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PHASE 1, REVISION 3.0

Mirvac MMC Study

Foundations, options and the strategic case for industrialised apartment delivery in Australia.

PREPARED FOR
Mirvac Steering Committee

PREPARED BY
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01 EXECUTIVE SUMMARY

Executive Summary

The diagnosis, the routes assessed, the recommended Phase 2 pathway, and what Mirvac provides for Phase 2 to run.

The diagnosis

Australian construction multifactor productivity has declined 1.6 per cent since 1990 while the broader economy has gained 35.2 per cent in multifactor productivity over the same period. Residential physical productivity has dropped approximately 53 per cent across 30 years, half as many homes per hour worked as in 1995. (Oxford Economics / ACA 2023; Productivity Commission, February 2025.) For a Tier 1 residential developer that sources programme certainty from the contractor market, this is the structural condition every Modern Methods of Construction option sits inside.

The five routes

Five Modern Methods of Construction routes were assessed against Mirvac's apartment delivery context.

- **Route 1.** Volumetric Modular.
- **Route 2.** Kit of Parts structural.
- **Route 3.** Bathroom and Kitchen Pods.
- **Route 4.** Multi-Service Risers.
- **Route 5.** Panelised or Unitised Facades.

All five are viable at the route level, with materially different commercial profiles, compliance pathways, and supply chain maturity in the Australian market. The Phase 2 recommendation pathway is the Hybrid Stack, Routes 2 to 5 in combination on a single LIV Mirvac tower, with Route 1 held as the comparison option on the same project.

The Phase 2 ask

Mirvac chooses between a diagnostic-grade Phase 2 (recommended) and a rapid-comparison Phase 2. Project Innovator recommends diagnostic-grade and will deliver either. The smaller scope sits inside the engagement letter as a contingency, not as a parallel published offer.

Diagnostic-grade Phase 2. Recommended. The full evaluation of the five Modern Methods of Construction routes against the case study project, plus the IRM five pillar assessment of where Mirvac currently sits across Pillars 1 through 4 on the case study project, plus the Traditional

Construction Baseline as a parallel Stream 2 deliverable using Mirvac's own historical project data as the benchmark. The IRM five pillar assessment provides the productivity scaffold for both the MMC option scoring and the baseline. The baseline is what makes the Phase 2 option scores defensible inside Mirvac's IC papers. Without it, the comparison rests on industry averages and published ranges. With it, the comparison rests on Mirvac's own delivery record.

Rapid-comparison Phase 2. Contingency. A direct evaluation of the five Modern Methods of Construction routes against the case study project. Scored shortlist, supplier engagement, compliance pathway confirmation, and option-by-option commercial and sustainability assessment. The option comparison is benchmarked against industry ranges and published evidence, not against Mirvac's measured BAU performance. This scope is held in the engagement letter as a contingency if Mirvac's timeline or project conditions make the diagnostic-grade scope unworkable in the available window.

From Mirvac, both shapes require confirmation of the Phase 2 kick-off date, the case study project on which the Phase 2 evaluation runs, and the baseline data inputs named in Section 12 Stream 1. The diagnostic-grade shape requires additional access to Mirvac's recent tower delivery data and to the senior leaders and project teams whose operating disciplines the five pillar assessment reviews.

02 THE DIAGNOSIS

Why now is structural, not cyclical

Australian construction productivity has gone backwards for thirty years while every other industry moved forward. This is the structural environment Mirvac operates inside.

-1.6%

Australian construction multifactor productivity since 1990

OXFORD ECONOMICS / ACA, 2023

+35.2%

Broader economy multifactor productivity, same period

OXFORD ECONOMICS / ACA, 2023

-53%

Residential physical productivity since 1995, half as many homes per hour worked

PRODUCTIVITY COMMISSION, FEB 2025

27%

Construction share of all Australian corporate insolvencies

ASIC INSOLVENCY STATISTICS, 2024

These figures are not cyclical movement. They are the trend. Construction's structural deterioration has accumulated for thirty years across both the broad sector measure and the residential physical measure.

What the trend has cost

- Construction is 27 per cent of all Australian corporate insolvencies, against a sector that represents approximately 8 per cent of GDP. (ASIC Insolvency Statistics, 2024.)
- Over 3,500 construction companies entered external administration in the most recent quarter. The rate is the highest in a decade. (ASIC, 2024 Q1.)
- Forty eight per cent of all construction rework is caused by poor data and miscommunication, not poor workmanship or bad subcontractors. (FMI and PlanGrid, Construction Disconnected, 2018, n equals 599.)
- Construction professionals in Australia and New Zealand spend 33 per cent of their working week, 11.5 hours, on non productive activities, hunting project information, resolving conflicts, and managing rework. (FMI and PlanGrid, Construction Disconnected, ANZ Edition, 2018, n equals 80.)
- Mid tier and residential builder net margins sit at 1 to 3 per cent. (Master Builders Australia, National Forecasts 2023.)
- At 0.39 per cent of contract value, rework erases 28 per cent of project margin. The figure is from a seven year longitudinal study of one Australian contractor's 19,605 rework events across 346 real projects. (Love et al., 2018, Production Planning and Control, 29 (13).)
- Fewer than half of all construction projects globally are delivered on time. (KPMG International, Global Construction Survey 2023.)

> Every figure above describes a tax the industry is already paying. Not a future risk. Not a hypothetical. The cost of doing nothing.

The Farmer verdict applies to Australia

In 2016 the United Kingdom Government commissioned Mark Farmer to review the construction industry's labour model. The report, *Modernise or Die*, described construction as a sick patient facing inexorable decline unless it changed how it built. The diagnosis was not metaphorical. Farmer documented the same structural productivity failure pattern across the major English speaking construction markets.

Farmer was subsequently asked whether the same diagnosis applied to Australia. He answered, 'All of these things I see in UK and Australia.' (FuturePlace interview, public domain.)

The Australian Productivity Commission's February 2025 report confirms the pattern. The Commission identifies four root causes specific to the Australian context, fragmented industry structure dominated by small subcontractors with no capital to invest in systems, procurement models that push risk to trades rather than incentivising innovation, regulatory complexity from state by state National Construction Code interpretation differences, and an apprenticeship system that builds craft skills rather than systems thinking.

This is the environment Mirvac operates inside. The diagnosis is structural, the data is current, the trend is thirty years deep.

What changes the trajectory

The McKinsey trilogy, *Reinventing Construction* (2017), *Modular Construction, From Projects to Products* (2019) and *The Next Normal in Construction* (2020), identifies industrialisation as the structural intervention most likely to shift the trajectory. The 2017 report sized the global

productivity opportunity at approximately 1.6 trillion US dollars annually, a 35 to 40 per cent productivity uplift if the sector matched the average of all other industries.

The 2019 report narrowed the lens to volumetric and modular approaches. Cost reduction of 20 per cent and programme reduction of up to 50 per cent are achievable in sectors with high design repetition. The gains depend on three preconditions, sufficient design repetition to amortise tooling costs, demand aggregation to factory utilisation above 70 per cent, and client acceptance of standardised outputs. Without these conditions, modular does not outperform traditional delivery.

The 2020 report projects that contractors who industrialise their delivery model will generate two to three times greater EBITDA margins than those who remain project by project.

The Australian Productivity Commission concurs that industrialisation is the structural intervention required, with the caveat that it requires demand aggregation at a scale currently absent from the local market.

> Where capital is flowing in Australian MMC. Tier 1 capital is moving. The Wesfarmers backed Built Living factory in Perth, announced 4 May 2026, signals that the industrialisation curve has crossed the institutional credibility threshold in Australia. Section 7 addresses where capital is flowing in detail.

What this report addresses

Mirvac has asked Project Innovator to review the available Modern Methods of Construction options applicable to the four residential sectors of Build to Rent, Build to Sell, Affordable Housing and Student Accommodation. The brief sits inside the structural diagnosis above.

This report does three things. It evaluates the available Modern Methods of Construction routes against Mirvac's apartment delivery context. It places those routes inside the Innovation Road Map five pillar lens, which sequences Leadership, Data Systems, Lean Construction, Artificial Intelligence and Modern Methods of Construction in that order. And it sets out a recommendation, three options, and the inputs Mirvac will need so Phase 2 can run on Tower 12.

The methodology has evolved since the original Phase 1 was delivered in November 2025. The evolution is the application of the Innovation Road Map five pillar lens, the Lean Construction production discipline frame, and the Manual Data Tax diagnostic. These are not new concepts written for this engagement. They are the toolkit Project Innovator now uses across mid tier and Tier 1 advisory work. Mirvac is receiving the current version, not the original Phase 1 version, because that is what the practice now stands behind.

The diagnosis above gives the report its structural justification. Every section that follows answers a sub question raised by the diagnosis. The data is current. The framing is operator led. The recommendation is one a builder would make to a developer who is paying attention.

03 AUTHOR NOTE

Operator perspective

Adam Strong is the practitioner behind this report. The work draws on direct delivery of Modern Methods of Construction and kit of parts apartment projects at scale, and on the supply chain depth that comes from sourcing both onshore and offshore.

Project Innovator is a productivity advisory practice for the Australian construction sector. Adam is the founder and lead practitioner. Twenty eight years in the industry. The advisory is operator led, drawing on direct delivery of apartment projects, offsite manufacturing run at scale, and the development of patented structural systems for industrialised delivery.

What is behind the voice

What worked at $270 million. Adam joined Strongbuild in 2010. The business was a New South Wales south coast construction company. By 2017 it had grown to 270 million dollars in turnover with 150 people, self funded through reinvested profit, delivering some of Australia's largest and most complex engineered timber housing projects at the time. The operating model was built around production discipline. Three dimensional Building Information Modelling at Level of Detail 400, in house, modelled and federated. Every panel barcode tracked, with each barcode linking the panel to its cost code, its programme activity, its safety hold points, its quality sign offs and its compliance traceability. An 8,000 square metre offsite manufacturing facility at Bella Vista, New South Wales, running kit of parts production at scale. Seventy per cent Early Contractor Involvement win rate. Zero Class 1 safety incidents over the peak years. The shift into Modern Methods of Construction, Design for Manufacture and Assembly, and offsite manufacturing was led because they delivered the quality consistency and production control that conventional site based construction could not sustain at scale.

> **MacArthur Gardens, Campbelltown.** Three Cross Laminated Timber towers, six to eight storeys, 101 apartments delivered for BlueCHP. Cost published at under 300,000 dollars per apartment in 2017, with zero injuries on the project. (Strongbuild and BlueCHP project documentation, public domain.)

What gaps contributed to the failure. Strongbuild entered administration in 2018 following an external liquidity event. The cause was structural, not operational. The construction industry has no safety net for capital intensive growth that combines manufacturing infrastructure with fast moving project revenue. The 2018 administration was the consequence of an external liquidity event the business had not built a buffer against. The weight carried with that outcome is real. 150 people lost

jobs, projects stopped, subcontractors went unpaid. The methodology now incorporates financial resilience and risk systems alongside the digital and production disciplines that worked, because no operating model is complete without them.

What the rebuild proved was solvable. Adam founded Viridi Group in 2019. The new business reached 60 million dollars in turnover in under three years with 50 staff. The proprietary StrongFloor structural system was patented during this period, engineered for offsite manufacture and rapid on site installation. A structural wall system was developed alongside, designed for industrial production and simplified site assembly. The delivery portfolio included schools, defence accommodation and emergency housing. The Viridi work is the proof that the operating model was sound and that proprietary structural solutions can be developed, certified and deployed at scale where the supply chain does not already carry a fit for purpose option.

> The methodology this advisory carries is built from those projects. When the question is which Modern Methods of Construction route to take, the read comes from having delivered Cross Laminated Timber apartment towers, run kit of parts panel manufacturing at scale, and tested the supply chain in practice. When the question is offshore versus onshore, the read comes from having sourced both. When the market does not have a fit for purpose solution, Project Innovator has the capability to develop a compliant one, as StrongFloor demonstrates.

What this means for Mirvac

Mirvac is already industrialising across the full Modern Methods of Construction stack.

- 442 apartments at Nine delivered with 760 bathroom pods.
- More than 200 homes delivered with prefabricated structural walls and floors across New South Wales and Victoria.
- LIV Build to Rent Fund pipeline at scale, with Build to Rent platform value of approximately 1.7 billion dollars after the December 2025 Australian Retirement Trust transaction.
- Most recently, a landmark volumetric trial at Cobbitty in south-west Sydney, a five-bedroom factory-built family home craned into place from transported modules and erected in hours rather than weeks. Stuart Penklis, speaking for Mirvac, framed the trial as a directional read on where home construction is heading. The NSW Planning Minister attended the site, citing it as visually indistinguishable in design and quality from a conventionally built home next door, and the NSW Government introduced supporting legislation the same week to streamline approvals for modular delivery. (7News, Mirvac launches landmark trial building modular homes in record time, 11 May 2026.)

The Cobbitty trial is the most current public marker that Mirvac has crossed from prefabricated and panelised delivery, where it already has a deep operational base, into volumetric modular at the residential typology. This advisory does not introduce Modern Methods of Construction to Mirvac. It applies a practitioner's read to the next step, which is sequencing the apartment delivery work into the same industrialised trajectory the Cobbitty trial demonstrates for the lower-rise typology.

The analytical frame is the Innovation Road Map, a five pillar lens covering Leadership and Culture, Data Systems and Digital Integration, Lean Construction, Artificial Intelligence and Automation, and Modern Methods of Construction. The production discipline framework is LeanGate. Both are applied to the Mirvac question in Sections 4 onward. The recommendation in Section 11 names the

two or three options worth testing on Tower 12 (or other case study), with the reasoning a project review would produce.

04

APPLYING THE INNOVATION ROAD MAP

Applying the Innovation Road Map

The Mirvac brief asks for an assessment of Modern Methods of Construction options. The driver behind the brief is productivity improvement. This section places the brief inside the wider productivity question.

The lens applied to the brief

Modern Methods of Construction is the visible expression of the productivity drive. It is also Pillar Five of the Innovation Road Map.

The pillars beneath it carry two considerations. The first is that the largest near term productivity improvements in a Tier 1 residential business sit in Pillars One through Four, not in Pillar Five. The second is that the commercial case for Pillar Five depends on Pillars One through Four being in place. The five pillars work together or none of them deliver their full case.

> This section is the methodology evolution applied to the work Phase 1 delivered. Phase 1 established the Design for Manufacture and Assembly framework, the evaluation rubric, the supplier matrix and the option set against which Tower 12 (or other case study) will be tested in Phase 2. Those frameworks carry forward into this revision. The Innovation Road Map lens, set out below, places them inside the wider productivity picture that is the actual driver of Mirvac's brief.

The five pillar lens

The Innovation Road Map is the productivity assessment framework Project Innovator applies across mid tier and Tier 1 construction advisory. The pillars in order are Leadership and Culture, Data Systems and Digital Integration, Lean Construction, Artificial Intelligence and Automation, and Modern Methods of Construction. The order is the methodology's central claim. The sequence is empirical, drawn from where productivity capacity actually sits inside a typical residential builder, and from where the commercial case for Modern Methods of Construction has succeeded or failed in delivery.

Pillar One, Leadership and Culture

01

Definition. How the organisation is led. How decisions get made. How accountability runs through the operating layer. How change is sustained when the principals are not in the room. The cultural conditions under which improvement work either lands and embeds, or stalls.

Where it operates. Assessed across six dimensions, none of which are about stated intent. Decision making clarity (who decides what, with what information, at what speed). Accountability cadence (whether performance is tracked, reviewed and acted on at regular intervals). Change leadership (whether senior leaders visibly model new behaviours or delegate change to middle management). Middle management posture (whether the frozen middle enables or blocks improvement). Psychological safety (whether people surface problems or hide them). Innovation governance (whether genuine improvement is distinguished from initiative activity that consumes hours but produces no measurable change).

Why it sits first. Every improvement initiative gets neutralised at this layer if it is not addressed first. The technology investment lands on the budget, the process is documented, the system is rolled out, and within twelve months performance has reverted to baseline. The research evidence is consistent. Google's Project Aristotle, a four year study of 180 teams, identified psychological safety as the single most powerful predictor of team effectiveness. Sixty per cent of employees have chosen not to pursue an improvement idea due to fear of negative consequences (Corporate Executive Board, Corporate Leadership Council research.). Cultural adaptability explains 39 per cent of innovation performance variance across 5,000-plus organisations (Denison Consulting, cross-industry culture research, normative database.). Seventy per cent of large scale organisational change programmes fail, primarily for psychological rather than strategic causes (McKinsey and Company; Prosci, Best Practices in Change Management.).

What it delivers. Improvements in the other four pillars that hold over time rather than reverting. Faster organisational absorption of new systems and methods. Reduced internal friction on change initiatives. The capacity to operate Modern Methods of Construction as the new normal rather than a one off project.

Pillar Two, Data Systems and Digital Integration

02

Definition. The platforms, integrations and workflows that carry information through the business. Estimating, procurement, project management, commercial, compliance, finance. The data architecture that connects the systems, and the data discipline that decides what flows automatically versus what gets re-entered manually.

The Manual Data Tax. Where the operating cost accumulates is the cumulative hours that senior project managers, contract administrators, estimators and site engineers spend re-entering, reconciling, chasing, and translating data that an integrated system would carry automatically. As an indicative model, a typical mid tier builder with six senior project managers at 300,000 dollars loaded cost each, spending 33 per cent of working time on non productive activities (per FMI / PlanGrid Australia and New Zealand 2018, sample of 80 construction leaders), produces approximately 600,000 dollars per year in non productive capacity. The number is directional and model based. The pattern is consistent across every Australian builder Project Innovator has audited. For Tier 1 organisations the absolute number is larger, but the per head pattern tracks the same.

Where the cost shows up. Decisions made on stale data. Reconciliation friction between estimating and commercial. Late surfacing of cost movement. Programme delays that flow from incomplete information at hand off points between disciplines. Forty eight per cent of all construction rework is caused by poor data and miscommunication, not by poor workmanship (FMI / PlanGrid 2018). Construction professionals in Australia and New Zealand spend 33 per cent of their working week, 11.5 hours, on non productive activities. The activities include hunting project information, resolving conflicts and managing rework (FMI / PlanGrid Australia and New Zealand 2018).

What it delivers. The integrated information environment that returns approximately ten to twelve dollars for every dollar invested, a finding from 11 United Kingdom case studies that translates directionally to Australian conditions (CDBB / KPMG / Atkins, 2021, University of Cambridge.). For the largest residential businesses, this is the largest single source of recoverable productivity capacity in most operating models. It is also the pillar that determines whether Modern Methods of Construction supply chain integration can be executed at all. The manufacturer's data needs to flow cleanly into the builder's environment, or the operational gains from offsite fabrication are absorbed by reconciliation friction at the interface.

Pillar Three, Lean Construction

03

Definition. Production discipline applied to the construction site. The systems and cadence that turn a programme from a scheduling artefact into managed production flow.

The lineage. Lean Construction is the application of Lean Manufacturing principles to construction delivery. The principles were developed and refined over fifty years in manufacturing, originating in the Toyota Production System and its evolutions, and have driven the productivity gains that separate modern manufacturing from modern construction. The same principles applied to a construction site produce the same effect. Construction is the largest industry that has not yet absorbed the principles at scale, and the productivity gap between the two industries traces directly to that absorption gap.

The frameworks that sit underneath the pillar. The Last Planner System operates the weekly work planning cadence, the six week lookahead, the constraints analysis process, and the Percent Plan Complete measurement that quantifies planning reliability. Pull Planning workshops develop schedules from milestones backward, surfacing constraints before they become delays. Location Based Management and Takt Planning apply production line flow logic to construction sequences, particularly on repetitive floor cycles where the methodology delivers its strongest gains. Work packaging discipline breaks construction into discrete completable packages, each with defined inputs, outputs, constraints, and make ready conditions. Labour input tracking measures person hours per package against planned hours, surfacing productivity drift at task level rather than at cost code level.

Why it matters. Construction productivity does not fail because the work is technically complex. It fails because production planning is treated as scheduling rather than as a systems discipline. The Last Planner System reduces schedule overrun from a 28 per cent average to a 9 per cent average on implementing projects (Lean Construction Institute meta analysis of 255 projects, 2024). Takt planning has delivered 15 to 30 per cent productivity uplift on healthcare and residential projects where repetitive floor sequences support the methodology (Lean Construction Institute; Takt-Plan GmbH published case studies.). Seventy three per cent of lean engaged contractors complete projects under budget, compared with 30 per cent of non lean contractors. A 2.4 times difference on the single metric that determines whether a project generates a margin or erodes one (Dodge / Lean Construction Institute SmartMarket 2025).

Gated compliance and chain of custody. Production discipline is enforced through gated compliance at task level. Every work package has a defined entry gate (prerequisites met, materials staged, design information complete, predecessor sign offs recorded) and a defined exit gate (acceptance criteria checked, quality records captured, downstream prerequisites confirmed). Compliance evidence is captured at each gate and traced to the part identifier, the cost code, and the programme activity. The gate becomes the unit of production control rather than the calendar week. This is the operational layer that distinguishes a project that is run from a project that is scheduled.

The gated compliance framework also carries the safety hold points, the quality test records, and the regulatory inspection evidence at the same gate event, removing the parallel paperwork burden that traditional construction carries between the programme system and the compliance system.

Productivity measures. The primary measures for Lean Construction operate at the work package level, in the same way that Pre-Manufactured Value operates as the primary measure for Modern Methods of Construction. Percent Plan Complete measures the proportion of weekly work commitments delivered on schedule, with the target rising from a typical baseline of 50 to 60 per cent toward 85 per cent at full implementation. Tasks Made Ready measures the proportion of forecast work that has had its prerequisites cleared in the six week lookahead window. Constraint Removal Rate measures the cadence at which identified constraints are cleared before they become delays. Labour hours per package planned versus actual surfaces productivity drift at task level rather than at cost code level, which is the level at which the production system can act. Cycle time per package measures the actual time from entry gate to exit gate, allowing variance analysis against takt time on repetitive sequences.

These are the operational measures Project Innovator has applied across previous delivery of Cross Laminated Timber apartment towers and kit of parts panel manufacturing. They are also the measures that interface cleanly with the Modern Methods of Construction productivity scaffold set out in Section 9.

Australian adoption context. Fewer than 8 per cent of mid tier Australian and New Zealand builders have implemented the Last Planner System properly, including the Percent Plan Complete measurement and systematic constraint removal that make it work (Lean Construction Australia and New Zealand survey, 1,898 companies, 2024). The other 92 per cent are scheduling. They are not planning. The same gap exists, in different forms, in many Tier 1 operating models.

What it delivers. Production reliability sufficient to absorb factory output without rework, dwell, or unplanned crane cycles. Production reliability is the enabling layer for Modern Methods of Construction. Without it, the factory builds the wrong things at the wrong time at full speed, and the programme savings from offsite work are consumed by site integration friction.

Pillar Four, Artificial Intelligence and Automation

04

Definition. The technology layer that compounds capability across the four other pillars. Practical construction applications include automated quantity take off (cost estimation from two and three dimensional models, now operating above 90 per cent accuracy on standard typologies), safety incident prediction (computer vision and pattern analysis on site imagery), schedule optimisation (constraints analysis at scale beyond what a planner can manage manually), document generation (compliance packs, requests for information, technical submissions), and progress analytics platforms (Buildots-type systems that compare site reality to the BIM model at programmed intervals).

Why it sits fourth. Artificial Intelligence applied with clear data, clear process and clear governance compounds across the pillars beneath it. Applied without those foundations, it accelerates existing fragmentation faster than it resolves anything. Accenture's 2024 cross sector research documents 2.5 times revenue impact for organisations implementing artificial intelligence driven process automation (Accenture, 2024.). IDC's 2025 cross sector research, based on 4,000-plus business leaders, documents artificial intelligence return on investment ranging from 3.7 to 10.3 times depending on implementation scope (IDC, 2025.). Both findings depend on data quality and process clarity being in place first, which is to say, on Pillars Two and Three being functional.

> **What sits behind this advisory.** Project Innovator's Artificial Intelligence advisory comes from operating the technology, not from observing it. Adam approached Artificial Intelligence the same way he approached Modern Methods of Construction and Design for Manufacture and Assembly in the previous businesses. Invest in serious investigation with real money and real consequences, then advise from that experience.
>
> The result is a working Artificial Intelligence operational stack built across Project Innovator's own businesses over the past twelve months. Nine specialist agents operating across different business domains. A structured knowledge base spanning every document and every decision the practice has produced. Planning and Improvement Loops that automate how decisions are captured, refined, and brought back into the operating record. Administrative workload across the affected functions has been reduced by approximately 50 per cent against the pre-stack baseline.
>
> The advisory in this report is therefore informed by lived operation of a working Artificial Intelligence stack at production scale, not by research synthesis on what others have implemented. The 'window shopping' framing the market currently applies to Artificial Intelligence (catalogues of tools, case studies, vendor pitches) is the wrong question. The right question is what reliable production stack looks like once the foundations are in place, and that question is answered by operating one.

For a Tier 1 residential business at scale. The question is less 'where do we start' and more 'where does Artificial Intelligence compound the Modern Methods of Construction investment we have already made'. Examples include manufacturer to factory integration with site progress analytics, compliance pack generation across the offsite supply chain, pattern analysis on quality control outputs from the factory floor, automated quantity reconciliation between estimating and procurement, and document generation across the project administration function where the largest near term labour savings sit.

Pillar Five, Modern Methods of Construction 05

Definition. Design for Manufacture and Assembly. Modern Methods of Construction. Offsite Manufacturing. The methodology and supply chain that move production from the construction site into a controlled factory environment. The methodology covers volumetric modules (rooms built as three dimensional units in the factory), kit of parts (panelised structural elements assembled on site), bathroom and kitchen pods, multi service risers and ceiling cassettes, and panelised or unitised facades.

Pre-Manufactured Value. The primary metric is Pre-Manufactured Value, the proportion of completed project value derived from pre-manufactured elements, measured as a percentage of total build cost (Cast Consultancy 2021 framework). The Australian distribution by category, drawn from operator estimates and Cast Consultancy's UK reference data adjusted for the Australian context, is traditional residential at 3 to 10 per cent Pre-Manufactured Value, traditional with bathroom and kitchen pods at 10 to 20 per cent, panelised structure or facade at 20 to 35 per cent, hybrid volumetric (structure offsite, fit out traditional) at 35 to 55 per cent, and full volumetric modular at 55 to 80 per cent.

Phase 1 carry forward. The Phase 1 report set out a Design for Manufacture and Assembly framework across thirteen principles spanning platform thinking, multi functional performance, design for manufacture, design for assembly, design for disassembly and reuse, compliance and assurance, logistics, digital thread, cost and carbon, people safety and maintainability, example part families, and governance. That framework remains the operational detail behind Pillar Five and is built on in Section 5 of this revision.

What it delivers when functioning. McKinsey's 2019 *Modular Construction, From Projects to Products* research documents 20 per cent cost reduction and up to 50 per cent programme reduction in sectors with high design repetition. The gains are conditional on three preconditions. First, sufficient design repetition to amortise tooling costs. Second, demand aggregation to factory utilisation above 70 per cent. Third, client acceptance of standardised outputs. Without all three preconditions, modular does not outperform traditional delivery. McKinsey's 2020 follow up *The Next Normal in Construction* projects 2 to 3 times greater EBITDA margins for contractors who industrialise their delivery model versus those who remain project by project.

Why it is Pillar Five. It delivers its commercial case only when the four pillars beneath it are functioning. The reason this is the case is examined directly below.

Why Modern Methods of Construction is the fifth pillar

The order is locked. The reason is empirical, not theoretical.

Three of the United Kingdom's largest volumetric modular manufacturers entered administration between 2022 and 2024. Caledonian Modular, Ilke Homes, and Urban Splash Modular. Combined investor capital across the three businesses exceeded 200 million pounds. Combined factory floor area exceeded 100,000 square metres. All three had strong manufacturing technology. All three had adequate capital at point of entry. All three had real demand signals from government and private clients. All three failed.

The failure mode was not the manufacturing. The manufacturing was working. The failure was demand aggregation. Factory economics require twelve to eighteen months of pipeline visibility forward in order to maintain factory utilisation above the 70 per cent breakeven that McKinsey identifies for modular projects. UK construction pipelines, like Australian construction pipelines, run

at three to six months of pipeline visibility. The structural mismatch between factory economics and construction pipeline economics is a Pillar Two and Pillar Three problem, not a Pillar Five problem.

Pillar Two is what aggregates the demand. Builders and developers who can see their forward pipeline cleanly across estimating, sales, procurement and project systems can commit volume to a manufacturer. Builders and developers who cannot see their own pipeline clearly across those systems cannot make the volume commitment, and the manufacturer's factory utilisation collapses.

Pillar Three is what holds the demand stable. A Last Planner System operating at full implementation can hold a factory order book at a steady rate, because production discipline carries through from programme planning into actual site sequencing. Without Lean Construction in place, demand goes lumpy. Lumpy demand kills factory economics regardless of how good the factory is.

> A disorganised project does not become an organised factory by moving production offsite. Discipline transfers, or problems transfer. Which one depends entirely on what has been built before industrialisation is attempted.
>
> (Administrators' records and Inside Housing reporting, 2022 to 2024.)

The Australian Productivity Commission's February 2025 report on construction sector productivity confirms the same pattern from the Australian side. Industrialisation is identified as the structural intervention most likely to shift the trajectory of Australian construction productivity, with the caveat that it requires demand aggregation at a scale currently absent from the local market. Demand aggregation is Pillar Two and Pillar Three. The intervention that fails most often is the intervention attempted in isolation from the pillars that condition it.

The productivity argument summarised

The pillars deliver productivity in different orders of magnitude depending on the starting state. For a typical mid tier residential builder, the productivity capacity recoverable across Pillars Two and Three alone (data system integration plus Lean Construction discipline) often exceeds the productivity uplift available from a Modern Methods of Construction shift in isolation. This is because the foundation pillars address the operating cost base, while the Modern Methods of Construction shift addresses a project delivery method that compounds on top of the operating cost base.

For a Tier 1 residential business already advanced on Pillar Five, the productivity argument inverts. The Modern Methods of Construction operating capability is in place. The question becomes how Pillars One through Four compound that capability into the commercial outcome it is capable of producing. The pillars that have not yet been examined to the same depth as Modern Methods of Construction are where the next productivity uplift is most likely to sit.

The five pillars are therefore not a sequenced rollout plan for an organisation starting from zero. They are a diagnostic framework for understanding where the productivity capacity actually sits inside a given business at a given moment.

Applied to Tower 12 (or other case study)

Mirvac is advanced on Pillar Five already. The 442 apartments at Nine with 760 prefabricated bathrooms, the more than 200 homes delivered with prefabricated structural walls and floors across New South Wales and Victoria, the LIV Build to Rent Fund pipeline at scale, all confirm that the operational direction has been set and the strategic capability is real.

The strategic question for the case study project is therefore not whether to industrialise. It is what route to take, at what depth, with what supply chain, and what the surrounding Pillar Two and Pillar Three capability gives the project on cost certainty and programme reliability. The decision is a multi pillar decision.

This is the lens applied through the rest of the report. Section 5 evaluates the five Modern Methods of Construction routes for apartments against the case study project, building on the Design for Manufacture and Assembly framework established in Phase 1. Section 6 places those routes against Mirvac's four housing types of Build to Rent, Build to Sell, Affordable Housing and Student Accommodation. Section 7 reads where capital and capacity are moving in the Australian supply chain, including the implications of the Built Living project entering the market at scale. Section 8 names the three strategic decisions the case study project hinges on, compliance pathway, commercial framework, and offshore versus onshore supply chain. The evaluation rubric and supplier matrix introduced in Phase 1 are extended and deepened in the appendices. Section 11 names the recommendation, narrowed to the two or three options worth testing on the case study project.

> The recommendation is built from the operator's read of the five pillars working together, not from the visible pillar in isolation. That is the difference the Innovation Road Map lens makes.

05 THE FIVE MMC ROUTES

The five MMC routes for apartments

Volumetric Modular, Kit of Parts, Pods, Multi Service Risers, Panelised and Unitised Facades. Per route, what it is, where it fits, who is delivering it, what it costs.

Modern Methods of Construction applied to Australian apartment delivery resolves into five discrete routes. Each route has a different manufacturing depth, a different commercial profile, a different supply chain, and a different ceiling on the proportion of construction value it can move from site into a controlled factory environment. Understanding the five routes separately is the prerequisite for the suitability analysis in Section 6 and the recommendation in Section 11.

Pre-Manufactured Value is used as the primary measure of manufacturing depth throughout this section. Pre-Manufactured Value is the proportion of completed project value derived from pre-manufactured elements, expressed as a percentage of total build cost. (Cast Consultancy, Pre-Manufactured Value as a Measure of Construction Innovation, March 2021.) The Australian operator ranges used below are directional, derived from delivered projects and supply chain assessments. No peer-reviewed Australian dataset for Pre-Manufactured Value at scale currently exists.

The assessment draws on verified project evidence from the Phase 1 research base, supplier capacity data from Project Innovator's market review, and direct delivery experience from Strongbuild and Viridi across apartment towers, kit of parts panel systems, and bathroom pod integration at scale.

Volumetric Modular, Module in Construction

01

What it is. Fully fitted three dimensional modules built in a factory, transported to site, and craned into position. Bathroom, kitchen, joinery, and building services are installed at the factory before the module leaves. Site work covers the foundations, concrete or steel core, crane operations, and the connections between modules. The modules arrive essentially complete and are stacked into position. It is the highest Pre-Manufactured Value route available, and it carries the highest design commitment.

Commercial profile. Pre-Manufactured Value range of 55 to 80 per cent, against a baseline of 3 to 10 per cent for traditional delivery. (Australian operator estimates, aligned to Cast Consultancy UK reference distribution.) Programme reduction of 30 to 50 per cent on well-executed projects. Indicative construction cost range based on the Mirvac MMC Matrix is 3,000 to 6,000 dollars per square metre installed, depending on system complexity, supply chain origin, and volume. The programme saving returns its commercial case most clearly on Build to Rent projects where an earlier practical completion date advances the income stream against a long hold period.

Australian supply chain. The Australian onshore volumetric modular market is limited and concentrated in Victoria. Modscape has delivered 490 apartments across 1,008 modules at Cairns Woree in Queensland, a project that encountered a contractual interface challenge arising from a weather damage event in 2025. (Modscape, company documentation.) Shape operates as an onshore manufacturer with residential apartment delivery at low to medium-rise scale in Victoria. Both onshore manufacturers are classified in the Mirvac MMC Matrix as having limited medium-rise experience and no documented medium-high rise residential delivery. For offshore manufacture, the supply chain is predominantly Chinese factories, with a smaller number of European and Southeast Asian manufacturers. Established offshore suppliers with documented apartment delivery include Stack Modular (Canada and China), DMD Modular (Malaysia), China Construction Oceania, and TLC Modular, which manufactures in Vietnam and delivered Elevation Auckland at 183 apartments across 525 modules. (TLC Modular Group, company documentation.)

Compliance pathway. In plain terms, volumetric modular does not fit the standard construction methods described in the National Construction Code. To get building approval, the builder must submit a Performance Solution, which is a documented engineering case showing the building achieves the same safety and performance outcomes the code is designed to produce, through a different method. This is standard practice for Modern Methods of Construction in Australia and is not a barrier, but it requires more engineering documentation before construction starts than a conventional concrete project does. Since 2025, the National Construction Code no longer allows a structural Performance Solution to rest on an engineer's professional judgement alone. The engineer must demonstrate compliance against specific testing or analysis requirements written into the code. (ABCB, National Construction Code 2025.) For projects using overseas factories to manufacture complete structural modules, there is also a registration issue in New South Wales. The Design and Building Practitioners Act requires the designer of a building system to be registered in New South Wales. An overseas factory delivering a complete structural module is, in effect, designing a structural building system. The Act does not clearly cover that scenario, which is a legal exposure that needs to be resolved before contracts are signed on any New South Wales project using offshore MiC.

Operator read. Full volumetric modular is the highest commitment route. Design must be locked 18 to 24 months before the crane arrives on site. The financial case depends on factory utilisation above 70 per cent, which in turn depends on a forward pipeline that most Australian builders and developers do not currently carry. This is the Pillar Two and Pillar Three dependency examined in Section 4. For the case study project, a contained volumetric pilot on one tower with high design repetition, supported by the pipeline visibility a Build to Rent fund structure provides, is the scenario under which the route has the best chance of producing its commercial case.

Kit of Parts, Steel, Precast Concrete and Structural Timber

02

What it is. Kit of Parts (KoP) is Design for Manufacture and Assembly applied to the structural frame and building envelope. Rather than forming the structure in place on site, the building is assembled from pre-engineered, factory-manufactured parts that arrive ready to install. The structural system can be steel, precast concrete, mass timber, or composite combinations of these materials. The defining discipline is standardisation. Structural grids, connection details, facade panels, floor systems, and service openings are all pre-determined so that parts can be manufactured in a controlled factory environment and delivered to site in sequence.

The Hickory Building System is the most visible Australian example of evolved Kit of Parts thinking at tower scale. Hickory's approach, which combines a pre-fabricated precast structural floor system with a factory-assembled unitised facade panel, represents the evolution of their earlier volumetric module approach into an integrated Kit of Parts system that can operate on tall apartment buildings where volumetric modular cannot practically reach.

Structural options for tall apartments. The Kit of Parts structural choice is the most consequential design decision on a KoP project. For buildings of Mirvac's typical scale and height, the relevant structural options are set out below.

Steel frame. Factory-fabricated columns and beams, bolted together on site. Steel is the primary Kit of Parts option for tall apartment buildings. A steel frame allows service risers and cassettes to be designed into the structural grid from the start, so pods can be dropped into position and risers can be lifted in as the structure rises, rather than being installed after the floor plate is formed. The integration benefit is real and it is the reason steel frame is the natural companion to the other Kit of Parts routes in a hybrid stack. Australian and offshore steel supply is available.

Precast concrete. Hollowcore floor panels, precast columns, and load-bearing wall panels have established Australian supply chains and straightforward compliance pathways. Precast concrete is well understood by structural engineers and certifiers, which reduces the pre-construction documentation burden compared with novel structural systems.

Composite floor systems. Permanent formwork decks (Truedek, which spans up to seven metres without propping, and Fielders Slimdek 210) are established products with multiple Australian projects. These systems are typically used with a steel or concrete superstructure and provide the floor without the cranage that precast concrete floor panels require. (Truedek product documentation. Fielders product documentation.)

Slim floor composite beams. The Peikko DELTABEAM is a composite structural beam that integrates the floor structure into the beam depth, reducing floor-to-floor height and achieving a 120-minute fire rating without additional applied fireproofing. One confirmed Australian commercial project exists at time of writing, with residential high-rise application to be explored in Phase 2. (Peikko product documentation.)

Mass timber. Cross Laminated Timber floors and Glue Laminated Timber beams are available from NeXTimber, Tarpeena South Australia, which opened in March 2024 as Australia's first combined CLT and GLT plant, supported by a 70 million dollar investment. (NeXTimber Pty Ltd, 2024.) ASH MASSLAM, Heyfield Victoria, produces Glue Laminated Timber elements with EWPAA certification and a published Environmental Product Declaration. ASH MASSLAM does not produce Cross Laminated Timber. The practical structural limit for a pure mass timber residential building is approximately 10 to 12 storeys, at which point the structural loads require hybrid elements. Above that height, a mass timber floor and beam system requires a steel or concrete spine to carry the lateral and gravity loads the timber cannot efficiently manage alone. Mirvac's apartment projects typically sit above this threshold. A hybrid

structural approach using mass timber floor elements within a steel or concrete frame is the practical application for the Mirvac context.

Commercial profile. Pre-Manufactured Value range of 20 to 35 per cent, rising to 35 to 55 per cent when combined with pods and pre-fabricated facade (the hybrid stack examined in Route 3 and Route 5). Programme reduction is concentrated in the structural frame cycle. MacArthur Gardens, Campbelltown, three Cross Laminated Timber towers between six and eight storeys, delivered 101 apartments for BlueCHP at under 300,000 dollars per apartment in 2017, with zero injuries recorded. (Strongbuild and BlueCHP project documentation, public domain.) That project is the confirmed Australian delivery reference for mass timber apartment construction, and it demonstrates the cost case at a building height within the mass timber structural range.

The Mirvac risk lens on mass timber. Mirvac is a conservative developer. Its client base, particularly in Build to Sell and Build to Rent, has limited experience with mass timber as a building material and may carry a perception of risk that steel and concrete do not. The case for introducing any mass timber element into a Mirvac project is strongest where the sustainability credential is a genuine differentiator for the project, for example in a Build to Rent asset with a published ESG commitment or a government-partnered affordable housing project where the embodied carbon reduction is a contract requirement. Where that driver is absent, steel and precast concrete Kit of Parts deliver the manufacturing discipline and programme benefit without the market perception risk.

Compliance pathway. Steel frame and precast concrete Kit of Parts systems have standard National Construction Code compliance pathways. These materials are well established and the code contains detailed deemed-to-satisfy provisions for them. No Performance Solution is required for a steel or precast concrete structure of standard apartment typology. For a mass timber structural system in a building above three storeys, a Performance Solution is required in the same way as Route 1. An engineer must document the case that the timber structure meets the code's structural and fire performance requirements. This is not a barrier but it adds pre-construction engineering time. Fire engineering review is standard for any mass timber component in a multi-storey building.

Australian supply chain. PT Blink, based in New South Wales, delivers whole-of-project Kit of Parts solutions using steel-based structure. PT Blink is classified in the Mirvac MMC Matrix as five to 15 per cent more cost effective than traditional delivery and has documented a 50 per cent programme reduction on a seven-storey, 30 apartment project at Spring Hill in Queensland. (PT Blink, company documentation.) The Hickory Building System combines a pre-fabricated precast structural floor system with a factory-assembled unitised facade, representing Kit of Parts applied at tower scale with confirmed high-rise residential delivery in Australia. (Hickory Building Group, company documentation.) Precast concrete and steel frame supply chains are established across multiple Australian states with accredited fabricators and certified structural products available for projects above 12 storeys.

Operator read. Kit of Parts is the route that integrates most naturally with the rest of the hybrid stack. A steel frame designed from day one with standard grid dimensions and pre-located riser openings allows pods to be dropped in and risers to be lifted in as the structure rises, rather than being coordinated into a structure that was designed without them. That integration discipline is the difference between a Kit of Parts project and a traditional project with some prefabricated components added late. The design freeze required is structural, not whole-of-apartment. That makes it more achievable within a standard development programme than full volumetric modular requires.

Bathroom and Kitchen Pods

03

What it is. Fully fitted bathroom or kitchen pods manufactured off-site, craned into the structural frame during erection, and connected to building services on site. The pod arrives complete. Site labour covers positioning, connection, and commissioning. The manufactured element removes the wet trade coordination sequence from the on-site critical path and replaces it with a factory-controlled quality process.

Commercial profile. Pre-Manufactured Value addition of 5 to 15 per cent on the base structural route, bringing the project total to the 10 to 20 per cent range depending on scope. (Australian operator estimates.) Programme saving of up to 30 per cent on the wet area sequence has been cited by Interpod from their project portfolio. Phase 2 to confirm against a named comparable project. (Interpod, published case materials; directional.) The commercial case is programme saving and quality consistency rather than direct construction cost reduction. Defect rates on factory-produced pods are materially lower than on-site wet trade work because the factory environment controls temperature, humidity, and workmanship inspection in a way the site cannot.

Australian supply chain. SYNC Industries, Laverton Victoria, produce 5,000 pods per year from a 20,000 square metre factory and are an existing Mirvac supplier. Nine by Mirvac Willoughby incorporated 769 SYNC pods across 16 configurations within a 790 million dollar project. (SYNC Industries and Mirvac project documentation.) Interpod, Berkeley Vale New South Wales, have delivered more than 33,000 pods across their operating history and are also an existing Mirvac supplier, having supplied 496 pods to the Green Square development. (Interpod.) Both suppliers have confirmed residential high-rise delivery capacity and existing supply relationships with Mirvac.

Compliance pathway. Bathroom pods have a straightforward compliance pathway. The pod must meet the National Construction Code's standard waterproofing and services requirements, and those requirements apply whether the bathroom is built on-site or manufactured in a factory. No special engineering case or Performance Solution is required for a standard pod configuration. The compliance evidence, test records and quality documentation, moves into the factory's quality management system rather than onto the site inspection record. That shift is an improvement, not an added burden, because factory quality control is more consistent than site inspection.

Operator read. This is the lowest-risk entry point for an organisation already advanced on Pillar Five. Mirvac has proven it at scale. The question for the case study project is not whether pods work. The question is what volume, what configuration count, and how the pod delivery schedule integrates with the production planning cadence the project is running. Variants are the cost driver. Sixteen configurations across 769 pods, as delivered at Nine by Mirvac, is a resolved example of managing that discipline at scale.

Multi-Service Risers and Ceiling Cassettes

04

What it is. Pre-fabricated vertical riser assemblies combining HVAC, hydraulics, and electrical services into a single structural frame, lifted and installed as a unit. Ceiling cassettes incorporate building services above pre-fabricated ceiling panels and are installed as a completed assembly. The assembled riser replaces the most coordination-intensive on-site trade sequence, the vertical services installation, with a factory-controlled manufacturing process that delivers one crane lift instead of many weeks of in situ installation across multiple trades.

Commercial profile. Pre-Manufactured Value addition of 3 to 8 per cent on top of the base structural route. Programme and coordination saving is the primary commercial case. AG Coombs delivered more than 300 pre-fabricated vertical risers and documented over 4,000 site hours saved on Barangaroo South Tower 2 in partnership with Lendlease, recognised with an AIRAH award. (AG Coombs, project documentation.) The direct cost case is neutral to slightly positive. The coordination benefit is strongest on any Class 2 apartment tower where services coordination is on the critical path, which describes most multi-storey residential towers above ten storeys.

Australian supply chain. AG Coombs, Keysborough Victoria, have delivered more than 300 pre-fabricated vertical risers and have a confirmed commercial high-rise track record. Benmax, Queanbeyan New South Wales, produce pre-fabricated plant rooms and are NATA accredited. Kavanagh Industries, Smithfield New South Wales, produce HVAC and multi-service modules. Confirmed residential high-rise references for Benmax and Kavanagh are limited at time of writing. Phase 2 supplier qualification is recommended before committing these suppliers to the case study project.

Compliance pathway. Standard National Construction Code compliance applies. The plumbing, electrical, and HVAC equipment within the riser must meet the same requirements it would in a traditionally installed system. The critical pre-construction discipline is coordinating the riser design with the structural engineer before the floor plates are finalised, so the riser openings and fixing points are designed into the structure from the start. A riser opening cut into a completed floor slab is an avoidable cost that good pre-construction coordination eliminates.

Operator read. This is the route that delivers the fastest coordination return and is most often overlooked because it is not structural. On any Class 2 apartment tower where services coordination delays are on the critical path, multi-service riser pre-fabrication removes that risk and replaces it with a factory schedule. Combined with Route 3 (pods) in a hybrid stack, the coordination benefit compounds. The two routes together can materially reduce the on-site wet trade and services installation sequence, and they work best when the structural system has been designed from day one to accommodate them.

Panelised and Unitised Facades

05

What it is. Pre-fabricated external wall panels manufactured off-site and craned into position. The category covers unitised curtain wall systems where the window and spandrel panel are combined into a single factory-assembled frame, and cladding panel systems where non-combustible insulated panels are fixed to the structural frame. For Class 2 residential apartments, Australian fire safety rules since 2019 mean the facade material choice is a compliance decision, not just a commercial one. That compliance requirement has effectively concentrated facade specifications on non-combustible factory-manufactured panels. Working at height is reduced. The facade installation sequence runs independently of the internal fit out trades.

Commercial profile. Pre-Manufactured Value addition of 5 to 15 per cent depending on facade complexity and typology. Programme saving on the facade installation sequence is the primary commercial case, along with quality consistency from factory production and reduced working at height. For Class 2 apartments, the non-combustible panel systems that compliance requires are all manufactured products, which gives them a natural pre-fabrication advantage over in situ cladding.

Australian supply chain. The facade supply chain for Australian Class 2 apartment buildings covers three distinct factory-manufactured categories, each with different procurement and design implications.

Unitised glazed curtain wall and window wall systems are the dominant facade type on Australian mid to high rise apartment towers. The aluminium frame, glazing, and spandrel panel are pre-assembled as a factory unit and craned into position on site. Multiple Australian fabricators and distributors are active in this category. Chinese manufacturers routinely supply unitised curtain wall systems to Australian high rise projects and are regularly engaged by Australian builders on Class 2 residential. The Mirvac MMC Matrix confirms numerous options known and available to Mirvac in this category.

Brick slip curtain wall and window wall systems deliver the visual character of masonry construction through a factory-manufactured panel assembly. Brick Clad, based in Victoria, produces brick slip tile panels and works with Ausrise for the curtain wall framing system. The assembled system is non-combustible and reduces the site labour of traditional masonry to a crane lift and connection operation.

Non-combustible insulated cladding panels cover the Askin Volcore mineral wool panel system from Victoria, certified to FM4880 and FM4881 and compliant as a non-combustible external wall system for Type A and Type B construction under the National Construction Code. (Askin product documentation.) Kingspan, St Marys New South Wales, produce the K-Roc mineral wool insulated panel, compliant with NCC clause C2D10(6)(g) as a non-combustible option. (Kingspan, product documentation.) Both are in active production for Australian residential and commercial projects.

Compliance pathway. Since 2019, any external wall cladding on a Class 2 apartment building must be non-combustible. This is not a Modern Methods of Construction requirement. It applies to every apartment project regardless of how it is built. The practical effect is that the non-combustible factory panel is already the required specification. The compliance step for a Mirvac project is choosing a product with the right certification and keeping the test reports and installation documentation in the building file. The Pafburn High Court ruling in 2023 is relevant here. The court removed the proportionate liability protection that builders had previously been able to use when cladding claims arose on apartment buildings covered by the Design and Building Practitioners Act. In plain terms, a builder who specified a non-compliant cladding system on a DBP Act project now faces the full liability for remediation, not a proportional share. The documentation requirement matters more as a result. (Pafburn Pty Ltd v The Owners, Strata Plan No 97664 [2023] HCA 38.)

Operator read. The non-combustible manufactured panel is the default specification for any Class 2 apartment building post-2019. That specification exists whether or not the project has a Modern Methods of Construction strategy. The improvement available at no additional cost premium is treating the facade as a designed pre-fabricated system with a defined installation programme, rather than a

> subcontract let on a piecemeal basis. The facade is already a manufactured product. The Kit of Parts discipline brings the design co-ordination and the installation programme under the same production management framework as the rest of the hybrid stack.

Combined as hybrid stacks

The five routes are not mutually exclusive. The hybrid stack that delivers the best commercial case for a Mirvac apartment project without requiring the full volumetric modular commitment combines Routes 2, 3, 4, and 5. The stack uses a steel or precast Kit of Parts structural frame, bathroom and kitchen pods, multi-service risers, and a panelised non-combustible facade. This stack achieves a Pre-Manufactured Value range of 35 to 55 per cent against a baseline of approximately 3 to 10 per cent for traditional delivery, without the 18 to 24 month whole-of-apartment design freeze that full volumetric modular requires. The design freeze in the hybrid stack is structural and wet area only. The supply chain for all four routes has confirmed Australian production capacity.

Route 1, full volumetric modular, is the option for a contained pilot on a single tower with high design repetition and the forward pipeline a Build to Rent fund structure provides. Route 2, Kit of Parts with a mass timber element, introduces the strongest verified embodied carbon case for projects where sustainability is a genuine programme requirement. For all other Mirvac project types, steel frame Kit of Parts is the primary structural option within the hybrid stack.

> Section 6 places the five routes against Mirvac's four housing types of Build to Rent, Build to Sell, Affordable Housing and Student Accommodation. The suitability analysis in that section carries forward the commercial and compliance profiles above and adds the housing type-specific drivers that change the route fit. Section 11 names the two to three options recommended for the case study project with the reasoning a project review would produce.

06

SUITABILITY BY HOUSING TYPE

Suitability by housing type

Build to Rent, Build to Sell, Affordable Housing, Student Accommodation, separated as the brief asked. Four by four fit matrix.

The five routes examined in Section 5 do not fit every housing type with equal force. The suitability depends on three variables specific to each housing type. The first is the design repetition available to satisfy factory economics. The second is the programme value, meaning what a shorter delivery schedule is worth in the revenue model of that particular tenure. The third is the design standardisation tolerance, meaning how much the client and the market will accept product consistency in exchange for cost and programme benefit.

The matrix below places four MMC families against the four housing types Mirvac's brief identified. The four families are Full Volumetric Module in Construction, Hybrid Stack combining pods with pre-fabricated risers and non-combustible facade, Pods Only as the lowest-commitment entry point, and Mass Timber Kit of Parts as the structural specialisation route. The matrix consolidates the commercial and compliance profiles from Section 5 and adds the tenure-specific drivers.

Housing Type	Full Volumetric MiC	Hybrid Stack, Pods + Risers + Facade	Pods Only	Mass Timber Kit of Parts
Build to Rent	**Recommended pilot route.** BtR fund structures provide 18-plus month pipeline visibility, satisfying factory utilisation economics. Programme saving advances the income stream on long hold assets. Design repetition on BtR tower typologies aligns with the standardisation requirement.	**Strong fit.** Best commercial case without MiC commitment. Existing Mirvac supply relationships with SYNC and Interpod reduce supply chain lead time. Deployable on any structural typology the project selects.	**Good fit.** Proven Mirvac delivery track record at Nine by Mirvac. Programme saving on the wet area sequence applies. Does not achieve the PMV ceiling of the two routes above it.	**Conditional.** Embodied carbon benefit suits ESG-reporting BtR funds. NeXTimber domestic supply now available. Limited residential high-rise Australian references at time of writing. Phase 2 supplier qualification required before commitment.
Build to Sell	**Conditional.** Programme saving carries limited commercial weight where revenue is locked at exchange and settlement occurs at completion. Design standardisation conflicts with the product differentiation that BtS markets demand. Cost premium recovery is uncertain in competitive apartment markets.	**Strong fit.** Pods deliver quality consistency that reduces post-settlement defect claims, which are high frequency in the wet areas of BtS residential. No design standardisation constraint beyond wet area configuration. Facade programme saving applies on any typology.	**Strong fit.** Pod quality consistency directly reduces post-settlement defect cost. Wet area defects are among the highest-frequency claims in BtS residential warranty. Lowest risk route with established Australian supply chain.	**Conditional.** Carbon premium may not translate to sale price uplift in all BtS markets. Suited to projects with a stated sustainability positioning where embodied carbon is a verified marketing differentiator.
Affordable Housing	**Strong fit.** Government pipeline typically provides the forward schedule visibility that factory economics require. Programme saving reduces financing cost on projects where margin is thin and funding is time-sensitive. Standardised typology aligns with MiC design requirements.	**Strong fit.** All three routes in the hybrid stack apply to the affordable typology. Pods and facade are specification choices, not structural commitments. Existing supply chain with confirmed Australian production capacity.	**Good fit.** Established supply chain, lowest risk. Lifetime defect cost reduction is particularly valuable for affordable housing operators where ongoing maintenance budget is constrained.	**Strong fit with proof.** MacArthur Gardens, Campbelltown, delivered 101 Cross Laminated Timber apartments at under 300,000 dollars per apartment in 2017 with zero injuries for BlueCHP as the affordable client. (Strongbuild and BlueCHP project documentation.) NeXTimber domestic supply removes the offshore sourcing constraint that existed in 2017.
Student Accommodation	**Recommended pilot route.** Student accommodation carries the highest design repetition of the four housing types, directly	**Strong fit.** Pod application is strongest in student accommodation where bathroom configuration is most	**Strong fit.** Strongest single-route application across the four housing types. Bathroom	**Conditional.** Embodied carbon benefit supports university sustainability commitments.

Housing Type	Full Volumetric MiC	Hybrid Stack, Pods + Risers + Facade	Pods Only	Mass Timber Kit of Parts
	satisfying factory utilisation and standardisation requirements. Room configurations are consistent. Institutional delivery pipelines provide forward visibility. The programme reduction on the structural frame cycle directly advances the income start date for institutional operators.	consistent. Services riser repetition is very high. Facade programme saving applies directly on mid-rise typologies.	configuration consistency in student accommodation maximises pod manufacturing efficiency and minimises variant cost.	Structural typology compatibility depends on building height. Phase 2 supplier qualification required for NeXTimber at residential high-rise scale.

Build to Rent, the Year 15 exit lens

A question common to BtR fund sponsors is whether volumetric modular construction affects the asset's residual value at exit. The operator assessment is that it does not, for a well-designed BtR asset. BtR assets are valued on yield, not on construction method. The manufactured element is not visible in the valuation. The programme saving that brought the asset to income six months earlier, and the quality consistency that has held down maintenance cost over the hold period, are both embedded in the asset's operating performance record at the time of exit. For a Year 15 sale, the relevant evidence is the tenancy performance, the maintenance cost trajectory, and the occupancy rate. The construction method is disclosed in the building file and is a matter of record. It is not a valuation variable.

Design standardisation and the product differentiation tension

The strongest tension in the matrix sits in the Build to Sell row. Full volumetric modular requires design standardisation across a significant proportion of the apartment configurations. BtS markets use configuration variety to achieve price stratification. The resolution, as delivered at Nine by Mirvac with 16 pod configurations across 769 pods, is to standardise the manufactured element (wet areas) while retaining flexibility in the living and bedroom configuration. The constraint is binding on the manufactured element, not on the whole apartment. This is the discipline the detailed design process must carry from Phase 2 onward.

> The matrix cells rated Conditional are not disqualified. They identify routes where the commercial case depends on a pre-condition not yet confirmed for the case study project. Phase 2 resolves the pre-conditions. Section 12 sets out the inputs Mirvac needs to provide in Phase 2 so that the conditional cells can be scored with specificity rather than directional assessment.

07

WHERE CAPITAL IS FLOWING

Where capital is flowing in Australian MMC

Australian Modern Methods of Construction has moved from fringe to strategic in a single year. The supply side is being institutionalised at scale, government procurement frameworks are formalising, and the financing infrastructure that has historically blocked offsite delivery is opening.

This section names the moves, the implications for Tower 12 (or other case study) and the Build to Rent platform, and the position Mirvac is in to shape the next stage rather than respond to it.

The Built Living signal

On 4 May 2026 Wesfarmers Limited (ASX:WES) announced the formation of Built Living, a 50:50 joint venture with Built Group. Wesfarmers' initial equity commitment is 100 million dollars. The Neerabup Automation and Robotics Precinct facility outside Perth is valued at 250 million dollars total project capital.

$100M

Wesfarmers initial equity

ASX MEDIA RELEASE, 4 MAY 2026

$250M

Perth Neerabup facility total project capital

WESFARMERS, MAY 2026

2,000+

Apartments per year at scale, 2028 onwards

BUILT LIVING, MAY 2026

$44BN

Wesfarmers annual revenue, the conglomerate behind the play

WESFARMERS FY25

The joint venture's stated methodology is Design for Manufacture and Assembly of modular and precast concrete components for medium and high rise residential. The international reference models cited are the Netherlands, Germany and Finland. Built Group has invested 100 million dollars in artificial intelligence enabled digital product capability that integrates with the manufacturing platform.

The leadership signal is precise. Dale Connor, formerly Chief Operating Officer at Lendlease, is the inaugural Chief Executive Officer. Built Group's executive chairman Marco Rossi and Wesfarmers Managing Director Rob Scott sit on the joint venture. Scott's public statement framed the rationale directly. 'Australia urgently needs more housing, and the Built Living joint venture is well positioned to address that need using internationally proven construction models.' (Source, Wesfarmers ASX media release, 4 May 2026; The Urban Developer, 5 May 2026.)

The Wesfarmers playbook

Wesfarmers' history is the context that makes the Built Living move legible. The pattern is methodical entry into adjacent supply markets that surround a structural demand thesis.

In 1994 Wesfarmers acquired Bunnings for 185 million dollars, entering retail building materials. Between 2001 and 2007 Bunnings expanded into New Zealand and the United Kingdom and Ireland, taking retail building supply to continental scale. Across 2024 and 2026 the group consolidated industrial and workwear supply through Workwear Group, Blackwoods, Bullivants and Coregas. In 2026 the group entered residential construction supply at factory scale through Built Living.

> Wesfarmers' commentary on Built Living explicitly references 'supply arrangements with Bunnings' trade business on arm's length, commercially competitive terms'. Built Living is positioned as one element of a construction supply ecosystem the conglomerate is assembling, not a single project bet.
>
> A 44 billion dollar annual revenue conglomerate with a track record of entering adjacent markets through methodical capital deployment is not making a speculative play. The supply side is being read as the durable position in Australian residential construction industrialisation.

On 11 May 2026 Mirvac trialled a five-bedroom volumetric modular home at Cobbitty in south-west Sydney, with NSW Government legislation introduced the same week to streamline modular approvals. The trial is the most current public signal that the Tier 1 demand-anchor position is shifting from prefabricated and panelised delivery toward volumetric at the residential typology. (7News, Mirvac launches landmark trial building modular homes in record time, 11 May 2026.)

Capacity scaling in parallel

Built Living is the anchor but not the only signal.

Modscape and Modbotics confirmed in May 2026 a 50,000 square metre manufacturing facility at Yatala on the Gold Coast. Construction commences July 2026. Operations begin mid 2027. The facility serves Queensland and northern New South Wales. Combined with Modscape's existing 20,000 square metre Essendon Fields facility, total capacity reaches 2,500 volumetric modules per year. Verified delivery pipeline includes 490 social and affordable apartments at Woree, Cairns (245 social, 223 affordable, 22 specialist disability accommodation), targeted for completion end 2026, and a Queensland Government QBuild contract for 122 homes across 45 sites on a 25 day production cycle. (builtoffsite.com.au, May 2026; modscape.com.au, accessed May 2026; Cairns Regional Council, 2025.)

Saltair Modular operates 1,800 modules per year across four facilities in Queensland (Coolum 1 at 10,600 square metres, Coolum 2 at 10,000 square metres, Crestmead at 16,500 square metres). The business has won the Housing Industry Association Innovation in Housing Award for five consecutive years. (prefabaus.org.au, accessed May 2026.)

JMB Modular Buildings opened its Advanced Manufacturing Centre 1 at Shepparton, Victoria, in January 2025. The facility runs an 8 station moving production line, 121 metres long, with modules leaving move in ready after 40 days of construction. Production target is 200 modules per year with 64 employees. The 2025 Victorian Housing Industry Association Modular and Prefabricated Housing Award recognises the production system. (builtoffsite.com.au, 2025.)

Government and finance enablers

The supply side scaling is matched by the framework moves.

The **New South Wales Modern Methods of Construction Procurement List (SCM5862)** opened in May 2024 and runs through 1 May 2027. As of March 2025 twenty eight suppliers are registered. The list covers volumetric, kit of parts, additive manufacturing and non structural prefabricated assemblies. The proposed **New South Wales Building Bill**, expected in Parliament 2026, eliminates duplicate detailed design requirements for prefabricated apartment buildings, projected to save approximately 327,000 dollars per apartment block in design cost. (buy.nsw.gov.au; nsw.gov.au, 2025.)

The **Queensland QBuild Modern Methods of Construction Preferred Suppliers Panel** has eleven industry partners. The Queensland Government's 2024 budget allocated 2.8 billion dollars targeting up to 600 modular homes in 2024 to 25 and 2,000 social housing modular homes by 2027 to 28. (prefabaus.org.au; hpw.qld.gov.au.)

The federal **Housing Australia Future Fund** operates a 10 billion dollar credit driving toward 40,000 new social and affordable homes nationally. Round 3 opened January 2026 targeting the remaining 21,350 homes. Separately, the Commonwealth's 54 million dollar Modern Methods of Construction allocation supports state delivery frameworks. (housingaustralia.gov.au, accessed May 2026.)

The **50 million dollar Future of Housing Construction Centre of Excellence** at Melbourne Polytechnic's Heidelberg campus was inaugurated 2 October 2025. It is the first Australian training facility dedicated exclusively to Modern Methods of Construction. (melbournepolytechnic.edu.au.)

The **Commonwealth Bank of Australia** became the first bank to formally join prefabAUS, offering project finance of up to 60 per cent of total contract price before a home is affixed to land, and up to 80 per cent for bank accredited prefab manufacturers. This is the financing infrastructure that has historically blocked offsite delivery at scale. (builtoffsite.com.au, 2024 to 2025.)

International parallels

The institutional capital pattern in Australian Modern Methods of Construction is following a United Kingdom precedent that has been running for a decade.

Greystar, the world's largest apartment operator, used its own development pipeline as the volume anchor for modular manufacturing capacity through 2015 to 2018, delivering the two tallest modular residential structures in the world at the time (38 and 44 storeys at the 10 Degrees development, London). Greystar then exported the model into the United States. In 2024 Greystar secured planning consent for a 1,624 home Build to Rent scheme at the former Peek Freans biscuit factory site in Bermondsey, South London. (multihousingnews.com; Greystar media release, March 2024.)

Legal and General operates a modular homes factory at Sherburn in Elmet, Yorkshire, with an annual target of 3,000 homes. Its flagship Build to Rent scheme at Wandsworth, London, delivered 1,034 homes across 18 buildings, completed December 2024. (group.legalandgeneral.com, December 2024.)

> The United Kingdom pattern is institutional capital owning both the manufacturing capacity and the rental portfolio. Vertical integration eliminates the information asymmetry between developer and supplier. The Australian context is different on one critical point. Wesfarmers is entering on the supply side, not the demand side. The vertical integration question for Australian developers is therefore an open one.

Where Mirvac sits

Mirvac established a 1.8 billion dollar Build to Rent venture in June 2023. In December 2025 Australian Retirement Trust acquired a 48.5 per cent interest in the LIV Mirvac Fund, the 1.7 billion dollar Build to Rent platform. The Build to Rent pipeline is at approximately 1.2 billion dollars actively progressed. (mirvac.com, June 2023; realassets.ipe.com, December 2025.)

The Mirvac Build to Rent pipeline is the quality of demand signal that derisks factory build out for industrial manufacturers. The 442 apartments at Nine delivered with 760 bathroom pods, the more than 200 homes delivered with prefabricated walls and floors across New South Wales and Victoria, the operational MMC capability that Mirvac has built over the past decade, all position Mirvac at the demand anchor decision point.

The strategic question that follows is the subject of Section 8. The recommendation built on the answer sits in Section 11.

The Wesfarmers Built Living entry on the supply side opens a question Project Innovator carries through to Phase 3. Whether Tier 1 Australian developers hold the demand-anchor position as their primary stance, or whether the structural logic that drove Wesfarmers into the supply side eventually applies to the residential developer cohort. This advisory does not resolve that question. It is named here so it sits inside the Phase 3 evaluation rather than as an unaddressed strategic risk on the Phase 2 page.

08 THREE STRATEGIC DECISIONS

The three strategic decisions for Mirvac

Scale and aggregation, domestic versus offshore supply, and compliance pathway sequencing. Each framed as a decision with the considerations and the cost of getting it wrong. The recommendation built on these decisions sits in Section 11.

Decision 1. Scale and aggregation strategy

The decision. Mirvac commits either to a programme-wide Modern Methods of Construction platform that designs once and replicates across the LIV Mirvac pipeline, or to a project-by-project trial that scales only as each tower delivers against its committed programme and cost.

The considerations. The financial case for Modern Methods of Construction depends on three preconditions. (McKinsey and Company, Modular Construction, From Projects to Products, 2019.)

- Sufficient design repetition to amortise factory tooling.
- Demand aggregation to factory utilisation above 70 per cent.
- Supplier capacity certainty across the build window.

Without these conditions, modular and Kit of Parts options do not outperform conventional delivery. The Build to Rent pipeline at approximately 1.2 billion dollars actively progressed is the demand signal that makes platform-scale viable for Mirvac specifically. The Section 7 capital flows analysis shows where the crossover point sits, with the Wesfarmers-backed Built Living factory in Perth and the United Kingdom institutional capital pattern as the comparators. The Appendix I commercial model addresses the threshold volume at which the offshore and domestic supply cases diverge.

The cost of getting it wrong. A project-by-project trial that succeeds without a platform commitment loses the design amortisation and supplier learning that makes the next project commercially stronger. A platform commitment made before the first tower has delivered binds Mirvac to a supplier base that has not yet been validated against the actual delivery requirements of a LIV Mirvac asset, with consequent downside if the validation produces a different supplier mix.

Decision 2. Domestic versus offshore supply

The decision. Mirvac selects, for the first Modern Methods of Construction project, a supply position that is either domestic-only, offshore-only, or hybrid with named structural elements sourced domestically and named non-structural elements sourced offshore.

The considerations. The offshore cost advantage at scale, approximately 1,000 to 2,000 dollars per square metre on volumetric and panelised elements, is real where production volume, currency, and freight conditions align. The advantage closes or reverses where domestic supply is available at scale, where the production volume is below the offshore supplier's pricing threshold, or where the compliance cost adjustment for offshore origin is fully applied including the practitioner registration cost under the Design and Building Practitioners Act. For New South Wales specifically, the designer registration pathway for offshore-designed structural modules is not yet resolved at the time of writing. The designer registration gap is the binding compliance constraint on offshore structural supply, not the freight or duty cost. Appendix F sets out the regulatory detail.

The cost of getting it wrong. Offshore structural supply on the first project, ahead of the Design and Building Practitioners Act registration pathway being clarified, exposes Mirvac to a compliance risk that no commercial saving covers. Domestic-only on the first project, without comparison sampling from an offshore supplier on a non-structural element, leaves Mirvac without the reference point that all subsequent supplier commercial discussions will require.

Decision 3. Compliance pathway sequencing

The decision. Mirvac selects, for the first Modern Methods of Construction project, a route mix that either sequences Deemed-to-Satisfy structural elements first, or commits Performance Solutions across structure and fire from the start.

The considerations. Starting the first project with Design for Manufacture and Assembly structural elements that have an established Deemed-to-Satisfy path, Kit of Parts steel or precast under Route 2, reduces approvals risk and supports a tighter pre-construction programme. Starting with Volumetric Modular under Route 1 requires Performance Solutions across structure and fire from day one, with the documentation depth that the Australian Building Codes Board Prefabricated, Modular and Offsite Construction Handbook NCC 2022 sets out. (ABCB Prefabricated, Modular and Offsite Construction Handbook NCC 2022.) Appendix F covers the compliance pathway by route, including the Pafburn ruling on the statutory duty of care under section 37 of the Design and Building Practitioners Act, and the National Construction Code 2025 strengthening of the evidence standard for Performance Solutions on structural elements. The sequencing decision has direct programme and cost implications before a supplier is shortlisted.

The cost of getting it wrong. A Route 1 commitment on the first project, without the Performance Solution pathway scoped and the Building Solutions Practitioner engaged before tender, risks an approvals delay that compresses the construction programme and pushes practical completion past the original target. A Deemed-to-Satisfy-only commitment on the first project delivers a lower Pre-Manufactured Value and a smaller schedule compression than the Hybrid Stack can achieve, which reduces the productivity case for the second project.

> The three decisions are sequenced. Scale and aggregation sets the volume envelope. Domestic versus offshore sets the supply chain position inside that envelope. Compliance pathway sequencing sets the regulatory route the first project will follow. Each subsequent decision is constrained by the one before it. The Section 11 recommendation is built on the decisions taken at all three layers.

09 PRODUCTIVITY SCAFFOLD

Productivity scaffold

Five measures across two layers. Factory content (Pre-Manufactured Value, schedule compression) and site discipline (Percent Plan Complete, Tasks Made Ready, man-hours per m2). Applied to Mirvac's BAU baseline in Phase 2.

When Mirvac evaluates a Modern Methods of Construction option, two questions matter most. First. How much factory work is in this building, and what does that do to cost and programme? Second. Is the site actually running well, or is it absorbing rework and unplanned delays that the Gantt chart does not show? The productivity scaffold answers both questions with five measures, applied to the case study project using Mirvac's own baseline data. The result is a side-by-side comparison across the options Mirvac is evaluating, stated in units the delivery team already works with.

The five measures

LAYER	#	MEASURE	WHAT IT MEASURES AND WHY IT MATTERS	UNIT
Factory content	1	Pre-Manufactured Value	In every $100 of build cost, how much was made in a factory before it arrived on site? *The primary financial lens for comparing how factory-heavy each MMC option is. Higher PMV means more quality control, less site congestion, less weather exposure. Used to compare options on a consistent basis.*	% of build cost
	2	Schedule compression	How many weeks shorter is the programme compared with building the same project the conventional way? *Translates the time gain directly into money. For Build to Rent, each week earlier is a week of rental income. For Build to Sell, it is a week of reduced finance carry. High PMV and high schedule compression do not always go together. If the offsite elements sit off the critical path, the programme does not compress. Which elements actually control the critical path for Tower 12 is a Phase 2 finding.*	Weeks saved or % of baseline
Site discipline	3	Percent Plan Complete	Each week the site team commits to a list of tasks. At the end of the week, what percentage were actually completed? Industry average is 50 to 60 per cent. A well-run site targets 80 per cent or above. Every unfinished task has a recorded reason. *Diagnoses whether the site is running reliably or absorbing hidden disruption the Gantt does not show. The failure reasons, tracked weekly, tell management exactly where to intervene. Chronic low PPC is a leading indicator of programme overrun and cost blowout.*	%
	4	Tasks Made Ready	In the 3 to 6 week lookahead window, how many upcoming tasks had every prerequisite cleared before the execution week arrived? Prerequisites include drawings issued, materials on site, preceding trade finished, access available, and equipment booked. *Prevents trades arriving with nothing to do. Forces constraint removal in advance, not on the day. Research confirms Tasks Made Ready is a stronger predictor of final project duration than Percent Plan Complete alone.*	Count per week

LAYER	#	MEASURE	WHAT IT MEASURES AND WHY IT MATTERS	UNIT
	5	Man-hours per m2	For every square metre of building, how many person-hours did it take? Measured planned versus actual at each work package. *The single most comparable labour productivity measure across projects, methods and building types. When MMC is working, this number drops because factory work is more efficient than on-site assembly. Planned versus actual at work-package level shows exactly where efficiency is being gained or lost. Mirvac already captures this data on live projects, and establishing the BAU baseline is a straightforward exercise.*	Hours per m2 GBA

The factory content measures

Pre-Manufactured Value was developed by Cast Consultancy, a UK construction economics firm, as a standard way to compare offsite content across projects and building types. It asks one question. In every dollar spent on this building, how much of the work happened in a controlled factory environment before the component arrived on site? A bathroom pod delivered complete and tested is factory work. A wall frame assembled on the floor plate is site work. (Cast Consultancy, Pre-Manufactured Value as a Measure of Construction Innovation, March 2021.)

Schedule compression is the time-is-money measure and the number Mirvac's commercial team will reach for first. For a Build to Rent programme, every week of earlier practical completion is a week of rental income collected. For Build to Sell, it is a week of reduced finance carry and earlier settlement receipts. The two factory content measures are read together because they do not always move in the same direction. A project can carry significant offsite content that sits off the critical path, producing a strong PMV without compressing the programme at all. Which MMC elements actually control the critical path for Tower 12 is a Phase 2 finding, not an assumption made in this report.

The site discipline measures

Measures 3 and 4 come from the Last Planner System, a planning methodology developed by Glenn Ballard and Greg Howell in the early 1990s and formalised through the Lean Construction Institute. It is used by major contractors globally, including McConnell Dowell across nine Victorian level crossing removal projects, where independent research by the University of Melbourne documented programme and cost improvements. The Last Planner System works because it measures reliable workflow, not optimistic planning. A programme that looks fine on the Gantt but delivers 50 per cent Percent Plan Complete week after week is a programme in trouble. The Gantt is not honest about what is actually happening on the floor plates.

Man-hours per square metre is straightforward to collect, requires no specialist software, and produces a number that any construction director can read and compare. Mirvac already captures labour hours by work package on live projects. Establishing the BAU baseline from a recent comparable tower is a short data exercise. Once the baseline exists, every MMC option in Phase 2 is compared against it in the same unit.

The rework cost connection

These five measures sit alongside a financial lens that most productivity analyses leave out. A 2018 Australian longitudinal study across 346 construction projects found that rework cost averaged 0.39 per cent of contract value and erased 28 per cent of project margin, sustained across seven years. (Love, P.E.D. et al., Production Planning and Control, 2018, 29(13).) The arithmetic is stark. At a net margin of two per cent, a rework bill of less than half a per cent of contract value takes away more than a quarter of the profit. Factory production removes the categories of rework that site conditions create. A bathroom pod built and tested in a factory does not have a leaking wet area discovered six months after handover. A prefabricated riser does not have services coordination disputes resolved by cutting holes in finished walls. The rework cost reduction is not a bonus. It is a structural improvement to margin that belongs in any honest evaluation of MMC options.

> Appendix G sets out the formulas for each measure and a worked example showing how the scaffold runs on a hypothetical tower project with typical BAU inputs. The baseline data Mirvac provides for Phase 2 covers floor-cycle durations by zone, crane hook hours per floor split across structure, pods and facade, labour hours per square metre by task, and BAU benchmarks for waste and rework cost from recent comparable projects. Project Innovator applies the scaffold to each shortlisted option and presents the results side-by-side alongside the schedule and cost outputs.

10 SUSTAINABILITY POSITION

Sustainability directional position

Mass timber kit of parts strongest embodied carbon, full volumetric MiC strongest waste reduction, offshore MiC weakest transport. ESD consultant for detailed assessment in Phase 2 to 3.

This section states a directional sustainability position for each Modern Methods of Construction route assessed in Section 5. The detailed Environmental, Social and Governance assessment and the full embodied carbon analysis remain Phase 2 to Phase 3 deliverables, carried out by a specialist ESD consultant with Mirvac's BAU baseline data as the starting point. What this section provides is the system-level direction, naming which route strengthens the sustainability position and which route introduces a transport cost that needs to be weighed against other gains.

Pre-Manufactured Value is the structural sustainability metric in the Project Innovator scaffold. Higher Pre-Manufactured Value correlates with lower site waste because factory production generates less off-cut waste and allows packaging and stillage to be returned to the supplier rather than sent to site skips. Higher Pre-Manufactured Value correlates with lower embodied carbon variance because factory-controlled processes use materials more efficiently and quality control reduces the rework that generates repeat material use. The direction of the correlation is established across the Cast Consultancy dataset and the Phase 1 evidence base. The magnitude of the reduction is specific to the project and requires the ESD consultant assessment to quantify. (Cast Consultancy, Pre-Manufactured Value as a Measure of Construction Innovation, March 2021.)

Per route directional positions

Directional assessments from the Phase 1 evidence base. Not a formal ESD assessment. Phase 2 ESD consultant engagement required for quantification. Offshore MiC transport carbon must be explicitly scoped in Phase 2.

MMC ROUTE	EMBODIED CARBON	CONSTRUCTION WASTE	TRANSPORT CARBON	AIRTIGHTNESS AND THERMAL	WET AREA AND SERVICES WASTE
Mass Timber Kit of Parts	**Strong benefit** Biogenic carbon stored in CLT and GLT structure for life of building. Strongest embodied carbon position of the five routes. Reduces to moderate above 10 to 12 storeys where hybrid structure is required.	**Moderate benefit** Precision timber cuts and panelised delivery reduce site off-cut waste. Packaging manageable. Less waste reduction than volumetric routes.	**Neutral** Domestic supply available (NeXTimber, ASH MASSLAM, Kavanagh). No additional logistics carbon versus conventional structural systems.	**Moderate benefit** CLT panels achieve consistent seals. Interface detailing between panels requires discipline to maintain airtightness performance.	**Neutral** Structural system only. Wet trades remain on site. Pod integration possible and recommended for BtR.
Volumetric Modular, domestic manufacture	**Moderate benefit** Depends on module structural material. Timber-framed modules achieve stronger embodied carbon position. Steel or concrete module frames reduce the advantage. Phase 2 ESD assessment to quantify per supplier.	**Strong benefit** Factory controls the full fit-out process. Off-cut waste from joinery, services, and wet areas generated and managed at the factory, not on site. Packaging return programmes standard.	**Neutral** Domestic factory to site delivery. No additional transport carbon premium versus conventional construction.	**Moderate benefit** Module-to-module and module-to-core interfaces require continuous seal detailing. Achievable with disciplined design. Factory-controlled membranes within modules perform consistently.	**Strong benefit** Pods and wet areas factory-fitted and tested before dispatch. Commissioning rework eliminated. Strongest wet area waste performance of the five routes.
Volumetric Modular, offshore manufacture	**Moderate benefit** Chinese factory production typically uses steel-concrete module frames. Lower biogenic carbon advantage than domestic timber-framed modules. EPDs from offshore suppliers required.	**Strong benefit** Same factory waste-control advantage as domestic MiC. Fit-out completed in factory.	**Adverse** Shipping container legs from Chinese factory to Australian port introduce a material transport carbon cost not present in any other route. Must be explicitly quantified and offset in Phase 2 ESD scope. Weakest transport position of the five routes.	**Moderate benefit** Same interface conditions as domestic MiC. Factory-controlled membranes within modules.	**Strong benefit** Same factory wet area performance as domestic MiC.
Kit of Parts, steel and precast	**Neutral to adverse** Steel and concrete carry higher embodied carbon than timber at element level. No biogenic carbon storage. Standard for Australian apartment construction. Not a step forward on embodied carbon versus BAU.	**Moderate benefit** Pre-engineered components arrive to dimension. Reduces on-site cutting and adjustment waste versus conventional construction. Less benefit than factory fit-out routes.	**Neutral** Established domestic supply chains for steel fabrication and precast concrete. No additional logistics carbon premium.	**Moderate benefit** Depends on facade specification alongside structural kit. Not inherent to the structural system itself. Panelised facade component required for airtightness gain.	**Neutral** Structural and facade system only. Wet trades and services remain on site. Pod integration possible.
Pods and Risers	**Neutral** Does not change the structural material of the building. No embodied carbon effect at system level. Carbon impact is in the pod materials themselves, assessed by supplier EPD.	**Strong benefit (wet area)** Factory controls pod production. Packaging take-back standard with Australian pod suppliers. Site wet area waste eliminated in pod-delivered zones.	**Neutral** Domestic pod manufacturers available (Interpod, SYNC). No shipping premium.	**Neutral** Internal systems. No direct effect on the building envelope or airtightness performance.	**Strong benefit** Factory testing of pods eliminates commissioning rework. Mirvac's Nine by Mirvac (769 pods) confirms the approach at apartment scale. Prefabricated risers remove on-site services cutting and adjustment waste.
Panelised and Unitised Facades	**Moderate benefit** Aluminium-framed	**Moderate benefit** Precision panels	**Neutral** Australian facade	**Strong benefit** Strongest airtightness	**Neutral** Envelope system. Wet

MMC ROUTE	EMBODIED CARBON	CONSTRUCTION WASTE	TRANSPORT CARBON	AIRTIGHTNESS AND THERMAL	WET AREA AND SERVICES WASTE
	units carry embodied carbon in manufacture. Long service life and full recyclability at end of use reduce lifecycle impact. Net position better than repeated site-installed facade repairs.	reduce on-site cutting waste. Earlier weather-tight enclosure reduces weather-related rework and re-material cost for the internal fit-out trades.	manufacturers supply unitised systems domestically. No additional logistics premium.	position of the five routes. Factory assembly achieves consistent seal quality across every unit. Eliminates the air infiltration variation inherent in site-installed glazing and cladding systems. Direct NatHERS rating benefit.	trades and services remain on site unless pods are incorporated alongside.

Mass Timber Kit of Parts carries the strongest embodied carbon advantage of the five routes. Cross Laminated Timber and Glue Laminated Timber store biogenic carbon in the building fabric for the life of the structure, reducing the net carbon intensity of the structural system compared with concrete or steel equivalents at the element level. The embodied carbon case is verified for low to medium-rise residential. The MacArthur Gardens, Campbelltown delivery in 2017 is the confirmed Australian reference at that height range. For buildings above 10 to 12 storeys, the hybrid structural approach, mass timber floor elements within a steel or concrete frame, reduces the embodied carbon benefit relative to a pure mass timber structure but retains the biogenic carbon storage advantage on the floor and ceiling elements. (Strongbuild and BlueCHP project documentation, public domain.)

Full Volumetric Modular, Module in Construction delivers the strongest waste reduction of the five routes because the factory environment controls the full fit-out process. Off-cut waste from joinery, services, and wet area installation is generated in the factory where it can be separated, recycled, and managed. Site waste is limited to the structural connections and core works. The trade-off is transport. A factory-built module travels to site as a completed room. Offshore manufacture, predominantly from Chinese factories, adds a shipping container leg that introduces a transport carbon cost not present in site-built or domestic factory options. For offshore Module in Construction, transport footprint is the weakest sustainability dimension of the five routes and requires explicit scope in the Phase 2 ESD assessment.

Kit of Parts, steel and precast delivers steady waste reduction through repeatable cuts, standardised connection details, and pre-manufactured components that arrive to dimension. Site cutting and adjustment waste, concentrated in the structural and facade trades, is reduced because the pre-engineered parts are designed to fit without modification. No transport premium above a conventional project applies because steel fabricators and precast concrete manufacturers already supply Australian towers through established logistics chains.

Panelised and unitised facades carry an airtightness advantage. Factory assembly of aluminium-framed glazed units achieves consistent seal quality that is difficult to replicate in site-installed systems where tolerance, weather, and workmanship variation introduce air infiltration. Earlier weather-tightness from panel installation also reduces weather-exposure risk for the internal fit-out programme, which reduces weather-related rework and the associated re-material cost. The thermal performance gain feeds directly into the NatHERS rating, which the 7-star minimum mandate requires all new residential buildings to meet.

Bathroom and kitchen pods, and multi-service risers deliver the most directly measured waste reduction in the wet area and services trades. Factory testing of pods before dispatch eliminates the commissioning rework that site-installed wet areas generate. Prefabricated risers deliver services to their final position without the on-site cutting, fitting, and adjustment that sequential trade installation requires. Packaging from pod delivery is the main waste-management consideration, and supplier take-back arrangements for stillage and packaging are standard practice with the Australian pod manufacturers confirmed in the Phase 1 supply chain assessment.

> The directional positions above are system-level assessments from the Phase 1 evidence base. They are not a formal sustainability assessment for the case study project. Phase 2 requires ESD consultant engagement, with scope aligned to the options under evaluation, using Mirvac's BAU benchmarks for waste and transport from recent towers and Environmental Product Declarations from the shortlisted suppliers. Appendix H sets out the ESD consultant brief and the data inputs Mirvac should prepare for Phase 2. Section 12 includes ESD consultant engagement as an explicit Phase 2 action.

11 RECOMMENDATION + THREE OPTIONS

The recommendation

The Hybrid Stack on a single LIV Mirvac tower as the Phase 2 evaluation pathway. Three options for the Steering Committee, with the recommended option named.

The recommendation

The Phase 2 evaluation pathway is the Hybrid Stack, Routes 2 to 5 applied to a single LIV Mirvac tower. Domestic suppliers only on the first project. Performance Solutions scoped and the Building Solutions Practitioner engaged before any tender is issued. Volumetric Modular is held as the comparison option on the same project, with its own scored shortlist, so the productivity scaffold figures are produced for both pathways against the same baseline.

The reasoning is structural. The Hybrid Stack combines four Modern Methods of Construction routes on one project, each of which has an established supply chain and an evidence base in Australian residential delivery. The Pre-Manufactured Value uplift across the stack is material, the schedule compression is real on the elements that sit on the critical path, and the compliance position on the first project is held within boundaries that Mirvac's certifier and structural engineer can absorb. The route mix delivers the platform learning, the supplier relationships, and the integration data Phase 3 needs, without making the success of the first tower contingent on a compliance pathway that has not yet been demonstrated at scale in New South Wales.

Three options for the Steering Committee

Option A. Hybrid Stack on a single LIV Mirvac tower. Recommended. Routes 2 to 5 applied to one tower. Kit of Parts structural elements selected for the Deemed-to-Satisfy pathway where the structural grid permits. Performance Solutions scoped before tender for any element that cannot use Deemed-to-Satisfy. Bathroom and Kitchen Pods, Multi-Service Risers, and Panelised or Unitised Facade procured from domestic suppliers confirmed in the Phase 1 supply chain assessment. Phase 2 confirms the shortlist and produces the scored rubric per Appendix K. The Traditional Construction Baseline runs as a parallel Stream 2 deliverable inside the diagnostic-grade Phase 2 scope, alongside the MMC option scoring on the same case study tower, using Mirvac's own historical project data as the benchmark, with the IRM five pillar assessment providing the productivity scaffold for both. The baseline is what makes the Phase 2 option scores defensible inside Mirvac's IC papers. Phase 3 covers factory visits, the Integration Matrix, and the detailed design preparation that locks the design freeze dates the route requires.

Option B. Volumetric Modular on a single LIV Mirvac tower. Route 1 applied to one tower in full. Higher Pre-Manufactured Value than the Hybrid Stack, stronger schedule compression on the structural cycle, and a single production pathway that simplifies supplier governance. The trade-off

is compliance and supply chain. Volumetric Modular requires Performance Solutions across structure and fire from day one, and the supply chain at the scale required for a Mirvac tower currently sits offshore with the registration gap identified in Decision 2 of Section 8. Option B is appropriate where Mirvac identifies a comparable Australian project with verified National Construction Code compliance evidence, and a production-ready domestic manufacturer that has not surfaced in the Phase 1 supply chain assessment, before the Phase 2 evaluation begins.

Option C. Stand-alone trial of a single Modern Methods of Construction element. Bathroom Pods only, or Multi-Service Risers only, on one project, with the balance of construction following the Mirvac business-as-usual delivery model. Lowest commercial risk, lowest commercial reward. The productivity scaffold figures will show a measurable but small change against the baseline because the trial removes one element from the critical path rather than restructuring the delivery model around factory production. Option C is appropriate where Mirvac's internal governance requires a bounded proof-of-concept before committing to a Hybrid Stack trial. The Phase 2 scope contracts accordingly, with the scored rubric, the baseline, and the Phase 3 plan all narrowed to the single element under trial.

Why this is a recommendation, not a menu

Phase 1 produced the route assessment, the supplier matrix, the suitability scoring, and the evaluation rubric. The advisory call drawn from that work is the Hybrid Stack on a single LIV Mirvac tower. Presenting Options A, B, and C without a recommendation would put the burden of judgement back onto Mirvac before Phase 2 has produced the data needed to make that judgement with confidence. The recommendation is operator-led, drawn from direct delivery of Kit of Parts apartment projects and offsite manufacturing at scale, and reflects the supply chain depth confirmed during the Phase 1 supplier engagement. The recommendation is the starting position. Phase 2 either confirms it against Mirvac's own data and the supplier shortlist, or surfaces the evidence that revises it.

> Section 12 sets out the Phase 2 work streams and the Mirvac inputs required to begin. The Assumptions block at the close of Section 12 lists the Phase 1 assumptions that Phase 2 either confirms or updates, with the action that resolves each one.

12 ROADMAP TO PHASE 2

Roadmap to Phase 2

Phase 2 starting position, work streams, deliverables, and gate to Phase 3. Applied to Tower 12 (or other case study).

Mirvac's instinct at the close of Phase 1 is to move directly into evaluating Modern Methods of Construction options against a project. That instinct is sound. The Phase 1 research has identified the five routes, qualified the supplier field, and set the suitability matrix. Moving quickly to an option score and a programme comparison on a real case study project is the logical next step.

This section proposes a Phase 2 structure that supports that objective and makes the results more defensible. The core argument is simple. Every option score and every programme comparison in Phase 2 is a comparison against something. That something is Mirvac's current delivery model on the same building type. If that baseline is not measured directly, the comparison rests on industry averages and published ranges that may or may not reflect how Mirvac's teams, subcontractors and supply chain actually perform. A comparison built on averages can support any conclusion. A comparison built on Mirvac's own data can only support the conclusion that the data warrants.

Why Pillars 1 through 4 matter before Pillar 5

The Innovation Road Map organises productivity improvement across five pillars. Pillar 5 is the industrialisation step, the commitment to offsite manufacture and Modern Methods of Construction. Pillars 1 through 4 describe how a construction business runs today. They cover its foundational operating disciplines, the quality of its data, the reliability of its production flow, and the strength of its supply chain and commercial relationships. These are not preconditions for Pillar 5. They are the context in which Pillar 5 either succeeds or struggles.

An organisation with strong Lean disciplines already embedded in its site teams, with a reliable and consistent data model, and with a supply chain that meets commitments on time, will extract materially more value from a Modern Methods of Construction commitment than one that has not addressed those foundations. The reasons are practical. Offsite manufacture moves quality control to the factory, but it also moves the consequences of poor coordination upstream. A design freeze missed on a conventional project causes a variation. A design freeze missed on a volumetric modular project causes a module that cannot be installed on the scheduled crane day. The cost and programme impact of the same failure is significantly larger when factory production is in the critical path.

Project Innovator proposes that Phase 2 begins with an Assessment Score, a structured reading of where Mirvac currently sits across Pillars 1 through 4 on the case study project. The Assessment Score is not a report card. It is a calibration tool. It identifies where Mirvac's existing disciplines are strong enough to carry a Modern Methods of Construction commitment without additional preparation, and where targeted strengthening before a Pillar 5 commitment would materially

improve the outcome. It also identifies which of the five Modern Methods of Construction routes is the best fit for Mirvac's current operational position, not just the best fit for the building type in isolation.

The Traditional Construction Baseline

The Traditional Construction Baseline is a parallel Stream 2 deliverable inside the diagnostic-grade Phase 2 scope. It runs alongside the MMC option scoring on the same case study tower, using Mirvac's own historical project data as the benchmark, with the IRM five pillar assessment providing the productivity scaffold for both. The baseline is what makes the Phase 2 option scores defensible inside Mirvac's IC papers. It covers floor-cycle durations by zone, crane hook hours per floor split across structure, facade and fitout, labour hours per square metre by task, Percent Plan Complete and Tasks Made Ready from the Last Planner System on recent comparable projects, and waste and rework cost from Mirvac's internal project records. These are the five productivity scaffold measures from Section 9, applied to Mirvac's own BAU performance.

The baseline does two things. First, it makes the Phase 2 option comparison quantitative on Mirvac's own terms. The question ceases to be "does Modern Methods of Construction typically reduce programme by X per cent" and becomes "does this specific route, applied to this specific structural grid and this specific procurement market, reduce Mirvac's programme by a measurable number of weeks against Mirvac's measured floor-cycle record." Second, it surfaces the areas of greatest friction in Mirvac's current delivery model. Where Percent Plan Complete is low and Tasks Made Ready is low, the cause is worth understanding before introducing a new system that depends on reliable planning discipline. Where rework costs are concentrated in specific trades, the case for removing those trades from the on-site critical path is strongest.

The baseline data is practical to collect. Mirvac carries this data internally across its recent tower projects. The Phase 2 kick-off session is the natural point to assemble it. Project Innovator provides the collection template and runs the baseline analysis as the first Phase 2 deliverable.

> The diagnostic-grade Phase 2 runs the IRM five pillar assessment and the Traditional Construction Baseline as parallel Stream 2 deliverables alongside the MMC option scoring on the same case study tower. Where Mirvac's timeline or project conditions cannot accommodate the diagnostic-grade shape in the available window, the rapid-comparison Phase 2 sits in the engagement letter as a contingency. The rapid-comparison shape delivers the MMC option evaluation against industry ranges and published evidence rather than against Mirvac's measured BAU performance. The engagement letter records the contingency so the procurement position is clear before Phase 2 begins.

Stream 1. Mirvac inputs

The Phase 2 kick-off session sets the baseline collection in motion. Mirvac provides floor-cycle durations by zone, crane hook hours per floor split across structure, pods and facade, labour hours per square metre by task, and waste and rework cost benchmarks from recent tower projects. Without this baseline, the option comparison cannot be conducted on a like-for-like basis. Mirvac also provides conceptual designs for the structural options under consideration for the case study project, so that each Modern Methods of Construction route can be evaluated against the same structural grid and programme assumptions. The ESD consultant engagement decision, covering

the scope of the sustainability assessment Mirvac wants to run alongside programme and cost, is confirmed at Phase 2 kick-off. Mirvac signs off the supplier shortlist that Project Innovator prepares from the Phase 1 research, enabling capacity confirmations and Phase 3 factory visit scheduling to proceed. For any route requiring a performance solution, Mirvac confirms the performance solution pathway, including the design and programme implications that Mirvac's certifier and structural engineer have advised.

Stream 2. Project Innovator deliverables

Project Innovator delivers the following during Phase 2. The Pillars 1 through 4 Assessment Score, produced from the kick-off session and the baseline data, opens the option evaluation with Mirvac's current position on record. The Traditional Construction Baseline report presents the five productivity scaffold measures for the case study project using Mirvac's own data, establishing the comparator that all subsequent option figures reference. Option scorecards then apply the evaluation rubric from Phase 1 (Appendix K) to the shortlisted Modern Methods of Construction routes, with scoring based on the Mirvac inputs and the verified supplier data from Phase 1. A two-date schedule for each option states likely and conservative practical completion dates, with floor-cycle logic and crane windows by package so Mirvac can assess the programme case against its own delivery record. A cost panel places each option against the baseline on construction cost, programme saving value and rework cost reduction, using the Project Innovator productivity scaffold (Section 9). Productivity scaffold runs (Appendix G) present the five measures for each option against the confirmed baseline. Approvals notes for each route requiring a performance solution name the standard, the Building Solutions Practitioner engaged, and the programme implications. A supplier shortlist with capacity confirmation status and known lead time constraints completes the Phase 2 deliverable set.

Stream 3. External engagements

Three external engagements run in parallel with the Phase 2 work streams. The ESD consultant, once appointed, carries out the sustainability assessment scoped in Appendix H against the options under evaluation, using the boundaries and data inputs confirmed at Phase 2 kick-off. The Building Solutions Practitioner, engaged for any route requiring a performance solution under the National Construction Code, prepares the performance solution report and provides the approvals-pathway programme for inclusion in the option schedules. Shortlisted suppliers confirm production capacity, lead-time ranges, and known constraints specific to the case study project, and confirm their readiness for Phase 3 factory visits where Project Innovator recommends their inclusion in the shortlist.

Phase 3 gate

Phase 3 opens when Phase 2 option scorecards are complete and Mirvac has selected a preferred option or a contained pilot structure for the case study project. Phase 3 covers factory visits and supplier due diligence for the preferred option, the Integration Matrix confirming how the chosen Modern Methods of Construction routes connect with each other and with the Mirvac delivery programme, and the detailed design preparation required to lock the design freeze dates the preferred route requires. Section 11 of Phase 1 Rev 2.0 defined the factory visit scope. Phase 3 executes it against the shortlist that Phase 2 produces.

Phase 2 commercial framework

A Phase 2 commercial framework accompanies this report in the engagement letter. The framework follows Mirvac's procurement standard with stage gates aligned to the Phase 2 streams set out in Section 12. The indicative fee range and milestone schedule are confirmed at engagement-letter execution. The commercial structure scales with Mirvac's chosen Phase 2 shape, diagnostic-grade or rapid-comparison.

Phase 1 assumptions to confirm or update in Phase 2

The Phase 1 conclusions rest on five operating assumptions. Each is stated as an assumption rather than a confirmed fact. Phase 2 either confirms the assumption against Mirvac's own data and the supplier shortlist, or updates it with a verified input and reissues the affected analysis.

> **A1. Programme.** Business-as-usual programme of approximately 36 months from substructure to practical completion for a comparable mid-rise Mirvac residential tower. *Phase 2 action, confirm from Mirvac's project records for recent comparable LIV Mirvac and Build to Sell deliveries.*

> **A2. Cost.** Contract value range of 1.35 to 1.55 million dollars per apartment for mid-rise residential in Sydney, 2025 to 2026. *Phase 2 action, confirm with Mirvac's cost team from recent comparable project final accounts.*

> **A3. Rental income.** LIV Mirvac rental income input for the schedule compression model in Appendix I uses an illustrative 700 dollars per apartment per week and a 6.5 per cent stabilised yield. *Phase 2 action, Mirvac provides the actual rental and yield assumptions for the case study project from the internal Build to Rent investment model.*

> **A4. Compliance.** The Design and Building Practitioners Act 2020 (New South Wales) designer registration gap for offshore structural module supply applies under the current Act as at May 2026. *Phase 2 action, confirm with Mirvac's legal team before any offshore structural option is shortlisted.*

> **A5. Pre-Manufactured Value methodology.** Pre-Manufactured Value calculated using Cast Consultancy methodology, with factory scope defined as work completed in a controlled offsite environment before delivery to site. *Phase 2 action, agree the methodology with the appointed Environmentally Sustainable Design consultant and the Mirvac project team before baseline data collection begins.*

> The assumptions above are the items most likely to move between Phase 1 and Phase 2. The Phase 2 kick-off session is the natural point at which each is reviewed against the case study project and updated where Mirvac's actual data differs from the indicative input. Any change to an assumption flows through to the productivity scaffold figures, the commercial model, and the compliance position for each shortlisted option.

A

FOUNDATIONS, DFMA PRINCIPLES

Appendix A. Foundations, Modern Methods of Construction and Design for Manufacture and Assembly principles

This appendix establishes the Design for Manufacture and Assembly framework underpinning all five Modern Methods of Construction routes evaluated in this advisory. The thirteen sub-sections below provide the reference material Mirvac needs to evaluate route options, scope supplier requirements, and structure Phase 2 procurement decisions with a common technical foundation. Readers seeking route-specific application should use this appendix alongside Appendix E (Comparative Integration Review) and Appendix F (Compliance Pathway Detail).

> **How to read this appendix.** Sub-sections A through M move from strategy to delivery. Platform design thinking (A, B), manufacturing and assembly principles (C, D), end-of-life design (E), compliance and evidence pathways (F), site logistics (G), digital integration (H), economics (I), people and safety (J), part families (K), procurement governance (L) and implementation phasing (M). Each sub-section is self-contained and cross-references to the relevant section of the main report where Mirvac-specific application is described.

13

DfMA sub-sections forming the platform framework, A through M

4

Priority part families, floor and roof cassettes, facade panels, MEP risers and pods

6

Implementation stages from platform definition through to scaled delivery

2

MMC methodologies that share a single agnostic DfMA design, Volumetric Modular and Kit of Parts

Modern Methods of Construction and Design for Manufacture and Assembly, foundational definitions

Design for Manufacture and Assembly means designing parts and their interfaces so they are straightforward to make in a controlled factory environment and quick to assemble on site. Value derives from three sources. Repeatable parts that improve with production volume, clean interfaces that eliminate coordination rework between trades, and the transfer of labour from congested weather-exposed sites to a factory setting where productivity, quality and safety conditions are all superior.

Two primary MMC methodologies operate within the framework. Volumetric Modular Construction (also referred to as Modular integrated Construction) delivers room-sized three-dimensional modules largely complete from the factory, connected on site. The principal benefits are parallel factory and site work, and a reduction in on-site trade interfaces. The challenges are module logistics, earlier design freezes and a more intensive compliance assurance burden. Kit of Parts construction delivers standardised structural and facade components designed to fit together consistently on site. The principal benefits are predictable installation sequences and earlier building enclosure. The challenges are interface discipline between package suppliers and clarity on who designs and certifies connections.

The DfMA design philosophy adopted in this framework is agnostic between the two methodologies. The same design should be buildable as conventional construction or with varying degrees of off-site content without requiring major redesign. This keeps procurement options open through the feasibility and design development phases, and allows Mirvac to right-size the MMC commitment to each project as market conditions evolve.

A. Platform thinking and standardisation

Platforms turn one-off project design into repeatable building systems. The transition from project-by-project design to a platform approach is the single most important organisational shift required to realise sustained DfMA benefits. Without a platform, each project repeats the same coordination and procurement effort. With a platform, learning compounds across projects, supplier relationships deepen, and the cost and time to mobilise MMC on any given project falls progressively.

Effective platform design requires four foundational actions. First, define a base grid and service zone structure including typical structural spans, vertical module heights and standard riser positions, then publish these as non-negotiable rules to prevent bespoke creep project by project. Second, build an interface catalogue that standardises connection geometries and fixing points across the structural, floor cassette, facade and MEP interfaces, using a minimal family of connectors and absorbing dimensional tolerances at the interfaces rather than through bespoke detailing. Third, map the modularisation decision, determining where two-dimensional panels, three-dimensional sub-assemblies and fully finished pods add the most value for Mirvac's target building typologies. Fourth, produce a deployment manual covering installation sequences, packaging and lifting plans, quality assurance checkpoints and the permitted range of field adjustments for each part family.

The platform rulebook is a living document. It should be updated after each pilot project with measured data on install rates, tolerance performance and defect incidence. The rulebook is also the mechanism through which Mirvac shapes its supply market. Suppliers who commit to the platform rules become eligible for multi-project preferred engagement. Suppliers who cannot meet the rules are identified before procurement, not during construction.

B. Multi-functional performance

The objective of multi-functional performance is to integrate structure, fire resistance, acoustic separation, thermal performance and surface finish into single factory-built elements wherever this is practical. Integrating multiple functions into one element reduces the number of site operations, eliminates coordination interfaces between trades, and shifts quality control to the factory where it can be measured, corrected and certified before the element leaves the production facility.

Floor and roof cassettes offer the highest integration opportunity in the residential apartment typology. A well-designed cassette combines structural capacity with factory-fitted fire linings to the required Fire Resistance Level, acoustic interlayers, a continuous air and vapour control layer, pre-routed service penetrations with tested collars, pre-installed ceiling fixings, and a pre-finished soffit where the underside is exposed to occupied space. Facade panels can integrate the weather barrier membrane, cavity barriers at floor levels, pre-installed window and door frames, slab-edge fire stops, and bracketry pre-set to the platform grid.

Service-ready features extend multi-functionality into the MEP trades. Standard penetrations with tested sealing collars, plug-and-play MEP connector positions, and pre-positioned fixings for secondary systems all reduce the scope of in-situ work. The whole-of-life dimension of multi-functional design requires that finishes are durable and that sub-components subject to wear, such as bathroom linings, acoustic layers or facade cassettes, are designed as replaceable assemblies accessible without demolishing adjacent structure.

C. Design for Manufacture

Design for Manufacture requires that parts are optimised for existing supplier production capabilities rather than designed in isolation and then presented to suppliers to price. The process-first approach reverses the conventional sequence. The first question is what the supplier's production line can reliably make, and the design is then configured to match those capabilities. This approach minimises changeovers, reduces waste, and allows the supplier to quote with confidence rather than carrying contingency for an unfamiliar process.

Practical DFM considerations include matching part dimensions to current production equipment. Roll-forming widths and lengths, CNC timber cutting envelopes, precast bed sizes, joinery jig patterns and curing press cycles. Tolerances should be specified to what is genuinely achievable in the factory and on site, with connections designed to self-locate and to handle the cumulative tolerances that develop across a multi-storey building without excessive shimming or field cutting. Material yield is addressed by standardising lengths and widths to stock sizes, nesting cut plans to minimise off-cut waste, using symmetric or reversible parts to eliminate left-hand and right-hand variants wherever possible, and establishing rules for the reuse or recycling of off-cut material.

The DFM discipline is most effectively established through co-development workshops with shortlisted suppliers in the pre-tender phase. A workshop that maps the supplier's current production process alongside the draft part specification will identify mismatches before they become RFIs or variations. Resolving production constraints and tolerance conflicts at this stage is materially more efficient than managing them as variations after contract award. The cost of a pre-tender workshop is a fraction of the cost of a single mid-programme deviation from platform dimensions.

D. Design for Assembly

Design for Assembly addresses the on-site half of the DfMA equation. The objective is fast, safe and repeatable site assembly with the minimum number of connection interfaces and the minimum requirement for skilled interpretation of drawings at the point of installation. Where DFM optimises the factory process, DFA optimises the site process. Both disciplines need to be applied in parallel during the design development phase.

Connection design is the single most consequential DFA decision. A minimal family of accessible, self-locating connectors reduces the training burden, minimises the opportunity for incorrect assembly, and allows site supervisors to detect non-conforming installation by visual inspection without detailed measurement. Pre-installed lifting points and pre-set receivers for edge protection systems eliminate the need for site-drilled anchors and reduce the risk of accidental omission of temporary fall protection.

Pre-finishing and pre-commissioning in the factory are the primary programme benefits of DFA. Wet areas, membranes, sealants and surface finishes completed under factory conditions are of consistently higher quality than equivalent work completed on a congested floor plate. Pods and MEP skids bench-tested and certified at the factory arrive on site with a QA record that eliminates the retesting and commissioning work otherwise required for in-situ installation. Site ergonomics and safety design should eliminate work at height wherever possible, minimise hot works, and design temporary stability into the installation sequence so each element is stable and braced from the moment it is set down.

E. Design for Disassembly, Adaptability and Reuse

Design for Disassembly extends the DfMA framework from initial delivery to end of useful life. The objective is to enable future reconfiguration, component recovery and material recycling at the lowest possible cost. For a residential apartment developer with long-term asset ownership ambitions, DfD reduces the cost of repositioning a building for a different tenure or use class, and preserves the embodied carbon value of the structure and facade over multiple lifecycle cycles.

Reversible joints using mechanical fasteners, with critical fasteners exposed and labelled, are the primary DfD enabler. Composite build-ups that permanently bond dissimilar materials should be avoided wherever an equivalent performance can be achieved with a separable assembly. Each part should carry a dismantling sequence and a 'passport' document recording material composition, fixing locations, test data and service history, maintained within the asset information model throughout the building's life. Replaceable sub-assemblies for wear items, specifically bathroom linings, facade cassettes and plant skids, allow individual components to be renewed without structural intervention, reducing the embodied carbon cost of maintenance cycles significantly.

F. Compliance and Assurance

The National Construction Code (NCC) provides two pathways for demonstrating compliance. Deemed-to-Satisfy (DtS), which requires conformance with prescribed solutions, and Performance Solutions, which demonstrate compliance with a Performance Requirement through calculation, test evidence, expert assessment or a combination of these methods. For MMC and DfMA systems, the DtS pathway is rarely available for the full system because the configuration of integrated elements does not match the prescriptive solutions written for conventional construction. Performance

Solutions are therefore the standard compliance mechanism for MMC in Australia. (ABCB, Prefabricated, Modular and Offsite Construction Handbook, NCC 2022, December 2024.)

Effective compliance design requires a performance specification for each part family, defining the structural capacity and robustness requirements, fire resistance level and compartmentation performance, acoustic ratings (airborne and impact), thermal and airtightness values, weather resistance and waterproofing, and accessibility standards where applicable. Verification methods should be prescribed at design stage. The decision of whether to use calculation, test report or third-party assessment should be made before factory production commences, not after a problem is identified on site.

Factory quality assurance and traceability are the practical mechanisms through which compliance evidence is generated and maintained. Control plans, process capability studies, first-article approvals, serialisation and traceability records form the evidence base for both NCC compliance documentation and for the contractual quality obligations between manufacturer and developer. These systems must be established and verified before production scale-up, not retrofitted after delivery begins. The ABCB Prefabricated Construction Handbook 2024 provides the framework for structuring evidence of suitability documentation in a form acceptable to certifiers and building surveyors in each Australian jurisdiction.

G. Logistics and Site Integration

Logistics and site integration planning is as technically demanding as the DfMA design itself, and failures in this domain have been responsible for some of the most significant MMC delivery problems documented in the Australian and New Zealand market. The Cairns Woree social housing programme (Appendix B, Case Study 3) illustrates the consequences of a logistics gap directly. Modules manufactured and delivered to site without a contractually accountable weather protection protocol sustained damage that required replacement. Planning logistics as a late-stage coordination task rather than an integrated design constraint is the most common and most costly error in MMC programmes.

Part dimensions must be set with transport and cranage constraints as primary inputs. The road route from factory to site, the largest crane available on the site footprint, and the clearance dimensions of any underpasses or overhead obstructions on the delivery route must all be confirmed before part dimensions are finalised. Flat-pack options should be considered for facade panels where delivery routes are constrained. Every part should carry integrated rigging points and provision for temporary weather protection where the construction sequence requires elements to be delivered and stored before permanent enclosure is achieved.

Legacy interfaces between platform parts and the in-situ structure are a consistent source of programme delay if not resolved in the design phase. Tolerance-absorbing brackets and adjustable fixing systems that connect platform components to the base structure should be designed and tested before the first parts are ordered. Just-in-time delivery flow requires that truck loads are pre-planned against the daily installation sequence, that laydown space and cranage windows are reserved in the construction programme, and that packaging is designed for rapid unpacking and safe return or reuse at the factory.

H. Digital thread, configuration and data

The digital thread is the data architecture that connects design intent to manufacturing instructions to site installation records to the asset information model. Without a digital thread, the benefits of

DfMA design are partially lost. Parts may be manufactured correctly but installed incorrectly, quality records may be generated at the factory but not linked to the installed component, and commissioning data may be captured on paper and not transferred to the building management system. With a digital thread, data is captured once and used many times across the programme lifecycle.

The core digital tools for a DfMA programme are a parametric part catalogue constrained by the platform rules, a rules-based configuration engine that links platform geometry to cost, carbon and compliance logic, and a BIM integration that connects the object library to procurement codes, quantity take-off rules and installation inspection and test plans. QR codes on physical parts provide the link between the digital model and the physical component, enabling field QA data and commissioning records to be synced to the asset information model in real time. This eliminates the manual data transfer step that is the primary source of record error and incompleteness on conventional projects.

I. Cost, carbon and business case

The business case for DfMA must be built from part-level economics, not from headline programme compression claims. At the part level, the business case compares the cost of factory manufacture and site installation of each part family against the conventional in-situ alternative, accounting for factory overhead recovery, logistics costs, on-site cranage, and the reduced wet-trade hours on site. The programme benefit is captured separately as a reduction in the finance carry, earlier rental income commencement, and reduced exposure to weather and industrial relations risk.

Target-value design is the recommended approach for managing DfMA economics through the design development phase. In target-value design, the allowable cost and the target productivity metrics (hours per part, square metres installed per day) are fixed at the outset of the design phase, and design decisions are evaluated against their impact on these targets throughout development. This prevents the common pattern where DfMA ambitions are progressively compromised in detailed design as individual cost lines are optimised in isolation without reference to whole-system performance.

Embodied carbon accounting should be conducted at part level, carrying a Life Cycle Assessment result per part family and tracking thermal bridging at connection interfaces where insulation continuity is disrupted. Factory-fitted membranes, gaskets and continuous insulation assemblies that improve airtightness and thermal performance also reduce operational energy demand and contribute to Mirvac's published net positive carbon and Scope 3 reduction commitments. (Mirvac Group, ESG Reporting and Sustainability commitments, mirvac.com, accessed 2026-05-11.)

J. People, safety and maintainability

Safety by design in a DfMA programme goes beyond the conventional construction health and safety obligation. The DfMA design process creates an opportunity to eliminate whole categories of risk by designing the build sequence so that high-risk activities either do not occur or occur in a controlled factory environment. Pre-engineered lifting points, pre-set edge protection receivers and pre-installed anchor points remove the three most common causes of working at height incidents during structural assembly. Single-sided fixings eliminate the need for workers to access both faces of a wall or floor to make a connection. Error-proof connectors that cannot be assembled incorrectly remove the risk of non-conforming installation going undetected.

Maintainability design requires that service access zones are established at the platform design stage and are preserved through detailed design. Removable panels and standard access hatches providing the same opening size and configuration across all buildings in the platform reduce the cost of training and equipping facilities management teams. Common spare parts across all part families reduce inventory holding costs. Inspection and maintenance intervals should be specified per part family and documented in the asset information model, so that planned maintenance programmes can be generated directly from the building information rather than requiring a separate building assessment.

K. Example part families

The four primary part families for the Mirvac residential apartment typology are described below. These families represent the highest-value opportunities for programme compression, quality improvement and carbon reduction in the building types relevant to Tower 12 and comparable Build to Rent and Build to Sell projects.

Floor and Roof Cassettes

01

Integrated structure with factory-fitted fire lining to the required Fire Resistance Level. Acoustic interlayers meeting the NCC acoustic separation requirements for the relevant building class. Continuous air and vapour control layer. Pre-routed service penetrations with tested and certified collars. Pre-installed soffit finish where the underside is exposed to occupied space. Lifting plan documentation and pre-installed anchor points. The cassette is delivered as a certified assembly. The performance of each integrated function is verified at the factory, not during or after installation.

Facade Panels

02

Rainscreen cladding assembly with integrated weather barrier membrane, cavity barriers at each floor level, and slab-edge fire stops tested to the NCC fire compartmentation requirements. Pre-installed window and door frames set to the platform grid with verified weather seals. Standardised bracketry pre-positioned to the structural grid for direct engagement without site setting-out. Pressure-equalised cavity designed to the external envelope performance specification. Factory QA records covering dimensional compliance, seal integrity and fire stop installation accompany each panel to site.

MEP Risers and Plant Skids

03

Bench-tested packages with standard couplings to the building's distribution network. Circuits labelled and QR-coded for direct integration with the commissioning and asset information model. Integrated acoustic seals and fire collars pre-installed and certified. Modular design for lifecycle replacement. The skid or riser section can be isolated and removed without structural intervention. Pre-commissioning at the factory eliminates the re-testing programme that conventional in-situ MEP installation requires after every floor.

Pods, Bathroom, Kitchen and Utility

04

Fully finished and commissioned in the factory. Base frame and plan dimensions set to the platform grid. Single-face service umbilicals for hot and cold water, drainage, mechanical ventilation and electrical connections. Proven fire and acoustic interfaces to adjacent structural and floor elements. The pod is the highest-integration, highest-value part family for the Build to Rent typology. The repetitive unit plan means a small number of pod configurations serves the entire programme, maximising factory volume and driving down unit cost with repetition. Mirvac has deployed bathroom pods on its Nine by Mirvac Build to Rent programme. A dedicated BtR tower programme with higher unit repetition and fewer plan variants would consolidate further and increase the programme benefit substantially. Pod count and configuration data for Nine by Mirvac to be confirmed in Phase 2.

L. Governance, procurement and market shaping

Platform-based DfMA procurement requires a different governance model from conventional project procurement. The platform rulebook, once published, becomes the qualification standard for all part family suppliers across the programme. Vendors are assessed against their ability to meet the platform rules. Grid compliance, interface geometry, acceptance criteria, QA regime and compliance documentation are the qualification dimensions. Vendors who cannot meet the rules are not considered for preferred engagement, regardless of unit cost. This shifts the procurement conversation from bespoke negotiation to managed category strategy.

Multi-vendor interoperability is a deliberate design objective. The platform rules should be developed so that no single supplier has a proprietary lock on any part family. This requires that the interface standards, not the supplier's specific product, are the non-negotiable element. Dual-sourcing for high-volume part families reduces programme risk if a supplier encounters a capacity or quality issue mid-project, and creates the competitive dynamic that prevents price escalation as the programme matures.

Market shaping is a legitimate and important function for a developer of Mirvac's scale. Publishing the platform rulebook, communicating forward programme volumes, and running structured supplier development workshops all contribute to developing the Australian MMC supply market's capability to meet Mirvac's needs. The current Australian market has limited depth in factory-built residential components at Tier 1 quality and NCC compliance standard. Mirvac's platform commitment is one of the mechanisms by which that depth is built. (McKinsey and Company, Modular Construction: From Projects to Products, June 2019.)

M. Implementation roadmap

The implementation roadmap moves from platform definition to scaled delivery across six stages. The stages are sequential in logic but can overlap in practice, particularly in the transition from prototype and test to pilot. The roadmap applies equally to a first-time DfMA adopter and to an organisation deepening an existing capability. The entry point is calibrated to current state, not assumed to be zero.

> **Stage 1. Define the platform.** Freeze the structural grid, interface geometries, dimensional tolerances and acceptance criteria for the target building typologies. This is the non-negotiable foundation. No subsequent stage is reliable if the platform definition remains open. Typical duration four to eight weeks with dedicated design and engineering resource.
>
> **Stage 2. Prioritise part families.** Select four to six high-value part families for the Minimum Viable Product, typically floor and roof cassettes, facade panels, bathroom pods and MEP risers. Prioritisation is based on value (programme, cost and carbon benefit) and on supply market readiness (capability to meet platform rules within the required lead time).
>
> **Stage 3. Co-develop with suppliers.** Run DFM and DFA workshops with shortlisted suppliers for each part family. Align part designs to stock sizes, machine limits and QA regimes. Lock the interface details before design documentation is issued. Resolve the compliance pathway (DtS or Performance Solution) for each part family before committing to production tooling.
>
> **Stage 4. Prototype and test.** Build first-of-type for each priority part family. Complete structural, fire, acoustic and weather resistance testing as required by the compliance pathway. Conduct factory acceptance testing. Update the platform rulebook with measured performance data and any dimensional corrections arising from physical production.
>
> **Stage 5. Pilot on a live project.** Deploy the part families on a cycle-planned project with structured measurement of install rates, defect rates, rework hours and safety incidents. Feed measured data back into the platform rulebook and the supplier qualification criteria. The pilot project is the primary learning mechanism. It should be resourced accordingly, not treated as a standard project with some new components.
>
> **Stage 6. Scale.** Expand the part catalogue, lock variant families, establish dual-sourcing for high-volume parts, and embed parametric configurators and digital QA across the programme. At scale, the platform delivers the compounding value that justifies the Stage 1 through 5 investment. Faster mobilisation, lower coordination cost, and improving quality and cost performance follow with every additional project.

Appendix B. Builder adoption case studies

This appendix documents six builder adoption case studies drawn from field research conducted in Phase 1 of this advisory. They span four of the five Modern Methods of Construction routes evaluated in the main report and cover international and Australian examples at apartment and Build to Rent scale. The Strongbuild MacArthur Gardens project is included because Adam Strong, Managing Consultant at Project Innovator, led its delivery as Managing Director of Strongbuild. The other five are drawn from publicly documented sources, independently verified where verification evidence exists and tagged accordingly where it does not.

> **Data quality note.** Programme claims in this case set are largely self-reported by the contractor or developer. Independent third-party verification exists for two projects. Greenford Quay (Heriot-Watt University analysis) and PT Blink Spring Hill (cross-referenced across PT Blink project page and developer statement). Cost outcome data is almost entirely absent from the public domain. Where figures cannot be independently verified, they are tagged accordingly.

Greenford Quay, Ealing, London

01

Developer and builder. The developer was Greystar with Ivanhoe Cambridge. Tide Construction was the main contractor. Vision Modular Systems manufactured at the Bedford factory.

Typology. Build to Rent.

MMC route. Route 1, Volumetric Modular (Module in Construction). 64 per cent volumetric completion ratio at Tillermans Court Phase 1.

Scale. 1,965 homes planned across seven buildings. Tillermans Court Phase 1 delivered 379 homes. Nearly 1,000 homes delivered across three completed buildings as at 2025. Manufacturing rate at peak reached 40 units per week.

50%

Programme reduction, Tillermans Court Phase 1 versus traditional construction

VISION VOLUMETRIC / HERIOT-WATT UNIVERSITY (INDEPENDENT ANALYSIS)

44%

Reduction in embodied carbon versus traditional construction, equivalent to 26,000 tonnes saved

HERIOT-WATT UNIVERSITY, THIRD-PARTY ANALYSIS CITED BY VISION VOLUMETRIC

80%

Reduction in site deliveries

BTR NEWS / VISION VOLUMETRIC

Programme outcome, verified. Tillermans Court Phase 1 completed in 18 months. The 50 per cent programme reduction against a comparable traditional build is independently verified by Heriot-Watt University analysis. Phased handover commenced after 12 months on site. Vision Volumetric, visionvolumetric.co.uk/project/tillermans-court/, accessed 2026-05-11; BTR News, accessed 2026-05-11.

Commercial outcome. Cost data not publicly disclosed. *To be confirmed Phase 2.*

Key learning for Mirvac. Greenford Quay is the most directly applicable international precedent for a Mirvac Build to Rent programme. The Greystar and Tide partnership demonstrates that a Tier 1 institutional developer can commit to volumetric modular at the scale needed for BtR viability, and that a 50 per cent programme compression figure can withstand independent academic scrutiny. The Build to Rent operating model at Greenford Quay, a single landlord managing a high-repetition unit typology across a precinct, is structurally analogous to Tower 12. No Australian BtR developer has yet commissioned a comparable programme at this scale. That gap is the opportunity this report addresses.

MacArthur Gardens, Campbelltown, New South Wales 02

Developer and builder. BlueCHP acted as community housing provider and developer. Strongbuild was head contractor and manufacturer.

Typology. Affordable housing apartments.

MMC route. Route 2, Kit of Parts (Cross-Laminated Timber panelised structure). CLT sourced from Binderholz, Austria. Panelised, not volumetric. This is a DfMA kit-of-parts precedent.

Scale. 101 apartments across three towers of six, seven and eight storeys over a two-level partially underground basement carpark. Approximately 22,000 m2 of CLT. Australia's largest residential engineered timber building and the first CLT residential project in New South Wales at time of completion.

<$300K

Cost per apartment, 2017 dollars, affordable housing specification

THE FIFTH ESTATE, 2017 (ONLY VERIFIED PER-APARTMENT COST FIGURE IN THE AUSTRALIAN APARTMENT MMC EVIDENCE SET)

35%

Reduction in carbon emissions from on-site construction

THE FIFTH ESTATE, 2017

0

Construction-related injuries recorded

THE FIFTH ESTATE, 2017

Programme outcome, verified. CLT structure for all three towers completed in just over six months. Five carpenters were required for CLT installation, compared with a conventional structural frame crew of substantially greater size. The Fifth Estate, 'Australia's largest residential timber building is an affordable housing project', thefifthestate.com.au, 28 November 2017, accessed 2026-05-11.

Commercial outcome, verified. Under $300,000 per apartment in 2017 dollars. This is the only publicly confirmed per-apartment cost metric in the Australian apartment MMC evidence set. Cost escalation since 2017 means the figure is not directly transferable to current feasibility modelling without adjustment. The Fifth Estate, ibid. 60 per cent reduction in on-site waste recorded. The Fifth Estate, ibid.

Author's note. Adam Strong led delivery of this project as Managing Director of Strongbuild. The programme, cost, safety and environmental outcomes above are from published third-party sources, not from internal project records.

Key learning for Mirvac. MacArthur Gardens is the most extensively verified Australian apartment MMC delivery. CLT panelised construction is a viable structural system for mid-rise residential to eight storeys and can deliver cost, programme, safety and carbon outcomes concurrently. The procurement lesson is as important as the system lesson. A CLT kit-of-parts delivery requires a head contractor with deep MMC capability, not a conventional builder managing a CLT subcontractor at arm's length.

Cairns Social and Affordable Housing Precinct, Woree, Queensland

03

Developer and builder. Community Housing Limited and Tetris Capital were joint developer. FCC Construction Australia was head contractor. Modscape and Modbotics manufactured the modules.

Typology. Social and affordable housing apartments.

MMC route. Route 1, Volumetric Modular. Timber modules manufactured to cyclone standard across two facilities.

Scale. 490 homes across 16 low-rise buildings. 1,008 volumetric timber modules. Australia's largest modular residential housing project by module count as at 2026. Total project value of $426 million.

1,008

Volumetric timber modules, manufactured across Victoria and Queensland factories

MODSCAPE / MIRAGE NEWS / FCC CONSTRUCTION, 2024

$426M

Total project value

QUEENSLAND GOVERNMENT MINISTERIAL MEDIA STATEMENT

Programme outcome. Target completion end of 2026. Completion timeline is currently uncertain following the 2025 weather damage event described below. FCC Construction Australia, fccco.com, accessed 2026-05-11.

Commercial outcome. Cost per apartment not publicly disclosed. *To be confirmed Phase 2.*

Critical risk event, 2025. A portion of installed modules sustained extensive water damage following unseasonal rain events during the construction programme. Modules had been delivered to site without permanent roofing installed. Affected units were removed and sent to landfill. Replacement modules were held off-site as at April 2025. Modscape operated under a supply-only contract. Installation, temporary weather protection and permanent roofing were the head contractor's responsibility. The accountability gap was between the factory gate and the permanent roof. Built Offsite, 'Demolition begins at Cairns modular housing project as weather-damaged modules removed', builtoffsite.com.au, accessed 2026-05-11.

Key learning for Mirvac. The lesson is not that modular fails in tropical climates. It is that a supply-only manufacturing contract combined with a conventional head contractor managing installation creates an accountability gap that can destroy factory-produced value in a single weather event. For any Mirvac BtR volumetric programme, the procurement model must require either a fully integrated design-manufacture-install contract with a single party responsible from factory to permanent roof, or a contractually explicit and tested weather protection protocol with hold-point sign-off before any module is left uncovered on site.

The Fells Apartments, Spring Hill, Brisbane, Queensland 04

Developer and builder. Entice Projects was the developer. PT Blink was the technology provider and manufacturer.

Typology. Residential, Build to Sell.

MMC route. Route 2, Kit of Parts (PT Blink Backbone system, post-tensioned steel superstructure).

Scale. 30 apartments, 7 floors. (PT Blink, ptblink.com, accessed 2026-05-11.)

11 DAYS

7 floors of superstructure erected, 10mm tolerance maintained

PT BLINK PROJECT PAGE / INNOVATORS MAGAZINE, 2024

50%

Total programme reduction, 8 months delivered versus 16 months conventional estimate

PT BLINK PROJECT PAGE; ENTICE PROJECTS MANAGING DIRECTOR

Programme outcome, verified. Seven floors of superstructure erected in 11 days. Total programme 8 months against an estimated 16 months conventional, a 50 per cent reduction. Confirmed by both the technology provider and the developer independently. PT Blink, ptblink.com/projects/the-fells-apartments/, accessed 2026-05-11; Innovators Magazine, 2024.

Commercial outcome. Not publicly disclosed. *To be confirmed Phase 2.*

Key learning for Mirvac. The Fells is the strongest published evidence for Australian kit-of-parts superstructure programme compression. The scale gap between 30 apartments and Tower 12 means this is a proof-of-concept precedent rather than a direct delivery precedent. PT Blink is a technology licensor and manufacturer, not a head contractor, meaning any Tower 12 application requires an integrator with structural construction capability.

Little Hero, Russell Place, Melbourne, Victoria

05

Developer and builder. Hickory was head contractor and system owner. Fender Katsalidis was architect.

Typology. Residential apartments, Build to Sell.

MMC route. Route 1, Volumetric Modular (Hickory UB System). 58 single-storey and 5 double-storey apartment modules.

Scale. 8 storeys, 63 apartments, 7 retail tenancies. Completion June 2010. Australia's first published volumetric apartment delivery at height.

8 DAYS

Module assembly for 8 modular storeys with finishes complete

FENDER KATSALIDIS / HICKORY, 2010

9 MONTHS

Total construction programme using parallel on-site and off-site construction

FENDER KATSALIDIS PROJECT PAGE

Programme outcome, verified. Eight modular storeys with finishes installed in 8 days. Total programme approximately 9 months. Programme saving versus conventional stated as more than six months. Fender Katsalidis, fkaustralia.com/project/little-hero/, accessed 2026-05-11.

Commercial outcome. 'At a cost comparable to that of a conventional process.' No specific figure published. Fender Katsalidis, ibid.

Key learning for Mirvac. Little Hero is the originating Australian precedent for volumetric apartment construction at height, establishing a 15-year track record for the domestic sector. The module assembly speed of 8 days for 8 storeys remains the most cited single-operation performance metric in the Australian set. For Tower 12, the relevant signal is Hickory's continued development of the HBS platform for larger projects, which is not yet evidenced by published outcome data at BtR scale.

GROPYUS, Immendingen, Baden-Wurttemberg, Germany

06

Developer and builder. GROPYUS operates as integrated developer, designer, manufacturer and general contractor.

Typology. Rental residential (developer-owned, analogous to Build to Rent).

MMC route. Route 2 / Route 5 hybrid. Timber-hybrid panelised system with load-bearing walls, ceilings and elevator shafts in solid wood. Unitised facade panels integrated with structure.

Scale. 9 buildings, 116 apartments, approximately 12,500 m2 GFA. Manufacturing plant at Richen is a 24,000 m2 facility with capacity for up to 3,500 residential units per year at 86 per cent automation level. GROPYUS website, gropyus.com, accessed 2026-05-11; KUKA press release, 2023.

3,500

Residential units per year factory capacity, three-shift operation

GROPYUS WEBSITE / KUKA PRESS RELEASE, 2023

EUR 100M

Financing round secured 2024 for climate-friendly housing delivery

SILICON CANALS, 2024; EIB LOAN CONFIRMED

Programme outcome. GROPYUS claims up to 50 per cent reduction in construction time versus conventional methods. No independently verified project-specific outcome for Immendingen has been published as at May 2026. *Project-specific outcome data to be confirmed Phase 2.*

Commercial outcome. Per-apartment cost data not publicly disclosed. The European Investment Bank provided a loan in 2024 supporting climate-friendly housing delivery. European Investment Bank, eib.org, 2024, accessed 2026-05-11. *Cost outcome to be confirmed Phase 2.*

Key learning for Mirvac. GROPYUS is the most relevant European technology direction signal for a DfMA-led timber system in a mid-rise apartment context. The integrated developer-contractor-manufacturer model eliminates the supply-chain interface gap that produced the Cairns weather damage event. This model is directly relevant to Mirvac as a developer-builder considering whether to vertically integrate MMC capability. The Immendingen project is best cited as a technology direction indicator for the 2027 to 2030 planning horizon, not as a current delivery precedent.

Cross-case patterns for Mirvac's attention.

Programme compression claims are consistent but rarely independently audited. The 40 to 50 per cent compression figure appears across all six case studies. Independent verification exists only for Greenford Quay (Heriot-Watt University) and PT Blink Spring Hill (developer and supplier cross-confirmation). All other claims are self-reported. A Mirvac Steering Committee should treat self-reported programme figures as directional indicators and commission independent benchmarking before embedding any figure into a business case.

The contractual interface between manufacturer and head contractor is the highest-risk point in every system. Two of six case studies expose this directly. Cairns (weather damage from unclear weather protection responsibility) and The Fells (technology licensor model requiring a capable integrator). In each instance, the system worked. The contract structure requires active management.

Cost data is almost entirely absent from the public domain. Of six case studies, only MacArthur Gardens provides a verified per-apartment cost figure (under $300,000 per apartment, 2017, affordable housing specification). No commercial BtR or private apartment project in this set has published cost outcomes. This is the single largest evidential gap in the Appendix B evidence base and a finding Mirvac should note when evaluating vendor programme and cost claims in Phase 2.

C

MMC MATRIX

Appendix C. Modern Methods of Construction matrix

This matrix maps the supplier landscape across all Modern Methods of Construction system categories relevant to Mirvac's residential tower programme. It is drawn from the Project Innovator Phase 1 field research (November 2025) with corrections applied to supplier location and categorisation data. All cost figures are supplier-provided estimates, not independently verified. Supplier websites are verified as active unless otherwise noted. Use this matrix alongside Appendix D (full supplier profiles) and Appendix E (integration patterns) to identify which suppliers are viable for each route option under evaluation in Phase 2. Filter by system category using the control below.

Filter by system All systems

System	Element	Supplier	Location	Strengths	Constraints	Cost indication	Risk
MiC On-shore	Full module manufacture	Modscape	Victoria	Established volume manufacturer, automated production, high quality output	Limited medium-to-high-rise experience, higher cost base	$5,000 to $6,000/m2 installed *(supplier-provided estimate)*	Low
		Shape Modular	Victoria / SA	Established volume manufacturer, VIC and SA operations	Limited medium-to-high-rise experience, higher cost base	$5,000 to $6,000/m2 installed *(supplier-provided estimate)*	Low
MiC Off-shore	Full module manufacture	China Construction Oceania (CCO)	China	Scale and capacity via CC-SCIGGC parent	Declined to respond to survey without factory visit. *Documented declination. CCO not progressed. Phase 2 may revisit if engagement resumes.*	Not disclosed	High
		HH Modular Technologies	China	Cost effectiveness, manufacturing capacity	No public web presence, contact not established	$4,000 to $5,000/m2 installed *(supplier-provided estimate)*	High
		TLC Modular	Vietnam	NZ-expat management, completed NZ projects, cost effectiveness	Limited Australian delivery record, compliance and quality risk	$3,000 to $4,000/m2 installed *(supplier-provided estimate)*	Med-High
		Stack Modular	Canada / China	Western management with Chinese supply chain, medium-to-high-rise experience, global delivery record	Limited Australian or NZ delivery history	$3,000 to $4,000/m2 installed *(Project Innovator directional estimate; Stack Modular declined to provide a $/m2 figure)*	Medium
		Note. Stack Modular's manufacturing facilities are in Shanghai, confirmed on the Stack Modular website. Some industry sources have cited Suzhou, which is a separate city approximately 100 km from Shanghai.					
		DMD Modular	Poland	Established European manufacturer, verified active	Higher logistics cost from Poland, no Australian compliance history	Not disclosed (survey confirms no data available)	Med-High
		CIMC	China	Most completed Australian projects of Chinese MiC manufacturers	No response to outreach. Not recommended for further pursuit.	Not disclosed	High
		Patience Modular, Reaplite	Malaysia	Cost and scale	No response to outreach. Not recommended for further pursuit.	Not disclosed	High
MiC Potential JV	Hybrid local / offshore	JK Constructions JV with offshore MiC manufacturer	NT / QLD	Indigenous business (49% BMD Group), local content component reduces offshore risk, bridging model between Chinese supply chain and Australian compliance	Higher cost than direct offshore procurement, offshore partner not yet identified	*to be confirmed Phase 2*	Medium

System	Element	Supplier	Location	Strengths	Constraints	Cost indication	Risk
Kit of Parts	Steel structure, whole-of-project	PT Blink	NSW	Proprietary steel and composite concrete floor system, parametric digital platform for design configuration and part marketplace, 3 to 4 completed Australian projects	Currently undertaking a capital raise, limited project volume to date	5 to 15% more cost effective than traditional construction *(supplier-provided estimate)*	**Medium**
	Mass timber structure, whole-of-project	Gropyus	Germany	Scale, manufacturing capacity, mass timber industrialisation at volume	No Australian delivery history, compliance pathway not established	Not disclosed (confidential per survey)	**Medium**
Pods Bathroom	Prefabricated bathroom units	Interpod	NSW	Volume manufacturer, established Australian track record, cost effective at scale	Cost advantage requires volume; not suited to small programmes	*to be confirmed Phase 2*	**Low**
		SYNC	VIC	Volume manufacturer, established Australian track record, cost effective at scale	Cost advantage requires volume; not suited to small programmes	*to be confirmed Phase 2*	**Low**
		Building Elements	NSW	Owner-operated by Brother Nature building company, suited to custom and integrated pod solutions incorporating entries, service risers and cores	Relatively new manufacturer, lower volume capacity than Interpod and SYNC	*to be confirmed Phase 2*	**Medium**
Structure Mass timber	Columns, beams, walls and floor/slabs in CLT or glulam	NeXTimber	SA	Australian manufacturer, local supply chain, carbon store advantage	Higher material cost, services reticulation constrained by deep beams, fire engineering required	*to be confirmed Phase 2*	**Low**
		ASH (MASSLAM)	VIC	Australian manufacturer, MASSLAM structural glulam system, biophilic finish option	Higher material cost, fire engineering required	*to be confirmed Phase 2*	**Low**
		Hasslacher	Austria	Established European CLT manufacturer, scale and capacity	Offshore supply chain, higher logistics cost, transport carbon adverse position	*to be confirmed Phase 2*	**Low**
		Local NSW suppliers known to Mirvac	NSW	Existing Mirvac relationships, local compliance, precast concrete available	Higher cost than offshore precast	*to be confirmed Phase 2*	**Low**
		Mass timber/concrete composite	SA / VIC / Austria	Satisfies structural, acoustic, fire and finish requirements in a single element; exposed timber soffit option	Common in US and Europe, less common in Australia; higher cost than conventional slab	*to be confirmed Phase 2*	**Medium**
Structure Steel and composite	Structural steel, steel/concrete composite, Deltabeam	Local NSW suppliers known to Mirvac	NSW	Existing Mirvac relationships, fast installation, enables services cassette and pod integration	Cost of locally fabricated steel	*to be confirmed Phase 2*	**Low**
		Shandong-region steel fabricators	China	Cost effectiveness, capacity, fire protection pre-applied in factory	Offshore supply chain logistics, compliance verification required	Circa $3,500 to $4,000/t fabricated and landed *(Project Innovator directional estimate; no named supplier*	**Low**

System	Element	Supplier	Location	Strengths	Constraints	Cost indication	Risk
						confirmed at Phase 1)	
		Note. 'Shandong Steel' designates a sourcing category, not a single named supplier. Shandong province hosts a concentration of structural steel fabricators with export experience. Phase 2 supplier identification will confirm named shortlist candidates, capacity, and NCC compliance pathways.					
Structure Steel/concrete composite	Deltabeam composite beams	Peikko	International / AU	Pre-manufactured composite steel beams, increases capacity and fire protection, concrete filled in situ	Specialist system requiring design integration early in programme	*to be confirmed Phase 2*	**Low**
Services Risers and cassettes	Prefabricated services risers, modular cassettes	Kavanagh Industries	NSW	Local manufacturer, established prefabricated services riser experience	Capacity may require advance booking at scale	*to be confirmed Phase 2*	**Low**
		Benmax	ACT	Local manufacturer, prefabrication capability	Geography may affect logistics to Sydney projects	*to be confirmed Phase 2*	**Low**
		AG Coombs	VIC	300th prefabricated vertical riser milestone achieved, established track record	Victoria-based; confirm logistics for NSW projects	*to be confirmed Phase 2*	**Low**
Services Electrical harnesses	Plug-and-play wiring harnesses	Apex Wiring Solutions	VIC	Factory-assembled plug-and-play electrical harnesses, reduces site wiring labour and error rate	Requires early design freeze on services layout	*to be confirmed Phase 2*	**Low**
	Plug-and-play wiring harnesses	My Modular	SA	Factory-wired electrical harness assemblies for modular and volumetric builds, pre-tested prior to site installation	Requires early services design coordination with head contractor	*to be confirmed Phase 2*	**Low**
Facade	Curtain wall and window wall, glazing	Multiple suppliers known to Mirvac	Various	Existing Mirvac supplier panel and procurement relationships	Unitised upgrade may require early design integration	*to be confirmed Phase 2*	**Low**
	Curtain wall with brick slips	Brick Clad (with Ausrise for curtain walling)	VIC	Brick slip system compatible with unitised curtain wall framing, traditional aesthetic with prefabricated assembly	Combination system requires coordination between Brick Clad and Ausrise	*to be confirmed Phase 2*	**Low**
	SIP cladding panels	Askin	VIC	Architectural standing seam panel range and applied batten system, non-combustible mineral wool core, cost effective at residential scale	Architectural range limited; confirm NCC Specification compliance for each panel type	*to be confirmed Phase 2*	**Low**
	Insulated facade panels	Kingspan	NSW	International product range with Australian presence, insulated panel systems for facade and wall applications	Product suitability for specific NCC Specification requirements requires verification per panel type	*to be confirmed Phase 2*	**Low**
Finishes Internal partitions	Closed wall panels with pre-installed services	Local fabricators or China supply	AU / China	Closed panels up to 1.2m wide with pre-installed services, insulation and secondary structure; fast site installation, mitigates high-cost partition trade	Design freeze required early; system selection depends on fire and acoustic performance requirements	*to be confirmed Phase 2*	**Medium**

Cost figures are supplier-provided estimates or Project Innovator directional estimates unless otherwise noted, and have not been independently verified at Phase 1. Risk gradings are Project

Innovator editorial assessments based on Phase 1 research. CCO declined to provide supplier information. Phase 2 due diligence to confirm cost ranges, capacity, and NCC compliance pathways for shortlisted suppliers.

D

SUPPLIER PROFILES

Appendix D. Supplier profiles

Twenty profiles plus one documented declination, organised by Modern Methods of Construction category. Eight Phase 1 profiles refreshed with November 2025 audit corrections. Twelve new profiles added. Cost figures retained as supplier-reported indicative ranges, not independently verified rates.

Each profile gives the verifiable facts a Phase 2 short-listing decision needs. Where a field could not be verified from public sources it is tagged 'Phase 2 confirmation' rather than filled with a survey number that has no audit trail. Cost figures from supplier surveys are retained as supplier-reported indicative ranges. They are not independently verified rates, and they are not a substitute for the cost build-up that the Phase 2 cost panel will produce against Tower 12 (or other case study) specification.

At a glance

Twenty-one suppliers, six categories, indexed by Mirvac status and Phase 2 priority. Click into the relevant category section below for the full profile.

SUPPLIER	CATEGORY	LOCATION	MIRVAC STATUS	PHASE 2 PRIORITY
Modscape	Volumetric Modular	Essendon Fields VIC, Yatala QLD (2027)	Existing relationship	High
Shape Modular	Volumetric Modular	VIC, SA, NSW (planned)	New supplier	Medium
TLC Modular	Volumetric Modular	Vung Tau, Vietnam	New supplier	Medium
Stack Modular	Volumetric Modular	Shanghai, China	New supplier	Medium
HH Modular Technologies	Volumetric Modular	Foshan, China	New supplier	Low (qualify first)
DMD Modular	Volumetric Modular	Skawina, Poland	New supplier	Low
CCO (China Construction Oceania)	Volumetric Modular	China	*Declination noted*	*Factory visit gate*
Gropyus	Volumetric Modular	Richen, Germany	*Benchmark only*	Low
PT Blink	Kit of Parts	Sydney NSW	New supplier	Medium
BrickClad	Facade panel (brick)	Sunshine West VIC	Existing supply	Low
Interpod	Pods	Berkeley Vale NSW	Existing client (496 pods)	High
Sync Industries	Pods	Laverton North VIC	Existing client (769 pods)	High
Building Elements	Pods	NSW	New supplier	Low (qualify first)
NeXTimber by Timberlink	Mass Timber (CLT, GLT)	Tarpeena SA	New supplier	High
ASH MASSLAM	Mass Timber (GLT)	Heyfield VIC	New supplier	High
A.G. Coombs	Multi-Service Risers	Keysborough VIC	New supplier	High
Kavanagh Industries	Multi-Service, ductwork	Smithfield NSW	New supplier	Medium
Benmax	Mechanical plant skids	Queanbeyan, Sydney	New supplier	Medium
Askin Performance Panels	Panelised facade	VIC, national	New supplier	Medium
Kingspan Insulated Panels	Panelised facade	St Marys NSW	New supplier	Medium
Truedek	Composite floor	Wetherill Park NSW	New supplier	Medium
Fielders Slimdek 210	Composite floor	National (BlueScope)	New supplier	Medium
Peikko Deltabeam	Slim floor beam	Finland, AU rep office	New supplier	Low

01 · VOLUMETRIC MODULAR

Ten profiles cover the Volumetric Modular and adjacent kit of parts platform options. Australian capacity sits with Modscape and Shape Modular. The offshore options (TLC, Stack, HH, DMD, Gropyus) require an offshore compliance pathway, traceability protocols and equivalence to Australian Standards as Phase 2 work before procurement consideration. Volumetric Modular is the most complete factory delivery of the five Modern Methods of Construction routes. The integration matrix in Appendix E names the critical interfaces.

MODSCAPE

VOLUMETRIC MODULAR · AUSTRALIA

MIRVAC CLIENT | AU DOMESTIC | PHASE 2 HIGH

LOCATION

Essendon Fields VIC (20,000 m2), Archerfield QLD interim, Yatala QLD 50,000 m2 from mid-2027

CAPACITY

Up to 2,500 modules per year (Essendon Fields stated)

MIRVAC STATUS

Existing relationship via Yarra's Edge display suite

INDICATIVE COST

$5,000 to $6,000 per m2 installed (supplier-reported)

KEY REFERENCES

Cairns Social and Affordable Housing 490 apartments / 1,008 modules; QBuild 122 homes across 45 sites; Mirvac display suite at Yarra's Edge

The Yatala facility receives development approval in 2025, construction begins July 2026, operations from mid-2027 serving Queensland and northern New South Wales. (Built Offsite, May 2026; Modscape, accessed May 2026.)

The Cairns project for Community Housing Limited and Tetris Capital is the largest publicly confirmed Australian apartment delivery in the volumetric category, with completion targeted end of 2026. (Cairns Regional Council, 2025.) Commonwealth Bank announced a financing model at Essendon Fields offering up to 60 per cent of contract price before a home is affixed to land, rising to 80 per cent for bank-accredited prefabricated manufacturers. (Built Offsite, 2024 to 2025.)

Modules and apartments are not equivalent units, two to four modules typically make one apartment depending on typology. Cost build-up at Tower 12 (or other case study) specification, full client list and compliance pathway sit in Phase 2.

SHAPE MODULAR

AU DOMESTIC | ASX LISTED PARENT | PHASE 2 MEDIUM

VOLUMETRIC MODULAR · AUSTRALIA

LOCATION

Victoria, South Australia, NSW (stated planned)

CAPACITY

Phase 2 confirmation

MIRVAC STATUS

New supplier

INDICATIVE COST

$5,000 to $6,000 per m2 installed (supplier-reported)

KEY REFERENCE

Government education sector pipeline (170 per cent half-year wins growth to FY26); modular delivery in Australia proven to 17 to 18 storeys

The modular capability sits inside SHAPE Australia (ASX: SHA), approximately 700 employees, FY25 revenue close to one billion dollars. (SHAPE Australia investor relations, 2025 to 2026; Stock Analysis, accessed May 2026.)

Modular delivery is described in Shape's public materials as proven to 17 to 18 storeys, with low to mid-rise as the primary market focus. ASX listed parent provides financial standing transparency. Modular delivery track record at residential high rise is the Phase 2 verification item.

TLC MODULAR

OFFSHORE | PHASE 2 MEDIUM

VOLUMETRIC MODULAR · VIETNAM

LOCATION

Two facilities at Vung Tau, Vietnam (41,000 m2 manufacturing, 45,000 m2 warehousing); design and engineering teams in Ho Chi Minh City

CAPACITY

Approximately 2,000 to 2,500 modules per year (supplier-reported)

MIRVAC STATUS

New supplier

INDICATIVE COST

$3,000 to $4,000 per m2 installed (supplier-reported); $2,800 to $3,500 per m2 GFA design and construct

KEY REFERENCES

Ranges Karratha 1,166 rooms; Elevation Apartments Auckland 183 apartments / 525 modules

The Auckland project experienced delivery challenges (programme delays, regulatory friction) and is documented in Appendix B. (Built Offsite, accessed May 2026; New Zealand Herald and Kainga Ora reporting, 2024 to 2025.)

The Singapore market history requires verification before being relied on for Mirvac procurement. The accrediting body for prefabricated manufacturers in Singapore is the Building and Construction Authority, not the Monetary Authority of Singapore. Specific Singapore hotel project references are supplier reported and not independently verified.

STACK MODULAR

OFFSHORE | PHASE 2 MEDIUM

VOLUMETRIC MODULAR · CANADA / CHINA

LOCATION
Canadian head office, three factories in Shanghai, China

CAPACITY
Approximately 3,360 modules per year (supplier-reported, not independently verified)

MIRVAC STATUS
New supplier

INDICATIVE COST
$3,000 to $4,000 per m2 installed (Project Innovator estimate based on offshore comparables)

KEY REFERENCE
Australian residential high rise references not publicly disclosed

The company's own materials confirm three Shanghai facilities. Earlier supplier survey responses describing the location as Suzhou are corrected to Shanghai per the company website. (Stack Modular, accessed May 2026.)

A 370 apartment Los Angeles project is supplier reported and not independently verified. Use for Australian projects requires an offshore compliance pathway, traceability protocols and equivalence to Australian Standards before procurement consideration.

HH MODULAR TECHNOLOGIES

OFFSHORE | QUALIFY FIRST

VOLUMETRIC MODULAR · CHINA

LOCATION
Foshan, Guangdong, China (no public website at time of research)

CAPACITY
Phase 2 confirmation

MIRVAC STATUS
New supplier

INDICATIVE COST
$4,000 to $5,000 per m2 installed (supplier-reported)

KEY REFERENCE
Ibis Hotel Perth via consultant pathway (not independently verified)

Risk grade in the Phase 1 matrix is high. Phase 2 engagement requires direct contact, factory visit, and full project portfolio verification before the supplier can be shortlisted. Without a public presence and an independently verifiable project list, HH Modular sits behind both the Vietnamese (TLC) and Polish (DMD) offshore options on procurement risk.

DMD MODULAR

OFFSHORE | NO AU FOOTPRINT

VOLUMETRIC MODULAR · POLAND

LOCATION

CAPACITY

MIRVAC STATUS
New supplier

Skawina, near Cracow Airport, Poland (11,500 m2 facility on 4.37 hectare site)

Approximately 1,000 modules per year (supplier-reported)

INDICATIVE COST

Phase 2 quotation (not disclosed in November 2025 review)

KEY REFERENCE

No publicly available Australian project history

Traceability to Australian Standards, NCC compliance pathway, and freight logistics from Poland are Phase 2 work before any procurement consideration. (Advanced Space Providers, 2024; DMD Modular, accessed May 2026.)

CCO (CHINA CONSTRUCTION OCEANIA)

DECLINATION

VOLUMETRIC MODULAR · CHINA · DOCUMENTED DECLINATION

A division of China State Construction International Group Company (CC-SCIGGC), CCO was contacted as part of the November 2025 market review. The supplier declined to provide cost indication, capacity, NCC compliance pathway and project portfolio without a factory visit being arranged. No data is included for CCO in this appendix. The declination is documented here in the interest of completeness. CCO remains a candidate for Phase 2 direct engagement if Mirvac elects to pursue an offshore Chinese option, with the factory visit treated as the procurement gate.

GROPYUS

OFFSHORE · STRATEGIC BENCHMARK

VOLUMETRIC MODULAR · GERMANY

LOCATION

Richen, southern Germany (24,000 m2 advanced manufacturing facility)

CAPACITY

Up to 3,500 residential units per year, three shift, 86 per cent automation, 45 to 48 robots

MIRVAC STATUS

Benchmark only

INDICATIVE COST

Not disclosed (supplier response, 'exact details remain confidential')

KEY REFERENCES

Weissenthurm 9 storey 54 unit (completed); Immendingen 116 unit; Hildegardstrasse Berlin 27; Schlichtallee Berlin 158; Blasewitzer Strasse Dresden 41

The Gropyus model is the European industrial scale reference Built Living's Neerabup facility is positioned against. (Gropyus, accessed May 2026; KUKA, 2023.) A direct engagement in Phase 2 is appropriate if Mirvac wishes to compare offshore industrial scale modular procurement against Built Living's domestic equivalent once that facility is operational from 2028.

PT BLINK

AU DOMESTIC · PHASE 2 MEDIUM

KIT OF PARTS PLATFORM · AUSTRALIA

LOCATION

Sydney NSW (network of accredited fabricators along the eastern seaboard)

CAPACITY

Approximately 390 accredited manufacturers (supplier-reported)

MIRVAC STATUS

New supplier

INDICATIVE COST

5 to 15 per cent more cost effective than conventional (supplier-reported)

KEY REFERENCE

The Fells Apartments, Spring Hill Brisbane (Entice Projects), 7 floors, 30 apartments, approximately 50 per cent programme reduction (8 month delivery against 16 month conventional estimate)

The supplier is included here under Volumetric Modular for matrix continuity, but the offering is more accurately described as Route 2 (Kit of Parts) per Section 5. (PT Blink, accessed May 2026.)

The Phase 1 figures of 10 levels and 31 apartments are corrected to the verified 7 floors and 30 apartments. (PT Blink, accessed May 2026; Channellife Australia, 2025.)

BRICKCLAD

EXISTING SUPPLY | AU DOMESTIC

FACADE PANEL (BRICK) · AUSTRALIA

LOCATION
Sunshine West Melbourne VIC

CAPACITY
Phase 2 confirmation

MIRVAC STATUS
Existing supply (Brunswick project tiler)

INDICATIVE COST
Phase 2 quotation

KEY REFERENCES
260 City Road (ICON), 51 Flinders Street (Lendlease), Brunswick LU Simon, Nelson Street Maxcon, Yarraville (Better Living Group), supplier reported

Project specific verification at Mirvac procurement gate quality is Phase 2. BrickClad is included as the brick clad panel reference for projects where a brick aesthetic is specified within a prefabricated facade strategy.

02 · PODS

Three profiles. Two volume manufacturers (Interpod, Sync Industries) carry the bulk of Australian bathroom pod capacity in 2026 and both hold an existing Mirvac client relationship, removing supplier qualification work in Phase 2. The third (Building Elements) requires a full qualification process before being treated as a comparable third option.

INTERPOD

MIRVAC CLIENT | AU DOMESTIC | PHASE 2 HIGH

PODS · AUSTRALIA

LOCATION
Berkeley Vale NSW (Central Coast)

CAPACITY
One pod every 15 minutes at peak (up to 9 per day production); up to 10 per day site installation; 33,000 plus pods delivered to date

MIRVAC STATUS
Existing client (Greensquare Zetland 496 pods)

INDICATIVE COST
Not publicly disclosed

KEY REFERENCES
Mirvac Greensquare 496 pods; Alfarn Rockdale 364 pods; Park Rise Apartments Waitara 517 pods; Blacktown Hospital 165 pods; defence and aged care portfolios

Compliance is described as meeting NCC, Australian Standards and the Design and Building Practitioners Act, with waterproofing, electrical and plumbing completed by licensed tradespeople. (Interpod, accessed May 2026; PT Blink, 2024.)

CodeMark or independent third party product certification is not cited on public materials and is a Phase 2 confirmation item with the project certifier. The existing Mirvac client relationship removes supplier qualification work in Phase 2.

SYNC INDUSTRIES

MIRVAC CLIENT | AU DOMESTIC | PHASE 2 HIGH

PODS · AUSTRALIA

LOCATION
Laverton North VIC (20,000 m2 covered, 40,000 m2 external, Australia's largest single bathroom pod manufacturing facility)

CAPACITY
5,000 pods per year (approximately 22 per day)

MIRVAC STATUS
Existing client (Nine by Mirvac 769 pods, 16 configurations, Willoughby NSW)

INDICATIVE COST
Not publicly disclosed

KEY REFERENCES
Nine by Mirvac 769 pods; LIV Albert Fields; Voyager Tower 11; Meriton Suites Melbourne 207 pods; 163 Abbott Street; Iglu and Ovolo portfolios

Compliance is described against AS3740 (waterproofing, third party inspection), AS3000 (electrical) and AS3500 (plumbing). (Sync Industries, accessed May 2026; Business View Oceania, 2024.)

3D modelling is used to verify regulatory compliance pre-production. CodeMark certification is not cited and is a Phase 2 confirmation item.

BUILDING ELEMENTS

AU DOMESTIC | QUALIFY FIRST

PODS · AUSTRALIA

LOCATION
NSW

PARENT
Brother Nature (existing Interpod client for Eighty Kunarma Jindabyne 24 pods)

CAPACITY
Phase 2 confirmation. 'Minimum order of one' positioning

MIRVAC STATUS
New supplier

KEY REFERENCES
No project portfolio publicly available

No project portfolio, technical specifications, compliance documentation, production capacity or lead time data are publicly available. (Building Elements, accessed May 2026.) The 'minimum order of one' positioning suggests a boutique production model not directly comparable to a 200 plus apartment programme.

03 · MASS TIMBER

Two profiles. Complementary, not competitors. NeXTimber supplies Cross Laminated Timber (CLT) for floor and wall panels, the only domestic Australian CLT manufacturer. ASH MASSLAM supplies Glue Laminated Timber (GLT) for post and beam columns. For a hybrid mass timber Tower 12 (or other case study), both suppliers are engaged concurrently.

NEXTIMBER BY TIMBERLINK

AU DOMESTIC | ONLY AU CLT | PHASE 2 HIGH

MASS TIMBER (CLT, GLT) · AUSTRALIA

LOCATION
Tarpeena SA (Limestone Coast); Australia's first combined CLT and GLT production facility, opened March 2024

CAPACITY
Annual production volume not publicly stated; CLT panels up to 16 m by 3.5 m; glulam beams up to 12 m

MIRVAC STATUS
New supplier

INDICATIVE COST
Phase 2 quotation

KEY REFERENCES

Two SA Government Technical Colleges of the Future (Mount Gambier, Tonsley); no residential high rise references publicly available at time of writing

Feedstock is Australian radiata pine plantation. Adhesive is melamine based for improved fire performance. Products are graded to AS/NZS 1748.1 and verified to AS/NZS 4490. Manufacturing is ISO 16696-1 certified. (NeXTimber, accessed May 2026; Wood Central, 2024 to 2025.)

Domestic supply removes container size constraints and international shipping lead time risk that affect imported CLT. CodeMark is not cited and is a Phase 2 confirmation item. The facility opened approximately 26 months before this report. For a 2026-27 programme, early design engagement is recommended to confirm production slot availability. Structural engineering design requires an independent structural engineer.

ASH MASSLAM

AU DOMESTIC | EWPAA CERTIFIED | PHASE 2 HIGH

MASS TIMBER (GLT) · AUSTRALIA

LOCATION
Heyfield VIC (13 production lines, three Hundegger CNC machines including K2i, plus or minus 1 millimetre stated tolerance)

CAPACITY
Annual production volume not publicly stated; maximum element 12 m length, 1,300 mm depth, 450 mm width

MIRVAC STATUS
New supplier

INDICATIVE COST
Phase 2 quotation

KEY REFERENCES
Cowes Cultural Centre (Phillip Island, 5.9 m by 0.42 m beams, 4.2 m by 0.42 m columns); 23 National Circuit Canberra; T3 Collingwood; Westfield Knox; UTAS shed Tasmania

Two structural grades, MASSLAM 45 (Australian Oak / Tasmanian Oak, F'b 45 MPa, equivalent to GL17) and MASSLAM 38 (Plantation Oak, F'b 38 MPa, equivalent to GL15). (ASH, accessed May 2026; EPD Australasia, 2025.)

ASH MASSLAM holds EWPAA certification (the only Australian mass timber glulam to do so by ASH's own claim), PEFC and Responsible Wood chain of custody, ISO 14001 and ISO 45001 certification, an EPD published and registered to 2030 (EPD-IES-0018032:001), E-0 formaldehyde emissions, and independent fire testing under AS1530.4 to 120 minutes. ASH does not supply CLT.

04 · MULTI-SERVICE AND PLANT SKIDS

Three profiles. Australia's only documented vertical riser supplier at scale (A.G. Coombs) is the anchor of this category. Kavanagh and Benmax provide adjacent capability in HVAC ductwork, multi-service frames and mechanical plant skids. Engagement model for Tower 12 (or other case study) is most logically A.G. Coombs for vertical risers, with Kavanagh or Benmax for horizontal ductwork cassettes and plant skids where A.G. Coombs does not self-perform. Scope split is a Phase 2 item with the mechanical consultant.

A.G. COOMBS

AU DOMESTIC | 300+ RISERS DELIVERED | PHASE 2 HIGH

MULTI-SERVICE RISERS · AUSTRALIA

LOCATION
Keysborough VIC (purpose built integrated prefabrication facility); Moorabbin VIC warehouse; founded 1945

CAPACITY
300 plus prefabricated vertical risers delivered to date

MIRVAC STATUS
New supplier (specialist contractor engagement model)

INDICATIVE COST
Not publicly disclosed

KEY REFERENCES

839 Collins Street Melbourne (300th riser milestone, 20 level office tower, ANZ Banking Group, 6 Star Green Star); Barangaroo South Tower 2 (43 storeys, with Lendlease, AIRAH Excellence in Innovation Award); New Royal Children's Hospital Melbourne (2010, first large scale project); Collins Square; International Towers Sydney

Vertical services risers are typically fabricated in 3 storey sections (each approximately the size of a semi-trailer). Each riser integrates mechanical, electrical, controls and fire protection, pre-tested and pre-commissioned in factory before transport to site. (A.G. Coombs, accessed May 2026.)

At Barangaroo, well in excess of 4,000 hours of complex site installation per tower transferred into the factory. Engagement model is as a nominated specialist services contractor rather than a direct product supply agreement, consistent with how vertical riser systems are procured across the industry. Residential high rise vertical riser references are not publicly disclosed and are a Phase 2 confirmation item with the supplier.

KAVANAGH INDUSTRIES

AU DOMESTIC | PHASE 2 MEDIUM

MULTI-SERVICE, DUCTWORK · AUSTRALIA

LOCATION

Smithfield NSW (main facility); Queensland facility operational 2023 to 2024

CAPACITY

Largest duct fabrication facility in Australia (supplier statement); 80 employees, approximately $20 million revenue; Queensland 25 prefabricated riser modules and 2,500 plus m2 of duct in first 5 months

MIRVAC STATUS

New supplier

INDICATIVE COST

Phase 2 quotation

KEY REFERENCES

Sectors served, commercial, industrial, hospital, education, retail, data centres; documented modules to 3,850 by 3,250 mm in plan, many over 12 m long, heaviest approaching 5 tonnes; AG Coombs named trade partner

BIM manufacture capability is confirmed. (Kavanagh Industries, accessed May 2026; PT Blink, 2024.) No residential high rise project references are publicly available. The Smithfield NSW location is geographically advantageous for Sydney based projects.

BENMAX

AU DOMESTIC | PHASE 2 MEDIUM

MECHANICAL PLANT SKIDS · AUSTRALIA

LOCATION

Queanbeyan (head office); Sydney 7,000 m2 dedicated fabrication facility; Newcastle; Hume ACT

CAPACITY

7,000 m2 fabrication plus 4,000 m2 assembly at head office; 7,000 m2 fabrication Sydney; 39 plus years of operation

MIRVAC STATUS

New supplier

INDICATIVE COST

Phase 2 quotation

KEY REFERENCES

CGS Music Centre Canberra (3,100 m2, geothermal HVAC, 90 per cent of plant room prefabricated off-site, entire plant room installed in 8 hours saving estimated 5,000 man hours); Firmus Technologies Singapore (AI data infrastructure); ANU Research School of Social Sciences (12,000 m2)

Compliance includes NATA Accreditation No. 20736, Global-Mark certification and NSW Contractor Licence No. 397090C. (Benmax, accessed May 2026.) Residential high rise project references are not publicly available and are a Phase 2 confirmation item.

05 · PANELISED AND UNITISED FACADE

Two profiles. Class 2 residential towers above 25 metres (Type A or Type B construction) require non-combustible external wall cladding under the NCC. Both Askin Volcore (mineral wool, FM-approved) and Kingspan K-Roc (mineral wool, NCC C2D10(6)(g) compliant) satisfy this requirement. PIR core products from either supplier do not, and must not be specified for high rise residential external facades by default. Procurement specification must call out the non-combustible variant explicitly.

ASKIN PERFORMANCE PANELS

AU DOMESTIC | VOLCORE FOR CLASS 2 | PHASE 2 MEDIUM

PANELISED FACADE · AUSTRALIA

LOCATION
Victoria (head office), national footprint

CAPACITY
Vertically integrated AU manufacturer

MIRVAC STATUS
New supplier

INDICATIVE COST
Phase 2 quotation

KEY REFERENCES
Melbourne Arena facade upgrade; Melbourne Girls College Block A recladding; Sydney Airport Terminal 2 upgrade; La Trobe University Sports Park; retail and aviation portfolios extensive (Coles, Woolworths, Bunnings, IKEA, Aldi, David Jones, Sydney Airport); residential high rise references not publicly available

Four core materials offered, XFLAM (proprietary thermoset foam, insurer endorsed fire performance claim), Volcore (mineral wool, non-combustible, FM-approved, sound absorbent), EPS-FR, and PIR. Volcore achieved FM4880 and FM4881 approval in August 2020 and is the panel range that meets NCC requirements for Type A and Type B construction. (Askin Performance Panels, accessed May 2026.)

A standing seam product referenced in earlier supplier discussions could not be confirmed via public sources at the time of writing and requires direct supplier confirmation in Phase 2.

KINGSPAN INSULATED PANELS

AU DOMESTIC | K-ROC FOR CLASS 2 | PHASE 2 MEDIUM

PANELISED FACADE · AUSTRALIA (LOCAL MANUFACTURE)

LOCATION
St Marys NSW (local manufacture). Shortest supply chain to Sydney sites of any panelised facade manufacturer in this appendix

CAPACITY
Phase 2 confirmation

MIRVAC STATUS
New supplier

INDICATIVE COST
Phase 2 quotation

KEY REFERENCES
Australian residential high rise references for K-Roc range not publicly available at time of writing

The K-Roc range (mineral wool core) is manufactured in Australia and is non-combustible per NCC clause C2D10(6)(g). It can be used wherever a non-combustible material is required by the NCC.
(Kingspan, accessed May 2026; Australian Manufacturing News, 2024 to 2025; The Fifth Estate, 2024.)

K-Roc Ultima provides fire resistance performance for partition applications. As with Askin, the procurement specification must call out the non-combustible variant explicitly.

06 · COMPOSITE FLOOR AND BEAM SYSTEMS

Three profiles. Each offers 7 metre unpropped span composite floor capability with shallow floor zones. Slimdek 210 carries the strongest Australian project record. Deltabeam carries the strongest

stated fire rating (R120 without additional fireproofing). All three require structural engineering specialist sign-off. Phase 2 selection should run a side by side assessment against the specific structural grid and Fire Resistance Level requirements for Tower 12 (or other case study).

TRUEDEK

AU DOMESTIC | PHASE 2 MEDIUM

COMPOSITE FLOOR · AUSTRALIA

LOCATION
Wetherill Park NSW (Premier Steel Technologies, manufactured to specification)

CAPACITY
Manufactured to specification

MIRVAC STATUS
New supplier

INDICATIVE COST
Phase 2 quotation

KEY REFERENCES
Specific named high rise residential projects, Phase 2 confirmation

Permanent truss based concrete formwork system. Truss depths 90, 110, 140 and 160 millimetres. Spans over 7 metres without propping. Configurations, solid, ribbed, partially voided, fully voided. Pre-cambered panels eliminate concrete ponding. (Truedek, accessed May 2026.)

Reinforcing reduction up to 50 per cent versus conventional concrete slab is supplier-claimed. Fitouts can commence the day after concrete pour. NCC compliance details and CodeMark are not publicly published. Structural engineering design and fire rating pathway are Phase 2 confirmation items.

FIELDERS SLIMDEK 210

AU DOMESTIC | STRONGEST AU RECORD | PHASE 2 MEDIUM

COMPOSITE FLOOR · AUSTRALIA (BLUESCOPE NATIONAL)

LOCATION
National (BlueScope distribution)

CAPACITY
National BlueScope supply chain

MIRVAC STATUS
New supplier

INDICATIVE COST
Phase 2 quotation

KEY REFERENCES
North Star multi-residential project; Unilodge student accommodation; Santa Sophia Catholic College; Blacktown Exercise Sport and Technology Hub; Western Sydney Airport

Deep deck composite floor steel formwork in the BlueScope KingFlor range. Nominal cover width 600 mm, rib height 210 mm. Unpropped spans up to 7 metres. Propped exceed 10 metres. Paired with asymmetric steel beams (SlimFlor construction), total structural floor zone reduces to as little as 290 to 300 millimetres, a 35 per cent reduction versus traditional concrete. Concrete savings up to 60 per cent claimed. (Fielders, accessed May 2026; EPC Group, 2024.)

Fire resistance validated against NCC 2016 criteria for normal density concrete (275 degree). Additional rib reinforcement may be required to meet specific Fire Resistance Levels in high rise. Phase 2 design item with the Fielders technical team. The reduced floor zone enables either an extra storey within a building height envelope or an overall height reduction.

PEIKKO DELTABEAM

OFFSHORE | LIMITED AU FOOTPRINT

SLIM FLOOR BEAM · FINLAND

LOCATION
Finland head office, Australian representative office

CAPACITY
Phase 2 confirmation of Australian fabrication and supply chain partner

MIRVAC STATUS
New supplier

INDICATIVE COST
Phase 2 quotation

KEY REFERENCES

Flagstone Village Shopping Centre QLD (210 beams, 1.6 km of Deltabeam, commercial retail); Australian residential high rise references not publicly available

Composite slim floor beam system. Steel beam with web holes at 300 millimetre centres, concrete infill converts to a composite member. Compatible slabs include hollow-core precast, filigran, composite steel decking, trapezoidal steel decking and cast-in-situ. Fire rating R120 (4 hours) without additional fireproofing material, meeting NCC Type A construction requirements. (Peikko Australia, accessed May 2026.)

International certifications cover Czech, Finnish, French, German, Hungarian, Polish, Slovak, Swiss, UAE and Ukrainian markets, plus ICC-ES Evaluation Report (ESR-4341) for the United States. CodeMark or Australian specific third party certification is not cited. Peikko Designer software, Deltabeam SELECT tool and a Tekla plugin are available to design teams. (Peikko Group, 2024; Peikko UK, 2023.)

Cross-supplier observations

Pods. The two volume manufacturers (Interpod and Sync Industries) between them deliver the bulk of Australian bathroom pod capacity in 2026. A 200 apartment project at one pod per apartment is approximately 22 days of Interpod production at peak rate. Both suppliers carry an existing Mirvac client relationship, removing supplier qualification work in Phase 2. Building Elements requires a full qualification process before being treated as a comparable third option. Indicative pricing for Australian bathroom pods sits in the range of $8,000 to $25,000 per pod depending on specification and volume. This is general industry context, not a supplier published rate. Phase 2 direct engagement will produce actual rates for Tower 12 (or other case study) specification.

Mass timber. NeXTimber and ASH MASSLAM are complementary. NeXTimber supplies CLT panels for floor and wall plates. ASH MASSLAM supplies GLT for post and beam columns. For a hybrid mass timber Tower 12, both are engaged concurrently. Australian residential high rise above 25 metres in mass timber is an emerging category. Structural engineering specialist (Arup, Aurecon, Thornton Tomasetti or equivalent) must be engaged in Phase 2 to validate the structural system before the supplier shortlist is confirmed. NeXTimber's facility opened March 2024. Production slot availability for 2026-27 is a procurement timing item.

Services and MEP prefabrication. A.G. Coombs is the only Australian supplier with a documented vertical riser portfolio at scale (300 plus risers, named high rise commercial references). Kavanagh and Benmax have prefabrication capability in adjacent product categories. For Tower 12, the most logical engagement is A.G. Coombs for vertical riser design and prefabrication, with Kavanagh or Benmax for horizontal ductwork cassettes and plant skids where A.G. Coombs does not self-perform.

Facade systems. Class 2 residential towers above 25 metres (Type A or Type B construction) require non-combustible external wall cladding. Both Askin Volcore and Kingspan K-Roc satisfy this requirement. PIR core products from either supplier do not and must not be specified by default. Kingspan K-Roc local manufacture at St Marys is the shortest supply chain to Sydney sites.

Composite floor systems. Truedek, Slimdek 210 and Deltabeam each offer 7 metre unpropped span composite floor capability with shallow floor zones. Slimdek 210 has the strongest Australian project record. Deltabeam has the strongest stated fire rating. All three require structural engineering specialist sign-off. Phase 2 selection should run a side by side assessment against the specific structural grid and Fire Resistance Level requirements for Tower 12 (or other case study).

> Twenty supplier profiles plus one declination. Phase 1 eight profiles refreshed with the November 2025 audit corrections applied (TLC Auckland 183 apartments not 381, Karratha 1,166 rooms not 1,268, DMD facility 11,500 square metres not 11,000, PT Blink Fells 7 floors and 30 apartments not 10 and 31, Stack Modular Shanghai not Suzhou, NREL citation removed). Twelve new profiles added for the categories not covered in Phase 1 (pods at scale, mass timber domestic supply, vertical risers and plant skids at scale, panelised facade non-combustible compliance pathway, composite floor and beam systems for shallow floor zone). Cost figures from supplier surveys are retained as supplier-reported indicative ranges and not as independently verified rates. Compliance pathway, full client lists and project specific cost build-ups for Tower 12 (or other case study) sit in Phase 2.

E

COMPARATIVE INTEGRATION REVIEW

Appendix E. Comparative integration review

Five Modern Methods of Construction families against six building elements. Thirty cell intersections. Per cell, integration pattern. Critical interfaces named so Phase 2 design coordination work can be scoped before procurement.

This appendix sets out the integration pattern between the five Modern Methods of Construction families (rows) and the six primary building elements of an apartment tower (columns). The matrix exists because no single Modern Methods of Construction route delivers an entire building. Every option leaves some elements as conventional site work, integrates with adjacent elements that another supplier delivers, or shifts a scope boundary that the head contractor's commercial team needs to plan around. The matrix gives the design and procurement team a single page reference for those scope boundaries before the rubric in Appendix K is applied to a specific shortlist for Tower 12 (or other case study).

The five families are the five routes evaluated in Section 5. The six elements are cores, structure, services, facade, pods, and finishes. Cells are described as owned (factory delivered, complete on installation), integrated (factory delivered partial, with named site interface), or separate scope (conventional site work or another supplier's delivery). Where a cell carries a 'critical interface' note, that is the line on which the success or failure of the option turns.

The integration matrix

MMC FAMILY	CORES	STRUCTURE	SERVICES	FACADE	PODS	FINISHES
Volumetric Modular (Modular integrated Construction)	**Site work.** Cores cast in-situ or precast on the critical path. Modules connect to the core at each level via designed connection plate and tolerance gap. Critical interface for waterproofing and acoustic performance.	**Owned.** Module steel or timber sub-frame is the primary structure for the apartment footprint. Module-to-module connection and module-to-core connection are the engineering work.	**Integrated.** Mechanical, electrical, hydraulic and fire services rough-in is complete inside each module. Trunk services from building riser to module connect at floor or ceiling plenum on site.	**Integrated or applied over.** External cladding can be factory applied to the module (more weather resistant transit) or applied site-built over the modules (allows facade design freedom). Watertight line is a design decision.	**Owned.** Bathroom and kitchen pods are part of the module, not separate units. Pod scope is built into module specification.	**Integrated.** Floor, wall, ceiling finishes complete in factory. Site work covers connection bands, corridor and lobby finishes, and any inter-module finish reconciliation.
Kit of Parts (structural)	**Site work or hybrid.** Conventional core construction. Mass timber kit can include CLT cores, which is a Phase 2 design decision against the structural engineer. Critical interface at slab to core junction.	**Owned.** Primary structural elements (columns, beams, floor cassettes, wall panels) are the kit. Connections engineered for repeatability across floor cycles.	**Separate scope.** Services run as a separate trade through riser shafts in the kit floor plate. Service penetrations and fire stopping are a site coordination item.	**Separate scope or compatible panelised.** Kit of parts carries no facade. Facade is a separate panelised or unitised system (Section 5, Route 5) or a conventional facade trade.	**Separate scope.** Pods sit on kit floor plate. Pod-to-floor interface (set-down, drainage, services) requires factory-to-factory dimensional coordination.	**Site applied.** Internal lining, paint, ceiling, joinery and final finishes are conventional site trades. Kit produces the structural shell only.
Bathroom and Kitchen Pods	**Not in scope.** Pods do not interact with cores beyond services connection at the riser.	**Not in scope.** Pods sit on the structural floor plate. Floor plate must accommodate pod drainage drop and weight (typically 3.5 to 5 tonnes per pod).	**Owned within pod.** All services internal to the pod (waste, supply, electrical, ventilation) are factory complete. Connection to building stack at four to six points per pod is the site interface.	**Not in scope.**	**Owned.** Entire pod, fully finished, ready to use after connection.	**Owned within pod.** Pod finishes complete. Surrounding apartment finishes are site applied. Door head and floor reveal at pod opening is the visible coordination interface.
Multi-Service Risers and Cassettes	**Integrated at riser shaft.** Vertical services modules occupy the riser shaft, often adjacent to the core. Crane access for module installation is a programme item.	**Not in scope.** Services modules require structural openings for the riser shaft and provision for module weight (typical 3 storey riser section approximately 5 to 10 tonnes).	**Owned.** Vertical services risers (mechanical, electrical, hydraulic, fire) and horizontal services cassettes are the scope. Pre-tested and pre-commissioned in factory.	**Not in scope.**	**Connection points only.** Pod stacks connect to the riser at each level. Stack alignment between pods and riser is a dimensional coordination item.	**Not in scope.** Riser modules are concealed behind finished walls. Access panels for service maintenance are a finishes design item.
Panelised and Unitised Facade	**Not in scope.**	**Connection at slab edge or column.** Facade panels connect to slab edge brackets or column-to-column. Connection design and tolerance build-up	**Integrated where specified.** Some unitised facade systems carry mechanical services (facade integrated ventilation, perimeter heating). Default	**Owned.** Entire external envelope including weatherproofing, insulation, structural cladding, glazing and external finish.	**Not in scope.**	**External face complete.** Internal lining behind facade panel is a separate trade (plasterboard, insulation, vapour barrier).

MMC FAMILY	CORES	STRUCTURE	SERVICES	FACADE	PODS	FINISHES
		between structural and facade trades is critical for both performance and programme.	is no services integration.			

Critical interfaces by route

The matrix highlights five interfaces that determine whether a Modern Methods of Construction option delivers the expected programme and quality outcome on Tower 12 (or other case study). These are the lines at which the design and procurement team should focus Phase 2 design coordination work and Phase 3 first article inspections.

Volumetric Modular, module to core. The connection at the core is the most exposed interface in volumetric construction. Waterproofing, acoustic seal, fire stopping, services connection and dimensional tolerance all converge at this line. Design, supplier specification and site sequencing all need to be agreed at the schematic design stage, not during construction documentation.

Kit of Parts, pod to floor cassette. Where a kit of parts structural option is paired with a pod option (Route 2 plus Route 3 in combination, the dominant Australian apartment Modern Methods of Construction pattern), the dimensional coordination between two factory deliveries is the line on which programme certainty depends. Both factories must work to the same tolerance protocol, agreed in Phase 2 before fabrication starts.

Multi-Service Risers, riser to pod stack. Vertical services risers depend on dimensional alignment with pod waste stacks at every level. A 50 millimetre dimensional drift between the two factory deliveries becomes a cumulative misalignment over 20 levels. Resolution is a coordinated set-out drawing issued before either factory begins fabrication.

Panelised Facade, slab edge to facade panel. The facade-to-structure interface determines weatherproofing, thermal performance, acoustic seal at the perimeter, and structural deflection accommodation. Design coordination with the structural engineer is the single most important Phase 2 output for any panelised facade option.

All factory deliveries, arrival sequence and logistics. The matrix shows owned and integrated cells as factory deliveries. The site must accept those deliveries in a sequence that suits the floor cycle. Factory delivery scheduling, lay-down area, and crane time are the binding constraints on programme. The Phase 2 logistics plan addresses this for each shortlisted option.

Reading the matrix for Tower 12 selection

The matrix is descriptive, not prescriptive. The intent is to make the boundaries between Modern Methods of Construction supply and conventional trade scope explicit so the head contractor's commercial team can assemble an honest cost panel and the design team can scope the integration design work for Phase 2.

Three patterns recur across the five families.

1. Owned cells reduce site labour and rework cost. Factory delivery removes weather risk, removes site coordination disputes, and produces measurable schedule compression where the element is on the critical path. Factory delivery does not by itself compress the programme if the

element is not on the critical path. Whether each owned cell is critical path on Tower 12 is a Phase 2 finding from the floor cycle analysis.

2. Integrated cells require Phase 2 dimensional coordination. Factory deliveries connect to other factory deliveries or to site work at named interfaces. Each integrated cell carries a coordination cost in design, and a tolerance management protocol in fabrication and installation. Integration cells are where Phase 2 design coordination work concentrates.

3. Site work cells remain conventional trades. No Modern Methods of Construction route delivers an entire building. Every option leaves some scope as conventional site work. The cost panel must make the conventional scope explicit, alongside the factory delivered scope, so the comparison with the BAU baseline is like-for-like.

> The combination most commonly applied to Australian apartment delivery is Kit of Parts structure (Route 2) plus Pods (Route 3) plus Multi-Service Risers (Route 4) plus Panelised Facade (Route 5), with a conventional in-situ core. This combination is the working hypothesis for Tower 12 (or other case study) until Section 11 (Opus return scope) presents the recommended option set with reasoning. Volumetric Modular (Route 1) remains the alternative for typology and site characteristics where module size and crane access can be planned for, with Section 6 setting out the typology fit.

F

COMPLIANCE PATHWAY DETAIL

Appendix F. Compliance pathway detail

National Construction Code 2025 staggered adoption, the Design and Building Practitioners Act July 2026 registration requirements, the Pafburn liability cascade, Professional Indemnity Insurance implications, and a compliance pathway table by Modern Methods of Construction route. Extends Section 5 and Section 7 with the regulatory detail Mirvac's certifier, structural engineer, and legal team will need to brief.

> **Compliance assumption.** NCC 2025, Design and Building Practitioners Act July 2026 amendments, Pafburn case law, and Professional Indemnity insurance positions cited in this appendix are accurate to publicly available sources at the time of writing. Phase 2 will confirm each citation against Mirvac legal team's current advice and against the live regulatory text in force at Phase 2 commencement. No clause in this appendix should be taken as a substitute for project-specific legal advice.

National Construction Code 2025 staggered adoption

The National Construction Code 2025 adoption is staggered across jurisdictions. New South Wales adopted the new edition on 1 May 2025, with remaining states and territories adopting on a phased basis through 2025 and into 2026. (Australian Building Codes Board, National Construction Code 2025 adoption schedule.) The structural element of the change that matters for Modern Methods of Construction is the strengthening of the evidence standard required for Performance Solutions. Performance Solutions for structural compliance now require analysis and test evidence, not professional judgement alone. The Performance Solution Report must set out the analysis method, the test standard, the test data, and the verification pathway. The change applies regardless of whether the structural element is delivered conventionally or as an offsite-manufactured module.

For Volumetric Modular and Kit of Parts structural elements, this is the binding compliance change. The Performance Solution Report cannot rest on the manufacturer's design certification alone. It must demonstrate compliance against the Australian Standards referenced in the National Construction Code, with test data that the certifier can review against named test methods. The Building Solutions Practitioner engaged for the Performance Solution must hold National Construction Code competency at the level required for the building class and rise.

Design and Building Practitioners Act July 2026 registration requirements

The Design and Building Practitioners Act 2020 (New South Wales) imposes registration requirements on practitioners involved in the design and construction of Class 2 buildings, including mixed-use buildings with Class 2 components. From July 2026, registration applies to designers and design practitioners producing regulated designs, including structural designs, fire safety designs, building services designs, and external waterproofing designs. (NSW Department of Customer Service, Design and Building Practitioners Act 2020 registration pathway.) The Act introduces a chain-of-evidence requirement, the regulated design certificate, that links each design element to a named registered practitioner.

For Modern Methods of Construction supply, the operative question is whether the offshore designer of a volumetric module can be registered as a design practitioner under the Act for a New South Wales project. The current position is that the registration pathway for offshore structural designers is not resolved at the time of writing. The practical implication is that Volumetric Modular and offshore Kit of Parts structural supply on a New South Wales project require either a registered New South Wales design practitioner to verify, accept, and re-issue the regulated design certificate against the offshore design, or a different procurement structure that places the structural design responsibility with a New South Wales-registered party.

Domestic Modern Methods of Construction supply does not face this constraint. Australian manufacturers, including the Australian Kit of Parts and panelised facade suppliers identified in the Phase 1 supply chain assessment, operate with locally registered designers and engineers, and the regulated design certificate sits inside the existing Australian design and certification chain.

The Pafburn liability cascade

The Pafburn ruling confirmed that the statutory duty of care under section 37 of the Design and Building Practitioners Act 2020 (New South Wales) is owed by every practitioner involved in the construction of a Class 2 building to current and subsequent owners. The duty is non-delegable. The duty is concurrent. (Pafburn Pty Ltd v The Owners – Strata Plan No 84674, HCA 2023.) A breach by any practitioner carries the full liability for the resulting loss, regardless of how the breach interacts with the work of other practitioners.

For Modern Methods of Construction, the Pafburn position has direct documentation consequences. Cladding, facade, and external waterproofing systems require a documented chain of compliance evidence from the manufacturer's specification through the design specification, the installation supervision, the testing, and the practical completion handover. The evidence chain must support a defence to the statutory duty of care for the limitation period applicable to the works. For Mirvac as developer, the practical effect is that supplier documentation must reach an evidentiary standard sufficient to discharge the statutory duty, not just the building approval requirement. The two standards are not the same.

Professional Indemnity Insurance implications

Professional Indemnity Insurance for Modern Methods of Construction projects in Australia has tightened materially since the Design and Building Practitioners Act commenced. Insurers now apply specific underwriting requirements where structural elements are sourced offshore or manufactured offsite, including evidence of the manufacturer's quality management system to

International Organisation for Standardisation 9001 or equivalent, evidence of factory production control to the relevant National Construction Code-referenced standard, and evidence of the manufacturer's own Professional Indemnity Insurance position. For offshore structural module supply specifically, coverage gaps exist where the offshore designer is not a registered Australian practitioner. The detail of the coverage position varies by insurer and project, and the Phase 2 procurement work confirms the position for each shortlisted supplier with Mirvac's insurance broker. (Source required, Phase 2 confirmation with Mirvac's insurance broker.)

Compliance pathway by Modern Methods of Construction route

ROUTE	DEEMED-TO-SATISFY AVAILABILITY	PERFORMANCE SOLUTION REQUIREMENTS	KEY EVIDENCE ITEMS
Route 1. Volumetric Modular	Limited. Volumetric modules above Class 2 low-rise generally require Performance Solutions for structure and fire.	Structure, fire compartmentation between modules, fire resistance level of module-to-module interfaces, services penetration sealing, acoustic separation. Building Solutions Practitioner engaged at concept design.	Module structural design certificate from a registered Australian design practitioner. Fire engineering report against National Construction Code Part C compliance. Factory production control records. Inter-module connection test data. Acoustic test data per AS/ISO 717.1. Module transport and installation method statement.
Route 2. Kit of Parts structural	Available for precast concrete and structural steel elements that comply with AS 3600, AS 3850 or AS 4100. Cross Laminated Timber elements use AS/NZS 1170 with the engineered timber compliance pathway.	Performance Solution may be required for novel connection details, hybrid material interfaces, or fire resistance level achievements outside the Deemed-to-Satisfy provisions.	Structural design certificate. Material compliance documentation per AS 3600, AS 4100, or AS/NZS 1170. Factory production control records. Element installation procedures. As-installed survey data for connection tolerances.
Route 3. Bathroom and Kitchen Pods	Available. Pods are non-structural and comply via product certification of internal services, finishes, waterproofing, and acoustic performance.	Limited. Performance Solution typically applies to acoustic boundary conditions where pod walls form part of an inter-tenancy separation.	Pod product certification including waterproofing test (AS 3740), fire test on internal linings (AS 1530.3), plumbing certification (WaterMark), and electrical certification. Manufacturer's installation procedure. Factory acceptance test records.
Route 4. Multi-Service Risers	Available. Risers comply via service-by-service certification of the contained mechanical, electrical, hydraulic, and fire services.	Limited. Performance Solution applies where fire dampers or fire-rated penetrations require a non-standard configuration to fit the riser footprint.	Service certification per discipline. Fire damper compliance per AS 1668.1. Penetration sealing test data per AS 1530.4. Manufacturer's installation procedure. Service commissioning records by floor.
Route 5. Panelised or Unitised Facades	Available. Facade systems comply via product testing under AS/NZS 4284 for water resistance, AS/NZS 1170.2 for wind loading, and AS 5113 for combustibility.	Performance Solution applies where the facade carries non-standard thermal performance, novel attachment details, or non-Deemed-to-Satisfy combustibility characteristics for buildings above 25 metres effective height.	Facade system test reports per AS/NZS 4284. AS 5113 combustibility test data for cladding materials. Structural connection test data. As-built installation records by panel. Manufacturer's Professional Indemnity Insurance certificate of currency.

Evidence of suitability folder outline

The Phase 1 evaluation rubric in Appendix K requires a Compliance score of 5 supported by named, verifiable evidence specific to the option being assessed. The evidence folder for a score of 5 contains the following items, all dated, all signed by named registered practitioners, and all linked to the regulated design certificate chain under the Design and Building Practitioners Act.

For all routes. A Performance Solution Report where required, prepared by a Building Solutions Practitioner with the relevant National Construction Code competency. Regulated design certificates from each registered design practitioner involved. Manufacturer's quality management system certification to International Organisation for Standardisation 9001 or the relevant equivalent. Factory production control records covering the production period of the elements supplied to the project. Construction-stage compliance verification records linking the as-delivered elements to the design specification.

For Routes 1 and 2 structural elements. Structural design certificate against the named Australian Standards. Connection detail test data for non-standard connections. Inter-element tolerance verification records.

For Route 3 and Route 4 services-based elements. Product certification for the contained services. Factory acceptance test records demonstrating the unit met its specification at the point of dispatch.

For Route 5 facade elements. Full test suite per AS/NZS 4284, AS 5113, and AS/NZS 1170.2. As-built installation records by panel. Practitioner-signed verification that the as-installed configuration matches the tested configuration.

> Phase 2 confirms the evidence folder outline against each shortlisted supplier and against Mirvac's certifier's documentation requirements for the case study project. The detail above is the starting point. The Phase 2 outcome is a confirmed evidence list per option, agreed with Mirvac's certifier in advance of tender, so the Compliance criterion can be scored against complete or substantially complete evidence rather than a documentation commitment.

G

PRODUCTIVITY SCAFFOLD DETAIL

Appendix G. Productivity scaffold detail

Formulas, Phase 2 input requirements, and a worked example for all five productivity scaffold measures. Extends Section 9.

This appendix sets out the calculation method for each of the five productivity scaffold measures introduced in Section 9, the baseline data Mirvac needs to provide for Phase 2, and an illustrative worked example. Phase 2 replaces all placeholder inputs with Mirvac's actual data from the case study project. The worked example uses a hypothetical 200-apartment mid-rise residential tower to show how the scaffold runs and how the outputs are read side by side.

Measure definitions and formulas

MEASURE	FORMULA	UNIT	INPUTS REQUIRED FOR PHASE 2
1. Pre-Manufactured Value	`PMV = (Factory work value / Total contract value) × 100`	% of contract value	Factory scope by trade package and contract value by trade package. Factory work is any work completed in a controlled offsite environment before delivery to site. Assembly on the floor plate is site work regardless of how far it is from the ground. (Cast Consultancy, Pre-Manufactured Value as a Measure of Construction Innovation, March 2021.)
2. Schedule compression	`SC = (BAU weeks - MMC weeks) / BAU weeks × 100`	% or weeks saved	BAU programme from a Mirvac comparable project (substructure to practical completion). MMC option programme issued by supplier with floor-cycle logic and crane-window allocation. Schedule compression is only real where MMC elements sit on the critical path. Off-critical-path prefabrication adds PMV but does not compress. (McKinsey and Company, Modular Construction: From Projects to Products, 2019.)
3. Percent Plan Complete	`PPC = (Tasks completed as planned / Tasks committed in weekly session) × 100`	%	Weekly task commitment and completion records from the Last Planner System on a current Mirvac project, minimum eight weeks. BAU baseline set from this data. MMC option target set by the supplier based on their comparable project record (named project required, not a general claim).
4. Tasks Made Ready	`TMR = (Upcoming tasks with all prerequisites cleared / Total upcoming tasks in lookahead window) × 100`	%	Three to six week lookahead records with prerequisite checklists per task type (drawings issued, materials on site, preceding trade complete, access confirmed, equipment booked). If Mirvac does not currently capture TMR, the Phase 2 team will establish it on the case study project. Eight weeks minimum required.
5. Man-hours per m2 GBA	`MH/m2 = Total person-hours (factory + site) / Gross building area (m2)`	Hours per m2	Trade labour records by work package from a recent Mirvac comparable project (at minimum the structural, facade, and wet areas packages); building gross floor area from design. Factory hours for MMC options provided by the supplier from their production records for a named comparable project. (Love, P.E.D. et al., Production Planning and Control, 29(13), 2018.)

Worked example

The following applies the scaffold to a hypothetical 200-apartment residential tower of 16 storeys and approximately 14,500 m2 of gross building area in Sydney. All inputs are illustrative. The BAU programme is set at 36 months from substructure to practical completion. Phase 2 replaces every figure with Mirvac's actual data from the case study project.

Three scenarios. BAU runs a conventional concrete frame with site-built wet areas. Hybrid Stack covers Routes 2, 3, 4, 5 (kit of parts structure, bathroom pods, prefabricated risers, and unitised facade). Volumetric Modular is Route 1 (complete apartment modules delivered factory-finished).

MEASURE	BAU	HYBRID STACK	VOLUMETRIC MODULAR
Pre-Manufactured Value	10%	**35%**	**68%**
Schedule compression vs BAU	0% (baseline)	**22% (~8 weeks)**	**42% (~15 weeks)**
Percent Plan Complete	57%	**72%**	**79%**
Tasks Made Ready	63%	**76%**	**83%**
Man-hours per m2 GBA	21	**16**	**13**

> **Reading the worked example.** Volumetric Modular scores higher than Hybrid Stack on the two site discipline measures. The logic is straightforward. The Volumetric site scope is narrower. Once modules are delivered, the site team is doing structural connections, service hook-ups, and corridor finishes, not coordinating structure, pods, risers, facade, and wet trade interfaces simultaneously. Fewer weekly plan dependencies mean fewer failure points. Percent Plan Complete and Tasks Made Ready are both higher as a result. Hybrid Stack PPC is still substantially above BAU because factory-supplied elements remove the trade-stacking and wet area unpredictability that drive most BAU PPC failures. Both options improve, and the gap between them reflects the scope of what remains on site.
>
> *All figures in this worked example are directional and illustrative. Percent Plan Complete and Tasks Made Ready in particular are implementation-dependent and cannot be estimated for a specific option without the supplier's track record from comparable named projects. Phase 2 replaces every placeholder with Mirvac's actual data. No figure above should be used in a feasibility or investment submission.*

Rework cost supplement

The five measures above do not explicitly capture rework cost, but the rework cost connection is central to the financial case for MMC. A 2018 longitudinal study across 346 Australian construction projects found that rework cost averaged 0.39 per cent of contract value and erased 28 per cent of project margin, sustained across seven years of real data. (Love, P.E.D. et al., Production Planning and Control, 29(13), 2018.)

The implications are substantial for a 200-apartment project at approximately $285 million contract value. At 0.39 per cent, the expected rework cost is approximately $1.1 million. At a net margin of 2 per cent, the total project margin is approximately $5.7 million. The rework cost consumes roughly a fifth of the project margin before any other overrun is counted. Factory production reduces the rework categories that site conditions create. A bathroom pod built and tested in a factory does not produce a leaking wet area discovered after handover. A prefabricated riser does not require holes cut in finished walls to resolve services coordination disputes. The rework cost reduction available from factory production is not a bonus. It is a structural improvement to project margin that belongs in any honest commercial evaluation.

Project Innovator will quantify the expected rework cost reduction for each shortlisted option in Phase 2, using Mirvac's own rework records from comparable projects as the BAU baseline and the supplier's production defect rates from their factory quality management system as the MMC input.

H

SUSTAINABILITY DIRECTIONAL DETAIL

Appendix H. Sustainability directional detail

ESD consultant brief checklist, directional embodied carbon ranges by MMC route, site waste intensity targets, transport reporting, and EPD requirements for Phase 2. Extends Section 10.

This appendix translates the sustainability directional position in Section 10 into the specific deliverables Mirvac and the ESD consultant need to produce in Phase 2. It sets out the scope of the embodied carbon comparison, the EPD requirements by system, the waste intensity targets, and the transport reporting approach. All figures below are directional. Certified EPD-based calculations are a Phase 2 deliverable.

ESD consultant brief checklist

The following is the minimum scope for the ESD consultant engaged in Phase 2 to produce a credible sustainability comparison across the shortlisted MMC options.

DELIVERABLE	SCOPE	REQUIRED BY
Embodied carbon comparison	Cradle-to-site boundary as minimum; cradle-to-practical completion preferred. Stated in kg CO2-e per m2 of gross floor area. Comparison to include BAU baseline and each shortlisted MMC option. Methodology to be agreed before data collection begins.	Phase 2 draft
EPD inventory	A list of available Environmental Product Declarations for the structural, facade, pod and services components in each option, with known data gaps identified. Where EPDs are unavailable, the consultant states the generic dataset applied and its source.	Phase 2 draft
Waste intensity targets and reporting	Waste intensity in tonnes per m2 of gross floor area, reported separately for factory waste and site waste. Packaging and stillage included in factory waste. Targets set by option relative to BAU benchmark. Reporting plan confirms the cadence and responsible party. (Mirvac Group, Net Positive Carbon programme and commitments, 2021 to 2025.)	Phase 2 draft
Transport reporting plan	Movements and kilometres per apartment by component category. Emissions calculated in kg CO2-e using the transport distance, vehicle type and load factor for each delivery route. For offshore options, the shipping calculation must include port-to-site legs, not only ocean freight. (Mirvac Group, Scope 3 approach and targets, 2025.)	Phase 2 draft
Resident energy projection	Modelled or measured star rating projection per dwelling type (1B, 2B, 3B) using the National Construction Code minimum as the baseline and the MMC option specification as the comparison. Scope 3 resident energy is a Mirvac reporting obligation under its Net Positive programme.	Phase 2 final

Directional embodied carbon ranges by MMC route

The following ranges are directional, based on available case study data and published industry benchmarks. They are not certified and must not be used in reporting, marketing or investor communications without an ESD consultant's verification against the specific project specification.

ROUTE	DIRECTIONAL EC RANGE (CRADLE TO SITE)	KEY DRIVER AND DATA GAP
BAU (concrete frame, site-built)	600 to 900 kg CO2-e per m2 GFA	Structural concrete dominates. Range reflects concrete specification and reinforcement density. Data gap. Mirvac-specific BAU figure requires ESD assessment of a comparable recent project.
Route 1, Volumetric Modular (local)	500 to 750 kg CO2-e per m2 GFA	Factory production reduces site waste. Steel-framed modules carry higher structural EC than concrete. Data gap. No certified EPD for any current Australian volumetric modular supplier at the time of writing.
Route 2, Kit of Parts (steel or precast)	580 to 850 kg CO2-e per m2 GFA	EC range tracks the structural material. Structural steel carries higher EC than post-tensioned concrete per element but generates less site waste. On EPD availability, Peikko DELTABEAM has published EPDs for European markets and Australian confirmation is required.
Route 2 (Mass Timber variant)	250 to 450 kg CO2-e per m2 GFA	Biogenic carbon stored in building fabric reduces net EC intensity materially. MacArthur Gardens, Campbelltown is the confirmed Australian reference at 6 to 8 storey height range. On EPDs, ASH MASSLAM has a published EPD via EPD Australasia. NeXTimber EPD pending at time of writing. Only applicable to buildings within the mass timber structural range.
Routes 3, 4 (Pods and Risers, added to any structural route)	Reduction of 5 to 15 kg CO2-e per m2 GFA relative to BAU wet trade equivalent	Factory waste reduction and reduced material use from precision manufacturing. Packaging and stillage return schemes reduce net waste intensity. Data gap. No Australian pod supplier has published an EPD at time of writing. Generic factory data used as proxy.
Route 5, Panelised Facade (non-combustible panels)	Comparable to or slightly higher than BAU facade equivalent per m2 of facade area	Mineral wool core panels have higher manufacturing EC than rendered masonry but reduce site waste and eliminate remediation risk. On EPDs, Askin and Kingspan both have product-level documentation. Boundary confirmation required for the specific panel configuration.

PMV and waste intensity connection

Higher Pre-Manufactured Value correlates with lower site waste intensity and lower embodied carbon variance, across the Cast Consultancy dataset and the Phase 1 evidence base. The direction of the correlation is established. The magnitude is project-specific and requires ESD consultant assessment to quantify. (Cast Consultancy, Pre-Manufactured Value as a Measure of Construction Innovation, March 2021.)

Factory production removes the categories of site waste that are hardest to control. Off-cut timber, plasterboard, wet area waterproofing off-cuts, and rework material are all eliminated. A bathroom pod produced in a factory generates packaging waste and some off-cut material at the factory, but both are managed in a single controlled environment with supplier return arrangements for packaging and stillage. The same bathroom built on the floor plate generates site waste at the work package level, spread across multiple trades, with no packaging return and no reliable waste stream separation.

Reporting cadence and hand-off date

> **Phase 2 sustainability deliverable dates.** The following sequence applies to the Phase 2 programme.
>
> At the Phase 2 kick-off session, agree the embodied carbon methodology and boundary with the ESD consultant and Mirvac before any data collection begins.
>
> At week 4, the EPD inventory for each shortlisted option is submitted by the relevant supplier. Missing EPDs flagged with the generic dataset to be applied as proxy.
>
> At week 8, the draft embodied carbon comparison, waste intensity targets, and transport reporting plan are submitted by ESD consultant for Mirvac review.
>
> At Phase 2 final report, certified or verified sustainability comparison is included for each shortlisted option. (Mirvac Group, Net Positive Carbon programme and commitments, 2021 to 2025; Mirvac Group, Scope 3 approach and targets, 2025.)

COMMERCIAL DETAIL

Appendix I. Commercial detail

The McKinsey trilogy on industrialisation, a directional time-value-of-money model for schedule compression on Build to Rent, the offshore versus domestic cost spread, the rework-to-margin connection, and three commercial risks specific to Modern Methods of Construction in the Australian context.

The McKinsey trilogy

Three McKinsey reports frame the global commercial case for industrialisation in construction. Reinventing Construction (2017) sized the global productivity opportunity at approximately 1.6 trillion United States dollars annually, a 35 to 40 per cent productivity uplift if the construction sector matched the average of all other industries. (McKinsey Global Institute, Reinventing Construction, 2017.)

Modular Construction, From Projects to Products (2019) narrowed the lens to volumetric and modular delivery. Cost reduction of 20 per cent and programme reduction of up to 50 per cent are achievable in sectors with high design repetition. The gains depend on three preconditions, sufficient design repetition to amortise tooling costs, demand aggregation to factory utilisation above 70 per cent, and client acceptance of standardised outputs. Without these conditions, modular delivery does not outperform traditional delivery. (McKinsey and Company, Modular Construction, From Projects to Products, 2019.)

The Next Normal in Construction (2020) projects that contractors who industrialise their delivery model will generate two to three times greater Earnings Before Interest, Taxes, Depreciation and Amortisation margins than those who remain project by project. (McKinsey and Company, The Next Normal in Construction, 2020.) The three reports read together produce a single commercial conclusion. Industrialisation is the structural lever that resets the cost curve for a residential developer with a large enough pipeline to aggregate demand against factory capacity. Mirvac's Build to Rent pipeline at approximately 1.2 billion dollars actively progressed is at the demand-aggregation threshold that the McKinsey case rests on.

The cost of a week of programme delay

Schedule compression on a Build to Rent tower translates directly into rental income earned earlier and construction finance carry held for less time. The framework below is directional. Phase 2 replaces the input variables with Mirvac's actual rental, yield, debt, and finance carry assumptions from the internal Build to Rent investment model for the case study project.

For an indicative 200-apartment Build to Rent tower at a market rent of 700 dollars per apartment per week, gross weekly rental income at full occupancy is approximately 140,000 dollars. Every week that practical completion is delayed, the asset forgoes that week of rent and the construction

debt continues to accrue interest for one additional week. The two together are the per-week cost of delay.

- **Lost rent for the week.** Approximately 140,000 dollars at full occupancy for a 200-apartment tower at 700 dollars per apartment per week. The income is shifted forward by one week, it is not added to a future year. Each week of delay is a week of rent that does not come back.
- **Construction finance carry held for one additional week.** Driven by the peak construction debt position and the interest rate. Order-of-magnitude only for an indicative 200-million dollar peak debt at 7 per cent per annum, the weekly carry is approximately 270,000 dollars. The actual figure depends on the lender, the staging, and the loan structure on the case study project.
- **Lease-up curve effect.** Earlier practical completion shifts the lease-up curve forward by the same period. The realised cash flow gain depends on how quickly the tower reaches stabilised occupancy from practical completion, which the Mirvac investment model holds.

The figures above are directional only. They are framed in Mirvac's own commercial units so the Phase 2 commercial work can populate them from the actual investment model inputs. The Mirvac internal Build to Rent investment model is the canonical source. The framework shows how Phase 2 connects the schedule compression measure from the productivity scaffold (Section 9) to a per-week cost-of-delay figure stated in dollars Mirvac's investment committee already works with.

> The earlier version of this appendix presented a per-week present asset value figure derived by capitalising one week of rent at the stabilised yield. That treatment is incorrect because it values one week of rent as a perpetuity rather than as a one-week cash flow shifted forward, and it has been replaced by the cost-of-delay framing above. Phase 2 confirms the per-week figure with Mirvac's investment team from the actual model.

Offshore versus domestic cost spread

The offshore Modern Methods of Construction cost advantage at scale, approximately 1,000 to 2,000 dollars per square metre on volumetric and panelised elements, is conditional. The conditions under which the advantage is real:

- Production volume at a scale that justifies the supplier's pricing position.
- Australian dollar to United States dollar or Chinese yuan exchange rate movement within a manageable band over the production period.
- Freight rates within the historical range, with no port congestion or international shipping disruption.
- Compliance cost adjustment for offshore origin fully applied, including the practitioner registration cost under the Design and Building Practitioners Act, the additional documentation work required for offshore design certification, and the import duty and Goods and Services Tax recoverable position.

The conditions under which the advantage closes or reverses:

- Domestic supply available at the volume required, where the domestic factory production cost approaches the all-in offshore landed cost.
- Single-project trial scope, where the production volume is below the offshore supplier's pricing threshold.
- Compliance cost adjustment becomes binding rather than nominal, including a Performance Solution scoped specifically for offshore-designed structural elements.

The directional position for the Mirvac first project is that the offshore advantage is unlikely to be the decisive commercial factor. The compliance position, the Professional Indemnity Insurance position, and the supply chain certainty on the first delivery are the dominant variables.

The rework-to-margin connection

Rework cost at 0.39 per cent of contract value erases 28 per cent of project margin in mid-tier and residential construction. The figure is from a seven-year longitudinal study of one Australian contractor across 19,605 rework events on 346 real projects. (Love et al., 2018, Production Planning and Control, 29 (13).) Mid-tier and residential builder net margins sit at 1 to 3 per cent. (Master Builders Australia, National Forecasts 2023.) A small movement in rework cost is therefore a large movement in commercial result.

Factory production reduces the rework categories that site conditions create. Wet area waterproofing rework, plasterboard finishing rework, joinery installation rework, and services coordination rework are the categories most consistently reduced when the element is delivered as a factory-finished module or pod. The Phase 2 productivity scaffold (Section 9 and Appendix G) measures rework cost as one of the five scaffold measures, with Mirvac's recent project records providing the baseline figure against which each option is compared.

Commercial risk register, Modern Methods of Construction specific

Risk 1. Currency exposure on offshore supply. Offshore Modern Methods of Construction supply is denominated in United States dollars or Chinese yuan at the point of contract. Production windows of 6 to 12 months from contract execution to factory dispatch expose the project to exchange rate movement that can erode or reverse the offshore cost advantage. Phase 2 commercial work confirms the hedging position with Mirvac's treasury team for any offshore-shortlisted option, with the hedging cost included in the all-in landed cost comparison.

Risk 2. Payment milestone mismatch between factory delivery and site readiness. Factory production milestones typically trigger progress payments at percentage completion against the manufactured element. Site readiness to receive the element depends on the construction programme. A factory-complete element that arrives before the site is ready creates storage cost, double-handling risk, and supplier dispute risk where storage cost is contested. Phase 2 commercial work confirms the payment milestone structure and the site-readiness verification process for each shortlisted supplier, with the payment trigger linked to a defined site condition rather than factory completion alone.

Risk 3. Programme extension risk where offsite elements sit off the critical path. Factory production reduces site duration on the elements it covers, but it only compresses the programme if those elements sit on the critical path. Where the offsite elements sit off the critical path, the programme does not compress and the commercial case rests on rework reduction and quality improvement alone. Phase 2 floor cycle analysis identifies which elements are critical path for the case study project, with the productivity scaffold figures presented separately for critical path and non-critical path scope.

> Phase 2 delivers the commercial assessment for each shortlisted option using Mirvac's actual financial inputs, the productivity scaffold figures from Section 9 and Appendix G, and the compliance cost adjustments from Appendix F. The figures in this appendix are directional and indicative, drawn from the published evidence base and Project Innovator's supplier engagement during Phase 1. The Phase 2 outputs are project-specific and signed off against Mirvac's commercial governance.

K

EVALUATION RUBRIC TEMPLATE

Appendix K. Evaluation rubric template

A weighted, evidence-based scoring framework for comparing Modern Methods of Construction options against the business-as-usual baseline in Phase 2.

> **Suggested rubric, not a locked one.** The rubric set out below is a suggested starting point developed in Phase 1. The criteria, the weightings, and the scoring scale are tabled for adjustment with Mirvac at the Phase 2 kick-off session, based on Mirvac's own priorities for the case study project. The intent is to land a scoring instrument that Mirvac's project team and investment committee both stand behind before any option is scored against it. The Phase 1 weights below are the default the conversation starts from.

This rubric gives Mirvac a consistent, evidence-based way to compare Modern Methods of Construction options against the business-as-usual baseline for a specific project. It was developed in Phase 1 as a draft framework and is carried forward to Phase 2 as the scoring instrument Mirvac's project team and Project Innovator will apply with real data, once the criteria, weightings, and scoring scale have been confirmed with Mirvac.

The rubric is weighted. Eight criteria reflect the factors that matter most for a mid-rise residential tower in the current market. Weights are adjusted by Mirvac to reflect the case study project priorities before Phase 2 scoring begins. The weights below are the default Phase 1 settings.

How scoring works

Each criterion is scored from 1 to 5.

- **Score 5.** Named, verifiable evidence specific to the option, including test certificates, programme schedules, and cost build-ups itemised by line.
- **Score 3.** Evidence is present but incomplete.
- **Score 1.** The option is at concept stage with material open items.

One rule overrides all others. If Compliance scores red (1 or 2), the option does not advance, regardless of how strongly it scores on other criteria. Compliance is not a tiebreaker. It is a gate.

Scores are multiplied by the criterion weight and summed to a weighted total out of 100. The option with the highest weighted total is the recommended shortlist lead, subject to Compliance being

green.

Scoring scale

SCORE	WHAT IT MEANS
5	Evidence is complete and specific to this option. Performance solutions listed, test standards named, option programme issued, cost build-ups itemised including logistics and rework, roles and responsibilities clear. Factory and site quality assurance examples provided.
4	Evidence is substantially complete. Key documents are in final draft. One or two minor items remain open with a clear path to resolution within the Phase 2 programme.
3	Evidence is part-complete. Main items outlined but some reports, programmes or cost details still in draft. Risks identified with a practical plan to close gaps.
2	Early evidence only. Supplier has provided indicative data but material items remain unconfirmed. Substantial work required before this option can be fully evaluated.
1	Concept stage. Limited evidence, major open items, or material uncertainty on approvals, logistics or supply. Not ready for detailed evaluation without substantial further work from the proponent.

Eight criteria and weights

The top four criteria carry 75 per cent of the weighted total. This reflects where the Phase 2 evaluation decision is actually made. An option that cannot clear compliance, deliver a credible productivity case, stack up commercially, and demonstrate quality assurance cannot be shortlisted regardless of its sustainability or scalability credentials.

#	CRITERION	WEIGHT
1	**Compliance and assurance** (gate criterion)	20%
2	**Productivity** (Pre-Manufactured Value, schedule compression, site discipline)	20%
3	**Cost and commercial**	20%
4	**Quality and safety**	15%
5	Sustainability	10%
6	Scalability and capacity	8%
7	Brand fit and local content	5%
8	Digital enablement	2%

Evidence checklist by criterion

The following sets out what good evidence looks like for each criterion. Assessors rate on the 1 to 5 scale above, and the checklist defines the upper anchor.

1. Compliance and assurance

20%

A score of 5 requires three components. A list of performance solutions by system (structure, facade, pods, services), with the verification method stated for each (Deemed-to-Satisfy or Performance Solution pathway). A responsibility matrix for critical connections. And an evidence of suitability folder outline showing how NCC compliance will be demonstrated for the option. (Australian Building Codes Board, Prefabricated, Modular and Offsite Construction Handbook, NCC 2022, December 2024.)

2. Productivity

20%

A score of 5 requires five measurable inputs, each referenced to the productivity scaffold in Section 9 and Appendix G.

Pre-Manufactured Value. Factory scope defined by system (structure, facade, pods, services) and expressed as a percentage of total construction value using the Cast Consultancy methodology. A score of 5 requires a completed Pre-Manufactured Value calculation with factory versus site split itemised by trade package. (Cast Consultancy, Pre-Manufactured Value as a Measure of Construction Innovation, March 2021.)

Schedule compression. A programme for the option showing both a likely and a conservative practical completion date, with floor-cycle logic by zone (structure, pods, facade) and crane-window allocation by package. The programme must show the option's critical path against the BAU baseline, not total duration alone. Programme compression of 20 to 50 per cent is the benchmark range from comparable projects. (McKinsey and Company, Modular Construction: From Projects to Products, 2019.)

Percent Plan Complete. Evidence that the supplier or delivery team operates a Last Planner System, with a Percent Plan Complete baseline from comparable recent projects. Target is 80 per cent or above at steady state. A score of 5 requires named project evidence with actual figures, not a process description alone.

Tasks Made Ready. A six-week lookahead process with a documented constraint-removal cadence. A score of 5 requires a description of the Tasks Made Ready process and at least one comparable project showing the constraint removal rate achieved.

Man-hours per m2. Labour hours per square metre of gross floor area for the option, split by factory and site, with a calculation method traceable to the option's scope and programme. Compared against Mirvac's BAU baseline established in Phase 2. (Love, P.E.D. et al., Production Planning and Control, 29(13), 2018.)

3. Cost and commercial

20%

A score of 5 requires four components. A cost build-up with assumptions traceable to drawings and specifications. Preliminaries shown by week rather than as a lump sum. Logistics budgeted as a separate line. And, for factory-supply options, a clear explanation of payment timing, milestone definitions and responsibility allocation between Mirvac and the manufacturer.

4. Quality and safety

15%

A score of 5 requires three components. A description of the manufacturer's quality management system, with documented quality assurance outputs from recent comparable projects. An expected defect profile by method with mitigations. And design-for-safety notes showing reduced hot works, reduced work at height and reduced wet trade exposure compared with BAU.

5. Sustainability

10%

A score of 5 requires four components. A confirmed method and scope for the embodied carbon comparison, at minimum cradle-to-site boundaries, stated in kg CO2-e per m2 of gross floor area. Waste intensity targets and a reporting approach covering both factory and site waste including packaging and stillage. A list of available Environmental Product Declarations for structural, facade, pod and services components with known data gaps identified. And a transport reporting plan stating movements and kilometres per apartment by zone. (Mirvac Group, Net Positive Carbon programme and commitments, 2021 to 2025; Mirvac Group, Scope 3 approach and targets, 2025.)

6. Scalability and capacity

8%

A score of 5 requires three components. Recent throughput numbers from the supplier, including shift patterns and identified bottlenecks. Lead-time ranges with the variables that affect them (materials, testing, changeover). And, for offshore options, a clear explanation of how traceability and equivalence to Australian standards will be demonstrated throughout fabrication and delivery.

7. Brand fit and local content

5%

A score of 5 requires three components. A statement of local manufacturing content with a pathway to increase it over the programme. A due-diligence summary for the shortlisted supplier. And a description of how the option aligns with Mirvac's after-care and long-term maintainability expectations.

8. Digital enablement

2%

A score of 5 requires three components. A confirmed model and file exchange format. A part-identification scheme that ties drawings, quality assurance photos and as-built records to the same identifier. And an example of a dashboard or report format Mirvac can reuse across Phase 2 and into the delivery phase.

Decision rule

Recommend the option with the highest weighted total, provided Compliance scores green (3 or above). If Compliance is red (1 or 2), the option is not shortlisted regardless of other scores.

Where two options score within five weighted points of each other, prefer the one with the clearer approvals path and the more clearly sequenced programme, using floor-cycle clarity and crane-window certainty as tiebreakers.

If Mirvac adjusts weights before Phase 2 scoring begins, apply the same decision rule with the adjusted weights.

Worked example, Route 1 vs Kit of Parts hybrid stack (Routes 2, 3, 4, 5)

The following example applies the rubric to two hypothetical options for a mid-rise residential tower. Numbers are illustrative and intended to show how scores combine, not to represent any specific project. Phase 2 replaces these placeholders with real data from Mirvac's shortlisted options.

The five routes assessed in Section 5 provide the framework. Route 1 (Volumetric Modular), Route 2 (Kit of Parts structural system), Route 3 (Bathroom and kitchen pods), Route 4 (Multi-service risers), and Route 5 (Panelised facade). The Kit of Parts hybrid stack in this example combines Routes 2, 3, 4 and 5.

Option A, Volumetric Modular (Route 1). A local manufacturer delivering complete apartment modules with structure, facade, fit-out and services integrated in the factory. Comparable project completed in Queensland (16-storey, 190 apartments). NCC compliance pathway via Performance Solutions for structure and fire.

Option B, Kit of Parts hybrid stack (Routes 2, 3, 4, 5). A panelised structural system (kit of parts columns, beams and floor cassettes) with bathroom pods from a separate local supplier, multi-service risers prefabricated in New South Wales, and a unitised facade system. Four suppliers coordinated under a single project delivery agreement.

CRITERION	WEIGHT	OPTION A SCORE	OPTION A WEIGHTED	OPTION B SCORE	OPTION B WEIGHTED
Compliance and assurance	20%	3	**6.0**	4	**8.0**
Productivity	20%	4	**8.0**	3	**6.0**
Cost and commercial	20%	3	**6.0**	3	**6.0**
Quality and safety	15%	4	**6.0**	4	**6.0**
Sustainability	10%	4	**4.0**	3	**3.0**
Scalability and capacity	8%	3	**2.4**	4	**3.2**
Brand fit and local content	5%	4	**2.0**	4	**2.0**
Digital enablement	2%	3	**0.6**	3	**0.6**
Weighted total	100%		**35.0**		**34.8**

Reading the example. Option A leads by 0.2 weighted points (35.0 vs 34.8), but both options fall within the five-point tiebreaker band. The tiebreaker applies. Option B scores higher on Compliance (8.0 vs 6.0) because the Kit of Parts structural system has an established Deemed-to-Satisfy path for the primary structural system, while Option A requires Performance Solutions across structure and fire. Option A scores higher on Productivity (8.0 vs 6.0) because a single integrated module supplier reduces interface risk and delivers a higher Pre-Manufactured Value with fewer coordination dependencies. The tiebreaker favours Option B. Compliance certainty is the factor Mirvac cannot recover from once the programme is live. A failed performance solution stalls the project. A missed productivity uplift is recoverable.

This is the outcome the rubric is designed to surface. Where two options are commercially close, the decision rests on the one criterion that cannot be fixed mid-delivery.

Phase 2 application. Project Innovator will complete a scored rubric for each shortlisted option, populated from supplier submissions and Mirvac's BAU baseline data. Phase 1 scores above are illustrative only. All Phase 2 scores will be documented with named evidence against each criterion checklist item.

M

EVIDENCE REGISTER

Appendix M. Evidence register

Sources used across this report, verified against primary sources as part of the Rev 3.0 audit (Track E, May 2026).

Audit note, C-04 removed. The citation previously listed as C-04 (National Renewable Energy Laboratory, 2024, Modular Apartments Case Comparisons) does not exist in any form. No NREL report by that title or covering programme compression case comparisons across apartment projects is publicly available. NREL's modular construction research is focused on energy performance of single-unit test modules, not programme delivery data. The citation was fabricated by the tool used to draft the Phase 1 document. It has been removed from Rev 3.0. The claim it supported, that shorter schedules are more common where repetition and supply coordination align, is retained and is now attributed to McKinsey and Company (C-01), which directly supports this assertion.

ID	FULL REFERENCE	TYPE	KEY POINT USED IN THIS REPORT	SECTIONS
C-01	McKinsey and Company (2019). Modular Construction: From Projects to Products.	Report	Programme compression of 20 to 50 per cent documented; shorter schedules more common where plans repeat and supply is coordinated; cost savings stronger at scale.	Sections 1, 8; App K
C-02	Modular Building Institute (2024). Permanent Modular Construction Annual Report.	Industry report	Programme gains consistent; cost benefit mixed in early adoption; predictability improves with repetition. North American data.	Sections 1, 8
C-03	Australian Building Codes Board (2024). Prefabricated, Modular and Offsite Construction Handbook (NCC 2022). Published December 2024.	Handbook	NCC approvals pathways; performance solutions; evidence of suitability framework; first article approval.	Sections 7, 8, 9; App K
C-05	Farmer, M. (2016). Modernise or Die: Time to Decide the Industry's Future. Construction Leadership Council (UK). (Australian relevance confirmed in FuturePlace interview, public domain.)	Industry review	Structural diagnosis of construction sector decline covering workforce atrophy, low productivity growth, and absence of innovation investment. Farmer confirmed the same diagnosis applied to Australia. Foundation for the productivity argument in Sections 2 and 4.	Sections 2, 4
C-06	Mirvac Group (2021 to 2025). Net Positive Carbon programme and commitments.	Corporate	Scope language; Net Positive Scope 1 and 2 achieved FY2022; Scope 3 drivers.	Sections 9, 10; App H
C-07	Mirvac Group (2025). Scope 3 approach and targets (overview).	Corporate brief	Scope 3 drivers covering embodied carbon, logistics, resident energy, and waste. Net Positive Scope 3 target by 2030.	Sections 9, 10; App H
C-08	Australian Securities and Investments Commission (2024). Insolvency statistics: Companies entering external administration, Q1 2024.	Government statistics	Construction accounts for 27 per cent of all Australian corporate insolvencies; sector represents approximately 8 per cent of GDP. Over 3,500 construction companies entered external administration in the most recent quarter, the highest rate in a decade.	Section 2
C-10	FMI and PlanGrid (2018). Construction Disconnected, ANZ Edition. Sample n equals 80 Australia and New Zealand construction professionals.	Industry survey	Construction professionals in Australia and New Zealand spend 33 per cent of their working week (11.5 hours) on non-productive activities. Forty-eight per cent of all rework is caused by poor data and miscommunication, not poor workmanship. Global sample n equals 599.	Section 2
C-12	Productivity Commission (2025). Building more homes: Opportunities and challenges in residential construction productivity. February 2025.	Government report	Residential physical productivity declined approximately 53 per cent over 30 years; half as many homes per hour worked as in 1995.	Sections 2, 4
C-17	Master Builders Australia (2023). National Forecasts 2023.	Industry report	Mid-tier and residential builder net margins sit at 1 to 3 per cent. Context for the financial pressure driving MMC adoption.	Section 2
C-18	KPMG International (2023). Global Construction Survey 2023.	Global survey	Fewer than half of all construction projects globally are delivered on time. Baseline for the programme performance argument.	Section 2
C-19	Lean Construction Institute (2024). Meta-analysis of 255 projects implementing the Last Planner System.	Research meta-analysis	Last Planner System reduces schedule overrun from 28 per cent average to 9 per cent on implementing projects. Supports the Lean Construction pillar productivity claim in Section 4.	Section 4

ID	FULL REFERENCE	TYPE	KEY POINT USED IN THIS REPORT	SECTIONS
C-20	Dodge Data and Analytics and Lean Construction Institute (2025). SmartMarket Report: Lean Construction 2025.	Industry survey	Seventy-three per cent of lean-engaged contractors complete projects under budget, versus 30 per cent of non-lean contractors. A 2.4-times difference on the single metric that determines project margin.	Section 4
C-21	Mirvac Group and Australian Retirement Trust (2023 to 2025). LIV Mirvac Fund Build to Rent capital events. mirvac.com, June 2023; realassets.ipe.com, December 2025.	Corporate announcement	Mirvac established a 1.8 billion dollar Build to Rent venture June 2023. Australian Retirement Trust acquired a 48.5 per cent interest in the LIV Mirvac Fund (1.7 billion dollar platform) December 2025. Active pipeline approximately 1.2 billion dollars.	Section 7
C-22	Pafburn Pty Ltd v The Owners, Strata Plan No 97664 [2023] HCA 38. High Court of Australia, 8 November 2023.	Case law	Removed proportionate liability protection for builders under the Design and Building Practitioners Act where non-compliant cladding is installed. Full liability for remediation applies. Documentation requirements for cladding compliance are materially more critical as a result.	Section 5
C-23	Strongbuild and BlueCHP (2017). MacArthur Gardens, Campbelltown, New South Wales. Project documentation, public domain.	Project documentation	Three Cross Laminated Timber towers, six to eight storeys, 101 apartments delivered under $300,000 per apartment in 2017 dollars, zero injuries recorded. Only publicly confirmed per-apartment cost metric in the Australian apartment MMC evidence set.	Sections 5, 9, 10; App B
C-24	The Fifth Estate (2017). 'Australia's largest residential timber building is an affordable housing project.' thefifthestate.com.au, 28 November 2017.	Trade media	MacArthur Gardens CLT structure completed in just over six months; 60 per cent on-site waste reduction recorded. Cost at under $300,000 per apartment confirmed independently of project documentation.	Appendix B
C-13	Cast Consultancy (2021). Pre-Manufactured Value as a Measure of Construction Innovation. March 2021.	Research report	Pre-Manufactured Value definition and methodology; higher Pre-Manufactured Value correlates with reduced site waste and embodied carbon variance.	Sections 9, 10; App G
C-14	Love, P.E.D. et al. (2018). Production Planning and Control, 29(13). Longitudinal study across 346 construction projects.	Journal article	Rework cost averaged 0.39 per cent of contract value; erased 28 per cent of project margin sustained across seven years.	Section 9; App G
C-15	Built Living and Wesfarmers (2026). ASX media release, 4 May 2026.	ASX announcement	Built Living and Wesfarmers partnership; capital allocation to Build to Rent and residential development platforms.	Section 7
C-09	To be populated in Phase 2. Factory and site quality assurance packs, material certificates, First Article Inspection records.	QA and ITP packs	Quality and traceability documentation by part identifier; first article approvals.	Section 7

N GLOSSARY

Appendix N. Glossary

Terms used in this report. Phase 1 terms refreshed and new Rev 3.0 terms added.

TERM	DEFINITION AS USED IN THIS REPORT
BAU	Business as Usual. The conventional in-situ construction method Mirvac currently uses for mid-rise residential. Concrete frame, site-built wet areas, and on-site services coordination. The baseline against which all MMC options are compared.
BCA	Building Code of Australia. The technical standards and performance requirements published by the Australian Building Codes Board and adopted as part of the National Construction Code. The BCA is Volume One (Class 2 to 9 buildings) and Volume Two (Class 1 and 10) of the NCC.
Build to Rent	A residential development model in which apartments are retained in single institutional ownership and rented rather than sold as individual lots. Returns to the investor come from rental income and capital growth. Programme compression from MMC has a direct financial value in Build to Rent because each week of earlier practical completion is a week of earlier income collection.
Built Living	The residential division of Built, the construction company. Built Living and Wesfarmers announced a partnership in May 2026 to expand into Build to Rent and residential development platforms. Cited in Section 7 as a signal of institutional capital commitment to the residential MMC sector.
CLT (Cross Laminated Timber)	An engineered mass timber panel product made from layers of solid sawn timber bonded with adhesive in alternating grain directions. Used for structural floors, walls and roofs. Stores biogenic carbon in the building fabric for the life of the structure. MacArthur Gardens, Campbelltown is the confirmed Australian apartment delivery reference.
DBP Act	Design and Building Practitioners Act 2020 (NSW). Requires registration of designers and building practitioners for Class 2 buildings. Imposes a statutory duty of care to subsequent owners of residential buildings. Relevant to MMC because an overseas factory delivering a complete structural module is, in effect, designing a structural building system, and the Act does not clearly cover that scenario.
Deemed-to-Satisfy (DtS)	A National Construction Code compliance pathway. A building element or system satisfies NCC requirements by conforming to a prescribed solution written into the code. Most conventional construction materials and methods have DtS pathways. Many MMC systems do not, because their configuration does not match the prescriptive solutions, requiring a Performance Solution instead.
DfMA	Design for Manufacture and Assembly. An engineering design discipline that optimises a product or building for factory production and site installation, rather than designing first and adapting for prefabrication later. DfMA requires design standardisation, interface discipline, and early supplier engagement. It is not a procurement strategy; it is a design methodology.
ECI	Early Contractor Involvement. A procurement model in which the head contractor is engaged during the design phase rather than at the completion of design documentation. ECI allows the builder to contribute buildability input, programme risk identification, and supply chain intelligence before the design is frozen. Critical for MMC because interface coordination between factory-supplied components must be resolved in design, not on site.
EPD	Environmental Product Declaration. A verified document quantifying the environmental impact of a product, prepared in accordance with ISO 14025 and the EN 15804 or relevant product category rules. EPDs are the primary data source for embodied carbon calculations on construction projects. EPD availability for Australian MMC suppliers is limited at the time of this report; a key Phase 2 data gap to be resolved before the embodied carbon comparison can be completed.
GLT (Glue Laminated Timber)	Glued laminated timber. An engineered timber product made from layers of solid sawn timber bonded with adhesive in parallel grain alignment. Used for beams and columns. Unlike CLT, GLT does not alternate grain direction. Combined with CLT floor panels in hybrid structural systems for mid-rise residential buildings above the practical height limit of pure mass timber structures.
GBA	Gross Building Area. The total floor area of a building measured to the external face of the enclosing walls, inclusive of all floors. Used as the denominator for the man-hours per m2 and embodied carbon per m2 measures in the productivity scaffold.
Hybrid Stack	The combination of MMC Routes 2, 3, 4 and 5 (Kit of Parts structural system, bathroom and kitchen pods, multi-service risers, panelised facade) under a single project delivery agreement. The hybrid stack is the primary recommendation pathway explored in this report for Mirvac's mid-rise residential programme. It allows progressive adoption with manageable compliance risk and supplier coordination complexity.
Innovation Road Map (IRM)	Project Innovator's consulting programme. A structured five-pillar assessment and implementation framework covering Leadership and Culture, Data Systems and Digital Integration, Lean Construction, Artificial Intelligence and Automation, and Modern Methods of Construction. Section 4 of this report applies the

TERM	DEFINITION AS USED IN THIS REPORT
	Innovation Road Map as the diagnostic frame for evaluating Mirvac's current position and readiness for MMC adoption.
Last Planner System	A production planning methodology developed by Glenn Ballard and Greg Howell and formalised through the Lean Construction Institute. It operates at four planning horizons. The master programme, the phase pull plan, the six-week lookahead, and the weekly work plan. The weekly work plan produces the Percent Plan Complete metric. The lookahead produces the Tasks Made Ready metric. The system measures reliable workflow rather than optimistic scheduling.
LIV Mirvac	Mirvac's Build to Rent platform, operating as the LIV Mirvac Fund. Australian Retirement Trust acquired a 48.5 per cent interest in the fund in December 2025. The LIV Mirvac pipeline represents the demand anchor for Mirvac's MMC investigation. Volume, repetition and early enclosure for rental income collection are the conditions that make MMC economically rational for the programme.
Manual Data Tax	The cost of manually re-entering, reconciling and correcting data that should flow automatically between connected systems. Defined in the Project Innovator Innovation Road Map programme as a directional indicator of the productivity loss caused by fragmented data systems. Measured as a model applied to headcount data; produces a directional figure, not a certified or audited number.
MiC	Manufacture in China (also used to mean Manufacture in Controlled environments in some contexts). As used in this report, MiC refers to the model of sourcing complete volumetric modules or structural assemblies from offshore factories, primarily in China, for delivery to Australian construction sites. MiC introduces traceability, DBP Act registration, and freight risk considerations that domestic manufacture does not.
MMC	Modern Methods of Construction. An umbrella term covering the range of offsite manufacturing and prefabrication approaches used in building construction, from individual prefabricated components through to complete volumetric modules. As used in this report, MMC refers specifically to the five routes assessed in Section 5 in the context of mid-rise residential apartment construction in Australia.
NCC	National Construction Code. Australia's primary set of technical construction requirements, maintained by the Australian Building Codes Board and adopted by each state and territory as law. The NCC includes the Building Code of Australia (Volumes 1 and 2) and the Plumbing Code of Australia. Most MMC systems require a Performance Solution pathway for compliance.
Percent Plan Complete (PPC)	The percentage of tasks committed in a weekly work planning session that were completed as planned by the end of that week. Industry average is 50 to 60 per cent. A well-run Last Planner System project targets 80 per cent or above at steady state. Low PPC is a leading indicator of programme overrun; the failure reasons recorded each week identify where management should intervene.
Performance Solution	A National Construction Code compliance pathway in which a building element or system demonstrates compliance with a Performance Requirement through calculation, testing, expert assessment or a combination. Performance Solutions are the standard compliance mechanism for MMC in Australia because most MMC system configurations do not match the prescriptive Deemed-to-Satisfy solutions written for conventional construction. Since NCC 2025, Performance Solutions for structure cannot rest on professional judgement alone; analysis and test evidence are required.
PMV (Pre-Manufactured Value)	In every dollar of construction contract value, the proportion that was manufactured in a controlled offsite environment before delivery to site. Developed by Cast Consultancy as a consistent measure for comparing offsite content across projects and methods. Used in this report as the primary financial lens for comparing how factory-heavy each MMC option is. Higher PMV correlates with lower site waste and lower embodied carbon variance.
Takt Planning	A production scheduling methodology derived from manufacturing that sets a fixed rhythm (takt time) for repeating work zones on a building project. Each trade completes its assigned zone within the takt period before moving to the next zone. When combined with the Last Planner System, takt planning eliminates the trade stacking and waiting time that account for a significant portion of non-productive site hours.
Tasks Made Ready (TMR)	The percentage of upcoming tasks in the three to six week lookahead window that had every prerequisite cleared before the execution week arrived. Prerequisites include drawings issued, materials on site, preceding trade complete, access confirmed, and equipment booked. Research confirms Tasks Made Ready is a stronger predictor of final project duration than Percent Plan Complete alone, because it catches constraint failures before they reach the work face.

DOCUMENT

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