Office of Regional Architecture

CASE STUDY 2

Bruce Rock Supermarket and Hardware

Embodied carbon calculation, modules A1–A5

Tuan Ngo, Director · October 2026



The entry and checkouts: high-level windows over the trading floor, polished concrete slab, MDF groove-board bulkhead. Photo: Natalie Davy Photography.

Summary

The Bruce Rock Supermarket and Hardware, completed in 2023, carries an upfront embodied carbon (modules A1–A5) of about **785 tCO2e, or 630 kgCO2e/m²** of gross floor area. That figure covers the building only, including a standard allowance for building services. Store fitout adds about 51 kgCO2e/m², and the asphalt yard and plant slabs about 5 kgCO2e/m².

This is ORA's second embodied carbon case study, and its first of a completed new building. The project was designed and built before ORA adopted its Sustainability Action Plan (SAP), so no carbon targets shaped its design. That makes it an honest baseline: it shows what a typical ORA regional commercial building emits when carbon is not considered, and it tells us where to act next time.

Three findings stand out:

- **Structure and concrete dominate.** Steel, concrete and reinforcement are about 60% of the building total. Structural steel alone is 252 tCO2e.
- **Aluminium is a hidden hotspot.** The roof plant deck, roof walkways, window frames and skirting add up to about 64 tCO2e (8%), more than the whole roof.
- **Data quality changes the answer.** Our first estimate, built from the cost plan, was 821 kgCO2e/m². Fabricator shop drawings brought it to 630. Early, element-based quantities are the single biggest improvement ORA can make to its carbon work.

The project

The Shire of Bruce Rock built a new Shire-owned supermarket and hardware store at 52 & 52A Johnson Street, Bruce Rock, in the eastern Wheatbelt. ORA designed it and administered the construction contract (ORA job 2020-0011).

Item	Detail
Client	Shire of Bruce Rock
Builder	Devlyn Australia Pty Ltd
Gross floor area	About 1,245 m² enclosed (41.7 × 29.9 m), plus a 232 m² rear yard
Pre-tender estimate	$4,292,000 construction cost, $3,459/m² (Rawlinsons, April 2022)
Construction	Issued for construction August 2022; built 2022–23
Structure	18 tilt-up concrete panels (150 mm, 40 MPa) on strip footings; steel trusses and rafters; 125 mm slab on ground
Envelope	Lysaght Spandek roof; Cemintel Barestone and Express Panel façade on a steel frame; Capral aluminium shopfront glazing
Inside	Trading floor, hardware, back of house, three coolrooms (one freezer), office, staff room, amenities
Key consultants and suppliers	Fulcrum Structural Engineering; AES (steel and precast shop drawings); AJ Baker (refrigeration); LGA-WA (windows); Lane Industries (store fitout)

The building is a typical regional retail shed: large spans, a high roof to the trading floor and a deep awning to the street. Those features drive most of its carbon.

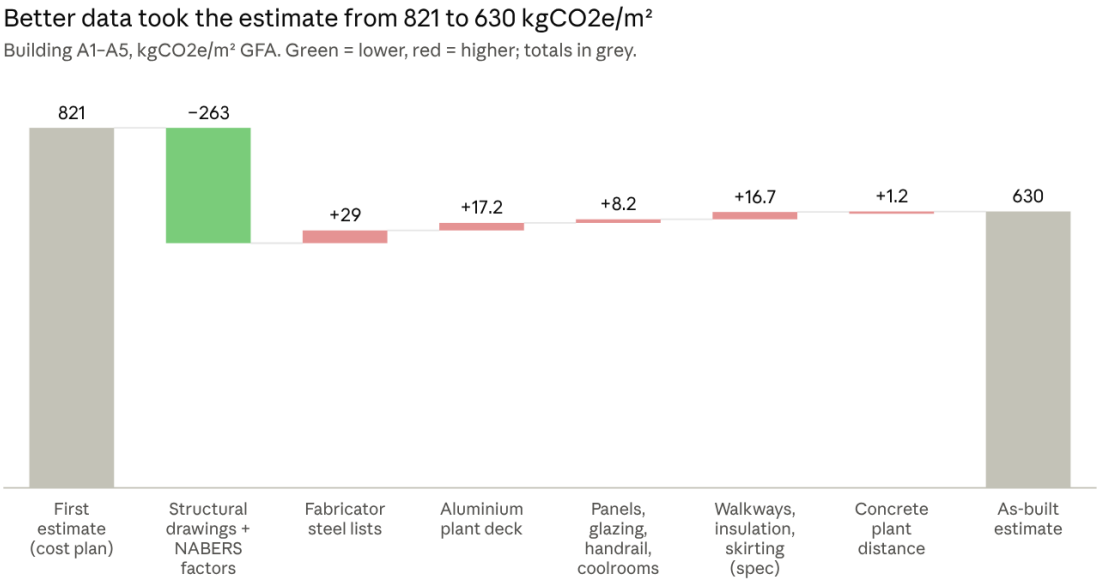
Method

We followed the same method as the Narembeen case study, updated to the NABERS Embodied Carbon framework, so the two studies and future ORA projects can be compared.

- **Scope.** Upfront carbon to EN 15978: materials (A1–A3), transport to site (A4) and construction (A5). Use, maintenance and end of life are excluded.
- **Quantities.** Taken from the as-built record wherever it existed: AES steel material lists and precast panel shop drawings, LGA-WA window shop drawings, the Safemaster plant deck drawing, the Moddex handrail drawing and the AJ Baker refrigeration layout (Rev C.03). The rest came from ORA's IFC drawings, the Fulcrum structural drawings and the IFC Materials and Finishes Schedule and Specification.
- **Emission factors.** NABERS National Emission Factors database v1.0, using its default (uncertainty-adjusted) values where the exact product is unknown. The BlueScope Colorbond EPD was used for roof and wall sheeting, as in Narembeen. EPiC 2024 filled two gaps (the slab membrane and the foil roof insulation).
- **Transport (A4).** 16 t truck from WCS Concrete's Kellerberrin plant (about 60 km) for concrete; Perth to site (about 245 km) for local products; rail or truck from the eastern states and shipping for imported steel, glass and aluminium.
- **Construction (A5).** GBCA/thinkstep-anz non-residential ratios interpolated to 2023: site activity 17.2% and waste 1.5% of A1–A3.
- **Building services.** The NABERS rate for low-rise offices and commercial buildings (67 kgCO2e/m²). NABERS requires a rate, not an item take-off, and has no retail rate.
- **Reported separately.** Store fitout (shelving, counters, desks, kitchen) and external works (yard asphalt, plant slabs). Refrigeration equipment, rooftop PV (installed by the Shire outside the contract) and loose items are excluded.
- **Timber storage.** Carbon stored in timber products is not netted off, in line with NABERS.

How the estimate changed as better data arrived

The estimate fell by almost a quarter once real quantities replaced cost-plan assumptions, and the steel tonnage did most of the work.

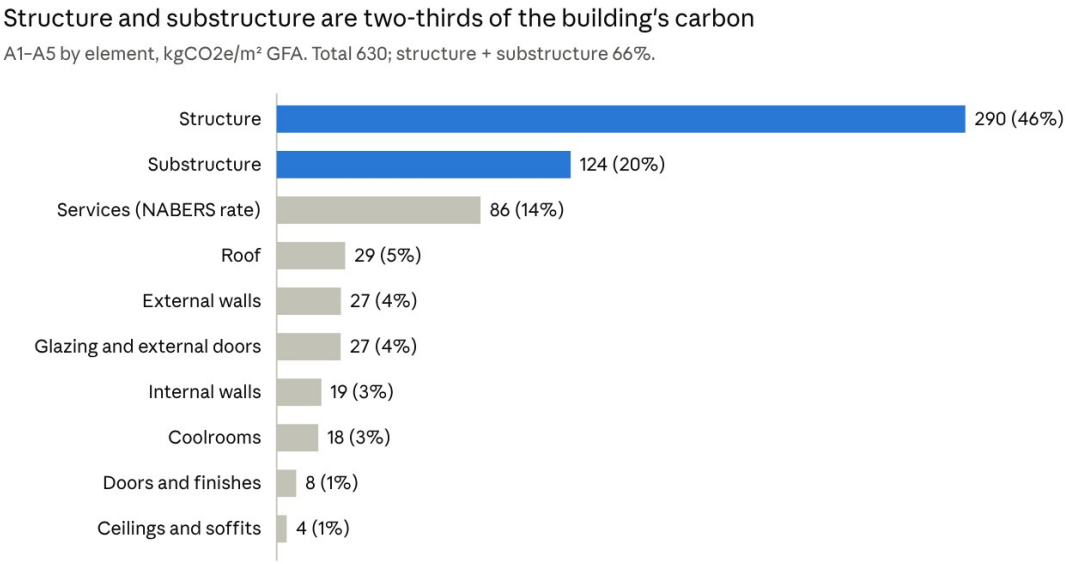


ORA Bruce Rock embodied carbon workbook, successive versions, October 2026

The first pass converted the QS's $807,000 structural steel line into tonnes at an assumed $8,000 per tonne, giving 101 t. Taking the steel off the structural drawings gave 43 t; the fabricator's lists gave 48.9 t, about 39 kg/m². Later documents mostly added items the drawings did not show, such as the aluminium plant deck, roof walkways and skirting. The lesson: a cost plan is not a quantity survey, and the order in which information arrives shapes the answer.

Results and hotspots

The building's upfront carbon is 785 tCO2e (630 kgCO2e/m²): materials 628 t, transport 39 t and construction 118 t.



ORA Bruce Rock embodied carbon workbook, Summary sheet, October 2026

The largest single items, in tCO2e (A1–A5):

Item	tCO2e	Share of building
Hot-rolled structural steel incl. plates (35.6 t)	181	23%
Building services (NABERS rate)	107	14%
Ground slab, 125 mm, 32 MPa	91	12%
Cold-formed purlins, girts, bridging (13.3 t)	71	9%
Tilt-up panels, 82 m³, 40 MPa	57	7%
Slab mesh SL92	31	4%
Roof sheeting (Spandek)	25	3%
Aluminium plant deck (650 kg)	23	3%

Steel stands out because its factor is high (about 4.1 kgCO2e/kg) and a long-span supermarket roof needs a lot of it: about 39 kg per m² of floor.



Produce area: the exposed steel rafters and purlins, the largest source of the building's carbon, above birch plywood produce bins. Photo: Natalie Davy Photography.

Fitout and external works

Fitout adds about 63 tCO2e (51 kgCO2e/m²) on top of the building. Almost all of it is the steel in the store shelving. NABERS excludes fixtures and fittings, so we report fitout separately; with it, Bruce Rock comes to about 681 kgCO2e/m², the closer comparison with Narembeen, which counted its furniture.

Item	tCO2e (A1–A5)	Basis
Qshelf shelving: 1,235 flat metal and wire shelves	35.1	Counted from the Lane Industries quote; 5 kg per shelf assumed
Qshelf uprights, perforated back panels, bases	26.1	230 bay faces; 20 kg per face assumed from site photos
Checkouts, help desk, office desks, staff kitchen	1.8	Particleboard and plywood; areas from the quote and drawing A6.20
Birch ply trims to shelving ends	0.4	Assumed area
Yard asphalt and plant slabs (external works)	6.3	211 m² asphalt; concrete only under the generator, switchboard, condensers and baler

The shelving weights are assumptions. Each kilogram per shelf moves the fitout by about 5 kgCO2e/m², so supplier weights would firm this up quickly. The footpath reused the existing brick pavers, which carry close to zero upfront carbon.



Hardware help desk (particleboard) with Qshelf steel shelving beyond. Photo: Natalie Davy Photography.

How Bruce Rock compares

Bruce Rock sits about where a typical new commercial building designed around 2020 would. There is no published Australian benchmark for supermarkets yet: supermarkets can be star-rated under NABERS Embodied Carbon, but the star thresholds sit inside its calculator and are not published.

Benchmark	kgCO2e/m²	Scope
Bruce Rock, NABERS default factors	630	A1–A5, building incl. services
Bruce Rock, NABERS average factors (rough re-run)	about 430	Same quantities
LETI commercial, 2020 target (UK)	600	A1–A5, incl. services and fitout
LETI commercial, 2030 target (UK)	350	A1–A5, incl. services and fitout
INDICATE, mean of 46 new buildings (Ireland)	546	A1–A5; services often missing
INDICATE, warehouses (3 buildings)	437	A1–A5

The method matters as much as the building. NABERS default factors include an uncertainty margin: the default for 32 MPa concrete is 468 kgCO2e/m³ against an average of 249. Re-running the same quantities with average factors gives about 430 kgCO2e/m². Most published studies use average or product-specific data, so the fair comparison sits between 430 and 630.

The RIBA 2030 Climate Challenge targets (under 650 by 2025, under 500 by 2030) cover the whole life cycle, A to C, so they are not directly comparable.

Narembeen (209 kgCO2e/m²) is not a fair comparison either: it was a refurbishment that kept its existing structure.

What we would do differently

The biggest realistic saving for a building like this is low-carbon concrete, not a change of structural system. We tested three options against the as-built result.

Option	Change in tCO2e	Change in kgCO2e/m²	Practicality in the Wheatbelt
Low-carbon concrete in slab, footings and panels (30% below the NABERS default)	about −51	about −41	Same design and trades; depends on what the batching plant can supply
Shorter roof spans: internal columns halving the ~19 m lower-roof span	Not yet quantified	Not yet quantified	Needs structural engineer input; columns must suit the trading floor layout
Lightweight timber-framed external walls instead of tilt-up	about −22 to −30	about −17 to −24	Needs extra steel for wind and bracing, cladding, and a fire-rated system on the boundary wall
Smaller building	about −63 per 100 m² removed	Little change	A brief and client decision, tested early
Mass timber roof structure instead of steel	Not costed	Not costed	Mass timber is expensive in WA and hard to substitute for steel trusses

Low-carbon concrete. Concrete is about 172 tCO2e (138 kgCO2e/m²) across the slab, footings and panels. Mixes with high cement replacement (fly ash or slag), backed by a supplier EPD, could plausibly cut that by around 30%, without changing the design or the builder's methods. The concrete came from WCS Concrete's Kellerberrin plant. We found no published EPD for its mixes, so the first step on the next Wheatbelt project is to ask the plant what it can batch and document.

Lightweight walls. Replacing the 548 m² of tilt-up with a timber-framed wall removes about 77 tCO2e of panels and their lining. Most of that comes back as about 3 t of extra steel columns and bracing, fibre cement cladding on top hats, and fire-rated plasterboard on the north wall, which sits against the neighbouring shop. The net saving is about 22 tCO2e, or about 30 tCO2e if no fire layers are needed. The LVL would also store about 10 tCO2e, reported separately. The gain is real but modest, and it needs an NCC check of the fire-rated wall system first.

Mass timber and the slab. Mass timber framing is costly in WA and rarely a straight swap for steel trusses. A slab on ground has no practical alternative to concrete, so the lever there is the concrete mix, not the material.

Shorter spans. The lower roof spans about 19 m between grids A and B on five steel trusses (250 PFC chords). In our drawing take-off those trusses are about 8 t of steel, roughly 40 tCO2e. Halving the span, with internal columns in the supermarket floor and within the bulk goods hardware wall, would let the trusses be much lighter: bending moment rises with the square of the span, so at the same 750 mm depth, half the span means

roughly a quarter of the chord force. Minimum practical sections and connections limit how much of that shows up as saved steel. A 2025 comparative study by Perrucci and Trabucco is a useful caution: long-span timber frames came out about 29% worse per m² than short-span ones, but its long-span steel joist roof was about 30% better per m², with fewer columns for the floor area covered. Some of the saving goes back into new columns and pad footings, and the columns must work with the shelving layout, so a structural engineer needs to size it before we can put a number on it.

A smaller building. The least carbon is in the floor area not built. At Bruce Rock's average, every 100 m² removed saves about 63 tCO2e. This barely moves the kgCO2e/m² figure, which is why ORA should track total tCO2e as well as intensity: a tighter brief is a real saving even when the rate per m² stays the same. Intensity alone can mislead: a 120 m² house for four people at 630 kgCO2e/m² is about 19 tCO2e per person, while a 500 m² house for two at an efficient 400 kgCO2e/m² is about 100 tCO2e per person (illustrative figures). The building that does the job with less floor area is the more sustainable one. Building to the minimum area the community needs also saves operational energy and capital cost, which regional councils rarely have to spare: at the pre-tender rate of $3,459/m², every 100 m² not built was about $346,000 in 2022 prices. A practical way to set that minimum is to compare similar supermarkets in surrounding towns, their floor areas and the catchment populations they serve.

Design to the population trend, not the peak. Many Wheatbelt towns have shrunk as farming became more productive while employing fewer people; nine of Australia's ten largest percentage population declines in one comparison were in rural WA, mostly the Wheatbelt (.id). A building sized for growth that does not come stays partly empty but is heated, cooled and maintained in full. Bruce Rock itself has held steady recently: the Shire had 930 residents in 2016 and 979 in 2021, with a median age of 48 (ABS 2016, ABS 2021). Forecasts for the region expect most smaller Wheatbelt areas to grow very little or decline, and to age (.id forecast). Briefs for community buildings should be tested against the Shire's and the surrounding Shires' population trend and age profile, not only today's demand.

Using both of the first two options would bring a building like this from about 630 to about 570 kgCO2e/m² under the conservative NABERS method. Product EPDs in place of defaults would take it below 500.

Other observations

- **Aluminium adds up quietly.** Aluminium carries about 30 kgCO2e per kg, roughly seven times steel. The 650 kg plant deck (23 tCO2e), about 60 m of roof walkway (15 tCO2e), the window and door frames (about 22 tCO2e) and 300 m of aluminium skirting (3.5 tCO2e) total about 64 tCO2e. A steel walkway, a lighter deck or a powder-coated steel skirting are easy wins at design stage.
- **Refrigerants matter more than the cases.** The Bonnet Névé quote lists R404a for the remote freezer cases and R134a for the dairy cases; the plug-in cases use R290. R404a has a global warming potential of about 3,900 times CO2. Leakage is an operational (B1) emission, outside this study, but a modest annual leak could exceed several tonnes of CO2e a year. A natural refrigerant requirement belongs in the brief.
- **Changes during construction change the carbon.** The composite timber battens in the schedule became MDF groove boards; the coolroom panels are 100 mm in the schedule but 75 mm in the refrigeration drawings. As-built records, not design documents, are what count.
- **Not everything was in the contract.** The rooftop PV was installed by the Shire outside the building contract, so it is not counted here, although the walkway that serves it is.
- **Reuse works.** The footpath relaid the existing brick pavers, a simple reuse with almost no upfront carbon.

- **Services are a blunt instrument.** At 86 kgCO2e/m² (14%), services are the third-largest item, but NABERS only allows a standard rate per m². A supermarket's refrigeration pipework and larger switchboards probably push the real figure higher.



Frozen food: refrigerated cases and plant are equipment, outside this study, but their refrigerants are a significant operational emission. Photo: Natalie Davy Photography.

Lessons for ORA's Sustainability Action Plan

Bruce Rock sets ORA's new-build baseline for goal G3 (project embodied carbon) at 630 kgCO2e/m², calculated by the NABERS method. SAP 2.0 sets the 2030 target at 40% below baseline, in line with WorldGBC (about 380 kgCO2e/m² for a building like this), with interim steps of −15% and −25%, and net zero embodied carbon by 2050 through reduction first and certified offsets for the residual. These are the changes it points to:

1. **Right-size the brief first.** Live within our means: establish the minimum floor area the community actually needs, benchmarked against comparable buildings, the catchment they serve and the population trend of the Shire and its neighbours, and design to that. It is the one decision that cuts embodied carbon, operational energy and cost at the same time.
2. **Ask for element quantities early.** Request an elemental bill of quantities from the QS at design development (concrete m³ by grade, steel tonnes, cladding m²), not only a trade cost plan. A cost line cannot be turned reliably into tonnes.
3. **Run a first carbon estimate at schematic design,** when the structural system and envelope can still change, and update it at tender. Test structural spans and floor area with the engineer and client at this stage, while internal columns and a tighter brief are still options.
4. **Specify low-carbon concrete** with a supplier EPD, and check what the nearest regional batching plant can supply before documenting it.
5. **Watch aluminium.** Challenge aluminium roof platforms, walkways and trims; use steel or timber where they do the same job.

6. **Ask for product data with shop drawings.** Add a clause requiring weights and EPDs (or product data sheets) with steel, precast, window, roof access and fitout submittals.
7. **Brief natural refrigerants** for supermarket and coolroom projects, and record what is charged at handover.
8. **Keep the as-built record.** Concrete dockets, fabricator lists and approved RFAs are the data a final calculation needs; collect them at practical completion.
9. **Report two figures:** the building (NABERS scope) and building plus fitout, so ORA projects stay comparable with each other and with NABERS ratings. Track total tCO2e and carbon per unit of use (per occupant, bed, student or user served) as well as kgCO2e/m², so that a smaller, well-used building counts as the saving it is.

Limitations and next steps

The building figure is now mostly based on shop drawings, but several inputs are still estimates:

- **Concrete:** slab and footing volumes are taken from the structural drawings, not delivery dockets. The slab grade is ambiguous (25 MPa in the drawing legend, 32 MPa in the notes; 32 MPa used).
- **Services:** a standard NABERS rate, not a take-off.
- **Assumed weights:** Spandek sheet thickness, window frame weights (2 kg/m), roof walkway (7 kg/m), skirting length, and the shelving.
- **Transport distances:** approximate road distances.
- **Steel:** within about ±10% of the fabricator lists, which moves the result between 610 and 650 kgCO2e/m².

Next steps:

- ☐ Enter the quantities in the NABERS Embodied Carbon calculator for an indicative star rating against market-average supermarkets
- ☐ Ask Lane Industries for shelf and bay weights, and Saferight for the walkway weight
- ☐ Ask WCS Concrete what low-carbon mixes and documentation it can provide
- ☐ Repeat the study for the Kondinin pavilion using the same workbook
- ☐ Add the 630 kgCO2e/m² baseline to SAP goal G3 (done in SAP 2.0, October 2026)

References and data sources

Project records

- ORA, Bruce Rock Supermarket IFC architectural drawings, Materials and Finishes Schedule and Specification (job 2020-0011, 2022–23)
- Fulcrum Structural Engineering, structural drawings 21214 S1.01–S5.04 (August 2022)
- AES, steel material, coldform and bridging lists (November 2022); precast panel shop drawings and register (Rev A, Nov 2022; register Rev 3, Jan 2023)
- LGA-WA, window and door shop drawings LGA-046 Rev B (February 2023)
- Safemaster, mechanical plant deck drawing SM 20356 (January 2023); Moddex trolley bay handrail drawing 15303 (March 2023)
- AJ Baker, refrigeration layout Rev C.03 (June 2023); Bonnet Névé case quote QD22-0073E (April 2022)
- Lane Industries, supermarket furniture tender quote (January 2023)
- Rawlinsons (WA), Pre-Tender Estimate 6.01 (April 2022)
- ORA, Bruce Rock embodied carbon workbook (October 2026)

Methods and factors

- NABERS, National Emission Factors database v1.0 and Embodied Carbon – The Rules v1.0; The Rules v2.1
- Crawford, Stephan and Prideaux, EPiC Database 2024, University of Melbourne
- GBCA and thinkstep-anz, Embodied Carbon and Embodied Energy in Australia's Buildings (2021), Table 7
- EN 15978, Sustainability of construction works – Assessment of environmental performance of buildings
- Perrucci, G. and Trabucco, D. (2025), Exploring the Impact of Span Length on Environmental Performance: A Comparative Study, Sustainability 17(9), 4183

Benchmarks

- IStructE, Setting carbon targets: the proposed SCORS rating scheme (LETI targets)
- Irish Green Building Council, INDICATE technical report (2025)
- RIBA 2030 Climate Challenge
- Shire of Kellerberrin business directory: WCS Concrete
- ORA, Case Study 1 – Narembeen Administration Office Refurbishment, Version 2 (October 2026)

Bruce Rock Supermarket & Hardware: embodied carbon baseline (A1-A5) - ORA Case Study 2

ORA job 2020-0011. 52 & 52A Johnson St, Bruce Rock. As constructed 2022-23. Calculated October 2026 from IFC drawings, QS PTE 6.01 (Rawlinsons, 6 Apr 2022) and the refrigeration layout. Method and factors as the Narembeen case study (GBCA/thinkstep-anz A5 split, non-residential). Emission factors: NABERS National Emission Factors database v1.0 defaults (uncertainty adjusted) unless the product is known; see column S on the A1-A5 sheet.

Quantities from the structural (Fulcrum 21214) and architectural IFC drawings; steel from the AES fabricator material lists (Nov 2022). Remaining assumptions are marked Assumed on the A1-A5 sheet. Status: final for Case Study 2 (October 2026) and the SAP 2.0 G3 new-build baseline. Yellow cells on the A1-A5 sheet are assumed values.

Element group	A1-A3 kgCO2e	A4 kgCO2e	A5 kgCO2e	A1-A5 kgCO2e	% of total	kgCO2e/m2 GFA
Substructure	122,833	7,986	23,057	153,877	19.6%	124
Structure	290,626	15,250	54,555	360,430	45.9%	290
Roof	29,046	1,357	5,452	35,855	4.6%	29
External walls	25,551	3,254	4,796	33,601	4.3%	27
Glazing	27,715	577	5,202	33,494	4.3%	27
Internal walls	18,250	1,776	3,426	23,453	3.0%	19
Coolrooms	18,230	163	3,422	21,815	2.8%	18
Ceilings	3,894	604	731	5,228	0.7%	4
Finishes	7,956	728	1,493	10,177	1.3%	8
Services	83,415	7,661	15,658	106,734	13.6%	86
TOTAL BUILDING	**627,515**	**39,357**	**117,793**	**784,665**	**100.0%**	**630**
External works (yard asphalt, plant slabs), separate	4,313	1,170	810	6,293		5
Fitout: shelving, counters, desks (assumed masses), separate	50,144	3,898	9,413	63,455		51
Building + fitout (closer to Narembeen, which included furniture)				**848,119**		**681**
Check: equals A1-A5 sheet total	0					
GFA (m2)	1,245.00					
Upfront carbon A1-A5, building (kgCO2e/m2)	630					
Total, building (tCO2e)	784.7					
Structural steel, all types (tonnes)	48.9					
Narembeen Administration Office refurbishment (A1-A5, revised 2026), f	209					

Sensitivity: steel +/-10% (shop drawing lists are close to as-built)

Steel factor	A1-A5 kgCO2e/m2
90%	610
100%	630
110%	650

Not counted (see A1-A5 sheet): pallet racking, coolroom racking, refrigerated display cases and condensing units, promo bins and produce displays, gates, kerbs and landscaping. PV was Shire works, outside the contract. External works and the fitout (shelving, checkouts, help desk, desks, staff kitchen) are shown separately. Narembeen used product EPDs for some materials and netted timber carbon storage, so the two results are not like-for-like.

Remaining uncertainties (would refine, not overturn, the baseline)

1. Concrete delivery dockets (as-built m3 by grade); steel now from the AES fabricator lists
2. Spandek BMT (profile now known from the Finishes Schedule)
3. Perth distance (A4); concrete from WCS Concrete, Kellerberrin (~60 km)
4. Roof walkway length and weight; skirting length
5. Plant slab sizes and thickness; yard asphalt thickness
6. Slab concrete grade: S1.01 legend says 25 MPa, S1.02 table says 32 MPa (32 used)
7. Shelving: Lane Industries shelf and bay weights

SAP 2.0 goal G3 targets against this baseline

FY2027/28: -15% (kgCO2e/m2)	536
FY2028/29: -25% (kgCO2e/m2)	473
2030: -40%, in line with WorldGBC (kgCO2e/m2)	378
2050: net zero embodied carbon - reduce first, then certified offsets for the residual	

Carbon per use (see Case Study 2, "A smaller building")

Saving per 100 m2 not built (tCO2e)	63
Shire of Bruce Rock residents (ABS Census 2021)	979
Building tCO2e per Shire resident (indicative: the catchment is wider thai	0.80

Bruce Rock Supermarket & Hardware: upfront embodied carbon A1-A5 (as built, historical baseline). ORA job 2020-0011. Prepared October 2026. Quantities from architectural and structural IFC drawings; see Status column.

Element / material	Number	Linear m	Area (m2)	Volume (m3)	Weight (kg)	A1-A3 ECF kgCO2e/unit	A1-A3 kgCO2e	A1-A3 kgCO2e per unit qty	A4 ECF kgCO2e/kg	A4 kgCO2e	A5a (2023) 17.24% of A1-A3	A5w (2023) 1.53% of A1-A3	Total A1-A5 kgCO2e	Status	Source / assumption	Element group	Emission factor source
SUBSTRUCTURE																	
Ground slab 125mm, 32 MPa			1,245.00	155.63	373,500.00	0.20	72,832.50	58.50	0.01	4,840.56	12,558.60	1,113.10	91,344.76	Measured	S1.01 legend: min. 125 thick slab on 0.2mm membrane, SL92 top. S1.02 concrete table: slabs on ground 32 MPa (legend says 25 MPa: 32 used, conservative). GFA 1,245 m2.	Substructure	NABERS NEF v1.0 default
ST1 load-bearing slab thickenings 500 x 250 (poured with slab)		60.30		7.54	18,090.00	0.20	3,527.55	58.50	0.01	234.45	608.26	53.91	4,424.17	Estimated	S3.01/S5.01: grid B (~41.7 m) and grid 4 A-B (~18.6 m). Full section counted (conservative).	Substructure	NABERS NEF v1.0 default
SF1 strip footings 550 x 300, 25 MPa		143.11		23.61	56,671.56	0.17	9,350.81	65.34	0.01	734.46	1,612.37	142.91	11,840.55	Measured	S1.01 footing schedule; S3.01 under perimeter panels, 2 x (41.675 + 29.88) m.	Substructure	NABERS NEF v1.0 default
Pad footings PF1-PF5, 25 MPa				11.95	28,675.80	0.17	4,731.51		0.01	371.64	815.86	72.31	5,991.32	Measured	S1.01/S3.01: PF1 1 x 2.0x2.0x1.5; PF2 2 x 1.5x1.5x0.8; PF3 11 x 0.55x0.55x0.3; PF4 9 x 0.5x0.5x0.45; PF5 1 x 0.75x0.75x0.6.	Substructure	NABERS NEF v1.0 default
Freezer room wear slab, 80mm topping 32 MPa (set-down 230mm)			24.01	1.92	4,609.44	0.20	898.84	37.44	0.01	59.74	154.99	13.74	1,127.30	Measured	AJ Baker refrigeration layout Rev C.03 For Construction (23/06/2023): freezer room 4,950 x 4,850, 80mm 32 MPa topping on F72 mesh.	Substructure	NABERS NEF v1.0 default
Slab mesh SL92 top (4.99 kg/m2 + 10% laps)			1,245.00		6,833.81	3.65	24,943.39	20.03	0.21	1,440.94	4,301.02	381.21	31,066.55	Measured	S1.01 legend. SL92 = 9mm bars at 200 each way.	Substructure	NABERS NEF v1.0 default
Footing reinforcement: SF1 5-L12TM, ST1 trench mesh, pad bars					1,384.75	3.65	5,054.33		0.21	291.98	871.53	77.25	6,295.08	Estimated	S1.01: SF1 5-L12TM (~4.7 kg/m +10%); ST1 3-L12TM assumed; PF1 N24/N20 @275, PF2 N20/N16 @300, PF3 N16 @250, PF4/5 SL81 (~470 kg total).	Substructure	NABERS NEF v1.0 default
Waterproof membrane 0.2mm polyethylene under slab			1,245.00		236.55	1.20	1,494.00	1.20	0.05	12.52	257.61	22.83	1,786.96	Measured	S1.01 legend. 1.2 kgCO2e/m2 for 200 micron HDPE film (EPiC 2024); mass 0.19 kg/m2.	Substructure	EPiC Database 2024
STRUCTURE																	
Tilt-up concrete panels 150mm, 40 MPa (18 panels P01-01 to P01-18)			547.73	82.16	197,176.80	0.23	45,745.02	83.52	0.01	2,555.41	7,887.87	699.12	56,887.42	Measured	AES precast shop drawings AES201109-PC Rev A (26/11/2022, for approval): sum of 18 panel sheets = 547.7 m2 net, 82.16 m3 (2,400 kg/m3). Panel sheets and S1.02 say 40 MPa; the AES GA sheet says 50 MPa (40 used; 50 MPa would add ~7 tCO2e). The IFC register DL-001 Rev 3 (12/1/2023) lists the panels at Rev 2 (P01-06 Rev 3); revised quantities not seen.	Structure	NABERS NEF v1.0 default
Panel reinforcement: SL82 central mesh + N16 bars (bar schedules)			547.73		2,896.90	3.65	10,573.67	19.30	0.21	610.82	1,823.23	161.60	13,169.32	Measured	AES reinforcement drawings P01-xx-2: N16 bars from bar bending schedules = 752 kg; SL82 central over 547.7 m2 (3.56 kg/m2 + 10% laps).	Structure	NABERS NEF v1.0 default
Structural steel, hot-rolled, incl. plates and fixings (fabricator list)					35,615.01	4.09	145,665.39		0.21	7,509.57	25,117.27	2,226.21	180,518.44	Measured	AES shop drawing Steel Material List ML-001 Rev B (Nov 2022), gross weight, less CC150 cold-formed. Galvanised factor used throughout (conservative: painted internal members would be ~2% lower).	Structure	NABERS NEF v1.0 default
Cold-formed galvanised purlins, girts, bridging, fascia channels (fabricator lists)					13,284.83	4.24	56,327.68		0.33	4,348.39	9,712.66	860.86	71,249.58	Measured	AES Coldform Material List ML-002, Bridging List ML-003 and CC150 channels from ML-001 (Nov 2022).	Structure	NABERS NEF v1.0 default
Roof walkways WW: 600mm aluminium (Saferight), mill finish		60.00			420.00	30.20	12,684.00	211.40	0.21	88.56	2,187.12	193.85	15,153.53	Assumed	Specification 07610 cl. 2.13 and Schedule WW. A2.20: walkways ~25 m + ~4 m to the plant platform and ~31 m along the PV array = ~60 m (scaled at 1:200). ASSUMED 7 kg/m including pedestals. NABERS aluminium extruded uncoated.	Structure	NABERS NEF v1.0 default
Mechanical plant deck and roof access platform, aluminium mill finish					650.00	30.20	19,630.00		0.21	137.06	3,384.83	300.01	23,451.89	Measured	Fabricator drawing SM 20356-FAB-PD-D1-01 (12/01/2023), submitted by Devlyn Australia as RFA-11: deck ~7.5 x 4.5 m with guardrails, tare 650 kg, aluminium mill finish. NABERS aluminium extruded uncoated 30.2 kgCO2e/kg. Replaces the earlier 400 kg steel allowance.	Structure	NABERS NEF v1.0 default
ROOF																	
Roof sheeting, Lysaght Spandek Colorbond (Shale Grey)			1,270.00		6,223.00	3.24	20,156.30	15.87	0.15	926.73	3,475.58	308.05	24,866.65	Estimated	Materials and Finishes Schedule IFC (7/11/2022): RS Lysaght Spandek. A2.20: lower roof 720, upper 475 (13 deg), yard 75 m2. BMT not stated: 4.9 kg/m2 assumed; 3.239 kgCO2e/kg from Colorbond EPD (18.3 kgCO2e/m2 at 5.65 kg/m2).	Roof	BlueScope Colorbond EPD (as Narembeen)
Awning roof sheeting, Colorbond			131.28		643.27	3.24	2,083.56	15.87	0.15	95.80	359.27	31.84	2,570.47	Estimated	East awning ~3 x 29.6 m, south ~14.16 x 3 m.	Roof	BlueScope Colorbond EPD (as Narembeen)
Flashings, cappings, gutters 0.55 BMT flat (allowance)			150.00		672.00	15.10	2,265.00	15.10	0.15	100.07	390.56	34.62	2,790.25	Assumed	150 m2 flat sheet allowance; 15.1 kgCO2e/m2 Colorbond EPD as Narembeen.	Roof	BlueScope Colorbond EPD (as Narembeen)
Roof insulation RS.I: AirCell Insulbreak 70 + AirCell Insuliner (foil-faced air-cell)			1,195.00		717.00	3.80	4,541.00	3.80	0.33	234.69	783.01	69.40	5,628.10	Estimated	Specification 07610 cl. 2.4: AirCell 3-in-1 reflective sarking, top layer Insulbreak 70, bottom layer Insuliner. RS.I to lower and upper roofs (1,195 m2); yard roof and awnings uninsulated (schedule). Site photos show foil-faced blanket. Factor: EPiC 2024 aluminium foil insulation 1.9 kgCO2e/m2 per layer x 2 (proxy). Mass 0.6 kg/m2 assumed for A4.	Roof	EPiC Database 2024 (proxy)
Rooftop PV array														Excluded	Not installed under the building contract: PV is Shire works (Tuan, Oct 2026). QS had a $65k provisional sum.	Roof	
EXTERNAL WALLS																	
W.C1 lining: 76mm steel stud to tilt-up		1,643.10	547.70		1,293.78	4.24	5,485.63	3.34	0.33	423.48	945.89	83.84	6,938.84	Estimated	A9.20 W.C1. 3 lm/m2, 1.27 lm/kg as Narembeen.	External walls	NABERS NEF v1.0 default
W.C1 lining: 13mm plasterboard			547.70		4,655.45	0.47	2,202.03	4.02	0.05	246.37	379.70	33.65	2,861.75	Estimated	A9.20 W.C1.	External walls	NABERS NEF v1.0 default
W.C1 insulation in stud cavity (glass wool)			547.70		1,330.91	0.96	1,277.67	2.33	0.33	435.63	220.31	19.53	1,953.15	Assumed	A9.20 "insulated concrete panel"; product not stated.	External walls	As Narembeen (product EPD/earlier factor)
Tilt-up paint: external (incl. mural) and internal			547.70		205.39	0.89	488.55	0.89	0.33	67.23	84.24	7.47	647.48	Estimated	0.5 + 0.392 kgCO2e/m2 as Narembeen.	External walls	As Narembeen (product EPD/earlier factor)
W.E1 textured concrete facade panel 10mm (FC.1, Cemintel Barestone)			43.00		709.50	1.39	986.21	22.94	0.33	232.23	170.05	15.07	1,403.56	Estimated	Schedule: Cemintel Barestone External Facade (or similar). A9.20 W.E1, ~43 m2 from A3.00. Fibre cement default per kg x 16.5 kg/m2.	External walls	NABERS NEF v1.0 default
W.E2/W.E3 Express panel 9mm (FC.2, Cemintel Express Panel Wall)			100.00		1,490.00	1.39	2,071.10	20.71	0.33	487.71	357.12	31.65	2,947.58	Estimated	Schedule: Cemintel Express Panel Wall. A9.20, ~100 m2 from A3.00. Fibre cement default per kg x 14.9 kg/m2.	External walls	NABERS NEF v1.0 default
W.E1/W.E2 steel top hats and battens		1,166.40			1,267.83	4.24	5,375.58	4.61	0.33	414.98	926.92	82.16	6,799.64	Estimated	A9.20: W.E1 2 layers, W.E2/E3 4 layers at 2.4 lm/m2; 0.92 lm/kg.	External walls	NABERS NEF v1.0 default
W.E1 90mm steel stud		129.00	43.00		101.57	4.24	430.68	3.34	0.33	33.25	74.26	6.58	544.77	Estimated	A9.20 W.E1 (W.E2/E3 framed off the facade frames).	External walls	NABERS NEF v1.0 default
W.E1/W.E2 13mm plasterboard lining			103.00		875.50	0.47	414.11	4.02	0.05	46.33	71.41	6.33	538.18	Estimated	Omitted in bulkheads and parapet rear; 43 + 60 m2.	External walls	NABERS NEF v1.0 default
Facade external paint			143.00		28.60	0.50	71.50	0.50	0.33	9.36	12.33	1.09	94.28	Estimated	143 m2.	External walls	As Narembeen (product EPD/earlier factor)
W.FR1 fire resistant wall: Express panel 9mm both faces			100.00		1,490.00	1.39	2,071.10	20.71	0.33	487.71	357.12	31.65	2,947.58	Estimated	A9.20 W.FR1 ~50 m2 x 2 faces.	External walls	NABERS NEF v1.0 default
W.FR1: 13mm MR Fyrcheck x 4 layers			200.00		2,060.00	0.47	974.38	4.87	0.05	109.02	168.01	14.89	1,266.30	Estimated	A9.20 W.FR1. Plasterboard default per kg x 10.3 kg/m2.	External walls	NABERS NEF v1.0 default
W.FR1: 92mm stud and top hats		390.00			307.09	4.24	1,302.05	3.34	0.33	100.52	224.51	19.90	1,646.98	Estimated	A9.20 W.FR1.	External walls	NABERS NEF v1.0 default
Spandek cladding W.E4, W.F1, W.F2			60.00		294.00	3.24	952.27	15.87	0.15	43.78	164.20	14.55	1,174.80	Estimated	A3.00 west RS above RD.01 ~29 m2, gables/parapets ~31 m2. 4.9 kg/m2 assumed.	External walls	BlueScope Colorbond EPD (as Narembeen)
Spandek walls: top hats		288.00			313.04	4.24	1,327.30	4.61	0.33	102.47	228.87	20.29	1,678.92	Estimated	A9.20 W.E4 / A9.21 W.F1.	External walls	NABERS NEF v1.0 default
Spandek walls: 13mm plasterboard			30.00		255.00	0.47	120.62	4.02	0.05	13.49	20.80	1.84	156.75	Estimated		External walls	NABERS NEF v1.0 default
GLAZING AND EXTERNAL DOORS																	
External windows, glass: 6mm EnergyTech toughened (G1)			69.75		1,046.21	2.38	2,489.97	35.70	0.21	220.60	429.35	38.05	3,177.97	Measured	LGA-WA window shop drawings LGA-046 Rev B (16/02/2023, Devlyn RFA-13): W01 2 x 4.77 x 1.5; W02 2 x 3.42 x 1.5; W09 2 x 4.41 x 1.5; HW.01 6 off 5.8 x 0.78; W03 0.9 x 1.2 and 2.66 x 1.2; W04 0.9 x 0.59. 15 kg/m2.	Glazing	NABERS NEF v1.0 default
External window frames: Capral 419 Flushline / 400 Narrowline, powder coated		203.24			406.48	32.00	13,007.36	64.00	0.21	85.71	2,242.88	198.79	15,534.74	Estimated	Frame length = perimeters + mullions from LGA-046 Rev B (~203 m). Section masses not on the shop drawings: 2 kg/m assumed (Capral catalogue weights would confirm).	Glazing	NABERS NEF v1.0 default
D01 store entry: 6mm toughened (G1) and spandrel (G2) glass			9.86		147.83	2.38	351.82	35.70	0.21	31.17	60.67	5.38	449.04	Measured	LGA-046 Rev B: D01 3.65 x 2.7 m, Capral 419 frame with Capral 225 sliding doors, Rubek auto operator.	Glazing	NABERS NEF v1.0 default
D01 aluminium frame and sliding door sashes		24.45			48.90	32.00	1,564.80	64.00	0.21	10.31	269.82	23.91	1,868.85	Estimated	Perimeter + verticals + transom (~24.5 m); 2 kg/m assumed.	Glazing	NABERS NEF v1.0 default
Internal glazing IW.01, IW.02 (6mm toughened, mirror film)			6.14		92.16	2.38	219.34	35.70	0.21	19.43	37.82	3.35	279.95	Measured	LGA-046 Rev B: IW.01 3.72 x 1.2, IW.02 1.4 x 1.2.	Glazing	NABERS NEF v1.0 default
Internal glazing aluminium frames (Capral 419)		16.24			32.48	32.00	1,039.36	64.00	0.21	6.85	179.22	15.88	1,241.31	Estimated	Perimeters + mullion; 2 kg/m.	Glazing	NABERS NEF v1.0 default

Aluminium door frames: Capral 400 Narrowline to D02 x2, ID.01 x5, ID.02 x1		42.28			84.56	32.00	2,705.92	64.00	0.21	17.83	466.59	41.35	3,231.69	Estimated	LGA-046 Rev B door schedule (~42 m of frame); 2 kg/m assumed.	Glazing	NABERS NEF v1.0 default
Roller doors RD.01 x3 (4.0 x 3.4) and RD.02 (4.0 x 1.8)			48.00		1,243.20	132.00	6,336.00	132.00	0.15	185.14	1,092.52	96.83	7,710.50	Measured	A9.02 sizes; A2.00 counts. NABERS roller door default per m2 (25.9 kg/m2).	Glazing	NABERS NEF v1.0 default
INTERNAL WALLS																	
W.I1 plasterboard wall: 92 x 0.75 BMT studs at 450		846.00	282.00		908.38	4.24	3,851.51	4.55	0.33	297.33	664.12	58.86	4,871.82	Estimated	A9.20 W.I1 ~282 m2 (A2.02). Stud mass scaled by BMT from 0.55.	Internal walls	NABERS NEF v1.0 default
W.I2 thick wall: 2 rows 92 x 1.15 BMT at 300		844.56	105.57		1,390.47	4.24	5,895.60	6.98	0.33	455.13	1,016.59	90.10	7,457.41	Estimated	A9.20 W.I2, grid B ~20.7 x 5.1 m.	Internal walls	NABERS NEF v1.0 default
W.I3 lightweight wall: 2 x 64 x 1.15 BMT back-to-back at 300		280.00	35.00		320.69	4.24	1,359.71	4.86	0.33	104.97	234.46	20.78	1,719.92	Estimated	A9.20 W.I3 ~35 m2.	Internal walls	NABERS NEF v1.0 default
W.IF fire wall 120/120/120: 76 stud		66.00	22.00		51.97	4.24	220.35	3.34	0.33	17.01	37.99	3.37	278.72	Estimated	A9.21 W.IF ~22 m2.	Internal walls	NABERS NEF v1.0 default
W.BH internal bulkhead walls: 92 stud		120.00	40.00		94.49	4.24	400.63	3.34	0.33	30.93	69.08	6.12	506.76	Assumed	A9.21 W.BH. 40 m2 allowance.	Internal walls	NABERS NEF v1.0 default
Internal plasterboard 13mm (W.I1, W.I2, W.I3 both faces; W.BH one face)			885.14		7,523.69	0.47	3,558.71	4.02	0.05	398.15	613.63	54.39	4,624.88	Estimated		Internal walls	NABERS NEF v1.0 default
Fire-resistant plasterboard 13mm x 2 each side (W.IF)			88.00		906.40	0.47	428.73	4.87	0.05	47.97	73.93	6.55	557.17	Estimated		Internal walls	NABERS NEF v1.0 default
W.WA wet area walls: HMR plasterboard both faces			60.00		510.00	0.47	241.23	4.02	0.05	26.99	41.60	3.69	313.50	Assumed	~30 m2 wall.	Internal walls	NABERS NEF v1.0 default
Internal paint, 2 coats			1,003.14		175.55	0.39	393.23	0.39	0.33	57.46	67.81	6.01	524.51	Estimated		Internal walls	As Narembeen (product EPD/earlier factor)
W.BT MDF groove boards to walls and ceiling/bulkhead (18mm assumed)			80.00	1.44	1,039.68	1,320.00	1,900.80	23.76	0.33	340.31	327.76	29.05	2,597.92	Estimated	A9.21 W.BT, changed from composite timber battens to MDF groove boards during construction (Tuan, Oct 2026). ~80 m2 (site photos show the groove boards on the bulkheads and soffits over the checkouts and produce). NABERS MDF 1,320 kgCO2e/m3, 722 kg/m3. Biogenic storage (1,290 kgCO2e/m3) not netted; NABERS reports it separately.	Internal walls	NABERS NEF v1.0 default
COOLROOMS																	
Coolroom insulated panels 75mm EPS (produce, dairy): walls, ceilings, panel doors			135.00		1,566.00	67.20	9,072.00	67.20	0.05	82.87	1,564.30	138.65	10,857.82	Estimated	AJ Baker refrigeration layout Rev C.03 shows 75mm EPS; the Finishes Schedule (IP.2/IP.3) says 100mm Bondor EPS-FR. Either way NABERS insulated panel <=100mm applies. Two rooms ~20 m2, 2.8 m high, ~135 m2.	Coolrooms	NABERS NEF v1.0 default
Freezer insulated panels 150mm EPS: walls, ceiling, floor			102.90		1,522.85	89.00	9,157.66	89.00	0.05	80.59	1,579.07	139.96	10,957.27	Measured	AJ Baker layout Rev C.03: freezer 4,950 x 4,850 x 2.8 m external, 150mm EPS: walls 54.9, ceiling 24.0, floor 24.0 m2. NABERS insulated panel >100mm.	Coolrooms	NABERS NEF v1.0 default
CEILINGS AND SOFFITS																	
Plasterboard ceilings 13mm			56.00		476.00	0.47	225.15	4.02	0.05	25.19	38.82	3.44	292.60	Estimated	A2.30 RCP ~56 m2.	Ceilings	NABERS NEF v1.0 default
Ceiling suspension system		168.00	56.00		182.61	4.24	774.26	4.61	0.33	59.77	133.51	11.83	979.37	Estimated	3 lm/m2, 0.92 lm/kg.	Ceilings	NABERS NEF v1.0 default
Ceiling paint			56.00		9.80	0.39	21.95	0.39	0.33	3.21	3.79	0.34	29.28	Estimated		Ceilings	As Narembeen (product EPD/earlier factor)
Soffit lining SL: Cemintel Express Panel 9mm to east awning			89.00		1,326.10	1.39	1,843.28	20.71	0.33	434.06	317.84	28.17	2,623.35	Estimated	Schedule SL: FC sheeting 1200 x 3000 x 9mm with 10mm negative detail. ~89 m2; fibre cement default per kg x 14.9 kg/m2.	Ceilings	NABERS NEF v1.0 default
Soffit battens		213.60			232.17	4.24	984.42	4.61	0.33	76.00	169.74	15.04	1,245.20	Estimated	2.4 lm/m2.	Ceilings	NABERS NEF v1.0 default
Soffit paint (external)			89.00		17.80	0.50	44.50	0.50	0.33	5.83	7.67	0.68	58.68	Estimated		Ceilings	As Narembeen (product EPD/earlier factor)
DOORS AND FINISHES																	
40mm solid core timber door leaves: D02 x2, ID.01 x5, ID.02 x2 leaves, ID.05	10		19.50		1,209.00	111.00	2,164.50		0.33	395.73	373.23	33.08	2,966.54	Measured	LGA-046 Rev B door schedule (leaves by others) + A2.00 for ID.05; ID.04 is a pressed-metal fire door (not counted). NABERS door default per m2: 10 leaves x ~1.95 m2.	Finishes	NABERS NEF v1.0 default
Door paint			40.00		7.00	0.39	15.68	0.39	0.33	2.29	2.70	0.24	20.91	Estimated	12 doors x 2 faces x 2 m2.	Finishes	As Narembeen (product EPD/earlier factor)
Stainless steel trolley bay handrail (Moddex TR30, 48.3 OD)		24.30			96.23	5.99	576.41	23.72	0.33	31.50	99.39	8.81	716.10	Estimated	Moddex DI drawing 15303 (2/3/2023), approved TN 2/3/2023 (Devlyn RFA-15). Two rails on posts: ~8.4 m run x 2 rails + ~7 posts x 1.05 m = ~24 m of 48.3 x 3.2 pipe at 3.6 kg/m, +10% fittings.	Finishes	NABERS NEF v1.0 default
Aluminium skirting SK: Gyprock Plano BF600, 60mm, white powdercoat		300.00			90.00	32.00	2,880.00	9.60	0.33	29.46	496.60	44.02	3,450.08	Assumed	Schedule SK. ASSUMED ~300 m of skirting to plasterboard-lined walls at 0.3 kg/m. NABERS aluminium extruded powder coated.	Finishes	NABERS NEF v1.0 default
Vinyl flooring VF.1: Armstrong Medintone homogeneous sheet vinyl			40.00		464.00	37.80	1,512.00	37.80	0.21	97.84	260.72	23.11	1,893.66	Estimated	Schedule VF.1. Office, staff, comms ~40 m2.	Finishes	NABERS NEF v1.0 default
Floor tiles 8mm			15.00		270.00	0.98	265.68	17.71	0.21	56.93	45.81	4.06	372.48	Estimated	UAT and cleaner ~15 m2.	Finishes	As Narembeen (product EPD/earlier factor)
Wall tiles 10mm (W.WA)			30.00		540.00	0.98	531.36	17.71	0.21	113.86	91.62	8.12	744.97	Assumed	~30 m2 allowance.	Finishes	As Narembeen (product EPD/earlier factor)
Waterproofing to wet areas			45.00		22.50	0.46	10.35	0.23			1.78	0.16	12.29	Estimated	~45 m2.	Finishes	As Narembeen (product EPD/earlier factor)
Concrete floor sealer / polish to trading floor														Excluded	Product not identified; minor.	Finishes	
BUILDING SERVICES																	
Building services MEP: NABERS rate, office/commercial low rise <7,500 m2			1,245.00		23,406.00	67.00	83,415.00	67.00	0.33	7,661.25	14,383.36	1,274.83	106,734.44	Assumed	NABERS Rules s.9.6: services by rate per m2, no item take-off. No retail rate in NEF v1.0; office low rise (67 kgCO2e/m2, 18.8 kg/m2) chosen over warehouse with HVAC (57.4). Refrigeration plant and refrigerant are excluded (equipment; leakage is B1).	Services	NABERS NEF v1.0 default
EXTERNAL WORKS (reported separately, not in the building total)																	
Plant slabs in rear yard: GEN SB, BGEN, FCN, BP (150mm assumed, 32 MPa)			20.70	3.11	7,452.00	0.20	1,453.14	70.20	0.01	96.58	250.57	22.21	1,822.49	Estimated	Tuan, Oct 2026: only concrete in the yard is under the plant marked on A2.12. Scaled from A2.12: GEN SB ~1.0 x 7.7, BGEN surround ~5.6, FCN condensers ~6.0, BP baler ~1.4 m2. Thickness and grade not on S-drawings.	External works	NABERS NEF v1.0 default
Asphalt rear yard, 40mm asphaltic concrete (thickness assumed)			211.30	8.45	20,284.44	0.14	2,860.11	13.54	0.05	1,073.45	493.17	43.71	4,470.44	Estimated	A2.12 yard 29.935 x 7.75 m less plant slabs. Base course not counted. NABERS Rules Table 7.3 includes hardstands for retail.	External works	NABERS NEF v1.0 default
Footpath: existing brick pavers lifted and reused														Measured	Tuan, Oct 2026. Reused material: zero A1-A3 (NABERS Rules s.7: reused materials carry transport only, negligible here).	External works	
FITOUT: SHELVING, COUNTERS AND DESKS (reported separately, not in the building total)																	
Shelving: Qshelf flat metal and wire shelves (powder coated steel)	1235				6,175.00	4.51	27,849.25		0.33	2,021.20	4,802.08	425.62	35,098.15	Assumed	Lane Industries quote 4/01/2023; flat metal shelves and plywood trims confirmed by Tuan (Oct 2026). Shelves counted from the quote (base + 3/4/6 per bay face): SH.B 30 faces x4, SH.GF 110 x5, SH.DS 18 x7, ends 19 x5, SH.OD 12 x7, SH.ON 6 x7, SH.L 9 x4, SH.HS 19 x7, SH.HD 7 x7 = 1,235 shelves. ASSUMED 5 kg per shelf.	Fitout	NABERS NEF v1.0 default
Shelving: Qshelf uprights, back panels, base brackets and kick plates (steel)	230				4,600.00	4.51	20,746.00		0.33	1,505.67	3,577.26	317.06	26,145.99	Assumed	230 bay faces from the Lane quote. Site photos (Tuan, Oct 2026) show full-height perforated steel back panels on every bay. ASSUMED 20 kg of steel per bay face: back panel ~0.9 x 1.8 m x 0.8 mm (~10 kg) + share of uprights, base plinth and brackets (~10 kg). Lane Industries bay weights would replace both steel lines.	Fitout	NABERS NEF v1.0 default
Shelving: clearcoat birch plywood kick fronts, top capping, portal features			15.50	0.28	142.01	968.00	270.07		0.33	46.48	46.57	4.13	367.25	Assumed	Lane quote: birch ply to 19 ends and 4 portal ends (250 deep, 1800 high). ASSUMED ~15.5 m2 of 18mm ply. NABERS plywood 968 kgCO2e/m3, 509 kg/m3; storage not netted.	Fitout	NABERS NEF v1.0 default
Checkouts x2 and hardware help desk counter: melamine particleboard carcasses			48.40	0.87	619.42	880.00	766.66		0.33	202.75	132.20	11.72	1,113.32	Assumed	Tuan, Oct 2026: particleboard is used in the checkout counters and the help desk counter next to the office. Lane quote: 2 mirrored Abacus checkouts 2,880 x 1,125 x 900 (FN.S); hardware POS/help desk F.HW custom (size not given). ASSUMED ~16.7 m2 of 18mm board per checkout (top, base, ends, front, back, partitions) and ~15 m2 for the help desk. NABERS particleboard 880 kgCO2e/m3, 711 kg/m3.	Fitout	NABERS NEF v1.0 default
Checkout and help desk tops: hex ply phenolic resin			8.48	0.15	77.69	968.00	147.76		0.33	25.43	25.48	2.26	200.92	Assumed	Lane quote: Hex ply phenolic resin tops. ASSUMED 2 x 3.24 m2 (checkouts) + ~2 m2 (help desk), 18mm. NABERS plywood 968 kgCO2e/m3.	Fitout	NABERS NEF v1.0 default
Office desks: melamine particleboard	2		8.00	0.14	102.38	880.00	126.72		0.33	33.51	21.85	1.94	184.02	Assumed	Tuan, Oct 2026: office desks are particleboard. Number and sizes not documented: ASSUMED 2 desks x ~4 m2 of 18mm board (top, modesty panel, ends). NABERS particleboard 880 kgCO2e/m3.	Fitout	NABERS NEF v1.0 default

Staff room kitchen cabinetwork: melamine particleboard (A6.20)	15.00	0.27	191.97	880.00	237.60	0.33	62.84	40.97	3.63	345.04	Estimated	Tuan, Oct 2026: staff room cabinetwork is particleboard. A6.20: 2,100 run; base cabinets ~1,575 x 870 x 600 with drawers and sink cupboard, overheads 2,100 x 600 x ~330, laminate benchtop 2,100 x 600. Carcasses, doors, drawers ~12.5 m2 + benchtop at double thickness ~2.5 m2 = ~15 m2 of 18mm board.	Fitout	NABERS NEF v1.0 default
NOT COUNTED														
Pallet racking (BOH and hardware), galvanised steel											Excluded	Lane quote: 4 runs (2,743 and 3,810 mm bays, 2,438 uprights). Mass not given.	Fitout-x	
Coolroom racking, aluminium and plastic (19 bays + corners)											Excluded	Lane quote: 5 starter + 14 add-on bays, 610 x 2000 high. Aluminium is carbon-intensive (30+ kgCO2e/kg): worth getting the weight if fitout is reported.	Fitout-x	
Refrigerated display cases and condensing units (AJ Baker / Bonnet Neve)											Excluded	Equipment, outside A1-A5 building scope. Bonnet Neve quote QD22-0073E (29/04/2022): dairy Rock Eco L20 5 x 3.75 m (R134a), freezer Crystal L20 2 x 3.905 m (R404a); plug-in cases R290. Refrigerant charge and leakage are use stage (B1): relevant to operational carbon, not this baseline.	Fitout-x	
Tobacco unit, promo bins x17, produce bins x8, produce islands x2, flower displays x2											Excluded	Lane quote items, MDF / birch ply / melamine (site photos show birch ply bins and islands with metal edge trims, on castors); dimensions given but not taken off.	Fitout-x	
Gates, kerbs, landscaping											Excluded	Minor external works.	Fitout-x	
TOTAL kgCO2e (building, excl. external works and shelving)					**627,514.55**		**39,356.57**	**108,203.16**	**9,590.31**	**784,664.59**				
kgCO2e per m2 GFA					**504.03**		**31.61**	**86.91**	**7.70**	**630.25**				
GFA (m2), enclosed, from A2.00	1,245.00													
Total tCO2e										784.66				

Ref: Table 7 (page 33), 'Embodied Carbon & Embodied Energy in Australia's Buildings', GBCA and thinkstep-anz for DISER (2021). Linear interpolation between 2019 and 2050 values, kgCO2e/m2 shares.

							Construction year (input)	
		2019	Proportion to A1-3	2050	Proportion to A1-3	Slope (m)	2023	Proportion to A1-3
Non-residential	A1-A3	7.35	1	9.44	1	0.067419355	7.6196774194	100.00%
	A4	0.13	0.01768707482993	0.21	0.02224576271186	0.002580645	0.1403225806	1.84%
	A5a	1.47	0.2	0.26	0.02754237288136	-0.03903226	1.3138709677	17.24%
	A5w	0.11	0.01496598639456	0.16	0.01694915254237	0.001612903	0.1164516129	1.53%
	C2	0.03	0.00408163265306	0.05	0.00529661016949	0.000645161	0.0325806452	0.43%
	C3-C4	0.04	0.00544217687075	0.06	0.00635593220339	0.000645161	0.0425806452	0.56%

Bruce Rock construction 2022-23 (IFC Aug 2022, last architectural revision Aug 2023). 2023 used; change H3 to test.

A4 Default Transport Emission

Project location:	Bruce Rock	
Distance from Perth (km)	245	ASSUMED: approx. road distance Perth to Bruce Rock via Great Eastern Hwy; confirm
Concrete plant distance (km)	60	WCS Concrete Pty Ltd, Kellerberrin batch plant (supplier per Tuan, Oct 2026). ~60 km by road via the Granite Way (Wheatbelt Tourism trail length); confirm

	Distance 1 km	Emission 1 kgCO2e/tkm	Distance 2 km	Emission 2 kgCO2e/tkm	A4 EF kgCO2e/kg
Local supply 16t truck (concrete)	60	0.216			0.012960
Perth supply 16t truck	245	0.216			0.052920
Eastern States product (truck) + Perth leg	4000	0.0686			0.327320
Eastern States product (rail) + Perth leg	4000	0.024			0.148920
Overseas product (Shanghai) + Perth leg	190	0.0686	9000	0.0161	0.210854

Same transport assumptions and emission factors as the Narembeen case study (2024), with Bruce Rock distances.

Drawing take-off (for comparison only; the fabricator lists below are used). From Fulcrum Structural Engineering drawings 21214 S1.01-S5.04 Rev 0 (IFC 10/8/22). Lengths scaled from 1:100 plans and 1:50 elevations (drawings say do not scale: treat as estimate). Section masses are nominal catalogue values (hollow sections calculated from dimensions), approx. +/-5%.

Mark	Member	Section	kg/m	No.	Length each (m)	Total length (m)	Mass (kg)	Finish / type	Source and notes
	Lower roof trusses: top and bottom chords + end verticals								S3.02 TR10 at grids 2-6, span A-B ~18.85 m; S4.01 750 deep
TR10		250 PFC	35.5	5	39.2	196.0	6,958.0	Painted HR	
TR10	Lower roof trusses: diagonals	75x75x4 SHS	8.6	5	24.0	120.0	1,032.0	Painted HR	S4.01 ~22 diagonals x ~1.1 m
TR1/TR2	Grid B trusses: top and bottom chords	200x100x8 RHS	34.4	2	41.5	83.0	2,855.2	Painted HR	S4.02, two trusses 7-4 and 4-1, 2.21 m deep
TR1/TR2	Grid B trusses: vertical chords	89x89x5 SHS	12.7	2	17.7	35.4	449.1	Painted HR	S4.02 ~8 internal verticals each
TR1/TR2	Grid B trusses: diagonals	89x89x3.5 SHS	9.1	2	35.2	70.4	640.6	Painted HR	S4.02 ~11 diagonals each
TR1/TR2	Grid B trusses: end verticals and clerestory posts	200 PFC	22.9	2	8.7	17.3	396.6	Painted HR	S4.02
TR1/TR2	Clerestory top beam (laid flat)	200 PFC	22.9	2	20.8	41.5	950.4	Painted HR	S4.02
C1	Column at B/4	200x200x9 SHS	52.3	1	7.3	7.3	381.8	Painted HR	S3.01/S4.01; height scaled
C2	Columns at B/7 and B/1	200UC59	59.5	2	7.3	14.6	868.7	Painted HR	S3.01
C3	Perimeter / facade / yard columns	100x100x6 SHS	17.0	11	5.0	55.0	935.0	Galvanised HR	S3.01 11 no. (PF3 pads); average height 5.0 m
C4	Awning columns	89x89x4 SHS	10.4	9	3.5	31.5	327.6	Galvanised HR	S3.01 9 no. (PF4 pads); member schedule says 90x4 SHS
C5	Facade columns	100x100x8 SHS	21.8	2	5.8	11.6	252.9	Galvanised HR	S4.03 east elevation
C6	Yard column	100x100x5 SHS	14.4	1	3.5	3.5	50.4	Galvanised HR	S3.01 (PF5)
RB1	Yard roof beams	250UB31	31.4	3	8.2	24.6	772.4	Painted HR	S3.02
B2	Yard edge beam	150 PFC	17.7	1	9.2	9.2	162.8	Painted HR	S3.02
RB2	Upper roof rafters	310UB46	46.2	7	11.2	78.4	3,622.1	Painted HR	S3.03 at grids 1-7, B-C on slope
RB4	Canopy roof beams	150UB14	14.0	1	26.0	26.0	364.0	Galvanised HR	S3.02 east and south awnings
S1	Roof struts	139.7x5 CHS	16.6	13	6.9	89.7	1,489.0	Painted HR	S3.02/S3.03
RBR	Roof bracing	90x90x6 EA	8.2	1	293.0	293.0	2,408.5	Painted HR	S3.02/S3.03 X-bracing, ~37 diagonals
WP1	Wall plates to panels	150 PFC	17.7	1	93.0	93.0	1,646.1	Painted HR	S3.02/S3.03 grids A, C and 7
SA1	Shelf angle	100x100x10 EA	14.2	1	18.9	18.9	267.7	Painted HR	S3.02 grid 1
Facade frame	East and south facade frames: top and bottom chords	200 PFC	22.9	9	8.5	76.5	1,751.9	Galvanised HR	S4.03: 7 east + 2 south bays
Facade frame	Facade frames: end verticals	100 PFC	8.3	9	6.1	54.9	457.3	Galvanised HR	S4.03
Facade frame	Facade frames: diagonals and centre post	75 SHS / 75x5 EA	7.0	9	10.5	94.1	658.4	Galvanised HR	S4.03 (mix of 75x4 SHS, 75x3 SHS, 75x5 EA; average 7 kg/m)
FR1	Infill frames above roller doors	125 PFC	11.9	3	19.0	57.0	678.3	Galvanised HR	S4.05 3 no.; S5.03 ~3.95 x 2.4 m welded frame
FR1	Infill frame bracing	75x4 EA	4.5	3	9.2	27.6	124.2	Galvanised HR	S5.03
WBR	Wall rod bracing	16 dia rod	1.6	1	64.0	64.0	101.1	Galvanised HR	Allowance
P3	Lower roof purlins @1100	C25019	6.3	1	821.7	821.7	5,168.5	Cold-formed galv	S3.02, 18 rows x 41.5 m, +10% laps
P4	Purlins under mechanical plant @400	C25024	7.9	1	124.0	124.0	982.1	Cold-formed galv	S3.02 extra rows in plant zone
P1	Yard roof purlins	Z15012	2.7	1	74.0	74.0	201.3	Cold-formed galv	S3.02
P2	Upper roof purlins @1100/900	Z20015	4.2	1	547.8	547.8	2,322.7	Cold-formed galv	S3.03, 12 rows
P5	Canopy purlins @1000	C20024	6.7	1	162.0	162.0	1,078.9	Cold-formed galv	S3.02 east and south awnings
	Girts @1000 max								Facade, south frame, roller door heads, clerestory, parapets; estimated
G1		C10015	2.3	1	418.0	418.0	969.8	Cold-formed galv	
FT1	Fascia trusses (150 stud frame, welded)	150 stud	8.0	1	38.6	38.6	308.8	Cold-formed galv	S4.03; 8 kg per m of fascia assumed

Totals (kg)

Hot-rolled, painted	24,901
Hot-rolled, galvanised	5,701
Cold-formed, galvanised	11,032
Connections, base plates, cast-in plates, cleats, bolts: +5% of hot-rolled (as Narembeen)	1,530
TOTAL STEEL (kg)	**43,164**
kg steel per m2 GFA	34.7

Cross-check: QS PTE 6.01 structural steel trade $807,000 implies ~$/t	$18,696
The implied rate is high for 2022 regional WA, so the QS trade may include items not shown on the S-drawings, or the take-off is light. Fabricator shop tonnage would settle it.	

FABRICATOR SHOP DRAWING MATERIAL LISTS (USED IN THE CALCULATION)

AES project AES201109, PO 0023, 28-29 Nov 2022: Steel Material List ML-001 Rev B, Coldform Material List ML-002 Rev A, Bridging List ML-003 Rev A, Drawing List DL-001 Rev A. Gross weights, including plates, cleats and cast-in items.

ML-001 Steel material list: all hot-rolled sections, plates, flats, studs (total)	36,562
less CC150-2.3 cold-formed channels in ML-001 (fascia frames), moved to cold-formed	-947
Hot-rolled steel incl. plates and fixings	**35,615**
ML-002 Coldform material list: purlins, girts, tie rods	11,594
ML-003 Bridging list	744
CC150-2.3 cold-formed channels from ML-001	947
Cold-formed steel	**13,285**
TOTAL STEEL, fabricator lists (kg)	**48,900**
kg per m2 GFA	**39.3**
Drawing take-off above, for comparison (kg)	**43,164**
QS PTE 6.01 structural steel $807,000 per tonne of fabricated steel	**$16,503**
The drawing take-off was about 12% below the fabricator lists (mainly plates, cleats and flybraces). Fabricator lists used.	