Growing in Ghosts: A Methodology To Retrofit North American Abandoned Big Box Stores Into Successful Suburban Farms

by

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Contents

Abstract

Vertical farming uses controlled environments to maximize growth of edible plants with minimal water and pesticides. Simultaneously, consumers are transitioning to digital platforms, resulting in decreased utility of big-box stores. These structures make excellent candidates for warehouse vertical farm (WVF) retrofits due to (1) their proximity to suburban communities and (2) their homogeneous form and assembly. This thesis answers the question: How can the retrofit of big box stores into vertical farms use food to enhance social and environmental conditions for peri-urban immigrant populations?

This thesis revealed how systems thinking may offer determine repeatable—yet site-specific—guidelines for architecture to mitigate social shortfalls and the ecological overshoots of peri-urban North America. Ecological overshoots are diminished through the reintroduction of ecosystem services into building systems. Social shortfalls are minimized by integrating cross-cultural suburban populations in agricultural activities. The resulting framework blends nature, culture, and engineering through modular and flexible architecture.

Acknowledgements

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Chapter 1: Introduction

1.1 Architecture and Climate Change

Researchers have been sounding alarms about humanity's impact on the environment since the 1960s, and yet action to mitigate our influence on the environment remains limited. The International Panel on Climate Change (IPCC) provides a credible and detailed summation of the global pressures acting not only on the architectural profession, but all human society. According to the IPCC, the changing climate is on track with worst-case predictions for the next century, threatening the long-term habitability of the planet (IPCC 2019). Despite the empirical nature of this alarm, this expression may appear sensationalistic, but it is not. The context in which future architects will work is increasingly that of depleted soil, missing permafrost, quiet forests, flooded lowlands, and devastating storms (IPCC 2019).

Architect as conceptual strainer.

Architects professionally oversee the process whereby raw materials from the earth's limited and delicate ecosystems are converted into buildings that satisfy the needs of society. Architects are like a conceptual sieve, letting pass what is exogenous to the design and retaining what is desired by the client or code. In the opinion of the author, the mesh of this sieve has for too long been wide enough to allow environmental externalities to fall through. According to the IPCC, the construction and operation of buildings is responsible for 39% of all global carbon emissions. Architects must take immediate steps to avoid locking-in the effects of inefficient, energy-intensive buildings. Retrofitting the work of the past can help address the pressing problems of today.

Levittown, New York. Sale of new subdivision homes in 1950 (Mathosian, 2019)

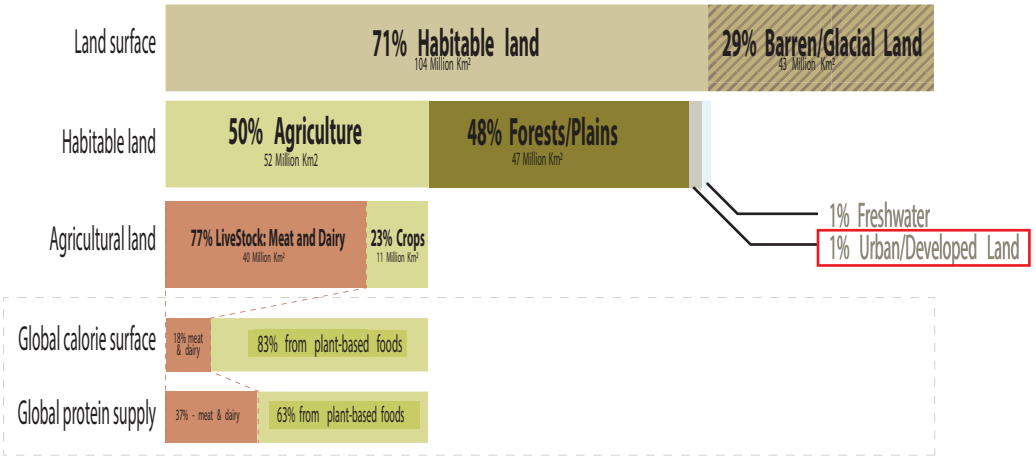
Photo of Phoenix, Arizona, from Google Earth. (Google Earth, 2020)

Ian McHarg inspired this thesis to dovetail ecological impact and social provision. His work Designing with Nature (1971) explore the human costs of society's gradual dis-integration from its environment and the resulting "coldness" this separation creates. Similarly this thesis aims to address the mundane and widely available commercial suburban landscape. Moreover, it focuses on one particularly unpleasant and unnatural subject, the big box store. It isolates people from nature due to the economic calculation which determined its homogenous form and dominant relationship to the adjacent wilderness. As a result, this design attempts to expose and introduce the retrofit's users to the adjacent wilderness, which could be done through integrating activities such as hiking, foraging, and camping. First, the suburban patter and big box development model will be discussed.

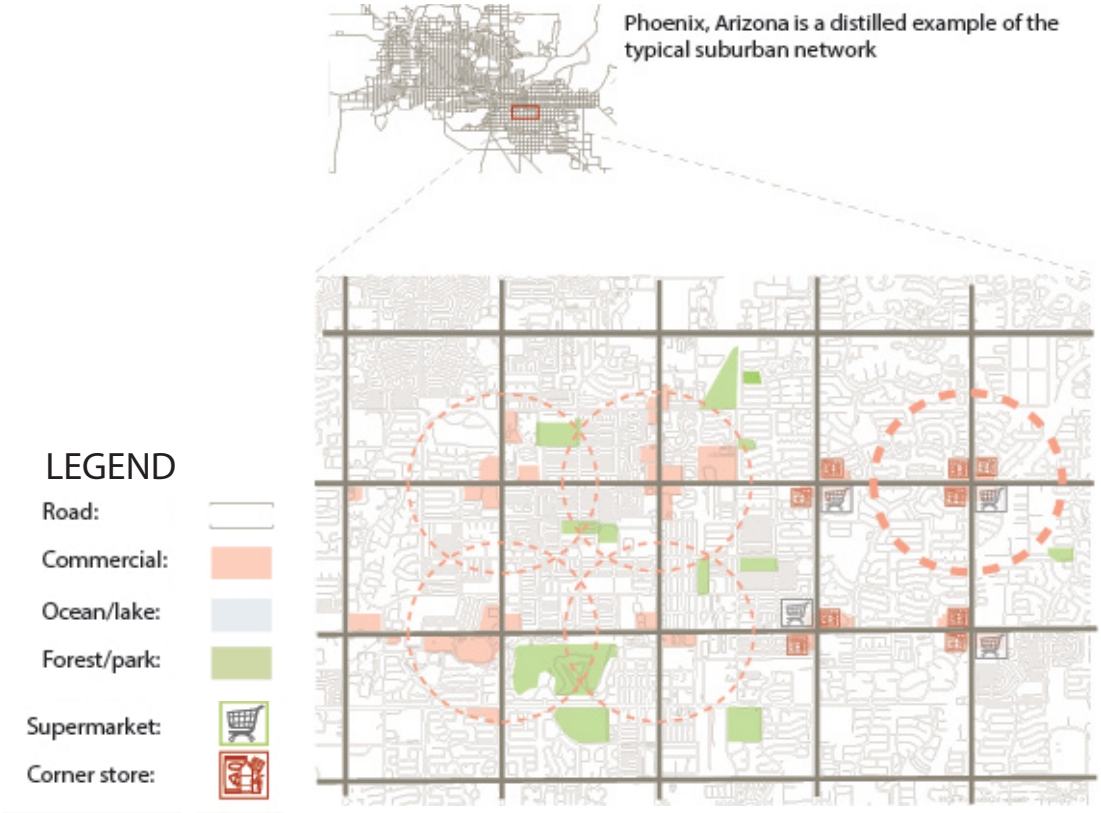
1.2 Suburban Development and Ecological Overshoots

Despite occupying less than 1% of the earth's surface, the suburban areas of North America have disproportionately contributed to CO_2 emissions (Steffen et al. 2015) making these areas prime candidates for ecological mitigation. In more recent years, growing intensification of urban cores has led to suburbs being adopted by lower-income, minority populations due to their relative affordability (Dunham-Jones and Williamson 2009). The implications of this demographic shift, according to Dunham-Jones, have been decreased public engagement, political participation, and affluence.

An exemplar of this is Phoenix, Arizona, once called by The Guardian " the world's "least sustainable" city (Walters 2018).

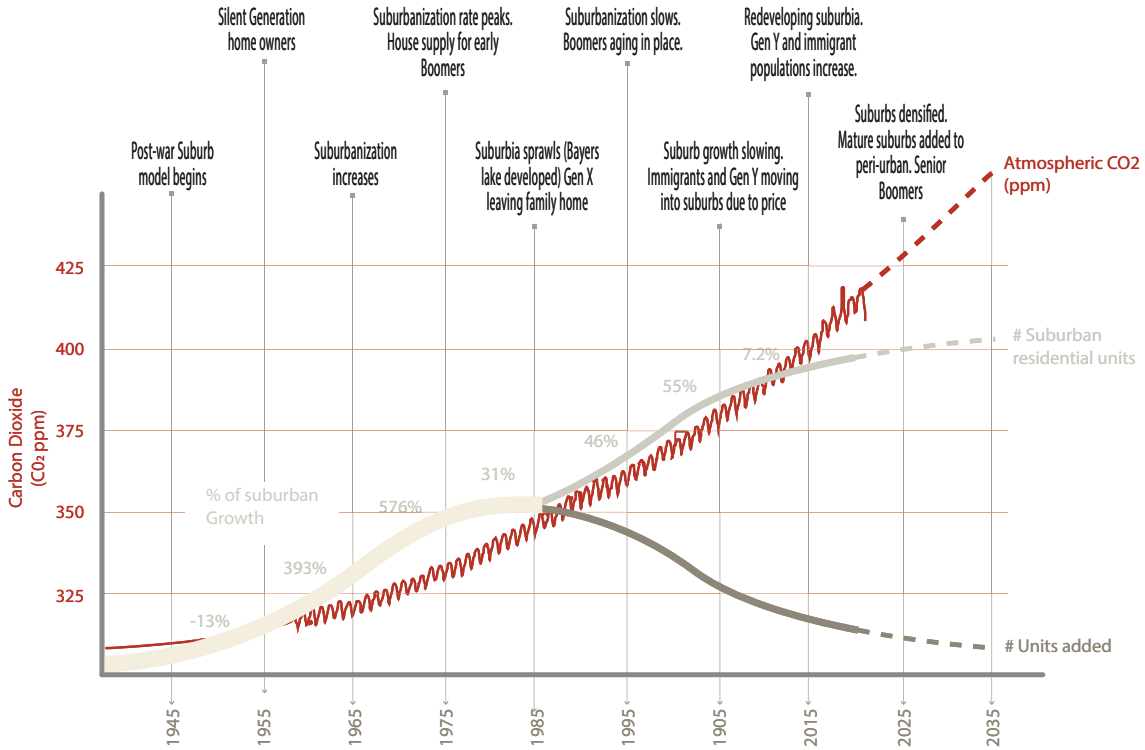


Global land use breakdown. only 1 percent of habitable land used for urban development while 50% of habitable land used for agriculture. (data from Ritchie and Roser 2019)



Map of Phoenix, Arizona. Callouts are provided to express the development pattern and commercial distribution. This map expresses a clear distillation of suburban sprawl elements. (OSM 2020)

Its characteristic grid pattern results from repeating low-density, detached-unit residential configurations. This is punctuated by commercial establishments—accessed almost entirely by car—at intersections of highways and arterials, and planners have placed parks in the centers of these square-mile blocks. There is little space to linger when not in a commercial establishment and even less public space for assembly. While suburban growth proceeded at a rapid pace, urban planning researcher Ellen Dunham-Jones has noted decreased investment in new suburban development over the last few decades (Dunham-jones and Williamson 2008). This trend, its demographic shift and its relation to CO2 emissions can be seen in the chart below.



Historical trends of suburban growth overlaid with CO_2 data across a century. (NOAA n.d; USCB 2020)

However, the last decade has seen greater investment in re-development and infilling of suburban North America (Chung 2014). This transformational trend gives hope to those looking to mitigate the shortfalls and overshoots of the suburbs. This thesis adopts the same optimism that densification and adaptive reuse in suburbs and business parks can help address the environmental obligations of society.

1.3 Challenges of the Current Food Supply System

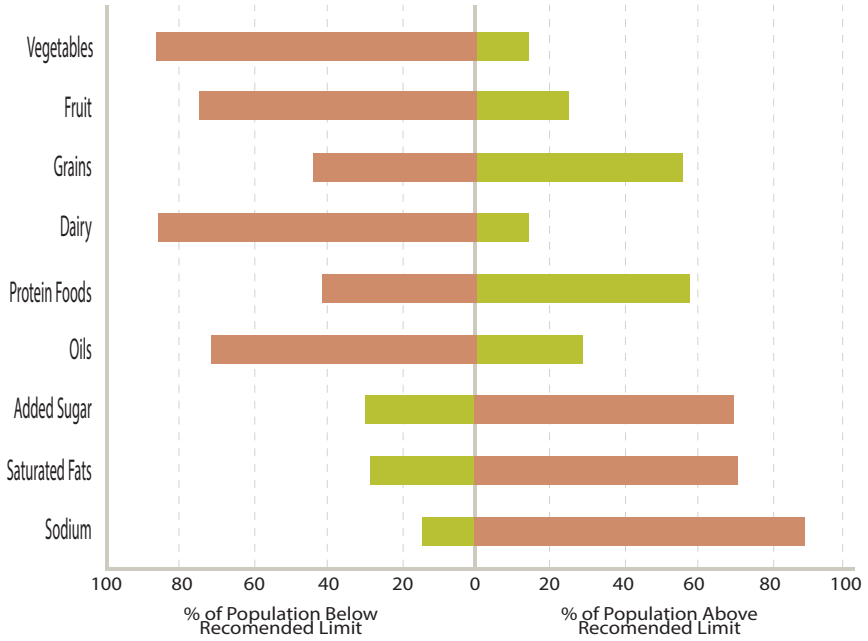
Observable impacts of climate change have already affected crop viability in many regions, resulting in production-level fluctuation of food crops globally and increasing food security issues locally (IPCC 2019). However, impacts on food security can be reduced through adaptation methods such as “climate-smart” agriculture and localized production. The IPCC (2019) recommends adaptation measures such as:

- improvement of water-use technologies
- de-motorization
- revitalization of ecosystems
- urban densification.

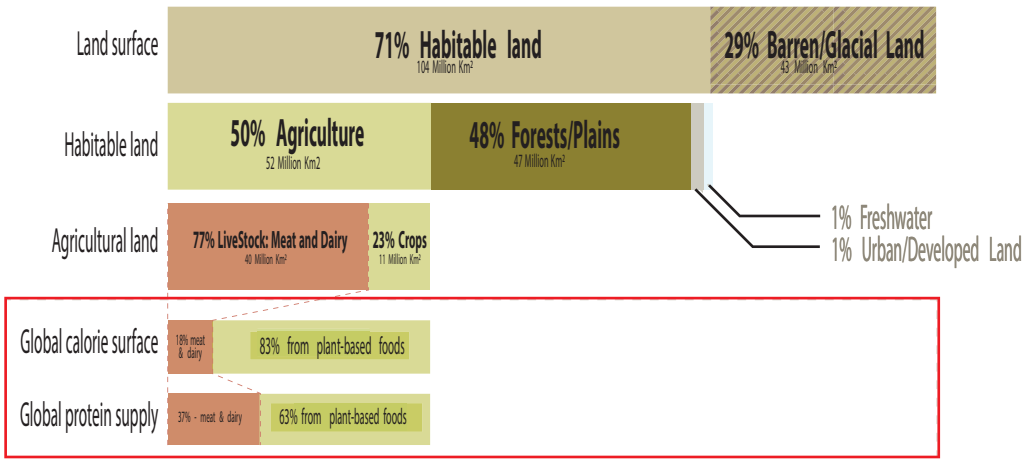
While nearly half of Earth’s habitable land is already used for agriculture, industrial practices often result in eutrophication, acid rain, CO_2 emissions, and erosion (IPCC 2019). The efficiencies of the globalized food supply network must be weighed against the unforeseeable vulnerabilities of the global supply chain, (e.g., pandemics, extreme weather, and trade wars).

The suburban development pattern and the global food supply chain exist within a complex system which amplifies environmental damage and social harm. Fruits and

vegetables supply 83% of global calories and 63% of global protein (Richie 2019). However the unfortunate reality is that fruits and vegetables are adequately consumed by only about 20% of the population in North America, while processed foods high in sugar, fat, and sodium are overconsumed by roughly 80% of the population (USDA 2015). Fruit and vegetable consumption is largely consistent



Dietary intakes vs recommendations. (data from USHHS 2020)



Global land use breakdown continued. Calorie and protein breakdown vegetable consumption and animal consumption versus landuse. (data from Ritchie and Roser 2019)

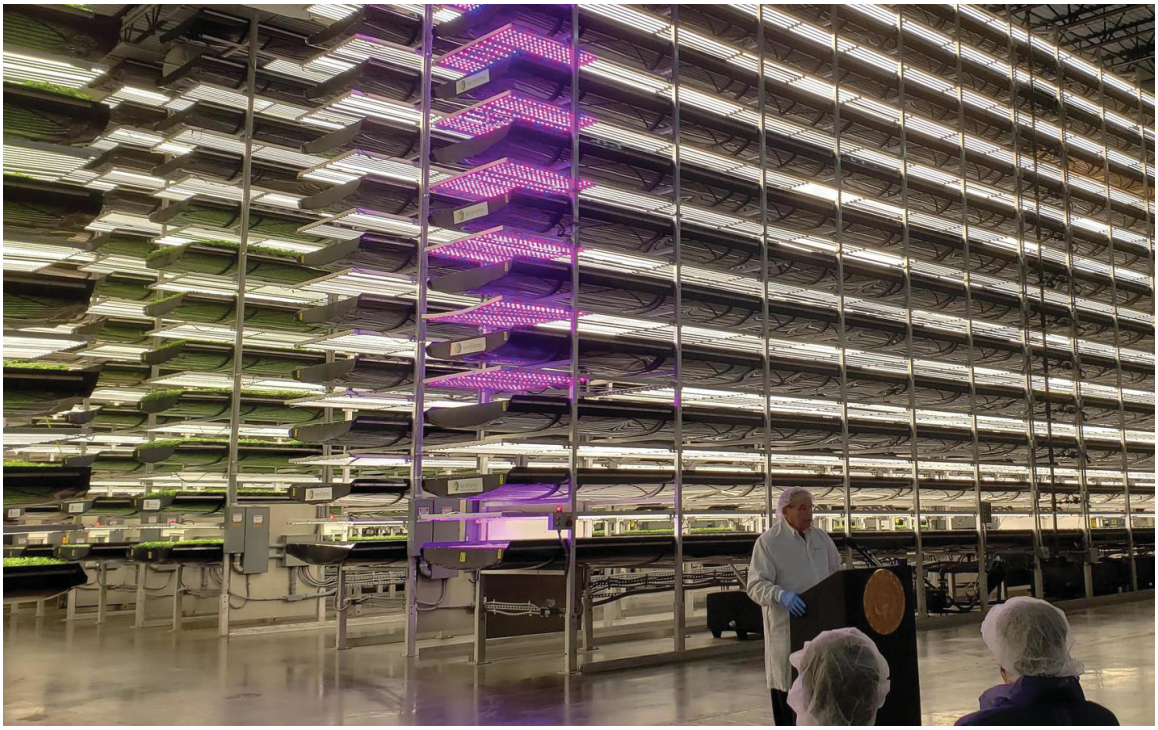
across North America when adjusted for demographic and income variations. The issue is not the supply of food, but rather its distribution, accessibility and its affordability (USDA, 2015).

1.4 The Creation of Ghost Boxes

Big box stores, also termed warehouse stores, are a recognizable part of suburbia across North America. Their homogenous design usually entails a light steel structure with a slab-on-grade for large spans which can be filled by stores in a flexible fashion. However, business parks are rapidly closing, largely due to the transition to online shopping (Schindler 2012). Once closed, these big box stores sit lifeless, hence the name “Ghost Boxes” termed by popular podcast 99% invisible (Kohlstedt 2020). They haunt neighbouring suburbs with numerous negative externalities, such as reduced property value, decreased tax revenue and environmental harm (Schindler 2012). As this trend continues, this paper argues that “Ghost Boxes” are ripe for redevelopment and that vertical farms are a potentially synergetic cross-programming option.

Abandoned Lowe’s hardware store. Photo selectively desaturated to highlight presence of plants reclaiming the site. (Mitchell 2009)

Costco in Halifax, Nova Scotia.



AeroFarms, Newark New, Jersey (AeroFarms Technology 2021)

1.5 The Growth of Vertical Farming and Urban Agriculture


Lufa Farms, Montreal. (physOrg 2020)

Vertical farming is an emerging practice of growing plants in stacked layers, taking advantage of vertical drip systems to efficiently irrigate plants with a nutrient solution in lieu of soil. These indoor production facilities have carefully controlled environments which optimize the yield of hydroponic crops. These facilities can grow year-round without the seasonal disruptions present in traditional farming and maximize growth (Birkby 2016). According to Birkby (2016), the indoor facilities are kept nearly sterile and due to limited contamination from pests, plants can be grown without the use of pesticides. The light sources used in these facilities range from partial sunlight to exclusively LED grow lights, depending on the crops being grown and the anticipated yield. Warehouse Vertical Farms (WVF)s have production levels 200-400-times that of traditional farming and with their resilience against drought and flood, many technological optimists hail them as the future of agriculture (Despommier and Carter 2010).

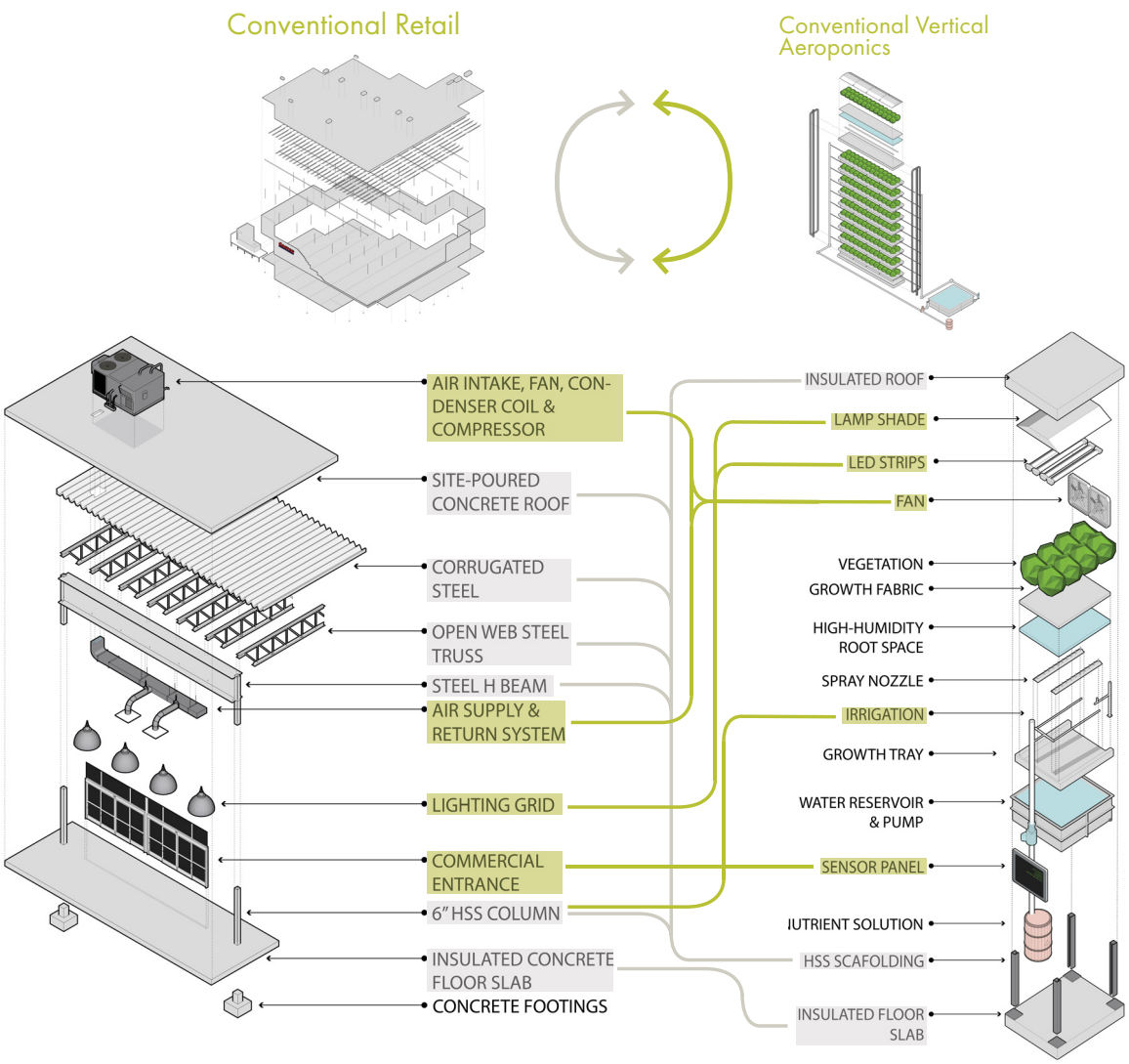

Lufa Farms, Montreal. (physOrg 2020)


Lufa Farms, Montreal. (physOrg 2020)

Among their strongest attributes, however, is that they can be located in close proximity to the consumers of their output. The supply chain, being shortened, becomes more robust.

1.6 Vertical Farm as Appropriate Retrofit Option

This thesis does not propose that big box stores are worth saving. Imagining a future business park of reused sprawling big box stores is as bad from a design point of view as the current trajectory (Schindler 2012). However, redundant big-box units would be excellent candidates



Big box store are a homogenous architype [left]. Synergies between the requirement for a vertical farming operations and the supply of existing structure can be identified by deconstructing both forms and looking for overlaps [right]. This diagram categorizes structural overlaps in grey and operational overlaps in green.

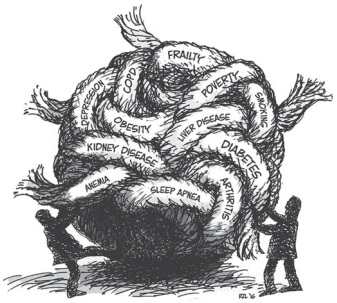
for vertical farming retrofits in particular because of their construction and location. The idea is not novel. Aerofarms successfully operates in an abandoned steel mill, while Lufa farms occupied the roof of a closed Sears.

Unfortunately, existing vertical farms have an inherent struggle between what is socially optimal and what is economically optimal - since the ideal intensive vertical farm operates with as little human interaction as possible. This tension presents architects with an opportunity to act as mediators and help guide both the social placemaking and industrial optimization of this conversion.

1.7 Critical Position and Thesis Question

> How can the retrofit of big box stores into vertical farms use food to enhance social and environmental conditions for peri-urban immigrant populations?

This thesis argues that vertical farming is a promising retrofit option for business parks to mitigate the ecological overshoots and the social shortfalls of suburban North America. While adaptive reuse of redundant large structures is a burgeoning topic in the design community, proposals often suffer from utopian thinking. The reality is that urban evolution and environmental damage form a complex social, political, and economic Gordian knot. Addressing it requires a method of design thinking that can observe and respond to the system as a whole. The following chapter will examine the ways systems thinking could be used as a tool to generate simple rules to guide design.



Gordian Knot illustration.
(Luo 2016)

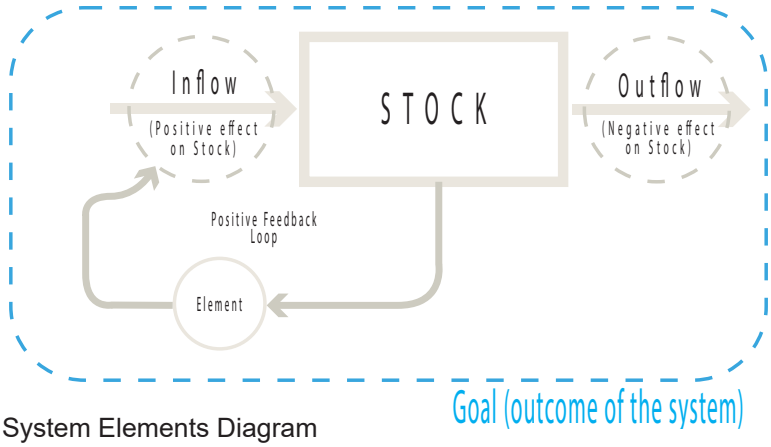
Chapter 2: Methodology

2.1 Finding Synergy Between Nature and Architecture

Author William Braham in Architecture and Systems Ecology (2016) explores how ecological stewardship occurs on various energy inputs which requires a perspective that extends past the site boundary. Braham and other ecological economists helped to reveal possible synergies between the building systems needed by a vertical farming operation and the ecosystem services openly supplied by nature. This thesis takes as axiomatic Braham's contention that human dwellings must be viewed as a part of ecosystem functions rather than separate from them and that re-integration of environmental services is a direction in which the profession of architecture must go.

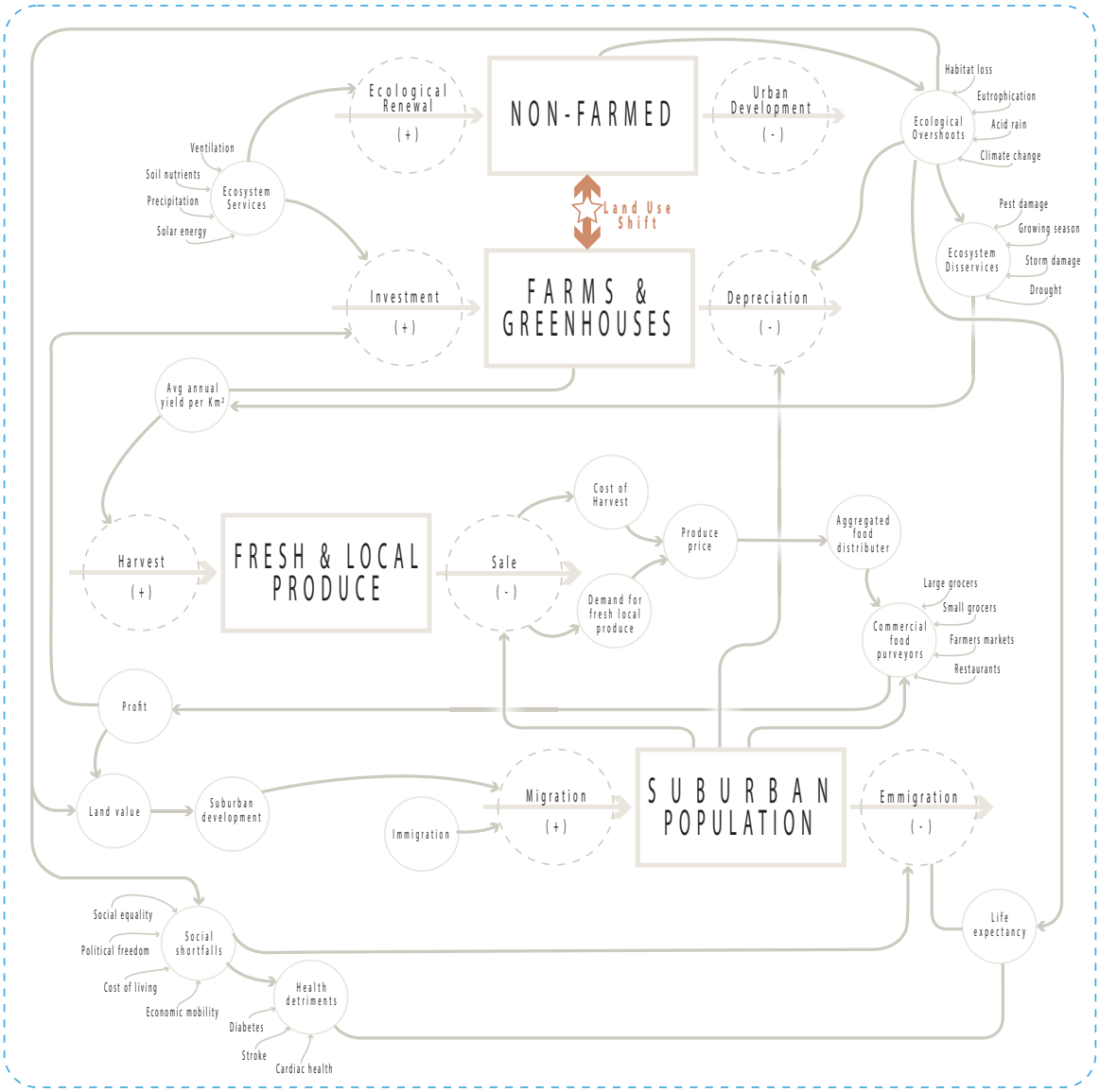
2.2 Systems Thinking as a Design Tool

According to Donella Meadows (posthumously 2008), systems thinking allows the observer to analyze the intricacies of multifaceted assemblies that may exist in a complex nexus (Meadows and Wright 2008). She describes a system as a bound "set of elements or parts that is coherently organized and inter-connected in a pattern or structure that produces a



System Elements Diagram

characteristic set of behaviors, or ‘function’” (Meadows and Wright 2008). The goal of this method of design thinking is to identify goals, inflows, outflows, stocks, and rates-of-change before introducing design solutions that shift the relationships between elements. Using this perspective, as well as contributing research from Ellen Dunham Jones



Basic system map of traditional peri-urban food distribution and consumption. Purpose of map is to display stocks, affiliations and flows of material. the purpose of this dynamics map is to understand what stocks participate in the generation social shortfalls and ecological overshoot feedback loops. The goal of this system is highlighted with a dashed blue line. The goal of this system is simply the effect which all moving parts cause. The current food distribution system goal is to produce fresh local crops at an economically efficient rate.

(2009), Sarah Schindler (2012), MacLeod and Scott (2010), Braham (2016), Hill et al (2013) and others, a minimally complex system map was generated. This map, shown on the previous page, helps visualize the feedback loops between ecological overshoots and social shortfalls in the fresh produce system. It is a time-independent, scaleless diagram that has uniform connections between agents. The mapping allows us to see the conceptual system of supply and consumption feedback, and its consequences for both nature and society.

According to Donella Meadows, the *goal* of a system is outcome that system causes. This can, and often is, counter to the intentions of those agents who participate in a given. The following system mapping exercise has been made intentionally simple. Details such as volume and frequency would be a source of distraction; these elements are to be addressed once a direction has been tested. The following sections describe the results of the system diagram from an ecological and social perspective.

This is not to say that system thinking is the only way of studying this system and testing a proposal. Business case modeling and cost benefit analysis are common ways of studying a system and testing a proposal; however, they omit non-priced social and ecological impacts. System thinking attempts to take social and environmental externalities into account. Doing so is necessary to address the non-financial factors in ecological overshoots and social shortfalls.

2.2.1 Ecological Overshoots

Planetary boundaries (PB) are biophysical measures used to illustrate the point at which a given human system surpasses the rate at which Earth systems can restore homeostasis (Steffen et al. 2015).

The PB framework offers two valuable perspectives. First, it helps interpret human activity in terms of Earth's limited ability to regenerate following human interference. Secondly, it provides an empirically-based safe operating space in which human systems can conceivably function (Steffen et al. 2015). This framework helps justify that a given architectural design need not reduce environmental impact to zero; rather, the goal should be to design an intervention which can be constructed and operated within the safe operating space.

The system map has been highlighted to illustrate the positive feedback of ecological overshoots within the typical urban food network. In short, human development is exacerbating ecosystem disservices by depreciating farmland.

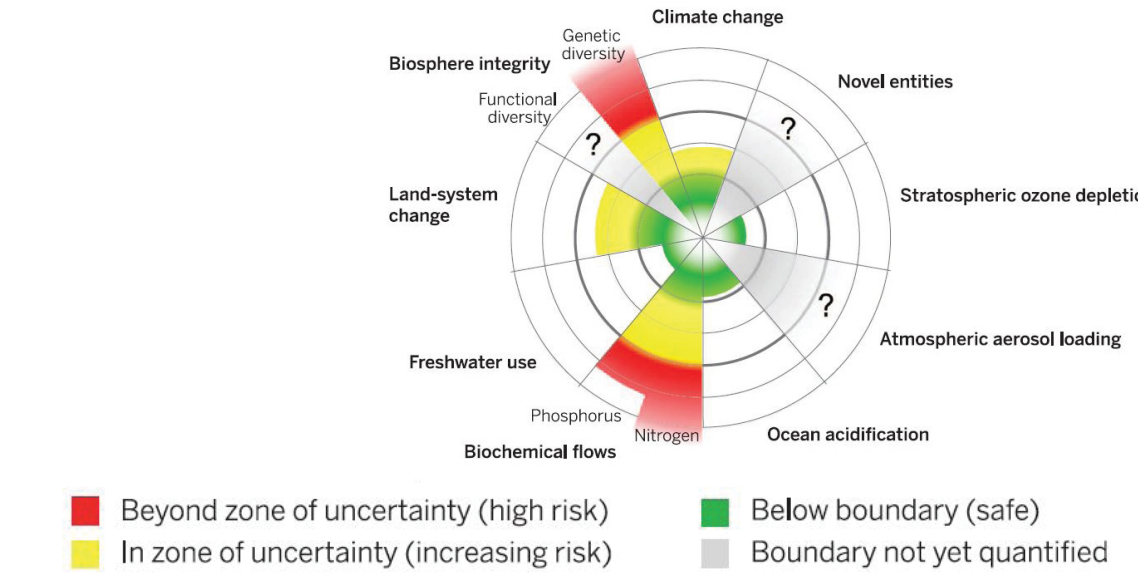
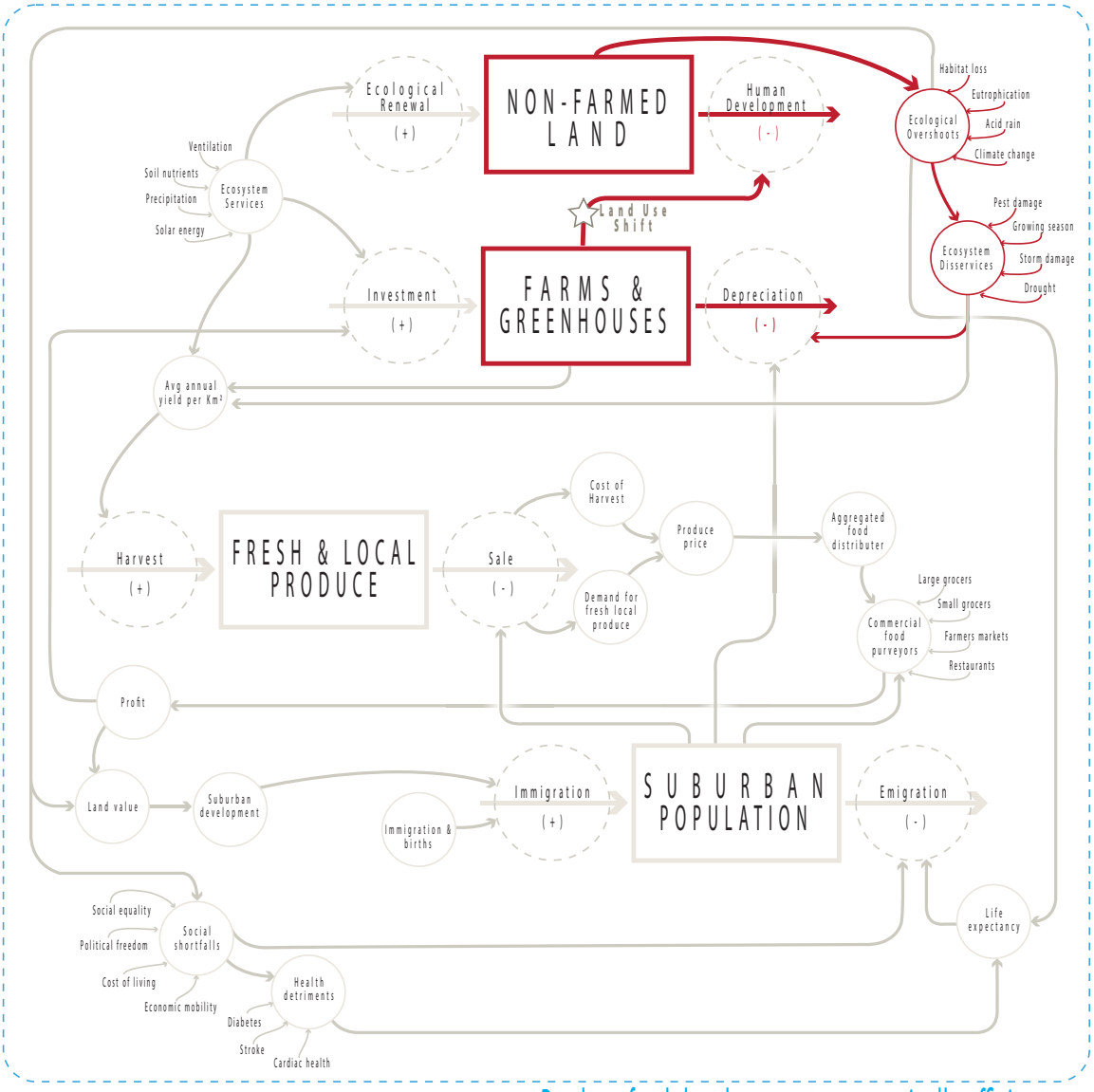
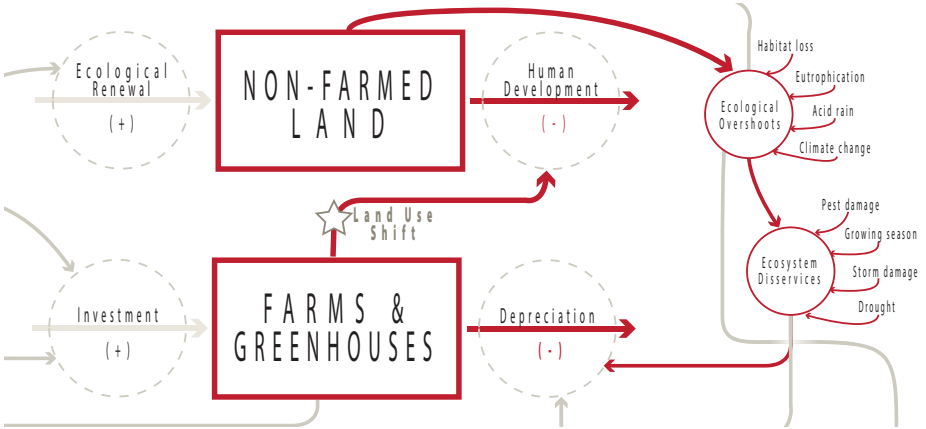


Diagram displaying planetary boundaries (Steffen et al. 2015)



Produce fresh local crops at ecomomically efficient rate

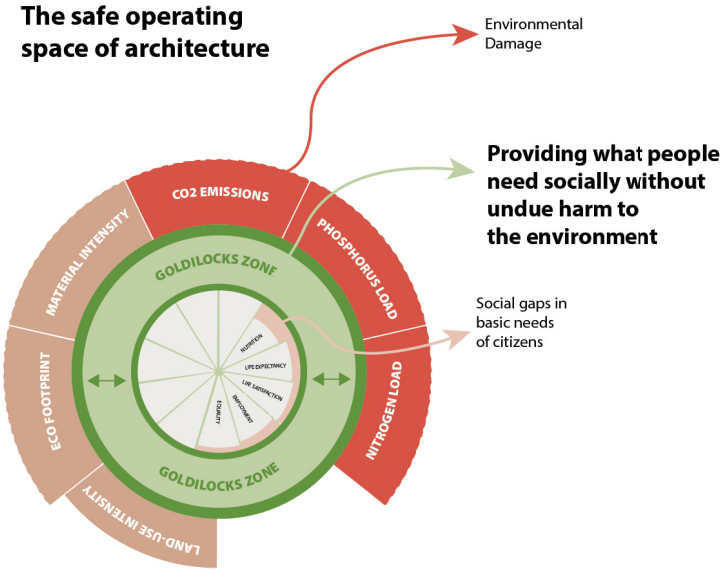


Highlighted to illustrate the positive feedback of ecological overshoots (red) within the suburban food distribution network

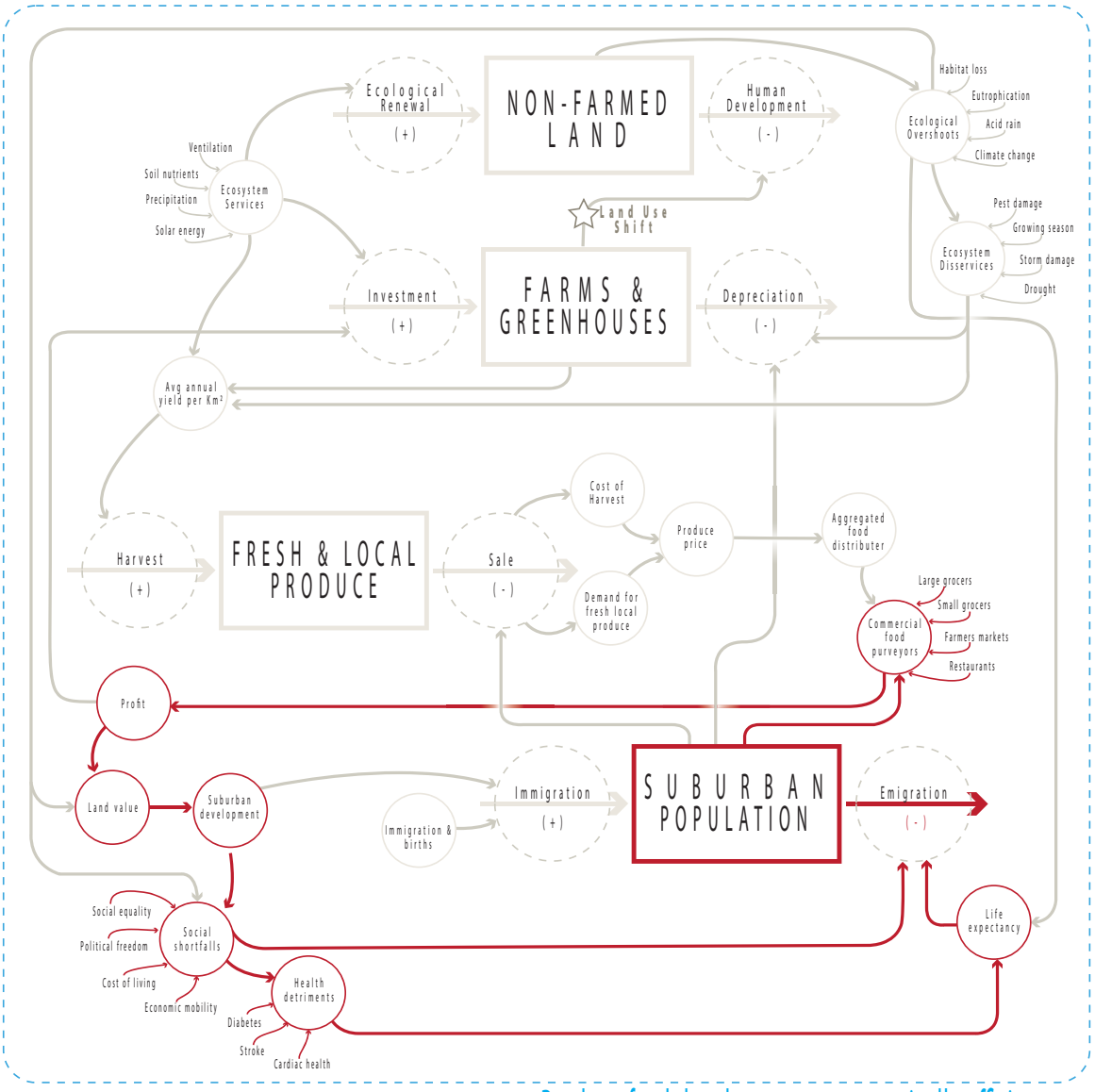
2.2.2 Social Shortfalls

Social shortfalls are deficiencies of human society to meet the needs of human populations. Global development theorists contend that a dignified human existence without social shortfalls can plausibly be attained while remaining in the ecological safe operating space (Raworth 2017). In A Doughnut for the Anthropocene, Raworth (2017) published a diagram which combines a radial chart of social shortfalls on the interior—as determined by the UN Sustainable Development Goals—with planetary boundaries, as defined by Steffen et al, on the periphery. The purpose is to show a conceptual “goldilocks zone” which is regionally specific and in which social shortfalls can be met without incurring ecological penalties. This thesis adopts the same optimistic, non-Malthusian, view that environment and social outcomes can be balanced to satisfy the needs of present populations.

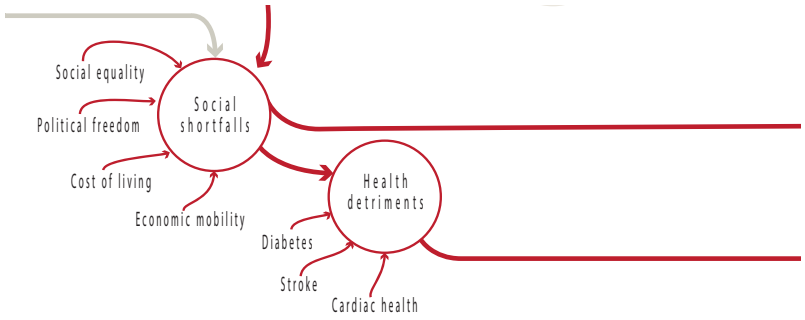
The system map has been highlighted to illustrate a prominent feedback loop associated with the social shortfalls present in the urban food distribution network.



Recreated donut diagram for Canada. the goal of this project is to operate in the goldilocks zone, mitigating the social shortfall of nutrition while avoiding additional ecological overshoots (data from Raworth 2017)



Produce fresh local crops at ecomomically efficient rate



Highlighted to illustrate a feedback loop associated with the social shortfalls (red) in the suburban food distribution network

2.2.3 System Thinking: Principles at the Conceptual Scale

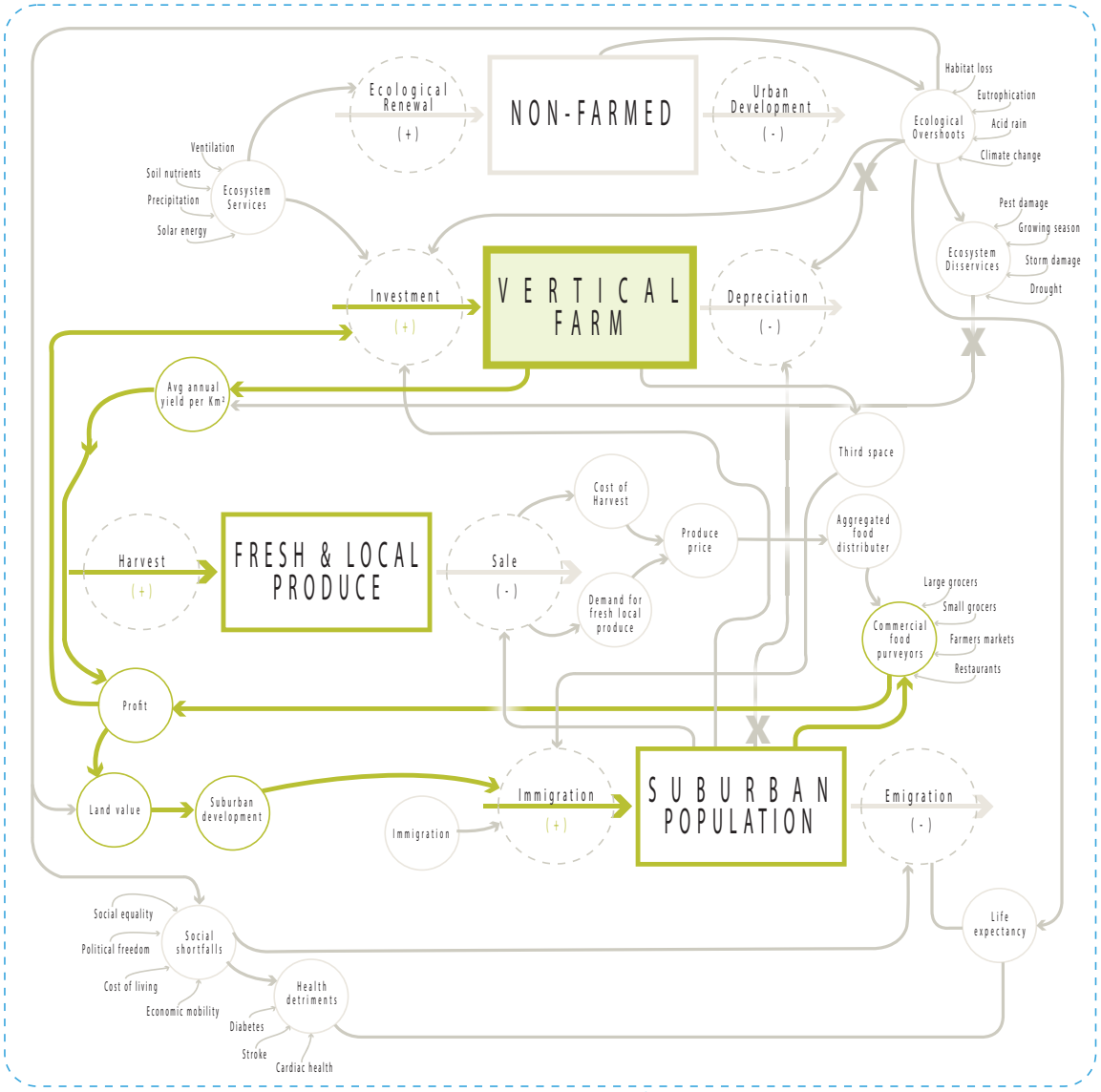
Now the introduction of a vertical farm can be overlaid on the diagram to try to identify the ways in which it might disrupt the negative feedbacks in this system. By adjusting the original system map, three areas of feedback have been identified and conditions have been described.

1. The WVF is to increase supply of local produce to suburban populations and food purveyors. Doing so can slow the decline of:
    a. property values
    b. suburban development
    c. decay of suburban livability

2. The WVF is to provide a much-needed third space for local residents to build community and cultural ownership.

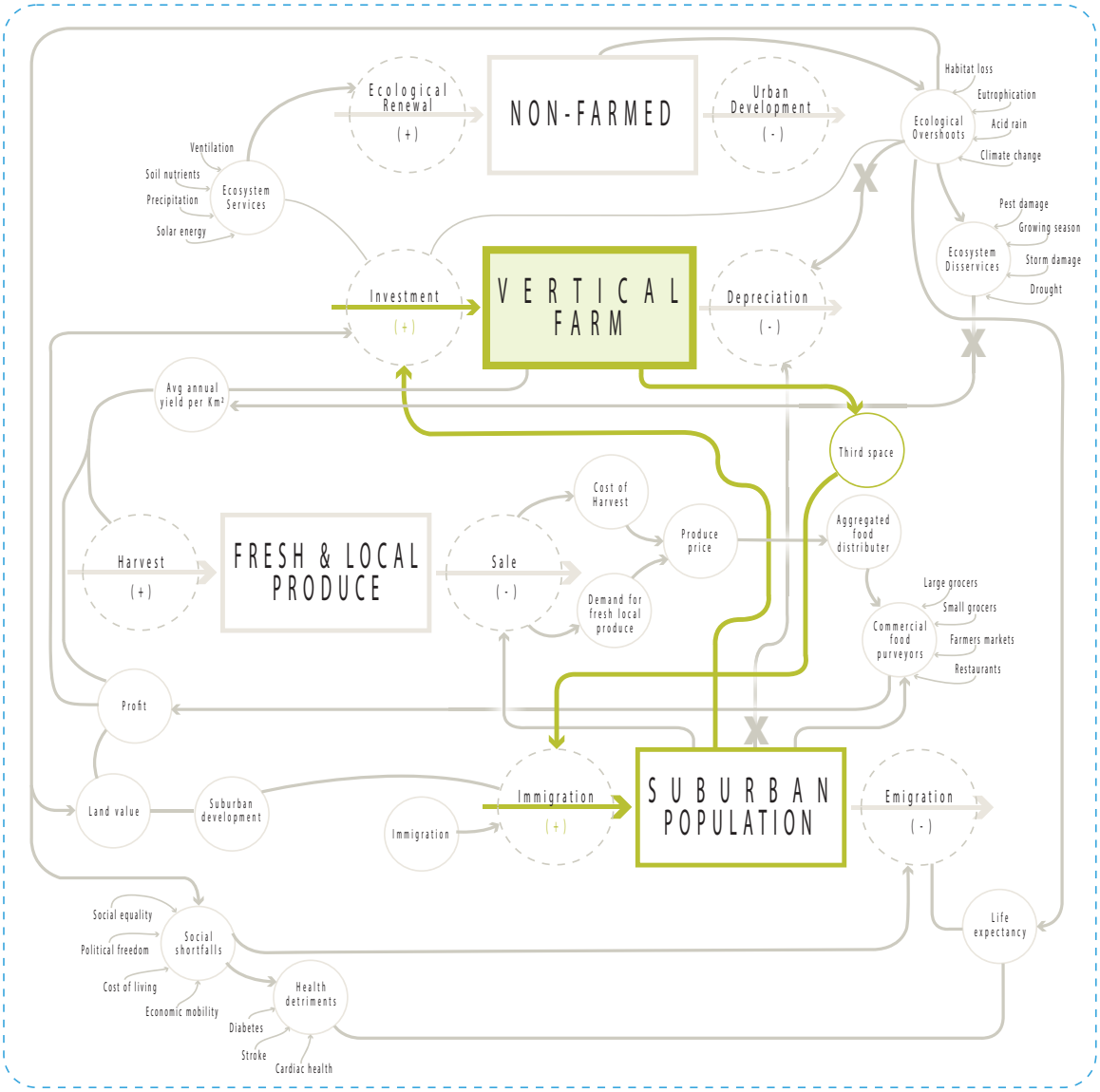
3. The WVF must operate using ecosystem services without making a net contribution to ecological overshoots.

The intention of these rules is for them to be repeatable, yet site-specific, and able to be explored in more detail. The purpose is to slowly narrow down the system into broad-stroke principles that are to be followed (Sull and Eisenhardt 2012). Borrowed from *Simple Rules for a Complex World* (2012) the impact of these simple rules as they apply to the the implementation of a vertical farm are mapped onto the previous system map. The result is a disruption of previously higlighted social shortfalls and ecological overshoots. This reflects a change in the goal of the system as well.



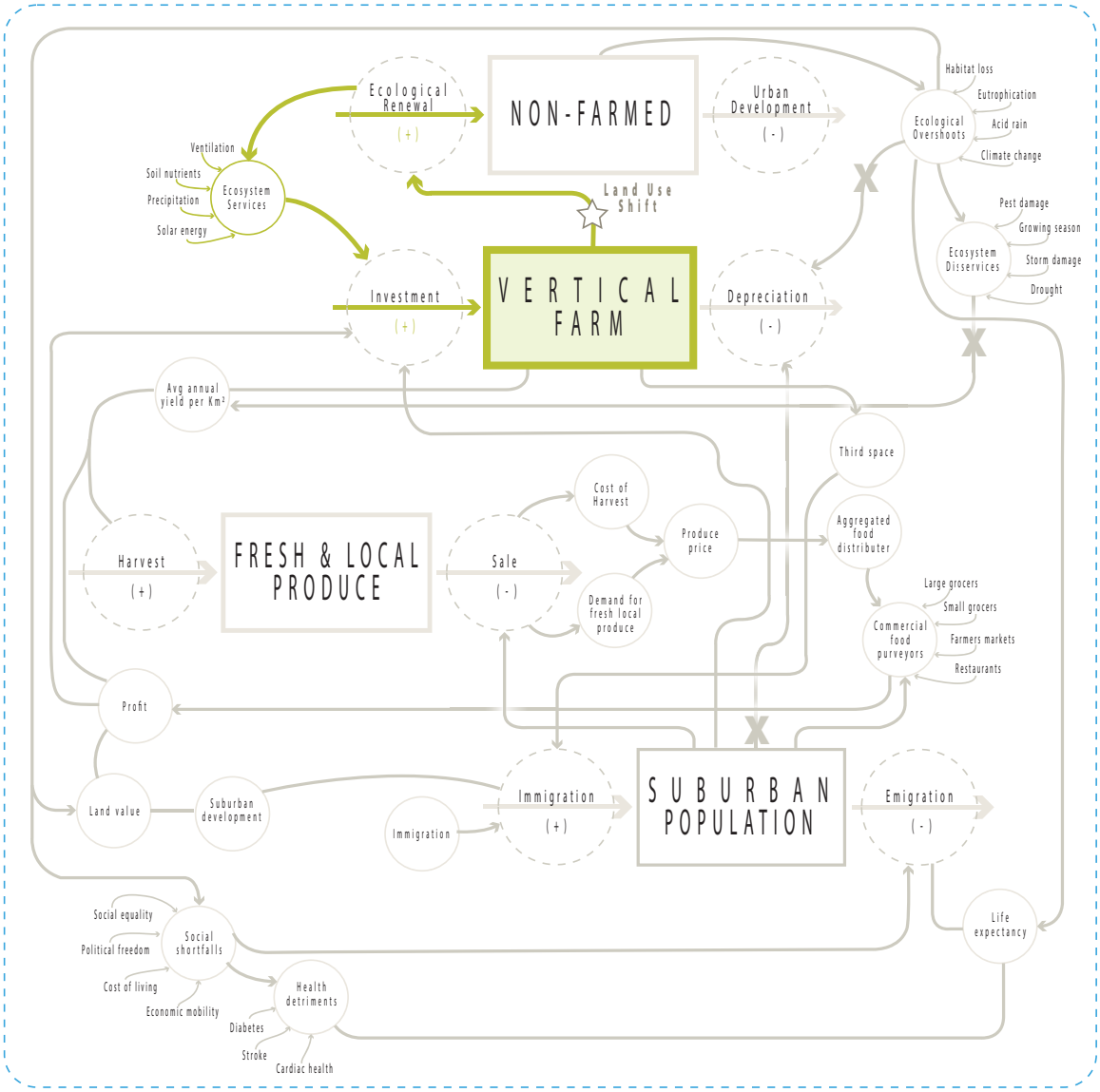
Produce fresh local veggies at socially sustainable rate

Highlighted to illustrate the positive feedback loop of principle 1: The WVF is to increase supply of local produce to suburban populations and food purveyors.



Produce fresh local veggies at socially sustainable rate

Highlighted to illustrate the positive feedback loop of principle 2: The WVF is to provide a much-needed third space for local residents to build community and cultural ownership.

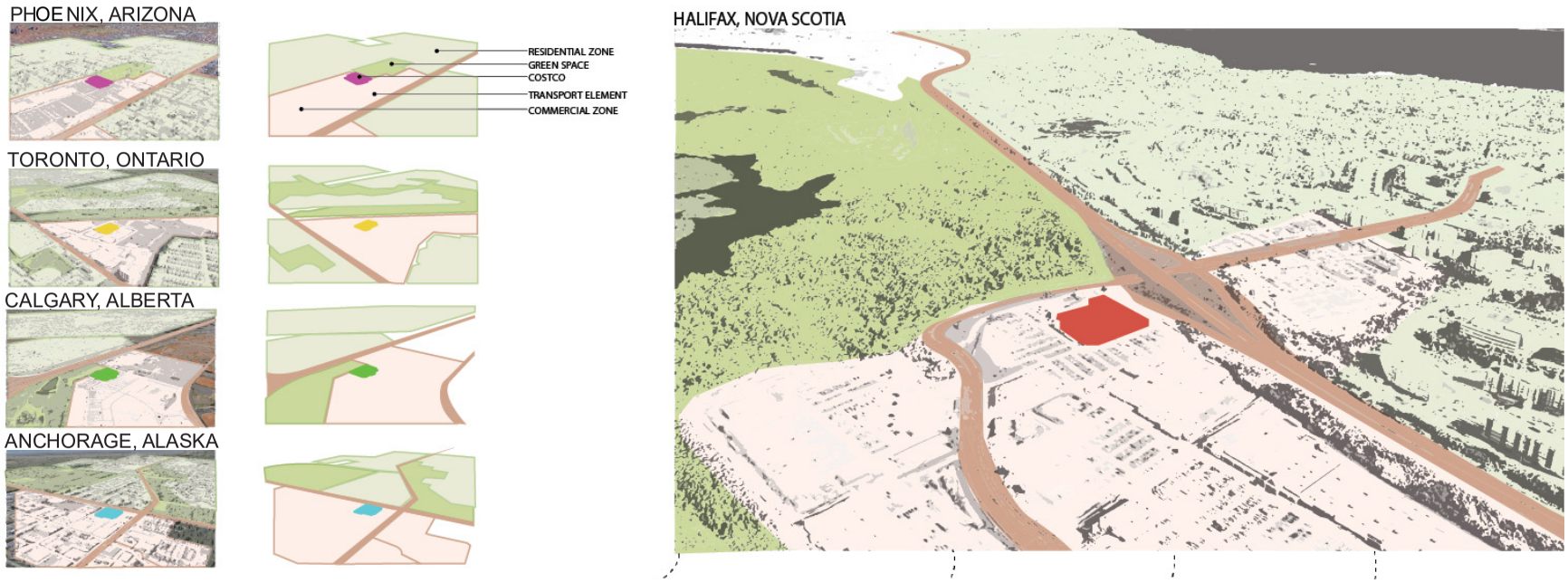


Produce fresh local veggies at socially sustainable rate

Highlighted to illustrate the positive feedback loop of principle 3: The WVF must operate using ecosystem services without making a net contribution to ecological overshoots.

Chapter 3: Design

Abstract collage of site visit experience



Site context as compared to costcos across North America. Basic elements are: Residential zone, greenspace, main transport axis and commercial zone. Despite differences in geography and cultural identify, there is a foundational similarity between development pattern between all the Costco locations studied. This may appear obvious; however, engaing this this broad exercise allows similarities and differences to be teased out further through the use of a site comparison matrix. (base map from Google Maps 2021a; 2021b; 2021c; 2021d; 2021e)

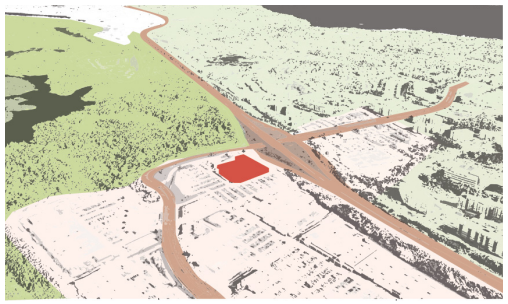
3.1 Site Analysis

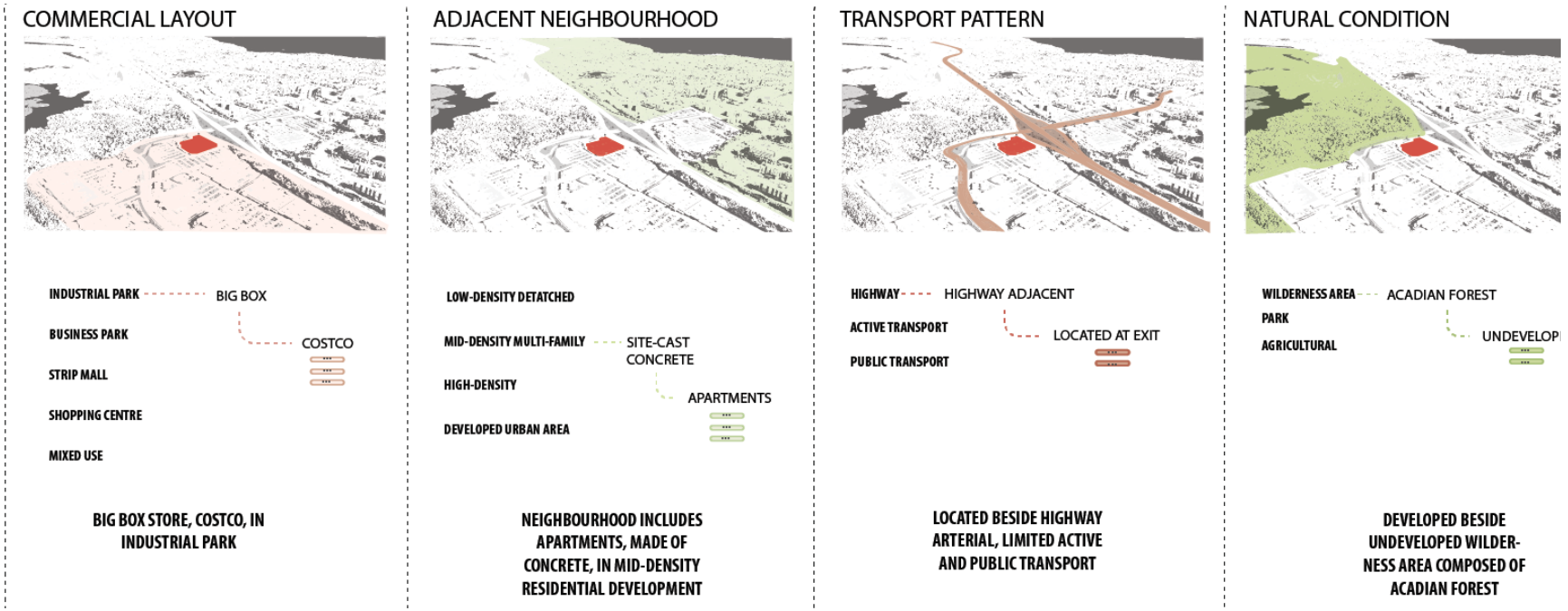
3.1.1 Site Selection

An existing Costco store, located at the northern edge of Bayer's Lake Business Park in the Halifax Regional Municipality (HRM) has been selected for the design component. The building is a 20,000m² warehouse which, if devoid of signage, would be indistinguishable from most other warehouse retailers. Costco stores are similar in design and layout, lending to the generalizability of the retrofit proposal. Given the purpose of this design project — to determine repeatable, yet site-specific, interventions for business parks across North America — the homogeneity of this warehouse form is desirable, based on the following assumptions:

1. If an intervention successfully uses the structural form of a Costco in Halifax, NS, then (allowing for minor adjustments to account for different climatic conditions) it would be suitable for other, similar warehouse stores.

2. This particular Costco and the adjoining business park have been developed according to civic-planning requirements that are consistent with similarly developed business parks across North America (e.g., truck turning-radiuses, parking-to-store area ratios, vehicular access by way of arterials, back-of-house and municipal servicing requirements).





Further breakdown and distillation of site elements. This lens allowed the specific subgroup of the Bayer's Lake Costco to be studied. If a different site were selected, this step would be repeated, and different breakdowns would be recognized. For example, a strip mall with low density residential housing and no major park or greenspace adjacent would require a different social approach to properly service the community. (Base map from Google Maps 2021e)

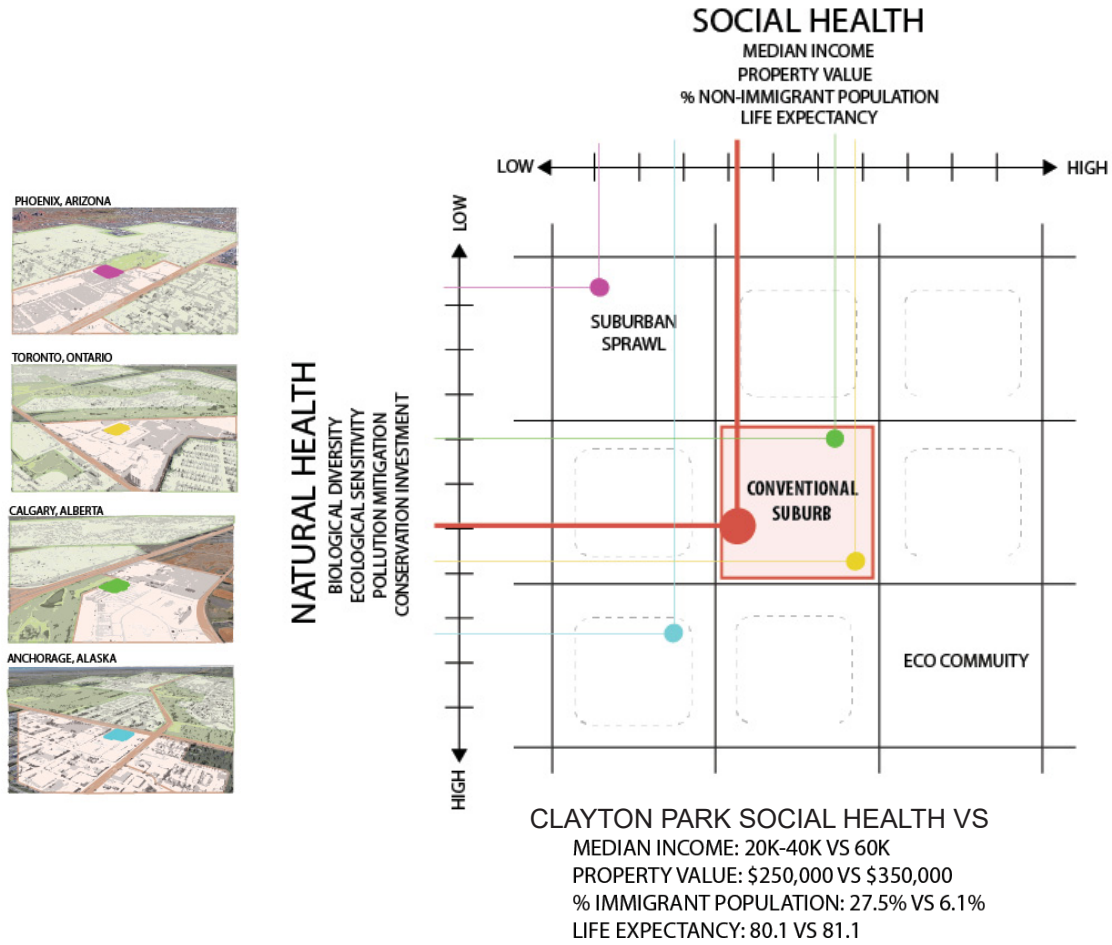
3.1.2 Site Comparison Matrix

Site photos

A perfect site does not exist; rather, some sites for are more conducive to retrofit than others to a successful retrofit. The thesis thus far assumed that the Costco in Bayers lake Halifax is a representable peri-urban site application of the methodology. To justify this assertion, the following site comparison exercises was conducted. The context surrounding Costco's ranging from Arizona to Alaska were compared. The sites were highlighted for their major suburban development elements, such as main arterial road, residential adjacency, and wilderness area. These elements were further classified into various context descriptions – this will be discussed in the following paragraph. All cases revealed largely similar contextual patterns to Bayer's lake, even in Anchorage, Alaska. Costco seems to represent a fairly standard context – locations are located almost directly beside a major highway, within zones for retail warehouses, near a suburban neighbourhood. The form of natural space appears to be the most significant source of variation.

The four context elements can be further broken down to reveal specifically what type of element is present. This was exemplified with Bayer's lake, as more detailed descriptions were rendered. For instance, the Bayer's lake Costco exists adjacent to site-cast concrete multi-unit residential apartment with an adjacent protected wilderness area. This exercise helps establish a basis on which suburban development patterns could be compared despite differing geographies.

To evaluate social and ecological context of a site in a comparative manner, a simple matrix was created on which sites could be plotted.



CLAYTON PARK SOCIAL HEALTH VS
MEDIAN INCOME: 20K-40K VS 60K
PROPERTY VALUE: $250,000 VS $350,000
% IMMIGRANT POPULATION: 27.5% VS 6.1%
LIFE EXPECTANCY: 80.1 VS 81.1

Social health versus natural health simplified matrix with accompanying precedence. Phoenix Arizona [left] and EFEKT's ReGen Villiages [right]. Empirical measures are not present but could be added to better inform matrix options. (data from Statistics Canada 2016; Base photos from Google Maps, 2021a, 2021b, 2021c, 2021d; photos from EFEKT Studio 2016; Google Maps 2021f)

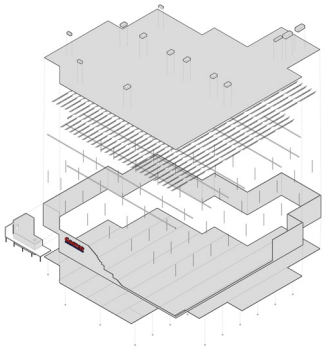
The result is a method to gauge the socio-ecological status of sites. Research indicates that median income, property value, immigrant population and life expectancy can be used to indicate the general social health of a suburb. The same quality exists for the selected natural health indicators. These indicators offer empirical methods to gauge how social and natural elements may describe prospective sites. This matrix operates at a macro scale and can be used to help quickly evaluate sites for further study. It is assumed that the best strata for this intervention to take place would be conventional suburbs. These create a socio-ecological goldilocks zone for retrofits would avoid areas of rampant suburban sprawl as well as highly developed eco-village suburbs. Such areas are assumed to be unconducive for successful retrofits due to poor existing social infrastructure and less demand for low-impact agriculture (respectively).

The building assembly of the Costco itself was not analyzed in this section and Costco are assumed to vary only minimally in their construction. This conclusion was reached after a comparison of Bayer's lake Costco and a set of plants for a Costco in Minnesota revealed very few differences.

Aeral of Bayers Lake. Wilderness area in green, big box stores in red and costco site outlined with dashed black line (Base image from Indoblue82 2016)

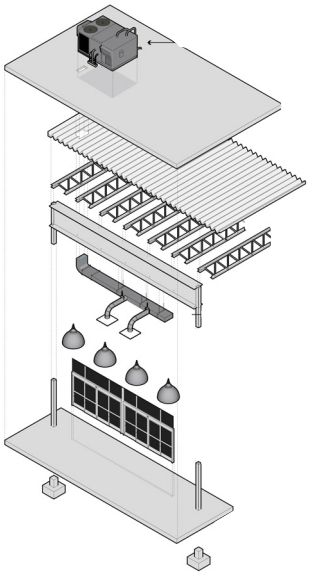
3.1.3 History

Opened in 1992, the store (then known as the Price Club) was one of the first retailers to build in the newly developed Bayer's Lake Business Park. The development was controversial at the time and opposed by existing grocery store chains because of perceptions of subsidized competition, by environmentalists because of the ecological sensitivity of the area, and by urbanists because of concerns that development to the west of NS Highway 102 (a circumferential ring-road) would contribute to sprawl The controversy has largely been forgotten and the business parks and its big-box stores have gained cultural acceptance. However, one question from a contemporaneous newspaper article may still be relevant:



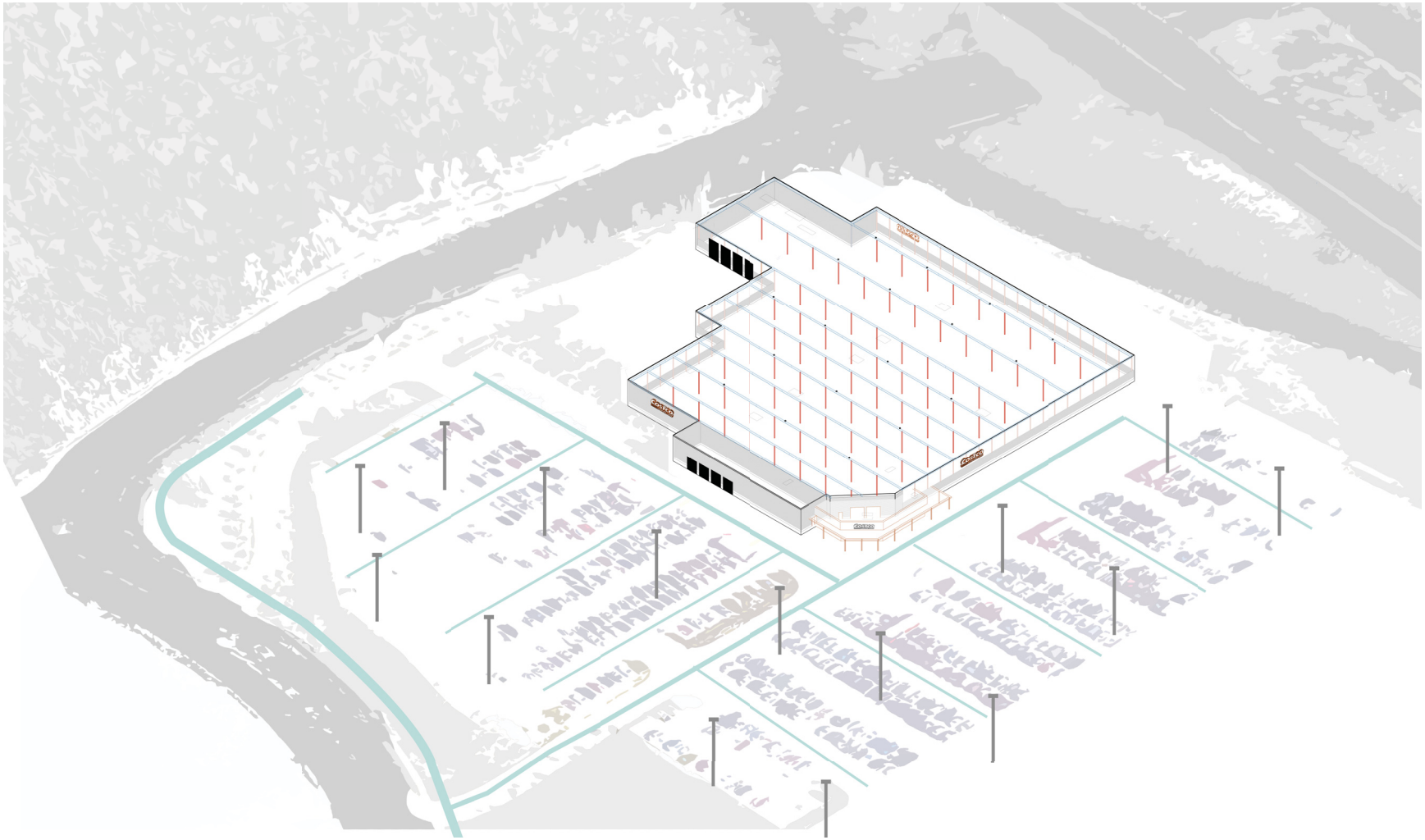
> Do you think Price Club will sponsor the City Parade next year, or the local basketball team? Those kinds of things are important to the quality of life. - Fred MacGillvray, general manager of Bolands IGA-Group and spokesman for the business group. (Grandreau 2012)

3.1.4 Site Description



Axo of Costco Assembly

- Total site area 63,000m2
- built area 20,000m2
- parking area 30,000 m2
- service road/access on north side off Chain Lake Drive
- customers access road on south side, also off Chain Lake Drive
- bounded on east side by Bicentennial Drive (NS Highway 102), north side by Lacewood Drive becoming Chain Lake Drive on west side (an arterial) and a Walmart Supercentre to the south
- site elevated ~105m above surrounding area
- drainage: Municipal stormwater collection
- Native forest: Blend boreal and Acadian Forest
- Ecosystem classification: Barren-bog
- Hardiness zone: 6a-6b



The structure and program of the existing Costco was studied to better understand how the budling assembly could be retrofitted feisably and efficiently (base image from Google Maps, 2021h)

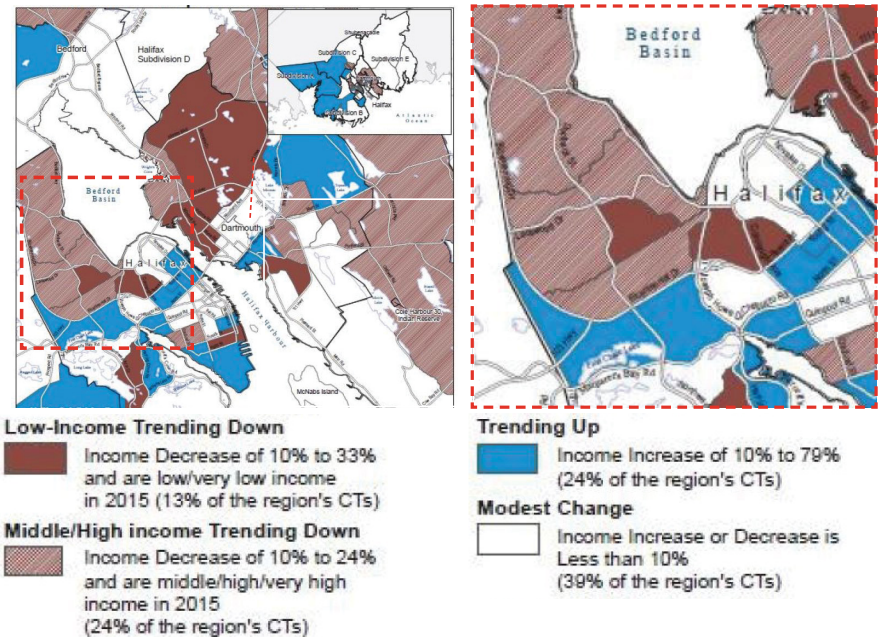
- Ecoregion: Border of 440-Eastern Interior and 780-St. Margarets Bay
- Geology: Quarry Lake Granodiorite.
- Presence of Acid Rock Drainage (ARD): Confirmed

3.1.5 Building Description

- slab-on-grade
- steel frame construction with HSS column grid of 10 m (typical), wide-flange I-beams and OWSJ
- shear walls located on SW and N elevations
- flat EPDM (likely) roof on rigid insulation on steel pan
- mechanical services: Central HVAC, building sprinklered
- Concrete block 3m in height, cement board to underside of ceiling. Generic moisture and vapour barrier rigid polystyrene insulation with corrugated steel cladding.
- Auto repair and tire service area entered from southwest garage doors.

3.1.6 Local Context

The proximal neighbourhoods of Clayton Park and Fairview have a combined population of 35,000. Approximately 27% are considered to be “new Canadians,” meaning recent arrivals or first generation. Many multi-unit apartment



Change in average individual income as a percentage of Halifax CMA between 1980-2015 (Devet, 2018)

buildings have been constructed in the last two decades. High-density and an extra-peninsular location renders these units affordable to new residents to Halifax, further concentrating immigrant populations (Prouse et al. 2014)

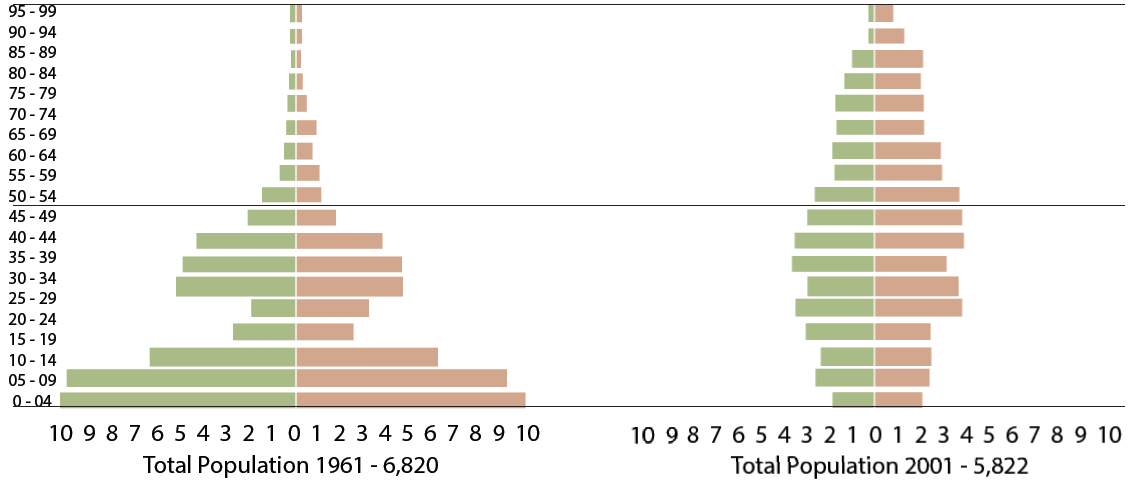
These neighbourhoods have been experiencing a slight downward trend in their average income between 1980 and 2015 relative to the census metropolitan area (CMA) (Prouse et al. 2014). An average 2-bedroom unit in Clayton Park west is $920.00 less per month than its downtown equivalent. However, downtown residents can go without a car and have many social amenities nearby (Zumper 2020). Suburbanites' lack of proximity to public amenities and community spaces can result in social and cultural isolation. This project presents an opportunity to address the cultural isolation present in the communities proximal to the Bayer's Lake Business Park.

> If you go to a place where you don't know anybody, how do you make friends? Do you go to people's houses? Do you wait for them to come to your house? I don't know how to get to know my neighbours – I don't know the people who live next to me. This is my concern. How do you expect can/ should newcomers to meet their neighbours? - Clayton Park West resident (Koshy 2019)

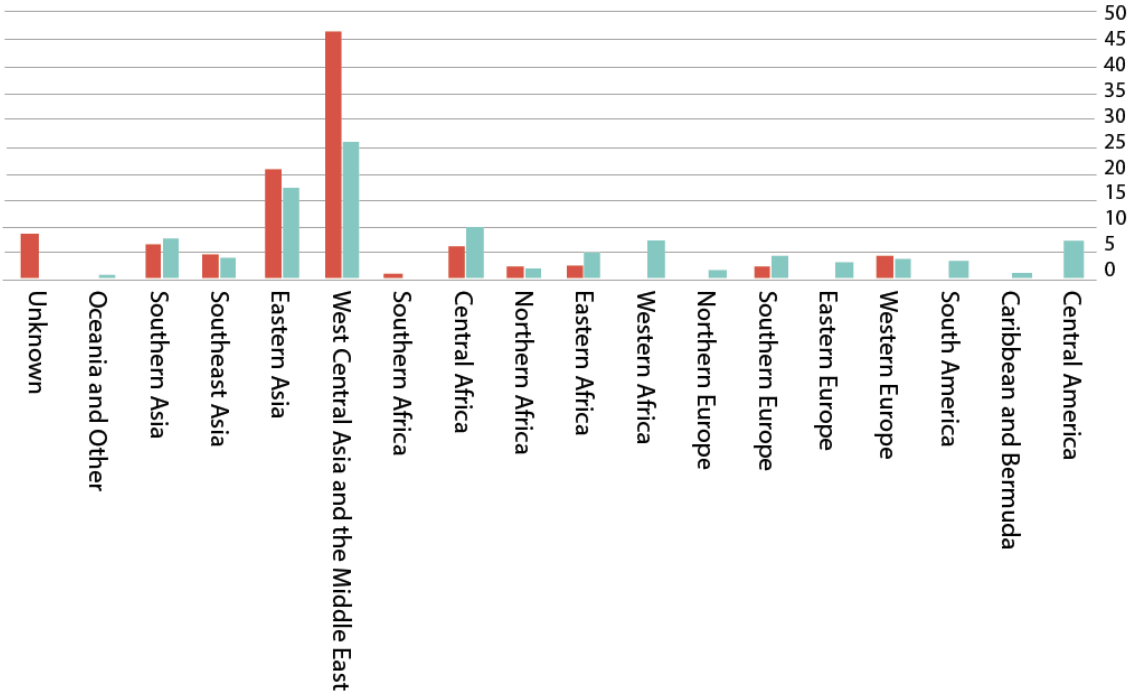
3.2 Culture and Context

3.2.1 Community Food and Culture

The residential areas bordering Bicentennial Drive (NS Highway 102) are the most diverse in Atlantic Canada, with an average of 27% new Canadians (defined by Statistics Canada as "persons residing in Canada who were born outside of Canada"). This contrasts with an average of 9.4% across the Halifax CMA and less than 6% across Nova Scotia (Statistics Canada 2016). Currently, the immigrant population is largely from the middle-east and south asia.



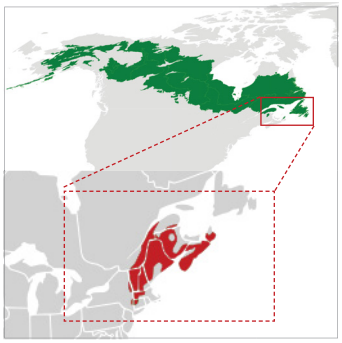
Age distribution of Fairview/Clayton Park, 1961 [Left]. Age distribution of Fairview/Clayton Park, 2001 [Right]. (Hill 2013)



Percentage comparison birthplace of urban recent immmigrant population [blue] vs. suburban recent immigrant population place of birth [red]. (Hill Community profile 2013)

Global boreal forest ecoregion [green] (Ricketts et al. 1999)

Global acadian forest ecoregion [red]. (Ricketts et al. 1999)



Comparison of boreal forest ecoregion [green] vs Acadian forest ecoregion [below in red]. (Ricketts et al. 1999)

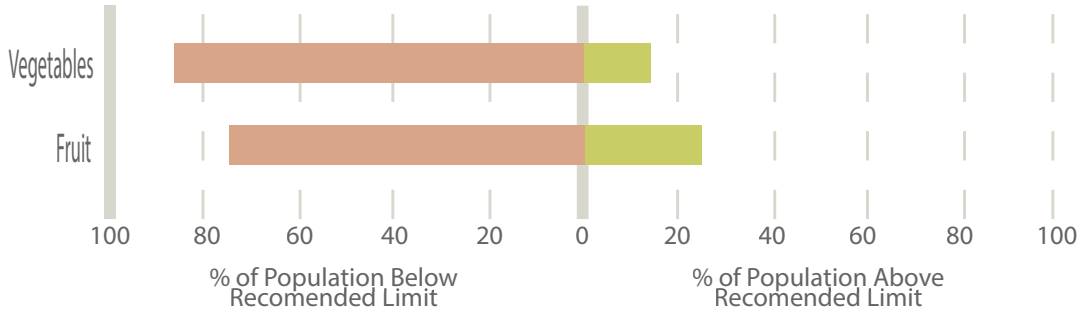
Arabic and Mandarin are the third and fourth most commonly spoken languages in Halifax. Of the Over 8,500 practicing Muslims in Halifax, a significant number are in the proximate community; therefore, practice of Ramadan near Bayer's lake is statistically more common. Hindus, Sihks and Budhist population may appreciate vegetarian exclusive options for their religious ceremonies, as well as Catholics during Lent (Statistics Canada 2011).

> During lunchtime, the aromas of Arabic food, Indian food and Canadian food waft in the cafeteria of Park West School. More than 60 different countries are represented in this school located in Clayton Park West." – Signal HFX (Koshy 2019)

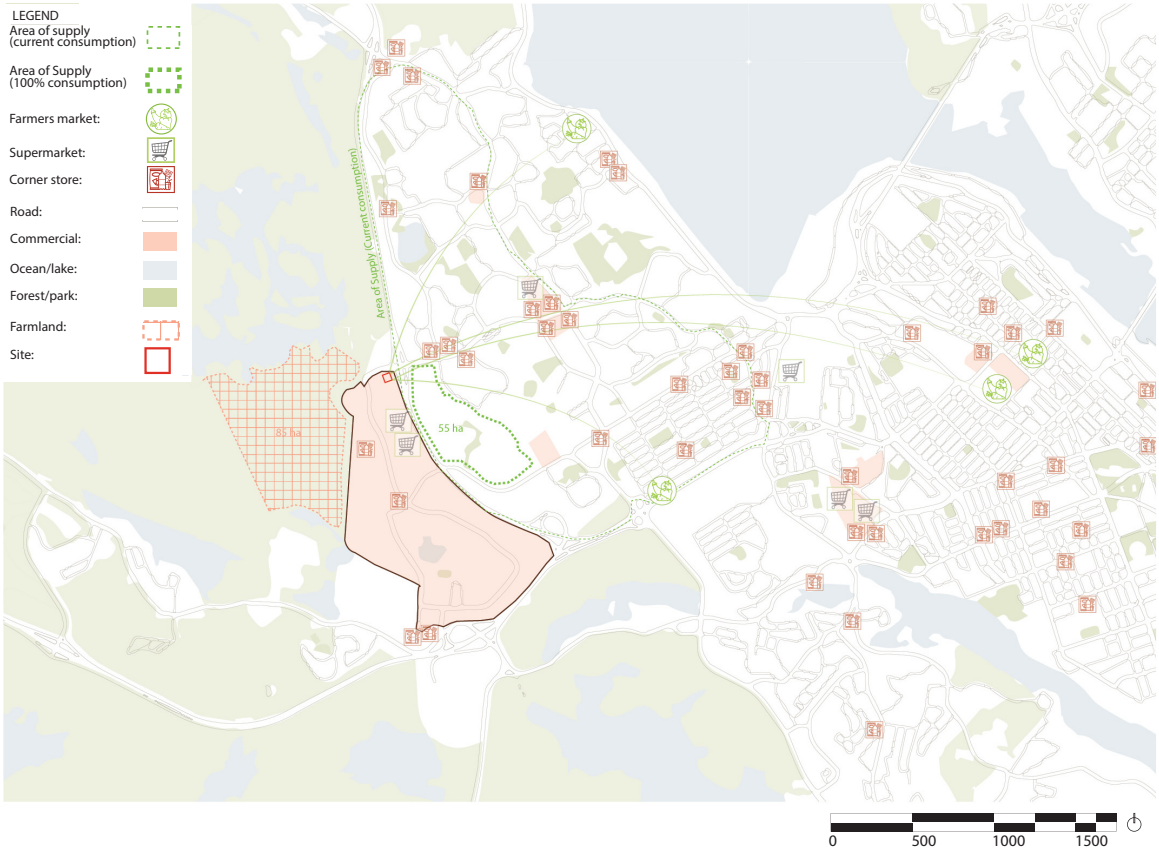
However, the cultural diversity found among nearby residents is not at all reflected in the food choices available in Bayer's Lake; prepared meals are exclusively from fast-food chains and chain restaurants (McDonalds, Harvey's, A&W, Subway, Boston Pizza, Smitty's, among others). The following map displays the current distribution of processed food vendors versus fresh produce vendors. On an ad hoc basis, fish and lobster vendor trucks will appear in the parking lot of the building supplies store to the west. Groceries are available through big-box outlets such as Walmart Grocery and Atlantic Superstore, and to a lesser extent, Bulk Barn. The food supply chain in Bayer's lake oversupplies non-perishable, processed foods and underdelivers local, fresh produce. Part of this is due to the limited growing season in Nova Scotia and a reliance on imported foods. 67.4% of Nova Scotians fail to consume 5-10 daily servings of vegetables (NSDH 2004). This equates to 3.5 cups of vegetables missing from consumption patterns per day. Income insecurity, proximity to grocery stores and being female predict for even lower vegetable consumption levels. As result, women in low-income, car-dependent

communities are especially at risk of developing nutrition-related deficiencies and heightened BMI (Ross et al. 2007). Studies support the claim that suburban sprawl significantly predicts health related quality of life (Ross et al. 2007).

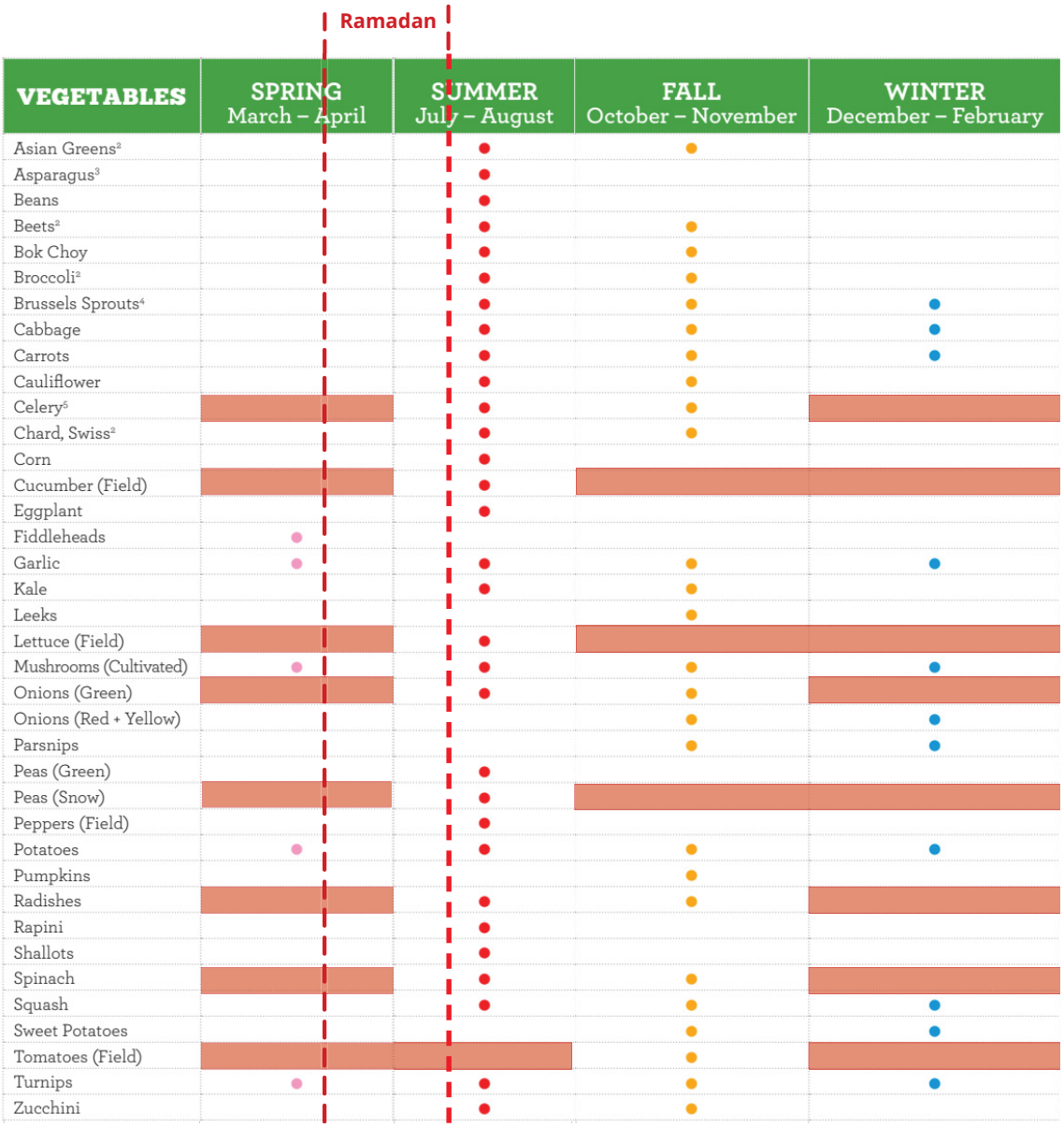
The association between suburban development patterns and declining health indicators suggests retrofitting suburbs to increase access to green space and vegetable



Dietary intakes vs recommendations. (data from USHHS 2020)



Vegetable consumption patterns Halifax, shown here, are similar to Phoenix, despite geographic difference. Access to local produce is limited by season. Procressed non-perishables are accessible year round. Retrofitting the Costco site into a WVF could supply 28,000 servings of vegetables daily, while saving 85 ha of arable land. (NSDH 2004; Avgoustaki and Xydis 2020)



Seasonal availability chart expresses the environmental limitations of year round fresh vegetable supply. Ramadan, a cultural event involving fasting, takes place during a period of fresh vegetable scarcity. This is exemplified through the scarcity of ingredients used for Fattoush, a common dish to start with to break Ramadan fast, highlighted in red. (Sobeys n.d.)

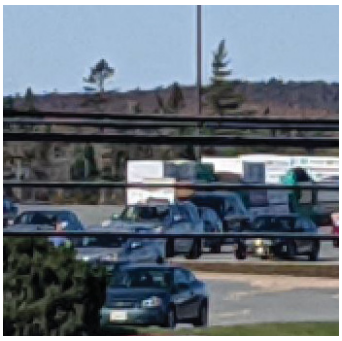
consumption as a possible avenue for health promotion and disease prevention. Moreover, there is an opportunity to meet the demand for fresh vegetables while increasing cultural cohesion. (PHAC 2011).

3.2.2 Public Use

Most Haligonians aren't aware of how beautiful it is out here and how much of an asset it is to have such an amaz-ing escape so close to the city. We want to bring people out here so they can appreciate it too, says Murray (Woodford 2019).

The park's location so close to Halifax has resulted in public pressure to protect the lands from development. In 2016 there was massive outcry when a proposed development

Comparison Kejimkujik national park [top] vs Blue Mountain Birch Cove provincial park [bottom]. (Woodford 2019)



Family sitting on grass preparing for their hike [foreground]. People are gathered around car to socialize and drink coffee [background].

Communal roasting sticks hung on tree beside informal fire pit.

Litter surrounding site adjacent to Costco.

was made public. As a result, within the last 20 years several hundred acres have been purchased by the city and province. This dispute is still working its way through the courts as developers wish to turn the park into suburbs (Bird 2020). Undeveloped land is currently a mix of provincial and private lands with several unofficial trails that punctuate the forests (Plourde 2020). Despite being desirable for Haligonians seeking adventure, there is no official entrance to the park and all trails are only marked by enthusiasts (Woodford 2019). Hikers can be found parking in Bayer's lake business park near Kent's before walking behind the wood supply store and onto the trails.

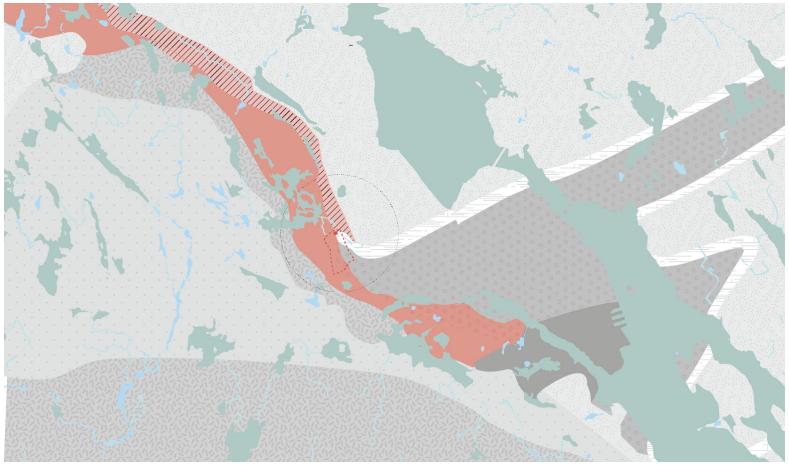
Bayer's lake business park has an observable impact on the local environment. Accumulation of litter and plastic pollution, oil and salt from roadways, light pollution from flood light, and air pollution are some of the negative externalities of the site's operation. This suggests that there is certainly an opportunity to mitigate these impacts through the retrofit of a big box store. Additionally, there may be an opportunity to engage the users and residents of Bayer's lake in the forest's protection and maintenance through activities like foraging, hiking, camping and trail-building.

> Most Haligonians aren't aware of just how beautiful it is out here and how much of an asset it is to have such an amazing escape so close to the city. We want to bring people out here so they can appreciate what Halfiax has to offer too, says Murray (Woodford 2019).

The following site maps attempt to explain the sites relation to the city, its transport network, protected greenspaces and geological nature.

Protected greenspace [dark green]

Nonspecific greenspace [green] and water versus access routes.



Geological layers [grey], Quarry Lake Granodiorite [red]

Roads [grey], walking [green], bussing [blue], personal vehical [red]

Context mapping: Provincial parks and wilderness areas (map based on OSM 2021) [top left]. Water and greenspace with connection routes (map based on OSM 2021) [top right]. Geological layers of Halifax (map based on OSM 2021) [bottom left]. Road network and with connection routes [bottom right] (Tarr and White 2015)

Simplified site map. (map based on OSM 2021)

Site plan with callouts for parking lot depaving. Adjacent Costco parking lot will be repurposed through the extension of the 10m x 10m grid and populated by modlues to serve social, ecological and programatic needs of the project as a whole. (map based on OSM 2021)

3.2.3 Existing Structure and Construction

A new 140 acre expansion planned for Bayer's lake, currently nicknamed Bayer's Lake 2.0 has been granted approval and the site is already in the process of being cleared. As Bayer's Lake 2.0 will include the planned location of the hospital's outpatient center, it is rumoured that the almost 30 year old Costco will be relocating, opening up the existing Costco site at 230 Chainlake drive site for a retrofit (Bird 2020)

3.3 Design Limitations

3.3.1 Systems Thinking: Principles at the Site Scale

In Chapter 2, system mapping at the conceptual scale revealed three principles for the implementation of a WVF into a suburban system:

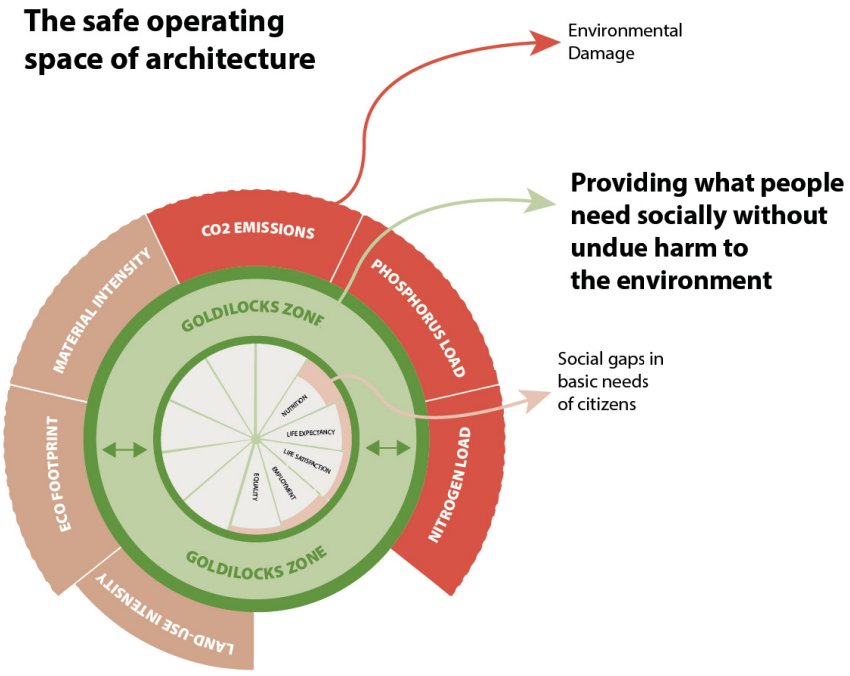
1. The WVF is to increase supply of local produce to suburban populations and food purveyors. Doing so can slow the decline of:
   - property values
   - suburban development
   - decay of suburban livability
2. The WVF is to provide a much-needed third space for local residents to build community and cultural ownership.
3. The WVF must operate using ecosystem services without making a net contribution to ecological overshoots.

These are consistent with chapter 5 and chapter 6 of Kate Raworth's article on donut economics (2018):

4. The food production network which is dependent on resources inherent to its site, such as sun, water and wind. The scale of production must be limited to that which can be collected by the site. (Raworth 2017)

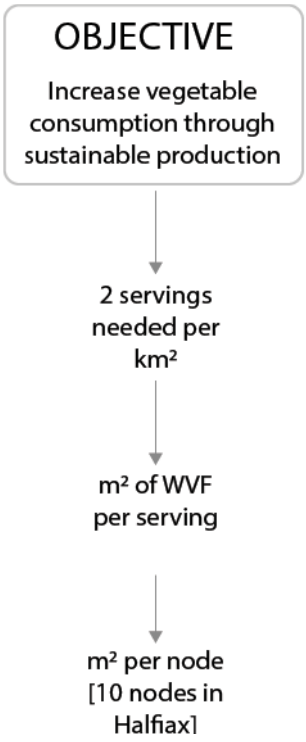
5. Means of production and generation of wealth are to be redistributive and decentralized. (Raworth 2017) As opposed to the first which are more conceptual in nature, Raworths principles offer an additional level of guidance to help avoid shortfalls and overshoots at the site level.

The following design project proposes one node in a hypothetical urban food network and attempts to satisfy the above principles. Recall the goal of the design retrofit is to occupy the goldilocks zone between social shortfalls and ecological shortfalls.



Donut diagram for safe operating space of architectural goldilocks zone. (Base data from University of Leeds, n.d.)

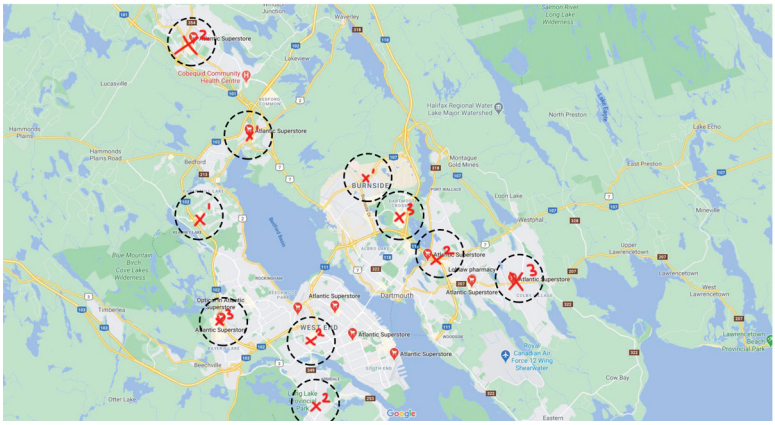
3.3.2 Systems thinking: Results at the Building scale



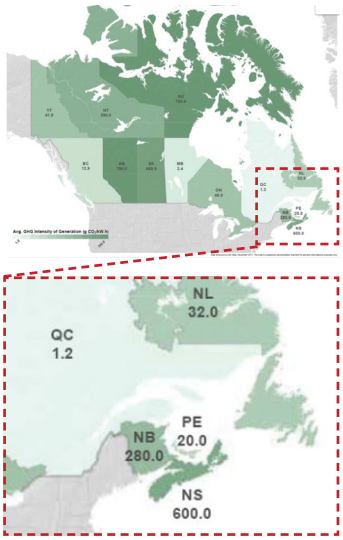
Calculation roadmap,

Food Production and Consumption

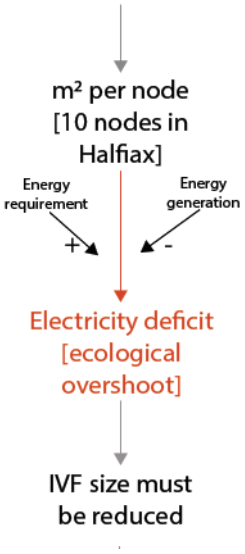
The system inputs and outputs place constraints on the size of this project. The roadmap above helps to explain the guiding decisions made in the analysis of these inputs. Underconsumption of veggies results in social shortfalls due to various diminished health indicators. At current rates, Halifax must consume two additional servings of veggies per person in order to get into recommended levels of consumption, rising from 4.6 to 6.6 servings daily (Health Canada 2020). Based on the population density, each square kilometer of Halifax requires 250m² growing at highest WVF productivity current observed (Aerofarms 2021). There are ten major shopping nodes in Halifax. This ratio concludes that 6500m² of WVF per growing node would be sufficient to supply each resident of Halifax with 2 servings of fresh local produce. This audit concludes that a 6500m² node is the ideal size to satisfy the social shortfall of fresh produce consumption.



Potential WVF node locations and distribution. (Google Maps 2021g)



Provincial carbon intensity (CER 2017)



Calculation road map continued

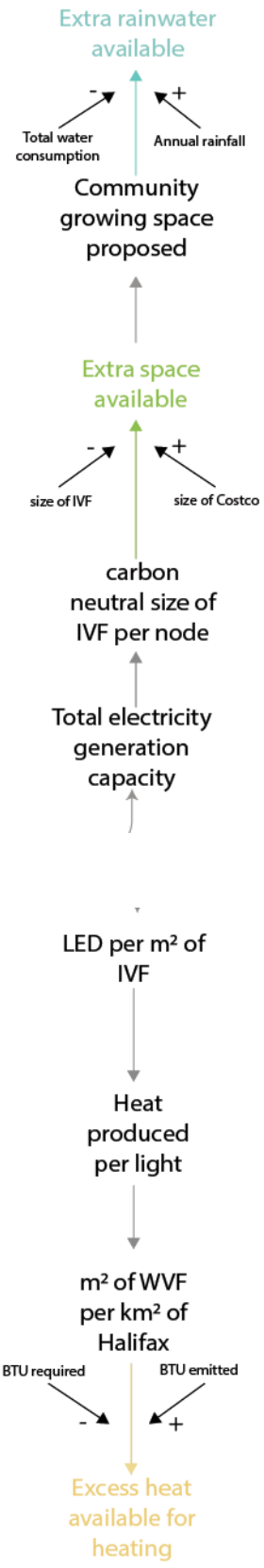
Energy Generation and Consumption

Now to address the ecosystem overshoots associated with the rectification of this social shortfall. A WVF is highly energy-intensive. The operation of a 6500m² WVF at the assumed food output operating with top-of-the-line efficiency upgrades could consume up to 150 gigawatts a year. That is equivalent to 6,129 typical Canadian households (Statistics Canada 2017). Furthermore, the Nova scotia power grid currently uses 60% fossil fuels for electricity, making it third highest CO_2 intensity per kwh in the country. Operating the WVF at this level would produce 90,000 tonne CO_2 per year, making it about 50 times more CO_2 emissions per kg of lettuce than shipping it from Arizona. This would be operating in the ecological overshoot (MacLeod and Scott 2010)

To operate in the goldilocks zone, the project would have to be carbon neutral. This limits the project to operating within its solar collection ability. The entire 20,000m2 and the adjacent parking lot could generate 6.072 Gigawatth/y, meaning that the dedicated intensive vertical farm section (IVF) must be restricted to 1359m² to satisfy principle 4 defined earlier. It is worth noting that Nova Scotia anticipates reducing the use of coal-fueled power by 80% by 2030 (Government of Nova Scotia 2020). As the carbon intensity of grid electricity decreases, the prospective yield of the vertical farm could grow proportionally, while remaining in the goldilocks zone.

Interior Requirement and Size of Existing Building

It is evident that if the IVF is limited to 1359m² of space, there will be ample room for additional programs within the building. This opens the door to other forms of indoor agri-



Calculation road map continued

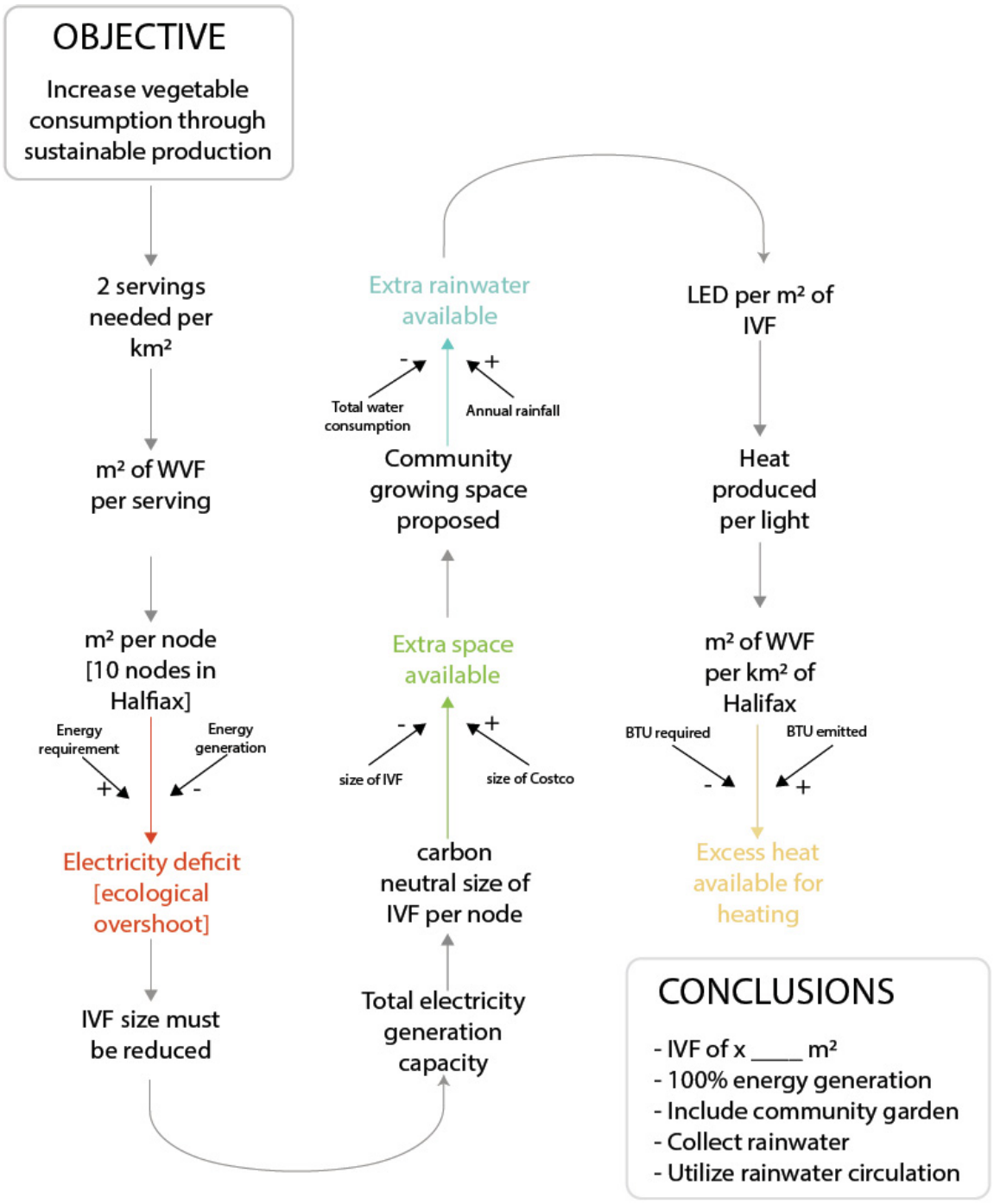
culture, so long as they operate accordance with principle 4.

Water Production and Consumption

Halifax averages 1388mm of rain annually. This equates to 27,760,000L falling on the 20,000m² site annually. This is ample water for irrigation as vertical farms are highly water efficient. A 1359m² IVF would only consume 480,000L, or 1.7% of the annual water which falls on the site. This means there are ample natural water services on the site for irrigation of the IVF and possibly other agricultural forms. While rain falls in great volume in Halifax, ¼ the total volume rains/snows/melts between the months of February-May. Storing rain from this period would require approximately 7,000m³ which is just under three olympic swimming pools.

Heat Generation and Interior Volume

80% of the electricity consumed by an IVF is used to power by LED lights. While highly efficient compared to other light types, LEDs generate a huge amount of radiant heat when used in this intensity. The 1359m² IVF proposed here can generate up to 18,684,931BTU/hr, while this much volume only requires 1,755,376BTU/hr to maintain at the proper temperature. The remaining BTU is sufficient to heat the 20,000m² facility; however, venting the air can be difficult since air handling can be energy intensive. The ventilation has to be done highly efficiently and with limited energy required.

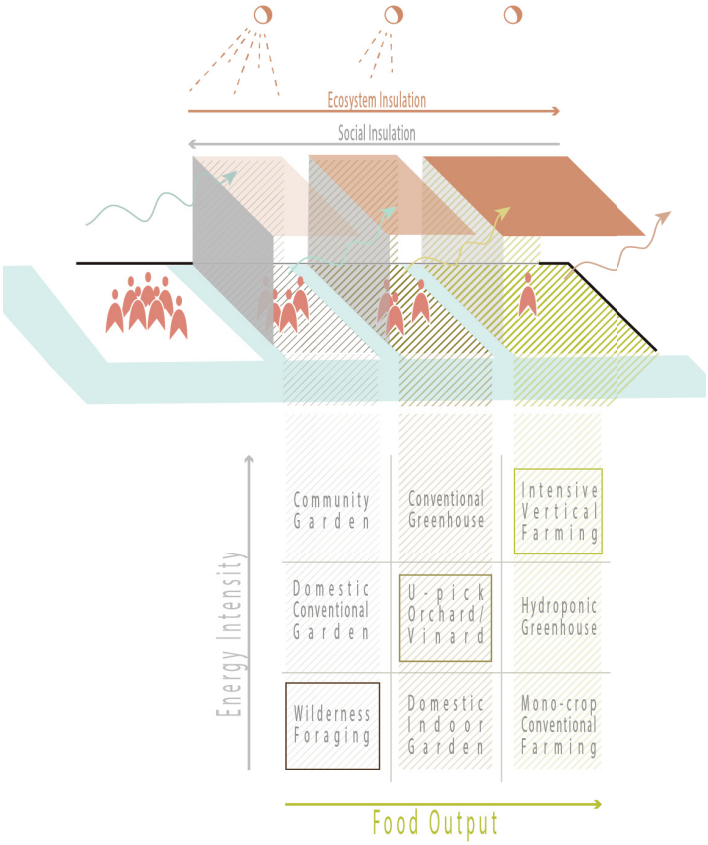


Complete roadmap of calculation decisions. Calculations can be found in appendix

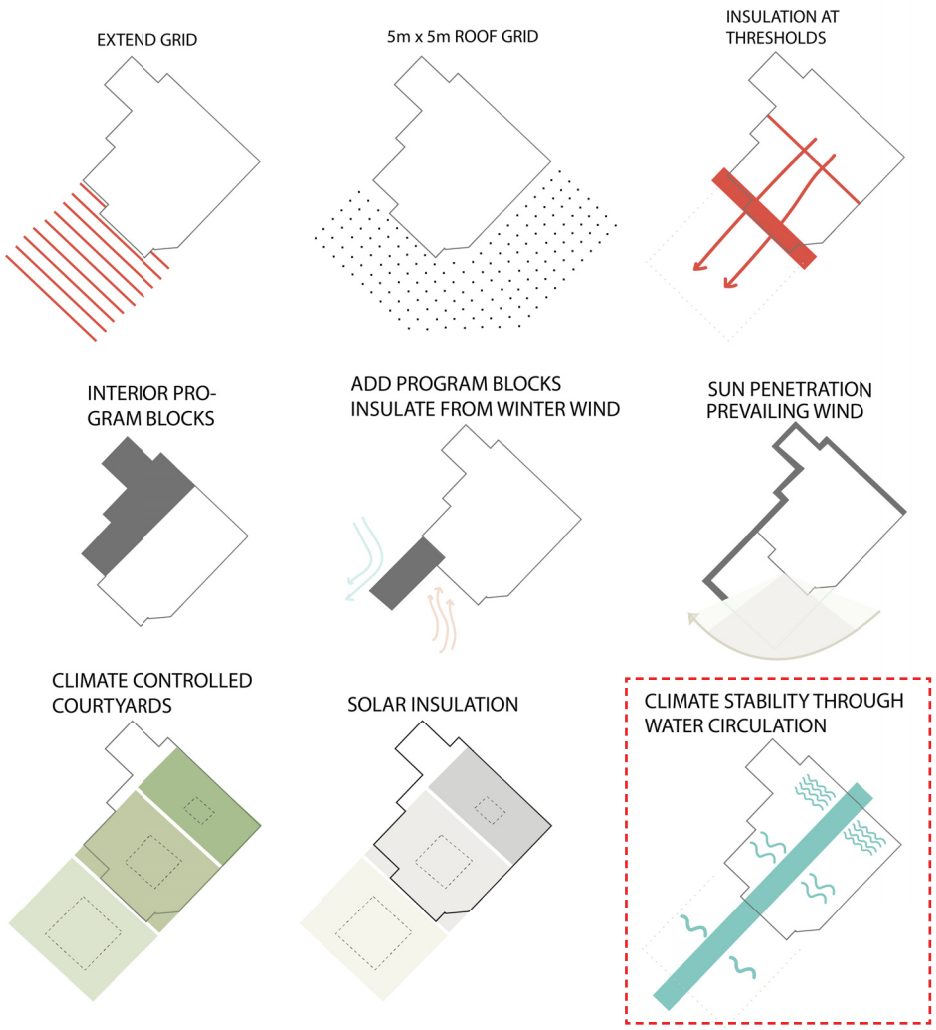
Chapter 4: Intervention Principles

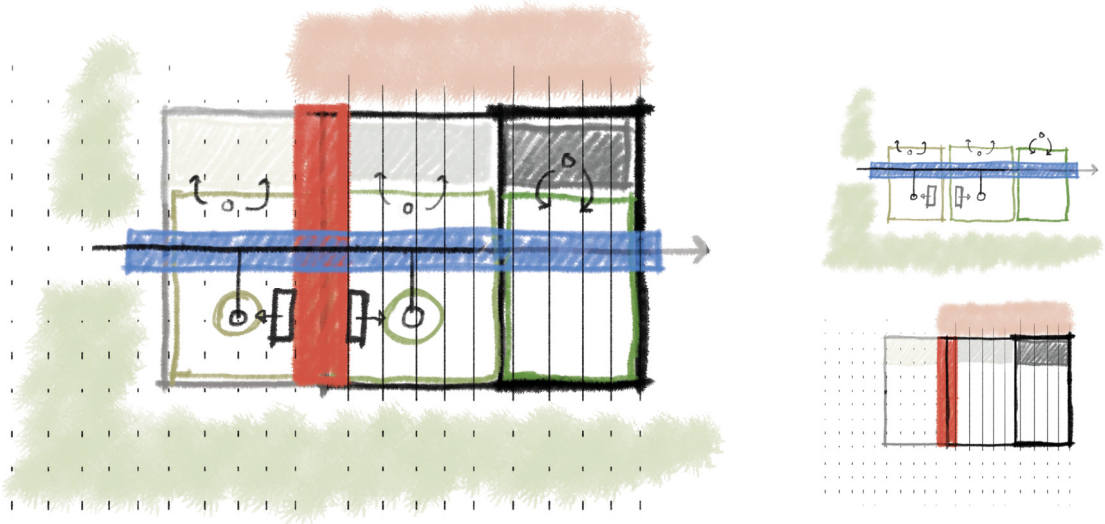
Recall that intensive vertical farms ideally operate with as little human interaction as possible. This creates a conflict between what is socially and what is economically optimal. This diagraming illustrates the path of least resistance for a given food output given its energy intensity. These correspond to different methods of food production frdiaom foraging at one end to intensive vertical farming at the other. This diagram started to grow, such as introducing water, and social thresholds to the space. This exercise, in tandem with the previous principles generated strategies for the retrofit.

As principles were layered, structural and mechanical synergies were identified which helped better develop the following parti. One synergy was recognised as particularly

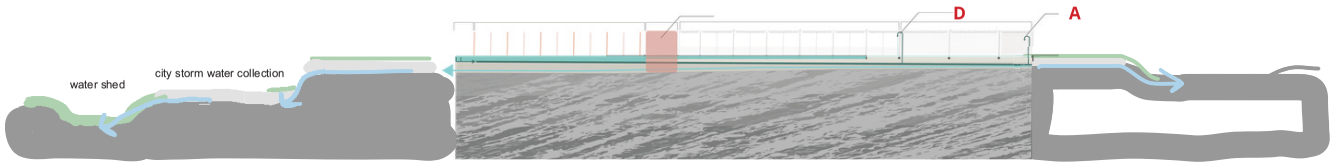


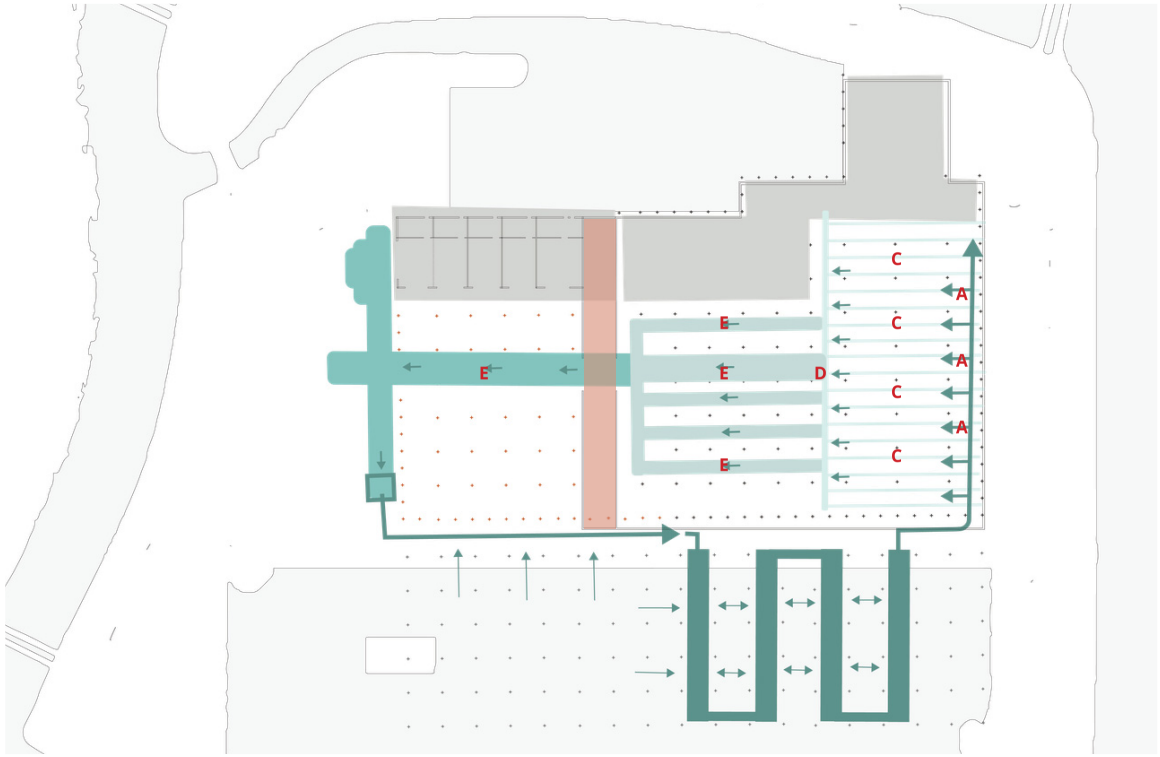
By formalizing the relationship between social and operational elements, this diagram can define the path of least resistance for a given food output or energy intensity that are more likely to remain in a safe operating space.





A parti was composed, from 9 main intervention principles. As principles were layered, structural and mechanical synergies were identified which helped better inform the parti's development.



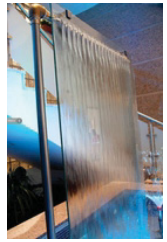


A. RAIN TOWER

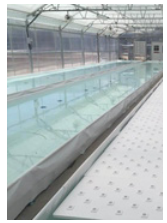
B. MICRON MISTERS

C. GUTTER SYSTEM

D. WATER WALL



E. WATER CHANNELS



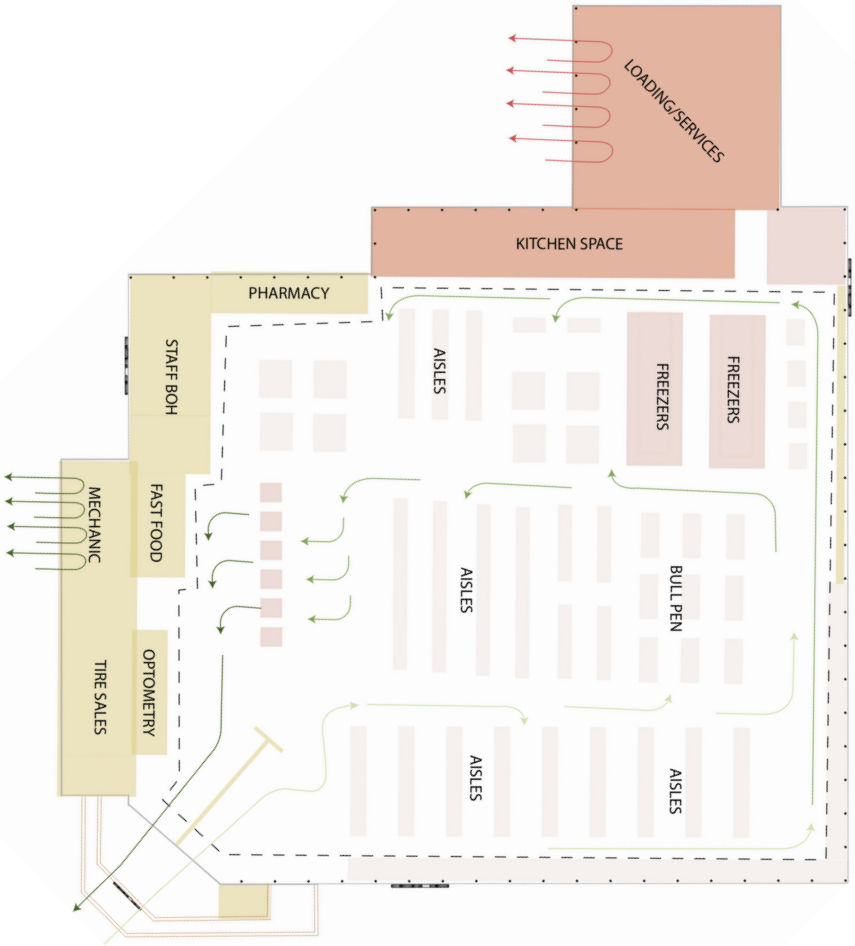
Geological section [top] and site use of water in plan [top left] and photo callouts [right]. citations from top to bottom (Designart 2012; Bridge Greenhouses 2021; Hynds 2021; Safe-rain 2021; Storey 2016)

informative to the design. The spine. Thermally, regulates temperature but also acts as a central street gathering point for social activity and circulation through the zones. These green zones, the intensive vertical farm, the IVF, the

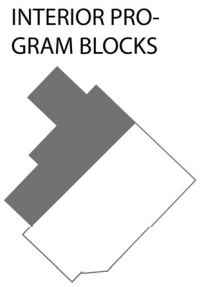
4.1 Re-develop

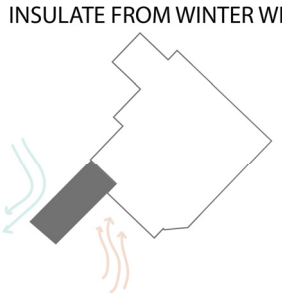
4.1.1 Minimal Intervention

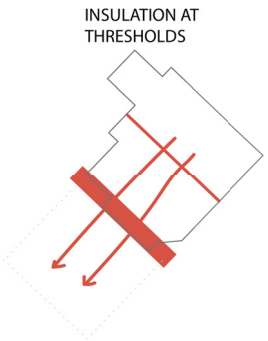
If the goal is to avoid unnecessary environmental impacts, then the first significant area of focus is understanding the extant structure and determining a retrofit method that minimizes the energy costs of adding elements.



Drawing of Costco’s existing program elements and layout.





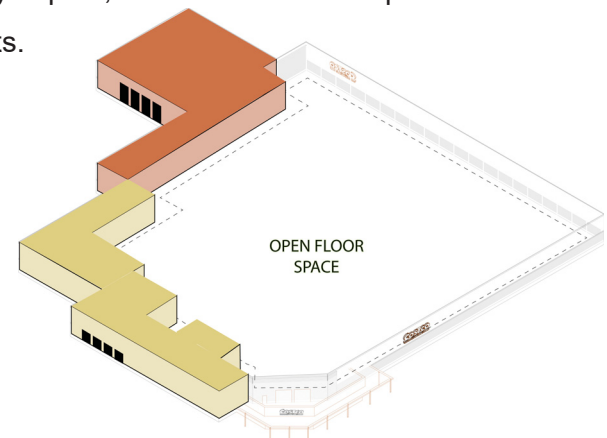


Minimial intervention strategies and efficient use of existing building.

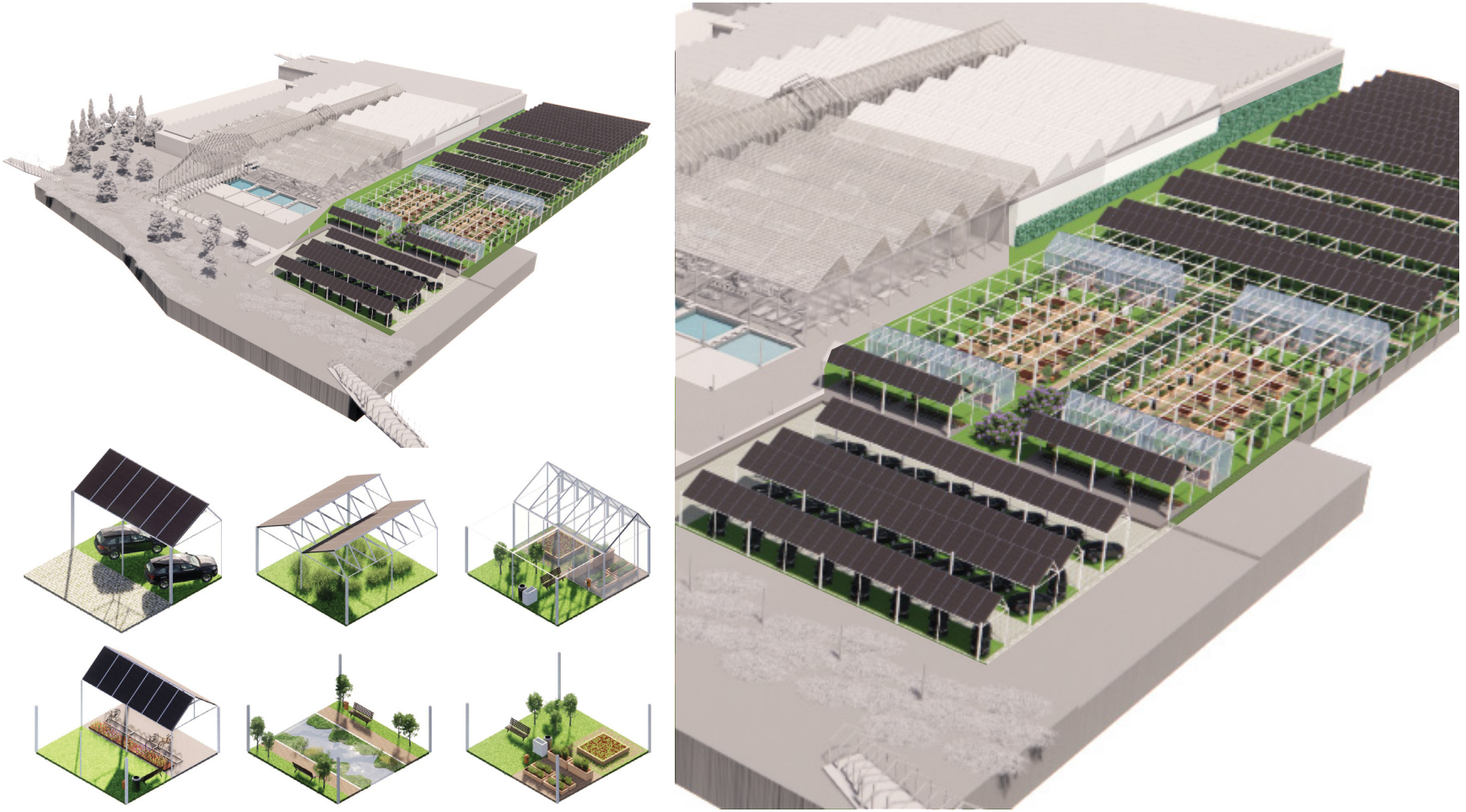
This principle of minimal intervention will be adhered to and can discipline the new program. Wherever possible, the existing Costco will be maintained unless changes are required by the amenities program, the agricultural activities, or the mechanical systems.

For example:

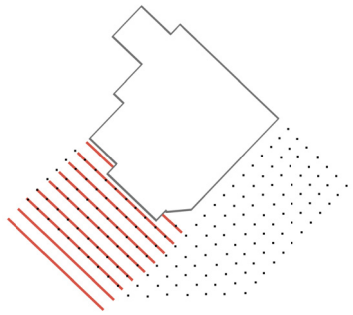
1. Shipping/receiving, preparation kitchen, and staff entrance will be kept to the extent possible by the functional adaptation
2. The existing tire centre and auto repair areas will be used to house the mechanical services of the intensive farm
3. block walls will remain as they currently act as shear walls and fire separations roof areas which do not need to be removed, such as above the IVF and back-of-house (BOH) processing areas, will be remain
4. Much of the exterior walls will remain intact, with only the removal of the entranceway at the southwest corner.
5. Minimal intervention entails changing only that which needs to be changed, not only in order to minimize energy inputs, but also to leave potential for future retrofits.



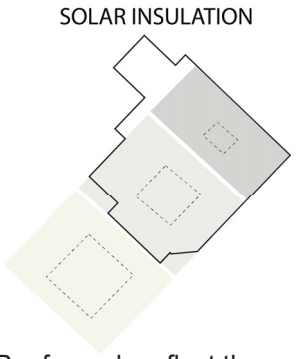
Drawing of existing program blocks, front of house (yellow) versus back of house (red)



Aeral view of greenhouse with rendered view of parking lot modules. Modules are sized to the same structural grid as the Costco and retrofit and would be added as the project develops. This requires depaving the current eastern parking lot, which could be done piecemeal and include coomunity.



Preserve the structural grid parti. Extend the grid beyond the Costco



Roof panels reflect the climate needs of the interior

Minimal intervention entails changing only that which needs to be changed, not only in order to minimize energy inputs, but also to leave potential for future retrofits.

4.1.2 Preserving the Structural Grid:

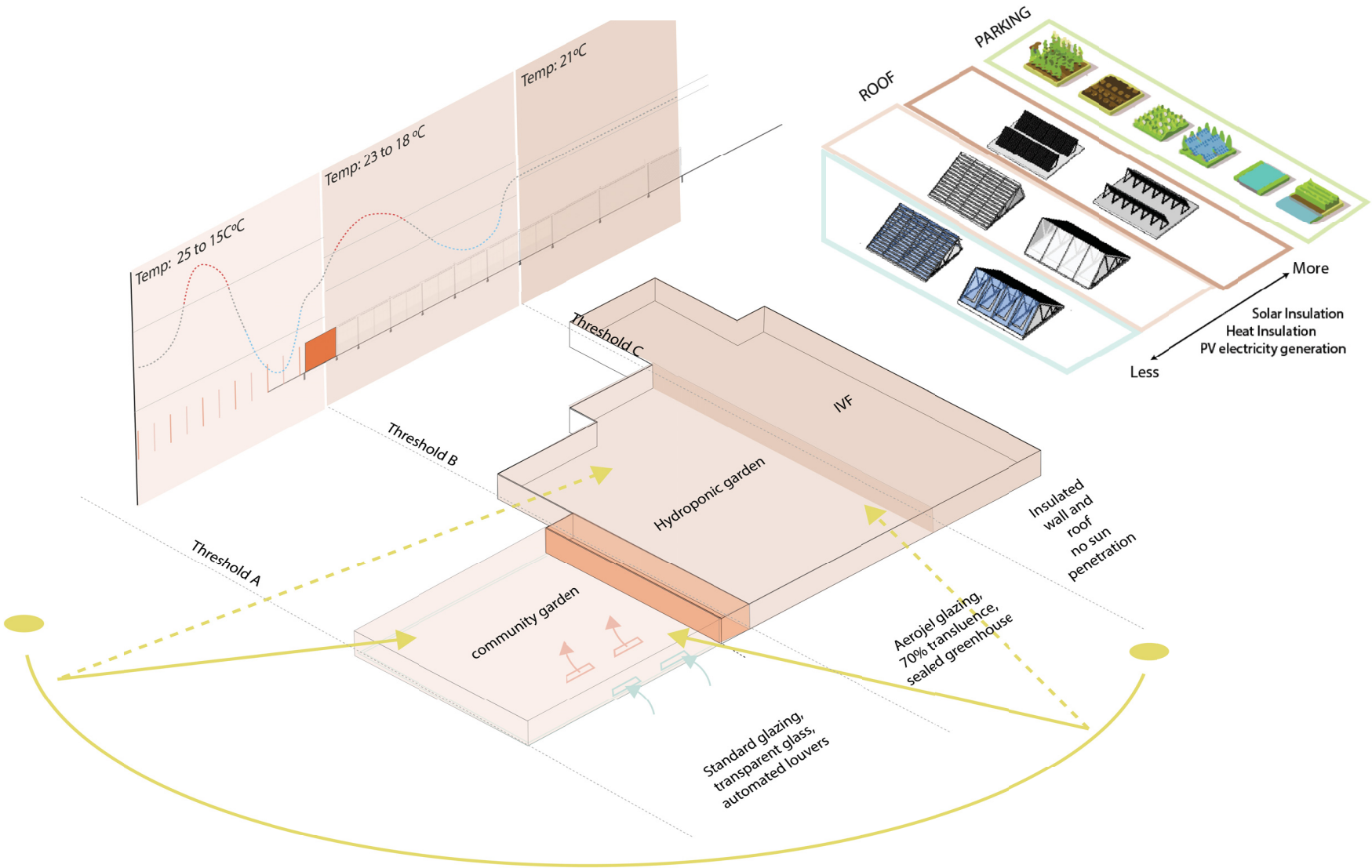
The largely open, 10 m x 10 m existing structural grid inherently allows for a great degree of programmatic flexibility. It can be added-to or subtracted-from to suit the requirements of the retrofit. This grid extends into the proposed greenhouse space to create the optimal spans for a flexible program. Furthermore, extending the existing grid into the site creates a thematic connection for users between what is the original Costco structure and the new intervention to the southwest. The modular subdivision of the large open spaces creates additional opportunities for smaller interventions. The grid will also extend into the former parking lot to organize its repurposing.

Envelope as Responsive Membrane:

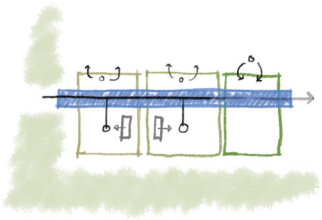
The envelope will be adapted to create suitable indoor conditions for the various zones. There are various ways in which this will be done.

The roof has been divided into 10 m x 10 m modules with differing insulation properties such that they can be customized to harvest ecosystem services. In the hydroponic garden roof, for instance, panels are insulated to help maintain consistent light penetration, while stabilizing the indoor temperature.

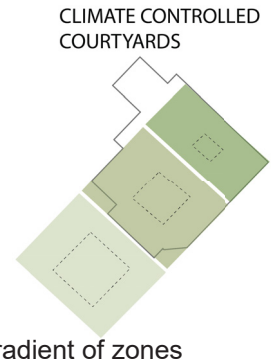
A similar strategy is taken with the wall assembly; as the agricultural program inside becomes more intensive, the envelope becomes more impermeable.



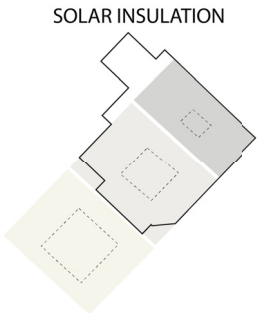
Climate strategy for specific zones and envelope modulation.



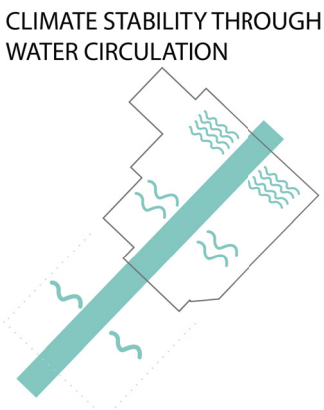
Stem as organizing element



Gradient of zones



Appropriate zone based insulation



Water chanels through building

4.1.3 Stem as an Organizing Element

The center axis—the stem— running from entrance to the boundary between the hydroponic farm (zone 2) and the IVF (zone 3) acts as the nave of a cathedral or the main street in a village. The higher ceiling and its distinctive, undulating geometry pull together and linearly organize the non-hierarchical spaces on either side by linking them together. The visual connection provided by this ceiling-scape is reinforced by the water channel beneath it.

4.1.4 Water Channels as Symbolic and Functional Elements

Water collection plays a key role in this design. Water has a high heat capacity, making it an excellent circulator of thermal energy. Water is collected from the site and used in the critical role of dissipating heat throughout the retrofit. It flows from the hot IVF (zone 3) to the cooler community farm (zone 1) before being pumped back to its origin in a mostly closed loop. The volume of water and method of circulation changes depending on the degree of heat collection and distribution needed.

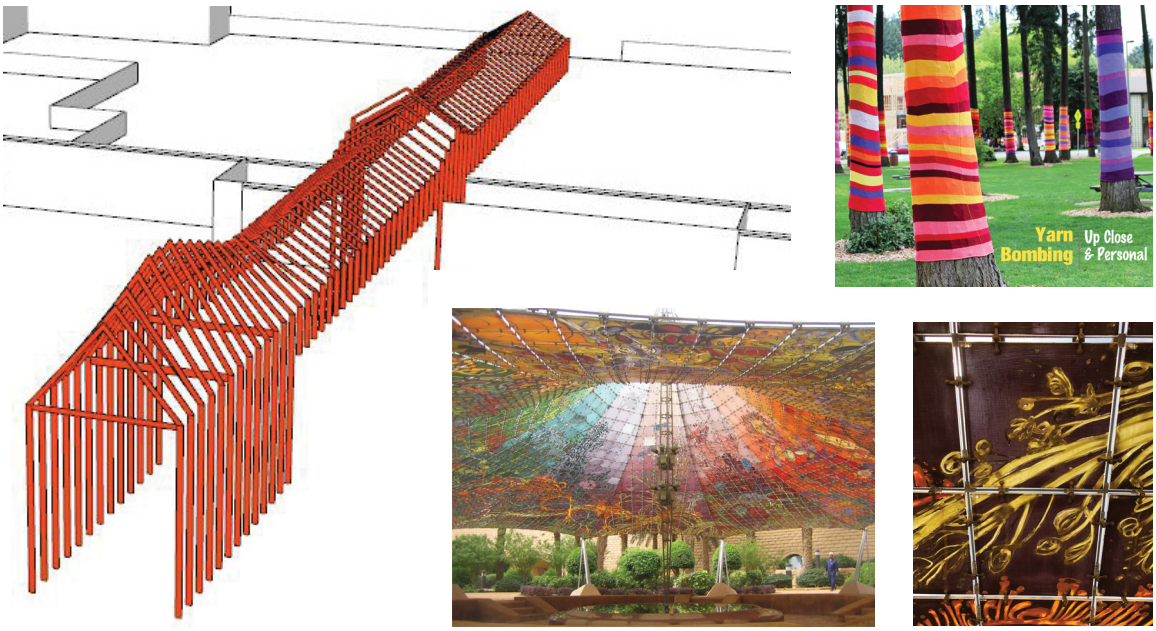
When flowing through the high-ambient-temperature of the IVF, its surface area is extended for greater heat absorption through the use of rain towers and a water wall. When flowing through the hydroponic garden, smaller streams diverge from the main channel while smaller water-features further dissipate the heat. And when flowing through the community farm, its volume is consolidated to create a thermal mass which helps manage the temperature fluctuations of the minimally insulated greenhouse.

4.1.5 Creation of Visual Identity and Landmark

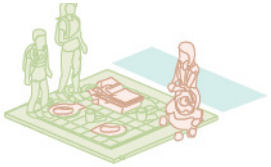
It is important for the success of the retrofit to create a landmark—a place clearly different from the rest of the business park.

The high twisting triangular form at the front signals the entrance of the greenhouse. It weaves its way along the main axis of the retrofit, like the stem and midrib of a leaf. It also pays homage to the entrances of such glass ancestors such as Chatsworth (1840) and the Crystal Palace (1851). However, the design of the entrance primarily mimics the formal language of the various bridges which symbolically act as roots that extend into the reimagined business park.

This stem elements offers an armature to clad the vertibrae in colour. Like Frei Otto, colour and texture could be used to create unique displays. Like the banners of festival tents, these could signal the change of season or events. This would contrast with the ubiquitous grey and white metal cladding in the adjacent buildings of the “park.”



Greenwall cladding (Stott 2015; Stott 2018; Steph n.d.)



Rendered view of greenhouse from south west trail sytem.

4.2 Re-inhabit

4.2.1 Use Zones to Organize the Program

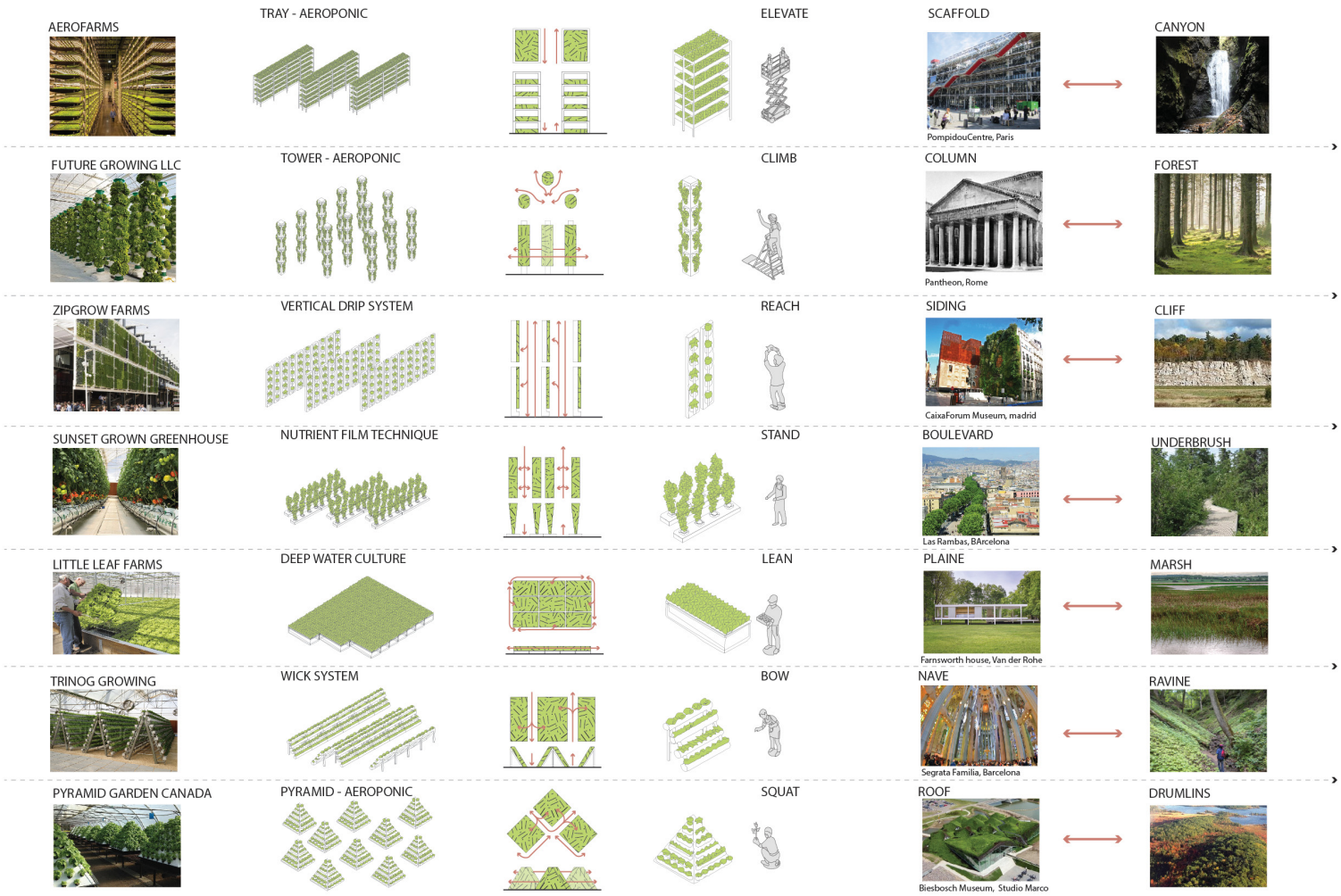
The first zone is the community garden; it is a highly social space for the growing, preparing, and sharing of food. This zone is the most public, hosting a flexible garden space on the south side, and restaurant bays, a market and open social space to the north—with the canal dividing the two.

This is an add-on to the west of the existing structure and provides a space which operates climatically like a conventional greenhouse. The space is kept flexible—for the most part— to adapt to whatever community decides to program for the area. The goal is to entice a variety of people to use the space while still allowing a sense of ownership to develop.

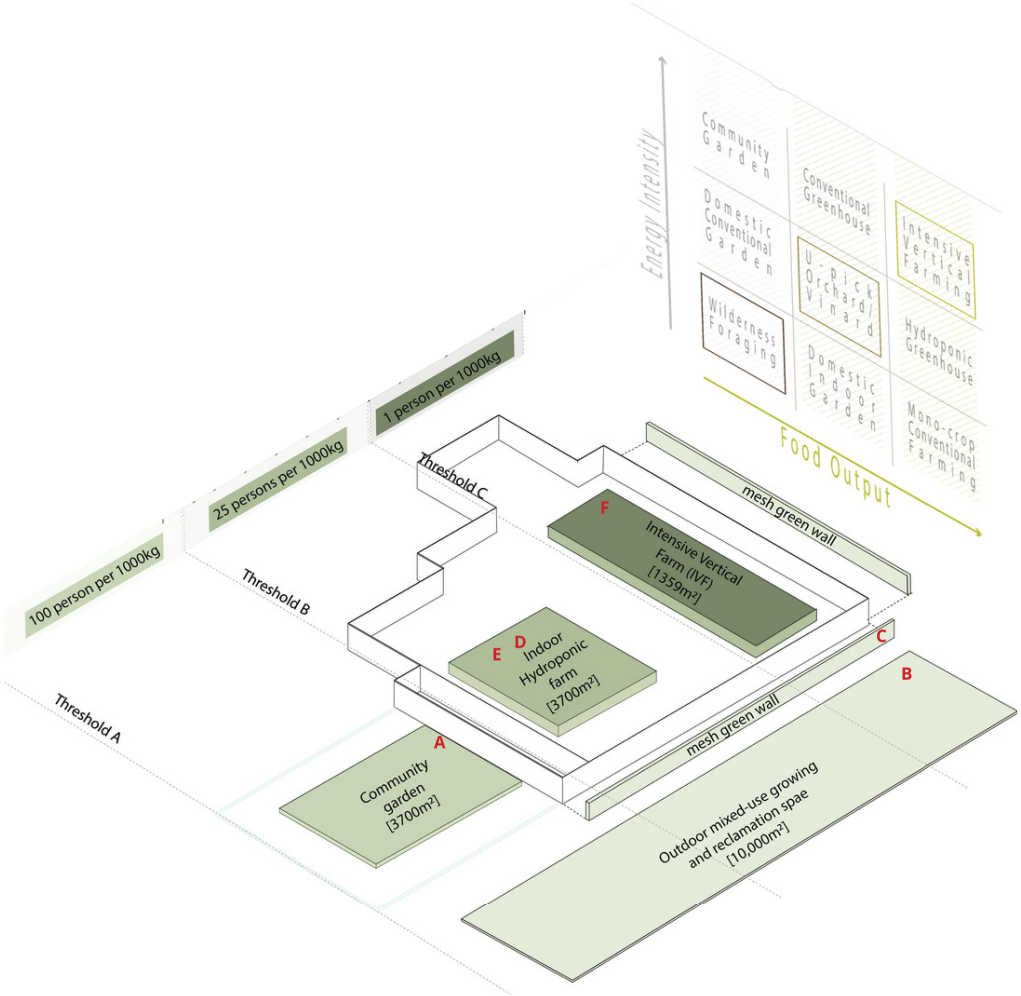
The hydroponic farm forms the second zone. Here is the hydroponic tower farm, which introduces more temperature and humidity controls as well as social and didactic spaces, albeit in a more limited sense along the north side

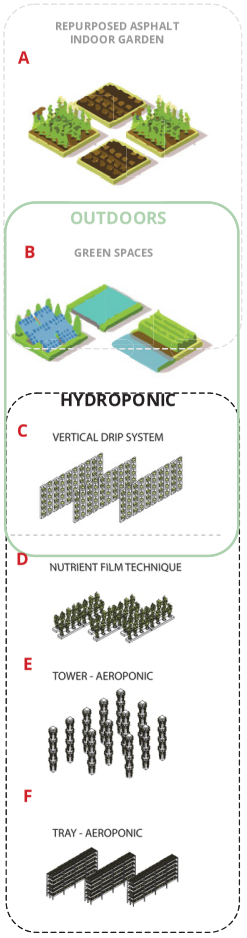
Through the ceiling and walls of this zone have well-insulated glazing, sunlight still penetrates the space and natural daylighting is the primary source of photosynthesis for the plantings in vertical hydroponic towers and aisles.

The third zone is the intensive vertical farm (IVF). It is the most industrial of the three, is largely dark (except for the specialized grow-lights) but is glazed on the southwest wall common with zone two; here, a large waterfall feeds the central channel. Despite this, zone three is highly insulated from the rest of the facility, as well as the outside. The following graphics explore the methods of farming in each zone and social experience each method may provide.



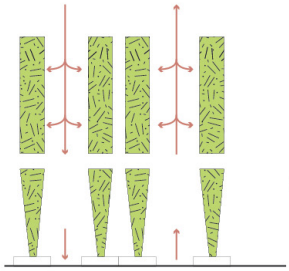
An inventory was compiled to create a kit of parts, identifying forms of vertical farming retrofit which can generate delightful user experience which continuing to be productive agriculture units. (photographs used in matrix were collected from online search, not owned by the author)

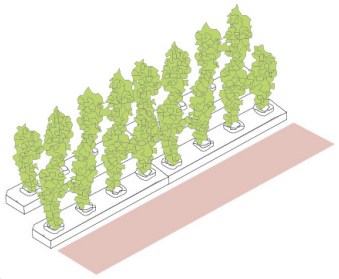




Zones were overlaid on the site, with their corrosponding outputs and thresholds. Methods of farming shown here are encorporated into cultivation zones with reference to their social experience. (Butler, 2018; Valley Forge n.d.; Agritechtomorrow 2018)

NUTRIENT FILM TECHNIQUE
Green Corridor





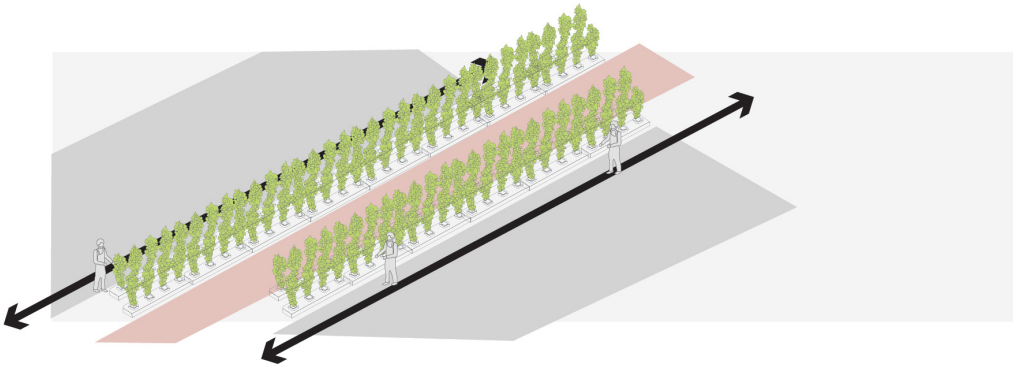
ORCHARD LINE
- More permiable than Zipgrow system

- Easy picking/engaging with growing process.

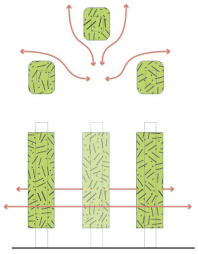
- Formalizes procession inwards/outwards

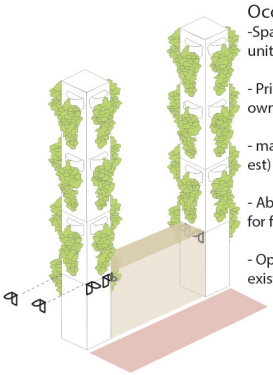
- Showcase the value of indoor growing climate.

- Possible transition to tower garden



TOWER - AEROPONIC
Your Place





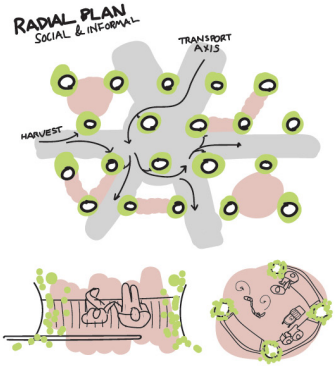
Occupying colums:
-Space for smaller gathering units.

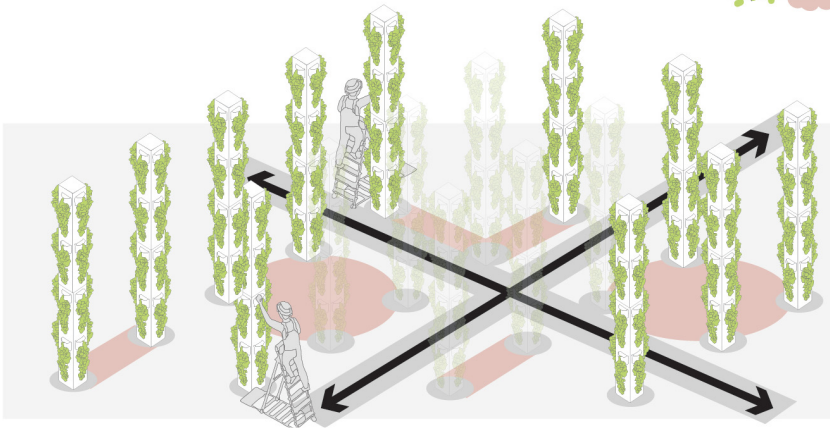
- Privacy allows for sense of ownership and refuge.

- makes use of lowest (darkest) park of tower garden.

- Able to be flexability allows for future retrofit.

- Opportunity to retrofit existing HSS columns





Forms which were appropriate for implementation in the hydroponic zone were further explored in order to determine more specific ways in which users could interact with them while spendig time in the hydroponic greenhouse.

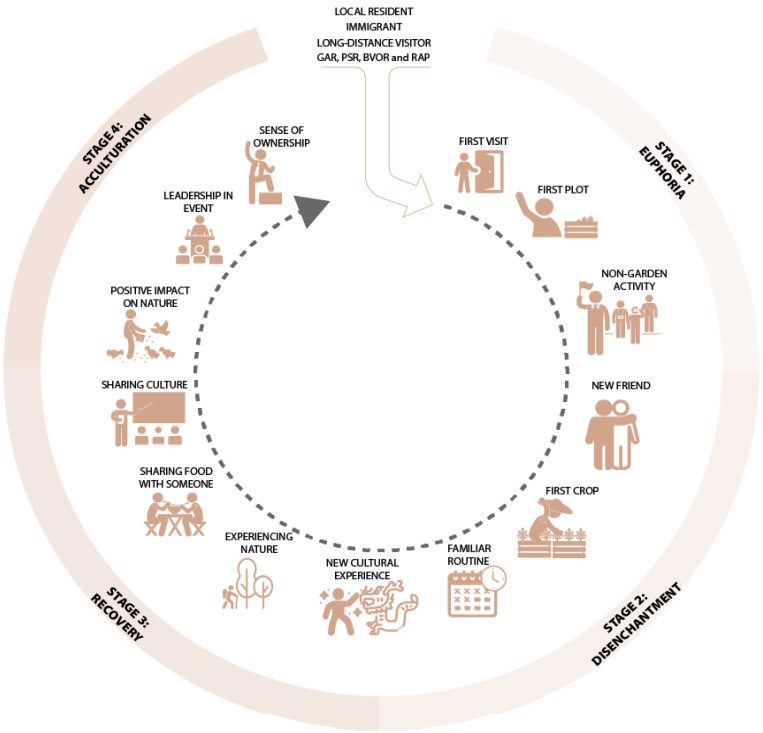
4.2.2 Create Culturally Adaptable Events

Stewart Brand's How Buildings Learn (1994) proposes the concept of layers of change. He expresses that overlaps between architecture, environment and community can generate moments of synergy which might be temporally and spatially scalable. This thinking helped inform the concept of a social and ecological overlaps as a method to generate programmatic moments. Other works like Bernard Tschumi's essays in Architecture and Disjunction (1994) helped wight the value of specified over generalized programmatic functions and experiential interaction over formalist elements. As a result, the implications of architecture's "impermanence" (according to Tschumi) are focused on the user's experience and adaptability of the retrofit rather than the retrofit formal properties of the retrofit itself. Traditional farming was not done alone, it was always communal in some form. The cycle of planting, tending, harvesting and consuming has always provided entry points for "events" of cultural significance; one only has to recognize them and foster them.

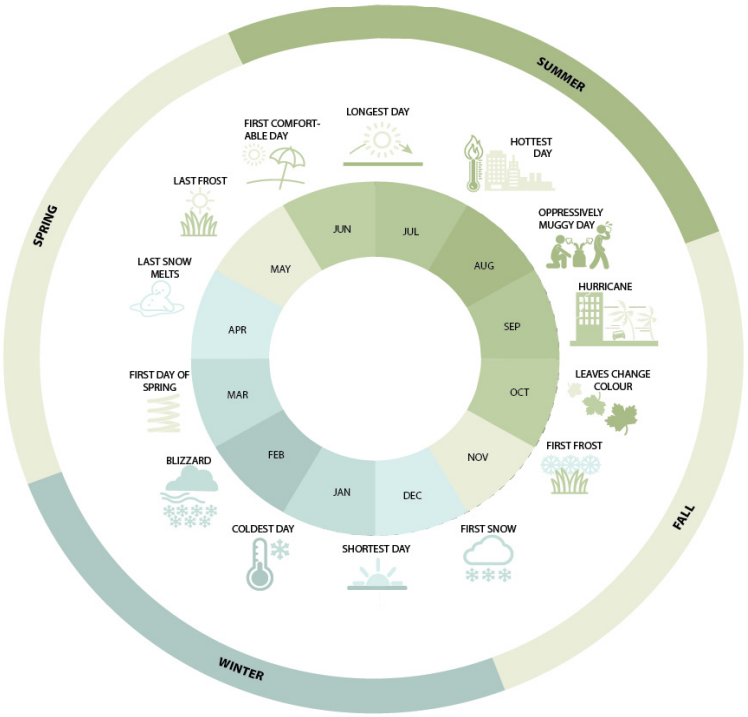
Synthesis of social events and seasonal cycles can be used to generate programmatic moments. The accommodation of these programs in spaces becomes the main goal of the architecture. The result was a largely flexible space which could be appropriated by communities, with a few select features. Like a colour wheel, these social and ecological events can be paired, expressing movement over time. The outcome was a series of synergies to be obtained. These necessitate certain programs which were incorporated into the design.Numerous such events come to mind as examples, ranging from the prized "vegetable shows" of country fairs to traditional celebrations following harvest,

from collective building of allotment sheds (modern barn-raisings) to quasi-religious celebrations of solstice.

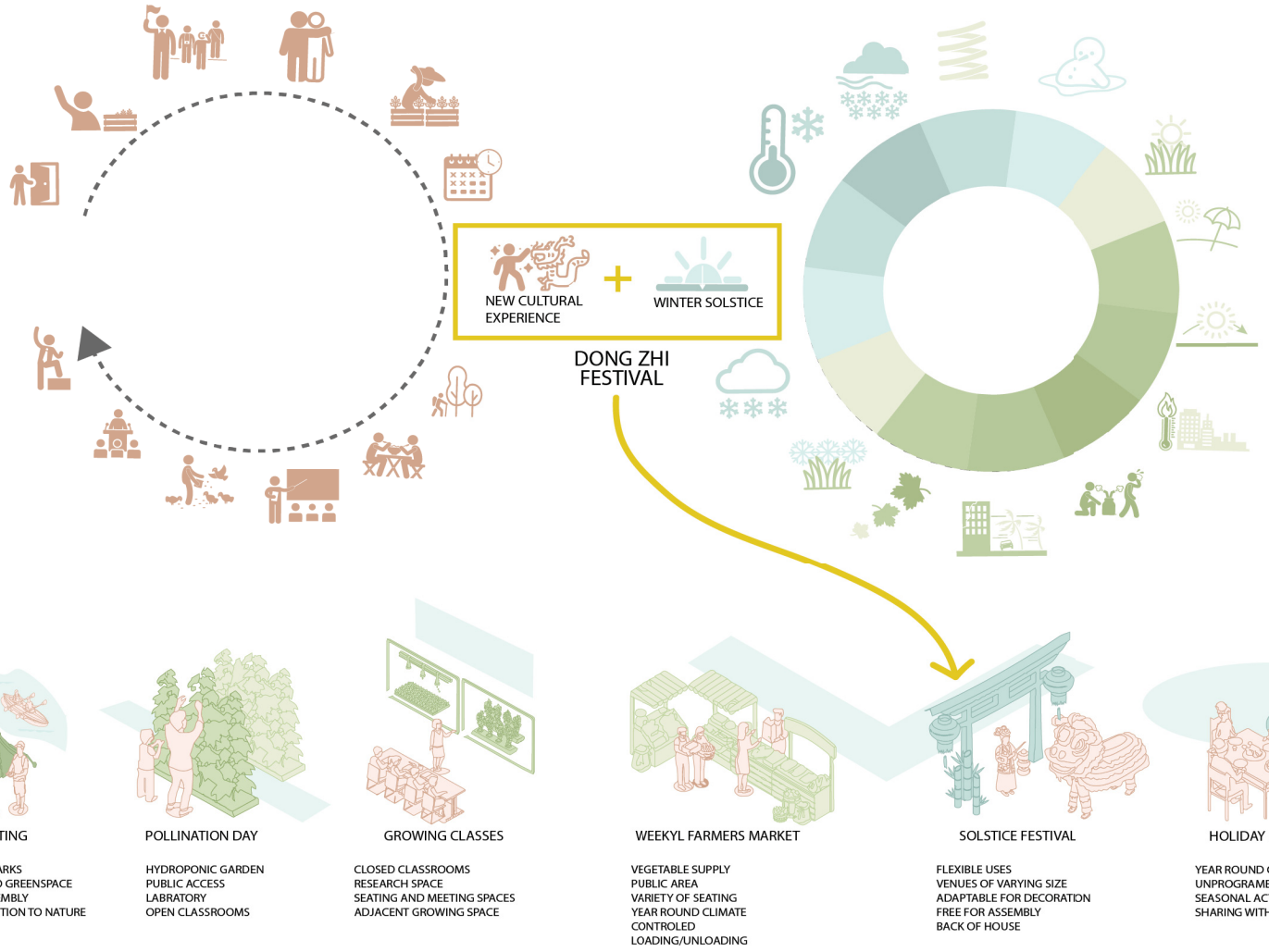
SOCIAL CYCLES



ECOLOGICAL CYCLES



Social cycles and ecological cycles were created that related to valuable immigrant user events and important events in nature, respectively. Social events are not time bound while ecological events are dependent on seasonal charactersitics. Both of these elements necessitate program functions



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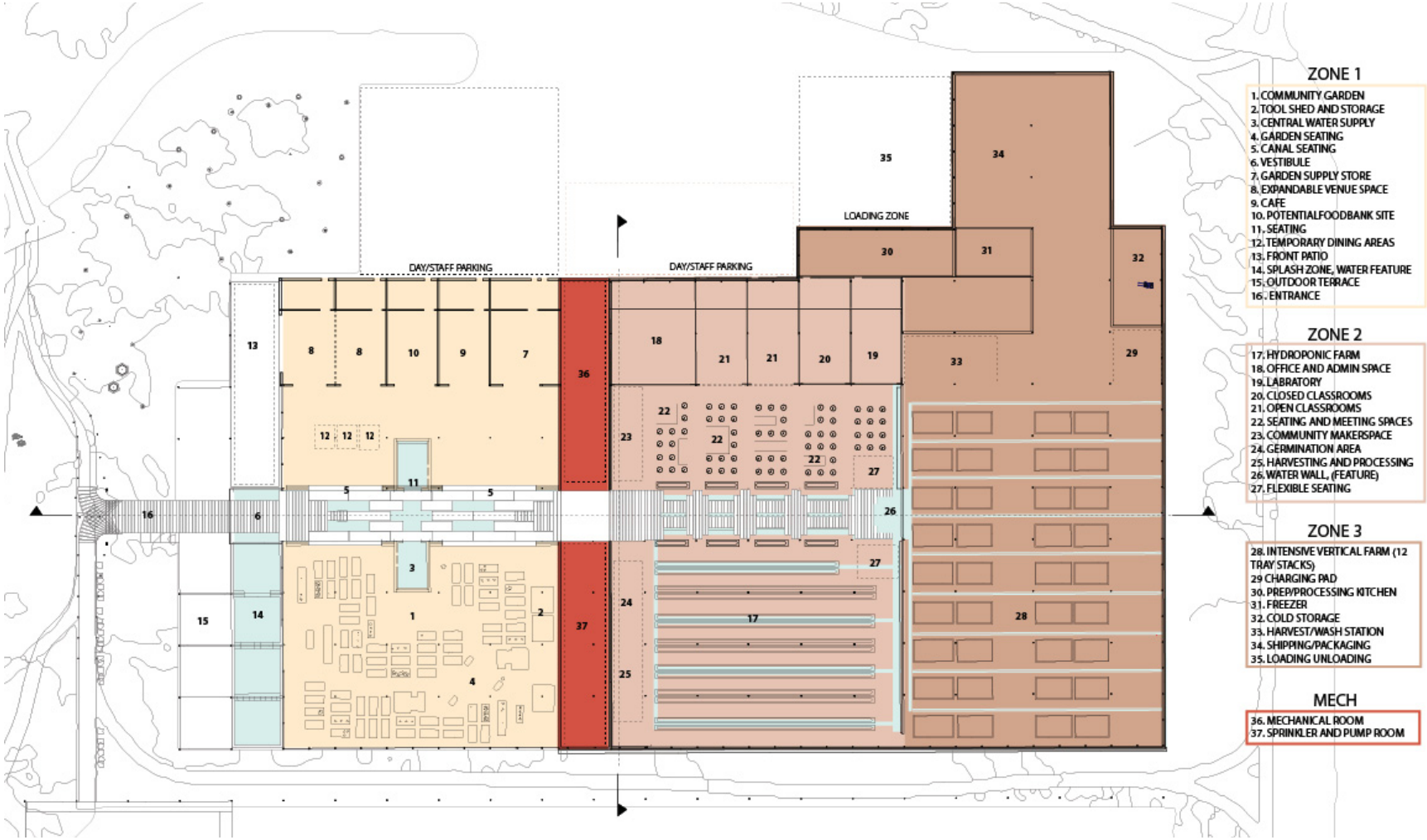


The program generation exercise was then divided into appropriate climate zones and overlaid onto the site. An emphasis was placed on providing flexible - yet insulated - spaces for to be appropriated for social activities. This flexibility decreases as zone productivity increases, resulting in a gradient of socially productive and agriculturally productive space.

4.2.3 Cultivate Not Just Food, but Ownership and Social Participation

Thai Pongal festival, photgraph, India (Lifestyle Desk 2018)

SupperNova Multicultural potluck, photograph, Halifax Nova Scotia (ISANS 2018)

Giant Omelet Celebration, photgraph, Belgium. (Kenna 2017)

Mooncake Festival, Manchester, England. (Edgington, 2019)

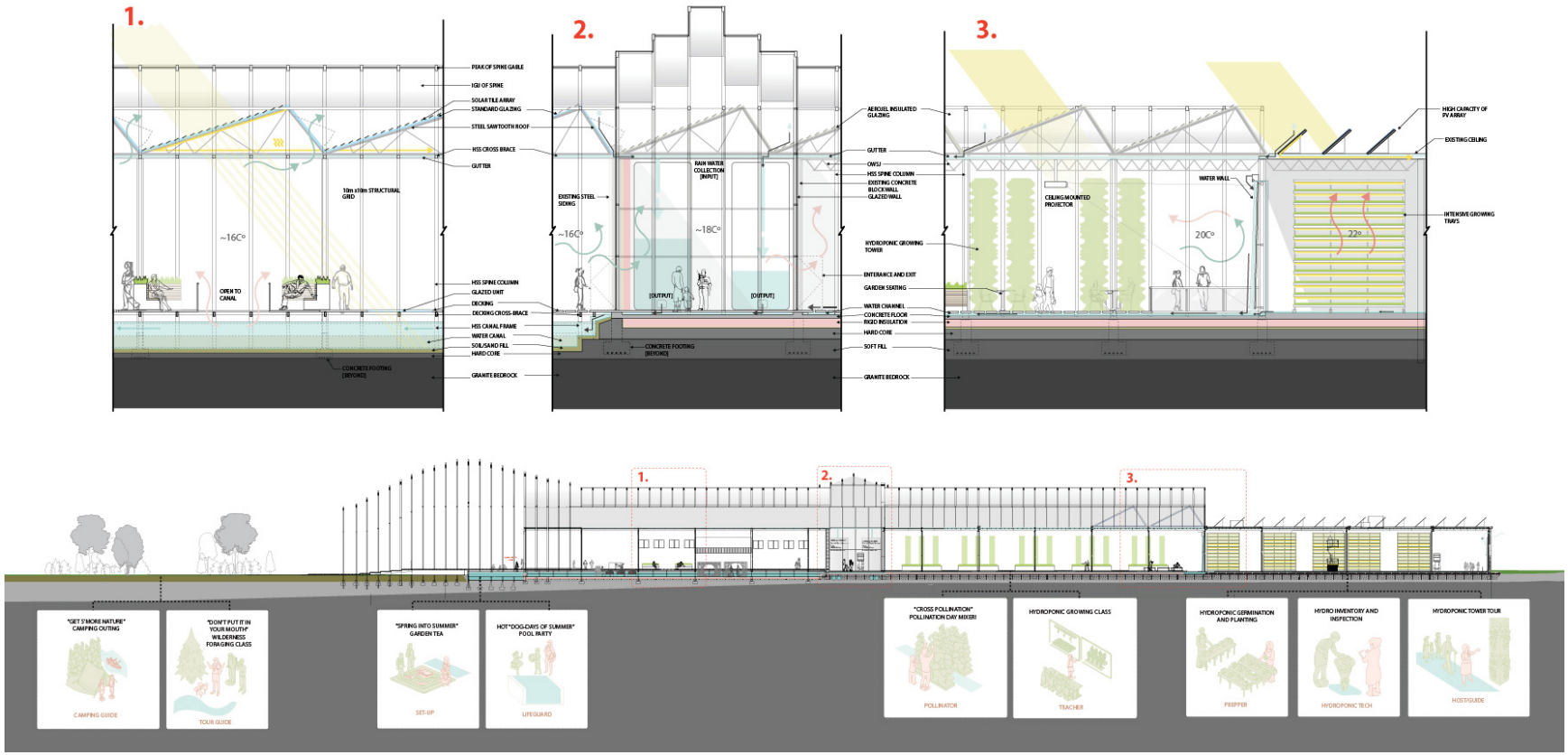
Cultivating plants offers several social benefits. Besides the increased sense of ownership from growing in individual plots similar to British allotments, collaborative plots could offer a more explicitly social form of cultivation. These gardening groups could be organized and expanded by way of businesses and community organizations. Finally, the IVF would be an exciting opportunity for the next generation of Nova Scotians to use modern agritech methods. These zones are illustrated in the following series of sections and renders.

4.2.4 Use Food Consumption as an Opportunity for Cultural Exchange

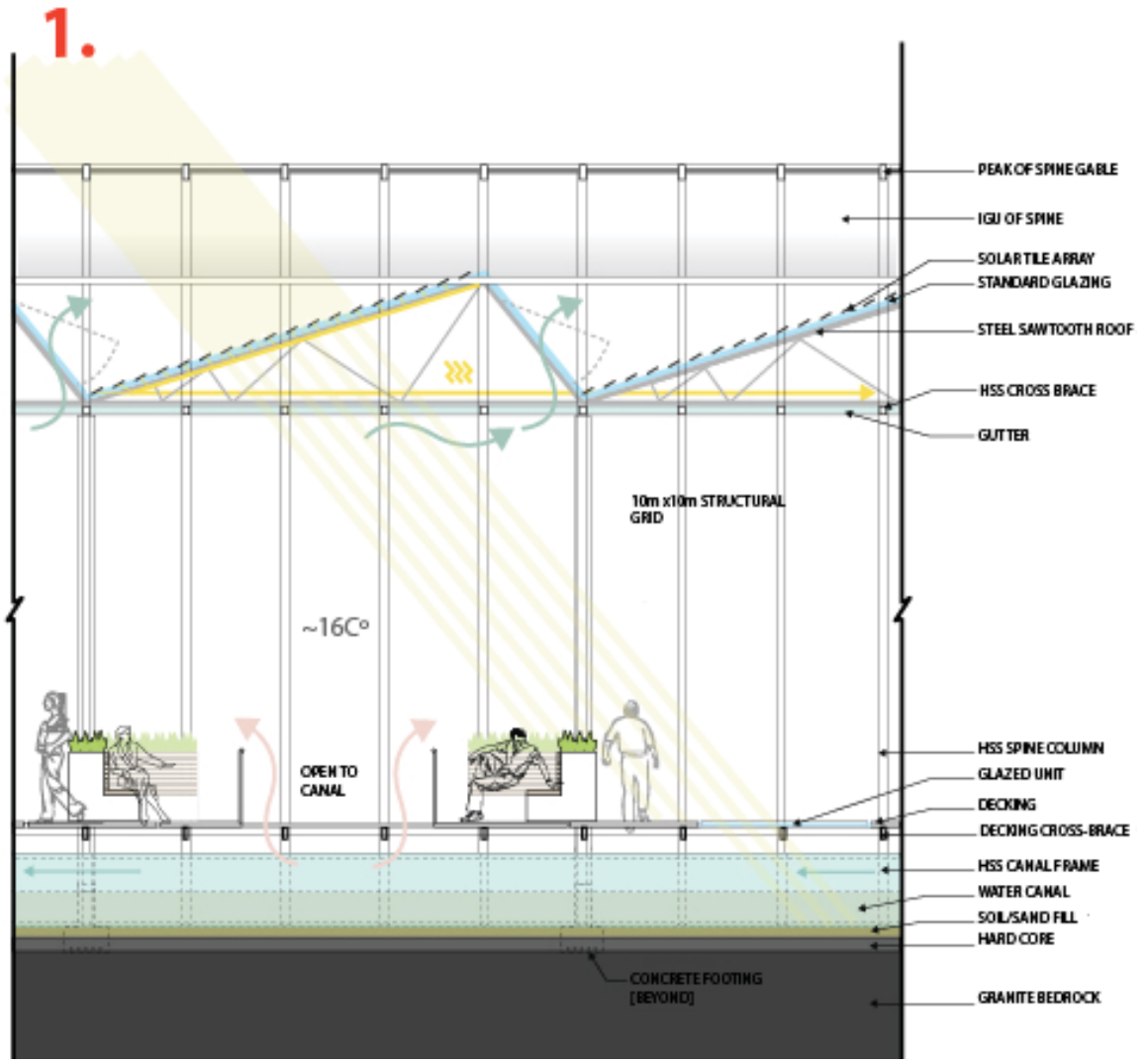
Food festivals are common opportunities to share food and cultural knowledge. Food festivals featuring harvest are common the world over. With its large, open venue and nearby culinary services, the market area would offer a year-round space for the numerous cultural festivals centered on food (e.g., Greek Fest,Mooncake, Thai Pongal, Homowo). Ethno-cultural food festivals serve the dual function of strengthening intra-groups bonds while putting on display cultural traditions (in a positive way, through food) for those of other communities.

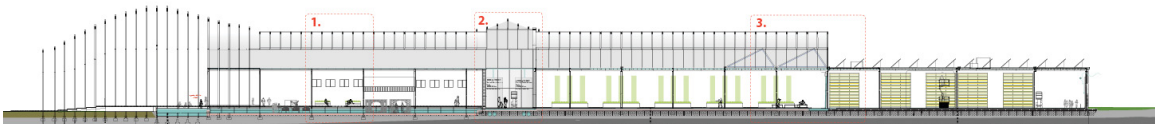
4.2.5 Create Opportunities for Teaching and Learning

There are three didactic opportunities: Gardening, hydroponics, and intensive vertical farming. Some could learn by doing, as they get their hands dirty in the community garden, while others could learn in a classical format by taking classes in the hydroponic farms.

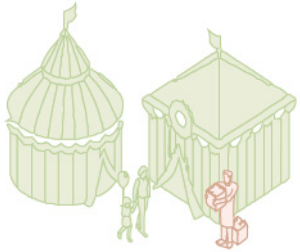


Compiled section and key explaining collection of rainwater and flow of water in canal. This section also highlights specific moments of inhabitation as they relate to the mechanical operation of the building.



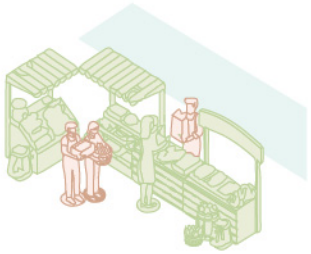


Community greenhouse callout [above]. Callout illustrates the depth and visual access of canal. Seating and planters are provided adjacent to a pond-like opening. Sectional key plan [below]



VOLUNTEER

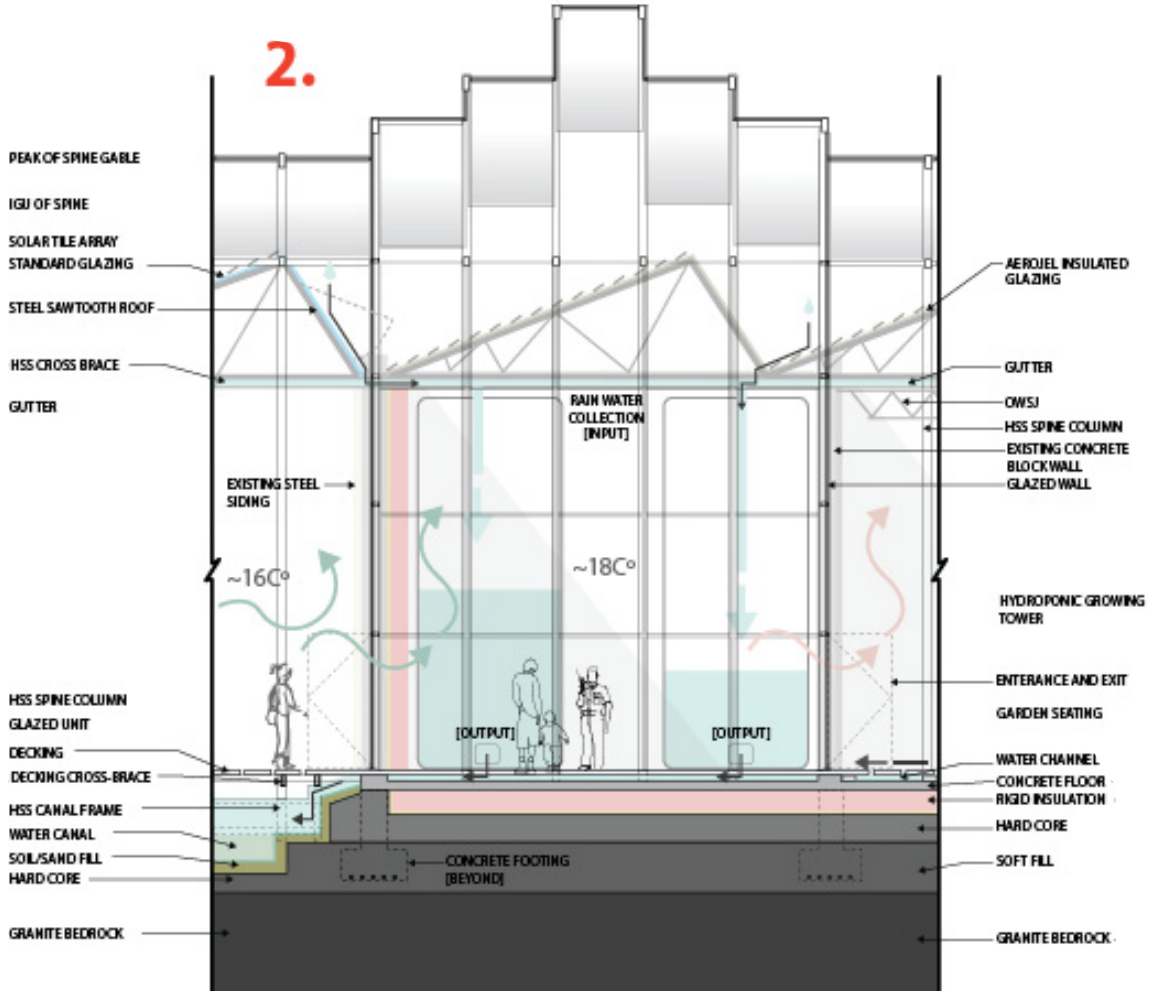
AMBASSADOR

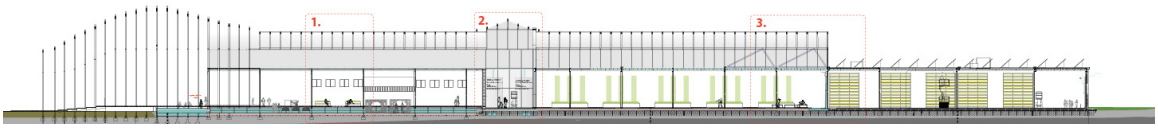


VENDOR

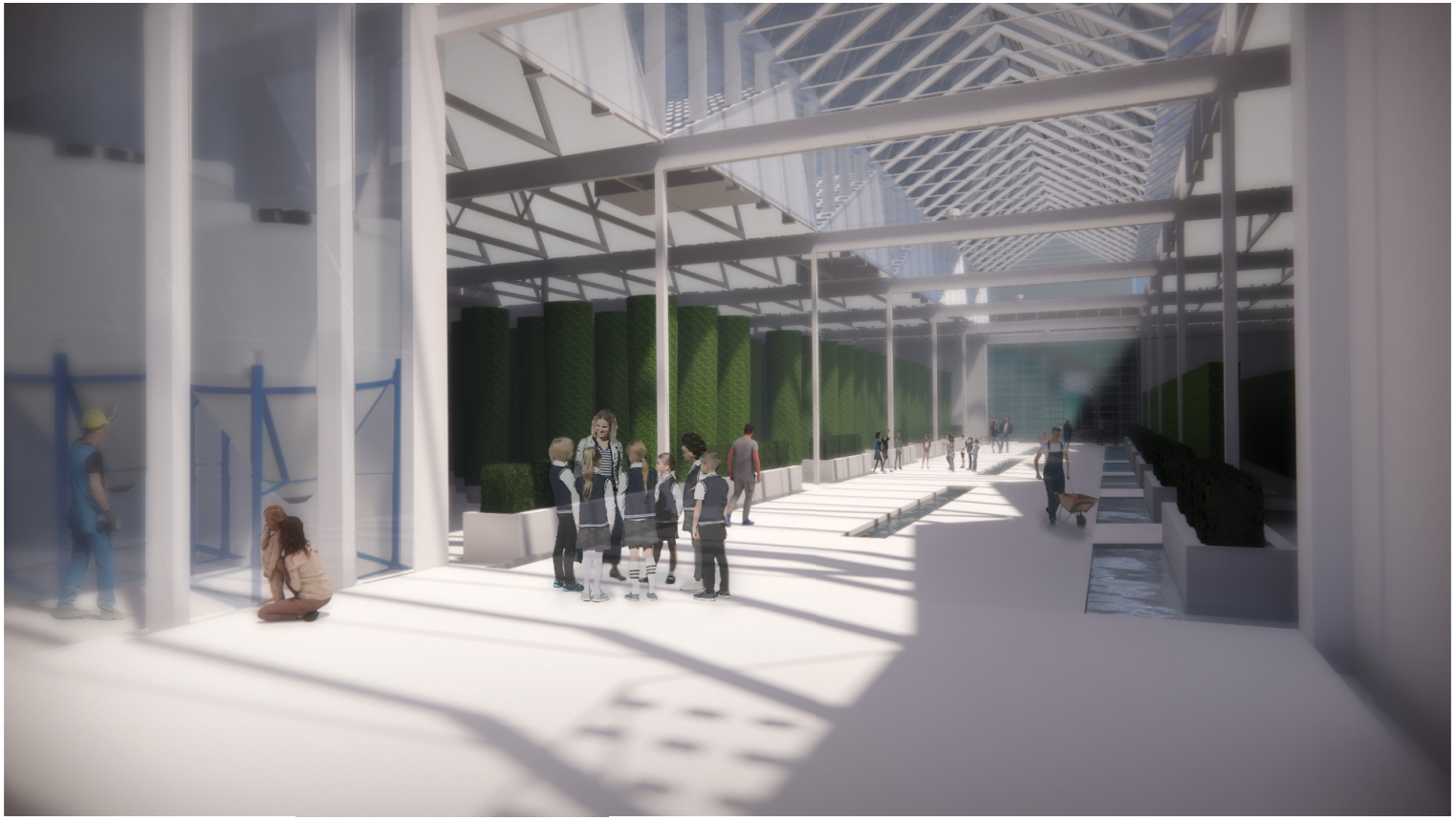
SERVER

Rendered view of community greenhouse entrance. Canal walkway [beyond] with community farm [right]

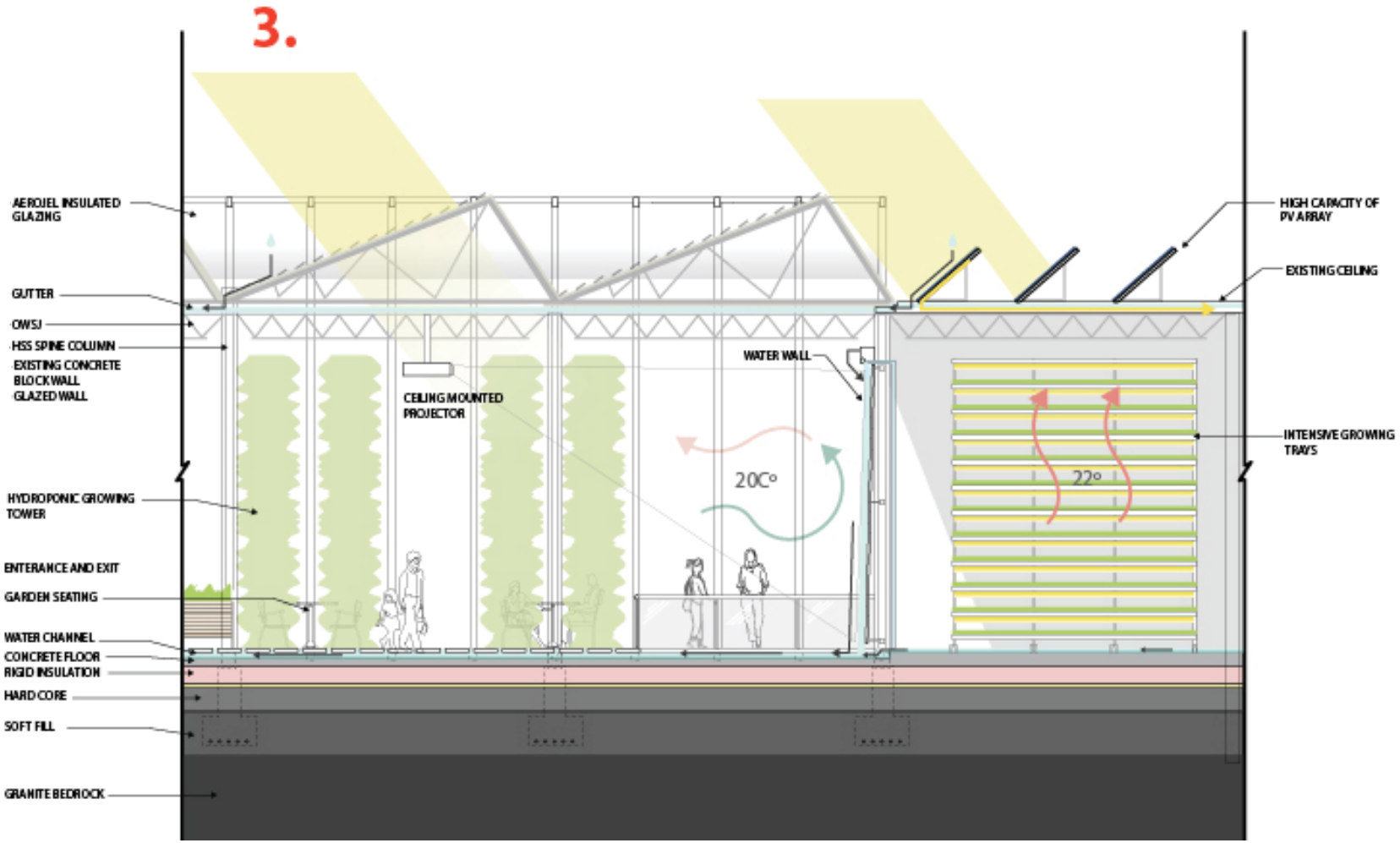




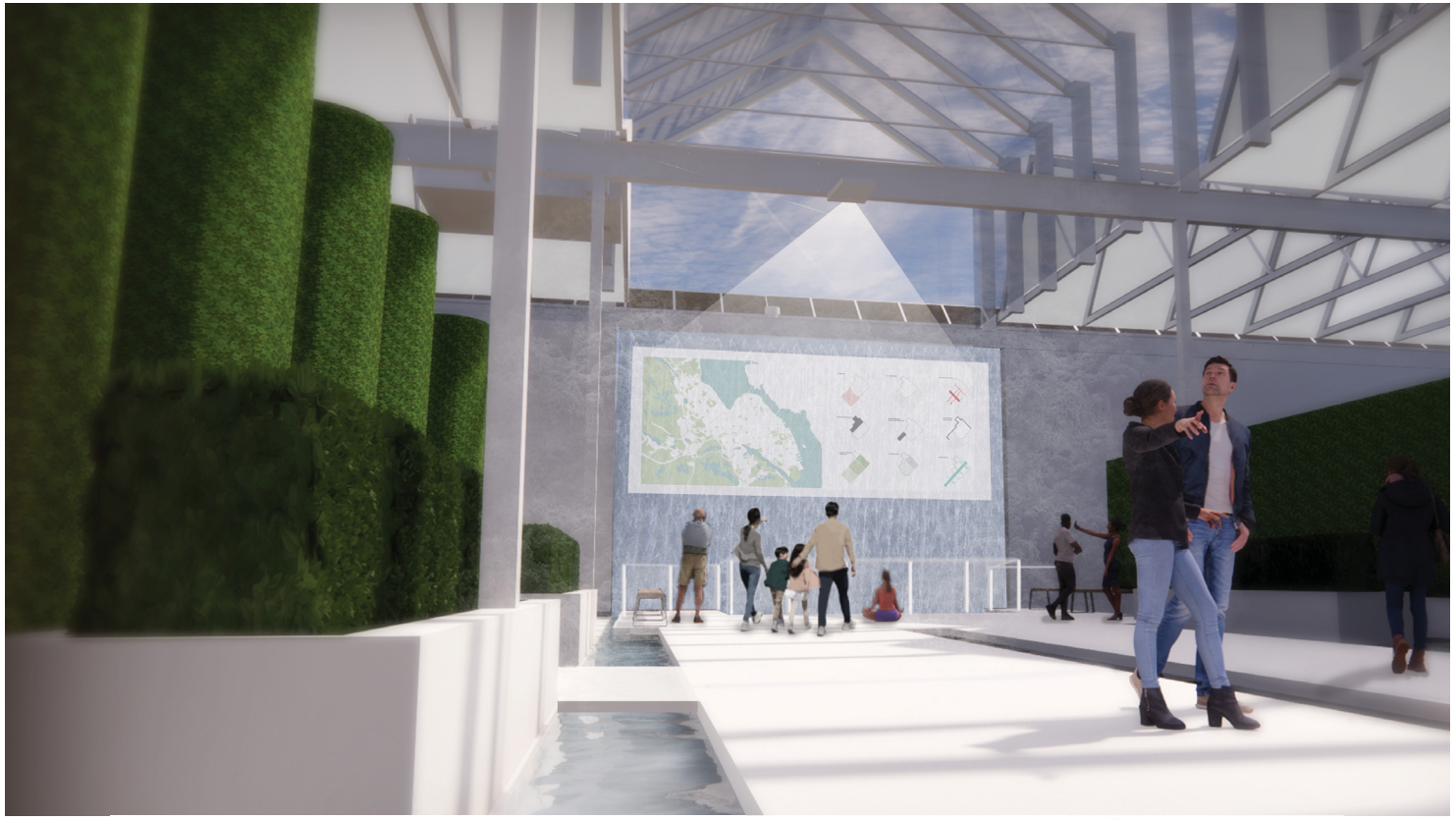
Mechanical threshold section callout [above]. Callout illustrates visual connection to mechanical space Sectional key plan and inflor and ourflow of water from roof to mechanical [below]



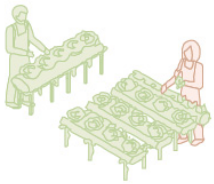
Rendered view of mechanic threshold and hydroponic greenhouse.



Hydroponic sectional callout [left] and IVF [right]. Callout shows water, inhabitation and adjacency of hydroponic farm to IVF.

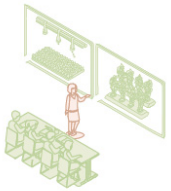


HYDROPONIC TECH



PREPPER

POLLINATOR



TEACHER

Rendered view of hydroponic garden and water wall. Seating nearby and opportunity for projector to provide educational experience to pathways leading to adjacent hydroponic farm.

4.2.6 Recognize the Role of Flowing Water in Community-Building

The water flowing through the facility acts as a circulatory element, drawing people in and guiding them through the building.

4.2.7 Celebrate the Idea and Value of Play

The garden, and especially the canal and water features, offers a public opportunity to play in an otherwise area void of public parks and without any playgrounds. The canal is to be populated with seating, daylight, plants, fountains and other water features—all meant to promote children (and others) to interact with the waters. Sandboxes and adventure playgrounds hold imaginative possibilities for future architects, engineers, builders and farmers.

4.3 Business and Participation Framework

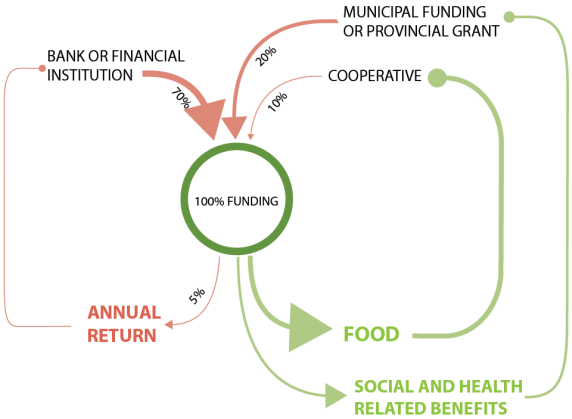
This project would commonly be funded through a public-private partnership (P3), where arrangements are made between business and government to acquire the necessary capital to build a project. P3 projects are often criticized as providing greater returns for private investors over public investors and their ability to provide transparency has become increasingly questioned (Hodge 2007).

Cooperatives are an alternative organizational framework in which joint-ownership results in shared distribution of potential economic benefits. Unfortunately, regional neoliberal policy has created a financial climate which is not conducive to cooperatives as a successful method of funding (Siebel 2016). This farm project would ideally operate under a cooperative framework, as it more directly

ties community members to the means and products of production (Kovalchuk 2017).

Environmental, Social and Governance criteria (ESG) are a set of standards which describe the contribution of a specific organization towards societal and ecological betterment (Chen 2021). ESG are becoming more sought after as large financial organizations are going through an ESG renaissance from investors growing demand ESG return on investment (Tarmuji 2016). While ESG do not generally offer a maximally profitable return, financial institution can see the investment into ESG as a political risk mitigation strategy of their adjacent investments.

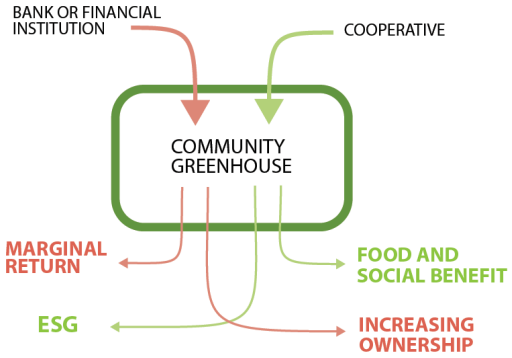
This farm would operate as a financial product through which institutions can increase their ESG exposure through a diminishing ownership framework. A bank would provide “X” precent of initial investment into a farm for a marginal annual return. The remaining percentage of necessary funding would be provided by a cooperative perhaps backed by municipal investment. The bank’s ownership decreases as its initial investment is returned. The cooperative increases its ownership, slowly getting a greater share of the physical means of production, while the bank can leverage this ESG into further alternative investment.



Funding breakdown between bank, cooperative and municipal lenders. Different benefits feed back into each donors.

Recall that the retrofit of this community farm is derived through on a method of maximizing the social and ecological benefits of the design. Its creation has used system thinking, ecological overshoots and social shortfalls specifically to maximize social and ecological outcomes for marginalized populations. This establishes it as a highly efficient ESG return when observed through a socio-ecological lens. While banks still recuperate their initial investment, the cooperative gains the benefits of said investment.

Finally, a unique model of a participatory buy-in could be implemented to enhance attendance in farm activities. In this model, time and effort working on/in the farm would be exchanged for membership in the coop. However, rather than simply exchanging hours worked for a spot in the coop, membership could be gained by participation in the farm's seasonal programs. Less like volunteering for a set number of hours and more like earning badges like cadets or scouts. This type of participatory framework would benefit the coop members by encouraging greater participation in a variety of farm activities. Additionally, this model would better link social cycles with ecological cycles by encouraging social experience of a various programs in varying seasons. These hypothetical volunteer opportunities have been listed in the following Bayers Lake Community Greenhouse brochure.



Community farm is a product which provides ESG, marginal returns, increasing ownership and social benefits.

Bayers Lake Community Greenhouse

upcoming events & volunteer opportunities

For a full list of events throughout the year and information on how to become a part of the Bayers Lake Community Garden visit our website or stop by during community hours.

getgrowing@blcg.org
www.bayerscommunitygarden.org
230 Chain Lake Drive, Halifax

in the sun...

"HOT DOG DAYS OF SUMMER"
POOL PARTY
Location : Front Patio
Date: August 8
Volunteer Positions : life gaurds, activity leaders
Community Involvment: water activities, vendors, games, and entertainment for all ages.

"SPRING INTO SUMMER"
GARDEN TEA
Location : Commnuity Garden Plots
Date: July 4
Volunteer Positions : tea steepers, teacup attendants
Community Involvment: Stop by for a cuppa and see what your neighbours have been growing in their plots.

around the world...

"PICK-UP WHERE WE LEFT OFF"
CULTURAL HARVEST FESTIVAL
Location : Community Multipurpose Space
Date: October 20
Volunteer Positions : cultural ambassadors, activity leaders
Community Involvment: learn about different traditions during fall harvest through vendors and community members with food and entertainment from their unique cultural backgrounds.

"HELLO NEIGHBOUR"
COMMUNITY FARMERS MARKET
Location : Commnuity Garden Plots
Date: Saturdays from May to September
Volunteer Positions : vendors
Community Involvment: Shop for your greens while discovering unique foods and spices from community members with diverse heritages.

in the kitchen...

"NOW YOU'RE COOKIN"
FOOD PREP & COOKING CLASS
Location : Community Kitchen
Date: weekly from October - February
Volunteer Positions : class instructors & assistants
Community Involvment: free cooking classes with fresh veggetables and herbs from the hydro garden, classes for all ages and skill levels.

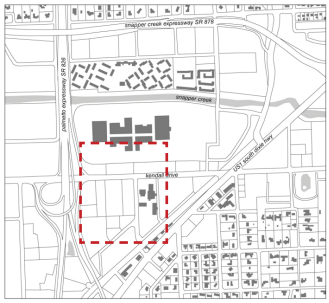
in the garden...

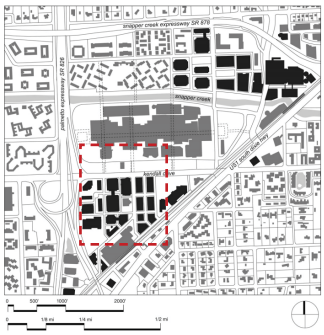
"POT IT LIKE ITS HOT"
PLANTING DAY
Location : Community Garden plots
Date: June 1st
Volunteer Positions : soil distibuters, planters, seed allocation.
Community Involvment: local garden supply stores have booths set up for all your spring garden needs.

"BETTER BEE-LIEVE IT"
POLLINATION DAYS
Location : Hydro Garden
Date: March 15, July 15, November 15
Volunteer Positions : group leaders, equipment booth attendees
Community Involvment: help pollinate the hyroponics, great activity for families. Snacks are served!

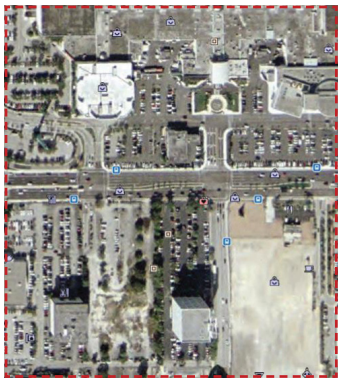
"VIRTICALLY LEARNING"
HYDRO GARDEN TOURS
Location : Hydro Garden
Date: Weekly Tuesday & Thursdays
Volunteer Positions : tour guides, activity leaders
Community Involvment: stop by on tour days to learn all about growing hydroponically and sample crops. Private group tours also available by appointment with growing activities - book your class feild trip today!

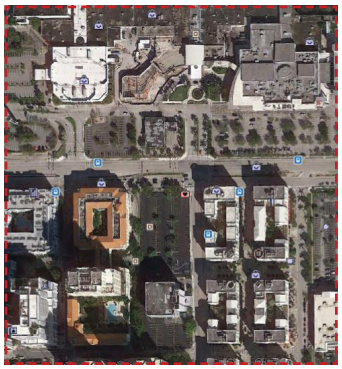
Event brocheur of sample events. This program provides opportunities for participants to enjoy the farm, and volunteers to help work in the cooperative. A schedule would be able to seamlessly advertise both opportunities to join the coperative or chances to simply enjoy it.





Site plan of Dadeland mall FL. 1980-2020 [top-bottom] (Dunham-Jones and Williamson 2009)





(Satellite from Google Earth historic imagery (Google Maps 1994; Google Maps 2021i)

4.4 Future Growth

4.4.1 Densification and Place-Making

The retrofit operates as an agricultural and social center in an area which is expecting to see increased densification in the coming years, yet lacks opportunities for people to congregate and socialize in non-commercial settings. The modularity and flexibility of the greenhouse should allow it to adapt to the demands of a changing neighbourhood, but the creation of a vibrant social and cultural centre is an amenity that encourages desirability of the area—which is positive feedback for further densification.

Concepts from urban theorist Jane Jacobs (1961) and Dolores Hayden (2004) could help to inform the livability of the design and its integration into both the local (the business park) and larger (Clayton Park) urban contexts. Along with Dunham-jones and Williamson, the future of business parks are trending along densificiation and this densification needs guidence to be successful. The introduction of a Bayers Lake community greenhouse is to act as a base for future residential, park and commerical interventions. As displayed by the Dadeland example, parking lots are easily adapted into small, urban scale blcoks. Concpepts like Jacobs' *as eyes on the street* would help to ensure these vaste horizonatal areas are receive appropriately scaled interventions.

4.4.2 Network of Linkages

A proposed master plan connects the site to existing residential neighbourhoods and Blue Mountain - Birch Cove, along with provisions for green buffers. Future pathways could serve to move some active transit away

from the traffic-clogged streets. These pathways re-envision the transport system in Bayer's Lake Business Park by increasing interconnections and by separating pathways from roadways with a buffer of greenspace created by de-paving some of the vast parking lots as they become less used.

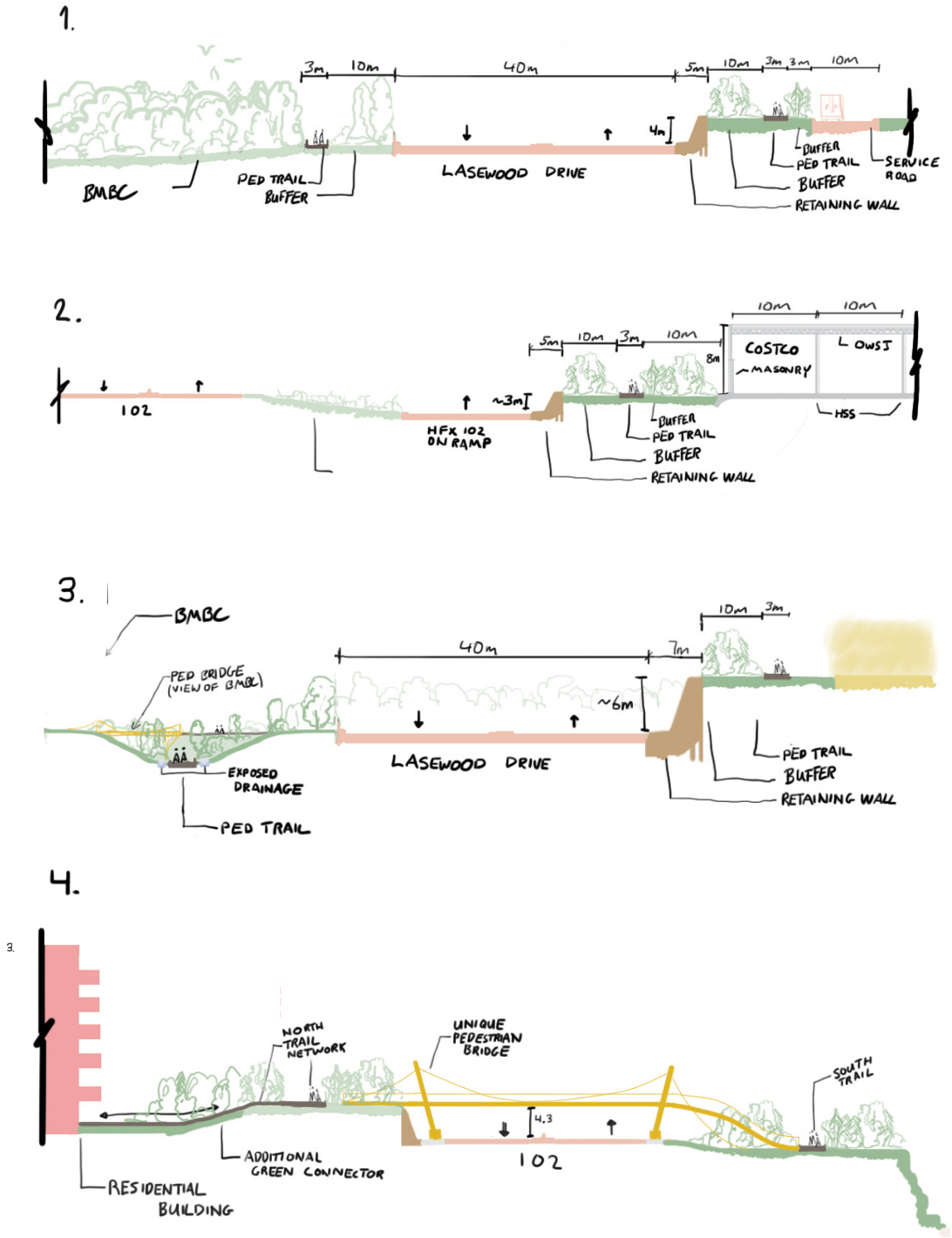
Like the ravines in Toronto, greenspace buffers could allow for the landscape of Blue Mountain - Birch Cove to regrow within the business park

4.4.3 Adjacent Retrofit Opportunities

As adjacent big box stores close over the next decade, new retrofitting opportunities could emerge. Successful retrofits act as seeds or exemplars for other projects. Other redundant big-box stores could potentially be converted to uses synergistic with the greenhouse/IVF project, such as aquaponics, mushroom cultivation and specialized composting.

Sève, designed by Collectif Escargo, is a an entry for "Sudbury 2050." The proposal aims to retrofit a large suburban site in Sudbury, Ontario into an eco-conscious village by introducing housing, urban agriculture and ecosystem renewal. (Escargo 2020).

Proposed masterplan for Bayers Lake. Proposal based on principles of buffers, points of interest and shrink the block. These interventions are informed by urban theorists referenced elsewhere. (map based on OSM 2021)



Hypothetical sketched sections of the proposed master plan sketched. These sections illustrate the desire to bridges [yellow] over current arterials [red] which act as barriers between existing neighbourhoods and the business park. Additionally, a trail pathways [brown] would be added adjacent but removed from road ways by a green buffer space denoting. Buffers remove inhance pedestrian experience and allow growth area for wildlife.

Rendered aerial view of greenhouse placed in business park. View displays the hypothetical master plan trails and moderate depaving of adjacent parking lots (based on Google Maps 2021j)

Chapter 5: Conclusion

How can simple rules guide the retrofit of big box stores into vertical farms that use food to enhance social and environmental indicators for suburban populations?

The use of rudimentary system mapping helped identify overshoots and shortfalls present in the suburban food distribution network.

1. The WVF is to increase supply of local produce to suburban populations and food purveyors.

2. The WVF is to provide a much-needed third space for local residents to build community and cultural ownership.

3. The WVF must operate using ecosystem services without making a net contribution to ecological overshoots.

Two additional principles were proposed for the site scale with the explicit goal of avoiding social shortfalls and ecological overshoots.

4. The scale of production must be limited to that which can be collected by the site.

5. Means of production and generation of wealth are to be redistributive and decentralized.

The goal of these principles was to create a base level of structure with which to inform the WVF retrofit of a generic big box store in Halifax as much as in Calgary.

Next, an input/output focused approach determined the scale of the project by calculating the excess and scarcities present in such a project specifically for the city of Halifax Cova Scotia. These calculations outlined the make or break

inputs and outputs required if such an agricultural retrofit were to fit into the goldilocks zone.

The result was a retrofit which ranged from high productivity industrial space to social community gardens with room to grow. Through a use of minimal intervention approach - with an understanding that social and industrial flexibility is to be encouraged - the structural grid of the Costco was maintained and extended outside the site creating three zones. These zones were created as to be two extremes with a moderator in the middle. Walls and roof acted as membranes to help passively provide the climate required by each zone. The thresholds between zones acted also as an organizing programmatic element, in some cases allowing views into he industrial space while protecting its sensitive operations. Finally, recognition of the excess water present in the ecosystem services, water was brought into the is building was used to inform architectural, programmatic, and mechanical operation of the WVF. Circulating through the building, water networks cool the space while offering a unique opportunity for a waters edge experience for the agricultural and market spaces. The canal serves passively maintains the comfort of the building while actively offering a unique and delightful experience users.

This thesis is optimistic that such a retrofit could provide an important landmark for this mundane business park and many others. It is this type of holistic approach that the author believes society urgently needs - not only to meet the ecological and social needs of the world’s growing population – but for our profession to help cultivate a movement of

architectural succession, deeply rooted knowing what our world offers and how it can bring us delight.

Programmatically, the garden, and especially the canal and water feature, offers a public opportunity to play in an area otherwise devoid of public parks and playgrounds. Some people get their hands dirty in the community garden, while others only visit occasionally for a farmers' market. The truth is that user-experience develops over time—the first visit being different from the last. Similarly, ecosystem cycles repeat over time, bringing both predictable and defined ecological events. By pairing the social and ecological events were paired, a chronology was created.This provided a powerful program generating tool, especially when populated with events significant to immigrant users. The result was a space which emphasized a degree of flexibility and adaptability.

Most importantly, this thesis proposes and then imagines how an ecological perspective can inform, restrict, and improve architectural interventions. Busines and retail parks are notoriously unpleasant and environmentally unsustainable, but they can be re-envisioned as sensible and sensitive spaces for growth and architectural succession

Wish image collage envisioning a future business park

Appendix A

Input and Output Calculations and Assumptions

Supply of veggies to Halifax:

o Halifax must consume 2 servings of veggies per capita to reach recommended levels (5-10) 67% is below recommendation. Raise from 4.5 servings to 6.5.

o 2 servings per capita requires 65720m2 of growing space. This is a 6572m2 WVF

Farming 100% size:

•Kg produced per year per year whole project.

- o Garden: 3.9kg/m2/y *3700 = 14,430kg/y
- o Hydro: 41kg/m2/y * 3700 = 151,700kg/y
- o IVF: 450kg/m2/y * 5000 = 2,250,000kg/y
- o Total: 2,416,130kg/y

•Electricity requirement: [97% is IVF]

- o 14,430kg/y *0.3kwh = 43,290kwh/y = .007%
- o 151,700kg/y *100kwh = 15,170,000kwh/y = 2.6%
- o 2,250,000kg/y *250kwh = 562,500,000kwh/y = 97%
- o TOTAL: 577,713,290kwh/y or 577.7 Gigawatth/y
- o Non-IVF electrical requirement =15.21Gigawatth/y
- o Industry leading efficiency, passive ventilation + daylighting = 158.14 Gigawatt/y

• ***Electricity generation from solar: [Also using parking lot]***

- o 6.072Gigawatth/y
- o Difference = 152.068 Gigawatts/y

• ***CO2 from electricity:***

- o NS emits 600 gCO2/kwh.
- o The vertical farm would emit 91240.8 tonne CO2/y
- o Vertical farm emits 40.5kg CO2/kg lettuce. Fifty times more emissions
- o Traditionally grown lettuce is: 0.705kgCO2/kg [EAC food report]
- o Would offset 1586 tonneCO2/y from the spinach shipped from Arizona,

Farm size at neutral CO2: Year 1

- ***Kg produced per year for the whole project***
    - o Garden: 3.9kg/m2/y *1700m2= 6,630kg per year
    - o Hydro: 20kg/m2/y * 3700m2= 74,000kg per year
    - o IVF: 176.6kg/m2/y * 1359m2 = 240,000kg per year
    - o Total 320,630kg/y

- ***Electricity generation: [roof and parking lot]***
    - o 6.072Gigawatth/y

- ***Water collection:***
    - o Annual rainfall: 1388mm
    - o Annual total collection capacity: 27,760,000L

- ***Water consumption:***
    - o Garden: 1700m2 @400 = 680,000L
    - o Hydro: 3700m2 @ 200L = 740,000L
    - o IVF: 1359m2 @ 353L = 480,000L per year
    - o Total: 1,900,000L

- ***Water Storage: Ample water storage capacity***
    - o Feb-May rainfall 390mm = 7,800,000L
    - o Storage capacity to be winter overflow and summer deficit = 3,900,000L

- ***Heat source:***
    - oTotal BTUs from IVF lighting = 18,684,931BTU/hr

- ***Heating requirements:***
    - o Garden space = 4,650,004.8BTU/hr
    - o Hydro farm 8,040,633BTU/hr
    - o IVF: 1,755,376BTU/hr
    - o Total: 14,930,389BTU/hr - 18,684,931BTU/hr = Extra 2,000,000 BTU/hr

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