of Health Promotion, 28*(3), 197-203.

Kaczynski, A. T., Potwarka, L. R., and Saelens, B. E. (2008). Association of park size, distance, and features with physical activity in neighborhood parks. *American Journal of Public Health, 98*(8), 1451-1456.

Kaplan, G. A., Salonen, J. T., Cohen, R. D., Brand, R. J., Syme, S. L., & Puska, P. (1988). Social connections and mortality from all causes and from cardiovascular disease: Prospective evidence from eastern Finland. *American Journal of Epidemiology, 128*(2), 370-380.

Kasirye, O. (2014, May 28, 2014). Interview by author.

Kaufman, J. S., and Cooper, R. S. (1999). Seeking causal explanations in social epidemiology. *American Journal of Epidemiology, 150*(2), 113.

Keirns, C. C. (2012). Allergic landscapes, built environments, and human health. In M. Zardini, G. Borasi, M. Campbell and Centre Canadien d'Architecture. (Eds.), *Imperfect health: The medicalization of architecture* (pp. 97-116). Montréal; Zurich: Canadian Centre for Architecture ; Lars Müller.

Khattak, A. J., and Rodriguez, D. (2005). Travel behavior in neo-traditional neighborhood developments: A case study in USA. *Transportation Research Part A: Policy and Practice, 39*(6), 481-500.

King, A. C., Satariano, W. A., Marti, J., and Zhu, W. (2008). Multilevel modeling of walking behavior: Advances in understanding the interactions of people, place, and time. *Medicine and Science in Sports and Exercise, 40*(7 Suppl), S584-93. doi:10.1249/MSS.0b013e31817c66b7 [doi]

Kneebone, E. and Garr, E., (2010). *The suburbanization of poverty trends in metropolitan America 2000 to 2008*. Washington, D.C.: Metropolitan Policy Program at Brookings.

Koch, T. (2005). *Cartographies of disease: Maps, mapping, and medicine*. Redlands, Calif.: ESRI Press.

Koch, T. (2011). *Disease maps: Epidemics on the ground*. Chicago: University of Chicago Press.

Kostof, S. (1985). *A history of architecture: Settings and rituals*. New York: Oxford University Press.

Krieger, N. (2000). Epidemiology and social sciences: Towards a critical reengagement in the 21st century. *Epidemiologic Reviews, 22*(1), 155-163.

Krieger, N. (2001). A glossary for social epidemiology. *Journal of Epidemiology and Community Health, 55*(10), 693-700.

Krieger, N. (1994). Epidemiology and the web of causation: Has anyone seen the spider? *Social Science and Medicine, 39*(7), 887-903.

Krieger, N. (2011). *Epidemiology and the people's health: Theory and context*. New York: Oxford University Press.

Kriesberg, J. (2013, June 7, 2013). More suburban poor? Think again. *Rooflines Blog* (National Housing Institute). Retrieved from http://www.rooflines.org/3252/more_suburban_poor_think_again/

Krugman, P. (2013, July 28, 2013). Stranded by sprawl. *The New York Times*, pp. 17.

Kuh, D., and Ben-Shlomo, Y. (1997). *A life course approach to chronic disease epidemiology*. Oxford; New York: Oxford University Press.

Kuo, F. E., and Sullivan, W. C. (2001a). Environment and crime in the inner city does vegetation reduce crime? *Environment and Behavior, 33*(3), 343-367.

Kuo, F. E., and Sullivan, W. C. (2001b). Aggression and violence in the inner city: Effects of environment via mental fatigue. *Environment and Behavior, 33*(4), 543-571.

Lathey, V., Guhathakurta, S., and Aggarwal, R. M. (2009). The impact of subregional variations in urban sprawl on the prevalence of obesity and related morbidity. *Journal of Planning Education and Research, 29*(2), 127.

Le Corbusier. (1967). *The radiant city: elements of a doctrine of urbanism to be used as the basis of our machine-age civilization*. New York: Orion Press.

Le Corbusier. (1971). *The city of tomorrow, and its planning* (3rd ed.) London: Architectural Press.

Lee, K. K. (2012). Developing and implementing the active design guidelines in New York City. *Health and Place, 18*(1), 5-7.

Lee, C., and Moudon, A. V. (2008). Neighbourhood design and physical activity. *Building Research and; Information, 36*(5), 395-411.

Leinberger, C. (2010, July 9, 2010) Walking - not just for cities anymore. *The Avenue Blog* (Brookings Institution). Retrieved from http://www.brookings.edu/blogs/the-avenue/posts/2010/07/09-walkable-spaces-leinberger

Leinberger, C. B., and Alfonzo, M. (2012). Walk this way: The economic promise of walkable places in metropolitan Washington, D.C. Washington, D.C.: Brookings Institution

Leopold, A., Schwartz, C.W. (1970). *A Sand County almanac: With essays on conservation from round river*. New York: Ballantine Books.

Lerner, M. (2011). Try “street smart” walk score. *Walk Score Blog.* Retrieved from http://blog.walkscore.com/2011/01/preview-street-smart-walk-score/#.VEXn_Pk7um4

Leslie E, Saelens B, Frank L, Owen N, Bauman A, Coffee N, and Hugo G. (2005). Residents’ perceptions of walkability attributes in objectively different neighbourhoods: A pilot study. *Health and Place, 11*(3), 227-36.

Leslie, E., Sugiyama, T., Ierodiaconou, D., and Kremer, P. (2010). Perceived and objectively measured greenness of neighbourhoods: Are they measuring the same thing? *Landscape and Urban Planning, 95*(1-2), 28-33.

Lewis, C.E., McTigue, K.M., Burke, L.E., Poirier, P., Eckel, R.H., Howard, B.V., Allison, D.B., Kumanyika, S., Pi-Sunyer, F.X. (2009). Mortality, health outcomes, and body mass index in the overweight range: A science advisory from the American heart association. *Circulation Circulation, 119*(25), 3263-3271.

Leyden, K. M. (2003). Social capital and the built environment: The importance of walkable neighborhoods. *American Journal of Public Health, 93*(9), 1546-1551.

Lindheim R, and Syme SL. (1983). Environments, people, and health. *Annual Review of Public Health, 4*, 335-59.

Link, B. G., and Phelan, J. (1995). Social conditions as fundamental causes of disease. *Journal of Health and Social Behavior,* 80-94.

Lo, R. H. (2009). Walkability: What is it? *Journal of Urbanism: International Research on Placemaking and Urban Sustainability, 2*(2), 145-166.

Lockett, D., Willis, A., and Edwards, N. (2005). Through seniors' eyes: An exploratory qualitative study to identify environmental barriers to and facilitators of walking. *Canadian Journal of Nursing Research, 37*(3), 48-65.

Lockton, D. (2011). Architecture, urbanism, design and behaviour: A brief review. *Architecture, 11*, 02-2009.

Lopez, R., and Hynes, H. P. (2006). Obesity, physical activity, and the urban environment: Public health research needs. *Environmental Health: A Global Access Science Source, 5*(1), 1-10.

Lopez, R. (2012). *The built environment and public health*. San Francisco: Jossey-Bass.

Lorig, K. R., Sobel, D. S., Ritter, P. L., Laurent, D., and Hobbs, M. (2001). Effect of a self-management program on patients with chronic disease. *Effective Clinical Practice, 4*(6), 256-262.

Lovasi GS, Hutson MA, Guerra M, and Neckerman KM. (2009). Built environments and obesity in disadvantaged populations. *Epidemiologic Reviews, 31*, 7-20.

Lukez, P. (2007). *Suburban transformations*. New York: Princeton Architectural Press.

Lynch, K. (1960). *The image of the city.* Cambridge, Mass.: Technology Press.

MacDonald, E., Sanders, R., and Supawanich, P. (2008). The effects of transportation corridors' roadside design features on user behavior and safety, and their contributions to health, environmental quality, and community economic vitality: A literature review. Berkeley, CA: University of California Transportation Center.

Macintyre, S., Ellaway, A., and Cummins, S. (2002). Place effects on health: How can we conceptualise, operationalise and measure them? *Social Science and Medicine, 55*(1), 125-139.

Marcus, C. C., and Barnes, M. (1999). *Healing gardens: Therapeutic benefits and design recommendations*. New York: Wiley.

Maslow, A. H. (1968). *Toward a psychology of being*. Princeton, N.J.: Van Nostrand.

Matthews, A. M. (1982). *Golden Notes: The great flood of 1861* (Vol. 28, 2nd ed.). Sacramento, CA: Sacramento County Historical Society.

May, J. M. (1961). *Studies in disease ecology.* New York: Hafner Pub. Co.

McClellan, M., McKethan, A. N., Lewis, J. L., Roski, J., and Fisher, E. S. (2010). A national strategy to put accountable care into practice. *Health Affairs (Project Hope), 29*(5), 982-990. doi:10.1377/hlthaff.2010.0194; 10.1377/hlthaff.2010.0194

McCormack, G., Giles-Corti, B., Lange, A., Smith, T., Martin, K., and Pikora, T. (2004). An update of recent evidence of the relationship between objective and self-report measures of the physical environment and physical activity behaviours. *Journal of Science and Medicine in Sport, 7*(1), 81-92.

McHarg, I. L., and American Museum of Natural History. (1969). *Design with nature*. Garden City, N.Y.: Published for the American Museum of Natural History [by] the Natural History Press.

McMichael, A. J. (1999). Prisoners of the proximate: Loosening the constraints on epidemiology in an age of change. *American Journal of Epidemiology, 149*(10), 887-897.

Mearns, A. (1883). *The bitter cry of outcast London.* London: J. Clarke.

Melosi, M. V. (2008). *The sanitary city: Environmental services in urban America from colonial times to the present*. Pittsburgh, Pa.: University of Pittsburgh Press.

Mitchell, R., Gleave, S., Bartley, M., Wiggins, D., and Joshi, H. (2000). Do attitude and area influence health?: A multilevel approach to health inequalities. *Health and Place, 6*(2), 67-79.

Mitman, G. (2005). In search of health: Landscape and disease in american environmental history. *Environmental History, 10*(2), 184-210.

Mitman, G., and Numbers, R. (2003). From miasma to asthma: The changing fortunes of medical geography in america. *History and Philosophy of the Life Sciences, 25*(3), 391-412.

Mokdad, A. H., Ford, E. S., Bowman, B. A., Dietz, W. H., Vinicor, F., Bales, V. S., and Marks, J. S. (2003). Prevalence of obesity, diabetes, and obesity-related health risk factors. *Journal of the American Medical Association, 289*(1), 76-79.

Moser, D. (2013, March 8, 2013). Driven into poverty: Walkable urbanism and the suburbanization of poverty. *CityTank.Org*. Retrieved from http://citytank.org/2013/03/08/driven-into-poverty-walkable-urbanism-and-the-suburbanization-of-poverty/

Moudon, A. V., and Lee, C. (2003). Walking and bicycling: An evaluation of environmental audit instruments. *American Journal of Health Promotion, 18*(1), 21-37.

Moudon, A. V., Lee, C., Cheadle, A. D., Garvin, C., Johnson, D., Schmid, T. L., Lin, L. (2006). Operational definitions of walkable neighborhood: Theoretical and empirical insights. *Journal of Physical Activity and Health, 3*, 99.

Moudon, A. V., Hess, P. M., Snyder, M. C., and Stanilov, K. (1997). Effects of site design on pedestrian travel in mixed-use, medium-density environments. *Transportation Research Record.* (1578), 48-55.

Mujahid, M. S., Diez Roux, A. V., Morenoff, J. D., and Raghunathan, T. (2007). Assessing the measurement properties of neighborhood scales: From psychometrics to ecometrics. *American Journal of Epidemiology, 165*(8), 858-867.

Mumford, L. (1986). Yesterday's city of tomorrow. *Architectural Record, 132*, 139-144.

Nagel, C. E. (1957). In McGowan J., Simpson A. F. and Wemmer F. A. (Eds.), *Golden Notes: Sacramento cholera epidemic of 1850* (Vol. 4, 1st ed.). Sacramento, CA: Sacramento County Historical Society.

Nash, L. L. (2006). *Inescapable ecologies: A history of environment, disease, and culture in the history of California*. Berkeley: University of California Press.

New York Department of Design and Construction, Department of Health and Mental Hygiene, Department of Transportation, Department of City Planning, Office of the Mayor (2010). *Active design guidelines: Promoting physical activity and health in design*. New York: City of New York.

Nicolaides, B. (2006). How hell moved from the city to the suburbs: Urban scholars and changing perceptions of authentic community. In Kruse, K. M., & Sugrue, T. J. (Eds). *The new suburban history* (pp. 80-98). Chicago: University of Chicago Press.

Northridge, M. E., Sclar, E. D., and Biswas, P. (2003). Sorting out the connections between the built environment and health: A conceptual framework for navigating pathways and planning healthy cities. *Journal of Urban Health, 80*(4), 556-568.

Oakes, J.M., and Kaufman, J.M. (2006). *Methods in social epidemiology*. San Francisco, CA: Jossey-Bass.

Oakes, J. M. (2004a). Causal inference and the relevance of social epidemiology. *Social Science and Medicine, 58*(10), 1969-1972.

Oakes, J. M. (2004b). The (mis)estimation of neighborhood effects: Causal inference for a practicable social epidemiology. *Social Science and Medicine, 58*(10), 1929-1952.

O'Brien, M. (2014, April 7, 2014). Alameda County: Gentrification could be hurting public health. *Contra Costa Times.* Retrieved from http://www.contracostatimes.com/news/ci_25515971/alameda-county-gentrification-could-be-hurting-your-health.

O'Campo, P., and Caughy, M. O. (2006). Measures of residential community contexts. In Oakes, and J. S. Kaufman (Eds.), *Methods in social epidemiology* (pp. 193-207). San Francisco, CA: Jossey-Bass.

Ogden, C. L., Carroll, M. D., Kit, B. K., and Flegal, K. M. (2012). Prevalence of obesity and trends in body mass index among US children and adolescents, 1999-2010. *Journal of the American Medical Association, 307*(5), 483-490.

Olmsted, F. L. (1971). *Civilizing American cities; a selection of Frederick Law Olmsted's writings on city landscapes.* Cambridge, Mass.: MIT Press.

Orsi, R. (2013). Railroads and the urban environment. In Castaneda, C.J., Simpson, L., (Ed.), *River city and valley life: An environmental history of the Sacramento region* (pp. 77-100). Pittsburgh, PA: University of Pittsburgh Press.

Owens, K. M. (2013). River city: Sacramento's gold rush birth and transfiguration. In Castaneda, C.J., Simpson, L., (Ed.), *River city and valley life: An environmental history of the Sacramento region* (pp. 31-60). Pittsburgh, PA: University of Pittsburgh Press.

Papas, M. A., Alberg, A. J., Ewing, R., Helzlsouer, K. J., Gary, T. L., and Klassen, A. C. (2007). The built environment and obesity. *Epidemiologic Reviews, 29*(1), 129-143.

Parascandola, M. (2011). Causes, risks, and probabilities: Probabilistic concepts of causation in chronic disease epidemiology. *Preventive Medicine, 53*(4), 232-234.

Perry, C.A., Heydecker, W.D., Goodrich, E. P., Harrison, S.M., Adams, T., Bassett, E.M., Whitten, R.H. (1929). *Neighborhood and community planning*. New York: Regional Plan of New York and its Environs.

Peterson, C. E. (1965). Prefabs in the California gold rush, 1849. *The Journal of the Society of Architectural Historians,* 318-324.

Phelan, J. C., Link, B. G., Diez-Roux, A., Kawachi, I., and Levin, B. (2004). "Fundamental causes" of social inequalities in mortality: A test of the theory. *Journal of Health and Social Behavior, 45*(3), 265-285.

Pikora, T. J., Bull, F. C. L., Jamrozik, K., Knuiman, M., Giles-Corti, B., and Donovan, R. J. (2002). Developing a reliable audit instrument to measure the physical environment for physical activity. *American Journal of Preventive Medicine, 23*(3), 187-194. doi:DOI: 10.1016/S0749-3797(02)00498-1

Pretty, J. (2004). How nature contributes to mental and physical health. *Spirituality and Health International, 5*(2), 68-78.

Prince, S. A., Adamo, K. B., Hamel, M. E., Hardt, J., Gorber, S. C., and Tremblay, M. (2008). A comparison of direct versus self-report measures for assessing physical activity in adults: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity, 5*(1), 56-79.

Reese, P. (2011, November 5, 2011). Sprawl's spread speeds up. *The Sacramento Bee.* Retrieved from http://www.sacbee.com/2011/11/05/v-mobile/4033576_sprawls-spread-speeds-up.html

Reynolds, G. (2013, April 2, 2013). Easing brain fatigue with a walk in the park. *The New York Times*, pp. D5.

Rice University Kinder Institute for Urban Research. (2013). *The 32nd Kinder Institute Houston area survey: Tracking responses to the economic and demographic transformations.* (Research Report). Houston, Texas: Kinder Institute for Urban Resarch.

Richardson, B. W. (1876). *Hygeia: A city of health*. London: Macmillan.

Robert Wood Johnson Foundation. (2014). County health rankings and roadmaps. Retrieved from http://www.countyhealthrankings.org/

Robert Wood Johnson Foundation. (2014). Prevention saves lives. Retrieved from http://www.rwjf.org/en/topics/rwjf-topic-areas/prevention.html

Rodríguez, D. A., Khattak, A. J., and Evenson, K. R. (2006). Can new urbanism encourage physical activity?: Comparing a new urbanist neighborhood with conventional suburbs. *Journal of the American Planning Association, 72*(1), 43-54.

Roemmich, J. N., Epstein, L. H., Raja, S., Yin, L., Robinson, J., and Winiewicz, D. (2006). Association of access to parks and recreational facilities with the physical activity of young children. *Preventive Medicine, 43*(6), 437-441.

Rogers, E. B. (2001). *Landscape design: A cultural and architectural history*. New York: Harry N. Abrams.

Rudolph, L., Caplan, J., Ben-Moshe, K., and Dillon, L. (2013). *Health in all policies: A guide for state and local governments.* Washington, D.C.: American Public Health Association.

Rybczynski, W. (2009). The green case for cities. *The Atlantic*.

Sacramento Area Council of Governments (SACOG). (2010). *Blueprint 2020: Sacramento city summary statistics.* (Planning Report). Sacramento, CA: Sacramento Area Council of Governments (SACOG).

Sacramento County. (2014). Sacramento county GIS data library. Retrieved from http://www.sacgis.org/GISDataPub/Pages/default.aspx

Sacramento County Historical Society. (1978a). *Golden notes: Clear clean water* (Vol. 24, No. 4 ed.). Sacramento, CA: Sacramento County Historical Society.

Sacramento County Historical Society. (1978b). In McGowan J. (Ed.), *Golden notes: Miasma in Sacramento "A gross and palpable danger"* (Vol. 24, No. 3 ed.). Sacramento, CA: Sacramento County Historical Society.

Sacramento Tree Foundation. (2014a). *Green prescription technical documentation: Executive summary.* (Technical Summary). Sacramento, CA: Sacramento Tree Foundation.

Sacramento Tree Foundation. (2014b). Greenprint summit. Retrieved from http://sactree.com/GreenprintSummit

Saelens, B. E., Sallis, J. F., Black, J. B., and Chen, D. (2003). Neighborhood-based differences in physical activity: An environment scale evaluation. *American Journal of Public Health, 93*(9), 1552.

Sallis, J. F., Owen, N., and Fisher, E. B. (2008). Ecological models of health behavior. *Health Behavior and Health Education: Theory, Research, and Practice, 4*, 465-486.

Sallis, J. F., Cervero, R. B., Ascher, W., Henderson, K. A., Kraft, M. K., and Kerr, J. (2006). An ecological approach to creating active living communities. *Annual Review of Public Health, 27*, 297-322.

Sampson, R. J., Morenoff, J. D., and Gannon-Rowley, T. (2002). Assessing "Neighborhood Effects": Social processes and new directions in research. *Annual Review of Sociology, 28*, 443-478.

Sandul, P. J. P. (2013). "Both country town and bustling metropolis": How boosterism, suburbs, and narrative helped shape Sacramento's identity and environmental sensibilities. In Castaneda, C., Simpson, L., (Ed.), *River city and valley life: An environmental history of the Sacramento region* (pp. 158-181). Pittsburgh, PA: University of Pittsburgh Press.

Satariano, W. A., Ivey, S. L., Kurtovich, E., Kealey, M., Hubbard, A. E., Bayles, C. M., Prohaska, T. R. (2010). Lower-body function, neighborhoods, and walking in an older population. *American Journal of Preventive Medicine, 38*(4), 419-428.

Scheer, B. C., and American Planning Association. (2010). *The evolution of urban form: Typology for planners and architects*. Washington, D.C.: American Planning Association.

Schenker, H. M. (2003). Central Park and the melodramatic imagination. *Journal of Urban History, 29*(4), 375-393.

Schlossberg, M. (2006). From TIGER to audit instruments: Measuring neighborhood walkability with street data based on geographic information systems. *Transportation Research Record,* (1982), 48-56.

Schultz, S. K., and McShane, C. (1978). To engineer the metropolis: Sewers, sanitation, and city planning in late-nineteenth-century America. *The Journal of American History, 65*(2), 389-411.

Schulz, A., and Northridge, M. E. (2004). Social determinants of health: Implications for environmental health promotion. *Health Education and Behavior, 31*(4), 455-471.

Scott, J. C. (1998). *Seeing like a state: How certain schemes to improve the human condition have failed*. New Haven: Yale University Press.

Sevtsuk, A. (2010). *Path and Place: A Study of Urban Geometry and Retail Activity in Cambridge and Somerville, MA.* (Dissertation). Cambridge, MA: Massachusetts Institute of Technology.

Sharifi, A., and Murayama, A. (2013). A critical review of seven selected neighborhood sustainability assessment tools. *Environmental Impact Assessment Review, 38*(0), 73-87. doi:http://dx.doi.org/10.1016/j.eiar.2012.06.006

Sierra Sacramento Valley Medical Society. (2014). Programs: Walk with a doc. Retrieved from http://www.ssvms.org/Programs/WalkWithADoc.aspx

Smith, K. R., Brown, B. B., Yamada, I., Kowaleski-Jones, L., Zick, C. D., and Fan, J. X. (2008). Walkability and body mass index: Density, design, and new diversity measures. *American Journal of Preventive Medicine, 35*(3), 237-244.

Smith, S. J., and Easterlow, D. (2005). The strange geography of health inequalities. *Transactions of the Institute of British Geographers, 30*(2), 173-190.

Solnit, R. (2000). *Wanderlust: A history of walking*. New York: Viking.

Southworth, M. (2003). New urbanism and the American metropolis. *Built Environment*, 210-226.

Southworth, M., and Owens, P. M. (1993). The evolving metropolis: Studies of community, neighborhood, and street form at the urban edge. *Journal of the American Planning Association, 59*(3), 271-287.

Southworth, M. (2005). Designing the walkable city. *Journal of Urban Planning and Development, 131*(4), 246-257.

Speck, J. (2012). *Walkable city: How downtown can save America, one step at a time*. New York: Farrar, Straus and Giroux.

Stokols, D. (1992). Establishing and maintaining healthy environments: Toward a social ecology of health promotion. *American Psychologist, 47*(1), 6-22.

Su, J. G., Jerrett, M., McConnell, R., Berhane, K., Dunton, G., Shankardass, K., Wolch, J. (July 01, 2013). Factors influencing whether children walk to school. *Health and Place, 22,* 153-161.

Subramanian, S. V. (2004). The relevance of multilevel statistical methods for identifying causal neighborhood effects. *Social Science and Medicine, 58*(10), 1961-1967.

Sugiyama, T., Francis, J., Middleton, N. J., Owen, N., and Giles-Corti, B. (2010). Associations between recreational walking and attractiveness, size, and proximity of neighborhood open spaces. *American Journal of Public Health, 100*(9), 1752-1757.

Sugiyama, T., Leslie, E., Giles-Corti, B., and Owen, N. (2008). Associations of neighbourhood greenness with physical and mental health: Do walking, social coherence and local social interaction explain the relationships? *Journal of Epidemiology and Community Health, 62*(5), e9-e15.

Susser, M., and Susser, E. (1996). Choosing a future for epidemiology: II. from black box to Chinese boxes and eco-epidemiology. *American Journal of Public Health, 86*(5), 674-677.

Susser, M., and Stein, Z. (2009). *Eras in epidemiology: The evolution of ideas*. Oxford; New York: Oxford University Press.

Talen, E., and Shah, S. (2007). Neighborhood evaluation using GIS. *Environment and Behavior, 39*(5), 583-615.

Talen, E. (2002). Pedestrian access as a measure of urban quality. *Planning Practice and Research, 17*(3), 257-278.

Talen, E. (2011). The geospatial dimension in urban design. *Journal of Urban Design, 16*(1), 127-149.

U.S. Census Bureau. (2014a). Sacramento (city) QuickFacts. Retrieved from http://quickfacts.census.gov/qfd/states/06/0664000.html

U.S. Census Bureau. (2014b). Tiger/line shapefiles and tiger/line files. Retrieved from https://www.census.gov/geo/maps-data/data/tiger-line.html

U.S. Department of Housing and Urban Development. (2012). HUD NO.12-164. Retrieved from http://portal.hud.gov/hudportal/HUD?src=/press/press_releases_media_advisories/2012/HUDNo.12-164

U.S. Green Building Council. (2009). *Green neighborhood development: LEED reference guide for neighborhood development.* Washington, DC: U.S. Green Building Council.

UCLA Center for Health Policy Research. (2012). California health interview survey. Retrieved from http://healthpolicy.ucla.edu/chis/Pages/default.aspx

Unwin, R. (1912). *Nothing gained by overcrowding!: How the garden city type of development may benefit both owner and occupier*. London: Garden Cities and Town Planning Association.

Urban Land Institute. (2014). Building healthy places initiative. Retrieved from http://uli.org/research/centers-initiatives/building-healthy-places-initiative/

Velarde, M. D., Fry, G., and Tveit, M. (2007). Health effects of viewing landscapes - landscape types in environmental psychology. *Urban Forestry and Urban Greening, 6*(4), 199-212.

Von Hoffman, A. (1996). High ambitions: The past and future of American low-income housing policy. *Housing Policy Debate, 7*(3), 423-446.

Von Hoffman, A. (2008). The lost history of urban renewal. *Journal of Urbanism, 1*(3), 281-301.

Wallace, R., and Wallace, D. (1983). Urban fire as an unstabilized parasite: The 1976-1978 outbreak in Bushwick, Brooklyn. *Environment and Planning A, 15*(2), 207-226.

Wallace, R., and Wallace, D. (1990). Origins of public health collapse in New York City: The dynamics of planned shrinkage, contagious urban decay and social disintegration. *Bulletin of the New York Academy of Medicine, 66*(5), 391-434.

Wang, C., & Burris, M. A. (1997). Photovoice: concept, methodology, and use for participatory needs assessment. *Health Education & Behavior: the Official Publication of the Society for Public Health Education, 24,* 3, 369-87.

Warren, D. I. (1978). Explorations in neighborhood differentiation. *TSQ Sociological Quarterly, 19*(2), 310-331.

Wener, R. E., & Evans, G. W. (2007). A morning stroll levels of physical activity in car and mass transit commuting. *Environment and Behavior*, 39(1), 62-74.

Wheeler, S. (2008). The evolution of built landscapes in metropolitan regions. *Journal of Planning Education and Research, 27*(4), 400-416.

Wheeler, S. (2002). The new regionalism : Key characteristics of an emerging movement. *Journal of the American Planning Association, 68*(3), 267-278.

Williamson, J. (2013). *Designing suburban futures: New models from build a better burb.* Washington, D.C.: Island Press.

Winslow, C. E. A. (1980). *The conquest of epidemic* disease. Madison: University of Wisconsin Press.

Wolch, J., Wilson, J. P., and Fehrenbach, J. (2005). Parks and park funding in Los Angeles: An equity-mapping analysis. *Urban Geography, 26*(1), 4-35.

Yamada I., Brown B.B., Smith K.R., Zick C.D., Kowaleski-Jones L., and Fan J.X. (2012). Mixed land use and obesity: An empirical comparison of alternative land use measures and geographic scales. *Professional Geographer, 64*(2), 157-177.

Young, T. (1995). Modern urban parks. *Geographical Review,* 535-551.

Younger, M., Morrow-Almeida, H. R., Vindigni, S. M., and Dannenberg, A. L. (2008). The built environment, climate change, and health. *American Journal of Preventive Medicine, 35*(5), 517-526.

Zardini, M., Borasi, G., Campbell, M., and Centre Canadien d'Architecture. (2012). *Imperfect health: The medicalization of architecture*. Montréal; Zurich: Canadian Centre for Architecture; Lars Müller.

Zusman, E. E., Carr, S. J., Robinson, J., Kasirye, O., Zell, B., Miller, W. J., Horton, M. B. (2014). Moving toward implementation: The potential for accountable care organizations and private–public partnerships to advance active neighborhood design. *Preventive Medicine* [in press].