

BUILDER INSIGHT



FACTS AND FIGURES

Construction timeline:

November 2023 – July 2026

Construction budget: \$54.9 M

Residential Units: 123

Site Area: 2,968 m², 31,945 ft²

Total Gross Floor Area: 13,039 m², 140,334 ft²

Net Floor Area: 10,446 m², 112,433 ft²

Building Height: 22.64 m, 74.29 ft

Volume of Mass Timber: 1,194.67 m³ of CLT

Annualized Whole Life Carbon Emissions:
7.8 kgCO₂e/m²/year

Total Energy Use Intensity: 49 kWh/m²/year

PROJECT TEAM

Owner: More Than A Roof Housing Society

Land: Non-Market Housing Development & Operations

Architect: PUBLIC Architecture

General Contractor: Kindred Construction Ltd.

Owners BIM Consultant: Summit BIM

Design BIM Consultant: BIMOne

Construction BIM Consultant: Modelo Tech Studio

Structural Engineering: Wicke Herfst Maver Consulting Inc.

Mechanical and Electrical: Introba

Fire Suppression: Introba

Energy Modeling: Introba

Passive House Consultant: Introba

Embodied Carbon Modeling: Introba

Civil: Core Group Civil Consultants Ltd.

Landscape: Matthew Thomson Design Ltd.

Building Code: GHL Consultants Ltd.

Building Envelope: Stantec

Acoustical: BKL Consultants Ltd.

Passive House Certification: Steven Winter Associates, Inc.

Elevator: GUNN Consultants

Project Management: CPA Development

Research Management: Scius

KEY STAKEHOLDERS

City of Vancouver

BC Housing

City of Vienna

Rüdiger Lainer + Partner

Bulletin No 11 | Vienna House

Lessons Learned from Moisture Management

Vienna House is a demonstration project under CMHC's National Housing Strategy and the BC Mass Timber Demonstration Program that showcases sustainability and innovation in construction. The building will be Passive House certified. It is the first non-market multi-family housing project in B.C. to use Building Information Management (BIM) through all stages of design, construction, and facility management.

The seven-storey mass timber and lightwood frame hybrid structure will provide 123 units ranging from studio to four bedrooms. It is an efficient mid-rise typology that can be easily replicated in B.C. and across Canada. Vienna House is named for its counterpart housing project in the City of Vienna, Austria. In reciprocation, the Austrian project is called Vancouver House. Together, these projects provide a unique opportunity to share knowledge and best practices in housing design.

This report is part of a series of insights describing the innovations incorporated into Vienna House and the lessons learned from their implementation. Moisture management was identified by the design and construction teams as an issue that warrants increased attention and recommendations for best practices for future projects, especially those using prefabricated closed wall panels.



Figure 1. Vienna House during construction, April 2026 (source: Bright Future Studio)

Design

Vienna House is designed primarily with prefabricated wall panels and 5-ply Cross Laminated Timber (CLT) floors. Gravity loads are supported by interior prefabricated open frame panels, while the lateral loads are supported by the interior and exterior prefabricated walls. CLT is also used for the elevator core. Steel structural elements provide additional load support as necessary. The stairs and walkways in the courtyard are independent of the structural system for the rest of the building.



Figure 2. Installation of exterior wall panels (source: Scius)

The exterior panels are stacked and offset below the floor level to maximise panel, floor and balcony connection efficiency. The building was constructed by installing the exterior walls first, followed by the interior walls, and then the CLT floors for each of the six levels above the parkade. The balconies are prefabricated aluminum that is designed to clip onto brackets attached to the structural elements.

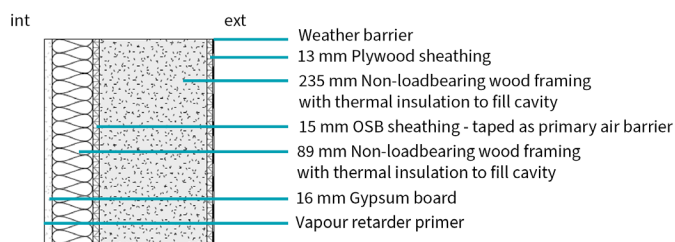


Figure 3. Exterior wall assembly (source: Public Architecture)

The exterior walls use a double-stud assembly with an exterior plywood sheathing covered by a water-resistant membrane. The outer cavity is filled with insulation, with an air barrier on the interior made of Oriented Strand Board (OSB) sheathing that is taped at joints and transitions. The OSB also serves as a vapour-retarding layer. Another

wood frame cavity on the interior holds additional thermal fiberglass insulation and is covered by gypsum board and a vapour retarder primer. The walls were prefabricated offsite at TAG Panels in Squamish, B.C. from the weather barrier to the OSB, with the additional interior framing and insulation completed on site.



Figure 4. Interior of a suite with wall panel for above level attached. (source: Scius)

Figure 4 shows the interior of a courtyard-level (L2) suite with the exterior wall panel for L3 connected above the window opening. A cavity for tie-down rods remains open, to be filled with insulation at a later date. Figure 5 shows another suite with interior framing completed and insulation installed above the windows.



Figure 5. Another suite with interior of double-stud framing completed and second layer of insulation partially installed. (source: Scius)

History and Challenges of Building with Wood Today

Researchers have long studied how wood used for construction behaves when exposed to moisture. The amount of moisture wood contains is one of the most important factors influencing its building-related performance including strength, stiffness, swelling/shrinkage, mould growth, and decay. The major durability concerns about the wetting of wood are mould growth and decay development. Mould needs a minimum surface relative humidity (RH) of around 80% to grow on wood at a temperature of 20-25°C; and will grow much faster when RH is closer to 90%. Mould primarily affects the appearance, not the structure, but can cause health issues if not treated.

Decay can cause weight loss and significant strength reductions and is the largest wetting-related durability concern for structural wood. The moisture supply is typically the most limiting factor for decay development for a given wood member. It is generally known that decay will need a minimum moisture content of fibre saturation point, around 30% to initiate and progress in wood.

Generally, wood is considered to be dry if it has a moisture content below 19% and it usually stabilizes at 8-14% in finished buildings. There are excellent resources available that describe the effects of moisture and how to design buildings to minimize its impact:

- [“Moisture and Wood-Frame Buildings,”](#) Canadian Wood Council, 2020
- [“Building Enclosure Design Guide - Wood-Frame Multi-Unit Residential Buildings,”](#) BC Housing, 2019
- [“Guide for Designing Energy-Efficient Building Enclosures for Wood-Frame Multi-Unit Residential Buildings in Marine to Cold Climate Zones in North America,”](#) FPIInnovations, 2013
- [“Moisture Management for Timber Construction: a practical guide”](#) Danish Technological Institute, 2025
- [“Handbook for Construction Moisture Management of Mass Timber Buildings,”](#) Canadian Wood Council, 2026

During traditional light wood frame construction, wood is often exposed to the weather. Once the exterior shell of roof and cladding are constructed, the wood is allowed to dry before it is enclosed on the interior. However, as wood

construction transitions to increased use of mass timber and prefabrication, this approach must be modified to limit the amount of moisture allowed to penetrate these building components. This can be achieved through speed of construction and measures that limit moisture ingress.

Mass timber consists of multiple layers of wood fastened together, increasing the volume and depth, and therefore time required to dry out. Stains can remain on the surface of mass timber after moisture content has returned to acceptable levels. However, since mass timber is often exposed, the resulting appearance can be undesirable. Guidance is available to evaluate the risks of moisture mass timber buildings, and to develop a customized moisture management plan in [“Moisture Risk Management Strategies for Mass Timber Buildings”](#) (RDH, 2022).

When prefabricated wall panels are enclosed and contain multiple layers of wood, insulation, and other materials, extra moisture can also be difficult to remove. Cellulose insulation is prized for its eco-friendly, thermal, and acoustic properties, however excessive moisture can cause it to settle in wall cavities, reducing its effectiveness. Other types of insulation are more resilient to these effects. However, they still retain moisture and can cause delays in completing construction if they get wet.

Closed prefabricated wall panels have been manufactured in British Columbia for many years. However, they have most often been used for single family homes and other smaller structures that are able to be sealed off from the elements quickly. Prior to construction of Vienna House, the risks of moisture on exposed closed wall panels over long periods of time were understood by the design team.

For moisture management, the design team for a multi-storey residential building is generally focused on how the building will perform when construction is completed. This performance includes how the roof, envelope, and mechanical systems work together to control interior temperature and humidity. The construction team is tasked with the means and methods to create what is designed, maintaining the integrity of the building components over the months required to build it. The construction team is the most exposed to the risks of weather during that time and they must address this risk through extensive planning.

Coastal Weather in British Columbia

Coastal British Columbia is a temperate rain forest. It is not only rainy, but there is limited drying potential in winter. Figure 6 shows a comparison of the normal monthly precipitation at Vancouver International Airport (YVR) from 1991 to 2020 alongside the monthly precipitation during construction of Vienna House. While the first autumn months experienced more rain than normal, January was drier and other months were within the range of what could be expected. Any project constructed over many months in the Vancouver lower mainland area should expect to manage periods of heavy or sustained rainfall.

Comparison of Monthly Precipitation during Construction vs. Normal 1991 to 2020
source: Environment and Natural Resources Canada

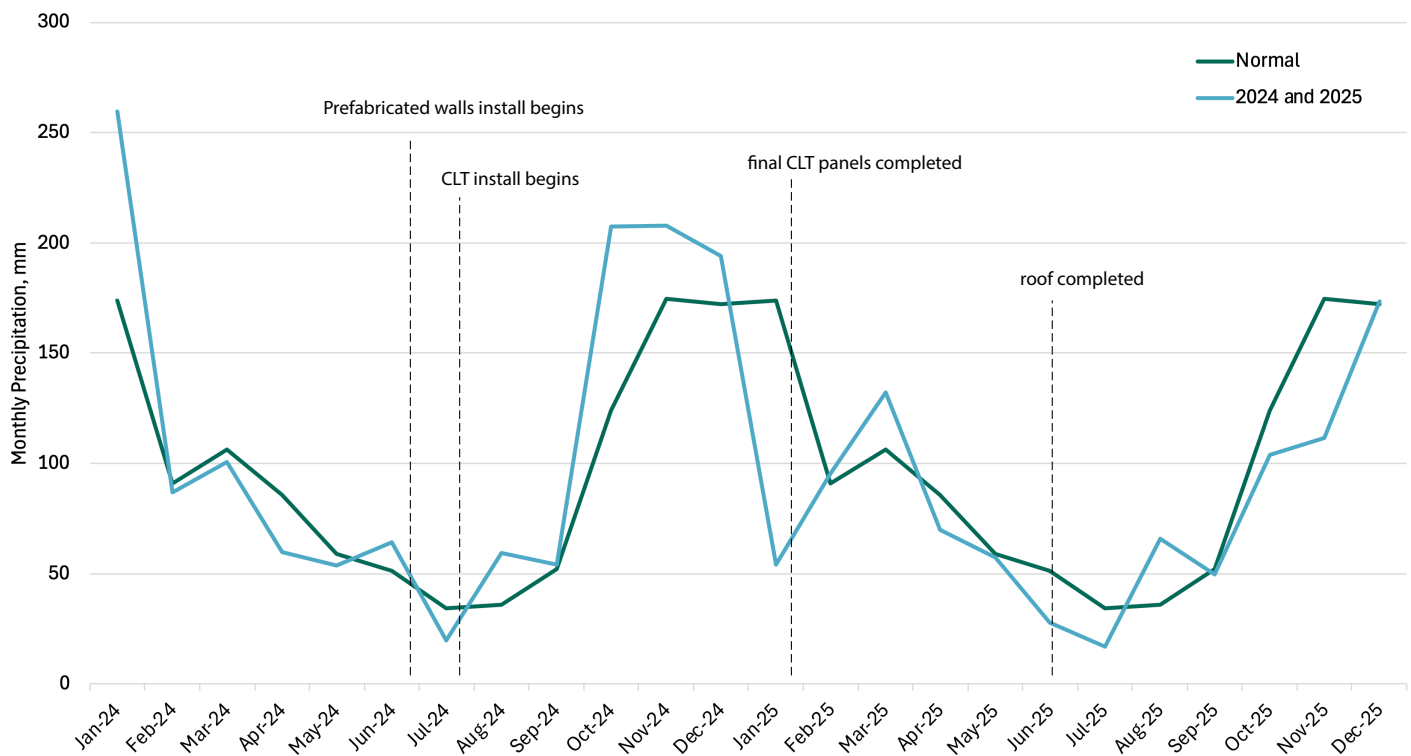


Figure 6. A comparison of the normal monthly precipitation at YVR alongside monthly precipitation during construction (data source: Environment and Natural Resources Canada)

Moisture Management in Vienna

In Vienna, where the companion project, Vancouver House, is constructed, exterior walls often are delivered complete with windows and cladding (Figure 7), limiting their exposure to precipitation once ceilings are installed at each level. This approach requires transportation of the panels vertically, not stacked horizontally. It also requires extra care to prevent damage during craning into position and larger cranes to support the increased weight of the panels.



Figure 7. A wall panel at the factory loaded for delivery in Vienna, Austria (source: Rüdiger Lainer + Partner)

Moisture Management Plans

Projects constructed with mass timber usually require a moisture management plan to mitigate the risk of moisture damage for these elements. This is a requirement from insurance companies and owners. The plan describes how the team will manage any precipitation that encroaches while the building is under construction. Prefabricated panels have not widely required a similar plan to date.

There is no standardized approach to a moisture management plan, because each building will be unique and experience different challenges depending on how it is constructed. Manufacturers of mass timber offer moisture management plans that can focus on risk and liability, but are limited in relation to specific design elements.

Moisture management of mass timber will have different requirements from those for prefabricated panels. A comprehensive plan should be developed in coordination with the manufacturers of the components, the trades who will be installing them, and the general contractor. Input should also be gathered from the design team and owner. This plan should be developed alongside plans for construction methods and logistics, and finalized before construction commences.

Information in a moisture management plan should include:

- Storage of components at the manufacturing site
- Transportation from the manufacturer to the job site
- Storage of the components at the job site before installation
- Mitigation of moisture using membranes
- Mitigation of moisture using tarps, tents, tapes, end-grain sealants, or temporary coverings
- Removal of standing water
- Identification of likely entry points for precipitation pathways where water will travel
- Instrumentation to detect and alert in case of excess moisture
- Risk assessment for different components that could be damaged by moisture
- Mitigation and remediation strategies for detected excess moisture

- Persons responsible for mitigation, inspection, and contingency plans
- Mitigation and remediation strategies for staining, mould, fungi, or decay
- Continued moisture management processes post-construction

The costs associated with the measures identified in the moisture management plan should be evaluated alongside the risk of moisture ingress and the cost of remediation measures. Tents and other coverings require scaffolding or other temporary structures to hold them in place. These come at a cost and may interfere with other construction logistics. The costs and schedule impacts of these approaches should be evaluated in relation to the likelihood and cost of required remediation during the planning stages.

Moisture Management for Vienna House

The Vienna House project helped to pioneer the use of prefabricated closed wall panels on multi-storey residential buildings in British Columbia. The risks associated with moisture over a prolonged period of time were evaluated with hygrothermal modeling for the closed wall panels prior to the start of construction.

A moisture management plan was developed by the general contractor, Kindred Construction, in coordination with the manufacturers and trades. The plan focused on the mass timber elements, since those were considered to be at the highest risk of moisture damage. It included general recommendations for procedures to be followed, transportation requirements, inspection of materials, storage and handling.



Figure 8. Panels stored inside protective coverings at the manufacturer (source: Scius)



Figure 9. Panels arriving at Vienna House after transportation from Squamish (source: Scius)

Care and remediation methods for CLT and glulam components was also identified. The plan mentioned that drainage paths should be identified and directed away from sensitive areas.

Details identifying persons responsible mitigation, inspection, and contingency plans were requested but not included.

The CLT panels on every second level were delivered with a weather protection membrane to minimize exposure to moisture during installation. The moisture management plan included direction to seal joints and areas around columns with tape or a membrane to ensure a continuous moisture barrier.



Figure 10. A weather protection membrane and taping on the top of installed CLT panels (source: Scius)



Figure 11. Exterior wall panels being installed (source: Scius)

It recommended that the roof and enclosure be installed as early as possible, and to cover the top floors or roofs with tarps to prevent water accumulation, promptly removing any standing water, snow or ice. Windows and other openings were to be sealed with temporary materials.

Pre-drilled openings in the CLT, such as those intended for future bathtub drains should be used to create temporary drains to direct water away from the building envelope.



Figure 12. Water being routed to the exterior of the building with a temporary drain (source: Scius)

The plan identified that some staining would likely occur, and that sanding, staining, and other cleaning methods could be used for remediation.

Dehumidification methods were identified using a combination of sensors that measured moisture content in the panels and desiccant based dehumidification paired with supplemental heating or cooling when necessary. These procedures were followed by the construction team.

Monitoring in Walls and Ceilings

Kindred Construction installed temporary sensors to measure surface moisture on the ceilings of suites throughout the building, on all levels containing CLT ceilings (Figure 13). As part of the performance monitoring research activities, FPIInnovations also installed ten long-term hydrothermal monitoring sensors in the CLT ceilings of the electrical closets on different levels. With the assistance of the manufacturer, TAG panels, they installed sensors inside the closed wall panels in 24 select locations.

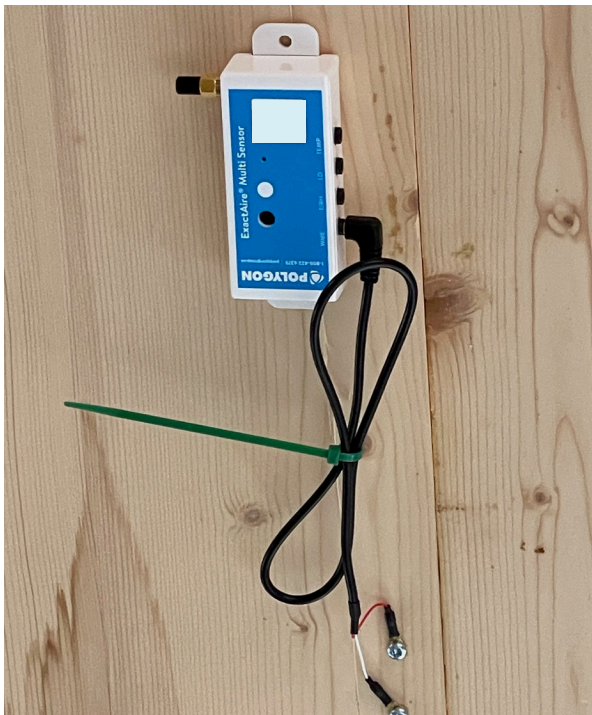


Figure 13. Temporary moisture sensor in the CLT ceiling (source: Scius)

CLT Sensors

Pins in the FPIInnovations sensors measured the moisture content of the CLT on the bottom surface (ceiling) and at a depth of 165 mm above that bottom surface (Figure 14). Two sets of sensors were installed on each level, located inside two electrical closets at the east and west ends of the building, where the CLT would remain exposed and the sensors should not be disturbed. The sensors measured ambient temperature (T), relative humidity (RH) and moisture content (MC). The data was transferred wirelessly to gateways located within the building, with data collection beginning in October 2024, during installation of the panels and floors.

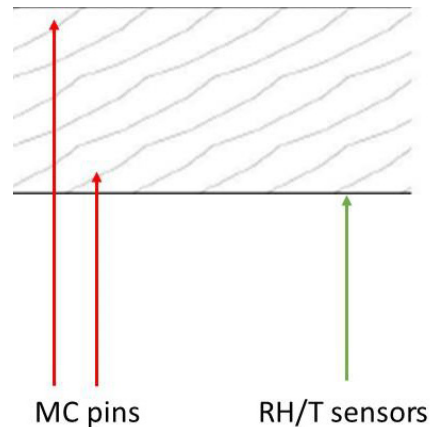


Figure 14. Diagram of moisture pin depth for CLT sensor (source: FPIInnovations)



Figure 15. Sensor installed on CLT in electrical closet (source: FPIInnovations)

Wall Sensors

Wall panels on Levels 5 and 6 were selected for installation of the sensors for moisture content (MC), relative humidity (RH), and temperature (T). The sensors were intended to evaluate long term performance of the assembly, not to identify any failures. They also provided information about wetting during the construction phase. These sensors were installed inside of the panels at the factory (Figure 16) to measure:

- the moisture content (MC) of a wall stud at a location adjacent to the exterior plywood sheathing
- the service environment adjacent to the plywood
- the service environment adjacent to the interior OSB sheathing between the double walls.

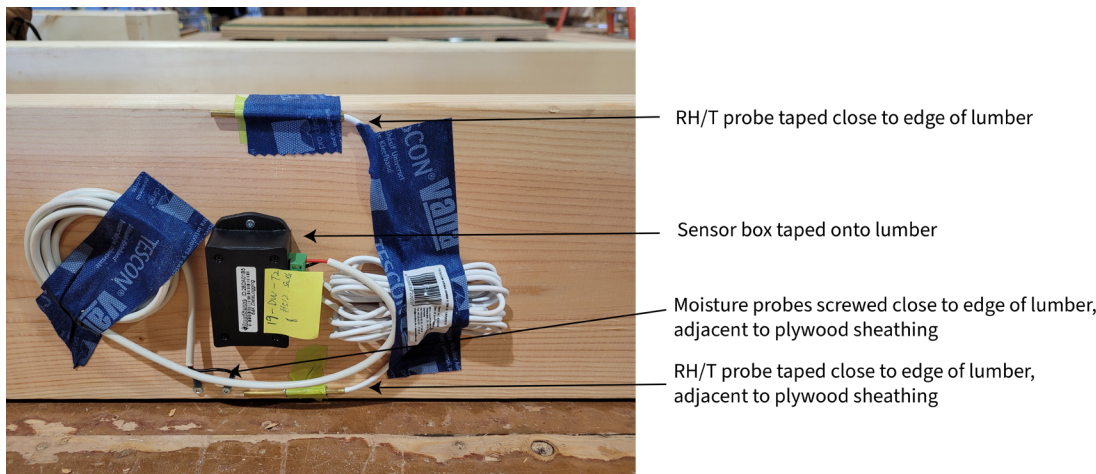


Figure 16. Sensors installed inside a prefabricated wall panel at the factory (source: FPIInnovations)

The plywood sheathing of this double-stud wall assembly is the wood structural member closest to the exterior environment and most susceptible to wetting caused by wind-driven rain. The interior OSB sheathing is also exposed to precipitation during construction. The plywood is also the most susceptible to moisture accumulation resulting from outward vapour/air movement in building operation.

Results of Measurements

The wall panel data was recorded from the time of installation and will continue through construction and early operation. The MC measurements were calibrated for wood species and environmental temperature. The wood inside the prefabricated wall panels remained dry from arrival at the site to the early stages of the construction, with a MC below 20% in the fall of 2024. However, after exposure to the rainy weather over the winter, the MC and RH measurements from most monitoring spots inside the wall panels indicated severe wetting, resulting from exposure to precipitation (mostly rain) on the site. Water can penetrate the prefabricated walls and get trapped inside easily, as the wall panels are not completely protected against ingress of water.

Based on preliminary readings, the CLT was drier, with limited wetting, compared to the wall studs inside the prefabricated panels. Field monitoring has limitations. Compared to the measurements inside the wall panels covering different locations and orientations, there is a higher level of uncertainty in measuring MC inside the CLT panels, with only two spots measured on each floor at similar locations from the bottom to the top level. Other areas of the CLT, particularly those more exposed to rain/pooled water, may have had higher MC than the measurements.

The MC of wood (wall panels, CLT) should be kept below 19% as much as possible and the duration of wetting should be kept as short as possible during construction. A lower MC, ideally around 16% should be achieved before further enclosure (e.g., installation of concrete topping, drywall etc.). The wood was expected to eventually reach an average MC of 8% in the winter and 12% in the summer, typical of a conditioned building on the west coast.

Possible Causes of Moisture

Several issues have been identified by project team members as possibly contributing to the excess moisture in the wall panels.

- The window openings and the gaps between the top of the exterior panel and the floor above exposed large areas to wind-driven rain that caused ponding on the interior and allowed water to drip down the side of the wall panels.
- Weather protection membranes on the CLT panels were damaged during construction.
- The installation of mechanical equipment on the roof provided pathways for additional moisture ingress and coincided with periods of inclement weather. Many weeks passed before ducting, insulation, and waterproofing were completed on the roof. Some water leaked through openings and down wall panels.
- Lifting points on the panels may not have been sealed, which could have provided a route for water ingress.
- Window preparations were modified after fabrication of the panels, exposing some areas to moisture.



Figure 17. Damage to weather protection membrane on the CLT (source: Scius)

- Vapour barrier taping was completed once all the panels were installed, instead of progressively during installation. This left some seams exposed. In some cases, interior wall studs covered the wall seams. These had to be temporarily cut out for access to complete the taping.
- Once the insulation inside the panels was wet, it added to the moisture content of the wood and slowed drying of wood components.
- Structural anchors were installed following the wall panels which delayed roofing and provided a pathway for water down the interior face of the walls.



Figure 18. Preparations for window installation (source: Scius)

Remediation

Kindred Construction worked to remove moisture as it was encountered. Openings for bathroom drains were used to create temporary drains that directed water away from the building. Water was swept to these drains to minimize standing water on the floor panels. Water entering the building through roof ducts during installation was collected and removed (Figure 19). Tarps and window coverings protected openings and horizontal surfaces, but were limited because they did not remain affixed during high winds, posing a threat to the neighbouring tracks for the commuter train. Fans and heaters were used in combination with a dehumidification system (Figure 20) to gradually draw the moisture out of the walls. This effort was limited by available power with temporary electrical service and the neighbourhood mandate to avoid the use of generators outside of normal construction hours.



Figure 19. Collection of water seeping in from ducts (source: Scius)



Figure 20. Dehumidification system installed in the parkade (source: Scius)

Engineers from Stantec, the building envelope consultant, measured surface and interior stud moisture content on panels throughout the building as the remediation measures proceeded. These measurements identified some areas where insulation was replaced or extra air was blown into the wall cavities to dry the panels. These efforts ensured that moisture content dropped to acceptable levels before enclosing the walls with gypsum board.

Lessons Learned

The importance of moisture management of prefabricated closed wall panels is one of the primary lessons learned in this Demonstration Project. Care should be taken on future projects with similar assemblies to fully evaluate the risks and costs of both preventative and remediation measures. A prefabrication or mass timber consultant can also be engaged during design to evaluate the moisture risks and suggest the most cost-effective methods to minimize exposure.

The following lessons learned should be considered for future projects:

- The design of a building and the components used greatly impact the time to construct and exposure to moisture. Wall panels take more time to install than point-supported designs. The walls and floors for Vienna House were completed in just over 6 months, with additional months required for completion of the roof, windows, and cladding.
- A comprehensive moisture management plan should be developed with the cooperation of:
 - the general contractor
 - prefabrication manufacturers
 - architect
 - structural engineer
 - mechanical engineer
 - building envelope engineer
 - owner
 - fenestration trades
 - wood installation trades.

An initial version should be completed with responsibilities assigned and means and methods agreed upon before construction begins.

- The design team should be consulted for potential design modifications that may minimize risks of water exposure and facilitate drying during construction.

- Construction sequencing and logistics should be planned with moisture management in mind. Understanding lead times and subtrade availability is critical, as delayed components or labour can affect exposure time.
- Capacity and location of cranes should be evaluated relative to panel size and weight. Larger cranes may facilitate use of more complete panels, with windows or cladding installed at the factory.
- If more complete panels are considered, increased transportation costs are likely, but on-site labour and time to construct will be reduced in addition to moisture risks. Prefabrication manufacturers would need to be engaged before the building permit application submission to agree on glazing and cladding specifications and availability.
- Providing a ledger detail on the exterior walls for the floors to land on would allow the exterior walls to be the shear component of the structure instead of the interior walls. In the opinion of the manufacturer, this would provide a better installation experience and an easier taping sequence for the vapour barrier.
- Generators used to implement drying solutions create significant noise and can disturb neighbouring properties. If permanent sources of electricity are not available, efforts should be made to minimize the disruption.
- Moisture mitigation solutions that involve tents, tarps or shrink wrap should be considered along with the extra costs, logistics, and schedule impact required. These can be compared to the risk of extra costs, logistics, and schedule impacts if excess moisture needs to be removed from prefabricated materials.
- Tents, tarps or shrink wrap can also be considered once the structure is complete, before roofing, windows or cladding are installed to limit additional moisture. Again, costs, logistics, and schedule impacts should be evaluated against risks.
- Minimizing upfront costs can introduce risk that should be thoroughly considered.
- If using monitoring sensors, the data should be correlated with construction and weather events to better tell the full story of what is causing the changes in measurements. Wetting may take time, especially for mass timber and closed wall panels. Measurements are localized and may not provide a holistic view.

The panel manufacturer for Vienna House, TAG Panels, also recommends some, or all, of the following:

- Finalizing the rough opening schedule and window preparation on exterior wall panels while they are in the factory
- Applying Solitex Adhero Visto or SIGA Wetguard membranes to the plywood roof and floor sheathings in the factory
- Applying Rothoblaas Defence Adhesive Speedy membranes to the plywood sheathing on load bearing and shear walls in the factory
- Cutting notches (in factory) in the bottom of the LVL plates so that the site crew can squeegee any excess standing water through the notches and down the outside of the building
- Using Rothoblaas Band taping for all floor and roof seams to create watertight faces as panels are installed on site
- Completing vapour barrier taping in tandem with the exterior walls being erected on site



Since 2020, the Province of British Columbia (B.C.) and Forestry Innovation Investment have invested over \$11.1 million through B.C.'s Mass Timber Demonstration Program (MTDP) to help with the incremental costs associated with the design and construction of 22 building projects and 8 research projects that demonstrate emerging or new mass timber or mass timber hybrid building systems and construction processes.



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Acknowledgement

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1701-4555 Kingsway, Burnaby, BC V5H 4V8 Phone: 604-439-4135
Toll-free: 1-877-919-9070 Email: research@bchousing.org www.bchousing.org