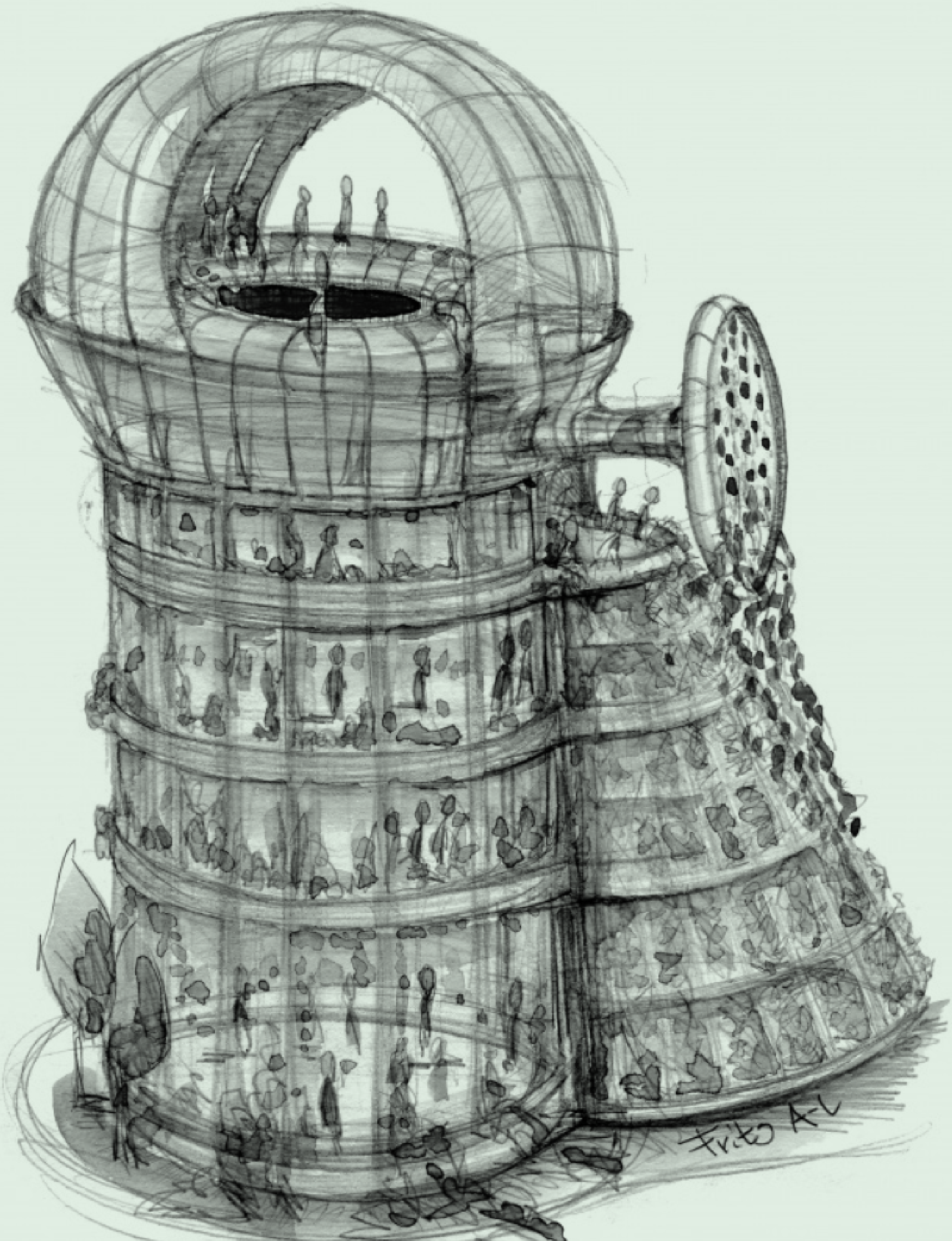


A NEW ROOT architecture for food production

figure 1.1

A NEW ROOT

A Design Thesis Submitted to the
Department of Architecture of
North Dakota State University

by

Rebekkah R. Gilbertson

In Partial Fulfillment of the Requirements
for the degree of
Master of Architecture

Cindy Urness
Primary Thesis Advisor

Stephen Wischer
Thesis Committee Chair

May 2023
Fargo, North Dakota

CONTENTS

TABLES & FIGURES

01 THE PROPOSAL

THESIS ABSTRACT

Only 17% of America's land is considered ideal for agricultural purposes. However, traditional agriculture ruins our land in the long run by depleting the soil of essential nutrients. By conserving the land, we can reap its many benefits. To name a few, conserving the land can play a role in reducing air and water pollution, preserving biodiversity, preventing soil erosion, and can aid in sequestering greenhouse gases. Because land is such a vital resource, we can further preserve it by bringing vertical farming into urban environments. This yields the question: **How can architecture be designed for food production to have an impact on the health of people and the environment?**

The research begins with analyzing several precedent studies of urban agriculture and its implementations within different architecture typologies. The research cumulates in the final design of urban farms designed for several settings, including new and existing markets, a stand-alone structure, and several scales of mixed-use buildings.

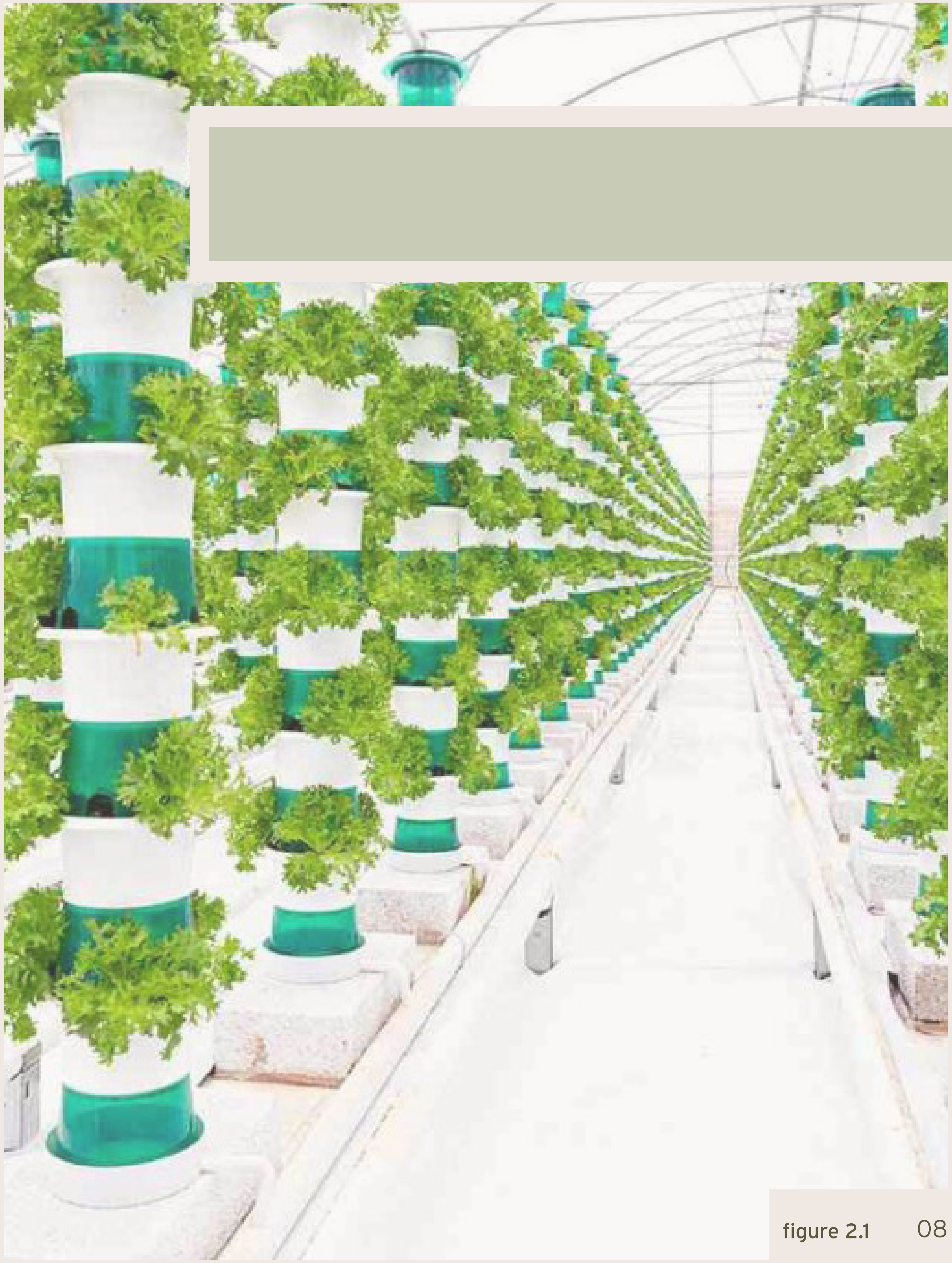


figure 2.1

THESIS NARRATIVE

figure 3.1

PREMISE FOR INVESTIGATION

This project investigates how the benefits of vertical farming greatly outweigh any drawbacks. It examines how traditional, crop and till, agriculture is harming the environment by contributing to climate change, utilizing more than what is necessary of important resources like land and water, and the challenges that growing faces with urbanization and other environmental-related factors. Even further, research explores how urban, vertical farms contribute to the community, and provide more nutritious food to the people at a more readily available time and location.
All of these explorations ultimately examine an issue that can be mindfully thought about and implemented in terms of architecture and urban planning.

THE EXPLORATION

The future is vertical. With a growing population and less and less land being available, we are being forced to build up. What is to say the same cannot go for farming? Much of the United States is suffering from the loss of land resources – cities and surrounding suburbs are among those with the fastest rates of loss. One particular loss is that of viable land goes to agriculture. Continuing with our current trajectory, the future is becoming less and less green.

Land and water are valuable resources. Land provides home to several ecosystem dynamics, such as vegetation, wildlife, and people. Land is also valuable to other resources. It harbors minerals and raw materials. It aids in the regulation, storage, and flow of surface water and groundwater. Water, like land, is not an infinite resource. This is important to note because traditional farming practices currently account for over 70% of global freshwater withdrawals.

Another environmental issue is that traditional agriculture and global climate change simultaneously harm each other. Agriculture is one of the largest contributors to global warming. Two of the harmful gases produced by farming are methane and nitrous oxide.
As we know, urbanization has led to the present-day issue we refer to as urban sprawl. Urban sprawl impacts the amount of land available for agriculture. Urbanization has called for an increase in demand of food for its residents. However, these urban settings have little to no immediate access to fresh food and many agricultural practices are nowhere in sight. By bringing vertical farms into urban areas, food can be ready for consumers within as little as an hour. Creating plans like these ensure that food should not be treated as a commodity; it is a necessity.

Farming year-round is not compatible in most climates. By creating controlled environments, you manage the soil, precipitation, humidity, and temperature. Indoors, there is no need to worry about the outdoor environmental conditions and food can be produced at a maximum yield with no off season. Several regions are not compatible for crops in the first place because of inadequate environmental factors. With this plan, food can also be produced in areas of the nation that have never had any local agriculture and crops from other climates can be brought to our nation. This gives easier access to not only food in general, but food that is healthy.

In North America, the average meal travels approximately 800 miles from its point of production to the consumer's plate.   In order for food to travel such a distance it must be harvested well before it becomes ripe. This causes the food to lose its nutrition value, as well as contribute to the negative emissions our Earth faces.

By growing food in a controlled environment, it is healthier for people and the planet. These local facilities can avoid using synthetic pesticides and fertilizers. Advances in technology allows for LED lights to improve the flavor of food. This is done through altering the wavelengths of the light and modifying the different amount of light intensity and exposure on a daily cycle.

THE CONTEXT

Washington, D.C. is home to the United States Department of Agriculture, the sector responsible for the development and execution of all federal laws related to farming, forestry, rural economic development, and food. Our country currently uses over 52% of its land for agriculture. And even though Washington D.C. is known to have high marks when it comes to green spaces and parks, it is still subjected to the inevitable slow and steady decline.

Like everything else in today's world, technology is creating new advances in how the built environment affects our lifestyle. The typical definition of an urban farm is the practice of cultivating, processing and distributing of food in and/or around an urban environment. Vertical farming is a newer term, meaning the practice of agriculture in vertically stacked layers.

The master plan for this project creates several options of how architecture, both new and existing infrastructure, can house the future of our food. This project explores some different implementations throughout the community. There will be an urban farm center housing various food-bearing plants, water features, nature walks, learning opportunities and other sustainability practices open to the public. There will be a grocery store addition, housing farms to grow local produce for the store to sell. There is an installation of how this can be incorporated into the typical multi-usage building, creating not only food but also refuges for people to rest and work in a biophilic environment. The final implementation is on an institutional campus where research and food production benefit each other.

figure 3.2

PROJECT TYPOLOGY

The proposed design will be the revitalization of the urban environment through multiple architectural typologies. One typology serves as the core of this project while the others are considered to be satellite typologies supported by the core.

01 Stand-alone urban farm community center

02 Mixed-use building typology with built in vertical farming

03 Farms integrated into a grocery store

04 Institutional farms for research/education, campus production

figure 4.1

figure 5.1

THE TYPOLOGICAL RESEARCH

figure 5.2

The typological research includes a variety of case studies, whether they are existing or proposed architectural projects, urban planning and design projects, journal articles, published scientific data, and other precedent information. Due to the different projects in this thesis and the varying of programs and usages, there are also varying research pieces. Some may pertain to only one project while others may contribute input to several or all of the projects in this thesis.

CASE STUDY ONE

URBAN FARMERS ROOFTOP

architect — ANTONIO SCARPONI

typology — INDUSTRIAL URBAN FARM

year — 2014

location — BASEL, SWITZERLAND

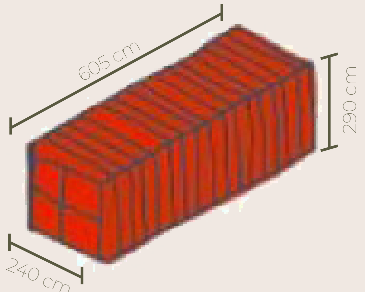
figure 5.3

figure 5.4


figure 5.5

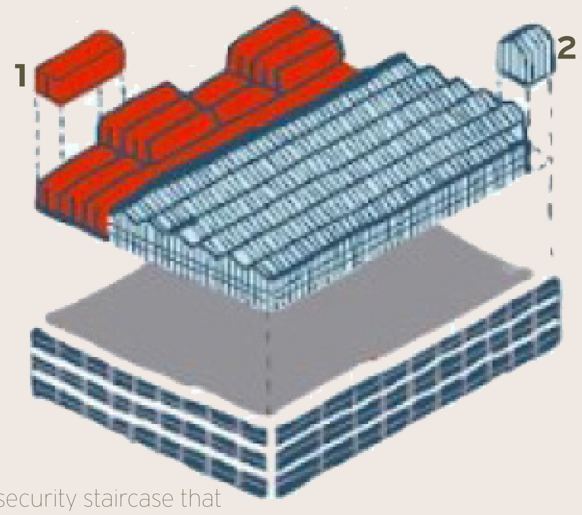
URBANFARMERS MODULAR SYSTEM

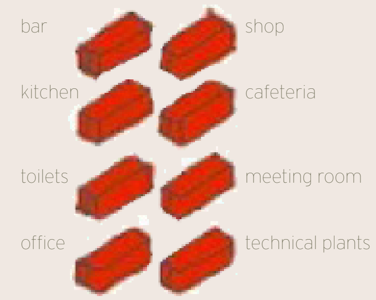
DESIGNED TO INSTALL AN AQUAPONIC URBAN FARM ON UNUSED TOP ROOFS. THE SYSTEM CAN BE SCALED AND ASSEMBLED TO COMBINE PRODUCTION NEEDS AND SERVICES INFRASTRUCTURE

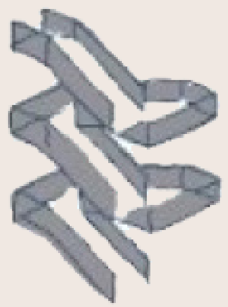


1 "high cube" cargo container, each module can contain a specific function

the whole system can be customized according to specific needs

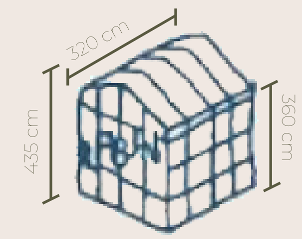






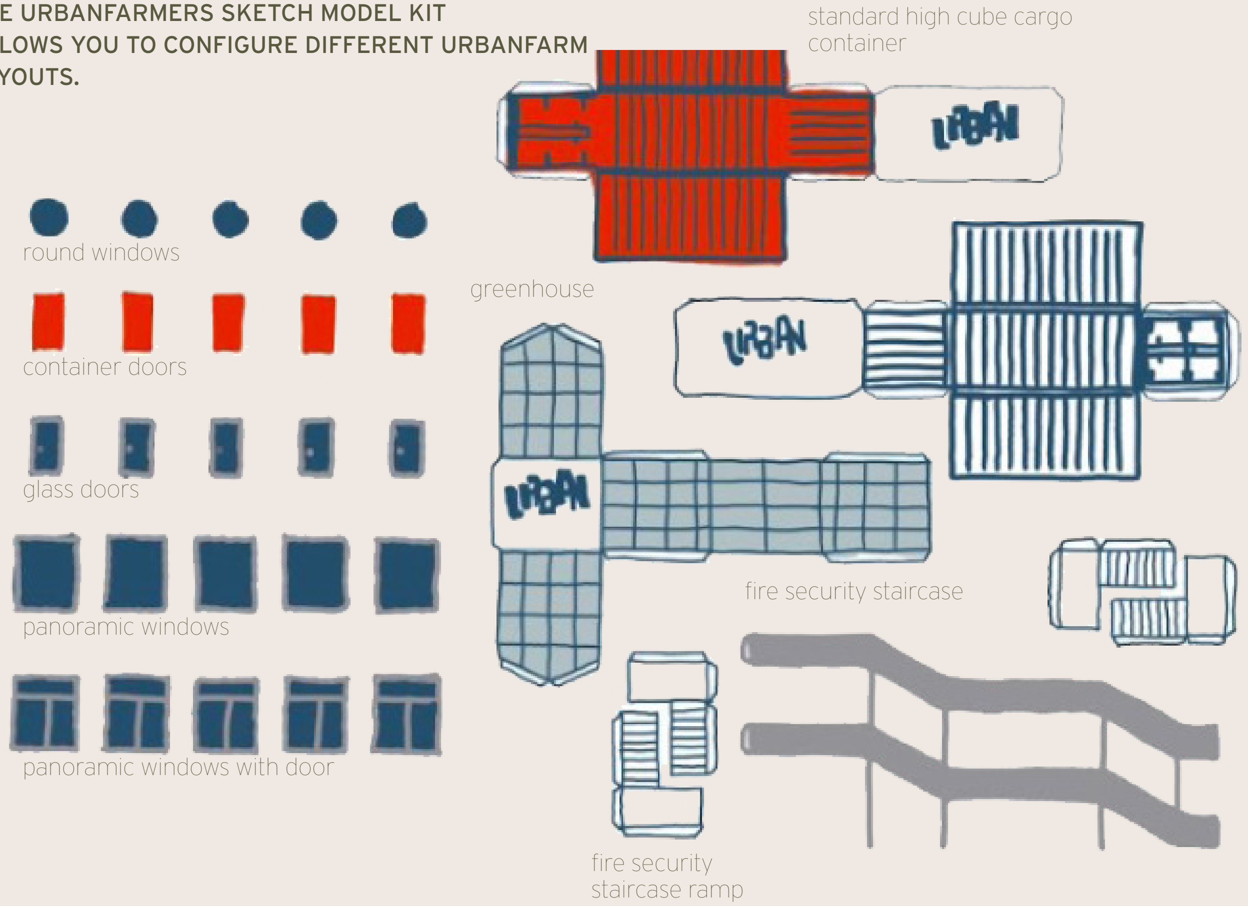
3 fire security staircase that allows direct access to the roof and security fire evacuation

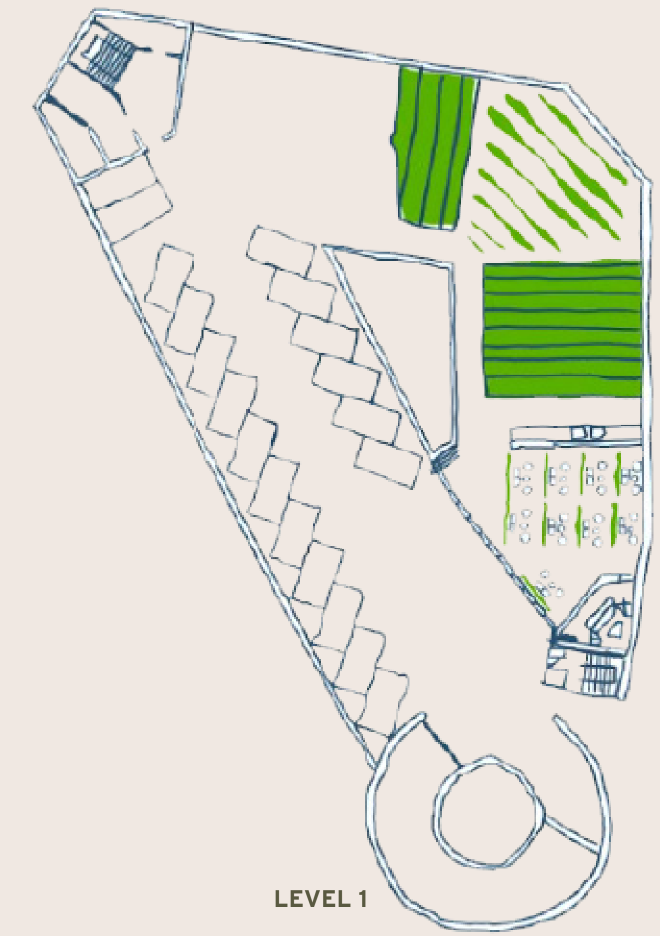
2 greenhouse modular unit

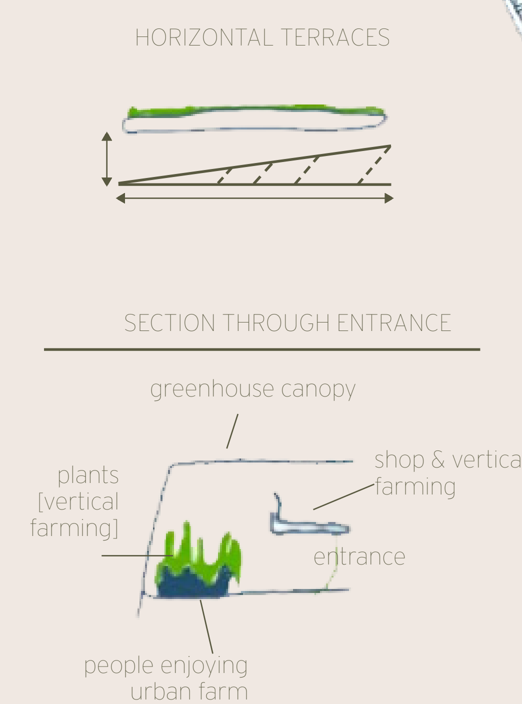


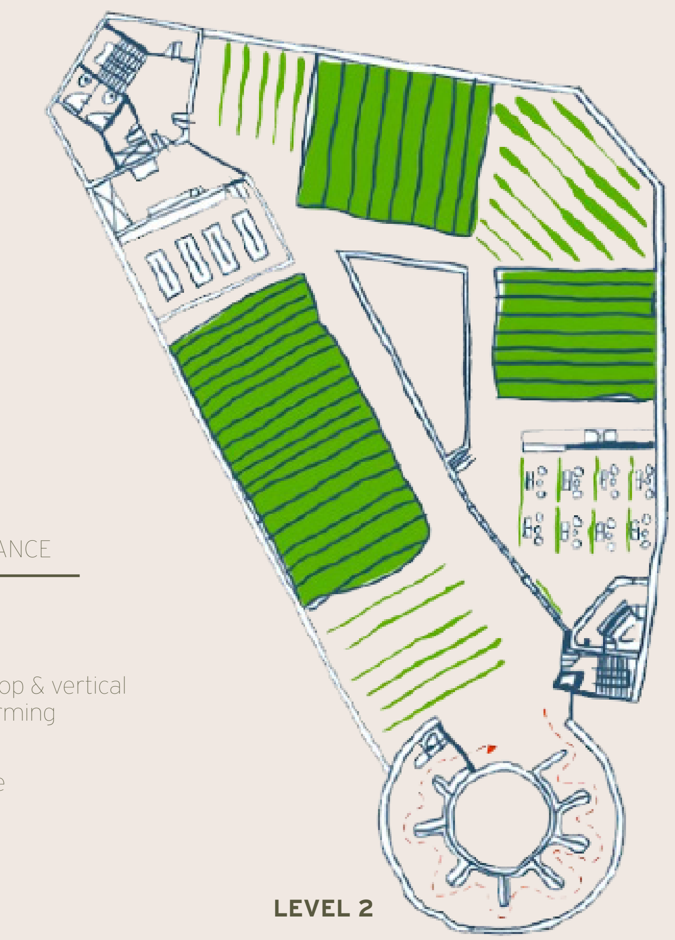
URBANFARMERS SKETCH MODEL KIT

THE URBANFARMERS SKETCH MODEL KIT ALLOWS YOU TO CONFIGURE DIFFERENT URBANFARM LAYOUTS.

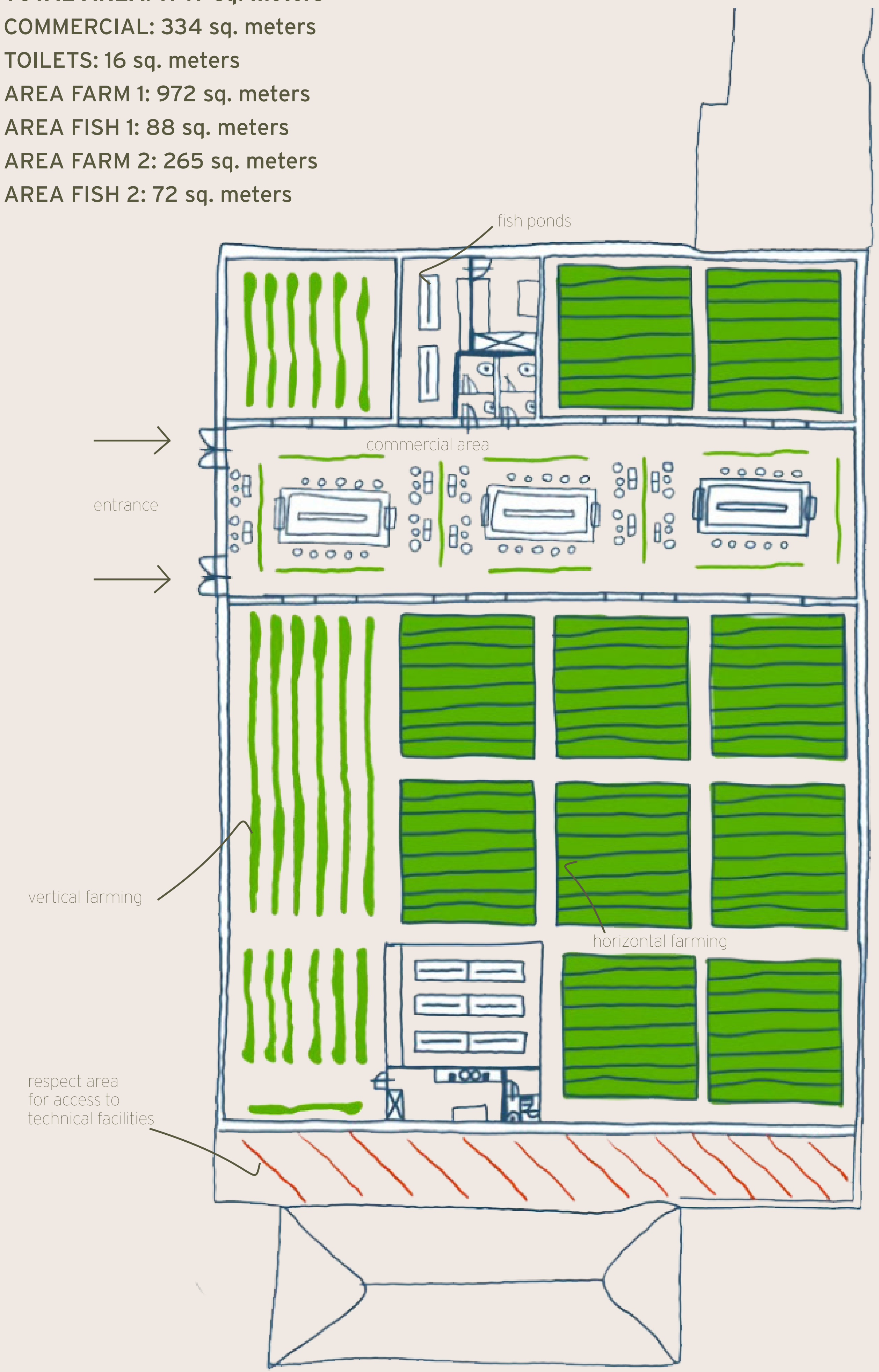




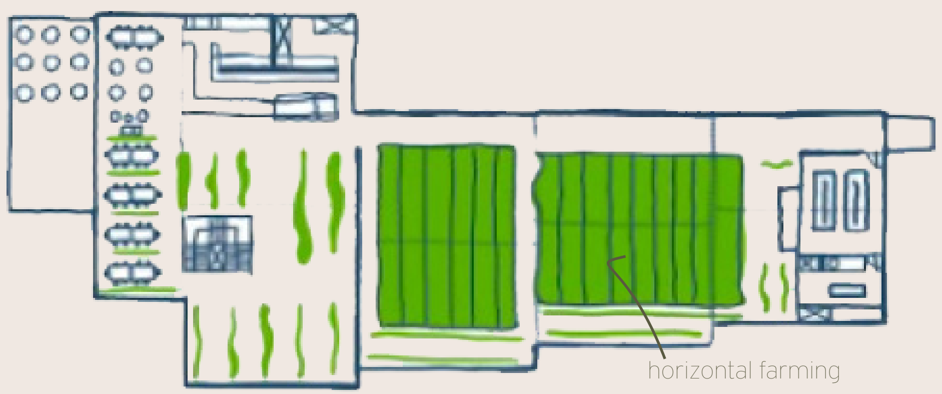


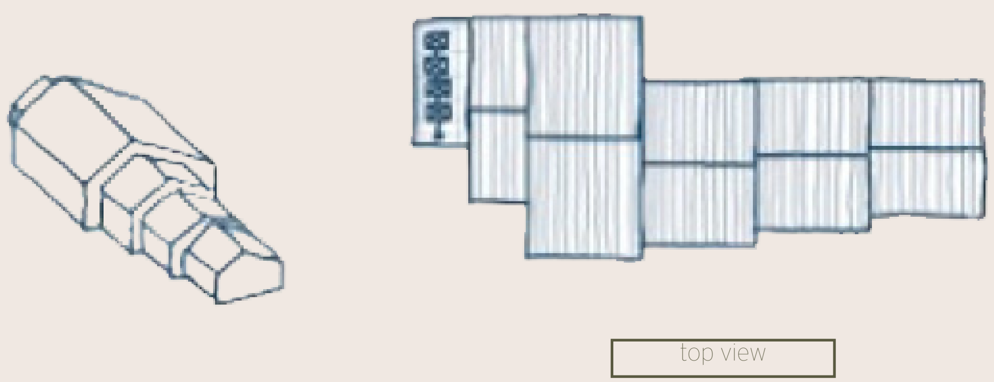


TOTAL AREA: 1747 sq. meters
COMMERCIAL: 334 sq. meters
TOILETS: 16 sq. meters
AREA FARM 1: 972 sq. meters
AREA FISH 1: 88 sq. meters
AREA FARM 2: 265 sq. meters
AREA FISH 2: 72 sq. meters



TOTAL AREA: 412 sq. meters
URBAN FARM AREA: 298,2 sq. meters
FISH AREA: 38,4 sq. meters
CAFETERIA+SHOP: 75,3 sq. meters





impressions

This project uses large, flat, homogeneous, and unused mechanical rooftops to create urban farms. Urban agriculture has a lot to do with the use of unexpressed potential of the metropolis, turning them into areas of productivity. This architecture consists of prefabricated modules that house the various areas of the program. The program includes greenhouses for plant production, administration offices, storage spaces, and more. This model allows for food production to happen on any flat industrial building.

CASE STUDY TWO

ANDORRATELECOM

architect

ALTURA ARQUITECTES

typology

OFFICE MULTISTORY

year

2021 [COMPETITION]

location

ANDORRA LA VELLA

figure 5.6


100% recycled copper facade
large void creates the garden atrium
andorra telecom
OLYMPIA
figure 5

figure 5.8

impressions

The Andorra Telecom New Headquarters is a prime example of how to bring healthy food to the working class. This project uses an existing building's central tower to implement agricultural techniques. This shows how having a void in new and existing infrastructure can be transformed into a biophilic space that allows for a growing atrium, natural refuges, and more.

Sustainability is approached through materials selection and its impact on energy efficiency.

CASE STUDY THREE

REGEN VILLAGES

architect

EFFEKT

typology

MIXED-USE

year

2016

location

ALMERE, NETHERLANDS


figure 5.9

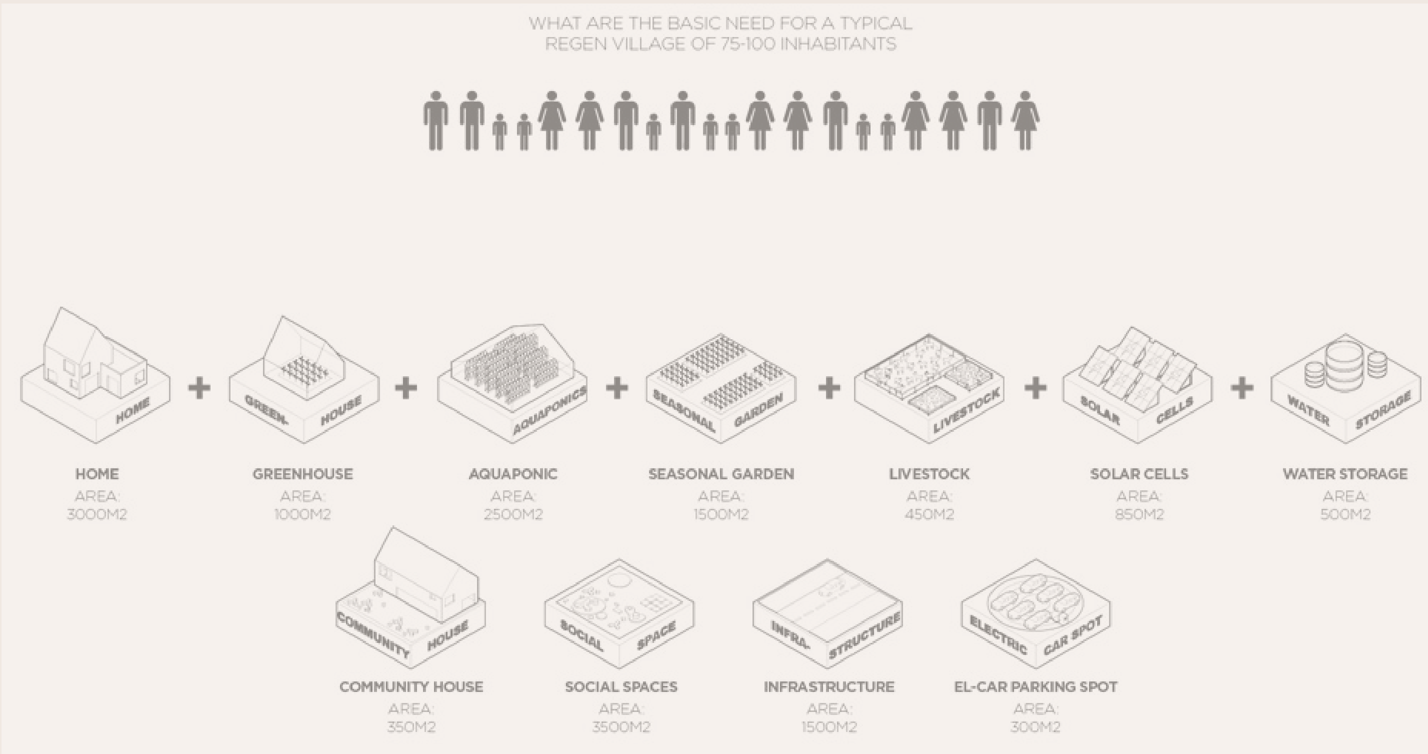

figure 5.10

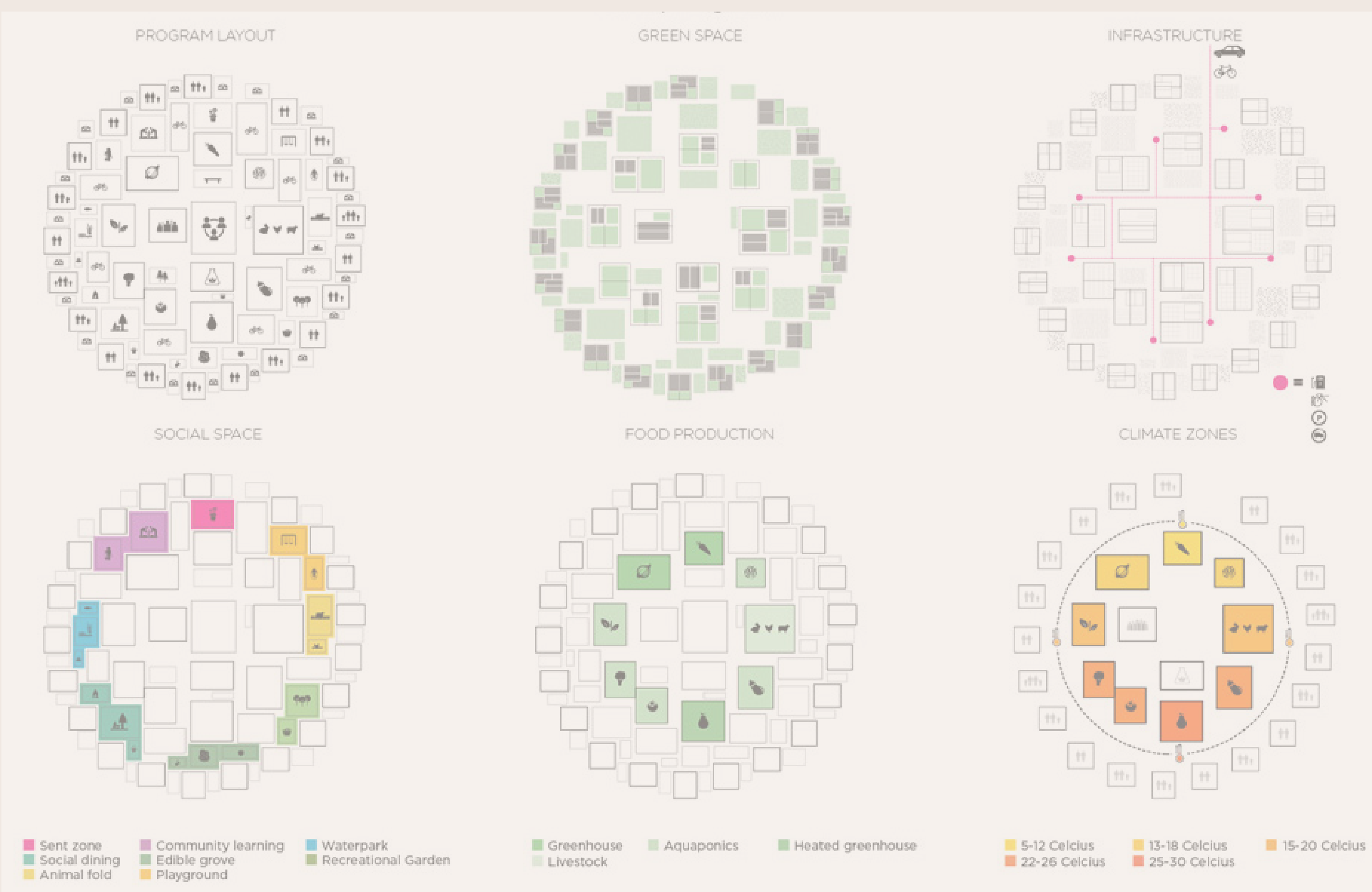

figure 5.11

figure 5.12

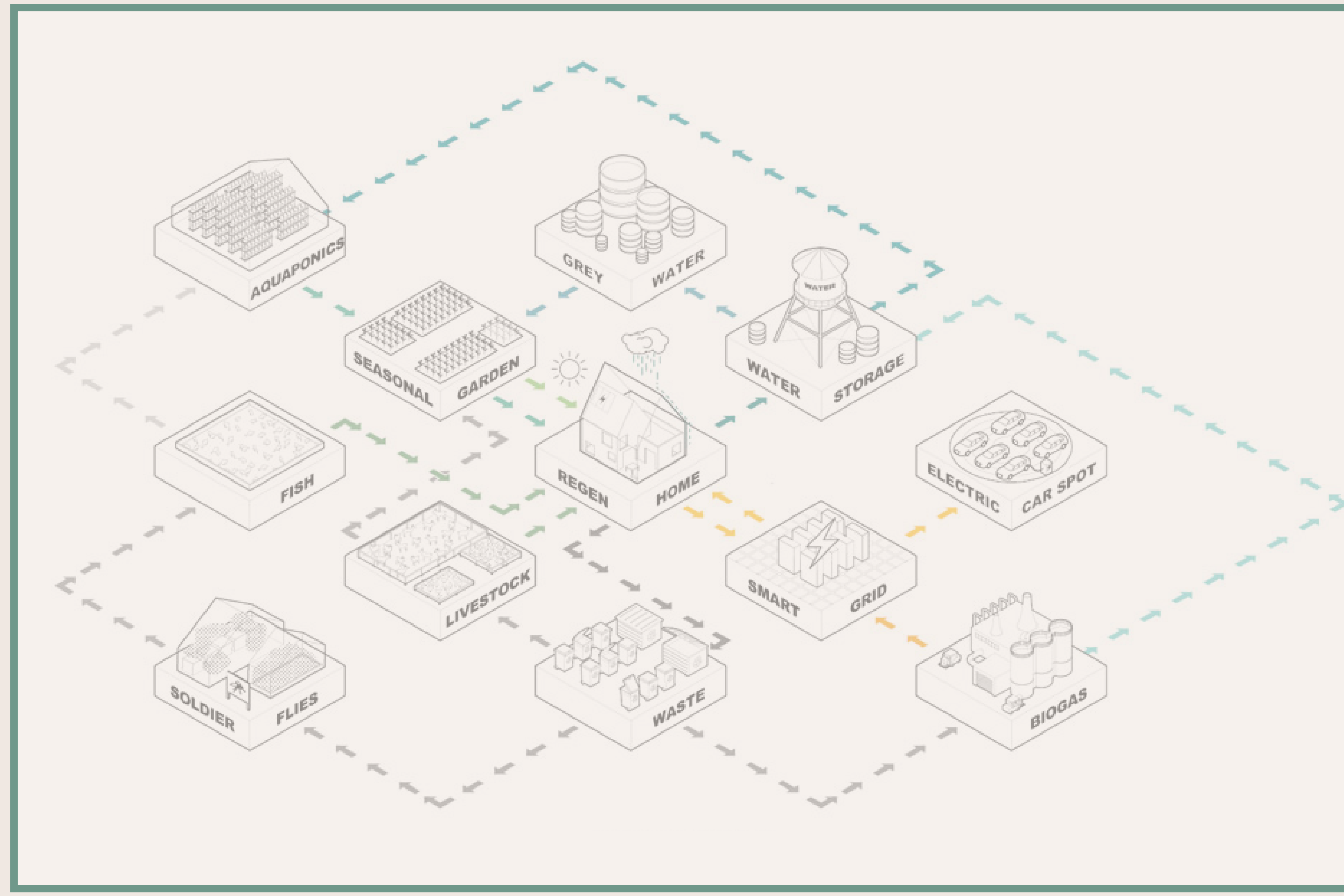
figure 5.13

THE PROGRAM

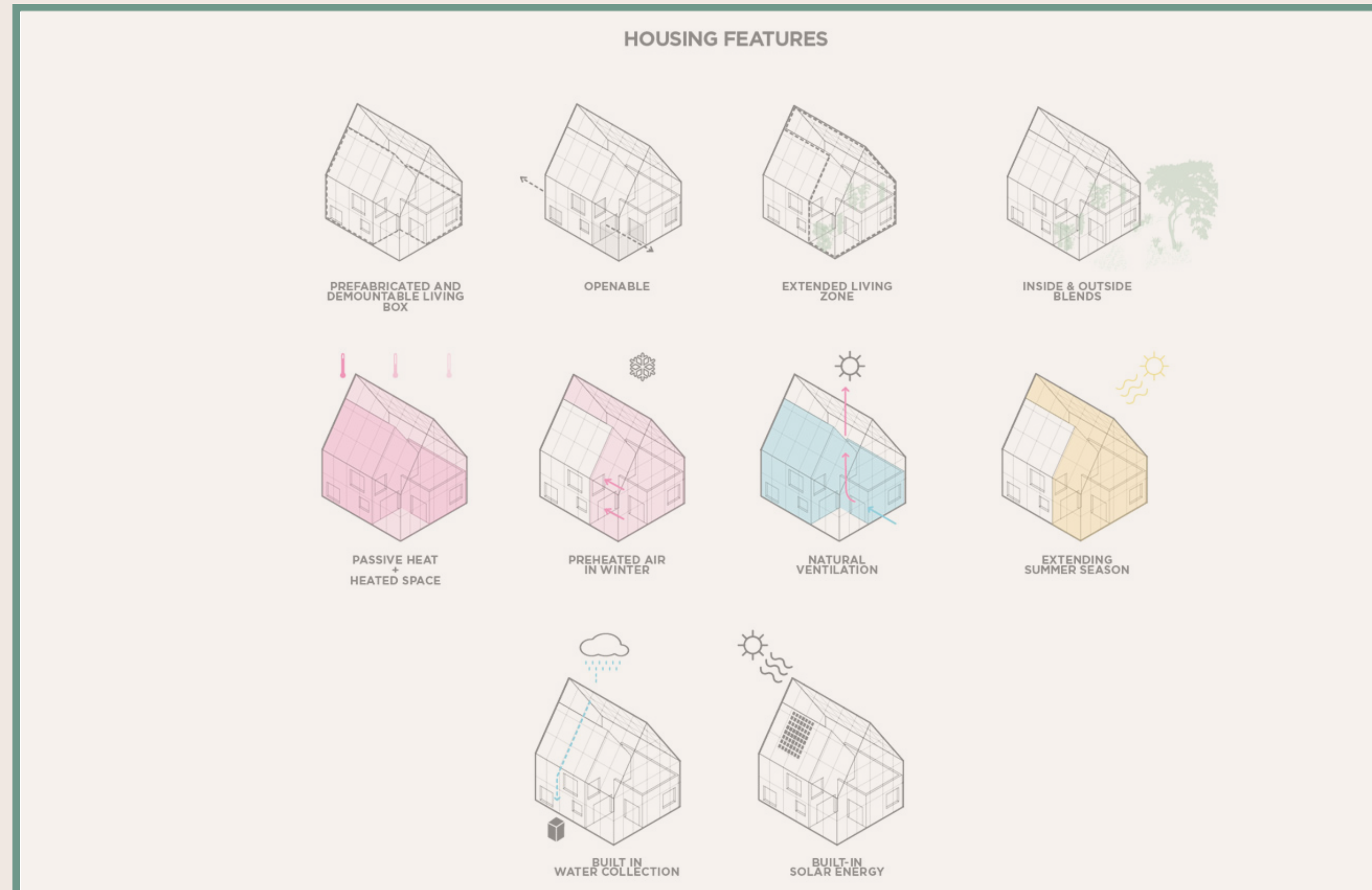




REGEN SYSTEMS



HOUSING FEATURES



SOCIAL SPACES

SOCIAL SPACES ARE CREATED BETWEEN THE BUILDINGS, TO ENSURE A COMPLETE INTEGRATION BETWEEN FOOD PRODUCTION AND THE HOUSING UNITS.

INFRASTRUCTURE

8 SQUARES ARE CONNECTED TO ENSURE, AN EFFICIENT INFRASTRUCTURE, THE SQUARES WORKS AS ELECTRIC CAR CHARGING STATION, AND A DROP OFF ZONE.

GLASS ENVELOPE

THE HOUSING UNITS ARE ENCASED IN A GLASS ENVELOPE, TO EXTENT THE GROWING AND LIVING SEASONS IN THE FOOD PRODUCTION FACILITIES AND THE HOUSING UNITS

FOOD PRODUCTION

FOOD PRODUCTION FACILITIES ARE PLACES IN THE CENTER OF THE HOUSING UNITS.

HOUSING UNITS

25 HOUSING UNITS ORGANISED IN A CIRCLE

HOUSING TYPOLOGIES

TYPOLOGY 1A

HOUSE 80 M2
GREENHOUSE 20 M2

TYPOLOGY 2A

HOUSE 110M2
GREENHOUSE 20M2
TERRASSE 20M2

TYPOLOGY 2C

HOUSE 130M2
GREENHOUSE 20M2
TERRASSE 20M2

TYPOLOGY 3A

HOUSE 140M2
GREENHOUSE 5M2
TERRASSE 40M2

TYPOLOGY 1B

HOUSE 80 M2
GREENHOUSE 20 M2

TYPOLOGY 2B

HOUSE 120 M2
GREENHOUSE 25M2

TYPOLOGY 2D

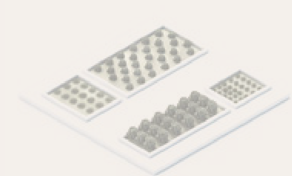
HOUSE 120M2
GREENHOUSE 15M2
TERRASSE 15M2

TYPOLOGY 3B

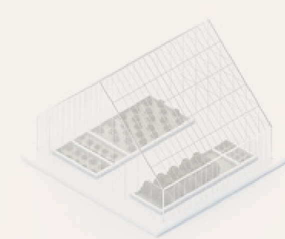
HOUSE 140M2
GREENHOUSE 10M2
TERRASSE 50 M2

FOOD PRODUCTION

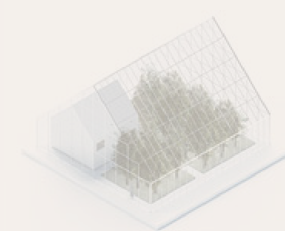
To ensure a year round yield



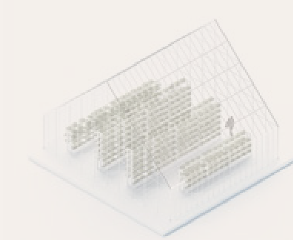
SEASONAL GARDEN



GREENHOUSE



HEATED GREENHOUSE



AQUAPONICS

impressions

EFFEKT is a self sustaining, off-the-grid village of greenhouse properties. The purpose of this project was to tackle a wide variety of global issues. Some of those being food shortage, water crises, and CO_2 emissions. This program includes homes, greenhouses, aquaponics, seasonal gardens, livestock, solar cells, water storage and systems, community houses, social spaces, infrastructure, smart grids, and electric car charging ports.

CASE STUDY FOUR

AGRITECTURE

architect

ANTONIO SCARPONI

typology

INDUSTRIAL URBAN FARM

year

2014

location

BASEL, SWITZERLAND

figure 5.14

AUTONOMOUS VEHICLE FUTURE

The need for parking lots is diminishing. The RAND team envisioned a purposeful solution. They re-purposed a 200,000 square-foot concrete IKEA parking lot in New Jersey for local food production. This plan includes greenhouses, vertical farms, and outdoor community spaces.

figure 5.15

RETAIL APOCALYPSE

Retail spaces are slowly dying as technology advances and online services are readily available. This site is comprised of 15 hectacres. The proposal is to update the site by integrating innovative food production with a new type of shopping experience.


figure 5.16

FUTURE CITY FOOD HUB

This concept illustrates the rehabilitation of a downtown parking structure into an indoor vertical farm and rooftop greenhouse. The hub also contains spaces for food processing and retail. This facility produces over 100,000 pounds of food annually.


figure 5.17

impressions

Global population is on the rise, natural resources involved in food production are threatened by climate change, and urban sprawls are continuing to take up more and more space. This is where architects and urban planners must come together to build a more food-secure future.

Henry Gordon-Smith explains *"Agriculture and architecture have been intertwined since the dawn of human settlement. But in recent history, we've lost that connection. 'Agritecture' is about bringing that connection back and making it work for a modern society through smart planning and data-driven solutions."*

CASE STUDY FIVE

FROM FARM TO FORK

author

CAMILLA GHISLENI

date

MARCH 02, 2021

figure 5.18

figure 5.19

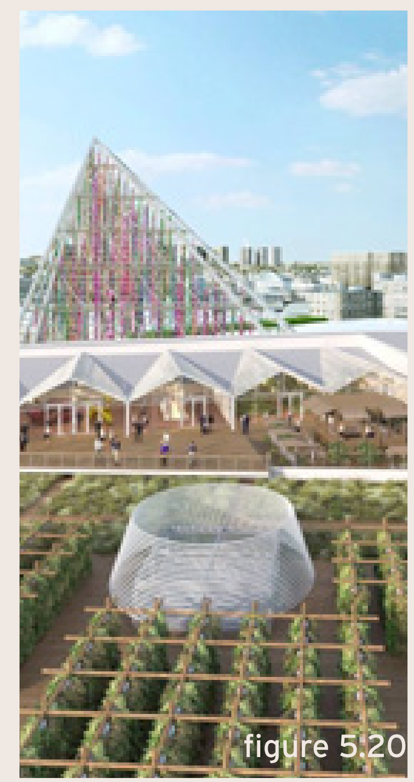


figure 5.20

figure 5.21

figure 5.22

impressions

Over 95% of food in the United States is required to travel more than 1.6 thousand kilometers to reach its retail location. This coins the term food miles. By significantly reducing food miles traveled, we can have food that is more nutritious and fresher, and environmental impacts are significantly lowered.

Food production projects are designed to bring food closer to the consumers. With a projected population of exceeding 9 billion people in the near future, we do not have the needed space to continue farming with horizontal and traditional methods.

These spaces create food and nutritional security, sources of jobs and incomes, and is inclusive of all people to be social involved. Some of these projects are making appearances across the world already. Some of these projects are listed below:

14,000 square-meter urban farm rooftop in Paris, France

modular aeroponic systems squeezed into dense areas of New York City, New York

urban agricultural district of Shanghai that includes farms, laboratories, innovation studios, and public interaction and education

an office in Tokyo, Japan that dedicated 20% of its area to vegetable cultivation

CASE STUDY SIX

ACROS FUKUOKA PREFECTURAL INTERNATIONAL HALL

architect

EMILIO AMBASZ

typology

MUNICIPAL GOVERNMENT

year

1995

location

BASEL, SWITZERLAND

figure 5.23

figure 5.24

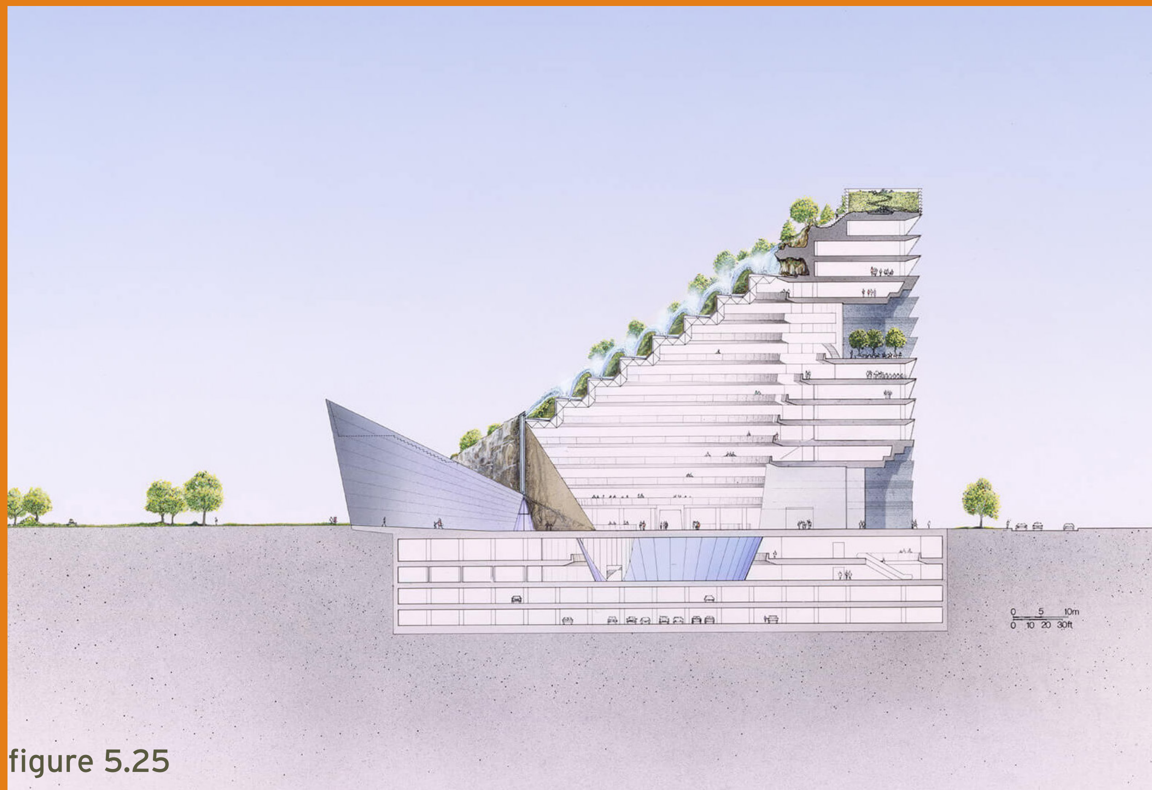


figure 5.25

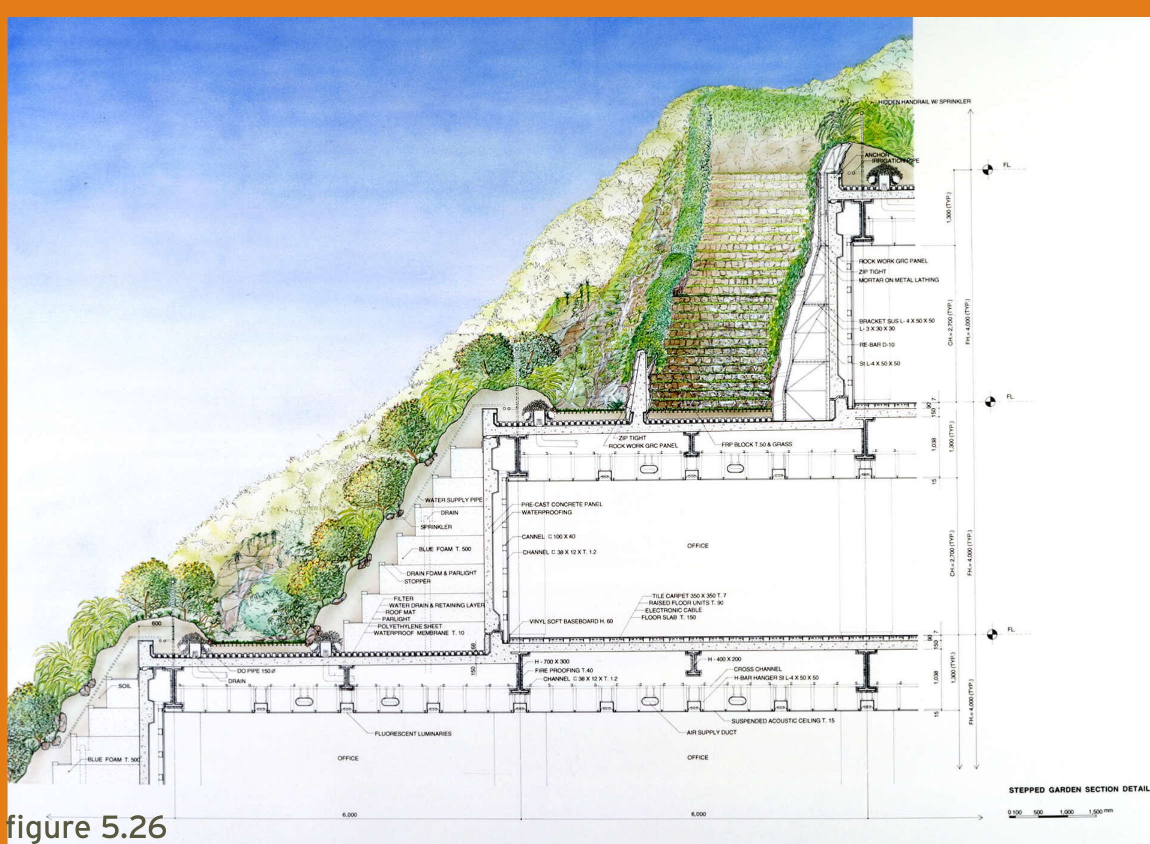


figure 5.26

figure 5.27

impressions

This older project is one of the first examples of green architecture. It had a vision for the future of greenspace that is slowly coming to life everywhere. This mid-rise building has 14 terraces that are open for public interaction to the newly developed 'park'. The program consists of reflecting pools, waterfalls, and over 50,000 plants. By entering this park you may no longer realize you are in a densely built city.

This self-contained ecosystem provides fresh air, reduces pollution and noise, and contributes to the reduction of the heat island effect.

CASE STUDY SEVEN

FIVE BOROUGH FARM

authors

NEVIN COHEN,
KRISTI REYNOLDS,
RUPAL SVANGHI

typology

URBAN AGRICULTURE

year

2012

location

NEW YORK CITY, NEW YORK

figure 5.28

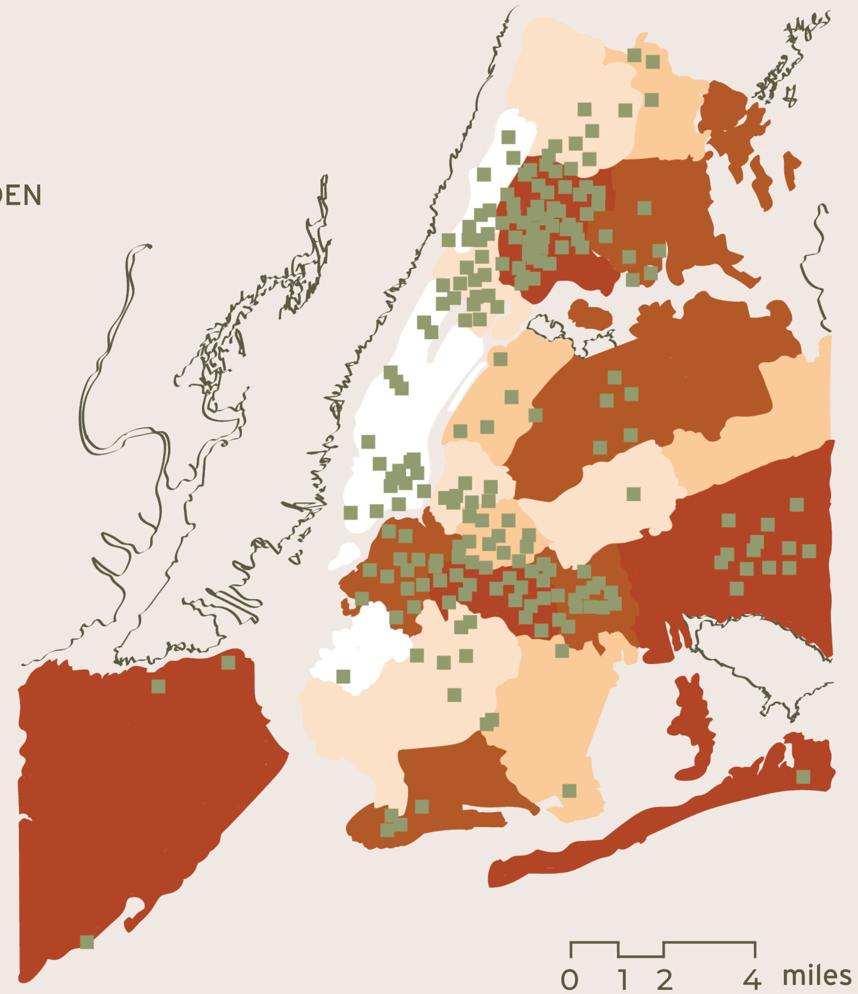
COMMUNITY GARDENS & VACANT LOTS

COMMUNITY GARDEN LOCATIONS

NUMBER OF VACANT LOTS

LOW

HIGH

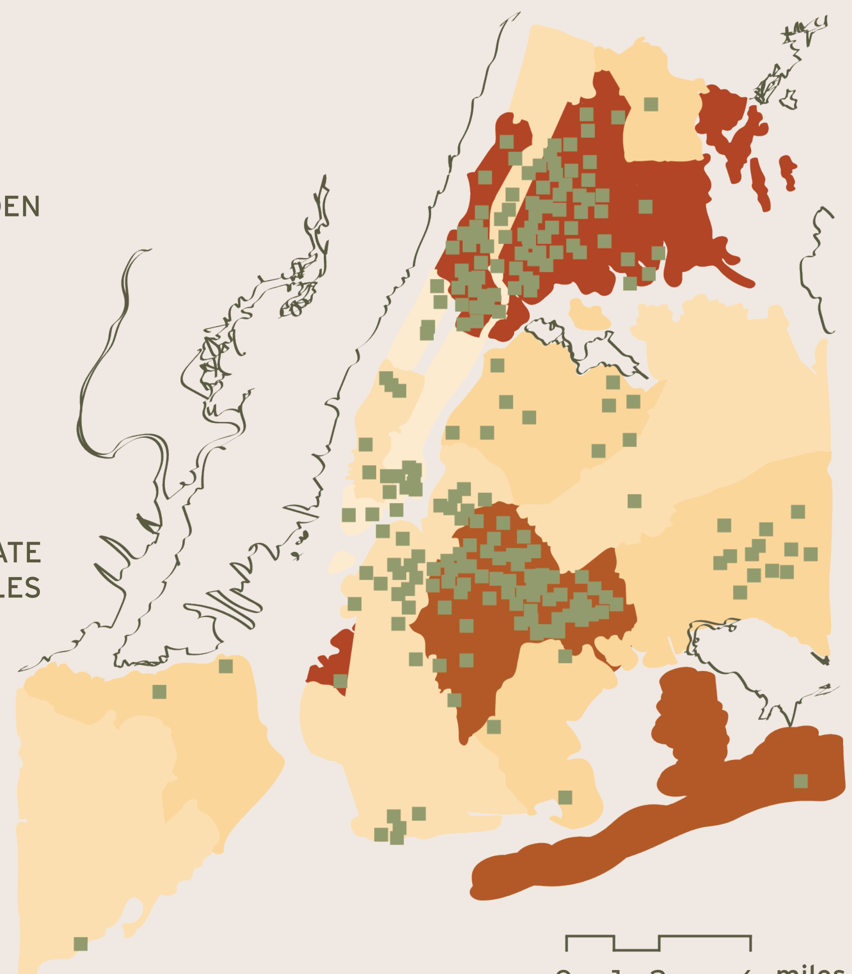


COMMUNITY GARDENS & VEGETABLE CONSUMPTION

COMMUNITY GARDEN LOCATIONS

PERCENT OF SURVEY RESPONDENTS WHO ATE NO FRUITS/VEGETABLES THE PREVIOUS DAY

1% - 5%
5% - 10%
10% - 15%
15% - 20%
25% - 30%



BENEFITS

HEALTH

access to healthy food
food-health literacy
healthy eating
physical activity

SOCIAL

empowerment + mobilization
youth development + education
food security
safe spaces
socially integrated aging

ECONOMICAL

local economic stimulation
job growth
job readiness
food affordability

ECOLOGICAL

awareness of food systems ecology
stewardship
conservation
storm water management
soil improvement
biodiversity+ habitat improvement

figure 5.29

metrics
OF BENEFITS

	RAINWATER HARVESTING	SEED SAVING	RAISING LIVESTOCK	BEE KEEPING	COMPOSTING	LAND REMEDIATION	PLANTING TREES	ENVIRONMENTAL EDUCATION	COOKING & NUTRITION CLASSES	FOOD SYSTEMS EDUCATION	HEALTH & WELLNESS EDUCATION
HEALTH											
access to healthy food			●								
food-health literacy		●						●	●	●	●
healthy eating									●		●
physical activity			●				●				●
SOCIAL											
empowerment + mobilization					●		●	●			
youth development + education			●						●	●	●
food security			●								
safe spaces			●			●					
socially integrated aging											
ECONOMIC											
local economic stimulation											
job growth											
job readiness								●			
food affordability			●								
ECOLOGICAL											
awareness of food systems ecology		●		●	●			●		●	
stewardship	●	●			●	●	●	●		●	
conservation	●	●			●	●					
storm water management	●										
soil improvement					●	●					
biodiversity + habitat improvement			●	●		●	●				

	SOCIAL/FOOD JUSTICE	SCHOOL PROGRAMS	YOUTH LEADERSHIP TRAINING	AG./FARM MANAGEMENT TRAINING	JOB TRAINING/CREATION	WOMEN-FOCUSED PROGRAMS	INTERGENERATIONAL PROG	COMMUNITY-BASED RESEARCH	POLICY WORK & ADVOCACY	VOLUNTEER PROGRAMS	SPECIAL EVENTS	CSA	VALUE-ADDED PRODUCTS	FARMERS MARKETS	SENIOR FOOD ACCESS PROG	RESTAURANT SALES	GROWING FRUITS/VEGGIES
HEALTH																	
access to healthy food		●	●		●	●	●	●	●		●	●	●	●	●		●
food-health literacy	●	●	●			●	●	●	●	●	●	●	●	●			●
healthy eating		●	●			●	●		●	●	●	●		●			●
physical activity			●	●		●	●			●							●
SOCIAL																	
empowerment + mobilization	●		●	●	●	●	●	●	●	●	●	●	●	●			●
youth development + education	●	●	●	●	●		●	●									●
food security			●					●	●			●			●		●
safe spaces			●			●	●	●	●		●	●			●		●
socially integrated aging							●				●						●
ECONOMIC																	
local economic stimulation					●	●						●	●	●		●	
job growth					●	●							●	●			
job readiness			●	●	●	●							●	●			
food affordability												●		●	●		●
ECOLOGICAL																	
awareness of food systems ecology		●	●	●	●		●	●		●							●
stewardship		●	●	●	●		●	●		●	●						●
conservation		●										●		●			
storm water management																	●
soil improvement																	●
biodiversity + habitat improvement																	●

figure 5.30

URBAN AGRICULTURE

figure 5.31

Urban agriculture involves many different types of food-producing spaces, stakeholders, resources, and policies, and contribute many benefits.

People

Local residents
Volunteers
Community organizations
Students
Visitors
Market customers

Soil & Compost

Self-produced
Purchased
Donated

Supplies

Seeds
Fertilizer
Tools
Construction Materials
Water
Electricity

Key Stakeholders

Farmers and Gardeners
Government Officials
Support Organizations
Funders

Financial Resources

Sales of produce
Grants
Donations
Fees for services

Support Services

Technical assistance
Advocacy and policy work
Environmental education
Networking events

Access to land and rooftops

PROJECT JUSTIFICATION

This project is important to me because I am passionate about a more sustainable future. I want our planet and its people to maintain and better their well-being. The best way to create a healthier planet is to change the course of how we treat our land. The best way to create healthier people is to provide them with food that is rich with the essential nutrients their bodies' need.

This is where urban farming contributes to both. Urban farming creates a more sustainable form of agriculture. It cuts down on the amount of land and natural resources we use, it creates and utilizes renewable energy sources, and builds a more practical future. By farming locally, we cut out the unnecessary pesticides and chemicals and are no longer required to harvest crops well before their time for transportation purposes. This provides the people with much healthier and nutrient-rich food.

Communities can benefit from this tactic for several reasons. Like previously stated, it is creating a healthier future. These spaces can be a place for people of all ages to grow, experience nature, and become educated in basic crop sciences. Like a typical community garden, these are spaces to network and be hands on through a farm to table process.

PROJECT EMPHASIS

Design Sustainably

01

These architectural pieces should be created in a way to maximize the amount of renewable energy collected and utilized. This is important for the environment as a whole, as well as the produce being grown.

Community Connections

02

These urban farms will foster the opportunities for networking of all ages and demographics. Several opportunities are created for people to be involved in different processes or even just enjoy the spaces without being hands on.

Design for Year-Round Usage

03

Year-round usage is important because the users need access to these nutrients at all times of the year. These facilities should be in production at all times as nutrient-rich, flavorful food is needed at all times. Designing for year-round usage allows the facilities to be built in less-than-ideal climates.

Accessibility & Convenience

04

It is important that these farms are accessible to everyone. Convenience is also key. People tend to eat healthier and lead healthier lifestyles when it is easy to obtain.

Implementation of Educational Opportunities

05

'Agritecture' is the art, science, and business of integrating agriculture into the built environment. This is a term that is on the rise and will be a part of our future. Food is an important aspect of our daily lives and it is important to understand where our food comes from, how we can lead a sustainable future while implementing technological advances, and maintain the health and wellbeing of ourselves and the environment.

MAJOR PROJECT ELEMENTS

When it comes to the program, there are several overlapping elements. Some of the commonalities consist of numerous spaces as well as attributes to be implemented.

SPACES

- crop beds, growing structures, greenhouse
- waste, green waste, composting and recycling
- bulk materials storage
- tool and facilities storage
- produce washing and packing stations
- aquaculture

ATTRIBUTES

- greywater system
- water storage cisterns
- water harvesting system
- irrigation system
- solar energy collection system and converter

community center

- children's garden beds
- nature paths, park, play area
- areas of refuge
- water features, koi ponds,
- pollinator patches
- cooking demonstration areas

mixed-use building

- areas of refuge
- work and hangout nooks
- adequate circulation

marketplace

- secluded farms
- viewing gallery
- individual vendor spaces
- consumer circulation

institutional

- research laboratory
- demonstration booths
- nature paths
- work nooks, areas of refuge

USER / CLIENT DESCRIPTION

This thesis project is constructed to serve both the people and the planet.

With numerous projects taking place in an urban setting, the overall goal is to serve the community. Each facility does its part to contribute and give back in their own ways.

community center

- HOBBYISTS
- WORKERS / SPECIALISTS
- FAMILIES
- COUPLES
- SINGLES

mixed-use building

- RESEARCHERS
- TENANTS

marketplace

- SHOPPERS
- STORE WORKERS
- FARM SPECIALISTS

institutional

- STUDENTS
- FACULTY
- RESEARCHERS

GOALS OF THE THESIS PROJECT


figure 6.1

Theoretical Goals

Generate a project that stresses the importance of a research-based design that utilizes my previous educational knowledge. 01

Create a primary example, future designers and architects can reference when moving forward with more sustainable vertical farming practices 02

Provide various solutions of how these urban farms can take shape – stand-alone, attached to other buildings, inside markets, etc. 03

Physical Goals

Design indoor urban farms that are sustainable and can be maintained year-round in less suitable agricultural climates 01

Create solutions that do not harm current architecture but instead contribute to the future 02

Social Goals

Create a contribution to the community through the proposed urban farms 01

Educate people on the importance of the future of our environment, the future of food, and how architecture can play a role in that 02

Personal Goals

Get 8 hours of sleep per night! Maintain a consistent bedtime and wakeup schedule. 01

Eat healthy and get outdoors even when school gets hard! 02

Make time to be social with friends and family. 03

PLANS FOR PROCEEDING

Definitions of Research Methods

unifying idea

To research for the unifying idea, a future of food and farming through architecture, we must understand the timeline. We need to know how we started, where we are now, and where we can go from here with architecture and urban planning as the solution. To create healthier people and a healthier planet, the necessary research is needed in these categories.

project typology

Researching the project typology will be done through various case studies. Because the proposal includes several different design typologies, there are also different case studies that apply to either one, multiple, or all ideas. Through this research, data was collected regarding scale, technology, amenities, and other specific traits to each proposed design. This data will aid in guiding the architecture to successfully serve the people and the planet.

historical context

To understand the historical context, it is important to research the beginning of traditional agriculture and where we are now. Understanding how traditional agriculture works and what the downsides of it in today's world is important in designing for the future. It is also important to research climate change, issues with natural resources, and other factors related to what makes traditional agriculture harmful.

site analysis

Site analysis for this project will be done virtually. Research will be done through scholarly articles that provide data related to urbanism, green spaces, and agricultural trends locally and nationally. Sites within the project vicinity will be chosen through research done with the geographical information system (GIS) and other land survey programs.

programmatic requirements

The programmatic requirements are based on several factors. The first set of requirements is found through researching what vertical farming needs to function. Another set based on the activities taking place in these facilities. And furthermore, investigating how to make the architecture more sustainable and what contributions it can make to the urban environment.

Plan for Design Methodology

One of the most utilized methodologies for this design proposal was case studies. Numerous case studies were found and analyzed. There will be special attention to how these buildings function and how these can be accomplished in a sustainable manner, what amenities they house, and what they contribute to the community.

Experimental research will be conducted to contribute data comparing nutrients in a select produce of a store-bought setting versus the content found in a locally grown hydroponic setting. This scientific experiment will measure the different values of nutrients, vitamins, and chemicals found on the produce. This will be conducted in a sterile and controlled environment. The hydroponic system will be a documented process as well to make general observations. This experiment is the premise of why architecture for food should be our future.

Case studies, journal articles, and all other precedent studies will be analyzed and documented in various forms of narrative, images, charts, and diagrams. These different sources of information come together to build the basis of design and the direction of the final project.

Plan for Documenting the Design Process

documentation of activities

Through readings and case studies, the necessary activities to make these spaces function were identified. These activities are based into different categories based on the different clients and users specified. **WHAT?**

These activities are to be determined throughout the research and design phases. **WHEN?**

These activities are recorded in numerous working documents. **HOW?**

documentation of spatial design elements

Once the activities are identified, the spacial programming and space-specific elements are to be determined. **WHAT?**

The spatial design elements are recorded after the activities are solidified. **WHEN?**

These elements are input into the working documents and eventually take diagram form throughout further research and design. **HOW?**

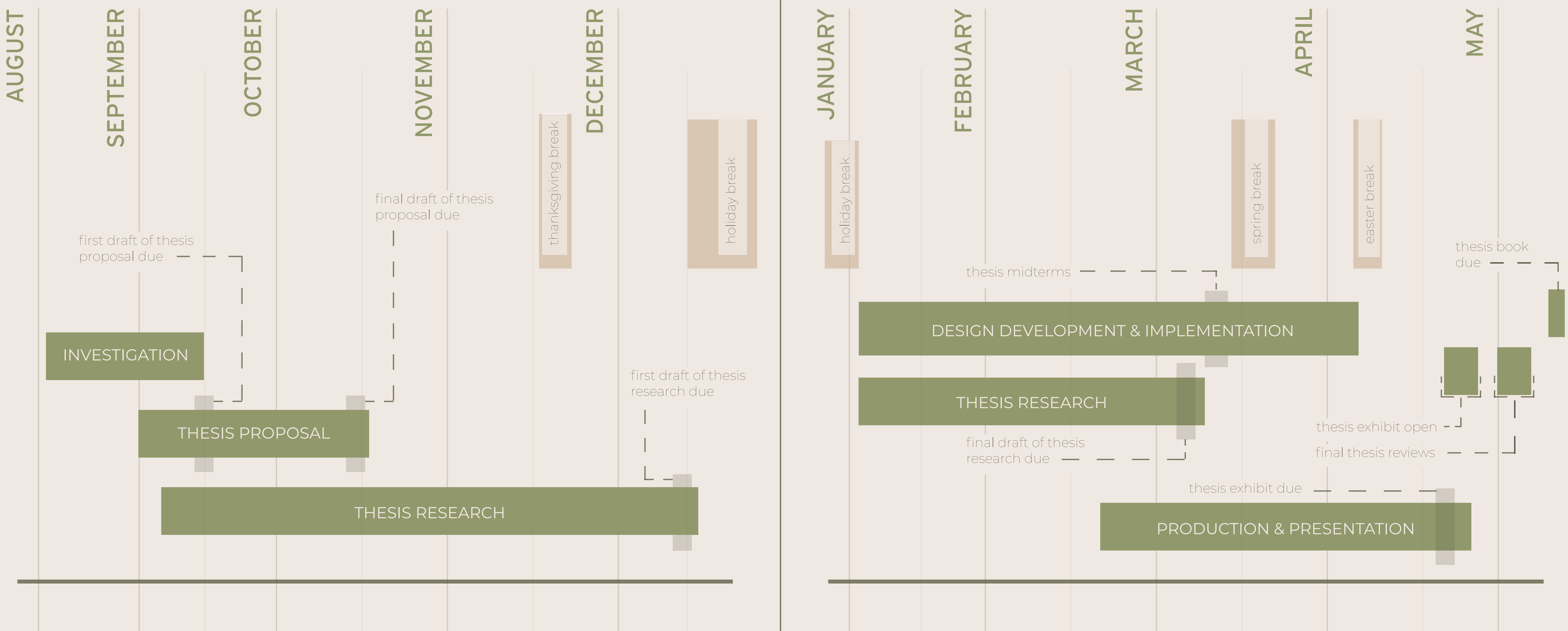
documentation of final design

The final design implementation will be documented in various ways. There will be physical documentations as well as virtual items. All items will be created with the aid of several software engines. **WHAT?**

The different methods of deliverables will be determined as design progresses **WHEN?**

There will be physical deliverables, boards and more, to be on display prior to presentation and to supplement the presentation. Virtual documents include project boards, and the thesis book to be posted to the NDSU repository. With the aid of VR, there will also be a three-dimensional project space. **HOW?**

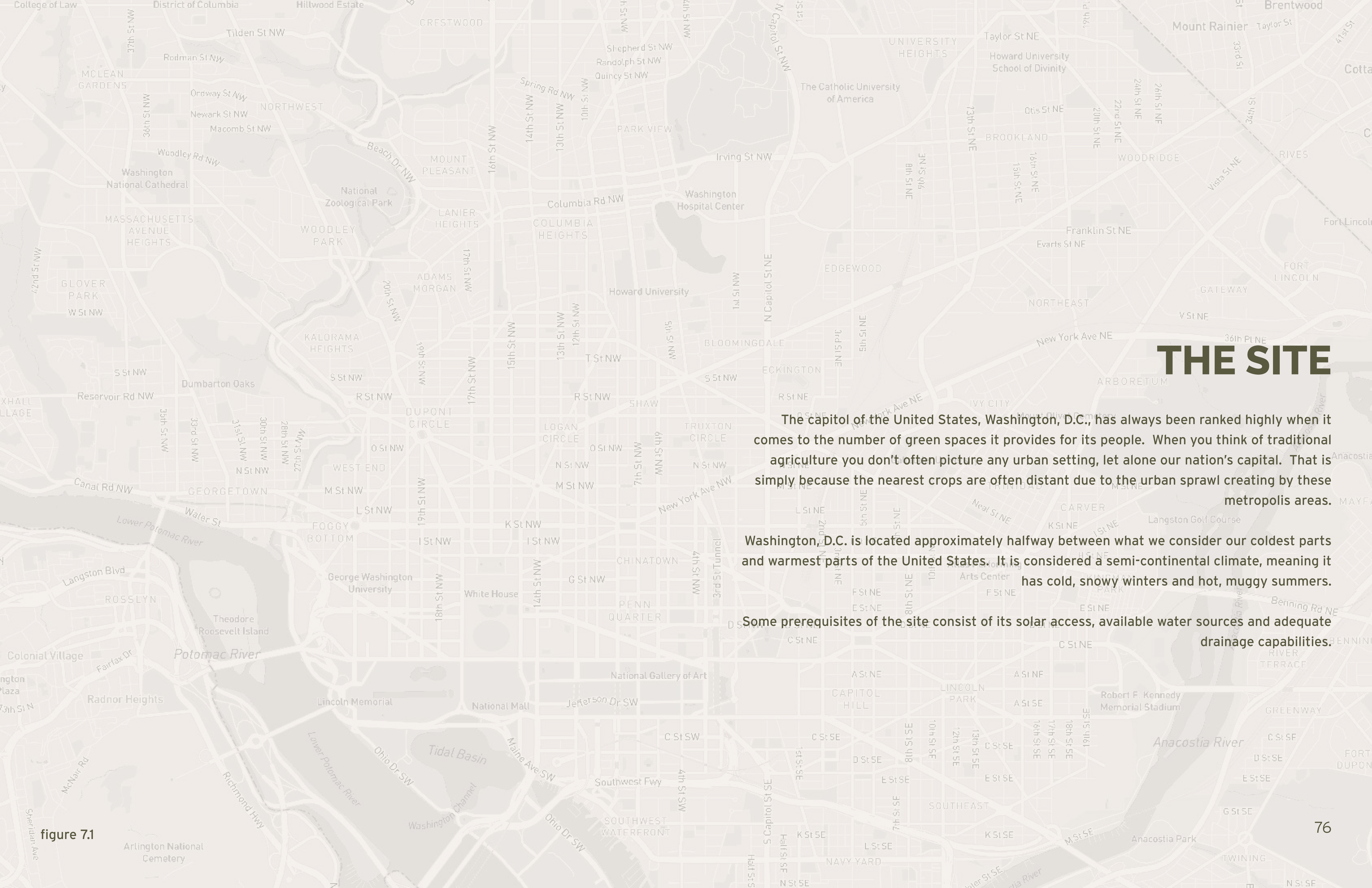
Project Schedule



FALL SEMESTER 2022

SPRING SEMESTER 2023

02 THE RESEARCH



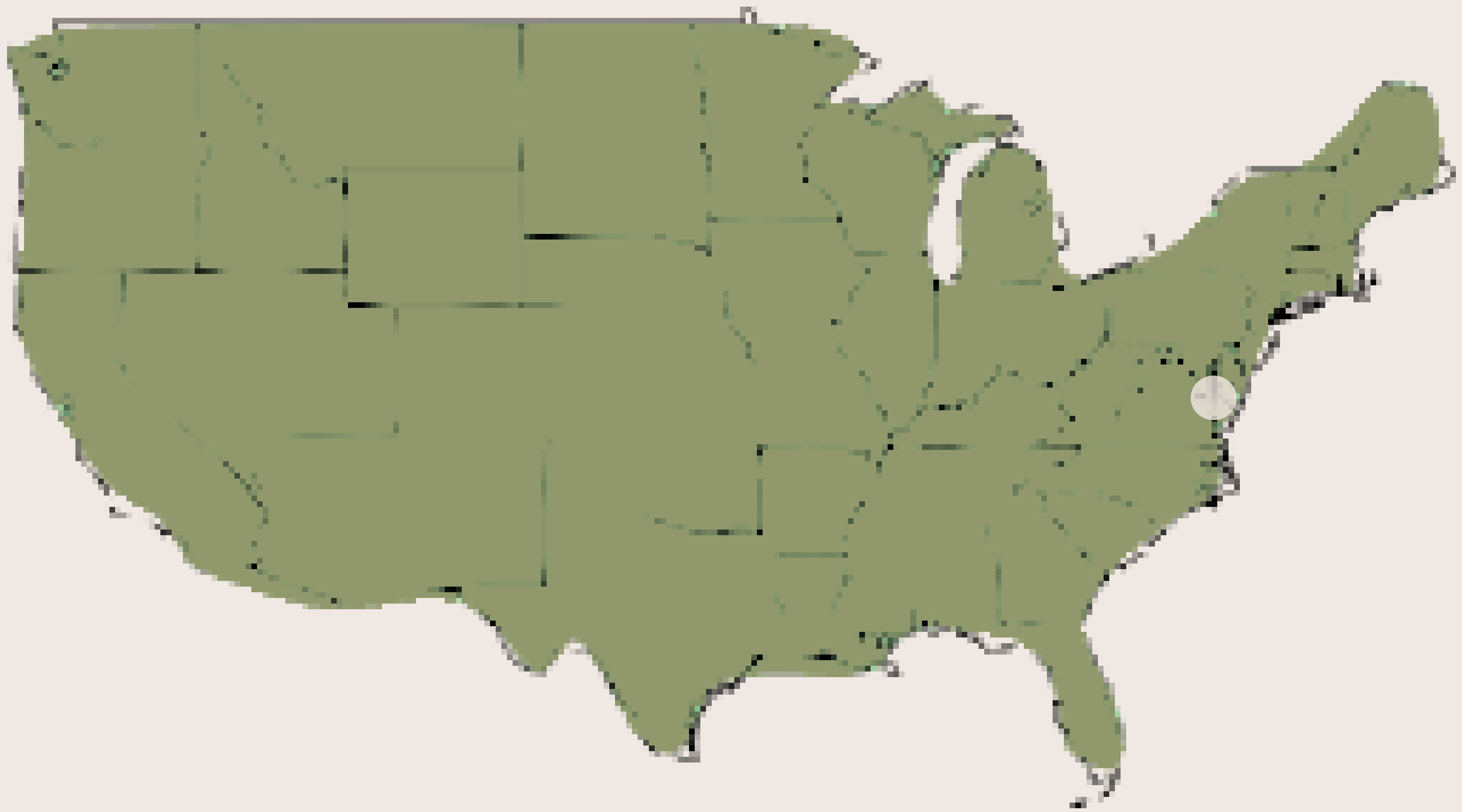
THE SITE

The capitol of the United States, Washington, D.C., has always been ranked highly when it comes to the number of green spaces it provides for its people. When you think of traditional agriculture you don't often picture any urban setting, let alone our nation's capital. That is simply because the nearest crops are often distant due to the urban sprawl creating by these metropolis areas.

Washington, D.C. is located approximately halfway between what we consider our coldest parts and warmest parts of the United States. It is considered a semi-continental climate, meaning it has cold, snowy winters and hot, muggy summers.

Some prerequisites of the site consist of its solar access, available water sources and adequate drainage capabilities.

figure 7.1



Washington, D.C. is the ideal city to accept this huge stride forward. The United States Green Building Council released that it is the first ever LEED Platinum City in the World. This city is also home to the Department of Energy and Environment. The Clean Energy DC Act (2018) is the most aggressive climate change legislation and is the first 100% renewable energy bill in the nation. These are just the surface of what this city represents when it comes to a greener future. This thesis project is taking this city and its policies to the next level of sustainability, agriculture, and architecture.

QUICK FACTS

population

701,974

density

10,984 people per square mile

parks

643+

parkland

7,800 acres

THE NUMBERS

#1 city for public transit

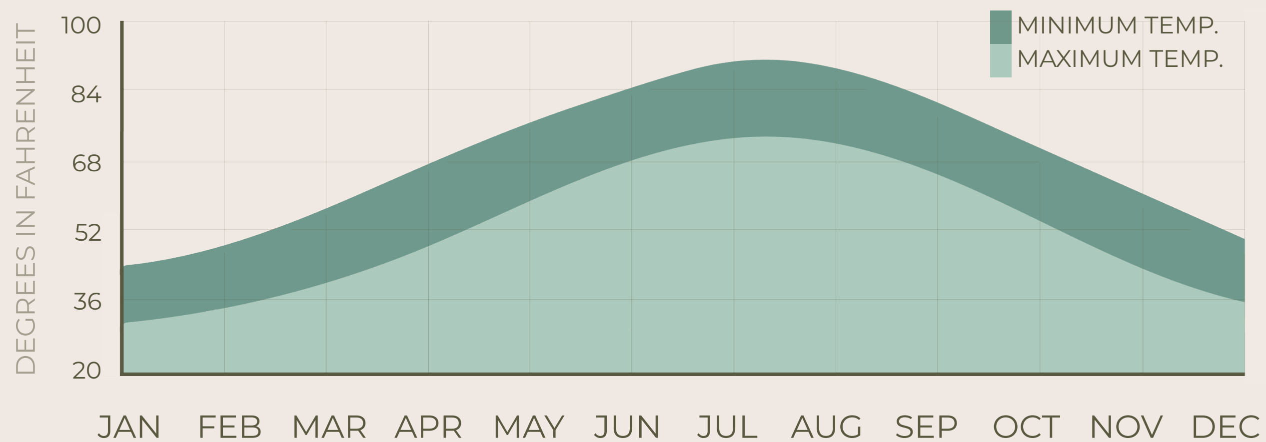
#3 greenest city in america

#1 city with access to farmers' markets

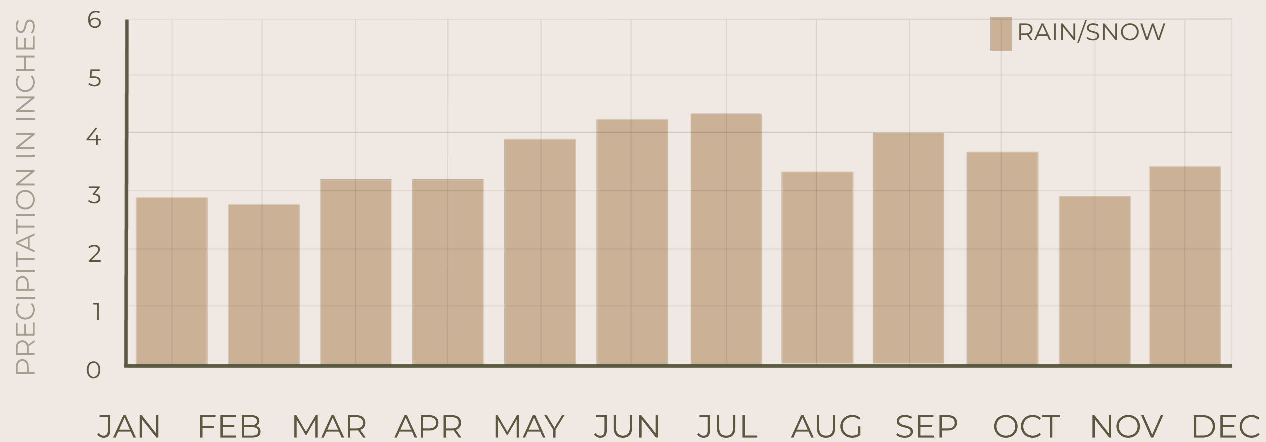
35+ organizations that focus on sustainability

CLIMATE DATA & DEMOGRAPHICS

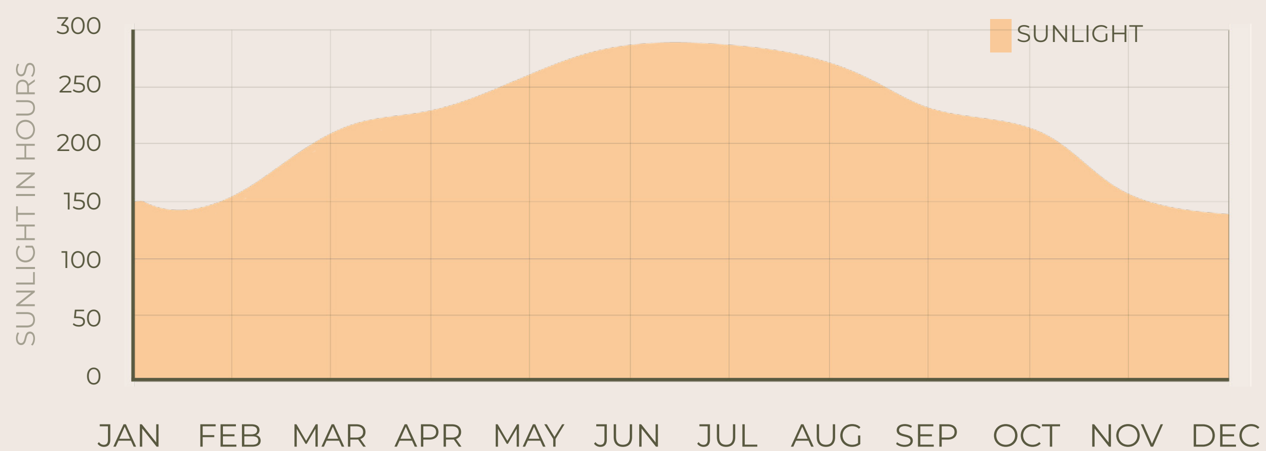
AVERAGE TEMPERATURES

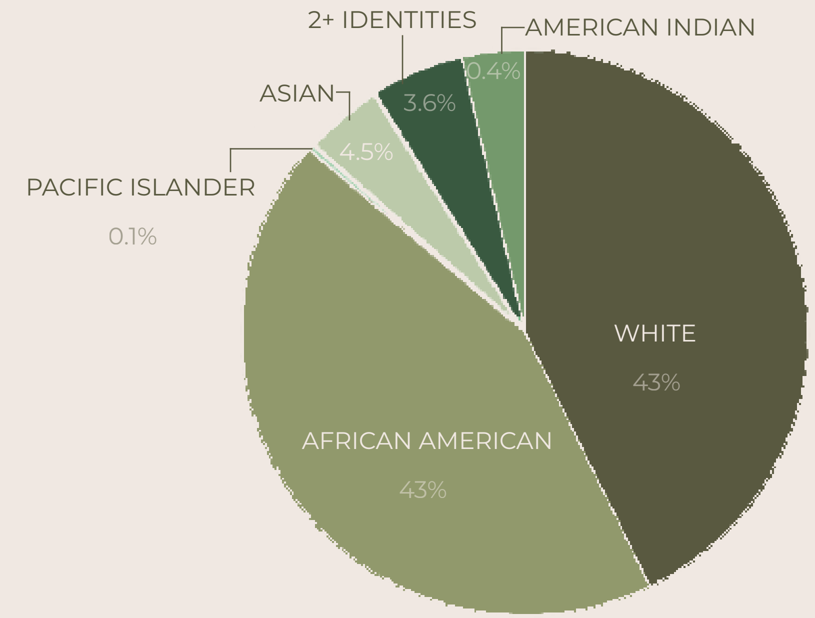


AVERAGE PRECIPITATION

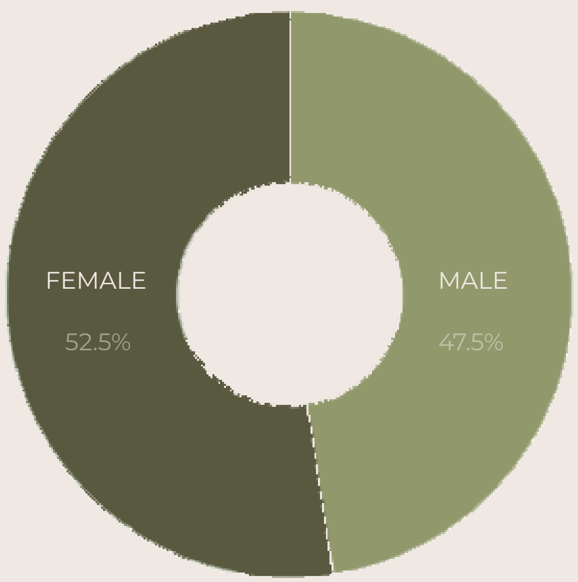


AVERAGE SUNLIGHT

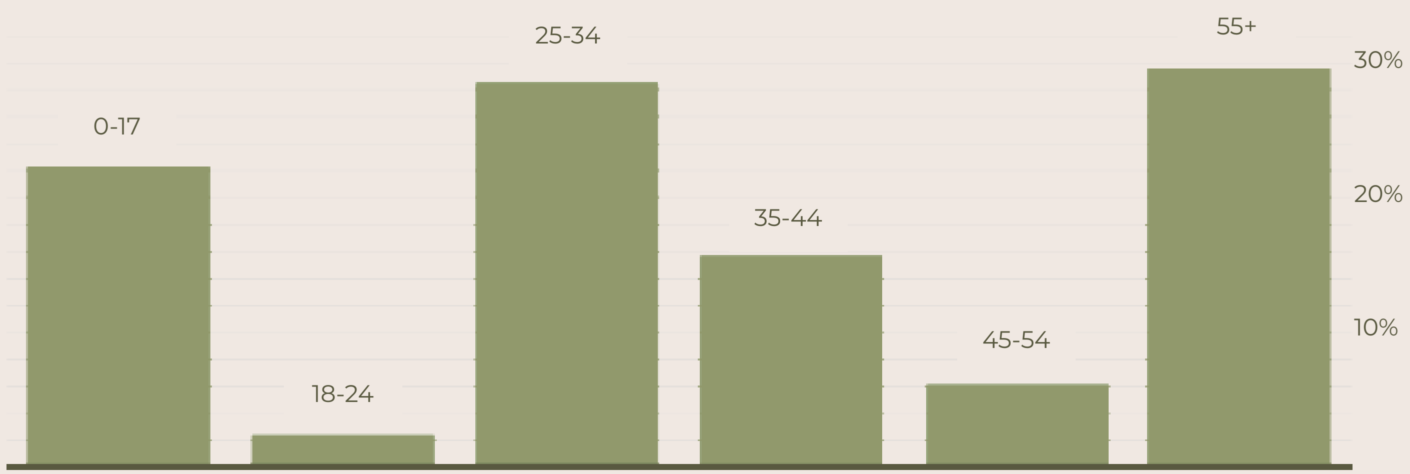




POPULATION BY RACE (%)



POPULATION BY GENDER (%)



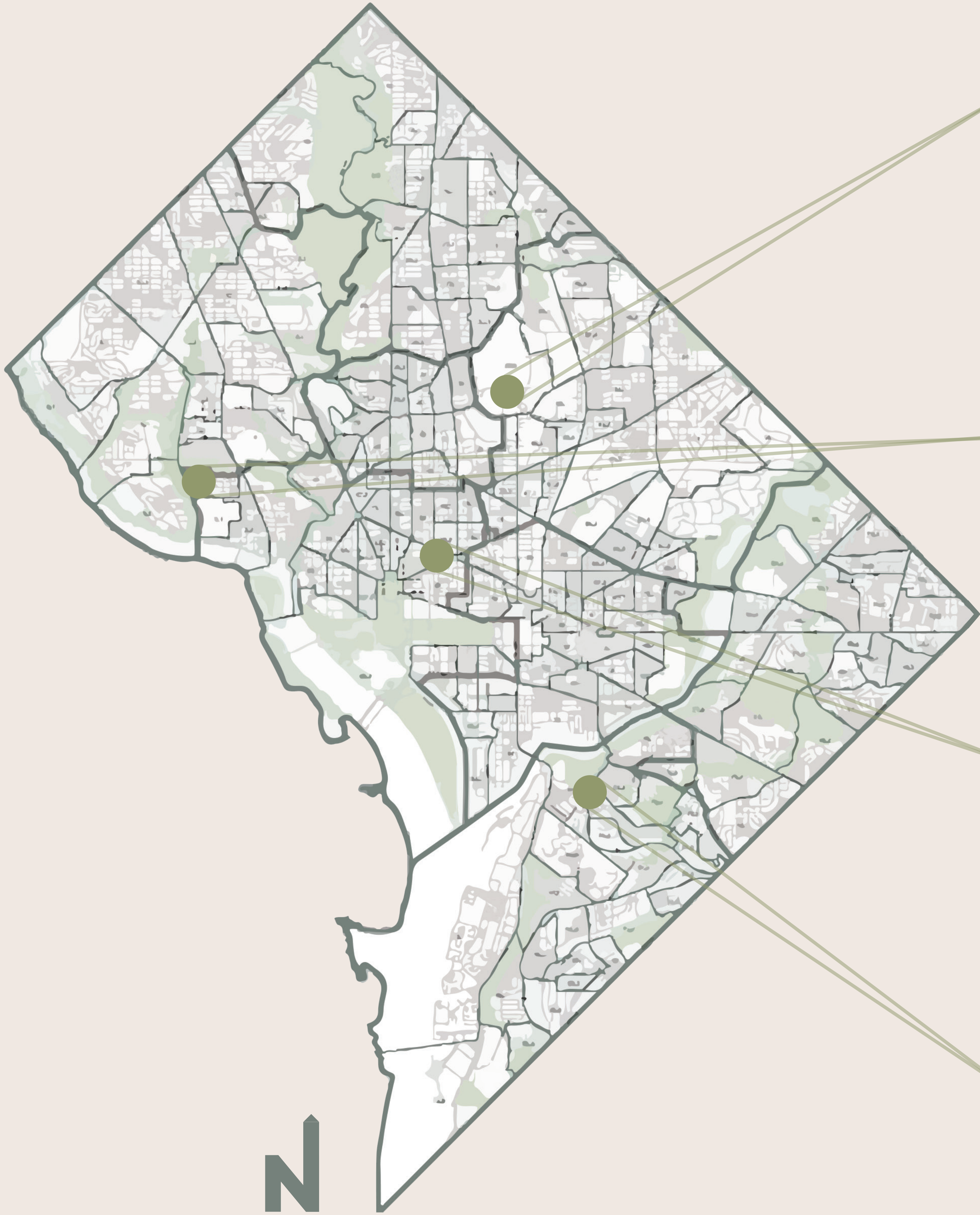
POPULATION BY AGE (%)

HOUSEHOLDS	FAMILIES
316,586 HOUSEHOLDS	131,238 FAMILIES
AVERAGE HOUSEHOLD SIZE	HOUSEHOLDS WITH CHILDREN
2.060 PERSONS	63,900 HOUSEHOLDS (20%)

HOUSEHOLD DATA

figure 7.2

figure 7.3



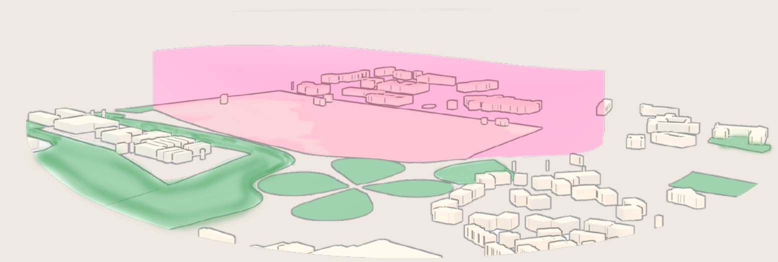
COMMUNITY COMPLEX

overview

50.00 ACRES

WARD 5

UNZONED PARCEL(S)



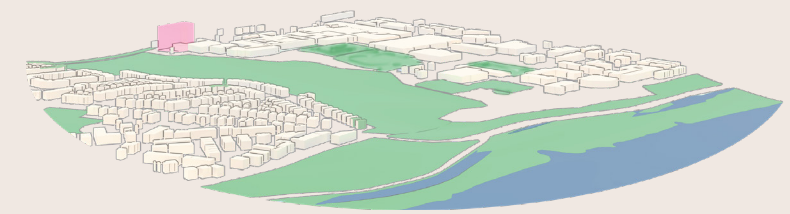
INSTITUTIONAL GARDENS
satellite location 1

overview

1.25 ACRES

WARD 2

R-3 ZONING



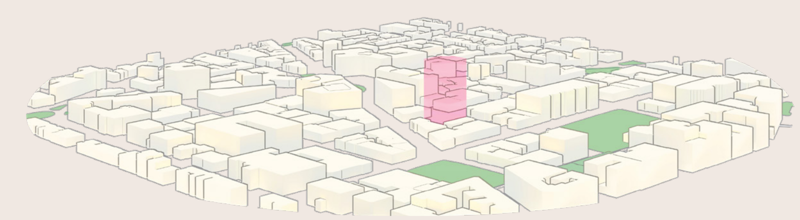
MIXED-USE FACILITY
satellite location 2

overview

0.50 ACRES

WARD 6

D-6 ZONING



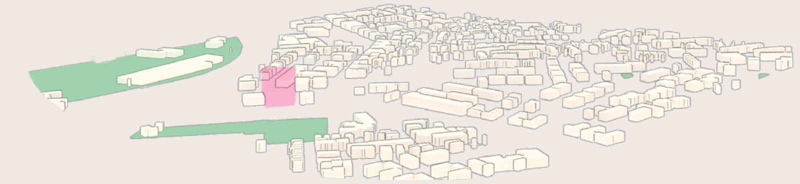
MARKETPLACE FARMS
satellite location 3

overview

1.00 ACRES

WARD 8

MU-14 ZONING



(ALL VIEWS TAKEN FROM SOUTHWEST)

COMMUNITY COMPLEX

3850 HAREWOOD ROAD NE

figure 7.4

INSTITUTIONAL GARDENS

4010 RESEVOIR ROAD NW

figure 7.5

MIXED-USE FACILITY

1400 L STREET NW

figure 7.6

MARKETPLACE FARMS

1101 HOWARD ROAD SE

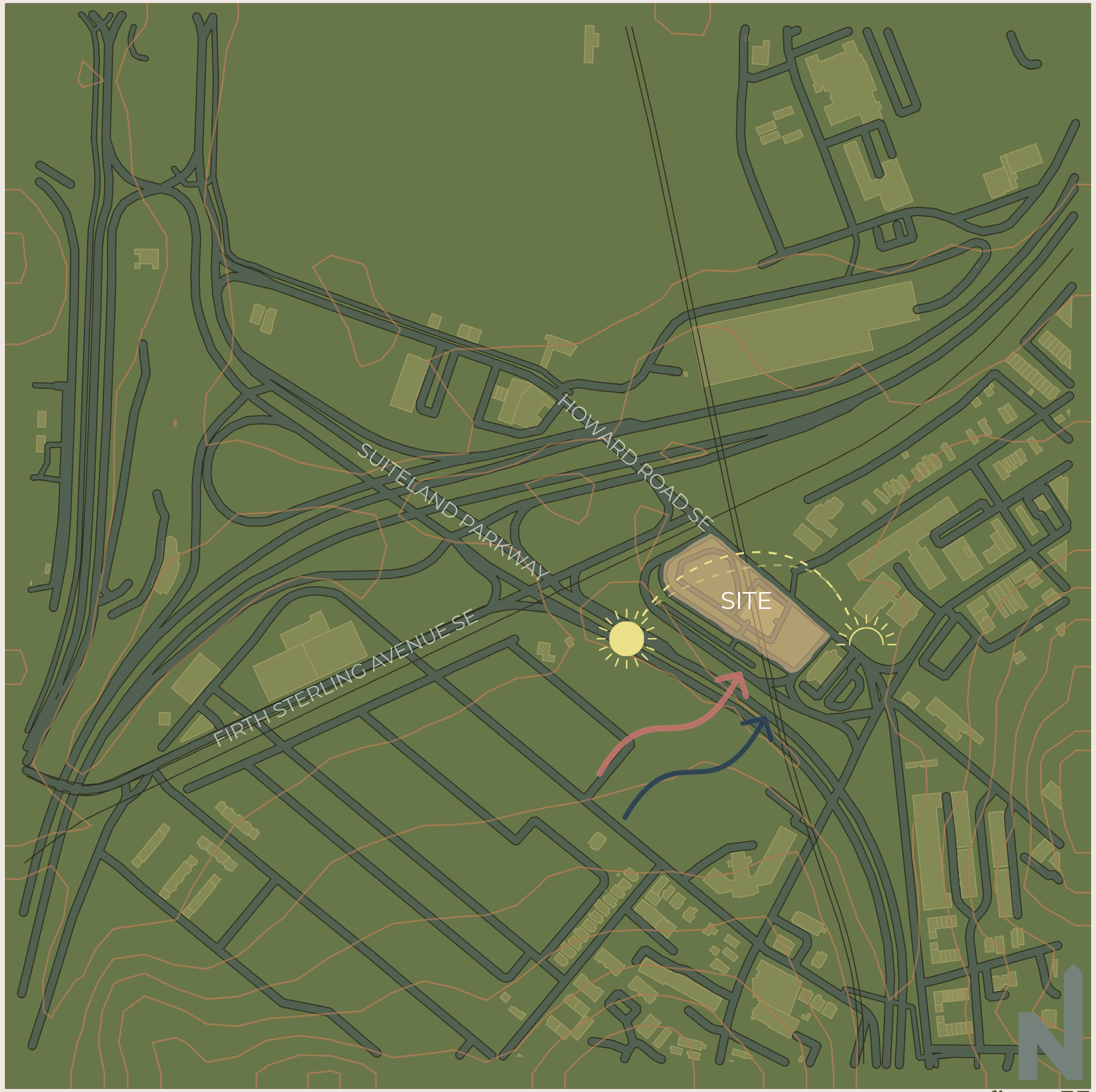
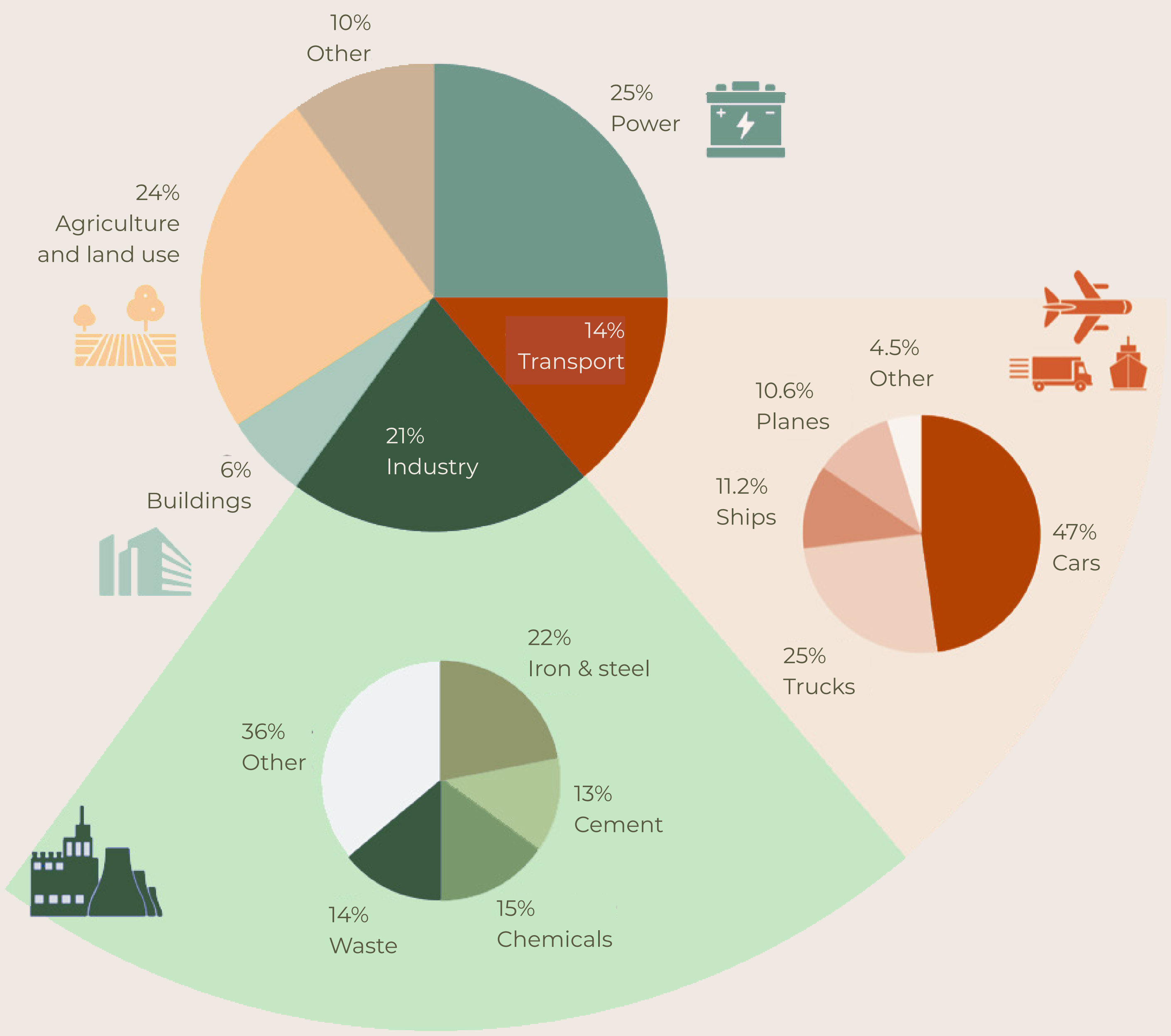


figure 7.7

CONTEXT

SOCIAL | CULTURAL | HISTORICAL

Our society has been struggling to combat climate change for years. Climate change has been harming our planet and our people since the beginning of settlement. A large portion of what leads to climate change is the world's carbon emissions. Each sector of global emissions relates back to the harmful impacts of traditional agriculture from the land use to transport to power to waste and more.



GLOBAL EMISSIONS BY SECTOR

figure 8.1

CULTURAL

Traditional crop and till agriculture is rooted deeply in American culture. Agriculture was first developed over 12,000 years ago and has seen many forms since, ranging from hunter-gatherer to permanent farm settlements.

Agricultural education has come to recognize the value of embracing a multicultural attitude and the need for recruitment of culturally diverse individuals. A multicultural approach allows for individuals of all backgrounds to teach and learn from each other of their differences when it comes to agriculture.

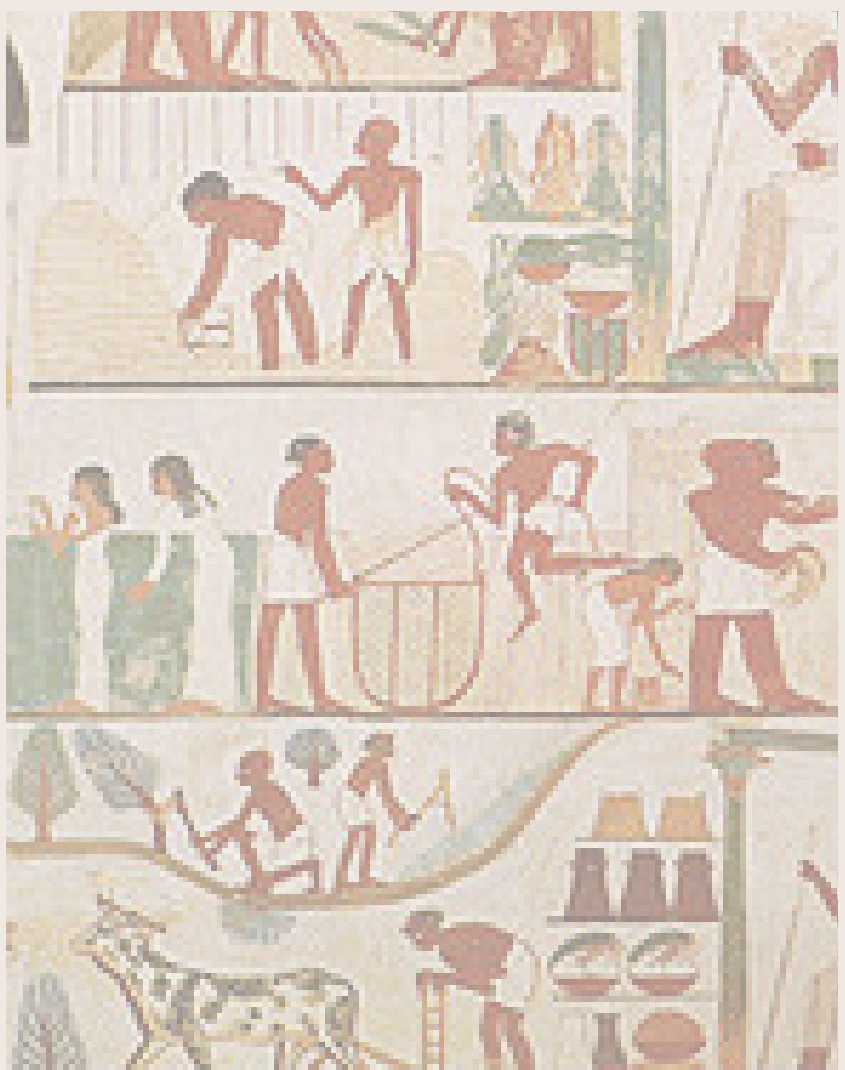


figure 8.2

HISTORICAL

NEOLITHIC — 8000 BCE
- SETTLED FARMING

ANCIENT AGE — 3000 BCE
- ROMAN GARDENS
- SACRED LANDS DEVOTED TO AGRICULTURE
- HANGING GARDENS OF BABYLON
- EGYPTIAN GARDENS

MEDIEVAL AGE — 476 CE
- HORTUS
- TOWN GARDENS
- JAPANESE GARDENS
- ARABIC GARDENS
- MONASTIC GARDENS

MODERN AGE — 1492 CE
- TROPICAL GREENHOUSES
- LANDSCAPE ARCHITECTURE
- ENGLISH GARDENS
- BOTANICAL GARDENS
- FRENCH & ITALIAN GARDENS

CONTEMPORARY AGE — 1789 CE
- Z-FARMING
- BUILDING-INTEGRATED AGRICULTURE
- AQUAPONICS
- VERTICAL FARMS
- COMMUNITY GARDENS
- ALLOTMENT GARDENS
- GARDENS IN INDUSTRIAL REGIONS

SPATIAL PROGRAMMING & PERFORMANCE CRITERIA

Executive Summary

The goal of this thesis project is to utilize architecture for food production to create healthier environments for both people and the planet. A large portion of this project is based on sustainability and community. To determine if these aspects are accomplished there will be performance criteria in place. The various performance criteria are established in compliance with The WELL Building Standard™ and the Living Building Challenge℠. To uphold these standards, there are also performance periods required by them to receive the certifications after construction.

energy consumption

Energy consumption can be estimated in simulation software. Real-time energy consumption is measured through metering systems. These hypothetical systems are to be installed during construction and track the amount of renewable energy that is obtained and stored. These systems also track how much energy is utilized on a daily basis by the essential functions of the facility. This specific criterion will be met if the renewable energy sources can provide for a set amount of the energy needed to keep the facility as energy clean as possible.

environmental performance

In order for these structures to perform their necessary functions, the facilities must maintain a balanced ecosystem that is appropriate for the program's needs. LEDs and natural daylighting will provide the required lighting. Thermal qualities will be controlled and measured through technological gauges. Appropriate software, like Autodesk Insight, can predict the ecosystem's performance. For example, we can track how well the materials used can maintain thermal heat. All of these performance criteria will be declared successful if they perform in unison and help the environment within the structures thrive and provide the necessary inputs into each space.

environmental impact

Environmental impact is measured in terms of carbon footprints and other unsustainable aspects. This performance can be obtained through equations and calculations that compare traditional agriculture's impacts versus those of vertical agriculture's impacts. These impacts would consist of the environmental impacts brought on by traveling, pesticides, water usage, infrastructure and more. This important performance criterion is met by proving that vertical agriculture harms the environment less than traditional agriculture.

behavioral performance

These facilities are performing functions at all times. However, the usage of these spaces is during a typical retail day, typically around 16 hours a day. These spaces will be equipped to provide year-round access and make contributions for the community. The facilities will be utilized for education, entertainment, recreation, and retail. To determine if these spaces meet their behavioral performance criterion, they will need to function for these set purposes. This can be tracked through observation and will be deemed successful when the building performs the essential functions at the necessary times.

code compliance

This design will be done in compliance with all required codes. The structures will follow the most recent version of the International Building Code (IBC), the Americans with Disabilities Act (ADA) Standards, and other necessary codes related to jurisdiction and zoning. This project will also be following various sustainability standards. As stated in the objective, The WELL Building Standard and the Living Building Challenge will be considered. Code compliance will be achieved and measured by the codes' respective checklists.

The WELL Building Standard

Y	?	N	Weight	ID	Part Name	
AIR						**0 POINTS**
Y			Required	A01.1	Meet Thresholds for Particulate Matter	0
Y			Required	A01.2	Meet Thresholds for Organic Gases	0
Y			Required	A01.3	Meet Thresholds for Inorganic Gases	0
Y			Required	A01.4	Meet Thresholds for Radon	0
Y			Required	A01.5	Measure Air Parameters	0
Y			Required	A02.1	Prohibit Indoor Smoking	0
Y			Required	A02.2	Prohibit Outdoor Smoking	0
Y			Required	A03.1	Ensure Adequate Ventilation	0
Y			Required	A04.1	Mitigate Construction Pollution	0
			2 points	A05.1	Meet Enhanced Thresholds for Particulate Matter	2
			1 point	A05.2	Meet Enhanced Thresholds for Organic Gases	1
			1 point	A05.3	Meet Enhanced Thresholds for Inorganic Gases	1
			2 points	A06.1	Increase Outdoor Air Supply	1
			1 point	A06.2	Improve Ventilation Effectiveness	0
			1 point	A07.1	Provide Operable Windows	2
			1 point	A07.2	Manage Window Use	0
			1 point	A08.1	Install Indoor Air Monitors	0
			1 point	A08.2	Promote Air Quality Awareness	0
			1 point	A09.1	Design Healthy Entryways	0
			1 point	A09.2	Perform Envelope Commissioning	0
			1 point	A10.1	Manage Combustion	0
			1 point	A11.1	Manage Pollution and Exhaust	0
			1 point	A12.1	Implement Particle Filtration	1
			1 point	A13.1	Improve Supply Air	0
			1 point	A14.1	Implement Ultraviolet Treatment for HVAC Surfaces	0

Y	?	N	Weight	ID	Part Name	
MIND						**0 POINTS**
Y			Required	M01.1	Promote Mental Health and Well-being	0
Y			Required	M02.1	Provide Connection to Nature	0
Y			Required	M02.2	Provide Connection to Place	0
			1 point	M03.1	Offer Mental Health Screening	0
			1 point	M03.2	Offer Mental Health Services	0
			1 point	M03.3	Offer Employee Mental Health Support	0
			1 point	M03.4	β Support Mental Health Recovery	0
			1 point	M04.1	Offer Mental Health Education	0
			1 point	M04.2	Offer Mental Health Education for Managers	0
			2 points	M05.1	Develop Stress Management Plan	0
			1 point	M06.1	Support Healthy Working Hours	0
			1 point	M06.2	Provide Nap Policy and Space	0
			1 point	M07.1	Provide Restorative Space	0
			1 point	M08.1	Provide Restorative Programming	0
			1 point	M09.1	Provide Nature Access Indoors	0
			1 point	M09.2	Provide Nature Access Outdoors	0
			2 points	M10.1	Provide Tobacco Cessation Resources	0
			1 point	M10.2	Limit Tobacco Availability	0
			1 point	M11.1	Offer Substance Use Education	0
			1 point	M11.2	Provide Substance Use and Addiction Services	0

Y	?	?	Weight	ID	Part Name	
LIGHT						**0 POINTS**
Y			Required	L01.1	Provide Indoor Light	0
Y			Required	L02.1	Provide Visual Acuity	0
			3 points	L03.1	Meet Lighting for Day-Active People	1
			2 points	L04.1	Manage Glare from Electric Lighting	0
			2 points	L05.1	Implement Daylight Plan	1
			2 points	L05.2	Integrate Solar Shading	1
			2 points	L06.1	Conduct Daylight Simulation	1
			1 point	L07.1	Balance Visual Lighting	0
			1 point	L08.1	Enhance Color Rendering Quality	0
			2 points	L08.2	Manage Flicker	0
			2 points	L09.1	Enhance Occupant Controllability	1
			1 point	L09.2	Provide Supplemental Lighting	0

Y	?	N	Weight	ID	Part Name	
THERMAL COMFORT						**0 POINTS**
Y			Required	T01.1	Provide Acceptable Thermal Environment	0
Y			Required	T01.2	Measure Thermal Parameters	0
			3 points	T02.1	Survey for Thermal Comfort	2
			2 points	T03.1	Provide Thermostat Control	1
			1 point	T04.1	Provide Personal Cooling Options	0
			1 point	T04.2	Provide Personal Heating Options	0
			1 point	T04.3	Allow Flexible Dress Code	0
			1 point	T05.1	Implement Radiant Heating	0
			1 point	T05.2	Implement Radiant Cooling	0
			1 point	T06.1	Monitor Thermal Environment	0
			1 point	T07.1	Manage Relative Humidity	2
			1 point	T08ß.1	Provide Windows with Multiple Opening Modes	0
			1 point	T09ß.1	Manage Outdoor Heat	0
			1 point	T09ß.2	Avoid Excessive Wind	0
			1 point	T09ß.3	Support Outdoor Nature Access	0

Y	?	N	Weight	ID	Part Name	
MATERIALS						**0 POINTS**
Y			Required	X01.1	Restrict Asbestos	0
Y			Required	X01.2	Restrict Mercury	0
Y			Required	X01.3	Restrict Lead	0
Y			Required	X02.1	Manage Asbestos Hazards	0
Y			Required	X02.2	Manage Lead Paint Hazards	0
Y			Required	X02.3	Manage Polychlorinated Biphenyl (PCB) Hazards	0
Y			Required	X03.1	Manage Exterior CCA Hazards	0
Y			Required	X03.2	Manage Lead Hazards	0
			1 point	X04.1	Assess and Mitigate Site Hazards	0
			1 point	X05.1	Select Compliant Interior Furnishings	0
			1 point	X05.2	Select Compliant Architectural and Interior Products	0
			2 points	X06.1	Limit VOCs from Wet-Applied Products	0
			2 points	X06.2	Restrict VOC Emissions from Furniture, Architectural a	1
			1 point	X07.1	Select Products with Disclosed Ingredients	0
			1 point	X07.2	Select Products with Enhanced Ingredient Disclosure	0
			1 point	X07.3	Select Products with Third-Party Verified Ingredients	0
			1 point	X08.1	Select Materials with Enhanced Chemical Restrictions	0
			1 point	X08.2	Select Optimized Products	0
			1 point	X09.1	Implement a Waste Management Plan	0
			1 point	X10.1	Manage Pests	0
			1 point	X11.1	Improve Cleaning Practices	0
			1 point	X11.2	Select Preferred Cleaning Products	0
			1 point	X12ß.1	Reduce Respiratory Particle Exposure	0
			1 point	X12ß.2	Address Surface Hand Touch	0

Y	?	N	Weight	ID	Part Name	
MOVEMENT						**0 POINTS**
Y			Required	V01.1	Design Active Buildings and Communities	0
Y			Required	V02.1	Support Visual Ergonomics	0
Y			Required	V02.2	Provide Height-Adjustable Work Surfaces	0
Y			Required	V02.3	Provide Chair Adjustability	0
Y			Required	V02.4	Provide Support at Standing Workstations	0
Y			Required	V02.5	Provide Workstation Orientation	0
			1 point	V03.1	Design Aesthetic Staircases	0
			1 point	V03.2	Integrate Point-of-Decision Signage	0
			1 point	V03.3	Promote Visible Stairs	0
			2 points	V04.1	Provide Cycling Infrastructure	0
			1 point	V04.2	Provide Showers, Lockers and Changing Facilities	0
			2 points	V05.1	Select Sites with Pedestrian-friendly Streets	0
			2 points	V05.2	Select Sites with Access to Mass Transit	0
			2 points	V06.1	Offer Physical Activity Opportunities	1
			2 points	V07.1	Provide Active Workstations	1
			1 point	V08.1	Provide Indoor Activity Spaces	0
			1 point	V08.2	Provide Outdoor Physical Activity Space	0
			1 point	V09.1	Offer Physical Activity Incentives	0
			1 point	V10.1	Provide Self-Monitoring Tools	0
			1 point	V11ß.1	Implement an Ergonomics Program	0
			1 point	V11ß.2	Commit to Ergonomic Improvements	0
			1 point	V11ß.3	Support Remote Work Ergonomics	0

KEY

Point Range

Y	?	N	Weight	ID	Part Name	
SOUND						**0 POINTS**
Y			Required	S01.1	Label Acoustic Zones	0
Y			Required	S01.2	Provide Acoustic Design Plan	0
			3 points	S02.1	Limit Background Noise Levels	1
			1 point	S03.1	Design for Sound Isolation at Walls and Doors	0
			2 points	S03.2	Achieve Sound Isolation at Walls	0
			2 points	S04.1	Achieve Reverberation Time Thresholds	0
			2 points	S05.1	Implement Sound Reducing Surfaces	1
			1 point	S06.1	Provide Minimum Background Sound	0
			1 point	S06.2	Provide Enhanced Speech Reduction	0
			1 point	S07ß.1	Specify Impact Noise Reducing Flooring	0
			2 points	S07ß.2	Meet Thresholds for Impact Noise Rating	1
			1 point	S08ß.1	Provide Enhanced Speech Intelligibility	0
			1 point	S08ß.2	Prioritize Audio Devices and Policies	0
			1 point	S09ß.1	Implement a Hearing Health Conservation Program	0

Y	?	N	Weight	ID	Part Name	
WATER						**0 POINTS**
Y			Required	W01.1	Verify Water Quality Indicators	0
Y			Required	W02.1	Meet Chemical Thresholds	0
Y			Required	W02.2	Meet Thresholds for Organics and Pesticides	0
Y			Required	W03.1	Monitor Chemical and Biological Water Quality	0
Y			Required	W03.2	Implement Legionella Management Plan	0
			1 point	W04.1	Meet Thresholds for Drinking Water Taste	0
			2 points	W05.1	Assess and Maintain Drinking Water Quality	0
			1 point	W05.2	Promote Drinking Water Transparency	0
			1 point	W06.1	Ensure Drinking Water Access	0
			1 point	W07.1	Design Envelope for Moisture Protection	0
			1 point	W07.2	Design Interiors for Moisture Management	0
			1 point	W07.3	Implement Mold and Moisture Management Plan	0
			1 point	W08.1	Provide Bathroom Accommodations	0
			1 point	W08.2	Ensure Bathroom Accommodations	0
			1 point	W08.3	Support Effective Handwashing	0
			1 point	W08.4	Provide Handwashing Supplies and Signage	0
			2 points	W09ß.1	Implement Safety Plan for Non-Potable Water Capture and Reuse	

Y	?	N	Weight	ID	Part Name	
NOURISHMENT						**0 POINTS**
Y			Required	N01.1	Provide Fruits and Vegetables	0
Y			Required	N01.2	Promote Fruit and Vegetable Visibility	0
Y			Required	N02.1	Provide Nutritional Information	0
Y			Required	N02.2	Address Food Allergens	0
Y			Required	N02.3	Label Sugar Content	0
			1 point	N03.1	Limit Total Sugars	0
			1 point	N03.2	Promote Whole Grains	0
			1 point	N04.1	Optimize Food Advertising	0
			1 point	N05.1	Limit Artificial Ingredients	0
			1 point	N06.1	Promote Healthy Portions	0
			1 point	N07.1	Provide Nutrition Education	0
			2 points	N08.1	Support Mindful Eating	0
			1 point	N09.1	Accommodate Special Diets	0
			1 point	N09.2	Label Food Allergens and Intolerances	0
			1 point	N10.1	Provide Meal Support	0
			1 point	N11.1	Implement Responsible Sourcing	0
			2 points	N12.1	Provide Gardening Space	0
			1 point	N13.1	Ensure Local Food Access	0
			1 point	N14ß.1	Limit Red and Processed Meats	0

Y	?	N	Weight	ID	Part Name	
COMMUNITY						**0 POINTS**
Y			Required	C01.1	Provide WELL Feature Guide	0
Y			Required	C02.1	Facilitate Stakeholder Charrette	0
Y			Required	C02.2	Promote Health-Oriented Mission	0
Y			Required	C03.1	Develop Emergency Preparedness Plan	0
Y			Required	C04.1	Select Project Survey	0
Y			Required	C04.2	Administer Annual Survey and Report Results	0
			1 point	C05.1	Utilize Enhanced Survey	0
			1 point	C05.2	Utilize Pre- and Post-Occupancy Survey	0
			1 point	C05.3	Implement Action Plan	0
			1 point	C05.4	Facilitate Interviews, Focus Groups and/or Observatior	0
			1 point	C06.1	Promote Health Benefits	0
			1 point	C06.2	Offer On-Demand Health Services	0
			1 point	C06.3	Offer Sick Leave	0
			1 point	C06.4	Support Community Immunity	0
			1 point	C06.5	β Provide Enhanced Health Benefits	0
			1 point	C07.1	Promote Culture of Health	0
			1 point	C07.2	Establish Health Promotion Leader	0
			3 points	C08.1	Offer New Parent Leave	1
			1 point	C09.1	Offer Workplace Breastfeeding Support	0
			2 points	C09.2	Design Lactation Room	0
			1 point	C10.1	Offer Childcare Support	0
			1 point	C10.2	Offer Family Leave	0
			1 point	C10.3	Offer Bereavement Support	0
			1 point	C11.1	Promote Community Engagement	0
			1 point	C11.2	Provide Community Space	0
			1 point	C12.1	Create DEI Assessment and Action Plan	1
			1 point	C12.2	Implement DEI Support Systems	0
			1 point	C12.3	Implement DEI Hiring Practices and Wage Equity	0
			2 points	C13.1	Integrate Universal Design	0
			1 point	C14.1	Promote Emergency Resources	0
			1 point	C14.2	Provide Opioid Response Kit and Training	0
			1 point	C15ß.1	Promote Business Continuity	0
			1 point	C15ß.2	Support Emergency Resilience	0
			1 point	C15ß.3	Facilitate Healthy Re-entry	0
			1 point	C15ß.4	Establish Health Entry Requirements	1
			2 points	C16ß.1	Allocate Affordable Units	1
			1 point	C17ß.1	Disclose Labor Practices	
			2 points	C17ß.2	Implement Responsible Labor Practices	
			2 points	C18ß.1	Support Victims of Domestic Violence	
			1 point	C19ß.1	Establish Education and Support	
			1 point	C20ß.1	Historical Acknowledgement	

Y	?	N	Weight	ID	Part Name	
INNOVATION						**0 POINTS**
			1 point	I01.1	Propose Innovation	1
			1 point	I02.1	Achieve WELL AP	1
			1 point	I03.1	Offer WELL Educational Tours	1
			1 point	I04.1	Complete Health and Well-Being Programs	0
			5 points	I05.1	Achieve Green Building Certification	5
			2 points	I06ß.1	Carbon Inventory	1
			3 points	I06ß.2	Carbon Reduction Goal	1
			3 points	I06ß.3	Carbon Reduction	0
			2 points	I06ß.4	Carbon Neutral	0

PRECONDITIONS
48 YES
0 MAYBE 100%
0 NO

OPTIMIZATION POINTS
0 YES
0 MAYBE
0 NO

Project Name:	
Date	
Enrollment type:	WELL Certification
Applicable Version:	v2 Q4 2022
Projected point total:	0
Anticipated milestone level:	Not Certified

*Subject to concept minimum points

Living Building Challenge

Sustainable Earth

ZERO CARBON CERTIFICATION

Carbon neutral with top tier efficiency.

- 100% building energy offset with on- or off-site renewables
- For existing buildings, combustion allowed
- Embodied carbon reduction reduction and offset

ZERO ENERGY CERTIFICATION

World class efficiency and characteristics, reinforcing a fossil fuel free future.

- 100% building energy offset load offset with on-site renewables, driving efficiency
- Pathway for premium off-site renewables for high energy building types.

CORE GREEN BUILDING CERTIFICATION

Responding to climate change with holistic high-performance.

Required imperatives:

1. ecology of place
4. human scaled living
5. responsible water use
7. energy+carbon reduction
9. healthy interior environment
12. responsible materials
17. universal access
18. inclusion
19. beauty+biophilia
20. education+inspiration

LIVING BUILDING CHALLENGE PETAL CERTIFICATION

One pillar of deep regenerative design built on a holistic high-performance foundation.

All Core Imperatives required as well as any additional imperatives in the area of Petal Certification: Water, Energy or Materials.

ALL CORE IMPERATIVES

water

6. net positive water

energy

8. net positive water

materials

13. red list 90%
14. responsible sourcing
15. living economy sourcing
16. net positive waste

LIVING BUILDING CHALLENGE FULL CERTIFICATION

Summit a holistic aspiration and attainment; fully restorative.

All Imperatives must be achieved to certify:

1. ecology of place
2. urban agriculture
3. habitat exchange
4. human scaled living
5. responsible water use
6. net positive water
7. energy+carbon reduction
8. net positive energy
9. healthy interior environment
10. healthy interior performance
11. access to nature
12. responsible materials
13. red list 90%
14. responsible sourcing
15. living economy sourcing
16. net positive waste
17. universal access
18. inclusion
19. beauty+biophilia
20. education+inspiration

SPACE ALLOCATION TABLES

COMMUNITY COMPLEX

	SPACE	AREA	PERCENT
indoors	vertical growing spaces	29,236	11.7%
	growing spaces for children	3,850	1.5%
	pollinator patches	2,012	0.8%
	aquaculture	2,000	0.8%
	water features	3,000	1.2%
	nature circulation+education	25,216	10.1%
	refuges	694	0.2%
	parks+playgrounds	6,850	2.7%
	demonstration areas	7,040	2.8%
	wash+pack	5,440	2.2%
	retail	12,544	5.0%
	restrooms	3,150	1.3%
	offices	7,520	3.0%
	utilities	1,080	0.4%
	bulk material storage	6,240	2.5%
	waste	2,510	1.0%
outdoors	seasonal growing spaces	5,400	2.2%
	utilities	1,550	0.6%
	circulation	110,000	44.1%
	parking	13,872	5.6%
		249,204 sq. ft	**100%**

INSTITUTIONAL GARDENS

SPACE	AREA	PERCENT
circulation	3,600	20.4%
restrooms	288	1.6%
retail	900	5.1%
demonstration spaces	1,200	6.8%
wash+pack	900	5.1%
utilities	225	1.3%
bulk material storage	400	2.3%
waste	150	0.8%
growing spaces	10,000	56.6%
	~17,663 sq. ft	**100%**

MIXED-USE FACILITY

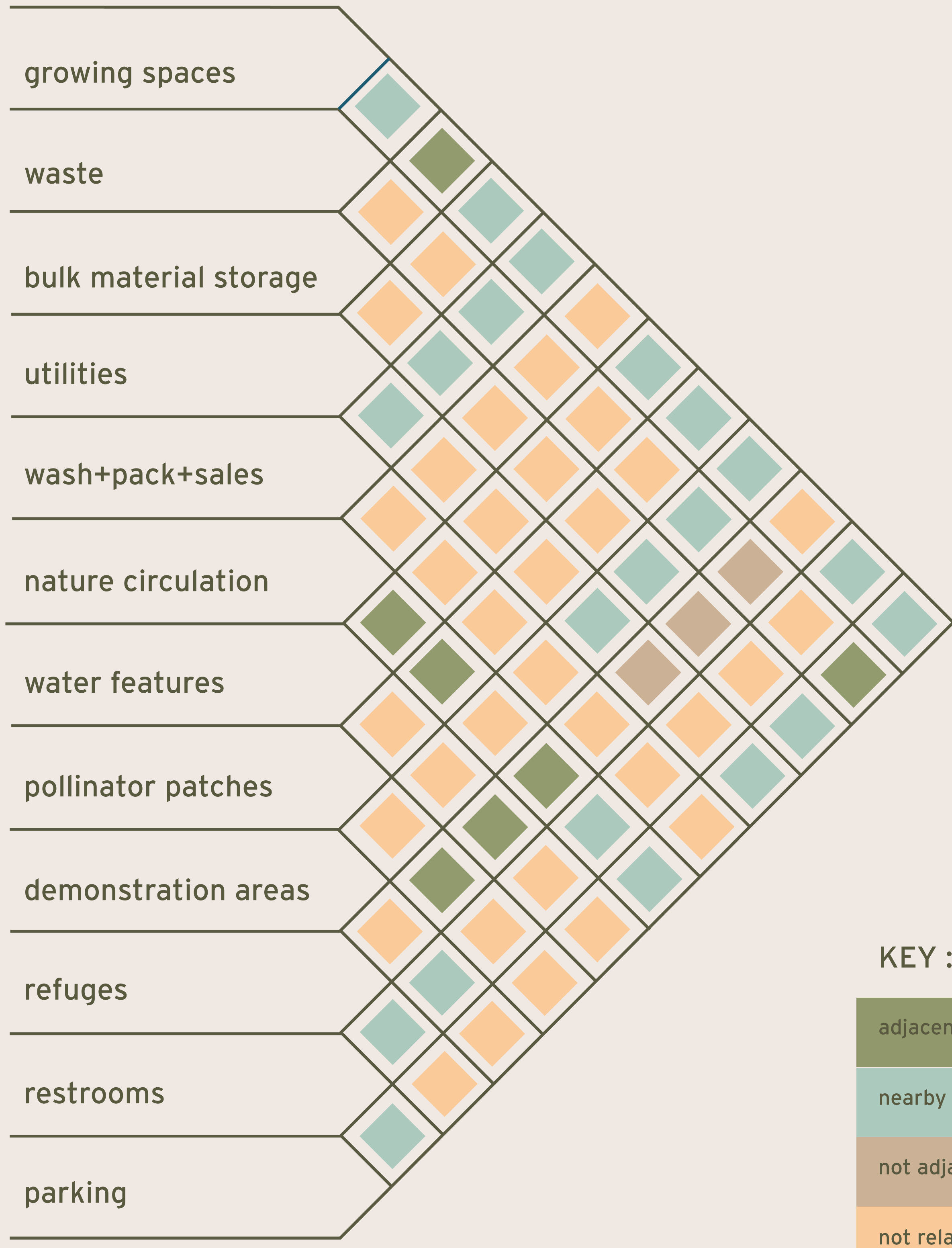
SPACE	AREA	PERCENT
circulation	1,850	13.9%
restrooms	288	2.2%
refuge	400	3.0%
retail	900	6.7%
wash+pack	600	4.5%
utilities	225	1.7%
bulk material storage	400	3.0%
waste	150	1.1%
growing spaces	8,500	63.8%
	~13,313 sq. ft	**100%**

MARKETPLACE FARMS

SPACE	AREA	PERCENT
circulation	625	4.2%
restrooms	288	1.9%
demonstration spaces	900	6.0%
retail	1,500	10.0%
wash+pack	900	6.0%
utilities	225	1.5%
bulk material storage	400	2.7%
waste	150	1.0%
growing spaces	10,000	66.7%
	~14,988 sq. ft	**100%**

SPACE INTERACTION MATRICES

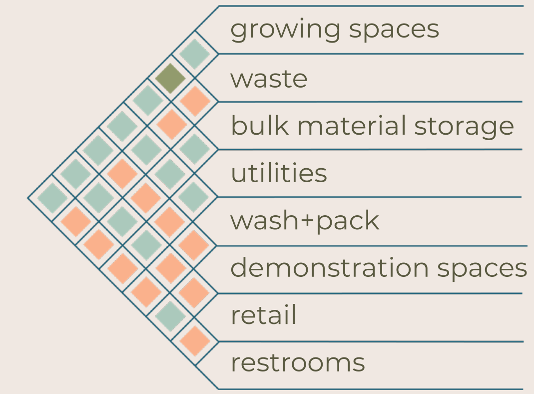
COMMUNITY COMPLEX



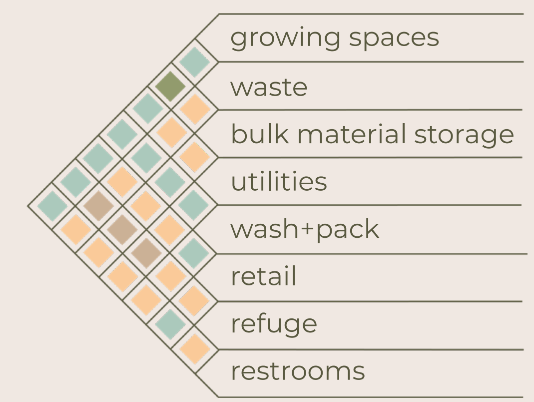
KEY :

- adjacent
- nearby
- not adjacent
- not related

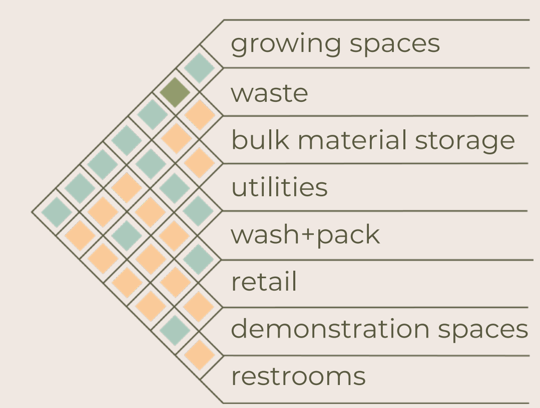
INSTITUTIONAL GARDENS



MIXED-USE FACILITY



MARKETPLACE FARMS



SPACE INTERACTION NET

INCORPORATED WITHIN:

CIRCULATION + REFUGE

POLLINATION PATHCES + KOI PONDS + WATER FEATURES

LITERATURE REVIEW

The Many Flavors of Urban Farming

HOERR SCHAUDT

The Many Flavors of Urban Farming explores the practices of urban agriculture. With today's technology we have the opportunity to manipulate several variables of urban faming on all sorts of scales. This article explores the different forms of urban agriculture.

The first is horizontal farming. Horizontal farms can be executed on both large and small scales. Large forms of horizontal agriculture in the urban setting are less common due to political and social issues pertaining to land use, ownership and maintenance through labor. On a smaller scale, we see several examples of horizontal farms in the form of community gardens and personal gardens that can manage growing small portions of food, typically fruits and vegetables. There are two typical examples of horizontal farming on the roof - rooftop gardens and rooftop greenhouses for colder climates. This approach has become more popular due to high land values and high population and building density. This can be done through intensive green roofs. This process can be more difficult and costly for existing buildings due to the roof needing to bear heavy loads. Greenhouse components can allow for higher production over longer periods of time.

A newer form of urban agriculture is vertical farming. Growing food indoors is becoming more common due to technological advances of hydroponics and aeroponics. Hydroponics is a technique that involves no soil but instead they roots grow in a nutrient rich water solution. Aeroponics a similar practice that suspends the roots in the air and they are sprayed with the nutrient rich water solution. These indoor growing techniques allow for plants to be produced year-round with maximized yields. Because vertical farms are in controlled environments, they can virtually exist anywhere on the planet.

The main reasons for urban agriculture are to produce food closer to home, reduce food insecurity and live a more sustainable life. More and more communities have now started including livestock, beekeeping, and various forms of aquaculture.

Hydroponics vs. Traditional Farming

EDEN GREEN TECHNOLOGY

Eden Green Technology posted an article comparing hydroponics and traditional farming. This article examines numerous improvements made by hydroponic systems. Vertical systems are known as the farms of the future. They allow for the production of great amounts of healthy food to feed a large amount of the human population. We will now examine some ways that hydroponic farming is making great strides compared to traditional farming.

The first improvement is greater yields. Hydroponic growing systems grow more nutrient-dense produce. The specific hydroponic vertical farms by Eden Green Technology grow approximately 240 times more crop than traditional agriculture. This is due partially to the fact that obtaining nutrients directly from water allows the plants to grow much faster and larger.

Hydroponic vertical farms also utilize far less space, and water than traditional methods. This flexibility allows for them to exist almost anywhere, whether that be a rooftop, parking lot, or within new and existing infrastructure. The possibilities are endless. As we have learned through the history of our climate and planet, land is a vital resource. When it comes to water, utilizing less than traditional farming is a big deal in today's climate. Hydroponic systems use approximately 99% less water. It is time to start prioritizing the preservation of land and water to make for a healthier environment.

Hydroponic farming is sustainable. Traditional methods contribute to soil degradation, which is causing us to lose fertile land at an alarming rate. Traditional methods also utilize massive amounts of water during dry seasons and creates a lot of uncertainty. This uncertainty leads to manipulating the natural environment in unhealthy ways. Since hydroponics do not use soil, this is an effective way to stop our soil degradation problem from getting worse. These hydroponic systems can also be designed to utilize solar power, recycled water, and other green design methods.

A self-explanatory improvement is the ability to grow in any climate at any time of the year and that these crops are seasonally agnostic. This is because these systems are indoors and have controlled environments. With these solutions, we no longer need to worry about flooding, drought, and other issues caused from the climate. These fabricated microclimates are immune to frosts and heatwaves. And without worrying about ideal soil conditions, we can harvest continuously, often times this equates to a dozen or so more harvests a year compared to a traditional farm's harvesting.

As we know, traditional farms are exposed to numerous sources of contamination. These often include birds dropping waste, and runoff from nearby animal agriculture getting into the groundwater. As with the climate in general, air and water pollution is a major concern. Because of all these contaminants, our food produced in these conditions is increasingly leading to food-borne illnesses. By closely monitoring these conditions in a controlled environment, we are reducing recalls and increasing food safety.

The last improvement is less food waste. These farms are managed within the community they contribute to. Hence, there is no longer a need for shipping produce so food has a longer shelf life. The communities the food is being produced for receives the produce within 48 hours of harvest. This makes a farm to table lifestyle a realistic option for those in dense urban areas.

GREATER YIELDS

LESS SPACE NEEDED

LESS WATER

SUSTAINABLE FARMING

CLIMATE PROOF

SEASONALLY AGNOSTIC

OUTDOOR CONTAMINANT PROOF

LESS FOOD WASTE

RESEARCH RESULTS

Food Deserts & Walkability

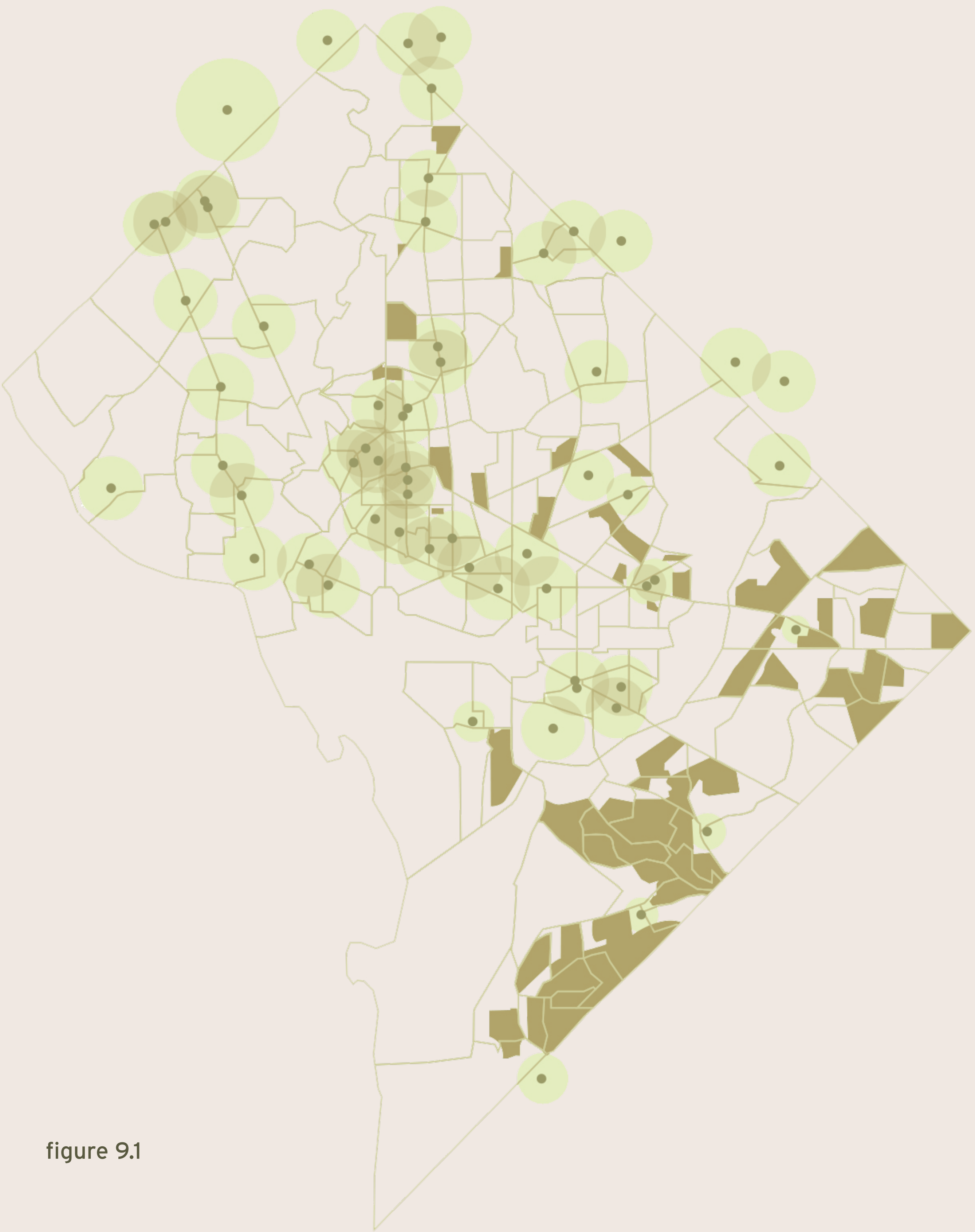


figure 9.1

Food Access & Median Income

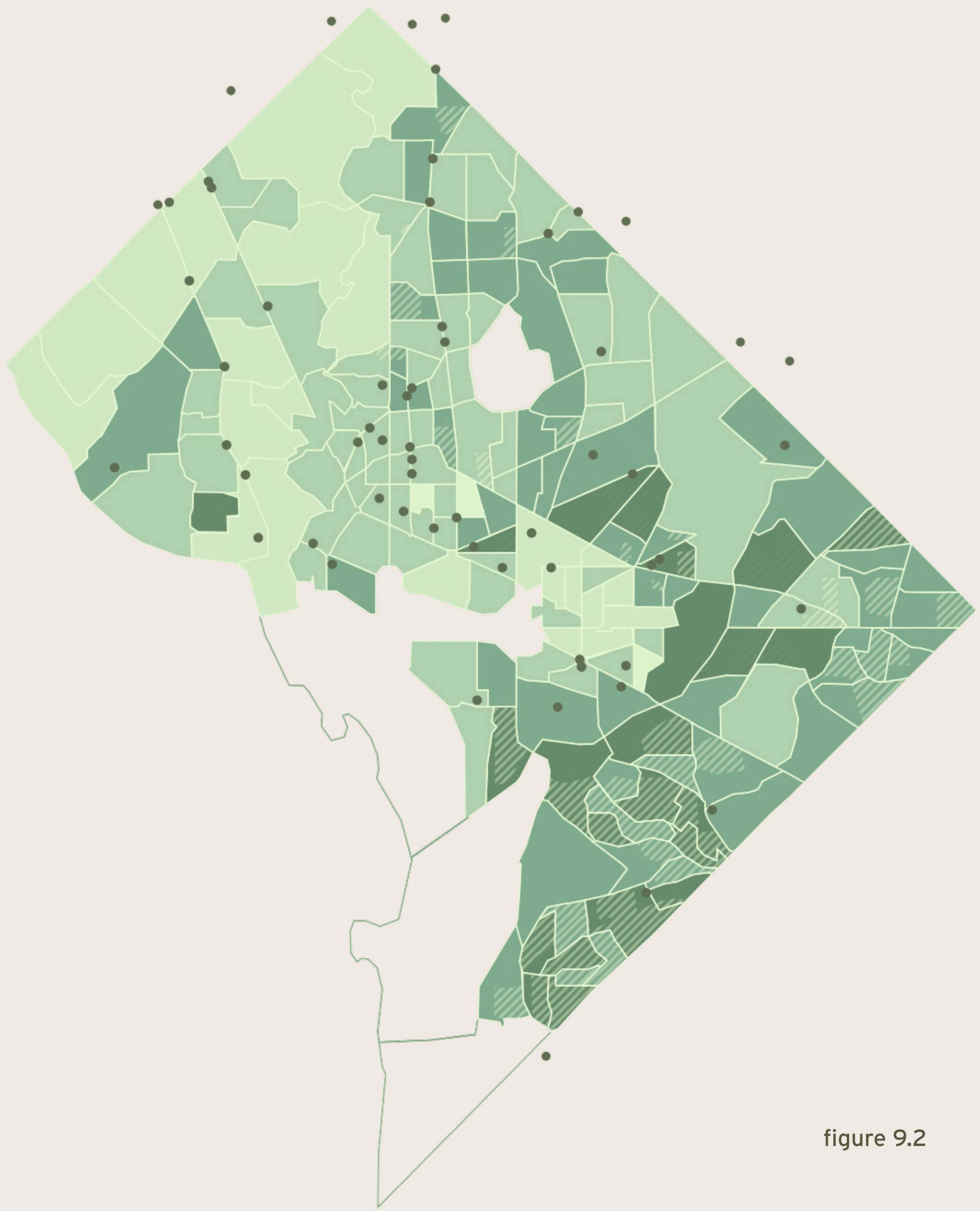


figure 9.2

Food Access & Diabetes Populations

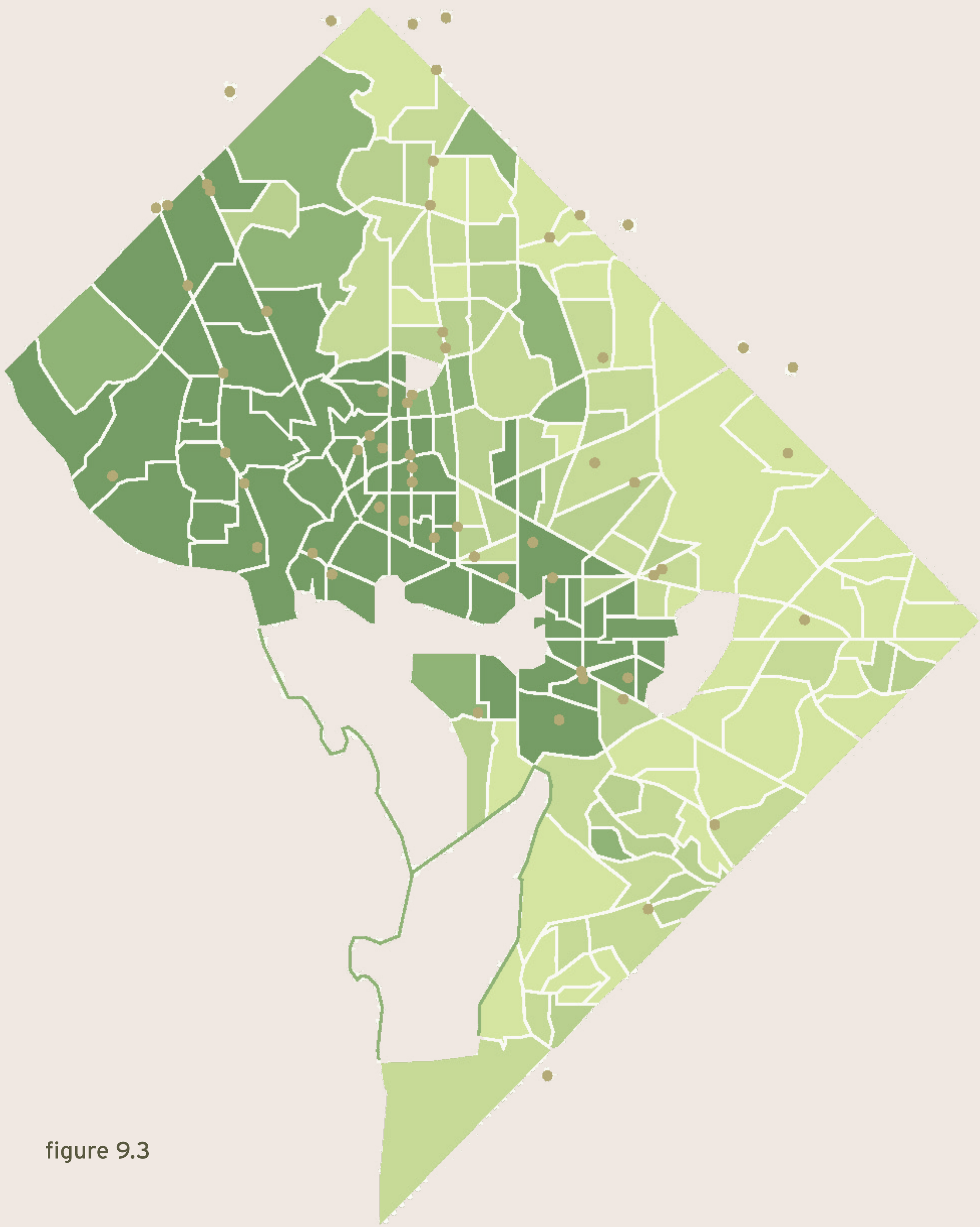


figure 9.3

The Grocery Gap was a research study completed in coordination with the city of Washington, D.C. and its residents. These location studies were done based on food accessibility and their respective topic of comparison. This first map demonstrated food deserts and walkability. The second portrayed food access and median income. And the third showed food access' correlation with the diabetes population. These three maps played a factor in determining satellite site locations.

To bread these studies down further, a food dessert is an urban area in which it is difficult to buy affordable or good quality food. In this case, we reference ½a mile as a walkable distance.

Picture this, if you live in a DC food desert you will most likely have to walk to public transit, make numerous line changes and still walk to the nearest market. "An average watermelon weighs 20 pounds, how far can you carry 20 pounds?"

Some conclusions of these three research studies include that over 40% of households have no vehicle access, household income is 185% below the poverty line, and good food should not equal dislocation, or in other words "good food is a bargain". You can also see that poverty, food access, and health conditions are in direct relation with each other.

The Food Produced by Hydroponics

BENEFITS OF GROWING ORGANIC HYDROPONICS

- prevents premature aging
- boosts immune system
- ensures safe and healthy world for future generations
- better flavor than non-organic food
- flavor can be manipulated for a more vast selection
- reduces risk of heart disease
- promotes animal welfare
- reduces presence of pesticides
- prevents cancer

Vertical Farming Market

2022

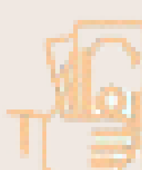
12.1 USD BILLION

2027

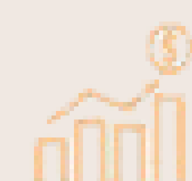
25.1 USD BILLION

The global hydroponics system market is projected to account for 25.1 billion dollars be the year 2027, growing at a CAGR of **15.6%** during the forecasted period.

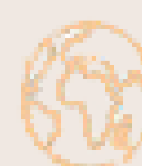
The growth of this market is attributed to the increase in demand for fresh food among the urban population across the globe.



Expansions & Investments and new product launches would offer lucrative opportunities for market players in the next five years, especially in the hydroponic equipment category.



Major manufacturers are planning to invest in and introduce new hydroponic systems and equipment. There is huge demand for automated hydroponic farm set-up.



Key players such as Signify Holding and Helios have a strong presence in Europe. These companies are expanding by adopting new innovative strategies.

BENEFITS OF LAND CONSERVATION

1. reducing air and water pollution
2. preserving open and green spaces
3. preserving fish and wildlife habitats, endangered species, and biodiversity
4. managing and protecting watersheds and wetlands
5. maintaining scenic landscapes and recreational amenities
6. preventing soil erosion and improving soil quality
7. reducing negative impacts of flooding
8. improving resilience to drought and invasive species
9. helping to sequester greenhouse gases
10. protecting sustainable capacities to produce food and fiber
11. limit fragmentation or parcelization

There are many benefits to both land conservation and creating more green spaces in our urban environments. To name a few of these benefits, both efforts aid in reducing the heat island effect, contribute positively to human health, and create a healthier outdoor environment on a planet suffering from climate change, pollution and many more dangers.

There are also advantages economically related to land conservation. Preserving and conserving natural lands can generate great financial returns and can create significant cost savings. Conserving land contributes to increasing property prices along these more desirable areas and saves tax dollars by encouraging more efficient urban developments.

Protecting land is protecting biodiversity. Biodiversity is the variety of life in the world or in particular ecosystems. Conserving the land offers habitat to numerous plants and animals, which enhances the ecosystem in a healthy, natural way. Biodiversity is a fundamental aspect for the provision of ecosystem services, which we depend on for food, air, and water security, to name a few. Many people believe that biodiversity not only contributes to the living outdoor environment but also humans.

By partaking in land conservation we are contributing to a world that is healthier for the people and the planet.

figure 9.4

VERTICAL FARMING & TRADITIONAL FARMING

TRADITIONAL FARMING VS VERTICAL FARMING

TRADITIONAL FARMING	VERTICAL FARMING
80% LAND IN USE	**0%** LAND IN USE
50% OF CROPS ARE UNHARVESTED	**90%** OF CROPS ARE HARVESTED
70% GLOBAL FRESH WATER USED IN SOIL-BASED FARMING	**70%-95%** LESS FRESH WATER USED FOR VERTICAL FARMING
FOOD MILES 1500 TO 2000 MILES FROM FARM TO PLATE	**LOCAL** DECREASES NEED OF FOSSIL FUELS AND ENSURES QUALITY

So why vertical? When comparing vertical methods with traditional methods, it is obvious why we should make the transition. Growing vertically uses 0% land, it yields 90% of its harvest, anywhere from 70%-90% less fresh water is required, and by growing local we decrease the need for fossil fuels and ensure the quality of our products.

By looking at this in a more visual graphic (to the right). This traditional crop takes up 3,750 square feet for a total of 1,016 plants. The same number of plants are grown in this singular vertical system, for reference, this system is less than 15 feet tall. Based on statistics, only 508 plants are harvested from the traditional crop while the vertical system will harvest approximately 914 of the plants.

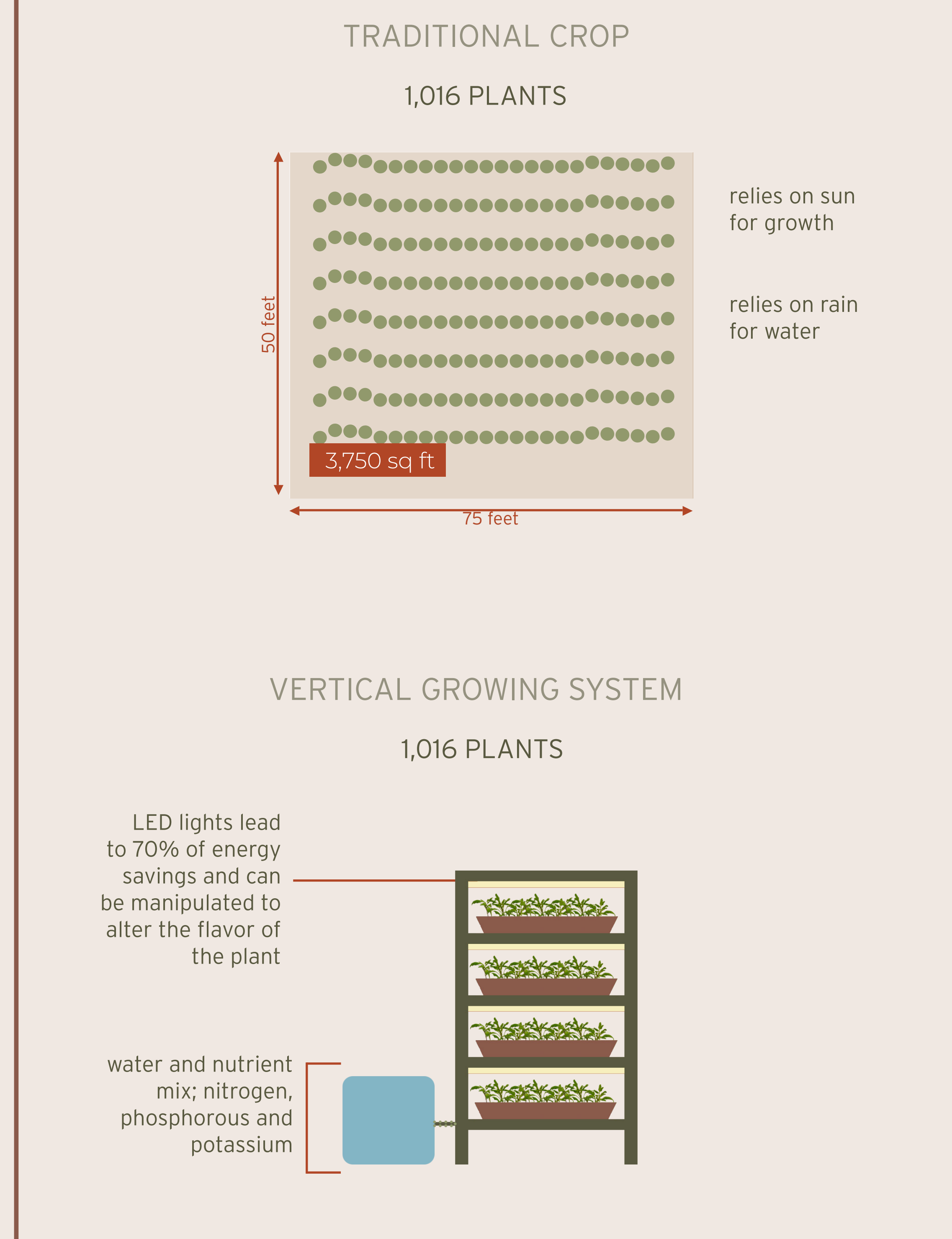


figure 9.5

Executive Summary

The research conducted in this thesis concludes that vertical agriculture is more suitable and sustainable than traditional agriculture. Vertical farming is the future and is necessary to contribute to the health of the people and the planet. There is already a 12.1 billion dollar market for vertical farming in the year of 2022 and it is projected to grow to a 25.1 billion dollar industry by the year 2027.

Agriculture has been around since the beginning of time and is constantly evolving with our cultural and societal needs. Architecture for food production is going to change our outlook on agriculture, especially in urban settings. Producing food in a controlled environment requires no land use, yields over 90% of its harvests, saves 70%-90% of water usage, and decreases the need of fossil fuels for transportation because it is locally sourced. Due to the product requiring little to no transportation, it ensures the quality and nutrition value of the food.

Implementing urban farming will also contribute greatly to the environment of our dying planet. The first set of benefits includes both land conservation and creating more green spaces in our urban habitats. To name a few of the advantages related to land conservation and green spaces, both efforts aid in reducing the heat island effect, contribute positively to human health, and create a healthier outdoor environment on a planet suffering from climate change, pollution and many more dangers.

There are numerous types of vertical farming systems. Some of these bing aeroponics, aquaponics and hydroponics. Aeroponic systems are a plant-cultivation technique in which the roots hang suspended in the air while nutrient solution is delivered to them in the form of a fine mist. An aquaponic system is a system of aquaculture in which the waste produced by farmed fish or other aquatic animals supplies nutrients for plants grown hydroponically, which in turn purify the water. Lastly, hydroponics is a type of horticulture and a subset of hydroculture which involves growing plants, usually crops or medicinal plants, without soil, by using water-based mineral nutrient solutions.

When it comes to site research, the capitol of the United States, Washington, D.C., has always been ranked highly in terms of the number of green spaces it provides for its people. When you think of traditional agriculture you don't often picture any urban setting, let alone our nation's capital. That is simply because the nearest crops are often distant due to the urban sprawl created by these metropolis areas.

Some prerequisites of the physical site consist of its solar access, available water sources and adequate drainage capabilities. Social prerequisites are already in existence. Washington, D.C. is home to some of the country's worst food accessibility issues. Looking at *The Grocery Gap*, there are numerous issues relating food accessibility with the numerous food desserts, the vast diabetes population, and the below average median income.

Washington, D.C. is the ideal city to accept this huge stride forward. The United States Green Building Council released that it is the first ever LEED Platinum City in the World. This city is also home to the Department of Energy and Environment and the Department of Agriculture. The Clean Energy DC Act of 2018 is the most aggressive climate change legislation and is the first 100% renewable energy bill in the nation. These are just the surface of what this city represents when it comes to a greener future. This thesis project is taking this city and its policies to the next level of sustainability, agriculture, and architecture.

This research summarized that vertical agriculture will thrive in comparison to traditional agricultural methods. It described the numerous benefits of how architecture for food production will contribute to the health of the people and the planet. It proves why the site, Washington, D.C., will be a successful start to what the future of agriculture and architecture yearn for.

03 DESIGN IMPLEMENTATION

figure 10.1

how much can this facility produce?

VERTICAL RACK:

24 plants per tray x
64 trays x
28 systems x
2 levels

= 86,016 plants

TOWER RACK:

400 plants per tier x
16 full levels x
4 3/4 full levels

= 7,200 plants

TOTAL PLANTS:
93,216 plants

ANNUAL HARVEST:

93,216 plants x
8 harvests (average)

= 745,728 plants harvested annually

GROWING STAGE REQUIREMENTS

propagation

-
78 DEGREES F
CRITICAL COOLING

vegetative stage

18/6 LIGHT CYCLE
78 DEGREES F
55% HUMIDITY

flowering stage

12/12 LIGHT CYCLE
82 DEGREES F
30%-50% HUMIDITY

HYDROPONIC PROCESS

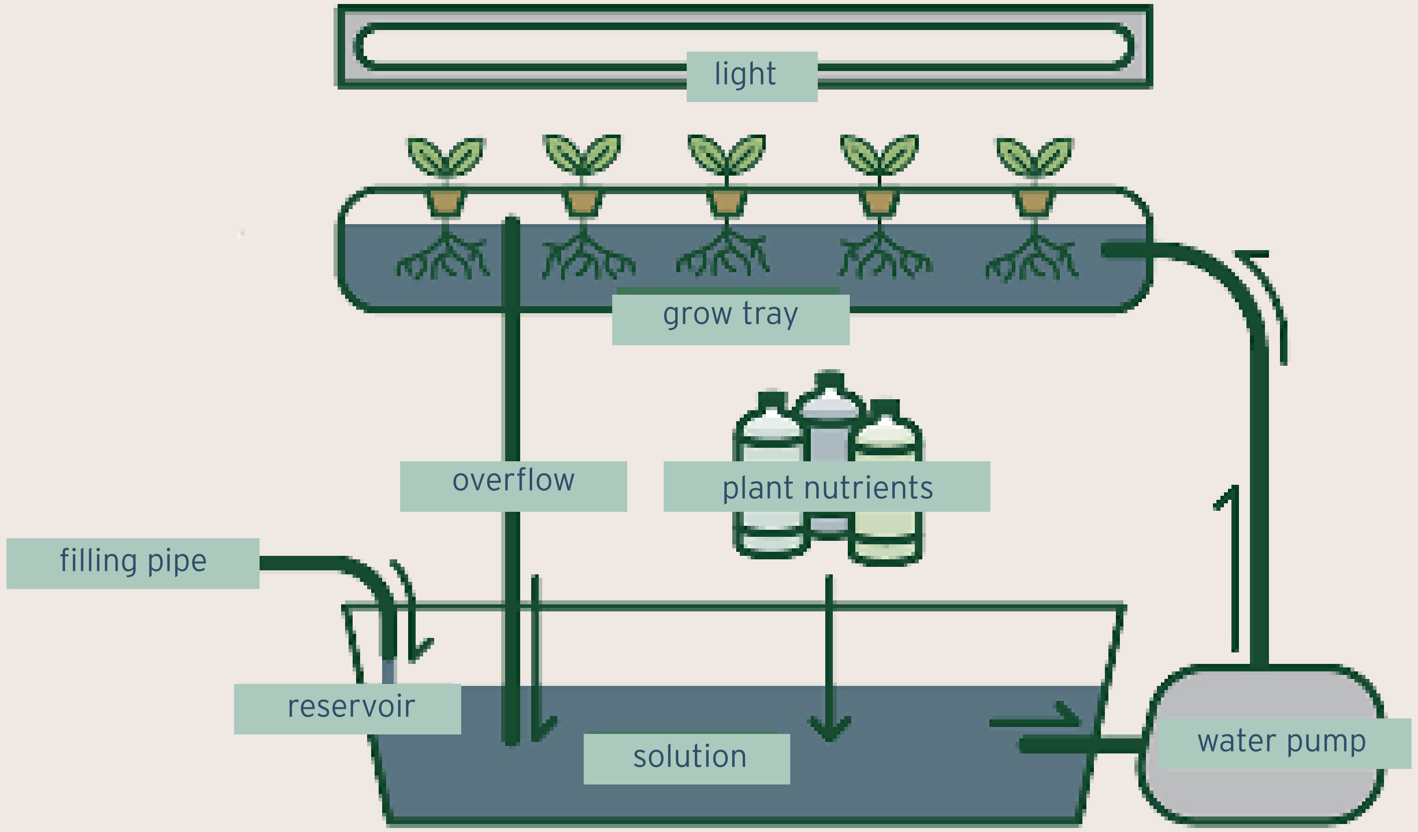


figure 10.2

how it works...

SPACE EFFICIENT

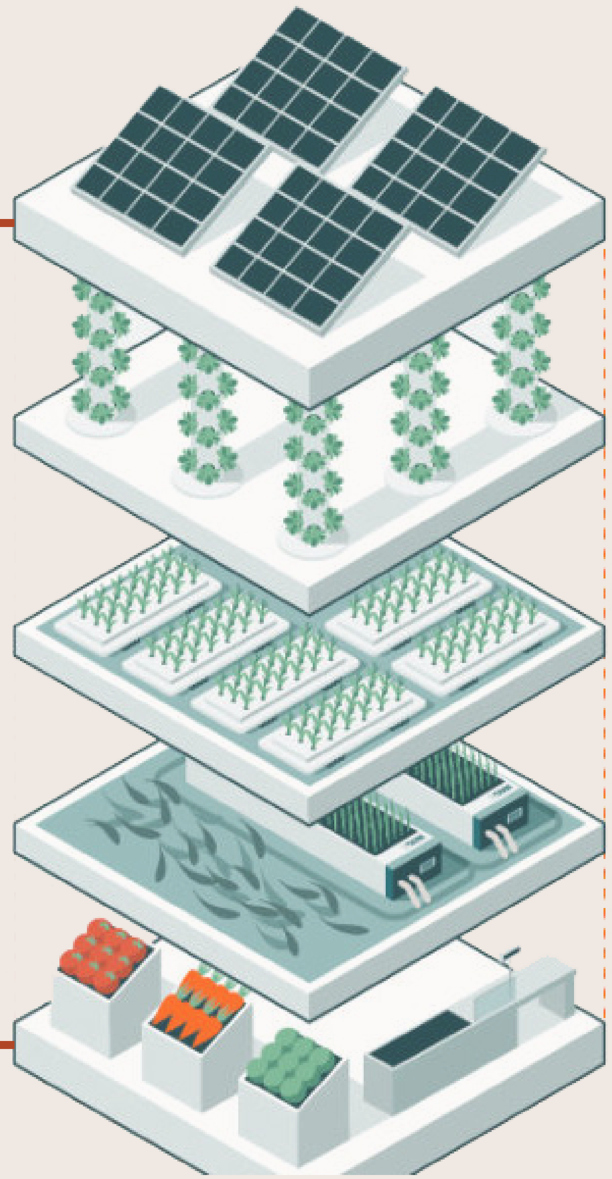
A vertical farm can grow 1 ton of lettuce with just 17% of the space needed by a traditional farm

LESS CHEMICALS

Indoor farming requires no pesticides, which in 71% of cases have been found to contaminate soil and reduce biodiversity

WATER CONSERVATION

By recirculating water, vertical farms can grow food with up to 90% less water



RENEWABLE ENERGY SOURCES

Artificial lighting and climate control systems require lots of energy

CONTROLLED ENVIRONMENT AGRICULTURE (CEA)

CEA refers to technologically advanced indoor farming

WASTE REDUCTION

Closer proximity to urban areas can shorten the supply chain and reduce food waste

sustainable systems

BUTTERFLY ROOF

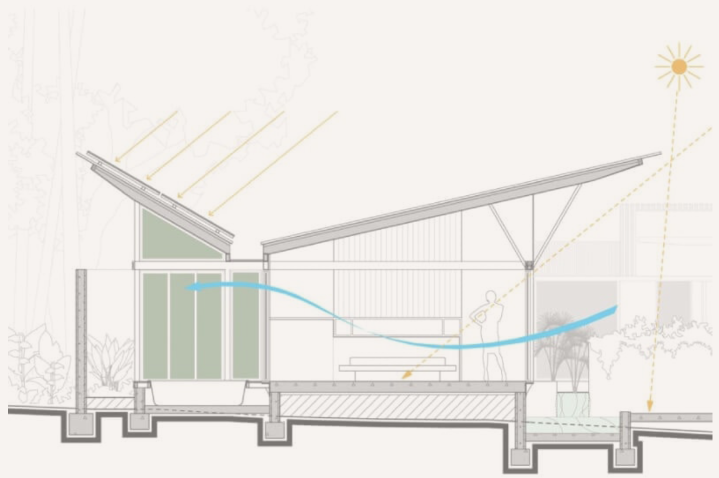


figure 10.4

The butterfly roof enhances the appearance of a modern building because of its unique design. There are numerous advantages associated with the use of butterfly roof design.

Thermal Efficiency
The roofing plan allows the room to retain enough heat and enhance proper ventilation to the interior space. This feature translates to the overall reduction in energy demand and costs.

Water Harvesting
The direction of the slope on both panels allows maximum collection of rainwater which benefits those who harvest rainwater. Irrigation is also possible through the roofing method because the collection central collection point makes it easy to channel water to a different area with ease.

Environment-Friendly
The broad area of the roof offers a large surface area for the installation of solar panels and water collection systems. Solar panels reduce the costs incurred in using electricity.

INTENSIVE GREENROOF

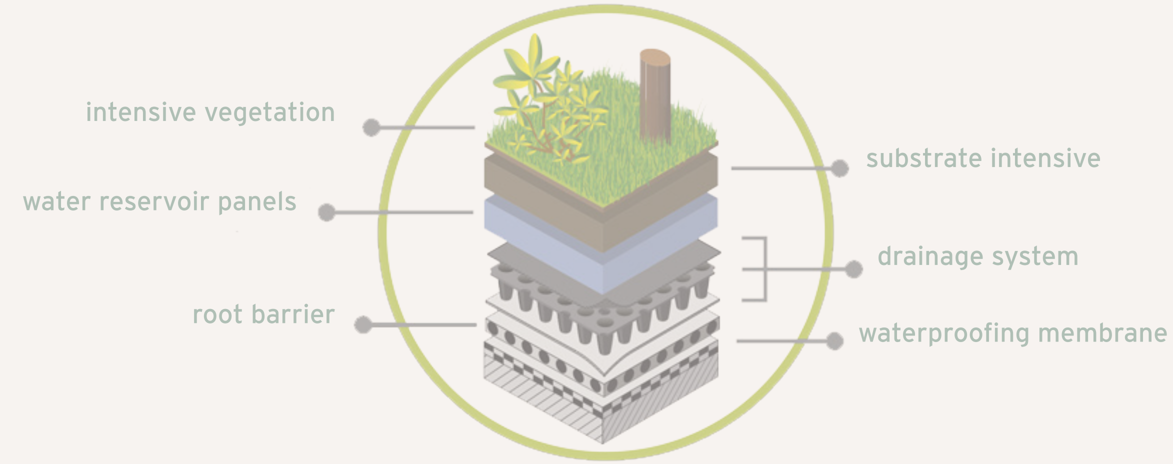


figure 10.5

An Intensive Green Roof or Roof Garden includes unlimited plant and design varieties. Likewise in open space planning, which allows any form of vegetation. Intensive greening may consist of perennials, grasses, bulbs, summer flowers, shrubs and large trees.

Stormwater Management
Most urban and suburban areas contain large amounts of paved or constructed surfaces which prevent stormwater from being absorbed into the ground. The resulting excess runoff damages water quality by sweeping pollutants into water bodies. Green roofs can reduce the flow of stormwater from a roof by up to 65% and delay the flow rate by up to three hours.

Energy
Green roofs reduce building energy use by cooling roofs and providing shading, thermal mass and insulation.

Biodiversity and Habitat
Green roofs provide new urban habitat for plants and animals, like birds and insects, thereby increasing biodiversity.

Urban Heat Islands
Cities are generally warmer than other areas, as concrete and asphalt absorb solar radiation, leading to increased energy consumption, heat-related illness and death, and air pollution. Green roofs can help reduce this effect.

Roof Longevity
Green roofs are expected to last twice as long as conventional roofs.

Aesthetics
Green roofs can add beauty and value to buildings.

RAINWATER COLLECTION SYSTEM

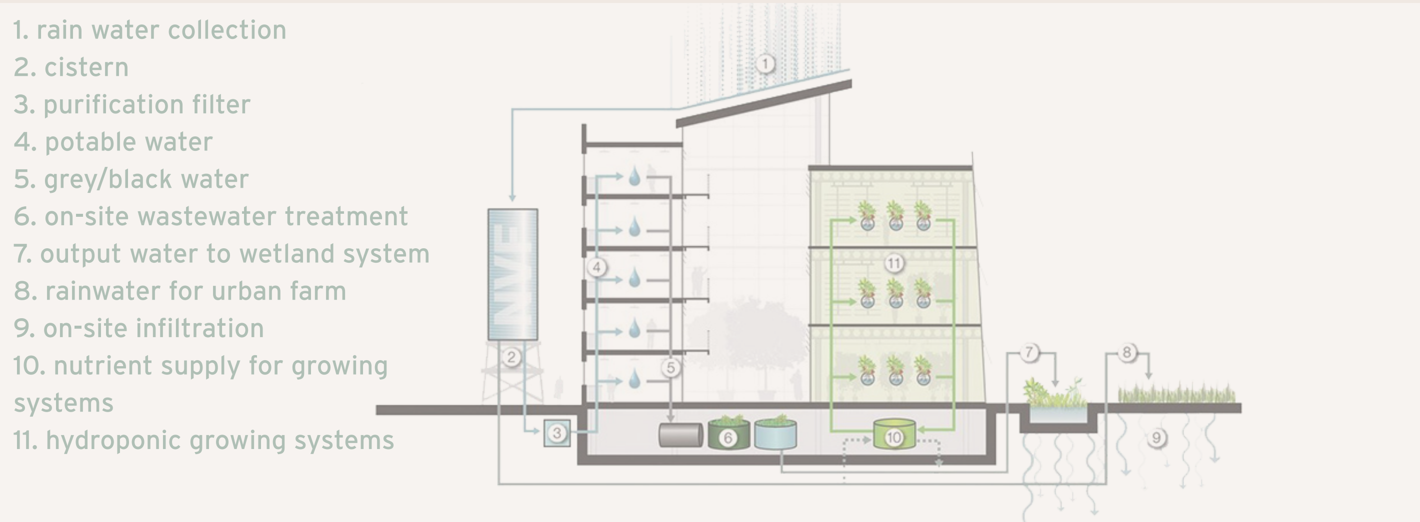


figure 10.6

The definition of rainwater harvesting is the collection of rainwater from a surface that allows for the rainwater to be stored and used at a later time. In a typical rainwater harvesting situation, rainwater is collected from an impervious surface such as the roof of a building and then stored inside of a tank or cistern.

Rainwater can be harvested and stored for many uses including landscape irrigation, potable and nonpotable indoor use, and stormwater management. Harvested rainwater can be particularly useful when no other source of water supply is available, or if the available supply is inadequate or of poor quality.

Health
Plants appreciate rainwater more than other source of water. This is because rainwater does not contain any harsh salts, chemicals, and minerals. By nature's design, it has the perfect pH balance and nitrate delivery. This benefit forms a healthy plant and soil ecosystem, which then contributes to cleaner air, carbon sink, pollinator habitats, temperature and precipitation regulations, and more.

Energy
There is a strong nexus between energy and water in the modern world. When reducing the reliance on pumped and treated water sources, you contribute to a collective savings in energy at the same time. Better yet, by pairing a rainwater catchment system with a user-friendly gravity-fed drip irrigation system, you do not need any electricity to run irrigation.

Environment-Friendly
Rainwater harvesting conserves water and reduces stormwater impacts, as well as, recharging groundwater. By protecting the local watershed, pollution and erosion are greatly reduced.

PHOTOVOLTAIC PANELS

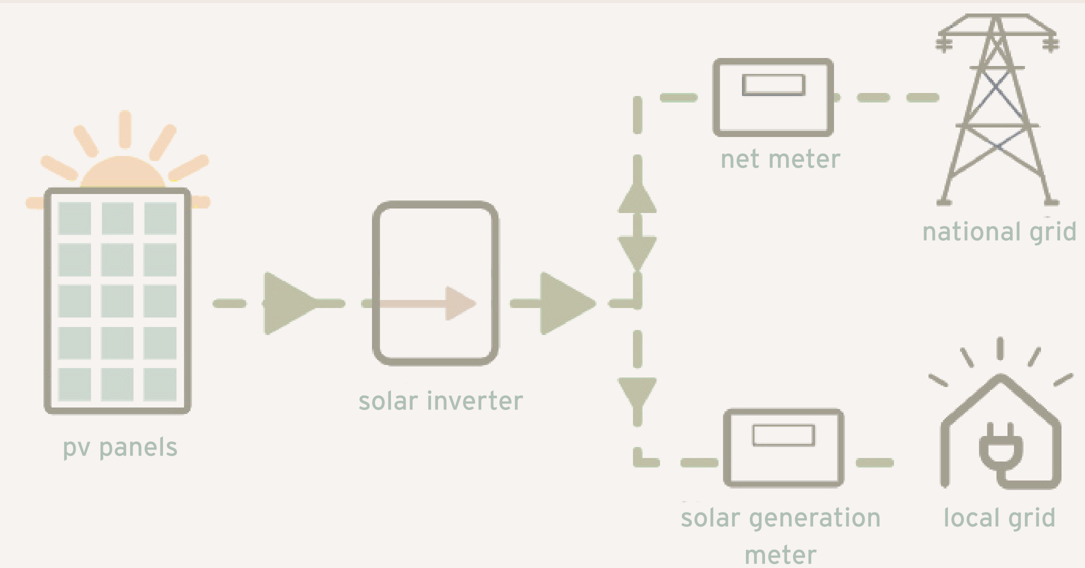


figure 10.7

A photovoltaic system is a special electrical system that produces energy from a renewable and inexhaustible source: the sun. A grid-connected system is a system that integrates with industrial electricity systems. These can be used when required in alternation or in combination with the electricity grid of a business in order to meet the energy requirements of the end user.

Quiet and Unobtrusive
Solar PV energy is completely quiet and doesn't intrude into your daily activities. In the same way, photovoltaic solar panels are visually unobtrusive. Most users choose to place photovoltaic solar panels on a rooftop where they're not necessarily visible from ground level, taking advantage of otherwise unused space and freeing up rest of the property for enjoyment.

Reduction of Energy and Costs
Solar PV energy systems can lower your energy bills in several significant ways. Because you're generating some of your own electricity, you're able to cut down drastically on what you pay your energy provider. Many government entities provide subsidies to help cover the initial costs of setting up PV solar panels through tax rebates and other incentive programs.

Little Maintenance
Operating costs for photovoltaic solar panels are minimal, even when compared to other clean energy sources. This is largely due to the fact that solar panels need little maintenance, even over the long term. Since there are essentially no moving parts, there's nothing to break and no need for regular lubrication to keep things running. They just keep working on their own.

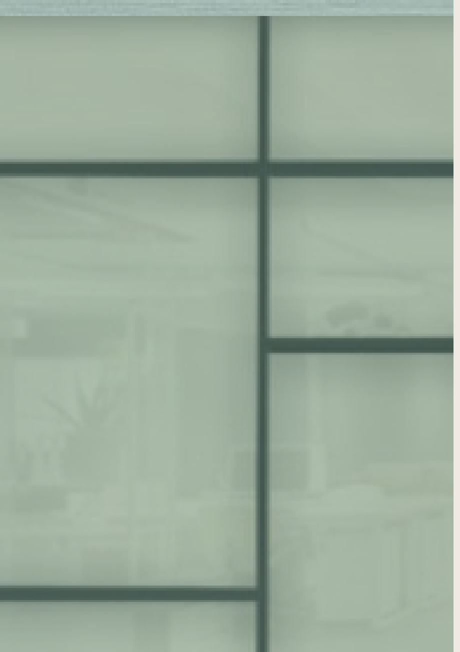
Customization
Whatever the energy needs are, solar panels can be configured to meet them. From a large business to a house, you can design the exact system you need to generate the energy you plan to use. Photovoltaic solar panels provide clean, renewable energy that's easy on your wallet.

MASS TIMBER

Wood is a renewable, sustainably sourced material and has a low carbon footprint. In fact, it is the only known material that can remove carbon from the atmosphere for the lifetime of its usage. A hybrid form of cross-laminated timber has been proven to have an average of 26.5% reduction in the global warming potential when compared to a typical concrete building. Mass timber buildings are constructed faster and create less waste, which further reduces its environmental impact. A few additional advantages include its safety and performance, reduced structural weight, thermal performance, and contain biophilic design benefits.

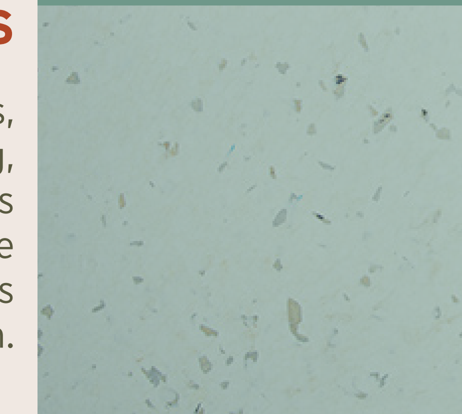
RECLAIMED STAINLESS STEEL

Steel is 100% recyclable and significantly reduces the ecological impact of new construction, especially the carbon footprint. Stainless steel is extremely durable and very cost effective. Reclaiming stainless steel saves over 35% of energy used in new steel construction.



SMART GLASS CURTAINWALL

The usage of curtainwalls is a notable trend in sustainability because it allows plenty of natural light which reduces the need of electric lighting. Low-emission glass is not a new concept but adding smart technologies furthers sustainability. This smart glass is comprised of five different technologies: thermochronic, photochronic, liquid crystal, suspended particles, and electrochromatics. This glass works by automatically adjusting to sunlight changes throughout the day, reducing interior heating and cooling loads imposed on building systems, which leads to a reduction in energy consumptions. Furthermore, these panels collect solar rays and convert them into solar energy.



RECYCLED PLASTICS

Recycled plastics are used in various forms - tables, structures, carpets, floors, pipes, and more. Rather than sourcing, mining, and milling new components for construction, manufacturers can utilize recycled plastics. By using this method, greenhouse gas emissions are greatly reduced and the reuse allots for less waste and plastic pollution.

CORK FLOORING

Cork is one material that grows very quickly. It has the ability to be harvested from a living tree which allows it to continue growing and reproducing more cork. Cork is resilient, flexible and reverts to its original shape even after enduring great pressures. Its resilience and resistance to wear makes it a common element in floor tiles.

CLAY TILES

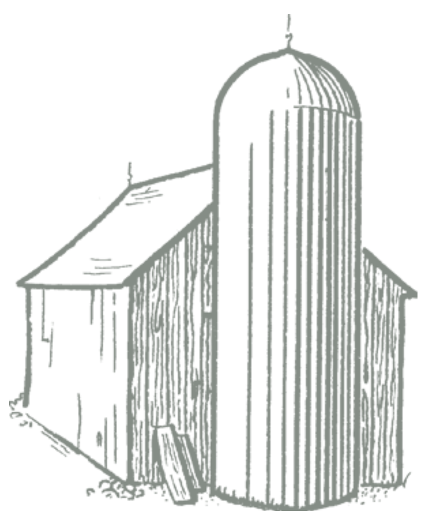
Clay tiles, typically terracotta, can be sourced locally and is considered to be carbon neutral as long as methane, a dangerous greenhouse gas, is captured and utilized responsibly or destroyed. These products are 100% natural, including the manufacturing process. These tiles can be recycled and reused, although they may not need to be as they are very long-lasting. One fun fact about this earthy, eco-friendly product is that it plays a part in strengthening peoples' immune systems.

This material is also promoting local artists and small business who create these pieces of tile.

sustainable materials

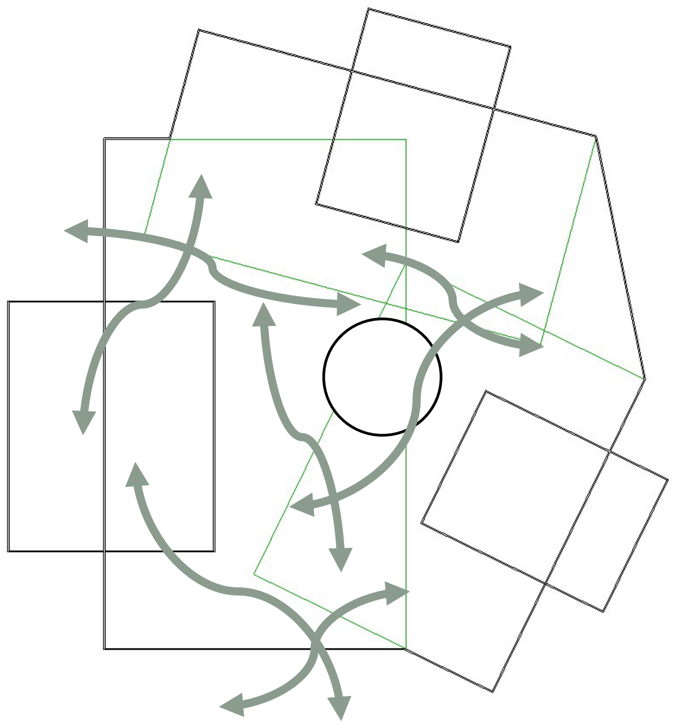
GUIDING IDEA

complex interconnectivity of how a traditional farm operates

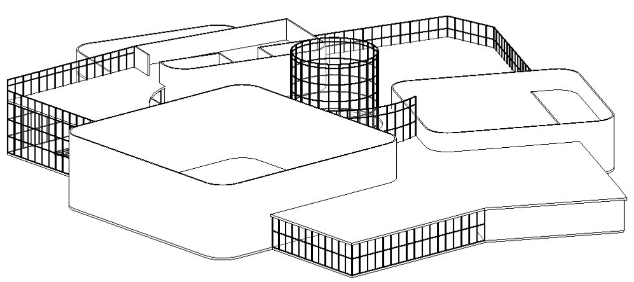


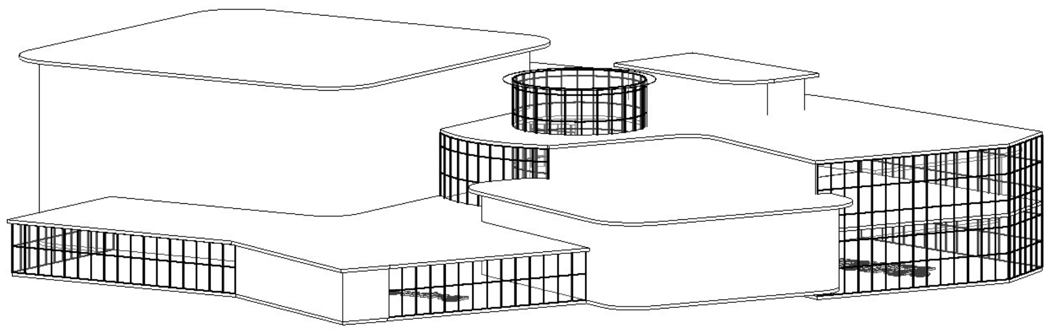
the silo as the center of food production and storage

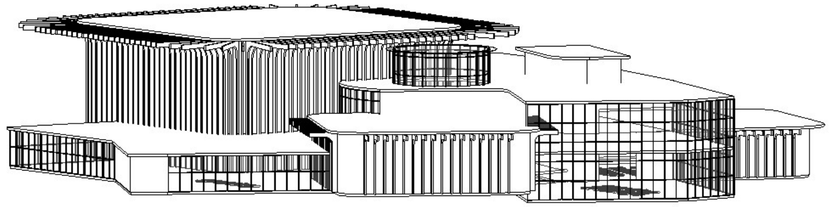
tree branching out to support and house life in the natural environment

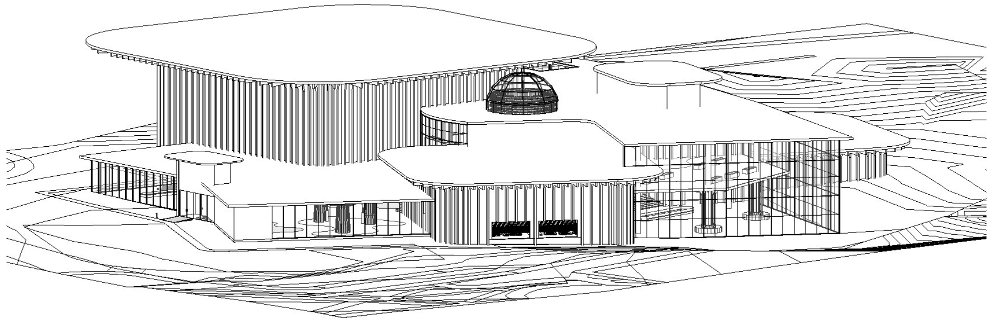


DESIGN PROGRESSION

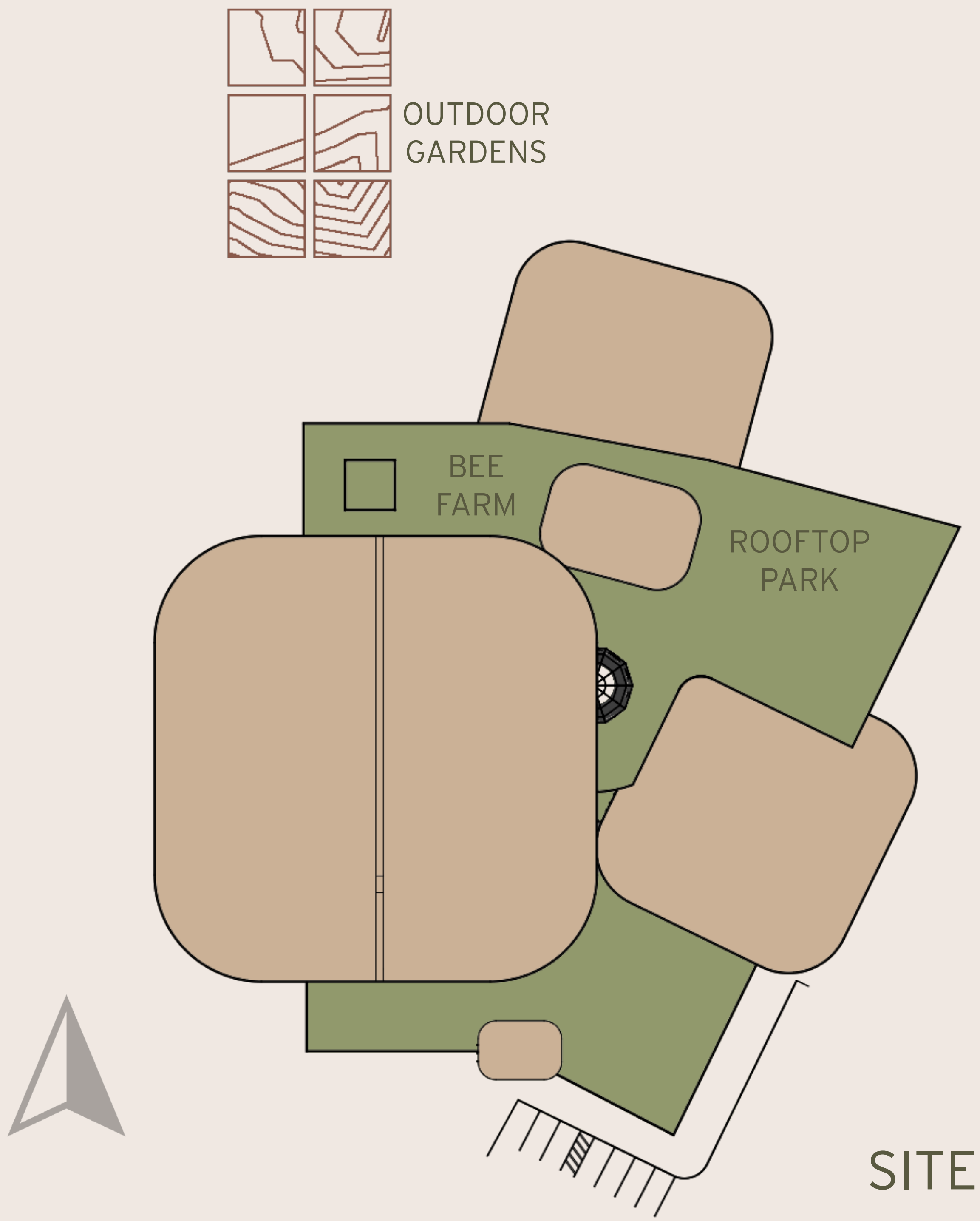




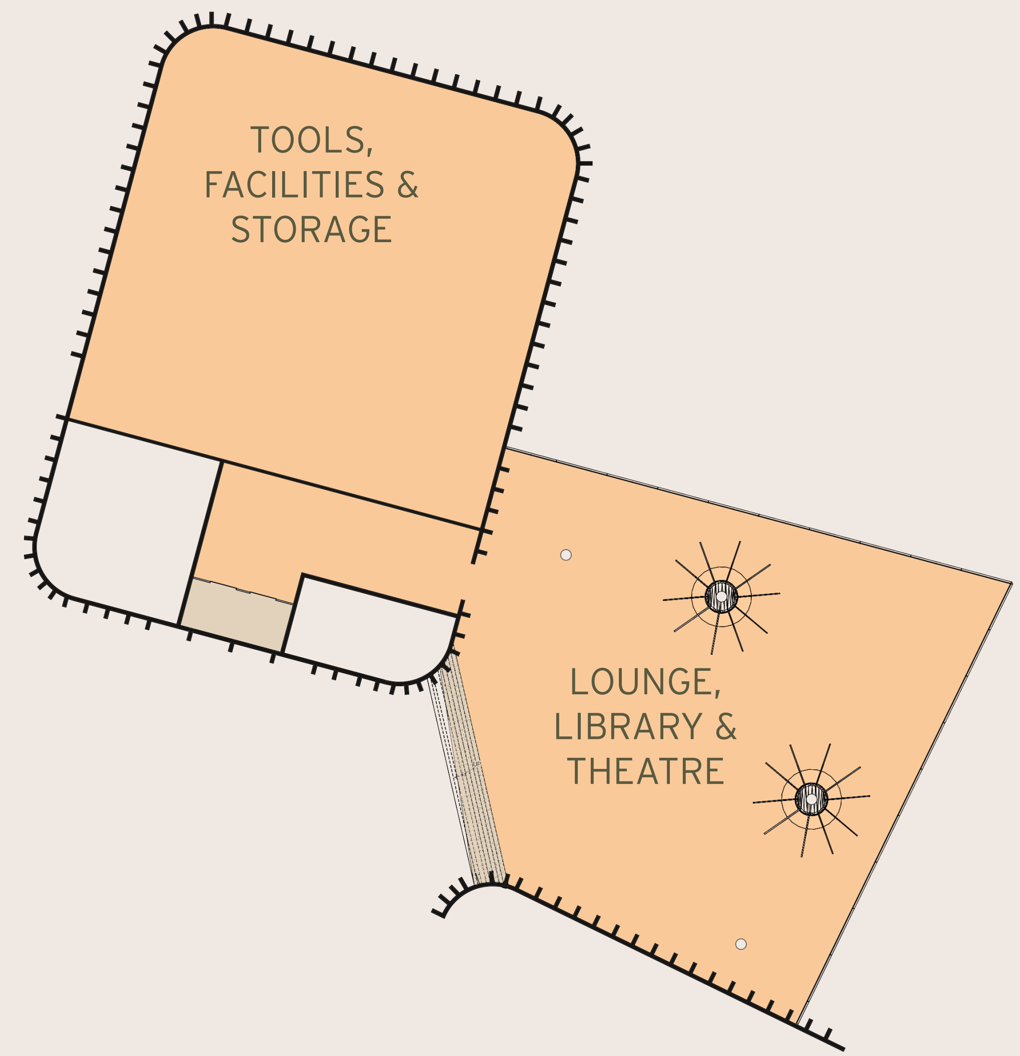




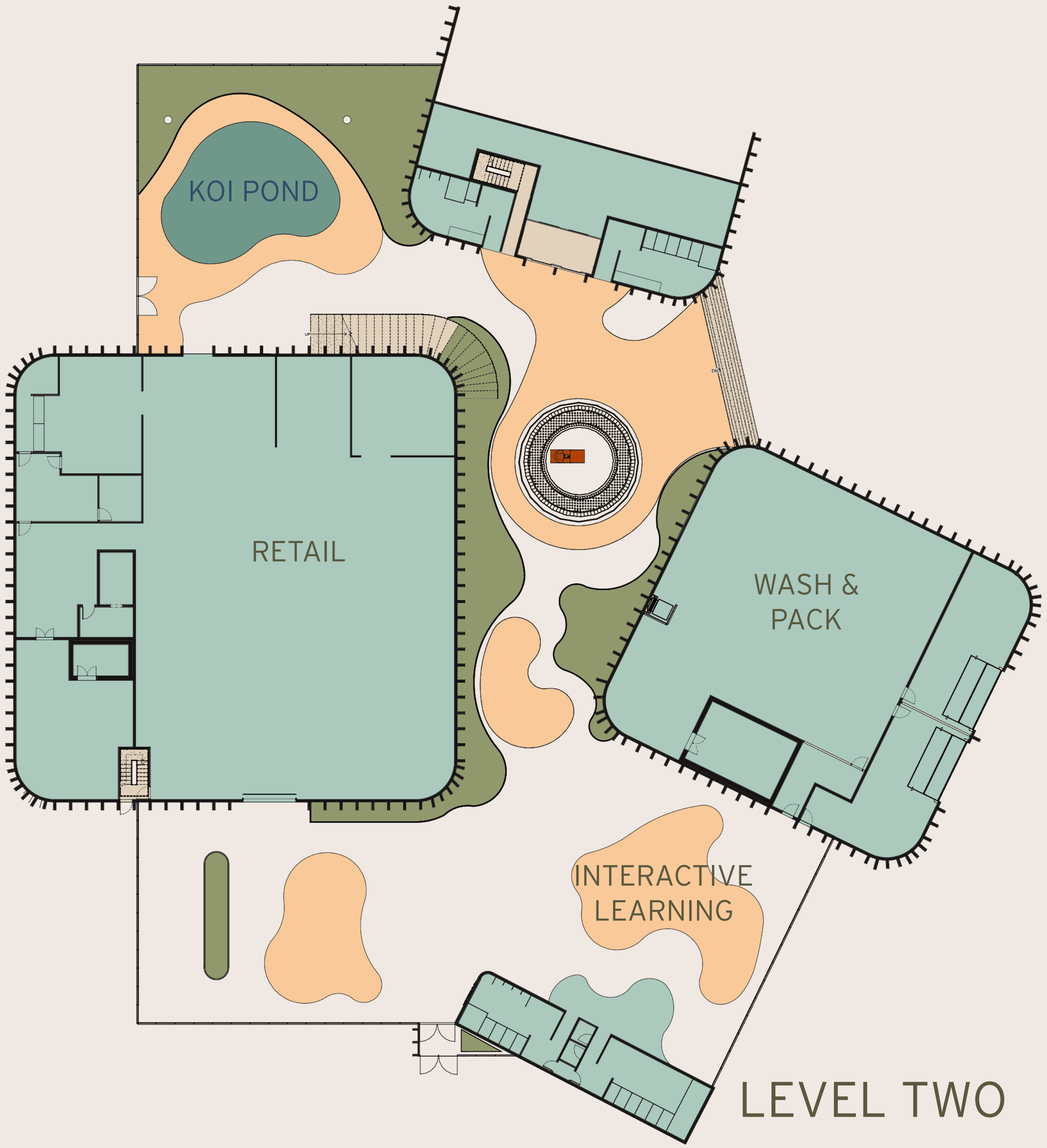
PROJECT EXECUTION



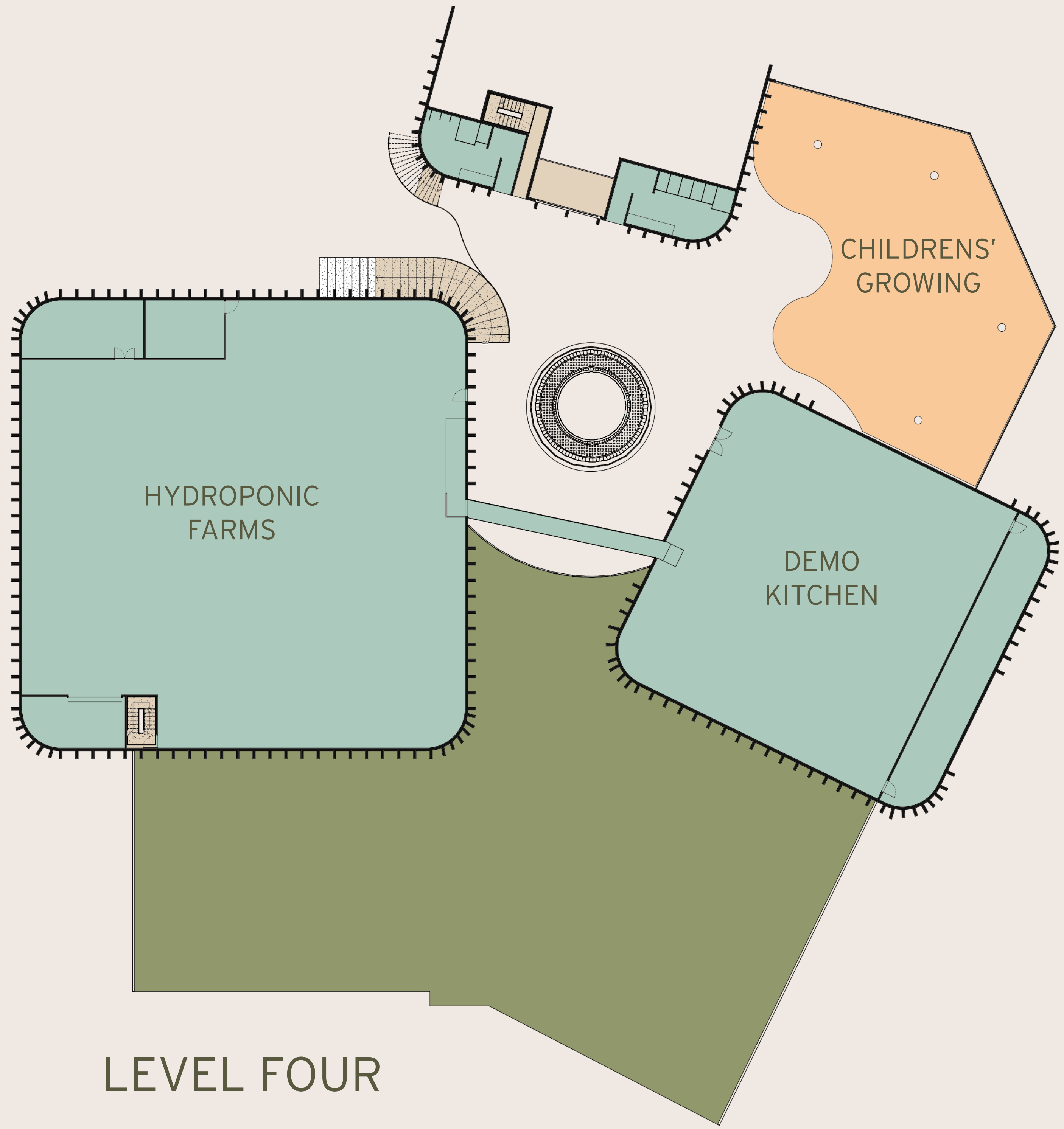
SITE



LEVEL ONE

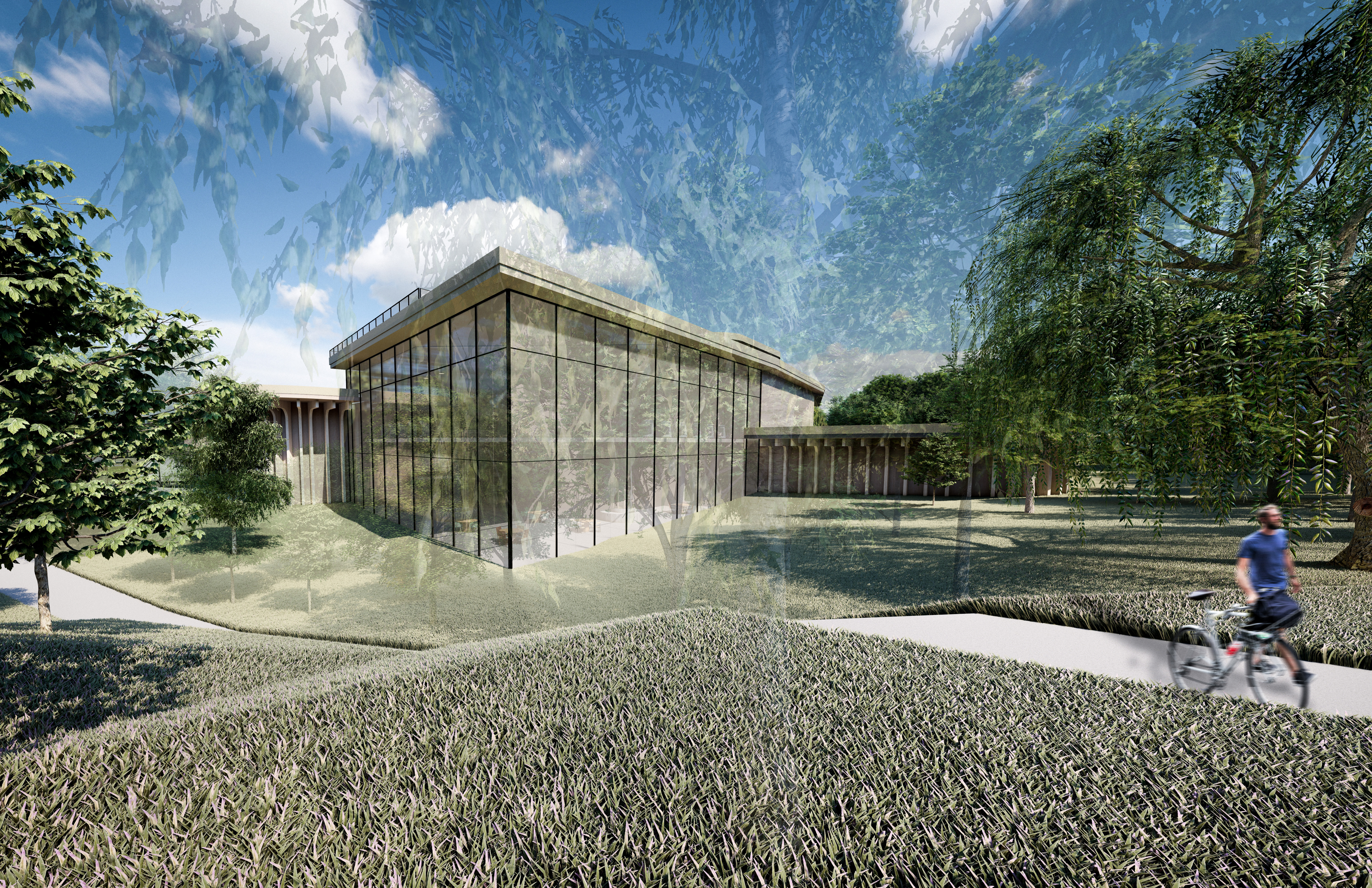


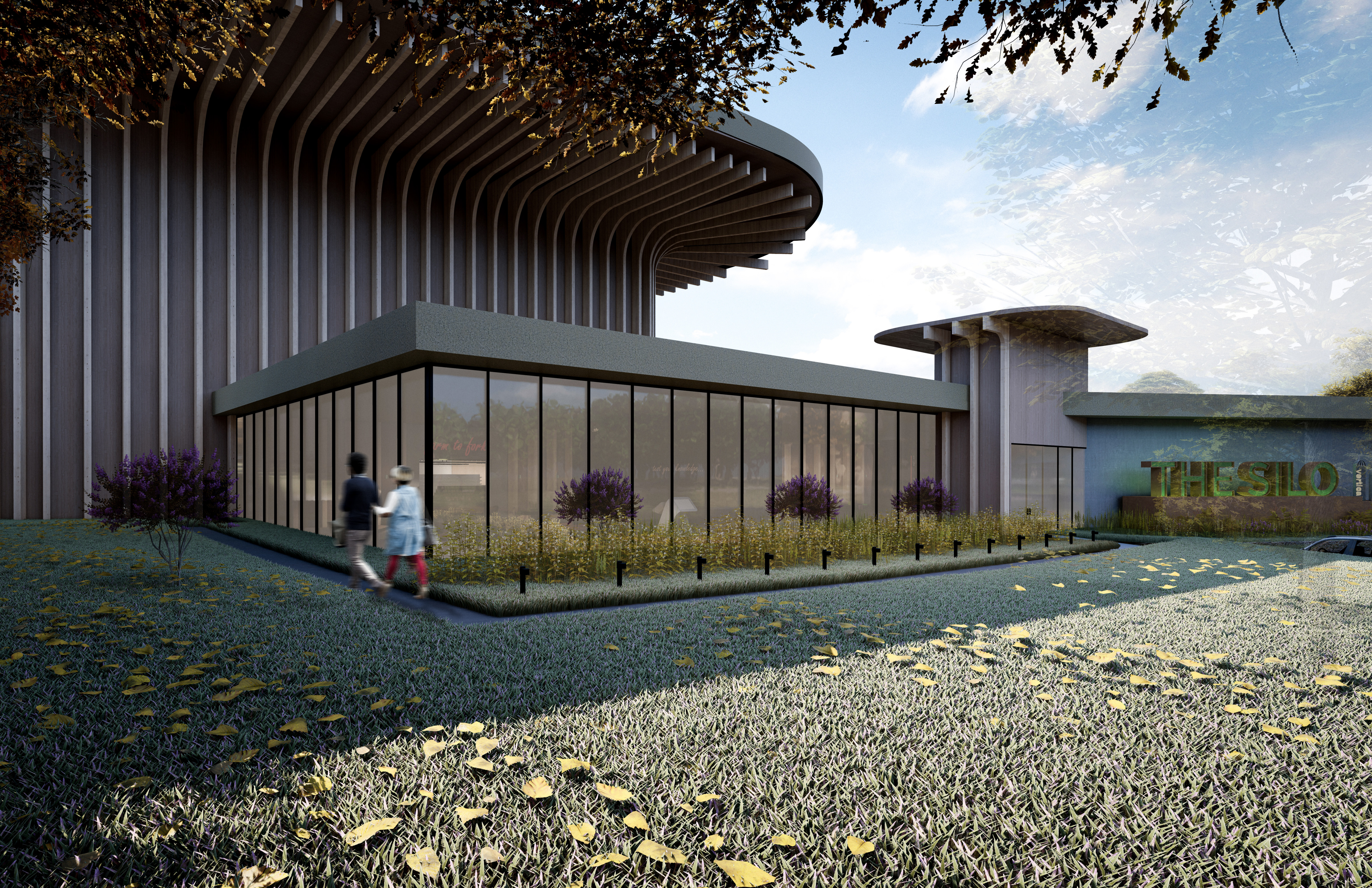
LEVEL TWO



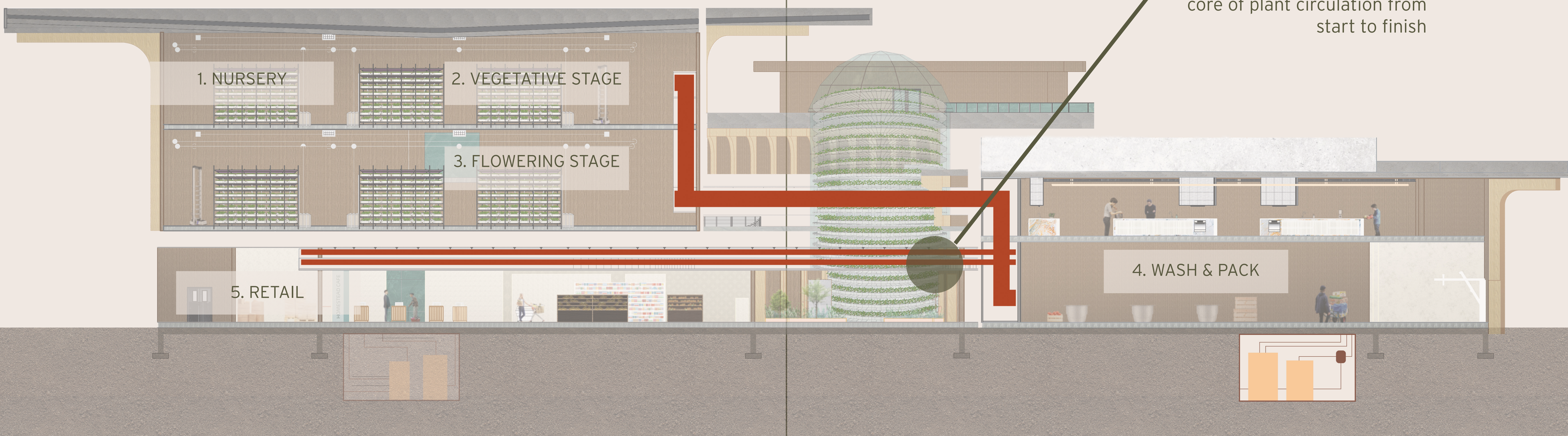
LEVEL FOUR


farm to fork




THE SILO

A series of conveyors is the core of plant circulation from start to finish



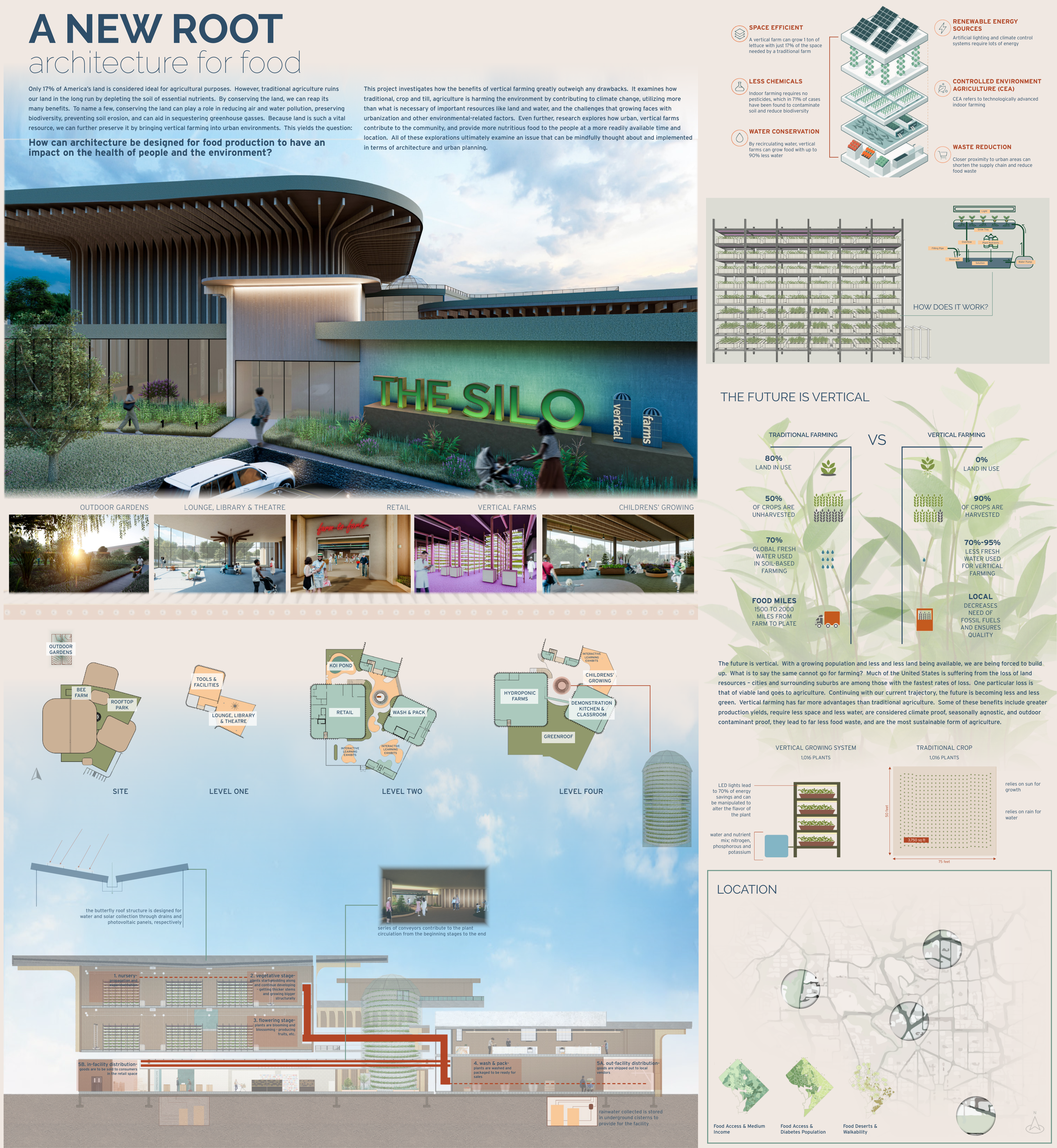
This plan focuses on how distribution plays a role in local environments. Starting at The Silo, we can follow how food is distributed to smaller satellite locations in parts of a community that struggle with food desserts, health issues, poverty and more.

The specifics of this Washington D.C. urban plan includes several different typologies. To name a few, vertical farming can be implemented within institutional settings, markets and other retail options, in office and multi-use buildings.

URBAN DISTRIBUTION


THE SILO
vertical

figure 11.1



final board layout

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previous design studio experience

2ND YEAR

FALL 2019 EMILY GUO

LIVE/WORK STUDIO | **ARTIST'S LOFT ; MOORHEAD, MN**

FACILITIES | **BOAT HOUSE ; MINNEAPOLIS, MN**

SPRING 2020 MILT YERGENS

SINGLE RESIDENCE | **DWELLING ; CRIPPLECREEK, CO**

MULTI-USE | **RAPE & ABUSE CRISIS CENTER / HOUSING ; FARGO, ND**

3RD YEAR

FALL 2020 NILOUFAR ALENJERY

SOCIAL ISSUE | **UNSEEN REALITIES OF SEX TRAFFICKING ; NEW YORK CITY, NY**

CLIMATE ISSUE | **AQUARIUMS & RESEARCH CAMPUS ; KAMCHATKA PENINSULA, RUSSIA**

SPRING 2021 PAUL GLEYE

COMMUNITY | **CULTURAL EVENTS CENTER ; FARGO, MN**

PAVILIONS | **DENNIS & MARY KAY LANZ COMPETITION ; FARGO, ND / MOORHEAD, MN**

4TH YEAR

FALL 2021 CINDY URNESS

CAPSTONE | **HIGH-RISE ; MIAMI, FL**

SPRING 2022 KRISTI HANSON

PRODUCT SHOWCASE | MARVIN WINDOWS LAKE HOME ; MN

URBAN DESIGN & MASTER PLANNING | **VISION FOR MEDORA ; MEDORA, ND**

GRADUATE DESIGN STUDIO

FALL 2022 CINDY URNESS

RESEARCH CAMPUS | **WETLANDS RESEARCH LABORATORY ; HAWLEY MN**

SPRING 2022 CINDY URNESS

DESIGN THESIS | **A NEW ROOT ; WASHINGTON, D.C.**

vertical farms

THE SILO