

# WHEN YOU COME TO A FORK, TAKE IT.

Navigating Choices in Residential High Performance

**Jesse JW Selman, AIA,**  
Architect

**Kent Hicks,** Builder

**Chris Briley, CPHC,** Architect



## **The Team: C&H + KHC**

### **Forks in Design**

- DER vs New Construction
- Pre-Fabricated vs Site-Built
- Energy & Systems
- Materials / IAQ vs Schedule

### **Forks in Construction**

- DER vs New Construction
- Pre-Fabricated vs Site-Built
- Energy & Systems
- Materials / IAQ vs Schedule

### **Post Occupancy Review**

## Who We Are: C&H Architects



c&h architects: design for the next hundred years.

designing buildings that are loved in the region where we live, for mission-driven clients with residential and institutional projects.

## Bruce Coldham - Emeritus



## Tom Hartman - Principal



# Jesse Selman—Project Architect Caught between a rock and a Hartman.







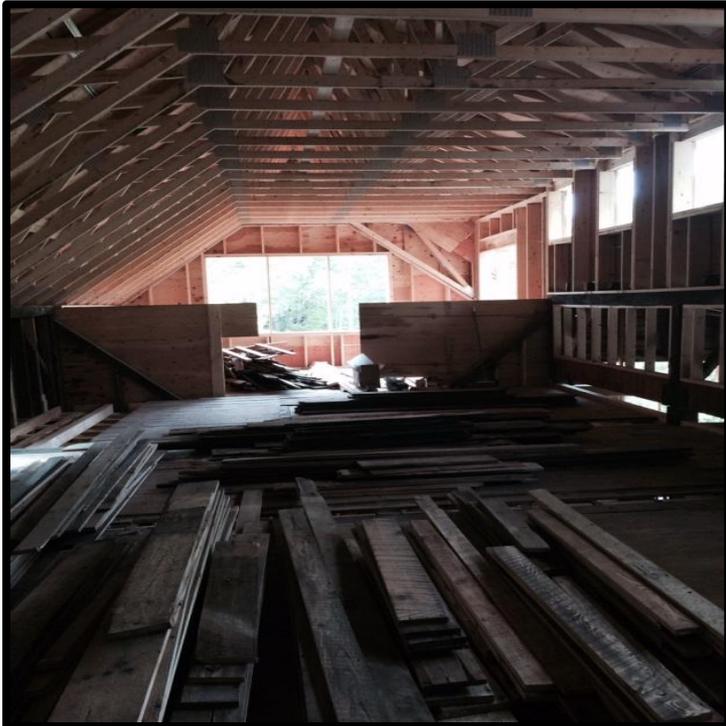








Reuse of old  
boards for  
new floors



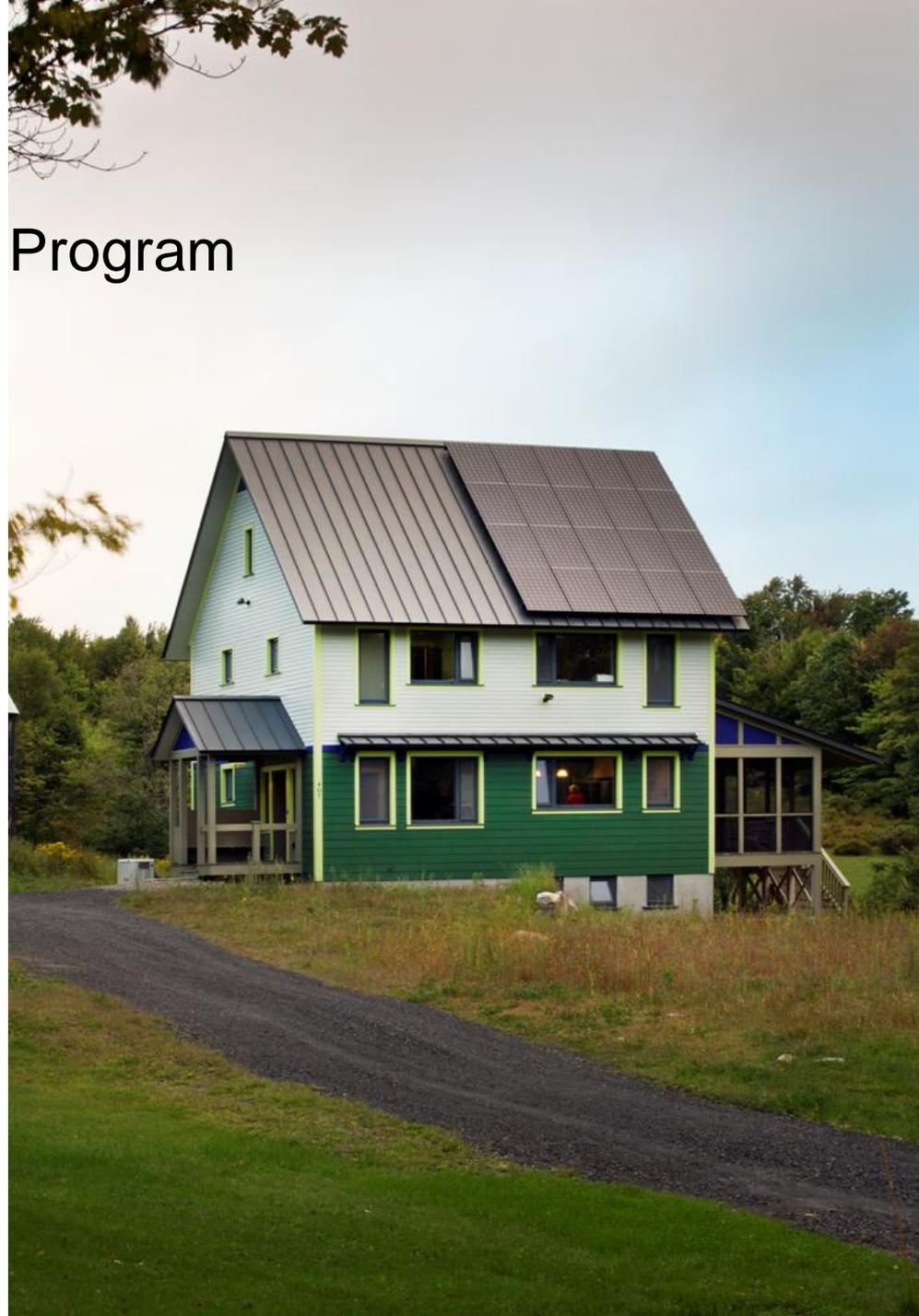
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## Design Program

1. Indoor Air Quality
2. Energy Conscious
3. Cozy Fortress
4. IAQ

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## Solution Concepts

1. Communication
2. Communication
3. Design - Construction
4. Communication

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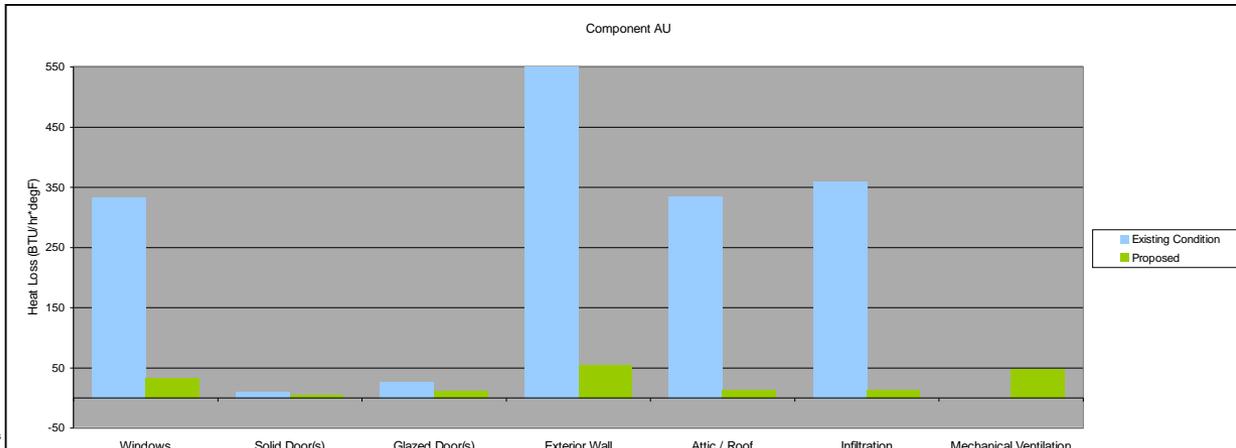
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# FORK # 1: Teardown OR rebuild (heads you win, tails I lose)

## Heat Loss Component Comparison

| Savoy House                         |                                      |        | Energy Cost ?                | HDD65  | 7700                     |  |                                      |
|-------------------------------------|--------------------------------------|--------|------------------------------|--|--------------------------|--|--------------------------------------|
| Design Temperature Delta            |                                      | deg F  | 70                           |  |                          |  |                                      |
|                                     |                                      |        | Existing Condition           |  | Proposed                 |  |                                      |
| Component                           | Units                                | Area   | Description                  | R-Value<br>1/(Btu/hr*degF*sf) AU (Btu/hr*degF) | Description              | R-Value<br>1/(Btu/hr*degF*sf) AU (Btu/hr*degF) |                                      |
| Floor area (nic basement for prop.) | Square Feet (sf)                     | 2,360  |                              |  | Adjusted Building Volume | 12,500   |                                      |
| Volume of Building (bid)            | Cubic Feet (cf)                      | 20,000 |                              |  |                          |  |                                      |
| Slab Edge                           | Linear Feet (ft)                     | 171    |                              | 1  |                          | 10   |                                      |
| Windows                             | Square Feet (sf)                     | 200    | Single Pane                  | 0.60   | 333                      | FG / 3pane                                     | 6.00                                 |
| Solid Door(s)                       | Square Feet (sf)                     | 20     | Solid door                   | 2.00   | 10                       | FG   | 4.00                                 |
| Glazed Door(s)                      | Square Feet (sf)                     | 40     | 1/2 Lite Door                | 1.50   | 27                       | FG / 3pane                                     | 3.50                                 |
| Exterior Wall                       | Square Feet (sf)                     | 2,100  | 2" empty cavity              | 2.00   | 1,050                    | 4" Polyiso + Cellulose                         | 32.00                                |
| Attic / Roof                        | Square Feet (sf)                     | 1,673  | 6" some FG                   | 5.00   | 335                      | 6" Polyiso + Cellulose                         | 55.00                                |
| Infiltration                        | ACH Natural                          |        | Equiv. AU                    | 1.00   | 360                      | Equiv. AU                                      | 0.06                                 |
| Mechanical Ventilation              | Cubic Feet per Minute (cfm)          |        | Ventilation system capacity  | 0  | 0                        | HRV Output                                     | 150                                  |
|                                     | Ventilation Heat Recovery Efficiency |        |                              | 0%   |                          |  | 70%                                  |
| AU Conduction Only                  | BTU/hr*degF                          |        |                              | 84%  | 1,873                    |  | 66%                                  |
| AU Total                            | BTU/hr*degF                          |        |                              |  | 2,233                    |  | 180                                  |
| Design Heat Loss                    | Btu/hr                               |        | (Capacity of Heating System) | 156,341  |                          | (Capacity of Heating System)                   | 12,621                               |
| Design Heat Loss                    | Kilowatts (kW)                       |        |                              | 45.81  |                          |  | 3.70                                 |
| Design heat loss per unit area      | Btu/hr/sf                            |        |                              | <b>66.2 BTU/hr/sf</b>                          |                          |  | <b>9.7 BTU/hr/sf (85% Reduction)</b> |



Peak Heat Loss Analysis

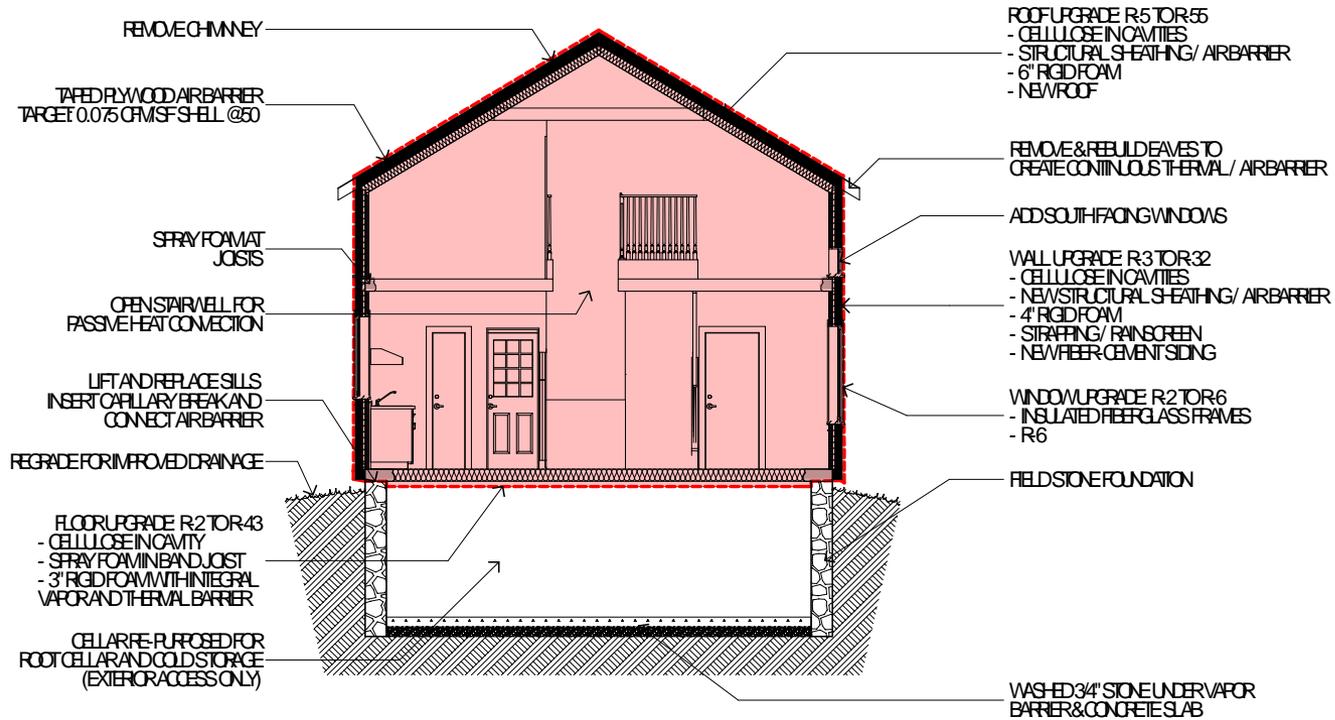
4/1/11

# Application to WEMECO DER program

CONCEPT PLANS



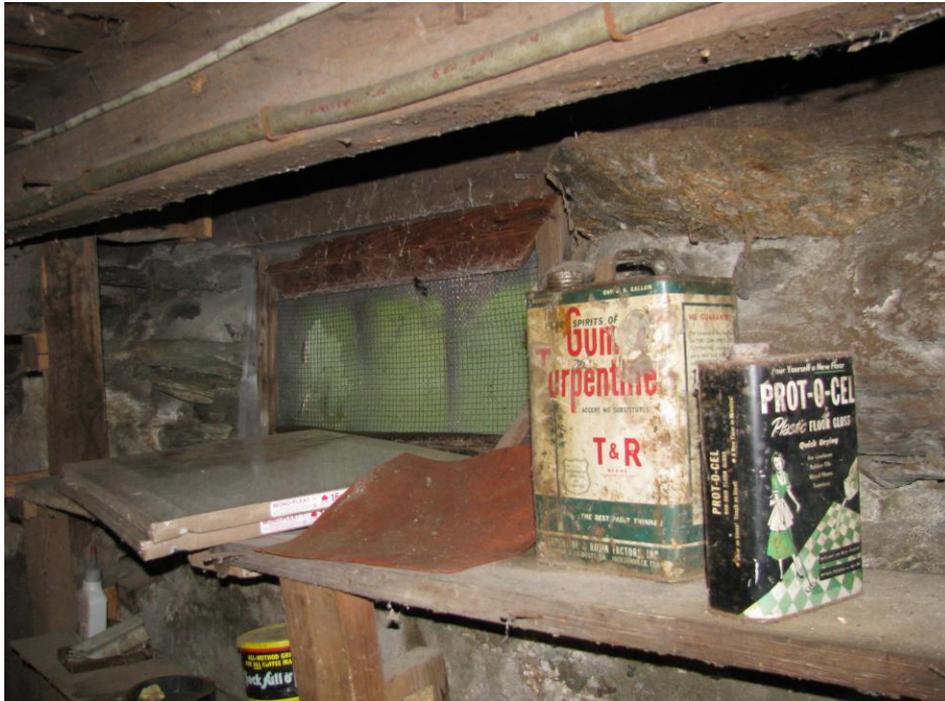
# EX-ULATION ISOLATE WET BASEMENT

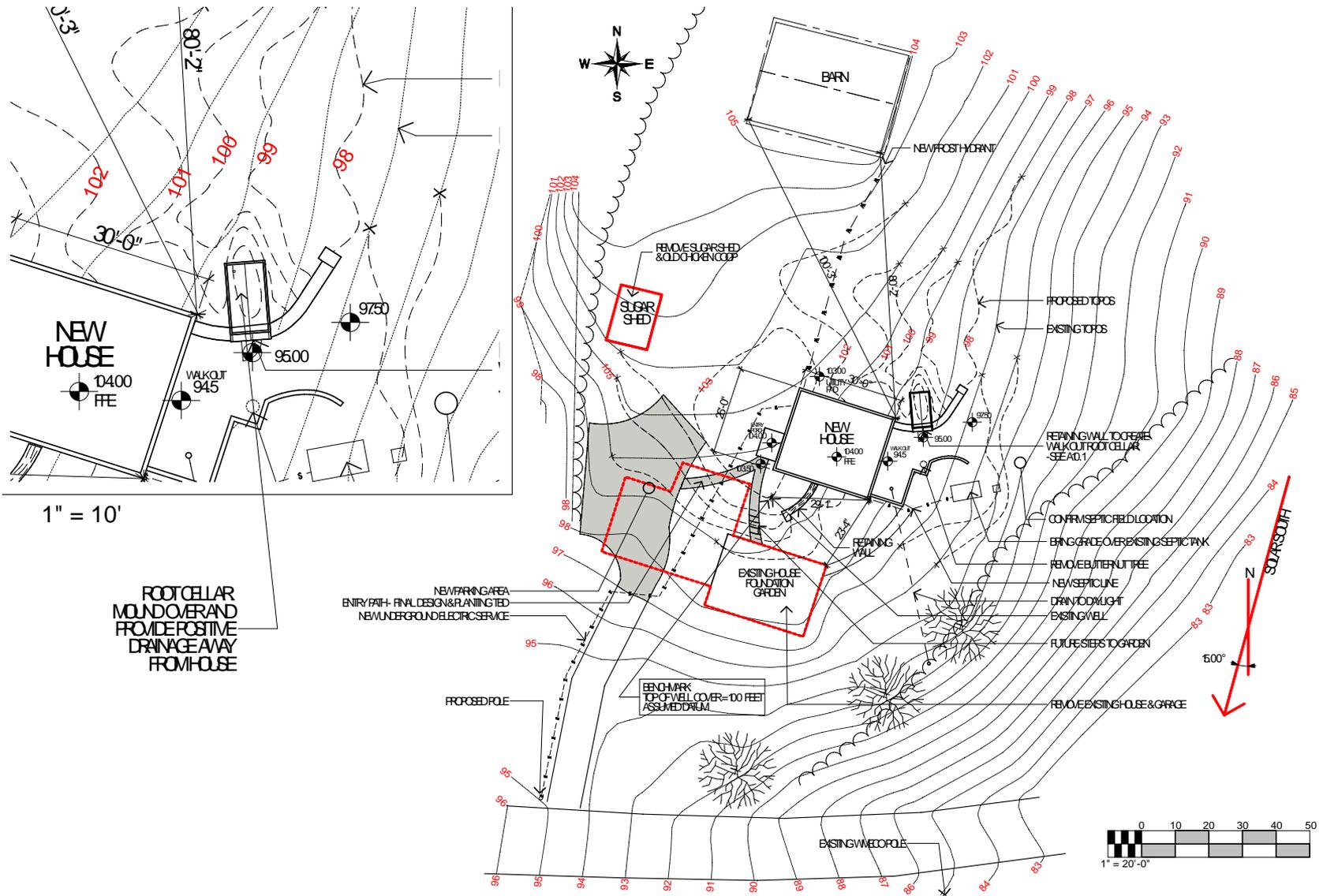




Too many contaminants  
Not enough control of existing variables  
No Cost Benefit (schematic pricing by CM)

Answer – New Construction – maintain aspects of history.





## Fork: Pre-Fab or Site Built?

### Pre-Fab

Not enough control / flexibility.

The value and advantages of pre-fab could not be realized with the required customization for materials and contaminant control.

Therefore, Site Built

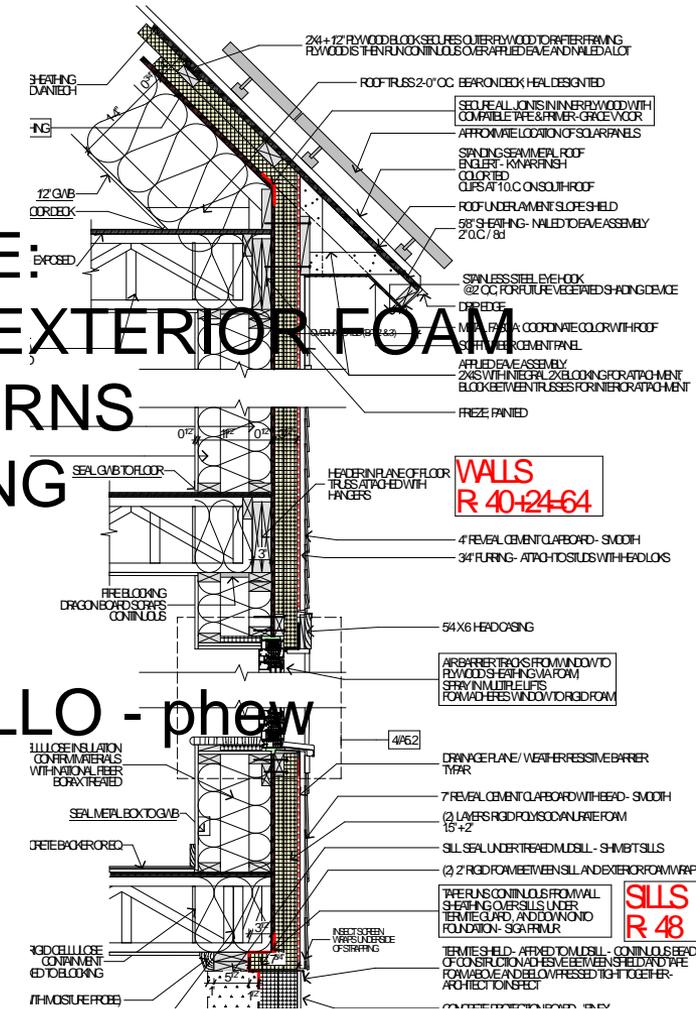
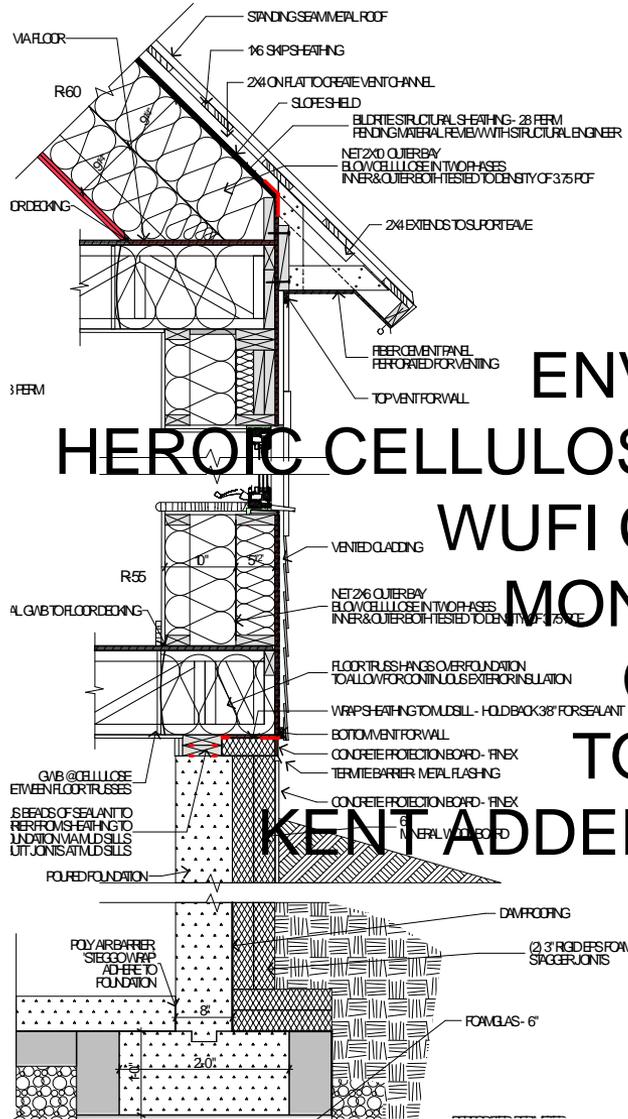


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FORK: Energy Consciousness, Systems  
DER  
PHPP  
NET-ZERO  
RESILIENCE  
SMART CHOICES = Low energy

How we get there depends on materials.



ENVELOPE: HEROIC CELLULOSE OR EXTERIOR FOAM

WUFI CONCERNS

MONITORING

COST

TOXICITY

KENT ADDED INTELLO - phew

WALLS R 40+24+64

SILLS R 48

## Air Leakage

|  |  |  |
|--|--|--|
| <b>Property</b><br>Satterthwaite & Buehler<br>407 Chapel Road<br>Savoy, MA 01256 | <b>Organization</b><br>Energy Efficiency Associates<br>978-793-3189<br>Mike Duclos | <b>HERS</b><br>Confirmed<br>9/25/14<br>Rating No:EEA_NH_33<br>Rater ID:7918396 |
| <b>Weather:</b> Savoy, MA<br>Savoy Passive Hosue<br>Savoy_2014_09_26.blg         | <b>Builder</b><br>Kent Hicks Construction  |  |

| Whole House Infiltration  | Blower Door Test |         |
|---------------------------|------------------|---------|
|                           | Heating          | Cooling |
| Natural ACH               | 0.02             | 0.01    |
| ACH @ 50 Pascals          | 0.20             | 0.20    |
| CFM @ 25 Pascals          | 50               | 50      |
| CFM @ 50 Pascals          | 79               | 79      |
| Eff. Leakage Area (sq.in) | 4.3              | 4.3     |
| Specific Leakage Area     | 0.00002          | 0.00002 |
| ELA/100 sf shell (sq.in)  | 0.09             | 0.09    |

| Duct Leakage | Leakage to Outside Units        | Faux ducts       |  |  |
|--------------|---------------------------------|------------------|--|--|
|              | CFM @ 25 Pascals                | 0                |  |  |
|              | CFM25 / CFMfan                  | 0.0000           |  |  |
|              | CFM25 / CFA                     | 0.0000           |  |  |
|              | CFM per Std 152                 | N/A              |  |  |
|              | CFM per Std 152 / CFA           | N/A              |  |  |
|              | CFM @ 50 Pascals                | 0                |  |  |
|              | Eff. Leakage Area (sq.in)       | 0.00             |  |  |
|              | Thermal Efficiency              | N/A              |  |  |
|              | <b>Total Duct Leakage Units</b> | <b>CFM25/CFA</b> |  |  |
|              | Total Duct Leakage              | 0.0000           |  |  |

| Ventilation | Mechanical                 | Balanced            |
|-------------|----------------------------|---------------------|
|             | Sensible Recovery Eff. (%) | 87.0                |
|             | Total Recovery Eff. (%)    | 0.0                 |
|             | Rate (cfm)                 | 108                 |
|             | Hours/Day                  | 24.0                |
|             | Fan Watts                  | 53.0                |
|             | Cooling Ventilation        | Natural Ventilation |

### ASHRAE 62.2 - 2010 Ventilation Requirements

For this home to comply with ASHRAE Standard 62.2 - 2010 Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings, a minimum of 47 cfm of mechanical ventilation must be provided continuously, 24 hours per day. Alternatively, an intermittently operating mechanical ventilation system may be used if the ventilation rate is adjusted accordingly. For example, a 93 cfm mechanical ventilation system would need to operate 12 hours per day, as long as the system operates to provide required average ventilation once each hour.

REM/Rate - Residential Energy Analysis and Rating Software v14.5.1  
This information does not constitute any warranty of energy cost or savings.  
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**BLOWER  
DOOR  
0.03 CFM  
@50 /SF  
SHELL**

**0.024  
ACH@50  
(0.06 PH)**

# ENERGY

## HEATING DEMAND

|               |             |
|---------------|-------------|
| PASSIVE HOUSE | 14 kwh/m2/a |
| DESIGN        | 16.3        |

## INFILTRATION

|               |             |
|---------------|-------------|
| PASSIVE HOUSE | 0.60 ACH 50 |
| DESIGN        | 0.60        |
| ACTUAL        | 0.24        |

## TOTAL SOURCE

|               |              |
|---------------|--------------|
| PASSIVE HOUSE | 120 kwh/m2/a |
| DESIGN        | 119          |

# ANNUAL ENERGY

## HEATING DEMAND

PASSIVE HOUSE 2,422 kWh/year

DESIGN 2,820 kWh/year

Range 398 kWh = \$78/year

## INFILTRATION

EXCEPTIONAL AIR BARRIER = +/- 1.15 MMBTU/YEAR  
= +/- \$30 PER YEAR

## TOTAL SOURCE

PASSIVE HOUSE 120 kwh/m2/a

DESIGN 119

ACTUAL NET ZERO w/2,000 kWh surplus!

# ANNUAL ENERGY

|               | <u>TOTAL SOURCE</u> |                               |
|---------------|---------------------|-------------------------------|
| PASSIVE HOUSE |                     | 120 kwh/m2/a                  |
| DESIGN        | 119                 |                               |
| ACTUAL        |                     | NET ZERO w/2,000 kWh surplus! |

*BUT WAIT . . .*

*Next year full occupancy & net zero expected but  
TBD*

# FORK: Materials Strategy – Test Everything

| Location     | Material   | Description  | Ordered   | Result   | Notes  |
|--------------|--|--|---|--|--|
|              |  |  |   | OK   | Sarah  |
|              |  |  |   | NO   | Kent   |
|              |  |  |   |  | Jesse  |
|              |  |  |   |  | Outside air barrier  |
| SITE         |  |  |   |  |  |
|              | Driveway<br>Drain pipe<br>Concrete retaining walls<br>Stone retaining walls  | gravel<br>by subcontractor<br>see foundation<br>large rough stones or versalok   |   |  |  |
| SCREEN PORCH |  |  |   |  |  |
|              | Wood Framing<br>Post Bases<br>Decking<br>Ceiling<br>Roof<br>Plywood Sheathing<br>Lights<br>Door  | we are getting a Timbersil and L3 is now called Simpson<br>Mahogany T&G<br>V-Groove - painted pine<br>Metal<br>phenol-based glue (NOT UREA)<br>cdx exterior plywood<br>recessed cans - LED<br>AFM Polyureseal  | OK<br>Have Mahogany<br><br>douglass fir depot)        | the<br>Yes, 10/14/2012<br>OK, 11/15/2012<br>painting<br>Yes, 10/3/2012<br>yes, doug fir<br>plywood is ok                         | <a href="http://www.building-products.com/readNews.aspx?ID=2765">http://www.building-products.com/readNews.aspx?ID=2765</a><br>Metal hardware, exterior, galvanized<br>Tight fit with pitch to exterior<br>Painted<br>assuming this is fine - Englert metal roof<br><a href="http://www.norbord.com/na/wall-sheathing/trubord">http://www.norbord.com/na/wall-sheathing/trubord</a><br>Sample for RK Miles was ok. |
| FOUNDATION   |  |  |   |  |  |
|              | RETAINING WALLS<br>Exterior insulation<br>EPS adhesive<br>EPS caulk<br>Waterproofing<br>Foamglas<br>Foamglas adhesive<br>Footing Drains<br>Termite Guards<br>Exterior insulation cover board | Precast stone<br>EPS<br>loctite PL300 foamboard adhesive<br>Loctite Polyseamseal All Purpose Caulk<br>Polywall<br>PC88 being tested<br>PittSeal CW Sealant being tested<br>by sub-contractor<br>Aluminum flashing<br>FINEX concrete board -UNFINISHED TEXTURED | Have sample, 10/9<br><br>Howie, 10/11<br>Howie, 10/11 | This looked fine<br>Yes<br>Yes, 10/17<br>Yes, 10/21<br>Yes<br>yes<br>No, 10/18/2012<br>Yes, 10/19<br>Yes<br>Yes<br>OK, 7/20/2012 | ??<br><br><a href="http://www.versa-lok.com/">http://www.versa-lok.com/</a><br><br>This eventually aired out fine after some months.   |

|                                  |  |                         |                             |  |   |
|----------------------------------|--|-------------------------|-----------------------------|--|---|
| BASEMENT                         |  |                         |                             |  |   |
| GWB                              | paperless  | have sample             |                             |  |   |
| Floor finish                     | Trowel Finish Premium Lithium Densifiers and water or solvent based sealers- VT Eco-Floors | Jesse trying to locate  |                             |  |   |
|                                  | Lionhard and Lumiseal FX   | Have samples            |                             |  | <a href="http://www.gofinex.com/english/contact-finex-fibercement-panels.html">http://www.gofinex.com/english/contact-finex-fibercement-panels.html</a> |
| Ceiling                          | Paperless GWB  | not using???            |                             |  |   |
| interior of Exterior wall finish | None?? Confirm   |                         | Yes, none                   |  | What brand?   |
| Interior Windows                 | tempered, single pane, FG  |                         | yes Yaro                    |  | <a href="http://www.vermontecofloors.com/floor-finishes.html">http://www.vermontecofloors.com/floor-finishes.html</a>                                   |
|                                  |  |                         |                             |  | Need samples of Lionhard and LumisealFX. info@lmcc.com<br>Paperless is problematic  |
| EXTERIOR WALLS                   |  |                         |                             |  |   |
| Mud Sills                        | we are getting a Timbersil and L3 is now called  | mahogany timbersil      | sills, 11/15/2012           |  |   |
| Sill seal                        | roll   | Have sample             | ok, 10/2012                 |  |   |
| Anchor Bolts                     | clean off oils   | na                      | Yes                         |  |   |
| Foam                             | OSI Green Series   | Requested 10/4          |                             |  |   |
| Caulking                         | OSI Green Series   | have sample             | OK , 10/3/2012              |  |   |
| Window sills                     | Options-Stone, Concrete, Tile?   |                         |                             |  | <a href="http://202080947/h_d2/ProductDisplay?catalogId=10053&amp;langId=">202080947/h_d2/ProductDisplay?catalogId=10053&amp;langId=</a>                |
| Ext. Door casing                 | "  |                         |                             |  |   |
| Interior Paint                   | Mythic Paint—color-by-owner<br>Ben Moore Natura Paint                                      | have sample             | OK, 11/28/2012<br>8/2013 ?  |  | <a href="http://www.osipro.com/greenseries.shtml">http://www.osipro.com/greenseries.shtml</a> Profoam (green) is not H2U acrylic Urethane sealant.      |
| GWB                              | Standard GWB??   |                         |                             |  |   |
| Electrical Boxes                 | Lesco -Style sealed to GWB - switch to metal for MC cable compatibility                    | have sample             | Not using?                  |  |   |
| Cellulose                        | National Fiber   | Have sample             | Yes, 5/9/2013               |  | <a href="http://www.mythicpaint.com/">http://www.mythicpaint.com/</a>   |
| Wood Framing                     |  |                         | Yes, doug fir               |  |   |
| Plywood sheathing                | exterior grade phenol glue only<br>or Trubord  | douglas fir?<br>Trubord | Yes, doug fir<br>Tubord no. |  | <a href="http://www.energyfederation.org/consumer/default.php/cPath/21_1272_1">http://www.energyfederation.org/consumer/default.php/cPath/21_1272_1</a> |
|                                  | Georgia Pacific CDX exterior plywood, unknown  | have sample, 10/22      | No, GP                      |  |   |
| Tapes                            | Grace Vycor with Green Primer  |                         | OK, 4.27.2013               |  | Construction sequence - air out framing prior to insulation &   |
| Exterior rigid foam              | Polyisocyanurate   | 10/4                    | Yes, 10/5/2012              |  |   |
| Exterior Rigid Foam at           | EPS  | Jesse                   | Yes                         |  | See Trufloor sample below   |
| Weather Resistive Barrier        | Typar over foam  | barn on 10/19           | Jesse yes                   |  |   |
| intello vapor barrier            |  |                         | Ok, -5/1/2013               |  |   |
| tescon vana tape                 |  |                         | OK outside, 4/2013          |  |   |
| Windows                          | Schuco Aluminum  |                         | YES                         |  | Branch River Plastics (401) 232-0270 branchriver.com  |
| Doors                            | Thermatru or schuco  |                         |                             |  | <a href="http://www.vaproshield.com/">http://www.vaproshield.com/</a>   |
| Strapping                        | 1x4  |                         | Yes                         |  | 475 high performance building   |
| Siding                           | Pre-finished Nichiha brand--Ended up with Hardie   | have nichiha sample     | Unfinished is fine          |  | 475 high performance building   |
| Trim                             | options - wood, fiber cement, pvc  |                         | ok, 6/7/2013                |  |   |
| Corner boards                    |  |                         |                             |  | Likely a cost issue. JS to prepare thinking   |
| Water table                      |  |                         |                             |  |   |
| Frieze                           | Metal?   |                         |                             |  | <a href="http://www.nichiha.com/prod_nichiboard.htm">http://www.nichiha.com/prod_nichiboard.htm</a>   |
| Flashing                         |  |                         |                             |  |   |
| Paint                            | Benjamin Moore Low VOC exterior  |                         |                             |  |   |

|                         |  |  |                      |                    |  |
|-------------------------|--|--|----------------------|--------------------|--|
| PARTITION WALLS         |  |  |                      |                    |  |
| Light guage metal studs |  |  |                      | 11/15/2012         |  |
| Gypsum Wall Board       |  |  |                      |                    |  |
| Electrical boxes        | metal  |  | have sample 10/4     | ok, 6/24/2013      |  |
| Cover plates            | metal  |  |                      | ok, 6/24/2013      |  |
| Switches & Recepticals  |  |  |                      |                    |  |
| Wiring                  | MC cable Sarah is going to retest fresher piece                |  | have sample, 10/9    | 5/20/2013          |  |
| MC Wire Cleaner         | KD Gold multi-use non toxic all purpose cleaner                |  | works to clean.      |                    |  |
| Paint                   | Ben Moore Natura   |  | Have sample          | 2013               |  |
| Doors                   | solid hardwood   |  |                      |                    |  |
| Baseboard               | poplar 1x6 painted   |  |                      |                    | We need to clean it before use. 2/17/2013<br><a href="http://www.kdgold.com/">http://www.kdgold.com/</a> ATHe MC Wlre delivered to Cambridge on 4/16/13  |
| Door Casing             | poplar   |  |                      | ok, 6/25/2013      |  |
| FLOOR ASSEMBLIES        |  |  |                      |                    |  |
| Wood framing            | Open Web Wood Truss 12" with metal plate connections - no glue |  | Have sample, 10/20   | OK, 11/5.          |  |
| Beams                   | Steel  |  |                      | Yes                |  |
| Columns                 | Steel  |  |                      | Yes                | <a href="http://www.ufpi.com/product/oj/index.htm?utm_source=Vanity%2B">http://www.ufpi.com/product/oj/index.htm?utm_source=Vanity%2B</a><br><a href="http://www.trussec.com/floor.html">http://www.trussec.com/floor.html</a> |
| GWB                     |  |  |                      |                    |  |
| Deck-Plywood            | no added formaldehyde OSB                                      |  | have sample          | doug fir           |  |
| OR Dragon Board         |  |  | Have dragonboard     | Sarah says NO      | What finish is on the steel?   |
| Flooring                | fir decking  |  |                      |                    |  |
| Hardwood                | oak 3.5" wide  |  |                      |                    | <a href="http://www.norbord.com/OSB_Trufflor_Home.shtml">http://www.norbord.com/OSB_Trufflor_Home.shtml</a>  |
| Tile                    | Floors, daltile  |  |                      |                    | <a href="http://www.dragonboard.com">www.dragonboard.com</a>   |
| Other?                  |  |  |                      |                    |  |
| Stairs                  |  |  |                      |                    |  |
| ROOF ASSEMBLY           |  |  |                      |                    |  |
| Rafters                 | Wood truss   |  | Have sample, 10/20   | OK, 11/5/2012      |  |
| GWB                     |  |  |                      | Yes?               |  |
| Cellulose insulation    | National Fiber - borax treated                                 |  | Have sample          | Yes, 5/9/2013      |  |
| Exterior Rigid Foam     | polyisocyanurate - foil faced                                  |  | Hae sample (HD)      | Ok, 11/15/2012     |  |
| Sheathing               | IDOTerm polyisocyanurate board                                 |  | Have sample          | 4/27/2013          | SPECIFY DOUGLAS FIR  |
| Water barrier           | see wall sheathing results                                     |  |                      | doug fir           |  |
|                         | Grace Water Barrier  |  |                      | OK, 5/21/2013      | Outside Air Barrier - Shown in drawings - Plan on using  |
| KITCHEN                 |  |  |                      |                    |  |
| Appliances              | by owner   |  |                      |                    |  |
| Cabinets                | and poplar have lowest naturally occuring levels of VOCs       |  | samples, including 1 | poplar core, maple |  |
| Bookshelf               | "  |  |                      |                    |  |
| Table                   | "  |  |                      |                    |  |



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|                |   |  |   |  |  |
|----------------|---|--|---|--|--|
| BATHROOMS      | Fixtures<br>Mirror - med cabinet<br>specialties<br>towel bars<br>Vanity | Owner<br>"<br>"<br>"<br>"  |   |  | <a href="http://columbiaforestproducts.com/">http://columbiaforestproducts.com/</a>  |
| OTHER FINISHES | Built-ins<br>Closet shelf / rod<br>Wood Glue                            | and poplar have lowest naturally occurring levels of VOCs<br>used for interior finish work   | samples<br>Ordered 10/14.                         | poplar core, maple<br>ok, 3/28/2013                      |  |
| STAIRS         | Treads<br>Risers<br>Finishes<br>Handrail                                |  |   |  | <a href="http://columbiaforestproducts.com/">http://columbiaforestproducts.com/</a><br><a href="http://www.ecospaints.net/store/organic-wood-glue-usa/prod_37.html">http://www.ecospaints.net/store/organic-wood-glue-usa/prod_37.html</a>   |
| ELECTRICAL     | see spec<br>tel/data<br>lighting fixtures                               |  |   |  |  |
| PLUMBING       | Supply Piping<br>Waste Piping<br><br>Pipe insulation                    | Copper<br>ABS<br>PEX PIPING<br>Cooper Piping   | Have sample<br>Have Sample<br>Have sample, 1/2013 | fine<br>wash outside with<br>using all copper<br>Yes     | Pex is out for hot water.<br>4/17/13 still working on pex  |
| MECHANICAL     | Radon pipe<br>Hot water heater<br>HRV<br>Ducts<br>Filters<br>ASHP       | ABS<br>ASHP<br>Zehender - working with Mike?<br>rigid ducts - MASTIC????<br>Mitsubishi Mr. Slim Hyper heat OR<br>Resistance in Ventilation | have sample                                       | wash outside with<br>PXHT 80<br>Good enough<br>10/3/2012 | directly to Sarah<br><br><a href="http://www.stiebel-eltron-usa.com/accelera.html">http://www.stiebel-eltron-usa.com/accelera.html</a><br><a href="http://www.zehnderamerica.com/">http://www.zehnderamerica.com/</a><br><a href="http://www.ductmate.com/product.aspx?id=27">http://www.ductmate.com/product.aspx?id=27</a> |

11-05 Savoy

23 June 2011

- Group the home runs and other circuit wires together (rather than spreading them out separately in the space) to help keep the magnetic fields contained to a more limited area and thus reduce the overall EMF exposure to people in the house.

Pre-Installation Meeting – prior to rough wiring; (CM, electrician, owner, & architect present) To review which particular locations in the home have the highest priority for avoiding the placement of nearby electrical wiring and discuss / resolve potential conflicts.

#### 5. BEDROOM SHUT-OFF SWITCHES

Install a special shutoff switch for all the wiring around the bedroom. The power supply for all the bedroom outlets and lights to be brought first to a switch box near the bedroom door, or to a special switch box several feet away from the bed but still reachable from the bed. Then the remaining outlets and lights in the bedroom can be wired from this master switch. In this way, the homeowners can completely turn off all the wiring near the bed (including all the electrical cords and devices plugged in to those outlets).

#### 6. LOW-EMF WIRING

Summary: Pay special attention to the connection of all neutrals, especially in multi-gang boxes which contain the neutral wires from two or more different circuit breakers.

Explanation: A common error in new and remodel construction is to simply gang the many neutral wires together, allowing the neutral return current from one circuit (or branch of a circuit) to cross over and return on another. This causes imbalanced “net currents” which can generate very high ELF magnetic fields throughout much of the home.

A similar problem occurs if any neutral wire is improperly or accidentally connected to a grounding wire. For example, if a bare ground wire touches the neutral post of a receptacle in an outlet box, some of the neutral current will return via the grounding system instead of the neutral wire. This can cause “stray currents” to flow in the grounding system of the building – which includes metal water and gas pipes – and can generate high magnetic fields.

Wiring of 3-way switches. Make sure that a “three-wire” (plus ground) cable is always used between the two 3-way switches. Sometimes, an electrician will forget (or save money) and run only a two-wire cable between the 3-way switches, and then pick up the needed neutral from another circuit or another part of the same circuit. This shortcut can also cause very high magnetic fields. (Advice: If a “three-wire” cable is always used between the 3-way switches, an improperly connected 3-way circuit can usually be repaired later without having to open walls or pull new wires.)

Follow all national and local electric codes for proper grounding. For example, the only neutral-to-ground connection (bond) should be at the main service entrance. This is one reason why the NEC now requires 4-prong plug connectors for electric ovens and dryers. The old 3-prong devices connected the neutral and ground wires, thus allowing neutral current to enter the grounding system.

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11-05 Savoy

23 June 2011

#### 7. FIXTURE SCHEDULE

The choice of fixtures to be based on lowest EMF and cost effectiveness. Assume for pricing purposes:

- No dimmer switches
- LED and Incandescent lamplighting
- Minimal fluorescent lights

#### 8. MAGNETIC SHIELDING AT THE ELECTRICAL PANEL

- Install a “high magnetic permeability” shielding materials such as MuMetal alloy or Giron.
- (2) layers of 6 mil (0.006 inch) thick “Hi-Mu 80” alloy, installed behind the panel and wrapping as much as possible around the top, bottom and sides of the panel.

The cost of these special magnetic shielding materials is often \$25 or more per square foot per layer, so material costs alone will usually be several hundred dollars per panel. Typically, this type of shield installation will reduce the magnetic fields by about 50 to 70%.

#### 9. POST TEST OF EMF

Even the best electrician can inadvertently make a number of small, accidental wiring errors that are only detected by using a gaussmeter. Both the magnetic fields and the electric fields to be retested after the work is completely done – when all of the lights and appliances are installed and the electrical power is turned on. Any remaining wiring issues can then be detected and corrected at that time.

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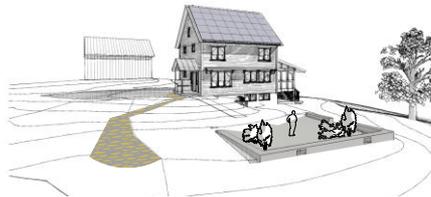
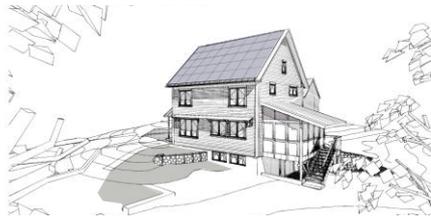
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## Drawing List

- L1 Site Plan
- A1.0 Cellar Plan
- A1.1 First Floor Plan
- A1.2 Second Floor Plan
- A1.3 Attic Plan
- A1.4 Roof Plan
- A3.1 Elevations
- A4.1 Building Section
- A4.2 Building Section
- A4.3 Building Sections
- A5.1 Detail Wall Section - Typ
- A5.2 Additional Details
- A5.3 Porch Details
- A6.1 Interior Details
- A7.1 Interior Elevations
- A9.1 Window Schedule /Details
- A9.2 Door Schedule / Details
- A10.1 Root Cellar
- S0 Foundation Plan
- S1 1st Floor Framing Plan
- S2 2nd Floor Framing Plan
- S3 Attic Floor Framing Plan
- S4 Roof Framing Plan
- E0 Cellar Electrical Plan & Notes
- E1 1st Floor Electrical Plan
- E2 2nd Floor & Attic Electrical Plan
- M0 Cellar Mechanical Plan
- M1 1st Floor Mechanical Plan
- M2 2nd Floor Mechanical Plan
- M3 Attic Mechanical Plan



Savoy House  
Savoy, MA

**PERMIT Set**  
**21 JUNE 2012**

**CONSTRUCTION**  
Kent Hicks  
Kent Hicks Construction  
W. Chesterfield, MA  
413.296.0123

**ARCHITECT**  
Coldham&Hartman Architects  
PM: Jesse JW Selman  
Amherst, MA 01002  
413.549.3616

**Coldham&Hartman Architects**  
www.coldhamandhartman.com 155 Pine Street Amherst, MA 01002 t: 413.549.3616 f: 413.549.6802

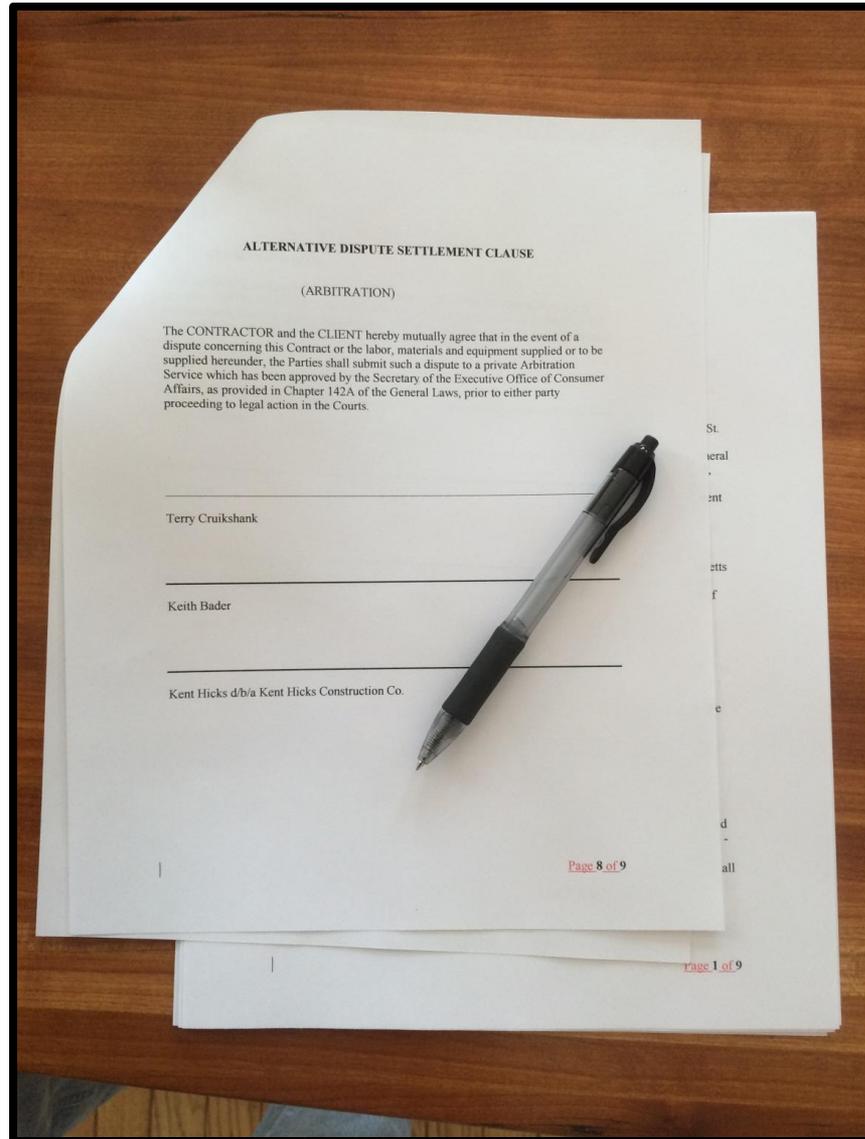
| Location     | Material   | Description  | Ordered   | Result   | Notes  |
|--------------|--|--|---|--|--|
|              |  |  |   | OK   | Sarah  |
|              |  |  |   | NO   | Kent   |
|              |  |  |   |  | Jesse  |
|              |  |  |   |  | Outside air barrier  |
| SITE         |  |  |   |  |  |
|              | Driveway<br>Drain pipe<br>Concrete retaining walls<br>Stone retaining walls  | gravel<br>by subcontractor<br>see foundation<br>large rough stones or versalok   |   |  |  |
| SCREEN PORCH |  |  |   |  |  |
|              | Wood Framing<br>Post Bases<br>Decking<br>Ceiling<br>Roof<br>Plywood Sheathing<br>Lights<br>Door  | we are getting a Timbersil and L3 is now called Simpson<br>Mahagony T&G<br>V-Groove - painted pine<br>Metal<br>phenol-based glue (NOT UREA)<br>cdx exterior plywood<br>recessed cans - LED<br>AFM Polyureseal  | OK<br>Have Mahagony<br><br>douglass fir depot)            | the<br>Yes, 10/14/2012<br>OK, 11/15/2012<br>painting<br>Yes, 10/3/2012<br>yes, doug fir<br>plywood is ok                         | <a href="http://www.building-products.com/readNews.aspx?ID=2765">http://www.building-products.com/readNews.aspx?ID=2765</a><br>Metal hardware, exterior, galvanized<br>Tight fit with pitch to exterior<br>Painted<br>assuming this is fine - Englert metal roof<br><a href="http://www.norbord.com/na/wall-sheathing/trubord">http://www.norbord.com/na/wall-sheathing/trubord</a><br>Sample for RK Miles was ok. |
| FOUNDATION   |  |  |   |  |  |
|              | RETAINING WALLS<br>Exterior insulation<br>EPS adhesive<br>EPS caulk<br>Waterproofing<br>Foamglas<br>Foamglas adhesive<br>Footing Drains<br>Termite Guards<br>Exterior insulation cover board | Precast stone<br>EPS<br>loctite PL300 foamboard adhesive<br>Loctite Polyseamseal All Purpose Caulk<br>Polywall<br>PC88 being tested<br>PittSeal CW Sealant being tested<br>by sub-contractor<br>Aluminum flashing<br>FINEX concrete board -UNFINISHED TEXTURED | Have sample, 10/9<br><br><br>Howie, 10/11<br>Howie, 10/11 | This looked fine<br>Yes<br>Yes, 10/17<br>Yes, 10/21<br>Yes<br>yes<br>No, 10/18/2012<br>Yes, 10/19<br>Yes<br>Yes<br>OK, 7/20/2012 | ??<br><br><br><br><br><br><br><br><br><br><br><br>This eventually aired out fine after some months.  |











# THE PROCESS

| Location     | Material   | Description  | Ordered   | Result   | Notes  |
|--------------|--|--|---|--|--|
|              |  |  |   | OK   | Sarah  |
|              |  |  |   | NO   | Kent   |
|              |  |  |   |  | Jesse  |
|              |  |  |   |  | Outside air barrier  |
| SITE         |  |  |   |  |  |
|              | Driveway<br>Drain pipe<br>Concrete retaining walls<br>Stone retaining walls  | gravel<br>by subcontractor<br>see foundation<br>large rough stones or versalok   |   |  |  |
| SCREEN PORCH |  |  |   |  |  |
|              | Wood Framing<br>Post Bases<br>Decking<br>Ceiling<br>Roof<br>Plywood Sheathing<br>Lights<br>Door  | we are getting a Timbersil and L3 is now called Simpson<br>Mahagony T&G<br>V-Groove - painted pine<br>Metal<br>phenol-based glue (NOT UREA)<br>cdx exterior plywood<br>recessed cans - LED<br>AFM Polyureseal  | OK<br>Have Mahagony<br><br>douglass fir depot)            | the<br>Yes, 10/14/2012<br>OK, 11/15/2012<br>painting<br>Yes, 10/3/2012<br>yes, doug fir<br>plywood is ok                         | <a href="http://www.building-products.com/readNews.aspx?ID=2765">http://www.building-products.com/readNews.aspx?ID=2765</a><br>Metal hardware, exterior, galvanized<br>Tight fit with pitch to exterior<br>Painted<br>assuming this is fine - Englert metal roof<br><a href="http://www.norbord.com/na/wall-sheathing/trubord">http://www.norbord.com/na/wall-sheathing/trubord</a><br>Sample for RK Miles was ok. |
| FOUNDATION   |  |  |   |  |  |
|              | RETAINING WALLS<br>Exterior insulation<br>EPS adhesive<br>EPS caulk<br>Waterproofing<br>Foamglas<br>Foamglas adhesive<br>Footing Drains<br>Termite Guards<br>Exterior insulation cover board | Precast stone<br>EPS<br>loctite PL300 foamboard adhesive<br>Loctite Polyseamseal All Purpose Caulk<br>Polywall<br>PC88 being tested<br>PittSeal CW Sealant being tested<br>by sub-contractor<br>Aluminum flashing<br>FINEX concrete board -UNFINISHED TEXTURED | Have sample, 10/9<br><br><br>Howie, 10/11<br>Howie, 10/11 | This looked fine<br>Yes<br>Yes, 10/17<br>Yes, 10/21<br>Yes<br>yes<br>No, 10/18/2012<br>Yes, 10/19<br>Yes<br>Yes<br>OK, 7/20/2012 | ??<br><br><br><br><br><br><br><br><br><br><br><br>This eventually aired out fine after some months.  |



|                                  |  |                        |                    |  |   |
|----------------------------------|--|------------------------|--------------------|--|---|
| BASEMENT                         |  |                        |                    |  |   |
| GWB                              | paperless  | have sample            |                    |  |   |
| Floor finish                     | Trowel Finish Premium Lithium Densifiers and water or solvent based sealers- VT Eco-Floors | Jesse trying to locate |                    |  |   |
| Ceiling                          | Lionhard and Lumiseal FX   | Have samples           |                    |  | <a href="http://www.gofinex.com/english/contact-finex-fibercement-panels.html">http://www.gofinex.com/english/contact-finex-fibercement-panels.html</a> |
| interior of Exterior wall finish | Paperless GWB  | not using???           |                    |  |   |
| Interior Windows                 | None?? Confirm   |                        | Yes, none          |  | What brand?   |
|                                  | tempered, single pane, FG  |                        | yes Yaro           |  | <a href="http://www.vermontecofloors.com/floor-finishes.html">http://www.vermontecofloors.com/floor-finishes.html</a>                                   |
|                                  |  |                        |                    |  | Need samples of Lionhard and LumisealFX. info@lmcc.com  |
|                                  |  |                        |                    |  | Paperless is problematic  |
| EXTERIOR WALLS                   |  |                        |                    |  |   |
| Mud Sills                        | we are getting a Timbersil and L3 is now called  | mahogany timbersil     | sills, 11/15/2012  |  |   |
| Sill seal                        | roll   | Have sample            | ok, 10/2012        |  |   |
| Anchor Bolts                     | clean off oils   | na                     | Yes                |  |   |
| Foam                             | OSI Green Series   | Requested 10/4         |                    |  |   |
| Caulking                         | OSI Green Series   | have sample            | OK , 10/3/2012     |  |   |
| Window sills                     | Options-Stone, Concrete, Tile?   |                        |                    |  | <a href="http://202080947/h_d2/ProductDisplay?catalogId=10053&amp;langId=">202080947/h_d2/ProductDisplay?catalogId=10053&amp;langId=</a>                |
| Ext. Door casing                 | "  |                        |                    |  |   |
| Interior Paint                   | Mythic Paint—color-by-owner  | have sample            | OK, 11/28/2012     |  | <a href="http://www.osipro.com/greenseries.shtml">http://www.osipro.com/greenseries.shtml</a> Profoam (green) is not                                    |
|                                  | Ben Moore Natura Paint   |                        | 8/2013 ?           |  | H2U acrylic Urethane sealant.   |
| GWB                              | Standard GWB??   |                        |                    |  |   |
| Electrical Boxes                 | Lesco -Style sealed to GWB - switch to metal for MC cable compatibility                    | have sample            | Not using?         |  |   |
| Cellulose                        | National Fiber   | Have sample            | Yes, 5/9/2013      |  | <a href="http://www.mythicpaint.com/">http://www.mythicpaint.com/</a>   |
| Wood Framing                     |  |                        | Yes, doug fir      |  |   |
| Plywood sheathing                | exterior grade phenol glue only  | douglas fir?           | Yes, doug fir      |  |   |
|                                  | or Trubord   | Trubord                | Tubord no.         |  | <a href="http://www.energyfederation.org/consumer/default.php/cPath/21_1272_1">http://www.energyfederation.org/consumer/default.php/cPath/21_1272_1</a> |
|                                  | Georgia Pacific CDX exterior plywood, unknown  | have sample, 10/22     | No, GP             |  |   |
| Tapes                            | Grace Vycor with Green Primer  |                        | OK, 4.27.2013      |  | Construction sequence - air out framing prior to insulation &   |
| Exterior rigid foam              | Polyisocyanurate   | 10/4                   | Yes, 10/5/2012     |  |   |
| Exterior Rigid Foam at           | EPS  | Jesse                  | Yes                |  | See Trufloor sample below   |
| Weather Resistive Barrier        | Typar over foam  | barn on 10/19          | Jesse yes          |  |   |
| intello vapor barrier            |  |                        | Ok, -5/1/2013      |  |   |
| tescon vana tape                 |  |                        | OK outside, 4/2013 |  |   |
| Windows                          | Schuco Aluminum  |                        | YES                |  | Branch River Plastics (401) 232-0270 branchriver.com  |
| Doors                            | Thermatru or schuco  |                        |                    |  | <a href="http://www.vaproshield.com/">http://www.vaproshield.com/</a>   |
| Strapping                        | 1x4  |                        | Yes                |  | 475 high performance building   |
| Siding                           | Pre-finished Nichiha brand--Ended up with Hardie   | have nichiha sample    | Unfinished is fine |  | 475 high performance building   |
| Trim                             | options - wood, fiber cement, pvc  |                        | ok, 6/7/2013       |  |   |
| Corner boards                    |  |                        |                    |  | Likely a cost issue. JS to prepare thinking   |
| Water table                      |  |                        |                    |  |   |
| Frieze                           | Metal?   |                        |                    |  | <a href="http://www.nichiha.com/prod_nichiboard.htm">http://www.nichiha.com/prod_nichiboard.htm</a>   |
| Flashing                         |  |                        |                    |  |   |
| Paint                            | Benjamin Moore Low VOC exterior  |                        |                    |  |   |



CHALLENG

ES





NESEA BE 2016

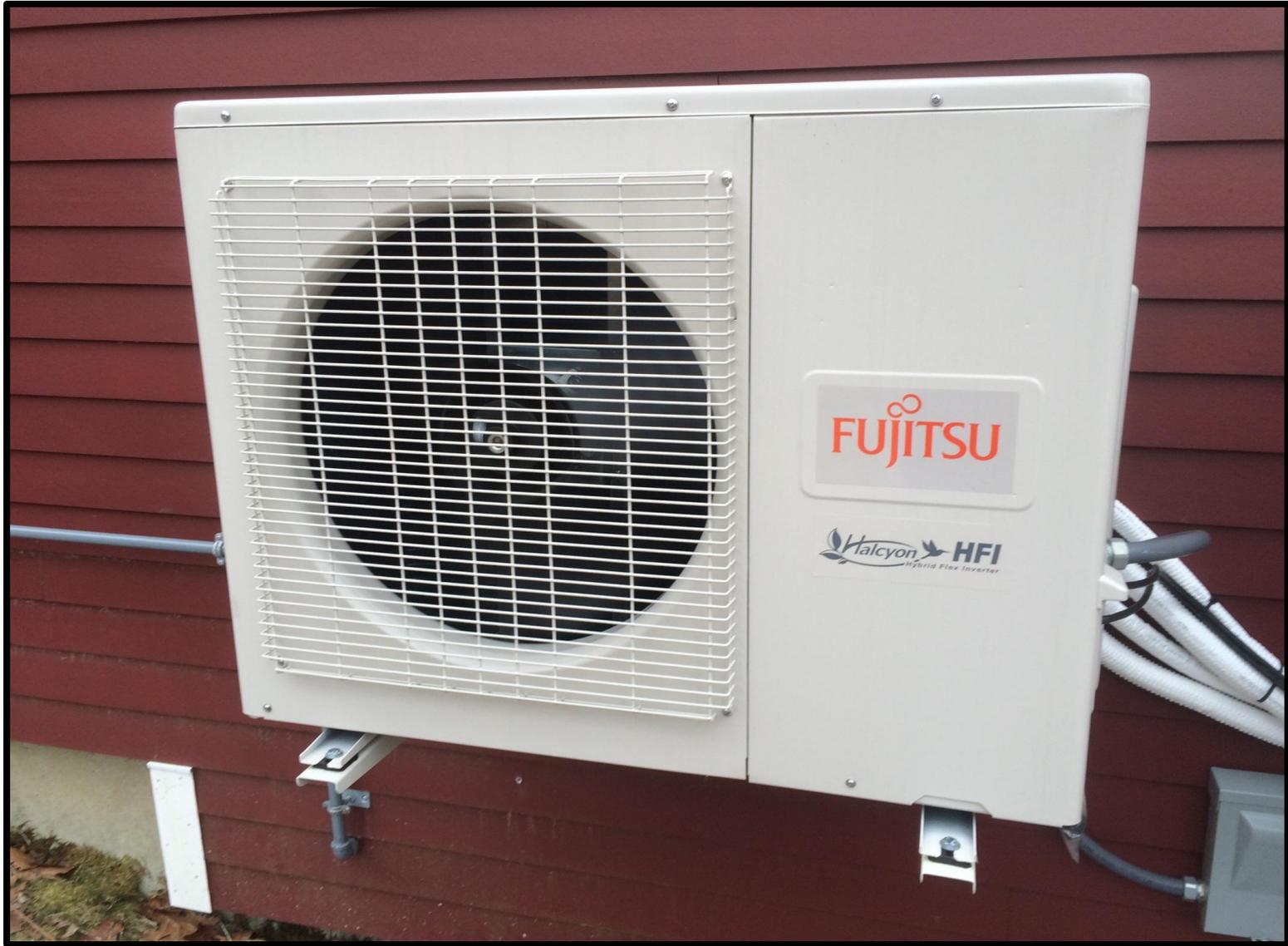
When you come to a fork in the road, take it.



KENT HICKS CONSTRUCTION CO.

c&h architects







THANK  
YOU!



NESEA BE 2016

## RESULTS

“I can live here.”

-owner after  
spending time in the  
finished house.

c&h architects

KENT HICKS CONSTRUCTION CO





## Monitoring

TEMP

RH

MC

DEWPOINT

In multiple locations

All is well, Kent & Jesse can sleep

Lessons:

Is it real? Does it need to be? Canary Theory

What else do we do that you would question - 1800 tfa or 600 sf/bedroom

Since WW2 - 80,000 chemicals introduced to earth – 10-20,000 in the world in a measurable way.

Regulations vary broadly - from none to very restrictive. 3,000 are HPV (high production volume)

4 billion pounds per year enter the world.

“Even if we did everything right, the result still could have been failure.”

Luckily

“The house really works”

References:

United States Environmental Protection Agency. Chemical Hazard Data Availability Study: What Do We Really Know About the Safety of High Production Volume Chemicals? Washington, DC: Office of Pollution Prevention and Toxics, 1998.

United States Environmental Protection Agency. Toxic Release Inventory (TRI) Program. Washington, DC, February 21, 2008.

Centers for Disease Control and Prevention (CDC). Third National Report on Human Exposure to Environmental Chemicals Atlanta (GA): CDC, 2005.

## Lessons:

No VOC only applies for regulated VOCs

Test Everything First

Not just chemicals – Pine was irritant while Fir was not

Oily residue on most manufactured metal - Washed MC cable

Garbage bags vs tin foil

Wireless/cellular free = device free = mindful usage

Cabinets – Board & Batten style Cabinets of solid maple to minimize glue

Outdoor room – South / East Porch as possible retreat

Isolated room positive pressure bedroom

Extra carbon filter on HRV – No Dust – HRV works

Screwed / not glued floor deck – collaboration with Structural Engineer

Air out between rough and finish

Porch as room

Hard, not porous surfaces

Listen to client.

