Eco-Renovation

ENDEAVOUR CENTRE, 2018

The Endeavour Centre undertakes sustainable building projects that engage a group of full-time students in the complete building process.

In 2018, the City of Peterborough began to allow for “secondary suites” within the city. Esther Vincent leapt at the opportunity to convert the empty concrete block garage attached to her home into a one-bedroom rental suite.

Endeavour helped her to do the work so the renovation would have no carbon footprint, would be highly energy efficient, completely non-toxic, and minimize waste.

This book follows the process of creating this exciting renovation…

Meeting the team

The class of 2018 arrives in Peterborough, coming four different countries and diverse skill sets

From left: Maya Chopra, Nicole Dulong, Diederik Schuring, Justin Hung, Justin Shaude, George Ansah, Genevieve Neelin, Chris Magwod.

CRITERION	1	2	3	4
Ecosystem impacts				✓
Embodied carbon				✓
Energy efficiency			✓	
Indoor environment				✓
Waste			✓	
Resilience	✓			
Maintenance & durability	✓			
Code compliance			✓	
Material costs			✓	
Labour cost/sources				✓
Additional criteria….	Remain within existing footprint, tie into house services, maximum re-use of materials			

Setting sustainable goals

Every project at Endeavour begins with a comprehensive goal-setting exercise. It is at this phase that we work with the owner to determine priorities for the design in ten categories of environmental performance.

The goal matrix for every project is different. Here, healthy indoor environment, low ecosystem impacts and zero carbon footprint receive the highest priority. These goals are balanced with budget constraints and code and maintenance considerations when we choose all the materials and systems that will go into the building.

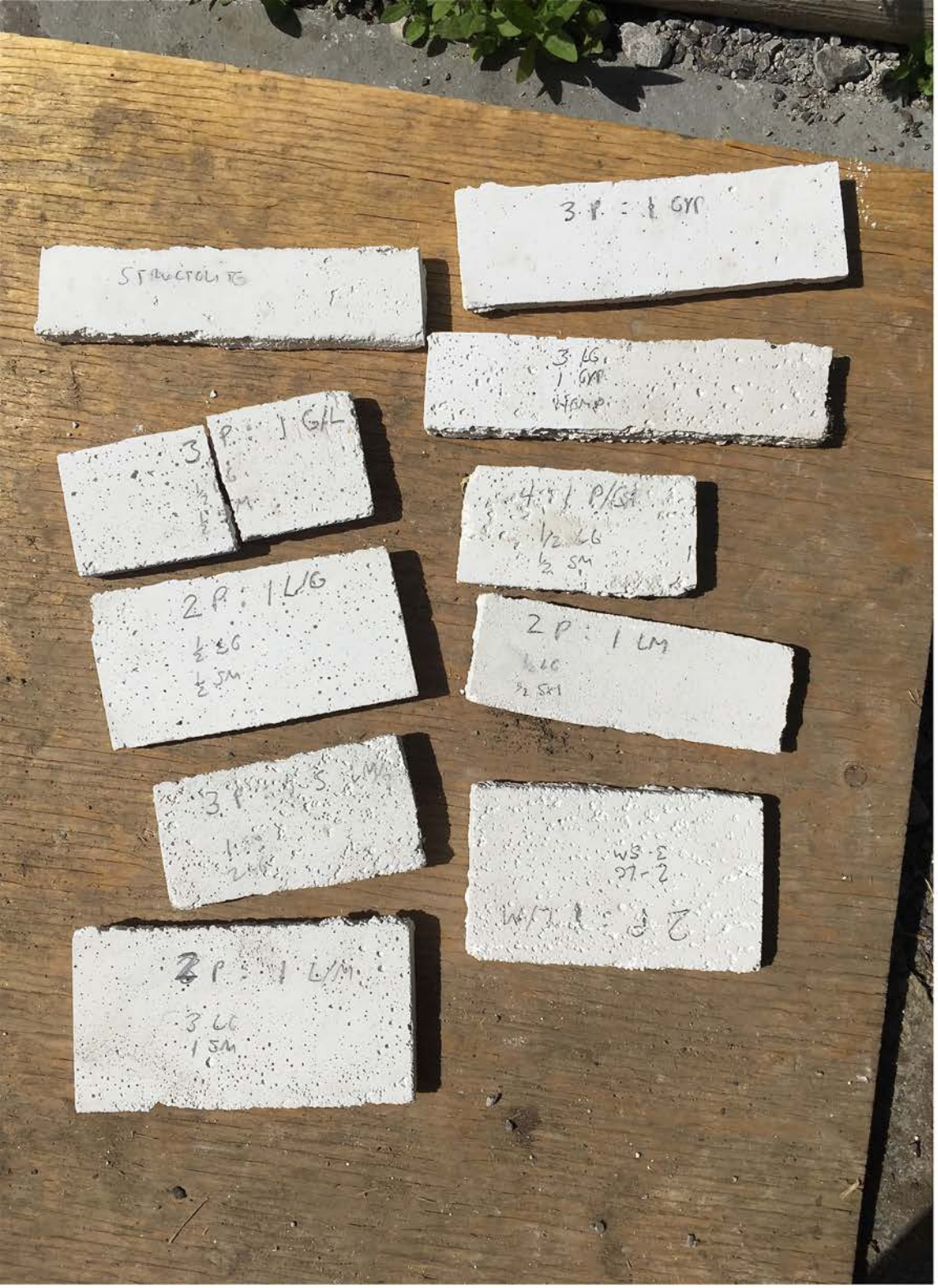
An empty shell…
This 100 year old garage is about to become a beautiful “secondary suite,” a separate dwelling attached to an even older brick home.

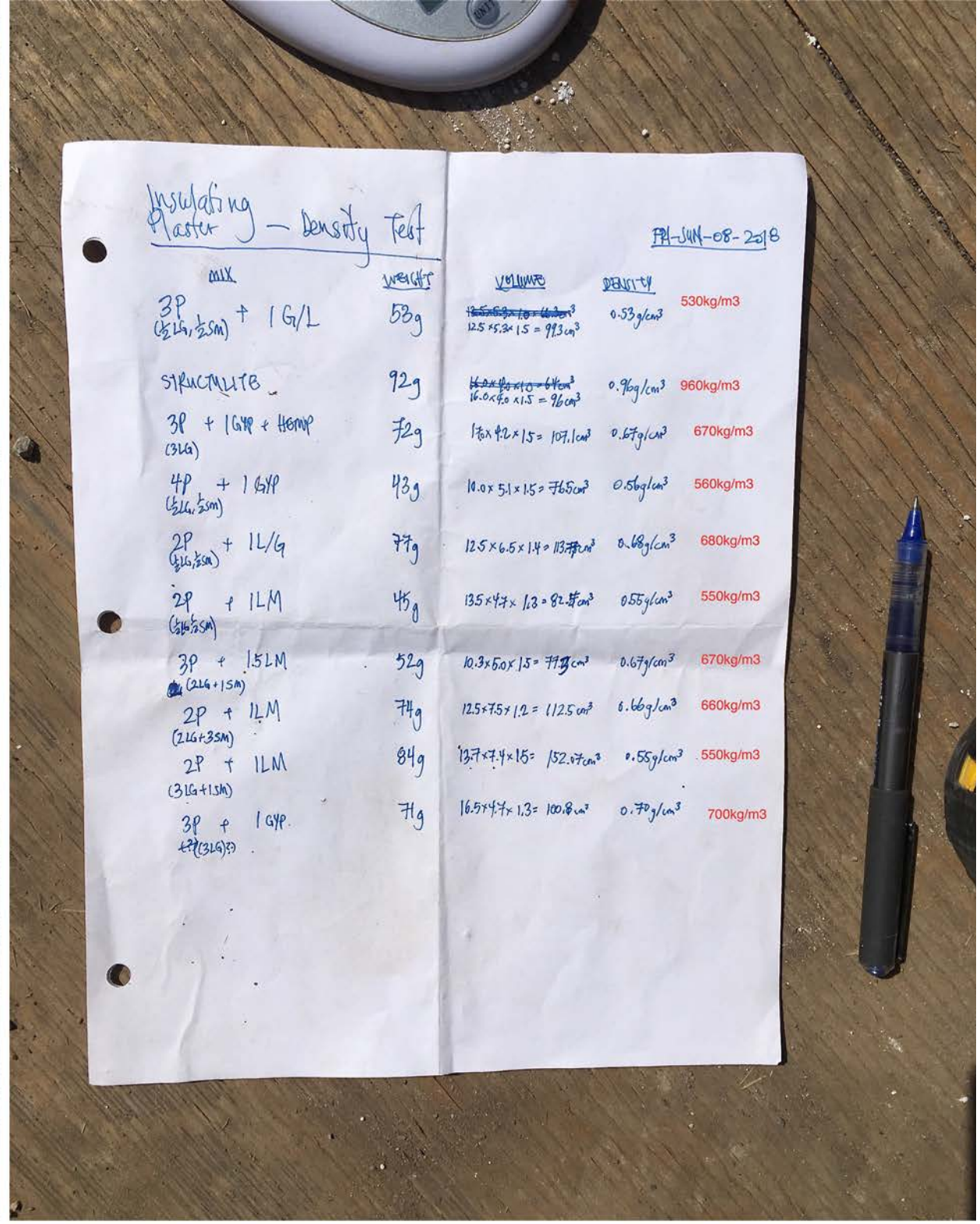
Unused space

The space has all the trappings of a neglected garage space. Can this become beautiful, healthy, efficient living space?

Learning about innovative new materials

Creating an insulating, air-sealing plaster mix using expanded glass beads, lime and metakaolin. This plaster will be applied to the interior of the concrete block walls to provide air sealing and insulation.





A recipe is discovered…

2 parts large Poraver beads, 1.5 parts small beads, 1/2 part lime and 1/2 part metakaolin results in a lightweight plaster and air barrier. The mix offers a density of around 350kg/m3, giving an R-value of ~2 per inch.

DIGGING IN TO CREATE DRAINAGE AROUND THE BUILDING…

The foundation of the garage is very close to grade. In order to protect the building from water, the team dug around the building and installed a weeping tile, and covered the tile in clear gravel. This will encourage water to move away from the building and to a “dry-well” and then to daylight.

Foundation insulation

In addition to a drainage tile, the foundation was given perimeter insulation to minimize heat loss around the edge of the building. Two layers of Rockwool drainboard offers R-12. A dimpled drainage membrane directs water away from the footing and the insulation.

Supporting the roof structure

The beam in the middle of the building needed replacement, so the roof structure is supported on temporary jack posts

Cement-free footings

New footings are created to support additional structural posts.
We use a lime/metakaolin concrete that is tamped into forms.
The lime-metakaolin mix is a type of non-Portland cement concrete based on old Roman concrete mixes.
Eliminating Portland cement dramatically reduces the carbon footprint of concrete.

Insulating plaster test patches

The insulating plaster is applied to the wall to test adhesion and workability. Our test mix works very well.

Plastering begins

This unique insulating plasters provides excellent air sealing of the old block walls, and creates a permeable thermal break between cold concrete and the insulation we will add later.


FEATHERLITE
FEATHERLITE

Air sealing details

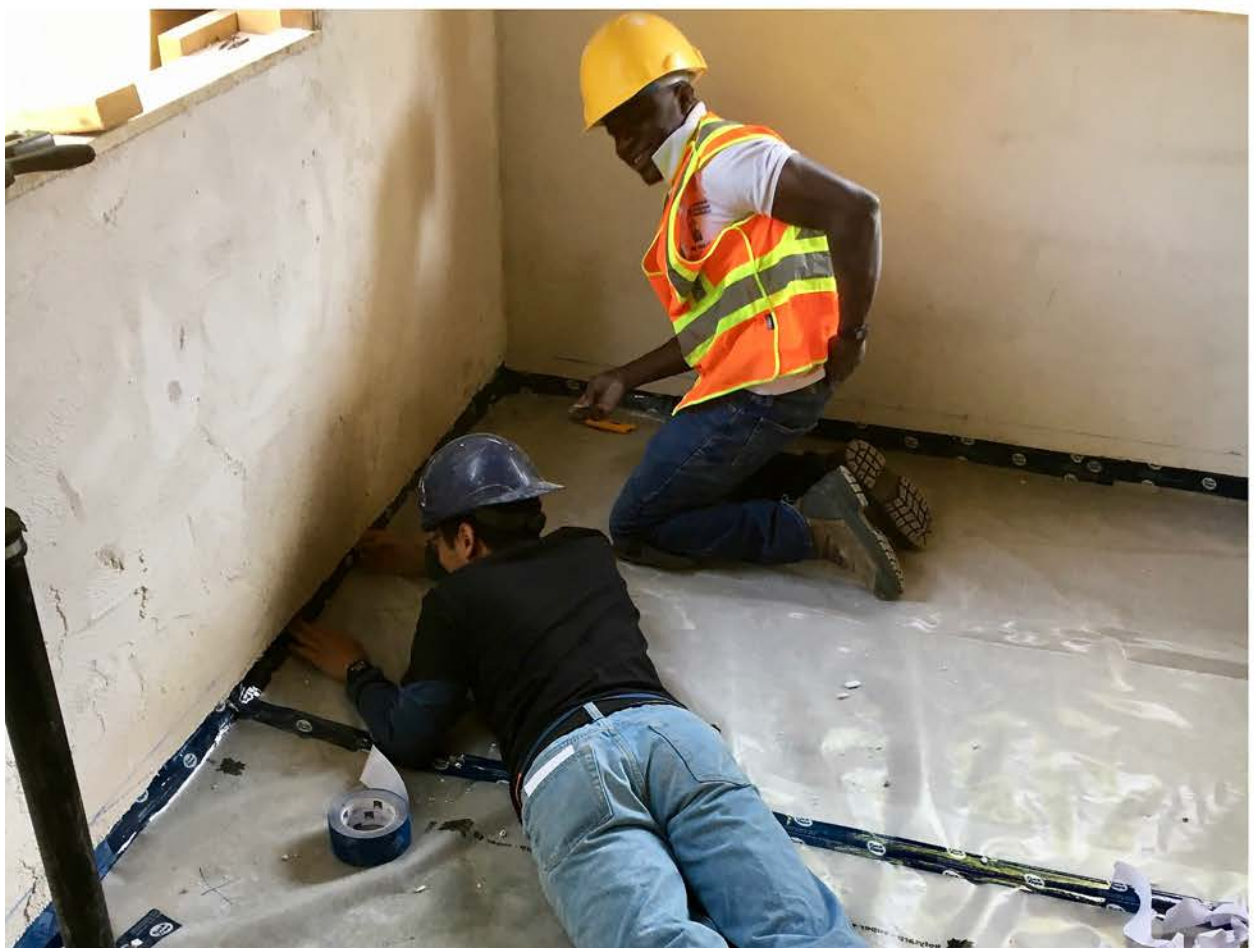
A strip of air sealing tape from ProClima bonds well with plaster, and will give us a place to seal the roof air barrier later. These kinds of details are important for keeping a renovation air tight.

A new beam

We put the new support beam flush with the ceiling joists to provide more head room. The joists were cut and the beam inserted, and then metal joist hangers connect joists to beam.

Beam installed and floor base prepared

The roof joists are supported on the new beam.
A layer of tamped gravel levels out the floor and provides a solid base for the insulation layer.



Vapour control layer for floor

A heavy-duty 10-mil poly vapour control layer is placed on the floor. All the seams are taped, and tape connections are made to the fleece tape used behind the insulating plaster.

This vapour control layer will keep rising damp out of the assembly and contribute to the overall air tightness by providing a good seal where the walls meet the floor.

Poraver floor insulation

Expanded glass beads provide insulation between the ground and our finished floor.

The recipe is 1000 litres of 2-4mm Poraver beads mixed with 44 kg of hydrated lime and 44 kg of metakaolin, plus water.

Placed at an average thickness of 8 inches, this layer provides an R-16 thermal break from the ground.

This material provides excellent bearing capacity (over 100 psi) and is impervious to moisture damage, while being locally sourced and non-toxic.

Poraver floor completed

Poraver floor and foundation insulation is a material we developed at Endeavour, with formulation help from the Poraver lab.
In our efforts to reduce both carbon footprint and chemical burden, we do not use foam insulation products and little to no cement. While options abound for above-grade products that avoid foam and cement, it is more difficult to find materials that can withstand the structural loads and the potential for moisture exposure that comes with being below grade or under a slab floor. By gluing together tiny, lightweight, expanded glass beads with lime and metakaolin (which is a by-product of making the glass beads), we create a completely non-toxic insulation that has a much smaller carbon footprint.

Altering the block walls

At the front of the building, a section of the block wall is removed and a new wall framed in its place to create the main entrance and window for the new bathroom. The old garage door opening gets two courses of blocks before new framing.

Framing and fibre board

The old garage door is framed using 2x6 lumber and Sonoclimat Eco4 wood fiberboard sheathing. These areas will be insulated with dense-packed cellulose after an additional wall is framed on the interior of the building.

More framing and fibreboard

The new entryway is framed in using 2x6s and SonoClimat Eco4.

Interior framing

To achieve the desired R-value for the walls, we added an interior frame wall that would provide 10-inches of thermal bridge-free insulation space between the block/insulated plaster and the interior face of the wall.

MIXING HEMPCRETE INSULATION

Hempcrete insulation uses the same lime and metakaolin binder as the Poraver sub slab insulation. In this case, hemp hurd is dry mixed with the two powdered binders, and then mixed with just enough water to make the mixture moist. Hempcrete is often mixed too wet, which significantly affects drying time in the wall.

The hemp hurd (left) is the centre portion of the stalk with the outer layer of fibre removed. It is ideal to have a distribution of large pieces (1/4-1 inch) and as little dust and fines as possible.

Hempcrete insulation

The east and west walls are packed with hempcrete using temporary forms on the stud walls. 4.5 parts of chopped hemp hurd are mixed with 0.5 lime and 0.5 metakaolin and a small amount of water.

Hempcrete complete

The east wall is fully packed with hempcrete. 10 inches of hempcrete will give the wall ~R24. Drying time for the hempcrete was longer than normal because it was up against the block wall on the exterior.

Lesson board

Every day begins at the white board, where tasks are assigned and key building details and building science considerations are covered before work begins.

AIR CONTROL LAYERS

An important part of making an energy efficient renovation is improving the air tightness of the building. We used sheet products from ProClima, obtained from 475 High Performance Building Supply. On the exterior, Mento 1000 wraps the new frame wall sections (top left). This material was also draped over the wall to tie into a layer of Mento 1000 on the roof (left), helping to seal the important top-of-wall junction. Intello (above) was used on the inside of the frame walls. This is a variable perm vapour control layer, able to allow drying to the inside of the wall if there is excess humidity in the wall assembly.

Cellulose insulation for walls

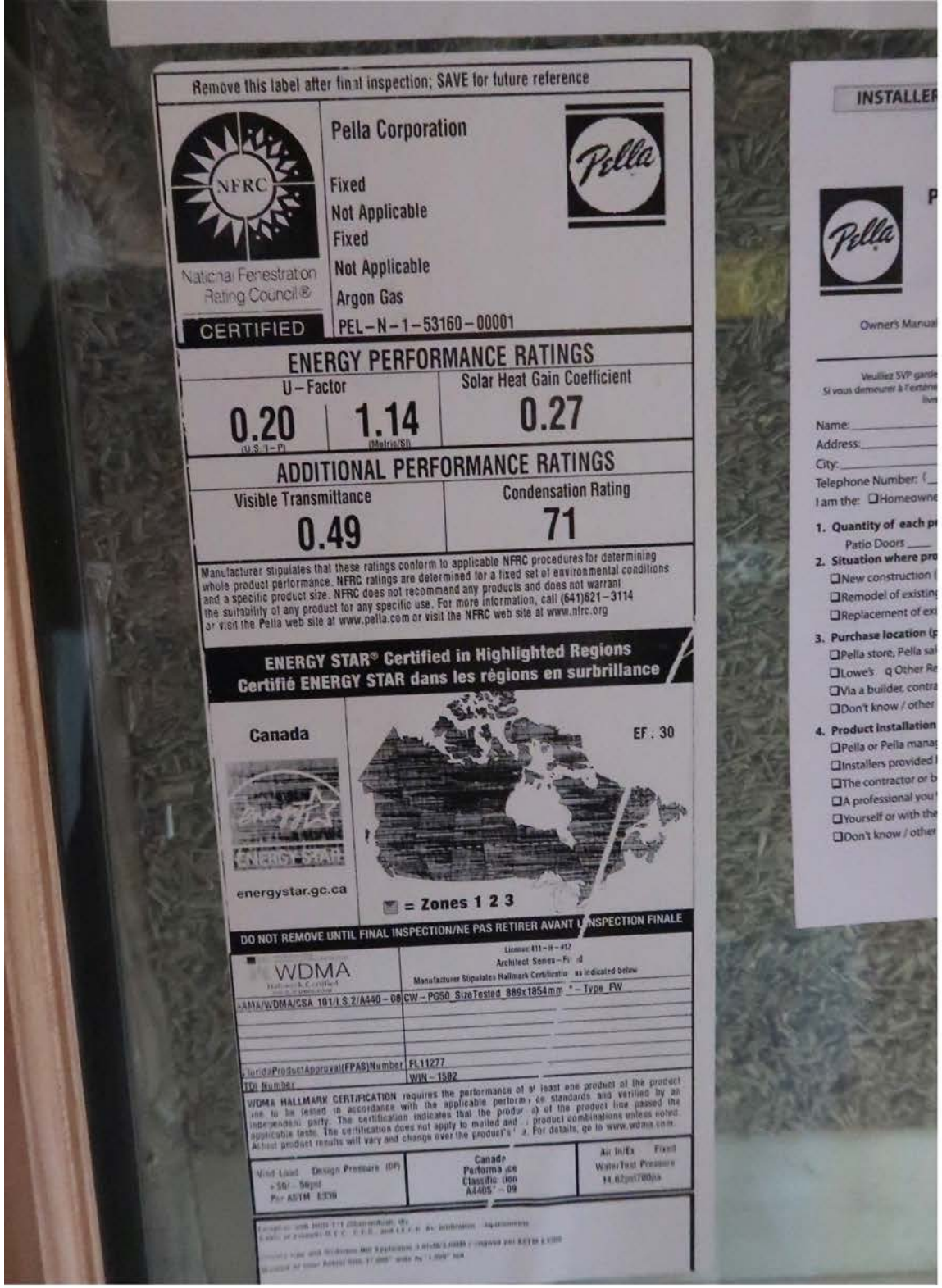
Cellulose, an insulation made from recycled newsprint, is dense-packed into the north and south walls at a density of at least 3.5 pounds per cubic foot to prevent future settling. These walls are now R-38.

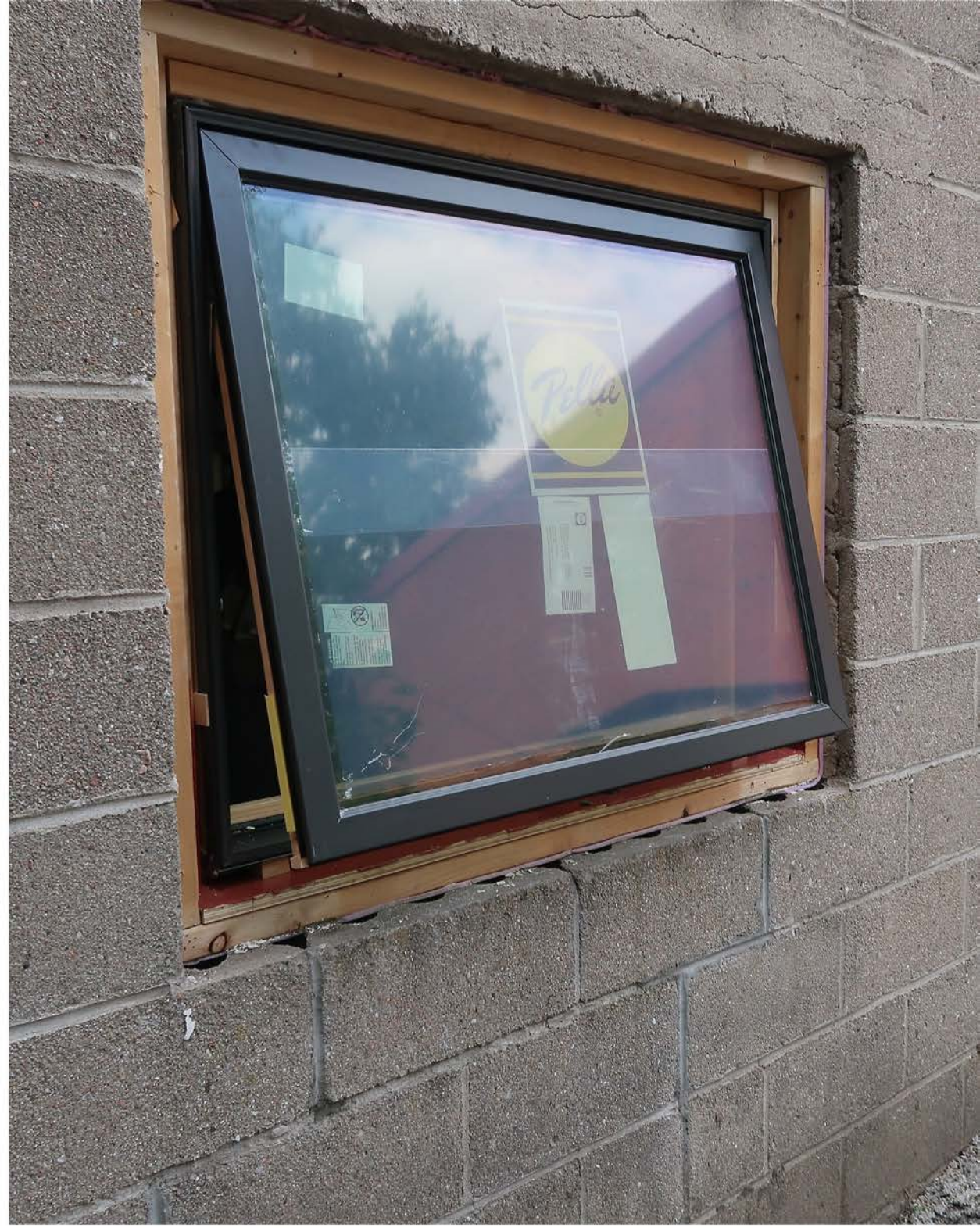
Ventilation

An energy recovery ventilator (ERV) was added to the space. This device exhausts air from the bathroom and kitchen and uses the heat and moisture in the exhaust to condition incoming fresh air bound for the living spaces.

A new roof on top of the old roof

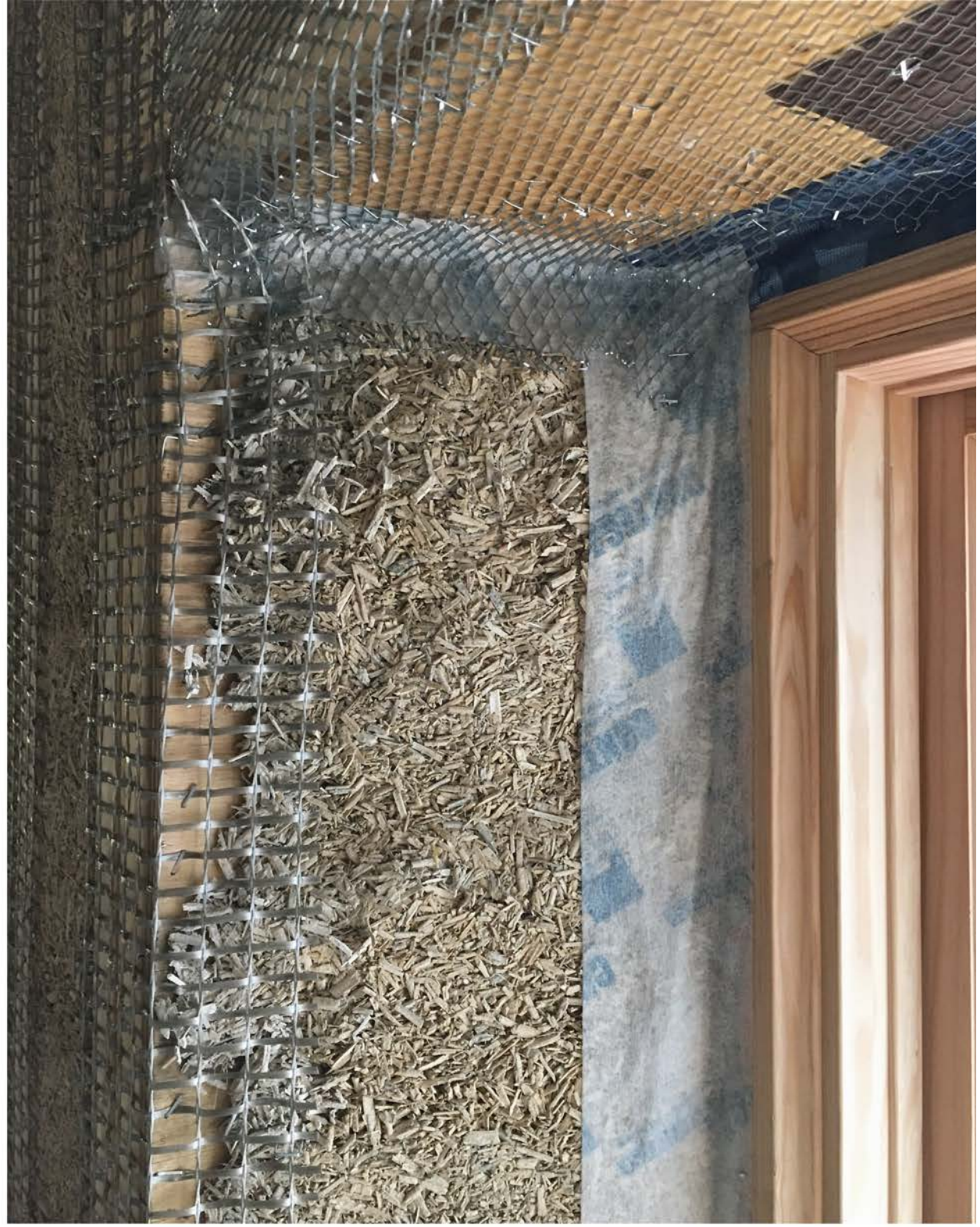
2x12s raised on strapping add room for 12” of cellulose insulation above the existing roof deck. With the addition of fiberboard sheathing, the roof has ~R-50. A layer of ice and water shield protects the low slope assembly.





New windows

New windows from Pella feature triple pane glazing and wood frames. The exterior frames are aluminum clad to minimize maintenance.



Window insulation and air sealing

Sheep's wool insulation is packed around the windows (above) and then ProClima air sealing tapes are used on both sides to prevent air or water leakage. Windows with hempcrete are prepared for plastering (right).

Keeping it non-toxic

It can be very difficult to keep all potentially toxic materials out of the building. In particular, caulking and sealant products can be highly toxic.

We make the effort to source the best possible products, using online resources like the Healthy Building Network's Data Commons to research the chemical content of everything that goes into the building.

Lime plaster

The first coat of traditional lime plaster is applied to the hempcrete walls. 1 part lime is mixed with 2.5 parts sand for this base coat. The adjacent walls are finished with drywall.

Front wall

The new frame wall section at the front of the building has a new window and door installed.

A new roof section will create a sheltered overhang around the door (below).

Brightening up

Non-toxic white paint from AFM Safecoat Naturals is sprayed onto the old ceiling joists and roof decking, helping to brighten up the space. The new beam and posts get the same treatment.

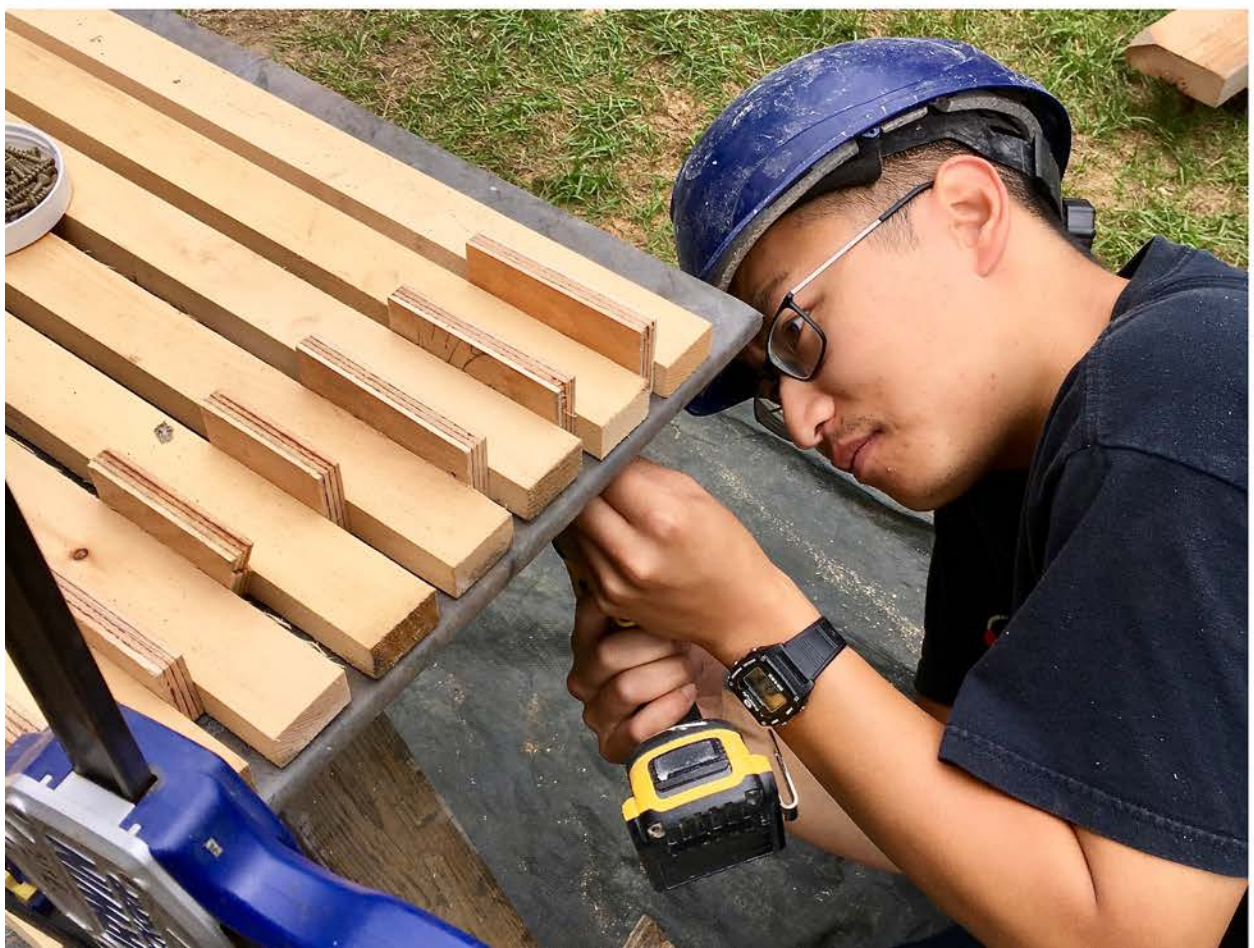
Drywall on the north and south walls covers up the cellulose insulation, while lime plaster at the east and west ends covers the hempcrete.

Details count

Galvanized trim acts as a plaster stop around windows and at the top and bottom of the walls. This makes for a clean line in the plaster and adds a nice visual detail with the shadow and silver reveal.

Wide sills for the well insulated walls

Reclaimed fir is laminated to make window sills for the wide walls. These sills are finished with natural linseed oil to protect the wood and enhance the grain.



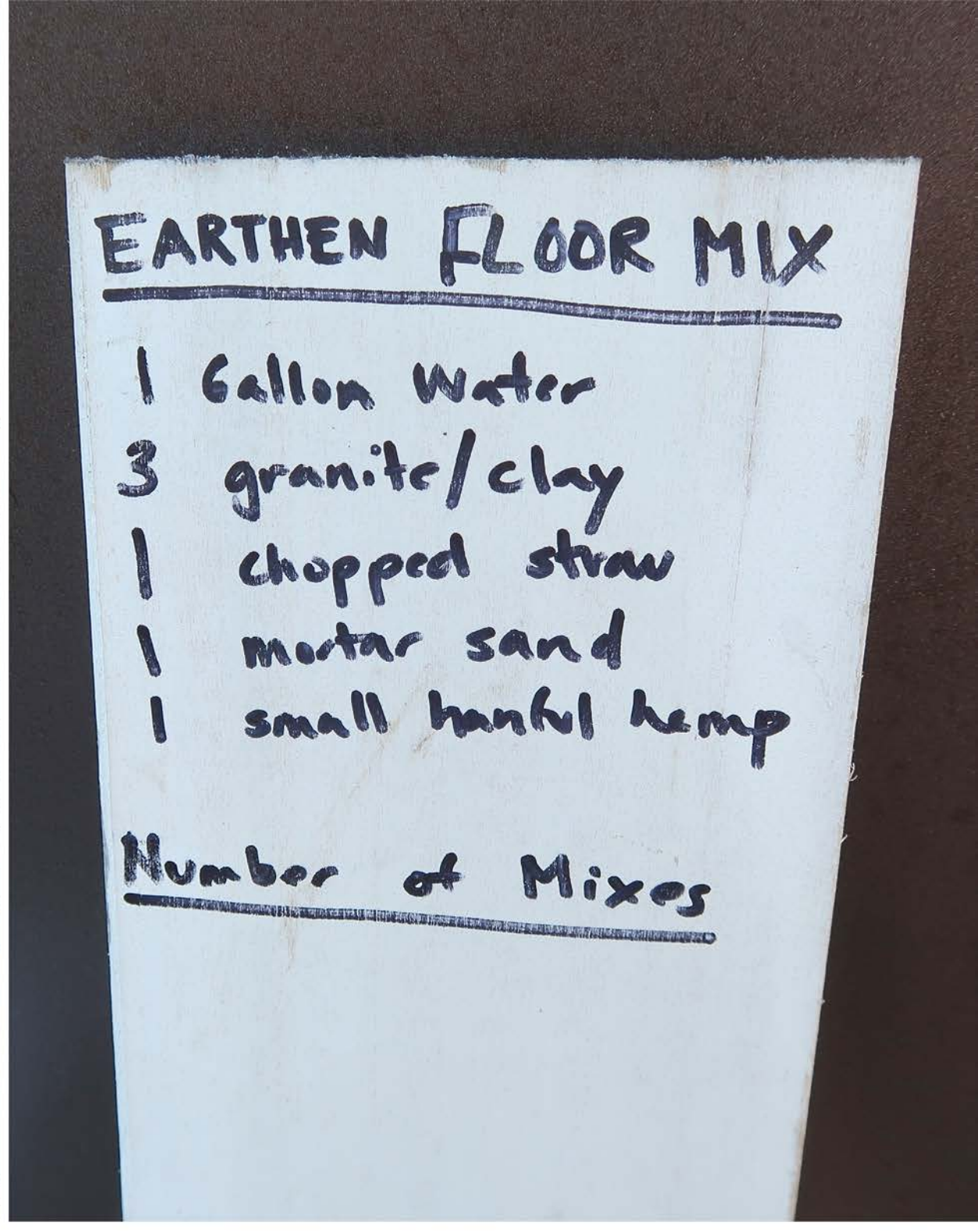
Reclaimed siding

The new frame walls are clad with recycled materials. A plywood backer was wrapped in old roofing membrane from the building. We milled strips of wood from larger pieces, and attached them to the backer, creating strong, water-resistant rain-screen panels.

The wood was treated with a clear, non-toxic product called Seal-Once.

Window flashing

Positioning new windows in this assembly requires careful consideration for the flashing that will keep water out of the wall at these critical junctions.



Making a clay floor

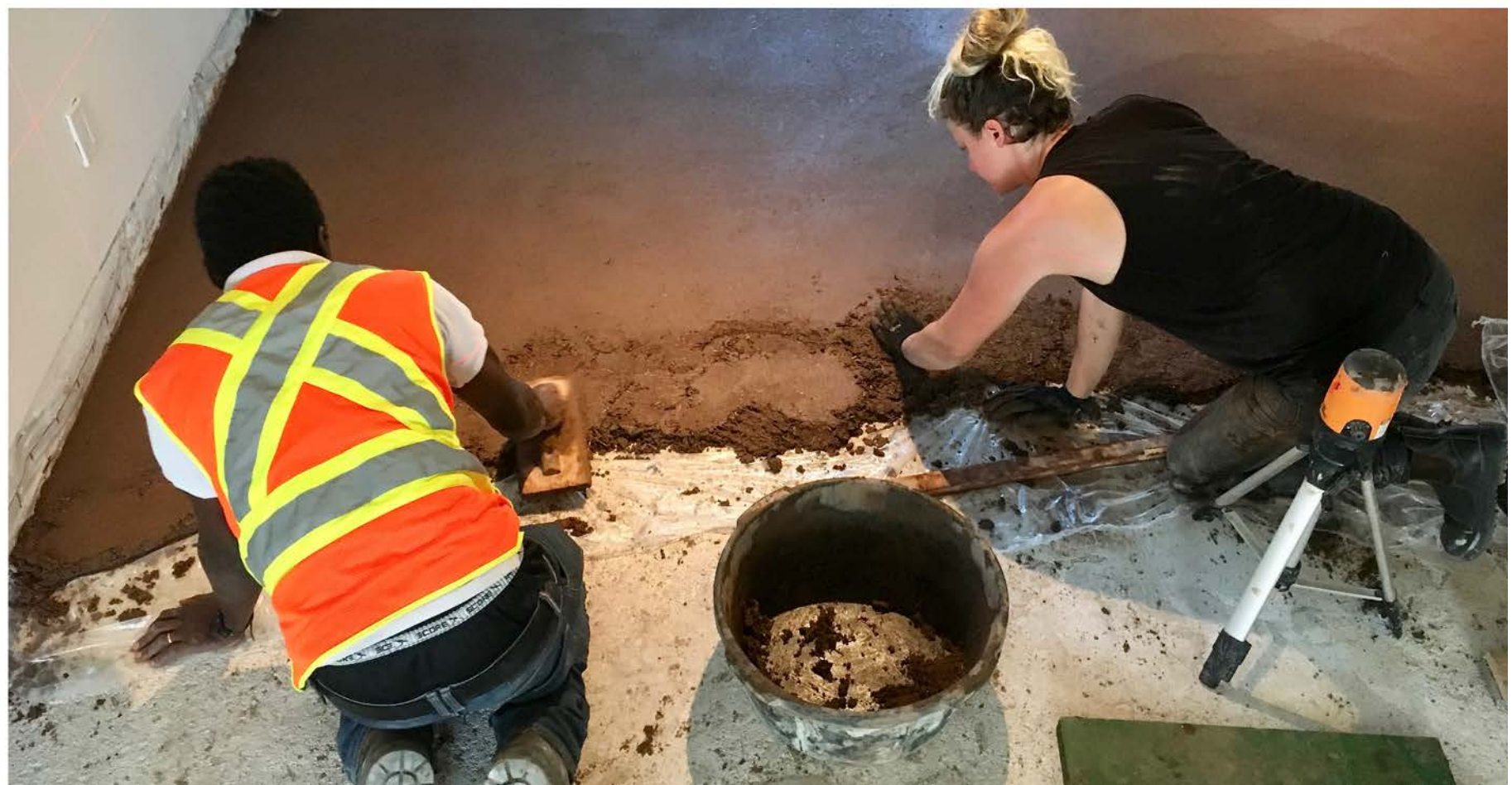
The mix is prepared for the clay floor. We use a granite/clay mix developed for sports fields as the base for the mix, and add chopped straw, hemp fibre, masonry sand and water, all tumbled in a mortar mixer.

Laying a clay floor

The clay floor mix is placed at a thickness of 3/4-inch.

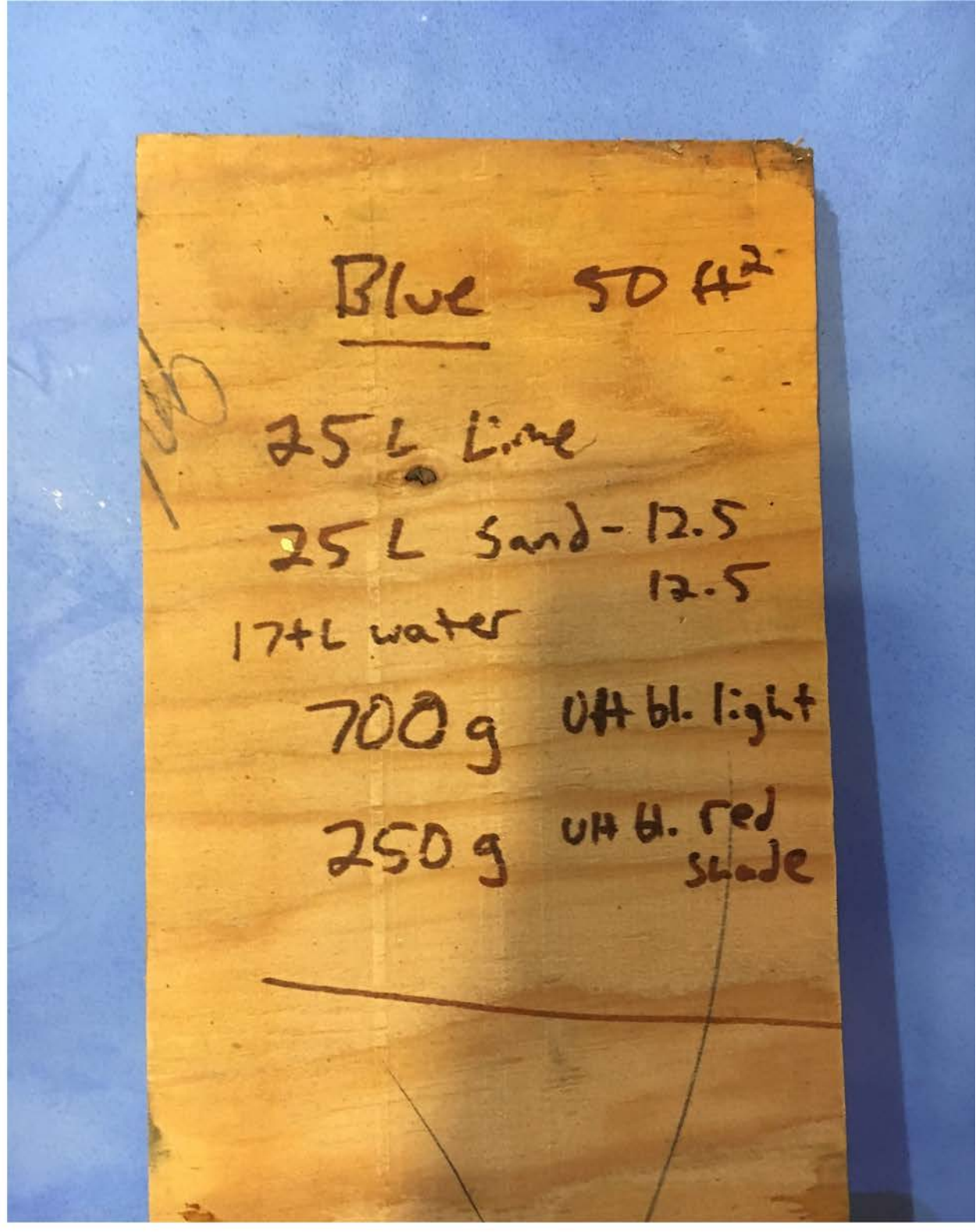
A wood float is used to compress the mix and do the basic placement. A laser level is used to get the floor as even as possible.

A metal trowel is used to make a few final passes to smooth out the surface.



Floor laid!

The mixers keep the loads of clay floor mix coming, and after a full day we have troweled our way out of the building.



Tadelakt plaster

The bathroom walls are finished with tadelakt plaster, a lime plaster applied in several thin coats and then polished with olive oil soap to produce a naturally water repellent surface.

Tadelakt

A sponge float is used to apply several coats of lime plaster.

As the plaster begins to cure, it is polished first with a trowel and then with a stone, compressing the surface.

The olive oil soap that is added during the polishing stage creates a natural wax that will make the surface very water resistant.

Tadelakt is ideal in any area that is exposed to regular wetting.

Tadelakt bathroom

Blue and yellow tinted tadelakt plaster provide natural, non-toxic waterproofing for the walls. Reclaimed wood is used for the vanity and tub surround.

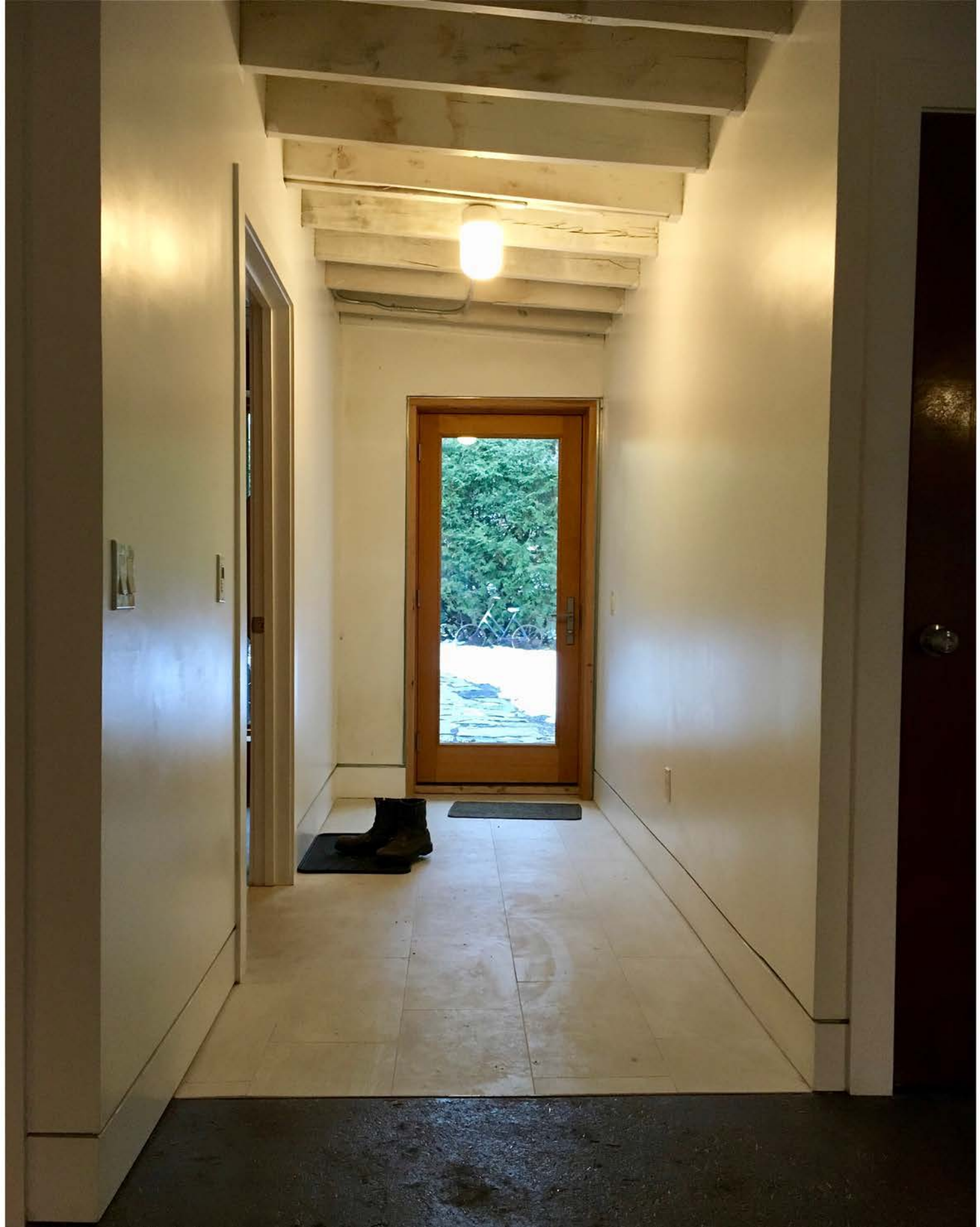
Mini-split heat pump for efficient heating and cooling

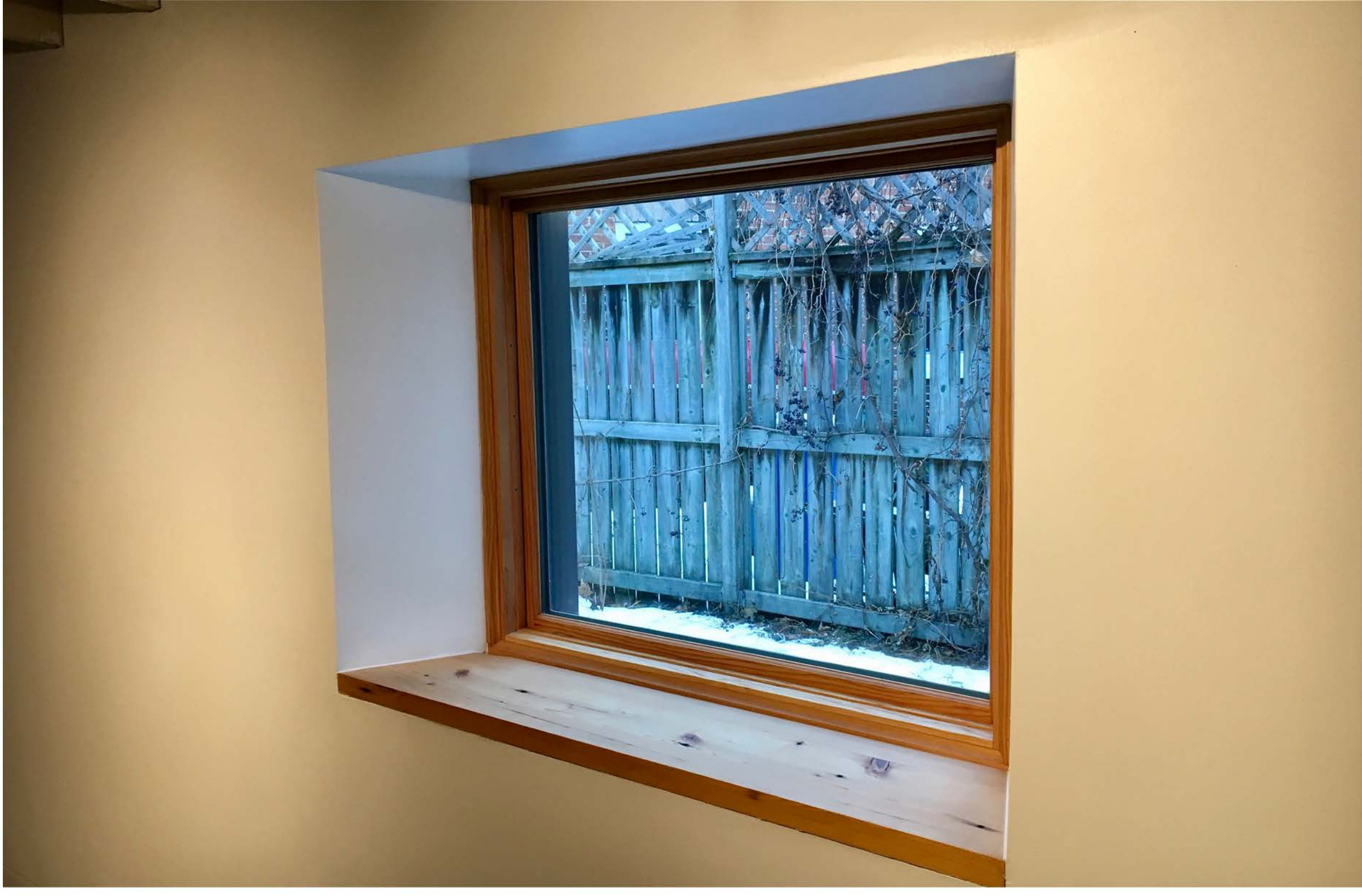
A cold climate air source heat pump (ASHP) provides heating and cooling through a single mini-split head (right, above window). With a coefficient of performance (CoP) of 3.5, this is efficient and affordable.

Finishing up

Tile is laid in the entryway and continues into the bathroom on the left.

We chose to install flush-mounted trim, separated from the wall finish by a galvanized metal shadow line.





Window casings complete

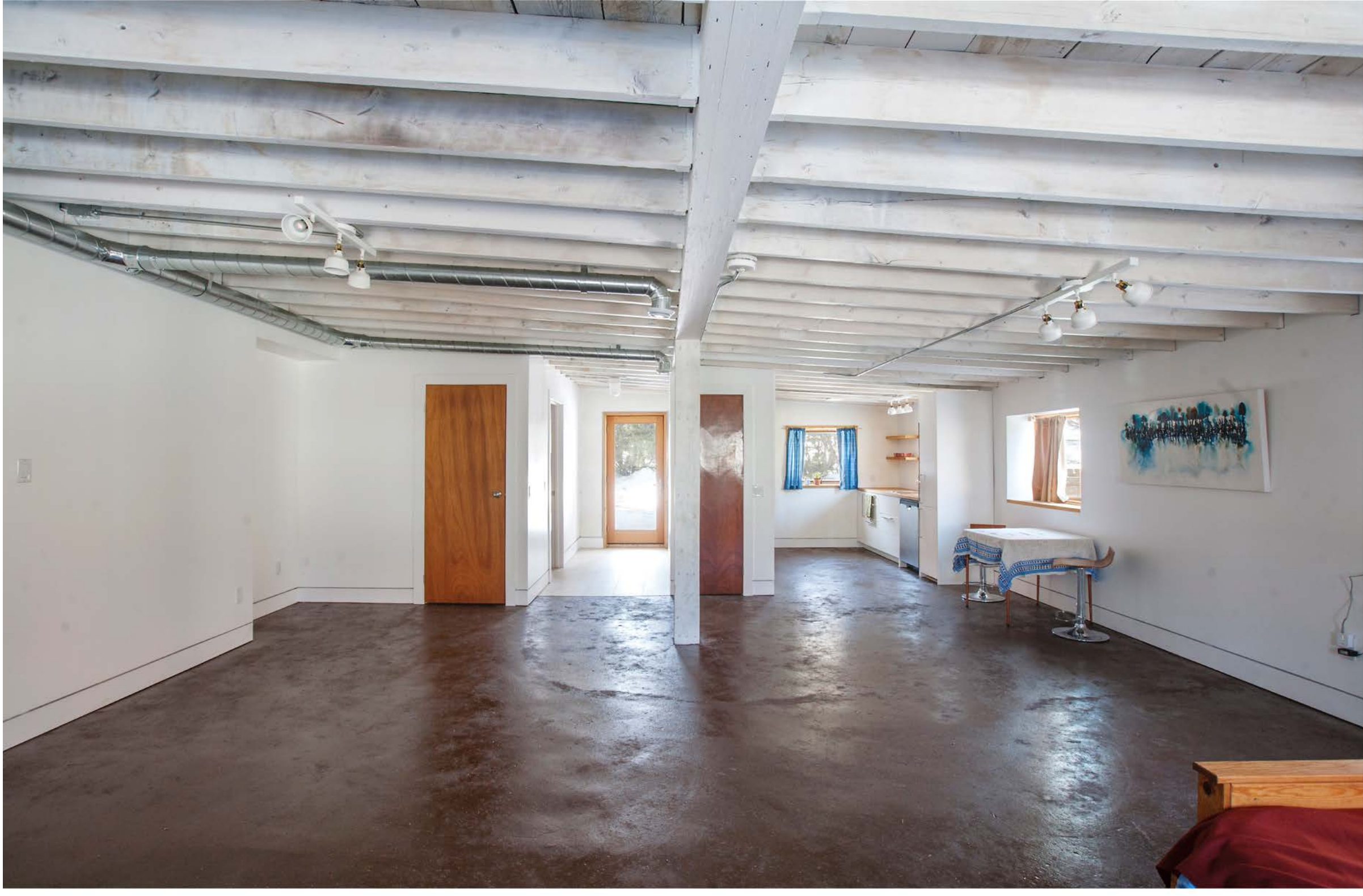
The oiled, reclaimed window sills are finished, and the full effect of the deep, angled window reveals and the wood window casing is revealed.

Kitchen installation

Kitchen cabinetry is installed. We used no-formaldehyde IKEA bases and drawer fronts, and wooden countertops and shelving.

Ready for cooking

The kitchen includes a reused ironing board as a fold-down counter and wooden countertops with natural oil finishes.

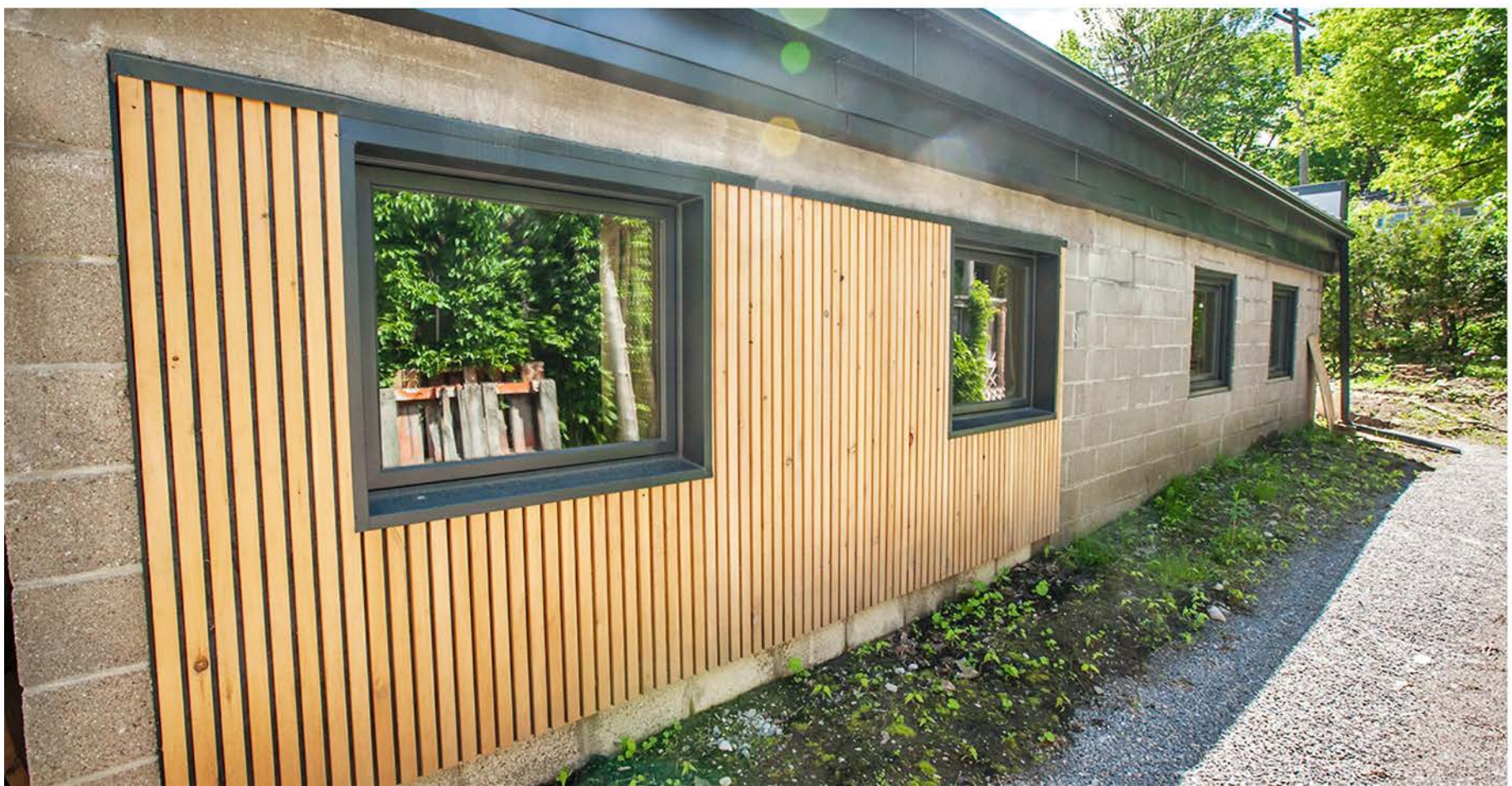


Interior finishes

The dark earthen floor contrasts with the white plaster and paint for a natural spin on a modern aesthetic.

Lighting adds depth

Warm white LED lights soften the white walls and ceilings.



All wrapped up

A natural stone walkway completes the entryway, and Endeavour's job here is finished.

What used to be an empty shell of a building is ready to begin a new life as an energy-efficient and healthy new living space in the city's downtown core.

Class of 2018

None of the work would have been possible without such an amazing crew contributing their time, effort and care!