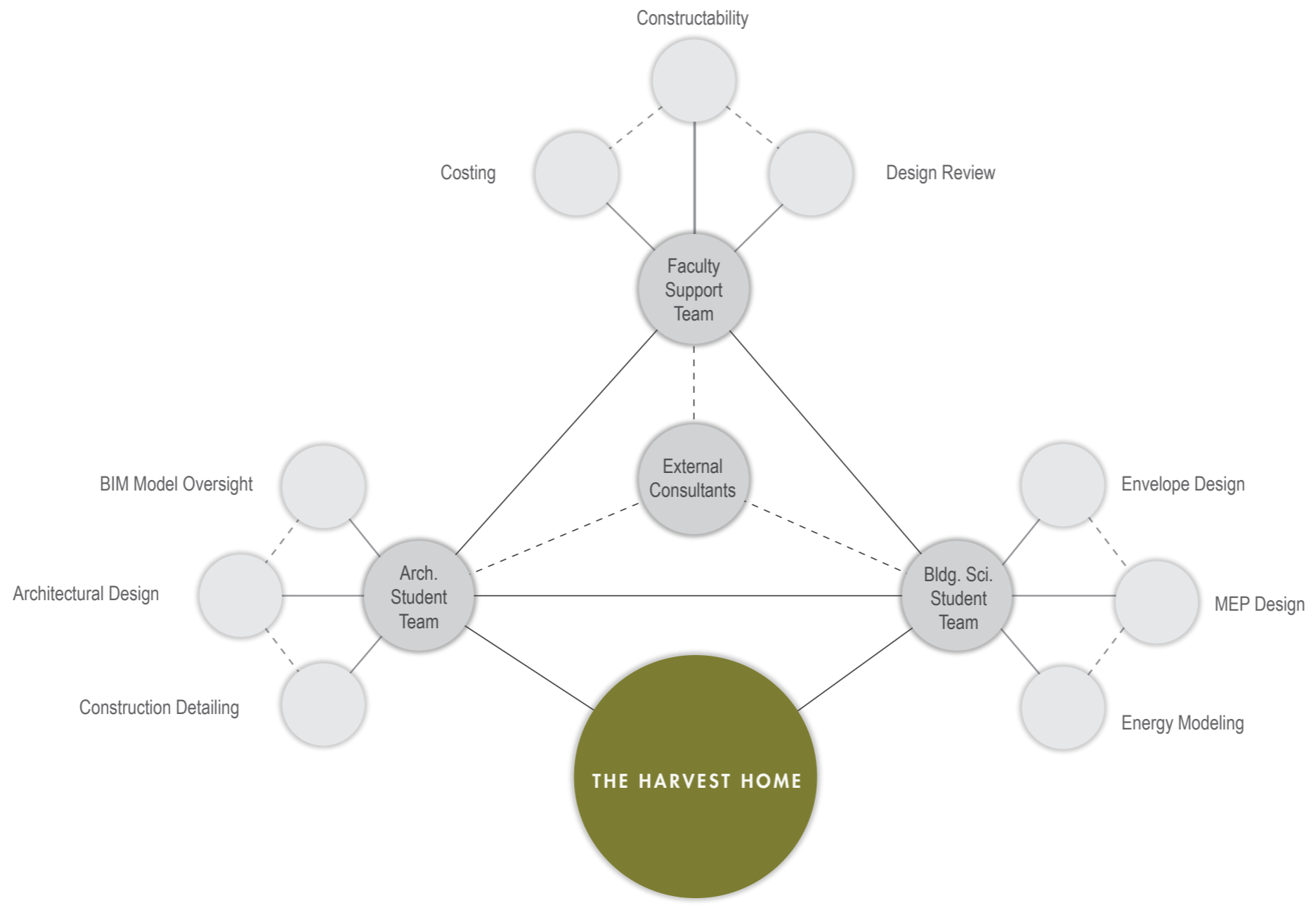




THE HARVEST HOME

U.S. DEPARTMENT OF ENERGY
CHALLENGE HOME STUDENT DESIGN COMPETITION

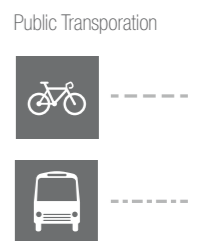




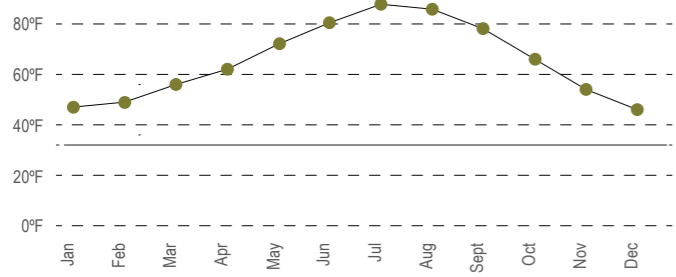
Aerial View to South West



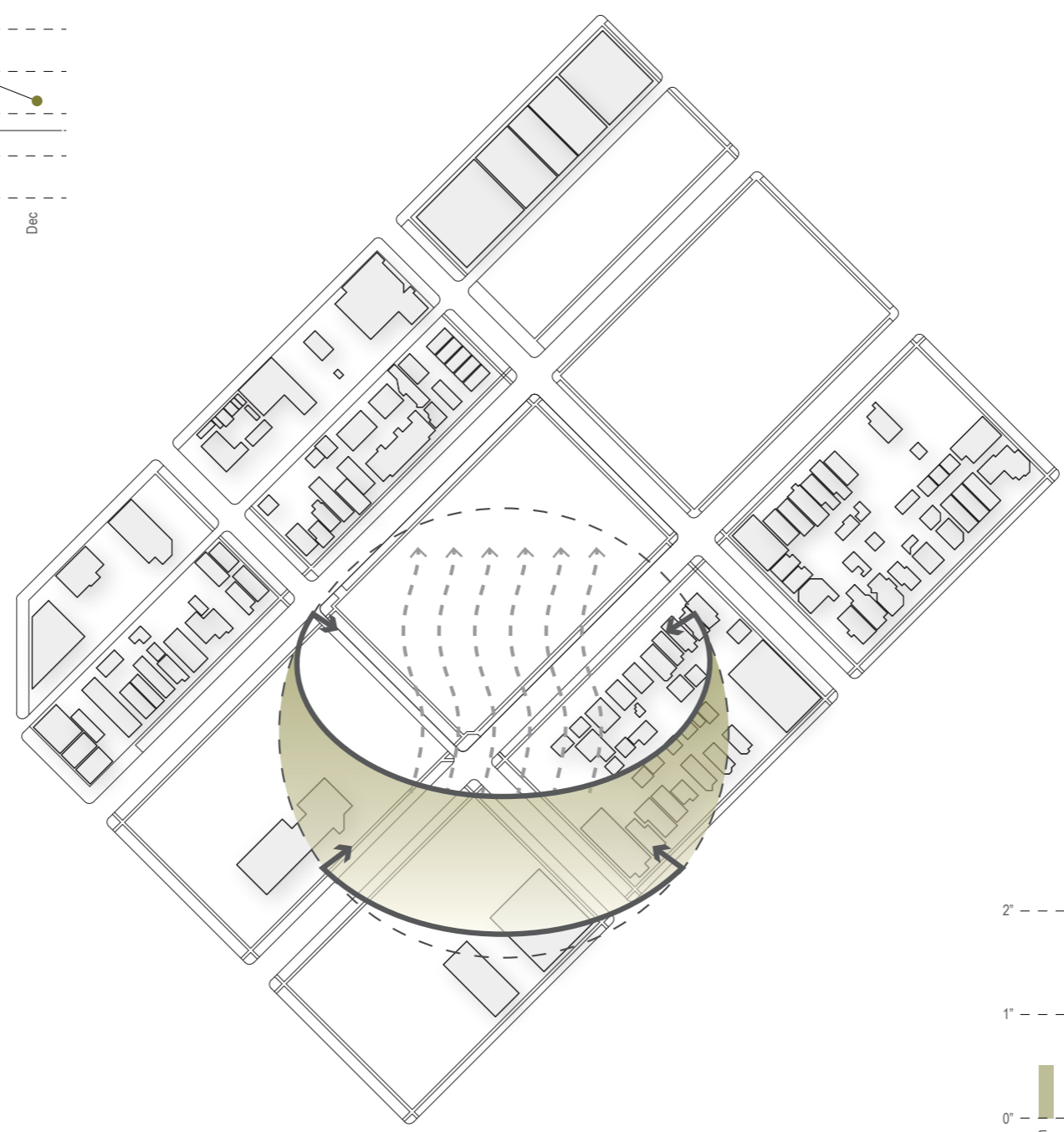
- Fire Station
- Urban Garden
- Place of Worship
- Restaurant & Bar
- Educational Facilities
- Gym & Fitness Center
- Arts & Entertainment Complex
- Employment and Office Centers
- Supermarket & Convenience Store



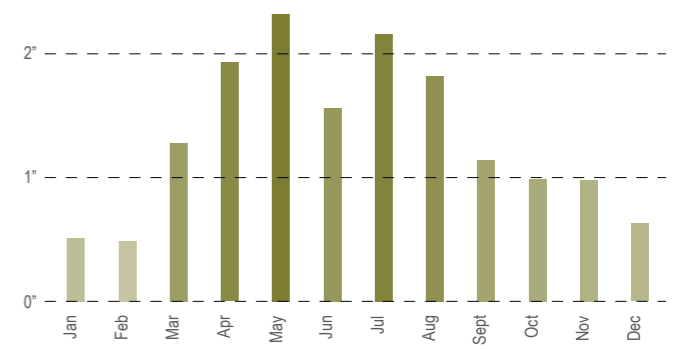
Area Plan - Existing



Monthly Average Temperature



Area Plan - Solar Orientation & Prevailing Winds



Monthly Average Precipitation



Design a **cost-effective** response allowing the average Denver family to purchase, operate and maintain a sustainable home.



Incorporate **flexible** interior and exterior spaces capable of accommodating a variety of familial scenarios.



Meet or exceed the requirements and standards outlined for certification by the **Passive House** Institute United States (PHIUS+).



Create a **net-zero ready** home with the potential of operating completely independent of municipal servicing.



Employ **traditional construction methods** coupled with readily available on-the-market materials, finishes, equipment and appliances..



Incorporate **open concept space planning** capable of hosting a variety of functions within the modest sized floor plate.



Design the **building envelope** to be air-tight and thermal bridge free throughout.



Consider the building as a **direct derivative of the natural context** allowing for rain water collection and optimal passive solar gains.



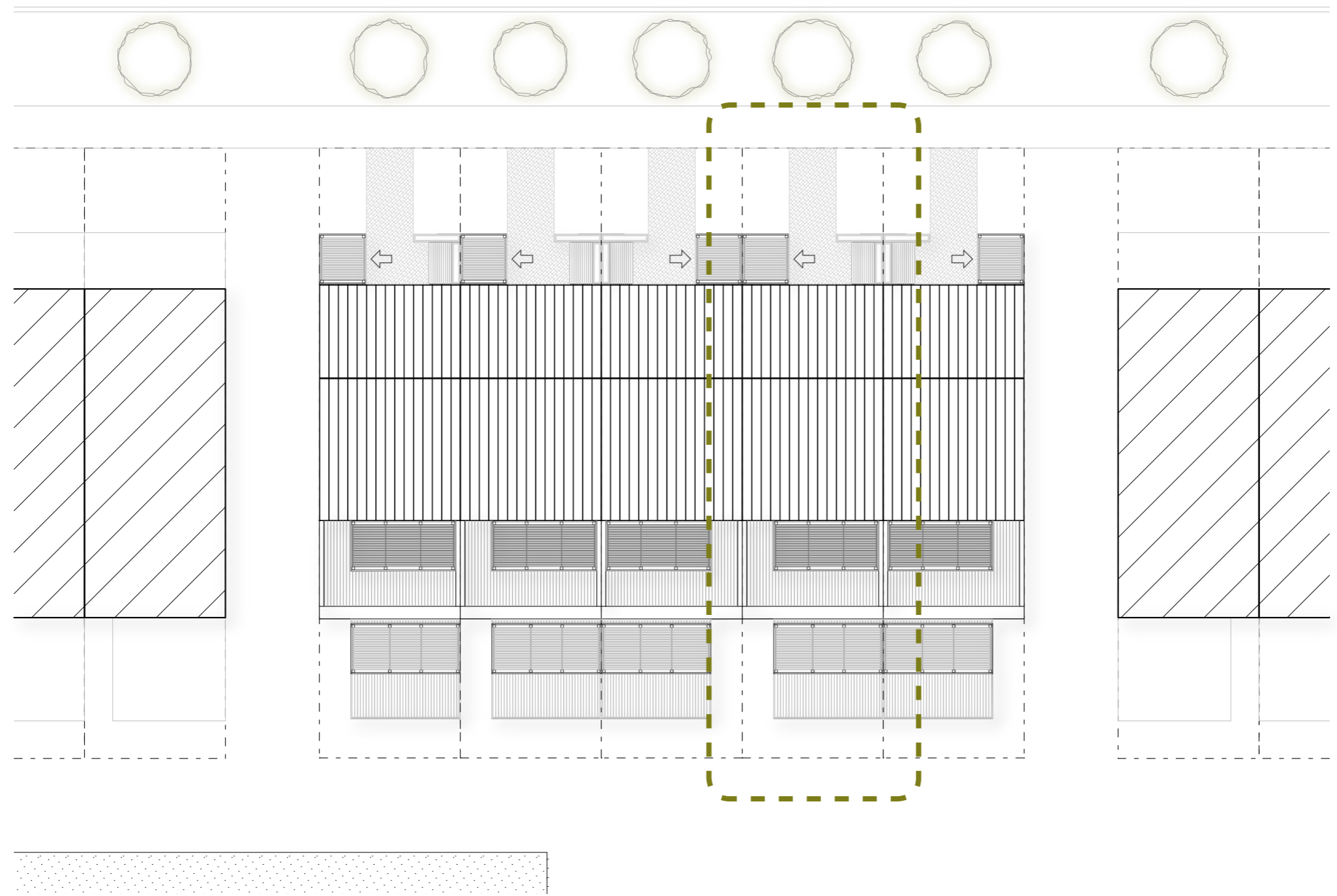
Frontage at Lawrence Street



Area Plan - Proposed



Lawrence Street



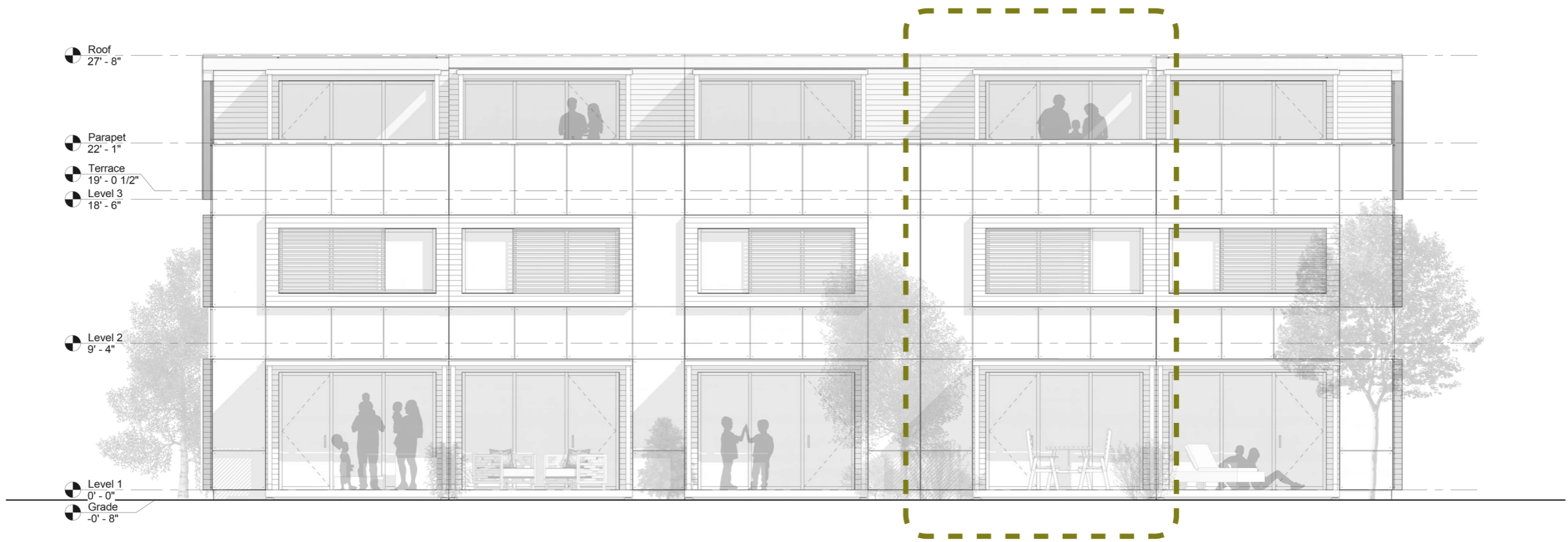
Site Plan - Proposed





Row Elevation - North

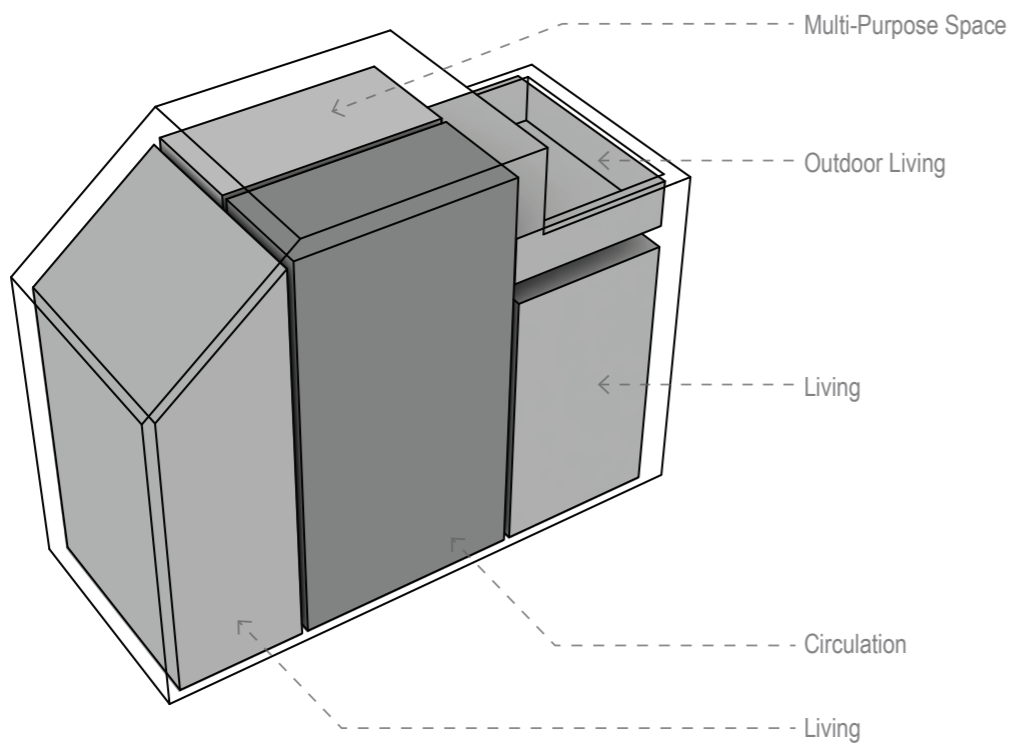




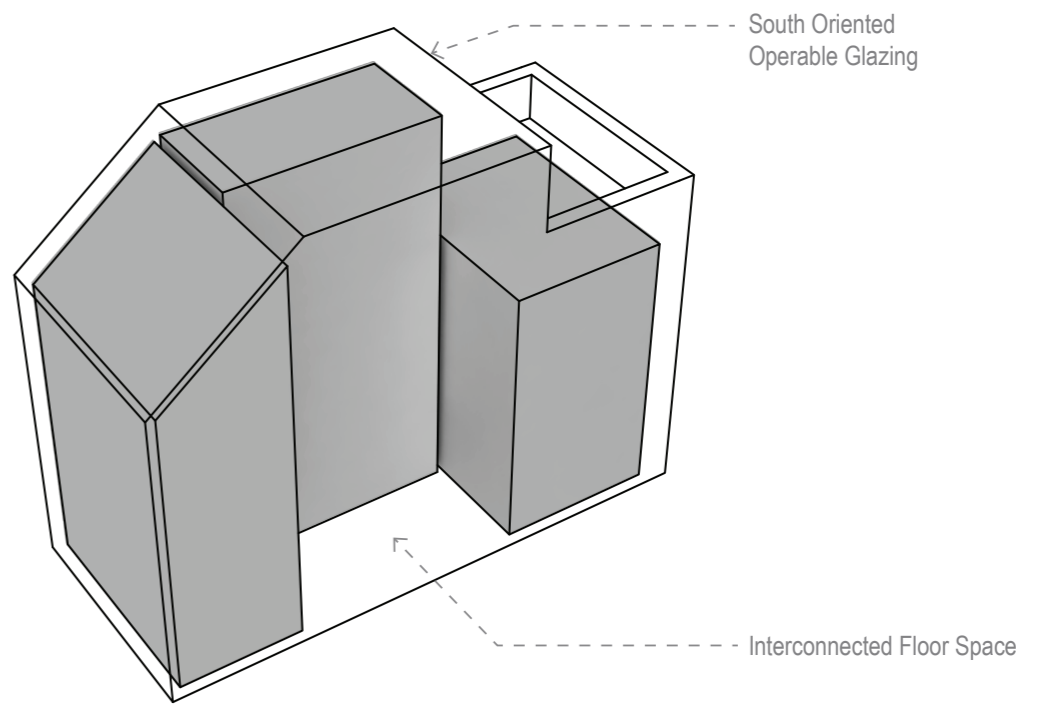
Row Elevation - South



CONCEPTUAL MASSING

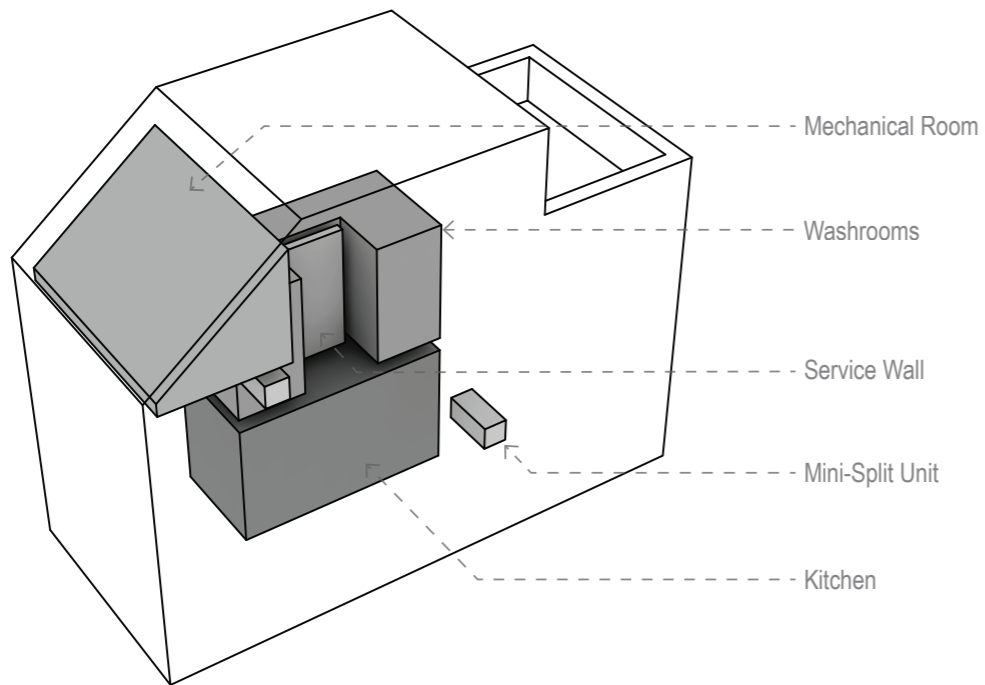


Interior Program Massing

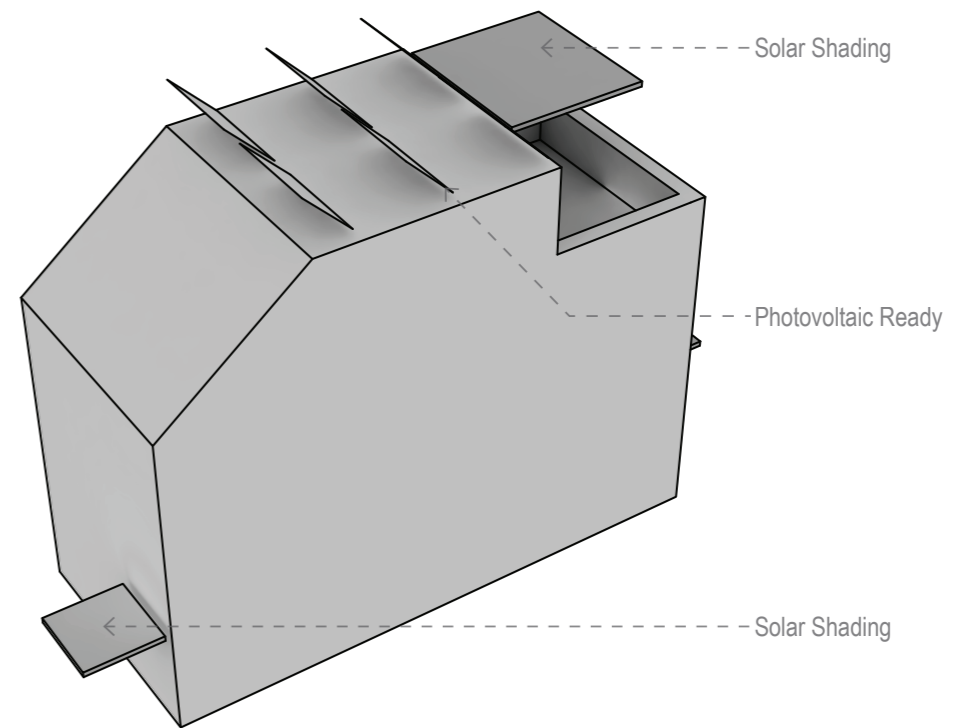


Central Stair

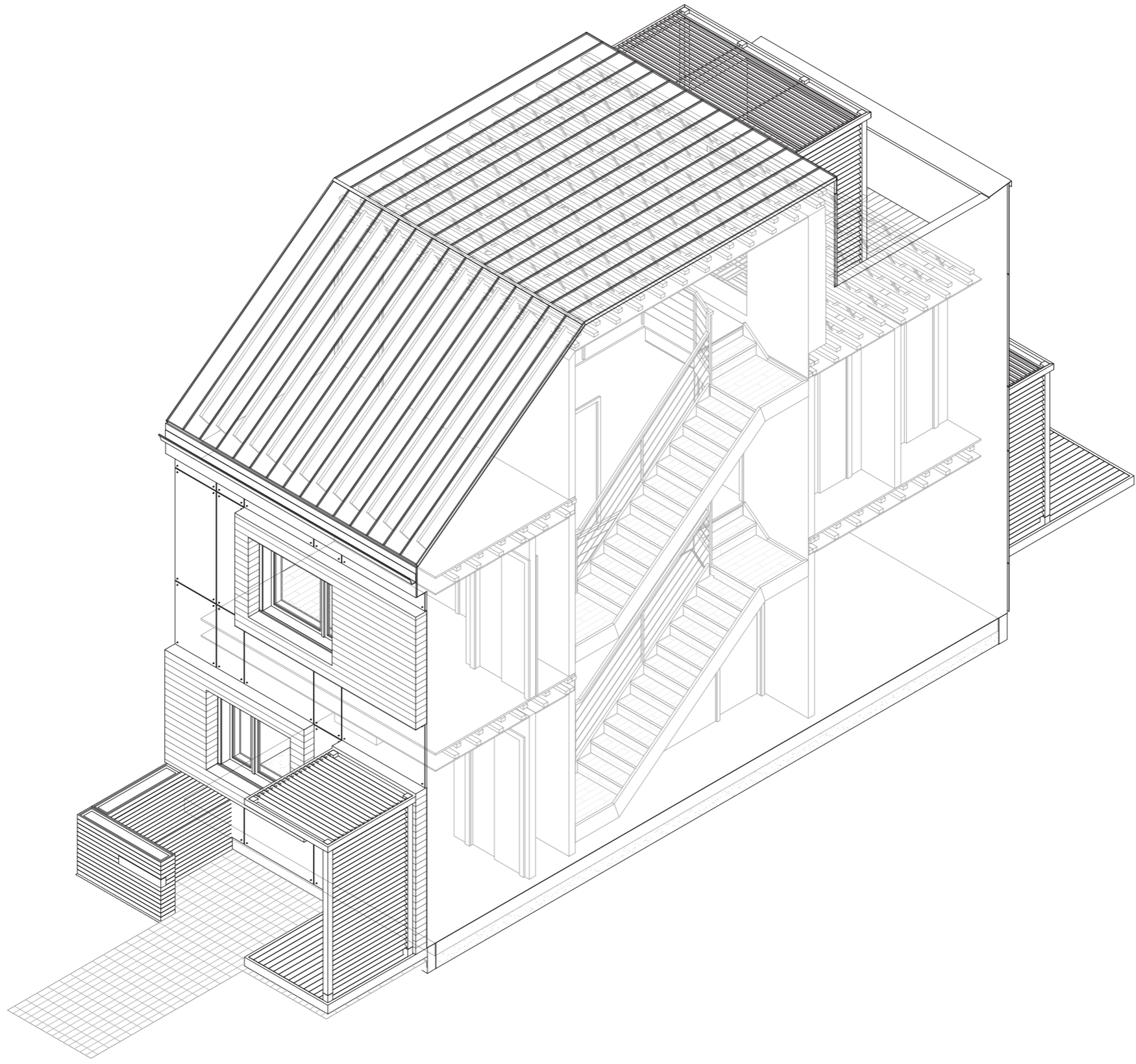
CONCEPTUAL MASSING



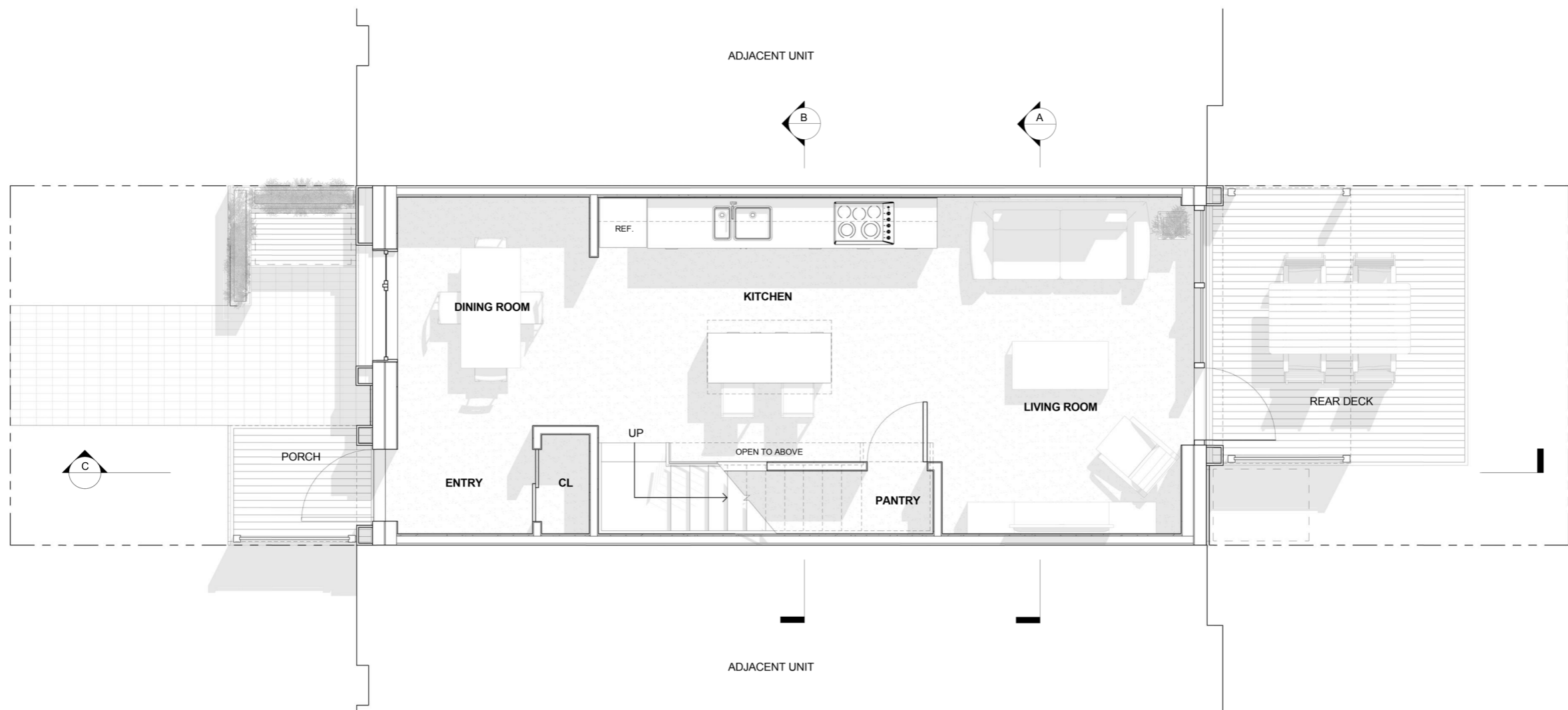
Building Services



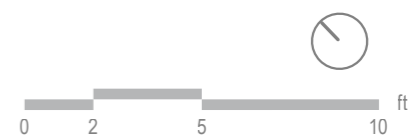
Polar Shading & PV Orientation

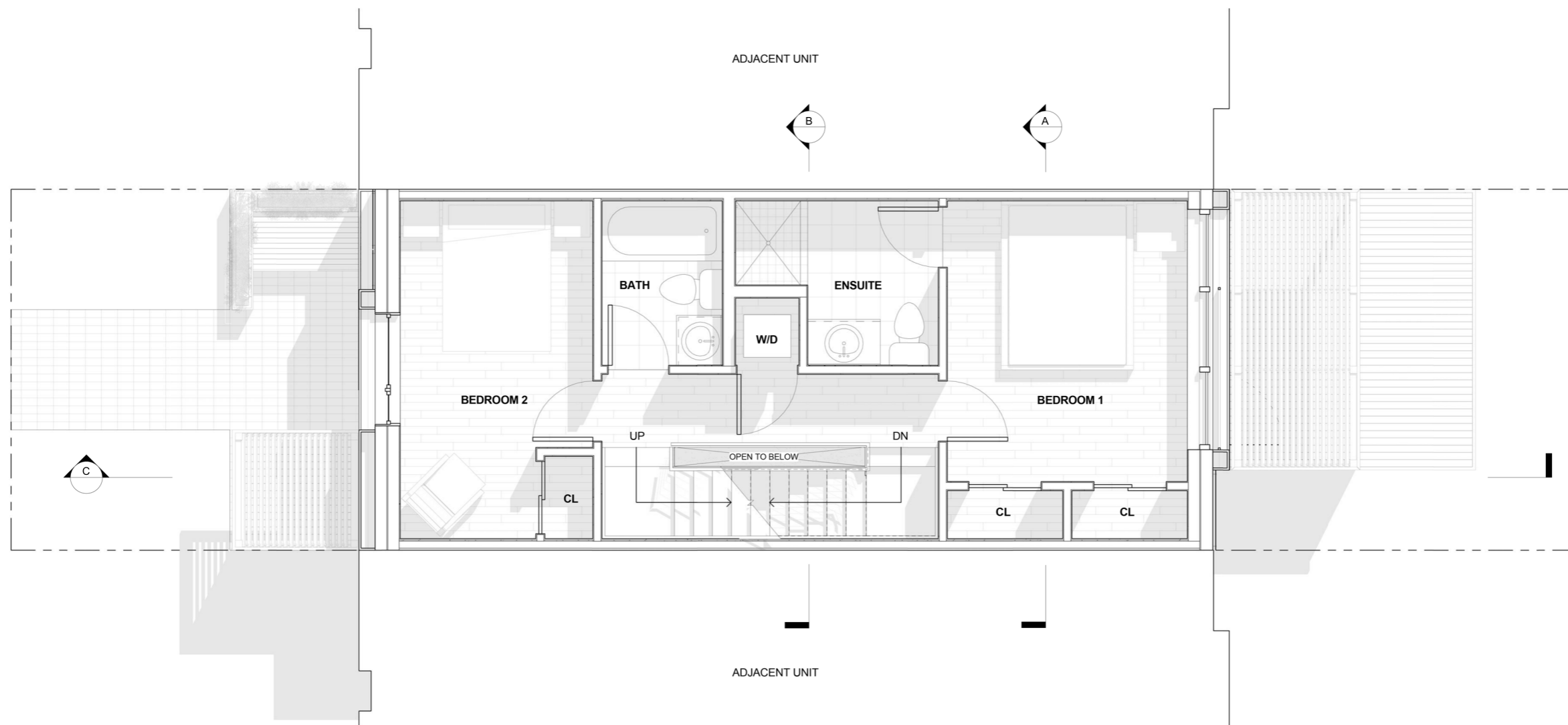


Building Axonometric



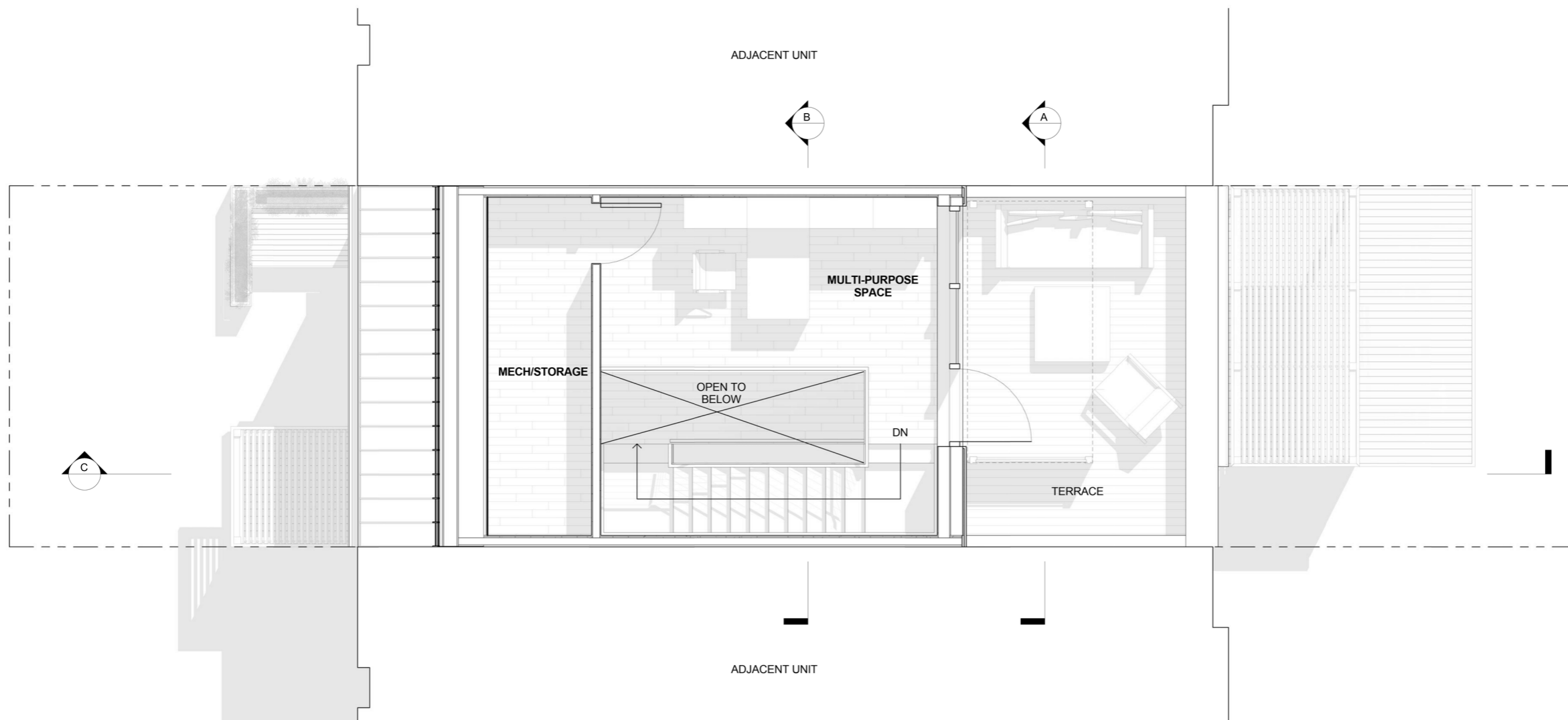
Floor Plan - Level One





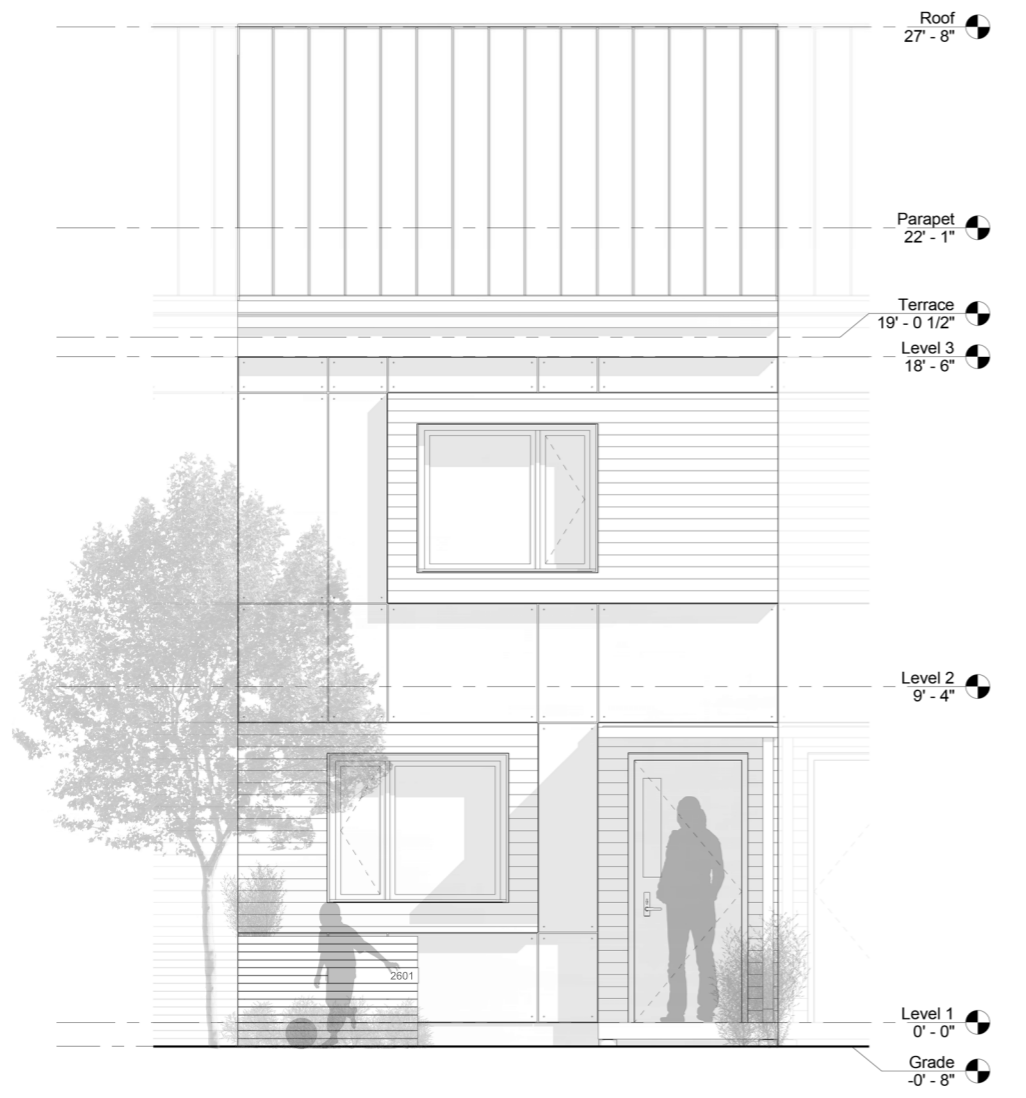
Floor Plan - Level Two



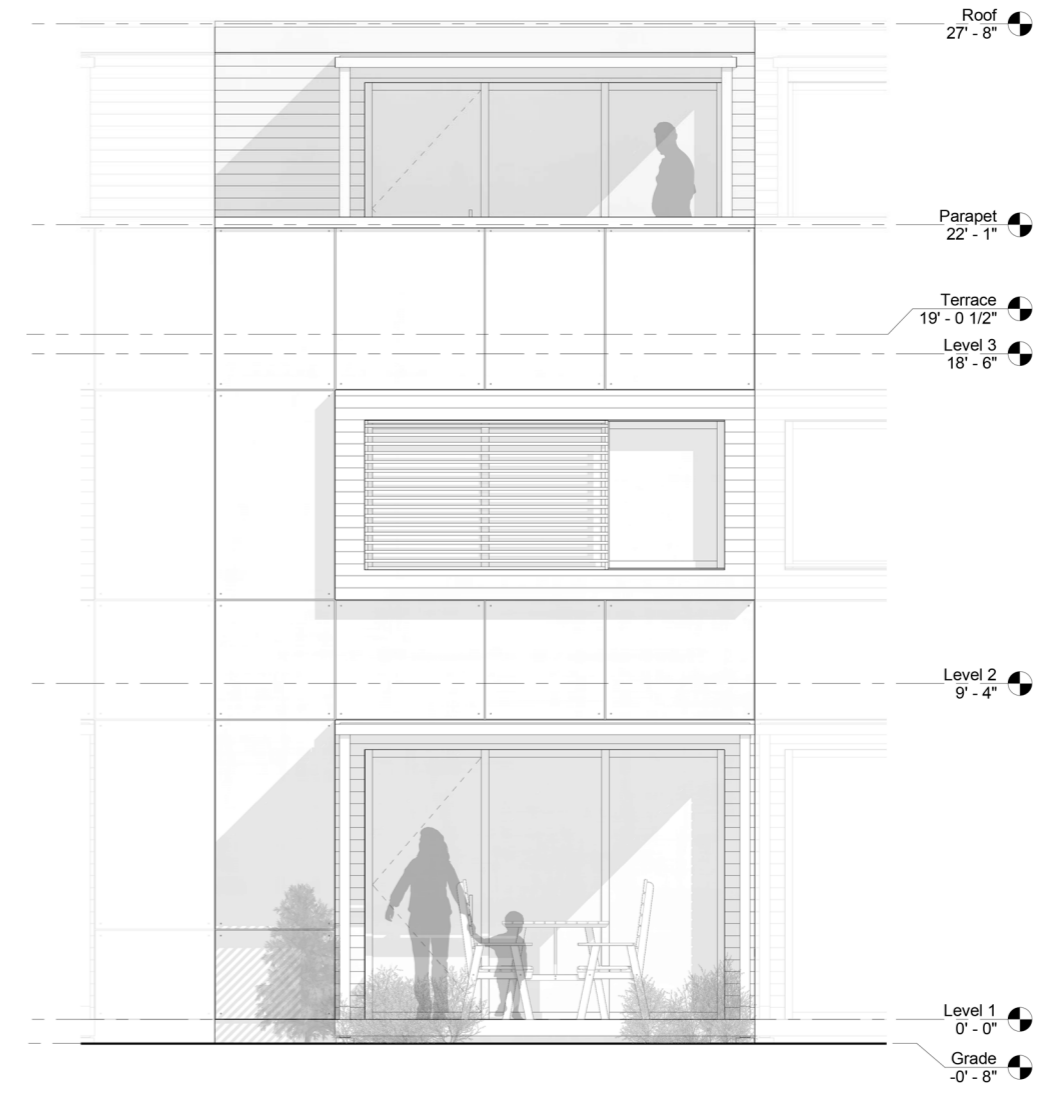


Floor Plan - Level Three

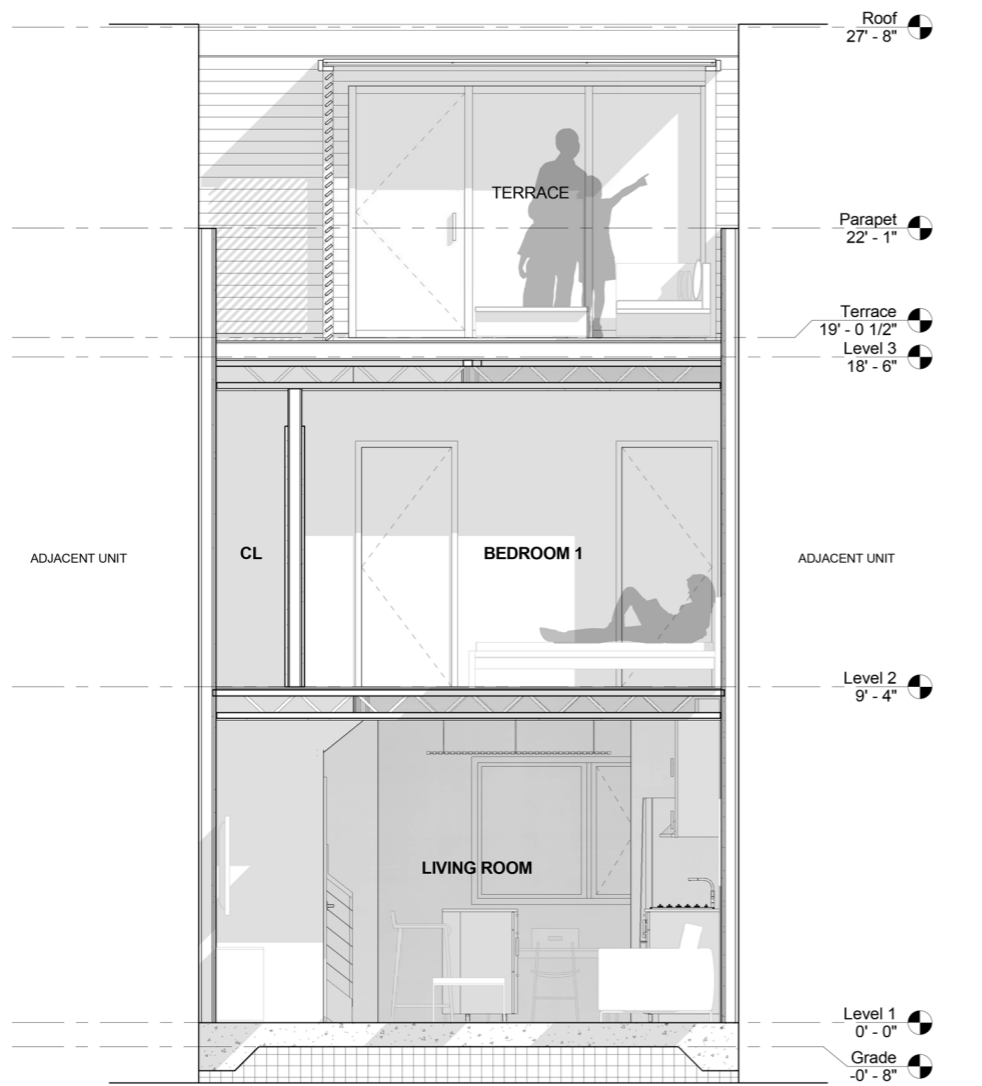




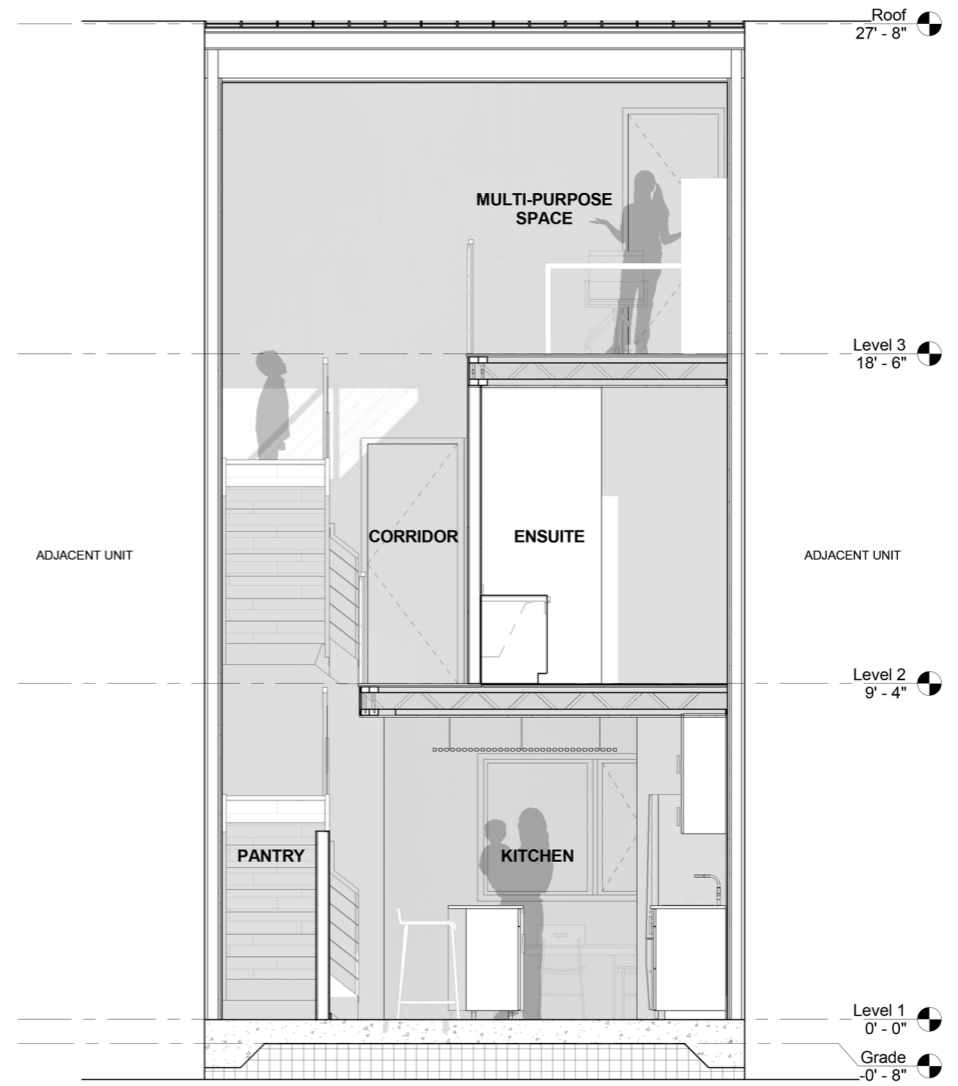
Unit Elevation - North



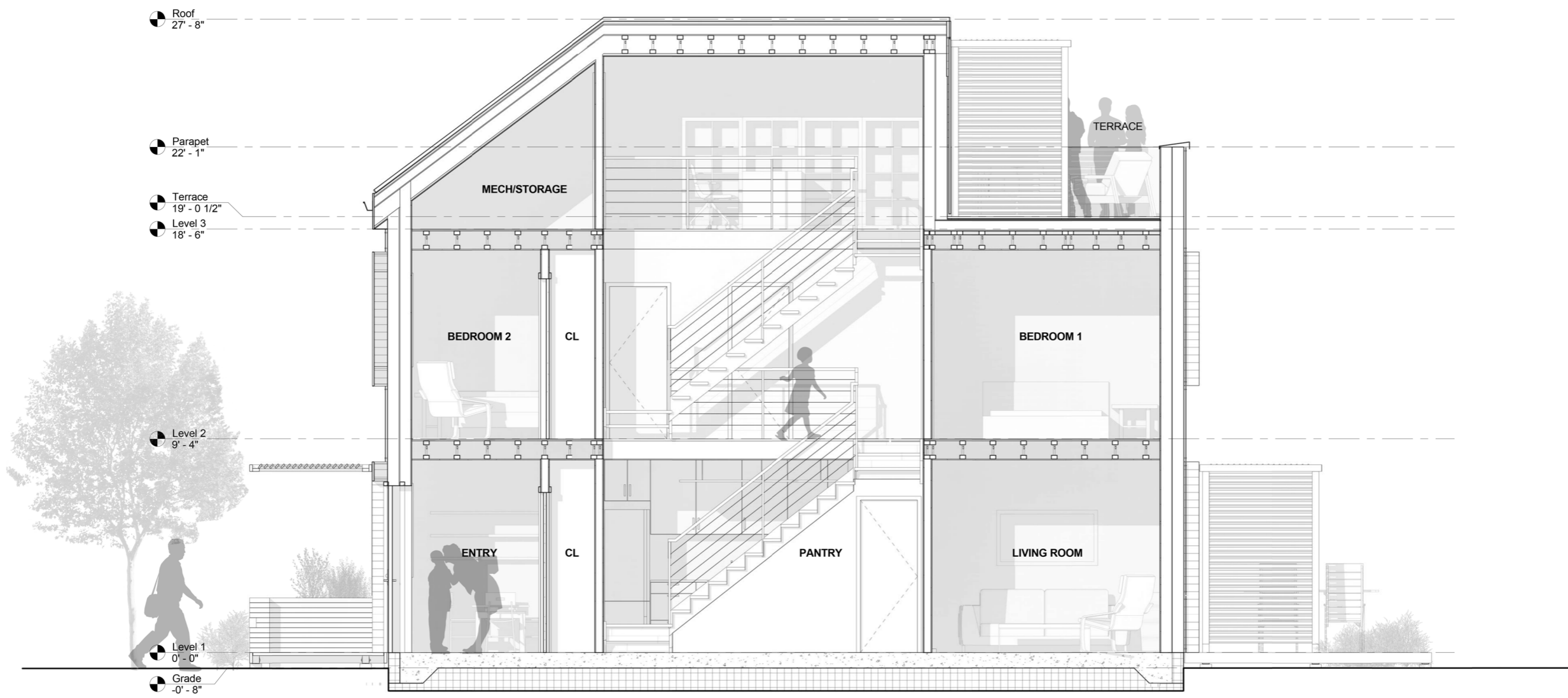
Unit Elevation - South



Building Section - A



Building Section - B

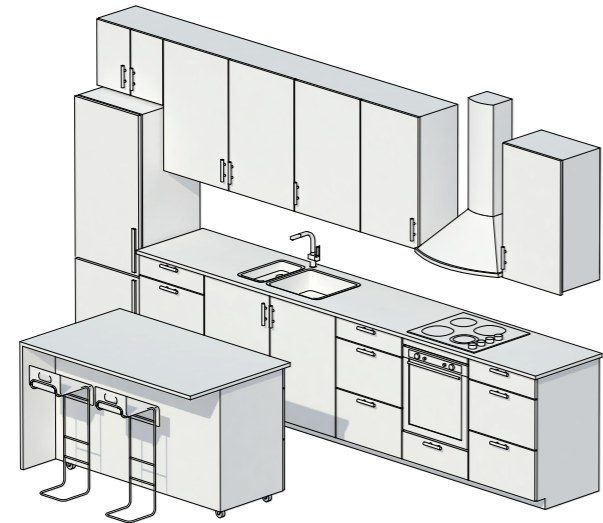


Building Section - C

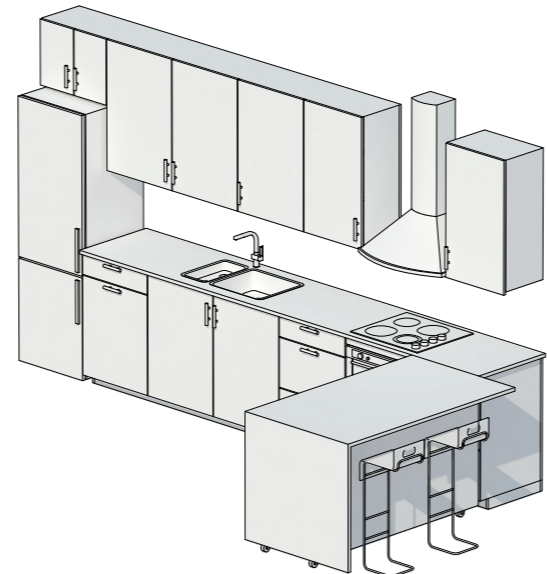




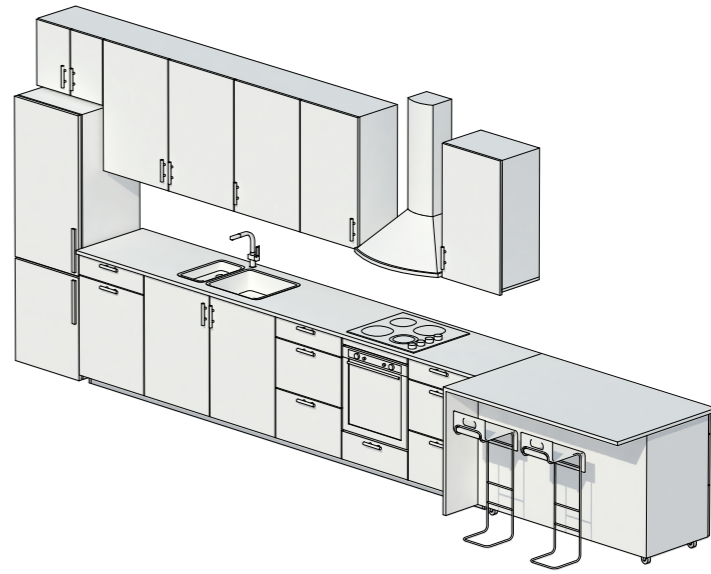
THE FLEXIBLE WORKSPACE



Centralized Island



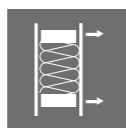
Peninsula Counter



Work Surface Extension



ENVELOPE DESIGN STRATEGIES



Eliminate **thermal bridging** across the entire envelope through external insulation.



Ensure an **air tight** envelope to limit undesired air infiltration.



Employ a **rain screen** approach to drain bulk water and ventilate envelope layers.



Control **solar gains** through optimized glazing distribution.

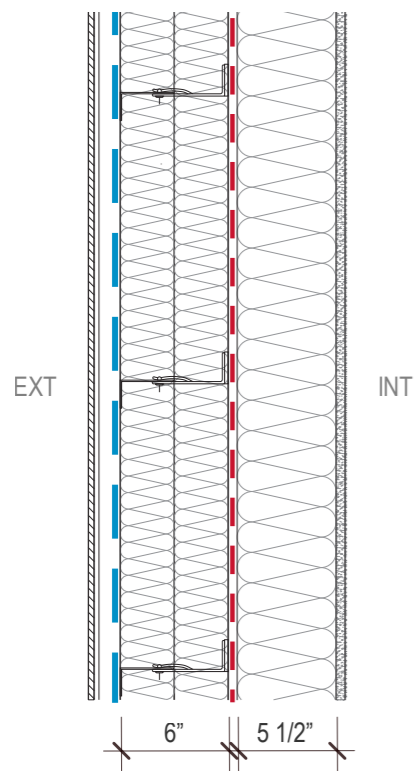


Design envelope to be **highly durable** using simplistic construction materials and methods.



Optimize **interior thermal comfort** through appropriate insulation and air sealing details.

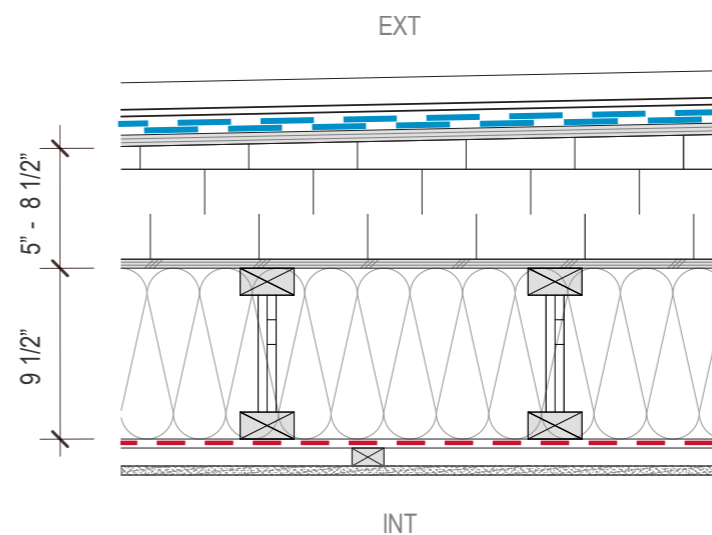
ENVELOPE ASSEMBLIES



Vertical Wall Assembly (R-44)

- Fibre Cement "Ecoclad" Panel
- 1" Air Cavity
- Tyvek Weather Barrier
- 2 Layers - 3" Roxul Rigid Insulation (R-25.8)
- 1/2" Zip System Air Barrier / Vapor Retarder
- 2 x 6" Structural Stud Wall (16" O/C)
- 5-1/2" Blown Cellulose Insulation (R-21)
- 1/2" Gypsum Wall Board
- Zero VOC Paint Finish

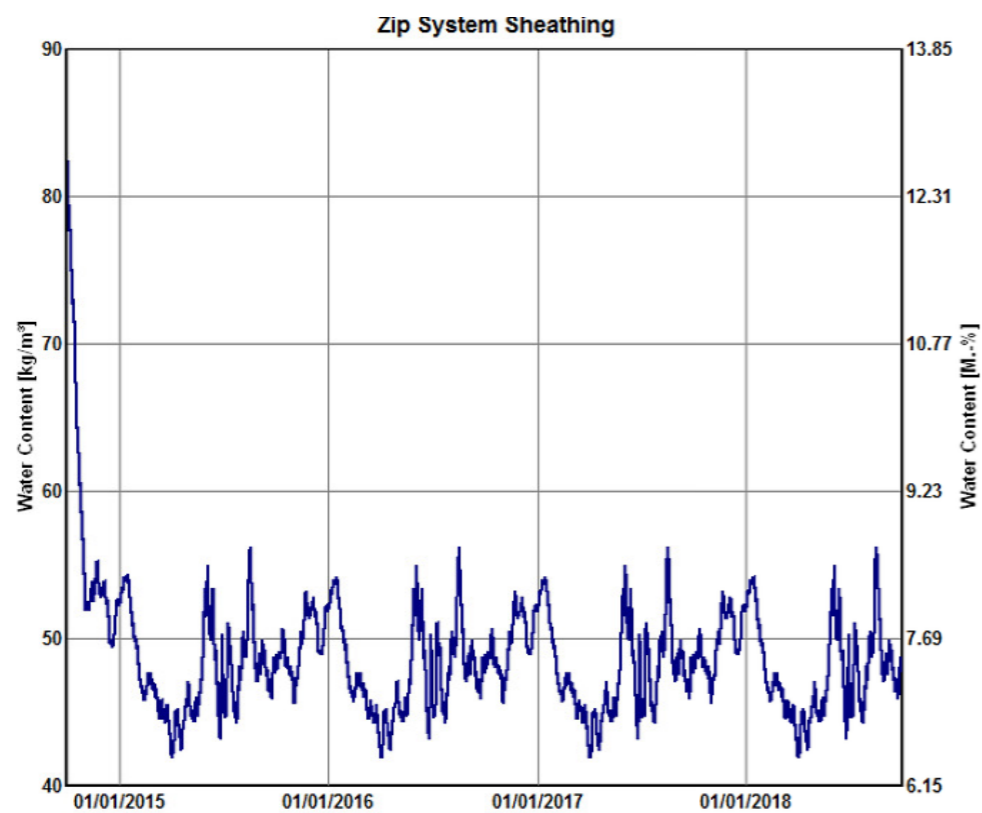
- Moisture Barrier
- Air Barrier / Vapor Retarder



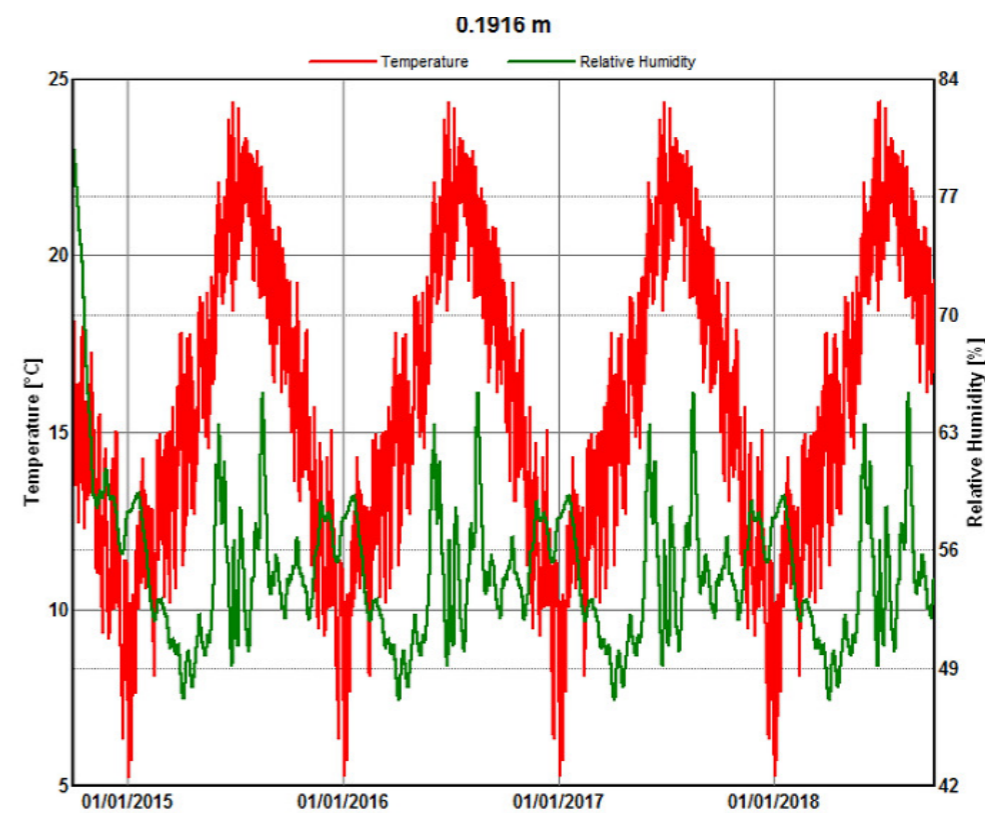
Roof Assembly (R-56)

- Standing Seam Metal Roof
- 1" Air Cavity
- 2 Layers - 15lb. Roofing Felt
- 5/8" Plywood Sheathing
- EPS Rigid Insulation (R-20)
- 1/2" Plywood Sheathing
- 2 x 10" Wood Joists (16" O/C)
- 9-1/2" Blown Cellulose Insulation (R-33.25)
- 1/2" Zip System Air Barrier / Vapor Retarder
- 1" Wood Furring
- 5/8" Gypsum Wall Board Type X
- Zero VOC Paint Finish

HYGROTHERMAL ANALYSIS

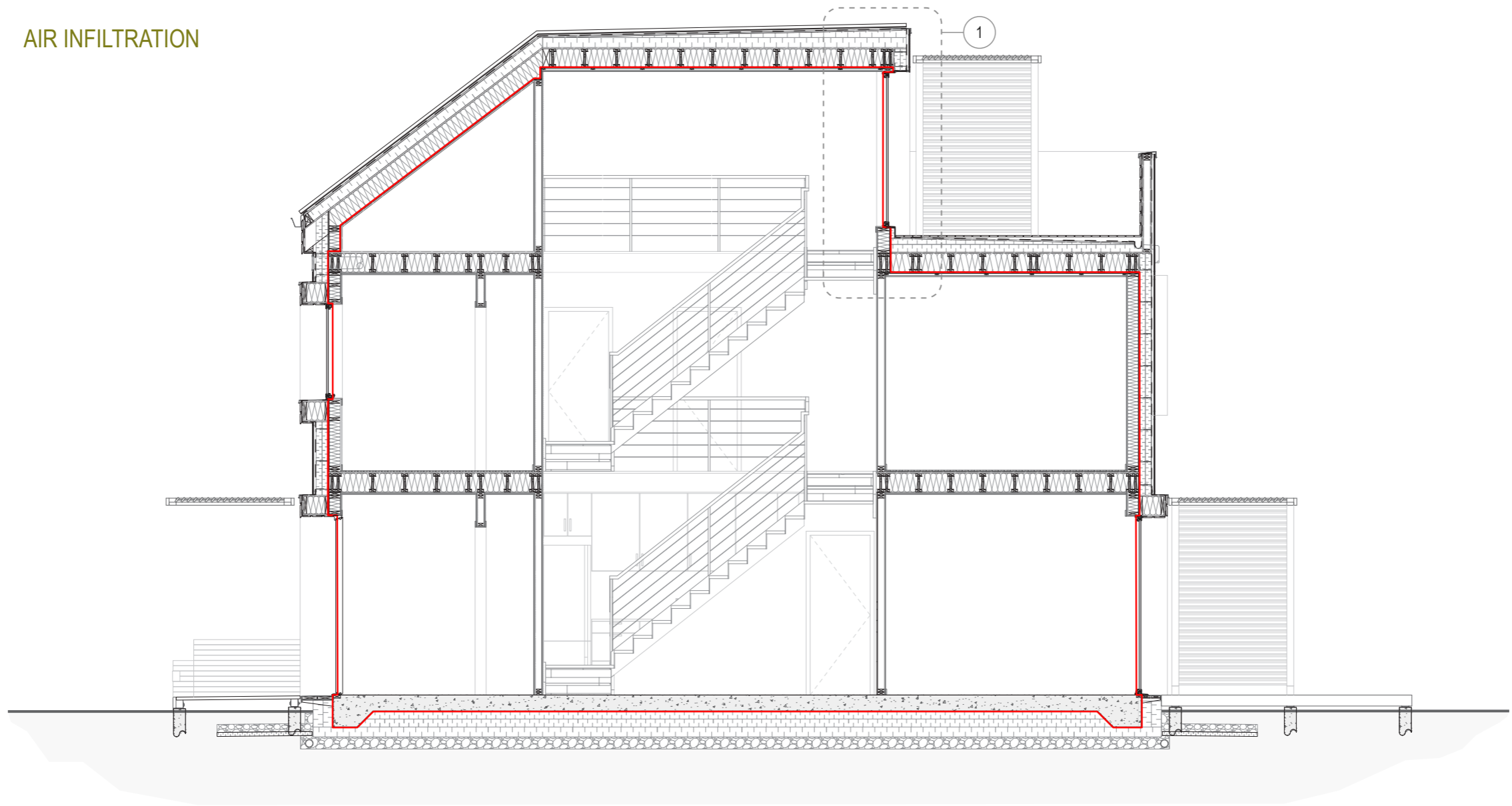


Exterior Sheathing Moisture Content



Exterior Sheathing Temperature & Relative Humidity

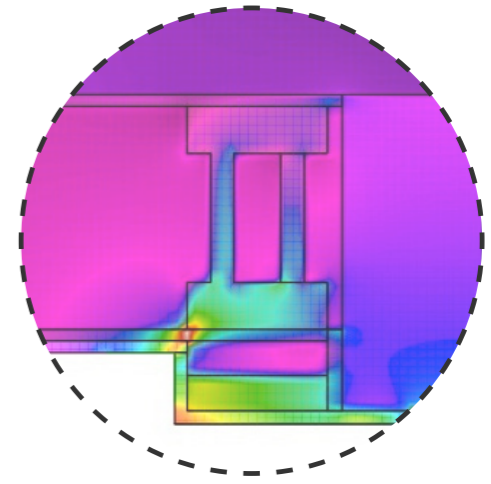
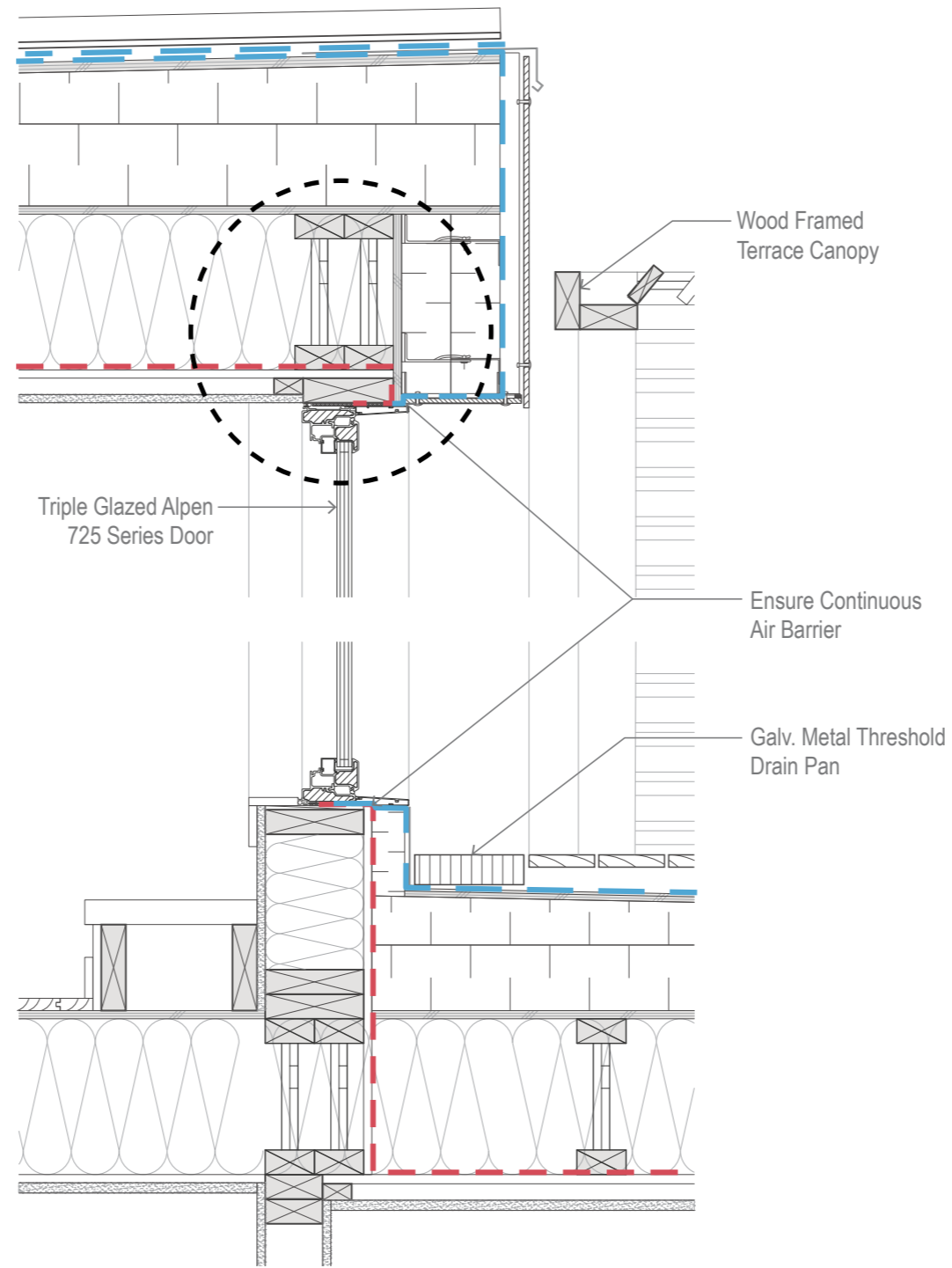
AIR INFILTRATION



Detail Section



THERMAL BRIDGING



THERM Analysis

Section Detail - Third Level Terrace Door

- - - - - Moisture Barrier
- - - - - Air Barrier / Vapor Retarder

INDOOR AIR QUALITY & VENTILATION STRATEGIES



Eliminate airborne pollutants within through **exceptional filtration** of circulated and fresh air supply.



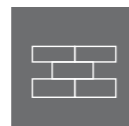
Incorporate **mechanical ventilation systems** to circulate and ventilate interior air.



Minimize noise generation and travel throughout the home.



Reduce, drain and **control moisture** within the building envelope.



Specify materials and finishes with low volatile organic compounds (VOCs).



Control supply and exhaust air to and from the home to ensure superior quality interior air.



Mitigate radon infiltration from surrounding soil.

SPACE CONDITIONING STRATEGIES



Appropriately size the mechanical system to meet the volumetric heating requirements.



Minimize operational costs throughout the mechanical system's entire life cycle.



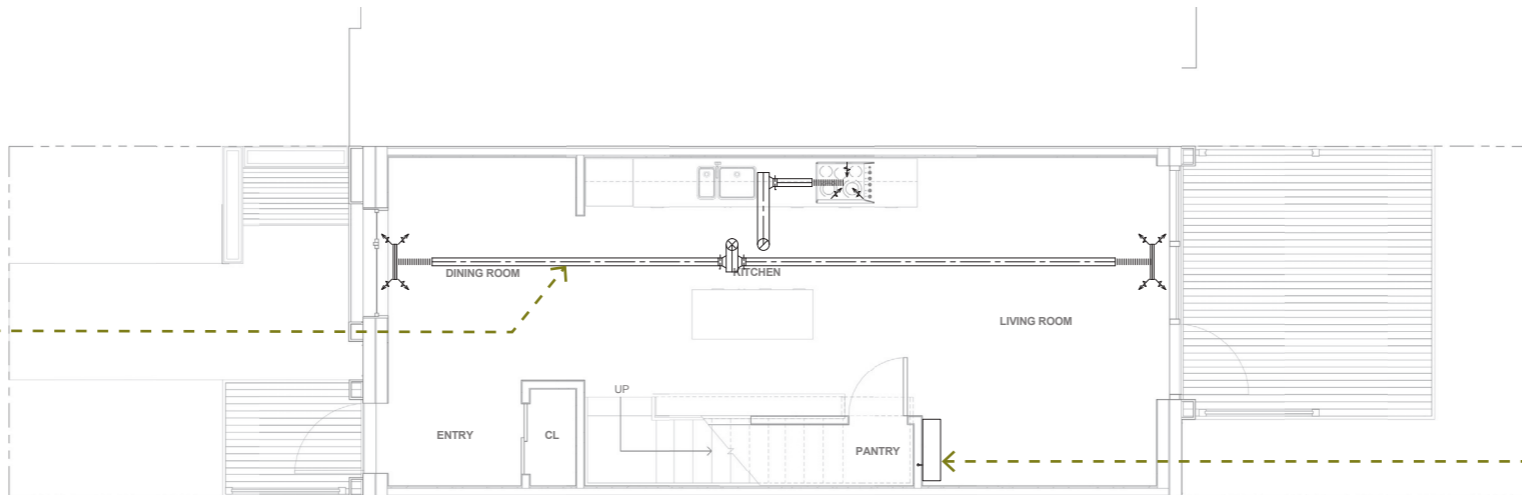
Employ a consistent energy supply source throughout all home systems.



Minimize residual heat loss in duct runs and exhaust air.



Ventilation Ductwork



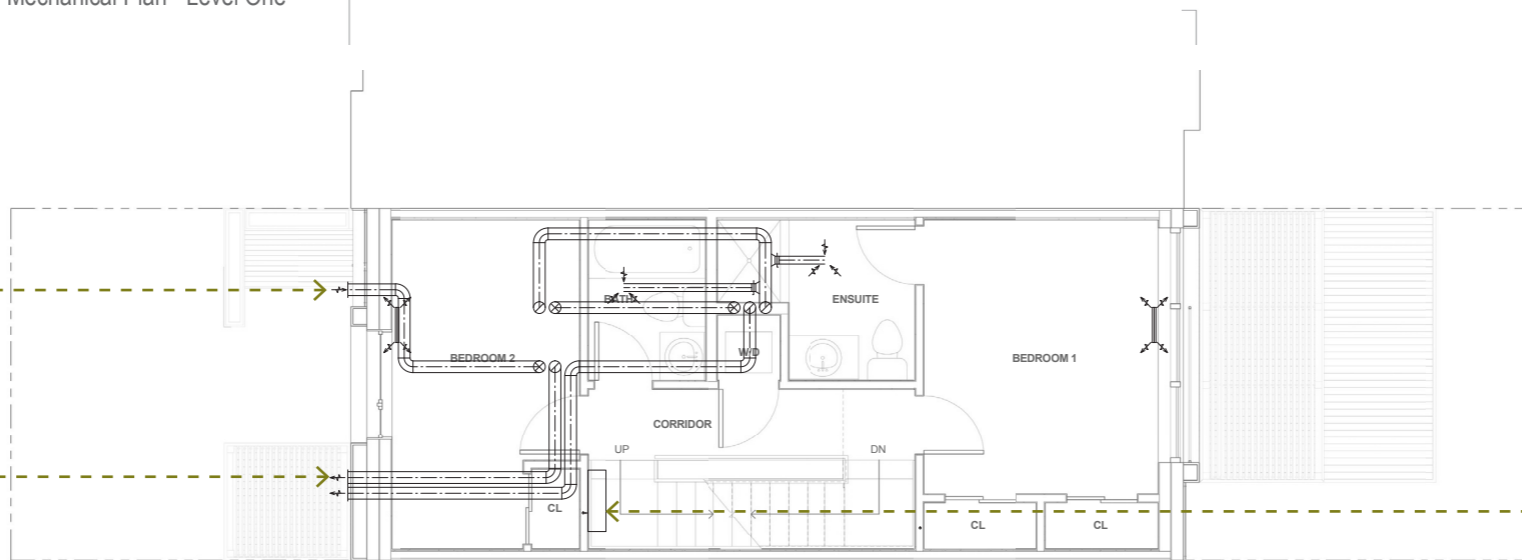
Mechanical Plan - Level One



Mitsubishi Mini-Split Heat Pump

Supply Air

Exhaust Air



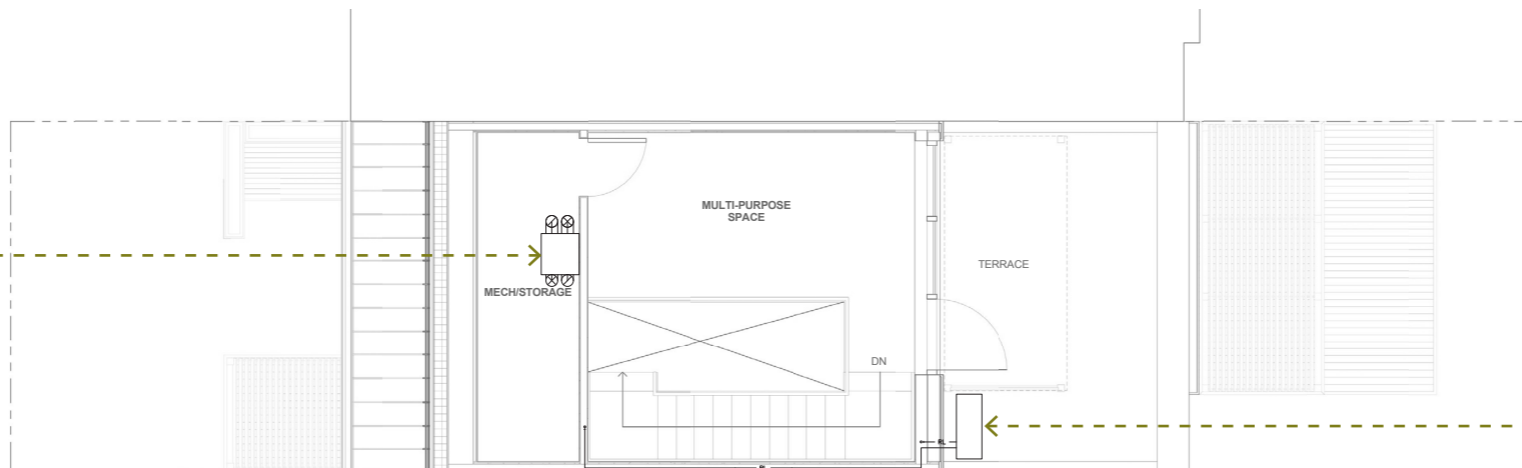
Mechanical Plan - Level Two



Mitsubishi Mini-Split Heat Pump



UltimateAir RecoupAerator ERV



Mechanical Plan - Level Three



Condensing Unit

DOMESTIC HOT WATER STRATEGIES



Utilize the same **energy source** as the HVAC system.

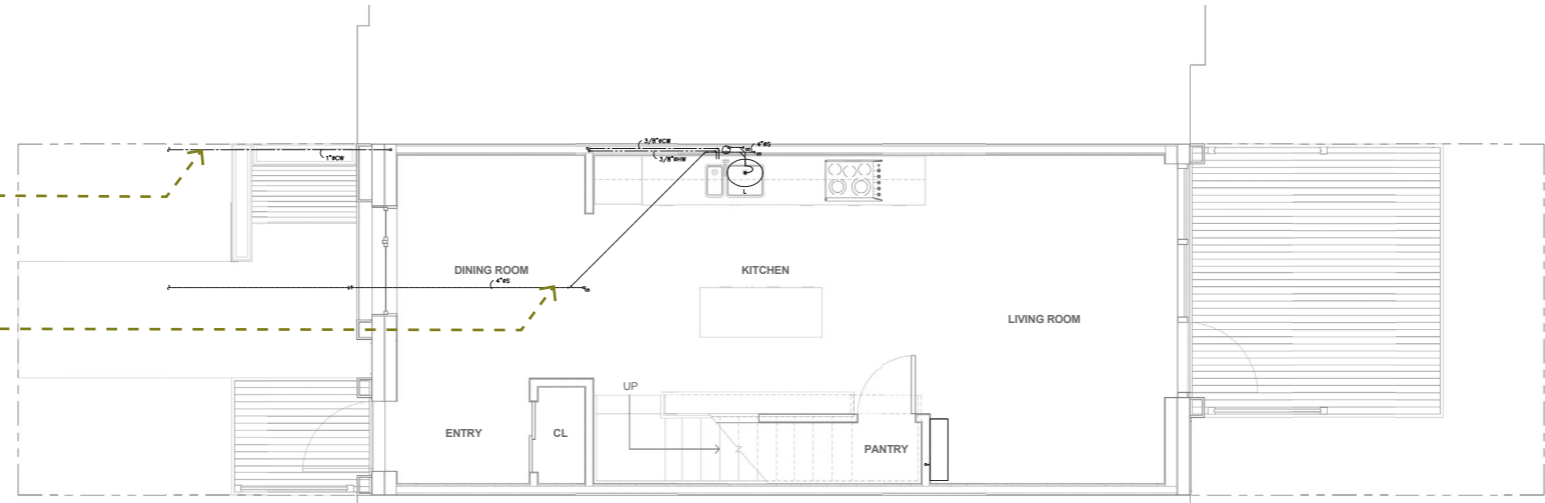


Minimize operational costs throughout the mechanical system's entire life cycle.



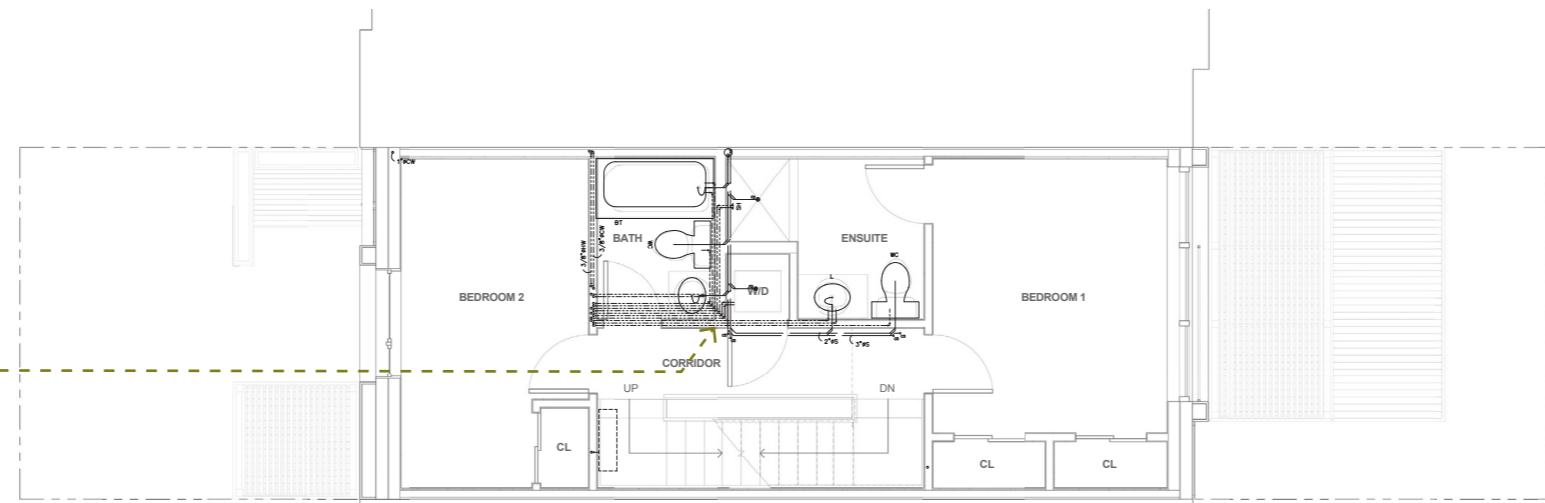
Eliminate the potential for **standing water heat loss**.

Sanitary Connection
Water Main Connection



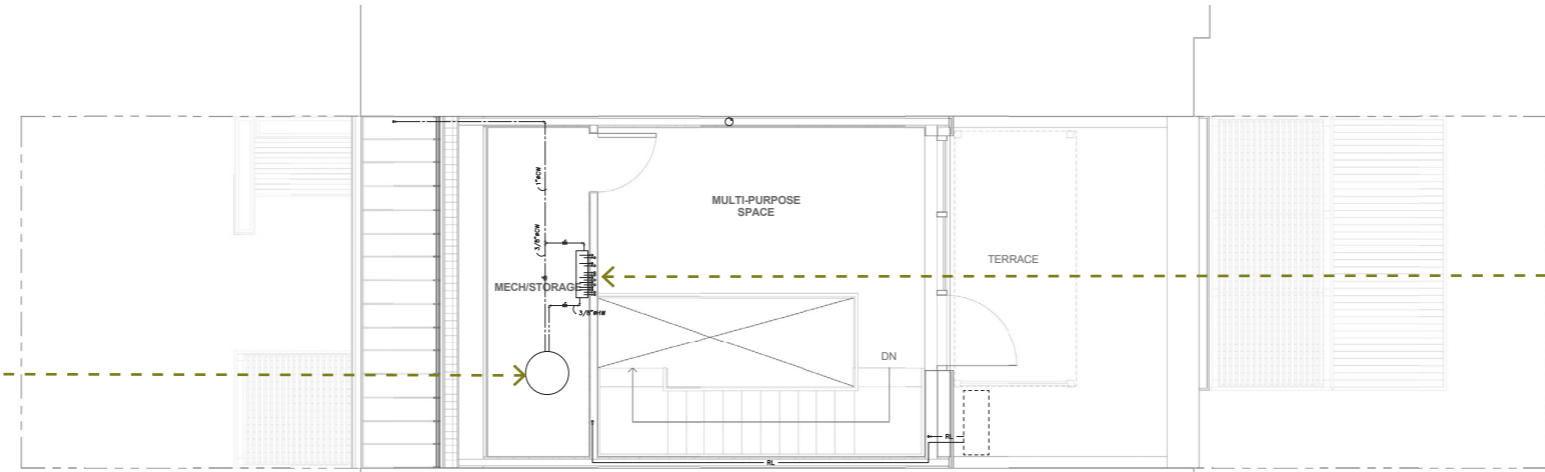
Plumbing Plan - Level One

Centralized Plumbing Stack



Plumbing Plan - Level Two

Hybrid Hot Water Heater



Plumbing Plan - Level Three

Home Run Manifold

ELECTRICAL, LIGHTING & APPLIANCE STRATEGIES



Specify *high efficiency fixtures and equipment* to reduce annual energy consumption.



Minimize operational costs throughout the mechanical system's entire life cycle.



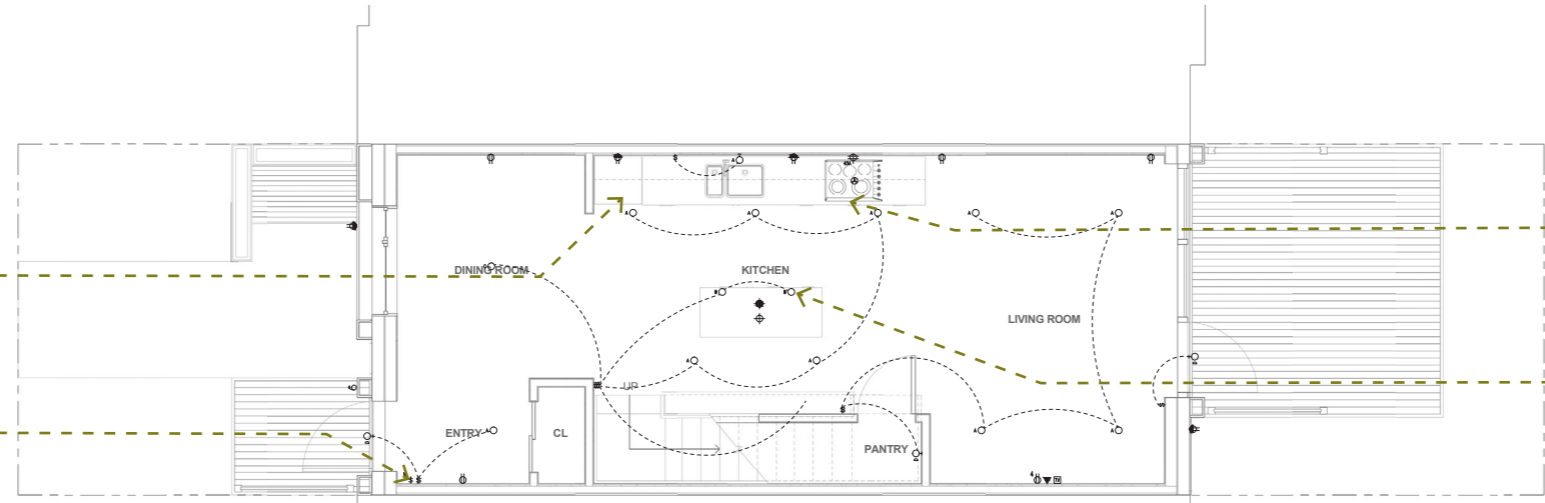
Specify *compact appliances and equipment* to alleviate space within the modest floor plate.



Maximize daylighting potential through the use of solar optimized glazing distribution.

\$ ☆ 🚪
 Compact Refrigerator

\$
 Master On/Off Switch

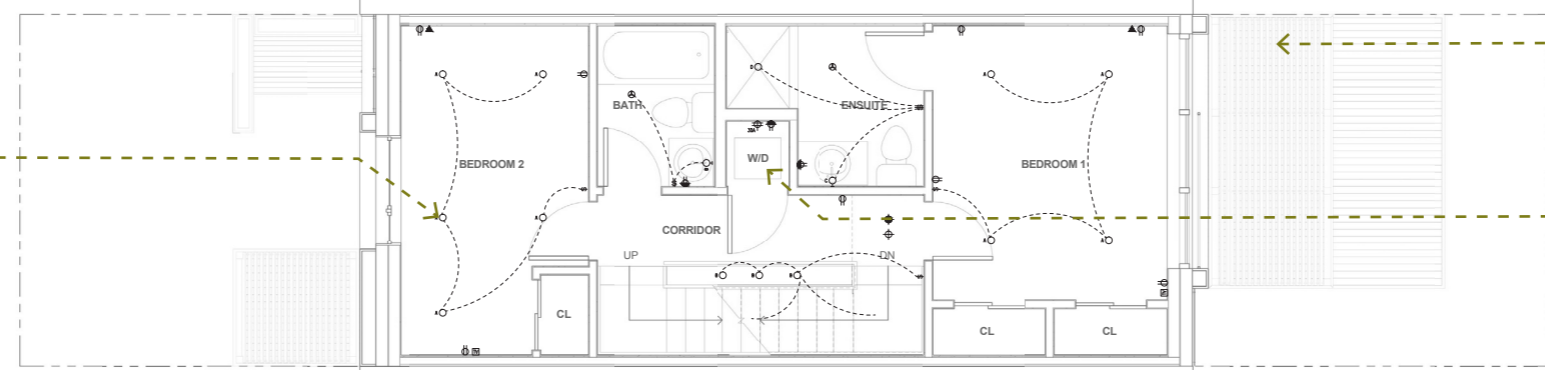


Electrical Plan - Level One

\$ ☆ 🚪
 Built-in Oven & Cooktop

\$ ☆
 Task Lighting

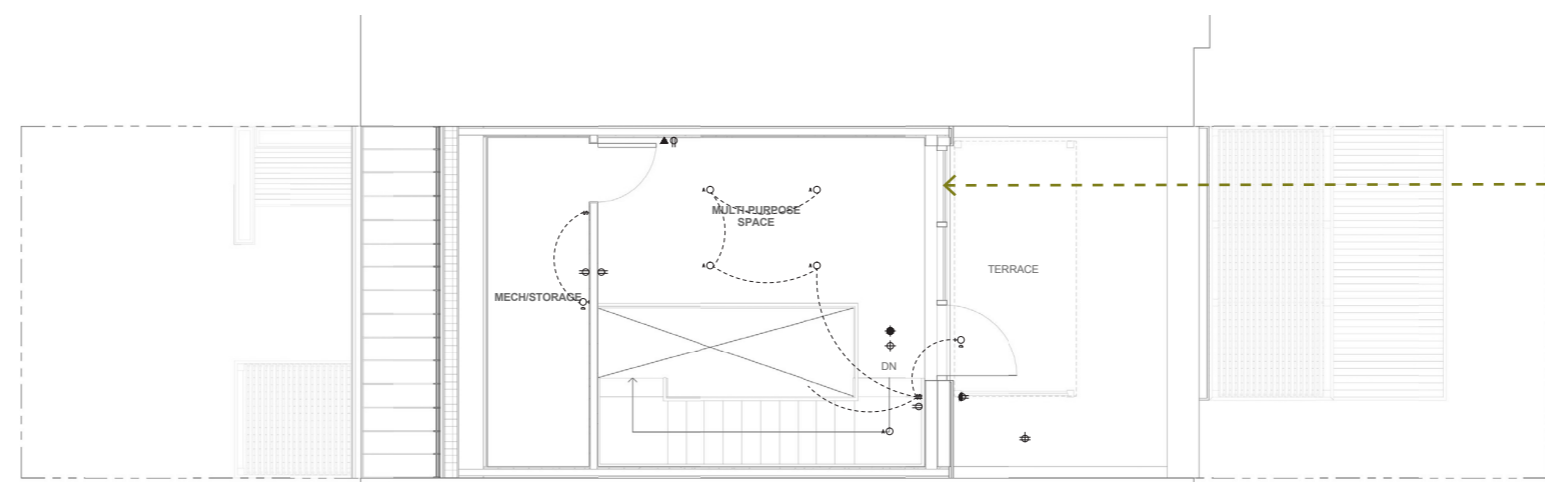
\$ ☆
 LED Pot Lighting



Electrical Plan - Level Two

\$ ☀️
 Shading Structure

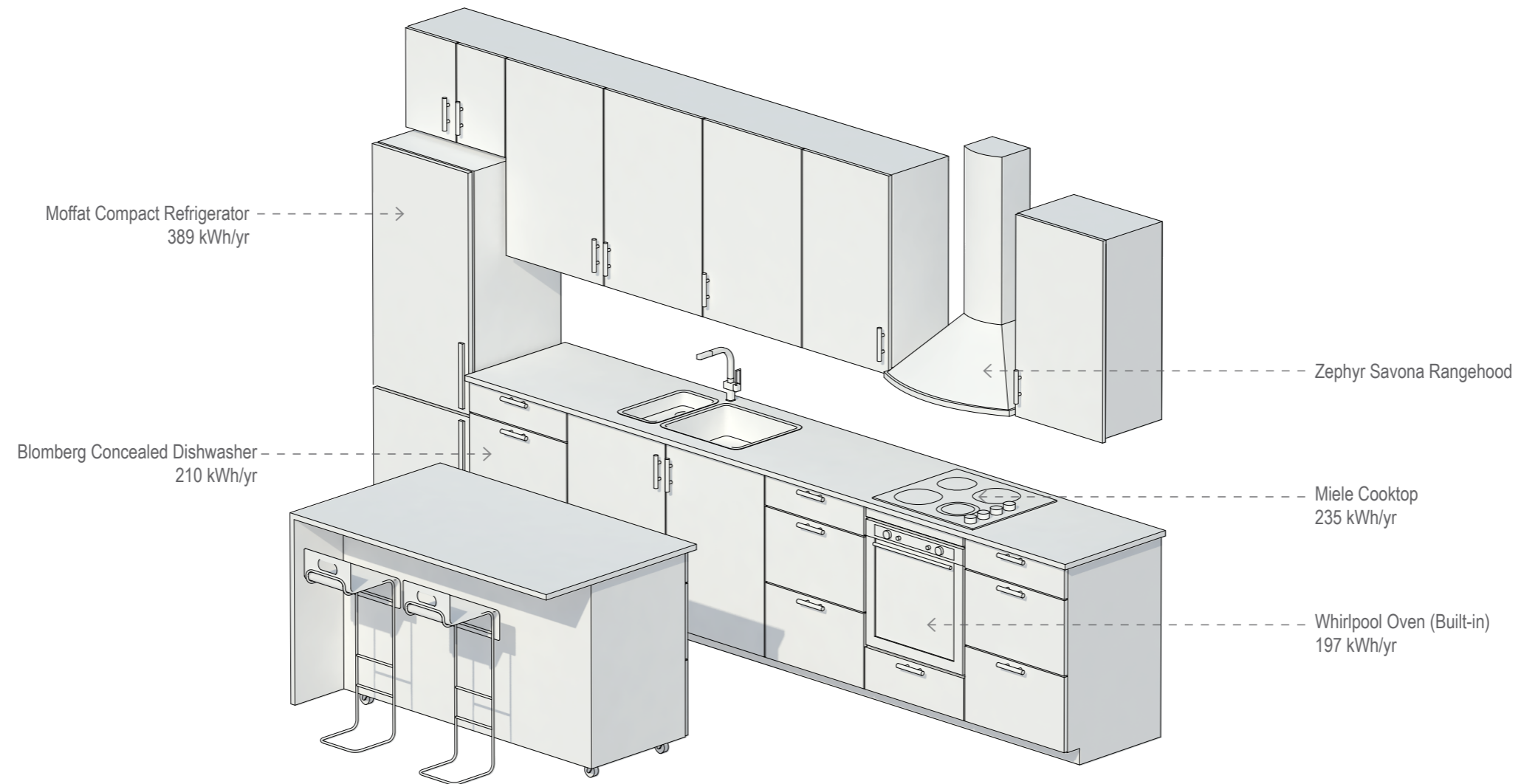
\$ ☆ 🚪
 Stacked Washer & Dryer



Electrical Plan - Level Three

\$ ☀️
 South Terrace Glazing

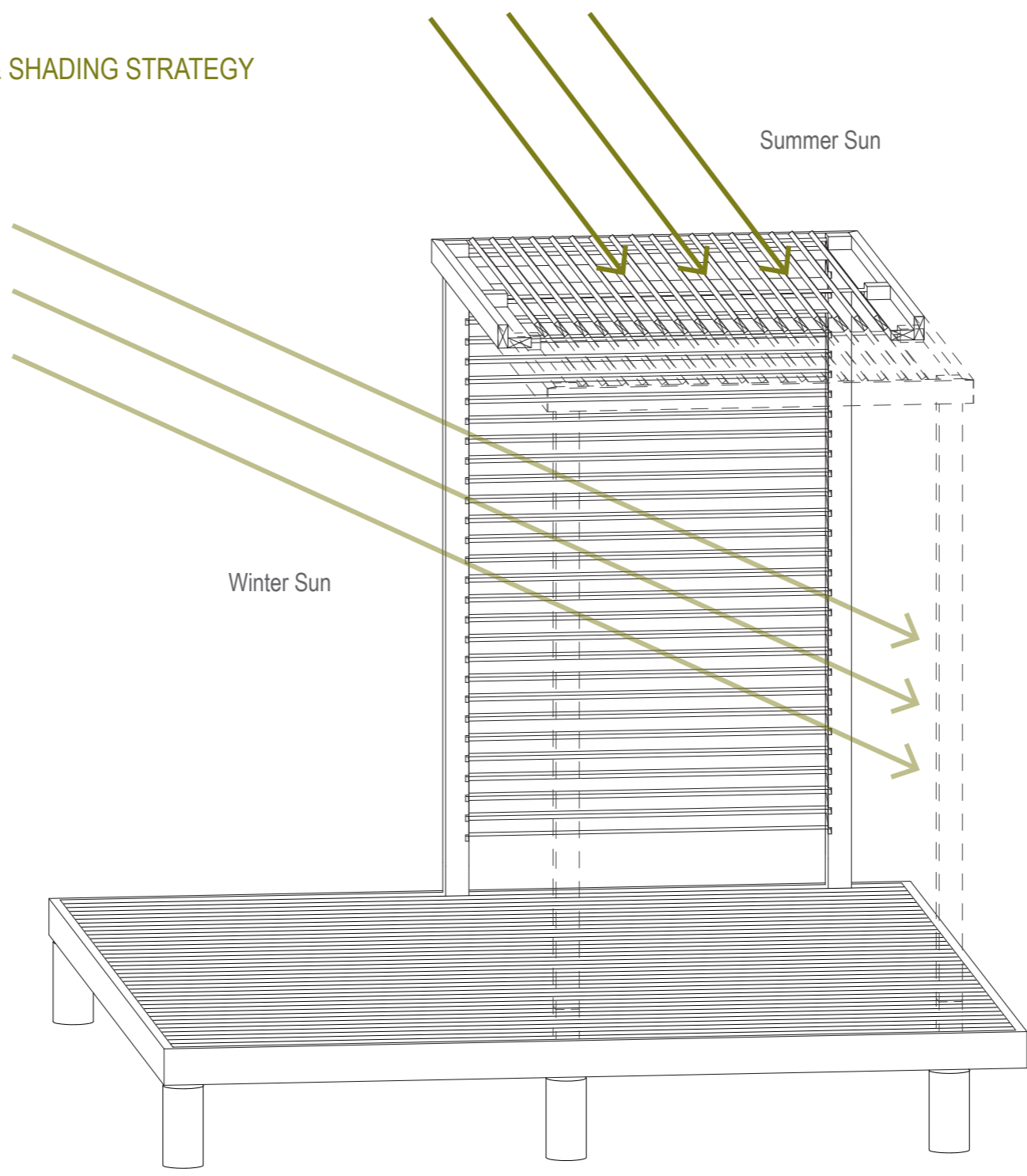
KITCHEN APPLIANCES



Annual Primary Energy Consumption **36.1 kWh/m² - yr**

Passive House Recommended **50.0 kWh/m² - yr**

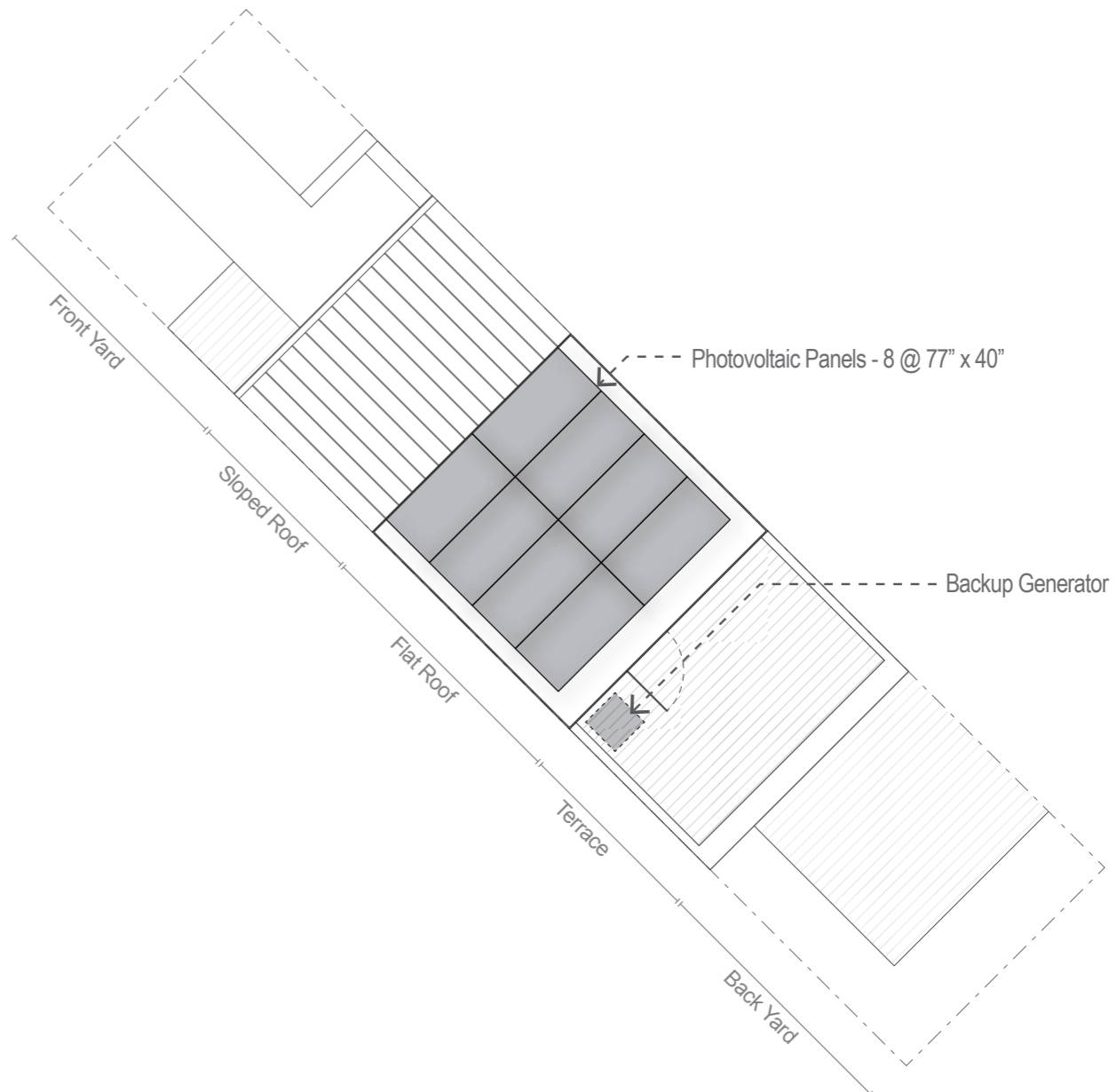
DAYLIGHTING & SHADING STRATEGY



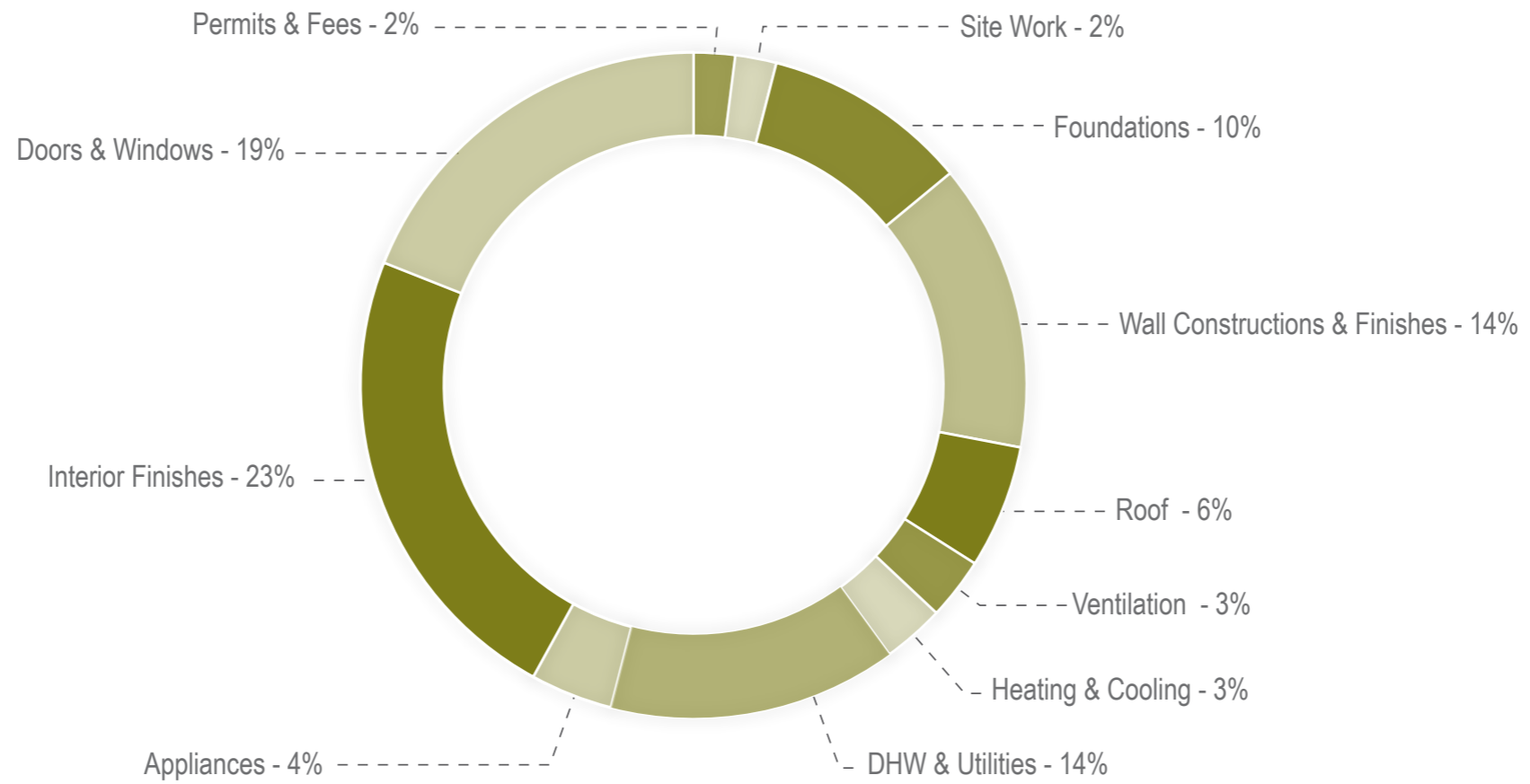
Solar Optimized Shading Canopies

PHOTOVOLTAIC INTEGRATION

Total Energy Consumption	3,800 kWh/yr
Total Energy Generation	3,010 kWh/yr
Total PV Capacity	2.4 kW
Gross Cost (Incl. Install & Tax Credit)	\$7,622
Pay Back Period	10 yrs
Net Cash Flow - 25 yrs	\$15,500



CONSTRUCTION COST ESTIMATE

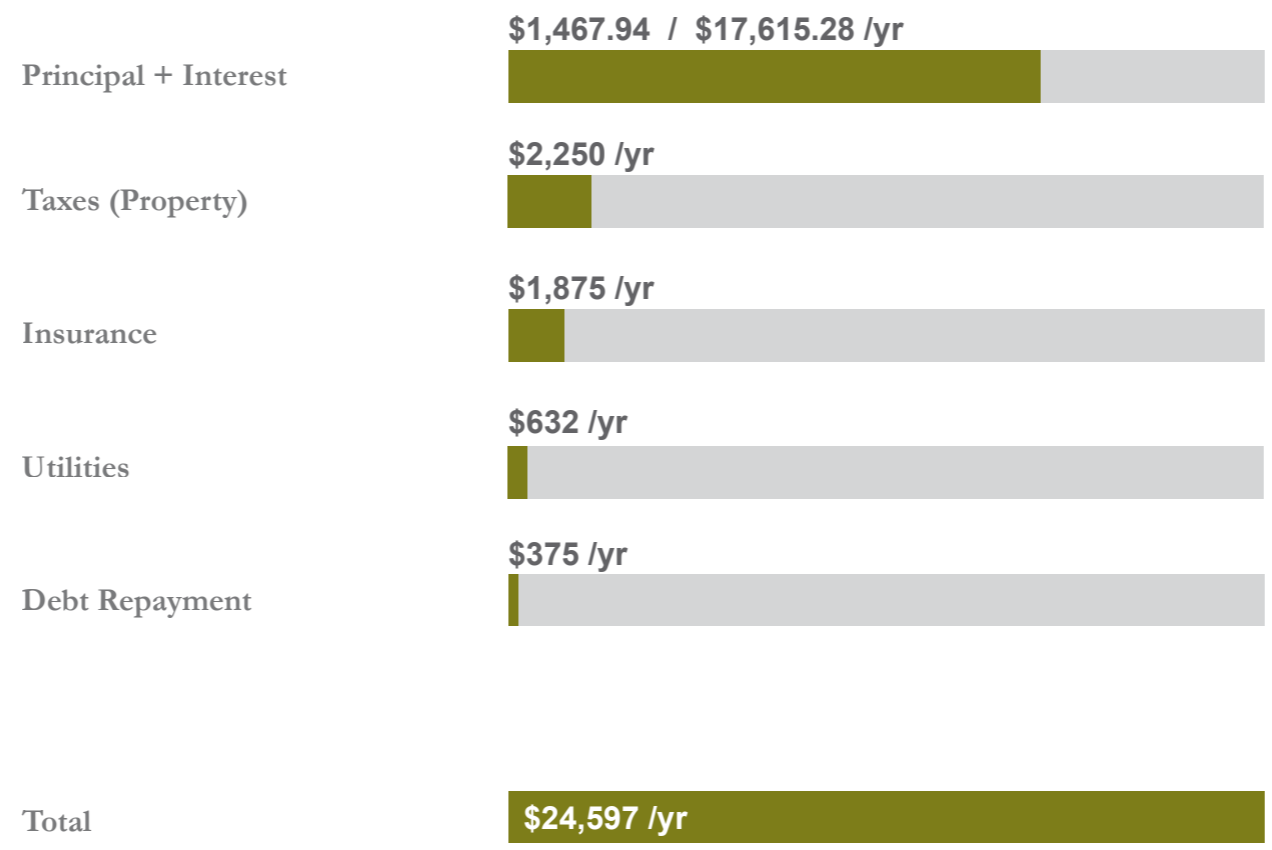


Total Construction Cost **\$181,000**

Cost / ft² **\$145**

High Performance Premium **9.0%**

AFFORDABILITY ANALYSIS - PITIU METHOD



AFFORDABILITY ANALYSIS - ANNUAL HOUSING EXPENSES

<p>Median Family Income (MFI) City of Denver</p>	<p>\$75,000</p>
<p>Typical Housing Expenses (33%)</p>	<p>\$25,000 /yr</p>
<p>Harvest Home</p>	<p>\$24,597 /yr</p>
<p>Critical Components Replaced Twice in 30 years</p>	<p>\$403 Net Annual Cash Flow</p>

RATING SYSTEMS



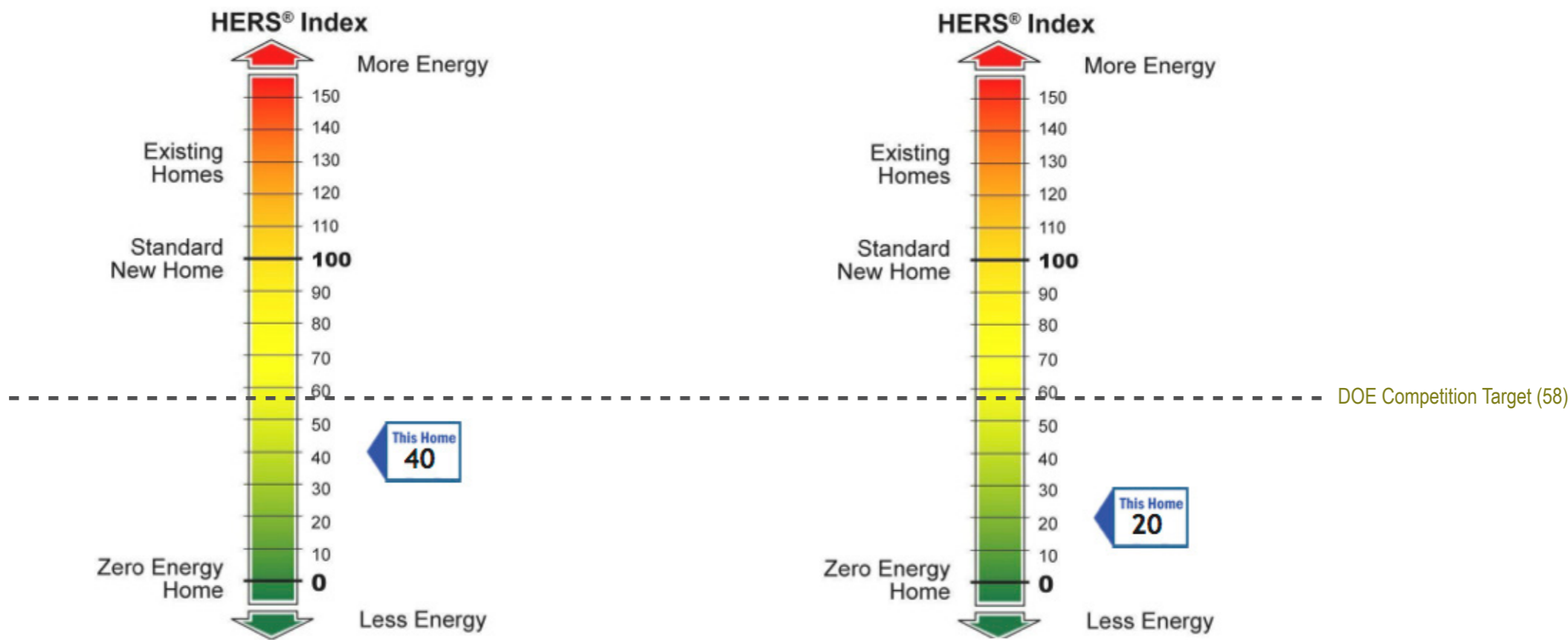
Passive House Institute US



THE PASSIVE HOUSE STANDARD

	Heat Demand kBTU/ft ² - yr	Cooling Demand kBTU/ft ² - yr	Primary Energy Demand kBTU/ft ² - yr
Passive House Standard	4.75	4.75	38
Harvest Home	2.4	1.74	37.82

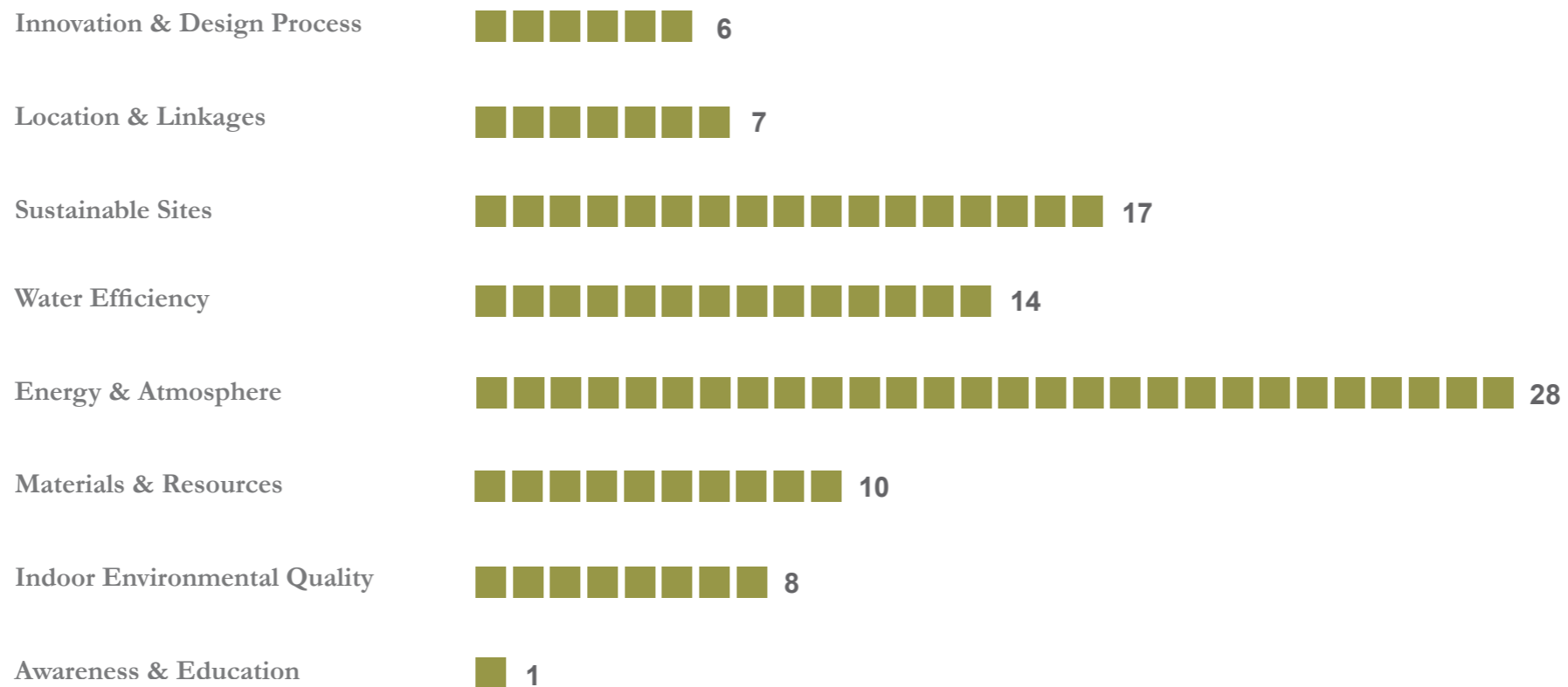
HERS RATING - REM/RATE SOFTWARE



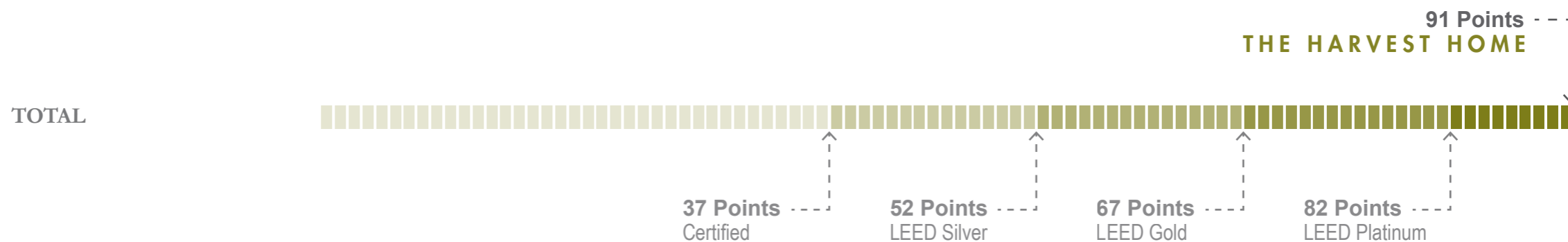
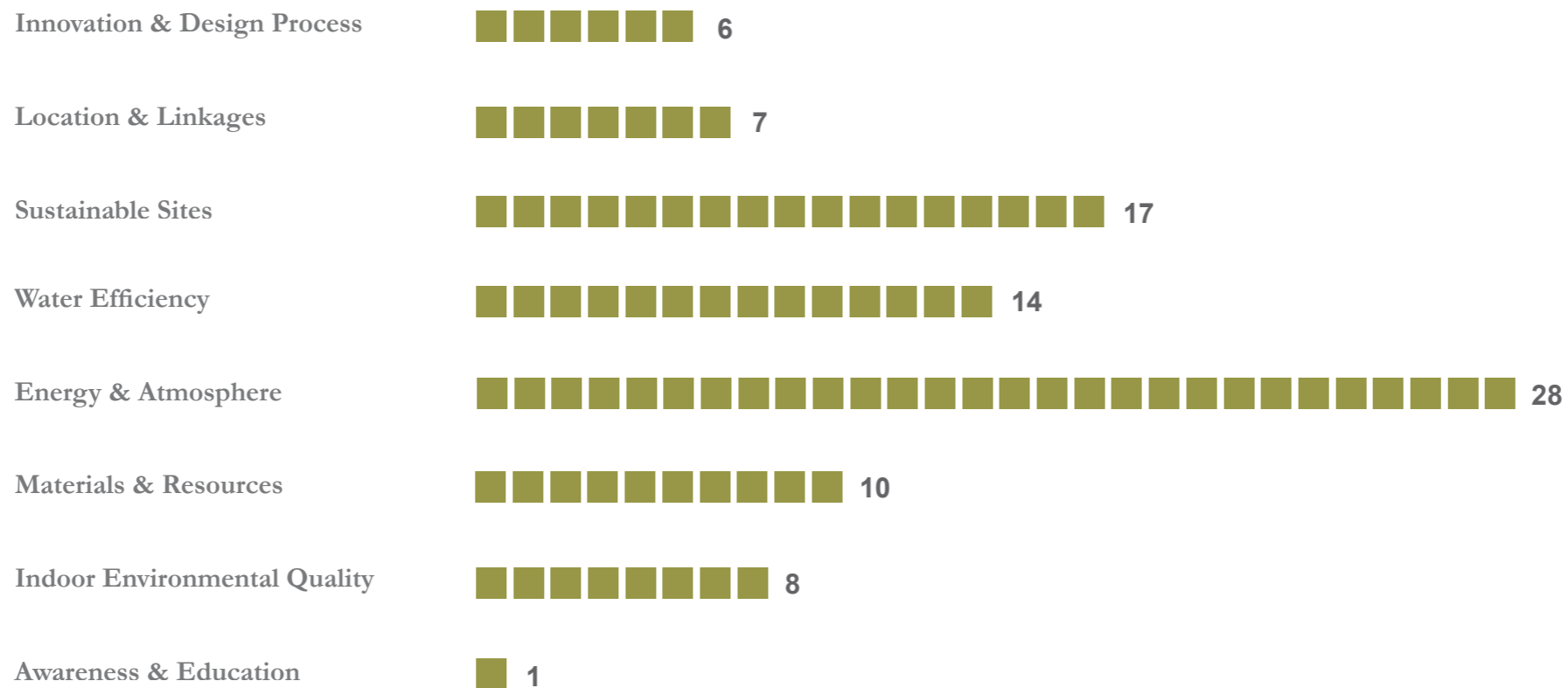
Harvest Home - Initial Construction

Harvest Home - On-site Photovoltaic Panels

LEED FOR HOMES



LEED FOR HOMES



	AVERAGE COLORADO RESIDENCE	THE HARVEST HOME
HERS Rating	100	40
Passive House U.S.	N/A	Certified
LEED Certification	N/A	Platinum - 91 pts
Annual Energy Consumption	102,000 kBTU/yr	23,600 kBTU/yr
Annual Heating + Cooling Cost	\$1,551 /yr	\$632 /yr
Gross Area	2,082 sf	1,175 sf
Construction Cost / ft ²	\$120 - \$300 /sf	\$146 /sf





Third Level South Terrace

THE HARVEST HOME

RYERSON UNIVERSITY | TORONTO, CANADA