



Carbon  
Leadership  
Forum

**Vancouver**



**Ben Checkwitch**

Senior Planner, Principal  
**Checkwitch Poiron**  
Architects



**Jeremy Field**

Senior Sustainability Advisor  
**Introba**



**Sharon McGeorge**

Senior Mechanical and  
BIM Designer  
**Introba**

# Discover Montessori: How We Become a 2023 BC Embodied Carbon Award Winner

Friday, Jan. 19<sup>th</sup>

11:00-12:00 pm PST



Carbon  
Leadership  
Forum  
**British  
Columbia**

Powered by **ZEIC**



Carbon  
Leadership  
Forum  
**British  
Columbia**

# Inspiring and spurring collective action to solve the embodied carbon challenge

A program area of ZEIC

# zeic

ZERO EMISSIONS INNOVATION CENTRE

MORE SOLUTIONS, LESS CARBON.

zeb<sub>x</sub>



**B2E**

Building to  
Electrification  
Coalition

**CLF**

Carbon  
Leadership  
Forum  
British  
Columbia

+ Retrofit Program (In Development)

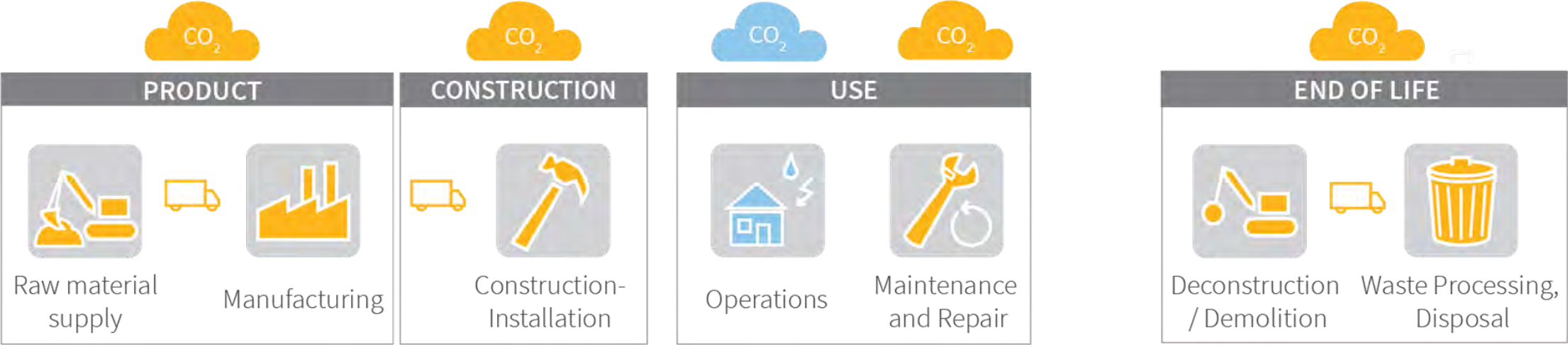
# The Embodied Carbon of Buildings



Image: S. Smedley Skanska

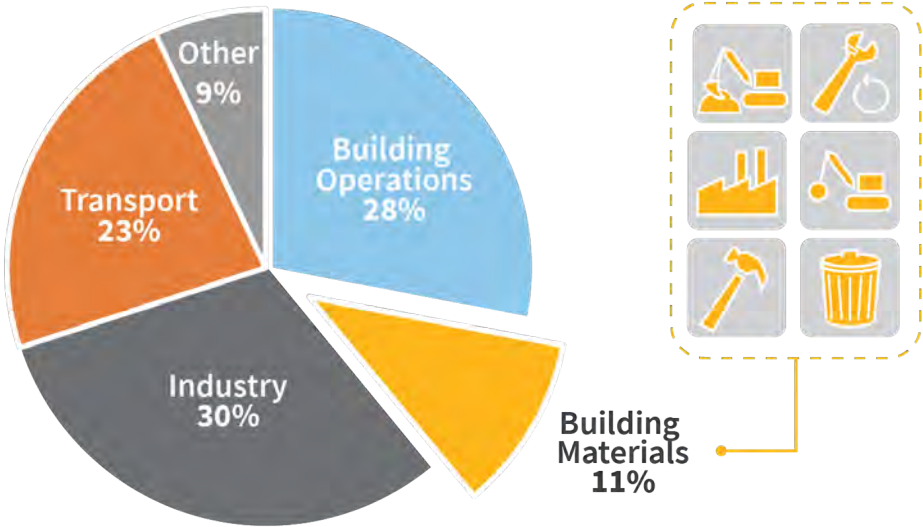


- Embodied carbon
- Operational carbon



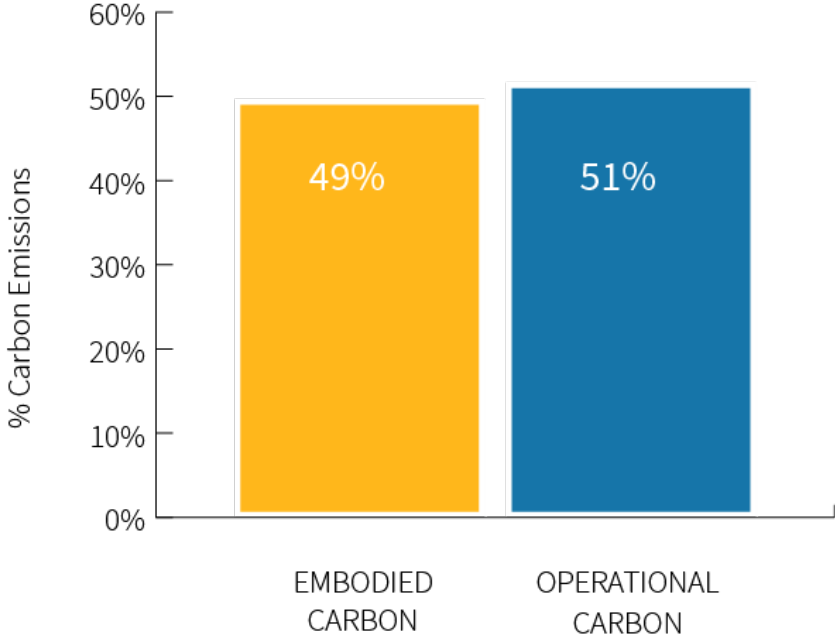
# Embodied carbon is **significant**

## Global energy-related carbon emissions



Data sources: UNEP Global Status Report 2017  
[EIA International Energy Outlook 2017.](#)

## Total Carbon Emissions of Global New Construction from 2020-2050 Business as Usual Projection

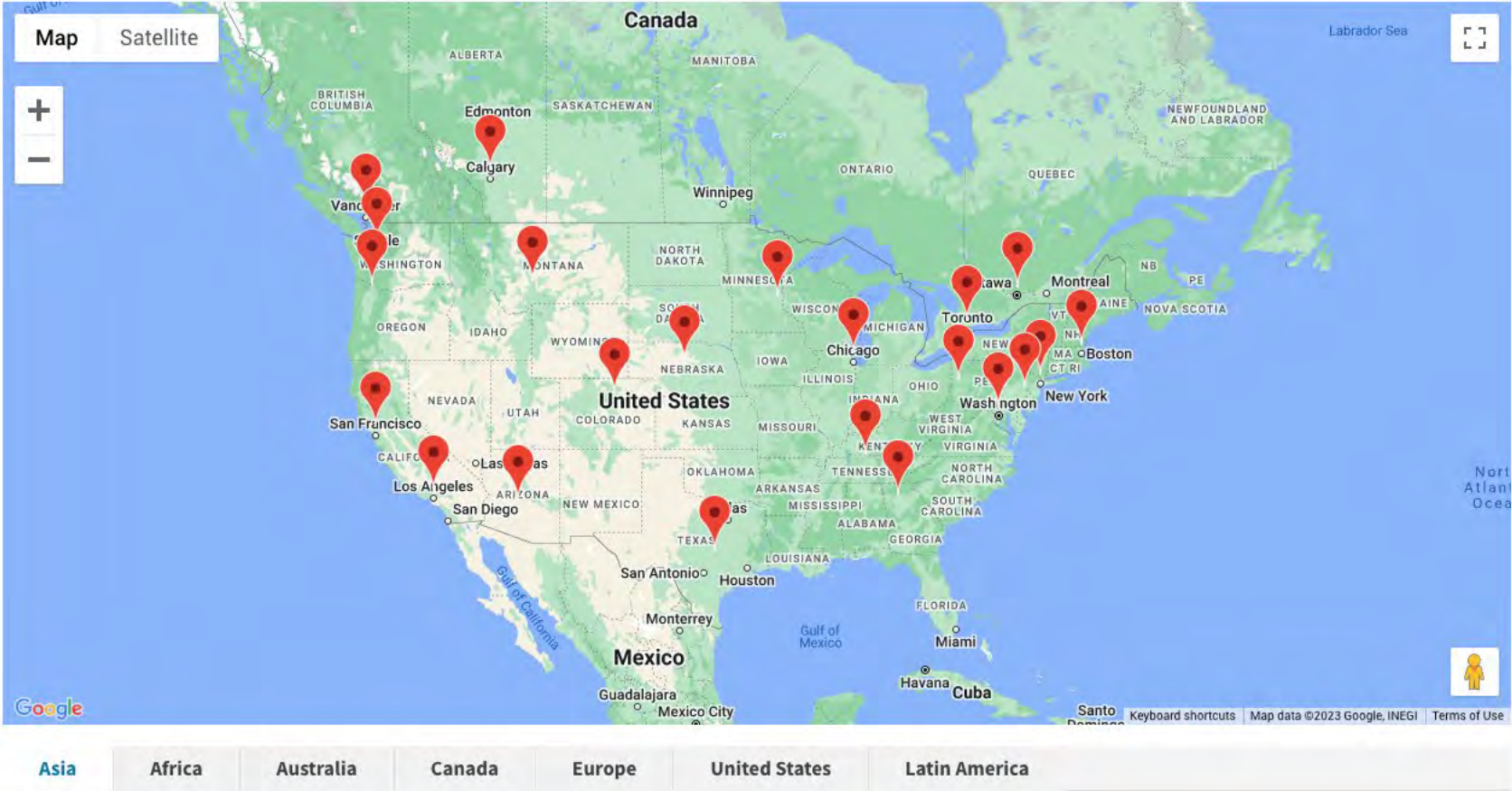


© 2018 2030, Inc. / Architecture 2030. All Rights Reserved. Data Sources: UN Environment Global Status Report 2017; EIA International Energy Outlook 2017

# Carbon Leadership Forum

We accelerate the transformation of the building sector to radically reduce the **embodied carbon** emissions associated with building materials and construction.

# Carbon Leadership Forum Network



# CLF BC Network Goals

- ❑ **Collective** Action
- ❑ Shared learning
- ❑ **Collective** problem solving
- ❑ Removing barriers to learning
- ❑ Going further, and faster **collectively**

## Embodied Carbon Exchange

The Embodied Carbon Exchange offers a place for open discussion relating to the daily challenges we face designing, developing and constructing low embodied carbon buildings.

[Get Involved](#)

## Embodied Emissions Peer Network

The Embodied Emissions Peer Network is a place for local government staff and invited guests to get together with the common goals of knowledge and resource sharing.

[Learn More](#)

## Embodied Emissions Research Network

The Embodied Emissions Research Network offers a place for those working in embodied carbon research to share knowledge, collaborate on initiatives and eliminate the duplication of research.

[Learn More](#)



## Refine your Search

Q Enter your search

## The Low-Carbon Material Sourcing Guide

[Read More](#)

### Categories

- [Past Events](#) (7)
- [Newsletters](#) (0)
- [Case Studies and Guides](#) (3)
- [Videos](#) (5)
- [External Resources](#) (0)

### Networks

- [Socials, Awards & Other Highlights](#) (0)

### Subjects

- [Certifications](#) (0)
- [Policy](#) (0)
- [Software Tools](#) (0)
- [Baseline Definition](#) (0)



### News: We're Hiring! Program Manager, CLF BC (Embodied Emissions)



### Embodied Emissions Case Study: Inlet View



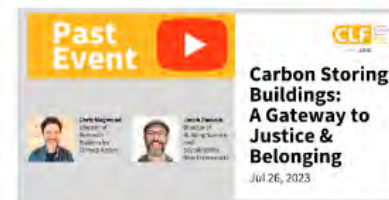
### Case Study: Passive House and Embodied Carbon



### Concrete: A Pragmatic Approach to Lowering Embodied Carbon



### Making the Case for Building Reuse



### Carbon Storing Buildings: A Gateway to Justice and Belonging



# BC EMBODIED CARBON AWARDS 2024

**CLF** Carbon Leadership Forum  
British Columbia

Powered by **zeic**



# BC Embodied Carbon Awards 2024

**Organizational Commitment to Change**

**Public Sector Leadership**

**Strengthening the Practice**

**Large Buildings**

**Small Buildings**

**Commitment to Circularity**

**Submissions: February 5, 2024**

**Awards: April 18, 2024**

# Discover Montessori

42% reduction relative to baseline  
Alternative construction methods  
Adaptability throughout design process



Discover Montessori School  
Nanaimo, BC





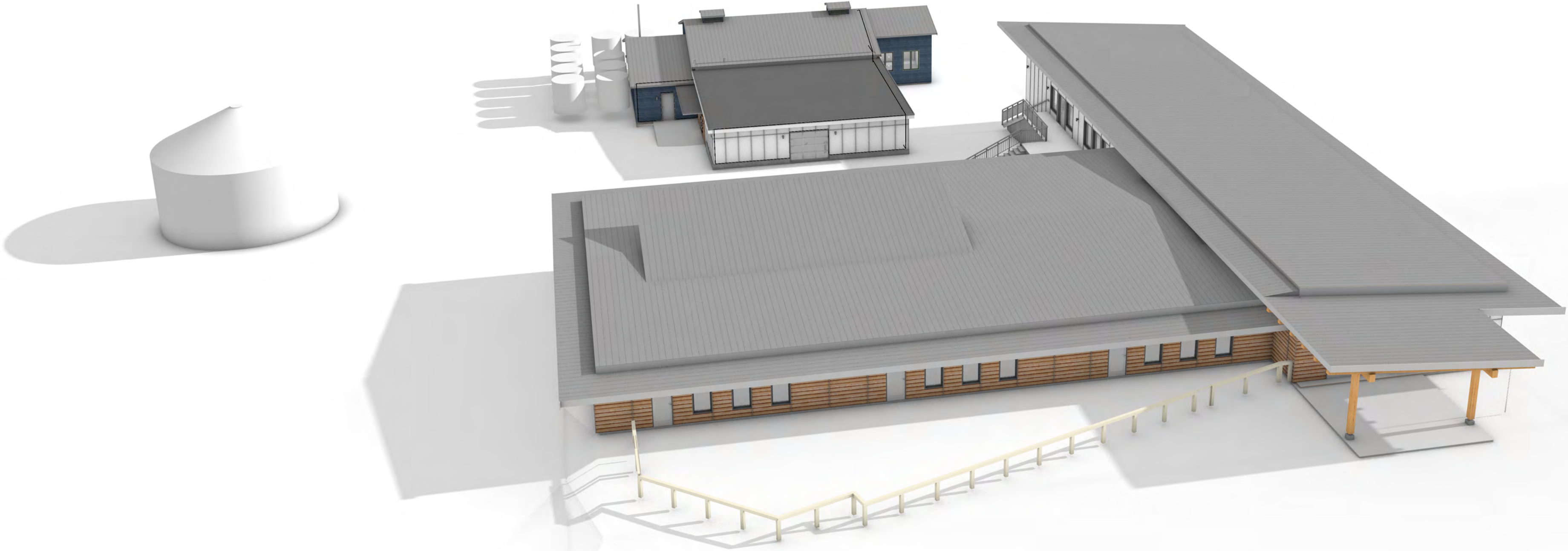










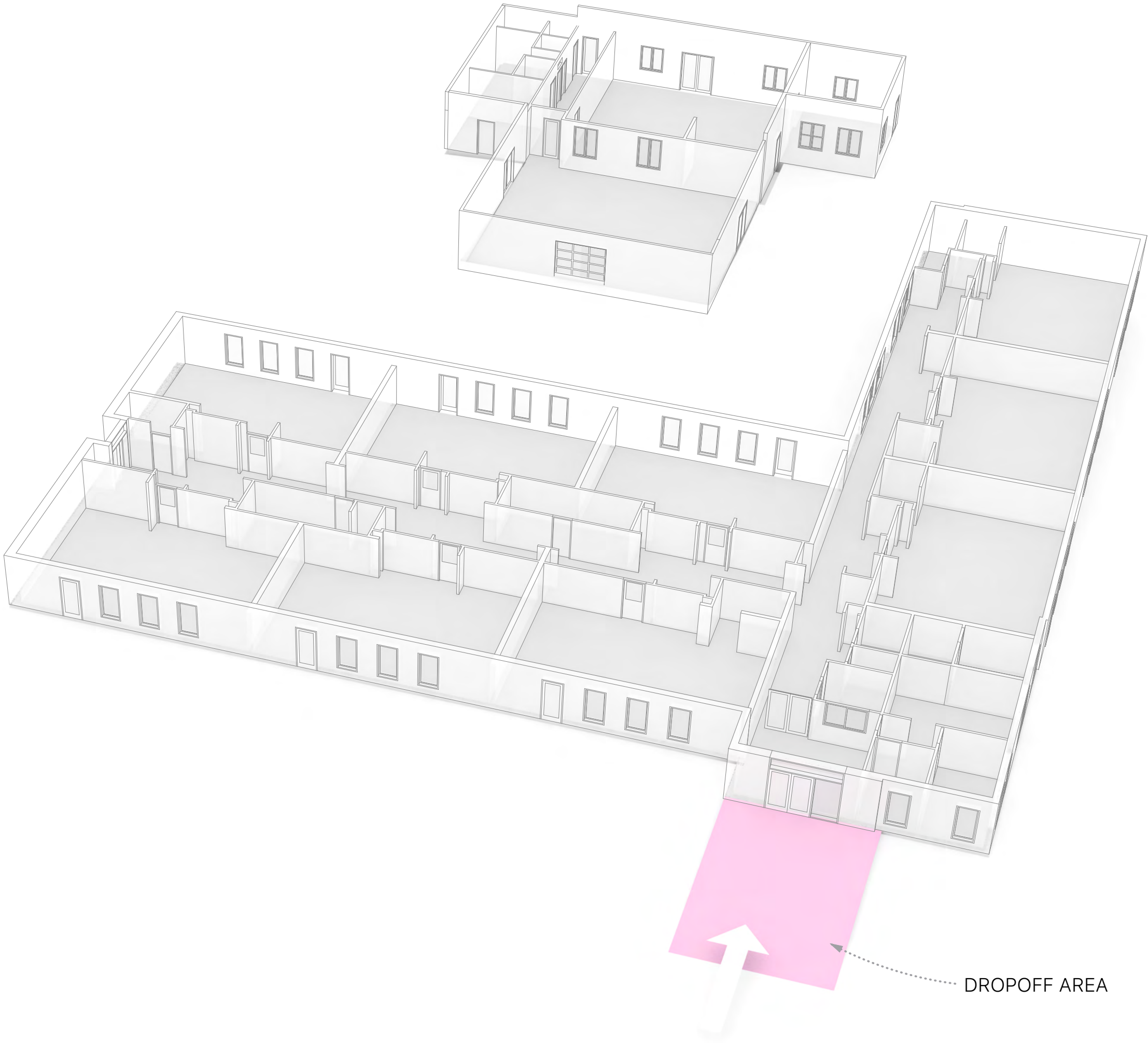


Isometric Floor Plan

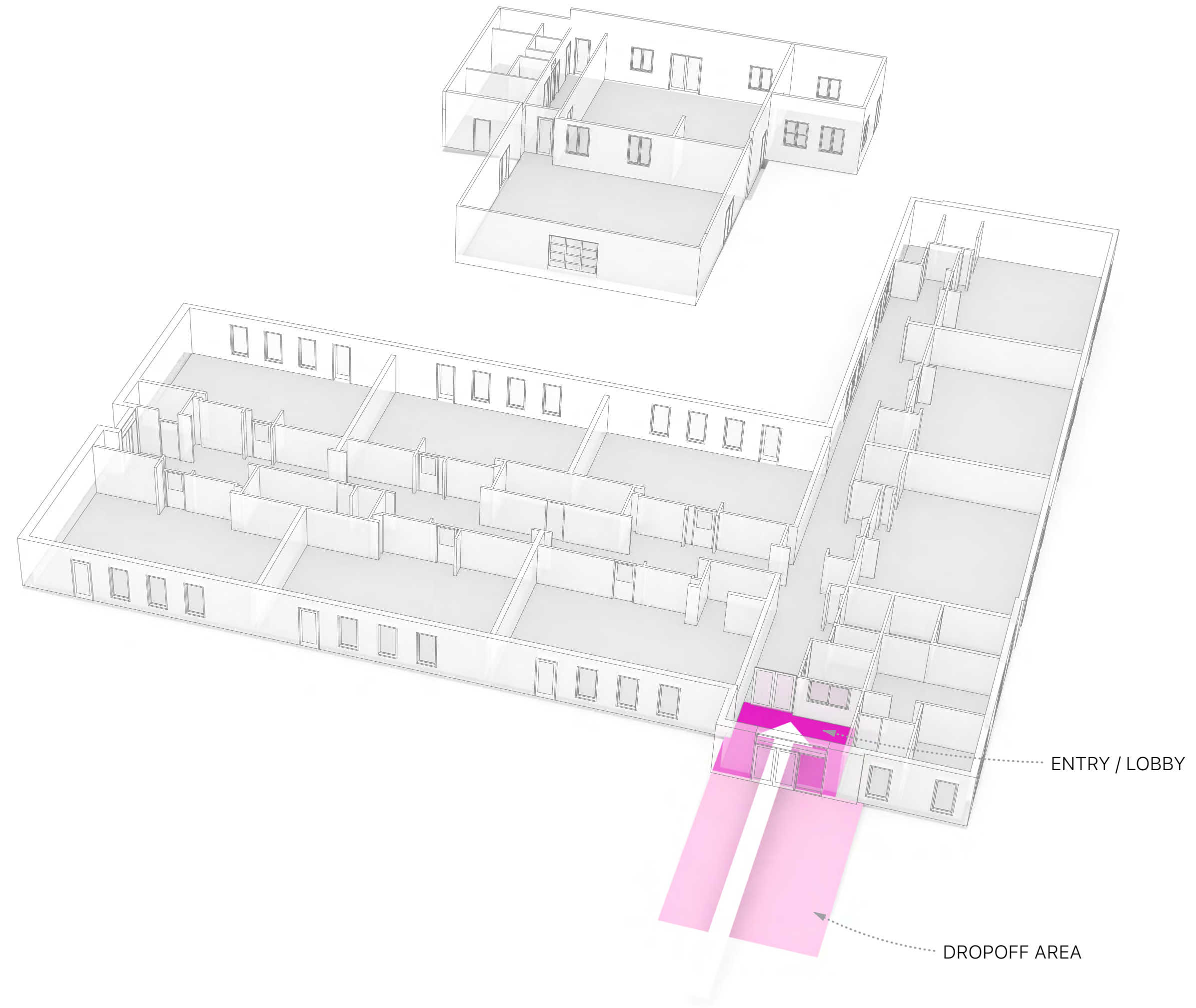


Isometric Floor Plan

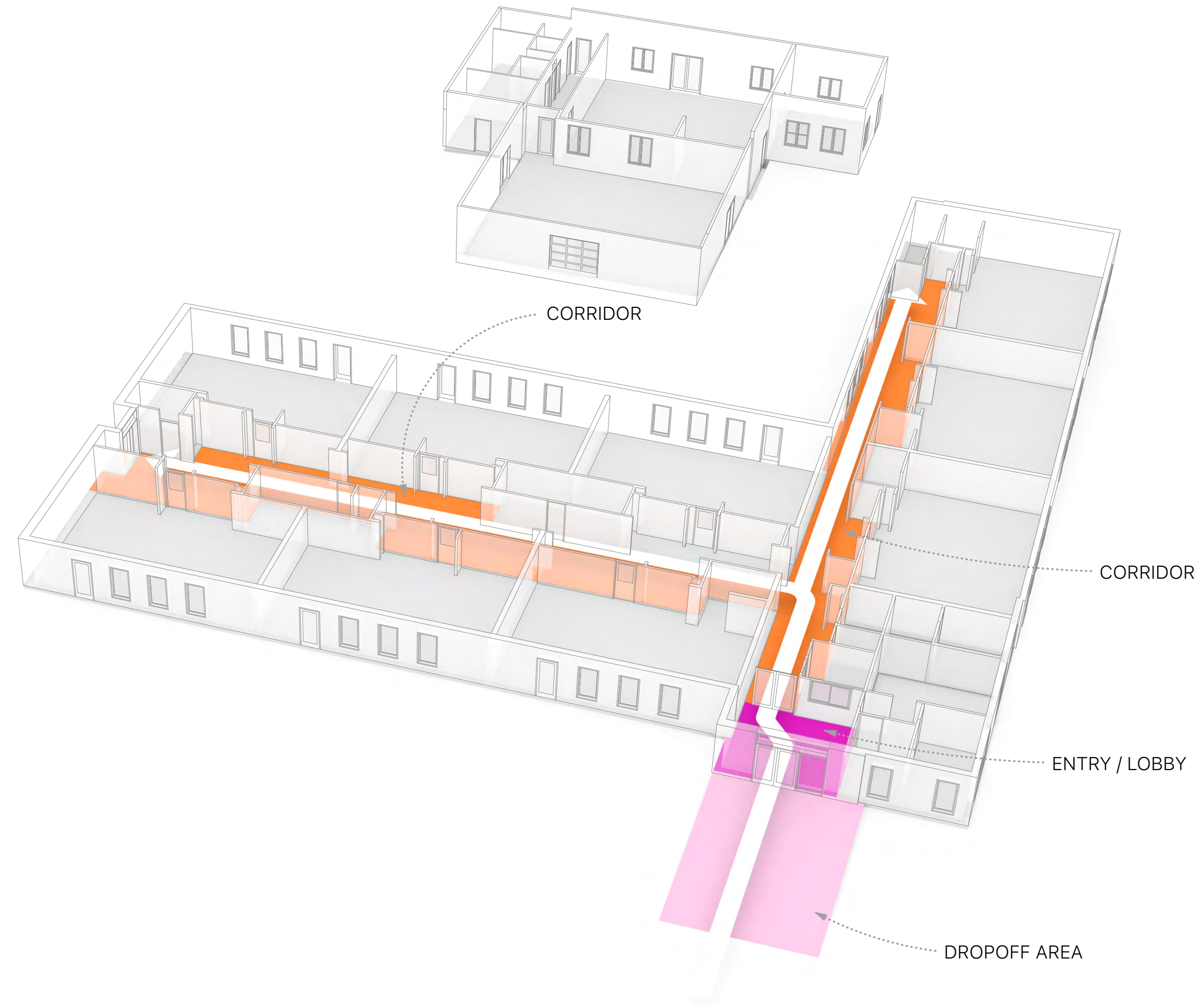




# Montessori Concept



Montessori Concept





# Montessori Concept



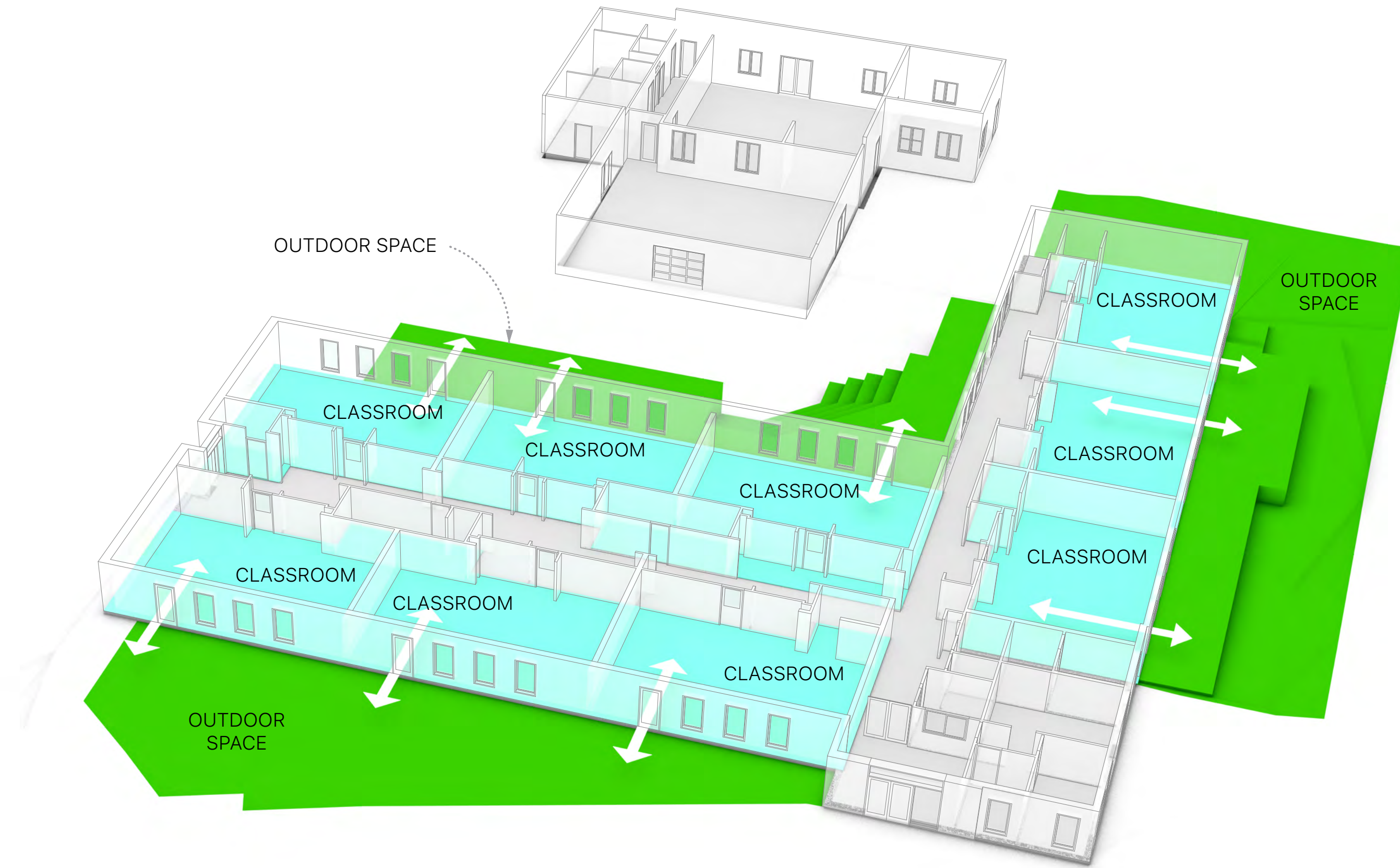
# Montessori Concept



# Montessori Concept

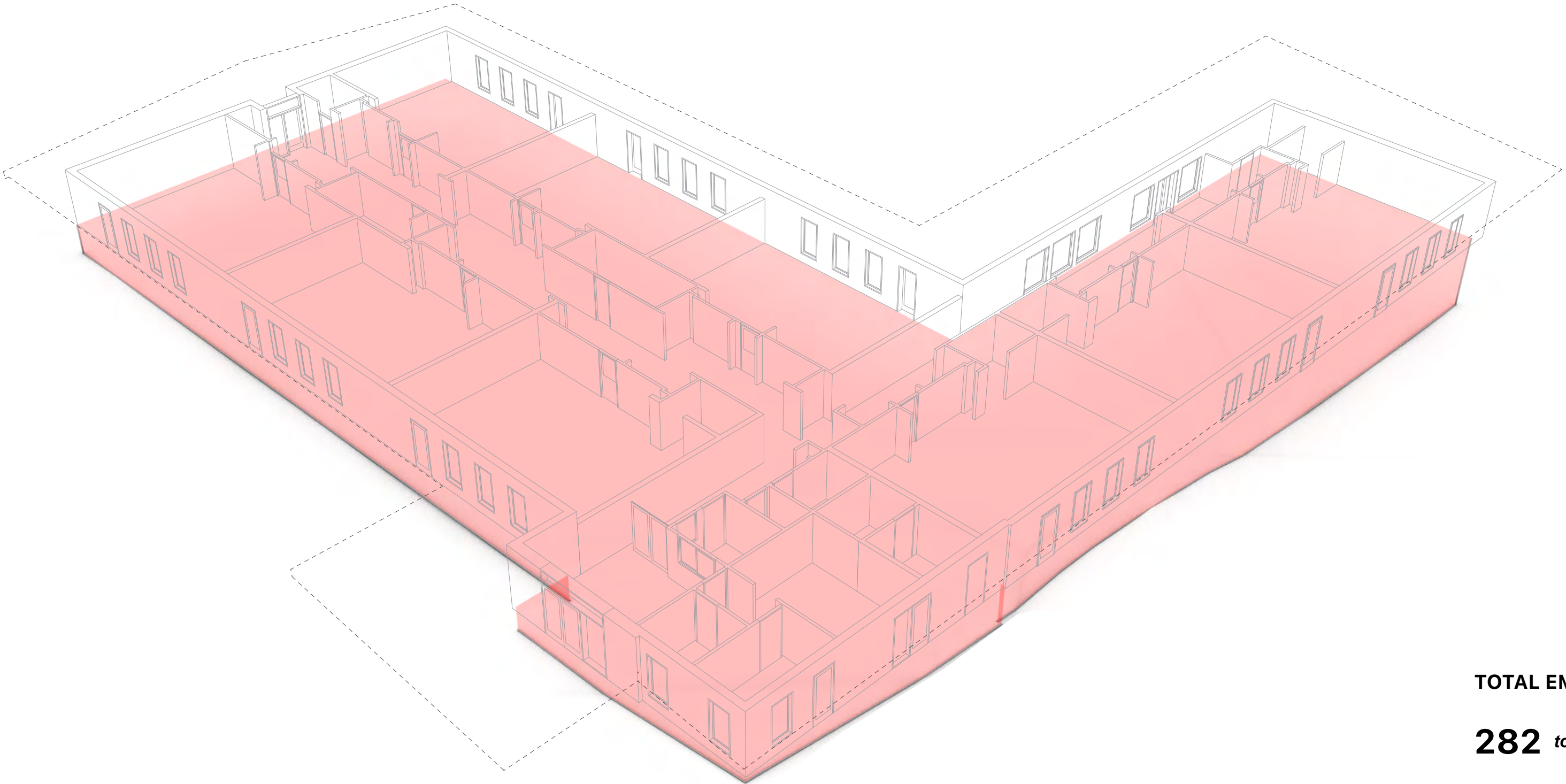


# Montessori Concept



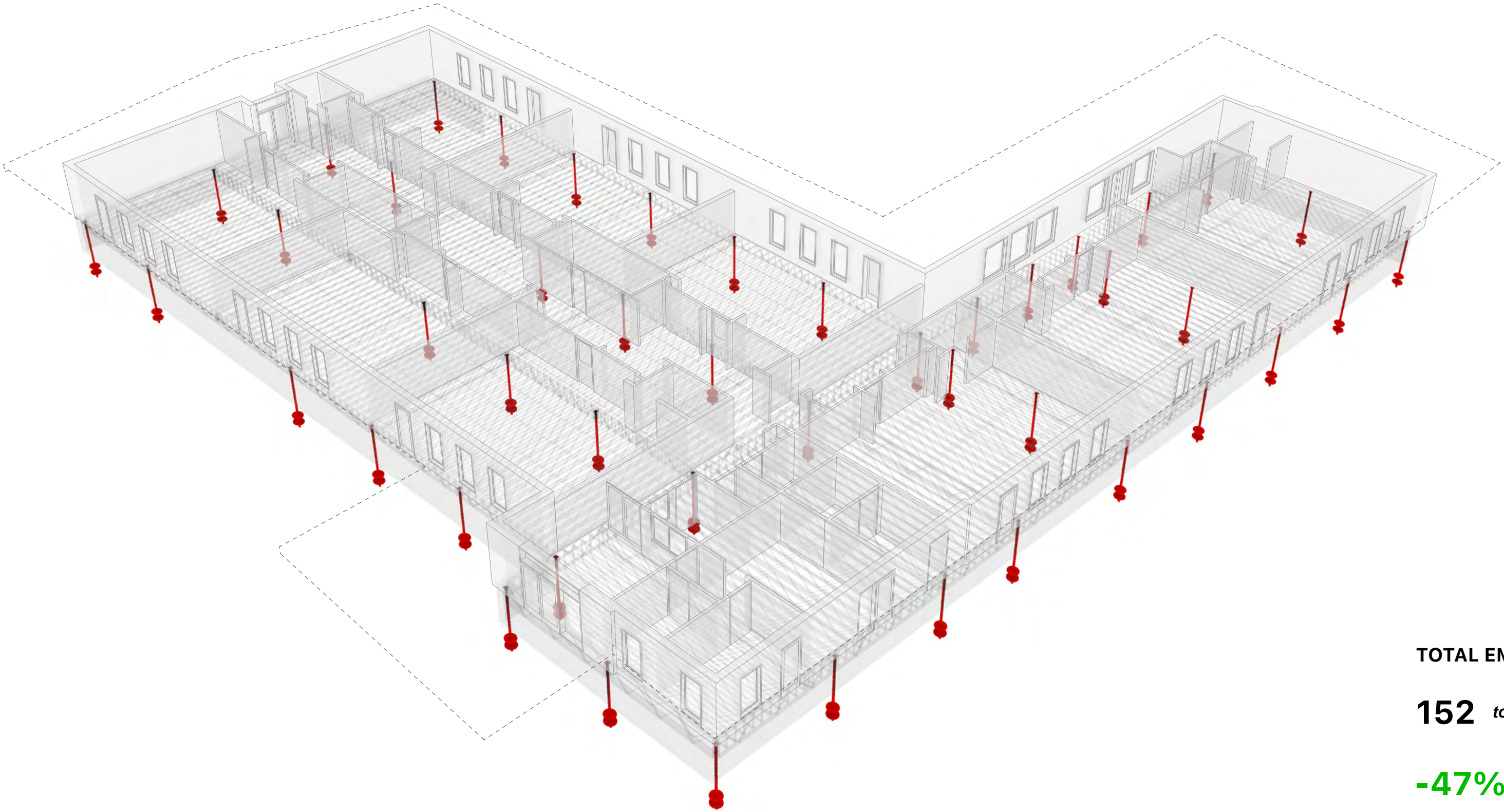






TOTAL EMBODIED CARBON USING CONCRETE SLAB:

**282** tonnes CO<sub>2e</sub>



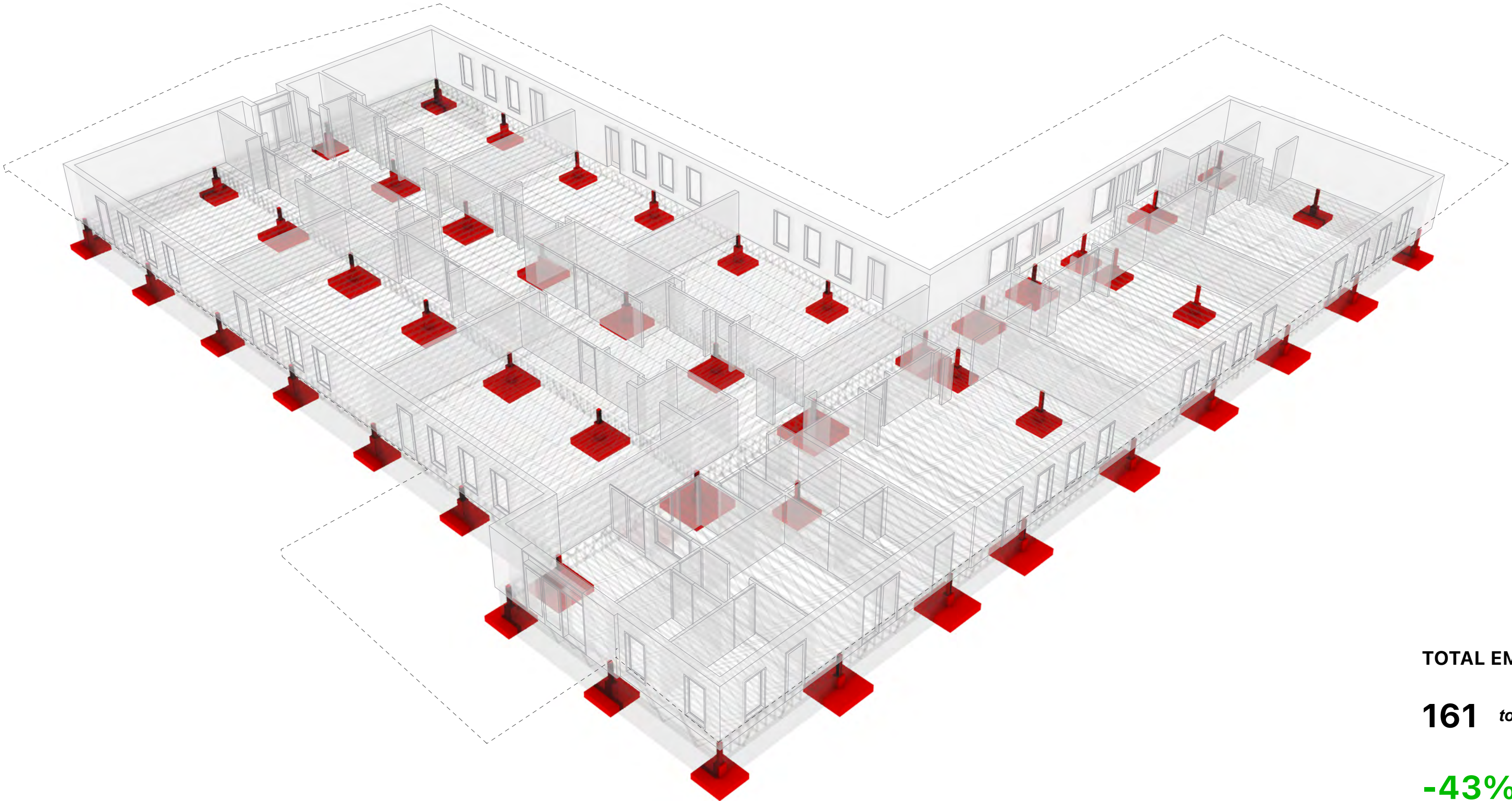
TOTAL EMBODIED CARBON USING HELICAL SCREW PILE:

**152** tonnes CO<sub>2</sub>e

**-47%** *reduction from concrete slab application*



# Concrete Pier Footing Study

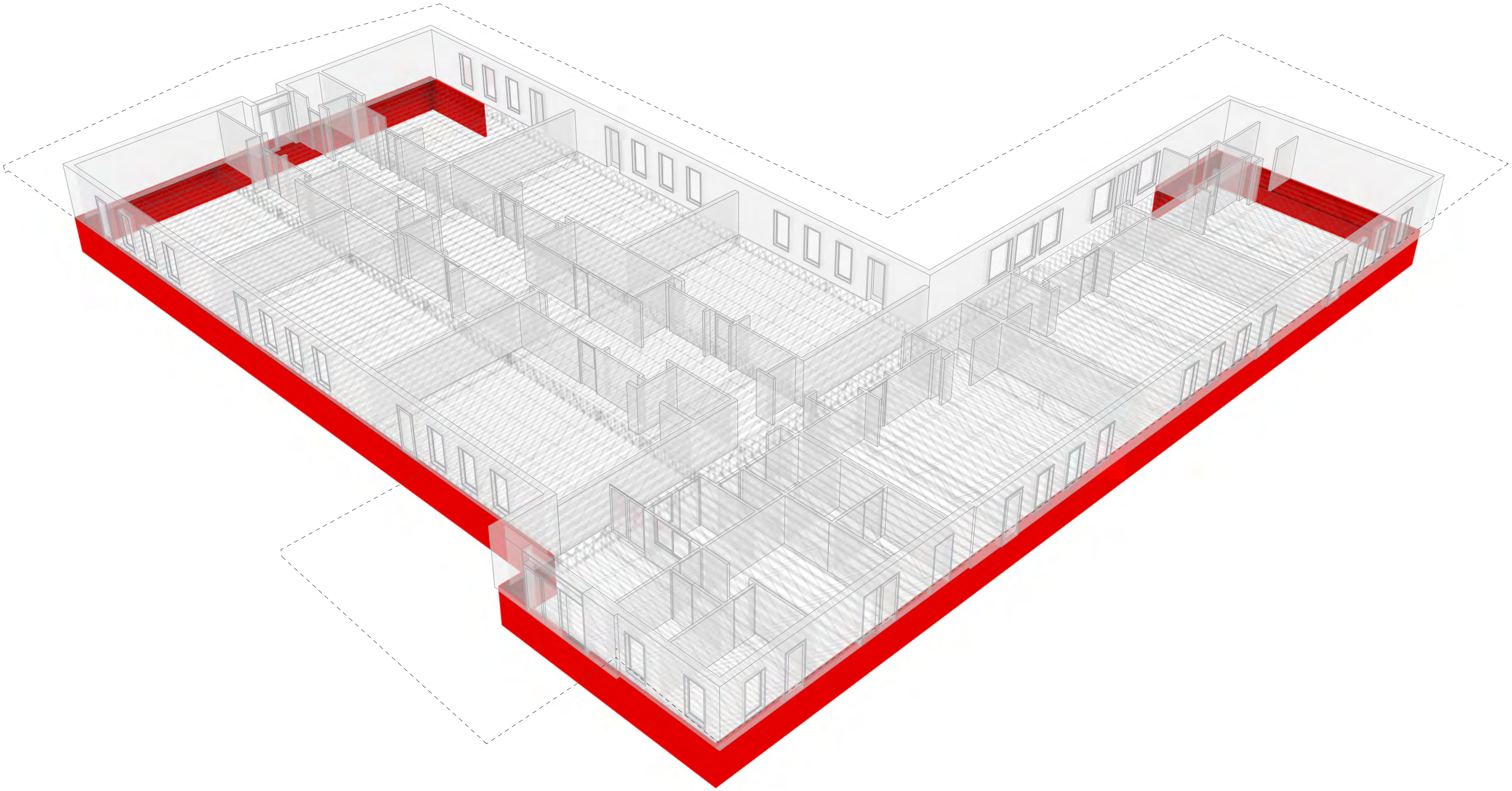


TOTAL EMBODIED CARBON USING CONCRETE PIER FOOTINGS:

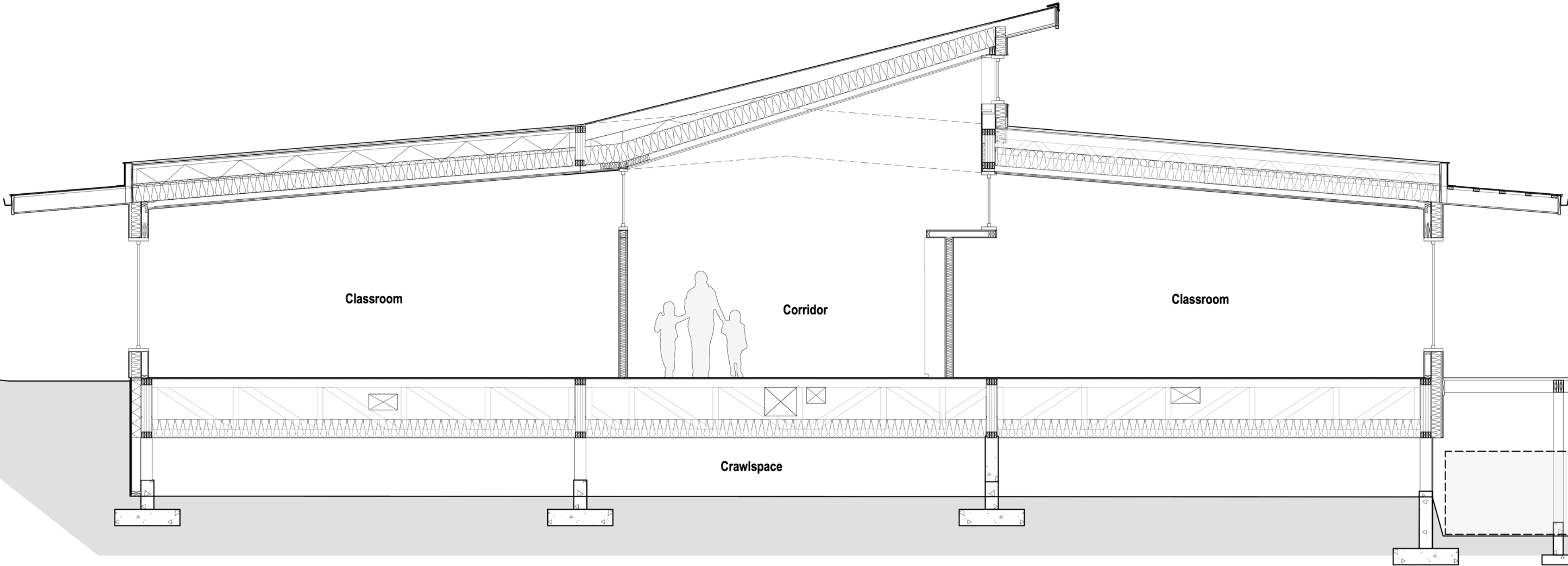
**161** tonnes CO<sub>2</sub>e

**-43%** *reduction from concrete slab application*

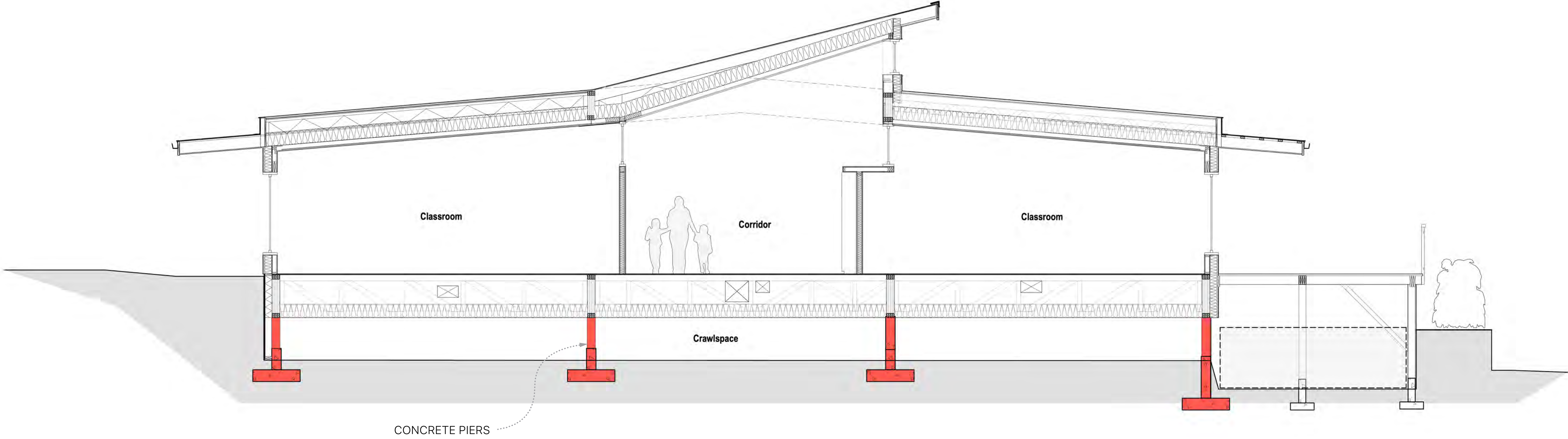
Wood Retaining Wall



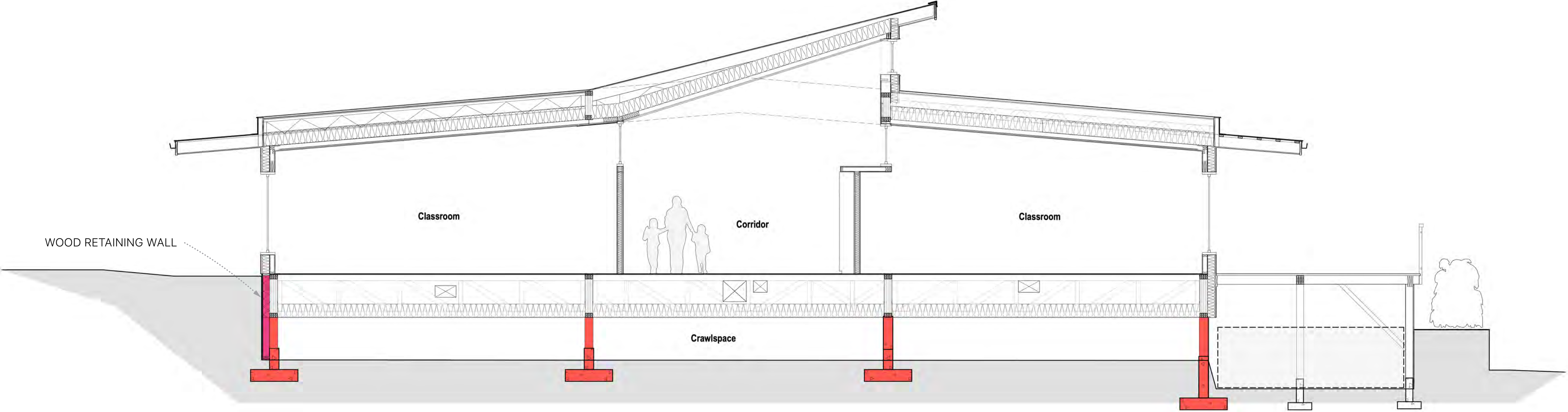
Building Section



Concrete Pier Footings

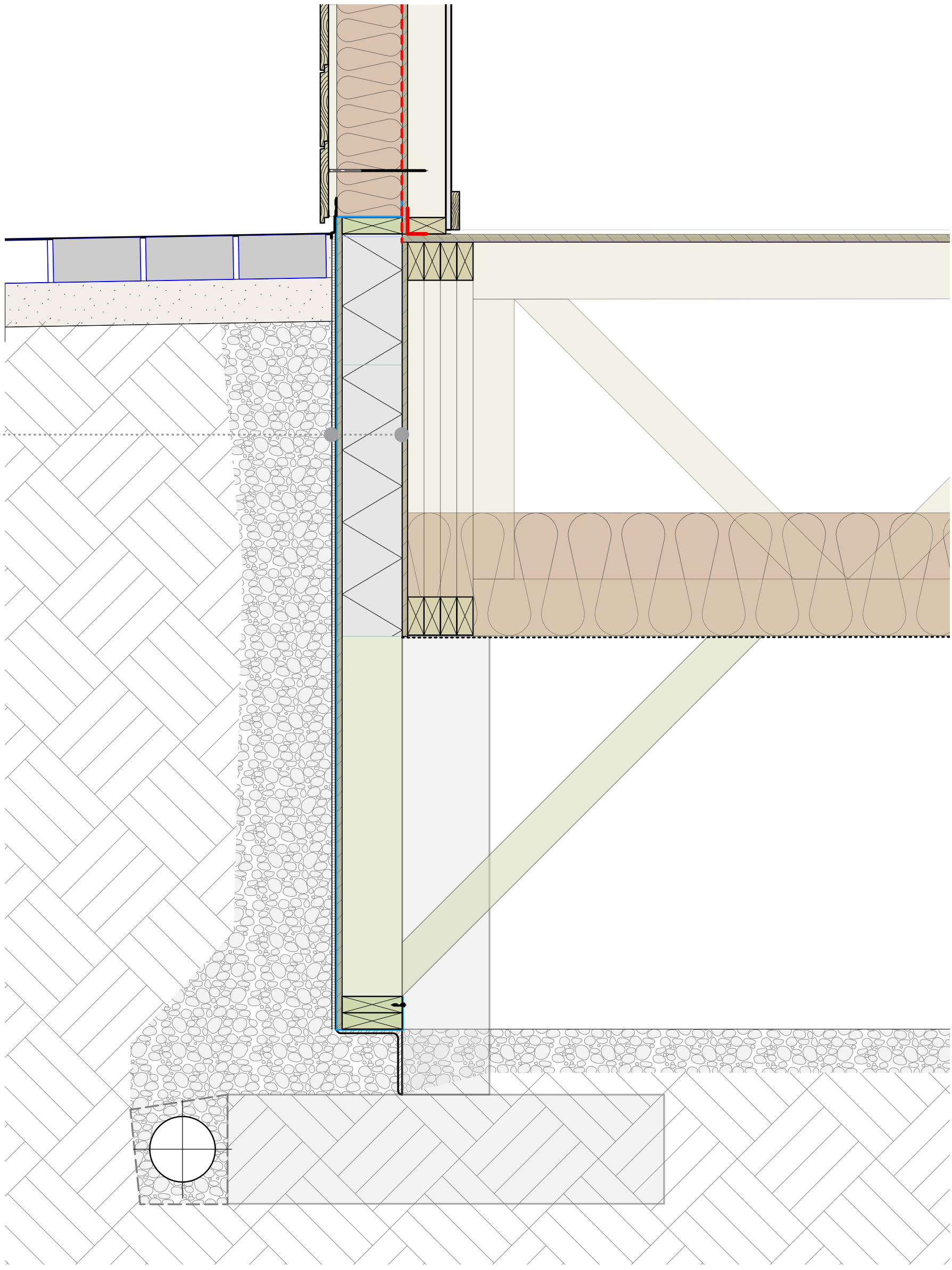


Wood Retaining Wall



# Wood Retaining Wall Detail

- WOOD RETAINING WALL**
- DIMPLE BOARD DRAINAGE MAT
  - SELF-ADHERED WATERPROOFING MEMBRANE
  - 1/2" PT PLYWOOD
  - 2X6 PT WOOD STUDS @ 16" O/C
  - 5.5" GPS FOAM INSULATION @ TRUSS DEPTH



# Envelope

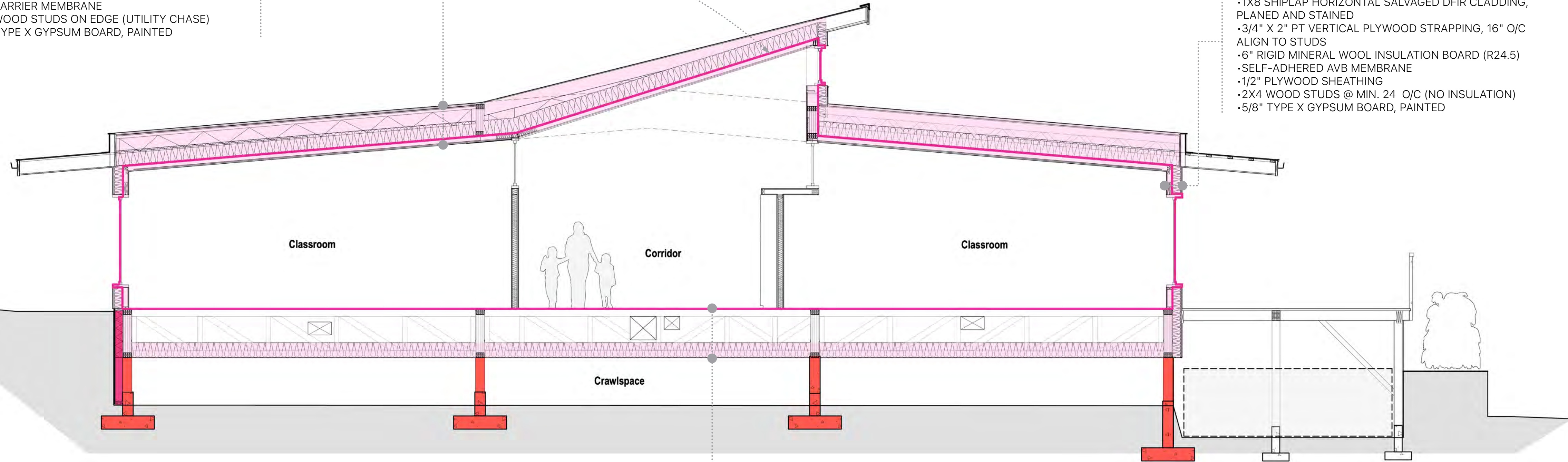
## ROOF ASSEMBLY

- PRE-FINISHED STANDING SEAM METAL ROOFING
- SELF-ADHERED ROOFING UNDERLAYMENT
- PLYWOOD SHEATHING AS PER STRUCTURAL
- ROOF TRUSSES AS PER STRUCTURAL C/W
- 12" FIBRE GLASS BATT INSULATION (R40)
- AVB BARRIER MEMBRANE
- 2X4 WOOD STUDS ON EDGE (UTILITY CHASE)
- 5/8" TYPE X GYPSUM BOARD, PAINTED

AIR BARRIER

## WALL ASSEMBLY (R24.5)

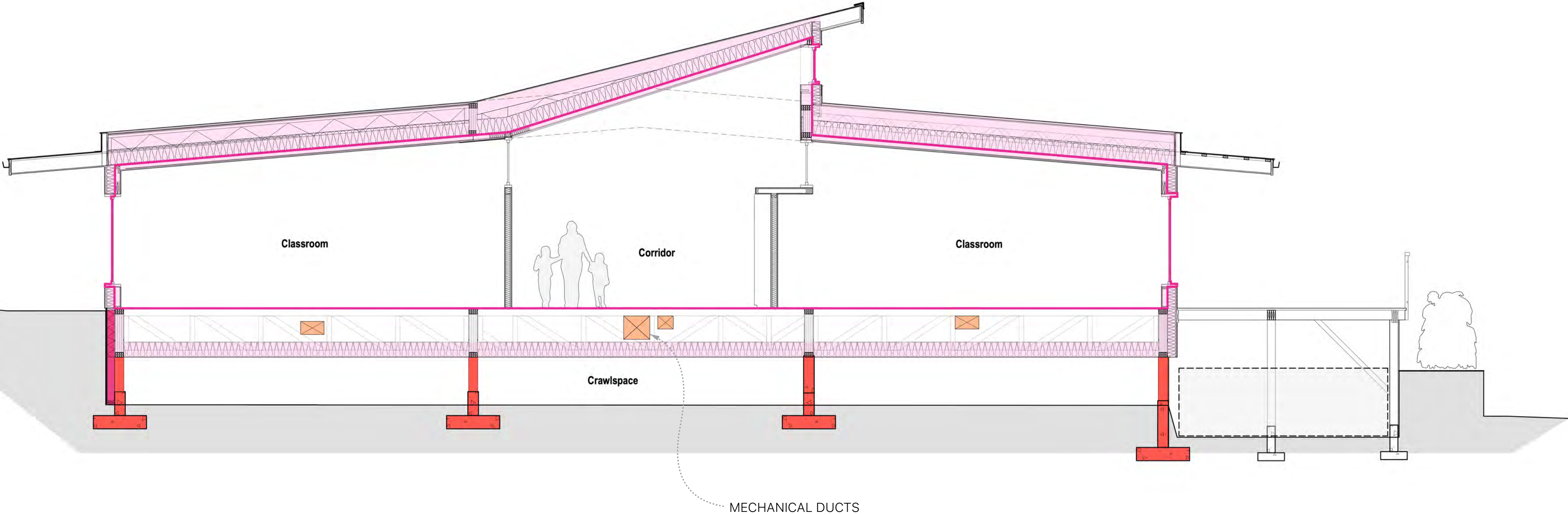
- 1X8 SHIPLAP HORIZONTAL SALVAGED DFIR CLADDING, PLANED AND STAINED
- 3/4" X 2" PT VERTICAL PLYWOOD STRAPPING, 16" O/C ALIGN TO STUDS
- 6" RIGID MINERAL WOOL INSULATION BOARD (R24.5)
- SELF-ADHERED AVB MEMBRANE
- 1/2" PLYWOOD SHEATHING
- 2X4 WOOD STUDS @ MIN. 24" O/C (NO INSULATION)
- 5/8" TYPE X GYPSUM BOARD, PAINTED



## FLOOR ASSEMBLY

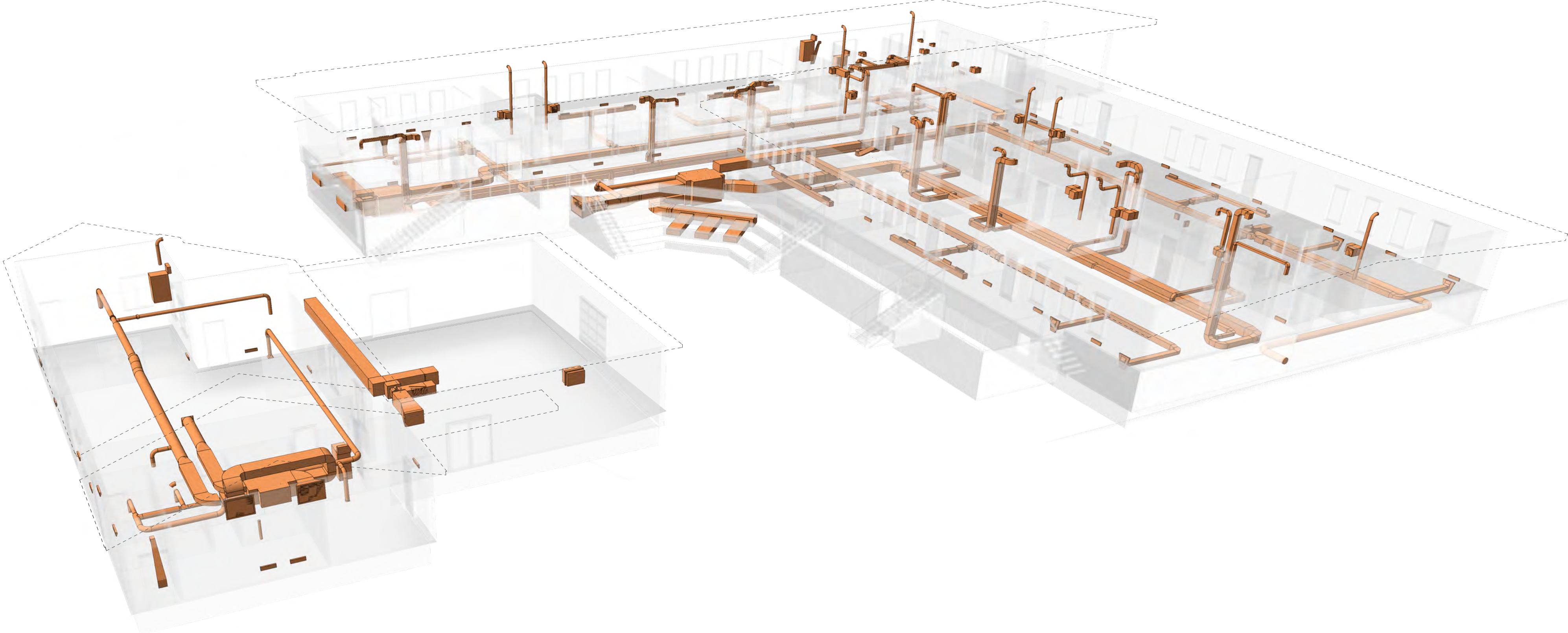
- FINISH FLOORING
- 3/4" PLYWOOD, TAPE SEAMS W/ AB TAPE
- 36" WOOD FLOOR TRUSSES C/W
- 5.5" FIBREGLASS BATT INSULATION (R22)
- 5.5" ROCKWOOL BATT INSULATION (R22)
- 1/8" STUCCO WIRE MESH

HVAC

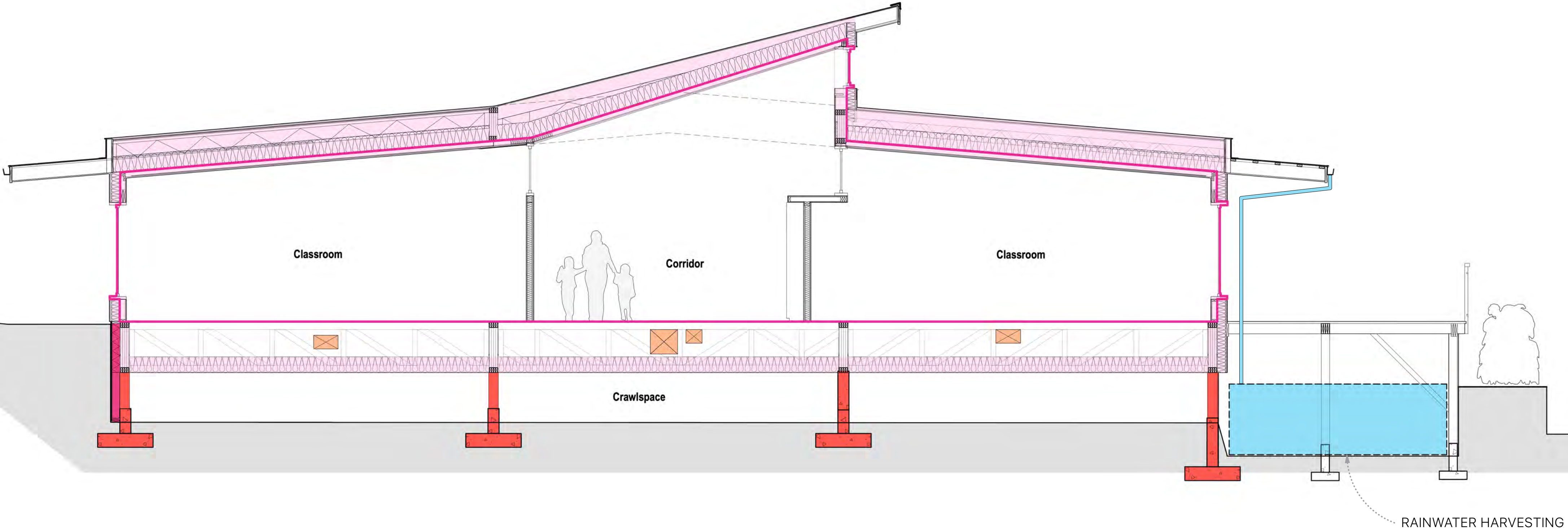




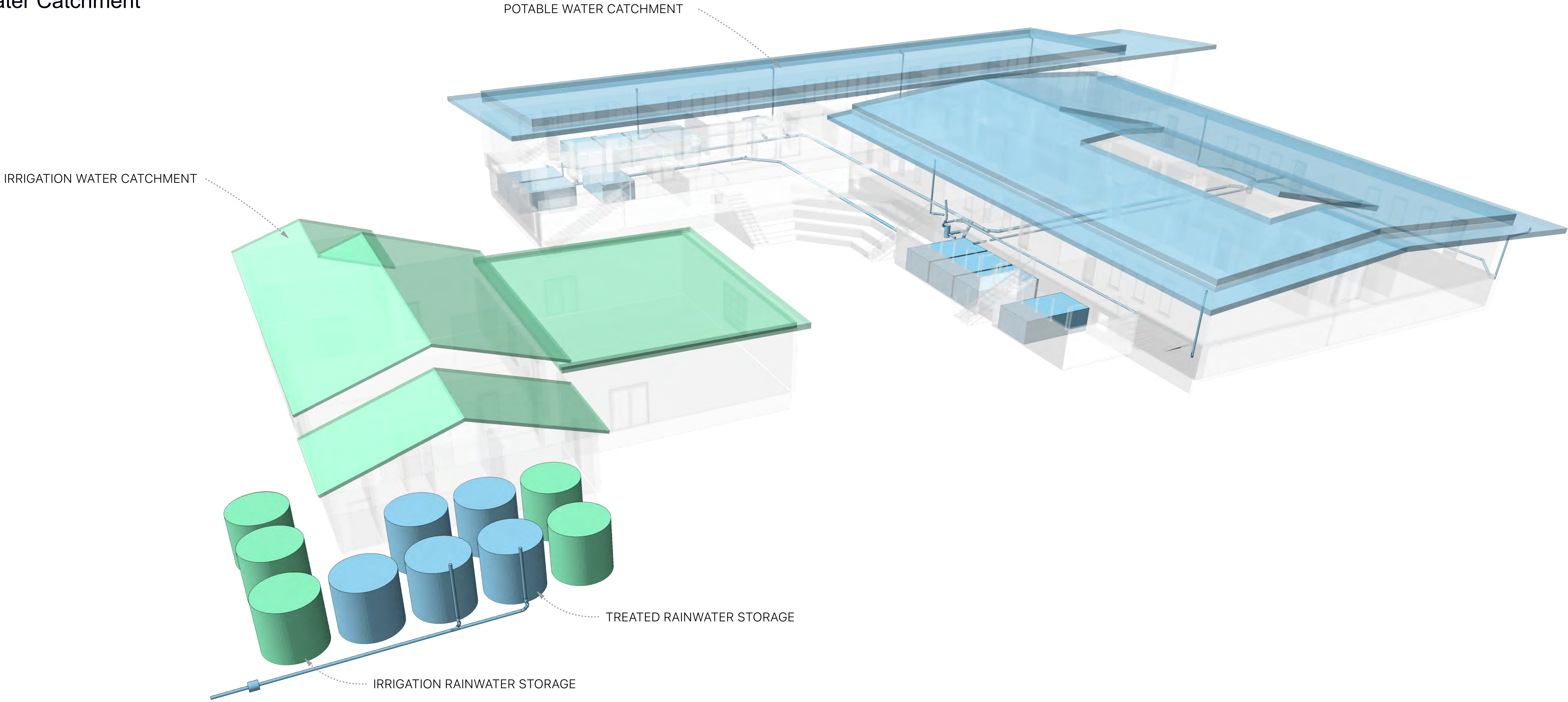
HVAC



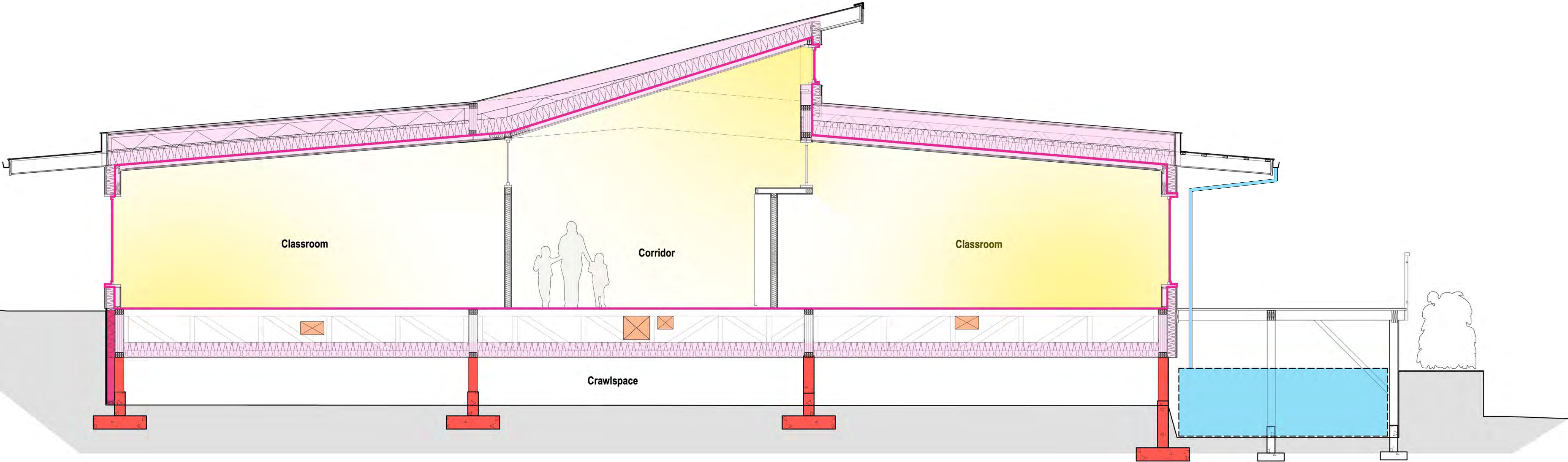
Water Retention Tanks



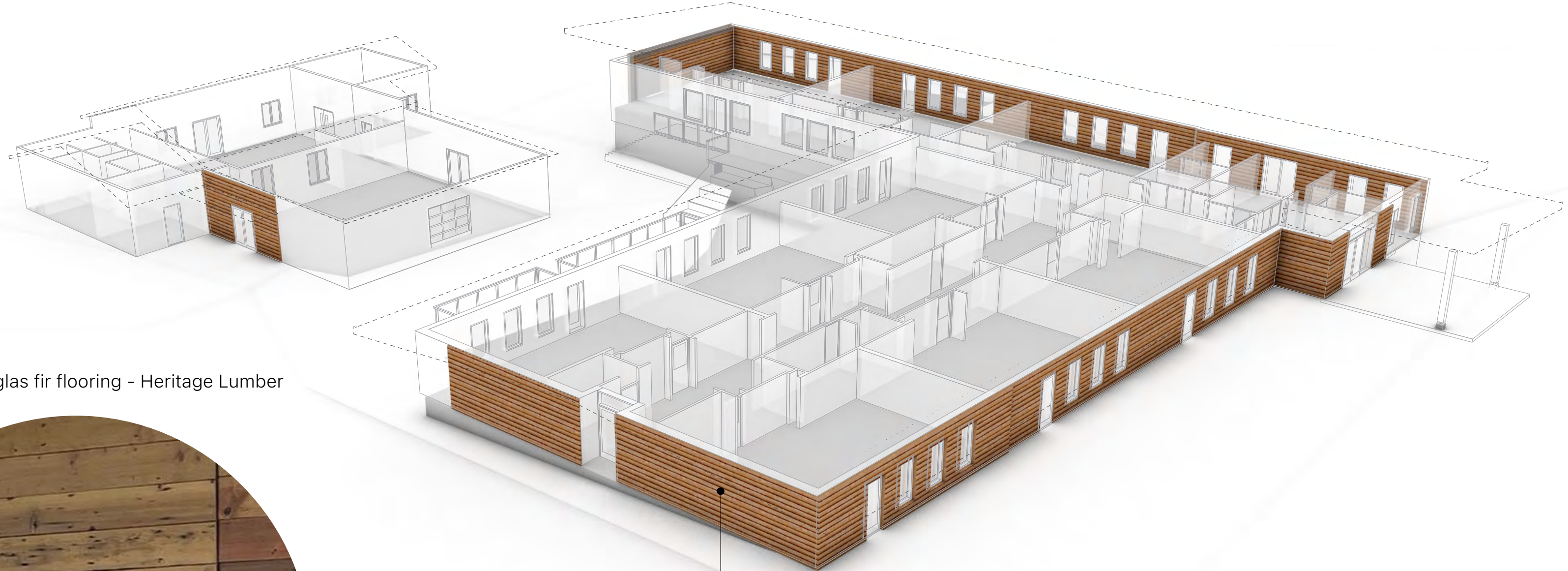
# Rainwater Catchment



Daylighting







Reclaimed douglas fir flooring - Heritage Lumber

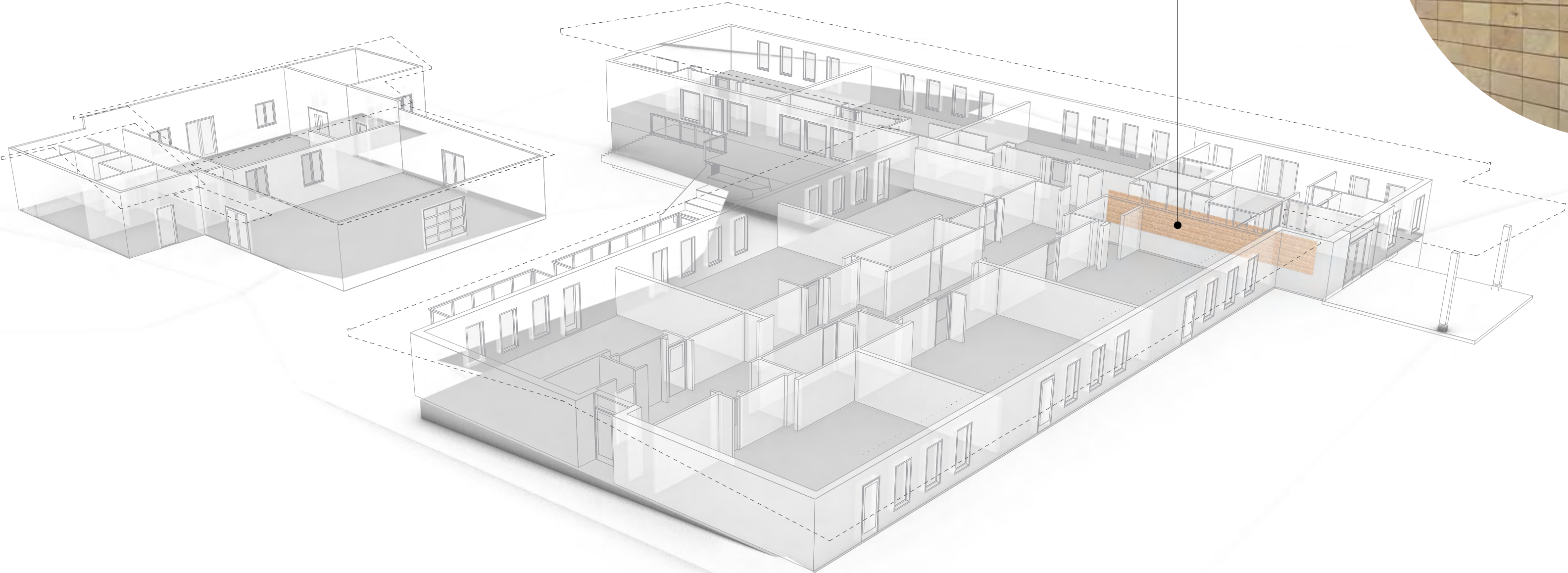


3D Model - Northwest View





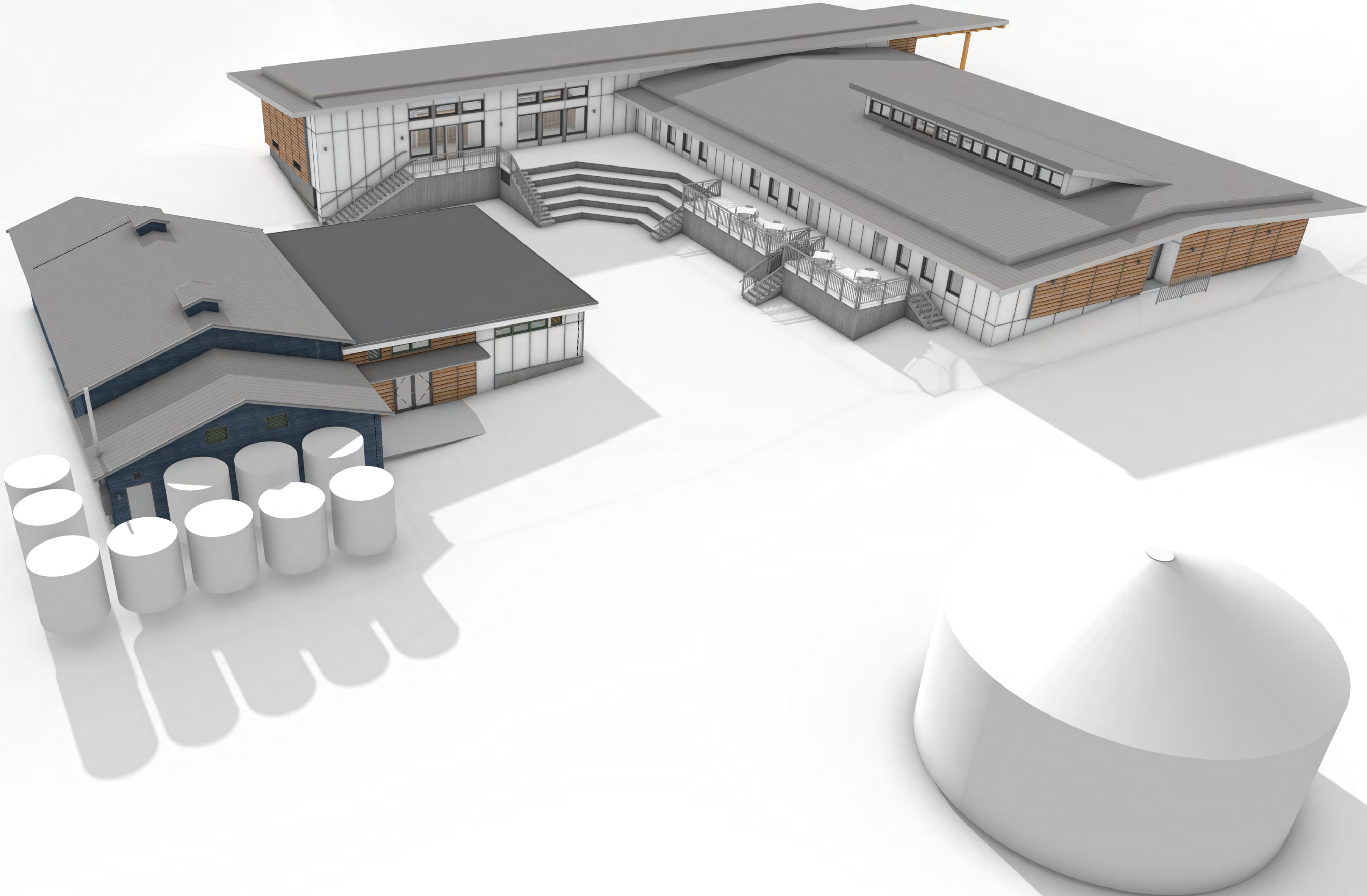




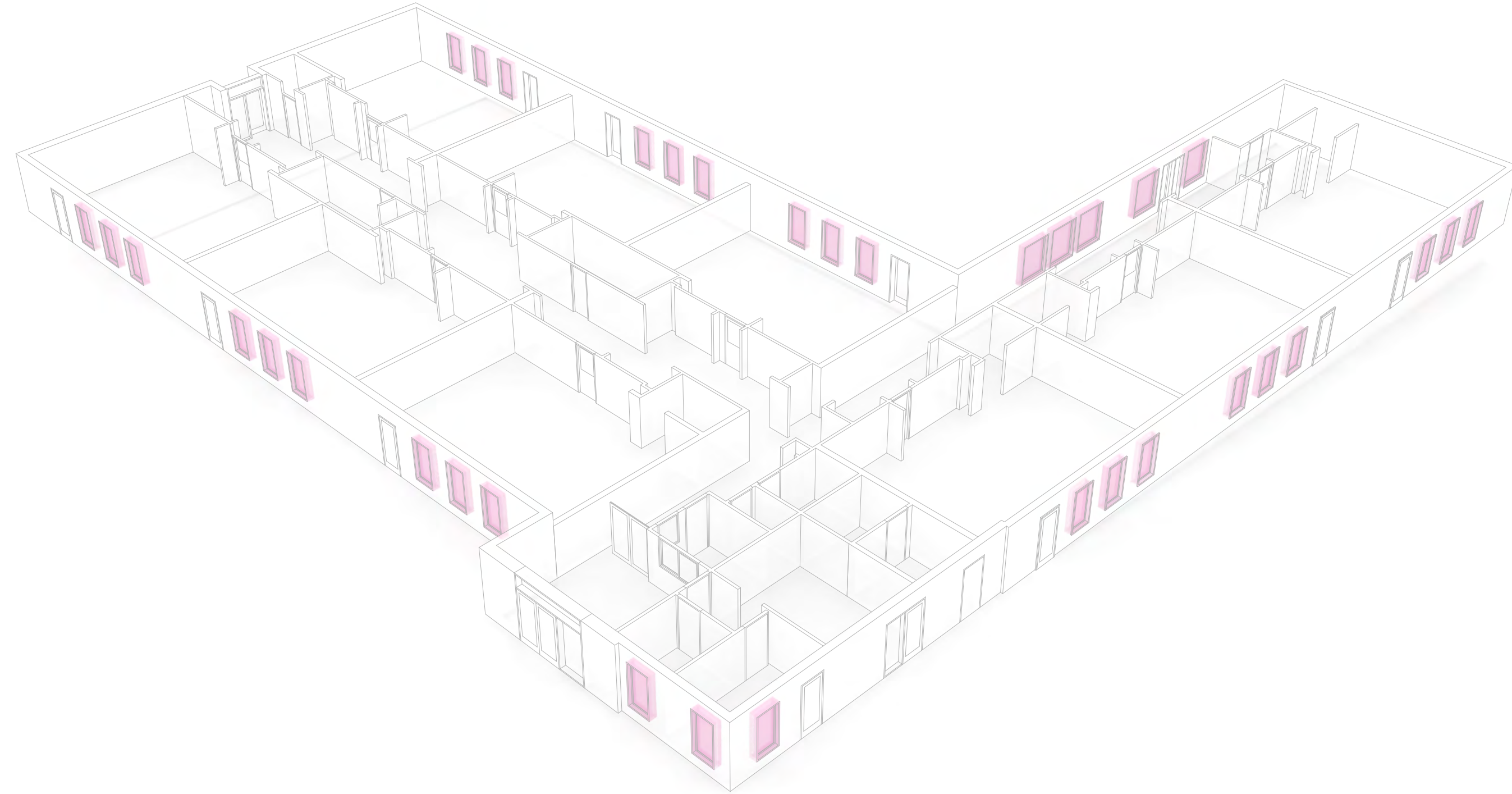




3D Model - Northeast View



# Windows



## Operational Carbon

- Highly efficient envelope
- Airtight envelope
- Good insulation
- Harvesting Free heat
- Solar Heat Gain through windows
- Internal Heat Gains
- Efficient & simple HVAC system
- Heat recovery Ventilation
- No Airconditioning
- Natural ventilation/Operable windows
- Electric heat,
- Natural daylighting
- Planned for PV

## Embodied Carbon

- Wood Construction
- Concrete pier foundation
- Fibreglass and Mineral Wool insulation
- Wood windows
- Reclaimed wood cladding
- Metal roofing
- Marloleum Flooring



**Embodied Carbon Award Winner**

# Discover Montessori

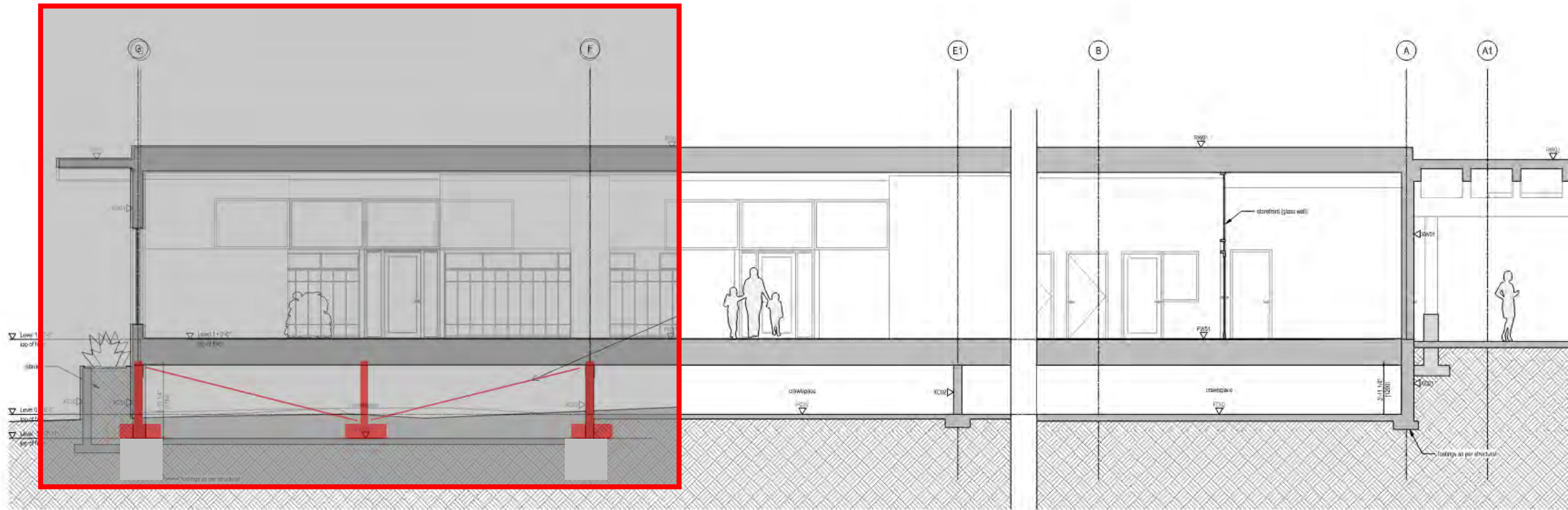
**January 19<sup>th</sup>, 2024**



CHECKWITCH  
POIRON  
ARCHITECTS  
INC



# How Significant Amounts of Embodied Carbon were Avoided



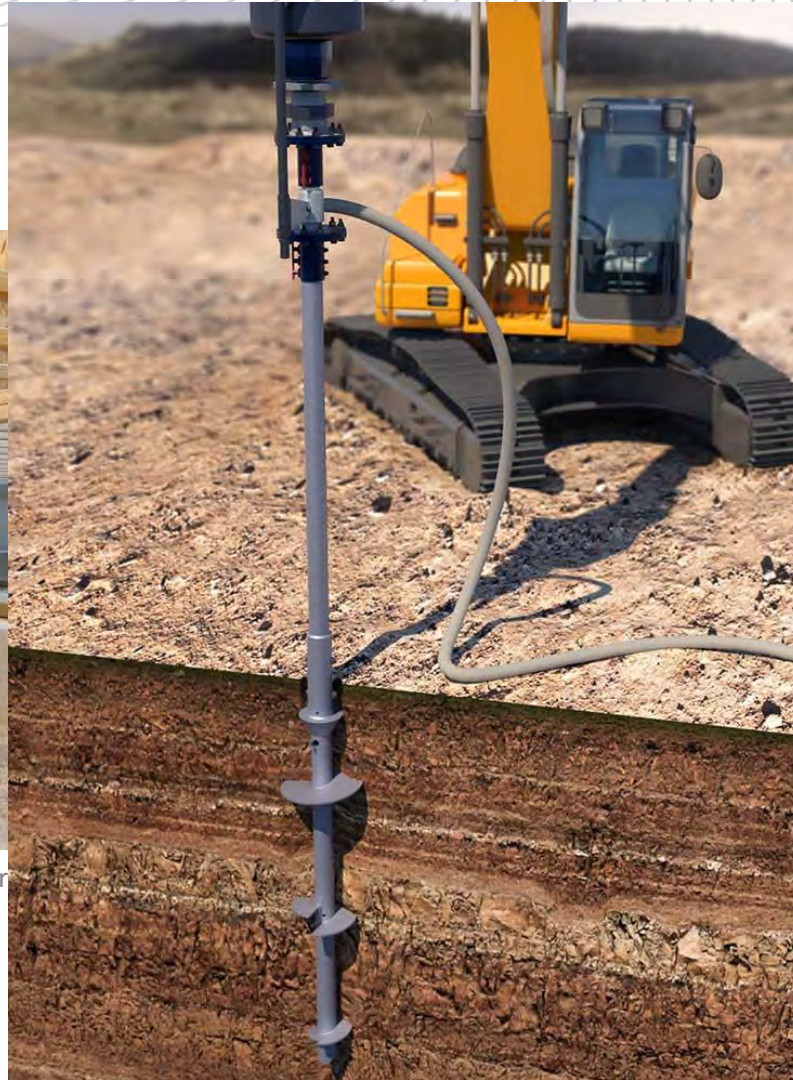
1 Section of South Wing  
A05.2b 1:50



# How Significant Amounts of Embodied Carbon were Avoided



Insulated Concrete

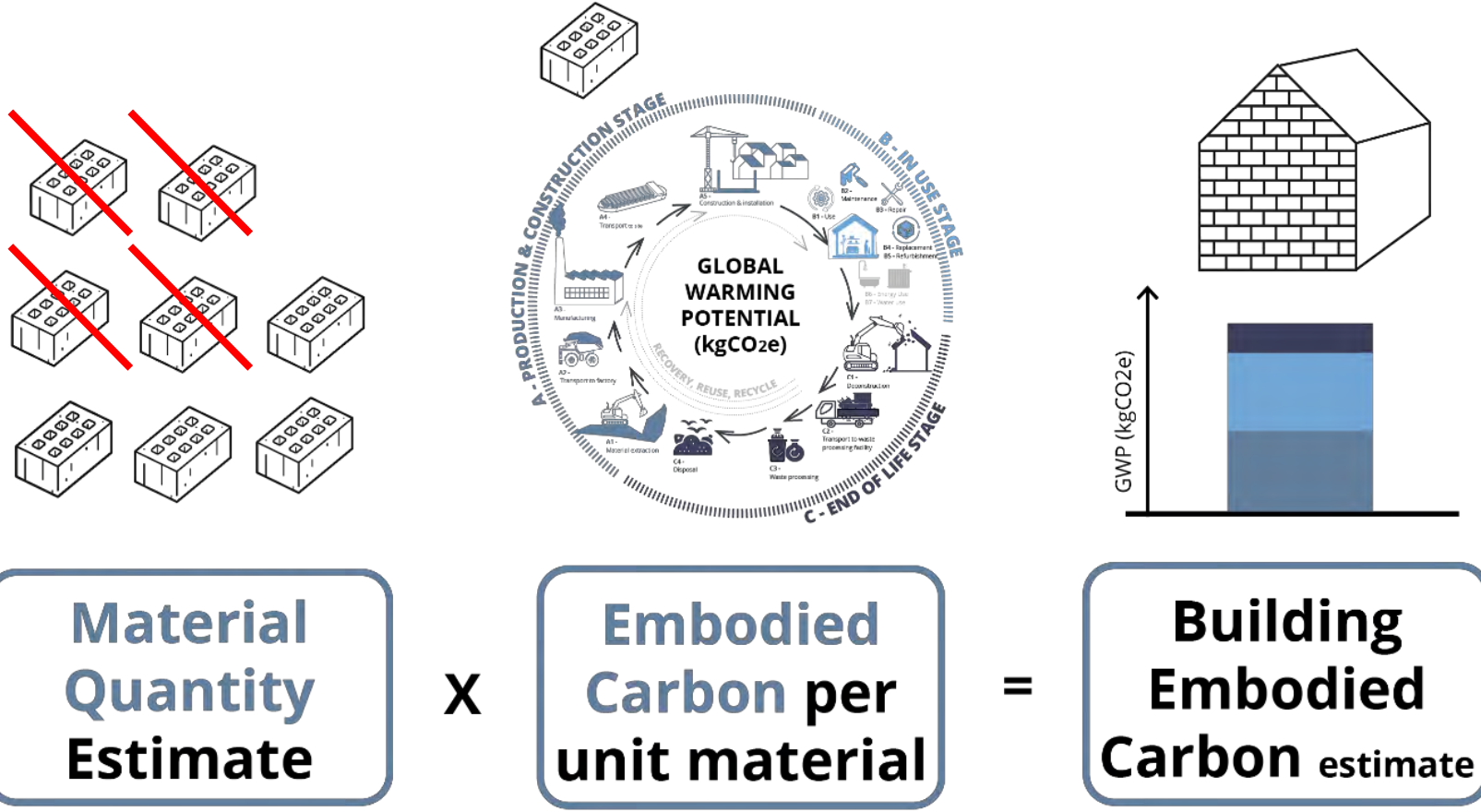


ALSO UNDER CONSIDERATION AT ONE TIME: Helical Screw Piles

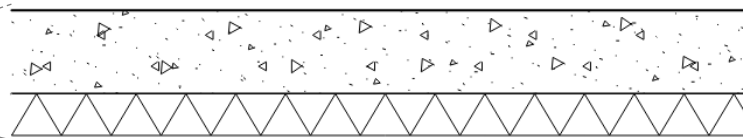
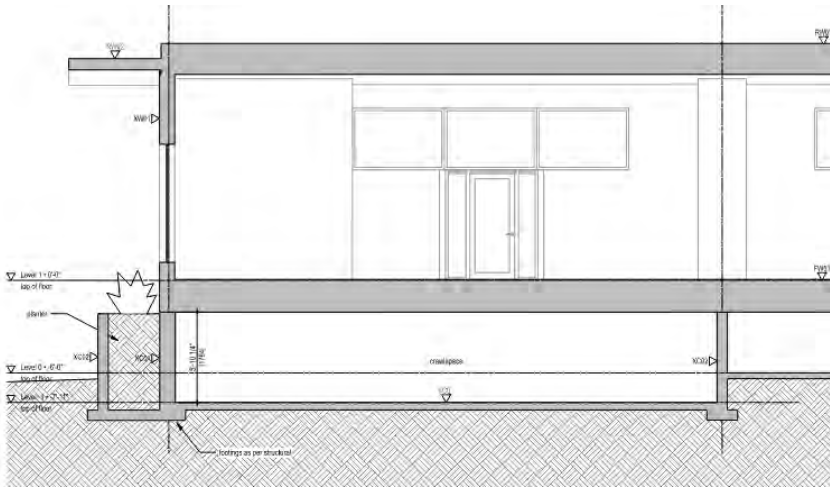
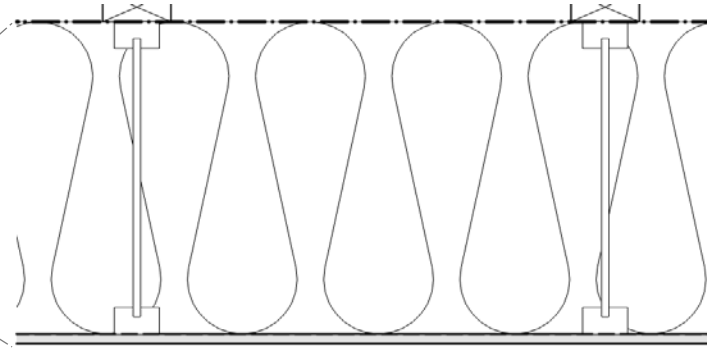
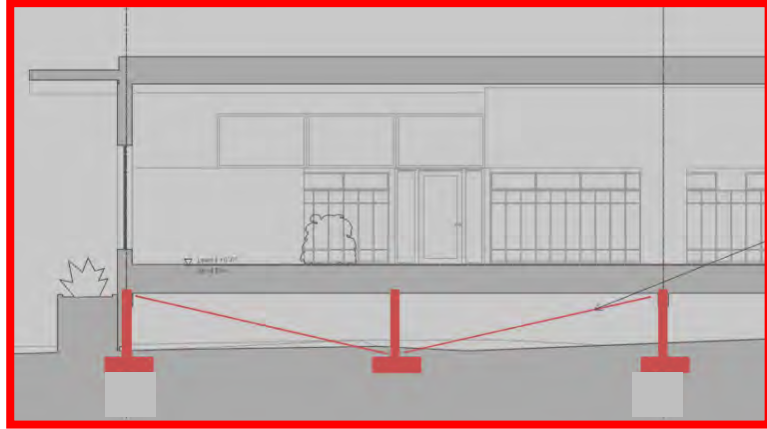


Crawlspace with Pad Footings

# How Significant Amounts of Embodied Carbon were Avoided

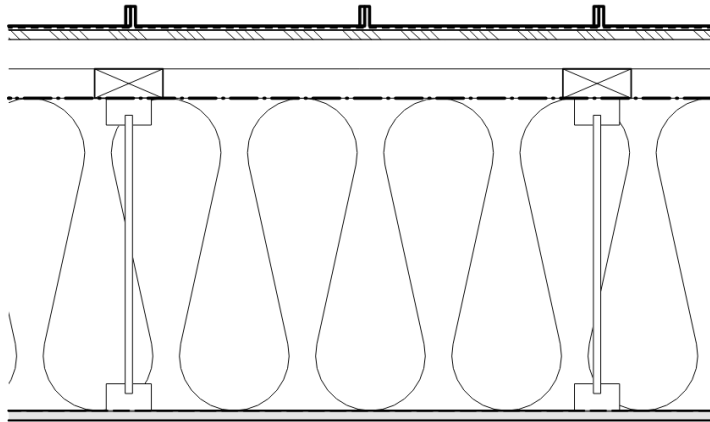


# How Significant Amounts of Embodied Carbon were Avoided



- FC01 Concrete Floor 4x"**
- 4" reinforced concrete slab as per structural
  - 2" XPS rigid insulation

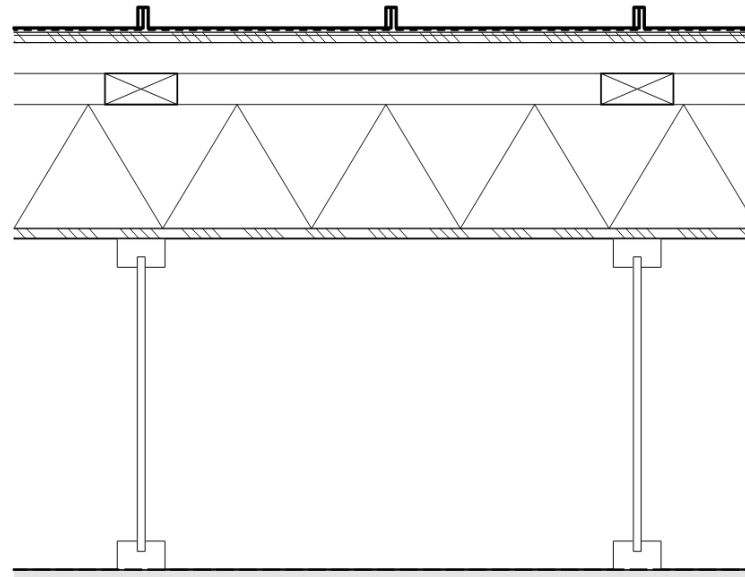
# How Significant Amounts of Embodied Carbon were Avoided



## RW01 Roof - Baseline option 1

FRR 45min BCBC F4d

- standing seam metal roofing
- peel & stick roofing membrane
- 1/2" plywood sheathing
- 2 layers 2x4 (purlins & strapping) ventilation space
- WRB membrane
- TJI rafters w/ dense pack blown-in cellulose insulation ←
- air barrier membrane
- 1/2" type 'X' drywall ceiling

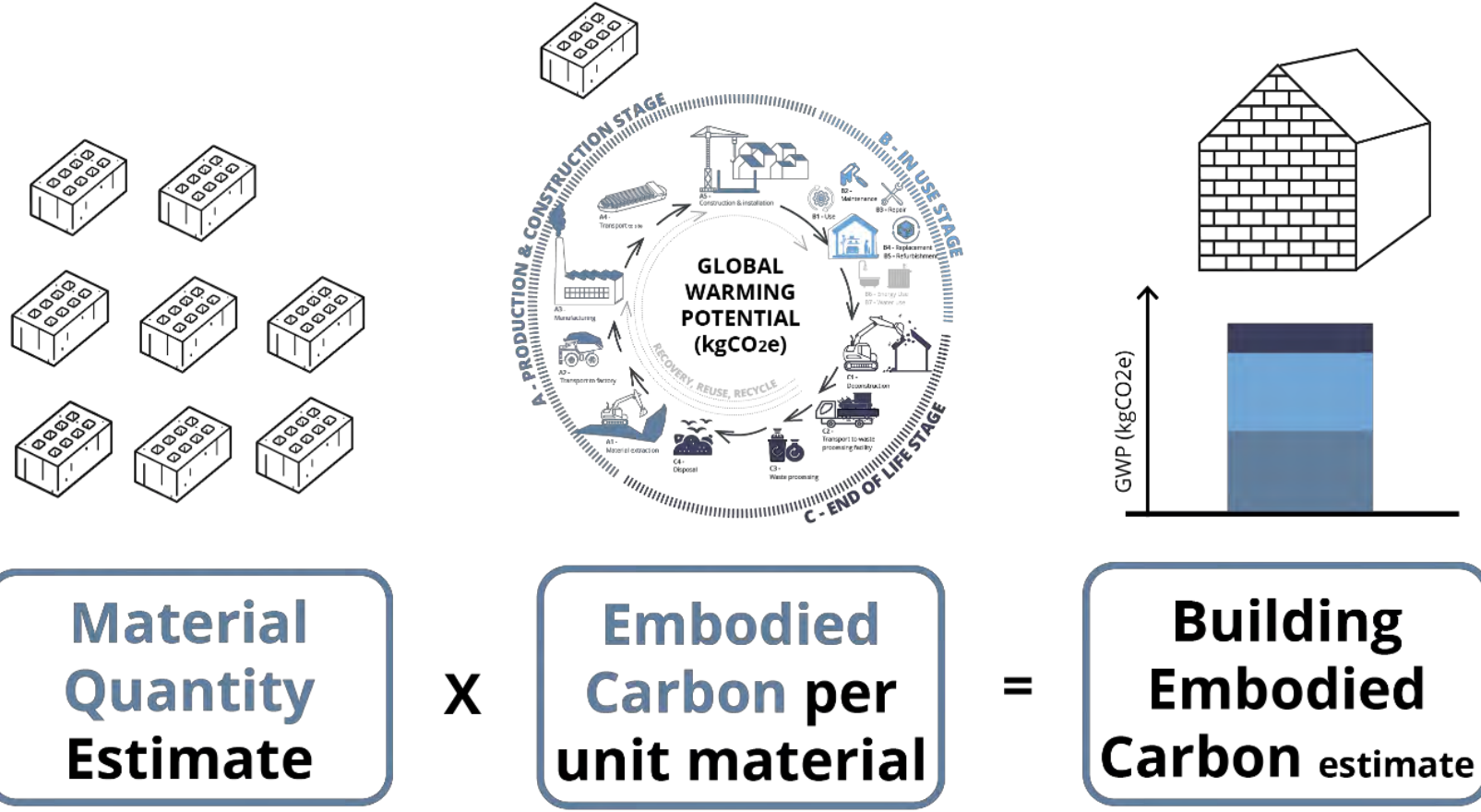


## RW01 Roof - Baseline option 2

FRR 1hr BCBC F4b

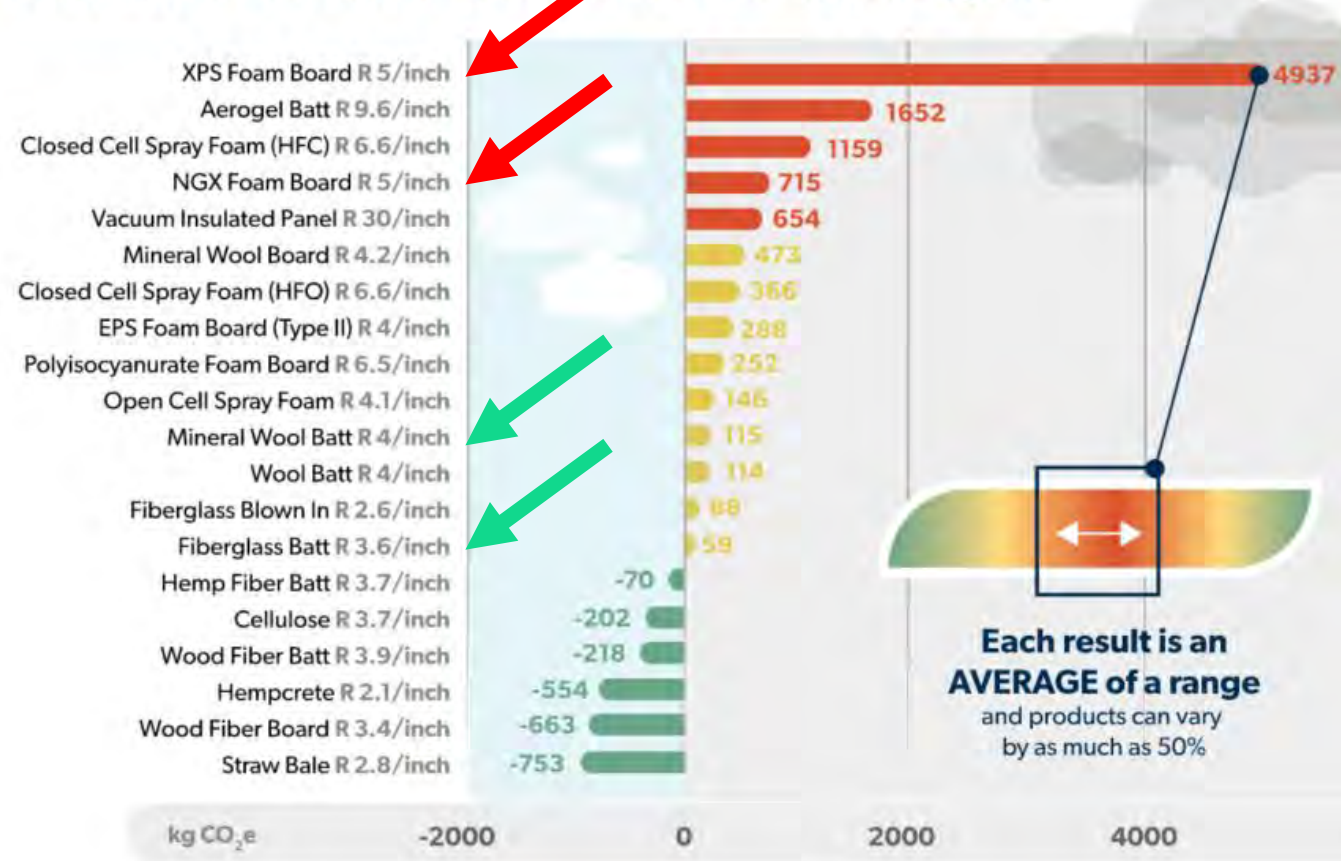
- standing seam metal roofing
- peel & stick roofing membrane
- 1/2" plywood sheathing
- 2 layers 2x4 (purlins & strapping) ventilation space
- 6" XPS rigid insulation ←
- air barrier membrane
- 1/2" plywood sheathing
- TJI rafters as per structural
- 1/2" type 'X' drywall ceiling

# How Significant Amounts of Embodied Carbon were Avoided



# How Significant Amounts of Embodied Carbon were Avoided

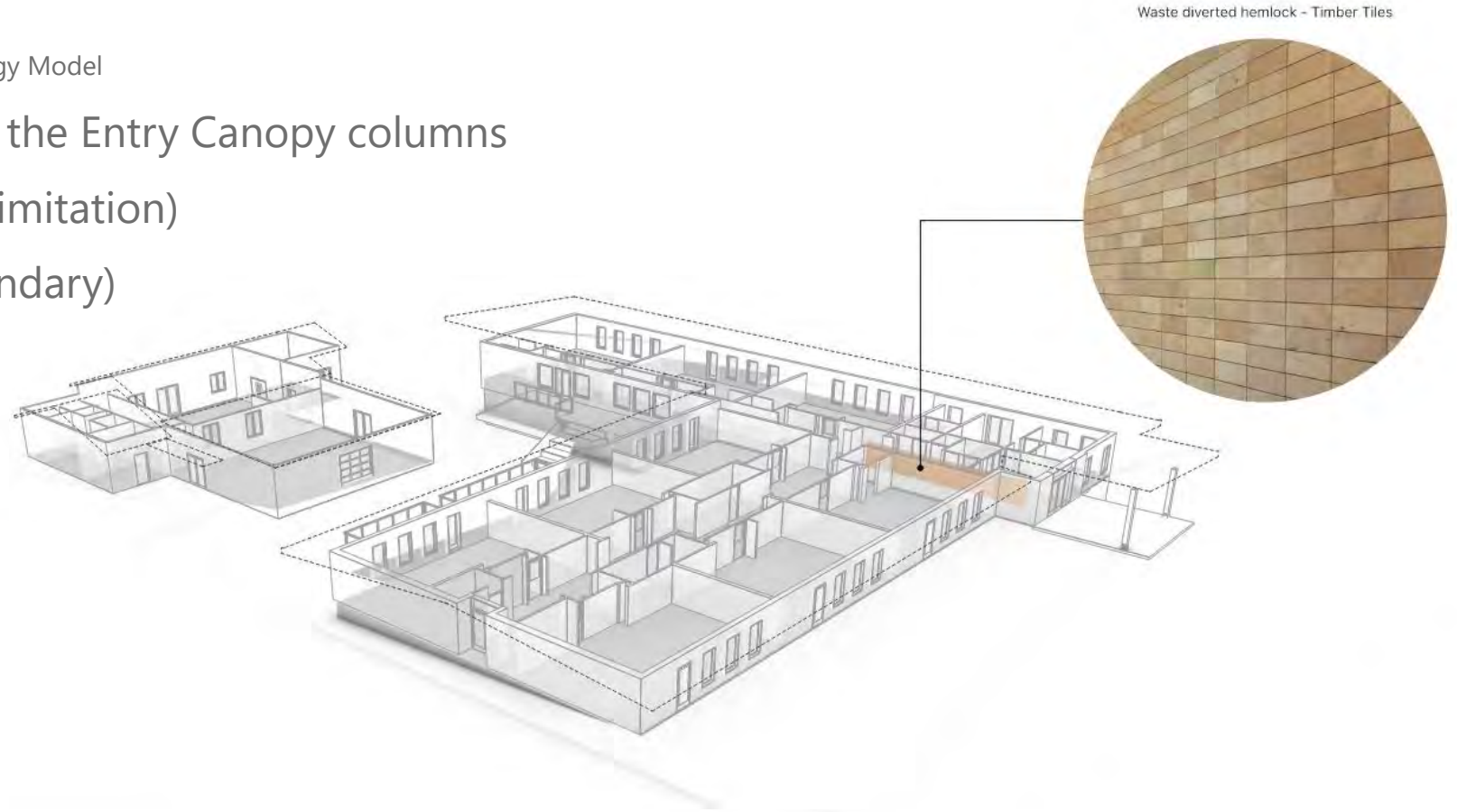
## Insulation Emissions Comparison for 100 m<sup>2</sup> @ R5



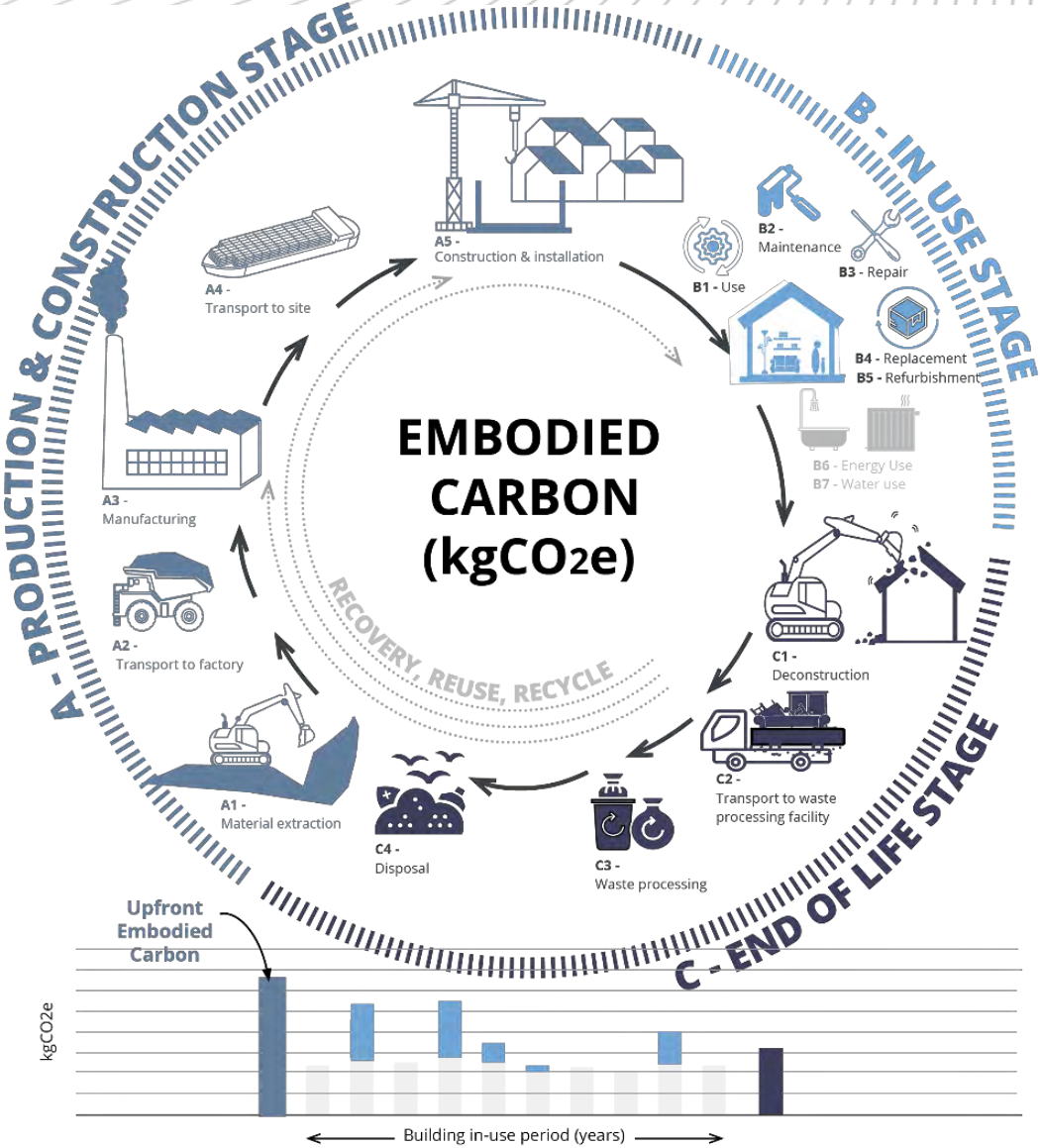
Source: EMBARC Report, Builders for Climate Action

# Interventions that were lower / unknown impact, but explored

- Alternate Window Frame Types
  - Especially tricky as Windows also affect Energy Model
- Using Wood instead of Steel for the Entry Canopy columns
- Reclaimed Materials (Software Limitation)
- Interiors Materials (Outside Boundary)



Carbon emissions associated with production, construction, use and end of life stages.





# Overall Results

LCA Modelling Tool:



**Athena**  
Sustainable Materials  
**Institute**

Modelled Lifespan:

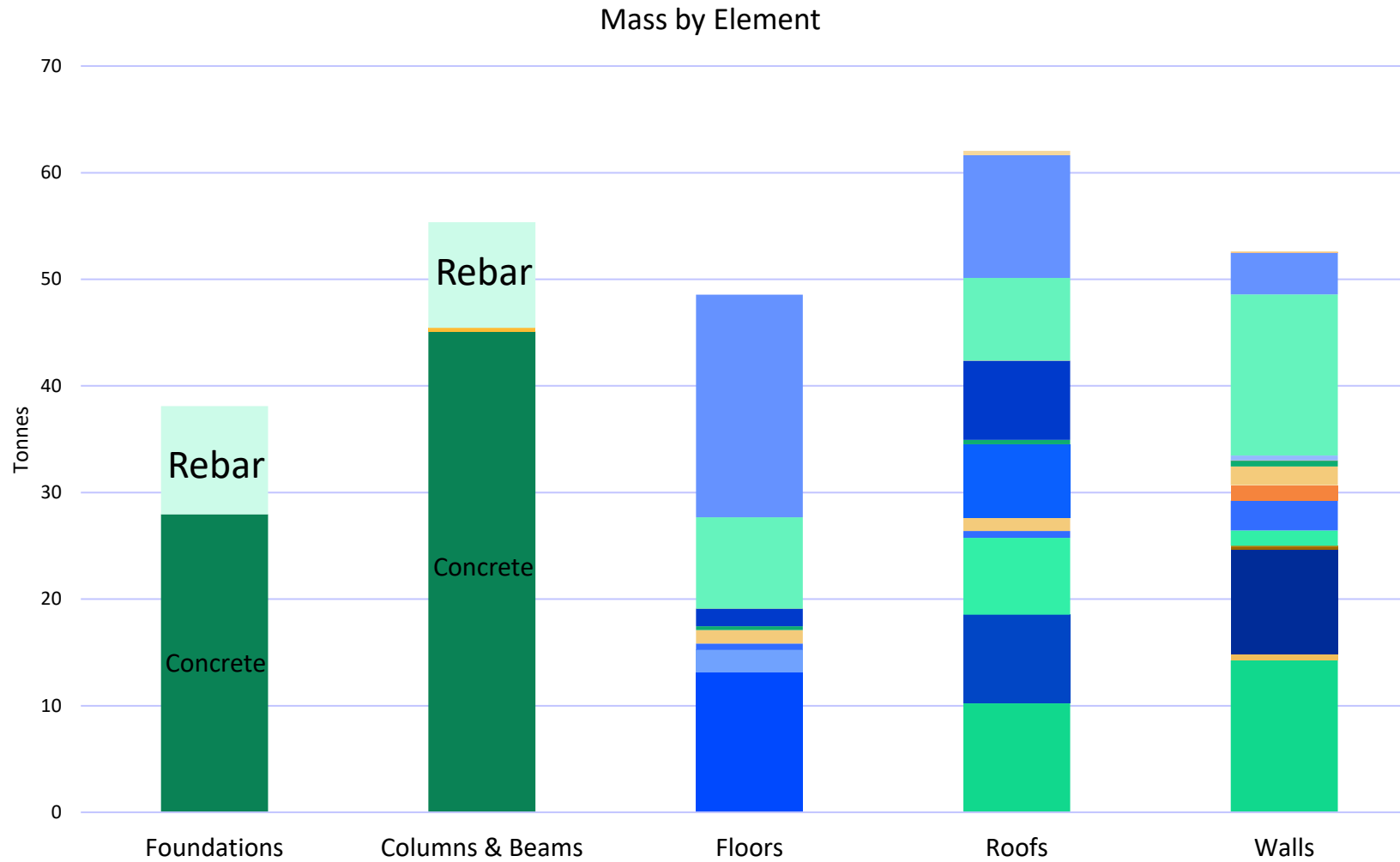
60 Years

Embodied Emissions until 2084

Modelled Scope:

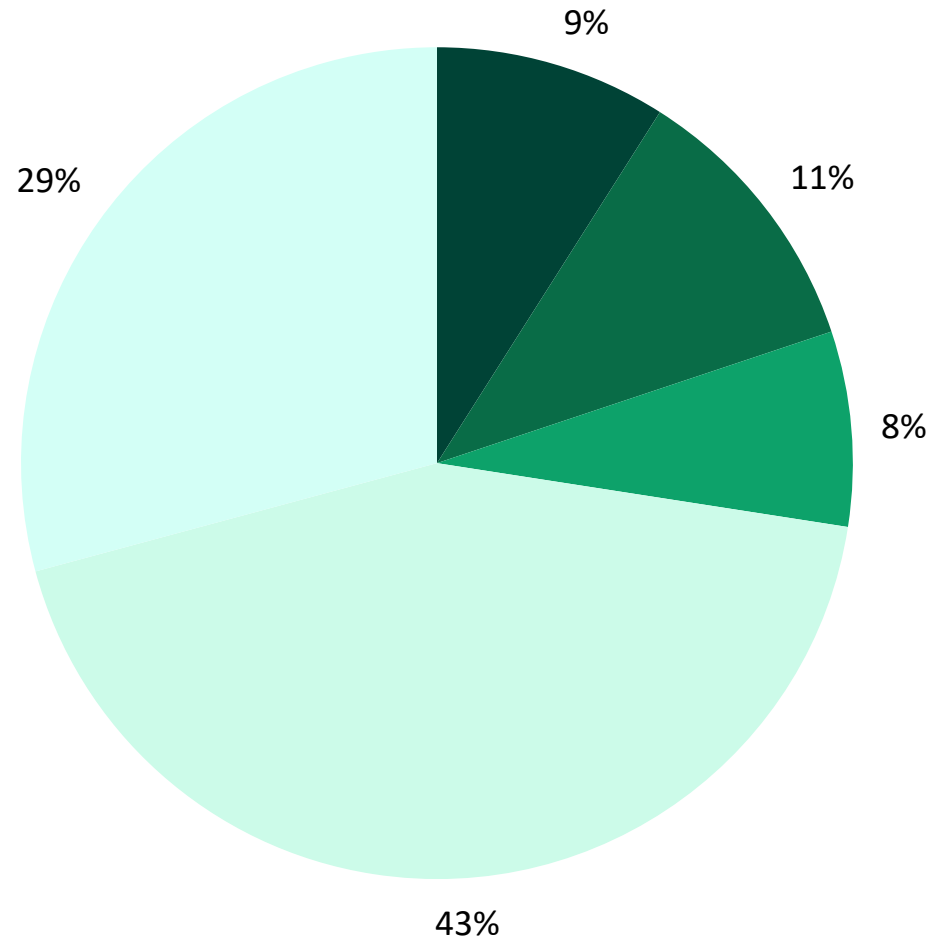
*Structure + Enclosure*

# Overall Results



# Overall Results

Embodied Carbon By Building Element



■ Columns & Beams ■ Floors ■ Foundations ■ Roofs ■ Walls

# Overall Results - Scenarios

## Impact of:

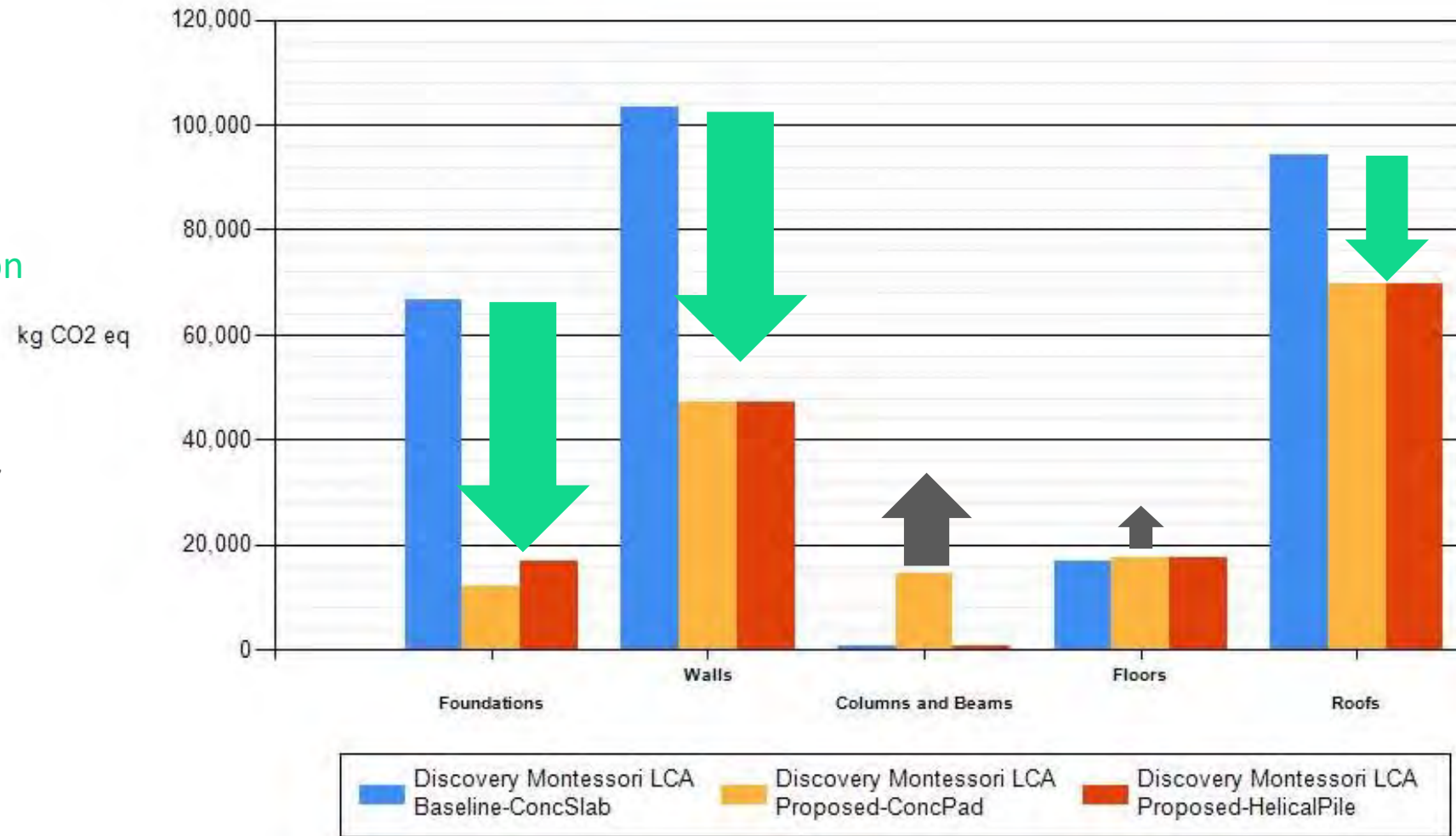
- Deleting Concrete Slab +
- Deleting Concrete Retaining Walls
- Deleting Concrete Strip Footings
- Deleting Subslab XPS Insulation
- Deleting Retaining Wall XPS Insulation

## Impact of:

- Adding Concrete Columns over Pad Footings (More of an accounting exercise than an increase, emissions just moved from "Walls" to "Columns and Beams")
- Adding Batt Insulation to TJI Floor

## Impact of:

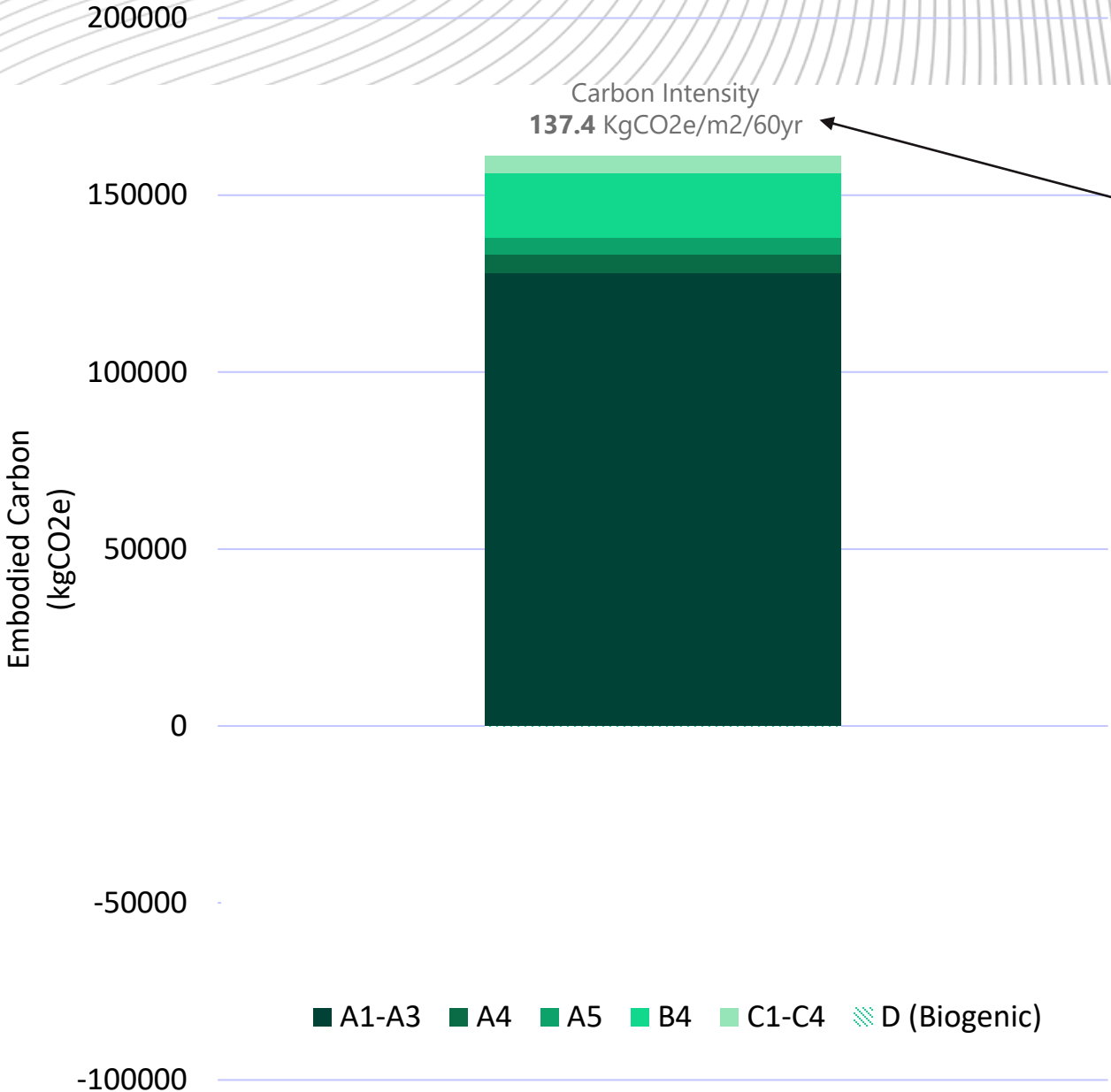
- Switching Roof Insulation Type



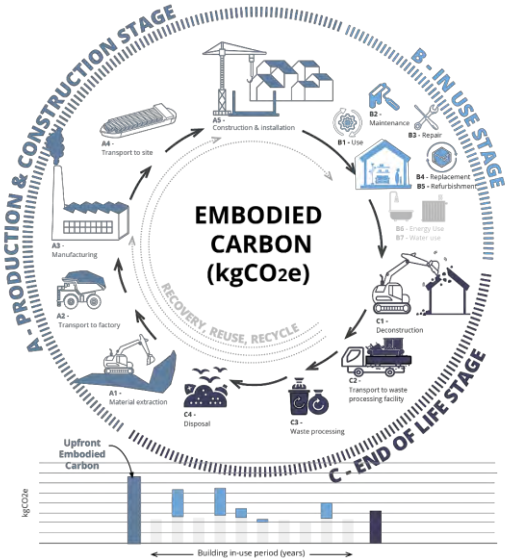
# Overall Results



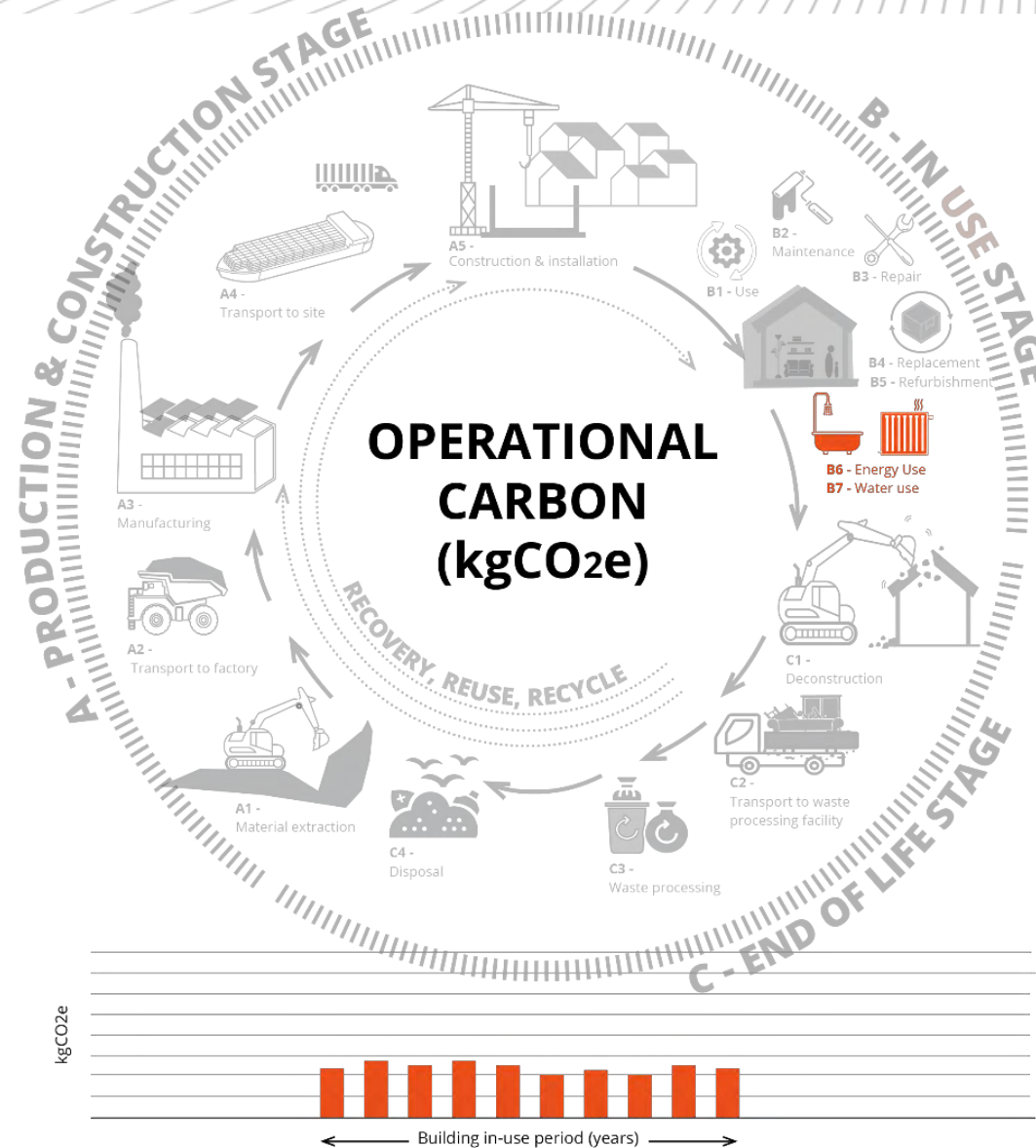
# Overall Results



For Context, the best threshold set in the CaGBC Zero Carbon Standard is <240 KgCO<sub>2</sub>e/m<sup>2</sup>/60yr



Carbon emissions associated with energy and water use during a building lifetime.



# Operational Carbon

## Energy Efficient Design Elements

- High performance opaque envelope (R38 Roof, R35 Floors, R19 Walls)
- High performance glazing systems ( $U_{ip} 0.25$ )
- Low window to wall ratio (15%)
- Low vertical façade to area ratio (VFAR)
- Heat recovery ventilators for preheating outdoor air (~75% Recovery Efficiency)
- Lower lighting load due to natural daylighting
- Demand controlled ventilation in classrooms and offices (via CO2 sensors)

**27.8 kwh/m2/yr**

TEDI

**82.8 kwh/m2/yr**

TEUI



# Operational Carbon

## Converting Energy to Emissions

TEUI x BC Electricity Emissions Factor (0.011 kgCO<sub>2</sub>e/kwh) = Greenhouse Gas Intensity (GHGI)

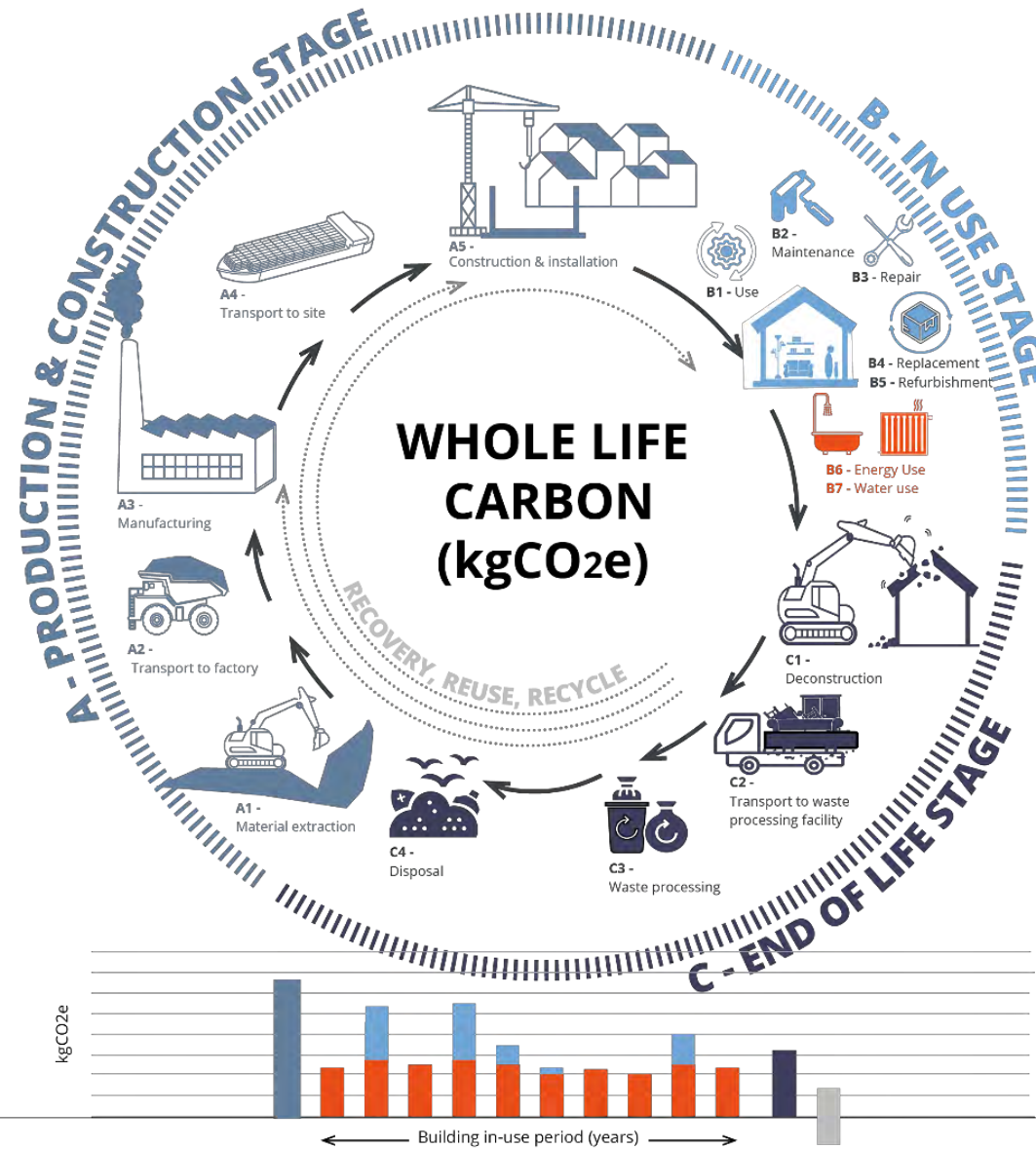
= **0.9108** kgCO<sub>2</sub>e/m<sup>2</sup>/yr

For context, a new condo built to the 2023 Zero Carbon Step Code "Moderate" step emits <**7.0** kgCO<sub>2</sub>e/m<sup>2</sup>/yr, while one built to the "Zero" step still emits <**2.0** kgCO<sub>2</sub>e/m<sup>2</sup>/yr

= Annual Operational Emissions of **1,038 KgCO<sub>2</sub>e**

= Projected Lifetime Operational Emissions of **62,298 KgCO<sub>2</sub>e**

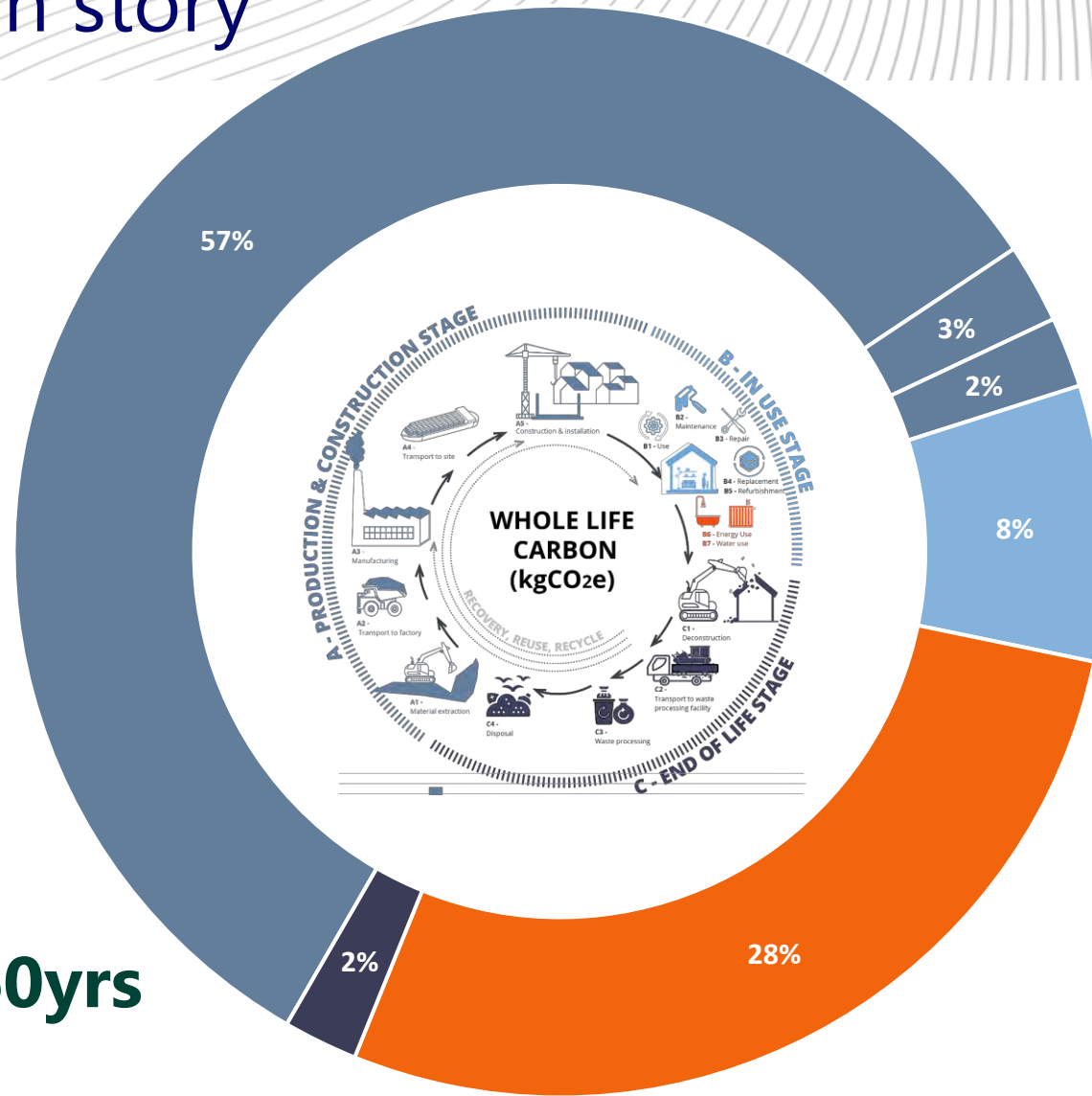
Carbon emissions associated with the whole life cycle.



# Whole Life Carbon story

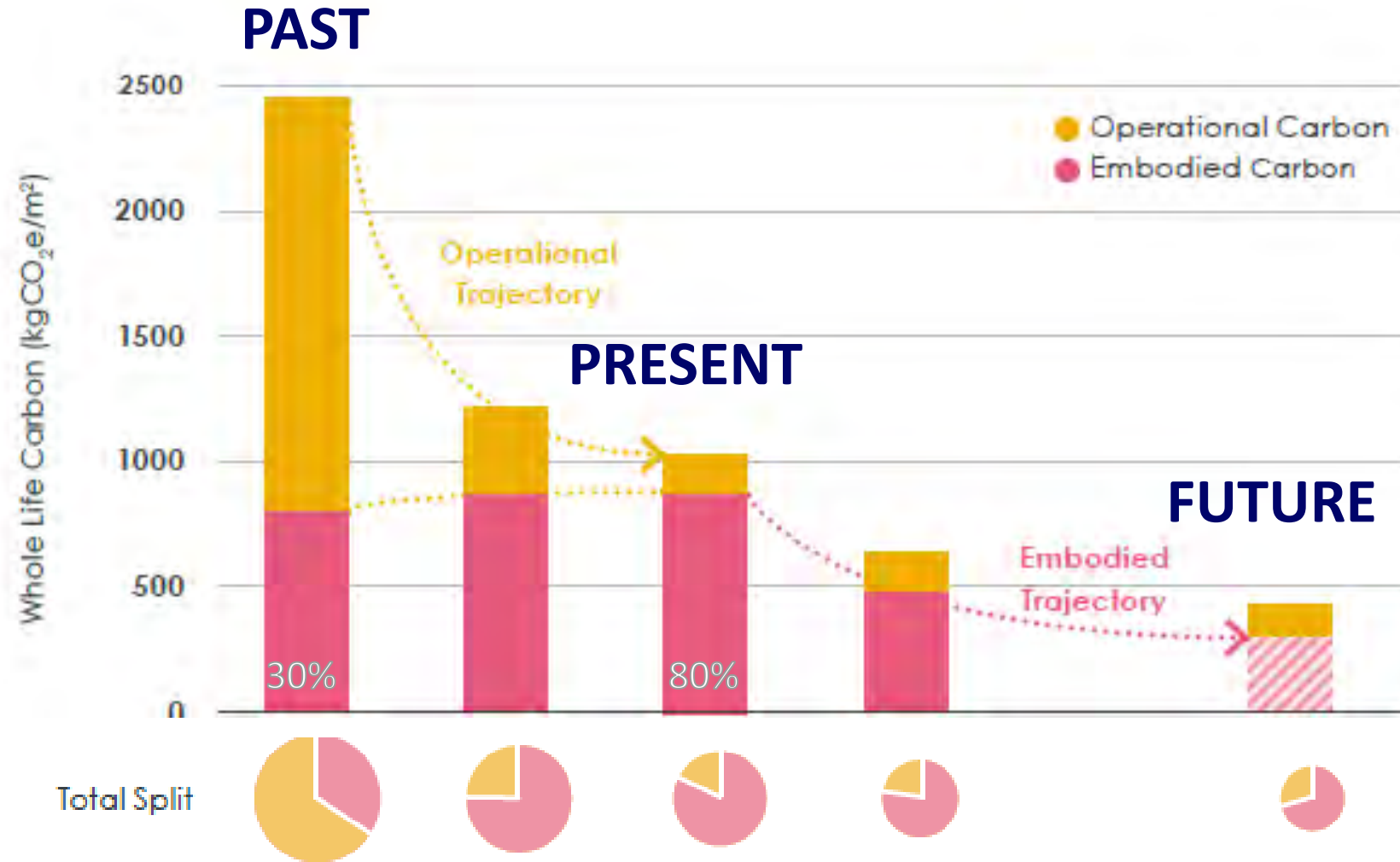
Lifetime Emissions of  
**223,347 KgCO<sub>2</sub>e**

Lifetime Intensity of  
**196 KgCO<sub>2</sub>e/m<sup>2</sup>/60yrs**



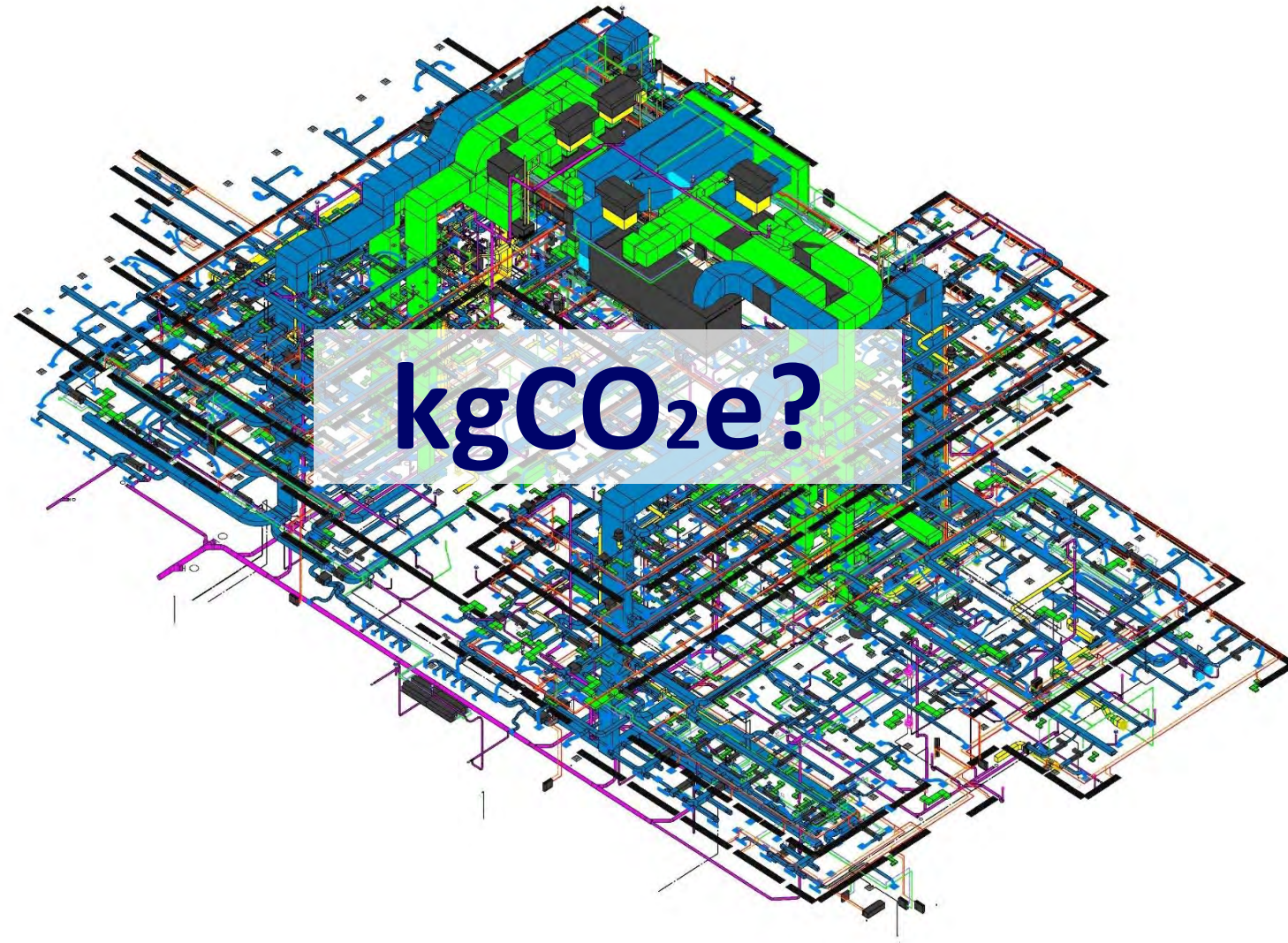
■ A1-A3 ■ A4 ■ A5 ■ B4 ■ B6 ■ C1-C4

# Whole Life Carbon story

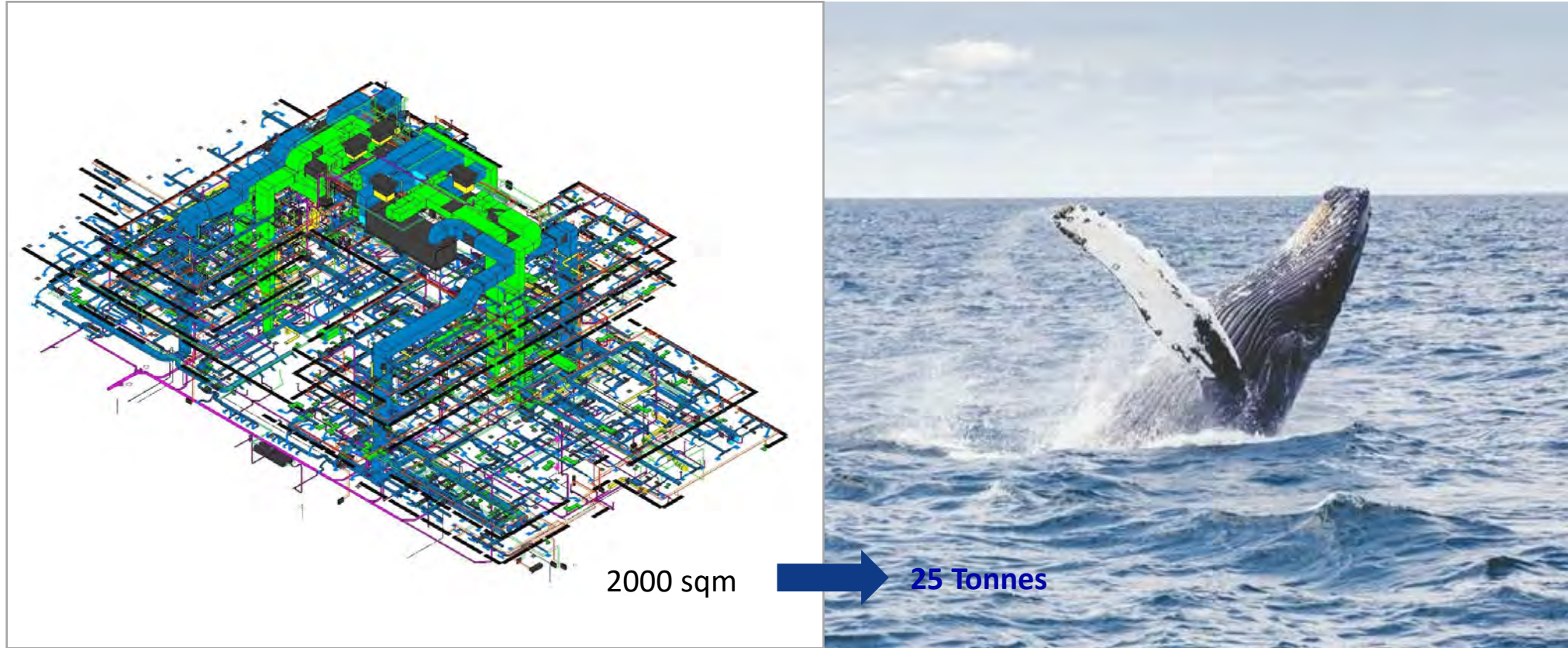


Source: LETI Embodied Carbon Primer, 2020

How it is Low Carbon in aspects most don't even consider



# How it is Low Carbon in aspects most don't even consider

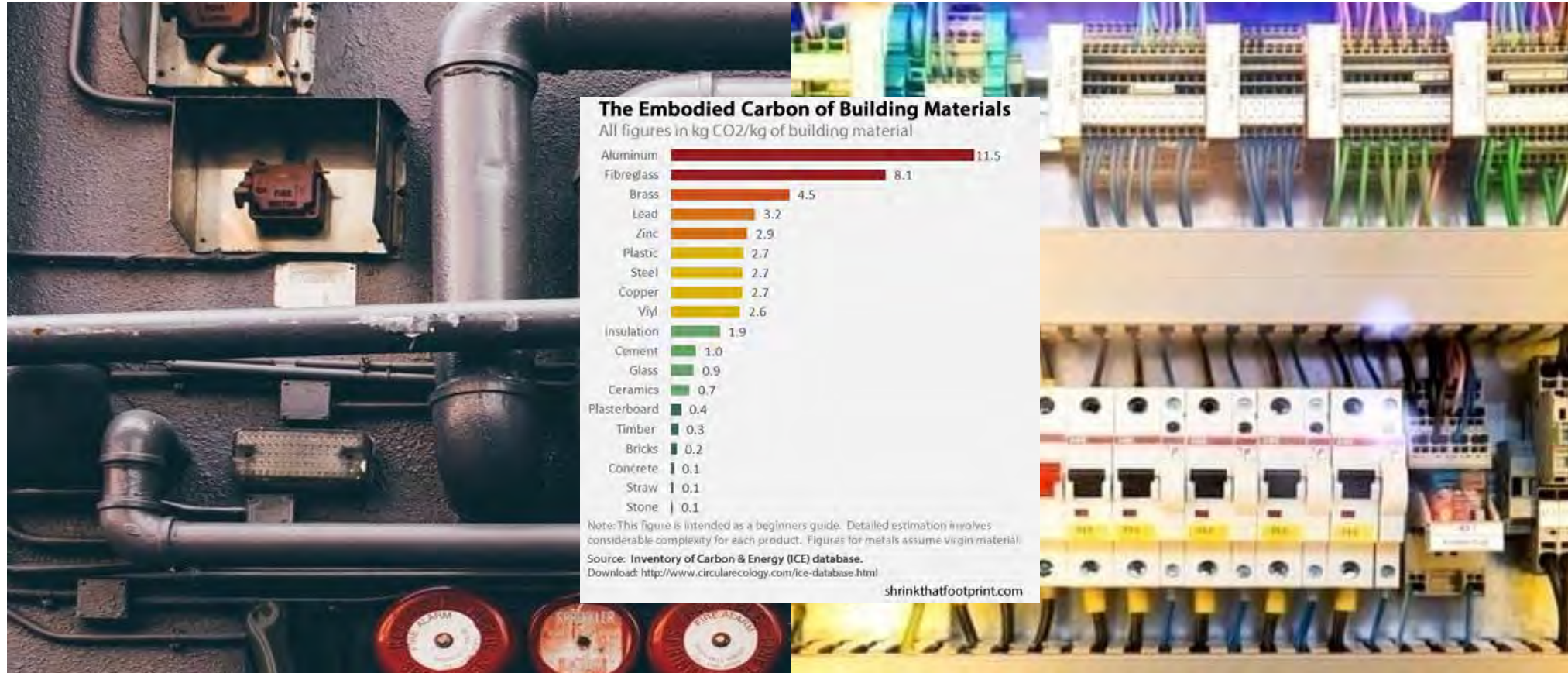


# How it is Low Carbon in aspects most don't even consider



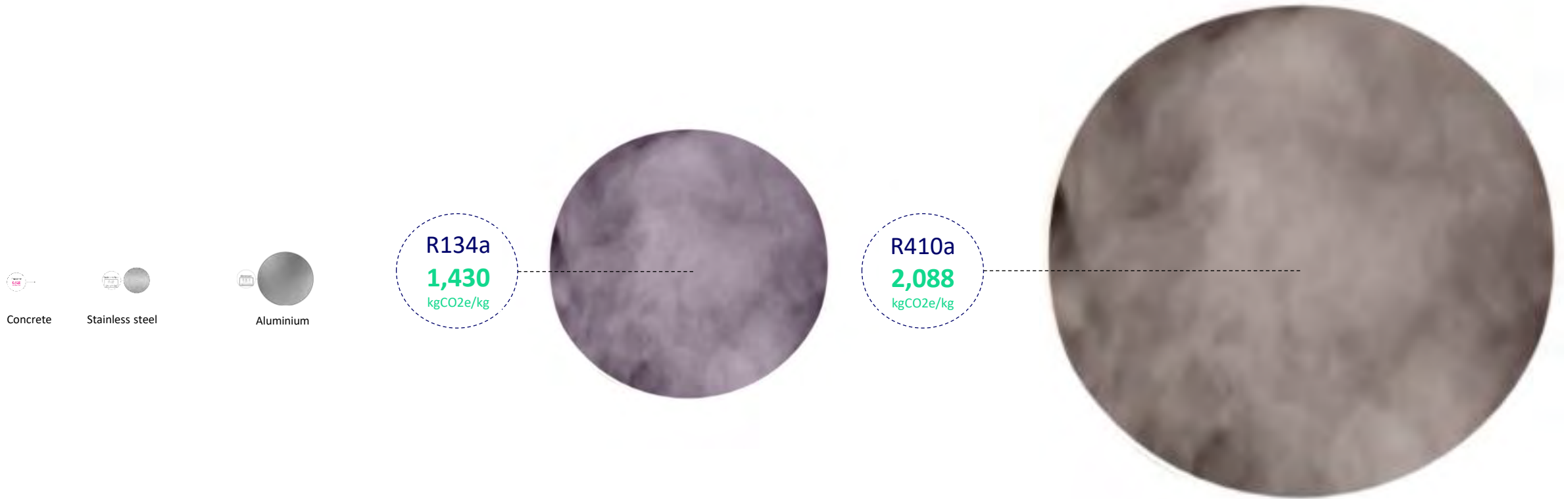
<b>SKIN</b>	<b>20 years</b>
<b>STRUCTURE</b>	<b>30 - 300 years</b>
<b>FITTINGS</b>	<b>1 day to ..</b>
<b>INTERIOR</b>	<b>3 - 30 years</b>
<b>SERVICES</b>	<b>5 - 20 years</b>
<b>SITE</b>	<b>Eternal</b>

# How it is Low Carbon in aspects most don't even consider

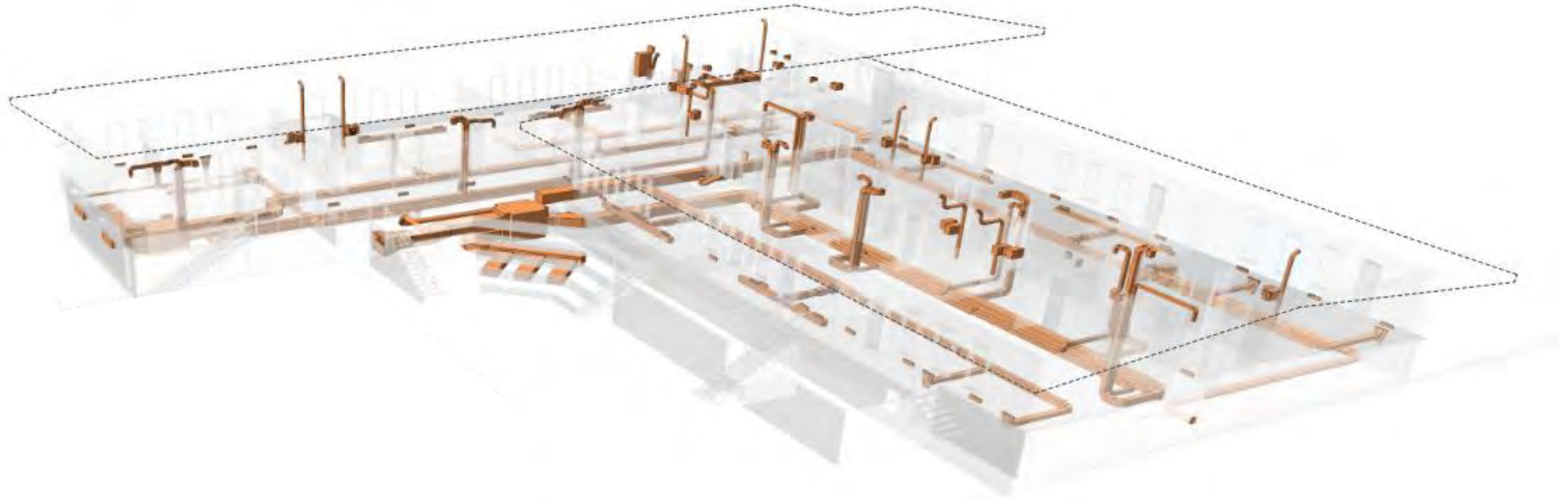




# How it is Low Carbon in aspects most don't even consider



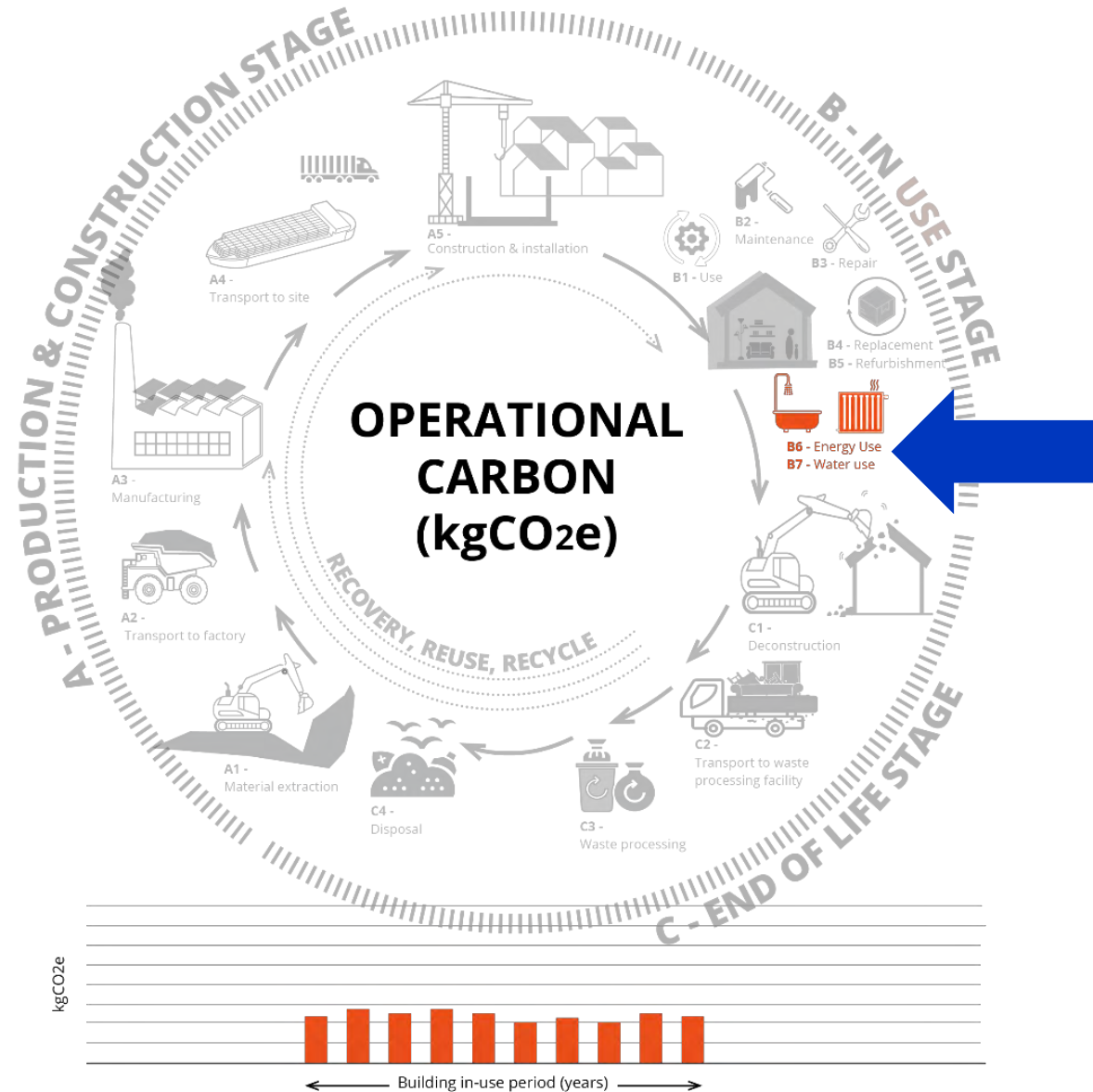
# How it is Low Carbon in aspects most don't even consider



# Reducing Operational impacts beyond energy

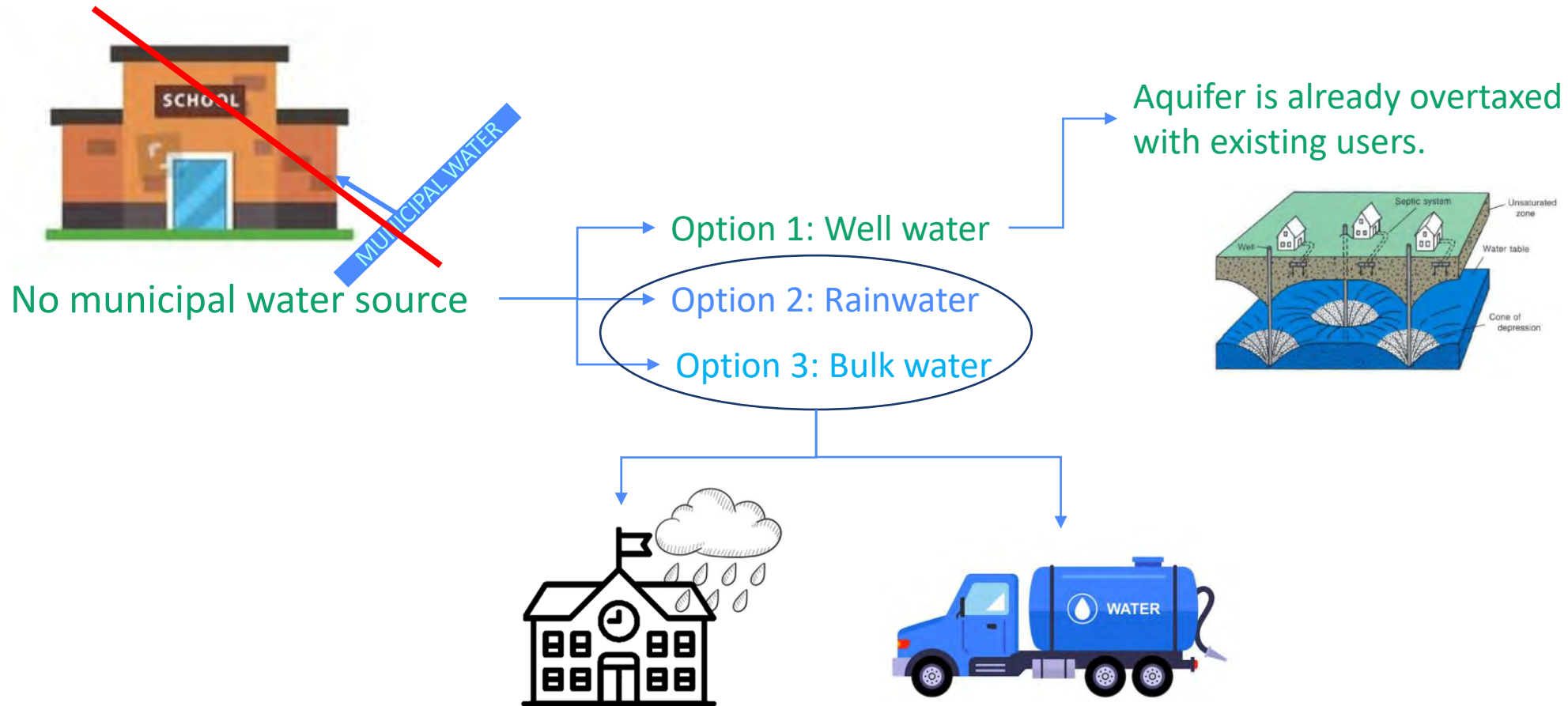
Carbon emissions associated with energy and **water** use during a building lifetime.

Note: While uncommon in North America, Module B7 is accounted for in LCA's under the Australian *Green Star* program



# Reducing Operational impacts beyond energy

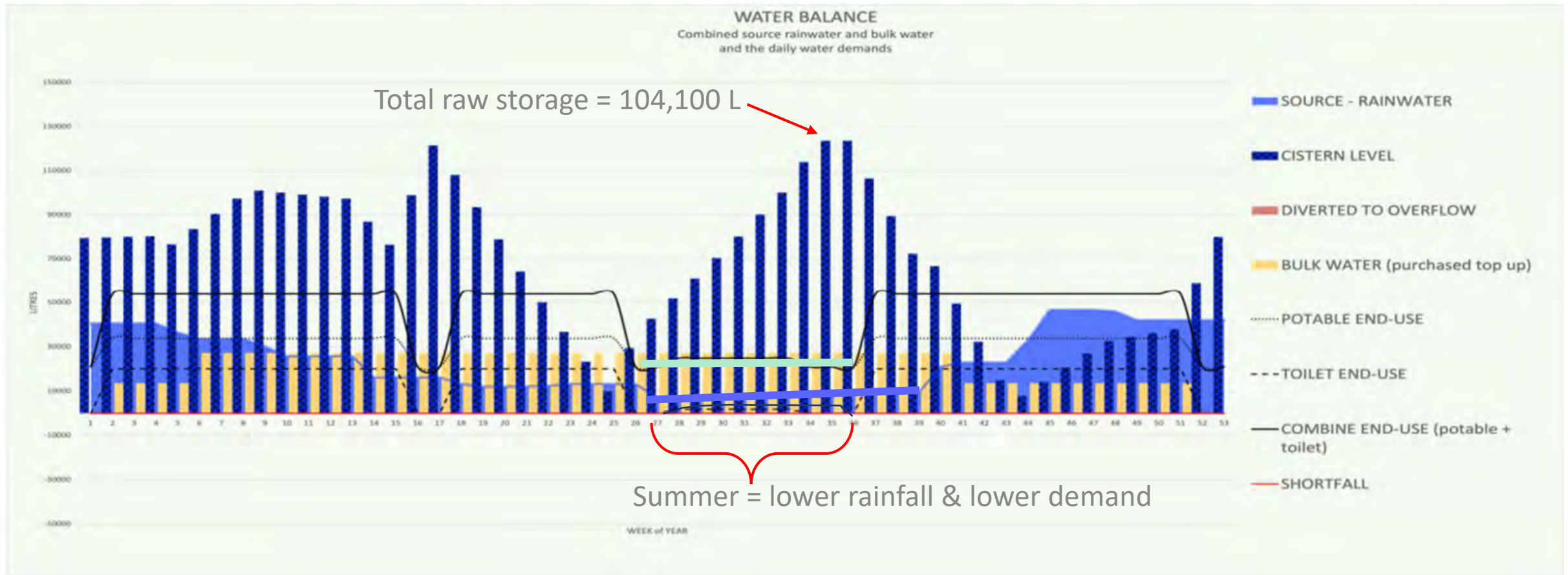
## RAINWATER FOR POTABLE USE – WHY?



# Reducing Operational impacts beyond energy

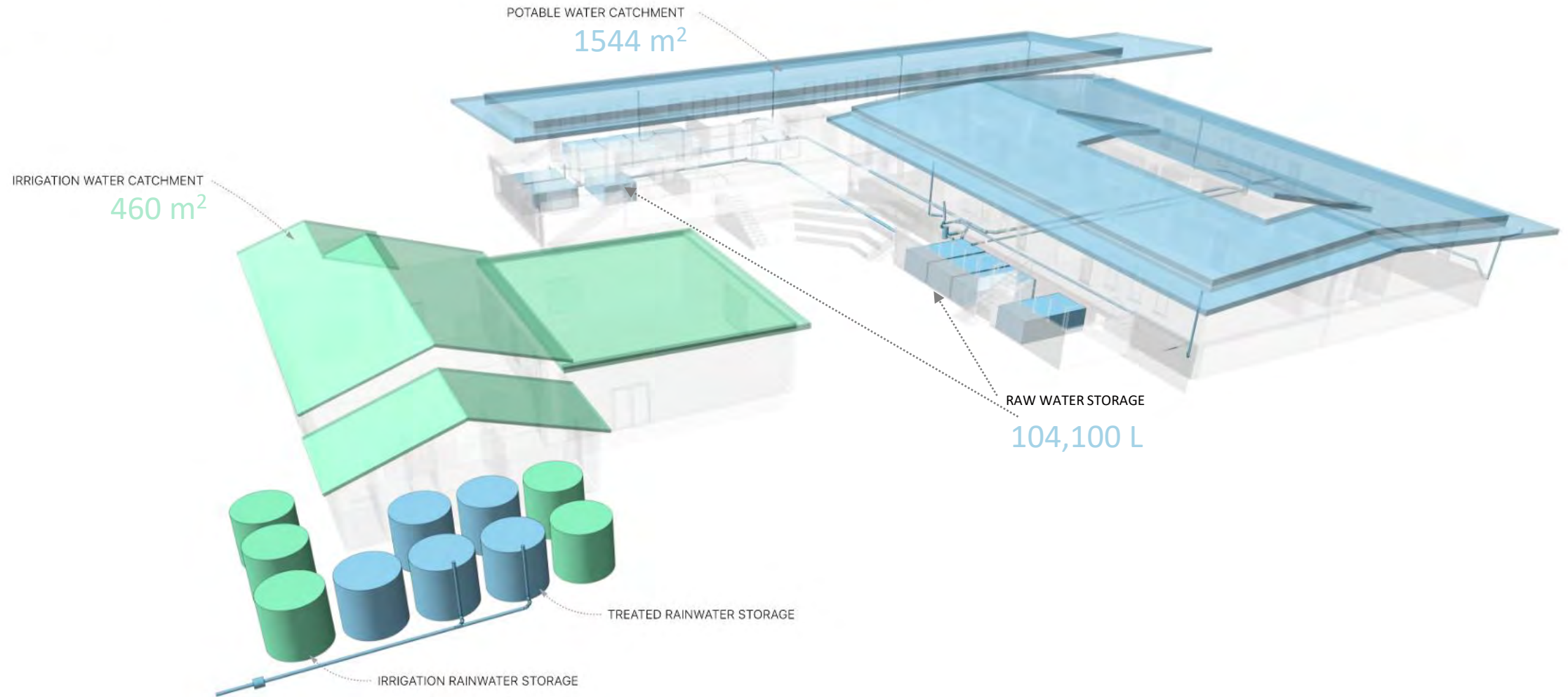
## RAINWATER CATCHMENT – WHY IT FITS WITH A SCHOOL WATER USE

Figure 2 Water Balance Graph – combined rainwater & bulk delivery matched to combined end-use demands (toilet flushing and potable)



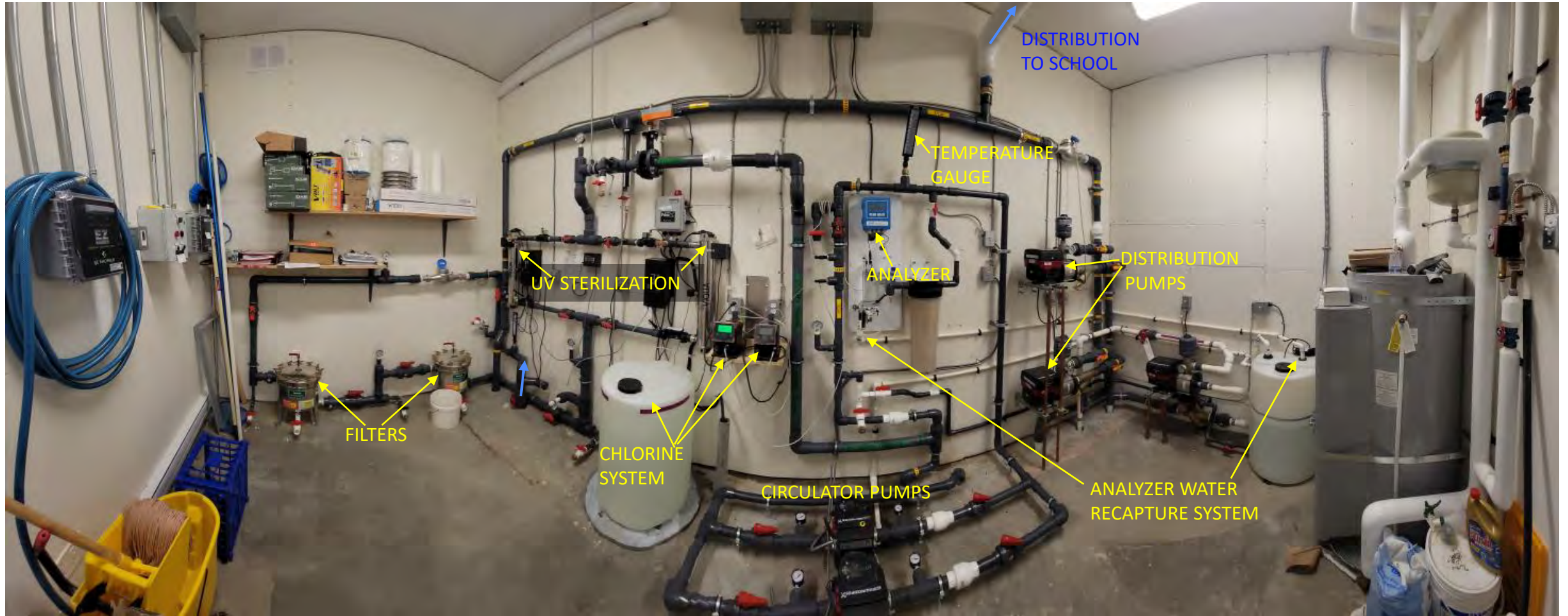
# Reducing Operational impacts beyond energy

## RAINWATER CATCHMENT - POTABLE AND NON-POTABLE WATER SYSTEM



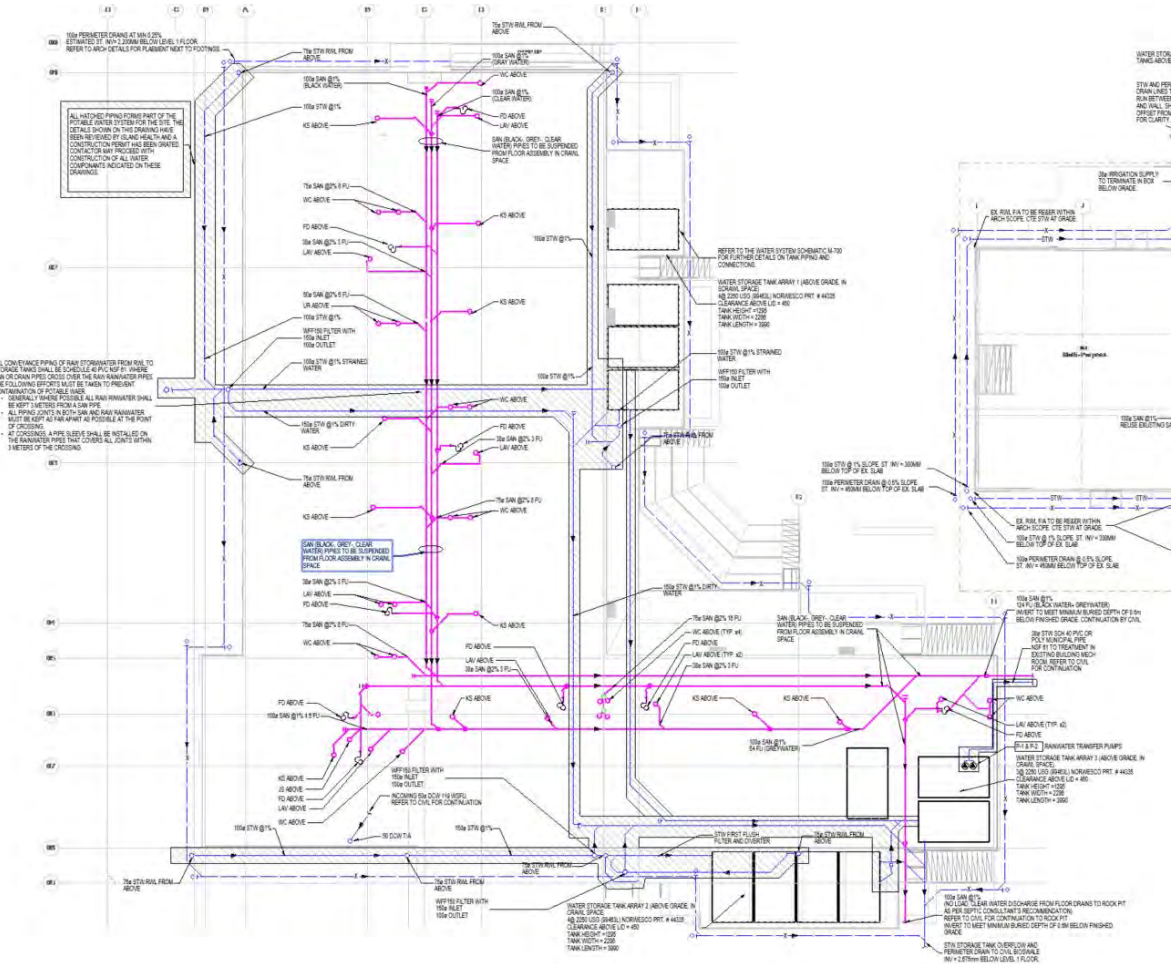
# Reducing Operational impacts beyond energy

## RAINWATER - TREATMENT



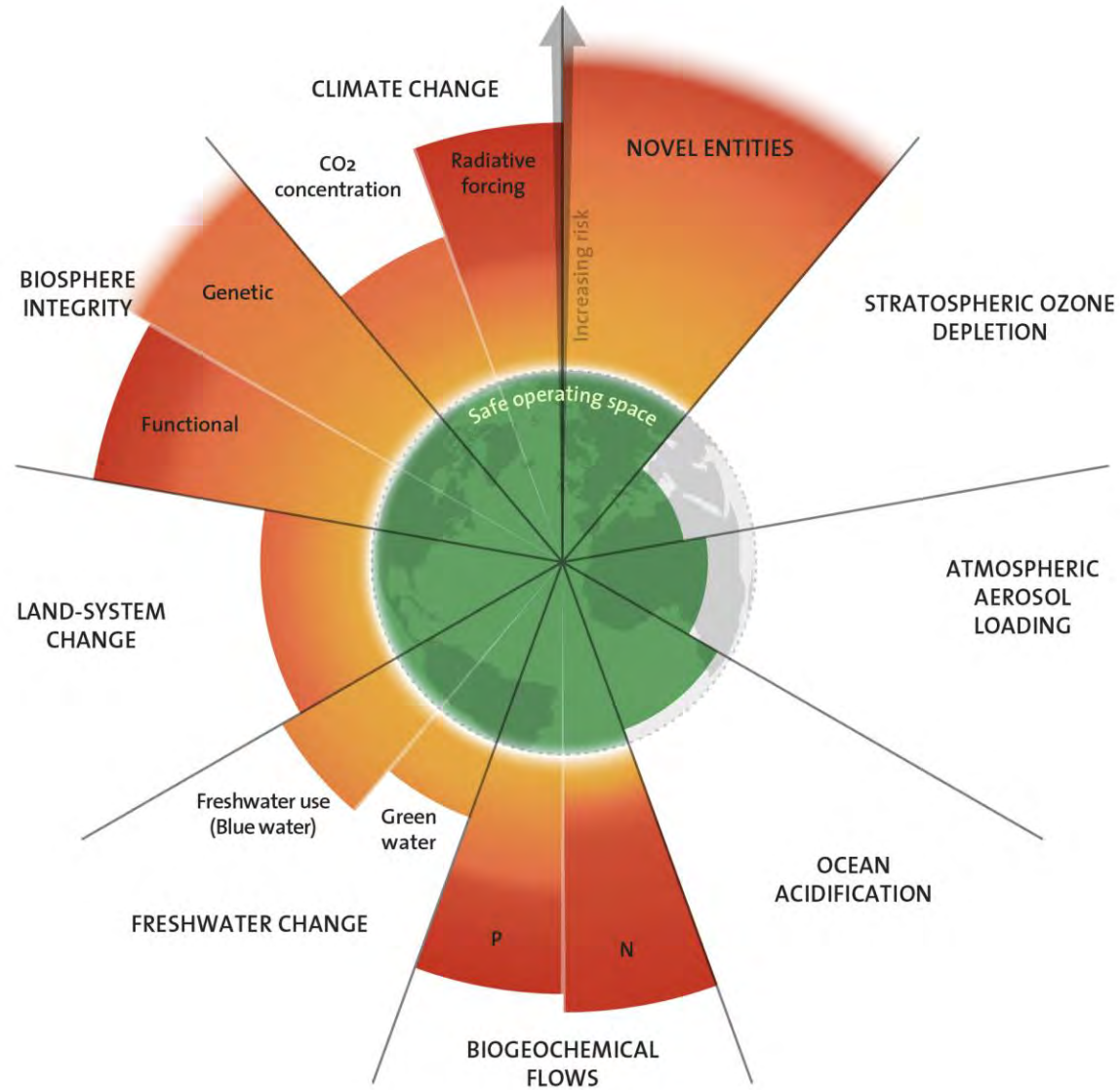
# Reducing Operational impacts beyond energy

## GREYWATER READY

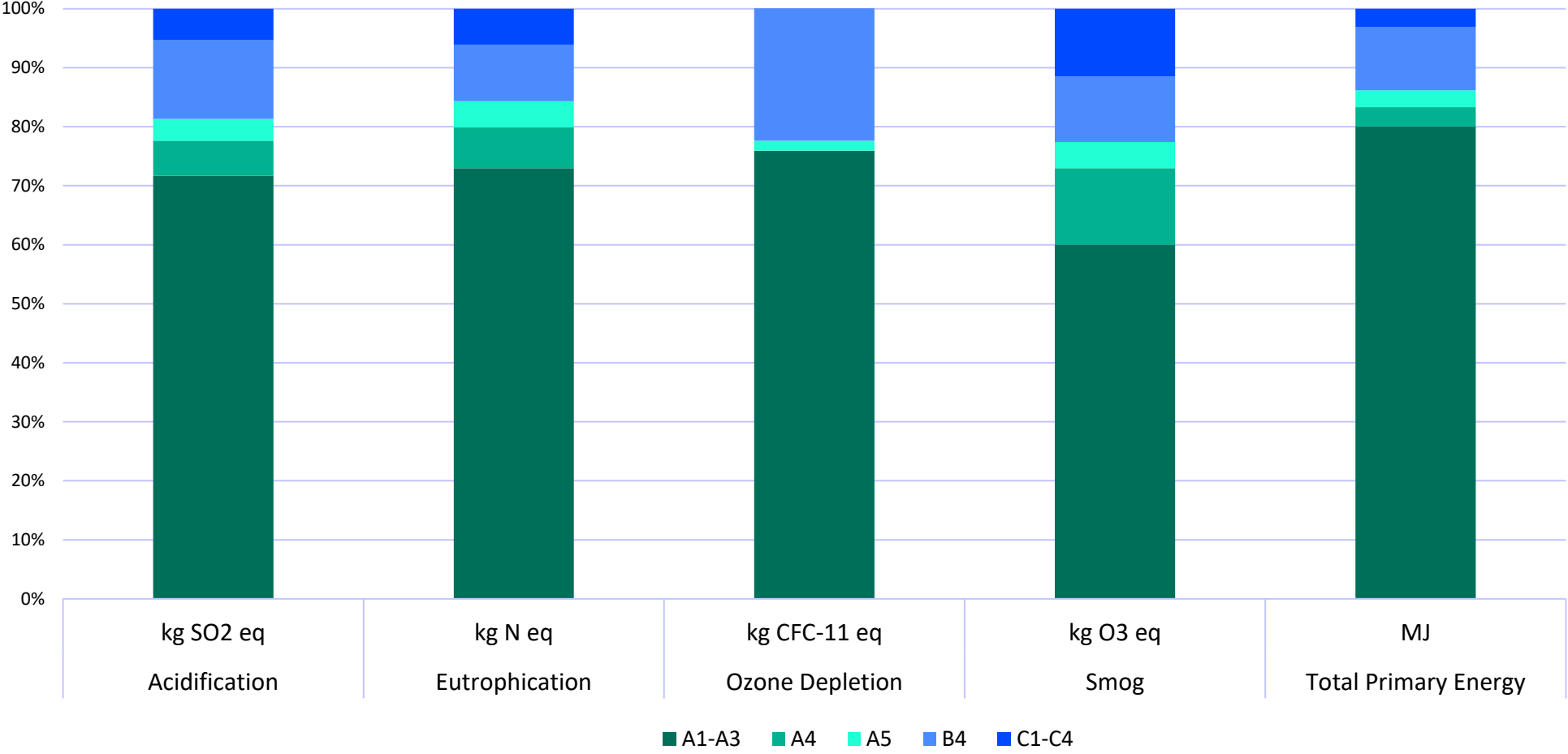




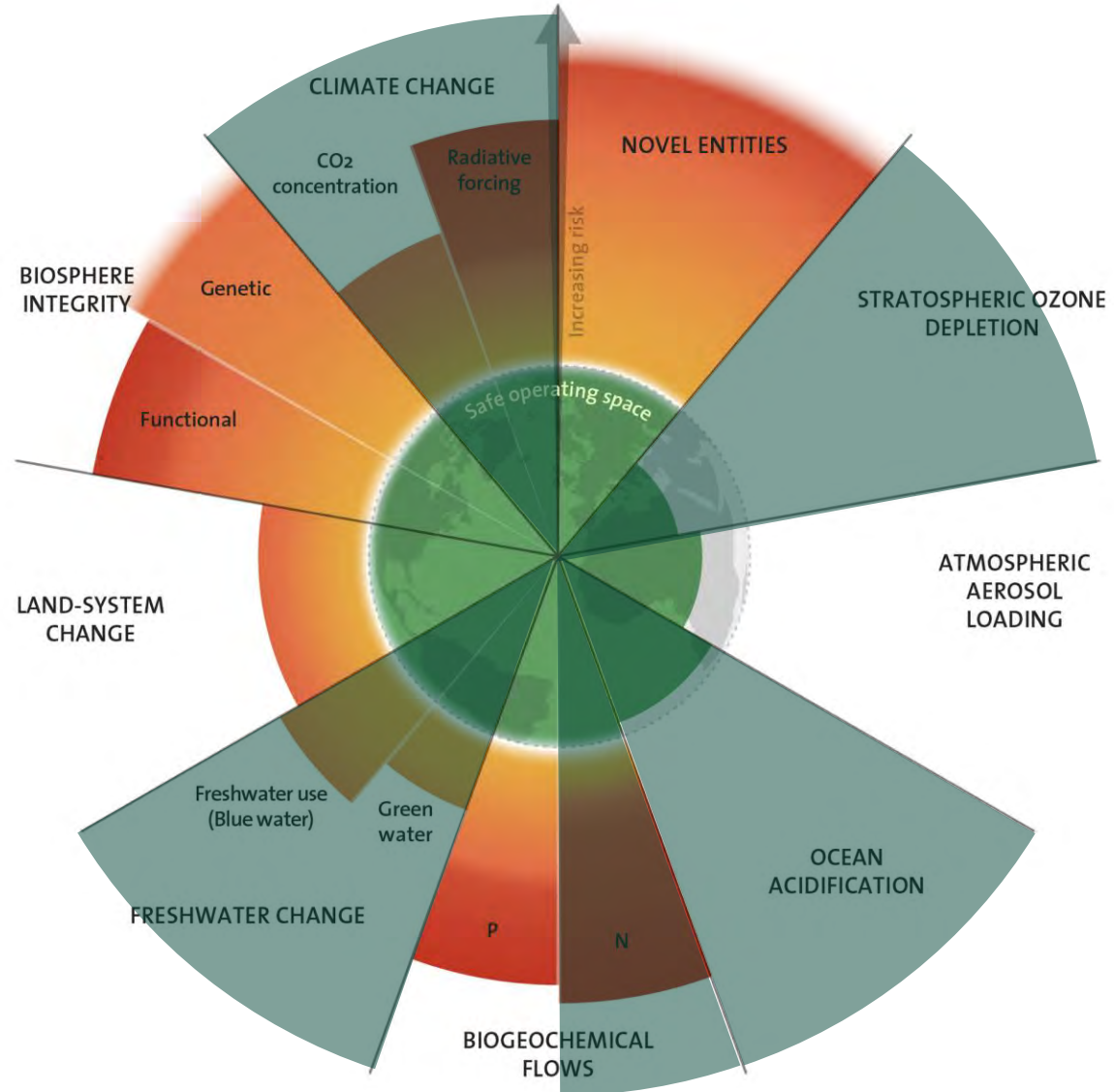
# Beyond Carbon



# Beyond Carbon



# Beyond Carbon





Q+A



Carbon  
Leadership  
Forum  
**British  
Columbia**

# Q&A



Carbon  
Leadership  
Forum

Vancouver

**Next Event**

**BUILDEX  
Presentations & Social Event**

**Wednesday, Feb. 14<sup>th</sup>**