Pilot Project
Passive House
Passive House Institute

1. Summary

South Elevation of the University of Chicago Warren Woods Field Station

137 High Street, Belfast, ME 04915 / 207 640 6300 / www.opalarch.us

1.1 Building Data

- **Project Name:** University of Chicago Warren Woods Ecological Field Station
- **Location:** Western Michigan, USA
- **Year of Construction:** 2013-2014
- **Treated Floor Area:** 209.83 m^2
- **Space Heating Demand (PHPP):** 12 kWh/m^2a
- **n50 (Airtightness):** 0.5/h
- **U-values:**
  - Wall: 0.107 $W/(m^2K)$
  - Roof: 0.049 $W/(m^2K)$
  - Cantilever Roof: 0.061 $W/(m^2K)$
  - Green Roof: 0.070 $W/(m^2K)$
  - Slab: 0.160 $W/(m^2K)$
  - Windows (U_f, Ug): 0.86 U_f, 0.54 Ug (all units $W/(m^2K)$); g-value: 0.50 and 0.62 (depending on window orientation)
- **Ventilation System:** Two (2) Zehnder 550 ERVs
- **Special Features:**
  - First Passive House certified laboratory in North America
  - Passive zoning: high heat-load lab placed on north side, shaded to the west, intermittent classroom space on south
  - Heat recovery from lab equipment (e.g. -80°C freezer) to shared zones
  - Operable stainless steel mesh external shading on south façade
  - Designed for autonomous, low-maintenance operation off-campus

1.2 Brief Description of the Construction Task

The University of Chicago Warren Woods Ecological Field Station is a 2,400 ft² Passive House-certified facility built in a meadow ecosystem used for botanical field research. It houses a laboratory, classroom, and upper-floor meeting space. Located in western Michigan, the facility serves an ecological and academic function for University of Chicago researchers.

The project sought to achieve North America's first Passive House certification for a laboratory. It was designed to operate efficiently and without daily maintenance due to its off-campus location. The layout emphasizes thermal zoning: the lab with high internal gains occupies the north side, while the classroom space is placed to the south to optimize solar gains. High-energy lab equipment waste heat is redirected to benefit adjacent spaces.

Ventilation is managed via two Zehnder energy recovery ventilators, ensuring fresh air with minimal energy loss. Operable stainless steel shading protects the large south-facing glazed areas. The building integrates technical performance, ecological design, and architectural clarity.

1.3 Responsible Project Participants

- **Design Architect:** Timothy Lock, AIA – GO Logic (now OPAL)
- **Energy Modeling:** Svea Tulberg
- **Certifying Body:** Passive House Institute (PHI)
- **Certification ID:** 9117-9118_PH_20140708_SG
- **Passive House Database Project ID:** 4080
- **Author of Documentation:** Timothy Lock
- **Date and Signature:**

2. Photographs of Views

View from the Northwest

West Elevation

South Elevation

East Elevation

View from the Northeast

North Elevation

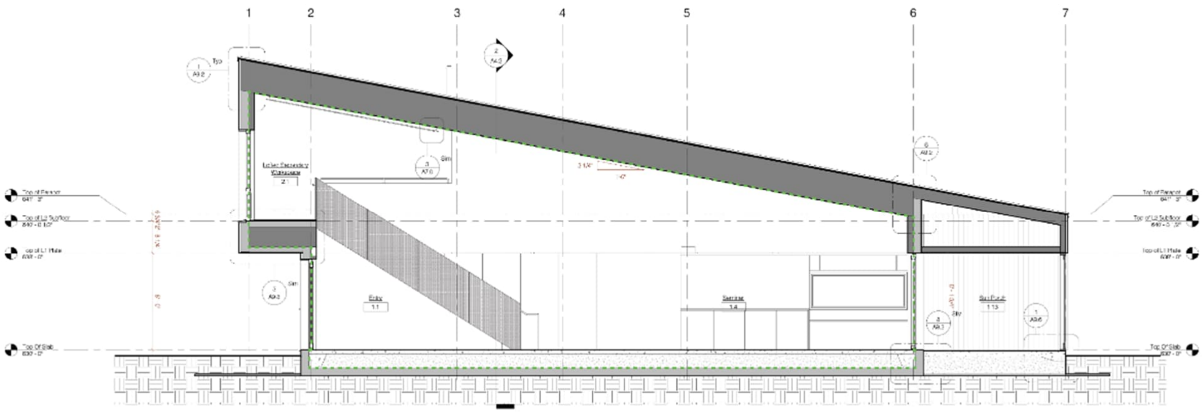
Interior general use classroom

Interior botany laboratory

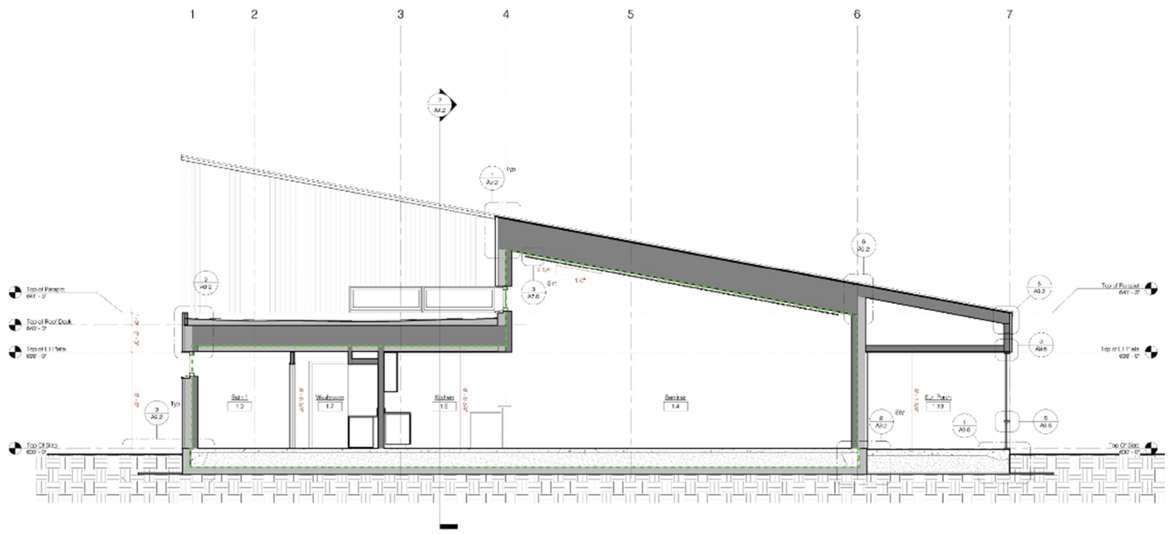
3. Sectional Drawing with Description

The University of Chicago is an asymmetric split-level frost protected wood slab-on-grade structure. The section profile seeks to use the two-story portion of the building to shade the more energy-intensive portion of the building (the laboratory). Passive House insulation levels are achieved through the use of 7.25" thick structural insulated panels, utilizing graphite-infused expanded polystyrene insulation. The roof is formed by continuous 30" deep open-web wood trusses, densely insulated with blown-in cellulose insulation.

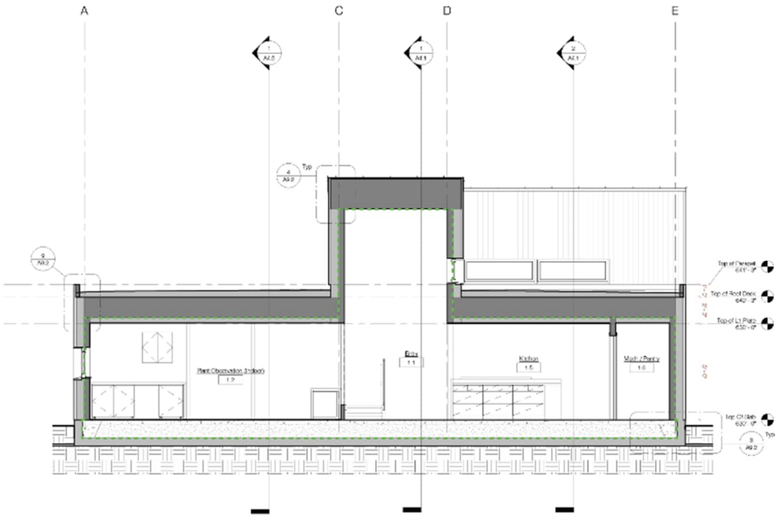
Air sealing was accomplished using a variety of products and connection/transition details. Under the slab, a 15mm, fully taped, Viper Vaporcheck cross-woven air sealing membrane was used. The walls were air sealed on the interior face of the SIPs, while the roof was air sealed from below using a combination of Zip sheathing, Proclima Intello, and Viper Vaporcheck. Given the complex building form, many flexible portions of the air barrier, particularly at transitions, were pre-installed during structural framing to tape into other continuous surfaces later in order to maintain continuity. The continuous air seal is indicated in green in the sections below:



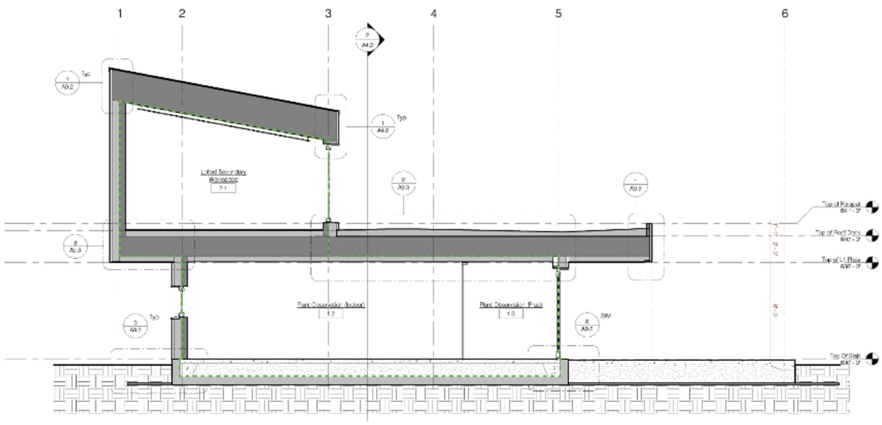
Section - Entry



Section - Seminar Classroom



Section - Cross

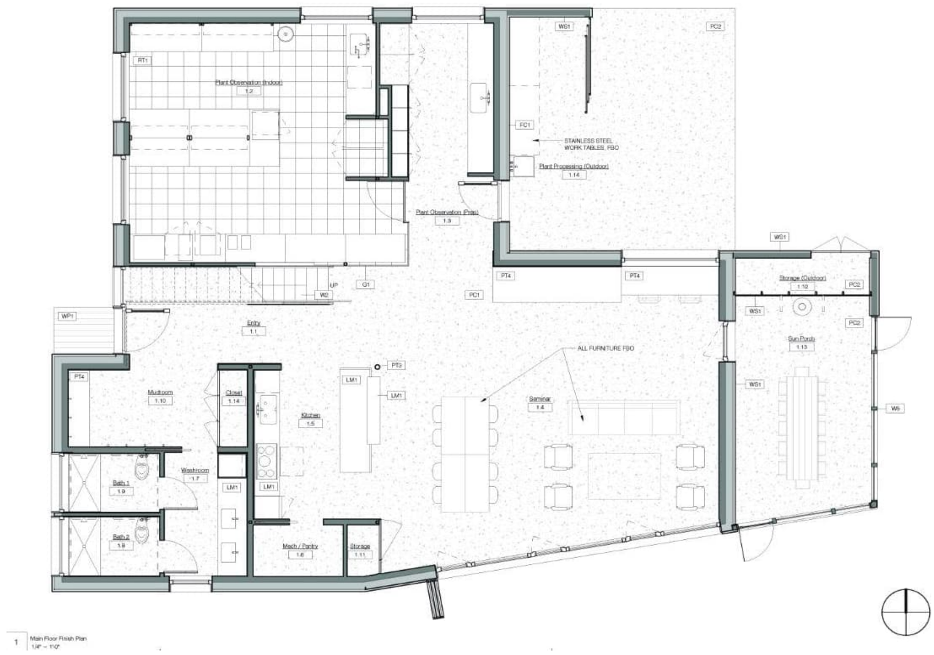


Section - Lab/Loft

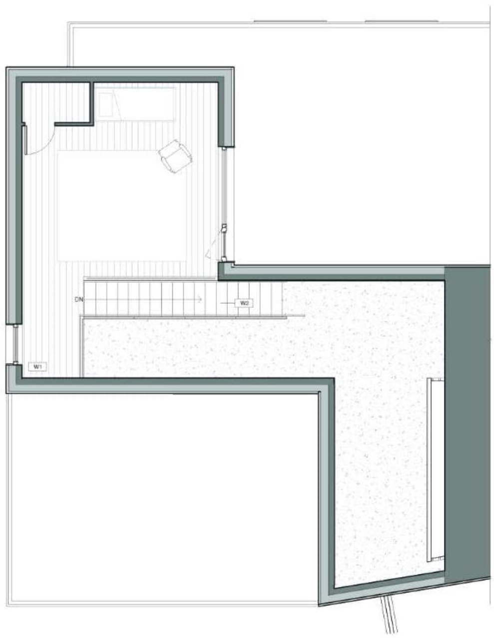
View of pre-installed flexible air barrier transitions during framing

4. Floor Plans with Description

Early in the design process it was clear that while the University prioritized Passive House certification, they would not be satisfied with a building that was not also architecturally distinctive. In fact, we were not convinced internally that the agreed upon form would be able to be certified. However, two early plan layout decisions helped us achieve certification even with the complex form. We located the high internal gain laboratory on the north side of the building, shaded by the cantilevered second floor meeting space. This space is further buffered to the west by an operable screened botanical specimen prep space. To the south, the intermittently used Seminar space has operable perforated metal solar screens to reduce overheating at peak load times while maintaining the ability to accept solar gain in the winter months. These screens offer the added function of securing the remote field station situated an hour from the main campus.



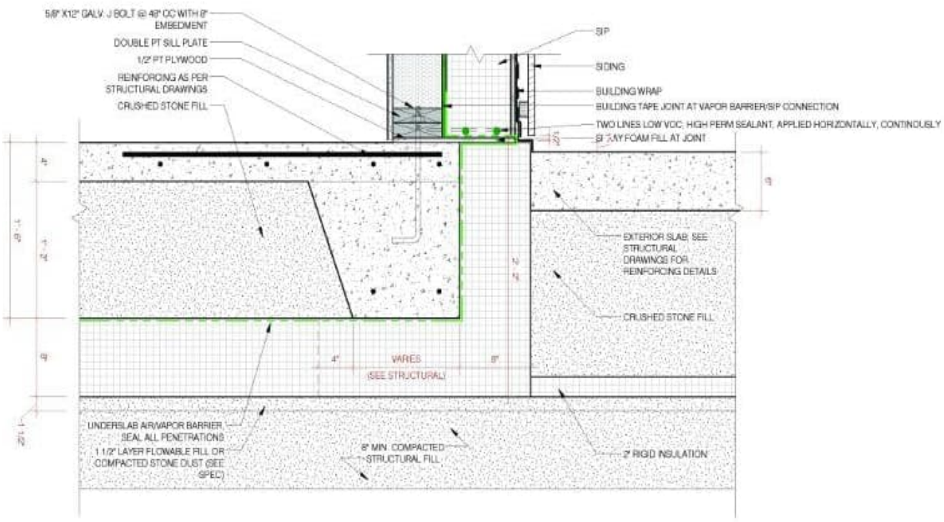
Main Floor Finish Plan



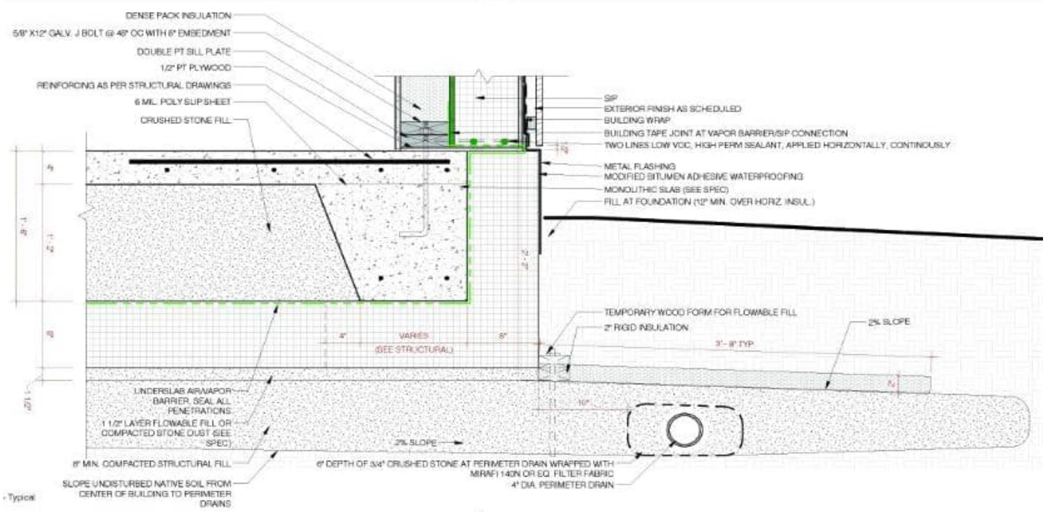
Second Floor Finish Plan

5.1 Description of the Construction of the Floor Slab

The project utilizes a frost-protected slab on grade along with point footings at major columns in the interior. Continuous underslab insulation unforming disconnects all foundation elements from grade; all utilities are positioned above the air barrier, radically reducing air barrier penetrations.



Slab Edge Transition Detail - Exterior Slab

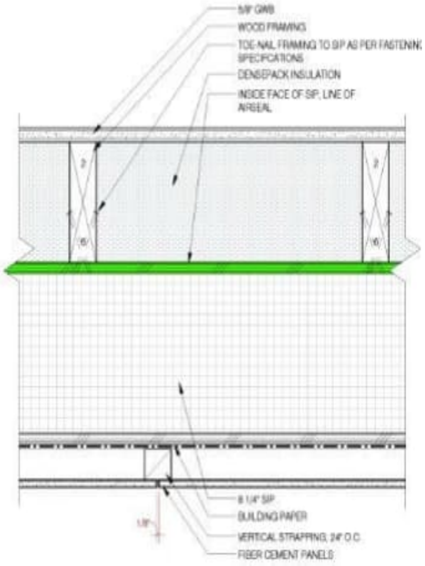


Slab Edge Detail - Typical

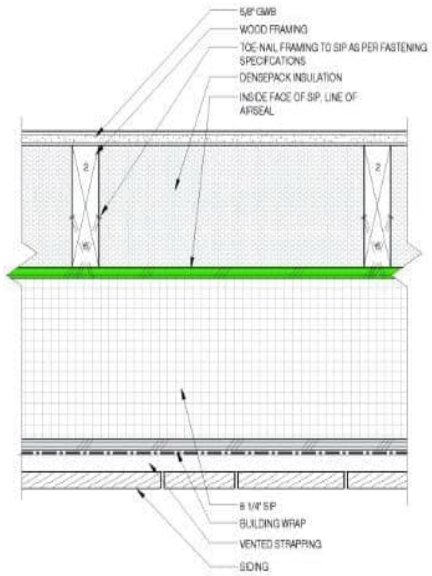
Underslab air barrier at foundation edge

5.2 Description of the Construction of the Exterior Walls

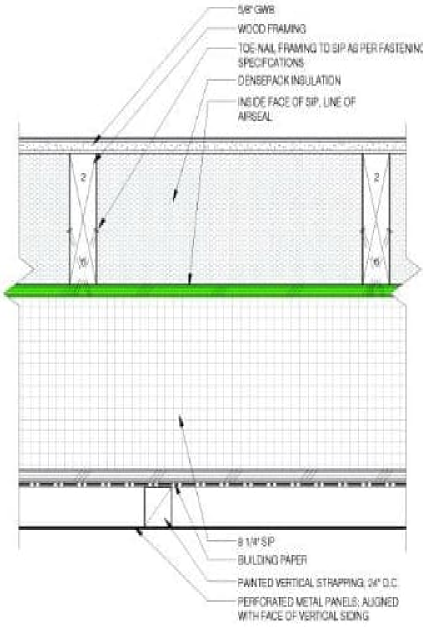
The exterior walls are two-part construction, with a wood-framed service wall and 7.25 inch structural insulated panel constructed with graphite infused expanded polystyrene. All air sealing is provided at the interior side of the SIP.



W1b, Wall Type 1b - Exterior Wall, Fiber Cement Panel



W1, Wall Type 1 - Typical Exterior Wall

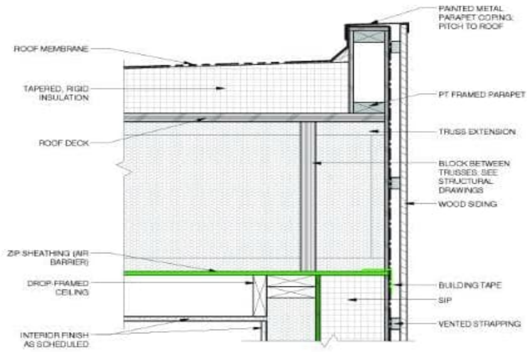


W1a, Wall Type 1a - Exterior Wall, Metal Mesh Finish

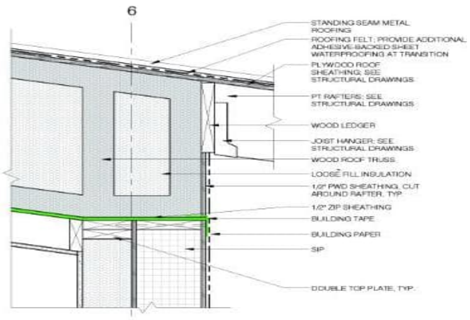
Panel installation

5.3 Description of the Construction of the Roof/Top Floor Ceiling

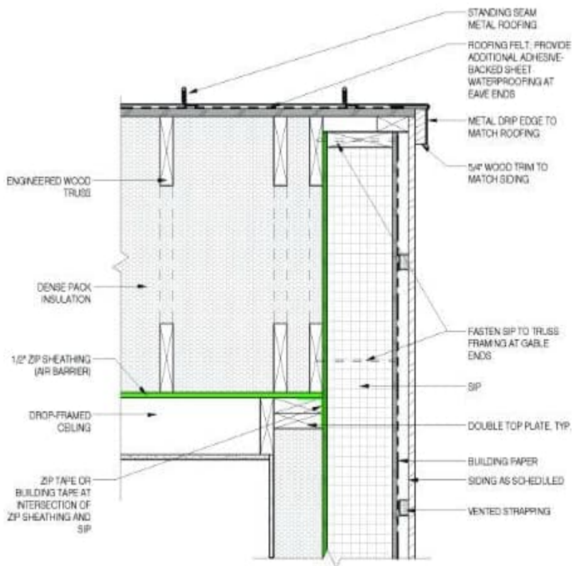
The roof is constructed of custom, open-web, wood trusses throughout, both on the sloped and flat portions of the building. The air barrier is fixed to the underside of the truss throughout. The truss cavity is filled with dense pack cellulose insulation. The trusses were baffled intermittently during insulation installation to ensure proper density of insulation throughout.



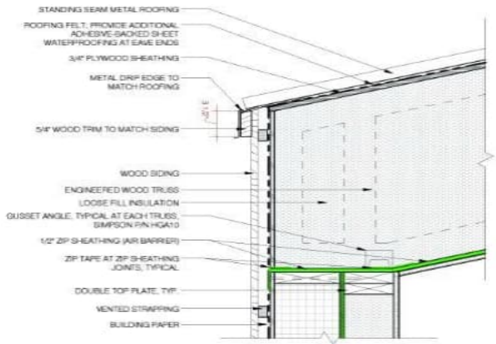
Section Detail - Roof/Wall Intersection at Flat Roof



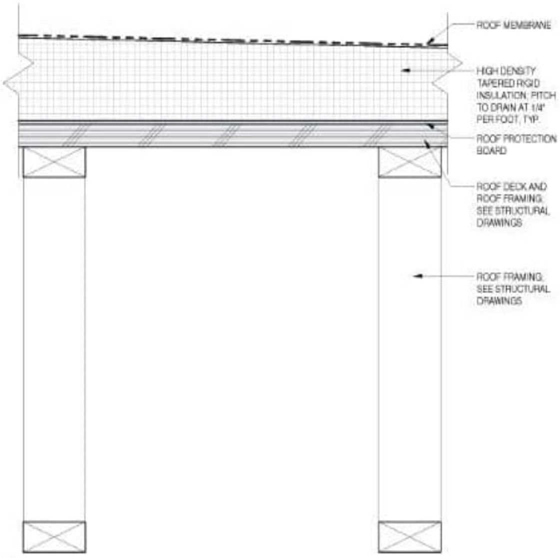
Section Detail - Sun Porch Roof



Typical Eave Rake



Typical Eave



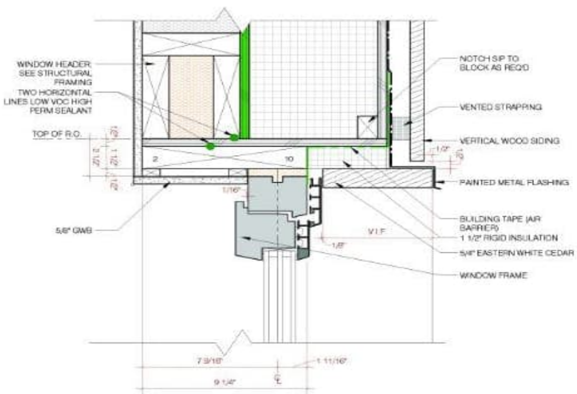
Assembly Green Roof - Typical

Roof truss installation

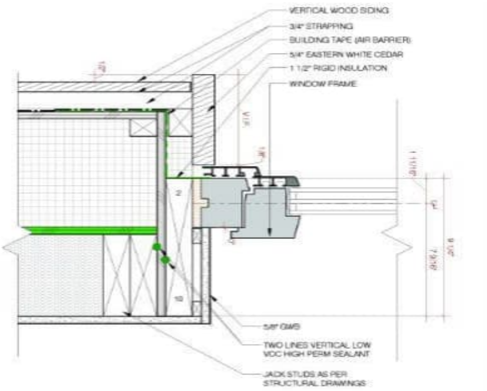
5.4 Description of the Window Sections Including Installation drawing

We worked with our partners at Kneer-Sudfenster to provide Passive House-level triple-pane windows throughout this project. All window frames are provided with insulation extensions on the exterior to cover frame thermal bridging. The windows are UPVC with aluminum cladding.

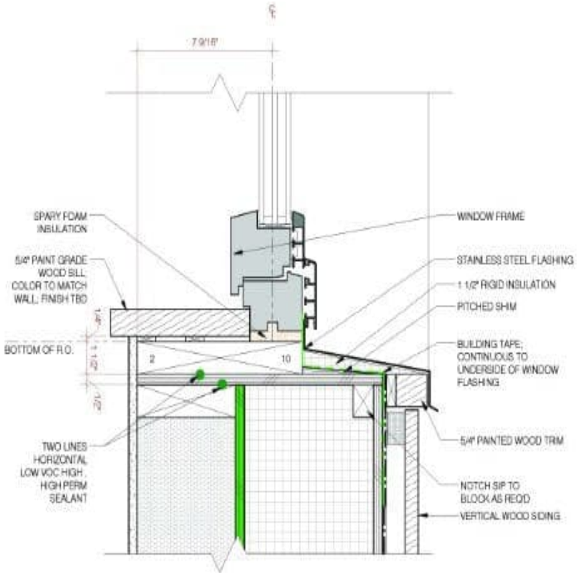
Window detail from exterior



Typical Window Head



Typical Window Jam



Typical Window Sill

6. Description of the Airtight Envelope

Infiltrometer Air Leakage Test Results, In Compliance with ASTM E-779-10, Warren Woods, 02-25-2014

BUILDING LEAKAGE TEST

Date of Test: 5/27/2014

Customer: G O Logic
137 High St.
Belfast , ME 04915

Test File: Warren Test Depressurized Office
Technician: Matt Rosendaul
Project Number: 1

Building Address: Warren Woods Field Station
7328 Warren Woods Rd
Three Oaks, MI 49128

Test Results

1. Airflow at 50 Pascals: (50 Pa = 0.2 w.c.)	186 CFM50 (+/- 1.4 %) 0.41 ACH50
2. Leakage Area:	10.2 in2 LBL ELA @ 4 Pa
3. Building Leakage Curve:	Flow Coefficient (C) = 11.5 (+/- 10.3 %) Exponent (n) = 0.712 (+/- 0.028) Correlation Coefficient = 0.99920
4. Test Settings:	Test Standard: RESNET Multi-Point Test Test Mode: Depressurization
5. Accuracy Level	Standard Level of Accuracy Test

Infiltration Estimates

1. Estimated Average Annual Infiltration Rate:		11.1 CFM 0.02 ACH		
2. Estimated Design Infiltration Rate:	Winter:	20.3 CFM 0.04 ACH	Summer:	11.9 CFM 0.03 ACH

Cost Estimates

1. Estimated Cost of Air Leakage for Heating: $ 13 per year heating
2. Estimated Cost of Air Leakage for Cooling: $ 0 per year cooling

Date of Test: 5/27/2014 Test File: Warren Test Depressurized Office

Building Information

Volume	**27510**
Surface Area	**27510**
Floor Area	**2800**
Height	**20**
# of Bedrooms	**0**
# of Occupants	**0**
Year of Construction	**2014**
Wind Shield	**S**

Location Climate Information

Ventilation Weather Factor	**0.89**
Energy Climate Factor	**18.00**
Heating Degree Days	**6294**
Cooling Degree Days	**372**
Design Winter Wind Speed	**11.4 mph**
Design Summer Wind Speed	**11.7 mph**
Design Winter Temp Diff	**67 deg F**
Design Summer Temp Diff	**12 deg F**

Heating and Cooling Cost and Efficiency Information

Heating Fuel	**Heat Pump HSPF**
Heating Fuel Cost	**$0.100/kwh**
HSPF	**9.80**
Cooling Fuel Cost	**$0.100/kwh**
Cooling SEER	**27.0**

Equipment Information

Type	Manufacturer	Model	Serial Number	Custom Calibration Date
Fan	Energy Conservatory	Duct Blaster B		-
Micromanometer	Energy Conservatory	DG700	5233-7	11/15/2013

Date of Test: 5/27/2014 Test File: Warren Test Depressurized Office

Depressurization Test:

Environmental Data

Indoor Temperature (°F)	Outdoor Temperature (°F)	Altitude (ft)
71.0	75.0	600.0

Data Points

Nominal Building Pressure (Pa)	Baseline Adjusted Building Pressure (Pa)	Fan Pressure (Pa)	Nominal Flow (cfm)	Adjusted Flow (cfm)	% Error	Fan Configuration
0.1	n/a	n/a				
-60.3	-60.4	177.1	210	213	0.2	Ring 2
-53.3	-53.4	148.3	192	195	-0.1	Ring 2
-48.0	-48.2	128.9	179	182	0.3	Ring 2
-42.2	-42.3	108.0	163	166	0.5	Ring 2
-35.3	-35.4	83.1	143	145	-0.1	Ring 2
-31.0	-31.2	69.3	131	133	-0.2	Ring 2
-24.1	-24.2	46.4	107	108	-2.4	Ring 2
-17.9	-18.0	33.3	90	92	1.8	Ring 2
0.1	n/a	n/a				

Time Averaging Period: 0

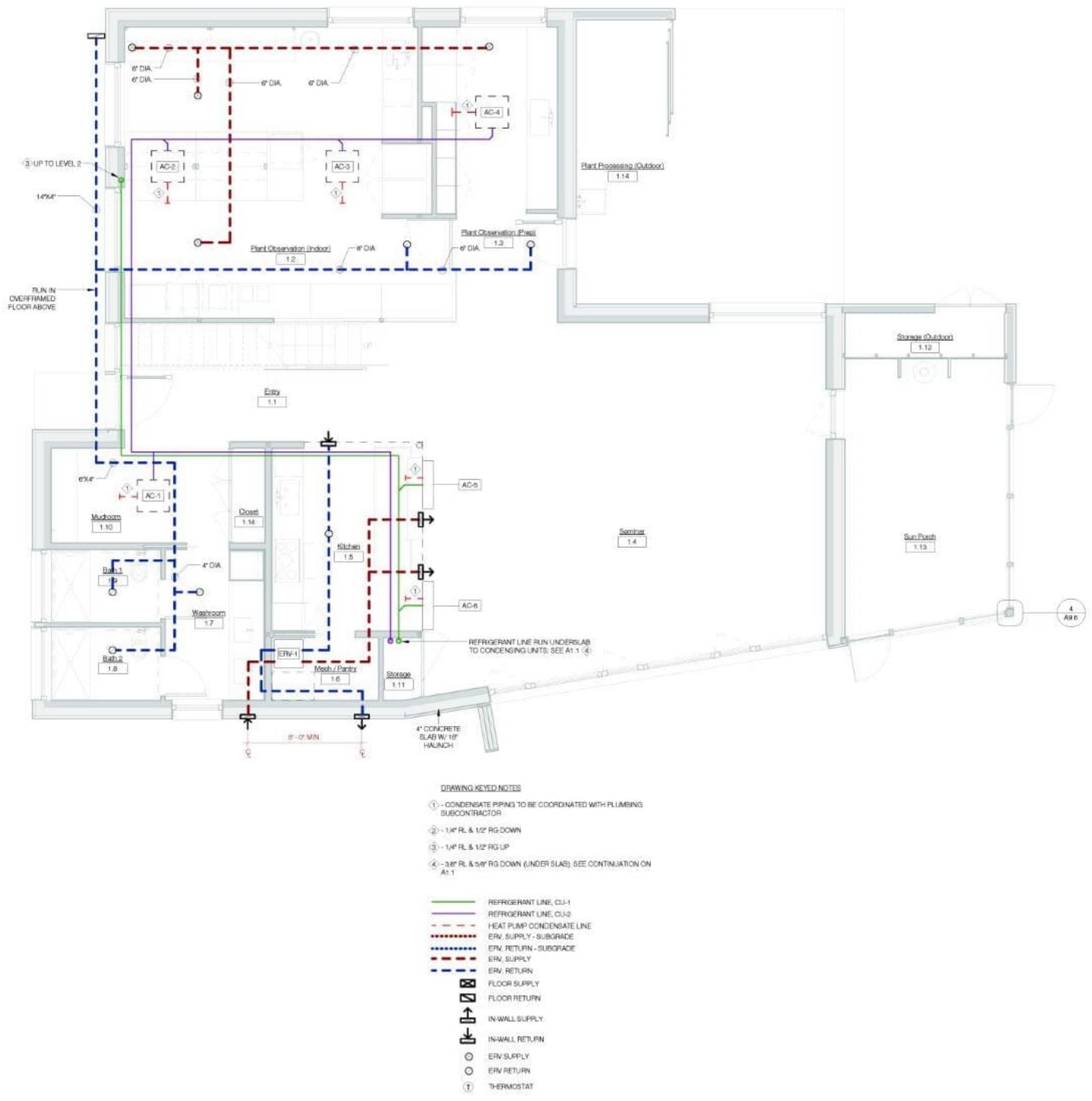
Deviations from Standard RESNET Multi-Point Test - Test Parameters

None

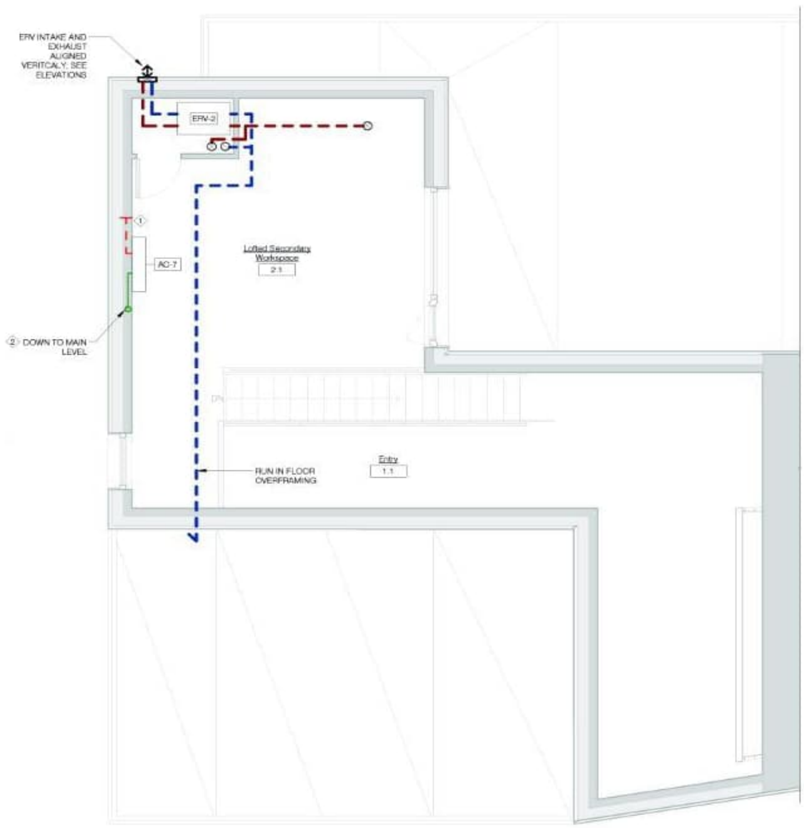

AIRTIGHT BUILDING
NO DRILLING AIRTIGHT CONSTRUCTION
NO CUTTING AIRTIGHT MEMBRANES
REPORT ALL PENETRATIONS TO SUPERVISOR

7.1 and 7.2 Description of the Planning of the Ventilation Central Unit and Ductwork

The building is served by two Zehnder 550 energy recovery ventilation unit. The delivery is decentralized to allow one unit to ventilate the ground floor public spaces from a vertical closet accessed from the the Seminar room, while the other is situated on the second floor and serves the laboratory from above and the bathroom and showers to the south. Over framing of the second floor meeting space allows for all ducting to occur inside the air barrier without penetration.



Main Floor Mechanical Plan



Second Floor Mechanical Plan

NOTES - PLANT OBSERVATION INLINE FAN:

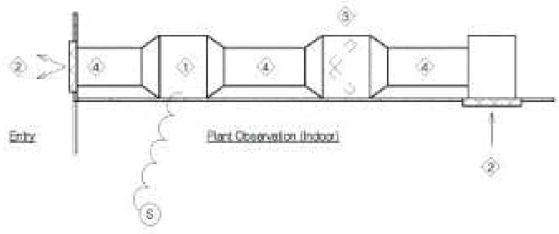
1 - ENERGY STAR RATED FAN, DC ULTRA-LOW ENERGY MOTOR W/ FULL SPEED CONTROL; FAN SHALL BE CAPABLE OF 0-600 CFM. PROVIDE TRANSITIONS TO DUCTWORK

2 - CEILING MOUNTED SUPPLY AND RETURN

3 - ANGLED FILTER BOX, ACCESS DOOR, FILTER RAILS, MERV 13 FILTERS

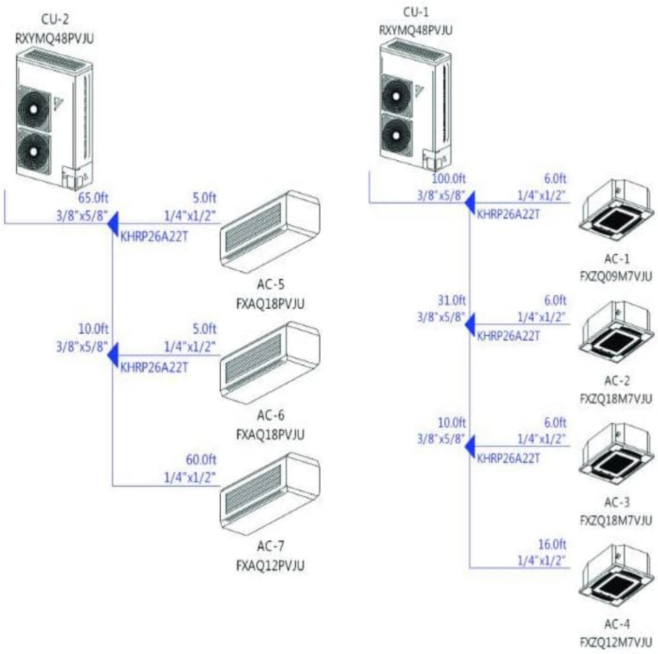
4 - GALVANIZED DUCTWORK, SEAL CLASS "B"

5 - OCCUPANT SPEED CONTROLLER, LOCATION TBD



8. Description of the Heat Supply System

The heating system for the Field Station consists of a two-compressor Variable Refrigerant Flow Daikin multi split heat pump delivering both heating and cooling. The VRF system allows for both heating and cooling to happen simultaneously, critical in a small Passive House with widely variable interior demands.



Heating and cooling distribution diagram

9. Brief Documentation of Important PHPP Results

The building, as designed, met the Passive House criteria with an annual heating demand of 12 kWh/m^{2}a and primary energy consumption limit with a predicted result of 64 kWh/m^{2}a. The field pressurization test was also in compliance, yielding a result of .5 ACH at 50 Pascal. The challenge on this project was the documentation of usage of laboratory equipment given the high heat load when in use. We used a separate schedule for this equipment and reviewed it directly with PHI to maintain compliance.

10.1 Overall Construction Costs

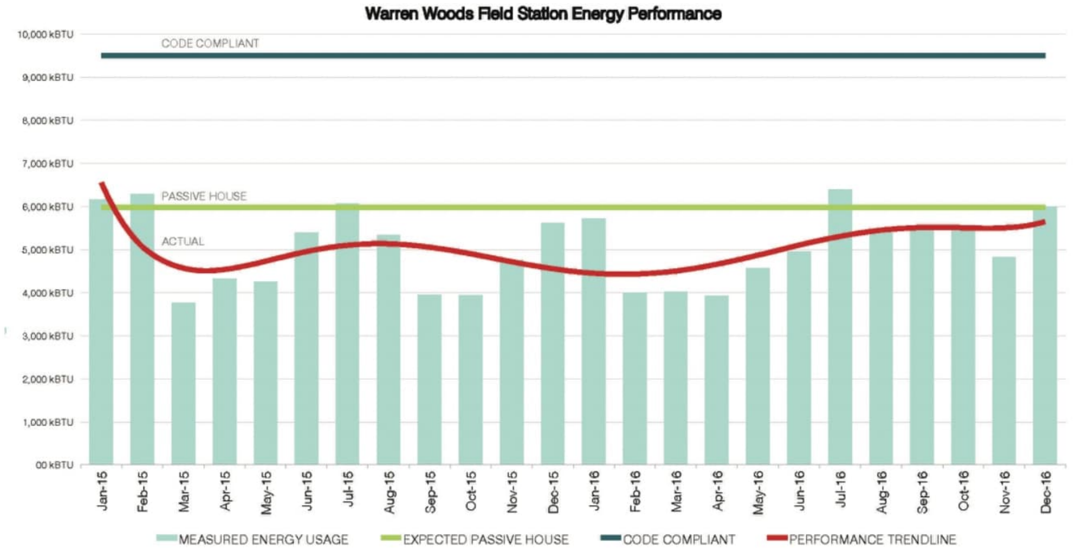
The entire construction cost was $864,714.51.

10.2 Building Costs

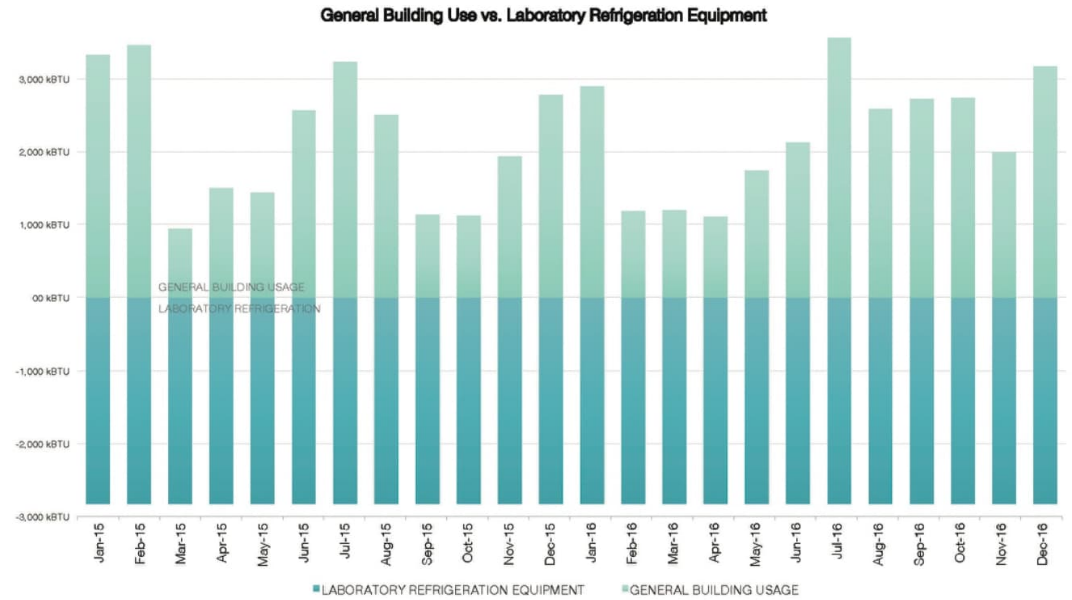
The direct cost of the building excluding site work was $772,714.51

11. Experiences (User Assessment, Actual Consumption Values)

We were able to conduct a Post Occupancy Evaluation after one year of occupancy and the results were consistent with the Passive House approach and PHPP predicted energy use. Additionally, it was interesting to see the success of a Passive House approach in that nearly all of the space heating needs were being covered by the lab equipment, and the heating system was very rarely running.



- 24-month average monthly documented total energy usage | **5,034 kBTUs**
- Estimated Passive House monthly energy total usage | **5,976 kBTUs**
- Documented monthly laboratory refrigeration energy usage | **2,828 kBTUs**
- Documented monthly remaining building energy usage | **2,206 kBTUs**
- Percentage of remaining building energy usage for heating | **3%**
- Percentage of remaining building energy usage for cooling | **15%**
- Percentage of remaining building energy usage for domestic hot water heating | **21%**



12. Reference to Existing Studies/Publications Relating to this Project

No direct studies have been done of this project, but it has been published extensively in the following publications:

- New York Times
- Architectural Record
- Detail
- ArchDaily
- Dezeen
- Architects Newspaper
- Phaidon Atlas
- Green Building and Design
- Architizer
- Inhabit

New York Times: https://www.nytimes.com/2014/11/27/garden/walter-white-would-not-be-welcome.html?searchResultPosition=1

Dezeen: https://www.dezeen.com/2014/12/31/university-of-chicago-warren-woods-ecological-field-station-go-logic-laboratory-cedar/

ArchDaily: https://www.archdaily.com/590604/warren-woods-passive-house-go-logic?ad_source=search&ad_medium=projects_tab