PASSIVE HOUSE OBJECT DOCUMENTATION

Rainbow Passive House – Whistler, BC, Canada
(Passivhaus project database ID 2752)

http://www.passivhausprojekte.de/projekte.php?detail=2752&keyword=whistler
(Technical drawings in this document are not to scale)

1. PROJECT OVERVIEW

LEAD PROJECT PLANNER: Alexander Maurer, BBA, LEED AP* – Director of Marken Projects (www.markenprojects.com)
**Leadership in Energy and Environmental Design Accredited Professional*

The Rainbow Passive House is located in Whistler, BC, Canada. The manufacturing of the prefabricated wall, roof and foor panels began in early summer of 2011. Onsite construction starting in summer of 2011 and the building was completed in March of 2012. This is the first residential project in Canada certified by the German Passivhaus Institute and one of only a few Passive Houses currently built in Canada.

SPECIAL FEATURES:
- Prefabricated Wood Panel Construction (Panelized Prefabrication of walls, floors and roof)
- Solar Hot Water
- Cross Laminated Timber (CLT) floor and decks (Cross Laminated Timber)
- Subsoil Heat Exchanger to prewarm/precool incoming air

U-value exterior wall: 0.121 [W/(mK)]
U-value floor over basement: 0.066 [W/(m²K)]
U-value roof: 0.086 [W/(m²K)]
U-value windows: 0.85 [W/(m²K)]
U-value entry door: 0.73 [W/(m²K)]

PHPP annual heating demand: 14.7 [Kwh/(m²a)]
PHPP primary energy demand: 106 [Kwh/(m²a)]
Pressure test n50 0.28h-1
Effective heat recovery: 93%

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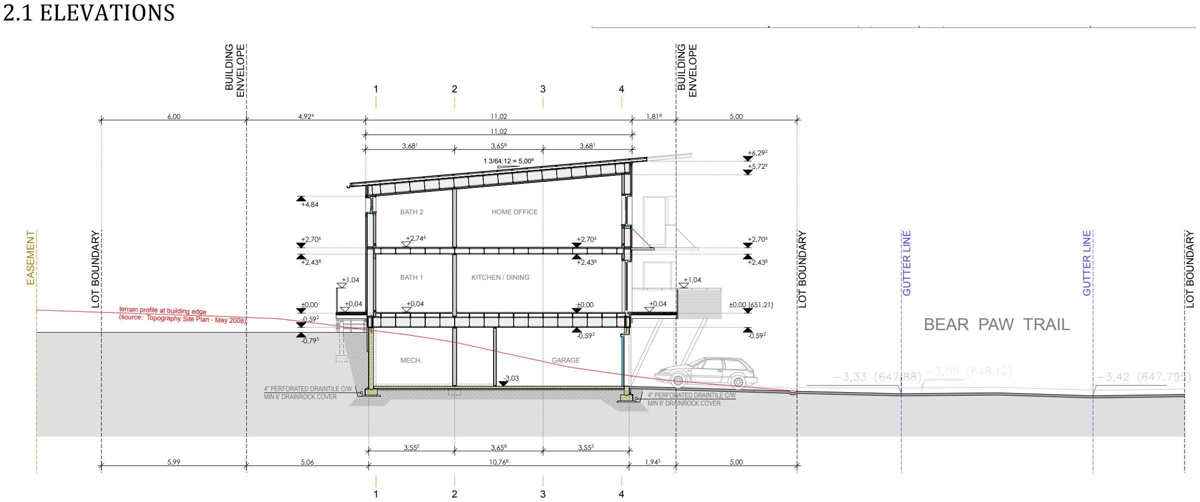
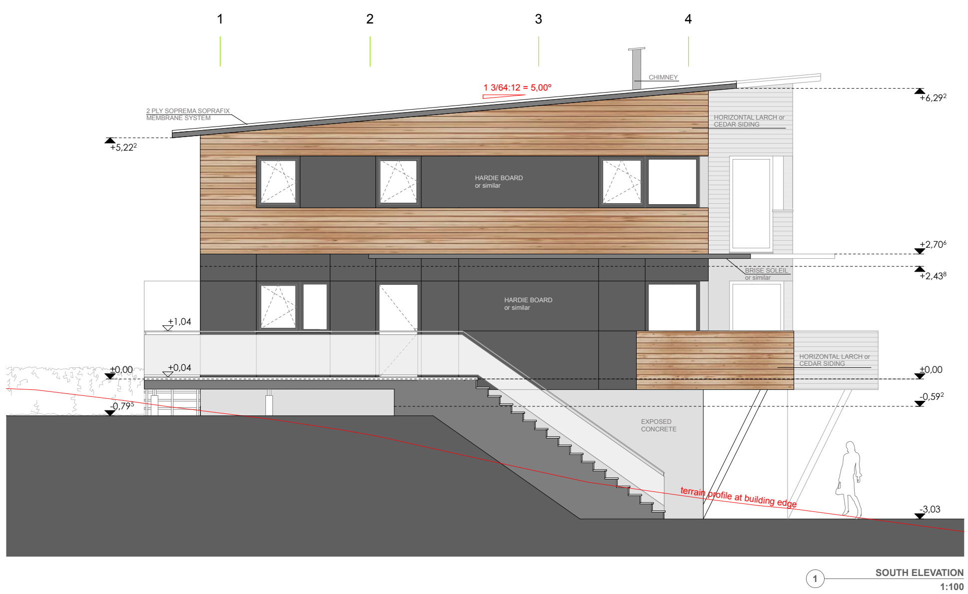
2. PROJECT DESCRIPTION

The Rainbow Passive House is a two bedroom, 145 square meter, two storey single-family residence with a lower level garage. This home is the first residence in Canada certified by the German Passivhaus Institute in Darmstadt. It is also the first Passive House residence in British Columbia. Developed by the Whistler Housing authority as part of the affordable housing initiative for Whistler residents, the subdivision where the project was built is located North of the resort municipality of Whistler, British Columbia. In terms of construction technique, the wall, roof and floors were prefabricated by BC Passive House, a new startup manufacturing high performance prefab wood panels for Passive House Buildings. You will find more information on this system here: www.bcpassivehouse.com.

2.1 ELEVATIONS



South Cross Section



South Elevation

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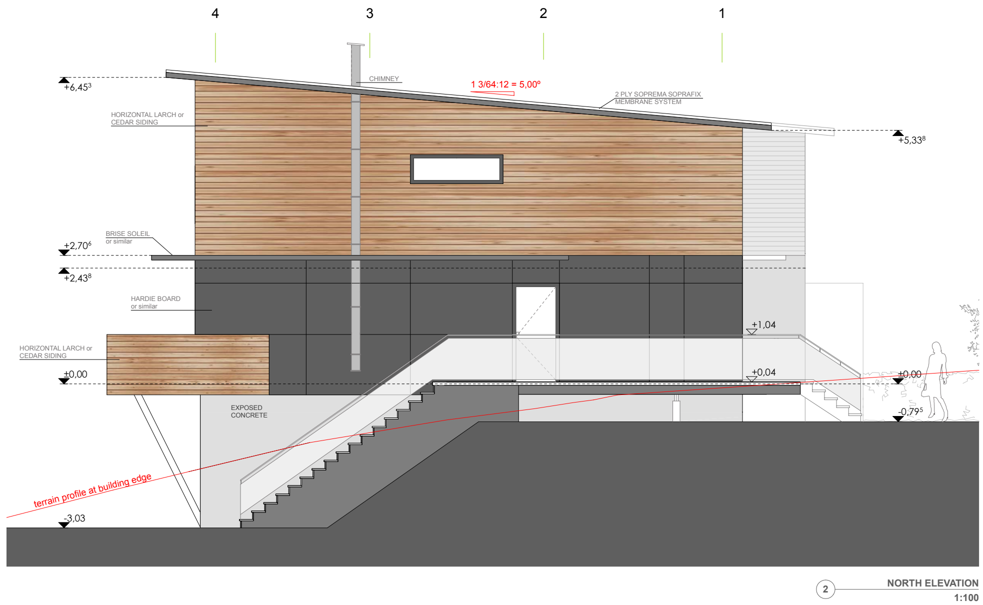
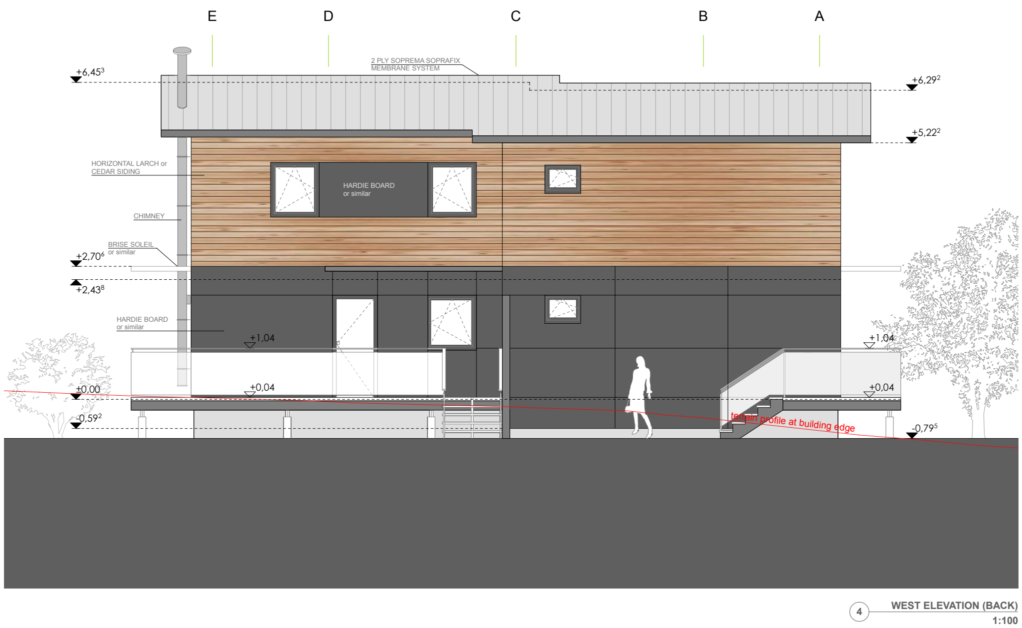


North Elevation

East (Front) Elevation



West (Back) Elevation

2.2 EXTERIORS

South West Perspective

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North East Perspective

Solar Hot Water Roof – South East Perspective

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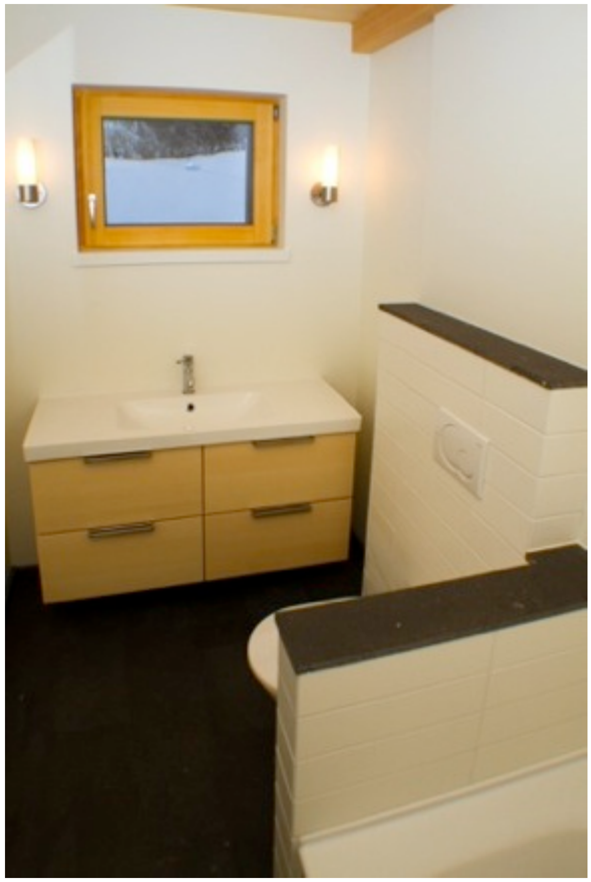
South East Perspective – Entry Way

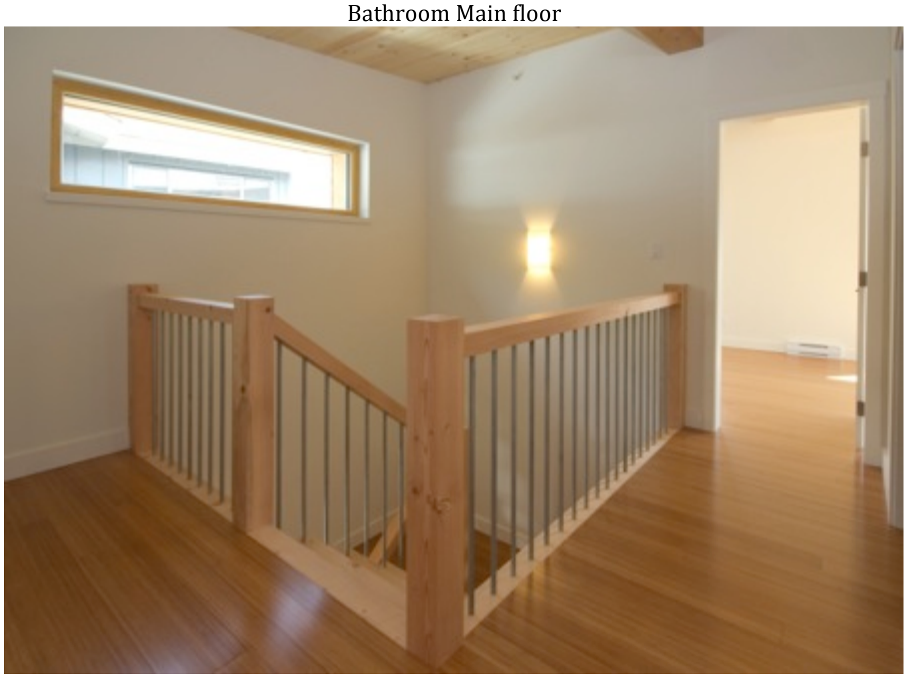

South East Perspective - Close up Shading Overhangs

2.3 INTERIORS


Kitchen Main Floor



Bathroom Main floor



Hall way Upper floor

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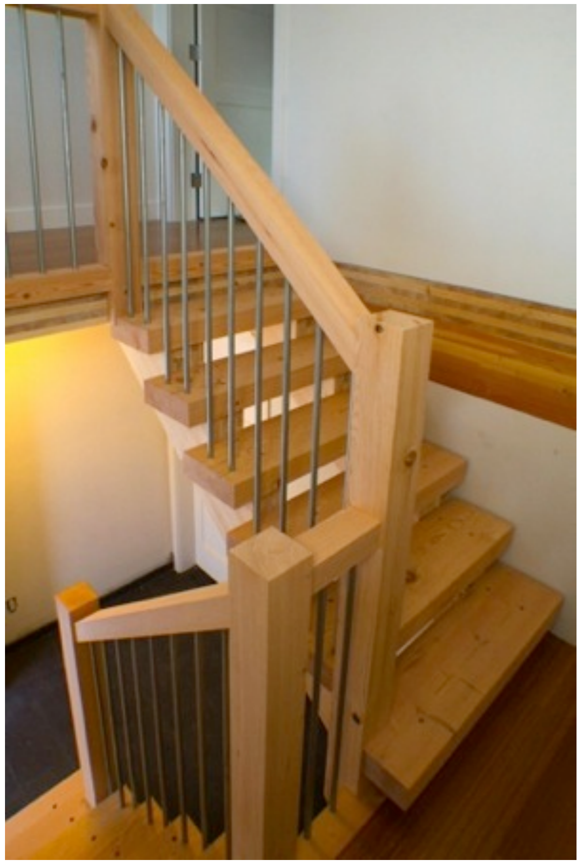
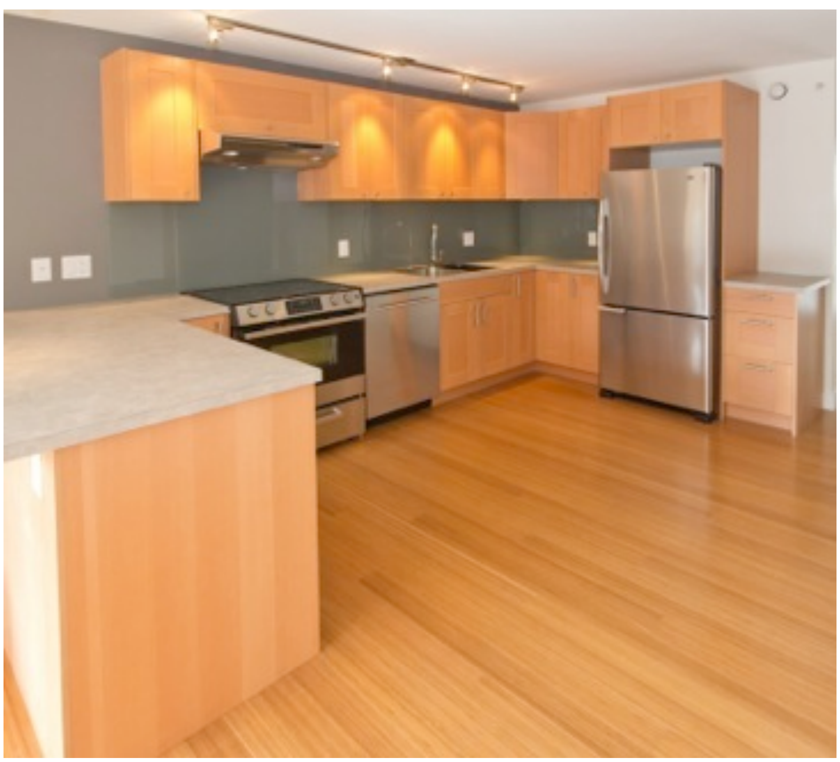


Cross laminated Stairwell | Main Floor-Upper Floor



Kitchen

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Living Room/Deck

2.4 BUILDING SECTION

Cross section Front (East)

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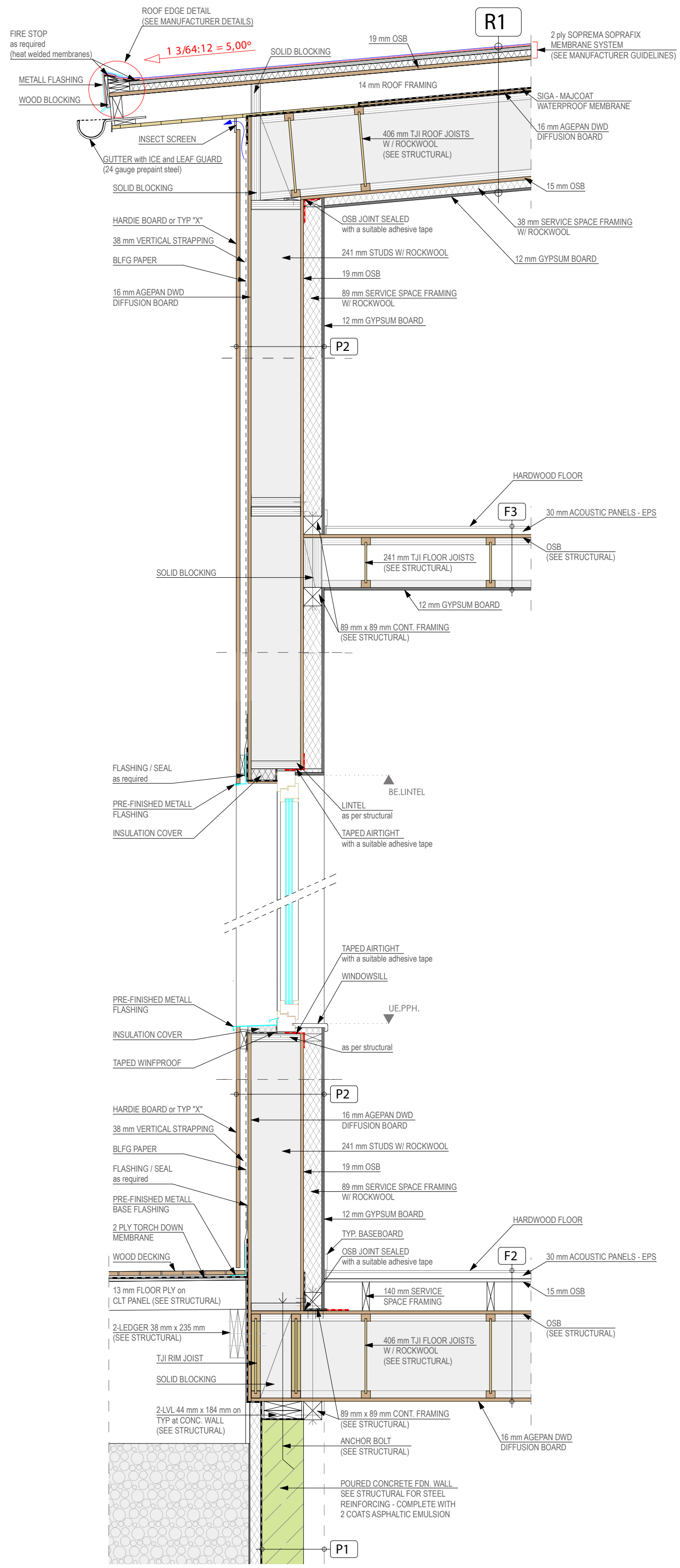
The building envelope of the Rainbow residence is very compact. Most of the below grade/lower level walls are concrete with exterior XPS insulation and finish system.

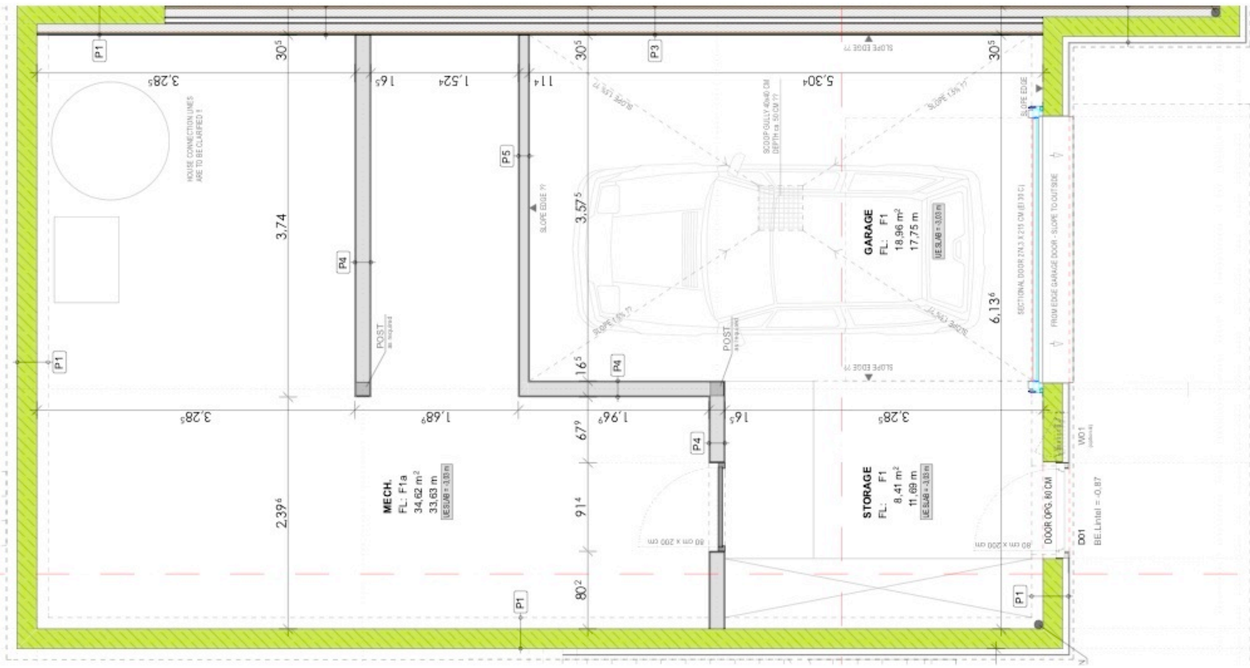
The subfloor structure between lower level, the exterior walls above grade and roof were manufactured by BC Passive House.

These are diffusion open wood panels with a wood fiberboard on the exterior, cellulose as insulation and OSB as vapor barrier. For more info on this system please visit www.bcpassivehouse.com.

For the deck and mid floor, CLT panels have been used as structural elements. Overhangs have been placed on the South/East side of the home to provide sufficient shading in summer, at the same time optimizing solar gain in winter.

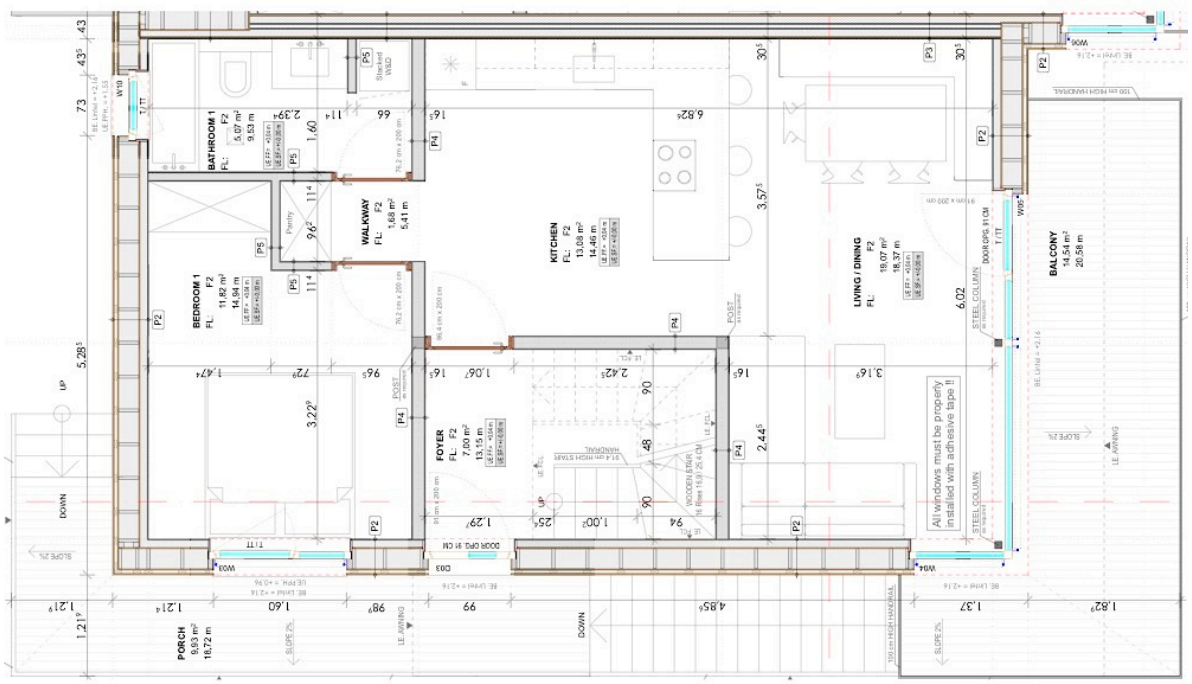


2.5. FLOORPLANS



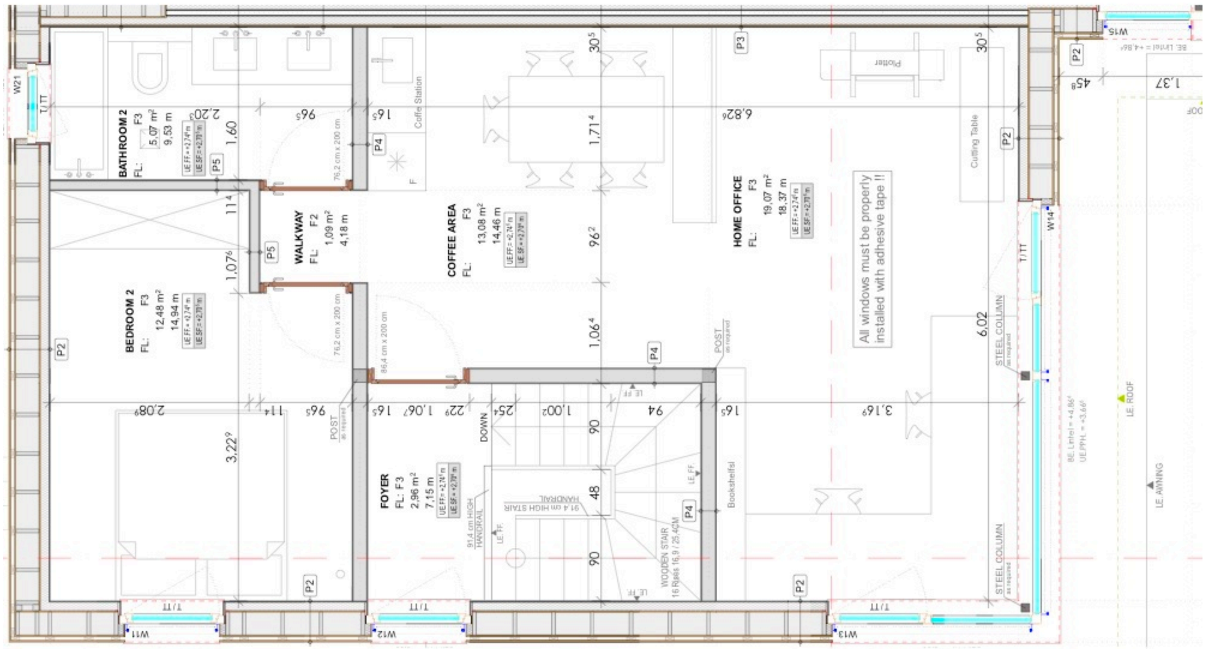
Lower Level – Garage

The lower level accommodates the garage, storage and mechanical room, which is not part of the Passive House envelope. These were the only uses allowed under the subdivision bylaws. The lower level is not connected to the upper main floor.



Main Level

The main level comprises of an open concept kitchen living area, a bedroom, one bathroom and the entryway. The living room opens to a large deck with incredible mountain views.

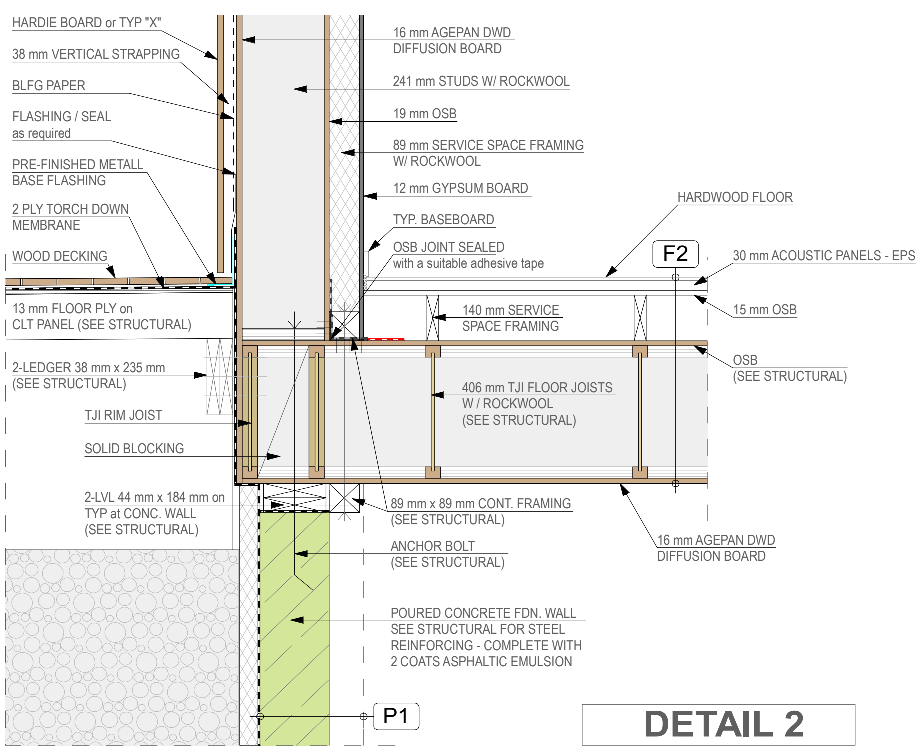


Upper Level

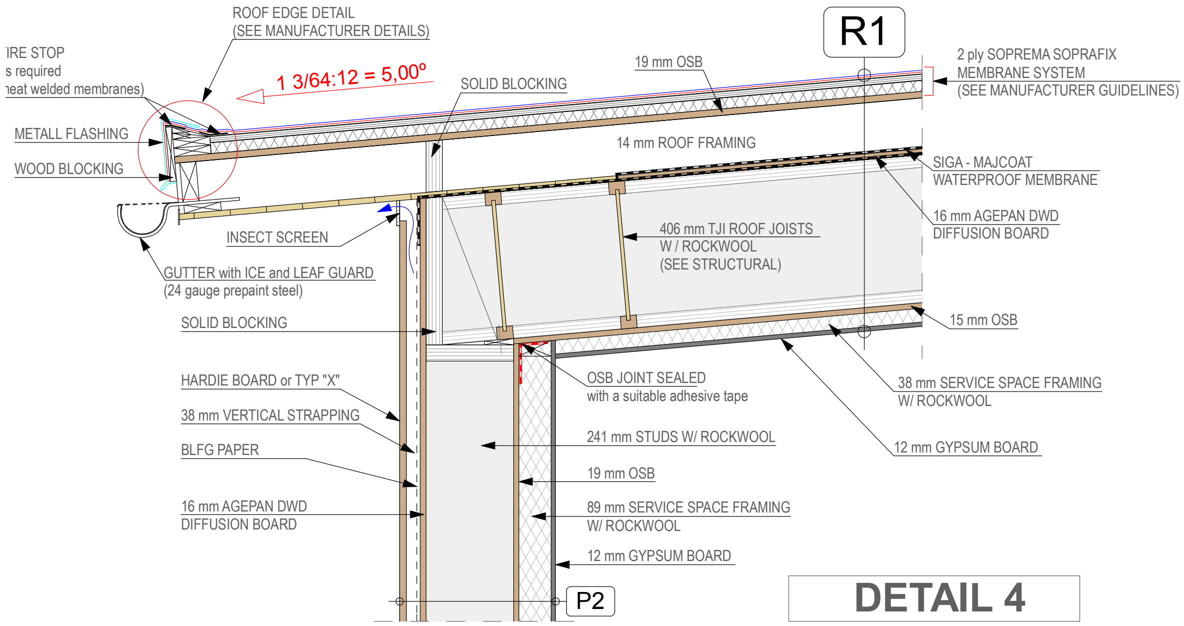
The upper floor accommodates the master bedroom, a bathroom and an open concept living/ work space for flexible use by the owners and their home based business.

2.6. CONSTRUCTION DETAILS

2.6.1. Subfloor to concrete wall- main floor and wall detail



2.6.2. Exterior wall to Roof detail

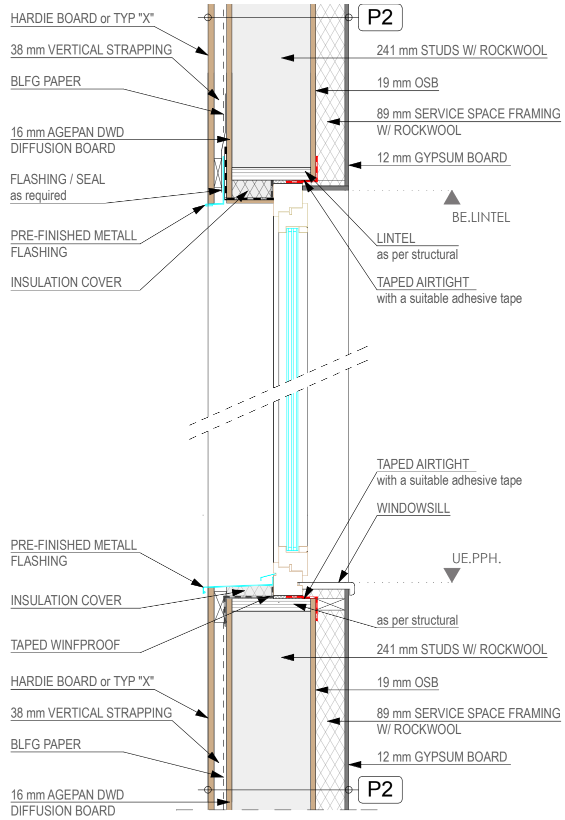


Wall to Roof Detail – Roof Framing

The connection details have been designed to minimize thermal bridging applying a continuous layer of insulation around the envelope avoiding envelope penetration as much as possible. Special attention as paid to all connection details where SIGA adhesive tapes where used to seal the OSB joints in order to ensure an airtight envelope (Detail 4). Insulation was placed in this area as to minimize thermal bridging.

SIga Adhesive tapes for airtightness control

2.6.3. Window details

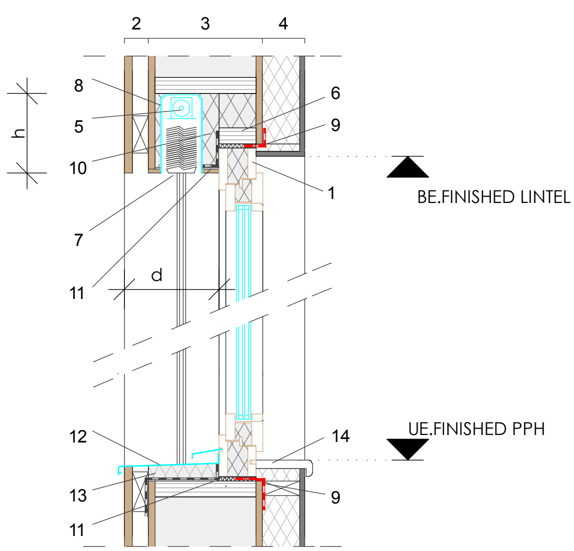


We used Passive House certified Optiwin Wood Aluminum windows from Austria with the following performance values:

- Uf – Value: 0.95 [W/(m²K)]
- Ug –Value: 0.6 [W/(m²K)]
- Uw –Value: 0.85 [W/(m²K)]
- g-Value: 0.52
- Glazing; Triple glazing filled with argon gas

In additional to the shading overhangs, exterior blinds were installed to provide additional shading on hot summer days, They can be operated electronically. On the exterior, an additional rigid insulation layer has been installed over the window frame to minimize thermal bridging.

1 window frame
2 curtain wall - ventilated
3 studs with insulation
4 installation wall with insulation
5 roll system
6 support frame
7 blind
8 mounting bracket
9 taped airtight
10 insulation cover as required
11 taped windproof
12 rain guard
13 caverns insulated
14 windowsill
d as required
h as required by window hight



2.7.5. DESCRIPTION OF AIRTIGHT ENVELOPE

The envelope (floor, walls, roof) consists of a prefabricated, panelized wood system manufactured in BC. The panels are super insulated, airtight but diffusion open to the exterior to ensure moisture is not trapped within the panels. The system is broken down into two main components: the structural component and the service wall component. The structural component contains the air barrier, superinsulation (densely packed cellulose) and structural requirements. The interior service wall component contains Roxul insulation, the plumbing, ventilation and electrical services. All panel connections and penetrations to the airtight barrier are taped and sealed with SIGA building tape and membrane products, maintaining the airtight barrier while still remaining diffusion open to the outside. (Credits: BC Passive House)

Infiltrometer Air Leakage Test Results

In Compliance with CAN/CGSB 149.10-2002

Standards (Imperial Units)

Test file name: **Passive house 8444**
Test technician:
Test company: **DW Energy Advisors**

Building address: **8444 Bear Paw Trail Whistler, BC**

Building Volume: **13,512 cu ft**
Envelope Area: **0 sq ft**

Building envelope:

Fan Model: **Retrotec 2000** Fan SN: Gauge Model: **DM-2** Gauge SN: **0**

Calibrated: Calibrated:

Depressurize Set

Environmental Conditions

Wind speed: **0 mph** from the
Wind variability: **dead calm**

Operator Location: **Inside** the building

Initial Conditions:
Baseline Pressure: **0.00 Pa**,
Temperature: indoors: **68 °F**, outdoors: **34 °F**

Final Conditions:
Baseline Pressure: **0.00 Pa**,
Temperature: indoors: **68 °F**, outdoors: **34 °F**

Test Results

Test Date and Time: **2012-2-28 12:17**

Air leakage coefficient, C_r: **1.940 CFM·Pa^n**

Exponent, n: **0.8606**

Correlation coefficient, r: **1.000**

Corrected Flow at 50 Pa: **56.15 CFM +/-0.0006**

Air Changes per hour at 50 Pa: **0.2495 /hr +/-0.0006**

Corrected Flow at 10 Pa: **14.20 CFM +/-0.0069**

Equivalent Leakage Area: **4.130 sq in at 10**

Normalized Leakage Area: **0.016 sq in / sq ft**

Permeability at 50 pa: **0.159 CFM / sq ft**

Specific Leakage rate, SLR at 50 pa: **cfm / sq ft**

Effective leakage area, EfLA at 4 pa: **1.810 sq ft**

Test Data

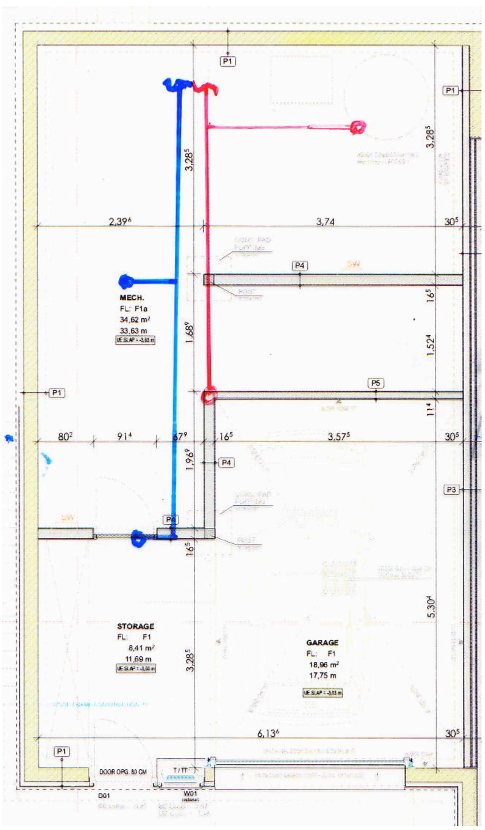
Set-up Conditons:
Deviations from the test method:

Induced pressure, ΔP_m (Pa)	**-60.0**	**-55.0**	**-50.0**	**-45.0**	**-40.0**							
Fan Pressure ΔP (Pa) Range: **CFM**	**68**	**63**	**58**	**53**	**48**							
Corrected Fan Pressure ΔP (Pa)	**68**	**63**	**58**	**53**	**48**							
Flow Q_m (L/s)	**68.00**	**63.00**	**58.00**	**53.00**	**48.00**							
Corrected Flow Q_r (L/s)	**65.77**	**60.94**	**56.10**	**51.26**	**46.43**							
Error [%]	**0.1%**	**-0.1%**	**-0.1%**	**-0.1%**	**0.2%**							

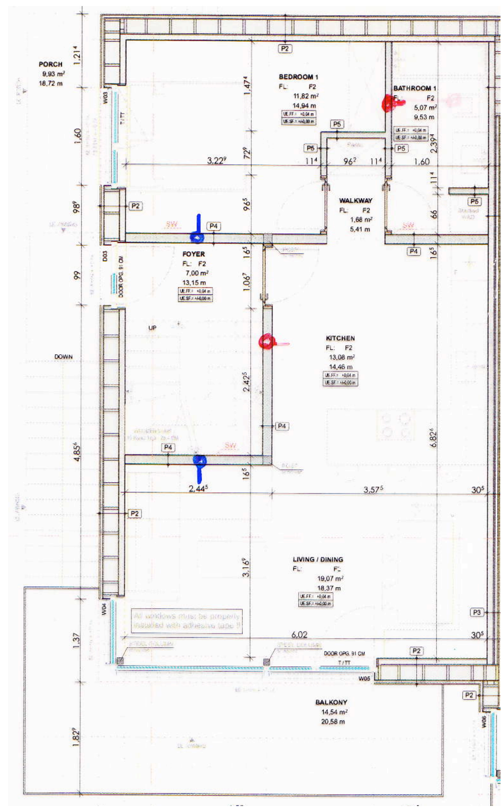
Building pressures taken for **20** seconds.
Baseline pressures taken for **30** seconds.

2.7.6. VENTILATION STRATEGY

For ventilation system in the Rainbow Residence we decided to go with the Paul Novus 300 ERV by Zehnder combined with the Zehnder Comfofond subsoil heat exchanger system. The subsoil heat exchanger system is intended to prewarm the incoming air during winter and precool during summer days. A ~60 meter Pex earthtube loop is buried ~1.8 meter in the ground filled with a brine and connected to the Comfofond heat exchanger unit.



Ventilation Plan lower level



Ventilation Plan main floor

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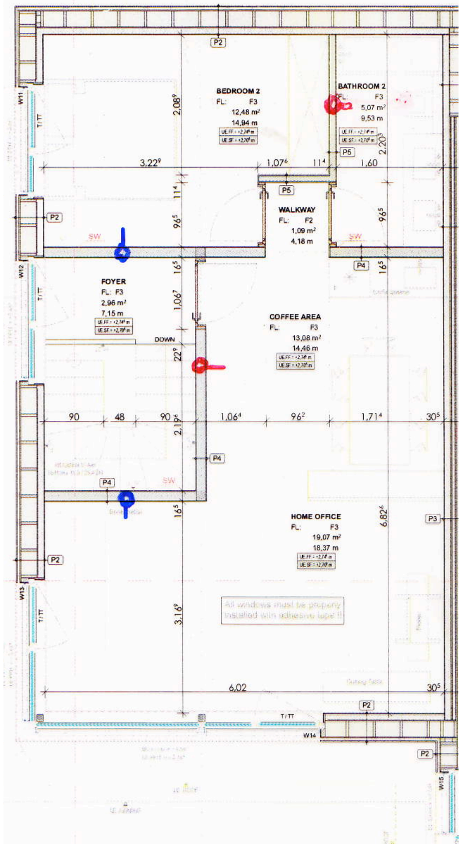

The duct system is run inside the 2x4 service wall in order not to penetrate the min exterior wall and to leave the airtight envelope undisturbed. Fresh air is supplied to the bedrooms and living spaces. Stail air (Exhaust Air) is drawn from the kitchen and bathrooms. Adjustable diffusers were used to precisely control air volumes.

The Ventilation and Comfofond unit are located on the lower level outside of the PH envelope with the air intake and exhaust running through the main floor service wall to the exterior.

Ventilation plan 2nd floor

2.7.7. TYPE OF VENTILATION, INSULATION FOR DUCTS, COMMISSIONING

The system was planned by Zehnder USA, installed my Terra Mechanical and balanced and commissioned by Matt Groves @ Zehnder USA. The ventilation unit has a summer bypass , which bypasses the ERV core to directly distribute cooler air to the inside during summer when available.

Ventilation Unit: ERV Unit Paul Novus 300:

Subsoil Heat Exchanger Unit: Comfofond by Zehnder

Values: 93% Heat Recovery / 0.26 Wh/m3 electric efficiency

2.7.8. HEATING STRATEGY

70% of the heat load for the home is delivered by an Air-to-Air Minisplit Heat Pump while 30% is delivered by electric mini baseboard heaters and electric Nu-heat mats with individual thermostats control for each zone.

Mitsubishi Minisplit Heatpump

The Mitsubishi ductless Air-to-Air "Mrs. Slim" heat pump features variable compressor speed inverter technology able to minimize the energy needed for maintain a comfortable indoor temperature and humidity level at all times. Further, it is equipped with an i-sensor which measures radiant hot and cold spots and focuses the airflow in these areas. This ductless technology works best for open spaces.

Mini baseboard heaters

Bedrooms are equipped with electric Mini baseboard heaters and individual thermostats able to provide heat when necessary. Nu-Heat heating mats are installed in the bathrooms for electric in-floor heating, also with individual thermostats for optimal temperature control.

2.8. PHPP VERIFICATION SHEET

Building:	Rainbow Passive House Duplex - South Unit			
Location and Climate:	Whistler*			
Street:				
Postcode/City:				
Country:	Canada			
Building Type:	Residential			
Home Owner(s) / Client(s):	Durfeld Log Construction Ltd.			
Street:	8440 and 8444 Bear Paw Trail			
Postcode/City:	Whistler, BC			
Architect:	Marken Projects			
Street:	#200-375 Water Street			
Postcode/City:	Vancouver, BC V6B 5C6			
Mechanical System:				
Street:				
Postcode/City:				
Year of Construction:	2011			
Number of Dwelling Units:	1		Interior Temperature:	20.0 °C
Enclosed Volume V_e:	466	m^3	Internal Heat Gains:	2.1 W/m²
Number of Occupants:	3.1			

Specific Demands with Reference to the Treated Floor Area

	Applied:	Annual Method	PH Certificate:	Fulfilled?
Treated Floor Area:	109.9	m^2		
Specific Space Heat Demand:	**15**	**kWh/(m²a)**	**15 kWh/(m²a)**	**Yes**
Pressurization Test Result:	**0.3**	**h^{-1}**	0.6 h^{-1}	**Yes**
Specific Primary Energy Demand (DHW, Heating, Cooling, Auxiliary and Household Electricity):	**106**	**kWh/(m²a)**	120 kWh/(m²a)	**Yes**
Specific Primary Energy Demand (DHW, Heating and Auxiliary Electricity):	59	kWh/(m²a)		
Specific Primary Energy Demand Energy Conservation by Solar Electricity:		kWh/(m²a)		
Heating Load:	16	W/m²		
Frequency of Overheating:	6	%	over 25 °C	
Specific Useful Cooling Energy Demand:		kWh/(m²a)	15 kWh/(m²a)	
Cooling Load:	10	W/m²		

2.9. CONSTRUCTION COST

Withheld

2.10. COST OF BUILDING

Withheld

2.11. YEAR OF CONSTRUCTION

2011/2012

2.12. DESIGN OVERVIEW

The building was designed with the clear goal to achieve the Passive House standard. The first preliminary PHPP was completed during the schematic design phase with subsequent updates as design milestones have been accomplished. The panelized construction method was selected to achieve max. airtightness and to eliminate thermal bridges. In addition, this construction method reduces construction time significantly, ensures a quality build of the envelope under controlled indoor conditions plus it minimizes material waste. The PHPP was used to optimize window size, placement and shading overhangs.

The design team took an holistic approach implementing additional sustainability features such as the use of local, non-VOC materials where possible, the use of local trades and the use of mostly renewable materials with focus on wood (wood first). Additional green features include a Solar Hot Water System, CLT floor and deck, water conserving appliances and fixtures, native landscaping, energy star appliances and more.

The residence was designed by Marken Projects and built by Durfeld Constructors with the prefab wood panels (exterior walls and roof) manufactured by BC Passive House. The CLT (Cross Laminated Timber) panels for the 2nd floor and deck were manufactured by Structurlam in Penticton. CLT cut off pieces were used for the interior stairs.

2.13. TECHNICAL DESIGN OVERVIEW

The technical systems were designed by Zehnder USA and Marken Projects (Alexander Maurer) in collaboration with Natalie Leonard (Passivedesign.ca).

2.14. PHPP MODELING & CERTIFICATION

The PHPP modeling was done by Alexander Maurer in collaboration with Natalie Leonard. Herz & Lang Consultants certified the building.

2.15. STRUCTURAL ENGINEER

Robert Malzcyk of Equilibrium Consulting was the structural engineer.

2.16. EXPERIENCES

The house is now occupied for over year and the feedback from occupants has been very positive. The energy consumption is being motored by the occupant.

2.17. REFERENCES

- Project website: http://www.markenprojects.com/en/rainbow-passive-house-duplex.html

- BC Passive House Prefab System: http://www.bcpassivehouse.com

- Project Media coverage: http://www.markenprojects.com/en/presse.html

- Project Construction Blog: http://passivegreen.wordpress.com/2011/11/16/another-sunny-day-at-the-whistler-passive-house/