STACK SHACK
A Modular Prefabricated Alternative to Affordable Housing

by

Cole MacIsaac

A thesis submitted in partial fulfillment
of the requirements for the degree of
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The Faculty of Graduate Studies
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ABSTRACT

HOW CAN THE EFFICIENCIES OF MODULAR & PREFABRICATED CONSTRUCTION METHODOLOGIES BE TRANSLATED INTO A MORE AFFORDABLE DWELLING UNIT FOR THE LESS FORTUNATE POPULATIONS OF DARTMOUTH, NOVA SCOTIA?

This thesis explores how modular design and prefabricated construction methods can sustainably alleviate the affordable housing crisis in Dartmouth, Nova Scotia. In particular, how the efficiencies of these methodologies can be translated into a less expensive dwelling for the owner, taking into consideration the entire lifecycle of the building.

The proposal is effectively divided into two parts. The first portion focuses on research, outreach, and partnerships. Part two uses the findings to set the parameters for a holistic design of a dwelling unit that is versatile enough to be successful in a variety of contexts.

The area of Dartmouth affectionately known as Between the Bridges is used as a case study for a housing intervention. This somewhat marginalized community of roughly 13,000 is a well established residential neighbourhood that has access to amenities and transit routes, and is ripe for the addition of minimally disruptive hidden density. With an average household income that is half of the rest of Halifax, the thesis proposes that if a model proves to be successful here, it could theoretically be implemented and replicated in other housing markets all over the country. In essence, the site is considered an epicentre instead of a one-off proposal.

It is argued that a multi-pronged approach is necessary, and that no single non-profit, institution, or private developer can relieve the stresses that people are feeling in the face of homelessness. For that reason, this proposal sets out to develop a unit that can be implemented through a variety of organizations, in a multitude of contexts and scales, and serves diverse and dynamic demographics.

Through strategic partnerships with non-profits, various organizations, social enterprises, and religious institutions, the aim is to secure funding and identify potential personnel who could benefit from the architectural proposal. The thesis process acts as the “front end design” required to develop a successful prefabricated housing unit.

ACKNOWLEDGEMENTS

This entire thesis can be boiled down to a single ideal - helping people. I suppose we can thank my parents for that. Altruistic values instilled by their own parents were passed down at an early age, while any means of helping others who found themselves in less fortuitous situations was vehemently encouraged. You didn't have to be wealthy, or a well established professional to make a difference in someone's life. Your character was a reflection of how you acted when you didn’t think anyone was looking. It never had to be a grand gesture, as long as you kept your social conscious in check. The only thing you needed to donate to make a difference in someone's life was your time, talent, or treasure - whichever you had a relative abundance of in that particular situation. So at this given moment, how can we use our position of privilege as designers to provide people with the basic human right of housing? How can someone who draws lines on a page for a living tap into the socio-economic fabric of a city and translate it into a roof over a family’s head? Nova Scotia is at a boiling point when it comes to housing, and I finally find myself in the unfamiliar position of being able to offer time, talent, and treasure towards finding a solution.

Architecture is a truly collaborative profession. Despite the autonomous nature of a Masters thesis, there are countless individuals who have dedicated their time and expertise towards augmenting the final product of this thesis proposal. Throughout my undergraduate education, I was frequently reminded that by relative definition, an expert is someone who has more comprehensive knowledge about a subject than you. These people can be found all around you, and I was encouraged to seek them out both within, and outside the confines of the school. Academic setting aside, this has also proven to be sage advice for all aspects of life. Practicing humility and accepting that you can learn things from people who are younger than you, or less educated than, can yield incredible results and provide you insights to knowledge bases that you otherwise would never be able to access. Throughout this process I spoke to a double PhD, someone fishing cans out of a dumpster for bus fare, and many others in between. Each had valuable observations, and brought a level of awareness to the project that the others couldn't possibly have.

There are a handful of individuals whom without, this proposal would have suffered gravely. First and foremost, I would like to thank my advisor Mark Baechler. His steadfast guidance at each turn provoked curiousity and excitement after every conversation. Mark's recent experience with professional practice, and expertise in the realm of wood frame construction brought a level of realism and practicality to the project that I did not think was attainable in our eight months together. His continued support, timely insights, and dedication to augmenting his student's experience will forever be appreciated.

Closer to home, I would like to extend a sincere thank you to my second reader, Roberto Menendez. A talented designer with decades of industry experience, he has been a staple in residential construction in Halifax since the 1980's. More importantly, Roberto brought to the table his self imposed humanitarian mandate. Placing others needs above his own, he has developed dozens of affordable units within the city and serves as an impeccable role model for the next generation of architects. I have been fortunate to work alongside and learn from Roberto for a number of years, and for that I have become a better designer and person.

Finally, I would like to recognize a number of individuals who took time from their busy schedules to meet with me, provide insights or guidance, and connect me to key stakeholders within the community. Ralph MacKenzie, Kevin Hooper, John MacRae, Benjamin John, Liam O'Rourke, Ted Krueger, Tim Halman *MLA*, Steve Craig *MLA*, Councillors Becky Kent and Tony Mancini, as well as countless local residents. Each of their contributions were unique and relevant, helping to shape this into a well rounded and truly multifaceted proposal.

LIST OF FIGURES

** AUTHOR COMPLETED FOR ARCH 5326

00 INTRODUCTION

The conceptual themes of this thesis were conceived early in 2015 when I began volunteering with the Nova Scotia Chapter of Habitat for Humanity. This experience instilled in me the value that architecture holds in ameliorating the human experience through the built environment, and laid the foundation for the direction in which I have chosen to pursue the remainder of my education, and forthcoming professional career. My past involvement with the organization merely scratched the surface of one affordable housing model, but brought me to the realization that good design does not have to cost more.

The structure of this thesis has been effectively divided into two parts that in conjunction will best position the proposal to help alleviate the housing crisis at hand. The nature of any housing intervention is such that the socio-economic ramifications must be taken into account as equally or arguably more important than the design of the dwelling itself. For that reason, months of research and outreach were conducted before even a single line was drawn towards the design of a building. These initial stages were devoted primarily to research, outreach, partnerships, and site analysis. Each of these facets of the proposal have been explored in depth and expanded on through a series of photographs, writings, and diagrams. Numerous meetings and interviews were arranged with city councillors, Members of the Legislative Assembly, the Housing Critic of the Official Opposition of Nova Scotia, private developers, builders, heads of non-profits, key members of community based associations, and leaders in the realm of religious institutions. This was all in an effort to gather a well rounded and diverse set of opinions on what lead to the province's current housing crisis, and also how we can collectively move forward.

The second part of the thesis focuses on the design development of a versatile, affordable, and sustainable dwelling in preparation for the eventual construction of a prototypical housing unit. The devotion of time and resources over the course of developing this thesis has culminated in a finalized set of construction drawings, targeted site selections, strategic partnerships, and potential funding options to begin construction post graduation.

The success of any prefabricated build hinders on the front-end design that is undertaken before a single board is nailed. Research into existing lot sizes, population demographics, household incomes, amenities and transit routes, have all informed the ideal scale of the housing unit. This research also helped affirm which locations would most benefit from, and best support this type of intervention. An exploration of materials, manufacturing facilities, and transportation methods became the driving factors behind the design of the proposed housing unit. Research in these areas dictated the ideal prefabricated module size and assembly method. As well, experimentation with materiality and construction methods resulted in the development of innovative building envelopes and assemblies.

FIG. 1 TEMPORARY SHELTER IN DOWNTOWN HALIFAX

01 NOVA SCOTIA HOUSING CRISIS

Recent census data and CMHC analysis over the last decade has yielded some truly shocking numbers for the tiny province of Nova Scotia. The 7th largest in the country, the province's population has yet to surpass 1,000,000 and is larger only than the territories and remaining Atlantic provinces. If you were to only glance at recent market figures however, you might gather the polar opposite impression. Of the 35 largest urban centres analyzed in Canada, Halifax had the lowest vacancy rate in the country at less than 1%[1]. This represents all time lows, putting an unprecedented stress on lower and middle class renters. The average rent for a two bedroom apartment has grown to more than $1200, and represents the highest of any city east of Toronto (fig.2)[2]. It is important to note that this averaged data references the amalgamated Regional Municipality as of 1996, which encompasses Halifax, as well as smaller sprawling communities such as Dartmouth, Cole Harbour, Bedford, and Sackville. The current rent of a two bedroom apartment in a new downtown development can easily eclipse $3200 per month[3].

	Vacancy Rates (%)				Turnover Rates (%)				Average Rent Two Bedroom ($) (New and Existing Structures)		Percentage Change of Average Rent Two Bedroom From Fixed Sample (Existing Structures Only)	
Centre	Oct-18	Oct-19			Oct-18	Oct-19			Oct-18	Oct-19	Oct-17 to Oct-18	Oct-18 to Oct-19
Newfoundland & Labrador 10,000+	**6.0 a**	**7.0 a**	**↑**		**24.3 a**	**20.8 a**	**↓**		**870 a**	**880 a**	**1.2 a**	**++**
St. John's CMA	6.3 b	6.9 a	–		27.3 a	24.5 a	–		961 a	966 a	1.5 b	-0.8 a
Prince Edward Island 10,000+	**0.3 a**	**1.2 a**	**↑**		**15.9 d**	**13.0 a**	**↓**		**903 a**	**921 a**	**2.9 b**	**2.8 b**
Charlottetown CA	0.2 a	1.2 a	↑		14.7 c	13.4 c	–		921 a	937 a	2.5 b	2.9 b
Nova Scotia 10,000+	**2.0 a**	**1.4 a**	**↓**		**21.0 a**	**18.4 a**	**↓**		**1,090 a**	**1,133 a**	**1.9 a**	**3.5 b**
Halifax CMA	1.6 a	1.0 a	↓		20.9 a	18.8 a	↓		1,156 a	1,202 a	1.8 a	3.7 b
New Brunswick 10,000+	**3.2 a**	**2.6 a**	**↓**		**24.0 a**	**21.2 a**	**↓**		**801 a**	**842 a**	**3.0 b**	**3.5 b**
Moncton CMA	2.7 a	2.2 a	–		25.3 a	19.6 a	↓		831 a	870 a	3.0 b	2.6 b
Saint John CMA	3.7 c	3.3 b	–		24.6 a	20.6 a	↓		755 a	797 a	3.1 c	4.4 c
Québec 10,000+	**2.3 a**	**1.8 a**	**↓**		**18.6 a**	**17.2 a**	**↓**		**775 a**	**815 a**	**2.4 a**	**3.0 a**
Saguenay CMA	5.0 c	3.7 c	–		21.5 d	24.8 a	↑		608 a	649 a	1.7 c	2.7 c
Montréal CMA	1.9 a	1.5 a	↓		17.4 a	15.7 a	↓		809 a	855 a	2.8 a	3.4 a
Ottawa-Gatineau CMA (Qué. part)	1.2 a	1.5 b	–		21.5 a	21.3 a	–		794 a	874 a	3.5 b	4.2 b
Québec CMA	3.3 a	2.4 a	↓		22.1 a	21.5 a	–		839 a	862 a	1.2 a	1.9 a
Sherbrooke CMA	2.6 a	2.3 a	–		23.0 a	22.4 a	–		639 a	658 a	1.6 b	2.1 a
Trois-Rivières CMA	3.9 b	2.3 a	↓		22.8 a	22.3 a	–		601 a	625 a	++	4.1 b

FIG. 2 CMHC RENTAL RATES & VACANCY DATA

1 CMHC Rental Market Survey Data Tables. Table 1.0, January 2021

2 IBID

3 Southwest Properties "The Maple" Suite availability: https://apartments.southwest.ca/apartments/ns/halifax/maple-2/floorplans.aspx Accessed Dec. 2020

Of course this did not happen overnight, it has taken decades for the municipality to reach this point. Removal of rent control in 1993[4] went unopposed throughout multiple successive governments taking power. Currently it is not officially part of any provincial party's platform, however with the announcement of the resignation of Premier Stephen McNeil, Liberal party leader candidates have been quick to add it to their campaign strategies[5]. When the aforementioned Liberal government took power at the end of 2013, Nova Scotia's population had become largely an aging and stagnant one[6]. In the five year period leading up to this shift in power, Nova Scotia's population increased by a mere 1,871 people[7]. This represents a miniscule increase of 0.20% and was second lowest only to New Brunswick during that time frame. To counter this trend, there was a major shift in immigration policy to help grow the population as well as the economy[8]. Annual immigrants coming into the province had never surpassed 3000 prior to 2013, and in 2019 the province welcomed almost 7000 new citizens (fig.3)[9]. Despite the uptick in population and economic growth, there were not any policies implemented at a provincial or municipal level to focus on housing and the influx of people. The equilibrium of the housing market that had recently balanced out after recovering from the economic recession in 2008 and 2009 began to be disturbed.

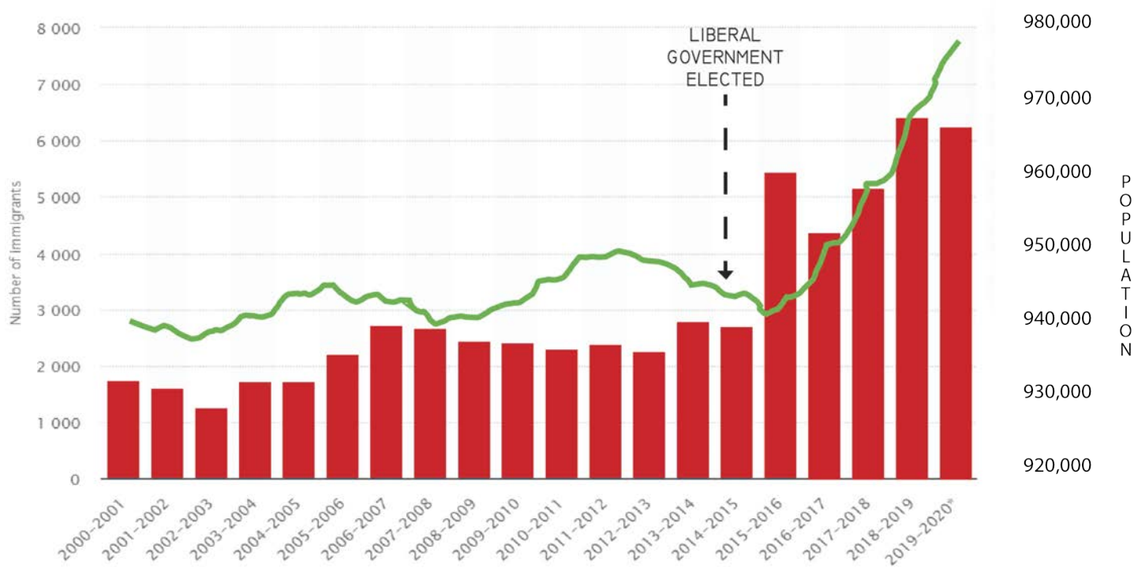


FIG. 3 NOVA SCOTIA IMMIGRATION & POPULATION DATA - STATISTICS CANADA

4 NS Historical Archives. News Release Dec. 20, 1996. https://novascotia.ca/news/archive/viewRel.asp?relID=/cmns/msrv/nr-1996/nr96-12/96122001.htm

5 Taryn Grant. "Liberal leadership contenders Rankin, Kousoulis make rent control part of platform" - CBC Article. November 12, 2020

6 Simona Varrella. NS Immigration and Population Data: https://www.statista.com/statistics/609156/number-of-immigrants-in-nova-scotia/ Mar. 9, 2021

7 2011 & 2016 Government of Canada Census Data https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/index.cfm?Lang=E

8 IBID

9 Simona Varrella. NS Immigration and Population Data: https://www.statista.com/statistics/609156/number-of-immigrants-in-nova-scotia/ Mar. 9, 2021

Exacerbating the situation is the incursion of university students between September and May. Home to three major universities, (Dalhousie, Saint Mary's, & Mount Saint Vincent) as well as a number of smaller colleges and post-secondary institutions, the demographic and demeanour of the city is noticeably altered throughout the academic year. Upwards of 32,000 students attend these schools every year, with only 6400 campus residences available[10]. These residences are earmarked primarily for incoming first-year students who may otherwise not be familiar with the city, or be part of an existing social circle. Once a student is in their second-year or later of an undergraduate program, or any year of a graduate program, they are on their own to find accommodations off campus.

Granted, not all of the students travel and require rented accommodations but we can use Dalhousie University as an example due to it providing the largest sample size, accounting for 19,000 of these students. At Dalhousie University, 82% of students come from out of province or internationally (fig.4)[11]. With the other institutions reporting similar figures, that leaves Halifax to house roughly 26,000 students on short-term leases with high turnover rates every single year. In a province that recently saw a growth of 1,871 people over a five year period, trying to house this many students as well as 7,000 new immigrants per year is nearly an impossible task. Of course international students bring with them sizeable tuition fees, and therefore this demographic trend is unlikely to reverse itself in the near future.

The pressure to relieve the situation has fallen on the shoulders of federal, provincial, and municipal levels of governments. Depending on who you talk to, there are mixed opinions on who fell short, and who is responsible for moving the province forward. The general consensus is that the federal government provides most of the funding, the province mandates and implements policy, and the municipality gets left with the problems and a lot of the blame despite their often handcuffed capabilities. The housing response to the population catalysts was sluggish at best, and almost non-existent. However, one group saw a profitable opportunity and has capitalized tremendously, contributing to the trickle down effect that has been seen in the real estate market. Private developers over the last decade have bought parcels of land at alarming rates in areas that would be deemed affordable by most standards. This neoliberal monetization has fueled gentrification within the municipality, and Dartmouth has been no exception. The up-cycling of these areas through tear-down and new builds, as well as 'renovictions' has pushed people out of their neighborhoods as the developments continue to set ever ascending precedents in rental prices.

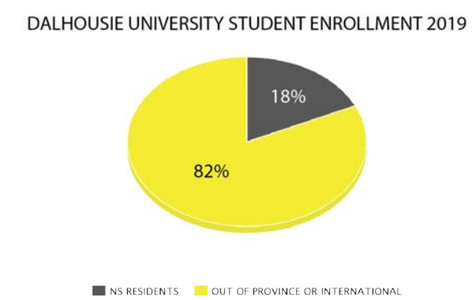
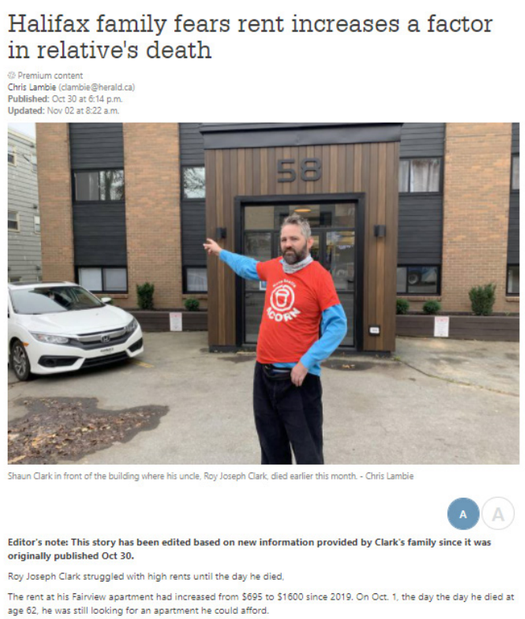


FIG. 4 DALHOUSIE UNIVERSITY STUDENT PROFILE - AUTHOR

10 Tim O'Neill. "Report on the University System in Nova Scotia" September 2010. https://novascotia.ca/lae/HigherEducation/documents/Report_on_the_Higher_Education_System_in_Nova_Scotia.pdf Accessed Dec. 20, 2020

11 "Dal at a Glance" Dalhousie : By the Numbers. https://www.dal.ca/about-dal/dal-at-a-glance.html Accessed Dec. 21, 2020

Rentals aside, between March 2020 and March 2021 the average price of a dwelling in Halifax/Dartmouth has increased 34.4% from $352,880 to $474,271[12]. This trickle down effect has been catastrophic, and has left vulnerable populations exposed and homeless. In the most dire of situations, people have allegedly turned to suicide, according to family members, to finally end the stresses associated with exponentially increasing rent[13]. Roy Joseph Clark lived in what most would deem an affordable area of Halifax. He saw his rent increase from $695 to $1600 in less than a year. His search for somewhere comparable turned up empty and he was found dead in his apartment on the morning he was set to be evicted. Even without the eviction data throughout the global pandemic being tabulated at this stage, chronic homelessness in Halifax has more than doubled in the last year alone[14]. This figure accounts only for people who have admittedly not been able to secure a permanent residence continually for a period of six prior months, and does not reflect the thousands of "hidden homeless" who bounce from couch to couch, or shelter to shelter throughout the winter months. The greater Halifax Regional Municipality has reached its boiling point, and the basic human right of access to shelter is becoming less accessible by the month.



Halifax family fears rent increases a factor in relative's death

Premium content
Chris Lambie (clambie@herald.ca)
Published: Oct 30 at 6:14 p.m.
Updated: Nov 02 at 8:22 a.m.

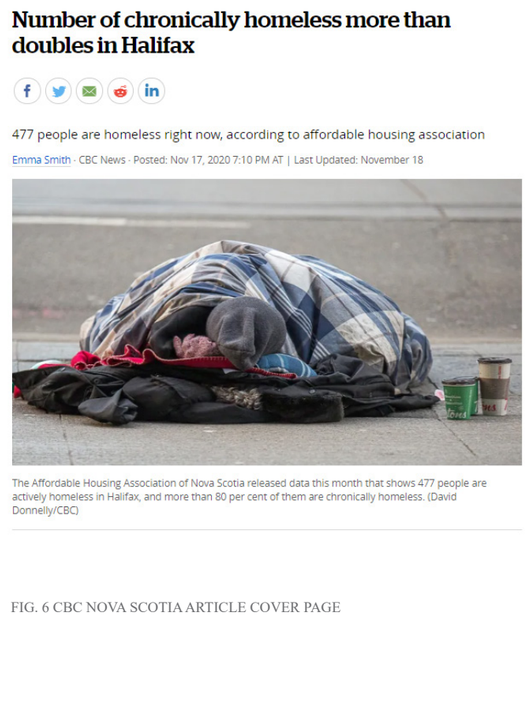
Shaun Clark in front of the building where his uncle, Roy Joseph Clark, died earlier this month. - Chris Lambie

Editor's note: This story has been edited based on new information provided by Clark's family since it was originally published Oct 30.

Roy Joseph Clark struggled with high rents until the day he died.

The rent at his Fairview apartment had increased from $695 to $1600 since 2019. On Oct. 1, the day the day he died at age 62, he was still looking for an apartment he could afford.

FIG. 5 CHRONICLE HERALD ARTICLE COVER PAGE



Nova Scotia

Number of chronically homeless more than doubles in Halifax

477 people are homeless right now, according to affordable housing association

Emma Smith · CBC News · Posted: Nov 17, 2020 7:10 PM AT | Last Updated: November 18

The Affordable Housing Association of Nova Scotia released data this month that shows 477 people are actively homeless in Halifax, and more than 80 per cent of them are chronically homeless. (David Donnelly/CBC)

FIG. 6 CBC NOVA SCOTIA ARTICLE COVER PAGE

12 NS Association of Realtors, April 2021 - https://creastats.crea.ca/board/nsar?fbclid=IwAR3XtGZakyyor15ow-uZoME60AIGFgJ5lYdfueoxEV_Je5OOuxLABptAcAA

13 Chris Lambie. "Halifax family fears rent increases a factor in family member's death." Chronicle Herald article November 2 2020

14 Affordable Housing Association of Nova Scotia via CBC News - Nov 2020

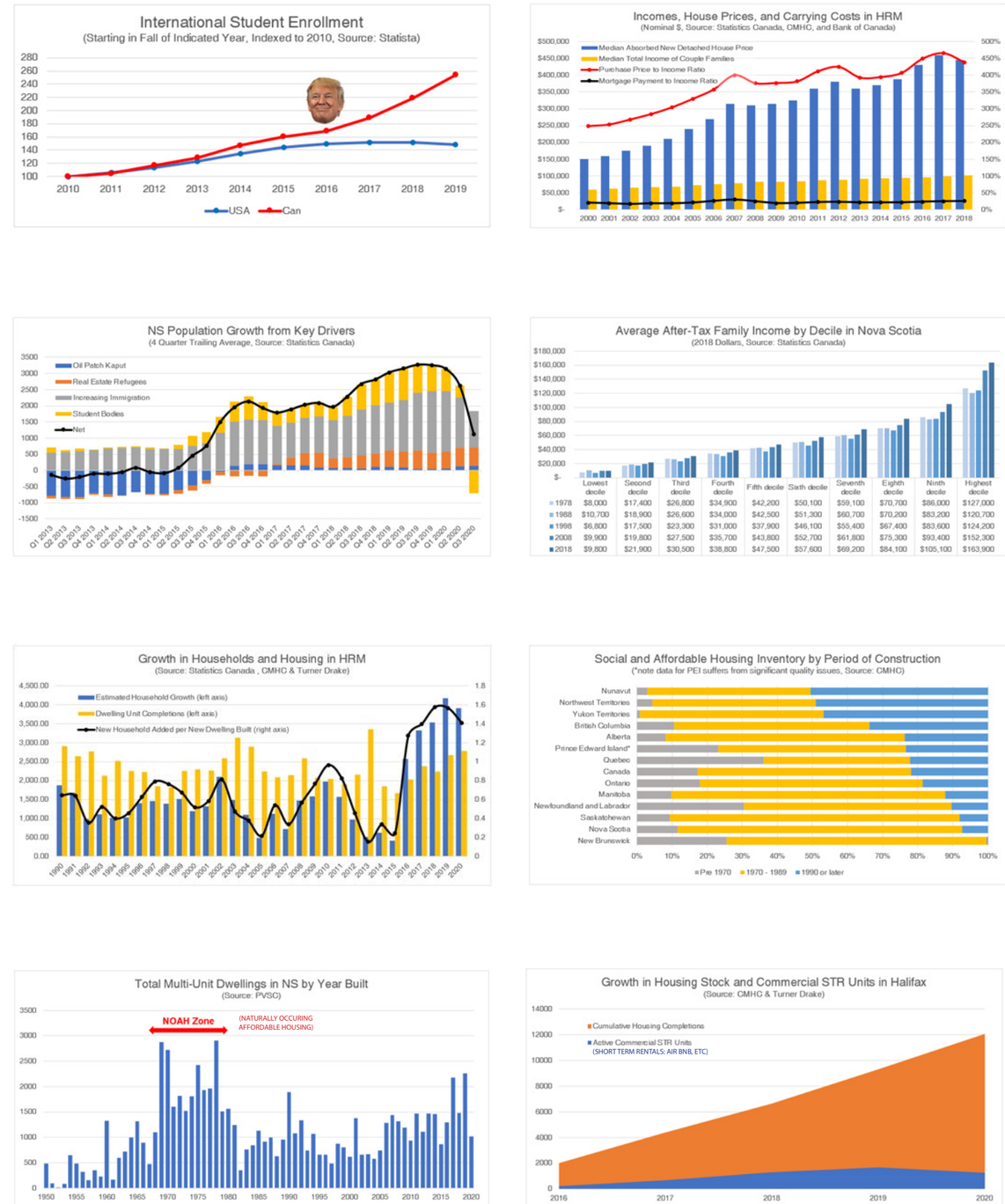


FIG. 7
A SERIES OF CHARTS PRODUCED BY NEIL LOVITT DEMONSTRATING NUMEROUS FACTORS CONTRIBUTING TO NOVA SCOTIA's HOUSING CRISIS. DEVELOPED FOR TURNER DRAKE & PARTNERS LTD DIGITAL BLOG PUBLISHED FEBRUARY 23, 2021

FIG.8 TUFTS COVE AND ANGUS L. MACDONALD BRIDGE

02 BETWEEN THE BRIDGES

The current housing situation in Nova Scotia is unsustainable. No area of the province has escaped unscathed, however the problems are exacerbated in the urbanized areas in and around the capital city. As with any North American urban centre, there is a wide spectrum of affluency. Areas that are typically lower class and impoverished are often anchored by failed centralized social housing projects developed throughout the tail end of the modernist movement. Dartmouth is no exception, with areas of the city suffering in comparison to the rest of Halifax Regional Municipality. In focusing this proposal on one of the most distressed communities in the area, it became a case study that provides grounds for a dynamic, versatile solution that could eventually be implemented in other regions as well.

Considering that this type of development affects the social, cultural, and economic fabric of its contextual neighborhood, the siting of the project is of utmost importance. With all of this accounted for, the focal point for this project is in Dartmouth, Nova Scotia. The 500-acre area affectionately known as 'between the bridges' is home to roughly 13,000 residents situated north of the downtown core between the MacKay & MacDonald harbour spans (fig.9)[15]. With a median household income less than half of the rest of Halifax Regional Municipality[16], the neighbourhood has struggled for decades to make ends meet. The rental:ownership ratio in the area is more than double the rest of the municipality[17], and 90% of the dwellings were constructed prior to the year 2000[18].

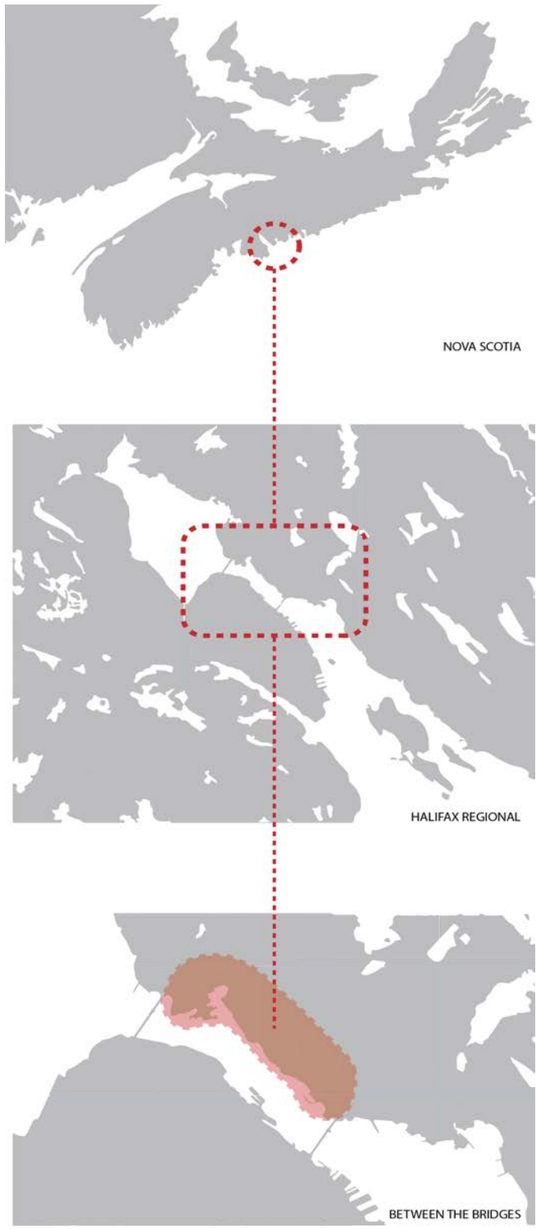


FIG. 9 NOVA SCOTIA & BETWEEN THE BRIDGES CONTEXT - AUTHOR

15 Dennis Pilkey. Between the Bridges Housing Report - https://inspiringcommunities.ca/wp-content/uploads/2019/09/BtB-Housing-Quality-2018.

16 IBID

17 IBID

18 IBID

The CMHC defines Core Housing Need as:

"[...the areas] housing falls below at least one of the adequacy, affordability, or suitability standards and it would have to spend 30% or more of its total before-tax income to pay the median rent of alternative local housing that is acceptable."[19]

Toronto and Vancouver are considered the urban centres with the highest core housing need in Canada at 19.1% & 17.6% respectively. The Dartmouth North area of Between the Bridges, a mere 2km away from downtown Halifax suffers at 31.7% (fig.10)[20].

A detailed report compiled by Dennis Pilkey at the end of 2018 shone a light on the situation, bringing to attention how dire things have become in the marginalized neighbourhood. The area is home to a higher percentage of at risk persons when compared to the rest of the Municipality, and this includes youth as well as young adults facing poverty, people who identified as Aboriginal or Indigenous, and single parent households[21]. A staggering 49% of people in the area are single and living on their own (fig.11), reducing that household to a sole income often at minimum wage[22]. Although there has been a strong sense of community in Dartmouth North for decades, residents have claimed that this is dwindling as the turnover rate increases year after year. More than 50% of residents polled in Pilkey's report had moved in the preceding five years[23], as people have been forced to relocate to these more affordable areas due to newer developments and gentrification pushing them out of their previous locations. A successful

19 CMHC Rental Market Survey Data Tables. Table 1.0, January 2021

20 Dennis Pilkey. Between the Bridges Housing Report - https://inspiringcommunities.ca/wp-content/uploads/2019/09/BtB-Housing-Quality-2018

21 IBID

22 IBID

23 IBID

2016 Census of Population	Percentage of Population/Households		
	DN BtB	HRM	Canada
Youth 20 to 24	8.6	7.5	6.4
Young Adults 25 to 29	10.1	7.5	6.5
Aboriginal identity	6.3	4.0	4.9
Female lone parent households	12.1	8.7	8.8
Single person households	49.3	29.5	28.2
Moved in last 5 years	56.7	39.8	38.2
Rented households	82.2	39.9	32.2
Core Housing Need*	31.7 (est.)	13.7	12.7
Shelter more than 30% of income	39.7	25.0	24.1
Major repairs required	10.9	6.6	6.5
Not suitable	6.0	3.5	4.9
Average household income	45,890	86,753	92,764
Low income measure after tax (LIM-AT)	33.6	14.8	14.2
Rent subsidies	7.4	8.3	13.0

FIG. 10 BETWEEN THE BRIDGES DEMOGRAPHIC DATA - PILKEY, D.

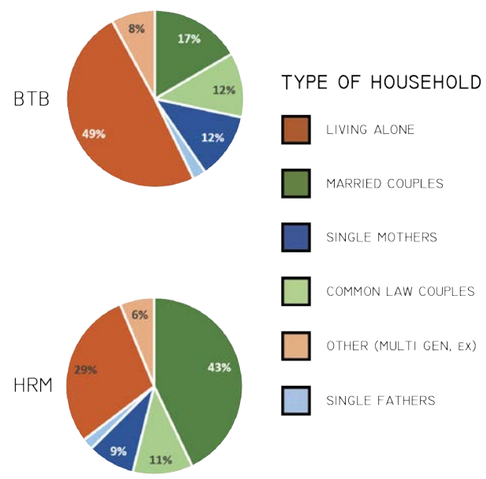


FIG. 11 BETWEEN THE BRIDGES HOUSEHOLD TYPE - PILKEY, D.

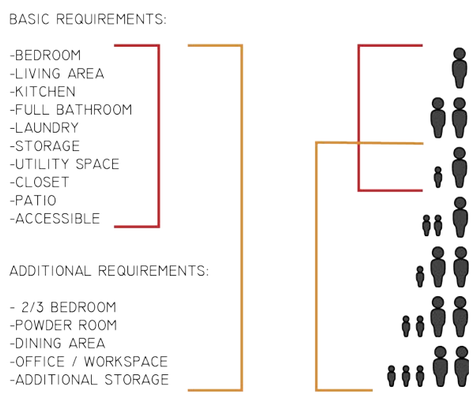


FIG. 12 FAMILY DYNAMIC & PROGRAMME REQUIREMENTS - AUTHOR

proposal would find a way to introduce affordable density to an already established neighbourhood in the least disruptive way possible, and allow people to stay in the communities that they call home.

Over the past number of months, and supported anecdotally by almost 30 years of residency in Dartmouth, this diverse urban area has been analyzed for potential intervention. Hours of walking the site, interviewing residents and organizations, mapping, and photographic documentation narrowed the focus to a key area where housing mediation could prove to be the most impactful. Proximity to transit routes, park space, food retail, amenities, schools, and religious institutions were all considered in choosing potential sites. It became evident that the southeast portion of the neighbourhood had adjacencies to the most densely clustered services. Locating empty, undesirable infill lots that would otherwise be difficult to develop became paramount. It is important to keep in mind that this site is being treated as an epicentre and feasibility study, rather than a one time site specific proposal. Dartmouth is not the only city facing an affordable housing crisis, so the success of the design will be judged in part by its replicability and adaptability in other markets.

FIG. 13 MACDONALD BRIDGE - AUTHOR

FIG. 14 STAIRS MEMORIAL UNITED CHURCH - AUTHOR

FIG. 15 VACANT LOT UNDER DEVELOPMENT AGREEMENT PROCESS - AUTHOR

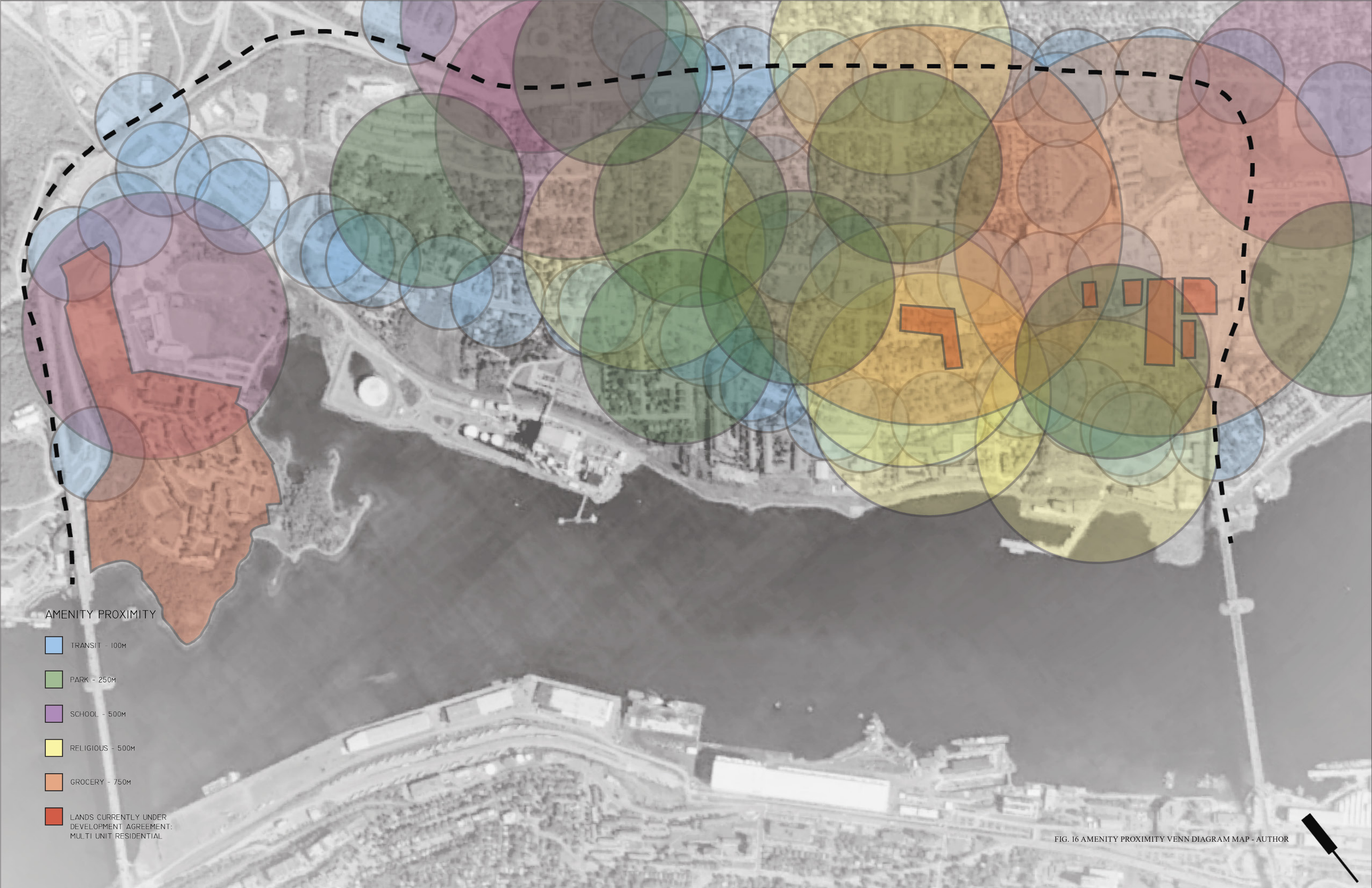


FIG. 16 AMENITY PROXIMITY VENN DIAGRAM MAP - AUTHOR

FIG. 17 POTENTIAL LANEWAY RESIDENCES w. SIDE DRIVES - AUTHOR

03 MODULAR HOUSING VERSATILITY

This design proposal is focused on a modular, prefabricated prototype housing unit. The unit is versatile enough to be successful in a variety of contexts, and draws on its modularity to flexibly adapt to a diverse range of sites. A major benefit of this approach is that it draws on its scale and construction methodology to capitalize on adding density to existing neighbourhoods in the least disruptive way possible. Known as 'hidden density,' this refers to the practice of adding units to existing neighbourhoods in a non-disruptive and often unnoticeable fashion. Examples of this may include the addition of a secondary basement suite to a single family dwelling (fig. 18), or dividing a single lot into two in order to develop a semi detached unit of the same scale. Cities such as Edmonton are leading the way in this regard as they venture to re-establish the 'missing middle'[24], providing decentralized affordable dwellings in established areas that are capable of piggy backing on the existing amenities and infrastructure.

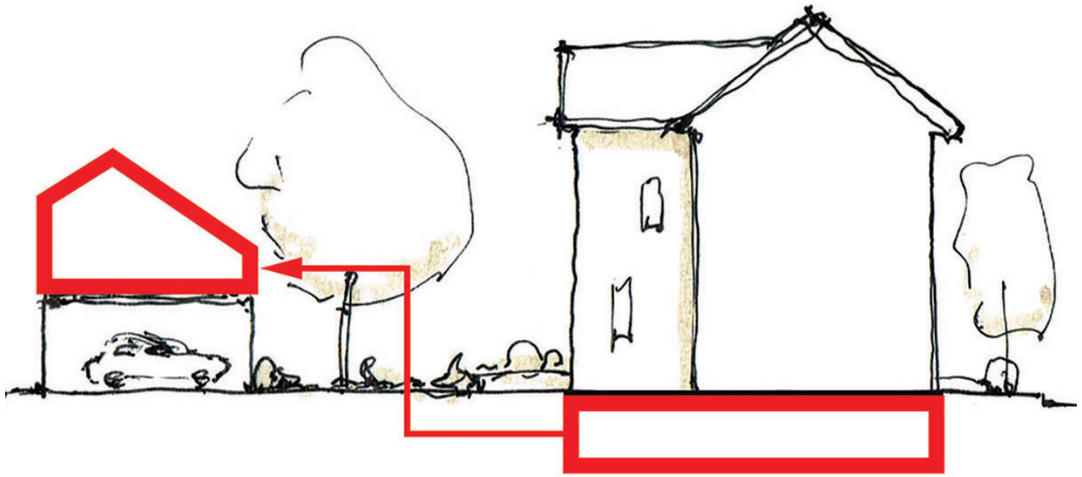


FIG. 18 LANEWAY DIAGRAM, EVERGREEN BRICKWORKS, TORONTO 2017

24 Alex McClintock. "Missing Middle Key to solving Housing affordability." - Globe and Mail article December 12, 2019

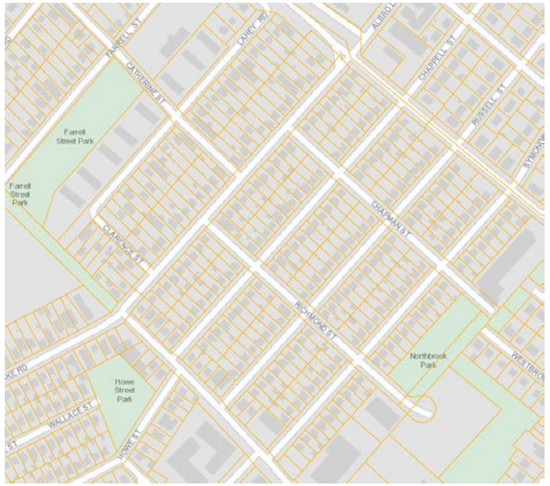


FIG. 19 TYPICAL RESIDENTIAL GRID BETWEEN THE BRIDGES

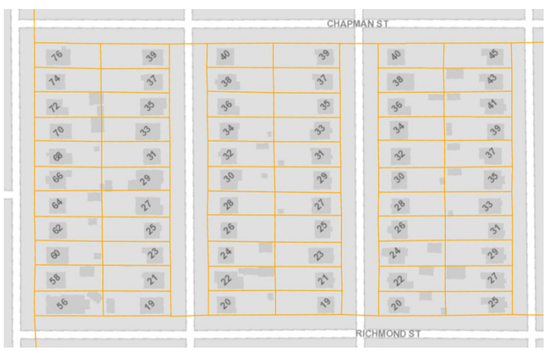


FIG. 20 TYPICAL REAR ABUTTING RESIDENTIAL LOTS - GOOGLE MAPS

Halifax Regional Municipality has been slow in catching up with the missing middle but council has recently taken steps to address potential solutions. Late in 2019, approval was announced to adopt a new by-law that will allow for backyard laneway suites to be added to single family dwelling lots, or any area zoned Residential 1 or Residential 2[25]. Given its typical lot organization, this would allow for the potential insertion of a backyard unit on almost every single residential lot Between the Bridges (fig. 19). Being able to add this hidden density is mutually beneficial to all stakeholders. It adds desperately needed rental stock in proximity to existing infrastructure and amenities, it allows people to stay in their neighbourhoods building a better sense of community, it provides options for supplemental income for homeowners, and provides opportunities to age in place or house other family members in their own space[26].

Using the multi-pronged approach of deploying these modules through backyard suites as well as multi unit clusters (3-8) on infill sites provides opportunity to disperse and diffuse the location of affordable units. Failed centralization of past social housing has led to new municipal policies that encourage the incorporation of affordable units into all new development through incentives such as post bonus density and height agreements[27]. The proposed approach of this thesis decentralizes and distributes affordable housing units in established residential neighbourhoods and aligns itself with the direction in which Halifax Regional Municipality is heading.

25 HRM Council Case 21162: https://www.halifax.ca/sites/default/files/documents/city-hall/regional-council/200128rc1515.pdf

26 IBID

27 HRM Council Item 14.2.2. December 06, 2016: https://www.halifax.ca/sites/default/files/documents/city-hall/regional-council/161206rc1422.pdf

LANEWAY

Laneway, Backyard suite, Granny flat. Some labels are more flattering than others but they all describe the same building typology: a detached accessory building behind the main residence that draws from the same services and utilities as the house. They are owned by the homeowner and are subject to a lot of the same setback and height restrictions in the eyes of the municipality. Most often they are implemented to provide supplemental income, but they can also be used to house care workers for aging populations, young adults returning with student debts, or immediate family members who require the privacy of their own space. In the case of Between the Bridges, the existing residential lots are divided perfectly to implement these types of structures (fig. 20).

The primarily residential portions of the neighbourhood are laid out in a cardinal grid, with rear abbuting lots (fig.19,20). Nearly every lot was surveyed to 40' (12.2m) wide, by 110' (33.5m) deep. The typical building footprint is 25' (7.6m) wide by 30' (9.1m) deep, and is situated 20' (6.1m) from the front property line and as close to one side of the lot as the bylaws of the time allowed. In most cases, this distance is 3 or 4' (0.9-1.2m). If you have spent any amount of time in a suburban neighbourhood, it is striking to walk these streets and notice the absolute lack of attached garages (fig.17). The houses are all situated to one side in order to allow for a bypassing driveway to the backyard, accessing secondary structures such as garages and sheds in the rear. Having a 10'-12' (3.0-3.7m) wide driveway that already accesses the backyard provides the ideal situation for the delivery of a secondary suite behind the main residence. With the dwellings hugging the front setback limitations, there is a generously deep backyard present in almost every case.

FIG. 21 FAULKNER STREET RESIDENCE w. SIDE DRIVE - AUTHOR

FIG. 22 TYPICAL NEIGHBOURHOOD GRID SATELLITE - GOOGLE EARTH

Outlined here are two possible methods that could be used to implement the laneway strategy. First, is the standard insertion of a unit into one's backyard. The prefabricated dwelling would be delivered by a truss boom truck as multiple modular units and installed on site. (fig 23) The modules have to be small enough to adhere to the truck bed dimensions, and light enough to be hoisted by the extendable crane arm. Each module would be lifted into place and secured to a prepared foundation consiting of a frost wall, slab on grade, or galvanized screw piles. The second option would require the city to introduce an easement to act as the lane itself. Roughly 5' (1.5m) would be used from each property to create a new access route to each of the backyard dwellings. (fig.24) This would essentially create a new mini street, allowing the unit to reorient itself away from the main dwelling, and towards the other suites that have recently been added. This option would create a micro community of laneways, and provides the main homeowner with an opportunity to integrate a fence or privacy screen in their backyard. There are positives and negatives to both options, but one underlying detriment to both of these arrangements is that there is no potential for home ownership. Although government incentives could ensure an affordable rent for the unit through subsidies, it still does not allow the person in need of the affordable housing to build equity and an economic base through home ownership. For this reason, alternative methods and models were explored in order to derive ways in which a similar, or even identical unit could be used to occupy a variety of sites.

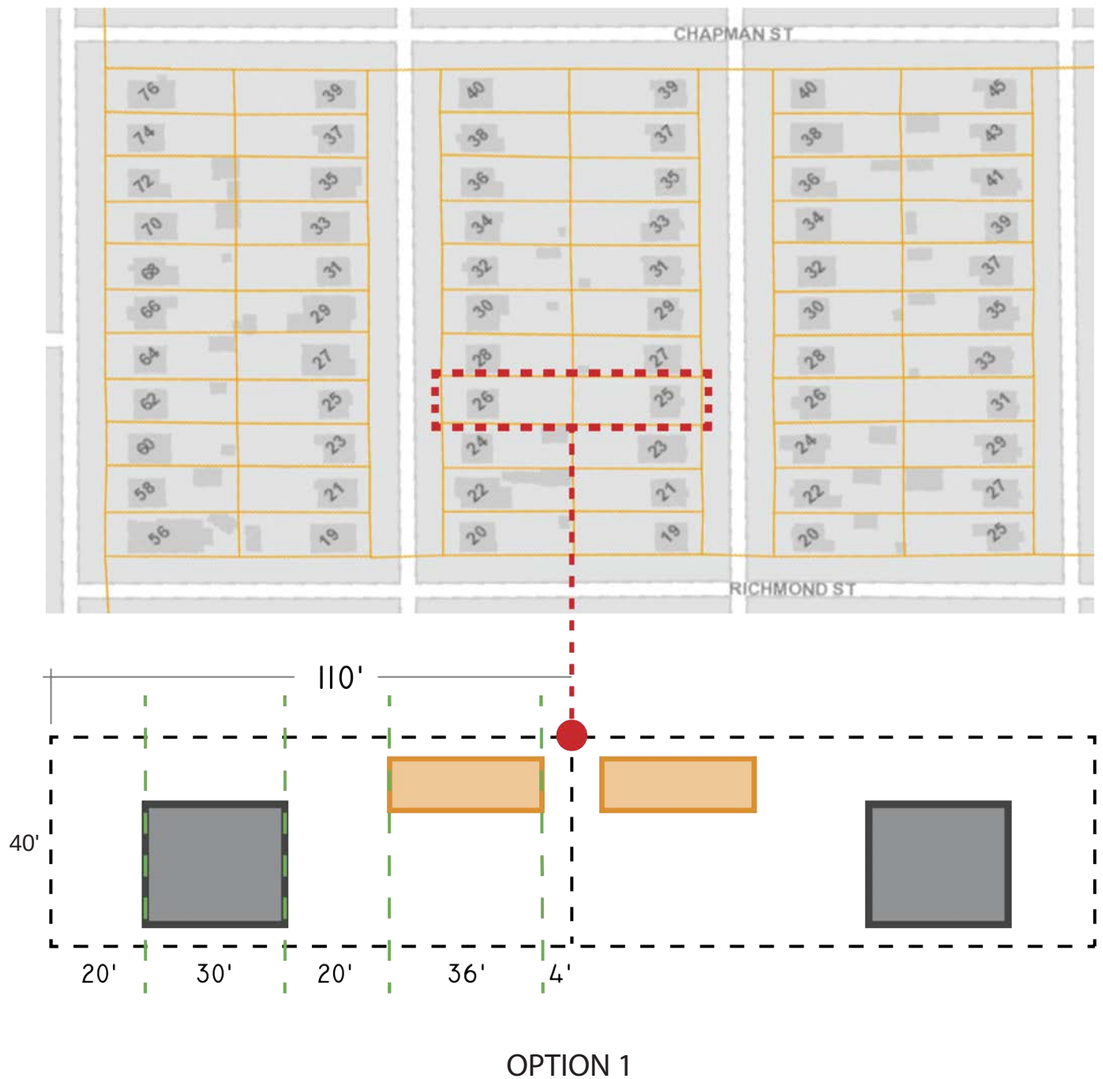


FIG. 23 TRADITIONAL LANEWAY OPTION DIAGRAM - AUTHOR

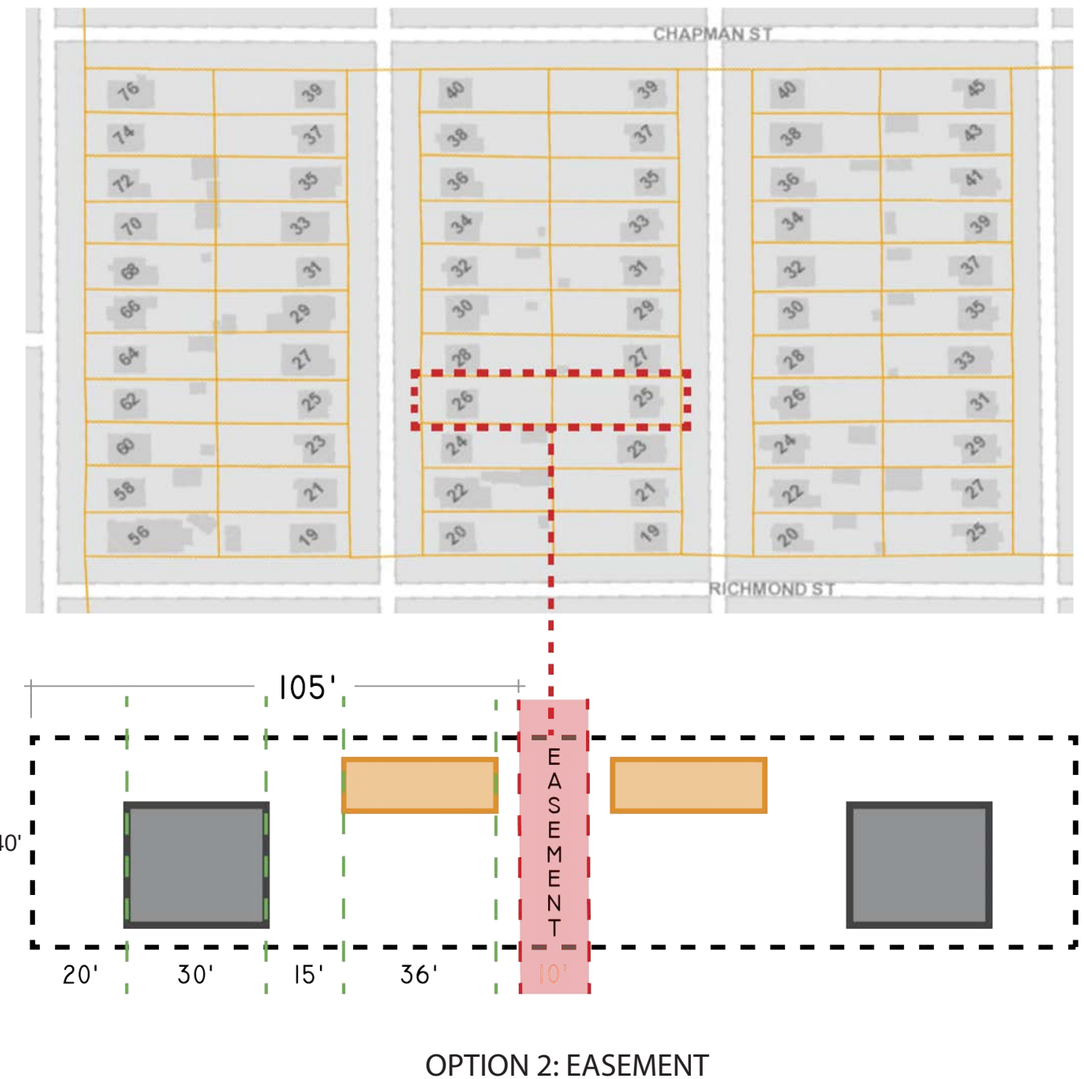


FIG. 24 EASEMENT LANEWAY OPTION DIAGRAM - AUTHOR

INFILL

In recalling the site analysis, (fig.16, 29) once the amenity and transit rich areas were identified, the search narrowed to vacant infill lots in the neighbourhood that otherwise may have been difficult to develop. These varying sized lots are all different shapes and sizes, so designing a unit that was versatile enough to shift and stack to respond to each context became paramount. The lots that were chosen were done so based on their proximity to amenities and transit, but also their unique dimensions, depths, and relations to the street. These factors served as a test to see if the unit could be successful on any site in which it was situated. The clusters of dwellings had to be arranged to respect municipal setbacks and lot coverage restrictions, while still providing green space and covered areas for parking. The addresses of the four sites studied are: 29 Brookside Avenue, 188 Windmill Road, 40 Jamieson Street, and 176 Windmill Road.

Each a charming misfit for one reason or another, these four lots sit vacant in the heart of the residential area Between the Bridges. With these lots selected, a series of massing studies was conducted using a typical 12' x 36' mass representing the dwelling. Standard front, rear, and side yard setbacks pursuant to Halifax's residential land use bylaws were all respected to determine the usable space of each site. With those in place, different combinations and densities were explored as the unit was repeated, shifted, rotated and stacked to fit the parameters dictated by the site.

With potential combinations ranging from 20-45 per site, each cluster was analyzed to select one or two that fit and embodied the site in the best manner. Particular attention at this stage was given to identifying options that addressed the street or corner condition, provided a healthy balance of occupied and green space, and offered covered areas that acted as a car park or portico. It was also at this stage that the preliminary analysis began in determining how two units might combine to serve a larger family. The modular and repetitive nature of the design allows for the stacking connection to always happen at the same location, so vertical circulation becomes integrated in order to build up instead of out when required. The demographic analysis spoke volumes about who would be best served in this neighbourhood, and that was single persons, and single parents. Both dynamics could be served by the 400 ft² unit used in the massing study, but it was important to develop a strategy to suit larger, or changing family structures.

FIG. 25 INFILL LOT 1 - GOOGLE EARTH + AUTHOR

29 BROOKSIDE AVE.
5,900 ft²

FIG. 26 INFILL LOT 2 - GOOGLE EARTH + AUTHOR

188 WINDMILL RD.
9,300 ft²

FIG. 27 INFILL LOT 3 - GOOGLE EARTH + AUTHOR

40 JAMIESON ST.
5,800 ft²

FIG. 28 INFILL LOT 4 - GOOGLE EARTH + AUTHOR

176 WINDMILL RD.
7,700 ft²

FIG. 29 AMENITY + TRANSIT LOCATION MAP - AUTHOR

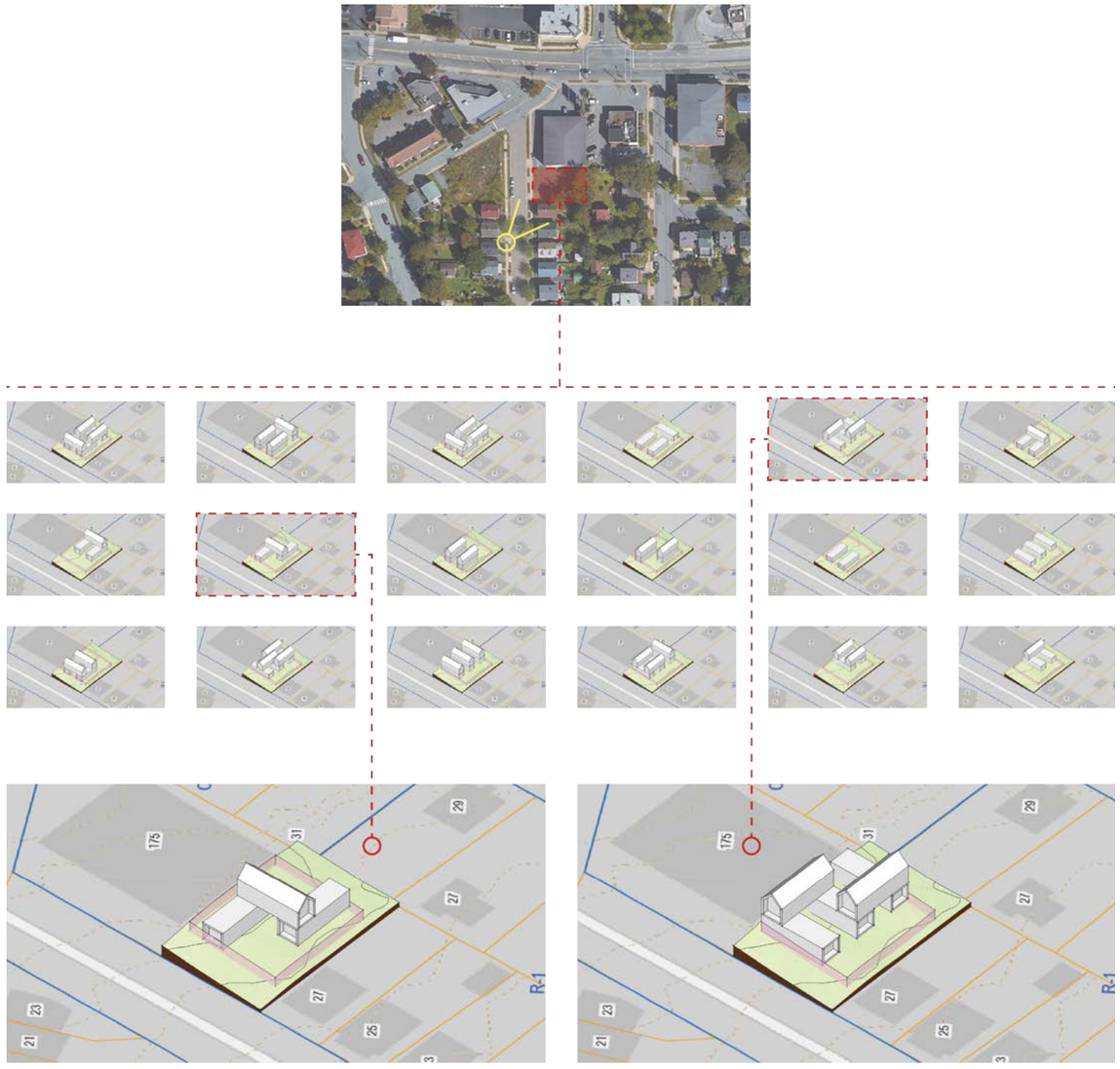


FIG. 30 BROOKSIDE MASSING STUDY - AUTHOR

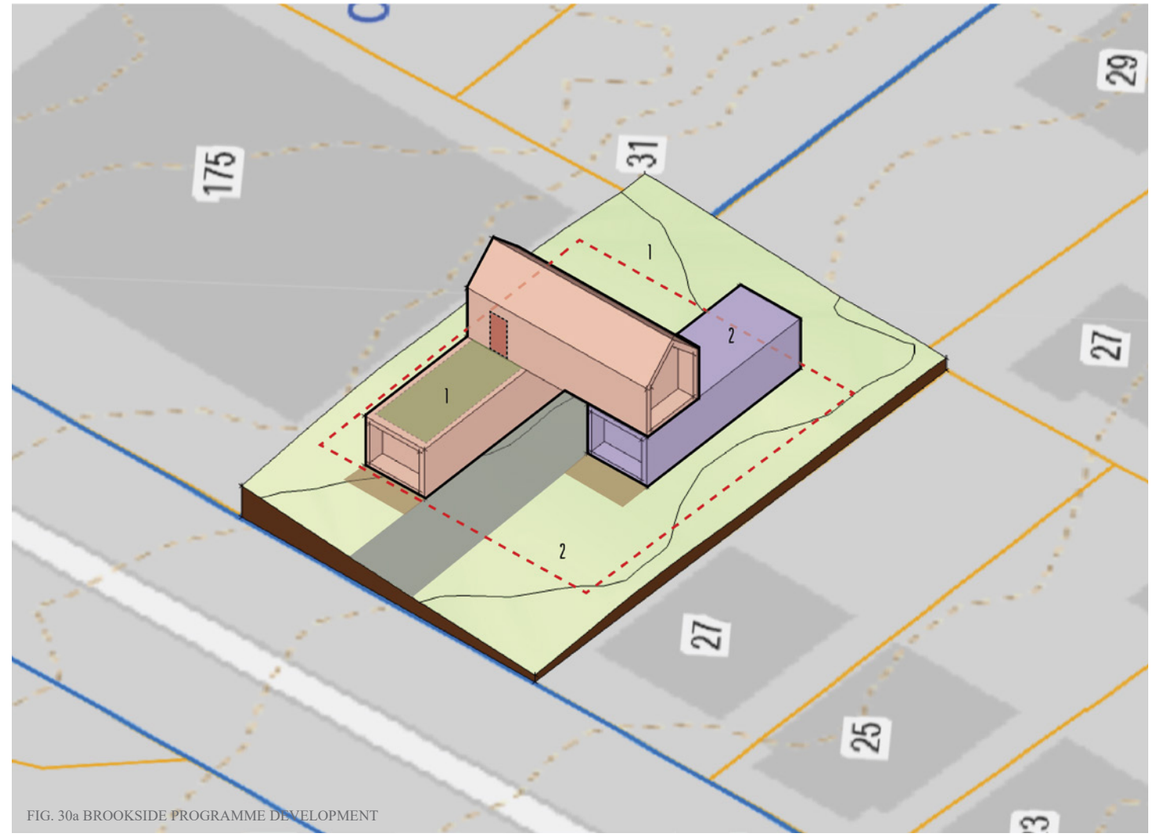


FIG. 30a BROOKSIDE PROGRAMME DEVELOPMENT

29 Brookside is located 50m from a transit route, and adjacent to a vacant commercial building to the North. The 5,900 square foot lot could contain up to 6 modules, however this particular organization was chosen to favour the inclusion of green space for each dwelling. A single unit, and double unit both address the street, while maintaining front and rear yards for each. The blank rear, and side 'service' walls are oriented toward the commercial building to promote privacy within the home. A central drive aisle allows for multiple cars to be parked, with at least one being offered protection under the portico condition. A roof top patio adds extra green space for the larger module.

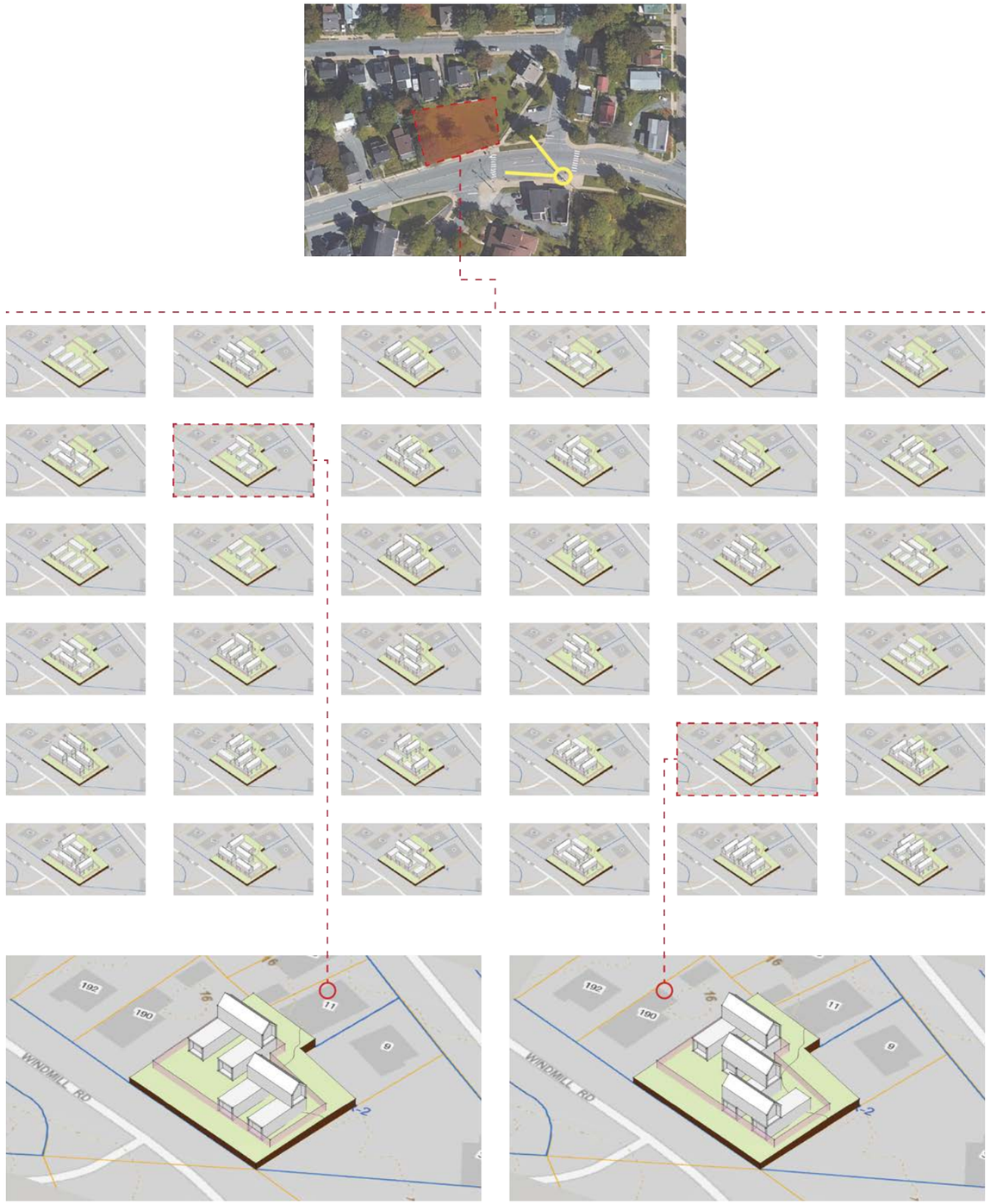


FIG. 31 188 WINDMILL MASSING STUDY - AUTHOR

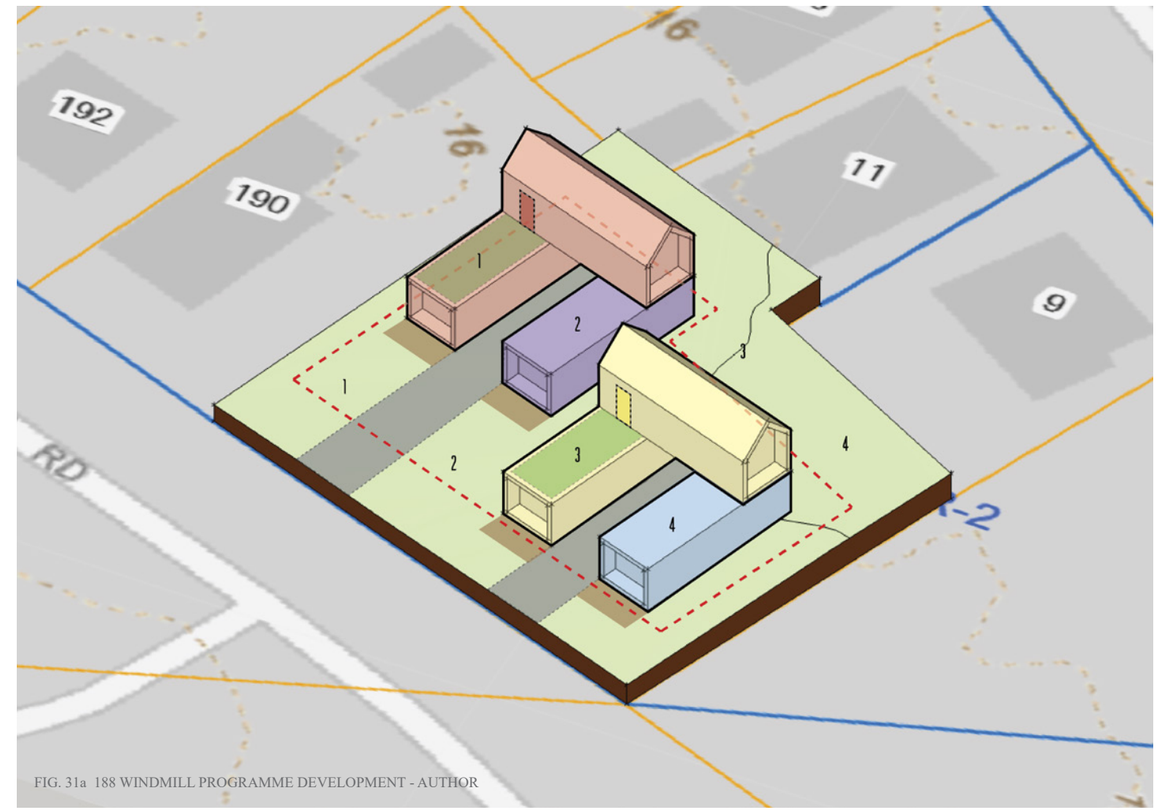


FIG. 31a 188 WINDMILL PROGRAMME DEVELOPMENT - AUTHOR

188 Windmill is located steps from a transit route, and represents the largest of the infill lots chosen for intervention. Upwards of ten modules could be placed on the site, however the green space availble would then be almost entirely reliant on roof top patios. This configuration illustrates two single module dwellings, and two multi module dwellings. Each dwelling would have a dedicated front or rear yard green space, while the double module units benefit from an additional roof top patio space. The four base units all face and address the main road on which they are situated, while the upper modules face the vacant residential lot to the east so they do not look in upon one another.

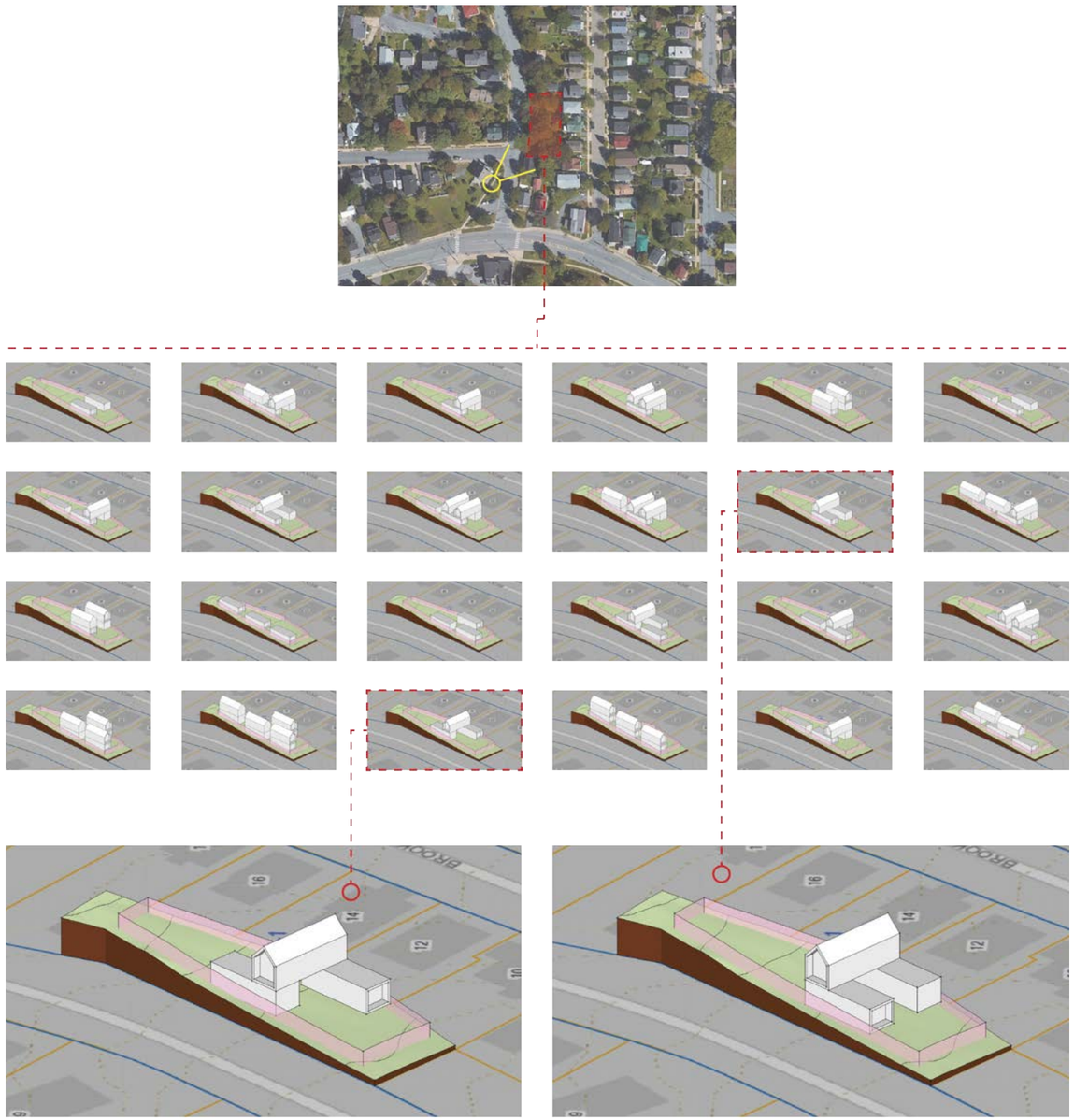


FIG. 32 40 JAMIESON MASSING STUDY - AUTHOR

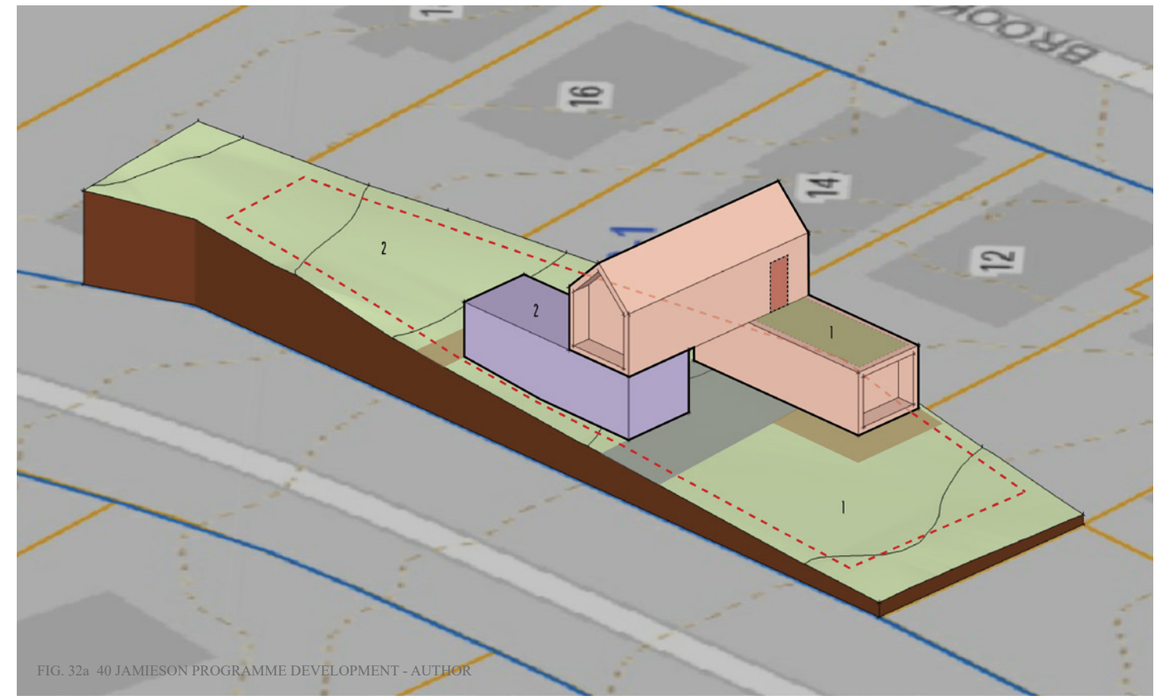


FIG. 32a 40 JAMIESON PROGRAMME DEVELOPMENT - AUTHOR

40 Jamieson is perhaps the most unique and difficult lot to develop of the four selected for study. The smallest of the bunch, its shallow depth, perpendicular orientation, and steep grade would not lend itself well to traditional intervention. Chosen in part to showcase the versatility of the proposal, this lot is the smallest of the four, and is located 70m from the nearest transit route. The orientation of the modules allows for a covered central portico, with separated and privatized green spaces for each dwelling. The upper module faces the street with expansive glazing, as to not ignore the street condition entirely.

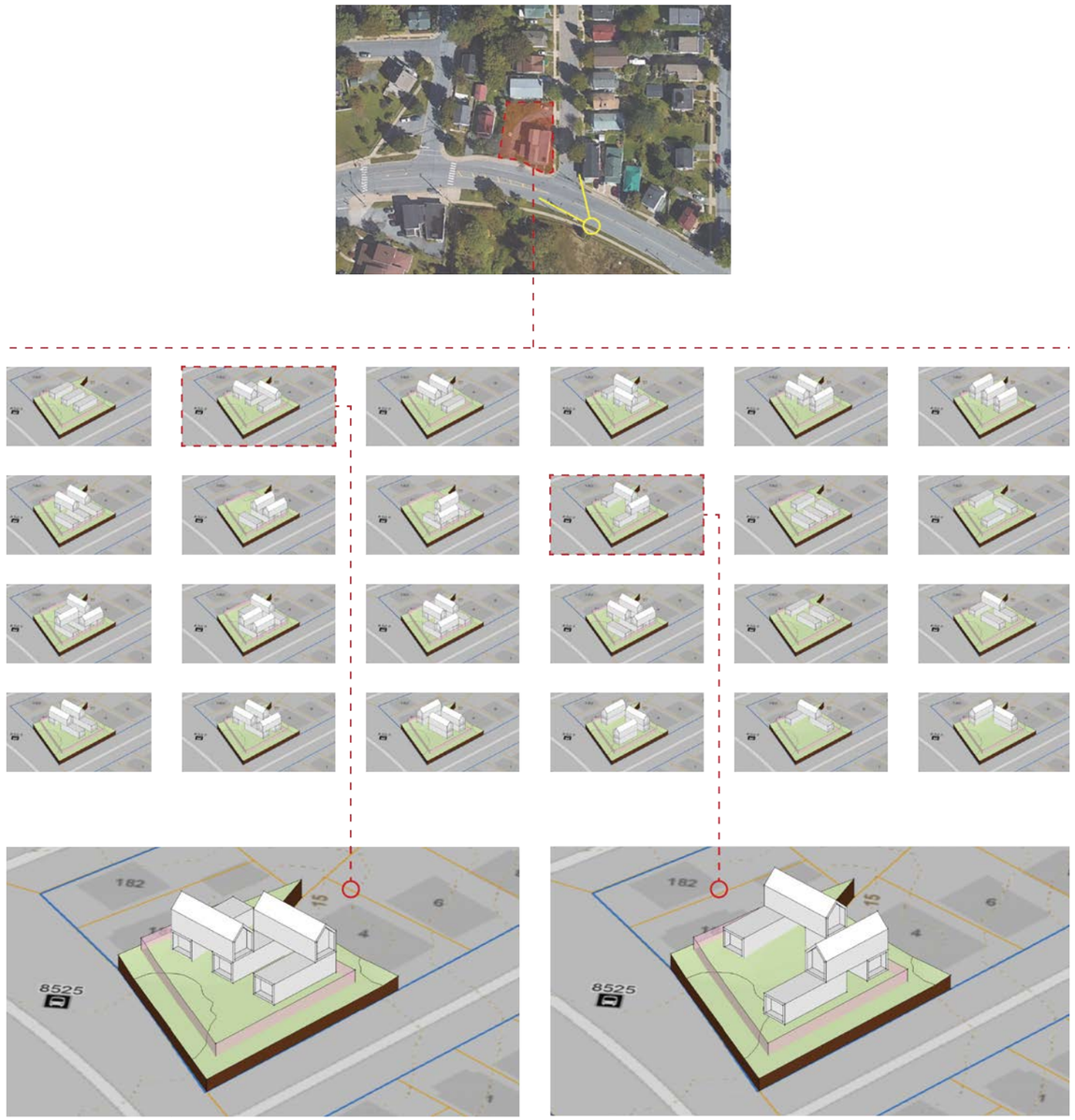


FIG. 33 176 WINDMILL MASSING STUDY - AUTHOR

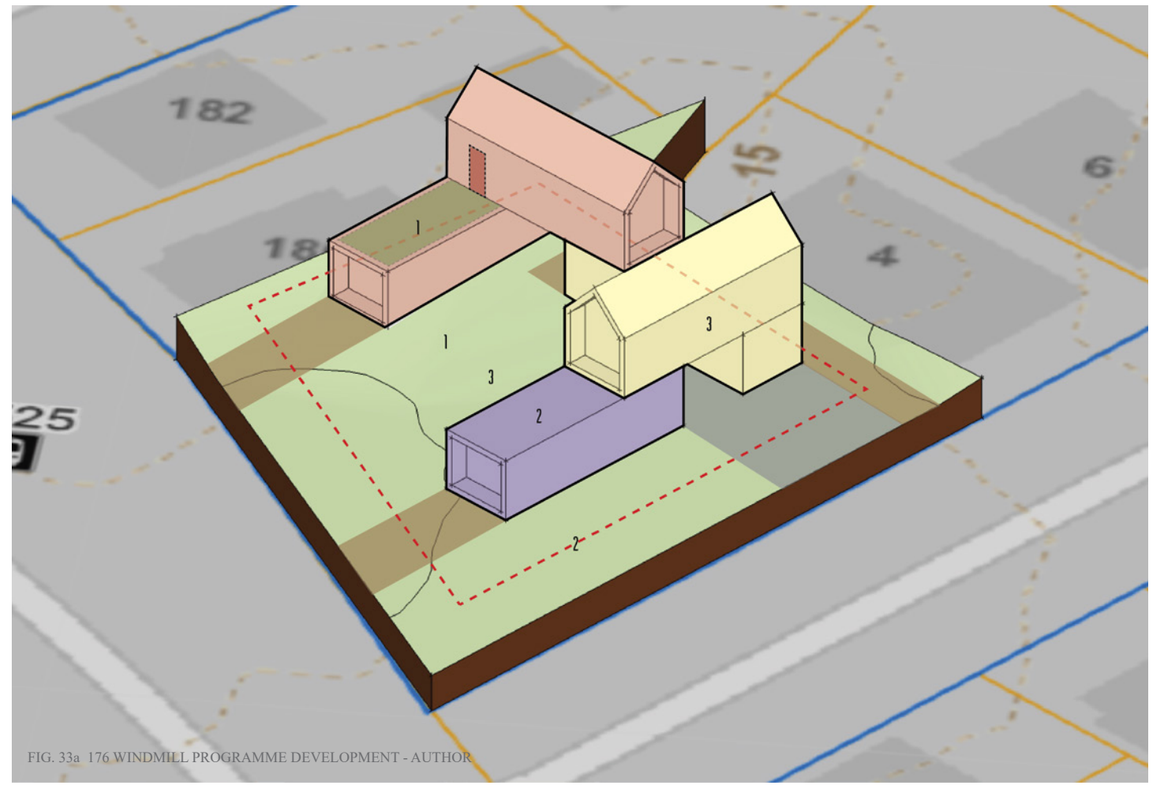


FIG. 33a 176 WINDMILL PROGRAMME DEVELOPMENT - AUTHOR

176 Windmill is situated on a street corner condition. This configuration was designed to address its context while providing selective perforation for vehicular and pedestrian traffic from the lesser busy of the two streets. Steps from the transit line, these modules frame the site to produce a communal green space courtyard. One single module, with two double modules provides versatility in what is availble for families of up to four. Each of the three dwellings has expansive glazing facing the street, and are set back as far as possible to abate some of the noise from Windmill road.

FIG. 34 DELIVERY OF 1/4 AIROH MODULES, POTTER, B.

04 PREFABRICATED HOUSING

PRE-WWII

While prefabricated construction methods to address rapid housing needs are not in wide use today, the technique does have an extended history. Dating back at least 2000 years, the ever expansive Roman Empire used prefabricated building elements to rapidly assemble new forts as they carved their way through modern day Britain[28]. Timber cut to standardized lengths that was pre-notched at the joints allowed them to secure their recently conquered land at an alarming rate, reducing susceptibility to counter attack. The first mention of prefabrication in written text was found in Robert Wace's Roman de Rou, in 1160[29]. French Historian Pierre Bouet confirmed that the text depicted the people of Normandy transporting a castle-like structure in kit form. Published in the May/June Special edition of Historia, the highlighted verses from the text read:

"They took out of the ship beams of wood and dragged them to the ground. Then the Count (Earl) who brought them, (the beams) already pierced and planed, carved and trimmed, the pegs (raw-plugs/ dowels) already trimmed and transported in barrels, erected a castle, had a moat dug around it and thus had constructed a big fortress during the night."[30]

In the early 17th century, European colonists began shipping panelized wood kits along with new settlers[31]. First erected as fishing settlements in Massachusets, this marked the beginning of prefabrication in North America that continues to evolve to this day. This also marked the beginning of wood prefabrication at a smaller housing scale, and it would evolve on separate but similar timelines throughout Europe and North America.

In 1837, London based carpenter Henry Manning designed and produced the 'Portable Cottage' to be exported to Australia[32]. A wildly successful strategy, hundreds of these dwellings were shipped to the continent over the next twenty years. On the other side of the Atlantic during the same decade, kit houses were transported by rail to California to keep up with the influx of settlers during the gold rush[33].

28 Shveta Berry. "The History of Prefabrication, from Roman Forts to Modern Modular Housing" via Redshift Autodesk Feb 2019
29 Britannica, T. Editors of Encyclopaedia. "Wace." Encyclopedia Britannica, April 23, 2020. https://www.britannica.com/biography/Wace.
30 IBID
31 Shveta Berry. "The History of Prefabrication, from Roman Forts to Modern Modular Housing" via Redshift Autodesk Feb 2019
32 IBID
33 IBID

After the turn of the century, this practice became more commercialized as Sears Roebuck & Co. introduced their 'Catalogue Homes' out of Chicago in 1908[34](fig. 35,36). Between 1890 and 1910 the population of the United States had increased by 50% as the industrial revolution had fully materialized in America[35]. The market for rapidly built and well priced houses seemingly expanded overnight, and was amplified further after the first World War. Beginning with 22 types to choose from in 1908, the manufacturer grew to eventually offer over 400 unique designs based on the same building components[36].

They shipped over 70,000 units mostly within a 300 mile radius throughout the lifetime of the project, reaching a peak production of over 300 per month[37]. Running from 1908-1940, the Sears Catalogue program offered a variety of styles and sizes that ranged from $360 (~$10,000 in 2021) to $4500 (~$100,000 in 2021). Savings were achieved largely in part by the 'do it yourself' nature of the delivery. Architects employed by the company maintained that the average carpenter hours required to assemble a Sears home was 352, as opposed to the 580 hours typical of a conventional house during this time[38]. This represents a labour savings of 40%, and the precut and fitted pieces allowed for non skilled workers to assemble the house on site without the help of professional trades. The packaged home arrived on site as a kit of thousands of components, with a 77 page manual titled: *How to Build your Ready Cut Honor Bilt Home*[39].

34 Amanda Cooke, and Avi Friedman. "Ahead of Their Time: The Sears Catalogue Prefabricated Houses." Journal of Design History 14, no. 1 (2001): 53-70.

35 IBID

36 "History of Sears Modern Homes" Sears Archives, accessed Jan. 26, 2021 http://www.searsarchives.com/homes/history.htm

37 IBID

38 IBID

39 Amanda Cooke, and Avi Friedman. "Ahead of Their Time: The Sears Catalogue Prefabricated Houses." Journal of Design History 14, no. 1 (2001): 53-70.

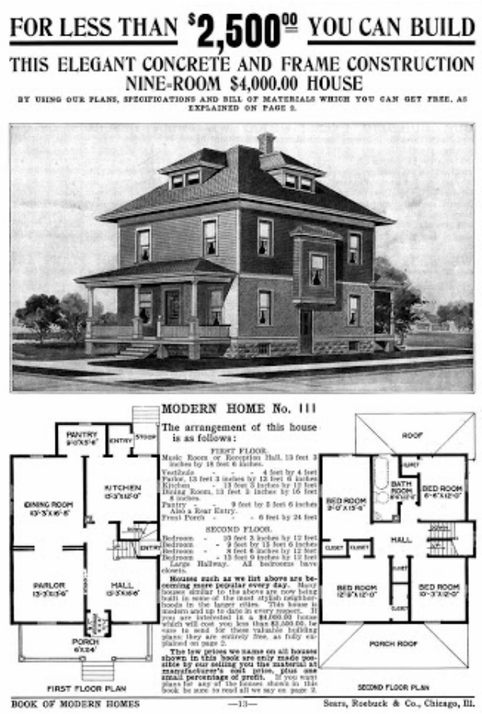


FIG. 35 SEARS ROEBUCK & co CATALOGUE HOME 111

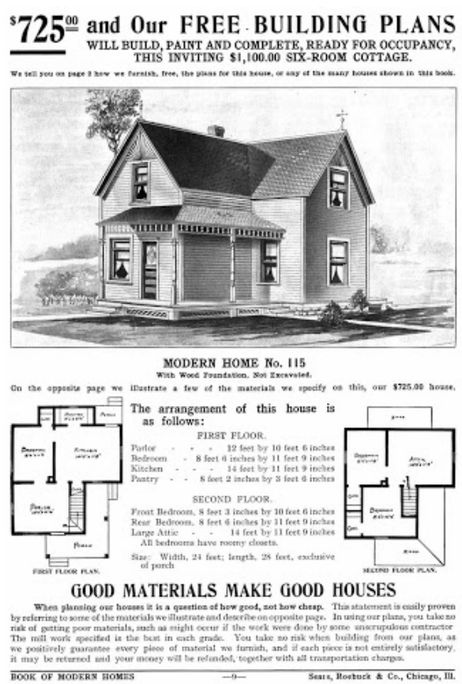


FIG. 36 SEARS ROEBUCK & co CATALOGUE HOME 115

As an evolution towards more modern forms of prefabricated construction, Sears had pushed the figurative and literal envelope of their precut homes towards a more panelized modularity for smaller scale dwellings. Known as the Simplex Cottages, these packages were intended for basic summer homes to be placed in remote locations (fig.37). With more labour up front for the company in the factory, it saved the customer an immense amount of carpenter hours during assembly. The average Simplex cottage could be assembled in 8 hours, by two people with relatively little skill[40]. Reports and testimonials spoke of families heading out for a weekend getaway, arriving at their retreat on Friday to assemble the cottage, and being able to sleep in it by early Saturday[41]. Depending on the location, the customer was also able to add prefabricated accessory buildings such as a garage, or outhouse (fig.38). Sears Roebuck & Co. modelled their production line after that of Henry Ford, electing to buy old factories and outfit them as assembly lines[42] (fig.40).

Sears Roebuck & Co. produced stunning visuals and advertisements for the catalogues (fig.39). It is still widely regarded as one of the best run marketing campaigns ever in North America[43]. Vibrant pictures depicting happy families throwing away their rent receipts in exchange for smaller mortgage payments adorned covers over a 30 year stretch, with the image of the house itself often depicted in the background.

40 Amanda Cooke, and Avi Friedman. "Ahead of Their Time: The Sears Catalogue Prefabricated Houses." Journal of Design History 14, no. 1 (2001): 53-70.

41 IBID

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43 IBID

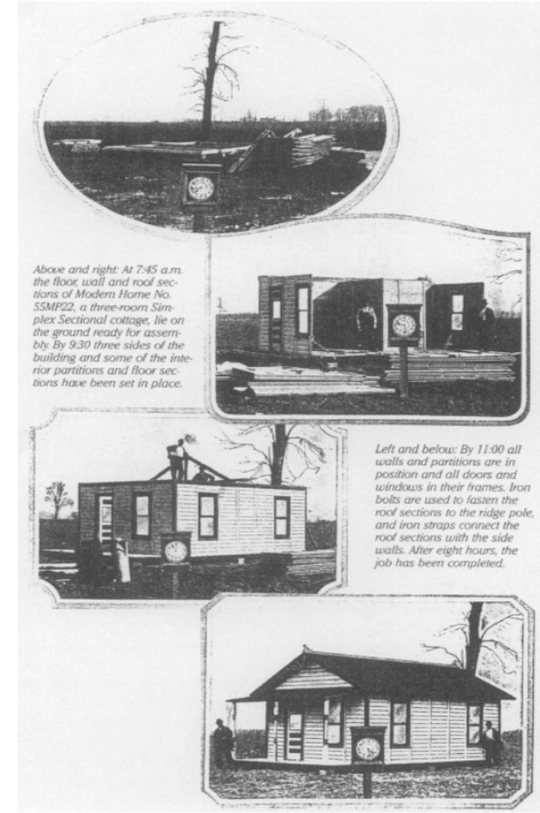
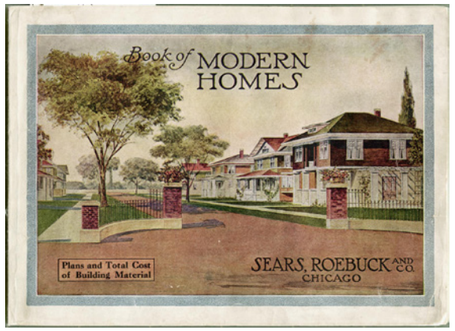
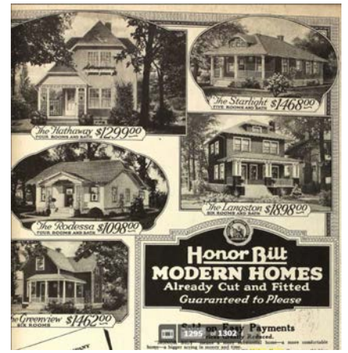


FIG. 37 TIMED CONSTRUCTION OF SIMPLEX COTTAGE

FIG. 38 TIMED CONSTRUCTION OF SIMPLEX GARAGE





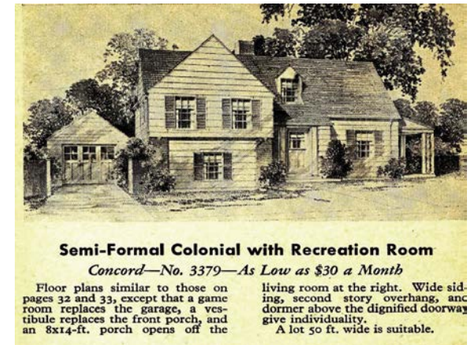


FIG. 39 SEARS CATALOGUE ADVERTISEMENTS - COURTESY LARA SOLONICKNE

Nurturing the initial ideas of the American Dream, Sears sold the idea that the stereotypical perfect family could and should have the picture perfect house for less. With a solid product and expert marketing, why then did the Catalogue Program fail by the time the United States had entered WWII? Orders were coming in at a torrid pace throughout the first twenty years of operation, so Sears Roebuck & Co. looked to grow revenue further by offering credit on materials, cash advances on labour costs, and other various mortgage associated loans[44]. Standard loans were 5 years but could be stretched to 15, and interest rates fluctuated between 5-7%[45]. This liberal financing policy eventually contributed to the demise of the catalogue program, as millions of dollars of mortgages were liquidated throughout the great depression leaving the program unable to ever fully recover[46].

The ultimate failure of the Sears model therefore can be attributed to this lack of financial oversight, and not the prefabricated construction methodology. This model proved that a standard dwelling could be designed, manufactured, and constructed in a fraction of the time, and with significant cost savings.

The customization of the design made it impossible to tell which homes were prefabricated, and which had used the more traditional balloon frame on site construction method. More recent quips about all modular homes looking the same would never have been uttered throughout the first half of the twentieth century. Unsurprisingly then, it would not be long until a similar model was implemented by multiple companies to address the housing crisis faced in both America and Britain in the wake of WWII.

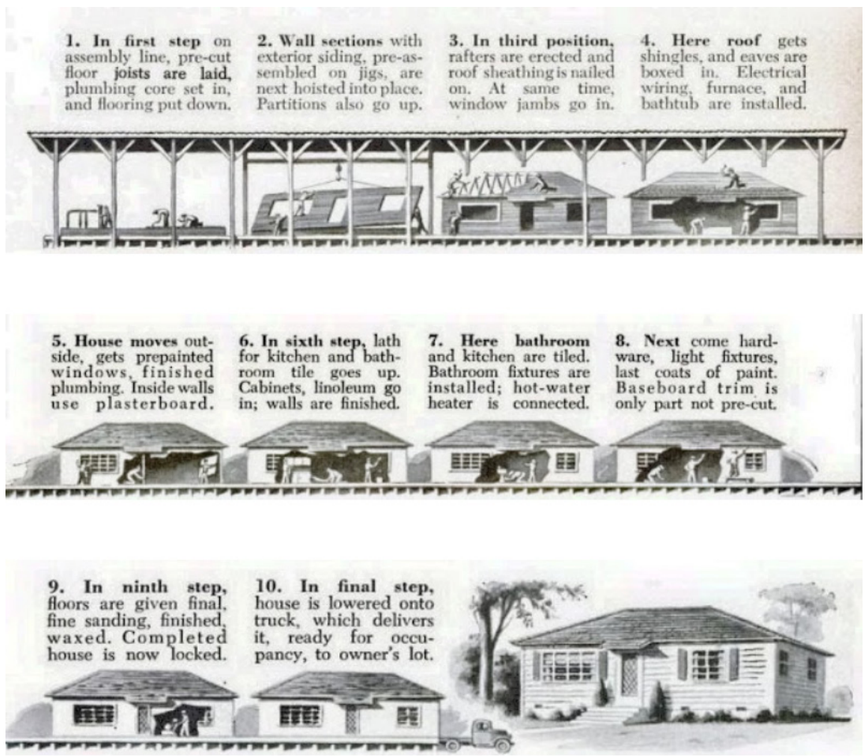


FIG. 40 DIAGRAMMATIC SEARS HOUSE ASSEMBLY LINE

44 Amanda Cooke, and Avi Friedman. "Ahead of Their Time: The Sears Catalogue Prefabricated Houses." Journal of Design History 14, no. 1 (2001): 53-70.

45 IBID

46 IBID

POST-WWII

The ingenuity and industrialization throughout and after the conclusion of the second World War was nothing short of astounding. Entire countries and kingdoms were mechanized, mobilized, and outfitted for the singular purpose of defeating the enemy. In the wake of the mass destruction of entire cities, a decisive strategy for rapid and affordable housing was required to house the general population as well as returning soldiers. There were some parallels between the British and North American approaches, but there were distinctions as well that made each solution unique to its contextual circumstances.

In Britain, Prime Minister Winston Churchill is credited with kickstarting the rapid housing campaign well before the war had an end in sight. As the Luftwatfe's Blitzkrieg petered out in the early 1940's, Britain had lost an estimated 450,000 homes (fig. 41-43).[47] Churchill finally revealed his plan in 1944, by rousing parliament as well as the general public with a speech that promised half a million homes rebuilt within 10 years. The dwellings would be constructed under the Temporary Accommodation Act, carrying a budget of £150 Million[48]. (£6.8B in 2021). These homes would be manufactured by different companies using a variety of innovative techniques and materials, but had certain standards that had to be met as dictated by the act. Specific modules and design features were to be standardized across the board, such as placing the kitchen and bathroom back to back to simplify routing of plumbing and electrical lines. No matter who was manufacturing the homes, they all had to carry similar aesthetic, size, and functionality. Guidelines for the design set parameters for

FIG. 41 HEINKLE BOMBER OVER LONDON, SEPT 7, 1940. BBC NEWS

FIG. 42 LONDON AFTER THE BLITZ - ft.com

FIG. 43 ST. PAULS CATHEDRAL AFTER THE BLITZ - theguardian.com

47 Peter Lobner. "Post-World War II Prefabricated Aluminum and Steel Houses and their Relevance Today"

48 IBID

everything from maximum square footage, to module size, to paint and trim color. This led to a monotonous repetitiveness that planted the seeds for the argument against prefabricated housing that all of them looked the same. Customization and design flexibility that was synonymous with the Sears builds gave way to standardization and rapid production to quickly address the housing crisis at hand.

What the British post-war housing developments lacked in customization, was certainly more than made up for in industrial ingenuity. The Temporary Housing Program became officially known as the *Emergency Factory Made (EFM) Housing Program*[49], as factories and warehouses initially created for the production of airplanes and artillery shifted their assembly lines to create housing components such as wall panels and trusses (fig.44). Particular focus was on using the surplus of available aluminum that had been stockpiled for airplane production. This cache was further supplemented by the reclaimed aluminum from downed airplanes throughout the preceding number of years[50]. Manufacturers who had created the Lancaster bomber, Hurricane, and Spitfire fighters credited with saving the Battle of Britain suddenly became instrumental in winning the impending battle even closer to home. The most successful and widely implemented program in Britain was the AIROH (Aircraft Industries Research Organization on Housing). Represented by 13 aviation firms, Morrison's Engineering, and architects A.F. Hare & Partners[51], the goal was to design an aluminum bungalow in large modules that would last at least ten years. The typical

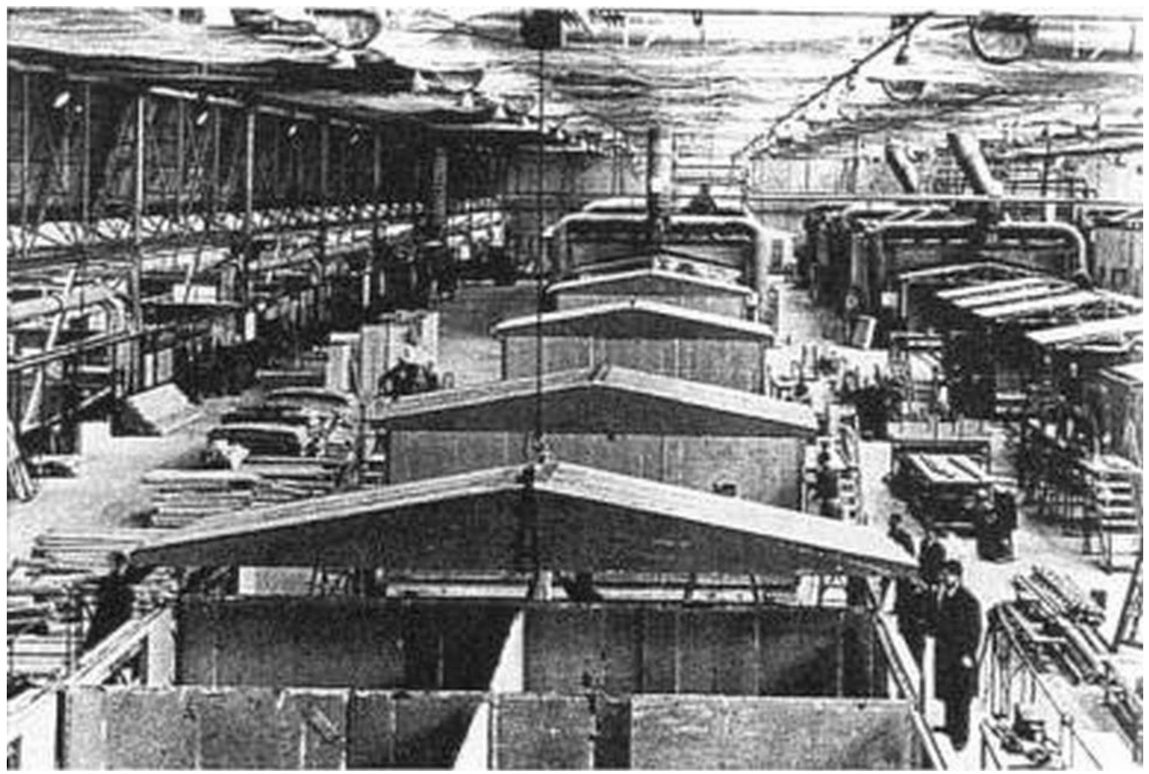


FIG. 44 HOUSING PRODUCTION LINE - VALE, BRENDA

49 Peter Lobner. "Post-World War II Prefabricated Aluminum and Steel Houses and their Relevance Today"

50 Peter Lobner. "AIROH Aluminum Temporary Bungalows. June 2020"

51 IBID

AIROH bungalow consisted of 2000 components, assembled into 4 modules that could be transported on trucks and craned into place (fig. 34,45)[52]. Factory workers at companies such as Bristol, and Vickers were highly skilled, and trained to assemble airplanes comprised of 20,000 parts so the production of houses was relatively simple with high productivity rates. At its peak, an AIROH house was being produced every 12 minutes[53]. This yielded 40 houses per factory over an 8 hour work day, or roughly 200 dwellings per week. To increase trust and foster public interest, demonstrations on bombed sites in London showcased the AIROH house being constructed and ready to inhabit in 4 hours[54]. The fastest construction recorded by Historic England was a mere 41 minutes upon arrival, in Brighton in November 1946[55]. Each AIROH house used 2 tonnes of scrap aluminum, considering it was a widely available construction material with high strength and low weight. Roof trusses reminiscent of airplane wing chords and struts capped the paneled wall and floor systems. The rigid frames were designed to durably survive the transportation process, and be lightweight enough to install with small cranes on prepared sites. Nearly 55,000 AIROH houses were completed by the time the program came to a close. The eventual depletion of the stockpile led to the purchasing and import of aluminum which drove the cost of construction up greatly. By the mid 1940's, Britain had gone through the heaps of scrap aluminum that had re-entered production, and turned towards importing two thirds of the required material from Canada[56]. AIROH houses began to cost roughly 25% more than their wooden counterparts in the

FIG. 45 AIROH MODULE BEING CRANED INTO PLACE - POTTER, B.

52 Peter Lobner. "AIROH Aluminum Temporary Bungalows." June 2020

53 IBID

54 IBID

55 IBID

56 Brian Finnimore. "The A.I.R.O.H. House: Industrial Diversification and State Building Policy." Construction History 1 (1985): 60-71

EFM. The aircraft industry was unable to enthrall the public with the products in the same way the airplane was romanticized, so their repetitious bungalows eventually fell out of favour. British polls as early as 1946 indicated that prefabricated emergency housing was already developing a bad reputation, with only 16% of people responding that they would live in such a dwelling, and 33% would only consider it if they had no other option[57]. Coupling the rising costs, public perception, and the government's transition to concrete highrise social housing projects eventually led to the demise of the AIROH house a decade after it took off[58].

Both the Sears Roebuck and AIROH models showcased the time, labour, and cost saving potentials of modular prefabricated construction methodologies throughout the twentieth century. When implemented correctly, one can provide a customized, efficient, and affordable unit in a fraction of the time. The technological advancements throughout these periods piqued the inventiveness of architects as they drew inspiration from Henry Ford's assembly line, and the use of skilled labour who had been trained in the efficient assembly of complex aircraft. Once components left the factory, modules were designed to be assembled on site by less skilled workers in an effort to secure further savings in labour. The evolution of module size between these two models has continued into the twenty first century, as it is not uncommon to now see entire cottages, and small houses being transported by truck. The transition of components from single stud, to wall panels, to cross sectional building segments, to entire dwellings being shipped has allowed manufacturers to build more of the unit in factory controlled conditions, without weather delays, while reducing the construction time on site.

Today, the ~$10 trillion construction industry continues to be notoriously one of the least efficient on the planet. According to the McKinsey Global Institute, the *construction productivity rate* - how much building workers accomplish for each hour of labour put in - has remained flat since 1945. In contrast, over that same period industries such as agriculture, manufacturing, and retail all saw explosive growth in the realm of 1500%[59]. While these other facets of the economy have cashed in and evolved using automation, machines, and robotics, the average carpenter is no more efficient than their predecessors were at the close of WWII.

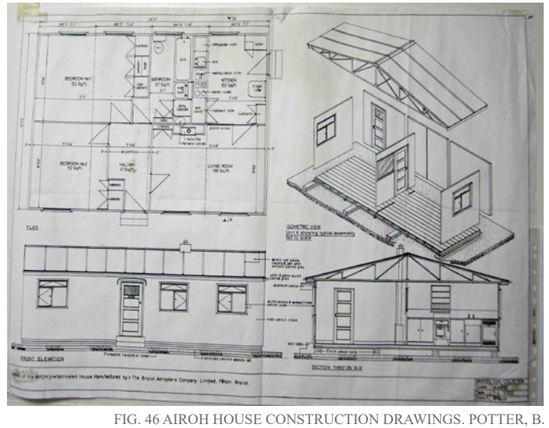


FIG. 46 AIROH HOUSE CONSTRUCTION DRAWINGS. POTTER, B.

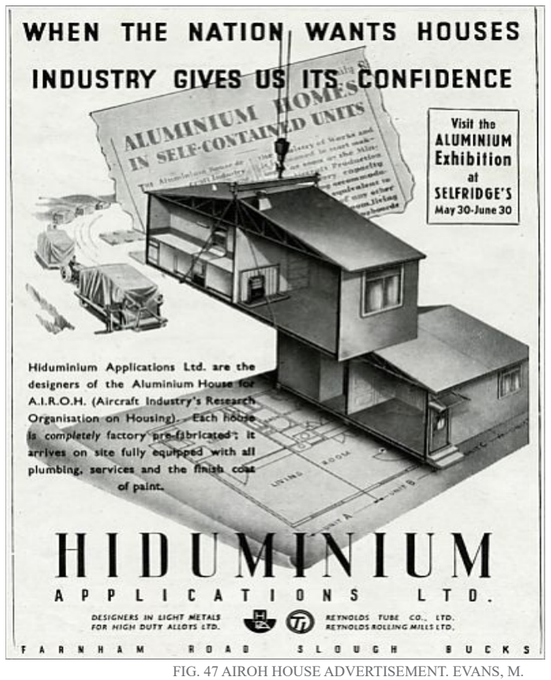


FIG. 47 AIROH HOUSE ADVERTISEMENT. EVANS, M.

57 Amanda Cooke, and Avi Friedman. "Ahead of Their Time: The Sears Catalogue Prefabricated Houses." Journal of Design History 14, no. 1 (2001): 53-70.

58 Brian Finnimore. "The A.I.R.O.H. House: Industrial Diversification and State Building Policy." Construction History 1 (1985): 60-71

59 Conor Doughery. "Piece by piece, a factory-made answer for a housing squeeze" New York Times (June 2018)

FIG. 48 FACTORY OS, VALLEJO, CA. DOUGHERTY, CONOR - NY TIMES

05 DESIGN DEVELOPMENT

Informing the core aspects of the dwelling design was an ongoing exploration of the benefits, as well as the limitations of modular and prefabricated construction methodologies. An examination of the efficiencies in construction time, as well as material waste and energy reduction drives the sustainability facet of the project[60]. The rich lumber heritage of Atlantic Canada plays a key role in the materiality, while celebrating the small scale vernacular forms of the coastal region. For example, as a port city Halifax is adorned with shipping containers. Despite their prominence, there are specific bylaws stating that one may not be used as a residence[61]. Pairing this massing with the materiality of fishing shacks found all over the province recalls Maritime tradition and celebrates the forms that the region has come to love (fig.50). A marriage of traditional craftsmanship methods and unconventional materials allows for the use of local skilled labour while modernizing the building envelope.

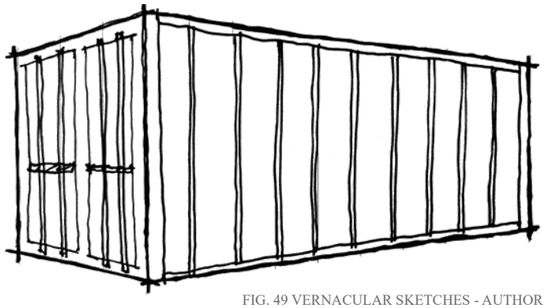


FIG. 49 VERNACULAR SKETCHES - AUTHOR

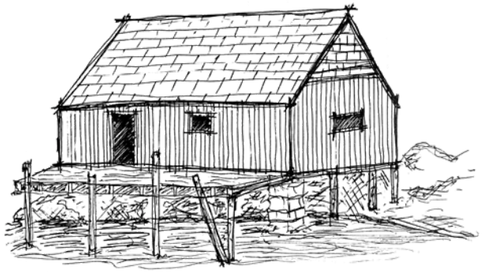


FIG. 50 VERNACULAR SKETCHES - AUTHOR

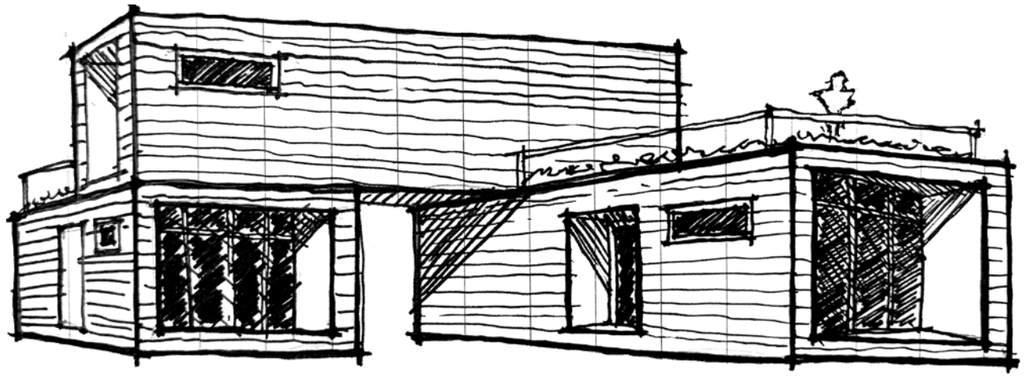


FIG. 51 MASSING SKETCHES - AUTHOR

60 Mark Gehloff. Wood Solutions Fair Lecture, Mississauga, ON 2019.

61 Halifax Land Use Bylaw Ed. 223 June 2017

The limitations of transportation, equipment, and deployment of the structure also played a leading role in informing the design and delivery method of each unit. Examining module size and delivery methods quickly became a major driving factor of design decisions. In determining module size, everything from crane availability and capacity, to the cost of securing a wide load transportation permit[62] was investigated to determine the final costs. Potential upfront transportation expenditures that may be associated with moving an entire 400 ft² assembled unit might be offset by 25 years of energy savings that come with a more airtight build in a controlled facility. It is imperative to consider the entire lifecycle of the building, and everything was scrutinized to determine the best approach to delivering the most efficient and sustainable unit possible. Successful prefabricated buildings spend a considerable amount of time on 'front end design'[63] in order to streamline construction. This proposal intended to develop a well conceived design and a full set of construction details that would best position the proposal to begin manufacturing post graduation.

Initially, the 12'-0" x 36'-0" sequence was derived to keep the building footprint in the 400 ft² range, while utilizing widths & lengths that would lend themselves well to the available space in rear yards in the Between the Bridges neighbourhood. These dimensions could also be neatly broken down into smaller modules as the proposal developed, considering the 3:1 ratio could be divided into whole numbers at a variety of scales (fig.53). As the design progressed, three distinct programmatic modules emerged. Each module encompassed a 12'-0" x 12'-0" area, transitioning from more public living areas near the entrance, to a more private bedroom toward the rear. The 12'-0" x 12'-0" module ensured no structural span greater than 12'-0" so that dimensional lumber could be employed as floor joists and rafters negating the need for costly pre-engineered systems. This was important for the laneway model, and perhaps even more important when considering the stacking and spanning nature required of the multi-unit configurations.

While this proved successful in helping to design and arrange the programme and initial floor plans, it was problematic from a delivery standpoint. The major issue in delivering a 12'-0" x 12'-0" module is that is exceeds the 8'-6" width of a standard flat bed truck (fig.52). Separate permits as well as secondary truck escorts would be required, driving up the cost every time a unit had to leave the facility. In an effort to utilize more standardized transportation methods and reduce equipment rental costs, the module had to be altered.

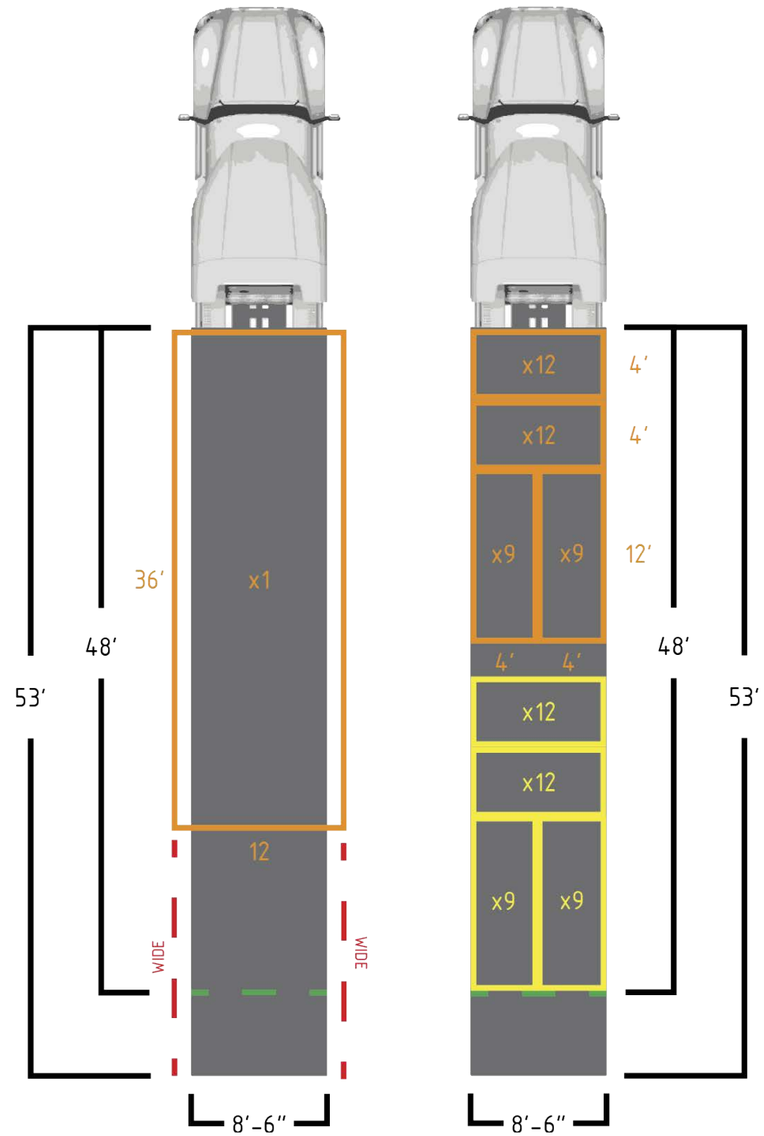


FIG. 52 INITIAL TRANSPORTATION CONSIDERATION - AUTHOR

62 "Weights and Dimensions of Vehicles Regulations." NS Flatbed Dimensions & Permits. https://novascotia.ca/just/regulations/regs/mvwd.htm

63 Mark Gehloff. Wood Solutions Fair Lecture, Mississauga, ON 2019

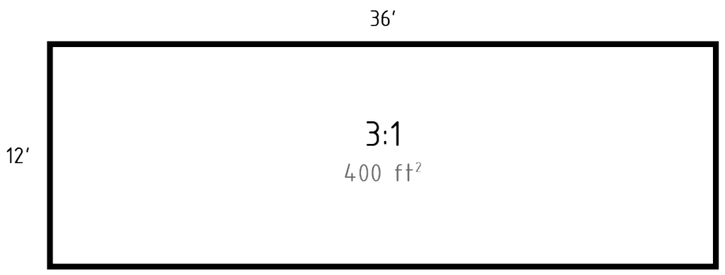


FIG. 53a
MODULE OPTION 1: FULL UNIT

In this option, the entire prefabricated unit would be deilvered as a fully complete dwelling onto a prepared slab or screw pile foundation. On site work would be limited to water & sewer hookups. The width exceeds limitations imposed by delevery trucks, requiring wide load permits and escort vehicles on delivery day.

FIG. 53b
MODULE OPTION 2: (3) 12' x 12' BLOCKS

This option breaks the dwelling into 3 equally sized modules. They would be craned into place and fastened together on site. This module size is still too large for a standard flat bed truck delivery system.

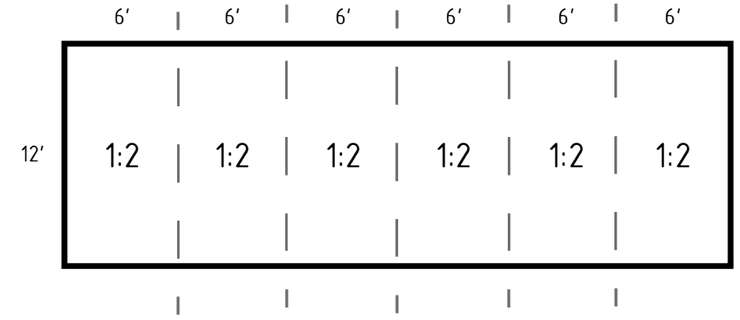


FIG. 53c
MODULE OPTION 3: (6) 6' x 12' BLOCKS

This option breaks the dwelling into 6 equally sized modules. Small enough to fit 3 on one truss boom truck, the dwelling would be delivered in two runs and pieced together on site. Each module would contain the floors, walls, and roof already assembled.

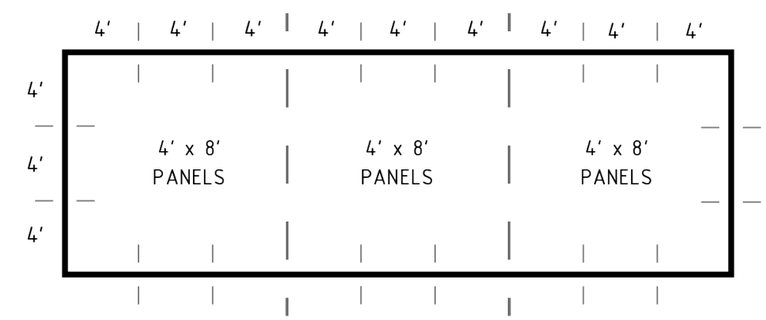


FIG. 53d
MODULE OPTION 4: (42) PANELS

The final option explored a panelized system that could be flat packed on a truck. The floor panels would be installed before each wall panel is tilted into place. A crane would likely still be required to hoist the roof panels into place. Although the entire unit could be delivered in one run, the on site labour would be the most extensive of all of the options.

LANEWAY MODEL

FIG. 54a
PUBLIC TO PRIVATE MODULES:

Module division can be considered at a variety of scales, from the entire 36' length, to 12' sections, to 6' or 4' wall panels. Breaking the unit down into at least 3 distinct modules provides a gradient from public to private services, where the living and kitchen areas can spill out into green space. The division of 12' sections provides consistent load bearing points for stacking units, and allows for only the rear module to be switched out if a second unit is to be added on top.

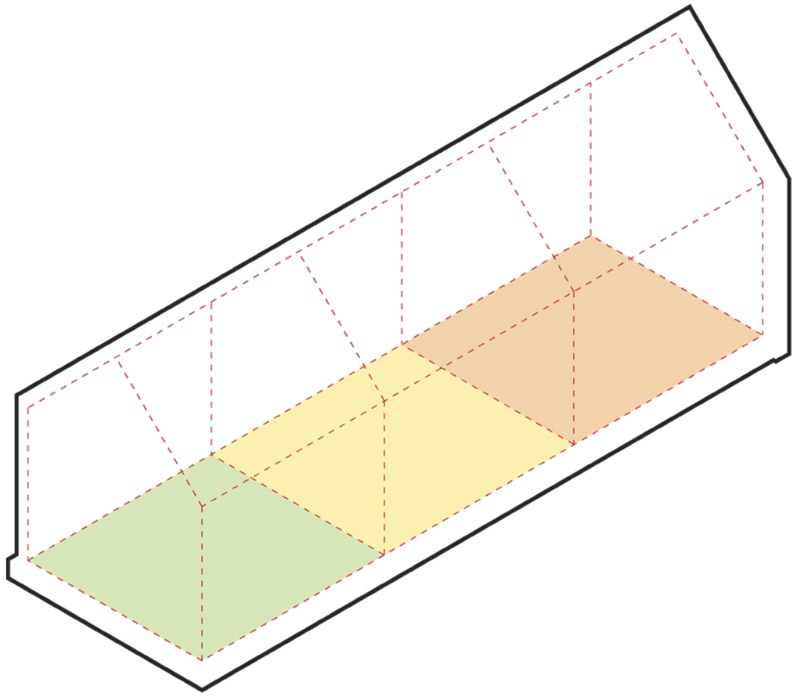
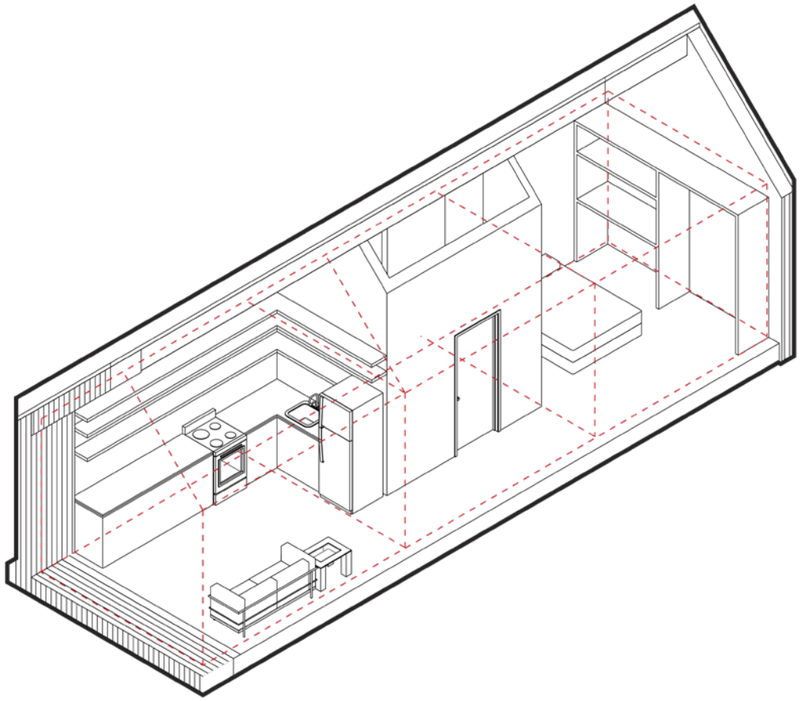


FIG. 54b
PROGRAMME DIVISION:

Careful consideration has been taken in the division of programme and interior space. With private bedrooms and storage at the rear, this leaves the middle module for shared semi private areas such as the washroom, and the front module for public features such as the kitchen and living areas. All utilities and plumbing will be situated within the middle "wet" module to reduce cost and expedite installation on site.



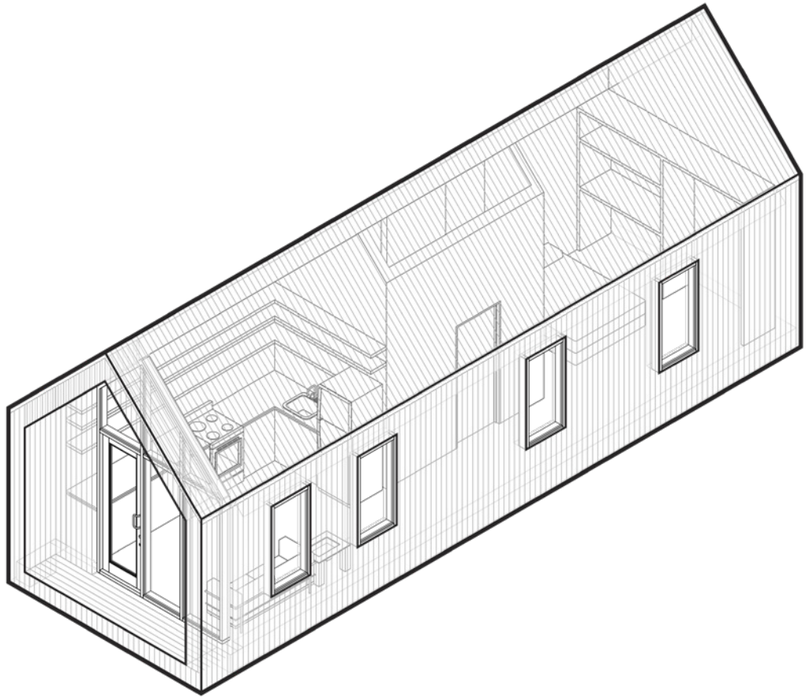


FIG. 54c
ENTRANCES + FENESTRATION:

The fenestration will play a key role in bringing in natural light, providing solar gain, defining entrances, and allowing for natural ventilation. A singular or dual entrance system can provide flexibilty for site placement, and allow for egress onto a balcony or roof top patio. Leaving the rear and one side wall blank will allow for the dwellings to be situated providing privacy from neighbours, while providing a "service" wall for ducts, wires, or water lines.

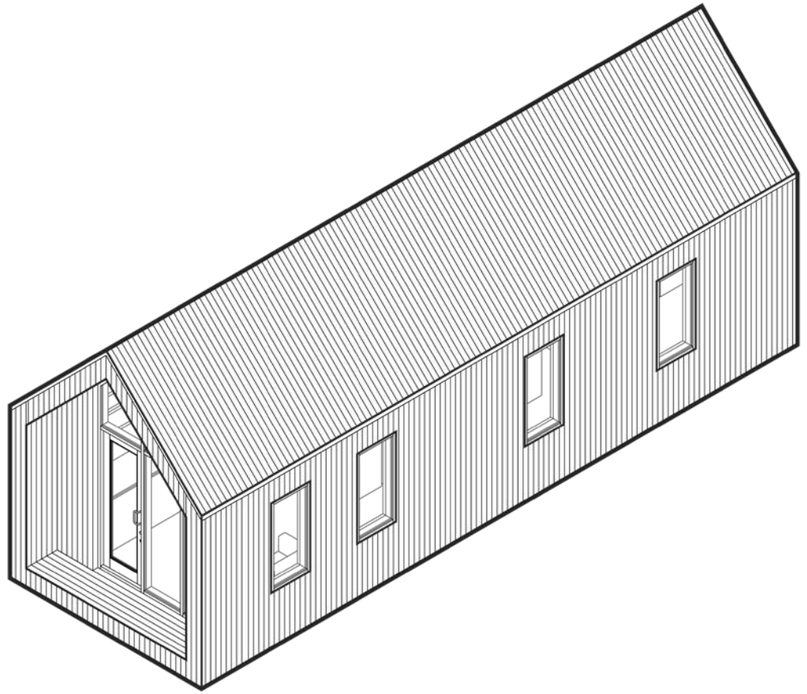


FIG. 54d
CLADDING + MATERIALITY:

Cladding, materials, and roof slope all had to be considered. The marriage of traditional structural materials and innovative insulators allows for the use of local skilled labour while modernizing the building envelope. Photovoltaic panels, and rainwater collection systems can aid the effort of keeping operational costs as low as possible throughout the entire lifespan of the dwelling.

It is a fine line trying to balance capitalizing on the efficiencies of prefabricated construction, while developing a module small enough to fit on a truck. Smaller modules capable of being transported this way require more work once on site than a single full unit, and suffer from a greater number of construction joints and connections. That being said, 3-12 modules would still be superior in this regard to a 42 panel tilt up system. Finding a middle ground that allows for most of the labour to occur off site in a controlled facility, while minimizing seams and on site construction time lead to the exploration of breaking the 12'-0" x 12'-0" programme modules in half so that the dwelling would be comprised of six 12'-0" x 6'-0" blocks (fig. 55).

Each original programme block was divided into two smaller modules of equal size. The 12' dimension of the module allows for the joists and rafters to span clear across without supports in the middle, or the use of pre-engineered systems. The 6' width allows the module to sit comfortably on a flat bed truck. Situated toe to toe, three modules could be strapped on a shorter 36' -40' long truck bed negating the need for the longer 54' bed and making it easier to navigate through residential neighbourhoods. A typical single unit laneway option can then be delivered in two runs, however it is a fair trade off to avoid wide load permits, additional escorts, and reduced maneuverability into tight back yards. It is important not to disregard the original programme blocks entirely. This arrangement allows for all of the plumbing, utilities, and interior walls and doors to be located in the two middle modules. The shower, washer, dryer, toilet, vanity, hot water heater, and kitchen sink are all situated within the two central modules. This serves as a constant anchor, no matter how the modules around or above it are altered. Having all of the services located within two modules saves time during construction, time during service hook ups, and reduces the amount of material required to service the entire unit.

With the module splits determined, the design and layout of the unit was altered slightly to avoid any walls, doors, or windows falling on a construction joint (fig. 56-60). Fixtures within the washroom were arranged so that each one fell fully within one module or the other. Window size was standardized and locations ensured that each could be properly framed in without jack or king studs falling on a module break. Even the appliance locations and subsequent counter and cabinet breaks were considered to allow for the kitchen millwork to come fully installed.

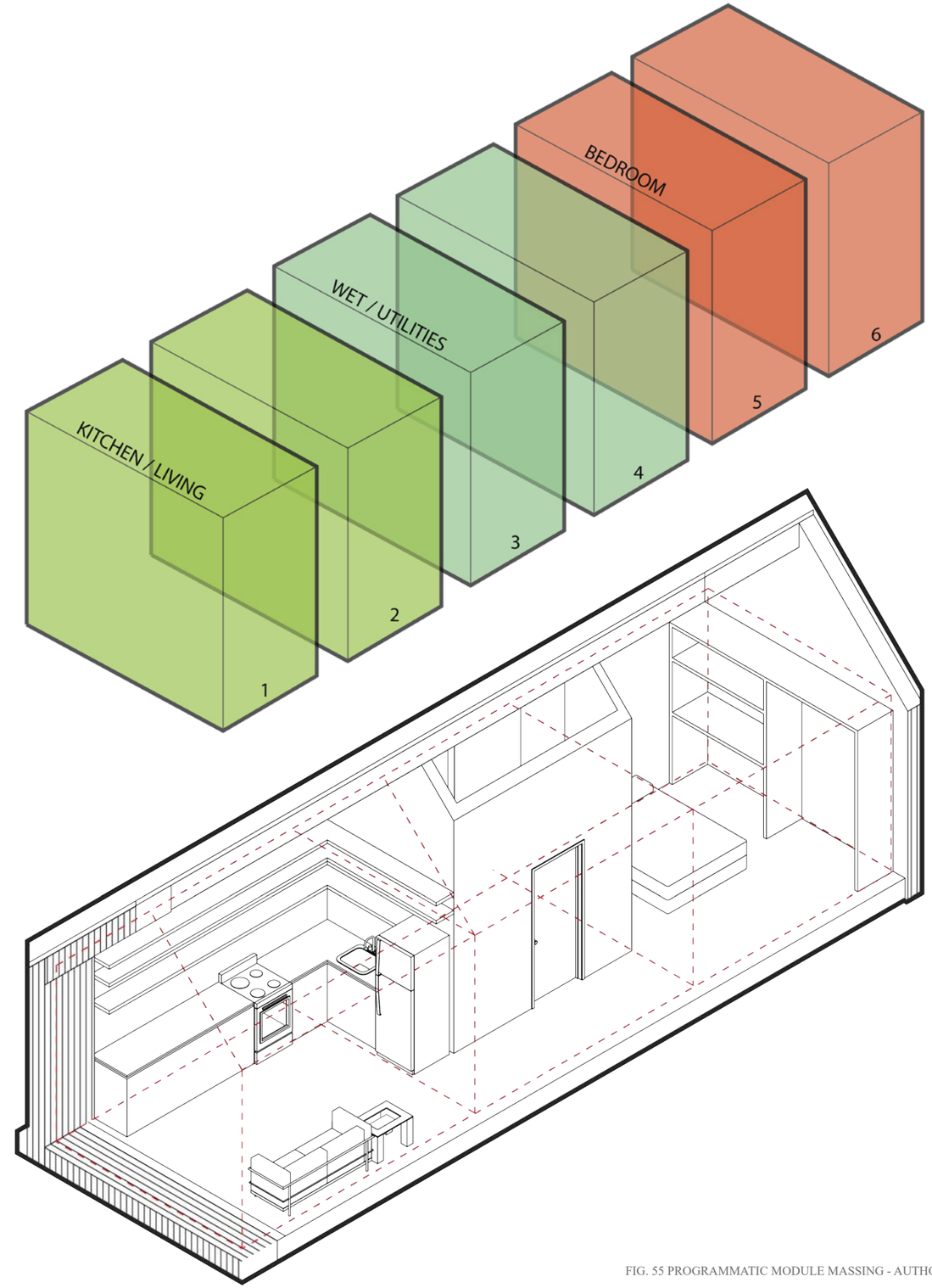


FIG. 55 PROGRAMMATIC MODULE MASSING - AUTHOR

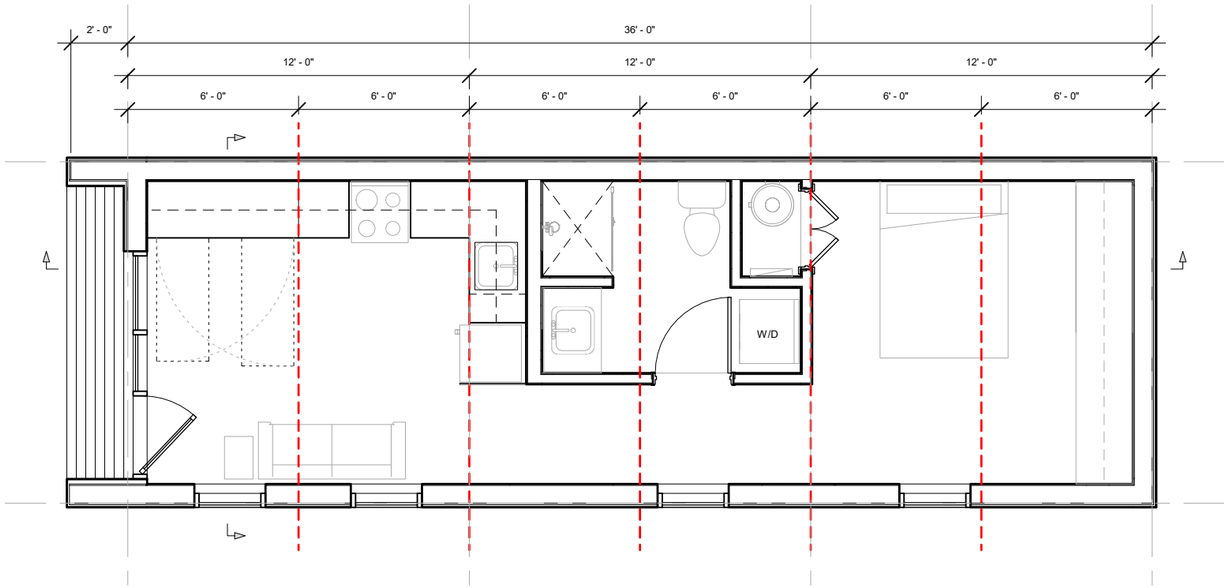


FIG. 56 LANEWAY FLOOR PLAN

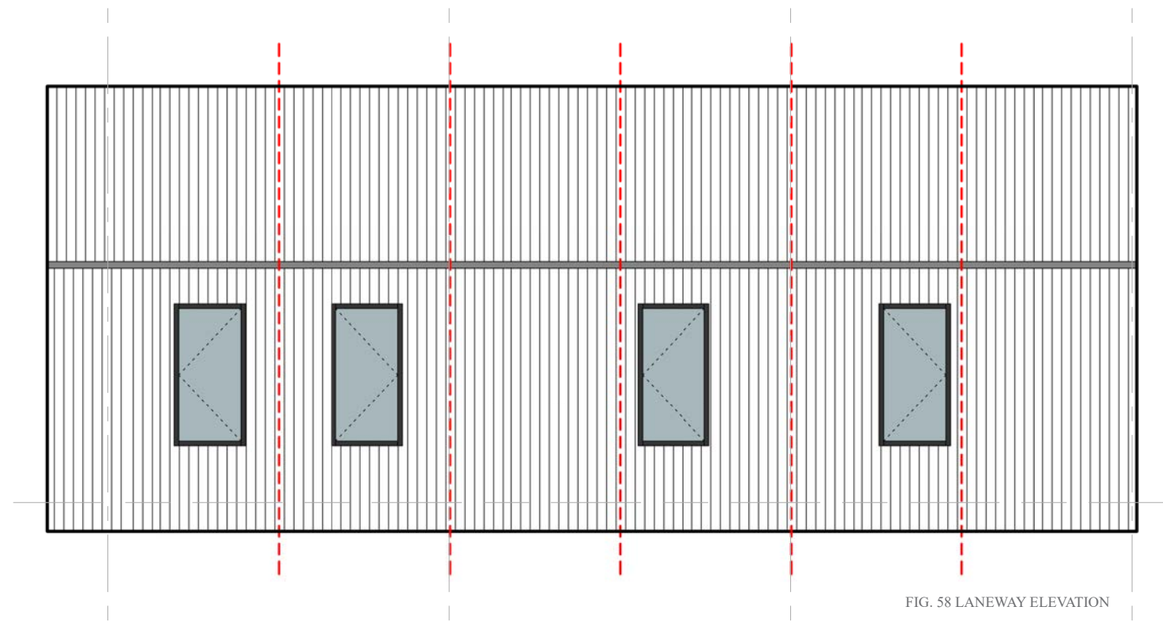


FIG. 58 LANEWAY ELEVATION

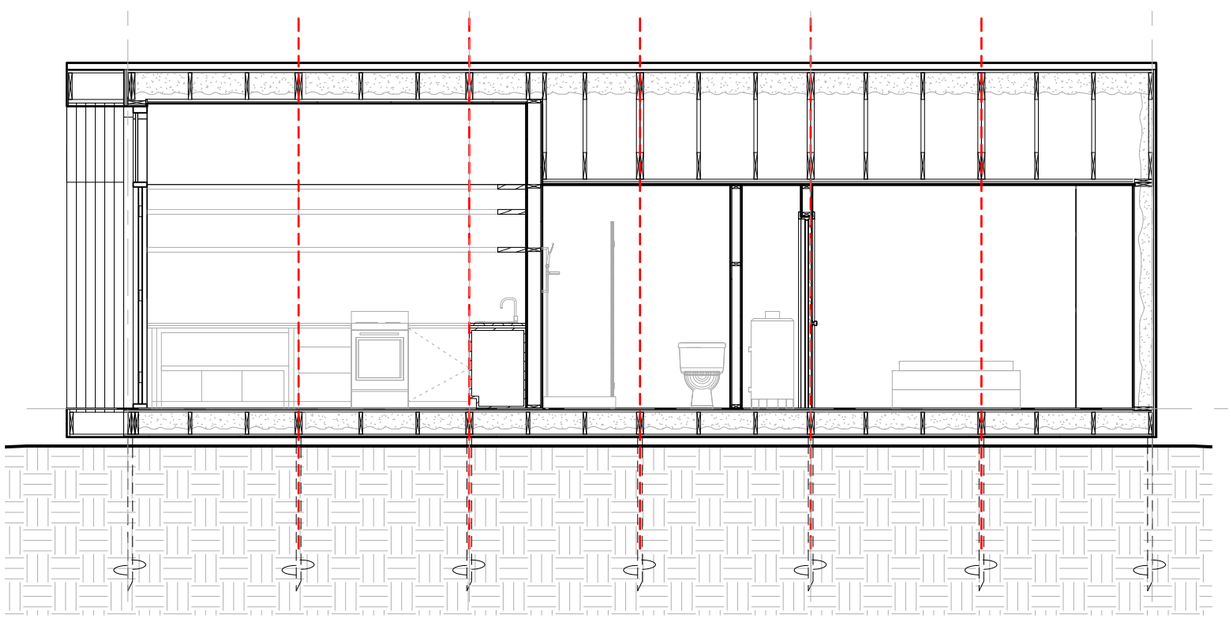


FIG. 57 LANEWAY LONGITUDINAL SECTION

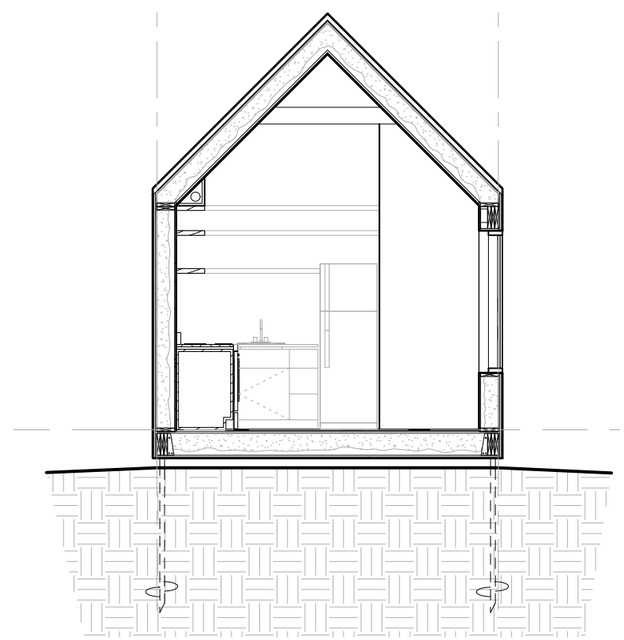


FIG. 59 LANEWAY LATERAL SECTION

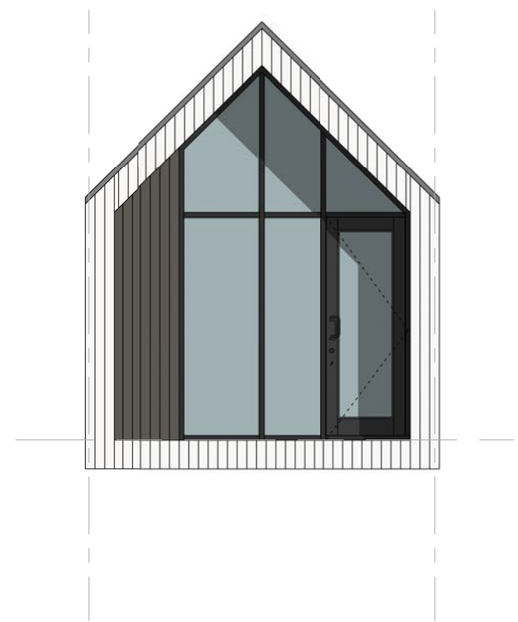


FIG. 60 LANEWAY ELEVATION

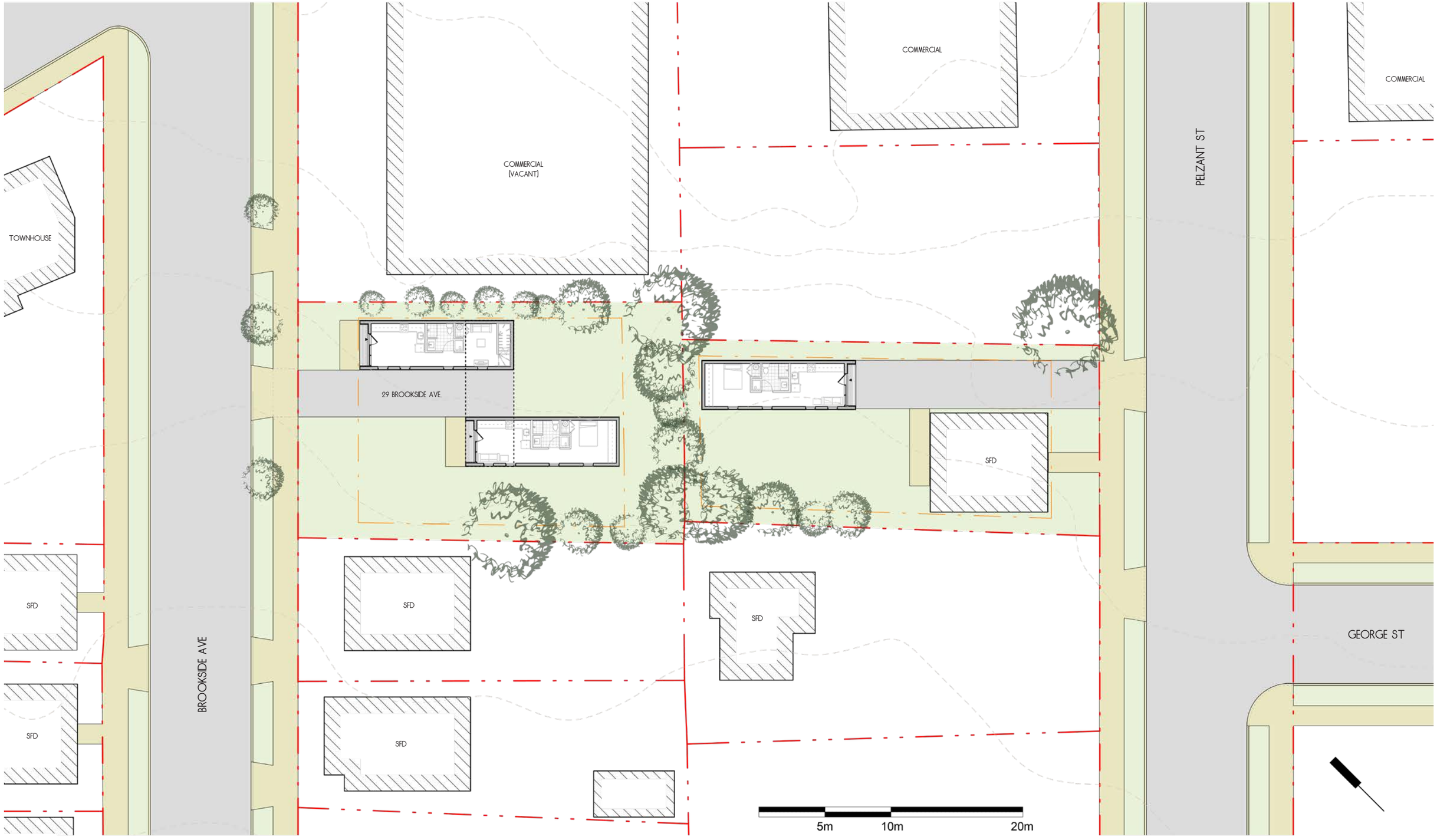


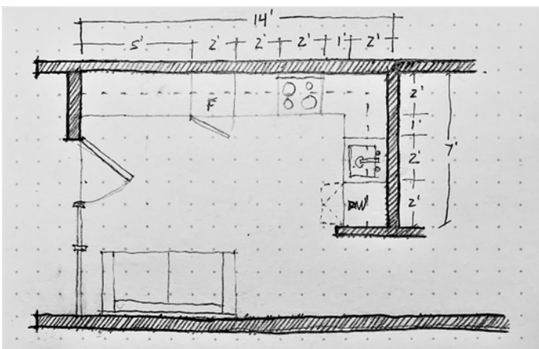
FIG. 61 SITE PLAN: 29 BROOKSIDE + LANEWAY

FIG.62 LANEWAY VISUALIZATION

From the onset, it was imperative that this dwelling did not feel like a stereotypical 'tiny home' or 'trailer'. Adhering to self imposed parameters, the design set out to avoid lofted sleeping quarters accessible only by ladder, or micro sized appliances such as a hot plate and a bar fridge tucked under a counter. Instead, the decision was made early on to facilitate the space that full size appliances require. It was important to have dedicated sleeping quarters with its own storage space instead of a bachelor style pull out couch. Ensuite laundry and a full size fridge reduces the number of transit trips required of the occupant to grocery stores and laundromats. An oven large enough to roast a turkey and vegetables promotes healthier eating habits and gives the user an opportunity to host family and friends. All of these concious design choices add to the price of the unit; there is a tangible cost associated with each of the afformentioned items. What cannot be calculated on a spread sheet is the pride of ownership. These small differences ammeliorate the human experience within the dwelling, and benefit the user day in and day out. For a slightly higher upfront cost and extra time spent on thoughtful design, the owner has a space they can be proud of throughout the life cycle of the building. While these benefits come with financial implications they also come with spatial, furniture, and feature sacrifices. The omission of a dining table and dedicated work space is glaring when looking at the plan. In a global market increasingly reliant on the work from home model, it was important to incorporate multi-functional and flexible furniture that would make the most of the available spaces within the dwelling.

To reduce construction time and labour costs, most of the interior of the dwelling will be dressed with a Baltic Birch plywood. Its rigidity and durability allow for it to be installed prior to delivery, as opposed to a gypsum wall board that is fragile and would require hanging, taping, mudding, sanding, and painting on site. Using standard 8'x4' plywood sheets on a smaller 6' module would yield a large number of 2' wide offcuts. To reduce waste and lower costs further, these 2' offcuts would be recycled into shelving, storage racks, and millwork within the dwelling.

Hidden within the cabinetry millwork when not in use, a credenza style unit houses a pivoting table and bench that can swing into the living and kitchen spaces when needed. With the table deploying first, it can provide additional prep space effectively transforming the kitchen into a "U" shape design. With the bench swinging into place, it offers a configuration that is suitable for an office work surface, or dining table for multiple people. Capitalizing on no more than construction waste and off the shelf hardware, this versatile piece transforms the living and kitchen areas into a multi-functional space.



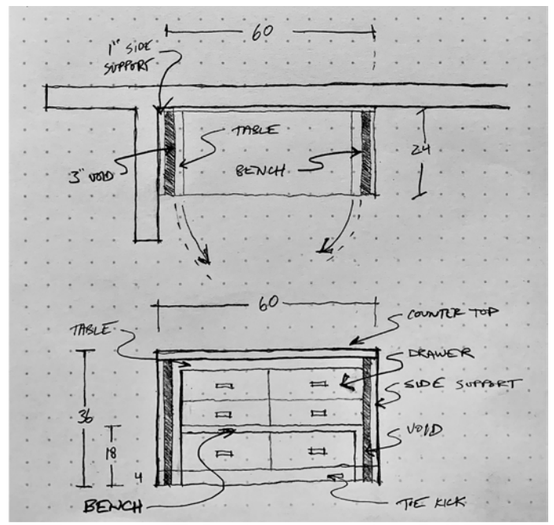


FIG.63 CREDENZA SKETCHES - AUTHOR

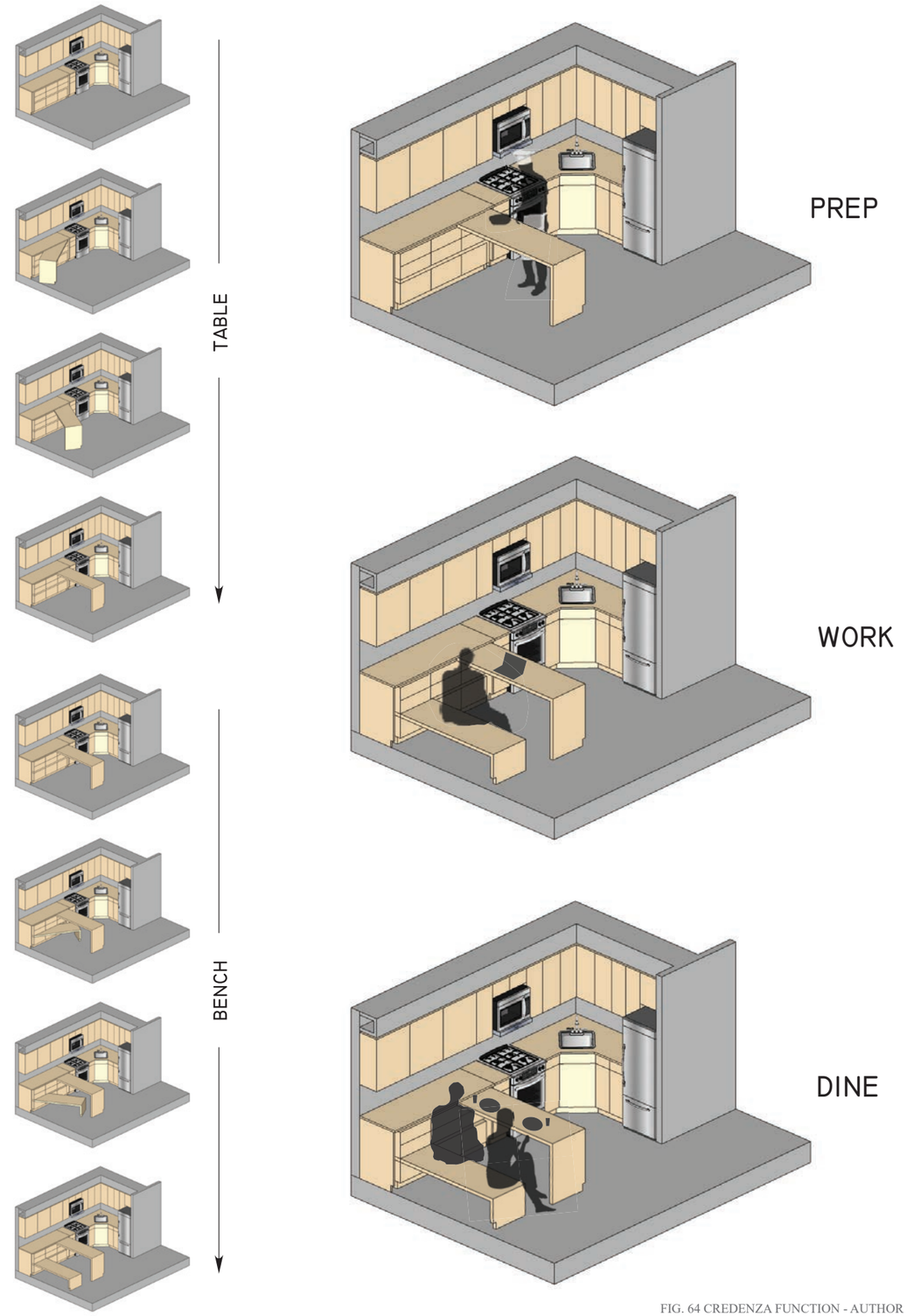
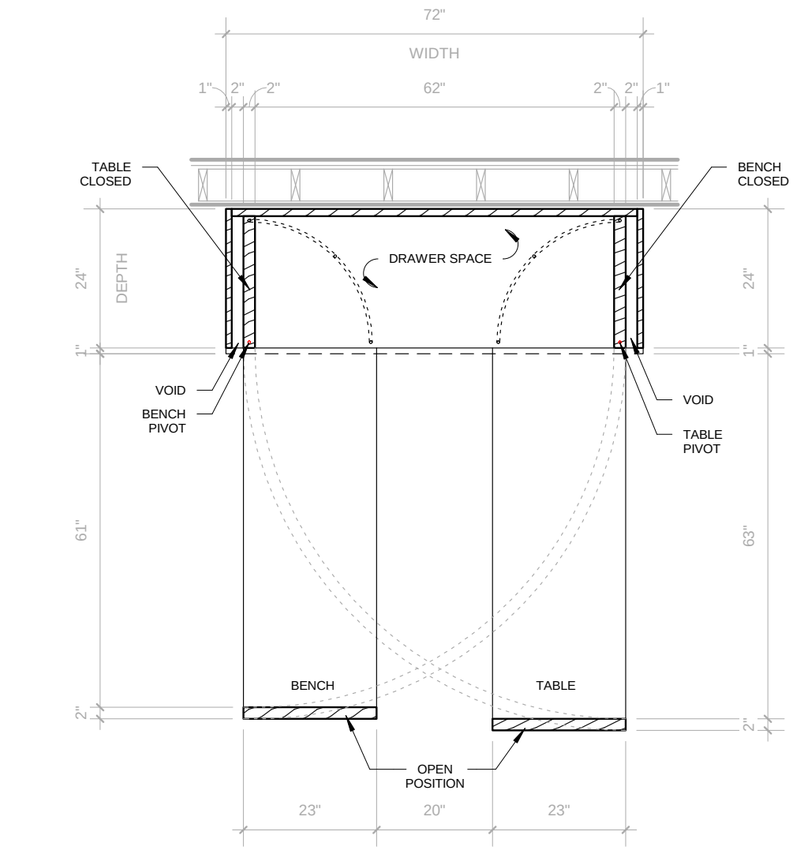


FIG. 64 CREDENZA FUNCTION - AUTHOR



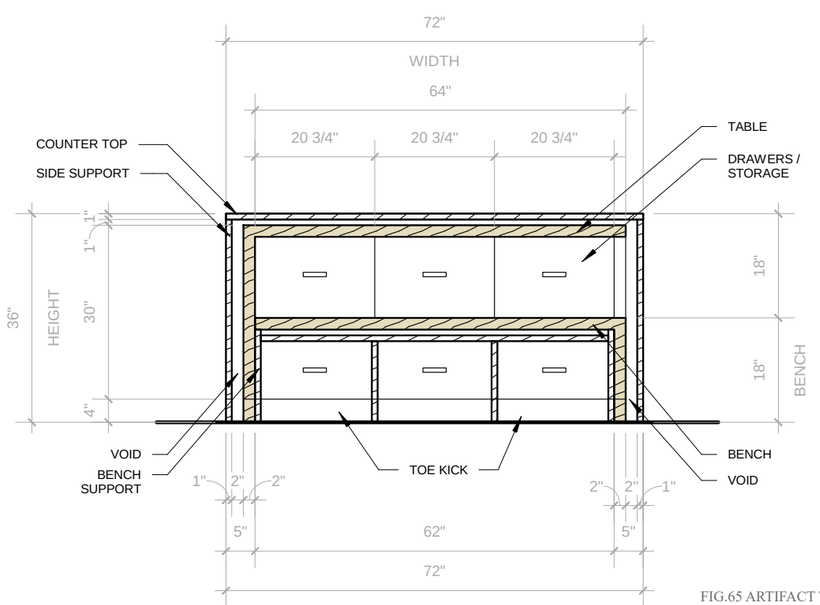


FIG.65 ARTIFACT TECHNICALS - AUTHOR

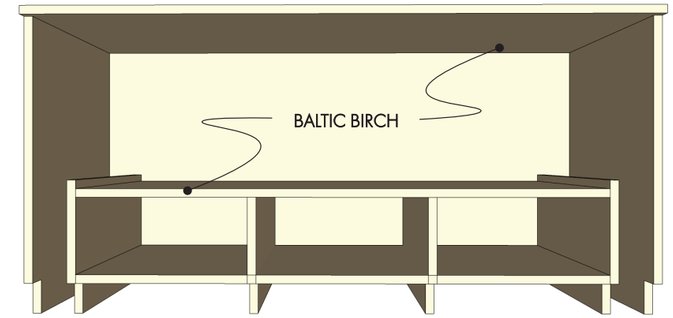


FIG. 66a STRUCTURE + CASING:

Constructed entirely of Baltic Birch plywood, the structure and side panels are designed to support the drawer system as well as providing bearing and hanging points for the bench and table. With no piece being wider than 24", the offcuts from the birch wall panels can be recycled to create the credenza and any other shelving present in the building. With standard 4'x8' panels being cut to the 6' module size, there will be an abundance of 24" wide panels to be used.

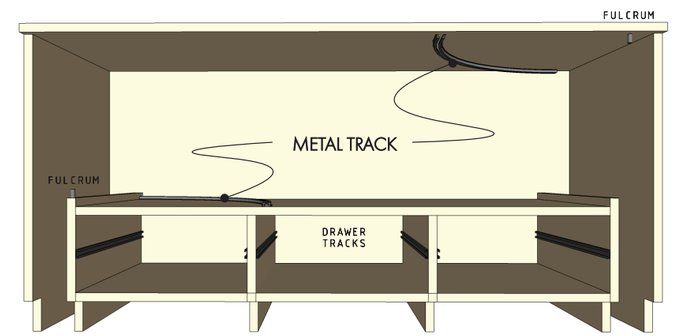


FIG. 66b HARDWARE:

Standard drawer hardware supports the three bottom drawers, while radial metal tracks are used to guide the table and bench as they rotate in and out of position. A stationary fulcrum for each provides the pivot point, while a ball bearing or puck style pin glides smoothly within the curved metal channel.

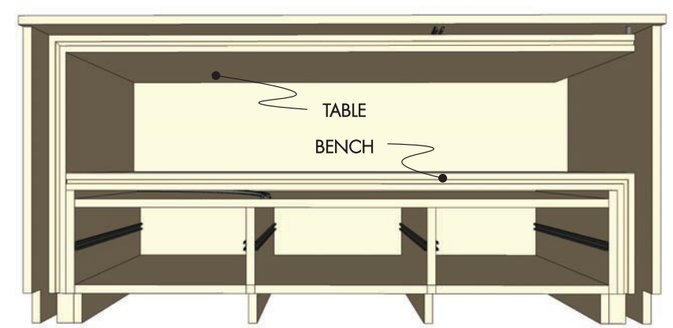


FIG. 66c TABLE + BENCH:

Sitting flush to the face of the millwork while in its closed position, it is not immediately evident what lies within the credenza. Doubled up plywood for additional strength makes these members thicker, while a beveled routered face adds a tactile component that entices the user to push and pull those surfaces.

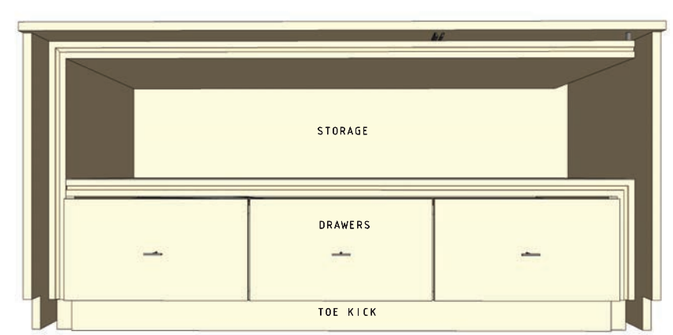


FIG 66d DRAWERS + STORAGE:

With the face of the drawers matching the adjacent cabinetry, the credenza unit will blend seamlessly into the adjacent kitchen millwork. A flush counter top and aligned toe kick match the heights, while the middle section could be used to store larger items. If desired, the middle section could also house another bank of drawers.

FIG. 67 INTERIOR VISUALIZATION

INFILL MODEL

In order to successfully occupy the larger infill lots in the Between the Bridges neighbourhood, the basic laneway model has to be adaptable to shift and stack. When recalling the four selected infill sites, each proposal consisted of a combination of singular units as well as a number of stacked multi unit clusters that could service larger families (fig. 30-33). For the single units, the same laneway module sequence could be used. If it were probable that more units would immediately or evetually be stacked on top, then a flat roof system would be used in place of the pitched - nothing else would have to change. To capitalize on the efficiencies of its modularity, the system was designed so that as few parts as possible would have to be altered in order to add the stacked unit above. Of the 6 modules in the basic unit, only the last one would have to change to a vertical circulation module in order to merge the two together. Adding a staircase to what was once part of the bedroom allows the living space to shift out of the kitchen, while the stair leads to two bedrooms and additional storage in the more private upper unit (fig. 70,73).

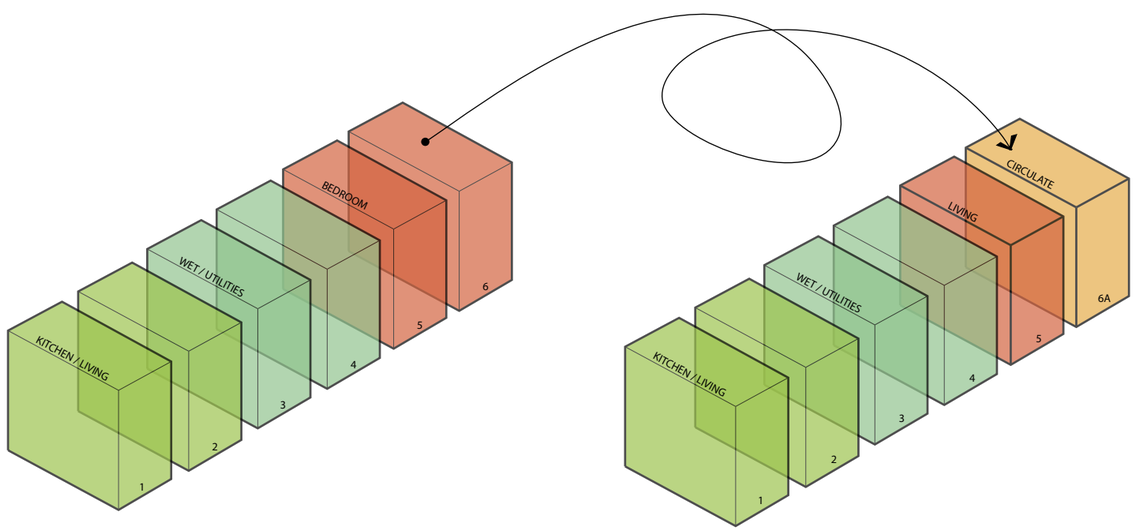


FIG. 68 INFILL BASE UNIT PROGRAMME

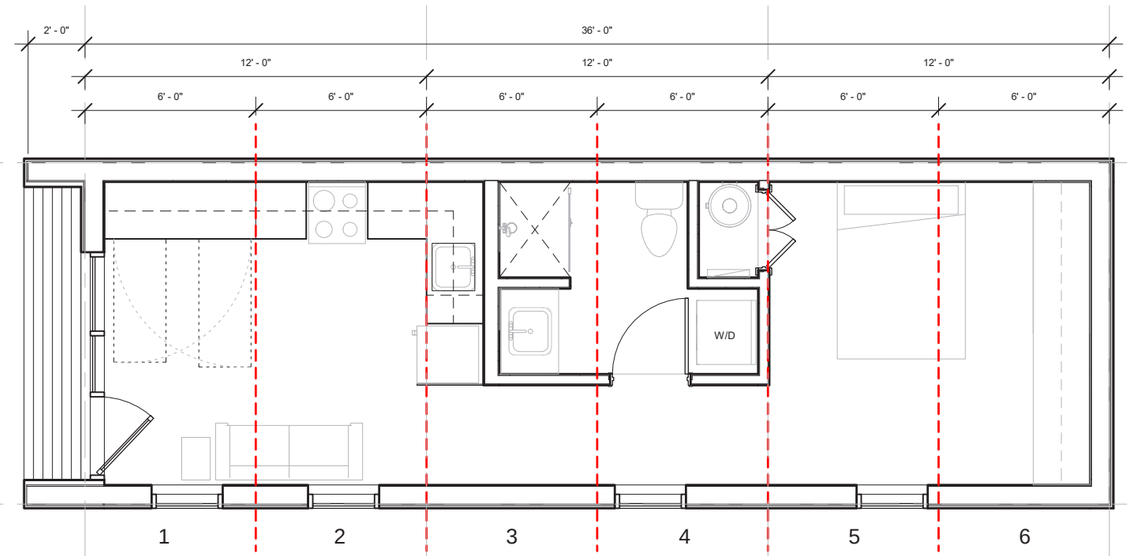
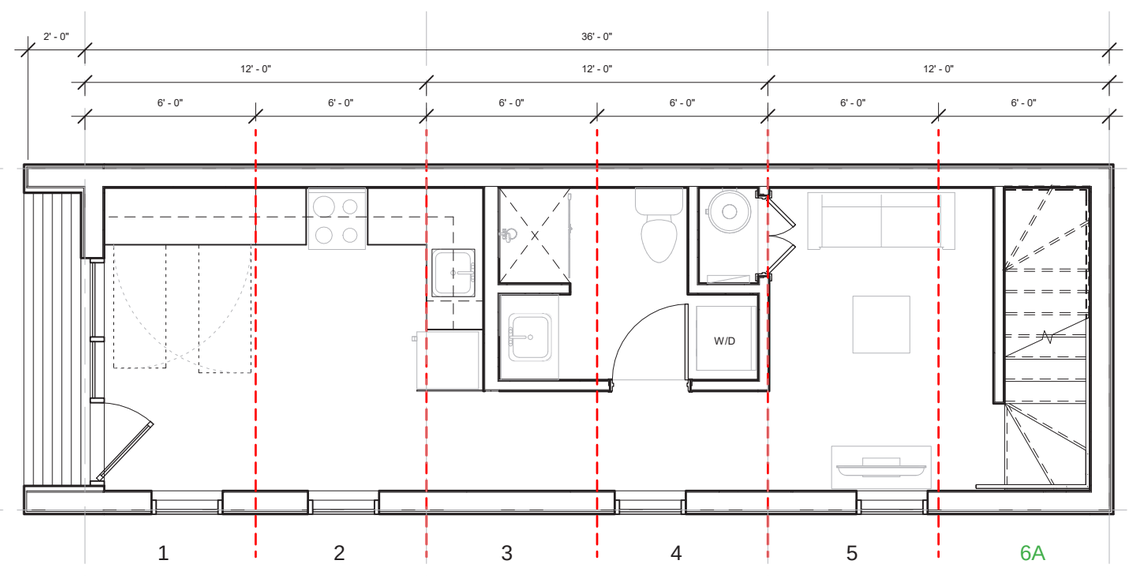


FIG 69 + 70 BASE LEVEL FLOOR PLANS

The design allows for only the 6th module to be switched for a stair case in order to access a unit placed on top. This can be pre-planned and constructed in the facility, or if responding to a change in family size it allows for the smallest amount of distruption possible.



With the vertical circulation established in the base unit, the upper unit comprised of additional storage and two bedrooms can be placed on top (fig.71). In an effort to utilize the space as efficiently as possible, the vertical circulation takes up only one module in the top unit as well. The remaining space is used for access to a roof top terrace, closet storage, and two bedrooms of varying sizes. The flat roof assembly of the base unit provides an opportunity for additional green outdoor space for the occupants. The orientation of the 6'-0" x 12'-0" modules varies on the upper unit, to account for the clear spans between the lower units while being careful to keep the framing of all fenestration intact. This arrangement provides space for a family of up to four, however the demographics of the area have suggested a majority of the families are made up of 1-3 people, which could function comfortably in this space.

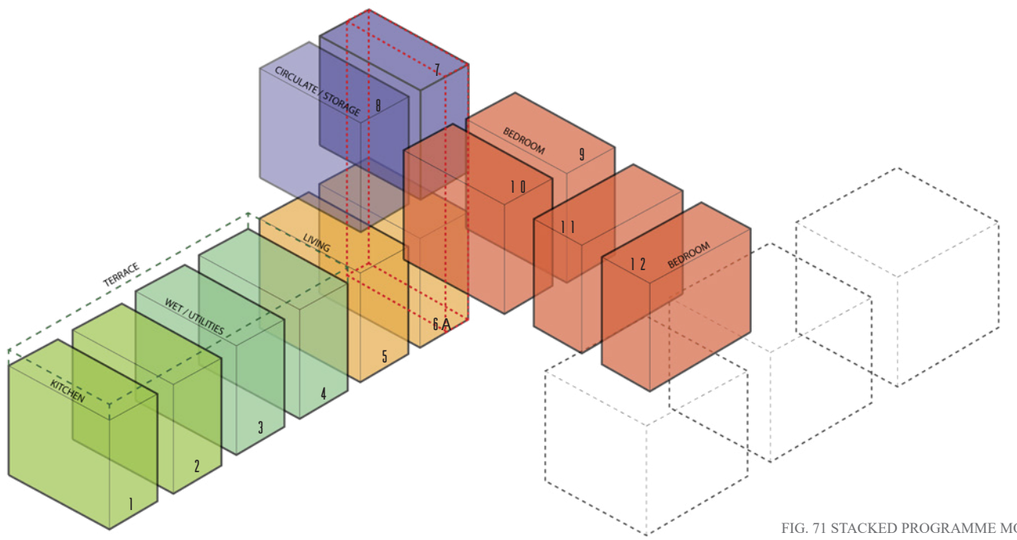


FIG. 71 STACKED PROGRAMME MODULES

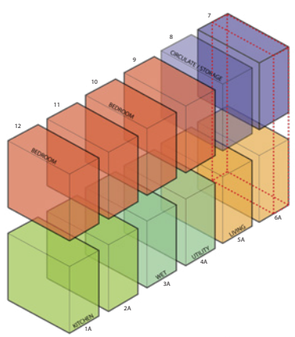
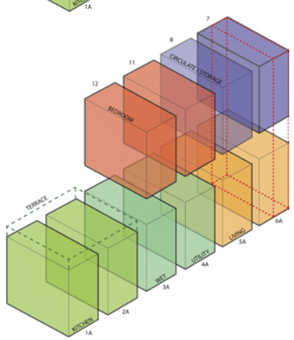


FIG. 72 STACKED PARALLEL PROGRAMME MODULES

For narrow lots or in the abscence of a secondary supporting base unit, the bedroom modules are able to rotate so that the upper unit sits parallel to the base. This arrangement would save space as its builds strictly upwards without sprawling to one side. It would also come at a cheaper price point considering the removal of the roof top terrace and the large glazed entrance system used to access it.



If only a single additional bedroom is required in this configuration, modules 9 & 10 can be removed so that modules 11 & 12 can slide back toward the storage. This removes the smaller of the two bedrooms, and allows for the terrace space to be implemented again by capitalizing on the patio access condition already present from the main bedroom.

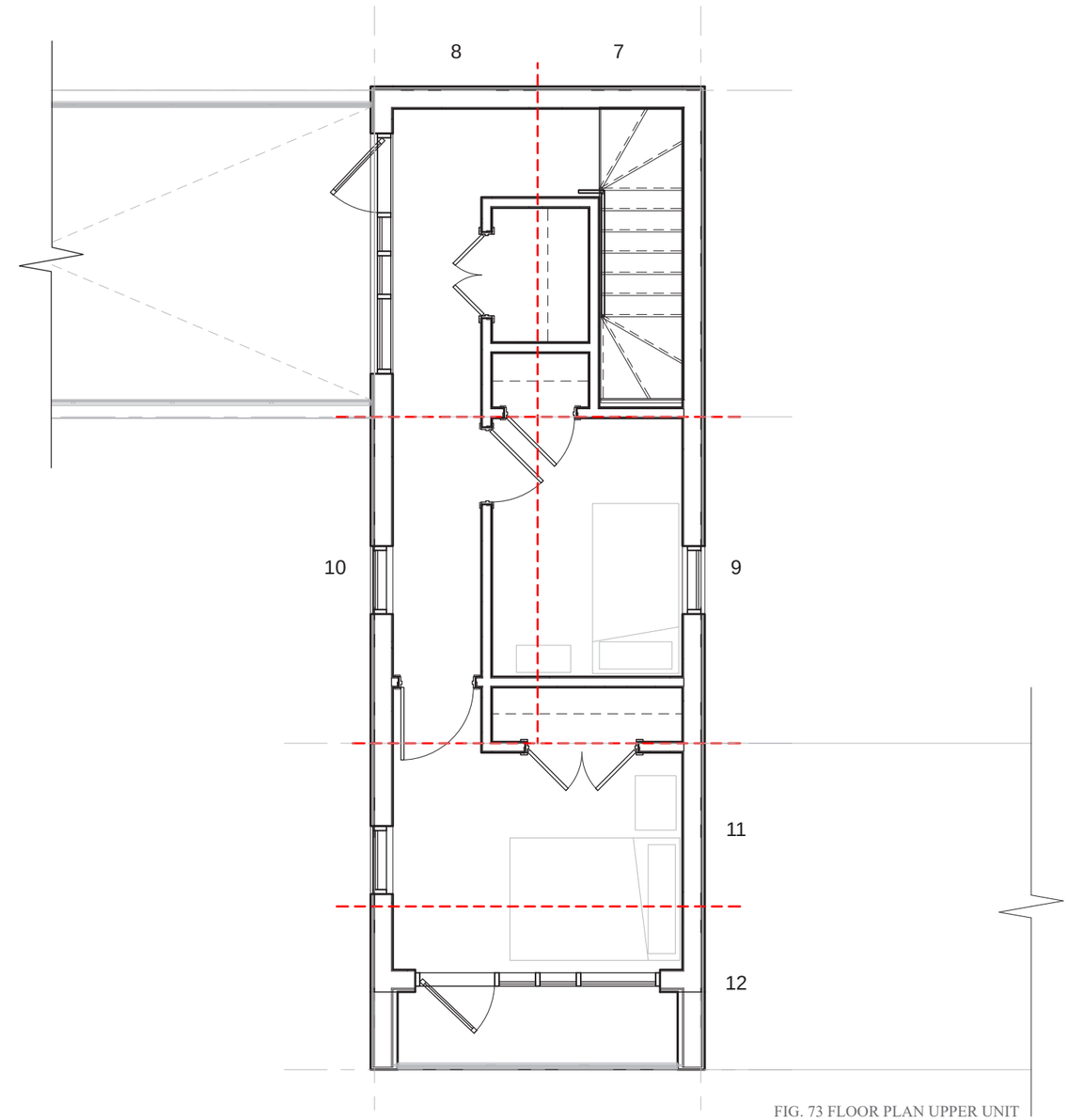
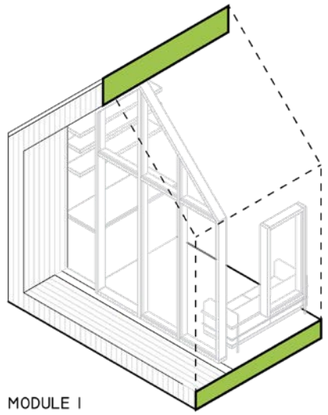


FIG. 73 FLOOR PLAN UPPER UNIT

FIG.74 MODULE DIAGRAMS (FOLLOWING PAGE)

The diagrams on the following pages are a representation of the 18 modules that can be used to create the hundreds of combinations similar to those on the four selected sites explored earlier in the proposal. Each one is 6'-0" x 12'-0", with the exception of modules 1 and 1A which protrude to 8'-0" x 12'-0" to provide a small awning condition above the entrance. Modules with an "A" label are identical in layout to their matching number module, with the distinction of a flat roof. The flat roof could be implemented from the beginning if stacking was imminent or probable, or if it were aesthetically preferred. The section cut colours of each module correspond to the programmatic designation assigned in earlier pages.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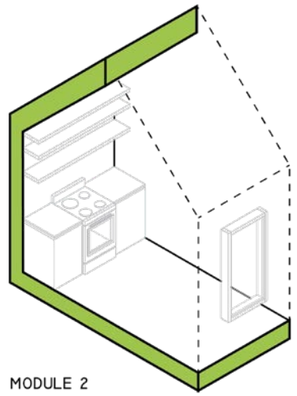
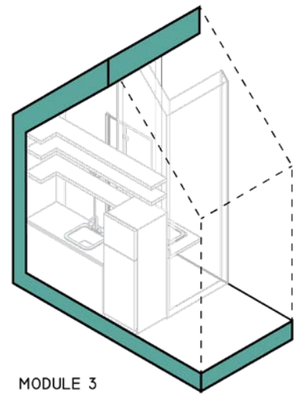
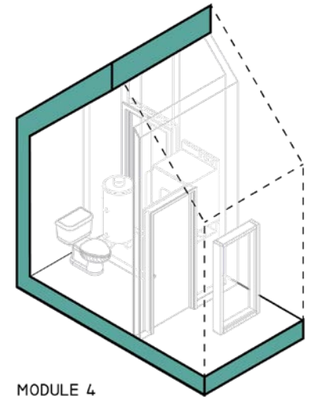
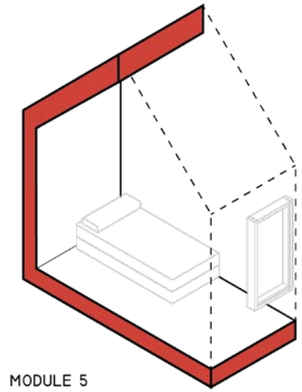

MODULE 2


MODULE 3


MODULE 4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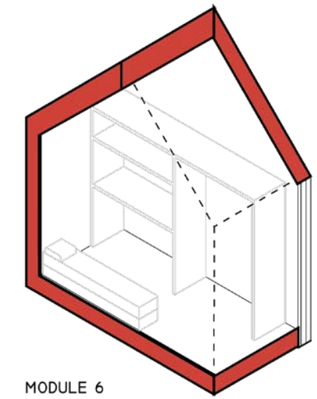
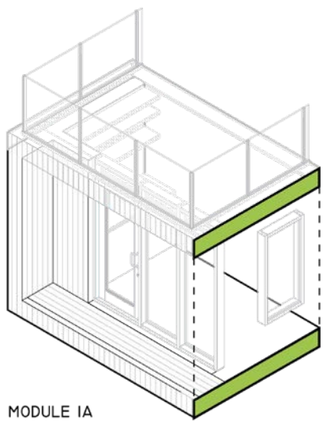
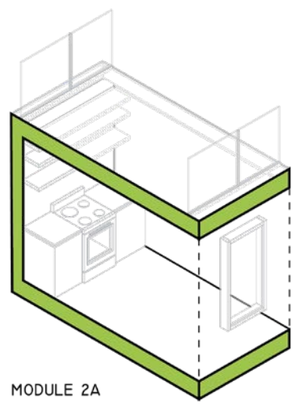
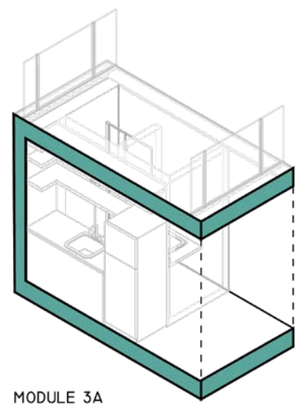
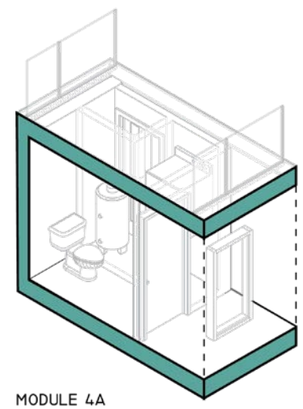
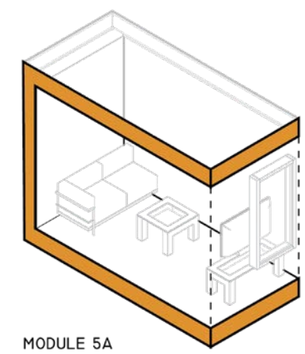

MODULE 6

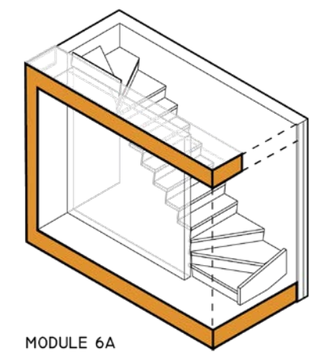

MODULE 1A

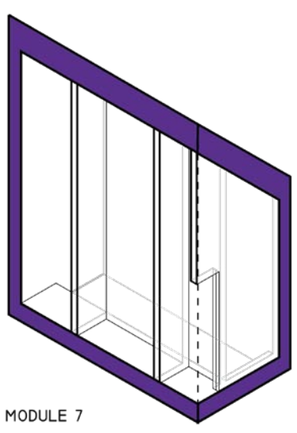

MODULE 2A

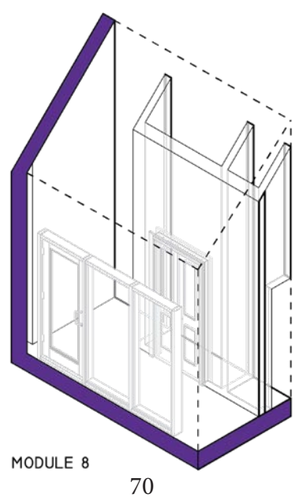

MODULE 3A

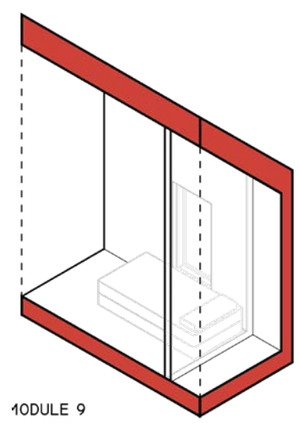

MODULE 4A

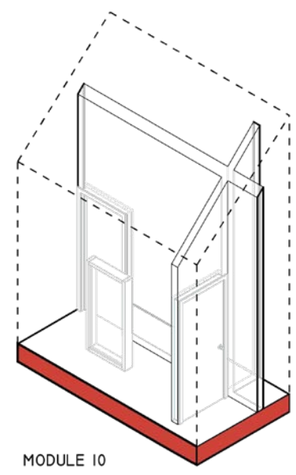

MODULE 5A

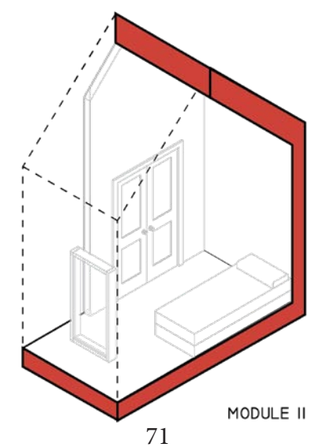

MODULE 6A

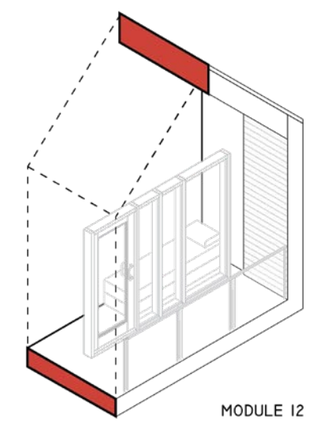

MODULE 7


MODULE 8


MODULE 9


MODULE 10


MODULE 11


MODULE 12

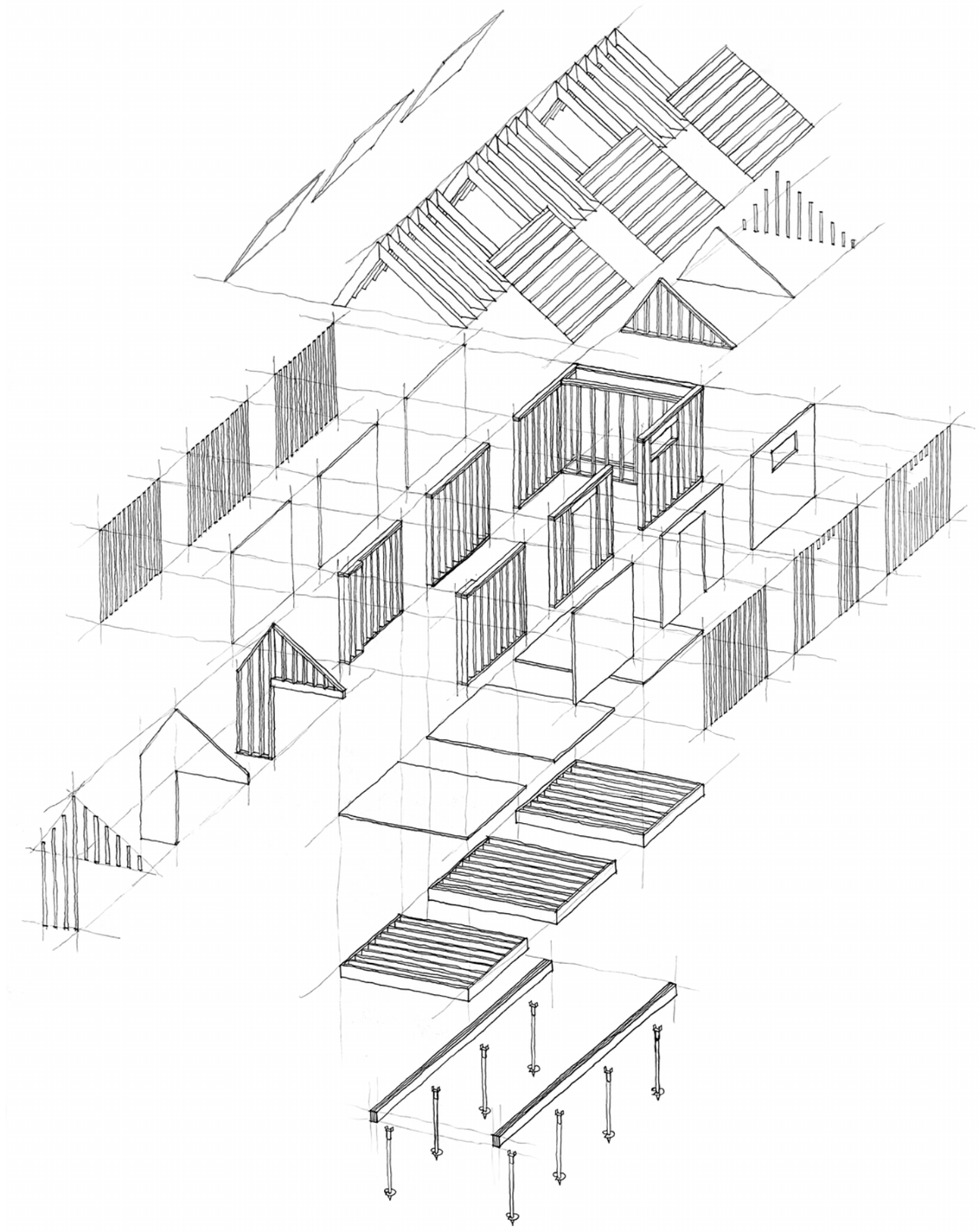


FIG. 75 EXPLODED FRAMING AXO - AUTHOR

06 CONSTRUCTION + TRANSPORTATION

With the programme modules being defined and arranged, they each had to be designed from the studs up in order to accurately account for the materials and subsequent cost. This also allowed for an exploration of every single component required for construction. Having this modeled and listed provided a base registry, which then shed light on which items could become standardized or removed all together in an effort to cut costs and fabrication time. Nova Scotia has a long and celebrated lumber heritage, so it was an obvious choice as the main structure for the units. Readily available at most hardware stores, each module was designed to be constructed from dimensional lumber so that no specialty parts or engineered systems would be required. A marriage of this traditional material with more modern skilled labour allows for the unit to be constructed by any local carpenter. With dozens of trades programs and community colleges in the province, it was important that local workers could easily put the modules together as quickly as possible. Despite its minimalist appearance and simplistic framing techniques, every small detail was examined in order to reduce cost, and increase performance. It was imperative throughout this process to refrain from selecting the cheapest material or building technique in the name of affordability. Each dwelling is a 30+ year commitment and investment by the owner, so small increases in upfront cost that would save on operational costs throughout the lifespan of the building were all weighed and considered accordingly.

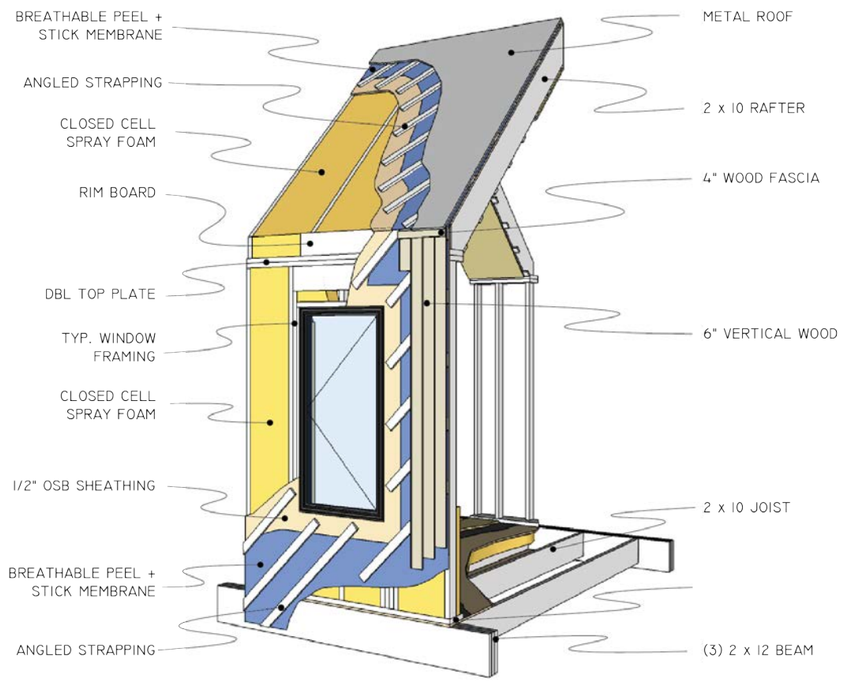


FIG.76 TYPICAL MODULE EXTERIOR

The exterior envelope of the modules is comprised of staggered 2x4 studs on a 2x8 sill and double top plate. This allows the insulation to snake, eliminating thermal bridging conditions. OSB sheathing provides shear strength as well as a surface to enclose the spray foam insulation. A breathable peel + stick membrane keeps the envelope weather tight. Slanted strapping provides air space and drainage planes for any water that gets behind the cladding. 3 ply beams act as a rim board for the hung joists, and would get dropped into saddle brackets on screw piles on site.

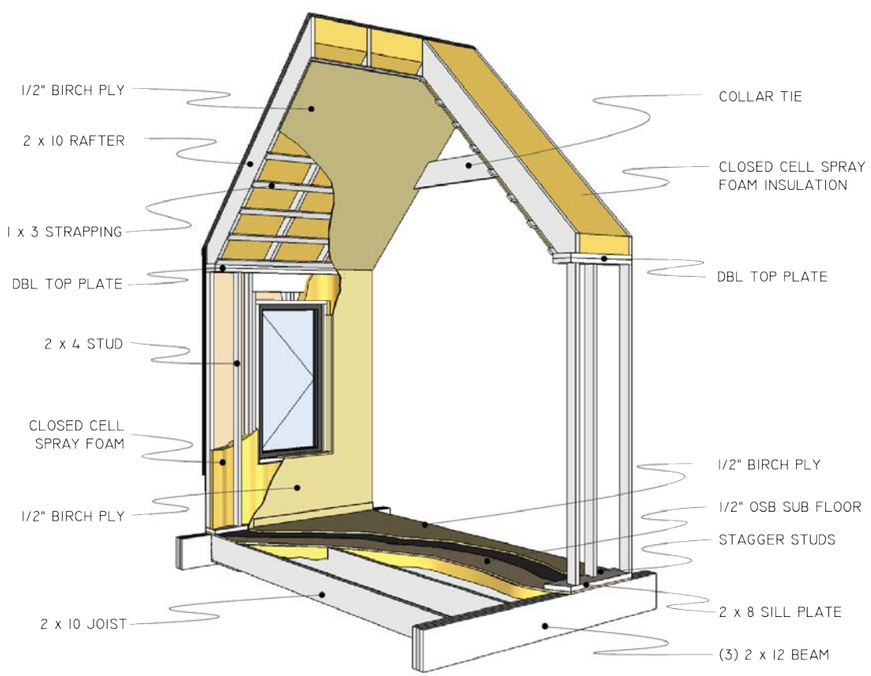


FIG.77 TYPICAL MODULE INTERIOR

The interior of each module is clad primarily in a Baltic Birch ply. Slightly more expensive than gypsum wall board, it more than makes up in savings on labour and can be installed prior to leaving the facility. In using standard 4'x8' sheets to clad a 6' wide module, an abundance of 2' wide off cuts will be used to create shelving and cabinetry thus reducing cost and waste. A collar tie at the end of each module keeps the roof from bowing, with the option to drop it to a flat 8' ceiling height above the utilities and bedroom modules to create attic storage.

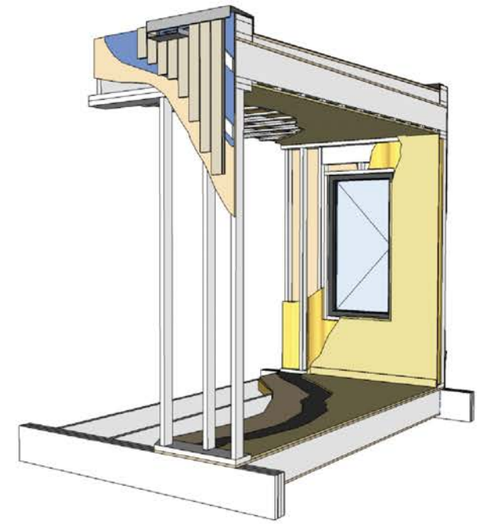


FIG.78 MODULE 5A FRAMING + INTERIOR

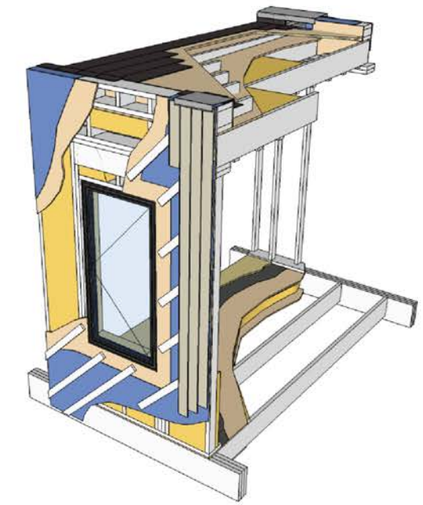


FIG.79 MODULE #5A FRAMING + ENVELOPE

For the flat roof modules the exterior wall envelope and interior finishes stay exactly the same. The staggered 2x4 studs on a 2x8 sill and double top plate provide continuous load bearing points around the entire perimiter of the structure. This allows for the freedom to place and space rafters as required, and stack units on top without having to worry about aligning structural points as the 1:1 ratio 12'x12' grid ensures corners will always align with a screw pile. With a flat rafter in place instead of two pitched rafters, a small gravel stop or parapet would be built up to contain and direct water flow. Ripped wedge sleepers provide enough slope for drainage, hidden under a protective cover board and torch on roof assembly. Low profile scuppers allow the water to exit under the parapet and cap flashing, keeping all water shedding outside the envelope. Considering one of the scuppers is located above the wet/utility modules, an alternate drain and gray water collection system could be implemented to service the toilet. If there is to be an upper unit stacked on top, aside from framing the stairs the only change required is to remove half of the rafters in module 6, and add a doubled up header to support the top of the stairs.

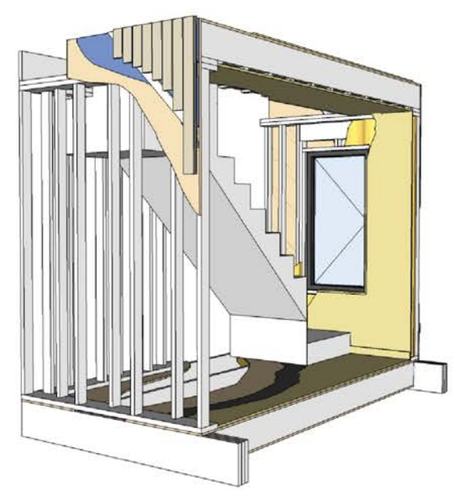


FIG.80 MODULE #6A FRAMING + INTERIOR

FIG.81 MODULE #6A FRAMING + ENVELOPE

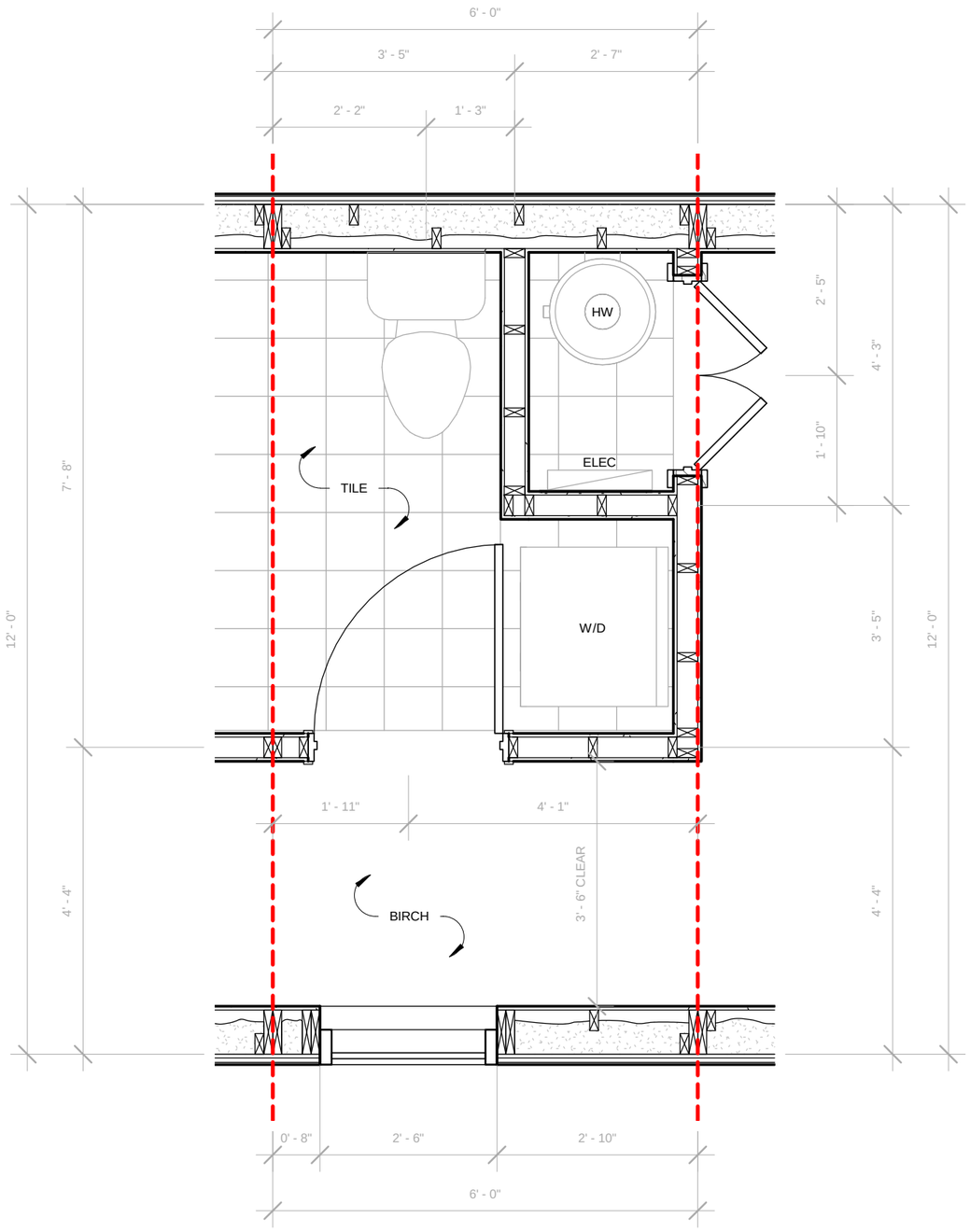


FIG.82 MODULE 4 CONSTRUCTION - SCALE 1/2" = 1'-0"

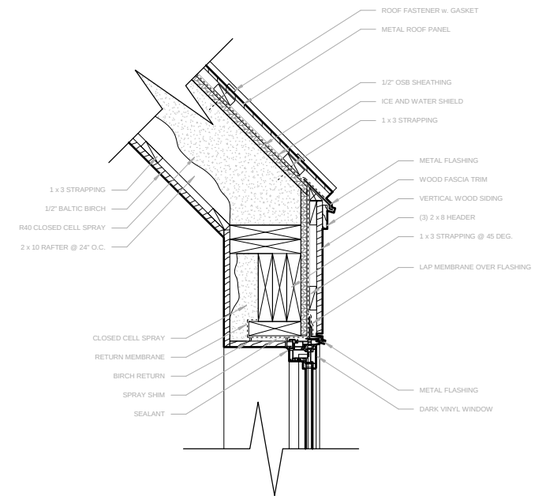


FIG.83 SLOPED ROOF EAVE DETAIL
SCALE 3/4" = 1'-0"

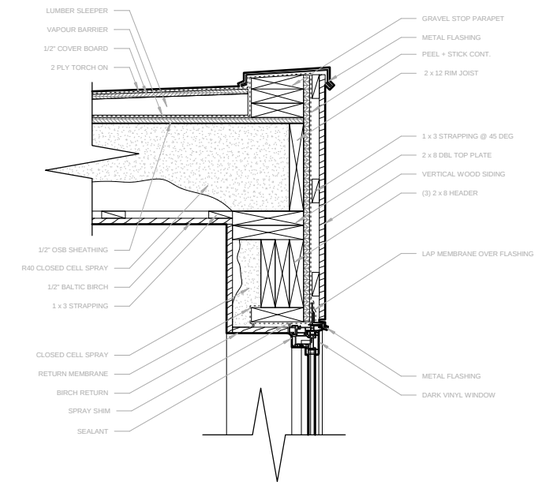


FIG.84 FLAT ROOF PARAPET DETAIL
SCALE 3/4" = 1'-0"

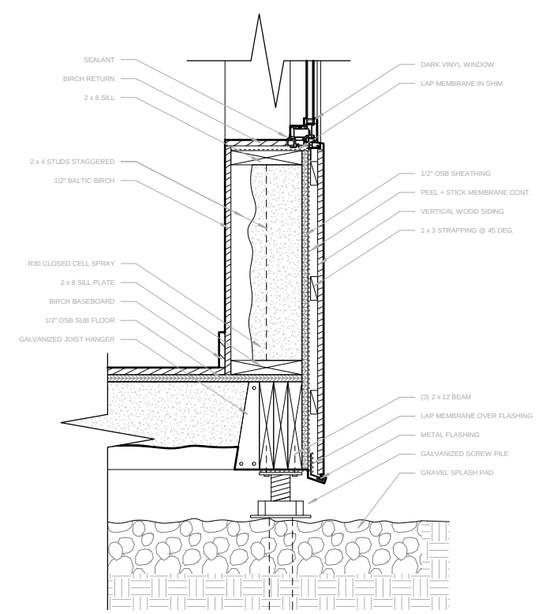


FIG.85 SCREW PILE FOUNDATION
SCALE 3/4" = 1'-0"

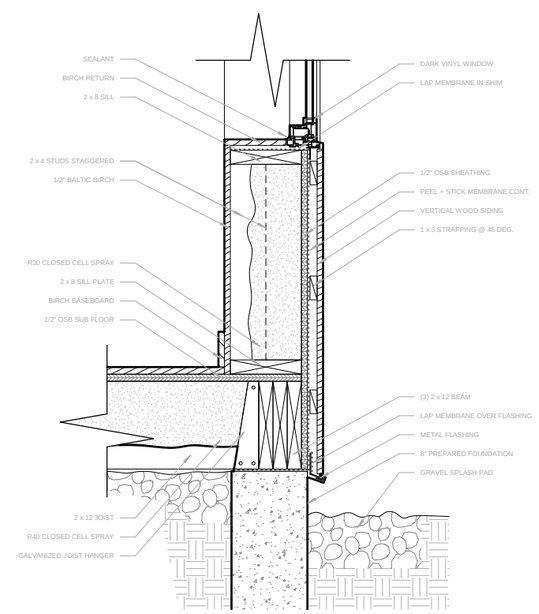


FIG.86 CONCRETE FROST WALL
SCALE 3/4" = 1'-0"

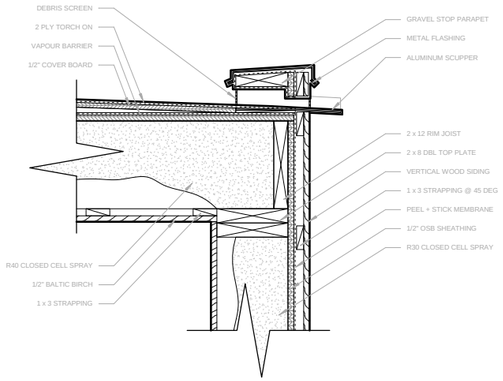


FIG.87 FLAT ROOF SCUPPER DRAIN
SCALE 3/4" = 1'-0"

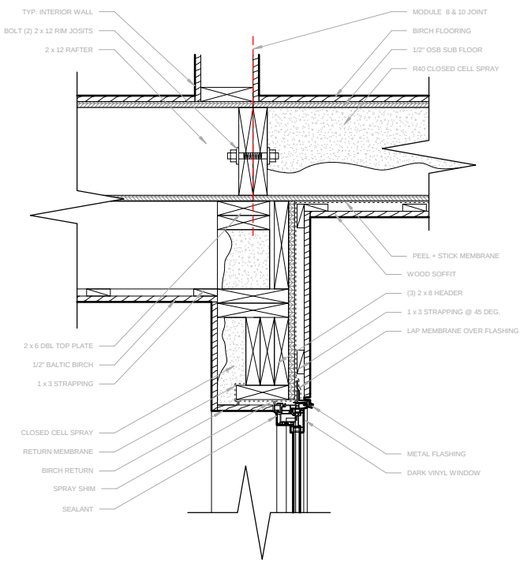


FIG.88 STACKED MODULE CONNECTION
SCALE 3/4" = 1'-0"

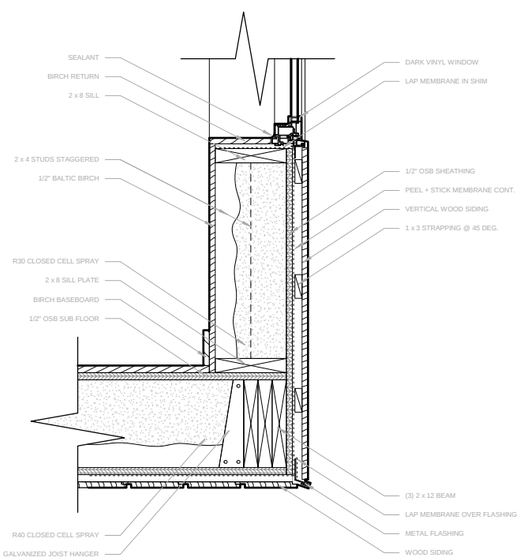


FIG.89 STACKED MODULE SOFFIT
SCALE 3/4" = 1'-0"

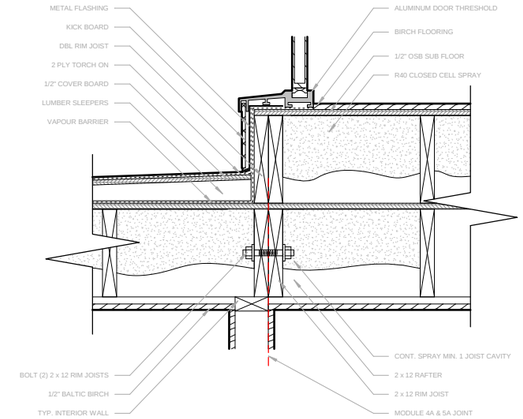


FIG.90 TERRACE THRESHOLD
SCALE 3/4" = 1'-0"

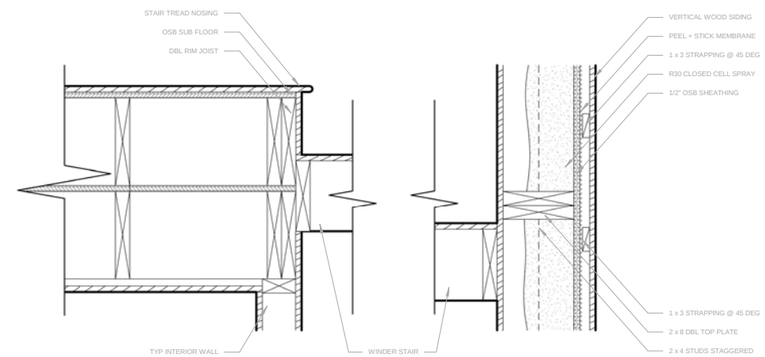


FIG.91 TOP OF STAIR
SCALE 3/4" = 1'-0"

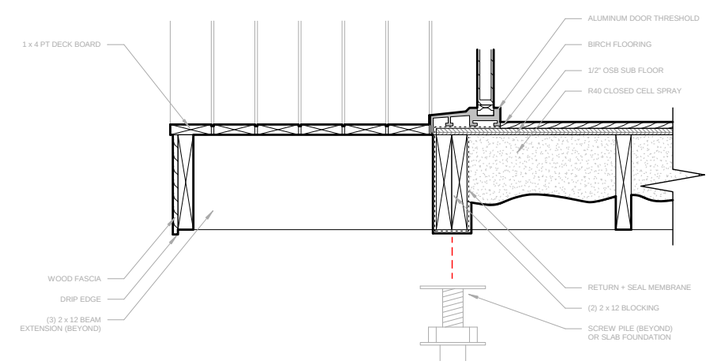


FIG.92 ENTRANCE THRESHOLD
SCALE 3/4" = 1'-0"

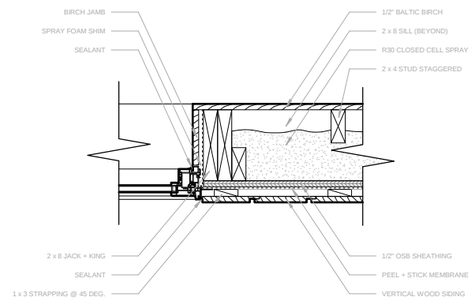


FIG.93 WINDOW JAMB (PLAN)
SCALE 3/4" = 1'-0"

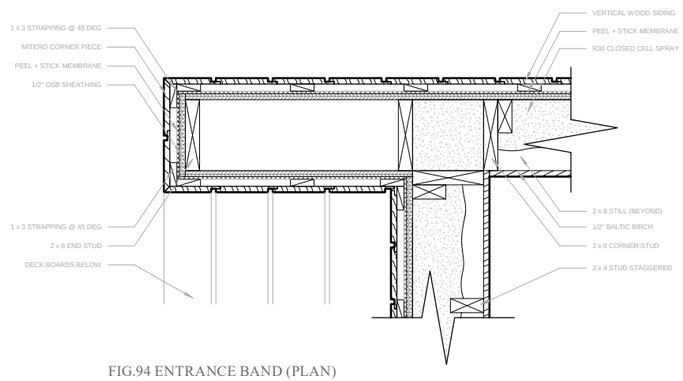


FIG.94 ENTRANCE BAND (PLAN)
SCALE 3/4" = 1'-0"

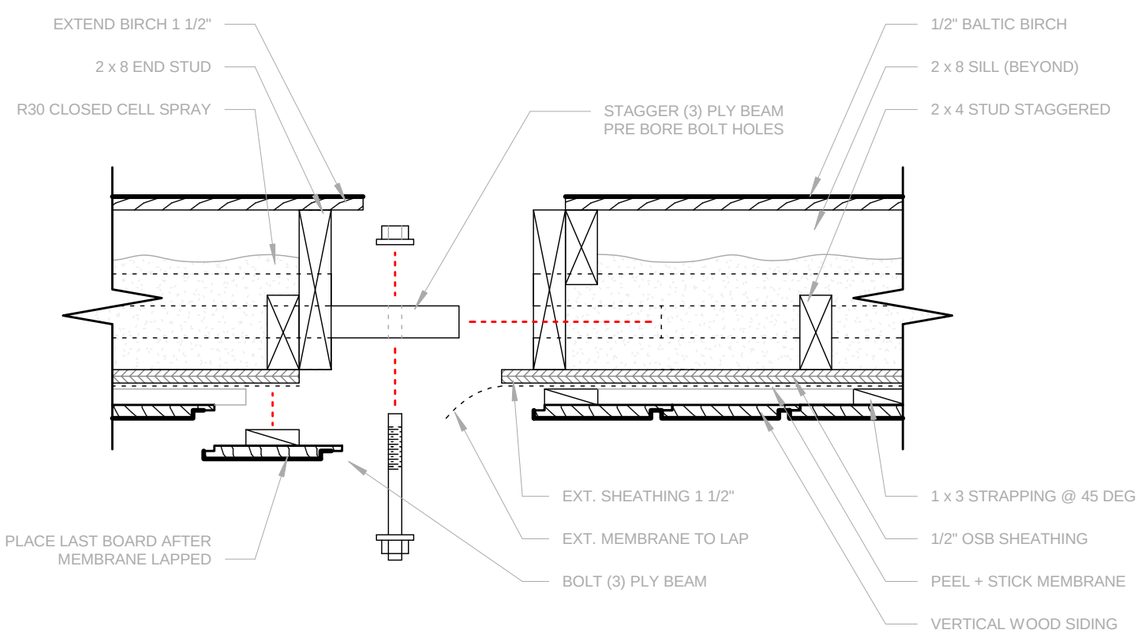


FIG. 95 TYPICAL MODULE CONNECTION (PLAN)
SCALE 1 1/2" = 1'-0"

In determining materials and module size it was important to consider not just the finished product but the transportation process as well. Finding the balance between constructing as much as possible in a controlled facility while still being able to use standard transportation equipment affects everything from the interior wall cladding to the orientation of the joists. The switch to birch plywood wall board instead of gypsum means it can be installed prior to delivery due to its rigidity and durability. Hanging the joists between two multi ply beams instead of bearing them on top provides shear rim board support as well as a solid member to take the force of a crane strap. Every design decision had to be thought through from the manufacturing, transportation, and lived-in cycles. For the transportation and delivery, the module size was determined in part by ensuring compliance with the dimensions of a truss boom truck. The *Elliott 1881TM* for example is capable of hauling varying flat bed sizes up to 54' in length. Its telescopic boom travels at 21', and can extend up to 91' with a lifting capacity of 36,000 lbs.[64] Slim outriggers and short side jacks allow the truck to set up in tight spaces, such as the bypassing driveways found in Dartmouth North. A 40' bed is more maneuverable than a 54' flat bed and would allow three 12' modules to be strapped down toe to toe. This means an entire unit could be delivered in two loads, to be installed on a prepared slab or screw pile foundation (fig.96). By the time the second load of modules arrive, the first three would be secured and fastened in place. Designing to utilize this type of equipment negates the requirement to rent a crane seperately, saving money, space, and time disturbing the site. Despite the decision to break the unit into six modules instead of three, the dwelling would still be air tight in a single day.

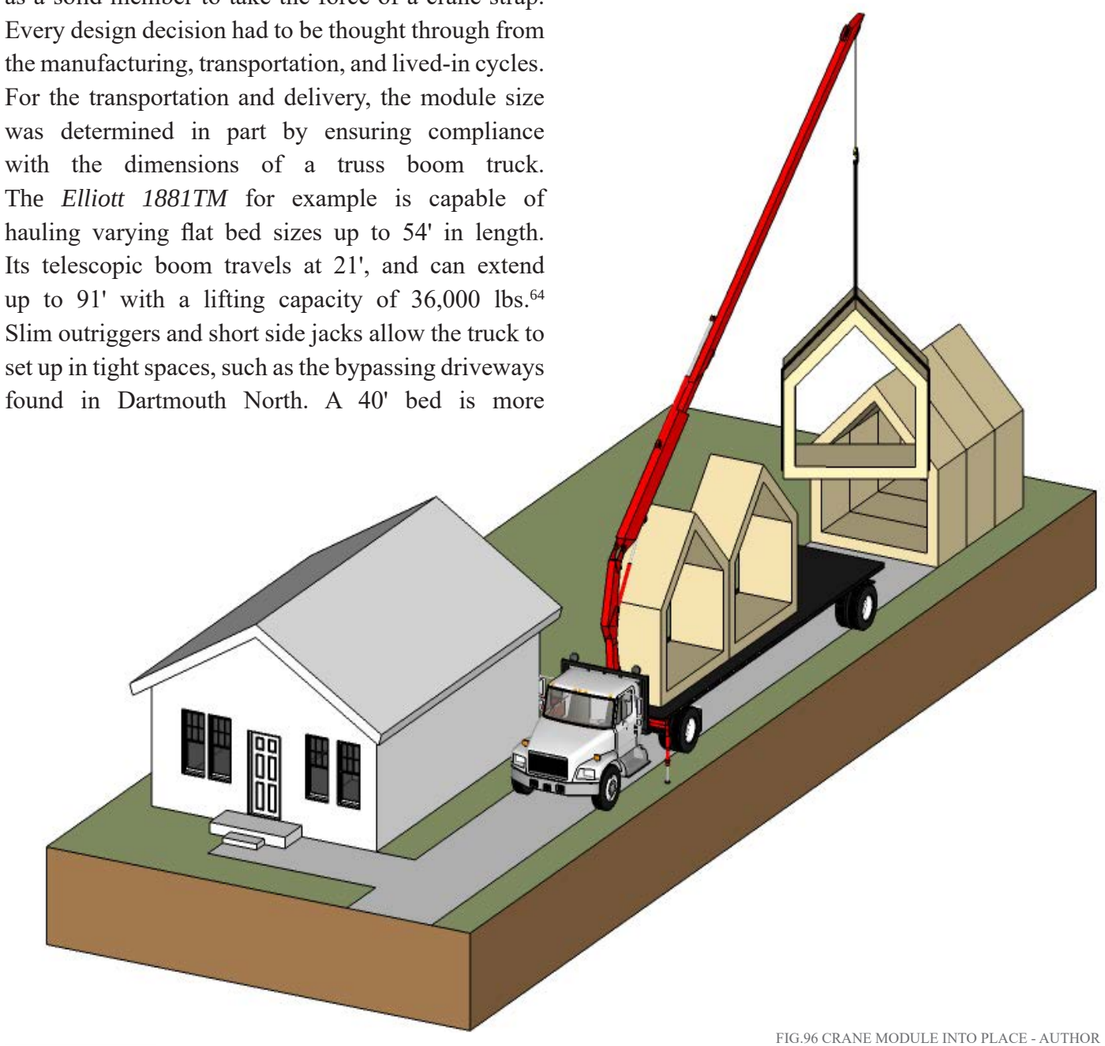


FIG.96 CRANE MODULE INTO PLACE - AUTHOR

63 "Using the 1881TM Boom Truck as a Truss Crane." Elliot Equipment Co Spec Sheet: Accessed Mar. 9, 2021. elliottequip.com/using-1881tm-boomtruck-truss-crane/

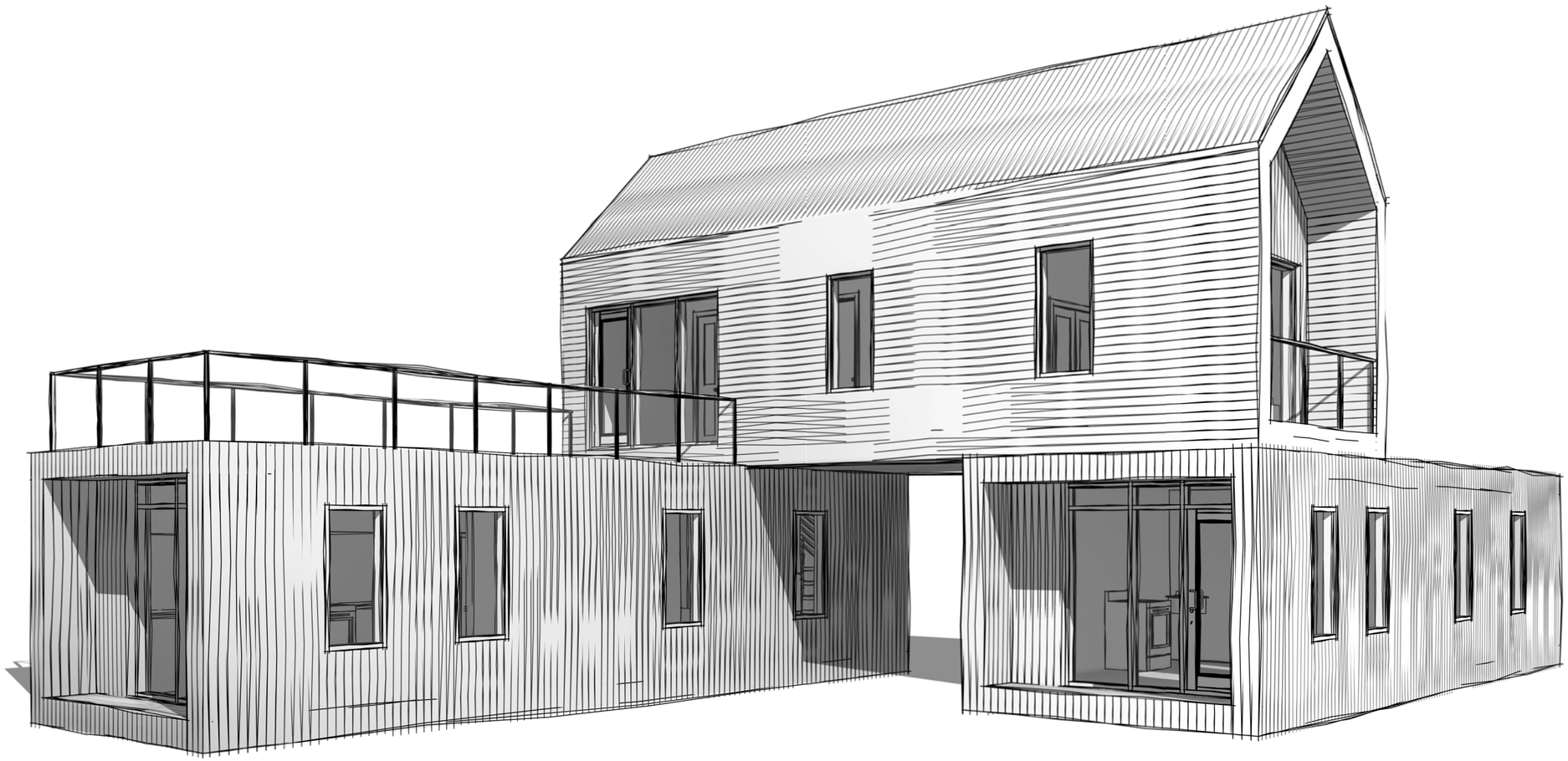


FIG.97 PERSPECTIVE VIEW OF STACKED UNITS

$473.80

The definition of affordable when it comes to housing is somewhat subjective. In some cases it refers to a certain percentage lower than the going market rate for accomodations. This targeted percentage is often 30%. In Halifax Regional Municipality for example, the average rent for a two bedroom apartment has eclipsed $1200.[65] By this definition, anything less than $840 would be deemed afforable. The CMHC prefers a more holistic definition that is aligned with spending no more than a certain percentage of one's pay to cover all accomodation related costs. This percentage also happens to be 30%, so in an ideal scenario one would never have to spend more than that to cover rent and utilities each month. This thesis proposal and finacial model set out to alleviate the housing strain in one of the most vulnerable neighbourhoods in Dartmouth. In order to be successful, the model had to be able to provide housing options for those working the lowest paying jobs. If it proves successful under these parameters, it could be of benefit to virtually any neigbourhood.

Drawing inspiration from the Auburn 20K Rural Studio program (fig.99), this thesis used local wages to set budgetary guidelines. In the case of the Auburn studio, the budget was derived by catering to Alabama residents who were living on social security.[66] On a 30 year mortgage, even someone collecting these minimal monthly payments would be able to afford a dignified, efficient, stand alone dwelling. Focusing on Between the Bridges, the goal was to design a dwelling that a single person working a minimum wage job in Nova Scotia could afford by spending less than 30% of their monthly take home pay. That number is **$473.80**

NS MIN WAGE: **$12.55**

@ 40 HRS/WEEK: **$502.00**

x2 BIWEEKLY PAY: **$1,004.00**

x2 MONTHLY PAY: **$2,008.00**

TAX BRACKET @ 15%: **-$309.20**

CPP @ 5.45%: **-$92.58**

E.I.: $1.58 / $100.00 **-$26.86**

TOTAL MONTHLY TAKE HOME: **$1,579.36**

30% FOR AFFORDABLE SHELTER: **$473.80**

	MORTGAGE LENGTH			
BUDGET	10 YR	15 YR	20 YR	25 YR
$25,000	$208 / mo	$139 / mo	$104 / mo	$83 / mo
$30,000	$250 / mo	$167 / mo	$125 / mo	$100 / mo
$35,000	$292 / mo	$194 / mo	$146 / mo	$117 / mo
$40,000	$333 / mo	$222 / mo	$167 / mo	$133 / mo
$45,000	$375 / mo	$250 / mo	$188 / mo	$150 / mo
$50,000	$417 / mo	$278 / mo	$208 / mo	$167 / mo

* NO DOWN PAYMENT DEDUCTED, NO INTEREST ADDED

FIG.98 MONTHLY MORTGAGE PAYMENT TABLE

65 CMHC Rental Market Survey Data Tables. Table 1.0, January 2021

66 Auburn 20K Rural Studio - http://ruralstudio.org/project_tags/20k/

FIG.99 2008 AUBURN 20K RURAL STUDIO

In the case of a rental suite to be situated in ones backyard, there has to be a financial model in place that is beneficial to all stakeholders. If the tenant were to be a family member, then the homeowner would be more likely to maintain a lower rent, and profit less in order to help their relative out. As previously mentioned however, this proposal set out to develop a model that could be successful in the worst case scenario. This scenario would manifest as a single parent working a minimum wage job, renting from a homeowner with whom they have no previous relationship. In order to make this feasible, the rent for the tenant has to remain below $500.00, and a portion of this would still have to stay in the pocket of the homeowner as profit, not just breaking even on the monthly finance payments.

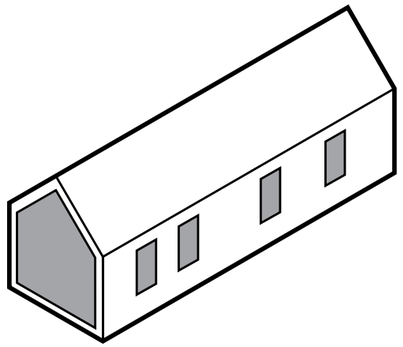
In order to make these numbers work, the mortgage payment for the homeowner would have to be between $200.00 and $250.00 per month (fig.98). That way, after receiving $500.00 in rent they are still able to keep a couple hundred dollars after making the financing payments. This way, the tenant spends no more than 30% of their take home income, and the homeowner makes a couple hundred dollars extra per month while providing someone a dignified place to live creating a mutually beneficial scenario for all parties involved.

By looking at rough monthly payments calculated in Figure 98, we can see that the ideal window to make this a reality without committing to a full length 25 year mortgage is between 10 - 15 years, with a budget of $35K - $45K. For example, a budget of $45K spread over 15 years yields a $250.00 monthly payment. This table was developed before the design and materials were finalized, and served as a project budget. As the design developed, material changes and their associated costs were plugged into spread sheets, so that the overall cost could be updated and manipulated in real time.

In modelling each module down to the stud, quantifying the amount of every material and component became a rudimentary exercise. Developing a list of each item, their quantities, and associated costs at an early enough stage allowed for the numbers to drive some design decisions, taking a pragmatic approach in some instances instead of a romanticized theoretical proposal. Broken down into the three distinct overall dwelling masses that would be formed, each unit type was analyzed to determine its material cost right down to the hurricane tie and nail.

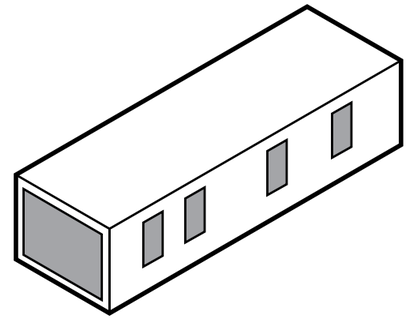
This list also helped to answer some questions that had been outstanding throughout the initial stages of the proposal process. Can the budget withstand including furniture and millwork? Can it be move in ready with all appliances installed? As items were added to the spread sheets, a close eye was kept on the bottom line. If the budget was exceeded, a step back was taken to analyze where components could be eliminated, standaradized, or swapped out for a cheaper alternative. Big ticket items that were over $1,000.00 were flagged in yellow. If the item in its current state could not be justified beyond its dollar figure, then alternative measures were explored to achieve cost savings.

It was critical during this part of the process to avoid the urge of specifying the cheapest possible material or solution in favour of the bottom line. Would a white vinyl siding box with three single hung windows cost less? Absolutely. Would anyone want to live there and be proud to call it their home? Probably not. The mandate from the beginning was to provide an affordable, yet dignified dwelling for the most vulnerable residents in the neighbourhood. For example, conversations with local residents who are in the market for a smaller scale affordable option quickly justified keeping the large glazed entrance system. Even after explaining the disparity in cost, comments for the most part echoed that the beauty and natural light would make it worth it, and it created a space that they would be proud to entertain in.



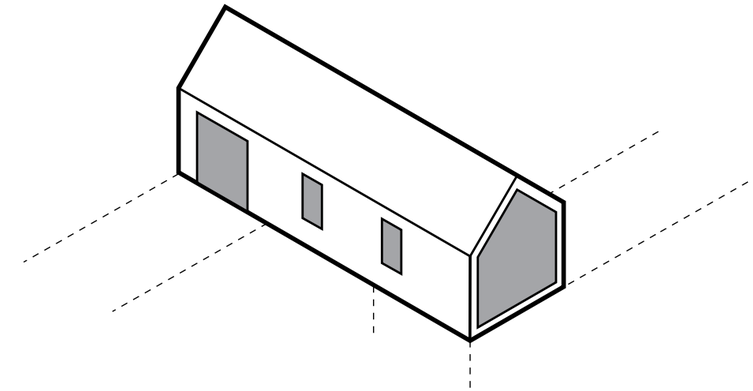
LANEWAY SLOPED ROOF				
MATERIAL	UNIT DIM / LENGTH	QUANTITY	PRICE / UNIT	TOTAL COST
2 x 12	12'	40	$39.90	$1,596.00
2 x 10	12'	20	$32.10	$642.00
2 x 8	12'	24	$26.90	$645.60
2 x 6	8'	8	$10.20	$81.60
2 x 4	8'	120	$7.30	$876.00
OSB	4' x 8' (1/2")	1825	$39.90	$2,275.54
Birch Ply	4' x 8' (1/2")	1600 SQ. FT.	$64.20	$3,210.00
Satin Clear Coat	3.78 L (450 SQ. FT)	4	$76.80	$307.20
1 x 3	12'	122	$3.10	$378.20
Breathable P+S	48" x 100' (400 SQ. FT)	1390 SQ. FT	$359.00	$1,436
Blue Skin Butyl Flash	4" x 75' Roll	2	$31.78	$64
Metal Roof	36" Panels	660 SQ. FT	$8.50	$5,610
Window "A"	2'-6" x 5'-0"	4	$349.00	$1,396.00
Window "B"	8'-0" x 12'-0"	1	$2,100	$2,100
Baseboard	12'	8	$5.90	$47.20
Closed Cell Spray Foam	3-5" Thick R28-R40	1825 SQ. FT	$5.19	$9,471.75
Cedar Siding	1' x 1'	900 SQ. FT	$2.90	$2,610.00
Screw Pile	6'	14	$175	$2,450
Joist Hanger	n/a	40	$1.80	$72.00
Hurricane Tie	n/a	40	$1.10	$44.00
Tile Floor	1' x 1'	60 SQ. FT	$1.20	$72.00
Bathroom Door	34" x 80"	1	$109.00	$109.00
Utility Door	34" x 80" (Double)	1	$124.00	$124.00
Toilet	Standard	1	$98.00	$98.00
Washer / Dryer	Stacking	1	$934.25	$934.25
Bathroom Sink/Faucet	Drop In	1	$89.10	$89.10
Bathroom Vanity	36" Single	1	$285.00	$285.00
Shower Fixture	Detachable	1	$79.90	$79.90
Hot Water Tank	40 GAL	1	$330	$330.00
LED Pot Lights	12 Pack	1	$199.00	$199.00
Metal Flashing	10'	8	$8.70	$69.60
Framing Nails	3.25" x 1000	1	$34.97	$34.97
Electrical Wiring	NMD90 @ 75m	1	$102.10	$102.10
Electrical Breaker Panel	100A - 120/240V	1	$81.80	$81.80
Electrical Box	2-3/8" x 1-7/8"	10	$1.89	$18.90
Refridgerator	24" (10.1 CU. FT)	1	$345.00	$345.00
Stove	24" (3.1 CU. FT)	1	$545.00	$545.00
Kitchen Sink	21" Single Bowl	1	$219.00	$219.00
Additional Cabinetry	Varies	1	$2,400.00	$2,400.00
				$41,449.27

$41, 449.27



BASE UNIT FLAT				
MATERIAL	UNIT DIM / LENGTH	QUANTITY	PRICE / UNIT	TOTAL COST
2 x 12	12'	18	$39.90	$718.20
2 x 10	12'	18	$32.10	$577.80
2 x 8	12'	24	$26.90	$645.60
2 x 6	8'	8	$10.20	$81.60
2 x 4	8'	120	$7.30	$876.00
OSB	4' x 8' (1/2")	1425 SQ. FT	$39.90	$1,795.50
Birch Ply	4' x 8' (1/2")	1250 SQ. FT.	$64.20	$2,507.81
Satin Clear Coat	3.78 L (450 SQ. FT)	4	$76.80	$307.20
1 x 3	12'	122	$3.10	$378.20
Breathable P+S	48" x 100' (400 SQ. FT)	1390 SQ. FT	$359.00	$1,436
Blue Skin Butyl Flash	4" x 75' Roll	2	$31.78	$64
Mod Bit Torch Roof	Roll Out	290	$3.25	$942.50
Window "A"	2'-6" x 5'-0"	4	$349.00	$1,396.00
Window "B"	8'-0" x 8'-0"	1	$1,600	$1,600
Baseboard	12'	8	$5.90	$47.20
Closed Cell Spray Foam	3-5" Thick R28-R40	1825 SQ. FT	$5.19	$9,471.75
Cedar Siding	1' x 1'	900 SQ. FT	$2.90	$2,610.00
Screw Pile	6'	14	$175	$2,450
Joist Hanger	n/a	40	$1.80	$72.00
Hurricane Tie	n/a	40	$1.10	$44.00
Tile Floor	1' x 1'	60 SQ. FT	$1.20	$72.00
Bathroom Door	34" x 80"	1	$109.00	$109.00
Utility Door	34" x 80" (Double)	1	$124.00	$124.00
Toilet	Standard	1	$98.00	$98.00
Washer / Dryer	Stacking	1	$934.25	$934.25
Bathroom Sink/Faucet	Drop In	1	$89.10	$89.10
Bathroom Vanity	36" Single	1	$285.00	$285.00
Shower Fixture	Detachable	1	$79.90	$79.90
Hot Water Tank	40 GAL	1	$330	$330.00
LED Pot Lights	12 Pack	1	$199.00	$199.00
Metal Flashing	10'	8	$8.70	$69.60
Framing Nails	3.25" x 1000	1	$34.97	$34.97
Electrical Wiring	NMD90 @ 75m	1	$102.10	$102.10
Electrical Breaker Panel	100A - 120/240V	1	$81.80	$81.80
Electrical Box	2-3/8" x 1-7/8"	10	$1.89	$18.90
Refridgerator	24" (10.1 CU. FT)	1	$345.00	$345.00
Stove	24" (3.1 CU. FT)	1	$545.00	$545.00
Kitchen Sink	21" Single Bowl	1	$219.00	$219.00
Additional Cabinetry	Varies	1	$2,400.00	$2,400.00
				$34,157.54

$34, 157.54



STACKED UPPER				
MATERIAL	UNIT DIM / LENGTH	QUANTITY	PRICE / UNIT	TOTAL COST
2 x 12	12'	40	$39.90	$1,596.00
2 x 10	12'	20	$32.10	$642.00
2 x 8	12'	24	$26.90	$645.60
2 x 6	8'	8	$10.20	$81.60
2 x 4	8'	120	$7.30	$876.00
OSB	4' x 8' (1/2")	1825	$39.90	$2,275.54
Birch Ply	4' x 8' (1/2")	1600 SQ. FT.	$64.20	$3,210.00
Satin Clear Coat	3.78 L (450 SQ. FT)	4	$76.80	$307.20
1 x 3	12'	122	$3.10	$378.20
Breathable P+S	48" x 100' (400 SQ. FT)	1390 SQ. FT	$359.00	$1,436
Blue Skin Butyl Flash	4" x 75' Roll	2	$31.78	$64
Mod Bit Torch Roof	Roll Out	660 SQ. FT	$8.50	$5,610
Window "A"	2'-6" x 5'-0"	4	$349.00	$1,396.00
Window "C"	8'-0" x 8'-0"	2	$1,700	$3,400
Baseboard	12'	8	$5.90	$47.20
Closed Cell Spray Foam	3-5" Thick R28-R40	1825 SQ. FT	$5.19	$9,471.75
Cedar Siding	1' x 1'	900 SQ. FT	$2.90	$2,610.00
Joist Hanger	n/a	40	$1.80	$72.00
Hurricane Tie	n/a	40	$1.10	$44.00
Bedroom Door	34" x 80"	3	$109.00	$109.00
Utility Door	34" x 80" (Double)	2	$124.00	$248.00
LED Pot Lights	12 Pack	1	$199.00	$199.00
Metal Flashing	10'	8	$8.70	$69.60
Framing Nails	3.25" x 1000	1	$34.97	$34.97
Electrical Wiring	NMD90 @ 75m	1	$102.10	$102.10
Electrical Breaker Panel	100A - 120/240V	1	$81.80	$81.80
Electrical Box	2-3/8" x 1-7/8"	10	$1.89	$18.90
Terrace Hand Rail	8'	8	$179.80	$1,438.40
				$36,464.42

$36, 464.42

MATERIAL TAKEOFF + PRICING:

- MATERIAL PRICES DERIVED FROM "OFF THE SHELF" HARDWARE STORE INVENTORY
- WINDOWS, SPRAY FOAM, ETC. PROCURED FROM SUPPLIERS AS A FREE QUOTE
- TAX (15% HST IN NOVA SCOTIA) NOT INCLUDED
- CONTRACTORS DISCOUNT AT MOST LOCAL HARDWARE STORES RANGE 10-15%
- HIGHLIGHTED CELLS REPRESENT ITEMS > $1,000

FIG.100 MATERIAL TAKEOFF & COST ANALYSIS

It is important to note that the lists do not include Nova Scotia harmonized sales tax (15%), however most local hardware stores offer a contractors discount ranging from 10-15% so for the purposes of this analysis it was considered a wash. The prices on this list were referenced directly from hardware store websites 'off the shelf' prices, and by contacting local suppliers for quotes in regards to materials such as spray foam, and windows. It is also important to note that this list focuses on materials only, and not labour. Although there would be labour involved within the facilty, it would be heavily subsidized if being done by some of the social enterprises explored later in this chapter. Although minimal, the on site labour would also rely somewhat on community engagement following the *Habitat for Humanity* model once the modules have been hoisted into place. A small number of skilled workers asssociated with the social enterprise or non-profit would lead a volunteer labour force to complete any of the remaining work on site.

With Halifax Regional Municipality recently waiving the permitting fees for affordable housing developments, the only other outstanding cost would be site services hook ups for sewer and water. Because the Halifax Water Commission is a seperate and private entity, their fees have yet to be waived for any affordable housing project. Estimated to cost between $3,000 - $5,000 per unit, this represents a barrier that affordable builders have been facing in the city considering the fee scales up with the number of units. Despite this price tag, it is still possible to build a laneway unit for less than $50,000, and a stacked multi unit for less than $70,000.

Of course, not every resident who owns a stand alone dwelling in the north end of Dartmouth can afford to finance an additional $50K+. Whether they own their house outright or not, it is still a large investment where the payback period might not fullty materialize for over a decade. For that reason, an alternative financial model was explored in an effort to implement the same laneway unit into backyards, with no upfront cost to the owner.

This alternative model would see a non-profit, social enterprise, or coalition use their funds (grants, donations, etc.) to construct one of the units. The homeowner would then lease a portion of their backyard, allowing the group to place a laneway suite on their land. This allows the homeowner to immediately start collecting lease payments with no upfront cost, in exchange for forfeiting 400 ft² of their property. The organizations would maintain ownership of the dwelling which means the set rental price would stay within the affordable range given their mandates to aid and serve people in need. Any 'profit' each month after paying the lease would go back into a revolving fund, to help finance the next build. Most of these groups have lists of people and families that frequently require resources and services. Although there would potentially be a list of renters in need, the homeowner would have the final say on tenant selection to ensure everyone is comfortable with the living situation.

FIG.101 UNITED WAY HALIFAX BANNER IN DARTMOUTH
https://www.unitedwayhalifax.ca/blog/one-hundred-thousand/

As with any housing project, there will be required land and funding. Throughout the initial stages of the proposal, strategic partnerships were fostered with local non-profits, developers, builders, as well as religious and educational institutions. This must be a multi-pronged approach and it will require multiple stakeholders as well as all levels of government to make a tangible difference. The Federal government has earmarked an enormous amount of funding through the *National Housing Strategy*[67], as well as the recent $1B influx towards the *Rapid Housing Initiative* through modular construction to be distributed early in 2021[68]. Local chapters of organizations are aiming to secure and delegate funds through partnerships and foundations that share their altruistic ambitions[69]. The CMHC is in desperate need of innovative strategies and ideas, and this approach presents elegant solutions to multiple obstacles that the country is facing.

Throughout the later portion of the thesis, these partnerships continued to grow and develop in hopes that it becomes possible to identify specific people in need, but also people willing and able to implement this proposal through either of the proposed options. Aside from non-profits, there are also social enterprises within the neighbourhood. Their ambition and mandate has recently shifted from offering finely crafted furniture, to small scale affordable housing for local residents. Each of these organizations have different approaches to combating homelessness and providing affordable housing, but ideally this design proposal is versatile enough to be deployed through all of their platforms.

If possible, the hope is to implement an aspect of social venture into the project moving forward. Having this as a facet of the proposal is important, as it helps to train, educate, and lift up marginalized groups or the next generation of designers and labourers. This can be possible in varying capacities, including but not limited to the aforementioned organizations, each providing something of value to a different group of people. In the case of prominent non-profits, they work directly with existing groups and organizations to empower local community leaders. The social enterprise that is shifting its focus toward affordable housing is located in the heart of Between the Bridges. In recent years they have shifted gears toward building tiny homes as fundraiser raffles despite not being able to place them anywhere in the municipality. With Halifax's newly adopted by-laws, there is now a plethora of backyards in which these could be inserted. What sets them apart, is that their workers are all disabled in some capacity, often mentally. They train their clientele in carpentry, wood working, and design to make them more attractive to potential employers in the future. A laneway home manufactured at this facility could be delivered anywhere Between the Bridges in less than 10 minutes.

Partnerships with other non-profits have also been fostered, in the hopes that this proposal can be delivered via yet another avenue. One in particular was founded by a South African immigrant and plumber by trade. The board members work tirelessly to raise funds before travelling to rural African nations to construct new toilet facilities for schools and public use. Their work allows females especially to stay in school through their teenage years, and empowers them to complete their education and break the cycle of poverty. Given recent global developments, the team has not been able to travel so they have been looking for projects closer to home. The board has expressed interest in lending a hand on local affordable housing, so their expertise in plumbing and construction on a budget would be invaluable.

67 Canada's National Housing Strategy https://eppdscrmssa01.blob.core.windows.net/cmhcprodcontainer/sf/project/placetocallhome/pdfs/canada-national-housing-strategy

68 Oliver Moore. "Ottawa promises $1-Billion to cities for affordable housing." Globe and Mail Article September 21, 2020

69 United Way Halifax. "Build Community" https://www.unitedwayhalifax.ca/what-we-do/build-community/

Finally, this proposal will be presented to local community colleges with carpentry and trades programs. Particular attention was paid in designing a unit that can be constructed by local skilled labour, and this scale of dwelling would offer students an introduction to wood frame construction that can be translated into much larger builds. With plumbing and electrial programs also available at these colleges, it presents an opportunity for a collaborative and integrated project that would prepare students for larger ventures in the industry. These community colleges have state of the art facilities, access to swaths of stored materials, teachers and mentors with hands on experience, and a focused group of students that could be a dedicated labour force for a number of months at a relatively cheap price point. If woven into the curriculum, material cost would already be accounted for, labour cost would be almost negligible, students would learn traditional framing techniques while pushing the boundaries of prefabrication, and each semester would culminate in a finished unit or two to benefit local residents.

In today's capitalist society, charity is not the encompassing answer to this issue. A sustainable, repeatable model is required in order to strategically bolster the housing stock in amenity rich areas. To borrow some wisdom from Habitat for Humanity, people are in need of a hand up, not a handout. The idea of using architecture to provide less privileged people with a base for better economic opportunity is one that has resonated with me for a long time. Good design does not need to cost more - I believe this thesis proves it.

FIG.102 EXTERIOR VISUALIZATION

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