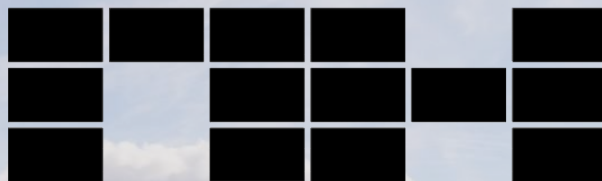


**HEALTH
+
WELLBEING**

AFFORDABILITY

**HIGH
PERFORMANCE**



NORTHSTAR HEALTHY HOMES



UNIVERSITY OF MINNESOTA

NREL Solar Decathlon 2023 Design Challenge
Multifamily Building Division
April 22, 2023

INTERDISCIPLINARY TEAM + INDUSTRY PARTNERS



TEAM: Billy Weber (Faculty Advisor), Sam Buttram, Madeleine Hallberg, Thanh Duong, Shane Herb, Will Barford, Raz Perl, Jacob Dommer, Marie Brehm, Ryan Getz, Clara Harter, Wen Du, Jack Archer, Hannan Minhas, Tanan Assefa



DESIGN GOALS

HUMAN + ECOLOGICAL HEALTH



- High Indoor Environmental Quality
- Biophilic Design
- Trauma-Informed Approach
- Healthy Materials
- Net-Zero Energy
- Low GWP

ADDRESS HOUSING NEED



- High Performance Envelope
- Consistency and Control
- Cost Savings Through Efficient Material Use and Reduced Construction Timeline
- Improved Working Conditions

NURTURE VIBRANT COMMUNITY



- Promotes Agency and Choice
- Foster Community Connection and Capacity
- Equitable and Intuitive Experience

AFFORDABILITY

LOCATION + CLIMATE



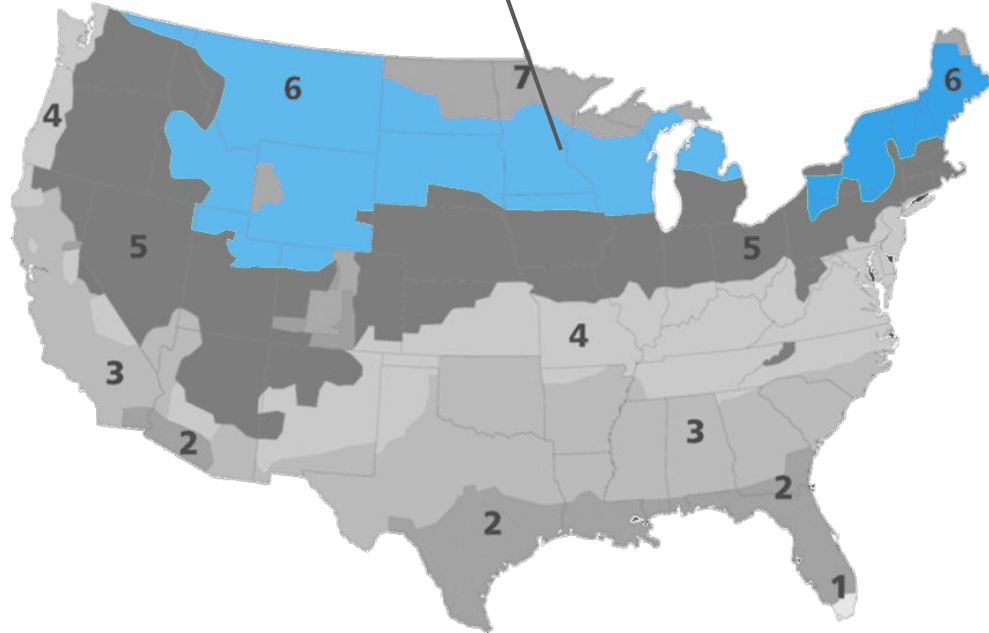
Hot, Humid Summers



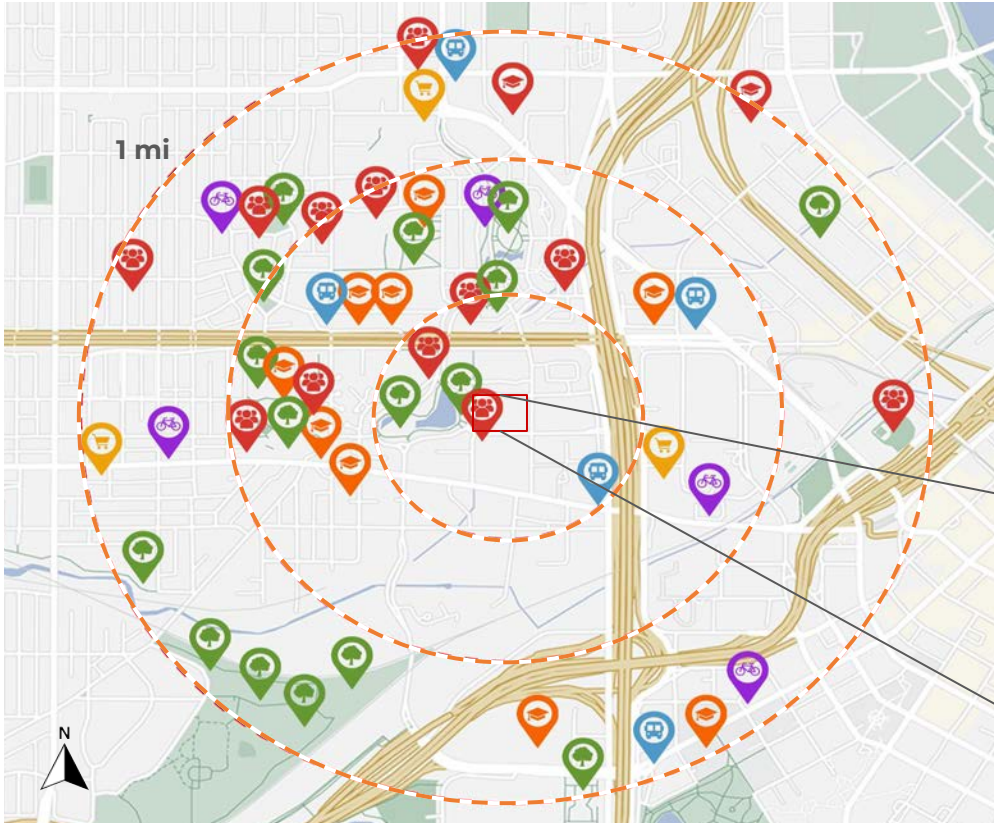
Harsh Cold Winters

Minneapolis, Minnesota







Climate Zone 6



SITE + CONTEXT



LEGEND

-  Public Parks
-  Community Centers
-  Education: K-12 and College
-  Farmer's Market and Grocery
-  Public Transportation
-  Bike Share



MARKET ANALYSIS

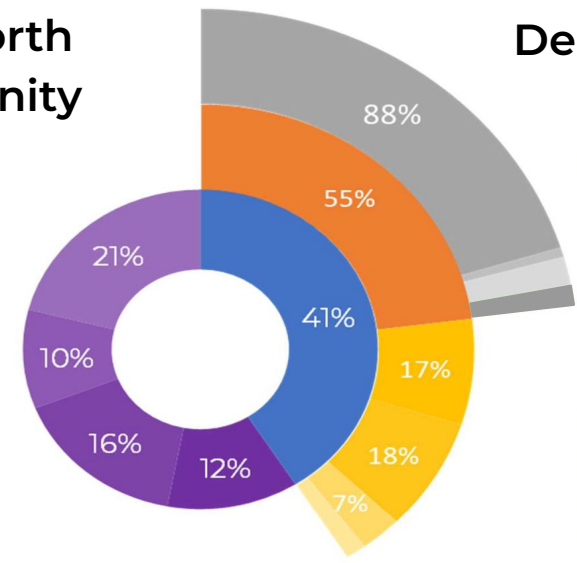
3-4
Bedroom
Homes

7500
People on AH
Waitlist

>50%
Households
Have 5+ Kids

Near North
Community

Deeply Affordable
Housing



Households by Income

- Under \$35K
- \$35K - \$50K
- \$50K - \$75K
- \$75K - \$100K
- Above \$100K

Age

- 0 - 17
- 18 - 29
- 30 - 49
- 50 - 61
- 62+

Race

- Black/African American
- Native American
- Asian
- White

COMMUNITY PERSPECTIVE

**More flexible space
for my family!**

More storage!

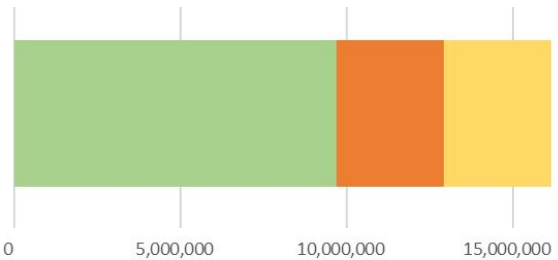
Bigger balconies!



MARKET FEASIBILITY



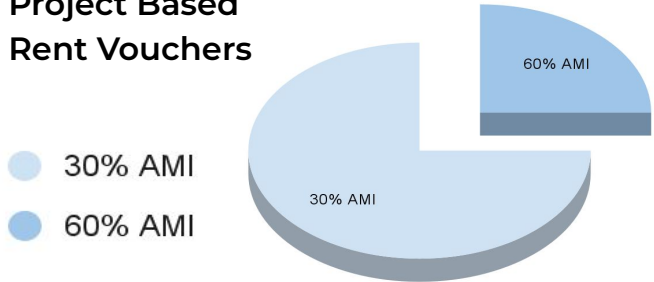
Total Cost: \$16,148,885 (\$216/sf)



Funding Sources

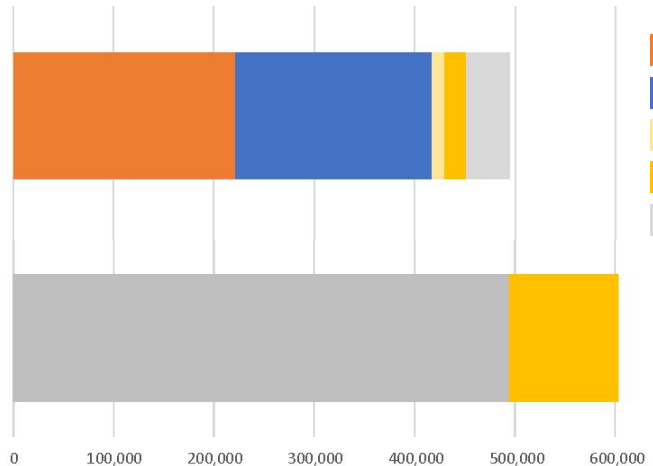
- LIHTC 9% Tax Credit
- Mortgage
- Gap Funding Sources

Project Based Rent Vouchers



Annual Expenses

- Primary Mortgage
- Building Operations
- Replacement Reserves
- Water and Sewer
- Electricity (without solar)



Positive Cash Flow

+\$180,640

SCHEMATIC SITE PLAN

TOTAL SITE SF: 169,521
GREEN SPACE SF: 105,103 = 62%
GREEN SPACE

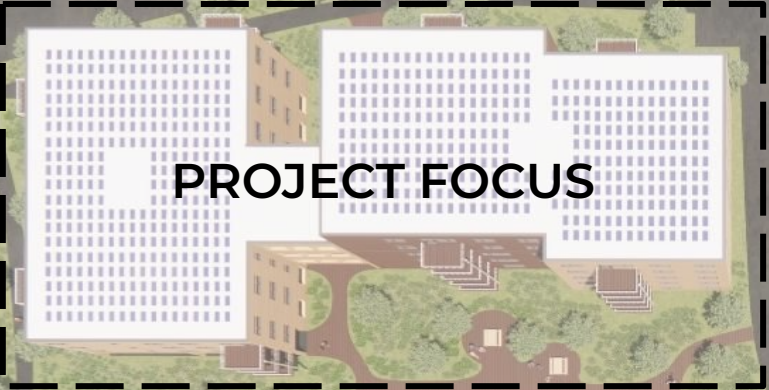




Commercial

Bike Storage

Breezeway



PROJECT FOCUS

- 1. Play
- 2. Walk
- 3. Rest
- 4. Socialize
- 5. Garden

2

1

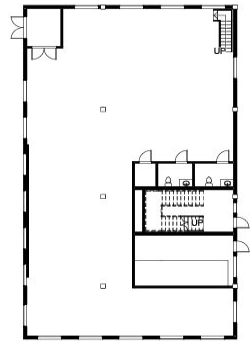
3

5

4



ARCHITECTURE



LEVEL 1



LEVEL 2-4
TYPICAL

KEY

			
1 BR	2BR	3BR	4BR

PROGRAM		
TYPE	QTY	AREA
1 Bed, 1 Bath	11	860 SF
2 Bed, 1 Bath	5	1140 SF
3 Bed, 2 Bath	10	1514 SF
4 Bed, 2 Bath	6	1610 SF
TOTAL	32	39,960 SF

COMMON SPACES



Childrens' Playroom



Study Area



Community Gathering

HIGH PERFORMANCE



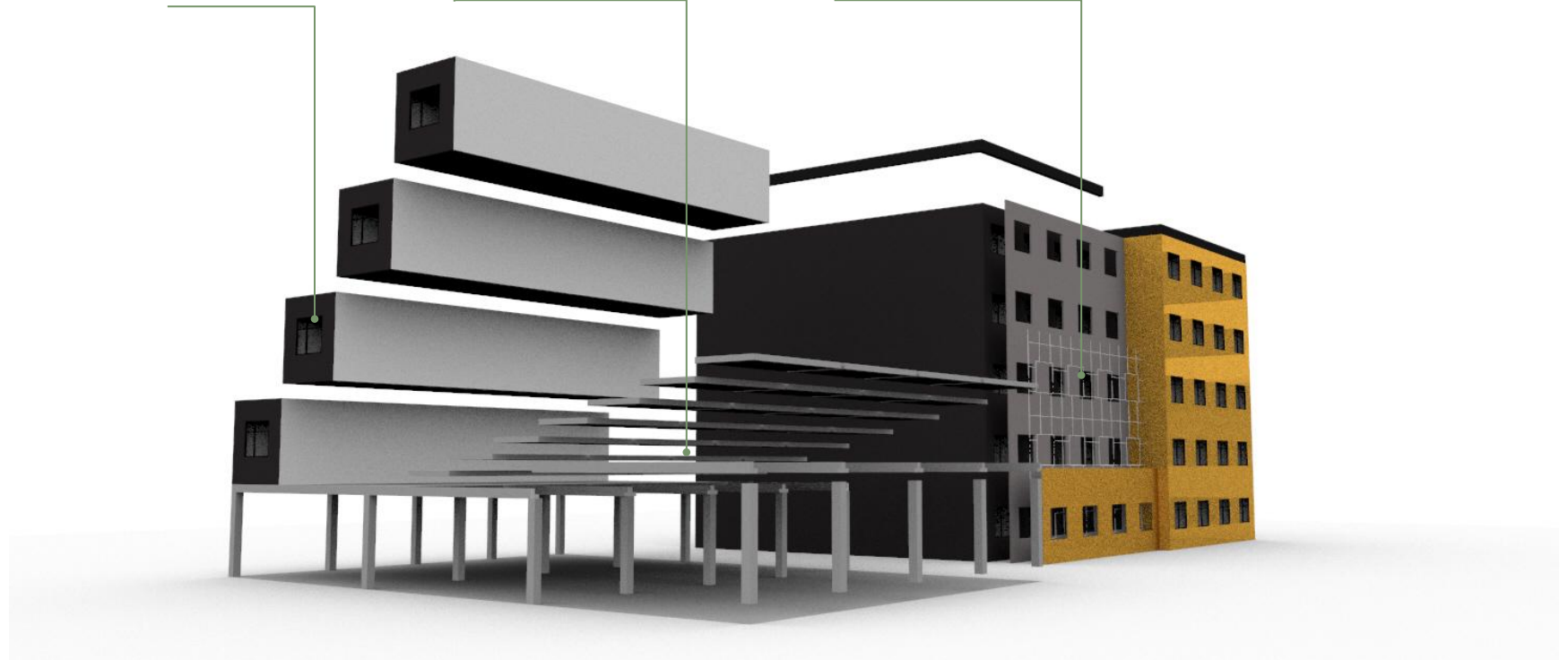
PROJECT FOCUS

MODULAR COMPONENTS

MODULE

PRECAST ASSEMBLY

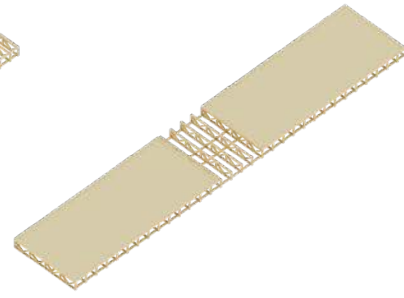
ENVELOPE ASSEMBLY



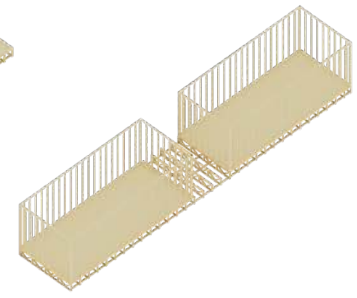
MODULE ASSEMBLY



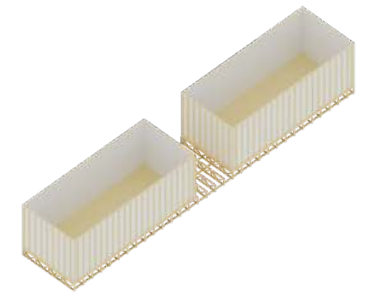
Step 1: Floor Truss Assembly



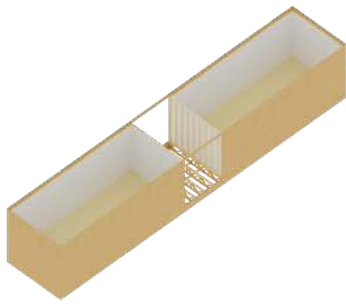
Step 2: Fasten OSB to Floor Trusses



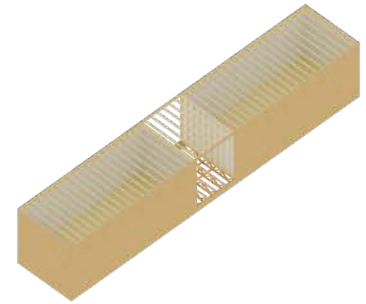
Step 3: Frame 2x4 Walls + Start Rough Ins



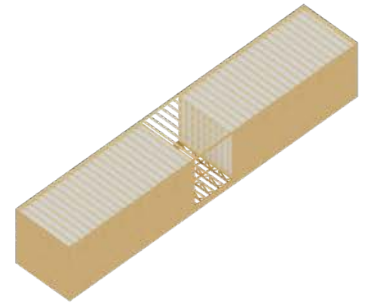
Step 4: Apply Sheetrock to Interior of Walls



Step 5: Apply OSB to Exterior of 2x4 Walls



Step 6: Frame and Install 2x6 Ceiling Joist + Finish Rough Ins

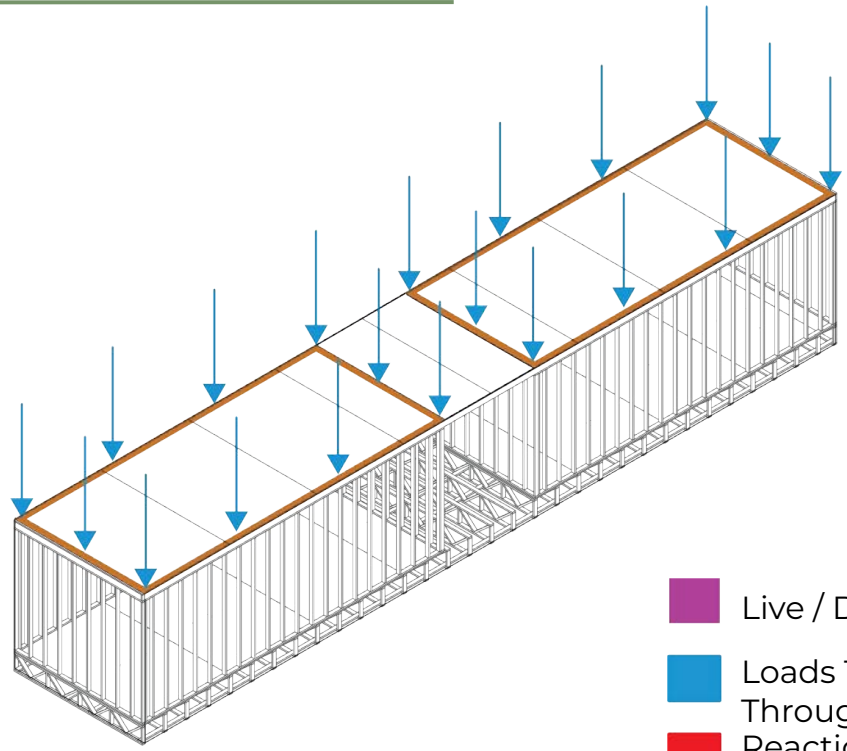






Step 7: Hang Sheetrock to Ceiling + Start Interior Finishes

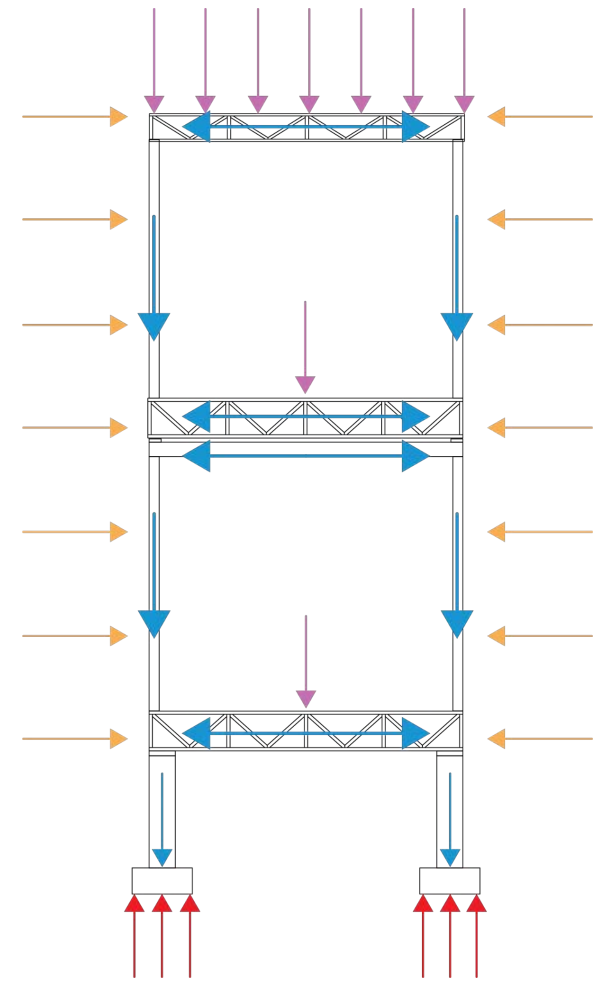


Step 8: Apply OSB to Ceiling + Finish Interiors + Prep for Shipping

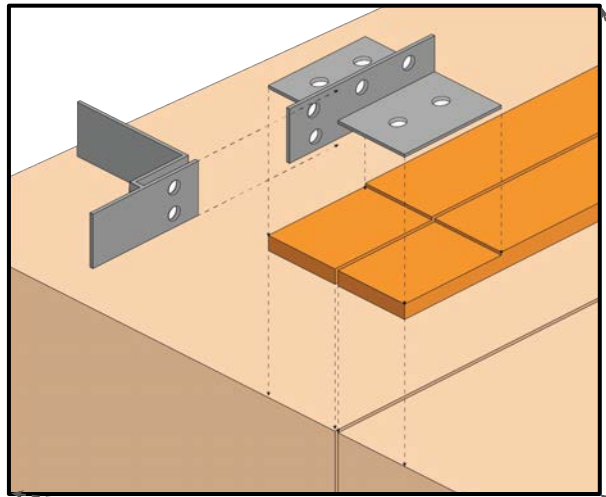
STRUCTURAL LOADS



-  Live / Dead Loads
-  Loads Transferred Through Building
-  Reaction Forces From Soil Pressure
-  Lateral Loads



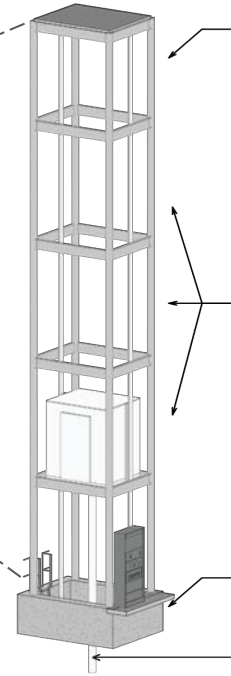
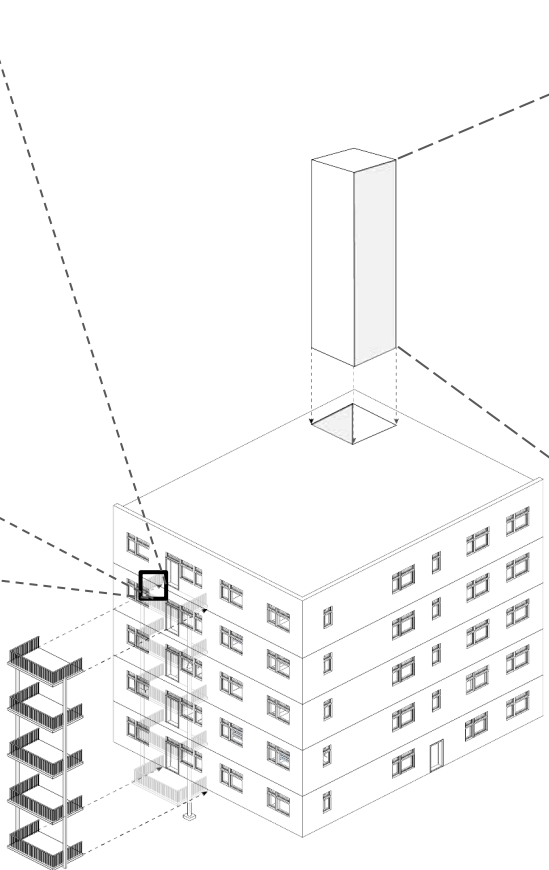
MODULAR COMPONENTS



Step 1: Fasten 2 x 6 Spacers to Modules

Step 2: Place Gusset Plate and Fasten Modules Together

Step 3: Connect Balcony System to Gusset Plate



6' x 5' Cab
2500 lb Capacity

Modular Framework:
HSS Column
6" x 6" AISC 14.1
Steel Beam

Precast Foundation Pit
Piston Cylinder Well

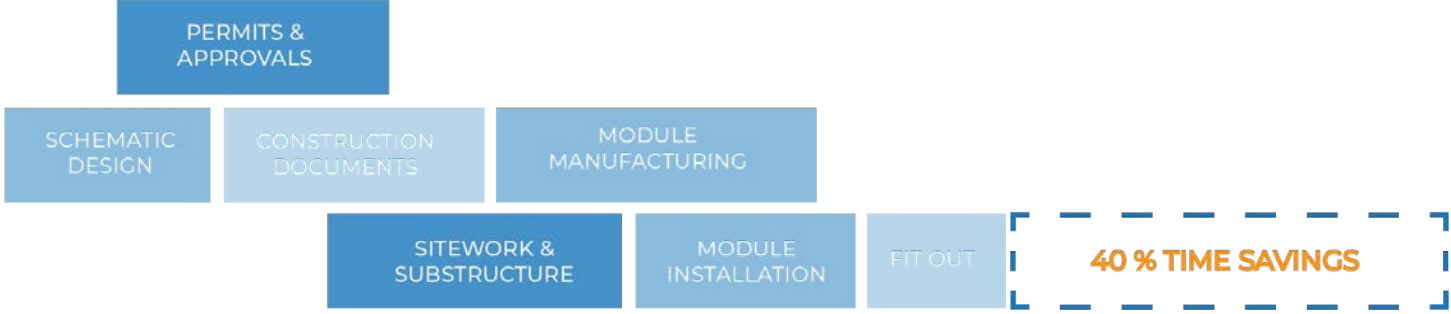
Elevator

WHY MODULAR?

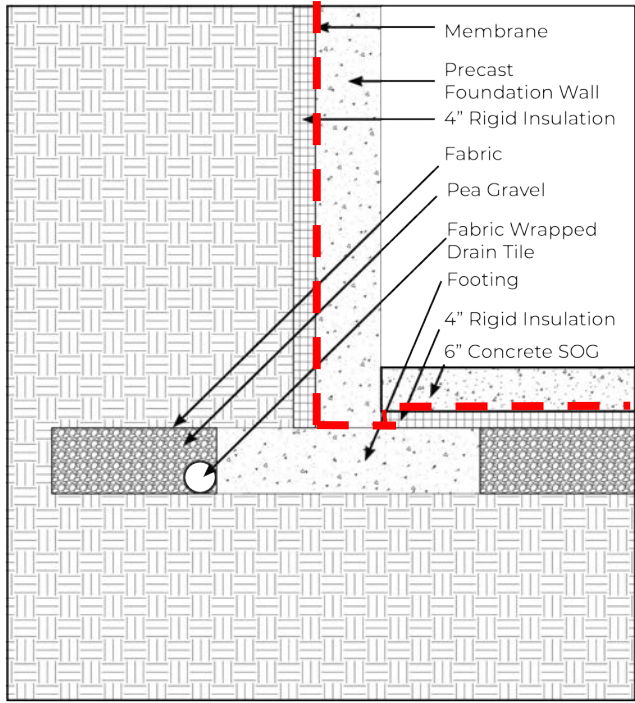
TRADITIONAL CONSTRUCTION SCHEDULE



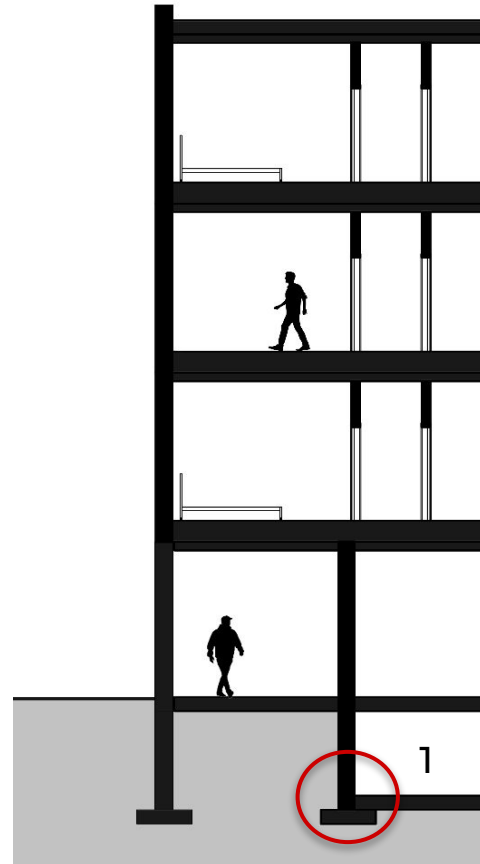
MODULAR CONSTRUCTION SCHEDULE

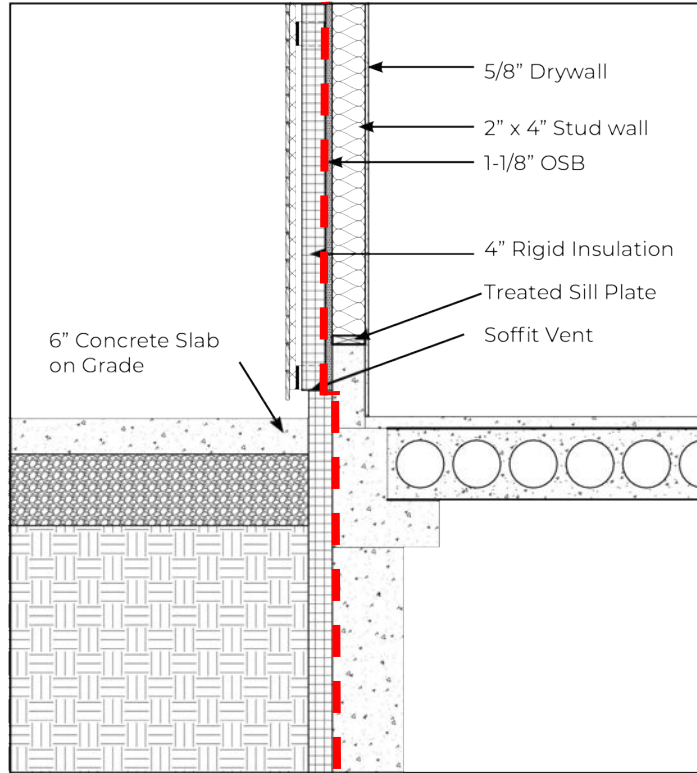


BUILDING CONTROL LAYERS

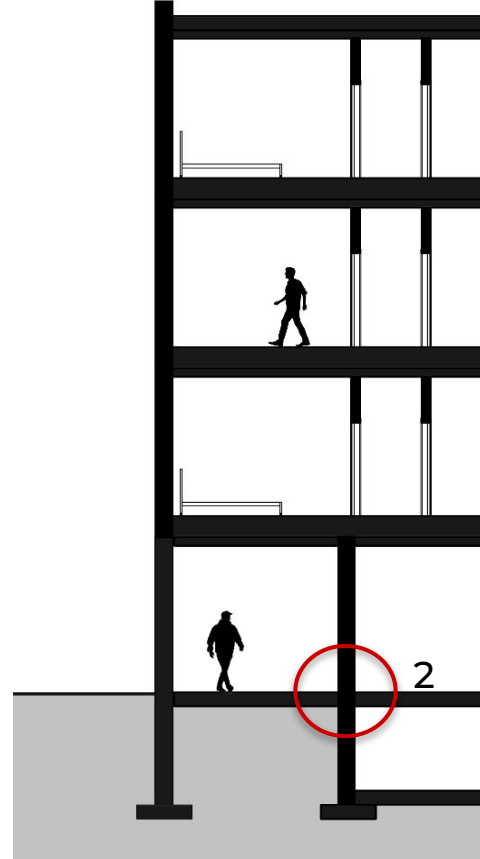


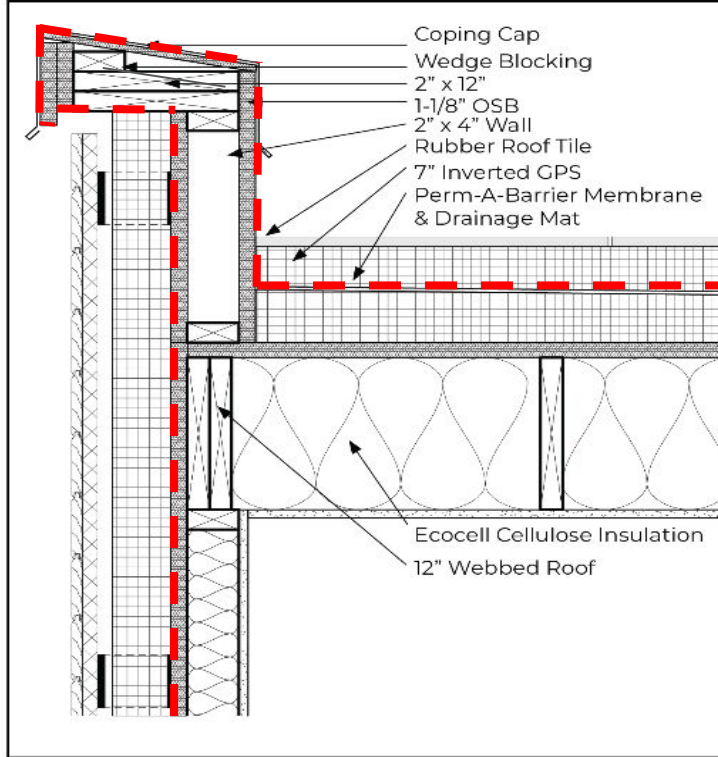
1. Precast Panel Foundation
R-36 Below-grade Wall



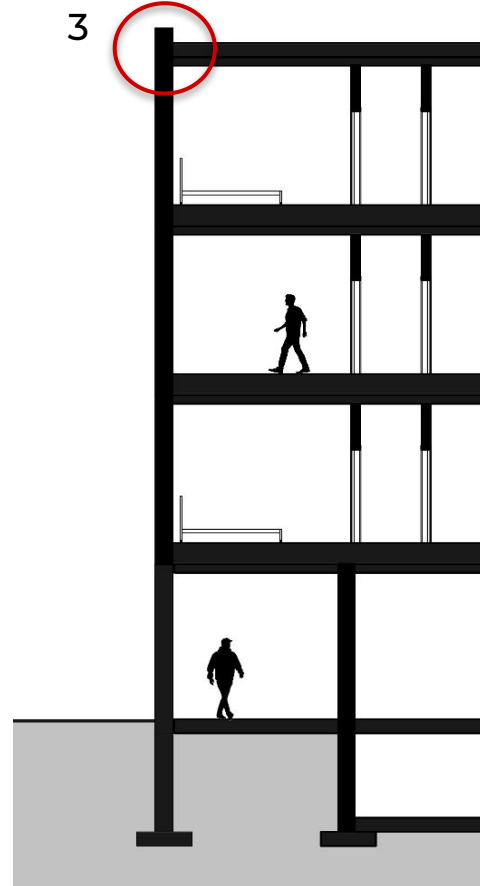


2. Hybrid Wall System, Above Grade
R-35

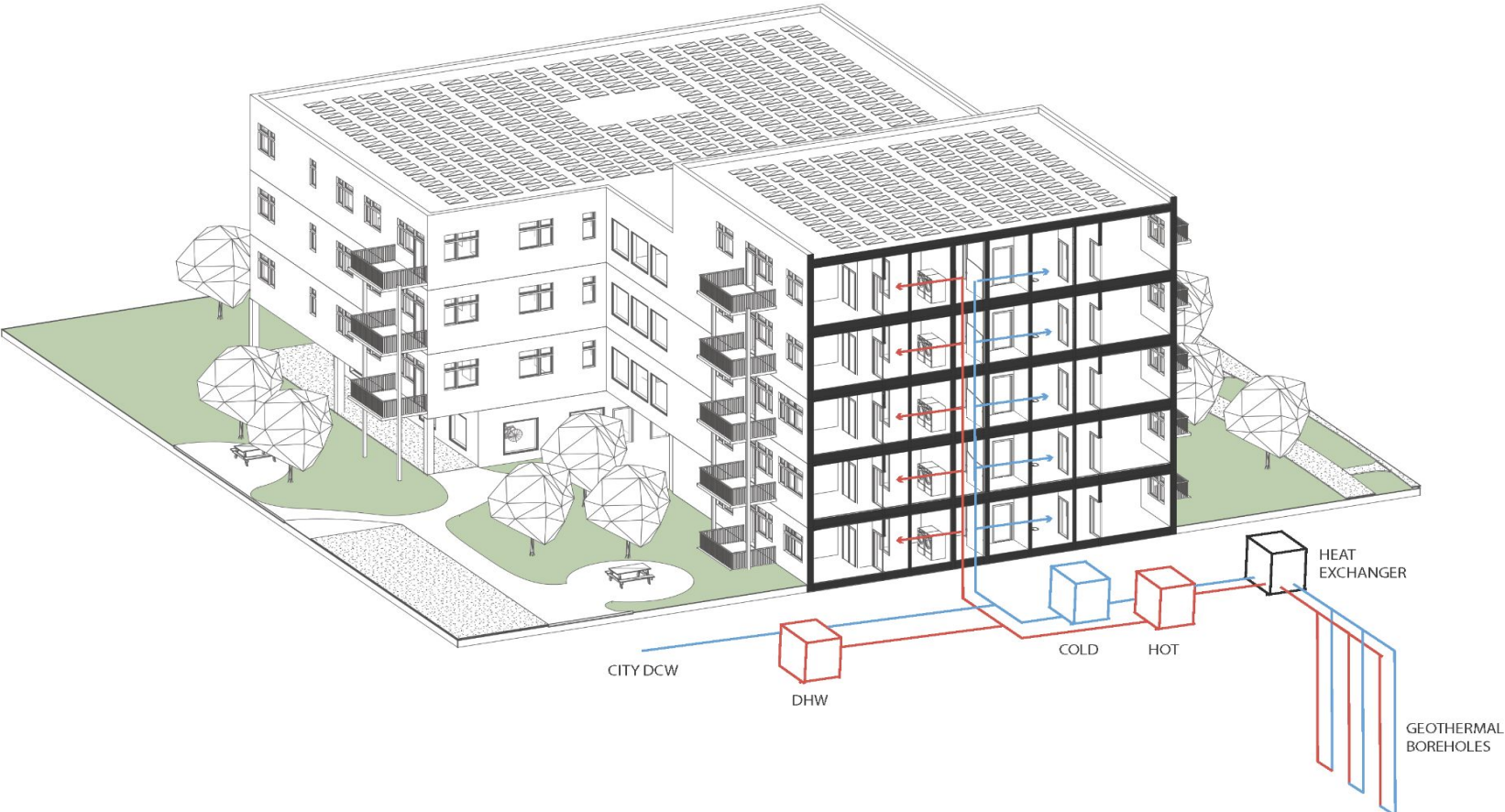




3. Parapet Cap
Roof: R-65



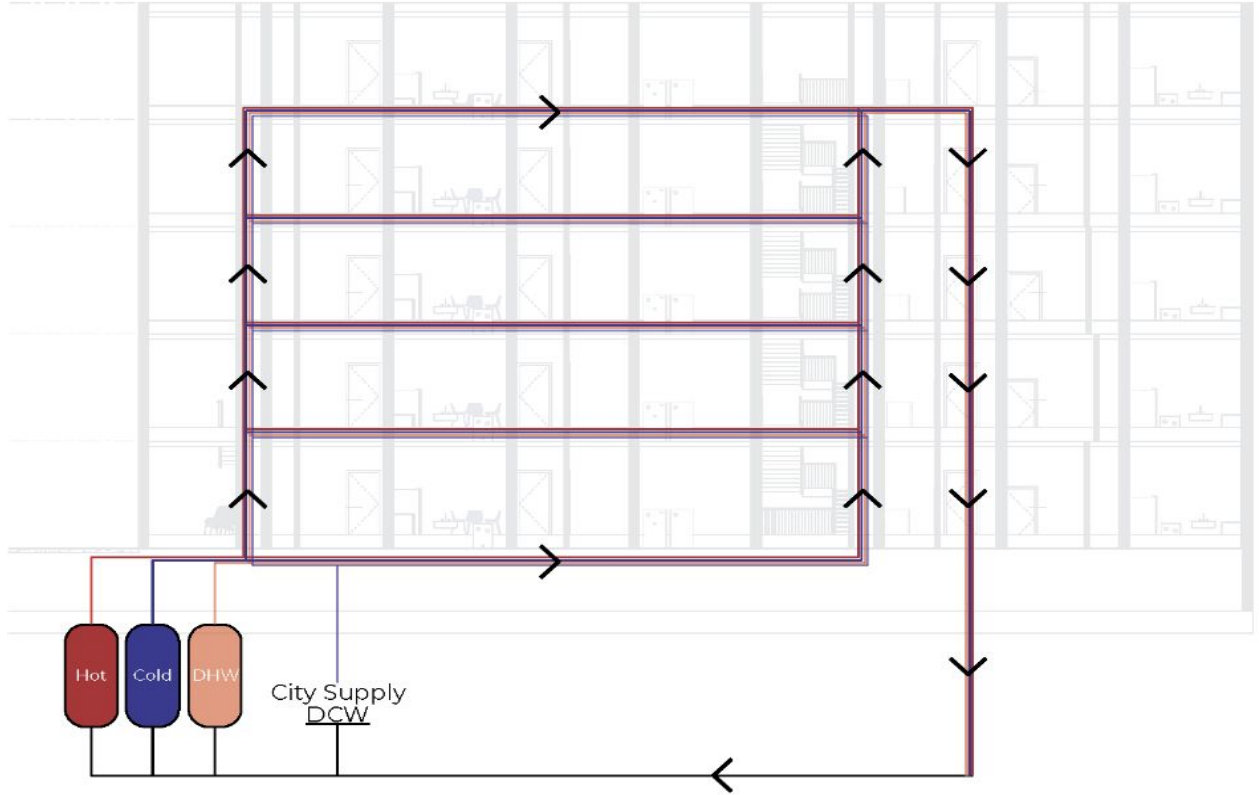
GROUND SOURCE



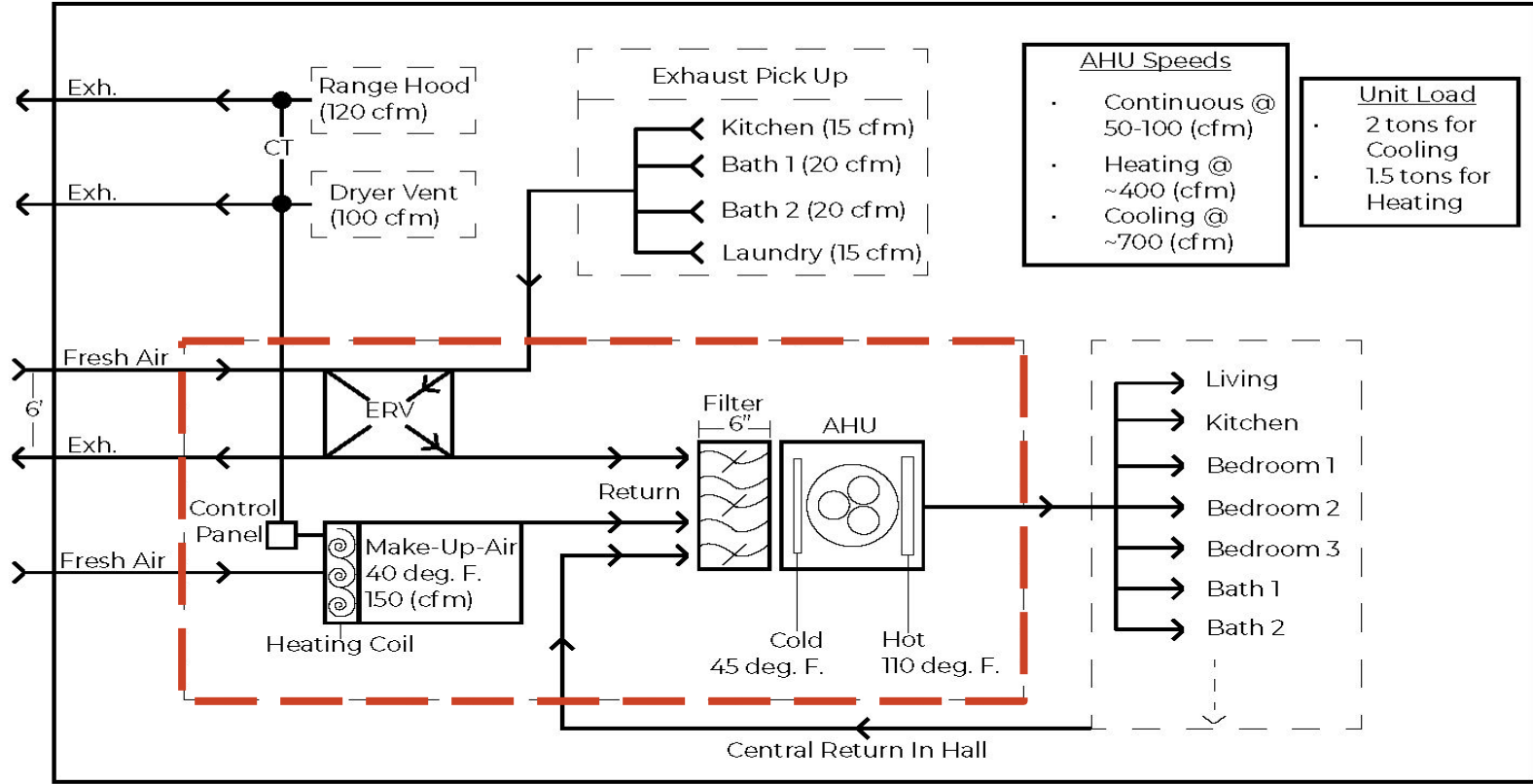
RISER SYSTEM

Features

- Reverse Return Recirculation Loop
- Two Domestic Hot Water Tanks



MODULAR MECHANICAL



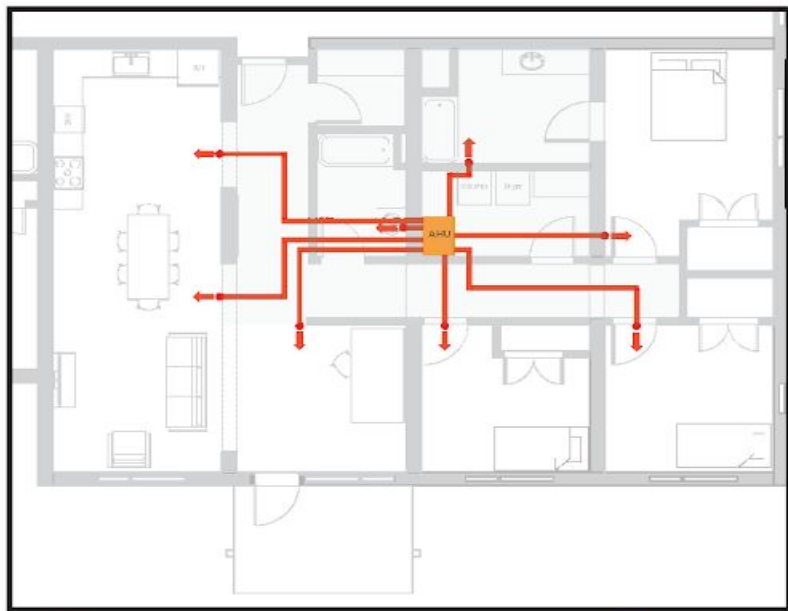
AHU Speeds

- Continuous @ 50-100 (cfm)
- Heating @ ~400 (cfm)
- Cooling @ ~700 (cfm)

Unit Load

- 2 tons for Cooling
- 1.5 tons for Heating

MODULAR MECHANICAL



■ Supply Duct Layout

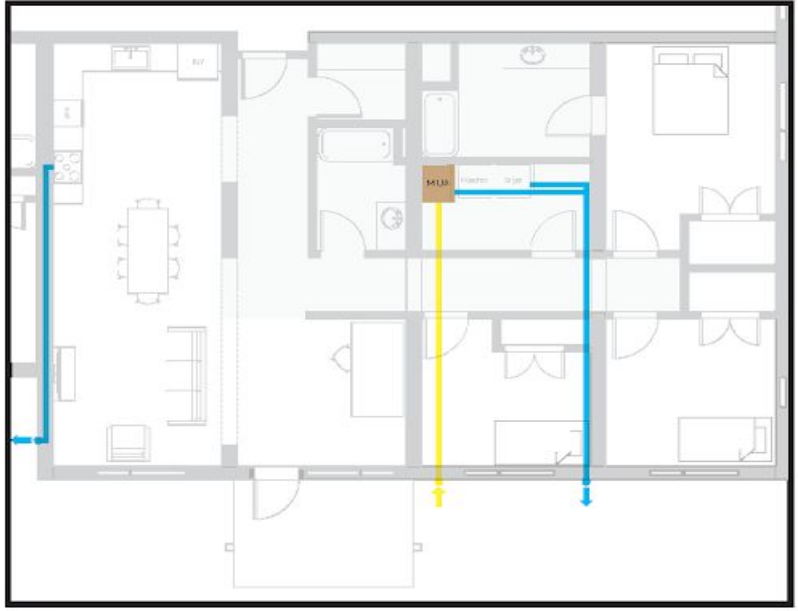
■ AHU



■ Return

■ AHU

MODULAR MECHANICAL



■ Make-Up Air (Fresh Air) ■ MUA
■ Exhaust



■ Return ■ AHU

WINDOW SELECTION

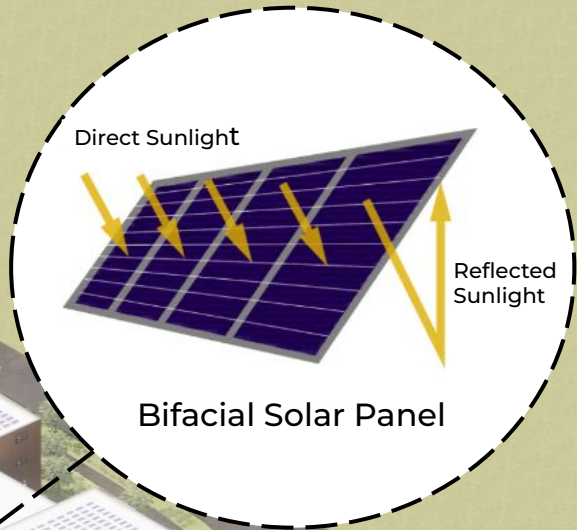


Low E Triple Pane

U-Factor	0.22
SHGC	0.27
VLT	0.45

22%
Window to
Wall Ratio

PV SYSTEM

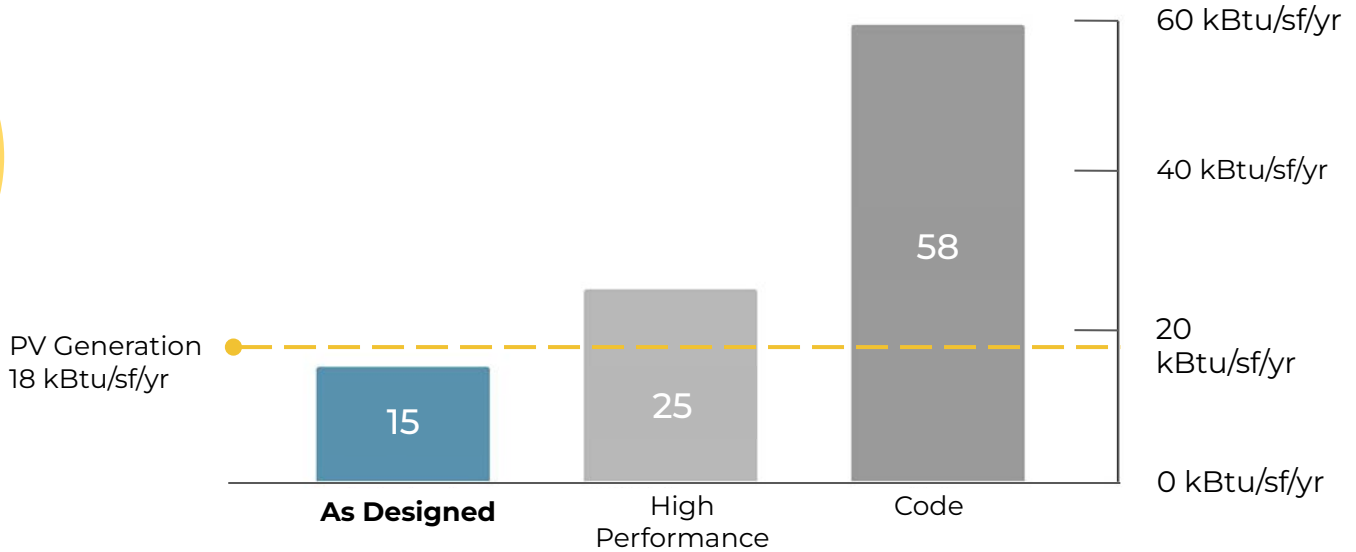


PRODUCES 309, 951 kWh/year

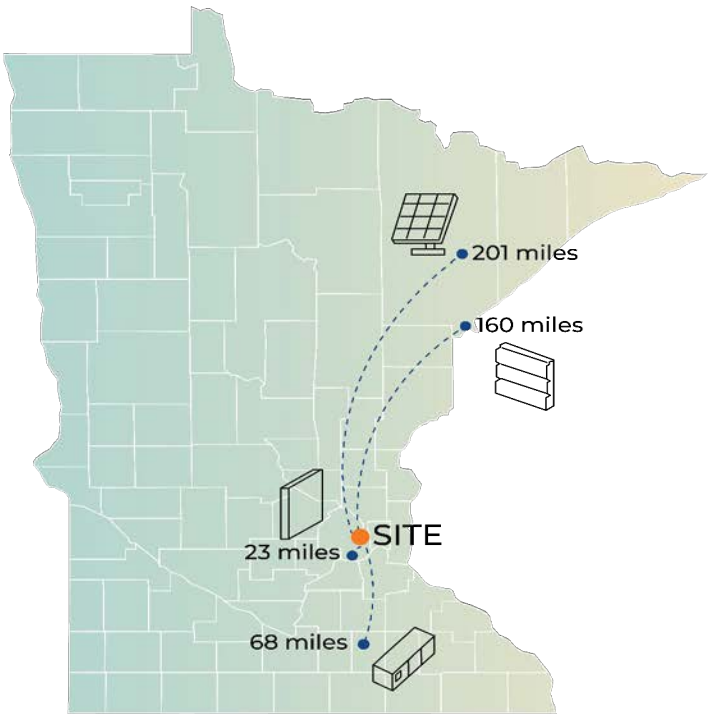
ENERGY MODELING

Robust Envelope + Efficient HVAC + PV System = NET ZERO!

120%
Maximum PV
Generation

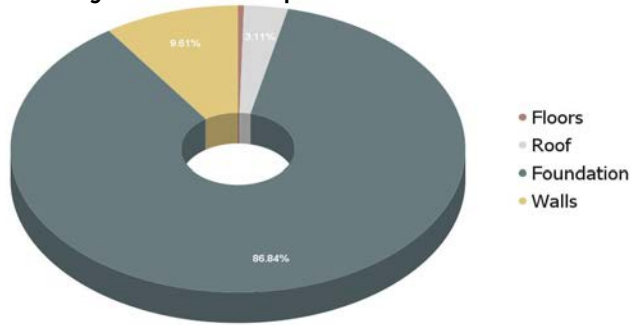


EMBODIED ENVIRONMENTAL IMPACT

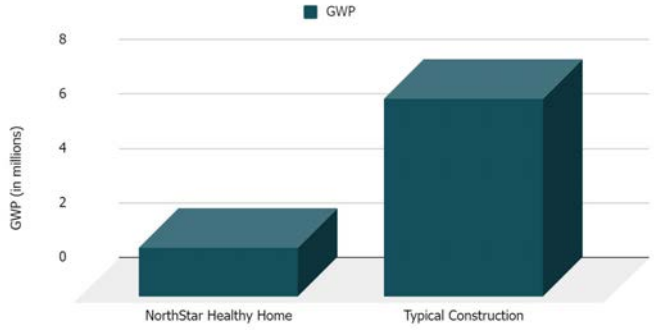


Minnesota-Sourced Building Components

Percent of Total Building GWP by Shell Component



GWP of NorthStar Healthy Home vs. Typical Construction in a 60,000 sf multi-family building



HEALTH + WELLBEING

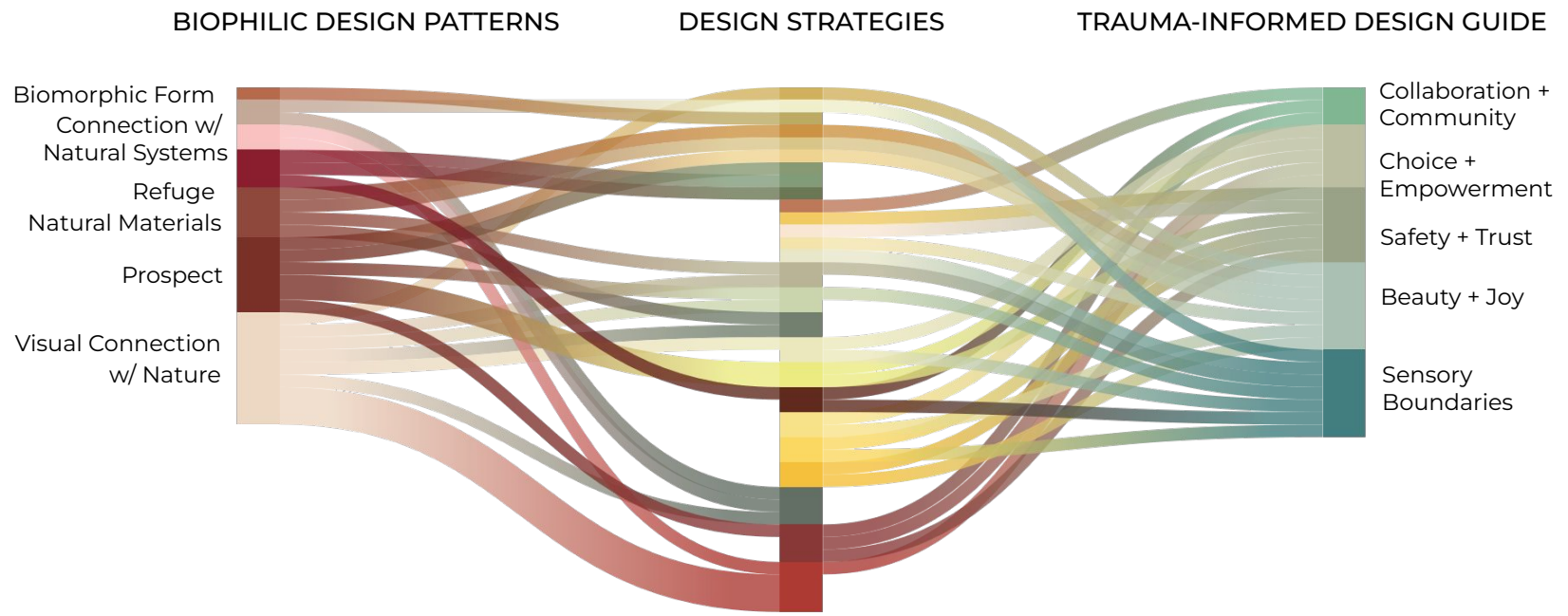
OCCUPANT EXPERIENCE

Empathetic design for empowering and intuitive experience.

- Biophilic
- Experience-Informed
- Community-Oriented
- Universal



BIOPHILIC + TRAUMA-INFORMED DESIGN

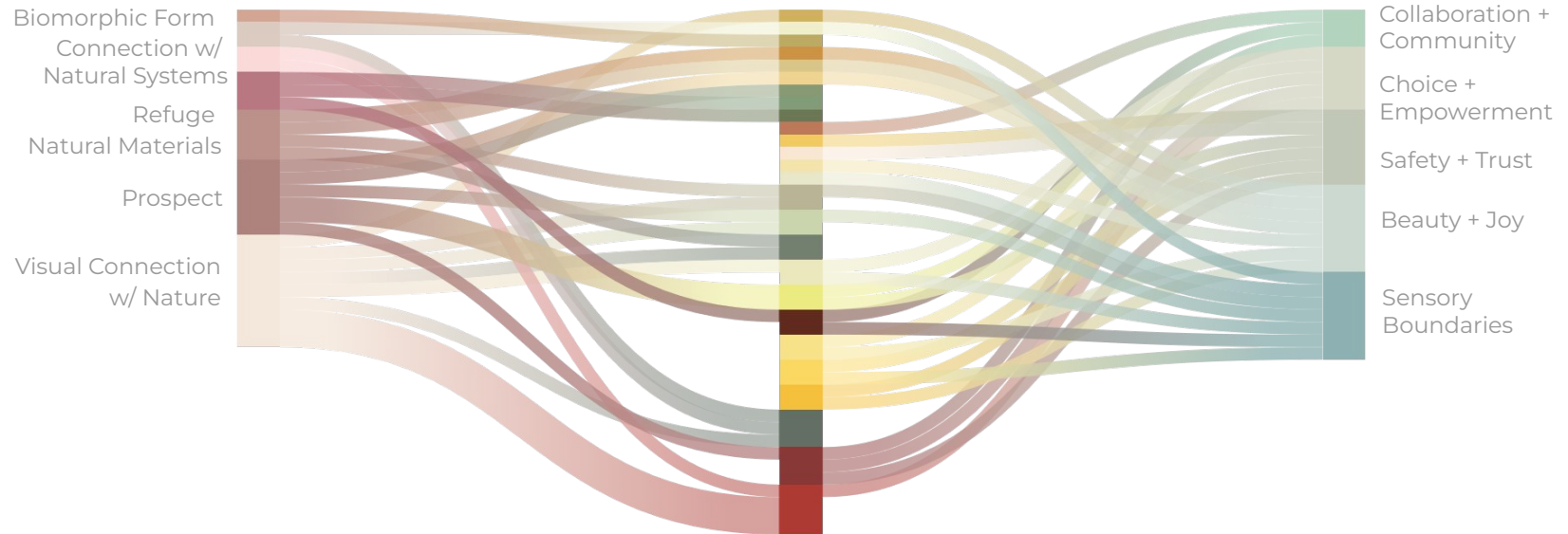


BIOPHILIC + TRAUMA-INFORMED DESIGN

BIOPHILIC DESIGN PATTERNS

DESIGN STRATEGIES

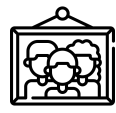
TRAUMA-INFORMED DESIGN GUIDE



Operable Windows



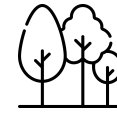
Spatial Availability



Choice to Personalize



Movable Furniture



Views to Greenspace



Quality Natural Materials



Community Placemaking



Daylight

NATURE-BASED PALETTE



landscape photography
by Gary Alan Nelson

Cool Meadow Palette Homes + Lobby



Warm Earthen Palette Common Spaces

LOBBY



Biophilic Design

- 1. Organic Forms
- 2. Nature-Based Palette
- 3. Vegetation

Trauma-Informed

- 4. Movable Seating
- 5. Opportunity for Community Art
- 6. Spatial Availability

Universal Design

- 7. Accessible Clearances
- 8. Low-Glare Surfaces

COMMUNITY GATHERING



Biophilic Design

1. Daylight
2. Prospect + Refuge
3. Natural Textures

Trauma-Informed

4. Movable Seating
5. Outdoor Views
6. Spatial Availability

Universal Design

7. Low-Glare Surfaces
8. Accommodates Mobility Devices
9. Flexible Space

TYPICAL THREE BEDROOM HOME



Biophilic Design

1. Balcony
2. Nature-Based Palette

Trauma-Informed

3. Visual Simplicity
4. Opportunity to Personalize

Community Preferences

5. Window Sill Height for Privacy
6. Movable Dining Table
7. Flex Spaces
8. Ample Storage

HEALTHY MATERIAL CRITERIA

Declare.

ECOS Eggshell Paint Imperial Paints, LLC

Final Assembly: Spartanburg, South Carolina, USA
 Life Expectancy: 10 Year(s)
 End of Life Options: Salvageable/Reusable in its Entirety

Ingredients:

Binder: Methyl Methacrylate Polymer, Polymethyl Methacrylate, Oleic Acid, Sulfonated Potassium Salt, Poly(2-(1,2-ethanedithiol) alpha-sulfo-omega-(2,4,6-trimethylphenyl)phenoxy), sodium salt (1); Polyaryletheracrylate, Vehicle; **Extender Pigment:** Titanium dioxide; **Thickener:** Limestone Calcium Carbonate; **Extender:** Kaolin Clay (Calcined); **Rheology Modifier:** Silica; **Dispersant:** Ammonium Polyacrylate; **Surfactant:** Ethoxylated-2,4,7,9-tetraethyl-5-decyl-4,7-diol; Ethoxylated-2,4,7,9-tetraethyl-5-decyl-4,7-diol (Surfynol 440); **Defoamer:** Paraffin Ole Polyoxyethylated Stearyl Alcohol; Polyoxyethylene Stearyl Ether; Tributylamine; **pH Stabilizer:** Ammonium Hydroxide; **Preservatives:** 1-Hydroxy-2-NH-Diethylammonium, Sodium Salt

Living Building Challenge Criteria: Compliant

I-13 Red List:
 LBC Red List Free % Disclosed: 100% at 100ppm
 LBC Red List Approved VOC Content: 0 g/L
 Declared

I-10 Interior Performance: CDPH Standard Method v12-2017
I-14 Responsible Sourcing: Not Applicable

IPA-0002
 EXP: 01 JAN 2024
 Original Issue Date: 2014

INTERNATIONAL LIVING FUTURE INSTITUTE™ living.future.org/declare

Declare.

PureBond® Decorative, Domestic, Veneer Core Interior Hardwood Plywood, Unfinished Columbia Forest Products

Final Assembly: Multiple Locations in North America
 Life Expectancy: 50 Year(s)
 End of Life Options: Salvageable/Reusable in its Entirety

Ingredients:

Core Veneer: Wood; **Decorative veneer:** Wood; **adhesive:** Defatted Soy Flour, Magnesium oxide (MgO), Hexanedioic acid, polymer with N-(2-aminophenyl)-1,2-ethanediamine and chloromethylbutane; Methylololamium Phosphate; Polyvinyl acetate; Glycerin; **Starch:** Calcium hydroxide (Ca(OH)2), Corn Starch

Living Building Challenge Criteria: Compliant

I-13 Red List:
 LBC Red List Free % Disclosed: 100% at 100ppm
 LBC Red List Approved VOC Content: Not Applicable
 Declared

I-10 Interior Performance: CDPH Standard Method v12-2017
I-14 Responsible Sourcing: Product Available with FSC Chain of Custody

CPH-0007
 EXP: 01 MAY 2023
 Original Issue Date: 2019

INTERNATIONAL LIVING FUTURE INSTITUTE™ living.future.org/declare

Declare.

USG Sheetrock® Brand EcoSmart Panels Firecode® X United States Gypsum Company

Final Assembly: Multiple Locations in USA
 Life Expectancy: 60+ Year(s)
 End of Life Options: Salvageable/Reusable in its Entirety; Recyclable (100%)

Ingredients:

Core: Gypsum; **Paper Facing and Backing:** Cellulosic Fire Endurance; Vermiculite; **Binder:** Starch; **Core Strengtheners:** Metaphosphoric acid (H3P5O9), Iridium salt; **Reinforcing:** Mineral wool; **Drying Additive:** Dextrose; **Dispersant:** Polycarboxylate Polymer; **Accelerator:** Aluminum sulfate; **Polyvinyl Alcohol:** Adhesive

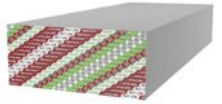
Living Building Challenge Criteria: Compliant

I-13 Red List:
 LBC Red List Free % Disclosed: 100% at 100ppm
 LBC Red List Approved VOC Content: Not Applicable
 Declared

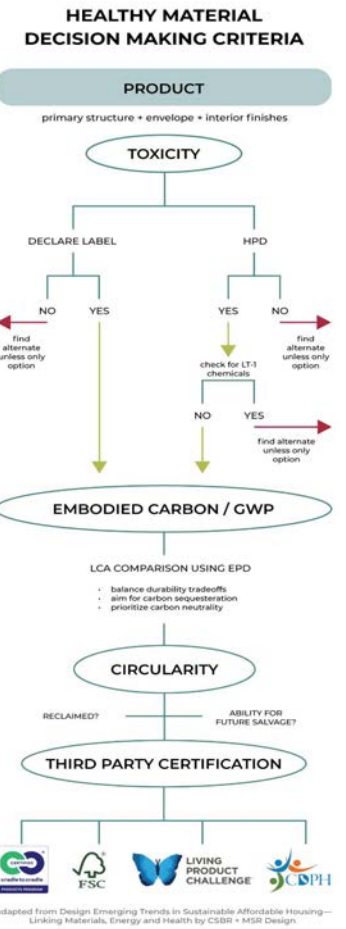
I-10 Interior Performance: CDPH Standard Method v12-2017
I-14 Responsible Sourcing: Not Applicable

USG-0001
 EXP: 01 MAR 2024
 Original Issue Date: 2017

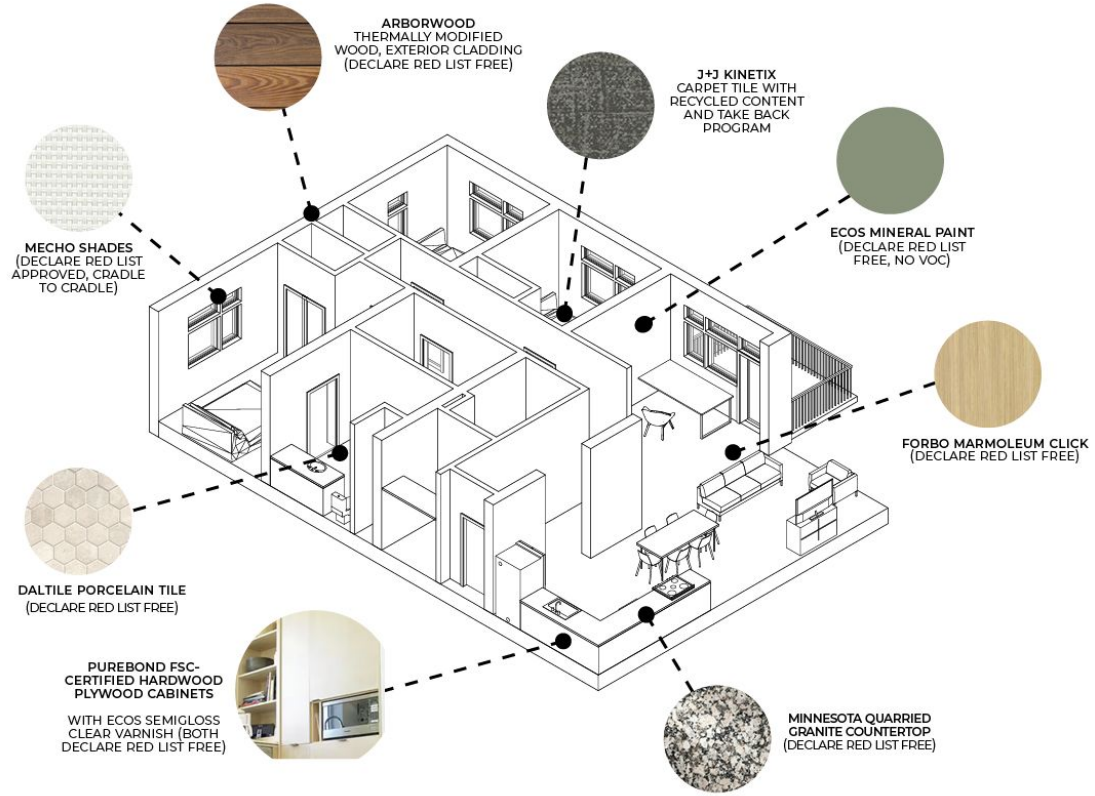
INTERNATIONAL LIVING FUTURE INSTITUTE™ living.future.org/declare



21 Finish Products are Declare Red List Free



HEALTHY MATERIALS IN HOMES



INTEGRATED DESIGN FOR HIGH ENVIRONMENTAL QUALITY

THERMAL COMFORT



GSHP

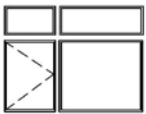


Thermal Controls



Operable Windows

LIGHTING



Design for Daylight



Dimmable, CT Adjustable LED



Adjustable Glare Control

AIR QUALITY



Healthy Materials

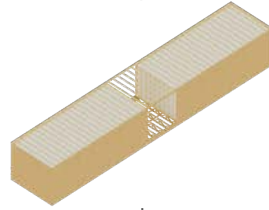


ERV w/ MERV 13 Filter



Spot Ventilation w/ Make-up Air

ACOUSTICS



Modular construction and tight building envelope



Carpeted Corridors

HEALTH + WELLBEING



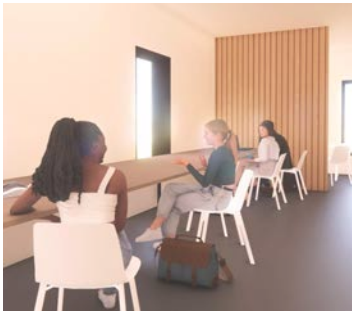
Biophilic, Trauma-Informed, and Universal Design

DESIGN GOALS FULFILLED

HUMAN + ECOLOGICAL HEALTH

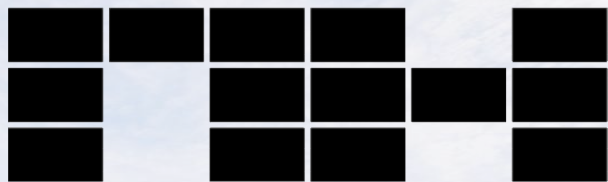


ADDRESS HOUSING NEED



NURTURE VIBRANT COMMUNITY





NORTHSTAR HEALTHY HOMES

THANK YOU

