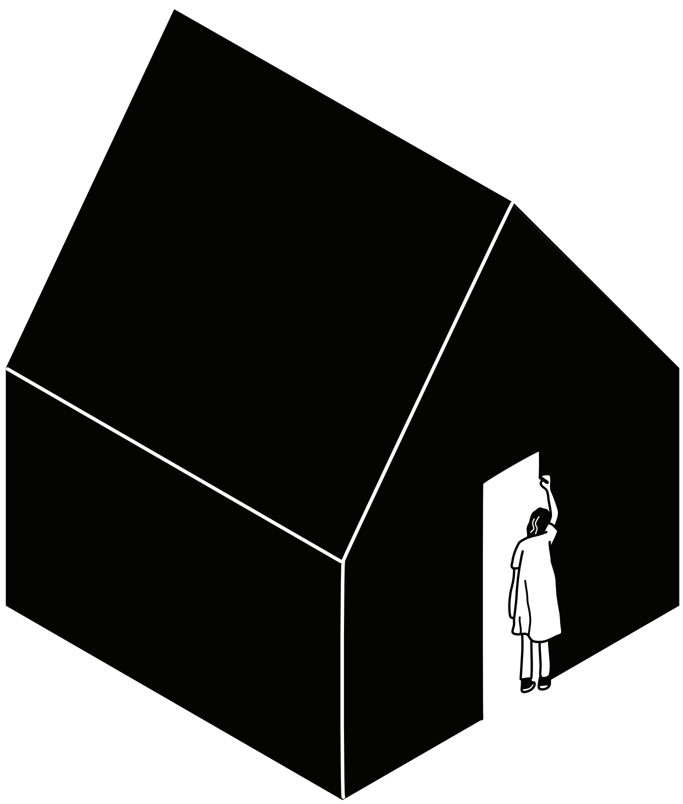
ARCHITECTURE
P O R T F O L I O



YINGXI DONG

2020-2024 SELECTED WORKS

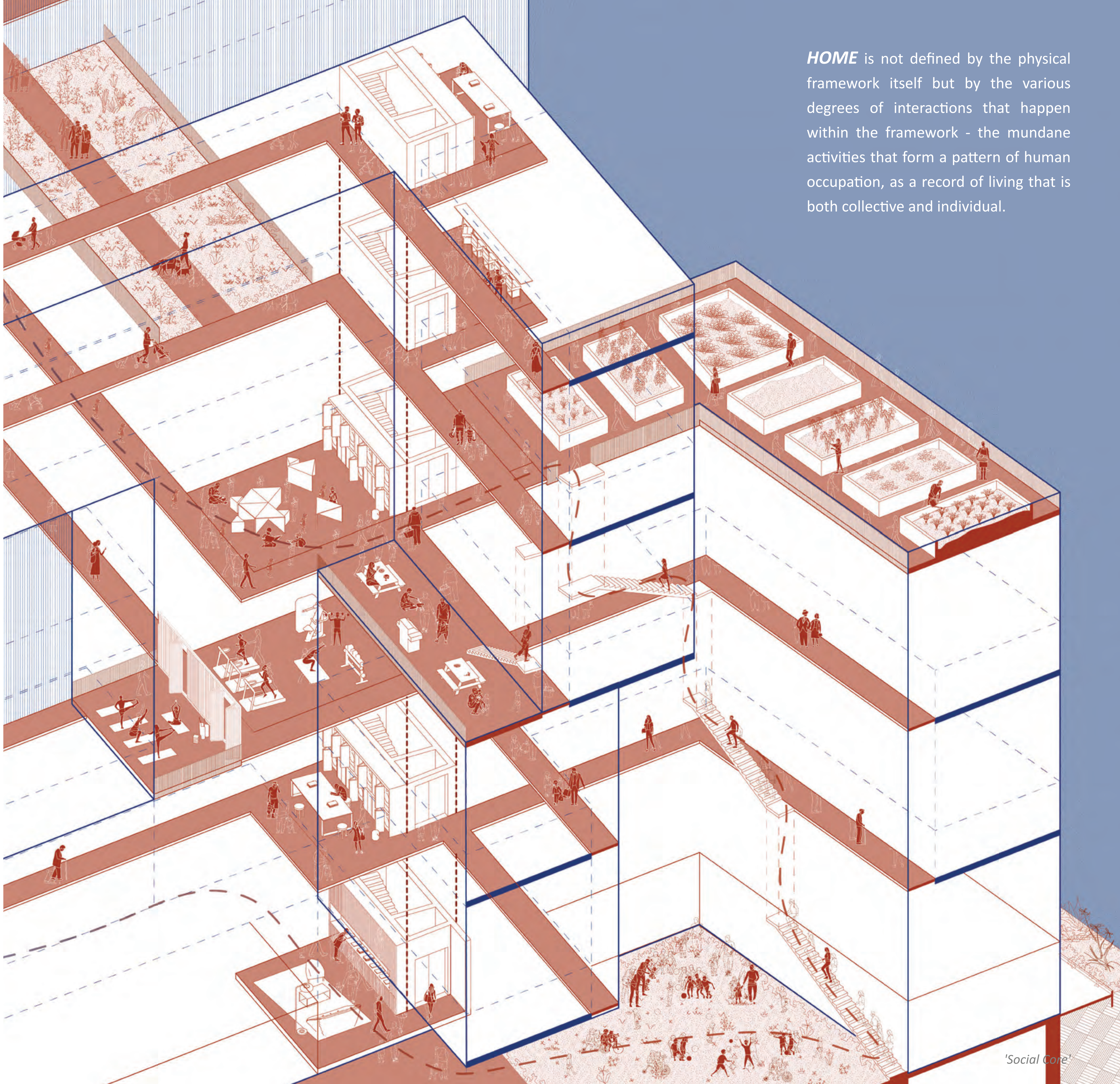
Columbia University GSAPP | M.Arch

TABLE OF CONTENT

01 THE COLLECTIVE

Instructors | Mimi Hoang
Collaborator | Wei Xiao
Program | Social Housing
Site | Mott Haven, New York

In response to the environmental and social challenges resulting from the close adjacency to transportation infrastructure, the high concentration of single-family households and the younger generation, as well as the lack of shared neighborhood amenities surrounding the site, the project proposes collective housing as a solution to enhance community connection and maximizing housing affordability under a protected urban environment. Through an interconnected courtyard system that embraces multiple scales of shared programs, the housing complex provides a layering of controlled collectiveness for residents. On and towards your way home, “housing” is constructed from both the various degrees of social interactions that can happen among residents themselves and the autonomy to enjoy privacy if preferred.



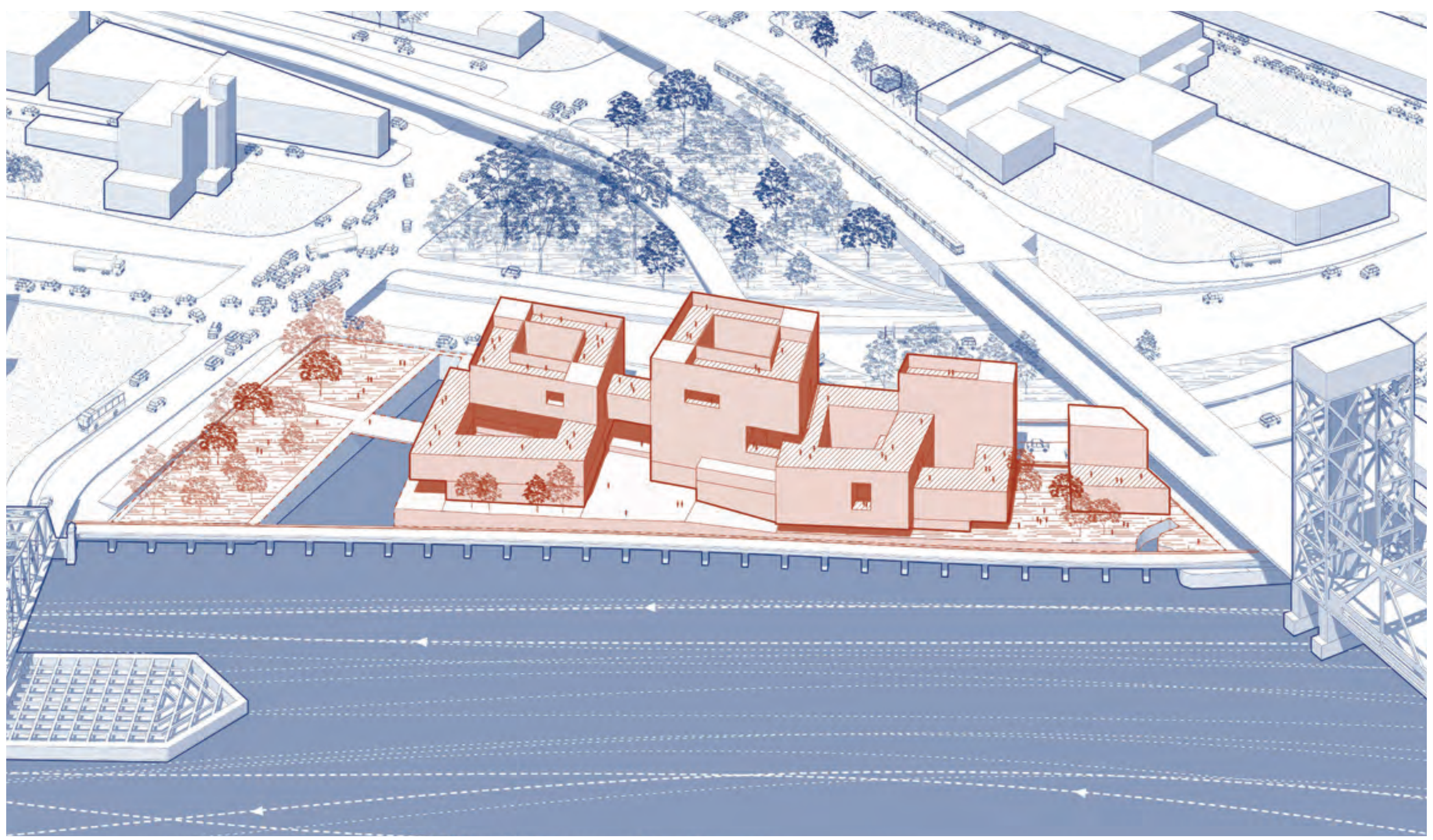
HOME is not defined by the physical framework itself but by the various degrees of interactions that happen within the framework - the mundane activities that form a pattern of human occupation, as a record of living that is both collective and individual.

'Social Core'

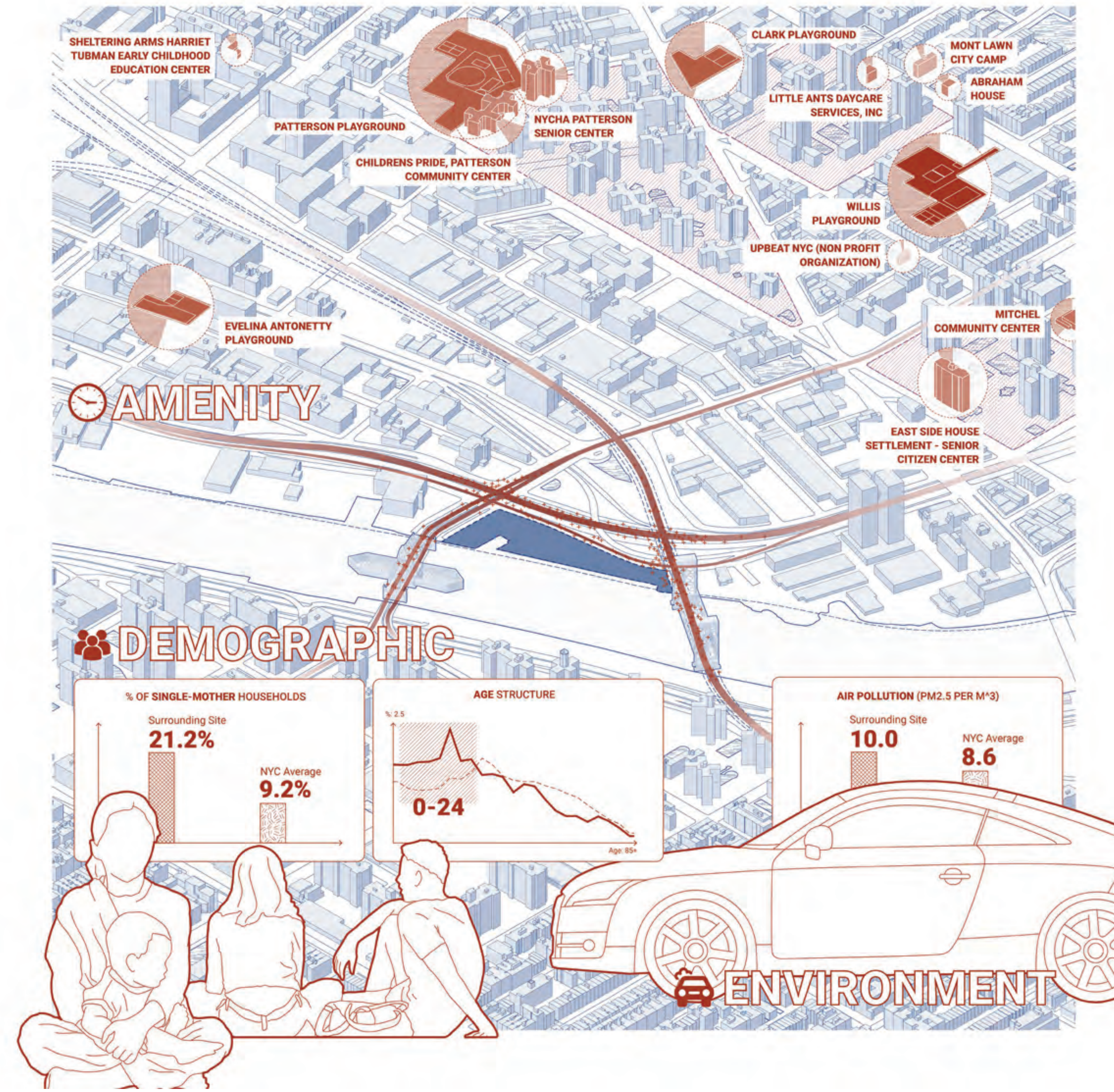
Site Context

Mott Haven has significantly higher rates of single-family households, especially single female families and younger generations aged between 0 and 24, compared to New York's average. The existing surrounding public amenities are more explicitly provided for the neighborhood that they are adjacent to or located in with limited hours of accessibility, raising the need for shared amenities for the new housing complex protected from the proximate extensive transportation infrastructure that poses additional environmental concerns. Based on this analysis, we aim to design an urban complex for shared housing wherein residents can benefit from the multiple shared amenities that the housing embraces to create a community that encourages social interactions through an intertwining courtyard system that provides supportive programs along with in-unit dwellings for those who come.

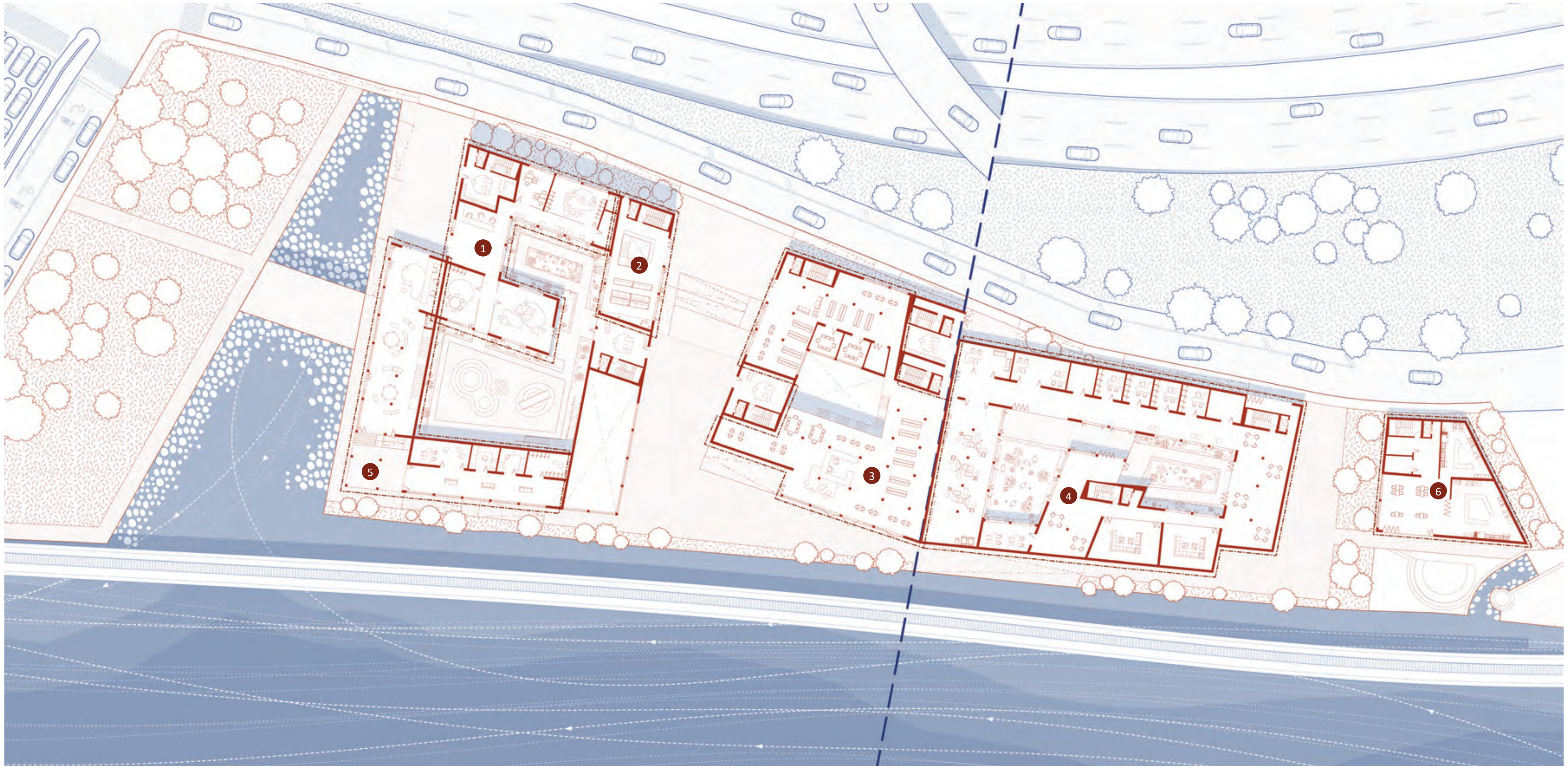
Zoning Analysis



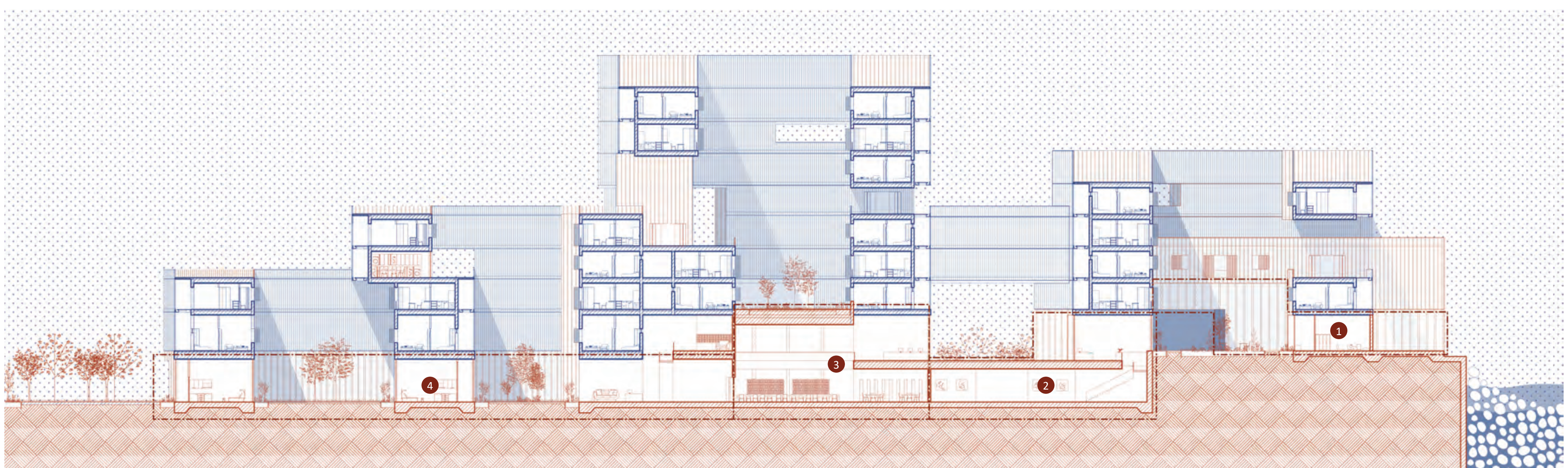
Aerial View



Site Analysis



Ground Floor Plan



Longitudinal Section

Building Community

At the ground level, programs are designed to maximize mutual benefits. They include a daycare center and gallery space where children's work can be displayed, library and senior care center where potential conversations across generations can happen through storytelling and other types of events, and a community kitchen/food yard where people can exchange food and invite street vendors for their business.

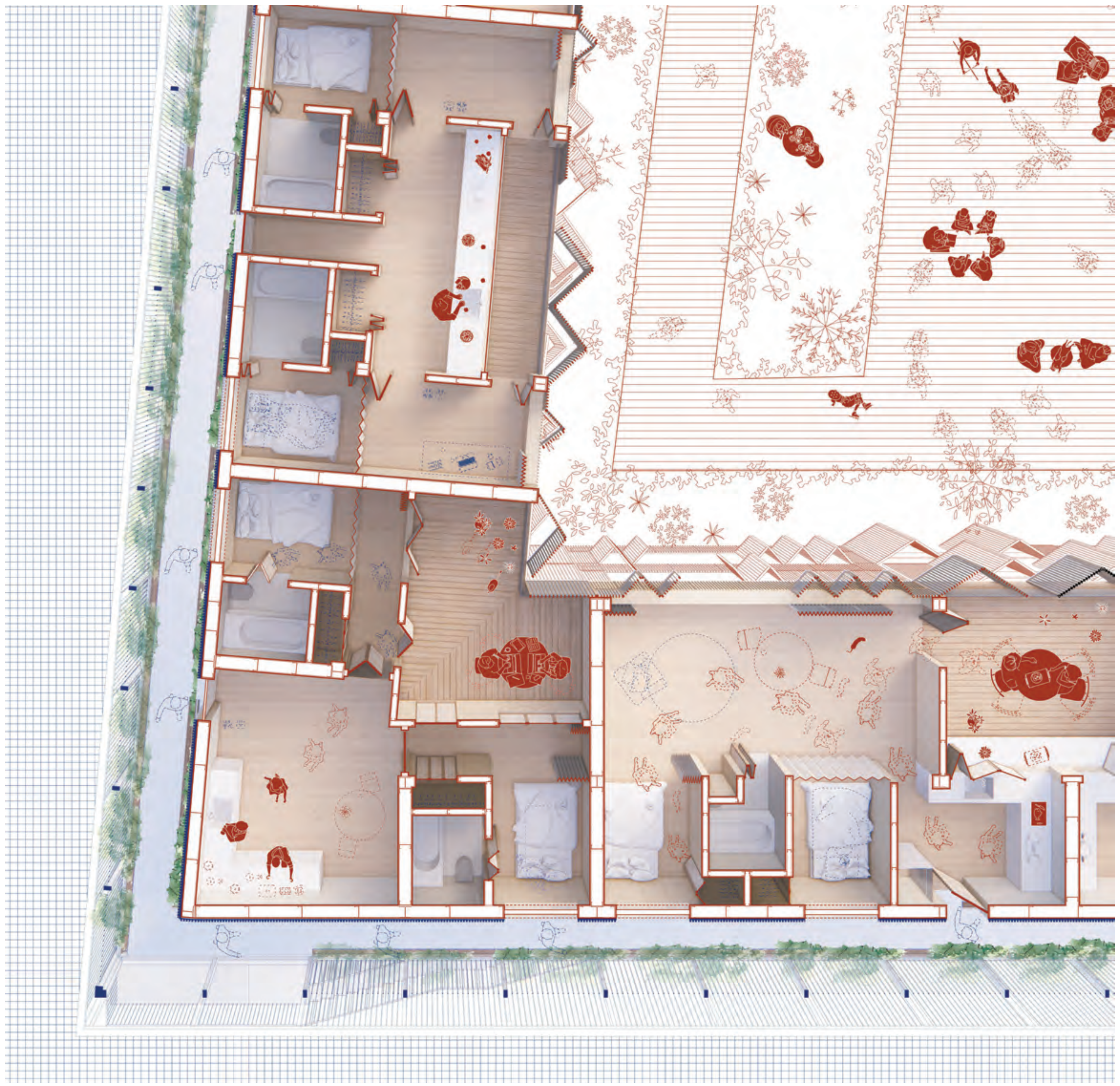
We also consider water as part of the ground programs where we invite water into the site through floodable landscapes at strategically chosen openings. Near the largest floodable lanscape, there is a nature lab that can work with the daycare and the library to promote sustainability concepts.

1. Day Care Center
2. Children's Museum
3. Library
4. Senior Care Center
5. Science (Nature) Lab
6. Community Kitchen (Food Yard)

Typical Floor Plan

Shared Space

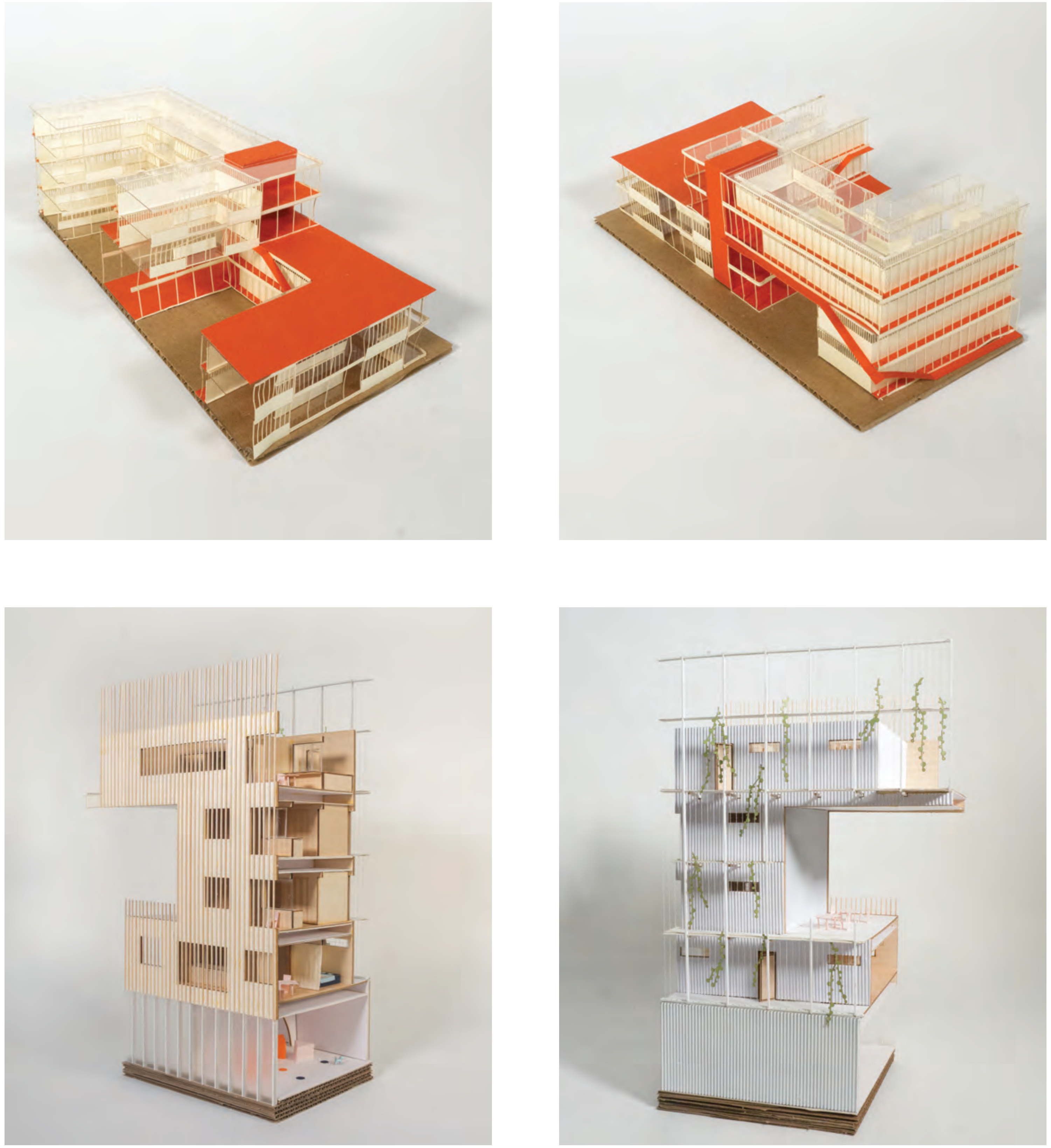
There are three main types of units designed, including single studio, one-bedroom, and two-bedroom units. Each unit type has a shared component with its neighbor, ranging from a shared balcony, a shared kitchen, and a shared living room. With operable elements such as windows and doors, the residents can control the degrees of sharing they prefer.



Plan Perspective

Kitchen Perspective (Two-Bedroom Unit)

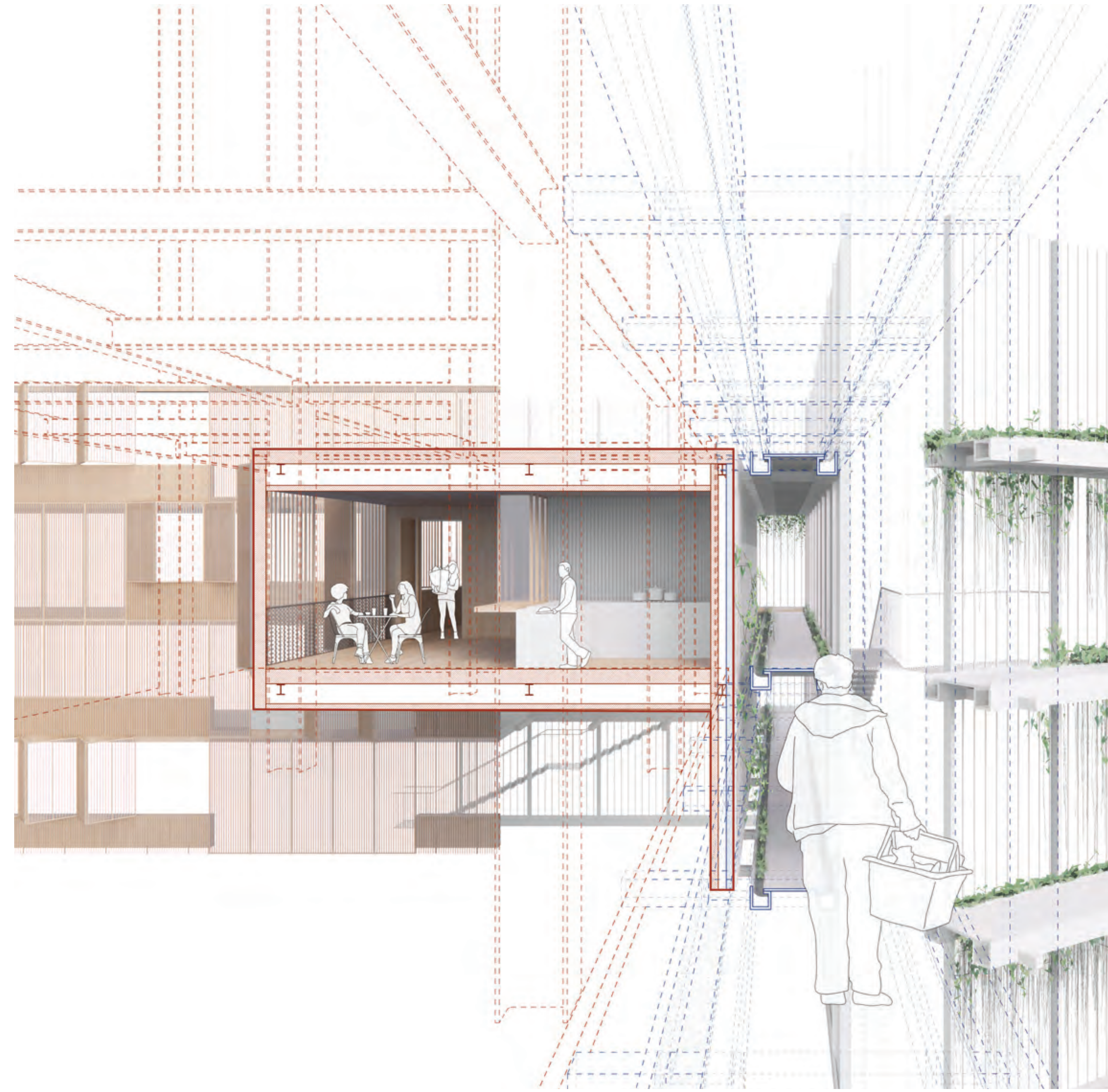
Bedroom Perspective (Singe Studio)



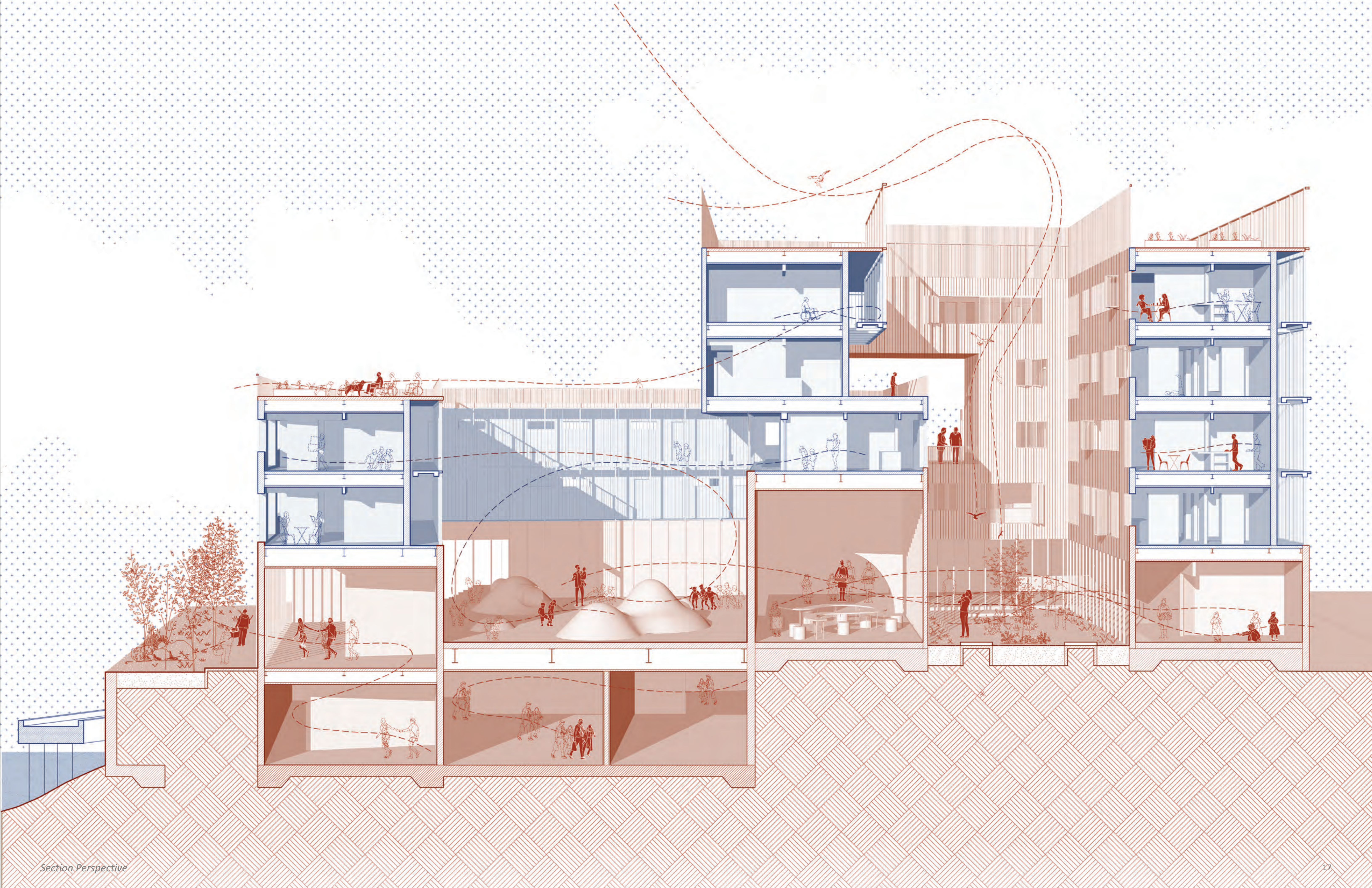
Physical Model

Building Structure

Given the location's susceptibility to flooding, the courtyards are elevated on a concrete ground level that prevents potential flood damage. The residential building above is designed to be steel and CLT structured with the extended green corridors attached, working as a green living zone that filters air and provides degrees of shading for the residents.



Corridor Perspective



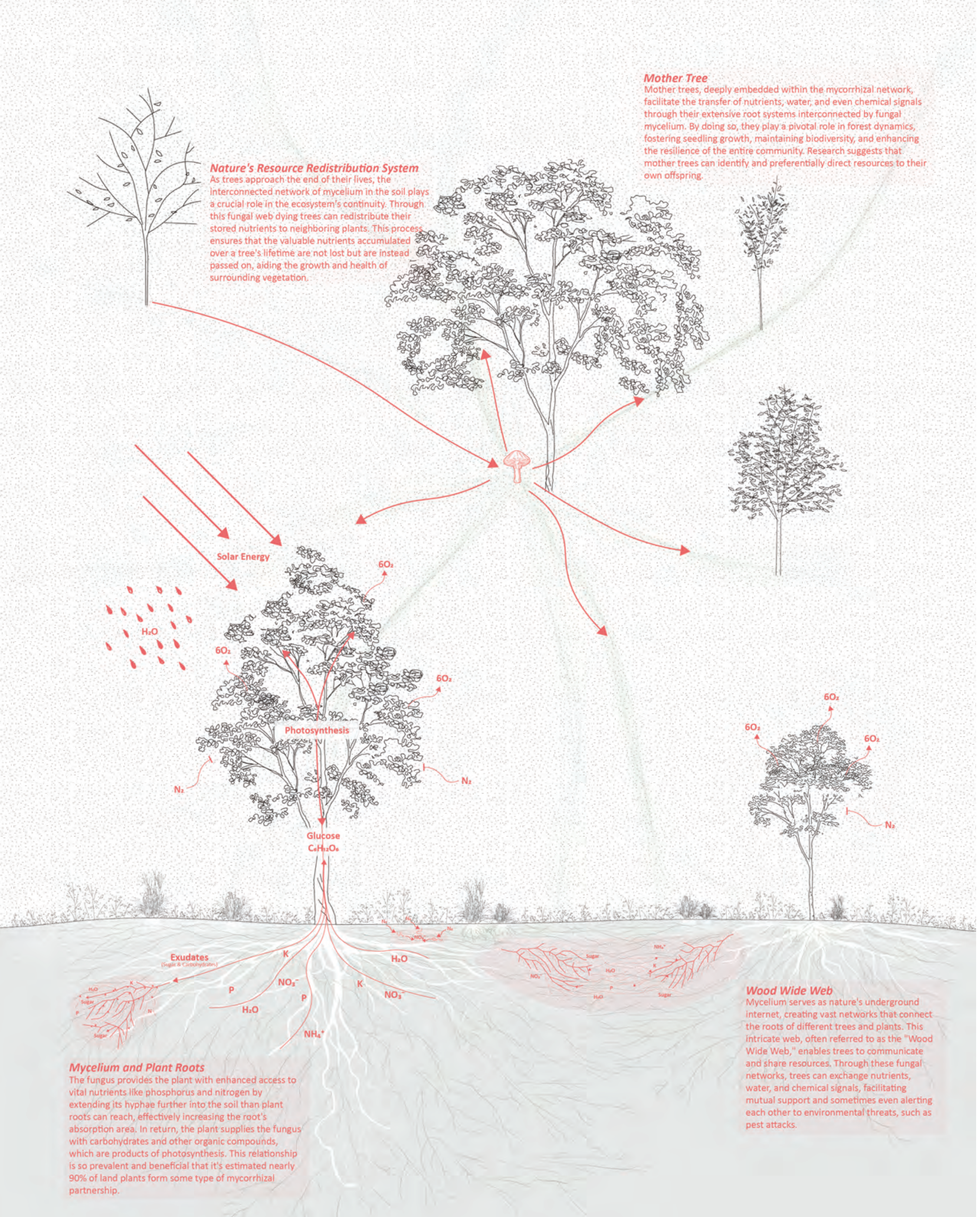
Section Perspective

02 REWILDING

Instructors | Philippe Rahm & Mariami Maghlakelidze
Program | Cooling Center
Site | Columbia University, New York

To address New York's escalating heatwaves due to global warming and the challenges to our soil and food systems, this project proposes a "Coldhouse." It explores alternative food systems such as insect farming and mushroom cultivation, offering sustainable solutions with minimal environmental impact. Additionally, it advocates for revitalizing campus landscapes, moving away from labor-intensive lawn maintenance reliant on pesticides and fertilizers to cultivating wildflowers and fostering biodiversity. Designed as a climatic refuge for both humans and wildlife, the "cold house" harnesses nature's elements to create a subtly cooled, semi-outdoor space conducive to exploration and innovation.

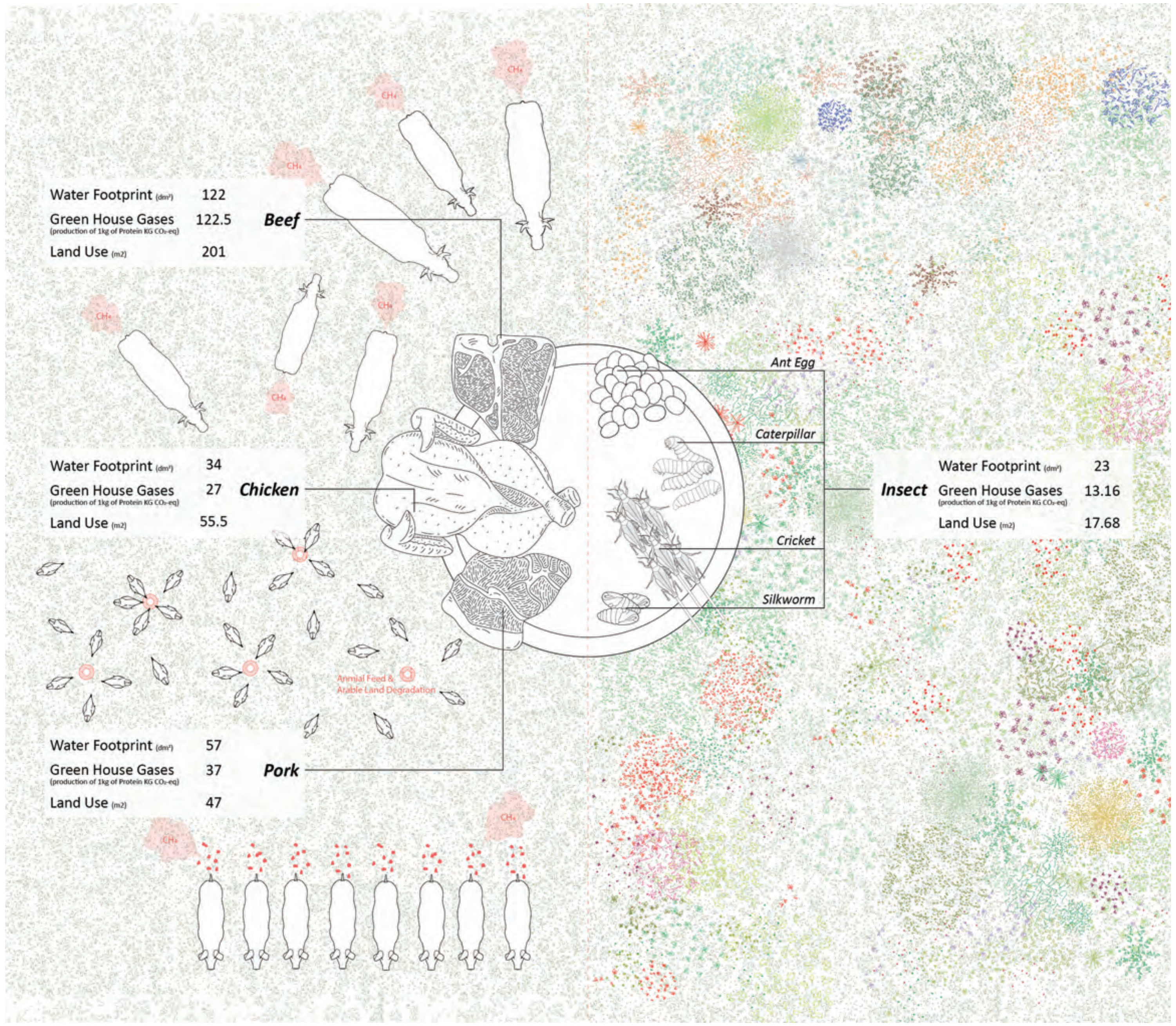
Exterior Perspective



Soil & Mycelium

Program Analysis

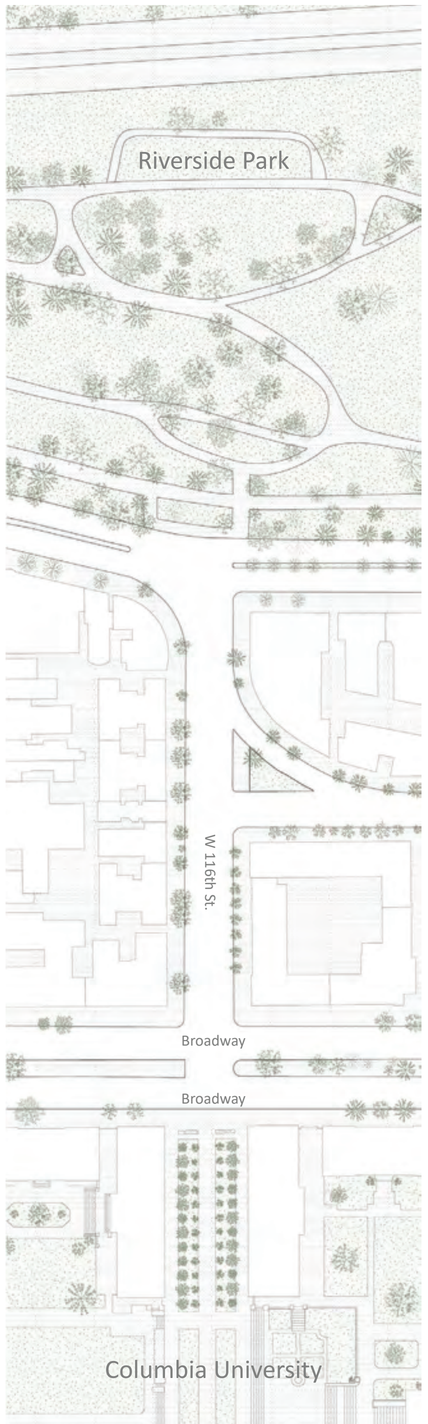
Soil, serving as Earth's primary nutritional foundation, harbors essential nutrients vital for life. Beneath its surface lies a complex ecosystem, where plants contribute up to 40% of their carbon-rich compounds, nourishing fungi and bacteria. This symbiosis facilitates organic matter decomposition, enriching the soil with nutrients crucial for plant growth while storing 75% of terrestrial carbon underground. However, current agricultural practices, reliant on monoculture farming, degrade arable land, exacerbated by global warming. Insect farming and mushroom cultivation offer sustainable solutions, with minimal water usage and greenhouse gas emissions. These methods tap into the richness of soil and mycelium networks, providing nourishment and presenting a compelling path toward resilient, eco-friendly food production.



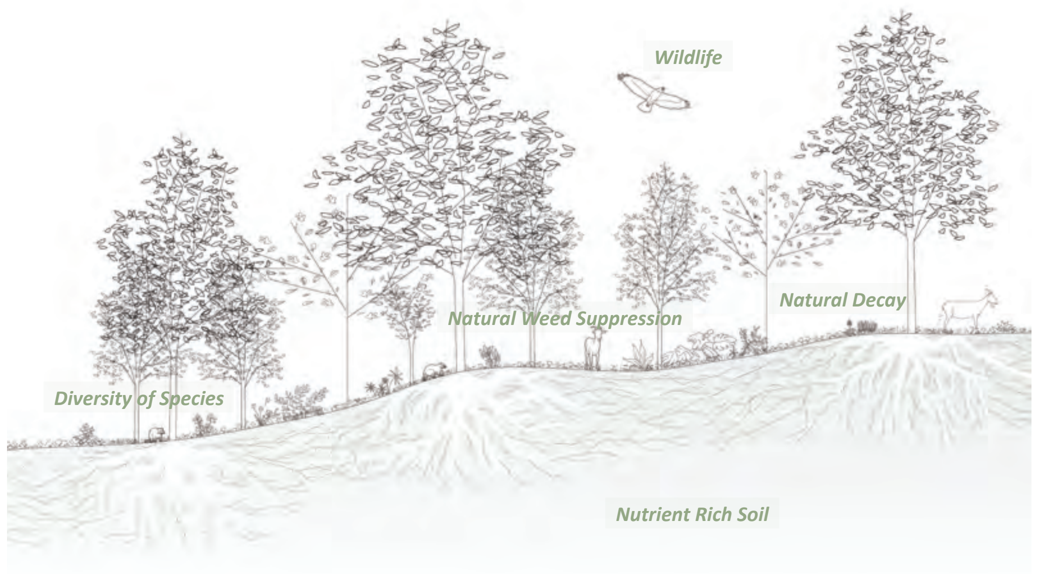
Alternative Food System

Site Analysis

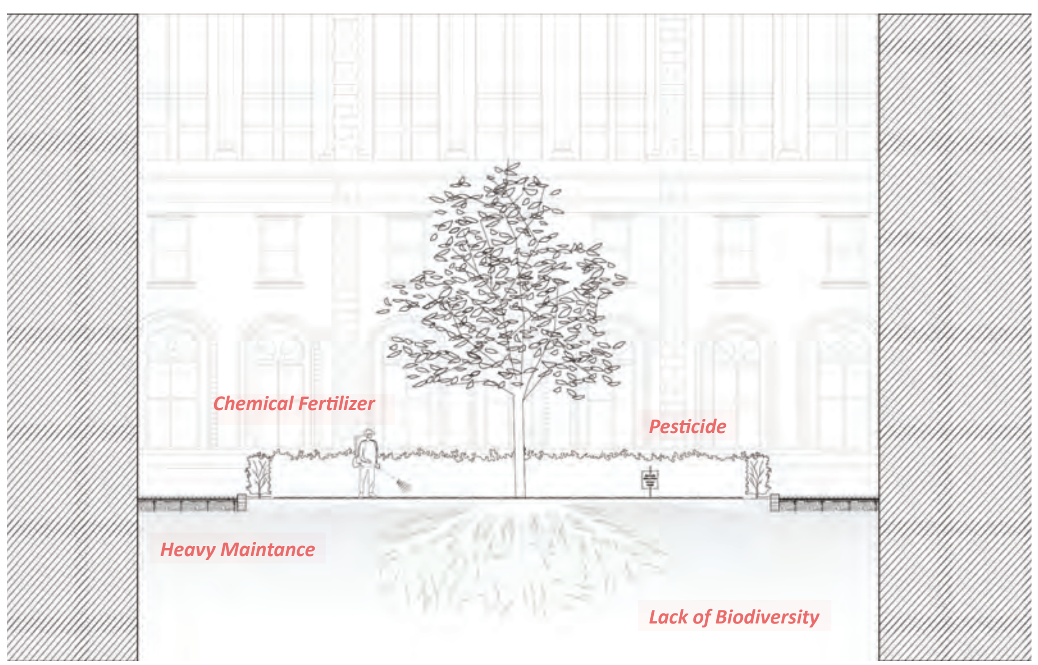
When we examine the soil conditions on our site in comparison to the nearby Riverside Park a significant disparity becomes evident. Unlike the thriving ecosystem in Riverside Park, the Columbia campus relies heavily on labor-intensive maintenance, along with the use of pesticides and fertilizers, to maintain a nice clean lawn.



Existing Site Plan

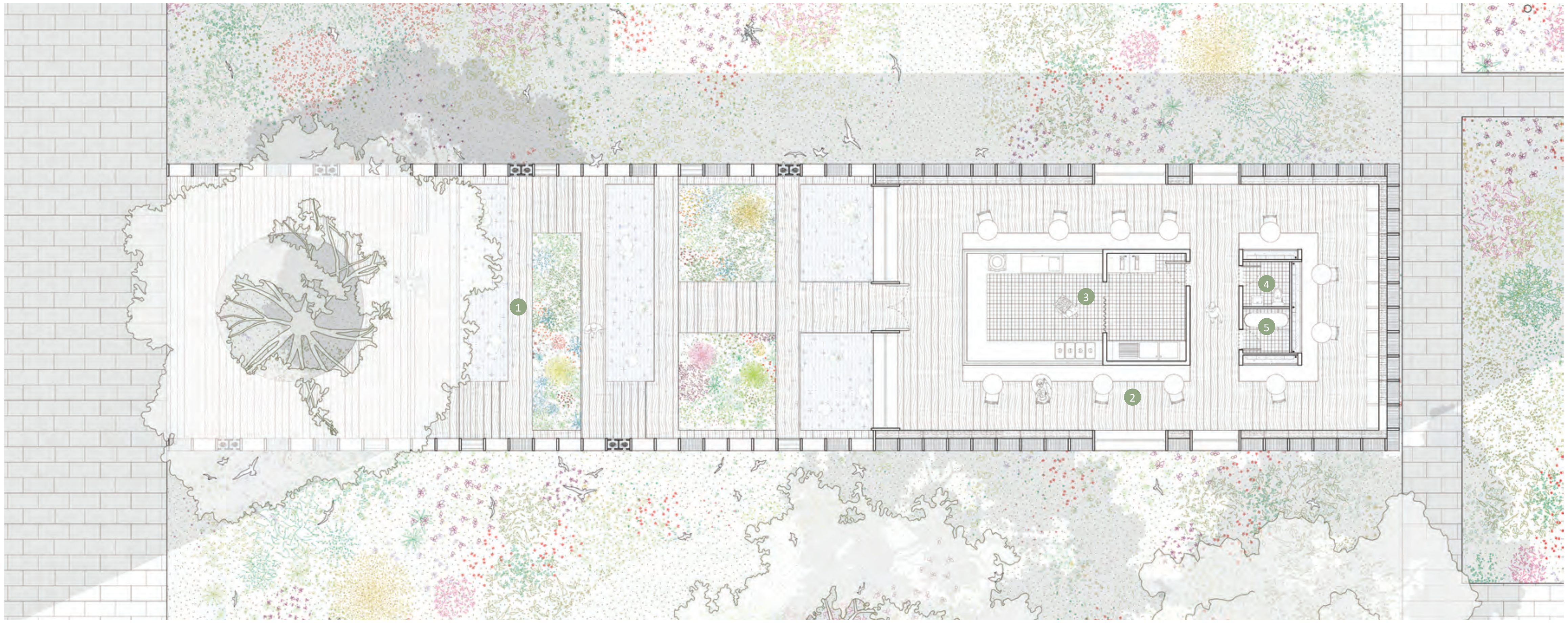


Riverside Park Section



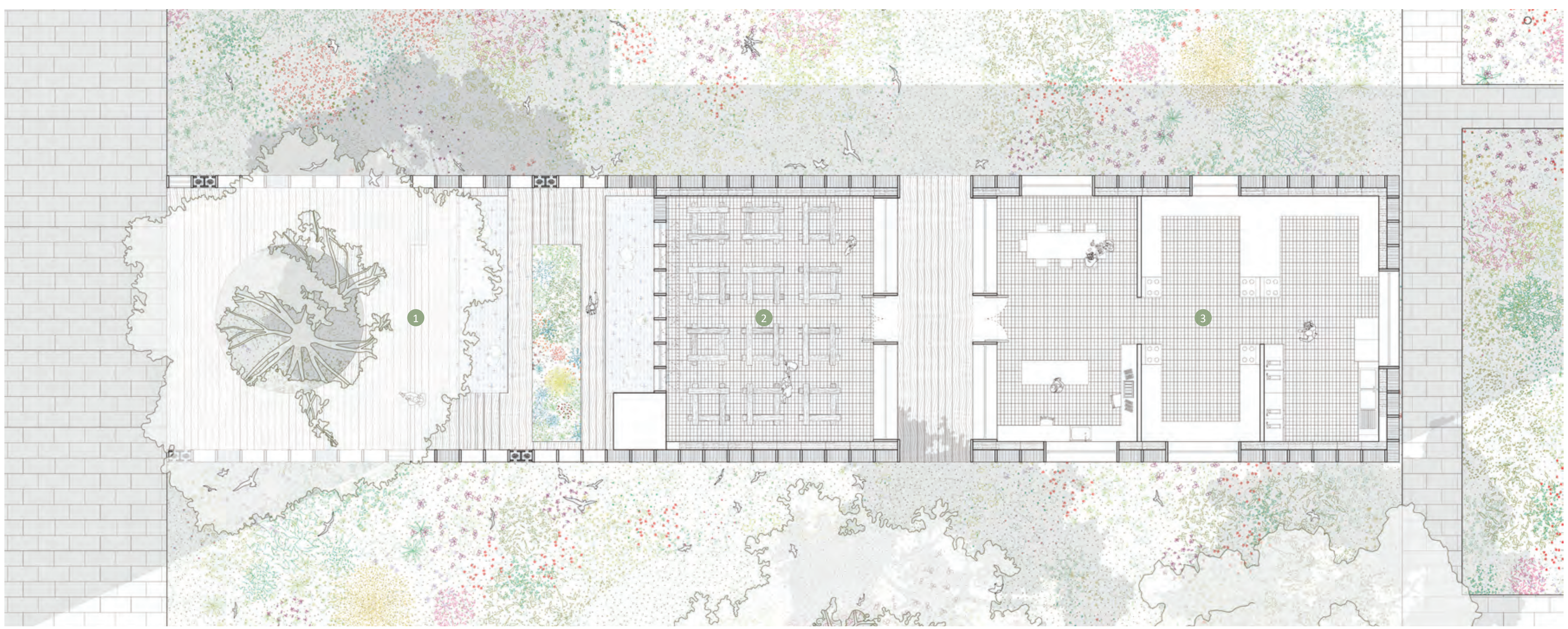
Columbia Campus Section

Proposed Site Plan



Second Floor Plan

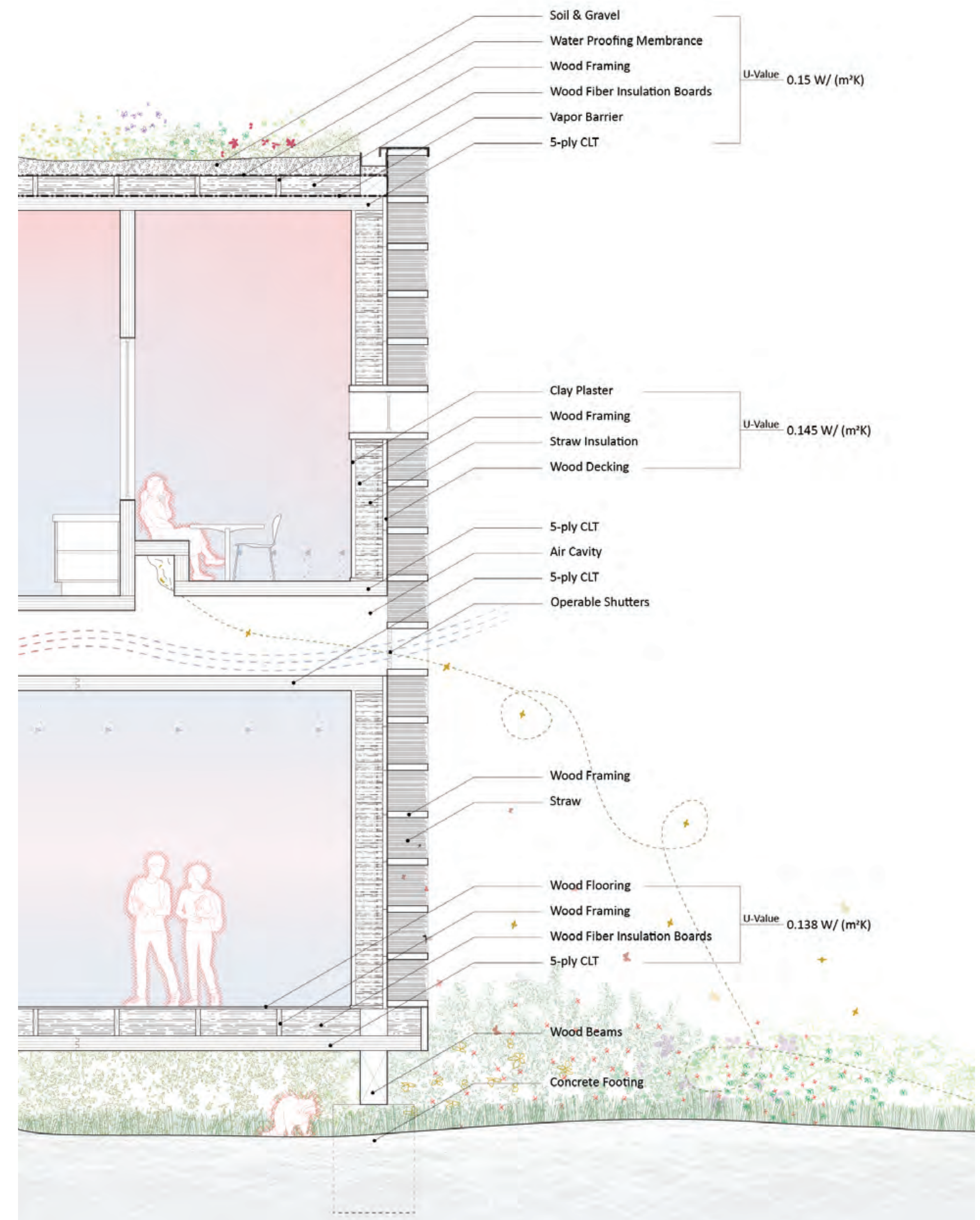
1. Cooling Garden
2. Dinning Area
3. Kitchen
4. Restroom
5. Greywater Processing Room



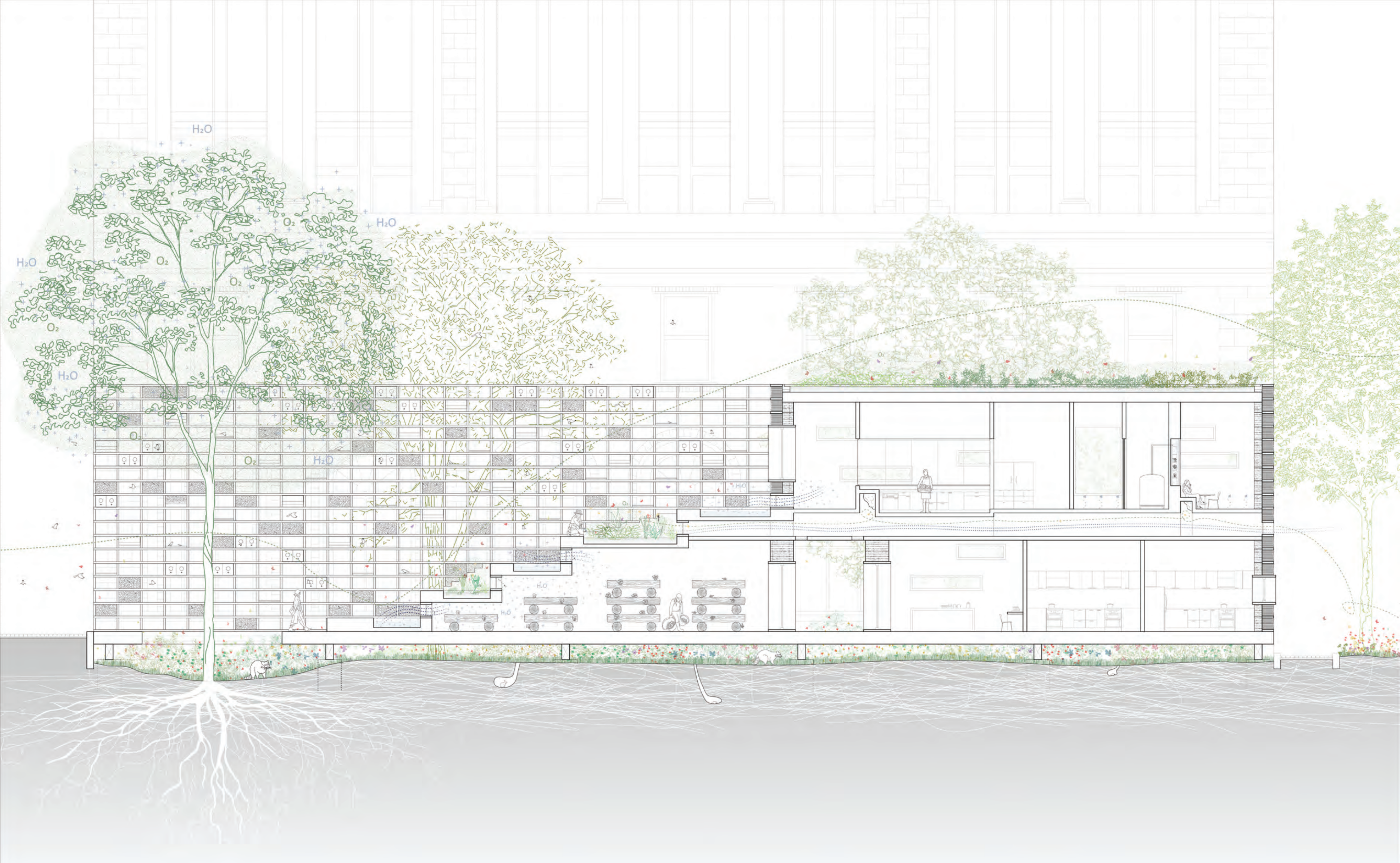
Ground Floor Plan

1. Cooling Garden
2. Mushroom Cultivation Lab
3. Research Center

Interior Perspective



Detail Section

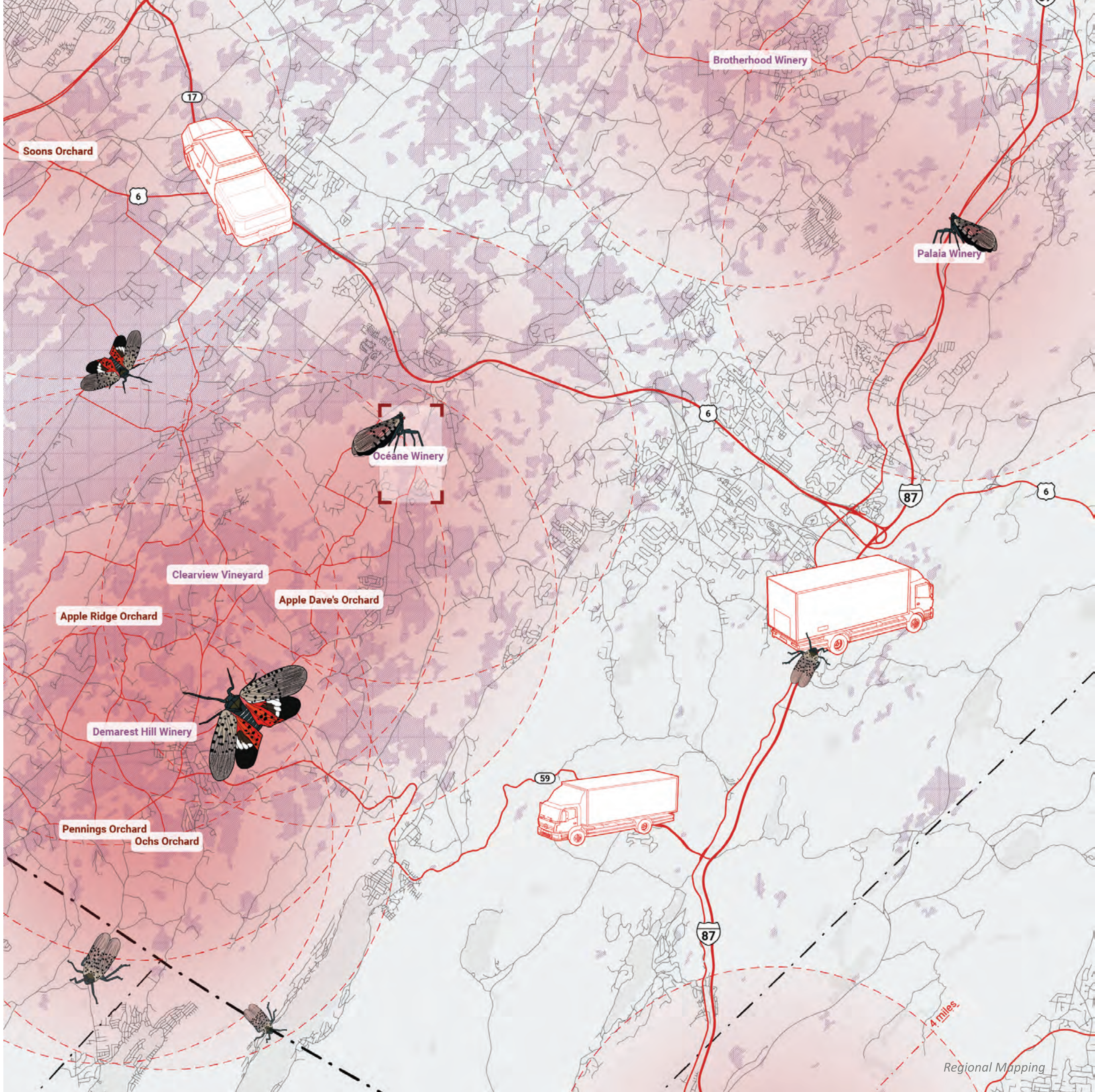


Longitudinal Section

03 ECO-WINE +

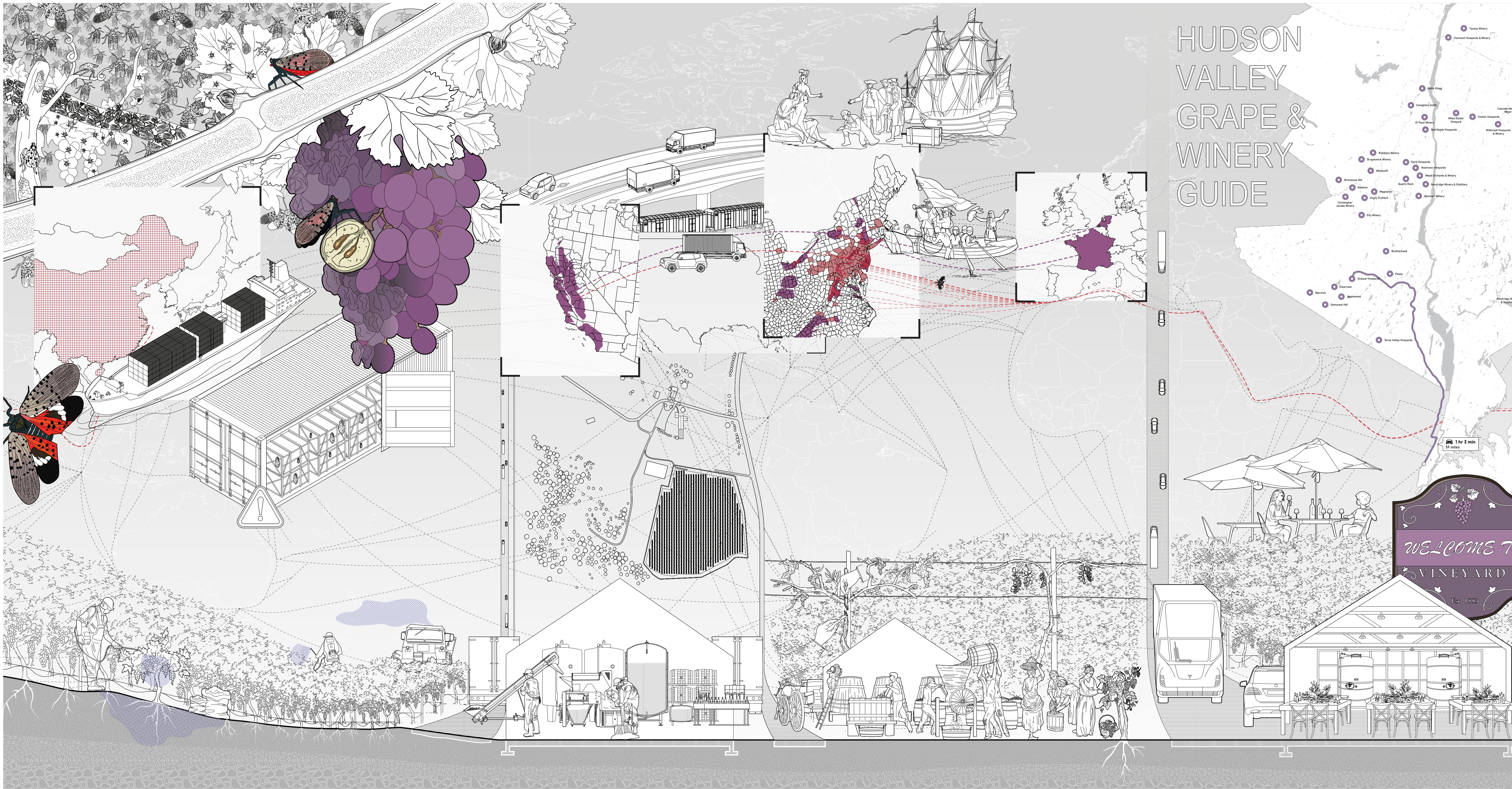
Instructors | Feifei Zhou & Galen Pardee
Collaborator | Wei Xiao
Program | Winery
Site | Orange County, New York

The global industrialization of trade has facilitated the movement of goods and people across the world at an unprecedented scale, leading to the inadvertent spread of invasive species to new habitats. Unfortunately, this has also become a growing concern for wineries, as their monoculture practices make them highly susceptible to the adverse effects of invasive species. Our project aims to mitigate this risk by using biodiversity as a design tool to promote natural balances between different species. By implementing inter-cropping techniques, we aim to diversify production patterns and achieve consistent economic outcomes throughout the year, while also aligning with the farm-to-table movement by promoting sustainable agricultural practices that prioritize the health of the environment and consumers.



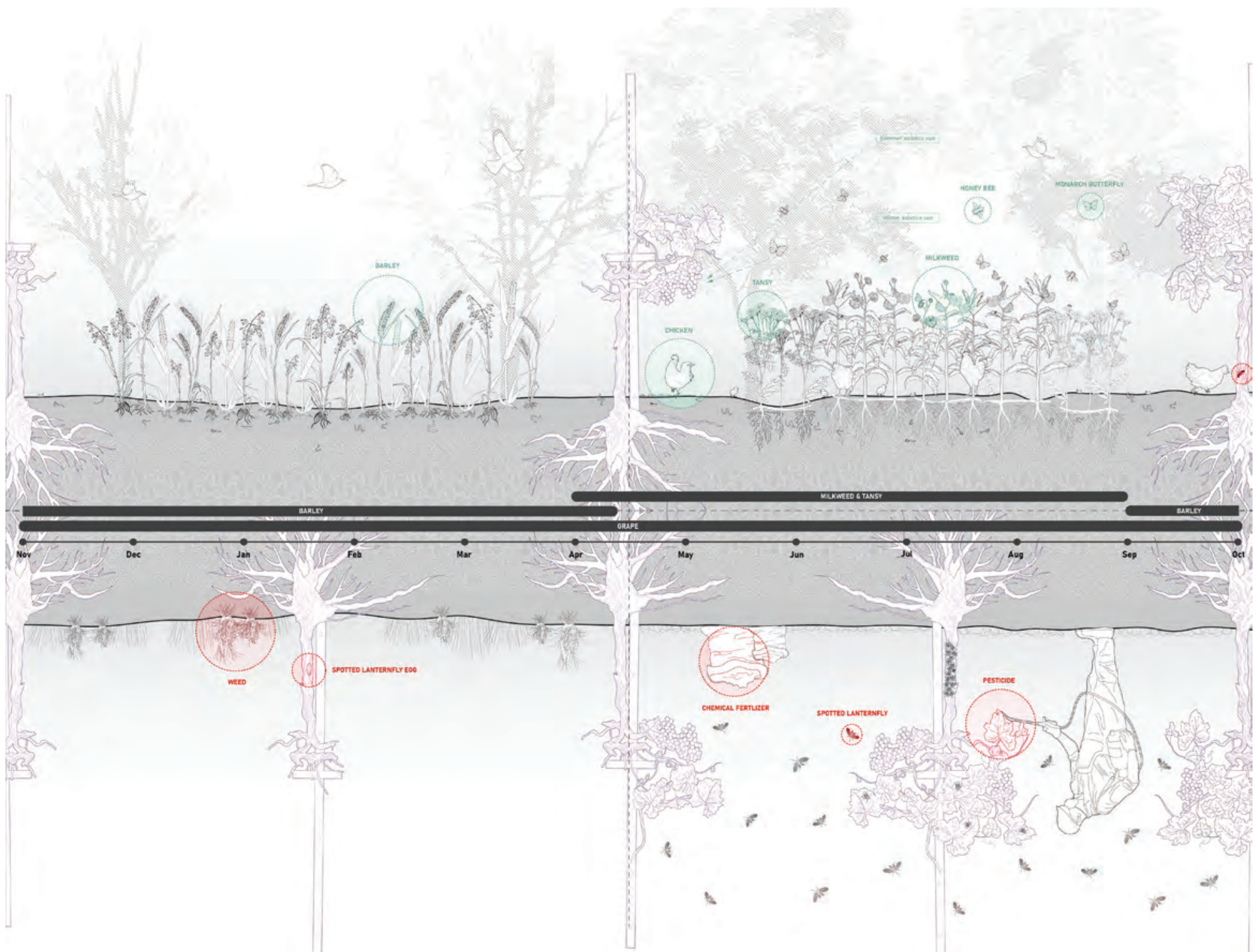
Program Analysis

The Hudson Valley region, dating back to the 1600s as the oldest grape harvesting and wine-making area, has become a prominent brand for New York State's tourism industry, housing over 80 vineyards across its five counties that contribute significantly to the regional economy. However, the grape harvesting process involves larger global networks of product and climate change, which pose various environmental and humanistic challenges. Modern commercial grape farms rely heavily on machinery, chemical pesticides, and fertilizers, which have adverse effects on the environment. Moreover, the invasion of spotted lanternflies, which originated from East Asia, is an additional challenge to the grape and winery industries. These insects were introduced to the United States via cargo shipments and have now spread to neighboring states. The lanternflies consume carbohydrates and nitrogen stored in grapevines, thus reducing vine health. This poses a significant threat to vineyards in Orange County, which are clustered and connected by roads, making them more susceptible to the invasion. Recently, vineyard owners in the area reported seeing spotted lanternflies in their fields. Recently, vineyard owners in the area reported seeing spotted lanternflies in their fields.

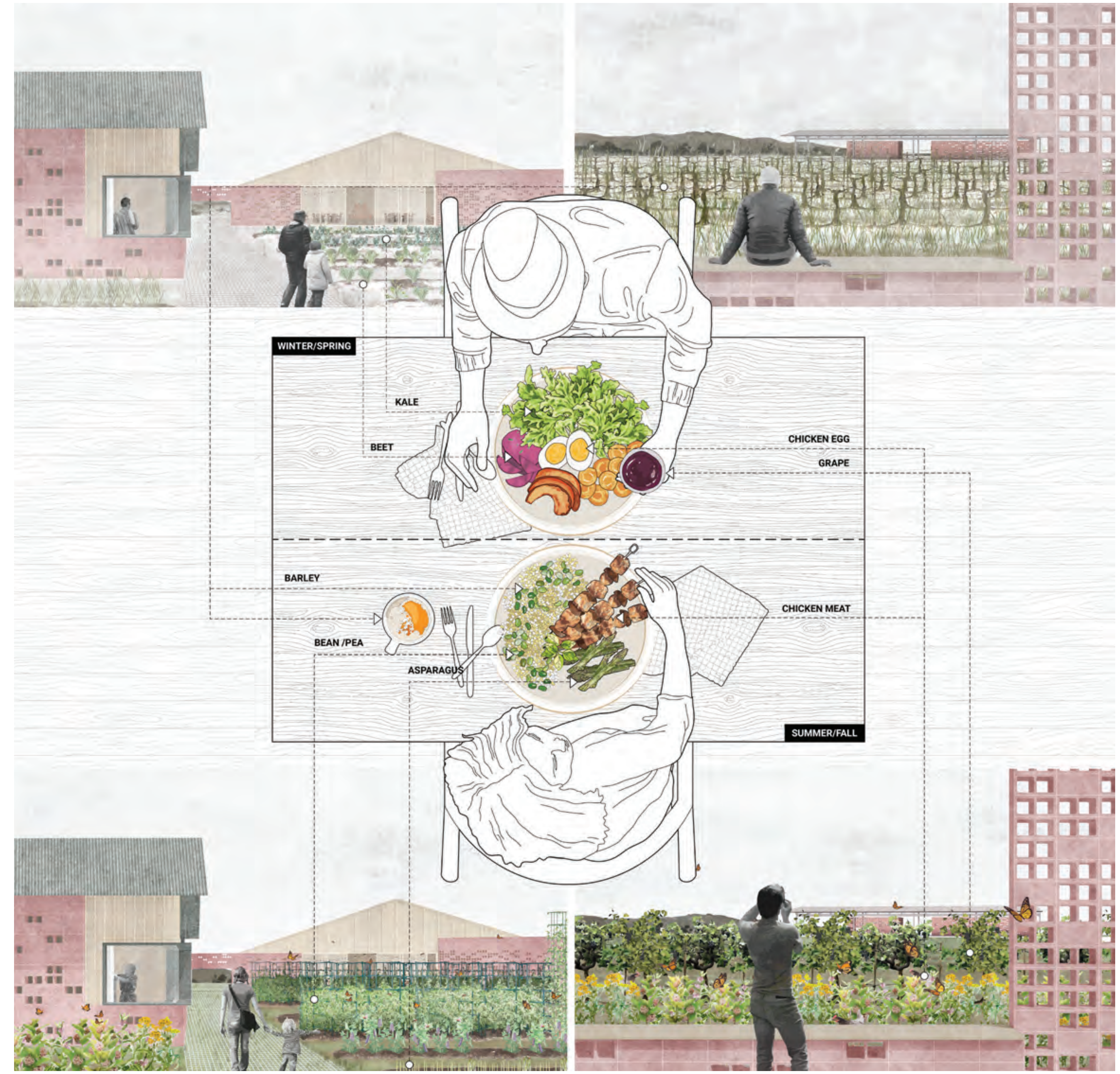


Design for Biodiversity

Currently, the grapevine rows are densely planted, with an eight-foot gap between them and no intercropping, creating favorable conditions for the spread of the spotted lanternfly. To counter this, the proposal involves doubling the spacing between the rows and introducing milkweed and tansy during the summer and fall. These plants are toxic to the spotted lanternfly and also attract beneficial insects like monarch butterflies and bees, significantly enhancing biodiversity in these seasons. Additionally, chickens are integrated into this ecosystem. They serve as natural predators to various invasive insects, including the lanternfly, and their droppings enrich the soil as a natural fertilizer. In the colder months of winter and spring, barley will be cultivated. This crop not only diversifies the produce, making it possible to brew beer, but also acts as a natural fertilizer when used as a cover crop. This rotational farming strategy ensures continuous production and diversifies what was previously a monocultural system.



Crop Field Intervention



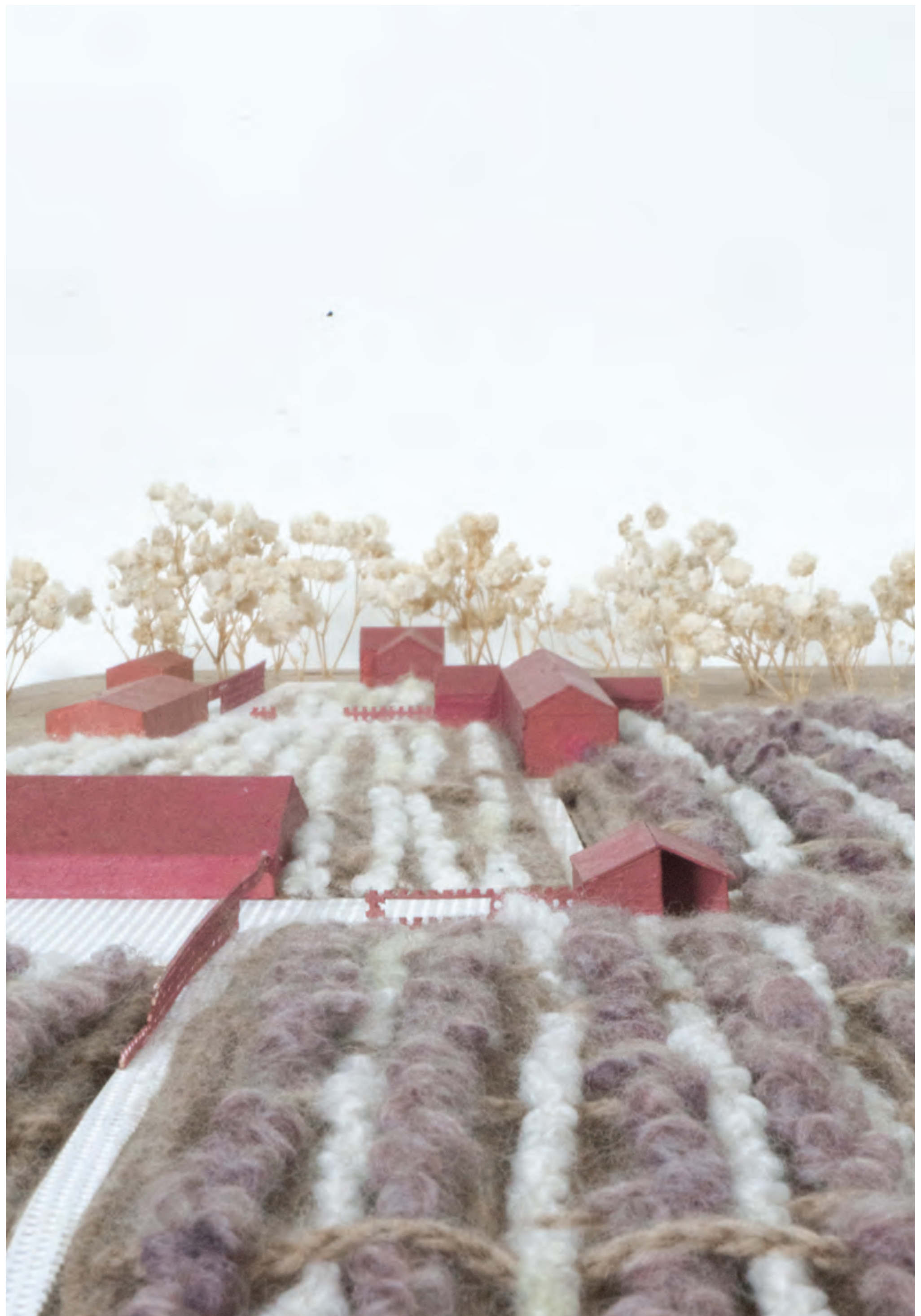
Seasonal Dishes

Design for Economic Resilience

The singularity of winery products often results in unprofitable winter seasons. To address this, two smaller crop fields have been introduced, utilizing previously unused spaces between buildings. This adaptation not only allows for the on-site production of additional vegetables but also enhances the farm-to-table model, helping the winery achieve consistent economic outcomes year-round.

Design for Integration

On a building scale, the existing structures are reorganized to accommodate farm programs, alongside the addition of five new buildings. These include a farm-to-table dining hall with production spaces, a worker resting station, a plant nursery center, and a lab/education facility for collaborative research. These structures seamlessly integrate with existing circulation paths throughout the growing fields, fostering a closer connection between consumption and production, as well as between users and the environment.



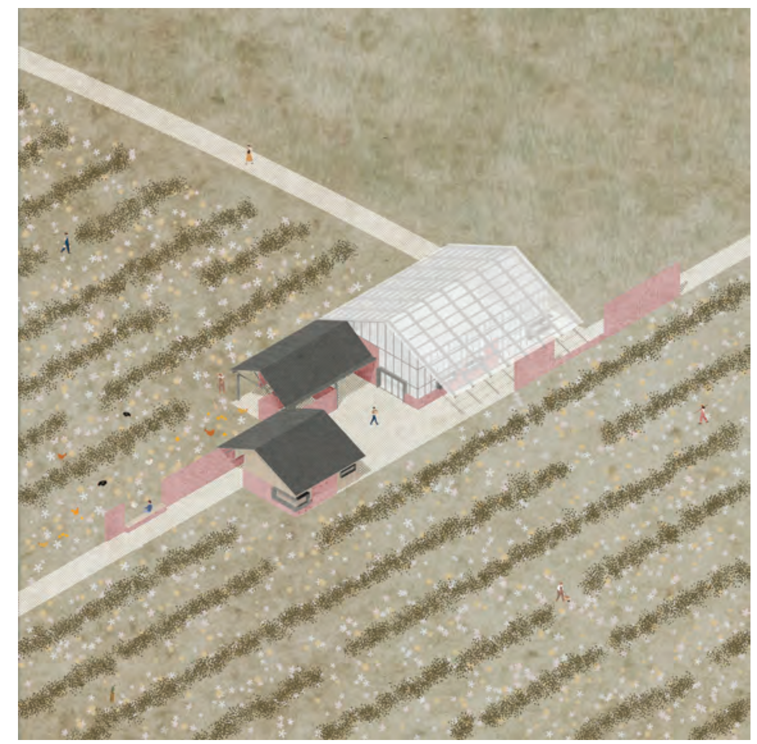
Physical Model

Site Plan

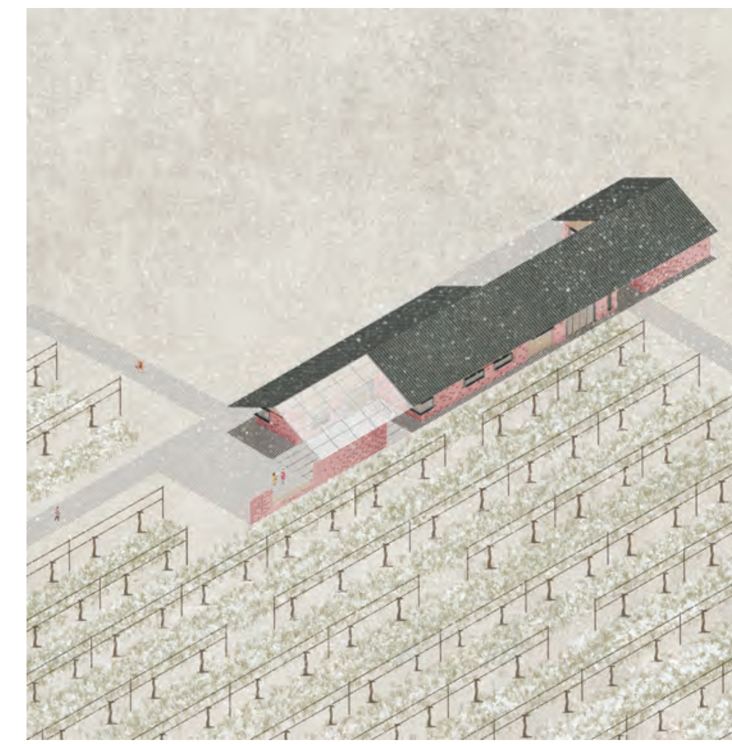
1. Visitor Center
2. Storage
3. Crop Field
4. Grape Field
5. Garage
6. Food Processing Area
7. Farm Kitchen with Winery & Brewery
8. Worker Resting Station
9. Chicken Coop
10. Plant Nursry Center
11. Research & Education Center

Farm Kitchen with Winery & Brewery

Worker Resting Station



Plant Nursry Center



Research & Education Center

Building Materials

Rammed earth masonry blocks have been incorporated alongside the existing wood and metal panel construction techniques. The porous nature of this material not only facilitates visual and light connections across the landscape and between rooms but also provides habitats for various insect species.

Floor Plan & Site Section

04 SCHOOL WITHIN SCHOOL

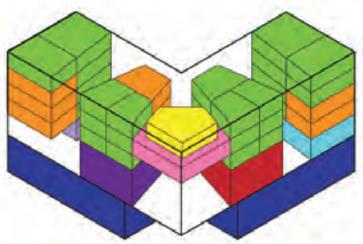
Instructors | Travis Allen & Michael Esposito
Aaron Davis & Ayumi Sugiyama
Collaborator | Yichun Liu & Han Qin
Jinghan Wang & Wei Xiao
Program | K-12 School
Site | East Village, New York

In school, students not only learn from teachers but also from their classmates, fostering connections within and across grades. This project aims to strengthen these connections by providing numerous optional communication spaces. By breaking up the building mass and incorporating open corridors and stairs, it facilitates movement and interaction, promoting both visual connectivity and physical engagement. Guided by the concept of solid versus void, the design strategically divides educational programs into sequential rhythms adaptable to varying levels of privacy. This results in a configuration of individual buildings under a larger enclosure framework, interconnected by circulation corridors and stairs weaving through central atriums.

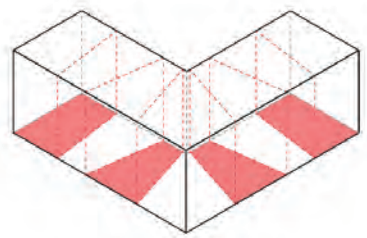
Section Perspective

Solid vs. Void

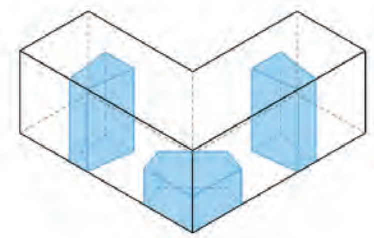
Guided by the concept of solid versus void, the project strategically divides educational programs into a rhythmic sequence that aligns with the spatial distribution of public versus private areas. This approach fosters a configuration of individual buildings within a broader architectural framework, linked through corridors and stairways that converge in central atriums, ensuring fluid movement and connectivity.



Solid as Enclosed Space



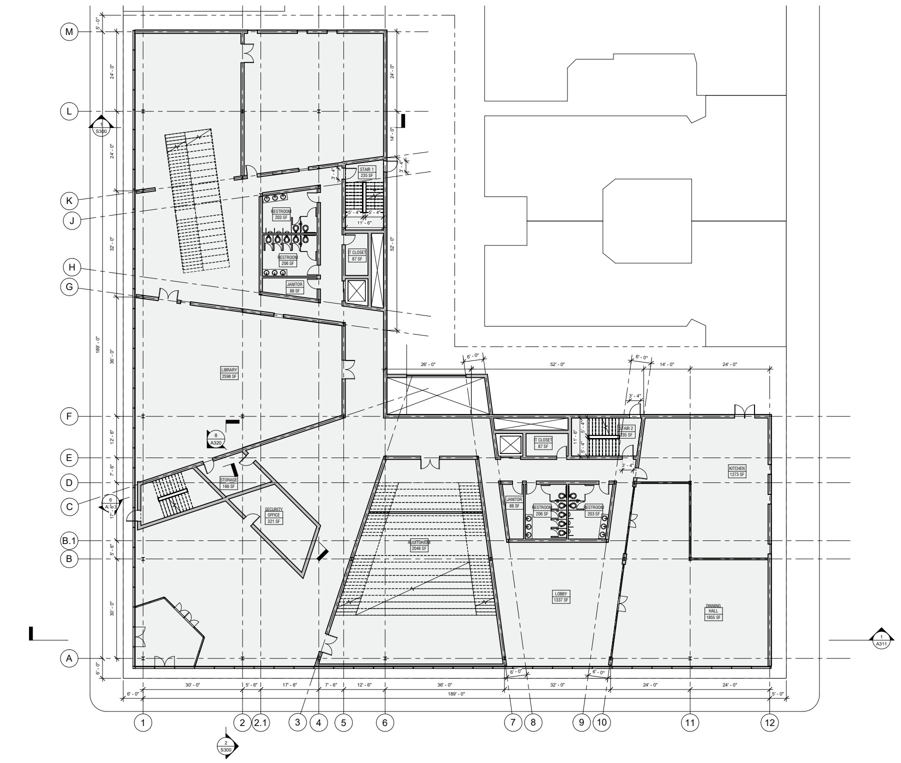
Solid vs. Void



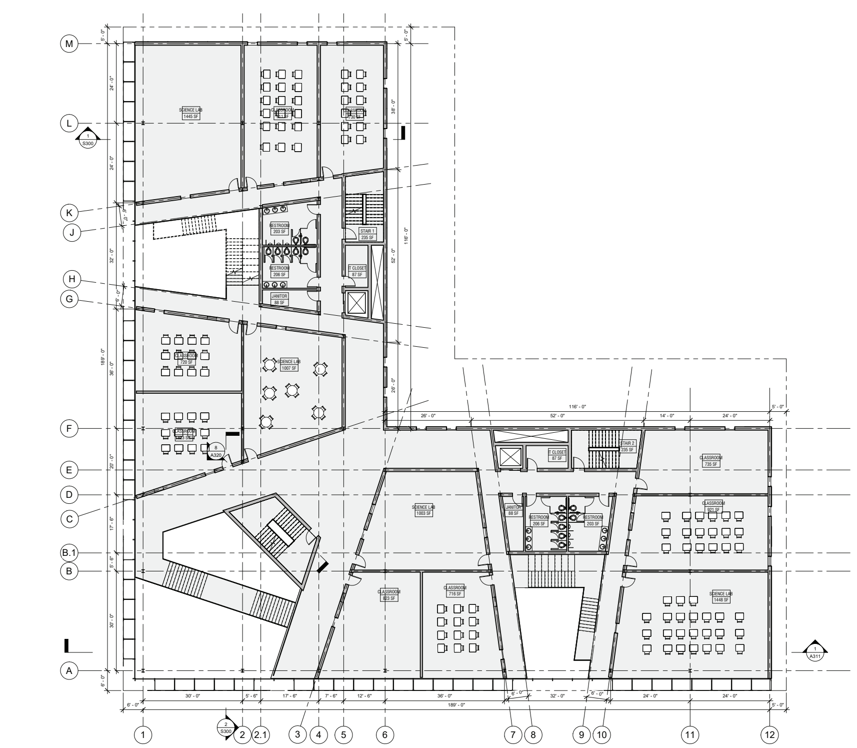
Void as Open Space

Concept Diagram

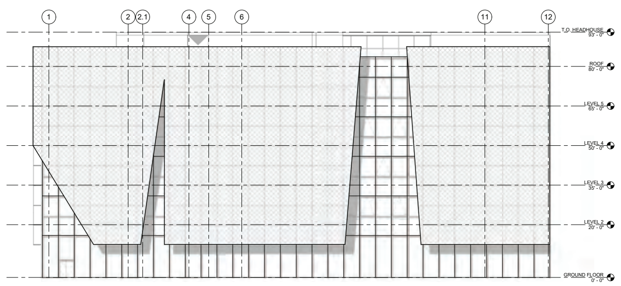
Interior Perspective



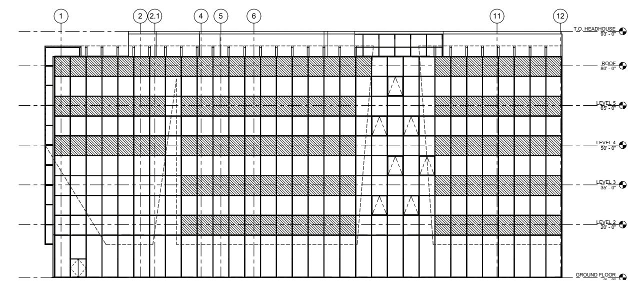
Ground Floor Plan



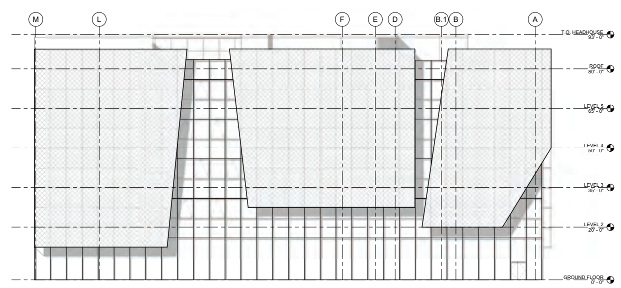
Level 3 Floor Plan



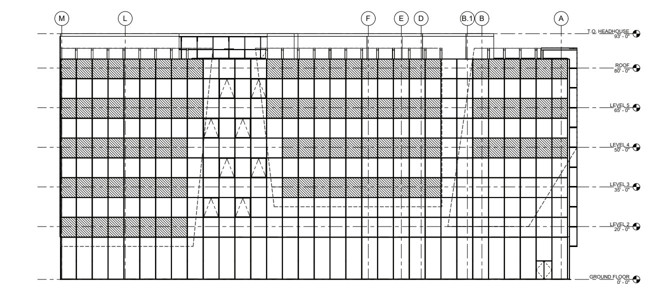
South Elevation



South Elevation Without Screen

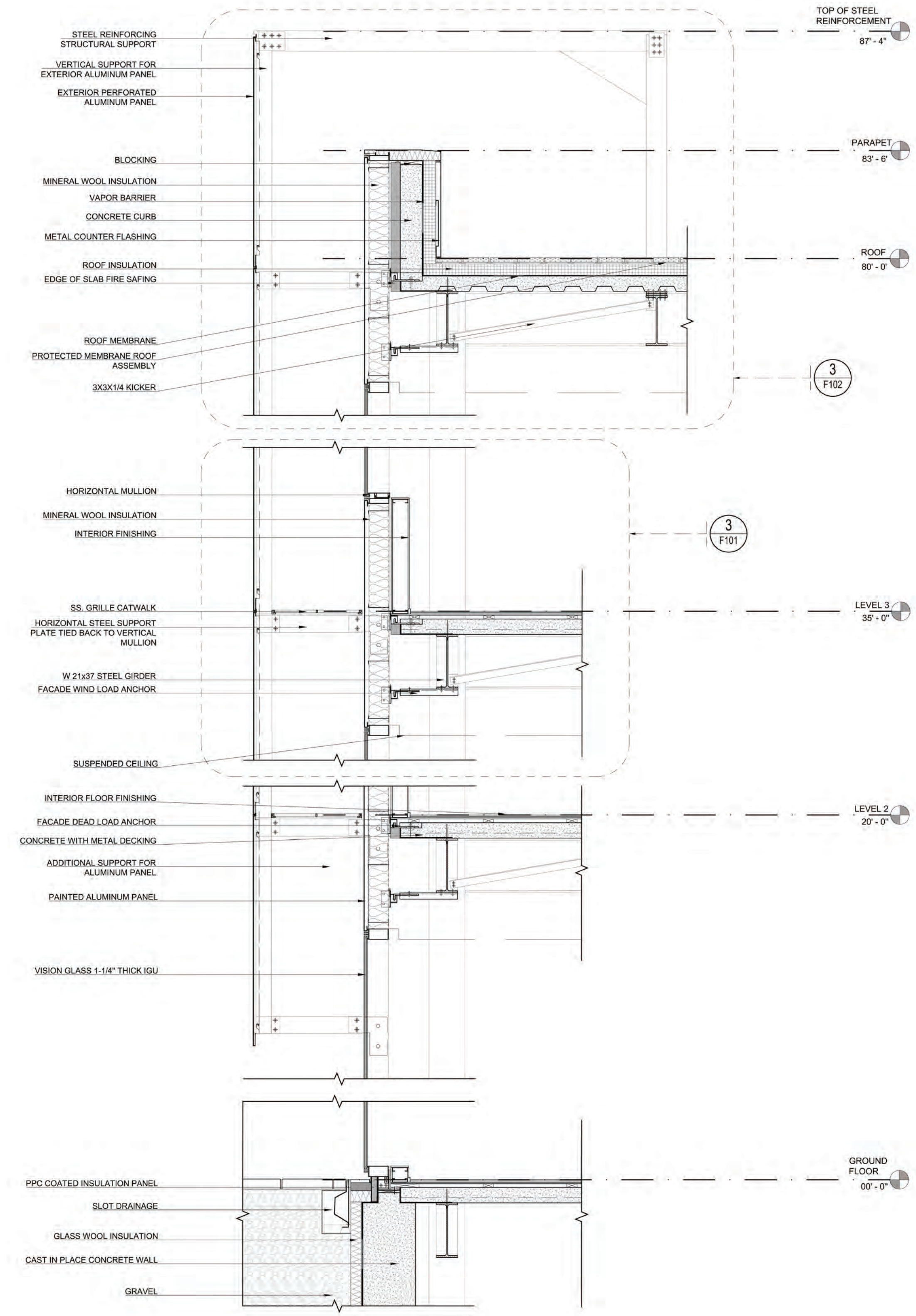


West Elevation

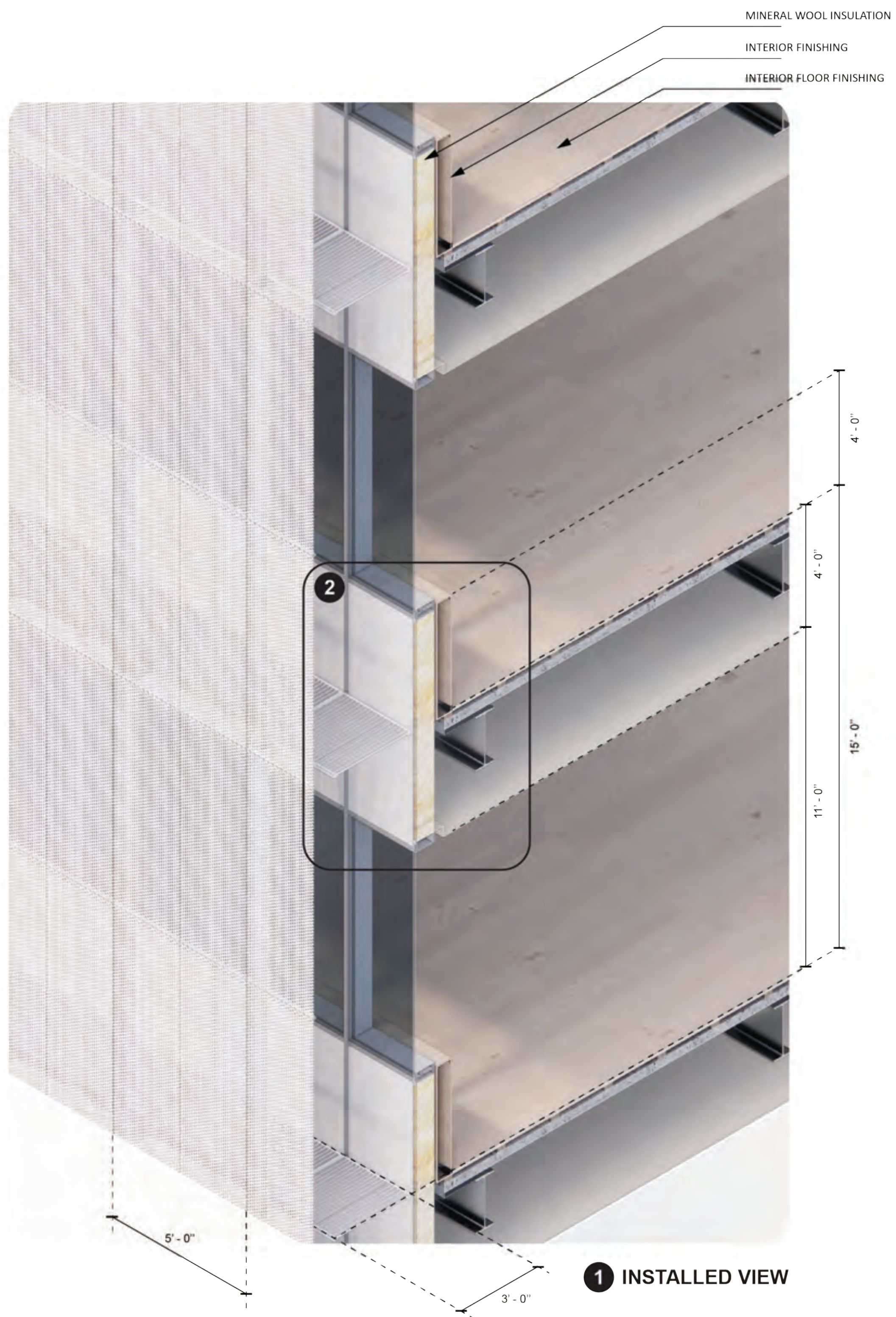


West Elevation Without Screen

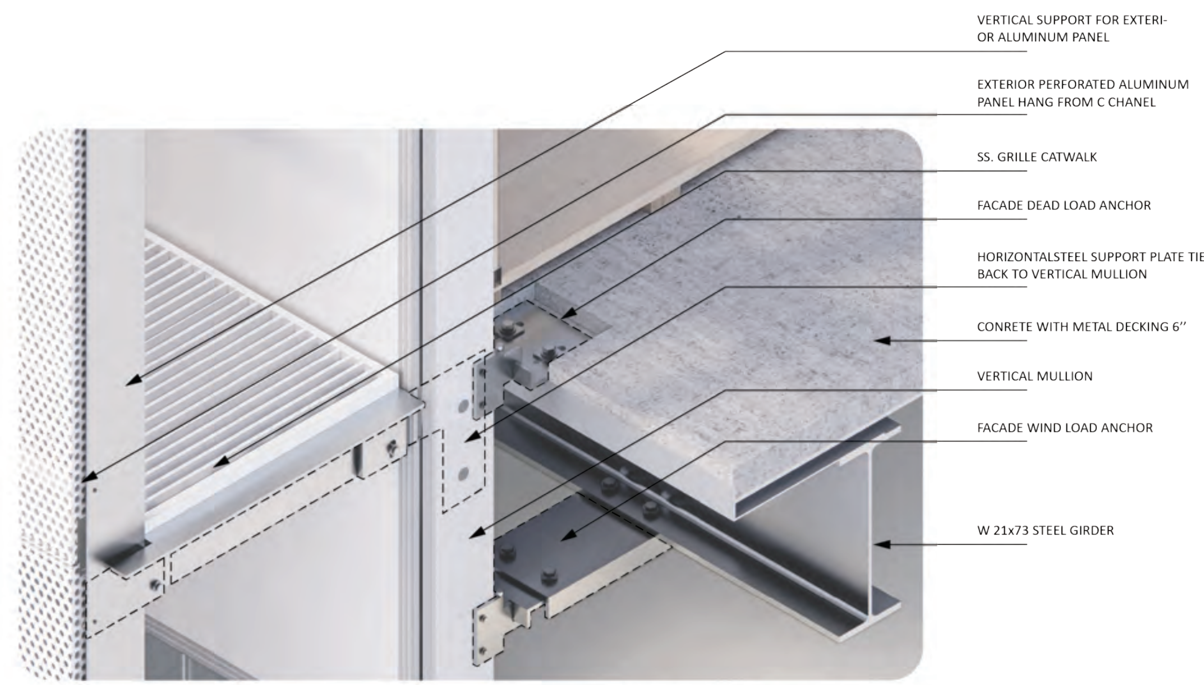
Exterior Perspective



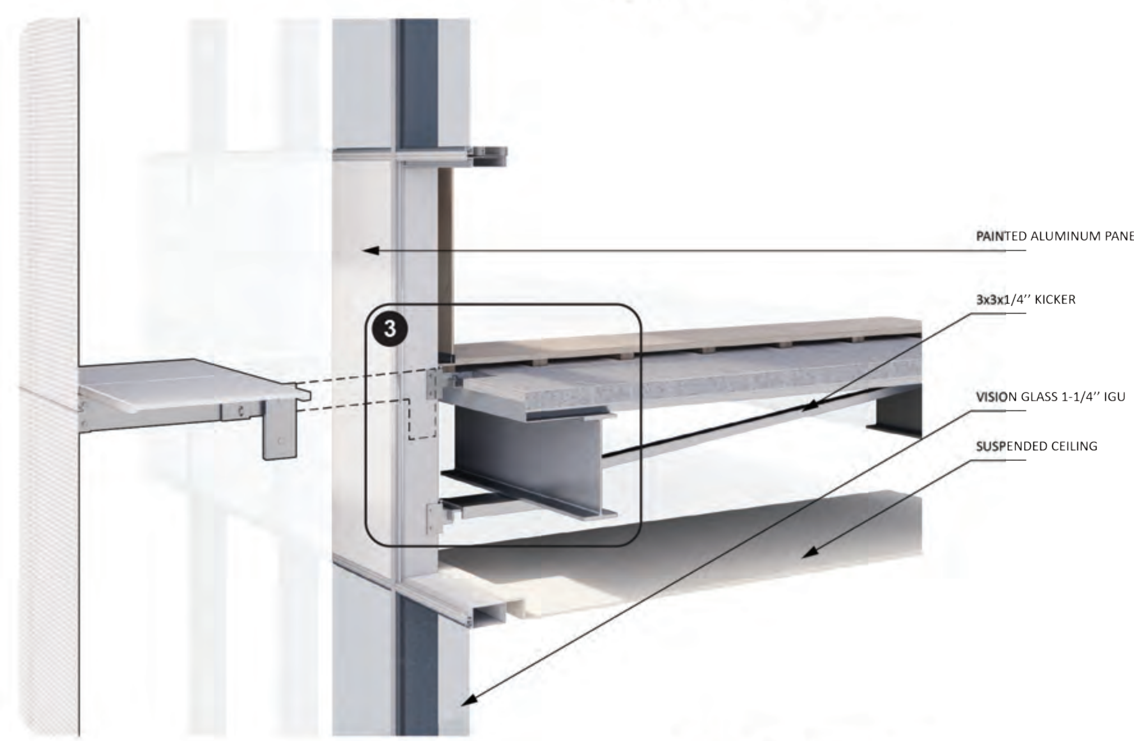
Double Facade Full Section



1 INSTALLED VIEW



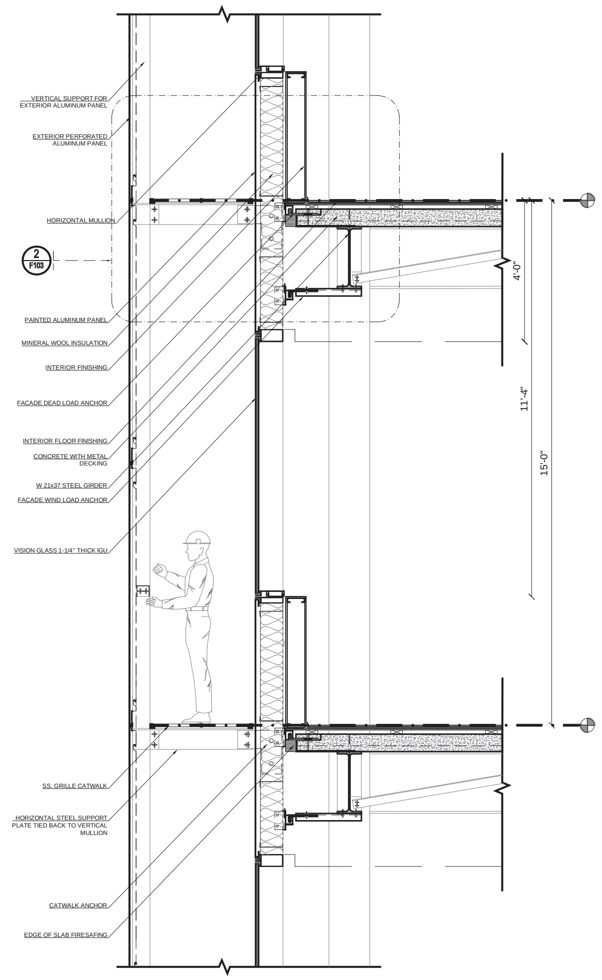
3 CONNECTION DETAILS



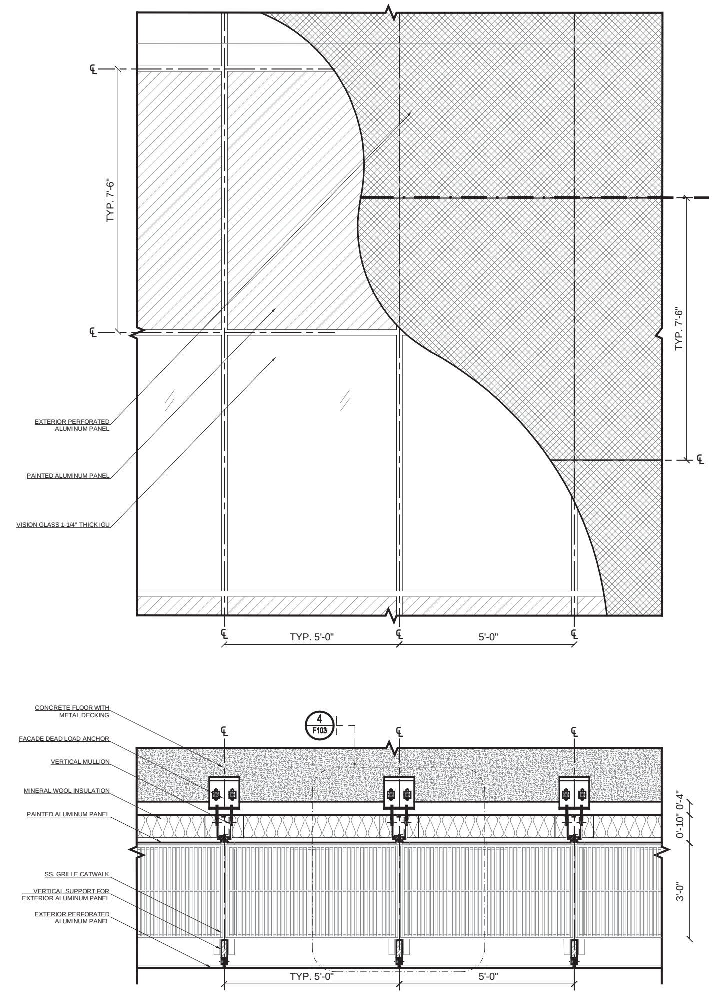
2 EXPLODED VIEW

Hanging Facade

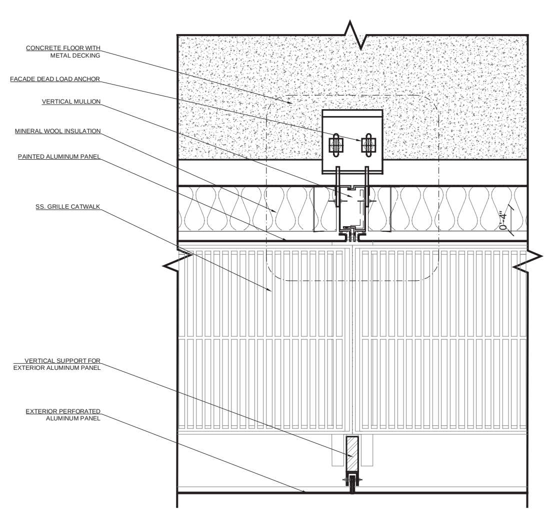
The double-skin facade system was developed based on the concept of hanging, driven by practical considerations of dead load and wind load transition from building envelope to interior structure as an integral system. This system integrates perforated aluminum panels mounted on steel framing, adding an extra layer to the building envelope. These are supported by horizontal steel plates that tie back to vertical curtain wall mullions, with additional reinforcement through anchors and kickers connecting to the primary building structure.



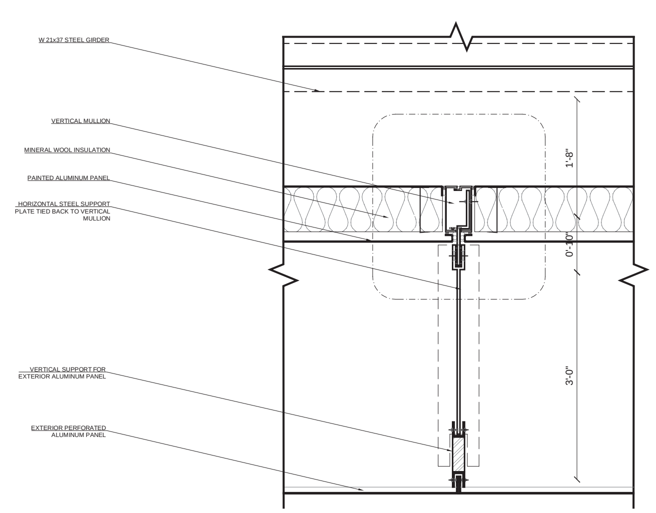
Double Facade Section



Double Facade Elevation & Plan



Double Facade Detail

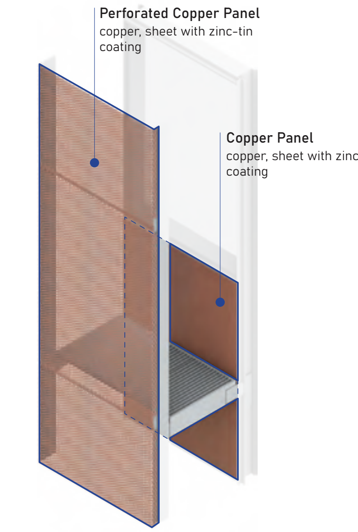


Double Facade Detail

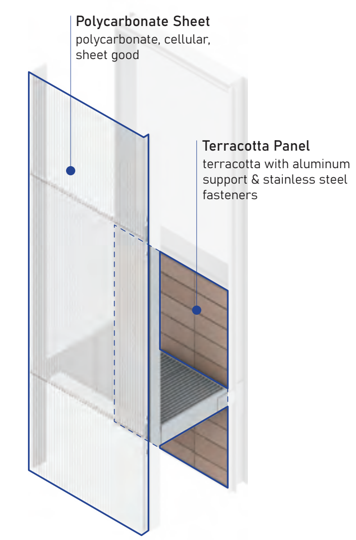
DESIGN OPTIONS

PRIMARY DESIGN OPTION 1

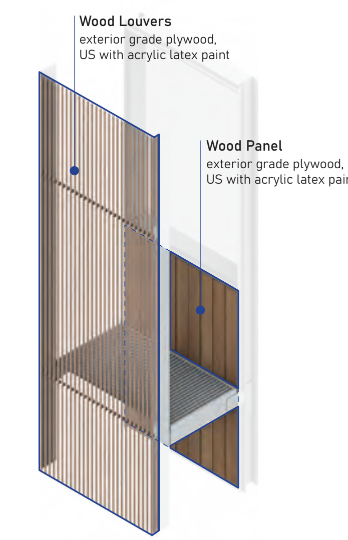
DESIGN OPTION 2



DESIGN OPTION 3

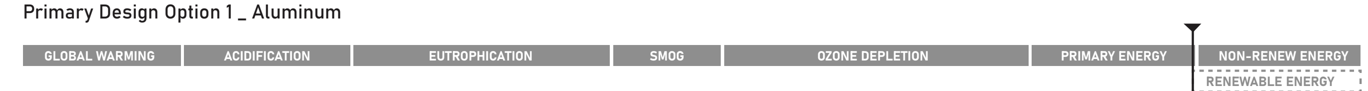


DESIGN OPTION 4

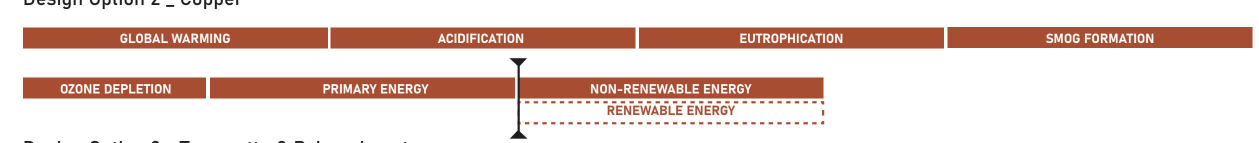


OVERALL PERFORMANCE COMPARISON

Primary Design Option 1 _ Aluminum



Design Option 2 _ Copper



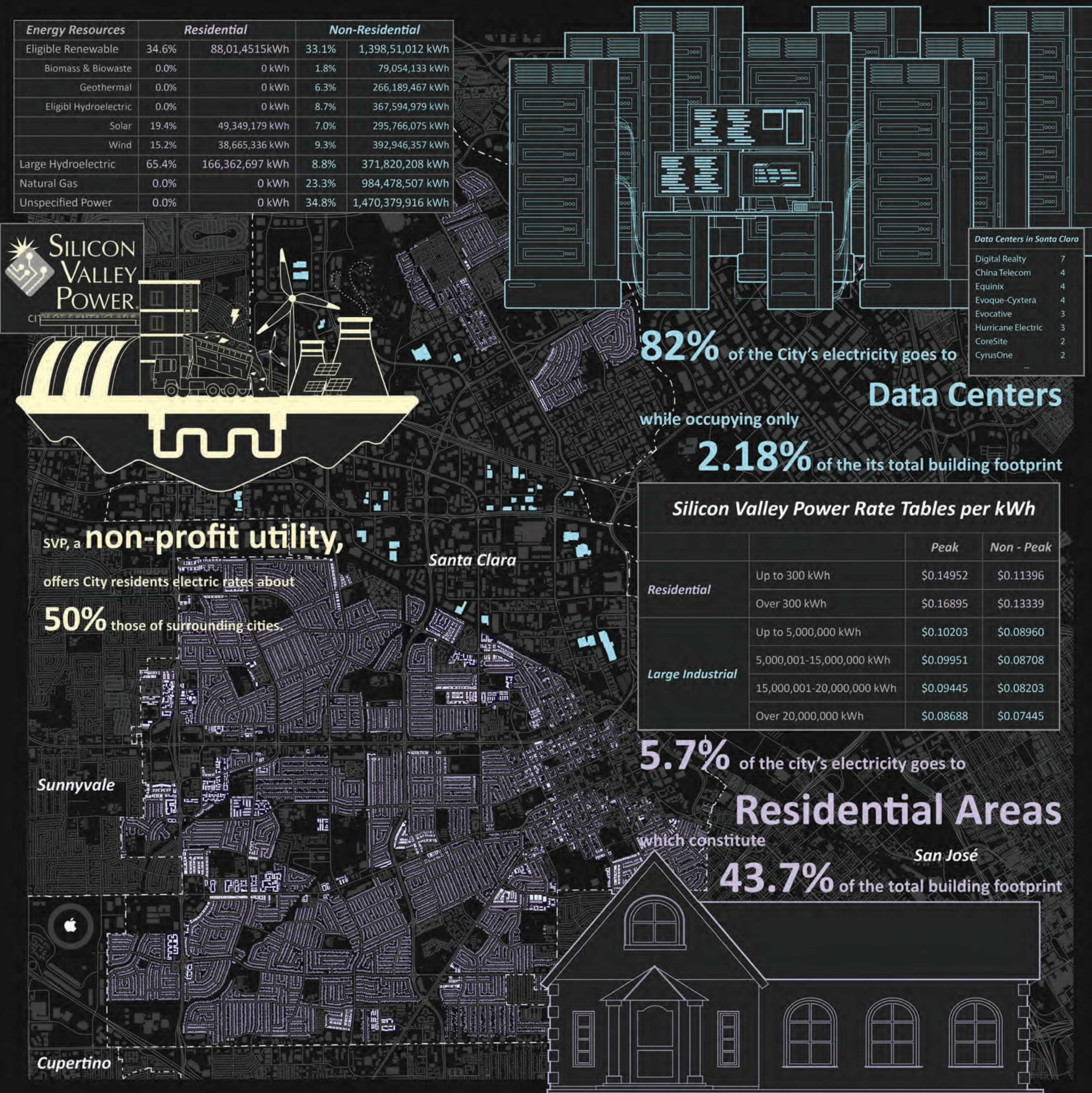
Design Option 3 _ Terracotta & Polycarbonate

Design Option 4 _ Wood

05 LIVING WITH DATA

Instructors | Michael Bell
Program | Data Center & Housing

The exponential expansion of the data center industry, driven by an escalating demand for data processing and storage, is poised to significantly impact the residential energy market. With data centers being inherently energy-intensive, their proliferation is anticipated to result in them consuming approximately 6% of the nation's total electricity by 2026. This projection represents almost half of the electricity consumption currently attributed to residential buildings. In regions where data center development is rapidly advancing, localized effects include heightened demands on power and water resources, highlighting the strain these facilities place on municipal infrastructure. This project aims to investigate the potential ramifications of data center expansion on residential energy provision while also exploring opportunities for integrating data center infrastructure with housing developments.



Energy Resources	Residential		Non-Residential	
Eligible Renewable	34.6%	88,01,4515kWh	33.1%	1,398,51,012 kWh
Biomass & Biowaste	0.0%	0 kWh	1.8%	79,054,133 kWh
Geothermal	0.0%	0 kWh	6.3%	266,189,467 kWh
Eligibl Hydroelectric	0.0%	0 kWh	8.7%	367,594,979 kWh
Solar	19.4%	49,349,179 kWh	7.0%	295,766,075 kWh
Wind	15.2%	38,665,336 kWh	9.3%	392,946,357 kWh
Large Hydroelectric	65.4%	166,362,697 kWh	8.8%	371,820,208 kWh
Natural Gas	0.0%	0 kWh	23.3%	984,478,507 kWh
Unspecified Power	0.0%	0 kWh	34.8%	1,470,379,916 kWh

Data Centers in Santa Clara	
Digital Realty	7
China Telecom	4
Equinix	4
Evoque-Cyxtera	4
Evocative	3
Hurricane Electric	3
CoreSite	2
CyrusOne	2
...	

Silicon Valley Power Rate Tables per kWh

		Peak	Non - Peak
Residential	Up to 300 kWh	$0.14952	$0.11396
	Over 300 kWh	$0.16895	$0.13339
Large Industrial	Up to 5,000,000 kWh	$0.10203	$0.08960
	5,000,001-15,000,000 kWh	$0.09951	$0.08708
	15,000,001-20,000,000 kWh	$0.09445	$0.08203
	Over 20,000,000 kWh	$0.08688	$0.07445

Energy Distribution in Santa Clara

U.S. Data Centers and Energy Consumption

The United States hosts approximately 2,700 data centers, comprising nearly 30% of the global data center servers—more than any other country.

According to the International Energy Agency, these facilities consumed over 4% of the nation's total electricity in 2022. This figure is projected to rise to 6% by 2026, which would be half of the 12% electricity consumption attributed to residential buildings.

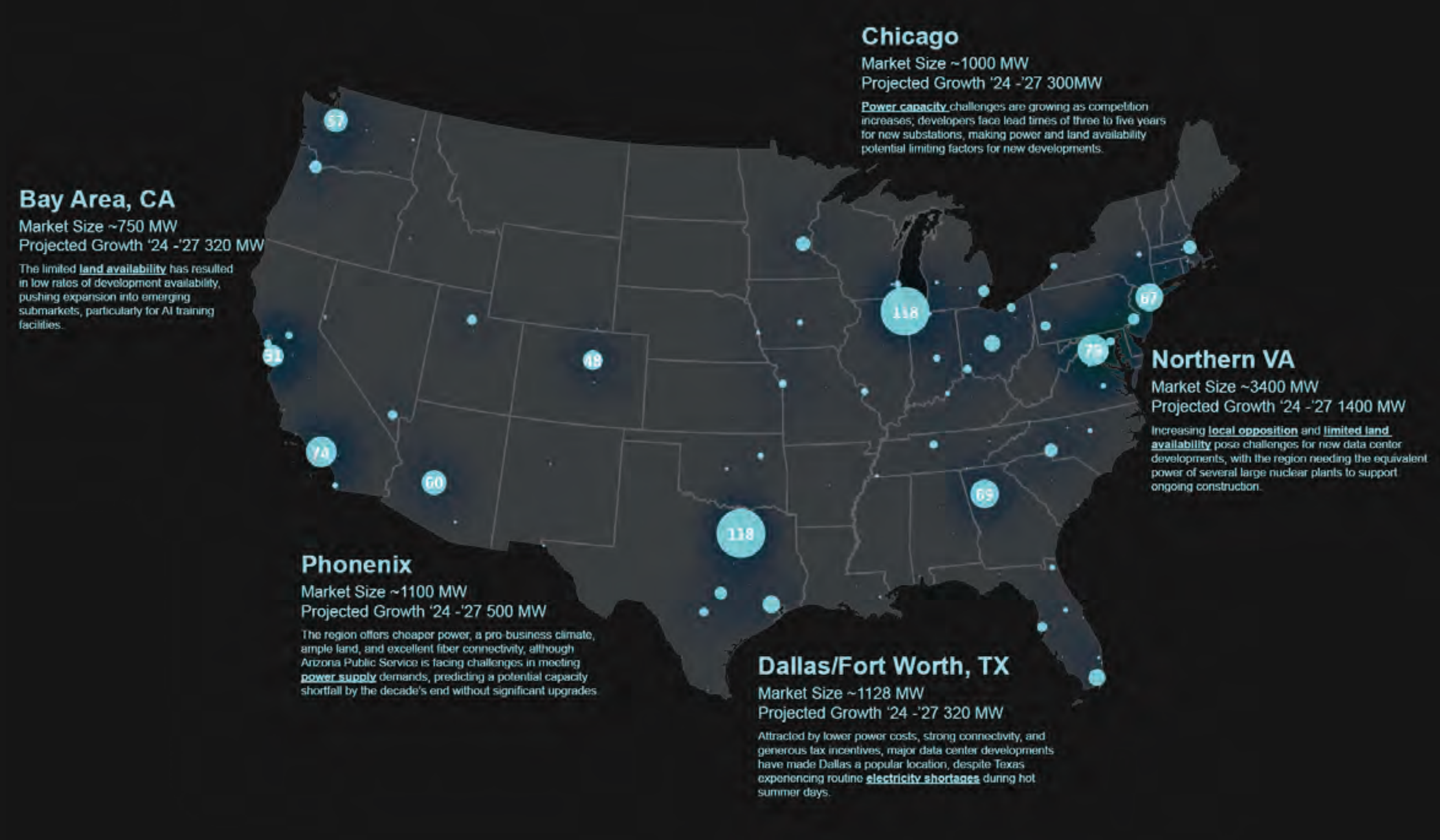
Industry forecasts suggest that data centers will continue to consume an increasing share of U.S. electricity. This comes as residential and smaller commercial facilities maintain relatively flat energy demands, thanks to advancements in the efficiency of appliances and heating and cooling systems.

Impact of AI on Data Center Market

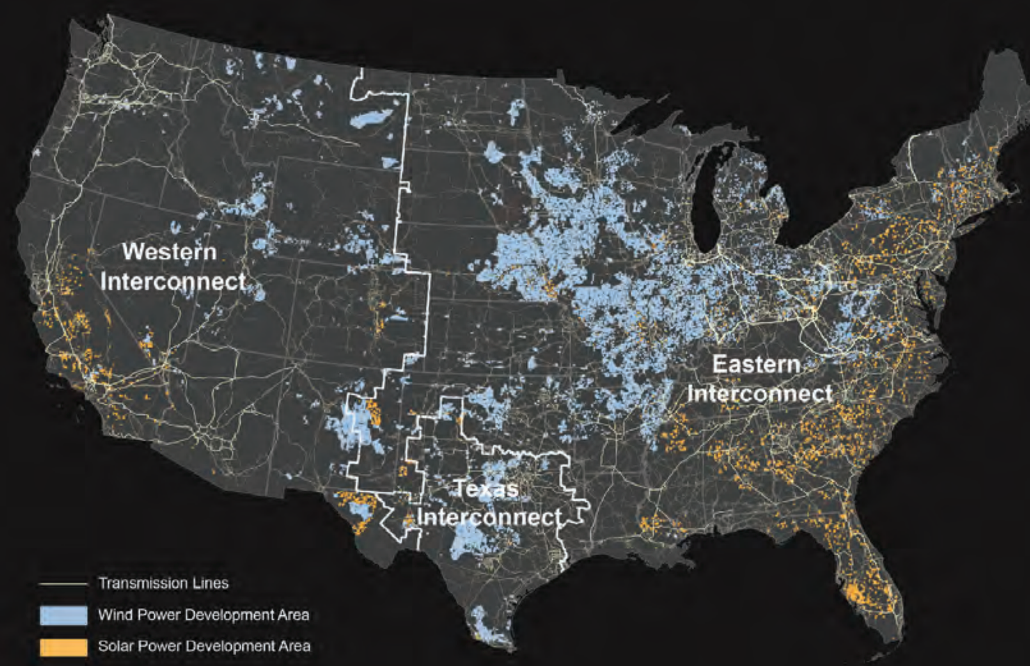
The rise of artificial intelligence (AI) and machine learning (ML) technologies is reshaping data center requirements, with AI applications projected to demand significantly higher power, up to 40-60 kW per rack compared to the current 10-14 kW. This shift stems from the adoption of energy-intensive graphics processing units (GPUs) over central processing units (CPUs), posing challenges for cooling and infrastructure.

Data Center Location and Community Impact

Data center location decisions hinge on factors like land availability, power costs, and connectivity, with cooling considerations paramount. However, expansion into new areas presents challenges such as power shortages, infrastructure strains, and community opposition, necessitating upgrades and raising concerns about resource use and environmental impact.



Data Centers Across the United States



United States' Power Grid and Future Sources

U.S. Power Grid: A Fragmented Landscape

The United States' power grid is not a unified structure but rather a mosaic of three main grids: one in the West, one in the East, and the independent grid of Texas. These grids are further fragmented into a multitude of operators with divergent interests. This fragmentation poses significant challenges, especially in transitioning towards cleaner energy sources like wind and solar.

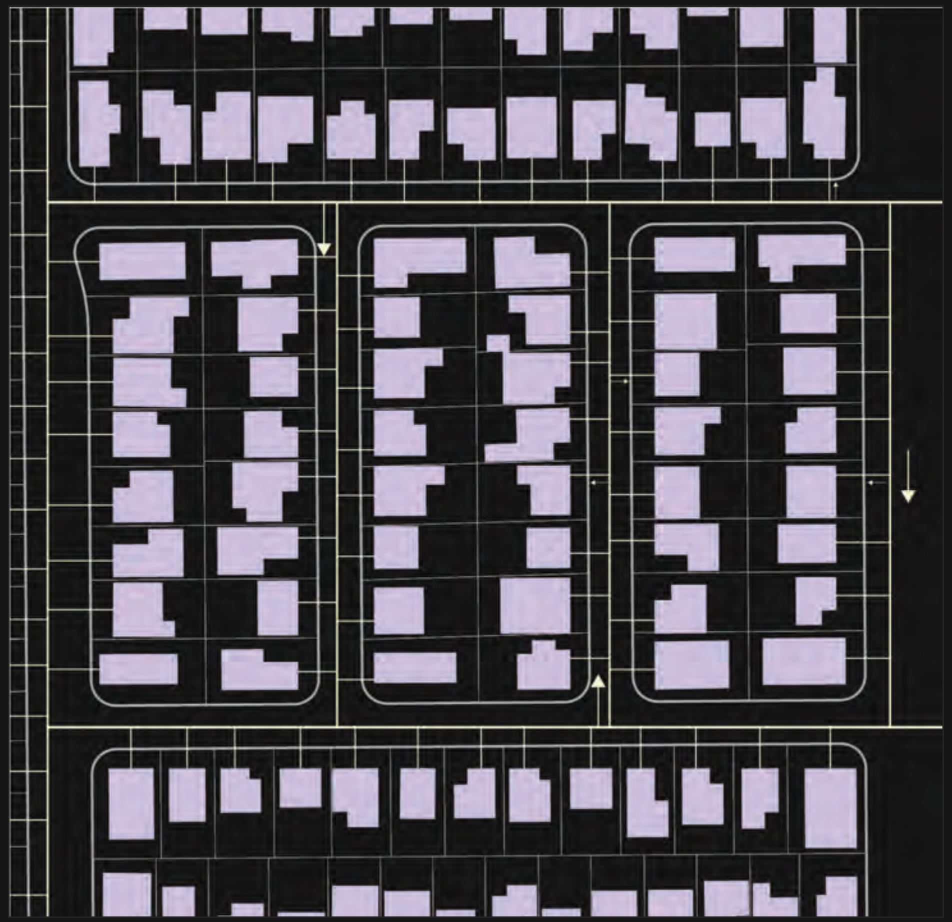
Challenges in Infrastructure Development

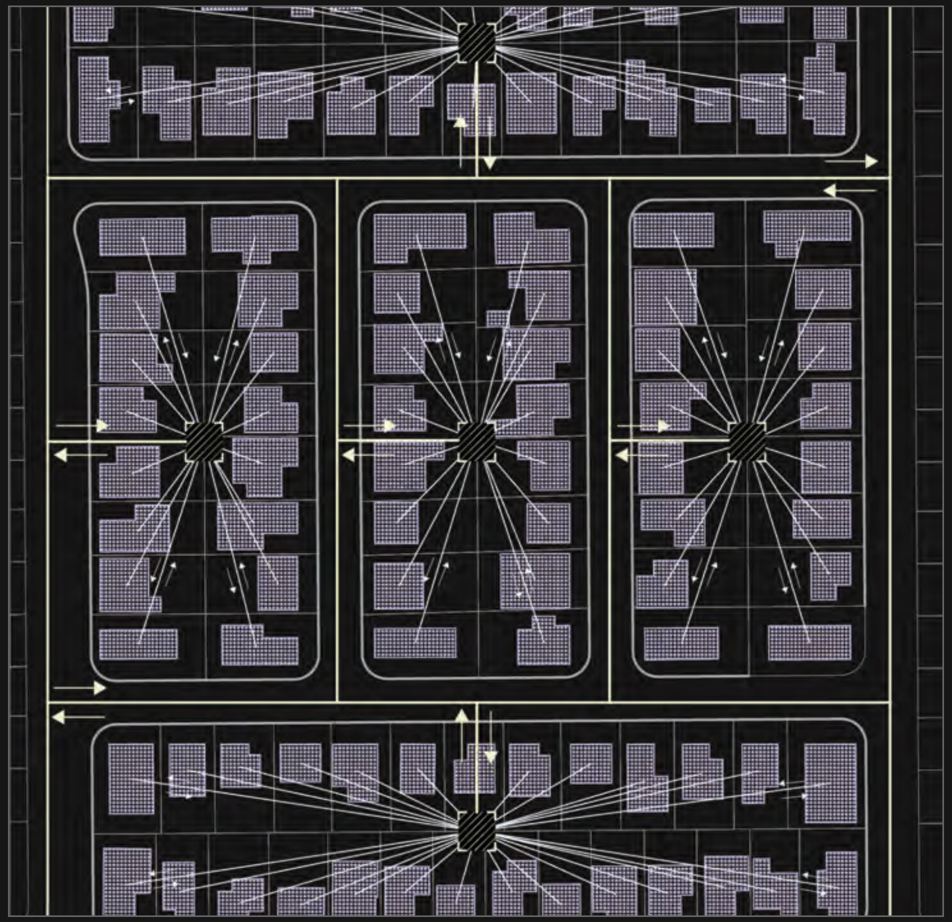
The deployment of longer-distance transmission lines essential for transporting renewable energy faces significant hurdles. Such projects require approval from multiple regional authorities, often leading to disagreements over necessity and financing. The intricate regulatory landscape and competing interests among stakeholders exacerbate the challenge of building the essential infrastructure needed for nationwide transmission of wind and solar energy.

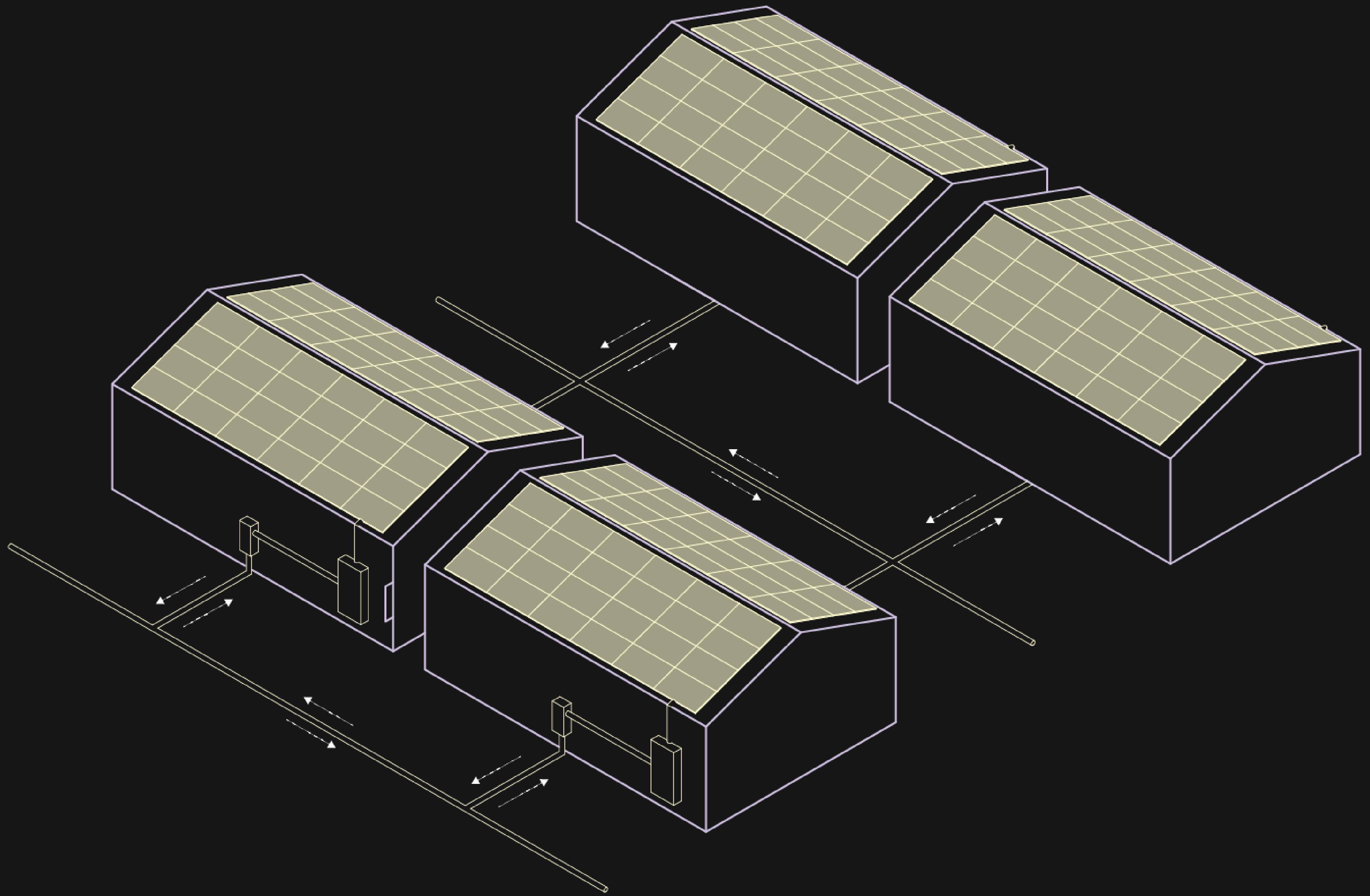
Obstacles to Clean Energy Transition

Originally designed to accommodate coal and gas plants, the fragmented nature of the U.S. electric grid presents a formidable barrier to combating climate change. Achieving the Biden administration's ambitious goal of generating 100 percent clean electricity by 2035 requires extensive development of renewable energy infrastructure.

This entails erecting thousands of wind turbines across the wind-rich Great Plains and sprawling solar arrays throughout the sunny South. These renewables, recognized as cost-effective means to reduce emissions, are pivotal in transitioning away from a grid system predominantly reliant on coal and gas, concentrated in the Northeast and West Coast.

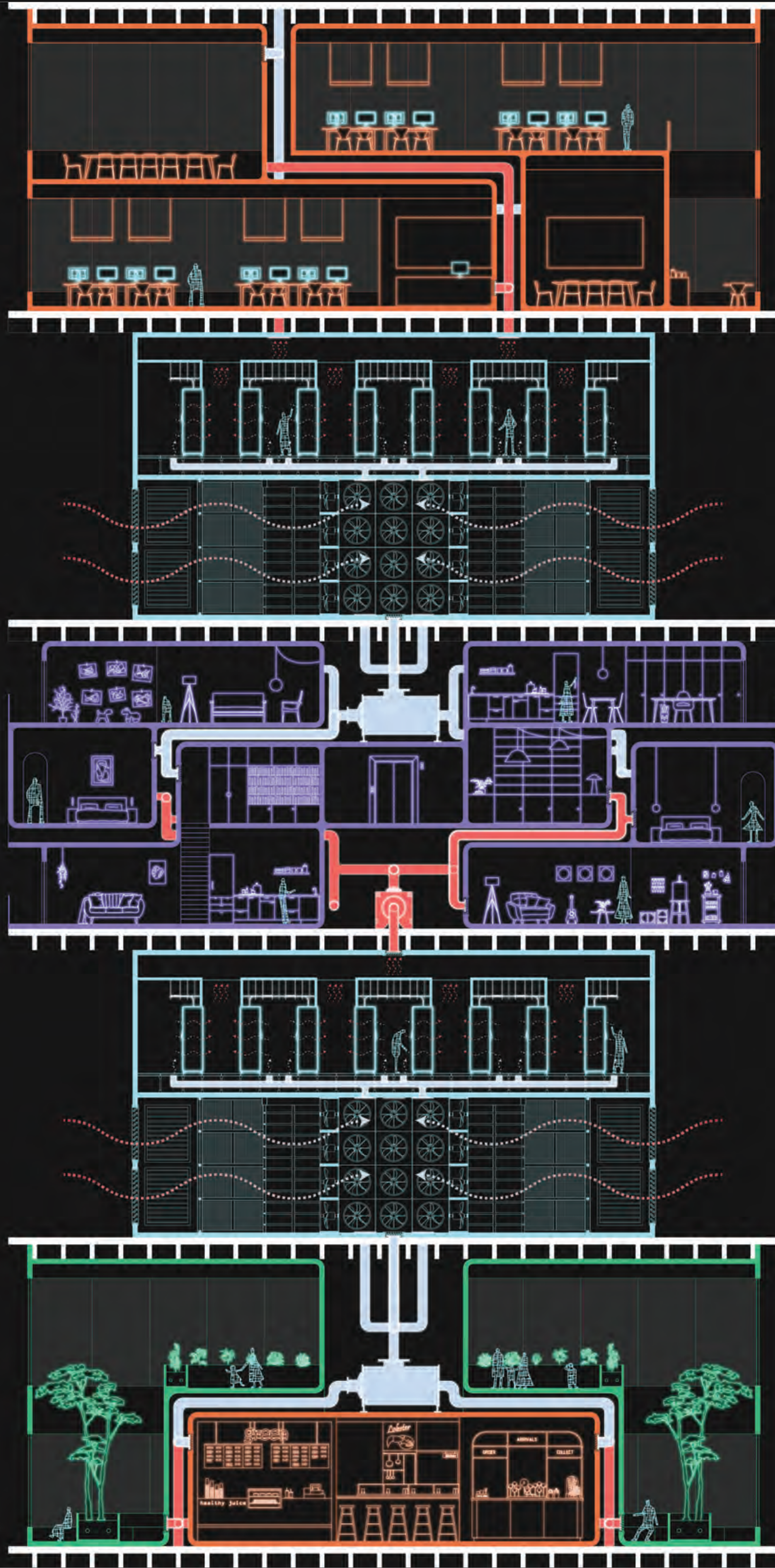

Current Power Grid


Micro-Grid

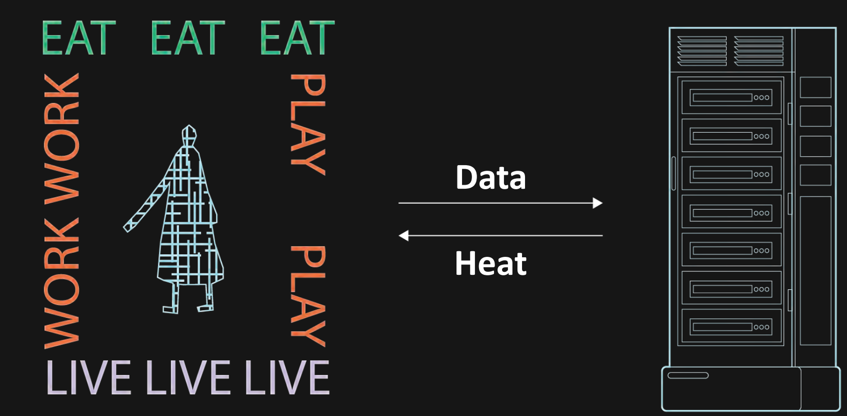


Micro-Grid

Most city power grids operate on a one-way system, delivering electricity from distant power plants to homes. By installing solar panels on residential rooftops, homes can act as mini power plants. However, a challenge is that solar panels produce the most energy during low-demand times. Utility companies buy back excess power but control prices. A solution could be a decentralized power grid, allowing homeowners to transmit and sell energy directly. This approach enhances resilience against grid failures caused by large energy consumers or extreme weather events due to climate change.



Vertical Integration



New Building Typology

Data centers are vast machines that processing data from our daily lives, essentially convert human activity into heat. As humans, we naturally seek sheltered spaces to conduct our daily activities, with heating and cooling being the most energy-intensive processes. By leveraging the natural properties of air—where hot air rises and cold air descends—we can harness the waste heat generated by data centers. This concept births a new building typology that blends elements of industrial, residential, commercial, and green spaces

These spaces are nestled amidst data centers, where cool air is drawn from beneath the data center using evaporative cooling. As this air passes through the servers, it absorbs heat and rises into a confined roof space. Utilizing external fans, the heated air is then extracted and distributed through air ducts to areas requiring heating.

Thank You