Evolution of the Modern Home

Reprioritizing Community, Sustainability and Plasticity

By:
Alexandra Telford

A thesis submitted to the Faculty of Graduate and Postdoctoral Affairs in partial fulfillment of the requirements of the degree of:

Masters of Architecture

Carleton University
Ottawa, Ontario

Abstract

North America has been plagued by the curse of seemingly unlimited space. The invention of the privately accessible automobile allowed for the outward spread of the city and the infinitely repeated form of modern-day suburbia. Developers have the luxury of buying cheaper land further from the city core and creating copy and paste neighborhoods. They ignore the existing landscape and any potential for passive design benefits. Clients who have the luxury of affording a new build can hire an architect and benefit from their understanding of alternative design methods as well as their knowledge of new technologies. This format of mass-produced housing has led to a lack of imagination in design or efficiency. The price of these homes continues to skyrocket and individuals have to choose between renting or owning in small surrounding towns. Residential areas are separated from amenities and commercial spaces and the homes themselves are separated by side yards and fences. The individuals inside these homes are essentially isolated. The feeling of community is no longer evident, neighbours can go days without crossing paths. In order to better reconsider the idea of neighborhood and community, It must be acknowledged that the demographic of owners of single family homes have also changed over the years, the "Nuclear family" no longer exists. The gender roles within families have been overturned and the incredible cultural diversity of immigrants and multi-generational changes within Canada's population cannot be ignored.

Acknowledgments

To my supervisor, thank you Zach for being a strong constant throughout the year, you always knew exactly what to say to help me continue forward.

To my family, thank you for your continuous support through all of my academic endeavors, I would not be where I am without you.

To my partner, thank you for your patience and support on this wild ride, I treasure your unconditional commitment.

To my coach and team, thank you for helping me achieve all my dreams.

Table of Contents

List of Figures

List of Figures

Glossary

Community Land Trust: *an area of land held by a non-profiting party for the purpose of affordable housing, through perpituity. Home owners purchase the individual houses not the land underneath*

Earthship: *is a style of architecture developed in the late 20th century to early 21st century by architect Michael Reynolds. Earthships are designed to behave as passive solar earth shelters made of both natural and upcycled materials such as earth-packed tires*

Ecological: *(ecology) the patterns of relationships between living things and their environment There was no ecological damage.*
Architecture ecology
creating green spaces that promote symbiosis between urban and natural environments.

Flood Plain: *is an area of land that is at risk of flooding during wet seasons or the post winter thaw cycle*

Modular Construction: *a method of assembly that allows for pieces to remain individual and repeatable without the need for destruction in order to expand or rebuild*

Ownership: *the importance on being able to lay claim to the value and authority of an object (ex. As opposed to paying a fee too rent) The owner can benefit from the inflation of value of the object over the time in which they maintain possession*

Permaculture: *holistic, living-in-harmony-with-nature worldview*

Permaculture12 Principles:
Observe and Interact. ...
Catch and Store Energy. ...
Obtain a Yield. ...
Apply Self-Regulation and Feedback. ...
Use and Value Renewables. ...
Produce No Waste. ...
Design from Patterns to Details. ...
Integrate Don't Segregate.
Use Small, Slow Solutions
Use and Value Diversity
Use Edges and Value the Marginal
Creatively Use and Respond to Change
(from https://ethical.net/ethical/permaculture-principles/)

Permeable: *intentional and strategical breaks in a solid surface allow for the flow through of other materials.*

Rammed Earth: *a construction method where layers of earth are mixed with a binding agent and compressed into solid structural walls. They are normally reinforced with steel and can be separated by a layer of insulation*

Sustainable lawn (Alternative Landscaping): *Using forms of vegetation that can survive without the need for excessive amounts of water or maintenance. Passive forms of vegetation*

1
Introduction

1.1 Introduction

As the human population continues to grow exponentially, the need for housing is in a game of constant catch-up. Developers are doing their best to keep up with demand while attempting to ensure maximum profits. As a result, materials are chosen based on their affordability, and quality is put on the back burner to make way for low costs and short timelines. The resultant houses are inefficient, uninspiring, and do very little to slow down the effects of the Anthropocene or prepare for climate change. Fig 1.1.1

"Tradition as a regulator has disappeared - notably in our own culture - for a number of reasons."[1]

Building materials being used are consumed at an unsustainable rate and suburban sprawl adds to the need for individual transportation methods and big-box store economies. In Canada and North America as a whole, space and resources are still abundant, however, these resources are not limitless and their rate of consumption cannot be ignored. An increase in dangerous weather conditions is putting more and more lives at risk. New housing designs have the opportunity to protect its inhabitants from the elements but also work to help protect the earth from humans.

1.1.1 American Suburbia

1 Lane, "Housing and Dwelling: Perspectives on Modern Domestic Architecture", 28

This thesis aims to explore new possibilities for the mass production of family homes by reimagining both the home and the neighborhood as a whole. By resituating the goal of mass produced housing from maximum profit, designs can explore a livable space at its maximum potential in terms of carbon footprint, physical footprint, and passive design features. Following this design process aims to test the flexibility of findings through a range of various scenarios seeking a middle ground that can support a wide range of diverse needs. The first part of the study focuses on a single structure and then proceeds to experiment with the findings at the scale of a neighborhood. What new opportunities are possible with mass production and larger scales? How do efficiency and sustainability improve or decline when working at larger scales? Developers and the general public resort to what they know, the unsustainable construction methods that are used by default. Solutions and alternatives currently exist however due to a lack of understanding, these options are considered daunting and understood as more expensive or less achievable. Options and information can be garnered and represented using recognizable terminology and illustrated diagrams.

1.1.2 Snohetta ZEB Pilot House

The real estate market is continuing to rise making it increasingly harder for individuals to buy instead of rent. If a house can be purchased and start to do more than provide just shelter it ultimately becomes a more valuable investment. Houses designed for rural areas include all manner of self-sufficient systems in regard to waste and water control as well as electricity. There is no reason that a house can't remain self-sufficient while being more centrally located. As the individual works with the house instead of the house solely working for them, inhabitants can begin to personalize and shape the house into a home that supports their emotional and physical needs. Adaptability can be a key design directive. The Covid 19 global pandemic acts as the most recent example of a need for adaptable homes. A sudden need materialized for home office space, exercise space, and separation between work and relaxation. The need to adapt a living space is often dictated by a changing and growing family. Renovations are expensive and often wasteful. How can the home adapt to the needs of evolving lifestyles without the necessity for new constructions?

1.1.3 Brighton Earthship

1.2 Site Selection

This research is situated on land in Northern Vanier, East of the Ottawa downtown core. The site is a vacant quarter-acre lot in a medium-density neighborhood previously home to a recently demolished school. Fig 1.2.2 Chosen for its location, and scale, research can benefit from the ability to compare design development to a local architect's existing development proposed on the site. Fig 1.2.1 Their firm has completed the necessary site research including traffic studies, geotechnical analysis, environmental assessment, tree conservation studies, and proposed an 85 unit community. The design includes current material trends and maximum build allowances leaving yardless homes that do not prioritize passive opportunities.

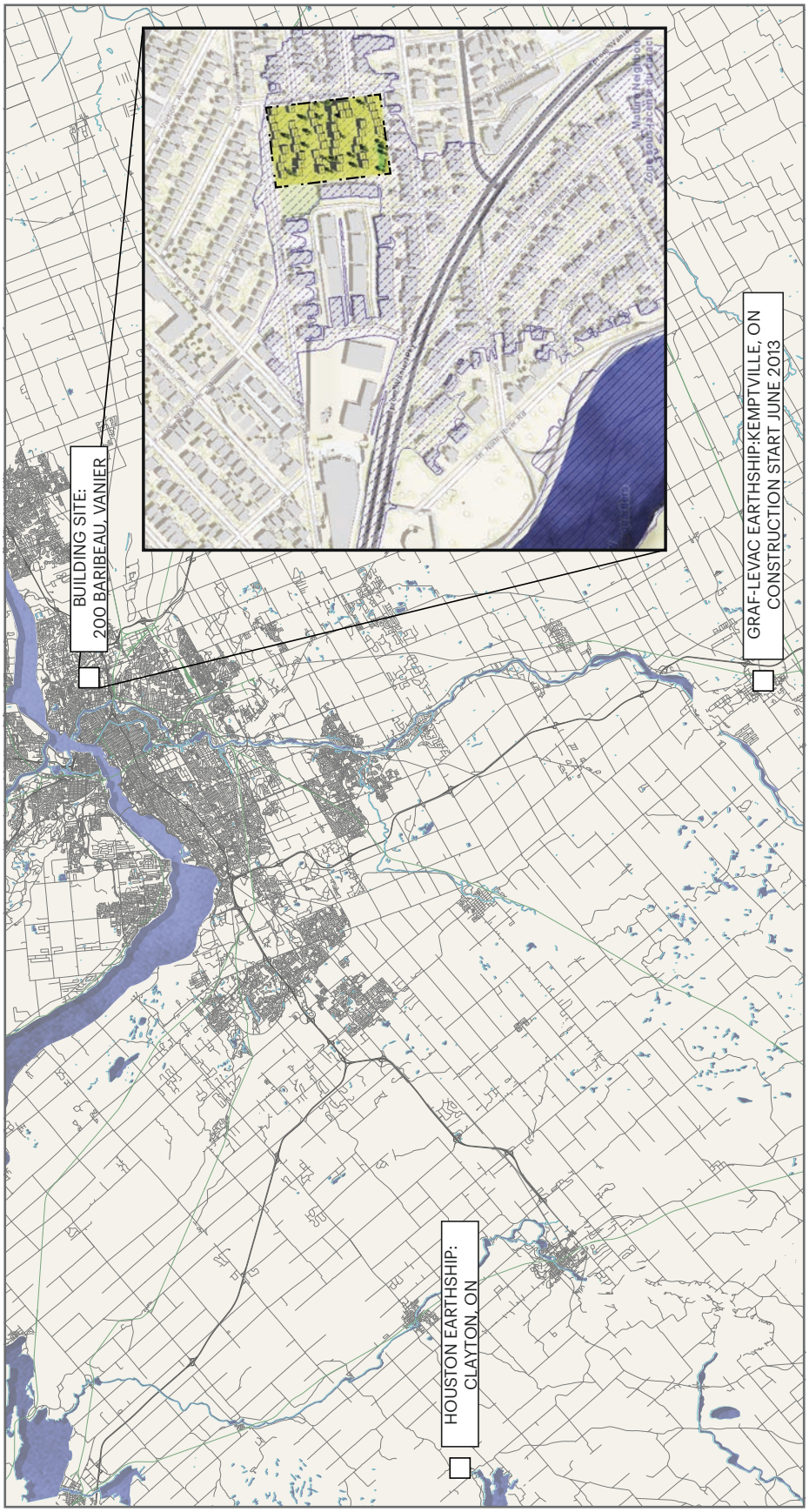
Many amenities including public transport are easily accessible. Design intention is to propose a desirable and sustainable living option that can be accessed by those with lower incomes and not promote an immediate route to gentrification.

Tree #	Botanical Name	Common Name	Caliper (cm)	Condition	High Quality Tree	Rare Tree	Comments	Disposition
1	Tilia cordata	Littleleaf Linden	40	Moderate	No	No	City owned, Symmetrical canopy, Pruned @ OH Utilities, Single stem, Co-dominant leaders: 2 @ ~2m above grade, Included bark, Suckering @ base	Remove
2	Tilia cordata	Littleleaf Linden	32	Good	No	No	City owned, Symmetrical canopy, Co-dominant leaders: 2 @ ~2m above grade, Included bark	Remove
3	Tilia cordata	Littleleaf Linden	24	Moderate	No	No	City owned, Asymmetrical canopy, Die back ~10% @ branches, Single stem, Included bark	Remove
4	Ulmus pumila	Siberian Elm	35	Moderate	No	No	Privately owned, Asymmetrical canopy, Pruned @ OH Utilities, Poor branch angle, Single stem, Co-dominant leaders: 2 @ ~2.5m above grade	Remove
5	Ulmus pumila	Siberian Elm	45	Moderate	No	No	Privately owned, Asymmetrical canopy, Broken limbs, Pruned @ OH Utilities, Single stem, Co-dominant leaders: 3 @ ~2m above grade, Bark rot @ limbs	Remove
6	Thuja nigra	Black Cedar	15, 17	Good	No	No	Privately owned, Asymmetrical canopy, Multi stem: 2	Remove
7				Dead				Remove
8	Acer ginnala	Amur Maple	23, 25, 30	Moderate	No	No	Privately owned, Asymmetrical canopy, Pruned leader branches, Multi stem: 3, Heart rot @trunk, Broken leader	Remove
9	Thuja nigra	Black Cedar	15	Poor	No	No	Privately owned, Die back ~40% @ canopy, Single stem, Co-dominant leaders: 3 @ ~0.5m above grade, Bark damage	Remove
10	Acer saccharum	Sugar Maple	32	Good	No	No	Privately owned, Symmetrical canopy, Broken limbs, Single stem, Bark rot @ crotches, Included bark	Remove
11	Acer ginnala	Amur Maple	18, 24, 15, 12	Moderate	No	No	Privately owned, Symmetrical canopy, Pruned leader, Multi stem: 4, Bark rot @ limbs, Existing feature: Bird house	Remove
12	Acer rubrum	Red Maple	68	Moderate	No	No	Privately owned, Broken limbs, Pruned, Heart & Bark rot @ limbs, large split in limb,	Remove
13	Thuja nigra	Black Cedar	18	Moderate	No	No	Privately owned, Asymmetrical canopy, Single stem, Co-dominant leaders: 2 @ ~1.5m above grade, Leaning	Remove
14	Acer ginnala	Amur Maple	15, 12, 12	Moderate	No	No	Privately owned, Symmetrical canopy, Multi stem: 3	Remove
15			23	Dead				Remove
16	Acer saccharum	Sugar Maple	72	Poor	No	No	Privately owned, Asymmetrical canopy, Pruned @ OH Utilities, Poor branch angle, Single stem, Co-dominant leaders: 2 @ 2.5m above grade, Bark rot @ trunk & crotches	Retain
17				Missing				
18	Acer negundo	Manitoba Maple	50	Poor	No	No	Privately owned by adjacent homeowner, Pruned @ OH Utilities, Poor branch angle, Multi stem: 5, Bark rot @ trunk, Included bark	Retain
19				Missing				
20				Missing				
21	Acer negundo	Manitoba Maple	40, 20	Moderate	No	No	Privately owned by adjacent homeowner, Asymmetrical canopy, Broken limbs, Poor branch angle, Multi stem: 2, Bark rot @ limbs, Included bark	Retain
22	Rhamnus cathartica	Common Buckthorn	12, 20, 18		No	No	Privately owned by adjacent homeowner, Bush	Retain
23	Populus balsamifera	Balsam Poplar	27, 22	Moderate	No	No	Privately owned, Symmetrical canopy, Single stem, Co-dominant leaders: 2 @ ~1.5m above grade, grown into chain link fence	Retain
24	Populus balsamifera	Balsam Poplar	35	Good	No	No	Privately owned, Symmetrical canopy, Single stem, Included bark	Remove
25	Ulmus pumila	Siberian Elm	23	Moderate	No	No	City owned: Park property, Symmetrical canopy, Pruned @ lower limbs, Single stem, Bark rot @ crotches, Grown into chain link fence	Retain
26	Ulmus pumila	Siberian Elm	>30 (4)	Poor	No	No	City owned: Park property, Symmetrical canopy, Pruned @ main leader, Single stem, Co-dominant leaders: 4 @ ~0.5m above grade, Grown into chain link fence	Retain
27	Gleditsia triacanthos var. inermis	Thornless Honey Locust	14	Good	No	No	City owned: Park property, Symmetrical canopy, Single stem, Co-dominant leaders: 2 @ ~1.5m above grade, Bark rot @ crotches	Retain
28	Picea glauca	White Spruce	12	Good	No	No	City owned: Park property, Symmetrical canopy, Single stem	Retain
29	Acer platanoides	Norway Maple	20	Good	No	No	Privately owned by adjacent homeowner, Symmetrical canopy, Single stem	Retain
30				Dead				Remove
31	Acer Saccharum	Sugar Maple	24	Good	No	No	Privately owned, Symmetrical canopy, Single stem, Bark rot @ limbs, Included bark	Remove
32				Dead				Remove

SITE DESCRIPTION:

1. THE EXISTING SITE CONTAINS TWO SINGLE-STOREY BRICK BUILDINGS, A LARGE ASPHALT-PAVED AREA, AN OPEN GRASS FIELD, AND A SMALL-PLAY AREA.
1.1. APPROXIMATELY 85m² IS OCCUPIED BY BUILDING FOOTPRINTS.
2. THERE ARE A TOTAL OF TWENTY-TWO TREES INCLUDED IN THE TREE CONSERVATION REPOR, IN VARYING CONDITIONS. TREES ARE LOCATED WITHIN THE SITE BOUNDARY, WITHIN THE CITY RIGHT-OF-WAY, WITHIN AN ADJACENT CITY PARK, AND ON ADJACENT HOMEOWNER PROPERTY.
3. THE EXISTING ON-SITE GREENSPACE IS MAINLY COMPRISED OF TURFGRASS.
4. THE DEVELOPMENT SITE IS NOT CONSIDERED OF PRIMARY OR SUPPORTING SIGNIFICANCE AS NATURAL LANDS IN THE GREENSPACE MASTER PLAN.

1.2.1 Tree conservation report by CWS Landscape Architects



1.2.2 Site plan, greater Ottawa area

Site prior to school demolition

Site August 2021,
existing mature trees
and natural overgrowth

1.2.3 Site photos taken from property line

Site August 2021, different views into site and from site centre

1.2.4 Site photos taken from centre of lot

Opportunity for Reclaim and Reuse of Materials

1.2.5 Materials from Demolished School

Aerial view of surrounding area and site prior to demo

1.2.6 Facing North-West

1.2.7 Facing North-East

1.2.8 Geo Ottawa zoning and site dimensions

2
The People

2.1 Community Alternatives

A byproduct of residential seclusion is a lack of exposure to alternatives. Without the benefit of education and travel, one may assume that everyone's normal is comparable to their own. Within individual cities, there is already a considerable variety in community styles. Within the global scale there are all ranges of successes and extremes in different styles of living. This study isolated ten of these communities for further study, located in BC[2 3], Ottawa[4], NY[5], Oregon[6], Iceland[7], Denmark[8 9], Norway[10], and Scotland[11]. The lot size and number of houses within each community varies and is represented in Fig 2.1.1 They can be compared to the Hobin Architecture development concept being constructed on the chosen site in Ottawa. The majority of the communities studied involved large areas of land that allowed community members to work together to grow their own food, others were more urban focusing on shared amenities, creating friendships, and prioritizing a more mindful lifestyle. All the communities appeared to be founded on certain shared ideologies, whether related to sustainability practices, religion or philosophical beliefs that naturally brought together a range of like minded people. Although this proposal's intention is not to be defined as an isolated community it aims to create spaces for shared amenities allowing the individual homes to be less excessive.

2 Belterra cohousing. Accessed March 17, 2022. http://belterracohousing.ca/index.html.

3 "Cranberry Commons." Canadian Cohousing Network. Accessed March 17, 2022. https://cohousing.ca/communities/bc/cranberry-commons/.

4 "Terra Firma." Canadian Cohousing Network. Accessed March 17, 2022. https://cohousing.ca/communities/on/terra-firma/.

5 "Living Greener." Ecovillage at Ithaca. Accessed March 17, 2022. https://ecovillageithaca.org/live/living-greener/.

6 "Ankenyrow." ankenyrow. Accessed March 17, 2022. https://ankenyrow.wordpress.com/.

7 "SJÁLFBÆRT SAMFÉLAG." Sólheimar. Accessed March 17, 2022. https://www.solheimar.is/.

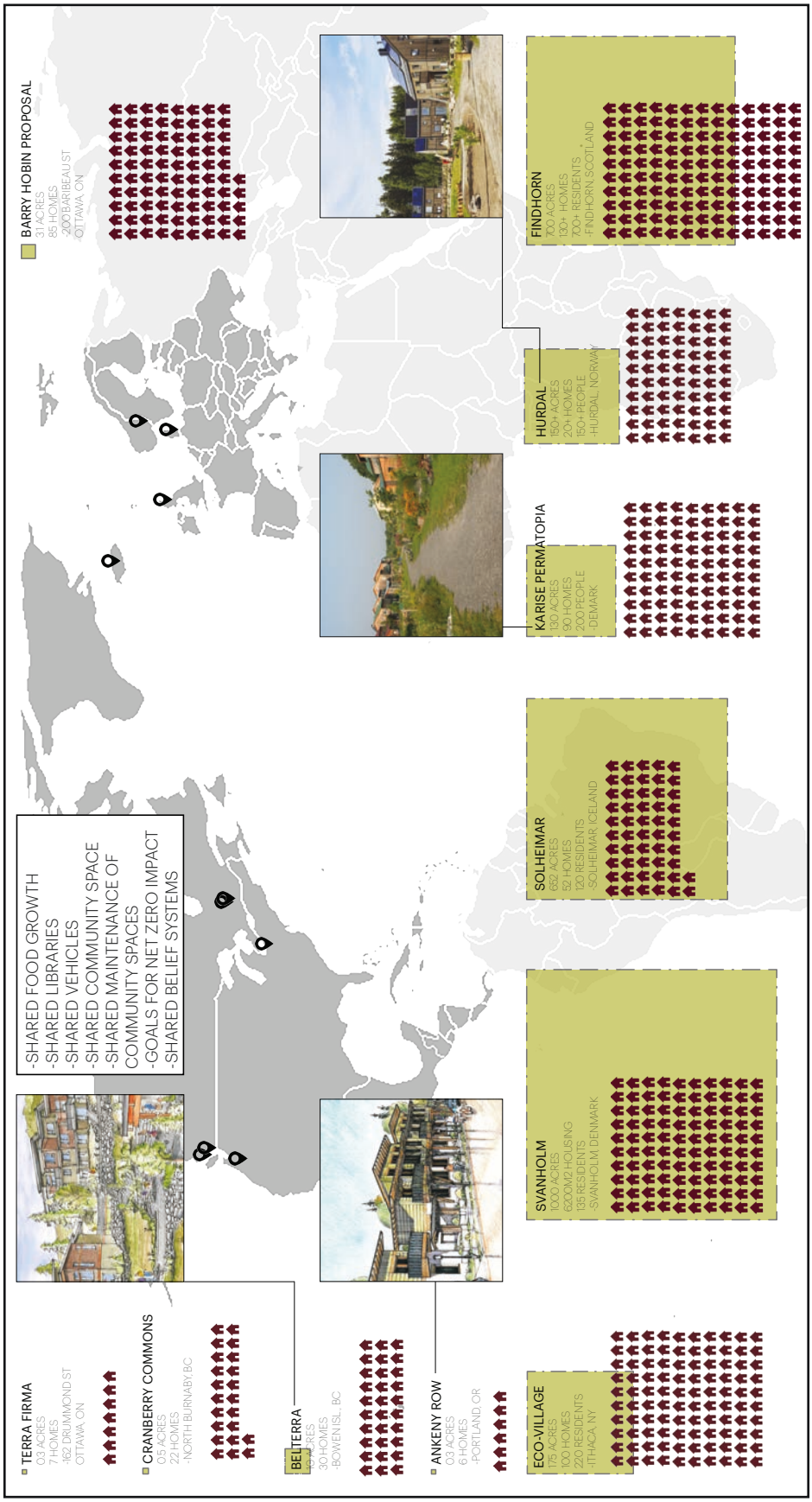
8 "Welcome to Svanholm." SVANHOLM STORKOLLEKTIV, September 22, 2020. https://svanholm.dk/english/.

9 "Boligerne." Permatopia, February 14, 2022. https://permatopia.dk/boligerne/.

10 "Hurdal Ecovillage." NuMundo. Accessed March 17, 2022. https://numundo.org/center/norway/hurdal-ecovillage-3.

11 Ecovillage Findhorn. Accessed March 17, 2022. https://www.ecovillagefindhorn.com/.

In order to help narrow research directives, design goals focus on creating a sustainable model for mass produced homes specifically prioritizing the demographic of independents as first time home buyers. By independent, this term refers to those who are receiving no help for a downpayment and are limited to their own savings. These home buyers also fall under the average or median pay range in entry level or non professional careers. Due to the exponential inflation of the local housing market, without assistance entry salary individuals are forced to move further and further from the city core to even have a chance at buying over renting.



2.1.1 Ecovillages around the world (# of houses compared to lot size)

2.2 Speculation on the Future of Single Family Homes:

It was important to identify a range of practical considerations, an estimate of the current generation's "wishlist" when choosing a new home. In order to isolate certain patterns within residential evolution, a mass produced local housing plan was identified from each decade dating back until the 1930s Fig 2.2.2. These floor plans exposed certain programmatic and spatial priorities. These visual representations are examined in correlation to statistics from public census data. Certain moments that stood out include the increase of single family homes built following World War II, the widespread use of birth control in 1970, the internet being made available to the public in the early 1990's and the most recent event being the outbreak of Covid 19 in late 2019. Some other trajectories that were noted included the prominent rise of registered cars in Ontario, the drop in fertility rates[12], that coincided with the widespread use of birth control, and the percentage of women in the workplace that has risen steadily since the 1950s. All of these changes can be examined in regard to the average floor plan of the single family homes being built in these decades. The introduction of the garage and the rise in floor area correlates with the increase in registered cars and the increase in women in the workplace.[13] A higher combined household income accommodates the cost of a larger home, however, the increase of floor area does explain the decrease in fertility. This suggests the growth of family homes is not a result of needing to house more children yet could make sense from an economic standpoint as children are a substantial financial commitment Fig 2.2.3.

12 Statistics Canada Government of Canada, "Fertility: Fewer Children, Older Moms," Government of Canada, Statistics Canada, May 17, 2018, https://www150.statcan.gc.ca/n1/pub/11-630-x/11-630-x2014002-eng.htm.

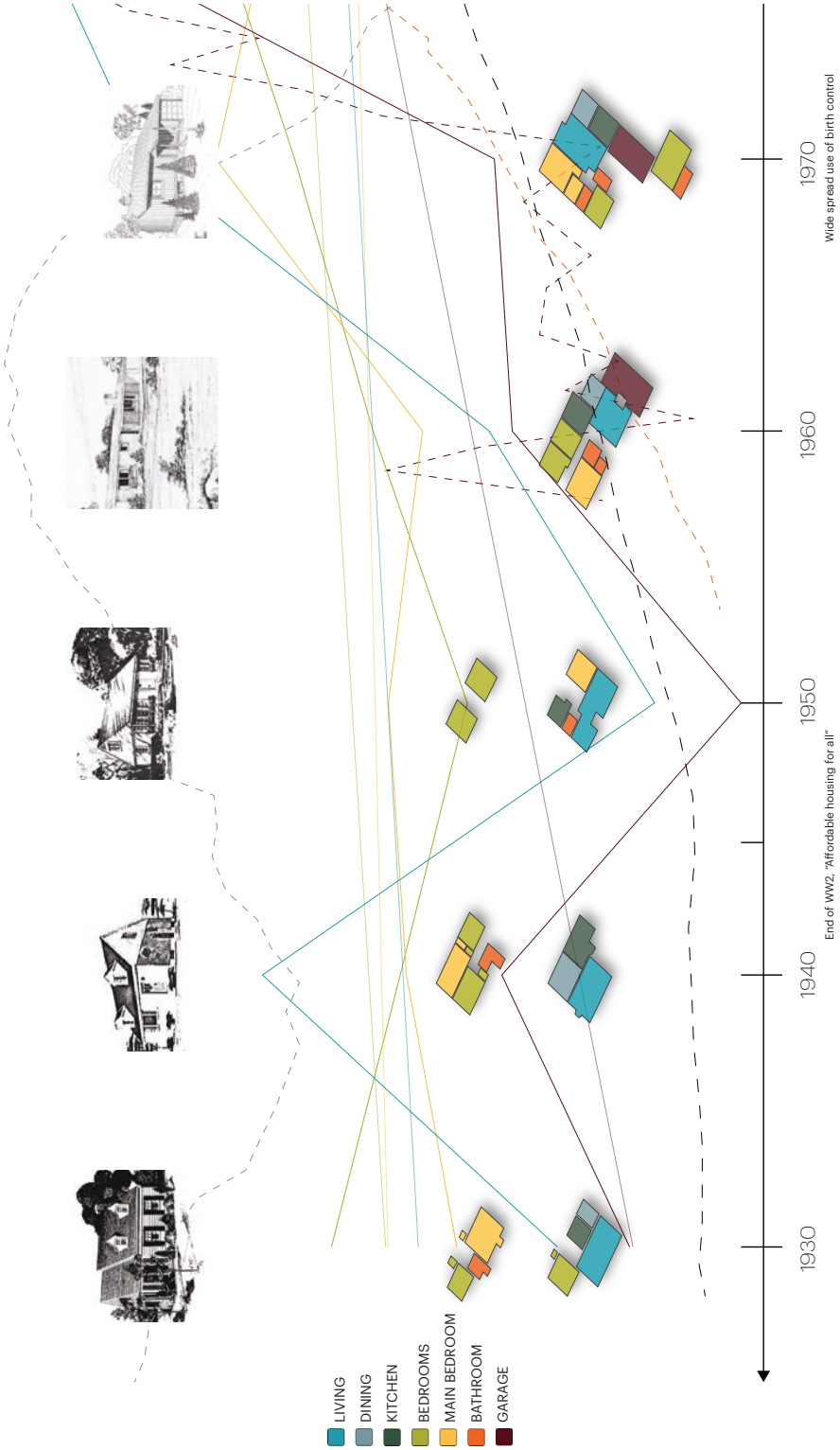
13 Statistics Canada Government of Canada, "The Surge of Women in the Workforce," Government of Canada, Statistics Canada, May 17, 2018, https://www150.statcan.gc.ca/n1/pub/11-630-x/11-630-x2015009-eng.htm.

After discerning potential cause and effect relations between lifestyle and housing, it made sense to speculate on the reactions in the housing market that may accommodate current and future trends. The Covid 19 pandemic has forced individuals and families to remain in their own homes. People have rushed to locate a space for a home office where they can take important calls without the noise pollution of roommates or other household noises. The importance of maintaining a healthy exercise regime has led to an influx of home gyms and the desire for outdoor spaces to both remain mobile and entertain in the safety of air circulation and UV sanitization. The majority of these elements are an additional cost, not previously considered by the average homebuyer. The cost of all housing continues to rise at a much faster rate than the average income.[14] How can these buyers afford even their minimum requirements?

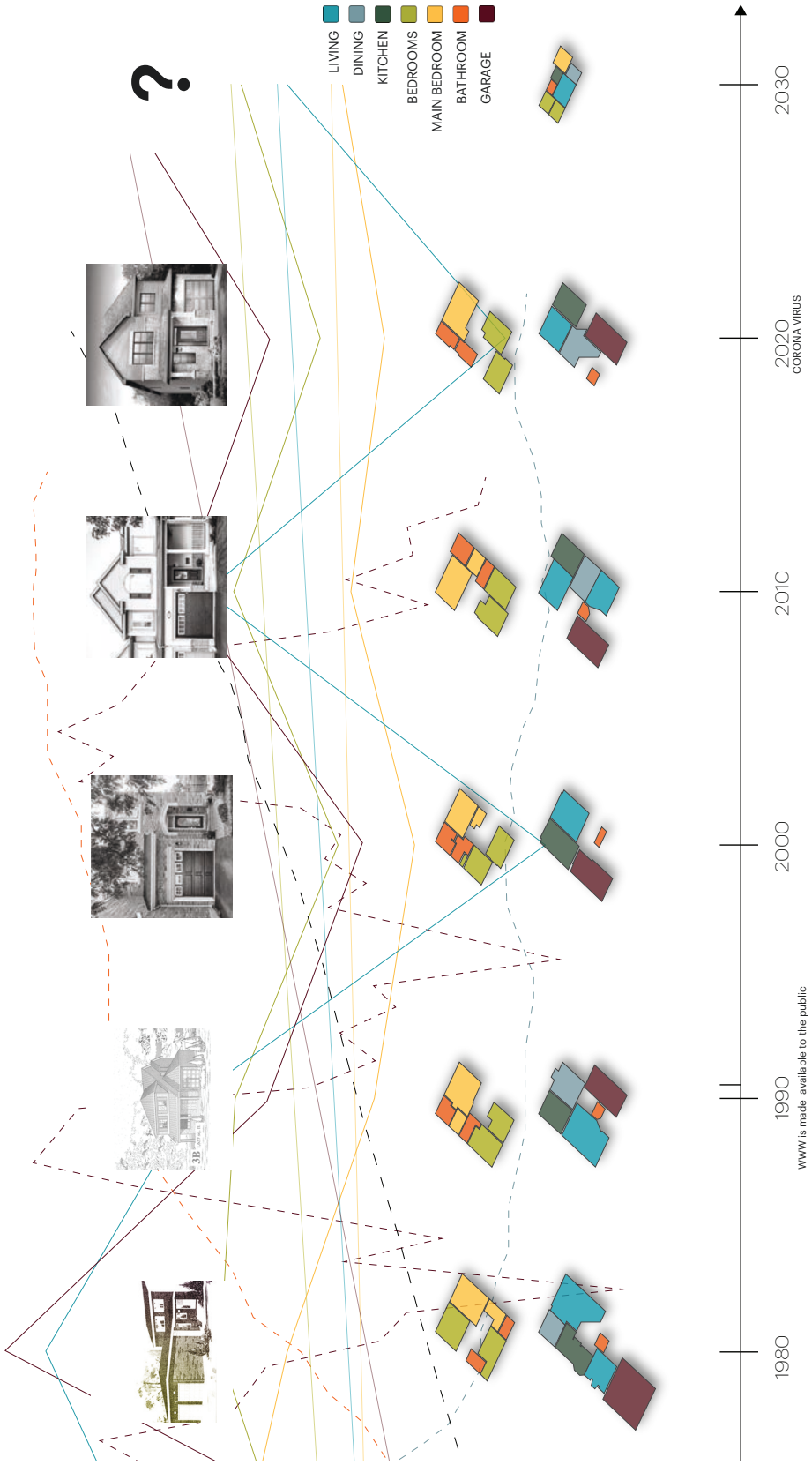
14 "Median Income," Census Mapper, accessed March 17, 2022, https://censusmapper.ca/.

A COLLECTION OF CANADIAN RESIDENTIAL ARCHITECTURE

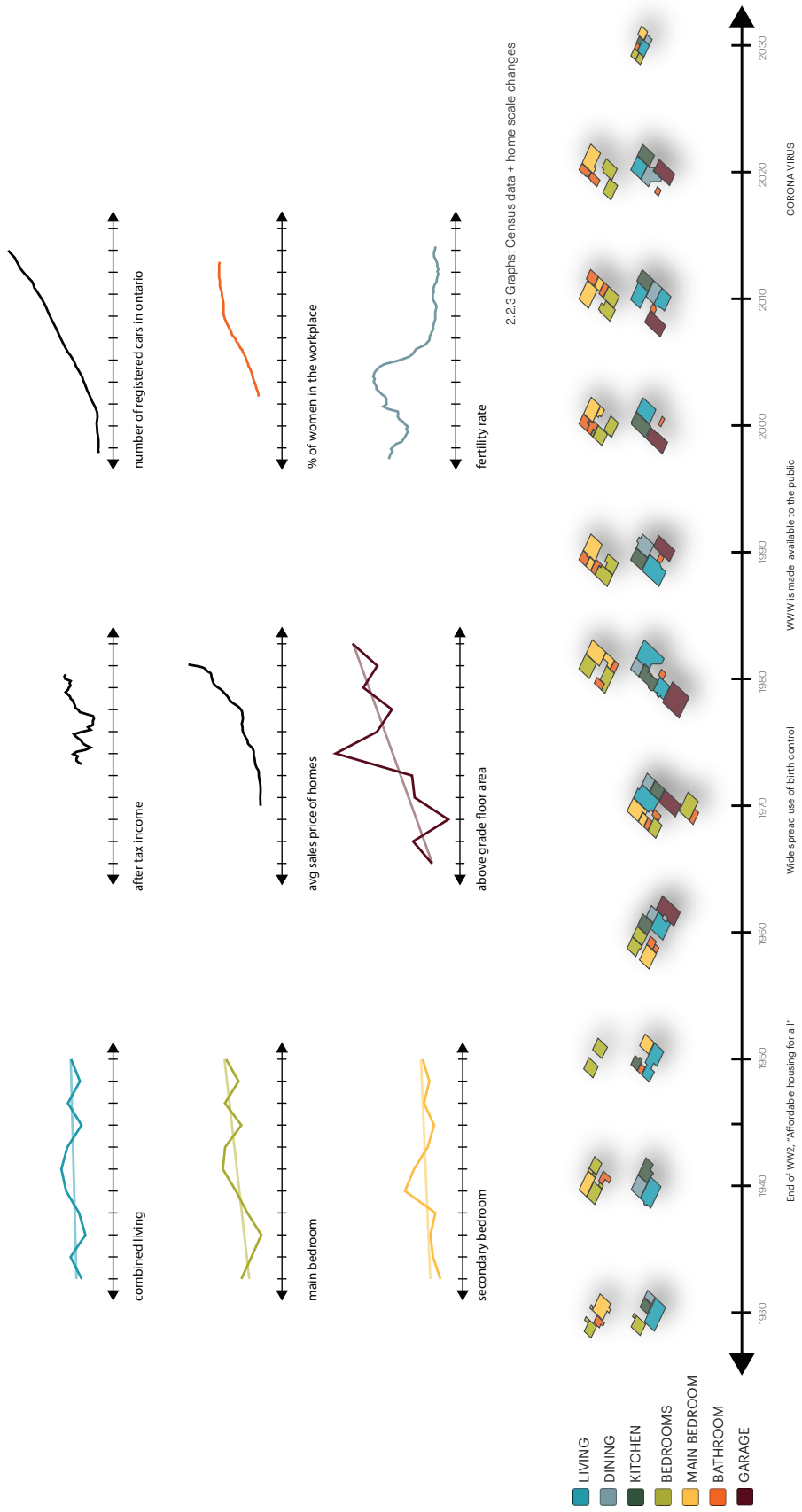
2.2.1 A collection of Canadian Residential Architecture



2.2.2 (a) Local historical housing styles + floor plans overlay



2.2.2(b) Local historical housing styles + floor plans overlay



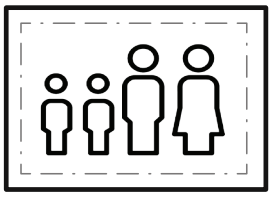
2.2.3 Housing scales and corresponding census data

2.3 Nuclear Familes:

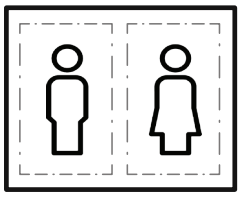
The dynamic of the family has also changed in the past few decades. The "Nuclear family" no longer exists. Fewer couples are getting married before moving in together and fewer people are getting married before having children. Higher rates of divorce have resulted in one family occupying two homes, or one family joining with a new similarly detached family. Some children grow up living out of an overnight back always passing between parents and sleeping in one of their multiple bedrooms. Couples are no longer only male and female. Same-sex couples and parents are more widely accepted in communities and such partnerships can change the dynamic and use of a home. The roles within the home have been shaken up, both by new types of relationships and the increase of women in the workplace Fig 2.3.1.

There is a clear argument that the "cookie-cutter" suburban sprawl homes can no longer be effective - if they ever even were - when there is no one size fits all family model in the twenty-first century. There is an opportunity to reimagine a middle class housing model in a way that it can adapt to the ever changing needs of buyers and the advancing climate crisis.

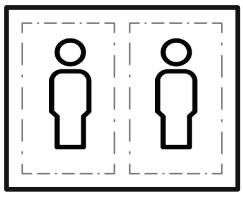
The global climate crisis is more imminent than ever and the construction industry is a large contributor to pollution, waste, and energy consumption. Homes need to evolve, the level of waste produced during renovations as well as initial builds is entirely unsustainable. By recalculating the current needs of families in terms of space there is the opportunity to improve priorities in terms of waste and overall quality, striving for a more circular process Fig 2.3.2.



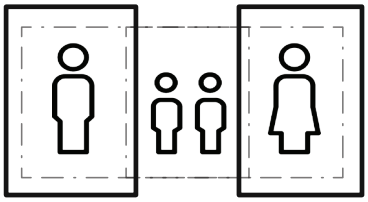
"NUCLEAR FAMILY"



PLATONIC ROOMMATES

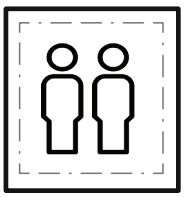


PLATONIC ROOMMATES

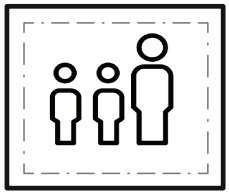


DIVORCED PARENTS, 2 HOMES

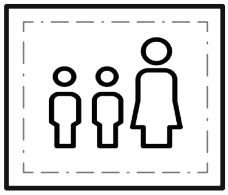
COUPLE



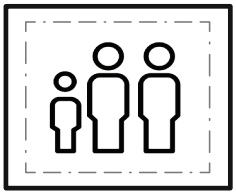
COUPLE



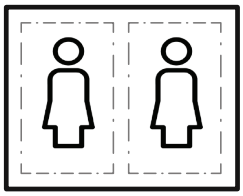
SINGLE PARENT



SINGLE PARENT

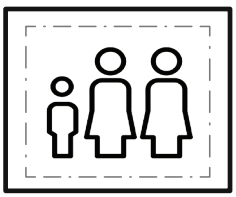


FAMILY



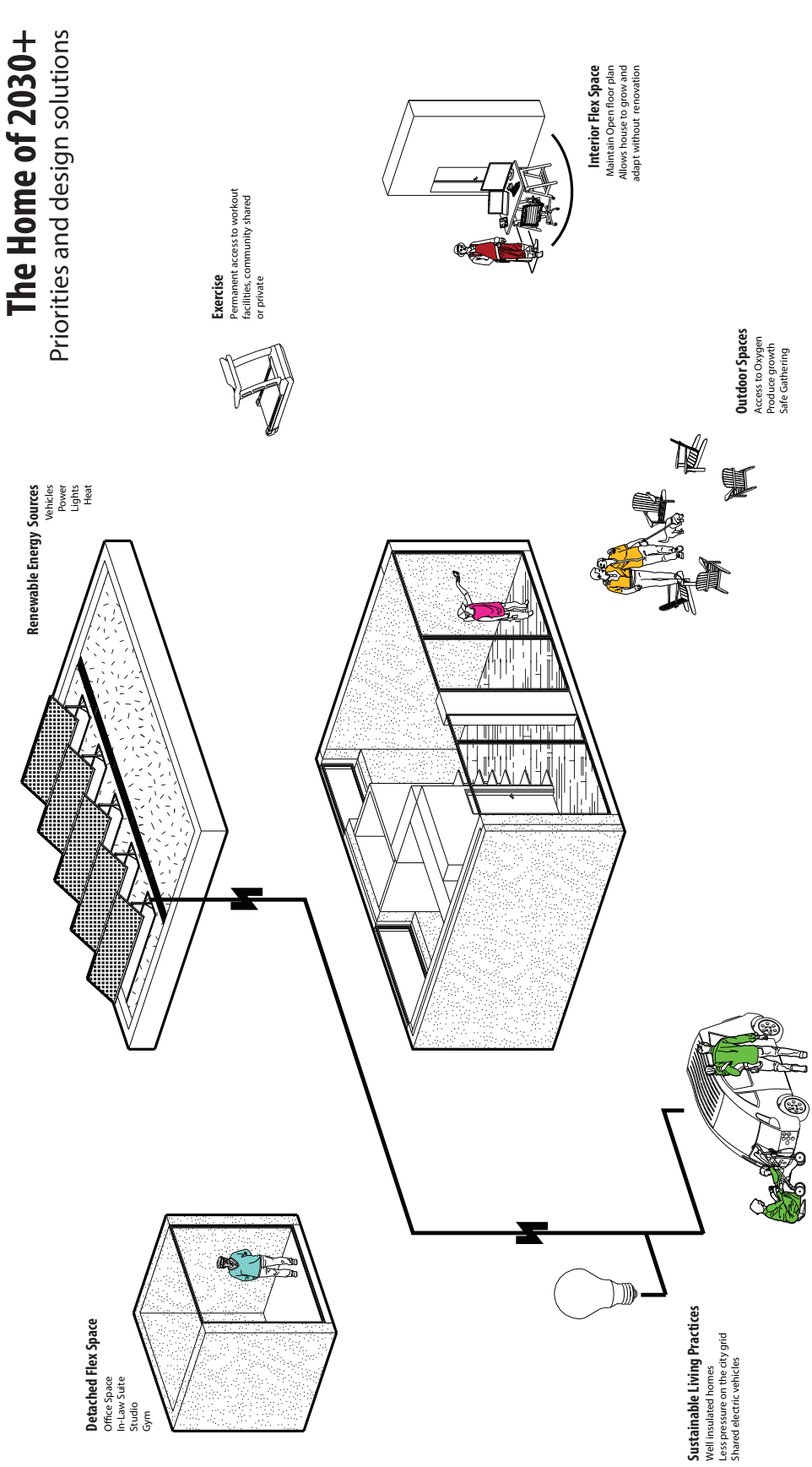
PLATONIC ROOMMATES

COUPLE



FAMILY

2.3.1 "Not so nuclear family"

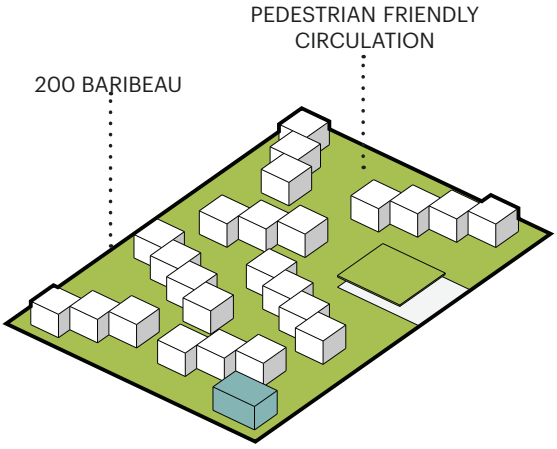


2.3.2 Future home speculations

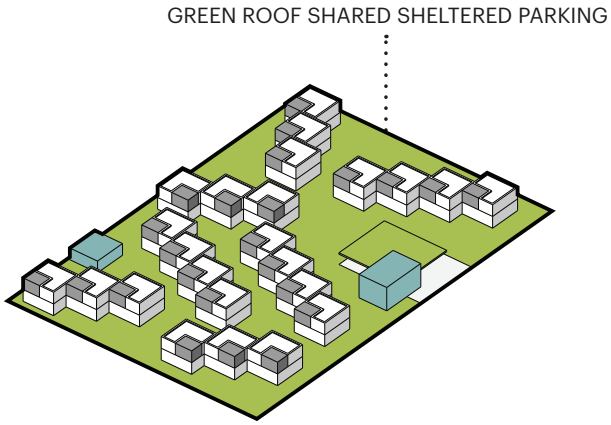
2.4 Preschematic Design Approach:

In order to avoid an arbitrary scale for initial orientation and massing studies, tests were completed using 10x10m 2 storey homes, this size being equivalent to the post war homes built across Ottawa. These massings were oriented on a pedestrian priority site, placing units one by one to maximize privacy, orientation, and greenspace. In an effort not to oversaturate the site the study works with only 25 units. At this early stage additional space on the site is designated to a green roof-covered parking area at the east end of the site as well as two opportunities for shared amenity spaces.

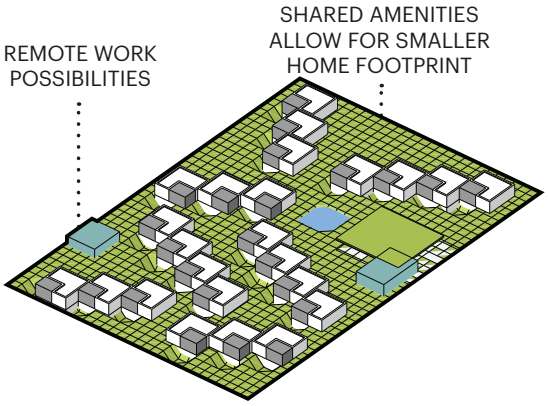
In Fig 2.4.1, units have been lowered into the ground creating a sheltered private sunken courtyard that makes basement living spaces more desirable and the natural cooling and insulation of the earth can be utilized. These massing studies were completed in order to calculate the ratio of lot size versus affordability. Maintaining green space and prioritizing site orientation for passive energy benefits limited the options to overpopulate the site. In order to accommodate more units, the units themselves needed to shrink.



SUN ACCESS STUDY
25 UNITS

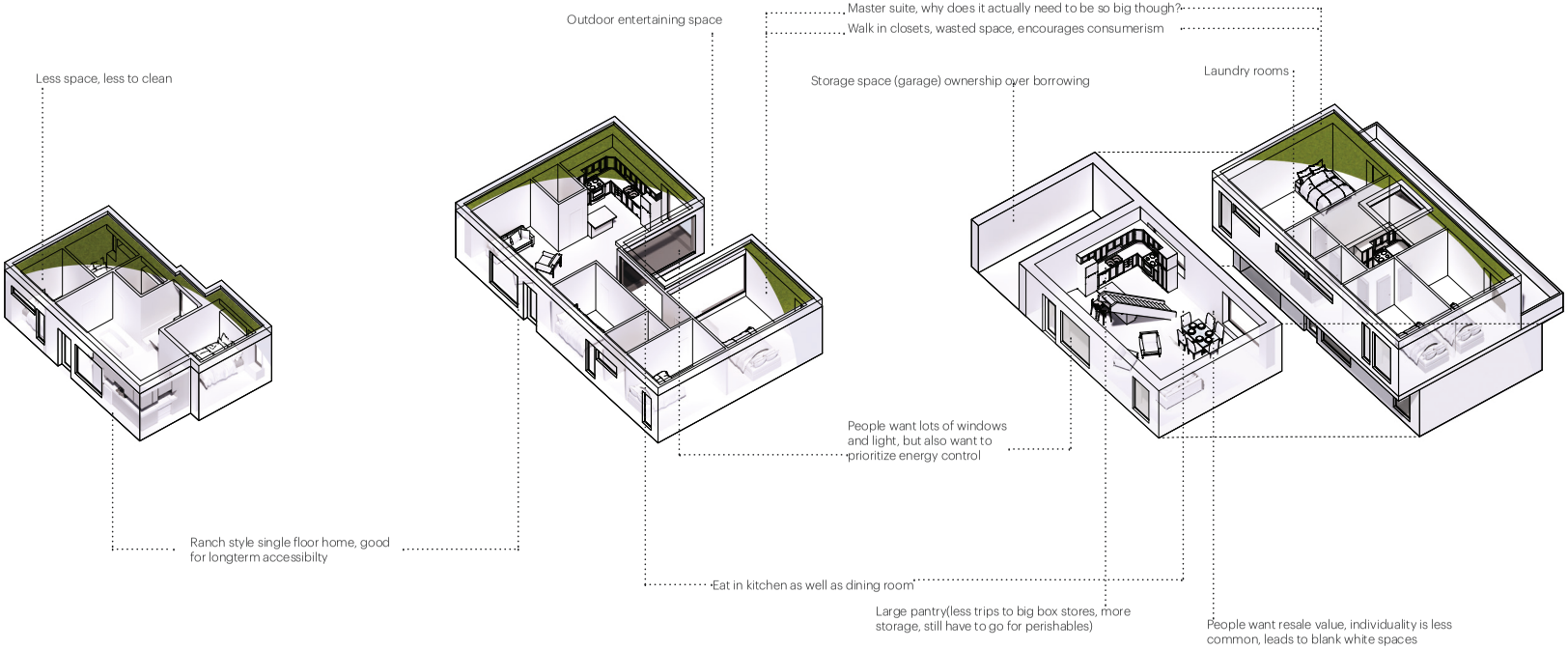


10mX10m Floor plan, 2 Storey
GREEN HOUSE LOCATION



LOWERED INTO EARTH
PRIVACY + COOLING BENEFITS

2.4.1 Orientation and organization study



More informal lifestyles, no need for casual and formal, opportunity for flexible spaces? Screens & flexible partitions vs interior wall
Convenience of private ownership over sharing
People dont like basements because theyre often shorter, and dark, but theres no reason for them to be- no real view, but option for private view

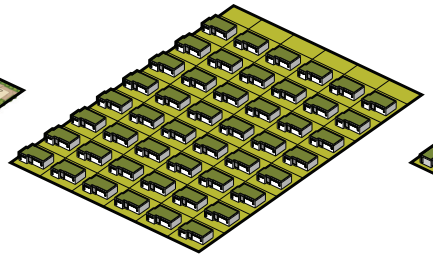
2.4.2 21st Century Housing Priorities

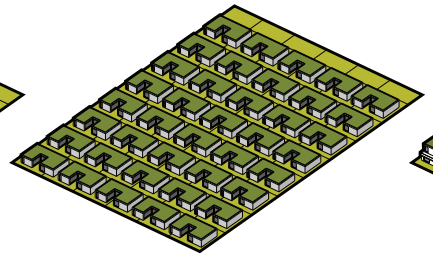
82 UNITS

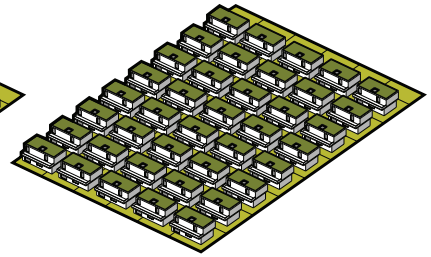
48 UNITS
$382,200
2600 sqft
520 sqft
=$460,200 @ cost

40 UNITS
$458,700
3150 sqft
1300 sqft
=$653,700 @ cost

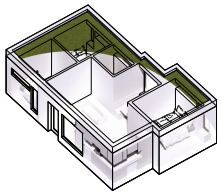
40 UNITS
$458,700
3150 sqft
2150 sqft
=$781,200 @ cost



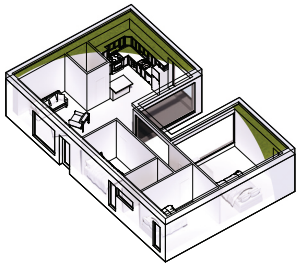




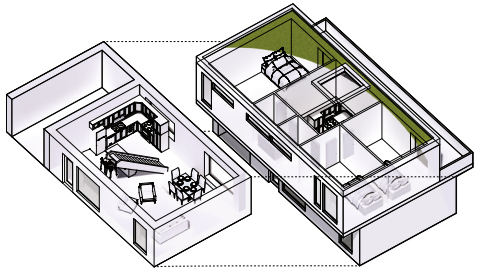
DEVELOPER TOWN HOUSE
200 BARIBEAU



TINY HOUSE PROTO



PROPOSED SCALE FOR FUTURE RESEARCH



PROJECTED SIZE OF 3 BDRM HOUSE 2030

2.4.3 Site layout of varying sq footage

The trajectory of data collected from housing plans throughout the past 10 decades, projected an average home size in 2030 to be 2150ftsq. Only 40, two-storey houses this size would fit on the lot and even at this low amount the yards would be negligible with access for emergency or private vehicle access essentially impossible. In response to this finding a single-storey three bedroom tiny house using the Ontario Building codes minimum room sizes became the new unit size. The result was a 520 sqft home of which 48 could fit on the site allowing a slightly increased yard space however site decisions still needed to be made as vehicle access was still an issue at this stage. Fig 2.4.3

"Designing smaller structures...can substantially reduce use of materials. Designing structures to modular material sizes can minimize construction waste." [15]

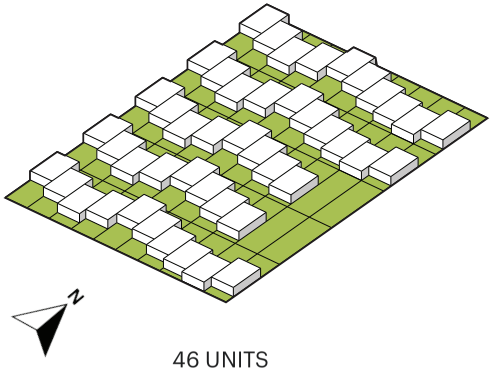
15 Calkins, "Materials for Sustainable Sites", 4

2.5 Community Land Trust:

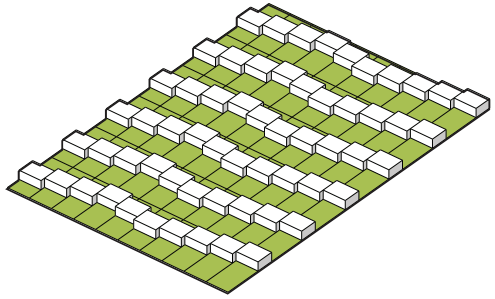
After modeling and estimating approximate costs of each option, the site needed to densify further with the individual house size shrinking from the "medium-scale option" initially considered. The unit size is equivalent to that of the tiny house option designed using building code minimums. The sites are further divided into 60 lots on the site on separate yards with one-way single car width access winding between the clusters. The entire land of the site is estimated at a cost of $18,342,000. For 60 units the land alone brings each lot to $305,700. Considering only this number, affordability of the design is already a concern. Fig 2.5.1

Community Land Trusts are becoming more prevalent in other countries and slowly being introduced to Canada. The premise revolves around individuals being able to own their home and not the land it sits on. A third party, often the government, owns the land in perpetuity and each house is sold on a 99-year lease. Each time a home is sold at an affordable rate the resale value is predetermined. By doing this the purchase of the home remains achievable for the next low-income tenant. In order to remain accessible, there is an application process in place that assesses the level of need within each applicant. Implementing this ownership model helps prevent the community from falling into a pattern of gentrification.[16] Fig 2.5.2 By removing the cost of the land from the equation, the importance of exterior spaces can be maintained and the community remains economically viable at a lower density. In utilizing the CLT system, the blurring of lines between neighbour's front and back yards as well as access roads is no longer an issue of ownership as the land is shared throughout.

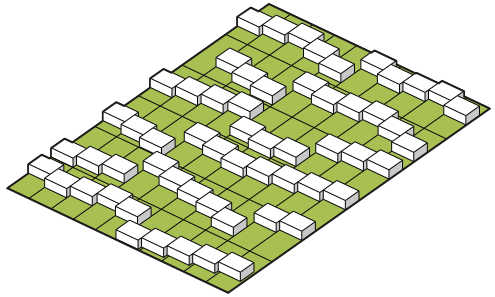
16 Canadian Housing and Renewal Association "Perpetual Affordability and Community Control of the Land: Community Land Trusts in Canada."



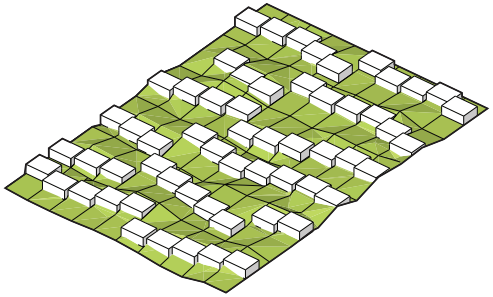
46 UNITS



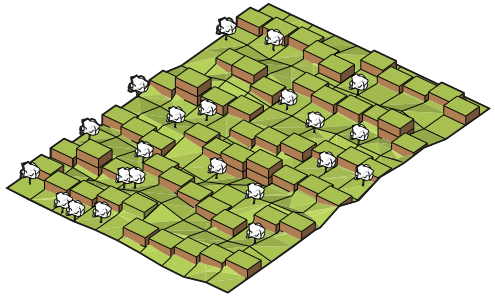
Denisty increase,
smaller units and lot sizes



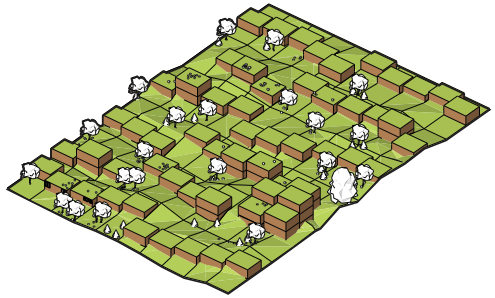
Shift dwelling location on plot
to open access paths



Manipulate berms for
geothermal benefits



Materiality and landscaping



Shift some units to midrise,
not all residents prioritise outdor space
opens up space for vehicle access

2.5.1 Orientation + Site study with increased units + decreased unit size

Affordable Living Solutions

Finances and Need

Avg. Ottawa Rent 2 bdrm

$2,023/month
$24,276/year

$24,276 = 30% Income

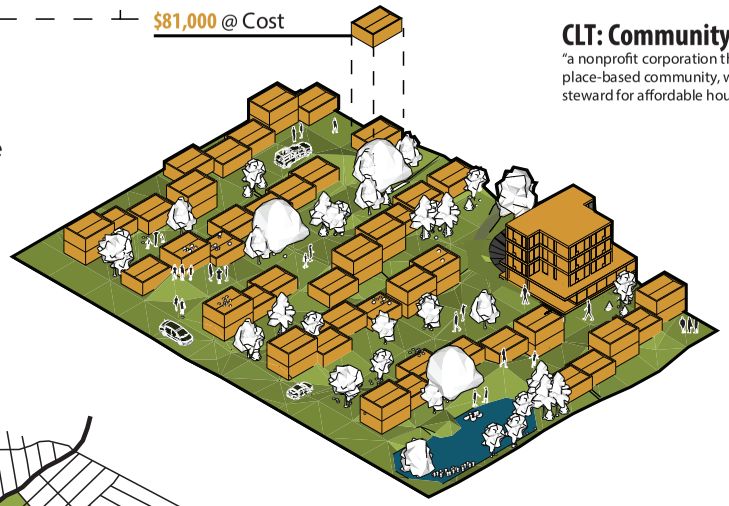
$78,900 = Avg. Household Medium Income for Site

3 Years 4 months of rent to Pay off House @ Cost

$81,000 @ Cost

$81,000 = 103% Income
$81,000 @ Cost

Price of lot only @ Cost
$305,700 (2098 ftsq)



99 Year Lease

House purchased @ affordable rate

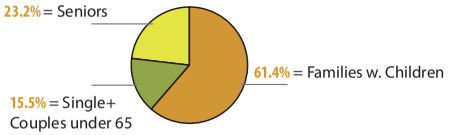
House sold @ previously determinded affordable rate

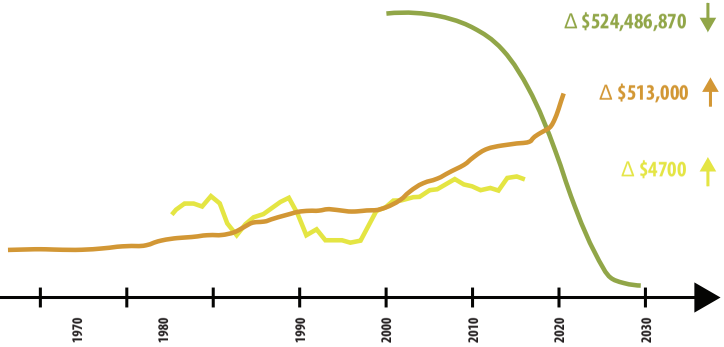
CLT: Community Land Trust

"a nonprofit corporation that holds land on behalf of a place-based community, while serving as the long-term steward for affordable housing"

Households on Waitlist for Affordable Housing

Ontario Non-Profit Housing Association (ONPHA) 2011 Survey





Avg. Price of Homes in Ottawa	$17,000	$530,000
Median Real Household Income in Ontario	$54,700	$59,400
Federal Social Housing Funding in Ontario	$525,000,813	$531,943

2.5.2 Affordable Living Solutions

3
The Unit

3.1 Earthship

The lowering of houses into the earth was further investigated following exposure to construction methods of the Earthship.[17] Fig 3.1.1 Michael Reynold's experiments with the Earthship design were predominately facilitated in the southern desert areas of the United States, a climate quite different to the thesis site in Ottawa. Although less common, people in the northern hemisphere have constructed successful versions across Canada including two Earthships in the greater Ottawa area.[18] Fig 1.2.2

There are several requirements in order for a construction to be classified as an "Earthship".

The principles as must incorporate:

Thermal and Solar heating and cooling

Solar and Wind electricity

Greywater, Blackwater, and Contained Sewage Treatment

Natural & Recycled Materials

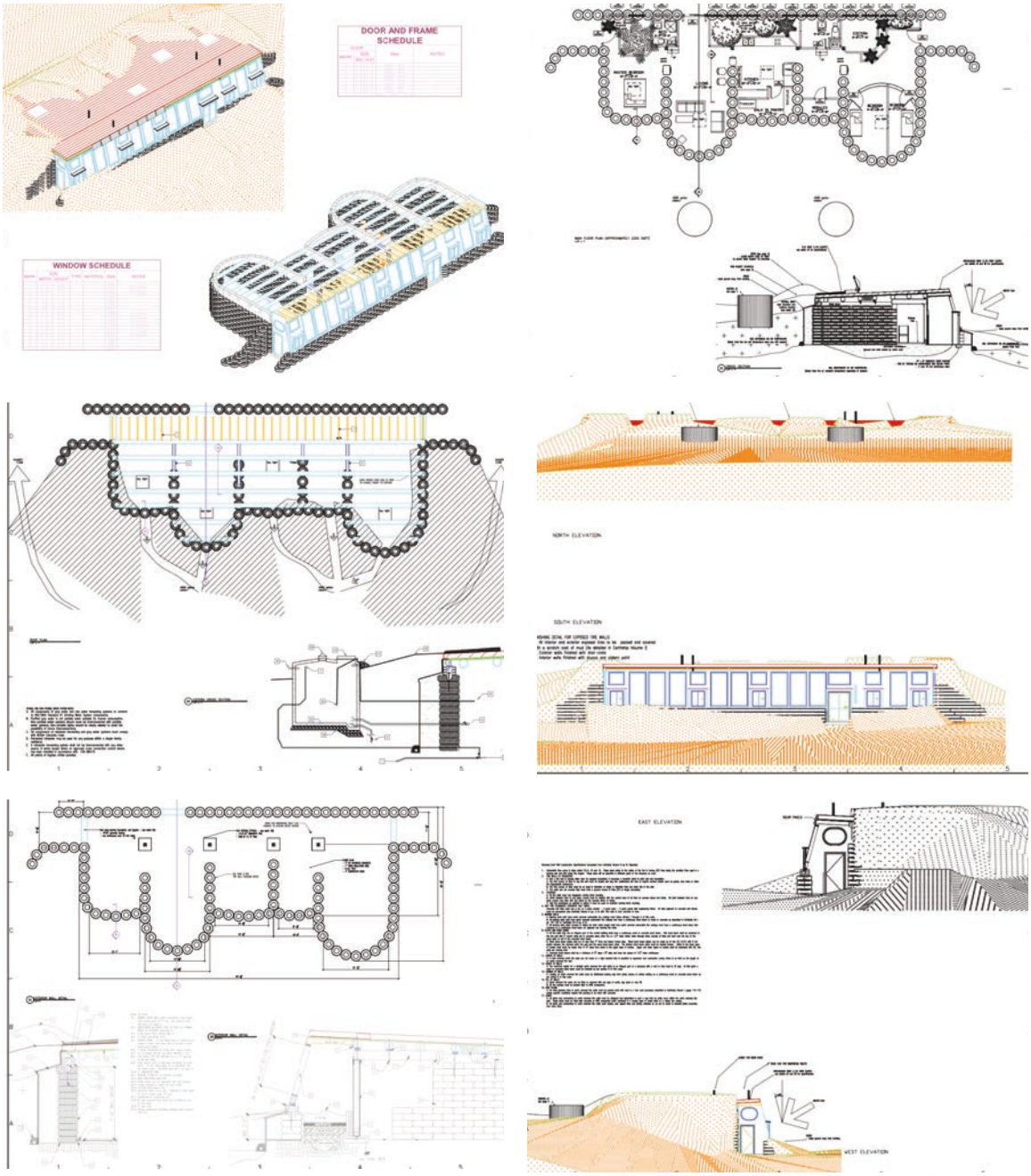
Water Harvesting

Food Production[19]

17 Darren Roberts "Earthships 6 Principles • Interconnected."

18 Blevac and Mgraf, "Graf-Levac Earthship," Graf-Levac Earthship, January 2, 2014, http://earthship.rlds.ca/.

19 Darren Roberts "Earthships 6 Principles • Interconnected."



3.1.1 Architectural plans from Darfield Earthship in South Central BC, Canada

Due to limitations from climate, proportions of each individual home within the greater site, and certain infrastructure requirements laid out in the building code, only some of these design decisions made sense to implement.

Fig 3.1.2 The house proposal would be lowered into the earth on the north side and opened up to allow sunlight to penetrate the south elevation, thus incorporating berming without the use of the reclaimed tires.[20] Buried into each berm would be a greywater collection system to take pressure off the local infrastructure. As Ottawa receives a large amount of renewable energy from the hydro dams in the Ottawa River the priority for solar panels would be an optional addition for homeowners. The decision to not include solar panels frees the roof to be used for food growth, utilizing the surface's unobstructed access to the sun.[21] The flat roofs are designed to be occupied by both humans and plantings, using a standard EPDM system covered with slats and decking. This allows rain to water the plants as well as collect and be transported to the grey water tank situated in the berm behind the units.

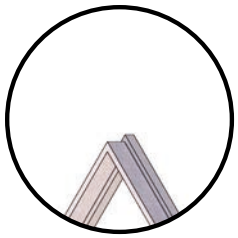
Concrete involves the exorbitant consumption of sand and water yet still has many beneficial qualities most notably its structural and durability.[22] It will be used for the footing and foundation retaining walls as the rammed earth is not strong enough to hold back the berms on the north side. Rammed earth has been successful used in various projects in the Canadian climate. Several of these projects were referenced when detailing the units.[23] Another embodied energy concern is the removal of earth from the site when digging foundations and basements. Site soil that meets the necessary requirements for rammed earth construction can remain on-site to be repurposed. The other earth can remain also, and be relocated to form the berms and proper grading of the site.

20 Olgyay, "Design with Climate: Bioclimatic Approach to Architectural Regionalism", 54

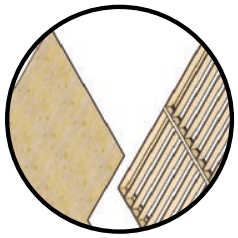
21 Friedman, "Fundamentals of Sustainable Neighbourhoods", 89

22 Sabnis, "Green Building with Concrete", 10

23 Rael, "Earth Architecture", 105



Concrete foundation



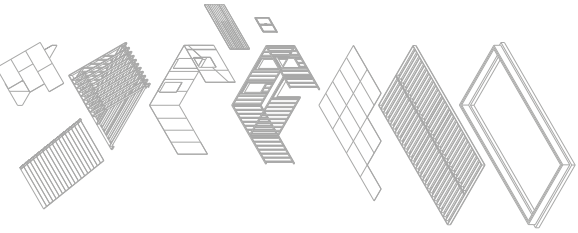
Wood frame floor plate

Bitumen roofing

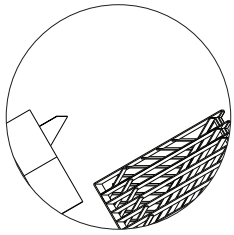
Tire retaining wall and berming

Grey water collection

Interior glazing for light and solar heat gain

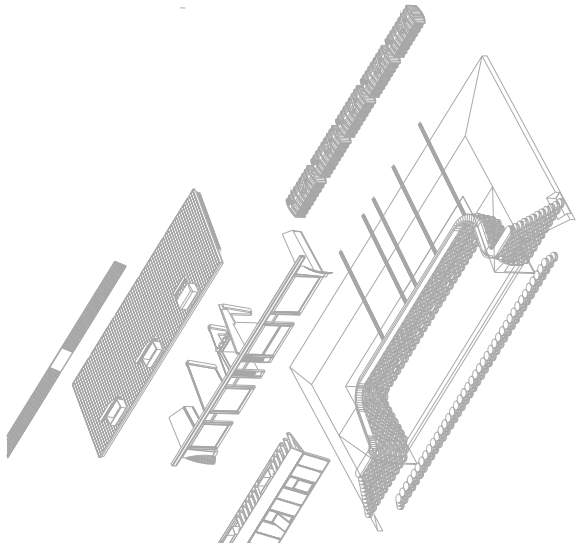


Light frame wood Construction

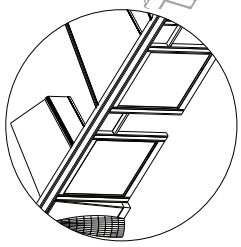


A frame roof

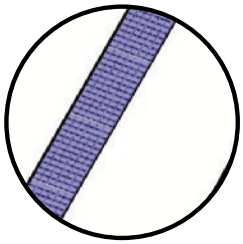
Light frame wall structure



Earthship Construction



Exterior glazing to create greenhouse envi-ronment for food production



Flat roof and solar panels

3.1.2 Construction Methods

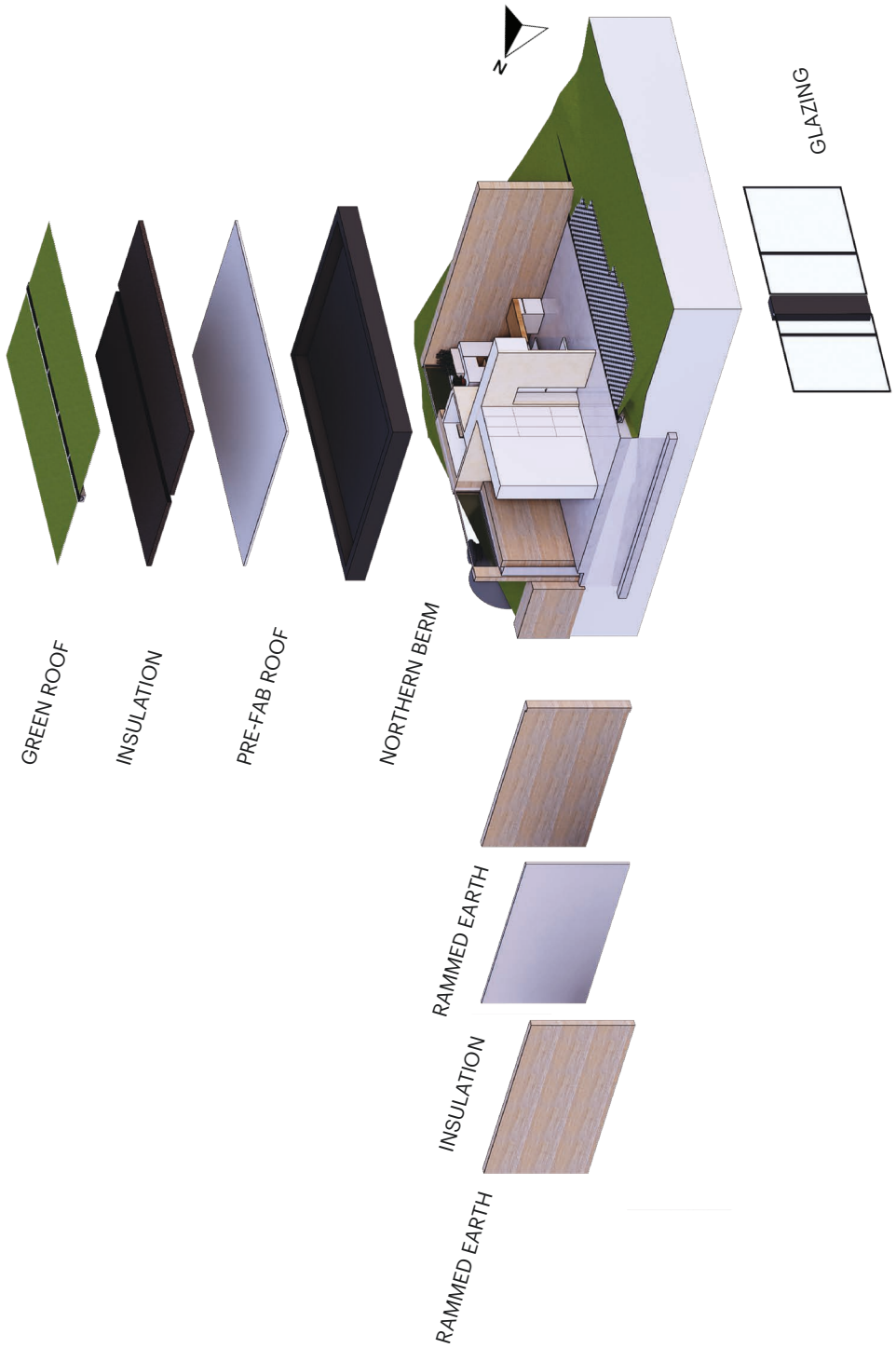
3.2 Light frame: Mass Production 21st C. Traditional

The design decisions from the Earthship construction methods are paired with modern traditional light-frame construction methods. The use of wood for small-scale buildings is encouraged as wood is in fact a renewable resource. The forests across Ontario allow for a sustainable amount of harvesting and regrowth. "Lumber, engineered wood products, and many biobased products sequester carbon until they decay; then it is released."[24] The priority for these developments would be to ensure that the processing of the harvested trees be done in local facilities to minimize the embodied energy of the lumber itself. Less transportation resulting in less pollution. The interiors of the ground floor along with the framework for the foundation would be constructed entirely with locally procured and prepared lumber. Due to the short spans of the home, lumber can also be used to construct the roof and wood framed high efficiency windows incorporated throughout the project.

The decision to use large mass walls for temperature control reduces usable floor area. In order to minimize losses the houses were clustered for efficiency of space and additional climate control.[25] The houses are positioned on the site in groups with shared party walls that sit with the lot line running at the halfway point. Removing the narrow access points between each home opened up a larger pathway or road between every four or five homes. The berms piled up on the north side of each cluster taper to street level grading on the glazed south side. Fig 3.2.1

24 Calkins, “Materials for Sustainable Sites”, 8

25 Friedman, “Fundamentals of Sustainable Dwellings”, 55



3.2.1 Phase 1 unit assembly

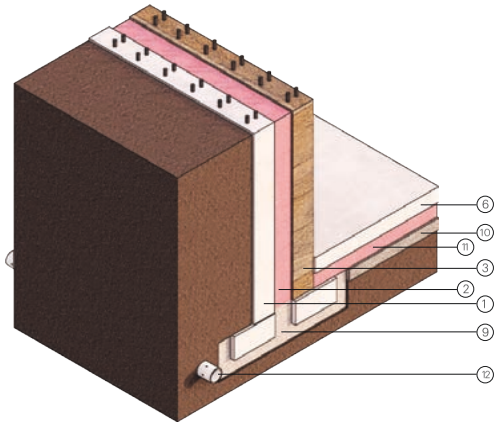
3.3 Modular Construction

In order to adapt to the various lifestyles and needs of an ever changing population these homes will accommodate, the need for flexibility is paramount. Flexibility to accommodate the owner's lifestyle as it evolves over time. Initial construction and conventional renovation techniques tend to result in an incredible amount of material waste. It is important for this proposal to be flexible without wasteful renovation, to be taken apart, and shifted in whole units without the need for complete destruction or discarding. The idea that a home is never truly complete opens up a wide range of possibilities. Due to the implementation of various structural and code requirements, “self-build” options have limitations. A series of modular components helps to limit the amount of waste. The initial phase of foundation style construction is functional on its own and incorporates the necessary parts to accommodate additions and transformations. Fig 3.3.1

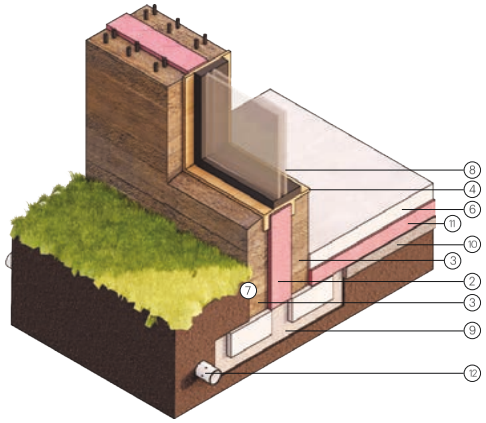
Renovation is often a long tedious process that tends to stretch out even longer than anticipated. It is a process that disrupts the tenant and also their neighbors. The intention with a prefabrication model is for the majority of assembly to be completed offsite with an extensively shortened installation time. Within the controlled environment of an factory there is more predictability throughout the entire process.[26] The buyer can travel to the local fabrication site and tour their new addition before it is delivered. Fig 3.3.2

Comparing the current proposal to a typical development proposal for the same site we start to see the potential for urban agriculture, a robust community, and site orientation that can make use of solar passive heating and cooling opportunities. Fig 3.3.3-4

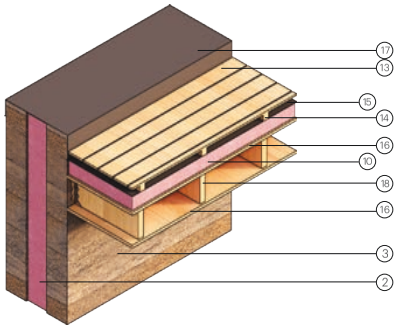
26 Smith, “Prefab Architecture: A Guide to Modular Design and Construction”, 288



3.3.1(a) Detail: Foundation @ Berm

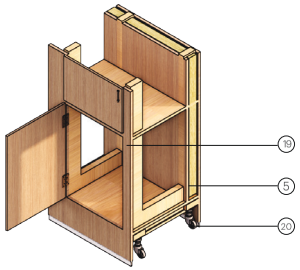


3.3.1(b) Detail: Exterior @ Grade

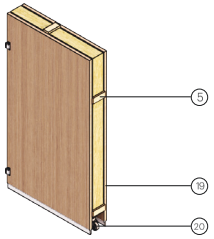


3.3.1(c) Detail: Exterior @ Roof

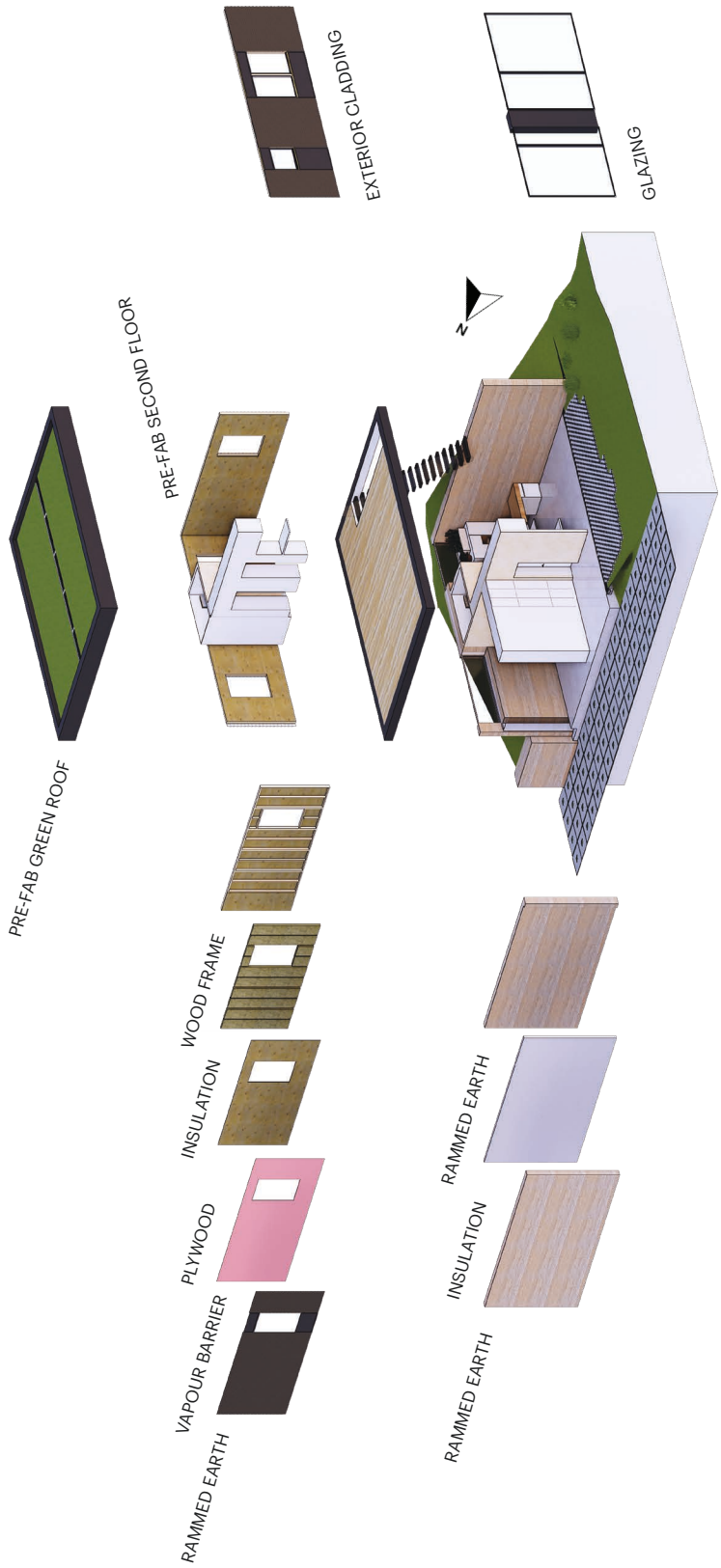
1. 6" Reinforced Concrete
2. 6" Recycled commercial-grade polysio foam
3. 6" Reinforced Rammed earth
4. Plywood buck
5. 2x4
6. 4" Concrete slab
7. Dimple drain
8. High Efficiency Window
9. Prefabricated EPS Footing Form
10. 4" XPS insulation
11. 4" Gravel drainage layer
12. Perimeter drain system
13. Decking
14. Tapered 2xPT sleepers resting on roofing
15. EPDM protection sheet
16. Exterior grade plywood
17. Metal flashing
18. 2x8 Joists @ 18" o/c
19. Treated plywood
20. Mobile wall system



3.3.1(d) Detail: Storage partition



3.3.1(e) Detail: Standard partition



3.3.2 Phase 2 unit assembly

82 UNITS

TOWNHOUSE

CAR ORIENTED

1500 sqft

MINIMAL GREEN SPACE

3.3.3 Hobin Architecture Site Plan

60 UNITS
$305,700
2098 sqft
540 sqft
=$386,700 @ cost

3.3.4 Schematic Site Plan (Cost Estimates prior to CLT incorporation)

3.4 A Housing Unit for the 21st Century:

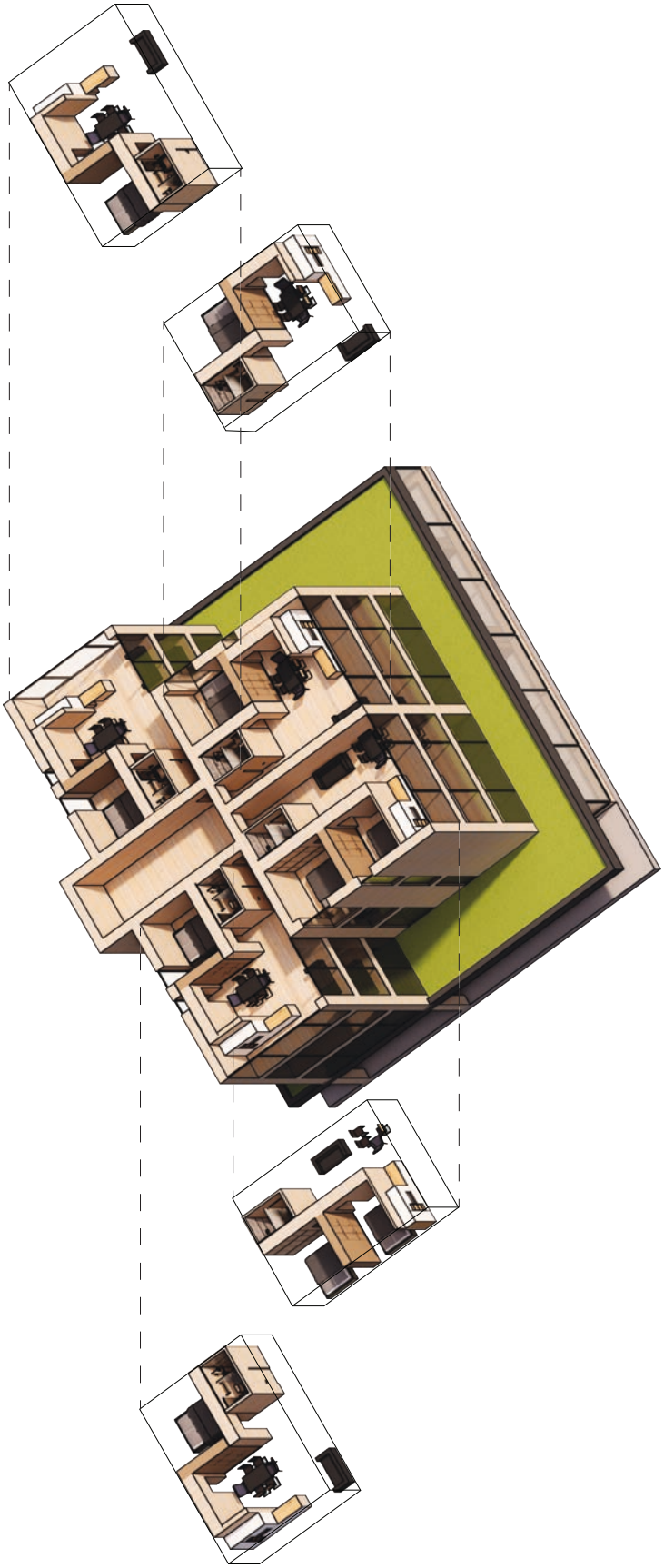
The same small-scale home can be adapted to some of the diverse living situations as previously discussed. The initial units built into the site are constructed using concrete foundation/retaining wall where structurally necessary. Concrete combined with rammed earth construction provides a more natural and sustainable approach to a dense thermal wall. Glazing is predominant in the south with clerestory windows on the north side,allowing for egress and less direct daylight access. Interior partitions have been thickened to double as storage opportunities and to hold service circulation. The flat roof allows for green roof technology and/or greywater collection. A water tank can be built into the northern berms.

As the homeowners begin to improve their financial situation, their foundation can accommodate a vertical expansion. The prefab design aims to prevent waste during buildout and consist of minimal time where the neighborhood is in a state of heavy construction.

Ecovillages previously referenced, scattered across the globe, incorporated certain facilities that enhanced the neighborhood's quality of life. In order to maintain a range of options for all types of low-income residential needs several of the initial housing units are clustered on the southeast corner of the site. These homes still utilize the project's passive design methods and provide an increased density midrise opportunity for individuals who do not prioritize having a yard. The site design decisions are primarily made to prioritize the pedestrian while maintaining necessary access opportunities for emergency and maintenance vehicles or close proximity to homes for larger deliveries, including second-story additions. Creating a midrise version of the units opens up the opportunity to house larger mixed-use community spaces, exercise facilities, as well as underground parking for those who are unable to rely solely on the nearby public transit system. Fig 3.4.1

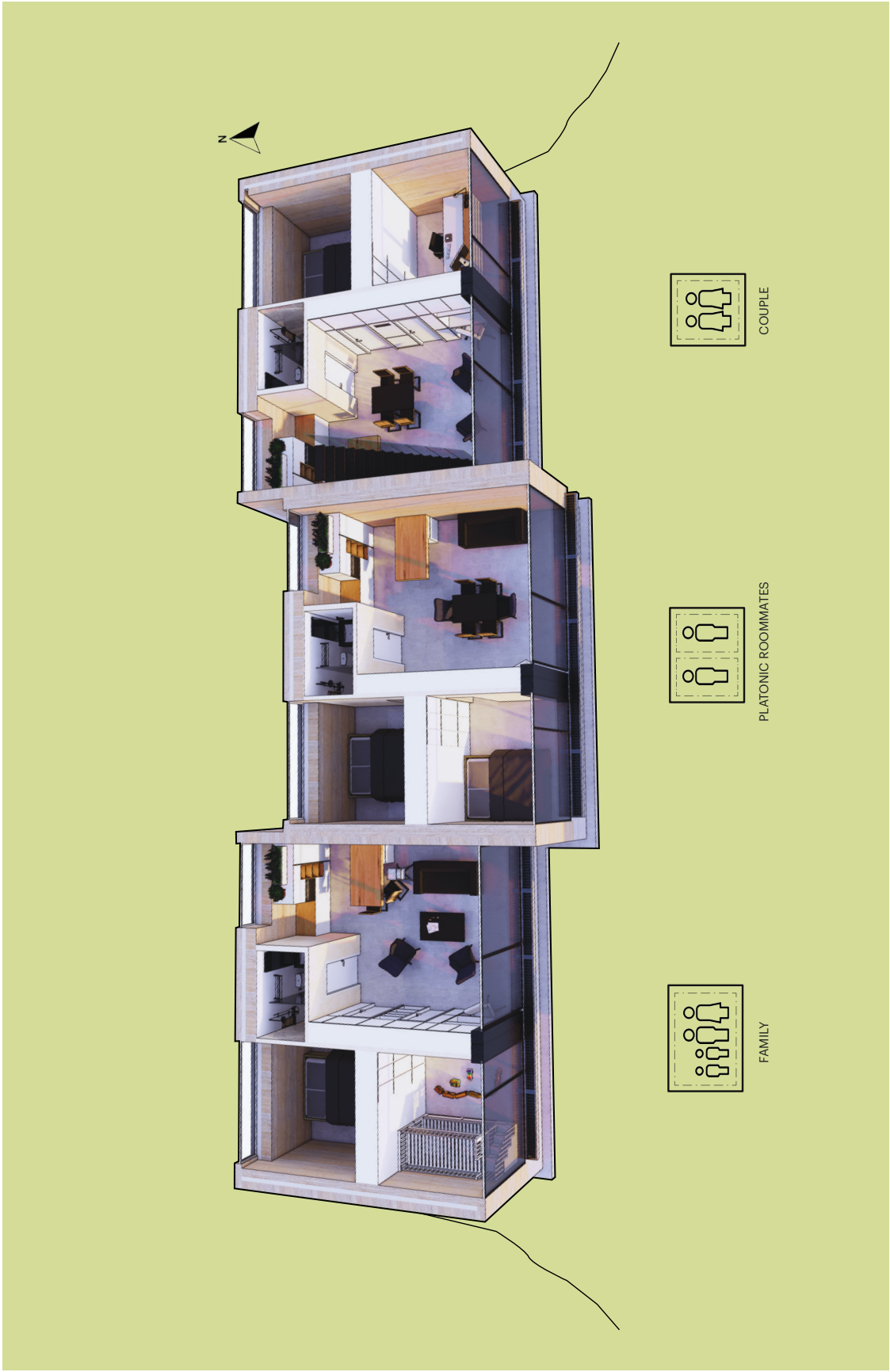
The number of units on the site has stayed the same and the vacant lots where houses were moved from open up a full length access road on the western and a stormwater collection pond on the Southwest corner to accommodate the needs required by the site falling into a flood plain.

The goal of this neighborhood format is to be repeatable across a range of sites and cities. The main concepts can be duplicated to meet the needs of each unique location. In order to maintain a sense of practicality, the design still considers solutions for site-specific conditions.



3.4.1 Midrise Unit Orientation

4
The Substructure



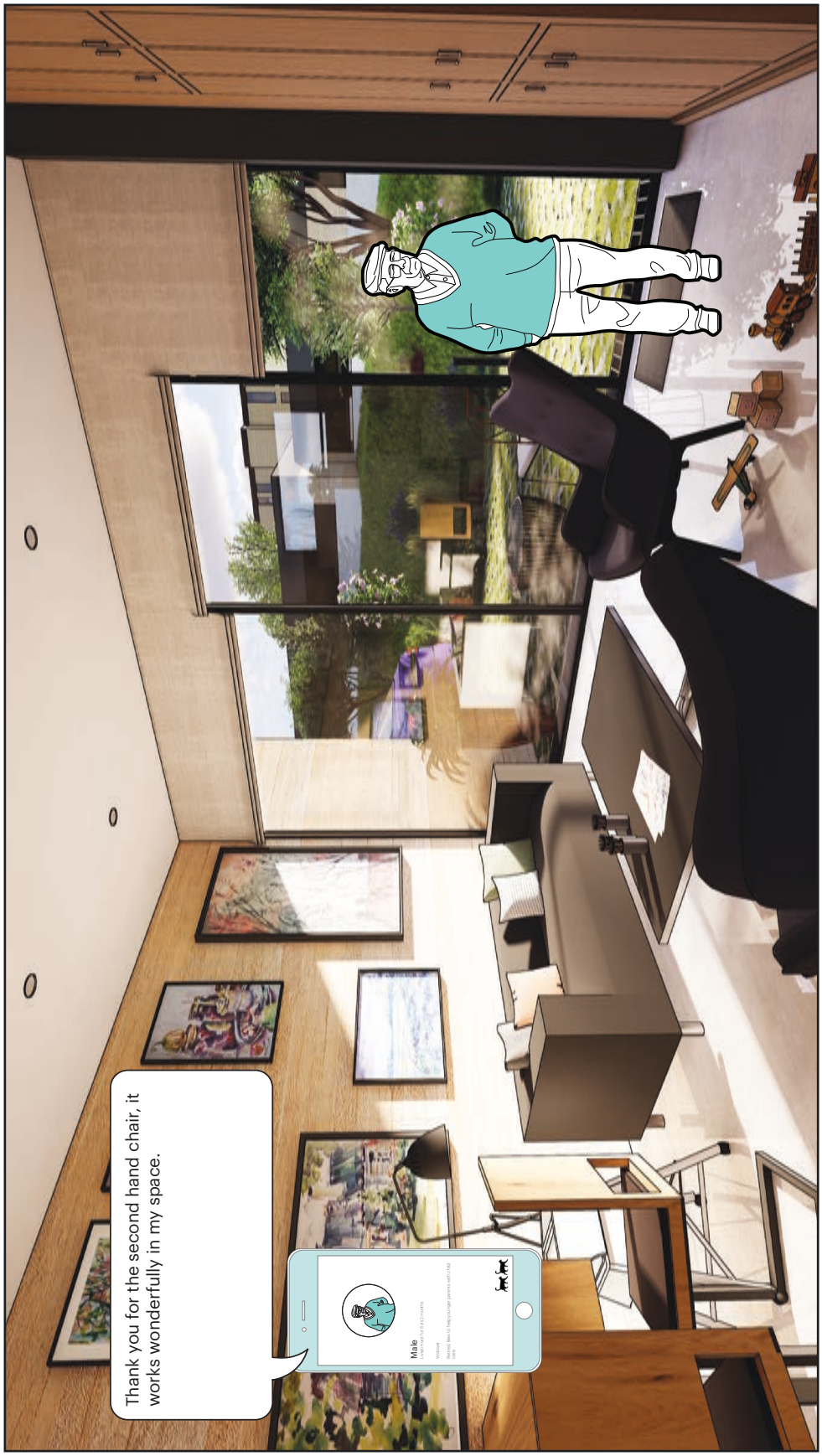
4.1.1 Diverse Living Options

4.1 Landscape:

The goal of this proposal is to combine affordability, flexibility for growth and densification, and an environmentally conscious approach to site. A large amount of water is repurposed to maintain lush green lawns and flower-beds across the country. In order to minimize this, the landscape is also carefully considered. Ground cover across the site consists of low-maintenance landscaping such as creeping thyme and clover. Where the grade slopes, and elevates, planting can consist of ornamental grasses, succulents, sedums, and other low water requiring foliage. Plants with a higher need for water can be situated at the base of the various berms.[27] Fig 4.1.3

Residents are encouraged to grow vegetables and other edible plants at grade alongside the porous paving as well as the rooftop gardens which can be accessed from the berms on the north side or a ladder on the south side. Bushels of kale, tomato vines, and corn stalks, can all act as ornamental plants when mixed in with a variety of native wildflowers. The function of the plant does not need to be mutually exclusive.

27 Friedman, "Fundamentals of Sustainable Dwellings", 206



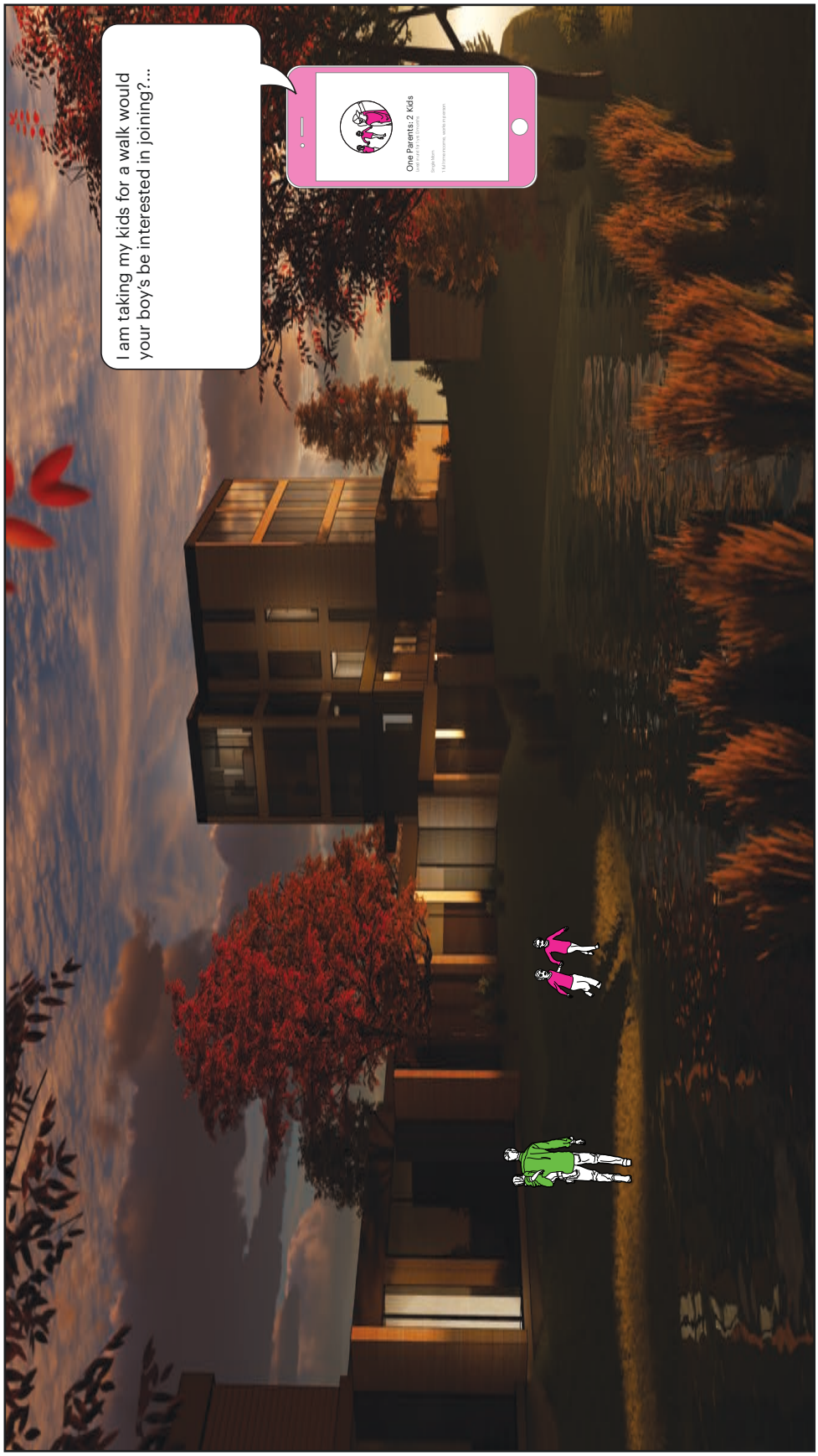
4.1.2 Vignette: Interior Exterior

4.1.3 Vignette: Exterior Circulation

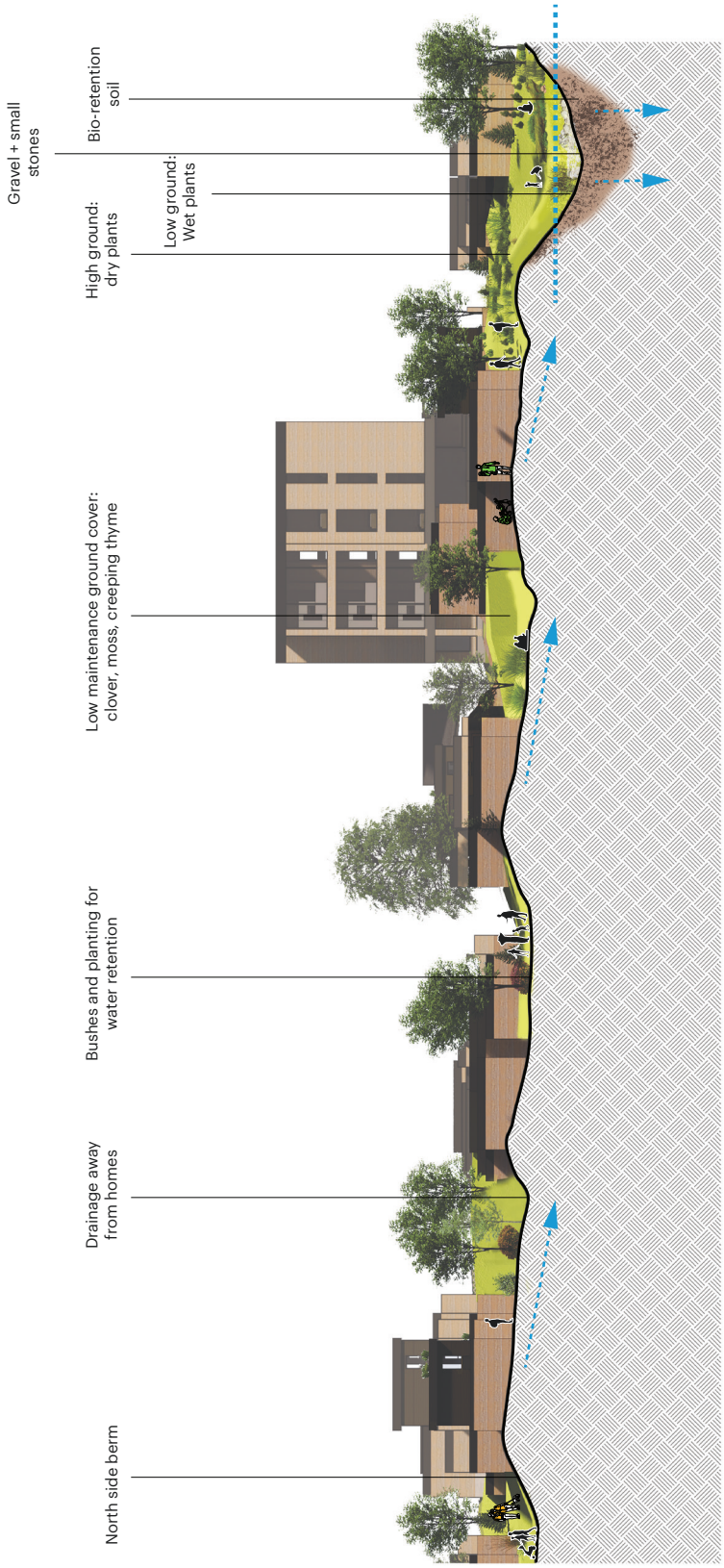
4.2 Flood Plain:

In order to use parts of the site to control the potential for flooding a storm-water pond has been located on the south end of the site. In addition, there are no impermeable surfaces on the site. Fig 4.2.1 All necessary access roads are constructed using permeable porous pavers that can still be cleared in the winter by raising the plow a couple of inches off the ground so as to not damage the growth and pavers underneath."The use of permeable cover rather than asphalt as a street surfacing material will better contribute to the returning of rainwater to nature."[28] Fig 4.2.2 The remaining snow can melt on its own accord or remain as a still navigable surface for cars and emergency vehicles. All flat roof surfaces are connected to gray water collection systems and therefore do not oversaturate the groundwater.

28 Friedman, "Fundamentals of Sustainable Urban Design", 22



4.2.1 Vignette Shared outdoor spaces



4.2.2 Site section flood draining strategy

4.3 Partitions:

Every building provides shelter and safety, yet a home becomes highly personalized as it is lived in. In this proposal, the interior partitions are a vehicle for this personalization. "But always the users make and remake their spaces _ by rebuilding, remodeling, decorating, furnishing, landscaping, or simply by dwelling within the forms and spaces of domestic architecture."[29] In most situations, a home is based on the predetermined positioning of these partitions. Buyers walk through a home and determine whether their needs can be supported within the permanent dissection of the space. Perhaps the space meets 80% of their needs but through a reasonable renovation, the space can perfectly support their current and foreseeable lifestyle.

What if a home could support the needs of a more diverse range of activities or spatial requirements without renovation?. The open floor plan is widely understood and has become commonplace. It allows the kitchen, dining, and relaxing spaces to blend into one another supporting both occupants who desire more eating space as well as those who require more lounging space. All one must do is occupy more of the open floor space with the appropriate furniture. It is the arrangement of the furniture that begins to divide and differentiate one function from the other. This layout solves the requirement of space but does not accommodate the desire for privacy. Sound, sight, and smell all intermingle within the space. If the need arises a new space is needed either detached or permanent, through destruction and renovation.

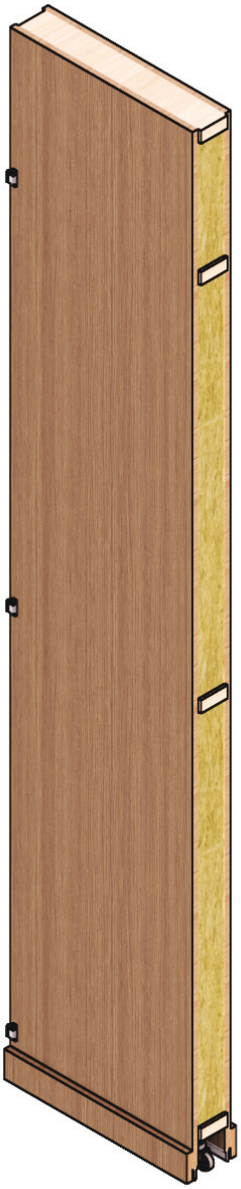
29 Lane, “Housing and Dwelling: Perspectives on Modern Domestic Architecture”, 2

A movable partition provides a solution for new spatial requirements. Movable and flexible partitions are no new concept and have been used for centuries. At this stage the majority of them appear to hold only a functional or institutional aesthetic, thus discouraging their implementation in a residential setting. But what differentiates a commercial or institutional partition from a residential partition? Quite often that difference comes down to finish and materiality, ease of usability, and hardware. All of these items can be refabricated to meet the needs of residential space.

Often partitions in residential spaces act as the backer for a desk, the home of a piece of artwork or infographic, and most commonly mesh together to provide closet space. Even if the partition moves the items inside may need to be relocated piece by piece. This can also be reimagined. By increasing the thickness of the partition the wall can become the storage and as a whole, the parts can be relocated to accommodate the new desired space.

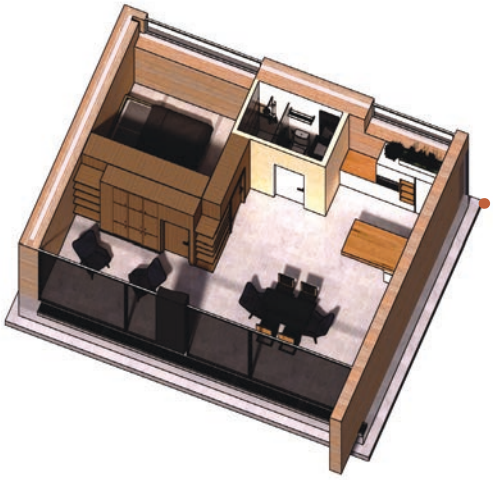
The importance of acoustic design will always be crucial when maintaining a sense of “home” but the sound dampening materials such as insulation can still be entrenched within the partition and allow for storage in the surrounding chasm. In order to remain a wall and not a screen, the connection to the floor and ceiling must be carefully considered. This has been explored more in the appendices.

Modular Storage Wall



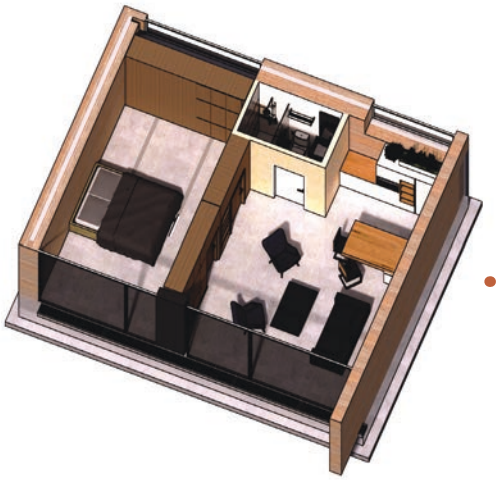
Modular Partition Wall

4.3.1 Partitions full height



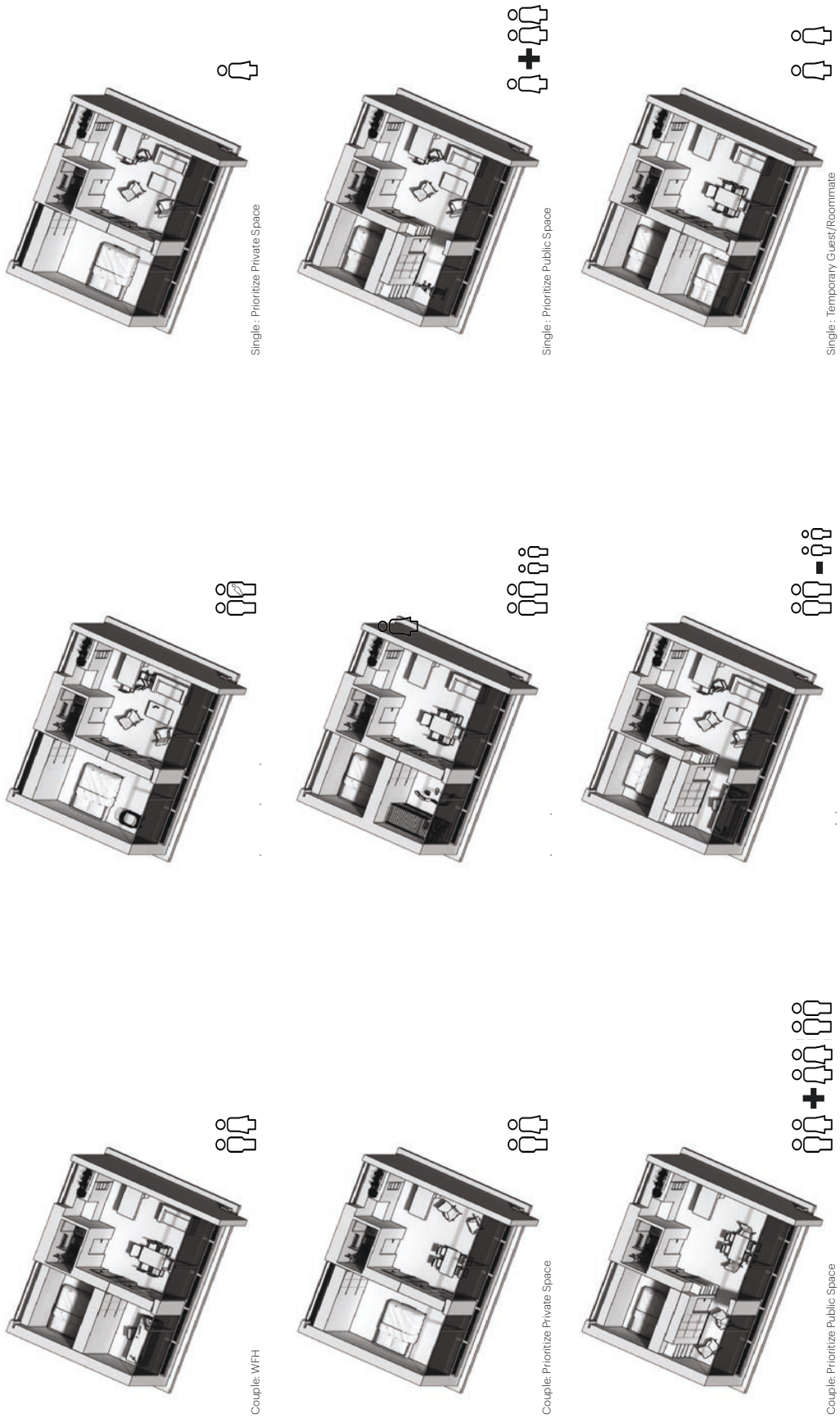
Wall in **OPEN** orientation

Maximum **DIVISION**



Maximum **OPEN SPACE**

4.3.2 Unit division options



4.3.3 Unit adaptability study

4.4 Neighborhood Sharing:

Low density suburban neighborhoods tend to engender social isolation. A large reason for this is simply proximity. Urban design paradigms that privilege vehicular circulation limit more natural face-to-face interaction. Those living in suburban sprawl can go weeks or months without once crossing paths. There is no formal organization of events or community programs without volunteers.

Suburban planning principles perpetuate the concept of independence and capitalist consumerism. Everyone is encouraged to own their own "everything" thus removing the need to rely on any neighbors. For example, a lawnmower is an expensive item. Depending on the weather and season it may be used for 20 minutes a few times a month. It is rare that everyone on a 20 house street will be mowing their lawn at the exact same time yet everyone owns their own and thus requires the space to store this large item. The same concept can be applied in winter when it comes to shovels and snow blowers.

There are certain opportunities that arise when you situate these houses in close proximity to one another. They say that good fences make good neighbors. The hope with the individual home designs is that they support affordability without compromising on privacy. This has been considered with the use of high mass exterior walls and strategic orientation of the glazing. The emphasis on pedestrian circulation throughout the site begins to open more consistent organic interactions between neighbors.

Not all residents of this community will necessarily need offsite workspaces, exercise facilities, larger meeting spaces, or other amenities. The privilege of living on the site does not aim to include a mandatory condo fee but rather uses the space to house amenities that can be opened up to the larger community. Those within the site will maintain some level of priority but the cost of running certain facilities can be subsidized by owners of the surrounding homes.

Fig 4.4.1 Additionally, not all services necessarily need to have a charge. The diversity of the neighborhood opens up the shared use of tools, non consumables and other items that may only be needed a few times a year or a lifetime. The trade of goods and services or simply a neighborly loan can be encouraged.

Fig 4.4.2 As well as useful objects the number of different skills that the individuals in the neighborhood hold allow for mentorship and local convenience.

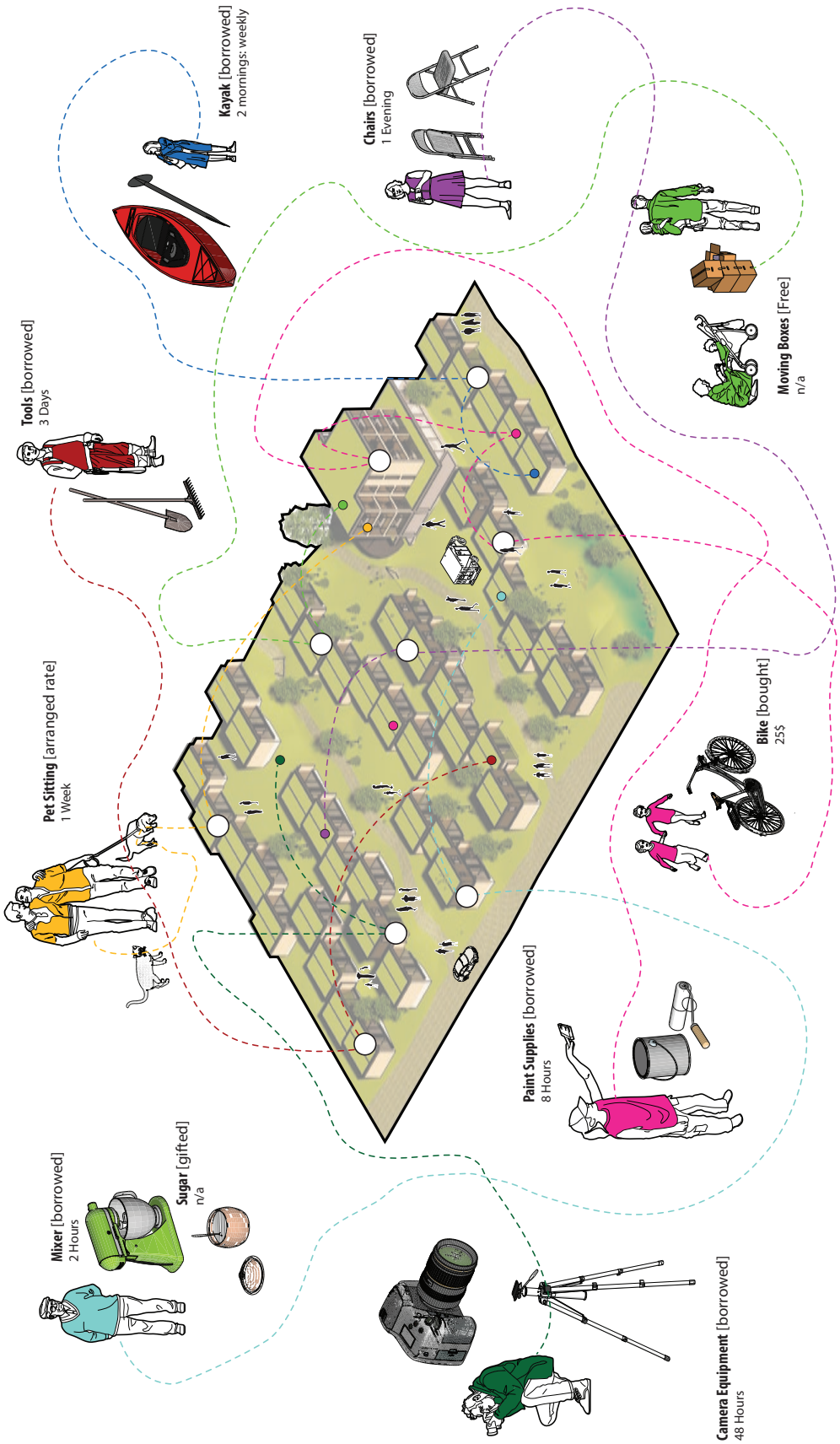
The proposed community space will utilize the same parition technology, providing a space that can be opened up or divided to support the community's needs. 4.4.3

West View

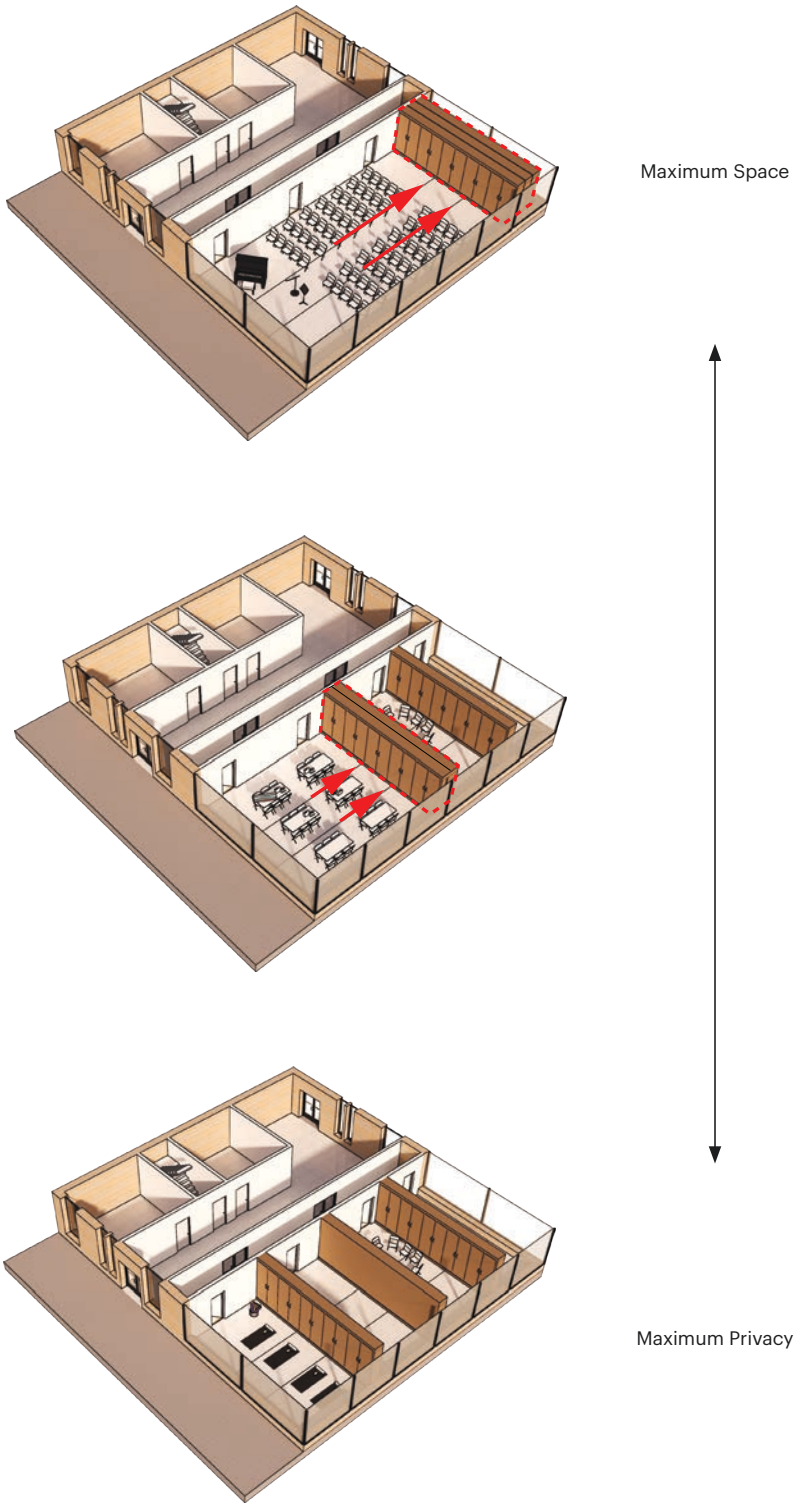
North View

South East View

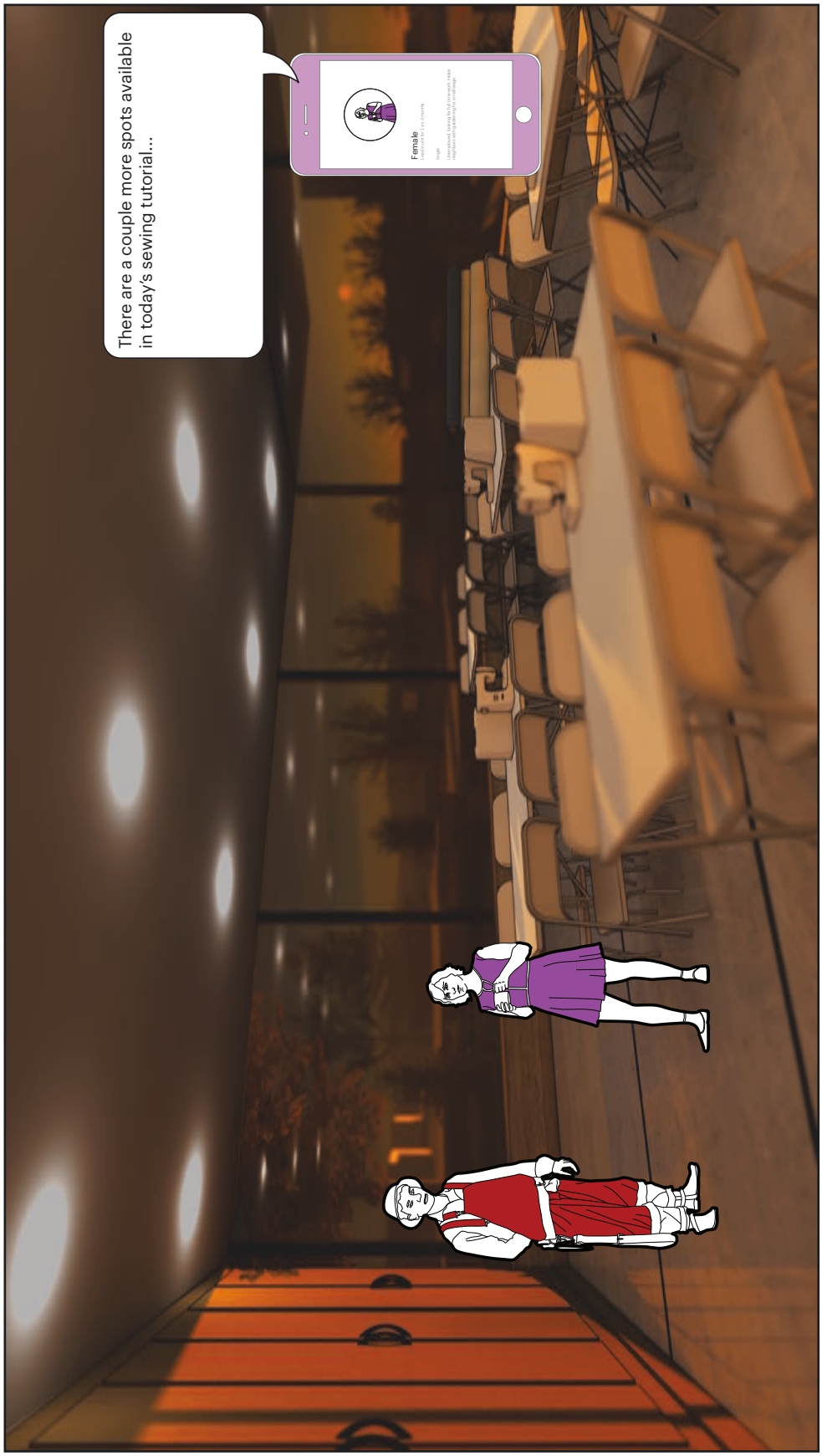
4.4.1 Midrise Views



4.4.2 Neighborhood sharing



4.4.3 Partition Adaptability Shared Spaces



4.4.4 Vignette Community Space

4.4.5 Vignette Residential Boundaries Bluured

4.4.6 Circulation and occupation within greater community

5
Conclusion

Conclusion:

This project aimed to provide an alternative for mass produced single family homes. As research progressed the goals evolved to accommodate both resource sustainability as well as the quality of life of these individuals. The unit design successfully incorporates passive design methods drawing inspiration from the Earth Ship design by Michael Reynold's. The design aims to take stress off of the earth through renewable material choices as well as incorporating water and heat collection methods that take stress off the existing infrastructure.

The modest unit size allows the occupants to be homeowners as opposed to rent tenants and promotes a more mindful lifestyle as the tiny house design cannot support the trends of consumerism and excessive individual ownership. As a member of the neighbourhood the tenants benefit from the shared green space in an urban core, made possible through the community land trust method. Additionally, exterior space is not the only thing the community members can benefit from, shared equipment and tools help neighbours to save both money and space. By working together to share their possessions, skills, and time they have the benefit of feeling a sense of belonging and purpose. This is a stark contrast to the isolation that car-based suburbs have created on the outskirts of downtown cores.

The incorporation of the midrise development provides opportunities to those who connect to the neighbourhood's concept but have no desire for a yard, preferring the privacy and sightlines gained from being elevated above the street. The footprint of the midrise's ground level allows for larger public shared and flexible amenity space. The continued use of the designed flexible partitions helps to divide or open up the space while acting as secure storage lockers for the community members. Class supplies and commonly used equipment can remain in the amenity space. Sharing locker combos can allow borrowing to occur without dealing with meetup availability conflicts.

Capitalist systems have accelerated the issues associated with consumerism and resource depreciation. This community design is an attempt to provide an alternative to those who desire the independence of ownership yet see the benefits that are possible when being a part of a larger collective.

Appendices

1. Prototype Documentation: Digital Fabrication, 1:12 Scale Device
2. Prototype Documentation: Acoustics, Sound box tests
3. Prototype Publication

1. Prototype Documentation: Digital Fabrication, 1:12 Scale Device

Computation_CNC Routing, 3D Printing, Lasercutting

Partition: Design and Fabrication

How does a small space remain functional yet flexible?
The home provides shelter and safety from the exterior elements. The roof and walls supply these two functions on their own, it is the interior partitions and contents that start to transform a shelter from a place of pure function to a personalized home. In most situations, individuals chose their home based on the predetermined positioning of these partitions. They walk through a home and calculate whether their needs can be supported within the permanent dissection of the space. Perhaps the space meets 80% of their needs but through a reasonable renovation, the space can perfectly support their current and foreseeable lifestyle.

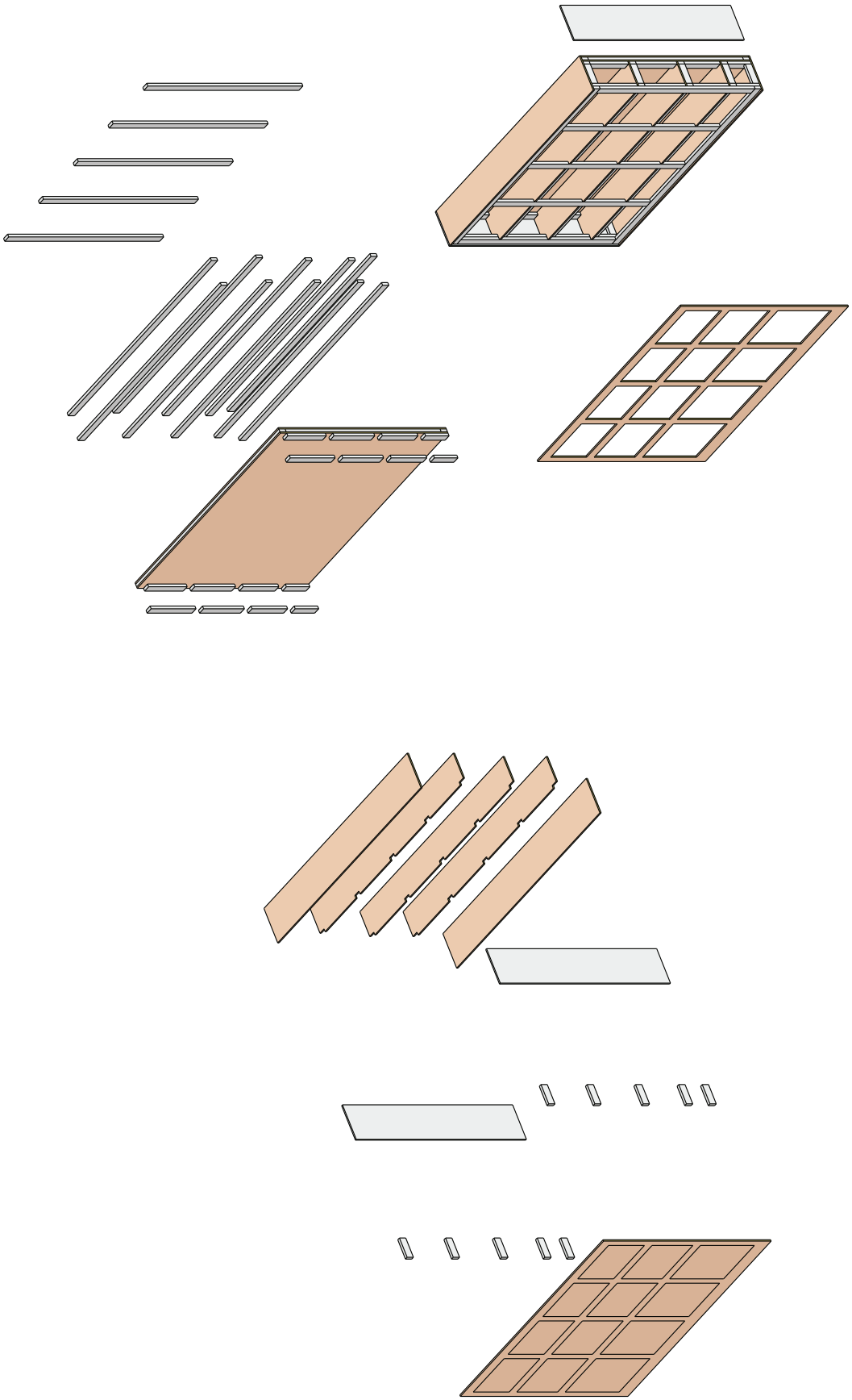
What if a shelter could be a home and support the needs of a more diverse range of activities or spatial requirements? When designing a home its occupants consider their dynamic needs as well as storage needs. They need space to use their tools and collectibles but also need the space to house those inanimate objects when they are not needed. The amount of space they have to store these objects dictates how many of the objects they can own and where they store them dictate how they use the remaining space both during and in between certain activities.

A movable partition provides a solution for new spatial requirements. Often partitions in residential spaces act as the backer for a desk, the home of a piece of artwork or infographic, and most commonly mesh together to provide closet space. Even if the partition moves the items inside may need to be relocated piece by piece. This can be reimagined. By increasing the thickness of the partition the wall can become the storage and as a whole, the parts can be relocated to accommodate the new desired space.

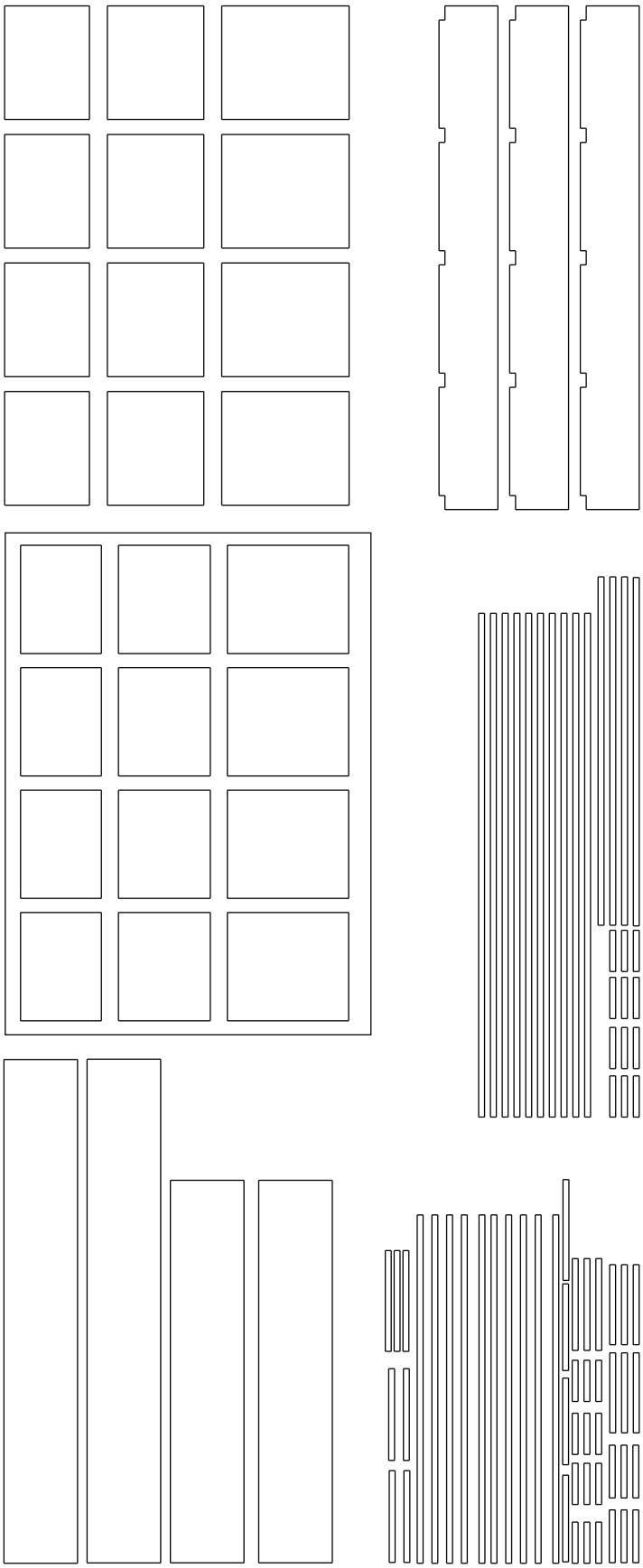
The construction and manipulation of these partitions can be designed and tested within the digital realm. The benefits of digital fabrication include the preservation of precision from the digital 3D test models. The laser cutter removes the aspect of human error during cutting and measuring and allows the same pieces to remain identical across all timelines and production volumes. The digital file is also directly scalable. The dimensions of available materials can be incorporated into the design to help confirm the accuracy of the concept before it is fully materialized. The device created to test certain mobility concerns of the partition prototype is a 1:12 scale model that allows data to be collected from more sensory aspects of the design. In the initial stages, these tests will include acoustics, friction, and ease of use.

Parition Orientation tests

Original Partition Concept
3D Digital Model 1:1



Digital Model Individual Component Testing:
3D Digital Model 1:12



Scaled Laser Cut File: Individual Piece Data

1:12 Device: Detail Section

1:12 Device: Elevation

2. Prototype Documentation: Acoustics, Sound box tests

Computation_Digital Actuation_(Digital Assessment)

Partition: Function and Testing

The open floor plan is a widely understood and popular concept. It allows the kitchen, dining, and relaxing spaces to blend into one another and support both occupants who desire more eating space as well as those who require more lounging space. All one must do is occupy more of the open floor space with the appropriate furniture. The arrangement of the furniture begins to divide and differentiate one function from the other. This layout solves the requirement of space but does not accommodate the desire for privacy. Sound, sight, and smell all intermingle within the space.

Movable and flexible partitions are no new concept and have been used for centuries. At this stage the majority of them appear to hold only a functional or institutional aesthetic, thus discouraging their implementation in a residential setting. But what differentiates a commercial or institutional partition from a residential partition? Quite often that difference comes down to finish and materiality, ease of usability, and hardware. All of these items can be refabricated to meet the needs of a residential space.

The importance of acoustic design will always be crucial when maintaining a sense of “home”. Sound dampening materials such as insulation can still be entrenched within the partition and allow for storage in the surrounding cavity. In order to remain a wall and not a screen, the connection to the floor and ceiling must be carefully considered. A soundbox was constructed to test the acoustic qualities of the 1:12 scale device. The issue with the need for flexibility is that the wall cannot be sealed or flush with the surrounding walls. The soundbox was created to fit the scaled partition, or device, and accommodate tracks for the movement of the device as well the necessary space for a buffer or temporary seal. The initial tests were completed using a felt perimeter. The acoustic dampening was then tested with gaps between the tracks and partition, and again with the track mechanism sealed using rubber around the sliding mechanism. These sounds were collected and translated to visual representation to confirm findings using a nonsubjective method.

Note: Tests were done treating partition as open shelf, no doors were included at this stage.

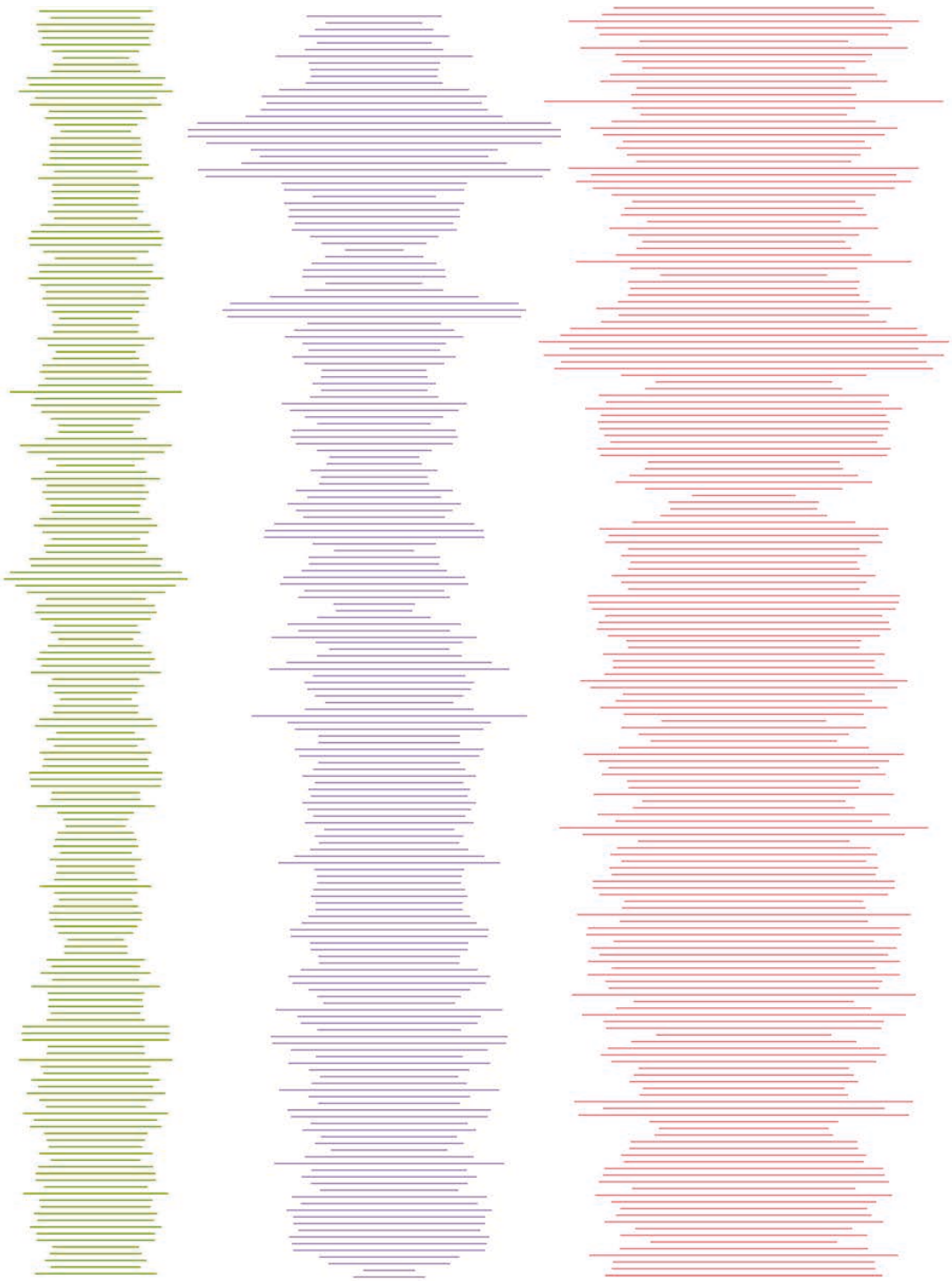
Hand Crafted *Soundbox*

Designed for Disassembly

Rubber Track Sealing

Felt Sealing

Data Collection

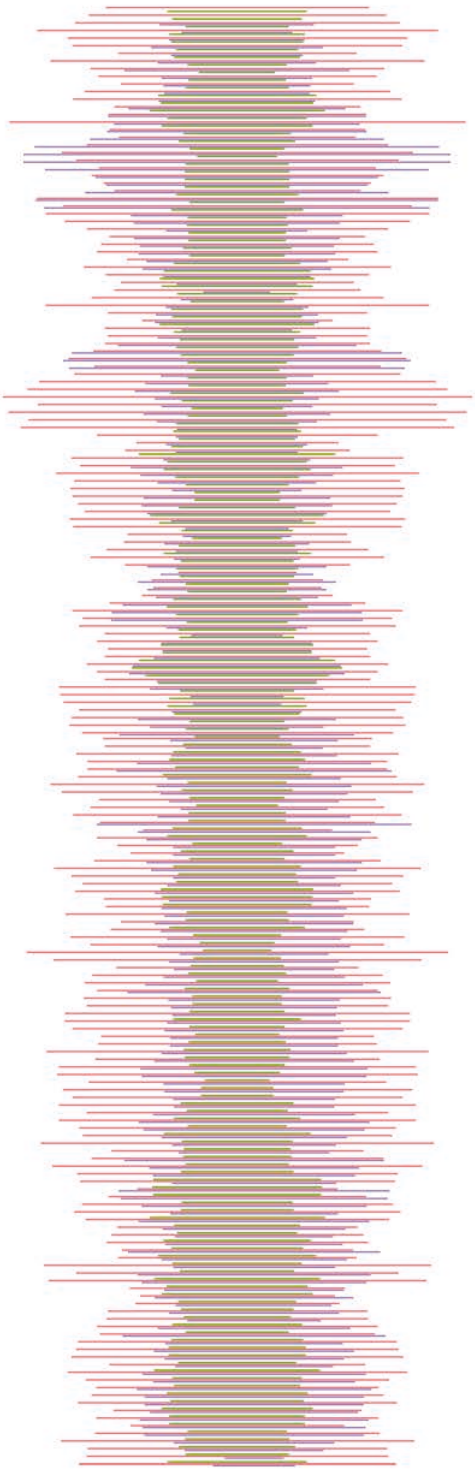


Sound Data:
Partition, felt and sealed tracks

Sound Data:
Partition and felt permieter ONLY

Sound Data:
NO Partition/Device

Note: Noise volume and type used is consistent yet not identical.



Sound Data:
Comparison

3. Prototype Publication:

Modular storage partitions:

Minimizing waste and improving functionality of storage and space division

The partition is an essential element of a building. With columns and structural exterior walls enforcing stability of lateral elements and holding the roof up, partitions have the freedom to divide the space in between. These partitions can be load bearing but in most cases they are light frame components that prioritize separation of sound, light and function. Partitions can start to house spaces large enough for human occupation but also separate storage areas and equipment from occupiable spaces. With this research, the line between closet and partition wall has been blurred, by creating a hybrid that works as both.

These particular partitions are designed for use within a tiny house. They are meant to expand the usable floor area as well as maximize the flexibility of the space. These orientations are referenced above. The ability to have a space that can be both open or closed without the need for renovation opens up a range of opportunities for a diverse selection of occupants. These partitions needed to be both "fillable" as in usable for storage, and moveable, in order to improve the capacity of a small floor plan. With mobility comes the issue of sealance. Although the partition aims to open up a range of programmatic possibilities, while in position there remains an importance in its ability to provide privacy for all senses: sight, smell, sound as well as climate.

"Should we view acoustics as an art rather than a science...The aim of room acoustics design should therefore be to incorporate the room acoustics issues in the design of the interior space and its surface in a sensible way." [1]

Modular storage partition: Open

Modular storage partition: Closed

Focusing primarily on the concept of acoustics the prototype will test its effectiveness through a series of sound tests. By creating a wall of smaller storage modules as opposed to a shelf and cavity system, the elements inside the containers can be organized and mobilized individually. A module filled with paint supplies can be removed and placed on the table nearby during an art session instead of having to unload the paint and reload following completion. Seasonal storage can be rotated from top to bottom for easy access. New iterations of the module can be designed and created. Possibilities includes a self watering hydroponic module that utilizes grey water collection from elsewhere in the house, or a glass or acrylic module that allows for the display of sculptural artwork or simply light flow.

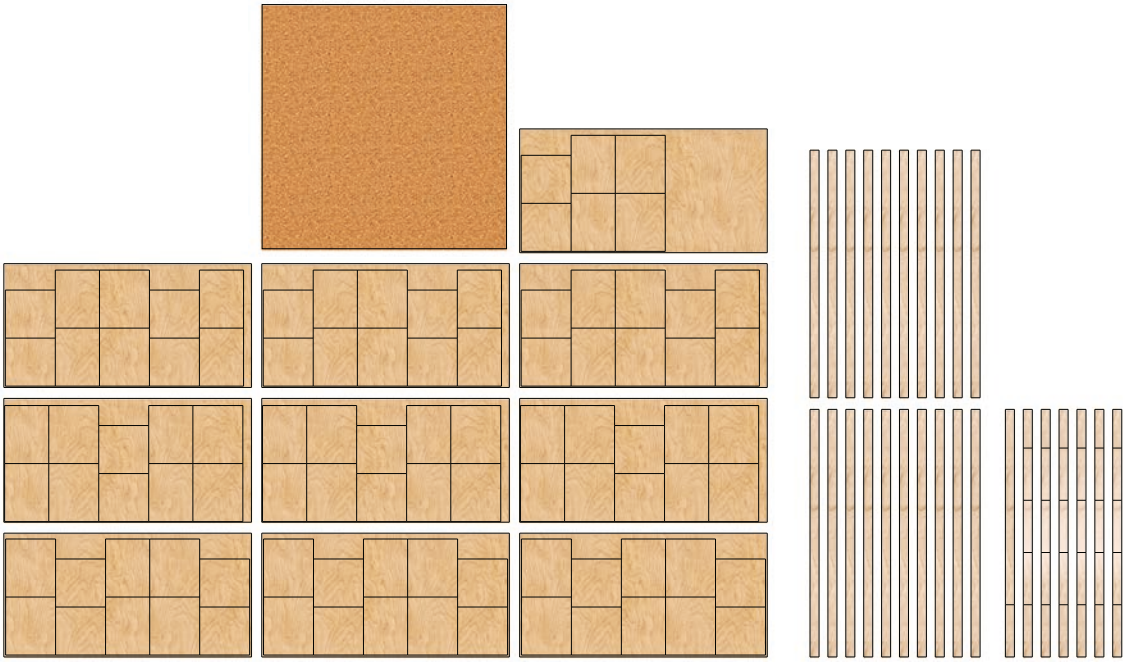
The tiny house in which these partitions are initially designed for has a large focus on sustainability, environmentally conscious design and low waste. The partitions are designed using standard building material sizes. This is an adaption to the initial partition design displayed at the the beginning. Eight foot long 2x4 dimensional lumber is used to construct the frame. Eight foot by 4 foot sheets of laser cut 3/4in plywood are used for the storage modules. The orientation of the module pieces on the full plywood sheets aim to fill as much space as possible, leaving a low amount of wasted material. Sheets of cork provide a more continuous seal on the non-operable side of the storage partition.

Modular storage partition: Movable modules

Modular storage partition: Continuous cork backing

The total amount of materials needed for one 8'x8' section of the hybrid partition wall are ten 2x4s for the length and height of the frame with four 2x4s segmented to supply the width of the frame. Ten sheets of plywood are laser cut into the 6 sides of the 16 needed storage modules that slide into the frame. The cork sheets are selected and attached to the back of the storage partition in a way that minimizes waste of the available product. The choice of cork was made for both its acoustic and thermal properties as well as its ability to be sustainably harvested. Cork insulation is predominantly used in the construction of walls and roofs and provides both thermal and acoustic protection.[2]

"Cork is a protective tissue known in the plant anatomy as phellem and is part of the periderm in the outer bark...The periderm of the cork oak has special characteristics which are not common among tree species: the phellogen is a continuous and regular layer enveloping the stem, with a high longevity and a considerable production intensity of cork cells. In addition, if the phellogen is destroyed, for example by human action, a new traumatic phellogen develops..." [3] The trees can be legally harvested or "debarked" every 9 years in Portugal and Spain.[4]



Materials needed for one 8'x8' Hybrid partition wall

The intent of the prototype was not to design hardware or mobility systems, and therefore no wheels or tracks are attached to the bottom of this prototype. The understanding of the design is that the partitions can swing or slide in order to transform the space. The necessary hardware would be concealed from everyday sight using a skirting or baseboard that is separated enough from the floor to allow for the necessary movement and still be sealed with a softer material.

The cork backing provides a certain level or acoustic value to the design however it can be enhanced by wrapping the plywoof doors of each storage module. A range of materials could be considered, however for the purpose of this research wool felt was used alongside the further assembly of smaller pieces of cork. The patterns created with the smaller remnants of cork are used to minimize the waste of excess cuts while still supplying a sense of design consideration to the functionality of the material application. In a traditional modern drywall partition, the acoustic qualities of the wall can be improved by filling the cavities between the supporting 2x4's and drywall with a range of insulation either organic or otherwise. This prototype tests the new possibilities of appearance by relocating the insulative material to the outside. "The audience in any room absorb or deaden a great deal of sound by their clothing and the amount of uneven, soft, unreflecting surface they present."[5] The soft material has the potential to work as both a thermal barrier, reverberation and absorption surface.

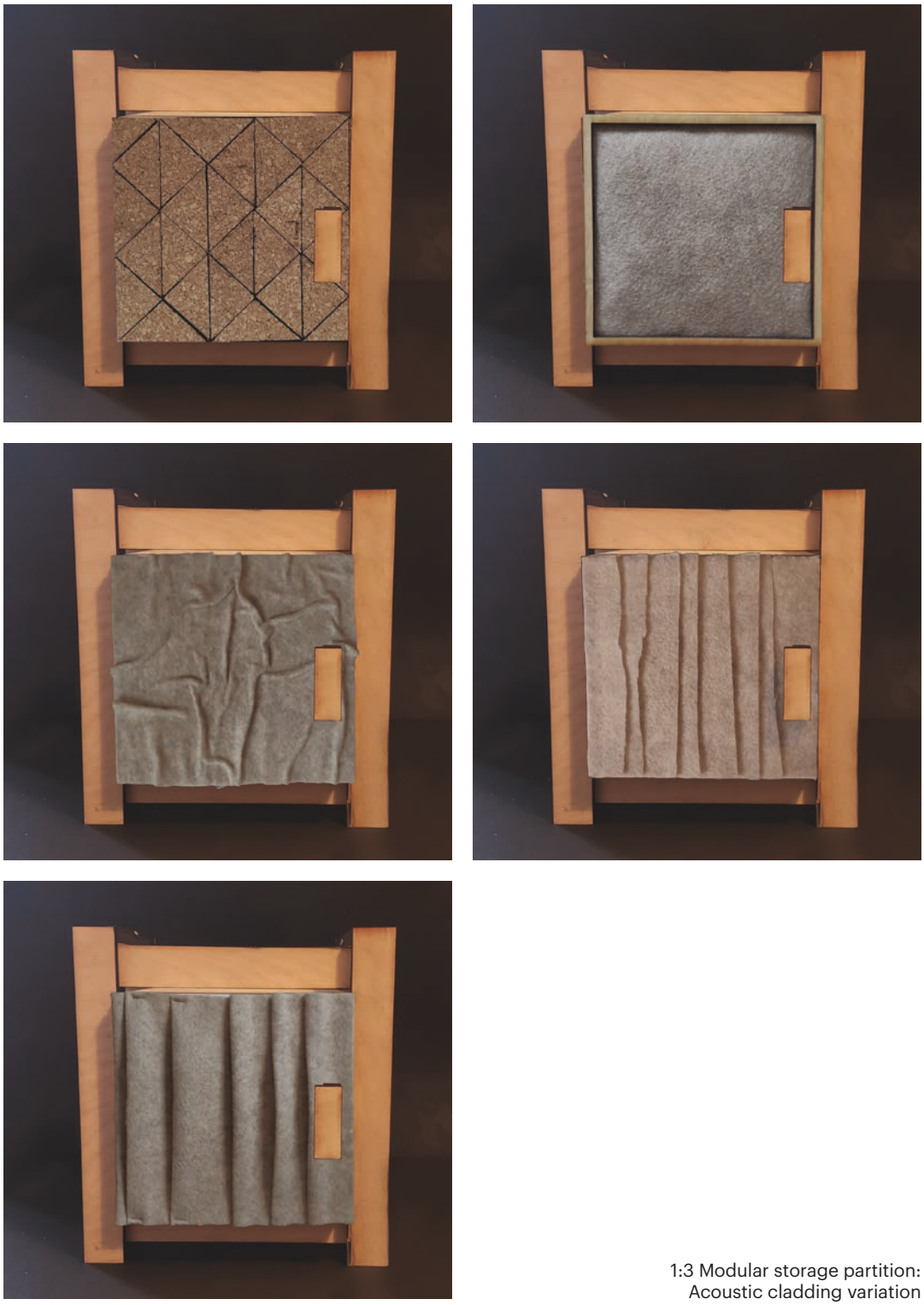
1:3 Frame and Module: Perspective Open Orientation

1:3 Frame and Module: Top View

1:3 Frame and Module: Side Elevation

1:3 Frame and Module: Front Elevation

1:3 Frame and Module: Front Elevation Open Orientation



1:3 Modular storage partition:
Acoustic cladding variation

The sound tests were completed using an assembled construction mimicking one of the modular storage units, fit into the “sound box” and maintaining the same width of clearance as would be between the sides of a full scale storage module and the 2x4 frame. Tests were completed with the module open and closed, sealed with felt and un-sealed around the perimeter, and clad with cork or felt panels on the operable module doors. Folds, creases, strips, and scraps were assembled to test different appearances of the felt coverings. In the same way that the cork scraps were used to create the geometric design, the felt wool scraps were collected and used to create a cushion of acoustic material. A larger piece of felt is held onto the module door by way of a frame and filled with scraps of excess wool. This provides both a thermal, acoustic, and aesthetic variation to the design.

By reconsidering the materiality of walls or cabinets we can enhance both appearance and functionality.

Sound test: no partition, open concept **(CONTROL)**

Sound test: box only, closed

Sound test: box only, open

Sound test: box closed, cork backing

Undulating cork surface

Flat scrap cork design

Acoustic cladding: Scrap collection

Acoustic cladding: Scrap cushion assembly

Acoustic cladding: Strips

Acoustic cladding: Scrap cushion

Acoustic cladding: Creases

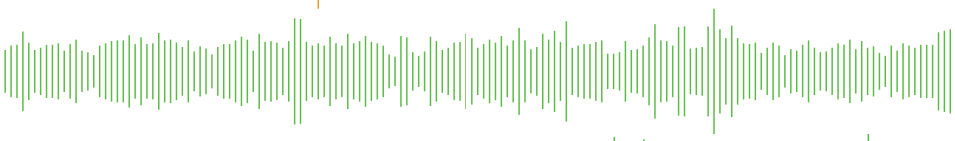
Acoustic cladding: Folds

Acoustic Data: Various material and thickness combinations

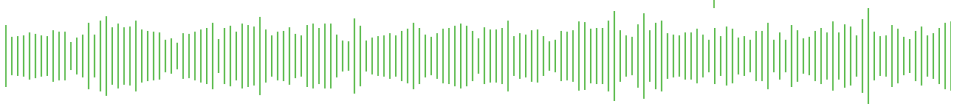
Sound Data:
Storage box closed
Cork on both sides
Flat + Dimensional

Sound Data:
Storage box closed
Filled with water

Sound Data:
Storage door with felt covering
1 Layer, folded pattern

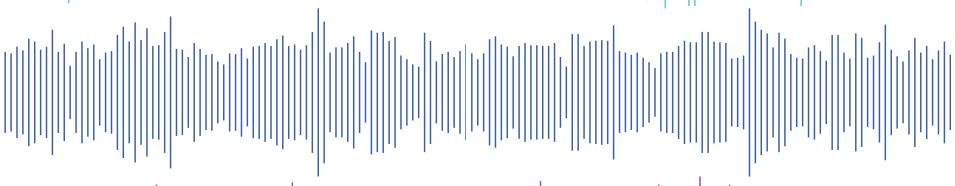


Sound Data:
Storage door with felt covering
3 layers



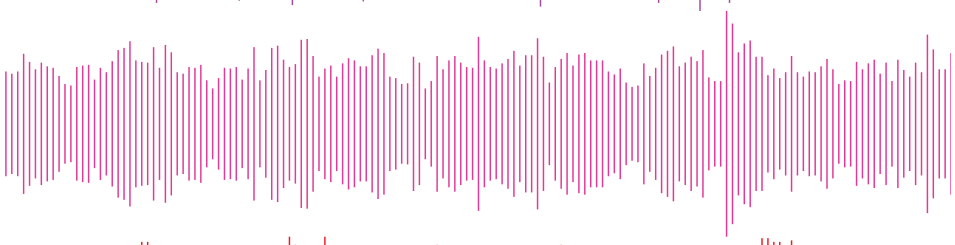
Sound Data:
Storage door with felt covering
1 Layer

Sound Data:
Storage box with full cork back
-Door open

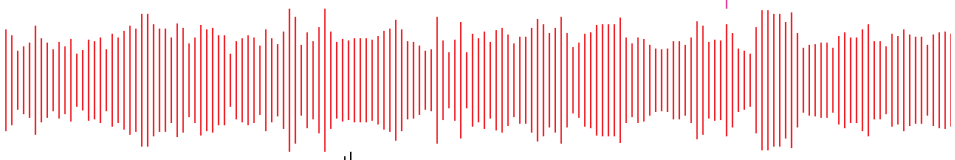


Sound Data:
Storage box with full cork back

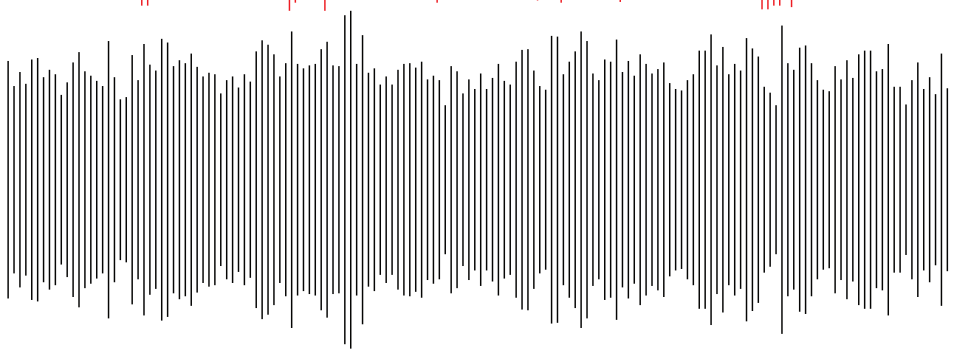
Sound Data:
Storage box only- Door open



Sound Data:
Storage box only



Sound Data:
Control
NO PARTITION



Notes

1. Mommertz, Eckard. Acoustics and Sound Insulation: Principles, Planning, Examples. Basel: Birkhäuser, 2009: p.12

2. José Silvestre et al., "Insulation Cork Boards—Environmental Life Cycle Assessment of an Organic Construction Material," Materials 9, no. 5 (2016): p. 394, https://doi.org/10.3390/ma9050394.

3. Sofia Knapic et al., "Cork as a Building Material: a Review," European Journal of Wood and Wood Products 74, no. 6 (February 2016): pp. 776, https://doi.org/10.1007/s00107-016-1076-4.

4. Ibid, 777.

5. Smith, T. Roger. Acoustics in Relation to Architecture and Building; the Laws of Sound as Applied to the Arrangement of Buildings. Crosby, n.d. p.39

Bibliography

Bibliography:

Calkins, Meg. Materials for Sustainable Sites. John Wiley, 2009.

Cheal, David J. “Canadian Families Today: New Perspectives.” Google Books. Oxford University Press. Accessed March 16, 2022. https://books.google.com/books/about/Canadian_Families_Today.html?id=8xHaAAAAMAAJ.

Ennals, Peter, and Deryck Holdsworth. Homeplace: The Making of the Canadian Dwelling over Three Centuries. Toronto: University of Toronto Press, 1998.

Friedman, Avi. Fundamentals of Sustainable Dwellings. Washington: Island Press, 2015.

Friedman, Avi. Fundamentals of Sustainable Neighbourhoods. Cham: Springer International Publishing, 2015.

Friedman, Avi. Fundamentals of Sustainable Urban Design. Cham: Springer, 2021.

Lane, Barbara Miller. Housing and Dwelling: Perspectives on Modern Domestic Architecture. Routledge, 2007.

Olgyay, Victor, and Aladar Olgyay. Design with Climate: Bioclimatic Approach to Architectural Regionalism. Princeton: University Press, 1973.

Canadian Housing and Renewal Association "Perpetual Affordability and Community Control of the Land: Community Land Trusts in Canada." Community Housing Transformation Centre - Centre de transformation du logement communautaire, July 30, 2020. https://centre.support/perpetual-affordability-and-community-control-of-the-land-community-land-trusts-in-canada/.

Rael. Earth Architecture. New York: Princeton Architectural Press, 2009.

Sabnis, Gajanan M. Green Building with Concrete. Boca Raton, Fla: CRC, 2012.

Smith, Ryan E. Prefab Architecture: A Guide to Modular Design and Construction. Wiley, 2010.

Wassenberg, Frank. "The Netherlands: Adaptation of the Carefully Planned Structure." Built Environment 32, no. 1 (2006): 12–31. https://doi.org/10.2148/benv.32.1.12.

Woolley, Tom. Low Impact Building: Housing Using Renewable Materials. Chichester West Sussex: John Wiley & Sons, 2013.

Websites:

"Ankenyrow." ankenyrow. Accessed March 17, 2022. https://ankenyrow.wordpress.com/.

Belterra cohousing. Accessed March 17, 2022. http://belterracohousing.ca/index.html.

Blevac, and Mgraf. "Graf-Levac Earthship." Graf-Levac Earthship, January 2, 2014. http://earthship.rlds.ca/.

"Boligerne." Permatopia, February 14, 2022. https://permatopia.dk/boligerne/.

Collingwood Earthship. Accessed March 17, 2022. https://collingwood-earthship.wordpress.com/.

"Cranberry Commons." Canadian Cohousing Network. Accessed March 17, 2022. https://cohousing.ca/communities/bc/cranberry-commons/.

Darren Roberts, "Earthships 6 Principles • Interconnected." InterConnected, November 27, 2020. https://www.interconnected.me/projects/earthships-6-principles/.

Ecovillage Findhorn. Accessed March 17, 2022. https://www.ecovillagefindhorn.com/.

Government of Canada, Statistics Canada. “Fertility: Fewer Children, Older Moms.” Government of Canada, Statistics Canada, May 17, 2018. https://www150.statcan.gc.ca/n1/pub/11-630-x/11-630-x2014002-eng.htm.

Government of Canada, Statistics Canada. “The Surge of Women in the Workforce.” Government of Canada, Statistics Canada, May 17, 2018. https://www150.statcan.gc.ca/n1/pub/11-630-x/11-630-x2015009-eng.htm.

“Hurdal Ecovillage.” NuMundo. Accessed March 17, 2022. https://numundo.org/center/norway/hurdal-ecovillage-3.

“Living Greener.” Ecovillage at Ithaca. Accessed March 17, 2022. https://ecovillageithaca.org/live/living-greener/.

“Median Income,” Census Mapper, accessed March 17, 2022, https://censusmapper.ca/.

“SJÁLFBÆRT SAMFÉLAG.” Sólheimar. Accessed March 17, 2022. https://www.solheimar.is/.

“Terra Firma.” Canadian Cohousing Network. Accessed March 17, 2022. https://cohousing.ca/communities/on/terra-firma/.

“Welcome to Svanholm.” SVANHOLM STORKOLLEKTIV, September 22, 2020. https://svanholm.dk/english/.

Thank you