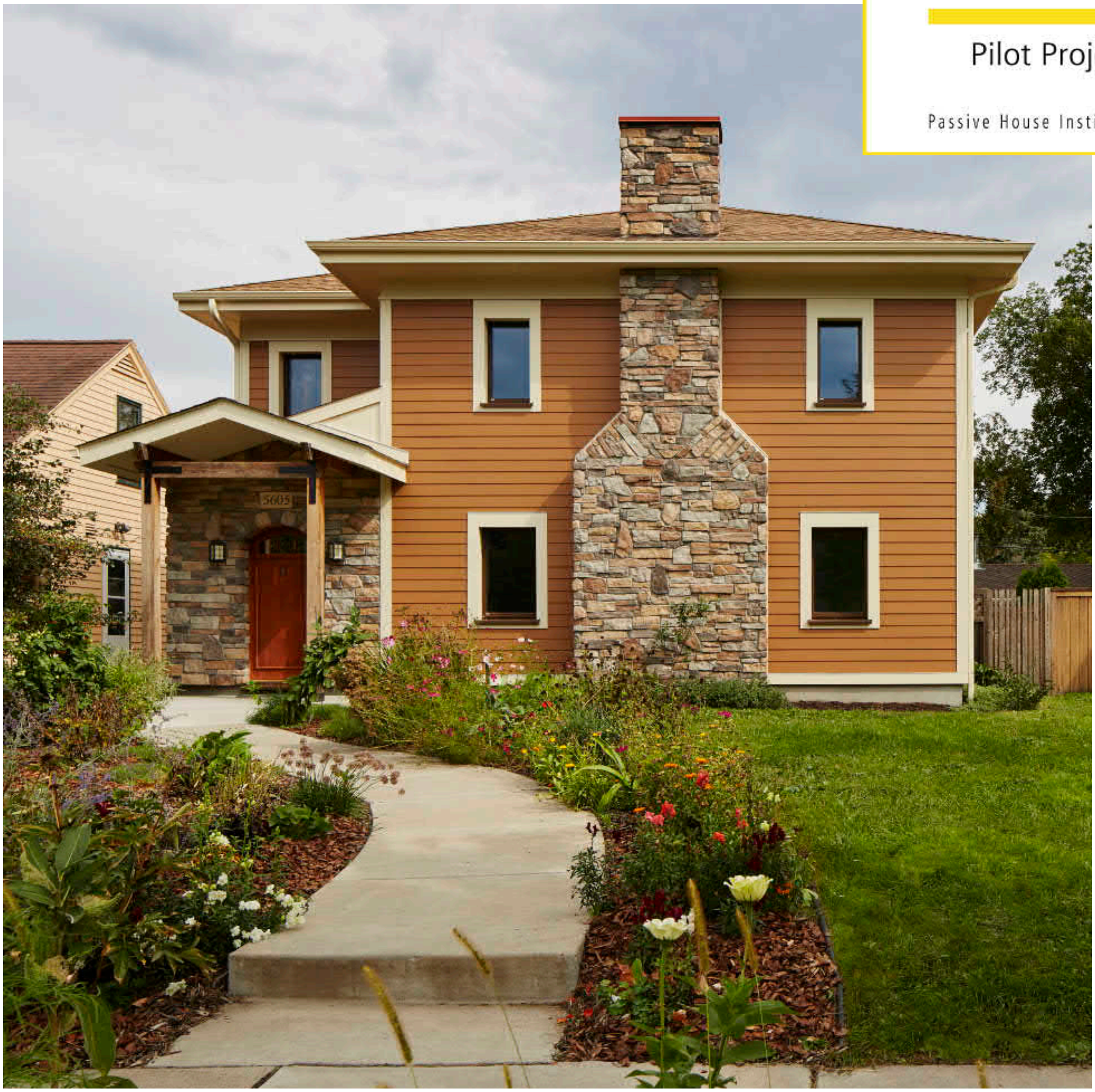
Passive House Object Documentation

MinnePHit Passive House Retrofit, Brazelton Residence – Minneapolis, MN (USA)
(Passive House project database ID 2069)

http://www.passivhausprojekte.de/#d_2069
Technical drawings in this document are not drawn to scale.

EnerPHit Pilot Project
Passive House Institute

1 ABSTRACT



Passive House Object Documentation

1.1 Data of Building

The MinnePHit Passive House Retrofit is a single-family home located in Minneapolis, Minnesota (USA) that was gut & retrofit to the (at the time) new EnerPHit standard. Based on the Passive House Institute's EnerPHit moniker & its Minneapolis locale, the clients coined this project the MinnePHit house. The final design included demolition and reconstruction of a small part of the footprint, a small addition, many different wall sections, a fully updated and upgraded building envelope, and new interior finishes throughout. Construction was completed in 2011-2012. The project is North America's first certified EnerPHit project & the first certified Passive House Retrofit in a very cold climate in the world.

Special features	Working with the structure of the existing house Fully updated home fits within historic neighborhood fabric Earth-friendly interior and exterior finishes throughout Automated continuous ventilation system with over 90% efficiency Successfully fit complex client program into small amount of space

Year of construction	2011-2012
U-value exterior wall (avg.)	0,11 W/(m!K)
U-value basement slab	0,17 W/(m!K)
U-value roof	0,073 W/(m!K)
U-value window	0,77 W/(m!K)
Effective heat recovery	89%

PHPP annual heating demand	**27** kWh/(m!a)
PHPP primary energy demand	120 kWh/(m!a)*
Pressure test n_{50}	0.65 h^{-1}

1.2 Brief Description

The MinnePHit House is a 5-bedroom, 3-bath, 185m^2 home that began as a 3-bedroom, 2-bath, 128m^2 home in Minneapolis MN. Commissioned by a private client, this home is the first certified Passive House EnerPHit in a very cold climate on the planet. It sits on an urban lot in an established neighborhood, near parks and trails and the historic Minnehaha Falls. With solid structural underpinnings but significant performance and size challenges for a family of five and two large dogs, the existing home was a prime candidate for a Passive House EnerPHit pilot. It demonstrates the amazing potential of high-efficiency retrofit design for existing homes in a cold climate. Find more about this project at http://testudio.com/projects/minnephit-house/.

1.3 Responsible Project Participants

Project Designer, Implementation Planning, Building Systems, Building Physics, Passive House Project Planning, Construction Management	Dipl.-Ing. Tim Delhey Eian - TE Studio, Ltd. (http://testudio.com)
Structural Engineering	Erik Bunkers, Mattson Macdonald Young (http://www.mattsonmacdonald.com)
Certifying Body	Passivhaus Institut Darmstadt
Certification ID	2069
Author of Project Documentation	Janneke Schaap, Intern Architect – TE Studio, Ltd. (http://testudio.com)
Date, Signature	25 May 2017

2 PROJECT ELEVATIONS AND PHOTOS

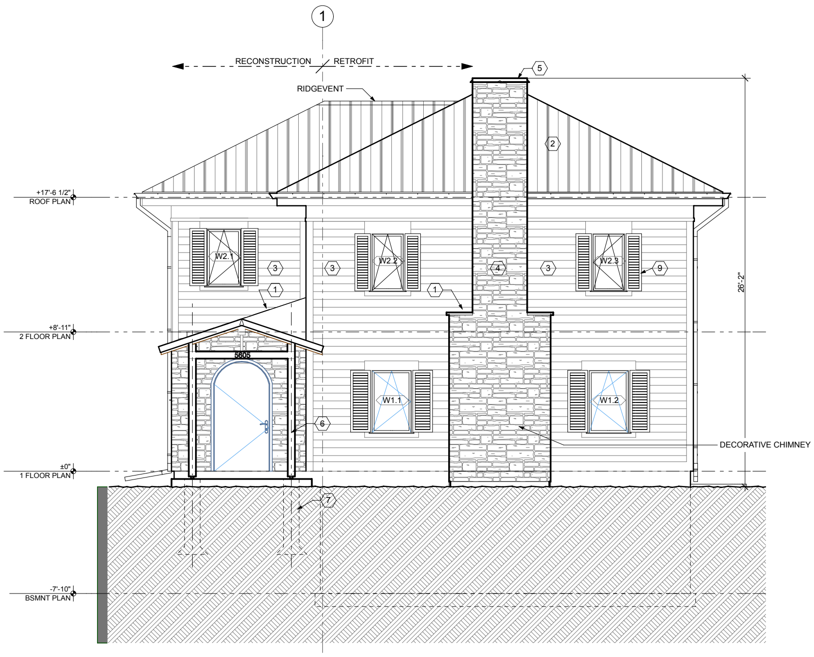
2.0 Existing Conditions

West elevation, before

Southwest perspective, before

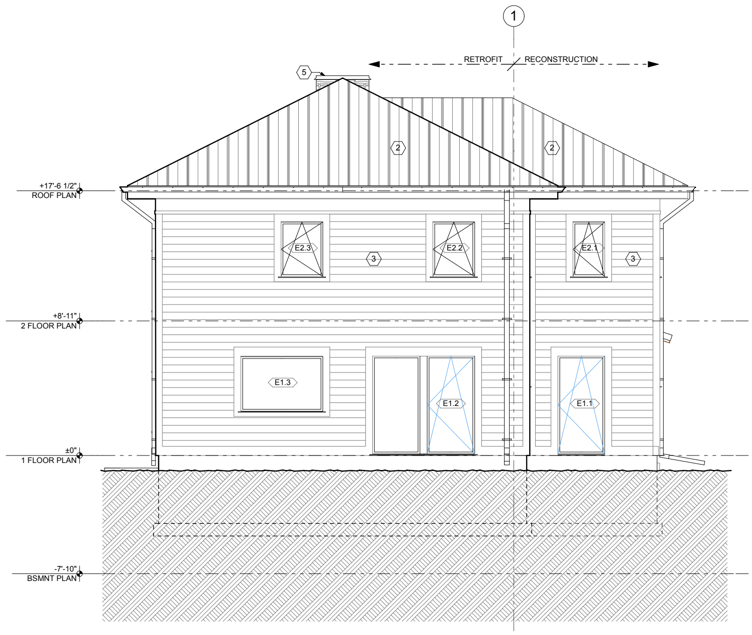
Passive House Object Documentation

2.1 Exterior



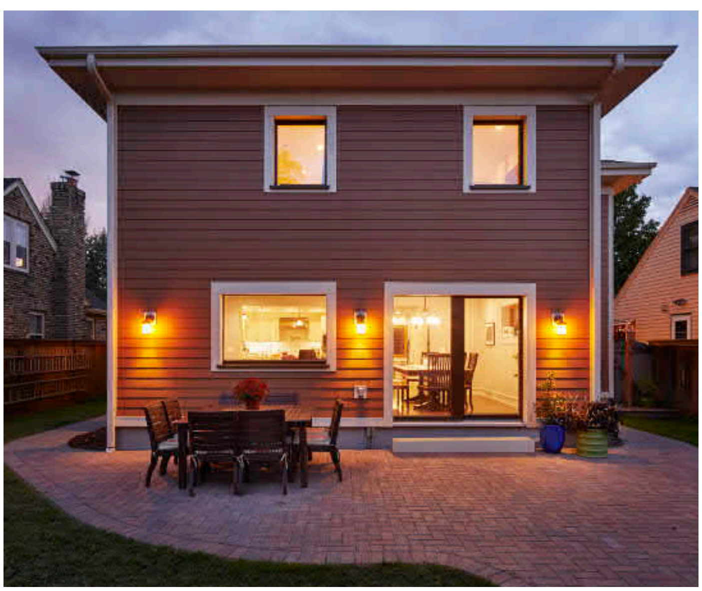
1. Sidewall flashing
2. Standing seam metal roofing
3. Cement board lap siding
4. Stone veneer
5. Sheetmetal cap
6. Timberframe entry canopy
7. Pier footing
8. Egress well
9. Functional shutters

West elevation (covered entry and street facade)

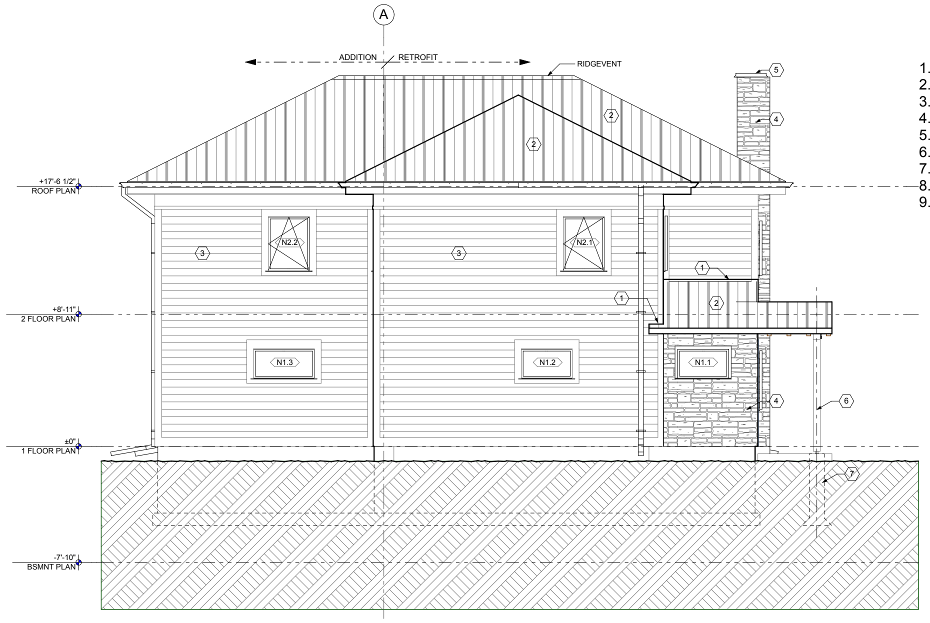


1. Sidewall flashing
2. Standing seam metal roofing
3. Cement board lap siding
4. Stone veneer
5. Sheetmetal cap
6. Timberframe entry canopy
7. Pier footing
8. Egress well
9. Functional shutters

East elevation (rear patio entrance)



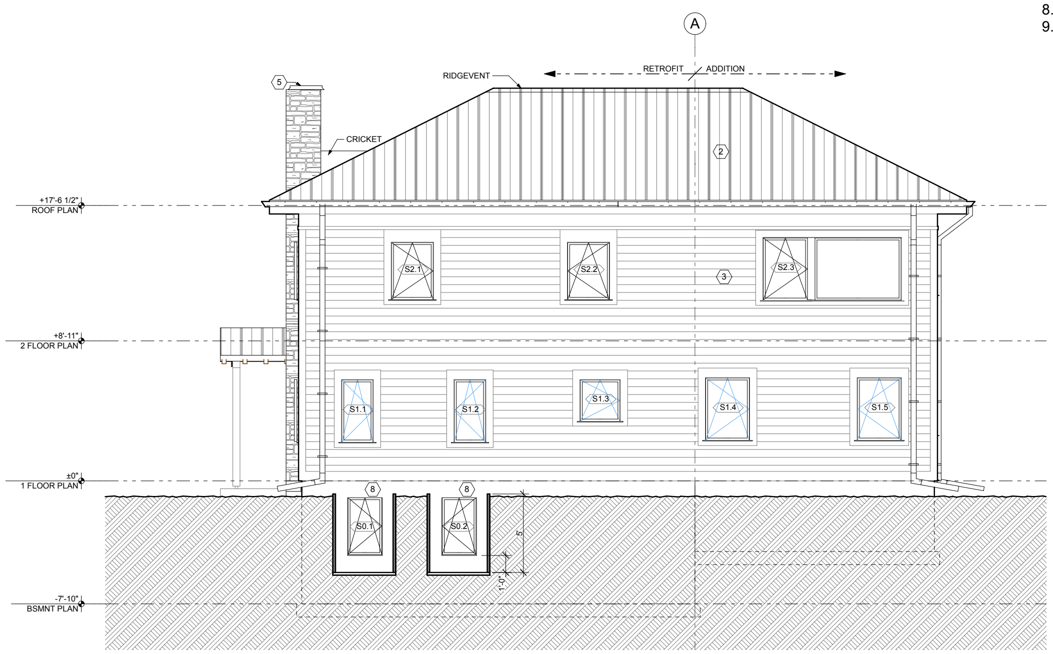
Passive House Object Documentation



1. Sidewall flashing
2. Standing seam metal roofing
3. Cement board lap siding
4. Stone veneer
5. Sheetmetal cap
6. Timberframe entry canopy
7. Pier footing
8. Egress well
9. Functional shutters

North elevation

1. Sidewall flashing
2. Standing seam metal roofing
3. Cement board lap siding
4. Stone veneer
5. Sheetmetal cap
6. Timberframe entry canopy
7. Pier footing
8. Egress well
9. Functional shutters



South elevation

Southwest perspective

Northeast

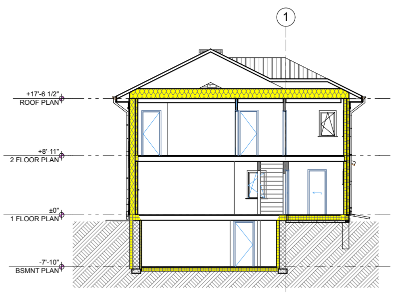
2.2 Interiors

Living room

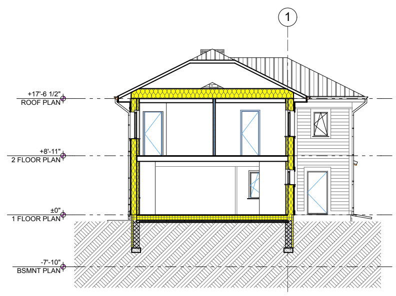
Kitchen

Passive House Object Documentation

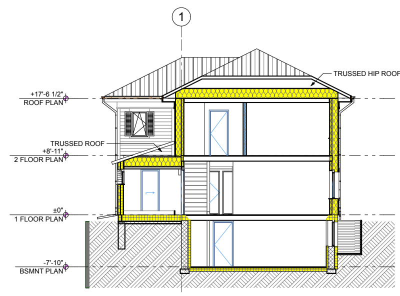
3 BUILDING SECTIONS



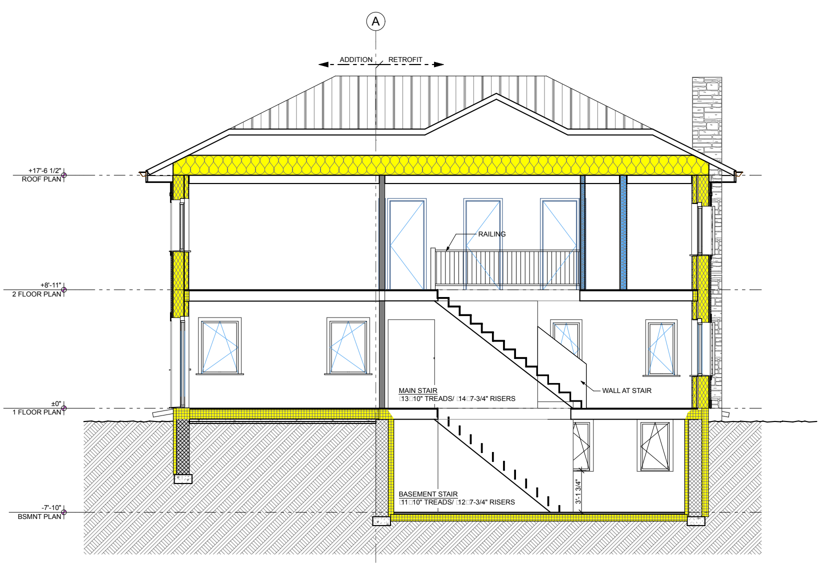
S-N Building Section @ Retrofit



S-N Section @ Addition



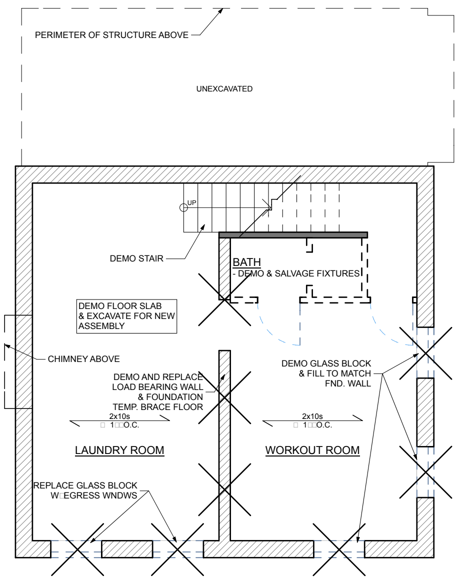
N-S Section @ Entry



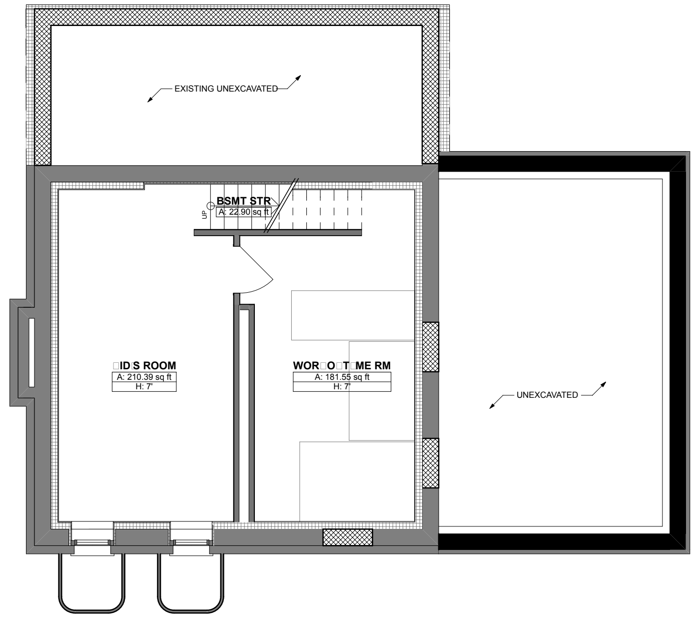
E-W Building Section @ Stair

The building envelope of the MinnePHit house is more diverse than most in effort to work seamlessly between new and existing assemblies. The basement slab was removed to insulate underneath a new concrete slab with rigid EPS foam. South and West below-grade exterior walls were excavated and insulated with rigid EPS applied to the exterior and closed cell spray foam from the interior for air barrier, while North and East below-grade walls received closed cell spray foam from the interior only for both insulation and air barrier, as excavation at these walls was not feasible. All new and existing above-grade exterior walls received new sheathing and i-joist framing added to the outside with dense-packed cellulose insulation, and the home has a completely new roof truss package that was meticulously air-sealed and insulated with loose-fill cellulose. New durable fiber-cement siding and Passive House windows complete the exterior package, and the result is a continuously air-sealed and insulated envelope that provides an efficient and comfortable interior in a cold climate year-round.

4 FLOOR PLANS

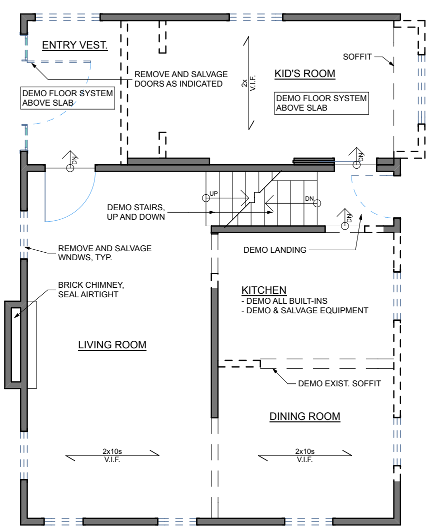


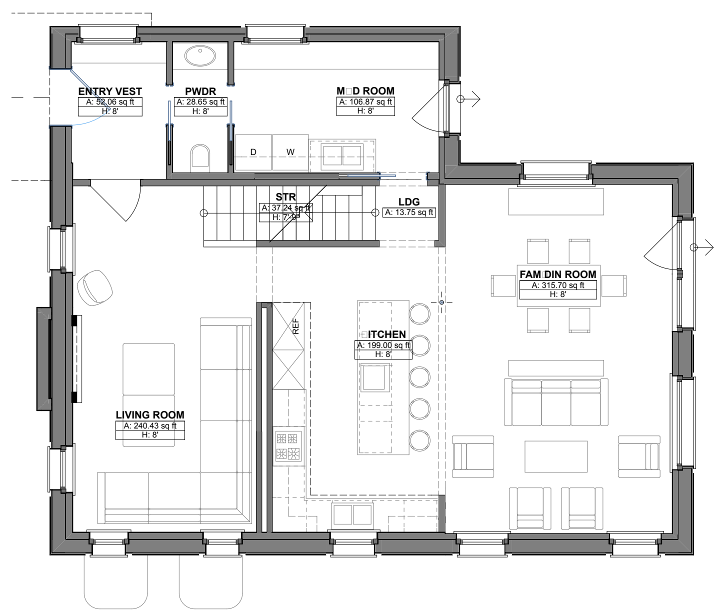
Basement floor plan – before



Basement floor plan - after

The basement level houses the kids' play room, which may double as a guest room with egress to the South when needed. A combination workout – mechanical room is used for exercise, equipment and storage. All below grade spaces are accessed from the North via a reconstructed stairway traveling through all levels. Two unexcavated areas flank the usable space – one existing to the North, one new under the addition to the East.



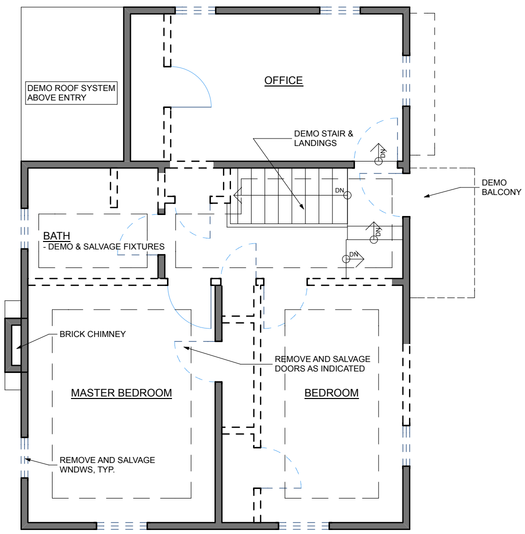


Main level floor plan – before

Main level floor plan - before

The main level holds the existing living area, as well as the expanded kitchen dining area, new mudroom and front entry with a walk-through powder room between.

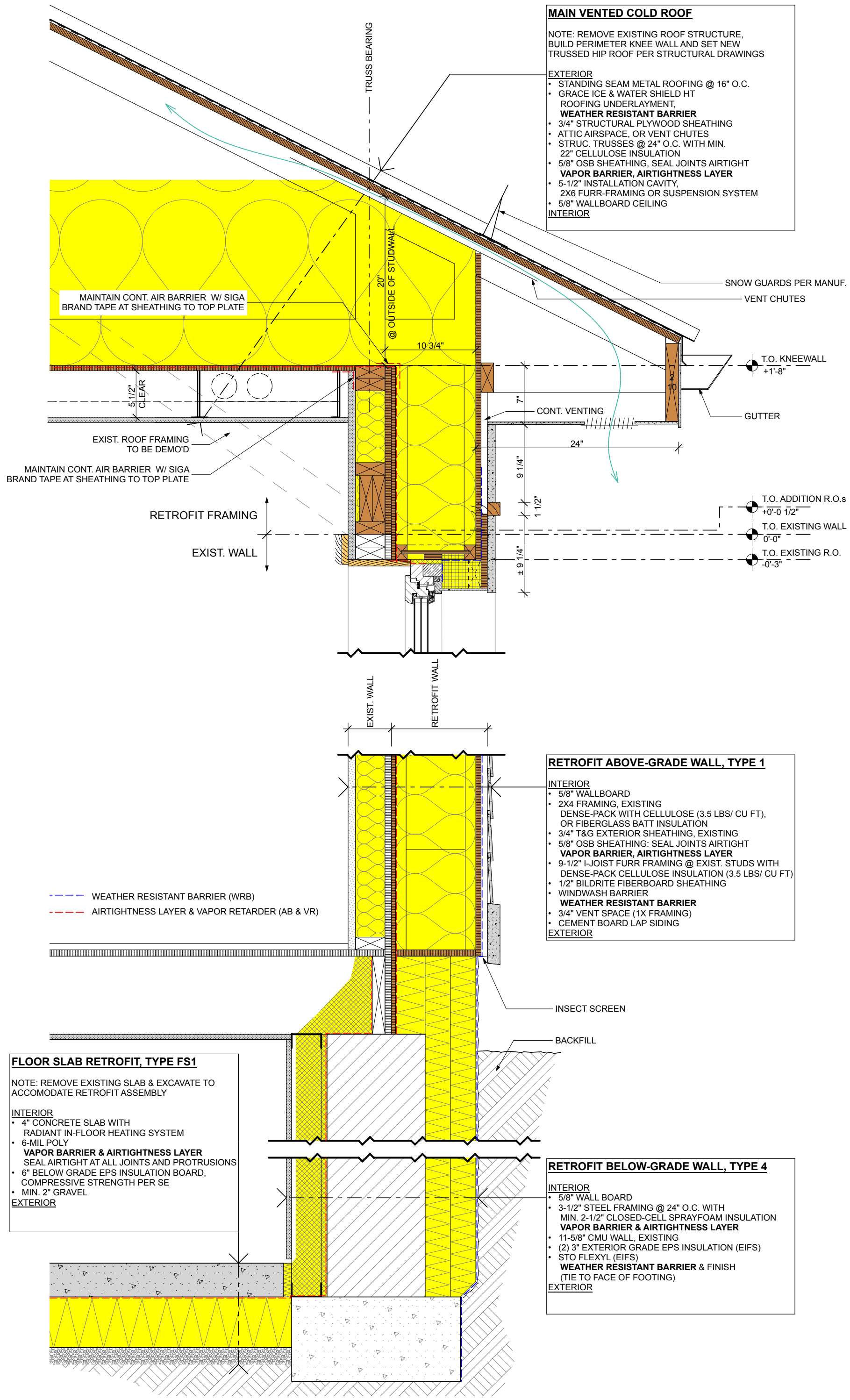
`



Upper level floor plan – after   Upper level floor plan - before

The upper floor contains the more private bedrooms and bathrooms. Space for two bedrooms was gained over the dining room addition below at the East, including that for a true master suite with walk-through closet and en-suite bathroom with shower. The existing bath was remodeled and is primarily used as a dedicated kid's bath, with a separate water closet moved to the hallway to accommodate multiple users at once.

5 CONSTRUCTION DETAILS



5.1 Typical retrofit assemblies section

Passive House Object Documentation

The building envelope of the MinnePHit house comprises a combination of existing and new assemblies. Connection details at interior walls and floors do not present a protrusion of the airtightness or insulation layers.

Above grade walls, typical

All existing 2x4 walls are insulated with batt insulation. OSB sheathing is added to the existing sheathing, which is taped at seams and transition details to provide the air barrier. 9 " ” [235mm] I-Joists are fastened to the existing studs. The newly created cavities are dense packed with cellulose providing an overall R-Value of 44 [U_{si} =0.128 W/(m^2K)]. Permeable fiberboard sheathing allows for drying potential to the outside. The new fiber cement board siding is mounted to furring strips (ventilated rainscreen) and gives the house a durable new façade that fits well with the historic original house and surrounding neighborhood.

Below grade walls, typical

6” [152mm] of EPS is added to the outside of the existing 11 $^5/_8$” CMU walls where accessible (South and West sides). On the inside 2” [51mm] of closed cell spray foam provide the air barrier. On the North and East sides excavation is not possible, thus 4 #” closed cell spray foam on the inside provide the air barrier and insulation in these areas. The below grade walls offer an R-value from 32 [U_{si} =0.176 W/(m^2K)] to 41 [U_{si} =0.138 W/(m^2K)].

Basement stair wall

Due to space restrictions at interior and inability to excavate at exterior, the below grade wall adjacent basement stair is insulated to the inside with Vacuum Insulated Panels glued to the block wall, taped at seams to provide the air barrier and covered with drywall. The R-value for this assembly is 26.9 [U_{si} =0.211 W/(m^2K] and is factored into the typical below grade average above.

Slab

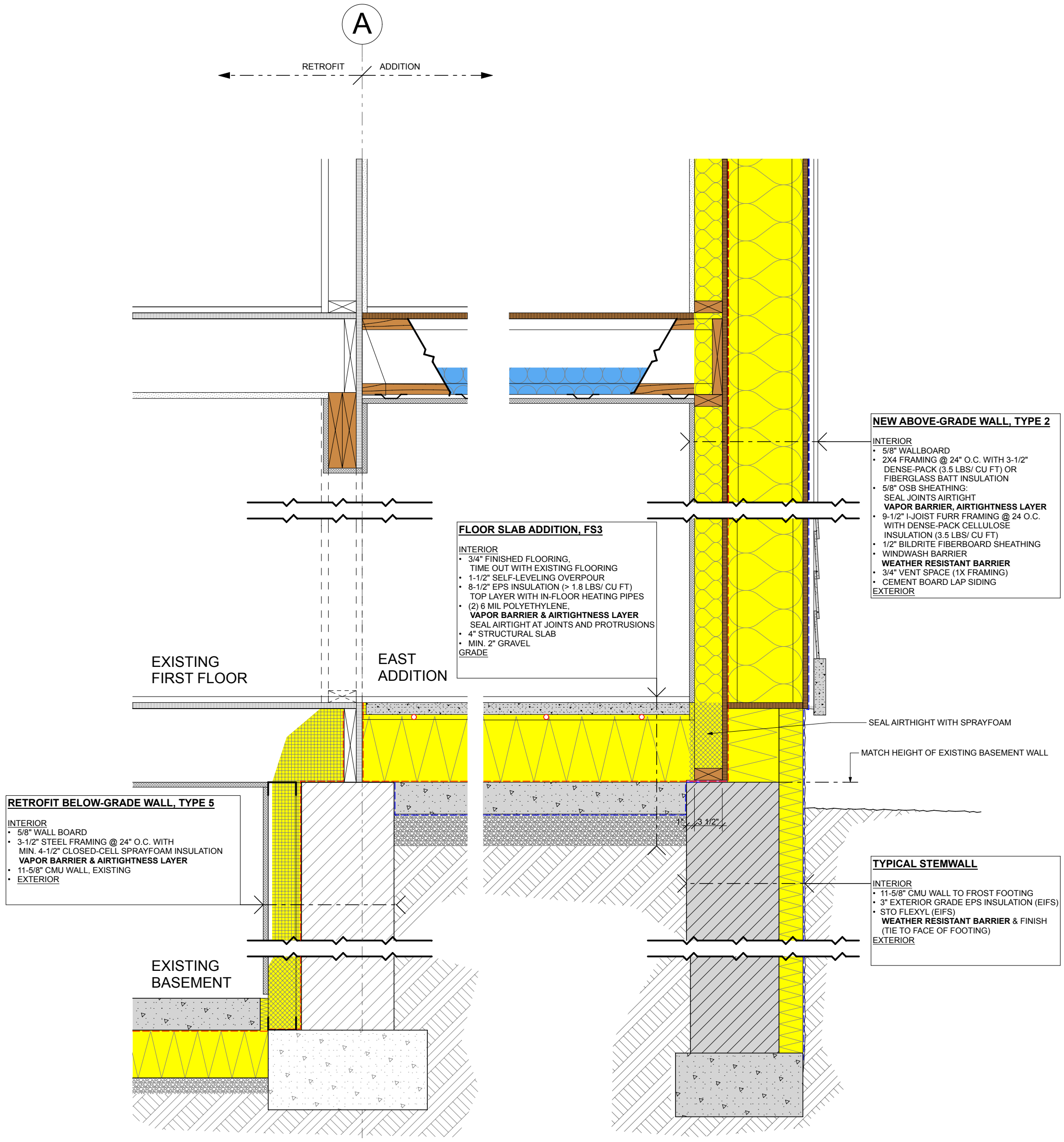
The existing slab was removed and ground excavated to the bottom of the footing. A new 4” concrete slab sits over 6” [152mm] of EPS insulation and two layers of 6 mil polyethylene membrane—taped at seams and transition details, which provide the air barrier. The new slab offers an R-value of 26 [U_{si} =0.219 W/(m^2K)].

Footing

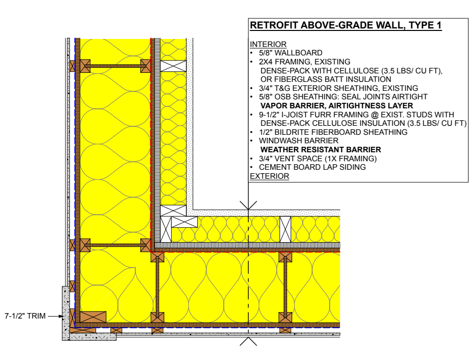
Existing footings are insulated with rigid EPS to the exterior where excavation occurred, and new footings have rigid EPS at interior and exterior as well as underneath.

Roof

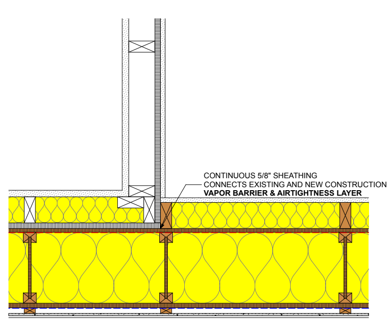
The existing roof was removed. The new roof is a cold roof finished with asphalt roofing. The 2nd story ceiling is insulated with 22” [559mm] of loose fill cellulose providing an R-value of 76 [U_{si} =0.074 W/(m^2K]. The underside of the trusses is sheathed with OSB taped at seams and transition details providing the air barrier. A suspended ceiling houses lighting and the ventilation ducts.



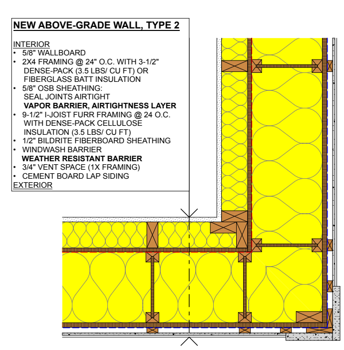
5.2 Typical transitions and assemblies



Typical corner at retrofit

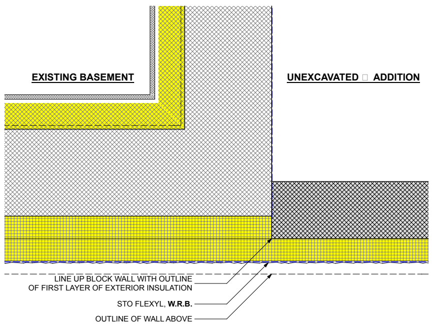


Existing to addition connection

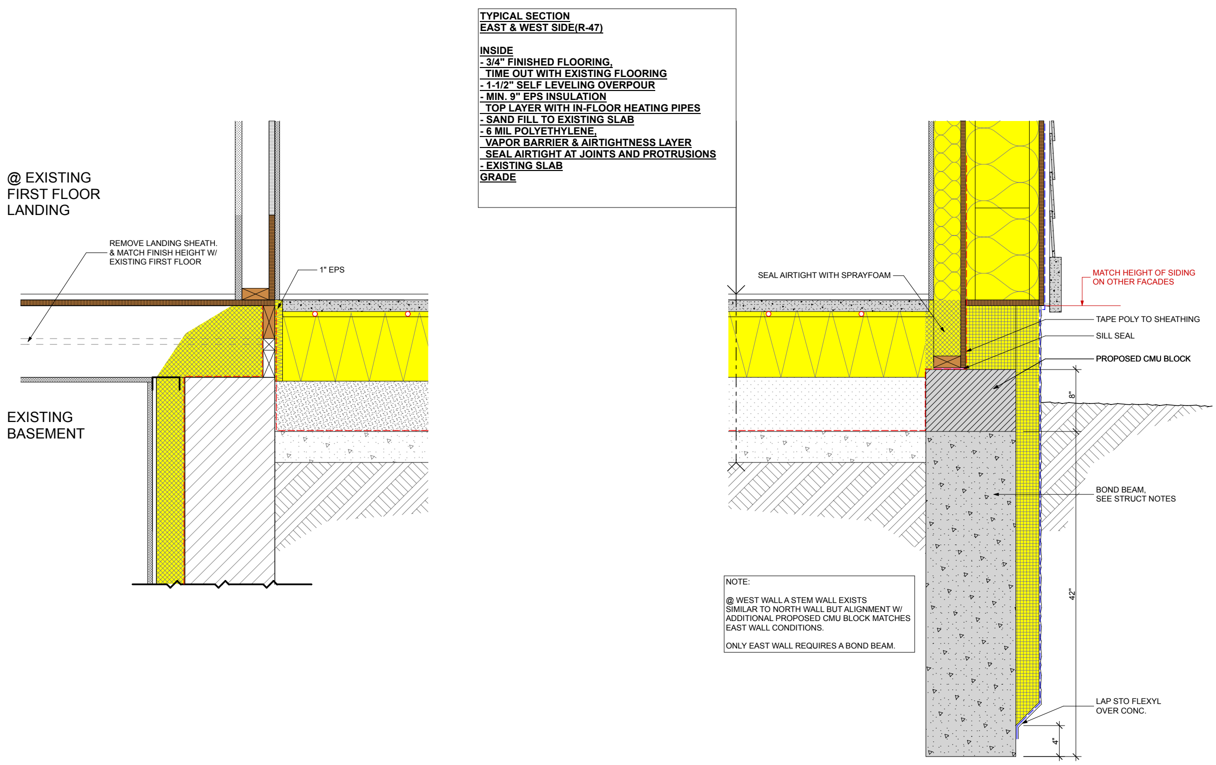


Typical corner at addition

Passive House Object Documentation

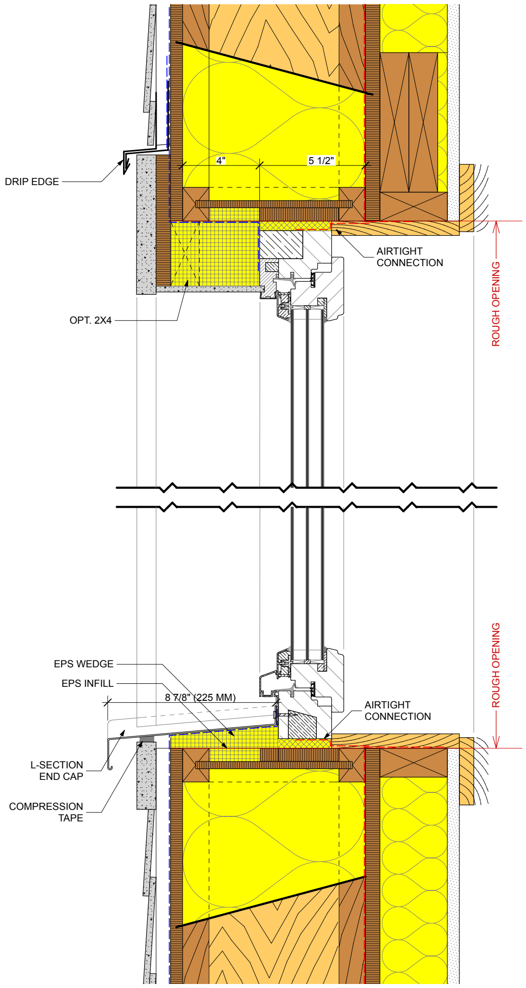


Basement transition

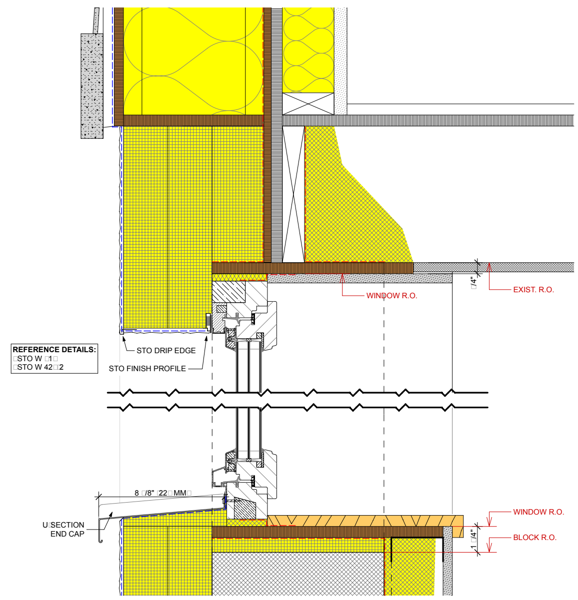


Typical North addition stemwall and basement connection

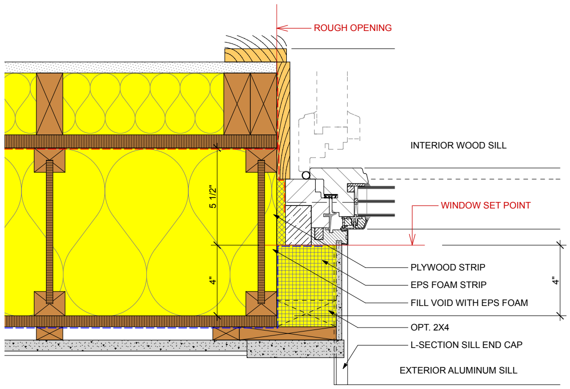
5.4 Window Details



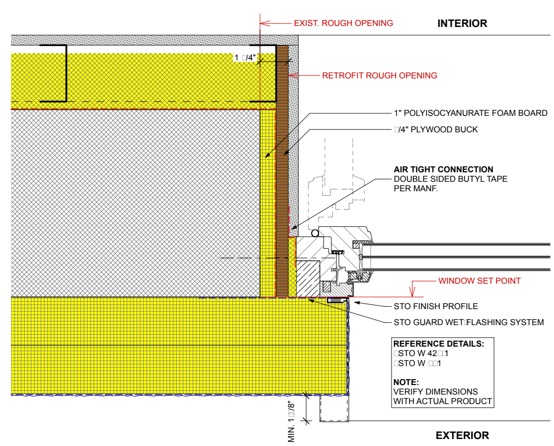
Typical window head and sill



Typical window head and sill, basement



Typical window jamb



Typical window jamb, basement

Passive House Object Documentation

The MinnePHit house has all new German-made Optiwin windows that are built into the insulation layer of the walls and eliminate thermal bridges.

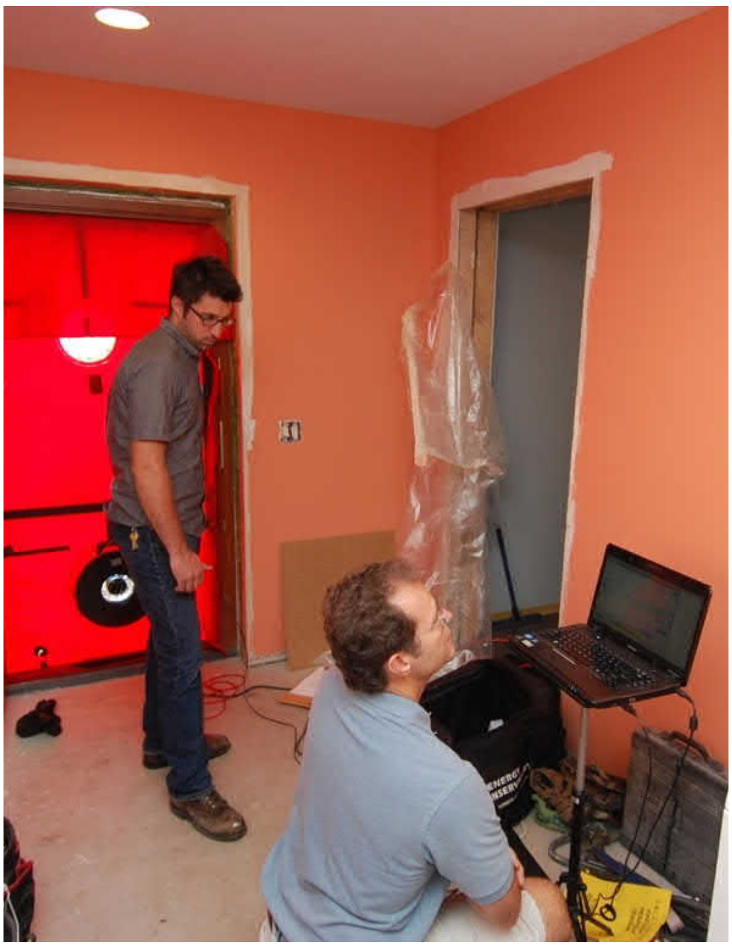
Frame: Optiwin, Alu2Wood
Aluminum-clad wood frame with cork insulation and Passive House certified at wall installation
$U_f = 0.93\ W/(m^2K)$

Glazing: Glas Trösch TRII 0,5 triple pane,
4mmm Eurofloat/ TRIII-/ Eurowhite 4mm/ Ar 95Lu5 18mm TRIII/ Eurofloat
$U_g = 0.5\ W/(m^2K)$
g = 52 %

The windows deliver an installed overall U_w of $0.76\ W/(m^2K)$.

6 DESCRIPTION OF THE AIRTIGHTNESS LAYER; INCLUDING TEST RESULTS

Two layers of polyethylene membrane, which are sealed and taped at connections and protrusions, provide the airtightness of the basement slab. Below grade exterior walls' airtightness is achieved with between 2-1/2" and 4-1/2" of closed cell spray foam insulation applied to the interior side. Above-grade exterior walls both new and existing are clad in a layer of OSB sheathing, taped at seams and transition details, which provides the airtightness. The underside of the new roof trusses is clad with OSB taped at seams and transition details, again providing the air barrier. Windows and doors are sealed with tape. Protrusions are caulked and foamed. The Energy Conservatory with the help of the Tectite software using the prescribed DIN EN 13829 protocol performed the pressure test. The building averaged 195 CFM_{50}, for depressurization and 197 CFM_{50} for pressurization for an average of 196 CFM_{50} or 0.65 ACH_{50}.



Air tightness test in progress

Air sealing at window

Air sealing at sheathing

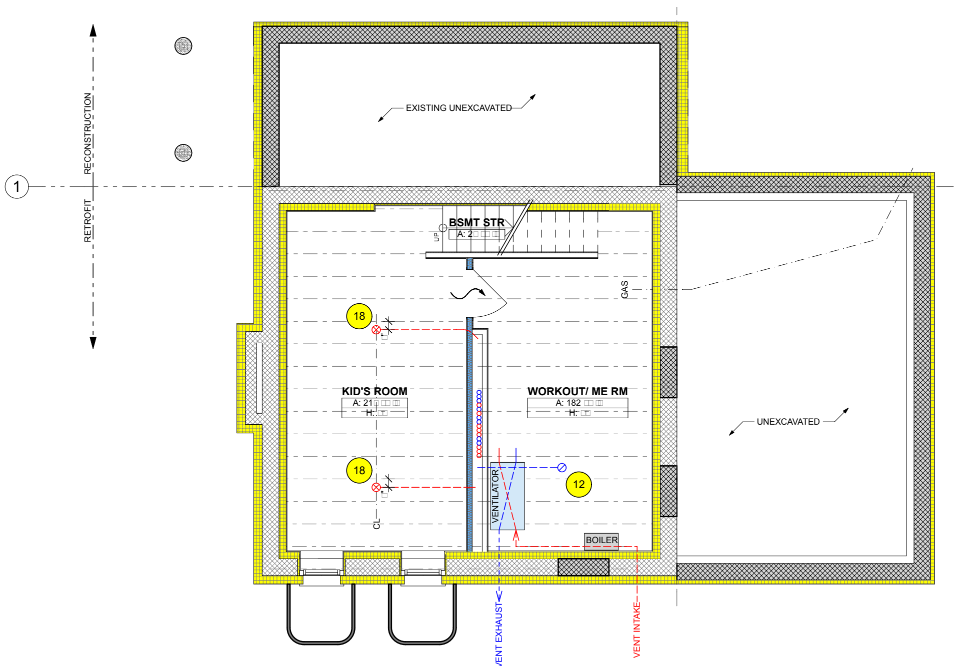
Air sealing at slab

7 VENTILATION LAYOUT

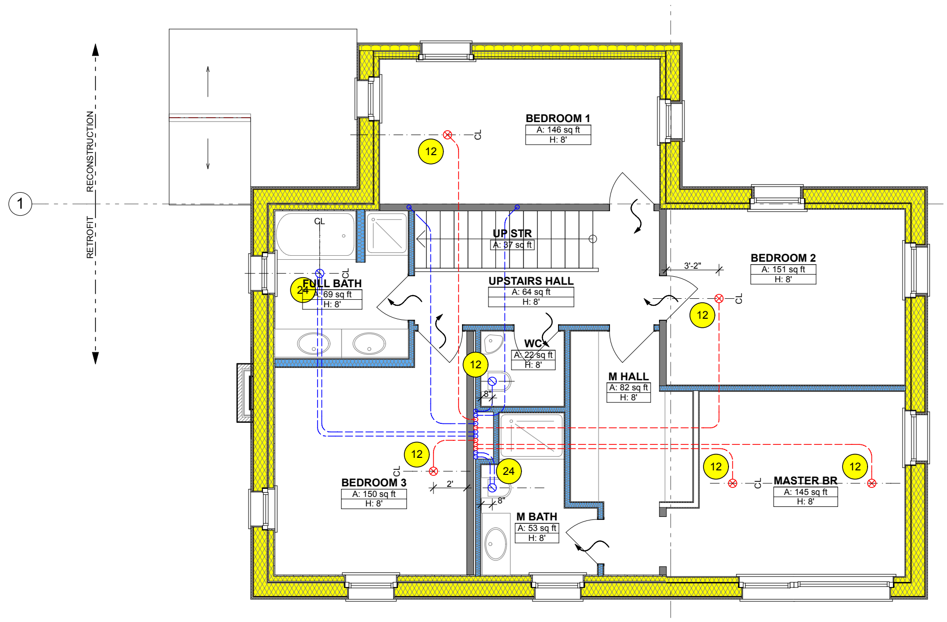
The ventilation system in the MinnePHit House revolves around a Paul Novus 300 HRV from Zehnder. It provides balanced ventilation with a rated heat recovery rate of 93%. An electric resistance pre-heater keeps the ventilator frost-free.

The duct system is home run. Outside air is supplied to living spaces and bedrooms, exhaust air returned from the kitchen, baths, and mechanical space. Adjustable diffusors are used to control air volumes. A common wall in the center of the home is used to keep vertical runs and overall duct lengths short.

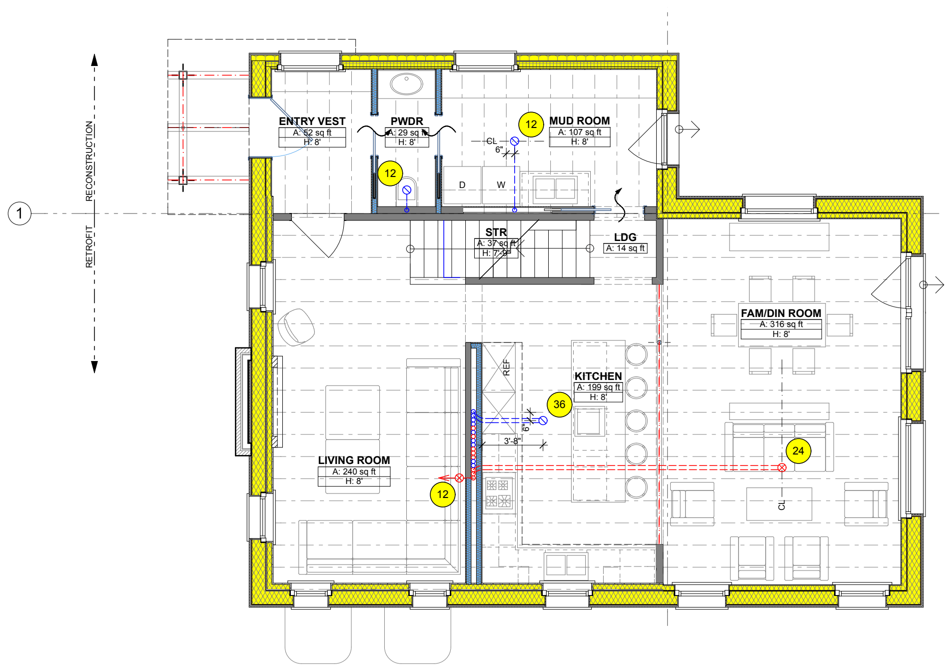
The ventilation machine is installed in the Workout / Mechanical room in the basement level adjacent the common wall that runs through all levels. Air intake and exhaust pipes connect straight through the wall.



Basement level ventilation plan



Main level ventilation plan

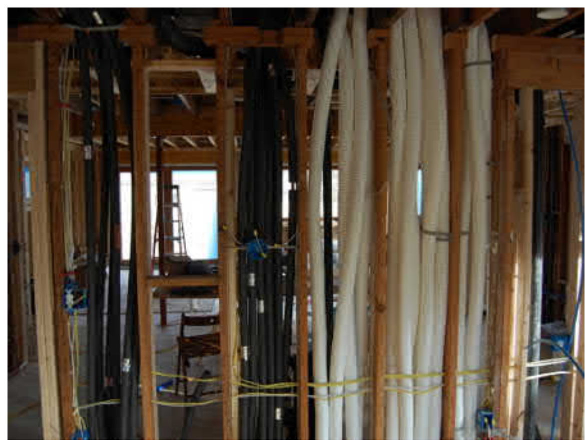


Upper level ventilation plan

Passive House Object Documentation

Zehnder Paul Novus 300 HRV

Zehnder ComfoDuct insulated exhaust



Zehnder ComfoTube supply and return ducts

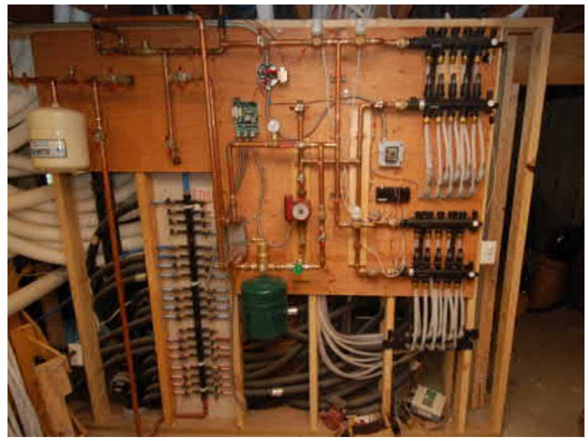
The ventilation system was laid out by TE Studio and commissioned by Zehnder. The ventilation machine offers a summer bypass to maximize passive cooling when available.

Central Unit:	Zehnder Paul Novus 300
Type:	HRV
Specific Values:	93% heat recovery/ 0.24Wh/m^3 electric efficiency

8 HEATING STRATEGY

The heat load for the home (approx. 4 kW) is delivered by an existing natural gas boiler connected to hydronic in-floor heat and the domestic hot water (DHW) system. It's efficiency is rated at 84%. The roof is engineered to receive a Solar thermal or PV system at a later date to further reduce the primary energy demand. The DHW system is home run.

Existing boiler: space heating and DHW



In-floor heat and DWH distribution system

Passive House Object Documentation

9 PHPP AND ENERPHIT

9.1 PHPP Verification Page

EnerPHit verification

Building:	"MinnePHit House", Brazelton Residence
Street:	5605 Bloomington Avenue S.
Postcode/City:	Minneapolis, MN 55417
Country:	USA
Building Type:	Single Family Detached
Climate:	Minneapolis
Home Owner(s) / Client(s):	Paul & Desiree Brazelton
Street:	5605 Bloomington Avenue S.
Postcode/City:	Minneapolis, MN 55417
Architect:	Tim Eian - TE Studio, Ltd.
Street:	212 2nd St.SE #222
Postcode/City:	Minneapolis, MN 55414
Mechanical System:	TE Studio, Zehnder USA, Paul Brazelton
Street:	
Postcode/City:	

Year of Construction:	2011-2012	Interior Temperature:	20.0	°C
Number of Dwelling Units:	1	Internal Heat Gains:	2.1	W/m²
Enclosed Volume V_e:	795.4			
Number of Occupants:	5.9			

Specific building demands with reference to the treated floor area — use: Monthly method

		Value	Unit	Requirements	Fulfilled?*
	Treated floor area	207.3	m²		
Space heating	Annual heating demand	27	kWh/(m²a)	-	-
	Heating load	20	W/m²	-	-
Space cooling	Overall specific space cooling demand		kWh/(m²a)	-	-
	Cooling load		W/m²	-	-
	Frequency of overheating (> 25 °C)	4.5	%	-	-
Primary Energy	Space heating and cooling, dehumidification, DHW, Auxiliary Electricity and household electricity.	120	kWh/(m²a)	134 kWh/(m²a)	yes
	DHW, space heating and auxiliary electricity	80	kWh/(m²a)	-	-
	Specific primary energy reduction through solar electricity	0	kWh/(m²a)	-	-
Airtightness	Pressurization test result n_{50}	0.7	1/h	1 1/h	yes

EnerPHit (retrofit): according to component quality

		Value	Unit	Requirements	Fulfilled?*
Building envelope	Exterior insulation to ambient air	0.11	W/(m²K)	-	-
average U-Values	Exterior insulation underground	0.17	W/(m²K)	-	-
	Interior insulation to ambient air		W/(m²K)	-	-
	Interior insulation underground	0.17	W/(m²K)	-	-
	Thermal bridges ΔU	0.01	W/(m²K)	-	-
	Windows	0.77	W/(m²K)	-	-
	External doors	0.79	W/(m²K)	-	-
Ventilation System	Effective heat recovery efficiency	89	%	-	-

* empty field: data missing; '-': no requirement

EnerPHit building retrofit (acc. to component quality)?	**PILOT CERTIFICATE FOR COLD CLIMATE**	**yes**

We confirm that the values given herein have been determined following the PHPP methodology and based on the characteristic values of the building. The PHPP calculations are attached to this application.

Name:	**Registration number PHPP:**
Surname:	**Issued on:**
Company:	**Signature:**

9.2 EnerPHit Certificate

Certificate

Certificate ID: 5583_PHI_EP-Pilot_20130110_STh

Passive House Institute
Dr. Wolfgang Feist
Rheinstraße 44/46
64283 Darmstadt, Germany

The Passive House Institute hereby awards the EnerPHit Pilot Project certificate to the following building:

EnerPHit Pilot Project in Minneapolis, 5605 Bloomington Avenue S., MN 55417 Minneapolis, USA

EnerPHit
Pilot Project
Passive House Institute

Client:	Paul&Desiree Brazelton 5605 Bloomington Avenue S., MN 55417 Minneapolis, USA
Architecture:	Tim Eian - TE Studio, Ltd. 212 2nd St.SE #222, MN 55414 Minneapolis, USA
Building Services:	TE Studio, Zehnder USA, Paul Brazelton

This building was designed to meet the Passive House component energy retrofit criteria as defined by the Passive House Institute Darmstadt. Given appropriate on-site implementation, this building has the following characteristics:

Building characteristics:	Achieved	Required	
Annual specific space heating demand	27 kWh/(m²a)	= 25 kWh/(m²a)	-[1]
Annual specific primary energy demand[2] for heating, DHW, ventilation and all other electric appliances for standard use	120 kWh/(m²a)	= 134 kWh/(m²a)	✔
Airtightness of building envelope n_{50} as per test result	0.7 h^{-1}	= 1.0 h^{-1}	✔
Mean value of individual building component thermal protection :			
Exterior insulation to ambient Thermal transmittance (U-value)	0.11 W/(m²K)		✔
Exterior insulation to ground Thermal transmittance (U-value)	0.17 W/(m²K)		-
Interior insulation to ground Thermal transmittance (U-value)	0.17 W/(m²K)		✔
Thermal bridges Δ_U Building envelope (window installation excluded)	0.01 W/(m²K)	No limiting value	
Windows Thermal transmittance $U_{w,installed}$	0.77 W/(m²K)		✔[2]
Exterior doors Thermal transmittance $U_{w,installed}$	0.79 W/(m²K)		✔
Ventilation unit Effective efficiency of heat recovery	89 %		✔

[1]Limiting value is not relevant. [2]Improved windows ($U_{w,installed}$ = 0.85 W/(m²K)) are recommended in order to meet comfort criteria in winter conditions as optimal thermal comfort directly near window areas cannot currently be guaranteed. Thick curtains or use of floor heating is thus recommended.

Certification criteria met? Selection of the evaluation method		
	Space heating demand	
	Component quality	✔

issued:
Darmstadt, 10.01.2013

Dr. Wolfgang Feist

10 BUILDING COST

Withheld per owner request.

11 DESIGN OVERVIEW

The building was designed from the outset to solve programmatic and spatial challenges while meeting EnerPHit criteria. The first PHPP was completed during schematics as a tool to explore the bounds of the retrofit and present potential opportunities to the clients, and was subsequently kept current with design evolutions. The construction methods were selected specifically with airtightness in mind, as the local building industry does not have a lot of experience with airtight buildings, especially in a retrofit application. Fenestration and glazing were fine-tuned using the PHPP.

In an effort to deliver a holistic and sustainable design, specifications were guided by their impact to indoor environmental quality and occupant health, water conservation, resource efficiency, site and community impact as well as comfort and energy performance.

The home was designed by Dipl.-Ing. Tim Delhey Eian of TE Studio, Ltd. with the help of Barbara Schmidt of Studio BStyle (interior design).

11.1 Technical Design

The technical systems were designed by Dipl.-Ing. Tim Delhey Eian of TE Studio, Ltd.

11.2 PHPP Modeling & Calculation

The PHPP modeling was done by Dipl.-Ing. Tim Delhey Eian of TE Studio, Ltd. The Passive House Institute of Darmstadt, Germany certified the building. Wolfgang Feist of the Passive House Institute in Darmstadt issued the EnerPHit certificate on 10 January 2013.

11.3 Structural Engineering

Eric Bunkers, P.E. of Mattson Macdonald Young provided structural engineering for the project.

12 REFERENCES

• Project on architect website: http://testudio.com/projects/minnephit-house/