

Passive House retrofits

PH retrofit plan case study

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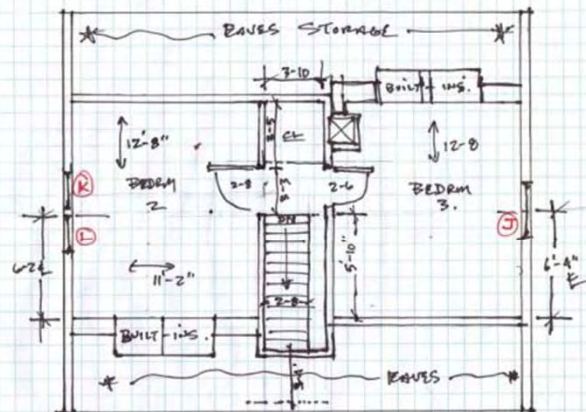
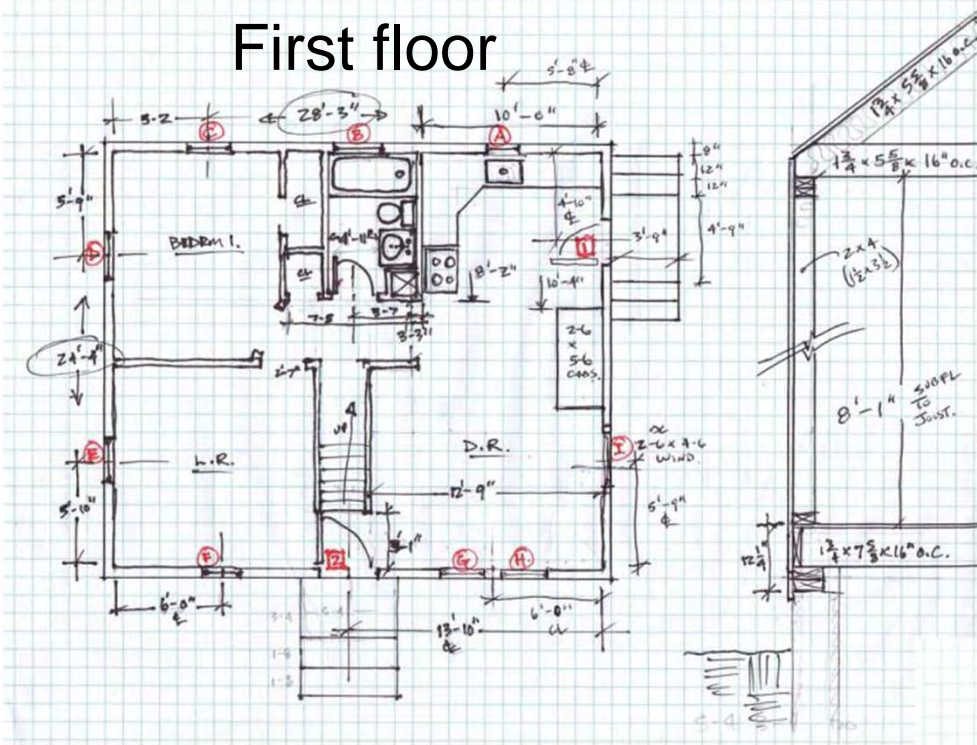
Overview

- Family of 4
- 900 sq. ft. of above-grade living space
- Full basement
- Current energy use:
 - 550 gallons oil for heat & DHW
 - Approx. 98K Btu/sf/yr total energy usage

Passive House Retrofit

- Most rigorous building energy standard in the world
- Small house is worst case for PH SHD
- New Home PH standard, not EnerPHit
- Severe budget restriction

First floor



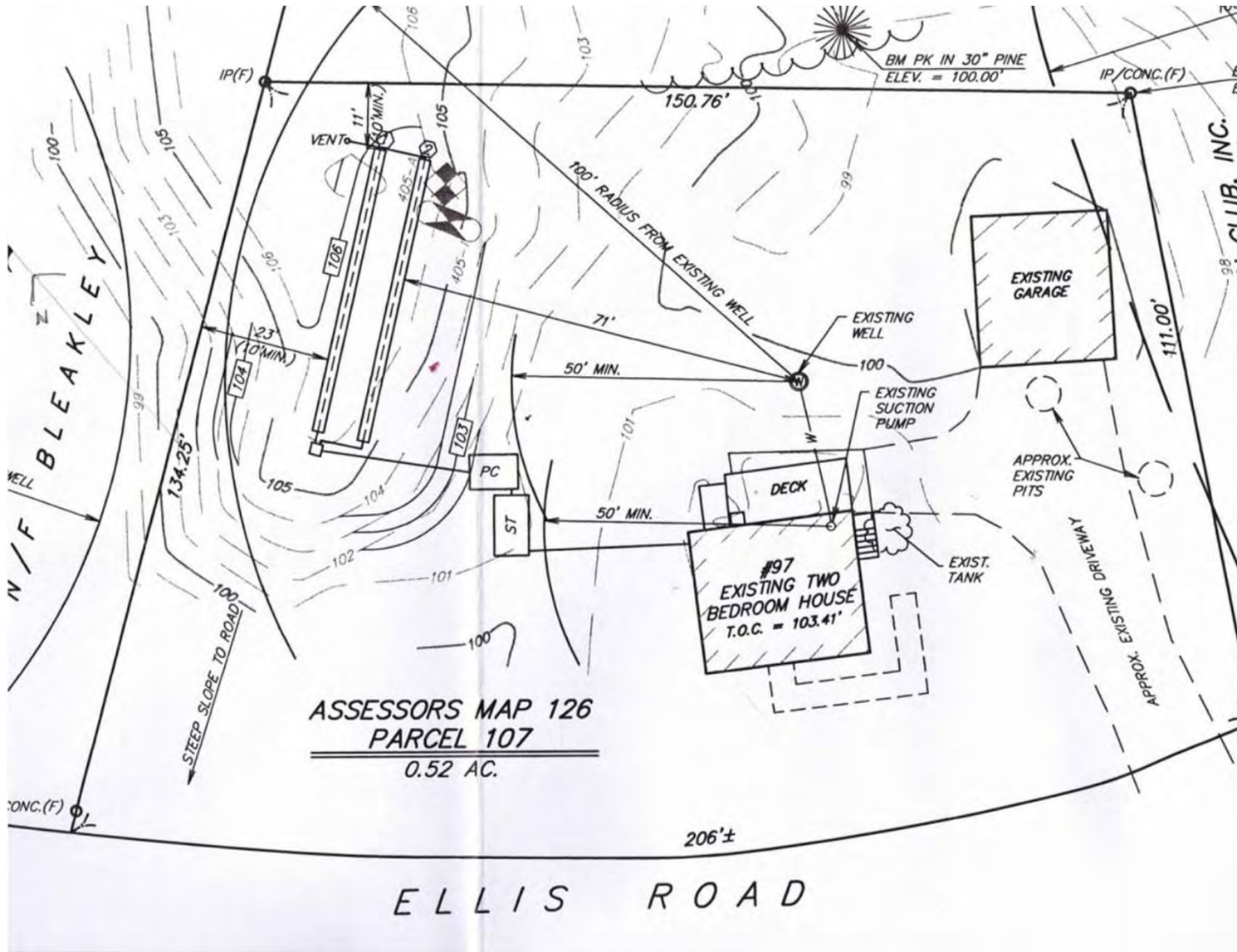
Second floor

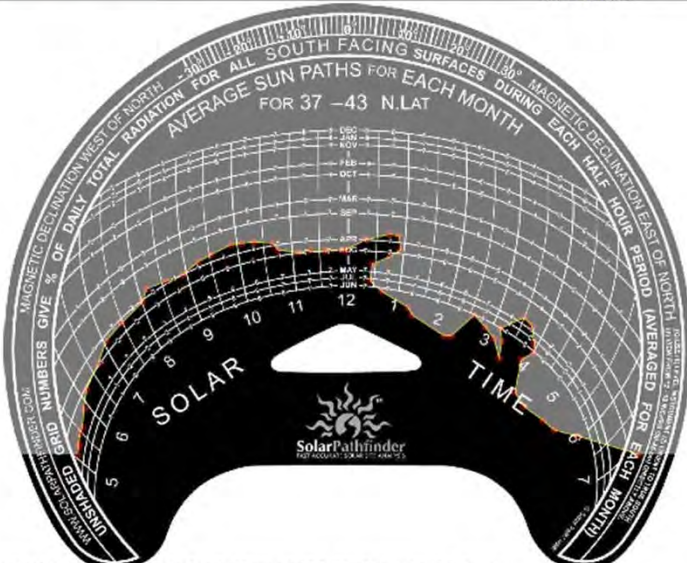
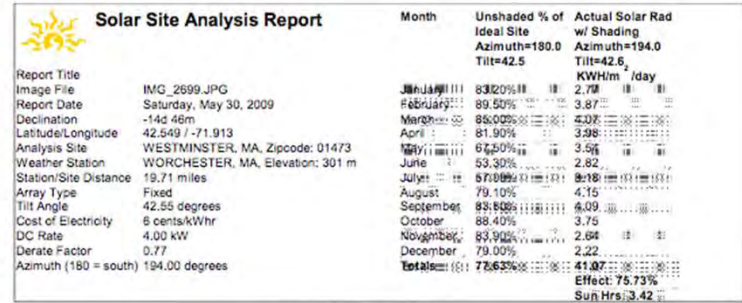
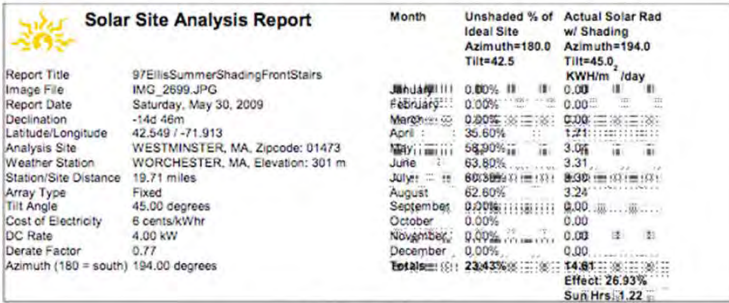
Project objectives

- Retrofit to Passive House standards
- Use almost 100% cellulose
- Minimal usage of foam insulation
- Add architectural interest

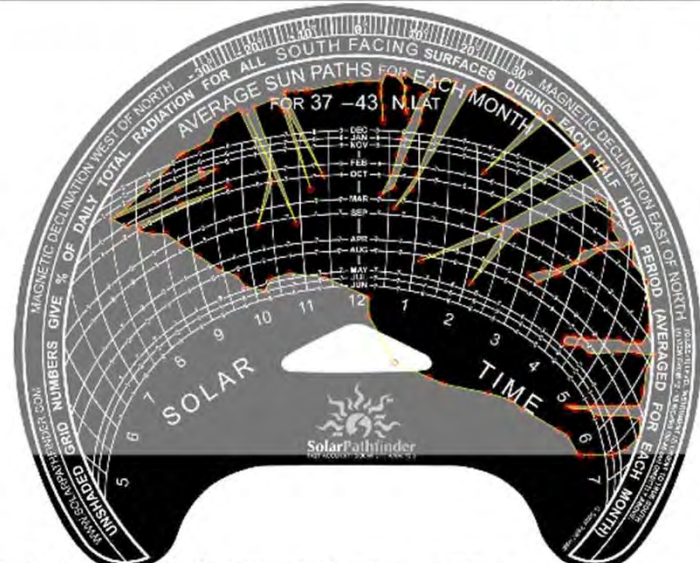
Tree coverage to south







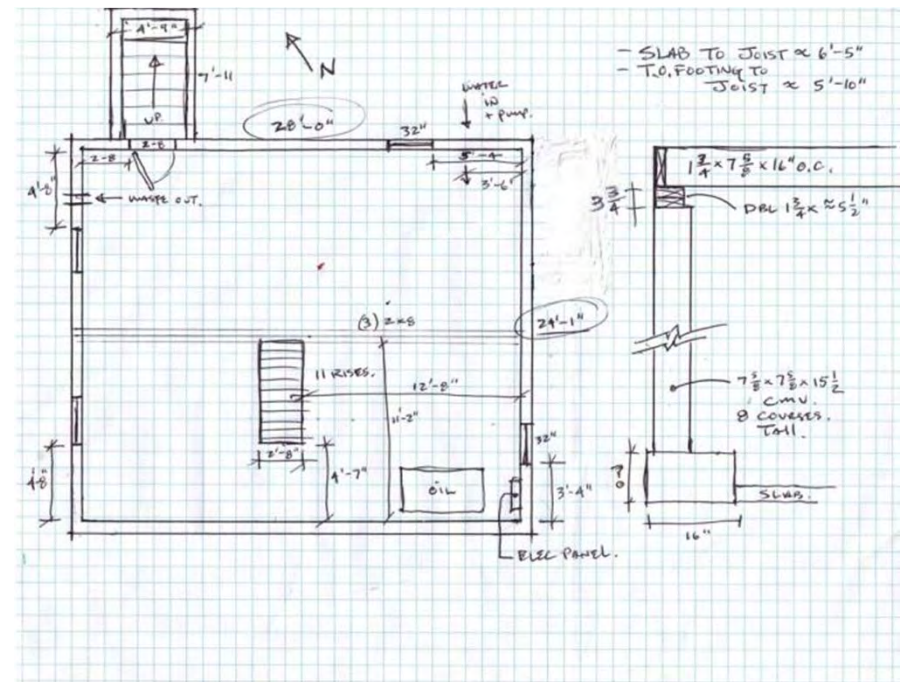
Report generated by SolarPathfinder Assistant Version 1.1.0.0. <http://www.solarpathfinder.com>

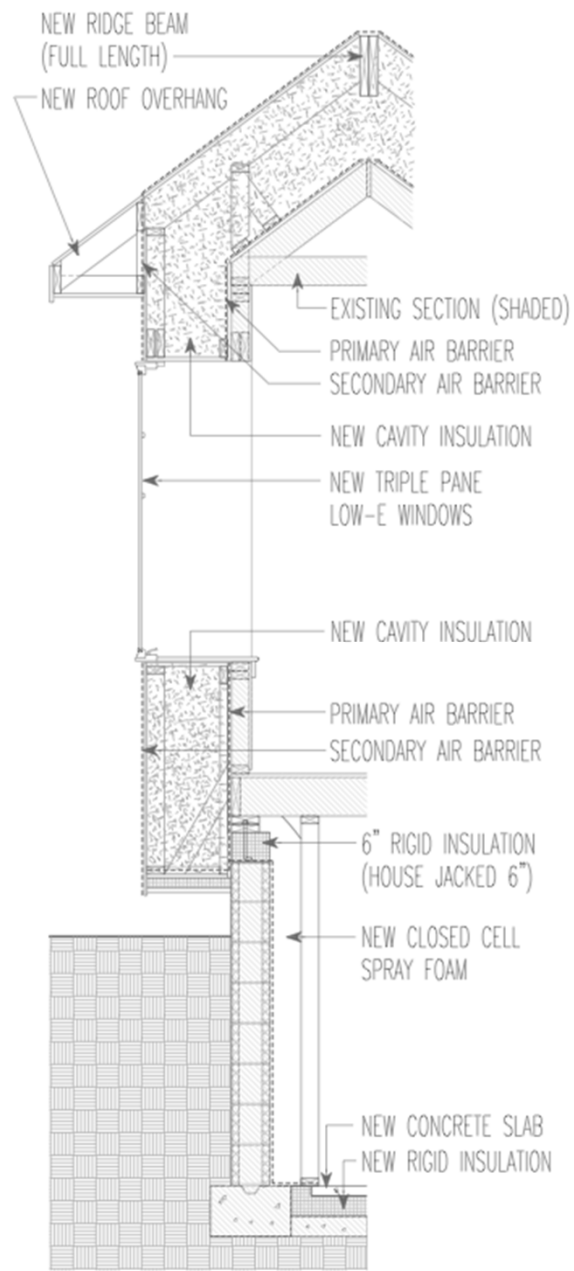


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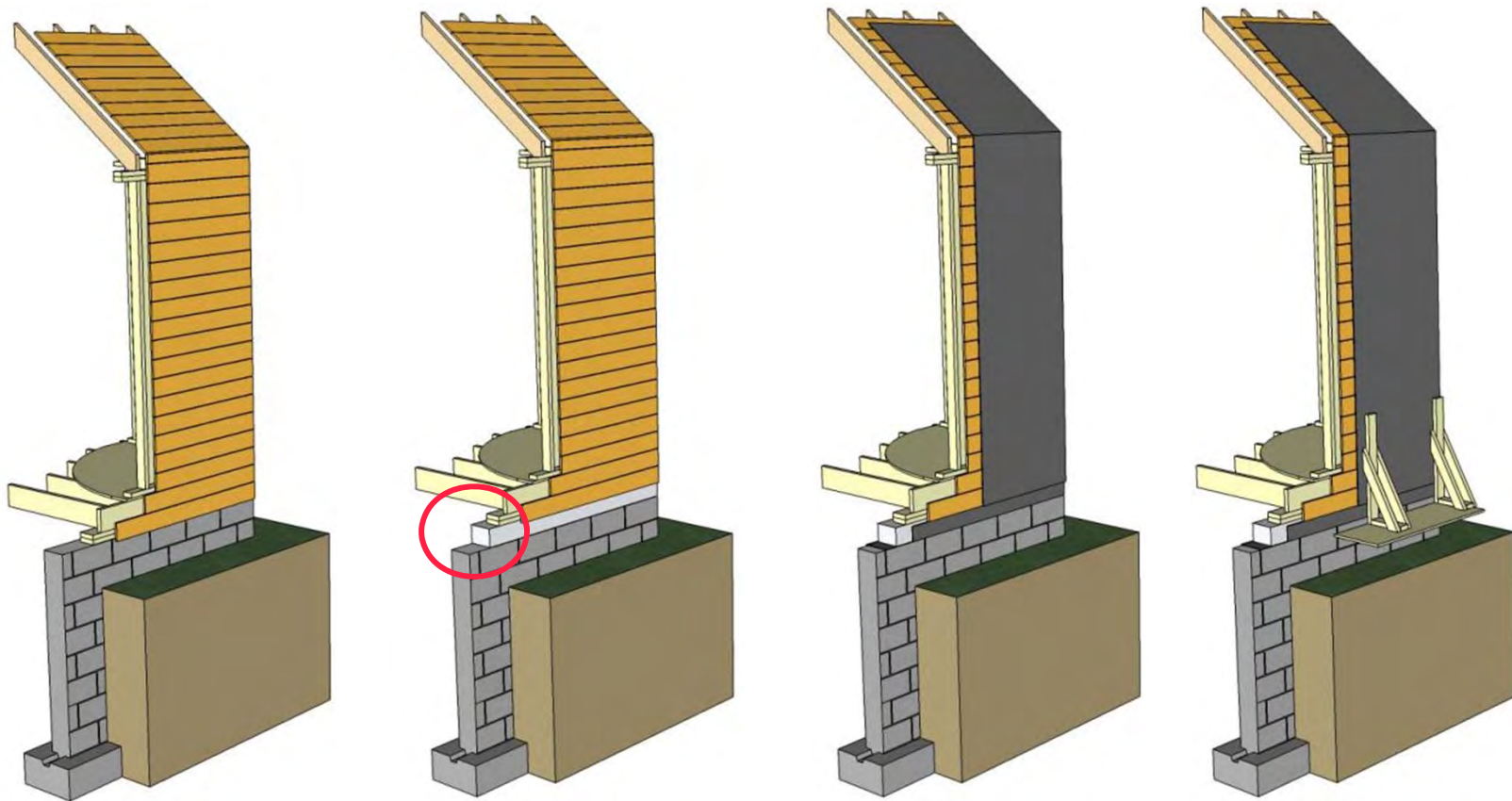


Basement & mechanicals





Sequence



Sill insulation

- <http://building.dow.com/na/en/products/insulation/highload100.htm>

U.S. PROPERTY CHART

TABLE 1

Physical Properties of STYROFOAM™ Highload 40, 60 and 100 Insulation			
Property and Test Method	Value		
	Highload 40	Highload 60	Highload 100
Thermal Resistance ⁽¹⁾ , per inch, ASTM C518, C177, @ 75°F mean temp., ft ² •h•°F/Btu, R-value, min.	5.0	5.0	5.0
Compressive Strength ⁽²⁾ , ASTM D1621, psi, min.	40	60	100
Water Absorption, ASTM C272, % by volume, max. (24hr water immersion)	0.1	0.1	0.1
Water Vapor Permeance ⁽³⁾ , ASTM E96, perms	0.8	0.8	0.8
Maximum Use Temperature, °F	165	165	165
Coefficient of Linear Thermal Expansion, ASTM D696, in/in•°F	3.5 x 10 ⁻⁵	3.5 x 10 ⁻⁵	3.5 x 10 ⁻⁵
Flexural Strength, ASTM C203, psi, min.	60	75	100
Complies with ASTM C578, Type	VI	VII	V

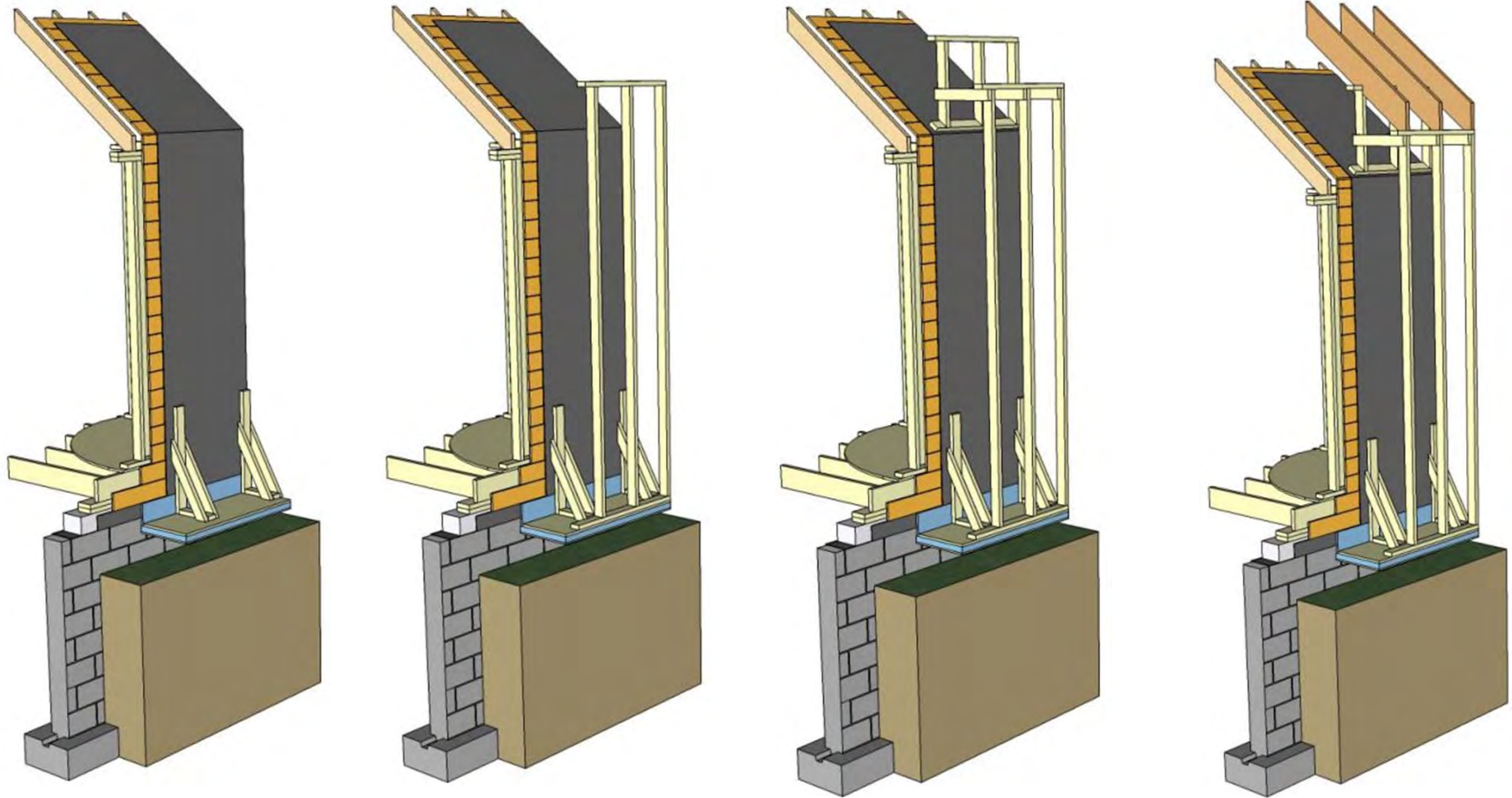
(1) For 1" material

(2) Vertical compressive strength is measured at 5 percent deformation or at yield, whichever occurs first. Since STYROFOAM insulations are visco-elastic materials, adequate design safety factors should be used to prevent long-term creep. For static loads, 3:1 is suggested. For dynamic loads, call 1-866-583-BLUE (2583) for safety factor recommendation.

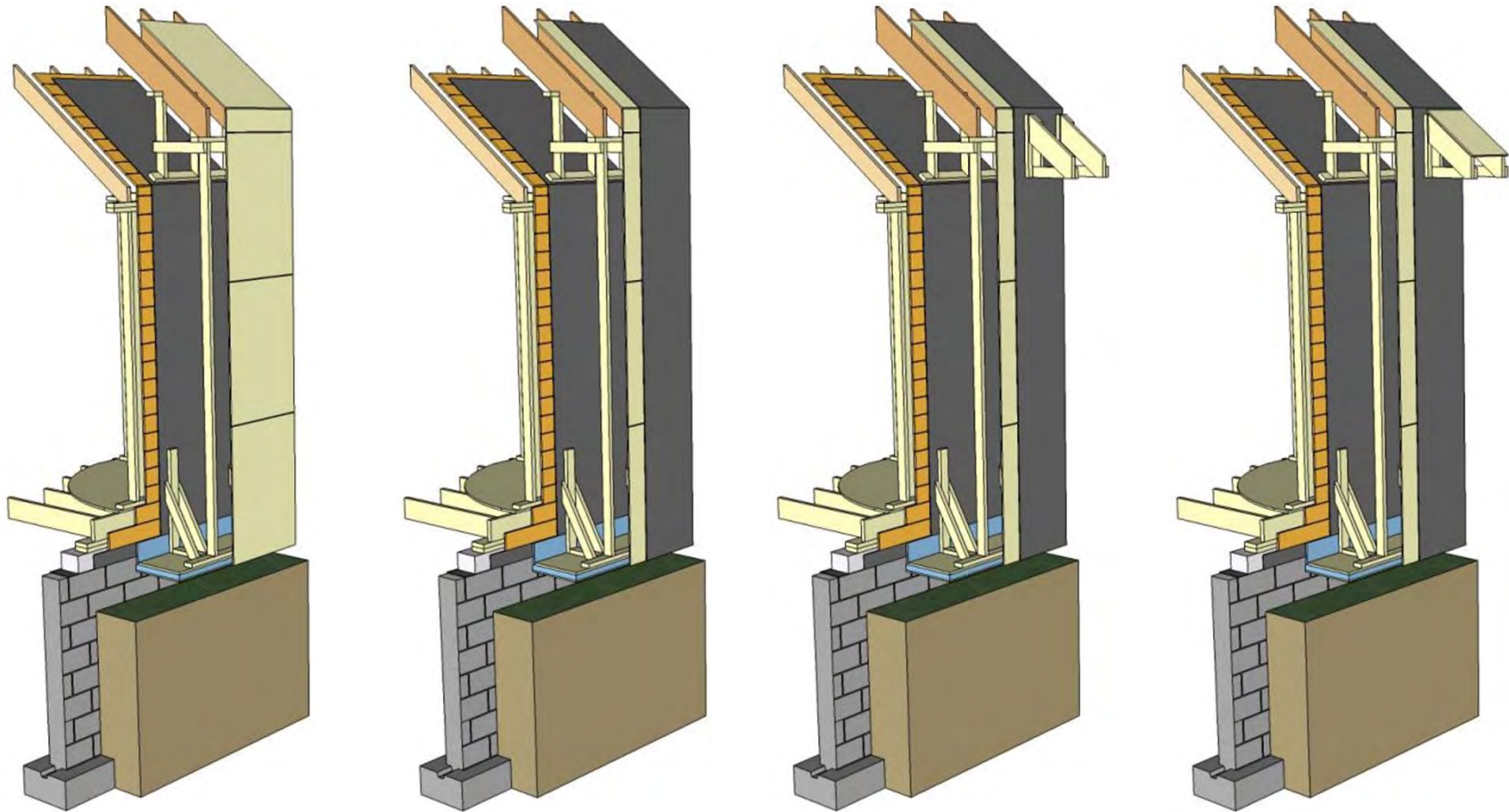
(3) Water vapor permeance varies with product type and thickness. Values are based on the desiccant method and they apply to insulation 1" or greater in thickness.



Sequence, continued



Sequence, continued





Current house



Neighborhood vernacular

Preliminary budget (a work in progress)

Koskinen Passive House retrofit				TOTAL			JOB	
\$134,299	LABOR	MATRL	SUBS	TOTAL	COST %	HRS	HRS %	COST %
CLEANUPS & PROJECT MAINTENANCE	3,600	0	920	4,520	3%	80	9%	3%
TRASH	0	0	1,800	1,800	1%	0	0%	1%
PROJECT MANAGEMENT	3,150	0	0	3,150	2%	70	8%	2%
PERMIT	0	0	1,250	1,250	1%	0	0%	1%
DEMOLITION	6,255	0	2,300	8,555	6%	139	15%	6%
CONCRETE & MASONRY	990	0	4,020	5,010	4%	22	2%	4%
FRAMING	0	10,710	8,000	18,710	14%	0	0%	14%
CORRECTIVE FRAMING	0	0	0	0	0%	0	0%	0%
WINDOWS & EXT DOORS	5,310	16,275	0	21,585	16%	118	13%	16%
EXTERIOR FINISH	10,800	6,825	0	17,625	13%	240	26%	13%
DECKS & PORCHES	0	0	0	0	0%	0	0%	0%
ROOFING	0	0	3,800	3,800	3%	0	0%	3%
ELECTRICAL	360	2,263	4,324	6,947	5%	8	1%	5%
PLUMBING & HYDRONIC HEATING	270	840	3,300	4,410	3%	6	1%	3%
HVAC	1,080	210	6,200	7,490	6%	24	3%	6%
INSULATION	1,800	3,885	8,000	13,685	10%	40	4%	10%
PLASTER	3,375	1,275	0	4,650	3%	75	8%	3%
INTERIOR DOORS & TRIM	4,968	2,144	0	7,112	5%	96	10%	5%
PAINTING	0	0	4,000	4,000	3%	0	0%	3%
SUBTOTAL	41,958	44,427	47,914	134,299	100%	918	100%	100%
OPERATING OVERHEAD	0	0	0	0	0%			
TOTAL	41,958	44,427	47,914	134,299				

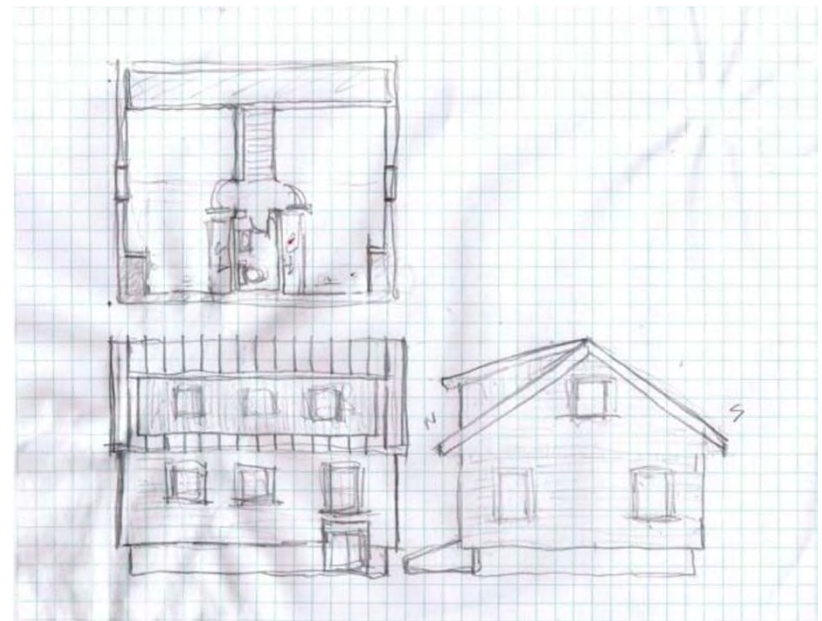
Note no profit & overhead added to these numbers yet

PHPP

- Impact of “Cape” style geometry
- Effect of orientation
- Wall & roof thickness

“Cape” style geometry

- Couldn't easily make PHPP work except by including basement in treated floor area...
- Or adding a dormer:



Effect of orientation

windows	Losses	Gains	Space heat demand
Base case (south)	6554	9156	4.34
45° (southwest)	6554	8268	5.17
90° (west)	6554	6425	6.30

Walls & roof (first pass)

- Thicknesses include existing structure
 - Above-grade walls: R54 - 20.5”
 - Roof: R90 - 27.5”
 - Foundation walls: R51- 23.5”
 - Slab: R54 – 20.0”