ADAPTIVE REUSE OF SURFACE PARKING LOTS FOR WINTER-CITY STREETSCAPE IMPROVEMENT: A CASE STUDY OF SASKATOON, SK

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Above all, do not lose your desire to walk.

Everyday, I walk myself into a state of well-being & walk away from every illness. I have walked myself into my best thoughts, and I know of no thought so burdensome that one cannot walk away from it. But by sitting still, & the more one sits still, the closer one comes to feeling ill.

Thus if one just keeps on walking, everything will be all right.

- Søren Kierkegaard

ABSTRACT

In winter-cities such as Saskatoon there exists a significant potential to improve cold-weather walking conditions for most pedestrians. To realize the walkability potential of a winter-city downtown, by necessity automobile traffic must be reduced. However, when surface parking lots are permitted to operate in abundance, isolated and uncoordinated, and detached from overall planning and transportation policy, automobile traffic reduction downtown cannot be efficiently achieved. In many winter-cities, Saskatoon included, downtown parking lots in fact are oversupplied. Vital space for housing, employment and public space is thereby reduced and pedestrian winter exposure to wind chill and sidewalk ice is increased by breaks in the urban fabric. Systematic conversion of surface parking lots into mixed use would not only enhance incentives to walk, but simultaneously would reduce the incentive to drive. The question thus arises whether and how can we screen a large number of surface parking lots for a limited number of candidate-sites that could be earmarked for infill redevelopment. A screening methodology that prioritizes potential parking-lot sites ought to account for a wide range of criteria that address urban design, development-potential, proximity, and microclimate. In a case study of parking-lots in downtown Saskatoon, a screening methodology has yielded one priority site out of an inventory of twenty-four sites. Integrated within public transit policy the proposed methodology has generic applicability to downtown areas elsewhere, and can advance the goal of safety and higher residential density downtown.

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LIST OF ABBREVIATIONS

AAA.	American Automobile Association
ACSM.	American College of Sports Medicine
CBC.	Canadian Broadcasting Corporation
CDC.	Center for Disease Control and Prevention
CFD.	Computational fluid dynamics
CMA.	Census Metropolitan Area
CMHC.	Canada Mortgage and Housing Corporation
CNU.	Congress for the New Urbanism
COS.	City of Saskatoon
COE.	City of Edmonton
CPTED.	Crime Prevention through Environmental Design
DMTI.	Desktop Mapping Technologies Inc.
ESRI.	Environmental Systems Research Institute
GBCI.	Green Building Certification Institute
H/W.	Height width ratio
IHT.	Institution of Highways and Transportation
ILFI.	International Living Future Institute
ISC.	Information Services Corporation
IP.	Imperial Parking
LEED-ND.	Leadership in Energy and Environmental Design – Neighbourhood Development
MIT.	Massachusetts Institute of Technology
MPR.	Minimum Parking Requirements
NPS.	Non-point-source
RPAA.	Regional Planning Association of America
SIAST.	Saskatchewan Institute of Applied Science and Technology
SIIT.	Saskatchewan Indian Institute of Technology
TRB.	Transportation Research Board
UHIE.	Urban heat island effect
UN.	United Nations
U of S.	University of Saskatchewan
USEPA.	United States Environmental Protection Agency
USGBC.	United States Green Building Council
VKT.	Vehicle kilometres travelled
WCI.	Winter Cities Institute (formerly Living Winter Cities Inst.)

CHAPTER ONE: INTRODUCTION

The subject matter of this thesis, and therefore its driving purpose, revolves around three distinct yet interconnected topics: winter cities, parking, and urban infill. Distinction among these topics may seem obvious, but the way they are connected calls attention to a particular avenue within urban design literature that has yet to be explored. That link is walkability, which provides a nexus through which these generally disconnected strands of city planning can be combined. Walkability has been called the foundation for the sustainable city (Southworth & Forsyth, 2008), but in winter cities, when poor design and maintenance of pedestrian facilities combine with extensive automobile use and abundant parking, intentions for restoring walkability become seriously challenged. This thesis intends to underline the different concepts and perspectives that surround this issue (i.e., parking mismanagement, urban blight, automobile dependency), and provide the first steps towards a solution.

1.1. Walkability and Winter Cities

Pedestrians encounter far different circumstances in winter cities than in cities with mild or tropical climates. Surely, climate and weather play a major role in the decision to walk. Some have argued that the perception of weather, rather than the weather itself, might be the greatest deterrent to walking (Aultman-Hall, Lane, & Lambert, 2009). Nevertheless, considering all the climatic conditions that affect walking rates such as heavy rain, fog, storms, and temperature, snowy weather is believed to have the largest impact (Cools, Moons, Creemers, & Wets, 2010). Winter cities are defined as metropolitan regions geographically situated where air temperature is below 0°C (32°F) and outdoor water is frozen during a considerable part of the year (Pressman, 1995, p. 17). This generates a profound impact on travel behavior and patterns of urban life in general. While winter extends over a large part of the year, pedestrians are subject to snow, ice, wind-chill, and reduced hours of daylight (Leng & Yuan, 2007; Pressman 1996, p. 527). Collectively, these barriers make walking a much less desirable mode of transportation compared to private cars, which offer their users weather-sheltered trips in almost all conditions. For this reason, most winter cities have higher rates of automobile use.

Discussion about how architecture and urbanism interact with climate is now a sub-field of urban design and architecture called bioclimatic urbanism, and is based on the analysis of climate and ambient energy represented by the sun, wind, temperature and humidity (Watson & Labs, 2003). Although its roots go back centuries, recently, bioclimatic urbanism developed as a way to escape the negative effects of winter while embracing the positive ones. At the site planning scale, the objective of bioclimatic design is to create favourable microclimatic[1] conditions on streets, around buildings and entryways, and outdoor spaces, while reducing energy consumed from heating and cooling structures. Experts in the field of bioclimatic urbanism insist that being unaware of the effects that design can have on exposure to the sun, wind, humidity, and air temperature in the urban environment is a significant limitation to the design of any project, large or small (Brown, 2010, p. 2; Erell, Pearlmutter & Williamson, 2011). Geometric relations between building heights and street widths determine things like shadows and winds at the pedestrian level. Solar trajectories and the principal frequencies of winds should be taken into account in order to avoid visual and thermal discomfort (Corbella &

[1]Microclimate, as defined by Geiger (1965, pp. 1-3), refers to the conditions of an individual site, at or immediately near surface levels, as affected by its physical and spatial attributes. These include orientation, surface slope, surface moisture content, vegetation cover, and surface frictional drag (of structures, trees, topography).

Magalhães, 2008). Yet these considerations are seldom included in urban design policy and disregarded completely from tools meant to encourage location efficient development. This knowledge-gap is precisely what this thesis will highlight, since it has yet to be approached in scholarly research.

The greatest deterrent to walkability in cities is the land use patterns that allow the excessive use of automobiles to occur beyond an optimal level. Litman (2002) defines automobile dependency as high levels of per capita automobile travel, automobile-oriented land use patterns (Figure 1), and fewer transport alternatives. The reality is that most cities in North America would be classified as automobile dependent, which has its benefits and drawbacks: Rapid mobility being a major direct and internal benefit for motorists; declining quality in the walking environment being a major drawback for almost everyone else. Likewise, serious economic, environmental, and social problems have been linked to urban sprawl growth patterns as related to excessive

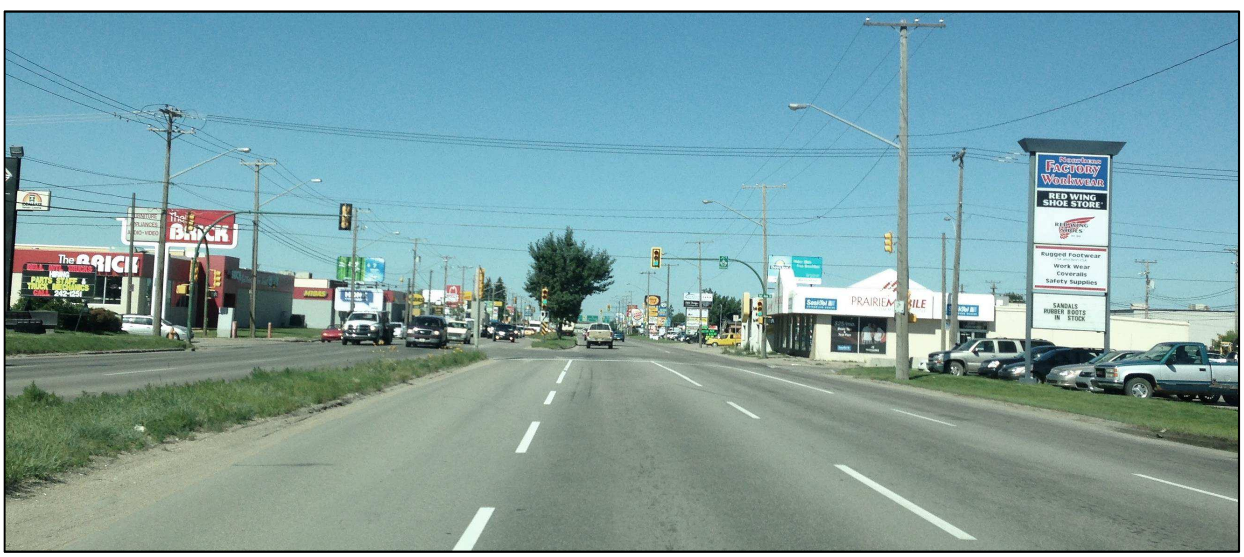

Figure 1. Automobile-oriented development, in the form of non-contiguous land uses, wide roadways accommodating high traffic volumes/speeds, and in the case of this photo, a lack of sidewalks, culminates in a very unaccommodating landscape for pedestrians. Circle Drive in Saskatoon, Canada.

automobile dependency (Frumkin, Frank, & Jackson, 2004; Lopez, 2004). Not surprisingly, in cities throughout the developed world there is considerable interest in how to overcome excessive automobile dependency (Newman, 2006). As well, the fields of urban design and public health have been drawn together by their mutual attention towards countering automobile dependency by creating more compact, walkable urban environments (Ewing & Handy, 2009).

1.2. Parking in the City-Centre

For cities in Canada's Prairie Provinces, where rates of per-capita automobile use are considerably high, congestion relief has been traditionally pursued by adding transportation capacity for automobiles (i.e., roads, parking). While this short-term solution may improve auto-mobility, it also undermines other modes such as public transit, cycling, and above all – walking[2], by inducing destinations to spread further apart (Levine & Garb, 2002). A popular opponent of the automotive approach to the city was William Whyte, an urban sociologist, known later for his writing and work as a planning consultant in New York City. Whyte, along with his small research group, The Street Life Project, devoted much to the analysis and design of downtown public spaces. He would later condemn cheap and abundant parking on the grounds that:

> "In some American cities, so much of the center has been cleared to make way for parking that there is more parking than there is city […], if they clear away any more of what's left, there would not be much reason to go there and park" (1988, p. 314).

[2] Since parking lots reduce overall density, they impede better transit (i.e., fewer destinations, smaller ridership, less frequent stops) and reduce incentives to use active transportation (cycling) due to fewer destinations throughout the route. In other words, having a neighborhood that is walkable (dense, connected, safe, etc.) is necessary for other modes to flourish like cycling and transit (rather than providing better transit and cycling routes as a strategy to improve walkability).

Whyte was pointing to the persistent conflict plaguing many cities between providing abundant parking, maintaining pedestrian traffic, and providing a high-quality public realm in the central business district [CBD]. Mukhija & Shoup (2007) identified this as a self-perpetuating cycle in which increasing the supply of parking only stimulates demand for it. Consequently, in many North American cities, there is an abundance of vacant downtown property being *under*used as surface parking (Thadani, 2010, p. 352). One study estimated that, at any one time, there are half a billion empty parking spaces across the continental U.S. (Betz, 2010). Canadian cities on the Prairies are also afflicted by too much surface parking. In Saskatoon, Winnipeg, and Calgary, surface parking covers 26%, 47%, and 27% of developable land, respectively (City of Saskatoon

Figure 2. In Saskatoon, approximately 24 privately-operated surface parking lots–like the one shown above–currently occupy the CBD. Photo: Saturday, February 9th, 2013 at 11:00 am.

[COS], 2011). In Saskatoon, the most recent traffic study estimated there were 4,800 surplus parking stalls downtown (Figure 2), with at least another 160 spaces to be added within the next 24 months (Colliers International, 2012b, p. 4).

Undoubtedly, parking lots provide a useful service to drivers and are an important part of urban transportation systems considering the majority of people in North America travel by car to most destinations. Parking lots, just as automobiles, are a central part of urban life, and an adequate supply of properly priced and well-located parking is crucial to the functioning of the city. However, parking lots can have a detrimental effect on the larger goal of achieving a more sustainable pattern of urbanism, which is dependent upon a balanced and efficient transportation system.

Whyte (1988) once stated, “The blight in parking lies in what is *not* there” (p. 314). From the pedestrian’s perspective, surface parking causes a break in the urban fabric. This tends to “interrupt the streetscape, expand distances between destinations, and undermine walkability” (Mukihija & Shoup, 2006, p. 296). For winter cities like Saskatoon, surface parking is especially problematic since wind chill exerts perhaps its most pronounced effect at wide-open spaces like parking lots. Pedestrian shelter from wind or snow, which would typically be offered by a dense urban fabric, is non-existent at parking lots or the sidewalks adjacent to them.

Donald Shoup (2011), a leading critic and scholar on parking policy has rigorously upheld cheap and plentiful parking to be directly at odds with the very aspect that makes a downtown area unique, namely, the density of people, services and amenities located in it (p. 159). Likewise, numerous studies have addressed issues related to parking across North American cities. Yet in spite of the severity of the problem posed by parking lots in winter cities, the link between parking and walkability in winter cities has yet to be addressed in scholarly research. This beckons for some investigation into how land for parking can be converted to help restore walkability to urban areas. One promising solution is the repurposing of surface parking lots by way of infilling them with mixed land uses, which this thesis intends to explore.

1.3. 'Walkable' Infill Development

The redevelopment of blighted urban land or infilling, where new development is channeled into existing urban areas and away from undeveloped ones, is a widely accepted strategy for promoting sustainable urban development (Duany & Speck, 2010, p. 1.6; Ewing, Pendall, & Chen, 2002). The revitalization of vacant, underused, or contaminated urban land avoids consuming greenfield land on the metropolitan fringe, and makes use of existing infrastructure and services (Thadani, 2010, p. 352). Greenfield locations have a competitive advantage over vacant sites in existing urban areas, in that they are relatively cheaper, lots are larger and less constrained by existing development, and financial markets are oriented around them (Fulton, 2010). For these reasons, only a small percentage of urban development occurs on brownfield or greyfield sites. The debate about infill, therefore, has hinged upon the desire to maintain the status quo of unbalanced suburban expansion, or permit certain neighbourhoods to densify and mature more naturally. Advocates insist it is about "focusing growth in places where it can properly be accommodated" (Ewing, Pendall, & Chen, 2002, p. 49). This view is supported by evidence suggesting that increased residential density can reduce dependence on automobiles, improve walkability, and thus, offset the negative impacts of suburban sprawl.

Over the past two decades, a handful of municipalities across North America have made efforts to rate or in other ways identify potential infill sites (U.S. Environmental Protection Agency [USEPA], 2012). Most have been incentive-based and applied as either a point system or checklist in order to show what changes produce a higher score. In practice, point/incentive programs have been the most effective tool for encouraging the right kind of development occurs at an infill site. This approach offers higher scores for achieving a higher benchmark, thus creating an incentive to adhere to what Litman (2012) categorized as *location-efficient* *development*. Location-efficient development is a way to designate areas where development should and should not happen. Similarly, studies have been dedicated to the development of decision support tools to assist the infill and brownfield revitalization process (Kirnbauer, 2012). Research has been broad in intent and varied in the specific type of decision designed to support, perhaps attributable to the complex nature and myriad of actors associated with infill/brownfield programs and policies (Bacot & O'Dell, 2006).

The significance of these tools, however, lies in how they encourage location-efficient development: growth is channeled to areas where public infrastructure is provided, access to destinations is greater, and commuting distances are lower (Litman, 2012). While current zoning codes and planning policies may favour suburban expansion over urban infill, rating systems or checklists can serve as incentives that encourage local governments and developers to choose locations that are more efficient. However, a common drawback among existing tools and rating systems is they overlook the regional climate, notably in winter cities that require unique urban design and architectural considerations.

It should be a necessity that any system used to evaluate the potential or performance of the built environment must incorporate factors related to local microclimate, if it is to maximize its beneficial outcomes. Therefore, this study sets itself apart in its attempt to evaluate and prioritize parking lots for repurposing to mixed use by strongly emphasizing factors related to walkability in winter. For instance, among other things, careful consideration was given towards the underlying potential of back alleys (adjacent to lots) to: 1) improve pedestrian connectivity and 2) provide a more comfortable urban microclimate by protecting from wind and preserving solar exposure.

1.3.1. Targeting Surface Parking Lots

In a recent work dedicated to the culture and design of parking, Eran Ben-Joseph (2012) stated, "parking lots are [...] so ordinary and familiar that we ignore their existence until we need them. Yet it is in this everyday, amorphous, banal, and repetitive collection of functional and utilitarian areas that an opportunity for change exists" (p. 9). Surface parking lots offer a unique infill opportunity to provide much needed density to an ailing downtown. The benefits of converting surface parking lots to mixed uses are far reaching, and include reducing overall vehicle miles travelled, enhancing the built environment for pedestrians, and improving safety and perception of security. To harness these benefits, municipalities must be able to identify which parking lots possess the most potential by understanding the dynamics between nearby land-uses and the built environment. Planners contend that urban design principles are based on the hypothesis that certain physical patterns support high-quality urban environments (Aurbach, 2005). That hypothesis ought to be tested, which is precisely why this thesis presents a method to recognize the physical patterns that are most conducive to walkability in winter cities.

As a potential target for infilling, the typical downtown surface parking lot requires a different frame of analysis than brownfields or vacant land for several reasons. One reason being that the potential for improving walkability by introducing mixed-uses is much greater for a downtown location—where density is already established—rather than an auto-oriented suburban location, where densities are lower and development is often non-contiguous. The sole purpose of a parking lot is to facilitate vehicular access to urban services and amenities. Due to the profit-driven nature of their operators, privately operated surface parking lots are located where people want or need to walk (i.e., downtown), and not low-density suburban neighbourhoods where walking primarily fulfills a recreational role and more importantly, parking is free. As a further advantage, parking lots located in a more compact urban core also typically have several points of access, namely a back alley (or two) which may be connected to a nearby node of activity and can improve connectivity if made into an enhanced pedestrian pathway. Potential infill sites located outside the urban core rarely offer the same potential for improving pedestrian connectivity, not because they lack alleys or pathways, rather they lack the necessary clustering of amenities and destinations within walking distance from one another.

Parking lots also require a different frame of analysis than vacant or brownfield sites because of their potential for reducing car-use in city-centre. Shoup (2011, pp. 194-195) confirmed that providing more parking downtown invites higher levels of car-use. Parking availability, therefore, is one of the most powerful demand management tools available, considering that abundant free parking can counteract virtually all other efforts to reduce vehicle kilometres travelled [VKT] or increase walking downtown (Cherry, Deakin, Higgins & Huey, 2006).

Underpriced and oversupplied parking creates a conflict for pedestrians as the majority of non-motorized travel occurs downtown and in areas near the city centre (Cervero & Kockelman, 1997; Salens, Sallis & Frank, 2003). Providing cheap and abundant parking downtown may increase vehicular mobility, but this comes at the expense of pedestrian access and the overall walking environment. More car-use also increases the demand for more parking, further perpetuating the cycle of automobile dependence. Consequently, systematic conversion of surface parking lots into mixed uses will not only provide an incentive to walk, it will simultaneously eliminate a major incentive to drive. Considering many cities are faced with increasingly scarce funds for transportation improvements, the identification of targeted areas for investments that offset automobile use and relieve traffic congestion would be cost effective (Leslie, et al., 2007).

1.4. Rationale of Study

Surface parking lots located in the urban core offers opportunity for repurposing to mixed uses. Higher density mixed uses can be built over a surface parking lot with no net effect to the parking supply[3]. Therefore, using criteria from the literature, this thesis develops an assessment tool to be applied in winter cities to assess viability of surface parking repurposing at a number of potential sites. Therefore, this study consists of carefully analyzing surface parking lots and their surrounding urban context to identify parcels that are highly suitable for infilling and converting to a mixed land-use (Figures 3 & 4). Justification is established for examining where an infill strategy would best fit into existing infrastructure, pedestrian linkages, land-uses, and microclimatic conditions of the study area, with the major criterion for selection being the

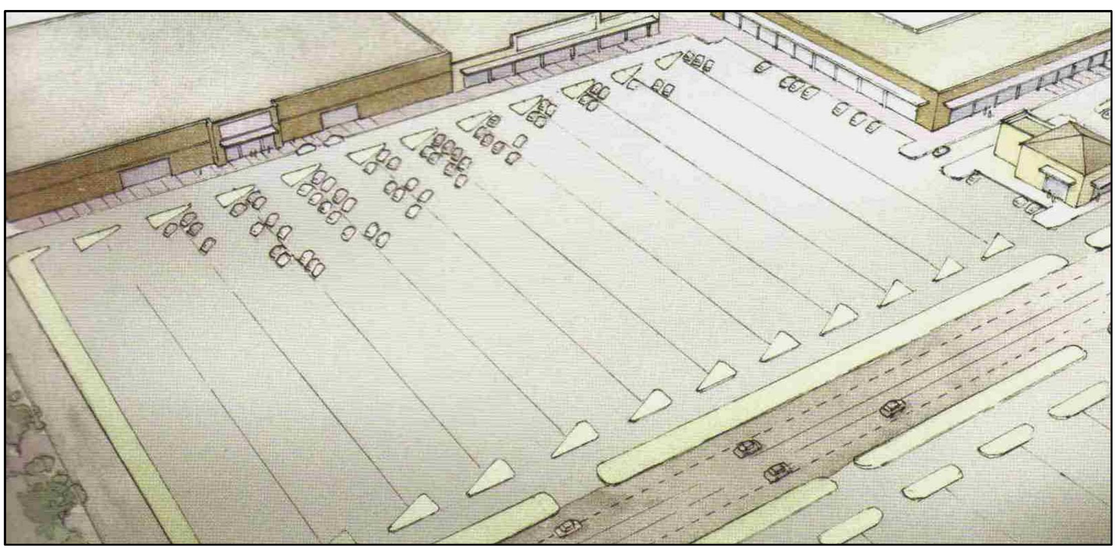

Figure 3. The most salient landscape feature of our built environment – the surface parking lot – makes an attractive site for walkable infill development.

[3] Parking can be provided underground, within the block shielded from pedestrian view, or within the core of a building hidden from outside view by a shell of commercial units and residential above. The point being that parking can still be provided, but it should not be provided by way of surface lots that abut the sidewalk in downtown districts where walkability is trying to be achieved.

potential that existing parking lots and adjacent back-alleys possess for enhancing the surrounding pedestrian realm.

Figure 4. Infilling with mixed-use buildings can gradually replace expanses of asphalt, forming an interconnected network of pedestrian pathways and public spaces. *Note*: images reprinted with permission from "The Strip Corridor Challenge" by V. Dover & J. Kohl, 2012, p. 71.

Places that are compact and mixed-use (such as downtowns) but offer little ability to get between destinations on a direct route should be identified and targeted for improvements in pedestrian connectivity (Leslie et al., 2007). Downtown surface parking lots represent a high-payoff area in this regard since, for some of them, the nearby built environment already possesses the qualities of what could constitute a walkable street (compactness, people, and destinations), except poor connectivity. By synthesizing appropriate data on parking lot characteristics, it would appear possible to develop a procedure that could identify specific parking lots that exhibit the greatest potential for redevelopment.

Davis, Pijanowski, Robinson, & Engel (2010) highlighted that changes such as converting unused parking lots when implemented on a large scale would reap the most benefit for walkability and overall aesthetics of the city. Similarly, architect and urban designer Ellen Dunham-Jones identified surface parking lots as a promising area of opportunity (Dunham-Jones & Williamson, 2011, p. xv). However, most cities have a much greater number of parking lots than resources available to put towards infill projects. It makes sense to proceed in phases beginning with parking lots that are most acutely in need of conversion, furthermore, raising the issue of which parking lot(s) should be selected for redevelopment first, and what would constitute the most suitable candidate? Approaching these questions invited the creation of a framework that can be used by planners during the preliminary assessment of other small- to medium-scale pedestrianization or infill projects in winter cities.

Dunham-Jones and Williamson (2011, p. xxi) recognize the use of "greyfield audits" as an important tool for encouraging infilling of vacant parcels and surface lots. However, this is not necessarily a recent planning endeavor. In the past, this has been referred to as *developability analysis*, and according to Chapin's (1957) classic text, *Urban Land Use Planning*, is a way to guide decisions about where to direct future growth. It is the process of "screening the land supply in order to locate areas suitable and desirable for future development or redevelopment" (p. 201). In this study the developability of land—traditionally, its capacity to be put to urban use—is refined to incorporate what is now regarded as major indicator of urban success, walkability: specifically how it can be supported (or constrained) through the built environment.

The effect of surface parking lots on walkability, or even the interaction between surface parking and pedestrian volumes, has been neglected in urban design and in transportation studies. This thesis is intended to address this research gap by developing a decision-support tool that will help planners, developers, and elected officials to make better project-level decisions for future urban development, specifically the redevelopment potential of urban core surface parking lots in winter cities. Whereas the majority of studies disregard climate from a design and planning standpoint, or were created and applied in cities with very mild climates, this thesis will address this omission by providing a comprehensive method to evaluate and prioritize potential infill sites based on which will yield the highest benefits in terms of increased pedestrian connectivity, volumes and thermal comfort.

1.5. Goal and Objectives

The broader goal of this thesis is to address the need for better pedestrian space in winter cities. This was approached by developing a decision-support tool to aid city builders (planners, urban designers, architects, developers, real-estate agents) in prioritizing surface parking lots for repurposing to a higher density mixed land use. It is based on similar indexing tools for identifying development potential yet is tailored to downtown surface parking lots in winter cities. This tool can help planners and developers take account of the full range of issues that must be considered from the earliest stages of the development process beginning with site selection. The potential for each parking lot is gauged by studying how effectively the nearby built environment would support or discourage pedestrian usage and how suitable introducing a medium to high-density mixed land use would be. The intent of this is threefold: to improve pedestrian connectivity; to enhance the retail core by promoting mixed-uses and ground floor retail; to provide opportunities for downtown housing, thereby addressing low nighttime population and stagnant population growth in the area. Therefore, the research question guiding this thesis asks:

What is the framework that would allow one to assess downtown surface parking lots in winter cities with a view of increased density and pedestrian movement?

Embedded in the research question are the following objectives:

Objective 1: To establish criteria sensitive to winter cities to be used in evaluating the potential of surface parking lots for mixed-use infilling

Objective 2: To synthesize the criteria into a measurable checklist and assign a rank to each parking lot in the context of a case study (Saskatoon, Canada)

Objective 3: To evaluate the results (ranking sequence & priority sites) and reconsider the significance of each criterion, in order to derive lessons learned from applying the tool

This thesis has been organized into six chapters. The present chapter introduces the project, including the context, goals, and objectives of the research. The second chapter introduces the major themes of this research in order to justify the importance of walkability in cities, and prepare a broader understanding of how walkability is achieved, namely in winter cities. The second chapter also covers several related issues on the topic of automobility, specifically how current policies on parking are detrimental to walkability, as well as existing methods used for identifying and evaluating potential infill sites. The third chapter consists of the methodology used during the research process, including a case study demonstrating how the research methodology was applied. The fourth chapter presents the overall results of the case study, including the final ranking sequence (or prioritization scheme) and any necessary re-calibration of the criteria. Chapter five provides a discussion of the results and their relationship to the research objectives. The sixth chapter offers conclusions from this research, including recommendations, implications, and significance of the tool that was created. A list of references used in this thesis is located in chapter seven. Detailed appendices can be found after the list of references, which includes a further explanation on the method used to estimate solar exposure and shadows in each of the parking lots and back alleys.

CHAPTER TWO: LITERATURE REVIEW

In order to build a foundation for the current study, a review of key literature is presented resting upon four interrelated themes pursued throughout: **1.** the influence of cold climate on urban design; **2.** the conflict between automobility and walkability; **3.** surface parking as an urban problem; and **4.** location-efficient development. The first section will give an overview of walking and cities, beginning from a historical perspective. Next, it will then introduce the role of cold climate in the organization and design of settlements, particularly how this has an effect on walking in cities. This discussion will then lead to topics that are more recent but applicable to the study, namely the contested relationship between walkability and automobility in the urban transportation system, and the debate between sprawl and compact urban form. The next section will outline the main factors related to walkability, including the most crucial elements to consider when planning for pedestrians. The introduction of surface parking as an urban problem is presented in the following section. The purpose of this section is not to vilify parking, as it is critical to urban transportation in automobile-oriented cities. In fact, parking is so important and takes up so much land in cities that it *deserves* to be rethought. As this section will argue, problems arise when parking is provided in an uncoordinated or haphazard manner. In this respect, large, downtown surface parking lots are framed as both an urban problem *and* opportunity, particularly for cities with cold climates. Since this study hinges on the assumption that the built environment can influence mode choice, section 2.6 gives a brief overview of this area of the literature. Finally, there is an overview of recent methods and tools created to evaluate the suitability of vacant urban land for redevelopment. Apart from introducing key concepts, this review will seek to uncover established and identifiable physical characteristics in the urban environment that support walkability. This will lay the groundwork for a discussion on the specific criteria that were selected for evaluating downtown surface parking lots on their potential for infilling.

2.1. A Brief History of Walking

The earliest and most extensive evidence for bipedalism or walking upright, the singular trait that defined the hominid lineage, was traced in 2009 from more than 110 specimens recovered from 4.4-million-year-old sediments in Ethiopia's Afar Rift (White et al. 2009). *Ardipithicus ramidus* retained primitive features such as long, curved fingers and toes, longer arms and shorter legs – an indication that the species main form of locomotion combined careful climbing with a form of terrestrial bipedalism. However, while early hominids were capable of walking upright, it was not until the emergence of *homo erectus* 1.89 million years ago that hominids grew tall, evolved long legs and relatively shorter arms, and became entirely terrestrial creatures, features that allowed them to expand geographically beyond a single continental region, originally Africa (Van Arsdale, 2013). For the species, this marked a point along an evolutionary pathway that would lead to the emergence early human civilizations and cities. Our ability as a species to stand upright and push off one foot, delicately balance the weight of our body, shift to the other foot and propel forward, is a universal human activity (Solnit, 2000, pp. 3-4).

Indeed the ability to walk upright was a major milestone in the cerebral development of human beings, and enabled a process of reflective thought that culminated in the capacity to make tools, count time, and measure physical distance. As these skills were honed, so was man's ability to build structures, monuments, and eventually cities, with early signs of systematic urban design appearing as early as 2600 BCE[1].

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[1] Mohenjo-daro (2600 BCE), the largest known city of the Indus Valley Civilization, provided the first signs of "systematic urban design" in the form of an orthogonal grid pattern of streets and blocks oriented to the cardinal points of the compass (Akkerman, 2012, p. 12).

2.2. Planning and Urban Design in Winter Cities

Local building traditions have always naturally considered climate in the organization and design of settlements (Eliasson, 2000). More than two-thousand years ago, Roman architect Vitruvius, in his treatise *De Architectura* stated "if our designs for private houses are to be correct, we must at the outset take note of the countries and climates in which they are built" (Vitruvius, 1914/1960, p. 166). During the Italian Renaissance, architect Leon Battista Alberti and later, Andrea Palladio explored the interaction between city layout and climate, in large part influenced by Vitruvius and other architectural writings from antiquity (Bosselman, Arens, Dunker & Wright, 1995). However, the Mediterranean climate of Rome, characterized by low latitude and excessive solar radiation, called for a drastically different approach to architecture and urbanism than the colder regions of northern Europe and what is now Canada.

Two centuries after Vitruvius, researchers have gathered huge amounts of data on the interaction between urban climate and the built environment; specifically, on the effects of wind speed, sunlight, and temperature as it relates to outdoor user comfort (Tacken, 1989; Arens & Bosselmann, 1989). Now, researchers and practitioners have available a number of tools and guidelines for urban planning such as climatic maps, wind tunnel simulations, thermal comfort indicators, and methods for modeling solar access (Eliasson, 2000).

Lenzholzer and Koh's (2010) study of Dutch squares looked at their actual microclimatic properties, and compared these with cognitive maps based on interviews. Their mixed-method approach argued that it is not only microclimate itself that people perceive, but also their visual perceptions of different spatial configurations (i.e., foot of buildings, entrance of street canyons, open squares). Chen and Ng (2011) analyzed research from the past decade on thermal comfort and outdoor activities, and recommended that town planners would benefit from a predicting tool for various design alternatives. This advice is somewhat expected, as the explosion in productivity created by widespread use of GIS in planning can now help sift through the complex invisible phenomenon of microclimate without having to familiarize oneself with the dynamic physics of it. Interestingly, knowledge on microclimate as it relates to the built environment progressed quite well through the ages since antiquity, long before computers and widespread access to information. However, now more than ever cities ignore what their ancestors knew for generations with respect to climate, or cite its complex nature as a barrier (Lenzholzer & Koh, 2010).

In spite of the available knowledge about climate and numerous promising examples from European countries (Gehl[2], 1987; 2010), the impact of climate and weather in the planning process for NA cities is quite low (Pressman, 1996, p. 526; 2005, p. 140). According to Patrick Coleman (2005), CEO of the Living Winter Cities Institute [WCI], overall the urban form, land-use patterns, development policies, and management strategies in Canadian cities have not been adequately adapted to winter. This is especially evident with regard to places for walking, even though it has been shown in practice that bioclimatic design can influence greater use of public spaces during cold winter months, and extend the comfortable outdoor season by up to six weeks (Pressman, 2005, p. 138).

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[2] Planner, architect, and renowned urbanist Jan Gehl was instrumental in the transformation of central Copenhagen from a car-dominated winter-city into one of the most walkable and bikeable major cities in Western Europe.

2.2.1. Recommendations for Winter Cities

Practical considerations are available within the literature regarding site selection, use of topography or vegetation, orientation of structures, location of building openings or outdoor spaces, and choice of building materials or surface colours (Bach & Pressman, 1992). Moreover, the literature has provided a range of innovative ways to structure urban space so that people can embrace winter weather rather than simply bear it (Pressman, 2005, pp. 139-140). For instance, Lenzholzer and Koh (2010) identified a number of "spatial configurations" (of the built environment) associated with certain microclimatic properties that have useful implications for urban design. Practical recommendations are:

i. <u>Open squares and acceptable height/width [H/W] ratios</u>

Height/width ratio sets the height of the surrounding buildings in relation to the adjacent street or square's depth (from wall to wall). Streets or open squares with a H/W ratio of less than 0.25 tend to be windswept, and therefore, should be avoided when possible. When this cannot be avoided, other remedies should be employed to mitigate the impact of wind such as vegetation, screens, or furniture.

ii. <u>Wind deflection at the foot of buildings</u>

The "foot areas" of tall buildings are perceived (and often proven) to be uncomfortably windy places (p. 12). This is especially problematic as the foot of buildings is also where most pedestrian movement takes place. The attempt should be made to deflect downward winds and snow drifts by adding awnings, overhangs, or canopies.

iii. <u>Semi-enclosed areas in terms of sun/wind</u>

It may seem obvious, but semi-enclosed areas are perceived to be the most comfortable areas in terms of wind and sun exposure. Therefore, it is ideal to provide semi-enclosed, south facing public spaces that offer protection from strong winds.

iv. <u>Avoiding sojourn functions at the entrances of "street-canyons"</u>

Street canyons are prone to higher wind speeds for two reasons: (1) they work as wind funnels due to higher pressure; and (2) since they are usually open on both ends, they often trap and channel wind, especially when oriented parallel to the prevailing wind direction. As a result, entrances to street canyons often receive an uncomfortable amount of wind. Lenzholzer & Koh (2010) pointed to how difficult this situation is to solve, since wind blows unpredictably from various directions. Unless landscaping or some type of screening is used to deflect the wind (which is difficult when a street also accommodates automobile traffic), sojourn functions like sitting or socializing should be avoided at the entrance of street canyons.

2.2.2. Role of Preference and Adaptation in Winter Cities

The previous recommendations are based on preferences taken from user interviews. The answer to how individual preferences actually influence walking behavior, however, is not yet evident (Zacharias, Stathopoulos, & Wu, 2001). Walton, Dravitzki, and Donn (2007) indicate that this is mainly due to people's ability to actively adapt to microclimatic conditions in outdoor urban environments, either by adding clothing, limiting exposure time, or seating themselves in particularly favourable locations. The extent that these measures affect thermal comfort, and thus, pedestrian activity, are difficult to separate from influences played by the spatial organization of built environment.

Weather can influence travel demand in different ways. The difficulty lies in pinpointing causality between cold weather and travel mode choice. This is in part due to a lack of understanding into how emotion, cognition, and activity influence tolerance levels for climatic comfort. Likewise, the psychological effects of thermal comfort on pedestrians have been studied extensively (Nikolopoulou & Lykoudis, 2006; Nikolopoulou, Baker, & Steemers, 2001; Nikolopoulou & Steemers, 2003). Nikolopoulou and Steemers' (2003) broad study of outdoor thermal comfort concluded that "although microclimatic parameters strongly influence thermal sensation, they cannot fully account for the wide variation between objective and subjective comfort" (p. 95). It is widely agreed that the physical environment plays an important role in outdoor thermal comfort, but a solely quantitative approach with regard to microclimate is inadequate and undermines the significance of psychological adaptation (Nikolopoulou, Baker & Steemers, 2001). As a result, for urban design, it is still necessary to consider the effects of urban microclimate on pedestrians without overlooking the variability in their tolerance and ability to adapt.

2.3. Automobiles and the Changing Shape of the City

Because walking was the primary means of human movement (other than cart, wagon, or slow-moving carriage), the layout of cities in antiquity and the Middle Ages – whether deliberately designed or spontaneously evolved, showed great attention to the welfare of pedestrians (Akkerman, 2008). Since antiquity until the industrial revolution and the onset of the modern city, it was necessary to lay out cities in a way that facilitated this type of human movement.

According to Southworth (2005), “patterns of activity had to be fine grained, density of dwellings had to be relatively high, and everything (homes, sanctuaries, markets) had to be connected by a continuous path network” (p. 247). Typically, cities would fit all the necessities of urban living within short walking distance from the central square; a pattern of urbanism that changed dramatically during the 20th century with the advent of the personal automobile.

While the world has been urbanizing for centuries, for most of the developed world the largest and most rapid phase of urbanization occurred in the decades following 1950, where the world urban population increased nearly fivefold from 0.75 billion to 3.63 billion in 2011 (United Nations [UN], 2012). Although the share of North American population in this increase was entirely negligible, automobile use in North America during this period exploded. Throughout what some have deemed the “urban age” (Burdett & Rode, 2011, p. 8), the dominant factor shaping cities in Canada and the United States was undoubtedly the automobile (Speck, 2012, pp. 75-80).

Society’s widespread adoption of personal automobiles had a profound effect on urban life, particularly the ability to move rapidly about the city. This dramatic improvement in personal mobility had the opposite effect on pedestrians as overall access steadily declined in most cities (Southworth & Forsyth, 2008). Increased mobility was eventually the catalyst for decentralization of urban populations and *sprawl*, characterized by relatively dispersed, low-density, single-family housing and non-contiguous, commercial strip developments served by a generous supply of free parking. This pattern of urban expansion whereby distances between destinations become further and further apart was the recipe for the extensive automobile use prevalent in North America today.

Mobility at the expense of accessibility forced people to accept tradeoffs between higher housing costs in more accessible locations, or lower housing costs in less accessible locations with considerably more time and money spent commuting. The concept of bid-rent, where households trade off accessibility to the urban core for land rent, has long been established in the fields of urban economics and location theory (Alonso, 1964, as cited in McDonald & McMillen, 2007, p. 5). People faced similar tradeoffs centuries before the automobile. The difference today, however, is that the distances between destinations – as a result of sprawl – are so large that mobility on foot in most cases is not even an option. Sprawl, therefore, is a radical departure from older and traditionally more compact and pedestrian-oriented European cities that were established centuries before the automobile.

2.3.1. Compact City versus Sprawl

Many current policies and planning practices unintentionally encourage sprawl and dependence on automobiles, in particular zoning codes that limit density, prohibit mixed-uses, and require excessive amounts of free parking (Litman, 2012). Today, low-density, single-family dwellings located in suburban neighbourhoods are the dominant market choice in Canada (CMHC, 2005), while the size of homes in the U.S. continues to increase (Emrath, 2013). Disagreement can arise as to whether this is a reflection of true consumer preference, or simply a lack of alternatives to suburban living, since planning practices that cause sprawl significantly reduce the options consumers have for housing type and transportation mode.

Contention surrounding this issue has fueled an ongoing debate between critics of suburban sprawl (Ewing, Bartholomew, Winkelman, Walters, & Anderson, 2008; Kunstler, 2006; Jabareen, 2006; Krier, 1998, p. 15) and critics of compact city-form (Neuman, 2005; Gordon &

Richardson, 2000). Opponents of compact urban form suggest a decline in the significance of physical space as a result of globalization, calling it ‘the death of distance’ (Cairncross, 2001). This viewpoint is typically upheld alongside a position that favours free markets instead of government intervention in guiding the built environment (Gordon & Richardson, 2000). Consequently, according to Ellis (2010), arguments in support of this *laissez faire* view have been characterized by an endemic, short-term economic logic where cities consist “only of consumers and taxpayers” (p. 263), rather than citizens, who are concerned with long-term public interest and the enduring value of their built environment (Beiner, 1992, p. 28).

Laissez faire policies can produce short-term benefits in terms of housing affordability, lower taxes, and shorter automobile commute times (O’Toole, 2001). However, as Sternberg (2000) argued, solely market-driven urban development fails to provide an adequate foundation for urban design, which is inherently public, integrative, and often distorted by concentrations of power. In fact, advocates of sprawl frequently ignore the role that decades of distorted public policies have played in subsidizing infrastructure for automobiles[3], while overlooking the ongoing costs of vehicle fatalities, traffic congestion and expensive infrastructure maintenance (Ellis, 2010). Furthermore, as a response to sprawl, a growing body of empirical research continues to mount evidence demonstrating the benefits of walkable urban environments

[3] Total subsidies for the automobile in the U.S. have been estimated between 500 billion and one trillion dollars per year (Bernick & Cervero, 1997, p. 64). According to Shoup (2011), in 2002 the total subsidy for just off-street parking in the U.S. was between $127 billion and $374 billion (p. 591). More recent figures show that between the (U.S.) Federal Highway Administration, the National Highway Traffic Safety Administration, and the Federal Motor Carrier Safety Administration, the U.S. government spends approximately $42 billion, more than four times the amount spent on all other transport modes (Chakrabarti, 2013). These figures should certainly be taken with some scrutiny. Nevertheless, one can justly assume that the cost of designing, building, and maintaining an urban environment to accommodate millions of private automobiles, has been pricey.

(Boarnet, Greenwald, & McMillan, 2008; Handy, Boarnet, Ewing, & Killingsworth, 2002; Saelens & Handy, 2008).

2.3.2. The Social and Environmental Costs of Too Much Driving

Today, the “modal share” (i.e., the division of travel into different transportation modes) in large and medium sized Canadian cities is mostly comprised of automobile travel (Figure 5) (Canada Mortgage & Housing Corp. [CMHC], 2005). The results of Statistics Canada’s 2005 General Social Survey showed that overall, dependence on automobiles continues to increase in Canada: (Turcotte, 2008). Conversely, the same findings show the proportion of Canadians who made at least one trip by either walking or cycling has gone down from 26% in 1992 to 19% in 2005.

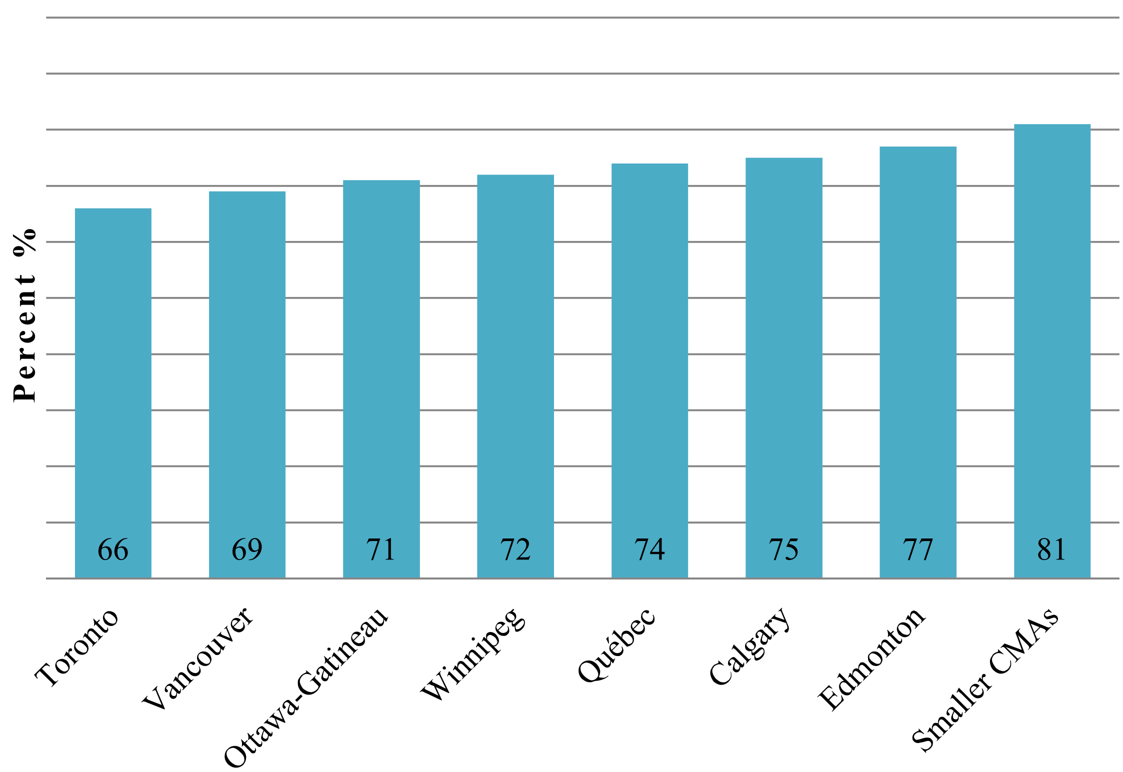

Figure 5. Percent of Population Aged 18 and Over Making All Trips by Car (as Driver or Passenger) by Census Metropolitan Area (CMA). Note: Adapted from “Dependence on Cars in Urban Neighbourhoods” by M. Turcotte, 2008, Statistics Canada.

As cities continue to grow, reliance on cars has resulted in more time spent driving. For many Canadians, time constraints, long distances between destinations, winter climate, and the mobility afforded by the automobile have made travelling by personal vehicle the preferred, sometimes only choice. Fortunately, it is the *total* level of physical activity that matters most for maintaining personal health, and not whether a person drives rather than walks to work (Transportation Research Board [TRB], 2005). Using an automobile for the majority of trips does not prohibit a person from getting enough exercise by other means like going to a gym, swimming, or yoga. Dependence on automobiles does contribute to physical inactivity, and even a modest increase in total physical activity can have positive effects on health (Haskell et al., 2007). Therefore, the health problems associated with physical inactivity are closely linked to over-use of private vehicles.

The health be nefits of walking, in particular, are widely recognized and have been broadly covered in the literature (Badland & Schofield, 2005; Saelens & Handy, 2008; Bauman & Bull, 2007). Numerous studies have confirmed an inverse relationship between regular physical exercise and disease outcomes like cardiovascular disease, thromboembolic stroke, hypertension, type 2 diabetes mellitus, osteoporosis, obesity, colon cancer, breast cancer, anxiety and depression (Kesaniemi, Danforth, Jensen, Kopelman, Lefebvre & Reeder, 2001). Scientific evidence continues to accumulate on the benefits of walking, including data that found walking to be generally associated with lower risks of stroke (Sattelmair, Kurth, Buring & Lee, 2010), and some cancers (Thune & Furber, 2001). Studies have also shown that people who perform a high level of physical activity were significantly (–38%) protected against cognitive decline (Sofi et al., 2010).

In addition, the increased personal mobility and independence afforded by private automobiles has exacted a mental health toll on drivers as well. Frumkin (2002) noted that social isolation and the "perceived erosion of civic engagement" (p. 209) because of excessive automobile dependency has been widely discussed in recent years. Robert Putnam (2000) in particular argued in *Bowling Alone* that more driving means less time devoted to family, friends and community engagements. In Canada, longer commuting times are associated with "higher stress and less satisfaction with work-life balance" (Turcotte, 2010, p. 34).

Increasing use of automobiles is associated with higher levels air pollution (Frank, Sallis, Conway, Chapman, Saelens & Bachman, 2006). For this reason, air quality must also be factored in considering the health hazards of air pollution are well known (Cohen et al., 2005). Specifically, at high concentrations, air pollutants from vehicle emissions can trigger shortness of breath and asthma (Frank et al., 2006). Even at ambient levels, air pollution can aggravate respiratory and cardiovascular ailments and contributing to morbidity and early mortality (Rabl & Spadaro, 2000). Particulate air pollution, derived largely from combustion engines, is consistently related to the most serious health consequences, including lung cancer and other cardiopulmonary mortality (Cohen et al., 2005). Certainly, as people spend more time in their vehicles, an increase in these health outcomes is likely. This is not because Canadians are ignoring the health concerns of sedentary lifestyles; it is because most destinations in cities are *driving* rather than *walking* distances.

As a result of "car culture", some researchers believe that city planning has become detached from its common roots with the public health field (Frank & Engelke, 2001, p. 202). In fact, according to Frumkin (2002), modern-day planning has exhibited a "striking departure" from the legacy of the 19^{th} and early 20^{th} centuries, where city planning and public health shared many of the same concerns like airflow and unhealthy sanitary conditions (p. 202). Likewise, a number of major planning projects undertaken during the 19^{th} and 20^{th} centuries were predicated on health-related concerns. Georges-Eugène Haussmann's rebuilding of Paris was part intended to improve airflow and sanitary conditions (Hall, 1998, p. 619). Ildefons Cerdà's proposal to extend Barcelona after its *muralles* (walls surrounding the city) were removed was meant to relieve oppressive conditions like sewage treatment and ventilation in homes (Rowe, 2006, p. 9-10), while more recently, congestion pricing on automobiles in central London is intended to improve traffic and environmental conditions in the city.

2.4. Walkability and the Onset of the Modern City

In pre-modern cities, attention to human scale was inevitable due to lack of technology and relatively slower, incremental pace of development. In modern cities, with their reliance on speed and efficiency, urban design to human scale is becoming more and more difficult to find. This is especially true for North American cities which experienced their largest (and for many, their first) period of urban growth during the same era that automobiles appeared. In other words, the younger cities of NA were a tabula rasa, whereas older cities of Europe had centuries of compact, human-scaled built environments.

Beginning in the late 18^{th} century in Western Europe and North America, the combined effects of rapid economic and urban growth created the preconditions for modern urban planning to develop, largely as a response to the dramatic changes occurring in cities (Ward, 2002, p. 11). However, with each advance in transportation technology – from horse-drawn carriage to combustion engine, the pedestrian environment has become more and more degraded

(Southworth & Forsyth, 2008). Widespread use of automobiles led to large-scale suburbanization and mass movement of people towards the urban periphery. To ensure the continuous flow of automobile traffic, immense road and highway networks were constructed, predicated on the perceived need for speed and automation. While automobiles made walking less safe, the extension of suburbanization made walking as a mode of transportation almost impossible due to the increasing distances between home and work, school, or shopping. Consequently, as Lewis Mumford penned over five decades ago, with the "destruction of walking distances" also came the destruction of walking as a reliable means of getting around the city (1961, p. 506).

2.4.1. Pedestrian Access

In modern cities, responsibility for the design of streets has predominantly been shaped by the imperatives of traffic engineers (Evans, 2009), while the walkways for pedestrians, according to renowned planner Kevin Lynch (1984), are seen as "insignificant adjuncts to the street" (p. 194). Transportation policy in North American cities, therefore, is mostly centered on mobility, where success in the transportation system is considered to be derived from rapid movement and faster vehicular speeds (Levine, Grengs, Shen & Shen, 2012). Yet relying solely on metrics of mobility to evaluate a transportation system understates the importance of proximity between origins and destinations. The main purpose of transportation is not *movement* but *access* to destinations[4], so increasing mobility is only desirable as long as it increases access in the long-run. For instance, to relieve congestion, (auto)-mobility can be accomodated by increasing roadway capacity (e.g., widening, lane addition) and spreading out destinations. Nevertheless, over the long-term, the

[4] One of the underpinnings of modern transportation planning is that demand for transportation is derived, and that people rarely travel for the sole pleasure of movement but instead travel to reach destinations (Handy, Boarnet, Ewing, & Killingsworth, 2002).

pursuit of mobility increases the distances people must travel between jobs, errands, and social events, which furthermore demands more travel, and costs more time and money.

Access is defined by Talen (2002) as “the quality of having interaction with, or passage to, a particular good, service, or facility” (p. 259) or simply the “ease of reaching places” (Cervero, 1996a, p. 1). Historically, better access (to goods and services) was the primary reason that cities were built, along with the equally important need to provide defense. Thus the quality of access in a neighbourhood, or, the amount of integration between activities, has long been a popular component among theories of good urban form. Notably, at the height of the modernist era of city planning, Jane Jacobs (1961) advocated for more mixed uses and higher densities as ‘incubators’ for healthy street life. Kevin Lynch (1981) deemed access – to people, activities, resources, and information – a key component of his theory of ideal urban form.

2.4.2. Proximity and Connectivity

High-speed traffic in modern cities had a lot to do with breaking up the pedestrian network, creating barriers to free movement on foot and destroying two key elements necessary for neighbourhood walkability: *proximity* and *connectivity* (Owen et al., 2007). Proximity is related to having mixed-land uses that create shorter distances between origins and destinations (e.g., residences and workplaces) while connectivity is the variety and directness of routes to those destinations.

The synergistic relationship between these two elements is reflected in Southworth’s (2005) definition of walkability: “The extent to which the built environment supports and encourages walking by providing for pedestrian comfort and safety, connecting people with varied destinations within a reasonable amount of time and effort, and offering visual interest in journeys throughout the network" (p. 248). Though the term 'access' is not mentioned, the ability to reach urban places is one of – if not *the* most vital element of walkability. Two other notions of walkability also stand out from Southworth's definition: the *quality* and *context* of the path, which, instead of relating to the ability to reach places, is related to the quality and attributes of places that can be reached.

2.4.3. Path Quality and Path Context

Path quality is concerned with the safety of pedestrians, where ideally the path network is continuous, without gaps, potholes, or encroachments like utility poles and poorly placed street furniture. For winter cities, path quality is a significant influence on walkability since snow and ice often create unsafe terrain for walking. Priority for snow removal is often given to roadways before walkways, or worse, walkways are turned into areas for snow-storage. This is especially problematic to vulnerable age groups (i.e., elderly, young children) and people with physical disabilities. Regarding the aesthetics of the path, even if it offers a variety nearby destinations, the dominating presence of noisy, high-speed traffic, polluted air, glaring lights, and cluttered signage can degrade the walking environment.

Perhaps the "least-hospitable" pedestrian path – according to Southworth (2005, p. 251), is the automobile-oriented commercial strip (Figure 1), a typology that has become ubiquitous in North

American cities despite decades of criticism and opposition[5]. Path context is distinct from path quality in that it refers to those qualities in the walking environment that help to engage the interest of pedestrians. Even if the path network is perceived to be safe with good connectivity, a monotonous physical setting will deter walking as an optional or social activity, resulting in either choosing a different side of the street or a different street altogether (Mehta, 2008).

Southworth's definition of walkability does not include the actual usefulness of destinations in the walking environment (Mehta, 2008) and instead, only refers to destinations that are "varied" (p. 248). It is interesting that Southworth singled-out the commercial strip as being the least hospitable to pedestrians, even less than surface parking lots (assuming parking lots and commercial strips were considered separate entities). At least a commercial strip provides one or possibly several destinations along the path, even if the path is uninteresting or uninviting. On the other hand, a standalone-surface parking lot offers absolutely nothing to pedestrians, unless their journey begins or ends in an automobile parked at that specific lot.

Therefore, although surface parking does provide usefulness as a facility to store automobiles, they can never be a useful end-destination for pedestrians. This is precisely how surface parking in the city centre – which affects development density, development cost and urban design – causes people to *over*-use automobiles, indirectly degrading the walking environment (Feitelson & Rotem, 2004). Fortunately, for drivers, many of the negative externalities associated with high

[5] For example, over forty years ago Lynch and Southworth (1974) called commercial strips among the most "polluted" man-made features of American cities, epitomizing the "irresponsible use of the public environment for private gain" (p. 579). In 1930, American conservationist and planner Benton MacKaye along with his colleagues at the Regional Planning Association of America [RPAA]—in large part as a response to widespread discontent towards commercial strip developments—proposed the concept of "townless highways" that bypassed urban areas. This was intended to minimize traffic in the city centre as well as eliminate sprawl along major roadways (Luccarelli, 1995, p. 95).

automobile use: pollution, congestion, noise, pedestrian injuries and fatalities – are passed-on to pedestrians.

So far, this chapter has outlined some of the problems associated with automobiles in cities. However, studies have shown that over 80% of a car's life is spent parked (Marsden, 2006). Certainly, the amount of land in cities used to store cars is significant enough to warrant attention from planners and academics, as walkability in many NA cities is often compromised by excessive parking. Indeed, parking policies are often compromised in their effectiveness due to the perceived assumption that parking shortages or restraint measures would damage the attractiveness of downtown. The following section outlines how it is in fact the opposite: cheap and abundant parking—that harms city centres.

2.5. Surface Parking as an Urban Problem

The problems created by surface parking lots are particularly acute in downtown areas, where density, a major advantage of the central city over suburban neighbourhoods, is often undermined by sprawling expanses of asphalt. Alternatively, a broad array of literature suggests that well-designed parking policies—a rare occurrence in Canadian cities—contribute to lower emissions, higher densities, better efficiency in the transportation system, and more "inclusive" urban design (Marsden, 2006, p. 448).

The environmental costs of surface parking lots have been well documented over the past several decades (Harbor, 1994; Scoggins, Mclintock, Gosselink, & Bryer, 2007; Davis et al., 2010). Research has alluded to an increase in both pollution and flood risks from surface parking lots due to "increasing storm water runoff and contaminant loads to freshwater systems" (Davis et al., 2010, p. 256). Increased water flow from large expanses of asphalt can lead to higher levels of sedimentation in streams and rivers as well as greater non-point pollutant loads[6] (Albanese & Matlack, 1999). In addition, paved surface parking lots contribute to the urban heat island effect [UHIE] (Davis, et al., 2010). In winter cities, this is less of a concern, although the UHIE can lead to decreased air quality in summer months. Despite these concerns, many cities with high dependencies on automobiles continue to oversupply parking lots (Shoup, 1999), underprice their users (Shoup, 2004), and fall short with appropriate regulations to mitigate their negative effects.

2.5.1. Parking and the Decision to Walk

The price and availability of parking figure prominently in a person's choice of transportation mode. Likewise, the more parking that is available in a city's downtown, the more people perceive driving as the most viable means of transportation. On the contrary, successful and vibrant downtowns arrive at this stature by keeping development compact and streets appealing for pedestrians. Surface parking lots are counterproductive to this end, in that they dramatically reduce density and discourage walking by increasing the distance through dull, paved landscapes. They are devoid of street level activity because they lack meaningful destinations, interrupt the continuity of the street, and because so little consideration for pedestrians goes into their design. Ben-Joseph (2012) argued that the design of the basic parking lot has yet to be significantly rethought since the 1950s, and when design is controlled, the concern is usually

[6] Currently, non-point-source [NPS] nutrients to water bodies are the main cause of eutrophication, and consequently, a significant threat to surface water quality (Brett et al., 2005). This is largely attributed to the impervious coal-tar sealant used for surfacing large parking lots that is intended to protect them from weather and chemicals but instead allows pollutants to accumulate before entering nearby water sources (Scoggins et al., 2007).

limited to size, entryways, and egress, instead of ensuring the surrounding edges are compatible with the existing streetscape.

Poorly designed illumination is a common feature among parking lots. Glare and harsh shadows caused by inefficient or ineffective illumination are intrusive to adjacent properties, and can obstruct visibility for pedestrians. This problem can be avoided by with proper luminaire optics, appropriate pole placement and height, and shielding methods to mitigate light-trespass. Unfortunately, since many surface parking lots are privately operated, it is unlikely for a profit-seeking entity would invest into better lighting, without any immediate or long-term increase in revenues. For this reason, most parking lots (and streets for the matter) in North American cities are illuminated by sodium-vapor lamps, characterized by their intense yellow or sometimes pinkish orange light.

Another way that surface parking lots harm the pedestrian environment is in how they obscure the edges between public and private space. The theory that urban design can be used to deter crime, otherwise known as “crime prevention through environmental design” [CPTED], consists of a number of strategies based on promoting good behavior and reducing fear of crime (Newman, 1973). They are access control, surveillance, and territorial control (Ben-Joseph, 2012, p. 47). According to this approach, indicating the identity of a place and marking entrances can increase perceptions of security. Likewise, placing planters, shrubs, or other design elements that create well-defined edges while not blocking lines of sight is now common practice within urban design. With this in mind, it is apparent that surface parking lots—particularly when lacking any vegetation or plantings to create a defined edge—are counterproductive to the goal of increasing perceptions of safety.

2.5.2. 'Public' Parking and 'Accessory' Parking

Within downtown surface parking lots, a distinction must be made between public parking and accessory parking. Both types are prevalent in Canadian central cities, but are created under different circumstances to serve somewhat different purposes. Accessory parking comes from minimum parking requirements that are explicit in municipal zoning codes, and set for every land use to satisfy the peak demand for free parking. Parking lots that are designated for customers, employees, or residents would fall under this category. In effect, accessory parking is a massive subsidy to automobiles, considering that 99 percent of vehicle trips in North America are to destinations with free parking (Shoup, 2011, p. 1). Public parking, on the other hand, is not necessarily associated with any particular land use, and is primarily intended to supplement the existing supply of parking.

Mismanagement of these two types of parking can cause major inefficiencies to the urban transportation system downtown, especially when perceived shortages of one type exist amid surpluses of the other. For example, minimum parking requirements force landowners to make parking free to customers, thus reducing the market price of parking down to zero. Free accessory parking is a major disincentive to use public parking, since the rational economic choice between two goods, when utility is held constant, is to consume the free good.

In the CBD's of Canadian cities, demand for short-term parking is accommodated by on-street metered spaces. When parking policies (prices, locations, capacities) are not aligned, then unfair competition can arise and inefficiencies manifest in underused public off-street parking lots. This is currently the case in Saskatoon, where the city's antiquated metering system allows free parking outside business hours, despite several public off-street lots operating simultaneously nearby and charging a fee.

Jurisdictional issues can also cloud the market for downtown parking. Saskatoon provides another good example of this. Like most Canadian municipalities, the City manages on-street spaces under the policy direction of the city council. Citizens, consumer groups, or downtown businesses therefore, can influence local government to alter parking rates, and often seek to *minimize* them under the false assumption that more and cheaper parking will induce people to come downtown. On the other hand, private firms usually manage off-street public parking lots, which operate under the incentive to *maximize* parking rates. The market relationship between parking supply and demand is distorted, as on-street parking rates are much lower than off-street facilities. Consequently, a considerable amount of downtown land intended for parking remains empty outside peak-parking times.

2.5.3. 'Cruising' and the Altered Economics of Surface Parking

Apart from its negative aesthetic properties, the accumulation of surface parking alters the economics of downtown parking in a number of ways. For instance, because parking (for short durations) is assumed to be inelastic (Kobus, Gutiérrez-i-Puigarnau, Rietveld, & Van Ommeren, 2013), overpricing of surface parking creates two major inefficiencies. Firstly, widening the price gap between curbside and off-street parking encourages more cruising for parking (explained below); and secondly, spatial competition between privately operated parking lots results in them often being inefficiently closely spaced (see Figure 29) (Arnott & Rowse, 2009).

As mentioned earlier, denser downtown areas have public curbside parking as well as garages and surface lots. When curbside parking is underpriced and overcrowded, and surface parking is overpriced, many drivers search for a curb space rather than pay the higher up-front cost of off-street parking (Shoup, 2006). The fee differential between curbside parking and off-street parking induces people to cruise-for-parking, creating a mobile queue of cars searching for vacant spots. Cars cruising for parking contribute to traffic congestion, air pollution, wasted fuel, and overall greater in-transit travel costs.

A popular and perhaps the most logical solution to the 'cruising' problem, which has been proposed by both economists and engineers alike (Arnott & Rowse, 2009; Qian, Xiao, & Zhang, 2011), has been to raise curbside parking fees to better represent the market rate, or at least a rate that is competitive with off-street facilities. In particular, Arnott & Rowse's (2009) analysis of spatial competition between types of downtown parking (off-street, on-street) found that raising the curbside meter rate does not alter the full price of trips by automobile. Instead, raising the meter rate converts the time costs from cruising-for-parking into meter revenue. The added benefit of this is the reduction in cars cruising for parking, and less price-distortion between surface parking and curbside parking. As well, the authors concluded that the social benefits from raising curbside parking rates might be several times the additional meter revenue generated[7].

2.5.4. Parking Policy Reform in North American Cities

Parking requirements have recently been reformed in a number of major cities across the United States. For example: San Francisco, Seattle, Portland, and Milwaukee have eliminated parking requirements in their downtowns for non-residential land uses, Los Angeles is now allowing car-

[7] The presence of off-street public parking magnifies the distortion caused by underpriced on-street curb parking. Specifically, Arnott & Rowse (2009) found that this "magnification effect" results in a $3.20 increase in social surplus for each dollar increase in revenue from meters (p. 2).

free (no parking required) development along a major rail line, and plans are underway for parking reform in Boston (Ross, 2013, July 05) and Cincinnati (Yung, 2013, April 02).

However, despite the fact that parking pricing and supply restrictions are the most accepted methods of lowering automobile use (Institution of Highways and Transportation [IHT], 2005), this topic has generated limited interest in transportation planning research (Marsden, 2006). Transportation and urban planners rely on empirical research upon which to ground the development of policies, so perhaps because of this literature gap, examples such as those cited above has been few and rare.

2.6. Built Environment and Mode Choice

From an urban design perspective, what makes a city walkable? Over the past few decades, experts have revisited this question in an attempt to understand how the built-environment can shape human activity patterns. According to Ewing and Cervero (2010), the potential to moderate travel demand by changing the built environment is "the most heavily researched subject in urban planning" (p. 267). Common consensus is that the quality of the pedestrian environment is directly related to the amount it gets used (Handy, et al., 2002). However, this raises questions as to who is walking, when do they walk, and why.

For instance, the reason to walk, referred to as trip purpose[8], is often differentiated between walking for transport (i.e., to get to and from places) and walking for recreation (i.e., exercise or

[8] Travel is generally defined according to "trips", which is the movement from one place to another and is usually differentiated by purpose (Handy, Boarnet, Ewing & Killingsworth, 2002). Trip purpose is categorized by the type of activity found at the destination, typically work or shopping (sometimes referred to as 'utilitarian' walking or walking for "transport"), and non-work such as recreation or exercise.

pleasure). Features of the built environment associated with walking for recreation are different from those associated with walking for transport (Owen, Humpel, Leslie, Bauman, & Sallis, 2004): attributes of a neighbourhood such as street connectivity and proximity to destinations have a positive effect on walking for transport; but these features have little effect on walking for recreation (Owen et al., 2007).

Studies assessing the walkability of the built environment generally include objective measures of the built environment such as street connectivity, land-use mix, and residential or population density. Yet studies that attempt to pinpoint the strength and magnitude of these characteristics – and therefore their degree of influence on walking levels – have been remarkably broad and often inconsistent (Frank & Engelke, 2001). This inconsistency seems to be mostly linked to limitations in the data and methodologies that researchers have used, making it challenging to compare studies of walkability.

For instance, like many other physical environmental features, walkability is often measured at different geographic scales, such as a buffer around a person's home, neighbourhood (Saelens, Sallis, & Frank, 2003), census tract, or entire metropolitan area (Learnihan, Van Niel, Giles-Corti & Knuiman, 2011). Researchers suggest that different types of travel behavior (driving, walking) are better understood after distinguishing between geographic scales. Boarnet and Crane (2001, pp. 56-60) posited that automobile trips were more heavily influenced by the structure of a metropolitan region, while other studies found that walking was most heavily influenced by the fine-grained characteristics of a neighbourhood (Greenwald & Boarnet, 2001). Generally, this is because at different geographic scales, access for pedestrians is affected by different conditions in the built environment.

At the fine-grained scale, walking is immediately affected by the quality of pedestrian conditions (sidewalks, street trees, safe crossings, appropriate buffers from traffic) and the clustering of activity within a site. At the larger metropolitan or regional scale, it is influenced more by street connectivity and transit availability[9] (Litman, 2011). Researchers have emphasized that this lack of standardization between measures of scale is problematic as it tends to produce conflicting results and makes comparison across studies difficult (Robertson-Wilson & Giles-Corti, 2010; Brownson, Hoehner, Day, Forsyth & Sallis, 2009). Consequently, there is little consensus on the most appropriate scale for measuring walkability, and it remains unclear at which geographic scale the built environment influences walking the most (Learnihan, Van Niel, Giles-Corti & Knuiman, 2011).

Numerous literature reviews have been conducted on empirical studies of land-use–travel relationships in order to sift through this complex area of research, notably Ewing and Cervero's (2001) assessment of over 50 studies, and their updated work (2010) which covers an additional 200+ studies that were completed since the initial review. Accordingly, a complete discussion of the complex associations between the built environment and walking is beyond the scope of this thesis, which sought only to draw from the literature generalizable conclusions for practice, which are:

1. The physical characteristics of a street, especially if it is compact and mixed-use, are consistently found to encourage walking (Cervero, 1996b).

[9] The overall influence of regional variables (i.e., regional density) on pedestrian travel remains in question: some studies have concluded that the influence of the built environment on pedestrian travel is highly localized and variables like regional densities are "not a significantly useful" set of predictors (Greenwald & Boarnet, 2001; p. 11).

2. Walking is strongly related to diversity of land uses, intersection density, and the number of destinations within walking distance (Ewing & Cervero, 2010).
3. Having destinations within walking distance from residences is the strongest correlate of transportation activity (Hoehner, Brennan-Ramirez, Elliot, Handy, & Brownson, 2005), as well, the largest effect on VKT (Ewing & Cervero, 2010).

2.6.1. Other Factors that Affect Mode Choice

Urban form in general (and density in particular[10]) is believed to strongly influence walking behavior; however, numerous studies have argued that the true determinants of travel patterns lie elsewhere. Socioeconomic and demographic factors are particularly important, such as gender, household composition, employment status, availability of a personal automobile, and income (Boarnet & Sarmiento, 1998; Bagley & Mokhtarian, 2002; Schwanen, 2002). Ewing and Cervero (2010) concluded that although mode choices depend on both socio-economic characteristics and the built environment, actual vehicle-kilometres travelled depend primarily on the built environment.

However, Schwanen and Mokhtarian (2005) argued that attitudes are a much greater contributing factor to walking behavior, implying that self-selection processes (on where people choose to live) should not be overlooked. The reasoning behind this is that people who prefer walking may choose to live in residential locations where the urban environment facilitates this type of behavior (Greenwald & Boarnet, 2001). Relatively compact and walkable neighborhoods may simply attract people who value walking more. This suggests that observed positive associations

[10] Density here refers to the clustering of diverse land uses, not strictly population or job density, which were found to have only a weak association with travel behaviour (Ewing & Cervero, 2010).

between density and walking "may not reflect true causality" (Schwanen & Mokhtarian, 2005, p. 128).

In an attempt to separate the effects of household location preferences (that influence walking) from the physical characteristics of neighbourhoods (that influence walking), Schwanen and Mokhtarian (2004) looked at the commuting behavior (mode choice for travel to work) of three separate neighbourhoods in San Francisco – one urban (walkable) and two suburban. After controlling for demographic characteristics, mobility limitations, lifestyle types, and travel attitudes, suburban residents who preferred to live in walkable neighbourhoods (call them unsatisfied suburbanites) commuted by private vehicle about as often as their neighbours who preferred their suburban location (satisfied suburbanites). Likewise, residents of walkable neighbourhoods who preferred a low density, suburban location (unsatisfied urbanites) commuted by car far more than their neighbours who preferred walkable environments (satisfied urbanites) like that which they chose to live in. The authors concluded that differences in travel patterns between neighbourhoods were more significant than the differences within them, indicating that neighbourhood structure has an "autonomous" effect on commuting behavior (p. 96). In other words, the influence that living in a low-density, suburban neighbourhood has on the choice to walk (or drive) prevails over people's preferences regarding their residential environment.

2.7. Ways to Identify and Rank Potential Infill Sites

Researchers have developed tools to identify current land and infrastructure capacity available for urban development (Knaap & Moore, 2000), established indicators to determine the success of brownfield redevelopments (Wedding & Crawford-Brown, 2007), and provided a process to evaluate human health risks on proposed redevelopment sites (O'Reilly & Brink, 2006). Chrysochoou et al. (2012) created a GIS indexing scheme to screen brownfields for area-wide redevelopment planning, or in other words, a tool that can be applied to large areas to identify brownfields with high priority for redevelopment. Bacot & O'Dell (2006) provided criteria to measure and assess government-sponsored brownfield programs based on indicators of economic and environmental performance. The method undertaken by Sounderpandian, Frank, & Chalasani (2005) resulted in a support system designed for mediating negotiations between stakeholders of brownfield redevelopment projects. Other studies on assisting the infill redevelopment process have focused strictly on site selection for the purpose of some specific end-use, notably Rosenberg & Esnard (2008), who introduced a scoring methodology to aid the selection of transit sites in South Florida, and Moudon (2001) designed a tool to target pedestrian infrastructure improvements to promote the increased use of non-motorized transport.

Yet despite the benefits gained from incentive-based tools, checklists, and scoring systems, each have their limitations. For instance, a common pitfall, when using scores to evaluate the urban environment, is that they are based on abstractions and generalizations, and as Garde (2009) pointed out, the weights are assigned subjectively, making it difficult to determine the relative importance of the criteria. Different communities may have different objectives and needs, and may favour affordable housing over architectural style or "greenness". In addition, no system is one-size-fits-all, partially because none account for or distinguish between regional differences in climate. This omission from scholarly literature is intended to be addressed by the following methodology.

CHAPTER THREE: METHODOLOGY

The method of scoring used here is as much a conceptual model as a practical tool that is logical to apply, and useful in other winter cities and at different scales. It was designed so its practicality would not be undermined by making extensive data collection or technical methods of direct observation necessary to apply it. Here, the nature of each criterion varies between those more prominent or perhaps difficult to alter (such as surrounding building heights for maximizing sunlight), to less significant, and which could be addressed through policy or design (such as occupancy of parking lots or distance to educational institutions). To this end, the following methodology was used.

3.1. Methods

i. Develop a set of site-selection criteria, based on key elements in urban design literature and practice, which together constitute a high-quality pedestrian space. The criteria are arranged into a checklist so each lot can be recognized by conditions that lead to a scale of significance regarding its suitability and potential for infilling. Criteria are divided into two categories: *requisite* and *auxiliary*[1]; the purpose being to permit a large number of parking lots to be screened, and to eliminate at the outset parking lots that fail to meet a minimum scoring threshold, thereby avoiding unnecessary, time-consuming, and costly data-collection.

ii. Application of the criteria to the case-study of Saskatoon, Saskatchewan, which involved detailed site analysis on parking lots throughout downtown, in order to locate, analyze, and

[1] These terms—requisite and auxiliary—were chosen on their basis in formal logic as modal operators, similar to *necessary* and *possible*. The requisite criteria are made up of things that are *necessary* for walkability; while the auxiliary criteria are things that can only help make walkability *possible*, if and only if the necessary (requisite) conditions are met.

screen each lot with regard to its potential for redevelopment. This resulted in identifying a small number of the best candidates for infill conversion to mixed use.

iii. Assess the results (which priority sites were found by applying the criteria to a case study) and evaluate the criteria, to determine which should possibly receive greater emphasis, and which should be upgraded, relaxed, or eliminated.

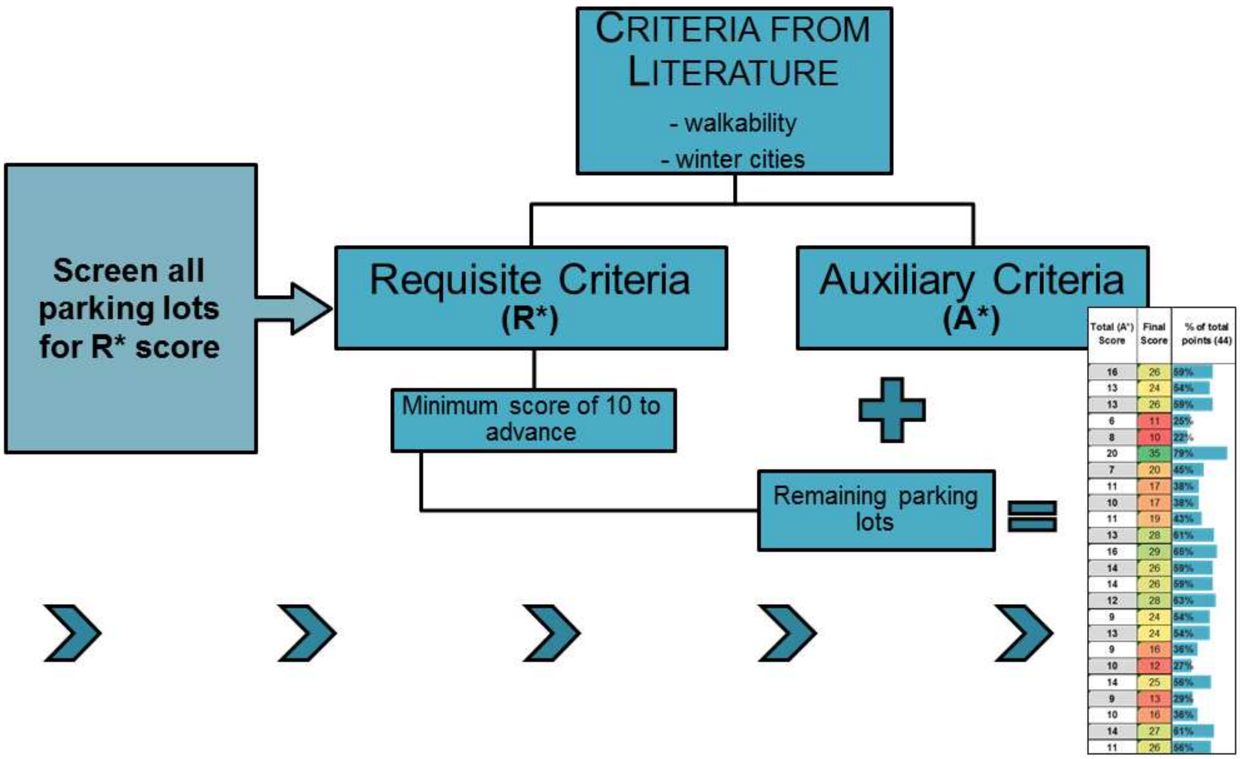

Figure 6: Flow chart showing the site selection process for ranking surface parking lots.

3.2. Caveats

For a parking lot to be considered in this study, it must not be attached as an accessory use to an existing building such as an apartment building or restaurant. It must be a standalone, surface parking lot, available for public or private use by fee (hourly or monthly). Emphasis is directed towards the specific share of the parking supply that is provided in addition to spaces required by municipal bylaws. In the case of Saskatoon, for the most part, these lots are all leased and operated (but not owned) by a single national corporation, Imperial Parking [IP]. For more discussion on the morphology of parking lots in downtown Saskatoon, see section 3.6.

The size of a parking lot, when viewed as a parcel available for development, will certainly alter how some criteria are measured. Smaller sites can affect neighbourhood *character*, but in most cases, it takes a larger site to affect neighbourhood *structure*, which is beyond the scale of this tool. The intention here was to provide incremental and context-sensitive improvements. Although larger infill sites may receive the bulk of community interest, the criteria here assume that overall size is not a critical component that could make a project 'more' or 'less' walkable in the long run, which hinges on urban design of the site. The bulk of consideration for each lot lies in their surrounding urban context rather than their size or geometry. However, each lot must be without severe physical constraints such as being located under a freeway overpass, and have access to urban services necessary to support infill redevelopment. For the purposes of this study, a small number of surface parking lots were initially left out of consideration due to recent construction at the site, anticipated future development[2], or having an irreconcilably poor location.

Finally, two descriptors are frequently used in the criteria, which must be defined initially: the notions of *nearby* and *walking-distance*. As a matter of convention, the notion 'nearby' will hereinafter refer to anything within one-hundred metres from any edge of the lot, the adjacent sidewalk, or anywhere in the adjacent back alley(s). Regarding walking-distance, the standard pedestrian shed was used, often defined as the distance covered by a five-minute walk or about

[2] As of Oct 2013, construction has begun on three former surface parking lots in Saskatoon's CBD, and an additional three are slated for development in the coming year.

400 yards (365 metres). This metric (400 yard radius = 4 to 6 minute walk) is not an exact science, as Murrain (2012) pointed out, but has been the standard structuring principle for over 80-years beginning with Clarence Perry's infamous 'Neighbourhood Unit[3]', and later resurrected by the new urbanists (Farr, 2008, p. 125). A four-hundred yard distance is adequate for summer or fall conditions. However, during winter, pedestrians are subject to slippery sidewalks and crossings, poorer visibility, and colder temperatures, all of which reduce the distance pedestrians are willing (or able) to travel. Thus, for this study, a 'winter walking distance' metric is more appropriate, which will be defined here as 100 metres.

3.3. Parking Lot Selection Criteria

The preceding literature review sought to introduce key topics in urbanism that together, act as a theoretical foundation for defining the critical elements that are influential in affecting rates of pedestrian activity. This section will discuss the justification for choosing each criterion, highlighting their definition, significance, optimal state, as well as any relevant references to them within planning and urban design literature. It begins with the most necessary or *requisite* criteria as they are referred to, continuing in descending order of significance to the *auxiliary* criteria. For each criterion, an assigned index with corresponding scores that summarize the redevelopment priority of different surface parking lots based on the justification provided in the following section.

[3] The Neighbourhood Unit – first promoted by sociologist planner Clarence Perry in his infamous Regional Plan for New York, 1929, has since become one of the most contested elements of North American urbanism, and believed by some to be a fundamental error on part of the new urbanists (Murrain, 2012). Kevin Lynch (1981) was among the opponents of Perry's neighbourhood unit who saw it as a "planning illusion", further stating that "to plan a city as a series of neighbourhoods is futile […]; any good city has a *continuous* fabric, rather than a cellular one" (p. 401).

3.3.1. Requisite Criteria

Perhaps one of the most mentioned and widely accepted elements of walkability in a neighbourhood is the presence of a ***diverse mix of nearby amenities or land uses*** (Jacobs, 1961, pp. 198-232; Southworth, 2005; Clifton, Ewing, Knaap, &Song, 2008; Ewing & Cervero, 2010). For the purposes of this study, which was to select a site(s) for a pedestrian-friendly infill development, the nearby mix of land uses was carefully analyzed. Distinction was made as to whether each lot was near a diverse and concentrated mix of land uses that foster economic interaction and pedestrian activity; or, if the parking lot were near land uses primarily served by automobiles, such as other parking lots, garages, loading docks, drive-through businesses, or gas stations.

According to Paumier (2004), planning of the downtown pedestrian system should begin with main street(s), or the core area's "central spine", that is, "the street where the greatest concentration of retail activity already exists and where new retail uses should be located" (p. 81). In Saskatoon, the main pedestrian streets are 2^{nd} Ave N and 21^{st} St E (Figure 7) which bisect the entire downtown creating four quadrants. These two streets are distinct from most others downtown by offering amenities that encourage walking such as having a variety of shops and building entrances fronting the street, wide sidewalks, enhanced mid-block crosswalks, well designed lighting, street trees, and lower traffic speeds. Therefore, a parking lot in closer proximity to the main pedestrian streets is a favourable asset.

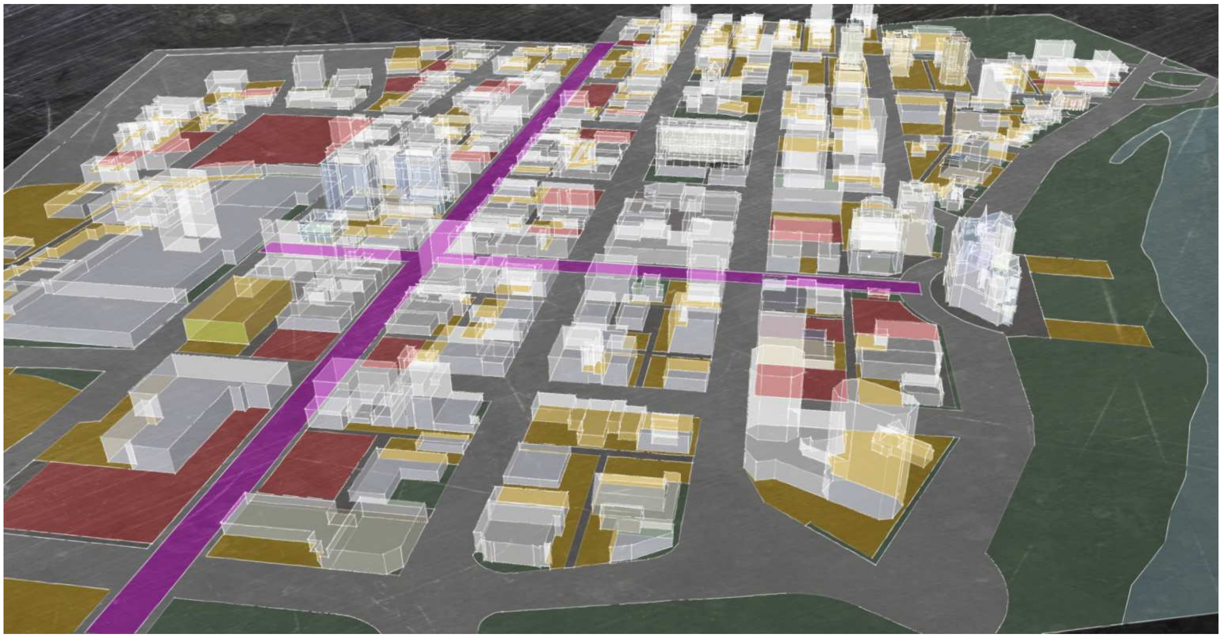

Figure 7: The main pedestrian streets (shown in pink) in downtown Saskatoon: 21st street and 1st avenue.

However, like other cities, in downtown Saskatoon there are small areas or pockets where pedestrian friendly amenities are clustered such as ground-level retail shops or cafés. New development should focus around these areas to take advantage of existing assets that support pedestrian life. Therefore, this criterion takes into account the overall presence of pedestrian-friendly amenities in the nearby vicinity of the site. To account for the unavoidable subjectivity in measuring this, all amenity types were grouped into the same category instead of differentiating between them. Examples of amenities are schools, daycare, food/convenience, farmers markets, cafés, restaurants, galleries, theatres, indoor malls, libraries, recreation centres, entertainment, and any types of street-level retail. For this study, amenities are distinguished from other similar features like landmarks, civic spaces, parks, and nodes, each of which is evaluated under a separate criterion. Sites with a noticeably higher incidence of these amenities in the nearby vicinity of the lot are more favourable for the purposes of redevelopment and thus, shall receive a higher score.

Still, the presence of pedestrian-friendly amenities is only valuable to non-drivers if the built environment fosters good connectivity to them for people on foot. An attractive system of pedestrian connections should not be limited to just the main streets downtown, and the true benefit of having a healthy mix of diverse uses is better harnessed by providing quality and easy *access* to them. In fact, the quality of access and its role in promoting the integration of activities and uses, as Talen (2002) indicated is a long-standing component of numerous theories about good urban form[4] (see section 2.2.1. or Jacobs, 1961, pp. 233-243 ; Lynch, 1981, pp. 187-204; Gehl, 2010, pp. 119-133). A number of recent studies on the topic have labeled connectivity as being the most essential aspect of neighbourhood design (Stangl & Guinn, 2011; Forsyth, Hearst, Oakes & Schmitz, 2008). In order to contribute to overall walkability, an infill site should provide access to a larger system of pedestrian connectors linking to one another and to the main pedestrian street. Therefore, it is essential to assess the number and quality of pedestrian conduits (not only streets, but alleys, leftover spaces, and public building entrances) leading to/from the parking lot. This measurement, called the ***site access*** or ***connectivity value***, includes everything on the perimeter of the site and the alleys that directly connect to it. One alley would have a connectivity value of two, meaning there are two ways in, two ways out. The sidewalk adjacent to the lot counts as one. In order to balance the need for detailed information with economy of administration, the marking for this category is divided into three thresholds based on the total number of pedestrian connections through the site.

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[4] Notable among these theories is that of renowned planner and urbanist, Kevin Lynch, whom held 'access' as a key component of his theory of *Good City Form* (1981).

So far, the criteria have been modeled under the guidance of Lynch's *The Image of the City* (1960) and his later work, *Good City Form* (1981). According to Lynch (1960), the most successful urban places reach that stature by balancing the following five critical elements: *districts*, *paths*, *landmarks*, *edges*, and *nodes*. Although none of these elements exists in isolation from one another, Lynch pointed out how they regularly overlap: "Districts are structured with nodes, defined by edges, penetrated by paths, and sprinkled with landmarks" (pp. 48-49). Yet some elements, specifically districts and edges, are more useful to consider at the city- or regional-scale, while the remaining three typically help to guide planning and design at a more fine-grained scale such as the urban block or individual streets and public spaces. If 'paths' were covered under connectivity value, then it is a logical next step to discuss how these paths are (or should be) linked together, which Lynch assigned the term 'nodes'.

The concept of a node is related to the concept of a path since nodes are usually found at the convergence of paths, or "events on the journey" (p. 48). Pedestrian nodes have also been classified as points where pedestrian related amenities are grouped together, mainly to encourage walking cycling, and transit usage. Concentrations of certain amenities, land-uses, or physical characteristics, such as a street corner hangout, often take on the function of a node. As Lynch (1960) explained in his landmark work, *The Image of the City*, a node is a "distinct, unforgettable place, not to be confused with any other" (p. 102). They have a boundary and may coincide with a decision point on a path, whereas the joint between the path and the node "must be visible and expressive" (p. 102). Therefore, the existence of ***nearby nodes of pedestrian activity***, daytime or nighttime, is a powerful indicator of how pedestrian friendly the surrounding area is. If the nearby area has one or several major focal points, intersections, gathering spaces, or loci[5] in sight, then a surface parking lot will more than likely disrupt the character of that street, in this case making it a favourable candidate for redevelopment. When pedestrian nodes are found in the immediate vicinity of a site, it has an advantage in terms of the benefits produced by increasing its density. Therefore, a site with a discernibly higher number of nearby pedestrian nodes will be given a higher score than a site with few or no nodes.Another important criterion has to do with the ***position of the site within the urban block***. This criterion was modeled after a previous study undertaken in Seattle, by the private firm Gehl Consultants, which looked at how to revitalize the city's back alleys, eventually culminating in a useful resource called *The Seattle Integrated Alley Handbook* (Fialko & Hampton, 2011). In this study, alleys were identified and categorized by where they were situated within the urban block and the type of land uses that were nearby, effectively creating a typology of the different alleys that could be found (Figure 8). This typology was then used to match appropriate land uses to be introduced to the alley.

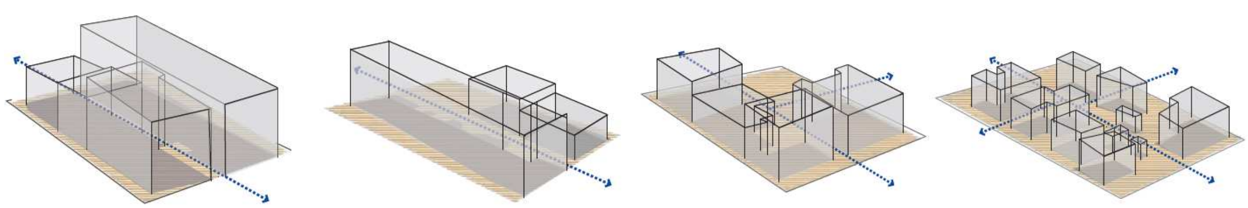

Figure 8. Seattle study categorized alleys based on position and surrounding land-uses. *Note:* Reprinted from "Seattle Integrated Alley Handbook" by Fialko & Hampton (2011).

[5] The term *loci*–plural for *locus*, which means "the centre or source of activities"–has been commonly used in art and architecture to describe the atmosphere or 'spirit' of place. Here, it is used in the same manner, which is to describe somewhere in the built environment that possess a 'sense of place', even if it as simple as a sidewalk bench with a striking view.

Four types of parking lots were observed with regard to their position within the city block, each of which are favoured differently in terms of improving nearby walkability (Figure 9). The least favourable are lots are situated by themselves with no adjacent or connecting land-uses (standalone). Development sites located away from the urban fabric usually require additional hard-services and infrastructure, and offer fewer synergies with other land uses. Other sites are partially connected to major commercial uses, such as shopping centres or theatres. These types are more favourable than standalone lots but still less favourable for infilling than ones that are situated at mid-block immediately between ground floor retail or other land-uses that bring activity to the street. Potential sites that are located mid-block, usually between two other buildings, create the opportunity to utilize existing city infrastructure and replace inactive, unsheltered breaks in the streetscape. Corner lots are the most favourable, being that they have the greatest distance adjacent to the sidewalk and thus, a greater impact on the pedestrian

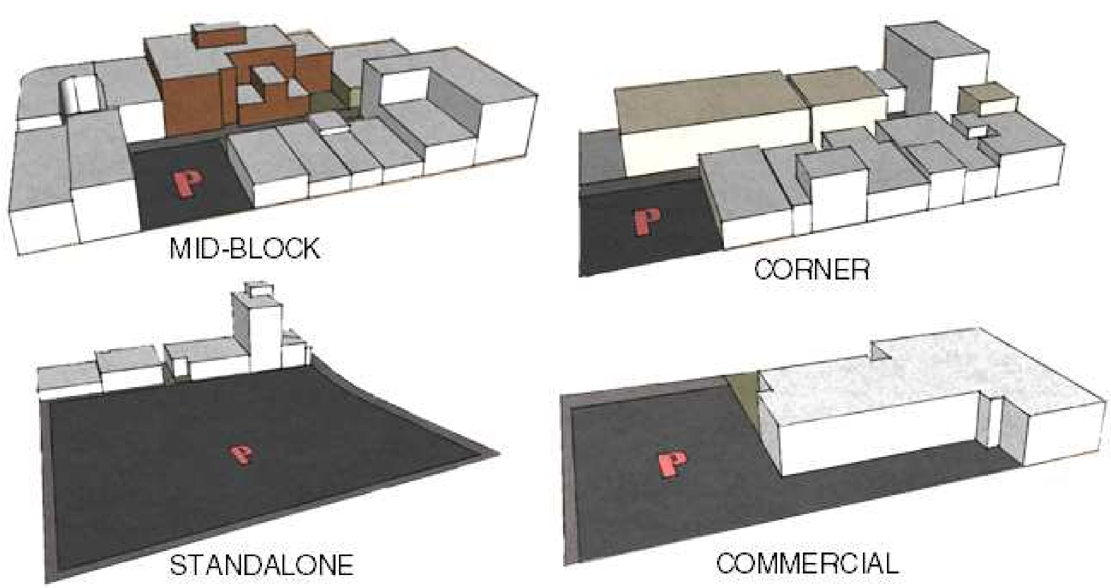

Figure 9. Four types public off-street surface parking lots.

experience. The ordering of these criteria is based on the relative suitability of each site in terms of its location within the block, beginning with standalone lots, lots adjacent to major commercial land uses, lots located at mid-block, and finally, corner lots.

Similar studies that sought to assess the walkability of a street have also taken into account the type of roadway adjacent to site specifically whether it accommodates a high or low volume of traffic (Clifton, Livi Smith, & Rodriguez, 2007). However, those studies were designed to cover all areas of the city (suburban, older residential neighbourhoods, industrial or business clusters, etc.), while the current study takes into consideration solely locations in the CBD. The traditional suburban neighbourhood, typically fed by a system of collector and arterial roadways, makes some areas naturally more walkable due to the presence of high traffic volumes. In the CBD, most streets are somewhat similar in their dimensions (grid) and traffic volumes, and more importantly, it was observed that streets with higher traffic volumes do not necessarily mean they have less pedestrian activity[6] (COS, 2011). In some instances, the situation is reversed due to the presence of other factors that make it walkable, outweighing the influence of nearby traffic. Therefore, the correlation between the amount of traffic on the street (within the CBD) and its walkability is somewhat ambiguous to account for.

Instead, the current study takes into account back alleys and laneways as potential pedestrian connectors, which unlike roadways vary considerably in terms of the amount of automobiles in

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[6] For example, within Saskatoon's CBD, streets that run north south, for the most part have higher vehicular traffic volumes than streets running east west (COS, 2010b, p. 21). Yet pedestrian traffic volumes are not necessarily higher on streets with less vehicular traffic. With the exception of 25th street—which receives relatively high vehicular and low pedestrian traffic––streets such as 2nd Avenue and 22nd Street still manage to attract some of the highest amounts of pedestrians (COS, 2011, p. 94-97) and cyclists (p. 98-101) while also accommodating some of the highest amounts of vehicular traffic (p. 89).

them, and a person willingness to traverse them on foot. For instance, some sites are attached to alleys that are used more heavily by automobiles than others. The ***presence of automobiles in an alley***, exhibited by driveways, passenger drop-off areas, loading docks, and entrances to garages, are indicators of how often people who drive utilize the alley, whether to access nearby parking, services, workplaces, or as a conduit to the street. Alleys lined with entrances to one or more garages are far less desirable since this means vehicular traffic will be greater and more difficult to re-route. Thus, alleys with fewer garages or parking spaces are more favourable, and the marking for this criterion is based on the number of connections the site has to automobile facilities.

The final requisite criterion also deals with conditions in the back alleys adjacent to the parking lots. However, a shift away from the *physical* elements found in the alley (cars) to the *spatial* characteristics of the alley itself is necessary in order to reveal the not-so-obvious assets each may contain. As mentioned earlier, perhaps the greatest opportunity for turning alleys into attractive pedestrian pathways is in their ability to provide shelter from winter conditions, most notably, the uncomforting effects of winter wind-chill. Yet not all alleys offer the same level of comfort due to their shape or orientation. The relationship between the orientation of the adjacent back alley and the prevailing wind direction plays a large part in determining how comfortable the microclimate will be within the area. Therefore, it was important to include a criterion that could single out infill sites that provided the best ***shelter from wind-chill***.

Average prevailing wind directions in Saskatoon are westerly to southwesterly (Figure 10). So, according to Pressman (1995), streets–or in this case, alleys–that are oriented crosswind or perpendicular to the prevailing wind direction should be favoured since building massing will create more protection from strong winds and blowing snow in winter. A recent study by Andreou & Axarli (2011) confirmed that the highest wind speeds are usually in streets with orientation parallel to wind direction. They highlighted several parameters such as street pattern, height/width ratio, and alley/street geometry that have been shown to influence microclimatic conditions in open spaces and street canyons. Their research resulted in a ranking sequence used to evaluate each parameter and their degree of influence on urban microclimate. This sequence began with the parameter with the greatest influence: wind direction and wind speed in association with street orientation, followed by planting of trees, increasing height/width ratio to 1.3, and increasing ground surface albedo (p. 362).

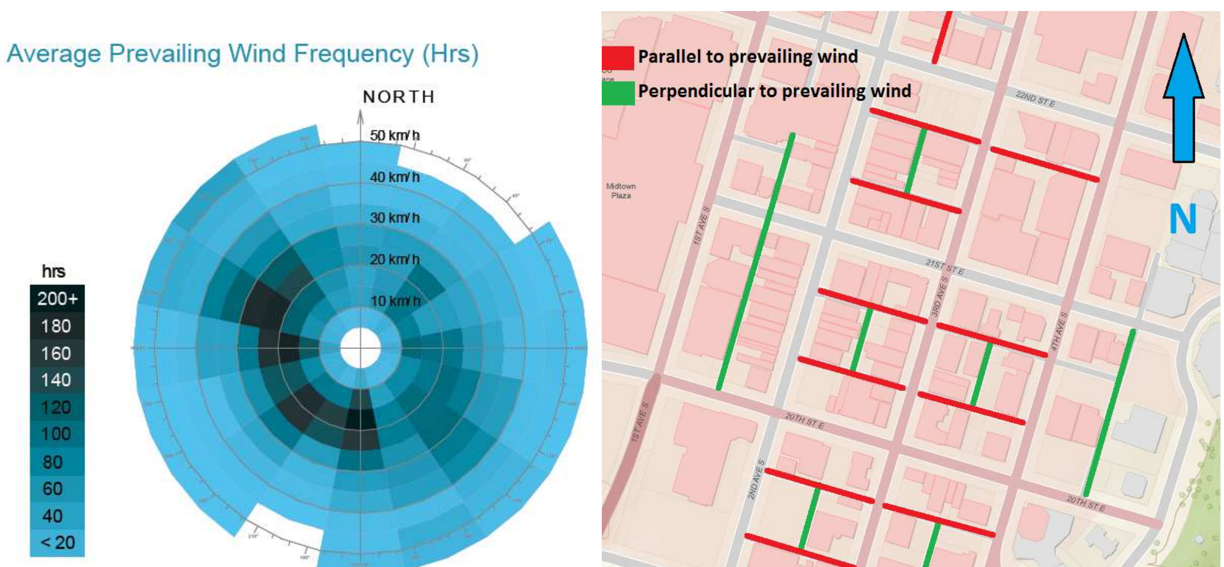


Figure 10. Prevailing wind direction for Saskatoon and map showing the relationship between orientation of alleys and wind direction. *Note:* Wind-rose reprinted from "Public Spaces, Activity and Urban Form" by COS, 2011, p. 29.

Noted is the fact that their research took place on the small, Greek island of Tinos, which has a very mild Mediterranean climate, and consequently the approach to microclimatic comfort was different from what would be for a winter city. For example, mitigating urban heat island and providing shade are concerns in cities with warm climates, which are approached differently that concerns in winter cities such as providing shelter from wind and maximizing sunlight. Therefore, considerations for ground surface albedo are irrelevant during winter and disregarded.

Measuring wind speeds at each site and comparing with estimated tolerance or comfort levels is one method to identify which sites perform better in terms of blocking wind, albeit a complex and somewhat ambiguous one. Rather than rigorously focusing on individual comfort level as a parameter than can be measured and subsequently anticipated through design, this criterion hinges upon identifying nearby spatial conditions that have a verifiable impact on reducing the prevailing wind speed. In other words, instead of setting a benchmark "comfort level" and measuring how close each lot comes to attaining it, this is simplified by making the evaluation of each back alley relative. The approach taken here was to score each site in relation to how well they perform against one another by comprehensively taking into account parameters such as height/width ratios, alley orientation, and canyon geometry.

3.3.2. Auxiliary Criteria

The following seven criteria were included not because they are necessary, but because they help to single-out the most exceptionally suited sites. They could also be referred to as supplementary or 'bonus' criteria, since by including them, only the resolution of the data (the individual ranking sequence) is influenced, rather than the overall result (location of priority sites). As a result, this also resulted in greater subjectivity for most of the criteria. For instance, the ***aesthetic***

appeal of alley (vs. visual blight) score, in essence, is based on purely subjective and perceptual assessments of (1) aesthetics (specific to the site and its surroundings); and (2) perceived blight derived through personal visits and photos. Nevertheless, a clearer definition of *appeal* and *blight* is needed to make this criterion practical and yield closely similar results from different users.

The Oxford dictionary defines *blight* as a thing that spoils or damages something, such as the degeneration of a landscape or urban area because of neglect. William Whyte (1988) said that the blight inflicted by parking "lies in what is not there" (p. 314). However, when taken in the context of alleys, the place where a city's most unappealing infrastructure is typically found (i.e., overhead wires, waste bins, transformer boxes), this definition becomes unclear since what is said to 'spoil' the landscape is actually necessary to its overall function (electricity, waste collection. etc.). In other words, blight observed in back alleys is attributed to what is there, instead of what is missing.

That being said, much of the utility equipment necessary for servicing modern cities is bulky, unattractive, and harmful to walkability. Transformers, utility metres, cable boxes, and other municipal hardware are usually placed in rear lanes, as they should be. However, if a back alley were to become a comfortable and appealing space for pedestrians, much of this hardware would have to be moved or shielded. Rerouting power transmission lines, transformers, or fiber-optic cable is a complicated and costly endeavor and may not be an option, both for financial or logistical reasons. Therefore, a site is favoured when its adjacent back alley(s) has less utility equipment that is noticeably difficult to move or remove.

The next criterion that was modeled after Lynch's work is the presence and importance of ***nearby landmarks or major civic spaces***. From the pedestrian's perspective, landmarks can symbolize direction and provide useful clues of identity and sometimes the structure of a neighbourhood (Lynch, 1960). Sites fronting heritage buildings, architectural landmarks, or important civic spaces such as squares or plazas should be reserved for more intensive uses than surface parking, especially when that parking appears underpriced and oversupplied. To illustrate this reasoning, an underused parking lot located adjacent to the Bessborough Hotel (Figure 11), one of the Saskatoon's foremost architectural landmarks, is more deserving of infilling than a lot located beneath a freeway overpass. In essence, preserving the character of the former street should take precedent over preserving the latter, or in other words, the potential for a successful and profitable infill project is much greater in the site with the superior location. Regarding

Figure 11. Two major landmarks (Bessborough Hotel and the Meewasin Trail behind it) are located very near to off-street surface parking lot.

indoor malls and shopping centres (in Saskatoon's case, Midtown 'Plaza'), these are also classified under this category since they fulfill the role, to some extent, of the traditional city square or market. Therefore, this criterion is measured by how many readily identifiable landmarks, civic spaces, or plazas are located near the site. More specifically, how many can be seen from the potential site.

The next criterion that was selected to analyze back alleys (when they are found attached to a parking lot) is the ***winter solar exposure*** score. This is the second criterion that explicitly takes into account the microclimatic conditions of the site regarding the position and form of the nearby built environment (the first was *wind shelter*). To do this, the concept of 'solar envelope' was used. This concept goes back at least 3000 years to colonial towns of ancient Greece (Figure 12), where houses were arranged to maximize heat and light (Knowles, 2003).

Indeed, certain arrangements of urban spaces can produce much better comfort in terms of solar access, if the design takes into account certain "imaginary boundaries derived from the sun's relative motion" (Knowles, 2003, p. 4.6-3). For instance, Figure 13a shows the

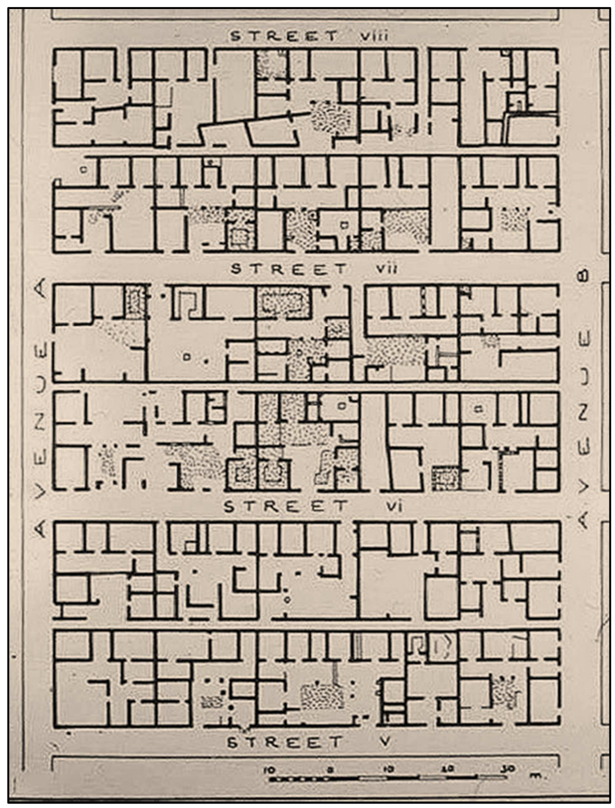
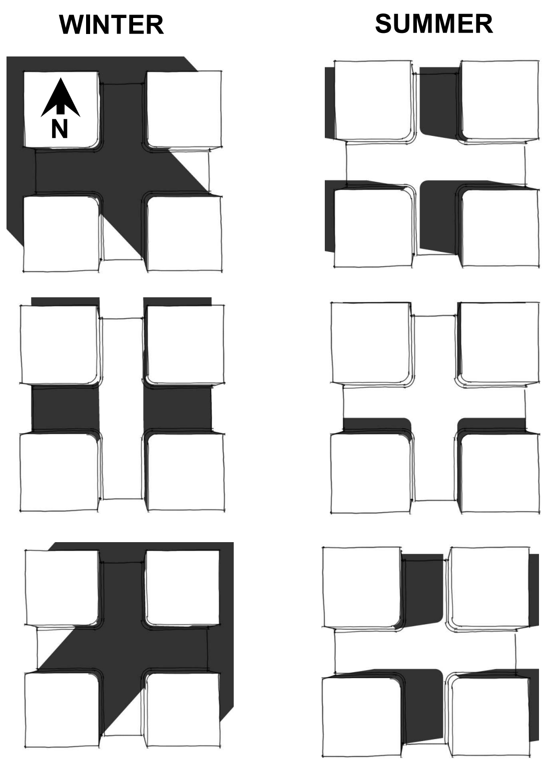


Figure 12. In the fifth century BC, for example, a neighbourhood was built in the city of Olynthus. The streets were built perpendicular to each other and ran in the east-west direction (horizontal streets in the plan), so that all houses (five on each side of the street) could be built with southern exposure (Knowles, 2006, p. 173).

typical shadow patterns in streets laid out in an E-W grid, and ones laid out off-axis, sometimes referred to as a ‘Spanish grid’ (Figure 13b). It is evident that streets and alleys laid out in an E-W grid do not produce the best street qualities of solar light and heat, which can make them especially uncomfortable.

Conversely, shadow patterns in streets and alleys laid out off-axis are an indication of greater comfort. A notable difference between the two layouts is that every street on the Spanish grid receives direct light and heat between 9:00 am and 3:00 pm, the hours of greatest solar insolation, whereas streets arranged in a proper grid are overshadowed and cold in winter, and bright and hot in summer.



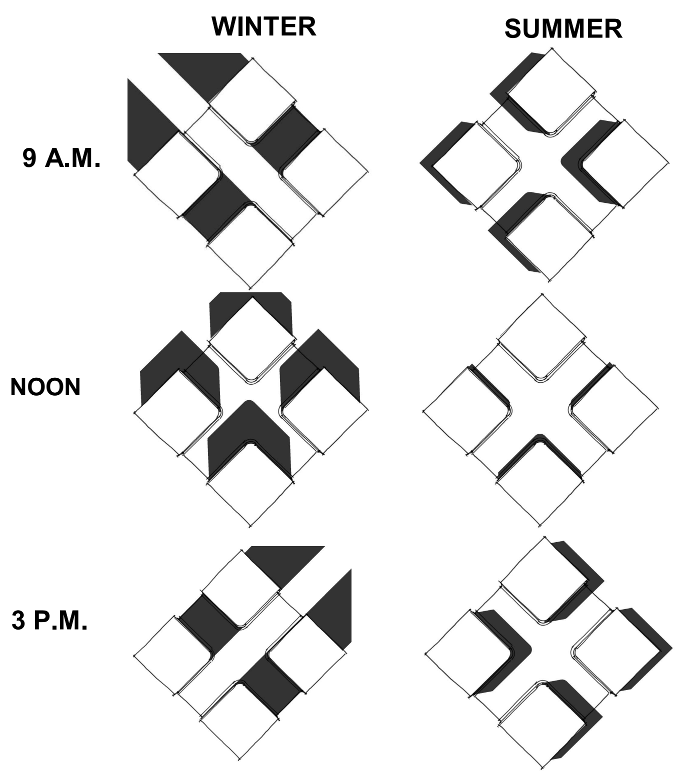


Figure 13a. Shadow patterns on streets with E-W grid are overshadowed and cold in winter, and bright and hot in summer. *Note*: Adapted from “The Solar Envelope,” by R. Knowles, 2003.

Figure 13b. Shadow patterns in off-axis grid receive the warming winter sun and cooling summer shade in all streets.

Saskatoon's older core neighbourhoods are mostly arranged on an E-W grid. However, streets and alleys in the CBD run about 15° off the cardinal points (Figure 14). This diagonal orientation is especially beneficial for a winter city in terms of maximizing solar light and heat. For example, the path of the winter sun from east to west means alleys that go E-W (technically, tilted 15°) will receive more sunlight especially during the winter. Alleys that go N-S will have limited solar access particularly during winter when the sun is lower, so surfaces in the alley (ground, building massing) will receive less solar radiation and emit less terrestrial radiation, significantly reducing microclimatic comfort. The height of nearby buildings also plays a role in how much solar exposure the site receives. Nearby buildings that surround the back alley will either obstruct the southern exposure or allow it, thereby maximizing heat gain and solar access in winter. Determining this will require comparing the sun angle with adjacent building heights (see Appendix 2).

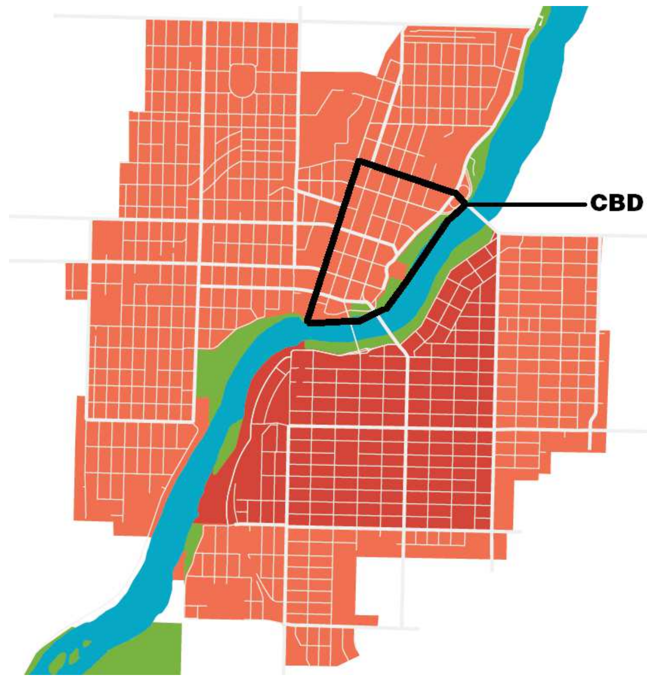


Figure 14. Older core neighbourhoods are a regular E-W grid; streets in the CBD are off-axis. *Note:* Reprinted from "Saskatoon Speaks - Moving Around," by COS, 2010a.

The next criterion concerned how frequently (or in most cases, how rarely) a parking lot was occupied by vehicles. The perceived parking shortage in downtown Saskatoon is not enough to proceed under the assumption that all the parking spaces are taken and being allocated efficiently. In fact, the majority of surface parking lots in downtown Saskatoon fulfill peak-parking demand only (weekday mornings & afternoons) while remaining abandoned over weekends and evenings. Allowing valuable downtown land to go unused means a loss of potential tax revenues for the city, potential commercial space for businesses, not to mention the blight generated by the empty expanse of pavement. Surface parking lots located downtown that are only used on certain days during certain time periods are an indication that the land is not being put to its highest and best use. Therefore, the intention to measure and analyze the ***parking lot usage*** is more so an issue of redevelopment potential rather than urban design. Still, the likelihood of redeveloping a parking lot is much greater if stakeholders can be assured its removal will not cause more parking problems. In other words, few people should object to ridding the area of a parking lot that is hardly even used.

In terms of time, usage of the parking lots was measured at four timeframes (weekday, weekend, daytime, evening) to capture when the lots were being used. In terms of capacity, each lot was measured based on the ratio of occupied to vacant spaces. This meant gathering usage statistics for each of the twenty-four parking lots at each timeframe to produce a score based on the presence or absence of unoccupied vehicles parked in each lot, indicating if the lot is performing its intended function. This will reveal if the current use of lot (parking) could be intensified (i.e., more parking could be accommodated) or changed to a use that contributes to better overall urbanism in the vicinity.

Similar to usage, the issue of ***ownership*** or the ***market availability*** of the land is more about developability than design. Although ownership is not an issue directly addressed in this study, as Shoup (2008) pointed out, the success of infill development often depends on the ability to assemble land. For instance, a parking lot that is privately owned and leased by a parking services company has an incentive to continue in the parking business if it is profitable. It is their prerogative to make money, and while it is not explicitly their intention to harm the urban environment, it is not theirs to improve it. On the other hand, publically owned parking lots offer greater opportunity for development because overall, it is in the best interests of the owner (the municipality) to put the land to the most economically intensive and environmentally responsible use. In downtown Saskatoon, ownership of surface parking lots range from private entities to the municipal or provincial government. Lots owned by the City and leased to private companies for parking are naturally given priority for redevelopment because of their apparent market availability. Therefore, the market availability (whether a public or private entity owns it) of a site is a valuable indicator of the economic feasibility of developing or redeveloping it.

The final two criteria – more than any of the others – were tailored to Saskatoon, where the prospective conversion of certain parking lots could be potentially useful in addressing an indirectly related problem: stagnant population growth in the city centre. As a planning endeavor, attracting more people to live downtown is crucial for the revitalization of a city centre. In Saskatoon, some downtown blocks, notably in the south downtown, have very few residential units in the vicinity and are abandoned after working hours. Other areas like the north downtown have higher residential densities, and, as one study recently indicated, a higher perception of safety (COS, 2011, p. 53). Greater ***nearby residential densities*** are an indicator of greater amounts pedestrian activity in the area, particularly after working hours.

If a parking lot is located where many people live nearby, the benefits of densification and infilling can be extended by increasing perception of safety, enhancing nearby built environment, and improving access to services and amenities for existing residents. Higher densities and the benefits gained from them because of infilling would be similar for each site, regardless of the number of people already living nearby. However, experts continue to suggest that the benefits in terms of efficient use of infrastructure, housing affordability, energy efficiency, and possibly street life, are greater for those with existing higher densities (Audirac, 1999; Forsyth, Oakes, Schmitz & Hearst, 2007). Consequently, for this measurement, parking lots with more people living nearby are more favourable.

Another way to bring more life to downtown streets after working hours is to take advantage of nearby student population, since students are generally more likely to walk, use transit, or be engaged in the public realm. Over the past decade, a number of Canadian cities[7] have used nearby educational institutions—or more precisely, their nearby student *populations*—as a way to revive and bring activity back to their downtowns. For cities like Saskatoon, where despite having 28,191 post-secondary students attending institutions in and around the CBD[8] (COS, 2011, p. 37), there is no formal student housing, and a lack of affordable units for student population downtown. This is not only an invitation for more car-use downtown, but also a wasted opportunity since so much land for parking goes unused. Therefore, it is considered an asset if a parking lot has an ***educational institution nearby.*** Just as the previous criterion (residential density), the problem of no student housing downtown is tailored to the case-study city, Saskatoon. This situation is not unique to Saskatoon, but had the study been undertaken in a city like Vancouver, which has a much larger share of its population living downtown, then each of the final two criteria could be disregarded.

[7] Some examples include Ryerson University for downtown Toronto, Concordia University for downtown Montreal's west end, and downtown Edmonton with Grant MacEwan University & the University of Alberta.

[8] The University of Saskatchewan (U of S), which supports 20,000 students, and the Saskatchewan Institute of Applied Science and Technology (SIAST), with another 6,000 students

3.4. Applying the Criteria

Each of the previously outlined criteria were formulated into two checklists (requisite and auxiliary), which were brought along for field observation to analyze downtown surface parking lots (Table 1 & 2). This section will go over how each criterion was specifically measured and recorded. These criteria are applicable to Saskatoon specifically, but could be adapted and

Table 1
Scoring Matrix for Requisite Criteria

Criterion	*Score*	*Lot #*
NEARBY AMENITIES	**0** - none **1** - poor **2** - moderate **3** - high	
CONNECTIVITY	0 ≤ 2 (**1 score**) 3 – 4 (**2 score**) ≥ 5 (**3 score**)	
NODES	0 (**0 score**) 1 node (**1 score**) 2 nodes (**2 score**) +3 nodes (**3 score**)	
SITE/LOT POSITION	standalone (**0 score**) commercial (**1 score**) mid-block (**2 score**) corner (**3 score**)	
WIND SHELTER (alley)	**0** (no shelter; EW) **1** (moderate; EW) **2** (moderate; NS) **3** (excellent; NS)	
CAR PRESENCE (alley)	no cars (**3 score**) 1 - 4 (**2 score**) +5 (**1 score**) no alley (**0 score**)	

applied to other cities as well, keeping in mind that the method used to score each lot is only relative to those lots that were analyzed. In other words, the results (scores) are meant to be analyzed as a whole and within one city, not individually and for comparative use among different cities.

Data collection and analysis was conducted using a combination of site visits, satellite imagery, and geographic information systems [GIS]. Data that required manipulation (e.g., estimating solar access) was performed using Google® SketchUp. The method used to estimate sunlight and shade has been verified by landscape architects and urban microclimate experts as an alternative to the more sophisticated, three-dimensional computer models that are normally used to determine the intensity of solar radiation in several locations (Brown, 2010, p. 137; Lenzholzer & Koh, 2010).

Following is an outline of how each of the thirteen criteria was specifically measured, and used to award a score. Each set of criteria was also converted into a checklist (Table 1) to bring along during field visits at each potential infill site.

1) NEARBY AMENITIES

The word *amenities* can bring about different meanings in different contexts. For this study, it specifically refers to land-use amenities that attract pedestrian activity. Examples of amenities are schools, daycare, food/convenience, farmers market, café, restaurant, gallery, theatre, indoor mall, library, recreation centres, and entertainment. Data was retrieved by visiting each site and conducting a visual survey of the nearby urban environment. Each visual survey was governed by the following rule: Without leaving the parking lot or the sidewalk in front of it, how many amenities can be seen up to a maximum distance of 100 metres, including across the street, down back alleys, and into buildings? Total number of amenities was then confirmed using available data from Walk Score®. This was scored on a scale of 0 to 3, based on the total number of amenities nearby. Lots with no amenities nearby received a score of 0, one amenity received a score of 1, and so on, up until a maximum score of 3.

2) CONNECTIVITY

This criterion was collected by counting the total number of pedestrian access points leading in and out of the parking lot and adjacent back alley(s) where necessary. An access point is any conduit, whether for pedestrians, cyclists, or cars, which connects directly to the lot. Example: *sidewalk* = one access point, *alley entrance/exit* = one access point (no alley can have just one point of access, unless it is a dead end, which adds no benefit to connectivity), *pathway* = one access point. This was scored on a scale of one to three, where every lot receives at least 1 score, since they are all connected by a sidewalk. If the parking lot has up to two access points, it receives 1 score. If it has three to four access points, then it receives a score of 2. Finally, if the lot has five or more access points, then it receives the maximum score of 3.

Figure 15. Scoring for connectivity involves assessing of the number and quality of pedestrian conduits—not only streets, but alleys leading to/from the parking lot. This measurement includes everything on the perimeter of the site and the alleys that directly connect to it. The example here depicts a parking lot with a connectivity value of four.

3) Nearby Pedestrian Nodes

Nodes are anchor points, gathering spaces, or major intersections where pedestrian activity is clustered. Each parking lot was visited to determine the total number of nearby nodes of pedestrian activity (examples: transit hub, pocket parks, or clusters of two or more pedestrian amenities such as benches, mailboxes, newspaper stands, poster boards, and transit shelters). The scoring for this criterion is the same as for nearby amenities. Parking lots with no nearby nodes of pedestrian activity received a score of 0. The presence of one node nearby garnered a score of 1. Two nodes received a score of 2, and so on, up until a maximum score of 3.

4) Site Position

This criterion required determining whether each parking lot is a standalone lot [S], mid-block between two other structures [MB], a corner lot [C], or connected to a major commercial land use [MC] (see Figure 9). Available satellite imagery from Google Earth™ allows this information to be retrieved without visiting the parking lots. Scoring for each lot classification involves ordering each 'type' by how favourable they are for infilling, beginning with the least favourable, the standalone lot (0 score), commercial lots (score of 1), mid-block lots (score of 2), and finally, the most favourable location, a corner lot (score of 3).

5) Wind Chill Shelter

Measuring and gathering data for this criterion required site visits to each parking lot and adjacent back alley to conduct a visual survey. If there is a back alley connected to the parking lot, it was evaluated according to its potential for wind-chill protection by asking the following questions: Is the back alley oriented parallel or perpendicular to the prevailing wind? Are there any adjacent structures or buildings that mitigate or block the wind and snow from blowing in the alleys and at the edges of the parking lot? The average prevailing wind directions are westerly to south-westerly, with an average of 20 km/hr. (see Figure 10). Concerning shelter from wind, alleys oriented north to south are more favourable than those running east to west. Therefore, each lot was awarded a score ranging from 0 to 1. Alleys that go east to west with relatively no wind shelter from surrounding buildings or structures received a score of 0. If an alley goes east to west but still had moderate shelter from wind, it received a score of 1. Many parking lots have more than one alley connected to them. In order for a parking lot to receive 2 or the maximum score of 3, it must have at least one north-south pointing alley (+/- 15°). If the alley that runs north to south has moderate wind chill shelter, then it received a score of 2. The maximum score of 3 was awarded to parking lots with at least one north-south pointing alley and exhibited excellent potential for wind protection.

6) Automobile Presence in Alley

For each parking lots that also was connected to an adjacent back alley, those alleys were evaluated according to the presence of automobiles and automobile amenities within them, such as private driveways, garage entrances, and loading docks. These elements, for the most part, are usually the most prominent features found in most back alleys. Indeed, alleys are the best place to put unsightly yet necessary elements of the city. However, some are much more overrun by the presence of automobiles than others are. For the purposes of improving pedestrian connectivity, even an alley with a high presence of cars is better than having no alley at all. Therefore, parking lots with no adjacent back alleys received the lowest score of 0 for this criterion. Some parking lots have more than one alley connecting to them, and these alleys themselves often differ in their appearance and amount of automobile amenities. Consequently, when there are multiple alleys, it is sufficient to analyze the each alley segment and choose the best one (lowest presence of cars). This will avoid under-scoring parking lots that have several alleys (and thus, very high connectivity) but cumulatively, since they cover much more area, exhibit a very high presence of cars. This also means the highest score for this criterion can be awarded to parking lots with relatively high presences of cars in them, as long as one segment of those alleys shows no presence of cars. Therefore, parking lots with at least one alley, with no parked cars, loading docks, garage entrances—a rare occurrence—would receive a high score of 3. If one to four of these features are found in the alley, it receives a score of 2. Finally, if the best alley adjacent to the lot has over five of these automobile amenity features, it receives a score of 1.

This marks the end of the requisite criteria. At this point, the total score for each parking lot would be calculated. Each parking lot with a score of more than 10 was considered a potential candidate for repurposing. The remaining parking lots, which scored 10 points or less, were all eliminated from consideration. Table 2 is a scoring matrix for the following set of auxiliary criteria. This set of criteria is supplementary to the six previously discussed ones.

Table 2
Scoring Matrix for Auxiliary Criteria

Criterion	***Score***	*Lot #*
LANDMARKS/CIVIC SPACES	0 (0 score) 1 (1 score) 2 (2 score) 3+ (3 score)	
AESTHETIC APPEAL/BLIGHT	0 (no alley) 1 (poor appeal) 2 (moderate) 3 (high)	
WINTER SOLAR EXPOSURE	0 (no sun or alley) 1 (0.5 - 2 hours) 2 (over 2 hours)	
WEEKDAY DAYTIME USAGE WEEKDAY EVENING USAGE WEEKEND DAYTIME USAGE WEEKEND EVENING USAGE	>50% (0) ≤50% (1) ≤25% (2) ≤5% (3)	
OWNERSHIP	private (0) government (1)	
EDUCATIONAL INSTITUTION	>200m (0) 100-200m (1) <100m (2)	
RESIDENTIAL DENSITY	none (0) low (1) medium (2) high (3)	

7) Landmarks & Civic Spaces

Determining the score for this criterion involved visiting the parking lots to determine the total number of nearby major landmarks or civic spaces. The total number was then used to award a score of either 0 (no landmarks or civic spaces nearby), 1 (one landmark or civic space), and so on, until a maximum score of 3. Examples of landmarks include buildings of heritage value or architectural significance, public squares or plazas, greenspaces (parks, trails), or any prominent monuments in the neighbourhood that afford assistance in wayfinding.

8) Aesthetic Appeal

Determining the score for this criterion required visiting each parking lot and their adjacent back alleys to determine the prevalence of utility equipment and municipal hardware. Google Street View™ is a very helpful tool that can be used to confirm and compare between different back alleys. Each alley was rated on a point-scale of 1 (unappealing), 2 (moderately appealing), and 3 (appealing), based on existence of utility equipment, trash bins, etc. Examples of unappealing features are overhead wires, transformer boxes, electrical poles, dumpsters, litter. An alley that is aesthetically appealing, therefore, is exhibited by absence of these features. Parking lots with no back alleys received a score of 0, since it was assumed that a relatively unappealing back alley was better than no alley at all.

9) Winter Solar Exposure

The purpose here was to determine how much solar exposure the back alley(s) receive during the winter hours of greatest insolation. A 3D model of each parking lot and back alley was drafted into Google SketchUp™ to simulate the path of the winter sun over the site and see how nearby buildings obstruct direct solar exposure of the site, especially in back alleys. The amount of time that a back alley received direct solar exposure was then assigned a score beginning with 0, for lots with no exposure or no alley. If the alley received moderate solar exposure (0.5 – 2 hours) at some point between 9:00am and 3:00pm, then it was awarded a score of 1. Alleys with over two hours of direct solar exposure were given a score of 2. See appendix 2 for a detailed description of how this process was undertaken by use of 3D SketchUp™ model.

10) Usage/Occupancy

In order to determine the extent that each parking lot was being used for parking, field visits to each lot was undertaken. This was necessary in order to determine their occupancy during four separate timeframes: on the weekend, during the week, and during the daytime and evening. Field visits for all parking lots were conducted on February 6th (Wednesday), February 9th (Saturday), February 23rd (Saturday), and February 25th (Monday), to determine the ratio of occupied to unoccupied parking stalls during both day and evening. If a lot was observed as being over 50 percent occupied, then it received a score of 0. Subsequently, if a lot was between ¼ and ½ full of parked cars, it received a score of 1. When a lot was between five percent and twenty-five percent occupied, this garnered a score of 2. Finally, the maximum score of 3 was awarded to lots that were five percent or less occupied (almost completely empty). In order to account for anomalies, usage statistics were randomly checked again on several different days throughout the winter and spring of 2013. The purpose of this was to gain a more confident understanding of which parking lots were unused the most and when.

11) Market Availability

Gathering data for this criterion, and thus, assigning a score, was conducted using the Information Services Corporation [ISC] database, to determine ownership of each parking lot, and whether the title is held by government or not. If a parking lot was owned by the City, then it was awarded a score of 1. All other parking lots were given no score for this criterion.

12) Educational Institutions

This criterion looks at the existence of any full-time post-secondary educational institutions or technical colleges within winter walking distance (200 metres). To calculate this, a GIS layer was created for Saskatoon's CBD, including the locations of all surface lots and educational institutions. A buffer of 200 metres was created around each educational institution to visualize if any parking lots were located within this threshold. If no institutions were found within 200-metres from a parking lot, then that lot would receive a score of 0. On the other hand, if one was found, but it is over 100-metres away, it received a score of 1. Finally, parking lots with educational institutions less than 100-metres away receive the maximum score of 2.

13) Residential Density

Data on residential population density from Statistics Canada and the City's recent (2011) strategic framework for the city centre was used to estimate the residential density within a 100-metre buffer of each parking lot and adjacent back alley(s) if present. GIS can be used to assist in calculating the correct distances. Parking lots with no residential population within 100-metres were given a score of 0. The next category, "low" population density, receives a score of 1, followed by "medium" (score of 2), and finally "high", which garners a maximum score of 3.

3.5. Case Study: Downtown Saskatoon, Saskatchewan

Saskatoon was chosen for this study for three main reasons: 1.) *setting:* choosing a winter city is essential, choosing a medium sized city (population approximately 220,000) means that the thesis can be applicable to larger urban centres, as well as smaller towns and cities; 2.) *familiarity:* granted by the author having lived in the city for over 15 years; and 3.) *access:* living in the city of study provides easy access to the downtown for conducting field observation or collecting necessary information. Specifically, the study area will be the city's CBD (Figure 16). Saskatoon is located in middle-southern Saskatchewan amidst the aspen parkland of the Canadian prairies, at 52°08' latitude N and 106°41' longitude W. The city covers an area of 170.8 km2 and has circa 222,189 inhabitants (Statistics Canada, 2012b).

The city region is characterized by four distinct seasons, which experience warm summers and extremely cold winters, with average temperatures ranging from -17°C in January to 19°C in

Figure 16: Google® SketchUp model of Saskatoon's CBD. This model was created to estimate shadow patterns in back alleys and other spaces throughout downtown.

July. Extreme temperatures are made more tolerable by the city's low humidity, resulting in a relatively dry and sunny climate that averages over 2,300 hours of sunlight per year (COS, 2011, p. 28). Winters in Saskatoon are typically long and cold, with daily average temperatures falling below 0°C for five months (late October to March), and the snowiest months reaching an average snow depth of 12-14cm. Average prevailing wind is 20km/hr. in a westerly to south-westerly direction.

Despite rapid growth and development occurring in several new subdivisions along Saskatoon's periphery, the city-centre has had considerably low population growth. Over twenty years ago, the City established a long-term goal of increasing the downtown residential population to 10,000 by the year 2025. The CBD, currently at 2817 people, has increased by only 342 people over the last ten years (Figure 17) (p. 32). In addition, the CBD boasts the lowest population

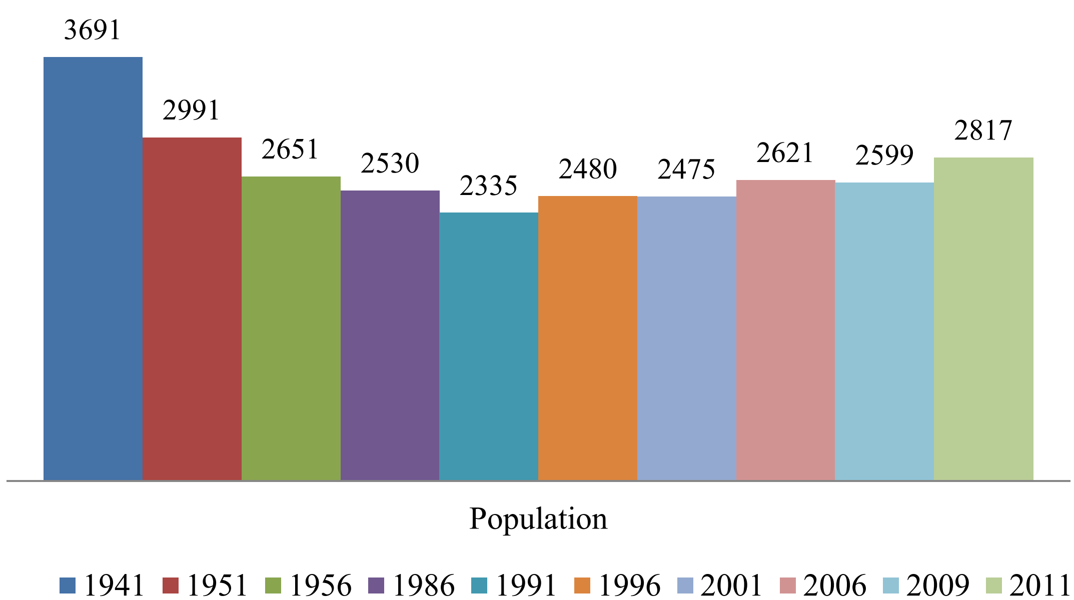


Figure 17. Population of Saskatoon's CBD. *Note*: Adapted from "Public Space, Activity, & Urban Form" by COS, 2011 & "Population and Dwelling Counts", Statistics Canada, 2012a.

density (16 people / hectare) among the major Western Canadian cities (Edmonton 72; Calgary 74; Regina 27; Winnipeg 76) (pp. 20-21). As of 2007, City Council established a target of 500 affordable and entry-level dwelling units annually. The result of this policy has been an average of 448 new units per year, but very few (if any) have been located downtown, which is adjacent to two major post-secondary institutions totaling almost 27,000 students, and six smaller institutions within the CBD serving about 800 students.

The stagnant city centre of Saskatoon can be said to be the product of the city's traditionally high automobile-dependency, which further fuels the demand for more parking. Saskatoon had the second highest percentage of automobile usage among the previously listed Canadian cities (COS, 2011, p. 22) and the lowest mode-share for walking, cycling, or taking transit to work (COS, 2010a). To make matters worse, downtown Saskatoon reached a 1.7 percent retail vacancy rate in 2011, the second lowest in western Canada (COS, 2011, p. 43). Also, it recently reached a record low 1.91 percent vacancy rate for downtown office space (Colliers International, 2012a), both of which cause increases in construction costs and rents, and pushes businesses wishing to enter the Saskatoon market to fringe locations. It is worthwhile now to shift the discussion from the city's car-dependence towards focusing on the underlying cause of this, and that is the lack of rational attention to parking downtown.

3.6. Saskatoon's Parking Paradox

One only has to pass through downtown Saskatoon to see how abundant surface parking lots have become, even amidst recent outcry from businesses and landowners over ongoing shortages of parking (Davis, 2013, January 14). A recent article in the *Saskatoon Star Phoenix* (2013) acknowledged the city has "long been blessed with an abundance of downtown parking", while also entirely ignoring the aesthetic and design impact of such. Still, many downtown residents, shoppers, and employees complain about not being able to find a spot, ironically while numerous surface parking lots throughout the downtown remain underused, especially outside regular working hours.

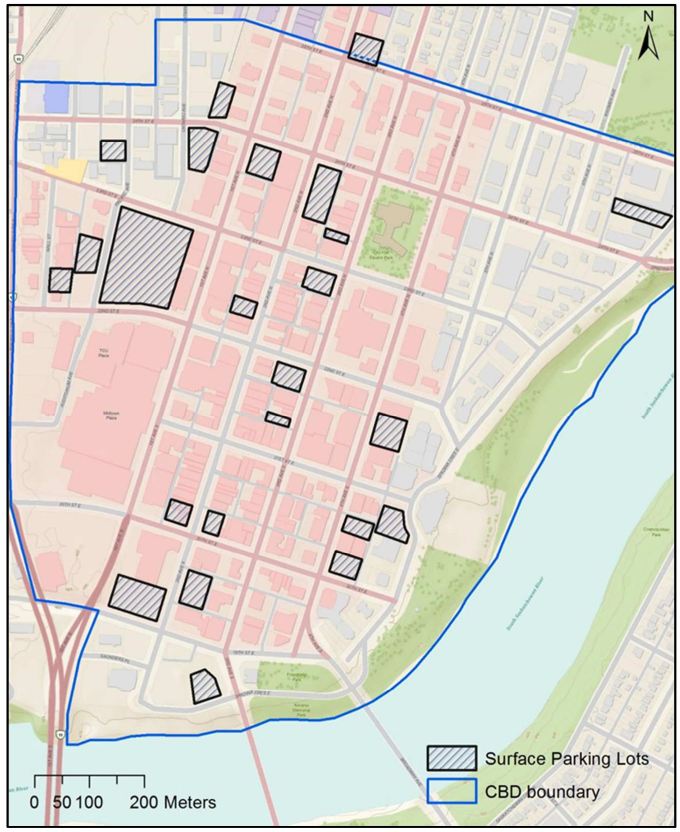


Figure 18. Public surface parking lots in downtown Saskatoon.

This problem can partially be attributed to Saskatoon's antiquated meters and pricing system which allows free parking at night, thereby inducing people to cruise and congest the streets in search of that hallowed but elusive free spot, while literally driving alongside half-empty off-street surface parking lots. It can also be attributed to policies and planning practices that resulted in an economically excessive supply of surface parking, whereby lots initially appear as an interim use, and subsequently endure as a permanent one. The dilemma of mismanaged parking imposes enormous hidden costs, and therefore, deserves further inquiry into how surface lots are utilized, as well as the policies and planning practices that allow them to become so prevalent.

It is fair to say that most surface parking lots in downtown Saskatoon are the creation of an older building being torn down, initially intended as an interim use until the land was redeveloped. Meanwhile, as time passed on, many were never built on again, which left behind a patchwork of unsightly, underused, gravel scars on the city's downtown. Indeed, surface parking can be replaced with underground facilities, or otherwise improved, yet many of these lots have been in operation for decades, and lacking any design standard as far as aesthetics go: gravel or asphalt base, unlit, and no trees or shrubs to somewhat reduce the blight they inflict upon the area[9] (Ben-Joseph, 2012, p. xi).

Recently, Saskatoon has seen a resurgence of development on vacant lots downtown, and according to the city's transportation manager "construction is quickly eroding the downtown supply" (Davis, 2013, January 14). Six parking lots have been "lost" to development since 2011; however, many of those were month-to-month long-term parking lots, rather than public by-the-hour lots. The significance of this distinction is that the majority of the "lost" lots were long-term, private parking lots mainly for downtown residents and workers. True, it has become more difficult to purchase a long-term parking space downtown, but the amount of underused public short-term lots sheds light on the mismatch between the overall supply of downtown parking (on-street meters, public lots, private lots) and the different types of demand for parking that persists downtown (workers, residents, and visitors). In other words, there is no reason people should have to wait two years for a parking space downtown when literally hundreds of spaces are sitting empty. The parking problem, rather, is parking provided inefficiently.

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[9] Interestingly enough, Saskatoon's current zoning bylaw (No. 8770) states that off-street parking and vehicular loading areas (within the downtown) shall be clearly demarcated and hard surfaced – two standards in which the majority of off-street parking lots downtown fail to adhere to (COS, 2013). It also strongly encourages off-street parking facilities located within the CBD and South Downtown (DCD1) areas be "enclosed, covered, or underground […] and must be screened from adjacent street-level view" (Sec. 13.1.3.5.b), which is puzzling since most Impark lots downtown do not follow (or are perhaps exempt from?) these rules . The lack of enforcement of these standards is partially to blame for the abundance of parking lots downtown that are gravel surfaced, have blurred edges with adjacent sidewalks, and provide little to no screening.

Figure 19. Many surface parking lots located in the heart of downtown Saskatoon are utilized Monday to Friday, but are abandoned on evenings and weekends.

Toronto at one time had a similar situation in its downtown: an accumulation of surface parking lots as “interim uses that won’t go away” (Belaieff, 2002). Citing the Toronto experience of this phenomenon ten years ago, Belaieff (2002) remarked, “business cycles come and go, but some parking lots remain untouched”. At the time, this was a real concern. However, a decade later, many of downtown Toronto’s surface parking lots have been redeveloped, according to one city official, in an effort to “recalibrate and rebalance the [city’s] transportation patterns”; an effort that has seen its share of success despite the usual outcry from the business community when cheap parking is taken away (“Parking Spaces Disappearing…” 2010, July 19). Saskatoon’s current arrangement, where surface parking appears to have been elevated to the de facto temporary use for vacant downtown land, has caused an accumulation of unappealing and/or underused surface parking lots to the detriment (and cost) or everyone else, especially pedestrians. Reasons for this are numerous and range from quick revenue to the landowners and lessees, inertia from past decades of intensive car-use, perhaps lack of foresight, definitely lack of imagination, disregard for street blight, urban ugliness, and ultimately contempt for pedestrians. This is a gross misuse of urban land for any city, but more so in Saskatoon where the CBD is starving for more residences and mixed uses.

CHAPTER FOUR: RESULTS

4.1. First Round of Data Collection: *Requisite Criteria*

Figure 20 shows a map of surface parking lots by their aggregated *requisite* scores for the City of Saskatoon based on a normal classification scheme with four classes. In order to move on to the next level of consideration (auxiliary criteria), a lot must receive a score greater than ten **(**R* score, Table 3**)**. According to this analysis a number of parking lots located in the CBD exhibit sizeable potential for mixed-use infilling: the first level of criteria yielded fourteen priority sites out of a total inventory of twenty-four. These parking lots advanced on to the next level of consideration, while the remaining ten lots were ignored[1]. Figure 20 shows the parking lots that were selected as priority sites in green. The remaining orange and red lots failed to meet the minimum scoring threshold, meaning they were relatively less suitable site for mixed-use infilling.

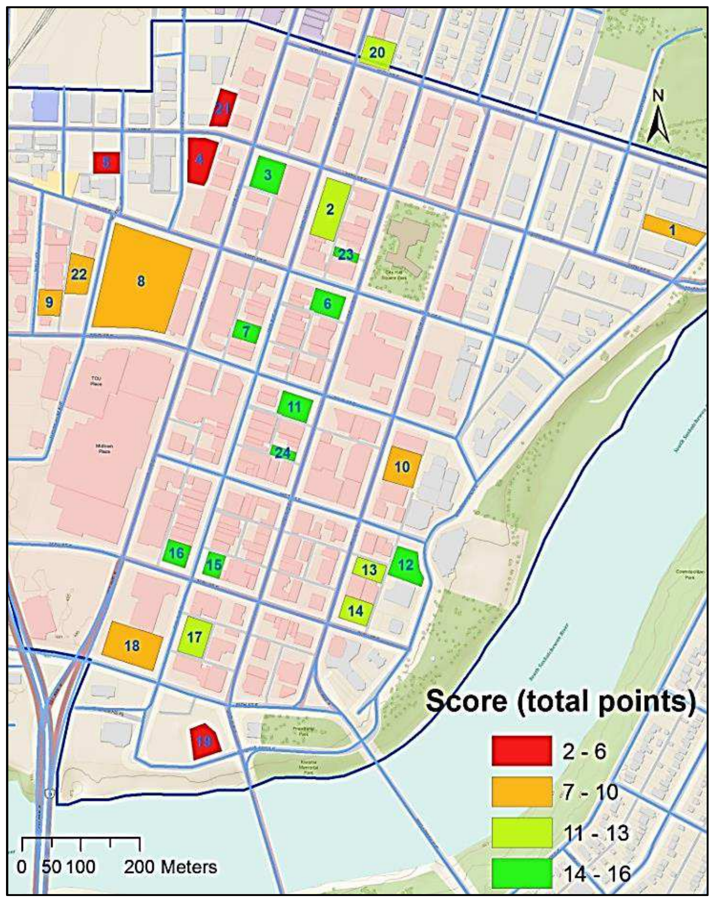

Figure 20. Parking lots (labeled by lot number) showing *requisite* scoring totals.

[1] In order to analyze the results and validate the 'tool', I have collected *all* the data for each parking lot, including ones that would have been eliminated after tallying their requisite criteria. The intent of this is to ensure that a parking lot that scored poorly on under the requisite criteria is not likely to make up for it in points when applying the auxiliary criteria.

Table 3 shows the scoring totals for all twenty-four parking lots based on the six requisite criteria (R* score). The following Table 4 shows the scoring totals for the final ten auxiliary criteria (A* score). Normally, lots that did not receive an R* score higher than ten would not be included here, and would have been eliminated. However, data was still collected and analyzed for them to confirm whether this method of scoring yielded a logical result, if it produced a clear set of winners and losers, and finally, whether that distinction was clear or vague.

Table 3
Requisite Criteria Scoring Totals

	nearby amenities	connectivity value	nearby nodes	site position	wind-chill shelter (alley)	car presence (alley)		
Lot	0 - none, 1 - poor, 2 - moderate, 3 - high	0 ≤ 2 (1 score), 3 – 4 (2 score), ≥ 5 (3 score)	0 (0 score), 1 node (1 score), 2 nodes (2 score), +3 nodes (3 score)	standalone (0), commercial (1), mid-block (2), corner (3)	0 (no shelter; EW), 1 (moderate; EW), 2 (moderate; NS), 3 (excellent; NS)	no cars (3 score), 1 - 4 (2 score), +5 (1 score), no alley (0 score)	**Total (R*) Score**	**% of total points (18)**
1	2	2	1	2	2	1	10	56%
2	2	2	1	3	2	1	11	61%
3	1	2	2	3	3	2	13	72%
4	1	1	0	3	0	0	5	28%
5	1	1	0	0	0	0	2	11%
6	3	3	1	3	3	2	15	83%
7	3	2	3	2	2	1	13	72%
8	2	2	1	1	0	0	6	33%
9	2	2	1	2	0	0	7	39%
10	2	1	3	2	0	0	8	44%
11	3	3	2	3	3	1	15	83%
12	3	2	2	3	2	1	13	72%
13	3	2	2	2	2	1	12	67%
14	2	3	1	3	2	1	12	67%
15	3	3	3	3	3	1	16	89%
16	3	2	3	3	3	1	15	83%
17	2	2	2	2	1	2	11	61%
18	2	2	2	1	0	0	7	39%
19	1	1	0	0	0	0	2	11%
20	2	2	1	3	2	1	11	61%
21	1	1	0	2	0	0	4	22%
22	2	1	1	2	0	0	6	33%
23	3	2	3	2	2	1	13	72%
24	3	3	3	2	3	1	15	83%
Total Awarded	52	47	38	52	35	18	242	

Table 4

Auxiliary Criteria Scoring Totals

Lot	nearby landmarks or civic spaces	aesthetic appeal (vs blight)	winter solar exposure	weekday daytime usage	weekday evening usage	weekend daytime usage	weekend evening usage	ownership	educational inst.	visible residential density	Total (A*) Score	Final Score	% of total points (44)
	0 (0 score), 1 (1 score), 2 (2 score), 3+ (3 score)	0 (no alley), 1 (poor appeal), 2 (moderate), 3 (high)	0 (no sun or alley), 1 (0.5 - 2 hours), 2 (over 2 hours)	>50% (0), ≤50% (1), ≤25% (2), ≤5% (3)	>50% (0), ≤50% (1), ≤25% (2), ≤5% (3)	>50% (0), ≤50% (1), ≤25% (2), ≤5% (3)	>50% (0), ≤50% (1), ≤25% (2), ≤5% (3)	private (0), government (1)	+200m (0), >100m (1), <100m (2)	none (0) low (1) medium (2) high (3)			
1	3	1	2	0	2	2	3	0	0	3	16	26	59%
2	0	1	1	0	2	2	3	0	2	2	13	24	54%
3	0	1	1	1	3	2	3	0	1	1	13	26	59%
4	0	0	0	0	2	2	2	0	0	0	6	11	25%
5	0	0	0	0	2	2	3	0	0	1	8	10	22%
6	2	1	1	2	3	3	3	1	2	2	20	35	79%
7	0	1	1	0	1	0	1	0	2	1	7	20	45%
8	1	0	0	2	2	2	3	0	1	0	11	17	38%
9	1	0	0	1	3	3	2	0	0	0	10	17	38%
10	2	3	0	0	1	1	1	0	1	2	11	19	43%
11	0	1	1	0	2	3	3	0	1	2	13	28	61%
12	2	2	2	1	2	2	3	0	2	0	16	29	65%
13	2	2	2	1	0	2	2	1	2	0	14	26	59%
14	2	2	2	0	2	2	2	0	2	0	14	26	59%
15	0	1	1	0	3	2	3	0	2	0	12	28	63%
16	0	1	1	0	3	1	2	0	1	0	9	24	54%
17	1	1	2	0	3	2	3	0	1	0	13	24	54%
18	1	0	0	2	2	2	1	0	0	1	9	16	36%
19	1	0	0	0	3	3	3	0	0	0	10	12	27%
20	0	1	2	0	3	3	3	0	0	2	14	25	56%
21	0	0	0	0	3	3	3	0	0	0	9	13	29%
22	1	0	0	0	3	3	3	0	0	0	10	16	36%
23	1	1	1	1	1	3	2	0	2	2	14	27	61%
24	0	1	1	0	2	0	3	0	2	2	11	26	56%
	20	21	21	11	53	50	60	2	24	21	283		

Table 5 shows all ten of the parking lots that were removed during this level of consideration (red and orange areas in Figure 20) ended up scoring very poorly overall. In future applications of this prioritization scheme, the user would be encouraged to avoid wasting resources on data collection for parking lots that do not meet the ten-point scoring threshold.

As hypothesized, several parking lots yielded the same score for *requisite* criteria. In fact, this resulted in a 4-way tie for the second spot under the requisite criteria (lot #6, #11, #16, #24 each received a score of fifteen; see Table 3), highlighting the usefulness of having a second level of criteria (*auxiliary*), which turned out to be essential for refining the final decision.

Table 5

Comparison of Requisite Scores and Final Rank

Lot	Total (R*) Score	Final Score	% of total points (44)	Overall Rank (out of 24)
1	10	26	59%	6
10	8	19	43%	16
9	7	17	38%	17
18	7	16	36%	19
8	6	17	38%	17
22	6	16	36%	19
4	5	11	25%	23
21	4	13	29%	21
19	2	12	27%	22
5	2	10	22%	24

The ***nearby amenities score*** (Figure 21) was perhaps the most telling criterion in terms of dictating later success in the prioritization scheme. For instance, a low score for this criterion typically corresponded with a low overall score later on. Table 6 shows the five overall most suitable lots, four most unsuitable lots, and their corresponding amenities score. As well, the lots that were ranked highest for nearby amenities finished with the highest overall scores (overall top four parking lots each received the highest score for nearby amenities). Parking lots that scores lowest here, for the most part, all ended up being the lowest scoring lots overall. Overall, this criterion appeared to have the greatest influence over the final scoring outcome.

Table 6

Nearby Amenities Score Compared to Final Score

Lot	nearby amenities score	Final Score
5	1	10
4	1	11
19	1	12
21	1	13
23	3	27
11	3	28
15	3	28
12	3	29
6	3	35

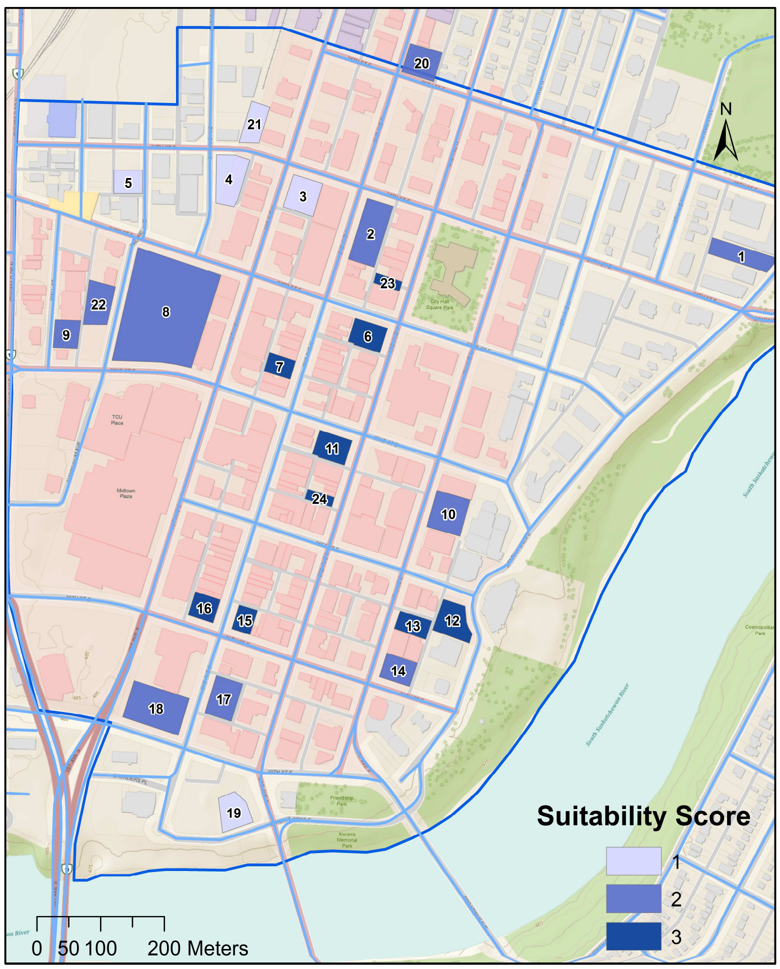

Figure 21. Map of parking lots and their score for nearby amenities, labeled by lot #.

The only other criterion to produce a similar correlation was ***connectivity value*** (Figure 22a) which is based on the total number of pedestrian conduits or informal pathways to the site. Figure 22a shows that parking lots closer to the centre of the CBD and its 'main streets', namely between 2^{nd} and 3^{rd} avenue and 20^{th} and 23^{rd} street, scored the highest for connectivity. When compared with the connectivity values of each lot to a map of retail density of the immediate area (Figure 22b), it is apparent that connectivity is highly correlated with higher levels of street-level retail activity, whether it is shopping, restaurants, or other services. This is a positive observation since it reveals the link between the two criteria: proximity of amenities & connectivity. Together, these elements determine the distances between complimentary activities, making them synergistic of one another (Owen et al. 2007). For instance, the presence of pedestrian-friendly amenities is only valuable to non-drivers if the built environment fosters

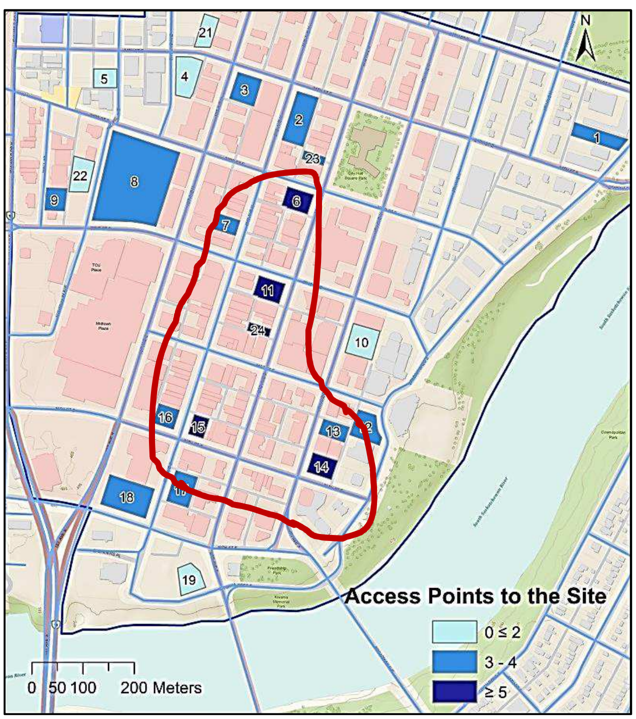

Figure 22a. Parking lots by connectivity value.

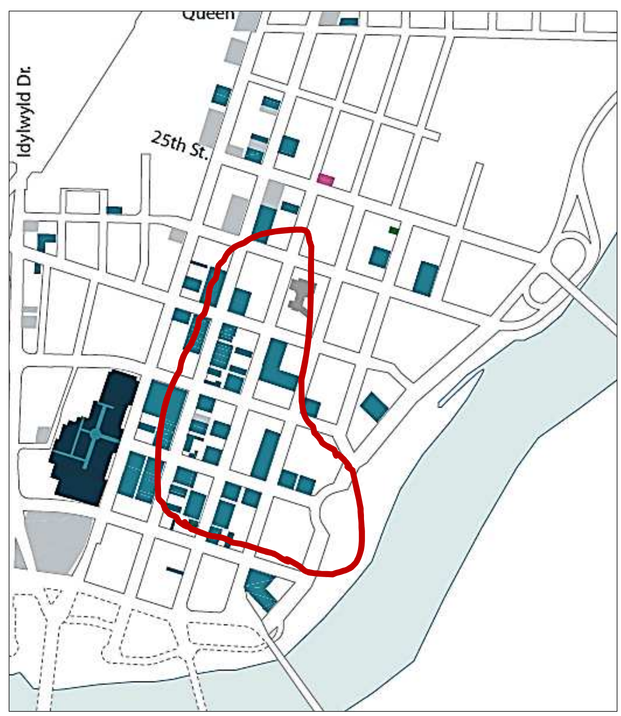

Figure 22b. Retail density in CBD.

good connectivity to them for people on foot. If parking lots with the highest rated connectivity were located furthest from the main pedestrian streets, that connectivity would be somewhat trivial because of the lack of pedestrian-friendly amenities being linked together.

Concerning ***site position***, ten parking lots out of the twenty-four surveyed were situated on a corner-lot (dark red in Figure 23). This was the most favourable site position option (corner, mid-block, major commercial, standalone). Another ten lots were located mid-block, which was then next best location. The three parking lots with the overall highest total score (lot #6 -1st, lot #12-2nd, lot #15-3rd) each were located on a corner lot.

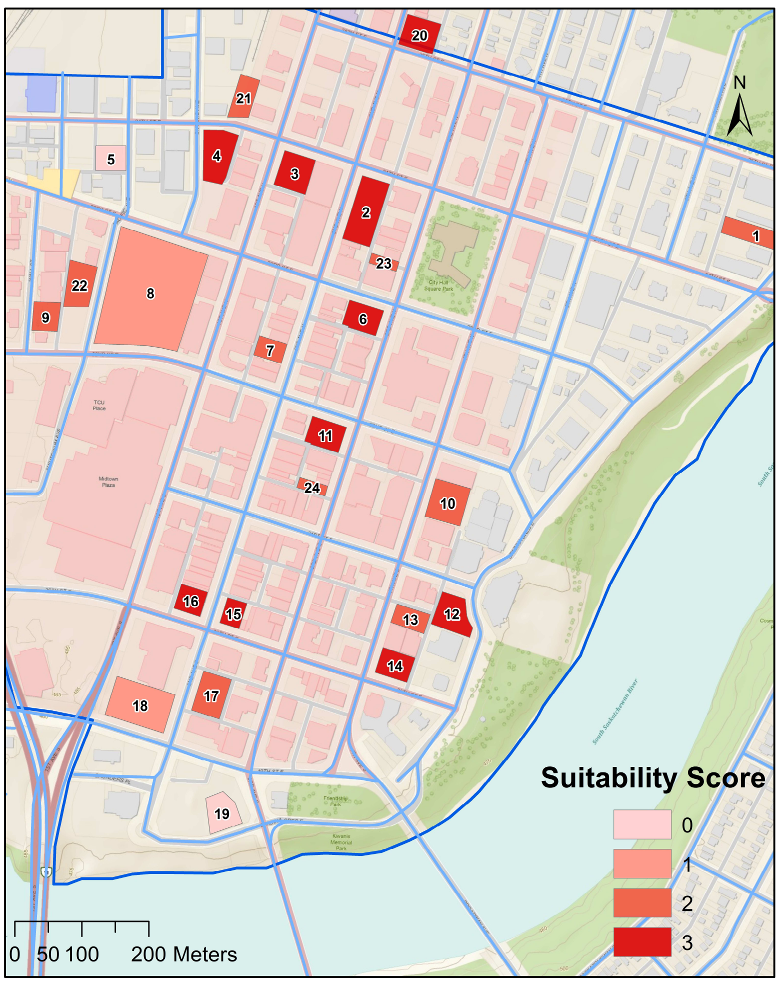

Figure 23. Parking lots by site position. Corner lots were the most favourable site position within the urban block.

Wind-chill shelter score (Figure 24) helped to set a clear distinction between highly suitable lots and those that failed to reach close contention. Considering that parking lots without an adjacent back alley did not receive any points under this criterion, wind-chill shelter score allowed the more suitable lots to pull ahead in points, leaving behind an impassable rift for lots with no alleys. This allowed parking lots without an adjacent back alley to be eliminated from consideration, which was the intent.

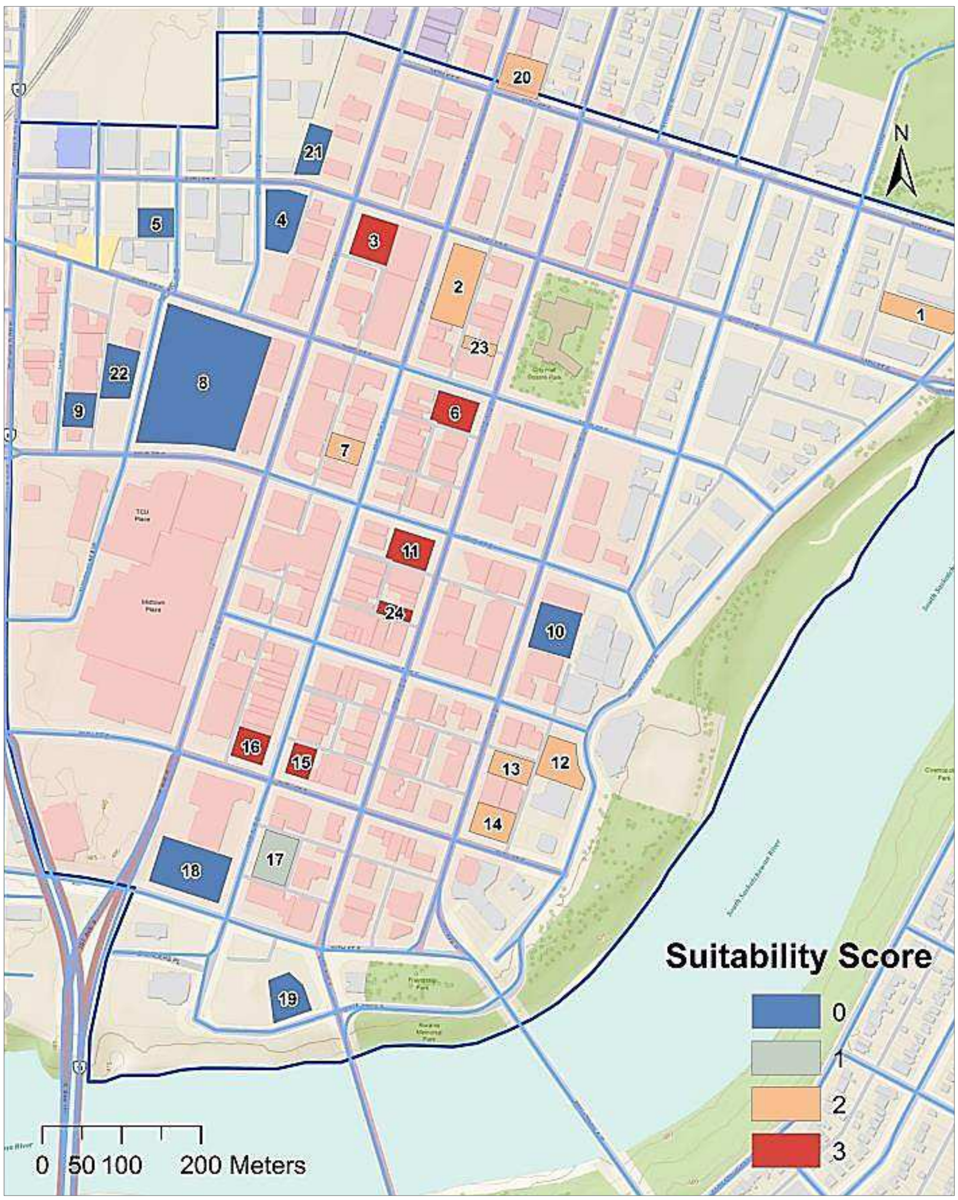

Figure 24. Wind-chill shelter score.

The alley behind lot #16 (Figure 25) has good potential for wind protection due to its orientation to the prevailing wind. This alley runs perpindicular to the prevailing wind direction, meaning that it is much less likely to be windswept at both entrances, compared to an alley that is parallel to the prevailing wind direction.

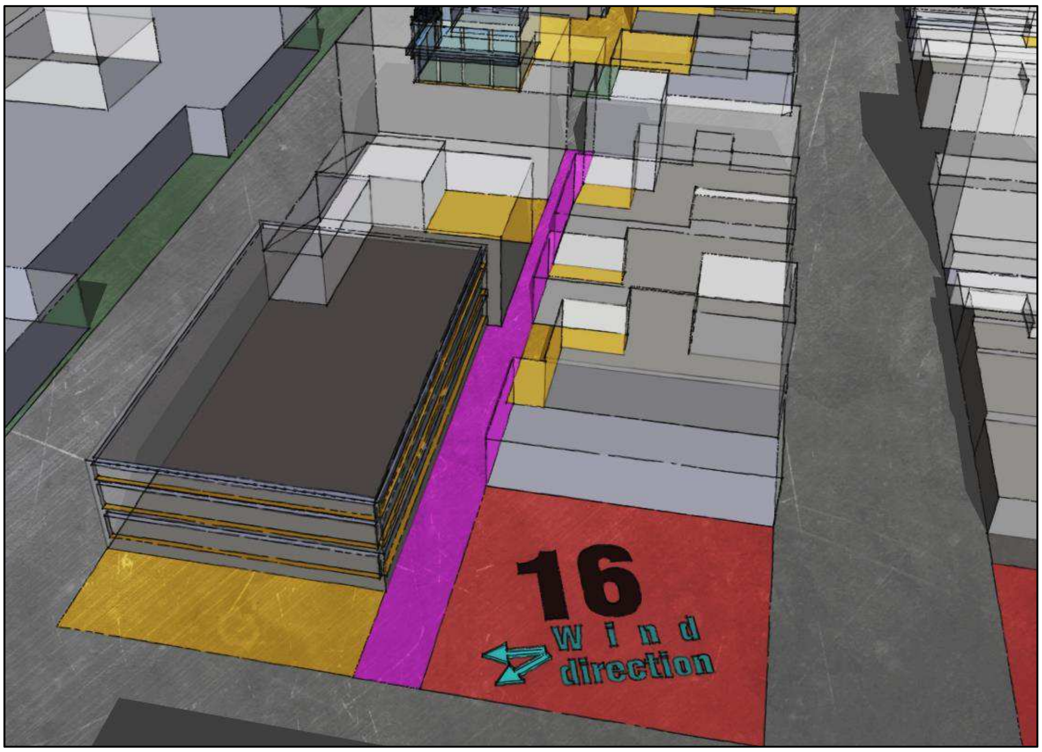

Figure 25. Lot #16 is oriented almost perpendicular to the prevailing wind; as well the building heights along the back alley are fairly evenly distributed, lessening the potential for downward gusts of wind.

4.2. Second level of Data Collection: *Auxiliary Criteria*

As in many cities, a large proportion of surface parking lots in Saskatoon were observed as unoccupied for a large portion of the day/evening, especially evenings during the weekend, validating the previously held assumption that the demand and supply of parking in downtown Saskatoon is mismatched and could be utilized much more efficiently. In addition, the fact that on-street parking is free during the evenings may be the reason why so many surface lots were empty during these times. Likewise, considerable points were given to parking lots that appeared to be significantly underused during peak periods (Figure 26).

Figure 26. Underused parking lot (#17) in downtown Saskatoon.

However, just the like the ***ownership*** criterion, ***parking lot usage*** does not capture any spatial or physical qualities of the built environment, and rather is based on principles *developability*, or the ability to assemble land, rather than principles of urban design which the remaining criteria are based. For this reason, these four criteria (collectively called usage), are likely candidates for testing their weight on the overall final scores, since this data is the least static, or most volatile to change. Table 7 shows the general usage statistics for the three top and the bottom scoring parking lots. When the overall weight for usage is reduced to 50%, this generally did not change the ranking sequence in terms of each parking lot's suitability for infilling. This could also be attributed to the fact that most parking lots were unoccupied (evenings) and occupied (weekday morning/afternoon) during the same times, and thus, received similar scores.

Table 7

Parking Lot Occupancy Scores Showing Overall Rank and Different Weight

Lot	weekday daytime usage	weekday evening usage	weekend daytime usage	weekend evening usage	Total usage points (out of possible 12)	weight = 50%	Final Score (Reduced Weight)	Final Score	Overall Rank	Weighted Rank
6	2	3	3	3	11	5.5	29.5	35	1	1
12	1	2	2	3	8	4.0	25.0	29	2	2
15	0	3	2	3	8	4.0	24.0	28	3	3
5	0	2	2	3	7	3.5	6.5	10	24	24
4	0	2	2	2	6	3.0	8.0	11	23	22
19	0	3	3	3	9	4.5	7.5	12	22	23

Figure 27 shows the map of parking lots by their aggregate final (*requisite* and *auxiliary*) scores. The most suitable lot for infilling is lot #6, which garnered 35 total points (won by a margin of six); coincidentally this lot is also one of the only two lots that are on city-owned land. This lot scored very high in connectivity, amenities, position, wind shelter, and usage (where it appeared to be the least-utilized parking lot of all those included in the study). Additionally, this parking lot is located directly adjacent to the downtown central transit (bus) terminal, which further increases its potential since it is a major origin/destination for non-drivers who work and visit the CBD.

Thus, given the economic stimulation and amenities its repurposing would contribute to, along with its considerable lack of use outside peak parking times, this parking lot (#6) is awarded the highest priority for repurposing.

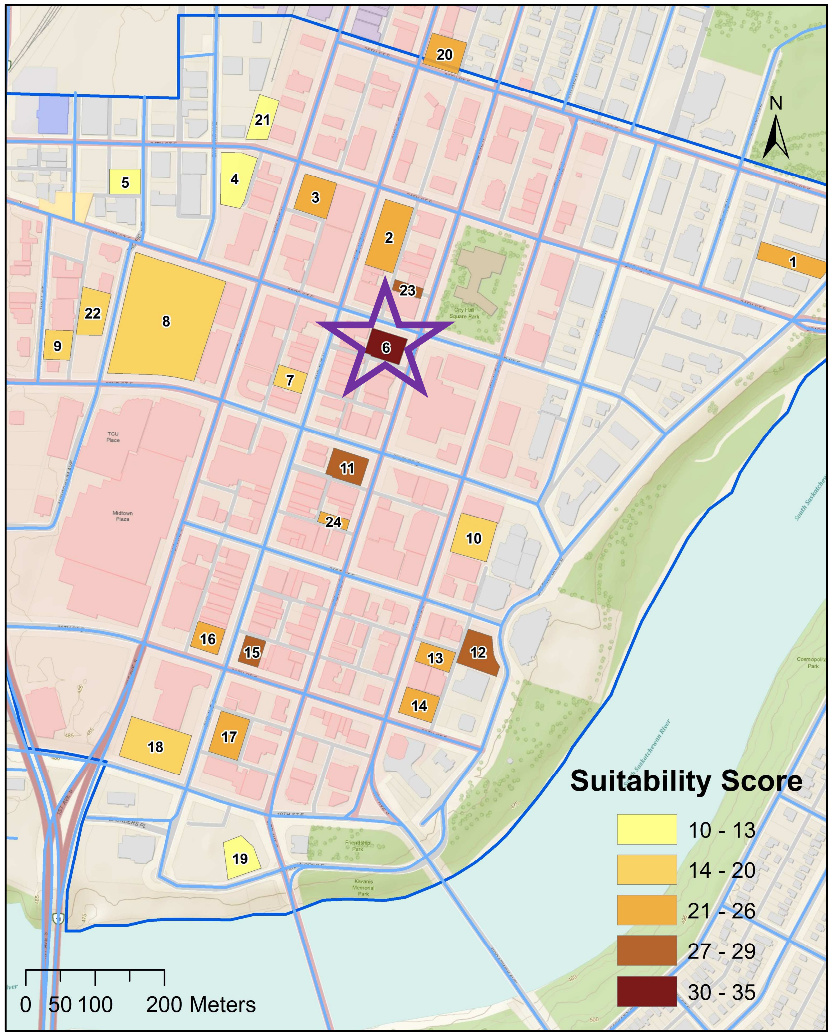

Figure 27. Aggregate (final) suitability score, showing lot #6 with the highest score.

Figure 28. Final site selection: parking lot #6, adjacent to central transit terminal (top of photo).

CHAPTER FIVE: DISCUSSION

Redevelopment of surface parking lots in a winter city—as a broader strategy to improve walkability—could be categorized as an extension of several frameworks or 'movements' that have recently entered the urban planning lexicon (i.e., Smart Growth, New Pedestrianism). So, as an attempt to detach ideology from the basic purpose, which is to incite more sustainable patterns of urban development, these labels were omitted. The concept of sustainable development is most commonly linked to the Brundtland Report (World Commission on Environment and Development [WCED], 1987) definition: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (p. 43). In biological terms, sustainability refers to an ongoing process of how to live and perpetuate the species (Neuman, 2005). In cities, while sustainability is something that can never fully be achieved, it is a constant endeavor. Just as altered or damaged ecosystems experience greater difficulty recovering after events such as floods or fires, cities rampant with vacant lots, abandoned buildings and deteriorating streets and neighbourhoods are faced with greater difficulty in reaching (or bouncing back to) a more sustainable urban design.

5.1. Adjustments to the Criteria

Applying the criteria to a case study allowed a number of adjustments to be made, mainly to the scoring rubric and either broadening or narrowing the conditions for a specific criterion. These areas where improvement can be made are highlighted here:

- The availability of public transit has a positive effect on the volume of pedestrians in an area just as more pedestrians in an area will lead to higher rates of transit usage. The question then is why were nearby transit stops not included as a criterion used to identify areas with high potential for walkability?

Firstly, the major advantage of Saskatoon's CBD over the rest of the city is its density, meaning things like services, amenities, and transit stops are already located within a relatively close proximity to each other. Granted, transit stops are a positive thing the nearer they are to an infill site, but since there are many transit stops throughout the CBD (approximately 39 stops), all going to different destinations, it is difficult to interpret which parking lots would receive preference. This is because the majority of parking lots currently have transit stops within a very short walking distance to them. Just as well, transit stops are not static, and can be introduced wherever new development increases the potential for ridership.

Perhaps if the tool was applied in a larger urban centre with more transit options such as light rail, then according to the broadly accepted tenets of transit-oriented development[1] [TOD], proximity to major stops would certainly need to be included as a scoring criterion so not to overlook their influence on mode choice (Cervero, 2002). Regarding smaller urban centres where usually the only public transportation service is by bus, transit networks is organized around one or a few major hubs or transfer points, which this study did overlook. In Saskatoon, this central transfer point has always been the block of 23rd Street between 2nd and 3rd Avenues (directly beside lot #6 in Figure 28, which this study identified as the most suitable for infilling). Had it not been the case that the lot directly adjacent to the central bus terminal was selected, it

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[1] Over the past decade, TOD has gained in popularity as a way for cities to promote smart growth. By channeling new investments and focusing redevelopment in and around transit nodes, TOD has been a promising tool for curtailing urban sprawl, reducing car-dependence, and improving neighbourhood walkability by improving transit connectivity (Cervero, 2007).

would have been appropriate to use 'proximity to a central transfer point' as another scoring criterion. Yet for the case here, it would make no difference in the outcome.

It is also worthwhile to mention that the focus of this thesis was on pedestrians and not on transit users. However, since virtually all transit users are pedestrians at some point, this distinction, as Ewing (1999) put it, is illusory. Pedestrian-friendly streets or features are inherently transit-friendly also, so a healthy transit system is reliant on a quality pedestrian system, and vice versa.

- No alleys reached the high score for ***car presence in alley***. Each alley had some presence of automobiles, whether parking spaces, loading docks, or entrances to parkades. However, nine parking lots did not have an adjacent back alley, so even having an alley with a high presence of cars is still preferable over no alley at all. Perhaps an improvement can be made by adjusting the scoring threshold to allow alleys with few cars to achieve the maximum score.

- A possible synergistic opportunity was uncovered for the cluster of four parking lots around the corner of 2nd Avenue and 20th St (Figure 29). Redevelopment of one or more of these parking lots offers the opportunity to address this open, windswept expanse of parking which happens to be located at a gateway to downtown's 'main' street. That street is 2nd Avenue, and includes the intersection of 20th St West (a major conduit

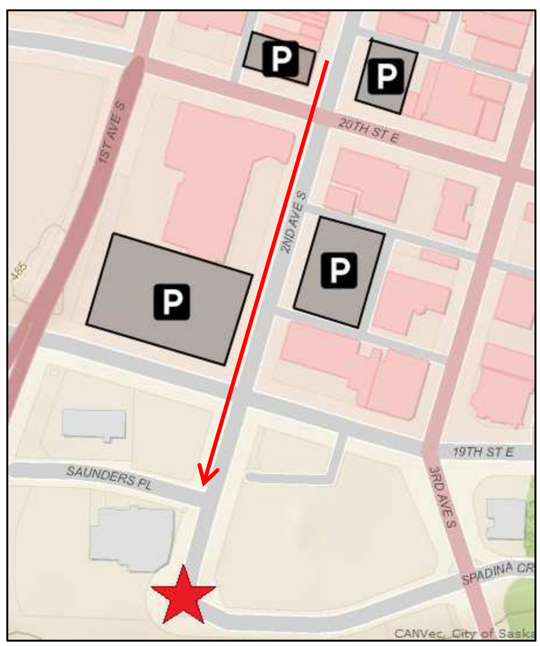

Figure 29. Cluster of parking lots along the gateway to River Landing.

to west-side neighbourhoods) and a block from where 2nd Ave terminates and enters the River Landing development. In fact, a key element of the most recent South Downtown concept plan was to extend 2nd Avenue south to the riverbank (Figure 30), stating the specific intent to draw visitors by incorporating visually interesting storefronts, access to restaurants and cafés, and strengthen the terminus of the extended 2nd Avenue (COS, 2004, p. 14).

Figure 30. Rendering of River Landing development showing the terminus of 2nd Avenue.

- From a planning perspective, the ***nearby landmarks and civic spaces*** is an appropriate principle in terms of improving walkability. However, downtown Saskatoon overall has very few large landmarks or major civic spaces, and it basically served as a score dictated solely on the distance from the lot to the river valley, kinsmen park, midtown plaza, the Bessborough hotel, or city hall. Perhaps this criterion could be adjusted to include landmarks of a smaller-scale, such as public art or semi-private public spaces around buildings.

- Within the literature on how the built environment influences travel mode, the majority of studies suggest ‘street pattern’ is a major contributor to the walkability of an area (Forsyth, Hearst, Oakes & Schmitz, 2008; Ewing & Cervero, 2010). With the growing widespread use of GIS, it is now difficult to find any study on walkability that does not include the street pattern or organization of urban blocks as an integral component of how walkable a place is (Leslie et al. 2007). Yet for the current study, only the pattern of back alleys was measured and not roadways. Street pattern was omitted because the focus here was strictly on the CBD, where the design and arrangement of streets and blocks in typical pre-war downtowns tend to be uniform sized, small blocks, and follow a similar grid pattern (Figure 31).

  Downtown Saskatoon is almost wholly made up of 30 meter-wide roadways that form a grid of (on average) 90x150 meter blocks (Figure 32). Just like how transit stops were omitted due to the inability to distinguish between which ones were favourable, street pattern was omitted because the streets generally form the same pattern throughout the whole downtown. If one were

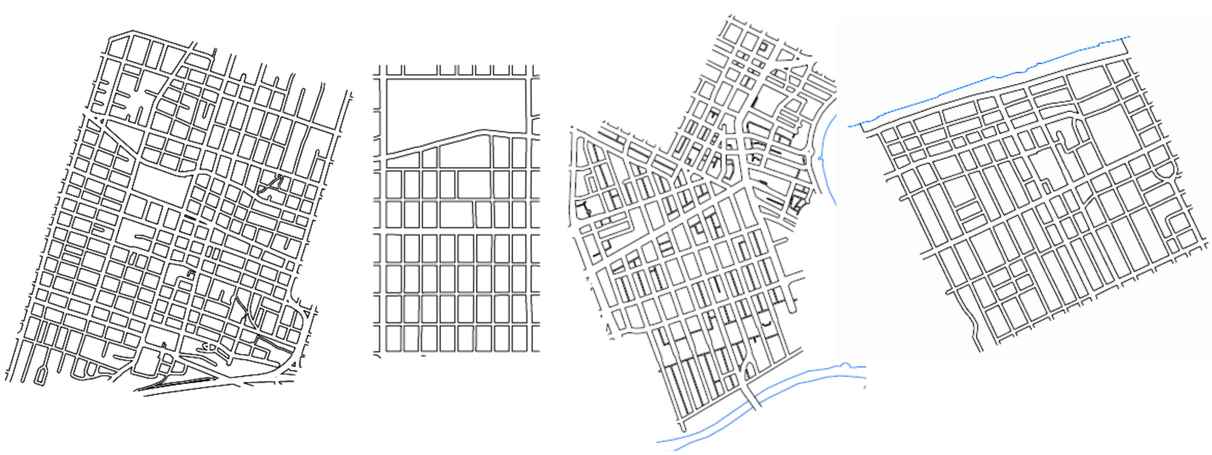

Figure 31 Street patterns of Canadian downtowns (left to right): Hamilton, ON; Regina, SK; Winnipeg, MB; Windsor, ON. *Note*: Reprinted from “Public Space, Activity, & Urban Form” by COS, 2011.

studying the infill potential of parking lots throughout the entire city, then street pattern would definitely be a useful criterion. Nevertheless, when it is only the CBD under consideration, the surrounding street pattern will yield unclear results as to which locations are superior to others.

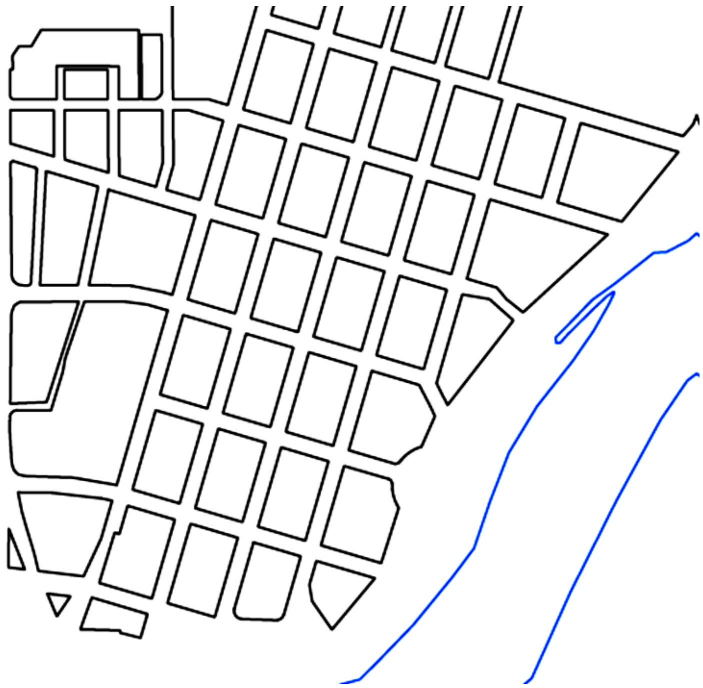

Figure 32 Grid pattern of downtown Saskatoon. Note: Reprinted from “Public Space, Activity, & Urban Form” by COS, 2011.

5.2. Additional Considerations

According to this analysis, a number of parking lots located in Saskatoon's CBD exhibit sizeable potential for mixed-use infilling. The CBD is the most densely developed and populated area of the city, which undoubtedly contributes to this potential. Overall, the redevelopment of surface parking lots in downtown Saskatoon would reinforce local and regional goals for transit, access, connectivity, and ongoing revitalization initiatives, namely those set out in the most recent strategic framework for the city centre (COS, 2011). However, some questions remain.

5.2.1. Private Ownership of the Lots

A noted concern had to do with the current ownership and land-value of the lots, which can naturally complicate the process of development. Admittedly, not all vacant land, or in this case parking lots, are developable, and may be constrained either partially or absolutely by a combination of factors, one of them being a landowner unwilling to sell. Therefore, this thesis does suspend, yet not ignore considerations for ownership (i.e. how to acquire the land for redevelopment), volatility (i.e. in real-estate markets and land values) and other impediments to infill that exist, yet are beyond the scope of this research (i.e. outdated zoning requirements, excessive parking standards, financing difficulties, lengthy permitting processes, site contamination, or neighbourhood opposition). Primarily, the thesis deals with urban land, within the context of an urban design theory, and not urban economics or urban real estate. Ownership issues are generally not subject to dispute, indeed, but public policy can be employed if there is political and public will to institute sanctions and incentives concerning land that is particularly and demonstrably critical to the well-being of a community. Therefore, although the author acknowledges the importance of cooperation with current owners of the lots, the nature of this cooperation, or how it would best be achieved, was not the focus and it was assumed that such obstacles could be overcome with political will and community support.

5.2.2. What to Build on the Chosen Parking Lot

Screening the surface parking lots in downtown Saskatoon for necessary and auxiliary conditions has shed light on identifying which are suitable for infilling and converting to a mixed land-use. This begs the question of what specific *type* of land use, if any, stands out as being more suitable for the parking lot(s) to be converted into. This question is outside the scope of this thesis; however, it does raise some interesting discussion.

Downtown Saskatoon has a higher number of jobs than residents, while suburban locations throughout the city present the opposite situation, typical in many North American cities, deserted at the urban core while the majority of people live in suburban neighbourhoods and commute to work. Comparing this result with downtown Saskatoon's low population density, and vacancy rates for office and retail, it becomes apparent the conflict between different land-uses in demand downtown: abundant surface parking, and walkable mixed-use development.

An important part of urban planning is identifying the economic basis for an urban area. Crawford (2009) pointed out that, typically, this is not part of the urban design process, but it does have an effect on it. For instance, the anticipated conversion of a parking lot would be somewhat contingent on the current demand for different facilities or commercial services such as retail, grocery, or possibly daycare services. Crawford (2009) stated, "The anticipated economy [of the urban area] affects the demand for commercial spaces of all kinds and is likely to affect the design of buildings in the project as well" (p. 234). The significance of this point for the current study is in recognizing that although a number of parking lots were found to be highly suitable for land-use conversion (five lots garnered more than 60% of the total available points; see Table 4), each presented unique opportunities for what was needed in its immediate area. In other words, places where employment density is high may be better suited for introducing daycare, whereas areas near to transit services and high residential densities are perhaps more suitable for a grocery store, which is lacking for the entire downtown area of Saskatoon.

5.2.3. Alleys, Leftover Spaces and Urban Voids

Even though marginal or "leftover" spaces such as back alleys, informal pathways, and vacant lands may be seen as places of tension and decay, they are consistently utilized by pedestrians. Not everybody, but many people often deviate from public sidewalks into back alleys or informal pathways if their route is made conveniently shorter. Indeed the emblematic leftover space within the city is the downtown back alley (Akkerman & Cornfeld, 2010). Certainly, each street or segment of the pedestrian network does not necessarily have to be aesthetically beautiful, as long as it can yield some type of utility to the person walking. In the case of back alleys, their value is in better connectivity and protection from the wind and blowing snow.

As elements of urban structure, the significance of alleys has been an ongoing topic within urban design literature. Jane Jacobs, one of the most influential urbanists of the 20th century, recognized the value of back alleys as network connectors, specifically "the fabric of intricate cross-use that they permit" (1961, p. 243). Seymour, Wolch, Reynolds, and Bradbury (2010) used a series of focus groups to investigate resident perceptions of alleys and their use, and uncovered a highly utilitarian relationship between residents and local alleys. Despite apprehension people may have about these spaces and their long association with blight or crime, they are important to people's daily lives. In this respect, alleys should be looked at as places of opportunity, especially their potential for pedestrian movement by offering protection from harsh winter weather.

Many North American cities are looking to alleys to improve urban and suburban walkability by transforming them into revitalized public spaces such. Recently, the resurgence of interest into adaptive reuse of back alleys as green infrastructure or pedestrian thoroughfares has initiated a number of ‘green alley’ projects in cities like Edmonton, Vancouver, Los Angeles, Chicago (Cassidy, et al., 2008; Phair, 2011). Notable examples are San Francisco’s ‘Chinatown Alleyway Renovation Program’, Seattle’s ‘Seattle Alley Network Project’, and perhaps one of the most ambitious in North America, Chicago’s “Green Alley Project’: a plan currently underway, commissioned by the city’s Department of Transportation, to retrofit some 1,900 miles of alleys throughout Chicago (Chicago Department of Transportation, 2010). In Baltimore, a city stigmatized by crime, an alley-improvement program is underway, organized by a neighbourhood group, and collaborated on with local government, to help reclaim rundown and often crime ridden back alleys (New Urban News, 2009).

Still, research on the potential for leftover spaces, alleys in particular, is thinly distributed and the majority of projects tend to be single purpose. For instance, in Chicago that purpose is runoff management; in San Francisco, to reduce illegal parking and vehicle access; and in Edmonton and Vancouver, the focus was mainly on pedestrianizing alleys located to retail hubs. More importantly, most projects are in cities with mild climates (excluding Edmonton, perhaps Chicago) like Los Angeles, (Seymour, et al., 2010; Wolch, et al., 2010) or Sacramento, CA (Scott, 2012), meaning their potential for winter cities has not been adequately approached in the literature, or in practice.

CHAPTER SIX: CONCLUSION

6.1. What was Learned

Several observations were made with respect to the results of applying the site-selection criteria to surface parking lots in downtown Saskatoon. Firstly, as evidenced by the three surface parking lots that are currently in the construction stages of redevelopment, it is apparent that the criteria compiled in this thesis were far outweighed by factors related to the real estate and land development markets, which have a significant influence over the developability of land as well. Lot #14 and #18 in particular, are currently being converted to high-rise commercial office space. Lot #14 received a total score of twenty-six, making it tied for the fifth most suitable parking lot for redevelopment. Likewise, lot #18 received a score of only sixteen, putting it near the bottom of the list, tied for eleventh place. According to their proposed designs, neither project appears to have taken into consideration the criteria used in this thesis when selecting a site for development. For instance, none thus far have shown consideration for microclimate or using alleys to improve connectivity. This result was generally anticipated prior to completing the analysis, as the tool developed was not intended to predict where development *will* occur; instead it is intended to guide where it *should* occur to promote better urbanism by taking advantage of existing attributes in and around the site. Therefore, these analyses were in essence a validation exercise, where the process described for determining site suitability is believed to be a useful and informative process to help articulate and uncover the inherent potential of these spaces.

This information can be used in the future by community groups, land developers, and municipal decision-makers in determining not only which sites are the most suitable for reuse, but also the specific attributes that set them apart from other sites. This way, certain opportunities within the site will not be overlooked (i.e., places within the site that receive considerable solar exposure during winter should be preserved and used for 'sun pockets'; nearby nodes of pedestrian activity should not be segregated from a new structure by blank walls or off-street parking). The criteria presented here provide a more complete suite of considerations regarding urban design in cold climate at the site planning scale.

These considerations are seldom part of the initial process of assembling land for development, and tend to come once land is already acquired, plans are being registered and servicing agreements are in place. By compiling this information into one inventory, it may not directly influence more parking lots to be converted. That is ultimately an issue of whether there exists demand for the uses that would occupy new buildings built in place of surface lots exists, and a private sector to respond to that demand by implementing the appropriate supply of vertical development. Nevertheless, when the next parking lot is slated for re-development (which eventually will happen, as it has happened several times throughout the course of this research), it can be used to help devise a more walkable, climate-responsive site plan.

6.2. Research Contributions

Planners, land managers, and municipal decision-makers can use this thesis and its associated methodology to help identify what assets and constraints should be capitalized on in their own jurisdictions, whether it be parking lots downtown, strip malls in suburbia, or other under-performing land uses. New methods will hopefully emerge that build upon the one presented here, that being the purpose of all scholarly research.

Like other social sciences, urban design as a practice is not only strengthened, but also dependent on thoroughly executed case studies (Flyvbjerg, 2006). In its attempt to contribute to the discipline of urban planning and design, it has offered a simple case study as an exemplar of the small changes in our cities that are needed to mount the immense change necessary to reclaim a better style of urbanism for the 21st century. The novel contribution of this research is that it brings together the notion of parking lots and urban space in a winter city, which up until now has been virgin territory in scholarly work. The theoretical significance of this thesis ought to be seen in the offering of a strategic choice that the city has to make, keeping in mind long-range public interest over short-range political scoring.

For instance, the ideas presented in this research have focused on the mismatch between the demand for and the supply of surface parking. While many people view driving, and inherently, parking, as sacred parts of urban life, truly 'smart' growth calls for keeping demand and supply of parking in reasonable balance, so as to avoid underutilization of prime, downtown land. The enormous hidden costs of oversupplied downtown parking certainly impede our progress towards important social, economic, and environmental goals. This thesis has argued that a better balance is possible with better information on both the demand and supply sides of the issue. This scenario analysis of a Canadian winter city aimed to illustrate that converting select surface parking lots to mixed use could deliver a more pedestrian friendly urban environment and help the city transition to a more sustainable urban design, particularly downtown.

A summary of the main contributions of this research are highlighted below:

A planning tool to evaluate site suitability for re-purposing downtown surface parking lots:

- Developed a comprehensive set of criteria for identifying and inventorying the physical and spatial attributes (i.e. location and condition) of surface parking lots in winter cities;
- Developed and presented a methodology for evaluating the suitability of parking lots for conversion to mixed uses with special consideration for cold climate;
- The information derived from the site selection criteria can be used by community groups and planners to generate meaningful discussions to help articulate and quantify/qualify the inherent potential of these spaces for future reuse;
- A systematic approach of this nature, if adopted by municipal governments, has potential to aid investment decision-making, as well as expedite applications for parking lot conversions for those that are highly suitable for re-development, or located on City-owned land.

6.3. Research Limitation

The scoring system developed in this study, unlike traditional GIS-based site suitability analysis, offers the advantage of easily combining qualitative data (in the form of visual quality surveys) and quantitative data (i.e., GIS or SketchUp results of parcel data evaluation). Still, certain limitation arose and new obstacles abound.

For instance, there have been significant advances in the techniques used to measure the criteria in this thesis, specifically instruments for analyzing wind and snow movement. The use of wind tunnels has proven to be a powerful tool in this regard (Setoguchi, 2008). Advances in computer technology have also allowed the use of computational fluid dynamics [CFD] for modeling wind and snow patterns (Beyers and Waechter, 2008). These techniques are inherently more complicated and expensive to utilize and furthermore, “cannot replicate the complex interactions with other processes such as radiation and heat storage” (Pearlmutter, Berliner, & Shaviv, 2007, p. 2396). For this reason, a simpler method was designed here, arguably more sensitive to the expertise and technological abilities of the person using it.

Another particular limitation is regarding the score for solar access, since the potential infilling of the site would definitely alter this. To explain this omission, one must revisit the topic of the solar envelope, which calls for a “scaling” impact on urban growth (Knowles, 2003, p. 4.6-1). The argument that erecting a building will destroy solar access is not in favour of overall urban quality, as this overlooks the natural and inevitable growth and densification of healthy cities. Indeed, a new building will create a new shadow. However, a design strategy can be used based on the natural rhythms of the sun, where the new building is shaped and proportioned with reference to preserving what southern exposure already exists. If the site is already overshadowed by surrouding buildings, then considerations for solar access in any new architectural design would be futile.

The solar access score is naturally difficult to calibrate and analyze for a large number of sites, for several different winter months and corresponding times of day. Certainly the scoring totals for solar access would change if they were analyzed during a *late*-winter month, rather than an *early*-winter one. However, the overall rank would not drastically be altered, and would only serve to boost a few lots up in score, and likewise, a few down. This was not believed to be sufficient reason to considerably increase the amount of data collection, since this was only one criteria out of sixteen.

6.4. Recommendations

One particular recommendation that echoes throughout the literature on parking policy is to abolish minimum parking requirements and allow the free market determine the price and number of parking spaces downtown (Shoup, 1999; 2004; 2006; Barter, 2010; Cutter & Franco, 2012). Instead of regulating the supply and price of parking, planners can focus on other important features of parking such as layout, location, landscaping, and pedestrian access. However, this would only serve to influence future urban development, and would be difficult to retroactively impose on existing parking.

This time-lag could perhaps be avoided through more immediate measures like levying a flat tax on parking lots as a function of the land area they cover, which has been explored (Feitelson & Rotem, 2004). Essentially, the more levels of parking provided, the lower the effective tax on the land. In this respect, the surface parking would be taxed the highest. Basically, a flat tax on surface parking (to the provider) would clearly raise the cost of providing surface parking, which will have direct implications for the overall supply of surface lots. As the price of parking rises, it is also likely that the proportion of free parking will decrease. Hence, a tax on surface parking could not only reduce the supply of surface parking, it could also affect parking patterns and commuting behavior.

However, a tax on its own would not ensure that new development immediately takes place on a former parking lot. Fortunately for Saskatoon—as in a small number of cities throughout North America—the city utilizes a land bank to manage and repurpose an inventory of vacant, abandoned, or surplus land. The mandate of Saskatoon's Land Bank Program is to ensure an adequate supply of serviced land for development, and also to design and guide new growth.

The Land Bank is an important asset for Saskatoon, especially since the city's economy is set to expand by 5.2 percent in 2014, which will attract many new migrants and young families whom will require places to live (Lefebvre, Arcand, Sutherland, Wiebe, & McIntyre, 2013). So far, the Land Bank has been successful in managing new development on the urban periphery[1], and one large neighbourhood near the city's airport. However, its role could perhaps be revisited and realigned with the City's goals for revitalizing downtown. Specifically, this could be reflected in policy by not using City-owned land for public surface parking. Additionally, if a tax to surface parking were levied, the land bank would be instrumental in acquiring the land and speeding up the infill process by eliminating title entanglements, as well as ensuring any new design is sensitive to community needs, transportation goals, and regional climate.

This thesis has revolved around the assuption that climate and weather conditions influence people's attendance in public spaces, as well as their travel habits. In winter cities, that influence is more apparent due to extreme temperatures and greater seasonal differences. Microclimate, therefore, is a significant indicator of redevelopment potential. Developing architectural and urban design guidelines that are specifically tailored to cold cities is one way to tap in to this potential. Guidelines can not only encourage, but ensure that climate knowledge is incorporated into the design of new development. In the absence of established guidelines, the decision to integrate climate with design is left to the will of the developer, where it is often neglected or overlooked.

[1] The Land Bank has been responsible for the design and development of the majority of Saskatoon's residential neighbourhoods located on the city edge, including Rosewood, Evergreen, and Willow Grove. In particular, the most recent development, Evergreen, boasts a design unlike a traditional suburban neighbourhood, and instead was designed to incorporate a number of housing choices, public spaces, and opportunities for mixed-uses.

Consequently, application of such knowledge in urban design and planning practice has been sparse (Ebrahimabadi, 2012). While there is an abundance of literature and publications on the concept of winter cities, few cities in Canada have actually established winter design guidelines. Some examples are the City of Fort St. John's "Winter City Urban Design Guidelines" (2013), and Edmonton, Alberta's "WinterCity" strategy (COE, 2012). Saskatoon could greatly benefit from following in the steps of winter cities who have taken a more proactive step in adapting to winter by intitiating a similar strategy.

In conclusion, this thesis makes hopeful that surface parking lots and alleys will be redesigned to incorporate multiple benefits—environmental, economic, and social. In order for these findings to galvanize such a strategy for parking lots in downtown Saskatoon, SK, intiative would need to be taken primarily by the City to incorporate principles and urban design guidelines suited to winter climate, as well as prohibit the long-term use of vacant parcels in the CBD for surface parking. The rapid growth and economic promise that currently characterizes Saskatoon will hopefully be the catalyst for enacting these changes.

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APPENDIX I:
DETAILED SELECTION CRITERIA

Table 8

Detailed Requisite Criteria

CRITERION	PROCEDURE	UNIT
nearby amenities	Without leaving the site or the sidewalk in front of it, how many amenities can be seen up to a maximum distance of 100 metres? This includes across the street, down back alleys, and into buildings. Total number of amenities can be confirmed using available data from Walk Score®. Examples of amenities: schools, daycare, food/convenience, farmers market, café, restaurant, gallery, theatre, indoor mall, library, recreation centres, entertainment.	*sum total*
site access (connectivity)	Count the total number of access points leading in and out of the parking lot and adjacent back alley(s) where necessary. An access point is any conduit, whether for pedestrians, cyclists, or cars, which connects directly to the lot. Examples: sidewalk=1, alley entrance/exit=1 (no alley can have just one, unless it is a dead end), pathway=1	*sum total*
nearby pedestrian nodes	Nodes are anchor points, gathering spaces, or major intersections where pedestrian activity is clustered. Each parking lot will be visited to determine the total number of nearby nodes of pedestrian activity. Examples: transit hub, pocket parks, or clusters of two or more pedestrian amenities such as benches, mailboxes, newspaper stands, poster boards, and transit shelters.	*sum total*
site position within block	Determine whether the parking lot is a standalone lot [S], mid-block between two other structures [MB], a corner lot [C], or connected to a major commercial land use [MC].	*S, MB, C, MC*
wind-chill shelter of back alley	If there is a back alley connected to the parking lot, it is evaluated according to its potential for wind-chill protection by asking the following questions: Is the back alley oriented parallel or perpendicular to the prevailing wind? Are there any adjacent structures or buildings that mitigate or block the wind and snow from blowing in the alleys and at the edges of the parking lot? The average prevailing wind directions are westerly to south-westerly, with an average of 20 km/hr.	orientation: *NS, EW* shelter: *minimal acceptable excellent*
automobile presence in alley	If there is a back alley connected to the parking lot, it is evaluated according to the presence of automobiles and automobile amenities, such as private driveways, garage entrances, and loading docks. If the alley has none of these elements, it receives three points. If it has one to four of these elements, it will receive 2 points. If the alley has five or more, it receives one point. Finally, if the lot has no alley, no points are awarded.	*sum total*

Table 9

Detailed Auxiliary Criteria

CRITERION	PROCEDURE	UNIT
nearby landmarks/ major civic spaces	Visit the remaining parking lots to determine the total number of nearby major landmarks or civic spaces. The total number will be used to award a score between 0 and 3. Examples: heritage buildings, architectural landmarks, squares or plazas, greenspaces (parks, trails)	*sum total*
aesthetic appeal vs. blight	Visit the remaining parking lots and their adjacent back alleys to determine the prevalence of utility equipment and municipal hardware. Rate each alley on a scale of 1 (unappealing), 2 (moderately appealing), and 3 (appealing), based on existence of utility equipment and trash bins. Examples: overhead wires, transformer boxes, electrical poles, dumpsters, litter = *unappealing;* absence of the above = *appealing.*	*unappealing* *moderate appeal* *appealing*
winter solar exposure	Determine how much solar exposure the parking lot receives during winter. If there are no surrounding buildings, then the lot has good solar exposure (although bad wind-protection). When buildings are adjacent to the parking lot, their heights will be estimated and drafted into Google SketchUp to simulate the path of the winter sun over the site, to see how nearby buildings obstruct direct solar exposure of the site, especially in back alleys.	exposure: *poor,* 0 hrs. *moderate,* 0.5–2 hrs. *high,* 2+ hrs.
weekday usage	Visit the remaining parking lots to determine their occupancy during regular working hours. Determine the ratio of occupied to unoccupied parking stalls.	*quartile: percentage*
weekend usage	Visit the remaining parking lots to determine their occupancy during the weekend. Determine the ratio of occupied to unoccupied parking stalls.	*quartile: percentage*
market availability	Using the Information Services Corporation [ISC] database, determine ownership of each parking lot, and whether the title is held by government or not.	*public/ private*
educational institution (winter walking distance)	Are there any full-time post-secondary educational institutions or technical colleges within winter walking distance (200 metres)?	*sum total*
nearby residential density	Using residential pop. density data from Statistics Canada and the City's recent (2011) strategic framework for the city centre, estimate the residential density within a 100 metre buffer of the parking lot and adjacent back alley if one is present. GIS will be used to assist in calculating the correct distances.	quartile: *none, low, medium, high*

APPENDIX II:
MEASURING SUN ANGLE & SOLAR ACCESS IN ALLEYS

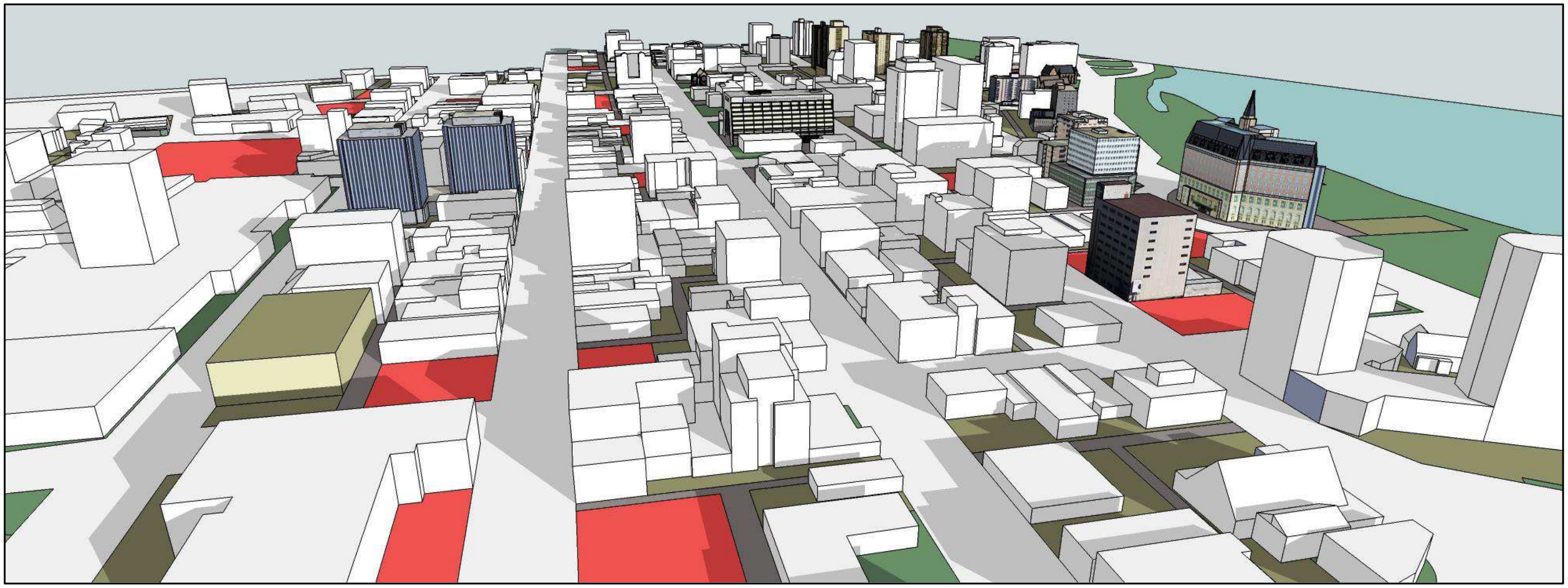

Figure 33: SketchUp model of downtown Saskatoon created for shadow simulations.

In order to assess further if the parking lots and alleys are prone to receiving direct sunlight in winter, a 3D model of the study area was created using Google® SketchUp (Figure 33). This allowed each site's spatial properties to be analyzed in detail. However, future applications of this tool would not require this amount of data collection and computer drafting. All that is required is a simple model of each parking lot under consideration, along with any adjacent buildings and alleys. This is sufficient to get a good idea of how the path of the sun travels across the site, including when and by how much do nearby buildings create shadowy spaces or sun pockets.

Lot #17 is a good example of a site with relatively good solar exposure. Figure 34 shows shadow simulations on a typical day near the end of November, which is roughly the beginning of the cold season. The coldest day of the year is January 10, with an average low of -21°C and high of -11°C (WeatherSpark, 2013). However, the coldest day of the year is also the least likely day that people will be walking around, for reason much more serious than thermal discomfort. In winter cities like Saskatoon, concerns like frostbite and hypothermia can occur in matter of minutes during extreme conditions. Attempting to influence pedestrian activity through changes in the built environment on the coldest days would at best be naïve, and at worst, rather far-fetched. It is for this reason that the figures shown here are during a rather mild part of the winter, which is still cold (average low of -13°C and high of -4°C), but manageable for pedestrians if they are provided shelter from wind and places to bask in sunlight.

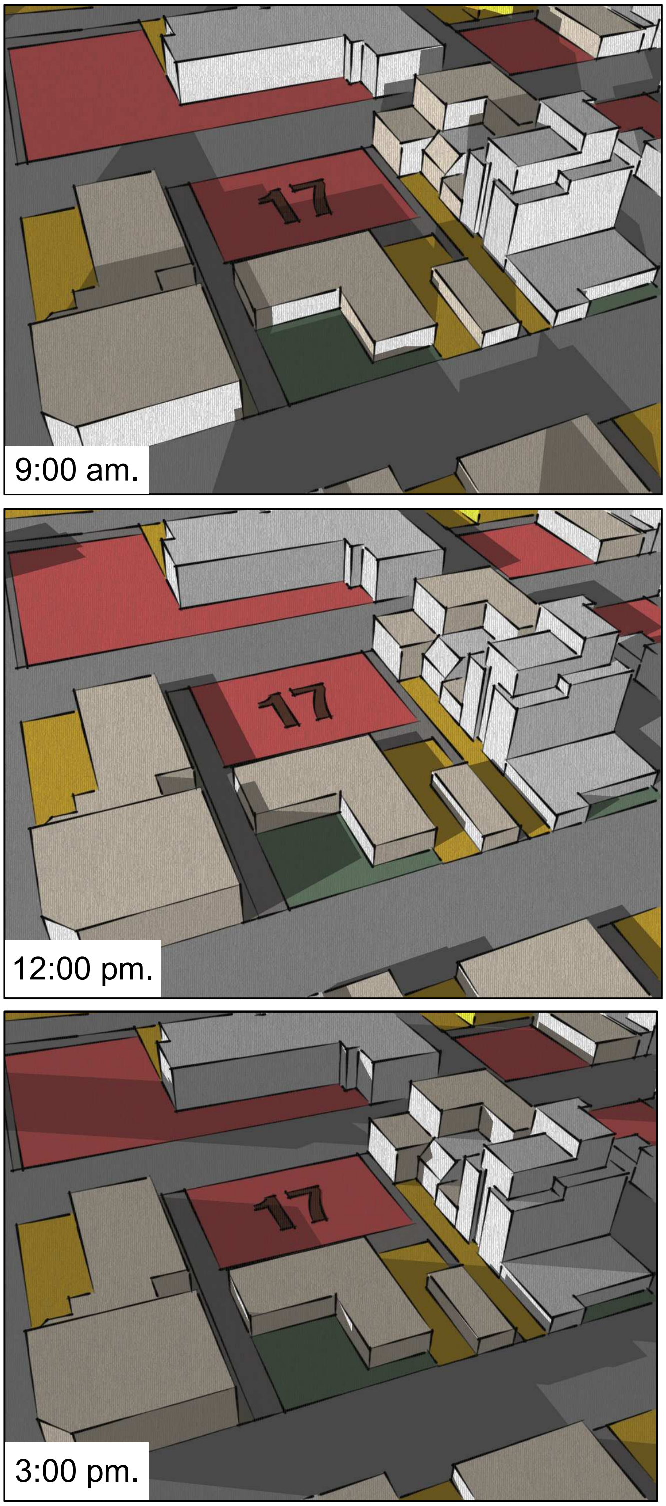

Figure 34: Shadow simulation for lot #17 shows numerous places within the lot and nearby alleys where solar exposure is preserved.

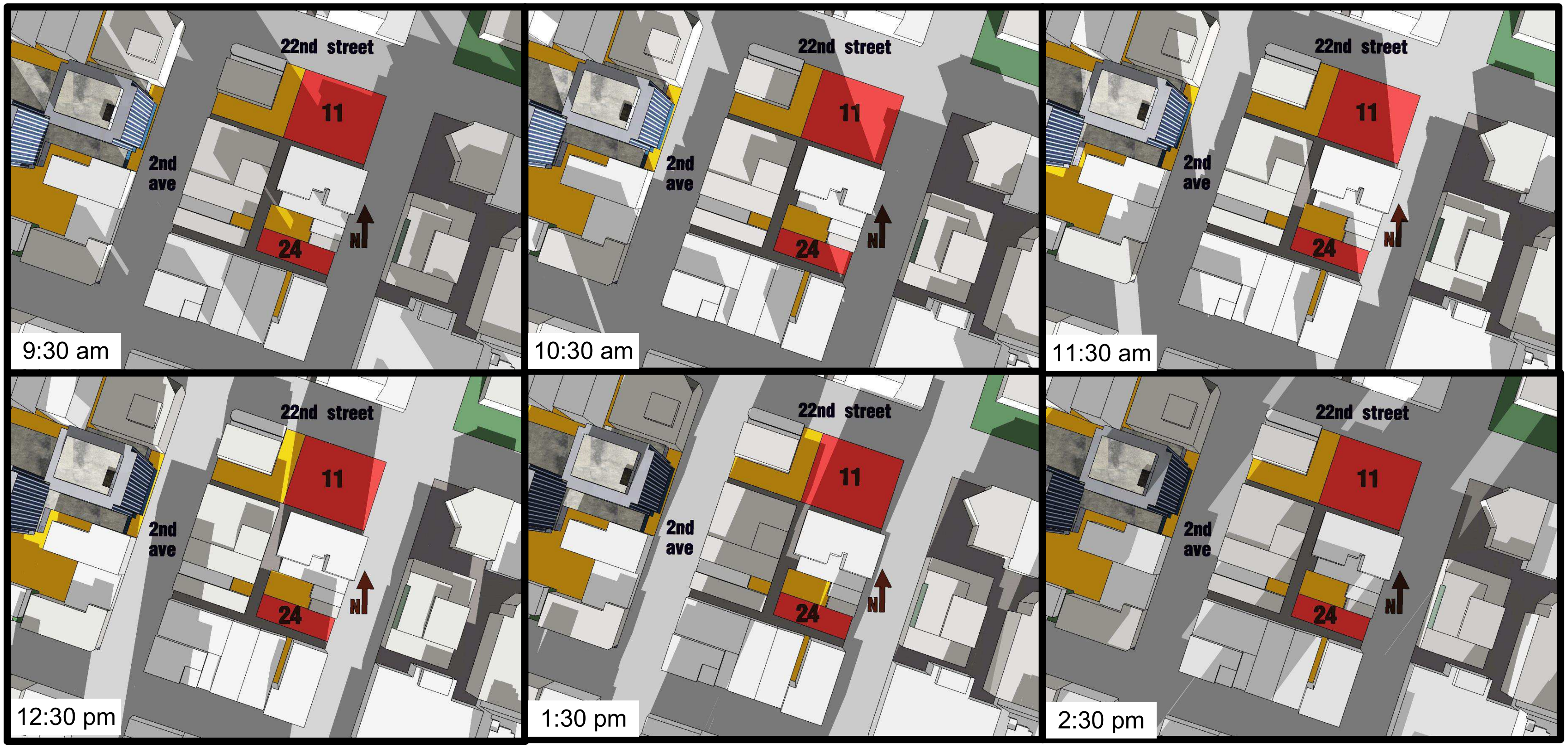

Figure 35: Winter shadow simulations for lot #11 and lot #24.

Lot #11 and 24 are examples of sites that have very poor solar exposure (Figure 35). Unlike lot #17, which receives direct sunlight in a few areas for the entire day, lot #11 is relatively shaded since it is situated on the north side of a moderately tall building. The tall building immediately to the south of lot #11 blocks the sun for most of the day. As well, tall buildings to their north shade the alleys running E-W, and the N-S alley only receives direct sunlight for about an hour and a half (Figure 36).

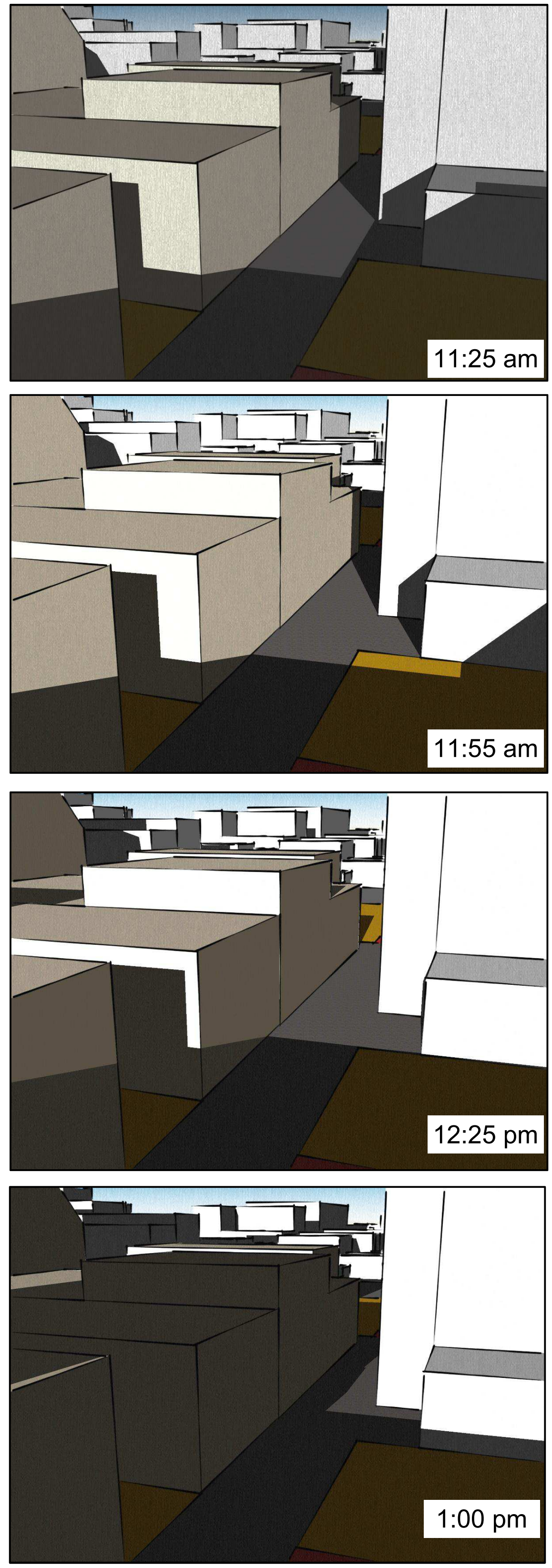

Figure 36: Winter shadow simulations for N-S alley linking lot #11 and lot #24. This is the only segment of the entire alley where the southern exposure is preserved, and only for about 1.5 hours.