From Suburban to Urban

Increasing Density and Housing Adaptability
via Small-Scale Infill Development in
Medium Sized Cities

by

Jeremy Alexander Johnson

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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

The combination of the drastic rise in housing prices and the post-pandemic emergence of remote work, has resulted in population migration from densely populated urban centres to smaller scale suburban communities across Canada. These communities have faced the challenge of dramatic population growth alongside unprecedented increases in real estate prices.

One such community that has experienced an influx of resident migration post 2020 is Brantford, Ontario, located approximately one hour from Toronto. A challenge for Brantford as well as other suburban communities is how to integrate new housing into existing infrastructure while continuing to provide a variety of housing options for its population.

In response to population growth, cities often resort to developing single-use dwelling types that respond to narrow demographics and static stages of life. Examples of this are large single family homes, townhouses and condominium towers.

In response to the limitations of these common strategies, this thesis will investigate the ability of centrally located original neighbourhoods in medium sized cities to absorb population growth via small scale infill development. Brantford's historic Holmedale neighbourhood will serve as the location for this investigation as well as a template for similar neighbourhoods in comparable Ontario cities. The main objective of this investigation is to create building prototypes that increase density, mixed-use possibilities and housing options in low density residential neighbourhoods, as a strategy to increase affordability and residential density. The proposed prototypes will also endeavour to address the need for adaptive re-use to accommodate ever evolving neighbourhood demographics.

To support the feasibility of the prototypes, this thesis will employ a variety of methods. It will begin with a brief synopsis of Ontario's housing crisis, accompanied by reviews of topical literature, common housing typologies and development strategies. Following this, the research will investigate target demographics and identification of neighbourhoods that are best suited for densification. Subsequently, an investigation of design parameters will be conducted to understand constraints and resultant design opportunities. Once parameters are defined, the thesis will illustrate the design of six prototypes and explain their features. To enhance the credibility of these design proposals, a study in resultant densification statistics will be investigated, demonstrating the ability of the prototypes to absorb population growth in Brantford. The applicability of the prototypes will be tested in similar neighbourhoods in Cambridge, Kitchener and Guelph demonstrating their adaptability to a variety of locations experiencing similar housing challenges. Finally, the research will assess the financial feasibility of multiple prototype variations, demonstrating their capacity to provide a greater variety of financial options that enhance affordability.

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Preface: A Personal History of Home.

The following is a biographical preface that informs my ongoing interest in housing, its design, its meaning to our everyday life and its impact on our happiness and engagement with the built environment and the communities that inhabit them.

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I grew up in the suburbs of Brantford Ontario, but for me it was not the suburbs, it was just home and for the first part of my life it was great. As a child I spent my time biking around the neighbourhood with my friends, delivering the local newspaper and playing soccer at the park down the street. Then one day around the time I started high school, Brantford became very, very boring. Everything I wanted to do, like go to the movies or hang out at the mall was a car ride away. I yearned for the freedom that having my driver's licence would bring, so much so that I bought my first car (a 1989 Toyota Tercel), before I had my driver's licence. Being able to drive in the suburbs for my friends and I was the greatest expression of freedom. However, once the limits of my home town had been thoroughly explored via my barely road worthy Toyota, the restlessness and boredom returned. I could now drive, but it soon became painfully evident to me that there were not many places worth driving to in Brantford. My friends and I opted, when the opportunity arose, to leave Brantford whenever possible as it was seen as the place where fun went to die. By the end of high school, I was so bored of Brantford that my lone goal was to get out as soon as possible. And so that is exactly what I did, accepting an offer to the Carleton School of Architecture and moving to Ottawa with the intention of never returning.

Ottawa was not a booming metropolis in comparison to bigger cities like Toronto or Montreal, however in comparison to Brantford, it was an urban paradise. There were so many things to do and you did not need a car to do them. You could live within walking distance of almost every amenity and the walk was both safe and enjoyable. One of my favourite places that I lived in Ottawa was the *Golden Triangle*, a neighbourhood within walking distance to the Parliament buildings, sandwiched between Elgin Street, a pedestrian friendly, mixed-use commercial strip, and the Rideau Canal. I lived in a 400 sq/ft bachelor apartment located in what used to be a bedroom in a large 19th century, red brick, Queen Anne revival home that faced onto a park that was flanked on both sides by similar style homes. It was an ideal location for a single person to live, anything you wanted to do was at your doorstep. Coffee shops, small grocery stores, restaurants, bars, book stores, movie stores, gyms, parks, and walking paths along the canal. Additionally, although being a very cold city, Ottawa was bikeable. Anything that was not within walking distance was always within biking distance, including school and then

Figure 1:
91 Cartier Street, Ottawa ON, a former single family house converted into an 11-unit apartment where I lived from 2006 - 2008

eventually work. Although having a car was sometimes convenient it was never necessary and it was always more enjoyable to experience the city by foot or on my bike.

Learning about the benefits of human scaled urban environments at Architecture School as well as living in my first urban environment had a profound impact on me and my sense of how enjoyable the built environment could be. Returning to Brantford to visit family at that time was like returning to a dull dream of the past. I wondered why anyone would choose to live in a place like this. Family members would nudge my girlfriend (now wife) and I about when we would be moving back and I would laugh as if it were a joke, but they were not joking and I was the only person laughing. Why would you choose to live in boring car-centric Brantford and not in a vibrant walkable urban place like Ottawa, Montreal, or Toronto?

My first job after graduating from architecture school was in a small residential design firm located in the *Glebe* neighbourhood in Ottawa which was a short 10-minute bike ride along the Rideau canal from my apartment. This firm specialized in residential infill projects in the downtown Ottawa area. Our main clients were small scale developers who would purchase oversized residential lots and try to squeeze as much house, or houses, onto their property to maximize their return on investment. Our challenge was to balance the developer's demands for size and profit with design solutions that were in keeping with the scale of the existing neighbourhood while maintaining a high standard of architectural integrity.

Throughout my time at this firm, I learned the intricacies of designing infill housing within the constraints of limited lot sizes, zoning restrictions and programmatic requirements that would ensure profitability for our client, while endeavouring to achieve a standard of design excellence that had been instilled in me through my architectural education. The learning curve was steep as a new graduate, however the scale of the projects was engaging as I was able to be involved in all steps of the process from design to working drawings to site supervision of over twenty projects. Although I was deeply passionate about the work I was doing, I also became increasingly aware of the fact that the houses I was designing were far out of my financial reach as a junior designer. It occurred to me that the architecture I was engaged in was primarily for wealthy people, and it somewhat saddened me to consider that I might not ever be able to afford to live in any of the houses I was designing.

Figure 2:
378 Winona Ave. Ottawa ON, a semi-detached infill project I designed while working for Hamel Design, which won gold prize for best Custom Urban Infill in the 2010 Greater Ottawa House Builder's Association design awards.

Eager to get into the real estate market myself, I started searching for properties that I could afford. One such property that popped up was a very old and badly in need of repair, triplex in *Mechanicsville*, a somewhat seedy neighbourhood just West of the Parliament Buildings in Ottawa. I was 25 at the time with limited financial resources, however the fact that all three of the units were already rented meant that the rental income would be counted as income on top of my salary.

Figure 3:
98 Carruthers Ave. Ottawa ON, triplex. The first house I owned, purchased in 2008 and sold in 2009.

This barely made me eligible for a mortgage as I still required my dad to sign on as a guarantor. Before I signed the final mortgage papers, the middle-aged mortgage broker at the bank stared me dead in the eye and said "Please don't default on this mortgage because it will make me look really bad".

The house was a triplex arranged in a back-to-back configuration, in which I moved into the middle unit after the existing tenants moved out. The plan was to fix the unit up and move into the next one and do the same once the tenants decided to leave. Unfortunately, the tenants that I inherited were less than punctual in their ability to pay their rents on time which made paying the mortgage rather stressful at times. But as new tenants replaced old, the income stream became more reliable. However, there were other problems, the main one being that this house was never designed to comfortably house three separate units. The walls that separated the units were paper thin and neighbours could be heard clearly even at reasonable noise levels. Additionally, the house shared the same furnace and ductwork which acted as perfect passages for smells, cigarette smoke and of course more noise. The house was in constant need of repair, repairs that I did not have the excess cash flow to properly address. My home had become another job that I could find no respite from. After almost two years of pouring all my limited financial and physical resources into fixing what I could, I decided that I'd had enough and opted to sell my house in favour of a living environment that offered more privacy, peace and tranquillity.

Similarly, after three years of working at my first job I decided it was time to move on. Although I found aspects of the work fulfilling, the time-lines were intense and so was the work environment. I had gained enough experience that I felt confident enough to take on projects of my own, however I had no idea how to create a self-sustaining business that could pay my bills. Feeling burnt out and secluded having spent the last three years in a basement office located in my boss's house, I decided that a big change was required. This change took the form of a lifelong aspiration to teach and so I reasoned that now was the time to make that change. The three years that I had spent working at this firm, in addition to my Bachelor's degree made me eligible to apply to teacher's college to teach technological education at the high school level. I applied to Western, Queens and U of T, hoping that I would get into Queens and I could stay put in Ottawa. However, the acceptance letter from Queens never materialized and I found myself both excited and apprehensive about the acceptance letter that I did receive from U of T. Move to Toronto? The city where as a child when we would exit the Gardiner off ramp my dad would lock all the car doors and roll up the windows despite the fact it was the middle of summer and we had no air conditioning? (This was at a time when automatic locks were not common, so my father would be frantically reaching across the car to lock all four doors manually). The city, where as a child walking down the street to see a Jays game, my dad would not hold my hand but rather maintain a death grip on my upper arm until we found our seats in the SkyDome? I was conflicted, however given the fact that my girlfriend had just received a job offer in Toronto, it seemed to make the most sense. I had adapted and thrived in the small-scale urbanity of Ottawa from my suburban existence in Brantford and so I reasoned that I was now prepared for my next urban adventure in Toronto.

I vividly remember walking down King Street East on a warm summer night in the first month of our arrival, hearing the street car rumble by with all the overhead wires creating spider web like mosaics that framed the top of the CN tower in the distance. I felt electric knowing that I lived in Toronto, the undeniable centre of the Canadian universe, an actual place with an identity where everything was happening. This place, I reasoned, was the only place to live, and at that moment, I could not think of anything that would make me want to leave.

After renting in multiple locations in the East then in the West of Toronto we finally settled on a location at Lansdowne and Bloor and bought our first condo. The location was ideal with the subway station being a mere five-minute walk and the neighbourhood was being invaded by hipsters opening coffee shops, bars and restaurants that made you feel cool just through proximity. Our condo was a 600 square foot 1 bedroom + den unit on the 10th floor of the building. Fortunately, at the time there were no other buildings impeding our view and on clear days we could see right across Lake Ontario and we enjoyed beautiful purple pinkish sunsets against the backdrop of the increasingly interesting Mississauga skyline to the West.

By this point in time, I had graduated from teacher's college and had been teaching for over a year. I was fortunate enough to get a full-time one-year contract immediately out of school, however I was disappointed to find out that the position I had enjoyed would no longer be available as the previous teacher would be returning from leave. I had hoped that I would be able to move right into a permanent teaching position but instead I was faced with the realities of taking a step back into supply teaching. Despite living in a central location on a subway stop in downtown Toronto I found myself being required to report to different schools at opposite ends of the city each day. My subway commutes would range from 30 minutes to 1.5 hours assuming the TTC would not break down. My wife, Lauren, on the other hand was commuting into Mississauga every day for work. The actual distance was not very far however she also found herself victim to the unpredictable whims of Toronto traffic. According to urban ideals, we were doing everything right, we were living in a dense, mixed-use urban centre close to public transit, and yet we still found ourselves commuting up to two hours every day. Nonetheless, being newly married and without children this was still manageable and we thoroughly enjoyed being in downtown Toronto enjoying all the cultural and social amenities right at our doorstep.

It was around this time that I started migrating back into the world of architecture. Deciding that the unpredictability of supply teaching was not sufficient to rely on for a steady income, I found a part time job at a small firm that was annoyingly back on the East side of Toronto. Being ambitious and missing the residential work I had done in Ottawa, I also decided to start my own residential design practice. My first solo project in Toronto came as a result of handing out promotional flyers of my work in residential neighbourhoods close to where I lived. One of these flyers found their way into the mailbox of a small-scale developer who was willing to take a chance on a young designer. This resulted in two residential infill projects, the first at 62 Harshaw Ave. in Bloor West Village and the second at 44 Fern Ave. just off Roncesvalles Ave. Again, the learning curve was steep and I began to understand that being an architectural designer required much more than just being a good designer. I was re-invigorated by these two projects and I began to understand that I did thoroughly enjoy architecture but maybe working on my own was a better fit for my personality. The houses that I was designing were large and luxurious single-family homes which represented the easiest and quickest return on investment for the client. I was again painfully aware that the houses I was designing were out of my price range. However, I still felt fortunate to be living downtown Toronto in our condo with a view. That was until the arrival of our first child, Tayler.

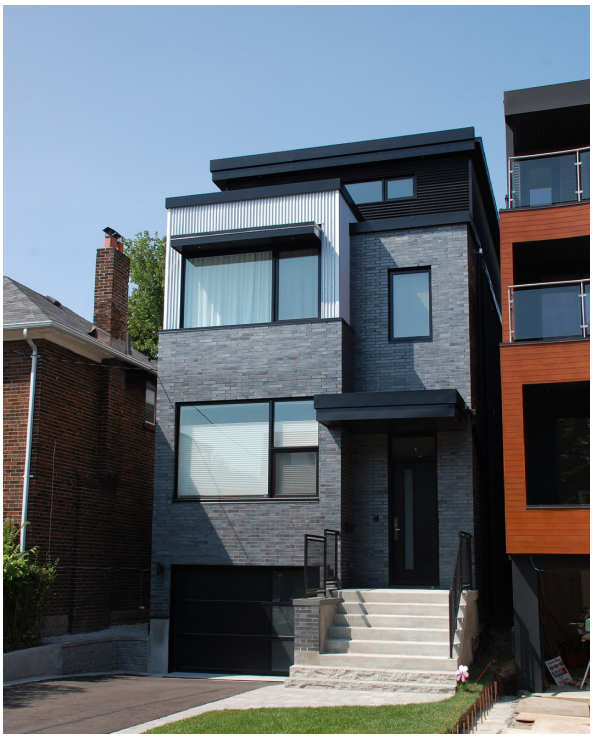

Figure 4:
62 Harshaw Ave, Toronto ON, my first independent architectural commission located in Bloor West Village

Figure 5:
44 Fern Ave, Toronto ON, my second independent project located in Roncesvalles.

All our values would shift and the financial and social situation we found ourselves in as a childless couple started to make less sense as a couple with a new-born baby. Suddenly we were faced with spatial constraints. Where would Tayler's crib go? In the den? But the den was right next to the noisy public corridor and it had no door (or windows for that matter). We also had to think about day-care. The closest to our condo was right beside a muffler repair shop located on Bloor St., a busy arterial road. Not only was the location less than ideal for a children's day-care centre, the cost per month was equal to the amount we were paying for the mortgage on our condo. When this all set in, I began to panic as I could not see a feasible way that we could stay in Toronto. My job security was low and precarious, we could not afford day-care at *mufflers-r-us* and we needed to move to a bigger dwelling. My heart sank as I knew what the answer was: we needed to move back to Brantford.

Although I was somewhat depressed about the prospect of moving back to Brantford, it still seemed preferable to staying in Toronto and plunging ourselves into debt that we might never get out of, debt that I was not even sure that we would qualify for. Everything in Brantford was more affordable - housing, day-care, food, and we had family who could help us with our new-born baby. So with that, the decision was made and I started my search for jobs close to Brantford. The search resulted in a job offer at a residential construction firm in

Figure 6:
Lauren & Tayler on the balcony of our 10th floor Toronto condo at Bloor and Lansdowne in 2014.

Cambridge who was looking for an in-house designer. This seemed like a perfect fit as I had always been interested in working for a design/build firm so I could see my projects through from design to construction. The realities of this however were much different than what I had envisioned. I became torn between my intentions to deliver the best design possible to the clients and the construction company's demands for speed and economy.

Figure 7:
Kallonen Residence, Puslinch ON, an addition and renovation I designed in 2015 while working as an architectural designer at Slotegraaf Construction in Cambridge ON.

After a year of working there, I decided that my expertise would be better served at a firm that solely focused on design. Once again, I began a job search that landed me back in the GTA at a *boutique* residential design firm designing luxury homes in Oakville. I learned a great deal about the financial aspects of running a profitable small firm at my time at this job. I also became very aware that what we were designing was not so much homes, but financial investments in the form of a house.

Figure 8:
546 Wingrove Ave, Oakville ON, one of several houses I designed while working for Keeren Design in 2016.

For this investment to maintain maximum value we needed to follow a formula of: as large as possible, plus all the necessary rooms that were required to satisfy a certain price point. This formula of rooms usually included: a three-car garage, study, formal living room, great room (another living room), dining room, kitchen and of course a butler's pantry (I was never sure if the people who lived in these homes actually had a butler). On the second floor there would be three to four bedrooms all with walk-in closets and ensuites, with the principal ensuite being at least 12'x15' in size and the walk-in closet being similar in size for what I assumed were the department store of clothes that these clients needed to store. All these requirements were dictated to us by real-estate agents who were basing these *necessities* on the last house they had sold. The reasoning went: this house sold for *x* and had all these amenities, so for you to get *x* you need to do it exactly the same. This also acted as adequate reasoning for the banks to provide construction loans for these houses. We were not designing houses; we were designing an alternate form of currency.

Meanwhile in Brantford we had purchased our first house. We had originally intended to start out renting as we had decided to keep and rent out our condo in Toronto. However, at the time (2014), it was actually less expensive to buy a reasonably priced house in Brantford than rent. We were also having issues trying to find someone to rent our condo in Toronto for a monthly rent that would cover our mortgage payment. In the end we concluded that selling our condo and buying a house in Brantford made the most financial sense. The house we purchased was a red brick, one and a half storey home built in 1906 located on Brant Ave.

which had become a busy arterial road over the decades. Originally, Brant Ave. had been one of the most prestigious streets in Brantford however as the automobile became more prevalent in the post war era, Brant Ave. ceased to be a quaint two-lane residential street when it was expanded into a four-lane arterial road, eating into the front boulevards of grand century old homes. The result was that Brant Ave. became a street stuck in limbo between pre-WWII residential and post war commercial. Luckily for us this meant a real-estate discount as properties on Brant Ave. were hard to sell as people were not sure what this street was and how to identify with it. It was not quite a neighbourhood and it also was not completely commercial. Regardless, we were thrilled with our purchase as we never would have dreamed of being able to afford a detached house in Toronto. One of the biggest and most welcome changes was not having to share floors or walls with our neighbours. No being annoyed at a noisy neighbour playing their music too loud or being overly self-conscious about the noise that we were making. I began to appreciate more thoroughly the benefits of living in a detached house and the peace that acoustic privacy provided. However, it was a different source of acoustic assault that caused us to leave this house four years later.

Figure 9:
Photo of 245 Brant Ave.

Due to the widening of Brant Ave, all the houses were pressed up against what was a constantly busy arterial road. Even with new modern windows, the road noise was constant and unrelenting. We woke up one morning to a very loud bang that shook our house. Looking out the front window, we could see that a car had wrapped itself around a utility pole in the front yard of our neighbour's house. At that moment we decided it was time to start looking for a house in an actual neighbourhood where it was quieter and safer for our now walking toddler. We were lucky enough to win out on a dozen person bidding war for a small Brantford cottage in the quiet neighbourhood of Holmedale, which was coincidentally where my parents had

moved when I was about my daughter's age. We moved in 2019 right before COVID and its resultant economic turbulence that saw a spike in real-estate prices that were ignited by reduced interest rates that had ripple effects that spread far beyond the GTA.

Figure 10:
27 Spring St. Brantford ON, current residence.

By this time, both my wife and I had been able to eliminate our commutes with Lauren's company transitioning into remote work and me securing a job at a Brantford Architecture firm specializing in Long Term Care homes, which was a ten-minute walk from our house. It had taken over a decade, but Lauren and I were finally able to design a life for ourselves that was balanced and affordable. It is frightening for me to consider that the moves and changes that we made to our living arrangements were all contingent upon an unpredictable time-line that allowed us to be able to afford to do what we did. Had we waited an additional year or two to make some of our decisions we may have been in a much different situation that would be severely restricted by the changes that have happened in the real-estate market over the past five years. Changes that have put many people in a position where what they could afford five years earlier is no longer in financial reach. For a large portion of the population, not only is living in Toronto not a financial option, but now places like Brantford have become out of reach. When leaving the GTA does not help you escape the exponential cost of living inflation, where do you go?

Part of the answer to this is to start looking at how missing middle housing types can be applied to existing low-density neighbourhoods within growing medium sized cities such as Brantford. This in combination with housing designs that facilitate mixed use and adaptive re-use possibilities that respond to the ever changing demographics of residential neighbourhoods. The remainder of this thesis will endeavour to explore such possibilities within the context of Brantford as a model of a medium sized city experiencing both population growth and increasing housing prices. Although in the end a complete solution to affordability will require governmental policy reform, soft densification in the form of adaptable missing middle housing is a key ingredient in providing people with more options for housing that allows them to be part of a community whose foundations are formed in a neighbourhood.

Introduction

The intent of this thesis is to explore the ability of centrally located original neighbourhoods within medium sized cities to absorb population growth via small scale infill development. This objective will be pursued by exploring alternate design options for small scale residential infill projects within the historic neighbourhood of Holmedale in Brantford Ontario as a template for similar sized cities experiencing population growth and increased cost of living. The goal is to create residential design solutions that increase density, mixed-use possibilities and housing options in low density residential neighbourhoods, as a strategy to increase affordability and residential density. The proposed design solutions will also address the need for adaptive re-use to accommodate ever evolving neighbourhood demographics.

This thesis consists of thirteen sections beginning with an overview of the current economic and housing circumstances, transitioning into reviews of topical literature and existing strategies for addressing the current housing challenges. The thesis will then narrow down to densification and design solutions for the neighbourhood of Holmedale in Brantford and then zoom back out to show how these solutions can also be applied to analogous neighbourhoods in similar sized cities. Lastly, the thesis will present several tenure-ship scenarios for the development and inhabitation of the proposed prototypes, providing detailed financial feasibility analysis for the development of the prototypes.

Section 1 : Analysis

1.1 - Housing Crisis in Ontario

The cost of living in Toronto has typically been the benchmark to which all other Ontario markets have been compared for the discernment of affordability. The closer a town or city is to Toronto the more costly real-estate will tend to be[1]. With this general rule in mind the solution to affordable housing seems to be simple: to reduce cost of living, move further away from Toronto. However, the caveat to this simplistic solution is that Toronto and the Greater Toronto Area (GTA) is where the most job opportunities are. So yes, it is more affordable to live in a smaller city further from Toronto, but not if you are unemployed.

The reality of the situation is that many people are forced to live in housing markets that are beyond their financial resources so they can be close to their place of employment. People whose income is not well above the median average in the city they work can deal with this challenge in different ways. One of the solutions is to live close to work and compromise on the size and type of dwelling. For example, an individual working in Toronto with a family of four might be financially limited to living in a two-bedroom unit in a condo tower on a busy arterial road instead of a single-family home that would be more conducive to their spatial needs and the need for proximity to amenities such as parks, day-cares and schools. Another alternative is to live further away from work in a more affordable location and commute to work. This allows for more options in size and type of housing; however, it is a significant sacrifice of time devoted to being in a car to commute to work each day. These options are further complicated when, as is common, two or more individuals in a household are employed in different locations.

As Toronto has become increasingly expensive over time so have the satellite cities in the GTA that permit a reasonable commute into the city[2]. One of the main strategies that Toronto and other major Canadian cities continue to engage to address affordability and population growth is intense densification of downtown areas in the form of high-rise apartment towers[3]. This has been an effective solution for adding vast amounts of dwelling units to cities such as Toronto[4], however it could be argued that the type and quality of living spaces produced by condo towers serve narrow demographics and do not respond to the needs of households over the size of two individuals. So although density has been added, housing typology and optionality remains low for a variety of demographics. The knock-on effect of this has been that as households grow and people have children, they are forced to make compromises in both living environment and quality of life (i.e., the amount of time spent in their cars).

One solution to this dichotomy of housing compromise has been the advancement of computer technology which allows many individuals to work remotely from home. Although this technology has been in place for years, most workplaces did not fully embrace this until the onset of COVID in 2020 and the resulting lock downs that necessitated people to stay home.[5] Although remote work does pose many social challenges it provides people the opportunity to break free of the oppressive cost of living restrictions imposed by proximity of their dwelling to their places of work. However, there is always a catch and complicating factors. One such factor is the dramatic decrease in interest rates implemented by the Bank of Canada in March of 2020, in attempt to buoy the economy during the COVID lockdowns which threatened to stop the economy in its tracks[6]. This resulted in lower mortgage rates which reduced the cost of borrowing money to purchase a home. Not only did this buoy the economy in the real-estate sector, it sent it into a frenzy, as people were looking to cash in on newly found buying power as well as cash out on the sharply rising value of their homes. This is especially true for people whose careers enable them to work remotely, permitting them to move farther away from the office to more affordable locations without having to take the quality of life hit of commuting to work[7]. The new found freedom to relocate to less expensive real-estate markets has resulted in an increase in demand that has drastically inflated house prices in medium sized cities such as Brantford ON, that previously enjoyed lower costs of living. This inflated cost of living has continued to expand as far as high-speed internet connections will allow, resulting in cities outside of the GTA seeing exponential real-estate price increases that eclipse the cumulative gains of the past decade[8]. Although the Bank of Canada has taken steps starting in March 2022, to increase interest rates in an effort to reduce inflation, the impact on the cost of housing has been slow and negligible, causing many to wonder if it is enough to slow down the runaway train that is the Canadian real-estate market.

So as high cost of living no longer seems to be a problem that is exclusive to the GTA in the post pandemic, remote work world, the question remains: How can we provide better housing options for everyone, especially those who are more frequently finding themselves priced out of various segments of the housing market? One solution that has been proposed is the reintroduction of *missing middle* housing into low density single family residential areas that monopolize the majority of the geographic areas in Ontario cities[9].

1.2 - Missing Middle Housing as a Solution

The term "Missing Middle Housing" was popularized by the architect and urbanist Daniel Parolek, founding partner of Opticos Design in his book: *Missing Middle Housing: Thinking Big and Building Small to Respond to Today's Housing Crisis*. The term, missing middle, refers to the large gap in housing options between low-density single-family housing and high density apartment towers. Missing middle housing represents housing typologies such as duplexes, triplexes, townhouses, courtyard apartments and small-scale apartment buildings. These typologies tend to be similar in size to large single-family homes, allowing them to easily fit into existing low-density single-family neighbourhood lots. The deficit of missing middle housing in many neighbourhoods has driven up the demand and cost of single-family homes which dominate the majority of the geographic areas in many cities in Ontario[10]. This has resulted in increasingly larger portions of the population being priced out of neighbourhoods consisting of mainly detached homes and being forced into high density housing. Not only does this represent a compromise in housing size and functionality, it is also a compromise in neighbourhood environment. Generally speaking, high density housing is not permitted in most residential neighbourhoods and is therefore relegated to busy arterial roads that lack human-scale, safety, walkability and neighbourhood amenities such as proximity to nature, parks, schools and day-care. Advocates of missing middle housing argue that the re-introduction of medium density housing typologies into single family zoned neighbourhoods would allow cities to absorb growing populations into existing neighbourhoods eliminating the need to develop precious farmland into car-centric suburban tract housing or further crowd the skyline with high-rise condo towers that cater only to very narrow demographics. Missing middle housing also facilitates a more equitable habitation of amenity rich human-scaled neighbourhoods by a more diverse socio-economic demographic. It is argued that the increase of missing middle housing in predominantly single family zoned neighbourhoods would lessen the demand for single family homes and increase affordability by offering more options between high density towers and low-density single-family homes.

Some of the main challenges facing the creation of missing middle housing is the existence of prohibitive zoning bylaws that permit only single family detached homes in neighbourhoods that dominate the majority of the geographic area in Ontario cities[11]. This is amplified by the feverish opposition of homeowners in these neighbourhoods who fear that the introduction of multi-unit housing will negatively impact their property values. These opponents, commonly referred to as NIMBY's (not in my back yard!), seem to be unaware of the history of missing middle housing that has harmoniously existed in historic neighbourhoods

across North America while retaining some of the highest real-estate values in their cities[12]. Examples of prestigious neighbourhoods containing a healthy mix of housing typologies in the Canadian context include: The Annex in Toronto, Strathcona in Vancouver, The Plateau in Montreal and the Glebe in Ottawa[13]. Advocates of missing middle housing propose eliminating detached single-family zoning to permit the creation of multi-unit housing within the abundance of low-density neighbourhoods that dominate many North American cities. This would help to address the lack of housing options that is at present negatively impacting housing affordability. Fortunately, over the past decade, as cost of living has become a bigger problem in most North American cities, government officials have started to listen, allowing for increased flexibility in zoning regulations that permit low rise multi-unit housing to be integrated into detached single-family neighbourhoods. Examples of North American cities that have eliminated single family zoning restrictions to pave the way for more equitable housing solutions include Portland Oregon who overhauled their zoning bylaws in 2016, Minneapolis in 2018[14] and Austin Texas in 2019[15]. Canadian cities such as Vancouver and Toronto have also been working towards integrating more missing middle housing into their urban fabric by permitting the creation of lane-way housing. However, the most significant legislation to date for Ontario is *Bill 23, More Homes Built Faster Act*, passed in 2022 which permits a maximum of three dwelling units in a single building on every building lot in Ontario. This opens up a vast amount of single-family zoned land, commonly referred to as the *Yellow Belt*, for densification to address the lack of housing options and supply that is detrimentally impacting housing prices.

1.3 - Housing Affordability

Parolek argues that missing middle housing is able to enhance affordability by increasing both housing options and supply throughout the vast amount of land currently dominated by detached single family homes[16]. However, one of the biggest challenges facing the implementation of missing middle housing are the economic incentives that make it easier and more profitable for small scale developers to build large single-family homes on infill lots. One of the primary reasons for this being that it is much easier to obtain funding for the construction of a single family home[17]. The underlying rationale for this hinges on the historical predominance of the detached single family home, which act as proof that the bank's money is invested in a secure asset. As explained by Andrew Sheffer, a small scale Toronto developer, in Andrea Oppedisano's essay *Why the Middle is Missing: A Developer's View*: "rental buildings are valued differently: they are always going to be worth less per square foot than a condo or town home, which means builders have to work harder to secure the funds needed to carry out construction"[18]. Consequently, when infill does happen in these yellow belt neighbourhoods, it is more likely to be in the form of large single family home simply because the existing financial system makes it easier to do so.

The other affordability issue, which has been exacerbated by inflation, is the emergent mutation of housing into a speculative form of investment for the generation of profit[19]. As a result, developers are reluctant to build new and innovative housing typologies, that may better serve the prevailing demographics, as they have little precedence for comparative value that provide a financial proof of concept. Instead, developers often default to building a typical housing typology, such as a single family home, as they are perceived as the safest option for ensuring a return on investment. The catch-22 is that this proven track record is based on a historical precedence that is no longer compatible with current day socio-economic realities. The commodification of housing has resulted in a dwelling's primary function becoming that of a financial investment instead of an affordable and functional space that responds to the needs of its inhabitants. A prime example of this is evident in the infill housing I designed while working as an architectural designer in Oakville. These houses all followed the same interior layout and room size requirements dictated by real-estate agents as a formula for achieving price points that were based on the last nearby house that was sold. Any deviation from this formula was viewed as a risk to the value of the *investment*.

All of these factors beg the question: can we rely on private industry to produce housing that actually responds to the needs of our population when economic incentives seem to be working against it? A portion of this answer resides in the ability of designers and architects to work with developers to create innovative housing solutions that are both functional as well as marketable. The other part of the equation is for governing bodies at all levels to facilitate the creation of missing middle housing types through flexible zoning bylaws as well as the facilitation of easily accessible funding and loans for construction.

One of the more radical solutions proposed is for governments and nonprofits to purchase land to create land trusts for the purpose of producing affordable housing[20]. One of the most successful examples of this is in Vienna, Austria where public ownership of land permits approximately 60% of the population to live in affordable government funded or social housing[21]. By removing the exorbitant cost of land from the development equation, housing affordability becomes more feasible. However, in Ontario where private ownership of land and real-estate investment is the norm, this change will not happen overnight. Nevertheless, as the cost of housing continues to rise, excluding increasingly more of the population from the possibility of home-ownership or even being able to afford rent, we may need to rethink our norms.

Recognizing that the macro-economic factors that impact the cost of housing are complex and worthy of an in-depth study unto themselves, this thesis will primarily focus on how alternative residential design solutions can increase affordability by expanding the supply and variety of housing options in the low density, single family neighbourhoods that dominate the geographic area of many cities.

1.4 - Brantford, Ontario:
Addressing the Housing Crisis in Growing Medium Sized Cities

One example of a medium sized Ontario city that has up until recently been immune to the GTA's high cost of living is Brantford ON, located approximately 100 km South-West of Toronto. Brantford is a city, like many others of similar size, that consists primarily of single family detached neighbourhoods. Since 2014 Brantford's average detached house price has more than doubled in most parts of the city[22]. Much of this can be explained by people being pushed further out of the GTA due to increased cost of living fuelled by low interest rates as well as the new found ability for a growing portion of the population to work remotely. Unsurprisingly, this has resulted in many people being priced out of a housing market that less than 10 years ago was within financial reach[23]. The typical municipal response to the deterioration of housing affordability has been the introduction of smaller housing typologies, such as townhouses and apartment towers, to increase affordability and augment the dwindling housing supply. However, these housing solutions have the tendency to create socio-economic segregation as new developments are typically excluded from desirable established neighbourhoods due to restrictive zoning by-laws[24].

With this in mind, this thesis will focus on the untapped development potential of original pre-WWII neighbourhoods, using Holmedale in Brantford as a template for similar neighbourhoods in comparable cities across Ontario. These original neighbourhoods commonly contain large low density properties that can easily absorb missing middle densification, have more permissive zoning bylaws as a result of their pre-by-law origins, and are typically located close to downtown cores which facilitate walkability. In addition to these advantages, original neighbourhoods exist in some of the more scenic and nature adjacent locations in their cities as they evolved, in the pre-automobile era, within walking distance to nearby factories which utilized water sources as a natural resource.

By increasing the supply of missing middle housing in original neighbourhoods, the goal is to enable a more equitable habitation of some of the most desirable amenity rich communities in our cities. Introducing missing middle housing in these neighbourhoods will expand housing options for a large under-served demographic that currently find themselves unable to afford the single family homes that are predominant in these areas.

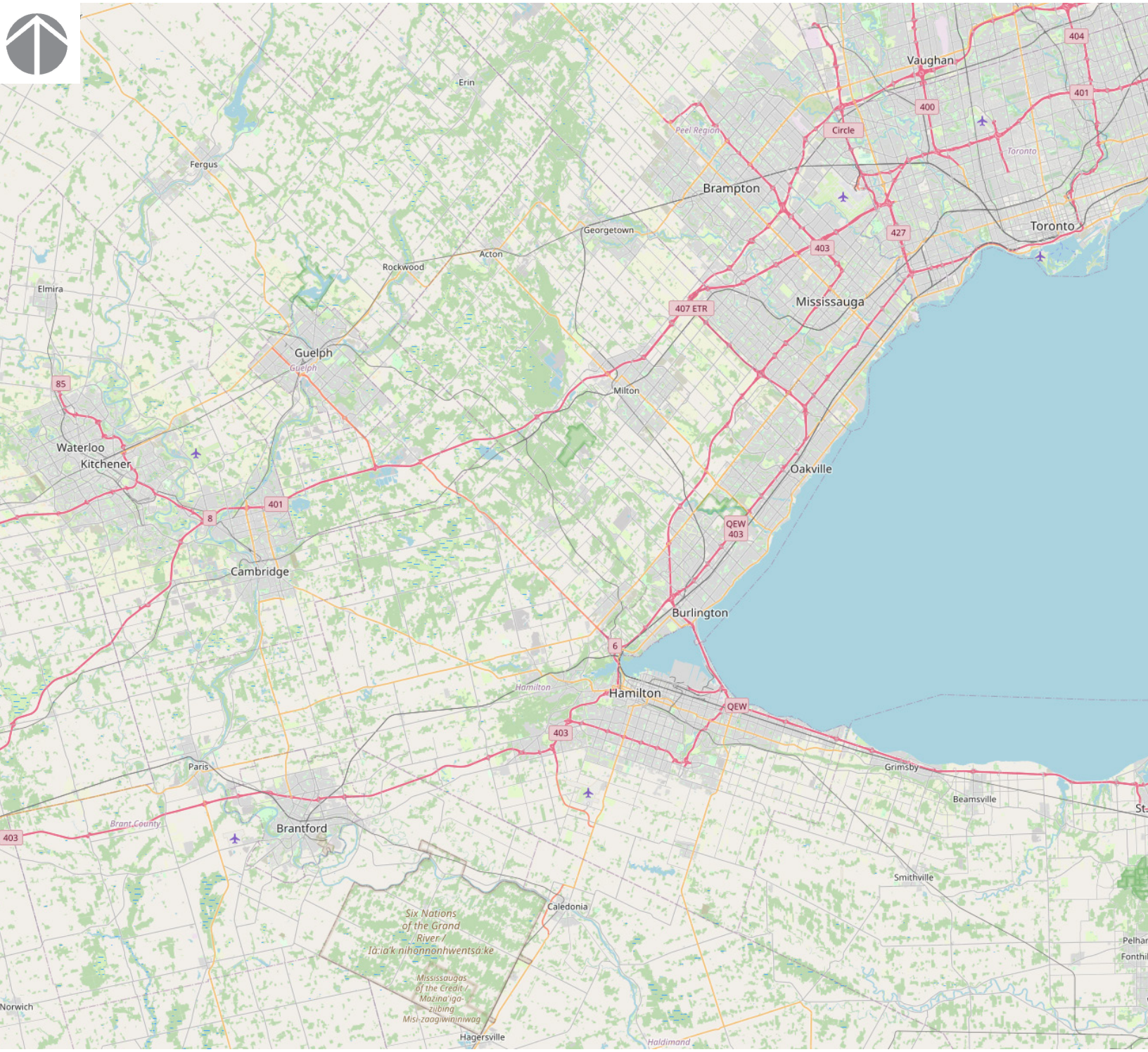

Figure 11:
Partial map of South-Western Ontario sourced from OpenStreetMap

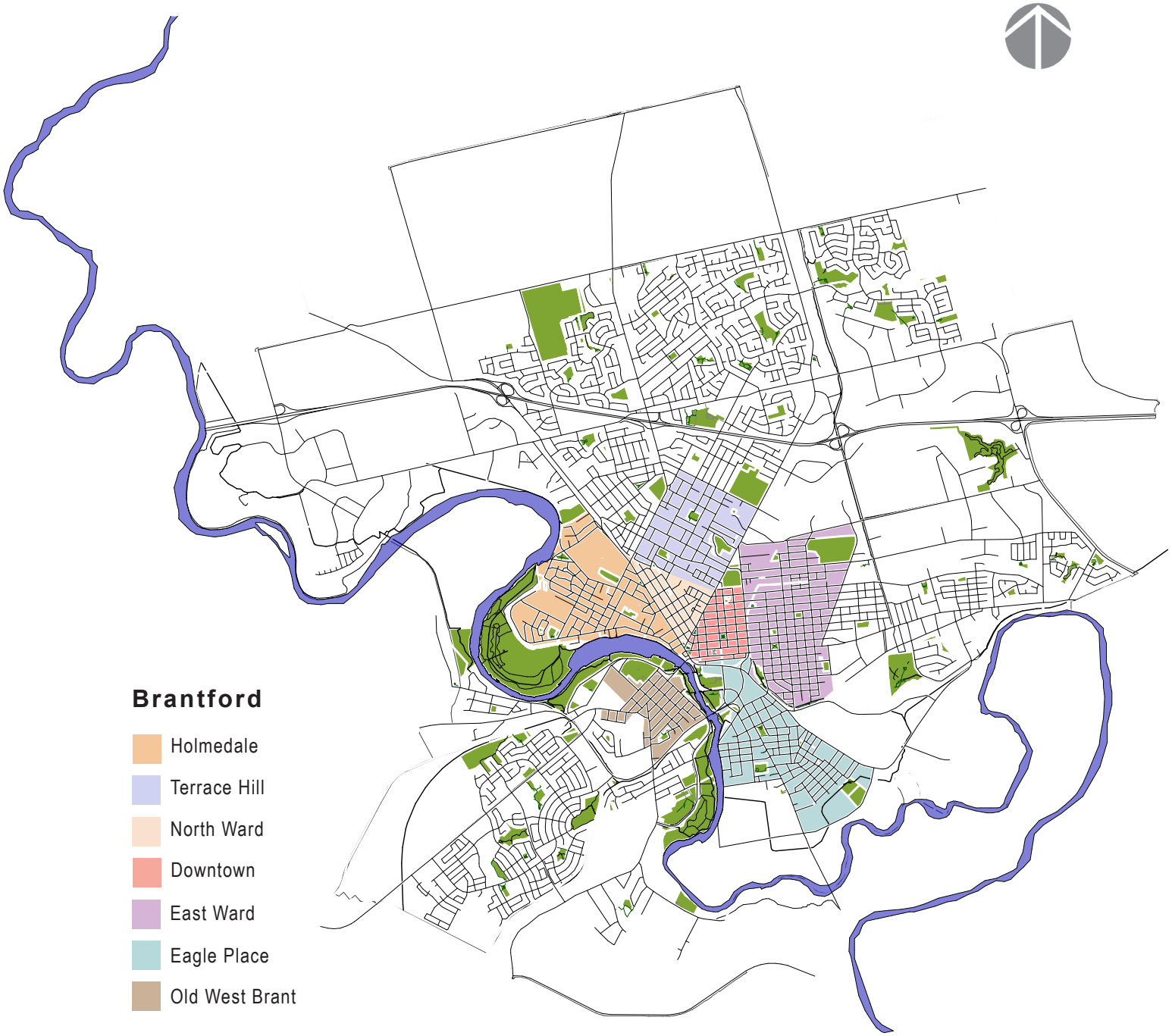

Figure 12:
Map of Brantford high-lighting it's original neighbourhoods.

Endnotes

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Section 2 :
Embracing Density and Urbanism:
A Review of Four Compelling Texts

2.1 - Introduction

The following reviews are not an exhaustive list of books that were consulted to help support the argument of this thesis, however they poignantly represent ideologies that closely resonate with its underlying philosophy. Most heavily drawn upon is the highly influential *Missing Middle Housing*, by Daniel Parolek as it provides a framework for the housing typologies that will be explored in this thesis. James Howard Kunstler's book: *Home from Nowhere* has also been immensely influential in satirically characterizing what ails our current built environment helping to further refine what makes places worth living in. *House Divided* is a diverse curation of thought provoking essays on our current state of housing affairs and steps we might take to get out the housing predicament we currently find ourselves in. Lastly David Sim's, *Soft City* challenges city building norms by providing expert principles through case studies that have withstood the test of time. The following review will include summaries for all of these books to set a ground work for and lend credence to the arguments set forth in this thesis.

2.2 - Daniel G. Parolek, *Missing Middle Housing: Thinking Big and Building Small to Respond to Today's Housing Crisis* (Washington: Island Press, 2020).

The term *missing middle* articulates a scale and type of housing that was once commonplace in historic neighbourhoods but is now *missing* in our housing stock. These housing types provide options between detached single-family homes and apartment buildings. The book argues that the lack of this type of housing, which includes duplex, triplex, fourplex, courtyard apartments, bungalow courts, townhouses, multiplexes and live/work units, has worsened housing affordability. The reintroduction of these housing types back into the housing stock would increase housing affordability, as well as promote less dependence on vehicles. Reintroducing these housing types back into North-American neighbourhoods will also help to re-establish human centric scale as opposed to vehicular based development which has resulted in dull monotonous suburban housing developments that are increasingly out of financial reach for the majority of the population. The book goes into detail about some of the reasons that these types of housing are missing, including financial viability of developing missing middle housing as well as bureaucratic roadblocks at the municipal zoning level. To counter these issues the book also includes many successful case studies across the US demonstrating how missing middle housing can be reintroduced into existing neighbourhoods. The book also expands on how to engage the public as well as local building authorities to explain the value of adding missing middle housing to their cities.

2.3 - James Howard Kunstler, *Home from Nowhere: Remaking Our Everyday World for the Twenty-First Century*, 1st Touchstone ed. (New York: Simon & Schuster, 1998).

Written by James Howard Kunstler who is not an architect, but an author and cultural critic, this book is a critique of the modern city that has evolved for the optimization of vehicular circulation since the end of WWII. To argue his case Kunstler describes how historic cities were designed to cater to the proportions and velocity of the walking human, naturally making them safer and more desirable places to spend time. Kunstler promotes the tenants of the *New Urbanist* movement which advocate for multi-use and loosely zoned neighbourhoods based on the template of historic, pre-vehicle city planning. The intended result is to promote diverse human scaled neighbourhoods that attract a variety of demographics and socio -economic classes and create a sense of place. Kunstler argues that the mono-zoned car-centric places that we have built have trapped us in our cars, alienating us from the everyday human contact we need to have fulfilling lives. The overarching theme of the book is that the cities and neighbourhoods that we have been building since WWII are bland, boring and indistinguishable from one another. The reason we are attracted to historic city centres is because they were built for humans, not cars. Kunstler proposes that we need to return to these historic planning principles to transform the vast modern landscape of *nowhere* into somewhere worth living.

2.4 - *House Divided* (Coach House Books, 2019).

House Divided is a collection of essays addressing the affordable housing crisis in Toronto, published in 2019. The editors and primary authors of *House Divided* include Alex Bozikovic, Cheryll Case, John Lorinc and Annabel Vaughan accompanied by essays from a variety of other writers and experts involved in the realm of urban planning and architecture. These essays are grouped into three sections entitled: First Floor: Housing Past, Second Floor: Housing Present and Third Floor: Housing Future.

First Floor: Housing Past focuses on Toronto's urban planning history and government decisions that precipitated the lack of low density (missing middle) housing within residential neighbourhoods which account for approximately 75% of the geographical area in Toronto. The result has been a lack of land to develop housing to keep pace with Toronto's exponential population growth since the 1950's.

Second Floor: Housing Present, elaborates on the current housing crisis in Toronto characterized by the over development of the downtown core with high rise condo towers as the only solution to the housing shortage. This section of the book also explains how current urban design guidelines, zoning by-laws and the influence of wealthy NIMBY's continues to stifle Toronto's ability to provide missing middle housing within established neighbourhoods. Many of the essays in this section argue that density restrictions that apply to 75% of Toronto's geographical area is a form of discrimination against the majority of the population who cannot afford to live in these neighbourhoods.

Third Floor: Housing Future, proposes legislation and planning changes that need to be made in order to allow for more low rise, human scaled residential developments to occur within established single family neighbourhoods in Toronto. The foremost and most obvious change being the removal of detached single family zoning restrictions. Authors in this section also propose alternative financial options, such as land trusts and cooperative housing in addition to an increase in supply, to address the crisis of housing affordability. Also included in this section are case studies of design proposals for low density multi-unit housing that fit within existing lot typologies in existing lower density neighbourhoods in Toronto.

2.5 - David Sim, *Soft City: Building Density for Everyday Life* (Washington, DC, USA; Island Press, 2019).

Soft City: Building Density for Everyday Life, was written by David Sim a practising Architect working for Gehl Architects in Copenhagen. This book challenges the norm of high-density cities, classifying them as inhospitable to human life. The main thesis of the book is that cities should not be designed to maximize the number of inhabitants in ever smaller spaces, but rather to emphasize human well-being and community through more thoughtful urban planning and human scaled density.

Sim emphasizes the importance of social and experiential qualities of spaces when designing in the urban context, arguing that all spaces should be comfortable, inclusive and encouraging of human interaction. He gives examples of various "soft cities" and the design principles they have implemented such as walkability, mixed land use and the incorporation of nature, to achieve a higher degree of human well-being.

Sim presents density not as a compromise but as an opportunity to create livable neighbourhoods that promote a strong sense of place, community engagement, creativity and overall well-being.

Section 3: Review of Typical Housing Typologies

3.1 - Introduction

The following section proposes a selection of residential typologies that attempt to represent some of the more common housing types that are employed to increase the housing supply to absorb population growth. The purpose of this section is to identify the advantages and disadvantages of these typologies so as to create a framework of design criteria for a more efficacious housing typology that better responds to the evolving needs of inhabitants. This section includes overviews of single family homes, semi-detached units/townhouses and apartment towers.

3.2 - Single Family Detached Homes:

Advantages:

The single family detached home continues to be a sought-after housing typology in the Ontario context[1]. One of the main reasons for this is the generous living area that detached houses provide to accommodate the spatial needs of a family. The detached house also offers the most privacy in the form of acoustics as it doesn't share walls and floors with neighbouring units. The structural autonomy of the detached house permits windows to be located on multiple directional exposures increasing the amount of natural light within the dwelling as well as enhancing the opportunity for natural ventilation. Detached homes also provide the most amount of exterior amenity space in the form of private yards, which creates further separation from neighbouring properties and increased privacy. As one of the primary ground based housing typologies, one of the more desirable features of the detached house is the direct access it provides to the ground plane. To augment this, detached houses are most commonly located in some of the most desirable areas of cities for families with young children due to their proximity to amenities like green space, parks, schools and day-care. The more human scaled built form of these neighbourhoods also lends itself to pedestrian safety as roads are smaller and experience less traffic, promoting a quieter atmosphere that is beneficial to well-being[2].

With all of these benefits in mind it seems that a detached house is the most ideal housing typology. However, there are many disadvantages to this typology that people tend to overlook or wilfully ignore in their pursuit of an ideal home.

Disadvantages:

The biggest disadvantage to single family detached housing has become its prohibitive cost. This is especially true in big city Canadian markets such as Toronto and Vancouver. Unfortunately, these prohibitive detached housing costs have also spread into smaller cities over the past decade making this housing typology further out of reach for the majority of the population. Table 3-1 provides a comparison of average detached house prices across the major real estate markets in Ontario to the annual income required to afford a detached house.

Table 3-1: Comparison of Housing Prices to Median Incomes in Major Ontario Markets

City	Average detached home price - Apr 18 May 16 2023*	Approximate Income req'd for Avg home**	Median household income***
Toronto	$1,648,298	$238,000	$98,640
Barrie and District	878,000	$180,000	$99,560
Hamilton	$871,682	$178,000	$103,820
Barrie and District	$878,000	$180,000	$99,560
Ottawa	$871,652	$153,000	$121,790
Kawartha Lakes	$746,000	$146,000	$90,490
London - St Thomas	$717,650	$134,000	$94,070
Niagara Region	$698, 000	$146,000	$87, 510
Kitchener - Waterloo	$685,000	$130,000	$101,690
Brantford	$670,000	$127,000	$79,500
Windsor - Essex	$595,400	$118,000	$92,180
Cambridge	$567,000	$114,000	$93,000

Sources:

***Detached House Price:** Average benchmark detached house prices were sourced from CREA, the most recently available price at the time of research was used.[3]

****Income required:** Income required to afford an average detached house price was calculated using CMHC's mortgage affordability calculator assuming 4.5% mortgage rate, 20% down payment, 30 year mortgage amortization and $1500 monthly expenses not related to housing.[4]

*****Median Household income**: median household incomes were sourced from Statistics Canada, 2021 Census[5]

As can be seen in the table 3-1, the required income to afford average house prices exceeds median household incomes in all major Ontario markets. In some of the more expensive markets, required income doubles median household income levels. What this demonstrates is that anywhere from 50%-75% of the population in these locations are unable to afford to buy a detached house despite it being one of the most ubiquitous housing typologies. Part of the problem is that detached housing is in short supply due to the amount of land required to accommodate them. Detached houses located in established neighbourhoods are consistently in high demand due to their prime geographic locations that place them within walkable, amenity rich areas. For the rest of the population who cannot afford to live in these established central neighbourhoods a more affordable option might be to buy a detached house in a remote suburban neighbourhood. However, the compromise that is incurred comes in the form of automobile dependency, as newer suburban developments necessitate the use of undeveloped land on the periphery of cities. Due to their remote location and single-use zoning, this type of suburban neighbourhood is typically referred to as a *bedroom community* as sleep is the only activity you have time left for when not in your car. The necessity of car dependence in these neighbourhoods also impacts the design of the house as well as the character of the neighbourhood, as it is a standard expectation that all new single-family homes come equipped with a two-car garage at minimum. These garages frequently dominate the front elevations of new houses creating inhospitable pedestrian environments. Although intended for the storage of vehicles, attached garages are rarely used for their intended purpose and massive SUVs and trucks dominate front yards, giving the streetscape the resemblance of a strip mall parking lot.

Figure 13:

Photo of a recently built single family home in West Brant, illustrating the overwhelming impact of vehicle storage at the front of the house.

In addition to these shortcomings, single family housing has the drawback of being designed for short lived and static demographic targets. Although most people gravitate towards a detached house because it provides for the spatial needs of a family, it is typically not designed to be adaptable to the reduction in household size that occurs when children leave home. This is exemplified in Toronto's Yellow belt neighbourhoods where there is estimated to be 2 million empty bedrooms left vacant by shrinking household sizes[6]. Although homeowners living in oversized houses have the space to rent out rooms, these houses were designed to accommodate the intimacy of a nuclear family, making living arrangements between strangers somewhat precarious and undesirable.

Prohibitive cost and automobile dependency make many detached living options either out of reach financially or not supportive of a higher quality of life. To address these shortcomings alternate typologies in the form of the *attached dwelling unit* have emerged and become more normalized as prices of detached housing have become further out of reach for the majority of the population.

3.3 - Semi-Detached & Townhouses:

Advantages

The greatest benefit of the semi-detached and townhouse dwelling type is that they encompass many of the same attributes of the single-family home, but at a lower price. This is primarily due to the fact that an attached unit can be accommodated on a smaller property, reducing the cost of land in the overall price of the house. In comparison to average detached housing prices in Toronto, the average townhouse price during the first quarter of 2023 was $1,200,000[7], still very expensive but 28% less expensive than a detached house. In Brantford, during the same time period, the average cost of a townhouse unit was $386,000[8], approximately 42% less expensive than its detached counterpart. Although they are usually smaller than detached houses by design, semis and towns still offer generous living space that can accommodate similar sized households.

Another advantage that these attached housing units share with detached houses is that they can be found in many established centrally located neighbourhoods, giving a larger portion of the population access to some of the more desirable residential areas in cities. Like detached houses, semi-detached and townhouses also provide direct ground plane access via autonomous entrances that provide an unmediated connection to nature and neighbourhood amenities.

Dis-advantages

The biggest disadvantage to semis and towns is that they share walls with their neighbours. This can be especially problematic in older attached units that have little to no sound attenuation in shared walls. Even in newer units, minimum code requirements for party wall construction typically do not block all noise from neighbouring units. This results in lower acoustic privacy that can be a major source of stress if you are unfortunate enough to have inconsiderate neighbours. These shared walls also reduce the opportunity for windows, decreasing natural light which can impact circadian rhythms of their inhabitants[9]. This is particularly evident in townhouses which share multiple walls with neighbouring units.

Similar to detached houses, semis and towns will tend to be more expensive in established older neighbourhoods such as the Annex in Toronto or the Glebe in Ottawa.[10] Due to the increasing cost of housing, semis and towns are now also more common in suburban tract development at the periphery of cities. This again creates car dependence and all of its disadvantages. An additional disadvantage, due to the reduced footprint of this dwelling type,

is the tendency of the garage to consume the majority of the ground floor, pushing all of the living space to the 2nd and 3rd floors. This disconnects the living space from the ground plane making it less likely for residents to engage with the outdoors and the neighbourhoods they live in. This monopoly of the ground floor by the garage necessitates additional flights of stairs that must be traversed to access frequently used amenities such as bathrooms, kitchens and access to the outdoors, which is especially problematic for individuals with mobility issues. Like the detached house, semis and towns also suffer from designs that are catered towards static demographics, especially units that are smaller in size. These units are typically marketed as a financial stepping stone between that of condo apartment units and a detached house. Consequently, the logic for purchasing a semi or town is usually financial in nature and not necessarily functional. Young couples, who may have recently moved from a condo, can quickly find themselves back in the situation of having inadequate living space for their future families. Similarly, older demographics who opt for townhouse living may eventually find themselves unable to manage the multiple flights of stairs and are forced to look for more accessible living options.

3.4 - Condominium / Apartment Towers

Advantages

One of the primary benefits of condominium towers is financial in nature as they represent one of the most affordable options for home ownership. In Toronto the average condominium price in the first quarter of 2023 was $785,000[11], 52% less expensive than the average detached house price and 35% less expensive than average townhouse price. In Brantford the average condo price in the first quarter of 2023 was $364,300[12], 45% less expensive than average detached house prices.

In addition to greater affordability, condos require less maintenance than owning a detached or semi-detached house. In exchange for a monthly maintenance fee, all landscaping, snow removal and building repairs are taken care of by an elected condo board who hire outside contractors to maintain the building and property. This can be particularly attractive for older demographics for whom maintenance of a house may no longer be manageable. An additional advantage to condominium towers is that they are equipped with elevators, allowing for greater accessibility for those with mobility restrictions. They also frequently offer additional built-in amenities like gyms, swimming pools, banquet rooms and rooftop terraces, that residents might not have immediate access to if living in a detached house or townhouse.

Due to the large scale built form of condo towers and restrictions on building height within most residential neighbourhoods, they are commonly located in high density downtown areas. Although this has drawbacks that will be discussed in the disadvantages section, it also has many advantages. Several of these include being able to live in areas of greater mixed use which enables and promotes walkability and reduced reliance on the automobile. The location of centrally located condo towers can permit residents to be within walking distance to a variety of amenities such as grocery stores, restaurants, coffee shops, gyms, museums, theatres and libraries. It also provides an opportunity for people to live closer to work, increasing the opportunity for a walkable commute. Although the height of some condo units create a disconnect between the resident and the ground plane, it compensates by providing expansive views unrivalled by other housing typologies.

Dis-advantages

Although the location of many condo towers in urban downtown cores has advantages for certain demographics, it can become a burden for others, specifically that of families with young children. Living in a downtown area of a city such as Toronto may be quite enjoyable for single people or couples without children as downtown amenities that surround these buildings tend to be adult centric. However, for a family with small children, navigating a busy downtown street on the way to the grocery store or park can become a very stressful and dangerous event. Due to restrictive zoning bylaws, most condo towers are relegated to busy arterial roads, dislocating their inhabitants from family friendly neighbourhood amenities such as quiet, low traffic residential streets, immediate access to green space and proximity to elementary schools that are most often located in lower density neighbourhoods. This problem is further exacerbated by the fact that many young families find themselves priced out of these human scaled neighbourhoods as demonstrated by the average cost of detached housing in relation to average median income levels.

The dislocation of condo towers from residential neighbourhoods also becomes a hindrance to fostering a sense of community. Although condos provide living quarters in which one finds themselves in very close proximity to neighbours, the opportunity to interact with a neighbour is limited due to the lack of usable shared public space. In a neighbourhood where dwellings have direct access to the ground plane and the public realm, people are more likely to interact with and get to know their neighbours. The lack of direct access to the ground plane, where the public realm exists, is not only detrimental to one's sense of connection to a community but also their connection to nature which is crucial to human well-being[13]

Disconnection from the ground plane can also pose further complications for those living in high rise towers. The main one being reliance on elevators that are frequently out of service. Although this may be manageable when living on a lower floor, many inhabitants frequently find themselves waiting excessive times to ride an elevator down from double digit floor levels. This may be a mere annoyance in day-to-day life, however this can prove to be a life safety concern in emergency situations such as a fire.

One of the most significant disadvantages to high rise condo living is the restrictive size of dwelling units that make it difficult to accommodate households over the size of two people. Although many municipalities have gone to efforts to ensure that new apartment developments include larger sized units that can accommodate larger household sizes, the prices of these units start to creep into the same price range as townhouses which are located in neighbourhoods where young families would prefer to be.

Although high rise condominiums do offer an alternative style of living that can be very appealing to single people, couples and elderly demographics, this typology has taken on the burden of housing a large portion of the population whose spatial and environmental needs are incompatible with that of condo living. This is primarily due to the high cost of detached housing that has been exacerbated by restrictive zoning bylaws prohibiting denser and more affordable dwelling types in residential neighbourhoods.

3.5 - Conclusion

Through assessing the advantages and disadvantages of these common housing typologies it becomes apparent why the single detached home is the most sought after dwelling typology. The autonomy of the detached dwelling offers maximum space, privacy, natural light and ventilation with direct access to the outdoors. Single detached houses are also commonly located in the most amenity rich areas in cities, offering access to nature, parks, schools and in older neighbourhoods, commercial amenities within walking distance. The main and obvious disadvantage to this housing typology is its prohibitive cost which disqualifies the majority of the population from being able to live in neighbourhoods that make day to day life easier and more enjoyable. Pragmatically, it is also not feasible to expect that everyone should be able live in a detached house given the amount of land required to accommodate this. This should by now be obvious given suburban sprawls seemingly unquenchable appetite for undeveloped land. The primary advantage that smaller attached dwelling types provide is increased affordability through smaller unit sizes and more efficient use of land.

As designers and architects the challenge we face is how to reconcile these seemingly contradictory values while endeavouring to design housing that provides functionality, comfort and affordability in locations where people actually want to live. Additionally, how can our buildings stand the test of time and not become obsolete as demographics ebb and flow through time. The design proposals in this thesis will endeavour to address these parameters by proposing housing prototypes which strike a balance between the advantages of the single family detached home with density, adaptability and increased affordability.

Endnotes

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12. 'Brantford Median Price', CREA, accessed 2 March 2023, stats.crea.ca/mls/brnt-median-price.

13. David Sim, *Soft City: Building Density for Everyday Life* (Washington, DC, USA ; Island Press, 2019), 90-91.

Section 4:
Review of Development Strategies

4.1 - Introduction

The following section will provide an overview of typical development strategies that are undertaken to increase the supply of housing that may be common in many North American cities but is primarily focused in Ontario. Each overview will include both advantages and disadvantages of each method in order to define a development strategy for the proposed building prototypes put forth in this thesis. Development methodologies included in this section are land development, land assembly, land severance and infill.

4.2 - Land Development

Typically land development refers to the practice of transforming large parcels of undeveloped land into a higher density use. Transforming farmland at the periphery of a city into a housing development is a common example of this. Installation of infrastructure such as water supply, sewers, electricity, roads, sidewalks and traffic signage are required prior to the construction of housing.

Figure 14:

Photo of under construction townhouses in West Brant which has been the site of consistent suburban sprawl since the late 1990's. Although this has been effective in adding a vast amount of dwelling units to the housing stock, walkability has been overlooked creating further car dependency and traffic congestion in Brantford.

Advantages

- Straightforward method of quickly adding a substantial amount of housing units to a city's housing stock.
- Mass production of housing lowers the cost per square foot of construction compared to single custom built projects.
- Can stimulate the local economy through construction, real-estate and population growth which acts as a catalyst to attract and create new businesses.
- Provides a blank canvas to create efficiently planned neighbourhoods with modern infrastructure
- Creates opportunities to incorporate sustainability into infrastructure such as geo-thermal heating.
- Modern infrastructure can be planned to accommodate future growth instead of retrofitting existing infrastructure which can be more complicated.

Disadvantages

- Loss of agricultural land that is required to grow food for growing populations.
- Loss of ecological diversity.
- Increase in car dependency as new developments are typically located on the periphery of cities further from existing amenities. New developments also tend to be single use residential due to restrictive zoning bylaws as well as the reluctance of developers to build mixed-use typologies which increase the complexity and cost of the development.
- Car dependency further contributes to traffic congestion and pollution.
- Additional cost of infrastructure adds to the cost of housing.
- Cost savings from mass construction of housing is not guaranteed to be passed on to the buyer as housing prices are set to comparable market values regardless of the cost of construction
- Housing typologies common in new suburban developments such as single detached homes, semi-detached units and townhouses are typically segregated into distinct districts creating a socio-economic hierarchy that is not conducive to fostering an inclusive community.

- New development housing typologies typically prioritize car storage in the form of attached garages due to the car centric nature of the development. This compromises the functionality of the dwelling unit and also negatively impacts the pedestrian realm as garages and driveways consume the greatest portion of the building's street facing elevation.

Figure 15:
Photo of a new suburban development in West Brant whose streetscape is dominated by garages and driveways.

4.3 - Land Assembly

Land assembly refers to the legal combination of two or more separate parcels of land into a single parcel of land. Developers will utilize this method of land development to create a larger property that provides increased development potential.

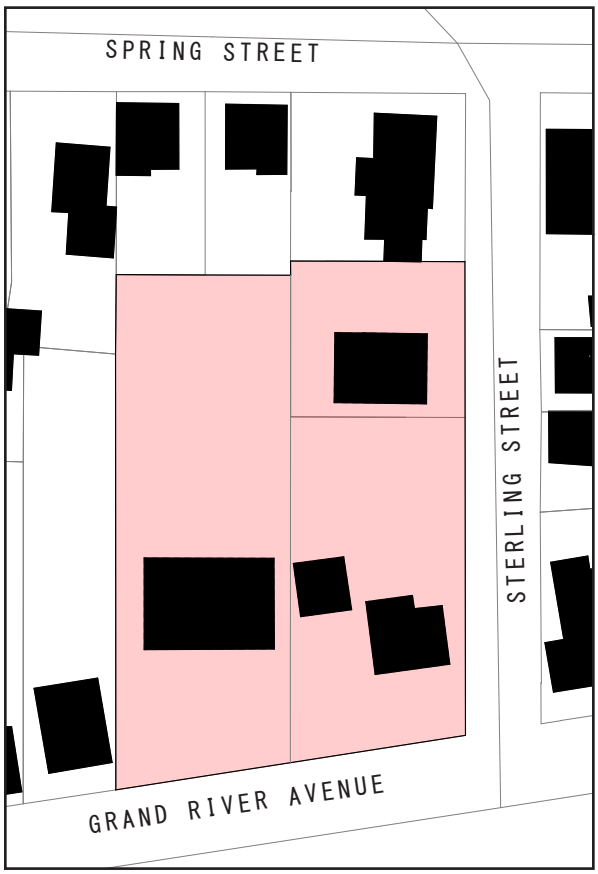


Figure 16:

Existing figure-ground diagram, before land assembly, consisting of three separate, low density properties.

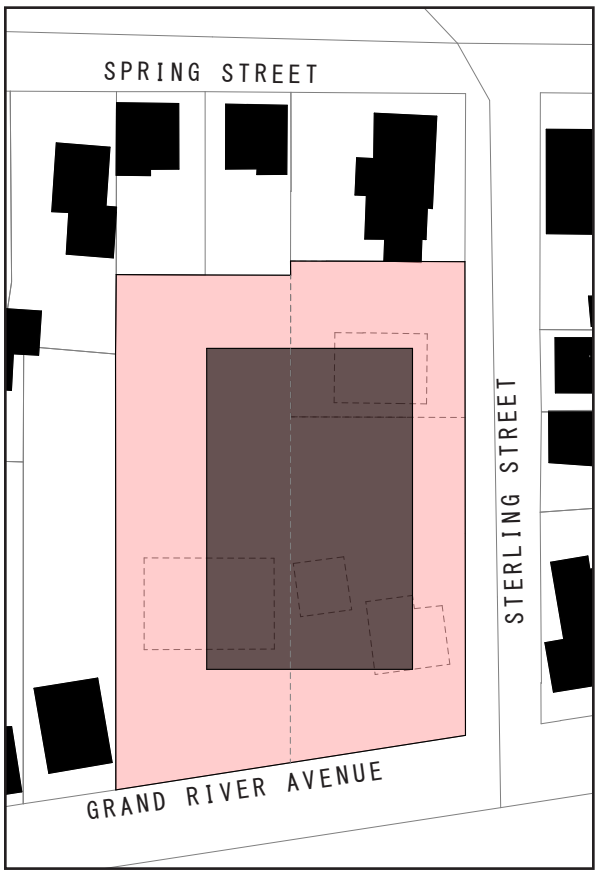


Figure 17:

Hypothetical figure-ground diagram, after land assembly. Three properties are combined to create a larger property that could accommodate a higher density building such as an apartment or townhouse complex.

Advantages

- Increases land development potential by creating more suitably proportioned lot sizes that are more easily accommodate a wider variety of housing typologies and vehicular circulation.
- Can accommodate larger building footprints that allow for increased density.
- May permit the use of existing infrastructure, reducing the cost of development.

Disadvantages

- It can be difficult to coordinate the purchase of multiple pieces of land for assembly. Acquiring adjacent pieces of land may take years or may not happen at all if sellers decide to sell on the public real-estate market.
- Bureaucratic red tape and financing logistics required for the assembly of land can take months to years to complete, prolonging the development process and increasing development costs.
- Land assembly may negatively alter the existing character and scale of existing neighbourhoods.

4.4 - Land Severance

Land severance is the practice of dividing one property into two or more pieces of property. An example of this would be the division of a large residential lot into two legally separate parcels, allowing for the creation of an additional principal building with a unique address. The severance of a property helps to circumvent the common zoning restriction that only allows one principal building per lot. Not every lot can be severed however, as zoning bylaws set standards for minimum lot sizes and lot frontage requirements.

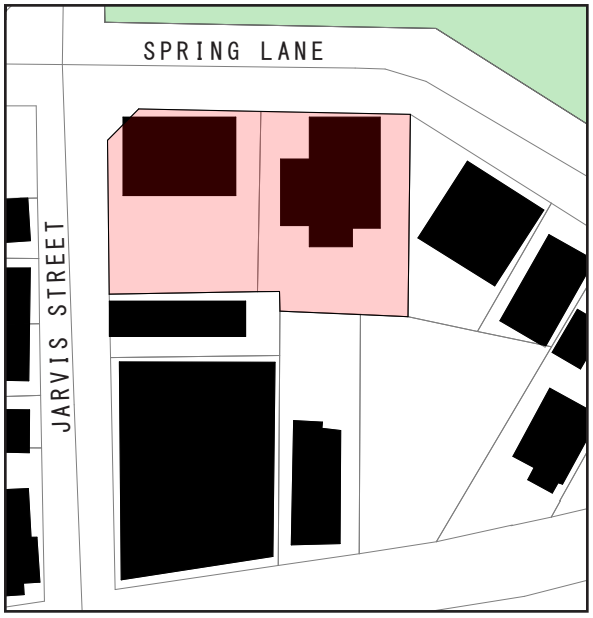


Figure 18:
Original figure-ground diagram of two existing properties before land severance.

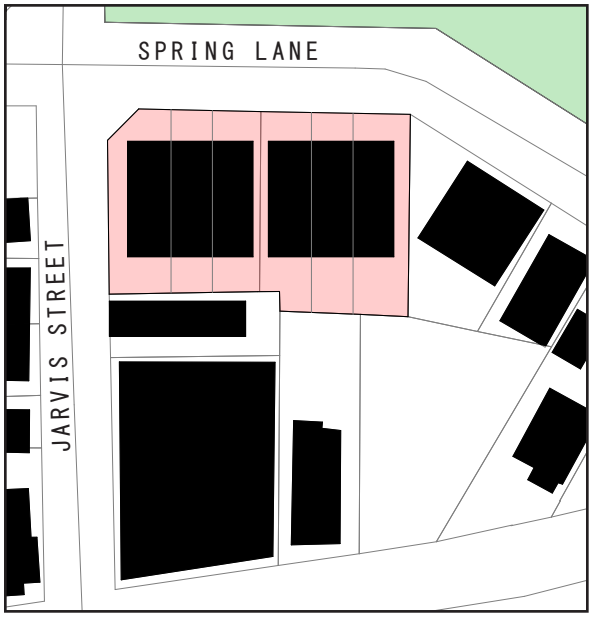


Figure 19:
Present figure-ground diagram showing two original properties being split into six new lots.

Figure 20:
Photo of completed infill development at the corner of Jarvis St. and Spring Ln. in Holmedale, consisting of two sets of three attached townhouse units, shown on figure 19.

Advantages

- Takes advantage of existing infrastructure reducing the cost of development.
- Decreasing the need for suburban sprawl and its related environmental impacts.
- Land severance enhances land use efficiency while increasing the housing supply.
- Creating multiple pieces of property from a single piece can decreases the cost of land making development and densification of existing neighbourhoods more financially feasible.
- Dividing large properties into smaller properties increases the opportunity for homeownership in established amenity rich neighbourhoods.
- Bill 23 eliminates third party appeals for minor variances and severance consents reducing the possibility of vocal Nimbys to halt missing middle housing developments.

Disadvantages

- Severance of land requires municipal approval which can take months to a year to complete. Additionally, the approval of applications is not guaranteed, adding cost and risk to potential development projects.
- Land severance applications are circulated to all neighbours within a stipulated radius of the subject property as dictated by the municipality. Neighbours are permitted to attend public hearings for the severance application to voice support or complaints. This process can open the doors for vocal NIMBYs to put pressure on local politicians to reject applications.

4.5 - Residential Infill

Residential Infill is the development strategy of replacing existing housing on an existing lot with new housing. In some cases this requires the demolition of existing houses to permit the construction of the proposed building. Other times the existing structure can be incorporated into the new development. Residential infill is commonly practiced in tandem with land severance to create new parcels of land permitting additional buildings to be added to the original lot. The aim for a successful infill project is to add more density in the form of built area to create financial viability for the development. Ideally, an infill project will also add density in the form of an increase in dwelling units.

Figure 21:
Photo of an under-construction infill project at the corner of Edwin St. and Grand River Ave. in Holmedale which converted an existing single family brick bungalow into three townhouse units.

Advantages

- Simplest and most straightforward method of development, saving money and time.
- Helps to maintain the character and scale of existing neighbourhoods by maintaining existing lot patterns.
- The densification potential of single lots is increased with the introduction of *Bill 23, More Homes Built Faster Act, 2022*, allowing up to three dwelling units per lot.
- Creates opportunities for architects and small scale developers to create unique residential designs instead of repetitive and bland housing typologies that are utilized by large scale developers for the mass production of housing.

- Provides opportunities for existing homeowners to re-develop and densify their property, creating additional revenue streams through rental units or the creation of multi-generational housing.
- Can stimulate neighbourhood economies through engagement of local trades people involved in the construction of infill projects.
- In comparison to larger scale developments, residential infill is much less disruptive to the day to day functioning of existing neighbourhoods.
- Small scale developments do not require the displacement of large portions of neighbourhood populations.
- Infill projects are able to tap into existing infrastructure, reducing the cost of housing and making more efficient use of existing services.
- Creates more housing in desirable amenity rich neighbourhoods, reducing the need for suburban sprawl and its negative environmental impacts.
- Increases equitable habitation of amenity rich neighbourhoods.

Disadvantages

- Small scale residential infill development, as a densification strategy, is not able to create additional housing units as fast as the development of vacant land or assembled land.
- Cost per square foot may be higher than mass produced housing developments.
- Limited to smaller, less dense building typologies due to the size of a property.
- Small scale developers may be more likely to create large single family detached homes as they are less complicated to build and easier to finance. This further exacerbates high cost of living and neighbourhood exclusivity.
- May result in the demolition of usable existing buildings that are still functional, creating unnecessary waste.

4.6 - Conclusion: Defining Development Parameters for Design Proposals

Although there is no one method of creating new housing that can solve the housing crisis by itself, there are methods which should take precedence to enhance the livability of cities. This can be accomplished by prioritizing strategies that supersede the deleterious impacts of suburban sprawl and facilitate equitable access to all neighbourhoods and city amenities. With this in mind, the design proposals put forth in this thesis will focus on densification of existing residential lots within established amenity rich neighbourhoods. In addition to all of the advantages listed in section *4.5 Residential Infill*, it provides the opportunity to simplify and expedite the development process to create much needed missing middle housing units as quickly as possible. To further simplify the development process the majority of the proposed prototypes are designed to conform to existing zoning bylaws. This design approach has been chosen in an effort to avoid additional delays caused by minor variances and zoning changes. The scale of these infill developments also negates the requirement for other lengthy development processes that are common in larger scale developments such as rezoning of land and site plan approval, which can add years to the project time-line resulting in increased development costs. The reduction of time and cost that results from avoiding these processes will simultaneously help to facilitate the financial viability of the proposed designs, making it a more viable option for small scale developers. Additionally, adherence to existing zoning bylaws and use of existing lots will help to ensure that new developments do not drastically alter the character and scale of the existing neighbourhood.

Although the proposed prototypes, in their higher unit density configurations, may presently require minor variances and zoning changes, an aspiration of this thesis is to demonstrate how a greater number of dwelling units per lot than is currently permitted can be subtly and tactfully incorporated into existing low density neighbourhoods. This will hopefully provide precedence for revisiting the restrictions in our zoning by-laws that are hindering housing affordability.

Section 5:
Target Demographics & Neighbourhood Selection

5.1 - Introduction

Having analyzed the current housing crisis in Ontario as well typical housing and development strategies, this thesis will now transition into the design proposal segment. As initial steps, this section will examine the viability of Brantford for residential densification, identify target demographics, and expand on desirable neighbourhood criteria for residential densification.

5.2 - Viability of Brantford Ontario for Residential Densification

Two of the major aspects that make Brantford a viable option for gentle densification of existing residential neighbourhoods is the dramatic increase in real-estate prices over the past decade and the increase in population.

In May 2015 the median home price in Brantford was $252,990[1] and the median household income was $62,640[2]. Eight years later, in May of 2023 the median home price in Brantford rose to $680,000[3] an increase of 169%, while the median household income grew to $79,500[4] an increase of only 27%. Housing affordability is also negatively impacted by the fact that the majority of Brantford's housing stock consists of detached single family homes, which represent the most expensive of all housing typologies. By increasing the supply of missing middle housing units, greater housing optionality will be created, allowing a larger portion of the population to have increased affordability in sought after residential neighbourhoods.

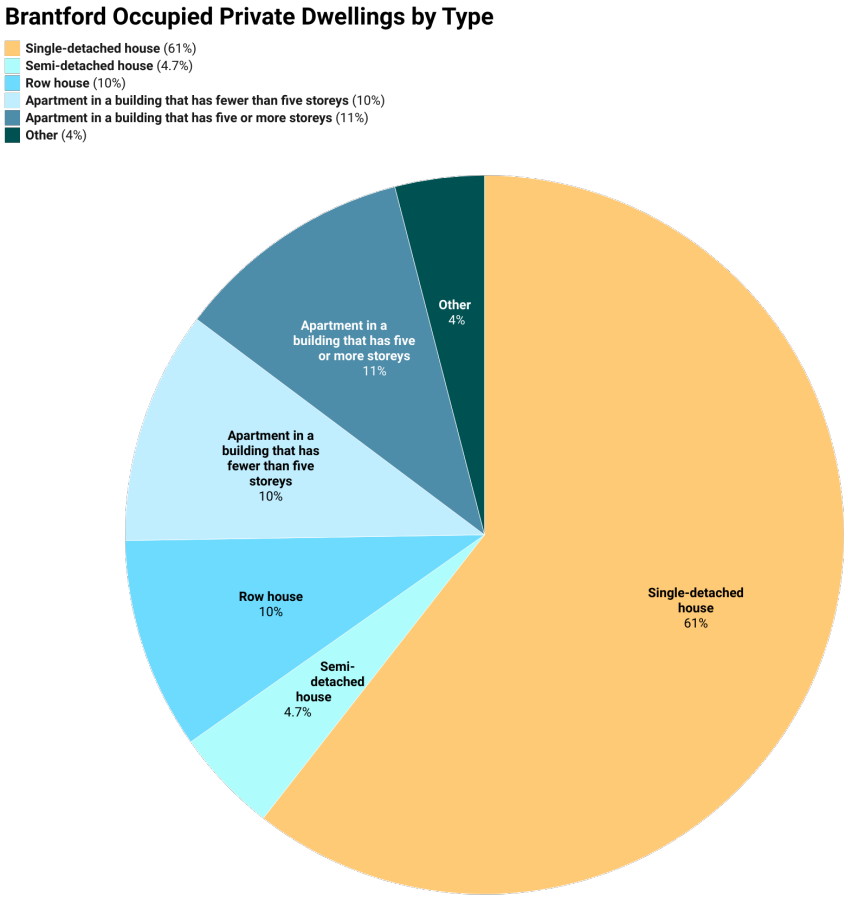


Figure 22:
Pie-chart depicting the distribution of housing types throughout Brantford ON. Data sourced from Statistics Canada 2021 Census Data.

5.3 - Target Demographics for Missing Middle Housing Typologies in Brantford

As exemplified in *Section 3, Table 3-1: Comparison of Housing Prices to Median Incomes in Major Ontario Markets*, the target demographic for missing middle housing ranges anywhere from 50% to 75% of the population depending upon the location. As discussed, many households over the size of two are limited to smaller than required living spaces due to lack of options between high rise apartment towers and single detached homes. Although missing middle housing is able to better accommodate the needs of larger households, it also provides the opportunity for households of one or two to live in some of the more desirable neighbourhoods in cities.

Identifying this large under-served portion of the population provides a compelling rationale for pursuing design strategies focused on adding missing middle housing to existing residential neighbourhoods in Brantford.

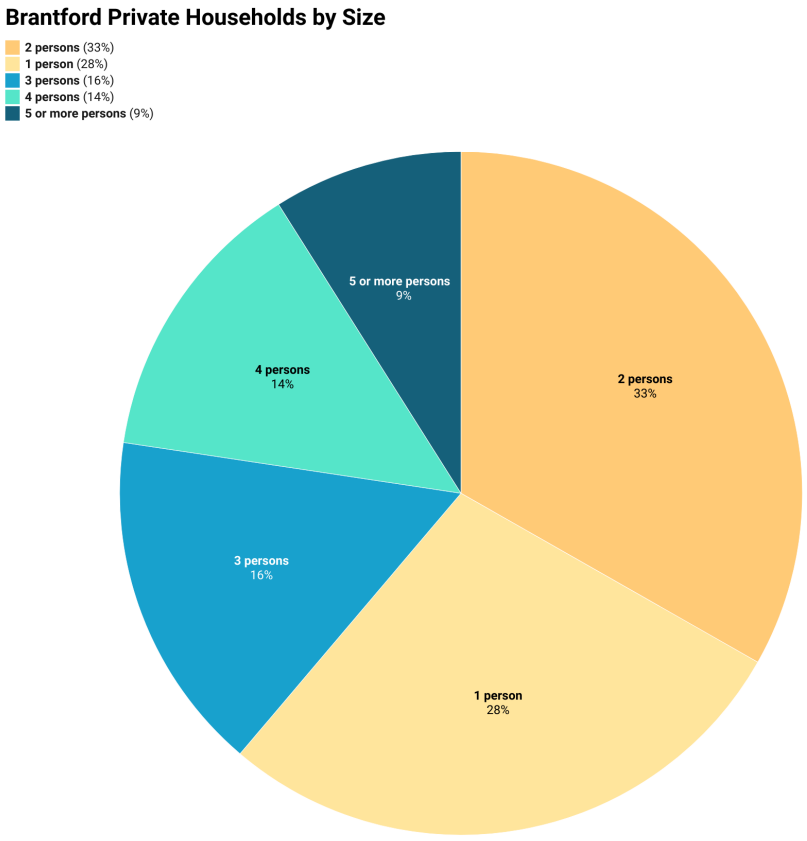


Figure 23:
Pie-chart depicting the breakdown of households by size in Brantford ON. Data sourced from Statistics Canada 2021 Census Data.

In addition to the increased cost in living, Brantford also requires additional housing units to accommodate an increase in population growth. Between 1996 to 2021, Brantford's population increased by 6.21% from 84,764 to 104,688 and is projected to grow 1.21% each year based on growth patterns between 2016-2021[5]. At the current population of 104, 688, this is an increase of over 1200 new residents every year that will be in need of housing. If a household size of 2.5 is assumed this represents roughly 500 additional dwelling units that will need to be added to Brantford's housing stock each year.

Brantford (City) Annual Population Growth

	Population	Calculated Annual Growth Rate
1996	84,764	
1997	85,092	0.39
1998	85,421	0.39
1999	85,752	0.39
2000	86,084	0.39
2001	86,417	
2002	87,159	0.86
2003	87,908	0.86
2004	88,663	0.86
2005	89,424	0.86
2006	90,192	
2007	90,873	0.76
2008	91,560	0.76
2009	92,251	0.76
2010	92,948	0.76
2011	93,650	
2012	94,613	1.03
2013	95,585	1.03
2014	96,568	1.03
2015	97,560	1.03
2016	98,563	
2017	99,759	1.21
2018	100,969	1.21
2019	102,194	1.21
2020	103,433	1.21
2021	104,688	
2022	105,958	1.21
2023	107,243	1.21
2024	108,544	1.21
2025	109,861	1.21
2026	111,194	1.21

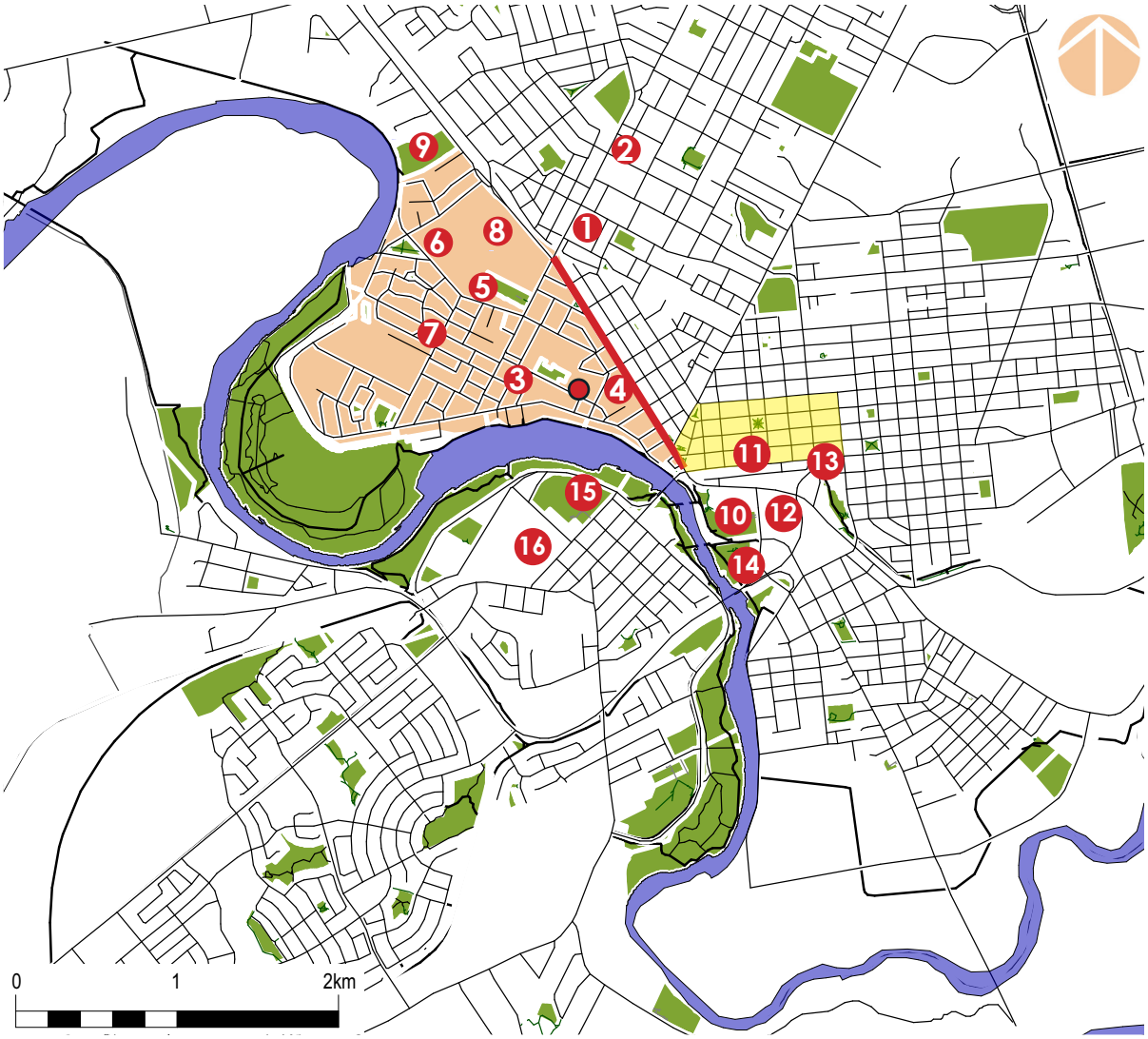
Figure 24:

Bar-graph depicting the increase in Brantford's population since 1996. Data sourced from Statistics Canada 2021 Census Data.

5.4 - Neighbourhood Selection

Identifying neighbourhoods that have flexible zoning bylaws is key to avoiding lengthy and costly processes such as rezoning and minor variances. A project which requires only a building permit in one neighbourhood may require both rezoning and minor variances in a similar neighbourhood that has more restrictive zoning. Fortunately, Ontario's *Bill 23: More Homes Built Faster,* has opened up many of these restrictively zoned residential neighbourhoods to soft densification in the form of missing middle housing[6]. This is a step in the right direction, however it is not a complete recipe for a vibrant mixed-use community, as many yellow belt neighbourhoods are zoned exclusively for residential use. As the New Urbanist movement has pointed out, many of the human centric city planning practices that make cities and neighbourhoods enjoyable places to live, such as mixed-use and walkability, already exist in older parts of cities. This is primarily due to the fact that these areas were built before automobile ownership had become ubiquitous and urban proportions were not burdened with the need to accommodate the circulation and storage of vehicles[7]. This resulted in a built form that is more in harmony with the scale and velocity of the pedestrian as opposed to that of the automobile. With this in mind, the design proposals in this thesis are proposed to be located in older, centrally located neighbourhoods that originated prior to the predominance of vehicle ownership. Holmedale, the selected neighbourhood, encompasses many of these human centric characteristics making it an ideal location for residential densification and the development of a vibrant walkable community.

Figure 25:
Community gardens located at Spring Street - Buck Park in Holmedale.



LEGEND

- Proposed Site
- Holmedale Neighbourhood
- Public Green Space
- Grand River
- Brant ave - Mixed use Commercial / Business District
- Historic Downtown District & Wilfred Laurier Campus

AMENITIES

1. Brantford General Hospital
2. Metro Grocery Store
3. Ecole Dufferin Public Elementary
4. BCI Public High School
5. Christ the King Catholic Elementary School
6. Lansdowne Public Elementary School
7. Neighbourhood Shops & Restaurants
8. W. Ross Macdonald School for the Blind
9. Glenhyrst Art Gallery
10. Brantford Civic Centre
11. YMCA
12. Shopping Centre
13. Brantford Farmers Market
14. Earl Haig Water Park
15. Cockshutt Park: Brantford Red Sox
16. Brantford Artisan Village: Mash Paddle Brewery

Figure 26:
Amenity map for the neighbourhood of Holmedale in Brantford ON.

The key conditions and considerations in the selection of a neighbourhood for densification include:

- *Large lot sizes:*
  Prior to the proliferation of suburban tract developments which prioritizes efficient land use to maximize profit, original neighbourhoods evolved in a piecemeal fashion over longer periods of time when efficient use of land was not a priority. This resulted in large low density lot sizes that have the capacity to accommodate multiple dwelling units.

Figure 27:
Figure-ground diagram illustrating the contrast between lot sizes that are typical in newer residential developments (highlighted in yellow) with existing lot sizes in Holmedale.

Figure 28:
Photo of Bank St. in Holmedale, a recent conversion of former industrial land to residential.

- *Deteriorating Housing Stock:*

  Due to the age of the neighbourhood and its houses, many are in need of repair or warrant removal to make way for denser missing middle housing.

Figure 29:
Photos of existing houses on large lots in Holmedale that are prime candidates for densification.

- *Existing Walkability & Mixed-Use:*

Figure 30:
Photo of a restaurant and shops located within the neighbourhood of Holmedale.

Figure 31:
Photo of Fume Resto-Bar, one of Brantford's most popular fine-dining establishments, located in Holmedale.

Figure 32:
Photo of Vic's Variety, a long standing commercial fixture in Holmedale.

- *Existing Walkability & Mixed-Use continued:*

  Most of these original neighbourhoods were built during a time when automobile ownership was not common or non-existent. Consequently, neighbourhoods evolved within close proximity to factories which permitted residents to walk to work. Similarly, other amenities popped up within original neighbourhoods such as butchers, green grocers, bakers, barber shops, tailors, general stores, pharmacies and other businesses that catered to the needs of the pedestrian neighbourhood population. Some of these businesses continue to operate, providing residents the opportunity to engage in a walkable lifestyle that reduces car dependency. In addition to having many businesses incorporated into its architectural fabric, the neighbourhood itself was commonly located within walking distance to downtown commercial centers. Holmedale is a prime example of this, as it is located within walking distance to Brantford's historic downtown core which is also now home to the Wilfrid Laurier University Campus.

- *Human Centric Scale: The Impact of the Automobile on Urban Form and Social Interaction*

  The impact of the automobile on new suburban developments is immense as it has become a primary design parameter. Houses are spaced as close together as permitted to maximize the amount of units that can be built in a new development. This results in homes being setback further from the street to permit driveways to be located in front of the house. Attached garages routinely dominate the front facade of the house disconnecting the house from the public realm and transforming streetscapes into mere parking lots.

Figure 33:
Photo of a typical attached housing typology in West Brant where the majority of the front elevation is dominated by garage doors.

The presence of the garage at the front of the house also limits inhabitants' visual access to the shared public realm of the street in the form of windows or functionally sized porches. Instead of being engaged in the public facing side of the house, residents are sequestered to private rear yards, cutting them off from social contact that might otherwise foster a sense of community.

In neighbourhoods that were established prior to the pervasiveness of the automobile, car storage is typically located beside the house, behind the house or better yet, off of a rear laneway. This allows houses to be more engaged with the public realm as they are typically located closer to the street. The adjacency of these homes to the street also helps to create a more intimate, human scaled public space where residents are more likely to spend time and interact with one another. The absence of a street facing garage that dominates the front of the house further permits the dwelling to have street facing windows and front porches that promote social interaction and the creation of a sense of community.

Figure 34:
Photo of a front porch, a common feature in Holmedale that helps to engage the public realm and create a sense of human-scale.

- *Flexible Zoning*

  When zoning bylaws came into existence, the regulations that were applied to existing neighbourhoods, such as Holmedale, were influenced by their existing conditions, continuing to permit mixed-use and a greater variety of housing typologies. This is in contrast to newer suburban neighbourhoods where restrictive single-use residential zoning is typically applied. Unfortunately, these restrictive zoning measures which were meant to ensure human safety have over looked the potential of more permissive mixed-use zoning to foster vibrant, walkable neighbourhoods. It has also paved the way for car dependence, a human safety concern in its own right.

- *Proximity to Nature*

  Original neighbourhood settlements are commonly located close to natural amenities such as rivers or lakes due to their proximity to factories that utilized these water bodies as natural resources for industry. Many of these factories are no longer operational and have been converted to modern low impact uses such as retail, commercial or loft condominiums. With industrial uses no longer dominating the water front, these neighbourhoods have direct access to some of the most scenic natural areas within cities. Older neighbourhoods also have the added benefit of a more mature tree canopy that provides shade and cooling, increased air quality and additional natural beauty and character. A neighbourhood's close proximity to nature provides its residents with increased opportunities for outdoor recreation promoting a healthier life-style and deeper connection to the surrounding environment.

Figure 35:
Photo of a former factory in Holmedale that has been converted into office space and a health spa.

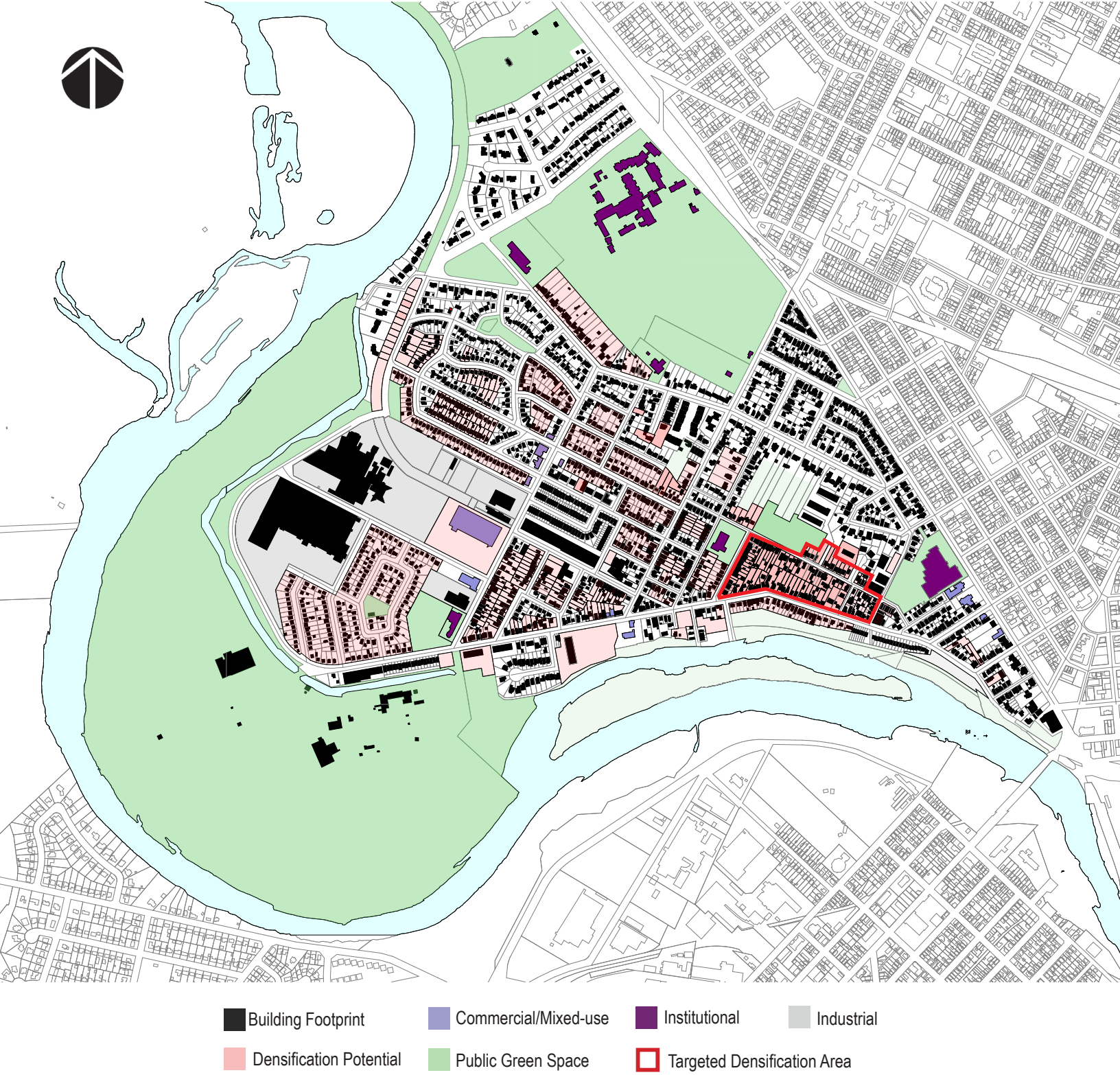


Figure 36:

Figure-ground diagram of Holmedale, highlighting oversized lots with potential for densification as well as the targeted area of Holmedale that will be focused on as the site for the design proposals.

5.5 - Conclusion

The key neighbourhood characteristics discussed in this section which include: Large lot sizes, deteriorating housing stock, existing walkability and mixed-use, human-centric scale, flexible zoning and proximity to nature are not unique to Holmedale. Instead they represent a common neighbourhood typology that can be found in the older sections of many similar sized cities. Within Brantford, several other neighbourhoods possess similar characteristics that make them compatible with soft densification and the creation of walkable communities. In addition to Holmedale, these neighbourhoods include: North Ward, Terrace Hill, East Ward, Eagle Place, Old West Brant and the Downtown district. Likewise, nearby cities close in size to Brantford such as Cambridge, Kitchener-Waterloo and Guelph also possess similar neighbourhoods that are compatible with the proposed residential densification in this thesis. A more detailed review of the compatibility of the design proposals to alternate locations will be explored in *Section 9 - Application of Prototypes in Similar Sized Cities.*

Endnotes

1. 'Brantford Median Price', CREA , accessed 3 April 2023, https://stats.crea.ca/mls/brnt-median-price.

2. Statistics Canada. 'Census Profile, 2016 Census - Brantford [Population Centre], Ontario,' accessed April 3, 2023. www12.statcan.gc.ca

3. 'Brantford Median Price', CREA , accessed 3 April 2023, stats.crea.ca/mls/brnt-median-price.

4. Statistics Canada. 'Census Profile, 2016 Census - Brantford [Population Centre], Ontario,' accessed April 3, 2023. www12.statcan.gc.ca.

5. 'Demographic and Census Information', accessed 2 March 2023, https://www.advantagebrantford.ca/en/data-centre/demographic-and-census-information.aspx.

6. 'More Homes Built Faster Act, 2022', Legislative Assembly of Ontario, accessed 23 October 2023, www.ola.org/en/legislative-business/bills/parliament-43/session-1/bill-23.

7. James Howard Kunstler, *Home from Nowhere: Remaking Our Everyday World for the Twenty-First Century,* 1st Touchstone ed. (New York: Simon & Schuster, 1998), 113-149.

Section 6:
Design Parameters

6.1 - Introduction

The development scope of this thesis will focus on the densification of existing lots within the Brantford neighbourhood of Holmedale. In an effort to expedite the addition of missing middle units to the housing stock, the majority of the proposed designs will adhere to existing zoning by-laws making the development process as simple as obtaining a building permit. However, there are circumstances where the pursuit of additional planning approvals may be warranted, such as the development of a large lot that could be severed to permit the construction of two or more prototypes, as most zoning by-laws permit only one principal building per lot. Additional scenarios where the prototypes do not comply with zoning is due to the ability of the prototypes to be configured into multiple unit configurations with anywhere from two to six units. Currently, anything above three units per lot is not permitted by zoning by-laws, despite the fact the size and appearance of the building remains unchanged. One strategy to avoid additional planning approvals when developing a proposed prototype is to initially construct it as a lower density version (2-3 units) that complies with current zoning by-laws. As zoning bylaws catch up with the need to add affordable missing middle units to existing neighbourhoods the flexibility of the prototypes will easily allow for re-configuration into denser versions (4-6 units). This inherent flexibility demonstrates that it is possible to integrate more density than is currently permitted in most zoning-by-laws without overwhelming the overall fabric and scale of the neighbourhood.

However, before advancing into the initial design stages, a thorough understanding of design constraints must be obtained through the review of municipal zoning bylaws and building code requirements. Once these less negotiable parameters are identified, design decisions can then be applied to achieve the desired architectural solution. To begin with, a review of Brantford's Zoning By-Law 160-90 will define the restrictions and requirements for the targeted neighbourhood of Holmedale.

6.2 - Zoning Parameters

Table 6-1: Brantford Zoning By-Law 160-90	
7.8. Residential Conversion Zone (RC)	
7.8.1. Permitted Uses	
.1 Single-detached dwellings. .2 Semi-detached dwellings. .3 Duplex dwellings. .4 Triplex dwellings. .5 Converted dwellings. .6 Street townhouse dwellings, comprising a maximum of three attached dwelling units. .7 Lodging houses. .8 Retirement homes.	.9 Bed and breakfast establishments. .10 Day nurseries. .11 Home occupations. .12 Mini-group homes. .13 Group homes. .14 Group residences. .15 Crisis residences. .16 Group correctional homes. .17 Accessory uses, buildings, and structures. .18 Uses permitted in Section 6.1.
7.8.2. Regulations	
Any use, building, or structure in a RC Zone shall be established in accordance with the following: .1 Single-Detached, Semi-Detached, Duplex, Triplex, Converted and Street Townhouse Dwellings, Lodging , Houses, and Retirement Home	
.1 Lot Area (minimum)	
.1 Single-detached dwelling, lodging house, or retirement home	270.0 m^2
2. Semi-detached, duplex, or triplex dwelling	230 m^2 /unit
3. Converted dwelling	360 m2
4. Street townhouse dwelling	185 m2 /unit

2. Lot Width (minimum)	
1. Street townhouse dwellings containing a maximum of three attached dwelling units on an individual lot	9m
2. Semi-detached, duplex,triplex or street townhouse dwelling	6m /unit
3. All other residential uses	9m
3. Lot Coverage (maximum)	
1. Street townhouse dwellings containing a maximum of three attached dwelling units on an individual lot	40%
2. One street townhouse dwelling unit on an individual lot	48%
3. All other residential uses	40%
4. Building Height (maximum)	3 Storeys
5. Front Yard (minimum)	6.0m or the Established Front Building Line, whichever is the lesser

6. Rear Yard (minimum)	7.5 m
7. Side Yard (minimum)	
1. Interior	0.6m
2. Exterior	0.6m
3. Common Walls	In accordance with Section 6.20

8. Gross Floor Area (minimum)	
1. Single-detached dwelling	70.0 m2/unit
2. Semi-detached, duplex, triplex, converted or street townhouse dwelling	55.0 m2 /unit
3. Lodging house, retirement home	15.0 m2 /bed
9. Parking	
Apartment	1.5 spaces/unit
Converted	1.0 space/unit
Duplex	1.0 space/unit
Fourplex or Double Duplex	1.5 spaces/unit
Semi-detached	1.0 space/unit
Single detached	1.0 space/unit
Street Townhouse	1.0 space/unit
Block Townhouse	1.5 spaces/unit
Triplex	1.0 space/unit
10. Landscaped Open Space (minimum)	
1. Converted Dwelling	20%
11. Setback from Rail Lines in accordance with	Section 6.30
12. The expansion of any building to be used for the purpose of a converted dwelling shall not exceed a total of:	
1. 50% of the gross floor area of the building which existed at the date of passing of this Bylaw; or	2. 110.0m2, whichever is the lesser.

Zoning Parameter Summary

Below is a list of zoning parameters that will inform the design of the proposed prototypes:

1. **Permitted Use:**

   One principal building per lot with a maximum of three dwelling units per lot.

   *A preliminary review of the prototypes was conducted by Brantford's Deputy Chief Building Official, confirming that each prototype would be considered one principal building as defined by Brantford's zoning by-law 160-90 and the Ontario Building Code. (personal communication, June 20, 2023 - refer to Appendix B)

2. **Lot Frontage & Lot Area Minimums:**

   These requirements apply primarily to the creation of new lots. As most of the proposed prototypes are to be developed on existing lots, this requirement will not apply as per *Section 6.5: Non-Conforming Uses* of *Brantford Zoning by-law 160-90*.

3. **Lot Coverage:**

   The building area which is defined by the Ontario Building Code as the greatest horizontal area of building above grade, cannot exceed 40% of the lot area. According to Brantford's zoning Bylaw this does not include: a carport, unenclosed porch, veranda, deck, unenclosed steps, or a ramp for physically disabled persons.

4. **Building Height:**

   3 storeys, no dimensional restrictions are provided.

5. **Setbacks:**

   Front Yard: 6.0m (19'-8") or the Established Front Building Line, whichever is the lesser.
   Side Yards: 0.6m (2'-0").
   Rear yard: 7.5m (24'-7").

6. **Minimum Gross Floor Area:**

   All proposed units will exceed required minimums.

7. **Parking:**

   Triplex: 1.0 space/unit.
   Apartment: 1.5 space/unit.

   *Denser iterations of the proposed prototypes may require relief from parking requirements.

6.3 - Building Code Parameters

The criteria below is not an exhaustive list of building code requirements but is instead intended to identify code parameters that have significant impacts on the architectural form of the proposed prototypes.

1. **Restrictions on Unprotected Openings (windows and doors):**

   The distance that an elevation of a building is from a property line dictates the amount of unprotected openings that are permitted on that elevation. This is expressed as a percentage of the overall elevation area. The closer a building elevation is to a property line, the less unprotected openings that are permitted. Unprotected openings are not permitted within 1.2m (3'-11") of a property line.

   Ontario Building Code, Table 9.10.14.4. Maximum Aggregate Area of Unprotected Openings in Exterior Walls

2. **Number of Required Exits:**

   At least two exits shall be provided from every floor area except a single exit is permitted from each storey in buildings of 1 and 2 storeys in building height.

   Refer to Ontario Building Code, 9.9.8.2. Number of Required Exits

3. **Exiting Requirements:**

   Ontario Building Code, 3.3.4.4. Egress from Dwelling Units

   (5) In a building of residential occupancy not more than 3 storeys in building height, a doorway from a dwelling unit is permitted to open directly into an exit stairway provided the dwelling unit has a second and separate means of egress.

   (6) If a dwelling unit has a second and separate means of egress, one means of egress from a dwelling unit is permitted to pass through,

   (a) an interior corridor served by a single exit,

   (b) an exterior balcony served by a single exit stairway, or

   (c) an exterior passageway served by a single exit stairway.

6.4 - Design Decisions

1. **Development Methodology**

   The development methodology will be infill of existing lots as well as lot severance where more than one prototype can fit on one lot. For an in depth explanation of the rationale for this development methodology refer to *Section 4: Review of Development Strategies*.

2. **Neighbourhood Selection**

   The location of the proposed developments will be in the established neighbourhood of Holmedale in Brantford ON which represents a common neighbourhood typology that can be found in the older sections of many similar sized cities. For an in depth explanation of the rationale behind the site selection refer to *Section 5.3 - Neighbourhood Selection.*

3. **Parking:**

   Parking and car storage will be located beside and behind the front elevation of the proposed prototypes. This design decision has many positive impacts on both the quality of the dwelling unit as well as the neighbourhood. By eliminating parking spaces and vehicle storage from the front of the building there are increased opportunities for windows, doors and outdoor amenity space. Not only does this increase natural light within the dwelling unit, it also helps to connect its inhabitants to the communal pedestrian realm, promoting a sense of community, pedestrian safety and human scale. Locating the parking to the side of the building necessitates the creation of a drive aisle which allows for an increased side yard setback on one side of the building. This increased setback permits increased unprotected openings in the form of windows, further enhancing natural lighting within the unit. This is an upgrade from typical new developments which tend to locate dwelling units as close to property lines as possible reducing the opportunity for windows at the sides of the house.

Ground Floor Located at Grade:

Locating the ground floor at grade allows the dwelling unit to meet the requirements for barrier free access as it eliminates the need for stairs. This also avoids ramps which require an extraordinary amount of space to comply with barrier free accessibility requirements. In addition to creating barrier free access, locating the ground floor at grade also helps to reduce the height of the proposed prototypes, which will be one to two stories taller than the majority of the existing houses in the neighbourhood. Another advantage to having direct access to the ground plane is that it increases the inhabitants connection to the outdoors and the public realm.

A perceived drawback of locating the ground floor at grade might be that it renders the basement unusable as habitable space. Although this was a consideration during the initial phases of the project, the value of creating barrier free access for individuals with mobility limitations is considered to be of greater value. Another consideration was the fact that in neighbourhoods that are close to water bodies, such as Holmedale, basements are more susceptible to flooding. Some building designs deal with this problem by raising the basement halfway out of the ground, locating it above the water table and allowing for bigger windows that are more suitable for a living space. However in doing so, both the basement and first floor are removed from the ground plane by a flight of stairs, eliminating or severely complicating the possibility for barrier free entry. Although raising the basement out of the ground does provide the opportunity for more natural light, it still falls short of a unit that is completely above grade. The attempt to create livable spaces below grade compromises the accessibility of both the basement and the first floor. Accordingly in the proposed prototypes, basements are programmed for storage and mechanical equipment with reduced ceiling heights that keep the basement above the water table.

6.5 - Conclusion

This concludes the fundamental parameters that went into shaping the form of the initial fit tests and massings, laying the groundwork for the design of the prototypes in the proceeding section.

Section 7:
Design Proposals

7.1 - Introduction

Having defined the design parameters in the previous section, this section will implement these parameters to develop housing prototypes. Initially, a lot coverage study was conducted within the target area. This study was then narrowed down to six sites that are specifically chosen to represent a variety of typical lot sizes within the neighbourhood of Holmedale. The fit-test results for the six selected sites were then further defined as three-dimensional massings that begin to give form and scale to the prototypes. The remainder of the section is devoted to the presentation of six prototypes that were developed in accordance with the design parameters established in Section 6. Prototype-1 consists of more detailed information and diagrams outlining design principals that will serve as the template for prototypes two through six. Adaptations to each subsequent prototype will be illustrated and discussed in their respective sections.

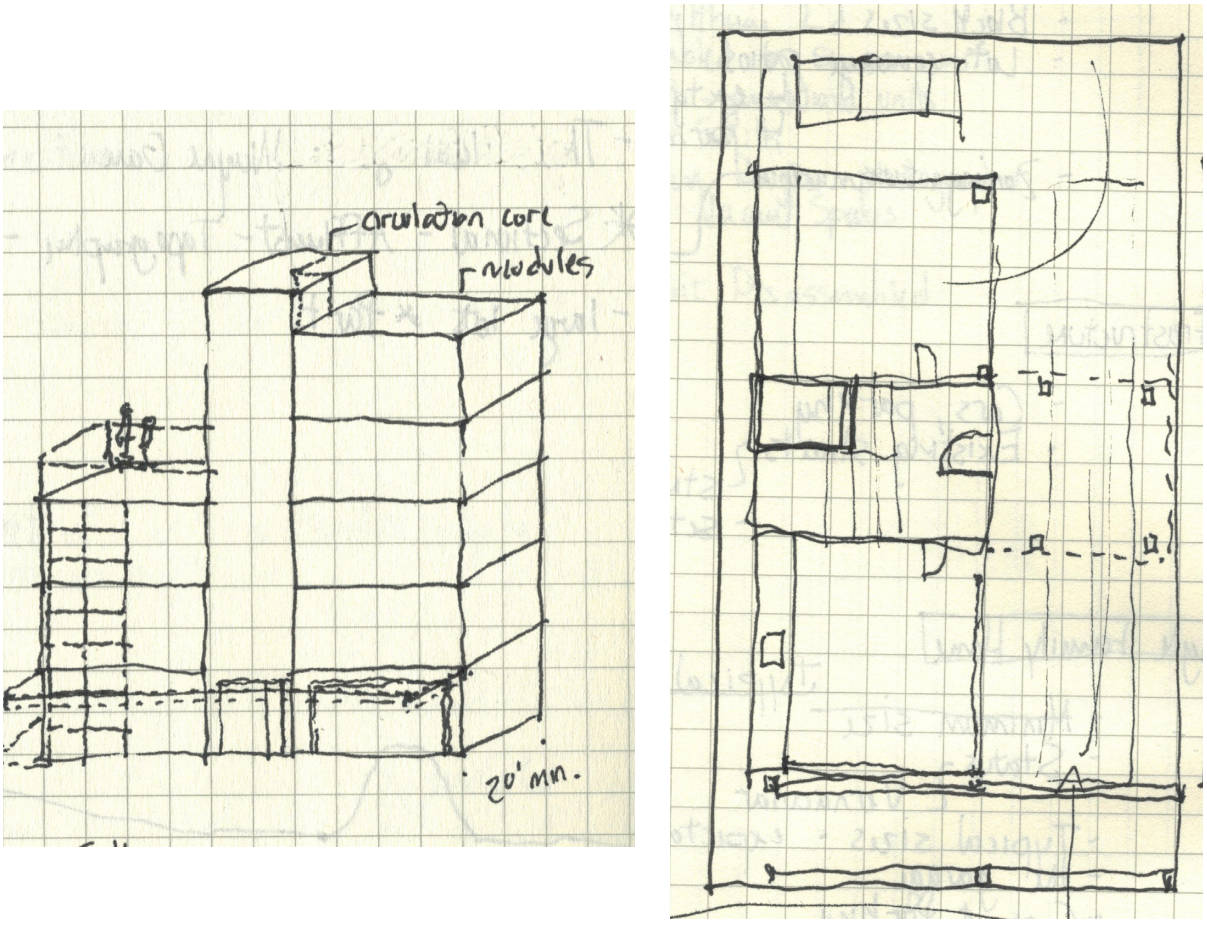


Figure 37:
Initial concept sketches of the prototype.

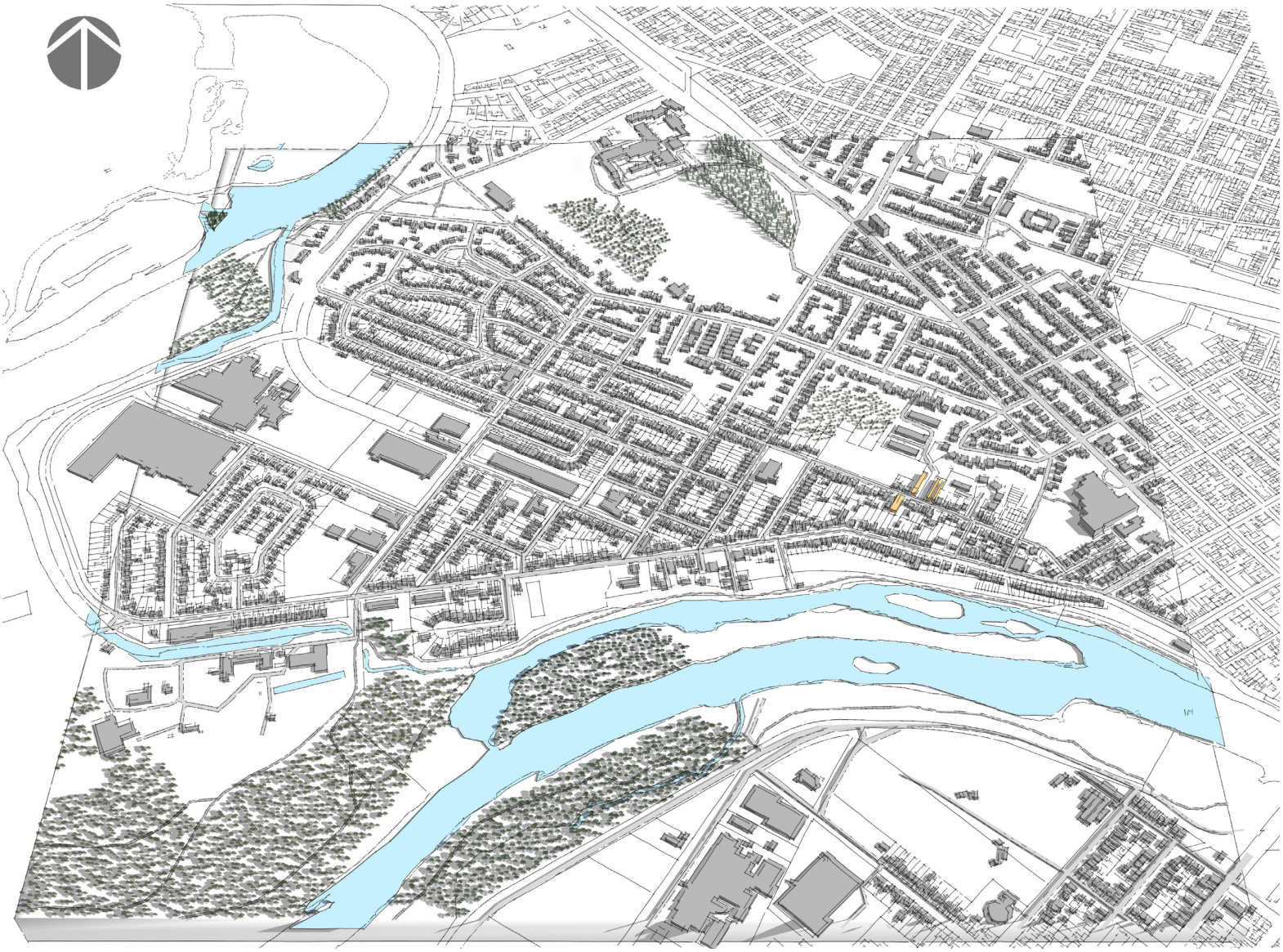


Figure 38:
Massing model of Holmedale.

Figure 39: Massing model of target area with initial zoning envelope fit-tests.

7.2 - Fit-Tests & Site Selection

The lot coverage study depicts the maximum building footprint that is permitted by the zoning bylaw. The purpose of this exercise is to demonstrate how much additional built form can be added to existing lots to ascertain the feasibility for densification. As can be seen in the block plan below, most of the properties within the target area are able to absorb a significant amount of additional built form while still adhering to the zoning bylaw's lot coverage restrictions. As mentioned in previous sections this is a common occurrence in older neighbourhoods that evolved over a longer period of time.

Lot Coverage Study

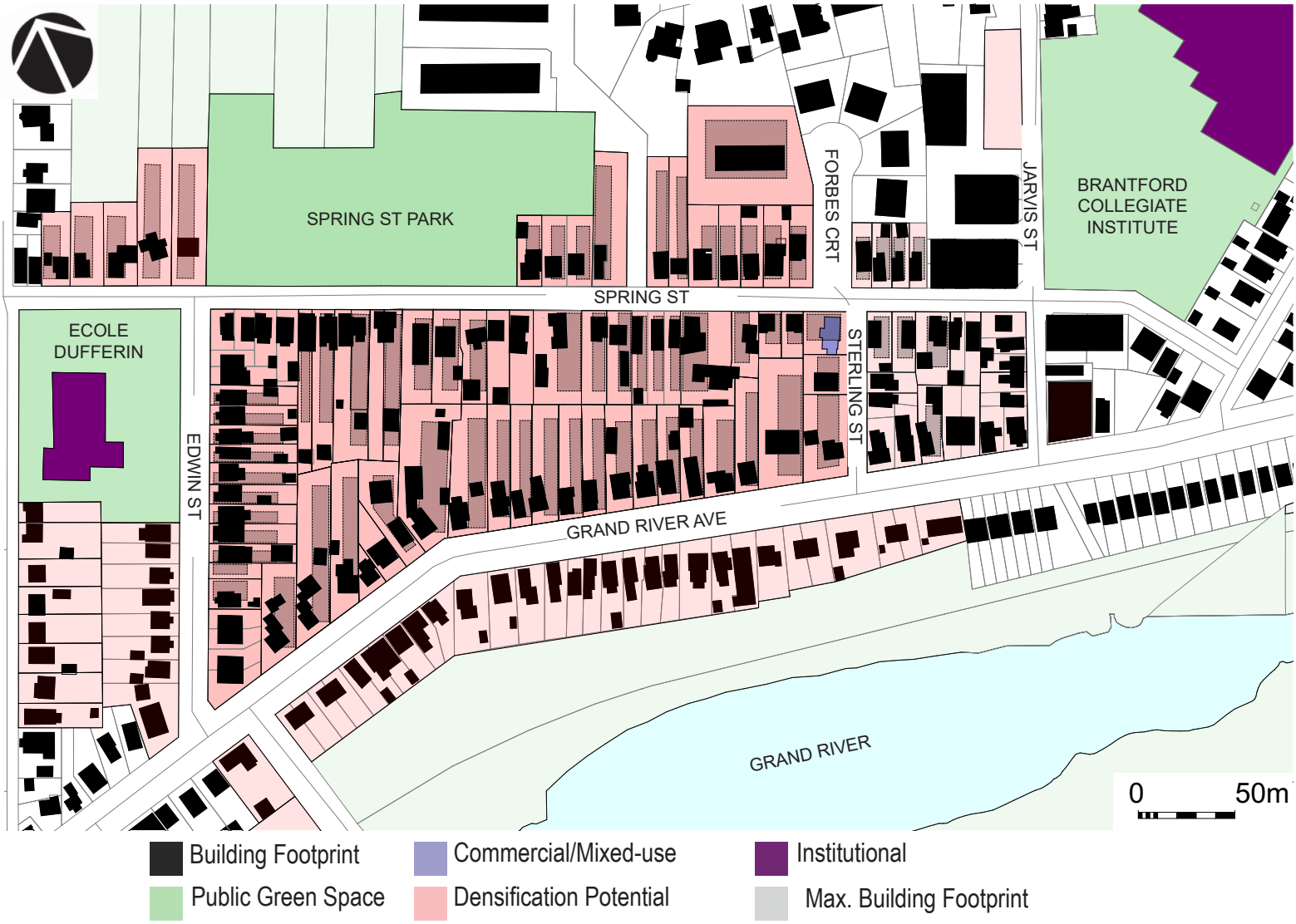


Figure 40:
Figure-ground diagram illustrating the maximum allowable 40% building footprint in contrast with existing building footprints to display the densification potential of properties within the target area.

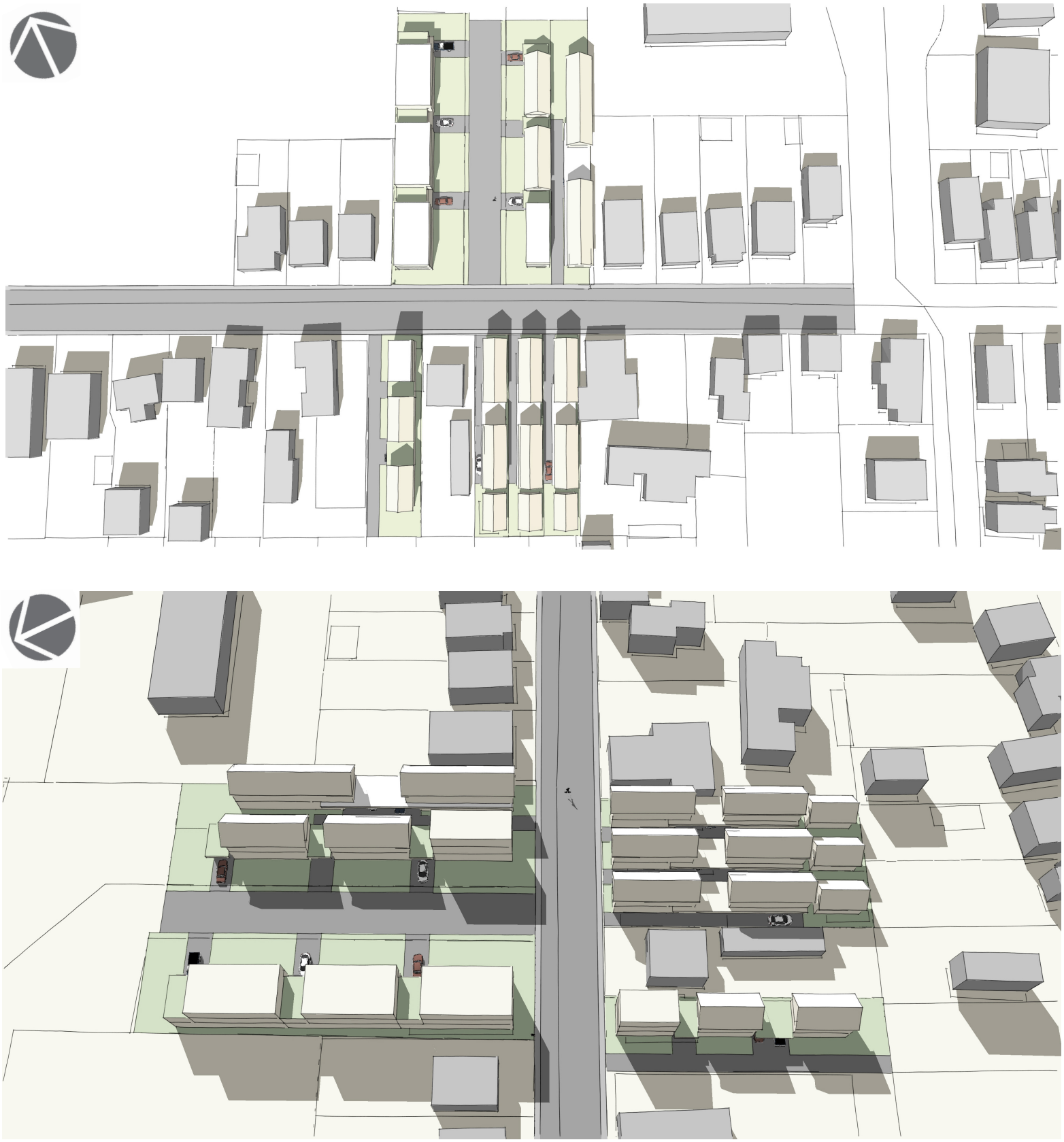


Figure 41: Aerial plan views of initial schematic 3D massings on various sites in the target area.

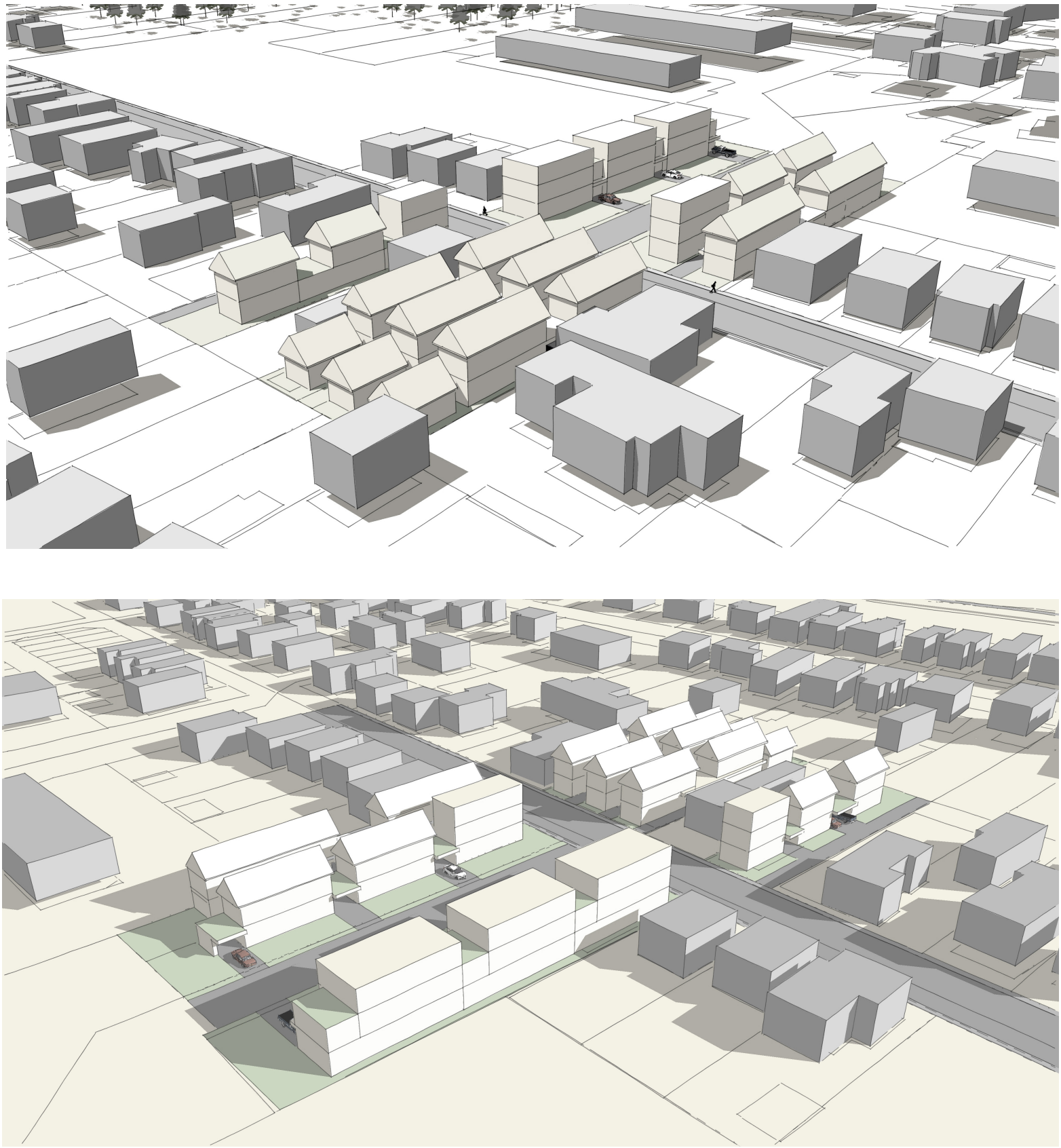


Figure 42: Aerial perspective views of initial schematic 3D massings on various sites in the target area.

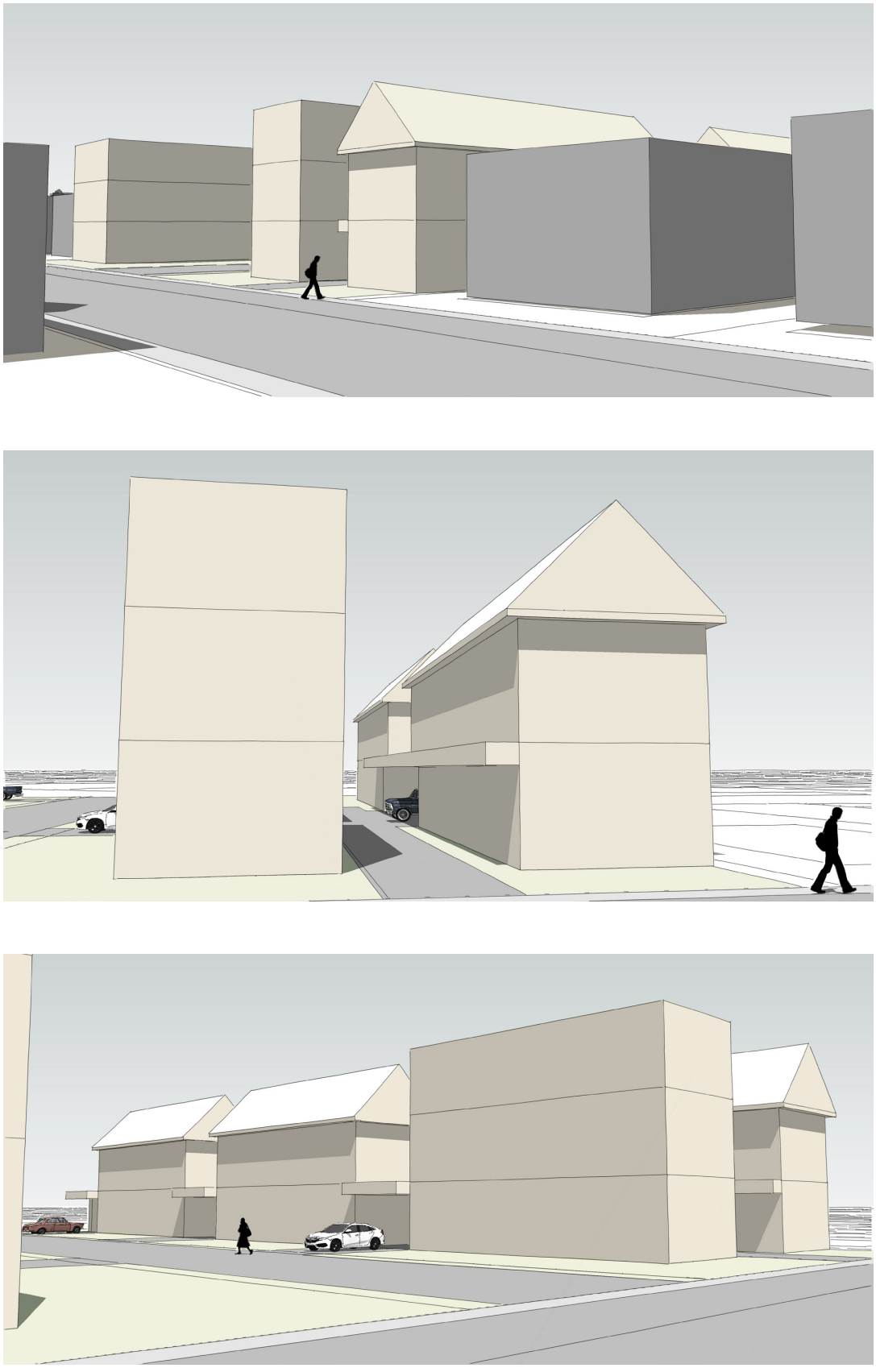


Figure 43: Street level perspective views of initial schematic 3D massings.

The figure-ground diagram below identifies the sites that have been selected for the development of six prototypes. These sites were not necessarily chosen because they demonstrated the highest development potential, but instead were chosen to represent typical lot sizes that are common throughout the neighbourhood of Holmedale and other neighbourhoods in Brantford, as well as similar sized cities.

Lot Selection

Figure 44:
Figure-ground diagram identifying the development sites for this thesis.

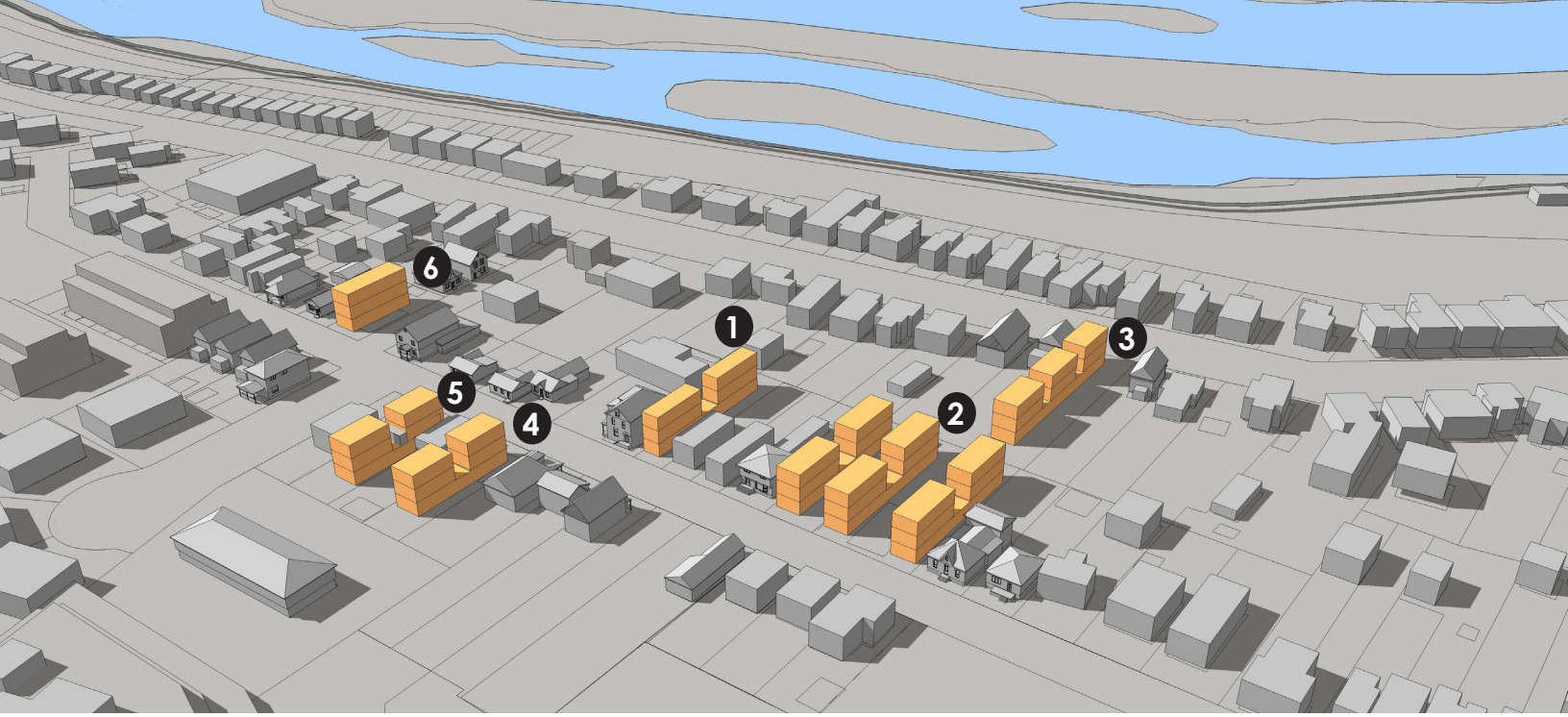


Figure 45:
North aerial view of 3D massings for prototypes one through six.

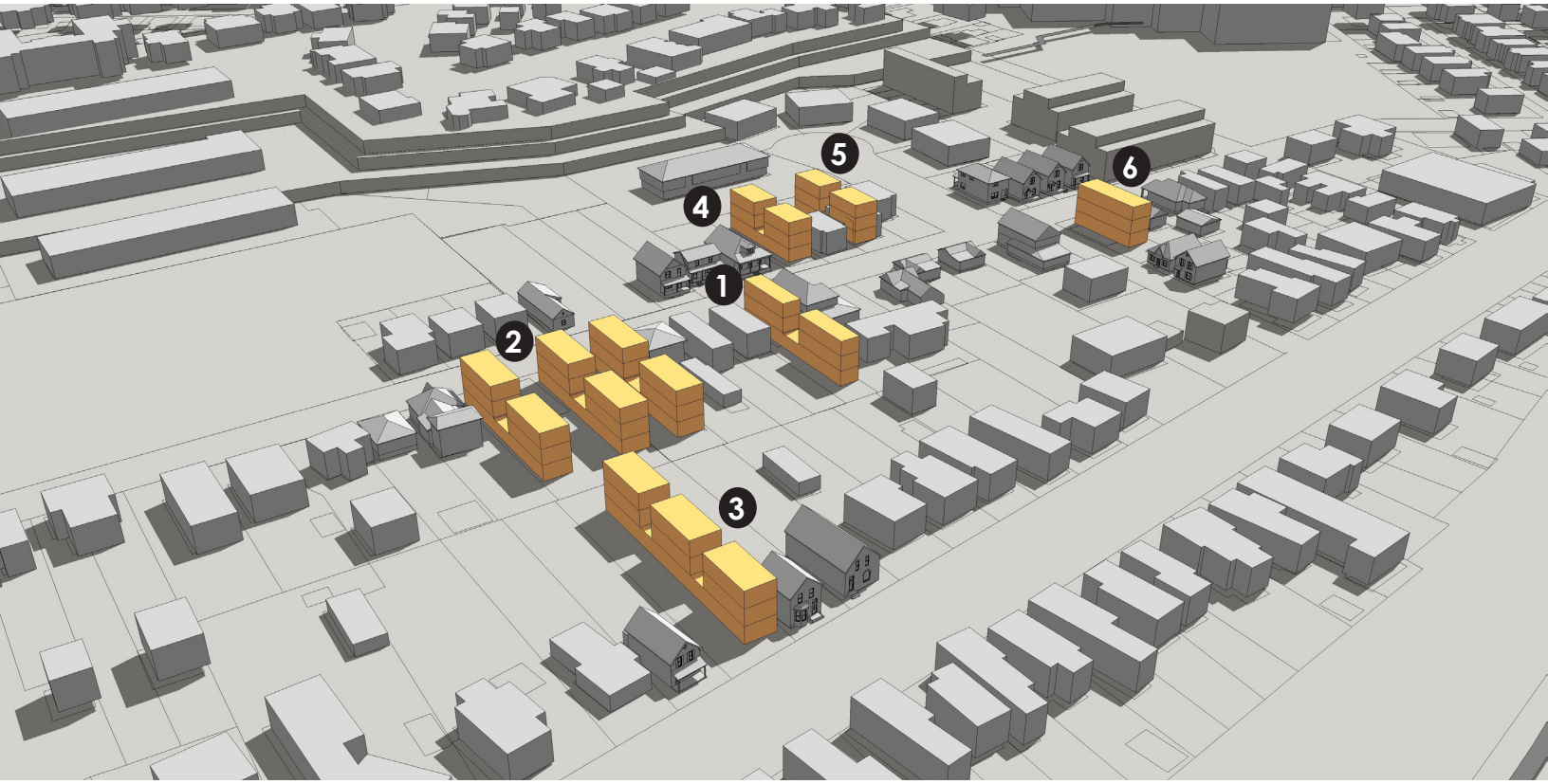


Figure 46:
West aerial view of 3D massings for prototypes one through six.

Progressing from the figure-ground fit-test study, the aerial perspectives above illustrate the initial massings of the proposed prototypes, displaying the maximum height permitted by the zoning bylaw. The architectural form has been refined into floor levels as well as the separation of units.

7.3 - PROTOTYPE - 1

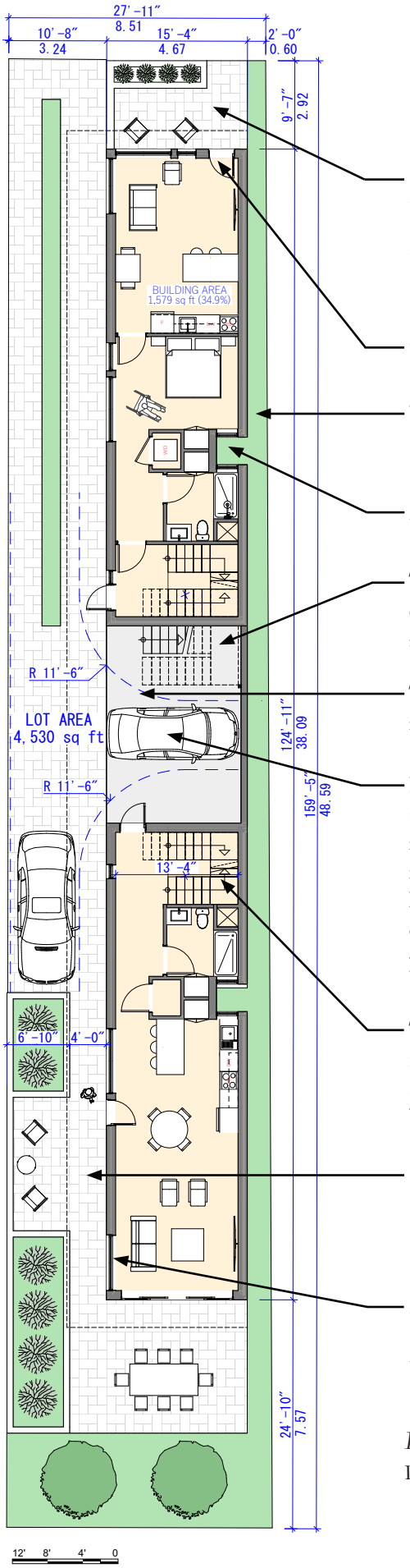
Figure 47:
North-East Perspective of two versions of Prototype-1 located at 38 and 40 Spring St.

7.3.1 - Introduction

Prototype - 1 is best suited to lots with a minimum lot frontage of 26 feet and a lot depth of 160 feet. This of course may fluctuate depending upon varying municipal setback requirements. This first prototype was conceived of as a proof of concept as it is located on one of the more challenging site typologies in the neighbourhood. 38 Spring St. is a long narrow site with a lot frontage of 28 feet and depth of 160 ft. Long skinny properties like these are more common in older neighbourhoods where densification was not a priority at the time of their creation. Similar to most of these long skinny lots, 38 Spring St. currently has a small single family detached house with a large underutilized back yard. This prototype addresses the challenge of accessing vast amounts of underdeveloped residential land without the need for the complicated, costly and the time consuming process of assembling multiple pieces of property. In doing so this prototype helps to preserve the existing character and scale of the historic neighbourhood of Holmedale.

The drawings and diagrams in section 7.3.2 to 7.3.7 serve to illustrate and describe the design principles that are fundamental to all of the prototypes.

Figure 48:
Figure-ground diagram identifying the location of prototype-1.



7.3.2 - Site Planning Principles

Removing garages and parking from the front of the house opens up the opportunity for windows, increasing natural lighting and connection to the public realm. This also enables the building to be set as closer to the street, helping to define human scaled public exterior space.

Locating the ground floor at grade permits barrier free access and encourages engagement with the public pedestrian realm.

The 2'-0" side yard setback permits combustible construction and adheres to zoning bylaws. The ideal side yard setback on this side of the prototype is 4'-0" to permit unprotected openings (windows).

An exterior light well is included where the building is closer than 4'-0" to property line.

The exterior stairwell provides a second means of egress for fire escape exiting from each floor. This is required for multi-level apartment buildings three stories and over.

The optimal driveway width is 10'-0" with a minimum 11'-6" turn radius, allowing medium sized cars to make a 90 degree turn.

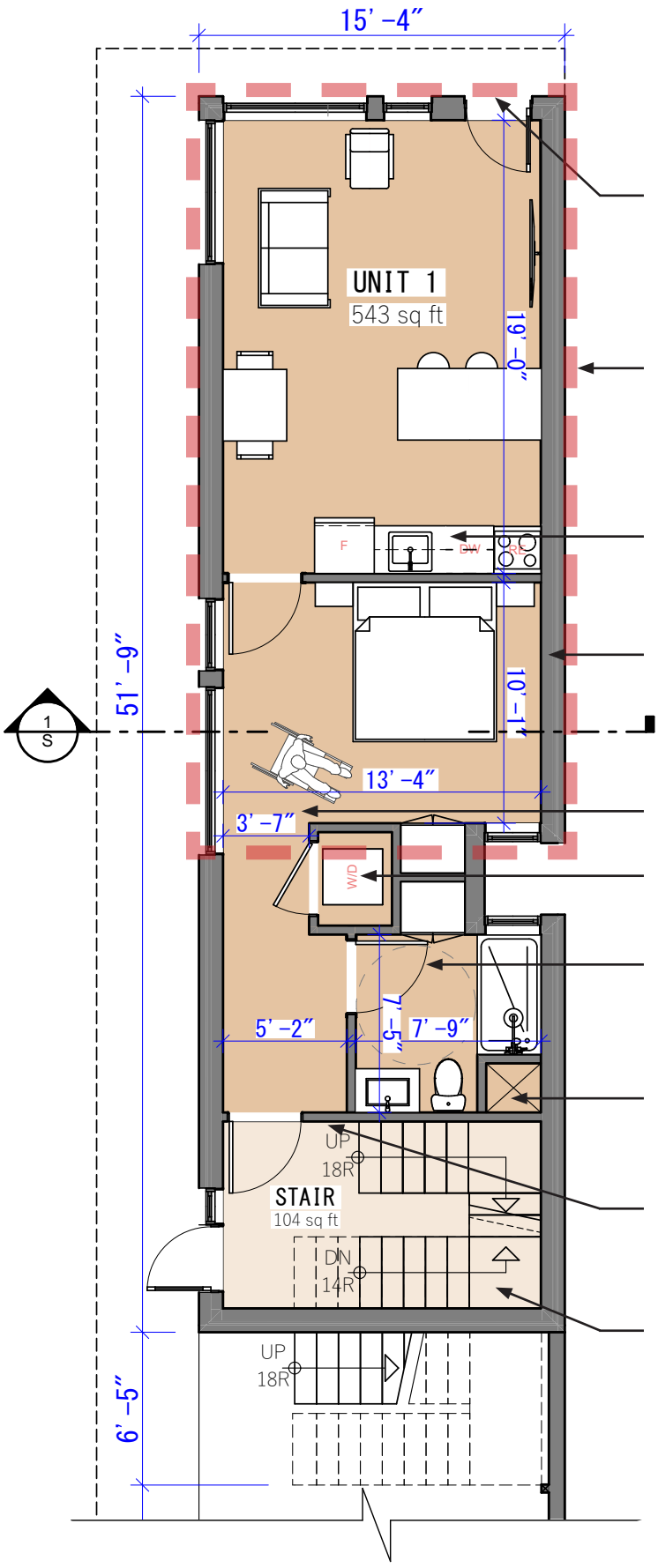
Parking is located in the middle of the building to provide acoustic separation between the front and rear units while also allowing natural light into the middle of a long narrow site. The site plan does not provide the same number of parking spaces as potential units, however this can be compensated for in a number of ways, including: on-street parking, car sharing, increased frequency and expansion of public transit and the walkability of the proposed neighbourhood.

The minimum interior width is constrained by the space required for the stairwell. 13'-4" is the minimum width required for stairs servicing a 10'-6" floor to floor height. To reduce the width of the building for a narrower site, a decrease in ceiling height is required.

Hardscaping is comprised of permeable pavers which increases the absorption of water runoff, preventing the overwhelm of municipal storm water systems.

Locating parking beside the building increases the side yard setback allowing for a higher percentage of unprotected openings (windows) which results in increased natural lighting and ventilation.

Figure 49:
Prototype-1 Site Plan.



7.3.3 - Programming Principles & Modules

Ground Floor at Grade: Barrier free modules located at the ground floor create a truly accessible dwelling unit catering to under served demographics with mobility limitations.

Re-programmable floor area: Minimal interior programming allows the floor space to be re-configured into a variety of alternate modules and unit configurations.

Standardized kitchen module. Plumbing rough-ins will be provided for barrier free module as well as the living space module to permit future adaptability.

Elimination of shared walls with neighbouring units increases acoustic privacy and the opportunity for windows on multiple exterior walls.

Minimum 43" provided for a barrier free path of travel.

Standardized closet modules include plumbing rough-ins for the installation of laundry machines.

Standardized barrier free bathroom modules are repeated in the same location on each floor simplifying construction and maximizing the adaptability of the remaining floor plate.

Service shaft located directly over the mechanical room in the basement allows for efficient distribution of mechanical services to each floor.

24" latch side clearance on in-swing side and 12" clearance on opposite side is provided to maintain a barrier free path of travel.

Autonomous fire rated stairwell modules allow floor levels to be separated or combined into a variety of unit configurations while maintaining privacy.

Figure 50:
Prototype-1 barrier free module floor plan.

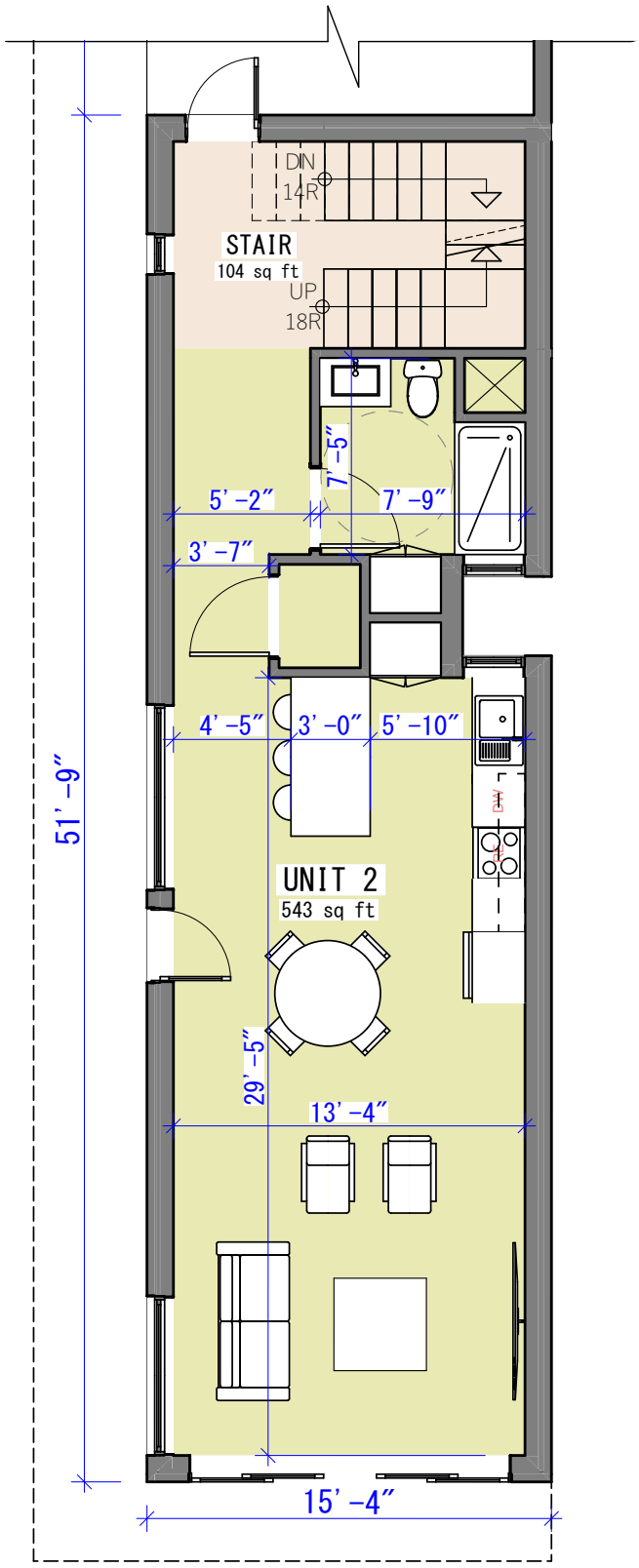


Figure 51:
Prototype-1 living space module floor plan.

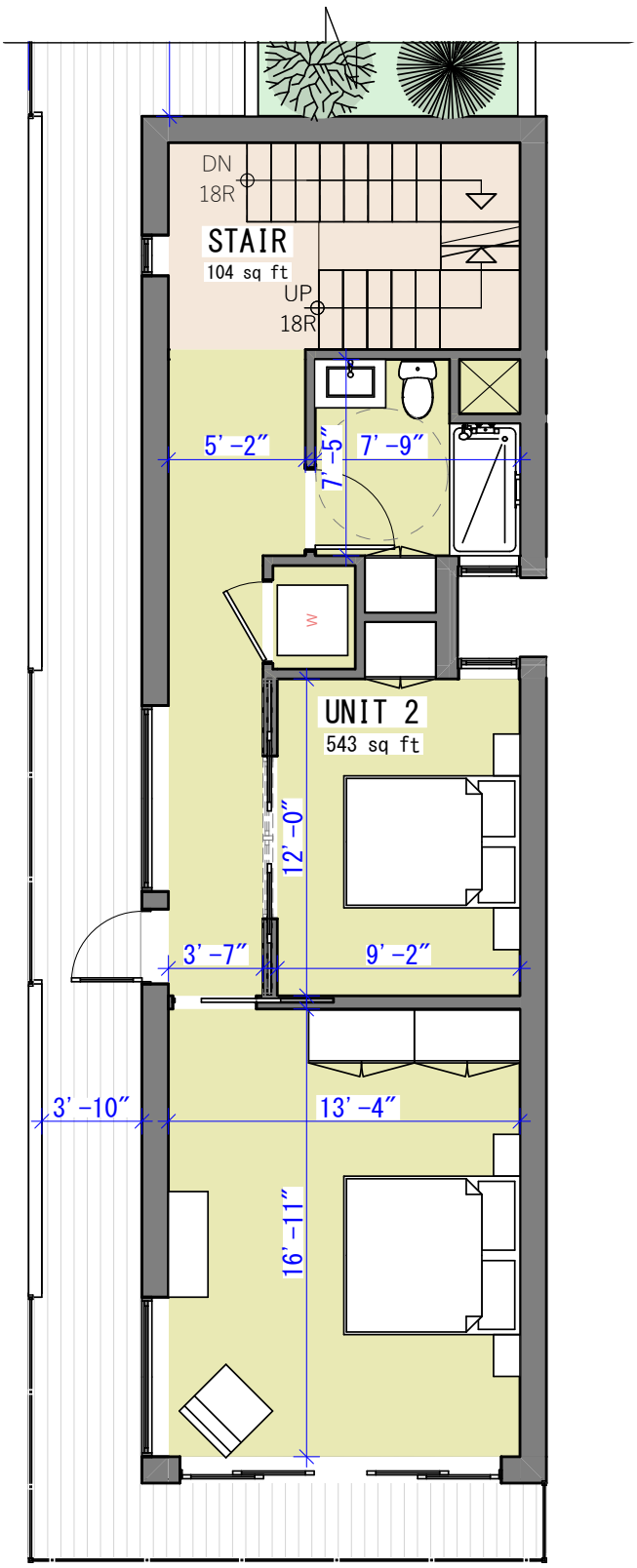


Figure 52:
Prototype-1 bedroom module floor plan.

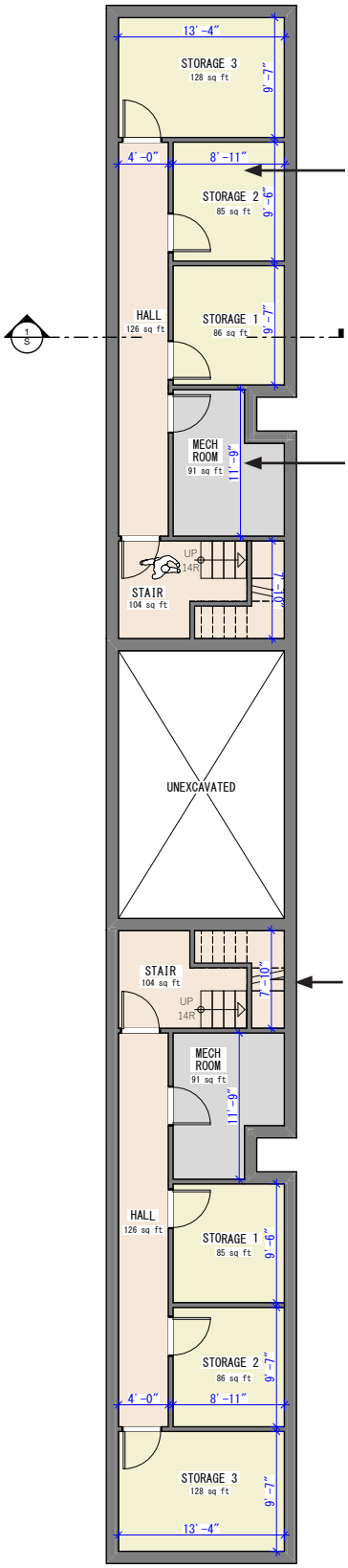


Figure 53:
Prototype-1 basement floor plan.

7.3.4 - Prototype Anatomy & Floor Plans

Storage

Due to the basement being located completely below grade, programming is limited to storage space and housing of mechanical equipment.

HVAC Systems

The mechanical room is located directly below the service shaft allowing for efficient distribution of services to all floors. Proposed heating systems for the prototypes include high efficiency boilers that will distribute heat to each floor through in floor radiant heating loops. Cooling and supplementary heating will be provided by mini-split ductless heat pump systems with condensers being located on roof tops or balconies. Fresh air exchange will be handled by ductless through wall heat recovery ventilators (HRVs) permitting each potential unit to have autonomous climate control.

Foundations

Insulated concrete forms will be utilized for foundations which provide a built in R-22 rating that insure the basement as well as the floor above stay warm.

Construction Method

The use of lightweight wood frame construction as a structural system will minimize the construction time frames and cost of the infill development. Commonly used for low-rise residential buildings in North America, each floor is built separately as a platform, with lightweight nominal lumber used as the structural component for walls, floors, and roofs. 'Stick-frame' buildings are easy to construct and provide flexibility in design modifications during and after construction.

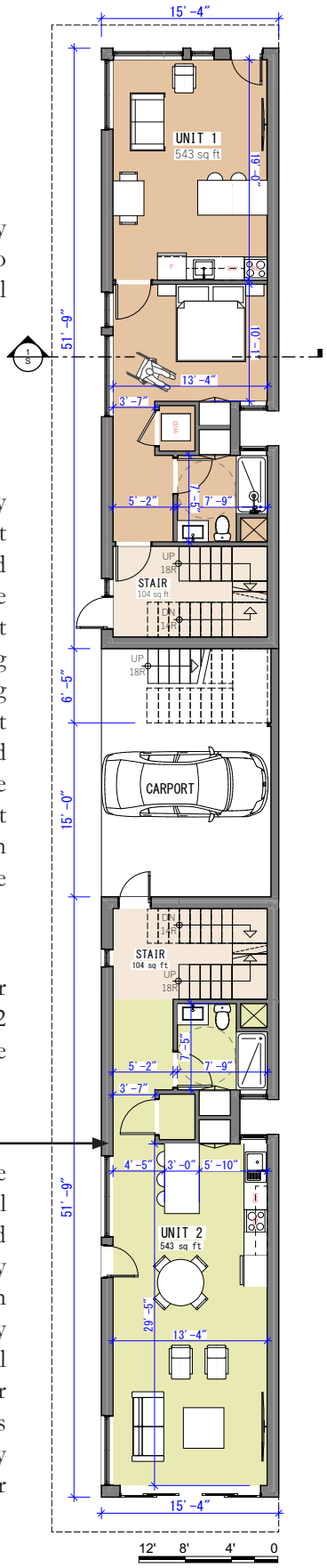
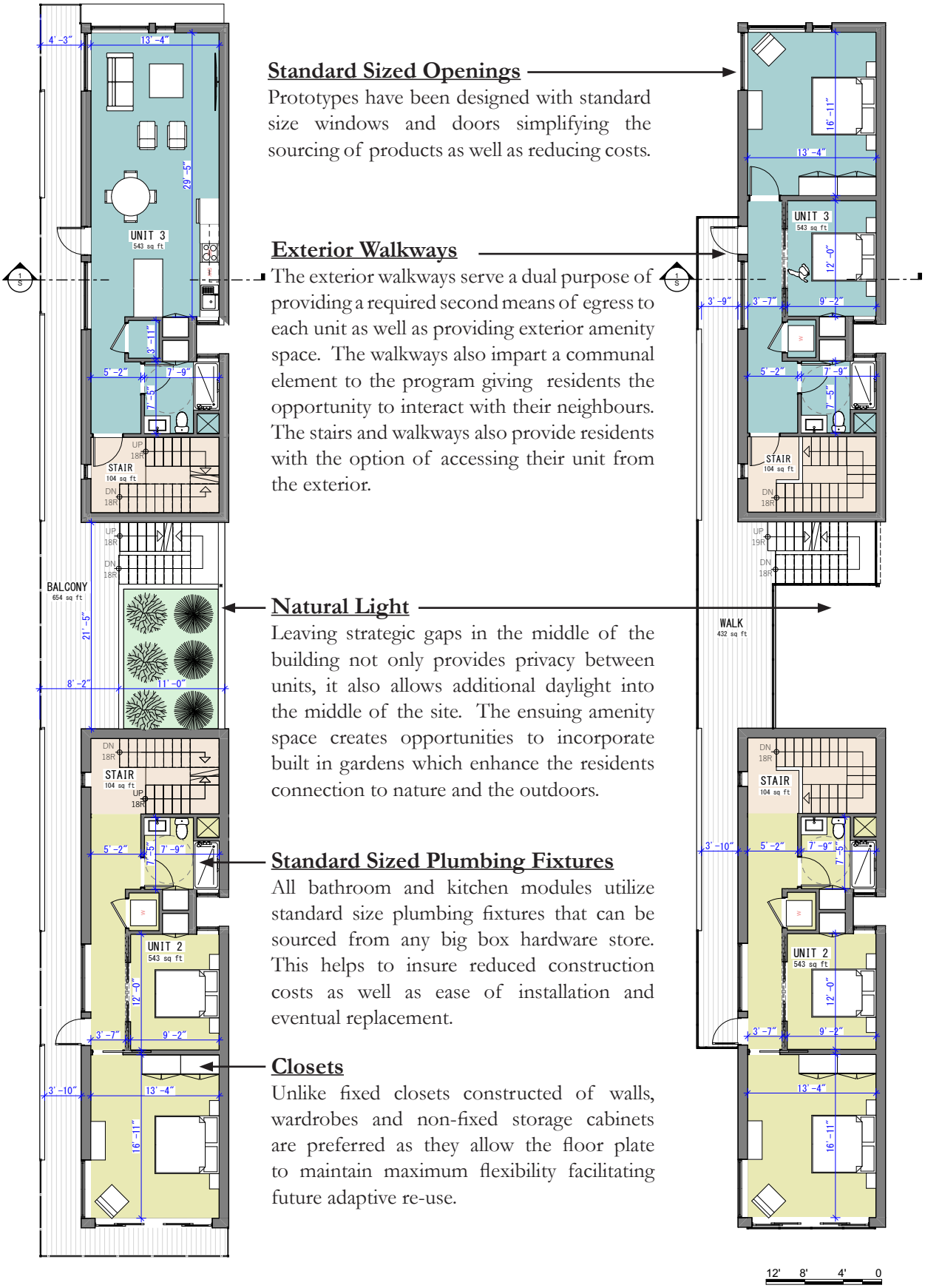


Figure 54:
Prototype-1 first floor plan.



Standard Sized Openings

Prototypes have been designed with standard size windows and doors simplifying the sourcing of products as well as reducing costs.

Exterior Walkways

The exterior walkways serve a dual purpose of providing a required second means of egress to each unit as well as providing exterior amenity space. The walkways also impart a communal element to the program giving residents the opportunity to interact with their neighbours. The stairs and walkways also provide residents with the option of accessing their unit from the exterior.

Natural Light

Leaving strategic gaps in the middle of the building not only provides privacy between units, it also allows additional daylight into the middle of the site. The ensuing amenity space creates opportunities to incorporate built in gardens which enhance the residents connection to nature and the outdoors.

Standard Sized Plumbing Fixtures

All bathroom and kitchen modules utilize standard size plumbing fixtures that can be sourced from any big box hardware store. This helps to insure reduced construction costs as well as ease of installation and eventual replacement.

Closets

Unlike fixed closets constructed of walls, wardrobes and non-fixed storage cabinets are preferred as they allow the floor plate to maintain maximum flexibility facilitating future adaptive re-use.

Figure 55:
Prototype-1 second floor plan.

Figure 56:
Prototype-1 third floor plan.

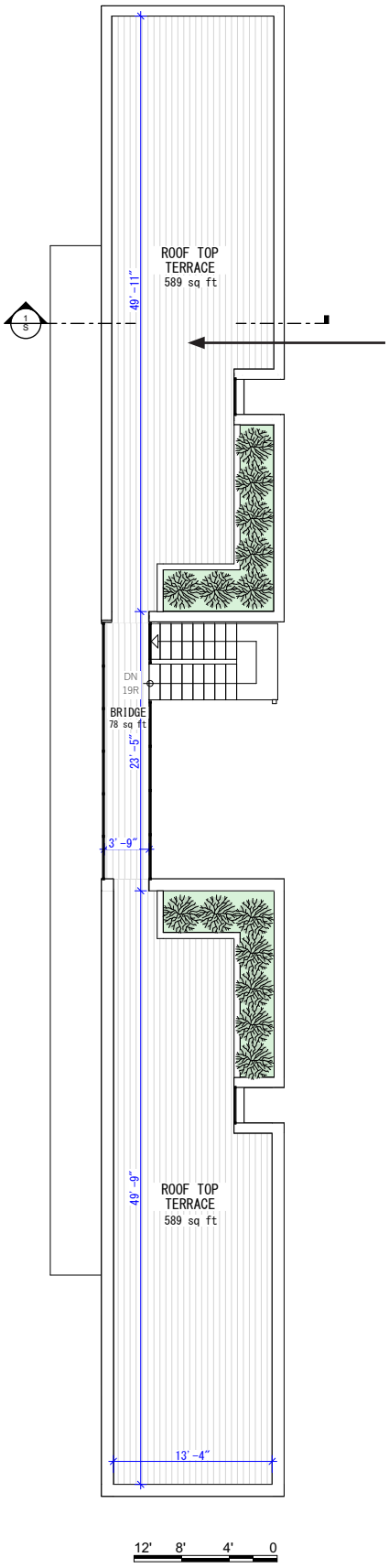


Figure 57:
Prototype-1 roof-top terrace plan.

Potential for Prefabrication

The standardized and repetitive form of prototype's design also lends itself to the construction process of prefabrication. Prefabrication has become a cost-effective solution that allows buildings to be erected quickly with a high degree of quality[1]

Roof Top Amenity Space

Prototypes that are designed with flat roofs provide the opportunity for additional amenity space in the form of a roof top terrace. The roof top terrace is accessible by exterior stairs which also serve as a second means of egress for the dwelling units. Despite the extra expense associated with incorporating a rooftop terrace, it proves especially beneficial on compact sites with limited ground level amenity space. The roof top terrace also provides the opportunity to incorporate additional green space such as a green roof or vegetable gardens. This has the added benefit of reducing the absorption of the sun's heat which mitigates the creation of urban heat islands.

7.3.5 - Construction Assemblies

The cross section below gives a general overview of the primary wall assemblies used to construct the prototypes. Floor type FW-1, the only assembly shared between units, provides an STC rating of 58. STC ratings close to 60 and over provide good soundproofing where residents are not disturbed by very loud noises in neighbouring units[2]. For exterior cladding, durable materials such as masonry and corrugated steel siding are preferable as they help provide the longevity that is necessary for adaptive re-use.

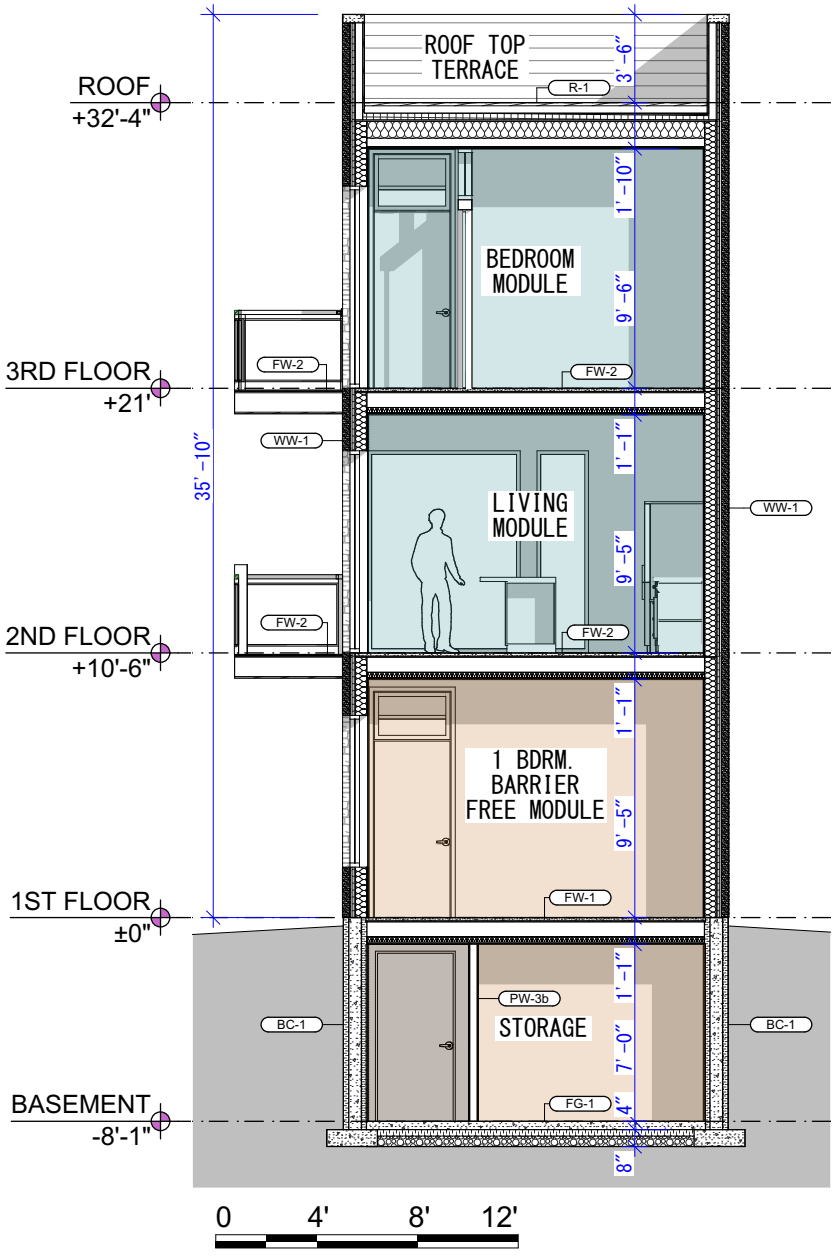


Figure 58:
Prototype-1 cross-section.

BELOW GRADE WALL ASSEMBLIES		
TYPE	PLAN	DESCRIPTION
BC-1		SIKAWALL-1000 ICF PARGING FOXBLOCK - INSULATED CONCRETE FORM FOUNDATION (R-22)
INTERIOR PARTITION ASSEMBLIES		
TYPE	PLAN	DESCRIPTION
PW-3b		1/2" GYPSUM BOARD 2X4 WOOD STUDS @ 16" O.C. 1/2" GYPSUM BOARD
PW-3bS		1/2" GYPSUM BOARD 2X4 WOOD STUDS @ 16" O.C. c/w 3.5" SOUND BATT INSULATION 1/2" GYPSUM BOARD
EXTERIOR WALL ASSEMBLIES		
TYPE	PLAN	DESCRIPTION
WW-1		3 1/2" STONE VENEER w/ MASONRY SUPPORTS 1" AIR SPACE 1" RIGID MINERAL WOOL INSULATION (R5) TYVEK HOME WRAP 7/16" PLYWOOD SHEATHING 2X6 WOOD STUDS @ 16" O.C. C/W ROCKWOOL BATT INSULATION (R22) SMART VAPOUR RETARDER 1/2" GYPSUM BOARD
WW-2		PRE FINISHED CORRUGATED STEEL SIDING 1X4 VERTICAL WOOD STRAPPING 1" RIGID MINERAL WOOL INSULATION (R5) TYVEK HOME WRAP 7/16" PLYWOOD SHEATHING 2X8 WOOD STUDS @ 16" O.C. C/W ROCKWOOL BATT INSULATION (R22) SMART VAPOUR RETARDER 1/2" GYPSUM BOARD
FLOOR ASSEMBLIES		
TYPE	PLAN	DESCRIPTION
FG-1		FLOOR FINISH 4" CAST IN PLACE CONCRETE SLAB C/W RADIANT HEATING LOOPS 3" TYPE 4 RIGID INSULATION(R15) 10mil VAPOUR RETARDER 8" CRUSHED STONE (CLEAR)
FW-1		FLOOR FINISH 1 1/2" CONCRETE TOPPING 3/4" T&G PLYWOOD SUBFLOOR ENGINEERED WOOD JOISTS ACOUSTIC BATT INSULATION RESILIENT CHANNELS 5/8" GYPSUM BOARD *58 STC RATING AS PER O.B.C. SB-3 ASSEMBLY # F14d *RADIANT HEATING LOOPS INSTALLED BELOW SUBFLOOR TO PERMIT FUTURE RELOCATION OF PARTITION WALLS
FW-2		WATERPROOF DECK MEMBRANE 3/4" T&G PLYWOOD SUBFLOOR ENGINEERED WOOD JOISTS 3/4" T&G SOFFIT c/w VENTING
ROOFING ASSEMBLIES		
TYPE	PLAN	DESCRIPTION
R-1		2X6 BROWN P.T. WOOD DECKING 2X6 P.T. WOOD SLEEPERS RIPPED TO MAKE DECKING LEVEL 2 PLY MODIFIED BITUMINOUS MEMBRANE SYSTEM (1% SLOPE MIN.) 1/2" FIBREBOARD OVERLAY TAPERED ROXUL INSULATION (R-10 min.) SMART VAPOUR RETARDER 3/4" T&G PLYWOOD ENGINEERED WOOD JOISTS w/ ROXUL BATT INSULATION (R32 MIN.) RESILIENT CHANNEL 1/2" GYPSUM BOARD

Figure 59:
Prototype-1 construction assemblies.

7.3.6 - Building Sections

Figure 60:
Perspectival sections of Prototype-1.

7.3.7 - Prototype Unit Configurations

The diagrams below illustrate all of the possible unit configurations for the prototypes. Each colour represents a single unit. Units that are three stories high are indicative of a three or four bedroom unit, two stories a two bedroom unit, and one storey a one bedroom unit. It should be noted that prototypes that exceed three units will require a minor zoning change in accordance with the zoning regulations for the proposed sites.

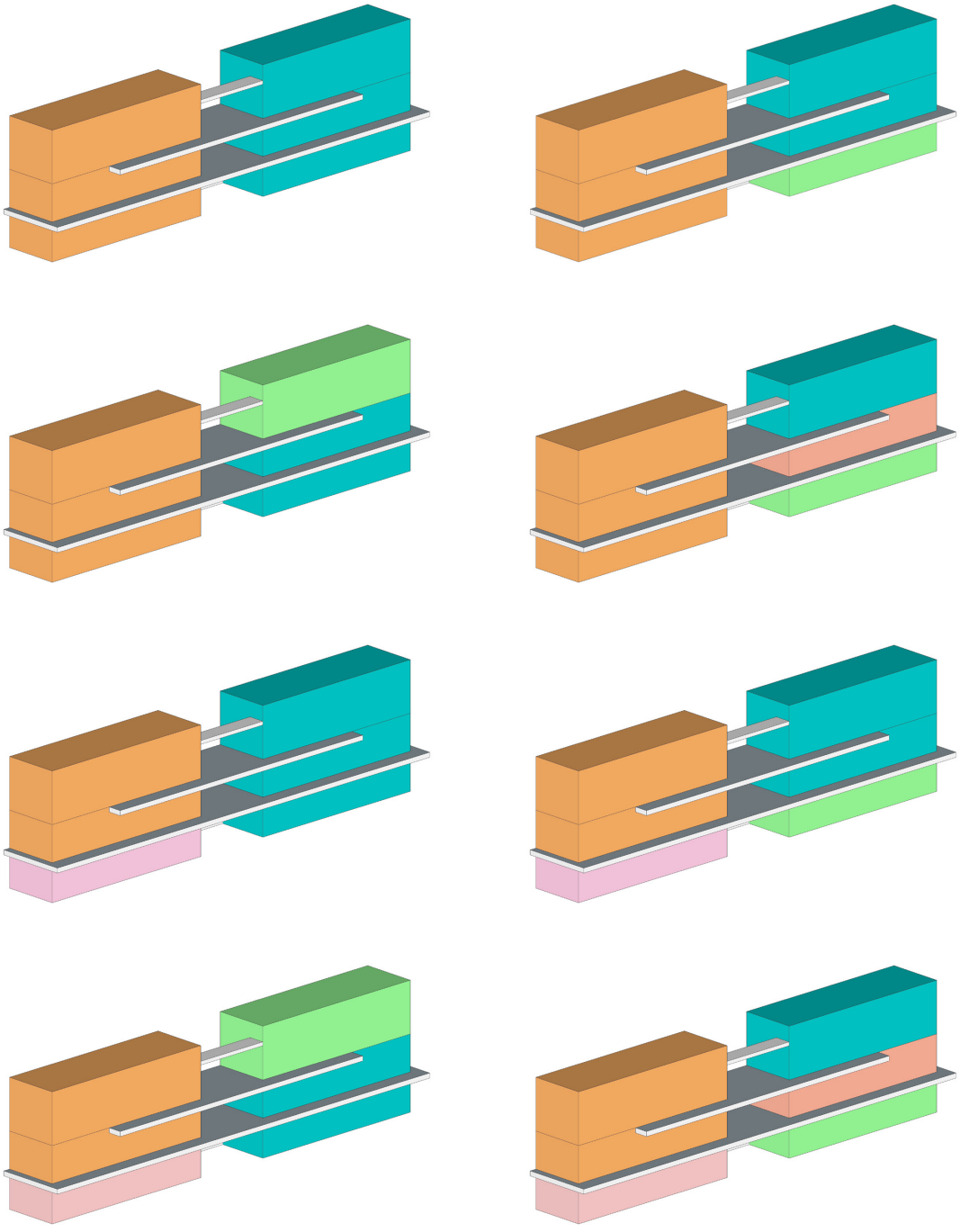


Figure 61:
Prototype unit configuration diagrams.

Due to the flexibility of the prototypes' programming a variety of housing tenure-ship models are possible, including: owner occupied, owner occupied + rental, rental housing, shared equity, co-living, co-operative housing, multi-generational, live-in care giving, student housing, live-work and commercial applications that will be explored in subsequent prototypes. Several of these tenure-ship models will be investigated in more depth in *Section 10 - Financial Feasibility.*

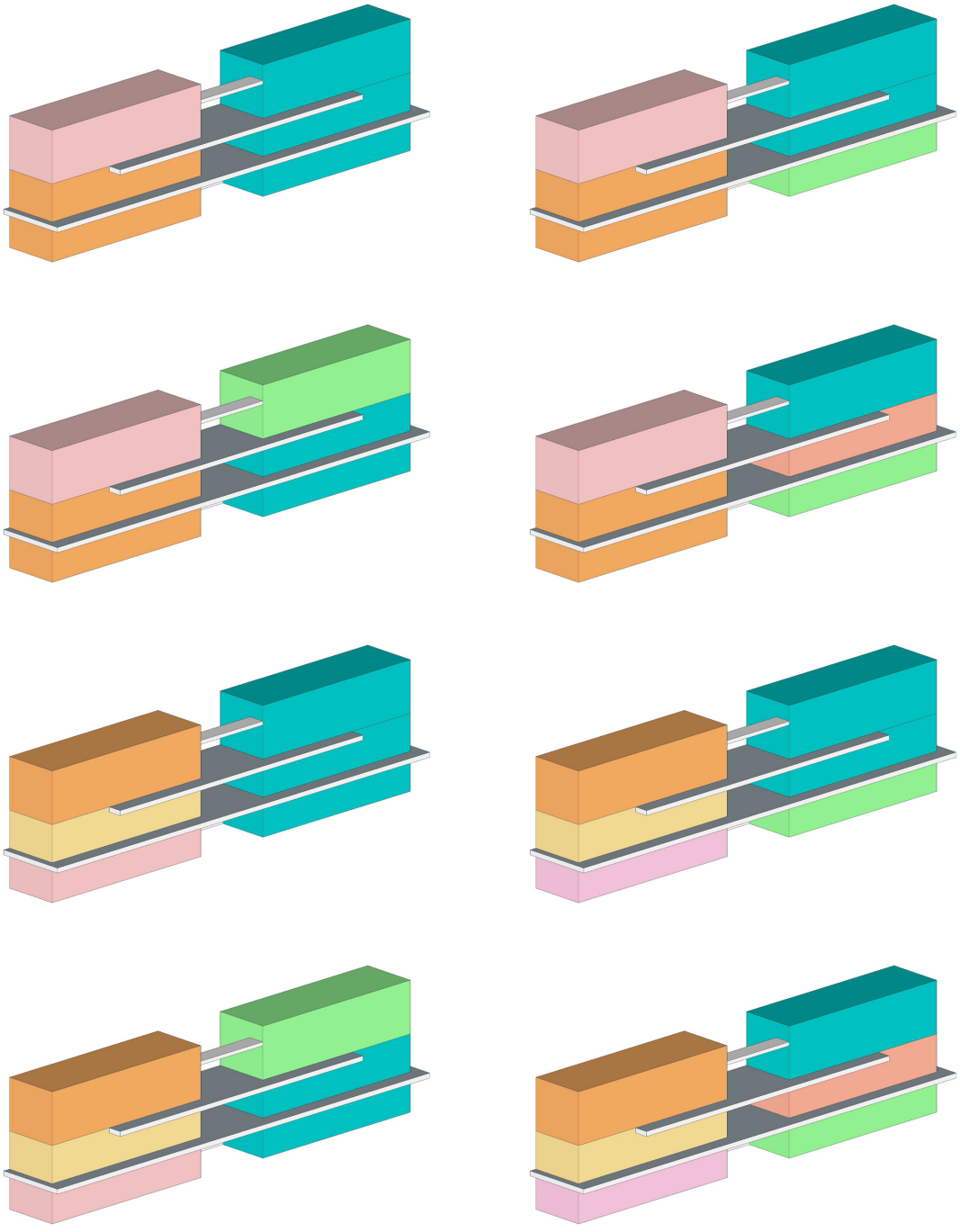


Figure 62:
Prototype unit configuration diagrams.

7.3.8 - Exterior Elevations & Renderings

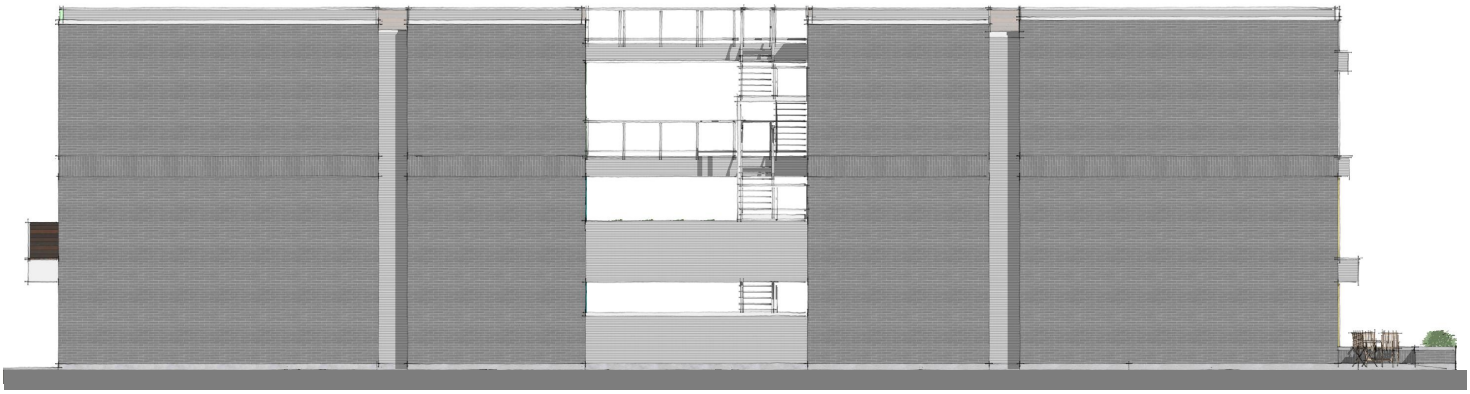
The front and rear elevations include two additional variants of Prototype-1; a three storey hip roof and two storey gable roof version. The prototypes allow for alternate exterior designs that best respond to the surrounding context as well as the financial feasibility of the development.

FRONT ELEVATIONS

INTERIOR SIDE ELEVATION

Figure 63:
Prototype-1 exterior front and interior side elevations.

REAR ELEVATIONS



EXTERIOR SIDE ELEVATION

Figure 64:
Prototype-1 exterior rear and exterior side elevations.

Figure 65:
North-West perspective of three iterations of prototype-1, 38-42 Spring St.

Figure 66:
Perspective looking South-West down Spring Street including three iterations of prototype-1 and prototype-2.

7.4 - PROTOTYPE - 2

Figure 67:
North Perspective of three iterations of Prototype-2 located at 46 and 50 Spring St.

7.4.1 - Introduction

Prototype - 2 is best suited to lots in the RC zoning area with a minimum lot frontage of 35 feet and a lot depth of 160 feet. The proposed sites for Prototype-2 are located at 46 & 50 Spring St. 46 Spring St. is a 42 foot wide by 160 foot deep property, another typical Holmedale lot size, which allows for less constraints in site planning as well as unit floor areas. 50 Spring St. could be considered a double lot having the same depth as 46 Spring St., but with a frontage of 82 feet. 50 Spring St. will be used as an example of how two prototypes can be accommodated on one site employing the development process of land severance to create two separate parcels of land allowing for the construction of two principal buildings.

Prototype-2 also introduces the office space module. The inclusion of office space within the dwelling unit takes advantage of the emerging ability for many people to work from home. This helps to facilitate a better work life balance as it eliminates lengthy commutes and reduces car dependence. The presence of businesses within the neighbourhood also contributes to its walkability as it can create jobs as well as office sharing opportunities for people living within walking distance. The introduction of work space into neighbourhoods can act as a catalyst for further neighbourhood amenities as it increases the demand for additional services such as coffee shops, cafes, restaurants and convenience stores. By enhancing mixed-use possibilities the neighbourhood becomes a more vibrant and active community for people to live.

Figure 68:
Figure-ground diagram identifying the locations of prototype-2.

7.4.2 - Site Plan

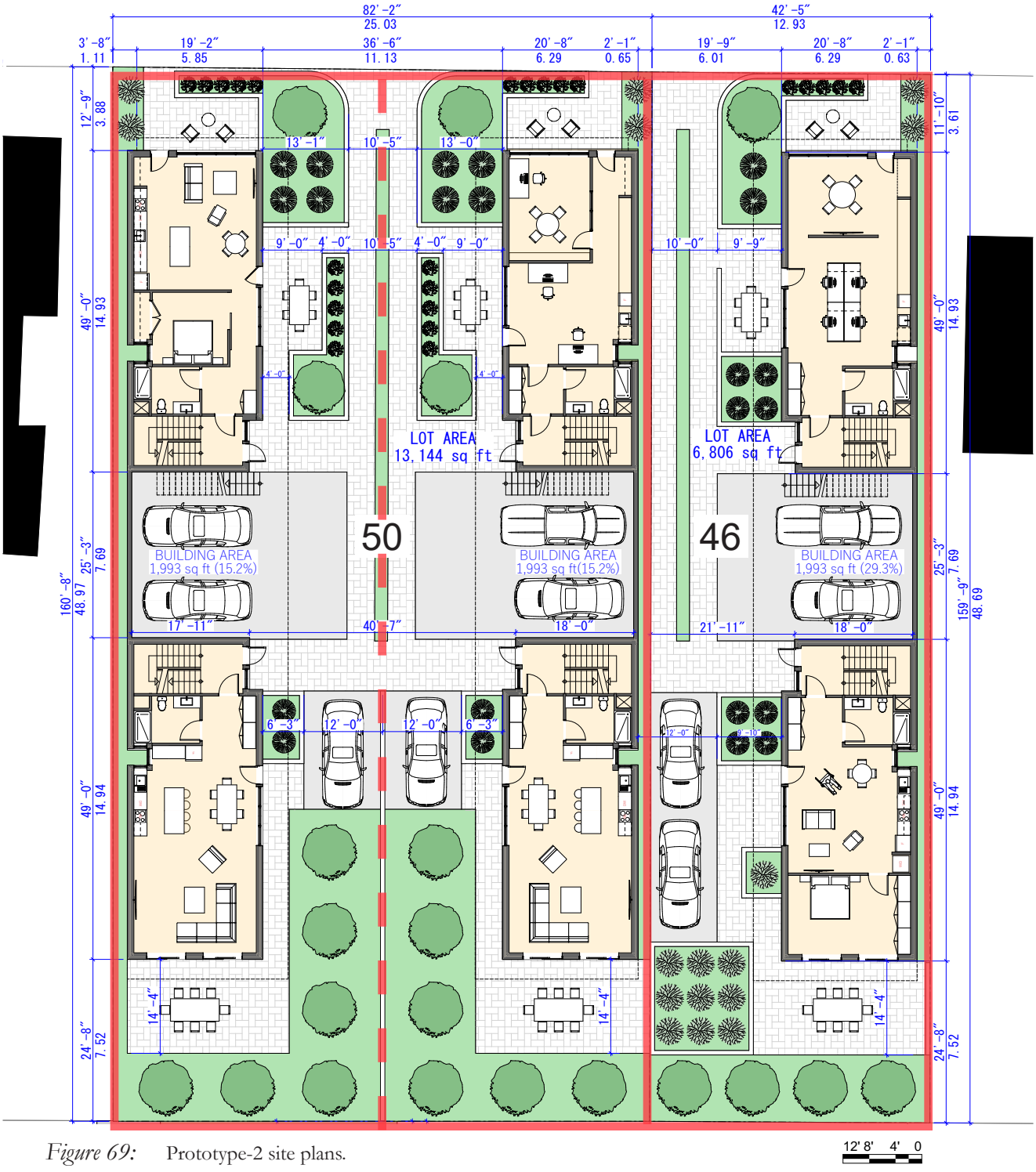


Figure 69: Prototype-2 site plans.

To maximize at grade amenity area the site design for 50 Spring St. proposes a shared right of way drive aisle centered on the new property line represented by the dashed red line. The mirroring of the two buildings permits additional day light into the middle of the site and into the dwelling units. This development strategy could also be used when developing two separate neighbouring properties in tandem.

7.4.3 - Floor Plans

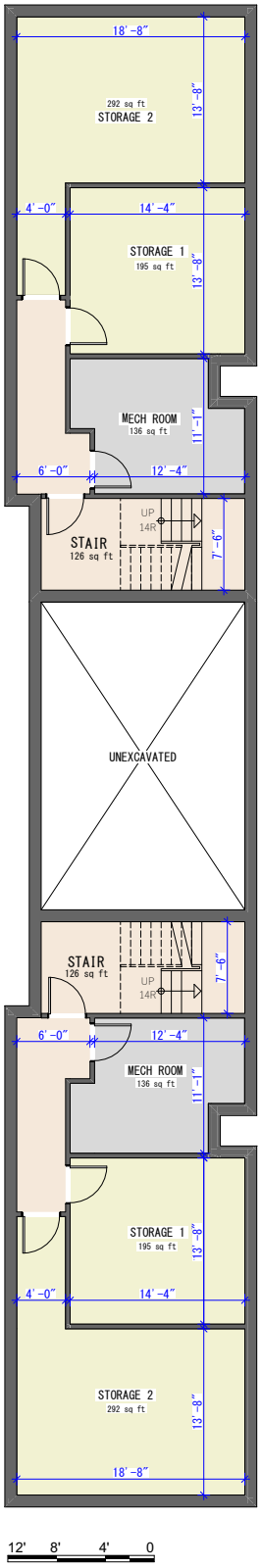


Figure 70:
Prototype-2 basement floor plan.

Office Space Modules

The flexibility of the prototype floor plate allows for the programming of office space. Home occupations is a permitted use within the RC zone of the Brantford zoning bylaw, creating the opportunity for live-work units.

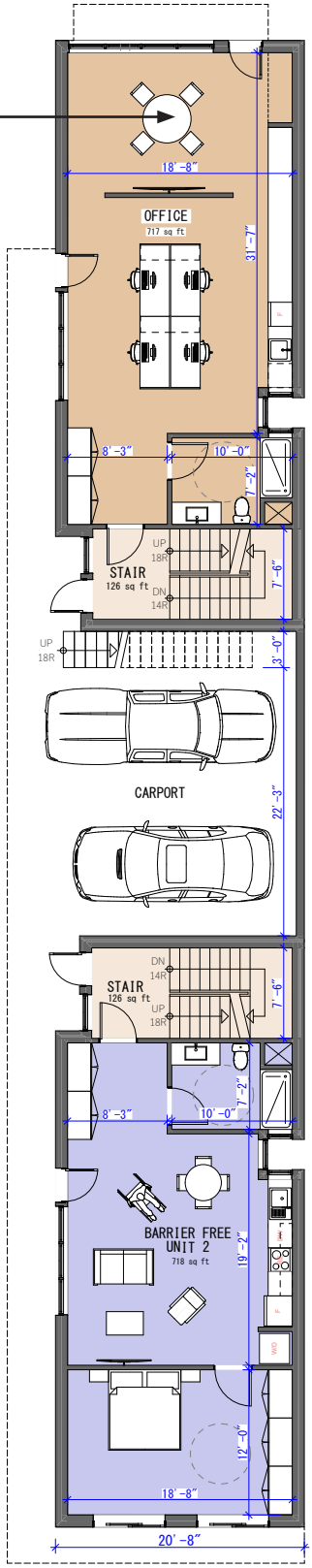


Figure 71:
Prototype-2 first floor plan.

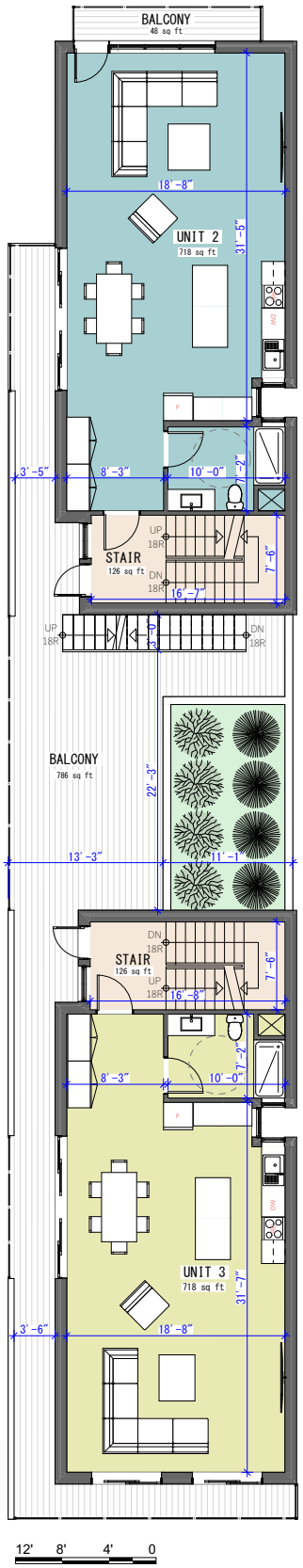


Figure 72:
Prototype-2 second floor plan.

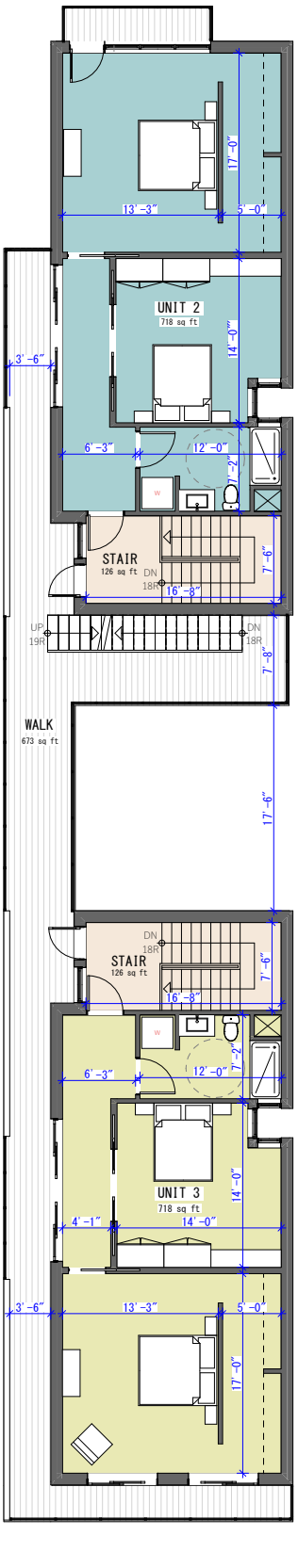


Figure 73:
Prototype-2 third floor plan.

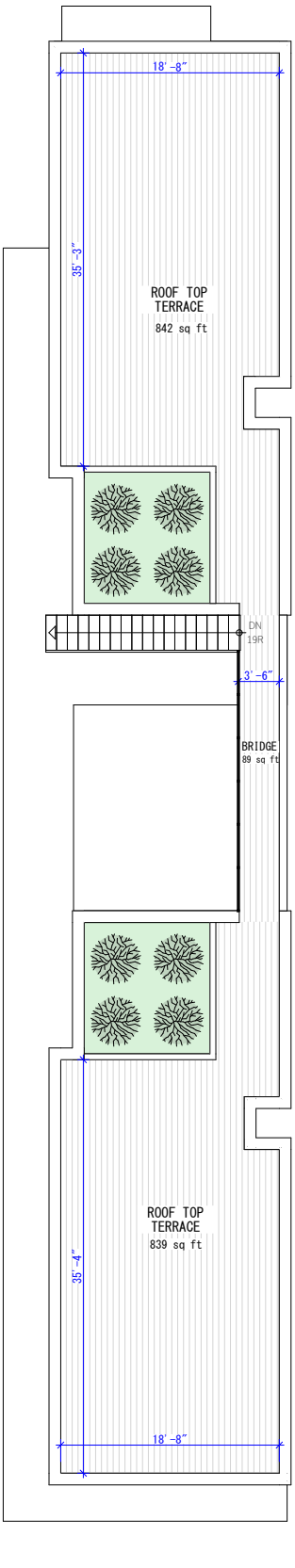


Figure 74:
Prototype-2 roof top terrace plan.

Alternate Floor Plans

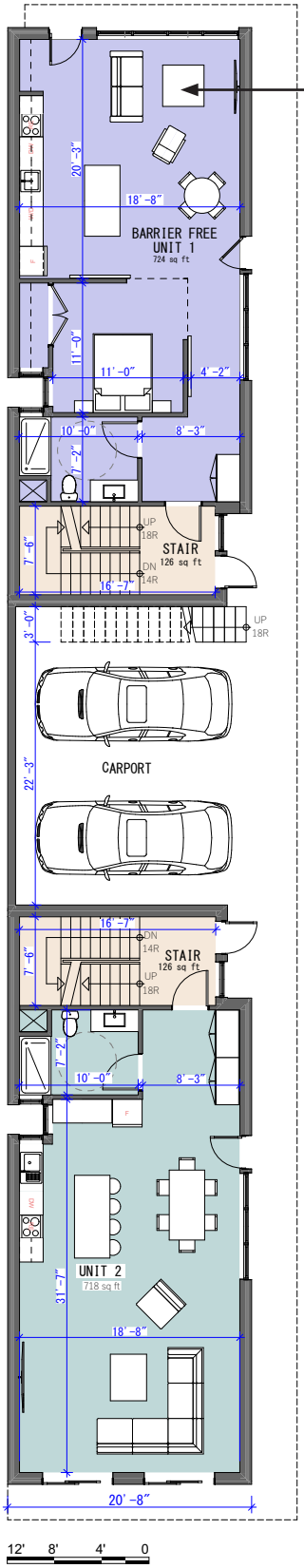


Figure 75:
Prototype-2 first floor plan, alternate barrier free unit.

Alternate Barrier-Free Module
This 1st floor plan depicts an alternate barrier free module design which responds to the differing privacy and circulation characteristics of a street facing unit.

Alternate Office Module
This alternate office module displays the flexibility of the prototype to accommodate varying programmatic needs of different types of workspace.

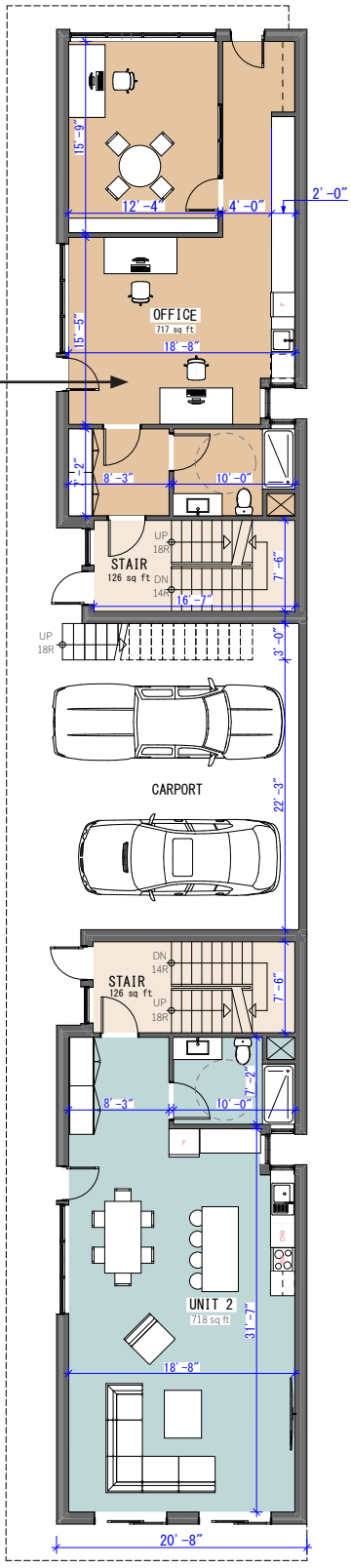


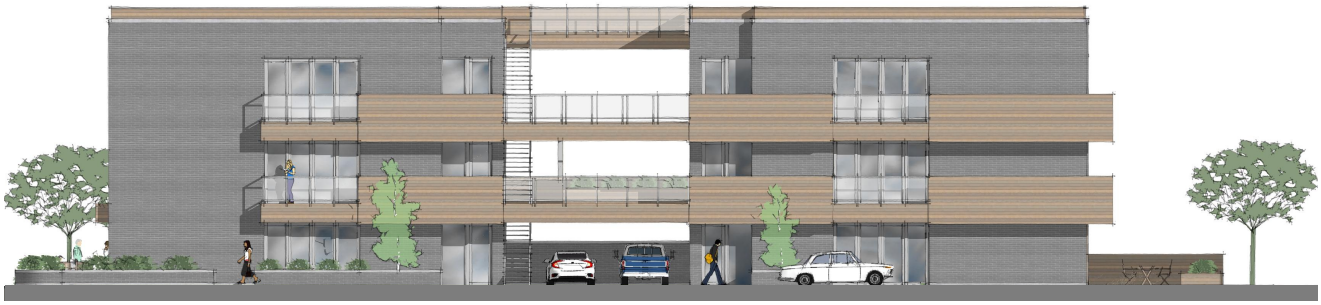
Figure 76:
Prototype-2 first floor plan, alternate office unit.

7.4.3 - Exterior Elevations

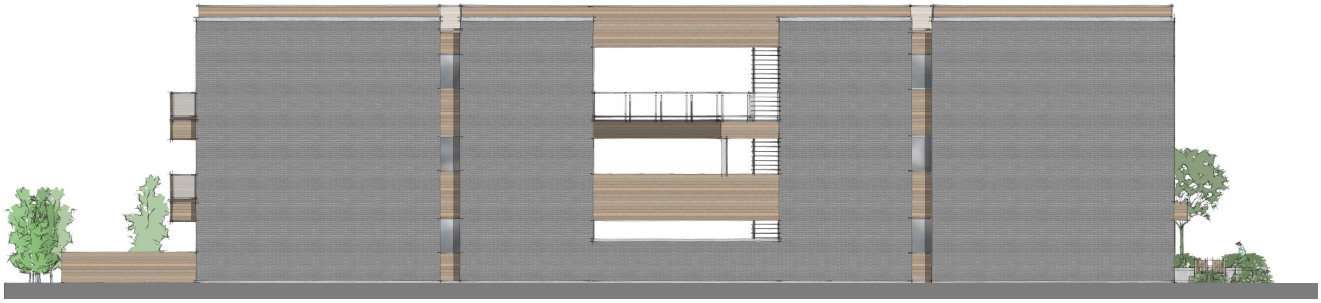
The front elevations depict the proposed streetscape spanning from 46 to 50 Spring St. The elevation on the left illustrates a gabled version of prototype 2, while the blond brick prototype on the right is a mirror image of the middle prototype, forming a courtyard between the two buildings.

FRONT ELEVATIONS

REAR ELEVATIONS



INTERIOR SIDE ELEVATION



EXTERIOR SIDE ELEVATION

Figure 77:
Prototype-2 exterior elevations.

7.4.4 - Building Sections

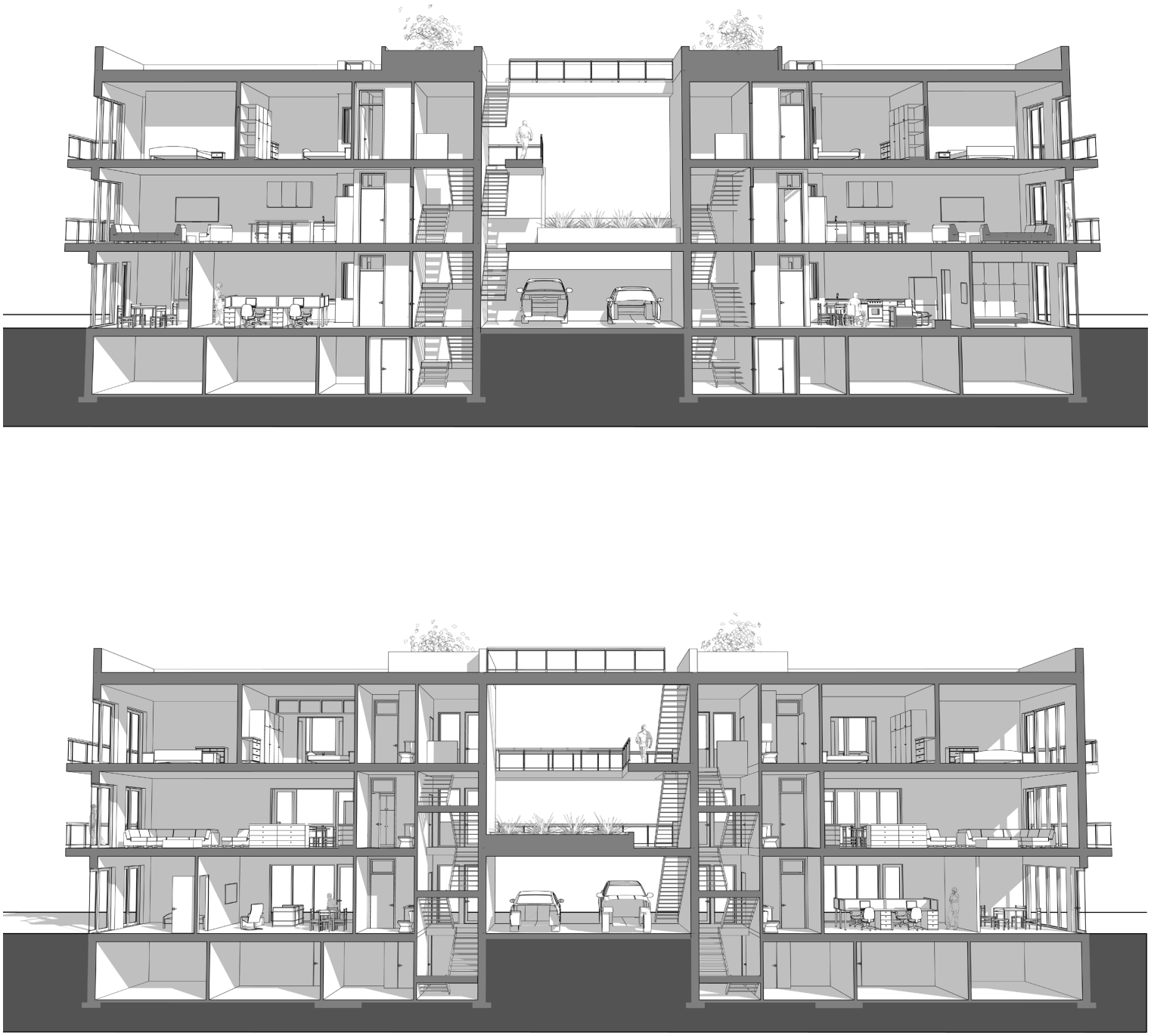


Figure 78:
Perspectival sections of Prototype-2.

Figure 79:
Interior courtyard perspective of prototype-2 at 50 Spring St.

Figure 80:
Perspective looking South-East down Spring St. including three iterations of prototype-2 and prototype-1.

7.5 - PROTOTYPE - 3

Figure 81:
South-West perspective of prototype-3 located at 115 Grand River Ave.

7.5.1 - Introduction

Prototype - 3 is best suited to lots in the RC zoning area with a minimum lot frontage of 35 feet and a lot depth of 195 feet. Prototype-3 is located at 115 Grand River Ave., representing one of the biggest lot typologies in the neighbourhood, having a lot frontage of 47 feet and lot depth of 200 feet. This prototype exemplifies how the basic design principles and modules can be replicated to develop a larger site. Prototype-3 is also the first design to introduce a module which demonstrates how the prototypes can not only be used for residential and office space but also commercial space in the form of a cafe or coffee shop.

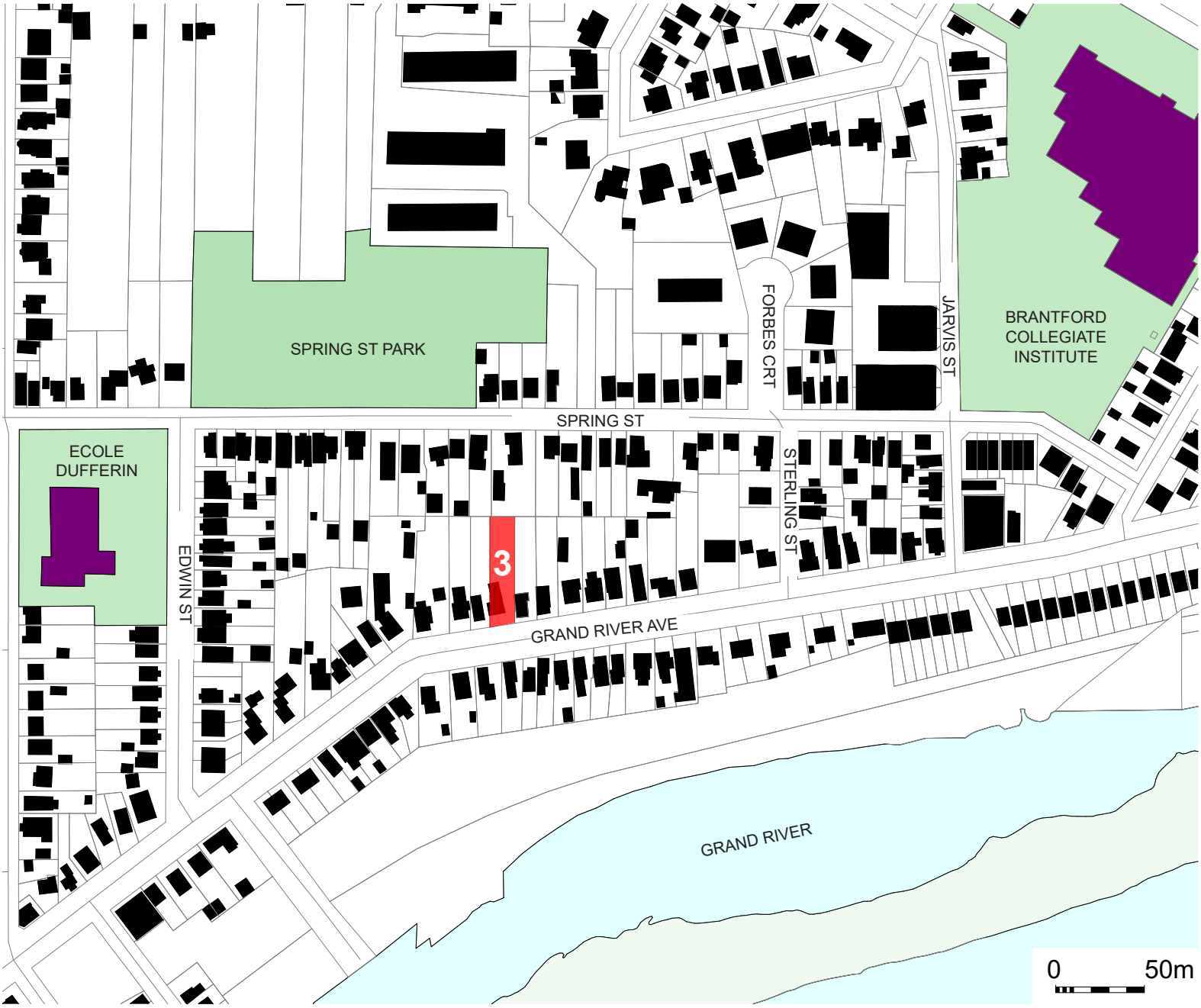
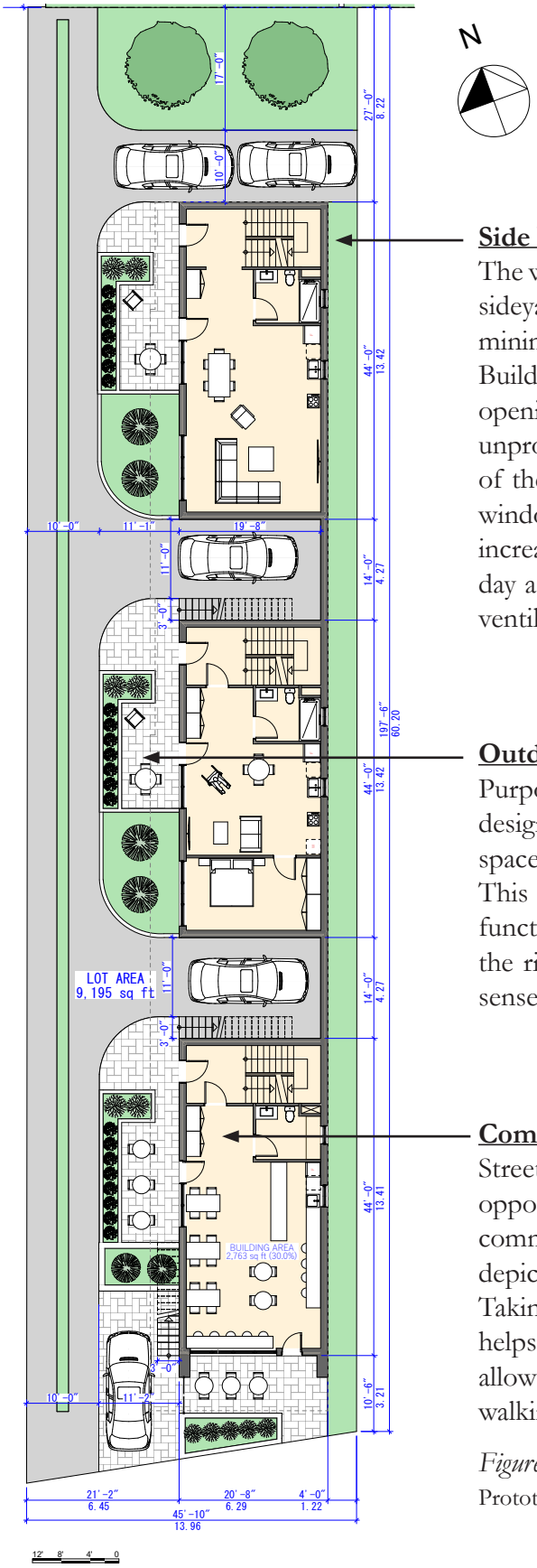


Figure 82:
Figure-ground diagram identifying the locations of prototype-3.

7.5.2 - Site Plan



Side Yard Setbacks

The wider lot size allows for an increased sideyard setback of 4 feet which is the minimum setback required by the Ontario Building Code to permit unprotected openings (windows). Although at 4 feet, unprotected openings are limited to 7% of the above grade elevation area, having windows that face multiple directions increases natural light throughout the day as well as providing improved cross ventilation.

Outdoor Amenity Space

Purposeful landscape and hardscape design help to delineate private amenity space from shared public space. This creates outdoor spaces that are functional, low maintenance and offer the right amount of privacy to create a sense of comfort.

Commercial & Retail Programming

Street facing units offer the perfect opportunity for the programming of commercial space such as the cafe depicted on the Prototype-3 site plan. Taking advantage of mixed-use zoning helps to create vibrant communities that allow residents to work and play within walking distance to where they live.

Figure 83:
Prototype-3 site plan.

7.5.3 - Floor Plans

BASEMENT 1ST FLOOR 2ND FLOOR 3RD FLOOR

Figure 84:
Prototype-3 floor plans.

7.5.4 - Elevations

FRONT ELEVATION

REAR ELEVATION

24' 16' 8' 0

INTERIOR SIDE ELEVATION

24' 16' 8' 0

EXTERIOR SIDE ELEVATION

Figure 85:
Prototype-3 exterior elevations.

7.5.5 - Building Sections

Figure 86:
Perspectival sections of Prototype-3.

7.6 - PROTOTYPE - 4

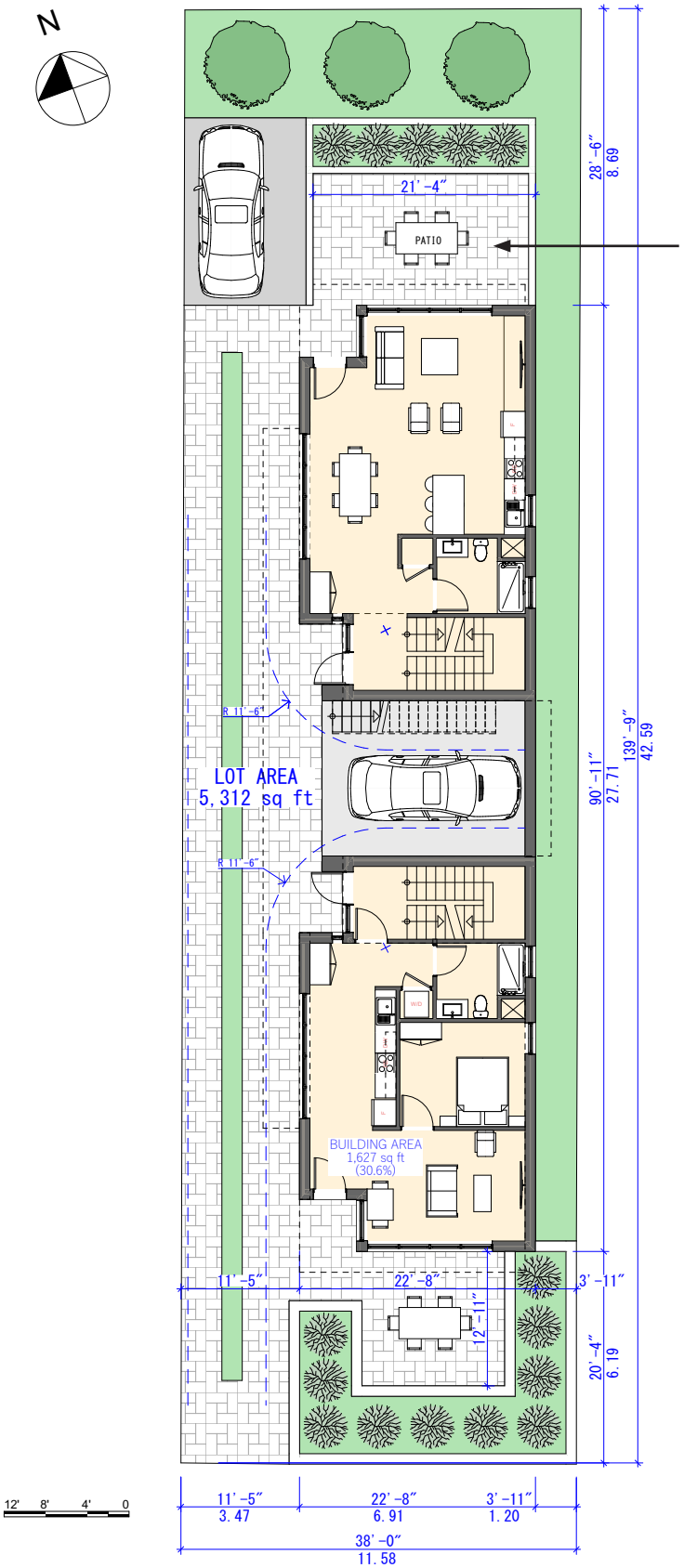
Figure 87:
South-West perspective of multiple iterations of prototype-4. 31 Spring St. is the proposed site for the three storey prototype.

7.6.1 - Introduction

Prototype - 4 is best suited to lots in the RC zoning area with a minimum lot frontage of 35 feet and a lot depth of 125 feet. The proposed site located at 31 Spring St. has a lot frontage of 38 feet and a depth of approximately 140 feet. While prototypes one to three primarily focused on the challenge of adding density to long skinny lots that are prevalent in older neighbourhoods, prototype 4 begins to address the development potential of a more typical lot size that is more readily found in a variety of neighbourhoods.

Figure 88:
Figure-ground diagram identifying the location of prototype-4.

7.6.2 - Site Plan

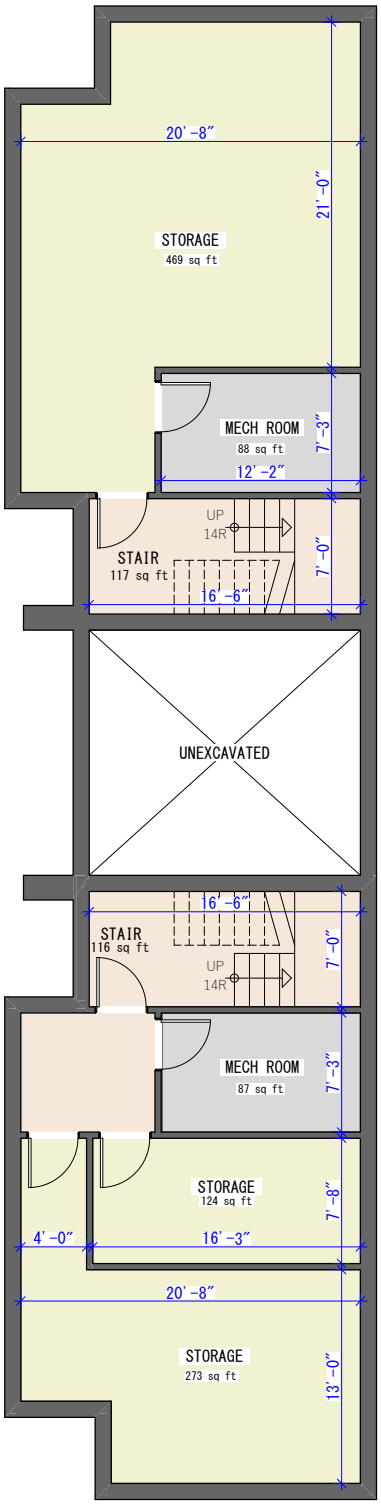


Lot Size Versatility

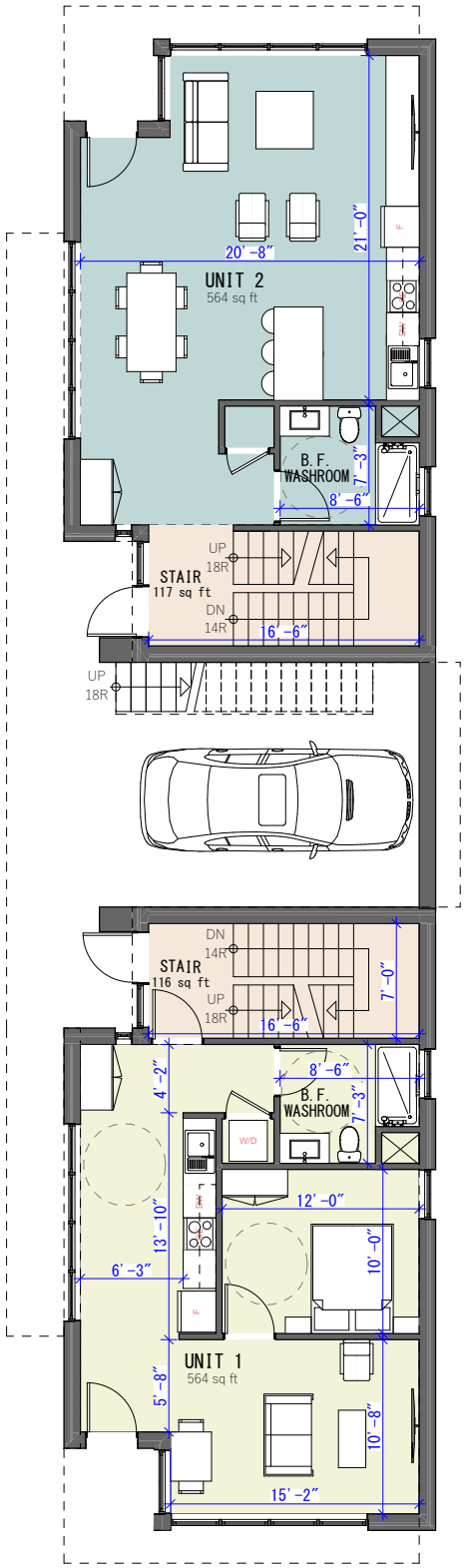
The Prototype-4 site plan demonstrates that even without excessive lot depths a property can be densified without being overwhelmed. Although the outdoor amenity spaces are smaller than typical yards in older neighbourhoods they are designed purposefully with spatial definition to create a sense of privacy and functionality.

Figure 89:
Prototype-4 site plan.

7.6.3 - Floor Plans



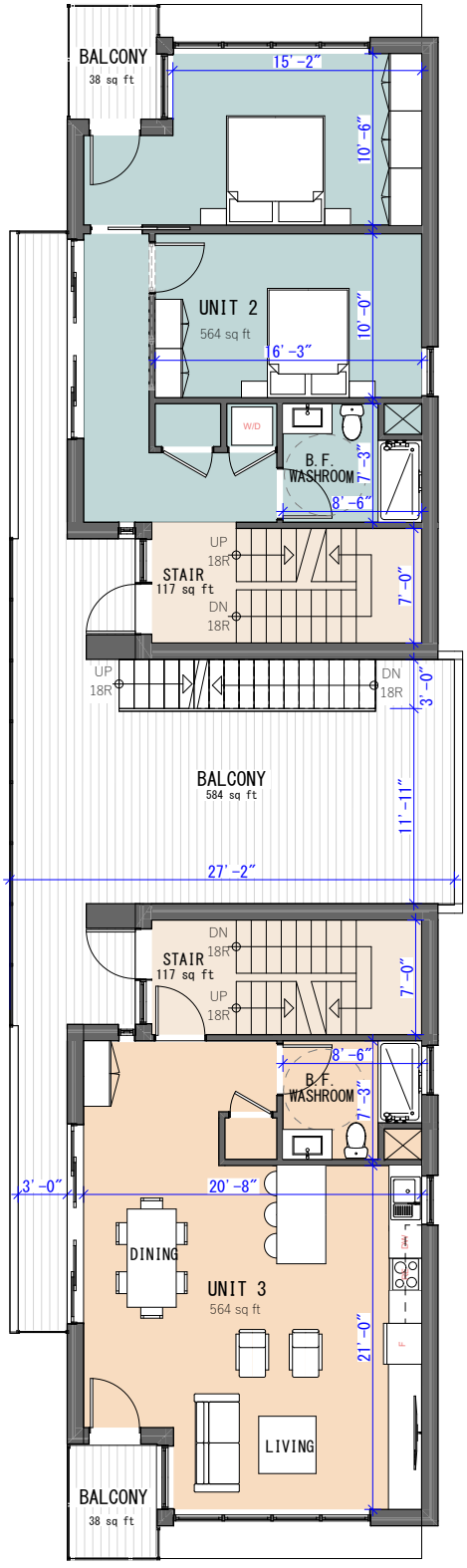
BASEMENT



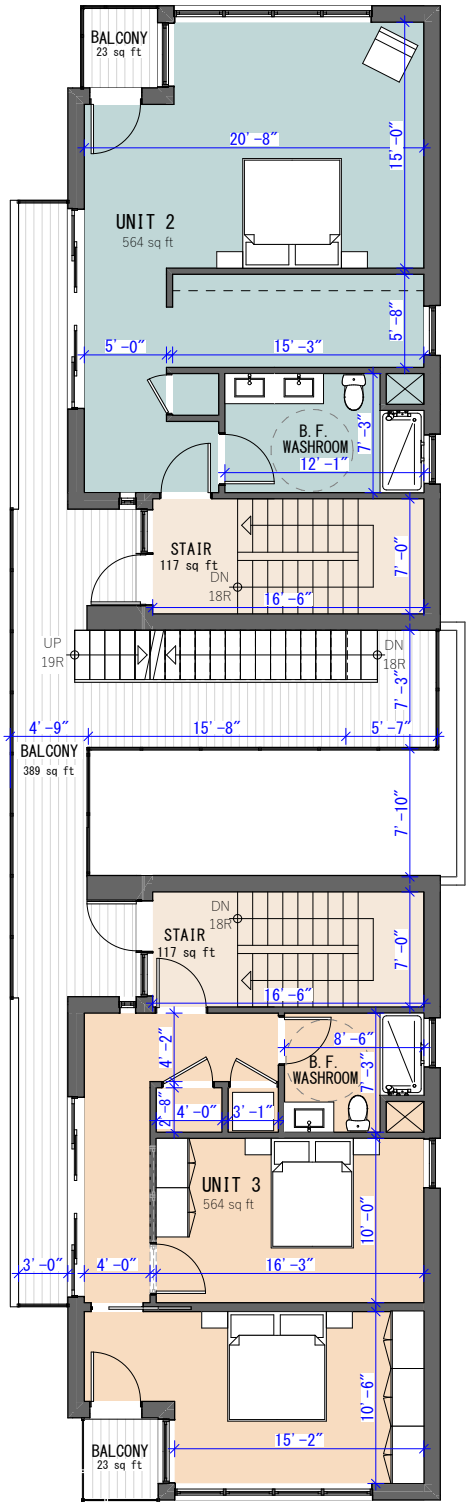
1ST FLOOR

12' 8' 4' 0

Figure 90:
Prototype-4 basement and first floor plans.



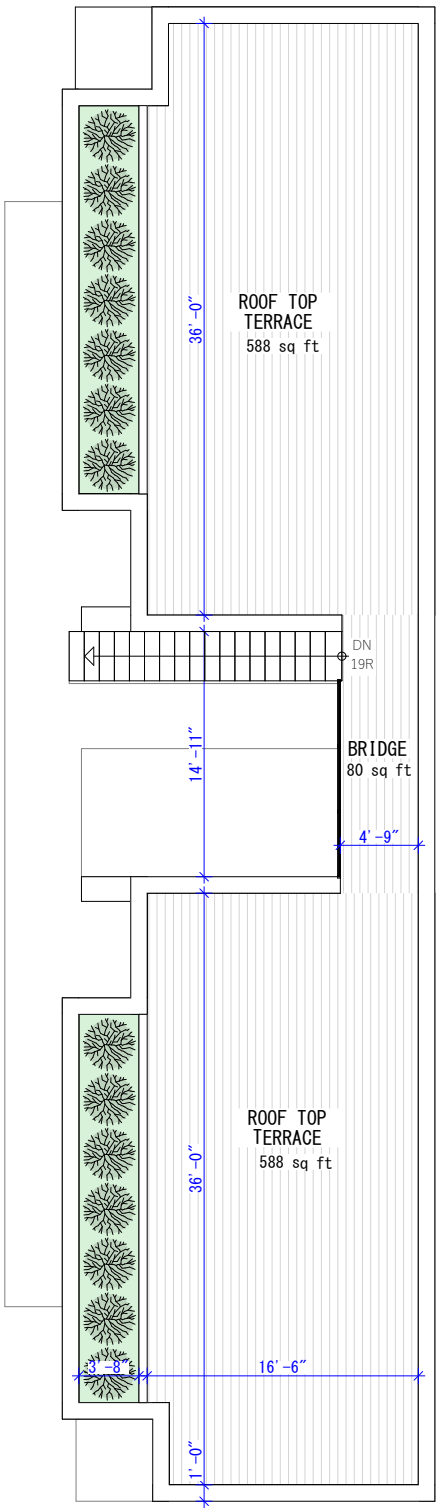
2ND FLOOR



3RD FLOOR

12' 8' 4' 0

Figure 91:
Prototype-4 second and third floor plans.



ROOF

Figure 92:
Prototype-4 roof top terrace plan.

12' 8' 4' 0

7.6.4 - Elevations

The front and rear elevations include an alternate 2-storey hip roof version of prototype 4. Although 2 storey versions of the prototype do not require a second exterior means of egress, the exterior walkways and stairs are maintained as they provide a connection to outdoor amenity space as well as providing exterior access to second floor units.

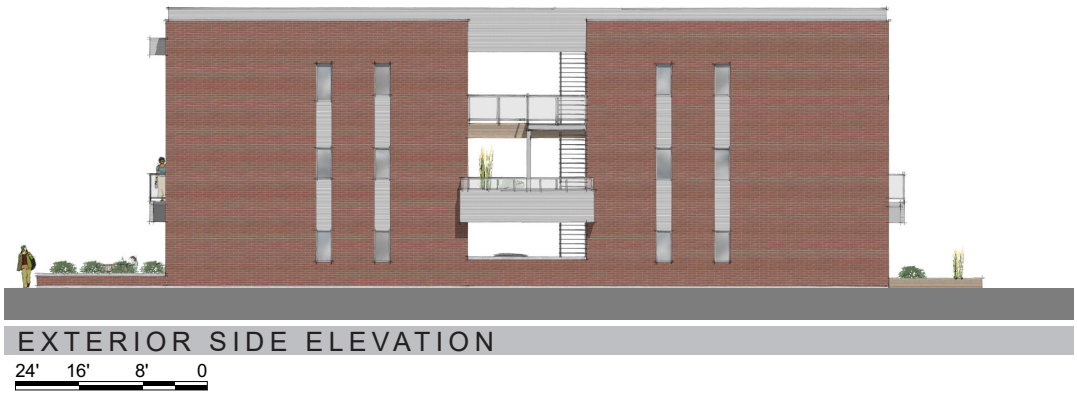


Figure 93:
Prototype-4 exterior elevations.

7.6.5 - Building Sections

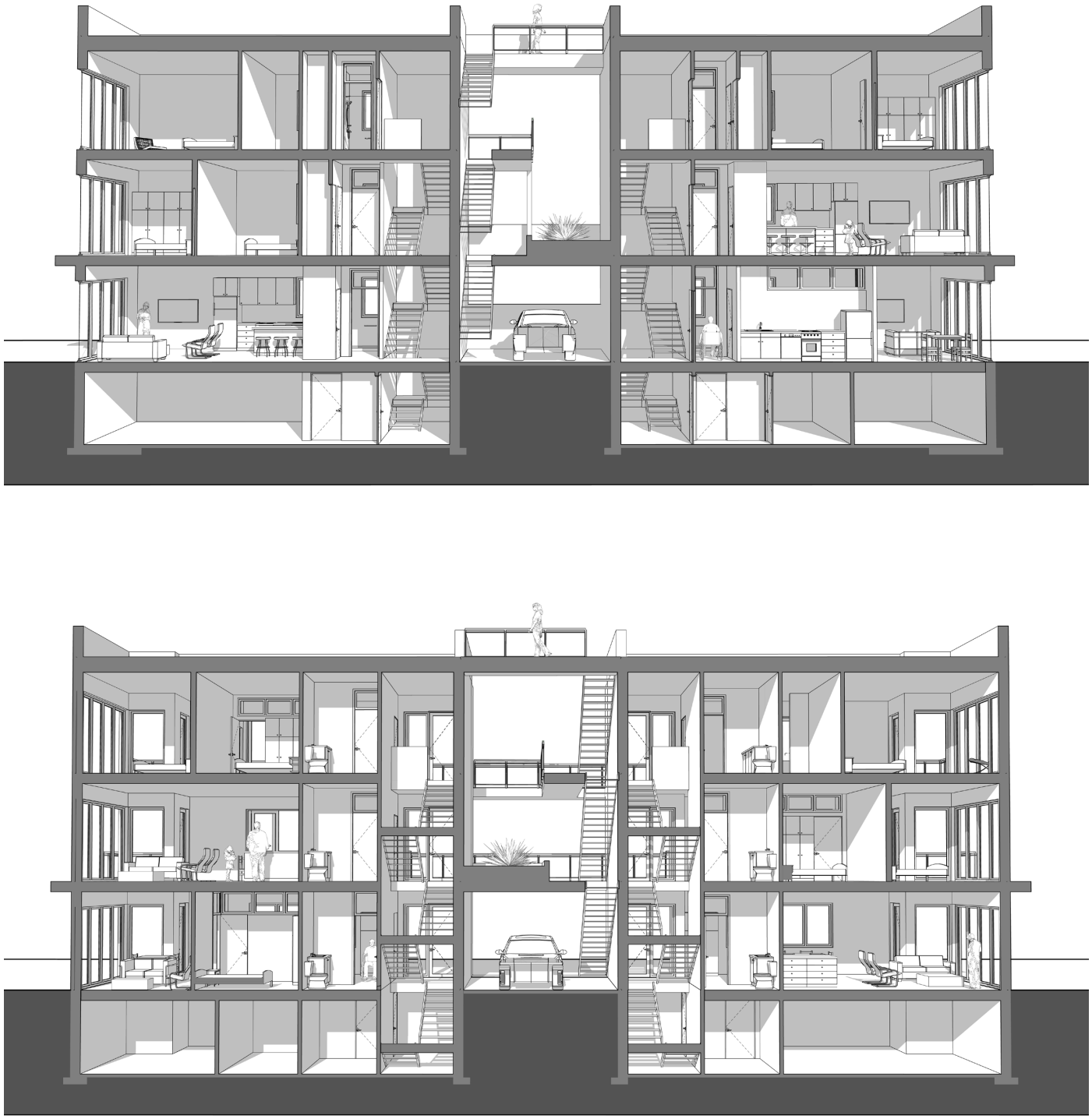


Figure 94:
Perspectival sections of Prototype-4.

Figure 95:
West perspective of multiple iterations of prototype-4 along Spring St.

Figure 96:
East perspective of a 2 storey version of prototype-4 located at the corner of Forbes Ct. and Spring St.

7.7 - PROTOTYPE - 5

Figure 97:
South perspective of the existing house at 27 Spring St. and the rear yard location of the prototype-5 addition.

7.7.1 - Introduction

Prototype-5 illustrates how the prototype modules can be configured to act as an addition to an existing house. It is best suited to lots with houses that have driveway access to the back of the property. The property also requires an approximate minimum back yard depth of 75 feet.

The proposed site is located at 27 Spring St., home to one of Brantford's iconic housing typologies, the *Brantford Cottage*. The lot is similar in size to Prototype-4, having a lot frontage of 44 feet and depth of 140 feet, accordingly the module design from prototype-4 can be utilized.

Prototype-5 offers a solution to how current homeowners can deploy equity in their home to develop their own property. As will be demonstrated in *Section 10 - Financial Feasibility*, the cost of tearing down an existing house and building one of the proposed prototypes may not be financially feasible for every homeowner, especially considering the logistical and financial complications of having to find temporary accommodations during construction. The design for Protoype-5 leaves the existing house relatively undisturbed during construction allowing the resident to stay in their home and reduce the cost of the project. Prototype-5 is an ideal option for creating multi-generational housing that allows families to share living space while maintaining the requisite amount of privacy required to make shared living arrangements more than a short term solution. Prototype-5 could also be used to create additional rental income that produces greater financial security in an expensive housing market, while also increasing the supply of much needed rental units to the housing stock.

Figure 98:
Figure-ground diagram identifying the location of prototype-5.

7.7.2 - Site Plan

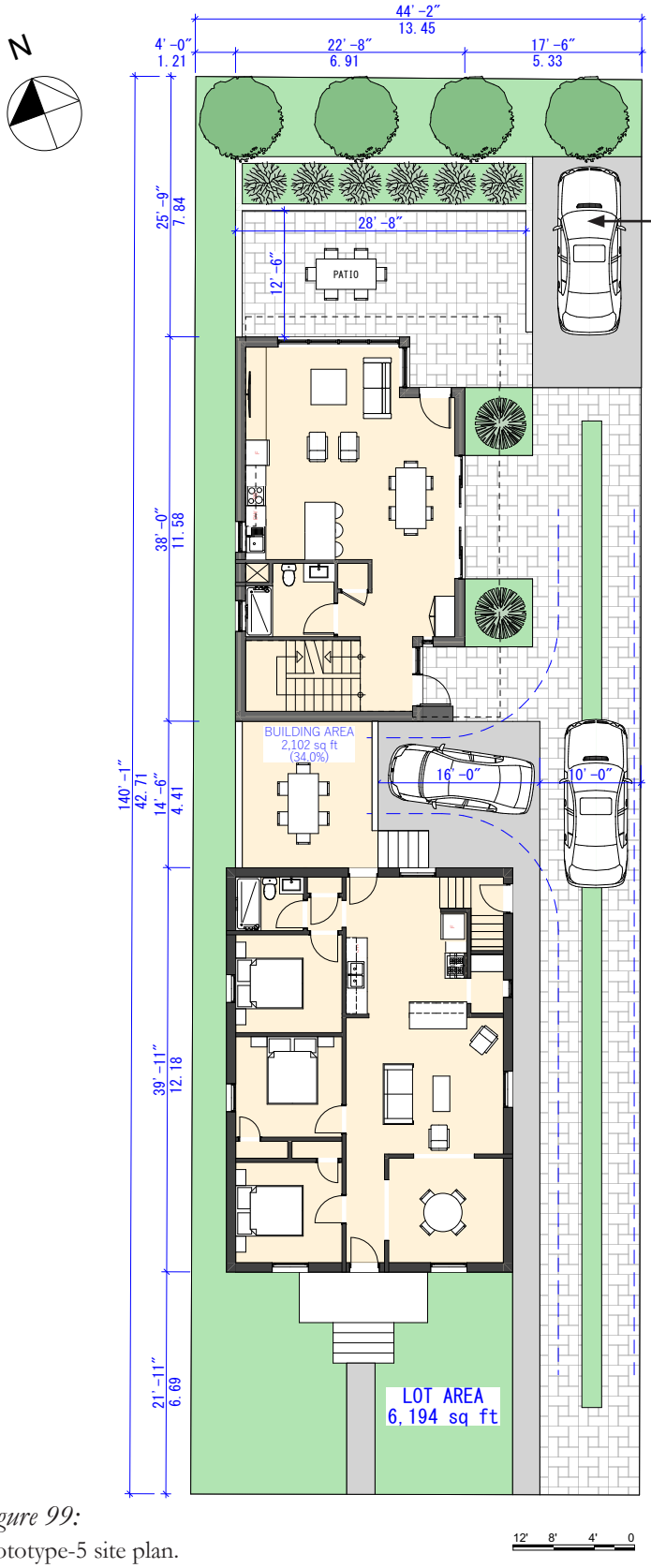


Figure 99:
Prototype-5 site plan.

Vehicular Access

The presence of side yard driveways on many properties in older neighbourhoods such as Holmedale, offers the opportunity for vehicular access to the rear of the lot. This is beneficial during construction to permit access to the site. It also removes parking from the front of the house which is crucial for the preservation of a safe and enjoyable pedestrian realm. Although not as common in Holmedale, the existence of a rear lane-way would be complement this prototype, eliminating the necessity to allocate a significant portion of the side yard to a drive aisle and thereby creating additional exterior amenity space. The presence of a rear lane-way also has the added benefit of providing autonomous vehicular access for the rear facing unit.

7.7.3 - Floor Plans

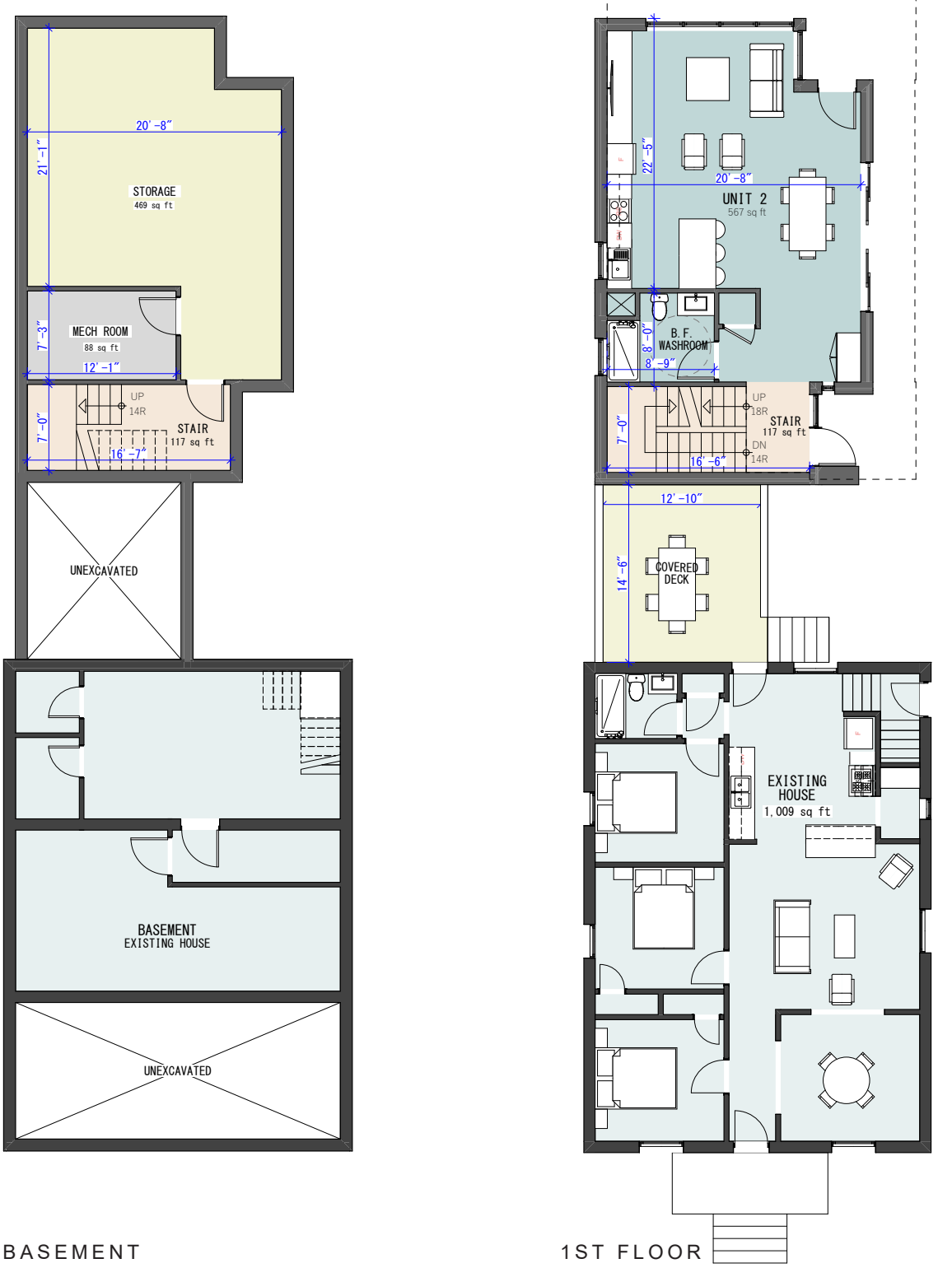
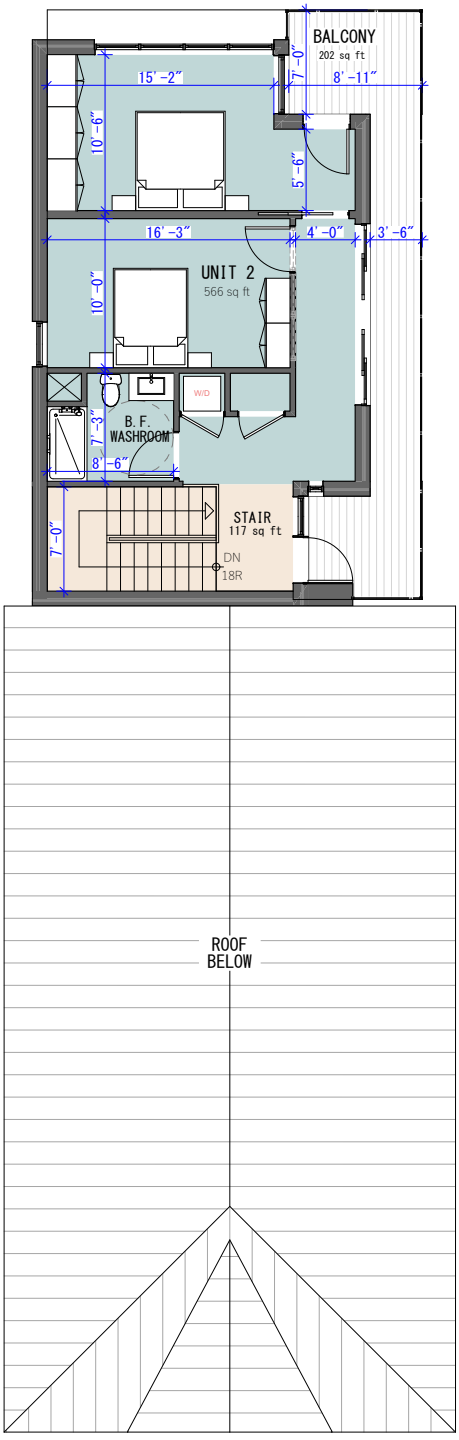


Figure 100:
Prototype-5 basement and first floor plans.



2ND FLOOR / ROOF

Figure 101:
Prototype-5 second floor / roof plan.

12' 8' 4' 0

7.7.4 - Exterior Elevations

FRONT ELEVATION

REAR ELEVATION

INTERIOR SIDE ELEVATION

EXTERIOR SIDE ELEVATION

Figure 102:
Prototype-5 exterior elevations.

7.7.5 - Building Sections

Figure 103:
Perspectival sections of Prototype-5.

PROTOTYPE - 6

Figure 104:
North perspective of prototype-6 located at the corner of Spring St. and Sterling St.

7.8.1 - Introduction

Prototype - 6 is the most versatile of all the prototypes allowing it fit on lots in the RC zone, as small as 26' x 95' or 35' x 85'. The proposed site for Prototype-6 is located at 18 Spring St. which represents one of the smaller lot typologies in the neighbourhood with a lot frontage of 42 feet and depth of 102 feet. The design could be considered a half prototype as there is not adequate space to mirror the modules at the rear of the site. Despite being smaller in size, prototype-6 still offers the potential to create three separate units on a lot. Not only is Prototype-6 applicable to a significant number of lots within the Holmedale neighbourhood, it could also serve as a template for how to design buildings in newer developments with more compact lot sizes. By implementing design principles from this thesis, new developments can shift from static single-use housing to dwellings that can adapt to the needs of ever changing demographics. The increase in programmatic flexibility has the added benefit of extending the building's life cycle through adaptive re-use. Prototype-6 is also unique in that it is located on a corner lot. This provides increased ground level amenity space as it is not required for a drive aisle. This creates opportunities for uses such as an outdoor restaurant patio, as will be illustrated in this design. Prototype-6 further exemplifies how designing for adaptability enables buildings to accommodate a variety of uses that allow neighbourhoods to evolve into vibrant mixed-use communities where people love to live.

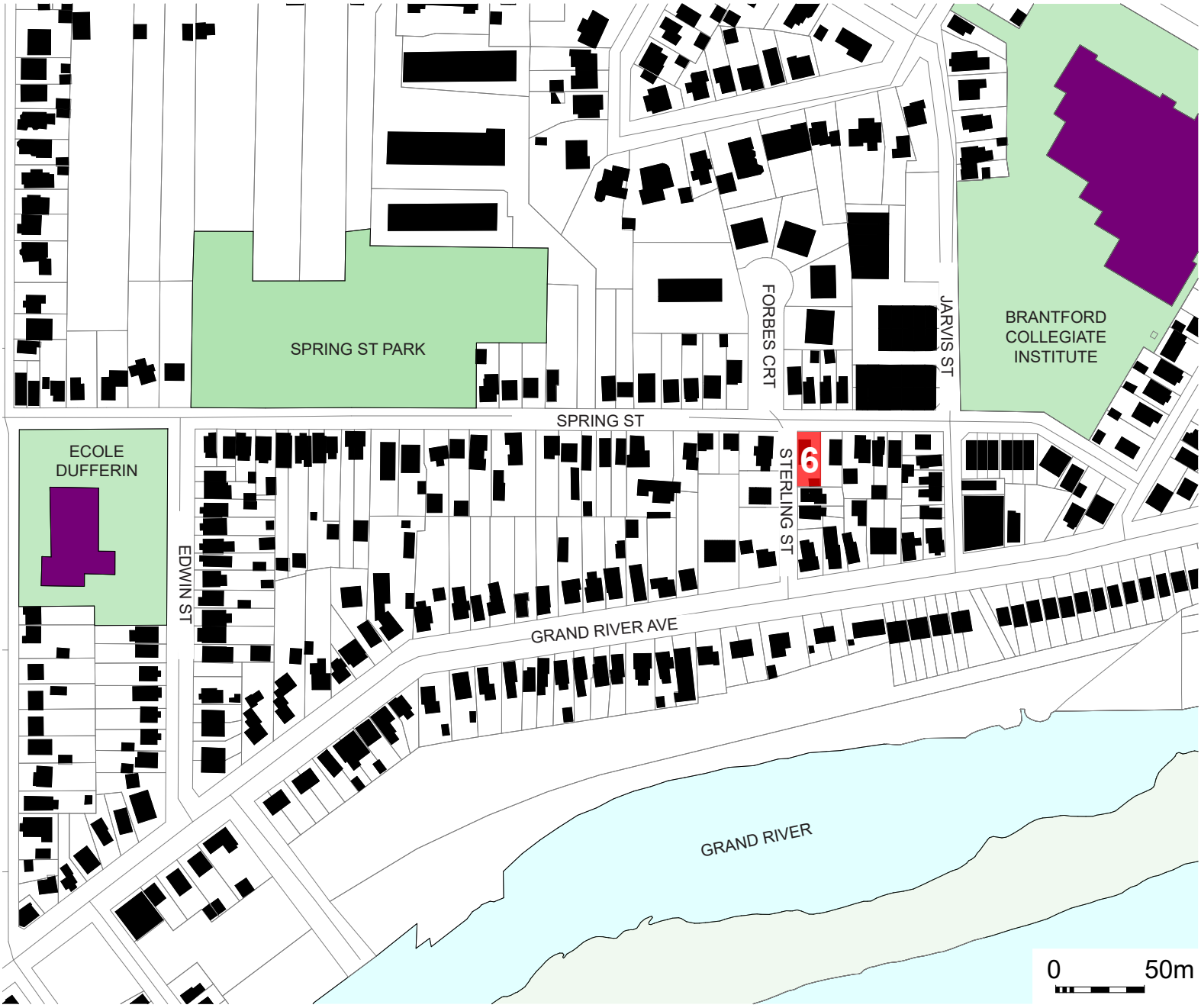


Figure 105:
Figure-ground diagram identifying the location of prototype-6.

7.8.2 - Site Plan

Negotiating Public and Private Space

A side-yard that would otherwise be consumed by a drive-aisle on an interior lot is freed up for exterior amenity space in the form of an outdoor patio for the proposed ground floor restaurant in prototype-6. An essential design consideration for exterior amenity spaces that are adjacent to public space is to negotiate a threshold that creates definition and privacy but not complete separation. This delicate balance is handled on many of the prototypes by introducing raised and structurally defined planter beds that create a sense of spatial delineation for private exterior spaces while maintaining a comfortable connection to the public realm.

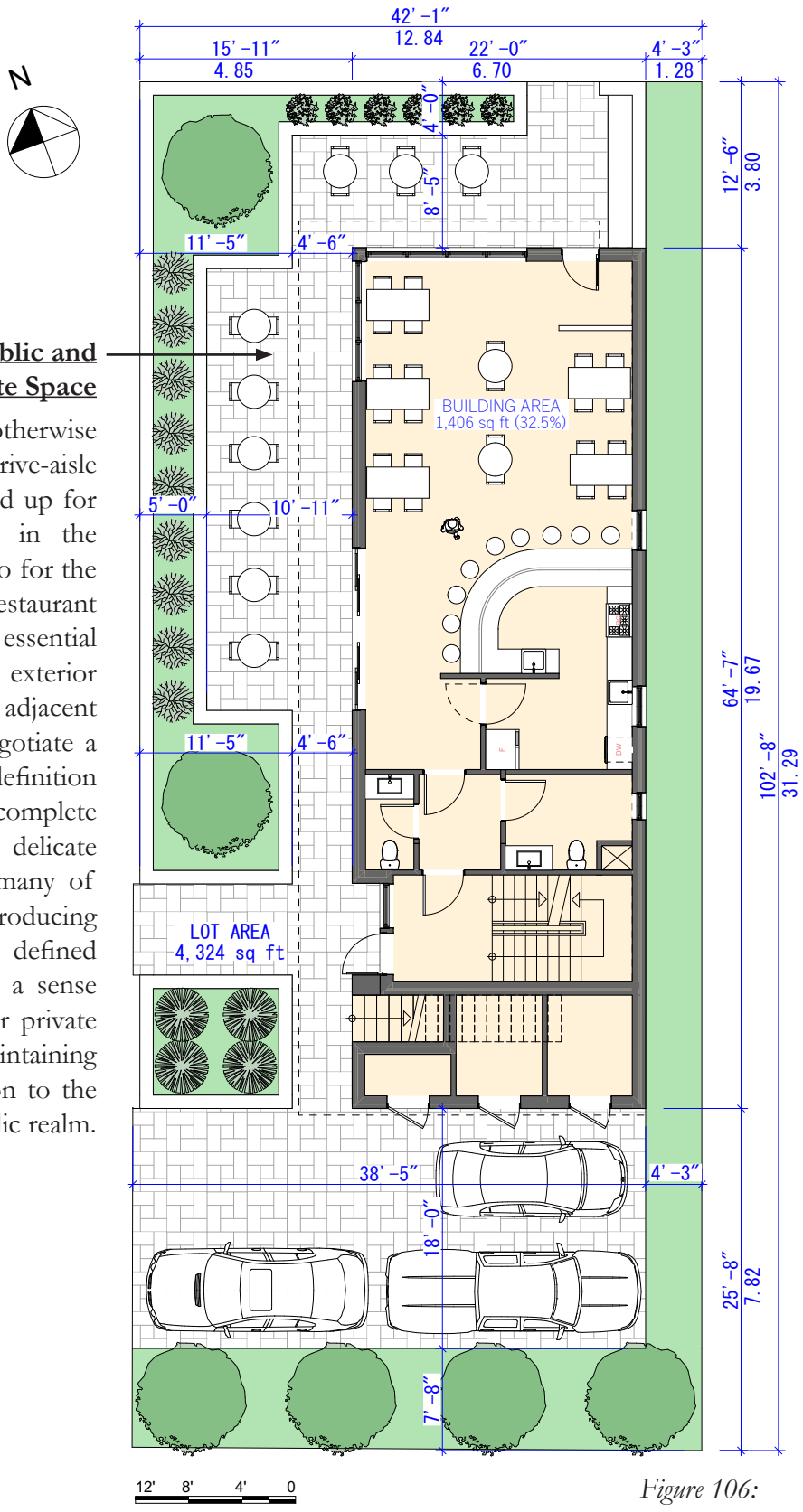


Figure 106: Prototype-6 site plan.

7.8.3 - Floor Plans

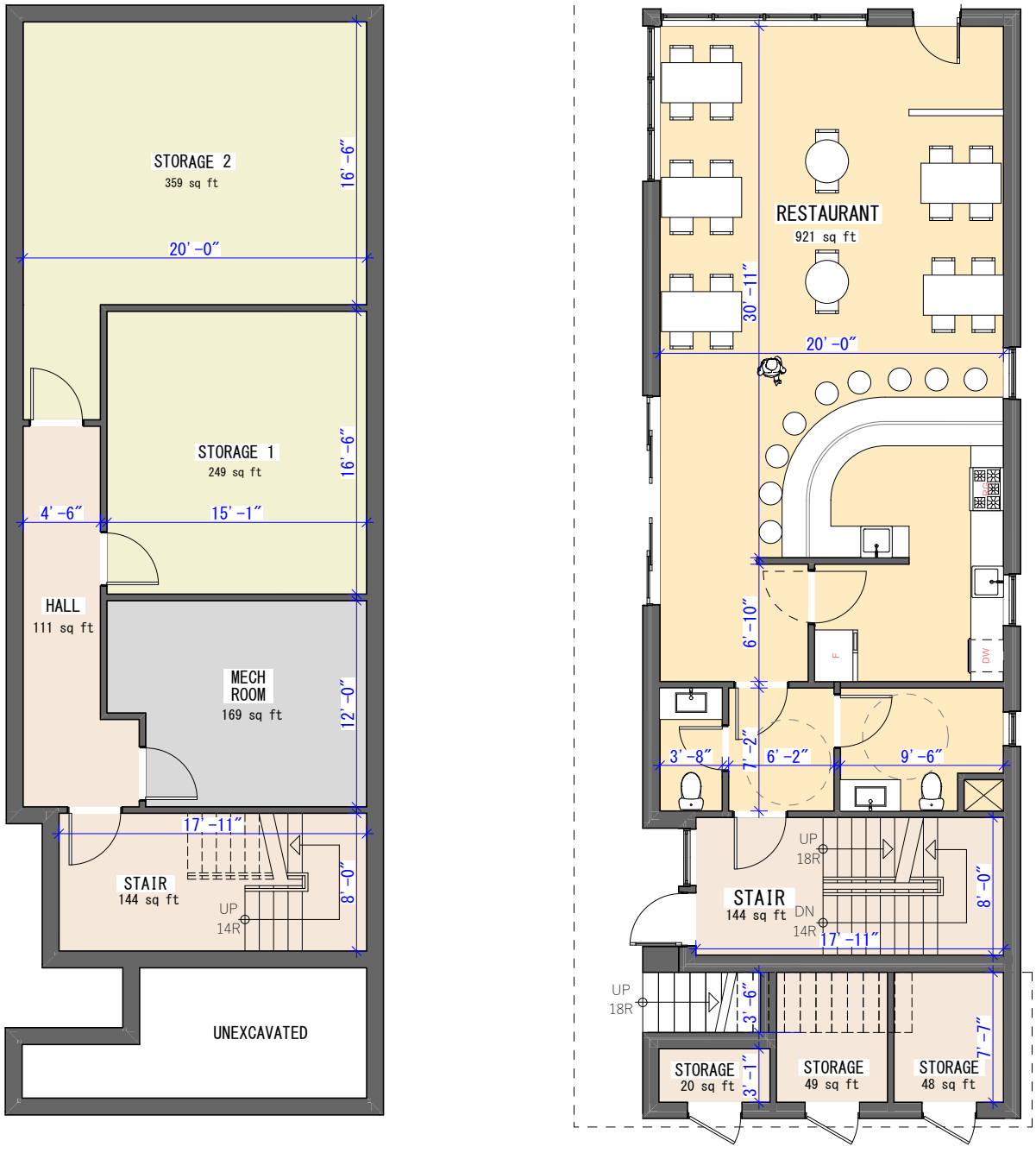
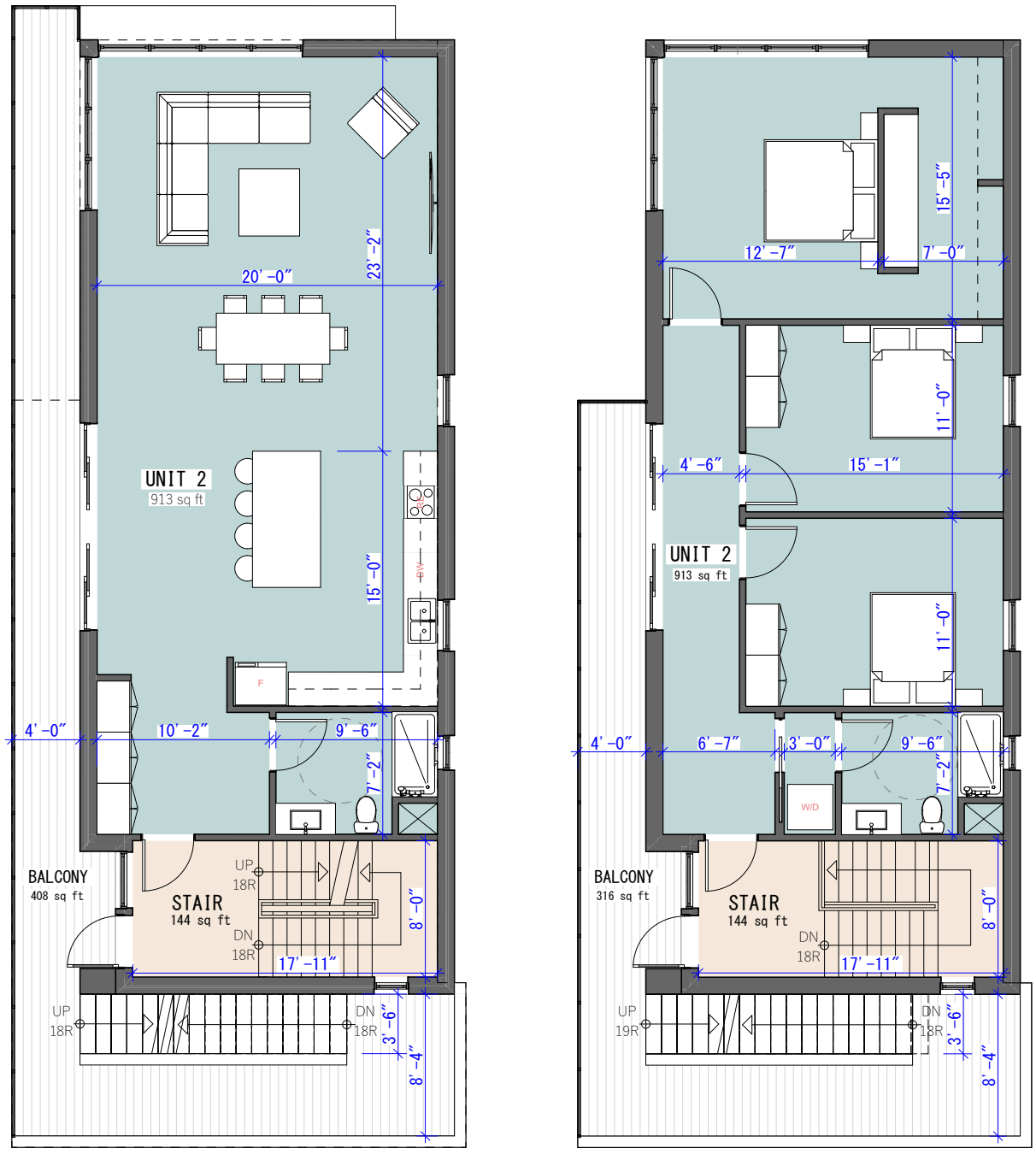


Figure 107:
Prototype-6 basement and first floor plans.

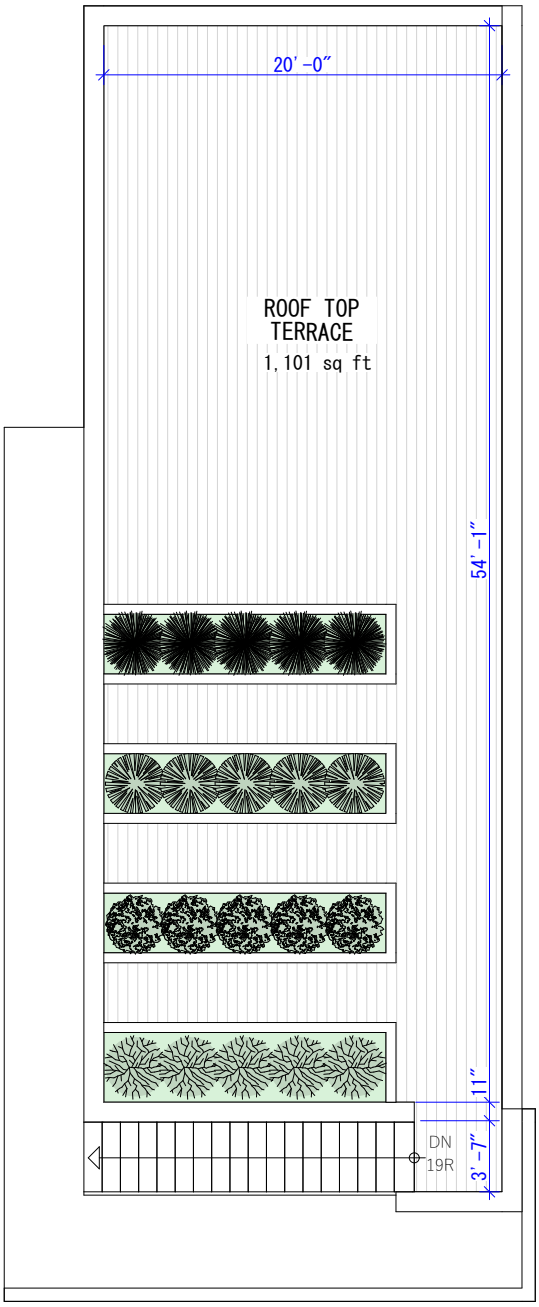


2ND FLOOR

3RD FLOOR

12' 8' 4' 0

Figure 108:
Prototype-6 second and third floor plans.



ROOF-TOP TERRACE

Figure 109:
Prototype-6 roof-top terrace plan.

12' 8' 4' 0

7.8.4 - Exterior Elevations

Figure 110:
Prototype-6 exterior elevations.

7.8.5 - Building Sections

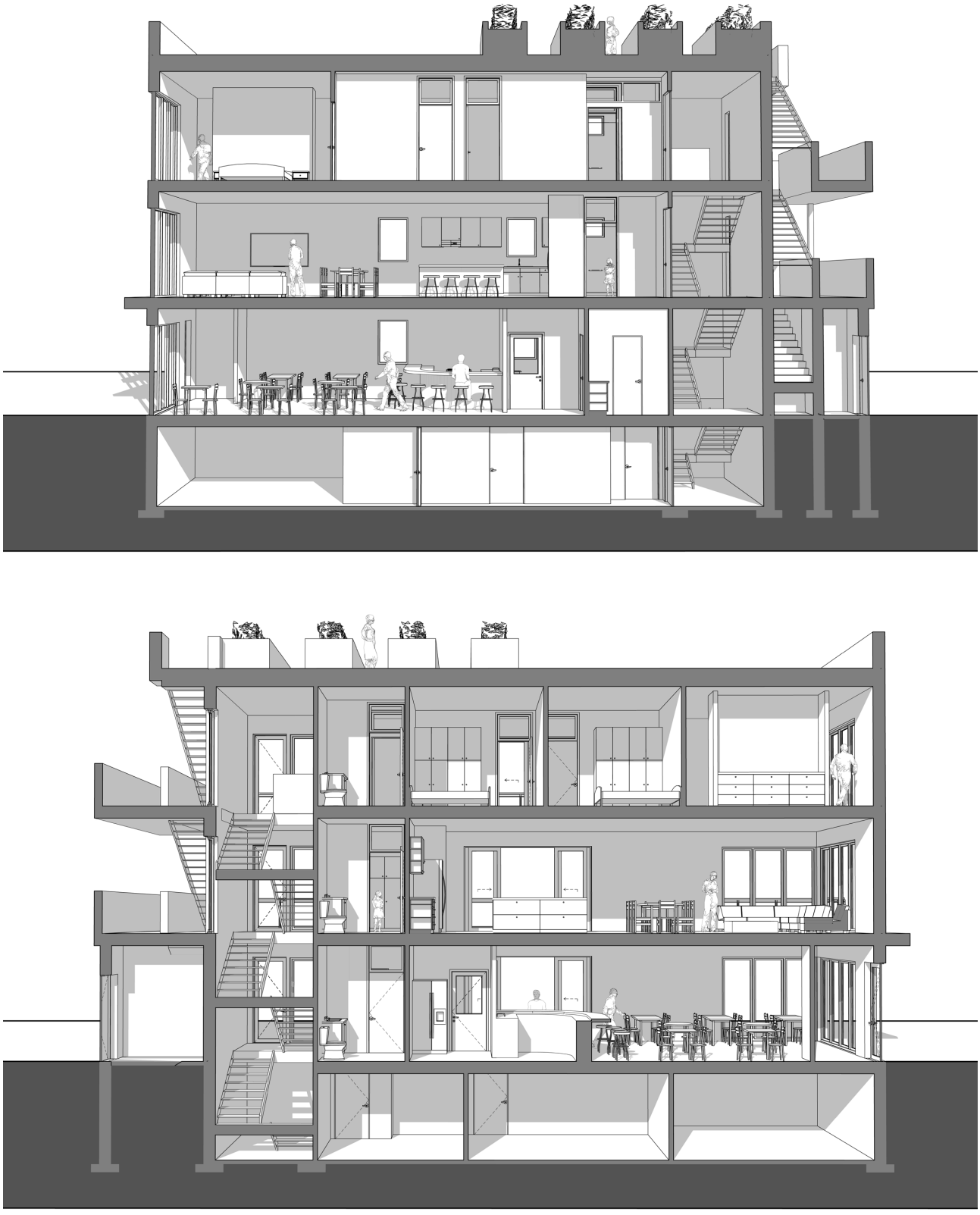


Figure 111:
Perspectival sections of Prototype-6.

Endnotes

1. Clara Pasieka · CBC News ·, 'Can Prefabricated Condos Help Solve Toronto's Housing Crisis? These Builders Think so | CBC News', CBC, 13 April 2022, accessed 10 November 2023, https://www.cbc.ca/news/canada/toronto/prefabricated-condos-toronto-1.6417473.

2. J S Bradley, 'Deriving Acceptable Values for Party Wall Sound Insulation from Survey Results', n.d.

Section 8:
Densification Statistics

8.1 - Introduction

The following section will demonstrate the projected increase in density within the target area under various development scenarios. As a baseline for comparison, the existing target area density will be identified in the first context map (figure 112). In the subsequent context map (figure 113) an additional 25% of properties will be identified as potential sites for densification with one of the proposed prototypes. In the last context map (figure 114) 50% of the properties within the target area will be identified as potential sites for densification. The tables that follow utilize the development scenarios in both the 25% and 50% densification maps to assess the potential dwelling unit per acre increase in the target area. Lastly, this information will be used to extrapolate the potential ability of the proposed prototypes to absorb potential population growth in Holmedale as well as other original Brantford neighbourhoods that possess similar amenity, zoning and lot size characteristics.

8.2 - Target Area Densification Study

Figure 112:
Figure-ground diagram depicting the existing block density at 7.9 du/acre

Figure 113:
Figure-ground diagram depicting 25% of lots being developed, generating 10.6 du/acre

Figure 114:
Figure-ground diagram depicting 50% of lots being developed, generating 12.6 du/acre.

The densification statistics in the following tables demonstrate how even modest increases in density can make a significant impact on a city's ability to absorb increasing populations into existing neighbourhoods.

Table 8-1 assumes that the prototypes on re-developed lots will be used in a lower density configuration. For example, a lot developed with Prototype-1 would only be counted as two units. However, in Table 8-2 the density is doubled, where the same lot with Prototype-1 is counted as four units.

Table 8-1: Lots Developed with Low Density Prototype (2-3 units)

	Dwelling Units / Acre
Existing Block Density	**7.9 du/acre**
25% Lots Developed	**10.6 du/acre**
50% Lots Developed	**12.6 du/acre**

Table 8-2: Lots Developed with High Density Prototype (4-6 units)

	Dwelling Units / Acre
Existing Block Density	**7.9 du/acre**
25% Lots Developed	**15.9 du/acre**
50% Lots Developed	**18.9 du/acre**

Table 8-3 uses the difference between the existing block density of 7.9 du/acre and the projected 10.6 du/acre in table 8-1 to calculate the approximate amount of population increase the target densification area can absorb with 25% of the lots being developed. The resultant 2.7 du/acre increase is then used to extrapolate the impact if applied to the entire neighbourhood of Holmedale as well as the remaining original neighbourhoods of Brantford. Table 8-4 performs the same calculations with the higher, 15.9 du/acre value in table 8-2, albeit with a slightly smaller household size corresponding to the smaller unit size.

8.3 - Multi-Neighbourhood Densification Study

Table 8-3:

Multi-Neighbourhood Densification Statistics with Low Density Prototype (2-3 units)

Neighbourhood	Acres (approximate)	DU/Acre increase @ 25%	Average household size	Absorbed Population Increase (# of people)
Targeted Densification Area	15	2.7	2.5	101
Holmedale	520	2.7	2.5	3,510
North Ward	140	2.7	2.5	945
Terrace Hill	379	2.7	2.5	2,558
East Ward	653	2.7	2.5	4,408
Eagle Place	720	2.7	2.5	4,860
Old West Brant	205	2.7	2.5	1,384
Total				**17,766**

Table 8-4:

Multi-Neighbourhood Densification Statistics with High Density Prototype (4-6 units)

Neighbourhood	Acres (approximate)	DU/Acre increase @ 25%	Average household size	Absorbed Population Increase (# of people)
Targeted Densification Area	15	7	1.5	157
Holmedale	520	7	1.5	5,460
North Ward	140	7	1.5	1,470
Terrace Hill	379	7	1.5	3,980
East Ward	653	7	1.5	6,857
Eagle Place	720	7	1.5	7,560
Old West Brant	205	7	1.5	2,152
Total				**27,636**

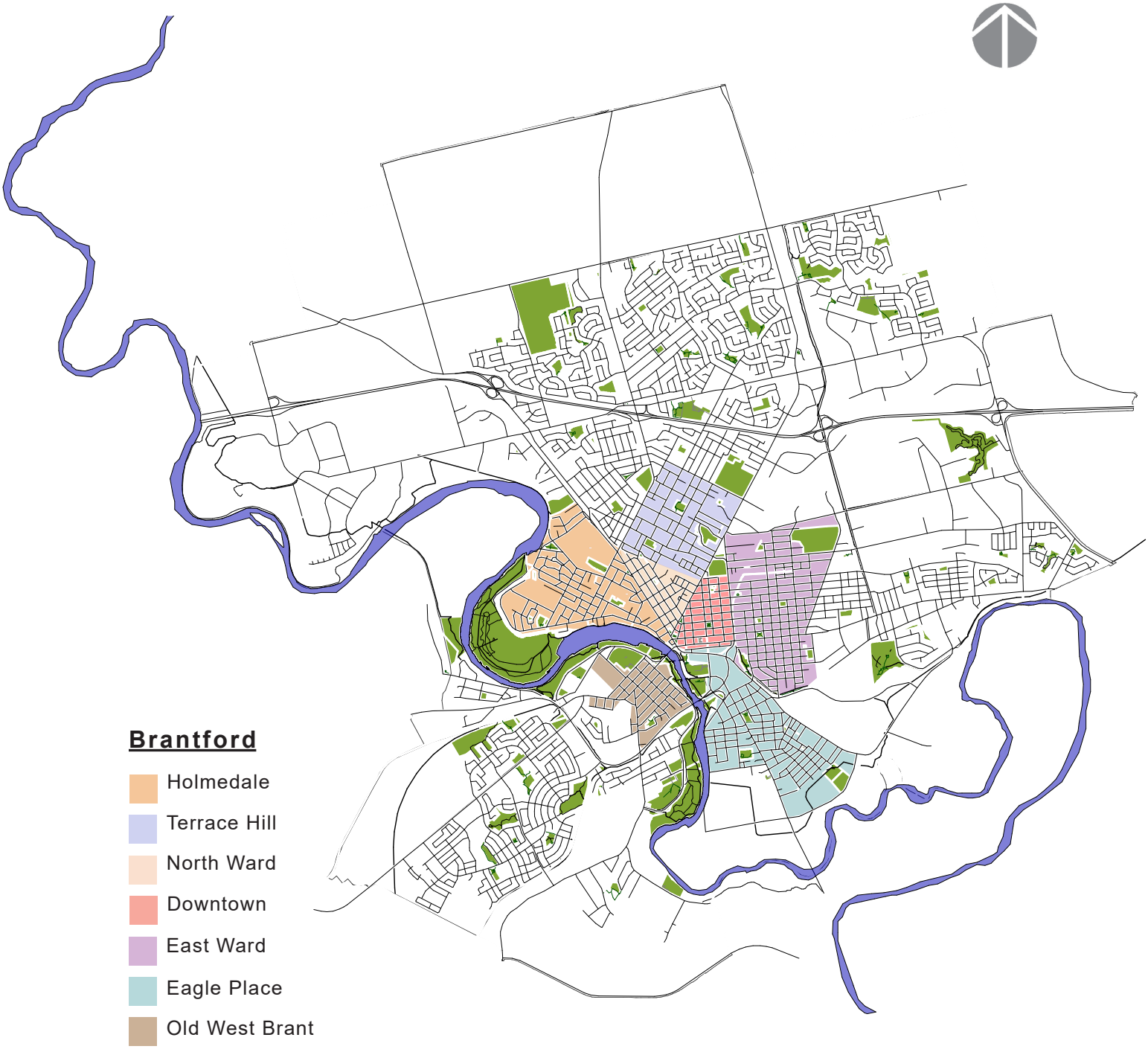


Figure 115:
Map of Brantford high-lighting it's original neighbourhoods.

8.4 - Conclusion

Although the population increase calculations are rough estimates, they provide valuable insights into the surprising ability of a city to absorb a sizable degree of population growth within existing neighbourhoods through soft densification. These tables also demonstrate the ability of the prototypes to absorb and shed density in sync with the ebb and flow of fluctuating demographics. Given these findings, it brings into question the perceived need to continue developing farmland into car-centric suburban sprawl or the other extreme of constructing excessively dense high rise towers located in pedestrian hostile environments. That being said, the development methodology of residential infill as a sole remedy for increasing the housing supply has pragmatic challenges. It is likely that achieving even a modest 25% re-development target within most neighbourhoods could take many years and properties that would be suitable for densification may be purchased by owners with other ideas in mind. However, with the rising cost of housing, the concept of alternative housing tenure-ships are gaining mainstream status as increasing media coverage has began to normalize concepts such as co-living, multi-generational homes or simply adding a rental unit to one's house to help pay the mortgage[1,2]. Given the benefits of applying moderate densification principles to existing neighbourhoods, what can be done to promote residential infill projects within our cities? At a municipal level, zoning bylaws need to be updated to align with recently passed provincial legislation that permits a maximum of three dwelling units per lot. Additionally, municipal zoning should further increase the amount of dwelling units that are permitted on one lot to be proportionate to its size. Obviously trying to squeeze six units on a 30'x60' lot may not make sense, however allowing six units on a lot that is 30' x 160' starts to become more reasonable. At a federal governmental level, the introduction of policies that make it at least as straight forward to obtain financing for a multi-unit residence as it is for a single family home would be a good first step. Currently, most big banks and private lenders have standardized processes for approving financing to build a new detached single family home, whereas obtaining the same amount of money to build a multi-unit building is less common and therefore more complicated. Although CMHC does offer various programs for financing the construction of rental units, gaining access to these funds is bogged down with enough bureaucracy to discourage most property owners or small scale developers from even trying. Providing incentives, such as tax cuts for building rental units or, better yet, discounted mortgage rates, could incentivize the construction of missing middle housing, addressing the need for additional housing options in many residential communities.

Lastly, potential developers need to be provided with examples of easy to build prototypes similar to the prototypical single-family housing designs that were published by CMHC in the decades following the end of WWII. In providing pragmatic, adaptable and simple to build multi-unit prototypes, this thesis aims to be an initial step in realizing the untapped potential within our cities to sustainably absorb population increases while enhancing the affordability and livability of the built environment. The next section will demonstrate how the adaptability of the prototypes to a variety of lot sizes make them viable not only in Holmedale, but in variety of other cities using Cambridge, Kitchener and Guelph as examples.

Endnotes

1. Bob Aaron Contributing Columnist, 'Co-Ops and Co-Ownership Are Emerging as Alternatives to Condos', Toronto Star, 7 July 2021, accessed 9 November 2023, https://www.thestar.com/life/home-and-garden/co-ops-and-co-ownership-are-emerging-as-alternatives-to-condos/article_1e23ed2a-4fca-5133-a0fc-0d1a55bdeb76.html.

2. 'Housing Innovation | Ontario.ca', accessed 9 November 2023, http://www.ontario.ca/page/housing-innovation.

Section 9:
Application of Prototypes in Similar Sized Cities

9.1 - Introduction

Using GIS zoning maps of similar neighbourhoods to Holmedale in Cambridge, Kitchener and Guelph, this section will identify properties that are compatible for re-development with one of the prototypes. The selected properties will be highlighted in red and designated with a number, 1 through 6, indicating the prototype that best suits the lot. Although not all potential sites are identified, the lots selected provide a sense of scale, showing how the prototypes might fit on various other properties throughout the neighbourhood. In each example, a zoning table summary will be provided to illustrate the impact different zoning restrictions may have on required minimum lot sizes for the prototypes. The aim is to avoid minor variances and zoning changes that can slow down the development process and inflate costs.

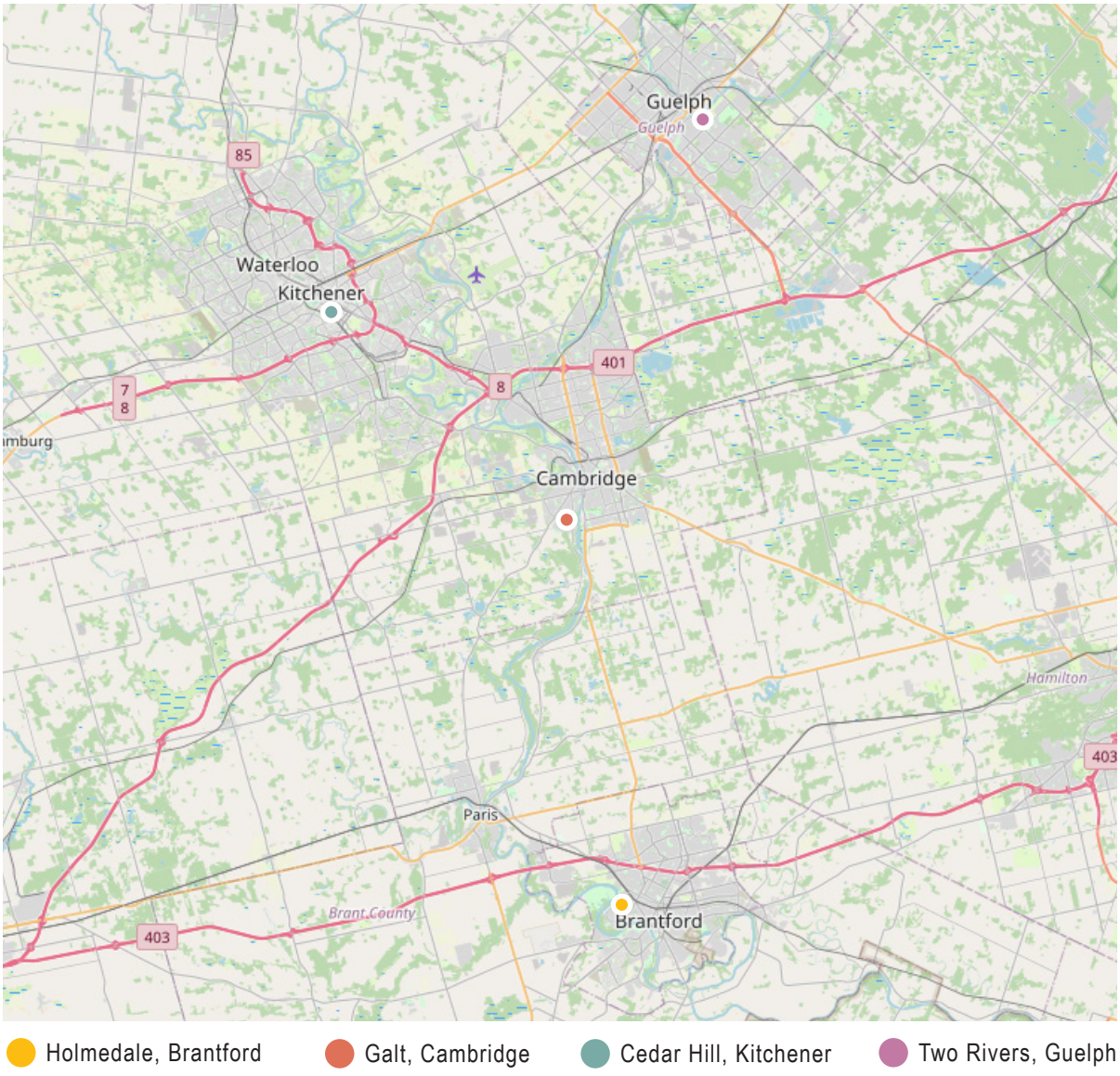


Figure 116:
Partial map of South-Western Ontario sourced from OpenStreetMap

9.2 - GALT - CAMBRIDGE

Figure 117: Image sourced from Google Streetview showing the corner of Grand Ave. and Victoria Ave. in Galt.

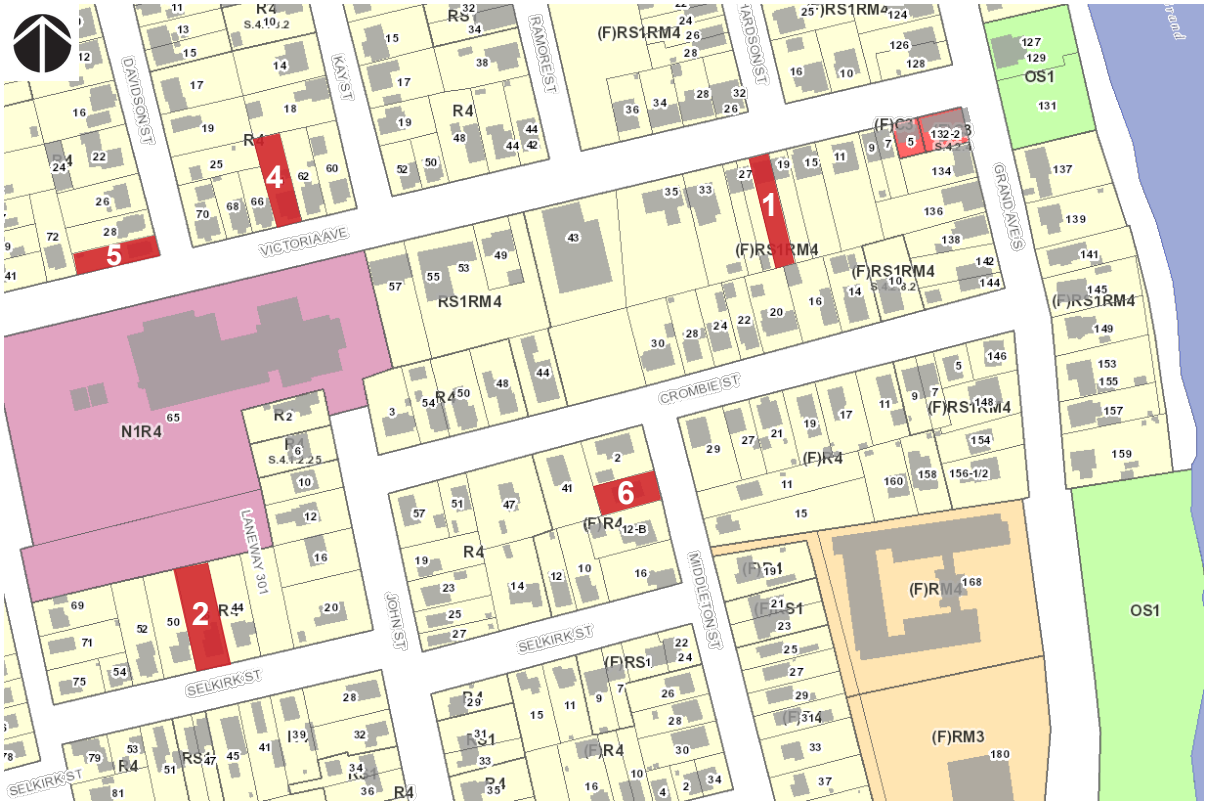


Figure 118: Partial zoning map of Galt, Cambridge as retrieved from the City of Cambridge website.

TABLE 9-1: CAMBRIDGE ZONING SUMMARY BY-LAW NO. 150-85	
Permitted Uses	Duplexes and triplexes permitted in RM zones, only single family detached permitted in R zones
Max Lot Coverage	**40%**
Min. Front Yard Setback	**6.0m**
Min. Side Yard Setback	**1.2m**
Min. Rear Yard Setback	**7.5m**
Building Height	**15m**

TABLE 9-2: IDENTIFIED LOT SIZES		
1. 29' x 165'	**2.** 50'x152'	**4.** 40'x135'
5. 31'x125'	**6.** 43'x92'	

Cambridge's increased side yard setback requirements add an additional 2 feet to the minimum lot frontage required for prototypes 1 and 2. Although the Cambridge zoning requires a 6.0m front yard setback, many municipal zoning bylaws permit encroachments into front yard setbacks allowing new buildings to be aligned with the front facade of neighbouring buildings further reducing the lot depth required to fit a prototype.

Figure 119: Image sourced from Google Streetview showing Peter St. South-West of Courtland Ave. in Kitchener.

Figure 120: Partial zoning map of the Cedar Hill neighbourhood as retrieved from the City of Kitchener website.

TABLE 9-3: KITCHENER ZONING SUMMARY ZONE R5 - BY-LAW NO. 85-1	
Permitted Uses	Additional detached dwelling unit, Duplex, semi-detached duplex multiple dwelling
Max Lot Coverage	**55%**
Min. Front Yard Setback	**4.5m** or the average of the front yards of the abutting lots, minus 1.0m
Min. Side Yard Setback	**1.2m** or a max. of 0.2m on one side, and a min. of 2.5 m on the other side
Min. Rear Yard Setback	**7.5m**
Building Height	**10.5m**

TABLE 9-4: IDENTIFIED LOT SIZES		
2. 40' x 180'	**3.** 40'x270'	**4.** 49'x145'
5. 35'x135'	**6c.** 43'x92'	**6i.** 35'x90'

The Cedar Hill neighbourhood is similar to Holmedale in that it is within walking distance to many commercial amenities on nearby King St. East and the City Commercial Core. The neighbourhood also consists of numerous oversized single family lots, offering significant potential for densification. The less restrictive zoning bylaws simplify the infill development process as well increasing the number of lots eligible for densification.

Figure 121: Image sourced from Google Streetview showing the corner of Toronto St. and Neeve St in Guelph.

Figure 122: Partial zoning map of Two River neighbourhood as retrieved from the City of Guelph website.

TABLE 9-5: GUELPH ZONING SUMMARY ZONE RL.2 - (2023)-20790	
Permitted Uses	3-unit apartment building
Landscaped Open Area	**35%**
Min. Front Yard Setback	**6.0m**
Min. Side Yard Setback	**1.2m** on one side **0.6m** on the other
Min. Rear Yard Setback	**7.5m or 20%** of lot depth wahtever is less
Building Height	**3** storeys

TABLE 9-6: IDENTIFIED LOT SIZES		
1. 25' x 150'	**2.** 42'x185'	**3.** 35'x200'
4. 35'x134'	**5.** 35'x185'	**6c.** 34'x100'
6i. 35'x95'		

Two Rivers is another example of an older neighbourhood consisting of oversized lots that is also within walking distance to Guelph's downtown core. Again, the existing fabric of the neighbourhood provides ample opportunity to introduce subtle density in the form of one of the proposed prototypes.

9.5 - Conclusion

These case studies illustrate how the prototypes can be applied to a variety of neighbourhoods similar to Holmedale in Cambridge, Kitchener and Guelph. This further exemplifies the versatility of the prototypes as comprehensive solutions for introducing sustainable density into many medium sized cities faced with the challenge of housing growing populations. Although the prototypes can be accommodated within the restrictions of the various zoning bylaws, it mostly restricts their density to three units. To permit a variety of dwelling types and buildings that are able to adapt to demographic needs, municipalities would be wise to revisit minimum dwelling units per lot. The design of the prototypes serve as an example of how seemingly excessive density can be successfully incorporated into the existing fabric of neighbourhoods without overwhelming it.

Section 10:
Financial Feasibility

10.1 - Introduction

So far this thesis has provided design feasibility showing how the prototypes can be accommodated on a variety of lot sizes within a variety of neighbourhoods. However, one of the most crucial ingredients to whether a project gets built is the cost. The following section will provide three potential development scenarios, that include *back of envelope* style pro-formas, providing further feasibility for the proposed prototypes. This section will also include detailed 5 year pro-formas for the last scenario which financially describes the prototype as a rental property. While this is not an exhaustive list of the variety of tenure options provide by the prototypes, it helps to demonstrate the financial flexibility they offer, a feature that is typically absent in conventional single-use dwelling typologies.

10.2 - SCENARIO 1

PROTOTYPE-5: Multi-Generational Dwelling

Figure 123:
Perspective of prototype-5.

An older couple has owned their house in Holmedale for the last several decades. They made their final mortgage payment this year and although they only paid $175,000 for their house in 1991 they are in disbelief that their house is now worth over $600,000. Although this is comforting in one sense, it also seems to be rather useless in a relative sense, as every other property has inflated to a similar degree. Meanwhile, their daughter and her partner who just recently started their careers are looking to buy a house, but lack the hefty 20% down payment that would allow them to purchase even the most modest of dwellings. To help their daughter out, the couple decides to use their new found equity to finance an addition to the rear of their property to create a multi-generational residence. The intent is to create a dwelling that will enable them to age in place, while providing affordable accommodations for their daughter and partner with sufficient privacy and autonomy.

Table 10-1 below provides a financial breakdown of the estimated cost to construct Prototype-5, as well as the mortgage payments required to pay back the re-mortgaging of the existing house. Removing the cost of land from the equation drastically reduces the cost of construction, leaving the daughter and her partner with a much more manageable mortgage payment. Scenario-1 may represent one of the most financially feasible options for densification of existing neighbourhoods as it eliminates the cost of land, empowering homeowners to leverage their equity and take on the role of developer.

Table 10-1

Back of Envelope Proforma - Prototyoe - 5 - Addition	
Early Rough Estimate of Total Costs	
Land	N/A
Hard Construction (1616 GFA @$205/sqft*)	$331,280.00
Soft costs and fees - 10% ref Appendix A	$33,128.00
Total	$364,408.00
Mortgage Repayment	
Total Loan amount	$364,408.00
Mortgage payment: 25 year amortization, 5 year fixed rate @ 5.94%***	$2,236.00
*Average cost of construction for wood framed single family residential with unfinished basement, Ottawa/Gatineau $140-225 ft2 - Altus Group - Canadian Cost Guide 2023 ** Based on comparable properties in Holmedale sold over the last 2 years: https://housesigma.com/ *** Mortgage information sourced from: https://www.ratehub.ca/mortgage-renewal-calculator	

10.3 - SCENARIO 2

PROTOTYPE-1: Co-Living / Shared Equity Mortgage

Figure 124:
Perspective of prototype-1.

The Developer

A small scale developer has purchased a long narrow lot in Holmedale with the intention of tearing down the existing house and building something much bigger that better utilizes the entire area of the lot. The first thought is to build a large single family home as it represents one of the easiest typologies to finance and build. However, with the cost of land, the amount that the house would have to be sold for to realize a profit is well above the one million dollar mark, substantially narrowing the target demographic that would be able to afford it. The next thought is to somehow try to sever the lot into multiple parcels to build two or three more affordable townhouse units, however the narrow width of the lot makes it challenging to accomplish and it is doubtful that the committee of adjustment would approve such small lot sizes with no lot frontage. In doubt about how to proceed, the developer engages the services of an architect who informs the developer of a new bill that has been passed that allows a maximum of three dwelling units in one building per lot. The architect devises a design that adheres to all of the zoning bylaws, while offering the ability of the *house* to be split into multiple units that permit a variety of tenure-ship options, increasing affordability for the potential buyer.

This seems like a great idea to the developer as it allows for maximum densification and profit while still making it financially accessible to a large demographic. It also allows the developer to get shovels in the ground sooner as there are no minor variances or zoning changes to apply for.

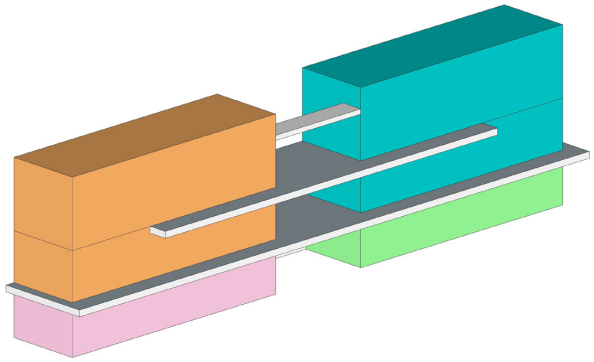


Figure 125:
Prototype unit configuration diagram, 2 - 1 bedroom barrier free units + 2 - 2 bedroom units

Table 10-2

Back of Envelope Proforma : Prototype-1 (2x4Bdrm)		
** Refer to Appendices for rationale of table values*		
Early Rough Estimate of Total Costs		
Land	$510,928.57	
Hard Construction (4737sqft @$185/sqft*)	$876,345.00	
Soft costs and fees	$151,399.76	
Total	$1,538,673.33	
Revenue		
No. of units	2	
Projected Sale Value** - ref Appendix B	$825,857.14	
Gross Profit	$1,651,714.29	
Construction Loan	$1,154,005.00	75.0%
Profit	$497,709.29	
Return		
Initial Equity	$384,668.00	25.0%
Profit	$497,709.29	
Return on Equity	$113,041.29	29.4%
*Average cost of construction for wood framed residential 3-storey stacked townhouse - Ottawa/Gatineau: $170-205 ft2 - Altus Group - Canadian Cost Guide 2023 ** Based on comparable properties in Holmedale sold over the last 2 years: https://housesigma.com/		

The Buyers

A young couple bought their 1 bedroom condo 6 years ago for $229,000. Although they were not able to put a noticeable dent in their mortgage, the sky-rocketing real-estate values that took place during the pandemic saw their condo value rise to over $400,000. The pandemic also highlighted their lack of access to nature as they found themselves essentially trapped on the 15th floor of their building during the lock downs. With their new found equity and desire to have greater access to nature, they decide it is time to move and start looking at houses in the nearby neighbourhood of Holmedale, which offers access to nature trails as well as a variety of other walkable amenities. Friends of theirs, who live on the 12th floor, find themselves in a similar situation having made substantial gains in equity and wanting to move to a house that has direct access to the outdoors. Unfortunately their individual gains in equity still do not amount to a sizable enough down-payment to transition into a single detached house in the neighbourhood of their choice. Frustrated by being out bid on over a dozen properties, the two couples decide to pool their equity together and look for a house that is compatible to co-living. Serendipitously, they find a newly built property in nearby Holmedale that not only offers multiple private dwelling units for each couple, but also the opportunity to rent out additional portions of the building to supplement their mortgage payments.

Table 10-3

Mortgage Repayment	
Cost of Building	$1,651,714.29
Minimum down payment (20%)	$330,342.86
Total Loan amount	$1,321,371.43
Mortgage payment: 30 year amortization, 5 year fixed rate @ 5.54%*	$7,484.00
Rental Income - 2x1bedroom unit	$3,446.67
Mortgage - Rental Income	$4,037.33
Mortgage - Rental Income / 2	**$2,018.67**
* Mortgage information sourced from: https://www.ratehub.ca/mortgage-renewal-calculator	

Conclusion

Although this scenario does offer substantial affordability once the mortgage is split in two and further supplemented by rental income, it is still quite restrictive considering that a 20% down payment is required for properties over one million dollars. To lower the barrier to entry, the federal government / Bank of Canada should consider permitting lending institutions to divide the sale price by the number of co-living households that are party to the mortgage. An example for this scenario would be to divide $1.65m, in half to $825,000, reducing the required minimum down-payment per couple to 7% amounting to $57,750, a significant decrease from $165,000.

Another solution to this problem, made possible by the ability of the prototypes to be easily sectioned off into separate units, would be to condominiumize the building, legally separating it into autonomous units that carry individual mortgages. This might also require hiring a property management company to maintain the common areas of the building necessitating a monthly condo fee. While this approach helps to create lower real-estate prices and down payments, it may also restrict future adaptability of the prototypes.

10.4 - SCENARIO 3

PROTOTYPE-4: Rental Property

Figure 126:
Perspective of prototype-4.

After successfully completing the first project with a return on equity of 30% the same developer purchases another property across the street, this time with the intent of building a similar prototype but with 4 or 6 units and keeping it as a rental property. The increase in dwelling units will require a minor zoning change, however given that the property is located in a residential conversion zone (RC zoning) with multiple nearby examples of buildings having greater than 6 units, the zoning change is approved. The other minor zoning change that is required is a reduction in required parking spaces per unit. Although only two parking spaces are provided, this is justified by the introduction of car sharing in the neighbourhood as well as an increase in public transit services over the past year. Additionally, the demand for parking spaces is much lower in this neighbourhood as there are numerous amenities within walking distance.

The developer initially prepares a detailed proforma to test the financial feasibility of the prototype's intended use as a rental property both as a 4 unit and 6 unit apartment. Although the proforma is profitable utilizing market rate rents, the developer intends to apply for CMHC's Affordable Housing Innovation Fund in an effort to provide below market rents.

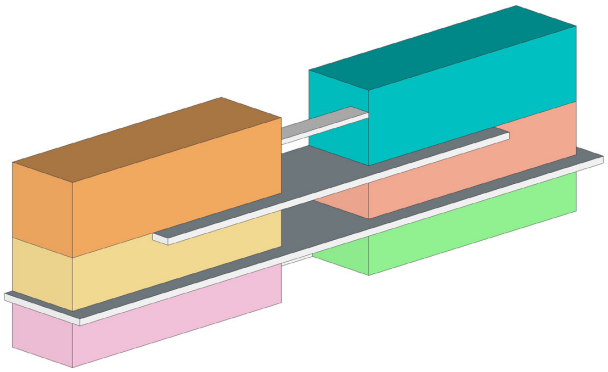


Figure 127:
Prototype unit configuration diagram, 2 - 1 bedroom barrier free units + 4 - 1 bedroom units.

Table 10-4

Rental Model Overview (6x1B)		
** Refer to Appendices for rationale of table values*		
Costs		
Land	$510,928.57	33.8%
Hard Construction (4362sqft @$185/sqft*)	$847,318.50	56.1%
Soft costs and fees	$151,399.76	10.0%
Total	**$1,509,646.83**	
Revenue		
Monthly rent per 1B no parking	$1,600.00	
No. of units	4	
Monthly rent per 1B with parking	$1,700.00	
No. of units	2	
Total Annual revenue	$117,600.00	
Operating expenses	$26,695.20	
Net Operating Income	**$90,904.80**	
Profit		
Cap rate	4.8%	
Discounted Cash Flow	$377,369.64	
Terminal Value	$2,087,368.91	
Debt Payments	-$1,463,573.82	
Profit	$1,001,164.73	
Return		
Initial Equity	$377,412.00	25.0%
Profit	$1,001,164.73	
Return on Equity	$623,752.73	165.3%

10.4.2

FUNDING BREAKDOWN

Table 10-5

FUNDING SUMMARY		
	Funds	% total
SOURCE OF FUNDS		
Equity	$377,412.00	25.00%
Construction Loan	$1,132,234.83	75.00%
Total Funds	**$1,509,646.83**	

Table 10-6

DEVELOPMENT BUDGET		
	Cost	% Total
Aquisition		
Land Cost	**$510,928.57**	33.84%
Soft Costs		
Building permit	$5,513.04	0.003652
Site Alteration	$3,600.00	0.24%
Architectural Fees	$48,418.20	3.21%
Surveyor / Grading	$5,000.00	0.33%
Structural Engineering	$5,000.00	0.33%
HVAC design	$1,000.00	0.07%
Design Contingency	$2,970.91	0.20%
Insurance	$10,490.61	0.69%
Legal	$2,000.00	0.13%
Zoning Bylaw Ammendment	$10,500.00	0.70%
Development Charges	$56,907.00	3.77%
Total Soft Costs	**$151,399.76**	10.03%
Hard Costs		
Residential Construction	$806,970.00	53.45%
Construction Contingency	$40,348.50	2.67%
Total Hard Costs	**$847,318.50**	56.13%
Total Cost	**$1,509,646.83**	

10.4.3

PROJECT STATISTICS

Based on the target market research showing 29% of households in Brantford consist of just one person and 33% consist of 2 people[1], the Pro-Forma will investigate two rental model configurations of the prototype. The first, a six unit apartment consisting of all 1-bedroom units and the second, a four unit apartment consisting of two 2-bedroom units and two 1-bedroom units.

Table 10-7

AREA TAKEOFF		
	Square meter	Square feet
GCA	449.3	4836
GFA	405.2	4362
NSA / NLA	314.4	3384
Efficiency	77.6%	77.6%

Table 10-8

UNIT MIX			6-1BD
	Unit Size (NLA)(ft2)	Unit Size (NLA)(m2)	Unit Count
1 Bedroom	564	52.4	6
2 Bedroom	1128	104.8	0
TOTALS	3384	314.4	6

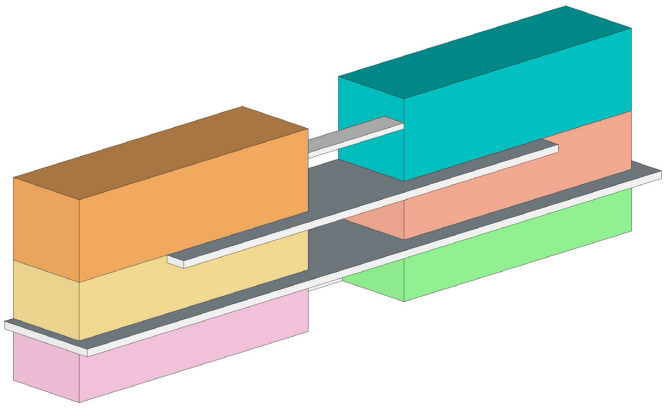


Figure 128:
Prototype unit configuration diagram, 2 - 1 bedroom barrier free units + 4 - 1 bedroom units.

Table 10-9

UNIT MIX			2-1BD + 2-2BD
	Unit Size (NLA)(ft2)	Unit Size (NLA)(m2)	Unit Count
1 Bedroom	564	52.4	2
2 Bedroom	1128	104.8	2
TOTALS	3384	314.4	4

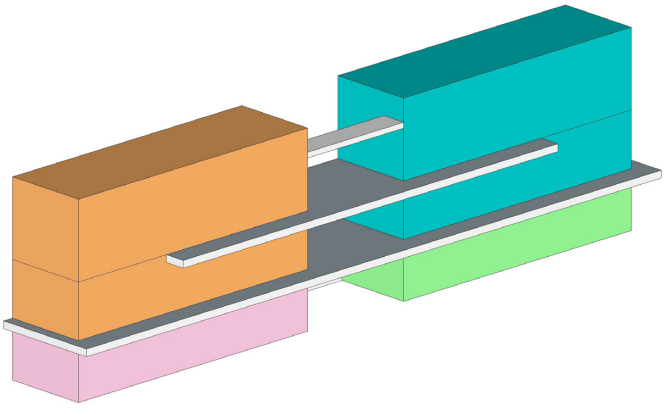


Figure 129:
Prototype unit configuration diagram, 2 - 1 bedroom barrier free units + 2 - 2 bedroom units.

10.4.4

INCOME ANALYSIS (ANNUAL)

Table 10-10

Income Analysis				**6-1BD**
Unit Type	Unit Rent per Month	Unit Count	Total Rent per Month	Total Rent per Year
1 Bedroom + parking	$1,700.00	2	$3,400.00	$40,800.00
1 Bedroom - no parking	$1,600.00	4	$6,400.00	$76,800.00
2 Bedroom + parking	$2,200.00		$0.00	$0.00
Annual Income				
Gross Residential Income				$117,600.00
Residential Vacancy (1.0%)				$1,528.80
Gross Overall Income				**$116,071.20**
Operating Expenses				
Property Tax				$5,000.00
Insurance				$2,000.00
Yard / Snow Maintenance				$3,600.00
Captial Expenses				$8,705.34
Painting				$3,000.00
Cleaning				$1,000.00
Rental Advertising				$3,000.00
Total Operating Expenses				**$26,305.34**
Net Operating Income				**$89,765.86**

Table 10-11

Income Analysis				**2-1BD + 2-2BD**
Unit Type	Unit Rent per Month	Unit Count	Total Rent per Month	Total Rent per Year
1 Bedroom + parking	$1,700.00	0	$0.00	$0.00
1 Bedroom - no parking	$1,600.00	2	$3,200.00	$38,400.00
2 Bedroom + parking	$2,200.00	2	$4,400.00	$52,800.00
Annual Income				
Gross Residential Income				$91,200.00
Residential Vacancy (1.0%)				$1,185.60
Gross Overall Income				**$90,014.40**
Operating Expenses				
Property Tax				$5,000.00
Insurance				$2,000.00
Yard / Snow Maintenance				$3,600.00
Captial Expenses				$6,751.08
Painting				$3,000.00
Cleaning				$1,000.00
Rental Advertising				$3,000.00
Total Operating Expenses				**$24,351.08**
Net Operating Income				**$65,663.32**

10.4.5

PROJECT TIMELINE

Table 10-12

	Month 0	Month 6	Month 9 (Excavation & Foundations)	Month 12 (Roof Finished)	Month 15 (Plumbing, Wiring, Drywall)	Month 18 (Interior Finished)	Month 21 (Construction Complete)
Land and Hard Costs							
Land Acquisition	$510,928.57						
Equity (25% development budget)	$377,412.00						
Land Acquisition	**$133,516.57**						
Construction			$121,045.50	$201,742.50	$201,742.50	$161,394.00	$121,045.50
Construction Contingency			$6,052.28	$10,087.13	$10,087.13	$8,069.70	$6,052.28
Soft Costs							
Building permit			$5,513.04				
Site Alteration Permit			$3,600.00				
Architectural Fees	$19,367.28	$14,525.46	$14,525.46				
Surveyor / Grading	$2,000.00	$3,000.00					
Structural Engineering		$5,000.00					
HVAC design		$1,000.00					
Design Contingency	$1,068.36	$1,176.27					
Insurance	$1,498.66	$1,498.66	$1,498.66	$1,498.66	$1,498.66	$1,498.66	$1,498.66
Legal (land acquisition)	$2,000.00						
Zoning Change	$10,500.00						
Development Charges			$56,907.00				
Total Development Cos	**$169,950.87**	**$26,200.39**	**$209,141.93**	**$213,328.28**	**$213,328.28**	**$170,962.36**	**$128,596.43**
Debt							
Principal							
Initial Balance		$169,950.87	$196,151.27	$405,293.20	$618,621.48	$831,949.77	$1,002,912.12
Draws	$169,950.87	$26,200.39	$209,141.93	$213,328.28	$213,328.28	$170,962.36	$128,596.43
Ending Balance	$169,950.87	$196,151.27	$405,293.20	$618,621.48	$831,949.77	$1,002,912.12	**$1,131,508.56**
Interest							
Accrued Balance	-	$8,381.14	$13,217.75	$23,211.28	$38,464.96	$58,978.79	$83,708.13
Interest	$8,381.14	$4,836.61	$9,993.53	$15,253.68	$20,513.83	$24,729.34	$27,900.21
Total Accrued		$13,217.75	$23,211.28	$38,464.96	$58,978.79	$83,708.13	**$111,608.34**
Total Principal	**$1,131,508.56**						

10.4.6

5 YEAR PRO-FORMA - 6 UNITS

Figure 130:
Prototype unit configuration diagram, 6 units.

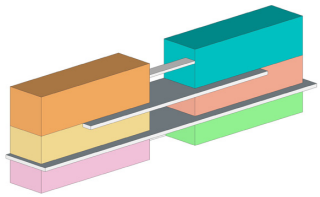


Table 10-13

OPERATING BUDGET						6-1BDRMS
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Rental Income		$116,071.20	$118,972.98	$121,947.30	$124,995.99	$128,120.89
Less Vacancy		$1,508.93	$1,546.65	$1,585.31	$1,624.95	$1,665.57
Effective Gross Income		$114,562.27	$117,426.33	$120,361.99	$123,371.04	$126,455.32
Less Operating Expenses		$26,005.64	$26,655.78	$27,322.17	$28,005.23	$28,705.36
Net Operating Income		$88,556.64	$90,770.55	$93,039.82	$95,365.81	$97,749.96
DEBT SERVICE						
Mortgage Amount	$1,131,508.56					
Beginning of Year Balance		$1,131,508.56	$1,116,925.58	$1,101,483.16	$1,085,130.65	$1,067,814.41
Interest Payment		$64,568.90	$63,709.46	$62,799.37	$61,835.65	$60,815.12
Principal Payment		$14,582.98	$15,442.42	$16,352.51	$17,316.24	$18,336.76
Total Payment		$79,151.88	$79,151.88	$79,151.88	$79,151.89	$79,151.88
Balloon Payment						$1,049,477.65
Total Debt Payment						$1,463,573.82
Year End Balance		$1,116,925.58	$1,101,483.16	$1,085,130.65	$1,067,814.41	
DSCR		1.12	1.15	1.18	1.20	
PROFIT (RENTAL)						
DCF Analysis						
CF from Operation		$88,556.64	$90,770.55	$93,039.82	$95,365.81	$97,749.96
CF from Sale						$2,087,368.91
Total Cash Flow		**$88,556.64**	**$90,770.55**	**$93,039.82**	**$95,365.81**	**$2,185,118.87**
Discount Factor		1.073	1.151329	1.235376017	1.325558466	1.422324234
Present Value (DCF)		$82,531.82	$78,839.81	$75,312.95	$71,943.88	$1,536,301.51
Total Present Value (DCF)						**$1,844,929.96**
Project Cost	$1,509,646.83					
Net Present Profit (NCF)						$335,283.13
Unlevered IRR						4.51%
EQUITY CASH FLOW						
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Total Cost of Investment	-$1,509,646.83					
Proceeds from Mortgage	$1,132,234.83					
CF from Operations		$82,531.82	$78,839.81	$75,312.95	$71,943.88	$68,725.51
Interest payment		-$64,568.90	-$63,709.46	-$62,799.37	-$61,835.65	-$60,815.12
CF from Sale						$2,087,368.91
Repayment of loan						-$1,049,477.65
Total before - Tax Equity CF	-$377,412.00	$17,962.92	$15,130.35	$12,513.58	$10,108.23	$1,045,801.65
Net Equity Cash Flow						$724,104.72
Equity IRR						24.99%
Terminal Value	**$2,087,368.91**					

10.4.7

5 YEAR PRO-FORMA - 4 UNITS

Figure 131:
Prototype unit configuration diagram, 4 units.

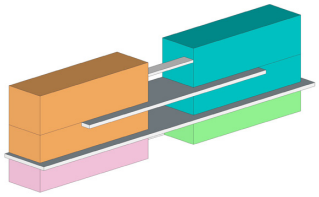


Table 10-14

OPERATING BUDGET						2-1BD + 2-2BD
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Rental Income		$90,014.40	$92,264.76	$94,571.38	$96,935.66	$99,359.06
Less Vacancy		$1,170.19	$1,199.44	$1,229.43	$1,260.16	$1,291.67
Effective Gross Income		$88,844.21	$91,065.32	$93,341.95	$95,675.50	$98,067.39
Less Operating Expenses		$20,167.64	$20,671.83	$21,188.62	$21,718.34	$22,261.30
Net Operating Income		$68,676.58	$70,393.49	$72,153.33	$73,957.16	$75,806.09
DEBT SERVICE						
Mortgage Amount	$1,131,508.56					
Beginning of Year Balance		$1,131,508.56	$1,116,925.58	$1,101,483.16	$1,085,130.65	$1,067,814.41
Interest Payment		$64,568.90	$63,709.46	$62,799.37	$61,835.65	$60,815.12
Principal Payment		$14,582.98	$15,442.42	$16,352.51	$17,316.24	$18,336.76
Total Payment		$79,151.88	$79,151.88	$79,151.88	$79,151.89	$79,151.88
Balloon Payment						$1,049,477.65
Total Debt Payment						$1,463,573.82
Year End Balance		$1,116,925.58	$1,101,483.16	$1,085,130.65	$1,067,814.41	
DSCR		0.87	0.89	0.91	0.93	
PROFIT (RENTAL)						
DCF Analysis						
CF from Operation		$68,676.58	$70,393.49	$72,153.33	$73,957.16	$75,806.09
CF from Sale						$1,618,775.89
Total Cash Flow		**$68,676.58**	**$70,393.49**	**$72,153.33**	**$73,957.16**	**$1,694,581.98**
Discount Factor		1.073	1.151329	1.235376017	1.325558466	1.422324234
Present Value (DCF)		$64,004.27	$61,141.07	$58,405.96	$55,793.21	$1,191,417.50
Total Present Value (DCF)						**$1,430,762.01**
Project Cost	$1,509,646.83					
Net Present Profit (NCF)						-$78,884.82
Unlevered IRR						-1.17%
EQUITY CASH FLOW						
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Total Cost of Investment	-$1,509,646.83					
Proceeds from Mortgage	$1,132,234.83					
CF from Operations		$64,004.27	$61,141.07	$58,405.96	$55,793.21	$53,297.33
Interest payment		-$64,568.90	-$63,709.46	-$62,799.37	-$61,835.65	-$60,815.12
CF from Sale						$1,618,775.89
Repayment of loan						-$1,049,477.65
Total before - Tax Equity CF	-$377,412.00	-$564.63	-$2,568.39	-$4,393.41	-$6,042.44	$561,780.46
Net Equity Cash Flow						$170,799.59
Equity IRR						7.67%
Terminal Value	**$1,618,775.89**					

10.4.8

CONCLUSION

After testing the financial feasibility of both the 4 unit and 6 unit prototype, assuming the property will be sold after five years, it becomes clear that the 6 unit building is more profitable, providing a return on equity of 25% compared to 7.7% for 4 units. The developer decides to initially construct the building with 6 units, but may alter the configuration at a later date depending upon demographic demand and the length of tenancy achieved with 1-bedroom units. The flexibility of the prototype also provides the developer with the option of occupying a portion of the building as their primary residence at a later date while continuing to collect rent to supplement their mortgage payments.

APPENDIX 10-A

FINANCIAL ASSUMPTIONS

Table A-1

APPENDIX A - ASSUMPTIONS			
Mortgage	5.74%		5 year term, 30 year amortization, 20% downpayment/equity https://www.ratehub.ca/best-mortgage-rates#BMRTable-tab-panel_best-market-rates-0
Loan repayment amount			https://www.calculator.net/amortization-calculator.html
Debt Service Coverage Ratio (DSCR)			Annual NOI / Annual Debt Service
BoC Inflation	2.80%		https://www.statcan.gc.ca/en/start
Discount rate (r)	1.073	0.073	Bank of Canada selected benchmark bond yields 2023-07-28: 5 year = 3.5% + 2.8% (inflation)+ 1.0% (risk) + 1.0- https://www.bankofcanada.ca/rates/interest-rates/canadian-bonds/. NOTE: (lower risk assumed due to high demand for housing)
Growth rate	1.02500		2.5% - https://www.ontario.ca/page/residential-rent-increases
Industry Cap Rate	0.04		KW - multi-family low rise a (3.25%-4.0%) CBRE Research - Q1 2023 - Canadian Cap rates and Investment Insights
Calculated Cap rate	0.048		discount rate (0.073) - growth rate (0.025)
Canadian prime rate	0.07		July 12, 2023 https://www.ratehub.ca/prime-rate
Construction loan rate	0.10		Prime rate + 2.8% https://www.ontarioconstructionloans.ca/construction-financing/construction-financing-interest-rates
Vacancy rate	0.013		October 2022 - https://www03.cmhc-schl.gc.ca/hmip-pimh/en/TableMapChart/Table?TableId=2.1.31.3&GeographyId=0125&GeographyTypeId=3&DisplayAs=Table&GeograghyName=Brantford
Unlevered IRR			https://www.calculatestuff.com/financial/irr-calculator
Accrued Interest formula			Accrued interest = loan amount x (yearly interest/365) x period for which the interest is accrued - https://www.wallstreetmojo.com/accrued-interest-formula/
Construction Draw Schedule			https://wowa.ca/construction-loans
INCOME			
1 bedroom rent per month w/ parking	$1,700.00		See Appendix B - Rental Chart
1 bedroom rent per month no parking	$1,600.00		$100 discount applied for additional cost of parking
2 bedroom rent per month w/ parking	$2,200.00		See Appendix B - Rental Chart
FUNDING			
Equity	25.00%		25% of total project cost
SOFT COSTS			
Building permit	$5,513.04		Group C – Residential occupancies (except hotels/motels) $1.14 per square foot x 4836ft2 https://www.brantford.ca/en/business-and-development/fees.aspx
Site Alteration	$3,600.00		Site Alteration permit - Infill lot residential construction - fee $600 + deposit $3000 https://www.brantford.ca/en/living-here/site-alteration-permit-fee-schedule.aspx
Architectural Fees	$48,418.20		approx 6% of hard costs, based on recent quote completed by:https://www.rubix-form.com/
Surveyor / Grading	$5,000.00		recent quote obtained from; https://www.vanharten.com/
Structural Engineering	$5,000.00		recent quote obtained from: https://www.eximiuseng.com/
HVAC design	$1,000.00		https://www.trtldesigns.com/
Design Contingency	0.05		5% of design fees - sourced from Class B Costing from Turner & Townsend

Table A-1 con't

APPENDIX A - ASSUMPTIONS			
Insurance	$10,490.61		1.3% of hard costs - https://remodelonpoint.com/list-of-soft-costs-in-construction-with-percentage/
Legal	$2,000.00		based on lawyer fees from purchase of personal residence
Zoning Bylaw Ammendment	$10,500.00		https://www.brantford.ca/en/business-and-development/planning-fees.aspx
Development Charges	$18,969.00		Small Apartment 70 sq. m or less https://www.brantford.ca/en/business-and-development/city-of-brantford-development-charges-effective-january-1-2023.aspx
Development Charge Exemptions			Exempting the 3 unit "gentle intensification" from Development Charges (DC), Parkland and Community Benefit contributions. Exempting affordable, attainable and inclusionary zoning units from DCs, and discounts to Community Benefits and Parkland Dedication. Attainable housing is still to be defined. Requiring a discount on development charges for purpose-built rentals, and a greater discount for larger units. https://engage.ottawa.ca/provincial-legislation-planning/news_feed/bill-23-2
HARD COSTS			
Residential Construction	$806,970.00		4362 GFA x 185 $/ft2 - Average cost of construction for wood framed residential 3-storey stacked townhouse - Ottawa/Gatineau: $170-205 ft2 - Altus Group - Canadian Cost Guide 2023
Construction Contingency	0.05		5% of residential construction - sourced from Class B Costing from Turner & Townsend
Land Cost	$510,928.57		See Appendix B - Land Value Study
Construction Time	1 year		Estsimated from previous constructed projects designed by: https://www.rubix-form.com/
OPERATING EXPENSES			
Property Tax	$5,000.00		based on property tax for 27 Spring Street
Insurance	$2,000.00		https://www.ratehub.ca/blog/average-home-insurance-cost-ontario/
Yard / Snow Maintenance	$3,600.00		https://gardenzilla.ca/rates/
Captial Expenses	0.075		7.5% of yearly rental income
Painting	$3,000.00		https://www.homepainterstoronto.com/2020/10/13/the-cost-of-painting-a-house-in-2020-2021/
Cleaning	$1,000.00		https://www.moneysense.ca/spend/shopping/how-much-you-should-be-paying-for-a-cleaning-service/
Rental Advertising	$3,000.00		https://rethority.com/how-much-does-a-real-estate-agent-make-on-a-rental/
Operating Cost %	0.227		Calculated from soft costs in year 1
TERMS & ACRONYMS			
GCA	Gross Construction Area		Inclusive of all above-grade areas, measured to exterior face of walls
GFA	Gross Floor Area		additional exclusions: garages, basements, storage, loading, support services, stair openings, mechanical,etc. (exclusion definitions vary per municipality)
NSA / NLA	Net sellable Area / Net Leaseable Area		additoinal exclusions: exterior walls and common areas such as: hallways, foyers, stair wells

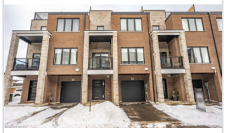
APPENDIX 10-B

COMPARABLE PROPERTY STUDIES

Figure 132: Images sourced from House Sigma showing recently sold attached properties in Brantford

Table B-1

COMPARITIVE REAL-ESTATE VALUE FOR CONDO SALE

Address + House Sigma Link	Listing price	Sold price	Date sold	Key facts	
"Unit 10 - 33 Jarvis Street Brantford"	$629,888.00	**$840,000.00**	2022-02-02	-Row/Townhouse, 3 Storey -1336 feet² -2 Bedrooms - 3 Bathrooms -Attached 1 garage, 2 parking -Days on Market:1 days	
"Unit 16 - 33 Jarvis Street Brantford"	$729,900.00	**$840,000.00**	2022-01-28	-Row/Townhouse, 3 Storey -1336 feet² -2 Bedrooms - 3 Bathrooms -Attached 1 garage, 2 parking -Days on Market:1 days	
"Unit 17 - 33 Jarvis Street Brantford"	$699,999.00	**$806,000.00**	2022-01-18	-Row/Townhouse, 3 Storey -1336 feet² -2 Bedrooms - 3 Bathrooms -Attached 1 garage, 2 parking -Days on Market:5 days	
"Unit A - 3 Spring Lane Brantford"	$699,900.00	**$825,000.00**	2021-10-26	- Row/Townhouse, 3 Storey - 1967 feet² - 3 Bedrooms - 3 Bathrooms -Attached 1 garage, 2 parking -Days on Market:4 days	
"24 Jubilee Avenue Brantford"	$489,900.00	**$741,000.00**	2022-02-24	- Row/Townhouse, 2 Storey - 1238 feet² - 3 Bedrooms - 2 Bathrooms -Attached 1 garage, 2 parking -Days on Market:2 days	
"Unit 14 - 60 Dufferin Avenue Brantford"	$869,900.00	**$879,000.00**	2022-09-16	- Row/Townhouse, 2 Storey - 2085 feet² - 3 Bedrooms - 4 Bathrooms -Attached 1 garage, 4 parking -Days on Market: 67 days	
"Unit 10 - 60 Dufferin Avenue Brantford"	$899,999.00	**$850,000.00**	2022-07-15	- Row/Townhouse, 2 Storey - 1976 feet² - 3 Bedrooms - 4 Bathrooms -Attached 1 garage, 4 parking -Days on Market: 24 days	
Proposed Address	**Average listing price**	**Average sold price**		**Key facts**	
33 Spring Street Brantford	$717,069.43	**$825,857.14**		- Row/Townhouse, 3 Storey - 1700feet² - 560 feet² roof top deck - 4 Bedrooms - 3 Bathrooms - 2 parking	

APPENDIX 10-B

COMPARABLE PROPERTY STUDIES

Figure 133: Images sourced from House Sigma showing recently sold detached properties in Brantford.

Table B-2

COMPARATIVE LAND VALUE STUDY					
Address + House Sigma Link	**Listing price**	**Sold price**	**Lot Size**	**Date sold**	
116 Grand River Avenue	$649,000.00	**$625,000.00**	42 x 200 feet	2023-05-25	
116 Wilkes Street	$499,900.00	**$487,500.00**	40 x 125 feet	2023-06-12	
111 Grand River Ave	$424,900.00	**$415,000.00**	42 x 200 feet	2020-10-01	
21 Leonard St	$399,900.00	**$390,000.00**	40 x 129 feet	2020-06-01	
48 Lansdowne Ave	$492,500.00	**$495,000.00**	43 x 165 feet	2020-08-01	
17 Sunset Avenue	$549,900.00	**$504,000.00**	45 x 134 feet	2023-06-29	
97 Grand River Avenue	$599,000.00	**$660,000.00**	41 x 175 feet	2023-04-26	
		Average Sold Price			
31 Spring Street	$516,442.86	**$510,928.57**	38 x 140 feet		

APPENDIX 10-B

COMPARABLE PROPERTY STUDIES

Figure 134: Images sourced from House Sigma showing recently rented 1-bedroom apartments in Brantford

Table B-3

COMPARABLE 1 BEDROOM RENTAL VALUE STUDY			
Address + House Sigma Link	**Rent**	**Key facts**	
#306 -120 COLBORNE ST Brantford, Ontario N3T2G6	**$1,700.00**	- 723 feet² - 1 Bedrooms - 1 Bathrooms - ensuite laundry	
#607 -1 WELLINGTON ST Brantford, Ontario N3T2L3	**$1,750.00**	- 640 feet² - 1 Bedrooms - 1 Bathrooms - 1 parking space - ensuite laundry	
120 St Paul Ave, Brantford, ON N3T 4G2, CAN	**$1,740.00**	- 540 feet² - 1 Bedrooms - 1 Bathrooms - on-site laundry	
Unit 126 - 85A Morrell Street Brantford	**$1,850.00**	- 795 feet² - 1 Bedrooms - 2 Bathrooms - 1 parking space - ensuite laundry	
11 West St, Brantford, ON N3T 3E4, CAN	**$1,600.00**	- 540 feet² - 1 Bedrooms - 1 Bathrooms - 1 parking space - on-site laundry	
150 Darling St, Brantford, ON N3T 6A7, CAN	**$1,700.00**	- 612 feet² - 1 Bedrooms - 1 Bathrooms - 1 parking space - on-site laundry	
#608 -7 ERIE AVE Brantford, Ontario N3S2E7	**$1,675.00**	- 550 feet² - 1 Bedrooms - 1 Bathrooms - ensuite laundry	
Proposed Address	**Average 1 bdrm rent**	**Key facts**	
33 Spring Street Brantford	**$1,723.33**	- 567 feet² - 1 Bedrooms - 1 Bathrooms - ensuite laundry	

1. All rental prices are current to within 1 year of August 2023
2. All comparable properties are located within a 2-3km radius of the proposed development site

APPENDIX 10-B

COMPARABLE PROPERTY STUDIES

Figure 135: Images sourced from House Sigma showing recently rented 2-bedroom apartments in Brantford

Table B-4

COMPARABLE RENTAL VALUE STUDY			
Address	**Rent**	**Key facts**	
#305 -7 ERIE AVE Brantford, Ontario N3S2E7	**$2,200.00**	- 790 feet² - 2 Bedrooms + den - 2 Bathrooms - ensuite laundry	
#214A -85 MORRELL ST Brantford, Ontario N3T4J6	**$2,200.00**	- 953 feet² - 2 Bedrooms - 2 Bathrooms - ensuite laundry	
#403-120 COLBORNE ST Brantford, Ontario N3T2G6	**$1,850.00**	- 813 feet² - 2 Bedrooms - 1 Bathroom - Coin laundry on site	
#204-150 COLBORNE ST Brantford, Onatri N3T1L2	**$2,200.00**	- 933 feet² - 2 Bedrooms - 1 Bathroom - Newly renovated	
#176 NORTH PARK ST Brantford, Ontario N3R4K5	**$2,250.00**	- 932 feet² - 2 Bedrooms - 1 Bathroom - Ensuite laundry	
Proposed Address	**Average 2 bdrm rent**	**Key facts**	
33 Spring Street Brantford	**$2,200.00**	- 1134 feet² - 2 Bedrooms - 2 Bathrooms - ensuite laundry	

1. All rental prices are current to within 1 year of August 2023
2. All comparable properties are located within a 2-3km radius of the proposed development site

Endnotes

1. Statistics Canada, 'Profile Table, Census Profile, 2021 Census of Population - Brantford [Population Centre], Ontario',accessed 7 September 2023, www12.statcan.gc.ca

Section 11:
Discussion

The initial aim of this thesis was to investigate the densification potential of existing neighbourhoods in medium sized cities to absorb population growth via small scale infill development. The proposed prototypes, as spatial design solutions, have demonstrated how a small-scale infill project can thoughtfully increase density, adaptability, mixed-use possibilities and housing options that increase affordability for a large portion of the population. However there are many undivorceable factors that have been highlighted and uncovered through the course of writing this thesis that create challenges and limitations to the implementation of the prototypes as built solutions.

One of the biggest questions encountered when considering the effectiveness of small scale infill development is: how can it be guaranteed that properties with densification potential will actually be redeveloped and intensified? The short answer at this point in time is: you can't. Unlike the sale of large acreages of undeveloped land, when a house goes up for sale, the market of potential buyers is much bigger and what the purchaser will end up doing with the property varies greatly. It is true, as exemplified by infill projects included in this thesis, that as populations in cities grow, infill development becomes more common. Especially in neighbourhoods like Holmedale that boast large lot sizes and less restrictive zoning. That being said, hoping that a developer wins out on a dozen person bidding war so they can build missing middle housing in your neighbourhood, is not a reliable development strategy. Potential solutions to this problem are tricky without severely impeding a homeowners ability to sell to whomever they want, or restricting the pool of potential buyers. Should local governments mandate that lots over a certain size or under a certain density be densified? It is likely that governmental efforts such as this would be greeted with righteous indignation on behalf of land-owners, replying something to the tune of, *what gives you the right to tell me what to do with my property?* However, it is interesting to consider how potential changes to zoning by-laws may help to create this desired impact. What if, instead of limiting lots to single unit detached homes, zoning by-laws were revised to state that no fewer than three units are permitted upon the redevelopment of a lot? Again, this may be seen as governmental overreach, but is it more so than prohibiting more than one dwelling unit per lot? This is debatable. Although the recently passed *Bill 23, More Homes Faster Act 2022*, does take a big step forward in permitting a maximum of three dwelling units per lot in Ontario, municipal zoning bylaws remain restrictive in a variety of ways, which decentivize densification. One of the biggest culprits is minimum parking requirements. A prime example of this is when one of the prototypes is configured into a six-unit building, which under the Brantford zoning by-law is considered an apartment requiring 1.5 parking spaces per unit. This would necessitate the provision of nine parking spaces, effectively killing the spatial feasibility of the project.

This is in contrast to the two parking spaces required for a two-unit configuration of a prototype that remains exactly the same size. Zoning restrictions like these not only act as impediments to the creation of missing middle housing, they also betray our continued collective addiction to creating car-centric environments.

Unlike larger cities such as Toronto or Montreal that have existing subway systems and extensive public transit, medium sized cities such as Brantford, typically have very little beyond irregular bus service demarcated by sporadic poles in the ground that announce bus stops. To make densification possible it is incumbent upon municipalities to provide transportation alternatives to the private vehicle. The densification of existing, centrally located neighbourhoods is a partial solution to the problem of car dependency as it creates greater walkability and acts as a catalyst for further walkable amenities. The creation of dedicated bike lane infrastructure is also helpful in alleviating the need for a car. Car-sharing is another option for lessening the dependence on the private automobile and of course, the obvious solution is expanding public transit. However, this is easier said than done, especially in localities where private car ownership has been the norm for generations. Anecdotally, one of the biggest observed impediments to expanding public transit and decreasing car dependence, is the stigma that is associated with taking public transit in smaller cities such as Brantford. However, as we are faced with an unrelenting housing crisis and the prospect of ever expanding suburban sprawl and its associated traffic, temporarily unpopular decisions will need to be made in order to supplant the car, with the human being as the primary design parameter in our built environments.

It could be argued that another challenge associated with infill housing is the stigma that may be affiliated with existing neighbourhoods that are potential areas for densification. In older neighbourhoods such as Holmedale, the prevalence of housing that is older and in need of repair could appear to some as undesirable for their living environment. This in comparison to a new suburb, that presents the shiny veneer of a brand new neighbourhood, devoid of any immediately visible problems. In Ontario, neighbourhood stigma is further exacerbated by the province's Education Quality and Accountability Office's (EQAO) ratings of schools that decisively dictates to parents if the surrounding catchment area is a suitable neighbourhood to raise their kids[1]. Whereas, in newer neighbourhoods, newly constructed schools with modern amenities lack the historic baggage of a bad reputation and create yet another incentive for suburban living. Although these issues are complex and sometimes difficult to talk about, they nonetheless represent potential challenges and societal biases that may inhibit the implementation of densification in existing neighbourhoods and act to perpetuate suburban sprawl.

It could be argued that initial revitalization of an existing neighbourhood requires a degree of fortitude by intrepid developers and future residents, who are undeterred by the status quo, before it is adopted as an acceptable place to live by the general public. However, relying on a minority of progressive individuals to enact change is also not a sound solution for the densification of our cities. Instead, the creation of financial incentives and policies that promote the development of infill housing, not only for affluent newcomers but also for the majority of the population that currently finds itself priced out of the housing market, may help to take the perceived risk out of densifying existing neighbourhoods.

The lack of financial incentives and supportive development policy for residential infill continues to be an impediment to the feasibility of missing middle housing. This became particularly evident when crunching numbers for the pro-formas of various prototypes in *Section 10 - Financial Feasibility*. It was surprising to see how dramatically the financial feasibility of the rental property in scenario 3 dropped from a return on equity of 25% to that of 7.7% when the building was reduced from six units to four. This provided some insight into why developers try to jam as many small units as possible into condo towers, instead of fewer large units that might better serve a broader demographic. The reality of these financial calculations also brings into question the feasibility of redeveloping a property with only three units, as Bill 23 now permits. Is this actually enough density if pro-formas for three unit rental properties do not actually work? It would seem not. This also brings into question the effectiveness of the unregulated free market to provide affordable housing that actually meets the needs of a diverse population by simply adding to the supply. Without guardrails in the form of human-centric development policies, it seems that an unsympathetic gamification of the capitalist system is inevitable.

As discussed in *Section 1.3 - Housing Affordability*, another economic challenge hindering the creation of innovative missing middle housing is the current financial system, which is set up in favour of producing traditional housing typologies that are out of step with current demographic needs and economic constraints. One recommendation to incentivize the construction of small scale multi-unit buildings could come in the form of easily accessible, discounted borrowing rates for missing middle housing. This suggestion is particularly poignant, in the higher interest rate environment of 2023 which was implemented by the Bank of Canada to fight inflation and lower cost of living. Ironically the increase in interest rates has had a detrimental impact on the financial feasibility of many residential developments, choking the supply of new housing units and driving up the demand and cost of existing units that were already in short supply[2]. In an effort to remedy this problem the Canadian Federal and Ontario Provincial governments, in 2023, have proposed to exempt all purpose built rentals from HST, effectively reducing the cost of construction by 13%[3]. At the end of the day, there are a

variety of financial levers that governments at different levels can pull to enhance the financial feasibility of missing middle projects. Levers that need to be pulled, according to Mitchell Cohen of Daniels Corp. who fears that "the value of our city (Toronto) will go down as a place to live and work if we continue to ignore affordability. The businesses will leave, because commuting two and a half hours from wherever is not the answer. We need to create places in the city for the key workers to live near where they work. We're gonna erode the value of the city by not making that investment."[4] However, the more challenging exercise may be in creating policies that tether financial incentives to perpetual affordability for end-users. Exploration of potential financial policies opens a Pandora's box of macro-economic philosophy that the scope of this thesis could not adequately address, however it is an important investigation that needs to be pursued in order to effectively address the current housing crisis.

One of the more surprising findings encountered when writing *Section 8: Densification Statistics*, is how relatively low targets for residential densification can result in a substantial absorption of population growth. The most conservative scenario tested, of 25% of existing lots being developed with two to three dwelling units per lot, was able to absorb a population increase of 17,766 when applied to the six original neighbourhoods in Brantford. When this was increased to four to six units per lot, the population absorption was even more impressive at 27,636. Given that Brantford's population is projected to increase at a rate of 1.21%[5] per annum, adding just over 1200 residents per year, densification of these neighbourhoods would appear to be a more effective and sustainable solution to that of continued suburban sprawl. To further illustrate this, if we assume an average household size of 2.5 people, Brantford would need to add approximately 500 dwelling units to existing neighbourhoods each year. Using the values from *Table 8-3: Multi-Neighbourhood Densification Statistics with Low Density Prototype (2-3 units)* This could be accomplished by densifying approximately 2% of the properties in each of Brantford's original neighbourhoods each year. A target that appears to be very manageable.

Finally, based on personal experience as discussed in the *Preface,* a somewhat obscured obstacle to increasing the supply of missing middle rental units is the reality that being a landlord is not for everyone. Although this may be an obvious statement, it has fairly serious ramifications considering the current push by the Canadian federal and provincial governments to incentivize the construction of rental units as a means to increase affordability. This begs the question: how many missing middle rental units can a city realistically expect to produce, if a) the pro-formas don't work for the permitted three units per lot and b) not everyone is interested in being a landlord? Are these government incentives not setting the stage for more large scale apartment towers located outside of desirable neighbourhoods? It is hard to say, however at this point in time it seems that incentivization for small-scale residential infill remains low and somewhat precarious.

Part of the solution to this problem may be the acknowledgement that there is still a sizable portion of the Canadian population that would prefer to own their dwelling instead of rent[6]. However, as the cost of housing has gone through the roof over the past decade spanning from 2014 to 2023, the Canadian government seems to have shifted away from the idea of achieving affordability through ownership. This shift is precisely where the proposed prototypes in this thesis as well as other missing middle housing typologies may find their niche in the Canadian market. By providing more affordable pathways to home ownership in vibrant, centrally located, walkable neighbourhoods. This can be achieved in a variety of ways with the prototypes in this thesis, including: shared equity mortgages, condominiumization, rental income and multi-generational homes. However, these solutions do not presuppose a static architectural typology. Instead they are among numerous solutions that are permitted by the flexibility and adaptability of the prototypes. The versatility of the prototypes refuses to dictate ill-fitting solutions to its residents, but instead provides the freedom to design the solution that best suits their evolving needs. At the same time, it allows neighbourhoods to evolve and adapt to the preferences and needs of future generations.

Endnotes

1. Ranu Basu, 'Geosurveillance Through the Mapping of Test Results: An Ethical Dilemma or Public Policy Solution?', ACME: An International Journal for Critical Geographies 3, no. 2 (2004): 87–111.

2. Denise Paglinawan, 'Higher Rates Are Hitting Homebuilding amid Already Languishing Inventories', financialpost, 26 April 2023, accessed 8 November 2023, https://financialpost.com/real-estate/cmhc-housing-starts-drop-high-interest-rates.

3. Vanessa Balintec · CBC ·, 'Could Tax Cuts Mean More Purpose-Built Rentals? Some Toronto Advocates Hope so | CBC News', CBC, 15 September 2023, accessed 8 November 2023, https://www.cbc.ca/news/canada/toronto/toronto-housing-gst-local-reaction-1.6967861.

4. Trevor Cole, 'Attested Development: How Mitchell Cohen of Daniels Corp. Went from Housing Activist to Big-Time Developer', The Globe and Mail, 25 October 2023, accessed 8 November 2023, https://www.theglobeandmail.com/business/rob-magazine/article-mitchell-cohen-daniels-corp-ceo-toronto/

5. 'Demographic and Census Information', 2 March 2023, accessed 8 November 2023, https://www.advantagebrantford.ca/en/data-centre/demographic-and-census-information.aspx.

6. Michelle Cyca, 'The End of Homeownership', Macleans.Ca (blog), accessed 8 November 2023, https://macleans.ca/longforms/the-end-of-homeownership/.

Section 12:
Conclusion

The purpose of this thesis has been to explore the ability of centrally located original neighbourhoods within medium sized cities to absorb population growth via small scale infill development. This objective was pursued by investigating alternate design options for small scale residential infill projects within the historic neighbourhood of Holmedale in Brantford, Ontario, further serving as a template for similar sized cities experiencing population growth and increased cost of living. The original goal was to create residential design solutions that increase density, mixed-use possibilities and housing options in low density residential neighbourhoods, as a strategy to increase affordability and residential density. The proposed design solutions have also endeavoured to address the need for adaptive re-use to accommodate ever evolving neighbourhood demographics.

Reflecting on these aspirations, the proposed prototypes are considered to be successful as spatial design solutions, having demonstrated how a small-scale infill project can thoughtfully increase density, adaptability, mixed-use possibilities and housing options for a large portion of the population. However, a design in and of itself is only a portion of a fully realized solution. Acknowledging this, the thesis has endeavoured to inform this solution through a variety of methods, beginning with a brief synopsis of Ontario's housing crisis accompanied by reviews of topical literature, common housing typologies and development strategies. The contextual information that was gained from these reviews then set the stage to investigate target demographics and identify neighbourhoods that are best suited for densification. Once demographics had been identified and a site located, the exercise of identifying design parameters was undertaken to understand the constraints and resultant design opportunities. From here the stage was set for the presentation of prototypes one through six. To add further validity to these design proposals a study in resultant densification statistics was investigated, demonstrating the ability of the prototypes to absorb population growth. Having demonstrated the prototype's ability to absorb population growth in Brantford, the applicability of the prototypes was then tested in similar neighbourhoods in Cambridge, Kitchener and Guelph to demonstrate how this solution could be applied to a variety of locations that are experiencing similar housing challenges. Finally, the financial feasibility of multiple variations of the prototypes were investigated to demonstrate the ability of the prototypes to provide a greater variety of financial options that enhance affordability.

It is hoped that this thesis will provide not just inspirational designs for housing, but also the supporting research, data and financial proof of concept that is required to realize the proposed prototypes as built solutions to the current housing crisis. This being said there are still many challenges to the implementation of missing middle housing typologies in existing neighbourhoods. One of the main one's being, how to craft financial policy to compliment and incentivize the creation of the proposed prototypes, while ensuring perpetual affordability for the end-user.

This together with a more thorough investigation of local zoning bylaws in Ontario, to further understand the barriers preventing the creation of missing middle housing in existing neighbourhoods, would be two beneficial areas of study to complement this thesis.

Had time permitted it would have been informative to further develop one of the prototypes into a full set of construction drawings. However, this may have tempted me to want to build it too.

Figure 136:
Photo of my daughter Tayler and me on the construction site of the addition I built at the back of our house in 2021.

Section 13:
Afterward
~
Post Defence Reflections

The thesis defence discussion that ensued after the presentation brought to light additional insights and further examples of concurrent work that could help to better define the advantages and disadvantages of the proposed prototypes in this thesis.

One reviewer provided examples of concurrent work addressing similar housing issues in Toronto and Ottawa. Having subsequently reviewed these initiatives including the *ReHousing* study, led by Michael Piper at the University of Toronto, as well as housing solutions produced by Hobin Architects and Colizza-Bruni Architects in Ottawa, key differences between their work and those put forth in this thesis began to emerge. Upon comparison, uncovered differences include the definition of tenancy as well as the facilitation of adaptive re-use. The issue of the definition of tenancy was brought to light by one of the reviewers who pointed out that the prototypes in this thesis have a lot of vague undefined communal space which leaves questions as to what belongs to who and who is responsible for what. This is a valid observation, as the adaptable, open ended nature of the proposed prototypes may leave too much open for interpretation for future owners or tenants. The loose boundaries between private, semi-private and public space in the prototype's programming may leave potential residents confused as to what the building is and how to inhabit it. This definition of tenancy can prove to be very important for marketing, as even in unfurnished houses for sale, potential buyers tend to have a hard time picturing themselves in a space without the aid of temporary staging. A further element that would be helpful to build upon the open ended adaptability of the proposed prototypes would be supplementary diagrams illustrating and describing how the more ambiguous spaces within the prototypes, such as the stairwells, exterior walkways and rooftop terraces get delineated depending on the type of tenancy the prototype is used for. However, where the prototypes in this thesis may have an advantage over more defined design solutions is the ability of the floor plan be reinterpreted and adapted to a multitude of future uses that may be unforeseen at this current point in time.

Another question that was brought to light was the necessity of having two stairwells as well as the practicality of their placement within the floor plan. After considering these design decisions subsequent to the thesis defence discussion, there are several reasons these design decisions were pursued. The first reason was a result of an effort to remove parking from the front of the property. In doing so, a drive aisle was required on one side of the site. Recognizing that this was a bit of a compromise in terms of efficient use of the site, an effort was made to reduce the amount of area that would need to be hardscaped to accommodate the storage of vehicles. The solution pursued was to provide parking, in the form of a carport, in the middle of the site. This also provided the opportunity to break up the long narrow mass of the prototypes, permitting natural light into the site as well as providing a requisite amount of

acoustic and spatial privacy between front and rear units. The division of the building by the carport necessitated the provision of two autonomous stairwells to service the now separate portions of the building. Although this might seem superfluous at first, its practicality became evident considering the viability of having all six units spill out into a single stairwell. This posed challenges for egress, requiring a central stairwell to take up as much, if not more space than the two separate stairwells combined.

In contrast to many of the design solutions provided in the *ReHousing* study, the proposed prototypes feature stairwells that are not embedded in the middle of the floor plate. Designing the stairwells as autonomous tower elements, adjoined by only one wall, not only allows the module's floor plate to take full advantage of an already narrow footprint but also facilitates the possibility of true modularity via prefabrication.

As building codes begin to become more permissive with egress requirements for buildings over three stories, it is feasible that the proposed prototypes could take the form of a prefabricated building that can be added onto at a later date to further increase density. This would most likely be accomplished by constructing the foundations and stairwells on-site, while the living modules would be prefabricated off site and then stacked on-site like lego blocks connecting to the autonomous framework of the vertical circulation tower. If this type of modularity is pursued, it opens the door for the fairly straightforward process of stacking further living modules on top of existing ones. This is further facilitated by the structural autonomy of the stairwell, which allows them to be more easily extended up without disturbing the adjoining structure of the building.

One of the more open-ended and thought provoking questions that was brought up during the discussion was that of: What is the role of design and the designer in the process of uncovering solutions to the housing crisis? One of the roles that was adopted as the designer of the prototypes in this thesis was to uncover and fully understand the existing parameters that are dictated by existing lot patterns, zoning by-laws and building codes. Many times as designers, these parameters are seen as restrictions to creative solutions, and no doubt, sometimes that is exactly what they are, warranting their review and possible removal. However, many times the idealistic zeal that is expressed in the revolt against these parameters strands designs on paper instead of being realized as built solutions. It was a guiding principle in this thesis that existing parameters needed to be taken seriously if the prototypes were going to carry weight as actual design solutions that could be realized as a constructed building. This responsibility of understanding and working within existing parameters is one that we as designers cannot be flippant about if we actually want to see our designs built. We need to be aware that we are playing a game that is presupposed by existing parameters that will not be easily cured or dismissed by unrealized ideals.

However, the question of: *What is the role of the designer?* still looms in the space defined by imposed parameters. What do we do with this space and how much say do we actually have with the remaining design decisions? Unfortunately, as architects and designers we most commonly find ourselves as consultants to clients with preordained visions that consume what is left of the design freedom. This paradigm, which is the predominant architectural business model, leaves the designer as the frustrated artist, desperately trying to convince their clients of superior design solutions as alternatives to the unquestioned solutions that are demanded. Only in the writing of this thesis, was I able to uninhibitedly explore design solutions without being accountable to a client's narrow focus on financial returns that are confined by unquestioned modes of operation.

Part of the solution may be the need for designers to get their hands dirty in the topics that we typically shy away from. An example of this is the exploration of the financial feasibility that was undertaken in this thesis to provide a financial proof of concept, recognizing that in our economically driven society, such evidence carries significant weight. As architects and designers seeking to have a greater impact on the built environment, we may also need to come to terms with the fact that we don't currently have enough skin in the game to afford us the design freedom that we crave. This realization also reignites the question of whether the profession of architecture has veered too far from its origins as that of the *Master Builder*, as we too often find our designs and ideals, unrealized.

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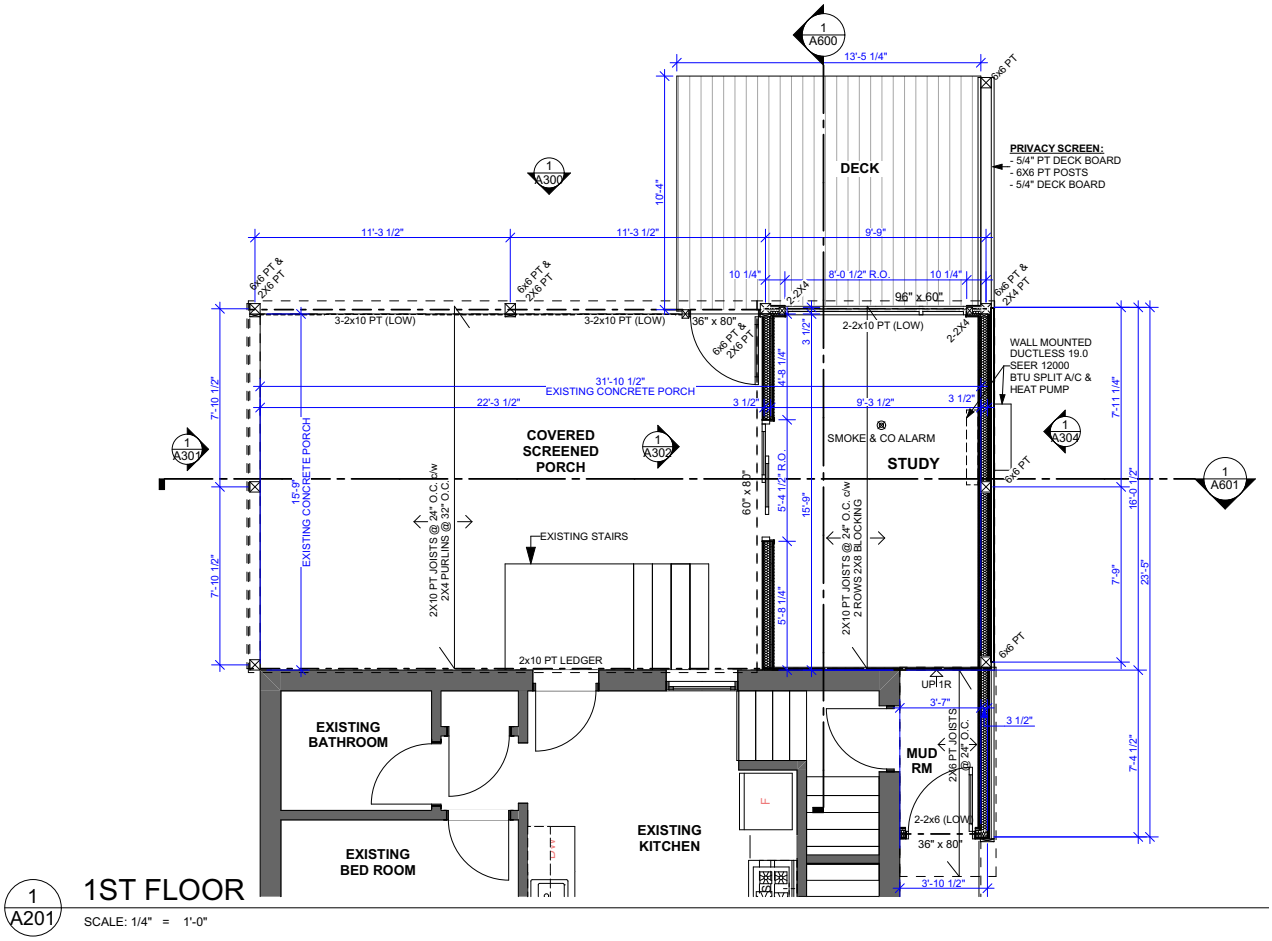
Appendix A:
An Exercise in Small Scale Densification

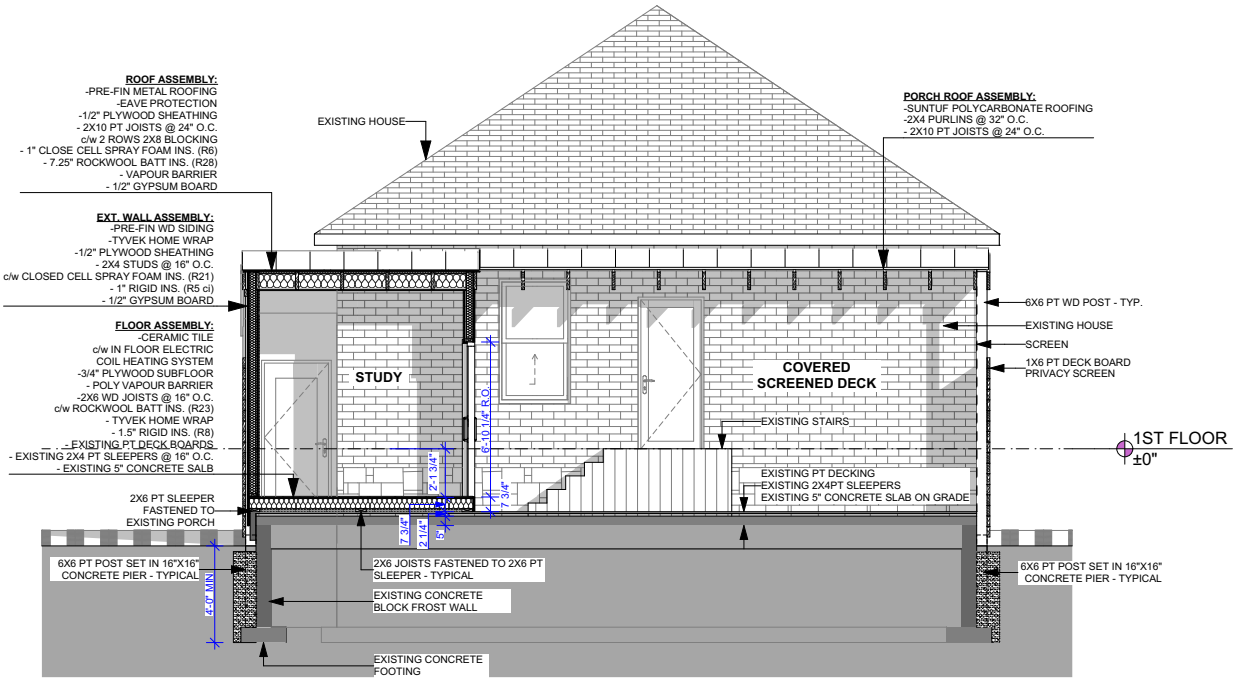
The following drawings and photos depict a small addition I designed and built on the back of our house in 2021. The catalyst for this undertaking was the approaching birth of our second child, Graham, in late fall. Up until that time, my wife and I had been sharing the third bedroom in the house as our full-time office space. However, with Graham's imminent arrival we were faced with the reality of losing our office to make room for a crib and change table. This is a common challenge faced by numerous expanding households, however it often results in having to move, as many dwellings do not offer the opportunity to adapt. Luckily, our house which is located in Holmedale, had a big enough lot to accommodate an addition, with the existing deck providing a perfect base structure for a new office as well as a screened-in porch. In order for this addition to work without completely disturbing our day to day life, it had to be designed so as to not disturb the existing structure and functioning of the house. The resultant design hugs the outside back corner of the house where there was an existing exterior door at grade. In doing so, the construction of the new office could be completely separate and shut off from the existing house. Likewise, now complete, the office space remains separate from the living quarters of the house, helping to maintain a healthier separation of work life and home life.

Figure A-1:
North-West Perspective Rendering of the proposed addition.



1 A201 1ST FLOOR

SCALE: 1/4" = 1'-0"



1 A601 EAST-WEST SECTION

SCALE: 1/4" = 1'-0"

Figure A-2:
Building permit drawings of the proposed addition.

Figure A-1:
Progression of the addition in photos, beginning from the top during construction and culminating in completion at the bottom of the page.

Figure A-4:
Interior photos of the office portion of the addition.

Appendix B:
Email Correspondence with the Brantford Building Department

Gmail

BIII 23 as it relates to missing middle housing

Jeremy Johnson Tue, Jun 20, 2023 at 10:05 AM
To: Rob Porteous

Hey Rob,

I am in the midst of writing my thesis about missing middle housing in Brantford at UWaterloo.
As part of my thesis I have been developing different missing middle housing prototypes to fit on common lot sizes, using Holmedale as a template.

Bill 23 allows for 3 units per lot, but only as part of one building.

I have attached some drawings of the prototypes I have developed and I was wondering if you could let me know whether they would be considered one building for the purposes of obtaining a building permit?

Thanks!

Jeremy Johnson
B.Arch.S., B.Ed.

230620 - housing prototypes.pdf
5874K

Gmail

BIII 23 as it relates to missing middle housing

Rob Porteous Tue, Jun 20, 2023 at 2:01 PM
To: Jeremy Johnson

Hi Jeremy,

Great drawings. Really good use of a typical width lot that still accommodates parking, that's something that designers really seem to struggle with. For both OBC and zoning purposes we would consider all of these designs to be one building.

FYI the City's current zoning bylaw does allow one ADU to be a detached unit. The language is slightly hidden, specifically:

6.32.1. Accessory Dwelling Units shall be regulated by the applicable zoning

provisions pertaining to the principal use and by the regulations of

Section 6.3 – Accessory uses, Buildings and Structures where

necessary.

6.32.8 Accessory Dwelling Units in accessory structures shall not be permitted

above the first floor.

This aligns with the requirements of Bill 23, item c below:

Restrictions for residential units

(3) No official plan may contain any policy that has the effect of prohibiting the use of,

(a) two residential units in a detached house, semi-detached house or rowhouse on a parcel of urban residential land, if all buildings and structures ancillary to the detached house, semi-detached house or rowhouse cumulatively contain no more than one residential unit;

(b) three residential units in a detached house, semi-detached house or rowhouse on a parcel of urban residential land, if no building or structure ancillary to the detached house, semi-detached house or rowhouse contains any residential units; or

(c) one residential unit in a building or structure ancillary to a detached house, semi-detached house or rowhouse on a parcel of urban residential land, if the detached house, semi-detached house or rowhouse contains no more than two residential units and no other building or structure ancillary to the detached house, semi-detached house or rowhouse contains any residential units.

As you may know the City is working on a new zoning bylaw. I have been a part of the discussion and review. Seems like the City's Planning Department is looking to be even more permissive with ADUs in the near future.

Let me know if you have any further questions.

Rob Porteous, CBCO, CPSO

Manager of Building Services – Deputy Chief Building Official

Building Department, People, Legislated Services and Planning Commission

Corporation of the City of Brantford