Infill Planner: A geo-questionnaire to gather public input on infill developments

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

Urban infill and intensification planning strategies aim to lead toward more efficient use urban land and ultimately urban forms that more sustainable and offer citizens improved quality of life. Due to the potential impacts of introducing change into established neighborhoods, the implementation of these planning strategies is not straightforward. Urban infill strategies often elicit public reactions, either positively or negatively, which ultimately influence the successes or failures of infill projects. Local knowledge and public input must therefore be considered during these planning processes. Map-based tools are increasingly being adopted to solicit public input in urban planning. However, the varying designs and implementation of these tools outpaces planning research. A research gap relating to what works, how and in which context therefore exists. This thesis seeks to understand how the public considers both site (i.e., property) and situation (i.e., neighborhood) factors when considering potential infill developments. *Infill Planner,* a web-based tool that combines interactive maps and questionnaires, was developed to allow participants to designate future land uses for potential infill development sites. The tool was tested in a simulated urban infill planning process for selected sites in the City of Stratford, Ontario. Despite the simulated nature of the planning exercise, the research contributes to our understanding of how individuals use map-based data and tools when considering the site-specific and neighbourhood level implications of infill developments. Lessons from the design and implementation testing as well as implications for planning practice and academia, are also discussed.

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Chapter 1
Introduction

1.1 Background – Urban infill and intensification

North America societies are experiencing changes in growth trends and approaches to land use planning and development. In recent years, since the invention of the automobile which encouraged outward urban expansion and sprawl development, there is a reversal in growth trends from the suburbanization of the population to net population growth occurring in urban areas and centers. This reversal is influenced by changes and patterns of preferences affected by population and demographic changes, interests in active transportation and land mixed-use development (Gallagher, 2013; Nelson, 2013; Holden, 2019). Urban sprawl is a practice of low-density, haphazard developments and outward expansion of cities away from the urban core and centers (Gómez-Antonio et al., 2016). This type of development is characterized by low-density single-family dwellings, automobile dependency, spiraling growth outward from existing urban centers, 'leapfrogging' patterns of development, undefined boundaries between urban and rural areas, among others (Brody, 2013). Outward expansion of cities results in land being consumed at a faster rate as population shifts from urban to suburban fringes, spatial segregation, and inequalities, declining of urban cores, environmental impacts (e.g., destruction of ecological zones, air pollution, etc.), and increased cost of municipal services and functions such as transit and provision of social amenities (Brody, 2013).

Over the past two decades, governments and planning authorities have been paying attention to and adopting planning strategies that encourage compact urban developments and intensification to eliminate the unwanted effects of urban sprawl, while sustainably accommodating the increasing population (Holden, 2019). These decision-makers implement policies and techniques to support urban intensification by concentrating urban growth in targeted areas, thereby restraining urban sprawling, and protecting environmental and ecological zones (for example see the Growth Plan of Ontario, Canada). Urban intensification or compact urban developments are planning approaches, practices or strategies which are an integral part of planning sustainable cities in advanced societies (Kim & Larsen, 2017; Searle & Filion, 2011). These urban growth concepts and strategies, which are encouraged and endorsed by governments and planning authorities as a planning approach to guide urban growth (Holden, 2019), generally emphasize increasing the population and economic densities of established urban areas. To contribute to higher density urban forms, urban intensification takes place across a mix of various land use forms, including residential, employment, retailing, institutions, parks, and transit-

oriented developments (Tayarani et al., 2016; Searle & Filion, 2011, Rahimi, 2016). The overarching goals of these strategies are to encourage more compact urban forms that afford cost-effective municipal service and public transit provision, foster vital and walkable neighborhoods, revitalize urban cores, reduce greenhouse gas emissions, and mitigate the need for development to occur on green field lands in the urban fringes (Searle & Filion, 2011; Neptis, 2014; Holden, 2019; Brody, 2013).

As a planning approach, urban infill (a component of intensification focused on development of vacant or underdeveloped sites) and intensification can be achieved using various development tools and processes. These include redevelopment of sites, such as the reuse of brownfields and grey fields sites; development of vacant and/or underused lots within previously developed and established areas; expansion/conversion/extension of existing buildings (e.g., creating additional housing units to a residential structure or office spaces to residential units); and the construction of new developments that combine a mix of uses for a more efficient use of land (Ontario, 2006). These development processes and tools fill gaps in established areas and play a vital role in achieving community revitalizations, and resource and land conservation (Rahimi, 2016). This is critical in supporting effective planning policy and functioning as it offers several potential benefits for urban residents and the economy. Urban intensification can, therefore, be pursued to achieve benefits relating to urban sustainability, quality of life goals, and subsequent economic outputs. Such benefits include promoting low energy or active transportation (e.g., transit, walking, cycling), supporting municipal cost-savings through the retrofitting of existing infrastructure (e.g., water, electrical grid, public transit), encouraging the integration of mixed-use accommodations (e.g., high rise apartment blocks), preserving nearby rural/agriculture/ecological functions, and supporting environmental sustainability by reducing human carbon footprints (Searle & Filion, 2011; Neptis, 2014; Holden, 2019).

1.2 Problem statement and research direction.

The adoption and implementation of urban intensification strategies offer several benefits; however, the implementation of these strategies is not without challenges and issues. First, planners need to consider multiple different future land uses and options for the vacant/under-utilized properties, as they face the challenge of reconciling the values and characteristics of existing and built-up environments with new urban infill and intensification goals (Schmidt-Thomé et al., 2013; An & Gu, 2018). This process of considering multiple land use scenarios and suitability can be described as a concept known as the ‘Highest and Best Use’ of a property (Leffers and Ballamingie, 2012). This concept highlights that the maximum utility, productivity, and value that can be realized from a property us based on three

factors: 1) Physical possibility, 2) legal permissions, and 3) financial feasibilities (Parker, 2016). In other words, for a property to be deemed suitable, first, the proposed use must be compatible with the site's physical features and characteristics such as size, topography, location, amongst others.

Next, the suggested land use must be legally permissible in terms of zoning regulations (e.g., designated land use, density requirements, etc.) and appropriate estate interests (e.g., allodial title, easements, etc.). The final factor, financial feasibilities, indicates that the proposed land use should generate revenue or some form of utility that is greater than direct and/or incidental costs (Parker, 2016). Suggestions have been made to assist planners in tackling this challenge of determining the best use of a property. For example, An and Gu (2018), suggests the concept of morphological region and the morphological mapping of the character of urban landscapes. This practical and analytical approach which identifies and maps the unique character of existing landscape and urban spaces, provides reference to urban planners and other stakeholders in managing and determining future urban changes and developments as well as landscape conservation (An & Gu, 2018). This prevents the loss of urban character and values, while also potentially facilitating the social acceptance of urban infill and intensification.

Second, the public reaction and acceptance of urban intensification projects is not straightforward as they determine the successes and failures of land use projects (McCrea & Walters, 2012; Holden, 2019). These reactions, based on the different perceptions of gains and losses of urban developments and potentially conflicting, can be in the form of NIMBY (not in my backyard) and YIMBY (yes in my back yard) (Kytta et al., 2013). NIMBY, based on the perceptions of loss of appreciated environmental qualities without added value (Kytta et al., 2013), is a concept that describes the public's opposition of local land use projects that are considered unwanted, unattractive, dangerous and a nuisance varying between waste dumps to renewable energy facilities (Brown & Glanz, 2018; Whittemore & Bendor, 2018; Burningham et al., 2007). YIMBY, on the other hand, refers to the public's positive attitudes and acceptance of higher density land uses that support population and economic growth (Brown & Glanz, 2018). Holleran (2020) identifies that this phenomenon is usually advocated by millennials (people born between 1980 and 2000) and renters who argue for higher density projects driven by the desire for good urban design, environmentalism, and social justice to improve equitable access to public services and functions (Holleran, 2020; Beyer, 2016).

Several factors and motivations account for either the acceptance or opposition of intensification strategies. This can be stratified under two interrelated categories. The first category stems from either

personal experiences and/or project-related characteristics. Such factors include visual/landscape factors (e.g., aesthetics, nuisance), environmental impacts (e.g., emission of harmful gases), socioeconomic variables (e.g., demographics, reduction of property values), and decision-making processes (Petrova, 2016; Devine-Wright, 2012; Scally & Tighe, 2015). The second category is focused on determinants of land use and future urban growth relating to scale or level of influence. Specifically, Verburg et al. (2019) and Briassoulis (2003) identify two distinctions of scale or level of influence: 1) factors that relate at the level of individual property or micro-level, i.e., property or site factors, and 2) factors that apply at a macro level or higher spatial, organizational or situation i.e., neighborhood factors. Examples of property and neighborhood factors include nature of proposed land use, proximity to suggested land use, zoning regulations, linkage aspects (e.g., walkability) and place values.

Public reactions vary and can be dependent on the type of higher density land use development (Brown & Glanz, 2018). Changes that higher density projects bring (e.g., increased diversity of people, changes in lifestyle) to established urban areas has implications for and threatens the senses of place (e.g., strong family ties) associated with specific areas, distrust among stakeholders (Pennanen et al., 2017), loss of green environment, extra traffic, loss of privacy, loss of streetscape quality and concerns about an influx of poorer households (Searle & Filion, 2011). This points out the spatial, context-specific, and cumulative effects of infill and intensification strategies (Jankowski et., al, 2016). In this regard, several scholars (Doberstein et al., 2016; Scally & Tighe, 2015; Devine-Wright, 2012) identify 'effective' public participation among various stakeholders (e.g., residents, planning authorities) as a strategy to address the challenges encountered (i.e., preferred future developments, reconciliation of infill goals with neighborhood characteristics, etc.) in implementing intensification and infill projects. Public participation approaches can be designed to gather existing place importance/values, development preferences, perceptions, and assessments of proposed land uses strategies to support the successes of intensifications strategies (Babelon et al., 2016).

Public participation are key features of modern urban planning processes which are adopted by contemporary societies that engage in communicative planning practices. This planning practice is defined as the process where planning authorities and other relevant experts inform, consult, collaborate and empower citizens, thus facilitating public interactions among stakeholders (e.g., residents, planners, business owners, indigenous communities) to solicit multiple and differing public inputs during decision-making and problem-solving processes (IAP2, 2018). These participatory consultations can be applied to achieve a range of planning objectives and purposes including normative (e.g., improve

democratic capacity, empower/emancipate marginalized groups), instrumental (e.g., generating legitimacy, conflict resolution) purposes and substantive (e.g., harnessing and incorporating local and experiential knowledge in decision-making (Glucker et al., 2013). Public interactions and consultations among various stakeholders to gather public input solicit more comprehensive, diverse, and critical feedback relating to proposed infill projects (Sun et al., 2016).

Several methods and approaches can be adopted to facilitate public participation processes during land use planning processes. These methods, including face-to face approaches (e.g., open houses, workshops, charrettes, focus groups, town-hall meetings) and/or the use of online tools and interactive innovations (e.g., social media, web-based applications), can be adopted based on goals of the participatory process (Bryson et al., 2013). Specific to urban infill and densification, map-based web tools and techniques are increasingly being adopted to facilitate public interactions (see Kahila-Tani et al., 2016; Babelon et al., 2017). Web map-based tools are features of a larger approach known as SoftGIS, which are rooted in communicative planning and community practice and knowledge building theories (Rantanen & Kahila, 2009). These methods acquire multi-layered, geographically contextualized, and localized experiential knowledge (Kahila-Tani et al., 2019; Kytta et al., 2013; Kahila & Kytta, 2011) relevant to the implementation of infill strategies and developments. This technique takes advantage of the increase in ownership of mobile devices and other technological innovations including the internet, multiple in-depth communication mediums (e.g., scales, surveys, commentary), and increasingly powerful digital platforms and software (Hofmann et al., 2020).

The prolific implementation of web map-based tools can be attributed to several reasons. First, the use of these tools is a context sensitive strategy that offers the ability of connecting public responses to the physical environment to facilitate the easy collection and analysis of public feedback, opinions, and sentiments towards intensification strategies (Kytta et al., 2013; Kahila-Tani et al., 2016). Also, in providing geographic information (e.g., land use preferences, place attachments, among others) people are willing to share spatial knowledge (Rzeszewski & Kotus, 2019), and want to contribute using map-based methods (Sieber et al., 2016). Undoubtedly, web mapping tools are a popular public participation approach and can be adopted to support urban planning intensifications issues by assessing the social acceptance of infill projects and providing evidence that land use changes may be needed (Brown et al., 2018). It is therefore imperative to understand how community planning during intensification strategies can be enhanced using web map-based tools.

For this research, a new web-map tool called *Infill Planner*, was designed, and developed to explore how web map-based tools can be used to enhance citizen participation in community planning (focus on infill planning). This tool can be described as a geo-questionnaire. Geo-questionnaires are map-based web tools that comprise of online multi-page questionnaires/surveys and interactive maps to facilitate data collection of object descriptions linked to geographical features, and descriptions without an explicit spatial reference using comments, points, markers, polylines, polygons, etc., (Jankowski et al., 2021; Jankowski et al. 2016). *Infill Planner* was designed to: 1) capture and display the city layout (i.e., building footprints and sample vacant sites) of Stratford, Ontario, 2) capture comments relating future development preferences based on property and neighborhood information 3) gather feedback on the tool design.

1.3 Research objectives and purposes

The use of web map-based tools continuously and rapidly deployed in multiple forms and complex designs for different urban planning processes. It is therefore important to significantly expand knowledge about what works, how, and in which planning contexts (Babelon et al., 2016). To contribute knowledge, this research aims to investigate how citizens consider both site (i.e., property) and situation (i.e., neighborhood) factors when considering potential future uses for vacant or underutilized properties. It also aims to understand how web map-based tools can help planners to gather and understand citizens' input regarding urban infill and intensification.

The following research questions are central to this study:

a) What property-related issues (e.g., property size, place bonds, compatibility of land use, etc.) and neighborhood-related issues (traffic impact, neighborhood revitalization, place bonds, etc.) do people consider in providing comments pertaining to urban intensification?

b) What web map-based tool designs of Infill Planner do users consider useful in providing comments on infill planning projects? What other tool designs do they consider useful? Are users of Infill Planner willing to use similar map-based tools in the future?

This research seeks to achieve the following research objectives:

a) Design and develop a map-based web tool known as Infill Planner.

b) To understand the impacts of site (i.e., property) and situation (i.e., neighborhood) factors on feedback from users based on simulated urban infill and intensification examples.

c) Test Infill Planner's effectiveness, in terms of its design, as a tool in soliciting public feedback during infill planning processes.

1.4 Organization of thesis

This thesis is comprised of five chapters. Following this chapter, Chapter 2 reviews literature pertinent to the research study. This section identifies the land use planning framework regulating urban planning processes, including urban infill and intensification, in Ontario, Canada, reviews the concept of public participation, and the current participation techniques, elaborates on the concept of urban infill and intensification including determinants of future land use options. Finally, the chapter highlights the tole of Geographic Information Systems (GIS), and the use of participatory mapping techniques, with a focus on geo-questionnaires. The chapter concludes by identifying research gaps and questions that guide this research study. Chapter 3 has two objectives. First, a background of the study area, Stratford, Ontario, is provided to identify the characteristics and opportunities present in the city in deploying the web mapping tool. Second, the methodology used in developing and deploying the map-based web application is outlined. This includes the spatial data needed and resources used in developing the map-based web application, key features of the tool (i.e., surveys and interactive maps), and user workflow to guide the use of the map-based application developed in the study. In Chapter 4, results from the use of the surveys in Infill Planner are presented and discussed in the context of pertinent literature. Finally, Chapter 5 concludes the study by reviewing and summarizing the study.

Chapter 2
Literature review

2.1 Introduction

The literature review is outlined in different sections. The first section focuses on the land use planning framework in the province of Ontario, Canada. This section highlights planning legislations, laws and policies, and various stakeholders that inform land use planning in the province. The next section focuses on public participation. This section reviews literature pertaining to public participation framework, theories, typologies, and methods of public participation. Section 2.4 describes the concept of urban infill and intensification and highlights the framework that supports urban growth in the province of Ontario. In this section, challenges and issues associated with the implementation of intensification strategies, motivations underlying attitudes towards higher density land use planning and determinants of land use decisions and options are also highlighted. Focus is also given to spatial attributes and variables of public inputs that can be solicited during land use planning processes. The final section highlights the role of Geographic Information Systems (GIS) in land use planning. This section addresses participatory mapping and emerging interrelated fields and concludes on the design and implementation of web tools, specifically geo-questionnaires in supporting planning processes and outcomes. These sections are then culminated to point out direction and contribution of this research to existing literature and academic scholarship.

2.2 Land use planning framework in Ontario.

Land-use planning in Ontario has experienced significant changes, in terms of approach and process over the last two decades. These evolutions in process and approach can be attributed to a shift in roles between municipal and provincial governments in land use decisions, as well as the identification of new goals the province seeks to achieve (e.g., protection of environmental features, directing strategic growth to encourage urban intensification) (ECO, 2011). Another note-worthy change in Ontario planning approach and process has been the adoption of the One Window approach. This approach established the Ministry of Municipal Affairs and Housing (MMAH) as the point of contact in all land use planning related matters in thereby reducing the roles of other provincial ministries (ECO, 2011). Land use planning in Ontario is a public process that impacts almost every public and even private domain in Ontario. Not only does the practice require employing tools to manage land and resources, but it also deals with balancing competing interests such as those of individuals against the benefits for

the wider community (MMAH, 2019). Aside from managing land and resources, municipalities can use land use planning practices and process to address social, economic, and environmental issues (MMAH, 2019). In Ontario, land use planning processes constitutes several planning laws, policies, individuals and organizations with different functions, roles, and responsibilities.

2.2.1 Planning laws, policies and legislations in Ontario

There are several legal processes and policies that inform land use planning in Ontario. These instruments are either general, that is, applicable to all parts of Ontario (e.g., The Planning Act, 1990 and Provincial Policy Statement (PPS), 2014) or geographically specific (e.g., Growth Plan for the Greater Golden Horseshoe). Aside from the geographic jurisdictions, these processes and policies are used to either plan for economic and population growth, and environmental or heritage protection (ECO, 2011). Examples of planning policies and legislations used in Ontario include the Planning Act, Provincial Policy Statement, municipal Official Plans, other provincial plans, amongst others.

Table 2-1 Planning laws and legislations in Ontario.

	The Planning Act, R.SO. 1990	**The Provincial Policy Statement (PPS), 2014**	**Municipal Official Plans (OP)**
Jurisdiction	• Province	• Province	• Municipal
Description	• Primary land-use legislation in Ontario.	• Overall land use planning policy directions and provincial interests	• Guides municipal councils' policies on land use planning
Purpose	• promotes sustainable economic development in a healthy natural environment within a provincial policy framework. • provides for a land use planning system led by provincial policy. • encourage co-operation and coordination among various interests	• promotion of healthy, integrated, and viable rural areas • the protection of employment areas to promote economic development and competitiveness. • efficient use of land and infrastructure	• provides a framework for establishing municipal zoning bylaws to set local regulations and standards, like the height of buildings. • provides a way to evaluate and settle conflicting land uses while meeting local, regional, and provincial interests. • helps all members of the community understand how their land may be used now and, in the future

Table 2-1 identifies and describes some planning laws and legislation, jurisdiction and purposes of laws regulating planning in Ontario. From the table, the levels and scope at which these laws are implemented is identified. The Planning Act, 1990, and Provincial Policy Statement (PPS), 2014, are laws which are applied together consistently at the provincial level to direct growth and planning in the province while identifying provincial interests, respectively. The Municipal O.P, implemented at the municipal level, is consistent with the PPS issued under the Planning Act and is often updated to address local priorities and changing community needs (MMAH, 2020). Other legislations that influence planning in Ontario include Growth Plans (provincial level), Niagara Escarpment Plan (provincial level), The Greenbelt Plan (provincial level), Zoning by-laws (municipal level). These laws are applicable to specific areas either at the municipal or provincial level and provides more specific direction in identifying and addressing specific needs and objective (e.g., environmental, economic growth, etc.) within these specified areas.

2.2.2 Stakeholders and systems involved in land use planning in Ontario.

Current urban land use planning practices subscribe to Advocacy and Transactive models which promote collaborative processes between experts/planning authorities and the public. Other persons and stakeholders involved include applicants interested in undertaking planning related projects (developers, architects, etc.). Experts include the provincial government, municipal councils, technical experts (planners and other related professionals), amongst others (MMAH, 2019). Each of the stakeholders involved in land use planning and development processes plays a different role during with respect to decision making proceedings. For example, while the province provides broad legal policy directions to guide planning, municipal councils devise and draft an official plan that is applicable to their jurisdictions and consistent with provincial interests and policies (MMAH, 2019). It is necessary to note here that a critical component of the Ontario planning system is its appeal body (Local Planning Appeal Tribunal) that addresses aggrieved persons and appeals on planning matters (MMAH, 2019).

The public is an important stakeholder during the planning process in Canada (e.g., residents, businesses, etc.). In Ontario, and Canada in general, other cultural and different governance structures, such as Indigenous communities, are also consulted during planning decisions and processes (MMAH, 2019). Importantly, different participatory processes are applied depending on specific group and land use development considerations. Consultation with Indigenous groups affected by planning decisions is conducted to maintain mutual respect and healthy relationships with vulnerable communities

(MMAH, 2019). However, planning decisions also directly affect broader, less distinct, populations living within municipalities and as such it is important that they are given the opportunity to participate the planning processes. The public can participate in various process by accessing information provided by municipalities or attending and speak at public meetings to provide input on various planning initiatives and decisions (ECO, 2011). They can also appeal planning decisions being made to various extents (ECO, 2011).

2.3 Public participation and land use planning

Public interactions among stakeholders (e.g., planners, residents, business owners, etc.) are an important component of urban planning practices in western democracies. Public participation can be defined as the process where the public or stakeholder interests are involved in making decision that affect them, either passively via consultation or actively via two-way engagement (Reed et al., 2018). Arguments in favor of public interactions between planning experts and the public during decision-making processes suggest that equitable decisions and quality planning outcomes can be realized due to the nature of different participants engaged. These participants include people affected by planning decisions, people with related important knowledge and people with the potential to influence the implementation of planning decisions (Schlossberg & Shufford, 2005). This planning practice can be pursued to achieve normative, substantive, and instrumental rationales (Glucker et al, 2013). The normative rationale of public participation includes capacity of public to influence decisions, empowering and emancipating marginalized groups, etc. Harnessing and incorporating "local knowledge" and experimental, and testing robustness of information from other sources are some objectives under the substantive rationale. Finally, the instrumental rationale of public participation includes generating legitimacy and resolving conflicts (Glucker et al, 2013).

Various concepts and typologies of public participation have been elaborated and explained by several studies and authors. Arnstein (1969) explains citizen participation using an eight-rung ladder of different gradations and power dynamics: non-participation (manipulation and therapy), degrees of tokenism (informing, consultation, and placation), and degrees of citizen power (partnership, delegated power and citizen control). This ladder represents the different levels of power that citizens may wield to influence governance outcomes. Reed et al. (2018) presents a typology of stakeholder and public engagement based on agency (who initiates and leads engagement) and mode of engagement (from communication to coproduction). These typologies, described using a wheel, include: "Top-down one-way communication and/or consultation", "Top-down deliberation and/or co-production", "Bottom-up

one-way communication and/or consultation", and "Bottom-up deliberation and/or co-production". Finally, Shipley and Utz (2012) summarizes and raises important questions to critically review and evaluate the utility of participation methods. Some of these questions are as follows: Are people better informed about projects and their impacts because of the public participation activity? Did the elected and appointed leadership respond to the input received from the public and did it make a difference in their decision making.? Were traditionally underrepresented groups brought into the process and did their opinions matter? Answers to these questions suggest and assess the efficacy of public participation methods to planning processes.

The review of different public participation typologies and theoretical frameworks, provides evidence to identify the heterogeneous nature of public participation processes, in the sense that, the roles of various participants in a participatory process change at various stages of its implementation. For example, in Canada, the public is more likely to have an influence on the implementation of zoning regulations at the municipal level which is more locally specific as compared to provincial plans and policies (MMAH, 2020). The heterogenous nature of public participation processes is captured by the International Association for Public Participation (IAP2) as it designed a Spectrum of Public Participation to represent various levels of participation based on the goals of the participation (see table 2-2 below).

Table 2-2 IAP2 Spectrum of Public Participation

Level of Participation	**Public Participation Goal**
Inform	To provide the public with balanced and objective information to assist them in understanding the problem, alternatives, opportunities and/or solutions
Consult	To obtain public feedback on analysis, alternatives and/or decisions
Involve	To work directly with the public throughout the process to ensure that public concerns and aspirations are consistently understood and considered.
Collaborate	To partner with the public in each aspect of the decision including the development of alternatives and the identification of the preferred solution.
Empower	To place final decision making in the hands of the public

Source: International Association for Public Participation (2018)

The table, from top to bottom, that is from "Inform" to "Empower", represents an increasing impact and role of the public on final decisions to be made. Each "level" of public participation captured in the IAP2's Spectrum of Public Participation is undertaken to achieve a certain goal or objective with some promise to the public in terms of its (public) role in the public participation process. At the lowest end

of the spectrum is “inform”. This level aims to keep the public informed about planning issues by providing the public with balanced and objective information to assist them in understanding the problem and/or solutions. The next level, “consult”, seeks to listen to, inform, and acknowledge public concerns and aspirations, and provide feedback on planning issues under considerations. At the “involve” level, public feedback, concerns and aspirations are purposely collected to be directly reflected in planning outcomes and alternatives developed. The fourth level, “collaborate”, is designed to facilitate direct communication between planning experts/governments and the public to advice and innovation in formulating solutions and incorporate public advice and recommendations into the decisions to the maximum extent possible. The final and highest level, “empower”, focuses on implementing what the public desires (IAP2, 2018).

The spectrum of public participation implicitly highlights a challenge encountered in planning processes, that is, the balancing of experts’ and stakeholders’ interests, knowledge, and opinions in the general planning process. Current planning practices ascribe to advocacy and communicative forms of planning. These approaches acknowledge the diverse nature of contemporary societies, i.e., existence of multiple truths, realities, and experiences, and therefore seeks to promote consensus-building between stakeholders (Hodge & Gordon, 2014). Power dynamics can therefore be seen to exist between the public and planning authorities and is manifested in the arrangements of public interactions between these stakeholders, where, for instance, planning authorities organize participation exercises on specific planning topics, and then invite the public to comment. Generally, the impossibility of a planning practice environment where all interests can equally engage in open dialogue and deliberative processes has been acknowledged (Kahila-Tani et al., 2019; Reed et al., 2018). This is somewhat directly counterintuitive to attaining the various levels of the public participation of engaging everyone.

Also, the existence of power dynamics influences the effectiveness and utility of current participation methods. Falleth et al. (2010) identifies four problems arising from the play of power dynamics which affects true participation in western contexts. The first problem is concerned with the timing of the involvement of stakeholders in the planning process, that is the stage at which stakeholders are invited to participate. Often, stakeholders (or public) are invited to contribute after major decisions have been made already thereby rendering inputs solicited ineffective in influencing final outcomes and decisions. The second problem is the asymmetry in the stakeholders’ resources to participate. There exists, therefore, an unequal right to participate as there is an inequality in stakeholders’ abilities to voice their opinions. This can be attributed to the choice of engagement approaches adopted by experts to solicit

public inputs. Next, it may be difficult to determine persons to be "directly" affected by planning projects. As a result, not all affected person would be engaged to the same extent. Finally, planning experts implement planning processes using minimal efforts. This is undertaken to merely fulfill legal obligations (Falleth et al., 2010).

There are different methods of public engagement, potentially influenced by various participation goals and objectives (as identified by Glucker et al., 2013), that can be adopted to engage citizens based on various factors. In the next sub-section, the different methods, based on medium of participation are presented. However, before addressing the different methods of public participation, it is important to note that, despite the utility of public participation, several factors inhibit the provision of public feedback during land use planning processes. Laurian (2004) identifies some factors that affect participation rates. These include sociodemographic characteristics, individual motivations, local social context and trust in government agencies. For instance, participation can be costly in terms of time, effort, and money required, and therefore affluent people (sociodemographic variables) are more like to participate. Also, Laurian (2004) identifies the public's lack of awareness of meetings as a limiting factor that influence attendance at public meetings.

2.3.1 Methods of public participation

There are a range of techniques and methods, based on medium of participation, that can be used to facilitate public participation. These can be grouped into either traditional or technological mediated approaches. Traditional approaches to public participation or participatory planning typically involves face-to-face or personal interactions and engagements between planning authorities and interested public (Jankowski et al., 2016). In terms of benefits and value, traditional approaches offer a rich and in-depth understanding of participants views and feedback. Examples of these methods include focus group meetings, charettes, open houses, town-hall meetings, among others. The nature and characteristics of traditional methods and approaches to participation are laborious and costly as they require intensive space and time commitments from the various stakeholders (Kahila-Tani et al., 2016; Laurian, 2004). This, to an extent, vitiates the potency of these approaches as they are unattractive to a wider audience including certain demographics (e.g., race, income levels, age), potential facilitate intimidating environments as discussions can be dominated by certain groups of people, among others (Laurian, 2004; Nyerges & Aguirre, 2011).

Technological mediated or online participatory tools and approaches have been suggested to address the inefficiencies of traditional engagement approaches. This has been identified by Afzalan et al.

(2018) to refer to two main technologies: 1) web-based tools particularly designed to engage the public during specific planning projects (e.g., geo-questionnaires, geo-discussions) and 2) social networking sites that are not designed for public engagement, however, relevant information could be extracted from their highly unstructured data and used by governments to identify geographies of public perceptions and opinions concerning public services and facilities (Zhang & Feick, 2016). Generally, online participatory tools are scalable, in terms of number of participants engaged and spatial extent, thereby attracting a wider audience (Jankowski et al., 2016; Kahila-Tani et al., 2015), and facilitate independent participation thus removing the barrier of intimidating environments (Kahila-Tani et al., 2015). However, despite the hype regarding the use of online tools, there are associated drawbacks. For instance, there is a lack of demographic representativeness as they are utilized mainly by young adults (ages 18 - 44). Also, the issue of digital divide, that is unequal access to digital skills and technologies, is presented (Jankowski et al. 2016).

The choice, design, and implementation of any of the above-mentioned techniques to public participation are dependent on a multitude of factors. It is expedient that these factors are considered in designing public participation processes, either as individual/sole processes or a part of a wider toolbox of participatory processes, to achieve intended and desirable outcomes as different planning contexts and problems require different decision-making approaches (Bryson et al., 2013). Various studies have highlighted various factors and provided recommendations that can be considered by implementing authorities in employing different public participation processes. For example, Bryson et al., (2013) and Reed et al (2018) explain and present design guidelines to facilitate the design and implementation of participatory processes in achieving intended outcomes. These include design to address contexts and problems, identify purposes and design to achieve them, power dynamics among stakeholders, use of inclusive processes to engage diversity productively, among others. Also, specific to the effective use of online participatory tools, Afzalan et al. (2018) identifies the following as factors that implementing agencies should consider: planning problem, participation goals, community capacity, norms and regulation and tool capacity.

The adoption of the various methods identified above, which can be designed to address topical issues during planning processes, can profoundly influence how participation takes place and the outputs and outcomes that are realized (Kahila-Tani et al., 2019). Several studies have evaluated the utility and effectiveness of these methods of participation both quantitatively and qualitatively. The evaluation of these methods is important for various reasons including financial (prudent use of public

funds), practical (learn from mistakes), ethical (fair representation) and theoretical/research (understand human behavior) reasons (Rowe & Frewer, 2004). Rowe and Frewer (2000) describe several evaluation criteria that are essential for effective public participation. These criteria include: representativeness (a broadly representative sample of the population of the affected public), independence (independent and unbiased process), early involvement (early involvement of public as soon as value judgments become salient), influence (genuine impact on policy), and transparency (stakeholders should see decisions are made). Participation-based studies, including Kahila-Tani et al. (2016), have adopted these criteria in assessing participation undertaken in practical urban planning situations.

Nelimarkka et al. (2014) uses the IAP2 Spectrum of Public Participation to evaluate online engagement platforms. The study quantitatively evaluates, using a 10-point scale (0 - 9), the user interface of each platform in terms of how well it supports the Spectrum's levels of civic engagement (inform, consult, involve, collaborate, and empower). The maximum score attainable at each level is 9, and the minimum, 0. This rating scale is captured in the Table 2-3.

Table 2-3 Rating Scale for Spectrum of Public Participation.

Level of Participation	**Description**	**Points if feature is present**
Inform	A description of a societal problem is given	4
	Factual material is provided or linked to support the description of the societal issue	5
Consult	Submitting a new contribution is possible	9
Involve	Elected leaders or public administration can response to contributions	6
	The system can highlight which contributions are seen as important through a voting mechanism or other method	3
Collaborate	Participants can read each other's contributions.	2
	It is possible to comment on the contributions	4
	The interface supports the sense making process	3
Empower	A formal decision-making mechanism is implemented and promoted in the system	9

Source: Nelimarkka et al. (2014).

Nabatchi (2012) considers the evaluation of public participation from two positions: process evaluation and impact evaluation. The former looks at enhancing a participatory process by understanding the inputs and outputs of its implementation and management more fully. It considers

the following key question: what is delivered by the participatory process in reality? The latter, impact evaluation, is a systematic assessment of whether a public participation method achieved its goals and produced its intended effects (Nabatchi, 2012). Finally, Haklay (2013) offers a 4-level typology framework for participation in citizen science. In Level 1, 'Crowdsourcing', individuals participate primarily by gathering data, typically through sensors on mobile phones, with little cognitive engagement in the data collection process. 'Distributed intelligence', the second level, engages the cognitive ability of participants to take some basic training to enable more informed use of their judgement and knowledge in data collection. 'Participatory science' (Level 3) is attained when consultative practices are carried out between experts and the participants – participants define problems, with data collection and analysis done in consultation with experts. 'Extreme citizen science', the final level, opens the possibility of citizen science without control of professional scientists, in which the whole process is carried out by the participants to achieve a specific goal (Haklay, 2013).

Public participatory approaches can be applied in a variety of urban governance contexts, including land use planning to influence planning outcomes. In the next sections, focus is placed on urban infill and intensification. These sections also highlight the spatial attributes and dimensions of public inputs that can be solicited during participatory processes to inform land use decisions. Public engagement strategies can be adopted to inform the public about future land use projects, potential impacts, and benefits of future densification projects (Doberstein et al., 2016), and solicit public opinions on urban growth, e.g., place values and development preferences (Babelon et al, 2017; Kahila-Tani et al, 2016).

2.4 Urban infill and intensification

Changes in growth trends and approaches to land use planning are being experienced in contemporary North American societies. In the past, outward growth and urban expansion were facilitated by invention and increased use of the automobile. This type of land use pattern, known as urban sprawl, is characterized by low-density single-family dwellings, automobile dependency, undefined boundaries between rural and urban areas, haphazard developments or leap-frogging patterns of urban development spiraling away from the urban core and centers (Gómez-Antonio et al., 2016; Brody, 2013). Urban sprawl results in unpleasant and unwanted land use changes. For example, outward expansion facilitates the consumption of land at a faster rate, spatial segregation and inequalities, declining of the urban core, increased cost of provision of municipal services and functions, among others (Brody, 2013). However, over the past two decades, governments and other planning authorities have been interested in adopting planning strategies that encourage compact and higher density urban developments or urban infill and

intensification. This planning approach, a reversal from the suburbanization of the population to net population growth occurring in urban areas and centers, seeks to eliminate the unwanted consequences of urban sprawl, while sustainably accommodating the increasing population (Holden, 2019). This urban strategy is therefore seen as an integral part of planning sustainable cities in advanced countries (Kim & Larsen, 2017; Searle & Filion, 2011)

Urban infill and intensification, as an urban growth strategy, emphasize the increase in population, housing, economic and other higher density developments (Holden, 2019). In other words, urban infill and intensification alters the existing urban fabric, e.g., filling gaps in established areas, through various development tools and processes: redevelopment of existing sites (reuse of brownfields and grey fields); development of vacant and/or underutilized sites, i.e., infill (infill is an example of urban intensification strategies) within already built-up urban areas; expansion/conversion/extension of existing buildings (e.g., creating additional housing units to a residential structure or office spaces to residential units); and the construction of new developments that combine a mix of uses for a more efficient use of land (Ontario, 2006). The shift to this type of urban development can be attributed to demographic changes and population growth, increase in housing and employment demands, interests in active transportation and land mixed-use development (Gallagher, 2013; Nelson, 2013; Holden, 2019; Holleran, 2020).

2.4.1 Urban growth in Ontario

In Southern Ontario, the provincial government has implemented the Growth Plan for the Greater Golden Horseshoe (GGH) (Growth Plan, 2006). This piece of legislation is a framework that represents Ontario's vision to encourage and facilitate how and where the region will grow based on several guiding principles such as the prioritization of intensification and higher densities in strategic growth areas to efficiently use land and infrastructure, and support transit viability (MMAH, 2020). The Growth Plan (2006) identifies population and employment forecasts to plan and manage growth within areas in the GGH, with growth mainly directed to settlement areas with a defined and delineated built boundary. Thus, to achieve set density goals and targets, municipalities determine how to meet these density metrics through various land use decisions and processes, to facilitate increase in densities and heights, such as infill vacant properties, conversion of existing buildings to more intensive uses, and construction of new developments such as high-rise structures and altering height and zoning bylaws.

The Growth Plan (2006) identifies density targets for different places within Ontario. The targets set by the Growth Plan informs how and where new developments are to take place, e.g., a minimum of

40% of all new residential development each year must be in the form of intensification and carried out within each built urban boundary of urban areas within the region (Neptis, 2014). Schedule 3 of the Growth Plan (2006) outlines growth forecasts and targets (i.e., population and employment) for various urban areas within the region, and municipalities are to use these forecasts to manage growth within their jurisdictions. For example, the Region of Waterloo has been assigned population and employment targets of approximately 835,000 and 404,000 respectively, by 2041, representing an increase of approximately 50% in both forecasts from the year 2016 (Statistics Canada, 2019).

Aside from meeting density targets, municipalities enjoy associated benefits of intensification practices such as the accommodation of an increasing population, environmental friendliness (e.g., reducing human carbon footprints), cost-savings on part of municipalities as cities as intensification efficiently takes advantage of existing infrastructure (e.g., water, electrical grid, public transit) thereby reducing development costs while preserving rural/agricultural land, active transportation, and the integration of mixed-use accommodation (Searle & Filion, 2011; Neptis, 2014; Holden, 2019). Despite these benefits associated with high density developments, its implementation is not straightforward as there are several associated issues, challenges and factors that need to be considered. The next subsections highlight the challenges and issues associated with implementation of intensification projects, determinants of land use options, and property and neighborhood factors that influence land use preferences.

2.4.2 Challenges and issues associated with the implementation of urban infill strategies.

Challenges and issues encountered during the adoption of urban intensification strategies can be explained from 1) consideration of multiple different land use changes and options and 2) social reaction and acceptance of proposed land use changes. The first identified challenge is one primarily encountered by planning authorities and experts, including governments. In determining and considering various potential land uses and options for a site, these land use experts and officials adopt a concept known as the “Highest and Best Use” of a property (Leffers and Ballamingie, 2012). The Highest and Best Use of a property, which focuses on the maximal productivity and highest value that can be realized from the use of a property, is determined by three factors. These include: 1) Physical possibility, 2) legal permissions, and 3) financial feasibilities (Parker, 2016).

A proposed use of land must be developable based on the site’s physical characteristics such as size, topography, location, among others. Legal permissions focus on the land use planning aspects and

zoning regulations that guide land use planning and development processes (e.g., designated land use, density, heights, etc.), and existing (and possibly overriding) land title interests (e.g., easements, etc.). Finally, financial feasibility highlights whether the proposed land use can generate revenue or utility greater than directly related and/or incidental costs (Parker, 2016). Similar to other land use planning processes (e.g., multi-criteria decision land use analysis), during the implementation of urban infill and intensification strategies, planners and other related authorities, consider these factors in assessing and deciding among alternative potential land uses and options for vacant and under-utilized sites (Leffers and Ballamingie, 2012).

The second challenge relates to the complex reactions, social acceptance, and attitudes of citizens towards urban intensification and infill developments (McCrea & Walters, 2012; Holden, 2019). These complex reactions and attitudes are described as phenomena known as either not-in-my-backyard (NIMBY) or yes-in-my-backyard (YIMBY). The public's opposition to local development projects that are unwanted, ranging from waste dumps to renewable energy facilities, is described as NIMBY (Burningham et al., 2007). This is based on perceptions and the fear of losing environmental qualities appreciated without getting added value (Kytta et al., 2013). Scholars describe this opposition as ranging from constructive activism (Whittemore & Bendor, 2018) to parochial, ignorant, irrational, and selfish interests that perceive development projects that intend to serve community needs (e.g., promote urban sustainability goals and improve quality of life) as unattractive, dangerous or a nuisance (Brown & Glanz, 2018; Whittemore & Bendor, 2018).

YIMBY, on the other hand, is the public's positive attitudes and acceptance of higher density development projects to support population and economic growth (Brown & Glanz, 2018). This phenomenon is usually advocated by millennials (people born between 1980 and 2000) and renters who argue for higher density projects, especially housing, driven by the desire for good urban design, environmentalism, and social justice to improve equitable access to public services and functions (Holleran, 2020; Beyer, 2016). The intent of this research is not to focus on the definitions and nuances in the phenomena, but to rather broadly understand the diversity of public attitudes, motivations, and concerns of citizens, either positive or negative, towards future urban growth, given a range of land uses and facilities.

2.4.3 Motivations underlying social and public attitudes towards land use developments.

The dimensions of NIMBY and YIMBY are broadly based on several factors, including different motivations, concerns and perceptions of losses and gains (e.g., increased traffic, improved streetscape quality), associated with future land use developments by citizens, and the subsequent preference of these land uses near them (Brown & Glanz, 2018). Devine-Wright (2012) explains these reactions using the role of personal variables, place attachment and project-related factors. Personal variables and characteristics include residency, age, education, income levels, among others. People with a high sense of place and place attachment to a given space are more diligent and aware of possible changes to such place, and likely to oppose these changes. Finally, project-related variables are concerned with the nature and characteristics of land use changes and impacts to existing the existing neighborhood in terms of aesthetics, nuisance, socio-economic impacts, reduction of property values, etc. (Devine-Wright, 2012; Scally & Tighe, 2015).

Petrova (2016) suggests a framework (named VESPA), consisting of four categories, to organize and interpret community concerns towards land use developments, specifically renewable energy developments. This framework can also be broadly applicable to other land use developments, including the adoption of urban intensification strategies. The categories of the VESPA framework, an acronym formed from the first letters of the categories, are as follows:

- Visual/landscape and noise factors: These are concerned with the perceived possible aesthetics and nuisance effects of new developments to existing urban environments.
- Environmental factors: This regards the public perceives local and global ecological effects of new developments. Such perceptions include the emission of harmful gases.
- Socioeconomic factors: This includes financial commitments and compensation associated with new projects, contribution to the local economy, impacts on property values, etc.
- Procedural Aspects: This focuses on the decision-making processes associated with the urban land use changes related to rights of participation, access to information, and trustworthiness of project developers and decision-makers.

The challenges and issues associated with urban intensification strategies identified above can, to an extent, be described as factors that influence the choice of urban growth and development preferences. In the next sub-section, these issues, and challenges, highlighted in this section, are presented as

determinants, and property and neighborhood factors that potentially influence future urban land use growth, decisions, preferences, and options.

2.4.4 Determinants of urban land use decisions and options

There are several determinants or drivers that influence the choice of urban land uses. Specific to infill and intensification processes, these emphasize the influence of various factors in development preferences and growth of urban areas. An important concept associated with determining potential land decisions and options during urban infill is "Geographical discounting" (Pocewicz and Nielsen-bi 2013). The concept of geographical discounting posits that, people prefer what they consider to be of utility closer to their domiciles, and what they do not consider to be of utility further from their domiciles (Hannon, 1994). Brown and Glanz (2018) also describe geographic discounting by land use type influenced location of residence and zoning. Findings from the study provided evidence to show a strong relationship between the public's land use preference and zoning regulations. The reference location of individuals, therefore, potentially influences place values of the public, and subsequent land use preferences across different landscapes (Pocewicz and Nielsen-Pincus 2013; Brown, 2016; Brown & Glanz, 2018), and even willingness to contribute to the planning process (Devine-Wright, 2012). The dimensions of NIMBY and YIMBY are examples of expressions of geographical discounting relating to future land use options, thus identifying, and mitigating possible land use conflicts (Pocewicz and Nielsen-Pincus 2013; Brown & Glanz, 2018).

Next, Poelmans and van Rompaey (2010) describe these determinants using five explanatory variables: biophysical factors (e.g., slope, waterbodies); social factors (e.g., population density, racial composition, income levels); economic factors (e.g., distance to urban centers, proximity to road networks, distance to public transportation); neighborhood interactions (e.g., land use compatibility); and spatial and planning policies (e.g., zoning, land use legislations). Finally, Briassoulis (2020) classifies these determinants as bio-physical and socio-economic drivers. The bio-physical drivers include the characteristics and processes of the natural environment such as topography, landform, weather conditions, drainage patterns, among others. On the other hand, the socio-economic drivers are concerned with demographic, social, economic, political, and institutional factors and processes. These include population changes, real estate values, land use planning policies and legislations, community organization and norms, sense of place and place attachments, among others (Briassoulis, 2020).

Despite the variations in the classification of determinants and factors influencing future urban growth as identified above, two distinctions can be identified: 1) factors related to the level of the

individual property and 2) factors that apply at neighborhood, community, and even city and national levels. These distinctions, which can also be described as at a micro-level, i.e., property or site factors, and at a macro-level, i.e., higher spatial, organizational, or situational factors, play a crucial role especially during the adoption and implementation of urban intensification strategies and land use options (Verburg et al., 2019; Briassoulis, 2003). In this present research, focus is given to property and neighborhood factors that potentially influences citizens' perceptions of future urban growth. These factors are, however, not exclusive to citizens but also applicable to other stakeholders (e.g., planners). Table 2-4 presents a set of property and neighborhood factors considered in determining future land uses preferences.

Table 2-4 Property and neighborhood factors that influence land use decisions.

Property and Neighborhood factors	**Sources**
Characteristics and nature of proposed land use (e.g., physical characteristics [lot sizes, shape, etc.], density, aesthetics, nuisance, economic growth and viability, safety)	Lewis & Baldassare (2010); Aly & Attwa (2013); Petrova (2016); Devine-Wright (2012); Scally & Tighe (2015); Parker (2016); Poelmans & van Rompaey (2010); Briassoulis (2020).
Proximity to suggested land use/geographical discounting	Brown & Glanz (2018); Gravelle & Lachapelle (2015); Pocewicz and Nielsen-Pincus (2013); Brown (2016).
Legal and planning legislations/zoning regulations	Puustinen & Viitanen (2015); Aly & Attwa (2013); Parker, 2016; Poelmans & van Rompaey (2010).
Property values	Aly & Attwa (2013); Petrova (2016); Brunes et al. (2020); Whittemore & Bendor (2018); Briassoulis (2020).
Access and linkage aspects (e.g., parking, walkability, active transportation, compatibility, connectivity, land use mix)	Holleran (2020); Aly & Attwa (2013); Poelmans & van Rompaey (2010).
Sense of place/place values/place attachments	Aly & Attwa (2013); Devine-Wright (2012); Briassoulis (2020).
Environmental impacts	Petrova (2016); Doberstein et al. (2016); Holleran (2020).
Personal and demographic characteristics (e.g., age, race, education, income levels)	Devine-Wright (2012); Holleran (2020); Poelmans & van Rompaey (2010); Briassoulis (2020).

These factors highlighted in the table above are informed by literature regarding factors considered by planners in determining land use options for an infill site, social reactions and attitudes towards urban changes, and determinants of urban land use decisions. Land use decisions and options made based on these factors have cumulative positive or negative effects at different spatial levels - local, regional and global. These impacts, described by Briassoulis (2020) as environmental and socio-

economic in nature, include destruction/enhancement of environmental qualities, changes in property values, urban density changes, changes to provision of municipal services, among others.

2.4.5 Spatial attributes and dimensions of public inputs during urban infill and intensification

As indicated in previous sections, the impacts of land use changes are of spatial dimensions and impacts, as these potential land use developments may alter the existing urban layout and associated place values. Various participatory methods (see section 2.3.1) can be adopted to capture and measure several spatially related variables and attributes of public input in land use planning. For instance, the existing place values people associate with various landscapes (e.g., therapeutic, spiritual) is a spatial attribute that can be solicited during urban growth land use decisions (e.g., "how important is this location to you?"). Several studies emphasize the importance of this attribute during land use planning (see Babelon et al., 2016; Brown et al., 2015; Brown & Raymond, 2007). Aspects of this spatial attribute can be expressed as place identity, i.e., personal mixture of individual feelings about physical settings; place dependence, i.e., functional connections to a place that satisfies individual needs to its utility; social bonding, i.e., place evokes feelings and emotional attachment due to shared history, interests, etc.; and finally, nature bonding, i.e., connections to the natural environment (Raymond et al., 2010).

Development preferences is another spatial attribute and variable that can be solicited from the public (e.g., "What type of land use project would you prefer to be developed here?"). In a study by Kahila-Tani et al. (2016), to facilitate the drawing up of a master plan to support urban infill in Helsinki, citizens indicated land use preferences across different places in the city. Next, the perceived impacts of future land use decisions and options on surrounding urban structure (e.g., "how does the proposed (re)development affect existing neighborhood qualities?") can also be solicited. Several studies, for example, Devine-Wright (2012), have collected, measured, and emphasized the importance of this spatial attribute to land use planning. Finally, public inputs gathered may reflect assessments of preliminary urban infill and (re)development strategy proposals and plans affecting an area to inform early comprehensive planning (Babelon et al., 2016).

Notably, analysis of these spatial attributes and variables identified in this sub-section may reveal land use preference conflicts and geographical discounting (see section 2.4.4). For example, a homeowner may not be pleased with a landfill site being placed near his home due to stench which may emanate from such use. Also, the analysis of development preferences and/or place values recorded by residents or non-residents may identify potential for land use conflicts. For example, citizens may

collectively agree or disagree that a vacant property be developed. The reverse may also be true where a consensus may be reached to leave an under-utilized property in its current state and be used for open space/recreational facilities. According to Brown and Raymond (2013), High potential for land use conflicts exists in areas mapped with land use preference disagreement, but with lower place importance and intensities. The converse, low potential for land use conflicts, is applicable for areas with land use preference agreement but with high place importance.

In conclusion, urban intensification and infill land use processes can be typically measured using municipality-wide indicators (e.g., jobs/ha, population density, percentage of new buildings, etc.) (MMAH, 2020). However, its impacts are inherently and evidently spatial in nature, local/context-specific and cumulative, while also eliciting public reactions, i.e., acceptance and/or opposition. It is therefore important that planning experts and authorities engage various stakeholders (e.g., businesses, local residents) during the procedural aspects and decision-making processes of land use processes to facilitate successful implementation and adoption of intensification strategies (Sun et al., 2016; Doberstein et al., 2016; Scally & Tighe, 2015; Devine-Wright, 2012). Consequentially, public input (which are potentially controversial), as well as effective spatial approaches and strategies are critical in facilitating the implementation of urban densification plans. In the next section, the operationalizing and utility of spatial approaches and strategies, particularly, Geographical Information Systems (GIS), to urban land use planning processes, specifically compact urban developments, and public engagement, are elaborated.

2.5 Geographic Information Systems (GIS) and urban planning

Planning practice and research adopts and implements Geographic Information Systems (GIS) in various aspects and fields such as tourism, land-use planning, amongst others, to aid in decision-making processes. GIS has been defined by different people over the years since these systems were first developed in the 1960s. GIS has been described as a container op maps in digital form, a computerized tool for solving geographic problems, and as a spatial decision support system (Longley et al., 2005). GIS has also been defined as "… a computer system capable of assembling, storing, manipulating, and displaying geographically referenced information, i.e., data identified according to their locations" (USGS, 2005). The ideas expressed by the above definitions posit that GIS is a collection of computer-based systems which are designed and implemented for the purposes of managing and processing geospatial data to address spatially tied problems (Lo & Yeung, 2007) including urban planning processes (e.g., suitable site selection analysis).

The implementation of GIS in urban planning processes (i.e., research contexts and professional practice) can be attributed to the inherent spatial nature of both GIS and land use planning (e.g., urban intensification). Furthermore, the nature and properties of GIS, that is, complex, reflexive, and powerful (Follett et al., 2018) facilitates its adoption in planning processes. The complex nature of GIS refers to its ability to capture and reflect the reality of the world, that is physical geographic features and attributes. Reflexively, GIS facilitates the understanding and analysis of causal relationships and other spatial relationships (e.g., proximity of events to various locations). Finally, GIS is powerful because it can endow various individuals (including citizens) and institutions (e.g., municipal governments) with competitive advantages in a multitude of contexts such as capture and display of geographic information and soliciting of public feedback (Follett et al, 2018).

The above identified nature of GIS (i.e., complex, reflexive and powerful), coupled with the inherent spatial nature of both GIS and spatial planning processes underlies why GIS is critical in planning processes. The process of GIS production (data production, analysis, visualization and use of GIS output) is underlined by political, economic, and social motivations. This has led to awareness of issues such as access to data and the political economy of information, and the presence of multiple coexisting perceptions of realities and epistemologies (Bunch et al, 2012). The awareness of these issues, along with discussions centered on socio-economic and spatial marginalization of groups and individuals, has led to a meteoric rise of GIS and other geospatial technologies in the public consciousness (Follett et al, 2018).

2.5.1 Participatory mapping in land use planning

Planning practitioners and academics are constantly looking out for authentic dialogues between planning authorities and the public/non-experts as a pathway to better planning outcomes (Brown, 2015). These include fully exploiting the potential of crowd wisdom and local knowledge (Glucker et al., 2013; Corburn, 2003). This has engendered the need to refocus the design and implementation of public participatory processes to enhance the quality of land use planning processes (Brown, 2015). During urban densification, it is important to adopt planning strategies that are sensitive to local contexts and seek contextually sensitive information, e.g., place experiences, while also mitigating potential land use conflicts (Kytta et al., 2013; Kahila-Tani et al., 2019). One of such context-sensitive planning strategies is participatory mapping. “Participatory mapping is a type of public participation that includes the generation and/or use of spatial information for a variety of purposes” (Brown et al., 2018: 65).

These strategies can be used to assess the consistency, compatibility, social acceptance of current and/or future land use, provide diagnostic evidence to support land use changes, and identify potential land use conflicts of zoning with public values and preferences (Brown et al., 2018; Kytta et al., 2013). There exists a diversity of designs and implementation of participatory mapping. This can be done in a deliberative, in-person manner, and may be expert-aided in a structured manner (e.g., workshops) with participants being solicited and assisted to contribute using approaches consisting of low technology digitized paper, web-based approaches, or the use software application such as Google Maps application (Sieber et al., 2016). The choice of participatory mapping method is determined by several factors including choice of map attributes, e.g., development preferences; sampling method; purpose, e.g., analysis of subjective experience; technology, e.g., use of the Geoweb; and location (Brown & Kytta, 2014).

Participatory mapping aims to expand the opportunities to reflect the interests of marginalized groups in society in important land use decisions and this has led to the emergence of the following interrelated fields of planning research and practice: Public Participation GIS (PPGIS), Participatory GIS (PGIS) and Volunteered Geographic Information (VGI) (Brown et al., 2018). As noted by Brown (2016) and Brown and Kytta (2014), there are ambiguities over the use of the terms, and have been used interchangeably. However, certain characteristics and distinctions are identified by Brown and Kytta (2014). PPGIS, led by government planning agencies in developed countries, aims to enhance public involvement to inform land use planning. PGIS is often led by charitable organizations (e.g., NGOs) in developing countries to enhance community empowerment, foster social identity and build social capital. Finally, VGI seeks to expand spatial information by using citizens as sensors and can be led by either organizations or individuals (Brown & Kytta, 2014).

2.5.2 PPGIS, PGIS and VGI

The use of GIS to facilitate public engagement originated at meetings of the National Centre for Geographic Information and Analysis (NCGIA). These meetings sought to frame, shape, and define the use of technological innovations in social and political contexts to empower the marginalized through inclusive access to GIS technologies and spatial data (Ghose, 2018; Sieber, 2006). Public Participation GIS (PPGIS) and Participatory GIS (PGIS) are an area of applied research and practice with the goal of empowering citizens/non-experts to be involved in participatory processes by representing their interests, experiences and concerns using spatial data and mapping tools within a formal participatory process to improve planning outcomes (Ghose, 2018). The application of these

P/PGIS in formal planning processes is important in improving equitable planning outcomes as it attracts people affected by planning decisions, people with related important knowledge and people with the potential to influence the implementation of planning decisions (Schlossberg & Shufford, 2005).

Volunteered Geographic Information (VGI). VGI, a term coined by Goodchild (2007), refers to the creation of geographic information by the widespread engagement of large numbers of private citizens, a function previously reserved to official agencies and experts, with little to no training or formal qualifications. This can be attributed to the rise in use of technologies, including web-based mapping applications. Modern technologies, specifically web 2.0 technologies (e.g., Geoweb), facilitate VGI and the rise of citizen data authoring. Web 2.0 technologies, a move from static and non-interactive web sites and pages, allow the development and interactions of web sites and pages such as the population of these sites through crowdsourcing, open data and citizen science initiatives and this has transformed business operations, government-citizen interactions (Goodchild, 2007; Johnson, 2016). Citizen generated data sources have spatial and/or temporal components from varying sources including, mobile phones, comments submitted via mapping applications, etc. (Kwan, 2016; Batty, 2013). The soliciting and analysis of VGI for urban processes can either be actively done within a formal participation process, e.g., use of Geoweb, specifically designed for planning participatory process or passive and sensor-based using citizens' mobile devices and other digital infrastructure.

The rise of citizen data authoring or citizens as data sources, and its data quality, has potential implications for urban governance, including the nature of public participation (Feick, in press). First, the cost-effective and efficient time management benefits offered by online methods of participation (e.g., Geoweb) will be increasingly favored over traditional and in-person approach to participation. This potentially gives rise to remote v. place-based (in-situ) forms of participation. Second, the focus of participation will continue to shift from locally specific, longer-term, and less well-defined problems to short-term and tractable issues. Experts such as IT firms and municipal decision makers, with vested interests in urban management tasks, are less likely to be motivated in engaging in long-term deliberative community planning and value-based considerations. Finally, participation is more likely to become passive and granular. This refers to directing to a more prescribed channels and transactional VGI (e.g., passengers tapping on a sensor to board a train) as it eliminates recruitment, gathers higher data volumes, and reduces the potential for human-induced error or sampling bias (Feick, in press).

There are interrelated themes central to the use of P/PGIS and VGI in planning research and practice (Hall et al, 2010). First, GIS technologies offer numerous opportunities for multiple forms of participation that facilitates its (e.g., GIS technologies) adoption in PPGIS research, studies, and practice (Hall et al, 2010). This theme focuses on broadening expertise and involving local knowledge in an open participation process to facilitate equitable access to spatial information. This is to represent a move away from the concentration of spatial knowledge and tools in the hands of a few experts. Another theme emphasizes the equal access to spatial information, tools, training, software, etc., to mitigate the differential access to GIS thereby reducing existing social and power structures (Hall et al, 2010). The identified themes surrounding PGIS tools, methods, and technologies, highlight the goals of P/PGIS in allowing people to tell their own stories, or engage in neo-geographic practices that enable participants or citizens share their stories and other related geographic information anytime, and anywhere (Haklay, 2013). However, despite the numerous benefits offered, there are no guarantees that the use of participatory mapping will be more influential than other traditional or non-map-based methods (Kahila-Tani et al., 2019).

The above-mentioned paragraphs identify and describe participatory mapping, and associated emerging fields, as context-sensitive strategies that are increasingly being adopted to facilitate land use planning, including densification, to improve participation goals and outcomes. One of such increasingly accepted and adopted participatory mapping methods are map-based web tools (Kytta et al., 2013; Czepkiewicz et al., 2016). Broadly, web tools take advantage of the rise in ownership of digital innovations (e.g., laptops), increased access to the internet, multiple in-depth communication mediums (e.g., scales, surveys, commentary), and increasingly powerful digital platforms and software (Hofmann et al., 2020). Aside from being a context-sensitive strategy, map-based web tools facilitate a relatively easier collection and analysis of public inputs as they offer the ability to connect responses to the physical environment (Kytta et al., 2013; Kahila-Tani et al., 2016), also people are willing to share spatial knowledge using map-based tools (Rzeszewski & Kotus, 2019; Sieber et al., 2016). The next sub-section focuses on the design and implementation of map-based methods, specifically geo-questionnaires, as a participatory mapping method during land use planning.

2.5.3 The adoption of Geo-questionnaires to support planning outcomes.

A geo-questionnaire is an online multi-page questionnaire that is connected to an interactive map to solicit two types of data from users/respondents: data directly linked to geographical features and data with no spatial reference (Czepkiewicz et al., 2016). The use of this tool involves participants

performing map interactions such as drawing geographical features (points, lines, or polygons) on a map or selecting map features such as buildings (represented by points, lines or polygons) from an active map layer and subsequently providing location-specific responses to questions triggered by the map interactions (Czepkiewicz et al., 2016; Jankowski et al., 2016; Czepkiewicz et al., 2018). This type of web tool facilitates the simultaneous collection of qualitative, quantitative, and spatial data from relatively larger population samples, compared to traditional methods such as face-to-face meetings (Czepkiewicz et al., 2018). A distinguishing feature of a geo-questionnaire from other online tools is that it is framed in a specific geographic context (e.g., city) referenced by a map (Jankowski et al., 2016).

Geo-questionnaires, due to its design features, can be operationalized to capture and measure the following attributes: patterns of social behavior (places often visited), place values (places that represent different meanings to various people), experiences and subjective evaluations (assessments of perceived environmental qualities), and development preferences (Czepkiewicz et al., 2018) – spatial qualities and dimensions of public inputs solicited during land use planning (see section 2.4.5). This makes the tool a suitable and effective participatory mapping method for urban densification contexts. Several benefits are related with the use of geo-questionnaires. For instance, a rich value of information is obtained as it avoids digressive and off-the-subject commenting and possibilities of individuals dominating discussions – undesirable features associated with other engagement methods like focus groups (Jankowski et al., 2016). Other benefits include potential to attract more people to participate compared to other traditional methods (Jankowski et al., 2016; Czepkiewicz et al., 2016), requires basic mapping and web-browsing skills (Czepkiewicz et al., 2016), and can be a wider part of a toolbox for public participation (Babelon et al., 2016).

The utility of geo-questionnaires to planning processes has been recognized as several of these online mapping tools have been designed and operationalized in numerous academic and real-life planning application domains to perform spatial multi-criteria analysis of housing preferences (Jaroszewicz, 2019), solicit perceived value of urban green space (Czembrowski et al., 2019), among others. However, despite its utility, there are associated limitations with the use of the web mapping tool. Like other online engagement tools, this web map tool is currently inherently biased as it attracts younger, better educated, and technology savvy sections of the public, thus perpetuating the issue of digital divide, i.e., the unequal access to digital skills and technologies (e.g., internet and laptops), low browsing and/or mapping skills (Czepkiewicz et al., 2016). Also, geo-questionnaires facilitate bottom-

up one-way mode of communication (see Reed et al., 2018) and not interactive exchanges among stakeholders.

2.6 Conclusion and research direction and focus

Planning legislations and tools encourage and facilitate changes to existing urban fabric in the form of intensification projects. While there are several benefits associated with this planning process, it also potentially impacts the existing personal, neighborhood and environmental qualities, thereby eliciting reactions from the public. Local knowledge, therefore, including contextually based relational processes, must be considered during planning processes. In planning for future land use, public judgment should embody thoughtful consideration about the current importance of the land as well as future options for that will alter the existing urban fabric. Public judgement, which would reflect the collective values the public has for the places under consideration, perceived impacts of future projects, as well as their preferences for future uses (Brown, 2015), can be solicited using PPGIS tools which gives broader access to maps and spatial data thereby expanding the forms of spatial knowledge (Elwood, 2006).

Generally, the assessments and understanding of various public engagement methods and approaches provide a framework to analyze the value of these methods in achieving the goals and objectives of public participation (see Rowe & Frewer, 2000; Rowe & Frewer, 2004; Uittenbroek et al., 2019; Blackstock et al., 2007). These frameworks assess utility of these methods based on various factors including design features. Specific to online participatory methods, the main design components – online maps and questionnaires – are being designed in multiple complex forms. These design components can be complemented with other tool design principles (e.g., user interface, choice of color) to improve user experience.

The questionnaire, connected to the map and triggered by map actions, can be designed using psychometric scales (e.g., likert scales), close and/or open-ended questions to capture and measure both spatial and non-spatial inputs. The design and type of questions have implications for analysis of survey data. For example, attributes georeferenced using residential locations can be analyzed in an aggregated (group) or disaggregated (individual) manner to identify potential for land use conflicts (Cziepkiewicz et al., 2018). The online map design component visualizes features (e.g., buildings footprints) of a specific georeferenced location using map features. The map offers tools and functionalities such as zooming, and other spatial analysis (e.g., distance/time). Map features are being designed in multiple

complex forms using various spatial data visualization techniques such as 3D, 4D, Virtual Realities (VR), Augmented Realities (AR), among others (Babelon et al., 2016), based on data complexity, display technology, task and/or application contexts (Dubel et al., 2014), and target audiences (Wastberg et al, 2020).

The prolific use of these online mapping tools has implications for planning practice and research, especially as research currently lags behind the increased, and complex design and implementation of online geospatial tools. It is therefore important to assess the efficiency and impacts of these tools to planning processes through understanding what works, how and in which contexts (Babelon et al., 2016). In this regard, to contribute knowledge, this research designs and implements a map-based web tool, a geo-questionnaire named Infill Planner, in an urban densification planning context. This research therefore seeks to help planners understand how web tools can be used to understand the factors that citizens consider in providing inputs during urban infill and intensification land use planning. Also, the influence and connotations of tool designs and functionalities in providing high quality data, representativeness, user experience and participant satisfaction and assessing citizen willingness are important in designing and implementing these online tools (Babelon et al., 2016; Cziepkiewicz et al., 2018). The following research questions are then presented:

a) What property-related issues (e.g., property size, place bonds, compatibility of land use, etc.) and neighborhood-related issues (traffic impact, neighborhood revitalization, place bonds, etc.) do people consider in providing comments pertaining to urban intensification?

b) What web map-based tool designs of Infill Planner do users consider useful in providing comments on infill planning projects? What other tool designs do they consider useful? Are users of Infill Planner willing to use similar map-based tools in the future?

The next chapter focuses on the study area, design and development of the web tool, and research methodology adopted for this study.

Chapter 3
The study area, data and web tool development and research design.

3.1 Introduction

This chapter describes the study area, the methods used in developing Infill Planner, features of the map-based web tool, and the research design. Section 2 describes the overall research method. Section 3 describes the City of Stratford, Ontario, as a study area for implementing the map-based tool. Section 4 focuses on the design and development of Infill Planner. This includes spatial data layers and design components created, processed, and utilized, and the subsequent creation of the map-based web tool using ArcGIS Experience Builder. The workflow and tasks required of users of the tool are also highlighted. The final section focuses on the research design adopted in this study. This section highlights the rationale and recruitment of participants.

3.2 Research Approach

A mixed methods research approach was chosen for this study. This research approach involves the integrated use of quantitative and qualitative methods of data collection to best understand a research process (Clark & Ivankova, 2016). While a quantitative research approach examines the relationships between variables by collecting and analyzing numeric data expressed in numbers or scores, a qualitative research approach focuses on exploring individuals' experiences with a phenomenon by collecting and analyzing narrative or text data expressed in words and images (Farthing, 2016; Clark & Ivankova, 2016). The Infill Planner tool embodies a mixed methods approach through the use of web-based surveys that gather both qualitative and quantitative data using open-ended and close-ended survey questions.

Close-ended questions are questions designed to include a limited list or number of options/answers that have been pre-determined and can only be answered by selecting one or more responses from this limited range of options provided. Open-ended questions are designed to enable the respondents write out responses to survey questions in their own words (Farthing, 2016; Lewis-Beck et al., 2004). The close-ended questions gathered quantitative data that were analyzed using descriptive statistics, while the open-ended questions gathered qualitative data which were coded and analyzed. The pros and cons of using closed and/or open survey questions are highlighted in the description and features of *Infill*

Planner. Overall, the mixed method research approach adopted in this study can be described as triangulation which seeks to obtain different but complementary data on the same topic (Cresswell, 2006). This enables the researcher to directly compare quantitative statistical results with qualitative findings or to validate or expand quantitative results with qualitative data (Cresswell, 2006).

3.3 Study Area

The study area, Stratford, located 143km west of Toronto, is along the Avon River in southwestern Ontario, Canada. The land area of the city is 28.28km², with a population of approximately 31,400, and population density of 1,112.5/km² (Statistics Canada, 2017). Stratford, Ontario is internationally renowned for its culture, as the city's famous Stratford Festival, one of Canada's leading attractions, generates $140 million in economic activity, $65 million in taxes, while creating 3000 direct and indirect jobs (investStratford, n.d). The city is strategically located in the southwestern Ontario region which has the largest concentration of manufacturing industries in Canada. This industry is one of the city's most successful and growing sectors with a promise of contributing to the economic growth of the city. The city is also situated within North America's second largest Information Technology (IT) Cluster, as well as being part of the Toronto-Waterloo Region Innovation Corridor. Over the past decade, the city has been recognized by the Intelligent Community Forum (ICF), in three different years, as part of the Top 7 Intelligent Communities of the Year (investStratford, n.d).

The City of Stratford is a mature medium sized city. In the past, the city witnessed a decline in its population, especially from 1991 to 2011, recording a decrease by an annual average rate of 0.2% between 2006 and 2011. This population growth rate is significantly lower compared to other cities and that of the province of Ontario. While experiencing a decline in population growth, it also has an aging population as the proportion of inhabitants within the 55+ age group keeps increasing and the reverse occurring for the number of persons aged below 55 (City of Stratford, 2012). In 2012, an Official Plan review background report prepared for the City of Stratford, Ontario on the "Demographic and Economic Profile and Population and Housing Growth Forecast" revealed that the City of Stratford is generally 'self-contained', that is with 81.4% of local residents employed within the city. This report also projects a population growth to 33,600, approximately 10% increase, between 2012 - 2032 and a corresponding supply of an average of 100 housing units per year within this stated period.

Presently, the city is strategically positioning itself to support the increase in both population and economic growth and densities. For instance, its Official Plan (OP) encourages intensification processes

such as infill and redevelopments to support higher density developments. Also, in 2019, the Stratford City Council identified and adopted some strategic priorities to support economic growth that seek to develop, attract, retain a diversity of businesses and talents, increase housing supply, among others. The presence of several vacant/under-utilized properties, including the former Grand Trunk Railway Locomotive Repair shops, in the city offer opportunities to increase its population, economic and housing densities. This can be supported by the existing municipal services and functions, opportunities, advantages, and services, including culture, higher education and skills training, industry, among others, present in the city. This makes the city attractive to businesses, advanced innovation, human talent and skills, and growth potential. Also, the City's interest in deploying technological innovations as solutions to urban problems, including digital inclusion and innovation, coupled with the potential for more compact urban developments, makes it suitable to implement a web tool to facilitate public interactions during infill development processes.

Figure 3-1 Map of Stratford. Inset: Location of Stratford in southwestern Ontario

3.4 Design and development of Infill Planner

A web-based mapping tool, *Infill Planner*, was developed to present property and neighborhood information of selected sample properties, and subsequently solicit property-related comments (e.g., land use preferences) from users of the tool. The design and development of *Infill Planner* was in fulfillment of the first objective identified in Chapter 1: "Design and develop a map-based web tool

known as *Infill Planner*". In designing *Infill Planner*, it was important to keep the User Interface (UI) simple. UI is concerned with design of what the user sees (text, visual cues, etc.) and interacts with (e.g., controls, menus) to make the web tool, *Infill Planner*, easy to use, intuitive in design, and eliminate confusion or inconsistencies. A simple UI enables users to understand efficiently and effectively, and complete required tasks thereby leading to better quality data. Existing conventions and symbols in web mapping familiar to persons with related mapping experience, and intuitive to the public were also adopted. Subsequent paragraphs further describe the web-based mapping tool, Infill Planner.

This tool is appropriate for this research study due to the nature of the research problem. The research problem and objectives, which seeks to understand how citizens consider site (i.e., property) and situation (i.e., neighborhood) factors when considering potential future uses for vacant or underutilized properties, is spatial in nature. Nuojua (2010) and Kytta et al., (2013), argue that map-based approaches, similar to the tool developed for this study, are ideal and most-efficient in facilitating interactions between stakeholders in acquiring useful local knowledge that can be tied to geographic locations, while also simplifying its integration with expert knowledge. Several different steps were undertaken in developing the map-based web tool, Infill Planner. These steps, highlighted in the following sections, include the preparation of the spatial data needed to support the functions of Infill Planner, and the design and development of using ESRI's ArcGIS Experience Builder software application.

3.4.1.1 Data Layers

In designing the web tool, two datasets were needed: building footprints of the City of Stratford, Ontario, and sample vacant/under-utilized properties in the city. The table below provides an overview of these data.

Table 3-1 Data layers

Data	Source	Format	Key attributes
Building footprints	Students from the 2017 and 2018 GP classes from the University of Waterloo.	Polygons	Building type, area (ha), building height
Sample properties	City of Stratford, Ontario	Polygons	zoning, area (ha), property and neighborhood information.

3.4.1.1.1 Data Processing

Different data preparation processes were done to acquire datasets needed to support the functions of the web tool. These steps including, creation of spatial database of building footprints of Stratford Ontario as a 2D feature layer, extrusion of the 2D feature layer of building footprints to 3D, and selection of sample properties, are elaborated below.

Building footprints of a city, referring the layout of all existing buildings in a city, plays an important role in urban planning and land use analysis (Shi et al., 2019). Specific, to urban infill and intensification, a spatial database of building footprints of the city helps highlight vacant and potentially under-utilized properties within the city. Different 2D building footprint sections of the city (120 sections) were originally created by undergraduate students from the 2017 and 2018 GP classes from the University of Waterloo. Students created this through heads-up digitizing based off a 2015 SWOOP satellite imagery.

The researcher then edited and consolidated the 120 individual sections to create a single, seamless city-wide feature class of 2D building footprints data layer. This consolidated feature class (named "Stratford Building Footprints") was saved and published to the University of Waterloo's ArcGIS Online organization (AGOL) account as a feature layer. ArcGIS Online is a cloud-based service that facilitates online mapping and spatial analysis. The creation, editing and publishing of this data layer (2D building footprint) was done using ArcGIS Pro. A main issue with this consolidated database is that students digitized roof lines of building based off a 2015 satellite imagery. Therefore, the digitized building roof forms may not be a true reflection of what currently exists in the city as various development projects, such as new construction and demolition of structures may have taken place since then.

Next, the 2D building footprint layer was extracted to show roof attributes such as gables slopes and building heights. This data processing stage was done by a different member of the research team using ArcGIS Pro. This member used the 2D building footprint layer, provincial lidar point cloud data (source: Land Information Ontario), and the building roof form extraction tool package to extract simplified level of detail (LOD 2) 3D multipatch polygons. These extracted polygons had the following relevant characteristics and attributes: building height, eave height, roof form. The 3D feature layer, saved as "3D Building Footprints", was published to the University of Waterloo AGOL account after checking for potential errors.

The final data layer, sample properties polygons, were identified and selected for simulation purposes for this study. The identification of sample vacant properties for the study was done using two feature layers: parcels of land feature class database of the city (source: City of Stratford), and the 2D consolidated building footprint of the city, in ArcGIS Pro. First, these two feature layers were intersected to filter for parcels without buildings. Next, the filtered parcels were vetted using aerial imagery to identify and eliminate parcels that were either too small or of irregular shapes (e.g., less than 0.06 ha) and therefore may not be suitable for land use development. This step yielded about 30 eligible sample properties. A site visit was also undertaken by the research team lead to inspect the site for suitability and to take photos (to be included as an attachment to sample properties). These attached photos were dated as properties may have undergone development changes after the day the photos were captured.

To ensure geographical representation, a variety of land use designations and select a suitable number of parcels for the study, the researcher purposely selected seven parcels for the research. The former Grand Trunk Railway Locomotive Repair shops, a property that has been identified by the city for redevelopment, was also selected as a sample property for the study. This brought the total number of sample properties to eight, and subsequently labeled as Site 1 to Site 8. The final selected sample properties, saved as ‘sample sites’, was published to the University of Waterloo AGOL environment as a feature layer.

Figure 3-2 Sample properties in map

In the University of Waterloo AGOL, the attribute table of the 'sample sites' was edited (eliminating irrelevant fields and adding relevant fields): site number, site address, land use zoning, additional information, lot size, image attachment and date of image. Address of the properties were determined from the Shaping Stratford website (accessed June 2020). The zoning information was acquired through a review of the City's Official Plan. 'Other details' were acquired through viewing the properties in google maps. Site images were obtained through site visits by the research lead. These attributes reflect both property and neighborhood details of the sample properties, relevant for urban infill and intensification land use processes.

Table 3-2 Property and neighborhood information of sample properties

Site No. (Address).	Current Land use/lot size in ha	Zoning	Notable properties and land use in proximity
1 (207 St. Patrick St.)	Vacant/0.29 ha	**Residential.** Permitted uses: residential, commercial, industrial, institutional	"A Hundred Church Street Bed and Breakfast", Mr. Sub, residential neighborhood, etc..
2 (91 Erie St)	Parking Lots and Garages (Erie St. Parking Lot)/0.62 ha	**Downtown Core.** Permitted uses: residential, commercial, industrial, institutional	Stratford City Hall, Sinclair Pharmacy, Bijou Restaurant, TD Bank, CIBC, etc.
3 (350 Downie St)	Unoccupied Industrial (Former Grand Trunk locomotive repair shops)/4.61 ha	**Downtown Core**. Permitted uses: residential, commercial, industrial, institutional	A railway line, University of Waterloo Stratford Campus, Chesterfield Warehouse, residential neighborhood
4 (3 GUELPH ST)	Vacant (Former location of a neighbourhood bar recently torn down.)/ 0.24 ha	**Commercial**. Permitted uses: Residential uses (only boarding house), commercial uses, religious, institution.	Old Grand Trunk Railway locomotive repair shops, Playmakers Theatre School, Downie Street Bakehouse, etc.
5 (126 Ontario St)	Parking Lots and Garages/0.06 ha	**Downtown Core**. Permitted uses: residential, commercial, industrial, institutional	The Milky Whey, Mercer Hall Hotel, Balzac's Coffee Roasters, etc.
6 (360 Railway Ave)	Vacant Industrial/0.49 ha	**Commercial** Permitted uses: agricultural equipment sales or rental establishment, business or professional office, factory store, veterinarian clinic.	Thai Hut Restaurant, Erie Drive In Restaurant, Mike's Bowling Lanes and residential properties.
7 (209 Waterloo St S)	Vacant Commercial/0.07 ha	**Downtown Core**. Permitted uses: residential, commercial, industrial, institutional	Old Grand Trunk Railway locomotive repair shops, Stratford-Perth Family YMCA, Chesterfield Warehouse, residential properties, etc.
8 (175 Waterloo St S)	Religious Organizations (Currently vacant as church building is demolished)/ 0.32 ha	**Downtown Core** Permitted uses: residential, commercial, industrial and institutional	Old Grand Trunk Railway locomotive repair shops, Jeanne Sauve School, Duggan Place, Buckingham House, residential properties.

3.4.1.1 Infill Planner design and development

After the preparation of the datasets, the tool functionality and component design were developed. In this section, the design components and functionality are highlighted. The map-based web tool, *Infill Planner*, developed for the study can be described as a geo-questionnaire. A geo-questionnaire is a map-based tool designed to gather public inputs and comments which have explicit and/or implicit spatial relationship (see Chapter 2). *Infill Planner* was developed to investigate the research questions identified in Chapter 1. The first objective of designing and developing a map-based web tool, using data layers processed from previous section, is highlighted in the next set of paragraphs.

Accomplishing this objective facilitated the fulfillment of research questions and other objectives identified in Chapter 1. To visualize various design processes, procedures and components of Infill Planner, the AGOL-based architecture is presented.

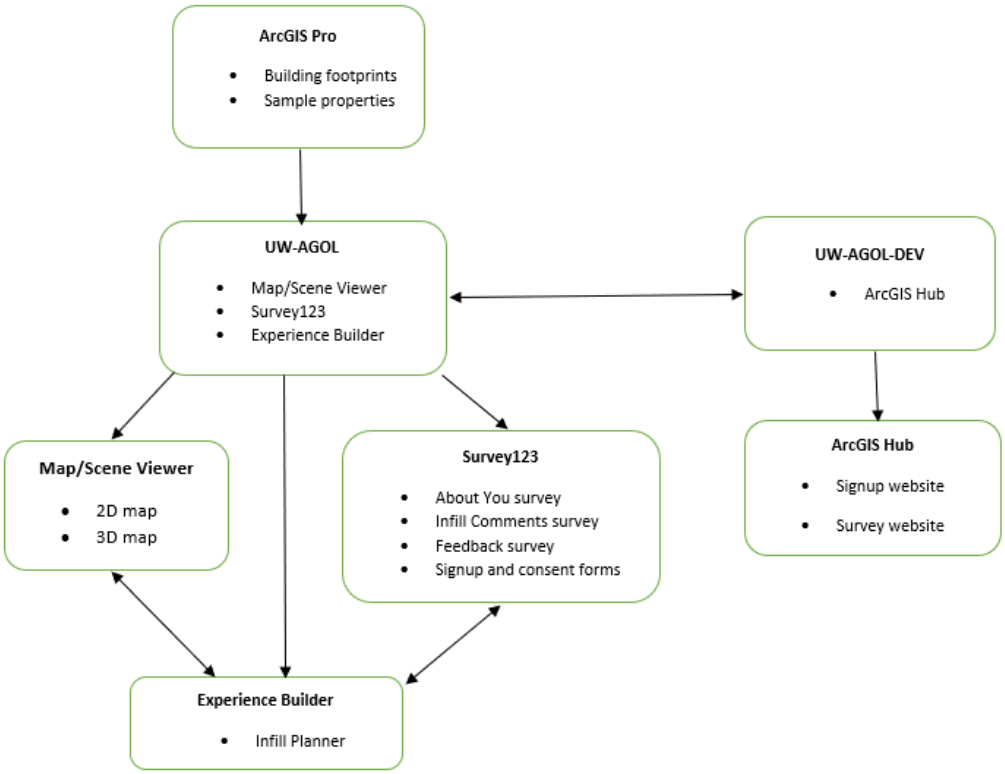

Figure 3-3 AGOL-based architecture

From the figure, two AGOL based environments, UW-AGOL and UW-AGOL-DEV, were used in this study. Two AGOL based environments were required to streamline the data collection process (i.e., creation of login credentials for study participants) as membership accounts could not be easily created for study participants in the main UW-AGOL environment. UW-AGOL-DEV was therefore established to manage users who were outside the main UW-AGOL environment, and to isolate the main UW-AGOL installation from the ArcGIS Hub add-on and to manage a licensing transition. A communication channel was established between the two AGOL environments: *Infill Planner* was designed, developed and made accessible to the UW-AGOL-DEV environment, which displayed the web tool in the survey website created.

Data processed from ArcGIS Pro (see Table 3-1) was published to the UW-AGOL environment. In this environment, the various design components of the web tool were developed. The 2D and 3D map views were created using the 'Map viewer' functionality and 'Scene viewer' functionality, respectively. The 'sample sites' and building footprint feature layers (both 2D and 3D) were datasets used in creating the map views. The 'sample sites' dataset was symbolized, labeled and configured (e.g., attribute information, distinguishable colors, and visibility range) to present property and neighborhood information in the map views.

The Survey123 application of the UW-AGOL environment was used to create three questionnaires/surveys component of the web tool. These surveys (About You, Infill Comments and Feedback) are elaborated in subsequent sections. Survey123 was also used in creating the signup and consent forms displayed in the signup website. Next, using the map views and surveys created, the Experience Builder software application was adopted to design and develop the Infill Planner geo-questionnaire web tool. This software application facilitates the creation of single-page or multi-page web tools by people with little to no coding/programming experience and is intuitively designed and deployed for different screen sizes. The key features and capabilities of the geo-questionnaire are elaborated in the next section.

Finally, in the UW-AGOL-DEV, ArcGIS Hub (an engagement platform) was used to create the survey website to recruit participants. This engagement platform was also used to create the survey website to display the *Infill Planner* web tool to be used by participants.

3.4.1.1.1 Description and features of *Infill Planner*

Infill Planner is a four-page geo-questionnaire created using the following functionalities afforded by ArcGIS Experience Builder (e.g., map, bookmark, survey, text, image, buttons, menu, section, and view navigations). The first page, *Introduction* page, provided a brief overview of the research by highlighting the concept of infill land use planning and expected workflow in using the web tool. The 2nd (*About You*) and 4th (*Feedback*) pages displayed the 'About You' and 'Feedback' surveys, respectively. These surveys are elaborated in the next subsection. The main page, *Map* page, is highlighted in Figure 4.

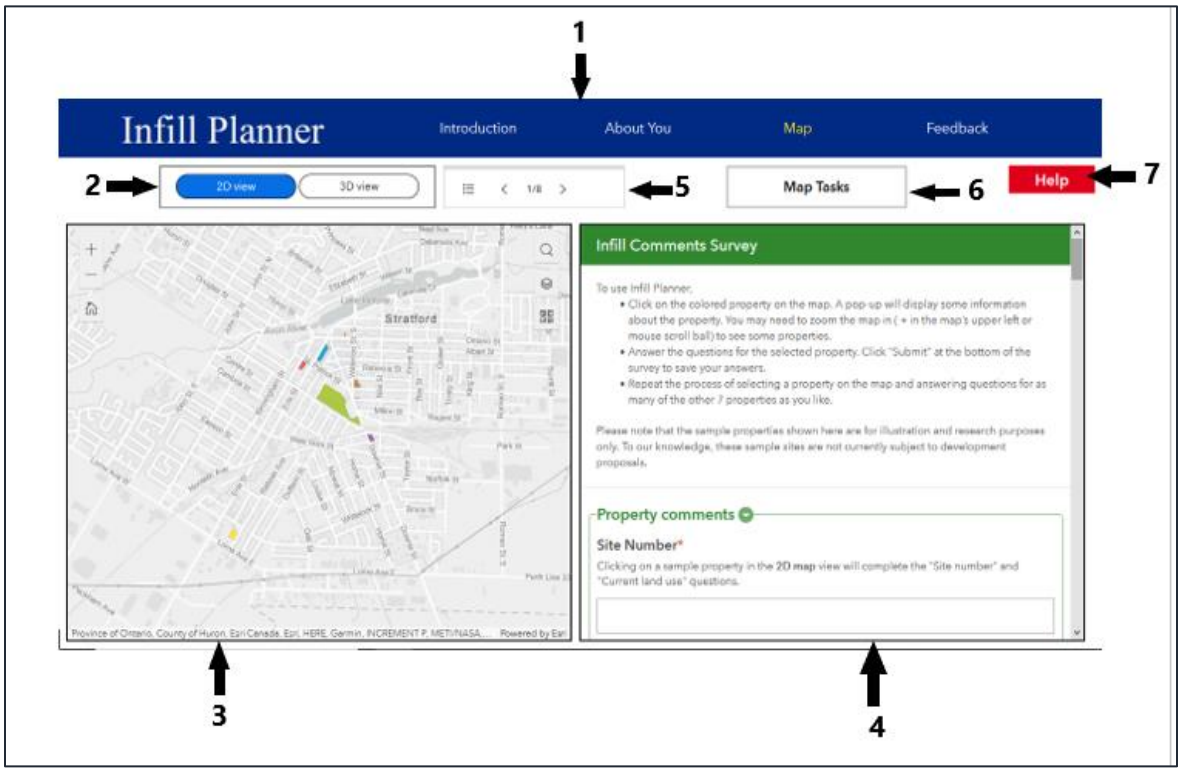

Figure 3-4 Map page

- Header (1): Displays the name of the web tool and menu bar to organize pages to enable users move from one page to another.
- Toggle button (2): Provides interactive access to the 2D and 3D map views. This enables users to switch between the two map views.
- Map views section (3): Displays the 2D and 3D map views created in Section 3.2. The "sample sites" feature layer is linked to the survey on this page to facilitate data collection. These map views were also in sync in terms of map extent. Therefore, actions that change map extent (e.g.,

zooming in and out, panning, home button) done in a map view is automatically done in the other map.

- Survey section (4): Displays the Infill Comments survey. Field/questions connections were established between the "sample sites" feature layer in the 2D map and "Site Number" and "Current Designated land use." questions in the "Infill Comments" survey. Thus, when a sample property is clicked in the 2D map, the survey question is automatically answered using the corresponding attribute of the sample property. This survey is highlighted in the next section.
- Bookmarks list (5): Stores spatial bookmarks, that is, all the eight sample properties, in the 2D map. This was to enable the easy identification of the sample properties. When a sample property is clicked from the bookmark list, the map views automatically zoom in to focus on the selected property.
- Map tasks button (7): Opens a window page that displayed steps, instructions and map actions users of the Infill Planner web tool were expected to perform.
- Help button (8): linked to a page that provided a description and features of the **Map** page, and features and tools of the 2D and 3D maps. This was to assist users in effectively utilizing the web tool.

3.4.1.1.1.1 Survey instruments

The surveys were developed and included in the web tool as the primary data gathering mixed method approach. Both close-ended and open-ended questions were included in these surveys to address the research questions. The close-ended questions provided contexts to questions and respondents an option to quickly select from a pre-defined set list of answers, including likert scales. These questions are answered more quickly and easy to analyze quantitatively. Several questions in the three surveys were close-ended. Five open-ended questions were included in the design of the surveys. This type of questions, which enabled participants provide answers in their own words, was selected to seek unique, insightful, and in-depth responses and to provide an opportunity for respondents to further elaborate on answers to preceding questions.

As previously described, the surveys designed in the study was a mixed-methods approach to obtain complementary qualitative and quantitative data using both open-ended and close-ended questions. The use of dichotomous or multiple choice close-ended questions facilitated easy data collection and analysis as respondents did not have to spend a lot of time in providing answers and provided easy

quantifiable insights. The open-ended questions were designed s to seek further insights about respondents' choices to preceding close-ended questions. For example, respondents were asked to further elaborate on why they preferred selected land use(s) on a vacant property. They also provided insights about respondents' opinions and feedback about the use of the web tool.

Questions in each of the surveys were thematically grouped. The "About You" survey which sought to provide context to survey data, comprised of close-ended questions (either using a 5-point likert scale or a list of pre-defined options). See Appendix A. These themes include demographic and personal details (i.e., age, gender, educational qualifications, and location of residence), familiarity and interest in city development and planning, including urban infill and intensification, and location of residence/reference location. The overall objectives of the questions in this survey sought to achieve the following:

I. Analyze demographic distribution of users of Infill Planner.

II. Ascertain participants' familiarity with land use planning processes.

III. Understand if opinions and inputs provided vary amongst neighborhoods.

The Infill Comments survey was created to be submitted by respondents up to of eight times, with each submission linked to one sample property. See Appendix B. Field/survey connections were established between two of the survey questions (i.e., "Site number" and "Current land use designations") and the 'sample sites' feature layer in the 2D map view, such that survey responses (based on relevant attributes of the 2D feature layer to respond to questions) were automatically provided when the user clicked on any property in the 2D map. The remaining questions in this survey were informed by literature review relating to spatial attributes and dimensions of public input that can be solicited during land use planning and determinants of land use choices: existing place values, future development preferences, site and situation factors considered in determining land use preferences and the perceived impacts of these choices. These were mainly close-ended questions, that is, a set list of options, informed by the geographic and socio-economic characteristics of both Stratford and the sample properties. The overall objectives of these questions, directly tied to RQ1 in Chapter 1, were to: 1) identify what site (property) and situation (neighborhood) factors are considered in determining land use options, and 2) reactions and perceived impacts of the nature of infill.

Questions in the Feedback survey were also thematically grouped, comprising mainly of close-ended (both likert scale and a pre-defined list of options) and two open-ended questions. See Appendix C. These themes include willingness to participate in future land use planning processes, and design features of the web tool. The questions sought to achieve the following aims:

I. Analyse the capacity and interests of users of the tool to participate in future land use planning processes (to answer RQ3).

II. Determine which design features of *Infill Planner*, i.e., data visualization of geographic features, relevant property and neighborhood information needed to inform land use options, and the use of map-based methods, do participants find useful and that which can be improved (tied to RQ3).

3.4.2 Preliminary field testing of *Infill Planner*

To ensure and enhance the performance and functionality of *Infill Planner*, students from the University of Waterloo were selected as part of a field testing of Infill Planner. These students provided comments and feedback on the tool design which were reflected to make relevant changes to improve user experience.

3.5 Implementing *Infill Planner* as a tool to solicit public feedback.

Testing the effectiveness of *Infill Planner*, in terms of its design and functionality, was important to understand how the web tool can be used as an approach to gather public feedback pertaining to infill planning processes. An in-person workshop would have been more suitable in testing the web tool as this provides flexibility of interaction with participants and quickly identifying the effectiveness and performance of the web tool. However, due to the COVID-19 pandemic, Infill Planner was deployed virtually and accessed by recruited participants remotely.

3.5.1 Workflow

As part of the design features of the web tool, participants were expected to provide feedback using surveys and/or linked interactive maps focused on addressing research questions identified in Chapter 1. Participants were expected to perform three main tasks in the use of the web tool, in the following sequence: “Complete About You Survey” (performed on About You page), “Explore and Comment on up to 8 sample sites using linked maps and surveys” (Performed on Map page) and “Complete Feedback Survey” (performed on Feedback page). The first task sought insights into participants demographic characteristics and familiarity with city development and infill planning. For task 2, participants considered property and neighborhood information, using the interactive maps, in determining future land use of the simulated sample properties. This task was directly connected to addressing the first research question. The final task solicited feedback directed towards assessing the willingness of users

to participate in the future (research question 2), the design and functionality of Infill Planner (research question 2).

Figure 3-5 Workflow

While tasks 1 and 3 (completing surveys) were straightforward, the Map Tasks button (see section 3.3.1.2.1) was created on the Map page to guide users of the web tool in undertaking task 2. Under task 2, users of the web tool were expected to perform various map actions (select sample property in map, review property and neighborhood information, view site images, etc.) and provide infill comments.

3.6 Recruitment of participants

Residents of the City of Stratford, Ontario, were initially identified as the target audience for this study as their subjective insights, familiarity, and experiences with the city's geography, economic and cultural history would provide valuable inputs in addressing the research questions identified in Chapter 1. However, due to the global COVID-19 pandemic, and the subsequent restrictions imposed, it would have been a challenge to recruit and engage residents in the research through in-person approaches such as workshops. For convenience, the target audience was therefore shifted to students from the Faculty of Environment, University of Waterloo. The criterion for identifying this target audience was based on the demographic most likely to contribute to planning processes using online tools and techniques. Evidence shows that the demographic representativeness of people who participate during public interactions using online tools is far greater in the 15 – 34 age group than any other age group. This can be attributed to access to digital skills and literacy (Jankowski et al., 2016).

Students, both undergraduate and graduate, are likely to fall within the 15 – 34 age group. Also, their academic backgrounds suggested an interest in environmental processes including land use planning and community development. Admittedly, there was a great likelihood that student participants may not be familiar with the subjective environmental qualities of the geographies and socio-cultural characteristics of the city (e.g., property values, place values). However, this was not critical as the

sample properties were selected for tool evaluation and simulation purposes (and therefore not known to be subject to pending development approvals). Also, background information regarding these sample properties (e.g., zoning regulations and neighborhood information) were provided to enable participants understand the property and surrounding neighborhood characteristics. Hence, they would be able to provide relevant information needed to address the research questions. Due to the COVID-19 pandemic, students were virtually and remotely approached in April and May 2021 using recruitment slides, emails, letters, and videos.

Recruitment of participants was done in two phases. The first phase involved using recruitment materials to inform the target audience about the research. These recruitment materials had a link used by interested participants to access a signup website. This website had three sections – description of the research study, Letter of Information (including rights of participants) and a consent form (see Appendix D). After reviewing the description of the project and letter of Information on the signup website, interested participants were required to provide their consents to participate in the research study. Participants who agreed to participate were then prompted to provide their email addresses. They were also encouraged to use email addresses not associated with the University of Waterloo. In the second phase, generic usernames and passwords were emailed to participants who provided their email addresses. These login details (username and password) enabled participants have access to a survey website, which had the web-mapping tool, Infill Planner. Both the signup and survey websites were created using ArcGIS Hub. A total number of 31 students signed up to participate in this research.

3.7 Summary

This chapter identified the City of Stratford as a case study for implementing *Infill Planner* as a tool to support public interactions during infill land use planning. It described the methodology behind the preparation of spatial datasets required and the subsequent creation, design and development of *Infill Planner* using ArcGIS Experience Builder. Finally, the research design and workflow in recruiting participants was elaborated. The next chapter presents research findings from the survey.

Chapter 4
Results and Discussion

4.1 Introduction

This chapter presents data gathered from users of the *Infill Planner* geo-questionnaire. Results from the survey data gathered from the questionnaires/surveys component of the web tool are presented and discussed in the following order: Section 4.2 presents the demographic and background characteristics of respondents. Sections 4.3 and 4.4 analyzes and discusses findings based on the research questions outlined in Chapter 1. Survey submissions gathered had a limitation; some survey responses were unmarked with the generic usernames of participants. The final section highlights this limitation and how it was addressed.

4.2 Demographic and Background Characteristics

Table 4-1 below presents demographic and background characteristics for 28 participants, representing a response rate of 90%. Participants were evenly distributed between males and females in terms of gender. All respondents were aged between 18 – 44, with majority falling specifically within the 25 – 34 (71.4%) age group, and minority within the 35 – 44 (10.7%) and 18 – 24 (17.9%) age groups. When asked about the highest level of education attained, approximately 93% of respondents had a postsecondary certificate, diploma, or degree (Bachelor's, Master's, etc.). At least 3 out 4 respondents expressed some high, that is 'very' and 'extremely', levels of interest in community planning and development issues. However, despite the high levels of interest in community planning and development issues, approximately 90% of respondents revealed they never, rarely, or occasionally provide feedback to the city on planning and development issues. "Unaware of the opportunity" and "Time constraints" were the most indicated factors that hindered provision of feedback by the respondents. These factors may be attributed to poor publicity (Laurian, 2004) or the costly (in terms of time and space requirements) nature of the methods of participation such as public meetings (Kahila-Tani et al., 2016).

Table 4-1 Participants' background and demographic characteristics

Theme	Modality	Total	%
Age	below 18	0	0.0
	18 – 24	5	17.9
	25 – 34	20	71.4
	35 – 44	3	10.7
	above 44	0	0.0
Gender	Male	14	50.0
	Female	14	50.0
	Other	0	0.0
	Prefer not to say.	0	0.0
Highest level of Education	No certificate, diploma, or degree	0	0.0
	Secondary (high) school diploma or equivalency certificate	2	7.1
	Postsecondary certificate, diploma, or degree (Bachelor's, Master's, etc.)	26	92.9
	Apprenticeship or trades certificate or diploma	0	0.0
	Prefer not to answer	0	0.0
Residency in Stratford.	Yes	0	0.0
	No	28	100.0
Level of interest in community planning and development	Not interested	0	0.0
	Slightly interested	1	3.6
	Moderately interested	5	17.9
	Very interested	11	39.3
	Extremely interested	11	39.3
Frequency in providing feedback on city planning and development issues in the past	Never	7	25.0
	Rarely	9	32.1
	Occasionally	9	32.1
	Often	3	10.7
	Always	0	0.0
Factors inhibiting provision of feedback on city planning and development issues	Unaware of the opportunity	15	53.6
	The issues were not of importance to me/lack of interest.	4	14.3
	Time constraints	11	39.3
	Complicated and intimidating environment and process	4	14.3
	Other	4	14.3
Familiarity with the concept of urban infill and intensification	Not at all familiar	1	3.6
	Slightly familiar	5	17.9
	Somewhat familiar	4	14.3
	Moderately familiar	9	32.1
	Extremely familiar	9	32.1
Witnessed higher density land use developments in the past	Yes	25	89.3
	No	3	10.7

Notably, none of the participants resided in Stratford, Ontario and this was very evident in responses in survey data gathered, especially in terms of familiarity and values associated with the sample properties. Survey responses, particularly relating to the themes of highest level of education attained,

age, residency, interest in community planning and development issues, and familiarity with the concept of urban infill and intensification, can be said to be largely influenced by participants being students recruited from the Faculty of Environment, University of Waterloo who may be mildly interested in the research topic and/or the tool and not the subject area.

4.3 Property-related submissions

A total number of 137 property-survey (Infill Comments survey) submissions were recorded. However, three of these survey submissions could neither be linked nor grouped, based on proximity of timestamps, to a respondent, and were subsequently removed from the survey data records, leaving a total number of 134 property survey-submissions to be analyzed. This total number of submissions (134) were provided by 28 survey respondents, representing a response rate of 90%. Participants in the study were tasked to provide property-related comments for up to the eight properties selected for simulation purposes in this research. 3 respondents commented on a single property, 4 commented on two properties, 5 on three properties, 2 people each commented on either 4, 5, 6, or 7 properties and finally, eight respondents commented on all eight properties.

An average of approximately 16 submissions were received for each site ranging from 12 submissions (Site 7) to a maximum of 27 submissions (Site 3). Figure 6 shows the distribution of submissions per site. Although not solicited as part of the survey questions, the researcher speculates two reasons for the differentials in submissions per site. 75% of the top 4 submissions per site (above the average number of submissions per site), that is Sites 3, 2 and 8, either had respondents indicating at least some form of place importance or were amongst the top 4 largest sites (in terms of lot sizes) in the map views, amongst all the eight sites, and therefore caught the attention of respondents.

Figure 4-1 Submissions per site

The eight properties, selected for simulation purposes for this research, are of varying land use designations and current use, property and neighborhood qualities and located across different parts of the city of Stratford, Ontario. As part of property-related submissions, participants responded to questions regarding associated place importance/values with the properties, preferred future land use of the properties, property and neighborhood factors that should influence future land use choices and the perceived impacts of their choices (see Appendix B for questions). Results from these submissions are captured and discussed in the sub-sections below.

4.3.1 Indicated place attachment and importance.

For each property commented on, respondents identified the importance or place attachment they associate with the selected property. The place values options presented in the survey reflect the socio-economic and cultural characteristics of the city, as well as property and neighborhood qualities. Respondents could indicate more than one associated place value. The results are captured in the table below.

Table 4-2 Indicated place attachment.

Place Values	Site 1 (n=14)	Site 2 (n = 19)	Site 3 (n=27)	Site 4 (n=17)	Site 5 (n =14)	Site 6 (n=14)	Site 7 (n=12)	Site 8 (n=17)
This site is currently a parking space that I use.	0%	5%	0%	0%	0%	0%	0%	0%
I use this site as a non-commercial parking location.	0%	5%	0%	0%	0%	0%	8%	0%
This open space provides an opportunity for casual recreation/Park/natural scenery.	21%	0%	7%	0%	0%	0%	0%	18%
I have associated some personal attachment and belonging to this site (e.g., cultural/heritage, social value, religious significance)	0%	0%	11%	0%	0%	0%	0%	18%
The site is of no importance to me.	64%	89%	74%	88%	100%	86%	92%	65%
Other non-defined uses/importance	14%	0%	15%	12%	0%	14%	0%	18%

From the table above, it can be observed that generally, respondents do not have any form of place attachment or associated with nor any familiarity with the properties, as at least 65% respondents indicated “The site is of no importance to me” across all the properties. Also, low values, of approximately less than one-fifth of respondents for each property, are observed where some form of place values/importance are indicated. This observation is expected as none of the participants lived in Stratford, Ontario (see Table 4-1).

Place values and importance influences willingness of people to participate and/or contribute to processes that could alter or bring about changes to existing perceived environmental qualities (e.g., compatibility of land use change with existing neighborhood). This is captured by Devine-Wright (2012) and Lewicka (2011). These studies identify that people who have attachment to a landscape are more likely to observe, become more interested and be aware of possible future changes to environmental qualities, and thus more likely to be involved or participate in related processes (e.g., town-hall meetings, protests) to either support or oppose any future changes. In this study, however, the interest of participants in contributing to this simulated planning process is not a function of place

attachment but rather an interest in the research topic (i.e., urban infill and the use of a web map tool), given participants academic background, as respondents do not possess local knowledge to 'effectively' contribute to urban changes. This is captured by a respondent who expressed the importance and role of local knowledge, including familiarity with the neighborhood, in determining future land use options.

> "*Based on the survey, neighborhood compatibility is a big factor for me and this was hard to judge without satellite view. However, this may have been less of an issue if I was actually familiar with the community."* – Infill User 32

4.3.2 Future land use preferences

Future land use preferences of respondents are aggregated and presented here to identify land use preference consensuses of respondents. It must be noted that respondents could indicate more than one land use preference for each property. To explore agreement and disagreement for each property, the responses were examined in terms of the most considered land use option(s), the collective agreement level, and the diversity of indicated land use preferences using the Simpson's Diversity Index are highlighted. Herein, the most considered land use options would be referred to as "Endorsed land use", the agreement level referred to as "Indicated Preference Score" (IPS), and the Simpson's Diversity Index referred to as Diversity Index (DI). Also, comparisons of preference for the development of property as against no developments and subsequently used to identify potential for land use conflicts are presented.

Approval voting was used in determining the "Endorsed land use" option for each property. With this method, 'voters' select or approve a subset of options (i.e., can approve multiple options) from a universal set, and the option with the most votes considered as the preferred option (Pacuit, 2019). For example, a group, consisting of 7 people, were to determine the group's preferred choice between two options labeled as A and B. Each person was permitted to select either one or both options. 5 people selected option A, while 6 people selected option B. Based on approval voting, option B is the group's preferred choice. Here, a land use option is considered as the "Endorsed land use" if selected by 50% + 1 of total number of respondents for each property. A property can therefore have more than one endorsed land use.

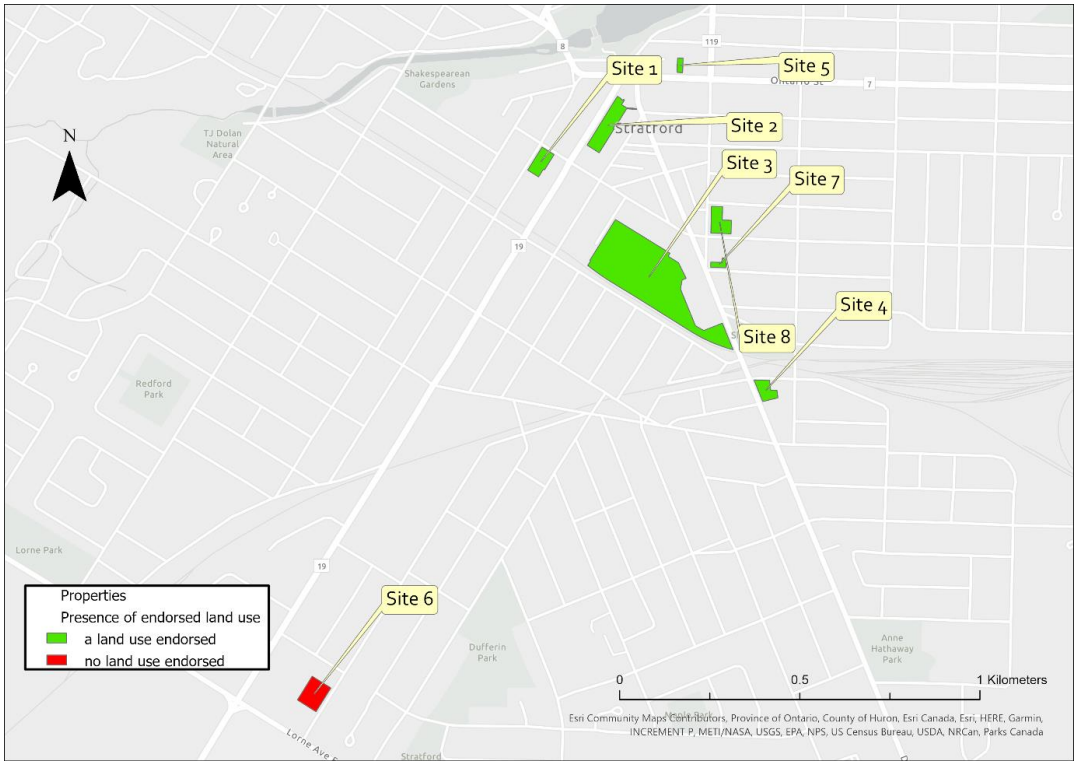

Figure 4-2 Presence of an "Endorsed land use."

Figure 7 shows properties that have endorsed land uses based on the condition identified. All properties have a land use endorsed except Site 6 which had an IPS of 36% for the most considered land uses - 'Medium to high density residential' and 'Commercial'.

Next, the table below shows the endorsed land uses, IPS and the DI for all properties. IPS, for a given property, is computed based on the total number of times a land use option is preferred and expressed as a percentage of the total number of respondents for the given site. See Appendix E for the table of IPS of all land use options for all the eight properties. Simpson's Diversity Index (DI) is a measure of diversity adopted in the field of ecology that considers the number of species present, as well as the relative abundance of each species. As species richness and evenness increase, so diversity increases (Barcelona Field Studies Centre, 2021). This can be adopted to measure the diversity of an opinion on an idea over a geographical location, in this case, the diversity of land use preferences for various landscapes. The resulting index is a value or ratio that ranges from 0 (complete uniformity) to 1 (complete diversity). For a given property, the DI is computed as follows:

$$DI = 1 - \frac{\sum n(n-1)}{N(N-1)}$$

Where n is number of times the land use option is selected, and N is the sum of all indicated land use options related to the property.

Table 4-3 Endorsed land uses.

Site No.	Endorsed land use	IPS	DI
1	Medium to high density residential	64%	0.834
2	Commercial	63%	0.806
3	Medium to high density residential	56%	0.822
4	Commercial	76%	0.809
5	Commercial	57%	0.827
6**	Medium to high density residential and Commercial	36%	0.897
7	Commercial	67%	0.831
8	Religious	71%	0.807

** Did not meet 50% + 1 condition.

In the table above, 7 out of 8 properties had one land use endorsed. From the land use options presented to respondents, 'Medium to high density residential', 'Commercial' and 'Religious purposes' were endorsed for at least one of the properties. 'Medium to high density residential' was endorsed for Sites 1 and 3. 'Commercial' endorsed for Sites 2, 4, 5 and 7. Finally, an overwhelming 71% of respondents on Site 8, considered and preferred the said property to be used for 'Religious purposes' in the future. Only Site 6 had no endorsed land use, as the highest considered land uses, 'Medium to high density residential' and 'Commercial', had an IPS of 36%. Generally, the high DI values show that several land use options were considered viable, even though just a single land use option garnered the most support for several sites based on the "50% + 1" condition.

Next, to compare preference for the development of properties as against no development to ascertain potential for land use conflicts, land use options presented to participants and considered as "to develop" include low density residential, medium to high density residential, commercial, religious, industrial, and institutional. The "not to develop" land use option is open space. The land use option, "no change – leave as it is", was considered as either "to develop" or "not to develop" depending on the property's current state in terms of being vacant or not. For instance, if the current state of a property is vacant, 'no change – leave it as it is' will be considered as "not to develop". All the sites, except Site

3, are vacant properties. “Other” numerical values were ignored as preference for development (or otherwise) could not be determined.

Potential for land use conflict for each site was calculated using the method identified by Brown and Raymond (2014). This method operationalizes development preferences as an indicator of conflict potential. Using this approach, a Conflict index, *C,* was computed by first, ascertaining the number of indicated preferences under each category, i.e., “to develop” or “not to develop”, and then using these values to assess potential for land use conflicts.

This ratio/level of agreement or *C,* ranging between 0 and 1, is calculated using the smallest number of indicated preference as the numerator and largest number as the denominator. *C* closer to or equal to 1 represents low levels of agreement (high conflict potential). The reverse, i.e., *C* closer to or equal 0 represents high levels of agreement (low conflict potential). The class breaks used are based on four equal divisions, interval of 0.25, from 0 – 1:

- Lowest – $C \leq 0.25$
- Low – $0.25 < C \leq 0.5$
- High – $0.5 < C \leq 0.75$
- Highest – $C > 0.75$

Table 4-4 Conflict Index

Properties	Conflict Index
Site 1 (n=14)	0.364
Site 2 (n= 19)	0.292
Site 3 (n = 27)	0.255
Site 4 (n=17)	0.37
Site 5 (n =14)	0.389
Site 6 (n = 14)	0.3
Site 7 (n = 12)	0.105
Site 8 (n = 17)	0.25

From the above table, all eight properties had support for development and not to be maintained as vacant properties. Aside from having support for future developments, low levels of potential for land use conflicts/high level of agreement can be observed across all the sites. The least value of *C* is recorded in Site 7 with a score of 0.105, and the highest value in Site 5 (score of 0.389).

Land use preferences of respondents aggregated and presented in this subsection, i.e., endorsed land uses for each property and the preference for future development projects, highlight a general support for urban densification and future higher density developments. All the properties in this study are either vacant/under-used or being used as parking lots and garages. However, respondents largely suggested that these vacant properties/parking lots be developed in the future and not left in their current under-utilised states. This is especially encapsulated as the endorsed land use for various properties were mainly intensive land uses, that is, "Commercial" and "medium to high residential density" uses. The "Low density residential uses" land use option was barely considered. Two respondents are quoted as follows:

> *"Using the space for residential will improve the housing stock in the area and attract new residents"* – (Infill User 16 on site 6).

> *"I believe that this site could be either used for intensification purposes to cater for the current increasing demand for living spaces (increasing the number of available residential units) … "* – (Infill User Y on Site 1)

Significantly, this supports findings in existing literature. A study undertaken by Holleran (2020) identifies that Millennials (persons aged between 24-35) have positive attitudes towards higher density development, including mixed-use developments, and support urban intensification strategies. Parallels can be drawn between this study and the study by Holleran (2020). Participants in both studies, expressing support for compact developments, have some high level of education, and are aged between 24 – 35, highlighting the lack of class diversity of participants.

4.3.3 Property and neighborhood factors that influence land use decisions.

This sub-section focuses on issues that respondents identified to inform land use decisions. The tables below present descriptive statistics of these factors.

Table 4-5 highlights the responses related to site-specific issues that should inform future land use decisions. The weighted average is the mean of percentage values of a given property factor across all properties which has been adjusted to reflect the different number of times a property was evaluated. Property factors least considered (with average less than 50%) include property values and the emotional bonds linked to various landscapes. Site-specific factors considered most (average of 50% and above) include zoning regulations, proximity to transportation options, physical conditions of properties, and the potential of new land use to change how people feel about the neighborhood/community.

Table 4-5 Property factors considered in determining land use options.

Property Factors	Site 1 n=14	Site 2 n=19	Site 3 n=27	Site 4 n=17	Site 5 n=14	Site 6 n=14	Site 7 n=12	Site 8 n=17	Weighted Average
Values of Land/site/property	43%	63%	44%	41%	43%	36%	42%	53%	**46%**
Current City zoning and official land use designations	50%	37%	52%	71%	50%	43%	42%	53%	**50%**
Proximity/distance to transport routes (e.g., roads, bus terminals, highway, transit, etc.)	71%	58%	74%	71%	64%	71%	67%	53%	**66%**
The site's physical factors and characteristics (e.g., lot size, shape, slope, etc.)	57%	63%	67%	59%	43%	71%	67%	65%	**62%**
The emotional bonds or attachment people have to the site.	29%	21%	37%	18%	21%	29%	50%	71%	**34%**
The potential for the new land use to change how people feel about the neighborhood.	71%	58%	70%	41%	43%	43%	75%	47%	**57%**
Other	0%	0%	0%	6%	7%	7%	0%	0%	**2%**

Outlier values, either significantly higher or lower than the weighted mean, can be identified across property factors considered. For example, significant dispersions from the weighted average of the property factor, "The emotional bonds or attachment people have to the site" (34%), can be identified in Site 4 (18%) and Site 8 (71%). This variation is interesting especially as background information pertaining to potential existing place attachment values were provided for Sites 4 and 8. Site 4 was described as a former location of a neighbourhood bar recently torn down, and Site 8 as a former location of a church building recently torn down. Other outliers can be seen across the property factor, "The potential for the new land use to change how people feel about the neighborhood". At least 70% of responses related to Sites 1, 3 and 7 indicated that potential of new land use to alter how people feel about the existing neighborhood should be considered.

Neighborhood factors considered by respondents are presented in the table below. Here also, the weighted average represents the computed mean of all values of a given neighborhood factor across the properties, adjusted to reflect the different number of times a property was evaluated. Neighborhood (or situation-specific) factors highly considered (average above 50%) include compatibility of land use with surrounding land uses, impact on neighborhood walkability, environmental impacts of preferred land use project, and neighborhood characteristics and identity. Neighborhood factors least considered (average less than 50%) include existing vehicular traffic flow, property values, and presence of service utilities and amenities.

Table 4-6 Neighborhood factors considered in determining land use options.

Neighborhood Factors	**Site 1 n=14**	**Site 2 n=19**	**Site 3 n=27**	**Site 4 n=17**	**Site 5 n=14**	**Site 6 n=14**	**Site 7 n=12**	**Site 8 n=17**	**Weighted Average**
Compatibility of the property's future use with surrounding/neighborhood land uses (e.g., aesthetics, zoning regulations)	71%	79%	81%	94%	79%	71%	75%	82%	**80%**
Existing vehicular traffic flow/Road network	43%	47%	56%	35%	43%	21%	33%	29%	**40%**
Impact of the site's proposed land use(s) on neighborhood walkability	64%	58%	67%	59%	43%	57%	50%	53%	**57%**
Environmental impacts of proposed land uses (e.g., noise pollution) on neighborhood	79%	37%	74%	47%	36%	64%	42%	35%	**53%**
Property values in the neighborhood	29%	21%	19%	29%	7%	7%	33%	24%	**21%**
Neighborhood characteristics/identity (e.g., demography, cultural/heritage)	86%	68%	70%	47%	43%	64%	75%	82%	**67%**
Presence of service utilities/services (e.g., transport, schools, gas, electricity, medical centres)	57%	42%	63%	29%	21%	43%	42%	41%	**44%**
Other	0%	0%	4%	6%	0%	0%	0%	0%	**1%**

Significant dispersions from the weighted mean can also be observed for some values of neighborhood factors considered. For instance, responses related to Site 4 had almost one-fifth more over the average for the neighborhood factor, "Compatibility of the property's future use with

surrounding/neighborhood land uses (e.g., aesthetics, zoning regulations)". Other significant dispersions from the weighted average of the neighborhood factor, "Neighborhood characteristics/identity (e.g., demography, cultural/heritage)" (67%), can be identified in Site 1 (86%) and Site 5 (43%).

Property and neighborhood factors that were selected frequently by respondents to be considered in determining land use preferences support existing literature related to determinants of future urban growth and land use options. These include legal and planning legislations (Puustinen & Viitanen, 2015), and environmental impacts (Petrova, 2016; Doberstein et al., 2016). Others include compatibility with surrounding land uses including physical qualities, aesthetics and walkability (Aly & Attwa, 2013; Poelmans & van Rompaey, 2010) and socio-economic impacts (Petrova, 2016; Devine-Wright, 2012; Scally & Tighe, 2015).

Details of properties, using pop-up text boxes, were presented to participants to help them understand property and neighborhood characteristics. Participants could also get further insights from the map views to further appreciate site and situational characteristics (e.g., proximity to transport routes). However, the background information presented, as well as contextual details that could be ascertained from maps, were not extensive and only covered the following themes: zoning, proximity to transport routes, and physical features of subject properties. This information can be described as *objective* factors. Beyond these *objective* factors, other background details are relevant in determining future land use options. These include specific place attachment values, traffic flow and movement, and existing property values in an area of interest. These are referred to in this study as *subjective* factors and issues, which can not be easily ascertained by people without local knowledge or experience relating to the property of interest.

An observation can be made between factors (i.e., property and neighborhood) that were highly considered, and factors least considered. Respondents in this study had little to no knowledge (and attachment) about the properties, and therefore could only consider *objective* descriptive data made available to them either via pop-up details and/or geographical features in map views. The reverse is observed for factors with little information presented such as the emotional attachments of residents to the properties, as respondents could not easily ascertain these qualities (also had no local knowledge), and thereby barely considered them. Significantly, this observation suggests and hypothesizes that people only consider *objective* factors and/or issues that they have knowledge of either through information presented to them and/or local knowledge in determining future land use options.

Two of the most considered property and neighborhood factors in the aggregated land use preferences (or endorsed land uses – see Section 4.4.2) are described here. First, there was a strong tendency for respondents to assign land uses that aligned or agreed with official zoning designations. This observation is captured in an open-text response by Infill User 43:

> *"Infill development on this site should reflect that zoning by either using the site as commercial, medium to high residential (promoting intensification of the core, and surrounding uses), or institutional/public buildings (core location enables accessibility, also site is close to UW Stratford campus)."* - (Infill User 41 on Site 3).

Agreement levels with zoning for the properties were computed based on the number of respondents that preferred a land use, related with official designated land use, expressed as a percentage of the total number of respondents for a given property. The future land use options presented to participants were classified under the official land use designations as follows: Residential (low density and medium to high density residential), Commercial (commercial, industrial purposes), Institutional (institutional and religious purposes) and open space. The official land use for Site 1 is "Residential". All others are "Commercial".

The map below illustrates the assessment of the levels of agreement with zoning, in the following classes:

- Inadequate levels – ranging from 0% to 25%
- Weak levels – ranging from 26% to 50%
- Moderate levels – ranging from 51% to 75%
- Strong levels – above 75%

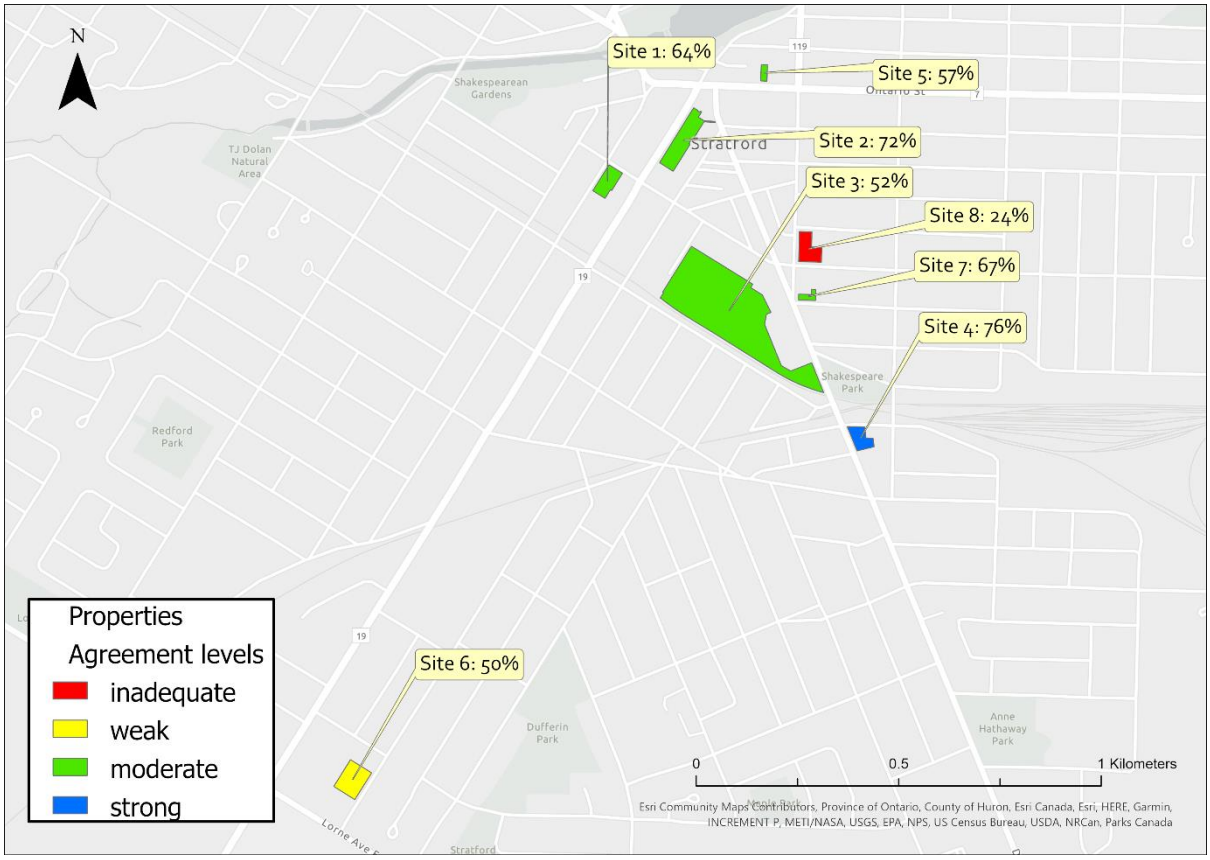

Figure 4-3 Agreement with zoning.

From the above figure, six out of eight properties recorded either moderate or strong levels of agreement to land use zoning - Site 4 recorded a *Strong* level of agreement with zoning and Sites 1, 2, 3, 5 and 7 recorded a *moderate* agreement level. These findings suggest that zoning and compatibility of future land use options with surrounding land uses are of priority to respondents in the determination of future urban growth. This can be attributed to the academic backgrounds of respondents. Respondents, students recruited from the Faculty of Environment, were likely to urban planning students who were presupposed to consider that official zoning designations are appropriate factors in determining future land uses in the absence of contradictory information. This is captured as the most favored/endorsed future land use option of respondents, non-residents of the city, for six out of the eight properties are consistent with the existing official land use designation.

Neighborhood characteristics and the potential for the suggested land use to alter place values are factors that can also be seen reflected in land use preferences. This is especially observed in survey responses related to Site 8. The endorsed land use for this property, “Religious purposes”, had the

highest IPS (71%) amongst all the properties (see Section 4.4.2) and *inadequate* agreement levels with zoning (see figure 8). In the web tool, this property was described as a former location for a church building that was recently demolished (*objective* information presented to participants). Respondents expressed a strong sentiment and preference for the continued use of the site for religious purposes to preserve any associated place values formed, as 12 out of 17 respondents stated considering potential associated values to the site as a factor to consider in determining future land uses for the site. This is expressed by respondents below:

> *"…[maintaining] this usage function could also help to preserve the character of the area and promote the local heritage and/or emotional attachments on the part of residents."* – (Infill User X)

> *"Using the space for church/mosque or open space would still maintain the people sense of place and attachment."* – (Infill User 16)

4.3.4 Impacts of land use preferences.

Finally, participants were asked to perceive or assess the impacts of their preferred land options to the existing neighborhood or environment. The results are summarized and captured in Table 4-7.

The first three impacts in the table are perceived positive impacts of land use preferences and the next three being negative impacts. The last column of the table is the weighted average of all values (to reflect the differences in number of property evaluations) of a perceived impact across the properties. Values, either significantly higher or lower than the weighted average, can be identified. For instance, significant differences from the weighted average of the perceived impact, "Preserves/improve neighborhood characteristics (e.g., aesthetics, walkability, social interactions, cultural/heritage value, etc.)" (69%), can be identified in Site 4 (35%) and Site 8 (94%). A similar pattern was observed under Section 4.4.3 where existing emotional bonds was frequently considered in survey responses related to Site 8 and least considered for Site 4.

Table 4-7 Perceived impacts of land use choices.

Perceived Impacts	Site 1 n=14	Site 2 n=19	Site 3 n=27	Site 4 n=17	Site 5 n=14	Site 6 n= 14	Site 7 n=12	Site 8 n=17	Weighted Average
Increase the population and/or economic density of the neighborhood.	71%	63%	81%	65%	50%	79%	75%	65%	**69%**
Potential improves property values in the neighborhood.	64%	47%	52%	76%	43%	43%	75%	47%	**55%**
Preserves/improve neighborhood characteristics (e.g., aesthetics, walkability, social interactions, cultural/heritage value, etc.)	64%	79%	78%	35%	57%	71%	58%	94%	**69%**
Negatively influences neighborhood identity/characteristics.	0%	11%	19%	6%	0%	29%	17%	6%	**11%**
Potentially reduces property values in the neighborhood.	7%	5%	11%	0%	7%	29%	8%	12%	**10%**
Increases traffic volume and flow.	21%	32%	48%	41%	43%	36%	33%	24%	**36%**
Other	0%	5%	4%	0%	7%	7%	8%	0%	**4%**

Respondents generally believe that their preferred land use choice contributes positively to existing neighborhood and environmental qualities. For instance, high values are consistently observed for the impact "Increase the population and/or economic density of the neighborhood" across all the eight properties. This supports the results and findings presented in Section 4.4.2 where participants in this study are described to be in support of higher density or urban infill developments.

Also, respondents believe their options either preserve or improve neighborhood features as an average of 67% indicated this positive impact and an average of 11% believing otherwise. The positive perception of their land use preferences on the existing neighborhood or situation is effectively reflected under Section 4.4.3 as zoning regulations, compatibility with surrounding land uses, neighborhood identity and potential to change how people feel about the community are among the most frequently considered property and neighborhood factors in influencing future land use options.

There is a possibility that the impacts, "Potentially reduces property values in the neighborhood" and "Increases traffic volume and flow" recorded low values because respondents lacked the local

knowledge to assess these impacts. Under Section 4.3.3, property values and traffic flow and volume were described as *subjective* factors that were least considered in determining land use choices. Therefore, with little/lack of information or local knowledge possessed by participants about these *subjective* situational characteristics, respondents were unable perceive impacts of their choice in this regard.

4.4 Lessons from the design and implementation of *Infill Planner* to support urban infill.

In this section, findings from feedback on the design and implementation of *Infill Planner* are presented. The next three paragraphs describe findings, and significance to literature, relating to tool design, willingness to participate using map-based tools in the future, preference of data visualization techniques, and efficiency of screen sizes in performing web-based tasks. Next, a table is also presented to summarize lessons from the design and use of *Infill Planner* in this study.

At a broader level, descriptive statistics of survey data revealed that, approximately 90% of respondents either 'agree' or 'strongly agree' to future participation in the provision of feedback during city planning processes. Also, two-thirds of users of *Infill Planner* expressed willingness to participate in planning processes in the future using map-based web tools. These results may seem significant in supporting findings made by literature pertaining to willingness of respondents to share spatial information and knowledge using online mapping methods (Rzeszewski & Kotus, 2019; Sieber et al., 2016) and the capacity of online tools in attracting wider audiences, especially demographics that find traditional engagement approaches unattractive (Jankowski et al., 2017; Rzeszewski & Kotus, 2019). However, the drawback with findings made in this present study is that, in terms of methodology, it did not consider other alternative approaches. For instance, interests of participants in using map-based tools in the future were not weighed against other non-map-based approaches (e.g., focus groups). The results, compared to literature, may therefore be likely biased.

In terms of comparisons of data visualization techniques, i.e., 3D and 2D spatial data visualization, there were no strong preferences for either viewing techniques. The lack of strong consensus on preference of data viewing techniques may be attributed to various reasons: incompatible web browsers, lack of clearly defined comparative tasks, indifference or equal preference for both data viewing techniques. These reasons are expressed by some respondents as follows:

> "*The 3D visualization tool did not work for me - maybe I did not give it enough time to load [display].*" – (Infill User 34)

> "*I'd like a combination of both, to be able to view the neighbourhood and existing uses in 3-d, while assessing the potential for land use conversion/ infill development*." – (Infill User 20)

> "*I really did not compare the two.*" – (Infill User 23)

Finally, participants were asked to use the web tool on large screen devices, that is desktop and laptop computers for maximum user experience and efficiency. Out of a total of 27 survey submissions (response rate of 87%), 26 participants used a large screen device (i.e., desktops or laptop computers) to undertake required web-based tasks in using *Infill Planner*. Participants were asked to rate the efficiency of performing web-based on large screen devices using a likert scale ranging from "Strongly disagree" to "Strongly agree". All 26 respondents either "agree" or "strongly agree" to performing required tasks efficiently on large screen devices. However, these findings, including preference of data visualization techniques, can be significantly improved, and assessed through comparative studies similar to Adepu and Adler (2016) and Jankowski et al. (2017).

Next, a table is presented to capture and summarize what users identify as useful design and implementation components of *Infill Planner* in providing feedback on infill planning. This table also captures comments from respondents that relate to improving the design of the web tool for future use.

Feedback of participants relating aspects of infill planning processes not covered in the web tool, preference of data visualization techniques, as well as the design components and performance of tasks considered useful, and that which needs improvement were used in generating the table. Survey responses were coded into three different categories representing different levels (from broader labels to specifics). "Theme" captures ideas and comments that are related at a higher level (Planning issues and process, Tool design and functionality, and user experience). "Sub-theme" comprises of finer issues that can be identified under the first category. The final category identifies specifics and insights at a detailed level. Sample quotes are also provided to represent ideas captured in the categories.

Table 4-8 Feedback from users of *Infill Planner.*

Theme	Sub-theme	Details	Sample Quotes
Planning issues and process	Provision of detailed background / contextual information about study area	Implications of new projects (e.g., social equity)	*Environmental impacts; e.g. how the development would impact air, water and soil quality; hydrological implications; implications for climate change adaptation objectives; implications for equity within the neighbourhoods.* – Infill user 42. *There was nothing about social justice and equity. For example, we are unable to say what the socio-demographic features of the people near the infill development are. Are they racial minorities? Low-income households?*- Infill user 15. *My willingness to participate, at least at the neighbourhood/city level, would be contingent upon receiving some sort of notification or invitation from my municipality to participate in the process.* – Infill user 32 *This task actually allowed me to appreciate infill planning and to know the considerations involved when considering to change the designated land use for a specific area.* -Infill user 24
		Population and demographic character (e.g., age, race)	
		Cultural and social importance of subject area (e.g., heritage)	
	Procedural Aspects	Goals of planning process	
		Flexible/remote participation	
		Publicity	
	Education	New knowledge and insights gained about the planning process (e.g., planning procedures, zoning)	
Tool design and functionality, user experience.	Survey Questions	Logical and coherence of questions (e.g., relevant number of questions asked)	*The tool provided the opportunity to answer questions in a variety of manners (e.g., descriptive options, text boxes) which feels more comprehensive from the respondent's point of view.* – Infill user X. *This tool was user friendly and easy to use which is really important. I liked that it provided multiple levels of visualization, the map, and the image. Additionally the descriptions provided were helpful. The questions were useful and helped me think about my suggestions.* - Infill user 33 *Very simple to use and it presented the information in a clear manner.* – Infill user 40.
		Different types of questions (e.g., use of open and close-ended questions)	
	Data visualization	Multiple data visualization techniques (e.g., photos, street views, 2D and 3D views)	
		Easy identification of data layers (e.g., use of color coding to represent zoning)	
	Technical requirements	User-friendly, intuitive, technical considerations (e.g., web browser requirements)	
	Tasks required	Tasks required from users of the web tool should be coherent and easy to understand (e.g., assistance in filling some survey questions if possible)	

Planning issues and process focuses on the presentation and of the planning problem under consideration, and publicity of the engagement process. Specifically, this focuses on how information presented in the web tool facilitated/can be used to facilitate the understanding and appreciation of various concepts (e.g., property and neighborhood information of subject area) needed to both encourage participation and make informed decisions relating to land use preference. This includes provision of detailed contextual information (e.g., perceived impacts of new planning projects, demographic characteristics, etc.) of subject areas. Finally, at a broader level, *Infill Planner* educated, and enabled participants gain insights about the processes involved in infill planning especially as approximately 75% of respondents either "agree" or "strongly agree" to the statement, "My knowledge on urban infill and intensification has increased."

Tool design and functionality focuses on the design components of the web-map tool which have implication on planning contexts and organizational capacity, e.g., users' capacity and experience in utilizing the tool in providing feedback (Babelon et al., 2017).This theme highlights the design of survey questions, data visualization in map views, ease of use, and other technical considerations. These designs potentially influence user perceptions and feedback solicited. For instance, a carefully designed questionnaire simplifies data collection, while also allowing participants to express themselves in elaborating their choices. Also, the use of different data viewing techniques such as 3D and 2D maps, photos, videos, etc., provides additional visual contextual information to understand certain aspects of property and neighborhood details such as density and vibrancy of subject areas.

4.5 Survey Data Limitation

As described in the previous chapter, recruited participants were assigned generic usernames (i.e., infill user 1, infill user 2, etc.) and passwords to access the *Infill Planner* web tool to provide survey submissions. Each survey submission is marked with the time and date of the submission(s), and the respondent's generic username. However, in some of the survey submissions, usernames of respondents were not captured along with the other user records. As described in Chapter 3, two separate AGOL environments, i.e., UW-AGOL and UW-AGOL-DEV, were used in this study to isolate the main UW-AGOL installation from the ArcGIS Hub add-on and to manage a licensing transition. The UW-AGOL was used to develop the web tool, and the UW-AGOL-DEV for the creation of login credentials and displaying of the web tool. To facilitate data collection, a communication channel was established between the two AGOL environments by making the web tool developed in the UW-AGOL

environment accessible to the UW-AGOL-DEV environment, which displayed the web tool in a website created.

However, if a user deviated from the provided instructions, it was possible for the user to access *Infill Planner* directly via its URL without being prompted to login, thus bypassing the established login protocols. Possibly, participants might have initially logged into the survey website using the established protocol and then switched to a different web browser (by copying and pasting the URL of the web tool in a different web browser) due to the possible challenge of the initial web browser's failure to effectively display components of the web tool (e.g., 3D map). Some respondents indicated addressing this challenge by switching web browsers. By doing so, usernames were not captured in survey submissions made where respondents directly accessed the web tool via its URL. Survey submissions without usernames were observed across all three surveys: About You survey – $2/28$; Infill Comments survey – $28/137$; and Feedback survey – $7/27$.

Based on the proximity of timestamps (i.e., dates and times) associated with each survey submission, two observations and a subsequent assumption could be drawn from the survey submissions. First, a respondent's survey submissions may be marked with the username in a survey (e.g., About You survey) and unmarked in another survey (e.g., Feedback survey). Second, in instances of multiple submissions with the Infill Comments survey, some survey submissions had usernames captured, while others did not. With these two observations, an assumption was made: survey responses with timestamps in close proximity (across the three surveys and/or instances of multiple submissions) were deduced to have been submitted by a participant whose username had been captured in a survey submission around that same period. Based on this assumption, survey submissions without usernames were thus associated to various participants by their usernames. Also, two sets of survey records which could be grouped based on proximity of timestamps but could not be effectively associated to a user record were labeled as "Infill user X" and "Infill user Y". All but three survey responses were associated to various usernames. Survey data, with either initially or deductively marked user records, were aggregated, and analyzed to answer the research questions guiding this study.

4.6 Summary

In this chapter, demographic and background details were presented. Next, participants' survey responses were grouped and analyzed to identify place importance, land use preferences, factors considered and perceived impacts of land use choices. Feedback from user of the *Infill Planner* web

tool was also summarized and presented. Finally, limitations associated with survey data gathered were highlighted.

Chapter 5
Conclusion

Map-based web tools are increasingly being accepted in planning practice and research to solicit public feedback on various urban planning strategies. As these tools are rapidly being deployed in varying forms and designs, it becomes essential to understand what works, how, and in which planning contexts (Babelon et al., 2016). This thesis sought to explore the use of map-based web tools during urban intensification planning contexts, and to understand how the public considers both site (i.e., property) and situation (i.e., neighborhood) factors when considering potential infill developments. Two main research questions and three research objectives were identified and addressed in the thesis (see Chapter 1). As part of the research objectives, a map-based web tool (or geo-questionnaire), *Infill Planner,* was designed and developed to solicit comments and feedback from users. First, this concluding chapter evaluates the research questions that guide the thesis. Further, it highlights implications of findings. Focus is also placed on the use of map-based web tools as a participation method. Directions for future research and limitations of the study are also presented. The section then culminates with some closing remarks.

5.1 Evaluation of research questions.

Research Question 1: What property-related issues (e.g., property size, place bonds, compatibility of land use, etc.) and neighborhood-related issues (traffic impact, neighborhood revitalization, place bonds, etc.) do people consider in providing comments pertaining to urban intensification?

Analysis of the results revealed significant findings that participants were broadly in support of future higher density developments of the subject properties in the city. Property-related and neighborhood-related issues considered in providing comments pertaining to urban intensification include zoning regulations, proximity to transportation options, physical conditions and characteristics of properties, and potential of new land use to change how people feel about the neighborhood/community. Other issues considered were compatibility of land use with surrounding land uses, impact on neighborhood walkability, environmental impacts of new projects and neighborhood characteristics and identity.

Issues not considered include property values, emotional bonds linked to various landscapes, existing vehicular traffic flow, and presence of service utilities and amenities. Significantly, the issues considered by participants in providing comments were described as *objective* factors, as they could be

easily assessed, by respondents from background details provided regarding each property, in providing comments pertaining to future land use preference and assessments of perceived impacts of land use choices. Respondents may not have considered certain background details and issues (e.g., property values and traffic flow) – *subjective* – not presented in the web tool in providing comments related to urban intensification. In response to the research question, a suggestion and hypothesis is presented from this thesis: People consider issues that they have knowledge of and/or can be ascertained, either through information presented to them and/or local knowledge, in providing comments pertaining to urban intensification.

Research Question 2: What web map-based tool designs of Infill Planner do users consider useful in providing comments on infill planning projects? What other tool designs do they consider useful? Are users of Infill Planner willing to use similar map-based tools in the future?

Study participants, who can also be described generally as millennials or a youthful age group, expressed interest in sharing spatial information during planning processes using map-based tools in the future. They also expressed greater efficiency in using large screen sizes to perform tasks required in this study. No strong preference was given to either the 2D or 3D data map views. Caution must however be stated in the conclusive use of these observations. These preferences were not weighed against other related alternatives, similar to comparative studies. For instance, participants did not compare efficiency in using large screens to smaller screen sizes.

A table was also presented to capture and summarize comments on the design features of *Infill Planner* that users considered to be of utility, and that which could be improved. The table is divided into three different categories that captures different levels of details and supported by sample quotes. Lessons are captured and enumerated below:

1. Detailed background and contextual information about subject property and surrounding regions should be provided. These, among other things, should include potential economic impacts of projects, existing cultural and social importance, population, and demographic character of area (e.g., age, race, income levels).
2. As part of the procedural and implementation of web tools during planning strategies, goals of the planning process must be elaborated. Also, the planning procedure and participatory process must be publicized.

3. People should acquire new knowledge and insights about the planning process. This facilitates transparency.
4. Simple and user-intuitive web tools should be used to solicit feedback.
5. Multiple spatial data visualization techniques facilitate understanding of contextual information including density, city layout, etc.
6. Different techniques in soliciting public feedback (e.g., use of pre-defined options and open text commenting) facilitates the gathering of rich and in-depth data from participants.

These lessons are useful for the future design and implementation of engagement strategies that adopt online tools to solicit public feedback.

5.2 Implications of findings

Results and findings presented in this thesis have implications for planning practice and academia. As planning practitioners and academics are constantly looking for authentic dialogues among stakeholders to improve planning outcomes, several implications for planning practice and academia can be gleaned to facilitate and improve the design and implementation of engagement approaches during urban infill strategies. Implications for planning practice are first presented and followed by implications for research.

Planning practice in this context refers to experts, consultants and practitioners who are involved in roles and functions relating to public participation and carried out in organizational settings. These include municipal planning departments, political offices, public and private engagement institutions, and industry setups. Based on the hypothesis presented from this thesis, there are implications for the type of background details presented to the public to guide land use decisions. The factors presented in the web tool to guide decisions where seen reflected in land use preference consensus of respondents (e.g., agreement levels with zoning). It is imperative that detailed background information is presented to the public to assist with soliciting of useful and informed public feedback.

While the public may possess local knowledge useful in providing comments pertaining to urban intensification strategies, it may be unfamiliar about certain information associated with specific expertise (e.g., traffic flow impact assessment). For example, the public may be unable to gauge the environmental impacts of new developments, and thus unlikely to consider these impacts in choice of future land use. Consequentially, this may impact public comments, such as future land use preferences

and perceived impacts of choices, gathered. The provision of detailed site and situation factors, therefore, potentially facilitates the collection of insightful, informed, and useful public feedback. Planning practitioners may therefore have to assess and recalibrate the type of information presented to the public during engagement strategies.

Planning research and academia may also benefit from findings made in this study. Overall, findings and lessons from this thesis contributes to providing new insights pertaining to future academic inquiry into urban intensification topics. Future studies can test the hypothesis/suggestion presented in response to the first research question. Participants in this study where persons with little to no information/local knowledge about the study area. In applying this hypothesis, future research design can engage residents who possess more subjective and local knowledge and are more likely to be directly affected by future local changes. This would contribute to literature pertaining the role of local knowledge in community planning. Also, key lessons identified under the second research question can provide guidelines to future research studies that focus on the design and implementation of web tools during community development issues. Other opportunities that further exploratory studies can take are elaborated in the study limitation and future research direction section.

5.3 Map-based tools as a public participation technique.

This section reflects on how tools like *Infill Planner* can contribute to planning participation in planning contexts. This is done by identifying the levels and typologies of participation achieved by these tools, types of information solicited from citizens and the capabilities, training needs and skillsets of planners and citizens.

5.3.1 Participation levels and typologies achieved by map-based tools

The rating scale presented by Nelimarkka et al (2014) in identifying how online tools can achieve various levels of participation (IAP2, 2018) can be used to assess *Infill Planner*. The performance of the web tool is seen in the table below. Broadly, *Infill Planner* can be seen to perform well in the lower levels of the spectrum of public participation, that is *inform* and *consult*, and the reverse seen as the participation levels increase. *Infill Planner* provided a description of the simulated infill planning situation and context. Also, supporting materials, in the form of property and neighborhood details of the sites, were provided by the tool. These details were either in the form of text descriptions, images and geographical features acquired from reviewing the Official Plan of the City of Stratford, Ontario, map views, as well as site visits. Thus, by describing the planning problem and providing additional

information to support this description, *Infill Planner* was able to attain the first level of participation in the spectrum - *inform.*

Table 5-1 Rating Score of Infill Planner

Level of Participation	**Description**	**Points if feature is present**
Inform	A description of a societal problem is given	4
	Factual material is provided or linked to support the description of the societal issue	5
Consult	Submitting a new contribution is possible	4.5
Involve	Elected leaders or public administration can response to contributions	0
	The system can highlight which contributions are seen as important through a voting mechanism or other method	0
Collaborate	Participants can read each other's contributions.	0
	It is possible to comment on the contributions	0
	The interface supports the sense making process	0
Empower	A formal decision-making mechanism is implemented and promoted in the system	0

A key feature of *Infill Planner,* as a geo-questionnaire, was its ability to solicit new contributions and inputs from users in the form of survey submissions. Therefore, based on the rating scale, *Infill Planner* aids *consultation* by facilitating the submissions of new contributions and inputs. However, beyond these lower levels, *Infill Planner* performed poorly as the level of participation increased along the spectrum. This is partly attributable to the design of the tool, as well as the research designed as a simulated process. As a simulated planning process, elected leaders, or experts (e.g., planners) were not *involved* and comments submitted were not part of formal decision-making mechanisms (*empower*). Since *Infill Planner* was designed to ensure that each participant's comments were private, users were not able to read, comment on nor assess contributions made by others (*collaborate*). However, due to the lack of interactions between users, *Infill Planner* can be described to be promoting *independence* as inputs made were outside the immediate influence of other respondents (Rowe & Frewer, 2000; Kahila-Tani et al., 2016).

A review of the use of similar tools in real-life and practical planning situations also reveal similar patterns of performance based on the rating scale (e.g., see Kahila-Tani et al., 2016; Jankowski et al,

2016; Babelon et al., 2016). These map-based tools captured and reflected real-life planning situations (*inform*), as well as solicited inputs from the public (*consult*). However, the other levels - *involve, collaborate,* and *empower* - were not realized. This can be attributed to constraints, including planning contexts and the tool design, encountered. For instance, time constraints and planners' difficulty to utilize information gathered via these tools made it impossible to realize the *empower* level of the spectrum (Kahila-Tani et al., 2016). Also, it is generally difficult to assess the influence of public participation on planning outcomes, and therefore impossible to assess *empowerment* even for other methods of participation. Finally, the tools were not designed to facilitate interactions among the public and, between planning authorities and the public (*involve* and *collaborate*).

The level, *collaborate,* can however be facilitated through geo-discussions that combine a discussion forum with an interactive map and enables stakeholders to select and input map features, and link them with discussion posts (Jankowski et al., 2017). While this type of web tool potentially facilitates interactions (*collaborate*), a key criterion in assessing participation, *independence,* is compromised. Tools like *Infill Planner* can generally be described to facilitate lower levels of participation; however, Reed et al. (2018) argues that this still offers utility to planning processes. By rejecting normative assertions that participation should always aim for higher levels on a spectrum such as Arnstein's (1969) ladder, this engagement approach can help affected parties to be involved in a dialogue and to develop shared goals and coproduce outcomes (Reed et al., 2018).

The design and nature of map-based tools present, capture and gather information of spatial attributes and implications. By virtue of being a geo-questionnaire, *Infill Planner* captured and displayed referenced the City of Stratford by displaying its layout (building footprint), sample under-utilized properties and other geographical features (e.g., roads, waterbodies, etc.). This is more 'effective' in facilitating communication on topics centered with spatial qualities, include urban planning processes (e.g., urban infill). As compared to non-map-based methods, this method can be more 'effective' because it provides geographical contexts to enable the easy identification and analysis of spatial relationships to aid spatial planning. By providing a geographical context, this method lends itself to gather and measure qualitative, quantitative, and georeferenced information, representing users' experiences, evaluations, preferences, and values (Cziepkiewicz et al., 2018). It is important to note that these tools are used in lone settings (or supervised), where users submit inputs individually. As a result, data gathered are not subjected to group setting dynamics and deliberations and may not reflect group consensuses.

Overall, regarding power dynamics regarding the use of map-based tools, typologies, levels of participation and information solicited, planning experts and authorities still wield a lot of power in terms of initiating the participation, deciding on the planning issue to be deliberated upon and the design of the mode of participation. Nonetheless, utility can still be derived from the design and implementation of these tools in planning contexts. Consequentially, these tools should not be adopted as stand-alone options, but should rather be a part of wider toolbox of public participation methods available to stakeholders.

5.3.2 Factors to consider in implementing map-based web tools

Similar to other participation methods, various factors need to be considered in deciding the implementation of map-based tools as a participatory method. These factors can be viewed from two perspectives: the planners' capacity and the public's interest and skillsets. The first perspective looks at the organizational/institutional capacities of public institutions to initiate, design and implement planning processes. This is influenced by several factors including planners' skillsets, attitudes, and perceptions about online tools (Afzalan et al., 2018). This eventually shapes the preference of these tools as a participation method, their design features, subsequent effectiveness, and how inputs solicited using these tools are evaluated and incorporated in planning outcomes. For instance, a planning department with personnel not familiar with the design and implementation of these type of tools would be less inclined to adopting such tools as a participation method.

Web-based tools, like *Infill Planner,* are increasingly being adopted in real-life planning processes. It therefore becomes imperative that planners acquire and constantly improve their skills to design and use these skills effectively. Different skills are needed for data editing and developing tools like *Infill Planner*. These include spatial literacy and awareness, programming language skills, map creation, familiarity with web environments and GIS software applications, spatial data management (including creation, storage, and distribution), among others. The acquisition of these skills, especially programming skills, may seem daunting and intimidating.

However, current GIS software applications such as the ArcGIS Experience Builder platform used to develop *Infill Planner* provide an easy-to-use environment that requires almost no software coding skills with drag and drop UI development and straightforward survey design. These skills can also be nurtured in educational institutions by designing GIS-based curricula for students, thereby potentially equipping future planners with these skills, including the familiarity with web environments. In addition, the skills of current planners can be enhanced through continuous professional development

courses (e.g., conferences) to keep planners abreast with new innovations and inventions, and equipping planning departments with relevant technologies and software applications (e.g., software licensing and subscriptions).

The second perspective, capacity, and interests of public in the use of these tools, is equally important in its effectiveness as a participation method. This perspective focuses on the public or community's capacity such as citizens' characteristics and skills and their attitudes towards the use of these tools for participation. Societies are complex and made up of individuals and groups that differ in interests and capacities. These capacities influence the community's preference for and acceptance of these tool in providing inputs. Differences in capacities can occur across different dimensions including sociodemographic characteristics (e.g., age, level of education, income levels, race), digital literacy (e.g., access to and familiarity with technologies), and level of involvement with democratic planning and integration (Afzalan et al., 2018).

For instance, tools like *Infill Planner* are more likely to be used by well-educated communities due to their higher proficiency and familiarity with performing web-based tasks. Ultimately, the approach in the design and use of map-based participation tools should be considered as an 'art and science'. The 'science' aspect refers to the technical aspects (e.g., skills, design principles) needed to design and develop these tools, while the 'art' aspect are the socio-economic considerations made (e.g., planning problem, community capacity) in the use of these tools. This influences the effectiveness of these tools as a participation method.

5.4 Study limitations and future research directions

The research objectives outlined in the thesis were successfully fulfilled, however, some factors limited the scope and capabilities of the research conducted in this thesis. One main limitation the research faced was the creation of login credentials (i.e., usernames and passwords) for participants. Participants in this study could not be easily incorporated into the existing University of Waterloo (UW) ArcGIS Online (AGOL) environment without disrupting the operations of the UW-AGOL account. This raised technical issues as the *Infill Planner* web tool was developed in the UW-AGOL. To address this limitation, a lot of time was spent in the development of a new AGOL institutional account to facilitate the creation of the login credentials needed. Ideally, the web tool used in the thesis could have been redeveloped in the new AGOL account to establish a secure connection. Unfortunately, due to time constraints, the web tool was made publicly available in the UW-AGOL and hosted in the new AGOL.

However, this approach vitiated the secure nature of the survey-data collection process as the web tool could easily be accessed via its URL. This limitation is also described in Chapter 4.

Another limitation encountered was the impacts of the 2019 Corona Virus Disease (COVID-19) pandemic. Due to the global health effects associated with the disease, cities in Canada, including the study area, were placed under health quarantines for several months, thereby reducing the ability for people to travel and move about the city safely. As a result, this affected the research design as modifications had to be made in terms intended target population of the study, participant recruitment, and research questions to be investigated. The initial research design of the study aimed at engaging residents of Stratford, Ontario in the use of the web tool. Without the impacts of the COVID-19 pandemic, residents would have been recruited and engaged using in-person and physical approaches, public settings, more interactive and extensive methods such as face-to-face recruitment, public booths, workshops, in-situ use of the tool (use of the tool at the physical location of the property), and parallel 'non-tech-based approach' (i.e., paper maps).

Unfortunately, it was impossible to carry out the research using interactive in-person and public approaches. To address this limitation, the target audience was shifted to remotely recruit and engage students from the Faculty of Environment, University of Waterloo, as they were likely to be familiar with the use of similar online technologies and interested in community planning issues. It was anticipated that there would a great likelihood that the student population would not be familiar with the study area, and therefore, property and neighborhood details of each identified property were provided to aid in property assessments. This limitation associated with the impacts of COVID-19 subsequently affected the representativeness of participants and data gathered, thereby limiting aspects of the research questions that could be investigated. Given the participants unfamiliarity with the study area, data gathered did not reflect local knowledge and attachment to the study area and were more indicative of the information provided in the web tool. Consequentially, aspects of research questions such as the role of geographical discounting and the influence of place attachment on land use preferences (significant issues that influence public inputs on planning topics) could not be investigated effectively.

Also, the non-representative nature of participants of this study hindered the investigation of research topics relating to the community's capacity in using *Infill Planner*. Recruiting residents of Stratford, Ontario would have provided an 'ideal world' scenario where participants would have likely comprised of people with different socio-economic demographics and characteristics (e.g., age, race, education). However, given this biased nature of participants, it was difficult to explore, assess and

identify the relationships between different socio-demographic characteristics and willingness to use the similar tools in the future. The students were also more likely to be familiar with performing web-based activities. Thus, it was impossible to effectively investigate aspects of the research question pertaining to community capacity in the use of web tools (e.g., paper surveys v web surveys: which method is preferred by residents of Stratford). Finally, restrictions on movements imposed as part of the health quarantines, constrained the nature of the research to a remote form of participation only. This limited the research as relationships between perceptions of place qualities and public feedback could not be explored (i.e., comparisons of remote forms of participation to in-situ forms of participation). Specifically, what different types of information can be solicited from the public while perceiving property and neighborhood qualities in-person and at the site under consideration, compared to perceiving and assessing property and neighborhood qualities remotely.

The limitations described in the paragraphs above present opportunities for future research. With a more representative and diverse target population, engaging residents of a study area, and with health quarantines and restrictions of movements lifted, future research can take one of the following ways. First, by engaging residents, future research can further investigate the role of subjective issues (e.g., place attachment, geographic discounting) on public inputs relating to urban infill topics in mid-sized North American contexts. This would contribute especially to the growing literature on the concept of geographic discounting. Next, community capacity of people with diverse socio-economic characteristics should be investigated. This includes exploring preferences for different types of map-based methods (e.g., paper surveys versus web surveys), ability to perform web-based tasks, and investigating the impacts and influence of various data visualization and design techniques (e.g., 2D versus 3D) in presenting geographic information on public feedback. This would provide evidence to planning experts in the choice, design, and implementation of appropriate participation methods. Finally, future studies can seek inquiry about research topics relating to how different perceptions of site qualities and factors, such as in-situ versus remote tool use, influence public inputs. Given the proliferation of mobile devices, this has implications to broaden citizen participation in urban governance through mobile-participation (m-participation).

5.5 Concluding remarks

Web tools, including geo-questionnaires, can be operationalized to solicit public comments in the context of urban intensification strategies. These tools can be designed to gather feedback such as associated place values, development preferences, perceived impacts of choices, among others, at

varying scales and intensities using various data collection techniques. The use of web tools appears to be an appropriate context-sensitive strategy that can be applied during urban intensification planning strategies, and therefore, careful thoughts and deliberations should be given to the design and implementation processes of these tools. Further inquiries into the use of these tools, especially related to its assessment and utility to planning outcomes and decisions, will ensure a robust engagement method that will be of great importance to advancing the goals of public participation.

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Appendix A

About You survey

A. About You

1. What is your age?
    - less than 18
    - 18 – 24
    - 25 – 34
    - 35 – 44
    - 45 – 54
    - 55 – 65
    - Above 65
    - Prefer not to answer.

2. Please indicate your gender.
    - Male
    - Female
    - Other
    - Prefer not to say.

3. What is the highest degree or level of education you have attained?
    - No certificate, diploma or degree
    - Secondary (high) school diploma or equivalency certificate
    - Postsecondary certificate, diploma or degree (Bachelor's, Master's, etc.)
    - Apprenticeship or trades certificate or diploma
    - Prefer not to answer.

4. Do you live in Stratford, ON?
    - Yes
    - No

5. How long have you been a resident in Stratford, ON? (**Hint:** For purposes of this survey, you are a resident if your primary principal residence is located in Stratford, ON.) (This question is shown in the web survey if respondent selects “yes” to previous question)
    - 0 -1 years
    - 2 – 4 years
    - 5 – 10 years
    - 11 – 20 years
    - More than 20 years
    - Prefer not to answer.

B. Interest in / experience with city development and planning

6. Please provide your postal code. (This is to help us understand if opinions vary between neighborhoods)

7. How interested are you in land development and planning issues in your community?

Not interested	Slightly interested	Moderately interested	Very interested	Extremely interested

8. Within the past 5 years, how often have you provided feedback to the city on development or planning issues?

Never	Rarely	Occasionally	Often	Always

9. If you hardly provide feedback to the city on development or planning issues, what factors account for this? (Select all that apply).
    - Unaware of the opportunity
    - The issues were not of importance to me/lack of interest.
    - Time constraints
    - Complicated and intimidating environment and process
    - Other

C. Interest in / Experience with urban infill and intensification

10. Using the scale below, how familiar are you with the concept of urban infill and intensification? (Urban infill and intensification are approaches adopted by governments and municipalities to increase population and employment densities of urban areas. This is done through development of vacant lots, and redevelopment/conversion/expansion of existing properties to higher density uses)

Not at all familiar	Slightly familiar	Somewhat familiar	Moderately familiar	Extremely familiar

11. Within your neighborhood or city, have you ever seen an empty lot being developed or an existing building being converted/changed to a higher density use?
    - Yes
    - No

Appendix B

Infill Comments survey

To use Infill Planner,

- Click on the colored property on the map. A pop-up will display some information about the property. You may need to zoom the map in (+ in the map's upper left or mouse scroll ball) to see some properties.
- Answer the questions for the selected property. Click "Submit" at the bottom of the survey to save your answers.
- Repeat the process of selecting a property on the map and answering questions for as many of the other 7 properties as you like.

Please note that the properties selected here are for illustration and research purposes only. To our knowledge, the sample sites selected for this study are not being considered for development.

A. Place Perceptions

1. Site Number. (Clicking on a sample property in the **2D map** view will complete the "Site number" and "Current land use" questions.)

2. Current designated land use. (Clicking on a sample property in the **2D map** view will complete the "Site number" and "Current land use" questions.)

3. Is the selected property or its immediate surroundings important to you? Select all options that apply.

- This site is currently a parking space that I use.
- I use this site as a non-commercial parking location.
- This open space provides an opportunity for casual recreation/Park/natural scenery.
- I have associated some personal attachment and belonging to this site (e.g., cultural/heritage, social value, religious significance)
- The site is of no importance to me.
- Other non-defined uses/importance

B. Preferred Future Developments

4. What would you prefer this site to be used for in the future? Select as many options as appropriate.
    - Low density residential

- Medium to high density residential
- Commercial (e.g., retail, restaurants)
- Religious purposes (e.g., church, mosques)
- Industrial purposes (e.g., warehouses, factories)
- Open space (e.g., park, recreation facilities)
- Institutional and public buildings (e.g., government offices, education, etc.)
- No change – leave it as it is.
- Other

5. Please elaborate your answer for the question above.

6. What property-specific factors should be considered when choosing possible future land uses for the selected property? (Select all that apply)
   - Values of Land/site/property
   - Current City zoning and official land use designations
   - Proximity/distance to transport routes (e.g., roads, bus terminals, highway, transit, etc.)
   - The site's physical factors and characteristics (e.g., lot size, shape, slope, etc.)
   - The emotional bonds or attachment people have to the site.
   - The potential for the new land use to change how people feel about the neighbourhood.
   - Other

7. What neighbourhood-specific factors should be considered when choosing possible future land uses for the selected property? (Select all that apply)
   - Compatibility of the property's future use with surrounding/neighborhood land uses (e.g., aesthetics, zoning regulations)
   - Existing vehicular traffic flow/Road network
   - Impact of the site's proposed land use(s) on neighborhood walkability
   - Environmental impacts of proposed land uses (e.g., noise pollution) on neighborhood
   - Property values in the neighborhood
   - Neighborhood characteristics/identity (e.g., demography, cultural/heritage)
   - Presence of service utilities/services (e.g., transport, schools, gas, electricity, medical centres)
   - Other

8. How might your choice of future use of the property affect the surrounding neighborhood? (Select all that apply)
    - Increase the population and/or economic density of the neighborhood.
    - Potential improves property values in the neighborhood.
    - Preserves/improve neighborhood characteristics (e.g., aesthetics, walkability, social interactions, cultural/heritage value, etc.)
    - Negatively influences neighborhood identity/characteristics.
    - Potentially reduces property values in the neighborhood.
    - Increases traffic volume and flow.
    - Other

Appendix C

Feedback survey

Designed to gather feedback on infill and tool design.

A. Infill and Planning Questions

1. My knowledge on urban infill and intensification has increased.

Strongly disagree	Disagree	Neutral	Agree	Strongly Agree

2. I am likely to provide feedback on City planning and development issues on my street in the future.

Strongly disagree	disagree	Neutral	Agree	Strongly Agree

3. I am likely to provide feedback on City planning and development issues in my community/neighborhood in the future.

Strongly disagree	disagree	Neutral	Agree	Strongly Agree

4. I am likely to provide feedback on City planning and development issues in my city in the future.

Strongly disagree	disagree	Neutral	Agree	Strongly Agree

5. What aspects of infill were not covered in the previous survey?

B. Infill Planner Web-map Tool

6. What tasks/procedures/actions did this web-map tool, Infill Planner, allow you to do well?

7. What tasks/procedures/actions did this web-map tool, Infill Planner, need to be improved?

8. What type of device are you using for this study?
    - Mobile phone or tablet / iPad
    - Laptop or desktop computer

9. The device I am using enables me to perform required tasks easily and efficiently.

Strongly disagree	disagree	Neutral	Agree	Strongly agree

10. Will you prefer to use this same device to perform similar online tasks in the future?
    - Yes
    - No

11. The complementary use of an interactive map and survey enable me to incorporate more property and neighborhood factors in my responses to infill questions.

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

12. I prefer to provide feedback and comments on city development and planning issues using a similar map-based survey tool over using other non-map-based methods (e.g., open houses; focus groups; neighborhood forums; online forums; phone/mail/internet surveys; others)

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

13. I prefer the **2D** visualization (map view) of geographic information over the **3D** visualization (map view).

Strongly disagree	disagree	Neutral	Agree	Strongly agree

14. Please elaborate on answer provided in previous question.

Appendix D
Letter of Information and Consent form

Title of Study: "Web-mapping tools to gather public feedback about urban infill developments."

This research is being conducted by master's student, Robert Arku, under the supervision of Dr. Rob Feick, in the School of Planning, University of Waterloo. To help you make an informed decision regarding your participation, the paragraphs below describe the study, possible risks and benefits to you, and your rights as a research participant. If you do not understand something, please ask one of the investigators prior to consenting to the study.

The objectives of this research study are to investigate how web-mapping tools can help enhance citizen participation in community planning, with a focus on infill planning. Infill planning is a process adopted by local governments to develop under-used or vacant properties and to increase population or employment densities within established neighborhoods. A new map-based tool, Infill Planner, made up of surveys and interactive maps, has been developed to allow users to access data and provide feedback on future land uses for potential infill properties.

As part of this study, you will use the web mapping tool to complete a series of tasks. This will entail providing some background information about yourself, exploring selected sites in 2D and 3D maps, sharing your thoughts about how you expect selected spaces to be developed, and providing feedback on the tool itself. We estimate it will take 25 - 35 minutes to explore the sample infill sites, complete surveys on infill issues and provide feedback on the use of the web tool, Infill Planner. Your participation in this study is voluntary. You may decline to answer any questions that you do not wish to answer, and you can withdraw your participation at any time by not submitting your survey responses.

Your participation in this study will contribute to the design and development of online tools to facilitate citizen participation in land use planning processes.

There are no known or anticipated major risks from participating in this study. However, when information is transmitted over the internet, privacy cannot be guaranteed. There is always a risk that your responses may be intercepted by a third party (i.e., government agencies, hackers). University of

Waterloo researchers will not collect or use internet protocol (IP) addresses or other information which could link your participation to your computer.

Your participation in this study, and your identity will be confidential. Although we are asking for some information about you to provide background context to survey responses, when results are shared information will be grouped so your identity remains confidential. Your name or email address will not appear in any publication resulting from this study. However, with your permission, anonymous quotations may be used. In these cases, participants will be referred to as Participant 1, Participant 2, … (or P1, P2, …). Furthermore, the optional question that asks for your postal code will be used only to examine if survey responses vary between neighborhoods and with proximity to the sample properties. If you decide to participate in this research study, a generic username and a temporary password will be sent to the email address that you provide. The data, collected from this research study, will be stored on a password-protected computer database in a restricted access area of the university. We will keep our study records for a minimum of 7 years. All records are destroyed according to University of Waterloo policy. Only Robert Arku and his supervisor, Dr. Rob Feick, will have access to this information. The data may also be published in a professional journal or presented at scientific conferences, but any such presentations will be of general findings and will never breach individual confidentiality.

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE#42517). If you have questions for the Committee, contact the Office of Research Ethics, at 1-519-888-4567 ext. 36005 or ore-ceo@uwaterloo.ca.

For all other questions about the study, please contact either student investigator Robert Arku (rarku@uwaterloo.ca) or Principal Investigator Dr. Rob Feick (rob.feick@uwaterloo.ca). Further, if you would like to receive a copy of the results of this study, please contact either investigator.

Thank you for considering participating in this study.

CONSENT FORM

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE#42517). If you have questions for the Committee, you can contact the Office

of Research Ethics at 1-519-888-4567 ext. 36005 or ore-ceo@uwaterloo.ca. For all other questions, contact Robert Arku on rarku@uwaterloo.ca

I have read the information presented by: Dr. Rob Feick and Robert Arku, School of Planning, University of Waterloo.

I have had the opportunity to ask questions related to the study and have received satisfactory answers to my questions and any additional details.

I was informed that participation in the study is voluntary and that I can withdraw this consent by informing the researcher and not submitting my data.

Please provide your consent below. The email address you provide will be used to contact you to give you a generic username and password to access the survey website that has the web map tool.

Do you agree to participate in this study? *

Yes	No

Please provide your email address*. (We will follow up with you soon).

I agree to the use of anonymous quotations in any thesis or publication that comes from this research.

Yes	No

Appendix E

Indicated Preference Scores (IPS)

Land Use Preferences	Site 1 (n=14)	Site 2 (n=19)	Site 3 (n = 27)	Site 4 (n=17)	Site 5 (n=14)	Site 6 (n=14)	Site 7 (n=12)	Site 8 (n = 17)
Low density residential	14%	0%	0%	18%	0%	21%	25%	12%
Medium to high density residential	64%	32%	56%	35%	36%	36%	33%	35%
Commercial (e.g., retail, restaurants)	43%	63%	41%	76%	57%	36%	67%	24%
Religious purposes (e.g., church, mosques)	14%	5%	7%	12%	7%	21%	8%	71%
Industrial purposes (e.g., warehouses, factories)	0%	5%	19%	6%	7%	21%	8%	0%
Open space (e.g., park, recreation facilities)	43%	21%	44%	47%	14%	29%	17%	41%
Institutional and public buildings (e.g., government offices, education, etc.)	21%	21%	48%	12%	21%	7%	17%	24%
No change – leave it as it is.	14%	16%	4%	12%	36%	14%	0%	0%
Other	0%	5%	4%	0%	0%	7%	8%	0%