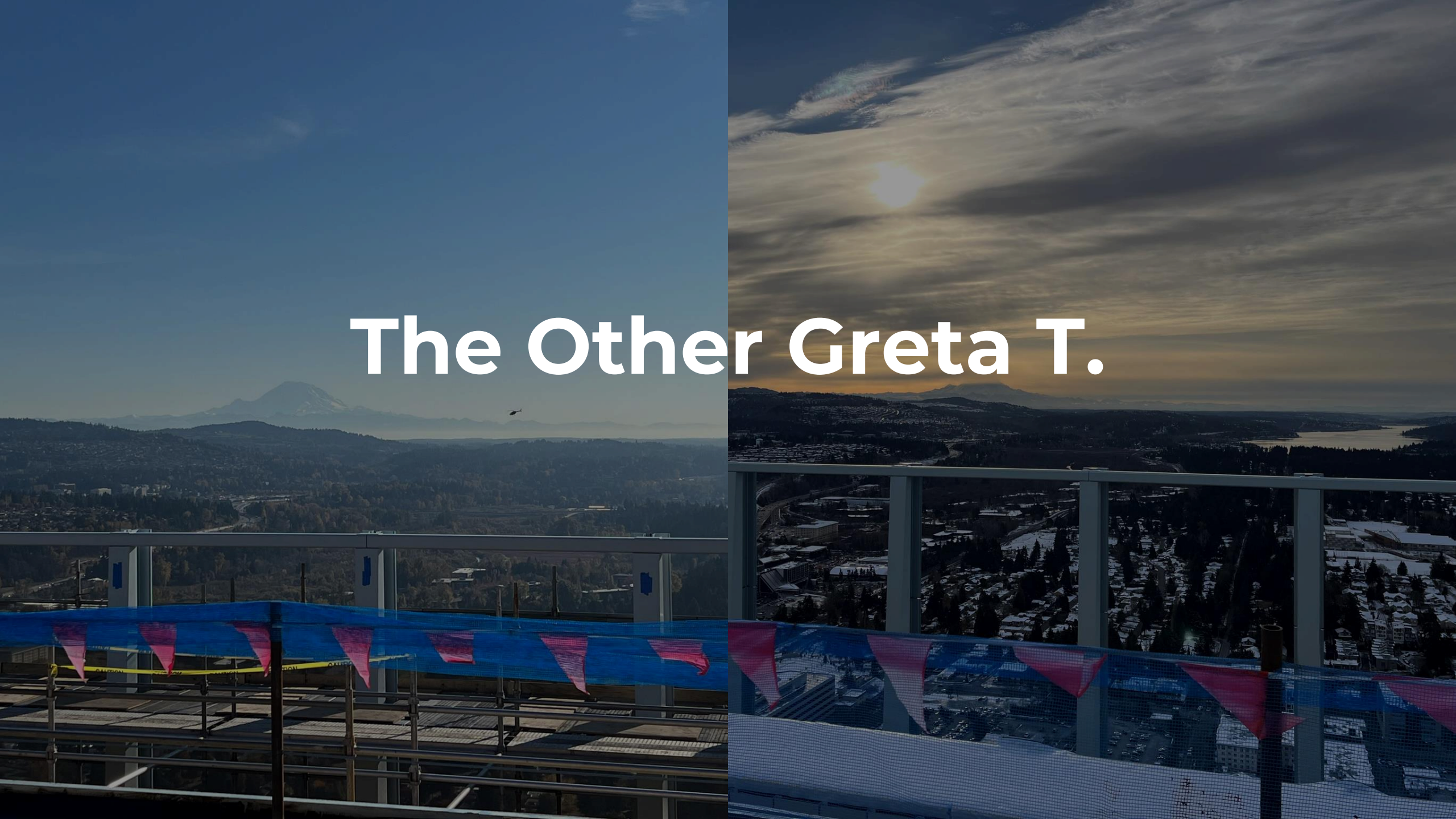


# Optimizing Indoor Environments: Strategies and Configurations for Ventilation and Air Barrier Testing in Multifamily and Commercial Buildings

Greta Tjeltveit, 4EA Building Science



# The Other Greta T.





# Considerations in Greater Seattle

An aerial photograph of Greater Seattle, Washington, showing the city skyline, the waterfront, and the surrounding mountains. The image is used as a background for the text.

- **Area becoming less of a “moderate” climate**
- **Wildfire smoke events**
- **Affordability**
- **Mold/moisture**

# Outline

- **Air Barrier Testing Strategies**
  - Utilizing mechanical closets and balanced ventilation ductwork
  - Linking “zones” via jump ducts
- **Balanced Ventilation Configurations**
  - Centralized, building wings with vertical stacks
  - Hybrid of centralized, horizontal (floor-by-floor) zones and unitized (individual units) systems

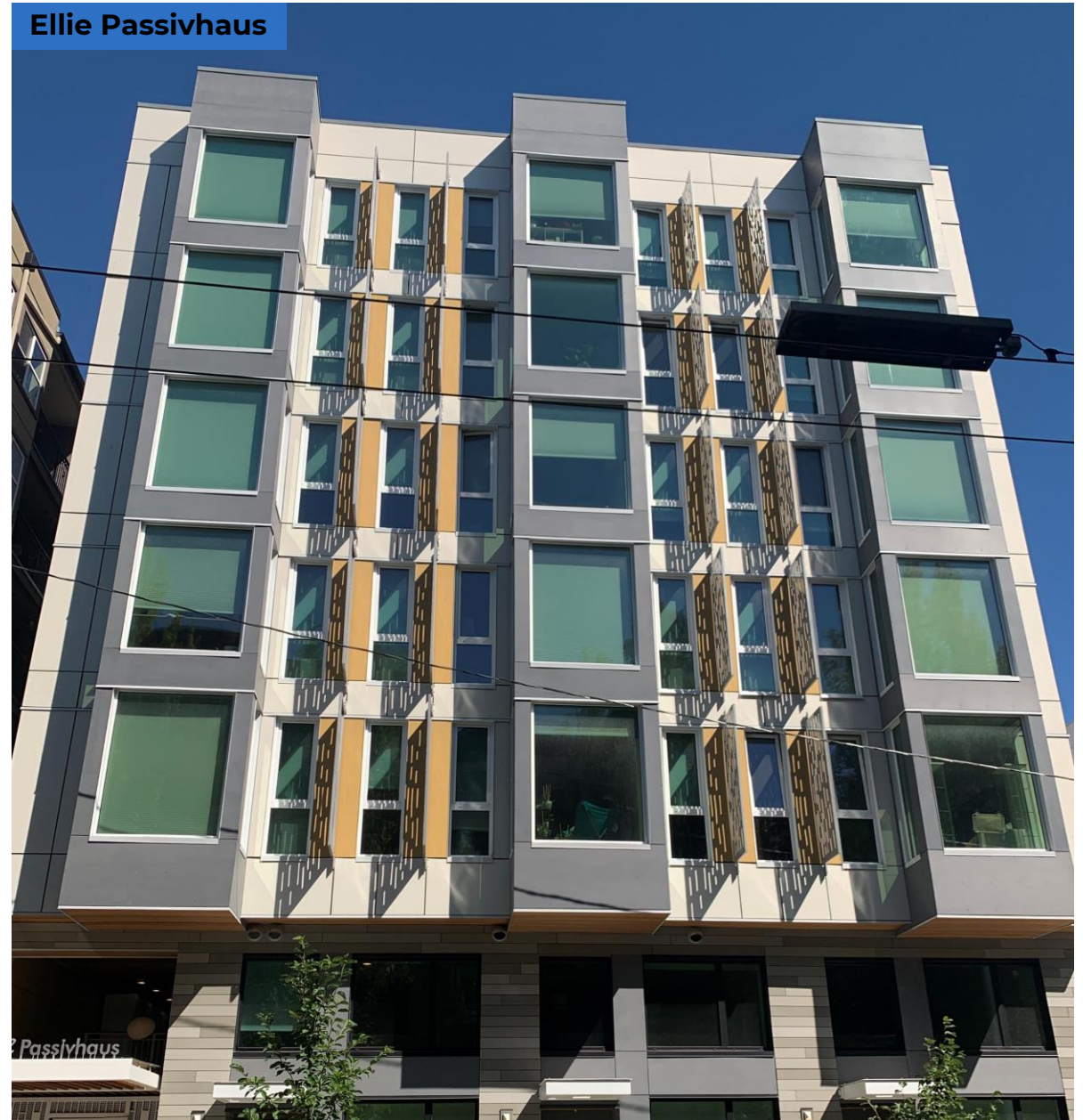




**Pax Futura**



**Ellie Passivhaus**



**Hobson Place South**





# Pax Futura

Owner: 3700 Hudson LLC

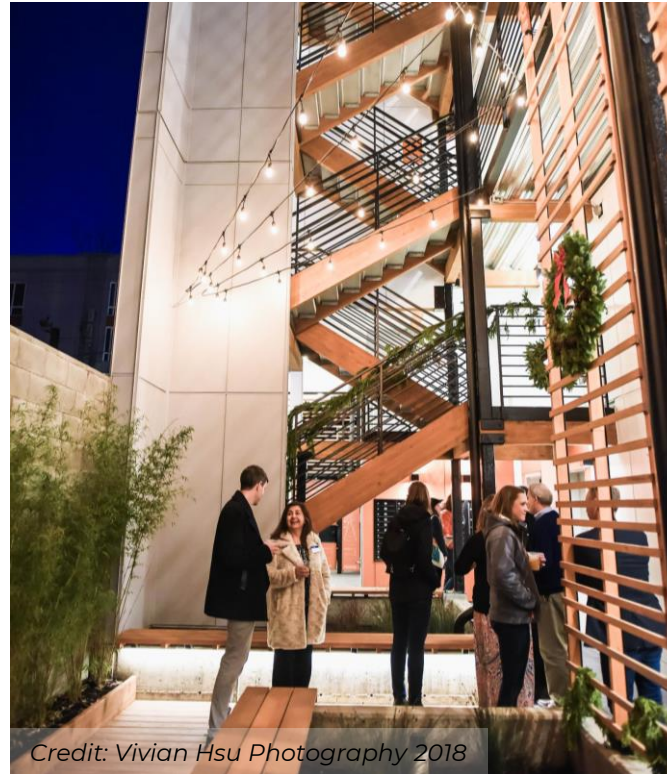
Architect: NK Architects

Mechanical Engineer: Staengl Engineering

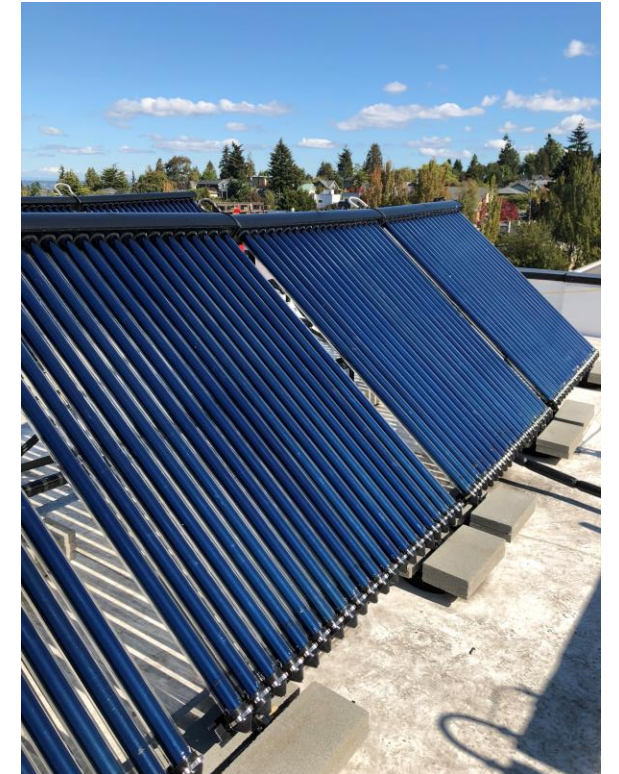
General Contractor: Cascade Built



Credit: Vivian Hsu Photography 2018



Credit: Vivian Hsu Photography 2018





# Building Enclosure

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# Building Layout

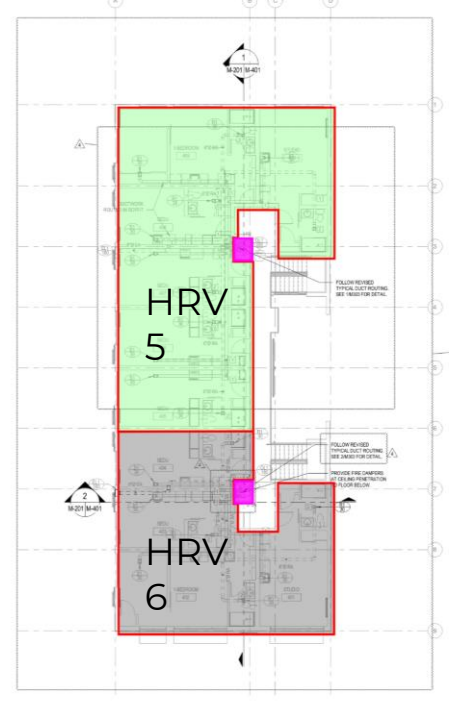
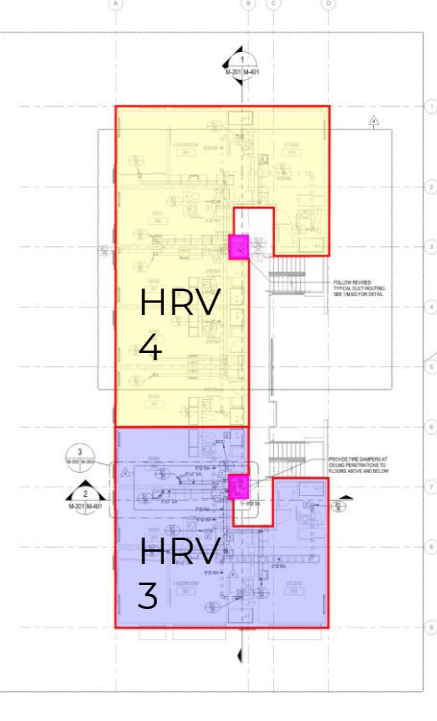
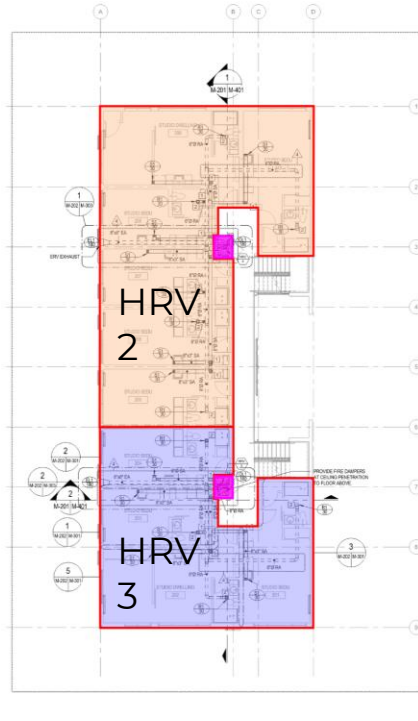
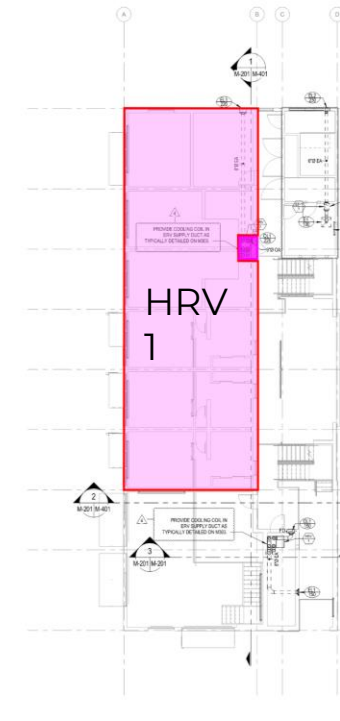
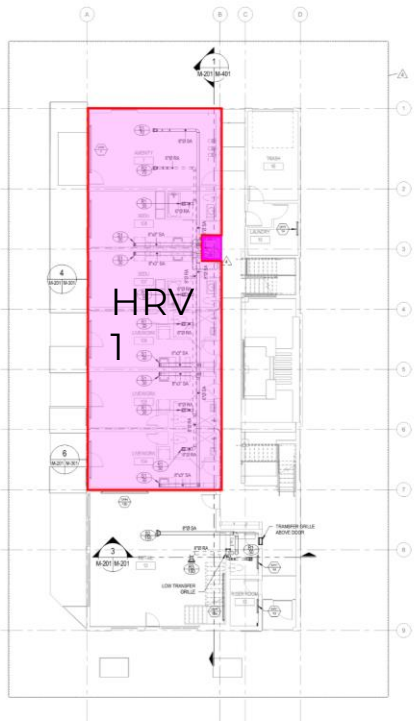
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*Credit: Vivian Hsu Photography 2018*







1  
LEVEL 1 MECHANICAL PLAN  
SCALE: 1/8" = 1'-0"

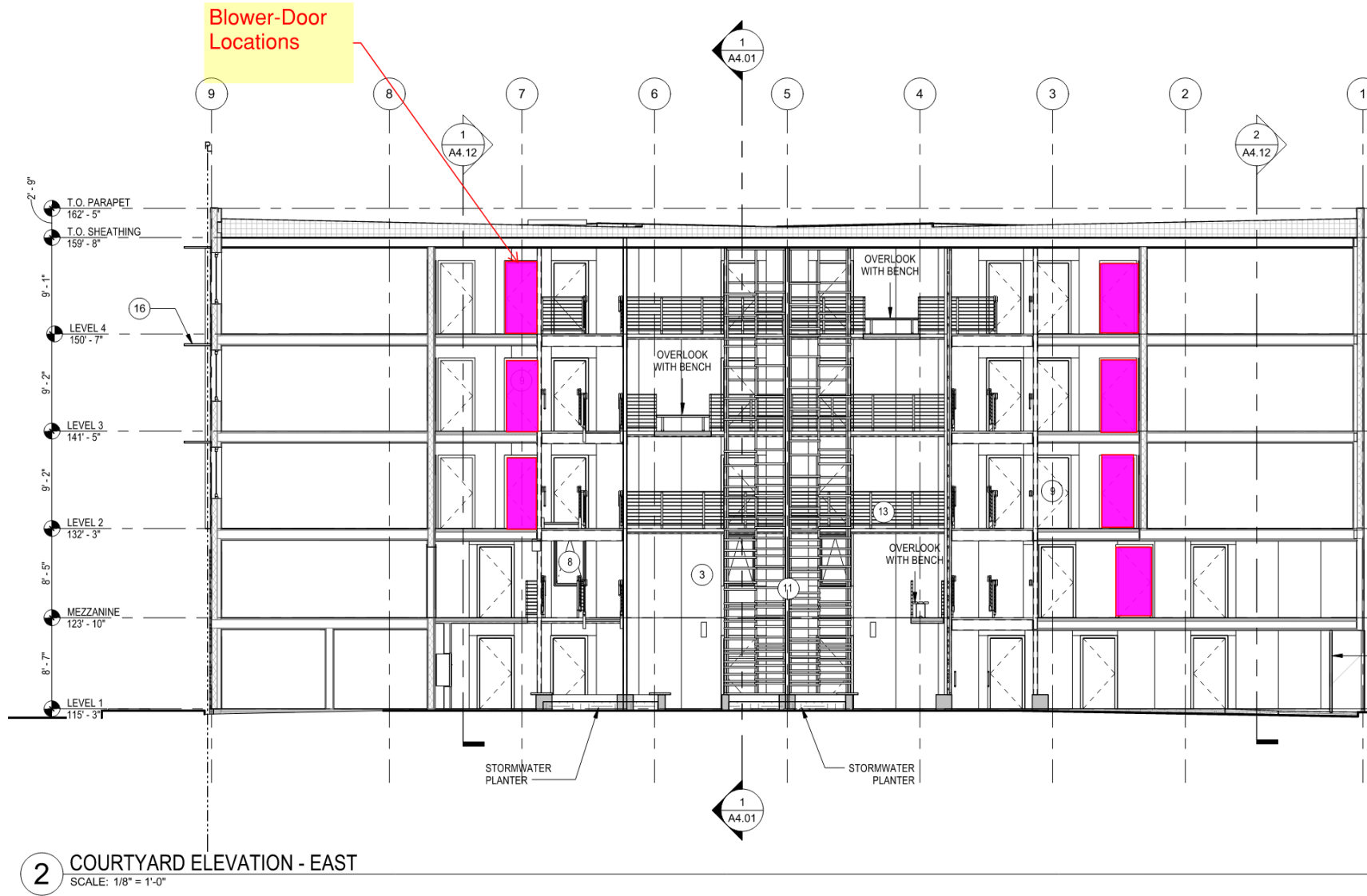
2  
MEZZANINE MECHANICAL PLAN  
SCALE: 1/8" = 1'-0"

1  
LEVEL 2 MECHANICAL PLAN  
SCALE: 1/8" = 1'-0"

2  
LEVEL 3 MECHANICAL PLAN  
SCALE: 1/8" = 1'-0"

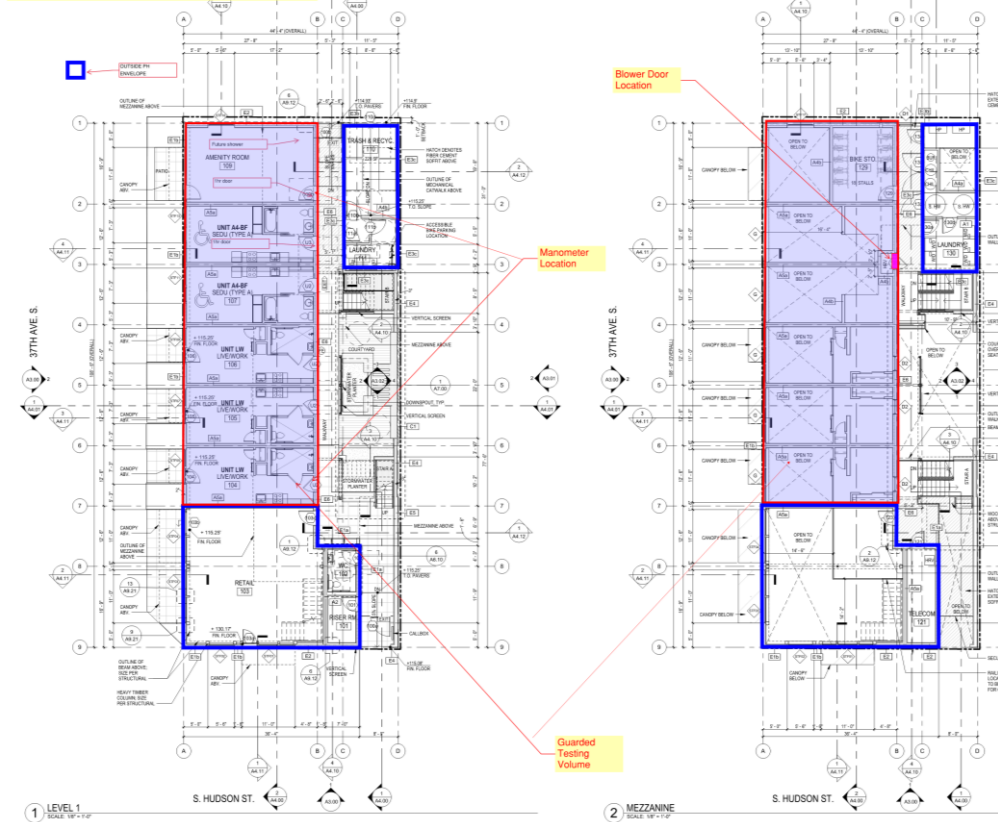
1  
LEVEL 4 MECHANICAL PLAN  
SCALE: 1/8" = 1'-0"



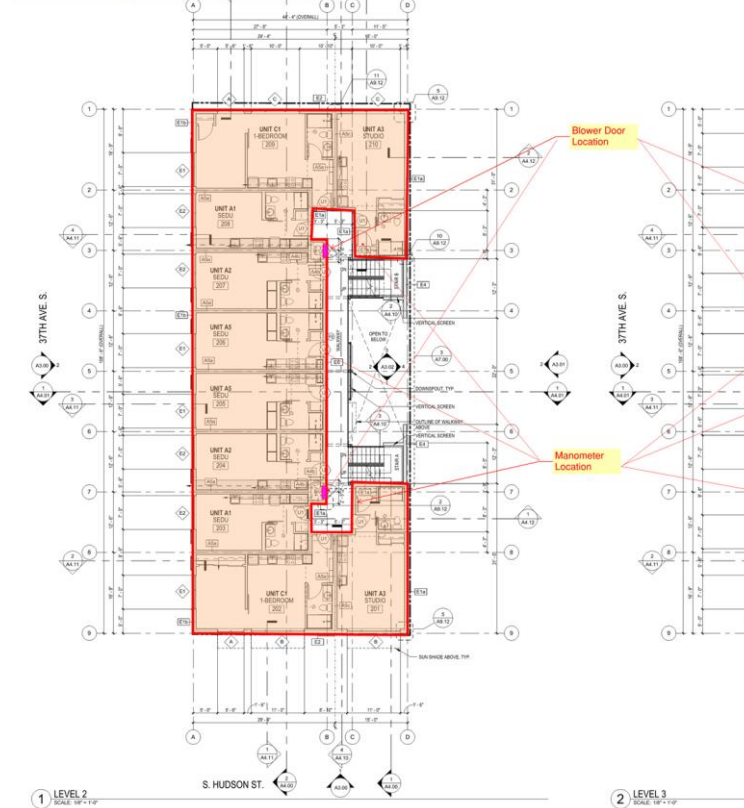




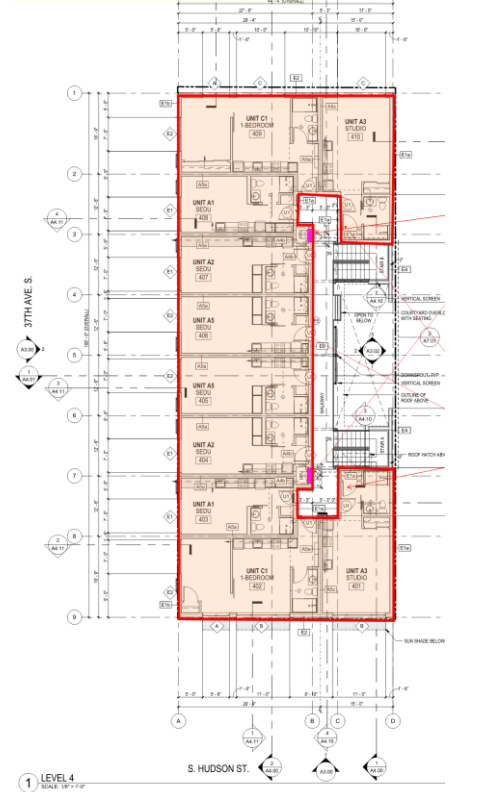
Test #1 September 12, 2018



Test #1 September 12, 2018

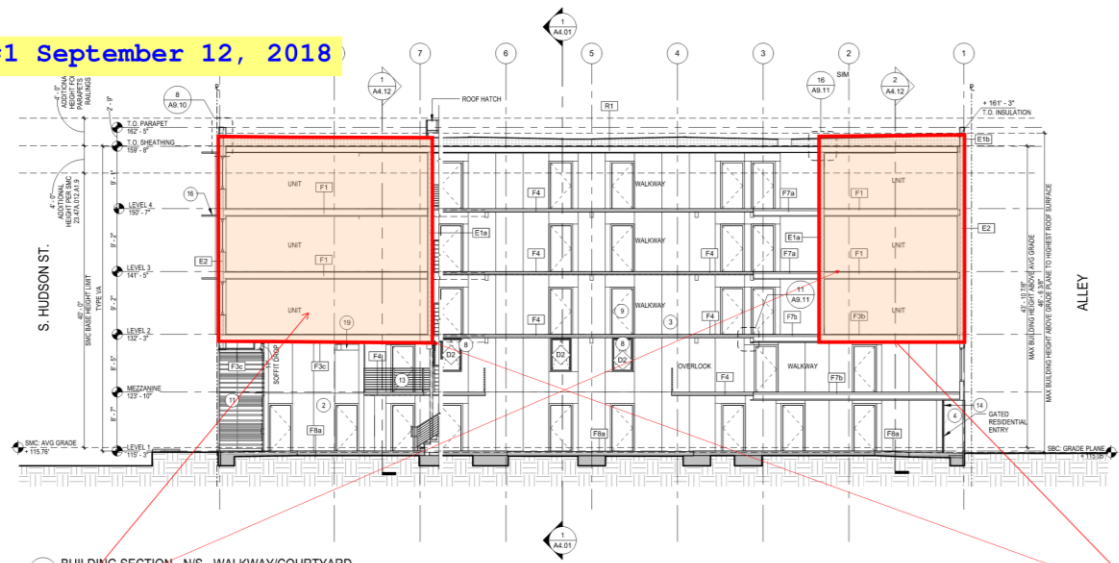


Test #1 September 12, 2018

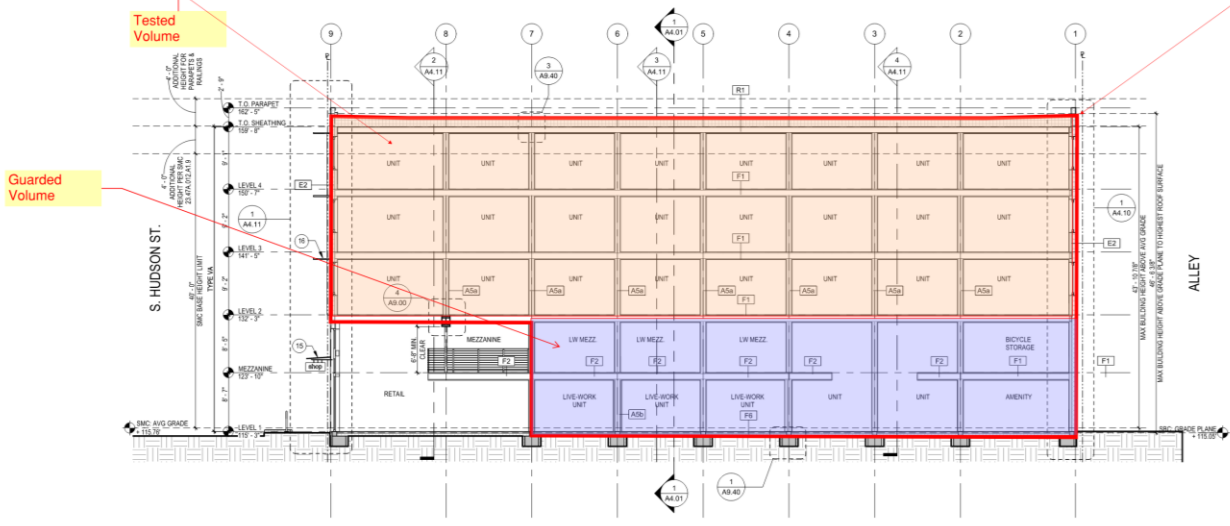




Test #1 September 12, 2018



1 BUILDING SECTION - N/S - WALKWAY/COURTYARD  
SCALE: 1/8" = 1'-0"



2 BUILDING SECTION - N/S - AMENITY/RETAIL/UNITS  
SCALE: 1/8" = 1'-0"

3 PARTIAL SECTI  
SCALE: 1/8" = 1'-0"

Pressure Boundary

Tested Volume

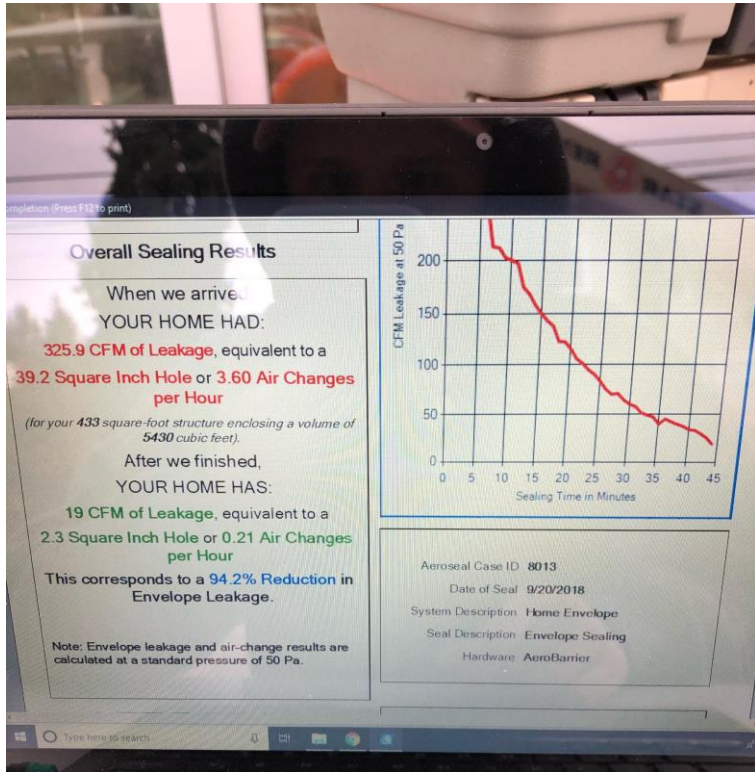
Guarded Volume



# Final Testing Part I

0.0534 cfm/sqft at 50Pa

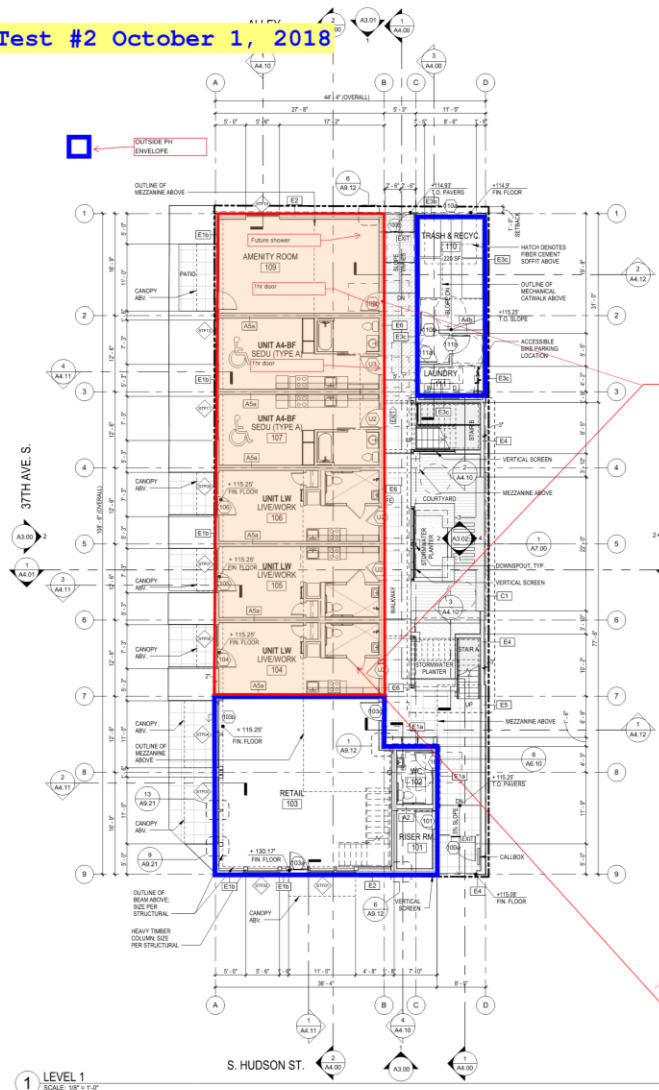




# Air Sealing of L1/Mezzanine



Test #2 October 1, 2018

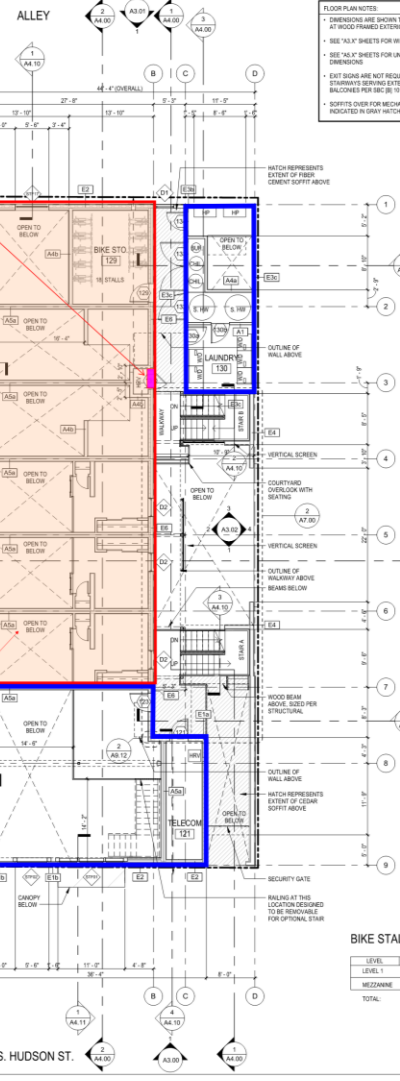


Blower Door Location

Manometer Location

Tested Volume

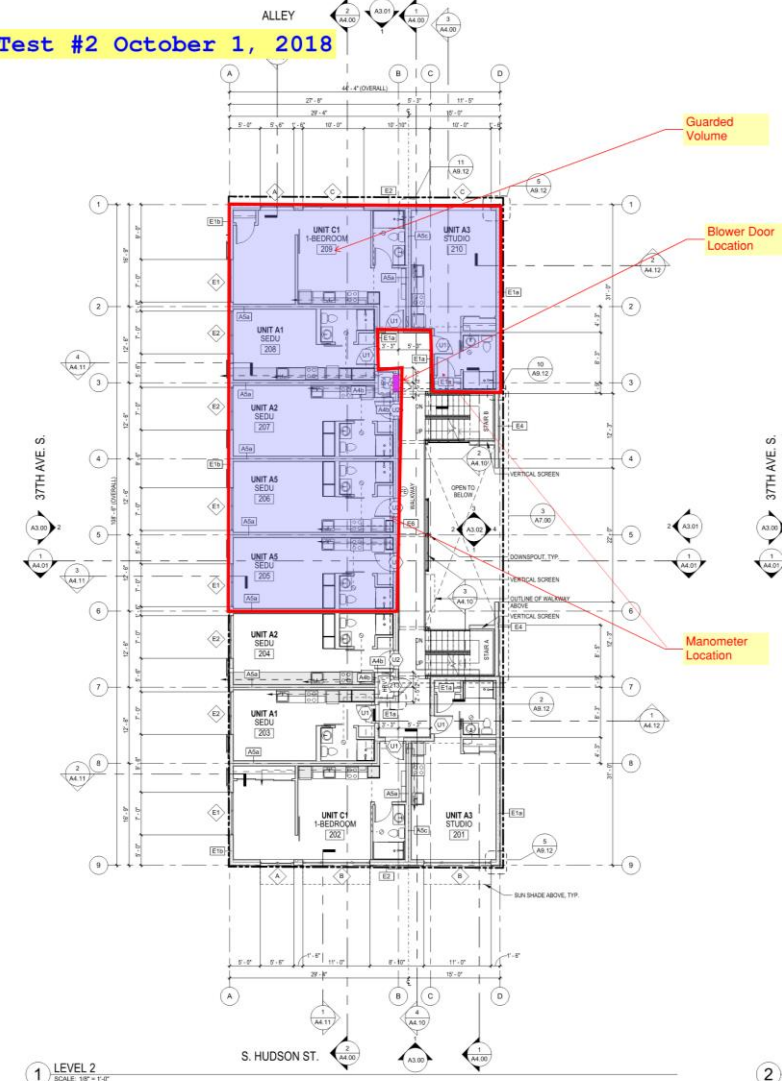
2 MEZZANINE SCALE: 1/8" = 1'-0"



FLOOR PLAN NOTES:  
 \* DIMENSIONS ARE SHOWN AT FLOOR FINISH EXTERIOR.  
 \* SEE "A&X" SHEETS FOR IRI  
 \* SEE "A&X" SHEETS FOR IRI DIMENSIONS  
 \* EAST SCALE ARE NOT IRI STAIRWAYS SERVING SITES BALCONIES PER IRI 08-11  
 \* SLOTTES OVER FOR MEDIA RELOCATED IN GRAY HATCH

LEVEL	LEVEL	MEZZANINE	TOTAL

Test #2 October 1, 2018



Guarded Volume

Blower Door Location

Manometer Location

2

# Final Testing Part II

0.0479 cfm/sqft at 50Pa







# Final Results

0.069 cfm/sqft at 75Pa

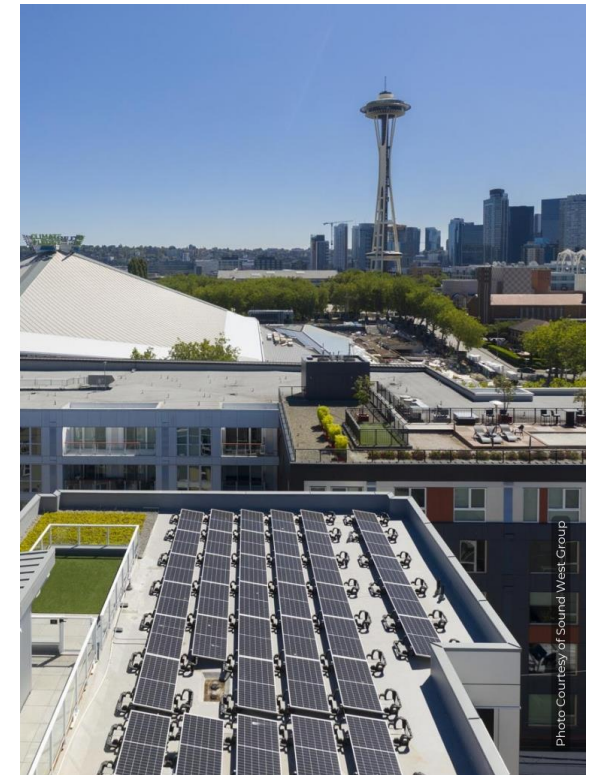
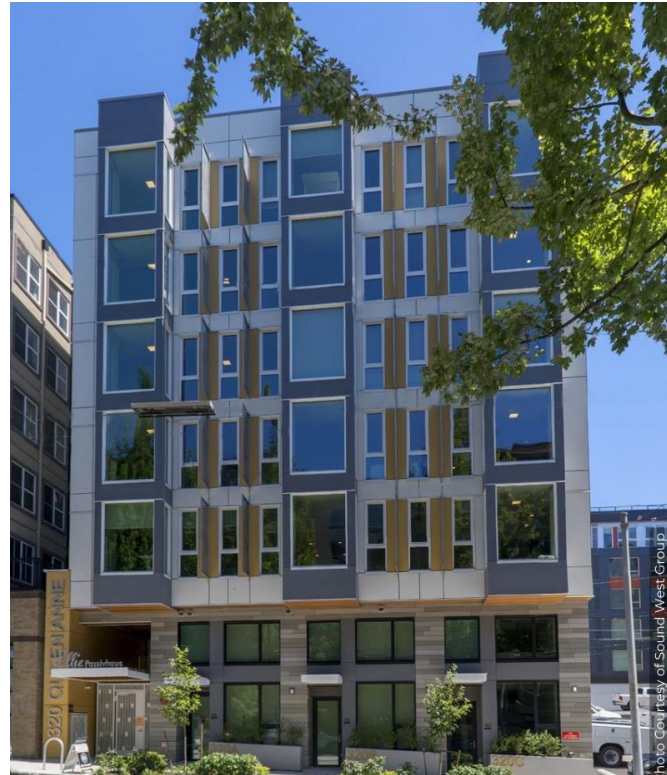
# Ellie Passivhaus

Owner/Developer: Sound West Group

Architect: NK Architects

Mechanical Engineer: Staengl Engineering

General Contractor: Cascade Built





# Building Enclosure

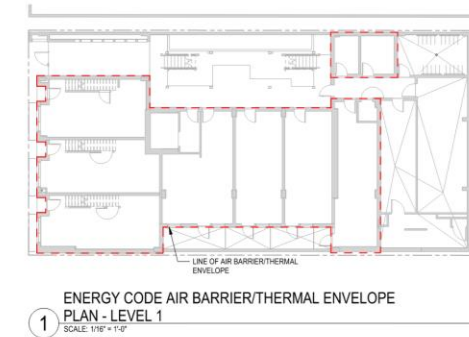
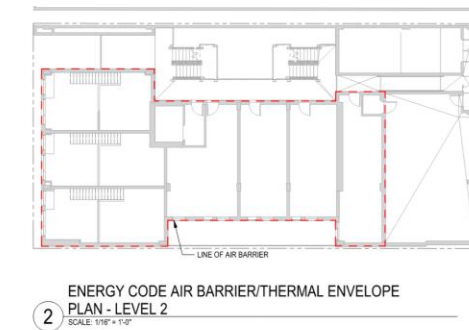
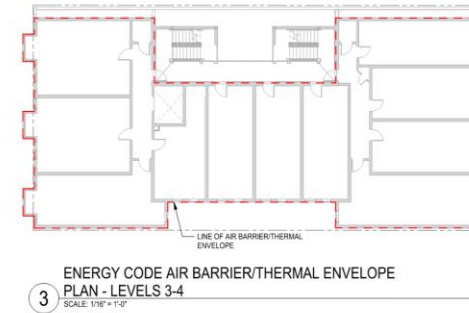
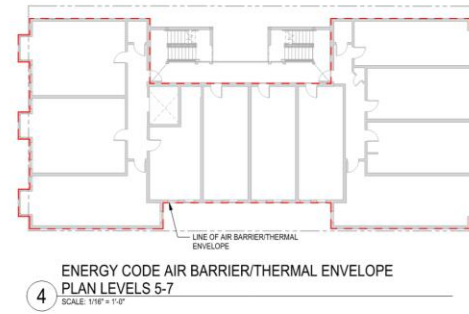
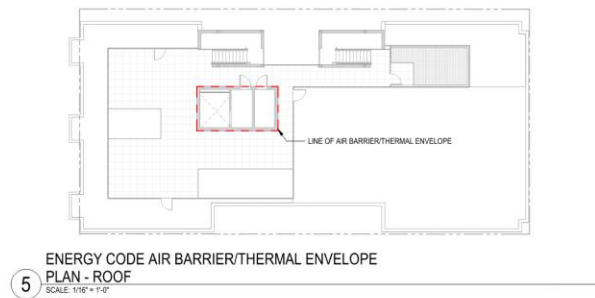
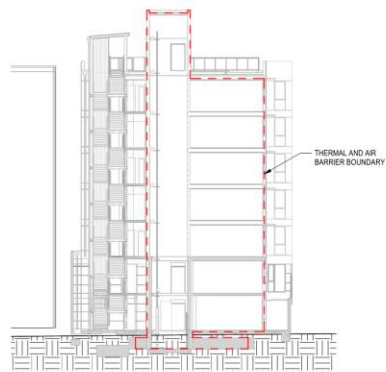
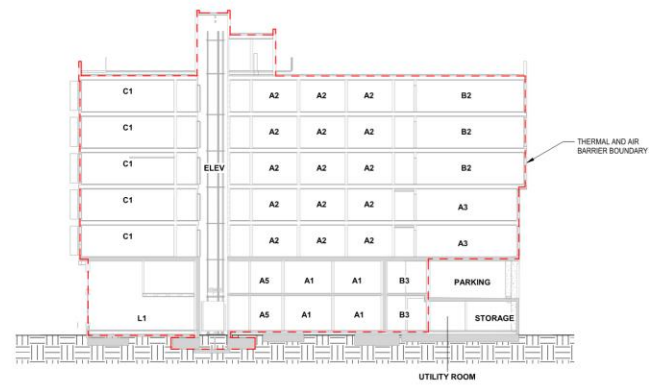
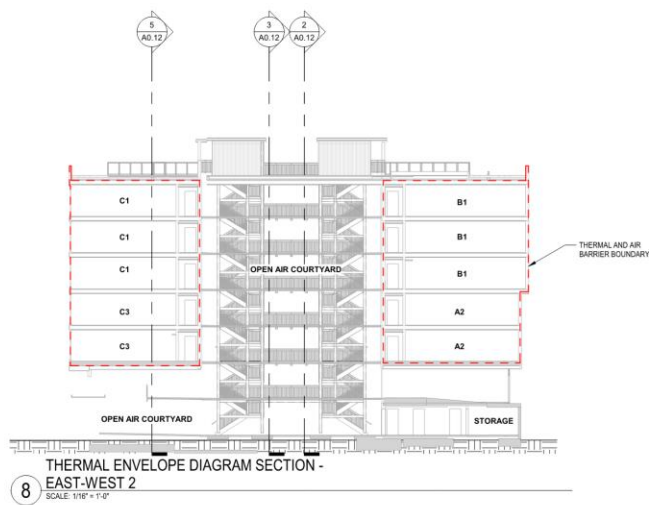
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AIR BARRIER AREA CALCULATIONS - ELEVATIONS	
ORIENTATION	AREA
EAST	8423 SF
NORTH	8574 SF
SOUTH	8752 SF
WEST	5482 SF
TOTAL	28031 SF

AIR BARRIER PLAN CALCS	
AREA	
TOTAL PLAN AREA	10629 SF

**TOTAL ENVELOPE AREA: 39,039 SF**

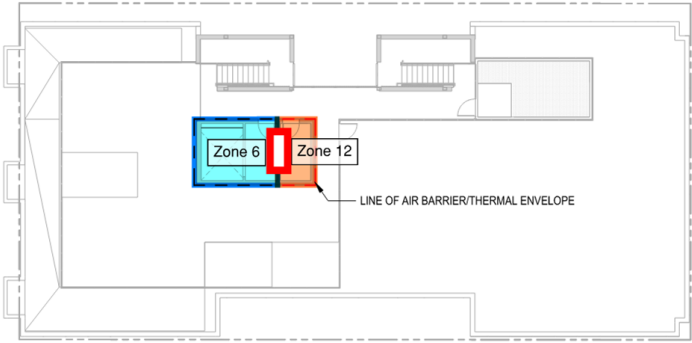




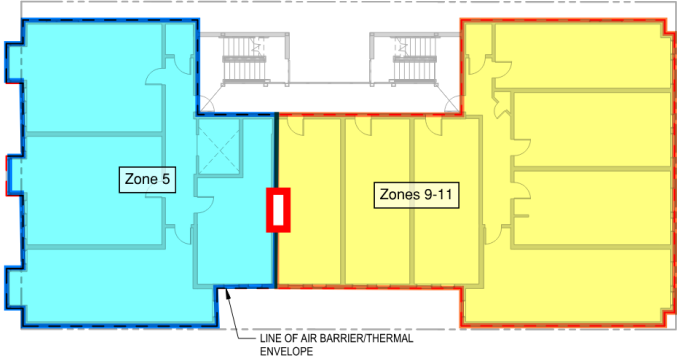
# Preliminary Test Set-Up

**Preliminary Air Barrier Test Set-Up:**  
 (Air distribution via HVAC ducts/openings,  
 elevator shaft & intentional openings)  
 Fans Required: 1

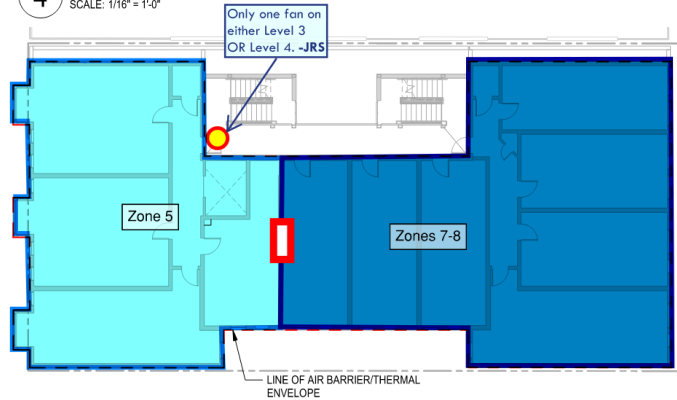
- Tested volume
- Intentional opening
- Test fan location



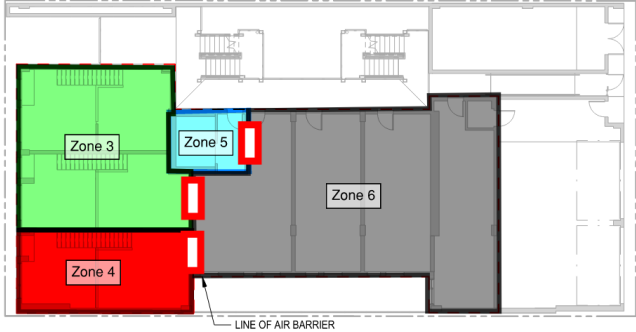
5 ENERGY CODE AIR BARRIER/THERMAL ENVELOPE  
 PLAN - ROOF  
 SCALE: 1/16" = 1'-0"



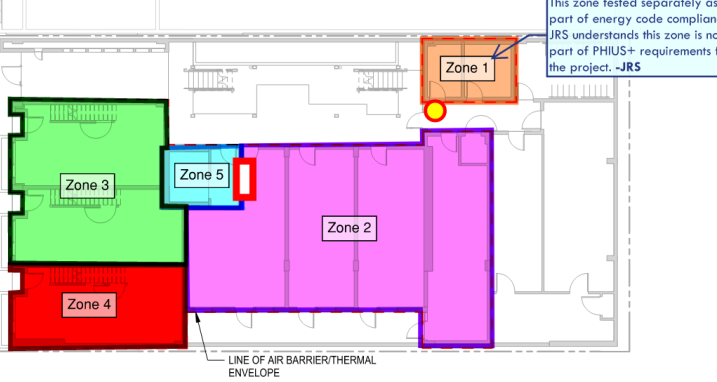
4 ENERGY CODE AIR BARRIER/THERMAL ENVELOPE  
 PLAN LEVELS 5-7  
 SCALE: 1/16" = 1'-0"



3 ENERGY CODE AIR BARRIER/THERMAL ENVELOPE  
 PLAN - LEVELS 3-4  
 SCALE: 1/16" = 1'-0"



2 ENERGY CODE AIR BARRIER/THERMAL ENVELOPE  
 PLAN - LEVEL 2  
 SCALE: 1/16" = 1'-0"



1 ENERGY CODE AIR BARRIER/THERMAL ENVELOPE  
 PLAN - LEVEL 1  
 SCALE: 1/16" = 1'-0"

This zone tested separately as part of energy code compliance. JRS understands this zone is not part of PHILUS+ requirements for the project. -JRS

# Preliminary Test Results

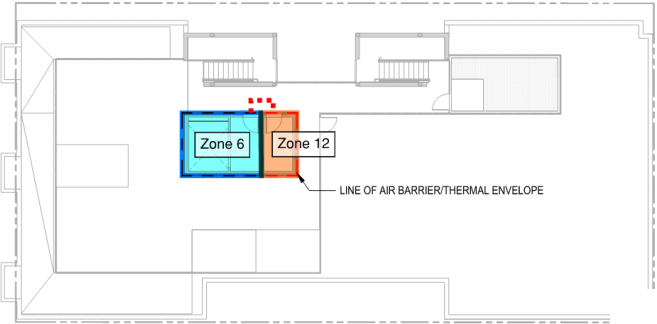
0.034 cfm/sqft at 50Pa



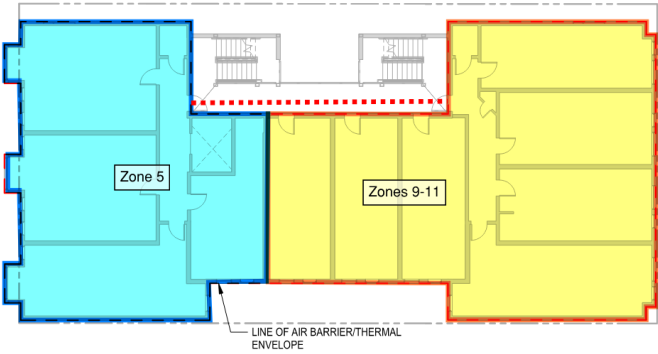
# Final Air Barrier Test Set-Up

**Final Air Barrier Test Set-Up:**  
 (Air distribution via HVAC ducts,  
 elevator shaft & "jump ducts")  
 Fans Required: 1

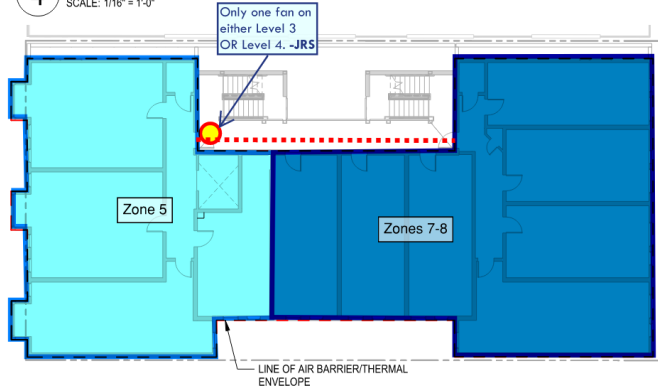
■ Tested volume  
● Test fan location  
⋯ Temp. jump duct



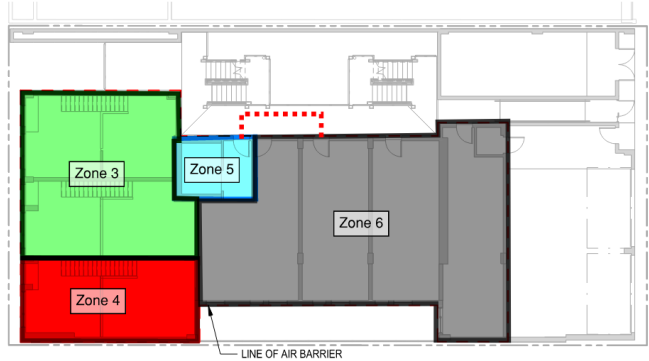
5 ENERGY CODE AIR BARRIER/THERMAL ENVELOPE  
 PLAN - ROOF  
 SCALE: 1/16" = 1'-0"



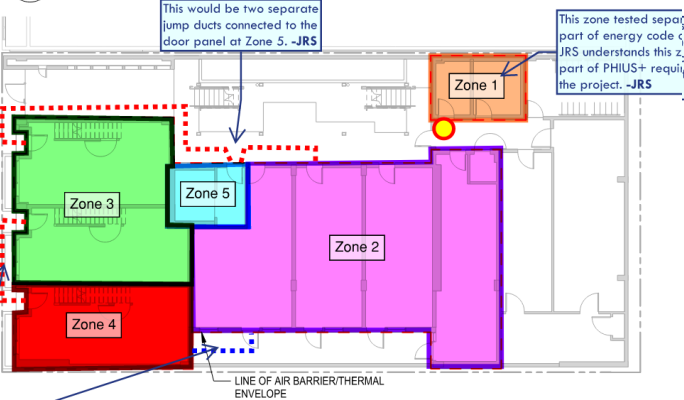
4 ENERGY CODE AIR BARRIER/THERMAL ENVELOPE  
 PLAN LEVELS 5-7  
 SCALE: 1/16" = 1'-0"



3 ENERGY CODE AIR BARRIER/THERMAL ENVELOPE  
 PLAN - LEVELS 3-4  
 SCALE: 1/16" = 1'-0"

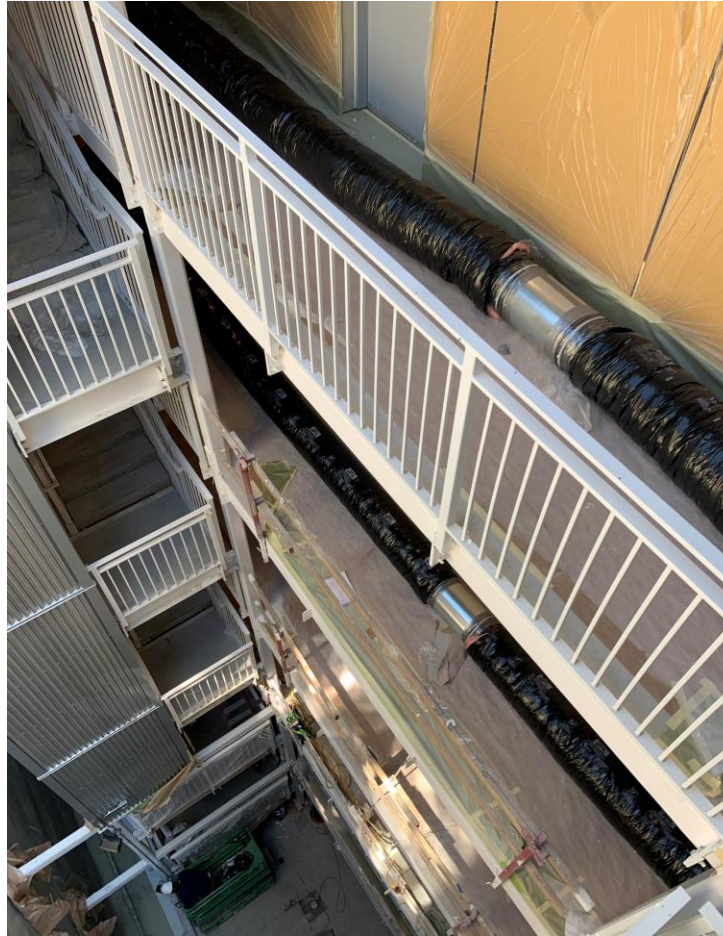


2 ENERGY CODE AIR BARRIER/THERMAL ENVELOPE  
 PLAN - LEVEL 2  
 SCALE: 1/16" = 1'-0"



1 ENERGY CODE AIR BARRIER/THERMAL ENVELOPE  
 PLAN - LEVEL 1  
 SCALE: 1/16" = 1'-0"

# Final Test – Jump Ducts





# Final Results

0.050 cfm/sqft at 50Pa







# Balanced Ventilation



# Hobson Place South

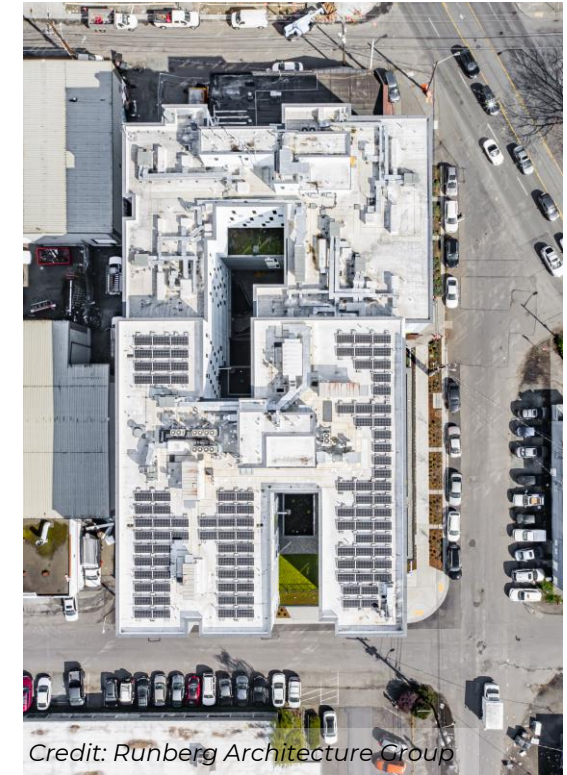
Owner/Developer: DESC

Owners Rep: Lotus Development Group

Architect: Runberg Architecture Group

Mechanical Engineer: Rushing Company

General Contractor: Walsh Construction Co.





## Systems & Efficiencies

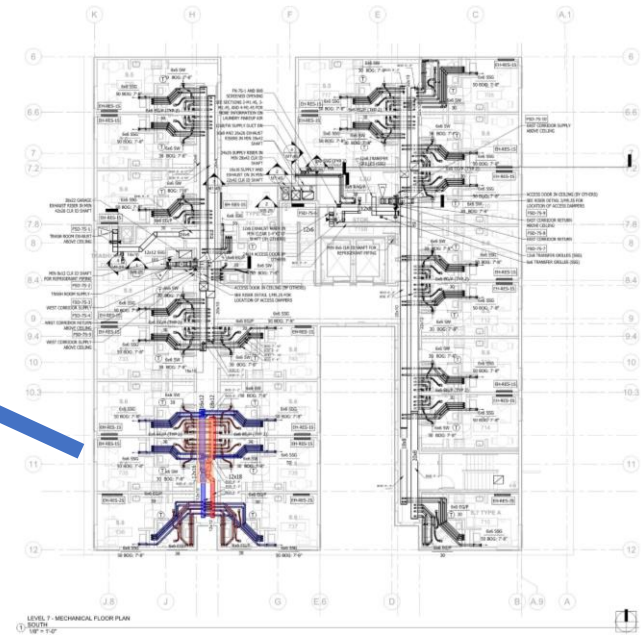
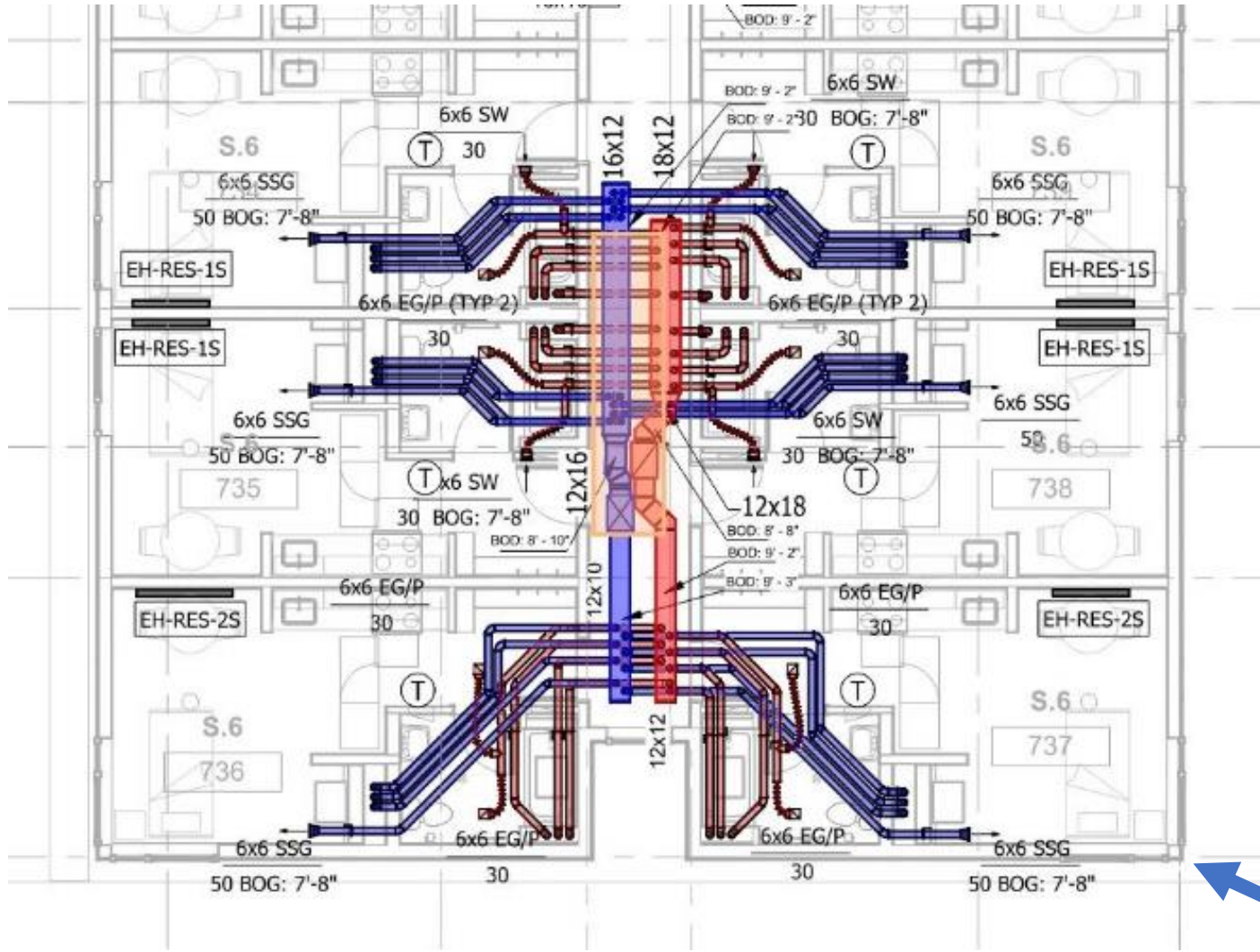
- Three Swegon rooftop ERVs serving four residential floors
  - Two Gold RX25s
  - One Gold RX11
- Minimum calculated heat recovery efficiency of 80%



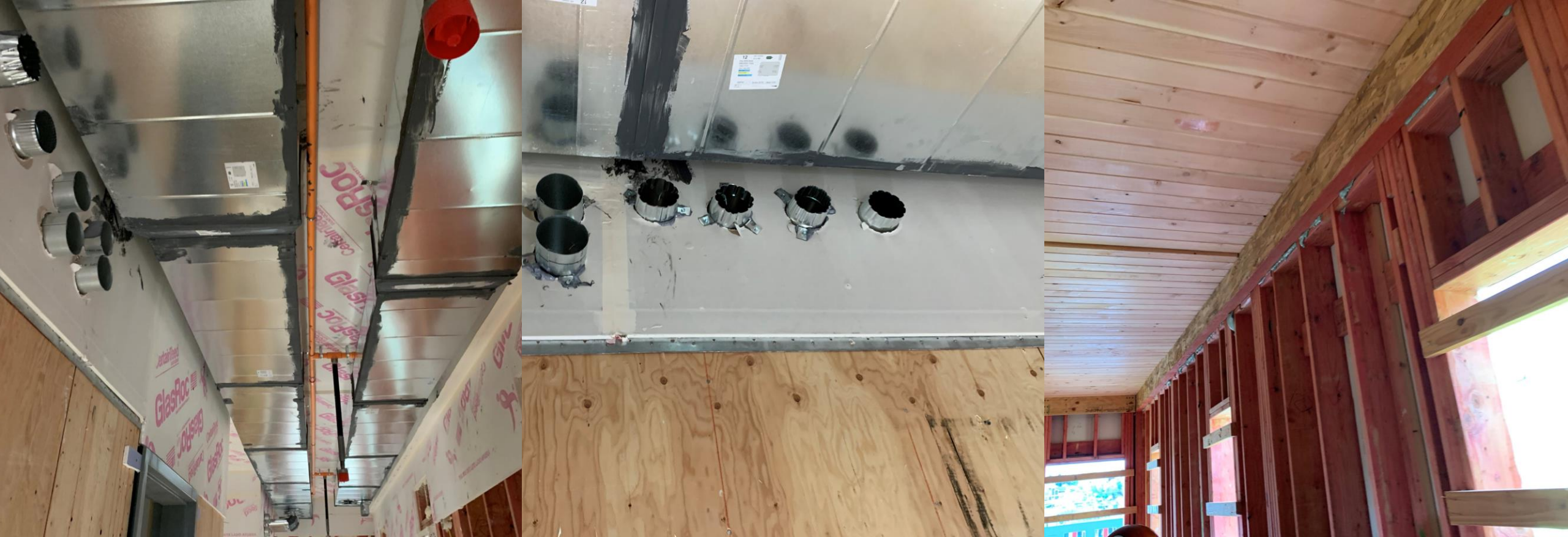


LEVEL 7 - MECHANICAL FLOOR PLAN  
 SOUTH  
 1/8" = 1'-0"









---

# Treatment of Main Trunks at Top Floor

# Balancing & Commissioning

- Involved TAB/mechanical contractor early on in process
- Equipment needed to verify Phius air flow targets



# Centralized Building Wings

## PROS

- Keeps most of the ductwork within building enclosure.
- Maintenance – fewer units and less invasive to residents.

## CONS

- Need additional height in top floor to accommodate ductwork (trunk).
- Requires code exception/alternate at jurisdiction's and Fire Marshal's discretion.



The background of the slide is a photograph showing several vertical pipes wrapped in white, crinkled insulation. At the bottom of the pipes, there are sections wrapped in silver, reflective insulation. The lighting is soft, highlighting the texture of the insulation.

# Ellie Passivhaus – Balanced Ventilation

Owner/Developer: Sound West Group

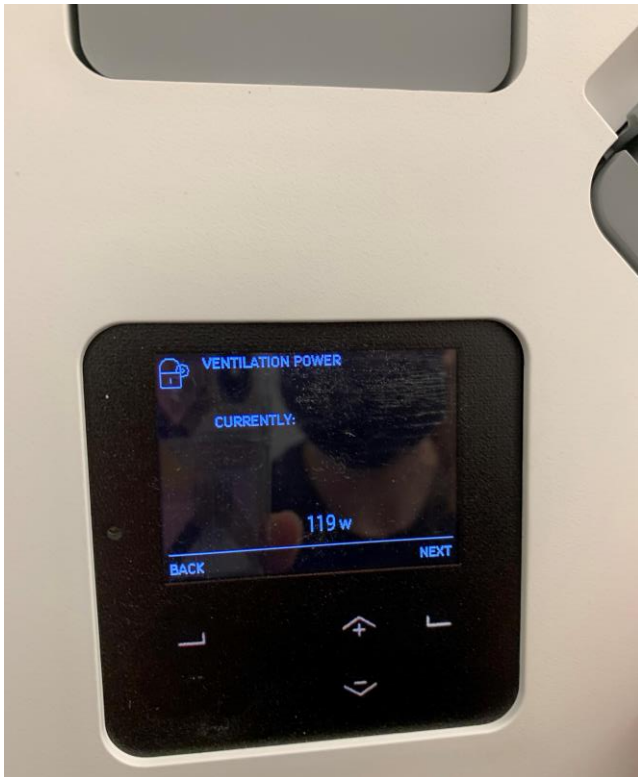
Architect: NK Architects

Mechanical Engineer: Staengl Engineering

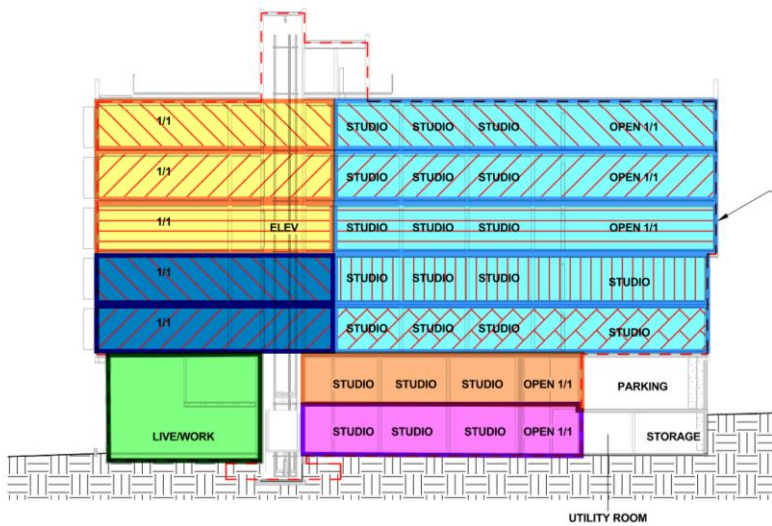
General Contractor: Cascade Built



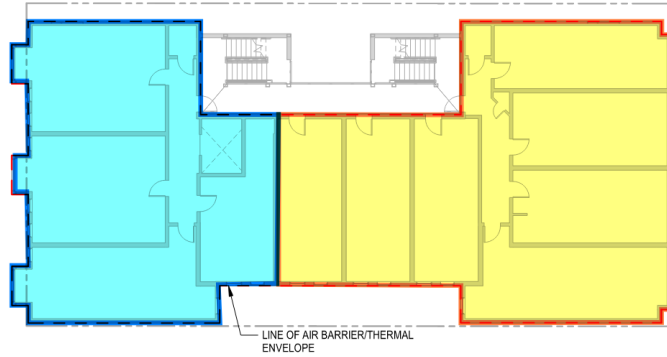
# Systems & Efficiencies



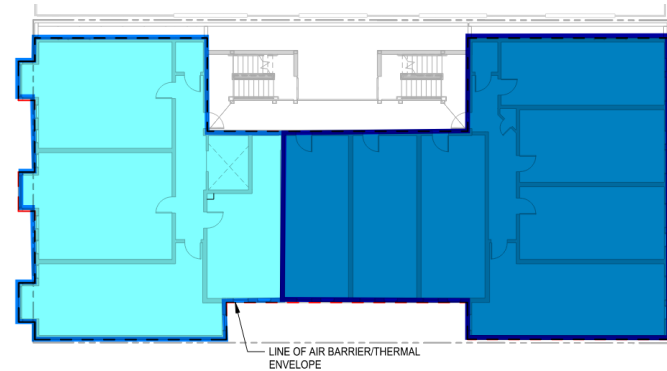
- Fifteen HRVs
  - Twelve Zehnder Q600s (heat recovery efficiency up to 87%)
  - Three Zehnder CA160s (heat recovery efficiency up to 95%)



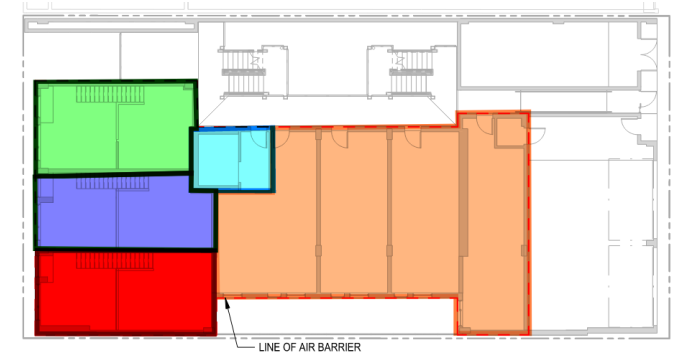
7 THERMAL ENVELOPE DIAGRAM SECTION - EAST-WEST 1  
SCALE: 1/16" = 1'-0"



4 ENERGY CODE AIR BARRIER/THERMAL ENVELOPE  
PLAN LEVELS 5-7  
SCALE: 1/16" = 1'-0"



3 ENERGY CODE AIR BARRIER/THERMAL ENVELOPE  
PLAN - LEVELS 3-4  
SCALE: 1/16" = 1'-0"



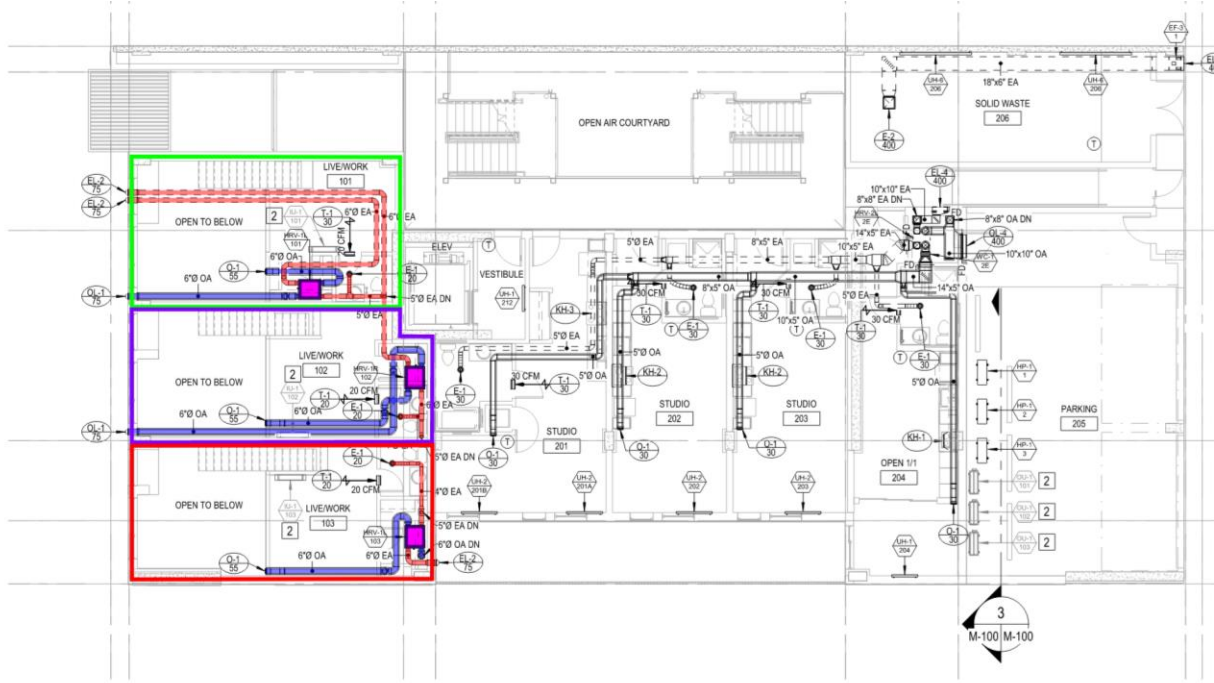
2 ENERGY CODE AIR BARRIER/THERMAL ENVELOPE  
PLAN - LEVEL 2  
SCALE: 1/16" = 1'-0"



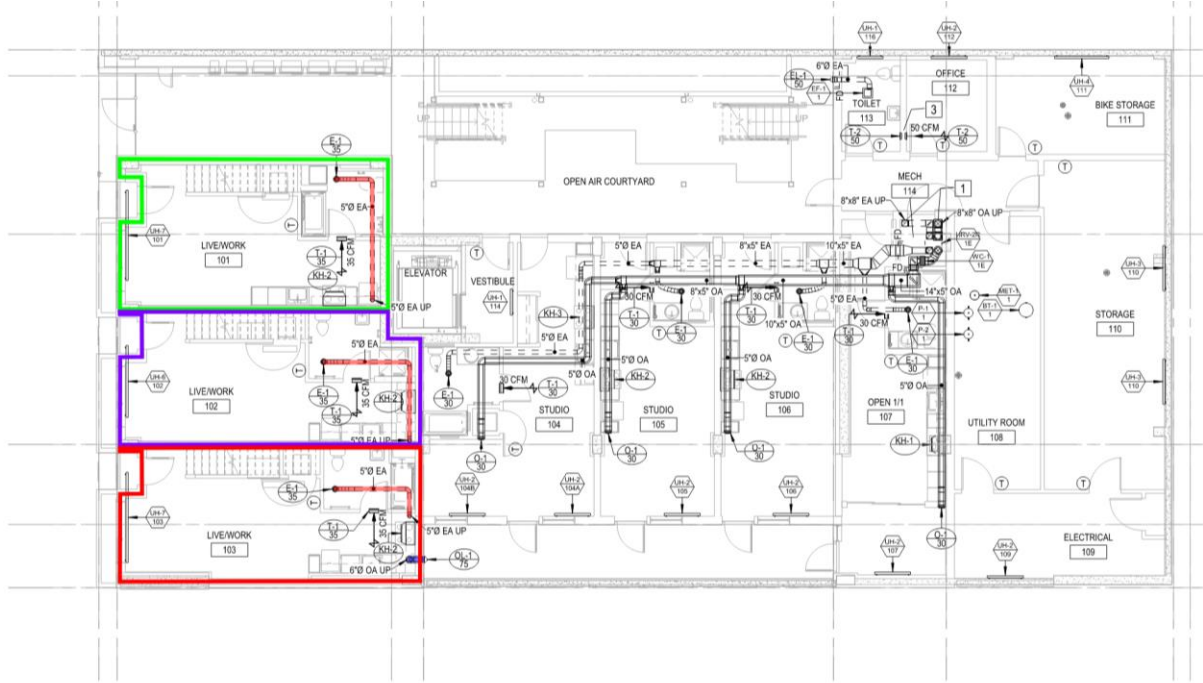
1 ENERGY CODE AIR BARRIER/THERMAL ENVELOPE  
PLAN - LEVEL 1  
SCALE: 1/16" = 1'-0"



# Unitized Systems

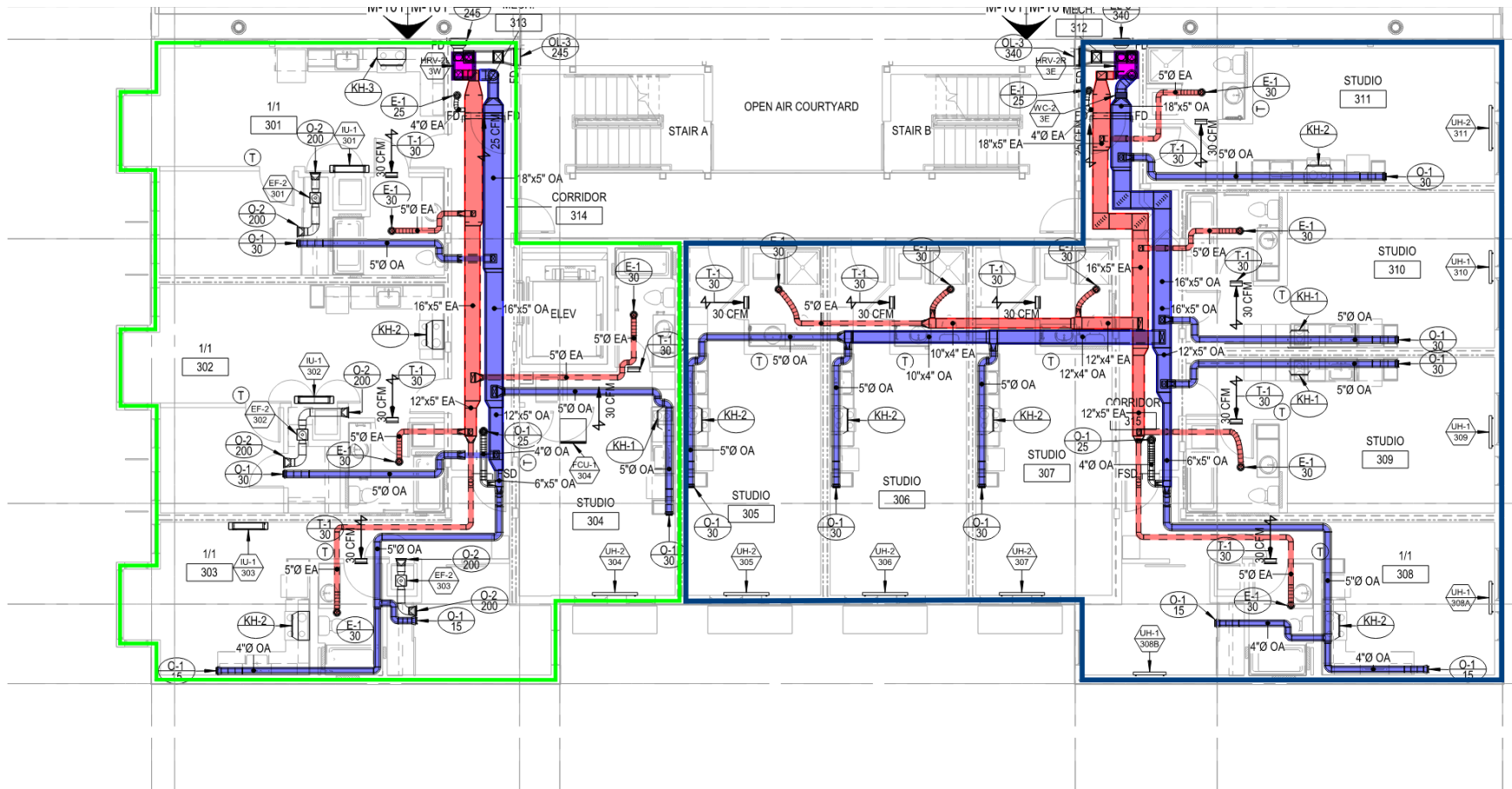


2 LEVEL 2 - MECHANICAL DUCTWORK PLAN  
1/8" = 1'-0"



1 LEVEL 1 - MECHANICAL DUCTWORK PLAN  
1/8" = 1'-0"

# Centralized Horizontal, Floor-by-Floor



① LEVEL 3 - MECHANICAL DUCTWORK PLAN  
1/8" = 1'-0"



# Mechanical Spaces



# Balancing & Commissioning

---





# Hybrid: Centralized, Horizontal (Floor-by-Floor) & Unitized Systems

- Pros:
  - No area required on roof
  - No vertical shafts running through each floor
  - Equipment is within building enclosure
- Cons
  - Room(s) or closet(s) on each floor
  - Locating intake and exhaust through side of building
  - More floor height to accommodate corridor soffit for horizontal trunk ducts



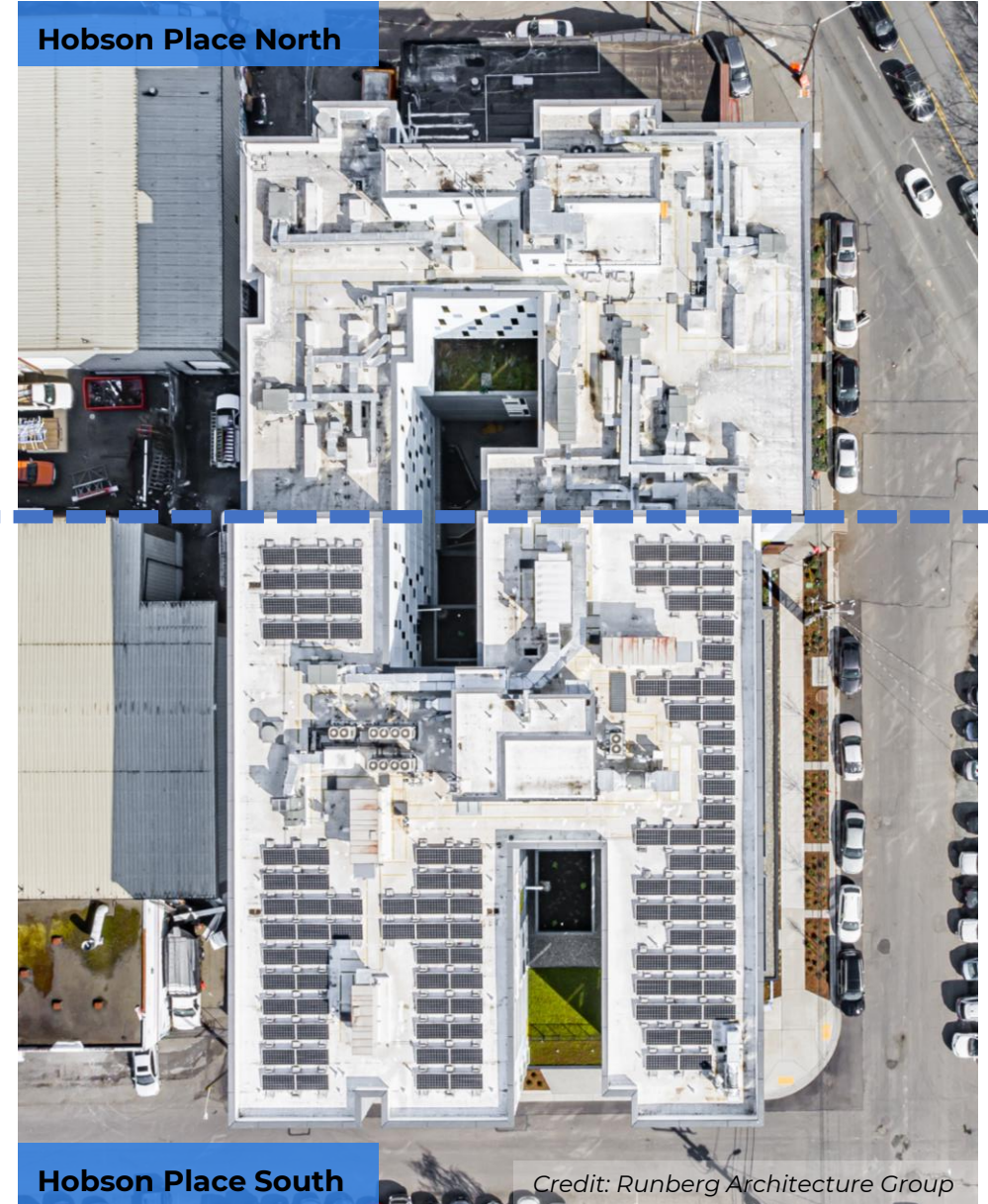




Ellie Passivhaus

## Advantages of Optimized Balanced Ventilation Configurations

- Additional solar panels
- More marketable amenity space



Hobson Place North

Hobson Place South

Credit: Runberg Architecture Group





# Conclusions

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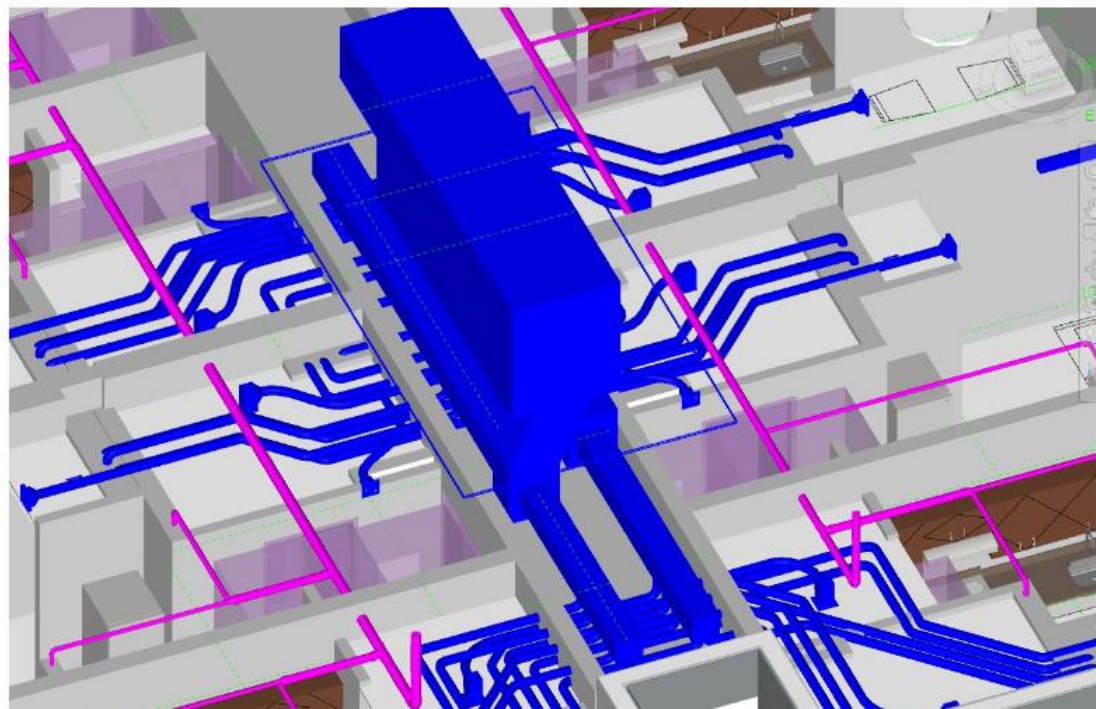
- **Integration of key testing and commissioning players (rater/verifier, TAB, etc.) early on in design.**
- **Pre-construction meetings for testing to get buy-in early on from project team to implement cost-effective testing methods.**
- **Design what makes sense for building type and project goals.**

# Acknowledgement

- Exemplary Building Program by Housing Development Consortium (HDC) of Seattle-King County

## GUIDELINES FOR **BALANCED VENTILATION WITH HEAT RECOVERY**

*Part of a series highlighting techniques for designing & building better affordable housing*





# Questions?





# Thank you!



Scan for more  
on 4EA!

